OCCASIONAL PAPERS ON METEOROLOGICAL HISTORY No.13

ALBERT WALTER, O.B.E. (1877-1972)

Meteorologist in the Colonial Service

Part II

First Director of the British East African Meteorological Service
First President, IMO Regional Commission No. I (Africa)
Group Captain in the Second World War and
advisor on meteorology to the Groundnut Scheme

Joan M. Kenworthy

Published by
The Royal Meteorological Society's
History of Meteorology and Physical Oceanography Special Interest Group

AUGUST 2014

ISBN: 978-0-948090-36-3

ROYAL METEOROLOGICAL SOCIETY
104 OXFORD ROAD – READING – RG1 7LL – UNITED KINGDOM
Telephone: +44 (0)118 956 8500 Fax: +44 (0)118 956 8571
E-mail: ***chiefexec@rmets.org***
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Abbreviations

AHQ	Air Headquarters
BEAMS	British East African Meteorological Service
IMO	International Meteorological Organization
OMI	Organisation Météorologique Internationale
Oxford DNB	Oxford Dictionary of National Biography
RAF	Royal Air Force

Maps

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Acknowledgements and author's note

Reference is made to the memoirs of Albert Walter with the permission of the Librarian, Bodleian Library of Commonwealth and African Studies at Rhodes House, Oxford, as agreed by members of the family of Albert Walter.

The help and the support of the following are gratefully acknowledged: Mssrs. Lindsay and John F. Walter; the late Peter Marsh, for finding family census data and ship records; David E. Pedgley for helpful comments on the draft; Howard Oliver for putting me in touch with Elizabeth Watkins (Mrs Knowles); J. Malcolm Walker, Editor; the Bodleian Library of Commonwealth and African Studies at Rhodes House, Oxford; the British Library; Durham University Library; Durham University Department of Geography; Harris Manchester College, Oxford; Kenya National Archive and Document Service, Nairobi**;** The National Archives, Kew; the National Meteorological Library and Archive, Exeter; the Radcliffe Science Library, Oxford; the Wellcome Library.

At the time of writing in 2014, Joan Kenworthy is an honorary research associate of the Department of Geography, Durham University, an honorary fellow of Harris Manchester College and a member (and former committee member) of the History Group of the Royal Meteorological Society. She was a postgraduate in East Africa in 1956-58 and has visited the region at intervals ever since.

1. Introduction

> **Walter, Albert, O.B.E**. (1935), F.R.A.S. – b.1877; ed. Roans Sch., Blackheath; war serv. 1943-47, G/capt.; appt., Royal Observatory, Greenwich,1892; asst.dir., Royal Alfred Observatory, Maur., 1897; statistical advr. to Maur. Royal comsn. 1909; census comsr., Maur., 1911 and 1921; dir., Royal Alfred Observ., 1911; food, trade and export contr., 1920-22; mem. of coun. of govt., 1922; headed deputation to India for the re-opening of emigr. to Maur., 21st Dec., 1922; statistician, Ken., 1926; statistician to govs.' Confce., 1926; dir., Br. E. A. Meteor. Serv., 1928; pres. reg. comsn. (No. 1) Africa internat. meteor. organ., 1936; author of Sugar Industry of Mauritius, Insurance of crops against cyclones, and articles on climate in E.A.; editor, Mauritius almanac.[1]
>
> I was forty-eight and it would mean abandoning once and for all time the work I loved so dearly: leaving the little island [Mauritius] that had meant so much to me; parting from so many wonderful friends, tearing myself away from surroundings which were intrinsically Catholic in their associations, and saying good-bye, probably for ever, to a country which had given me so much happiness, afforded me so many great opportunities and where my work and reputation were so deeply appreciated. It meant giving up all this for what? A new country; new surroundings; new fundamental work and ... the Unknown.[2]

Towards the end of 1925, Albert Walter, Director of the Royal Alfred Observatory, Mauritius, accepted the post of statistician to the Kenya government with immediate secondment to the Secretariat of the newly established Governors' Conference of the East African territories. He had no sooner got a Statistical Department under way than he was asked to organize 'a service of meteorological information for the use of airways'.

Walter's early life and career were outlined in Part I[3] and a short account of his career in East Africa has already been published,[4] but, as was written at the beginning of Part I, his memoirs and papers, deposited in the Bodleian Library of Commonwealth and African Studies, Rhodes House, Oxford,[5] provide such a comprehensive record for historians of meteorology and colonial science that this study is written so that those resources may be more widely known.[6] They tell us much of what it was like to be a meteorologist in tropical Africa from the beginnings of civil aviation to the establishment of the IMO Regional Commission No. I (Africa), the Second World War and its immediate aftermath.

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[1] *The Colonial Office List 1950*, Colonial No. 251, HMSO, 618. Walter appears in the Lists from 1913 to 1950.

[2] Walter, A., 1963. *Echoes of a vanishing Empire, being the memoirs of a meteorologist and civil servant in the colonial Empire 1897-1947,* Volume I, 1963. MSS. Brit. Emp. r. 9, Bodleian Library of Commonwealth and African Studies, Rhodes House, Oxford, 118.

[3] Kenworthy, J. M., 2013. Albert Walter, O.B.E. Meteorologist in the colonial service (1877 – 1972), Part I: His early life and work in Mauritius, *Royal Meteorological Society Occasional Paper* No.12.

[4] Kenworthy, J. M., 1997. Albert Walter, O.B.E., Meteorologist and Civil Servant in the Colonial Empire: Some aspects of his contribution to meteorology in East Africa, Contrib. to Kenworthy, J.M. and J.M. Walker. (eds.), *Colonial observatories and observations*: *meteorology and geophysics: proceedings of a conference held at St.Mary's College, University of Durham, 8-10 April 1994*, Department of Geography, University of Durham, in collaboration with the Royal Meteorological Society, 105-116.

[5] I am grateful to the Librarian of Rhodes House for permission to draw on the memoirs of Albert Walter (Volume I, op.cit. 2, and Volume II, MSS. Brit. Emp. r. 10, received by Rhodes House Library, June 1969) and the following materials:
1897-1960, Meteorological Papers*,* Kenya and Mauritius*,* MSS. Brit. Emp. s. 391*.* (received by Rhodes House Library, July 1971);
1921-1960, Correspondence, tables, charts and statistics, 4 Boxes, MSS. Afr. s. 1864*. (1-4),* (received by Rhodes House Library possibly 1967-8);
1925-1946, Kenya (papers), MSS. Brit. Emp. s. 441(2). (received by Rhodes House Library possibly 1967-8).

[6] Quotations and other references to Walter's Memoirs are given in footnotes as *Echoes* with page number. Other sources are also indicated in footnotes. Family details have been checked with Albert Walter's 6th son, Lindsay John Joseph Walter, and his son, John F. Walter, Walter's grandson, both of whom were met by this writer in November, 2010.

Walter based his memoirs on reports, papers and publications in his possession in retirement, most of which he also deposited in the library of Rhodes House.[7] He states that the first volume, which covers his time in Mauritius and his first months in East Africa, was written in 1963. No date is given for the second volume, although he refers at one point to 1967. Despite his reluctance to leave Mauritius, Walter found work in East Africa congenial and full of challenges. He set up a lovely family home on the outskirts of Nairobi.

Plates 1 and 2. Albert and Louisa Walter at home in Nairobi and (below) the house they set up near the Ngong Road, Nairobi.
Photographs supplied by Mr. John F. Walter.

[7] These include *Annual Reports of the East African Meteorological Service.* Some publications were passed to the Radcliffe Science Library. See also National Meteorological Archive Y17 F2, BEAMS Annual Reports 1937-1953 (Bound Series).

Already a Fellow of the Royal Astronomical Society, Walter was informed of his election as a Fellow of the Royal Meteorological Society on 18 December 1929.

As he approached retirement in 1947, Walter was anxious to follow up work he had done in Mauritius on the relationship between crop yields and climate. An invitation to advise the Groundnut Scheme seemed particularly appropriate and his plan for the memoirs included a section on his involvement that was not in the end included.[8] Nevertheless, there is a correspondence file[9] covering the period from his initial enthusiasm, when he was happy to provide advice on climate and appropriate meteorological observations, to the failure of the managers of the Scheme to follow through his suggestions. He also began work on crop-climate relationships for the East African Agriculture and Forestry Research Organization.[10] In 1947, Walter and his wife, Louisa, undertook an extensive safari in what was then known as the Northern Frontier District of Kenya. They left Africa to live in England in 1949, but Walter continued to write and publish until 1969. He died in 1972.[11]

2. The call to Kenya

2.1. Invitation to the 'unknown'

A telegram offering Walter the post of Statistician to the Kenya Government, with a salary of £800-900, reached him towards the end of December 1925. E. W. Evans, Colonial Secretary of Mauritius,[12] advised him that, should he refuse, no other offer of promotion would be made and, on further advice from Evans, Walter cabled Kenya that he would accept with a salary of £1,000 and quarters. Agreement came on 24 December. Edward Denham, Colonial Secretary in Kenya[13] wrote that he was very glad to know that Walter would come to Kenya, recommending the climate and the life of 'a young active and enterprising country'. Walter left Mauritius for East Africa on 31 December on a French mail boat.

Denham was largely responsible for Walter's appointment. As Colonial Secretary for Mauritius, he had admired Walter's role as Director of the Royal Alfred Observatory, his wide-ranging work for the Government of Mauritius and editorship of the *Mauritius Almanac*.[14] Denham had recommended Walter's appointment to a committee that was set up in Kenya under the chairmanship of A. Holm, Director of Agriculture, to report on the organization of statistical services for the Colony.[15] He was to be disappointed in his hope that Walter would produce a year book similar to the *Mauritius Almanac.* It turned out that a year book was already published by the *East African Standard*.

Walter had considerable experience in handling voluminous data and had studied and used methods of statistical analysis, particularly in his work on sugar yields in Mauritius. Nevertheless, his appointment as statistician has led to confusing comments. This author was incorrect to write[16] that

[8] *Echoes*, 146. Listed but not included are: The making of a Kenya home and social contacts; The European Catholic Association and St. Vincent de Paul; The Nairobi Scientific and Philosophical Society; Our vacation leaves in Europe; Retirement and the Ground-nuts affair.
[9] op. cit. 5, MSS. Afr. s. 1864, Box 1, File 2.
[10] The organization was at Amani, Tanganyika (now Tanzania) as the East African Agricultural Research Institute until it moved to Muguga, Kenya, in 1948 and was renamed the East African Agriculture and Forestry Research Organization (EAAFRO). The research station at Muguga is now the Kenya Agricultural Research Institute (KARI).
[11] See obituary by Walter Grinsted, Albert Walter's colleague in the BEAMS: W.A.G., 1973. *Q. J. R. Met. Soc.* **99**: 795.
[12] Edward Walter Evans (1890–1985).
[13] Sir Edward Brandis Denham, GCMG, KBE (1876-1938), awarded KBE in 1927, had served as Colonial Secretary of Mauritius, 1920-1923, and became Colonial Secretary, Kenya, 1923-1928, serving as Acting Governor of Kenya February to October 1925 and January to August, 1927. The letter is in the Rhodes House Library, op. cit. 5, MSS. Brit. Emp. s. 441 (2).
[14] op. cit. 3, 22.
[15] *Echoes*, 147.
[16] op. cit. 4.

he was a 'statistician' when he was employed as a young 'computer' at the Royal Greenwich Observatory under William Ellis, Director of the Meteorological and Magnetic Department. It was also misleading of E. B. Worthington in 1938[17] to refer to the central office of the British East African Meteorological Service (BEAMS) at Nairobi, where 'a qualified statistician, Mr. Walter, is in charge of the correlation of all data', failing to mention that Walter had developed forecasting for aviation over East and Central Africa, let alone Walter's meteorological work in Mauritius.

2.2. The Statistical Department

Walter's account of work in the Statistical Department from 1926 to 1933[18] makes it barely credible that he found time to set up a meteorological service within that period. He was asked to reach Nairobi in time for the first session of the newly instituted Conference of Governors of the Dependencies of British East Africa on 25 January 1926.[19] After an interesting journey to Mombasa, which he describes vividly in his memoirs, he proceeded to Nairobi and after discussing the requirements of the new department asked permission to spend time in Europe to look at developments in the mechanical compilation of data. Permission was granted and he left Kenya on 14 February, spending time at Mombasa to discuss the forms and methods of compilation used by the Officer in Charge of Customs Statistics. He left Mombasa on the French Mail steamer *Roland Garros* for Marseilles and travelled overland to Paris, where he visited offices concerned with statistical work, including those of the Bank of France and the Citroen Company. Proceeding from there to London, he reported to the Colonial Office, acquired letters of introduction and visited other institutions where compilation of data took place, including offices of the Registrar-General and the Treasury. He was particularly interested in seeing Powers and Hollerith tabulating machines in use. He took the opportunity to 'select the necessary reference works on statistical theory and practice for the library of the new Service'.[20] Returning to Paris, he visited more institutions, before travelling to Mauritius to wind up his affairs. The family left Mauritius for Kenya at the end of June 1926. Once again, Walter spent time in the Customs Department at Mombasa, discussing the possible use of Hollerith machines, before embarking on the train for Nairobi. His son, Lindsay, remembers that they were covered in red dust by the end of the journey.

Walter recommended that for reasons of economy machines should be introduced later in lieu of the appointment of additional staff, and a set of Hollerith machines was hired from the British Tabulating Company towards the end of 1929 in preparation for the Census of 1931. Walter's initiative led to their use by the Agricultural, Education, Judicial and Native Registration Departments and later by the Railway, Treasury and Customs Departments.

The Statistical Department was fully inaugurated on 19 July 1926, with a junior clerk and a stenographer from Europe, who arrived in Kenya in December after training in the use of Hollerith

[17] Worthington, E.B., 1938. *Science in Africa, a Review of Scientific Research Relating to Tropical and Southern Africa*, Oxford University Press, 99. Worthington refers to no publications by Albert Walter, nor is this omission corrected in E. B. Worthington, 1958. *Science in the Development of Africa*, C.C.T.A. and C.S.A..

[18] *Echoes*, from 136, and Walter, A., 1930. Report on the Statistical Department of the Conference of East African Governors 1926-1929, Duplicated typescript, 12pp. The copy used is found inside the Annual Report of the Sudan Customs Department 1935, Durham University Library, Special Collections, Palace Green.

[19] Having found little support for federation, the Commission, set up by L. S. Amery as Colonial Secretary to look into the possibility, had recommended that there should be regular, periodic conferences of Governors to deal with local administration, communications, land policy and labour. Hughes, A. J., 1963, *East Africa: The Search for Unity,* Penguin Books, 215. 'The Conference met about once a year in the various territorial capitals to discuss such matters as customs tariffs, railway rates and scientific research activities', Leys, C. and Robson, P. (Eds.), 1965, *Federation in East Africa: Opportunities and Problems*, Oxford University Press, 30. In 1926, the Governors were: Sir Edward William Macleay Grigg (Kenya); Sir Donald Charles Cameron (Tanganyika); Sir William Gowers (Uganda); Sir Herbert James Stanley (Northern Rhodesia); Sir Charles Calvert Bowring (Nyasaland). The British Resident (Zanzibar), Alfred Hollis, who was directly responsible to the Colonial Office from 1925, was also included.

[20] op. cit. 18, Report.

machines.[21] Colonel Oscar F. Watkins,[22] who had been in East Africa since 1908, advised on matters concerning the African population and a small committee was set up to consider the best way to achieve a picture of the economic conditions of local communities.

> At the first meeting of this committee, which included the Head of the Medical Department, Dr. Patterson, we suggested that information should be collected in one specific administrative district at a time, so that details of population, climate, agricultural activities, land tenure, births and deaths, prevailing diseases, etc., could be co-ordinated and studied.[23]

Between 1927 and 1929, Walter made several visits to Uganda, Tanganyika, Northern Rhodesia and Zanzibar, to discuss collection of data and standardisation. His first Bulletin was published in April 1927. His appointment required him to deal with statistical questions bearing on all the East African Territories and to act in an advisory capacity to the Governments. He describes the routine work of the Department as covering special investigations, an agricultural census, magnetic statistics, crime statistics, price levels of commodities, bank statistics, registered births and deaths (always incomplete because of the difficulty of getting registration in the reserves), immigration and emigration statistics. He was consulted on several problems of statistical enquiry, including the diets and physical condition of people in the reserves, variations in the cost of living in the principal towns of Kenya, the relative taxable capacity of Kenya, Uganda and Tanganyika, even a murder enquiry. His report[24] states that the Medical Department had frequent recourse to the Service. Walter was appointed a member of the Kenya Cost of Living Commission and, in 1927, of a committee to look into pension regulations for the Kenya Government. In 1928, his concern for accuracy put him at loggerheads with the irascible Lord Delamere, the most influential member of the settler community in Kenya. When a report in the Statistical Bulletin showed that the price of flour had been raised disproportionately, merchants immediately brought the price down. Delamere reported the revised figures to the Legislative Council and accused Walter of publishing incorrect returns. Fortunately, the Governor accepted Walter's explanation. Trust in Walter was also shown when Colonel C. W. Walker, DSO, Secretary to the Governors' Conference, asked Walter to act for him during his leave in June 1928. Walter was on leave from 6 July 1929 to 15 March 1930. He was later involved in an investigation into economies that could be made by reducing leave entitlement.

Kenya suffered badly from the economic depression and the Statistical Department did not survive the cuts that were made. Walter was called upon to say what the Department had achieved and writes:

> I must take a large portion of the blame for their decision to abolish it: the questions they asked me were so utterly stupid that I believe I lost my temper and told them that if the Administration were unable to understand the implications of such statistics as had been prepared by the department, their only course was to abolish it.
>
> I ought to have made a greater effort to save it and I look on its abolition as one of the biggest failures of my official career.[25]

He ceased to be listed as Government Statistician on 1 January 1934, receiving a letter of appreciation of his services, which referred to reorganization of the 'Statistical Section'.[26] However, in 1942, Walter was called upon by the Governor, Sir Monk-Mason Moore, to reinstate a statistical department. He writes that, as he was fully involved in the war-time needs of meteorology, he chose a member of his meteorological staff to assist him who was a qualified statistician with a degree from London University. In 1943, at the request of the Chargé d'Affaires in Cairo, Walter was

[21] Walter's office was first in rooms within the Kenya Native Registration Department, from July 1929 in a new Railway Building opposite the Post Office in Whitehouse Road, and later in Railway Headquarters.
[22] Watkins, E., 1995. *Oscar from Africa: the biography of O. F. Watkins*, London: The Radcliffe Press.
[23] *Echoes*, 136.
[24] op. cit. 18, Report.
[25] *Echoes*, 254.
[26] Letter of 14 February 1934, op. cit. 5, MSS. Brit. Emp. s. 391.

appointed by the Governors' Conference as delegate to a statistical conference convened by the Middle East Supply Board to consider Air Ministry supplies in the Middle East.[27]

3. A meteorological service for British East Africa

3.1. Inspection of stations

(See Map 1)

Walter was taken on his first safari by Oscar Watkins in late 1926.[28] He writes:

> The journey through the Kenya Highlands with Colonel Watkins was an intensely interesting one for me. It not only served to introduce me to a new way of life, coming as I did from the restricted limitations of the little island where I had spent the greater part of my life hitherto, but it gave me an insight into the economy of one of the most important of our Colonial possessions, enabling me to plan with confidence the organization of the two services entrusted to my control.[29]

He soon fell in love with his new surroundings.

> We passed through Limuru to the tip of the Rift Escarpment. At that time the roads were mere murram[30] tracks and full of dangerous potholes. The view from the top of the Escarpment was breathtaking. As far as the eye could reach the deep Rift Valley presented a magnificent spectacle. The descent was very steep and very hazardous and the road was strewn with boulders. Watkins slipped the car into second gear and kept his hand on the brakes. Since the war Italian prisoners of war have constructed a fully tarmac road and the excitement of motor travel into the Rift has now passed into history, but at the time of my first safari and for many others later on it was an exciting and hazardous experience.[31]

On the return journey, the undulating landscape and temperate vegetation of the highlands west of the Rift reminded him of the English countryside.

It is not clear whether, at the time of this safari, Walter was aware that he would be asked to set up an independent meteorological service, but he had been asked as Statistician to the Governors' Conference to look into the better organization of meteorological services for Kenya Colony (Walter 1929b) and he took the opportunity on safari to assess the suitability of various sites for meteorological observations, some of which had been equipped as weather stations by the Department of Agriculture. He was later to express sympathy with the Director of Agriculture, who had no staff for regular inspections. He made notes on the exposure and the state of 'such equipment as I could find'. He found many observations to be 'quite useless for scientific record.'

> At all of them the thermometers were out of order; the hygrometers were invariably dry and in most cases the minimum thermometers had large bubbles in the spirit, recording temperatures permanently below freezing, which were being religiously published in the printed records of the Agricultural Department.[32]

[27] See also page 40 of this paper on his visit to Cairo.
[28] op. cit. 22. There are many splendid descriptions of travel in Africa in Walter's memoirs, too many to detail in this paper.
[29] *Echoes*, 138.
[30] Murram is the East African term for laterite.
[31] An earlier road into the Rift was the so-called Mackinnon-Sclater Road, which reached the Rift from the south. The Italian road mentioned by Walter has in turn been superseded by a major highway. In some areas of East Africa, road travel continues to be difficult and research has been undertaken into the causes of premature cracking of tarmac.
[32] *Echoes*, 139.

Map 1. East Africa showing place names mentioned in the text, provided by the Cartographic Unit, Department of Geography, Durham University.

At Nakuru, he found the instruments in 'fair condition', and made arrangements with the District Officer to increase the equipment at a later date. He noted the sulphuric smell given off by Lake Nakuru and the low water level. At Kisumu, he discussed the meteorological possibilities with the Port Officer, predicting that it would become one of the principal lake stations for seaplanes. He noted that the observing site at Bukura, an Agricultural Experimental Farm (near Kakamega), was in a 'deplorable state': the rain gauge receiving surface was elliptical, the copper can was leaking and the hygrometer was completely dry. He was interested to learn from the nearby CMS Mission at Buherri that storms frequently came off Lake Victoria and could be severe enough to unroof the building. On the return journey, he found the minimum thermometer at Kapsabet to be 10 degrees too low. He identified Soy, Sergoit and Marakwet hospital as potential sites in a new network. He added:

> The Kenya and Uganda Railway rises to a height of 10,000 feet in the neighbourhood of the Equator and I noted the site as one on which to erect a meteorological station which would be unique as a high level station exactly on the Equator.[33]

3.2. A meteorological service

Walter writes that

> Some months previous to my arrival in Kenya, Mr. Holm, the Director of Agriculture in Kenya, had written to Dr Simpson the head of the Meteorological Office in England, [34] asking for information which would lead to the forecasting of the rain in East Africa, to which enquiry Dr. Simpson had replied that it would be necessary to organize an efficient meteorological service covering the whole of East Africa. With this stimulus and my experience and background, it was only natural that the Governors Conference Organization should ask me to inaugurate the service as an adjunct to the Statistical Service – a request with which I was only too happy to comply, in view of the reluctance with which I had given up the profession in which I had spent my whole life up to that date in Mauritius. Moreover, the prospect of carrying out research problems over an uncharted area, with all the resources of the machinery and staff of the Statistical Service at my command, was a fascinating one. I gladly agreed to accept the modest additional salary of £300 to carry out a project so dear to my heart and revert to a profession which I had relinquished with so much regret when I accepted the post in East Africa.[35]

In response to Simpson's recommendation, the Air Ministry had sent stocks of pilot balloons, a theodolite, slide rule and gas cylinder for observation of the upper air at Nairobi, and meteorological equipment for observations at Mombasa.

Pressure also came from Egypt and the Sudan, where a meteorological service was started at the turn of the century by Sir Henry Lyons. The White Nile, which has its origins in the Great Lakes of East Africa, ensures through-the-year flow of the Nile in Egypt. By the 1920s, the Egyptian Public Works Department was looking into schemes to control the Nile floods and setting out to improve knowledge of the White Nile Basin. Missions were sent up the Nile in 1923, 1924 and 1926. Towards the end of 1926, Dr. H. E. Hurst,[36] Director of Irrigation for the Egyptian Government, visited Kenya to persuade the authorities to establish a meteorological service to collect information on climatic conditions affecting the flow of the White Nile. He offered to contribute £2000 a year

[33] *Echoes,* 144. The highest point on the railway is at 9150 feet (2789 metres) near Timboroa. A meteorological station was set up at Equator railway station at 8,706 feet (2653 metres).
[34] George Clarke Simpson (1878-1965), CB 1926, KCB 1935, FRS., Director of the Meteorological Office 1920-1938. Pedgley, D. E., 1995. Pen portraits of Presidents – Sir George Clarke Simpson, KCB, FRS., *Weather* **50**: 347-349.
[35] *Echoes,* 145.
[36] Harold Edwin Hurst (1880-1978).

towards a service on the understanding that Egyptian officials might make periodic inspections.[37] Walter records in his memoirs that during Hurst's visit they drew up a scheme for the organization of a service to cover all the East African Territories with the objective of providing for:

> (a) Egypt and the Sudan with the information which they required for the Nile flow,
> (b) the air services which were in process of development from Cairo to the Cape,
> (c) the requirements of agriculture throughout the East African Territories,
> (d) the formation of a forecast service, and
> (e) finally, a service which could take its place in the world-wide network of the International Meteorological Organization.[38]

It is easy in retrospect to see that the assumption that a meteorological service could be an 'adjunct to the Statistical Service' was totally inadequate, particularly in view of the relative ignorance of the controls of weather in equatorial regions and the complex topography of the area concerned, which covered the whole of East and part of Central Africa. However, Walter spoke to the Kenya Branch of the British Medical Association (Walter 1927) suggesting that

> a small monthly stipend to an officer, otherwise employed, would suffice. This question has been referred to here, as additional payments for services rendered to other departments by junior clerks in the administrative office has not so far been considered feasible by the Administration. If an efficient service is to be organized an exception must be made in the case of the Meteorological Department.

His concern was to create a network of meteorological stations providing reliable records. He emphasised the utmost care required in field work and analytical procedures and drew attention to the importance of regular inspection of stations, expressing sympathy for the struggles of the Department of Agriculture to meet meteorological needs. [39]

> It must be clearly understood that reference to deficiencies and erroneous results is not intended as an adverse criticism. The defects of the service are only too well known to our able Director of Agriculture, who has shouldered the responsibility in the absence of an independent organization. A great deal could have been effected had funds been available.
>
> In all about 250 stations have reported to the Department, but at only 27 stations has any attempt been made to secure temperature observations. Inspections do not appear to have been possible within the limited funds at the Department's disposal, with the result that anomalies in temperature records are frequent.

With regard to the possibilities for seasonal forecasting, dear to the hearts of the white farming community, Walter pointed out that

> no progress can be made until gaps in our knowledge of atmospheric conditions are filled adequately. The greatest gap of all we are now endeavouring to fill: it stretches over the whole of Central Africa between 20 deg. North and 20 deg. South latitude. It is not difficult to see that the task which lies before us is not only fraught with great parochial interests, but the results to be ultimately attained are of world-wide importance in their application.

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[37] Hurst, H. E. 1952. *The Nile: a general account of the river and the utilization of its waters,* London: Constable, 168. See also, Hurst, H. E. & Phillips, P. 1931. *The Nile Basin: Vol. I. General Description of the Basin, Meteorology, Topography of the White Nile Basin.* Ministry of Public Works, Egypt, Physical Department, Paper No. 28. Preface and pages 6-7. Negotiations were underway with the Uganda government for setting up a hydrological branch of the Survey of Uganda to be paid for by Egypt and the Minister of Public Works in Egypt was to thank the '... Governments of the Sudan, Uganda, Kenya, Tanganyika and the Belgian Congo, by whose assistance work in the remote parts of the Nile Basin has been rendered possible'.

[38] *Echoes,* 187.

[39] A scheme had been agreed in 1910 for the exchange of data in the British Empire 'to place the various centres of the Empire in possession of the necessary information about the weather (Meteorological Committee, 1906 - 1910. *Reports to the Lords Commissioners of His Majesty's Treasury*). Annual reports from the Department of Agriculture in Nairobi became the official source of climatic information for British East Africa received by the Meteorological Office in London.

Walter was formally 'entrusted with the organization of a Meteorological Service for Kenya' in early 1927, when the possibility of 'extending this Meteorological Service to the whole of the East African Territories was investigated'.[40]

> While these negotiations were in progress, the Kenya Government inserted in its estimates for the years 1927 and 1928 the sum of £1000 for the erection of a first order station at Kabete, about five miles out of Nairobi. The equipment for this station was ordered in 1927 and was received during the course of the year 1928. The observatory building itself was actually donated to the service by the East African Broadcasting Company in return for the issue of time signals and weather reports. This service was in charge of a Capt. Robinson until it was taken over by Cable and Wireless. The equipment erected at this station consisted of:
>
> > Dines float barograph,
> > Richard pattern barograph,
> > thermometer screens containing hygrometer and maximum and minimum thermometers,
> > Richard pattern thermograph,
> > Richard pattern hygrograph,
> > Dines pressure tube anemometer recording direction and velocity of the wind,
> > self-recording rain gauge,
> > earth thermometers reading at 1 ft and 2 ft below the surface respectively,
> > Campbell Stokes sunshine recorder,
> > hydrogen generators and pilot balloon equipment for observing the direction and velocity of the upper currents,
> > synchronome astronomical clock for the time service,
> > a le Roy pendulum clock for time scaling the self recording registers.
>
> During the whole of 1927 and 1928, the embryo staff of the new service carried out observations on the Upper Air by means of pilot balloons. These pilot balloon ascents were made in Nairobi and were utilised to provide information for the projected air services over these territories. A temporary station was also set up in Kisumu to supply the first trial flight in 1927 with upper air information.
>
> In 1928, the Air Ministry sent out an officer to examine the general conditions with special reference to the selection of a landing station in Mombasa and on my suggestion they provided certain equipment to be erected there which would form part of the general meteorological organization as soon as it was established.[41]

4. Developments in aviation

4.1. Aviation

When Walter was asked to provide a meteorological service, it was not so much to provide Egypt with information concerning the flow of the White Nile, or for agriculture, as for 'the use of airways'. Developments in civil aviation had been delayed by the First World War, but, by 1920, it was clear that an international network of meteorological services with the capacity to provide aircraft with information and forecasts would be essential.[42] The following summary of developments in civil aviation over Africa is to illustrate the growing complexity of the situation that faced Albert Walter when he set out to provide weather information and forecasts for pilots from 1929.[43]

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[40] op. cit. 18, Report.

[41] *Echoes*, 187-8 and Walter 1929b.

[42] Crewe, M. E., 2002 (on line). Meteorology and aerial navigation, *Occasional papers on meteorological history* 4, Royal Meteorological Society.

[43] For studies of funding from the Imperial government, struggles between rival air lines and disagreements, particularly in Kenya, over local and imperial needs, see McCormack, R. L., 1989. Imperialism, air transport and colonial development: Kenya, 1920-46, *Journal of Imperial and Commonwealth History* **17**, 374-95; *Bluffield*, R., *Imperial Airways: The Birth of the*

Powered flights to observe German lines in Tanganyika had taken place from Kenya during the First World War. After the war, test flights on the route to the Cape were designed to assess whether aircraft could be fit to carry passengers with safety and reasonable economy. The RAF prepared landing grounds and flew in replacement aircraft when needed. Accidents and losses of aircraft were common.[44] In 1920, Cockerell, Broome and Mitchell set out from England for the Cape in a Vickers Vimy, but did not get beyond Tabora in Tanganyika, while the South Africans, Van Ryneveld and Quintin-Brand reached Cape Town in a Vickers Vimy after 45 days, but only after changing planes in Egypt to another Vimy lent by the RAF and then to a de Havilland at Bulawayo. In the Belgian Congo, a programme of aerodrome construction was finished in 1926, when Sabena began flights within the colony.[45]

There continued to be much to learn about the feasibility of long haul flights, hence the attention paid to Alan Cobham's successful and much publicised 1925-1926 flight to the Cape and back in a de Havilland with a Siddeley Jaguar engine using 26 landing grounds.[46] Further survey flights were undertaken by Captain W. E. Gladstone in February 1927[47] and continued by Cobham, with a view to setting up a mail service between Khartoum and Kisumu on Lake Victoria using seaplanes, the cost to be borne in part by the Kenya, Uganda and Sudan Governments. By 1928, negotiations were taking place between Cobham-Blackburn Air Lines Limited and Imperial Airways.[48]

The Associated Chambers of Commerce of East Africa had called upon the Governments of Kenya, Uganda and Tanganyika to make provision for intercommunication by air between the three territories and, following a meeting of the East African Governors at the Colonial Office, arrangements were made with the Air Ministry for Captain F. Tymms to carry out a six-month survey to advise the East African territories. The Tymms report[49] summarised climate across relevant parts of Africa, based on the reports of the Department of Agriculture for Kenya, a paper by C.E.P. Brooks for Uganda,[50] and a paper by H. G. Lyons for Tanganyika, the former German East Africa.[51] Reference was also made to a paper on climatic conditions for aeronautical purposes by F. Entwistle of the Meteorological Office.[52] Tymms paid particular attention to times when low cloud might prevent flying over 'ridges and spurs at and above 3,000 feet [914 metres] until the middle hours of the morning'. He suggested that for the most part landing grounds could be prepared easily and that safe forced-landing grounds were abundant.[53] Tymms pointed out that seaplanes could use the Nile and the lakes to avoid extensive areas of black cotton soils and swamps in the Sudan and Uganda, but that land machines were essential south from Kisumu to the Cape.

British Airline Industry 1914-1940, Hersham: Ian Allan Publishing; Pirie, G., 2009. *Air Empire: British imperial civil aviation, 1919-1939*, Manchester University Press; Omissi, D. E., 1990. *Air power and colonial control: the Royal Air Force 1919-1939*, Manchester University. Press.

[44] As far as weather information was concerned , the situation may have been similar to that written of the USA: 'It is assumed that pilots themselves exchanged notes on weather along their routes for pilots on later flights, or used the telephone to call their destination airfields', p 447 in Cartwright, G.D. and Sprinkle, C.H., A history of aeronautical meteorology, personal perspectives, 1903-1995, contrib. to Fleming, R.F. (ed.), 1966. *Historical essays on meteorology 1919-1995*, Boston. American Meteorological Society, 443-480.

[45] Article on the 'Sabena' airline (Wikipedia, accessed 2 December 2013); Worthington, 1938, op. cit. 17, 100.

[46] Cobham, A. H., 1926. *My flight to the Cape and back,* London: A. &. C. Black, Ltd. Penrose, H. J. 2004. Sir Alan John Cobham (1894-1973), aviator, *Oxford DNB*, OUP.

[47] Also in 1927, the first solo flight to the Cape in a light aircraft, a DH60 Moth, was achieved by Richard Bentley in 28 days.

[48] op. cit. 43, McCormack, 1989.

[49] TNA: CO 822/14/9. Air Development in East Africa, Captain Tymms (Air Ministry), Tour and Reports 1929. This is In the file described as an unrevised proof of Tymms' paper. Tymms' report was first given as a lecture to the Royal Aeronautical Society on 9 May 1929.

[50] Brooks, C. E. P., 1924. The distribution of rainfall over Uganda, with a note on Kenya Colony, *Q. J. R. Met. Soc.* **50**: 325-338.

[51] Lyons, H. G., 1917. Climatological Studies: German East Africa, *Q. J. R. Met. Soc.***43**: 175-196.

[52] Entwistle, F., 1928. The development of meteorological services for civil aviation, *Q. J. R. Met. Soc.* **54**:293-298.

[53] Cobham, op. cit. 46, page 32, wrote that 'forest' characteristic of southern Tanganyika (Miombo) and across Central Africa could be a problem for emergency landing so that prepared grounds were essential.

A belief had grown up that the tropical atmosphere posed a problem, particularly over the high plateaux.[54] Tymms calmed this fear, commenting that no better proof to the contrary was needed than the 'constant stream of Moths, Avians, and bigger craft flitting up and down to the Cape apparently quite normally'. He recommended an increase of 50% in the run for takeoff at high altitudes at 90°F in the dry season, and an increase of 23% for landing. He suggested that the ideal aircraft for trans-Africa flights should be of metal not wood (because of alternating dryness and humidity and damage by insects). He recommended an increase in power compared with normal light aircraft and three engines, to enable flight on any two engines at 7000 feet (2134 metres) without loss of height, with a cruising range of 300 miles in still air.

In 1930, the British Government, Imperial Airways and the various governments in Africa agreed to provide weekly services from London to Cape Town. The first part of the route was opened on 28 February 1931, with weekly services to Mwanza on Lake Victoria using the Calcutta Flying Boat. The first passengers left London for the Cape on 27 April 1932, taking 10-11 days (reduced to 8 ½ days the following year). Meantime, an aircraft commanded by Arthur Harris visited Kenya, Tanganyika and Uganda, a visit said to have been an Air Ministry propaganda exercise to impress the white population and imperial administration with the defensive potential of air power.[55]

By 1935, Empire flying boats were flying regularly, with numerous stops, from Southampton to Kisumu on Lake Victoria. Air taxi services between major centres became important and, as Walter experienced (Walter 1932c) routes were often worked out during flights. Landing grounds were developed to keep pace. The *Colonial Office List* for 1932 indicates customs aerodromes in Kenya at Mombasa, Nairobi and Kisumu, and aerodromes maintained by the Kenya Government at Nakuru, Naivasha, Voi and Makindu. By 1933, an aerodrome controlled by the municipality had been licensed at Eldoret. Wilson Airways Limited[56] operated a weekly coastal air mail and passenger service that linked Nairobi and the Cairo-Cape route with Mombasa, Tanga, Zanzibar and Dar es Salaam and a service from Nairobi to Mwanza via Longorien and Musoma. The *Colonial Office List* also records an experimental passenger and freight service between Entebbe, Jinja and Tororo in Uganda and Eldoret and Kisumu in Kenya. By 1936, licensed grounds had been established at Njoro and Kitale and 'approved grounds' at Lamu and Kakemega. East African Airways operated a bi-weekly service from Nairobi to Kisumu via Eldoret and a weekly service via Musoma.

4.2. Establishment of a network

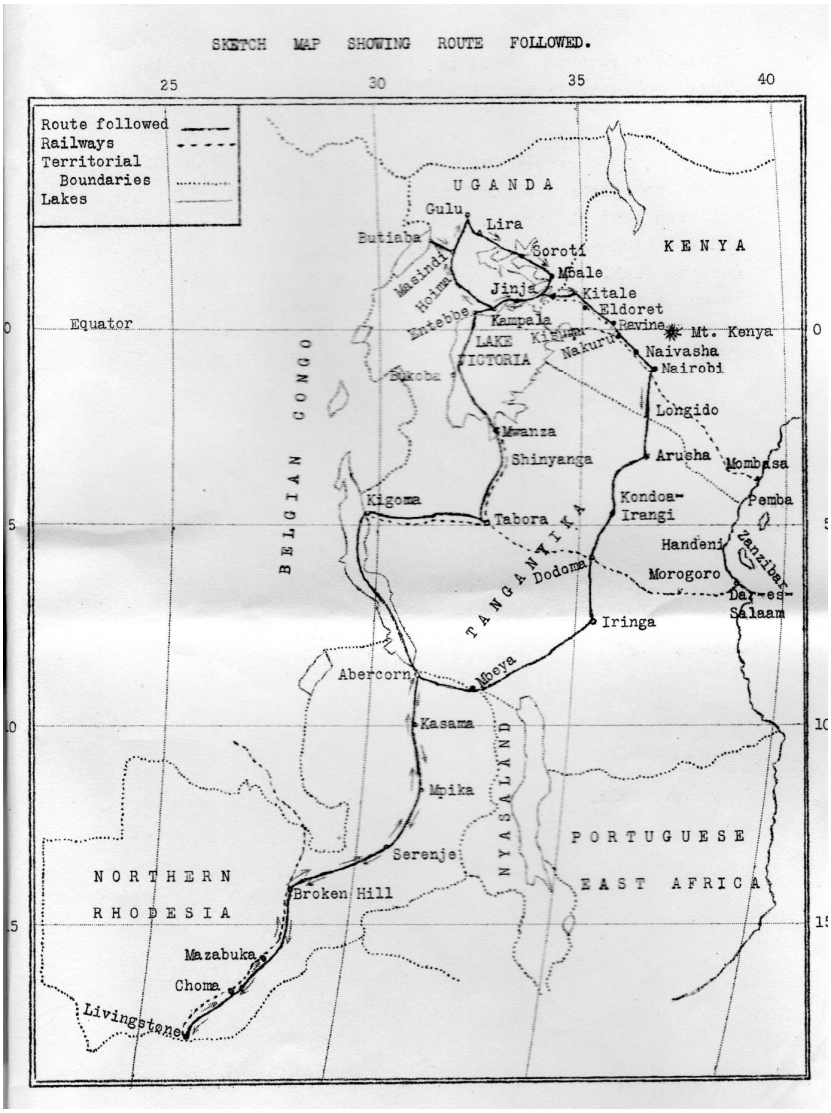
Once engaged as Director of a meteorological service, Walter travelled frequently to review the state of existing observing sites and identify new ones. He travelled in Uganda and Zanzibar in 1927, Uganda, Tanganyika, Northern Rhodesia and Zanzibar in 1928, and Zanzibar, Tanganyika and Uganda in 1929. He published an account (Walter 1932b) of a journey made by road from September to December 1930 (Map 2), when an additional objective was to inspect the Carnegie Institute magnetic stations with a view to re-occupation and determination of the magnetic elements in 1930, 1931 and 1932.

[54] Cobham, op. cit. 46, page 29, reported a near accident when people '... rushed across my fairway at the last moment. Thinking that I should most certainly run into them, I did what I should have done at home or in Europe and landed a bit shorter, with the object of pulling up before I reached them. Landing shorter meant landing slower, and in the sudden moment of emergence I forgot that I was well over 4,000 feet above sea level in a rarefied atmosphere with a consequently much higher flying speed necessary to keep me in the air. ... The result was that when I pulled out of my little side-slip my machine literally fell out of the air for the last ten feet, and it was only the robustness of the undercarriage that saved the situation'.

[55] op. cit. 43, Omissi, 1980, 57.

[56] Wilson Airways Limited was set up by Mrs Florence Wilson. The first Nairobi airport was at Dagoretti in 1927 and moved to its present site in 1928. In 1962, It was named Wilson Airport after its founder and is used mainly for domestic flights. https://www.kaa.go.ke/airports/wilson-airport (accessed November 2012).

The journey by road, interrupted by breakdowns, proved so time consuming and hazardous for delicate instruments that it was decided to combine the transport of equipment by air with inspection of the air route 'with a view to ensuring efficient weather reports from those sections in which danger to aircraft from meteorological conditions might occur' (Walter 1932c). By air, Walter took photographs of cloud effects and collected information on lapse rates of temperature in the free atmosphere. He exposed an Assmann psychrometer through the open window of the plane.



Map 2. Walter's Journey by road in 1930 (Walter 1932b).

Travel over difficult roads and by air when the pilot had to find the best route over the west Kenya highlands during the flight were not the only unusual experiences of setting up meteorology in Africa. Walter gives examples:

> The zoological difficulties have at times been exciting. Telegrams were received at Head Office informing us that a lion had been shot at the station at Tabora. Another that a Black Mamba was in the office at another station. Other reports came in that an eagle had flown off with the wedge photometer and that an elephant had stepped on the rain-gauge. I do not suppose that the instrument division of the Air ministry has been able to construct an elephant proof rain-gauge, but they might help to make them less attractive.[57]

Walter published a list of first, second and third order stations, with a summary of procedures (Walter 1932a). Five first order stations were set up: Kabete (Kenya), Port Bell (Uganda), Tabora (Tanganyika), Chukwani Palace (made available by the Sultan in Zanzibar) and Broken Hill (Northern Rhodesia – Map 2). Second order stations were described as telegraphic reporting stations and the international code by which observations were sent was listed. Third order stations, with only a wind vane and a rain gauge, also sent information by telegram. A day and night telegraphic service was provided by the railways.

> Telegrams are not forwarded from the 1st order stations for each Territory every day, but are coded into the forms … These forms are then posted every week or as occasion offers to the Central Territorial Office, and are only telegraphed when desired to do so by the office concerned in connexion with aviation reports.

Of the second order stations in Tanganyika, Moshi was equipped with balloons for measuring the height of cloud. At Tabora, Dodoma and Mbeya, there was full equipment for pilot balloon observations to give direction and velocity of wind at varying heights and the height of cloud. The station at Zanzibar was connected by wireless and a wireless station was planned for Abercorn (Northern Rhodesia – Map 2).

> It will be seen from this description of the existing organization that planes receive weather reports, including direction and velocity of the wind in the upper currents, from the time they leave Juba until they pass the latitude of 15° South. Special attention is given to the danger zones over the Lake, over the Rift, and at Moshi and Mbeya.
>
> The Director of the Service has already flown over the route from Kisumu to Livingstone and has issued a report on the conditions … He will fly over the southern portion of the route again as soon as the rains have broken this year.

We owe further information to correspondence on meteorological observations preserved by the District Commissioner's office at Nakuru and later deposited with the Kenya National Archives.[58] Letters from the BEAMS headquarters emphasised the hope that observers would make published returns as accurate and complete as possible. Economies were suggested, including a decision to discontinue the daily coded telegram. The observer was asked to enter codes daily on a form to be posted every Saturday afternoon. A telegram would be sent if data were required more urgently. Other correspondence, most of which was circulated to all Districts, related to care of the minimum thermometer, difficulties in the estimation of cloud and differentiation between high and low cloud and to the importance of entering all observations to the day on which they are made. The maximum was not to be entered to the previous day. It was noted that some observers entered their observations on scraps of paper or memorised them even though the observation book was designed to be carried to the screen. Arrangements were made with the Hon. Postmaster General to permit observers to frank telegrams themselves. At Nakuru, the wet-bulb thermometer was not being kept sufficiently moist and advice was given on the supply of water for hydrogen for pilot balloons.

The need to ensure that observations were taken seriously continued. A circular letter, dated 15 June 1936, was sent from The Secretariat in Nairobi to all Provincial Commissioners and to the

[57] *Echoes* 342 Walter in reply to a toast at the dinner of the Conference of Empire Meteorologists, London 1935.
[58] DC/RVP67/30 – 1930-1939, Kenya National Archives (now Kenya National Archives and Document Service), consulted in 2005.

Officers-in-Charge of other districts, with sufficient copies for District Commissioners. Reference to a memorandum from the Director, East African Meteorological Service makes it clear that the letter was sent at Walter's request.

INSTRUCTION IN METEOROLOGY

An accurate knowledge of climatic conditions over East Africa is becoming increasingly necessary in determining the choice of economic crops for various localities, in furthering the solution of the problem of forecasting rain conditions and in assisting research officers.

2. Most of the observations of temperature, humidity and rainfall and weather are secured by the Clerks at District Headquarters, who are given the instruction referred to in the Office Circular Letter No. S/E. 13/2/2/3 of 17th June, 1933. The taking of these observations is a simple matter, but the Director of the British East African Meteorological Service finds that a certain amount of supervision is essential if the necessary accuracy is to be secured. It will therefore be of great assistance to him if District Officers and Cadets can spend an hour or two, when they are in Nairobi on other business, in the Central Office of the British East African Meteorological Service where the use and care of the instruments used at District Headquarters will be explained. At the same time an explanation will be given of the method adopted for forecasting and the use which can be made of these forecasts at the time of the long and short rains. A leaflet indicating the main points to which attention should be directed will be given to each officer visiting the Central Office.

3. Administrative Officers should arrange to undertake this short course of instruction as opportunity occurs and, if possible, should make an appointment with the Director (Telephone No. 2675) the day before it is proposed to attend his office for advice.

C. W. Hayes-Sadler

For Colonial Secretary

The archived correspondence ends with a letter, dated 11 September 1939, from Walter Grinsted.[59]

As the Director is now maintaining a continuous service for forecasting purposes, I shall be grateful if you will instruct your Meteorological Observer to send in his afternoon reports by telegram immediately after the observations on Saturday and Sundays.

5. Funding a meteorological service

5.1. Funding estimates

At a meeting on the history of civil aviation meteorology in 1993, Richard J. (Dick) Ogden asked, 'Can civil aircraft fly safely without meteorology?'[60] The answer was a definite 'no'. No doubt, that was the assumption of the authorities when a meteorological service was proposed for East Africa, but, when arguments developed on how to pay for it, the colonial governments were not willing to

[59] See page 20 for the appointment of Walter Grinsted. There is one further relevant item in the Nakuru archive, dated 11 January 1944, when the Director (as Group Captain) enquired about the difference in the cost of obtaining foodstuff for the observer at Equator compared with Nakuru.

[60] George, D. J. 1993. The history of civil aviation meteorology, *Weather* **48**: 162-3; Cornford, S. 2004. Obituary: Richard J. Ogden, *Weather* **59**: 346.

guarantee permanent financial support and Walter faced uncertainties about the future throughout the early years of the BEAMS. As British colonies, the East African territories were young and under-resourced. They were badly hit by the Depression.[61] The Governors were facing other demands on limited funds.[62] In Kenya, there had been a series of disasters – an invasion by desert locusts, a devastating drought and a slump in commodity markets that hit coffee, sisal and maize. The Government had debt charges and pensions to fulfil, and was lending money to severely hit farmers. A short-term gold rush at Kakamega in the early 1930s did little to help. A Commission sent out in 1925 had recommended an 'Imperial Transport Loan Guarantee' of £10 million for railway extension, harbour development, main roads and mechanical transport. The financial circumstances in the mid 1920s were described by Sir George Fiddes, formerly Permanent Under-Secretary of State for the Colonies.

> The crux of the situation is finance. Since the British Government assumed responsibilities in East Africa, the Treasury has assisted that country on a larger scale than it has ever done elsewhere. It has spent $5^1/_2$ millions in providing a railway; it has given about 6 millions in grants-in-aid, and made loans of upwards of $1^3/_4$ millions. Kenya on becoming a Colony has raised a loan of 5 millions. ... they are but a fraction of what is required if development is to proceed and if the Colonial Office, as trustee of the native population, is to discharge its responsibilities with satisfaction to itself. An indispensible preliminary to progress in any territory is to free it from Treasury control, and East Africa is only kept solvent, under present conditions, by the exercise of a severe economy which involves the starving of necessary services.[63]

On leave in July 1929, Walter discussed the Service with Dr. Simpson at the Meteorological Office and finalised its official recognition with the Colonial Office, gaining approval for a capital expenditure fund based on savings on any year's exercise.

> Naturally I was accused by the Secretariat in Nairobi of over-estimating the expenditure estimates with a view to creating a surplus ... This was palpably unfair as the estimates were assessed on funds voted by so many independent authorities.[64]

The East African governments, together with Northern Rhodesia, Egypt and the Sudan, had agreed contributions for a period of five years to expire at the end of 1933 (Walter 1929b). Walter again discussed the Service with Simpson[65] and they proposed estimates for the following five years to be shared by the same territories:

> 1934 £ 8,000
> 1st year £12,000
> 2nd year£13,750
> 3rd year £15,000
> 4th year £15,750
> 5th year £16,000
> (with additions over the subsequent twelve years to a total of about £20,000).

Walter writes:

> Of course, we were not able to foresee the rapid development in Upper Air Research and the introduction of expensive Radio-sonde equipment which was developed during the war as well as the enormous increase in salary scales. As the suggested expenditure was to be shared between five governments and the Sudan and Egypt it can hardly be considered an exorbitant programme, but

[61] See Harlow, V. Chilver, E. M. and Smith, A., 1965. *History of East Africa,* Volume II, Oxford: Clarendon Press. Kenya and Uganda had also been in financial difficulties in 1921. In the early 1930s, Walter quotes a friend who had held high office in Kenya as saying, 'No one in England seems to take the slightest interest in any of the colonies; they have more to talk about nearer home'. *Echoes*, 267.

[62] See the first few chapters on the period before 1940 in Jeffries, Sir Charles, 1964. *A review of colonial research 1940-1960*, HMSO.

[63] Fiddes, George V. (Sir). 1926. *The Dominions and Colonial Offices,* London: G. P. Putnam's Sons Ltd., 121-2.

[64] *Echoes*, 192.

[65] On this leave, he also renewed his acquaintanceship with Sir Gilbert Walker, by then retired from India.

> neither the Colonial Office nor the Governments of East Africa could be persuaded to consider the proposal.[66]

5.2. Unwillingness to pay

The Governors agreed to continue contributions for a second five years, 1933-1938, but were not prepared to consider any increase in amounts[67] and the Colonial Office accepted that matters would have to remain as they were until budgetary equilibrium was established in the East African colonies. In the meantime, the Governors' Conference was asked to consider the position of the Service and report on their findings.

Walter outlines what followed in his memoirs, but reference to Colonial Office papers in The National Archives reveals much detail, although readers should note that there is more in those papers than can be mentioned here. On 20 December 1933, Colonel C. W. Walker, Secretary to the Governors' Conference, wrote to the Under Secretary of State at the Colonial Office to ask whether the Governments of Egypt and the Sudan were ready to consider making any increased contributions during the coming year. The response was that no useful purpose would be served by approaching the Governments of Egypt and the Sudan and that it had been agreed with Mr. Walter that the Meteorological Service must be carried out for the present within the limits of expenditure commensurate with its existing income.[68] Walter had accepted a salary that merely supplemented his pension from Mauritius and other officers were employed on a temporary basis with no pension provision.

Walter writes:

> Looking back over this period of my career I am frankly amazed that I was able to accomplish so much with so little encouragement from the Authorities and with so restricted a staff of trained assistants. I had only three European Assistants between 1929 and 1934 and these were men who had little or no experience in meteorology except what I had given them myself and who moreover were employed as my deputy in the territorial offices of Uganda, Tanganyika and Northern Rhodesia, and so were not available for work in the Central Office. It was not until March 1934 that my first trained assistant was appointed in the person of Mr. Grinsted.

The failure to increase funds had made it necessary

> to curtail routine expenditure on travelling and inspections and to substitute Asiatic and African clerks for the more expensive European staff. The utmost economy on administrative work became necessary in order to release funds, not only to meet the needs of a continuously expanding service, but to constitute a reserve to meet the normal increments of salary for permanent officials, which every service of this nature must inevitably be called upon to make.[69]

The Governors continued to be negative at their Conference in May 1934.[70] Sir Harold MacMichael, Governor of Tanganyika, doubted whether the Service was of much value to Tanganyika and, if it could not be shown to be rendering a useful service, he would propose discontinuing Tanganyika's contribution after the five years committed. He thought, as did other Governors, that the Egyptian Government might well increase its contribution. It was reported that Air-Vice Marshall Newall had recently been in Nairobi and thought the work done by the Director of the Meteorological Service. 'was very valuable and likely to increase in value'. Sir Bernard Bourdillon of Uganda agreed that the Service was doing valuable work, but was not ready to commit Uganda to continuing its subscription

[66] *Echoes,* 266.
[67] *Echoes*, 268-9. Notes from his annual report for 1933.
[68] TNA: CO 822/59/3. East Africa: Original Correspondence 1933-1934. The East African Meteorological Service: future status and organization.
[69] *Echoes,* 279.
[70] op. cit. 68, Conference of the East African Governors, Nairobi, May 1934.

beyond the five years agreed, as he considered that the Government of Egypt might well make an increased contribution in a year or two.[71] Sir Joseph Byrne of Kenya held the same view and Zanzibar concurred, claiming that it was not an appropriate time to raise the question. The Governors concluded that 'the Service could not be placed on a permanent basis'.

It was suggested that the Director should discuss the possibility of closer cooperation with meteorological activities in Southern Rhodesia, but the Governor of Uganda recognised that difficulties would arise from the differing political status of Southern Rhodesia. Moreover, Colonel Walker reminded them that amalgamation with Southern Rhodesia would necessitate establishing the East African service on a permanent basis.[72] He added that the Secretary of State did not regard it as satisfactory to establish a meteorological organization and abandon it after five years.

Clearly it had become necessary to shatter any illusion that an effective meteorological service could be run on a shoestring. A note from the Air Ministry to the Under Secretary of State at the Colonial Office, dated 15 August 1934, explained the organization of meteorological services worldwide.

> In the nature of the case the meteorological information required by any given country cannot be obtained solely within its borders, and the practise has been followed since the early days of Government meteorological services that each country should arrange for meteorological observations at its own expense and make them available to all other countries free of charge. In this way, the meteorological work of the world has been co-ordinated without financial adjustment. The only exceptions to this rule have been a few cases in which one country needs another country's observations which that country does not need for its own purposes. For example, very full observations from certain stations in Iceland, taken at definite times, are needed by the countries of Europe in connection with their weather forecasts. In this case a small payment is made to Iceland to cover the actual additional observations and to pay for the cost of the cablegrams.[73]

On 12 September 1934, the Secretary of State wrote to the Secretary of the East African Governors Conference that the time had arrived for them to take seriously the practical certainty that it would be necessary to maintain and even extend the Meteorological Service in order to secure the necessary data for aviation, if for no other reason. Notes in the Colonial Office file show recognition of the financial difficulties, but also show concern that Tanganyika Territory might withdraw, particularly as the Territory was served by the Air Mail route to which the Meteorological Service contributed substantial and necessary assistance.

J. E. W. Flood, Assistant Secretary in the Colonial Office, pointed out that it was only by good and numerous weather observations over a long period of years that any reliable conclusions could be drawn. His memo continued:

> The Service was admittedly initiated because of Egypt and the Sudan – mainly Egypt. But there is more in it now because of the Air Service and there will be more in it still if East Africa goes 'air-minded' in its defence arrangements. One of the main tasks of the E. A. Meteorological Service is to supply data for air use.

He wrote further on 22 August 1934:

> It is necessary somehow or other to hammer into the heads of the East African Governments that they have got to have a Meteorological Service if they are going to depend on Air Mails and have through air services and have bits of the Air Force stationed in Kenya. To have a meteorological service they will have to pay for it, and there is no use making it a small or a temporary affair. A Meteorological Service which has not got enough stations to give adequate information is worse than useless, and a temporary service for a period of years is also of very little advantage to man or beast. Whatever they think, the

[71] A handwritten note in the Colonial Office file pointed out that 'Egypt could get all they really want without a lot of the stuff required for the air service'.
[72] There are also notes in the Colonial Office file relating to the position of British Somaliland.
[73] op. cit. 68.

> East African people have got to contemplate having a regular Meteorological Service and paying for it themselves, without spoiling the Egyptians.[74]

Meantime, Walter reduced costs by replacing a European with a trained Asian and promoting an African. It is clear from the files that the Colonial Office response to his economies was simply one of relief.

5.3. Intervention by Simpson from the Meteorological Office

Simpson wrote to Colonel Walker in time for the Governors' meeting in January 1935, referring to the minutes of a meeting Walter had held with his European assistants in July 1934.

> As you know, I have followed with the greatest interest the progress of the BEAMS and have had a general idea of the difficulties with which this young service has had to contend, but I am literally appalled at the position revealed at this conference. I am familiar with the work and organization of many meteorological services, but nowhere have I come across a service working under so many difficulties. The difficulties are of many kinds, administrative, geographical and scientific. I need say little to you about the two former as you are better aware than I of the difficulties of working with a mixed staff of African, Asiatic and European assistants, of establishing a new service without sufficient funds and of trying to run a service which depends on rapid communication in a country without roads and telegraphs. Such difficulties are not peculiar to the Meteorological Services and most people in East Africa are familiar with them. but I wonder whether the additional difficulties of a scientific nature are sufficiently realised.
>
> The East African Meteorological Service is faced with scientific problems of the first magnitude. Demands are made on it to issue weather forecasts, both for aviation and agriculture, yet there is no body of scientific knowledge – such as we have in temperate regions – on which forecasts can be based.

Simpson explained the problem of constructing synoptic charts when observing stations vary greatly in height above sea level, the inadequate knowledge of normal conditions for comparison and the need for years of intensive study.

> These scientific problems alone would be sufficient to occupy the whole attention of a perfectly organized meteorological service.
>
> While I am appalled at the difficulties I am equally filled with admiration at the way they are being tackled … here is a team of workers admirably led, every one of whom while clearly seeing the difficulties, is determined to find a way round and make a success of the Service. When I compare the conditions under which we work here in England, I feel that either we are pampered here or too much is being asked of the men and women of the East African Service …

He understood the financial circumstances, but

> A modern government cannot function without scientific data on which to base its decisions; executive officers increasingly need meteorological information for their work and aerial traffic is practically impossible without an efficient meteorological service …
>
> I trust that as soon as the financial position improves grants will be made to the Meteorological Service which will relieve the almost intolerable burden under which the Service is now working.[75]

On 18 January 1935, Simpson wrote to Flood at the Colonial Office:

> To my mind it is quite immoral that the Governors should take advantage of Walter's position in order to get him to do work below its economic value.[76]

It is noted in the same file that Walter had a pension of c. £760 from Mauritius and Kenya funds – and only £434 from the Meteorological Service and that, if Walter were to leave, c. £1200 would

[74] ibid.
[75] TNA: CO 822/66/8. Draft sent by Simpson to the Colonial Office.
[76] ibid. Letter from Simpson.

have to be offered to get anyone else to go to East Africa. Colonel Walker wrote to the Secretary of State, on 24 January 1935, on the danger that Asiatic staff could easily obtain employment at a higher salary elsewhere and resign from the Meteorological Service as soon as general conditions improved in the commercial world.

5.4. Reluctant Approval

On 13 March 1935, Flood wrote that

> … they will have to spend a good deal more money than they now do. At the present time, of course, it is quite useless to consider any expansion as an immediate issue because Governments simply have not got the money. But it is I think necessary that we should impress upon Governments that they must bear in mind the great desirability (I will not go so far as to suggest absolute necessity) of expansion, and that they must always have at the backs the of their minds the prospect of increasing their meteorological vote.[77]

Further records[78] include information that the Governor of Tanganyika Territory had reiterated (15 March 1935) that

> Any question of its continuance and of affording it a guarantee of permanence must be based on the current financial situation of the Territory … In the present financial circumstances, this Government is unable to agree to an increase in its commitment to the Service.

Tanganyika believed that a contribution from the home government should be made to reduce contributions of East African Governments. The Kenya Government (19 March 1935) gave support for a permanent service provided likely commitments were adequately stated and the intentions of the Egyptian and Sudanese Governments clarified and also gave its support for an application for funds for a central office in Nairobi. A memorandum from the Government of Uganda, dated 29 March 1935, approved and clarified Walter's wish for a grant from the Colonial Development Fund of £10,000 for a new central office, with £500 annually for running costs and assumed it might be possible to obtain a grant from the Colonial Development Fund. Uganda was willing to agree that a permanent meteorological service of increasing importance was required, but wanted to contribute a smaller proportion of costs.

On 17 May 1935, a Colonial Office note recorded that it was thankful that Uganda, Kenya and Zanzibar were seeing the way forward, but that Tanganyika Territory remained 'a bit of a stumbling block' and suspicious of the Meteorological Service, believing that it was not getting value for money. On Walter's wish for a grant from the Colonial Development Fund on the grounds that the Service provided valuable information for the Imperial Government, it was noted that this ignored the point made by the Air Ministry that it was an established principle that each Government supplied meteorological information for general consumption. The estimates still made no provision for placing the Service on a permanent footing and no provision had been made for the extra expense that would result from the improved air service that was to be introduced through East Africa. Once again, pressure came from the Air Ministry, but with better understanding by then of the finances of the colonies. A member of the Colonial Office who attended a conference at the Air Ministry wrote a memorandum for his colleagues that

> it was made clear to all and sundry that a very large expansion of the Meteorological Service would be absolutely essential. It was realised that the East African Governments could not face the cost (which was casually hinted at somewhere in the neighbourhood of £20,000 a year as the absolute minimum, apart from capital expenditure and other things that would be required and quite apart from expenditure on the re-equipment of air landing grounds and provision for night flying). These latter things will be the subject of official communications in due course and will have to come off the

[77] op. cit. 75.
[78] TNA: CO 822/66/7.

> Colonial Development Fund or the Air Ministry votes, since everybody recognises that the East African Governments have no money.[79]

By August 1935, there was evidence that the three Governments were ready to accept pooling of recurrent charges to provide an increase in the meteorological vote for the new air services. Walter and Simpson met at the Warsaw conference of European Meteorologists In September and Simpson prepared a diplomatic but firm *Memorandum on the East African Meteorological Service*, dated 8 November, 1935.[80] He indicated that a minimum requirement was that the BEAMS should take its part in the network of Imperial Meteorological Services.

Simpson went on to list essential functions of the service, including processing of statistics and forecasting. He outlined the types of stations needed for reporting, for pilot balloon observations and for forecasting, and also the need for a properly financed Headquarters. He pointed out that

> It is true that the weather is much more unsettled in the British Isles than in East Africa, but even allowing for this more stations will be required along the African air routes as soon as they can be provided … if synoptic weather service is to be provided in East Africa it cannot be successfully operated with less than those indicated in Mr Walter's scheme. … Mr Walter has personally done practically all the forecasting work; this is entirely wrong …

Simpson included lists for staffing, adding that

> It is only an appreciation of the difficult financial position in the East African Territories which prevents me from urging a much larger staff; the absence of any provision for inspection and investigative work is much to be deplored.

Flood summarised the financial situation. Whilst the East African Governments had agreed to increase recurrent expenditure by £4,800 on the then current £8,100 a year, there remained a discrepancy of £12,000 to give full effect to Simpson's revised requirement for £25,000, which comprised £5,000 if the Service was to provide a 24-hour service and regular synoptic forecasts 'in place of the point-to-point forecasts which were present in the minds of those who were engaged in the Nairobi discussions' and £7,000 if the terms of employment of the personnel in the Meteorological Service were to be placed on a permanent basis and 'assimilated to the terms generally applicable to Government Service in East Africa'.

Some progress was made when, in January 1936, a contribution of £5,000 from the Air Vote was given Treasury approval if the East African governments would not accept full responsibility for costs, but the money was not to go towards the cost of expanding the central office in Nairobi, as that was not in the interests solely of aviation. No money was forthcoming from the Colonial Development Fund or from the Colonial and Middle East Vote, as it was understood that would only be 'practicable in the case of grant-aided colonies subject to financial control by the Treasury'.[81]

Walter remained concerned to place his staff on a permanent basis and papers relating to the East African Governors Conference of June 1936[82] show that, while the Governors were no longer prepared to increase their contribution by the £4,000 previously agreed, they were prepared to consider further funds for the improvement of the terms of service of the staff.

Even so, the Governors continued to play hard to get. From Tanganyika came the comment that

> the claims of meteorology must be viewed in relation to other demands upon Governments' resources, some of which were at least equally urgent, and promised a more immediate return.

The degree to which some individuals in Britain were not 'on message' is indicated by a cynical note in the Colonial Office file:

[79] ibid.
[80] ibid.
[81] TNA: CO 882/73/1.
[82] ibid.

> The proposals for the expansion of the Meteorological Service were put forward by Sir G. Simpson as the minimum which would enable the E. African Meteorological Service to 'take its part in the network of Imperial Meteorological Services', an ideal which arouses no enthusiasm in me in these hard times. The Treasury seems to have been the first to assume that a service on Sir G. Simpson's scale was essential for the purposes of the Empire Air Mail and we have got, in the mass of papers arising out of the Governors' Conference discussion, a definite statement by the local Director, Mr. Walter, that this is so. I confess that I think that his view may be coloured by his enthusiasm to get the scheme through.[83]

Walter was left to juggle with rates of pay, pensions, European, Asian and African staff, increases in recurrent costs, the need to appoint someone with scientific training (hoping for a first-class physicist), finding a location for a central office and agreeing to an annual rent to the RAF for a site, adjacent to, but without encroaching upon, the area indicated for the aerodrome buildings, having been offered one among buildings shortly to be constructed.

The Colonial Office file includes evidence of support for a meteorological service in an extract from the Conference on Co-ordination of Agricultural Research in the East African Territories, held at the Amani Research Station in February 1936, at which the fundamental need for accurate data on climate was stressed. A committee of the conference agreed that the Governments should give the greatest possible support to the BEAMS as the sole authority for amassing data on the standard climate – as distinct from data on eco-climates, which were the concern of agricultural research stations. A paper was also received on the need for a close network of meteorological stations to provide information for the study of the incidence of pests. A Colonial Office official commented that these points might come in useful if there was need to press East African Governments for additional expenditure on meteorology, as they showed that 'clearly the Met Service is of considerable value apart from the Air Service.'

Meantime, Walter had been appointed O.B.E. in 1935. When raising the possibility, Colonel Walker outlined Walter's career in Mauritius and East Africa, adding:

> Walter has undoubtedly had a difficult time organizing this Service over this very large area with not very much interest being shown in what he is doing as in the nature of things people are not ready to think very much of a new Service which can produce no concrete results at once, especially if it is a Service like the Meteorological one which needs many years' records before it can do anything at all. However, people who understand meteorology, with whom I have discussed his work, all pay a high tribute, particularly Simpson, the Director of Meteorology in England, who is always very eulogistic, and also Air Vice Marshal Newall last year when he was in Nairobi. At my request he inspected the Meteorological Service and paid a high tribute to Walter. In addition, other senior Air Force Officers and Imperial Airways have always been very satisfied with what he has done for them. I attach the last letter I have received from Simpson on the Meteorological Service in East Africa.[84]

The letter from Simpson contained the words 'a hard man to replace and then only at a much increased cost'.

Approval was finally given in April 1937 for placing the East African Meteorological Service on a permanent basis, following the offer of £5,000 per annum from the Air Ministry. The East African Governments agreed to provide the additional recurrent expenditure necessary to enable the Simpson Scheme to be carried out, although they were not prepared to undertake provision of funds in excess of what had been agreed, 'having regard to the many other claims upon their limited resources, for the purposes of greater or more immediate importance'. The permanent service came into operation officially on 1 June 1937 and arrangements were completed in July for transfer of the meteorological work of Northern Rhodesia to the Southern Rhodesian Service from the beginning of 1938.

[83] ibid..

[84] Papers of Colonel C.W.G. Walker. MSS. Afr. s. 717, Bodleian Library of Commonwealth and African Studies, Rhodes House, Oxford.

6. Developments in forecasting and research

6.1. Research, forecasting and public relations.

Walter had relatively few opportunities to follow up topics in climatology that had interested him in Mauritius, although he contributed a foreword to Nicholson's study of the relationship between forests, climate and water supply in Kenya (Walter 1929a) and a chapter on climate in Uganda with reference to agricultural districts in Tothill's *Agriculture in Uganda* (Walter1940). He later spoke on forests and climate at a conference of the IMO (Walter 1937). In 1930, equipment was obtained to make a comprehensive magnetic survey of East Africa. Seismological research was undertaken from 1933 and the Meteorological Service maintained precision clocks for a time service in each territory from 1933 to 1945.[85]

Walter's interest in the relevance of climate for agriculture had been clear when he spoke to the Conference of Empire Meteorologists, Cairo-Durban Airship Route and the Cairo-Cape Town Air Route Sub-committee on 26th August, 1929.

> Almost every known plant can be grown somewhere between the snow line of Mount Kenya and Kilimanjaro and the coastal region, while at altitudes of about 6,000 feet on or near the Equator a large variety of plants of both the tropical and temperate regions can be grown in production side by side. The exploitation or these great potentialities has so far not been the subject of co-ordinated enquiry and has been left mainly to the personal efforts of individual colonists. It is not too sweeping a statement to say that for the most part, with some notable exceptions, these individual colonists had little or no previous training in agricultural work. In the selection of farms and the crops which should be grown on them, in the early days of colonial development, the local governments and the agricultural departments could offer little assistance because they were little better informed than the intending colonists themselves.[86]

On 26 November 1942, he spoke on Nairobi Agricultural Shows:

> Since the inauguration of the Meteorological Services in East Africa meteorological exhibits have been staged at each of these shows. The exhibits included diagrams showing how various economic crops depended on climatic factors, stressing the significance of marginal climates and emphasising the necessity for making careful enquiries in regard to the climatic factors. One visitor, after listening carefully to the explanation of the technical officer in charge, exclaimed 'You are more than right. I planted coffee at the wrong altitude and, thank God, I sold my farm to another mut.'
>
> ...
>
> It does the reputation of these Colonies little good for the Government to stand indifferently by while self-styled 'mut' after 'mut' loses his hard earned savings. In the strenuous days which lie before us the husbandry of every cent of capital as well as the proper use of credit facilities must form the basis of all development.[87]

As far as tropical weather was concerned, there had been a lot to learn. Detailed explanation of rainfall occurrence proved elusive. Walter described the main air masses affecting East Africa (Walter 1929b) and, in 1932, Brooks and Mirrlees outlined the basic wind directions and seasonal changes in air mass over the whole of tropical Africa.[88] In 1935, Walter and Grinsted set out to

[85] East African Meteorological Department Annual Report for 1954-55, which includes a survey of previous years.
[86] op. cit. 5, MSS. Brit. Emp. s. 441 (2), Kenya 1925-46.
[87] ibid.
[88] Brooks, C. E. P. and Mirrlees, S. T. A., 1932. A study of the atmospheric circulation over tropical Africa, *Geophysical Memoir* **6** (55), Air Ministry, Meteorological Office, London: HMSO. The idea of the Intertropical Front, later revised to the Intertropical Convergence Zone, had come earlier: Brooks, C. E. P. and Braby, H. W., 1921. The clash of the trades in the Pacific, *Q. J. R. Met. Soc.***17**: 1-11.

inform a sceptical public of progress in understanding the climate of East Africa in a series of articles.[89] They were no doubt aware of developments in the frontal meteorology of the North Atlantic on which Gold published his magisterial summary.[90] Walter referred to conditions revealed by a study of synoptic charts 'now prepared daily by the British East African Meteorological Service', and identified seasonal changes and a permanent low over Lake Victoria. Grinsted outlined climatic zones, described the drawing of synoptic charts and referred to the possibilities of frontal, orographic and convection rain. He outlined the control of the south-east monsoon by cyclonic disturbances moving from South Africa to Madagascar and suggested that long-term forecasts would have to take into account the probable strength of the monsoon current and the activity of comparatively short-lived disturbances.

> A period of fifteen months, it is true, is very short time when compared with the long series of weather charts available in other countries, but the problem of the rains is so vital to East Africa that it is perhaps pardonable to exhibit a certain amount of impatience to reach a solution, however imperfect this may be. In some quarter, in fact, the question has already been asked: What has the Meteorological Service done? A very incomplete and partial statement of what has been accomplished is that during the six years of its existence it has covered an area of one million square miles with a network of controlled observing stations, and now draws a daily picture of the meteorological conditions over the greater part of East and Central Africa.

Later in the series, Walter suggested that the so-called 'long' and 'short' rains might be 'frontal rains', although

> The daily charts have not yet revealed indubitable indications of these frontal rains.
>
> ... An understanding of these frontal rains is our only hope of forecasting with certainty for periods longer than twenty-four hours. The patient accumulation of data, their scientific and technical interpretation combined with continuity in collection on a pre-arranged programme, will eventually lead to a solution of this all-important problem of practical and applied meteorology.

The article concludes:

> The solution of the problem of local forecasting will be greatly hastened if the planting community themselves will assist, by noting the general wind direction on their rainfall returns and by sending in to the Meteorological Service all records of rainfall, no matter how close their station may be to others already included in the official monthly records. ... Intensive study, in which all interested must help, is our only hope of an early solution to this all important problem of forecasting, both generally and particularly.

Walter continued to seek data and added the following message:

> It is known that many people maintain records of rainfall who do not send in returns to the Meteorological Service. As the amount of labour involved in filling up and sending in a monthly return is slight, the Director of the BEA Meteorological Service, Box 31, Nairobi, would be grateful if anyone willing to submit such returns would communicate with him. The more complete the rainfall data can be made, the greater use of it will be to all investigators, especially to the Agricultural and Meteorological Departments.[91]

As time went on, the service ceased to look for fronts comparable with those experienced in the north Atlantic. Walter (1938) wrote:

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[89] Papers in Volume **1**, *East African Agricultural Journal*, 1935.

[90] Gold, E., 1935. Fronts and occlusions, *Q. J. R. Met. Soc.* **61:** 107–158; Gold, E., 1919. Meteorology and aviation, *Journal of the Scottish Meteorological Society*, **18:** 68-76; Field, M., 2003. Pen portraits of Presidents – Ernest Gold, CB, OBE, DSO, FRS, *Weather* **58**: 467-410; Sutcliffe, R. C., 2004. Gold, Ernest (1881-1976), meteorologist, *Oxford DNB,* Oxford University Press.

[91] Walter 1936c. Editorial Notes, *East African Agricultural Journal* **1**(4): 262**.**

> The meteorological survey of the equatorial region is quite recent. It is not yet possible to account for all the processes of weather changes which are being observed, but one thing is overwhelmingly apparent – the tropics are by no means the static and stagnant region which they have hitherto been considered. Although there is no evidence of travelling weather systems as generally understood in temperate extra-tropical regions, the tropical zone is the meeting ground of the two great air currents just referred to [*the northern and southern air currents*] and suffers the consequences of the interplay of vast forces, the significance of which has yet to be studied. Small changes of pressure which would pass unnoticed in temperate regions become highly significant in their effect on air movements, which are often of quite unexpected dimensions and directions.
>
> ...
>
> Although daily synoptic charts of this region are now being drawn they have not reached the stage at which it would be safe to use them for descriptive weather or climatic purposes. They are, however, of great interest and reveal the fact that changes in the tropics from day to day are far more important than was formerly supposed.

And in conclusion:

> To the meteorologist the problems which the recently organized services offer are endless. The tropics constitute the heating chamber of the atmospheric machine and it is surprising that the same attention has not been devoted to its examination in the past, as to the cooling chamber of the poles. Methods of forecasting which have been developed in temperate regions do not apply in the equatorial regions where the geostrophic component of the gradient wind is zero and the cyclostrophic is not easily interpretable at present. The forecaster examines his chart for humidity changes; for indications of increasing turbulence; he seeks to interpret the effect of on-coming air masses from higher latitudes as they become caught up in the intense convective action of the tropical belt.

After emphasising the essentially three-dimensional nature of the land surface, the importance of reductions in pressure at great surface heights and the effect of density on wind records, Walter concludes that

> ... it is becoming more and more evident that the weather in the tropics is not one of unchanging pressure and stagnant air currents, accompanied by torrential rains, but one in which the great air masses from the south and north interact under conditions in which the forces of turbulence, viscosity and friction play a greater part than those due to pressure gradients, the measurement of which can be made by observations from a few scattered stations. The weather processes are intensely active and will probably demand for their elucidation a much closer network of observing posts than has yet been contemplated.

The Annual Report of the BEAMS for 1938 records the development of further ideas:

> The weekly forecasts are based mainly on the relative positions of the high and low pressure systems to the north and south of the tropics and the consequent probable changes in pressure gradients and mean air currents. The effect of high or low pressure appearing on the West Coast of Africa is generally felt about a week later...

The report indicates continuing concern at the lack of understanding of variations in thunderstorm occurrence.

In 1940, Walter gave a series of lectures at Makerere College (now University) in Uganda.[92] He emphasised the importance of knowledge of the upper air.

> ... it is being realised more and more each day that accurate forecasting of weather depends in great measure on our knowledge of the conditions in the upper air, even in those layers which extend to great heights....

[92] op. cit. 5, MSS. Afr. s. 1864, File 1.

6.2. The Nairobi Scientific and Philosophical Society[93]

Walter contributed considerably to the scientific life of the Colony in another direction. As described earlier, he and Colonel Watkins had seen the need to co-ordinate the work of various research offices and, together with the Director of Medical Services, had suggested that Kenya should be 'divided into specific areas in which research could be carried out intensively and exhaustively on all problems connected with Native Welfare'.

> Unfortunately, nothing came of this suggestion and as soon as I made the acquaintance of the various research workers in the departments devoted to scientific work I persuaded them to come together, quite unofficially, to meet at each others' houses for afternoon tea and discussion of the various problems on which we were all engaged. We called it 'The Waffle Group'.

The group met sporadically between 1927 and the outbreak of war in 1939 and between 1942 and 1947. These 'social *cum* scientific' gatherings became practically a monthly event.

> There were some able scientists among the group ... gradually we all began to realise the necessity for some recognised forum where the various problems in which we were interested could be fully discussed. I suggested we should try and form a Nairobi Scientific Society.

The inaugural meeting took place in the Town Hall on 9 April 1947. Walter gave a Presidential Address on 5 January 1948 on the importance of climatology in relation to development, making reference to the Meteorological Services. He presented further papers to the Society on statistical frequency curves and on aspects of climatology in relation to European settlement in East Africa.

On 16 February 1951, Grinsted wrote to Walter, by then in England:

> At the Annual General Meeting of the Society a new class of membership was approved to enable the Committee to award Honorary Membership 'to members for outstanding service to the Society and to science and philosophy in East Africa'. At the last committee meeting the committee elected you the first0 & so far only Honorary Member as qualifying for such award under all heads, having been a leader in the formation of the Society and having contributed so much to science in East Africa.
>
> As this year's President I have the pleasure & privilege of asking you to accept this, the one award the Society can make. I am at the same time delighted personally to be able to inform you of this, in view of our close association in East Africa & the kindness you invariably showed to me.
>
> On behalf of the Society I also send our greetings & best wishes to you and to Mrs Walter.
>
> Yours very sincerely
>
> W A Grinsted

7. International Involvements

7.1. The origins of Regional Commission No 1 (Africa)

At the 1929 London Conference of Empire Meteorologists, Walter submitted two memoranda. One called attention to differences between the requirements of stations in high latitudes and those in the tropics, where the diurnal variation was the dominating factor. The other detailed aspects of the diurnal variation of meteorological elements in the Kenya Highlands, making reference to morning monsoonal and afternoon convectional rains and to the large diurnal changes in temperature and humidity and their possible effects on animals and human beings.

[93] op. cit. 5, MSS. Brit. Emp. s. 391. The present author heard L. S. B. Leakey talk on his life with the Kikuyu at a meeting of the Society in 1965.

> With regard to agriculture it was of interest that in Kenya fruit and plants from temperate climates were found side by side with those of tropical regions; this might be due to the alternation of high values of the intensity of solar radiation with the cool night temperatures; but whatever its cause, the inter-relation of crops and weather could only be studied if detailed observations were available.[94]

In the subsequent discussion, Sir Napier Shaw said that Mr. Walter had raised a question that would become in course of time a subject of great importance, namely the utility of mean values.

The conference covered several aspects of aviation meteorology in the British Empire and Walter contributed to the Sub-committee on Meteorological Organization on the Cairo-Durban Airship Route and the Cairo-Cape Town Air Route.[95] He attended a reception at the Science Museum hosted by Sir Henry Lyons and later travelled to the IMO Conference in Copenhagen. On his return journey, he stopped in Hamburg, where he had been authorised to meet the former Director of the Meteorological Service in German East Africa, who informed Walter that the records of the service had been stored in the attic of one of the buildings in Dar es Salam.[96]

At the 1935 Conference of Empire Meteorologists, Walter took part in discussions on the drawing of synoptic charts in equatorial regions and their interpretation for forecasting.[97] He pointed out that the pressure line 1200 gdm was equivalent to the average height of stations on the African plateau and this was confirmed by N. P. *S*ellick from Southern Rhodesia. Sellick submitted a memorandum as follows:

> It appears likely, with the possible exception of the extremities of the continent, that the weather sequences over the whole of Africa are closely related, and the development of individual services is bound up with the whole. Owing to the vast areas involved and the sparse civilised population, the burden of maintaining a weather service comparable with European standards is too great even in the most developed areas and over a large part of the continent meteorology is in a pitifully backward state; furthermore, the continent is cut up into a large number of administrative areas each of which is being developed or not developed without reference to the rest. Under these conditions there has developed a sort of meteorological "Babel" with a chorus of mutes, and future progress is dependent on the formulation of an agreed policy by a central advisory body on lines similar to the Sub-Commissions of the International Committee. ... it is suggested that the matter receive consideration at the Empire Conference, with a view to placing concrete proposals before the International Conference for the formation of an African Sub-Commission under the Committee for the development of meteorology in this continent.[98]

A resulting minute[99] noted that a sub-committee be appointed to look into the organization of meteorological services in Africa and Walter was appointed Chairman. The sub-committee met on 19 August, 1935[100] and set out the following resolution:

> In view of the rapid development of aviation in Africa, a Conference of representatives of the meteorological services in that continent should be convened in 1936 to consider the co-ordination of

[94] *Echoes* 340 and Appendix XIII of the Report of the Conference of Empire Meteorologists, London August 20-September 3, 1929, published by Authority of the Meteorological Committee, London: HMSO, 1930.
[95] ibid. Report.
[96] Walter subsequently made enquiries about the German records in Dar es Salam, but writes that 'there was no trace of them and no one seemed to have any knowledge of them' (*Echoes*, 195). Whether they were found later is not clear, but several stations in Tanzania have rainfall records dating from the time of German occupation. See, for example, East African Meteorological Department, 1964. *Climatological Statistics for East Africa and Seychelles, Part III, Tanganyika & Zanzibar*.
[97] Report of the Conference of Empire Meteorologists, London, August 12-31, 1935, published by Authority of the Meteorological Committee, London: HMSO, 1936. See also review of the conference by F. Entwistle in *Met. Mag*. **70**: 177-181.
[98] ibid. Appendix XXI 145.
[99] ibid. Minute IX 52.
[100] The following were present:- Mr. A. Walter (East African Group) in the Chair, Mr. W.H Beckett (Gold Coast), Lt.-Cmdr. S. H. Butler (Nigeria), Mr. G. W. Graham (Anglo-Egyptian Sudan), Mr. N. R. McCurdy (Mauritius), Mr. N. P. Sellick (Southern Rhodesia), Dr. T. Schumann (South Africa), Mr. F. Entwistle (Meteorological Office). Ibid 103-4

the work of the respective services. It is recommended that the Secretary to the Conference of East African Governors should be asked to take the necessary steps to this end.[101]

Walter records that

> The findings of this sub-committee led me to propose the resolution at the Warsaw meeting of the International Meteorological Organization which resulted in the appointment of Regional Commissions.[102]

Map 3. Political map of Africa in the colonial period, provided by the Cartographic Unit, Department of Geography, Durham University.

Regional Commission No. 1 (Africa) was established on 13 September 1935 at the meeting of Directors, following the meeting of the IMO in Warsaw, and included South Africa, Southern Rhodesia, Portuguese East Africa (Mozambique), British East Africa (Uganda, Kenya, Tanganyika,

[101] op. cit. 97, 103.
[102] *Echoes,* 342.

Northern Rhodesia and Zanzibar), Bechuanaland, Swaziland, Belgian Congo, Portuguese West Africa (Angola), Sudan, Egypt, Libya, Italian Somaliland, Morocco, Algeria, Tunisia, Tripoli, French Equatorial Africa, Eritrea, British Somaliland, Madagascar, Mauritius and Nyasaland.[103]

Walter was reported as saying that

> In view of the rapid developments of meteorology in Africa and the urgent need for cooperation, the Directors of the Meteorological Services concerned request that they may be allowed, with the authority of the International Meteorological Organization, to call meetings periodically for the discussion of their particular problems, in order to ensure developments in meteorology in conformity with the requirements of the I.M.O.[104]

Simpson proposed Walter as President of the Regional Commission.

7.2. Regional Commission No. 1 (Africa)

The first Regional Conference took place in Lusaka, 17-26 August 1936. His Excellency, the Governor of Northern Rhodesia, Major Sir Herbert Young, KCMG, DSO, gave a welcoming speech emphasising the importance of meteorology for aviation and agriculture.[105]

At the closing meeting, held at Livingstone close to the Victoria Falls, Walter summarised the achievements of the conference:

> The hospitality of the Northern Rhodesian Government has made it possible for us to close an International Conference at a spot which is truly international, for the Victoria Falls belong not to one nation but to the world. ....
>
> Our Commission is, I believe, the first African Conference which has brought together representatives of all nationalities engaged in the work of developing this great continent. Africa is credited with having been the birthplace of man. Whether this is so or not I am not competent to say, but it seems certain that she is destined to play an increasingly important role in the future of mankind. ...
>
> Africa is awaiting still further intensive development and I am convinced that if she is to fulfil her great destiny, the word cooperation must be written large across every page of her future history. ...
>
> One of the newest things in Africa is aviation. Whatever the future holds in store for Africa, this means of communication will play a great role. It will surely be one which will do more than any other enterprise to speed up progress.
>
> To this means of communication meteorology is an essential adjunct. The result of our labours of the past few days has made it possible for pilots of aircraft to travel from one end of Africa to the other and find on their path the same methods, the same system of weather information, the same measure of warning and protections, wherever they fly and whatever their nationality or language. The language of our codes is in numbers – the only truly international language understandable to all.
>
> But if aviation is new, disease and pestilence are old. Africa is pre-eminently their home. There are perhaps many reasons why they thrive, but there is one which is predominant and that is climate. In the low-lying lands, and often in many of the highland regions, the country may be divided up into zones where climatic conditions favour these enemies of development.
>
> It is for our Meteorological Service to demarcate these danger zones and so to help concentrate the efforts of research officers that the virulence of these enemies to progress may be mitigated and the moment of their extermination brought nearer. Neither the great air masses which affect aviation, nor the danger zones for man and beast and crops, know any political boundaries, and so it becomes

[103] See Gregg, W. R., 1935. Progress in international meteorology, *Monthly Weather Review* **63**, 339-342, for comments on the importance of the meetings in Copenhagen and Warsaw for improvements in the standardization of methods of international communication, although he does not mention the introduction of Regional Commissions.
[104] *Echoes,* 345.
[105] *Echoes,* 347-8.

> essential for us to secure as complete uniformity as possible in the study of them. This uniformity we have reached.[106]

Dr. T. Schumann concluded:

> This great measure of success I attribute mainly to two things: the prodigious amount of labour which our first President and his staff expended in preparing the ground for our discussion and the wonderful tact he displayed in leading the deliberations of the conference. I consider the first Regional Conference has been a great success and I may be allowed to express the conviction that the regional conferences covering other parts of the globe will profit by the results of the Lusaka conference. In conclusion I should therefore like to express the sincere thanks of the O.M.I. to Mr Walter for the excellent service he has rendered to International Meteorology by leading the first Regional Conference to such a successful conclusion.[107]

No doubt Walter's fluency in French had been a great help. That Walter was later justified in suggesting the conference of 1936 as a high point, if not the highpoint, of his career, was confirmed by the address of a representative of the French Colonies at the meeting, praising the firm guidance that Walter had given and his calm diplomacy. Possible disagreements had been ironed out by ensuring that motions went through a committee stage before being considered by a plenary session.

The Annual Report of the BEAMS for 1937[108] refers to the increase in the number of meteorological services throughout the African continent.

> Each organization forms a mesh in the network of meteorological services, which now covers the whole world, and whose task it is to observe and investigate the climatic and weather conditions, a knowledge of which is essential for the safety of aviation and for the agricultural and economic development of the territories which they serve.
>
> Emphasis is laid on this aspect of the Service at the commencement of a new era in African Meteorology so that the essential nature of the cooperative work of the Meteorological services should be fully appreciated.

At the 1937 meeting of the IMO Committee in Salzburg, Colonel Gold,[109] President of the Commission for Synoptic Weather Information, 'never a great admirer of the Colonial Services', referred to great advances made at the regional meetings in Lusaka and Hong Kong, suggesting that the result of their discussions will greatly assist in efforts to secure a well-founded world synoptic system.[110]

Resolution 84 of the Committee noted that:

> While the Committee recognises to the full the intrinsic differences which occur, both in administrative procedures and in weather conditions, between the temperate regions and the tropics, it ventures to express its conviction that the attitude adopted by the recently formed Regional Commissions will make it possible to achieve a large measure of uniformity which could not have been secured without their assistance. At the same time it wishes to assure the Regional Commissions that it will give such consideration to any of their recommendations as will lead to modification in International Resolutions, Codes and Practice, to meet their needs and so realise that world-wide uniformity which is so desirable.[111]

Walter comments in his memoirs:

> This resolution was a great achievement for me as it gave official recognition to a principle for which I had been contending for several years, that the colonial services, and especially those in the tropics,

[106] *Echoes,* 350-351.
[107] *Echoes, 353.*
[108] op. cit. 7.
[109] op. cit. 90.
[110] *Echoes,* 353.
[111] *Echoes,* 357.

had to deal with conditions both administrative and scientific which had no parallel in the more advanced organization of Europe and the meteorological conditions of higher latitudes.

Up to the present there had been a tendency on the part of our English colleagues in the Air Ministry to treat with contempt the Colonial Director who had not been recruited from the ranks of the Air Ministry Officials, if they dared to suggest that problems of tropical meteorology were not amenable to treatment by methods laid down by the pundits who pontificated from Kingsway. I was particularly pleased that we had not only received the 'imprimatur' from the International authorities, but had wrung an approving recognition from our principal critic in the English service, Colonel Gold himself.[112]

Plate 3. The assembled Conference of the IMO, Berlin, 1939. Photograph kindly supplied by Mr. John F. Walter.

At the 1939 meeting of the IMO committee in Berlin, Walter informed the committee that

... since the Lusaka Conference, Services have been organized to cover the whole of Africa. The Belgian Congo has inaugurated an entirely new service during the past year with a field network of observing stations under the control of qualified technical officers. The British West African Service has also been organized on a plan similar to the British East African Service under the direction of Mr. Smith. In the Sudan an independent Service, formerly incorporated in the Egyptian Service, has also been inaugurated, while in British Somaliland additional stations have been opened up as a result of Lusaka Resolution 1X. This service was inspected and reported on to the British Air Ministry by one of the assistants of the BEAMS in 1938. Additional stations are expected to be opened in French Somaliland during the course of the present year.

Although much remains to be done in connection with the co-ordination of wireless broadcasts of synoptic messages, especially from Central and West Africa, three collective issues arranged for under Lusaka Resolution XLII have been in full operation since the beginning of 1938. ... It is now possible to draw two synoptic charts daily, covering the whole of the Eastern and Southern parts of Africa from the

[112] *Echoes,* 358.

> Mediterranean to Cape Town and from the Seychelles and Reunion in the Indian Ocean on the east to the Southern part of the Atlantic on the west.[113]

Walter was later to plead for the independence of Service Directors, since their being under the management of varying departments of government in their home territories made reaching agreements difficult.[114]

8. The Second World War

8.1. East Africa

With the outbreak of war in September 1939, there could remain no further uncertainty about the need for meteorological services and new controls were soon to take over. Walter attended the 1939 meeting of the IMO in Berlin, where he was more often amused than annoyed by what he described as 'Nazi antics'.[115] In England, he recuperated from illness on a farm, visited Sir George Simpson, attended the General Meeting of the East African Board by invitation[116] and returned to Kenya in late December, delayed, he writes, because of some misunderstanding by the Colonial Office.[117]

The service had been asked to make certain changes in the event of war and these were implemented by Walter Grinsted. Forecasts were to be issued in secret code and it was thought advisable for security reasons to limit access to weather information and codes to Europeans. Volunteers were recruited from other Departments to work in the forecast section between 4 and 8 a.m. and 5 and 11 p.m. and other appointments were made from the European population. Elizabeth Watkins, daughter of Colonel Watkins,[118] was among a group employed in Nairobi. Her pay was £15 a month. She writes:

> Four times a day maps had to be plotted neatly in two-coloured inks, six items of information written in against each of about fifty stations, temperatures and pressures converted to the metric system. We had to use two colours, red and blue ink, and to do this had devised a system of splicing two wooden nib-holders together. ...
>
> When Italy joined the Germans and declared war on Britain ... Reinforcements poured into Kenya from South Africa, Rhodesia, Tanganyika, West Africa.[119] The RAF establishment in Nairobi was strengthened by the South African Air Force. Overnight the meteorological office gained importance. Both the area and the frequency of observation were extended, we were all sworn to secrecy, even routine reports came in cypher, the office worked eighteen hours a day and our team of four workers was doubled to eight. Before my seventeenth birthday I had become one of the old hands. ...
>
> For two years I kept doing my watches, plotting material from all over Africa, coding and decoding, working the telex to the wireless station.[120]

In his Annual Report for 1938, Walter had considered problems to be faced in the event of war, particularly the need

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[113] *Echoes* 359. Report of the President of Regional Commission No 1 (Africa) to the Committee of the IMO at Berlin, 1939.
[114] *Echoes,* 364.
[115] *Echoes* 287.
[116] Probably invited to attend the East African Currency Board as a statistician.
[117] *Echoes* 289. The delay may have been connected with the arrangements for his return passage.
[118] op. cit. 22.
[119] Also from India. Churchill complained to Wavell about delays in the deployment of so many troops in Kenya. Churchill, W. S., 1949. *The Second World War, Volume II: Their Finest Hour.* London: Cassell & Co. 338-9.
[120] Watkins, E., 2008. *Cypher Officer in Cairo, Kenya, Caserta,* Brighton: Pen Press Publishers, 26-**30.**

> ... to so organize the work as to fit the military demands with the civil requirements without any unnecessary dislocations of the latter ... any discontinuity in meteorological records must affect the efficiency of their military value as much as it would destroy their utility in the subsequent return to civil activities.[121]

His report elicited an excellent review in *Nature*, which noted that there was much of interest both on the climatological and synoptic side and evidence that important contributions were being made to the understanding of meteorological processes. The review concluded that the report deserved to be regarded as a model for a young progressive meteorological service in the tropics.[122] No annual report was published for 1939. Instead, Walter prepared a memorandum on the work of the service in 1939-40 (Walter, A., 1941). He explained that the plan for staffing and additional observation posts had been brought into operation without disruption. Forecasts were no longer issued to the public. The 24-hour service was almost entirely devoted to providing both regular and 'on demand' information required by military authorities. Reliable time signals were provided for military survey. Additional synoptic charts were introduced at 1800 and 0100 GMT. The report lists the number of observing stations, including additional sites, although locations were not given. Nineteen of the first or second order stations were pilot balloon stations. Despite the internment of German nationals in Tanganyika, there was a net increase in rainfall data received. Territorial offices, that is in colonies other than Kenya, maintained essential work and a new office building was completed in Dar es Salaam in December 1939. The Central Office remained in the commercial centre of Nairobi, but authority was obtained to erect a fire-proof room at Kabete for the storage of records. Walter was optimistic that the extra war efforts would have long-term beneficial results.

> The experience gained, during the extended work and activities demanded by the war effort, will bring in its train many improvements in forecasting methods and in the treatment of climatological data utilised for this and other purposes.

In addition, he pointed to the important assistance given by special meteorological flights by the South African Air Force.

> It had, of course, been realised that the occasional failures in forecasting were due in part to changes in upper air temperature and humidity conditions which could not be detected from surface observations or the results of Pilot Balloon ascents. The results obtained from these special aeroplane meteorological flights show that it is imperative to introduce radio-sounding in East Africa if any further major advances in forecasting is to be made.

In the early part of the war, military involvement in East Africa arose from proximity to Italian Somaliland and Abyssinia (Ethiopia) and the British need to maintain control of the Red Sea, Egypt and the Suez Canal. On the northern border of Kenya, Moyale was lost to the Italians in 1940, but from its Nairobi base, the army under Wavell was able to take El Wak on the Kenya-Somaliland border, advance into Italian Somaliland and retake British Somaliland, before sweeping north-west via Marsabit into Addis Ababa (Italian East Africa) in April 1941.[123] In contrast to the failure to find the meteorological records of German East Africa in Dar es Salaam after World War I, arrangements were made, following the rapid liberation of Abyssinia, to take over the meteorological records of Italian East Africa. Dr. R. C. Rainey, then serving in the newly-formed meteorological section of the South African Air Force, met staff from the meteorological service of the Regia Aeronautica (the Italian Air Force) in Addis Ababa and thousands of volumes of routine observations were taken over. Italian meteorologists continued to work under the new administration and climatological summaries completed during 1941 were deposited with the BEAMS. Valuable technical equipment

[121] *Echoes* 286; *Annual Report for 1938*, BEAMS.

[122] *Nature* **145** (3672): 418, 1940.

[123] This barely adequate summary is to give context. See: Sutherland, J. & Canwell, D. 2009. *Air War in East Africa 1940-41: The RAF versus the Italian Air Force*, Barnsley: Pen & Sword Books Ltd. For details of army movements and the response of the Abyssinians, see *The Abyssinian campaigns: the official story of the conquest of Italian East Africa.* London: HMSO, 1942.

was also obtained, which helped equip South African Air Force meteorological stations elsewhere in Africa.[124]

Substandard airplanes had played a crucial and ultimately successful part in the campaign.[125] Not only were planes outmoded, but overland operations across the Northern Frontier District of Kenya had faced appalling conditions in both dry and wet seasons. Meteorological support for the air and land operations was not easily given. Walter notes that

> ... difficulty arose in providing reliable weather forecasts, as we were not allowed, in our capacity of a civilian organization, to be given information concerning the areas in which operations were taking place.[126]

Once Berbera on the Red Sea (British Somaliland) was recaptured from the Italians and Mogadishu (Italian Somaliland) on the Indian Ocean and Massawa on the Red Sea (Italian Eritrea) were both in British control, the Allied war effort in Africa was free to concentrate on the northern desert. Bases in Kenya continued to be important as food and equipment was moved north from Kenya to Egypt using the African Line of Communication.[127]

8.2. The Indian Ocean

By 1942, East Africa had become the focus for meteorological support for aviation and naval activity in the Indian Ocean, which was as important as the Red Sea for obtaining oil from the Middle East and important for maintaining communications with parts of the British Empire and delivering aid to China and the Soviet Union. The Germans had bombed the Suez Canal early in 1941, closing the canal for weeks at a time[128] and the route via the Cape was perceived to be vital. There was anxiety about a possible Japanese threat to India and concern that the Germans and Italians were planning to link up with the Japanese.[129] The harbour at Kilindini (Mombasa) became an important base for the British Eastern fleet.[130] Madagascar was taken by the British amid increasing fears that, as the French Government of Madagascar was sympathetic to the Vichy regime, the Japanese might use its harbours for submarines. Walter summarises the situation:

> With the closing of the Suez Canal and the fall of Singapore, the South Indian Ocean and the passage round the Cape to the Far East became a major operational area both for the Navy and the RAF, while the harbour of Kilindini was an essential adjunct of the Navy ... With the flying boats in use for the RAF in the Indian Ocean patrol it was essential to give early warning of the possibility of a swell, as when this became considerable it was impossible for them to take off from their anchorage.[131]

The position of a civilian organization with military responsibilities became cumbersome[132] and Commander Bishop, Chief Naval Meteorological Officer at the South Atlantic Station, Simonstown (near Cape Town) South Africa,[133] signalled the authorities that he intended to take over the BEAMS

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[124] Rainey, R. C., 1946. Further outlook unsettled, *The Empire Cotton Growing Review* **23**: 172-181. Information given by David E. Pedgley.

[125] op. cit. 123, Sutherland & Canwell.

[126] *Echoes*, 295.

[127] Killingray, D. and Rathbone, R. (eds), 1986. *African and the Second World War*, Introduction, 9.

[128] Ball, S., 2009. *The Bitter Sea*, London: Harper Press, 73.

[129] Black, J., 2009. Midway and the Indian Ocean, *Naval War College Review*, **62**(4), 131-140.

[130] Winston Churchill, *The Second World War, Vol. 4: the Hinge of Fate*, 695.

[131] *Echoes,* 290. Walter writes that it was to the credit of the service that throughout the war period in the Indian Ocean no casualties occurred to ships in convoys or to flying boats due to weather conditions.

[132] According to correspondence in the Kendrew papers, formerly housed in the School of Geography, Oxford, and now in the Bodleian, weather reports from island stations were seemingly getting through by wireless but coming to the Navy at Mombasa via R. A. F. Colombo and from Mombasa to Nairobi by telephone.

[133] Instructor Commander William Alfred Bishop, OBE, MA. Chief Naval Meteorological Officer, South Atlantic Station at HMS Afrikander, naval base at Simonstown, South Africa, from 7 April 1939 onwards. Personal communication from J. N. Houterman, naval historian.

as a naval unit. This prompted the Air Ministry to take responsibility and the BEAMS was militarised on 18 January 1943. Walter was given the rank of Group Captain in the RAF and other members of staff were given appropriate ranks. Radio-sonde equipment and wireless facilities were increased. Accommodation was provided for some work of the service at the airport later to be known as Wilson airport and the forecasting section was eventually located at the RAF airport at Eastleigh (on the outskirts of Nairobi). A. G. Forsdyke came out from the Air Ministry to act as Deputy and Liaison Officer. Colonel Sellick from Southern Rhodesia, where the meteorological service was combined with that of South Africa, spent time in Nairobi to liaise with the East African Service.[134] At the age of 65, Albert Walter found himself in command of meteorology in East Africa and the South Indian Ocean, an area of about four million square miles, travelling widely to co-ordinate activities.[135] Communications with observing stations and forecasting became the responsibility of the RAF.

Plate 4. Albert Walter, Group Captain and Chief Meteorological Officer, AHQ, East Africa.
Photograph kindly supplied by Mr. John Walter, Albert Walter's grandson.

Walter was directing attention to the South Indian Ocean once more in his career and published a note on the forecasting of cyclones in the South Indian Ocean (Walter 1942) and on the South Indian Ocean cyclone of January 31st to February 11th 1944 (Walter 1944) – the latter signed as Group

[134] Although meteorology had developed earlier in South Africa, the Meteorological Office in Pretoria was established after the Union in 1912 as a branch of the Department of Irrigation. The military section of the war-time meteorological service under the South African Air Force was commanded by Colonel Sellick. Jackson writes that Sellick and Bishop set up a joint weather service to serve the needs of shipping and aircraft and that officers of the South African Air Force and the Royal Navy worked together in cordial partnership for the duration of the war. Jackson, S. P., 1977. Meteorology and Climatology, Chapter 17, in Brown, A. C., *A history of scientific endeavour in South Africa*, Cape Town: Royal Society of South Africa. See also Jackson in Kenworthy and Walker, op. cit. 4.

[135] E. A. S. Ratcliffe wrote on weather forecasting during the Second World War for the RAF in Europe and the North Atlantic (*Weather* **39**, 219-221).

Captain, Chief Meteorological Officer, Air Headquarters, East Africa.[136] He drew attention to documents submitted to A.H.Q. on forecasting, security techniques and cyclonic warnings for flying boats. The conclusion reflects his earlier experience:

> ... small concentrated cyclonic systems are a positive danger and forecasts coming from the central office must be regarded as the official advice of the Meteorological Service to be acted upon as such. That the Mauritians 'get away with it' on this occasion is no answer to this statement. I have had experience of a ship (The Loodiana) having lost all hands under similar conditions within a hundred miles off Port Louis.

Map 4. Mauritius and nearby islands (with inset to show their relationship with the African mainland), provided by the Cartographic Unit, Department of Geography, Durham University.

[136] The following was also published: Nairobi A.H.Q. RAF, 1943-44. Weather of East Africa, Madagascar and islands area. Part I. General weather, Part II, Tropical cyclones.

Walter travelled several times through Kenya and Uganda during 1940, inspecting stations and supervising the work of observers at Naivasha, Nakuru, Kisumu, Kololo Hill (Kampala), Butiaba, Masindi, Mbarara, Kabale, Kichwamba, Fort Portal, Mubendi, Busia, Equator, Gulu, and Arua[137] and took the opportunity to measure magnetic elements at as many stations as possible. By 1943, he was travelling more widely, often with Walter Grinsted, to absorb the meteorological services of various states and colonies into the East African and South Indian Ocean Command for the duration of the war. His involvement in the co-ordination of meteorological services under Regional Commission No. I (Africa) had been timely.

He visited the military authorities and security officers in Madagascar and discussed the plotting and interpretation of synoptic charts with Thomas, Director of the Meteorological Service, having 'a very interesting and fruitful exchange of views.' In the Seychelles, he looked into the organization of the cable and wireless facilities and the meteorological reporting service and ascertained which smaller islands might be used as observing posts. He climbed Signal Mountain to visit the station there.

Walter visited his old base at Vacoas, Mauritius, where N. R. McCurdy was in charge of the meteorological service that was absorbed into the general East African command. Arrangements were made for additional staff from the Air Ministry to join the forecasting section at Plaisance in the south east of the island, where the airport was used extensively by the RAF.

Walter visited Cairo to discuss Met Flights, staffing difficulties, and the telephonic delays experienced between Kololo Hill (Kampala) and Entebbe in Uganda. The airport at Entebbe was to be enlarged to serve as the main airport (regular flying boat services in peace time were envisaged) and It was agreed to transfer staff from Kampala to Entebbe. It was also decided to press for Met Flights from Mogadishu, Mauritius and Diego Suarez. Passing through Khartoum, he was able to visit Ireland at the meteorological office there and discuss matters of interest to the two services, 'especially in regard to the rapidly developing forecast services'.

A large area of the Indian Ocean remained devoid of observation posts and Walter was 'required to visit the Island area' again in 1944. His aim was to explore every channel through which information could be obtained. From Mauritius, he visited neighbouring islands by ship - Rodrigues, St. Brandon and the two Agalega Islands, where a large Mauritian company owned the estate producing copra and coconut oil. Agalega had been visited in 1942 by W. G. Kendrew,[138] sent to East Africa with the rank of Lieutenant in the Royal Naval Volunteer Reserve to gather data on climate through Central to East Africa. Kendrew had been directed by the Navy to set up a base at Agalega to report on impending cyclones affecting the East African coast. His party had landed on 14 December 1942 and observations started on 16 December, but there were endless delays in the delivery of supplies and a note to Kendrew from a naval colleague in Mombasa apologised for all the inconveniences and congratulated Kendrew on what he had achieved 'in the face of adversity'.[139] Walter must have been the recipient of many of Kendrew's grumbles and writes that he was surprised at the lack of success on the part of the Naval Expedition under Lt. Kendrew and the impression he had left concerning hardships. Walter writes:

> But then I may be prejudiced, as I have a passionate love for all these sun-drenched spots in the Indian Ocean. There is a beautiful beach; wonderful boating and fishing and a pleasing company of people from Mauritius who provided social amenities and companionship. Had his expedition gone to St. Brandon I could have understood his grumble.

[137] A list of journeys is included in papers to be found in MSS. Brit. Emp. s. 391, op. cit. 5.

[138] Kenworthy, J. M., 2007. Meteorologist's profile - Wilfred George Kendrew (1884-1962), *Weather* **62**, 49-52. Kendrew, W. G., 1945. *Meteorological conditions for aviation in Kenya, Uganda and Tanganyika Territory.* F° typescript, National Meteorological Archive, Y17 F2. Kendrew, W. G., 1945. Climatic influences in the Highlands of Kenya, *Q.J.R.Met.Soc.* **71**: 426-430.

[139] Papers of W. G. Kendrew, Bodleian Library, Oxford; op. cit. 132.

Walter visited Mozambique again, as reports of weather conditions in the Mozambique Channel were becoming important. He refers to considerable improvements in synoptic charts. He called on Sellick in Southern Rhodesia and travelled on to South Africa. He visited Southern Rhodesia and South Africa in his capacity as President of the Regional Commission to discuss post-war arrangements, only to be shown a minute by Sellick indicating that he was no longer President as he was a commissioned officer in the RAF and the BEAMS had become an integral part of the Meteorological Office of the Air Ministry. Walter took this up with the Director of the Meteorological Office and writes:

> when I accepted a commission in the R.A.F. my civil position was explicitly reserved as well as the internal administration of the B.E.A. Meteorological Service, and further that the ... constituted International Commission could not become defunct or the President dismissed except through the action of the body which formed it.[140]

No more was said and Walter continued to act in capacity as President of the Regional Commission. The Navy continued to concern itself with meteorology for its own needs. A memoir on The Tropical Cyclones of the Indian Ocean was published In November 1942 under the auspices of the Office of the Commander-in-Chief, Eastern Fleet (amended November 1943 and reprinted in September 1944). In the list of references, a paper by Huddart[141] is attributed to 'Huddart and Walter' (Walter being the authorising Director), but three Figures from Walter's book on the relationship between climate and the sugar crop in Mauritius[142] are reproduced as a prelude to the text, but not acknowledged.

Walter made a later visit to the islands, accompanied by Forsdyke, leaving Mombasa for Seychelles and thence to Mauritius to make 'final arrangements for the coming cyclone season and confirm the organization for staffing on the islands'. This time, they flew over Agalega taking an aerial view of the island and the site of the observatory.

In February, 1945, Walter travelled with Forsdyke through the Kenya Highlands and Uganda to inspect and check instruments against standard ones. His aim was to give Forsdyke 'an opportunity of seeing at first hand the working of these Central African stations and to enable him to appreciate the difficulties which had been encountered in the initial organization of the service.' His only criticism was that some administrative officers had planted trees 'to beautify their stations', without regard for the need to keep their observing station free from obstructions.

Walter may have felt disappointment that much of the forecasting work was taken from him by the RAF, but no one with experience of Africa will underestimate the effort involved in widespread road and air travel to co-ordinate meteorological services. When flying between French territories, Walter was concerned to find a lack of dinghies or 'mae wests' (nickname for life jackets) and recommended to British authorities that 'such appliances' be kept at airports for the use of French aircraft when carrying British personnel between Africa, Madagascar and Mauritius.

Walter's pride in war service is seen in the following description of his time in Cairo when, on 29 October 1943, he

> lost no time in contacting my son Lindsay, who was a Captain working in Signals for the Eighth Army. I had not seen him since we parted in England in 1939 on the outbreak of war and it was great for both of us to meet in such historic surroundings, each of us in His Majesty's uniform during the greatest war of

[140] *Echoes,* 324.

[141] Huddart, J. J., 1942. Cyclone tracks in the South Indian Ocean. BEAMS.

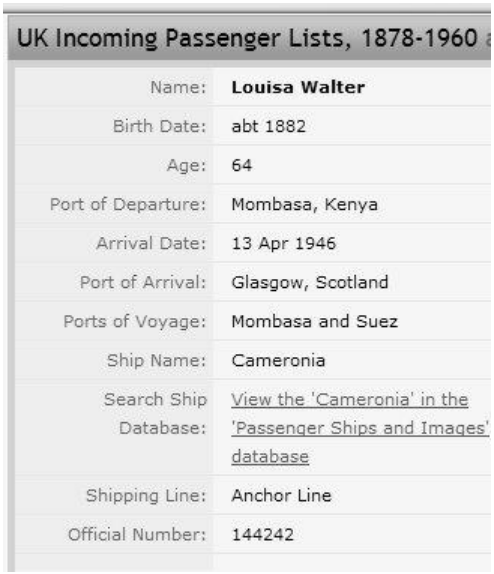
[142] Walter, A. 1910. *The sugar industry of Mauritius: a study in correlation; including a scheme of insurance of the cane crop against damage caused by cyclones,* London: A. L. Humphreys, 228 pp. and 22 plates.

> all time. We visited several places of interest together. I was staying at Shepherds and Lindsay had several meals with me there.[143]

He recalls his greatest thrill in England in 1946,

> when I was able to take my youngest son, Clifton, out to dinner at Monseignors, both in uniform of the RAF. He had earned the right to put up his wings as a pilot and it was great to parade the streets of dear old London in the same glamorous uniform, with more than forty years between us.

He was in England to attend an extraordinary meeting of Directors under the IMO, having travelled by flying boat from Kisumu via Luxor, where he visited the Valley of the Kings, and Cairo. In England, he was invited to the homes of Colonel Gold, Captain Garbett, Sir George Simpson and others. He met Kucynski, the Colonial Office advisor on demography, who took an interest in Walter's work on census taking in East Africa and Mauritius. He met Dr Hurst, by that time retired from Egypt. Louisa, who had to travel by boat from Mombasa, had a very distasteful journey. Travel was still affected by war conditions and most boats were carrying troops. She landed at Glasgow on 13 April, where Walter met her and their sons Maurice and Clifton.[144]



UK Incoming Passenger Lists, 1878-1960

Name:	**Louisa Walter**
Birth Date:	abt 1882
Age:	64
Port of Departure:	Mombasa, Kenya
Arrival Date:	13 Apr 1946
Port of Arrival:	Glasgow, Scotland
Ports of Voyage:	Mombasa and Suez
Ship Name:	Cameronia
Search Ship Database:	View the 'Cameronia' in the 'Passenger Ships and Images' database
Shipping Line:	Anchor Line
Official Number:	144242

In June 1946, Walter attended a meeting of the IMO Commission in Paris and returned to Nairobi in July. The British East African service was demilitarized in 1947 and he received his discharge from the RAF on 22 April. He retired on 31 October 1947 at 70 years of age.

A full report of the activities of the Service during the war years is given by Walter Grinsted as Acting Director.[145]

8.3. The future of the meteorological service

In January 1947, Walter and Grinsted were involved in discussions with E. B. Worthington and others on the future of meteorology in the Empire.[146] Worthington was in East Africa from 1946 to 1949, as Scientific Secretary to the Colonial Research Council. His objectives were to assess what resources

[143] *Echoes*, 183.
[144] *Echoes, 332.* On this leave, both Albert and Ernestine Walter had tonsils removed 'by the famous surgeon and specialist Mr. J. C. Hogg'.
[145] East African Meteorological Department Report for the period 1939-1947.
[146] MSS Afr s 1425. Box 4. Papers of Edgar Barton Worthington, Bodleian Library of Commonwealth and African Studies, Rhodes House, Oxford. See also op. cit. 17. Worthington was Scientific Secretary to the East Africa High Commission, 1950-1951 and Secretary-General to the Scientific Council for Africa South of the Sahara from 1951-1955.

could and should play a part in colonial development and to keep contacts going between scientists in East Africa and the Colonial Office.

A scheme had been proposed for meteorological services to be responsible to the Air Ministry. Walter was concerned that this would mainly involve short-term forecasting when there was also need for an increase in observations and the analysis of records to provide background to developments in agriculture, medicine and other activities. He had previously prepared several memoranda with estimates relating to the post-war requirements of the East African meteorological service. He suggested a division of the service into meteorology for air-navigation under the British Empire scheme and services for other developments as a separate scheme for East Africa.[147] He wrote to Worthington in June with a draft to form the basis of their discussions:

> I think it sets out without technicalities what should be expected of the Met. Service in its relation to development and land utilisation. There is of course a great deal of information already available, but it requires intensive analysis before it can be brought into the development picture.

After his signature, he added:

> I am somewhat surprised that in the large scale schemes for groundnuts we have not been asked to carry out some investigation of our existing records. Two private enterprises in tea and sugar came to me before considering other factors.

Worthington acknowledged the draft, making some changes, and added:

> Your remark that you were never consulted concerning the climatic data available for areas of Tanganyika and Kenya scheduled for groundnut development astonishes me because I imagine your office has much information concerning these areas which is not available elsewhere, but could have been analysed as a special job and made available to those responsible for the scheme. We will try to put this matter to rights in due course.

The proposed Empire scheme was not endorsed at the Civil Aviation Conference held in London in April 1947. In August, Worthington submitted a draft development plan for East Africa to the Chairman of the Colonial Research Committee and the Chief Secretary of the East African Governors' Conference. It included detailed proposals for agricultural and forestry research, a section on meteorology and allowed for a 'modest expansion in climatology'. He estimated a cost of £95,000 per annum. Air Ministry responsibility for the BEAMS would be reduced from its wartime level and responsibility for the service returned to East Africa. A 'substantial contribution was to be expected from the United Kingdom on account of the needs of trunk air services, the remainder to be contributed by the East African Governments and Egypt'.

9. Retirement

9.1. The Groundnut Scheme

Walter deposited his correspondence with the managers of the Groundnut Scheme from May 1947 to October 1948, and with S. H. Frankel in 1950, in the Library of Commonwealth and African Studies, Rhodes House, Oxford.[148] The papers were deposited around 1967-8, but writers on the Groundnut Scheme since that time seem to have been unaware of Walter's involvement.[149]

[147] ibid. Letters from Walter dated 10 and 13 November 1946.
[148] op. cit. 9.
[149] It is of course possible that this author has missed a publication referring to Walter's correspondence. Examples that do not are Ehrlich, C., 1976. The poor country: The Tanganyika economy from 1945 to Independence, Chapter VII in Low, D. A. and Smith, A. (Eds), *History of East Africa*, Volume III, Oxford: Clarendon Press, 309; Yao, A. Y. M., 1973. Evaluating climatic

The Scheme was originally suggested by Frank Samuel of the United Africa Company. It was proposed for several areas in West and East Africa and adopted by the British Government to rectify a shortage of vegetable oil following the Second World War, with the additional hope of encouraging development in the agricultural economies of the colonies. Unfortunately, the Scheme was poorly conceived, driven by haste and anxiety and ultimately a failure, partly because of unforeseen difficulties in the use of machinery for clearing the bush. It was decided at an early stage to concentrate effort on an area near to Kongwa, north of Mpwapwa in Central Tanganyika, despite Walter's advice that it was the least suitable of the proposed areas for development. Communication links with Mpwapwa were attractive, whereas in a proposed area in Southern Province (Nachingwea) port and railway developments were not yet complete, and in the third proposed area in Western Province (Urambo) mining development seemed likely to affect labour supply.[150]

Given his work on climate and sugar yield in Mauritius[151] and the concern he had expressed to Worthington, It is easy to understand why Walter was glad to receive an invitation to act as Meteorological Adviser. He wrote on 5 May 1947 to A. J. Wakefield, who headed the mission to determine the feasibility of the plan[152] that it would give him the opportunity to get a few of his long cherished ideas into operation. It becomes clear that he envisaged a long-term project to test climatic potential in the several areas of the scheme and failed to realise the speed with which the managers and their political bosses wanted results. Even before receiving a formal letter of appointment, he expressed concern about detail. He pointed to the need to print forms and for mechanical tabulation and computing. In a letter to Wakefield, dated 10 May 1947, he sent an analysis of the rainfall records of existing stations, together with a pamphlet on the correlation between climate and crops. The longest available rainfall records for the Kongwa area were 19 years at Mpwapwa, 17 years at Dodoma and 8 years at Kongwa Mission. Walter submitted a plan for a climatic survey of the project area. He proposed the establishment of first order stations (one in each block of 25 units with a distance of 50 miles in between), second order stations including the observation of evaporation, humidity and soil temperature (every three units of 30,000 acres), and rainfall stations (five to ten on each unit of 30,000 acres according to rainfall distribution).

Based on 15 units for the Kongwa area, Walter listed the following to be obtained locally: 7 tropical thermometer screens and 100 rain gauge containers in galvanised iron (to diminish the chance of theft); and to be obtained from Europe for each first order station he listed: 1 Dines pressure tube anemometer, 1 distant-recording mercury-in-steel dry- and wet-bulb temperature recorder, 1 Campbell Stokes sunshine recorder with Curtis's improved adjustment for latitude + cards for 2 years, 1 Dines tilting-syphon rain gauge, 1 solarimeter as advised by Met Office, 1 set earth thermometers for 1, 2 & 4 feet, 4 mercury-in-steel recording earth thermometers, 1 Robinson cup anemometer, 10 maximum thermometers, 10 minimum & 20 ordinary, 20 reservoirs, 20 Piche evaporimeters for two years supply, 3 Assmann psychrometers, 10 minimum terrestrial radiation thermometers, 3 tank evaporimeters, 1 slide rule, 3 Bilham slide rules. For second order stations, he listed: earth thermometers for 1, 2 & 4 feet, right angled earth thermometers for 5, 10, 15 & 20 cms, Robinson cup anemometers. Also required were brass rims and glass measures for 5-inch rain gauges. He asked Negretti & Zambra to supply particulars of their electrically recording thermometers for measuring the micro-climate within plants.

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limitations for a specific agricultural enterprise, *Agricultural Meteorology* **12**: 65-73; Hogendorn, J. S. and Scott, K. M., 1981. The East African Groundnut Scheme: lessons of a large-scale agricultural failure, *African Economic History* **10**: 81-115.

[150] TNA: CAB/129/37. Strachey, J., 1949. *First Annual Report and accounts of the Overseas Food Corporation, 1948-49: Memorandum by the Minister of Food*, London HMSO. Readers should note that current administrative regions of Tanzania are different from those in the 1940s. Evelyn John St. Loe Strachey was Minister of Food, 1946-49.

[151] Walter, A., 1910. *The sugar industry of Mauritius*, London: A. L. Humphreys. See also op. cit. 3.

[152] Wakefield had previously been Director of Agriculture for Tanganyika and Inspector General of Agriculture in the West Indies.

Walter went further in suggesting that Rothamsted[153] should be consulted on suitable equipment for determining soil moisture depths with cylinders as used in Mauritius. For the complete Tanganyika programme, he pointed to the need for a suitable central building set up with duplicating machinery and tabulating machines (he recommended the Remington agency in Nairobi), one supervising European, three Asians for tabulating and computation and six African clerks. He listed books required, including observers' handbooks, log and other tables and added:

> One other matter of paramount importance to the scheme is the organization of a planting programme based on the forecasts. The observations secured from each area will have to be transmitted promptly to the Central Forecast Service of the B.E.A.M.S, who will be asked to supply special regional forecasts for the areas concerned.

All this was signed by Walter as Director of BEAMS, as he had not yet retired from his post.

By 28 June 1947, Walter was complaining that he had heard nothing further from Wakefield and concluded from newspaper reports that organization was passing to a higher level, adding:

> The politicians will not thank the technical officers if they interfere with their pet schemes. I can only hope that some of you are independent enough not to allow public money to be squandered to please the politicians if the conditions are definitely unfavourable scientifically. We have seen Athi plain wheat schemes, Taveta developments, cotton growing at Embu, aerodromes in Kampala and various other stunts and I hope any developments in agriculture will be handled with full knowledge of environmental factors. In the marginal areas experimental plots should be established for at least 10 years before big scale operations are permitted.

When E. B. Worthington had asked him to comment on possibilities in Uganda, Walter had suggested Kitgum, but questioned whether a 6 weeks dry period there would be long enough for harvesting and drying. On Tanganyika, he had emphasised that the area northwards from Mpwapwa appeared definitely unfavourable and strongly advised waiting for a complete analysis before going ahead. This suggestion was ignored.

In a letter dated 15 July, Walter refers to an offer of £600 - at least until the Overseas Food Corporation took over.[154] He would resign from Government Service as Director of BEAMS in October, when Walter Grinsted returned to Kenya from a visit to Washington. Once again he encouraged a firm stance by Wakefield:

> I do hope you will do all you can to keep the scheme on a rational basis. I know the politicians are difficult to handle but you are quite capable of doing it.

He received a letter, dated 6 August 1947, from the United Africa Company, appointing him as Meteorological Advisor under the Groundnut Scheme in East Africa for a period of two years at a salary of £600 per annum.

Wakefield shows clear awareness that Walter had advised against Mpwapwa in a letter to W. A. Faure, Managing Director of the transitory Managing Agency, dated 5 August 1947. He quotes Walter as stating:

> (1) Masasi [*previously mentioned as the proposed Nachingwea* area] is very favourable, but planting should be rather late in December in order to get a good drying harvest; in only two years were there periods of drought exceeding 11 days in the growing period;
>
> (2) Tabora [*previously mentioned as the proposed Urambo area*] is also favourable with better drying conditions in the fifth month;
>
> (3) Mwapwa is not so favourable. There is a chance in seven out of thirteen seasons of dry periods for 12/15 days.

[153] Rothamsted Experimental Station in England, now known as Rothamsted Research.
[154] The Overseas Food Corporation was established by the Overseas Resources Development Act, 1948.

Even so, Wakefield claimed that locally grown crops indicated that there had been adequate rainfall in 3 out of 5 units at Mpwapwa in 1946, a dry year, and that the vegetation seen from the air suggested that rainfall would be adequate to the north (Kongwa), although one official warned that the vegetation could be misleading as 1947 had been a year of good rainfall.[155]

On 29 August 1947, Walter noted that the equipment ordered from Negretti and Zambra would be available from April 1948. On 30 October, he wrote to A. H. Bunting, Chief Scientific Officer of the Overseas Food Corporation,[156] anxious for rainfall observations to start without delay so as to secure a record over the planting season. On 4 November, Bunting wrote to Walter from Kongwa asking, on behalf of Wakefield, whether the shortage of water supplies there had any bearing on the likely rainfall and, on 21 November, Bunting wrote to Walter proposing one rain gauge per unit in the early stages. Although he hoped to select African assistants for training, he preferred for the time being to confine readings to points where Europeans were working, such as offices, stores and unit headquarters. On 2 December, he apologised for not getting Walter down there, intending to attempt a booking in the next week or so, adding:

> The rains here have broken, and we shall be busy planting soon, but it will be very valuable to me to have the benefit of some discussions with you on the planning of our meteorological work.

There was a further message for Walter dated 5 December:

> ... our accommodation position is so serious that it is only occasionally that we can bring in additional people, but I am still trying!

Bunting added:

> The rains began here a week ago, and we have had about 1¼" at Kongwa. It is evident that we shall need to record rain at a great number of places on each Unit. All the storms which have brought this early rain have been quite small – perhaps not more than a mile or two wide at most. We shall definitely need to have some means of finding out when the individual fields are ready in the Units of fifty square miles, and I am sure that systematic recording will be more effective than daily inspections.
>
> We have some ideas now about handling the recording of scattered rain readings by means of coloured bottles. It is also evident that our rainfall is coming from the east and north-east, rather than from the south-east. No storm has yet been seen to come over the top of the Kiboriani Mountains, which lie between us and Mpwapwa. I imagine that the rainfall is diverted by the mountains to the north of Kilosa and sweeps round the northern end of the range, thus coming into our plains from the east.

Walter wrote to Bunting on 8 December that the position was not satisfactory from his point of view and offered to stay in Dar es Salaam, if a service plane could take him from there to Kongwa. Bunting replied on 15 December that Martin[157] would rather have him stay at his house than in a tent. Still no visit was arranged, but on 29 December the United Africa Company sent Walter a service agreement and, on 14 January 1948, Bunting wrote to Walter about instruments, adding that Wakefield had approved the appointment of an Assistant Meteorologist.

It seems that Walter was struggling to get his voice heard. A letter from the secretary to Arthur Creech Jones, Secretary of State for the Colonies, dated 22 January 1948, acknowledged a copy of the first volume of the *Proceedings of the Nairobi Scientific and Philosophical Society* and an advance copy of Walter's address to the Annual General Meeting.

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[155] Wood, A., 1950. *The Groundnut Affair,* London: The Bodley Head, 37 writes: 'Wakefield decided that the only reasons why such fertile ground had not been used before were the impossibility of clearing the tangled bush by primitive methods and the absence of domestic water supplies. There was, however, perhaps another reason. An official rainfall map, published in 1942, showed Mpwapwa lying outside, and the projected groundnut area well inside, a yellow band which marks the lowest rainfalls in Tanganyika – under 25 inches'.

[156] Bunting was later Professor of Agricultural Development Overseas, Reading University. He was interviewed by D. E. Pedgley on 28th January 1997 – see Royal Meteorological Society: Distinguished Voices (available on order from the Society).

[157] D. L. Martin, East African General Manager (Agriculture) on secondment from the United Africa Company, had been a member of the Wakefield Commission. He left the Scheme in December 1948,

Walter was informed by letter of 23 March 1948 that responsibility for the Scheme had been transferred on 1 March to the Overseas Food Corporation. He wrote to Bunting on 25 March suggesting one of his own high grade African field clerks as Field Assistant Meteorologist, but Bunting replied on 12 April that he believed an African clerk would not be able to help until they had the equipment to establish a first or second order station. He added that rain gauges were proving attractive to local people and work on site involved much persuading of other departments to do things. They were coping with a situation in which everything was in short supply. A 'responsible European' was needed and

> Surely there would be no difficulty in securing a thoroughly well-trained Meteorological Assistant with RAF experience?

On 23 September 1948, Bunting referred to a letter that Walter had received from Martin at the Overseas Food Corporation, which formally dispensed with Walter's services:

> I should like to express to you my thanks for the help and encouragement you have given us in the past, and to say how much I regret that owing to the lack of trained staff to assist you, it has not been possible to take more advantage of the help you would have been able to give us. I am told that London has now taken upon itself to decide that no Meteorologist at all is required, but I have put in a strong rejoinder, which has the support of the whole management here, pointing out that in three fields of applied physics – meteorology, soil moisture and percolation studies, and soil physics with special reference to the compaction problem on the red soils here and elsewhere – we can occupy the full time of a qualified man, and that the need so far from being reduced over the last twelve months, is greater than ever. We await results.

Walter replied, 10 October 1948, that he was not altogether surprised at the London decision:

> With you I think they are making a grave mistake to leave out of the analysis of the results of one of the most important factors on which the success of the undertaking depends, but they intend to approach it in a different way and with someone in whom they may have more confidence. I have no inkling of what they intend to do with the equipment which is on order. Without the equipment and without observing personnel my position was certainly becoming difficult. ...
>
> Keen[158] seems to think that they intend to centralise the research on these problems under him.
>
> ... I am naturally very disappointed because I looked upon this final piece of agricultural climatic research as my swan song, as I have studied these problems for so many years. In fact Dr Brunt has sent me a kindred research problem which the Colonial Office has instructed me to carry out, but I should have been very happy to link it up with the great undertaking on which you are all engaged.
>
> I still think that the area is not the most suitable and I hope you will soon be able to concentrate on the Lindi zone [*i.e. the proposed Nachingwea area*] where I think the conditions are much more favourable.

He wrote to Martin on the same date:

> Unless they intended to make full use of my services and enable me to link up the climatic data with the yields per acre and carry out the research plan which I outlined for them at the start of the operation it is certainly preferable to discontinue my employment.

It becomes evident that a thorough and ongoing investigation into climate did not appeal to managers of the Scheme, beset as they were with other problems and costs. They were in too much of a hurry to take an interest in Walter's long-term perspective. There were objections to Walter's ordering of supplies – orders should have gone through Bunting, who would have placed indents using proper channels.

The later correspondence between Walter and S. H. Frankel, Professor of Colonial Economic Affairs at Oxford, [159] arose from the latter's comment in an article in *The Times* of 4 October 1950 that:

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[158] Bernard Keen (Knighted in 1952) was Director of the East African Agricultural Research Institute, later the East African Agriculture and Forestry Research Organization (op. cit. 10). Ratcliffe, R. A. S., 1993. Pen Portraits of Presidents – Sir Bernard Keen, F. R. S., *Weather* **48**: 379-381.

> Before work was begun at Kongwa no time could be spared ... for adequate investigation of meteorological information bearing on rainfall.

Frankel was a member of the working party that recommended abandonment of the Groundnut Scheme.

Walter hoped to send an article to the Times about Frankel's article on the groundnut scheme, but received a letter from Norman Wright at the Ministry of Food,[160] dated 18 October 1950, that it was not desirable to publish it. Instead, Walter wrote directly to Frankel that his statement was incorrect:

> The rainfall statistics of all the projected areas both in Kongwa and Tanganyika, which have been collected since the formation of the East African Meteorological Service in 1928 (of which I was the founder and Director for 20 years) were analysed by me with special reference to the groundnut requirements.

Walter explained that, given the main wind currents and topography, isohyets can be interpolated for a given area with only slight geographical error, if rainfall stations surround the area under review. He referred to his work in Mauritius, and that

> It is not the total rainfall or the mean temperature which constitutes the controlling climatic factors of crop production, but the type of rainfall – its distribution and incidence and its effect on soil moisture, i.e. the balance between rainfall and evaporation and run off.
>
> The findings of this analysis were submitted to the administrative group, at the time represented by United Africa, early in 1947 before any work had been started. The projected plans for ten Kenya units at Mackinnon Road [*between Makindu and Voi*] and on the coast near Lamu were abandoned as the conditions were shown to be entirely unsuitable and several million pounds must have been saved. The climatic conditions in the southern area were favourable. Kongwa was shown to be a marginal area and I strongly advised no large scale operations in that region at least until further investigation had been carried out. The distribution of rainfall at Kongwa is of the thunderstorm type and hence liable to interruption for long intervals even during the rainy season. Agricultural experts were, however, consulted and after flying over the area it was decided that the vegetation showed a wetter condition than the statistics I submitted indicated. It was also argued by the administrative group that there were no rainfall stations in the uninhabited area which it was proposed to exploit.
>
> When this decision was communicated to me, as I had been appointed consultant in climatology on a contract for a period of two years (I was dismissed after nine months for reasons not stated) I again wrote to the head office pointing out the danger of undertaking large scale operations in this marginal area and the likelihood of wasting vast sums of public money if persisted in. That was in July 1947.
>
> In January 1948, I forwarded both to the Secretary of State for the Colonies and to the United Africa Company a copy of my presidential address to the Nairobi Scientific and Philosophical Society in which I stressed the 'fundamental relation which exists between climate and ... every aspect of human endeavour' and 'the part which climatology must play in the counsels of those who are to be entrusted with the carrying out of the many development plans proposed'. I stated further 'it is not too much to say that in the past records of these Colonies thousands if not millions of pounds have been wasted, either because the basic climatic information was not available or the administration had not utilised to the full such expert advice as had been available'.

Frankel replied on 23 October 1950, explaining that he was in an invidious position in referring to this matter in his articles because what he had heard was confidential.

> It may interest you to know that when I wrote that 'no time could be spared for <u>adequate</u> investigation of meteorological information bearing on rainfall' I had at the back of my mind the fact that your criticisms had been ignored. I did not then know the full extent to which your criticisms had gone nor did I know the extent of your investigation and I am glad to have that information now.

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[159] op.cit. 5, MSS. Afr. S. 1864, Box 1, Files 3 & 4

[160] ibid., Box 1, File 5.

Frankel reproduced two articles on the Groundnut Scheme, which had previously appeared in *The Times* of 4 and 5 October 1950, in a book of essays, adding an introductory note but making no mention of Walter's involvement in the Scheme.[161]

An account of the climate at Kongwa is included in the Annual Report of the Overseas Food Corporation, presented to Parliament by the Minister of Food in 1949.[162] Referring to 1947, the Minister reported that:

> Mr. A. Walter (formerly Director, BEAMS) was Meteorological Advisor to the Scheme during the year.

Rainfall data for Kongwa are given,[163] possibly supplied by Bunting, and the Minister's report states that

> The climate is good ... Rainfall is spread over a five-six month season from November to April, usually with a short dry spell in January and February.

It is admitted in the report that little formal meteorological work had been possible, mainly due to lack of equipment and that all of the areas in which the scheme was operating were semi-arid, in that their climates were marked by a practically rainless season of at least six months. The report added, less accurately, that the rainy seasons were in general more or less continuous from December to the end of April. This was corrected by a further paragraph that

> The 1947-48 season was a relatively dry one throughout the Central Province. Failures of maize and bulrush millet, due to the drought, were common. The midseason gap was a very long one, lasting at Kongwa from about January 20 to the beginning of March, and this was a factor of great importance in considering the results of the agricultural operations, since it covered the early growth period of many of the plantings.

Following details of rainfall at Kongwa headquarters and in two other units there follows a comment similar to the one made by Bunting in a letter to Walter:

> These figures illustrate the wide spatial variation which appears to be characteristic of the Kongwa rainfall. Individual storms are frequently confined to an area only a mile wide, although their path may run for several miles.

More optimistic is the suggestion that

> Although at Kongwa total rainfall is low, it is compressed into a season of 4 to 5 months. The average rainfall per week is thus higher than might be assumed. The variability of rainfall may be expected to be offset to some extent by effective water conservation measures.

No mention is made of Walter's advice that large scale operations should not take place in the Kongwa area until further investigation had been carried out. Indeed, there is evidence that the managers of the Scheme avoided making reference to his advice in their reports. For example, in a paper presented to the First Conference of the British Society of Soil Science held in Oxford in 1947,[164] Wakefield referred merely to the 'employment of a meteorologist'. In a later article on the Scheme in which he referred to the widespread drought affecting large parts of the African continent in 1948-9, he made no mention of advice from a meteorologist.[165] In an article in *Nature*, Bunting referred to soil and vegetation surveys, laboratory and field studies of soil fertility, alternate cropping and rotations, and plant protection problems, with no mention of meteorology.[166] In a further article in *Nature*, he referred to 'the assembly of meteorological data, with special reference

[161] S. Herbert Frankel, 1953. The Kongwa Experiment: Lessons of the East African Groundnuts Scheme, in *The economic impact on under-developed societies*, Cambridge, Massachusetts: Harvard University Press, 141-153.
[162] op. cit. 150.
[163] ibid. 103-4.
[164] Wakefield, A. J., 1947. The groundnut scheme. Reproduced in *East African Agricultural Journal* **13**: 131-134.
[165] Wakefield, A. J., 1950. Groundnut scheme in East Africa, *Nature* **165**: 234.
[166] Bunting, A. H., 1949. Science in the East African Groundnut Scheme, *Nature* **163**: 293.

to rainfall in the Kongwa area' and to an experiment at Kongwa on the artificial stimulation of rainfall, but makes no mention of the employment of Walter or the advice he had given.[167]

Much quoted on the Groundnut Scheme is the damning account by A. Wood, who was employed from April 1948 as Head of the Information Division, a position that he believed justified his critical appraisal of what had happened.[168] Wood makes many references to rainfall, but no mention of Walter. It is possible that he was never told of Walter's employment.

It is important to remember that the failure of the Groundnut Scheme has been attributed to many causes and particularly to the mistaken use of heavy machinery, but Walter would no doubt agree with Worthington that:

> ... the failure of the great venture on the Groundnut Scheme in East Africa ... was not due to the inherent unsoundness of such projects so much as to the hurry in taking far-reaching decisions which cut out the pilot stage. Had pilot schemes been adequate and designed to reveal the pitfalls, there would have been far less financial loss and perhaps, by selecting different areas and methods, the schemes might have been successful.[169]

9.2. Weather and Crops

When, in a Colonial Office discussion on a policy to replace shifting cultivation with permanent farming, it was asked whether the meteorological services were collecting appropriate data for the delimitation of climatic zones and their suitability for agriculture, Professor David Brunt of Imperial College suggested that an approach be made to Albert Walter, 'who has studied for some fifty years the correlation of climate and agriculture, and whose work years ago in this field on the sugar industry of Mauritius is classic'. Walter subsequently obtained a small grant from the Colonial Development Fund[170] to begin a project under Sir Bernard Keen at the East African Agriculture and Forestry Research Organization, which moved from Tanganyika to Kenya in 1948.[171] He outlined the objectives of the research In the *Annual Report* of the Organization for 1948:

> (1) To determine some function of temperature showing a close relationship to the temperature requirements of specific crops,
> (2) to establish if possible a relationship between air temperature and increasing radiation,
> (3) to determine a function of rainfall which bears some relation to soil moisture.

In the *Annual Report* of 1949, he reported that the integral of the diurnal temperature curve during sunlight hours (sunrise to sunset) in East Africa was clearly related to the measurement of solar radiation and that on average the correlation co-efficient was above 0.9. The scatter on individual days was found to depend in great measure on the values of T/e, where T was the mean absolute temperature for the daylight hours and e the mean vapour pressure. Having established a close approximation of incoming solar radiation as a function of temperature and vapour pressure in a standard screen, he set out to compare the results with measurements determined by H. C. Pereira[172] and to analyse the rainfall records of 300 East African stations. In characteristic fashion, Walter wrote that he would discuss the method of analysis with the Hollerith representative in London. The punching and analysis would be carried out in East Africa by arrangement with the Statistical Department and, in a letter dated 12 May 1950,[173] he refers to the need for a clerk to

[167] Bunting, A. H., 1951. Agricultural research in the groundnut scheme 1947-51, *Nature* **168**: 804-6.
[168] op. cit. 155.
[169] op. cit. 17, Worthington, 1958, 26.
[170] op. cit. 5, MSS. Afr. s. 1864, Box 1, Files 5 and 6 (Boxes 2, 3 and 4 contain charts and statistics).
[171] op. cit. 10.
[172] McCulloch, J. S. G., 2008. Sir Herbert Charles Pereira, 12 May 1913 – 19 December 2004, *Biogr. Mems Fell. R. Soc.* **54:** 247-256.
[173] op. cit. 170.

extract the data needed. He corresponded widely on the project, in particular with Pereira and Sir Bernard Keen.

Walter continued to work on the project when living in England, but was frustrated by the difficulties involved in processing data. He arranged for the use of computers at Kew and for a time the Hollerith Section of the Treasury Department helped. Funding ceased in 1953,[174] but Walter's enthusiasm was not dimmed and he circulated a draft paper on a 'Proposal for a research programme designed to lead to the provision of assistance to the under-developed countries of the world'. There is a letter of July 28 1960 referring to the paper from a friend and colleague in the U.S. Department of Agriculture.[175] In 1963, he wrote to the U.S. Soil survey with notes on a paper he hoped to submit to the Agricultural Section of Unesco. In his files is the draft of a paper on the significance of marginal climates in the tropics, emphasising the importance of only small changes in temperature and humidity. Walter suggested that regions should be divided into their natural drainage areas and that selected teams of scientists and engineers should be appointed to examine the suitability of each area for specific crops, taking into consideration rainfall regime, temperature, irrigation and land tenure. In other drafts, he referred to the need for a single-value function of the complex of meteorological factors.[176] He published two papers based on his work (Walter 1967 and 1969).

10. Conclusion

Writers on the history of colonial science have largely ignored meteorology, focussing on developments in botany, ecology (including ideas on climatic change and acclimatization), conservation and disease.[177] Some have been obsessed with science as a tool of imperial power. Moreover, official recognition of the importance of scientific research in the colonies was slow until the African Research Survey of 1938 led to the setting up of the Colonial Research Fund from 1940.[178] Some might ask why there had been no earlier call for an organized meteorological service in East Africa. After all, British India had seen Blandford's work on climate and weather in 1889 and the subsequent work of Gilbert Walker[179] on the circulation across the Pacific and the Indian monsoon. Yet, in 1911, the Meteorological Committee was content to ask the Kenya Department of Agriculture to supply weather data. That the laws of atmospheric circulation understood in middle and high latitudes could not apply in equatorial regions, where the geostrophic relationship broke down, delayed recognition that there were links between what was going on in the atmospheres of the tropics and higher latitudes.[180]

Writers on the history of aviation have also shown limited interest in meteorology. The arrival of air travel certainly provided a potential tool for imperial power by making colonies more accessible, but, significantly for meteorology, aviation brought about an urgent need for weather forecasts. It also brought about a change in global connectivity, which encouraged fundamental advances in the science. When Walter retired in 1947, he received letters of appreciation from colleagues

[174] op. cit. 5, MSS. Brit. Emp. s. 391, Letter from the Colonial Office, 14 April 1953.
[175] ibid. Letter from the USA.
[176] MSS. Brit. Emp. s. 441 (2), Kenya 1925-46.
[177] Exceptions are factual accounts such as Worthington 1938 and 1958, op. cit. 17 and Jeffries, op. cit. 62.
[178] Jeffries, op. cit. 62; Hailey, W. M. 1938. *An African survey: a study of problems arising in Africa south of the Sahara; issued by the committee of the African Research Survey under the auspices of the Royal Institute of International Affairs*, London: OUP.
[179] Sir Gilbert Walker was Director-General of Observatories in India from 1904-1924.
[180] For a summary of the interpretation of tropical weather before 1950 see Palmer, C. E., 1951. Tropical Meteorology, contrib. to Malone, T. F. (ed.). *Compendium of Meteorology*, Boston, Mss.: American Meteorological Society, 859-880 and Palmer, C. E. 1951. Reviews of Modern Meteorology – 5. Tropical Meteorology, *Q. J. R. Met. Soc.* **78**: 126-164.

worldwide, some of which reflected those advances. When Sir Nelson Johnson[181] wrote from the Meteorological Office thanking Walter for his loyal assistance during the 1939-1945 war, he pointed out that:

> The 50 years' service which you have rendered meteorology represents an achievement which few are privileged to attain, and you may well be proud of the distinction which has fallen to you. It has also been your privilege to witness and take a leading part in the great developments which have occurred during the past half century, and you may well look with pride upon the leadership which you were able to exercise in your capacity as President of Regional Commission I of the I. M. O.

The breadth of Walter's activities is reflected in the letter from Arthur Creech Jones at the Colonial Office:

> On the occasion of your leaving the Colonial Service, I should like to take this opportunity of expressing my warm appreciation of the long and valuable service in the field of meteorology and as a pioneer in the work of colonial census which you have rendered to the Governments of Mauritius and of the East African territories since your first appointment in 1897.

Albert and Louisa Walter celebrated their 72nd wedding anniversary (Plate 5) not long before his death. He had been in his late eighties when he completed the memoirs deposited in Rhodes House and turned ninety when he published his last paper. It is fitting to suggest that in a long working life he had 'given it his all'. Walter recognised that his 'varied and colourful experiences associated with half a century of work in the twilight of our Colonial Empire', were 'experiences which can never be re-lived as the conditions which gave rise to them have passed into history'.[182]

Plate 5. Albert and Louisa Walter on the celebration of their wedding anniversary in 1972, Photograph from a Ramsgate Newspaper, supplied by Mr. John Walter, Albert Walter's grandson.

[181] Sir Nelson King Johnson, Director of the Meteorological Office, 1938- 1953. Gold, E., Obituary: Sir Nelson Johnson, *Weather* **9**: 116-117.
[182] *Echoes,* 1,

11. Postscript

Funding anxieties in the 1930s were not confined to the meteorological service for East Africa. Someone had to make decisions and money was short. Colonial Office papers relating to the West African service refer to questions on whether a meteorological officer transferred at one week's notice from Nigeria to the Gambia should have the cost of transporting his car and the customs duty on his household belongings,[183] whether the date of appointment of D. E. Smith as meteorologist in Nigeria, 23 June 1937, should be regarded as that of the inauguration of a combined West African service, disputed because it was a retrospective proposal,[184] and whether payments to Nigeria by the Gambia, Sierra Leone and the Gold Coast for administration of the service should be quarterly in advance or in arrears.[185] Other services suffered. Macdonald describes how the East African territories were persuaded to fund a team of survey engineers continuing observations along the 30th meridian through Tanganyika - 'It was not a propitious moment … as there was a serious financial crisis at home and, in 1933, the joint funding arrangements collapsed and the team and its expertise were dispersed'.[186] Macdonald continues the story of the struggle for finance and control until the outbreak of war interrupted proceedings.

With the formation of the East Africa High Commission in 1948, the meteorological service became a High Commission responsibility with the title of East African Meteorological Department.[187] How the service was funded from its later transfer to the East African Common Services Organization in 1961 and its separation into services of the independent territories in 1977 would be a story beyond this account of Albert Walter's work in East Africa, but it is interesting to note that financial uncertainty plagued the service for many years. When war-time control was relinquished in 1948 and a reassessment of financial responsibility between the Governments of East Africa became necessary, negotiations continued throughout 1949. The Annual Report of the service for 1949 comments that

> This uncertainty in the permanent financial arrangements inevitably gave rise to some difficulties in the administration of the Department. In particular, it was not possible to recruit staff to the level of the proposed establishment.

The old offices in Government Road were closed down in July 1954. A new headquarters building was completed at Dagoretti Corner on the outskirts of Nairobi and formally opened by His Excellency Sir Evelyn Baring. The Radio Sonde section remained at Eastleigh.[188] The cost of the new building was met from funds made available under a Colonial Development and Welfare Scheme.[189] That funding delays continued is illustrated by the following:

> A good start was made on the programme of development and expansion approved for the Department in the year 1955/56 and it has been hoped that this process would gather momentum during the period now under review and that there would in consequence be a very marked improvement in the facilities available to the Department and thus in the services given to the public. However, at the beginning of the year it became known that Her Majesty's Government was not prepared to continue its contribution to the Department on the same level as had previously been agreed and it was, therefore, necessary to freeze much of the anticipated expenditure pending the negotiation of a fresh agreement. This was not finally reached until the beginning of 1957 and ratified in March of that year. As a result it was not possible to make good the delay in the implementation of the year's programme and the final

[183] TNA: CO 554/125/3.
[184] TNA: CO 554/115/3.
[185] TNA: CO 110/554/7.
[186] Macdonald, A., 1996. *Mapping the World: a history of the Directorate of Overseas Surveys 1946-1985*, London: HMSO, 8-11.
[187] Davies D. A., 1952. *East Africa's weather service*, East Africa Meteorological Department (East Africa High Commission), Eagle Press, Dar es Salaam, Nairobi, Kampala, 1952.
[188] East African Meteorological Department Annual Report for 1954-55. National Meteorological Library and Archive.
[189] Following the African Research Survey of 1938, a series of Colonial Development and Welfare Acts was set up from 1940. and a revised Colonial Research Committee from 1942. Jeffries op. cit. 62.; Hailey, W. M. 1938, op. cit. 177.

expenditure for the year totalled only some £234,000 against approved estimates of £266,000. The shortfall of £32,000 indicates the extent to which achievement fell short of what had been authorised and desired.[190]

12. Major publications by Albert Walter after his time in Mauritius

Walter's publications during his time in Mauritius are listed in Occasional Paper 12. Most of the following can be found in the National Meteorological Library and Archive, the Radcliffe Science Library or Rhodes House Library, Oxford. Please note that this list may not be complete. Walter published notes in local journals and presented papers to IMO/WMO conferences and conferences of Empire Meteorologists that are not all listed here.

1927. Notes on meteorological research in British East Africa, *Kenya and East African Medical Journal* **4:** 132-147.

1929a. Foreword to J. W. Nicholson, 1929. *The influence of forests on climate and water supply in Kenya*, *Forest Department Pamphlet* no. 2, Colony and Protectorate of Kenya, Nairobi: East African Standard, v-vi.

1929b. Note on the inauguration of a Joint Meteorological Service for British East African Territories, *Memoirs* **1**, BEAMS, Nairobi: Government Printer.

1929c. Some general considerations on the dependence of agriculture on climatology, Conference of Empire Meteorologists, Cairo-Durban Airship Route and the Cairo-Cape Town Air Route Sub-committee, 26th August, 1929.

1930a. Note on the storm on Victoria Nyanza, May 18th-19th, 1930. *Memoirs* **2**, BEAMS, Nairobi: Government Printer.

1930b. Note on the construction of a portable generator for hydrogen gas required for filling pilot and sounding balloons. *Memoirs* **3**, BEAMS, Nairobi: Government Printer.

1932a. Report on arrangements for the supply of weather information for East Africa in connexion with the aviation services, Nairobi: BEAMS.

1932b. Report on a journey through East and Central Africa in connection with the organization of the BEAMS: September-December, 1930, Nairobi: BEAMS.

1932c. Report on a journey by air over the British East African Territories, October 23rd - November 5th, 1931, Nairobi: BEAMS.

1934. Climate and white settlement in the East African highlands, *East Afr. Med. Journal* **11**: 210-225.

1935. The climate and weather of East and Central Africa. *East African Agricultural Journal* **1**: 87-89 [Subsequent papers in the series by W. A. Grinsted, 1935 & 1936. **1:** 165-168; 248-250].

1936a. Pressure reductions, *O.M.I., Publ. No.* 32, Reg.Comm., No.1 (Africa), Lusaka, 79-82.

1936b. The British East African hydrogen generator for pilot balloons, *O.M.I.*,.Publ. No. 32, Reg.Comm. No.1 (Africa), Lusaka, 87-89.

1936c. Editorial Notes, *East African Agricultural Journal* **1**: 262.

1936d. The weather of 1935, *East African Agricultural Journal* **1:** 338, 339, 398 and 412.

[190] The Annual Report of the Kenya Commissioner for Transport, which incorporates the Annual Report of the Director of the Meteorological Department for 1956/57.

1936e. The climate and weather of East Africa, *East African Agricultural Journal* **1**: 512-514.

1937. Forests and climate, *O.M.I.* Publ. No. 36, *Kom. Landw. Meteor.,* Salzburg, 63-64.

1938. The climate of British East Africa, *Q. J. R. Met. Soc.* **64:** 97-116

1939a. A note on the meteorological conditions of East Africa, BEAMS, Nairobi.

1939b. A note on the seasonal rains of East Africa and their causation, *Tanganyika Notes and Records* **9:** 21-26.

1940. The climate of Uganda with special reference to agricultural districts, in J. D. Tothill, *Agriculture in Uganda*, Section II, Part II, Oxford University Press, 14-23.

1941. Memorandum on the administration of the BEAMS for the years 1939-40, BEAMS, Nairobi.

1942. A note on forecasting cyclones in the South Indian Ocean, BEAMS, Nairobi.

1944. Note on the South Indian Ocean cyclone of Jan. 31st to Feb. 11th, 1944, BEAMS, Nairobi.

1946. Upper wind frequencies, prepared under the direction of A. Walter, BEAMS, Nairobi.

1948. Observations of atmospheric pressure in East Africa. Part I, Results from first order stations, *Memoirs* **II** (1), East African Meteorological Service.

1949. Research scheme on climatic data in relation to agriculture, *Annual Report 1948*, East African Agriculture and Forestry Research Organization, 36-37.

1950. Research scheme on climatic data in relation to agriculture, *Annual Report 1949*, East African Agriculture and Forestry Research Organization, 41.

1967. Notes on the utilization of records from third order climatological stations for agricultural purposes, *Agricultural Meteorology* **4**, 137-143.

1969. A relation between incoming solar radiation and degree-hours of temperature, *Agricultural Meteorology* **6**, 435-438.