Scientific Instrument Society

RMetS
Royal Meteorological Society

The weather, measur'd

400 years of meteorological instrument technology

A joint meeting between the

Worshipful Company of Scientific Instrument Makers (WCSIM)
Scientific Instrument Society (SIS)
Royal Meteorological Society (RMetS)

To be held on

Saturday 13 June 2020

River Room, Glazier's Hall, 9 Montague Close, London SE1 9DD

Prior registration is required for this meeting;
for further details and booking form please contact one of the participating societies

MEETING PROGRAMME

The weather, measur'd: 400 years of meteorological instrument technology

Saturday 13 June 2020 - Glazier's Hall, 9 Montague Close, London SE1 9DD

Time	*Topic/title*	*Speaker*
0945	Registration, tea/coffee	
1000	SIS AGM *[no fee to attend AGM only]*	
1030	Welcome and introduction	Master, Worshipful Company of Scientific Instrument Makers
Session one – Temperature measurements *(WCSIM Chair)*		
1040	The first thermometers in England and the Central England Temperature series	Stephen Burt FRMetS *University of Reading*
1105	From mercury to silicon	Dr Simon Bell *University of Birmingham*
1130	The challenges of making temperature measurements in Antarctica	Steve Colwell *British Antarctic Survey*
1155	*Morning session speaker Q&A panel*	
1210	*LUNCH*	
Session two – Pressure measurements *(SIS Chair)*		
1330	Early barometers: instruments, scales and makers in England to 1851	Dr Gloria Clifton *National Maritime Museum and Royal Observatory at Greenwich*
1355	Luke Howard's barograph clock and urban climate studies	Alison Boyle FRAS *Science Museum, London* and Stephen Burt FRMetS *University of Reading*
1420	Early barometer observations and their use in modern climatology	Dr Richard Cornes FRMetS *National Oceanography Centre*
1445	Using historic pressure observations to reconstruct extreme weather	Dr Philip Brohan *Met Office Hadley Centre, Exeter*
1510	*Refreshments*	
Session three – Wind measurements *(RMetS Chair)*		
1540	Aeolus: a 21st-century spaceborne anemometer	Dr Roland Meynart *European Space Agency*
1605	From the surface of the ocean to the top of the atmosphere – meteorological observing, how hard can it be?	Stuart Goldstraw *Met Office, Exeter*
1640	*Panel – all speakers*	
1700	Wrap up and meeting close	Master, WCSIM

ABSTRACTS AND SPEAKER BIOGRAPHIES

Stephen Burt FRMetS *Department of Meteorology, University of Reading (Retired)*

The first thermometers in England and the Central England Temperature series

In 1661, Robert Southwell (1635-1702, later PRS) was on his Grand Tour in Europe. His diary shows he was in Florence on 3 April 1661, and it was almost certainly there, at the Medici court, that he saw one of the examples of exquisite glassblowing we now know as Little Florentine Thermometers. He brought back one or two of these delicate instruments to England, and later that year or in early 1662 showed them to Robert Boyle and his assistant Robert Hooke at a Royal Society meeting in London. Hooke, as Curator and chief experimentalist to the Royal Society, was instantly fascinated, had copies made and began England's first temperature measurements: Boyle and Hooke together worked on the thermal properties of gases, publishing Boyle's Law $PV=k$ in 1662.

Stephen Burt has published extensively on British weather and climate for over 40 years, covering topics as diverse as historical and contemporary gales, heatwaves, blizzards and cloudbursts, meteorological instruments and observing, and the humidity records from the Ben Nevis Summit Observatory. He has written or co-authored five books on meteorology, most recently Oxford Weather and Climate since 1767*, published by Oxford University Press in 2019. Stephen is a Fellow of the Royal Meteorological Society, a member of the American Meteorological Society and the Scientific Instruments Society, and an Honorary Fellow of the University of Reading.*

Dr Simon Bell *University of Birmingham*

From mercury to silicon

Let's take a journey through modern air temperature sensing. From daily manual readings with mercury thermometers through to automated readings from platinum resistance thermometers, thermistors and tiny 3 mm wide thermometers found on electronics boards. The advantages and disadvantages of each technology are discussed. We'll delve into how these technological advancements have unlocked fascinating use-cases. In particular, how the miniaturisation of components, combined with increased affordability, lower battery consumption, and cutting-edge wireless communications have enabled dense roll-outs of thermometers across UK cities. Providing insights into city-scale phenomena such as urban heat islands.

Simon is a research fellow at the University of Birmingham. He's spent the last 5 years developing and commercialising a low-cost infrared temperature sensor to help highways managers efficiently and safely grit their road network in winter. He's now the technical lead on the Birmingham Urban Observatory project, developing best practices for deploying sensor networks across a city and managing and visualising the constant stream of incoming data. He's also working on sensors to predict the infamous "leaves on the line" issue that plagues the UK railway network throughout autumn.

Steve Colwell *British Antarctic Survey, Cambridge*

The challenges of making temperature measurements in Antarctica

Antarctica is the coldest, windiest and driest continent on Earth and this makes making temperature measurements particularly challenging. When the wind increases in Antarctica it starts to pick up snow from the surface and this becomes blowing snow, in winds above 20 m/s this can reduce visibility to just a few tens of meters.

The lowest temperature ever recorded at the surface in Antarctica was -89.2 °C: here, electronic sensors and loggers are often operating at temperatures well below what they are rated for by their manufacturers. These challenges and others will be presented.

Steve Colwell has worked for the British Antarctic Survey (BAS) for almost 30 years. He overwintered at Halley research station in 1991 and has returned to Antarctica 10 times since for Antarctic summer seasons. He is currently head of meteorology and ozone monitoring (MOM) at BAS which is responsible for its operational meteorology program. He is actively involved with the World Meteorological Organisation (WMO) and sits on the panel of experts on polar and high mountains observations, research and services and chairs the Antarctic Task Team with this group. BAS also carries out the Global Climate Observing System (GCOS) monitoring of Antarctica for the WMO and Steve leads this. He is also the Chairman of the RMetS Special Interest Group on Meteorological Observing Systems, the group responsible for organising this meeting. Steve was awarded a Polar Medal in 2012 for services in the Antarctic, which he received from the Queen at Buckingham Palace.

Dr Gloria Clifton *National Maritime Museum and Royal Observatory at Greenwich (Retired)*

Early barometers: instruments, scales and makers in England to 1851

After the invention of the mercury barometer in Italy, primarily by Evangelista Torricelli (1608-47) in 1643, the instrument was soon being tried in England, but the earliest evidence for it being produced commercially dates from the 1670s. Several different patterns emerged which continued to be produced, at least as reproductions, well into the 20th century. In the 1840s the mercury barometer had a new rival in the aneroid barometer, invented in France by Lucien Vidie and patented in 1844. It was soon being offered for sale in England. The talk will outline these developments, including the different styles of barometer, and examine who was producing and selling them, and who was buying them.

After completing a PhD, Gloria Clifton first encountered the history of scientific instruments as research officer on a project begun by Professor Gerard L'E Turner at Imperial College, London, to research scientific instrument makers. She then moved to the National Maritime Museum and Royal Observatory at Greenwich as curator of navigational instruments, a collection which included barometers. The Museum enabled her to publish the results of the earlier work under Professor Turner as The Directory of British Scientific Instrument Makers c.1550–1851 (1995). Now retired, she regularly goes to the museum as a volunteer and to continue research on instrument makers.

Alison Boyle FRAS *Science Museum, London*
Stephen Burt FRMetS *Department of Meteorology, University of Reading (Retired)*

Luke Howard's barograph clock and urban climate studies

Chemist and meteorologist Luke Howard (1772-1864) is best-known for developing the naming system for clouds. But he was also a key figure in the birth of urban climate studies, keeping decades-long records of temperature, pressure and rainfall in London. Most of the pressure recordings were done with a barograph clock made in 1766 by Alexander Cumming, clockmaker to King George III. In this talk we will describe the workings of the clock, now preserved in the Science Museum, and discuss some of Howard's key observations.

Alison Boyle is Keeper of Science Collections at the Science Museum, London, managing a team of curators responsible for physical sciences collections ranging from 600 BCE to the present day. She is Secretary of the Scientific Instrument Society and a Fellow of the Royal Astronomical Society.

Dr Richard Cornes FRMetS *National Oceanography Centre*

Early barometer observations and their use in modern climatology

The recording of instrumental observations was widely encouraged by the learned institutions of the late-seventeenth/early-eighteenth century. The analysis of such data and particularly the comparison of simultaneous observations from different locations was seen as a vital component in the construction of a "natural history of meteors" and many Natural Philosophers took up this call by keeping diaries of regular observations. The French physician Louis Morin kept an exceptional diary of meteorological measurements in Paris from 1670 until 1713, which consists of thrice-daily barometer and thermometer readings alongside several other non-instrumental observations. Although few observers recorded measurements with the consistency of Morin, the observations that exist from this time have been used to great effect in numerous modern climate analyses. This presentation will explore the barometer observations recorded in these weather diaries and will describe the use of such data in furthering our understanding of past states of the atmospheric circulation.

Richard Cornes is a research scientist at the National Oceanography Centre in Southampton where he conducts research on global climate using marine observations. He holds a PhD in climatology from the University of East Anglia for his work on the recovery and homogenization of 300-year-long data series.

Dr Philip Brohan *Met Office Hadley Centre, Exeter*

Using historic pressure observations to reconstruct extreme weather

Today's weather forecast combines billions of meteorological observations with a sophisticated mathematical model of the atmosphere and a lot of supercomputer time - to make a detailed, precise, and accurate estimate of the state of the weather all over the world. We'd like to do the same for historic weather events – essentially to re-run today's forecast to look at important storms, drought, and floods from decades or centuries ago. The challenge is that we have few observations from these historical periods, and we need to use them very effectively.

Philip works at the Met Office as a climate scientist. His job is to find out what the weather was like 100 years ago, so we can compare that with our experience today and our projections of the future. Philip became a data scientist before it was fashionable. Now he works mostly with weather data, particularly historical observations. While he enjoys model building, he is strongly of the opinion that quantity of data trumps cleverness in analysing it. So he devotes most of his time to digging-out more observations.

Dr Roland Meynart *European Space Agency (Retired)*

Aeolus: a 21st-century spaceborne anemometer

ESA's Doppler Wind Lidar Space Mission, Aeolus, was launched in August 2018. The mission provides vertical profiles of tropospheric and lower stratospheric winds for the improvement of numerical weather prediction and atmospheric dynamics research. The Aeolus profiles of line-of sight winds will allow an improved determination of the tropospheric and lower stratospheric circulation, particularly in the tropics and Southern Hemisphere, over the oceans and in polar areas, where atmospheric winds are currently not well measured. In addition, Aeolus provides valuable information of aerosol and cloud layer vertical distribution and their optical properties.

The Aeolus satellite carries a Doppler Wind Lidar estimating wind velocity from the Doppler shift of ultraviolet laser pulses, backscattered by atmospheric aerosols and molecules. The instrument combines, in an advanced space system, the latest technology (e.g. pulsed UV lasers, quasi-photoncounting detector arrays) with modern implementations of classical optical devices (Fabry-Pérot and Fizeau interferometers). The presentation will summarize the mission objectives and measurement principles, the space system implementation and, in particular, highlight the technologies used in the Doppler Wind Lidar.

Roland Meynart holds an engineer's degree and a PhD in Applied Physics, both from the Free University of Brussels (ULB). He is a specialist in optical systems, optical detection and in space instrumentation. He has been working 30 years at the European Space Agency (ESTEC, The Netherlands) in the definition, demonstration and technology risk reduction of Earth observation spaceborne instruments. In particular, he worked in the development of the Doppler Wind Lidar of the Aeolus satellite. He has recently retired from ESA and lives in Belgium. He is a member of SIS and now has more time to indulge in his collection of various types of 19th-century optical instruments.

Stuart Goldstraw *Head of Observations – Operations, Met Office, Exeter*

From the surface of the ocean to the top of the atmosphere – meteorological observing, how hard can it be?

The Met Office operates a wide range of meteorological observing networks endeavouring to meet as many user requirements as possible. The challenges of operating observing networks to monitor the state of and any changes in the climate, through ensuring our weather watch networks provide key information during high impact severe weather events, to obtaining observations from the oceans, will be presented along with a glimpse at the next set of observing challenges we face as the demands for weather watching increase apace.

Stuart Goldstraw joined the Met Office in 1989 and after a varied career is now the Head of Observations Operations with responsibility for the operation of a wide variety of meteorological observing networks. Most of his career has been spent in Observations or International Relationships with spells working on overseas capability development projects. Eight years as the Chair of the World Meteorological Organisation (WMO) Expert Team on Surface Based Observing has led to his recognition that, whilst we have come a long way in the last three centuries, there is still a long way to go if we as part of the global community are going to continue establish, operate and sustain truly global meteorological observing networks. As Head of Observations Operations the day-to-day and decade-to-decade challenges of maintaining the national meteorological observing networks are at the forefront of his mind. It is a challenge that is enjoyed every hour of every day.