Meteorological Observing Systems Special Interest Group

Newsletter Issue 53

Spring/Summer 2023

Contents

Front Cover Photo – The Chilbolton Advanced Meteorological Radar (CAMRa) and control room. The largest steerable meteorological radar in the world. The 25m antenna produces a very narrow beam (0.28 degrees), which is essential for probing turbulent processes in convective clouds.

Photo Credit: Picture courtesy of the National Centre for Atmospheric Science.

You can now find us on Twitter!

https://twitter.com/RMetS_MetObs

Introduction

Welcome everyone to the 53rd edition of the Meteorological Observing Systems Special Interest Group newsletter.

Hope you find this edition of the Newsletter informative! Thanks!

Mark Dutton, Newsletter Editor

Group Website: Members are encouraged to regularly check the Group's pages on the RMetS website at Meteorological Observing Systems | Royal Meteorological Society (rmets.org) for details of meetings and booking information, including on-line registration for meetings. Whilst every effort is made to publicise meetings via the inserts in Weather magazine and the Newsletter the website is the quickest medium of communicating with you.

Have Your Say: This is your Group and your Officers are always happy to receive feedback about what is being done on your behalf. If you have any comments or suggestions on matters relating to the Group and our activities, please do not hesitate to get in touch with any Officer. Contact details are shown on the last page of the Newsletter. Suggestions for future meetings and speakers are always very welcome.

Material for Publication: Written material must be in electronic format, preferably in MS Word or Excel, although PDF format can be accepted. Digital image format should be JPEG (preferable) TIFF or BITMAP. Short news items as email are acceptable. Material can be sent as email attachments to mark@emltd.net In all cases please include your name, address and email or telephone number with submissions.

Publication deadlines *are 31st March for Spring/Summer Newsletters and 31st October for Autumn/Winter Newsletters.*

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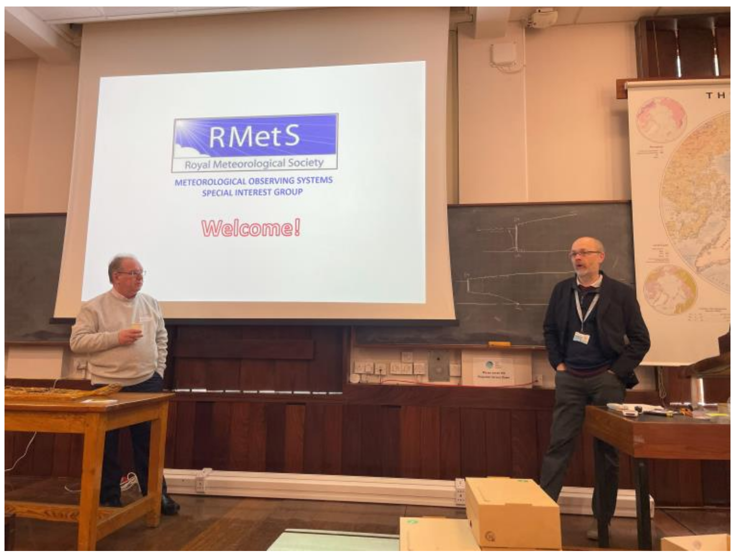
Meeting Reports

Making Weather and Climate Measurements in Difficult Places

Meeting report by Mike Brettle

Weather and climate observations in remote or inaccessible locations are fraught with difficulties, whether on our home planet or other planets in our Solar System. Achieving reliable measurements in such places stretches measurements beyond normal operating limits. This meeting examined how such measurements are made in five particularly difficult environments.

This meeting was held on the 14th March 2023. It was rescheduled from its original date in 2022 owing to industrial action on the train network. It was chaired by Stephen Burt and held at the Scott Polar Research Institute in Cambridge. There were 42 attendees.



The first presentation covered Atmospheric Measurements over Arctic Sea Ice and was given by Prof Ian Brooks of Leeds University. He is well qualified to describe the problems of Arctic measurements with 5 research cruises to the region under his belt.

The climate of the Arctic is changing rapidly, warming up to four times faster than the rest of the world. Climate models broadly represent the enhanced warming but show greater variability than at lower latitudes suggesting a failure to properly represent physical processes. Addressing these requires detailed in situ measurements. Ian described the logistical problems in accomplishing this notably the year-long MOSAIC project. This was an 'ice drift' cruise with the research ship Polar Stern fixed in ice and moving with it. A 442 strong science team from 20 nations were involved. Instruments suffered issues of rime and ice accretion and those on-board ship were subject to severe vibration too. Most instruments were installed on ice several hundred metres from the ship requiring power cables totalling kilometres. The ice proved to be a more dynamic environment than expected. On one occasion the ice around the ship broke up cutting off access to sensors and on another occasion mast anchor points moved causing the mast to bend and finally fail. It was repaired and collecting data in just three days. Polar bears provided an unusual problem to add to the elements, not just as a potential danger to personnel but also to equipment, such is the curiosity these animals exhibit.

Mike Kendon of the Met Office gave a presentation on observations of the UK's mountain climate as observed by weather stations operated by the Met Office. A small network of high-level stations provides observations representative of mountain conditions which could not be provided by nearby low-level stations. These stations are important for representative data for the UK. Out of the 413 stations in the UK network only 6 are at high level. They use non-standard equipment since the instruments normally present at a standard Met Office low-level weather station would fail in the mountain environment (surprisingly though, around the winter solstice, Scotland's mountain summits are often the sunniest and warmest place in the UK being above the widespread temperature inversions and in clear weather).

Data outages may be most likely during periods of extreme weather but that may be exactly when we want the data the most. Therefore, instruments must be designed for resilience and redundancy. All sensors and even junction boxes and data loggers are duplicated. Heated sonic anemometers with no moving parts are used and 'whip thermistors', less susceptible to icing. Finally, Mike explained that these stations also have a real time operational function. The Scottish Avalanche Information Service carry out detailed avalanche risk assessments and observations from the mountain stations provide valuable information about the snowpack.

Next Steve Colwell, head of meteorology and ozone monitoring at the British Antarctic Survey, spoke about measurements in Antarctica. His presentation looked at the challenges faced when installing and maintaining meteorological equipment on this beautiful but hostile continent. For me the most interesting problems that Steve described were UV radiation and blowing snow. The 'ozone hole' is still present and as a result UV levels are much more intense than usually encountered. This takes a toll on equipment made of plastic and we saw an image comparing radiation screens of the same age, one had been deployed in Antarctic the other in the UK. The difference was startling. The screen from Antarctica was noticeably degraded and darker in colour. Blowing snow causes interesting problems. It can fill Stevenson screens, bad enough in sub-zero conditions, but if it melts and refreezes it can cause serious damage. Steve showed a dramatic image of a Double Fence Intercomparison Reference (DFIR). The surrounding fence was filled with snow to a level about a metre higher than the surroundings. It was only used for one winter. Interestingly blowing snow is also very abrasive.

Low temperature is a rather obvious problem (in common with the other environments discussed during the day). All equipment must be tested irrespective of manufacturers claims. To really achieve reliable performance measures such as heating particular components and scrupulous selection of components is necessary. Steve gave a simple example of tantalum capacitors, as opposed to conventional electrolytics, that have superior low temperature performance. Temperature sensor mounting height is a big issue in Antarctica because of the high temperature gradient near the surface, there is often an extreme surface inversion and the tendency for the snow surface itself to rise with snow accumulation only makes things worse.

Richard McKay of Campbell Scientific Ltd. followed with a presentation on measurements at another hard to reach environment. In 2019, five automatic weather stations were installed on the slopes of the highest Himalayan peaks by Campbell Scientific Inc. This is an important site for global climate and is effectively sampling the sub-tropical jet stream. This project set some serious challenges for the team in choosing equipment and in reaching, installing, and communicating with automated sensor packages at extreme altitudes. Transport problems had wide reaching effects as weight was severely limited to that which could be carried by hand. Power was obviously very limited ruling out, for example, sonic anemometers. Sensors and communications (satellite and cellular modems and 400MHz radio) all had to be duplicated. It was not just equipment that faced a very challenging environment, including the risk of flying rocks driven by possible 200mph winds. The altitude took its toll on the engineers doing the installation. Even motor skills were degraded so the equipment had to be straightforward to install with a minimum of dexterity required. Special mountings for sensors and guy ropes were devised and all the whole design was tested in an installation on Mt Washington, New Hampshire, itself a very challenging environment. Overall, the main thing I took away from this presentation was the huge amount of planning, preparation and practice involved. The project was a success and is now returning data of great significance.

Finally, we had a presentation regarding the most difficult places to access, let alone measure – other planets. Colin Wilson, a Senior Research Fellow in the Atmospheric, Oceanic, and Planetary Physics group at Oxford University, gave a presentation on the difficulties of meteorological measurements on

Mars and Venus. The problem is often made especially difficult because there is no prior knowledge of the range of values to be measured.

Mars meteorological stations face low temperatures (down to -100 °C) and pressures (5-8 hPa) and windblown dust and sand, even so the longest of these records now approaches 10 Earth years in duration. Wind is probably the most difficult measurement, mainly due to the low air density. The Pathfinder and Phoenix landers had a kind of wind-sock approach with a small cone dangling in front of a camera. Most measurements now use heated wires but simultaneous temperature measurements are critical, Martian air temperatures can change by 10 degrees in 10 seconds.

Venus landers face very different environments, high temperatures (475 °C) and pressures (90,000 hPa), and a challenging chemical environment; none have lasted more than two hours. On the surface it is a challenge simply to keep electronic systems operational with ambient temperatures higher than silicon-based electronics can cope with Balloons in the clouds of Venus can enjoy more benign environmental conditions with temperatures and pressures in the 0–60 °C and 300 - 700 hPa ranges respectively – but still face sulphuric acid cloud droplets. Measurements have been made by balloons released by the Soviet Vega 2 probe in 1985 and this approach may well be the most promising for the future. Colin finished with a brief overview of plans for exploring Titan. Another ‘interesting’ environment which might also benefit from the use of balloons.

The 5 presentations gave interesting perspectives on obtaining reliable and accurate meteorological data from different severe environments. The problems are similar but different circumstances led to different solutions. For example if sufficient power is available then heated sonic anemometers are ideal but if not then good quality mechanical sensors are needed. Duplication of sensors is normal. A common theme was the ingenuity and attention to detail of those designing these stations and their resourcefulness in installing them and keeping them running.

SPRI were excellent hosts for the meeting and treated those who were able to stay a while after the meeting to a fascinating visit to their museum.

Summer Visit to Eskdalemuir Observatory

Meeting Report by Richard Griffith FRMetS

On an overcast and wet afternoon members from the Scottish Local Centre of the Royal Meteorological Society along with members of the Climatological Observers Group *(COL)* and guests attended Eskdalemuir Observatory situated in the Southern Uplands of Scotland. The observatory was built in 1904 and opened in 1908. It was built because of disruption to geomagnetic measurements at Kew Observatory following the advent of electric tramcars at the beginning of the 20th century. The British Geological Survey took over responsibility for magnetic observations from the Meteorological Office in 1968.

Figure 1 - Eskdalemuir Observatory showing Rain Gauges and Trials Site. The Dines Pressure Tube Anemometer can be seen on the roof of the building.

Situated on a rising shoulder of open moorland, the observatory is situated in the upper part of the valley of the White Esk river at an altitude of 242m, and so represents the climate of highland in northern Britain. It is surrounded by young conifer forests with hills rising to nearly 700m to the NW. The observatory is 100 km from Edinburgh and 25 km from the towns of Langholm and Lockerbie. As a long standing synoptic meteorological station, Eskdalemuir is involved in measurement of solar radiation, levels of atmospheric pollution, and in chemical sampling. The observatory operates a US standard seismograph and an International Deployment Accelerometer Program long-period sensor. The British Geological Survey has a broadband three-component seismometer set installed at the observatory and records data from four remote sites transmitted to the observatory by radio link.

Over the long history of Eskdalemuir some distinguished persons have worked at the observatory including meteorologist and mathematician Lewis Fry Richardson who served as Superintendent at the Observatory between 1913 and 1916, Dr Arthur Crichton Mitchell, a Scottish physicist with a special interest in geomagnetics who worked for many years in India as a professor and head of a meteorological observatory before returning to Scotland. He was superintendent of the observatory between 1916 to 1922 and Dr Douglas Haig McIntosh who became a meteorological forecaster for RAF Coastal Command in Scotland. In 1944 he became Deputy Chief Meteorological Officer for Southeast Asia. After the war he returned to the Edinburgh Meteorological Office in 1950. In 1953 he joined Eskdalemuir Observatory for two years.

Figure 2 - On 21st June 1913 a Garden Party was held at the Observatory to introduce the new Superintendent, Lewis Fry Richardson, who was to commence duty on 1st August.

Figure 3 - Eskdalemuir Observatory 18th November 1948

Figure 4 - Eskdalemuir Automatic Weather Station – June 2023

Figure 5 - Plaque presented to Eskdalemuir Observatory stating "Eskdalemuir recognized as a long-term observing station by the World Meteorological Organization in May 2017 for more than 100 years of meteorological observations"

Figure 6 - Tour of the Automatic Weather Station by Station Manager Peter Harvey

Figure 7 - Monitoring Equipment operated by the British Geological Survey at Eskdalemuir Observatory

The area has a low background of seismic activity, so is ideal for these measurements. There is a second seismic array approximately 3 km north of the main observatory established by the United Kingdom Atomic Energy Authority, this provides the UK part of an international monitoring network of the Comprehensive Test Ban Treaty. This network allows covert nuclear tests to be detected via their seismic signatures. At Eskdalemuir it consists of an array covering 10 square km, consisting of two intersecting lines of 10 pits containing seismometers, a seismological vault, and a recording laboratory.

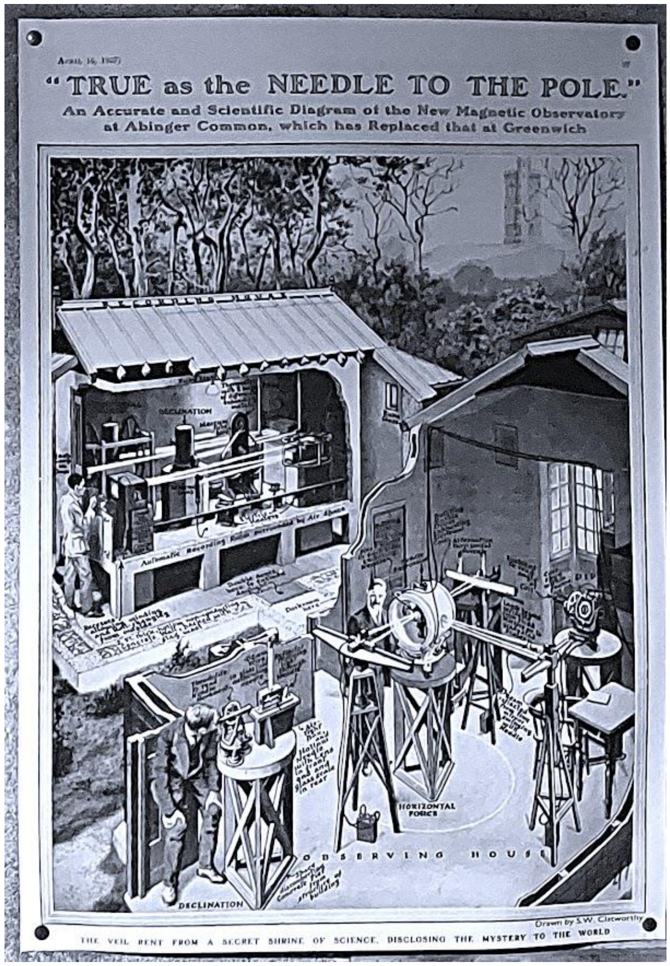


Figure 8 - Old Poster showing "an accurate and scientific diagram of the new Magnetic Observatory at Abinger Common, Surrey, which has replaced that at Greenwich

Shortly after 19:00 GMT on 21 December 1988, the observatory's seismometers recorded the ground impact of Pan Am Flight 103, which crashed into the nearby town of Lockerbie 23 kilometres *(14 miles)* away after being destroyed by a bomb. The event registered 1.6 on the Richter magnitude scale.

I would like to pass on my sincere thanks to Peter Harvey, Station Manager at Eskdalemuir and his colleague Claire Brown, Site Manager at Eskdalemuir along with Chris Turbitt, Observatories Manager for the British Geological Survey for their time in showing the group around the observatory and explaining the important work carried out at this long standing meteorological and geological observatory.

Please Note: A summer visit to Eskdalemuir Observatory will take place on **Wednesday 24th July 2024 commencing at 11am.** Following presentations about the history, meteorological and geological work carried out at Eskdalemuir Observatory there will be a site tour of the Meteorological and British Geological Survey facilities including the small museum which houses a collection of instruments, photographs, and historical documents. The tour will last approximately 2hrs. More details in the next newsletter. Thanks!

Scientific Article

Probing turbulent processes in the atmosphere

By Thorwald Stein (University of Reading), Steve Abel (Met Office), Paul Barrett (Met Office), Humphrey Lean (MetOffice@Reading), Ryan Neely III (University of Leeds and NCAS), Jeremy Price (Met Office Research Unit, Cardington Airfield), and Alison Stirling (Met Office).

This summer, the Met Office will lead observational efforts to measure turbulence and related atmospheric processes during convective spells in southern England during the Wessex UK Summertime Convection field campaign (WesCon). The largest turbulent eddies in the atmosphere are approximately 1km across and hence turbulent processes are parametrized in weather prediction models such as the operational Met Office UKV model, which has a 1.5km grid length. Future models may run at grid lengths less than 1km and capture some of the larger eddies, but will still rely on parametrization. Turbulence parametrizations have been developed from theory and tested with very fine resolution idealised simulations, but recent advances in radar measurements and drone technology enables us to evaluate these against real-world observations.

Research grade radars provide observations at the resolution that can sample the largest turbulent eddies, while estimates of turbulence intensity can be derived from the radar Doppler spectrum. The Doppler spectrum captures variations in the radial winds due to various physical processes, including wind shear and changes in fall speed: larger particles such as snow flakes and rain drops fall faster than smaller ones such as droplets and ice crystals. Wind variations are also due to turbulence at scales smaller than the radar sample volume, and the contribution of turbulence to the Doppler spectrum can be isolated and related to the turbulence eddy dissipation rate. This latter quantity is a measure of intensity that can be simulated in numerical models.

During WesCon, the National Centre for Atmospheric Science in collaboration with the University of Reading will deploy several mobile radars across southern England. The Chilbolton Advanced Meteorological Radar and the “Kepler” cloud scanning radar (deployed from Lyneham) will jointly be operated in an automated track-and-scan mode, targeting the core updraft of convective showers in real-time. Repeated scans from these radars at 1-minute intervals and their separate viewing angles allow us to observe and measure changes in the core updraft structure in 3D, including the changes to turbulence intensity in space and over time.

Crucial to the campaign success will be to coordinate the clouds and showers targeted by the radars with in-situ measurements made from the FAAM Airborne Laboratory, the UK’s BAE-146-301 large research aircraft, which carries two turbulence probes that capture air motion at up to 32 Hz (approximately 5 m at 100 m/s aircraft speed), from which turbulence characteristics of the flow can be derived. A simple chat facility allows the mission scientists on board FAAM to inform the radar team which clouds they are heading to next, while the radar team will share “quicklook” images with scientists onboard the aircraft to inform the air crew of the heights and intensity of the clouds they have recently scanned.

The FAAM aircraft will carry out a number of pre-defined sorties, including a 100 km track below the clouds. Small-scale variations of wind, humidity, and temperature, are crucial for understanding the scales of thermals and convergence lines in the boundary layer, which typically precede convective storms. The lack of targets such as cloud particles and the low altitude make it difficult to sample this region of the atmosphere with the scanning radars, although a suite of vertically pointing radars, lidars, and radar wind profiles will provide time-height views of wind variations. Scientists from JADE University of Applied Sciences in Germany will support this part of the campaign by flying in the boundary layer with their DIMONA glider aircraft.

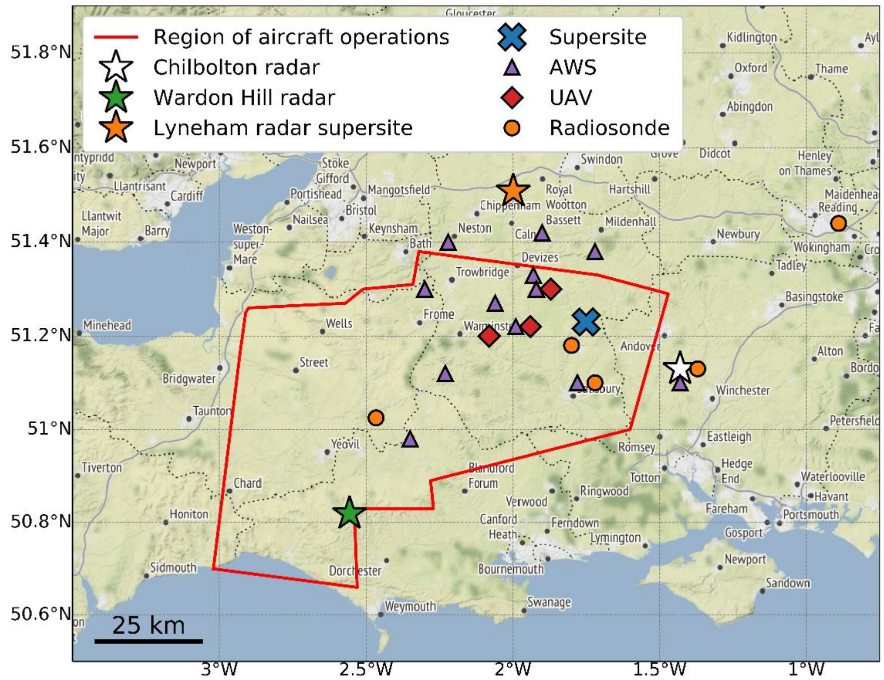


Figure 1 - Map showing the location of ground-based instrumentation and the region of aircraft operations (avoiding busy air space). Background map tiles by Stamen Design, under CC BY 3.0. Map data by OpenStreetMap, under ODbL.

The radar and FAAM measurements will be complemented by two sets of observations. Firstly, hourly radiosondes will be launched from several sites across southern England from 7am to 5pm by a large number of team members and volunteers. The soundings provide information about environmental factors affecting cloud development, such as wind shear and stable layers, and provide suitable context for further model evaluation and development.

Secondly, a small number of uncrewed aerial systems will be deployed in the Salisbury Plain area. These UASs carry meteorological equipment and pilots can fly these in a stacked formation, thus creating a "virtual" mast from which estimates of temperature, humidity, and turbulence variations can be derived. A range of surface weather stations have also been deployed with the aim of helping to quantify the boundary layer conditions in the pre-convective environment.

Figure 2 - A photograph of the FAAM Atmospheric Research Aircraft in flight. One turbulence probe is encased in the aircraft nose and another will be carried on one of the wings. https://www.faam.ac.uk/what-is-faam/ Picture courtesy National Centre for Atmospheric Science.

This is the largest atmospheric field campaign in the UK in 10 years, with additional instruments and collaboration from the Universities of Exeter, Oxford, Leeds, Manchester and Imperial College along with the Centre for Ecology and Hydrology and Jade University of Applied Sciences in Germany. It is funded as part of a joint NERC-Met Office research programme to improve the representation of turbulent processes in km and sub-km scale models, which was launched in February 2023 and runs for four years. This programme brings together observers and modellers so that the campaign results can be used directly to inform the development of better turbulence parametrisations within Met Office models.

Figure 3 - The Chilbolton Advanced Meteorological Radar (CAMRa) and control room. The largest steerable meteorological radar in the world. The 25m antenna produces a very narrow beam (0.28 degrees), which is essential for probing turbulent processes in convective clouds. Picture courtesy National Centre for Atmospheric Science.

Committee Meeting Minutes

Thursday 20th April 2023 at 13:00 at the society headquarters and online

1. Apologies

None.

2. Minutes of last meeting

Agreed.

3. Chair's Report

Nothing to report.

4. Treasurer's Report

Our financial position remains good.

There is a cheque for £40.80 yet to clear for expenses and the invoice for £617.02 from SPRI had only just arrived so has not been paid yet.

We can pay reasonable expenses if required to invite speakers to meetings, who otherwise may not attend and to support activities that the committee might deem worthwhile and relevant but unlikely to proceed without our support.

Membership stands at 47, down from 48.

It was suggested that a message could be sent to all of the people who attended the meeting on Climate measurements in difficult places to see if they wanted to join the SIG if they were not already members.

5. Newsletter Editor's Report

In 2022 we produced two newsletters (Spring/Summer and Autumn/Winter editions). I would like to thank the committee and members for their support in the production of these.

Spring/Summer 2022 Newsletter contained the following:
Forthcoming Meetings - Making weather and climate measurements in difficult places and Celsius Symposium – celebrating 300 years of weather statistics.

Meeting report on "Measuring Climate Change".

Article – "Proxy Climate Data".

The last edition, Autumn/Winter 2022 contained the following:

Forthcoming Meetings - Celsius Symposium – celebrating 300 years of weather statistics.

Biral Article - Monitoring volcanic activity using an electrostatic lightning detector.

Summer Committee Meeting minutes.

Autumn Committee Meeting minutes.

Annual General Meeting minutes.

Spring/Summer 2023 ideas:

Report on Cambridge meeting.

Summer visit.

Any other ideas welcome?

Other ideas that were suggested for inclusion on the newsletter were:

An article about the automation of the Dobson spectrophotometers as BAS

The upcoming WesCon observation campaign

> https://www.metoffice.gov.uk/research/foundation/observational-studies/wessex-convection-experiment

Biodegradable cords for radiosondes

6. Committee membership/recruitment

   We are still looking to get one or two representatives from the Met Office and also still need a secretary for the SIG

7. The UK Climate Extremes Review Committee: Membership and topics

8. Past meetings

(a) Climate measurements in difficult places.

It was felt that this was a very successful meeting with about 40 people attending in person and most of them visiting the SPRI museum after the meeting. It was felt that the charges from SPRI to cover the meeting were very reasonable.

9. Future Meetings

(a) Meteorology for transport

This was a meeting that had been proposed a few years ago, Dave said that he would check if it could be hosted at Vaisala in Birmingham.

This could include observations for road transport but also for rail and air transport.

It could also include the observations that can come from transport like Aircraft Meteorological Data Relay (AMDAR).

(b) Climate measurements in difficult places (the hot one)

The idea of having a second meeting on measurements in difficult places was suggested but with this one focusing on hot places.

10. Possible visit to Eskdalemuir Observatory

A visit to Eskdalemuir Observatory that was proposed by Richard Griffith was discussed as there are possible dates in June and July but it was felt that this was very short notice and so it was suggested that Steve ask Richard if it could be later in the year or even next year.

11. Any other Business

None.

12. Date and venue of the next committee meeting

Steve to check availability of the main society meeting room for September.

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	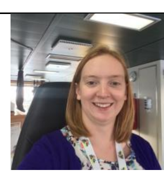 **Katie Muchan** Environment Agency (EA) katie.muchan@environment-agency.gov.uk	