Meteorological Observing Systems
Special Interest Group

Newsletter Issue 37
Spring 2014
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*Front Cover Photo*- Two views of a coronal mass ejection observed by the UK-led Heliospheric Imager on the STEREO spacecraft. – Meeting report (page 6) ©

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QR – link to our RMetS webpage
Introduction

Welcome everyone to the 37th edition of the Meteorological Observing Systems Special Interest Group newsletter.

A big thanks to our new member, Simon Bell (Aston University) for supplying a very interesting article on “Quantifying Uncertainty in Citizen Weather Data”. This can be found in the research news section.

I would also like to welcome new committee member, Alan Hewitt from the Met Office.

Hope you enjoy this edition!

Mark Dutton, Newsletter Editor

Group Website: Members are encouraged to regularly check the Group's pages on the RMetS website at http://www.rmets.org/activities/groups/SIG/detail.php?ID=10 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, or on floppy disk, CD or DVD to Environmental Measurements Limited, 7 Jupiter Court, Orion Business Park, North Shields. NE29 7SE. Please say if you would like disks returning. In all cases please include your name, address and email or telephone number with submissions. Publication deadlines are 31st March for Spring Newsletters and 31st October for Autumn Newsletters.

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Chilterns Observatory Trust request

- Do you know of meteorological instruments surplus to requirements and looking for a good home?

One of the principal functions of the Chilterns Observatory Trust is to be able to lend meteorological instruments (at a nominal, one-off rental) to amateur observers, schools, and students. The Trust already has several rain gauges, a Campbell Stokes sunshine recorder and a selection of mercury-in-glass thermometers, but it is important to be able to develop a wide-ranging store of instruments, both traditional and electronic.

We have a limited income, so the Trust also needs the goodwill of private companies and institutions to augment our stock of instruments and to help us to replace parts and carry out repairs, and we will be very happy to accept any meteorological equipment that is, for whatever reason, surplus to requirements. The same is true of books and periodicals which are no longer needed.

Contact details as follows:

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Forthcoming Meetings

- Summer visit & AGM, CEH Wallingford, Friday 25th July 2014.


- Future measurements for climate monitoring, Wednesday 18th March 2015, RMetS national meeting, Imperial College London.

The space weather national RMetS meeting held at Imperial College London last November was jointly organised with the Royal Astronomical Society. It was a follow-up meeting to that held in November 2007 entitled “Space Weather: from mud to magnetopause”.

Space weather describes the changing environmental conditions between the Sun’s atmosphere & the Earth’s atmosphere. Most space weather occurs due to the Sun’s emissions. Magnetic fields, radiation, particles & matter ejected from the Sun travel through interplanetary space & can interact with the Earth’s atmosphere & surrounding magnetic field. Modern society is ever more dependent upon ground-based and spaceborne technology which can be vulnerable to space weather. Satellites, GPS, radio communications & power grids are all at risk. Ground-based & satellite instrumentation are used to monitor space weather including near-real time observations of the solar surface & atmosphere to detect new active regions, & magnetometer networks to monitor changes in the Earth’s magnetic field. This meeting was held to discuss the importance of long-running, continuous observations for forecasting, nowcasting & for research in space weather.

The meeting’s chairman, Mark Gibbs, Met Office Space Weather Business Manager, opened proceedings with a general introduction to the subject. He highlighted that space weather is included in the UK’s National Risk Register alongside natural hazards such as flooding & volcanic eruptions. Mark described the 24x7 space weather forecasts & warnings service which the Met Office would be providing from May 2014. The accuracy of current forecasting techniques to predict the impact of a CME at Earth is +/-6hrs (at best).

Prof. Mike Hapgood, RAL Space, spoke about the vital role of ground-based observations, for example in monitoring the upper atmosphere, geomagnetic field & flux of cosmic rays reaching the Earth’s surface. He described the use of magnetometers, ionosondes & the Super Dual Auroral Radar Network. He concluded that a coherent international programme would be required to deliver a space weather observing system.
Prof. Cathryn Mitchell, University of Bath, described the vital role that GPS plays in the monitoring of space weather providing a global network of measurements of the ionosphere. A description was given of the use of GPS in research & in real-time ionospheric forecasting. The effects of space weather on the GPS system were also outlined.

Dr. Jonathan Eastwood, Imperial College London, spoke about the importance of solar wind magnetic field observations & the NASA Sunjammer solar sail mission. Sunjammer will launch later on this year & is designed to demonstrate the use of a 1200m² solar sail for spacecraft propulsion & space weather monitoring. Detail was given on MAGIC, the pound coin-sized magnetometer which will be aboard Sunjammer. It was emphasised that there was a need for monitoring platforms further upstream of the Earth than existing satellites, to understand the solar wind.

Mr. Dhiren Kataria from Mullard Space Science Laboratory presented the Solar Wind Analyser (SWAN) which will also travel on the Sunjammer mission. SWAN is a miniaturised particle sensor designed to provide real-time measurements of the solar wind plasma for advanced space-weather warnings & for research purposes.

Prof. Richard Harrison, RAL Space, demonstrated the power of heliospheric imaging to track CMEs from the Sun to the Earth. UK-led Heliospheric Imagers (HIs) are aboard the NASA STEREO spacecraft. HI is a wide-angle visible-light imaging system. The techniques & experiences gained from developing HIs are being fed into studies to assess the best strategy for space weather applications, e.g. through ESA’s Space Situational Awareness programme.
Mr. Dave Pitchford of SES Engineering spoke from a spacecraft operators point-of-view. He described the importance of in-situ radiation & plasma monitoring on operational spacecraft. As few commercial satellites have such space weather sensors & there's such sparse data coverage at geostationary orbit, he explained that one solution could be to include small space weather sensors as a secondary payload on commercial satellites.

Dr. Terry Onsager, NOAA Space Weather Prediction Centre, introduced the international opportunities & challenges for the long-term continuity of data. He explained that the growth in space weather activities was due to increased awareness of the impacts of space weather on economic & security infrastructures. Various international organisations were discussed (World Meteorological Organization, International Civil Aviation Organization, International Space Environment Services). These organisations are defining requirements for space weather observing networks for space-based components (e.g. observing the Sun, interplanetary space & the Earth’s upper atmosphere) & for ground-based (e.g. to detect local disturbances). It was emphasised that there was a challenge in coordinating countries to ensure long-term continuity of observations.

The speakers were experts from both the observation provider & observation user communities, providing an overview of current UK space weather research. Dr. Terry Onsager gave an important international perspective. It was clear from the audience discussion that there is strong public interest in space weather. The general view expressed was that there were challenges ahead & that international coordination was essential to provide long-running, continuous space weather observations.

Presentations from the meeting can be accessed at: http://www.rmets.org/events/space-weather-importance-observations
An RMetS ‘Weather’ magazine special edition on space weather is planned for later on this year.

Suzy Bingham
Research News

Precipitation measurements at Rothera research station in Antarctica
Steven Colwell

Measuring precipitation in the Antarctic is very difficult and at present no reliable way of ground truthing the data exists. At the British Antarctic Survey’s Rothera station on the Antarctic Peninsula at (67.5S, 68.1W) we are trialling a selecting of precipitation gauges to assess which is the most accurate.

The first sensor that we have is a Thies Laser Precipitation Monitor (LPM) and this uses an infra-red laser to measure water droplets and snow that pass between its sensor heads. It measures the reduction in the received signal and the length of time of the reduction and from this it can calculate the diameter of the particle and the fall speed, additional information can be found at http://www.biral.com/met/precipitation/lpm.htm

Alongside this is a Biral VPF 730 combined precipitation and visibility sensor that operates using an infrared beam and looking at off axis scatter to calculate visibility and looking at backscatter to calculate precipitation type and intensity. Additional information about the VPF 730 can be found at http://www.biral.com/meteorological-sensors/visibility-and-present-weather/hss-vpf-730-visibility-and-present-weather-sensor

The final optical sensor that we have is a Campbell Scientific PWS100 and consists of a Digital Signal Processor (DSP) housing unit connected to a sensor arm that contains one laser head and two sensor heads. Each sensor head is 20° off axis to the laser unit axis—one in the horizontal plane and the other in the vertical plane. From the measurements taken it then uses fuzzy logic to calculate precipitation type and intensity. Additional information can be found at http://www.campbellsci.com/pws100
There is also a UPG1000 - Universal Precipitation Gauge snow gauge that is made by Environmental Measurements Ltd (EML). This is surrounded by a wind shield and when snow falls into the gauge it is melted and then measured using a tipping bucket, pictures can be seen below and additional information can be found at http://www.emltd.net/products/precipitation/upg1000-universal-precipitation-gauge

Initial results show a large difference between all of the gauges on a monthly scale but in low wind speed conditions there is close agreement between all of the sensors. More analysis of the data is being carried out to try and ascertain which of them is most accurate for use in the Antarctic. Below is a graph of the data from the UPG1000 gauge which shows the annual cycle of precipitation at Rothera.
Quantifying Uncertainty in Citizen Weather Data
Simon Bell. Aston University.

Background
The challenge of quantifying uncertainty in citizen weather data has been taken up by Aston University. The PhD project, now in its final year, is being undertaken by Simon Bell under the supervision of Dan Cornford and Lucy Bastin (Aston University, Computer Science), and Mike Molyneux (Met Office). The project focuses on data collected by the Met Office’s WOW website (wow.metoffice.gov.uk). The number of weather stations uploading to WOW has been on the increase since day one (Figure 1). This high resolution network could have benefits in many applications, but only if the data quality is well characterised.

![Figure 1. The number of weather stations uploading to the Met Office's WOW website.](image)

Project Aims
1. **Identify and parameterise common biases** – The low-cost, ‘off-the-shelf’, automatic weather stations used by many citizen observers are prone to instrumental biases. Parameterising these biases will be crucial if we hope to correct them operationally.
2. **First-guess the weather at citizen stations** – Quantifying a station’s bias will rely on obtaining a reliable estimate of the weather at its location against which we can begin to verify the observations. Observations from professional networks, such as the Met Office’s MMS, can be interpolated, and even combined with short range forecasts from high resolution NWPs.
3. **Build a model to learn station bias** – With a reliable estimate of the weather at a citizen location a model can then begin to learn any instrumental biases over time; separating them from the natural spatial variations which we wish to capture.

Throughout each of these steps it’s crucial we propagate any uncertainty forward. Only once we have reduced any biases and characterised residual uncertainty can we recommend principled use of the data in scientific applications. For example, the data could be fed into a data assimilation scheme or used in urban heat island studies.

Recent Work
A yearlong field study tested common citizen weather stations at a professional Met Office enclosure. The stations included 2 Davis Instruments’ Vantage Pro 2s, 2 Vantage Vues, an Oregon Scientific WMR200, a La Crosse WS2350 and Fine Offset WH1080.
A summary of the results has recently been accepted into *Weather* (awaiting publication). Many of the low cost stations tested overheated under strong solar irradiance (Figure 2). The overheating was also partly responsible for large relative humidity biases. Figure 3 illustrates how the bias can be parameterised and corrected using collocated global radiation and wind speed measurements. Although these stations observed the timing and intensity of rainfall events relatively well, their longer term totals were less accurate; most under-caught, some by over 10%. The study saw signs of biases inherent to particular brand of weather station but also cases where seemingly identical stations displayed very different bias characteristics.

![Figure 2](image)

*Figure 2. Time series plot of air temperature recorded by the 7 CWS and the MMS Professional PRT housed within a Stevenson screen for 26 May 2013. A time series of MMS global radiation is shown in orange.*

![Figure 3](image)

*Figure 3. Demonstration of correcting CWS temperature bias using a multiple linear regression model. The figure shows a histogram of the La Crosse WS2350 temperature bias before and after the correction along with a scatter plot of a sample of its observations overlaid with a grid of the learnt model. The data was randomly split in half to form the training and test datasets.*

**Future Work**

Developing of our interpolation and bias models remains our priority. However, with many citizen stations located in sheltered gardens representativity errors cannot be ignored. We are looking into novel approaches for quantifying this additional source of error.
News from the Manufacturers

A New Operating System for the Campbell Scientific CS135 LIDAR
Ceilometer

Campbell Scientific Ltd. has a new operating system for the CS135 ceilometer with several new features. These include sky condition (assessing cloud cover as well as cloud base height) and 2 novel features:

Stratocumulus based calibration

Calibration of the actual magnitude of the scatter returned by a ceilometer is not simple. The CS135 now includes a process to make this calibration easier for users looking for more information than basic cloud height or sky condition. The attenuated backscatter is calibrated by an automated process based on the method develop by O'Connor et al (2004)*. The method uses the well-understood scattering properties of a fully-attenuating stratocumulus cloud as a reference. The calibration requires a stable stratocumulus layer with no precipitation present. The integrated lidar signal measured can then be scaled to match the expected integrated attenuated backscatter. This is carried out in response to a set of simple commands entered via a serial link.

The CS135 can output a scatter profile with a 5m resolution at intervals between 2 and 600 seconds.


Mixing Layer Height

In addition the new operating system includes a Mixing Layer Height assessment option. This retrieves the height of the mixed aerosol layer by applying the gradient method to the ceilometer’s backscatter signal. The automated process is based on the operational algorithm used by KNMI* and searches for the drop in backscatter associated with the transition from boundary layer aerosols to free troposphere. Since the signals measured depend on the type and amount of aerosol present as well as the background light level, the accuracy of the method varies and therefore a quality factor is assigned which indicates the confidence in the reported layer height.

*Determination of mixing layer height from ceilometer backscatter profile, Marijn de Haij; Wiel Wauben; Henk Klein Baltink
A research project aiming to solve the problem of wind affecting rainfall measurement

Traditional cylinder-shaped rain gauges are inaccurate due to the effect of wind blowing over the orifice. The physical presence of the gauge causes air to accelerate, carrying rainfall away from the collecting vessel. The effect of this can be up to a 20% reduction in rainfall catch, and can be even greater in stormy high wind conditions. The unique aerodynamic shape of the EML range of scientific standard precipitation sensors reduces the magnitude of this effect, ensuring a higher level of confidence in the accuracy of data measurements.

Through a £200K NERC-funded Knowledge Transfer Partnership (KTP) project North East based company Environmental Measurements Limited (EML) are teaming up with Newcastle University to tackle this problem. By incorporating new technologies in the development of a new precipitation sensor the KTP Research Team aims to reduce this data capture inaccuracy to just 1%. This 3 year project aims to decisively deal with an age-old problem, the solution to which has so far eluded scientists since rainfall measurement began.

A Graph showing the significant rainfall undercatch of a straight-sided gauge (blue) against an aerodynamic gauge (red) over 18-month period
Committee Meeting Minutes

held from 12.30 to 16.15 on Thursday 20th March 2014
at 104 Oxford Road, Reading.

Minutes of the Meeting

Those present:
Steve Colwell, Chairman
Mark Dutton, Newsletter Editor
Mike Brettle, Treasurer
Suzy Bingham, Secretary
Ian Strangeways
Keri Nicoll
Alan Hewitt (Surface Observations, Met Office. Introduced to committee before next AGM when he will be nominated to replace SBi as secretary.)

Item 1. Apologies
Apologies were received from Stephen Burt & Dave Bullock.

Item 2. Agreement of agenda
The agenda was agreed.

Item 3. Minutes of last meeting
The minutes of the committee meeting & AGM held on 12th September 2014 were agreed as being correct.

Item 4. Items arising
Actions from the previous committee meeting were considered and the following matters were discussed:

Rain gauge raffle – At the 2013 RMetS Amateur Meteorologist Symposium, MD organised a SIG stand where he raffled an EML rain gauge, signed-up 29 new members & raised £145. MD was thanked for his hard work.

New committee member – MD has contacted, but not yet had a reply from, Mark Wilkinson (James Hutton Institute, Aberdeen) to invite him to join the SIG committee. The SIG has offered to pay travel expenses for Mark for one trip/year to attend a SIG committee meeting & the plan is to use skype for the other committee meeting. The bandwidth at RMetS HQ is sufficient to skype one person at a time.

RMetS exhibition – The Society has invited representatives from Local Centres & SIGs to take part in an exhibition during the drinks reception, after the AGM in May 2014, to highlight past & present activities. SC suggested he’d be attending the AGM so would man a SIG stand.
Action: SC to contact Marcia about a SIG stand & to ask for more details of the event.
Item 5. Treasurer’s report
MB tabled a statement of the SIG’s accounts showing the net assets to be £4415.03. MB’s report covering the period 12/09/2013 to 20/3/2014 stated that the SIG’s overall financial position remained healthy. The main items of interest were that the rain gauge for auction at the Amateur Meteorologist’s Symposium was paid for by the SIG (£145) & that membership from new members at the Symposium (£155) balanced this amount out. MB noted that the SIG could pay reasonable expenses if required to allow meeting organisers to invite speakers & could also pay for travel to one committee meeting/year for Mark Wilkinson who is based in Aberdeen.

Item 6. Newsletter Editor’s report
MD reported that he had produced an Autumn Newsletter which covered:
- EMS2013 Event, Reading UK
- RMetS Second Amateur Met Conference, Reading
- Research News - Measuring energetic particles from met weather balloons, University of Reading
- Manufacturers - BIRAL, Electrostatic Eavesdropping on Thunderstorms

MD suggested that possible future Newsletter articles could include:
- Update on precipitation data – Antarctica (BAS, EML, CS, TerraData, etc)
- Manufacturers – EML to launch a new amateur (Hobbyist) rain gauge
- Research – EML/Newcastle University, three year KTP project investigating wind effects on rainfall measurements.
- SPICE (WMO) intercomparison – FMI (Arctic Circle visit Dec 2013), cover photo.
- Space Weather article.
- Met Office news.
- Aston University news on urban met measurements.
- A link to IS’s AWS for Mars article in ‘Weather’.

Deadline for the spring Newsletter articles is 31st March.

Action: SC to write introduction to SPICE, the solid precipitation intercomparison.
Action: MD to ask Mike at EML to write an introduction to the KTP project.
Action: SBI to email those in the Met Office who may have news for the Newsletter.
Action: AH to contact Aston University for any articles to be included.
Action: SBI to email MD upcoming meetings for Newsletter.
Action: MB to look into an article about the new operating system for the Campbell Scientific ceilometer.

Item 7. Past meetings
There was an RMetS national meeting held on 13th Nov 2013 on ‘Space weather –the importance of observations’ at Imperial College London. This was jointly organised by SBI & the Royal Astronomical Society. 86 people attended & positive feedback was received from the speakers & audience. A special edition of ‘Weather’ on space weather will be published around September 2014 which follows on from this meeting.

Item 8: Future Meetings
- Weather on other planets: measurements & interpretation. IS, SBI, AH. This meeting has been postponed after low numbers registered for the initial date in November 2013.
It was noted that the British Interplanetary Society hadn’t yet refunded the registration fee due to it being postponed rather than cancelled. IS has contacted the Royal Astronomical Society (RAS) & the British Astronomical Association (BAA) to ask if they would like to help organise/publicise the event. RAS have offered to hold the meeting (free venue) as one of their specialist discussion meetings in London on the third Friday of a month. BAA are happy to publicise to their members. The committee agreed that IS should ask RAS if we could hold the meeting as a discussion meeting in autumn 2015.

**Action:** IS to continue discussions with RAS to hold meeting in autumn 2015 & to send RAS the list of speakers.

**Action:** SBI/AH to publicise (Astrium, ESA, amateur astronomy groups in London, etc) the event after IS has confirmed details with RAS.

- **Weather measurements for renewable energy sources**, Wednesday 24th September 2014, Whitelee Wind Farm, near Glasgow. MB, SB & KN. MB reported that he had been jointly organising this meeting with the Scottish Centre. Five speakers were confirmed (3 from companies, 1 amateur meteorologist, 1 Met Office) & the Whitelee Wind Farm meeting room, which had a limit of 30 people, had been booked. There’s a cafe next to the meeting room for lunch.

**Action:** KN to ask a colleague at Reading University if they would like to speak about wind data.

**Action:** MD to ask a contact at Durham University to speak on geothermal measurements.

**Action:** MD to ask Mark Wilkinson if he knows of someone who would like to speak on hydroelectric.

**Action:** MB to forward MD email of invitation which has been sent to other speakers.

**Action:** MB to maybe ask someone to give a general introduction to renewables.

- **Summer visit**, third Friday in July would be ideal. A summer visit was discussed. Rothamstead has occasional public seminars although the one already organised for this summer wasn’t directly related to surface met measurements & so it was decided to keep this location in mind for a summer visit in the future. CEH Wallingford was suggested as an appropriate excursion as the SIG had not visited for a number of years & there was a new met site. IS offered to contact CEH to arrange a SIG visit & tour. It was suggested that the AGM should be held on the same day.

**Action:** IS to contact CEH for a SIG summer visit & talk/tour, preferably on the 3rd Friday in July.

- **Future measurements for climate monitoring**, Wednesday 18th March 2015, RMetS national meeting at Imperial College London. IS, SC. The US Climate Reference Network speaker has been confirmed & will speak over the internet. A list of possible subjects & speakers was discussed: (1) general overview (IS), (2) The US Climate Reference Network (Tom Karl, NOAA), (3) Ocean buoys & Argo floats (Southampton, possibly as two separate talks), (4) Radiosondes (KN or other from Reading University), (5) Satellite measurements (Met Office), (6) The Global Climate Observing System (Tim Oakley or SC).

**Action:** IS to send MD email of the meeting’s details so that MD can forward to contact at Southampton.

**Action:** SBI to invite Roger Saunders, Met Office, to speak.

**Action:** KN to invite her colleague to speak on radiosondes otherwise for KN to speak herself.
- **Summer visit 2015.** SB suggested the SIG could help to organise/attend the planned History Group’s one day meeting in May 2015. This is to be held in Oxford & is broadly on the history of scientific instruments in atmospheric science. At least one session will cover the bicentenary of the Observatory’s records. It may be held in or close to Green-Templeton College where the current met observing site is located. There’s a possibility for evening dinner too. It may also be a planned excursion for the SE Centre. A Friday in May is currently the preferred date, TBC. The committee discussed this possibility & agreed that this would certainly be worth while pursuing.

  **Action:** SB to pursue further.

- Advances in precipitation detection & measurement, 2016. To include results from SPICE (Solid Precipitation Intercomparison Experiment). SB, MB, MD.

- UAV measurements.

- Lightning detection. As a follow up to the meeting held in 2002.

- Air pollution monitoring.

- Rothamstead for a summer visit/AGM.

**Summary of meetings:**

- [TBC: Summer visit & AGM, CEH Wallingford, July 2014]


- [TBC: Committee meeting, 12:30 Thursday 16th October 2014]

- Future measurements for climate monitoring, Wednesday 18th March 2015, RMetS national meeting, Imperial College London.

- [TBC: Summer visit, May 2015, Oxford, to be organised with History Group.]


**Item 9. Any other business**

The committee thanked SBi for all of her efforts as secretary.

**Item 10. Date of Next Meeting**

The next committee meeting will be held at RMS HQ, Reading at 12:30 on Thursday 16th October 2014 (TBC).

  **Action:** SBi to book a room through RMS HQ.

The meeting closed at 16:15.

Suzy Bingham, Secretary
24th March 2014
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WE NEED YOU...!
NEW COMMITTEE MEMBER NEEDED!