Minutes of the 42nd Experimenters’ Meeting
The Cosener’s House, Abingdon, Thursday 29th January 2009

Present:
Dr Catherine Gaffard\(^2\) (CG)
Dr David Hooper\(^3,4\) (DAH) Secretary
Mr Dan Housley\(^5\) (DJH)
Mr Chris Lee\(^5\) (CFL)
Dr John Nash\(^2\) (JN)
Mr Tim Oakley\(^2\) (TO)
Dr Graham Parton \(^1,4\) (GAP)
Dr Jeremy Price\(^2\) (JP)
Mr Hugo Ricketts\(^5\) (HMAR)
Prof Geraint Vaughan\(^5\) (GV) Chair
Mr Charles Wrench\(^3,4\) (CLW)

\(^1\)British Atmospheric Data Centre (BADC)
\(^2\)Met Office (MO)
\(^3\)NERC MST Radar Facility
\(^4\)Rutherford Appleton Laboratory (RAL)
\(^5\)University of Manchester

Other abbreviations used in this document:
ARSF (NERC) Airborne Research and Survey Facility
BLWP Boundary-Layer Wind-Profiler
CEDA Centre for Environmental Data Archival (of which the BADC is a part)
DPW Dave Wareing
FAAM (NERC/MO) Facility for Airborne Atmospheric Measurements
FUND Future Upper-Air Network Development (Met Office project)
GPS Global Positioning System
IMAPS Institute of Mathematics and Physics (Aberystwyth University)
MST(R)(F) Mesosphere-Stratosphere-Troposphere (Radar) (Facility)
NERC Natural Environment Research Council
NTP Network Time Protocol
PC Personal Computer
TX transmitter
UFAM Universities’ Facility for Atmospheric Measurement
UPS Uninterruptible Power Supply
WMO World Meteorological Organisation
ZAKO Tony Olewicz

1. Minutes of the previous meeting
GAP pointed out that, in the first paragraph of Section 6c, the minutes should have stated that the BADC may be able to offer GPS data from all European stations - not that they would do so. The minutes were accepted as being otherwise correct. DAH drew attention to the fact that once minutes are accepted, they will be made available through a publicly-visible archive (see Section 3b).
2. Matters arising

| 40.4.1 | DAH to improve the short time-scale MST radar diagnostic tools in time for the 41st Experimenters’ meeting. | ONGOING |

Plots of the latest 24 hours’ worth of cloud base data and of MST radar data (derived from Met Office 30 minute average messages) are now generated automatically. DAH plans to extend the scope of such plots to cover the other instruments.

| 40.4.2 | DAH to install more strategically-positioned web-cams at the radar site as an aid to the remote diagnosis of problems. | ONGOING |

DAH must place an order the additional cameras before the end of March 2009. NERC have already allocated money for this and it must be spent during the 2008-2009 financial year.

| 40.7.1 | DAH to establish, by the time of the 41st Experimenters’ meeting, the technical and capital requirements for replacing the MST radar transmitters. | DISCONTINUED |

As will be reported in Section 3d, a change in thinking with regards to the necessary upgrades has made this action obsolete.

| 41.3.1 | DAH and CLW to provide TO, by September 2008, with a five year projection of MSTR data provision costs which take hardware improvements into consideration. | DISCONTINUED |

As for the previous action item, a change in thinking with regards to the hardware improvements made this action obsolete.

| 41.3.2 | All who are in the process of writing facility-related papers should ensure that their manuscripts are submitted for publication before the end of the 2008 calendar year. | COMPLETED |

The publication list was updated with details of all papers in print or accepted by the end of December 2008.

3. Facility Report

3a) BBC at the MSTRF

A film crew interviewed GV at the MST Radar site on 8th August 2008. They were making a documentary about the impact of the wind on people’s lives for BBC4. The series of three (?) programmes is due to be broadcast in early 2009, although the exact dates are not known. Shortly after the first interview, GV was filmed by an S4C crew for a programme which was broadcast in December 2008.

3b) Archiving of minutes in the CEDA document repository

DAH reported that, as had been agreed at the 41st meeting (section 8), minutes of Experimenters’ meetings would now be deposited in a publicly-accessible archive as soon as they had been approved at
the subsequent meeting. Copies of the minutes for meetings 32 through to the 40 are now available through the Centre for Environmental Data Archival (CEDA) document repository. CEDA is an umbrella organisation which encompasses the BADC. GAP explained that the purpose of this repository - http://cedadocs.badc.rl.ac.uk/ - was to ensure that useful information about instruments and about data, which is not published in a traditional sense, could remain accessible to the user community in the long term. DAH added that he aimed to eventually store a number of legacy documents in the repository.

JN and TO drew attention to the fact that some of the information they reported at Experimenters’ meetings could be viewed as being commercially sensitive. They were unhappy for the minutes to be made publicly available. It was agreed that the documents should not be made publicly available until three years after the meetings to which they related.

**ACTION ITEM 42.3.1** GAP and DAH to immediately remove minutes relating to meetings held within the last three years from public visibility.

### 3c) NERC Services Review Group 2009

The current cycle of Facility funding will end in March 2010. A renewal application was submitted to NERC on 5th January 2009. The application will be reviewed by the Services Review Group in early March 2009 and the outcome should be known by around July 2009.

### 3d) Proposed MST Radar upgrade

The radar hardware has remained virtually unchanged since construction was completed in 1990. The maximum useful altitude for wind-profiling purposes has reduced from around 20 km in 2000 to nearer 15 km in 2009. Although, at the time of the last meeting, this change had been attributed to a degradation in transmitter (TX) performance, this is not now thought to be the case. An initial inspection of the entire radar system was conducted in collaboration with engineers from the Chilbolton Observatory in July 2008. A more detailed study in October 2008 concluded that the valve-based TXs, the individual Yagi aerials, and much of the radio frequency cabling did not require replacing. However, many of the electro-mechanical relays, which are used to perform beam switching operations, show signs of severe contact erosion. These units perform over a million switching operations per year and have been repeatedly refurbished rather than being replaced. The boxes within which they are mounted no longer provide adequate protection against the elements or against snails and insects. Moreover, many of the relay control cables show signs of severe damage from being chewed by rabbits. Replacement of the above mentioned components is a prerequisite for operations to continue over the next 5 years. It would be desirable to replace some additional components at the same time. For example, the beam steering unit is undocumented and so would be time-consuming to fix in the event of a failure. As part of the funding renewal process (see Section 3c), the Facility obtained an initial quote for the upgrade from one company.

JN asked what diagnostic features would be built into the proposed upgrade. He drew attention to the fact that the WMO are putting increasing emphasis on the need to be able to track degradations in instrument performance. Such an approach allows repairs to be implemented in a timely fashion and alerts operators to possible changes in data quality. DAH reported the the original relay units have integrated sensors for monitoring whether or not a switching operation has been completed successfully. However, the reliability of the information was found to be so low that it is ignored. On the subject of solid-state TXs, DAH reported that although, in principle, they can be operated at a higher duty cycle than a valve-based TX (and therefore achieve a greater altitude coverage), this might not be possible in practice. If the duty cycle of the Aberystwyth radar was doubled from its current 2.5%, mesospheric summer echoes would be range aliased into the lower-atmospheric wind-profiling altitude range. This had initially been a problem for the South Uist system. JN recommended that the Facility consider replacing the TR switch so that the lowest altitude visible to the radar could be reduced below the current 1.6 km. On the subject
of rabbit damage to cables, JP reported that using “pig-tail” stakes to suspend wires above the ground had proved to be an effective method of avoiding rabbit damage at Cardington.

**3e) Changes to MSTRF technical support**

Tony Olewicz (ZAKO), who semi-retired from his role as site manager in February 2007, will retire fully at the end of March 2009. Part-time local technical support will be provided by a technician from the Institute of Mathematics and Physics (IMAPS) in Aberystwyth University. Additional technical support, for once-yearly maintenance tasks, will be taken over by engineers from the Chilbolton Observatory.

**3f) Site developments**

Site maintenance work, which has been arranged by NERC Estates, will finally begin on 2nd March 2009. DAH drew attention to the fact that shape of the fenced-off instrument compound will need to be changed slightly so that the width of the fire escape route from the TX room complies with new rules.

As a separate issue, work is due to begin on “electrifying” the large shed. This will involve creating a dedicated feed from the mains supply in the small shed and installing electrical sockets, lighting units and a heater in the large shed. GV expressed surprise at the small number of electrical sockets to be installed and wondered whether Dave Wareing (DPW) was aware of this.

**ACTION ITEM 42.3.2**

GV and DAH to check with DPW, as soon as possible, whether or not the specified number of electrical sockets for the large shed will suffice.

**3g) Site connections (electricity and internet)**

There have been no problems with the broadband connections over the past 6 months.

Within the last week DAH has started to use the web space provided as part of the broadband package for displaying quick-looks of MST radar and ceilometer data collected within the latest 24 hours. These are updated every 30 minutes. A link to this supplementary website [http://www.mstrf.eclipse.co.uk/](http://www.mstrf.eclipse.co.uk/) can be found through the main Facility website.

There have been 3 electricity blackouts at the site in the last 6 months. The first, which occurred on 4th July 2008, was reported at the previous meeting. The second, appears to have started at around 17:10 UT on 23rd July 2008 (i.e. outside of working hours) and to have lasted for just over an hour. This was long enough for the Uninterruptible Power Supply (UPS) units to become discharged. Although all PCs restarted automatically when the mains supply was resumed, the acquisition programs for the MST radar and for the Vaisala WXT510 instrument did not. DAH pointed out, as an aside, that although it should be simple to arrange for the WXT510 acquisition program to restart automatically, a little more thought would be required in the case of the MST radar. It is important to allow the TXs time to warm up before transmissions can begin. In this particular instance, the reason for the MST radar acquisition program having stopped was not immediately apparent. Consequently DAH initiated a reboot of the associated PC when he spotted the problem the following morning. The resultant disk checks can take over an hour when the PC has not been rebooted for several months and so it was 11:18 UT before radar observations were resumed. The third blackout, which was associated with a thunderstorm in the area, occurred at around 11:20 UT on 28th October 2008 and lasted for about 2 minutes. The UPS units were easily able to maintain power for all equipment during such a short break.

NERC are installing electricity-usage monitors at all of their sites. This necessitated disruptions to the mains supply and the powering down of all instruments between 13:15 and 13:39 UT on 20th November 2008 and between 10:10 and 13:47 UT on 10th December 2008.
3h) Frozen water pipes
Temperatures at the site dropped close to freezing during the latter part of 26th December 2008 and reached night time lows of -5°C every day between 30th December and 7th January 2009. This caused the water in the hot water tank in the attic to freeze hard. DPW spotted this on Friday 2nd January 2009, drained the tank, and reported the situation to DAH, who arranged for a plumber to visit the site on the following Monday (5th January). Nevertheless, the repairs to the cracked section of pipe were themselves frost-damaged the following night. DPW left the tank drained until the cold spell has passed, when ZAKO implemented a more robust repair. There is some minor water damage to the ceiling in the immediate vicinity of the tank.

4. NERC Instrument Report
4a) Campbell Scientific surface met sensors
The only sensor which has given any problems over the last six months is the tipping bucket raingauge, which has failed to record rain during a number of periods. Mostly the problem was caused by objects such as seeds blocking up the gauze at the bottom of the collecting bowl. However, in one instance (late July 2008) a big black snail had taken up residence in the middle of the tipping mechanism. On several occasions, water had to be poured into the instrument in order to test whether or not it was working correctly (dates and times of these tests are recorded in the instrument performance blog). DAH stressed that users should not rely on data from the tipping bucket raingauge alone and should cross-check with measurements made by the new Vaisala WXT510 instrument (see section 4c).

4b) Campbell Scientific surface wind sensors
There have been no problems with the sensors. However, between 25th September and 9th October 2008 it was not possible to establish a dial-up connection with the data logger at Frongoch (DAH was on leave during most of this period). The problem was eventually traced to a blown fuse, which was replaced by staff from IMAPS, who also operate equipment in the Frongoch bungalow. The wind data for this period were lost.

4c) Vaisala WXT510 surface met and wind sensors
The data from this instrument began to be made available (in netCDF files) through the BADC in August 2008. Quick-look plots are created in the same format used for the Campbell Scientific surface met sensor data. Moreover, for diagnostic purposes, data from both sets of sensors are additionally shown together on a separate plot. Temperature and relative humidity data from the two sets of instruments are typically well matched, although the WXT510 measurements tend to be a fraction of a degree warmer and a percent or so drier. There is no reason to doubt that occasional larger differences reflect actual small scale variability. The WXT510 instrument is located approximately 15 m to the north of the site bungalow, whereas the Campbell Scientific sensors are approximately 50 m further to the north. Although the measured rain rates are closely matched for stratiform events, the WXT510 piezo-electric sensor tends to indicate much higher rates (sometimes by as much as a factor of 10) for convective rainfall. This is unsurprising given that the tipping bucket raingauge is only sampled once every 10 minutes whereas the WXT510 sensor is sampled every 10 s. Despite the fact that the WXT510 inherently requires less maintenance than a tipping bucket raingauge, it had to be power cycled on two occasions (10th June and 13th November 2008) after it had stopped generating rain messages.

4d) Vaisala LD40 laser ceilometer
The time stamps for ceilometer data are generated by an internal, free-running clock. This can drift by up to a few minutes over the intervals of several months between re-synchronisations. Synchronisation requires a connection to made to the instrument through a dedicated serial interface from a laptop and so it only carried out when DAH is on site. It was last done on 7th August 2008 when the clock was found to be running slow by 45 s. Ideally the data would be captured using the same method employed for the WXT510 data, i.e. together with a date-time stamp indicating when the samples arrived on a Network Time Protocol (NTP) enabled PC. However, the priority for this task will remain low until there is a user
demand for more-accurate time keeping. Similarly, there are no plans to release ceilometer backscatter profile data in netCDF files in the near future.

**ACTION ITEM 42.4.1** DAH to synchronise the LD40’s internal clock at the start of the turbulence campaign on 23rd March 2009.

Since 22nd January 2009, a quick-look plot of the latest 24 hours’ worth of cloud base data has been made available through the Facility’s supplementary website. The new plots show a coarse, instrument-generated precipitation index. Although this information is of some use, it is not always consistent with the rain rates measured by the tipping bucket raingauge or by the WXT510.

**4e) Sky camera**

There have been two notable gaps in 1-minute interval image capture. The first, 13:55 - 15:20 UT on 29th October 2008, coincided with the acquisition PC being rebooted. The second, from 19:40 UT on 30th December 2008 until 12:40 UT the following day, was caused by a hard drive overflow.

**4f) MST Radar**

On 15th January 2009, in response to a request from TO, DAH changed the time stamp used for 30 minute average Met Office (MO) wind-profile messages to reflect the end rather than the start of the averaging period. The following day he optimised the timing of the data transfer and signal processing routines so that these messages are always available within 20 minutes of the end of the averaging period. This delay cannot be reduced much further owing to the self-adjusting way in which signal processing is carried out. Previously messages were not available until almost 30 minutes after the end of the averaging period.

A quick-look plot of the latest 24 hours’ worth of MO message data is now available through the supplementary website. Although tropopause altitudes are not included within the MO messages, they are derived from the profile of averaged radar return signal power and shown on the plot. DAH compared plots of unaveraged and 30-minute-averaged data for a single day. He demonstrated that although the averaged horizontal winds apparently capture all the features seen in the unaveraged data, and that although the averaged vertical velocities give a useful (if somewhat coarse) indication of mountain wave activity, the signatures of convection are almost completely obscured. The purpose of the new plot is primarily diagnostic.


There has been only one extra-ordinary problem in the last 6 months. The beam steering unit became stuck in an off-vertical direction between 03:30 and 15:10 UT on 7th November 2008. This resulted in the wind-profile data being unrealistic. The source of the problem was difficult to trace and was eventually solved (somewhat mysteriously) by ZAKO removing a legacy PDP-11 interface unit.

Although there have been 36 instances of interference, this led to only a mild level of contamination of the wind-profile data in seven of these cases. Interference is typically associated with high temperatures in the control room. However, almost all of the cases reported above have occurred since 28th November 2008, i.e. during a notably cold period. DAH speculated that this is the result of the air within the control room being less-efficiently circulated by the air conditioning unit when the outside temperature is significantly lower than the inside temperature.

A new type of interference began to affect Doppler spectra episodically starting on 29th November 2008.
It was manifest as a series of bands of high power-spectral-density, with a regular Doppler velocity spacing, at the lowest range gates. This is similar to the pattern seen in spectra which are affected by the recovery of the TR switch. The problem, which led to contaminated vertical velocities and to gaps in the horizontal winds, became increasingly common and persistent during the exceptionally cold period which began on 26th December 2008. The problem disappeared at 12:00 UT on 6th January 2009, shortly after DPW had switched off the extractor fans in the TX room. The latter was an attempt to allow the building to warm up and so prevent the water pipes from refreezing (refer to section 3h). Since this “comb” interference appears to have been the result of very cold temperatures in the TX room, DAH plans to install a thermostat which will automatically switch off the extractor fans when the internal temperature drops below a set level.

Wind-profile model-comparison statistics provided by the MO indicate that the radar data quality has been good over the past six months.

5. Guest Instrument Report

5a) UFAM instruments
The boundary-layer wind-profile (BLWP) is currently at Cardington but will return to Capel Dewi in early February 2009. It and the radiosonde kit will be operated there in support of the forthcoming turbulence campaign (see section 6b). The two “mushroom” radiosonde antennas will be mounted at opposite ends of the MST antenna array, which have different fields of view. The choice of which one to use will be based on the predominant wind direction. The aim is to prevent the line of sight to the radiosonde being obscured by the mountains. The Elight lidar is currently in Edinburgh.

5b) University of Manchester static instruments
The water vapour lidar is fully functional and can now be operated remotely from Manchester. The ozone lidar will be operated in support of the forthcoming turbulence campaign.

5c) Met Office GPS receiver
The MO plan to operate a water vapour radiometer alongside the GPS unit so that comparisons of water vapour measurements can be made. The operational processing of GPS data has been optimised to feed into the model and so it smooths out details. Owing to the fact that the accuracy of retrieved water vapour is limited by the accuracy of the assumed satellite orbits, and these are better known after the event, the retrievals at +12 hours are better than the real time data. Owing to the fact that significant changes in water vapour concentrations might occur above the boundary layer, the associated changes in integrated water vapour can be relatively small.

5d) Aberporth radiosonde data
Aberporth have provided the BADC with a 10 year archive of their radiosonde data (i.e. for launches from approximately 50 km to the south-west of the MST radar site) in the binary edt format. The latter is used for all other radiosonde data stored on the BADC, whereas pre-existing holdings of Aberporth data were in an ASCII format. The edt files for 1990 - 1996 are now available and those from 2006 onwards have only ever been provided in this format. However, it has not been possible to find a suitable tape reader to extract the data for 1997 - 2000. The BADC hope to fill the data gap for 2001 - 2005 and are keen to establish a near-real-time data feed for future Aberporth data.

6. Science and technical presentations

6a) The 2008 turbulence campaign - CFL
The campaign took place during March and April 2008. The ARSF Dornier aircraft flew level tracks at different altitudes across the MST radar site. More time was spent at altitudes visible to the UFAM BLWP than at altitudes visible to the MST radar. Although the aircraft was fitted with a 20 Hz turbulence probe, the corresponding data were corrupted and so it was only possible to analyse the 1 Hz data. This
did not provide sufficient spatial resolution to produce a turbulence spectrum for the scale sizes of interest. An initial examination of the MST radar data suggests that (interlaced) observations made at 150 and 300 m lead to different estimates for the eddy dissipation rate. Moreover, corrected spectral width values did not differ as much as was expected between active and quiet conditions.

6b) The 2009 turbulence campaign - GV
The first week of this year’s campaign, 23rd - 27th March 2009, will be dedicated to preparations. Radiosondes will be launched from the site but the aircraft will not fly until the second week. Sixteen hours of available flight time will be divided between 4 flights. A secondary objective of the campaign will be to make in-situ ozone measurements, which can be compared with data from the two ground-based lidars and with data from an ozonesonde, which will be launched from the radar site. It is anticipated that there is a low chance of encountering suitable turbulent conditions in March and a follow-up campaign has already been provisionally scheduled for July 2009. A number of additional instruments will be brought to the site for the duration of the March campaign. It will be important that help is available at site so that instruments can be appropriately installed (ZAKO will have finished work the week before the campaign) and that the instruments are not disturbed once they are in place. Some of the instruments will arrive on site before the first week of the campaign.

**ACTION ITEM 42.6.1** DAH to request NERC Estates, as soon as possible, to delay carrying out work on the concrete instrument compound until after the end of the March 2009 turbulence campaign and to avoid carrying out any work on site during the two weeks of the campaign.

**ACTION ITEM 42.6.2** DAH to be available on site during the week of 23rd - 27th March 2009 so that he can supervise the appropriate installation of instruments.

**ACTION ITEM 42.6.3** DAH to operate the MST radar between 23rd March and 3rd April 2009 using the same observation format as for the 2008 turbulence campaign, i.e. with interlaced 150 m and 300 m resolution observations.

6c) What I have learnt so far - DJH
DJH’s PhD work is funded by a CASE studentship in collaboration with the MO and he will be co-supervised by GV and CG. He will look at the synergies between co-located remote sensing instruments with the aim of extracting novel, high-resolution data products which are suitable for assimilation into the MO’s numerical weather prediction scheme. This work will require an improved understanding of the clear-air echoing mechanisms responsible for MST radar returns.

JN pointed out that the MO were primarily interested in data up to mid-tropospheric levels. Consequently the ability to extract data products only within the lowest few km of the atmosphere could be useful. For a technique to be of practical value, it must have the potential to be used at a number of sites. The forecast cannot be improved simply by providing enhanced data products from a single site.

6d) An update on the Elight lidar - HMAR
HMAR has used lidar observations to determine ozone fluxes across the top of the boundary layer. The observations show much more variability in ozone structure than is predicted by modelling. The photo-chemical production of ozone is faster in the free troposphere than in the boundary layer. Moreover, the boundary layer acts as a sink for ozone (e.g. owing to the presence of plants and atmospheric humidity). Observations show an influx of ozone into the boundary layer during the morning followed by a period of low net exchange. Lidar observations will be made at the MST radar site during the 2009 turbulence campaign.
6e) Status of the FUND project and the potential for future collaboration - JN and CG
The aim of the MO’s Future Upper-Air Network Development (FUND) project is to define the observation requirements for the forthcoming decade. Horizontal spacings of 30 km between wind measurements are desirable and spacings of 3 km would be ideal. However, neither option is currently financially viable. The MO’s 4d-VAR assimilation scheme should be able to accommodate discrete pieces of information - e.g. the altitudes of significant levels, of the top of the convective boundary layer, or of a radar bright band - and so new data products do not necessarily have to be in the form of altitude profiles. New techniques only need, initially, to be able to handle cases which are easy to interpret. It is anticipated that integrated solutions, with several instrument types being operated in parallel, will be required. For example, it can be difficult to interpret GPS water vapour maps without access to the wind information. The MO aim to use both Capel Dewi and Chilbolton, in addition to their own sites such as Cardington, for carrying out integrated instrument observations. The MO are willing to collaborate with NERC scientists who have overlapping interests. Although MO BLWP data are already stored by the BADC, the high-time-resolution data have not yet been made available.

7. Any Other Business
GV drew attention to the fact that there was an opportunity for the FAAM aircraft to perform routine overflights of NERC facilities. He would like the MST Radar site included in such flights.

Attention was drawn to the following forthcoming conferences: MST12 to be held 17th - 23rd May 2009 in Canada, the Royal Meteorological Society 2009 Conference to be held 29th June - 2nd July 2009 in Reading, and ISTP8 (International Symposium on Tropospheric Porfiling) to be held 18th - 23rd October 2009 in the Netherlands.

The next meeting is provisionally scheduled for Thursday 25th June 2009 at the Cosener’s House.