Minutes of the 35th Experimenters’ Meeting
Penbryn, University of Wales Aberystwyth, Wednesday 8th December 2004

Present:
Miss Helen Clark¹ (HAC)
Dr David Hooper² (DAH) Secretary
Miss Emily Norton¹ (EGN)
Mr Tim Oakley³ (TO)
Mr Tony Olewicz² (ZAKO)
Mr Graham Parton¹ (GAP)
Dr Sam Pepler²,⁴ (SJP)
Mr Hugo Ricketts¹ (HR)
Prof Geraint Vaughan¹ (GV) Chair
Dr Richard Worthington¹ (RMW)

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1. Minutes of the previous meeting
The minutes of the 34th Experimenters’ meeting were accepted without correction.

2. Matters arising
Ag Stephens to improve the way in which MO wind-profiler data become available through the BADC (page 1):
Data are now available for up to the end of 2003. The task of providing updates at regular (and frequent) intervals is in hand. GV reported that HR had been experimenting with Ag’s data extraction tool. He commented that although there are a number of bugs which need to be fixed, this appears to be a good way forward.

SJP to provide information on who is making use of MO wind-profiler data (page 1):
For the calendar year 2004, there have been 11 registered users and 8 active downloads corresponding to 1280 files and 218 Mbytes of data. (SJP did not have this information at the meeting).

DAH to clarify, on the MST website, the location of the different datasets (page 2):
This information is now available through:
http://mst.nerc.ac.uk/data_access.html

John Nash to give a presentation on the GPS network (page 2):
TO to cover this in the science/instruments section in John’s absence.

SJP to arrange for the upgrade of the internet connection to the radar site (page 4):
SJP to report on this in Section 4.
DAH to implement improved MST radar signal processing (page 4):
DAH to report on this in Section 6.

DAH to contact Jeremy Gillham (MO) when the new MST radar data stream is available (page 5):
TO reported that a mechanism is now in place to evaluate the new data stream as soon as it is available. It will therefore be necessary to contact TO rather than Jeremy Gillham.

DAH to give a presentation at the COST-720 meeting (page 5):
This was done on 10th November.

John Nash to provide DAH with justification for the need for an MST radar at Aberystwyth (page 6):
This was not felt to be important at this stage, since the Facility had just secured a further 5 years of funding.

TO to visit the Frongoch site in order to account for MO equipment left there (page 7):
TO reported that he had not yet done this but that he hoped to do so immediately after the meeting. GV pointed out that he (GV) would have no control over the future of the UWA huts at Frongoch once he left for the University of Manchester in January 2005. TO pointed out that Capel Dewi was not a suitable location for sonde tracking owing to the fact that valley sides would limit the altitude to which sondes could be followed under strong jet conditions. Since HAC has a continuing need for sonde launches from Aberystwyth, SJP proposed that the Facility pay rent for the huts, thereby ensuring future access. It was agreed that there was a scientific need to maintain the ability to launch sondes to complement the radar observations. GV pointed out that it was likely that some work would need to be carried out on the huts in order to ensure that they continued to meet Health and Safety standards.

**ACTION ITEM 35.2.1:** SJP to investigate the possibility of renting the UWA huts at Frongoch in order to ensure the continued facility for sonde launches.

DAH and ZAKO to check on status of the MST radar within the peace time frequency allocation (page 8):
ZAKO had provided a copy of the original letter which indicated that the Aberystwyth MST radar had permission to operate at 46.5 MHz. However, DAH had yet to follow up on this. TO pointed out that the 64 MHz band was not allocated for wind-profiled use, but that a line had been added to the Peace Time Frequency Allocation table to state that the South Uist radar was operating at this frequency.

**ACTION ITEM 34.6.1:** DAH and SJP (to continue action) to check on the status of the Aberystwyth MST radar within the peace time frequency allocation table.

3. Site operations report - ZAKO
A new radar observation schedule was introduced on 21st June. Vertical beam observations are now made every other dwell. These high time resolution observations will be needed for convection, precipitation and Brunt-Väisälä period determination studies.

A technical problem with the site security system resulted in a Police Rapid Response team being called to the site twice within a month - the second time on 28th June. The site was temporarily blacklisted by the Police, until Dyfed alarms retested the system and resolved the problem.

The locking transmitter went down at 0805 UT on (Sunday) 4th July. This caused the data to be unreliable until 0800 UT on (Monday) 5th, when ZAKO spotted and fixed the problem.

The MST radar was down for about 30 minutes on the afternoon of 12th July. This was to allow MANWEB to install a new electricity meter for the lidar hut.
The tipping bucket raingauge was cleaned on 19th July to clear fungus which was preventing the device from registering rain.

NERC personnel visited the site on 27th July to carry out an “underground” survey, i.e. of water and electrical routes as well as of antenna cabling.

ZAKO carried out work on the antenna array on 2nd, 3rd, 10th and 13th August.

The locking transmitter failed at around 2330 UT on 16th August causing the wind profile data to be unreliable. ZAKO fixed the problem by 0835 UT on the 17th.

The radar was shut down at around 1235 UT on 18th August because of a fear of a lightning strike. The thunderstorms, which had persisted for much of the morning, soon cleared and normal operations were resumed at 1405 UT.

The high voltage unit on one of the transmitters failed on 19th August. The spare transmitted was substituted, so there was no loss of operations. The unit was fixed and returned to working order by 1400 UT.

Dyfed Alarms carried out a 6-monthly check on the site alarms, including the panic alarm, on 19th August.

A buildings survey was carried out by NERC personnel on 24th August. NERC Health and Safety inspectors also visited the site on 25th. No serious problems were found.

The tipping bucket raingauge had to be cleaned again on 25th August because of blockage by fungus.

The locking transmitter failed at around 2200 UT on 7th September. This caused corrupt data to be sent to the Met Office for approximately 8 hours. The problem was spotted first thing on the morning of 8th by DAH and he was able to block the transmission of data to the Met Office. However, this was during a week when ZAKO was away on holiday and so it was not until 1200 UT that Dave Wareing could switch the locking transmitter and normal operations were resumed. DAH restarted the transmission of data to the Met Office later in the afternoon, once he was satisfied that the radar was functioning correctly. ZAKO repaired the failed transmitter on 12th September, when he had returned from his holiday. DAH noted that although he had relevant pictures for the procedure of changing the locking transmitter, no documentation existed.

ZAKO shut down the radar for approximately 20 minutes just after 1500 UT on 14th September. This was to allow him to check whether a problem with a relay unit had caused the failure of the locking transmitter on 7th. It wasn’t.

On 21st September ZAKO had to take action to remove a virus infection from the Logger PC.

Jonathan Jones, from the Met Office, visited the site on 1st October in order to change the PC on the GPS water vapour receiver.

An brief power outage caused the radar to stop at around 0726 UT on 4th October. ZAKO restarted the system immediately on arrival at site at 0755 UT. He also restarted the Met Office’s GPS water vapour receiver PC.

ZAKO cleaned out the tipping bucket raingauge on 7th October.
A NERC audit officer visited the site on 14th October to check on matters relating to access and maintenance. She found that everything was in order and therefore considered her visit to have been a waste of time.

At around 0845 UT on 19th October, a jumper failure on MANWEB’s high voltage transmission system caused a power outage in the Capel Dewi area. Power did not return until 1505 UT. The radar was up and running again by 1515 UT.

The radar was shut down around 1600 UT on 21st October because of fears of a lightning strike. There had already been power fluctuations which were causing problems for the radar. Thunder continued to be audible until midnight. The radar was restarted at 0715 UT on 22nd.

ZAKO carried out winter preparations in the field (e.g. securing boxes and cables) on 28th and 29th October. This did not require the radar to be powered down.

Approximately 10 people from the Ceredigion Amateur Radio Club visited the site from 6:30 - 9:30 pm on 11th November. They were very interested in the transmitters. A mention of their visit appeared in the Cambrian News.

A Hercules aircraft flew very low over the radar site, from west to east, at around 1300 UT on 13th November.

Two engineers from Anritsu visited the radar site on 15th November to demonstrate their hand-held cable and antenna analyser. The MST radar was shut down from approximately 1345 - 1715 UT in order to allow them to demonstrate the instrument’s capabilities on various parts of the antenna system. However, the instrument was found to be not working properly (see below).

One of the transmitters went down at around 1445 UT on 17th November after its blower motor seized up. It was not possible to repair the transmitter, and return it to working order, until around 1230 UT the following day.

A NERC buildings surveyor visited the site on 18th November in order to inspect the site bungalow and fence. He finished the survey around 1200 UT the following day.

The radar was down from 1550 - 1605 on 18th November in order to allow ZAKO to carry out an inspection of the field boxes.

ZAKO received a working cable and antenna analyser from Anritsu on 22nd November. The radar was down from 1100 - 1400 UT on the 23rd in order to allow him to test 30 of the 100 quads with the unit. Dave Wareing and EGN tried out the instrument on the UFAM equipment on 24th. It was found to be useful in both cases. The Logger PC was used to download the field test data from the instrument. The use of the Logger PC in this way appears to have disrupted the normal collection of data from the Campbell Scientific instruments. This was not noticed, and rectified, until 30th November. Although this led to the loss of several day’s worth of surface wind data, the surface met data appear to be complete.

Students from the UWA Institute of Geography and Earth Sciences visited the site on 30th November in order to carry out their surveying practical. This required the radar to be shut down from approximately 1245 - 1545 UT.

GV pointed out that the information provided in the site report (particularly that concerning the status of the MST radar transmitters) was directly relevant to the work of HAC, who is investigating patterns
in MST radar return power. He therefore requested that this information be made available on a more frequent basis through the website.

**ACTION ITEM 35.3.1:** DAH and SJP to introduce a frequently-updated weblog to report changes in instrument status.

TO enquired as to whether the frequency of problems associated with the transmitters was increasing with age. ZAKO thought probably not. DAH pointed out that NERC was presently in a good position for funding capital items and so that replacement transmitters, which would fail less often, should be considered for the medium term. ZAKO expressed concern that there was no replacement for the high-voltage transformer. Although this had never failed, and could easily be replaced, there would be significant downtime between placing an order for a new unit and receiving it. The cost of a spare unit was estimated to be of the order of £500.

**ACTION ITEM 35.3.2:** DAH, SJP and ZAKO to investigate the potential cost of replacement transmitters.

**ACTION ITEM 35.3.3:** SJP and ZAKO to order a spare high-voltage transformer.

### 4. Facility report - SJP

**a) Site internet upgrade.** The process for upgrading the connection has now been initiated and completion is expected within 90 days, i.e. before April 2005. Initially a 2 Mbps link will be allocated, although this can easily be increased to 10 Mbps at a later date. Although the NERC networking people are acting as an “intelligent customer” for this procedure (i.e. communicating between the relevant bodies involved), progress has generally only been achieved when the UWA networking contact by-passed the official procedures. TO pointed out that the MO would require advance notice if changes were to be made to the IP addresses of site computers which currently send them data.

**b) The RAL 78 GHz FMCW cloud radar.** DAH and SJP have held a meeting with the RAL Millimetre-Wave Technology group to discuss the possibility of operating their cloud radar at the MST radar site. The measurements would be very useful for studies of humidity structure and precipitation. It now seems that the radar will be taken by the MO to Mauritius, in February 2005, as part of a radiosonde inter-comparison campaign. It is hoped that it can subsequently be operated at the MST radar site for a long period.

**c) The NERC Health and Safety inspection.** A group of 6 NERC personnel visited the MST radar site on 24th and 25th August. They identified work, such as painting and decorating, which would need to be done in order to maintain the site. However, no serious Health and Safety issues were identified. Moreover, NERC have subsequently promoted the Facility’s risk analysis document as an example for other Services and Facilities (S&F) to follow. The Head of S&F complimented ZAKO on his outstanding work in this respect.

**d) UWA shed replacement.** ZAKO, SJP, DAH and Dave Wareing carried out an inspection of the UWA sheds at the MST radar site on 7th December. It was agreed that the smaller shed, and the piles of timber, should be removed. A car-port, which would provide space for carrying out work on UFAM equipment, would be put in its place. However, the larger shed appears to be structurally sound (it was fitted with a new roof a few years ago) and so should be renovated rather than removed. All non-essential contents will be disposed of, and the internal partition will be removed. EGN requested that it be fitted with shelves for storage. TO pointed out that the Health and Safety requirements for a storage area were less stringent than those associated with a workshop.

**ACTION ITEM 35.4.1:** SJP and ZAKO to arrange for disposal of junk items, for the renovation of the large shed, and for the installation of a car-port in place of the small shed.
5. NERC funded upgrades - SJP

In August 2004, the Facility was awarded £100k from NERC to carry out upgrades and to invest in new equipment:

a) Replacement of the MST radar control and data acquisition system. The first phase will be to replace the WindowsNT system with a Linux-based one. Some modifications will also be made to make the radar control more flexible and to allow data weighting windows to be applied to the radar samples in the time domain. This work is due to be completed by May 2005. The second phase will involve transferring the coherent integration and phase decoding tasks, which are currently carried out on the hardware pre-processor board, to software. This phase is due to be completed by the end of 2005. DAH is currently formalising the requirements.

b) Laser ceilometer. A Vaisala LD-40 unit (which is capable of detecting clouds at altitudes of up to 40,000 feet) is due for delivery in February 2005. This unit outputs the backscatter profiles, which can be used to infer the boundary layer depth.

c) Cable test instrument. As mentioned in Section 3, ZAKO has field-tested an Anritsu “Site Master”. An order for such a unit has now been placed.

6. Data processing/management - DAH

a) Reclassification of the Ken Slater format files. In an effort to tidy up the “mst” data area on the BADC, all Ken Slater format product files (currently in directories /power, /radial, /rw, /vector, and /vw) will be reclassified as corresponding to processing version-0 and will be placed in directory /badc/mst/data/mst-products-v0. The newer NASA-Ames format (Cartesian and radial) product files, corresponding to processing version 1, will be shifted from directory /badc/mst/data/samples to /badc/mst/data/mst-products-v1.

b) Reprocessing of entire MST radar archive. It is known that the (time-continuity) reliability-flagging scheme used by the version-1 processing has difficulties rejecting contamination caused by ground-clutter, RF interference and Rayleigh scattering signals. The first of these, which gives rise to long-duration bands of apparently low wind speeds at specific altitudes, is not a problem for the version-0 processing, since it uses a peak tracking routine (the version-0 processing is vulnerable to the other two forms of contamination). However, such data points can be identified in the version-1 data by considering the complementary beam horizontal velocity variability factor. DAH has therefore introduced a new processing scheme (version-2) which makes use of this information in the reliability flags. The new files, which are stored in the directory /badc/mst/data/mst-products-v2, are being produced for 1996 to the present. They will be of particular immediate use for GAP, who needs to carry out a statistical analysis of the low-level winds.

c) Multi-peak processing. The enhanced reliability flagging scheme used for the version-2 processing is effective at removing contamination signals. However, an improved scheme should be able to fill in the data gaps in many of the cases. DAH has developed a multi (spectral) peak processing scheme to do this. At the lowest level, it features improved discrimination between overlapping signal components. This is particularly important when the strength of hydrometeor returns becomes comparable to that of the clear-air returns. Nevertheless, it is often hard to discriminate between such signals by eye and some level of contamination can be hard to avoid under precipitation conditions. Although the new software has been written to identify any given number of peaks within each Doppler spectrum, in practice two appears to be an optimal number for the MST radar returns (EGN reported that a larger number generally gave better results for the UFAM boundary-layer wind-profiler observations). The most appropriate clear-air peak at each range gate is then selected by applying a radial continuity scheme, which attempts to link “chains” of overlapping peaks. Thereafter the existing processing algorithms can be applied.
DAH is in the process of writing the version-3 processing as operational software, which he aims to have running in early 2005. It is likely that the data from this scheme will be written in netCDF (binary) files, for which input routines are readily available in a number of common programming languages (including Matlab, IDL, Fortran, Python and C).

7. Science/instrument presentations
   a) Field campaigns with the Aber-UFAM instruments - EGN
   ECMWF analysis and boundary-layer wind-profiler wind speeds for the summer-2003 phase of the Tropospheric Organic Chemistry (TORCH) showed good overall agreement. A number of different meteorological conditions were encountered during this time. During the period 2nd - 18th August, a ridge of high pressure over the UK blocked the advance of frontal systems and caused warm air to be advected from continental Europe. This gave rise to the heat wave, with peak temperatures in excess of 30°C between 3rd and 12th August. The sharp decrease in humidity typically found at the top of the boundary layer can give rise to a layer of enhanced UHF radar signal. This has allowed boundary layer heights to be retrieved using an objective algorithm under certain conditions. Good agreement has been found between boundary layer heights derived from both the aerosol lidar and the boundary-layer wind-profiler. However, sometimes there are multiple radar layers and on other occasions there is no boundary-layer-top signature at all.

   During the first phase of the Convective Storm Initiation Project (CSIP), conducted during July 2004, the boundary-layer wind-profiler was operated in the vicinity of Chilbolton. Layers of enhanced radar return signal were found to correspond to stable regions inferred from radiosonde data. For the case of 20th July, regions of convection could be seen gradually breaking through the stable layers as the day progressed.

   b) Patterns in MST return signal power and their relationship to wind factors - HAC
   HAC has compared MST radar return signal powers with various derivatives of the wind vector, including the vertical gradient of the vertical velocity, the vertical wind shear and horizontal derivatives of the zonal and meridional wind components. For 30th July 2004, enhanced wind shears correspond closely to the enhanced signal power along an upper-level front. However, no such pattern is seen in association with a thunderstorm for 21st October. DAH suggested that HAC might like to consider other radar factors such as the aspect sensitivity - reductions of which are known to correspond to large vertical wind shears in the lower stratosphere - and complementary off-vertical beam power imbalances - which RMW has shown to be related to mountain wave activity and wind shears.

   c) Update on remote sensing projects within the Met Office - TO
   The South Uist 64 MHz wind-profiler passed its final acceptance tests in November 2004 and now data from both the low and high modes are being assimilated. Consensus files from July 2004 onwards will be made available to the academic community and high-resolution data can be provided upon request. Although there is no operational need to keep historical data, the development team have been archiving all spectra. The new MO CEO is much happier for make data publicly available. TO expressed his concern that the MO should install a second wind-profiler within the next few years before some of the key people involved with the South Uist project had retired. They had learnt much from this first installation which would make a follow-on project run much more smoothly. Three outstanding actions now remain. The first is to upgrade all of the UHF profilers with digital receivers. The second is to move the South Uist 915 MHz profiler (which was formerly operated at Aberystwyth) to the Isle of Man in 2005. This will provide some operational redundancy for the Northern Ireland radiosondes. The Camborne profiler will be reclassified as a semi-development profiler and so can be taken off-line, when required. Thirdly, staff resources have been allocated for testing the new data stream to be provided by DAH’s multi-peak processing.
The RAL 78 GHz cloud radar has undergone considerable development over the last few years under MO funding. Although the MO are pleased with this instrument, they would like further development of 10 - 20 operational prototypes. The cost of these is anticipated to be of the order of £50k - £100k, as opposed to £1M for a pulsed cloud radar. These instruments are able to detect fog tops and upper level clouds (which cannot be seen with a laser ceilometer if low-level cloud is present) and so would fulfil an operational need. Work is expected to begin on the new instruments in 2005. The existing instrument is due to be taken to Mauritius, in February 2005, to participate in a campaign for the inter-comparison of radiosondes in a humid tropical environment.

The use of radiometers, together with GPS receivers, for water vapour profiling is covered by the COST-720 action (for the integration of diverse instruments). Although, in principle, boundary-layer wind-profilers can add to such measurements, it is thought that the beam widths may be too wide for such a purpose. The final COST-720 workshop is due to be held in Toulouse in Autumn 2005.

The main drive behind early GPS receiver networks was for detecting movements of the Earth’s crust. Ordnance Survey (OS) was the main user. The effect of water vapour on the signals was initially regarded purely as a problem for which a correction factor must be applied. It was only later that this factor was exploited for deriving integrated water vapour values. The MO are developing their own real-time processing scheme. They have 8 of their own GPS receivers but have access to data from a further 56 stations through collaboration with OS. The cost of a single receiver is the order of £20k. The potential exists for a network of 100+ sites across the UK. The data from a single station are not nearly as useful as UK-wide contoured data, which are available approximately 2 hours after observations are made. It is currently necessary to wait 30 minutes for raw data, but this could soon be reduced to 5 minutes. The ability to produce profiles of humidity is thought to be 2 - 3 years away.

d) On the interpretation of MST radar returns from regions of convection - DAH

DAH reported that the high-time-resolution vertical beam observations made (every other dwell) since 21st June 2004 had proved to be very useful for convection studies. These have revealed that vertical velocities can change by several metres per second over intervals of just 47 s. Such rapid changes will clearly broaden the spectral widths, since each dwell represents observations made over 21 s. Therefore although enhanced values of beam-broadening corrected spectral widths are a signature of convection, the values cannot be interpreted in terms of turbulence intensity. However, it is hard to distinguish between turbulent motions and background winds under such active conditions. Moreover, the assumptions that the three dimensional wind vector is stationary over the time scale for a complete cycle of observations (~3 minutes) and over the spatial scales separating the radar observation volumes for the different beam directions (< 2 km at altitudes up to 10 km) are clearly invalid under such conditions. Enhanced values of the complementary beam horizontal velocity variability factor (which indicate that the horizontal wind components are unreliable) are a signature of convection. DAH expressed his surprise that vertical velocities as large as 10 m s\(^{-1}\) were sometimes observed. This can lead to velocity aliasing. More importantly, most of the vertical velocities associated with convection are initially rejected by the time-continuity reliability flagging.

Finally DAH showed that anomalously large values of radar return signal power can be associated with convection in the upper troposphere. For a case study of 5th February 2002, he showed that the median power profile for the day was broadly consistent with a saturated atmosphere, based on pressure and temperature data from a radiosonde launched at Camborne. However, during the convective periods the signal power was enhanced by 20 dB (a factor of 100). He speculated that this was caused by entrainment processes which are known to give rise to inhomogeneities within cumulus clouds.
8. Any Other Business

TO pointed out that the domain name for the MO has changed from metoffice.com to metoffice.gov.uk. This applies to both the websites and e-mail addresses, although the old domain name will remain valid for the foreseeable future.

TO raised several possibilities for MO involvement in the summer-2005 phase of CSIP. Although the Dunkeswell wind-profiler is outside of the 100 km circle of interest around Chilbolton, it could provide useful information about features tracking up from the south-west. It might also be possible to construct an additional wind-profiler from existing spare parts. The MO would additionally be able to launch radiosondes. The UFAM boundary-layer wind-profiler will be operated at a site 15 km from Chilbolton.

GV reported that Les Dean, a technician at the UWA, was interested in building a special receiver to be used on the Aberystwyth MST radar for undergraduate radio-astronomy projects. DAH pointed out that he had already spoken to Les and that he (Les) might be able to make use of noise level fluctuations (at lower stratospheric altitudes) for this purpose.

GV reported that the SAOZ instrument, which has been in long-term operation on the roof at the UWA, is due to be transferred to the radar site. SJP reported on plans to extend the hardstanding area at the site. This will be of benefit for other guest instruments. The SAOZ instrument is zenith pointing and so should not suffer from the fact that the radar site is in a valley.

DAH reported that he had finally succeeded in making the MST radar control and acquisition programs function on a Windows2000 PC. This had involved re-compiling the programs. The new system had been tested from approximately 1200 - 1300 UT on 7th December 2004. This is a backup PC and it should be replaced entirely when the new control and acquisition system is installed in mid-2005.

GAP enquired as to the progress with installing a sky-pointing camera at the radar site. TO pointed out that such a simple device had proved to be invaluable for the TUC campaign in Payerne.

**ACTION ITEM 35.8.1:** SJP to arrange for the installation of a sky-pointing camera at Capel Dewi.

The next Experimenters’ meeting is due to be held in May 2005, before the start of the main phase of CSIP. It remains to be confirmed whether the meeting will be held at the Cosener’s House, in Manchester, or even back in Aberystwyth.