Minutes of the 41st Experimenters’ Meeting
The Cosener’s House, Abingdon, Thursday 10th July 2008

Present:
Dr Helen Clark\textsuperscript{1} (HAC)
Dr Catherine Gaffard\textsuperscript{3} (CG)
Dr David Hooper\textsuperscript{4,5} (DAH) Secretary
Mr Chris Lee\textsuperscript{6} (CFL)
Dr Emily Norton\textsuperscript{6} (EGN)
Mr Tim Oakley\textsuperscript{3} (TO)
Dr Graham Parton\textsuperscript{2,5} (GAP)
Prof Geraint Vaughan\textsuperscript{6} (GV) Chair
Mr Charles Wrench\textsuperscript{4,5} (CLW)

\textsuperscript{1}Aberystwyth University (AU)
\textsuperscript{2}British Atmospheric Data Centre (BADC)
\textsuperscript{3}Met Office (MO)
\textsuperscript{4}NERC MST Radar Facility
\textsuperscript{5}Rutherford Appleton Laboratory (RAL)
\textsuperscript{6}University of Manchester

Other abbreviations used in this document:
BLWP boundary-layer wind-profiler
CCW Countryside Council for Wales
DPW Dave Wareing
GPS Global Positioning System
IMAPS Institute of Mathematics and Physics (in AU)
MST Mesosphere-Stratosphere-Troposphere
NERC Natural Environment Research Council
NTP Network Time Protocol
SJP Sam Pepler
UFAM Universities’ Facility for Atmospheric Measurement
UPS Uninterruptible Power Supply
ZAKO Tony Olewicz

1. Minutes of the previous meeting
Two minor errors were found in the minutes of the 40th Experimenters’ meeting. Sam Pepler (SJP) was shown incorrectly, on page 1, to be affiliated to the Met Office. The location of Chris Lee’s (CFL’s) pilot campaign was incorrectly given as being Camborne, in Section 7a. This should have been Cardington.

2. Matters arising

\textbf{34.6.1} DAH and SJP to check on the status of the Aberystwyth MST radar within the peace time frequency allocation.

\textbf{COMPLETED}
A five year Science and Technology license was issued by Ofcom at the beginning of June 2008.

<table>
<thead>
<tr>
<th>39.3.3</th>
<th>DAH to provide site keys and alarm codes to TO and to provide GV with keys to the instrument compound gates by September 2007.</th>
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<td>COMPLETED</td>
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DAH reported that he had already given two sets of keys to GV and had deposited one with the Earth Observation and Atmospheric Science Division office at RAL. He provided TO with a set of keys for the MO at the meeting.

<table>
<thead>
<tr>
<th>40.4.1</th>
<th>DAH to improve the short time-scale MST radar diagnostic tools in time for the 41st Experimenters’ meeting.</th>
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There has been no time for this action item over the past six months.

<table>
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<tr>
<th>40.4.2</th>
<th>DAH to install more strategically-positioned web-cams at the radar site as an aid to the remote diagnosis of problems.</th>
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<tbody>
<tr>
<td>ONGOING</td>
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DAH reported that he would review requirements when he visited the site during the following week.

<table>
<thead>
<tr>
<th>40.4.3</th>
<th>GV to investigate whether the instrument event log is suitable for automatically blanking periods of unreliable data and to report, to the 41st Experimenters’ meeting, what changes (if any) are necessary to make it suitable for such a purpose.</th>
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GV reported that the current event log gave a useful narrative of problems. However, what he required was a simple file giving start and stop date-times of missing and corrupt MST radar data. This could then be used by anyone making a climatological analysis of the long term dataset.

<table>
<thead>
<tr>
<th>40.5.1</th>
<th>EGN and DPW to arrange for construction of a BLWP clutter screen at Capel Dewi in time for the atmospheric turbulence measurement campaign in March 2008.</th>
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Dave Wareing (DPW) had completed construction of the new clutter screen in time for the start of the turbulence campaign.

<table>
<thead>
<tr>
<th>40.6.1</th>
<th>DAH to determine the causes of the reduced reliability and reduced altitude coverage of MST radar wind-profile data and to take corrective action as a matter of urgency.</th>
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<tbody>
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<td>COMPLETED</td>
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This is reported is Section 7c.
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.

ONGOING

DAH reported that he would be visiting the site, together with engineers from Chilbolton, specifically to address this issue during the following week. TO reported that the MO’s South Uist radar was a valve-based system, although it had proved to be highly robust. Solid state transmitters, which are being considered for the Aberystwyth radar, have only started to become a viable alternative within the last few years.

3. Funding Renewal
DAH reported that the current cycle of funding for the MSTRF will end in March 2010. A renewal application must be submitted to NERC by the end of the 2008 calendar year. TO pointed out that the MSTR is an important part of the MO’s current operational upper-air network. The MO will provide a letter of support to NERC as part of the renewal application. Moreover, the MO are willing to contribute towards the cost of necessary hardware improvements, e.g. for the replacement of the radar transmitters. This could either be through capital investment or through an increase in the rate of the commercial contract for the provision of wind-profile data. However, the Facility must first demonstrate that an upgraded radar has the potential to fulfill the MO’s requirements for upper-air measurements for the next 10 years. He pointed out that the Aberystwyth radar is over-specced from the MO’s point of view. They would probably opt for a high-power boundary-layer wind-profiler (BLWP) if they were going to install a new system. Nevertheless, investment in the existing system represents a more cost-effective way of providing the appropriate data.

ACTION ITEM 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.

DAH reported that he would also be reviewing man-power requirements for the next funding cycle when he visited the site during the following week. Tony Olewicz (ZAKO) is reducing the amount of time that he spends at site. It is likely that his major bi-annual maintenance tasks will be taken over by engineers from Chilbolton. The Facility is currently investigating the possibility of a technician from Aberystwyth University’s (AU’s) Institute of Mathematics and Physics (IMAPS) taking over the weekly maintenance tasks. A local contact is particularly important for dealing with trivial problems, such as power-cycling equipment, which would otherwise necessitate a nine hour round trip from RAL. TO reported that the trend within the MO over the past few years is away from in-house technical expertise. They rely instead on manufacturers’ technical support and on hardware redundancy. The South Uist site is completely unmanned and has only had one serious problem in five years.

GV drew attention to the fact that investments made in the Facility over the past couple of years had already led to considerable improvements. The new large-shed, in particular had proved to be indispensable for the recent turbulence field campaign. It provided a sheltered location for filling balloons and for working on equipment. Nevertheless a strong science case will be essential for securing renewed funding from NERC. GAP reported that his sting jet paper was currently under review and that he was planning to submit a radar-radiosonde wind distribution comparison to Met Apps. HAC potentially has two papers to write up from her PhD work. DAH currently has a signal processing paper under review and he and GAP are co-authors on a silent aircraft manuscript, which is due for submission to Met Apps.

ACTION ITEM 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.

DAH drew users’ attention to the fact that the radar site is located at 4.01°W, not at 4.1°W as appears in a number of papers.
4. Site Report
   a) Changes to the MSTRF management
   DAH reported that project management for the MSTRF has been taken over from Sam Pepler by CLW, who is already in charge of the Chilbolton facility.

   b) Health and Safety Site
   DAH reported that a family of stoats had taken up residence in the attic of the site bungalow at the end of the first week of July 2008. ZAKO had contacted the Countryside Council for Wales (CCW) for advice. He was told that stoats are not a protected species and that live-capture and re-release is the best way of removing them. However, the CCW could not recommend anyone for the job. ZAKO instead tried subjecting the stoats to a weekend of Radio 2 at loud volume. This had the desired effect and at the beginning of the following week he sealed cable ducts, which the stoats had been using for access, with foam.

   c) Site developments.
   The only change in the last six months is that radiosondes can now be launched from the site. This is reported in more detail in Section 7a.

   c) Site connections
   There was an unexpected loss of telephone connection to the site starting (apparently) on Friday 29th February 2008. This was triggered by the transfer of billing from AU to RAL. Although BT, in response to DAH's enquiries, restored the telephone connections first thing on the morning of Monday 3rd March, they warned him that the broadband connection would also inevitably be broken and have to be reconnected. They claimed that there was nothing that they could do to prevent this once the process had been set in motion. Moreover, Eclipse (the Facility's internet service provider) were unable to initiate the re-connection process until the break had actually occurred. They warned DAH that it could take up to 10 days for the re-connection to be completed. The broadband connection eventually went down at around 8 am on Wednesday 5th March and was back in operation by around 10 am on Friday 7th.

   There have been two unexpected power cuts in the past six months. The first occurred between approximately 11:00 and 15:30 UT on 31st March 2008. Dave Wareing (DPW), who was on site at the time, immediately informed DAH, who was able to begin powering-down equipment in a controlled manner. Although the Uninterruptible Power Supply (UPS) unit powering the broadband router became discharged before DAH was able to complete his task, all pieces of equipment came back up cleanly when mains power was restored. The second incident occurred between approximately 11:00 and 14:00 UT on 4th July 2008. On this occasion ZAKO was on site and DAH had sufficient time to to power everything down cleanly before the UPS unit became discharged. DAH pointed out that if the mains is disrupted for more than a few seconds, it tends to down for several hours. At the time of installing UPS units, a deliberate decision was made that they should only have sufficient capacity to keep equipment running for half an hour after a mains failure. Longer breaks are too rare and variable in length to justify making provision for.

   d) Frongoch farm
   There is nothing to report from Frongoch.

5. NERC Instrument Report
   a) Surface met sensors
   ZAKO cleaned the tipping bucket raingauge on 23rd April 2008 in order to remove a partial blockage. It is not clear when the raingauge was last working reliably. The apparent rain spike around 12:00 UT
was caused by him pouring water into the mechanism to test it.

b) Surface wind sensors
There was a brief loss in the ability to download surface wind data from Frongoch when BT discon-
nected the telephone lines on 29th February 2008 (see Section 4c above). However, the data logger can
store over a week’s worth of data before it starts to overwrite itself. Consequently it was possible to
download the entire backlog of data when the telephone lines were reconnected.

c) New Vaisala surface met and wind sensors
DAH reported that he had recently begun to put effort into creating netCDF files for the data from the
Vaisala WXT510. Although the instrument has been in operation since December 2007, DAH has been
too busy with high-priority tasks until now to look into the data. The way in which precipitation data are
recorded has required particular attention. This was not described adequately in the User’s Guide and
on 18th March 2008 DAH was obliged to change the measurement parameters in response to recom-

d) Ceilometer
There have been no problems with this instrument in the past six months. At present, only cloud base
altitude data are being made available in standard-format files, although backscatter profiles are also be-
ing recorded in the raw data files. DAH advised anyone who would like to make use of the backscatter
data to give him plenty of warning. The priority for creating netCDF files will otherwise remain low.

e) Sky-camera
DAH supervised a second work experience student during the last week of April 2008. She worked on
updating the sky-camera event log for the period July - August 2007. This information is now available
through the website.

A disk over-flow on one of the site computers resulted in no sky-camera images being recorded between
05:56 UT on 10th February 2008 (a Sunday) and 09:45 UT on the following day.

f) MST Radar
The radar was powered down for several hours on each of 30th January and 4th, 5th and 6th February
2008 to allow ZAKO to carry out a routine inspection of the antenna relays.

Although the radar has not had any major problems over the past six months, it suffered from interfer-
ence (or instabilities) on a number of occasions between 30th January and 19th February 2008 and again
between 4th April and 5th May. There have only been sporadic instances outside of these times. Full
details can be found through the instrument performance log on the website.

The beam steering unit became stuck in an off-vertical pointing direction, apparently as a result of a
short circuit in relay box 39, between 20:30 UT on 14th April 2008 and 08:18 UT the next day. This
caused all Cartesian data products to be corrupted for this period.

a) UFAM mobile instruments.
EGN reported that the boundary-layer wind-profiler (BLWP) was operated at Cardington between Au-
gust 2007 and February 2008 and then at Capel Dewi until May 2008. It is currently back at Cardington.
Degreane installed new software in November 2008. DPW has added new air conditioning. The clutter
screen, which he built at Capel Dewi in time for the turbulence campaign, appears to have reduced the
level of non-atmospheric signals. Nevertheless, during the turbulence campaign in late March and early April 2008 a new form of contamination was seen. It was characterised by Doppler shifts close to (but not quite) what would be expected for clear-air returns. However, the signal strength was more consistent with Rayleigh scatter from hydrometeors. There tended to be an abrupt onset of these signals at around 22 UT each night and then a gradual decrease in occurrence towards 06 UT. The altitudes varied and could be up to 3 km at around 22 UT but tended to be lower during the latter parts of the night. DAH, who had been on site during the early part of the campaign, suspected that these may be insect echoes. He contacted Curtis Wood, whose PhD work was based on observations of insects by an X-band radar. Curtis had thought that this was too early in the year, too late at night, and at too high altitude to be insect echoes. TO suggested echoes from migrating birds as another possible cause. He reported that Redwings over-winter in the British Isles and then migrate back to Russia in the Spring. They only fly at night and they favour clear sky conditions and when they have a tail wind.

TO reported that whereas Degreane used to claim that clutter screens were not necessary, they now add them to all new systems. Despite the fact that signal processing software can remove the effects of clutter, this can require human intervention in order to optimise the processing parameters for particular atmospheric conditions. Sharp screen corners appear to be undesirable and modern screens tend to be (at least partially) rounded. Linderberg was described as having the mother of all clutter screens, something which has proved vital owing to its proximity to wind farms. EGN reported that the air field at Writtle had been one of the best sites in terms of absence of ground clutter but that Cardington was one of the worst.

TO reported that the MO were due to sign a contract with Degreane the following day for the provision of a new BLWP. This will not be part of the operational wind network but will be used as part of an integrated test environment. It is intended to operate it alongside a radiometer, which has a poor vertical resolution for temperature profiling. By contrast the BLWP is highly sensitive to sharp vertical temperature gradients and so there is interest in combining the data from the two instruments. The BLWP will have five rather than three beam pointing directions. The antenna for the vertical beam will be four times the standard area. This will reduce the beam width sufficiently (from 8.5° to 5.5°) for it to be of use for turbulence studies. The new instrument is expected to be delivered by the end of 2008 and will begin operations at Chilbolton.

b) University of Manchester static instruments.
GV reported that there has not been much work done on the static lidar in the last six months owing to the fact that DPW has been focusing his time on the BLWP. The water vapour lidar can now be operated remotely. GV will have a new PhD student starting in September. The same student will spend the summer analysing data from the SAOZ instrument.

c) The Met Office GPS water vapour receiver.
There have been no significant changes to the network in the last six months. TO stated that anyone wanting higher-than-standard resolution data should contact him directly. GAP reported that data from all European stations will soon be made available, in netCDF files, through the BADC. As an aside, EGN pointed out that she was using netCDF files to make BLWP data available from the Convective and Orographically-induced Precipitation Study (COPS). The lowest-level BLWP data are not available in a standard-format files and so it is difficult to read them with anything other than Degreane software. Owing to the fact that Degreane often update the software, there can be issues with backwards compatibility.

CG commented that although the precise time stamps are recorded in the raw BLWP data files, this was not the case for the higher-level product files. In the latter case, the time stamps relate to the end of the cycle and so it is not possible to determine the order in which observations were made in the different beam-pointing directions. This is a problem when trying to track the motion of small-scale
features as they are advected from one observation volume to the next. DAH commented on the fact that precise timing information is problematic for instruments, such as the laser ceilometer, which have a free-running internal clock (which can drift by over a minute in the course of a few months). This problem has been solved for the Vaisala WXT510 surface met unit since the data are recorded directly by a Linux computer together with a time stamp which relies on Network Time Protocol (NTP). DAH has previously had trouble enabling NTP on Windows machines, but now uses Dimension 4 (from Thinking Man Software), which is the standard solution at Chilbolton. GV commented on the difficulties of coordinating field campaigns when there was no common time standard for everyone to use.

7. Science and Technical Presentations

a) A partial reflectivity model for tropospheric MST radar echoes - HAC
In the literature, clear-air radar return signal power is typically related to the mean vertical gradient of potential refractive index \( M \), which is evaluated over the vertical scale of hundreds of metres. HAC has taken an alternative approach based on the idea of partial reflection. Reflection coefficients are calculated from the vertical changes in refractive index, but not specifically from the gradient. The profiles of signal power estimated by this method show better agreement than those derived from the \( M \) method with the observed profiles. DAH pointed out that in order for partial reflection to occur, it is thought that a step change in refractive index must be confined within a vertical extent of the order of the radar’s wavelength. Features of this size are not likely to be easily detectable even in high-resolution radiosonde data. However, “temperature sheets” have been identified in ultra-high-resolution measurements made e.g. by Dalaudier et al. (1994). GV conceded that although he had been somewhat sceptical about this line of enquiry, the results have demonstrated that it is worth pursuing. He will be getting his new PhD student to investigate a fractal model of refractive index structures.

b) The Easter 2008 turbulence campaign - CFL
The campaign, which took place at the end of March and the beginning of April 2008, involved simultaneous MST radar and BLWP observations being made, (RS92 GPS) radiosondes being launched from the radar site, and the Dornier aircraft flying overhead. The aircraft typically flew four legs parallel/anti-parallel to the wind direction, with a flight path designed to avoid the MST radar and BLWP observation volumes. At the beginning of the campaign, radiosondes were tracked using a mobile dipole antenna. However, continuous data coverage typically only extended to 3 or 4 km, with gaps at higher altitudes. Consequently, after the first week, the old mushroom antennas were brought down to site from Fron-goch. These gave considerably better coverage, with continuous data up to about 10 km and then again for some altitude above 14 km. The gap between 10 and 14 km is thought to be the result of the sonde passing behind the shadow of a mountain. The winds were westerly on all occasions and so the sondes tended to be launched from near the main gate so as to avoid the nearby power lines. The new site shed proved to be invaluable as a sheltered location for inflating the balloons.

c) The cause of reduced MST radar wind reliability during 2007 - DAH
The MO’s model comparison statistics had indicated that there was a reduction in the Aberystwyth wind-profile data quality as soon as the new data acquisition system began operations in February 2007. However, the only obvious change in the processing had been a switch from a Rectangular to a Hanning data weighting window in deriving the Doppler spectra. A switch back to a Rectangular window (albeit using the new acquisition system) in April 2007 failed to improve the situation. The cause of the problem turned out to be an altitude error of -4 range gates. However, this was far from obvious when comparing data from immediately before and after the switch to the new acquisition system. In fact, it is only when there is a sharp change of wind speed as a function of altitude (e.g. around the jet) that the problem can be seen in comparisons of radar and Aberporth radiosonde data. Otherwise, the error is often only apparent from a comparison of the radar return signal power and the radiosonde-derived temperature gradient. Both tend to show a sharp change at the tropopause level.

DAH had first assumed that the altitude error was associated with the (complementary code) decoding
routine in the acquisition software. This process necessitates an alternative interpretation of the range
gate numbers and DAH assumed that a +7 range gate offset would be needed for an 8 \mu s pulse. He
introduced a “double hack” solution in February 2008, whereby the acquisition system was first in-
structed to acquire data at range gates offset by -7 relative to normal and the signal processing software
subsequently offset them in the opposite direction. Although this led to an overall improvement in data
quality, it was clear that the data for the lowest three range gates were unreliable. This is consistent with
the fact that the range gate numbers were being over-corrected and so data were being considered from
range gates which are low enough to be affected by the T-R switching.

In his attempt to better understand the problem, DAH worked through the circuit diagrams of the
receiver-computer interface units in fine detail. However, the legacy documentation proved to be both
limited and confusing in this regard. Consequently, DAH was unable to establish exactly the timing
sequence of control signals, which determine the interpretation of the range gate numbers. More limit-
ingly, it turns out that a PROM in the receiver-computer interface units performs a range gate number
translation, for which there is no documentation. Consequently DAH was obliged to carry out a line-
by-line comparison of the legacy and the new data acquisition software. He found an uncommented line
in the legacy code which offsets the range gates by half the pulse length (in \mu s), i.e. 4 range gates for
an 8 \mu s pulse, which had been overlooked in the new. He now has a high degree of confidence that
the new data acquisition software is consistent with the legacy software. Regrettably, he can only be con-
dent that the legacy system was doing what it was supposed to be doing based on the fact that it used to
produce good results. There is insufficient documentation to allow for a full understanding of the system.

DAH attempted to use aircraft echoes as a way of verifying his range gate assumptions. Despite CFL’s
attempts to prevent the Dornier from flying through the radar observation volumes during the Easter
2008 turbulence campaign, there is clear evidence of aircraft echoes. It is likely that the aircraft was
mainly seen through side-lobes of the radar whilst it was still horizontally distant, rather than through
the main lobe whilst flying directly overhead. This would explain the fact that the range of the echoes
can change by a few km from one dwell to the next, i.e. at intervals of 24 s. Therefore, despite the fact
that the altitude of the aircraft was known as a function of time, there was seldom a close match to the
ranges of the aircraft echoes from the radar.

As a final test, DAH carried out a statistical comparison of wind-profile data from Aberporth radioson-
des (launched 50 km to the SW of the radar site) and from simultaneous radar observations. He offset
the radar data one range gate at a time and calculated the correlation coefficient. This results in a very
smooth curve, with an implied peak (with a correlation coefficient of approximately 0.97) associated
with a range gate offset of between +4 and +5 relative to the first incarnation of the new data acquisition
system. On 8th April 2008, a correction was added to the data acquisition software which offsets the
range gates by half the pulse length (in \mu s) in the ST mode. The data for the period February 2007 -
April 2008 will need to be reprocessed to correct the errors. There is still some uncertainty as to the
appropriate offset for M-mode data. DAH congratulated GAP on his success in recently restarting the
capture of the high-resolution Aberporth radiosonde data by the BADC. This sort of comparison would
have been much less convincing if radiosonde data were taken from the next nearest station, which is
almost 200 km away.

d) The Met Office Future Upper-Air Network Development (FUND) - TO
The MO are in the process of drawing up costed options for their upper-air observation requirements
for the period 2010 - 2020. This process recognises the availability of satellite observations but needs
to provide higher spatial and temporal resolutions to meet internal users’ requirements. The data are
ultimately required for assimilation purposes. It is hoped that the future network will either reduce costs
or provide more information for the same amount of money. The current network already provides
more information than is being used operationally. The Mark II RAL (94 GHz) cloud radar has been
in operation at Camborne since January 2008. An initial problem with banding was solved by placing
an absorbing strip within the antenna assembly. Although this had the desired effect, it also appears to have reduced the sensitivity. This type of radar is anticipated to be one of the key instruments to be used within an integrated systems environment. Other instruments at Camborne include a 12 channel microwave radiometer, a GPS water vapour receiver, and a Jenoptik CHM15k laser ceilometer. The MO want to develop a suite of processing tools which can ultimately be rolled out to new sites. They will need to identify a field site in the London area for MO support of the 2012 Olympics.

8. Any Other Business

TO reported that he had recently taken up a new post, of Upper Air and Remote Sensing manager, within the MO. Although he is no longer a member of John Nash’s team, he will be directly in charge of the contract for provision of wind-profile data from Aberystwyth. He hopes to continue attending the Experimenters’ meetings.

DAH raised the issue of archiving the minutes from previous Experimenters’ meetings. He pointed out that these are an invaluable source of verbose metadata and so it is important that they should be preserved. The BADC have proposed that they be placed in a publicly-accessible document repository. It was agreed that the minutes could be made available in this way as soon as they had been accepted at the subsequent meeting. However, DAH should remove e-mail addresses, which might otherwise be harvested for junk mail purposes. It is acceptable for attendees’ affiliations to appear in the minutes.

The next meeting is provisionally scheduled for Tuesday 20th January 2009 at the Cosener’s House.