**SERVICES & FACILITIES ANNUAL REPORT - FY April 2009 to March 2010**

| SERVICE | FUNDING | AGREEMENT | ESTABLISHED as S&F | TERM |
|---|---|---|---|---|
| The NERC MST Radar Facility at Aberystwyth http://mst.nerc.ac.uk | BLOCK | SLA | 1996 | 5 YEARS |

**TYPE OF SERVICE PROVIDED:**

The Mesosphere-Stratosphere-Troposphere (MST) Radar at Aberystwyth is the UK's most powerful and versatile wind-profiling instrument. It is unique in being able to provide continuous measurements of the three-dimensional wind vector over the altitude range 2-20 km at high resolution (typically 300 m in altitude and a few minutes in time). It can also provide information about atmospheric stability, turbulence, humidity and rainfall. It is therefore ideally suited for studying everything from small-scale atmospheric phenomena through to large-scale weather systems. Wind-profile data are supplied to the Met Office, for numerical weather prediction purposes, through a commercial contract. Developments in the signal processing have lead to measurable increases in data quality over the past few years.

The Facility operates and hosts additional instruments whose observations complement those made by the MST radar. The Met Office operates a GPS water vapour receiver at the site, and has previously operated a boundary-layer wind-profiler there. The NERC Facility for Ground based Atmospheric Measurements (FGAM – formerly UFAM) boundary-layer wind-profiler and ozone lidar are often operated at the site in-between campaigns. During the past year the Facility has supported three NERC-funded field campaigns.

The mission of the Facility is:

- To operate the MST radar on behalf of the UK atmospheric science community
- To operate, and host, instruments whose observations complement those made by the MST radar
- To participate in appropriate NERC supported field campaigns
- To support facility users with analysis and interpretation of the data

The projects supported by the Facility cover the NERC priority themes of Climate Change, Sustainable Use of Natural Resources, and Natural Hazards.

**ANNUAL TARGETS AND PROGRESS TOWARDS THEM**

The MST Radar has maintained operations for 98.0% of the available time, achieving its target of 98.0%.

| SCORES AT LAST REVIEW (each out of 5) | | Date of Last Review: | | March 2009 |
|---|---|---|---|---|
| Need | Uniqueness | Quality of Service | Quality of Science & Training | Average |
| 4.5 | 5.0 | 4.5 | 4.0 | 4.5 |

| CAPACITY of HOST ENTITY FUNDED by S&F | Staff & Status | Next Review (March) | Contract Ends (31 March) |
|---|---|---|---|
| 75% | Project Manager: Mr Charles Wrench- 10%<br>Project Scientist: Dr David Hooper – 100%<br>Site Technician: Mr Les Dean – 30% | 2014 | 2015 |

| FINANCIAL DETAILS: CURRENT FY | | | | | | |
|---|---|---|---|---|---|---|
| Total Resource Allocation £k | Unit Cost £k | | | Capital Expend £k | Income £k | Full Cash Cost £k |
| | Unit 1 | Unit 2 | Unit 3 | | | |
| 137.1 | General user support £1.648k | Guest instrument/campaign support £2.000k | | 506.3 | 45.0 | 182.7 |

| FINANCIAL COMMITMENT (by year until end of current agreement) £k | | | | |
|---|---|---|---|---|
| 2009-10 137.1 | 2010-11 135.4 | 2011-12 140.0 | 2012-2013 144.8 | 2013-2014 149.1 |

| STEERING COMMITTEE | Independent Members | Meetings per annum | Other S&F Overseen |
|---|---|---|---|
| NARFSC | 8 | 1 | CFARR and UK EISCAT |

| APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2009/10) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | α5 | α4 | α3 | α2 | α1 | β | R*/Pilot | Reject |
| NERC Grant projects* | | 2 | | | | | | |
| Other academic | | | | | | | | |
| Students | | | | | | | | |
| Pilot | | | | | | | | |
| **TOTAL** | | 2 | | | | | | |

| APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2006/2007, 2007/2008 & 2008/2009) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | α5 | α4 | α3 | α2 | α1 | β | R*/Pilot | Reject |
| NERC Grant projects* | | 2.33 | | | | | | |
| Other Academic | | 2.33 | 1.00 | | | | | |
| Students | 1.00 (applications in this category are graded as Pilot) | | | | | | | |
| Pilot | 1.33 (applications in this category are graded as Pilot) | | | | | | | |
| **TOTAL** | | 4.66 | 1.0 | | | | 2.33 | |

| PROJECTS COMPLETED (current FY – 2009/10) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | α5 | α4 | α3 | α2 | α1 | β | R*/Pilot |
| NERC Grant projects* | | 1 | 1 | | | | |
| Other Academic | | 2 | 1 | | | | |
| Students | | | | | | | |
| Pilot | 1 (applications in this category are graded as Pilot) | | | | | | |

| USER PROFILE - funding type (current FY – 2009/10) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grand Total | Infrastructure | | | | | PAYG | | | | |
| | Supplement to NERC Grant * | Student | | NERC C/S | Other | NERC Grant* | Student | | NERC C/S | Other |
| | | NERC | Other | | | | NERC | Other | | |
| 14 | 2 | 2 | 4 | | 5 | Supply of data to the Met Office (counts as 1 user) under a commercial contract | | | | |

| USER PROFILE - funding type (per annum average previous 3 financial years - 2006/2007, 2007/2008 & 2008/2009) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Grand Total | Infrastructure | | | | | PAYG | | | | |
| | Supplement to NERC Grant * | Student | | NERC C/S | Other | NERC Grant* | Student | | NERC C/S | Other |
| | | NERC | Other | | | | NERC | Other | | |
| 22.33 | 5.66 | 3.33 | 5.33 | | 7.0 | Supply of data to the Met Office (counts as 1 user) under a commercial contract | | | | |

| USER PROFILE – user type (current FY – 2009/10) | | | | |
|---|---|---|---|---|
| Academic | Centre/Survey | NERC Fellows | PhD | Commercial |
| 8 | | | 5 | 1 |

| USER PROFILE - user type (per annum average previous 3 financial years - 2006/2007, 2007/2008 & 2008/2009) | | | | |
|---|---|---|---|---|
| Academic | Centre/Survey | NERC Fellows | PhD | Commercial |
| 15.0 | | | 6.33 | 1.0 |

| OUTPUT & PERFORMANCE MEASURES (current year) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Publications (by science area & type) (calendar year 2009) | | | | | | | | | | |
| SBA | ES | MS | AS | TFS | EO | Polar | Grand Total | Refereed | Non-Ref/ Conf Proc | PhD Theses |
| | | | 7 | | | | 7 | 4 | | 3 |

| Distribution of Projects (by science areas) (FY 2009/10) | | | | | | |
|---|---|---|---|---|---|---|
| SBA | ES | MS | AS | TFS | EO | Polar |
| | | | 14 | | | |

| OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Publications (by science area & type) (Calendar years 2006, 2007 &2008) | | | | | | | | | | |
| SBA | ES | MS | AS | TFS | EO | Polar | Grand Total | Refereed | Non-Ref/ Conf Proc | PhD Theses |
| | | | 7.16 | | 0.17 | | 7.33 | 3.33 | 3.33 | 0.67 |

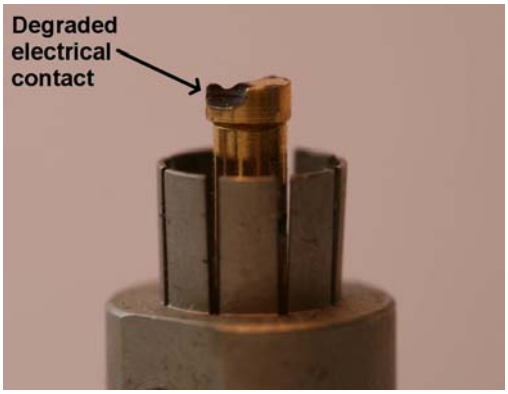
| Distribution of Projects (by science areas) (FY 2006/2007, 2007/2008 & 2008/2009) | | | | | | |
|---|---|---|---|---|---|---|
| SBA | ES | MS | AS | TFS | EO | Polar |
| | | | 22.00 | | 0.33 | |

| Distribution of Projects by NERC strategic priority (current FY 2009/10) | | | | | | |
|---|---|---|---|---|---|---|
| Climate System | Biodiversity | Earth System Science | Sustainable Use of Natural Resources | Natural Hazards | Environment, Pollution & Human Health | Technologies |
| 8.83 | | | 0.5 | 2.33 | | 2.33 |

**Combined Responsive Mode and Directed Programme grants*

**NOTE: All metrics should be presented as whole or part of whole number NOT as a %**

**OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2009/10):**

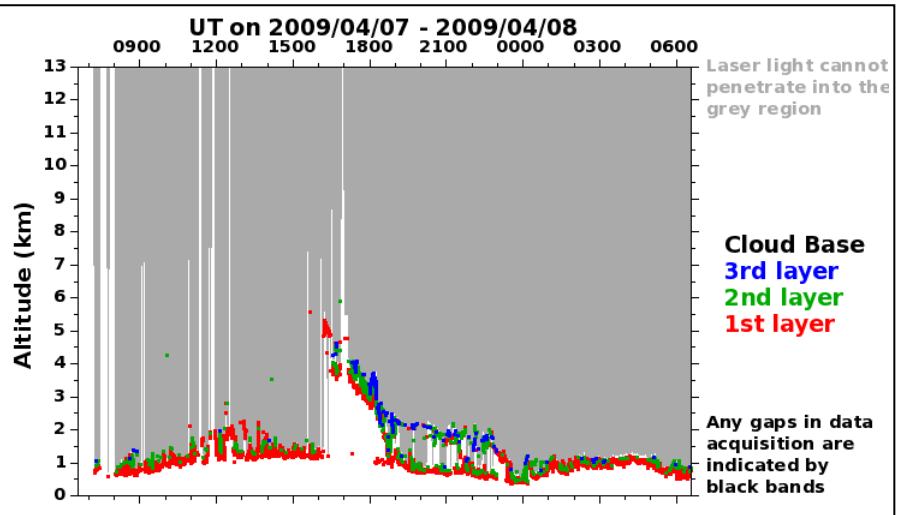



*An example of one of the radar components which is prone to degradation through continual use. This is a "relay contact", which performs in excess of 1 million high-power electrical switching operations every year. This has led to gradual erosion of the contact surface, which has contributed to the reduction in the radar's performance.*

**A capital idea**. The Facility has received its first major capital investment from NERC in its 20 year lifetime. This will allow much-needed renovation work to be carried out on the radar, thereby boosting its performance and improving its reliability.

Although the MST radar remains a powerful instrument, its performance has decreased noticeably over the past decade. This is a consequence of the original hardware having remained virtually intact. Some components are prone to degradation through continual use. They have been repeatedly reconditioned rather than being replaced. Although this has made the radar relatively inexpensive to run, operations cannot continue in this way indefinitely. The Facility's primary focus over the past year has therefore been on creating a specification for the necessary renovation work and on finding a company with the necessary technical expertise to undertake it. A winning bid was selected through an EU competitive tendering process in January 2010. A key feature of this bid was the proposal to use replacement components which will have a significantly longer lifetime than the originals and which will require a low level of on-going maintenance.

**Making data products more accessible.** The Facility has extended the range of quick-look data plots that it produces in order to support 3 separate NERC-funded field campaigns. These plots allow scientists to easily and rapidly identify features of interest – and this has enabled the scientists to optimise the flight patterns of instrumented research aircraft, which were also involved in the campaigns. Previously the quick-look plots were only made available (in 24 hour blocks) on the day after the observations were made. Plots of the latest 24 hours' worth of cloud base altitudes (from a laser ceilometer) and of MST radar data products are now automatically updated on a frequent basis. The range of plots was further extended during April 2010, to show the raw backscatter data from the laser ceilometer, in order to support the emergency campaign to detect the presence of ash from the Eyjafjallajökull volcano. The instrument was only able to detect the ash layer when it had reached a low altitude.




*An example of one of the new quick-look data plots, which shows the (lowest) altitudes of up to 3 separate clouds layer as a function of time, which was created to support a NERC-funded field campaign.*

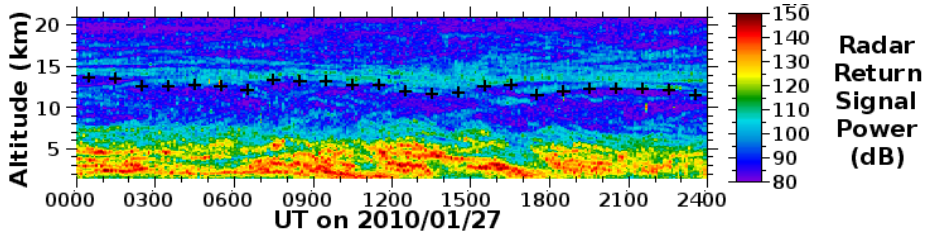
**Student Training.** The Facility supported 5 PhD student projects over the past year. In two of these cases, the students spent extended periods working at the radar site (as part of field campaigns), gaining valuable experience of operating a variety of equipment. Moreover, nearly 50 undergraduates from the University of Manchester visited the radar site as part of an Environmental Science field trip. This gave them exposure to the activities taking place on an atmospheric field station.

**Promoting NERC expertise to an international audience.** The Facility's project scientist played a significant role in the "Twelfth International Workshop for the Technical and Scientific Aspects of MST Radar", which was held in Canada in May 2009. He was a member of the international steering committee, gave two lectures at the associated post-graduate radar school, and is currently acting as a guest editor for a special workshop issue of a journal.

**Podcast for NERC's *"Planet Earth"* publication.** The Facility was the subject of a podcast, which was first made available in February 2010, for NERC's *"Planet Earth"* publication. It features an interview with the Facility's project scientist and with Prof Geraint Vaughan, director of NCAS-Weather. It can be downloaded from http://planetearth.nerc.ac.uk/multimedia/story.aspx?id=660.

**SCIENCE HIGHLIGHTS:**

**Measuring more than just wind.** Our understanding of the Earth's atmosphere is reliant upon knowledge of its temperature and humidity fields. The standard method of measuring the profiles is with an instrumented meteorological balloon. However, this is both costly and labour intensive and so national meteorological services typically only launch two or four balloons a day from a small number of sites. The MST radar offers a potential alternative method of measurement since the return signal power depends on the vertical gradients of both temperature and the humidity. Since the radar is already operated on a continuous basis for the purpose of measuring winds, the new information would be available at no additional cost and as frequently as was required. Nevertheless, separating the temperature and humidity information from a single, combined measurement presents a considerable technical challenge. It will require a better understanding of the radar return mechanism. This was the motivation behind a field campaign conducted at the MST radar site in late 2009. It was part of a collaborative project between the University of Manchester and the Met Office.




*An example of 24 hours' worth of MST radar return signal power, which depends on the gradients of both temperature and humidity. This indicates considerably more variability than could be seen by just 4 profiles measured from meteorological balloons.*

**Extreme weather.** One of the publications from the 2009 calendar year (Parton et al, 2009) presents the first observations of an extreme weather phenomenon known as a Sting Jet – a relatively small region of fast moving air, which can cause extreme damage when it descends to the ground level. One of the reasons that such a phenomenon had not previously been detected (although its existence had been predicted) is that the strong winds themselves prevented meteorological balloons (which are the "traditional" means of measuring winds) from being launched. Wind-profiling radars, such as the MST radar, can continue to operate under all weather conditions. Moreover, they do so with high time resolution – i.e. typically generating a new wind measurement every few minutes. Meteorological balloons are seldom launched at intervals of less than 6 hours. Consequently the MST radar captures a much fuller and more detailed picture of the atmosphere than a meteorological balloon is capable of. This capability is becoming increasingly important as the power of atmospheric models advances to the point at which the models are capable of simulating these small-scale but high-impact phenomena.

**Details of publications supported by the Facility**


1. G. A Parton, G. Vaughan, E. G. Norton, K. A. Browning, and P. A. Clark. Wind profiler observations of a sting jet. *Q. J. R. Meteorol. Soc*., 135(640, Part A):663-680, 2009. (Journal Impact Factor: 2.522)
2. Andrew Russell, Geraint Vaughan, Emily G. Norton, Hugo M. A. Ricketts, Cyril J. Morcrette, Tim J. Hewison, Keith A. Browning, and Alan M. Blyth. Convection forced by a descending dry layer and low-level moist convergence. *Tellus A*, 61(2):250-263, 2009. (Journal Impact Factor: 2.214)
3. R. M. Worthington. Radar measurement of the effect of boundary-layer saturation on mountain-wave amplitude. *Meteorol. Atmos. Phys*., 105(1-2):29-35, 2009. (Journal Impact Factor: 0.872)
4. G. S. Aglietti, S. Redi, A. R. Tatnall, and T. Markvart. Harnessing high-altitude solar power. *IEEE Trans. on Energy Conversion*, 24(2):442-451, 2009. (Journal Impact Factor: unavailable)


Three PhD students, whose research has been supported by the Facility, submitted and successfully defended their theses during the past year.

**FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK**

A major focus of the forthcoming year will be on the installation phase of the MST radar renovation work. In preparation for this, staff from RAL will visit the radar site in early June 2010 in order to test the working condition of individual antenna units. The company responsible for the renovation work is currently manufacturing the replacement components and it is anticipated that the installation work will take place later in the year. A number of tests will need to be made on the radar, once the work is complete, in order to ensure that the renovated radar continues to operate as expected.