SERVICES & FACILITIES ANNUAL REPORT - FY April 2012 to March 2013

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. Its data are therefore ideally suited for studying everything from small-scale atmospheric phenomena through to large-scale weather systems. There is no alternative source of comparable data for many of the projects which it supports.

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-funded field campaigns
- To support facility users with analysis and interpretation of the data

During the past year, the Facility has supported projects which address all 7 of the NERC priority themes: (1) Climate System, (2) Biodiversity, (3) Sustainable Use of Natural Resources, (4) Earth System Science, (5) Natural Hazards, (6) Environment, Pollution and Human Health, and (7) Technologies. It has supported one NERC-funded field campaign.

Data from the Facility have demonstrable economic, social and practical impacts. Real-time wind-profile data are used operationally by the Met Office for the purposes of numerical weather prediction This is undertaken through a commercial contract, which provides 33% of the Facility's budget. The study of noctilucent clouds and mesospheric radar echoes (see page 3) has resulted in engagement with an amateur observing community.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

The MST Radar has maintained was operated for 99.6% of the available time, exceeding the target of 98.0%. More details are given on page 3.

SCORES AT LAST REVIEW (each out of 5)		Date of Last Review:		
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)
66 %	Project Scientist : Dr David Hooper – 85% 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 User Support 2.3	**Unit 2** Guest instrument/ Campaign support, 19.5			
131			0.0	67.0	246.1

FINANCIAL COMMITMENT (by year until end of current agreement) £k				
2012-13: 131	2013-14: 131	2014-15 131	2015-2016 ?	2016-2017 ?

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen
NARFSC	7	1	CFARR and EISCAT

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2012/13)													
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**R***	**Pilot**
NERC Grant projects*			1										
Other academic				**1**									1
Students				**1**									
TOTAL			**1**	**2**									**1**

PROJECTS COMPLETED (current FY – 2012/13)												
	10 (α5)	**9**	**8 (α4)**	**7**	**6 (α3)**	**5 (α2)**	**4**	**3 (α1)**	**2**	**1 (β)**	**0 (Reject)**	**Pilot**
NERC Grant projects*												
Other Academic			**1**									
Students			**1**				**1**					**1**

Project Funding Type (current FY – 2012/13) (select one category for each project)										
Grand Total	**Infrastructure**					**PAYG**				
	Supplement to NERC Grant *	**PhD Students NERC**	**PhD Students Other**	**NERC Centre**	**Other**	**NERC Grant***	**PhD Students NERC**	**PhD Students Other**	**NERC Centre**	**Other**
14	**3**	**2**	**1**		**7**					**1**

Project Funding Type (per annum average previous 3 financial years - 2009/2010, 2010/2011 & 2011/2012)										
Grand Total	**Infrastructure**					**PAYG**				
	Supplement to NERC Grant *	**PhD Students NERC**	**PhD Students Other**	**NERC Centre**	**Other**	**NERC Grant***	**PhD Student NERC**	**PhD Student Other**	**NERC Centre**	**Other**
15.00	**2.33**	**3.33**	**2.67**		**5.33**					**1.33**

User type (current FY – 2012/13) (include each person named on application form)				
Academic	**NERC Centre**	**NERC Fellows**	**PhD Students**	**Commercial**
10			**3**	**1**

User type (per annum average previous 3 financial years - 2009/2010, 2010/2011 & 2011/2012)				
Academic	**NERC Centre**	**NERC Fellows**	**PhD Students**	**Commercial**
8.0			**5.67**	**1.33**

OUTPUT & PERFORMANCE MEASURES (current year)

Publications (by science area & type) (calendar year 2012)										
SBA	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**	**Grand Total**	**Refereed**	**Non-Ref/ Conf Proc**	**PhD Theses**
			3				**3**	**2**	**1**	

Distribution of Projects (by science areas) (FY 2012/13)							
Grand Total	**SBA**	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**
14			**0.33**	**12.33**	**0.33**	**1.0**	

OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)

Publications (by science area & type) (Calendar years 2009, 2010 & 2011)										
SBA	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**	**Grand Total**	**Refereed**	**Non-Ref/ Conf Proc**	**PhD Theses**
			8.67				**8.67**	**3.67**	**3.33**	**1.67**

Distribution of Projects (by science areas) (FY 2009/2010, 2010/2011 & 2011/2012)							
Grand Total	**SBA**	**ES**	**MS**	**AS**	**TFS**	**EO**	**Polar**
15.00				**15.00**			

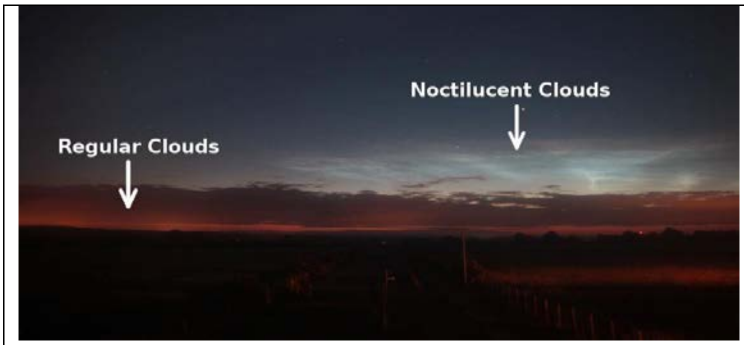
Distribution of Projects by NERC strategic priority (current FY 2012/13)							
Grand Total	**Climate System**	**Biodiversity**	**Earth System Science**	**Sustainable Use of Natural Resources**	**Natural Hazards**	**Environment, Pollution & Human Health**	**Technologies**
14	**4.42**	**0.25**	**1.0**	**0.33**	**4.50**	**0.25**	**3.25**

**Either Responsive Mode or Directed Programme grants*

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

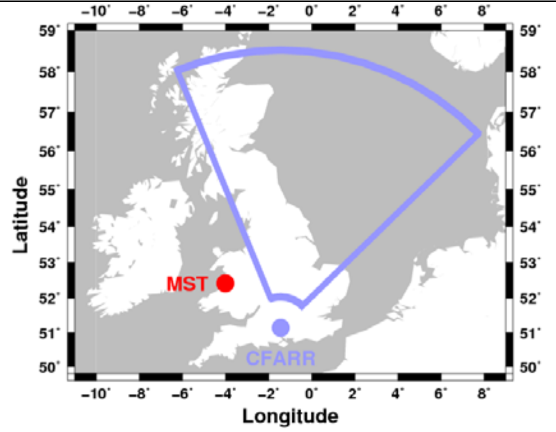
OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2012/13):

A new instrument for observing the Mesosphere



Noctilucent Clouds (NLCs) observed by the Facility's new sky-camera during the early morning of 25th June 2012

The Facility has begun to operate a new sky-camera in support of investigations into a remote region of the Earth's atmosphere. The Mesosphere, which lies between altitudes of approximately 50 and 90 km, is at the cusp between the familiar atmosphere below and the near-space environment above. Since few instruments are capable of observing these altitudes, the mesosphere remains relatively-unstudied. This has also made it difficult to interpret the MST radar's mesospheric echoes, despite the fact that regular observations have been made since 2005. However, the occurrence of mid-summer echoes is known to be related to the presence of tiny ice crystals. The latter form as a result of the extreme cold of the uppermost mesosphere (at around 82 km) at this time of year. Although the crystals are too faint to be seen during daylight hours, they appear as Noctilucent Clouds (NLCs) – see image above - during twilight, when the lower atmosphere and the regular clouds (which are confined to the lowest 10 km) are already in darkness. Consequently, the Facility has been engaging with amateur NLC observers in order to gain a better understanding of the MST Radar's mesospheric echoes. Most of these observers are based to the north of the MST Radar site. In order to photograph any NLCs occurring directly above the radar, the optimal location for the new sky-camera would be approximately 100 km to the south. By operating the new camera at the Chilbolton Facility for Atmospheric and Radio Research (CFARR) – see map below – it is at least possible to see any NLCs that occur at the same latitude as the MST radar. The Facility would like to install similar cameras at other locations within the British Isles.



Owing to their high altitude, NLCs can be seen for up to several hundred kilometres away. The blue sector marks the range of potential NLC locations that fall within the new sky-camera's field of view..

Improved MST Radar reliability

The major operational success of the 2012-2013 year was in developing software for remotely interrogating and controlling each of the MST radar's 5 transmitters. One of the transmitters had become prone to sporadically shutting down, which led to reductions in the radar's useful altitude coverage. Frustratingly, the affected transmitter was still in a functional state and simply needed someone to reset it (as opposed to carrying out repairs on it) before it could recommence operations. This required a minimum of a one hour round trip to allow the part-time site technician to visit the site. However, the problem typically persisted for up to a few days, until the technician had an opportunity to get to the site. The new software allowed the same operation to be carried out over the internet. This led to an immediate reduction in the amount of time affected by the problem. Moreover, the status information that was returned by the transmitters soon led to the underlying cause of the problem being identified and fixed. This uptime of 99.6% significantly exceeded the 98.0% target for the year.

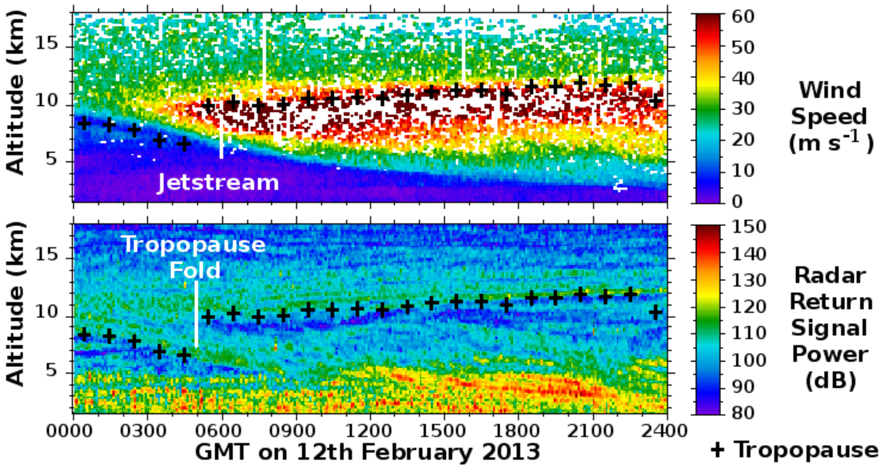
A year characterised by relentless rain.

The 2012 calendar year was the second wettest on record for the UK as a whole. Almost 80 mm of rain fell at the radar site during one remarkable 60 hour period in June 2012. The bulk of this (almost 70 mm) fell during a 36 hour period on the 8th and 9th June. The consequent flooding in the area, including of the BBC's nearby Springwatch site, attracted widespread media attention. This weather event has also been the subject of a student project. Although the radar site was not flooded (despite it being located within a designated flood risk zone), it has suffered a number of consequences of the ground being perpetually water-logged over the course of the year. Willow tree saplings, which are notoriously fast-growing and water-loving, became established in one part of the antenna array. They appeared to have grown by around a metre during the course of a single year and some were over 2 m tall. There was a danger that they would start to interfere with the operation of the radar and a bespoke clearance operation had to be undertaken. In another part of the antenna array, some small wooden huts (which house power distribution modules) started to show signs of water damage. Their supporting posts had to be raised onto a tiles in order to avoid the structures perpetually sitting in puddles.

SCIENCE HIGHLIGHTS:

Support for the TROSIAD Field Campaign

The final observational phase of the TROSIAD field campaign was conducted at the MST radar site between 23rd July and 3rd August 2012. Its aim was to study the effects of upper-level features, known as tropopause folds, on convective activity that originates at lower levels. Deep convection is responsible for heavy rainfall (amongst other things) and so it is important to be able to forecast it accurately. Although some of its causes are well-understood and relatively-easy to predict, the role played by tropopause folds is more complicated. It has long been known that they can promote deep convection by destabilising the upper levels of the lower atmosphere. However, more-recent work has shown that they can alternatively inhibit convection by acting as atmospheric lids that limit its vertical growth. The motivation of the TROSIAD campaign was to examine the relative importance of these two mechanisms. As shown in the figure below, MST radar observations are particularly good for identifying tropopause folds.



An example of a tropopause fold seen by the MST Radar. The fold is found on the underside of the Jetstream (a region of fast-moving upper-level air) and is accompanied by a discontinuity in tropopause altitude. The tropopause marks the boundary between the lower-atmosphere and the overlying stratosphere. Its altitude (black crosses) is derived from the radar return signal power using an objective algorithm.

A 5-Year Climatology Of Tropopause Folds And Convective Storms

In addition to carrying out a field campaign, the TROSIAD project made use of MST radar's data archive. This resulted in a 5 year climatology of tropopause folds and convective storms, which was published by Antonescu et al. 2012. Convective storms were found to be considerably more-common than tropopause folds and just over 50% of the tropopause folds were found to have convection associated with them. The association was strongest in December. The study went on to show that the multicellular convection was most-common when the fold was on the eastern side of an upper-level trough, whereas isolated cells predominated when the fold was on the western side.

Diabatic Processes In A North Atlantic Cyclone

A second publication (Chagnon et al., 2012) also made use of MST radar observations in order to study atmospheric processes in the upper part of the lower-atmosphere. It was primarily concerned with the way in which diabatic heating, i.e. that caused by the condensation of water vapour, and diabatic cooling, i.e. that caused by evaporation of rain/snow, affected the development of a mid-latitude storm system. The focus of the work was on the ability of two different models – a coarse-scale global model and a high-resolution local area model – to represent the processes of interest. This storm system featured a tropopause fold and the MST radar observations were used to provide a cross-section through it. As might be expected, the patterns generated by the local area model were in better agreement with the radar observations than those generated by the global model.

Publications supported by the Facility

1. Antonescu, B., G. Vaughan, and D. M. Schultz, *Mon. Wea. Rev.*, A five-year radar-based climatology of tropopause folds and deep convection over Wales, United Kingdom, http://dx.doi.org/10.1175/MWR-D-12-00246.1, 2012. [journal impact factor 2.67; 5-year value 3.00]

2. Chagnon, J. M., S. L. Gray, J. Methven, *Q. J. R. Meteorol. Soc.*, Diabatic processes modifying potential vorticity in a North Atlantic cyclone, DOI:10.1002/qj.2037, 2012. [journal impact factor 2.91; 5-year value 2.91]

FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

The management of the MST Radar Facility will undergo a major change during the forthcoming year. Responsibility for all of NERC's Services and Facilities is being transferred from a central unit to a number of discipline-specific centres. All three of NERC's atmospheric radar facilities will be transferred to the National Centre for Atmospheric Science (NCAS). It's not yet clear what this will entail, although changes are expected.