covered themes which included:

- The current status of weather and climate modelling and strategies for seamless prediction.
- Strategies for next-generation modelling systems.
- Prospects for current high-end computer systems.
- Strategies for model evaluation and experimentation.
- Strategies for revolutionizing climate prediction.

In essence, these themes dealt with how to enhance human and computing resources and what could be the requirements and possible organizational frameworks in the future.

The various themes were discussed in more depth during the breakout group sessions on the third day of the summit, and on the final day a draft of the summit statement was developed in plenary session. This draft version has now been finalized by the organizing committee of the summit. The statement contains 12 conclusions which can be found on the website of the summit (URL given below).

Overall it was felt that the summit was a very successful event in many respects. Not least it was a first step in bringing together the weather and climate community with a view to achieving the common goal of providing society with reliable regional predictions of climate change at all timescales that are necessary to develop mitigation and adaptation strategies.

The summit attracted considerable interest amongst the scientific and more general media. A press briefing held in London was attended by journalists from major UK print media, TV stations and international news agencies. Furthermore, the scientific journal *Nature* reported on the summit in its issue published on 15 May with an editorial and two other articles.

More information on the summit can be found on its website:

http://wcrp.ipsl.jussieu.fr/Workshops/ModellingSummit/index.html

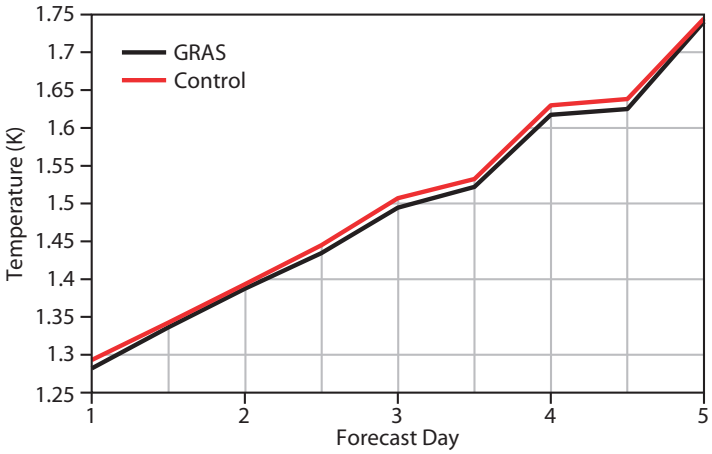
This includes the final summit statement, a number of background documents and a link to the presentations and reports of breakout groups.

Operational assimilation of GRAS measurements at ECMWF

SEAN HEALY

ECMWF started assimilating bending angle profiles from the GRAS GPS radio occultation (GPSRO) receiver on MetOP-A on 20 May 2008. GRAS was declared operational by EUMETSAT on 17 April 2008 – it is the first fully operational GPSRO mission. GRAS provides around 650 bending angle profiles per day, and they have a small positive impact on stratospheric temperature forecasts.

GPSRO bending angle profiles have been assimilated operationally at ECMWF since 12 December 2006 (*ECMWF Newsletter No. 111*). The measurements are globally distributed, have good vertical resolution and an all weather capability. They provide information about the atmosphere that is complementary to that derived from satellite radiance measurements. Furthermore, GPSRO measurements can be assimilated without bias correction. This means that they provide an "anchor point" for the Variational Bias Correction scheme (VarBC, *ECMWF Newsletter No. 107*) in the stratosphere that prevents the bias corrected radiances drifting towards the forecast model climatology. GPSRO measurements also have important reanalysis applications.



The root mean square temperature error at 50 hPa in the northern hemisphere, verified against radiosonde temperature observations. The black line shows the results when the GRAS measurements are assimilated and the red line is for the control experiment.

ECMWF typically assimilates around 2,000 bending angle profiles per day from the six satellites in the COSMIC GPSRO constellation. We assimilate bending angles as a function of impact parameter, which is a variable that measures how close the tangent point of the ray gets to the surface (*ECMWF Newsletter No. 111*). For profiles from the COSMIC constellation we can assimilate bending angles from the surface up to a height of 40 km.

It is not currently possible to use GRAS measurements in the mid and lower troposphere because of known biases. The GRAS Product Processing Facility (PPF) at EUMETSAT is still evolving and improving. This is evident in the time series of observation statistics calculated daily by the GRAS Satellite Application Facility (SAF), which are available on the web at www.grassaf.org. The current GRAS processing is based on the "phased-lock-loop" method to track the GPS signals, and the inversion of the measurements uses the geometrical optics approximation. This approach

is known to introduce biases in the troposphere and consequently it is difficult to use the GRAS measurements in this region. However, EUMETSAT is already working on the implementation of more advanced processing methods based on wave optics, which will mitigate these problems.

ECMWF has performed a 54-day 4D-Var forecast impact experiment with the GRAS measurements, covering the period 25 February to 18 April 2008. The GRAS bending angles are blacklisted below 8 km in the northern and southern hemispheres, and below 10 km in the tropics. Given the blacklisting, it is not surprising that the results are neutral in the troposphere. However, we have found some improvements in the stratospheric temperatures when verified against radiosonde observations. This is encouraging because the GRAS information content is expected to be good in the stratosphere.

We anticipate further improvements in the GRAS processing at EUMETSAT – including the implementation of wave optics processing – in the coming year. These will enable the exploitation of the measurements in the troposphere.

ECMWF Annual Report for 2007

BOB RIDDAWAY

The *ECMWF Annual Report 2007* has been published. It is intended to be an important way of maintaining the flow of information to all the people and institutions that have an interest in ECMWF.

The report draws attention to some of the key events of 2007 that affected operational activities.

- **Assimilation of radiances from AMSU-A and MHS**. Assimilation of radiances from the Advanced Microwave Sounding Unit (AMSU-A) and from the Microwave Humidity Sounder (MHS) on-board EUMETSAT's polar orbiting MetOp-A satellite, launched on 19 October 2006, became operational (11 January).
- **Upgrade of web services**. A major upgrade of the web service hardware systems was completed resulting in a significant improvement in the response when accessing the web pages (24 January).
- **New seasonal forecast system**. Operational forecasts started using System 3, the new seasonal forecast system (15 March).
- **Assimilation of radiances from HIRS**. Assimilation of radiances from the High-resolution Infrared Radiation Sounder (HIRS) instrument on-board EUMETSAT's polar orbiting MetOp-A satellite, launched on 19 October 2006, became operational (19 March).
- **TIGGE database**. The TIGGE database of operational ensemble forecasts from various global forecasting centres became accessible to scientists in near real-time for research and educational purposes (22 May).
- **Implementation of IFS Cy32r2**. A new cycle of the ECMWF forecast and analysis system was implemented (Cycle 32r2). The changes produced a significant improvement in the forecasts of the tropical troposphere at all forecast ranges (5 June).
- **Upgrade of RMDCN**. A new milestone was reached in the Centre's Regional Meteorological Data Communication Network (RMDCN) with the successful completion of the migration of the architecture from Frame Relay to a new Internet Protocol Virtual Private Network (8 June).
- **Assimilation of data from IASI and ASCAT**. Radiance data from the Infrared Atmospheric Sounding Interferometer (IASI) and surface winds from the Advanced Scatterometer (ASCAT) on-board EUMETSAT's polar orbiting MetOp-A satellite, launched on 19 October 2006, were incorporated into the operational forecasting system (12 June).
- **Implementation of IFS Cy32r3**. A new cycle of the ECMWF forecast and analysis system was implemented (Cycle 32r3). This included significant changes to the model physics with a beneficial increase in model activity globally, particularly in the tropics (6 November).
- **Contract with IBM**. The contract for the Centre's next High Performance Computing Facility was signed with IBM (20 December).

As well as the Annual Report describing the wide range of activities at ECMWF there is particular emphasis on the prediction of severe weather. Indeed ECMWF's strategy puts the early warning of severe weather as its principal goal. In the report there are examples of:

- Good predictions of severe weather: severe storm Kyril over northern Europe in January, high temperatures in Europe in April, heat wave in south-eastern Europe and flooding in England and Wales in June.
- Use of hydrological ensembles for flood prediction.
- Support provided by ECMWF for severe weather events.

The Annual Report can be downloaded from:

www.ecmwf.int/publications/annual_report