REPORT
ECMWF ANNUAL SEMINAR 2016

Earth System Modelling for seamless prediction

The European Centre for Medium-Range Weather Forecasts has organised an annual seminar every year since it was established in the 70's. The seminar is an educational event, aimed at young and established scientists working in meteorology and related fields. The topic for this year was the role of Earth system modelling in numerical prediction, and the processes that should be better understood and better represented to improve atmospheric predictive skill. From the 5th to the 8th September, the facilities of the European Centre in Reading attracted research scientists and students from all over the world. About 80 partecipants and 24 lectures discussed, in a stimulating environment, challenges and strategies for the implementation of Earth system models.

A scientific challenge

Earth system science is the multidisciplinary approach to the description of the Earth as a unique, complex system resulting from the interaction of several components. The European Centre for Medium-Range Weather Forecast, based in Reading UK, is a research institute and an operational centre whose primary mission is to produce numerical weather forecasts. It is the leading centre in operational, global forecasting. The title of the seminar this year is: "Earth System Modelling for Seamless prediction: On which processes should we focus to further improve atmospheric predictive skills?" The interest of the centre for the science of the Earth system is well justified by the potential impact on the forecast. A deeper understanding and a better representation of the components of the Earth system can improve the quality of the forecast from the medium-range to the seasonal and sub-seasonal time scale. However, the task is not simple, and a strategy must be planned.

These considerations were pointed out in the first session of the seminar. Including more processes into the forecast system implies increasing the complexity and the cost of the system in terms of computational time and maintenance resources. Many lecturers explained how one has to deal with this cost. On the other hand, improving the system allows to deliver new forecast products and to provide better traditional forecast. In particular for the seasonal and subseasonal time scale, ocean, stratosphere and cryosphere processes, are actually a crucial step to fill the gap of operational predictability in this range.

Cost and benefit of each improvement must be considered in terms of an "optimal choice between complexity, resolution, and ensemble size" (Andy Brown, UK Met Office). Increasing complexity is a matter of selection, and to make a selection first we need to understand the role of the process, then we must find out how it improves the quality of the forecast. Comprehension, selection,

implementation are the logical steps for this scientific challenge. Along these lines, 4 sessions of the seminar focused on the specific components of the Earth system and on their role in numerical weather prediction, namely: atmosphere, ocean, land and atmospheric composition.

Troposphere-stratosphere interactions can be drastically important on time scales longer than few weeks and modelling both the upward and the downward exchange of information is an ongoing research.

Similarly, the skill on slow tropical variability in the troposphere (e.g. the Madden-Julian Oscillation, MJO) is likely to evolve as the model representation of deep convection changes through the years, but is also sensitive to atmosphere-ocean coupling. El Nino Southern Oscillation and the Atlantic Multidecadal Oscillation are two nice examples of atmosphere-ocean interactions that shape coupled patterns of variability across latitudes and across time scales. To improve the long range prediction, the

modelling of the state of the ocean must be improved, but "modelling of the ocean variability requires high resolution" (David Ferreira, University of Reading). Hence, dynamical sea-ice models, eddy resolving ocean models, more realistic air-sea interactions are on the agenda.

Atmospheric composition can affect the predicition of the state of the atmosphere in a wide range of time scales, from aerosols-clouds feedbacks to ozone dynamics. The use of more realistic models can be of great value. Finally, land surface processes strongly rely on the quality of the initialization.

These are some of the messages delivered by the lecturers, they demonstrate the variety of the scientific and technical problems raised by the task of modelling the Earth system. The definitive answer to the question in the title will be found in the future, but certainly this seminar pointed out that it requires a joint effort in modelling, observations and data assimilation techniques. The ECMWF experience shows that the inclusion of key processes (e.g. a coupled dynamical ocean) can improve the accuracy and reliability of the forecast, exploiting predictability of atmospheric oscillations (e.g. the MJO).

The educational value

Young scientists approaching research in meteorology or related fields had the opportunity to interact with established scientists and to learn more about present and future, high-profile research projects. This is the main motivation of the event, and clearly contributes to widening the scientific background of the participants. There is also a more direct benefit, from a perspective of a student. Having a clear message, a precise indication of what is needed, can help improve an individual research project. Eventually, it can make it more valuable in future research activities.

A collaborative effort

The last session of the seminar addressed the problem of operational implementation strategies, the range of different approaches seems to have a common point in "cooperation". After the seminar was closed, at the European Meteorological Society Annual Meeting in Trieste, the Director General of ECMWF announced publicly the new strategy of the centre. One of the two pillars of this ten years roadmap is Earth system modelling.

The guidelines to achieve the process of selection and implementation were clearly identified at the annual seminar. Still, the achievement of the task relies on collaboration between operational centres and research and academic institutions. In this scenario, the seminar provided young scientists with a stimulating and encouraging message to foster their research and to make it valuable and relevant for this new scientific challenge.

LINKS

Annual Seminar Info and Presentations

http://www.ecmwf.int/en/annual-seminar-2016

ECMWF New Strategy Announcement

http://www.ecmwf.int/en/about/media-centre/news/2016/ecmwf-launches-new-strategy