

**30 Years of Ensemble
Forecasting and Symposium
for Prof. Tim Palmer**

Report of Contributions

Contribution ID: 1

Type: **not specified**

How ensemble forecasts enhance the energy sector

Monday, 5 December 2022 14:25 (25 minutes)

Solar and wind generation are obvious examples of where good weather forecasts are important, and so we will start there. As we go into a little detail about the influence of renewables on the supply/demand balance, it will become evident that the temporal and spatial coherence of ensembles are a good match to the largely instantaneous, and interconnected, nature of power systems. Renewables are only one element of the energy sector, and as we broaden our view we will show how ensemble forecasts help in decision making –both financial and environmental.

Presenter: FINNEY, Isla (Lake Street Consulting Ltd)

Contribution ID: 2

Type: **not specified**

Ensemble forecasts at ECMWF today

Monday, 5 December 2022 16:35 (25 minutes)

This talk will provide an overview on the ensemble forecasts as they are performed at ECMWF today. The talk will cover the latest developments towards the 9 km resolution upgrade and provide a perspective on future developments towards km-scale simulations.

Presenter: DUEBEN, Peter (ECMWF)

Contribution ID: 3

Type: **not specified**

Ensembles and probabilities in the 1980s: Pioneering the use of dynamical ensembles in real-time monthly predictions

Monday, 5 December 2022 10:35 (25 minutes)

During the 1980s the Met Office produced experimental monthly forecasts, provided to users on a regular basis. While medium-range dynamical predictions were used for days 1-5 ahead, forecasts for days 6-15 and 16-30 were based on statistical methods driven by observations. During this period, Tim and I developed a prototype system for dynamical monthly forecasts that could be run in real-time. A shared understanding of the uncertainties inherent in monthly prediction informed both the statistical forecasts (which were presented in a probabilistic format) and the dynamical predictions, which were presented as an ensemble and became an additional contribution to the Met Office forecasts. In addition to describing these initiatives, I will give a few examples of how Tim's support for the use of ensembles and probabilities helped to inspire their adoption in later work on prediction systems for longer time scales, including the UK's national climate change scenarios.

Presenter: MURPHY, James (Met Office)

Contribution ID: 4

Type: **not specified**

Perturbations in the ECMWF operational ensembles

Monday, 5 December 2022 12:00 (25 minutes)

One of the major advances in weather prediction of the past three decades has been the provision of accurate and reliable uncertainty estimations. This has been achieved by shifting from issuing a single to an ensemble of forecasts. Since the first implementation in 1992, the key questions that we had to address have been ‘what are the sources of forecast error?’, and ‘how are we going to simulate them in the ECMWF ensemble?’ In this talk, I will briefly review how we evolved the first version of the operational ensemble that included only the simulation of initial uncertainties over the Northern Hemisphere without considering observation errors, to the current version that in the initial perturbations also considers observation errors, and that takes into account model uncertainties.

Presenter: BUIZZA, Roberto (Scuola Superiore Sant’Anna)

Contribution ID: 5

Type: **not specified**

Representing uncertainty in initial conditions: experimentation from lagged average forecasting to singular vectors

Monday, 5 December 2022 11:00 (25 minutes)

Research on ensemble predictions started at ECMWF in the mid 1980's, using a time-lagged approach to generate 30-day ensemble forecasts initialised from consecutive operational analyses produced every 6 hours. While early experiments showed some positive results, it soon became apparent that the lagged ensembles were under-dispersive in the medium-range, and research on alternative methods was initiated under Tim Palmer's leadership. In synergy with developments occurring in data assimilation, linearised dynamical models and their adjoints were used to compute the fastest-growing singular vectors from different idealised initial conditions. The singular vectors computed from a 3-level quasi-geostrophic model proved to be sufficiently realistic to allow interpolation onto a medium-resolution version of the operational forecast model. Ensemble experiments performed with this approach gave promising results and paved the way for the operational ensemble design based on primitive-equation singular vectors.

Presenter: MOLTENI, Franco (ECMWF)

Contribution ID: 6

Type: **not specified**

Sensitivity to initial conditions and external forcing in climate predictions

Monday, 5 December 2022 14:50 (25 minutes)

Near-term climate predictions exploit the predictability of the climate system arising both from the initial condition information and from external forcings resulting from changes in atmospheric composition, solar radiation, and land use. Predictions from one to several years in advance represent the natural extension of seasonal predictions, so they can be considered as initial-value problems where the correct initialization of the ocean surface and subsurface variables together with the sea ice plays a central role in keeping the trajectory of the system close to the observed one. However, as lead time increases from one season to several years, the component of predictability arising from changes in the external forcing becomes more and more important. As such, these climate forecasts represent a hybrid problem at the edge between predictions of the first and the second kind (following the definition given by Edward Lorenz). In this talk I will trace-back some of the work on climate predictions done in collaboration with Tim including the introduction of probabilistic skill measures such as reliability into multi-annual forecasts.

Presenter: CORTI, Susanna (Institute of Atmospheric Sciences and Climate - National Research Council)

Contribution ID: 7

Type: **not specified**

ECMWF road towards the extended range ensemble forecasting

Monday, 5 December 2022 14:00 (25 minutes)

In the mid-eighties, the interaction of atmospheric low frequency variability between tropics and extra-tropics became a hot topic. Tim, anticipating its practical importance, promoted a series of experiments to quantify the influence of the tropical circulations on forecast of extratropical weather. Our results showed that the impact of the tropics was particularly important for the predictions beyond the medium range. We concluded that, with a substantial reduction of tropical systematic errors, the extended range predictions could be viable.

Thanks to the work of many scientists, ECMWF has been successful in the development of sub-seasonal forecasts and its scientific contribution in the topic is well recognized. Since 2004, ECMWF issues, operationally, an ensemble of extended range predictions. In this talk I will review the research, promoted by Tim, that facilitated the development of the ensemble forecast at the extended and seasonal ranges.

Presenter: FERRANTI, Laura (ECMWF)

Contribution ID: 8

Type: **not specified**

Ensemble forecasting for anticipatory humanitarian action

Monday, 5 December 2022 16:10 (25 minutes)

Acting before a disaster can help humanitarian organisations to reduce the impacts on lives and livelihoods, but sufficient lead-time is required to support this decision-making. In this talk I will discuss the use of ensemble forecasts within the Red Cross Red Crescent movement and beyond, highlighting examples of how earlier identification of extreme weather events enabled humanitarianians to support vulnerable communities before disaster strikes.

Presenter: PAPPENBERGER, Florian (ECMWF)

Contribution ID: 9

Type: **not specified**

Evolution of Ideas Leading to Dynamical Seasonal Prediction

Monday, 5 December 2022 10:10 (25 minutes)

During the 1970s, the “butterfly effect” or “chaos” was the dominant theme of predictability research, and the community was skeptical about the prospects for dynamical prediction beyond weather. I will give an overview of the evolution of the ideas that lead to the notion of predictability in the midst of chaos and established a scientific basis for dynamical seasonal prediction.

Ever since I met Tim in Liege, Belgium in 1984 for a meeting on Intercomparison of GCM sensitivity to 1982-83 El Niño SST anomalies, Tim and I have been fellow travelers in our journey through WCRP panels and committees, numerical experimentation groups including coordinated experiments on dynamics and predictability of monsoons, India’s advisory panel on weather and climate forecasting, and the World Modeling Summit. My talk will briefly touch on these topics with renewed commitment to pursue the yet to be realized dream of kilometer scale global climate models. Finally, I’ll also mention briefly a memorable visit by Tim and Gill to the village of my birth in India.

Presenter: SHUKLA, Jagadish (George Mason University)

Contribution ID: 10

Type: **not specified**

From Hazard Anticipation & Mitigation to Increasing Food Security: Utilizing Ensemble Forecasts in the Developing World

Monday, 5 December 2022 15:45 (25 minutes)

“...one can prepare, one can strive, one can make a choice, but ultimately life is an elaborate game of providence and probability...”
(Daniel Silva, 2021)

During the last three decades, there have been extraordinary advances in the field of weather prediction. At the forefront of these advances have been the creation of ensemble systems using global models with models of ever increasing resolution. ECMWF has been at the forefront of this revolution within which Tim Palmer has played an inspiring role.

Our early work developed probabilistic forecasts of floods of the transboundary rivers of the Ganges and Brahmaputra on the 1-14 day time scales based on ECMWF predictions. These proved to be useful and the system continues to be generated operationally through RIMES (Regional Integrated Multi-Hazard Early Warning System for Africa and Asia) for flood forecasts in Bangladesh. We adapted the system to produce forecasts for the Indus Valley region and for heat wave forecasting in Gujarat, India. The utility of these hazard forecasts have allowed anticipatory actions to be taken which have minimized property, crop loss and fatalities. We provide several examples where probabilistic forecasts have been used successfully in South Asia to mitigate the impact of weather hazards.

More recently, we have shifted our efforts to the agricultural sector of the developing world noting that over 80% of agricultural land across the globe is “rain-fed” (no irrigation) and are regions of food and income insecurity. We are of the belief carefully crafted probabilistic forecasts conveyed to the farmer will allow an optimization of agricultural activities and, hopefully a minimization of food insecurity. In collaboration with PxD (Precision Agriculture for Development: a no-profit organization to support people living in extreme poverty by providing customized digital information and services that increase productivity, profitability, and environmental sustainability) we currently have two regions in our “forecast for farmers” project: The Punjab of Pakistan and Karnataka, India to whom we provide probabilistic 1-14 day forecasts and intraseasonal and seasonal outlooks. PxD acts as the interpretive interface working directly with farming communities and groups.

However, many regions of the world are not reaping the potential benefits from advanced weather forecasting systems, sometimes impeded by social, technological and political reasons, but mainly revolve around the issue of communication. We propose a broader strategy for communication of probabilistic forecasts to user communities across the globe that is simple, rapid and economical in essence the same mode of communication we have developed for the Punjab-Karnataka “forecast for farmers” project in conjunction with PxD. There is a broader aim of this new paradigm whereby aid, relief and lending agencies can concentrate less on recovery following a hazardous event but more on prevention minimization of impacts through capacity building, optimizing agricultural practices, supporting hazard anticipation and mitigation planning. Central to this ambition is the generation of probabilistic forecasts and their communication. We argue that probabilistic forecasts and their thoughtful communication translates into increasing resilience in the face of weather hazards and improving food security in a changing climate.

Presenter: WEBSTER, Peter (School of Earth and Atmospheric Sciences Georgia Institute of Technology)

Contribution ID: 11

Type: **not specified**

Evaluation of ensemble forecasts

Monday, 5 December 2022 12:25 (25 minutes)

Ensemble forecasts play an essential role in quantifying the uncertainty inherent in all weather forecasts. They give a direct assessment of the range of possible future weather scenarios. This provides forecast users with the necessary information to assess the risk of specific events that may affect their activity and to take appropriate decisions. It is important also to provide users with information about the quality of the forecasts and to demonstrate how, for example, using the ensemble can benefit decision-making.

In this talk I will review the different measures used to assess the quality of ensemble forecasts, with a focus on probabilistic scores. The simple cost-loss model of economic decision making gives a useful introduction to the evaluation of forecasts from the user's point of view, illustrating how probabilistic forecasts are inherently more valuable than deterministic forecasts. A key conclusion is that different users will not all gain the same benefit from a given forecasting system. In this framework, several traditional skill scores can be interpreted in terms of economic benefit: different scores are related to different aspects of usefulness and will be relevant to different groups of users.

Presenter: RICHARDSON, David (ECMWF)

Contribution ID: **12**

Type: **not specified**

Welcome

Monday, 5 December 2022 10:00 (10 minutes)

Presenter: RABIER, Florence (ECMWF)

Contribution ID: **13**

Type: **not specified**

Registration

Monday, 5 December 2022 09:30 (30 minutes)