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VIEWPOINT

Describing ECMWF's forecasts and forecasting system

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Describing ECMWF's forecasts and forecasting system

ECMWF Directorate

The terminology we use for our forecasts and forecasting system has evolved over time, taking account of scientific and technical advances, but there is now a need to simplify and improve its consistency. So for example, the medium-range weather forecast at ECMWF is variously referred to as the 'deterministic forecast', 'operational forecast' and 'EPS'. Consequently, the ECMWF Directorate has decided to introduce new terminology with the goals of simplification, minimising confusion and promoting clarity of communication.

The name of the ECMWF forecasting system is the 'IFS', short for the 'Integrated Forecasting System'. The term IFS ought to be the only name used for the system used at ECMWF – a consequence of this is that we will drop other system labels such as the 'EPS' and 'seasonal system'. Another word we need to be careful with is 'operational' to make sure, for example, that it is not used as a label for just one component of the forecasts we disseminate.

The term 'medium-range' is, of course, fundamental to ECMWF given our name. Following guidelines from the WMO, we have been using the definition of lead times from 3 to 10 days to define medium-range. WMO refer to the range from 10 to 30 days as extended-range (although at ECMWF we often use instead the word monthly), and from 30 days to 2 years as long-range. WMO have designated ECMWF as a Global Producing Centre of long-range forecasts – one of 12 around the world.

New definitions

We will describe our medium-range forecast as comprising two component forecasts – the high-resolution and the ensemble forecasts.

The ECMWF global medium-range forecast comprises a high-resolution forecast (HRES) and an ensemble of lower-resolution forecasts (ENS).

This means we will be replacing the term 'deterministic forecast' with 'high-resolution forecast' with the following definition. The HRES is a single prediction that uses observations, prior information about the Earth-system, and ECMWF's highest-resolution model. On average over many forecasts, the HRES is ECMWF's most accurate prediction of future weather up to about 10 days ahead.

The ENS is an ensemble of lower-resolution forecasts; it provides an estimate of the reliability of a single forecast. Reliability is estimated using an ensemble of predictions, and can be expressed as probabilities of forecast weather actually occurring. The ensemble also gives an estimate of the likelihood of significant weather developments by providing other scenarios that might occur. For any particular medium-range forecast it is impossible to know in advance which specific member of the ENS, or indeed the HRES, will be closest to what actually happens.

Twice a week, the ENS is extended up to 32 days using an ensemble of lower resolution forecasts. ECMWF also produces long-range forecasts (seasonal or SEAS) using an ensemble of low-resolution forecasts coupled to an ocean model.

With this new terminology we wish to encourage users of ECMWF forecast products to regard both the HRES and ENS as an inseparable pair. The HRES and ENS forecasts should, wherever possible, be used together to provide the most detailed description of future weather and of the associated uncertainties; this is the theme of the recently revised User Guide (http://www.ecmwf.int/products/forecasts/guide/) which is discussed in *ECMWF Newsletter No. 128* (8–12). The new terminology is clear that HRES and ENS are forecasts from one and the same forecasting system, the IFS.

The presentation of forecast products on the web will be reviewed and over time corresponding HRES and ENS products will be developed and shown jointly. Enhanced technical infrastructure providing fast, on-demand access to large volumes of ENS data will be developed, building on the success of ecCharts.

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a Key characteristics in 2012 of the operational configurations of the ECMWF IFS

	Forecast/Analysis	Number of members	Horizontal resolution	Vertical levels and pressure at model top (hPa)	Perturbation models	IFS cycle
HRES	Forecast 0–10 days	1	T1279/16 km	91/0.01	No	Latest
ENS	Forecast 0–10 days	51	T639/32 km	62/0.5	Yes (in analysis & model physics)	Latest
	Forecast 10–32 days		T319/64 km			
4DVAR	Analysis	1	T1279/16 km (T255 inner loops)	91/0.01	No	Latest
EDA	Analysis	11	T399/50 km (T159 inner loops)	91/0.01	Yes (in observations & model physics)	Latest
SEAS	Forecast 0–13 months	51	T255/80 km	91/0.01	Yes (in analysis & model physics)	2011 version
ERA	Analysis	1	T255/80 km	60/0.1	No	2006 version
BC	Forecast 0–90 hours, hourly output	1	T1279/16 km	91/0.01	No	Latest

b Key characteristics in 2012 of the ENS and SEAS re-forecasts

	Forecast/ Analysis	Number of members	Horizontal resolution	Vertical levels	Top of the Atmosphere	Perturbation models	IFS cycle	Number of years
ENS	Forecast 0–10 days	5 run once a week	32 km	62	0.5 hPa	Yes (in analysis & model physics)	Latest	Most recent 20
	Forecast 10–32 days		64 km					
SEAS	Forecast 0–13 months	15 run once a month	80 km	91	0.01 hPa	Yes (in analysis & model physics)	2011 version	30 (1981–2010)

c Key characteristics in 2012 of the ocean component models of the ECMWF IFS

	Forecast/Analysis	Number of members	Horizontal resolution	Vertical levels	Model cycle
NEMO	Forecast 0–13 months	51	1°	42	Latest
ORA-ORTA	Analysis	5	1°	42	Latest

d Key characteristics in 2012 of the ocean-wave component

	Forecast/Analysis	Domain	Number of members	Horizontal resolution	Number of directions	Number of frequencies
LAM WAM	Analysis + forecast 0–5 days	Limited: 5°N-90°N, 98°W-54°E	1	11 km	36	36
WAM HRES	Analysis + forecast 0–10 days	Global	1	28 km	36	36
WAM ENS	Forecast 0–10 days	Global	51	55 km	24	30
	Forecast 10–32 days				12	25
WAM SEAS	Forecast 0–13 months	Global	51	111 km	12	25

Table 1 The ECMWF Integrated Forecasting System (IFS).

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ECMWF forecasts and the ECMWF Integrated Forecasting System

The following text will be used on the website and elsewhere as a description of the forecasting system and the forecasts.

ECMWF produces a suite of operational forecasts for various lead times:

- ***Medium-range forecast:*** comprises the high-resolution and the ensemble forecasts of weather, at the space and time-scales represented by the relevant model, up to 10 and 15 days ahead, respectively, and the associated uncertainty.
- ***Extended-range (monthly) forecast:*** comprises ensembles of individual forecasts and post-processed products of average conditions (e.g. weekly averages) up to 1 month ahead, and the associated uncertainty.
- ***Long-range forecast:*** comprises ensembles of individual forecasts and post-processed products of average conditions (e.g. monthly averages) up to 13 months ahead, and the associated uncertainty.

In addition re-forecasts are calculated operationally using the current system configuration but applied to the weather over past decades:

- ***Re-forecasts:*** comprise forecasts run for past decades necessary to estimate the model climate and the level of skill and to generate some of the operational products.

These forecasts are produced using the ECMWF Integrated Forecasting System (IFS). The IFS comprises various components. These are described below and their key characteristics are summarised in Table 1.

There are five component models of the IFS.

- ***Atmospheric model*** with various configurations suited to the space scale and time range of the required forecasts. The current configurations for HRES, ENS and Boundary Conditions (BC) are given in Table 1a.
- ***Ocean wave model*** is a version of the WAM model which has been further developed in house. It is coupled to the atmospheric model or run as a standalone model in the Limited-Area Wave (LAW) configuration.
- ***Ocean model*** is a version of the NEMO (Nucleus for European Modelling of the Ocean) model.
- ***Process models*** are used to describe, for example, land-surface processes, surface ocean waves, and sea-ice.
- ***Perturbation models*** are used to simulate the effect of uncertainties in the observations, initial conditions, surface boundary conditions, and modelled processes. These produce perturbations for use in ensemble forecasts.

In addition, there are five components for analysing the state of the atmosphere and oceans.

- ***4DVAR (4-Dimensional Variational analysis)*** provides a detailed estimate of the current state of the atmosphere computed utilising as optimally as possible observations and prior information about the Earth-system using ECMWF's highest resolution model.
- ***EDA (Ensemble of Data Assimilations)*** provides an ensemble of estimates of the current state of the atmosphere and its uncertainty. The EDA estimate of the analysis uncertainty can be used as an approximation of the 4DVAR uncertainty. The current configuration of EDA is given in Table 1a.
- ***ORTA (Ocean Real-Time Analysis)*** provides an estimate of the ocean initial state and its uncertainty. The current configuration of ORTA is given in Table 1c.
- ***ERA (ECMWF Reanalysis)*** provides consistent estimates of the state of the atmosphere generated using a fixed, lower-resolution version of 4DVAR for the past decades. The latest ERA product, ERA-Interim, covers the period since 1979 and is continued in real time to support climate monitoring. ERA-Interim is also used to define the atmospheric initial conditions of the re-forecasts.
- ***ORA (Ocean Reanalysis)*** is the equivalent of ERA for the oceans.

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What next?

It is envisaged that the new terminology will be consistently used in the Web2013 project (*ECMWF Newsletter* No 131, 2–4) which will provide a redesigned ECMWF website and more accessible information about the forecasting system, and the ECMWF products and services. In the meantime, on the current web pages, the page describing the forecasting system (http://www.ecmwf.int/about/forecasts.html) and the dissemination manual will be updated and replaced. The new terminology will also be used for the autumn sessions of the Council and the Committees. We encourage everyone to start using the new terminology!

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