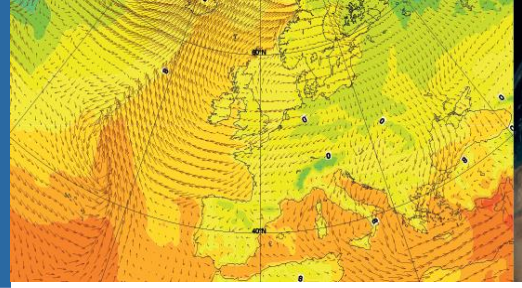



How ECMWF has addressed requests from the data users

David Richardson
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ECMWF

Overview

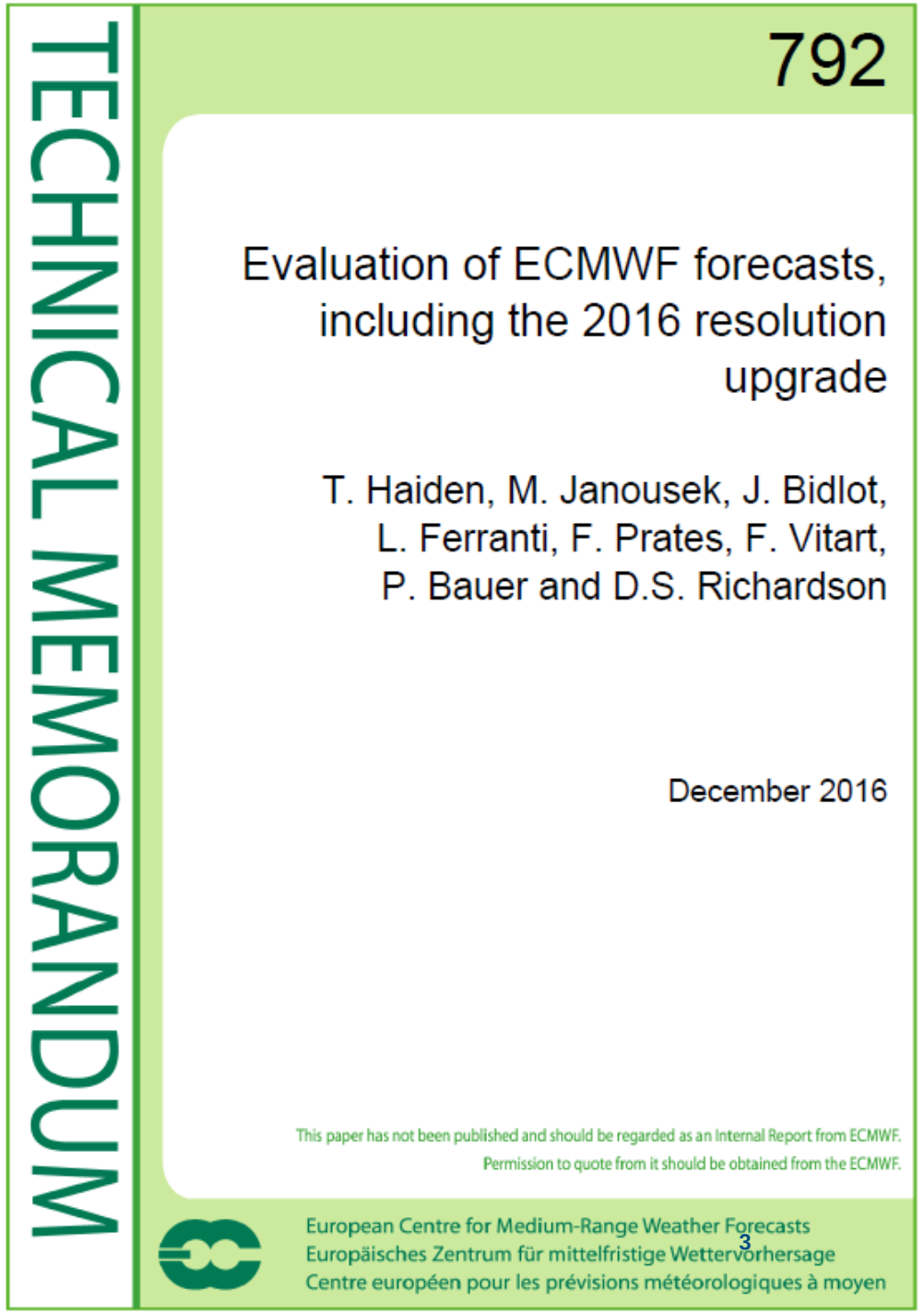
Review the efforts made by ECMWF to address feedback and requests from users of ECMWF forecasts and data over the last year

- Forecast performance – more extensive verification on www, more on surface
- New forecast output fields:
  - four cloud and freezing diagnostics,
  - new direct-beam solar radiation diagnostic, revised sunshine duration diagnostic
  - extended set of ocean wave forecast parameters
- New web Charts catalogue, additions to ecCharts
- Earlier delivery of the medium-range ensemble forecasts

Forecast performance

- 6 headline scores
  - HRES and ENS upper-air skill
  - HRES and ENS precipitation
  - Severe weather: TC position and EFI for extreme wind
- Comparison with reference systems
- Comparison with other centres
- Evaluation for severe weather
- Additional verification and in-depth diagnostics
- See ECMWF web site for latest results

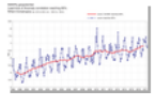
www.ecmwf.int/en/forecasts/quality-our-forecasts



Verification – more scores on www

- All 6 headline scores, including TC position (6-monthly) and wind speed EFI ROC (3-monthly)
- TIGGE-based model intercomparison: binned spread-skill, T850 CRPSS, etc; updated 3-monthly
- ENS surface verification
- Wave forecast ENS verification

Headline scores


Lead time of ACC reaching a threshold


Lead time of CRPSS of T850 reaching a

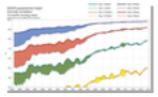

Lead time of CRPSS of 24h precipitation

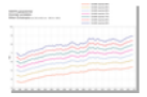

Lead time of 1-SEEPS of 24-h


ROC skill score of Extreme Forecast


Errors of tropical cyclone forecasts

Verification of high-resolution forecasts


Anomaly correlation of ECMWF 500hPa

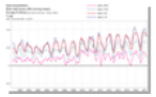

Lead time of ACC reaching multiple


Verification of the high-resolution

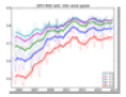

Lead time of ACC reaching a threshold


Lead time of 1-SEEPS of 24-h

Verification of ensemble forecasts


Brier skill score of weather parameters


Cost loss ratio diagrams for


ROC skill score of EFI


Reliability diagrams for weather

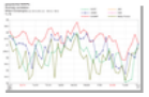
Comparison of verification scores to other centres

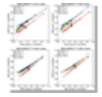

Monthly WMO scores over Europe


Monthly WMO scores over Extra-


Monthly WMO scores over Tropics


Verification of other centres (MSL


Verification of other centres (upper air)

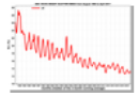

Spread reliability diagram for ENS

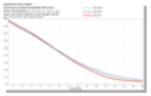
Wave products comparison against in-situ data and analysis


Ocean waves and 10m wind


Annual scores for waves and wind

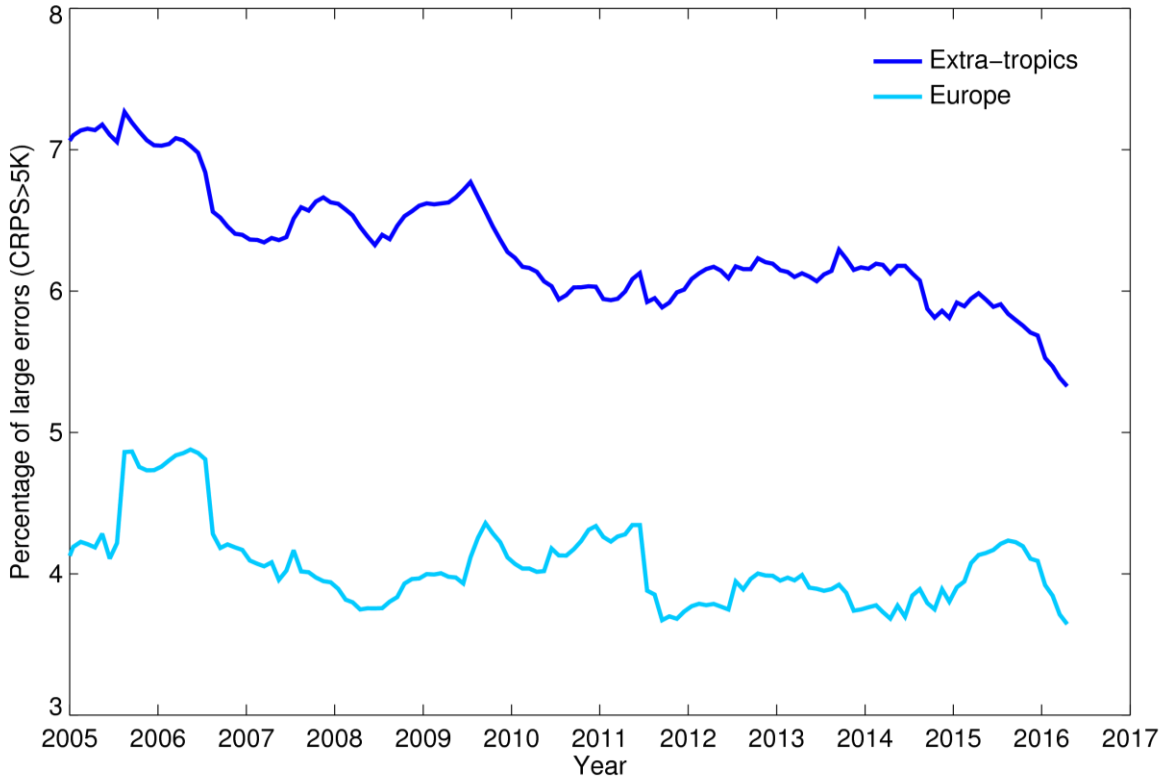

Comparison with other operational


Timeseries of statistics for wave


Skill scores of ENS forecasts of ocean

TAC Subgroup on verification measures 2016-17

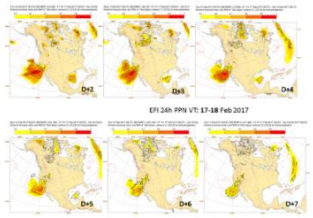
- Technical Advisory Committee review
- propose two additional ENS headline scores:
  - frequency of large 2 m temperature errors as measured by the Continuous Ranked Probability Score (CRPS) exceeding a given threshold
  - skill in predicting weekly means of 2-m temperature anomalies as measured by the Ranked Probability Skill Score applied to terciles or higher quantiles
- Recommend to include the routine evaluation of additional (non-headline) scores, such as for precipitation and 10-m wind speed in the extended range
- Recommend the use of ERA5 as a reference forecasting system



Severe event catalogue

https://software.ecmwf.int/wiki/display/FCST/Severe+Event+Catalogue

Featured



201702 - Rainfall - California

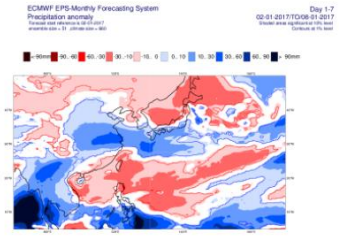
A major storm was responsible for the floods in California on 17-19 February (strong winds were reported as well). This was not the first event of the season and California has been battered by anomalous wet weather. The week before more than 150K people were forced to abandon their homes due to a problem with a crack in Lake Oroville's dam as a result of excessive water. The anomalous wet season came after several years of drought conditions in California.

Read more . . .

201701 - Cold spell, snowfall - Europe

During the first week of January the north-eastern central and south-eastern part of Europe was hit by a cold spell resulting in temperatures below 40C in Sweden and Finland and temperatures below 30C far down on the continent. In connection, many countries in southern and south-eastern Europe (e.g Italy, Greece and Turkey) were hit by severe snowfall.

Read more . . .



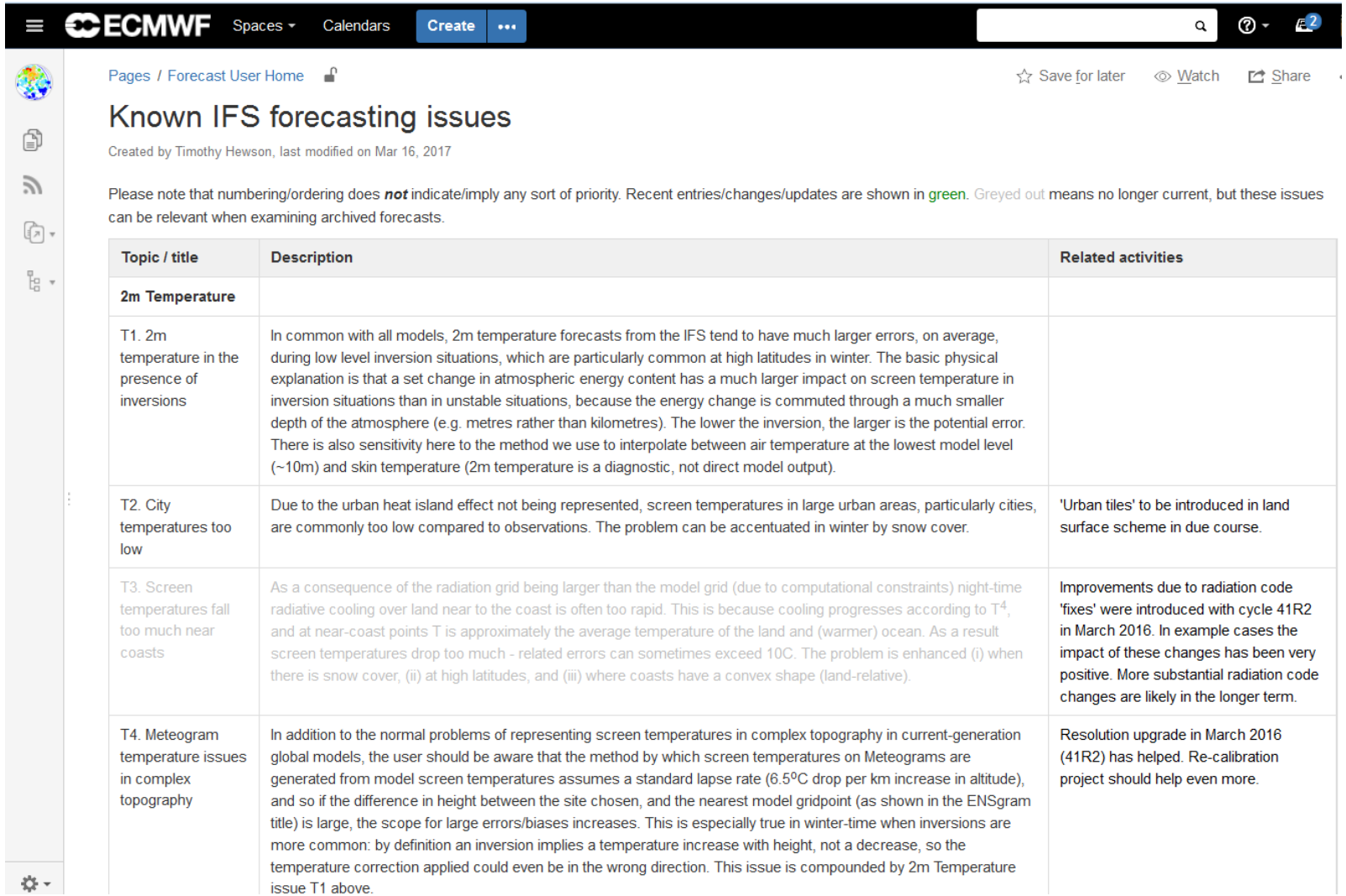
201701 - Rainfall - Thailand

In the beginning of January severe and unseasonal rainfall hit southern Thailand, with daily rainfall reaching above 600 mm (5 January) for the worst station. At least 21 people have been killed due to the rain.

Read more . . .

201607 - Rainfall - China
201607 - Tropical cyclone - Nepartak
201608 - Rainfall - Louisiana US
201608 - Rainfall Macedonia (FYROM)
201609 - Heatwave - Western Europe
201609 - Tropical Cyclone - Hermine
201609 - Tropical Cyclone - Matthew
201609 - Windstorm - Australia
201611 - Rainfall - SE Europe
201611 - Rainfall - Southern Europe
201611 - Rainfall - Valencia Spain
201611 - Snowfall - Stockholm
201611 - Windstorm - Angus
201612 - Cold spell - US
201612 - Rainfall - S Spain
201612 - Windstorm - Barbara / Conor / Urd
201701 - Cold spell, snowfall - Europe
201701 - Rainfall - Thailand
201701 - Windstorm - Egon
201702 - Heatwave - Australia
201702 - Rainfall - California
201702 - Windstorm - Doris
201703 - Rainfall - Peru
201703 - Snowfall - US eastcoast
201703 - Windstorm - Zeus
201704 - Cold Spell - Europe
201704 - Convection -US

Known forecasting issues



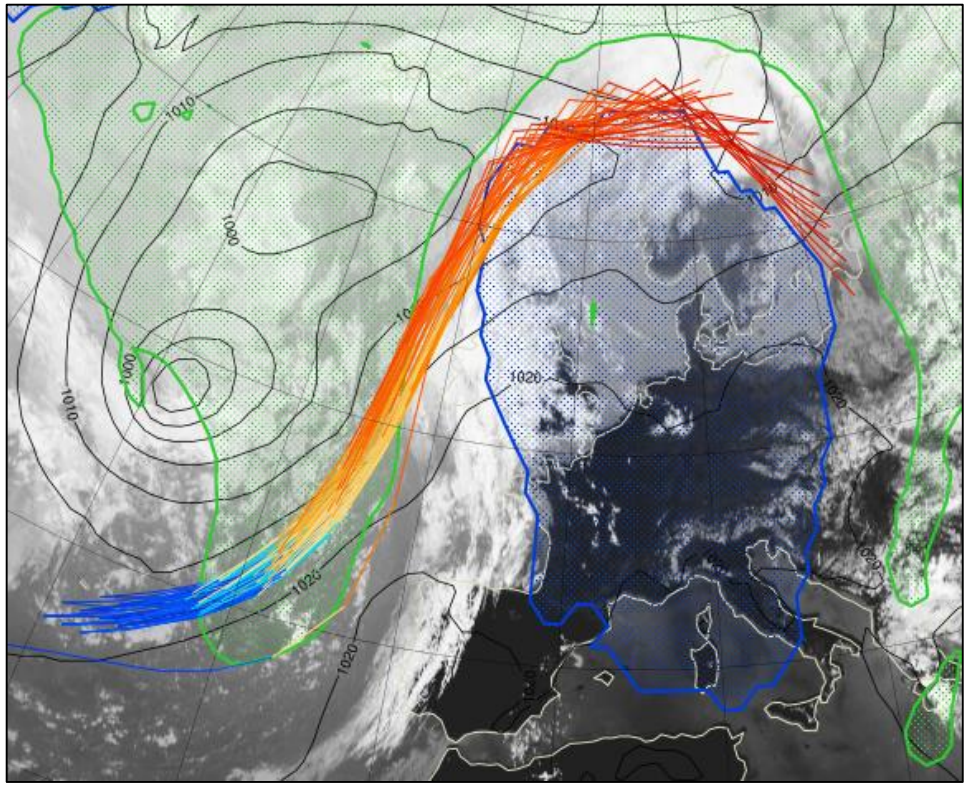
Topic / title	Description	Related activities
2m Temperature		
T1. 2m temperature in the presence of inversions	In common with all models, 2m temperature forecasts from the IFS tend to have much larger errors, on average, during low level inversion situations, which are particularly common at high latitudes in winter. The basic physical explanation is that a set change in atmospheric energy content has a much larger impact on screen temperature in inversion situations than in unstable situations, because the energy change is commuted through a much smaller depth of the atmosphere (e.g. metres rather than kilometres). The lower the inversion, the larger is the potential error. There is also sensitivity here to the method we use to interpolate between air temperature at the lowest model level (~10m) and skin temperature (2m temperature is a diagnostic, not direct model output).	
T2. City temperatures too low	Due to the urban heat island effect not being represented, screen temperatures in large urban areas, particularly cities, are commonly too low compared to observations. The problem can be accentuated in winter by snow cover.	'Urban tiles' to be introduced in land surface scheme in due course.
T3. Screen temperatures fall too much near coasts	As a consequence of the radiation grid being larger than the model grid (due to computational constraints) night-time radiative cooling over land near to the coast is often too rapid. This is because cooling progresses according to T^4, and at near-coast points T is approximately the average temperature of the land and (warmer) ocean. As a result screen temperatures drop too much - related errors can sometimes exceed 10C. The problem is enhanced (i) when there is snow cover, (ii) at high latitudes, and (iii) where coasts have a convex shape (land-relative).	Improvements due to radiation code 'fixes' were introduced with cycle 41R2 in March 2016. In example cases the impact of these changes has been very positive. More substantial radiation code changes are likely in the longer term.
T4. Meteogram temperature issues in complex topography	In addition to the normal problems of representing screen temperatures in complex topography in current-generation global models, the user should be aware that the method by which screen temperatures on Meteograms are generated from model screen temperatures assumes a standard lapse rate (6.5^{o}C drop per km increase in altitude), and so if the difference in height between the site chosen, and the nearest model gridpoint (as shown in the ENSgram title) is large, the scope for large errors/biases increases. This is especially true in winter-time when inversions are more common: by definition an inversion implies a temperature increase with height, not a decrease, so the temperature correction applied could even be in the wrong direction. This issue is compounded by 2m Temperature issue T1 above.	Resolution upgrade in March 2016 (41R2) has helped. Re-calibration project should help even more.

https://software.ecmwf.int/wiki/display/FCST/Known+IFS+forecasting+issues

Diagnostics

Diagnostic tools are continuously reviewed and developed:

- EDA variance budgets
- EFI for water vapour transport
- Regime transitions
- Error tracking
- Review of diagnostics work and associated tools



The aim is to improve ECMWF's abilities to access process-level information for diagnostic studies:

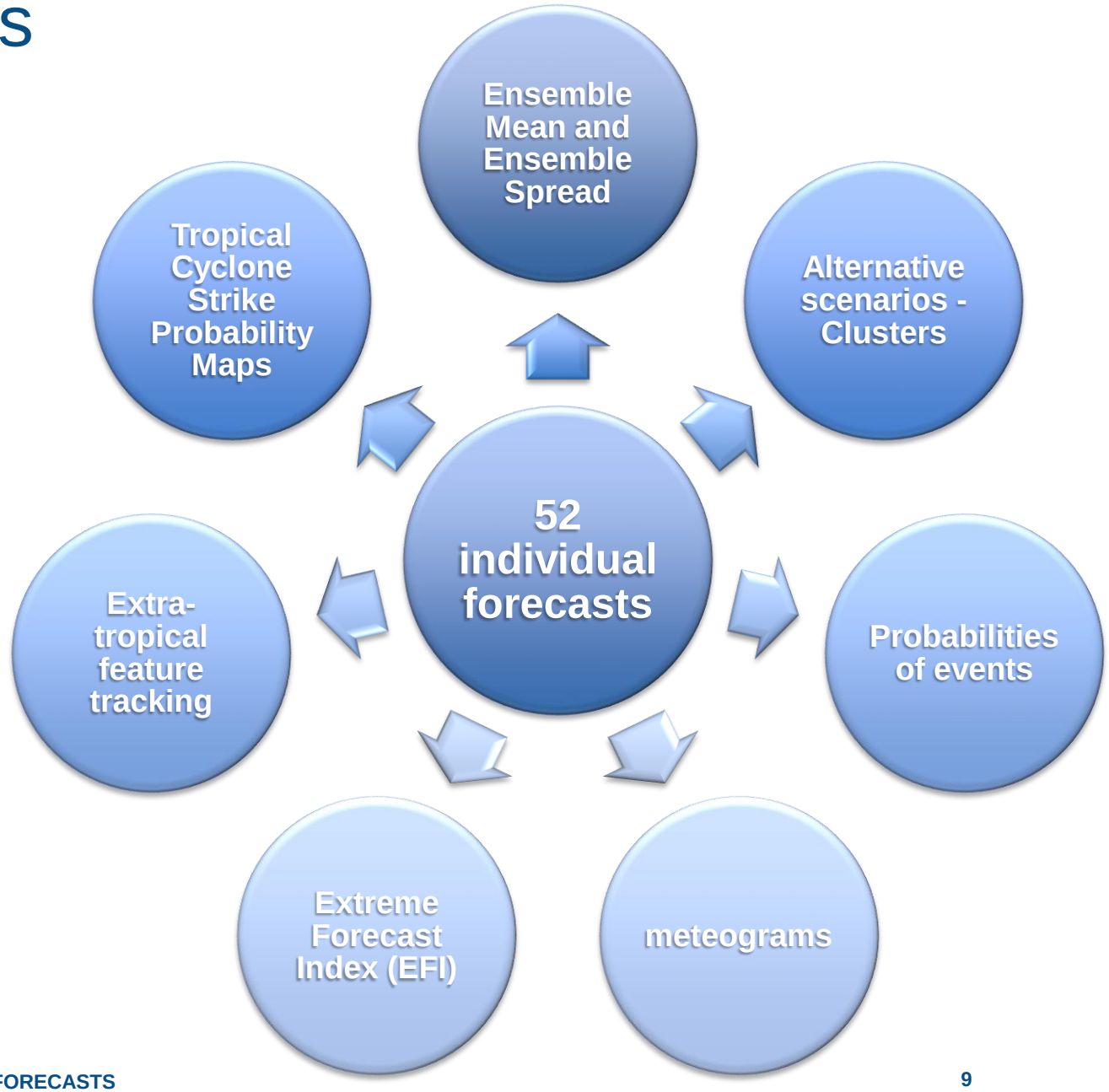
- More spatio-temporal decomposition of forecast variances and errors
- Maintenance and use of non-assimilated/independent data sources
- External collaboration (e.g. with ETH Zurich on the role of "warm conveyor-belts" in the development of downstream forecast error).

ECMWF forecast products

- Summarise information in HRES and ENS
- Represent uncertainty
- Broad-scale evolution out to 15 days
- Changes in weather regime
- Highlight potential for severe weather few days ahead
- Monthly and seasonal outlooks

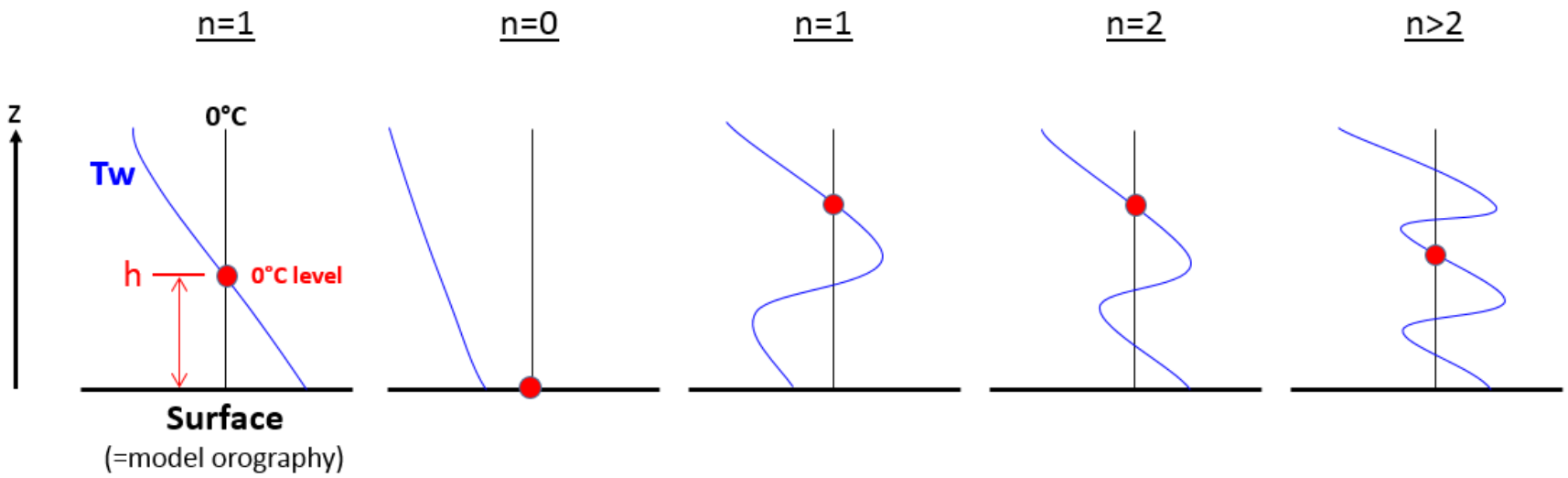
- To assist operational forecasters (in Member States)

- Users generate their own tailored products for specific applications



New freezing level outputs (November 2016)

- Height of zero-degree wet-bulb temperature
- Height of one-degree wet-bulb temperature

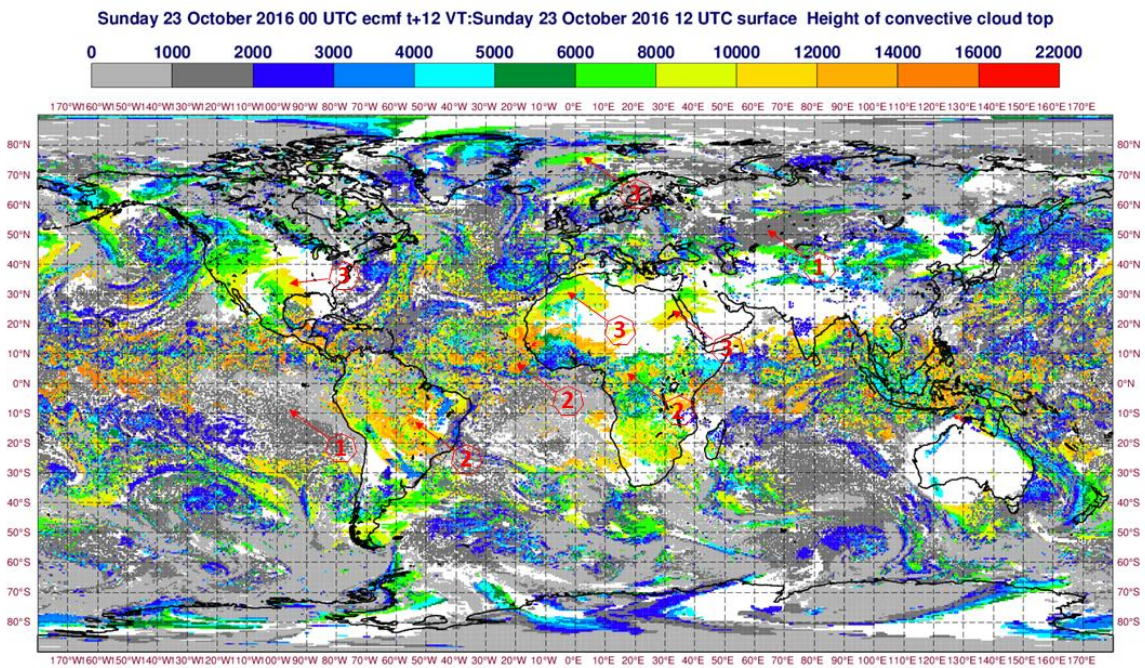


Blue lines show wet bulb temperature profiles, in different scenarios
n = number of levels at which Tw drops below zero when scanning upwards

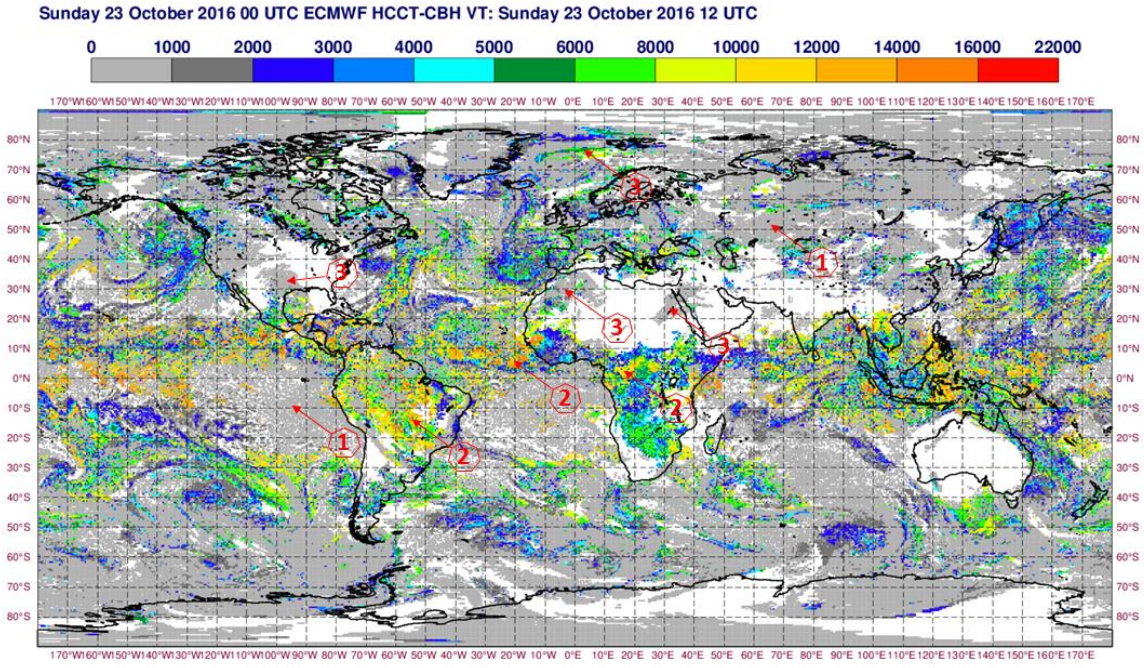
Stored value = h, where h = height above model orography, or lake/sea (in metres)

New cloud outputs (November 2016)

- Height of convective cloud top (HCCT)



Convective cloud top (m above ground)

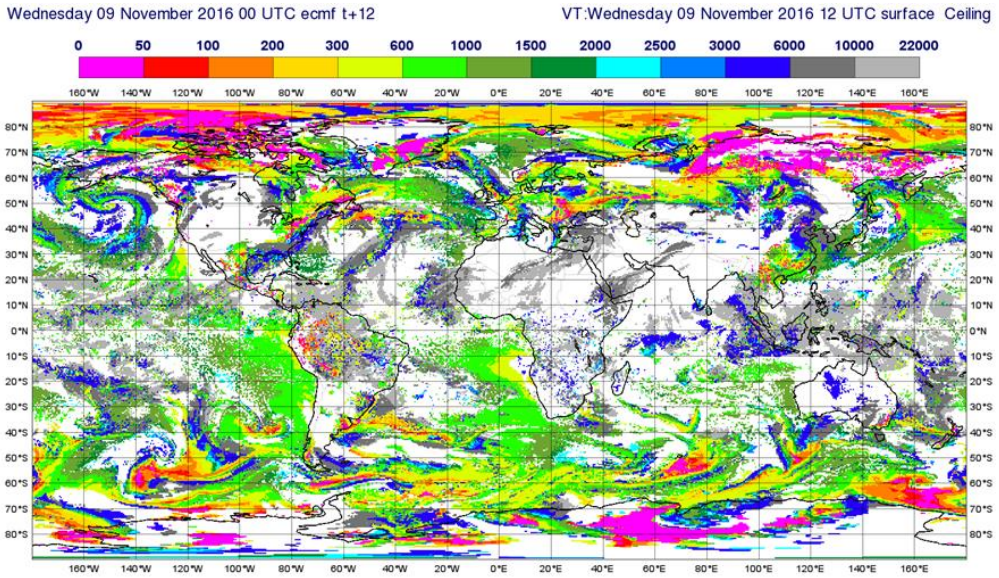


Cloud depth: HCCT – cloud base height (m)

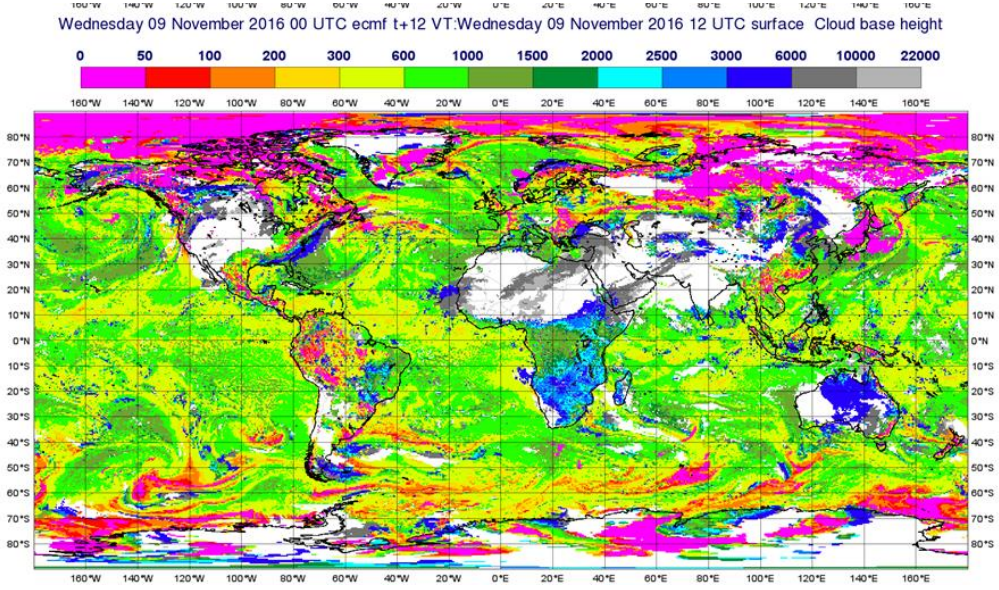
1 → Shallow convection, 2 → DMC, 3 → Mid-level convection

Ceiling (November 2016)

- Ceiling: height in metres (m), above the level of the model orography, of the base of the lowest cloud layer covering more than 50% of the sky (more than 4 oktas). This follows the definition of Ceiling used in aviation (ICAO), except that we also represent situations of >6000 m (~20000 ft).



Ceiling (>50% cover)

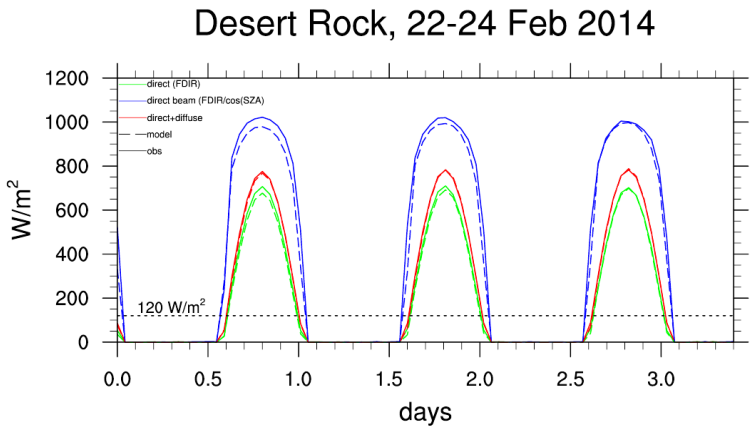


Cloud base height (>1% cover)

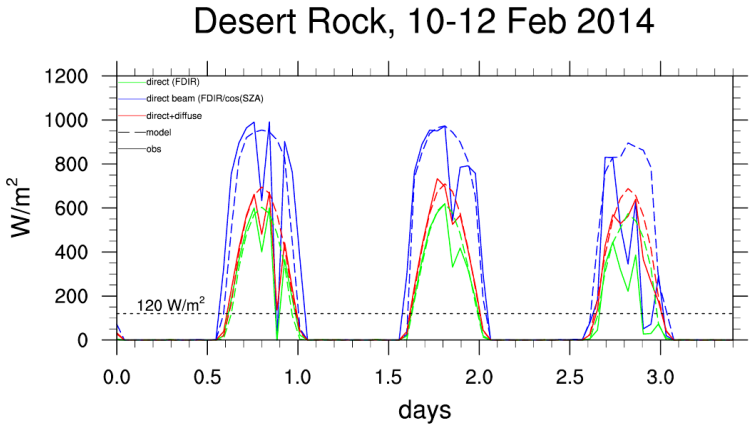
New solar radiation outputs (November 2016)

- New direct-beam solar radiation diagnostic
- Revised sunshine duration (to match WMO specification)

- What else do you need?



[a]

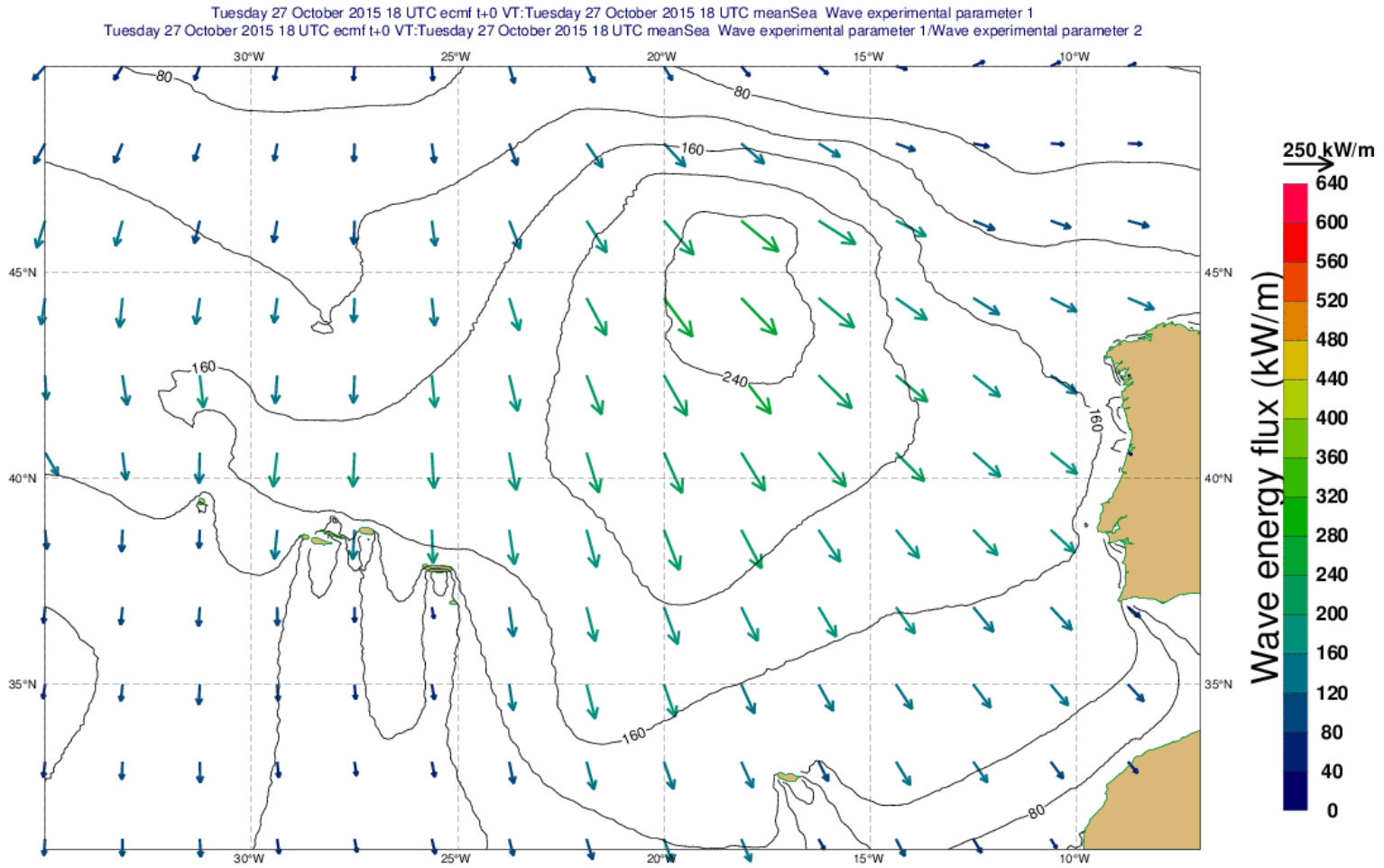


[b]

Figure 2: Hourly instantaneous surface solar radiation at the SURFRAD station of Desert Rock, Nevada for a) three clear sky days and b) three days with mixed sky conditions. Dashed lines for model values, full lines for observations.

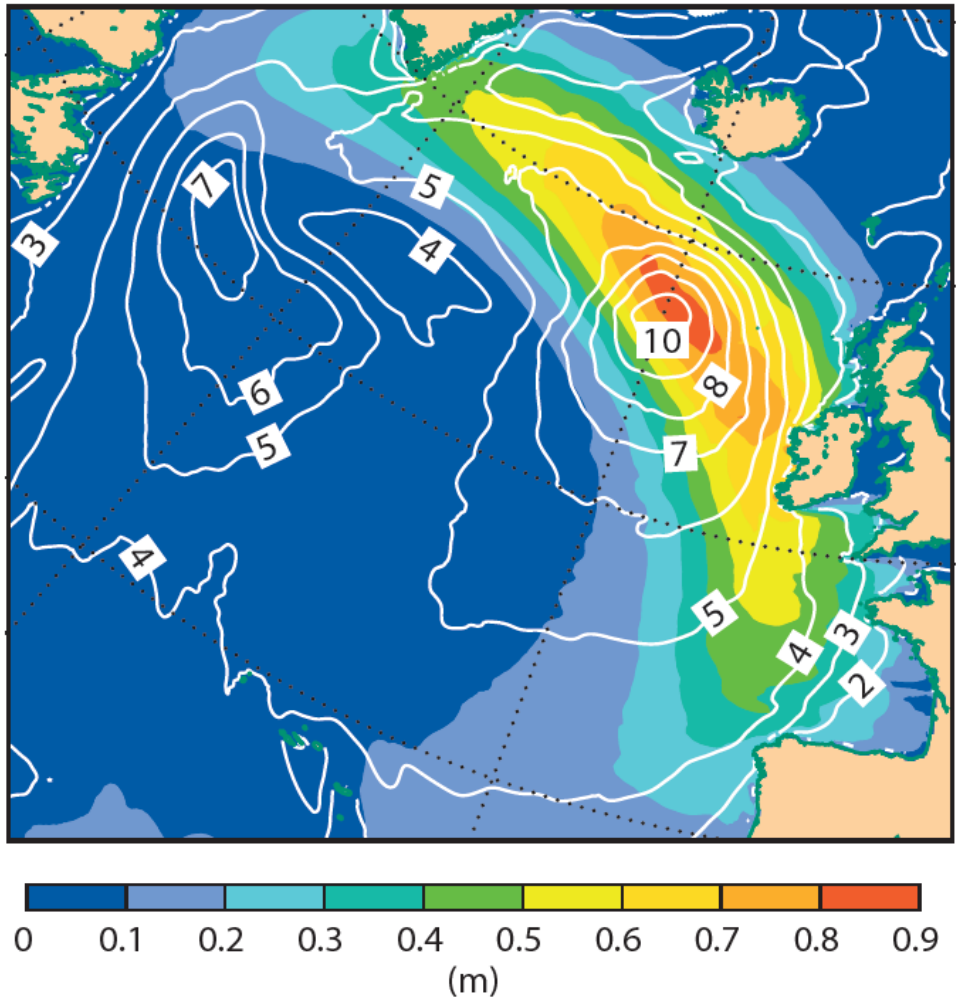
New ocean wave outputs (November 2016)

- The magnitude and direction of the wave energy flux that is responsible for the impact of the waves on coastlines and offshore structures



New ocean wave outputs (November 2016)

- Significant wave height of all waves in six different period ranges to help with the detection of low frequency wave energy

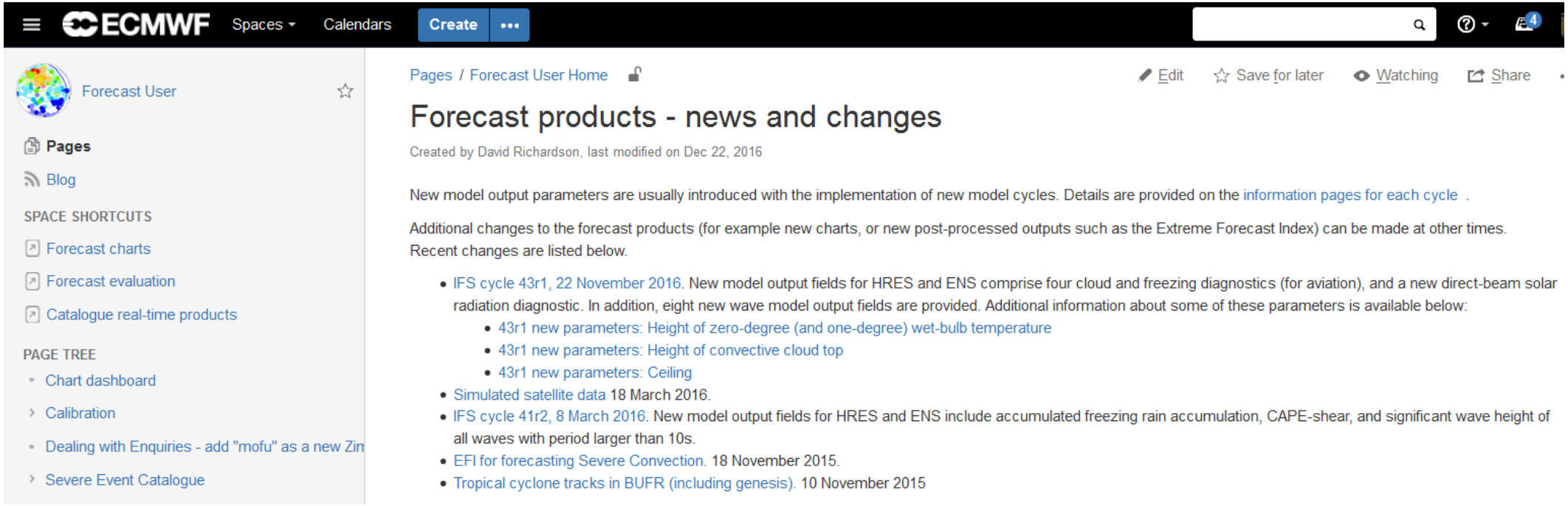


180-hour initialised at 00 UTC on 2 December 2016

- significant wave height for all waves (contours)
- significant wave height for all waves with periods between 21 and 25 seconds (shading)

Highest significant wave heights are confined to the storm location (south of Iceland) but long waves from that storm are already affecting coastlines from Iberia to South Greenland

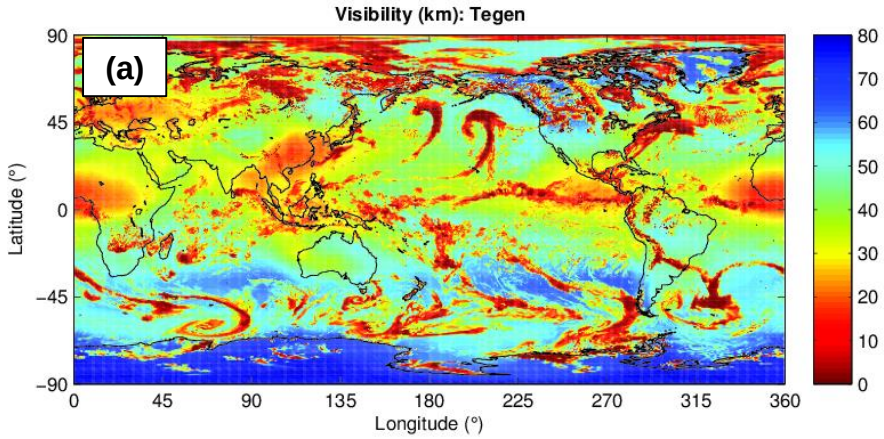
News on forecast products – forecast user portal

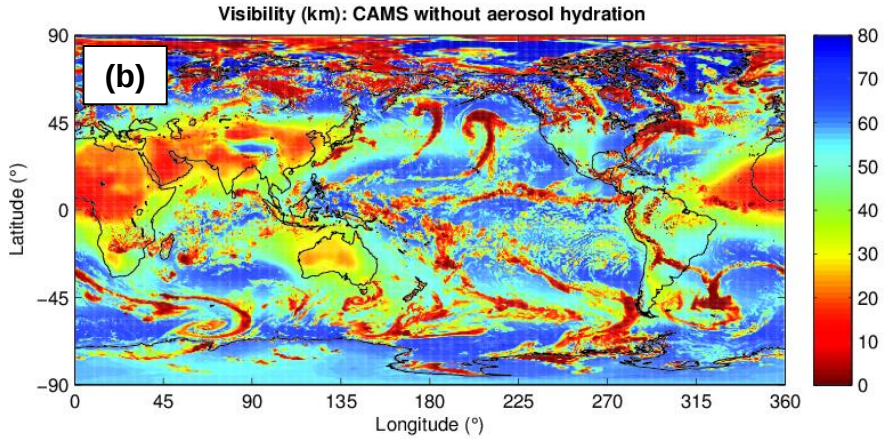


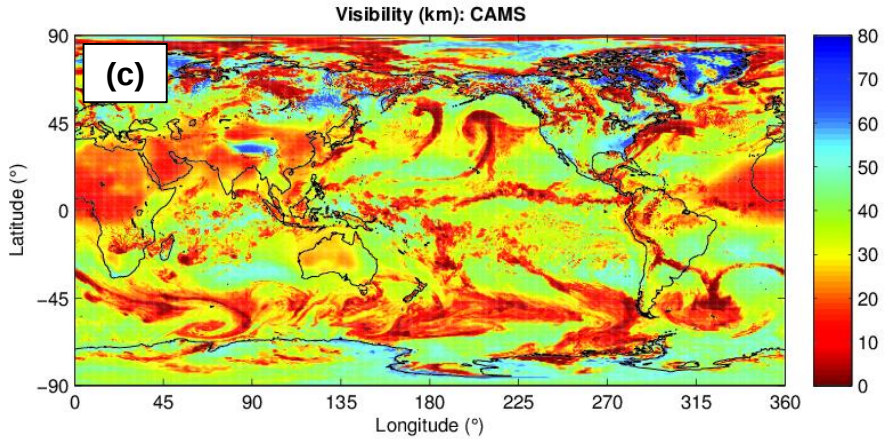
Visibility – revised July 2017 (43r3)

- New aerosol seasonally varying climatology based on CAMS aerosol re-analysis including dependence on relative humidity in 43r3
- Visibility clear sky calculation uses the new aerosol and will vary with relative humidity

Example snapshot of visibililty using:
(a) current Tegen aerosol climatology (**43r1**),
(b) new CAMS aerosol climatology with no hydration
(c) new CAMS aerosol climatology with hydration (**43r3**)

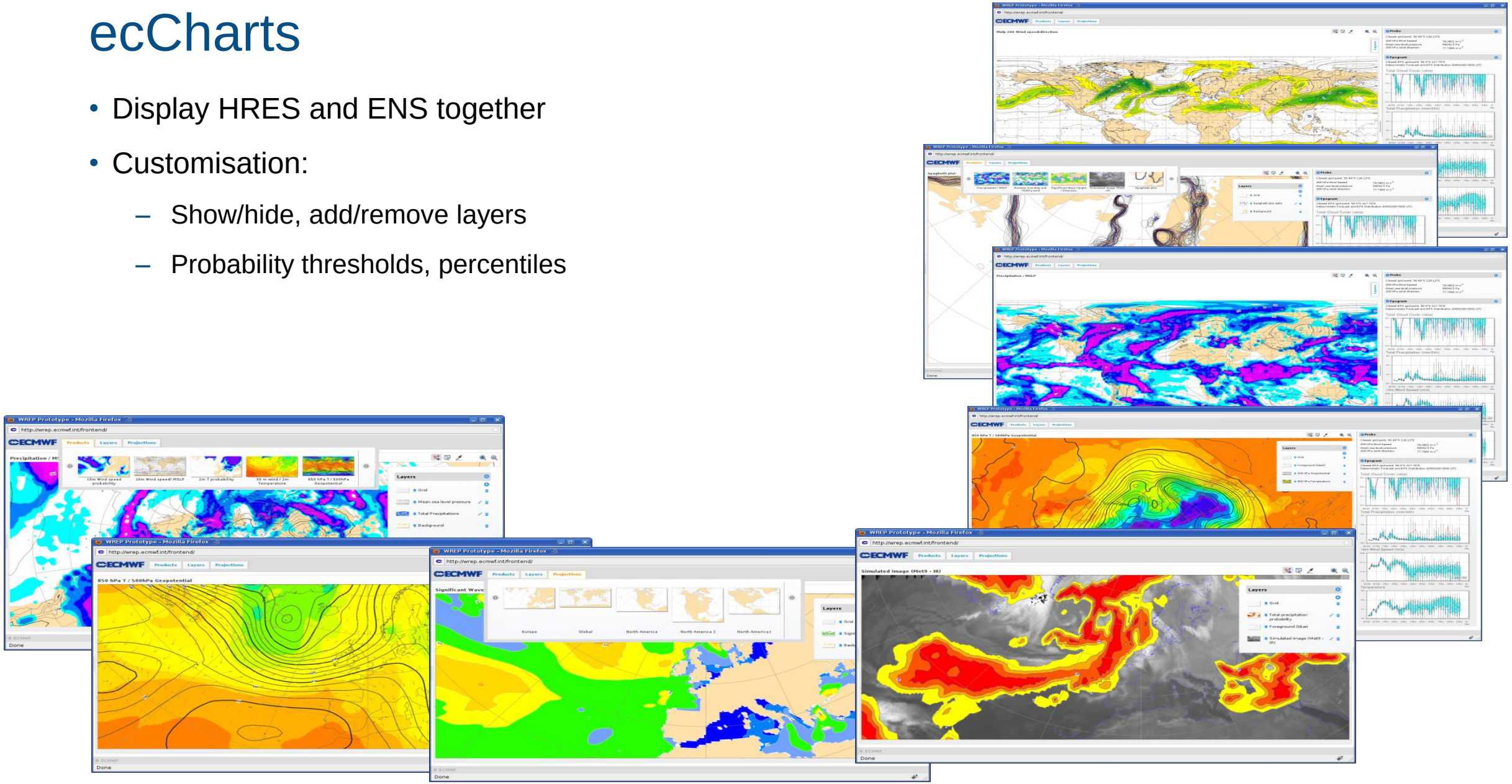






ecCharts

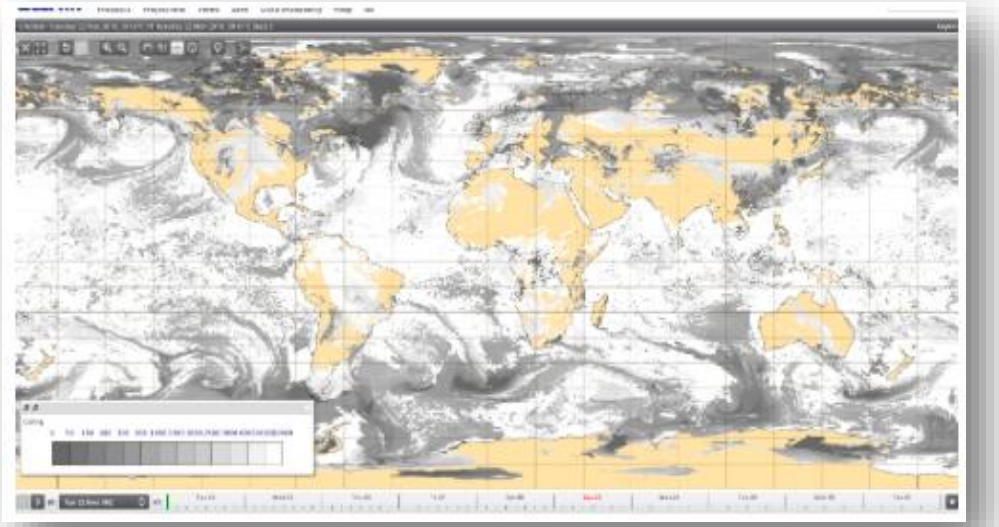
- Display HRES and ENS together
- Customisation:
  - Show/hide, add/remove layers
  - Probability thresholds, percentiles



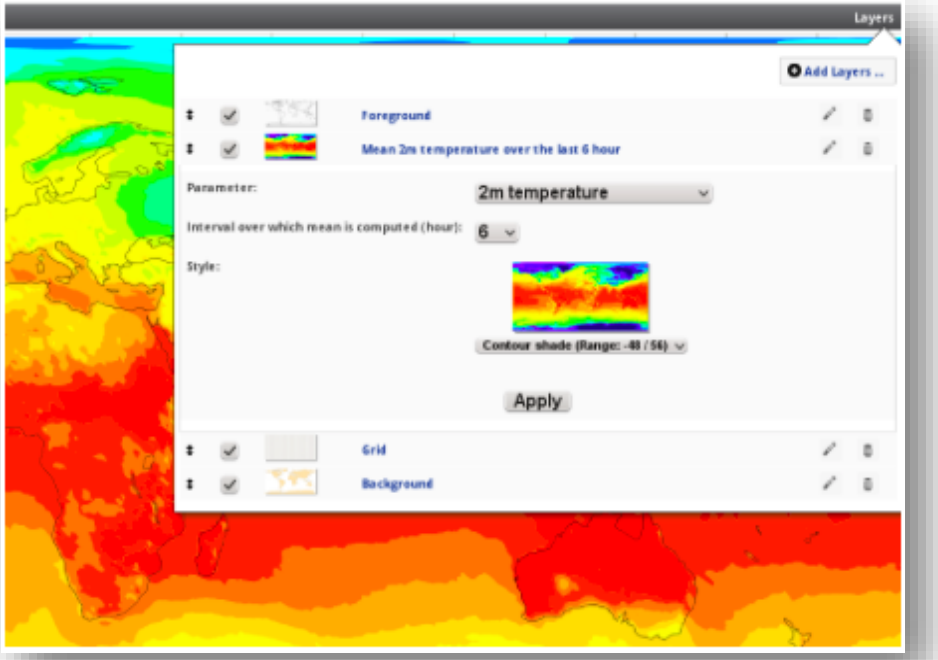
New products in ecCharts

ecCharts products are
updated on a regular basis

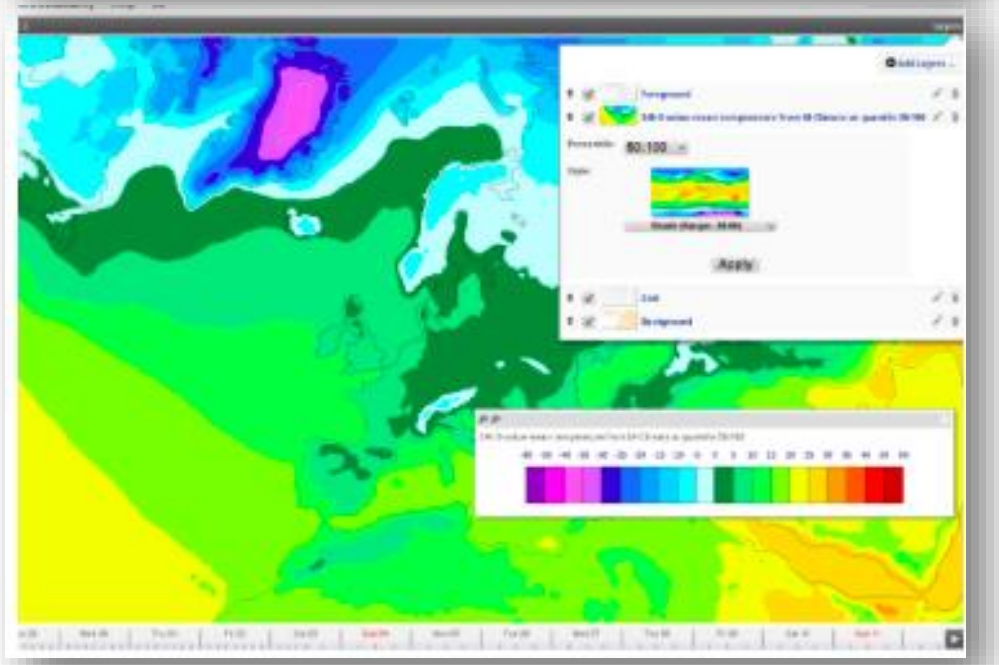
Cloud ceiling



2m mean temperature computed over
user selected time periods



M-climate



The charts catalogue

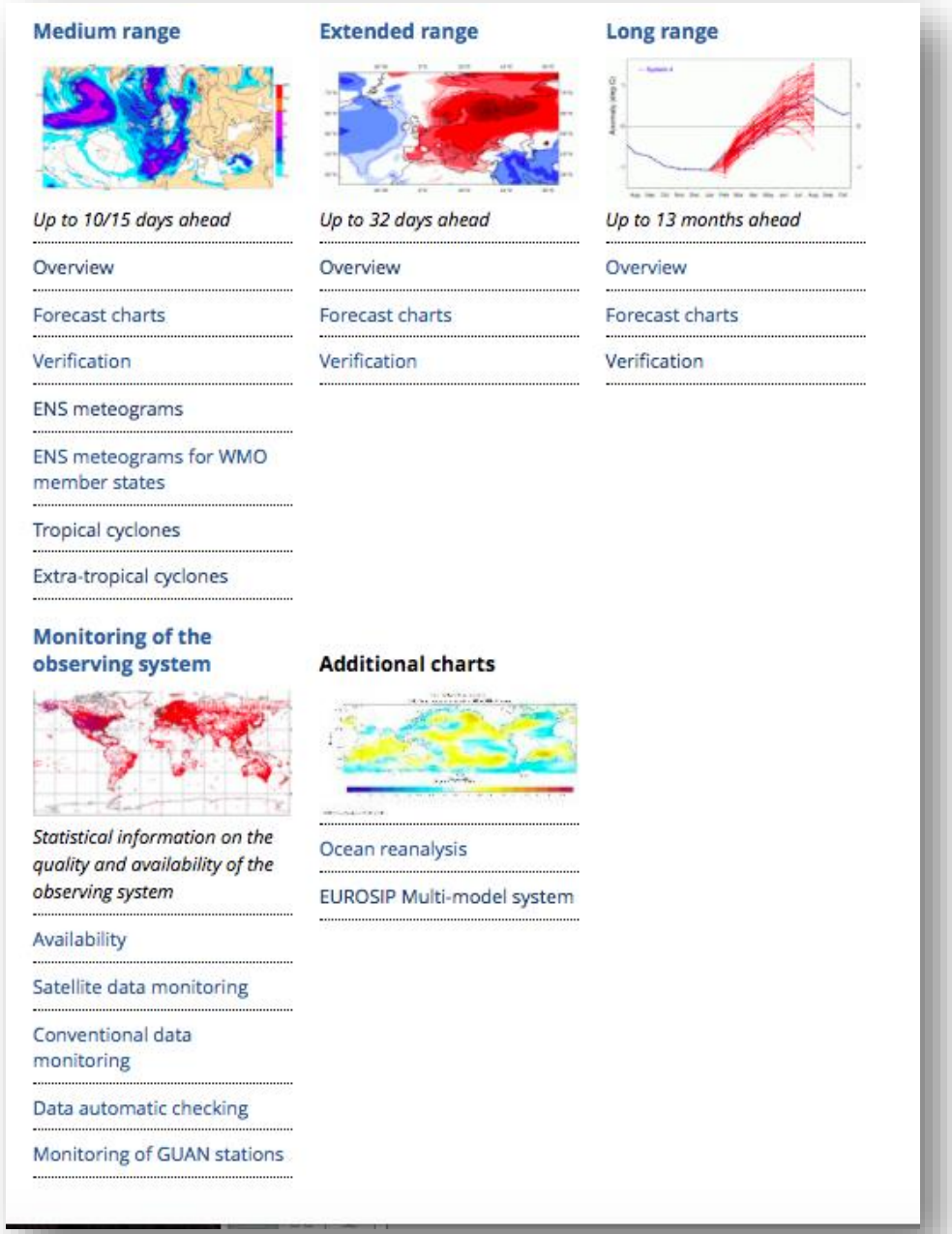
Implemented on 3rd May 2017!

NEW! Welcome to our new Charts catalogue.

In this version:

* we have merged our charts in a single catalogue that can be browsed through facets.
* we have reviewed the medium range charts:
  - charts are generated from native data resolution.
  - high resolution charts are made available based on ECMWF dissemination schedule.
  - we have increased their size and prepared more geographical domains.
  - with a single click you can now access the meteograms at any point.

We hope you enjoy it, and we welcome your feedback.



Earlier delivery of ENS

- 7 March 2017: ECMWF started disseminating medium-range ENS 40 minutes earlier
- 15-day ENS from 0000 UTC analysis available at 0800 UTC.

Dissemination schedule

Expand all **Collapse all**

Real-time data are pushed to users' servers on the schedule shown below. If you need to re-transmit files login to ECPDS.

▶ Set I - Atmospheric Model high resolution 10-day forecast (HRES)

▶ Set II - Ocean Wave Model high resolution - Analysis and 10-day Forecast (HRES-WAM & HRES-SAW)

▼ **Set III - Atmospheric Model low resolution 15-day forecast (ENS)**

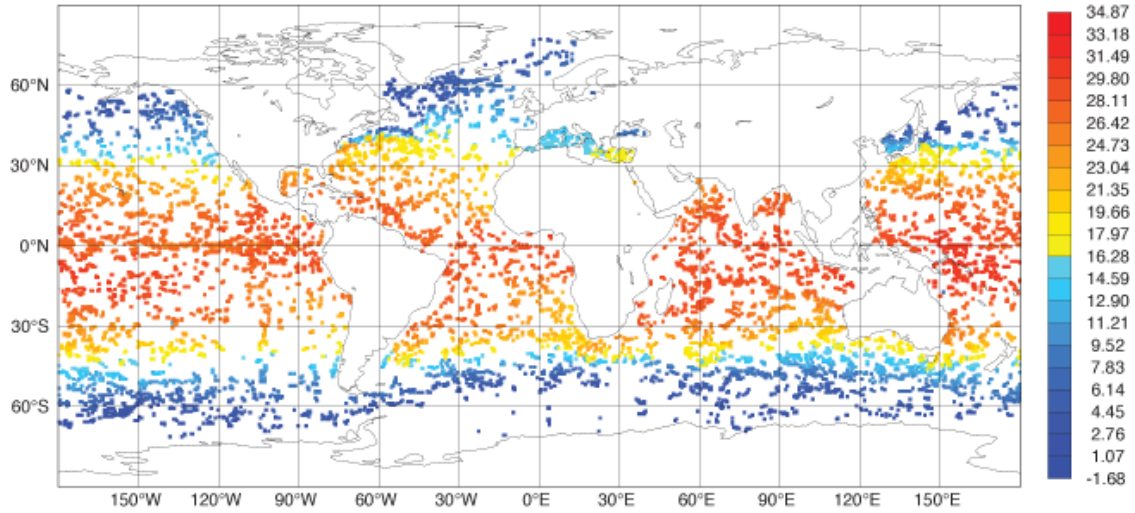
(dissemination data stream indicator = E)

NEW! New Schedule valid from 7 March 2017

12 UTC based Forecast time	Time Available	00 UTC based Forecast time	Time available
Forecast Day 0	19:00	Forecast Day 0	07:00
Forecast Day 10	19:40	Forecast Day 10	07:40
Forecast Day 15	20:00	Forecast Day 15	08:00
Derived products Step 0 to 240	19:41	Derived products Step 0 to 240	07:41
Derived products Step 246 to 360	20:01	Derived products Step 246 to 360	08:01

Observation monitoring

- Routine monitoring of all available observations
  - Provide valuable feedback to data providers and other NWP centres
  - Assess model developments and highlight analysis issues
  - Safeguard the analysis from poor-quality observations
  - Improve observations usage
- Automatic alarm system
- Participating in the modernisation of WMO's monitoring, and contributing to the WMO Integrated Global Observing System (WIGOS)
- Contributing to EUMETNET's Obs. Programme
- Supporting the migration to BUFR
- NEW: monitoring of ocean data



Mean potential temperature (in °C) of the first 5 metres of the ocean as measured by Argo floats over the period 1 February 2017 to 27 March 2017.

Working with users to improve performance and products

- Annual meeting Using ECMWF's Forecasts (UEF) for all users of ECMWF forecasts
- Liaison visits by ECMWF staff to Member and Co-operating States
- Annual reports from Member and Co-operating States on "The application and verification of ECMWF's forecast products"
- Forecast user portal (severe event catalogue, known issues)
- Real-time feedback from operational forecasters