

# ecCharts

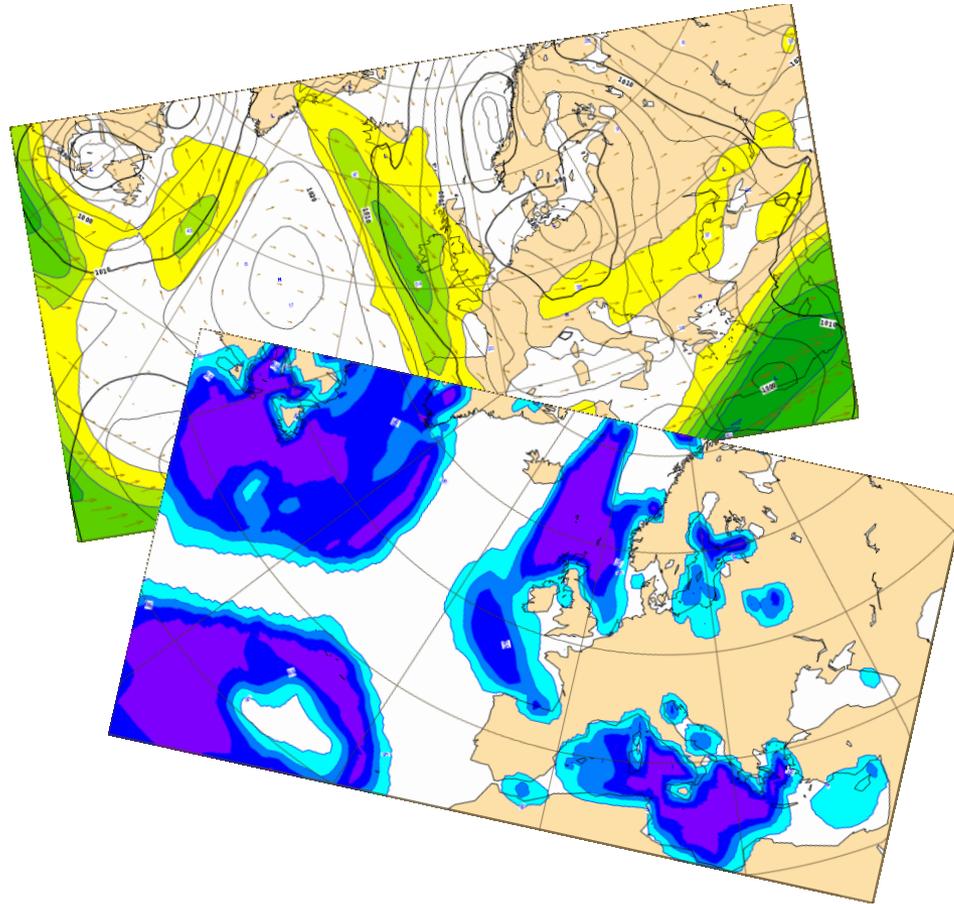
## Cihan Sahin

*on behalf of the ecCharts development team*

***Peter Bispham, Andy Brady, Jose Casado, Ricardo Correa, Tim Orford, Baudouin Raoult, David Richardson, Cihan Sahin, Stephan Siemen, Sylvie Lamy-Thépaut, Carlos Valiente***

# Outline

- Requirements
- Components
- Technologies
- Product availability
- Product generation
- User interfaces
- Performance



# Motivation

ECMWF web products are valuable but they are too static !

What do our users expect ?

Web developers  
Meeting

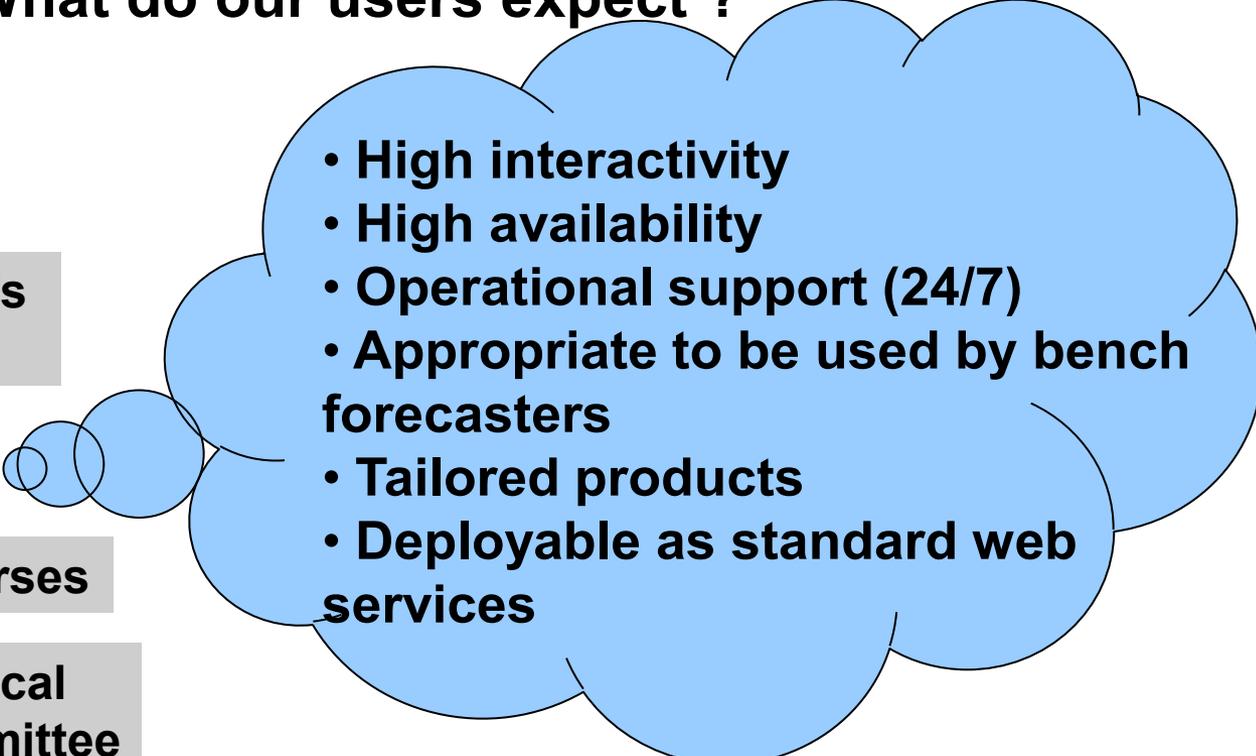
ECMWF Forecast User's  
Meetings

Forecasters & Users

ECMWF Training Courses

ECMWF Technical  
Advisory Committee

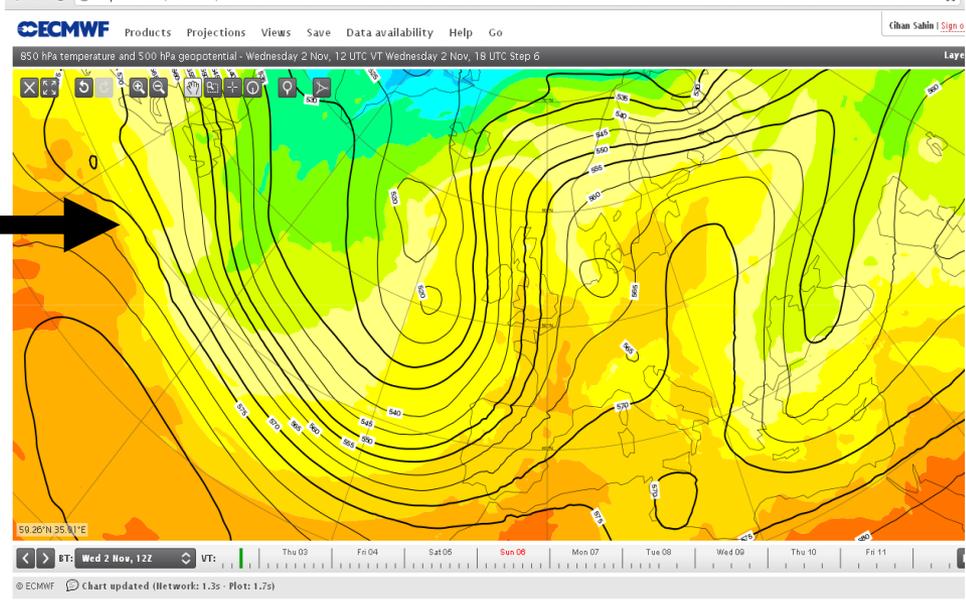
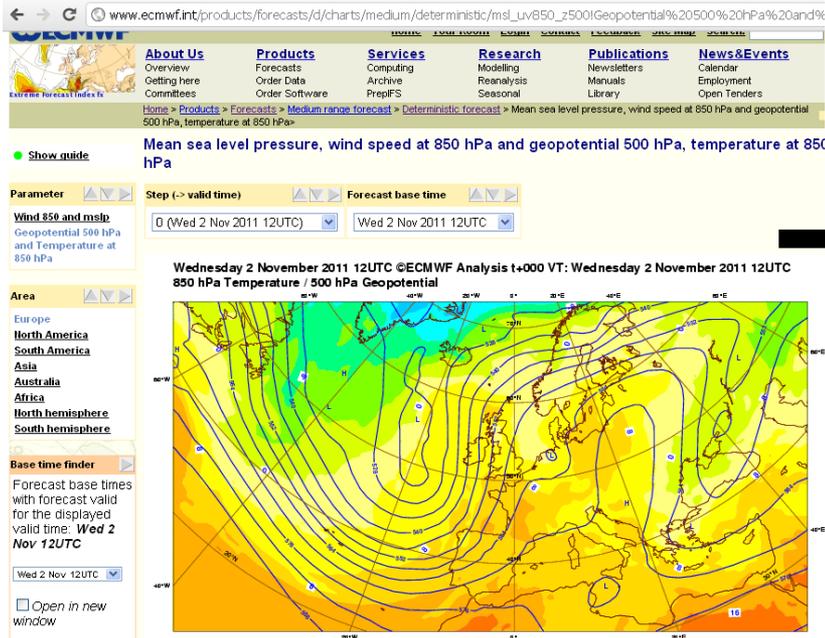
Member State Visits

- 
- High interactivity
  - High availability
  - Operational support (24/7)
  - Appropriate to be used by bench forecasters
  - Tailored products
  - Deployable as standard web services

Well, we had some  
Ideas as well

# ecCharts

*ecCharts is a highly interactive, highly available, operationally supported web based service to explore and visualise ECMWF graphical forecast products. It allows tailored product development and can be deployed as standard web services to be used by other software packages.*

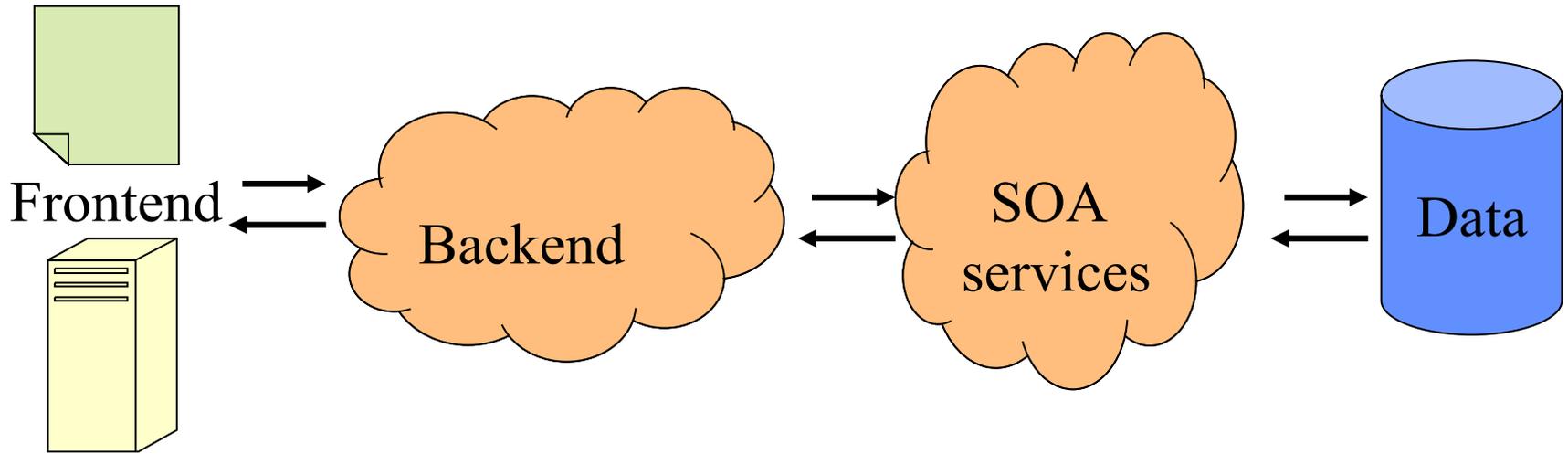


*Current web products*



*ecCharts*

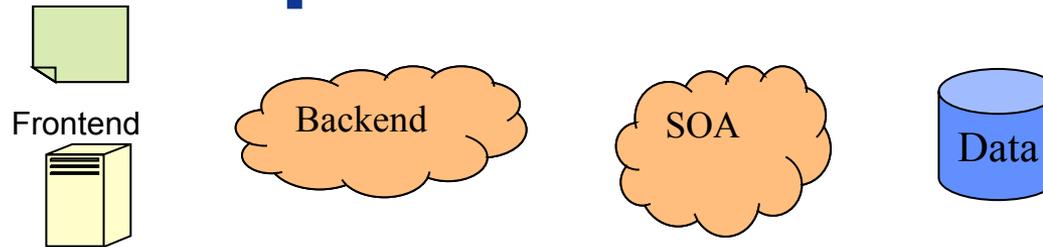
# ecCharts components



**Highly available end-to-end service is achieved;**

- **Load balancing**
- **Distributed architecture**
- **Virtualization**
- **Service Oriented Architecture (SOA)**

# ecCharts components - II



- **Frontend – Web based user interface (UI)**
- **Backend – Load balanced web application services to handle incoming requests. Also manages Web Map Service (WMS) requests, product meta-data and user preferences.**
- **Service Oriented architecture (SOA) – Orchestrates the graphical product generation.**
- **Data storage – Highly available that holds the necessary meteorological data**
- **Secondary components**
  - **Meta-data and non-GRIB data services**
  - **Distributed object caching**
  - **Request logging and monitoring services**

# Service Oriented Architecture

- A “service” is a single purpose program that can be invoked over a network. There are several instances of each service running on many machines.
- Services are invoked in a given chain (“orchestration”) to create a product (ie. “retrieve ->compute->plot”)
- SOA advantages;
  - Resilience
  - Scalability and maintainability
  - Load balancing
  - Heterogeneous hardware
  - Legacy code encapsulation

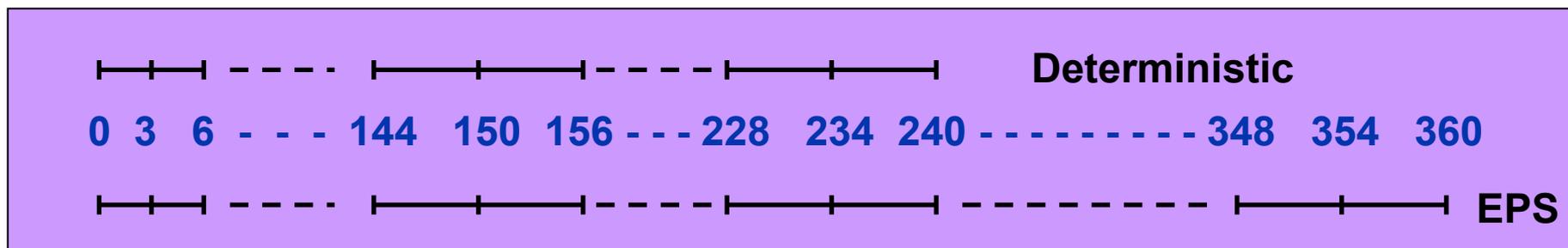
**The cost comes on troubleshooting, debugging gets harder!**

# Technologies used

- Frontend : JQuery & AJAX based web application
- Backend : Django web framework
- Catalogue of products & User preferences: MongoDB collections of JSON documents
- Distributed Object Caching: Memcached
- SOA components : Bespoke python based framework (with twisted)
- SOA services: mostly in Python and C.
- Plot and plot metadata generation : Magics++
- Metview like macro for complex products (e.g. Spaghetti plots)
- Data : From MARS (Retrieve to ingest on ecCharts data clusters)
- Data cluster : Data replicated on standard unix file system.
- Data access: Based on MARS language
- Data related operations : GRIB API

# What is in ecCharts ?

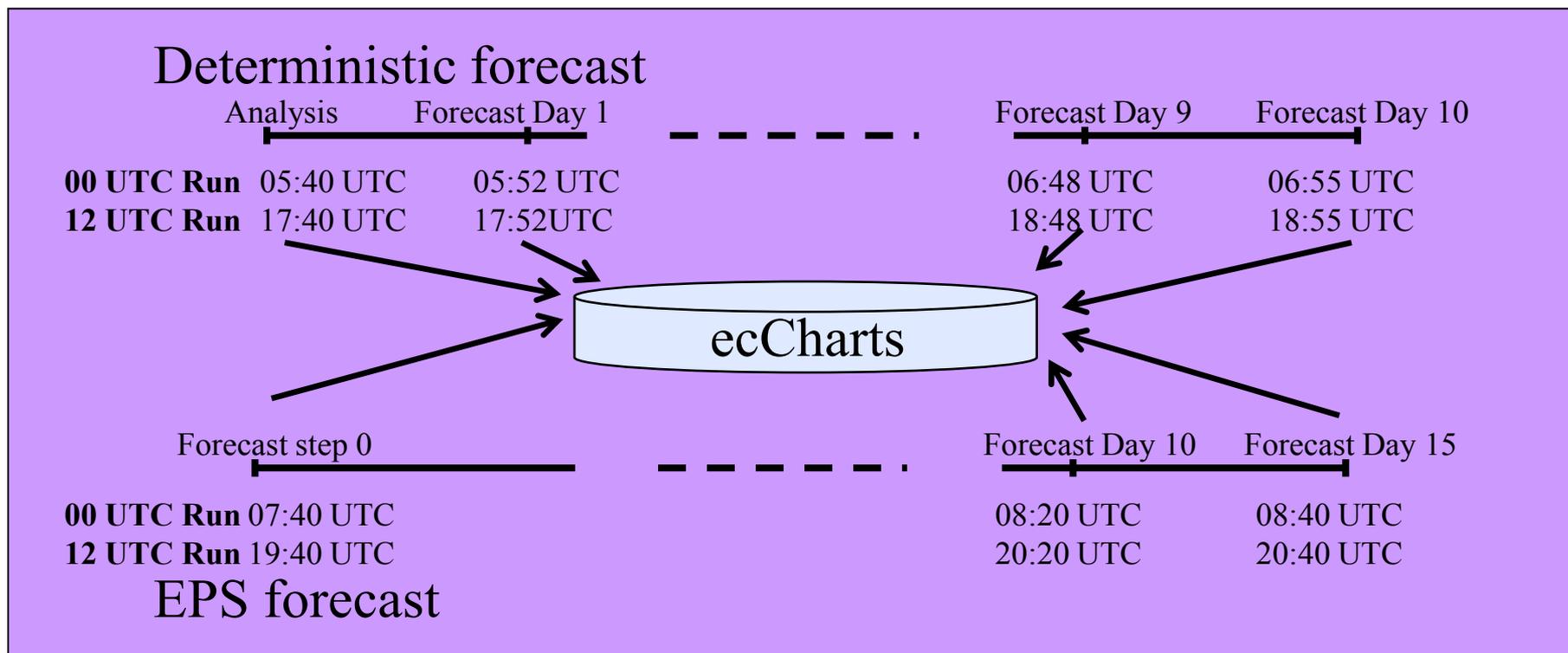
- High resolution deterministic and Ensemble Prediction System (EPS) model output (atmospheric & wave model)



- Point extracted data (for a given latitude/longitude)
  - Time series from all available parameters
  - EPS meteograms for a selected parameter set
- EPS derived data
  - Probabilities, percentiles, EFI, mean, spread ...
- Coastlines, country borders , rivers

# When are they available ?

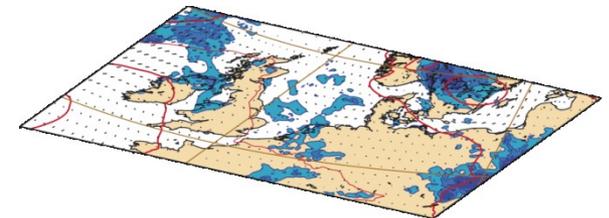
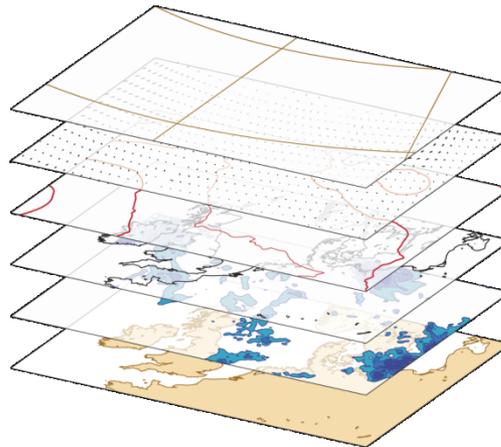
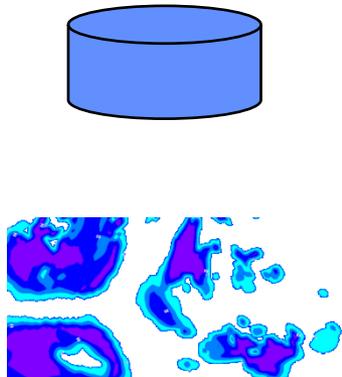
- Data is provided according to ECMWF dissemination schedule.



- Products generated on demand from direct model output data.

# Concepts – Layers, Styles, Products ...

- Layer, Product, Style, Projection are the basic components to build a plot.
- Layer is the basic visual element with a default style applied to the data (usually a meteorological parameter).
- A product is a combination of several layers on a selected projection.
- A projection is the combination of a geographic area and a map projection (ie. Europe on cylindrical)



Data + Style



Layer(s)



Product

# ecCharts catalogue

Plot – call Magics



Apply a style



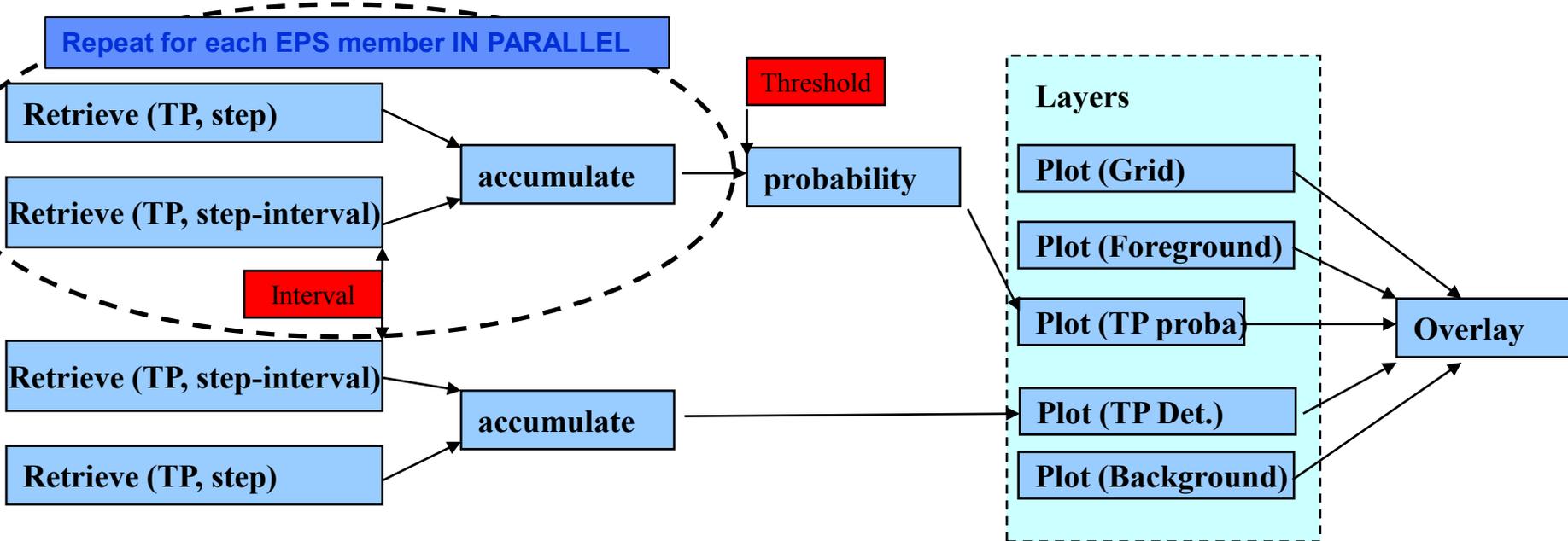
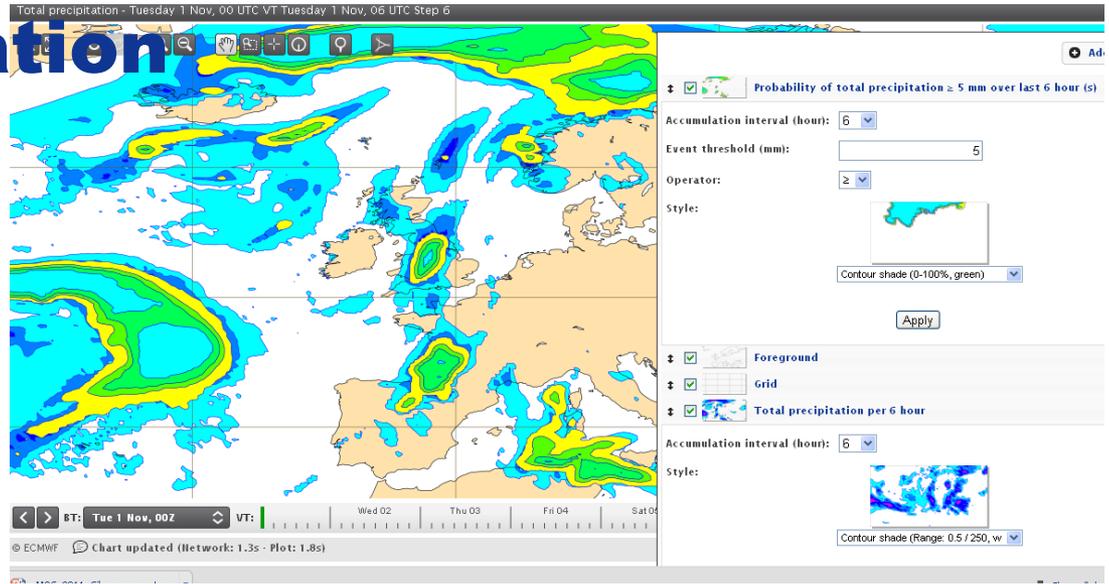
Retrieve and Compute

- Contains JSON formatted meta-data to define an object (layers, products, projection and styles).
- Contains the “business logic”.
- Backend converts an AJAX request into a workflow (a service call tree) by using the catalogue object(s) and submits it.

```
{  
  "plot": {  
    "data": {},  
    "service": "plot"  
  },  
  "probe": {  
    "service": "probe"  
  },  
  "style": "sh_all_fM48t56i4",  
  "styles": [  
    "sh_all_fM48t56i4",  
  ],  
  "retrieve": {  
    "data": {  
      "base_time": "$base_time",  
      "class": "od",  
      "expver": "$expver",  
      "param": "167.128",  
      "step": "$step",  
      "stream": "oper",  
      "type": "fc"  
    },  
    "service": "retrieve"  
  },  
}
```

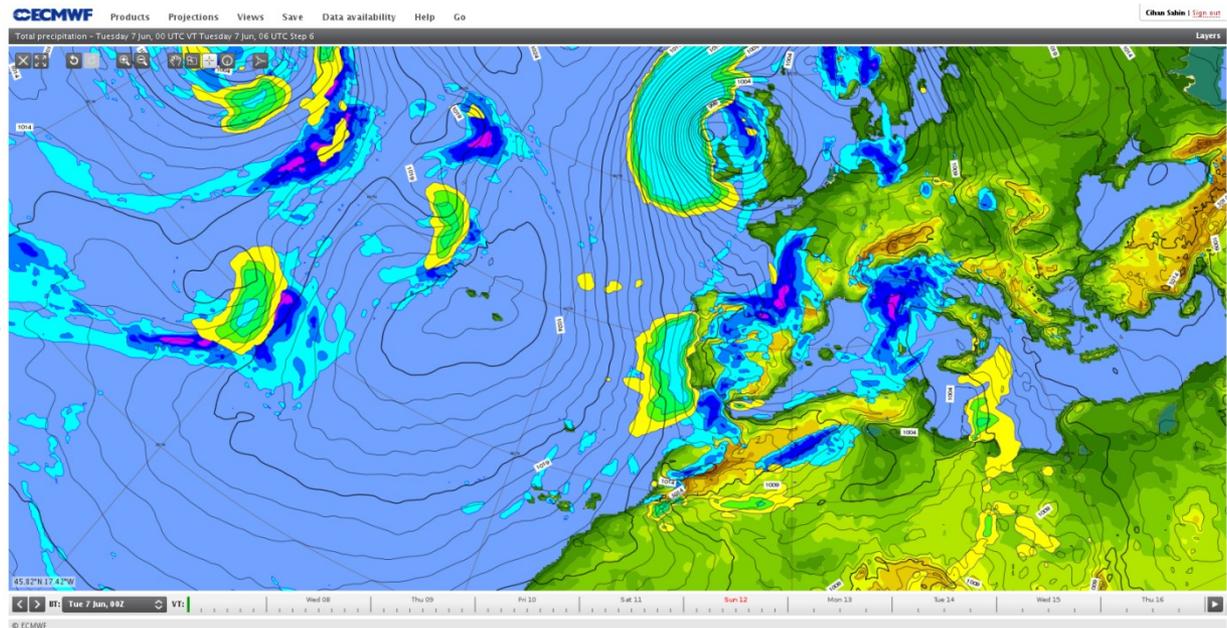
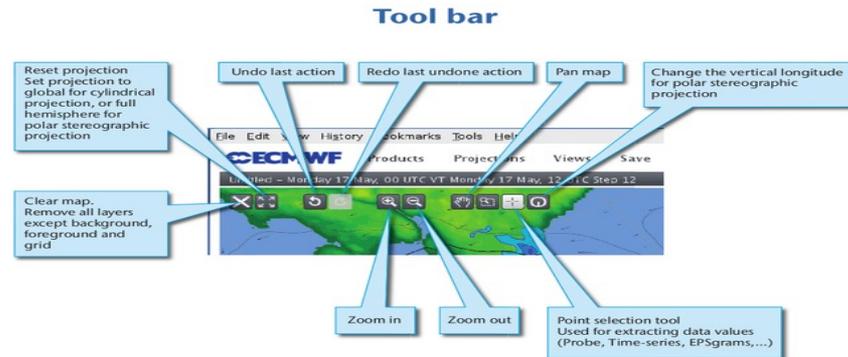
# Product generation

- A workflow is a service call tree generated by the request.
- Call tree is invoked in parallel .
- Call tree is chained.
- Each intermediate result is cached.



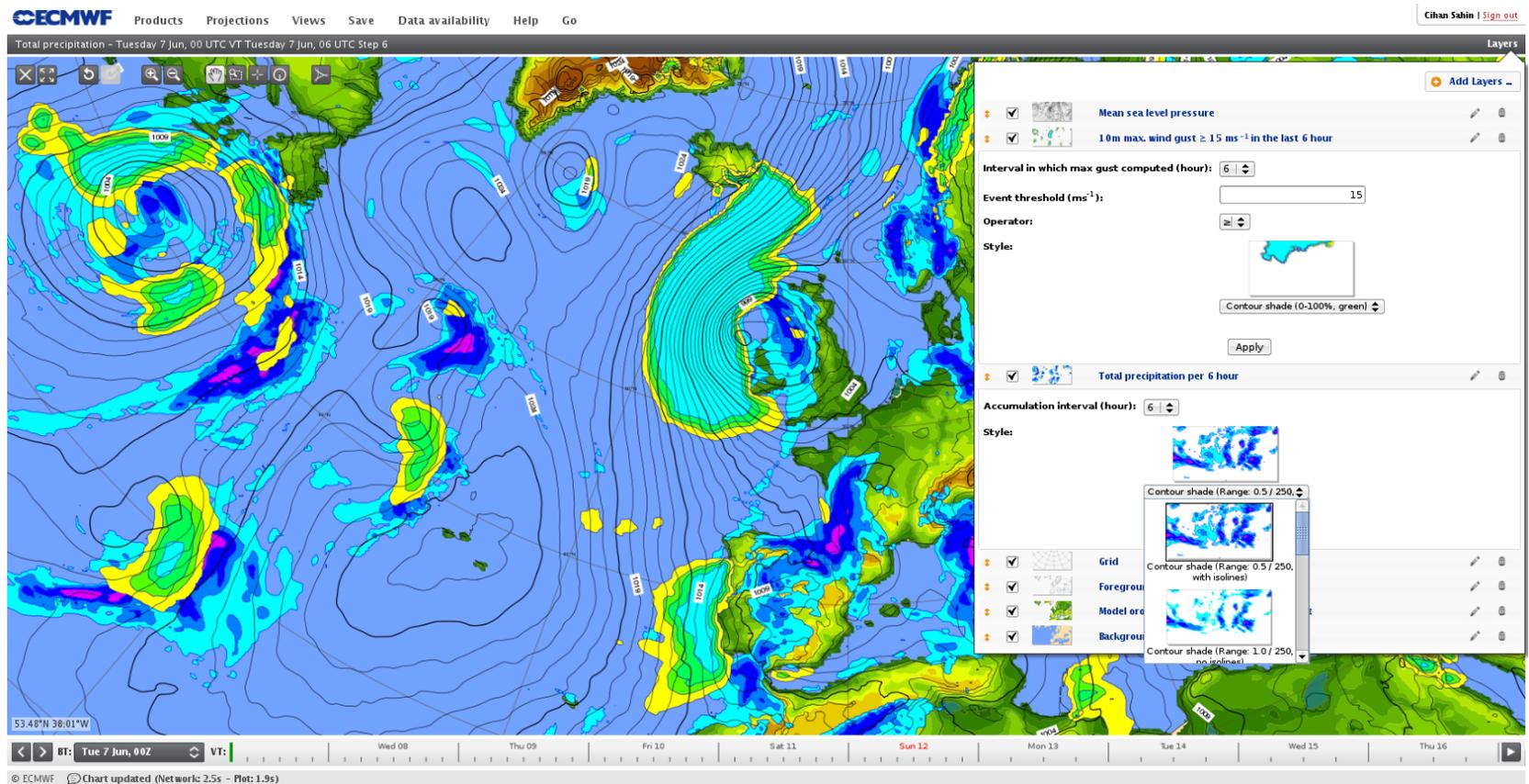
# Main User Interface (Forecaster Tool)

- Zoom, pan, undo, redo a plot
- Plot area maximised
- Overlay & order layers
- Save it as your own product
- Change projection
- Time control
  - Animate
  - Partial animation (StepX->Y, inc++)
  - Step selection
  - Forecast run time



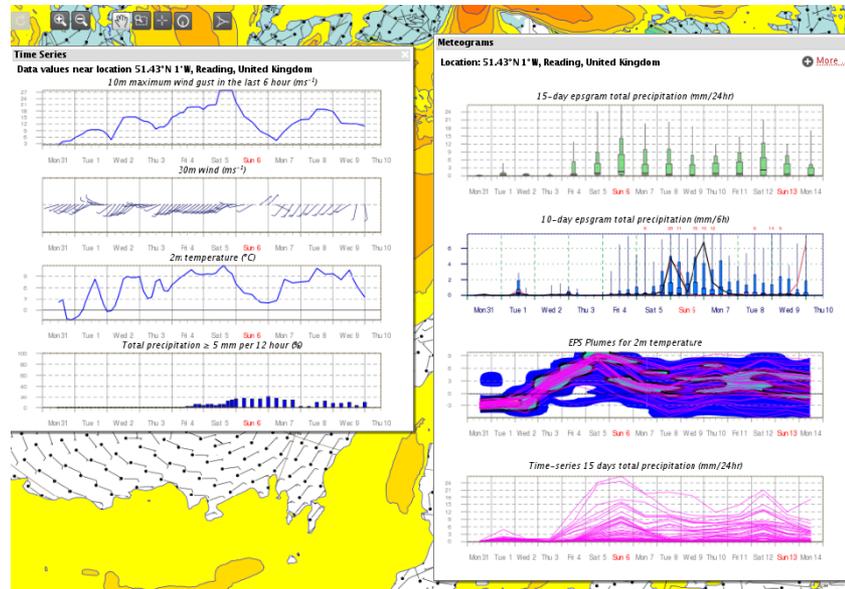
# Layer operations

- Customise a plot (ie. Accumulation period for total precipitation, Event threshold and event operator for probability layers, Interval in which maximum wind gust computed)
- Change the stacking order of layers, remove or disable.
- Apply a pre-defined style to a layer.



# Data exploration tools

- They provide point (latitude/longitude) extracted information.
- Time series are available for all the layers in ecCharts and displays the values of the layers on a selected position.
- EPS Meteograms are only available for a relatively small subset of parameters (Same parameters as in current web Epsgram pages)



# Forecaster tool in a single picture

ECMWF Products Projections Views Save Data availability Help Go Gihan Sahin | Sign out

Total precipitation - Tuesday 7 Jun, 00 UTC VTuesday 7 Jun, 06 UTC Step

07 Jun 00Z  
06 Jun 12Z  
05 Jun 00Z  
04 Jun 12Z  
03 Jun 00Z  
02 Jun 12Z  
01 Jun 00Z

Location: 51.43°N 1°W, Reading, United Kingdom

EPS cumulative distribution function (CDF) for 2 metre temperature  
Base date: Tuesday 7 Jun, 00 UTC Valid for: Wednesday 8 Jun, 00 UTC, adjusted to 48m height

10-day epsgram total cloud cover (okta)  
Base date: Tuesday 7 Jun, 00 UTC

10-day epsgram 2m Temperature (C)  
Base date: Tuesday 7 Jun, 00 UTC, adjusted to 48m height

Probe

Data values near location 51.43°N 1°W, Tuesday 7 Jun, 00 UTC T + 6, Reading, United Kingdom

Layer	Value	Point selected	Location	Distance
Mean sea level pressure	1004.48 hPa	nearest	51.38°N 1.04°W	6.75 km
10m max. wind gust $\geq 15 \text{ ms}^{-1}$ in the last 6 hour	0 %	nearest	51.57°N 0.83°W	18.99 km
Total precipitation per 6 hour	0.02 mm	nearest	51.38°N 1.04°W	6.75 km
Model orography from deterministic forecast	74.2 m	nearest	51.38°N 1.04°W	6.75 km

Data values near location 51.43°N 1°W, Reading, United Kingdom

Mean sea level pressure (hPa)

10m max. wind gust > 15 ms<sup>-1</sup> in the last 6 hour (%)

Total precipitation per 6 hour (mm)

Model orography from deterministic forecast (m)

ECMWF Layers

Select one or more Layers to add to the current chart.

Filter:

Deterministic forecast

- Mean sea level pressure
- Mean sea level pressure

EPS mean and spread

- Ensemble mean for mean sea level pressure
- Ensemble mean for Mean sea level p...
- Ensemble spread for mean sea level pressure
- Ensemble spread for mean sea level p...

City Finder

Reading, United Kingdom 10 matches [hide](#)

Matches may be very close to each other and show as one point on the map.

Layers

- Mean sea level pressure
- 10m max. wind gust  $\geq 15 \text{ ms}^{-1}$  in the last 6 hour
- Total precipitation per 6 hour
- Grid
- Foreground
- Model orography from deterministic forecast
- Background

Mean sea level pressure

Interval 1

10m max. wind gust  $\geq 15 \text{ ms}^{-1}$  in the last 6 hour

Total precipitation per 6 hour

Model orography from deterministic forecast

City Finder

Reading, United Kingdom 10 matches [hide](#)

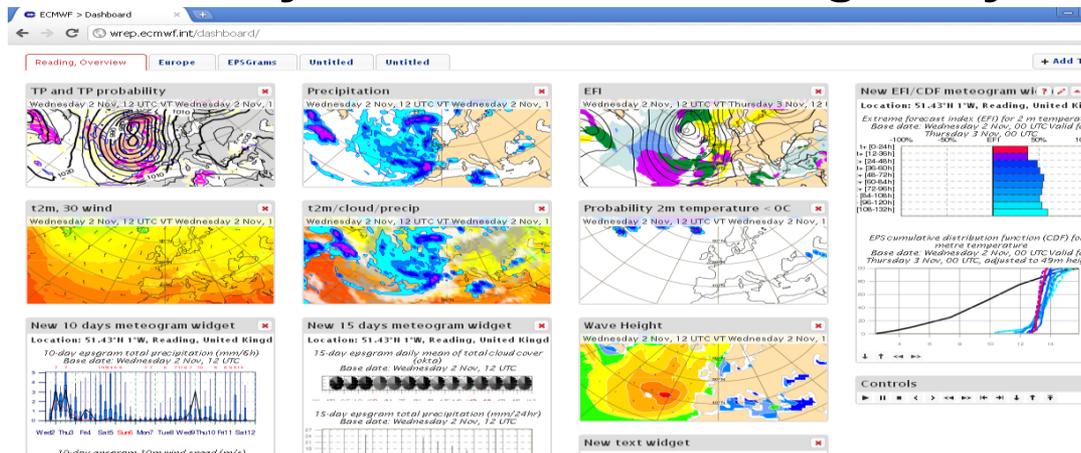
Matches may be very close to each other and show as one point on the map.

BT: Tue 7 Jun, 00Z VT: Wed 08

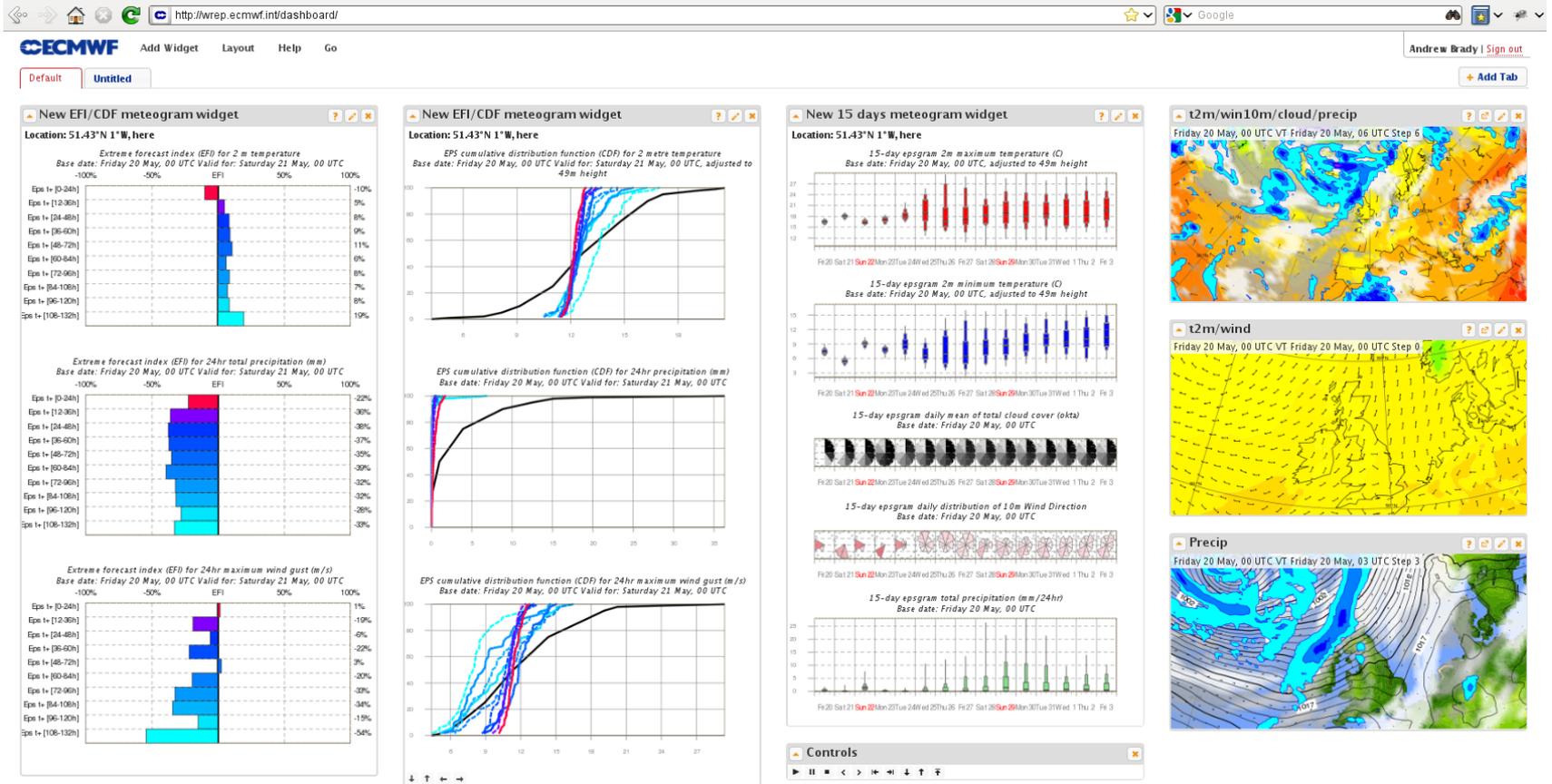
© ECMWF Product added.

# Dashboard interface

- Organise multiple charts and epsgrams in the same “page”. Basic elements are called widgets.
  - A chart widget is used to display a product either from ECMWF pre-defined set or your saved products.
  - EPS meteograms widgets (10 days, 15 days, EFI/CDF)
  - Control widget to apply collective actions for the charts on the same page ie. All charts in a tab animate simultaneously.
- User can create many tabs each containing many widgets.



# Dashboard in a single picture



© ECMWF Widget 'New chart widget' deleted

# Performance - usage

- From <http://www.useit.com/papers/responsetime.html>, Miller 1968; Card et al. 1991:

- 0.1 second is about the limit for having the user feel that the system is reacting instantaneously

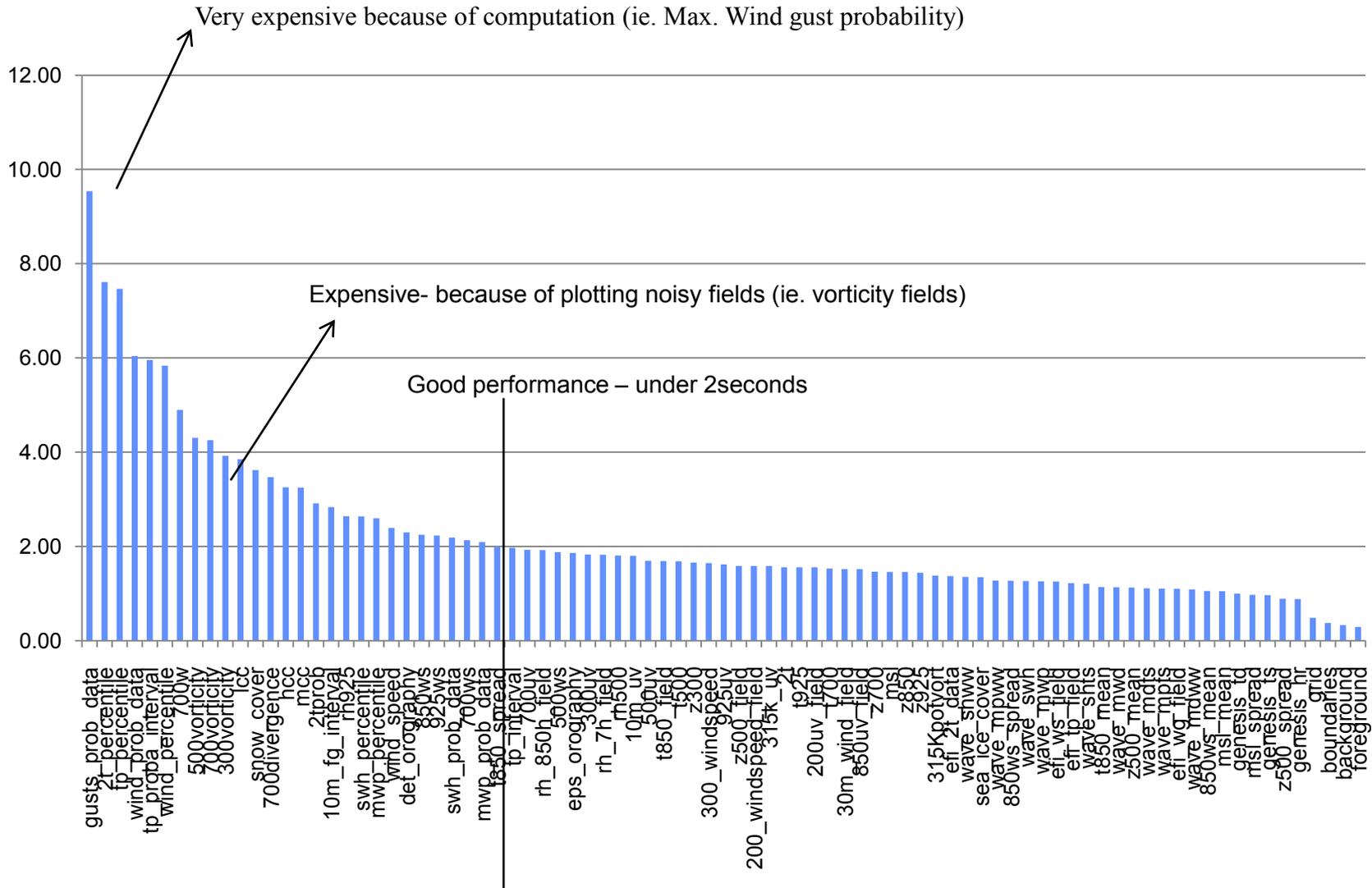
- 1 second is about the limit for the user's flow of thought to stay uninterrupted

- 10 seconds is about the limit for keeping the user's attention focused on the dialogue

- >10s and users will want to perform other tasks while waiting for the computer to finish

- ecCharts “get\_chart” are nominally in the range 1s to 10s (typically 2s)
- ecCharts “animation” is nominally in the range 10s to 60s.

# Layer plots times (total elapsed in seconds)



# Future work ...

- **ecCharts content is dynamic, we regularly add new layers as requested.**
  - Latest update has 15 meteorological layers added to the catalogue (snow parameters, CAPE, convective and large scale precipitation, 2 metre min/max temperature ...)
  - Spaghetti plots on the way (Test in progress soon in operations)
  - Model simulated satellite images (Work in progresss ...)
- **PNG level transparency (Test in progress ...)**
- **Print-able PDF output (chart + title + legend)**
- **Workspaces on User Interface**

# Thanks ! (DEMO IN EXHIBITION)

- MS/CS meteorological service forecasters should contact their Computing Representatives to gain access.
- ecCharts can serve maps based on WMS protocol for other software packages. Note that map customisation and style selection is possible on WMS requests (threshold, accumulation, blue contours ...).
- Users can report problems 24x7 to ECMWF
- “Report Issue” triggers email to [calldesk@ecmwf.int](mailto:calldesk@ecmwf.int) (Operators)
- Telephone & e-mail ECMWF Operators
- Contact developers to discuss additional features & meteorological products.