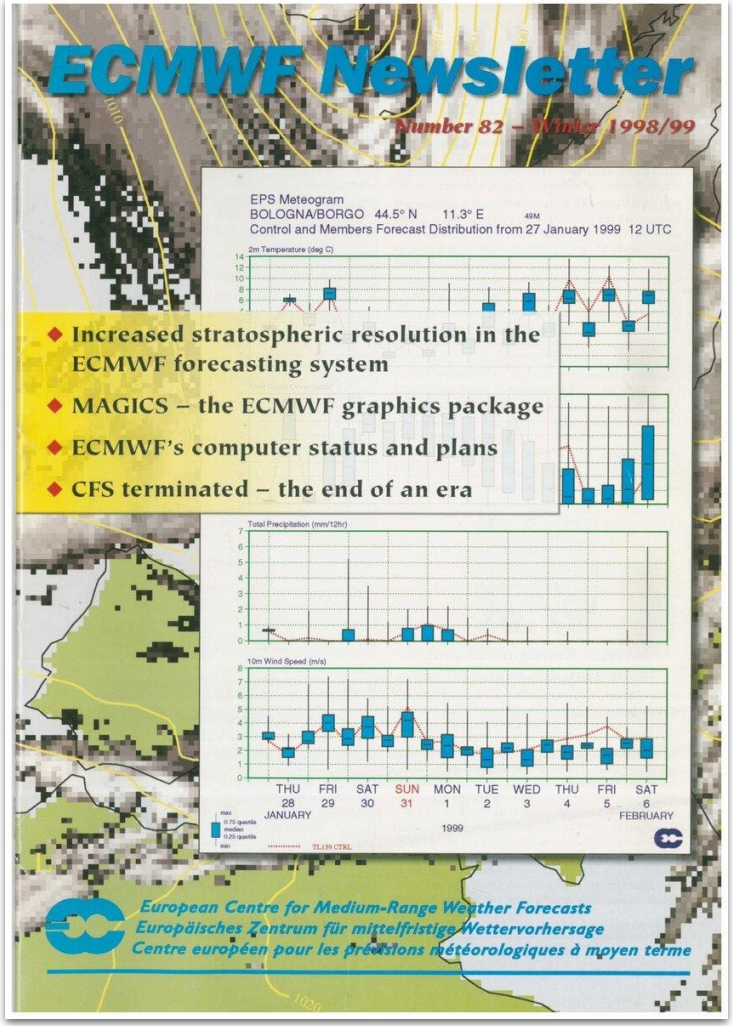


Past and future of the probabilistic meteograms

Federico Grazzini - Arpae Emilia-Romagna
Cihan Sahin - ECMWF (on behalf of many colleagues)

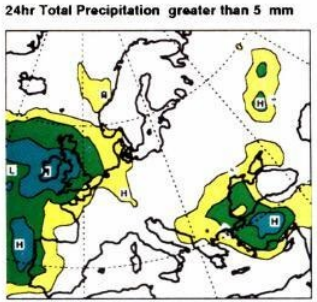
arpae agenzia prevenzione ambiente energia emilia-romagna

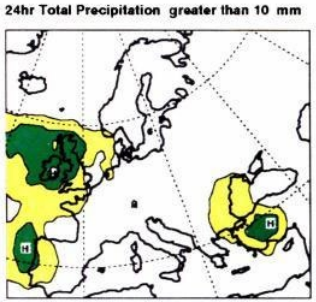
ECMWF

Outline

1. Beginning of the EPS and the need for an effective visualisation
2. First attempts
3. The launch
4. Evolution of Meteograms and current portfolio
5. How to access them
6. Future of meteograms
7. Final notes

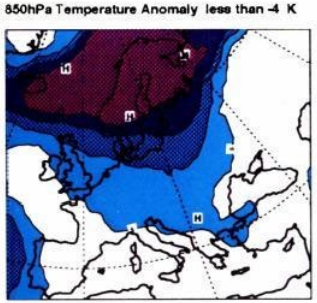
EPS beginning and need for an effective visualisation (1)

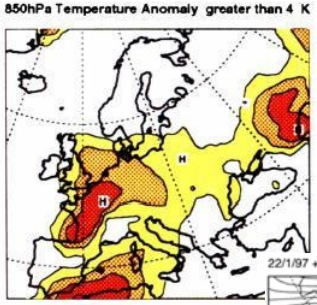




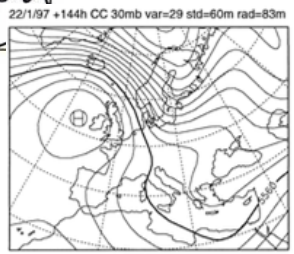
The first of may 1994 ECMWF started daily runs of the ensemble system on a Cray T3D (a first attempt of parallel supercomputer).

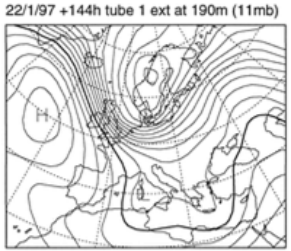
EPS products were gradually set up including ensemble mean and spread maps, clusters, probabilities, mostly thought for evaluating forecast confidence.

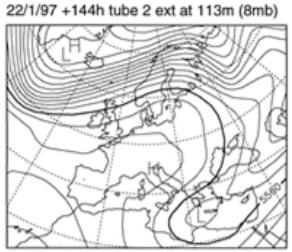




Later, Tubes and stamps maps we added to complement the range of products with informations on the most different scenarios. Only in the early 2000 a specific products to evaluate extremes was developed, the EFI (*extreme forecast index, Lalaurette 2003*)

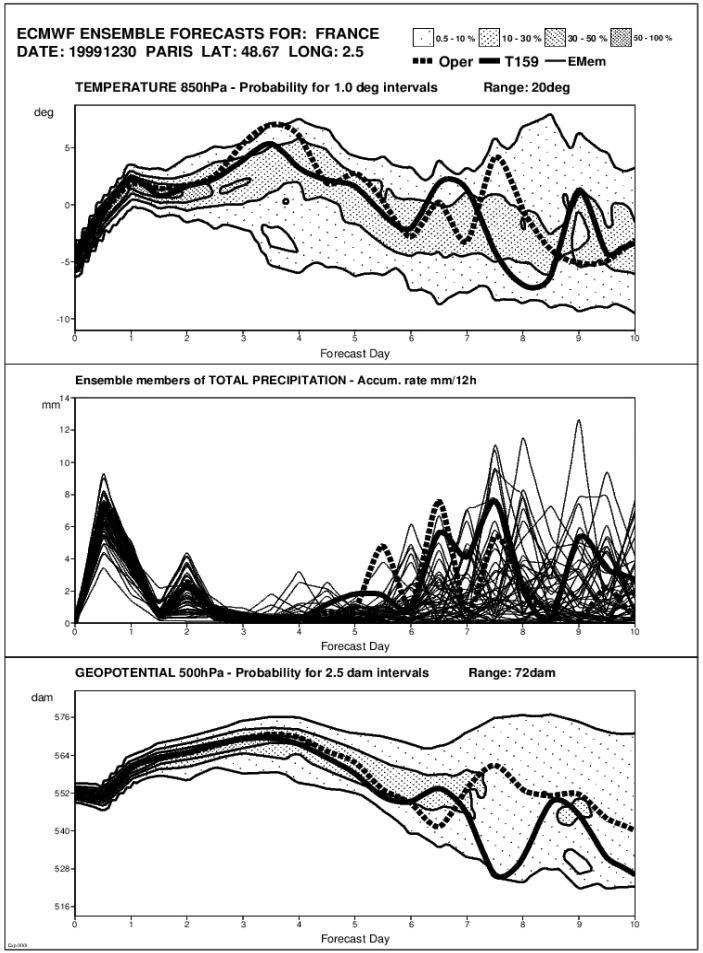






Tubing classification, Atger 1999

EPS beginning and need for an effective visualisation (2)



With increasing computer power and new research EPS was making fast progress. In October 1998 ECMWF EPS underwent a major upgrade, reaching a mature stage, with the introduction of the evolved singular vectors and random model perturbations.

However the **graphical output** was substantially unchanged **mostly not showing details of the underlying distribution**. Plumes at selected points, were the only exception showing the time series of all ensemble members for the forecast interval. However, this solution was more suitable for continuous variables, such as temperature, while for precipitation, the result was often difficult to interpret in a quantitative way.

Early EPS plumes faxed to MS countries (4-5 point every day for each country)

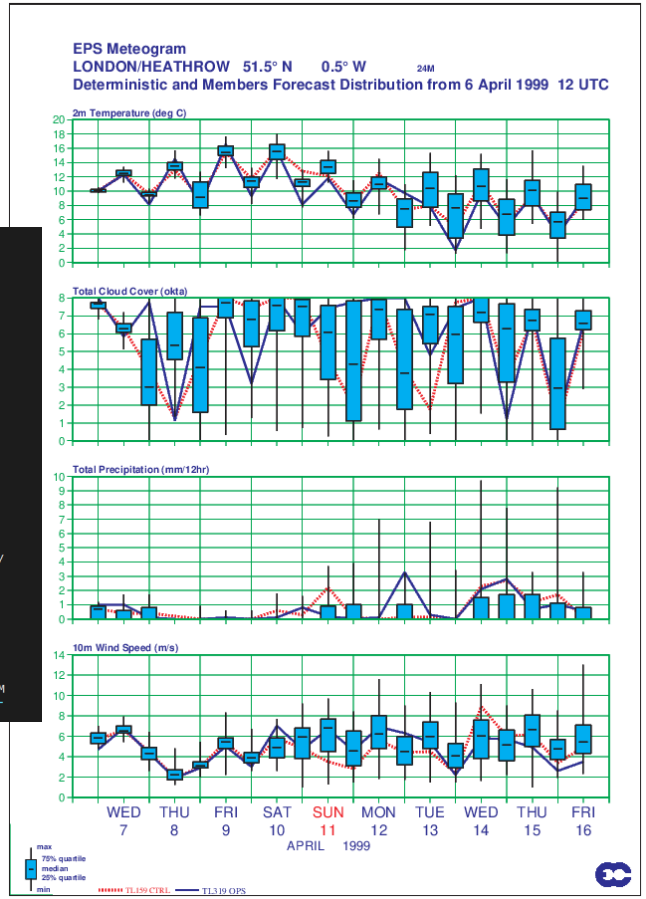
There was the need to enrich ens products showing more of the underlying distribution : the EPS meteogram

…after a bit of coding in fortran and Magics subroutines

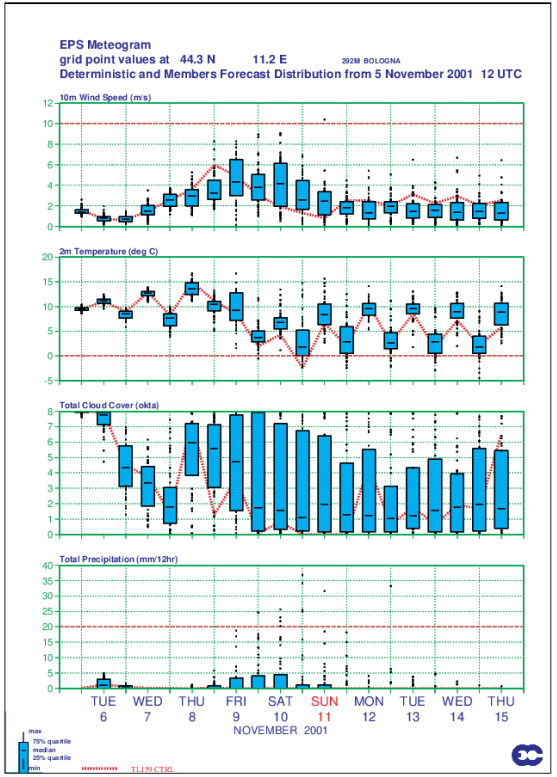
```
      PROGRAM RET
*
*     PROGRAM TO PREPARE DATA FOR METEOGRAMS( ONLINE )
*     DATA WILL BE STORED IN SEPARATE ARRAYS AFTER INTERPOLATION
*     AND SCALING.  THESES ARRAYS ARE PASSED TO THE METEOGRAM
*     PLOTTING PROGRAMS TOGETHER WITH DETAILS OF THE DATA AND
*     INFORMATION ON THE AXES TO BE DRAWN,
*
*     WRITTEN:
*
*     MODIFIED
*
      DIMENSION XVAL(20),OUT_OP(5,20),OUT_CTRL(5,20),BAR(5,20,5)
      DIMENSION YMIN(5),YMAX(5),YINC(5),RLAT_POINT(4),RLON_POINT(4)
      REAL      UPPER_EL(5,20,12),LOWER_EL(5,20,12)
      CHARACTER UNI(6)*10,CPAR(6)*30,CXMIN*20,CXMAX*20
      CHARACTER NAME*30, PROV*10,GRIDPOINT_PROV(4)*10
      LOGICAL COLOUR

      REAL RLAT,RLON
      INTEGER IPOINT,NUMB,JERR,ISTHEI,ISTNR,FLAG_T,MODEL
      INTEGER GRIDPOINT_HEIGHT(4)
      DATA RLAT_POINT/44.299,45.420,45.420,44.299/
      DATA RLON_POINT/11.2,9.8,11.2,12.6/
      DATA GRIDPOINT_HEIGHT/292,355,413,0/
      DATA GRIDPOINT_PROV /'BOLOGNA','MILANO','VICENZA','ADRIATICO'/

*     READ DATE MODEL AND TEMPERATURE FLAG
*     ------------------------------------
      CALL READPAR(0,IRET,COLOUR,ISIZE,IQUAL,MAP,NAME,ISTNR,IFCDAT,
     X             MODEL,FLAG_T)
      IF(IRET.EQ.999)STOP
c     write(*,*)' after DATE ',IFCDAT,'  MODEL ',model,
c    x  ' FLAG_T ',flag_t
*
*     READ IN CURRENT REQUEST FROM USER - EOF TERMINATES THE PROGRAM
*     --------------------------------------------------------------
      NDAYS=10
```



in different flavours..



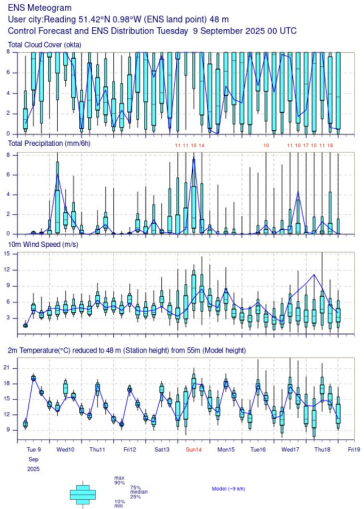
Evolution (1)

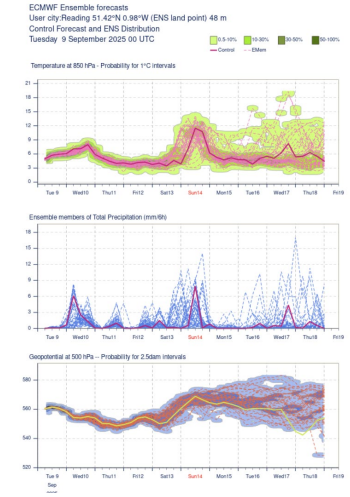
Early 2000s
- *10-day meteograms (4 essential weather param)*
- *Plumes*
- *10-day meteograms for wave parameters*

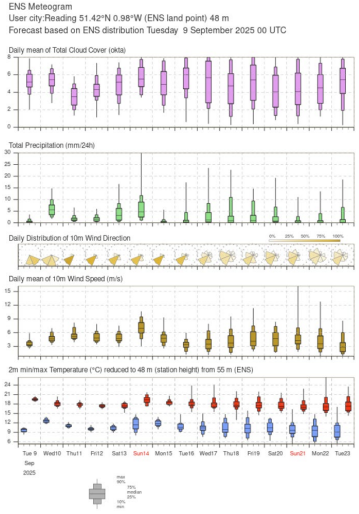
Late 2000s & early 2010s
- *15-day meteograms*
- *Improved modern web infrastructure*

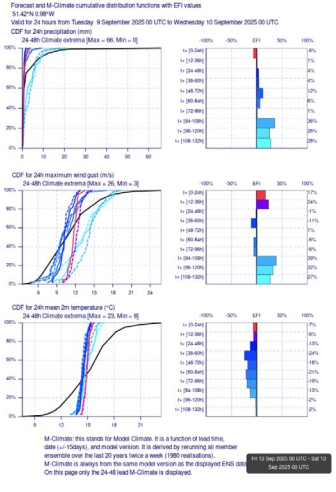
Late 2010s;
- *15-day meteograms with model climate*
- *EFI and CDF diagrams*
- *10-day meteograms (Additional parameters)*
- *15-day meteograms (Additional parameters)*

Horizontal resolution upgrades are reflected.









Evolution (2)

2020;
Open data is here! All graphical products including Meteograms were made publicly available.

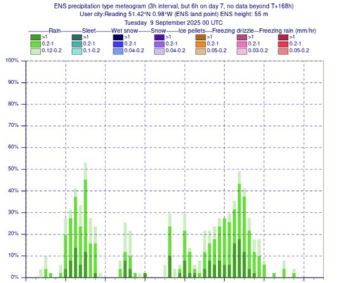
Around 2020s;

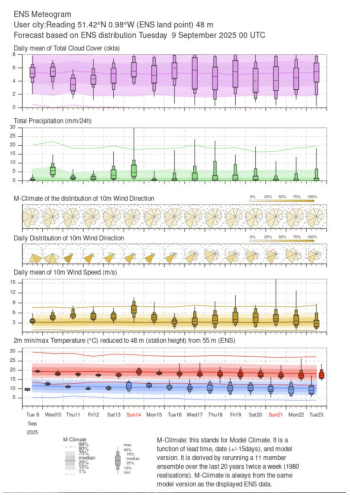
- *ENS Vertical profiles*
- *Precipitation type meteograms*
- *Visibility meteograms*
- *Sub-seasonal meteograms (Anomalies)*
- *Sub-seasonal range CDFs*

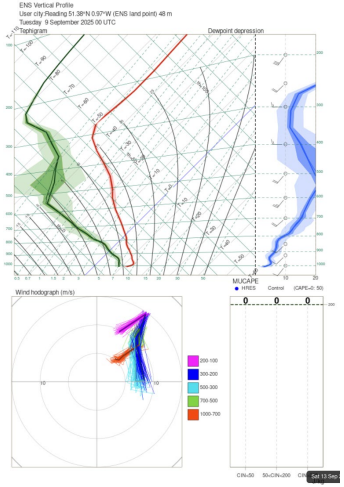
Most recent;

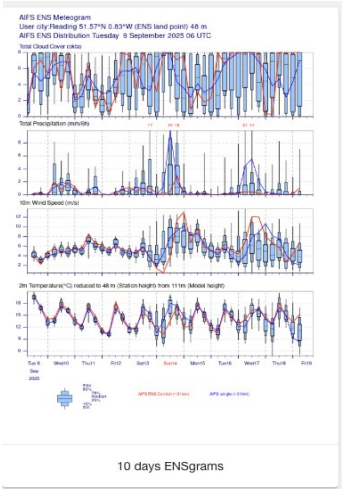
- *AIFS meteograms (10-days and Plumes)*
- *10-day meteograms (Additional parameters)*

Horizontal resolution upgrades are reflected.

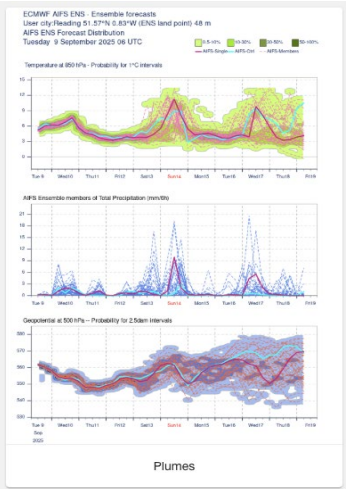






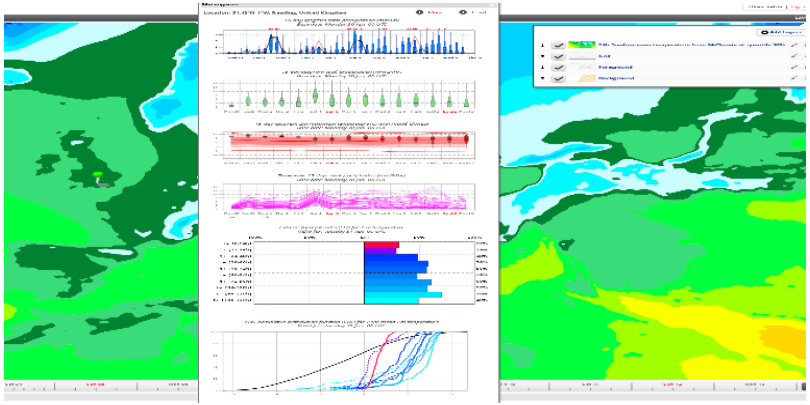


10 days ENSgrams

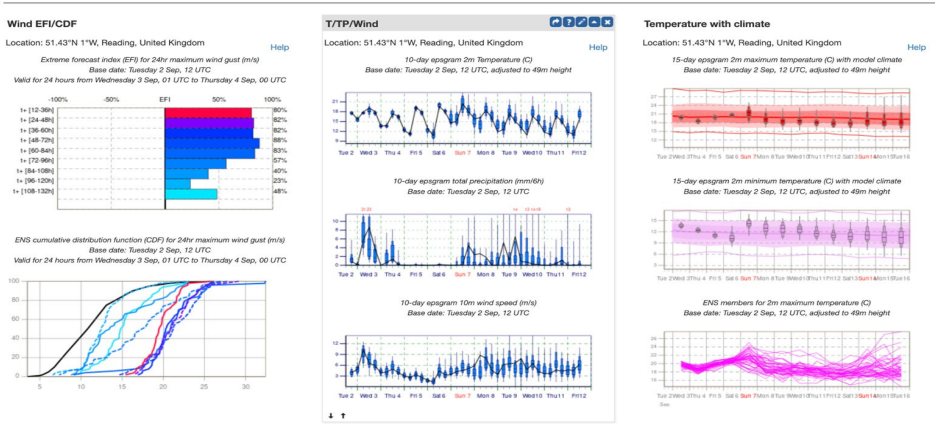


Plumes

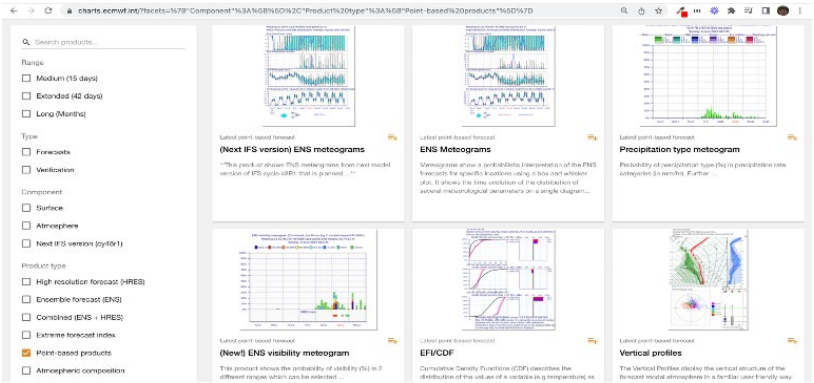
Accessing - Interactively



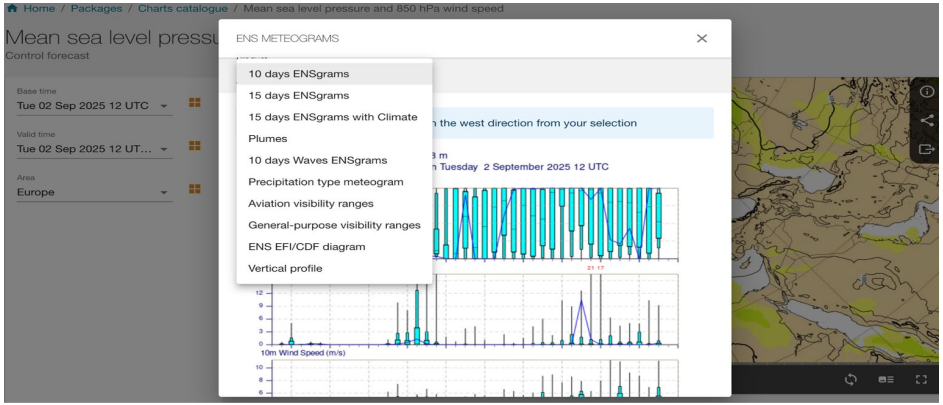
ecCharts (Interactive application for expert users)



Charts Dashboard (Save to create for easy access)

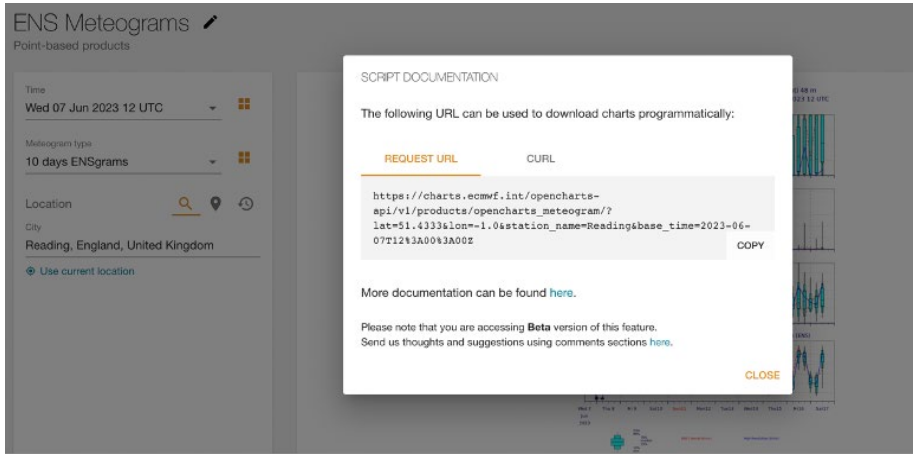


OpenCharts (Access for public users, see "Point-based products)



OpenCharts (Access for public users, click on maps)

Accessing - Automatically



OpenCharts API - Download plots automatically

```
{
  "meteogram": "10days-ws",
  "param": "ws",
  "location": "30/-1",
  "date": "YYYYMMDD",
  "time": "HHMM"
}
```

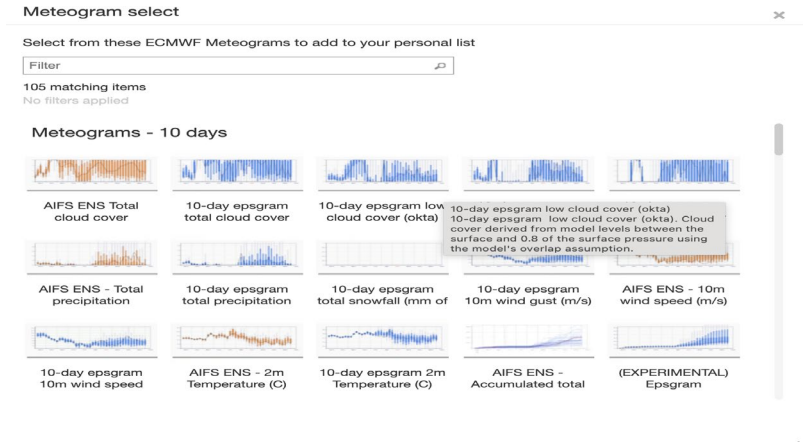
https://

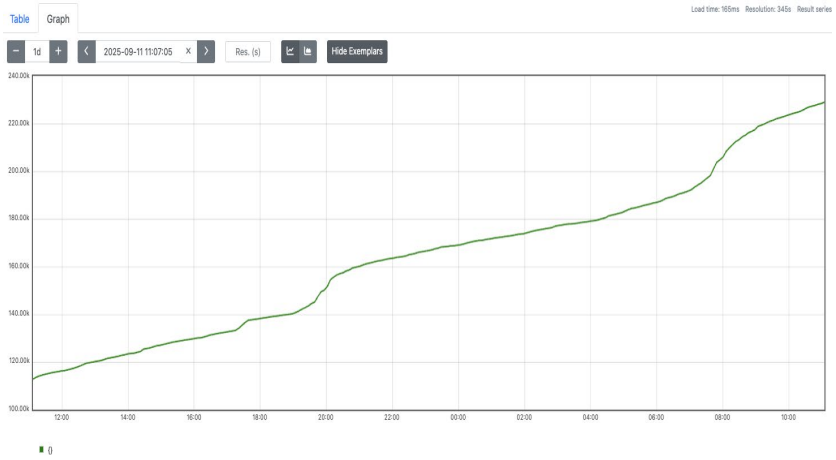

```
{
  "date": "20250908",
  "distance": {
    "angle": 168.991708109,
    "direction": "south",
    "distance": 7,
    "distance_unit": "km"
  },
  "eps_height": -0.560836791992,
  "land_sea_mask": 0.0,
  "location": {
    "lat": 30.2928524017,
    "lon": 289.720275879
  },
  "time": "0000",
  "ws": {
    "control": [
      4.07648563385,
      3.73947954178,
      .....
```


ECMWF webAPI - Returns a JSON object with data values

Some technical information

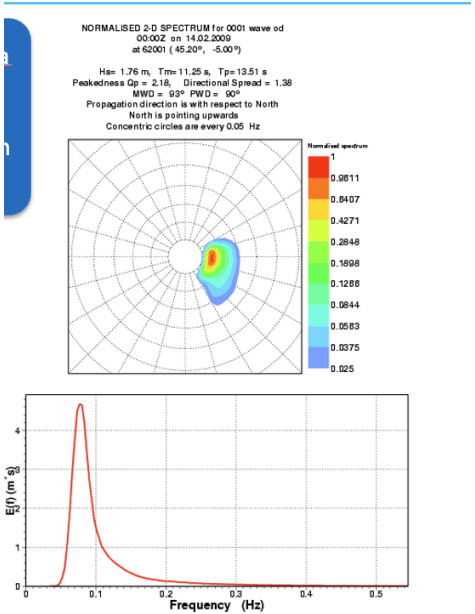
- > 60 meteogram types (Parameters, Forecast ranges, Accumulation periods, plot types, Forecast model …)
- Growth in data sizes ~50 times increase in 25 years.
  - Horizontal resolution increase from T159 to O1280
  - Grid data points increase from 138,346 to 6,599,680
- A modernised web service that can handle various use cases and scales up with load.
- Current DBs are around 15 TB rolling online archive
- Performance and user expectations
  - We aim < 2 sec per parameter.
- Daily access;
  - ecCharts+ webAPI: > 100,000 queries
  - Opencharts + Plot download: > 150,000 queries

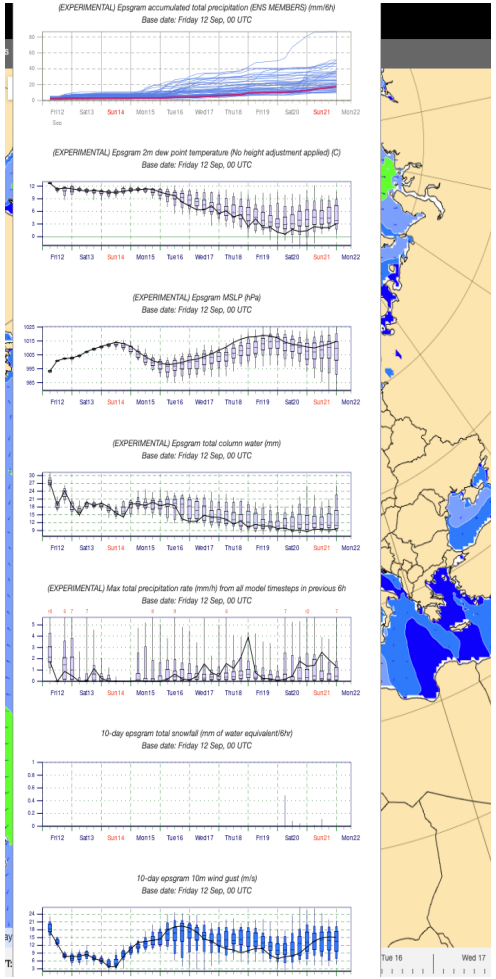




Future - More parameters

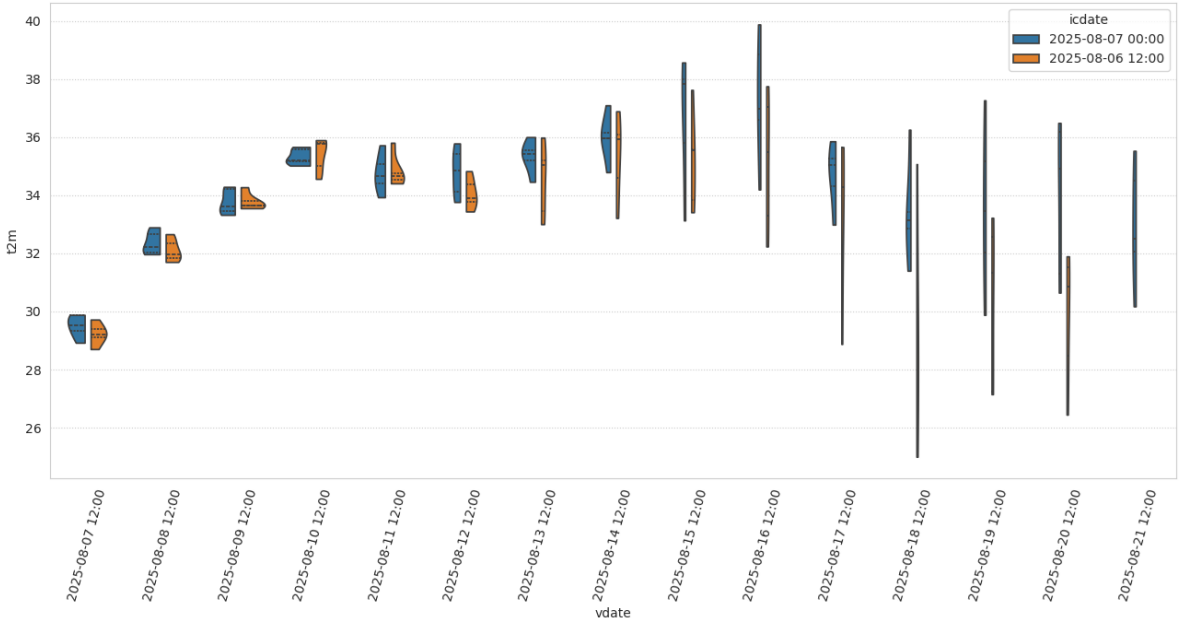
- Additional meteograms/parameters wave spectra in progress (Requested by MetNorway and Portugal Met service)
- Parameters which are only in ecCharts to be made available to public through Opencharts
  - Max wind gust, total snowfall, Accumulated precipitation, max precipitation rate, MSLP, 2m Dew point, total column water, and more …





Future - even better exploration of Ensemble data

- Interactive meteograms
  - Read data values on diagrams
  - User defined time-periods (ie: Accumulation
  - Additional cycles (06 and 18 utc)
- Possible visualisation ideas
  - Violin plots
  - Blended visualisation (several runs, IFS/AIFS …)



Final notes

- Meteograms are one of the most popular products ECMWF offers
- Completely user-driven (internal and external users).
- Collaboration/co-design opportunities with our MS/CS members
  - Visibility meteogram co-designed with Hungarian Met Service & Croatian Air control
  - 2m Dew point Temperature, MSLP, Total column water, .. with DWD
  - 2D wave spectrum diagrams with MetNorway and Portugese Met Service

Contact us if you have ideas, requests, requirements to improve the service.

Thanks a lot