Ensemble forecast products

Supporting users’ decision making

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Thanks to many colleagues (past and present)
<table>
<thead>
<tr>
<th>Deterministic prediction</th>
<th>Verification</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Deterministic prediction image" /></td>
<td><img src="image2.png" alt="Verification image" /></td>
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Ensemble forecast of the French / German storms (surface pressure)
Start date 24 December 1999 : Forecast time T+42 hours

<table>
<thead>
<tr>
<th>Forecast 1</th>
<th>Forecast 2</th>
<th>Forecast 3</th>
<th>Forecast 4</th>
<th>Forecast 5</th>
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<th>Forecast 11</th>
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Ensemble forecast products

- To assist operational forecasters
- Users generate their own tailored products for specific applications
Ensemble mean and spread

Day 2, red = HRES, black=ENS Mean
Ensemble mean and spread

Day 6, red = HRES, black=ENS Mean
Ship routing

Figure 2: Ship routes for the crossing leaving Brest at 12 UTC 28 February 1999 and arriving in New York at 00 UTC 7 March 1999. Routing either to the north or to the south circumvents a storm centre. The ensemble-mean route method fails to provide an optimum track in these circumstances.
Probability that IRMA will pass within 120 km radius during the next 240 hours
tracks: solid = HRES; dot = Ens Mean [reported minimum central pressure (hPa) 967]
Alternative scenarios - clusters
Alternative scenarios - clusters
Regime transitions
Alternative scenarios

1. MOST LIKELY
   - Risk of Gusts
   - 70mph

2. LESS LIKELY
   - Rain and Snow
   - Heavy Rain
   - 70–80mph Gusts
Probabilities

Total precipitation probability >10
Tuesday 12 Sep, 00 UTC T+24 Valid: Wednesday 13 Sep, 00 UTC
Interactive probabilities (and more …) ecCharts

What is the probability of precipitation > 5 mm/6 hr? How about over 24 hr?

• Similar customisation applies for percentiles and probability of combined events and weighted probabilities …

• ENS combined and weighted probabilities
• ENS mean and spread
• EFI s
• SOTs
• Cyclone strike probabilities
• Cyclone tracks
• Model-climate
• Meteograms
• …
Point forecasts: time-series

ECMWF Ensemble forecasts
Reading, United Kingdom 51.52°N 0.97°W (ENS land point) 83 m
High Resolution Forecast and ENS Distribution
Friday 8 September 2017 00 UTC

Temperature at 850 hPa - Probability for 1°C intervals

Ensemble members of total Precipitation (mm/h)

Geopotential at 500 hPa - Probability for 2.5dam intervals
Point forecasts: time-series (meteogram)

Highest value of all members
90th centile
75th centile
Median
25th centile
10th centile
Lowest value of all members
Point forecasts: time-series (meteogram)

Highest value of all members
90th centile
75th centile
Median
25th centile
10th centile
Lowest value of all members
Global EFI map

CDF for 24h maximum wind gust (m/s)

24-48h Climate extrema [Max = 24, Min = 4]
Extreme forecast index (EFI)

• Measures the distance between the ENS cumulative distribution and the model climate distribution
• Ranges from −1 (all members break climate minimum records) to +1 (all break climate maximum records)
• Indicates places where the ENS distribution is towards the extreme of the climate distribution

CDF for 24h maximum wind gust (m/s)

24-48h Climate extrema [Max = 24, Min = 4]
Forecast and M-Climat cumulative distribution functions with EFI values
25.29°N 80.5°W
Valid for 24 hours from Sunday 10 September 2017 00 UTC to Monday 11 September 2017 00 UTC
CDF for 24h precipitation (mm)
- 24-48h Climate extrema [Max = 56, Min = 0]

CDF for 24h maximum wind gust (m/s)
- 24-48h Climate extrema [Max = 27, Min = 4]

CDF for 24 mean 2m temperature (°C)
- 24-48h Climate extrema [Max = 30, Min = 25]

M-Climat: This stands for Model Climate. It is a function of lead time, date (±15 days), and model version. It is derived by rerunning all members ensemble over the last 20 years twice a week (1995 realizations). M-Climat is always from the same model version as the displayed ENS data.

On this page only the 24-48 lead M-Climat is displayed.

ENS Metogram
Key Largo, United States 25.29°N 80.5°W (ENS land point) 1 m
Extended Range Forecast based on ENS distribution Friday 8 September 2017 00 UTC
Daily mean of Total Cloud Cover (okta)

Total Precipitation (mm/24h)

M-Climat of the distribution of 10m Wind Direction

Daily Distribution of 10m Wind Direction

Daily mean of 10m Wind Speed (m/s)

2m minimum Temperature (°C) reduced to 1 m (station height) from 4 m (ENS)

M-Climat: This stands for Model Climate. It is a function of lead time, date (±15 days), and model version. It is derived by rerunning all members ensemble over the last 20 years twice a week (1980 realizations). M-Climat is always from the same model version as the displayed ENS data.
Extra-tropical cyclonic feature tracking

User can click on any spot (= cyclonic feature) to see how that feature evolves in the forecast.
Extra-tropical cyclonic feature tracking
Tropical cyclones

Date 20170901 00 UTC  @ECMWF

Probability that IRMA will pass within 120 km radius during the next 240 hours tracks: solid=HRES; dot=Ens Mean [reported minimum central pressure (hPa) 967 ]

List of ensemble members numbers forecast Tropical Cyclone
Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] HR3[> 95 kt]

Probability (%) of Tropical Cyclone Intensity falling in each category
TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] HR3[> 95 kt]

10m Wind Speed (kt) solid=HRES; dot=Ens Mean

Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean
Supporting decision making: societal and economic value of forecasts

- Forecasts only have value if people use them
  - make a decision or take an action which would not otherwise have been made
- Decisions can be based on deterministic forecasts, but …
- Decisions involve assessment of risk
Decisions, risk and flow-dependent uncertainty