

Use of ensemble forecast products at the Met Office

Dr Joanne Robbins

With contributions from the Weather Impacts Team and VIPP

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NCMRWF Workshop: Use of products from Ensemble Prediction Systems



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Why use ensemble forecasts?

MOGREPS-UK live thickness of snowfall amount 6hr sum Cycle Time: 03 UTC on Mon 26/02/2018 Validity Time: 18 UTC on Thu 01/03/2018 (T+81 - T+87)

Met Office



Ensembles help us:

- Take account of uncertainty
- Assess confidence
- Estimate probabilities and risks (e.g. 9 out of 36 members = 25%)
- Ensemble average provides
 best estimated single forecast

Using ensemble forecasts





MOGREPS-G Probability of 6 hour Snowfall > 5mm

Met Office Global and Regional Ensemble Prediction System

Global Component (MOGREPS-G)

- 20km resolution
- 70 vertical levels
- 18 ensemble members (36 time-lagged)
- 4 updates daily
- 174 hour forecast
- ETKF for initial conditions
- Stochastic physics (SKEB2)

UK Regional Component (MOGREPS-UK)

- 2.2km resolution
- 70 vertical levels
- 12 ensemble members
- Hourly cycling
- 120 hour forecast
- Nested in MOGREPS-G
- Based on UKV physics
- Neighbourhood processed to account for spatial uncertainty...





Multiple Model Blending



Ensemble forecast applications

- High-impact weather tools
- Multi-hazard visualisation tools
- Automated tools to support the Met Office National Severe Weather Warning Service (NSWWS)
- Medium-range ensemble forecast products

MOGREPS-G: Forecast tropical cyclone tracks

for AMPHAN from 12UTC 16/05/2020

Tropical Cyclone Products



NCEP GEES

Observations



MULTIMODEL ensemble (out to 8 days):

Forecast tropical cyclone track probability

for AMPHAN from 12UTC 16/05/2020

Deterministic:

Met Office GM

Ensemble mean: MOGREPS-G -- EC ENS -- GEFS --

ECMWE -

GES -

Multimodel =



MULTIMODEL ensemble: Tropical Cyclone storm-following meteogram AMPHAN (10.3N 86.0E) from 12UTC 16 May 2020



- The Met Office produce and verify global multi-model ensemble forecasts for all tropical cyclones globally.
- Here the forecast for Cyclone Amphan shows that the landfall location and signal for intensification were overall well forecast by the ensembles around 4 days ahead of landfall, although the rate of intensification was underestimated, and the timing of the peak intensity was 24 hours later than observed.
- Strike probability verification continues to show that the most skilful individual ensemble can vary from storm to storm and basin to basin, but that additional skill is gained by using a multi-model ensemble (Titley et al, 2020, QJRMS)

Global Hazard Map





- GHM is a GIS Web Map Service created by the Weather Impacts team for Global Guidance Unit forecasters
- Aims to summarise where highimpact weather is forecast across the globe out to 7 days using global ensembles
- Web Map Service easy to overlay info, zoom/pan, flexible format for data layers
- Symbol-based summary map, coloured by lead time, sized by probability, to give an "at a glance" view of all hazards and lead times
- Can then drill down to particular variables / days / models / areas of interest
- Can overlay vulnerability and exposure layers to give information on likely impact

Met Office GHM forecast layers: Creation of summary map



Summary polygons, coloured by lead time, show the areas where the probabilities are significant for that lead time and hazard

Visualising multi-hazards

Ensemble mean tracks from ECMWF, MOGREPS-G (and now NCEP) & the multi-model, as well as the deterministic track



TC Tracks with forecast wind gust, summary polygons overlain (based on multi-model)

United States KANSAS OKLAHOMA Orlando Tampa COARUIL FLORIDA levico

TC Tracks with 24hr precipitation summary polygons overlain (based on multi-model)



Ensemble Prediction System First Guess Warnings (EPS-W)

EPS-W supports the risk-based National Severe Weather Warning Service (**NSWWS**).

- Based on likelihood and impact
- Derived from MOGREPS and ECMWF
- Impact thresholds vary by region and by season
- First guess warning maps aid forecasters in drawing warning areas



Ensemble Prediction System First Guess Warnings (EPS-W) Warning impact matrix



Met Office





Crown Copyright 2014, Source: Met Office

Crown Copyright 2014. Source: Met Office

Hazard Impact Modelling using ensembles



Hazard Impact Models support the risk-based National Severe Weather Warning Service (NSWWS).

- Hazards are determined using impactorientated thresholds
- Use MOGREPS-UK to provide wind gust and wind direction information.
- Use vulnerability and exposure scores to define how susceptible the road network is to impact at each time step.
- Multiply hazard, vulnerability and exposure to obtain a maximum risk forecast for each road network point and forecast lead time.



Vehicle OverTurning (VOT) Hazard Impact Model



- Automated calculation of the risk of vehicle overturning for each time step of the model.
- Categorise forecast risk into low, lowmedium, medium-high and high risk.



Weather Patterns

30 **weather patterns** derived by clustering of over 150 years of PMSL observations.







Weather pattern forecast applications in the UK

Fluvial flooding



Flow from Iceland

Decider - Flow from Iceland to London FIR ECMWF monthly

Summary:

- Make use of ensembles to help understand uncertainty in hazard and impact forecasts.
- Generating ensemble products requires processing a huge amount of input data can use summary products to enable easier interpretation.
- Impact forecasts provide advance warnings of low probability, high-impact events and can be specifically orientated to user needs.
- Member clustering enables advance planning for worst-case scenarios.
- IMPROVER post-processing system has been developed with ensembles at its core.

Questions?

Thank you for your attention!