Probabilistic Forecasts in Support of Aviation

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With thanks to
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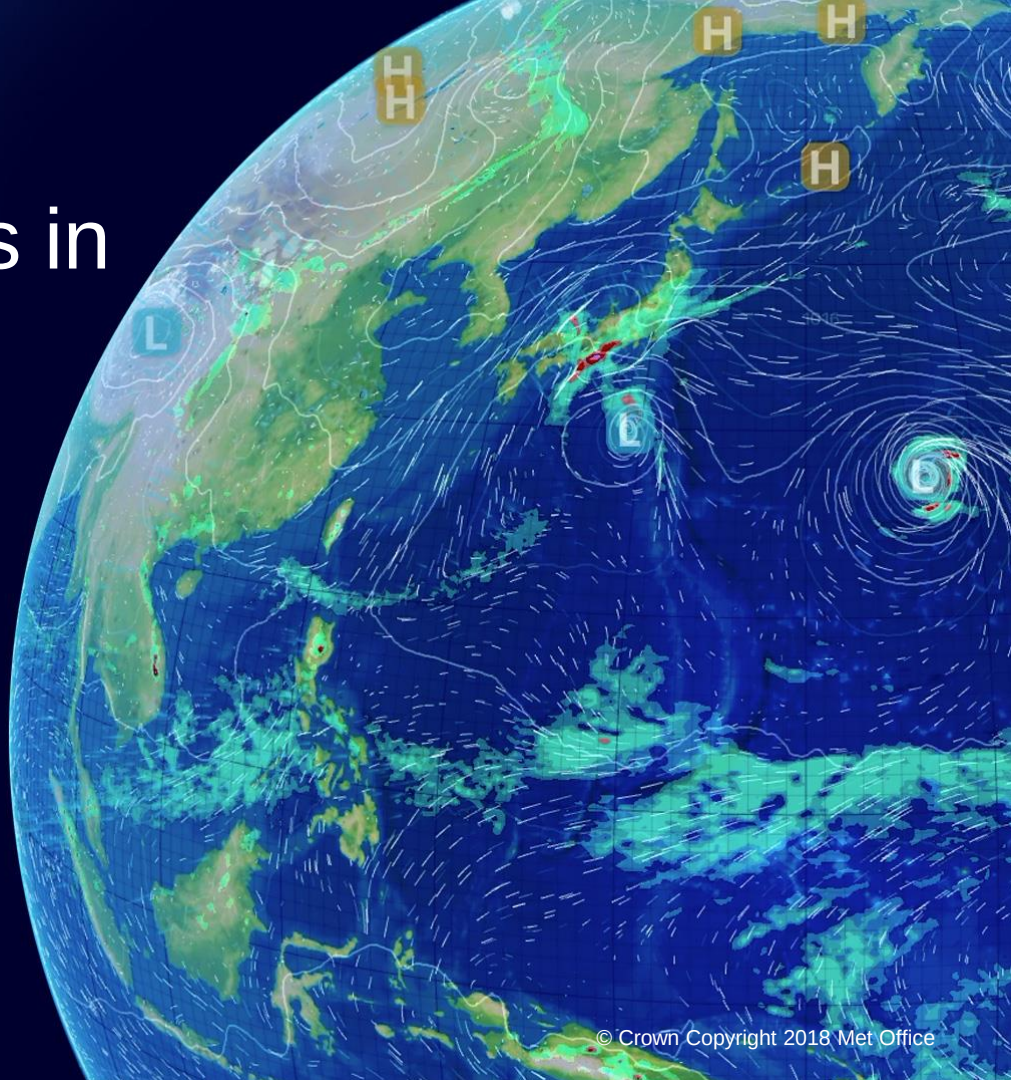

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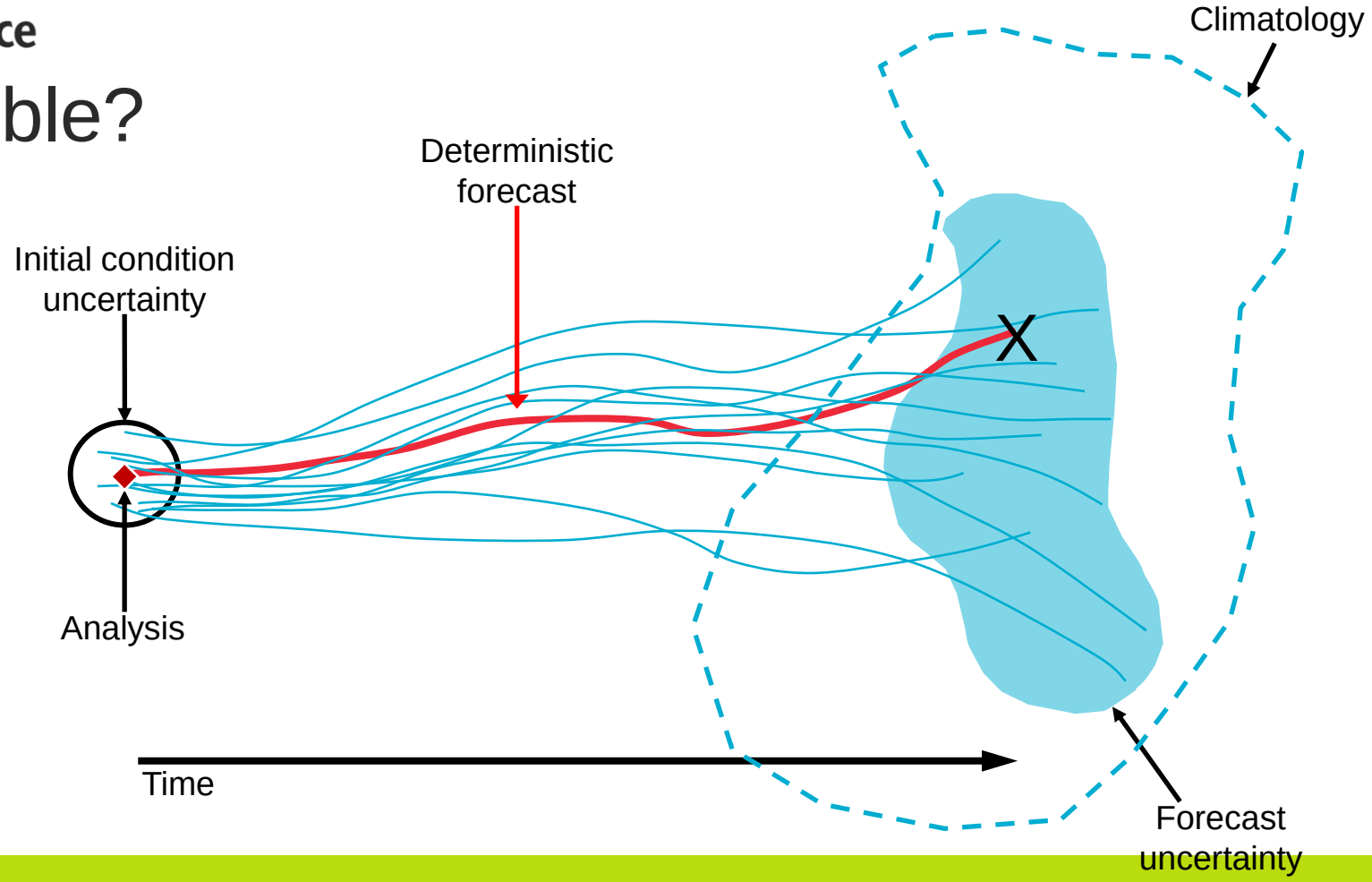
Overview

- Ensemble models
- Probabilistic forecast examples
- Concluding remarks

Ensemble?


Climatology
Deterministic forecast
Initial condition uncertainty
X
Analysis
Time
Forecast uncertainty

Met Office Global and Regional Ensemble Prediction System (2018)

Global component (MOGREPS-G)

- 20km, 70 Levels
- 18 members
- 4 updates daily
- 174 hour lead time (T+168h lagged to produce a 7 day forecast)
  - Plan to increase to 10 days in 2019

- Ensemble Transform Kalman Filter for initial condition perturbations
- Stochastic physics (SKEB2) and random parameters for model physics peturbations.

What other Global ensemble models are used in Met Office products?

ECMWF EPS

51 members every 12 hours at 18 km resolution

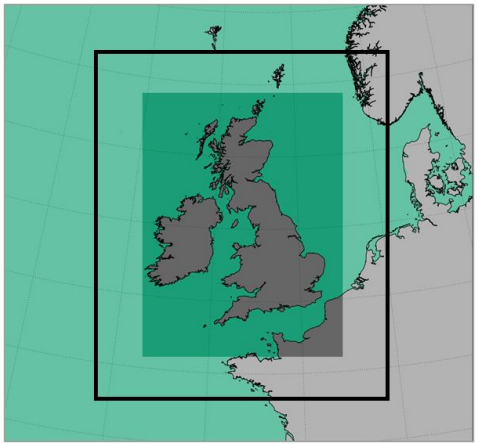
NCEP GEFS

21 members every 6 hours at 28km resolutions

Met Office Global and Regional Ensemble Prediction System (2018)

Regional component (MOGREPS-UK)

- 2.2km inner domain (Increasing to 1.5km 2018/19)
- 12 members
- Nested in MOGREPS-G
- Based on UKV physics
- 54 hours
- 4 updates daily (Changing to hourly updates in 2018)



- Neighbourhood processing accounts for spatial uncertainty not covered by ensemble spread...

Probabilistic forecast examples

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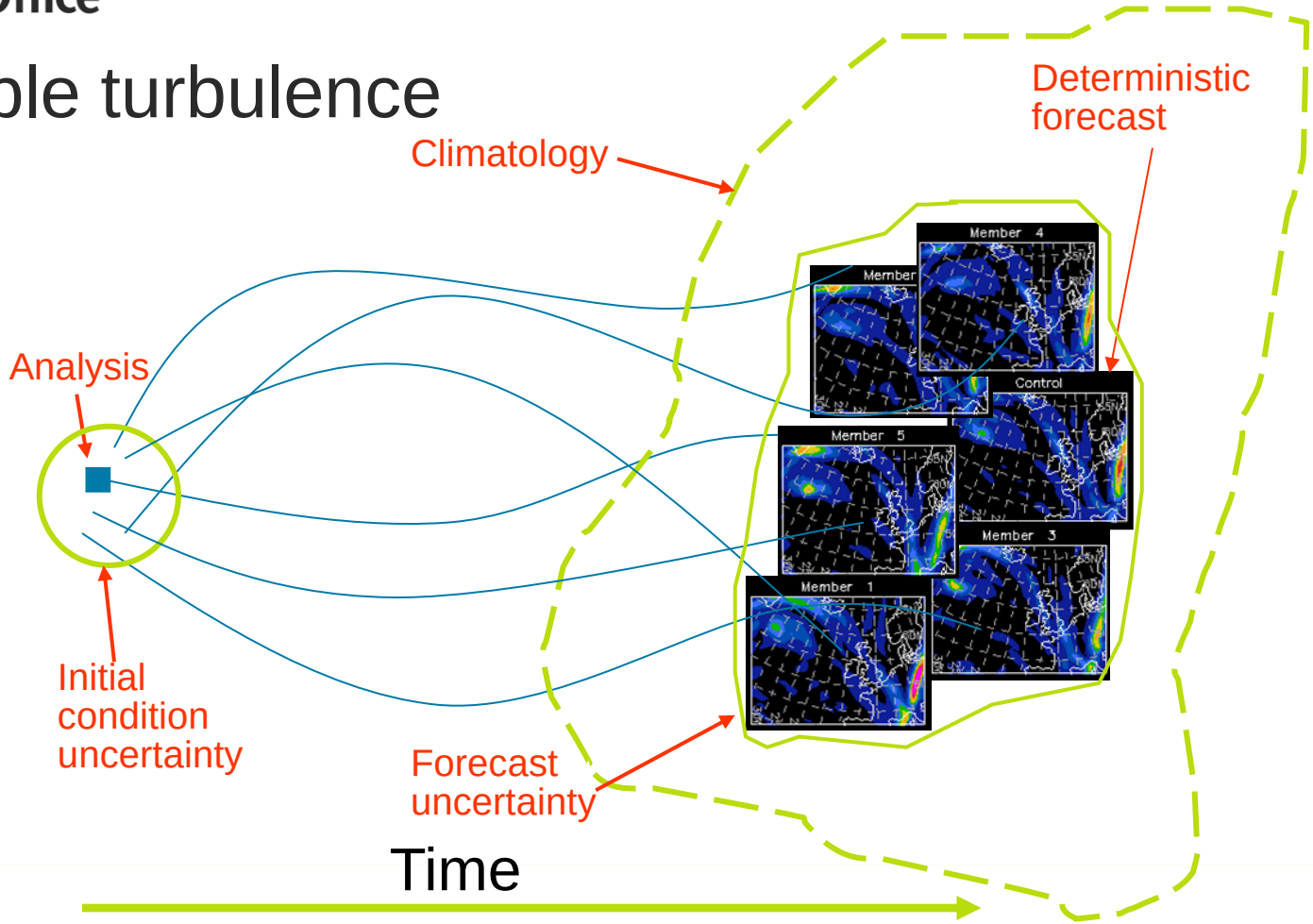
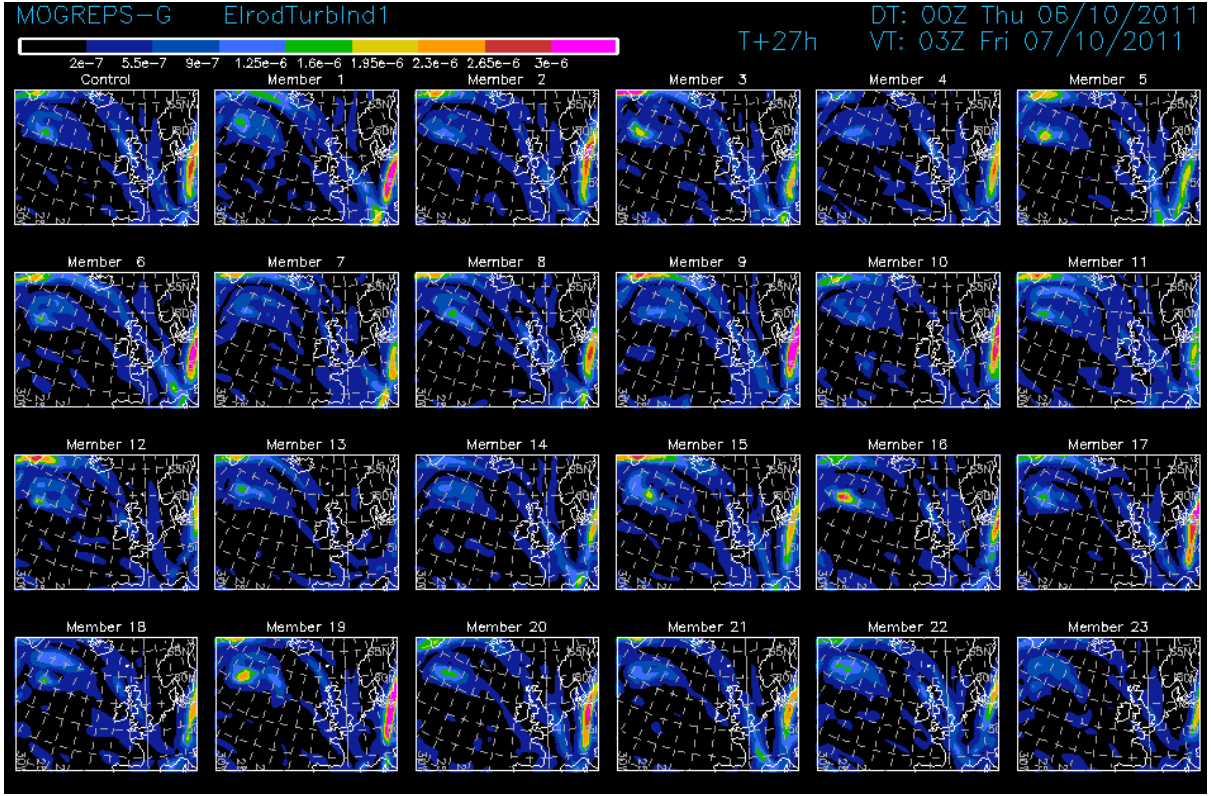
Ensemble turbulence



‘Postage stamp’ plots for turbulence predictor.



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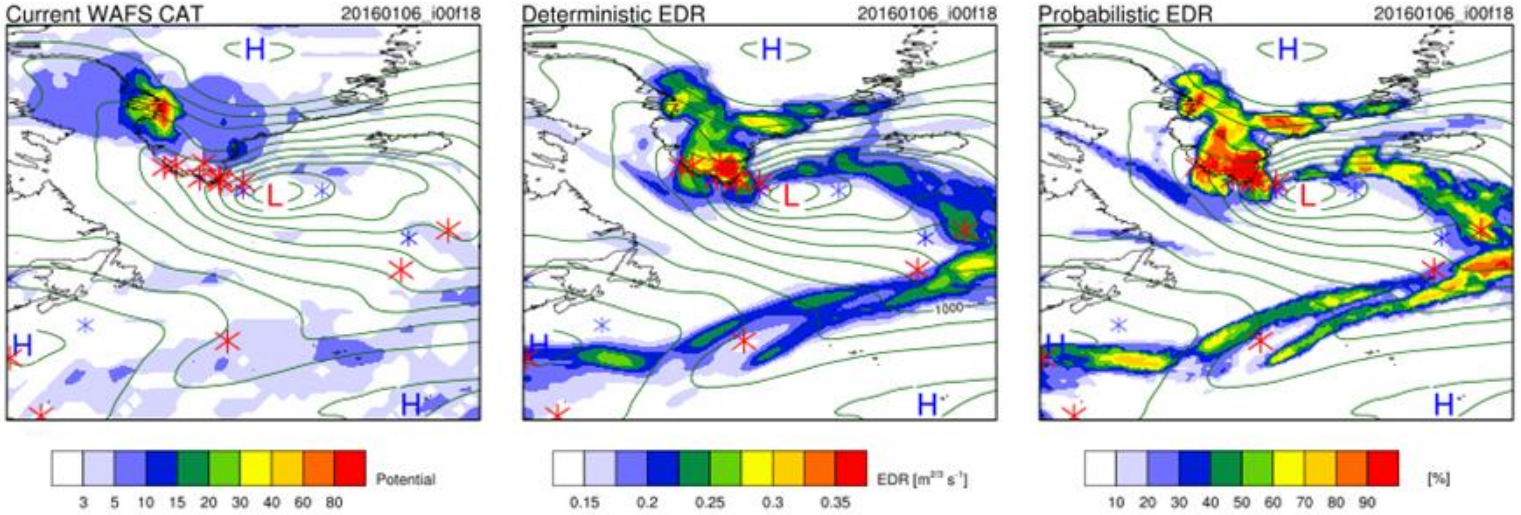
Trial probabilistic WAFS hazard forecasts for GTG turbulence.

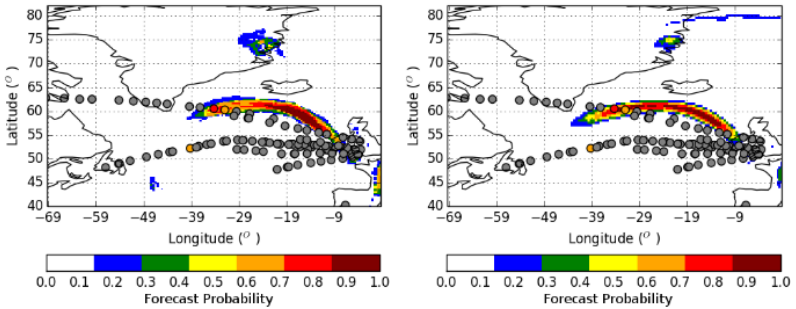


Kim, Sharman, Strahan, Scheck, Bartholomew, Cheung, Buchanan and Gait: 'Improvements in Non-Convective Aviation Turbulence Prediction for the World Area Forecast System (WAFS)', accepted for publication by BAMS, 2018

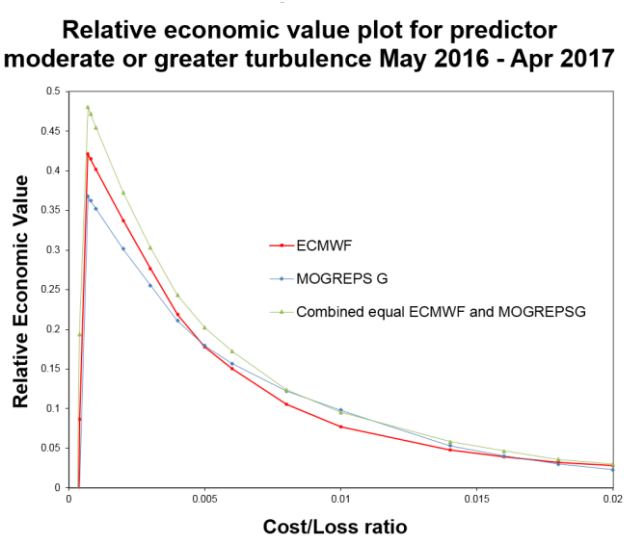
Multi-model ensemble turbulence research

Blending the Met Office (MOGREPS) and ECMWF ensembles for turbulence forecasts

MOGREPS ECMWF



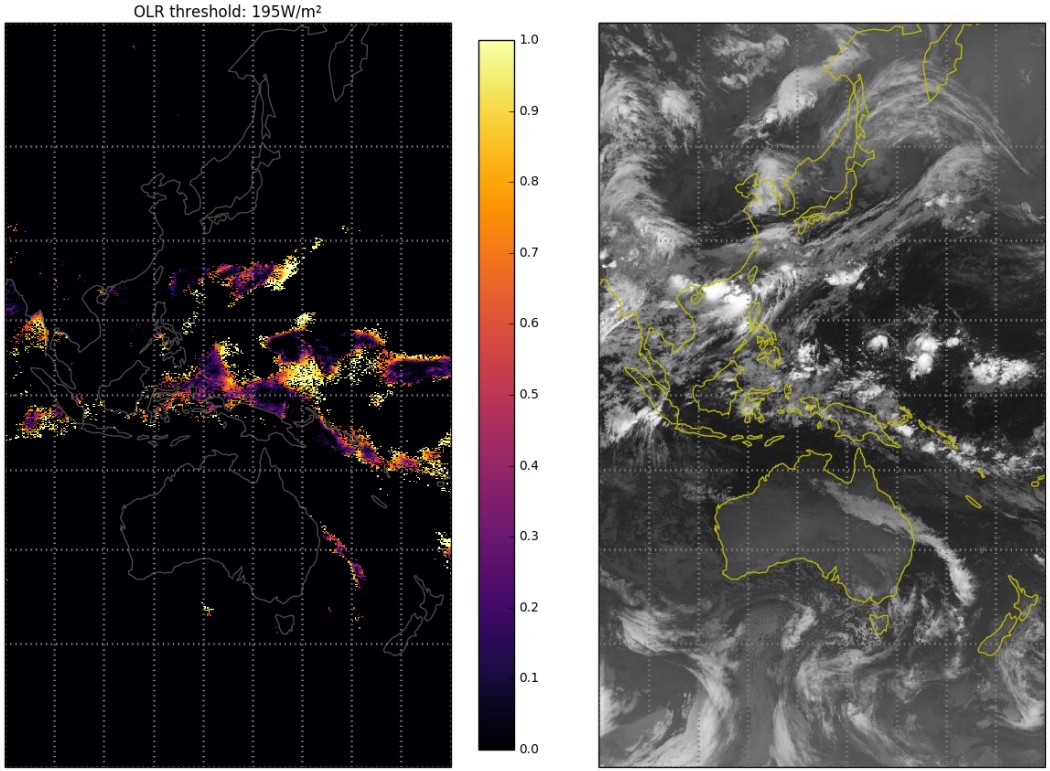
Ellrod TI1 indicator probabilities with aircraft observations overlaid



Combining ensembles can **improve forecast skill** and **user value.**

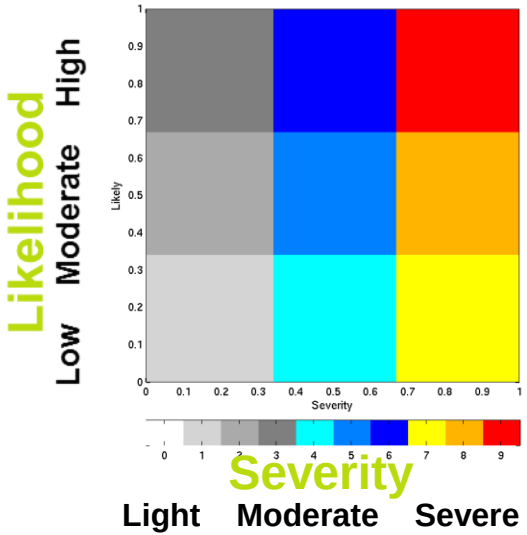
Luke Storer and Paul Williams (University of Reading), Philip Gill (Met Office)

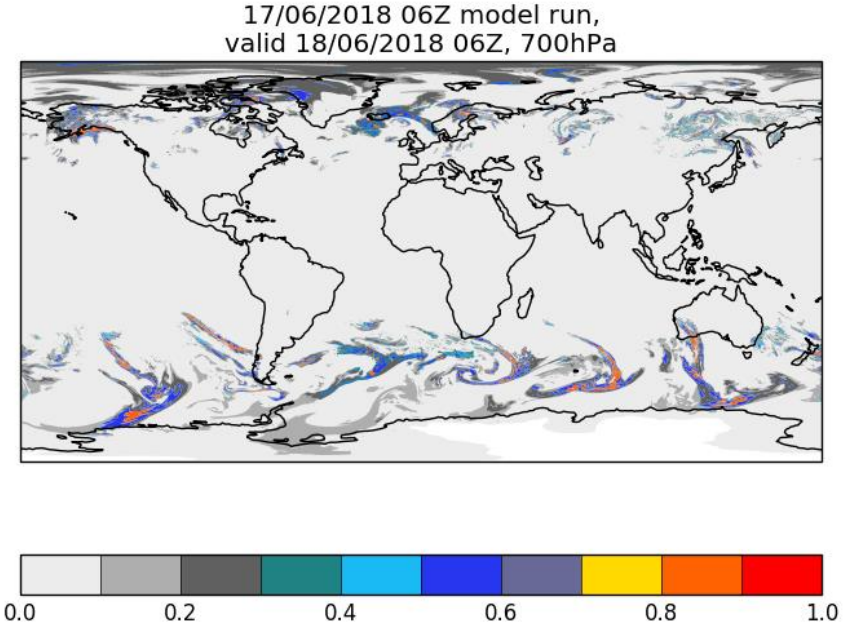
Probabilistic Cb



Probabilistic icing forecasts

- Keeps likelihood and severity as individual components which can be used for probabilistic visualisation





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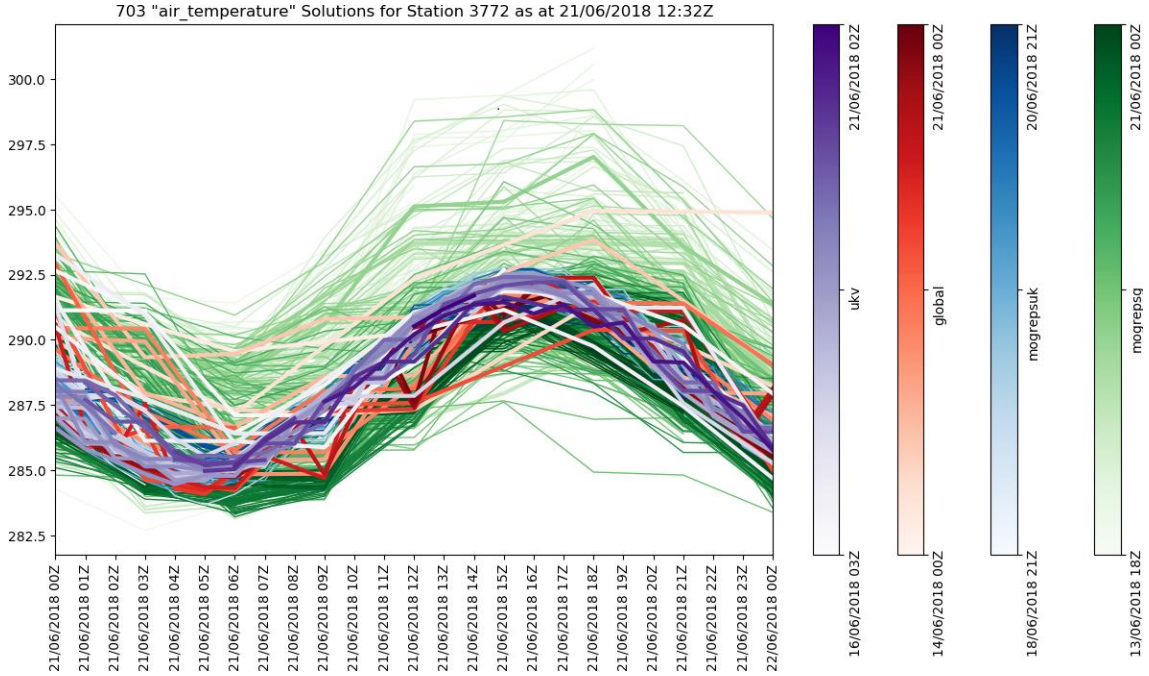
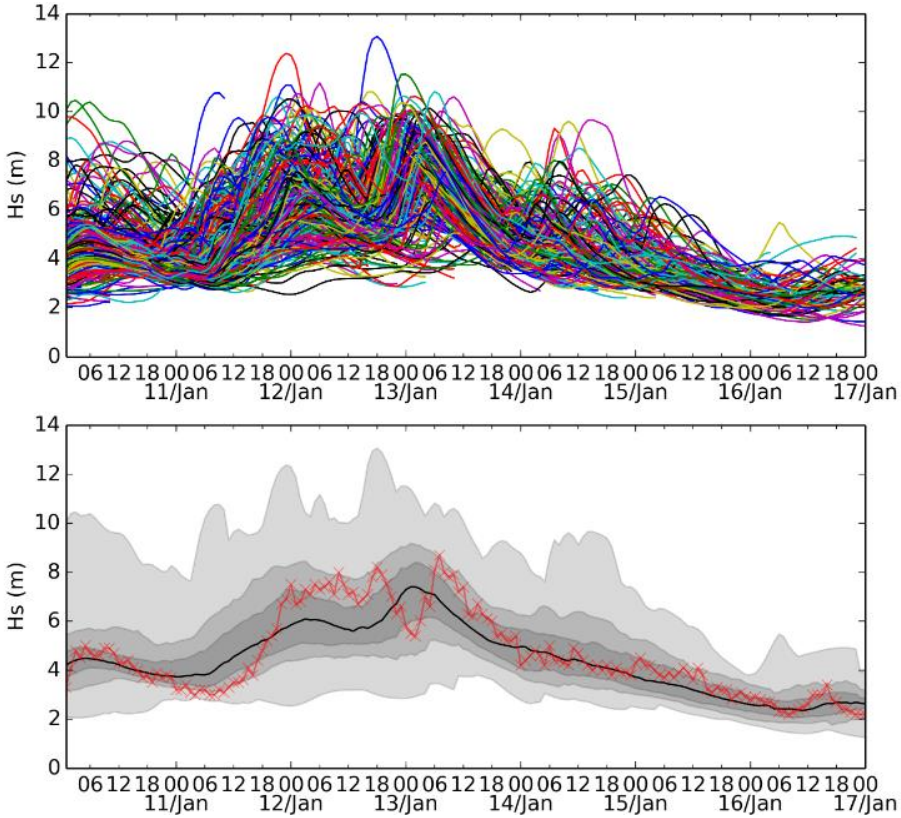
Local weather at an airport

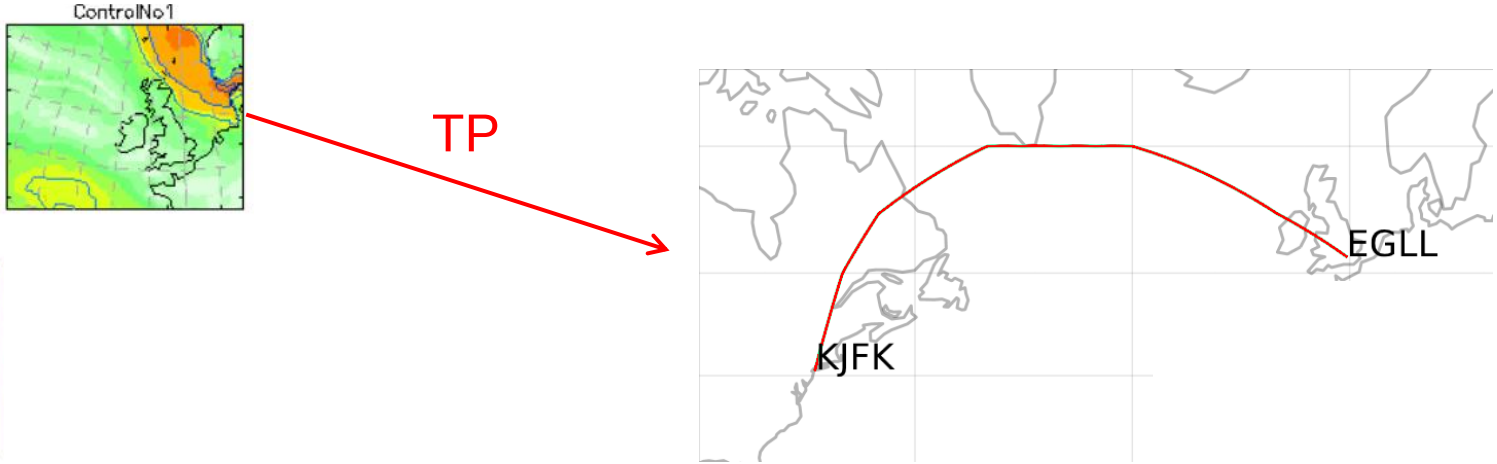


- Superset of solutions:
- Multi-centre, Multi-model, Multi-run;

- Best estimate (& measure of spread)
- → but how to determine?

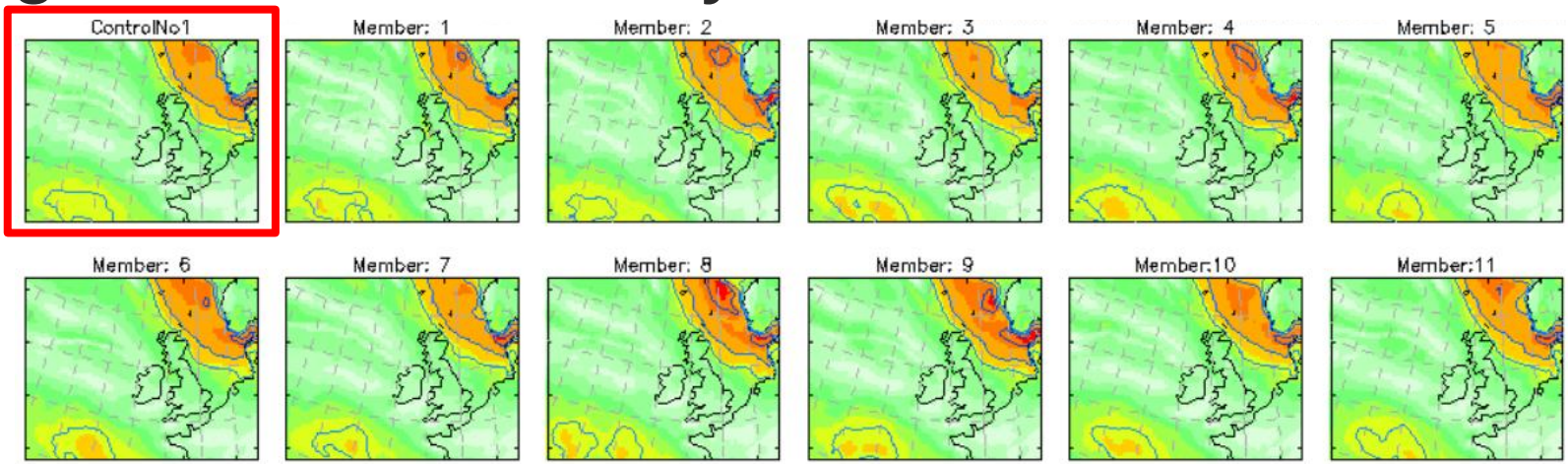


Flight time uncertainty



No uncertainty information!

Flight time uncertainty



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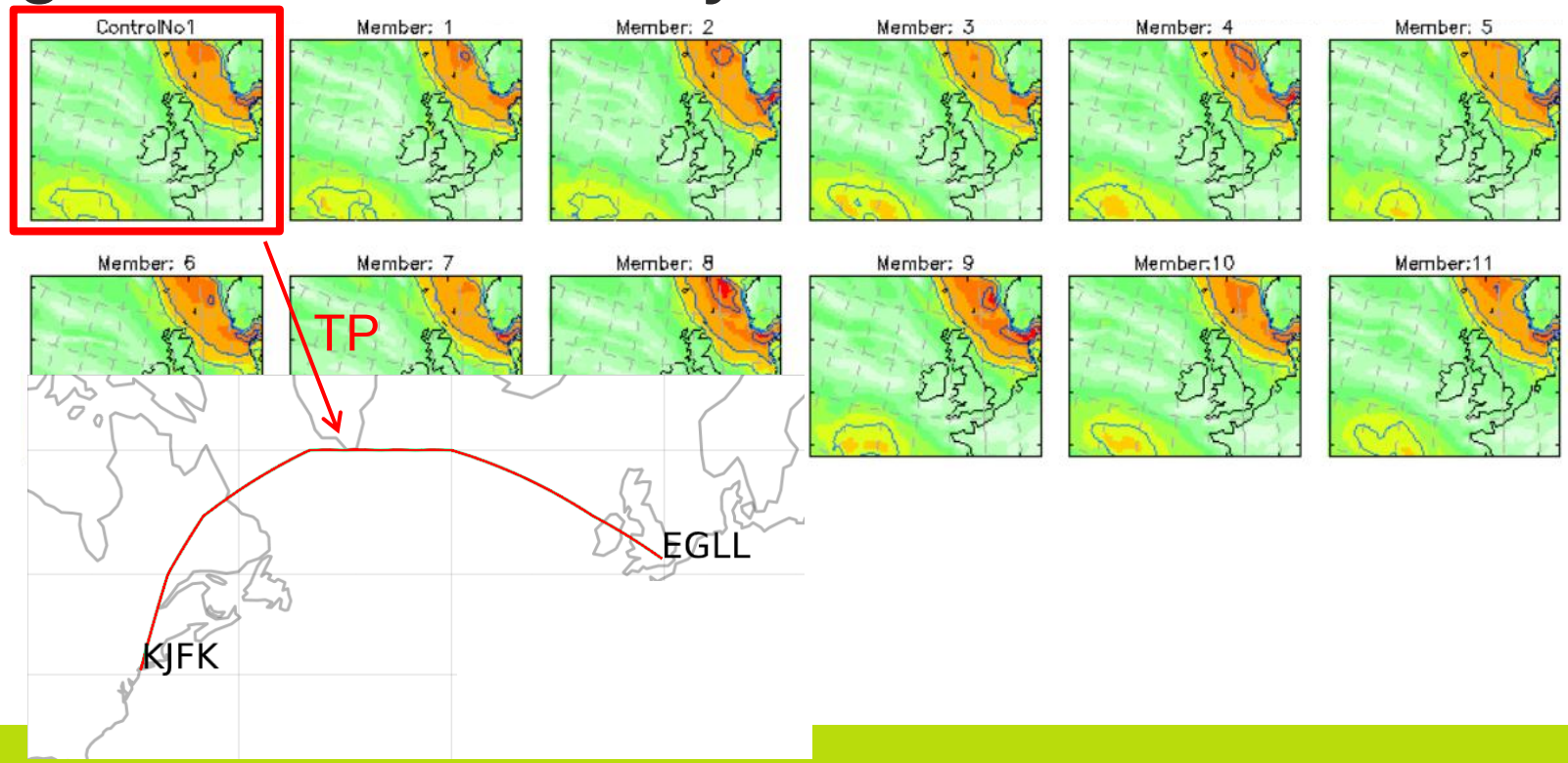
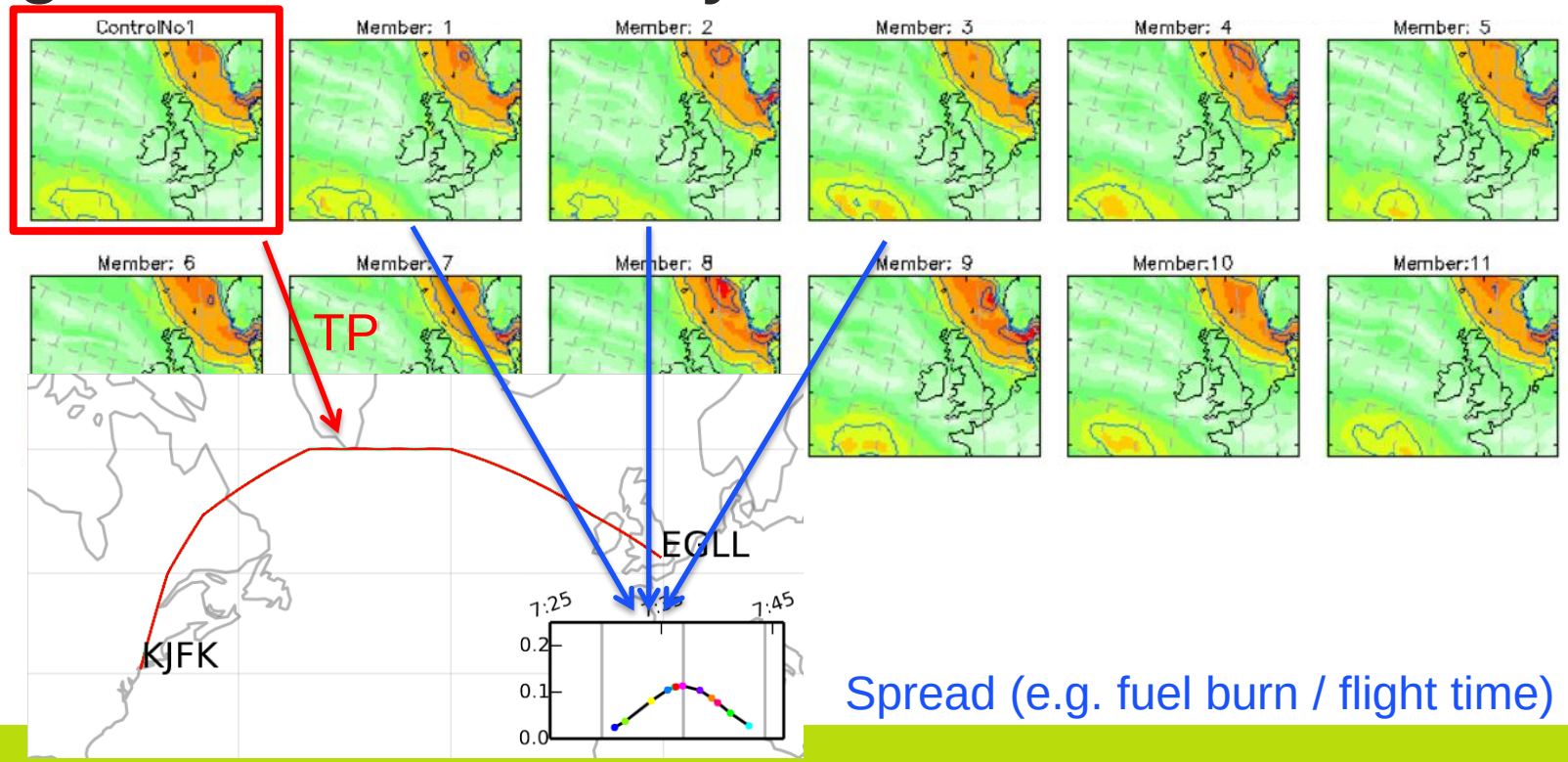


Flight time uncertainty



Spread (e.g. fuel burn / flight time)

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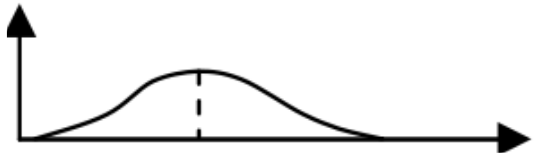
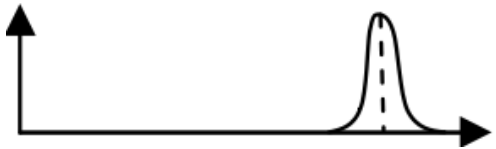
Flight time uncertainty



Low cost but high uncertainty



Higher cost but least uncertainty

Concluding Remarks

- The Met Office runs both UK and global ensembles which are continually being developed
- Use of ensemble data helps to determine the uncertainty in a forecast and the range of possible scenarios
- Data from different centres can be combined to create a larger ensemble and a more reliable estimate of uncertainty
- There are different ways to communicate uncertainty and they need to be chosen carefully with the end user in mind
- The Met Office has ongoing work looking at more sophisticated methods for calibration and blending of ensemble data

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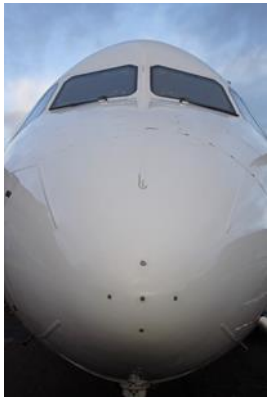
Questions?



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