Developing an icing index for aviation

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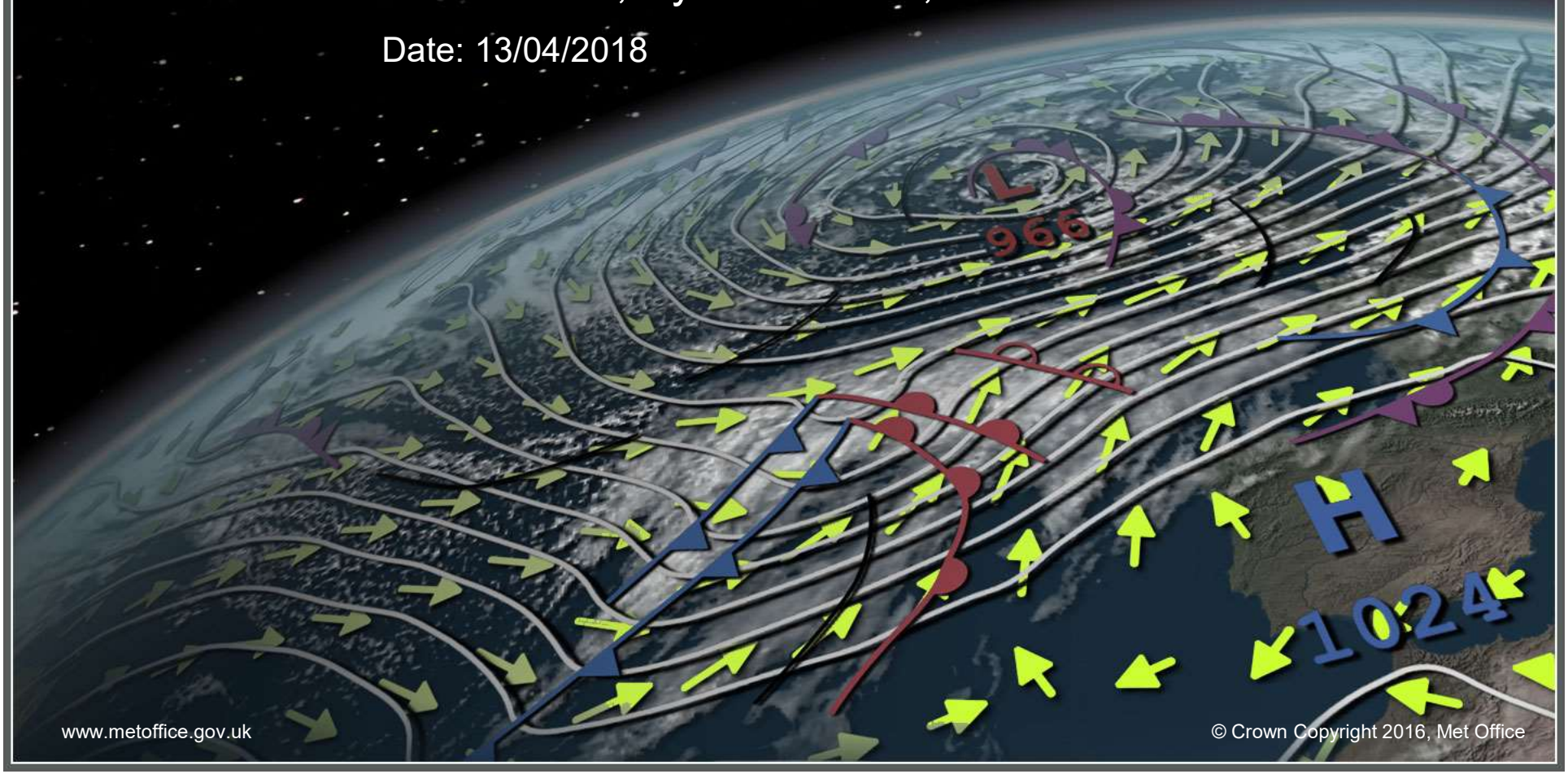
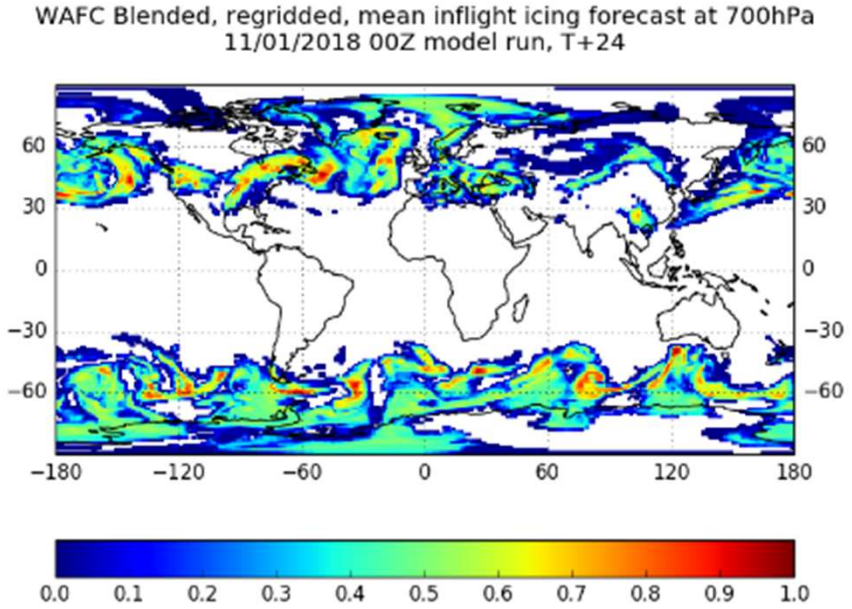


Super-cooled clouds and the risk to aviation

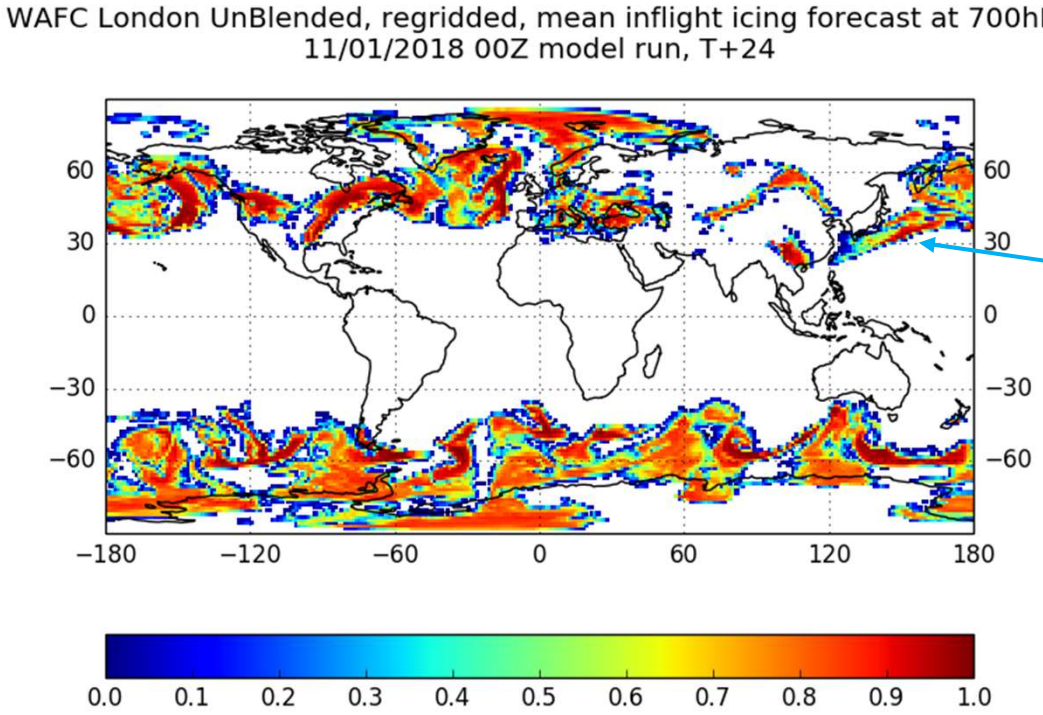
- Water can exist in a liquid state below 0°C
- Leads to “super-cooled cloud”
- Affects aerodynamics and handling
- Global gridded forecasts of inflight icing risk



The current operational Inflight Icing Index

- If -20°C < Temp <0 °C and cloud is present:

  Icing index = relative humidity

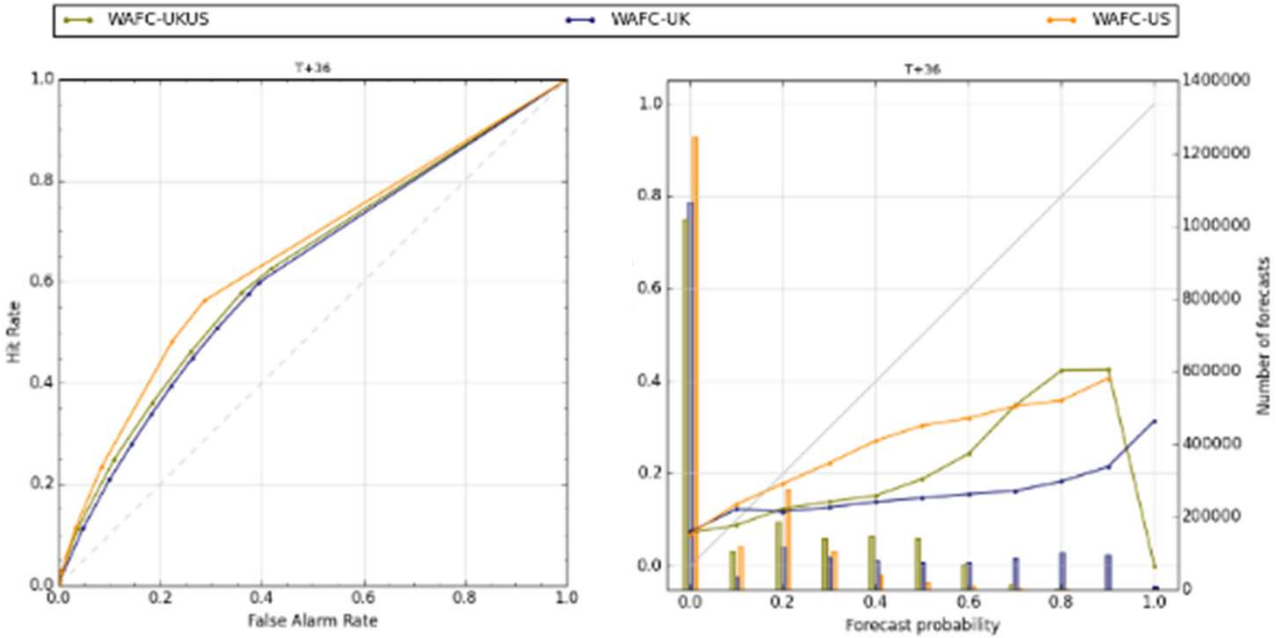


Almost binary output

Improving Inflight Icing forecasts

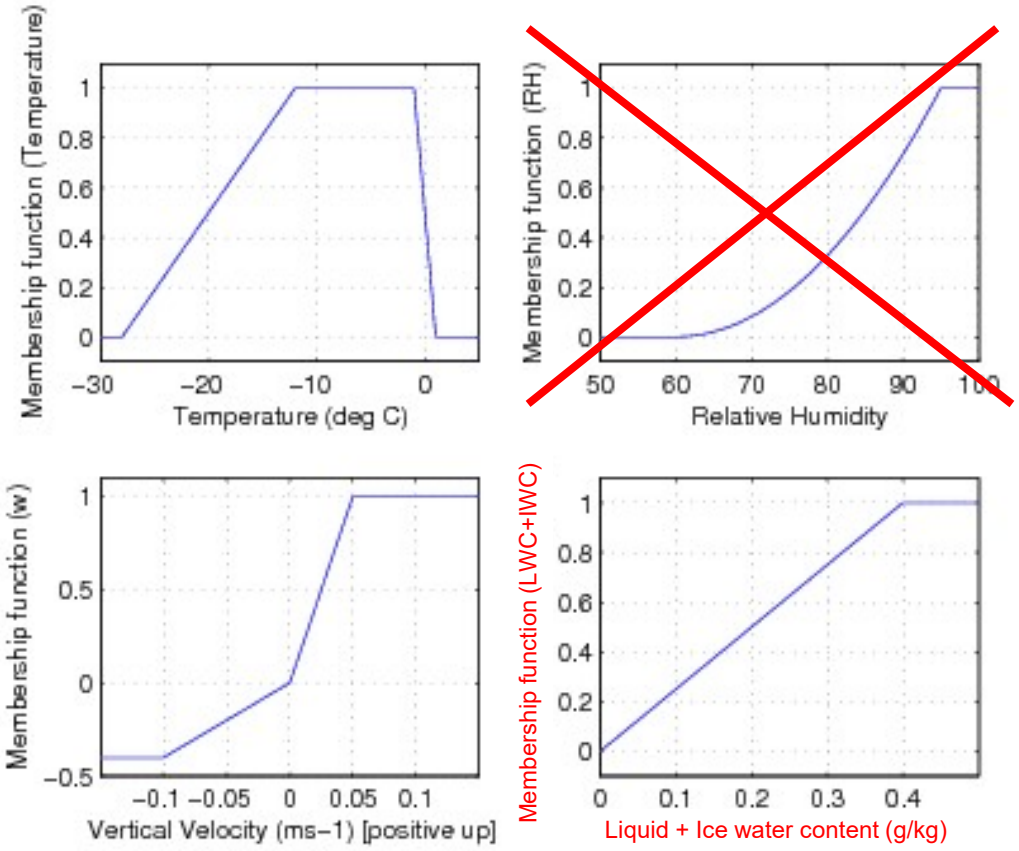
- Important for safety to have accurate forecasts
- Improved and more accurate guidance can be given by meteorologists to customers
- Current index not skilful enough to be relied upon

WAFC Mean Icing January 2015 to December 2015



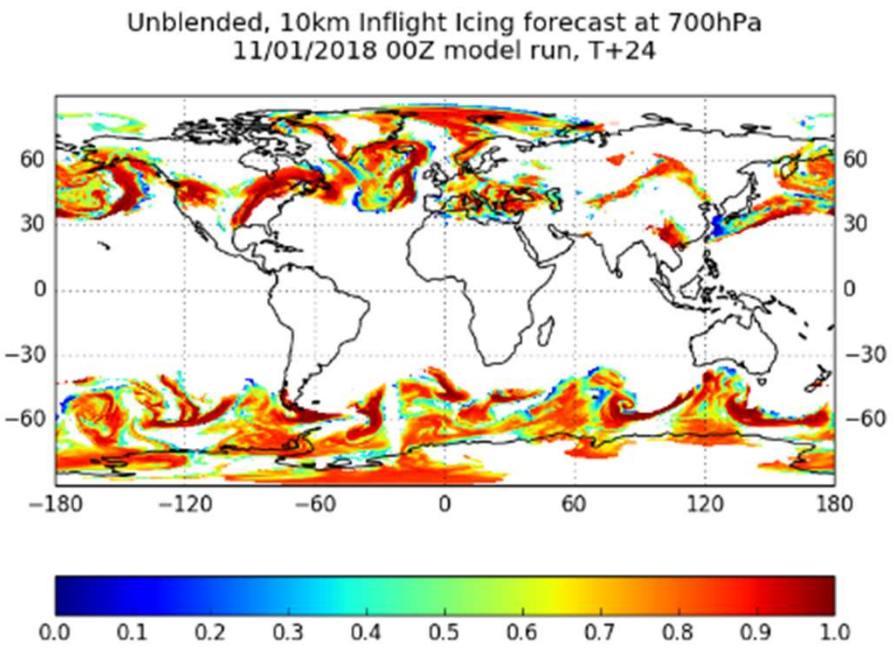
Developing a new icing index from the literature

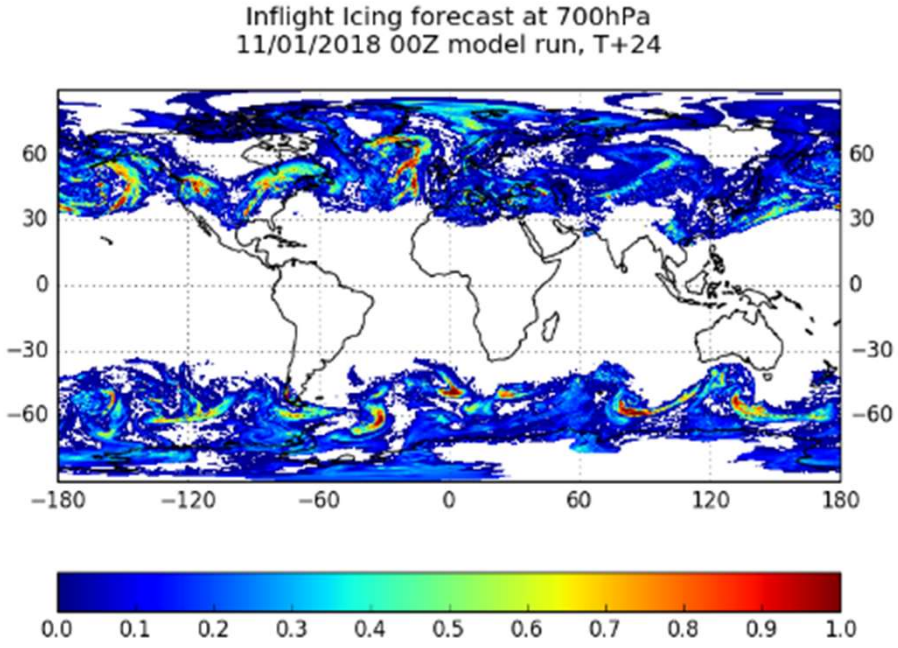
$$SFIP = M_T(cr \times CF + cw \times M_w + cc \times M_{LIWC})$$



Belo-Pereira, M. (2015), Comparison of in-flight aircraft icing algorithms based on ECMWF forecasts. Met. Apps, 22: 705–715. doi:10.1002/met.1505

Deterministic icing index





Current

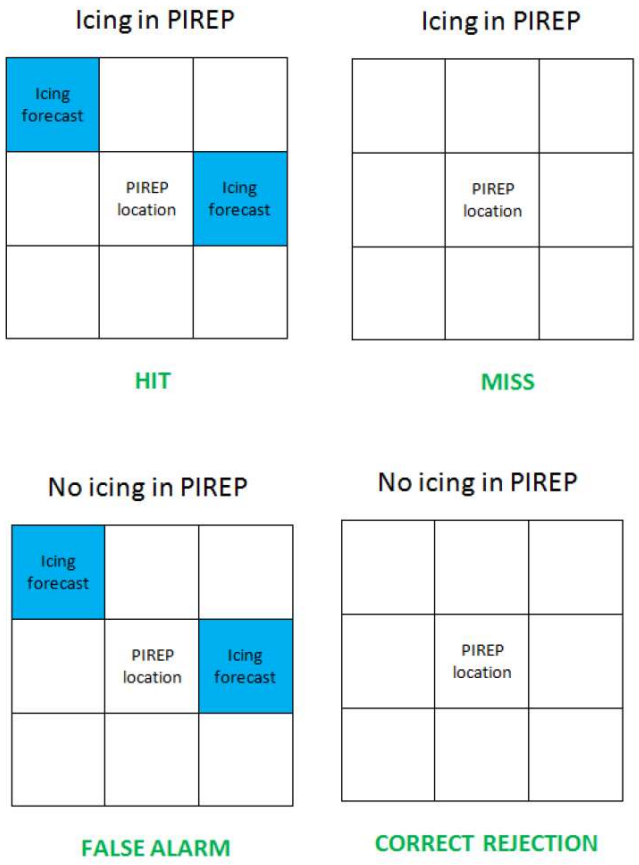
New

- Values <0.01 masked for both visualisations
- Linear interpolation for model level to pressure level conversion in ‘New’

Verification challenges

Using PIREPs

- Verified December 2014.
- Very different outcome for WAFC London reliability than in routine verification.
- Inaccurate in time and space.
- Investigate other methods of verification…



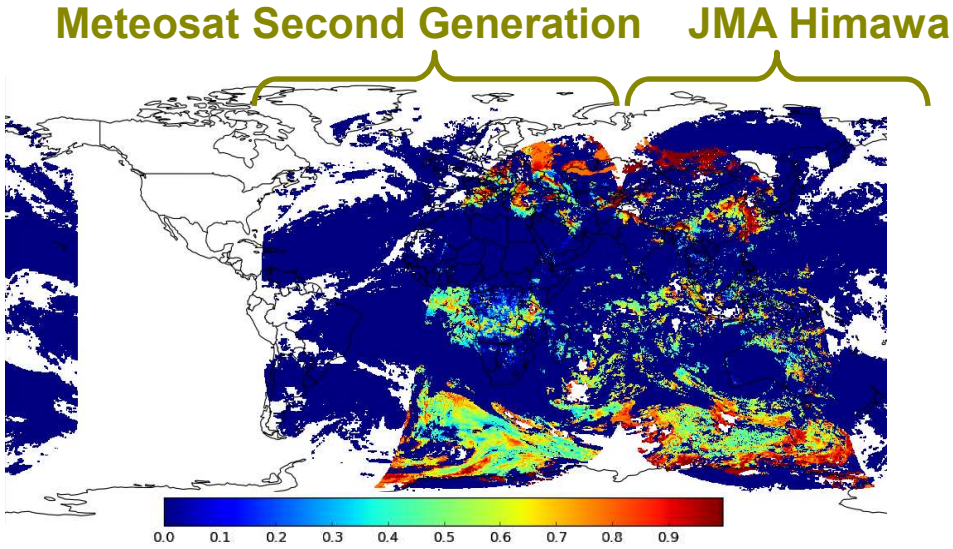
Example PIREP

DD	MM	YY	HH	MM	LON	LAT	H_L	H_U	H_M	I
01	12	14	06	54	45.23	09.69	99999	99999	14000	2

$I = 0 - 3$ represents None, Low, Moderate, Severe Icing

Objective Verification System

- Objective verification system developed for WAFC Inflight Icing forecasts (Stretton, 2016)
- Met Office satellite icing potential product used as source of truth data (Francis, 2007)



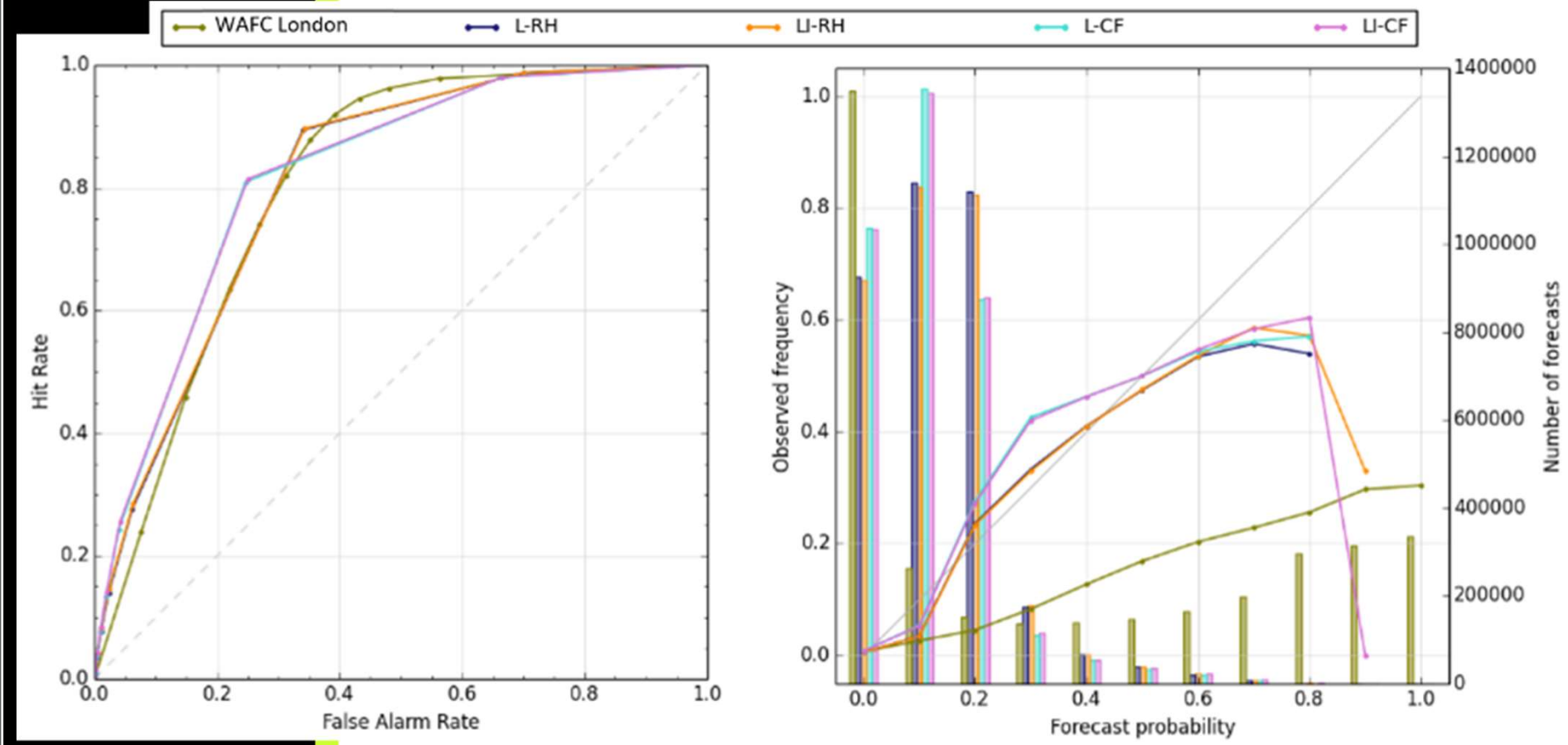
Icing potential satellite product coverage valid 11/02/16 0730Z.

Francis, P.N., 2007. Detection of aircraft icing conditions over Europe using SEVIRI data. AMS/EUMETSAT Meteorological Satellite Conference Session 3, 24-28 September, Amsterdam, The Netherlands.

Stretton, R., Buchanan, P., Francis, P., 2017. Verification of Met Office Global Icing Potential Forecasts using Satellite Observations. AMS 18th Conference on Aviation, Range, and Aerospace Meteorology, 23-26 January, Seattle, Washington.

Verification Results

January 2015 to December 2015, T+36 forecasts for the whole area covered by the satellites.



Work in progress..

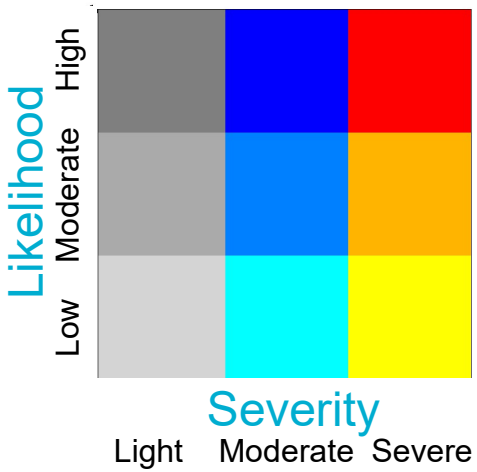
A New Visualisation

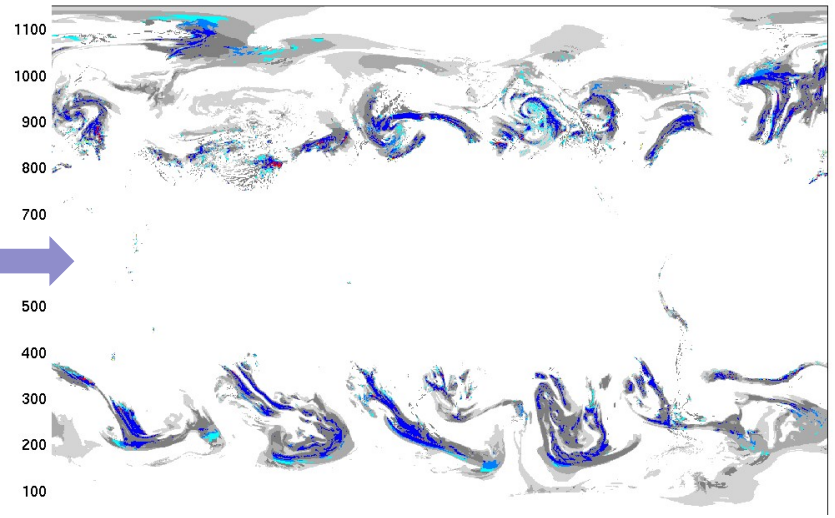
- Icing forecast as light, moderate, severe

$$SFIP = \underbrace{crM_T CF}_{likelihood} + \underbrace{cwM_T M_w + ccM_T M_{LIWC}}_{severity}$$

$$MOSFIP = likelihood + severity$$

Trial use of impacts matrix





Met Office

Work in progress..

The Future is Probabilistic

$$SFIP = \underbrace{crM_T CF}_{likelihood} + \underbrace{cwM_T M_w + ccM_T M_{LIWC}}_{severity}$$

$$MOSFIP = likelihood + severity$$

3 orthogonal operations:

A. Neighbourhood smoothing

B. Ensemble Averaging

C. MOSFIP calculation

ORDER MATTERS

A. → C. → B.

- Keeps likelihood and severity as individual components which can be used for probabilistic visualisation
- Does the neighbourhood size make a significant difference?

Overview

- New version takes account of a wider range of meteorological factors and so is more physically realistic.
- New deterministic icing index is improvement on the current operational index.
- No visualisation to distinguish likelihood from severity, the new index gives scope to provide this.
- Probabilistic icing algorithm in progress..

Questions?