Better de-icing with probability forecasts

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Conclusions

• We propose a procedure for creating and calibrating wing temperature probability forecasts.
• This procedure (BMA) adds skill and calibrates probabilities for near-future forecasts.

Introduction

Airplanes need to be free of ice before take-off. This puts a scheduling challenge on airports when the weather is uncertain. A calibrated and skillful wing temperature probability forecast is essential for planning de-icing capacity. While current ensemble probability forecasts are skillful, they are often underdispersed for short-range forecasts. We propose an approach for skillful, sharp and calibrated wing temperature probability forecasts.

Wing Temperatures

To calculate wing temperatures we use an energy balance model configured for wings. We installed sensors on a measurement wing at Schiphol airport for validation.

Bayesian Model Averaging

We create an ensemble by using many different weather predictions. Probabilities then become relative frequencies. With a small amount of members, these probabilities are uncalibrated.

Instead, BMA [1] fits each member with a probability density function – Normal for temperature – and jointly fits the ensemble parameters and the weighting. We use Expectation-Maximization to fit these parameters.

Results

Uncalibrated

Calibrated

The Probability Integral Transform (PIT) histograms show how predicted probabilities correspond with observed frequencies. Uniform is better.

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References

[1] Using Bayesian Model Averaging to Calibrate Forecast Ensembles, Raftery et. al. (2005), University of Washington, Monthly Weather Review, vol 133, no. 5

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