Forecasting Icing for Aviation: Some thoughts for discussion

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Current Icing Algorithm used by “WAFC-London” (i.e. used by Met Office in the UK)

- **Icing index=relative humidity if -20°C <T<0 °C and cloud is present.**
- **Pros:**
  - **Simple**
  - **Captures broad atmospheric conditions we are interested in.**
- **Cons:**
  - **Simple**
  - **Does not make use of:**
    - **value of cloud fraction**
    - **liquid water content**
    - **information about local cloud variability or microphysics.**

As an atmospheric model developer: good idea of the quality of information that a numerical weather prediction (NWP) model can produce.

Know about level of complexity assumed in the representation of physical processes in the atmosphere.

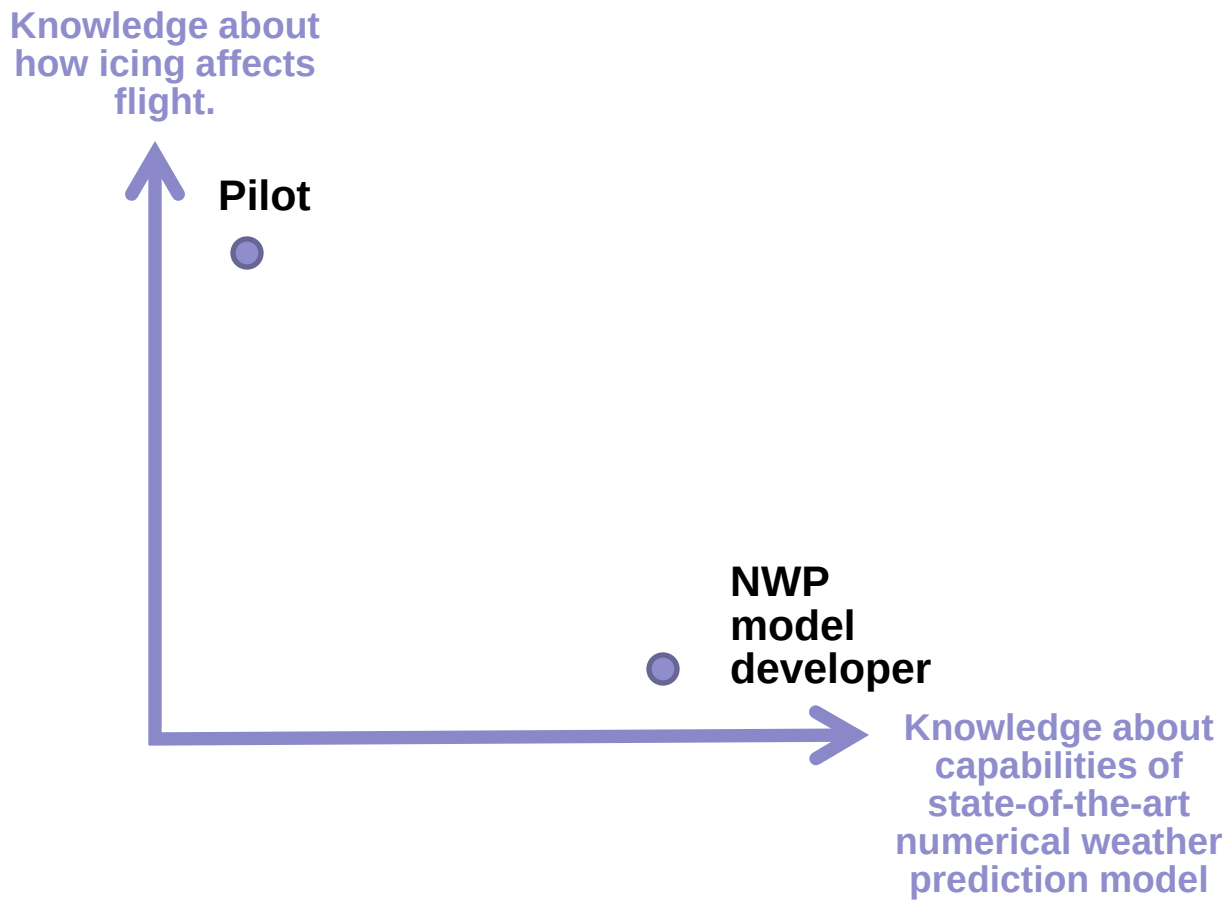
But I don’t know very much about what the end-user of the icing forecast really needs.

What would they really want.

Our forecast model can provide a lot of information.

But what information would be most useful from the point of view of aviation icing and its forecasting.

A very simple schematic



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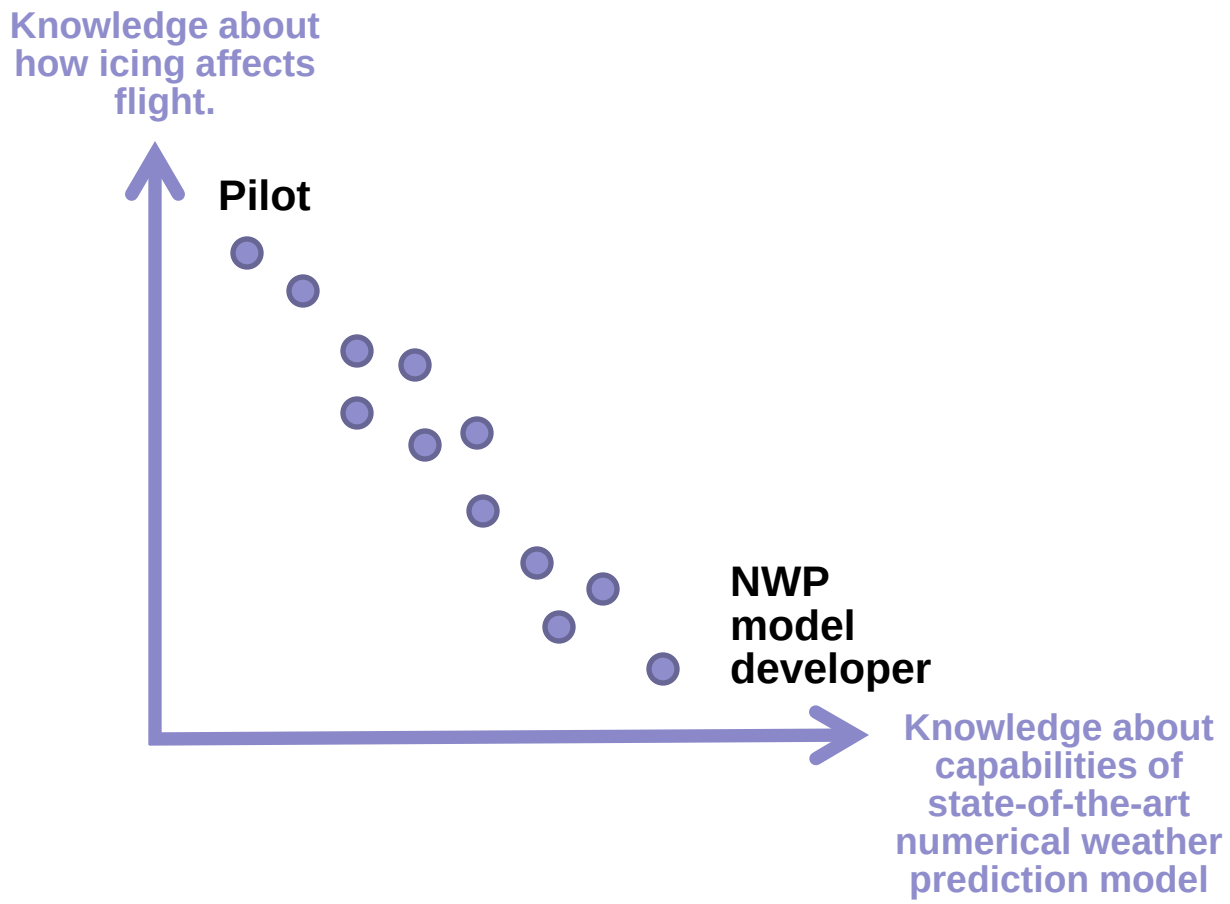

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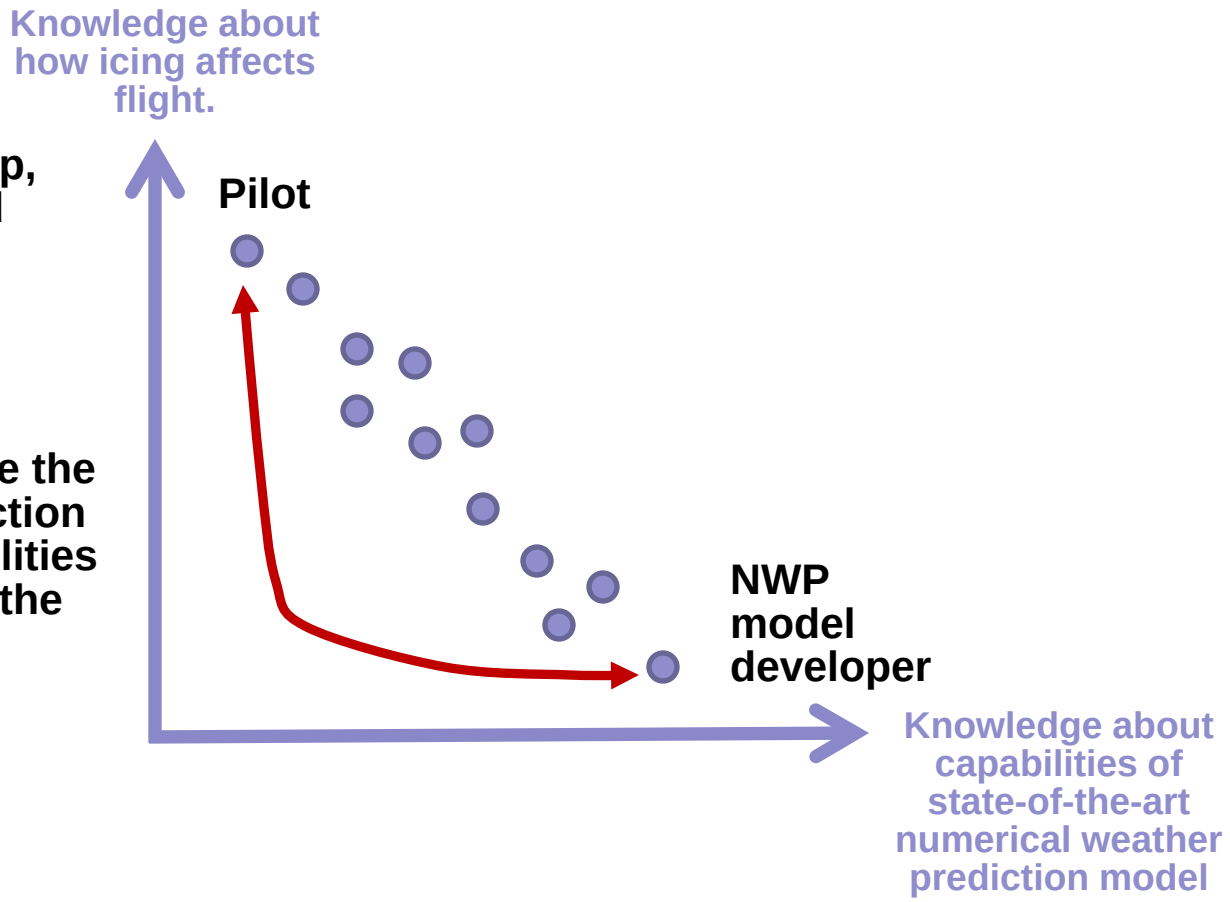
Is there a communication gap, between NWP developer and pilot and vice-versa.

Is the dialogue along the red line?

(Going through a point where the icing product is a poor reflection of weather prediction capabilities and a poor reflection of that the pilots need).



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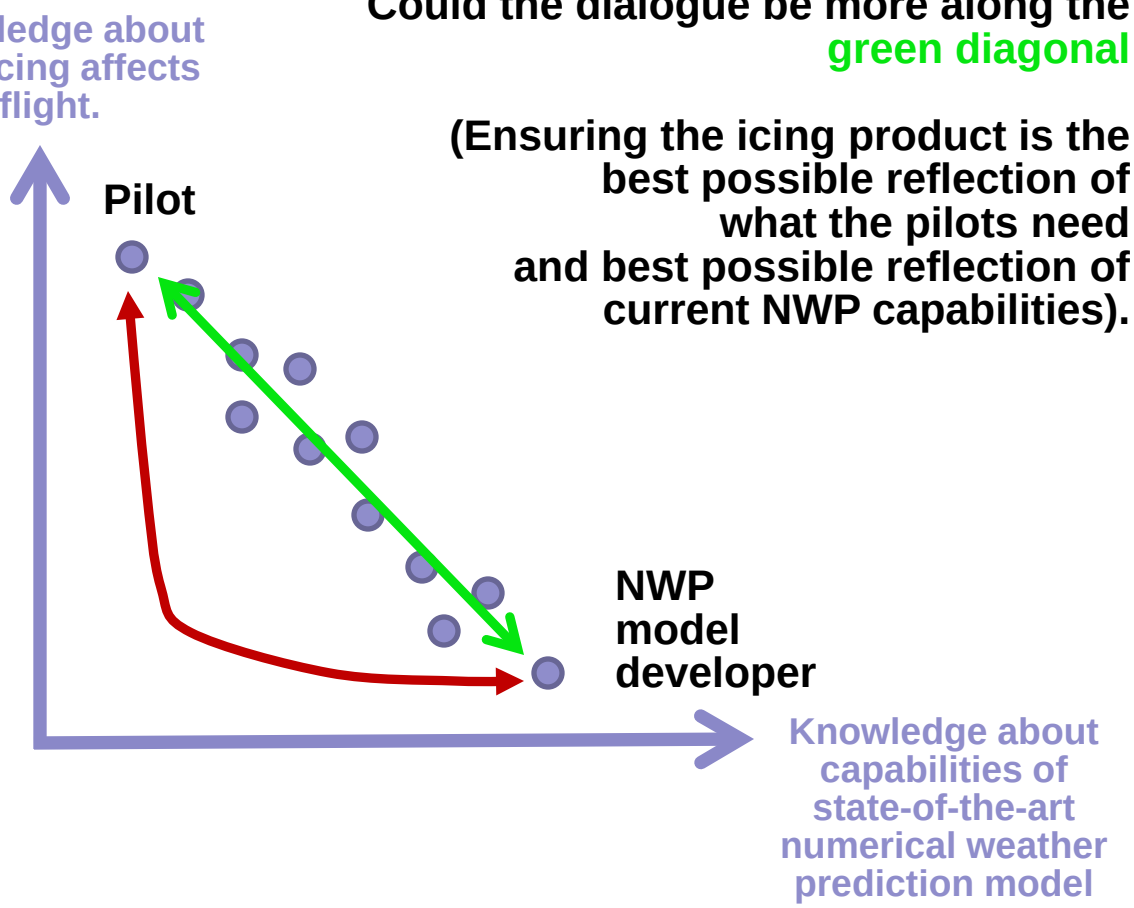

Could the dialogue be more along the green diagonal

(Ensuring the icing product is the best possible reflection of what the pilots need and best possible reflection of current NWP capabilities).

Risk, Avoidance and Verification

- If we forecast an icing risk, presumably the area is avoided by aviation. [For discussion]
- Hence less likely aircraft will encounter the threat and report it hence validating the forecast.
- Also less likely to fly through it and say “no there was nothing there, you were wrong”.

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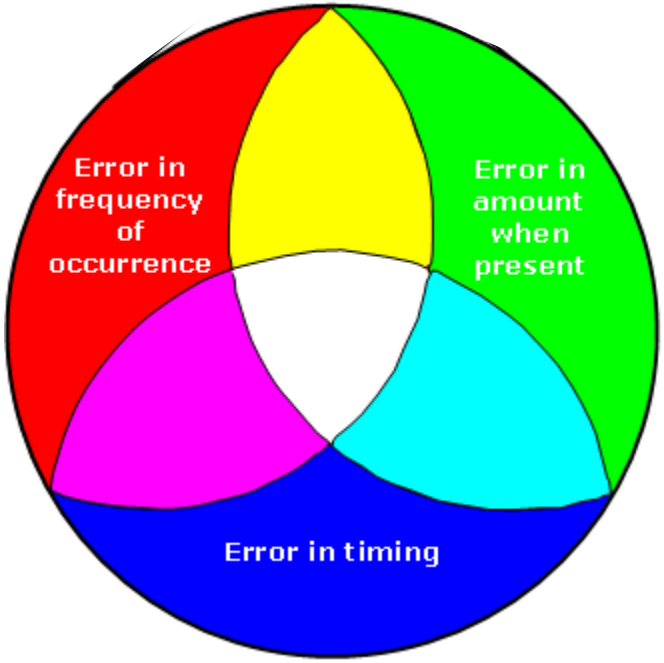
- So, if we were over-predicting icing risk. Would we know?
- Creates a conundrum for verification.
- How do you calculate a skill score for something that you predict is a danger, if the danger is then avoided and hence not encountered as often as it might be.
- What can statisticians tell us about how to verify this kind of scenario (there must be analogue in other fields e.g. medicine/epidemics, aviation turbulence, tornados, weather-related road accidents...)

When is one icing prediction method “better” than another?

- Imagine we have an existing icing-risk prediction system.
- Now we develop a new method of predicting icing risk and we want to make it operational.
- For this to happen, need to show that the new method is “better”.
- So, which one is “better”?
- Clearly, the “better” one has smaller errors!
- But...

There are different TYPES of icing prediction errors.



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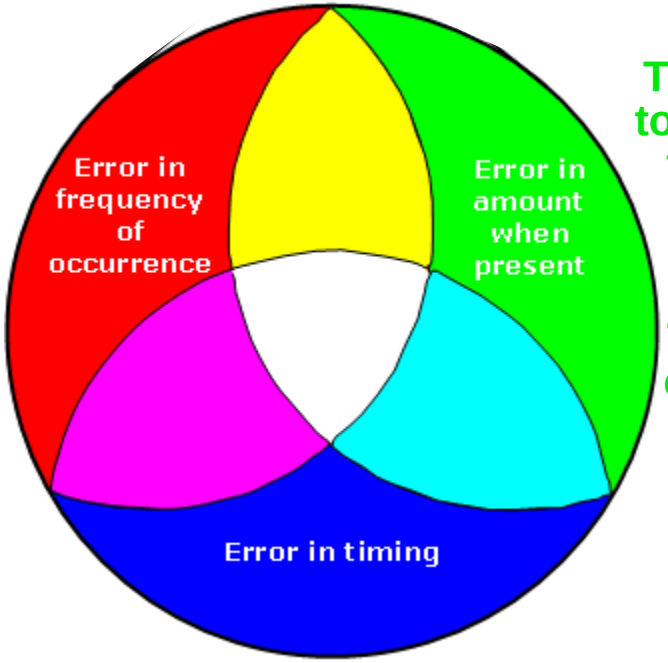

Or “severity”.

This is strongly related to aircraft type, de-icing technology, fuselage temperature (or flight history).

These effects can be called “aeronautical” rather than “meteorological”.

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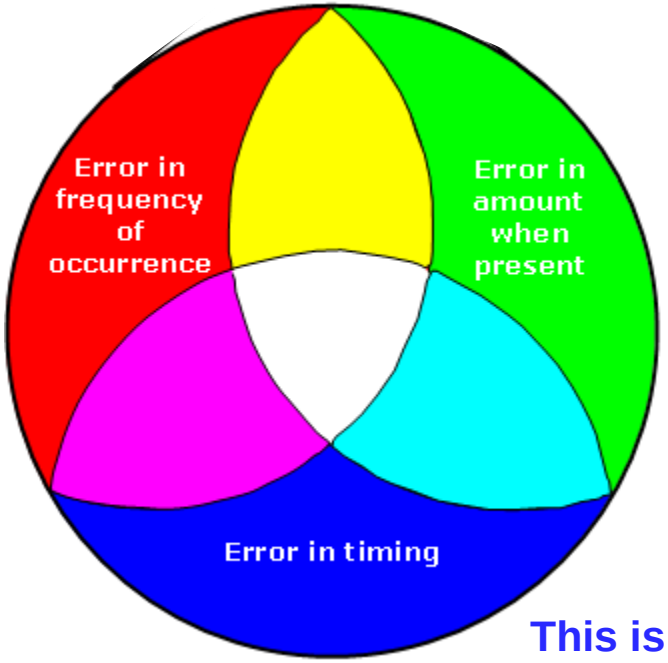


This is strongly affected by errors in the prediction of the large-scale weather pattern.

So linked to errors in NWP model.

Changes to icing prediction method, unlikely to lead to improvement in icing index if front is in the wrong place or arrives earlier than predicted.
So is comparing "hit-rate" or "ETS" that helpful when <u>developing</u> ideas for a new icing prediction?

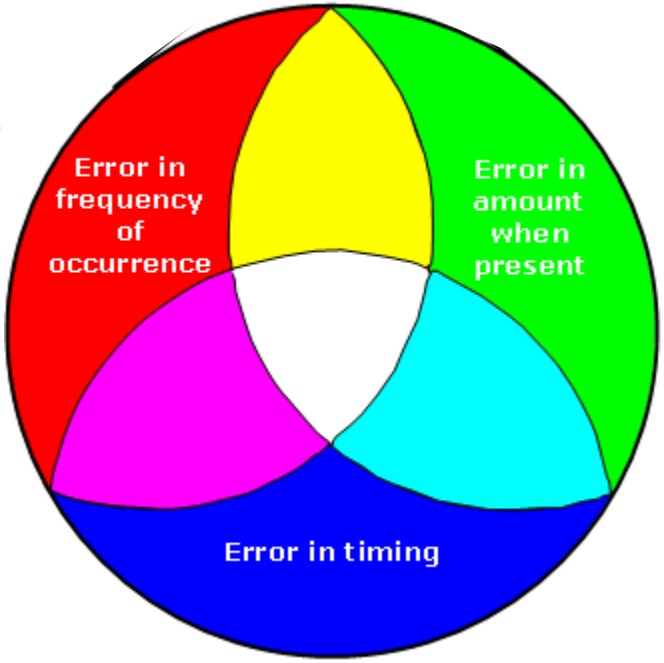
There are different TYPES of icing prediction errors.

This will reflect biases in the way the icing index is formulated, what inputs it uses and the science that it is built upon.

One way of assessing biases in the frequency of occurrence is to look at climatologies.

So (while testing new ideas) don't assess icing prediction in terms of "did you predict icing at 8Z over IAD on 26 Feb 2015".

Instead, given a long-rerun of an NWP model (quite cheap to do really) how frequently do different icing indices predict icing over IAD in each month. Compare that to long term statistics.



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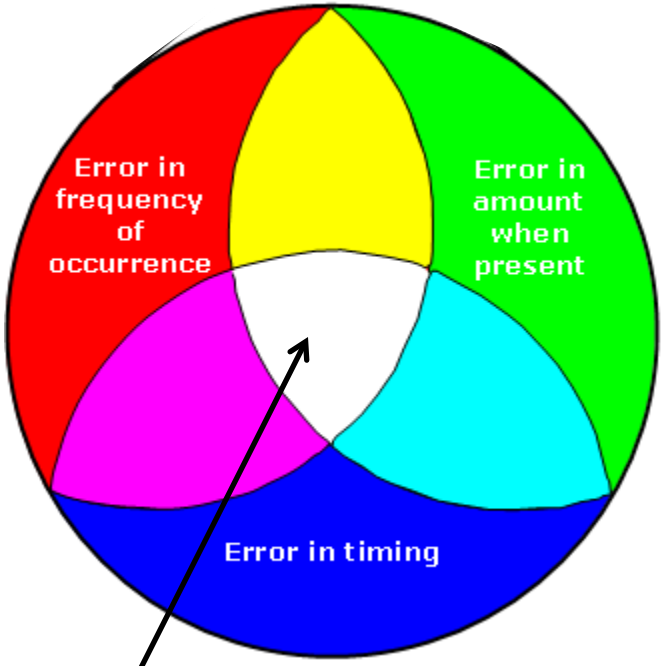

Any icing-risk prediction will have some errors associated with it and they will be a **COMBINATION** of all 3 of these types.

Useful to assess the different types of errors separately when developing potential new icing products.

Making progress.

1. We would welcome increased dialogue between interested parties.
2. We feel evaluating frequency of occurrence is a useful and important first step, while new indices are “tuned”.
3. Case studies and skill scores still useful, but AFTER (2).
4. We have ideas for how to improve the current WAFC-London icing algorithm, but...
5. We would benefit from an observational data-set to use to validate our new ideas...
6. Does anyone have such a data-set?
7. Ideally something quality-controlled, peer-reviewed and accepted by the community as a fair record of observational occurrence of icing.

Questions

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