Flip-Flop Index: Quantifying Revision Stability for Fixed Event Forecasts

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Example of a Flip-Flop

Chance of Rain Forecast

Decision Thresholds experiencing a Flip-Flop

Issue Time

$f_1 = 20\%$

$f_2 = 70\%$

$f_3 = 40\%$
Motivation

• Messaging
  (Flip-Flops make messaging difficult)

• Soundness of probability forecasts
  (Flip-Flops suggest not all information used)

• Understanding characteristics of a forecast system.
  (Will Flip-Flops become worse if we upgrade a system?)

Examples in this talk compare manual forecasts to automated forecasts (calibrated consensus of NWP).
Flip-Flop Index Definition

- For sequence of three forecasts.

$$|f_1 - f_2| + |f_2 - f_3| - \left( \max_{i} f_i - \min_{i} f_i \right)$$

For example,

- 50% - 70% - 50% has a Flip-Flop Index of 20%.
- 50% - 90% - 70% has a Flip-Flop Index of 20%.
Flip-Flop Index Definition cont.

- No dependence on Observations
- When extended to longer sequences (see abstract), lots of small Flip-Flops can equal one large Flip-Flop.
- Accepted for publication (Meteorological Applications)
Extending to Forecasts of Direction

- What do we do with the circular arithmetic?
- Can we replicate the decision threshold interpretation?
Direction – the easy ones

If all directions are in a 180° sector, we can treat them (essentially) like a scalar.

No Flip-Flop

A Flip-Flop of 50°

Flip-Flop Index =

\[ d(f_1, f_2) + d(f_2, f_3) - \min(180^\circ, \text{encompassing_sector}) \]

\[ d(f_1, f_2) \] is the smallest angle between the two directions

encompassing_sector is the angle of the smallest sector that includes all three directions
Direction – the harder ones

- The largest directional Flip-Flop is 180°.
- Hence, a forecast sequence


has some amount of Flip-Flop.
Consider a question: "Does the forecast direction have a northerly component?"

The decision might be how to land on a N-S runway, or where to set up to shelter from the wind.

Then the decision threshold is an east-west line, dividing the northerlies from the southerlies.
Direction - Interpretation

\[ f_3 = 290^\circ \quad f_1 = 70^\circ \quad f_2 = 180^\circ \]
When we have a northerly component the planes will take off towards the north.
If we have a southerly component the planes will take off towards the south.
Here we are back to forecasting a northerly component so have a Flip-Flop.
We discussed N-S aligned runways but there are a range of nearly N-S aligned runways that would consider this a Flip-Flop.
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For this example,

Flip-Flop Index = 40°
Direction - Interpretation

For this example,

Flip-Flop Index = 40°

For a sequence of length three, the Flip-Flop Index is

\[ d(f_1, f_2) + d(f_2, f_3) - \min(180°, \text{encompassing_sector}) \]

\(d(f_1, f_2)\) is the smallest angle between the two directions

\(\text{encompassing_sector}\) is the angle of the smallest sector that includes all three directions
Our short term forecasts Flip-Flop by more than 45 degrees only 4% of the time. Eg N – NE – N or N – E – NE

At longer lead times it is about 10% of forecasts.
Summary of Australian Results and Implications

Chance of Rain, Wind Speed, Wind Direction:
Automated guidance less flip-floppy than manual forecast.

Decision to use automated guidance can be based on skill.
Summary of Australian Results and Implications

Chance of Rain, Wind Speed, Wind Direction:
Automated guidance less flip-floppy than manual forecast.

Decision to use automated guidance can be based on skill.

MinT, MaxT:
Manual forecast less flip-floppy than automated guidance.

Automated guidance shows good skill.

A more difficult decision.
Thank you...

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