Uncertainty Considerations in AA Operations

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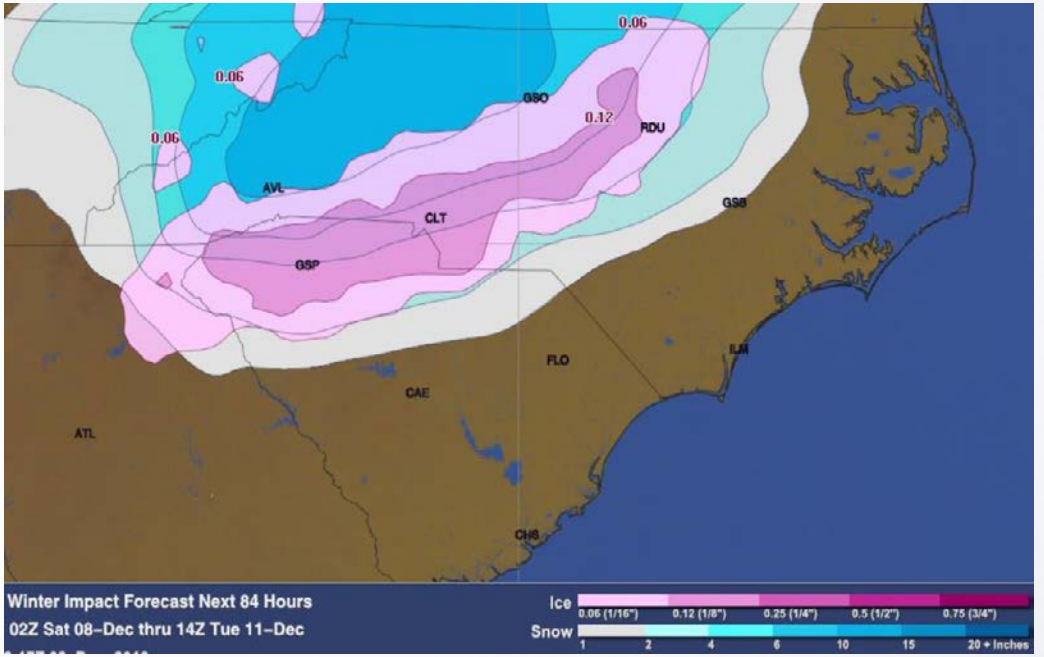
Uncertainty Terminology

- Uncertainty words/concepts such as risk and forecast confidence are playing an increasingly important role in strategic planning for weather events.
- We have asked our weather provider, The Weather Company (formally WSI), to add confidence levels to certain products.
- In the example here, Charlotte, NC is right on the mixed precip line. In the forecast discussion, the TWC meteorologists are adding detail about the confidence in a particular forecast.
- "Risk" is also at play here because CLT is not an airport that experiences frequent winter weather events. AA may be more proactive in these areas when tolerance is low. (And BTW, "tolerance" another one of those key words)



Forecast Concerns: Winter Storm Diego is organizing across the southern Plains tonight. Diego pushes across the Deep South tomorrow and thru the Carolinas on Sunday. A trailing upper level system behind Diego will linger light wintry precip around into Monday morning before moving offshore. The main concern with the forecast is determining the timing of multiple precip type changeovers. A slight shift by less than 20 miles in the precip lines tomorrow night and on Sunday will determine which edge of the ranges the snow and ice will be. A slightly more northerly track brings more ice pellets and freezing rain while a more southerly track will bring higher snow amounts. Confidence is increasing as models slowly come into better agreement. However, the thin nature of the precip line continues to bring lower than normal confidence.

Considerations when using uncertainty terminology

- There is a fine line between adding confidence measures and sounding like you don't have a clue. We are still working on the best terminology by talking to our decision-makers.
- For now, we are not using "medium" confidence. This is a pet peeve of mine, but I find it hard to understand what the user can do with medium confidence???
- TWC using "Low confidence" or "high confidence" and then providing a short discussion as to why. This is still a work in progress, but early feedback has been positive.
- The probability concept is not dead at all! When applicable, point probabilities still used. This is best understood in convective forecasts.
- Hard to imagine there is a future in using point probabilities for events such as turbulence, icing, C&V or other weather variables that have a low probability of detection (POD). Maybe areal probabilities or regions of high risk might be better suited.
- Decisions that leave the strategic time frames and become more tactical are complicated and may never be suited for complex uncertainty terminology.

The Role of Human Decision Support

- AA was never waivered from the need to have meteorologists in our operations center, even with numerical model forecasts better than ever.
- Maybe it's a bit more sophisticated than 25 years ago, but the "art" of tailoring the weather forecast, or better yet, the uncertainty in a weather forecast, is still appreciated by dispatchers, ATC coordinators, operations managers, and more.
- Some experimental text products have been collaboratively developed by AA and TWC to better use the model output for decisions made throughout the AA enterprise:
  - Will we have enough staff?
  - Should we allow our passengers the ability to change flights in advance?
  - Should we proactively cancel flights?
  - Should we secure anything that can damage aircraft in high winds?
- *The common thread with all of the these decisions is that there is NEVER 100% certainty*.

American Airlines

The Weather Company

CONVECTIVE WEATHER OUTLOOK

Forecast Issued: April 12, 2019; 17Z

Terminal	Convective	Wind	Valid Times	Summary
DFW	C		09Z/(04L) -13Z(08L)	Scattered showers and thunderstorms will initially impact the northern cornerposts by 09z. Slight chance at the field.
DFW	B		13Z(08L)-17Z (12L)	Thunderstorms likely at the field moving from west to east… likely in a line.

CONVECTIVE IMPACT KEY	
HIGH	A: Extended period (3 or more hours) with thunderstorms directly over the terminal
	B: Direct impact to airport & arrival/departure fixes by steadily moving front or squall line
MEDIUM	C: Direct impact to arrival/departure fixes, but lower confidence in direct terminal impact
	D: Scattered thunderstorms expected in the terminal area, but location/timing not certain
LOW	E: Widely scattered thunderstorms, but location/timing of storms not certain

WIND IMPACT KEY	
HIGH	Convective Wind Gusts greater than 45kt expected
MEDIUM	Convective Wind Gusts between 30-45kt expected
LOW	Convective Wind Gusts less than 30kt expected

Conveying Uncertainty in Weather Forecasts at Southwest Airlines

TYPES OF WEATHER

Winter storms

- Forecaster confidence of Low, Low-Medium, ~~Medium,~~ Medium-High, High for the following: Storm timing, Precipitation Type, Total Accumulation
- Forecaster assessment of Anticipated Station Impact of Low, Medium, High (focused on greatest impacts of each storm and based on factors such as Station's ability to handle winter weather, ability of Passengers and Employees to get to/from airport)

Hurricanes

- Base forecast track on Tropical Prediction Center information, then address specific impacts for each Station (e.g. time windows of: maximum wind speed and direction, > ~25kt crosswind limit on wet runways, impact on Company's infrastructure at airport) to ensure protection for Passengers, Employees, assets

Major Thunderstorm Outbreaks

- Forecaster confidence about type (e.g. squall line, MCS), phenomena (strong winds, hail, tornadoes) and duration of impact

Dense Fog

- If expected to occur more than ~four hours from now, the Forecaster mentions possibility but does not write TAF below operating limits until closer to event

In all cases above, Meteorologists assign non-percentage confidence factors to phenomena in all forecasts except TAFs

OPERATIONAL PLAN

- Winter storms and hurricanes (e.g. lead time for flight adjustments) based on Forecaster confidence of these factors and on non-weather factors (e.g. load factors, Pilot and Flight Attendant availability (sometimes limited at end of month and due to vacations), number aircraft out of service)
- Major thunderstorm outbreaks often triggers draw-down of flights preceding, during and succeeding the arrival of storms; plan also dependent upon expected ATM initiatives
- Dense fog very tactical, with additional fuel/alternate added at Dispatchers' discretion, and diversion (and possibly canx) plan developed

OBSERVATION

- I have learned from 40+ years of experience that weather forecast confidence in commercial aviation best conveyed in person. True today as when hired on at American Airlines in 1978.