Background and Goals

- To support the National Weather Service (NWS) goal of building a Weather-Ready Nation, the National Blend of Models (NBM) project was started in 2014 to create a skillful and consistent suite of calibrated guidance to leverage in the forecast process (Gilbert et al. 2016).
- Goal of this work: Provide operational forecasters with the ingredients necessary to build the precipitation elements for the National Digital Forecast Database (NDFD) Weather grid while allowing flexibility to adapt to rapidly changing conditions.

The Top-Down Approach

Assessing the Ice-Producing Layer

- Ice nucleation probability increases as temperature decreases through the -6 to -15°C range.
- Ice nucleation and the introduction of ice hydrometeors determines the activation/use of the warm layer aloft concept in the Top-Down Approach.
- Sleet thunder: Sleet layer sublimation of ice is more probable for increasing depth greater than 9°C ($\pm 5$°C) with RH < 70%.

Assessing the Warm Layer Aloft

- A strong linear relationship exists between maximum warm layer depth and warm layer depth.
- Therefore, in the Top-Down Approach, the warm layer character is estimated by the maximum temperature (with bubble) above 5°C (WATFAX).
- Observed sounding analysis of WATFAX shows:
  - S cold bubble freezing point aloft.
  - 8°C (or higher) mixing (of ice water).
  - ET data ice mixing ratio aloft.

Assessing the Surface-based Cold Layer

- For MaxTwAloft ≥ 3°C, indicative of cold hydrometeors falling into the layer, observed soundings against the probability shows for a warmth layer aloft with:
  - Maximum layer temperatures: -6°C
  - Layer depth = 750 m (2000 ft)

Data and Methodology

Ice Nucleation and Microphysics Data

Over 15 published studies and books were reviewed on cloud microphysics and ice nucleation science and used to create the approach used in the Top-Down methodology. Much of the research used in the methodology consisted of field aircraft long studies and observations—providing a probabilistic distribution of supercooled liquid water content.

Precipitation Type Observational Data

Robust analysis of observed sounding and surface data was accomplished using two main data collections to arrive at the Top-Down approach: Rauber et al. (2001) and Just (2017). These were considered independent as they covered the years 1970-1996 and 1994-2015, respectively.

The Rauber et al. (2001) data consisted of 78 ice pellet soundings and 420 freezing precipitation soundings, of which 366 were freezing rain and 430 were freezing drizzle. Surface observations consistent with the soundings and < 3 hours of the launch were analyzed to only allow the given type to position within that time-range. Thus, a refined Rauber et al. (2001) data set was analyzed for the Top-Down approach which included 21 “pure” ice pellet and 124 “pure” freezing drizzle soundings.

The Just (2017) sounding data consisted of 120 soundings from 1994 to 2015, with observations coming from 4500 sites located within 30 km, with an hour check for drizzle, 56 freezing cases, 48 freezing rain, 3, 5 “pure” ice pellets, and 55 snow.

Most recently, Reeves et al. (2014) collected a set of 125 ice pellet (sleet) cases from 2002-2013, confirmed by Automated Surface Observing Stations (ASOS) located within 35 km of the radiosonde launch locations with no change of type during the 40-min launch window.

National Blend of Models

- In March 2014, work began to develop blended model Probability of Weather Type inputs based on the Top-Down concept approach (e.g., Probability of Snow, MaxTwAloft, and Probability of Refreeze To Sleet). From these inputs, conditional precipitation type probabilities are derived.
- Below: The first test case for the NBM's 3-blended models and derived conditional probability of types: 24-hour forecast valid at 1200 UTC 13 Dec 2016 (bb9f(confid) LFC = 16°C, Dec 2016).