Exploration of Global Model Predictions of a High Impact Winter Weather Event Using the THORPEX Interactive Grand Global Ensemble (TIGGE)

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Goals:

- Explore the performance of global numerical weather prediction models for a winter storm that occurred on January 28-30, 2010 and contained various types of winter precipitation.
- Focus on the ability of these global ensembles to improve lead times.

Introduction:

- Winter storms are high impact events that have costly consequences for power companies, agriculture, industry, businesses, schools, and motorists.
- January 28-30, 2010 winter storm caused nearly 200,000 homes and businesses to lose power (NWS Tulsa, 2010). County infrastructure as well as rural electric losses totaled more than $69 million (Oklahoma Dep., 2010).

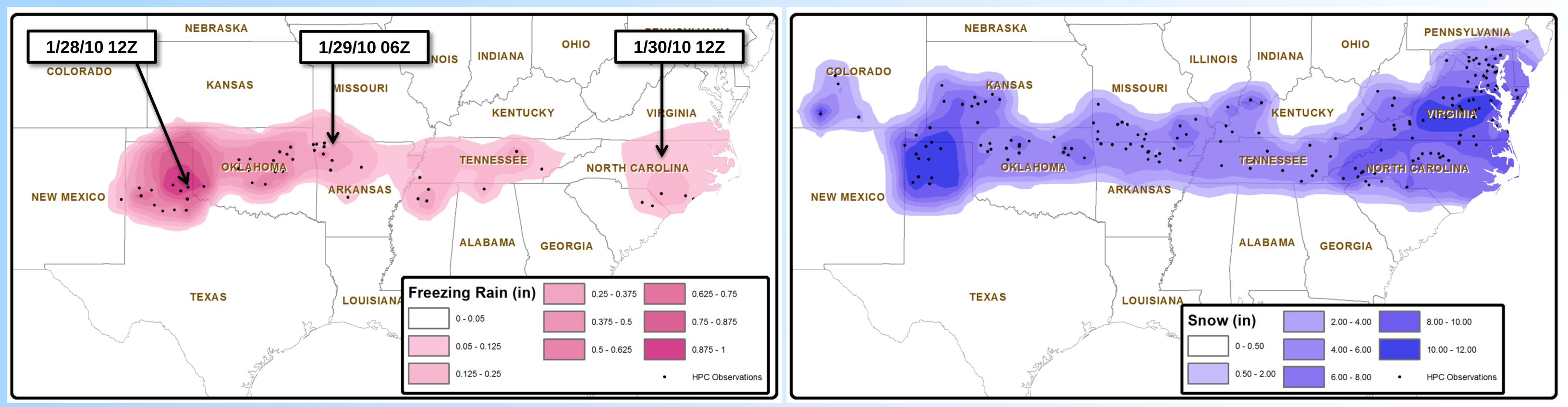

Figure 1: Freezing rain (left) and snow (right) accumulations using data from the HPC event summaries. Freezing rain shading and contours represent every eighth of an inch (Hydrometeorological, 2010). Snow shading and contours represent every two inches. City Shapefile Source: AHIPS Map Database, Cities, 2012).

- The National Weather Service in Norman began discussing the possibility of a winter storm on January 24th.
- Precipitation began as rain across much of Oklahoma before changing to freezing rain, then sleet and finally snow. There was a break in precipitation during the evening of the 28th before snowfall began again on the 29th.
- The freezing precipitation moved east through central portions of the United States including Arkansas, North Carolina, Tennessee and Virginia.

TIGGE:

- Comprised of 10 different ensemble centers across the world accumulating approximately 500 forecasts per day
- Control, deterministic, and perturbed model runs from each center can be gathered up to 384 hours in advance (Bougeault et al., 2009).
- In the past, use of multiple ensembles has been limited due to differences between model resolution, ensemble center accessibility, file format, and meteorological parameters.
- TIGGE archive sets a standard for comparison between global ensembles .

Methods:

- Downloaded deterministic forecasts for surface temperature, total precipitation, and 850 mb temperature, from United Kingdom Met Office (UKMO), National Center for Environmental Prediction (NCEP), and the European Centre for Medium-Range Weather Forecasts (ECMWF) all on the same model grid and resolution
- Created a binary indicator set equal to 1 for each grid point and ensemble member that had surface temperature less than 0° C, 850 millibar temperature greater than 0° C and precipitation greater than 5 kg m^{-2} over the six hour forecast. If any conditions were not met, the binary indicator was set equal to 0.
- Added the binary indicator for all ensembles and divided by the total number of ensemble members from the three centers (93 members) to create a "combination forecast" which is defined by the percentage of ensemble members meeting the arbitrary thresholds set within the binary indicator
- Created "combination forecasts" for ECMWF, NCEP, UKMO individually to determine the performance of each ensemble center.
- Created contoured maps for the "combination forecasts" showcasing highest probability for freezing rain
- Combined HPC Storm Summary reports to create plots of accumulations for freezing rain, snow and sleet in order to determine locations of greatest freezing precipitation accumulations.

Results:

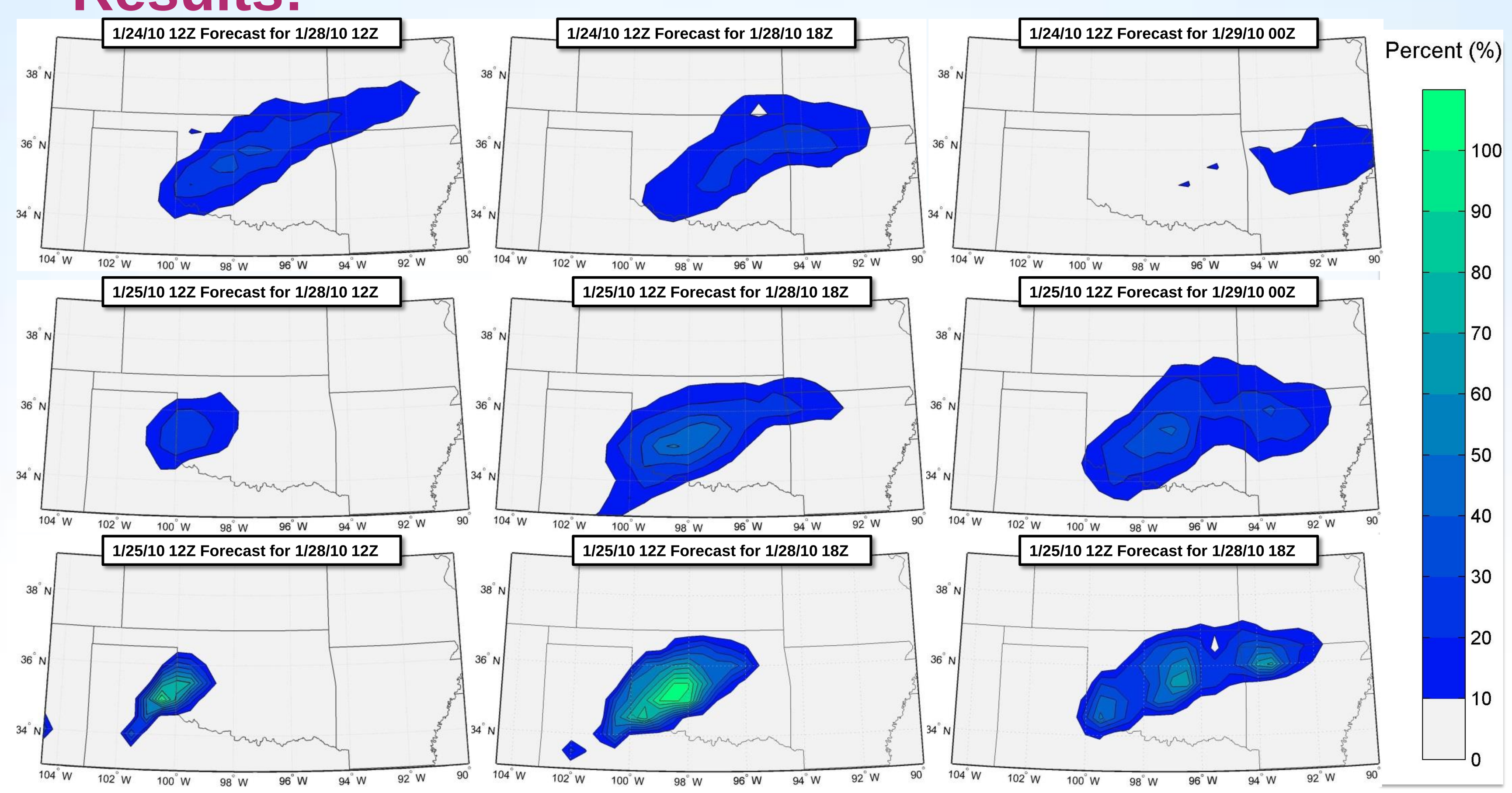

Figure 2: "Combination forecast" for Oklahoma region beginning with 4 day forecast (top row), two day forecast (middle row) and same day forecast (bottom row)

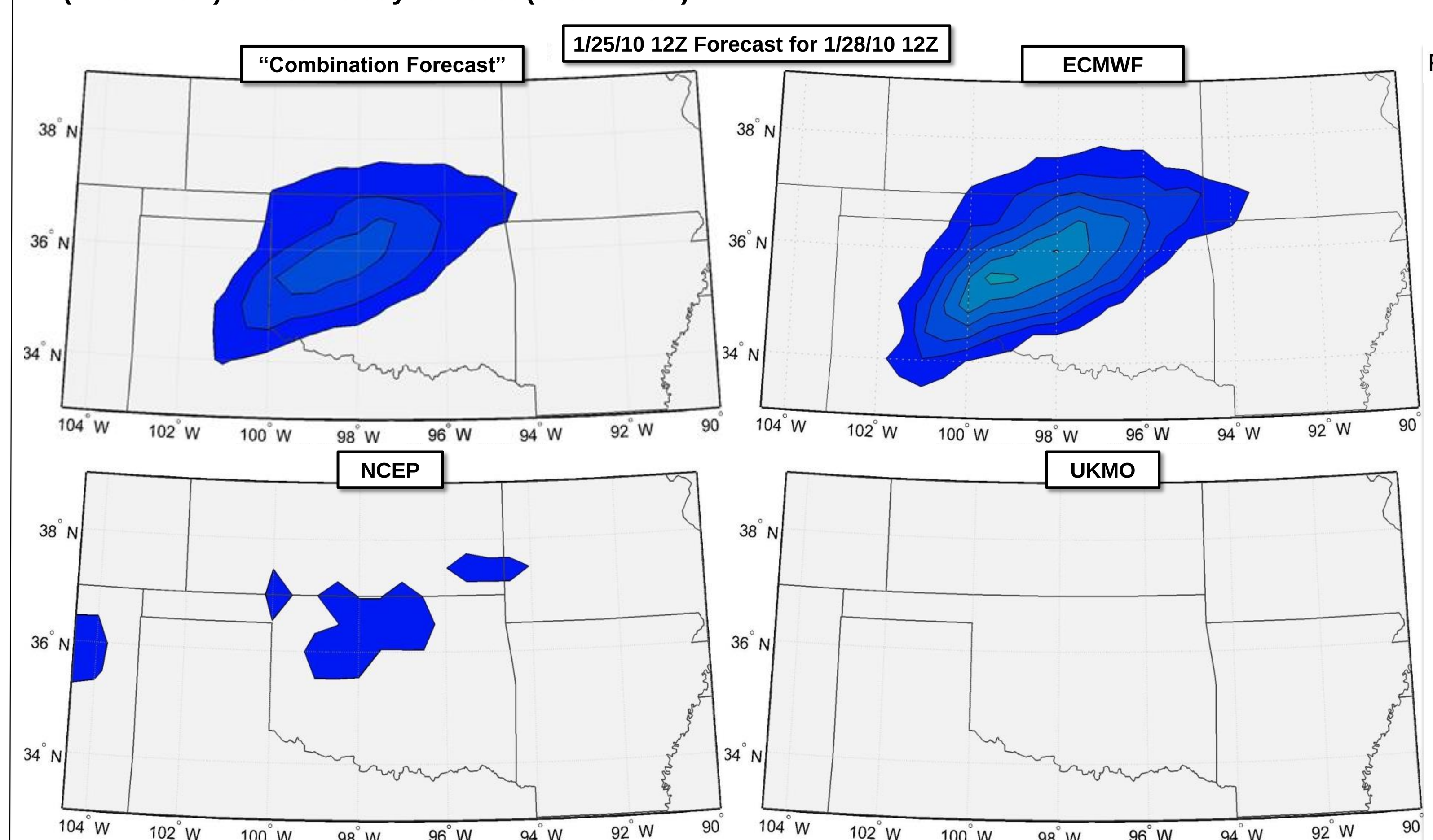

Figure 3: "Combination forecast" (top left) for Oklahoma region three days before storm. Percentages of ensembles meeting the binary indicator are contoured.

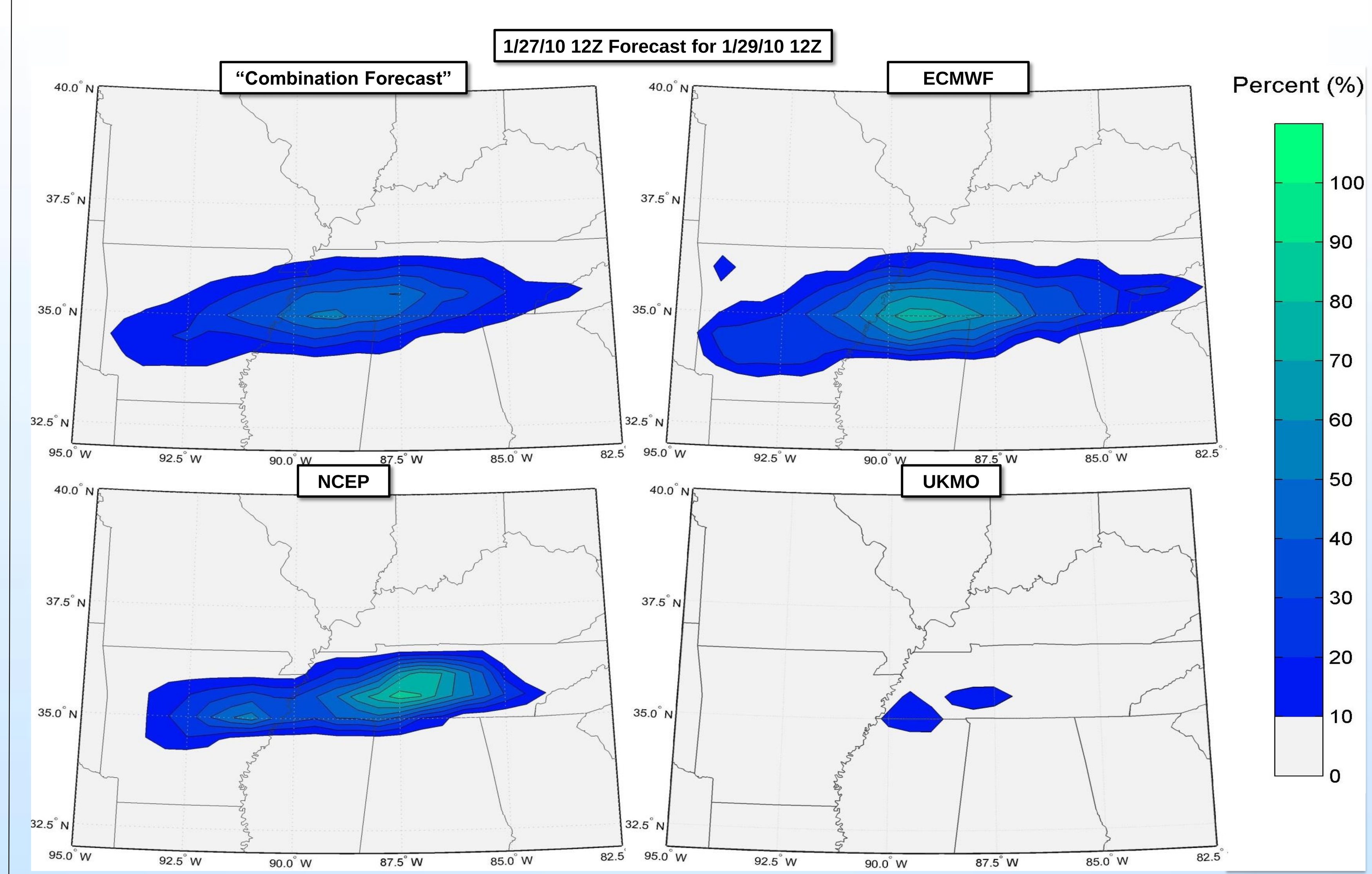

Figure 4: "Combination forecast" (top left) for Tennessee and Arkansas region two days before storm. Percentages of ensembles meeting the binary indicator for the ECMWF (top right), NCEP (bottom left), and UKMO (bottom right) for same time

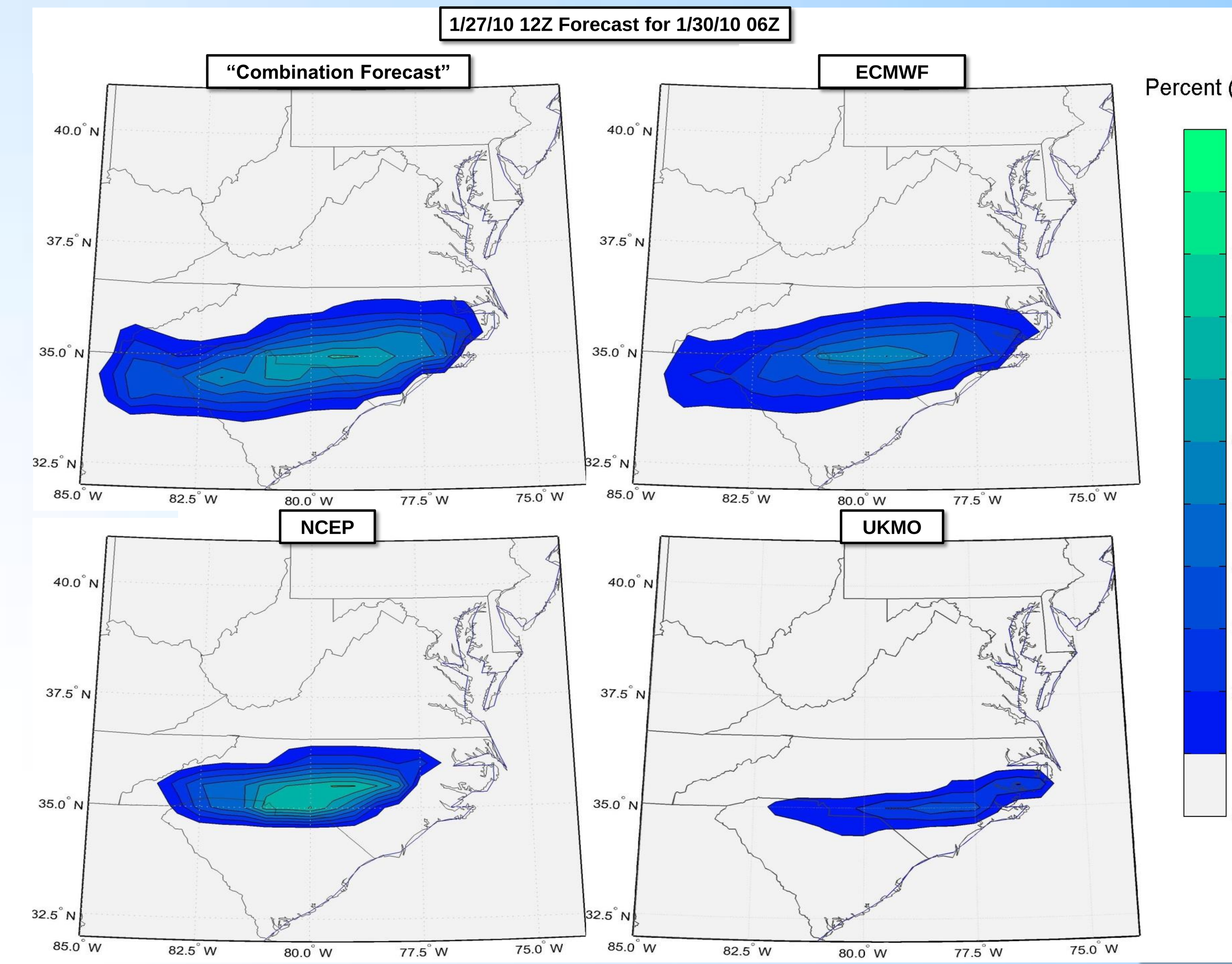

Figure 5: "Combination forecast" (top left) for North Carolina region three days before storm. Percentages of ensembles meeting the binary indicator for the ECMWF (top right), NCEP (bottom left), and UKMO (bottom right) for same time

- "Combination forecast" showed 30% of ensemble members had characteristics indicative of a freezing rain event four days before the event (Figure 2).
- Agreement between the ensemble members increased as lead time decreased.
- For much of this storm, the ECMWF showed greater agreement of ensemble members for a freezing rain event earlier than the NCEP and the UKMO (Figure 3).
- Surface temperatures were the most uncertain in the days preceding the event and prevented greater agreement for the "combination forecast" up until the day of the event.
- Individual "combination forecasts" displayed scenarios where an ensemble center would be strong in one region with agreement for the parameters predicting freezing rain, while weak in another region (Figure 4, 5).

Conclusions:

- "Combination forecast" showed some agreement between ensembles members for the parameters that are indicative of freezing rain up to four days before the event in the Oklahoma region
- Under current construction of the TIGGE, many existing operational freezing precipitation predictors could be used in conjunction with the "combination forecast" instead of the binary indicator chosen here
- Mapping the percentage of ensemble members exceeding a threshold is an effective way of condensing information into a useable image for forecasters
- With the exploration of additional cases, multi-ensemble forecasts for this type of event may prove useful in advancing lead time

Acknowledgments:

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