321. NCAR AutoNowcaster Performance Using Total Lightning and NLDN Data

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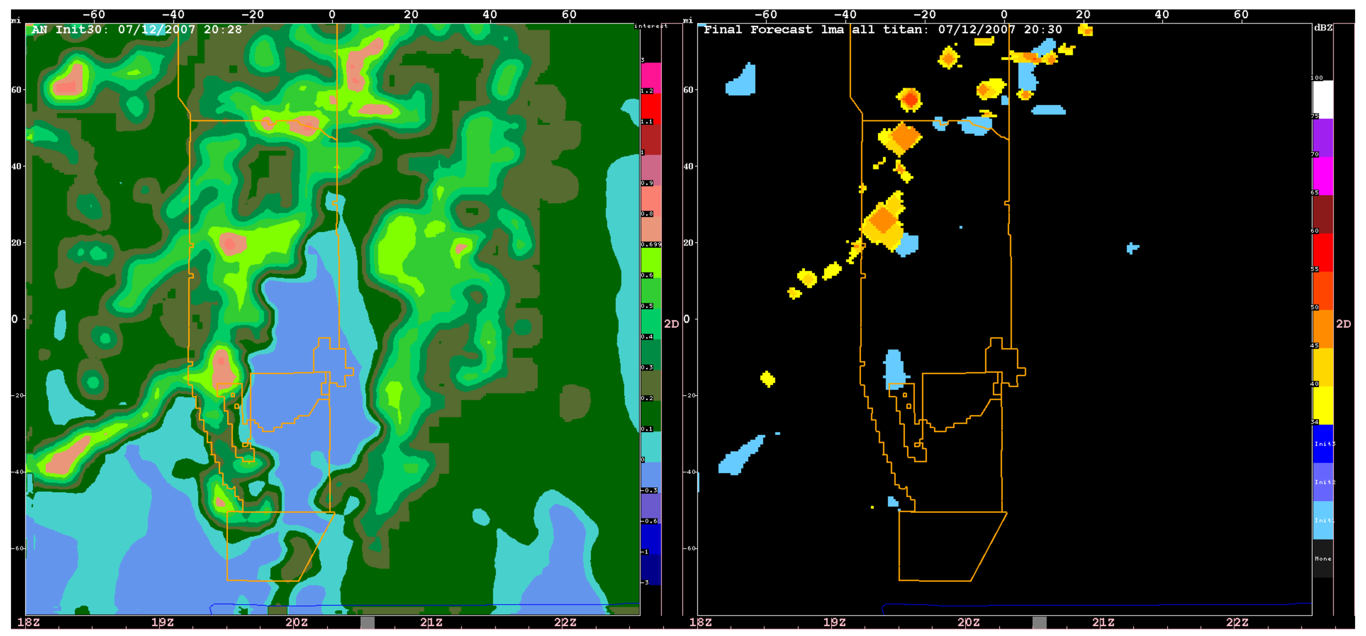
1. Introduction

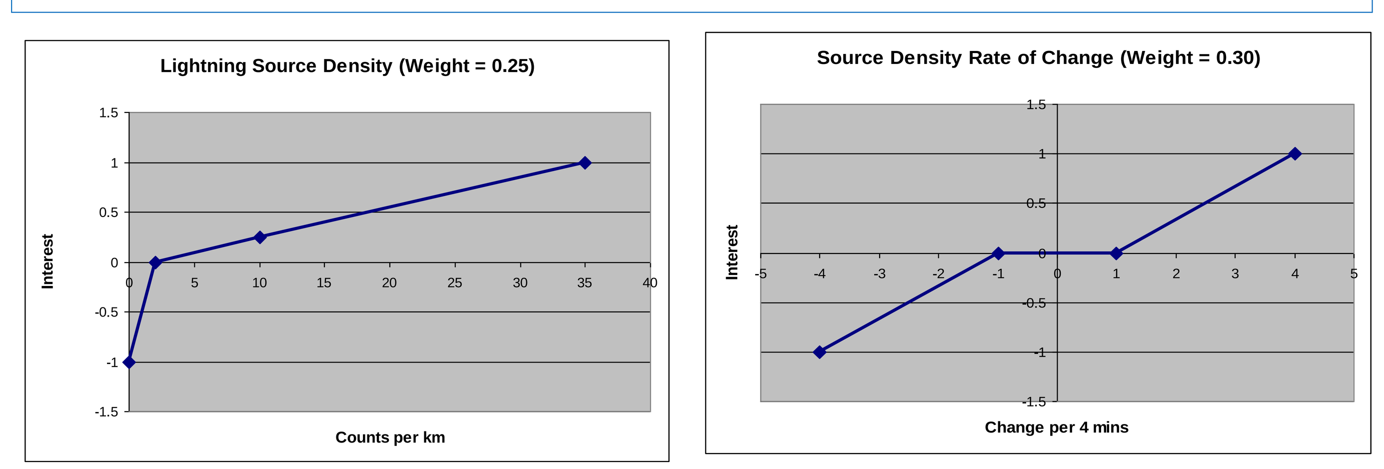
The 4DWX program operated by the Research Applications Laboratory at the National Center for Atmospheric Research supports the forecasting and nowcasting needs of the Army Test and Evaluation Command (ATEC) White Sands Missile Range (WSMR; Lui et al., 2008). The NCAR AutoNowcaster (ANC) is a component of the 4DWX program that provides very short-term forecasts of thunderstorm initiation, growth, decay and lightning potential to the forecasters at the WSMR meteorology branch since 1997 (Mueller et al. 2003; Saxen et al. 2008.) Here we explore the utility of total lightning and National Lightning Detection Network (NLDN) data available at WSMR to improve convection growth and dissipation forecasts within the ANC.



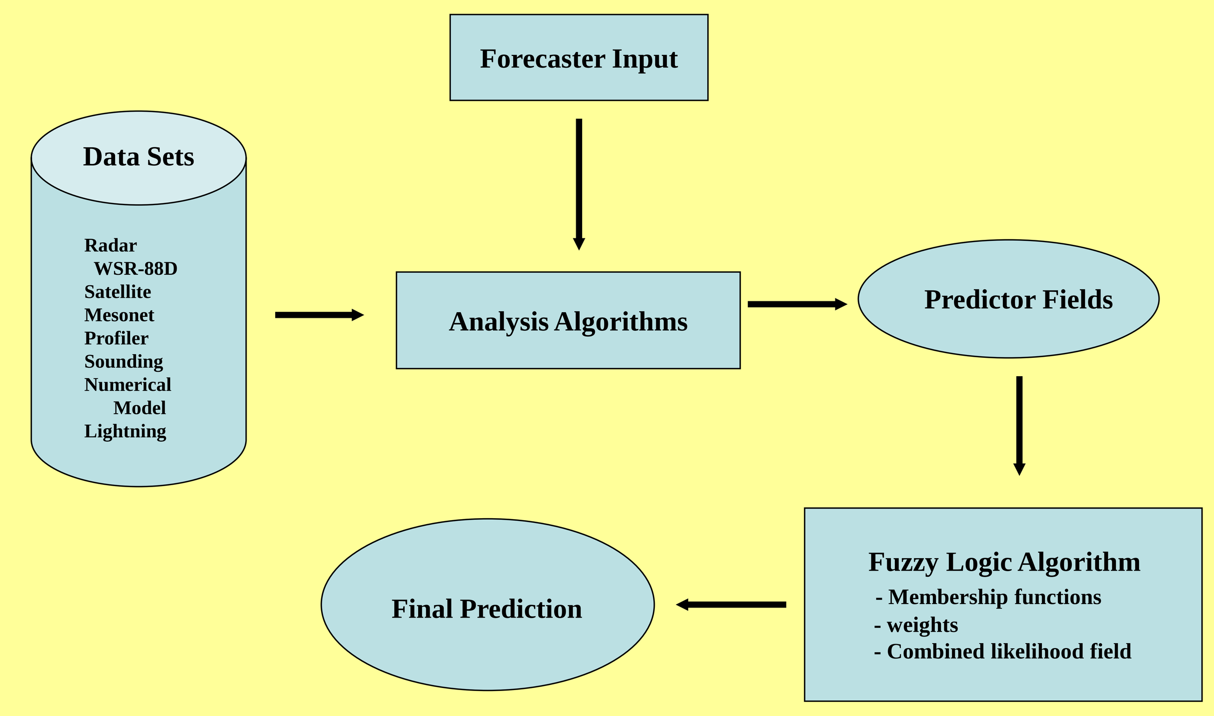
Examples of ANC output the initiation likelihood field and the ANC final forecast.

3. Lightning Mapping Array (LMA)

The lightning mapping array at White Sands Missile Range was developed by Langmuir Laboratory for Atmospheric Research at the New Mexico Institute of Mining and Technology. Installed in 2005, the LMA at WSMR consists of 12 measurement sites located on the range which can relay data back to the WSMR meteorology branch or the command center in real-time.



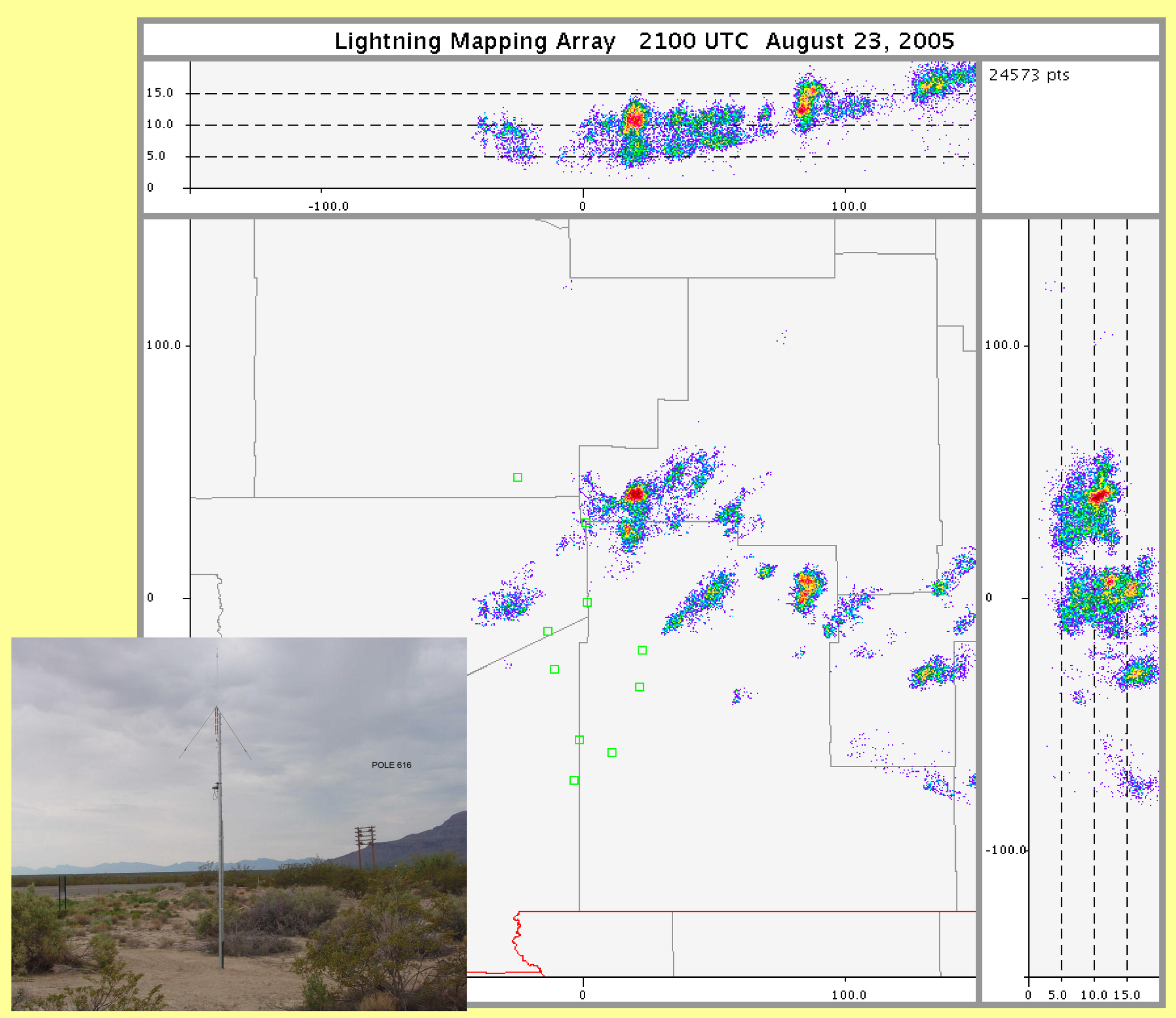
Membership functions for the lightning source density and lightning source density rate of change predictors computed from LMA data.



Flow chart of the forecast logic with the Auto-Nowcast system

2. NCAR AutoNowcaster (ANC)

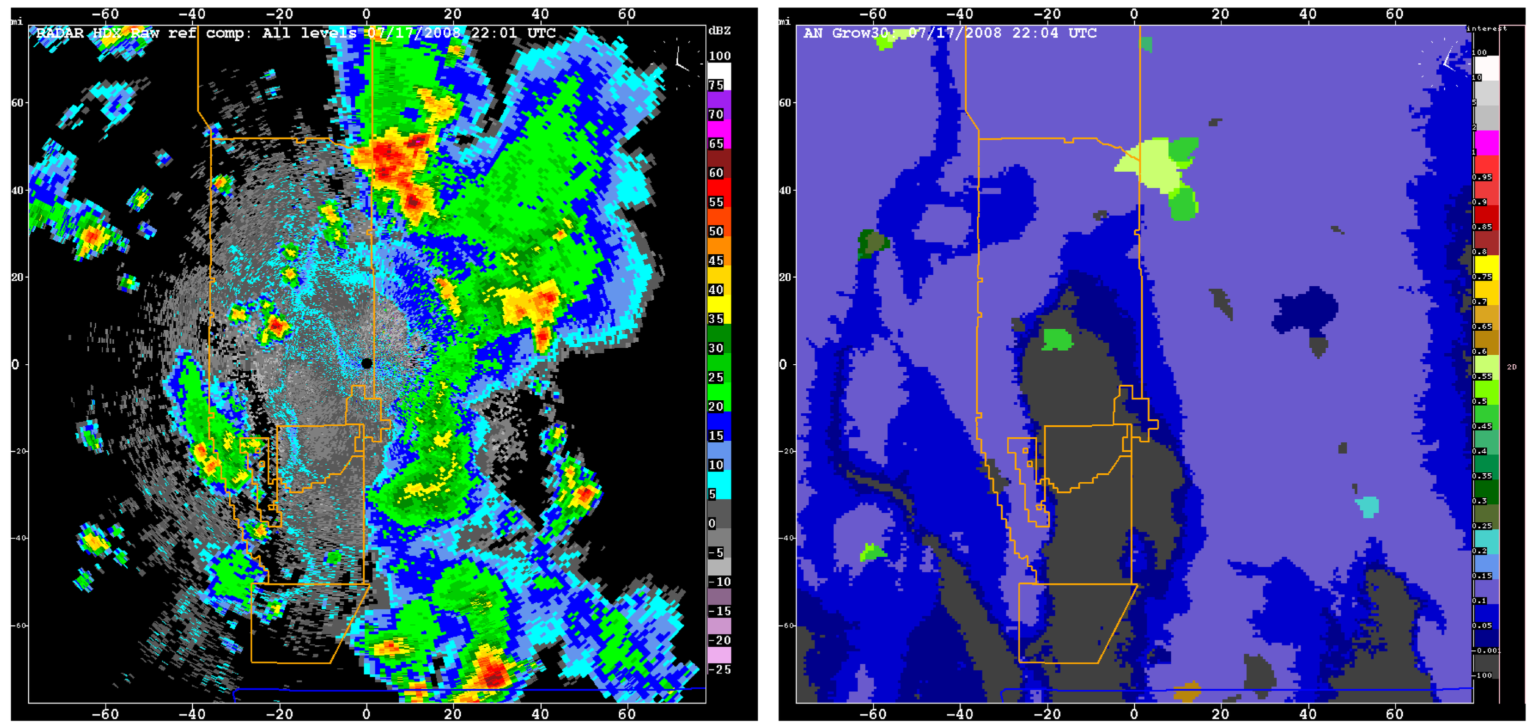
The NCAR AutoNowcaster is an expert system that uses fuzzy logic to produce nowcasts for convection initiation, lightning potential, storm growth and dissipation. The ANC ingests a wide variety of meteorological data, including volumetric radar data, satellite, surface, and rawinsonde observations, numerical model output and lightning data. Each predictor field that goes into the forecast process has a membership function and a weight. Once the membership function and the weights have been applied, interest fields are produced and the final nowcasts are the summation of all the applicable interest fields.



Example of LMA data display and inset picture of receiver antenna.

4. Case Study: 17 July 2008

On 17 July 2008, scattered thunderstorms formed along high terrain to the east and west of the White Sands Missile Range. The storms moved towards the south with convection initiation occurring along several outflow boundaries. The AutoNowcaster 30-min, real-time nowcasts are compared to nowcasts that were rerun during post-analysis to examine how the addition of LMA data could improve the nowcasts. Post-analysis nowcasts used the LMA source density and its rate of change as predictor fields. Further, the ANC was run with the LMA variables and with reflectivity estimated from the NLDN strike rate (Weber et al. 1998; Megenhardt et al. 2004) instead of radar reflectivity to examine ANC performance during radar outages.



Radar mosaic composite reflectivity (left) over the WSMR domain at 2201 UTC.

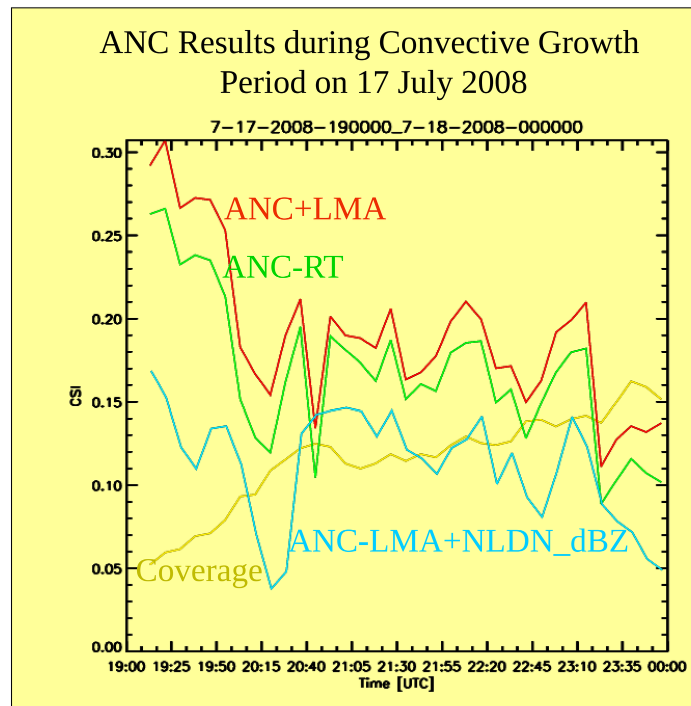
ANC growth and decay interest field from the real-time system (right) at the same time.

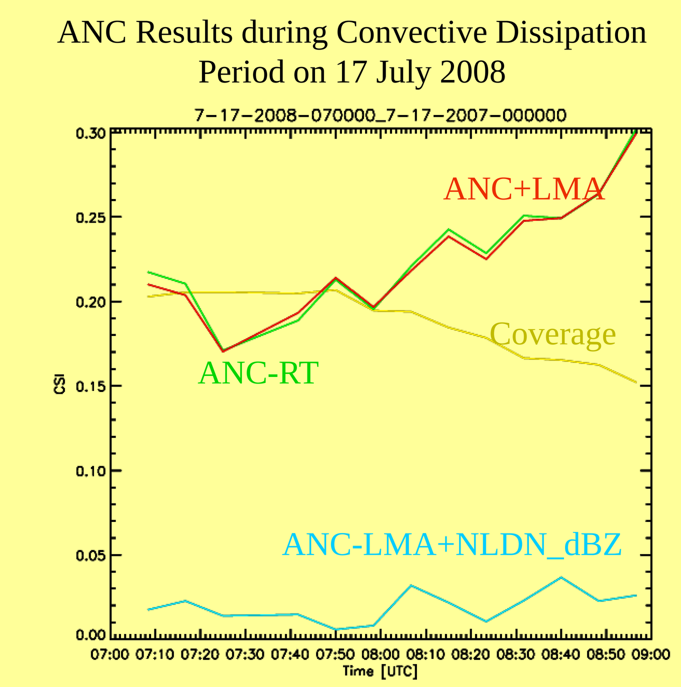
5. Results and Additional Work

Results from the 17 July 2008 case for a 30 min nowcast show that the addition of the LMA variables as predictor fields improves the ANC performance during the convective growth period. During the convective dissipation period, results from the two techniques are nearly identical. As these storms dissipated, the number of and area containing LMA sources decreased significantly. Thus leading to a lessened contribution to nowcast skill for the LMA predictor variables and a greater reliance on radar reflectivity predictor variables that are common to both.

The post-analysis ANC run that used only LMA predictor variables (removing radar reflectivity predictor variables) that acted upon reflectivity estimated from the cloud-to-ground strike rate of the NLDN shows that these nowcasts can provide a lessened level of skill when compared to the ANC-RT and ANC+LMA results. In situations of radar outages, this technique is useful during periods of electrical activity as seen in this convective growth period but has far less skill during storm dissipation when fewer cloud-to-ground strikes are present.

- The LMA flash extent and its rate of change predictor fields will be added to the growth and decay forecast logic.
- Cloud-to-ground climatology has been constructed and is planned to replace the terrain predictor field.
- The ANC+LMA system has been implemented at the White Sands Missile Range and will be implemented at the Redstone Test Center.
- The ANC-LMA+NLDN_dBZ system must be recalibrated to use the LMA total lightning data to estimate reflectivity. Future implementation of this system is planned at both ranges.





Critical Success Scores (CSI) are shown that compare nowcasts from the real-time run (ANC-RT; green) to the post-analysis run with LMA predictors (ANC+LMA; red) and to the post-analysis run with LMA predictors and NLDN-estimated reflectivity (ANC-LMA+NLDN_dBZ; blue). Area coverage of radar reflectivity is shown by the yellow line. Statistics are shown during a convective growth period (top; 19-00 UTC) and a convective dissipation period (bottom; 07-09 UTC) on 17 July 2008.

6. Acknowledgements

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