

Toward an Integrated Approach to Nowcasting Convective Initiation using Satellite, Radar and Lightning Observations

John R. Mecikalski
Retha Matthee
John R. Walker
Chris P. Jewett

Department of Atmospheric Sciences
University of Alabama in Huntsville
USA

Presented is an analysis that focuses on the use of geostationary-based infrared and visible observations combined with derived satellite parameters, numerical weather prediction (NWP) fields, and conventional and dual-polarimetric radar observations to gain increased understanding for making 0-1 hour nowcasts of convective initiation (CI) and lightning initiation (LI; the subset of cumulonimbus that produce lightning). Many previous activities considered only radar or only satellite observations when nowcasting CI and LI, whereas now an integrated approach is considered, one that combines satellite, numerical weather prediction (NWP) model, radar and lightning fields. The presentation theme will be to highlight several research studies.

The algorithm, the SATellite Convection Analysis and Tracking (SATCAST) system, as developed by researchers at the University of Alabama in Huntsville, is evolving to use non-satellite data as a means of enhancing the information content within Meteorat Second Generation (MSG) SEVIRI and GOES Imager data. Enhancements to SATCAST over the past two years include an “object-tracking” based methodology, which provides superior tracking capabilities of growing convective clouds, and therefore greatly improves the ability to monitor the characteristics of convection in its early stages. The object-tracking version of SATCAST was unveiled in the spring of 2010 and tested at the GOES-R Proving Ground at the Storm Prediction Center (SPC) in Norman, OK. Additional testing is planned for Spring 2012 at SPC as part of their annual Spring Experiment. Within 2012, incorporation of NWP fields from the Rapid Update Cycle (RUC) model within a logistical regression methodology is helping SATCAST to use GOES data operate in a more efficient manner, providing a “strength of signal” (probabilistic) versus a “yes/no” CI nowcast. RUC fields of CAPE, elevated instability, cloud-base temperature and convective temperature depression, provide information on when certain infrared CI and LI “interest fields” are more valuable than others. Discussion of the overall SATCAST methodology, its performance, and results from the SPC tests will be provided. Also, results of a substantial validation effort will be covered that provide a test database for this effort.

Other recent research shows strong promise for using cloud-derived properties (cloud optical depth, effective radii, cloud top pressure) as a means of diagnosing CI beneath cirrus clouds, delineating and nowcasting relative storm intensity across a region, and

obtaining improved CI nowcasts where the warm rain process dominates. The focus here is on use of fields derived from the Optimal Cloud Analysis (OCA) algorithm at EUMETSAT and the Visible Infrared Solar-Infrared Technique (VIST) algorithm from the NASA Langley Research Center.

Lastly, analysis done over the NASA African Monsoon Multidisciplinary Analyses (NAMMA) experiment domain near Dakar, Senegal was toward understanding how SEVIRI and NASA NPOL S-band dual-polarimetric radar observations behave for 30 non-lightning and 33 lightning producing convective storms. Highlights of this research are (a) that very distinctive cloud top signatures of glaciation are seen when lightning is present, despite clouds extending above the freezing level, (b) stronger updrafts prevailed in lightning producing storms, (c) modes in Contoured Frequency with Altitude Diagrams (CFAD) are vertical above the melting level, with large ice volumes in the anvil and signatures of melting hail below the melting level, and (d) a mostly positive mode in differential reflectivity below the melting layer and negative above, which indicates more ice/graupel in the mixed phased layer for lightning-producing storms. Similar work was performed over the U.S. using GOES and WSR-88D radar for 59 LI events, in two distinctly different environments, Oklahoma and Florida. Main findings are that lead times for LI nowcasts are longer in Florida, where a ~30-min warm rain process occurs up to an hour before first lightning, that well-defined anvils exist over Florida versus in Oklahoma at the time of LI, and that Oklahoma storms tend to form much quicker (over ~30 min total) with explosive growth.