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Enhancing Satellite–based Nowcasting Convective Initiation using Radar and Lightning Observations

John Mecikalski (1), Retha Matthee (1), Xuanli Li (1), and Chris Jewett (2)

(1) University of Alabama in Huntsville, United States (johnm@nsstc.uah.edu), (2) Earth Systems Science Center, University of Alabama in Huntsville, United States

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, dual-polarimetric radar and lightning fields.

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 Meteosat Second Generation (MSG) SEVIRI and GOES Imager data. Enhancements to SATCAST over the past two years include an "object-tracking" based methodology, which provides enhanced tracking capabilities of growing convective clouds, and therefore greatly improves the ability to monitor the characteristics of convection in its early stages. SATCAST was tested at the GOES-R Proving Ground at the Storm Prediction Center (SPC) in Norman, OK in 2010–2012, and additional testing is planned for Spring 2013 at SPC as part of their annual Spring Experiment. Within 2013, incorporation of numerous NWP fields from the Rapid Refresh (RAP) model within a logistical regression methodology affords an enhanced use of GOES data, providing a "strength of signal" (probabilistic) CI nowcast. RAP fields of CAPE, CIN, elevated instability, cloud-base temperature and convective temperature depression, provide information on when certain infrared CI "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. Near-term plans are to begin assimilating the SATCAST GOES fields into RAP via a digital filter procedure to increase CI forecast accuracy in this model.

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 U.S. and 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) very distinctive cloud top signatures of glaciation occur when lightning is present, despite clouds extending well above the freezing level, implying large ice volumes, (b) stronger updrafts prevailed in lightning producing compared to non-lightning storms, and (c) 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 lightning 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.