Integrated GOES-R GLM/ABI Approaches for the Detection and Forecasting of Convectively Induced Turbulence (CIT)

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In this study, we investigate the potential for satellite detection and short-term forecasting of turbulence and other aviation hazards associated with rapidly growing and mature convective cells. Satellite derived cloud top cooling rates and total (i.e., in-cloud and cloud-to-ground) lightning trends are strong inferences of convective updraft intensity and growth rate. More specifically, we utilize integrated Advanced Baseline Imager (ABI) proxy cloud top cooling and overshooting-top (OT)/enhanced-V and Geostationary Lightning Mapper (GLM) proxy total lightning flash rates for diagnosis of storm intensity and growth rate. GLM proxy total lightning data are obtained from the VHF-based Lightning Mapping Arrays (LMAs) over Alabama, Florida, Oklahoma and Washington DC. Cloud top cooling and OT detection are obtained from Geostationary Operational Environmental Satellite (GOES) observations over the LMA operational domains (roughly out to 150-250 km from LMA center). Turbulence occurrence is determined objectively using eddy dissipation rate (EDR) data from the NCAR turbulence algorithm applied to commercial aircraft navigation data over the LMA domains.

During Year 1, our primary efforts have been 1) identifying and developing a database of concurrent LMA, GOES, EDR and other (e.g., radar) data during a variety of convectively induced turbulence (CIT) conditions (light, moderate, severe) over Northern Alabama LMA (NA-LMA), 2) processing NA-LMA for total lightning flash occurrence and rates and GOES for convective cooling rate, OT occurrence and other properties, and 3) investigating the temporal and spatial relationships between these total lightning properties, overshooting-tops (OTs), infrared (IR) cooling rates and CIT events.

We have identified 28 days during 2010-2011 that have at least one moderate or stronger turbulence event (and many light turbulence events) over the Alabama domain and have processed them for NA-LMA total lightning flashes. Total lightning occurrence, heights, and flash densities within various temporal and spatial radii from the EDR events on these 28 days have been investigated by turbulence intensity. Several moderate-to-severe turbulence events from 2010 and 2011 are being studied in more detail with LMA, GOES and radar data (e.g., 1/24/10, 3/12/10, 5/2/10) to determine the specific concurrent relationships between lightning, infrared cloud-top cooling and radar

intensity proxies and turbulence occurrence. Since the temporal and spatial relationships between the various convective intensity proxies themselves (e.g., total lightning flash rate and OT occurrence) are not well understood, we have also identified and processed over 400 GOES-12 and -13 OT detections within 250 km of the NA-LMA center from 11 events during 2009-2010. We are investigating the temporal and spatial evolution of total lightning flashes within convective radii (10 km, +/- 10 mins) of OT's in vigorous storms. A sample of these and other Year 1 accomplishments will be summarized along with a discussion of future (Year 2) objectives.