NOAA ROSES Semi-Annual Report

Reporting Period: September 2020 – February 2021 (1st report)

PI: Anthony Wimmers

Project Title: Probabilistic Nowcasting of Aviation Turbulence Using Deep Learning Applied to Advanced Geostationary Imagery

Executive Summary (1 paragraph max)

In spite of the progress made by numerical models in forecasting aviation turbulence, major hazards remain undetected. Today's geostationary imagery provides an alternate approach, with high spatial precision and low latency that reveal structures associated with turbulence not captured by numerical models alone. Processing this geostationary imagery with deep learning offers a new and *comprehensive* way to quantify the hazards posed by turbulence-forming atmospheric structures that surpasses the skill of previous heuristic methods. During this period, we have developed and deployed a deep learning model that uses integrated ABI imagery and GFS model fields to produce high-accuracy multi-layer nowcasts of turbulence at cruising altitude.

Progress toward FY20 Milestones and Relevant Findings

Overhaul of methodology and code: In September of 2020 we updated the model to apply the relatively new Tensorflow 2 module in order to greatly simplify the code structure and collaborative capabilities. This also had the side benefit of speeding up the real-time code execution.

Integration of ABI imagery with GFS fields: In the October-December quarter of 2020 we tested and finalized a new method for integrating ABI and GFS fields into a single deep learning framework. This resulted in a very significant increase in product skill (roughly doubling the Brier Skill Score), introducing multiple *vertical* layers within the product, and revealing the complementary roles of satellite and GFS fields for estimating the distribution of turbulence. For example, the deep learning model clearly identifies ABI-resolved deep convection and major gravity waves in their association with turbulence, whereas the GFS fields identify areas of significant wind shear in dry, featureless downwelling air that can be highly turbulent. The new ABI+GFS product version was deployed in February 2021 (website and AWIPS product) and has been extremely successful in matching (and contextualizing) areas of real-time turbulence reports.

Engagement with NWS aviation forecasters: In September 2020 we presented an introduction to the turbulence product at the Satellite Book Club series, introducing the product and its performance to many new attendees from the NWS. Later, in February 2021 we followed up with several dozen of the NWS forecasters and NOAA collaborators for a webinar updating the new advancements in product capabilities.

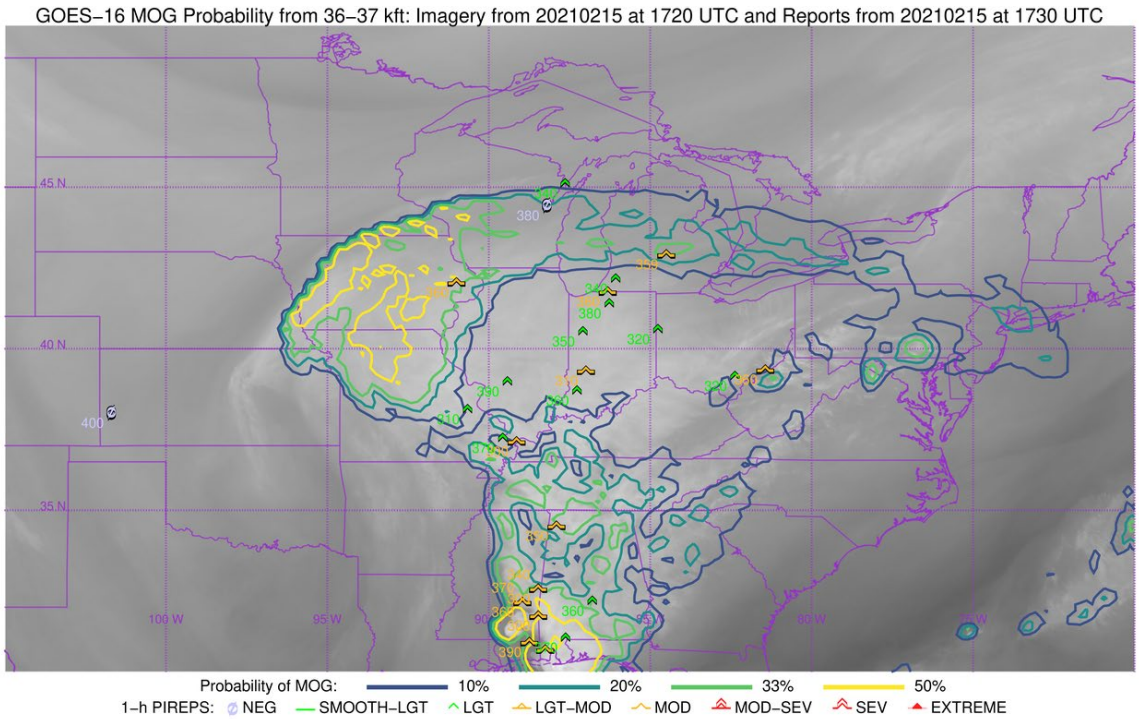

Figure 1. Early demonstration of new ABI+GFS product accuracy. Contours are model-estimated probability of moderate-or-greater (MOG) turbulence. Colored symbols are manual reports of upper-air turbulence at the same time (legend at the bottom of the image).

Plans for Next Reporting Period

For the next six-month period we plan to

- Explore the application of the model to additional GOES ABI channels and the GLM
- Begin the production of model fields for MWT cases
- Continue tailoring the website and AWIPS products for better forecaster access