NOAA ROSES Semi-Annual Report

Reporting Period: September 2021 – February 2022 (3rd report)

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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 enhanced the real-time product distributed in AWIPS, expanded the product to better serve the Alaska Aviation Weather Unit and completed the WRF dataset of mountain wave turbulence cases.

Progress toward FY21 Milestones and Relevant Findings (with any Figs)

<u>Enhancement of real-time product for AWIPS</u>: At the request of the AWC and WFO Honolulu, the turbulence product was changed from a single image to a gridded field split into three layers at cruising altitude: 30-33,000 feet, 34-37,000 feet and 38-41,000 feet (Figure 1). The gridded product, while taking more effort to produce at CIMSS, allows forecasters to overlay the probability fields on other imagery for a fully integrated view of the meteorological context of turbulence events.

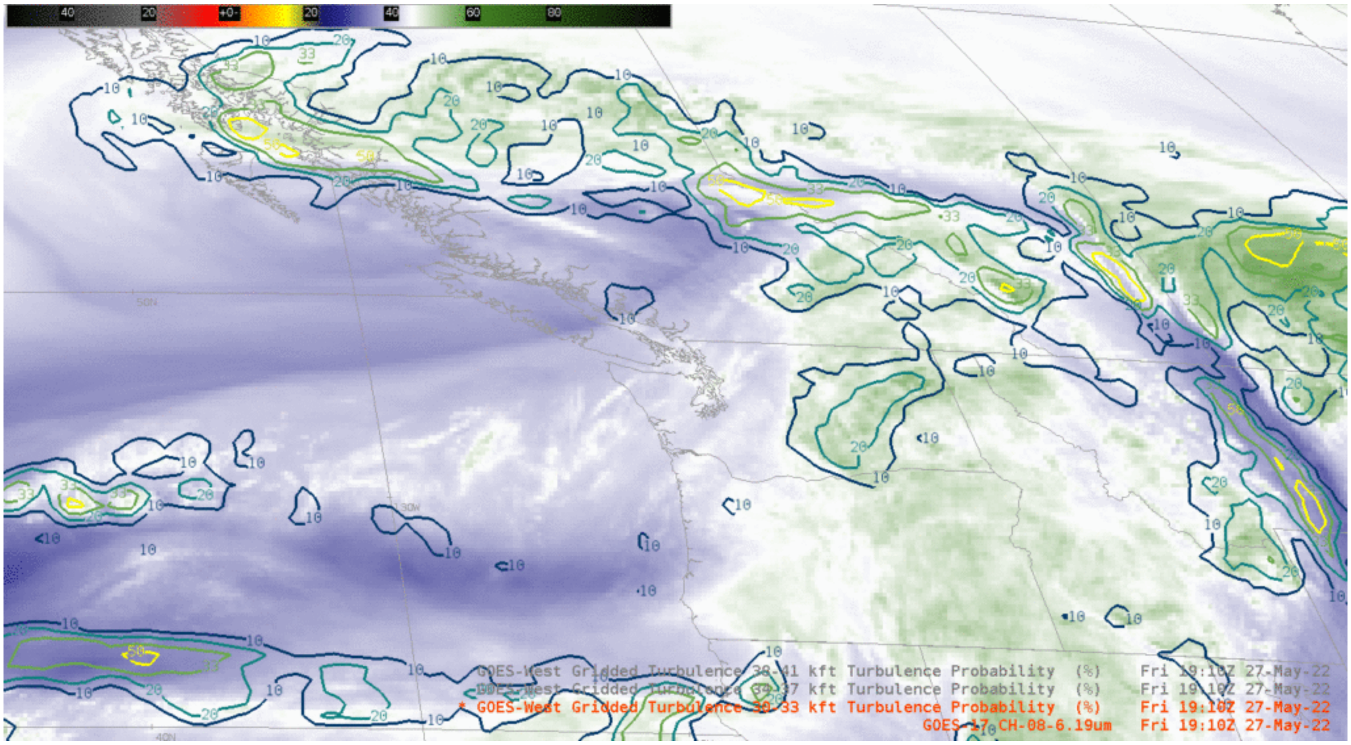

Figure 1. GOES-17 Band 8 (“Low-level water vapor”) Infrared (6.19 μm) fields, 1910 UTC on 27 May 2022, along with derived Turbulence Probability for 30-33 kft, 34-37 kft, 38-41 kft.

Expansion of the online product for the AAWU:

We have applied the product to a new domain at higher latitudes at the request of the AAWU. This is now a regular part of the online web tool (Figure 2). Previously, the product was limited to <60 degrees north latitude, which primarily covered trans-ocean flight corridors.

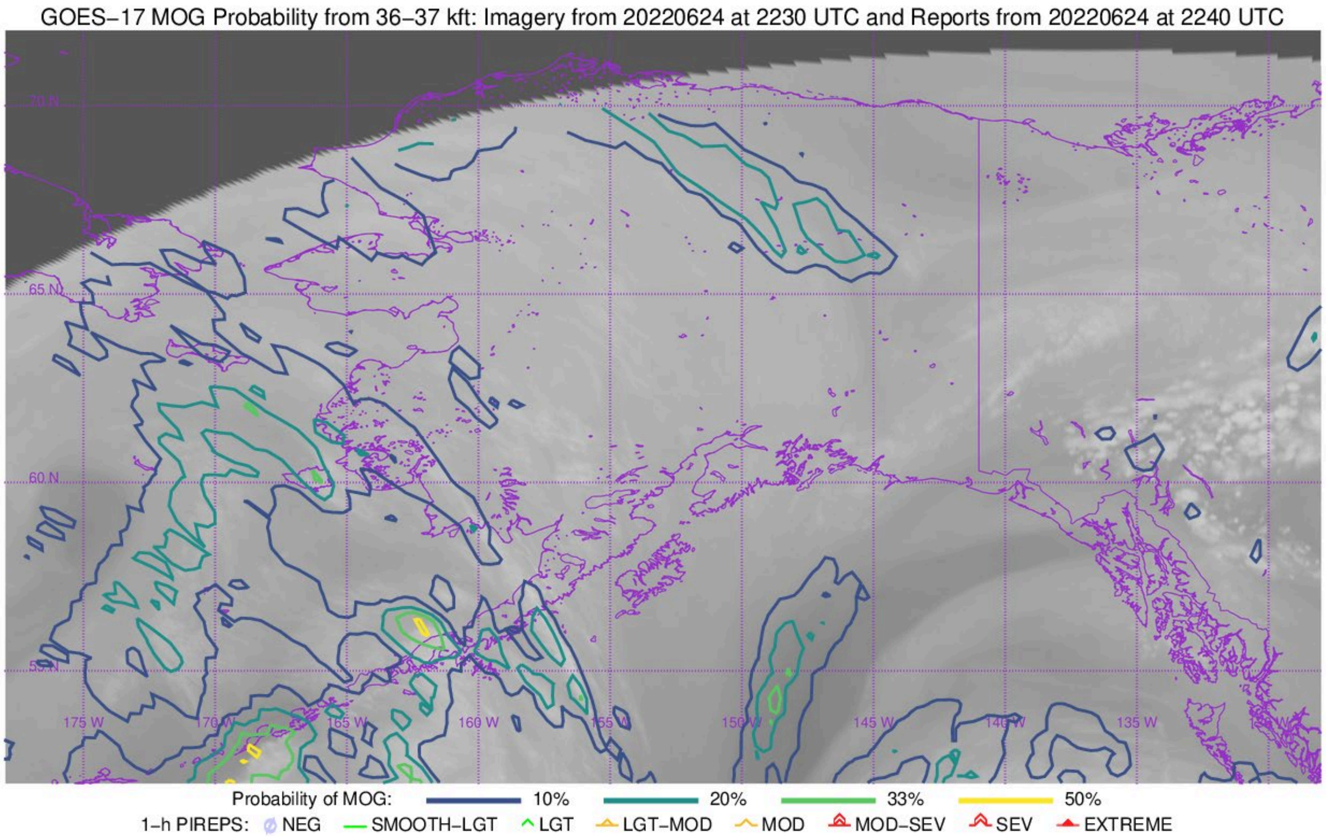

Figure 2. Turbulence probability for Alaska domain, from the online tool.

Production of WRF dataset for mountain wave turbulence cases:

We have just completed running the 1-km WRF model for twenty cases of mountain wave cases over the United States. Mountain wave turbulence (MWT) has been notoriously difficult to capture either in GOES imagery or in the operational global GFS. Although gravity waves are indeed quite detectable around mountain ranges, the small subset that break down into aircraft turbulence are difficult to distinguish. With this dataset we will attempt to isolate the features in both GOES and NWP that are associated with MWT.

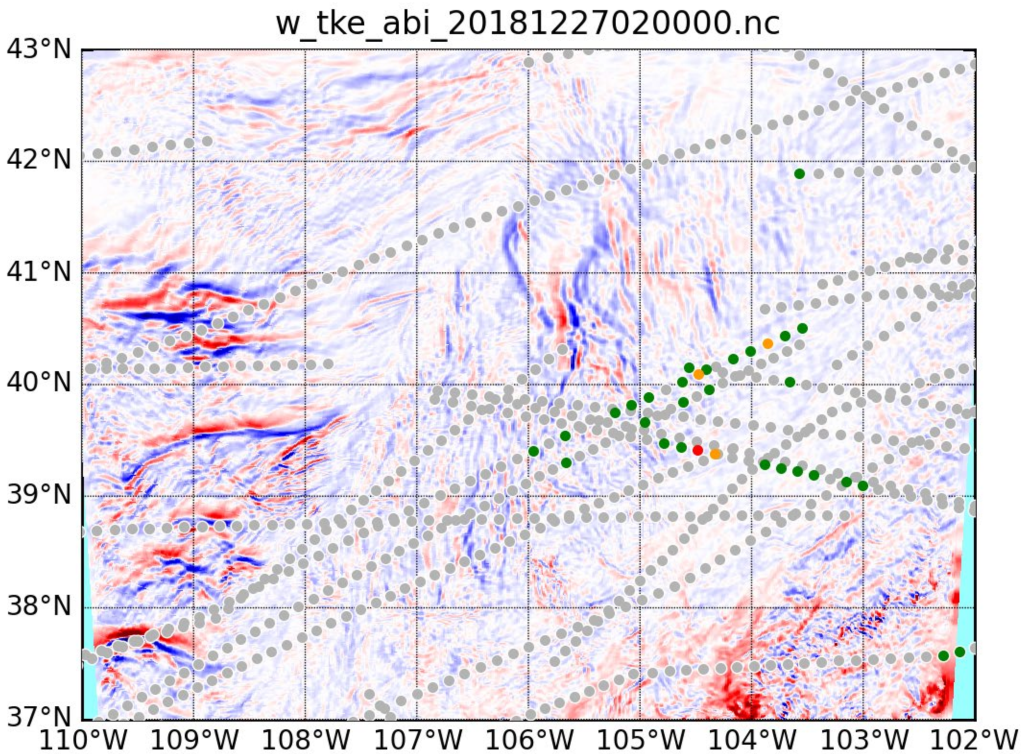

Figure 3. WRF-derived Turbulent Kinetic Energy (colormap) and corresponding aircraft EDR (plotted points) for one of the modeled cases.

Plans for Next Reporting Period

For the next six-month period we plan to

- Continue examining online cases of weak performance
- Analyze model fields of mountain wave turbulence cases with deep learning models
- Adapt the model to additional GOES ABI channels and the GLM
- Improve the model with multi-image temporal data