Near-Real Time Monitoring of Cold Air Aloft for Aviation Safety in the United States and Canada

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1. INTRODUCTION

Monitoring temperature at cruising altitudes is important for aircrafts flying over the United States and Canada during winter months. Cold air aloft can be hazardous as jet fuel begins to gel at -65 C, which can cause engine malfunctions and increase risk of aircraft loss. Flight planners and dispatchers therefore desire to avoid these regions of cold air aloft, but the scant number of upper air observations (especially at the higher latitudes where both cold air and great circle airways are common) makes it difficult to identify regions to be avoided.

Near-real time observations from polar-orbiting satellite sounders are one way to address this issue. Temperature observations from five pressure levels near cruising altitudes are retrieved from the NOAA-Unique Combined Atmospheric Processing System (NUCAPS) thermodynamic profiles. NUCAPS uses brightness temperature observations from the Cross-track InfraRed Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) onboard the NASA Suomi-NPP (SNPP) and the NOAA-20 satellites. These observations are displayed in RealEarth, a web-based display program developed by the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison, and update in near-real time. This presentation demonstrates the utility of such a product by examining a case during the 2019 polar vortex over North America; validation of the product will be demonstrated against contemporaneous AMDAR observations.

2. DATA

In this study, NUCAPS data for the case studies were downloaded from the NOAA Comprehensive Large Array-data Stewardship System (CLASS) (www.class.noaa.gov). The real-time displays on RealEarth use direct broadcast data created using the University of Wisconsin Community Satellite Processing Package (CSPP) (https://cimss.ssec.wisc.edu/cspp/). Aircraft Meteorological DAta Relay (AMDAR) data was used in this study to validate NUCAPS near common cruising altitudes (https://www.wmo.int/pages/prog/www/GOS/ABO/data/ABO_Data_Access.html).

3. VALIDATION

For this paper, a case study was conducted during the 2019 North American Polar Vortex. The specific days used in this study were 28-31 January 2019. The hourly AMDAR temperature data was matched with both SNPP and NOAA-20 NUCAPS data that was gridded to a 0.7x0.7 degree grid and smoothed by a 3x3 boxcar convolution. Five NUCAPS pressure levels were chosen that correspond with

common flight altitudes: 180mb (41,000ft), 200mb (38,600ft), 235mb (35,270ft), 260mb (34,000ft), and 286mb (32,000ft). The aircraft data was filtered to find points within ±10mb of the NUCAPS pressure level. Then, AMDAR data were matched spatially within 100km of the NUCAPS grid point. Figures 1 and 2 display AMDAR and NUAPS matchups for 2 hours during the case study. The corresponding scatterplots show NUCAPS cold air aloft is well correlated with the AMDAR data.

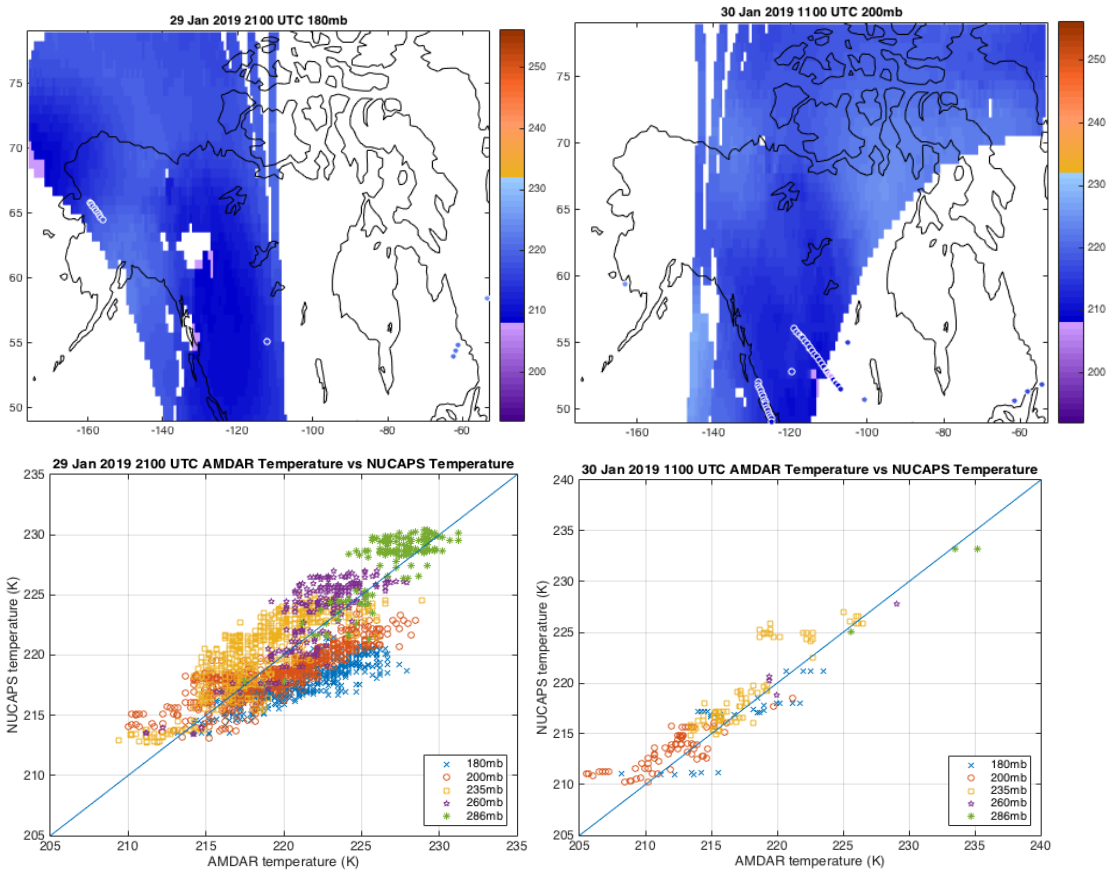

Figure 1. Two hourly examples of NUCAPS and AMDAR matchups. Left panels are at 29 Jan 2019 21:00-22:00 UTC while right panels are for 30 Jan 2019 11:00-12:00 UTC.

4. SSEC REAL EARTH

The five NUCAPS cold air aloft pressure levels mentioned in the previous section (180mb, 200mb, 235mb, 260mb, and 286mb) are displayed on the University of Wisconsin - SSEC's RealEarth. The products are updated in near-real time with a latency of around 15 to 30 minutes after the NUCAPS overpass. The CSPP NUCAPS is used for the display because of its low latency. Software to process the data is available from the Community Satellite Processing Package (CSPP) available from SSEC at http://cimss.ssec.wisc.edu/cspp. Currently, the cold air aloft NUCAPS products are merging data from 6 direct broadcast sysems for better coverage of the continental United States, Alaska, and Canada. These stations include SSEC from the University of Wisconsin – Madison, NOAA CREST from the City College of New York,

3 sites from the Geographic Information Network of Alaska, and Edmonton, Alberta, Canada. The five NUCAPS cold air aloft pressure levels are displayed under the 'JPSS - NUCAPS' tab https://realearth.ssec.wisc.edu, and this user friendly display can be displayed on a web browser or on the RealEarth app.

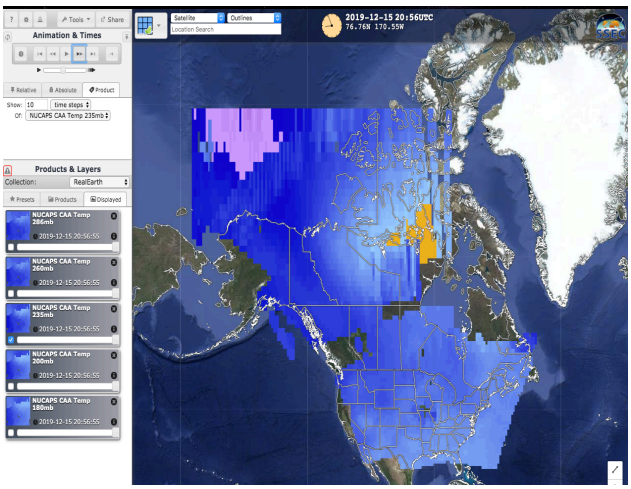

Figure 2. Screenshot from SSEC's RealEarth of cold air aloft using NOAA NUCAPS retrieved temperature at 235mb. This product updates in near-real time after the satellite overpass. Other levels are selectable from the side menu.

5. CONCLUSIONS AND FUTURE WORK

A case study from the January 2019 North American polar vortex shows that NUCAPS temperatures correlate well with the observed aircraft temperature for five common cruising altitudes. The five NUCAPS pressure levels are displayed on SSEC RealEarth, and are updating in near-real time with data from six direct broadcast sites. Future work will include a validation of the NUCAPS boundary layer. NUCAPS profiles will be compared to AMDAR takeoff and landing aircraft observation profiles.