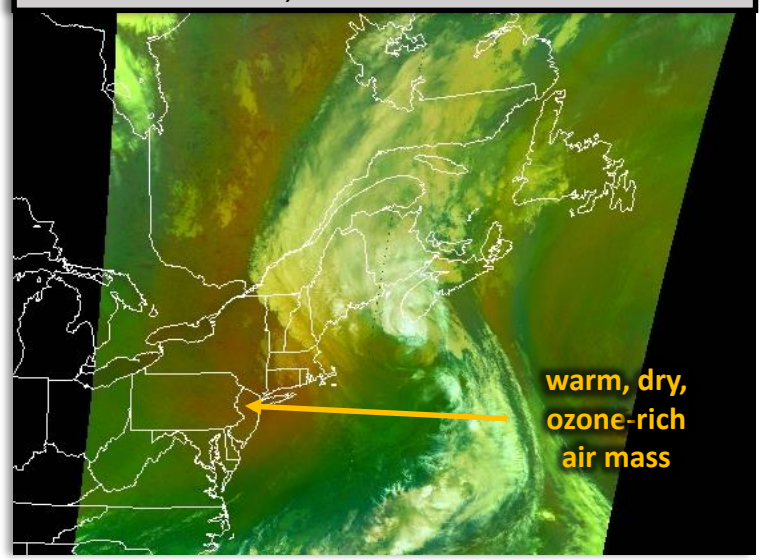
Hyperspectral Infrared Sounder Ozone Products Quick Guide by NASA/SPoRT

Why are Hyperspectral Infrared Sounder Ozone Products Important?

The SPoRT Ozone products are derived from hyperspectral infrared sounder ozone retrievals from three instruments: Atmospheric Infrared Sounder (AIRS), Cross-track Infrared Sounder (CrIS), and Infrared Atmospheric Sounding Interferometer (IASI). The Total Column Ozone, Ozone Anomaly, and Tropopause Level products were designed as quantitative comparisons to compliment the Air Mass RGB (see images below from 5 July 0740 UTC). These products can be used to identify regions of warm, dry, ozone-rich stratospheric air and indicate the possible presence of a stratospheric intrusion or tropopause fold for anticipating cyclogenesis or hurricane extratropical transition.

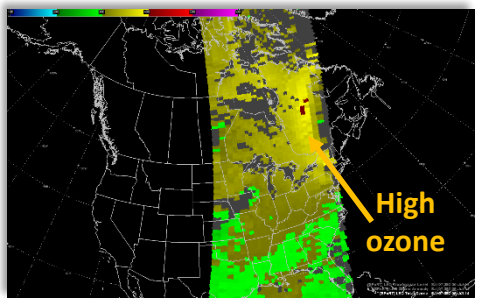
AQUA MODIS Air Mass RGB during Arthur (2014)
5 July 2014 0635-0645 UTC



What are Hyperspectral Infrared Sounders?

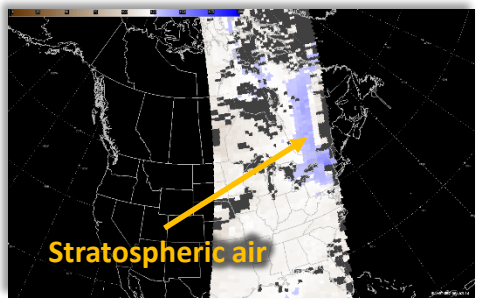
Hyperspectral infrared sounders use thousands of channels to measure temperature and water vapor with height, as well as clouds, ozone, and other trace gases. Hyperspectral infrared sounding measurements are best quality in clear conditions. The measurements from the infrared sounders are combined with microwave measurements from instruments such as the Advanced Technology Microwave Sounder (ATMS) or Advanced Microwave Sounding Unit (AMSU) and this allows for measurements in partly cloudy regions. Despite use of both infrared and microwave measurements, measurements are still blocked or limited in regions with thick clouds since the clouds absorb the energy before it reaches the satellite.

Product Specifications



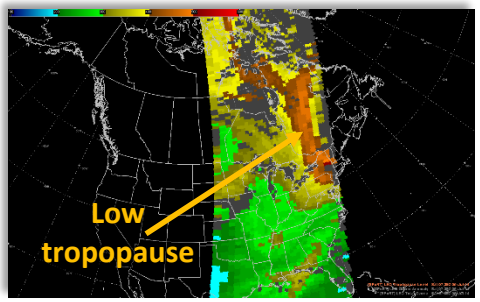
Total Column Ozone (Dobson Units)

- High ozone is a tracer for stratospheric air and tropopause folding
- Identification of stratospheric air based on high ozone alone (e.g. 300 DU) can be misleading since ozone values vary by season and latitude
- Produced from AIRS, IASI, and CrIS



Ozone Anomaly (Percent of Normal)

- Stratospheric air can be identified where ozone values are at least 25% greater than the climatology (Van Haver et al. 1996)
- Product displayed in Percent of Normal 0-200%
- Shades of blue (values >= 125%) indicate stratospheric air and the ozone values are anomalous for the month and latitude (Ziemke et al. 2011)
- Produced from AIRS, IASI, CrIS



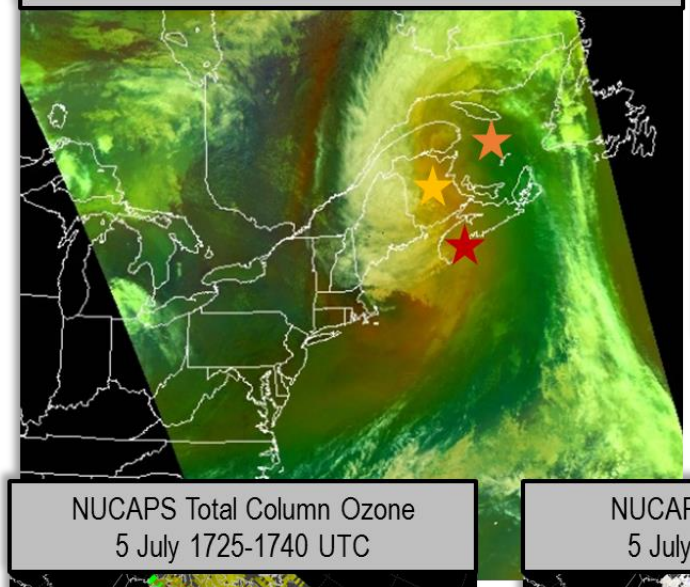
Tropopause Level (Millibar)

- Ozone can be used to identify the tropopause level, use of a single value (e.g. 100 ppb) is misleading
- The seasonal variation of ozone at the dynamic tropopause (2 PVU) is described by Thouret et al. (2006)

  91 + 28 sin(pi*(month-2)/6)
- Tropopause level is found by matching the level where the ozone value is greater than or equal to the Thouret et al. (2006) value
- Produced from IASI and CrIS

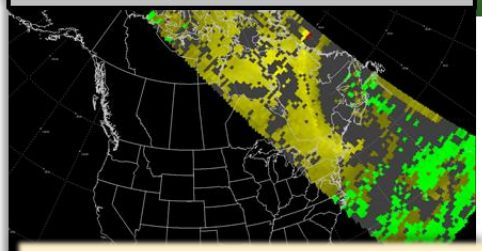
Application Example Arthur (2014)

AQUA MODIS Air Mass
5 July 2014 1735-1750 UTC



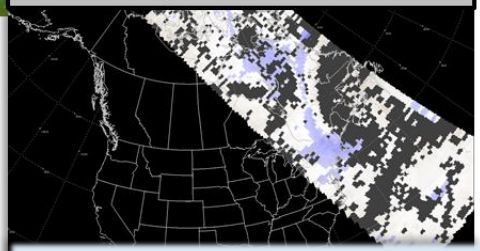
Arthur was classified as extratropical by 1200 UTC 5 July. The extratropical low continued on a northeastward track toward the Gulf of St. Lawrence. Gale-force winds and heavy rain were observed in Nova Scotia, Prince Edward Island, and New Brunswick. The system reached eastern Newfoundland late on 6 July and dissipated off the eastern coast of Newfoundland by 0000 UTC 10 July. Review each product for a closer look at Arthur during the 1700 UTC hour, after it was considered extratropical.

NUCAPS Total Column Ozone
5 July 1725-1740 UTC



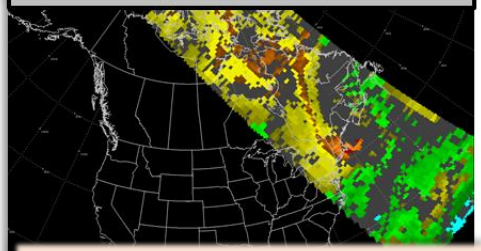
High ozone values, 300-400 DU, cover much of the image. Higher concentrations closer to 380 DU correlate with the streamer of red/orange coloring across Canada and the northeast that represent warm, dry, ozone-rich air drawn into the storm.

NUCAPS Ozone Anomaly
5 July 1725-1740 UTC



The ozone anomaly shows the higher ozone values are anomalous and considered stratospheric for this time of year and latitude. The blue shades represent stratospheric air influence and the potential for tropopause folding.

NUCAPS Tropopause Level
5 July 1725-1740 UTC

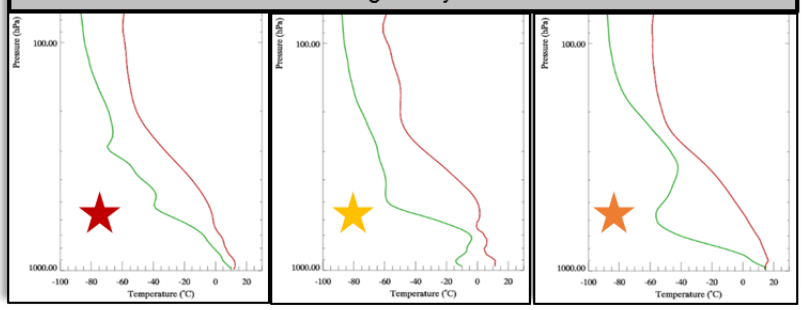


In this same region, the tropopause level product shows the vertical extent of the stratospheric air down to 500 mb. The depth indicates a likely stratospheric intrusion or tropopause fold. Model cross-sections verified a folding event.

Supporting Products

CrIS/ATMS profiles are processed through the NOAA-Unique Combined Atmospheric Processing System (NUCAPS) and are available in AWIPS II. These sample graphics are provided as a proof of concept.

NUCAPS Sounding 5 July 1725-1740 UTC



The profiles at the red and yellow star confirm upper-level dry conditions in the red/orange region of the RGB and show the dry air is also present at mid-levels, suggesting the stratospheric air has enveloped the core and eastern quadrant of the cyclone. The profile at the orange star confirms the upper-level moist conditions in the green region of the RGB. Although upper-level moisture is present, the NUCAPS Soundings show mid-level dry air is present, indicating the slant-wise descent of stratospheric dry air coincident with the dry slot.

Resources

COMET: Advanced Satellite Sounding: The Benefits of Hyperspectral Observations, 2nd Ed.
VISIT: NUCAPS Soundings in AWIPS II
SPoRT: JPSS Satellite Products for Extratropical Transition Events