A Comparison of the Red Green Blue (RGB) Air Mass Imagery and Hyperspectral Infrared Retrieved Profiles and NOAA G-IV Dropsondes

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The Problem

- RGB air mass imagery is derived from multiple channels or paired channel differences.
- The combination of channels and channel differences means the resulting imagery does not represent a quantity or physical parameter such as brightness temperature in conventional single channel imagery.
- Without a specific quantity to reference, forecasters are often confused as to what RGB products represent.
- Hyperspectral infrared retrieved profiles and NOAA G-IV dropsondes provide insight about the vertical structure of the air mass represented on the RGB air mass imagery and are a first step to validating the imagery.

Background

- The RGB Air Mass product is able to identify temperature and moisture characteristics surrounding synoptic features.

Color	Band/Band Diff.	Physically Relates to…	Little contribution indicates…	Large contribution indicates…
Red	6.7-7.3	Vertical water vapor difference	Moist upper levels	Dry upper levels
Green	9.7-10.7	Estimate of tropopause height based on ozone	Low tropopause, more ozone, polar air mass	High tropopause, less ozone, tropical air mass
Blue	6.7	Water vapor ~500-200 mb layer	Dry upper levels	Moist upper levels

Table 1. RGB Air Mass product recipe based off EUMETSAT RGB guidelines

- **Red/Orange** → Vorticity/Jet Streak, dry air pulled down on anticyclonic side of the jet
- **Olive** → Warm, mid-upper level dry air
- **Green/Blue** → warm (cool), mid-upper level moist air

- The Atmospheric Infrared Sounder (AIRS) and Cross-Track Infrared and Microwave Sounder Suite (CrIMSS) are hyperspectral IR sounders on the polar orbiting Aqua and Suomi polar orbiting spacecrafts. Both are capable of measuring temperature and water vapor with height and other gases. AIRS Level 2 retrievals are available with a vertical resolution of 100 levels, but CrIMSS resolution is not as high.
- Ozone anomalies were calculated as a percent of normal using AIRS and CrIMSS total column ozone and a satellite derived ozone climatology, stratospheric air has ozone values ≥125% of normal and is shaded blue.
- GPS dropsonde data are from NOAA's G-IV high altitude jet flying at 41-45,000 ft and were collected during a Synoptic Surveillance mission on 27 October and an Extratropical Transition mission on 28 October. The GPS dropsondes provide thermodynamic information at ~5 m vertical resolution and were quality controlled.

1800 UTC 27 October 2012 Sandy Near Bahamas

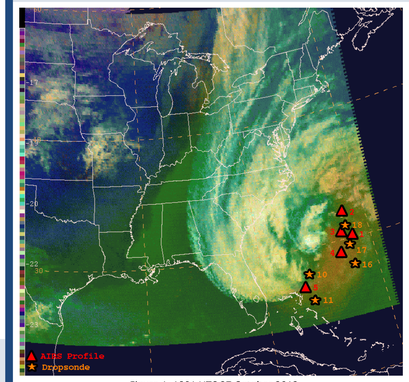

Figure 1. 1801 UTC 27 October 2012
CIRA/SPoRT GOES Sounder proxy RGB Air Mass image

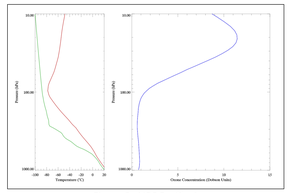

Figure 2. AIRS Profile 1

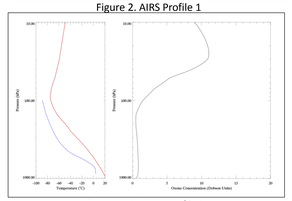

Figure 3. CrIMSS Profile 1

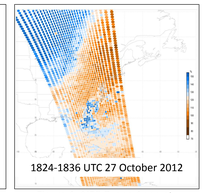

Figure 4. AIRS Ozone Anomaly

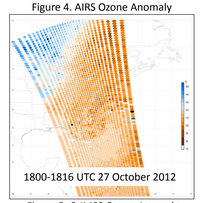

Figure 5. CrIMSS Ozone Anomaly

- AIRS Profiles 1, 3, and 4 in the orange region showed drier mid-levels (Fig. 1, 2).
- AIRS and CrIMSS profiles 1-5 show uniform ozone with height up to 150 mb. (Fig. 2 and 3).
- AIRS ozone anomaly confirms stratospheric air (blue) in the RGB air mass orange region; but CrIMSS does not (Fig. 4 and 5).
- Profiles with mid- to upper- level dry air and uniform ozone with height indicate the orange coloring in the RGB air mass is a result of mid-level drying with some stratospheric influence.

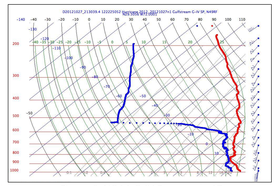

Figure 6. NOAA G-IV Dropsonde 17

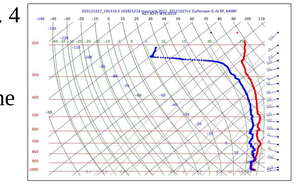

Figure 7. NOAA G-IV Dropsonde 10

- Dropsonde 17 (Fig. 6) has a moist atmosphere up to about 600 mb similar to AIRS. However there is more drying in the mid-levels. Even though the dropsonde was released 4 hours after the air mass image (Fig. 1), it was still near the center of the orange region.
- Dropsonde 10 (Fig. 7), similar to AIRS profile 5 has moisture throughout the atmospheric column and saturated conditions below 800 mb.

1800 UTC 28 October 2012 Sandy Off North Carolina

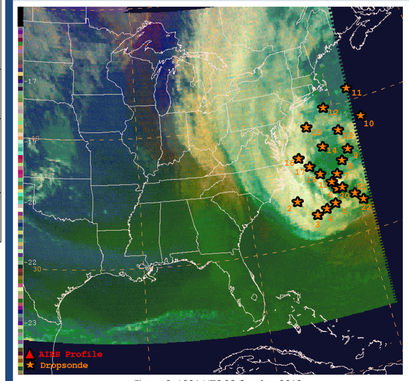

Figure 8. 1801 UTC 28 October 2012
CIRA/SPoRT GOES Sounder proxy RGB Air Mass image

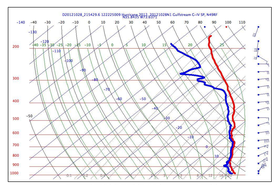

Figure 9. NOAA G-IV Dropsonde 16

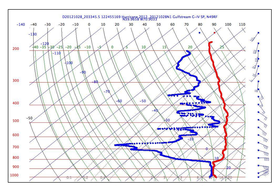

Figure 10. NOAA G-IV Dropsonde 12

- Dropsondes on the southern, western, and eastern sides of the storm (Fig. 8), away from the eye had moist low- and mid-levels that extended as high as 500 mb (Fig. 9)
- Profiles north of the storm had much drier mid-level air (Fig. 8 and 10).
- The mid-level dry air north of the storm may be too low to result in orange coloring in the RGB.

1800 UTC 29 October 2012 Sandy Off Mid-Atlantic

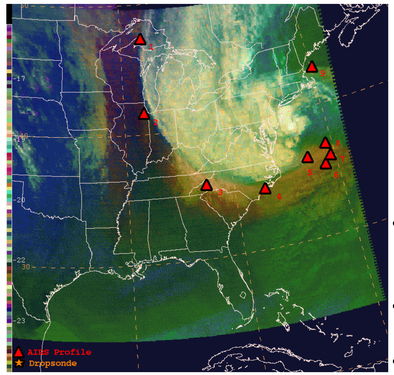

Figure 11. 1801 UTC 29 October 2012
CIRA/SPoRT GOES Sounder proxy RGB Air Mass image

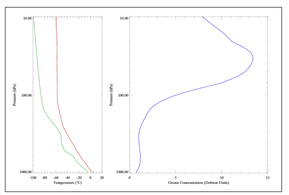

Figure 12. AIRS Profile 1

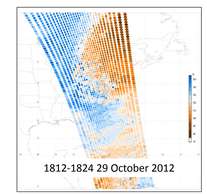

Figure 13. AIRS Ozone Anomaly

- AIRS and CrIMSS profiles 1 and 2 confirm higher values of ozone down to 300 mb in the RGB air mass blue region (Fig. 11 and 12).
- AIRS ozone anomaly confirms profiles 1 and 2 ozone values are representative of stratospheric air (Fig. 13).
- AIRS profiles 4-8 in RGB air mass orange regions confirm mid-level dry air with some stratospheric influence.

0600 UTC 30 October 2012 Sandy at Landfall

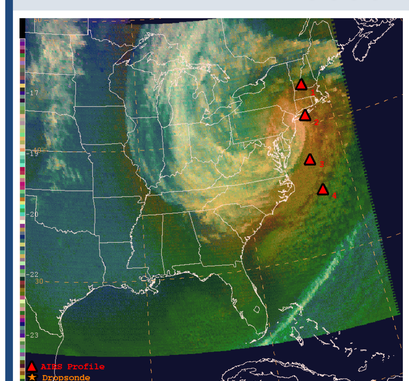

Figure 14. 0601 UTC 30 October 2012
CIRA/SPoRT GOES Sounder proxy RGB Air Mass image

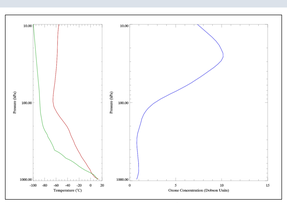

Figure 15. AIRS Profile 2

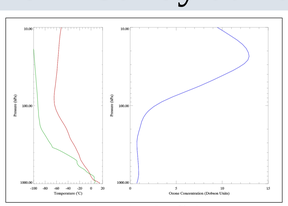

Figure 16. AIRS Profile 3

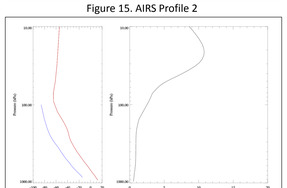

Figure 17. CrIMSS Profile 2 0700 UTC

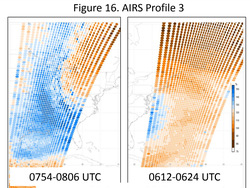

Figure 18. AIRS Ozone Anomaly

- AIRS profiles 1-4 in RGB air mass orange regions confirm mid-level dry air and higher ozone values down to 200 mb (Fig. 14, 15, 16).
- CrIMSS profiles 1-4 differ with drier low levels than AIRS, but show higher ozone down to 200 mb similar to AIRS (Fig. 17).
- AIRS ozone anomaly confirms ozone values are representative of stratospheric air with less stratospheric influence on the eastern and northern regions of the storm (Fig. 18).

Summary

- Profiles in blue regions (indicative of moist, cold, polar, ozone-rich air) had higher ozone values as low as 300 mb and were neither extremely moist nor dry throughout the atmospheric column.
- Profiles in the center of orange regions had mid- to upper-level dry air and high ozone values down to 200 mb.
- Differences in low level moisture between AIRS and CrIMSS profiles may be due to differences in the number of vertical levels.
- Dropsondes confirm the features in the AIRS profiles.
- These atmospheric and ozone profiles lend support to the idea that the RGB air mass product may be used to identify stratospheric interaction during tropical to extratropical transitions. Sandy was a unique situation, therefore more cases will be studied to determine confidence.