Progress Report for NASA Grant NAG5-11100
Title: "Validating AIRS Ozone Observations"

Report to the EOS Program Office
1 March 2003

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Research Objectives

We propose to assess the accuracy of the EOS/AQUA/AIRS ozone retrievals by comparison to accepted standards of measurements through a well-constructed, sequential approach. By close interaction with the AIRS algorithm team, we will quantify and minimize the precision and bias of the ozone measurements. Through interaction with the global modeling community, we will identify the areas of significant agreement and disagreement between our understanding and our measurements of atmospheric ozone.

In the first year, we will assess the total ozone column measurements with TOMS and Dobson measurements in the most benign atmospheric conditions. Then, with dedicated ozonesonde launches we will focus sharply on the accuracy of the ozone retrievals over more difficult conditions including partly cloudy scenes, day/night differences, and difficult viewing geometry.

In the second year, we will introduce additional standard correlative data (Umkehr, TOMS, SAGE, lidar) to assess the precision and accuracy of the tropospheric and stratospheric columns and extend the domain of comparison in both time and space. We will also focus on day/night differences using dedicated ozonesonde launches at Huntsville, AL.

In the third year, we will investigate the accuracy of AIRS to measure Stratospheric/Tropospheric exchange morphology and convective boundary layer diurnal differences. We will also place the AIRS measurements into the context of derived tropospheric ozone fields and of global 3-d chemical transport models to assess our understanding of tropospheric ozone morphology.

This comprehensive plan will result in a well quantified assessment of the AIRS ozone measurements in the troposphere and stratosphere over a wide variety of conditions, times, and places. We will also place these measurements into the context of regional and global ozone morphology.

Summary of progress and results

In the first year, we have:

- Reported ozonesonde files in NetCDF format to the AIRS team and posted on the TLSCF.
- Compiled a list of 143 Brewer/Dobson/Ozonesonde/Umkehr stations around the world that have reported ozone data to the World Ozone and Ultraviolet Data Centre (WOUDC)

since June 01, 2001, see Figure 1, that we will use to validate AIRS ozone measurements. We are obtaining the data from the WOUDC and NOAA/CMDL as it becomes available.

- Established collaborative efforts with ozonesonde stations at Trinidad Head, CA, Boulder, CO, and Wallops Island, VA, to launch dedicated ozonesondes during AIRS overpass to quantify the continental gradient and verify the observed emerging climatology of [*Newchurch et al.*, 2002].
- Established collaborative efforts with Mauna Loa Observatory and Table Mountain Facility to obtain their ozone Lidar data [*McDermid*, 1993]. We are downloading the lidar data from NDSC as it becomes available.
- Launched 16 dedicated ozonesondes measuring the vertical profile of ozone, temperature and water vapor from Huntsville, AL as part of our AIRS validation efforts.

Flight	Date	Launch (GMT)	Overpass (GMT)	Elevation Angle
*HU143	07/20/2002	18:52:32	19:06:14(18:50:08)	73.8(75.1)
*HU144	07/22/2002	07:25:48	07:52:25(07:36:26)	72.6(76.6)
*HU145	07/25/2002	06:08:28	06:46:00(08:08:11)	21.2(47.5)
*HU146	07/27/2002	18:41:07	19:14:28(19:06:12)	59.1(86.3)
*HU147	07/28/2002	05:59:55	07:17:29(07:08:53)	46.1(31.6)
*HU148	07/28/2002	18:06:41	18:20:00(18:11:16)	34.4(24.4)
HU152	09/08/2002	17:43:46	(18:55:00)	(85.8)
HU155	09/23/2002	17:46:12	18:22:17(18:16:00)	37.2(32.1)
HU156	09/28/2002	18:12:09	(18:35:15)	(51.8)
HU157	10/05/2002	18:48:49	(18:42:37)	(63.1)
*HU161	11/01/2002	07:13:30	(07:25:29)	(59.1) Voemel payload
*HU162	11/02/2002	19:34:09	(19:10:33)	(63.1) Voemel payload
*HU163	11/08/2002	06:48:52	(07:32:13)	(70.7)
*HU164	11/08/2002	18:17:48	(18:34:27)	(51.3)
*HU165	11/13/2002	18:04:15	(18:52:54)	(82.7)
HU166	11/14/2002	19:35:34	(19:35:51)	(32.7)

NOTE: Overpass times and elevation angles within brackets () are times and angles obtained from the overpass predictor AFTER the time and date of the overpass.

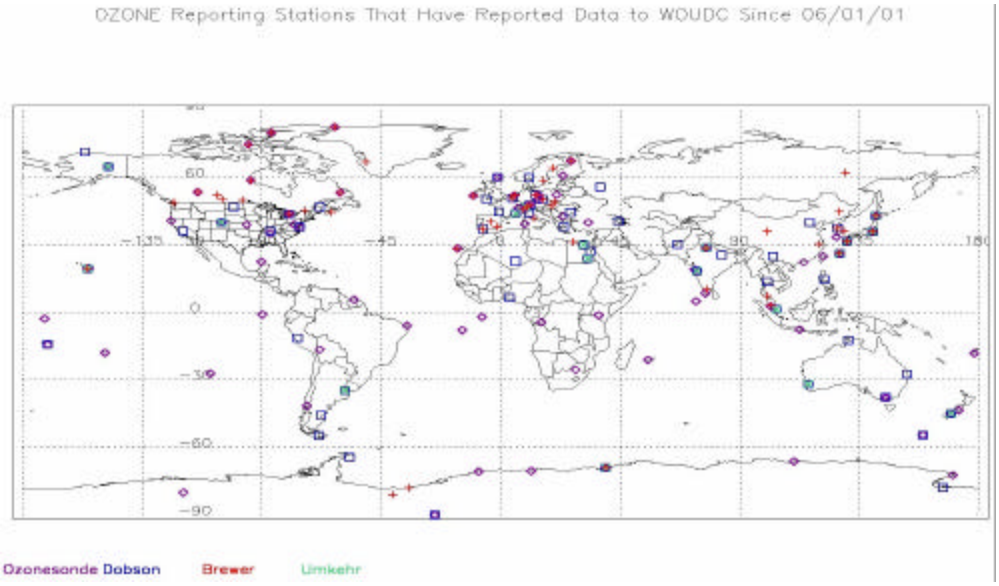

Figure 1. Map of stations that have contributed Brewer and/or Dobson and/or Ozonesonde and/or Umkehr data to the WOUDC since June 01, 2001.

Initial analysis

Figure 2 compares Sept 6, 2002 focus day AIRS retrievals of the ozone column with ozone columns from the Earth Probe Total Ozone Mapping Spectrometer (TOMS). These initial comparisons are restricted to mostly tropical and subtropical latitudes where column ozone tends to be more zonally symmetric. Gridded TOMS data resolution is 1 deg in latitude and 1.25 deg in longitude. AIRS results are daytime type 0 (all retrieval stages acceptable) and type 10 (MW acceptable, FIRST not acceptable, FINAL acceptable). Maximum land fraction was 0.001. Note that TOMS retrievals on Sept 6 were missing part of an orbit near the dateline..

For September 6, 2002, the average difference, defined as (AIRS-TOMS)/TOMS, is 7 +/- 7 %. Broken down further, type 0 retrievals are high by an average of 10%, and type 10 are low by an average of 4% (Figure 3). AIRS tends to be significantly higher (~25%) in regions of high dust blown off the northwest coast of Africa. These are mostly type 0 retrievals.

AIRS tends to be significantly lower than TOMS (~ -20%) in regions of high, thick clouds for retrieval type 10s. There is a (tenuous) anti-correlation between cloud fraction and AIRS/TOMS difference in Cloud top #1 at pressures below about 400 mb (Figure 4).

Conclusion

1. Single-day sample of preliminary retrieval shows AIRS global total column ozone columns within 10% of EP/TOMS over most of the oceans.
2. Largest AIRS/TOMS differences occur in regions of aerosol loading, high cold cloud, or ice.
3. AIRS ozone retrievals over land still need work.
4. No apparent, first-order cloud-retrieval effects on ozone retrievals in tropical latitudes.

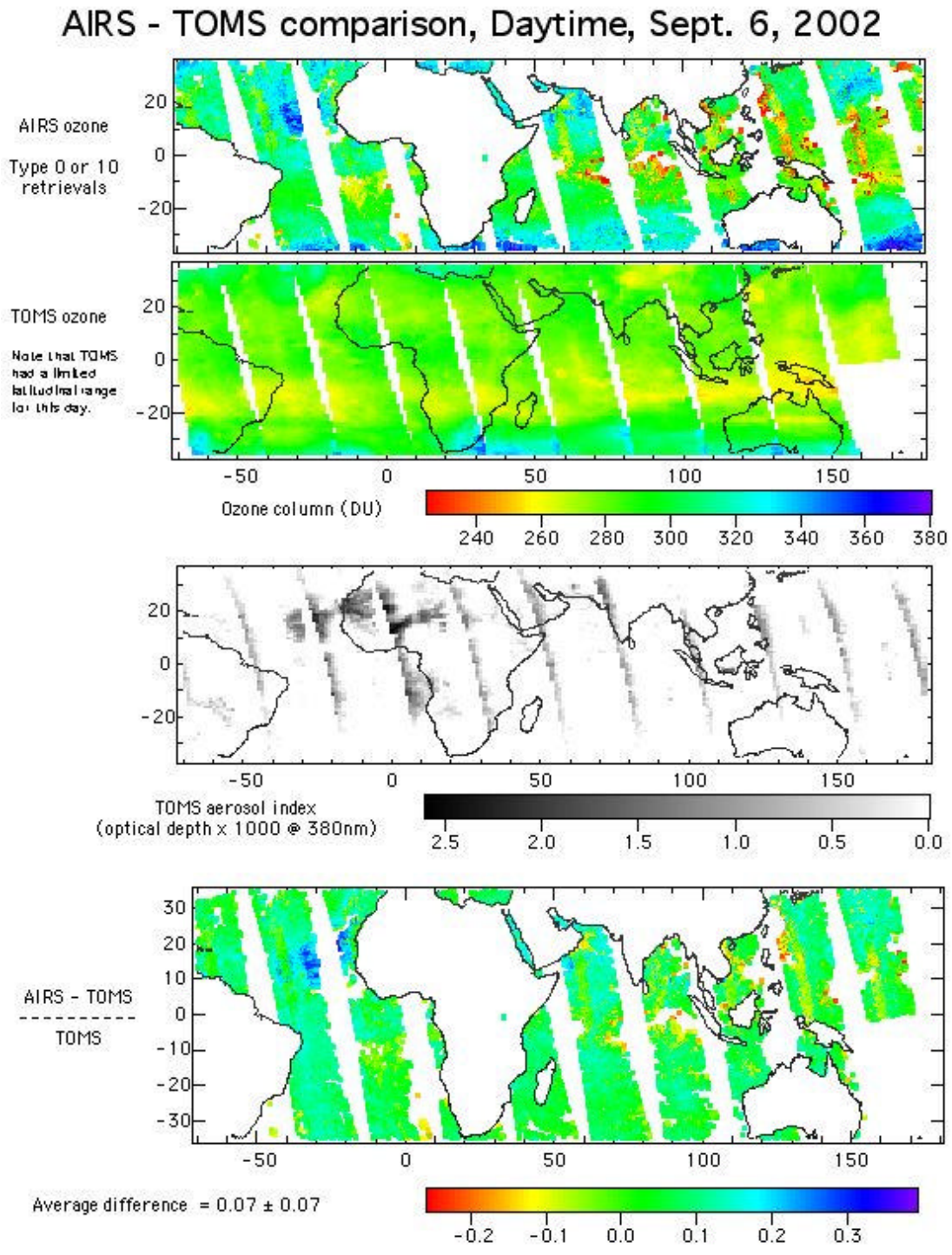

Figure 2. Sept 6, 2002 focus day AIRS retrievals of the ozone column along with the Earth Probe Total Ozone Mapping Spectrometer (TOMS) observations.

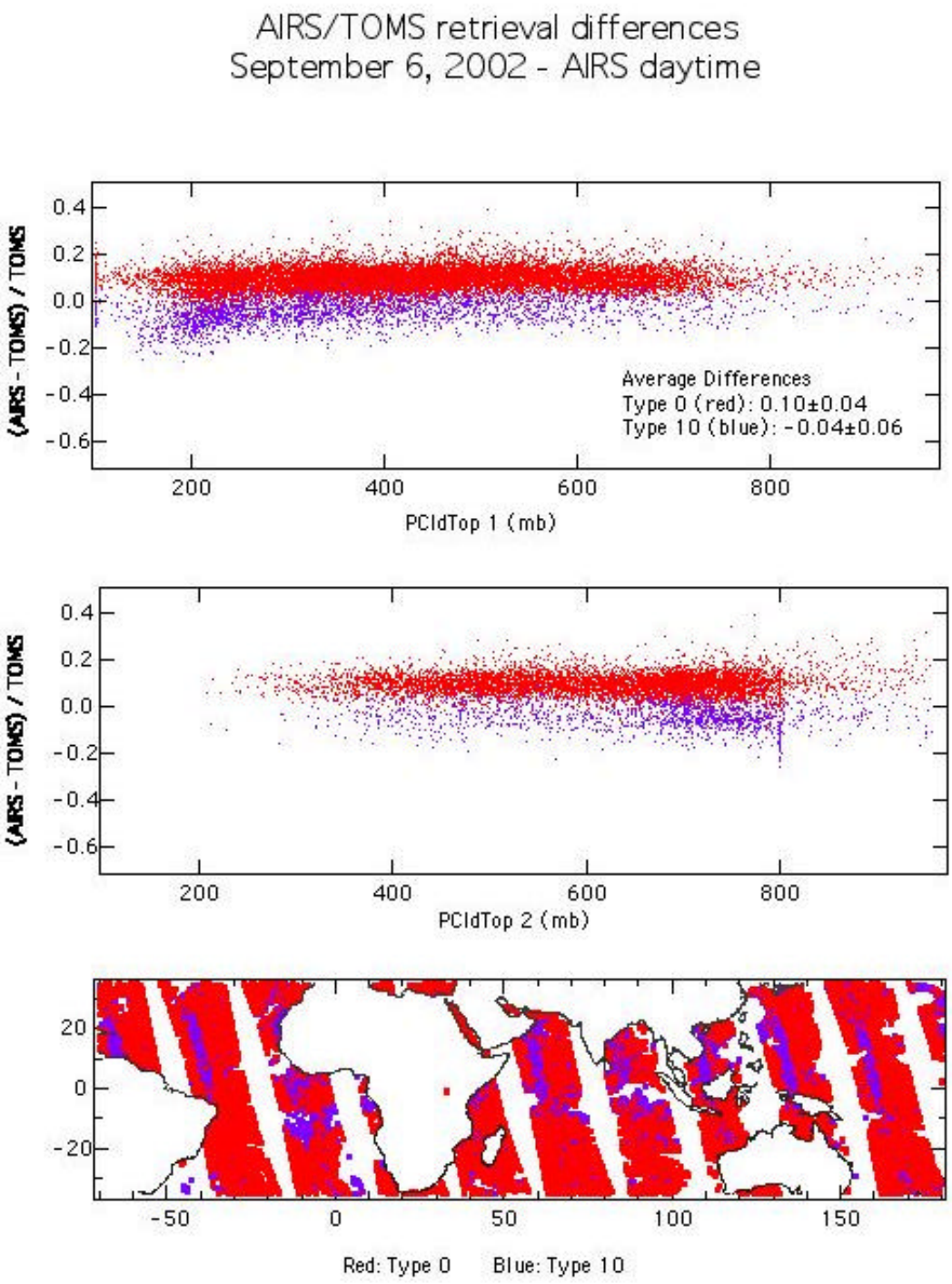

Figure 3. AIRS/TOMS differences as a function of cloud top pressure for type 0 (red) and type 10 (blue) retrievals.

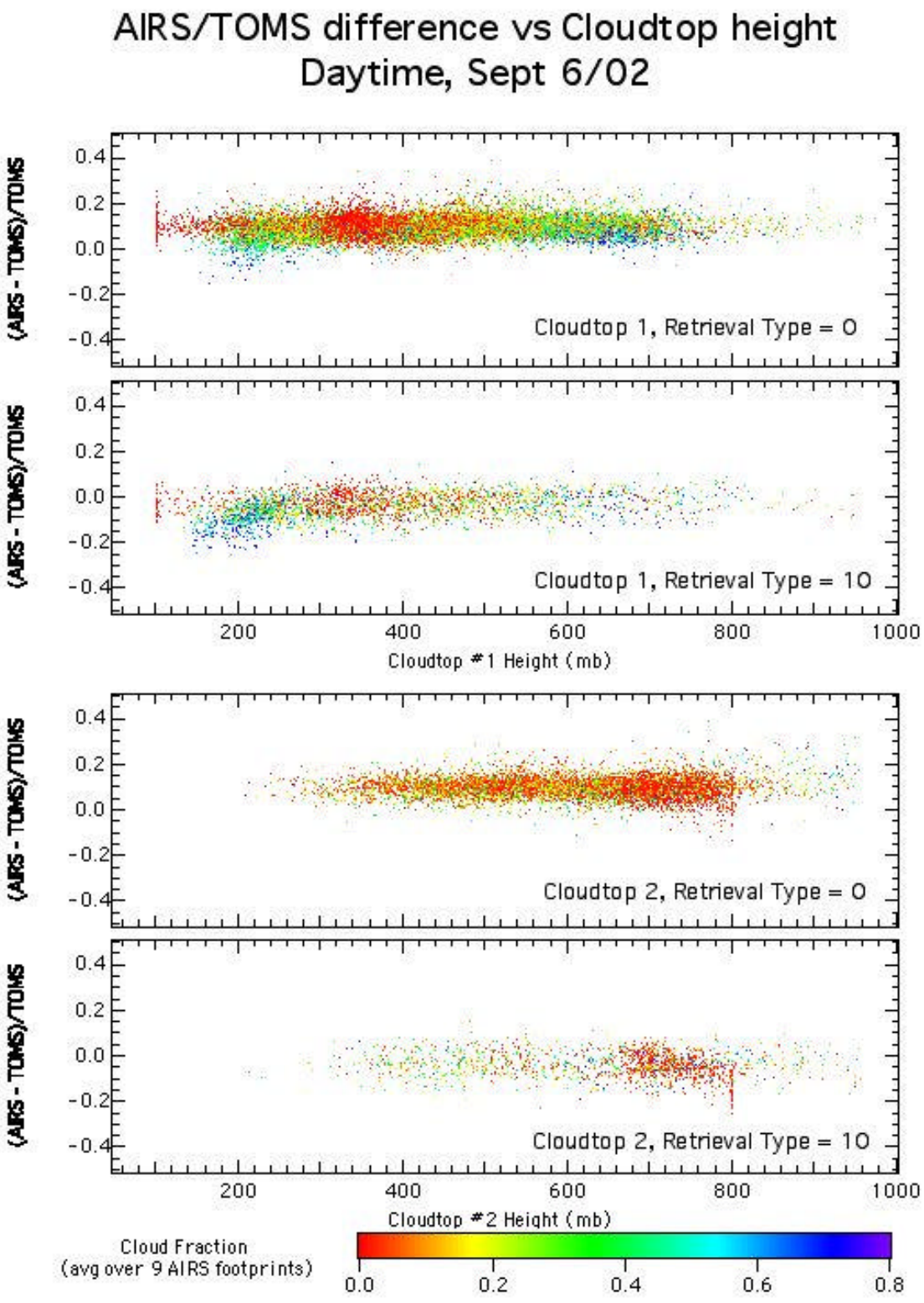

Figure 4. AIRS/TOMS differences as functions of cloud-top pressure and scene cloud fraction.

References

McDermid, I.S., A 4-year climatology of stratospheric ozone from lidar measurements at Table Mountain, 34.4°N, *J. Geophys. Res.*, *98*, 10,509-10,515, 1993.

Newchurch, M.J., M.A. Ayoub, S. Oltmans, B. Johnson, and F.J. Schmidlin, Vertical Distribution of Ozone at Four Sites in the United States, *in press J. Geophys. Res.*, 2002.