Stratospheric ozone from EOS MLS on Aura: version 1.5 and preliminary version 2 data comparisons with satellite, balloon, and aircraft data

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and other contributors (for correlative data in particular)

satellite, balloon, aircraft teams

MLS provisional version 2.1 data: O_3

- **Main changes from MLS version 1.5 to 2.1 data: Stratospheric Ozone**

➢ Indirect Changes: treatment of retrievals for temperature and tangent pressure

- Different bands/channels and calibration adjustments

  → a few K cooler & P_{tan} diffs. (from small near 100 hPa up to ~300 m near 1 hPa)

- Halve the retrieval's vertical grid spacing (from 1000 to 22 hPa)
  from 6 coefficients/decade in pressure to 12/decade

- **Systematic changes are observed in the (standard, O3-240) ozone product**

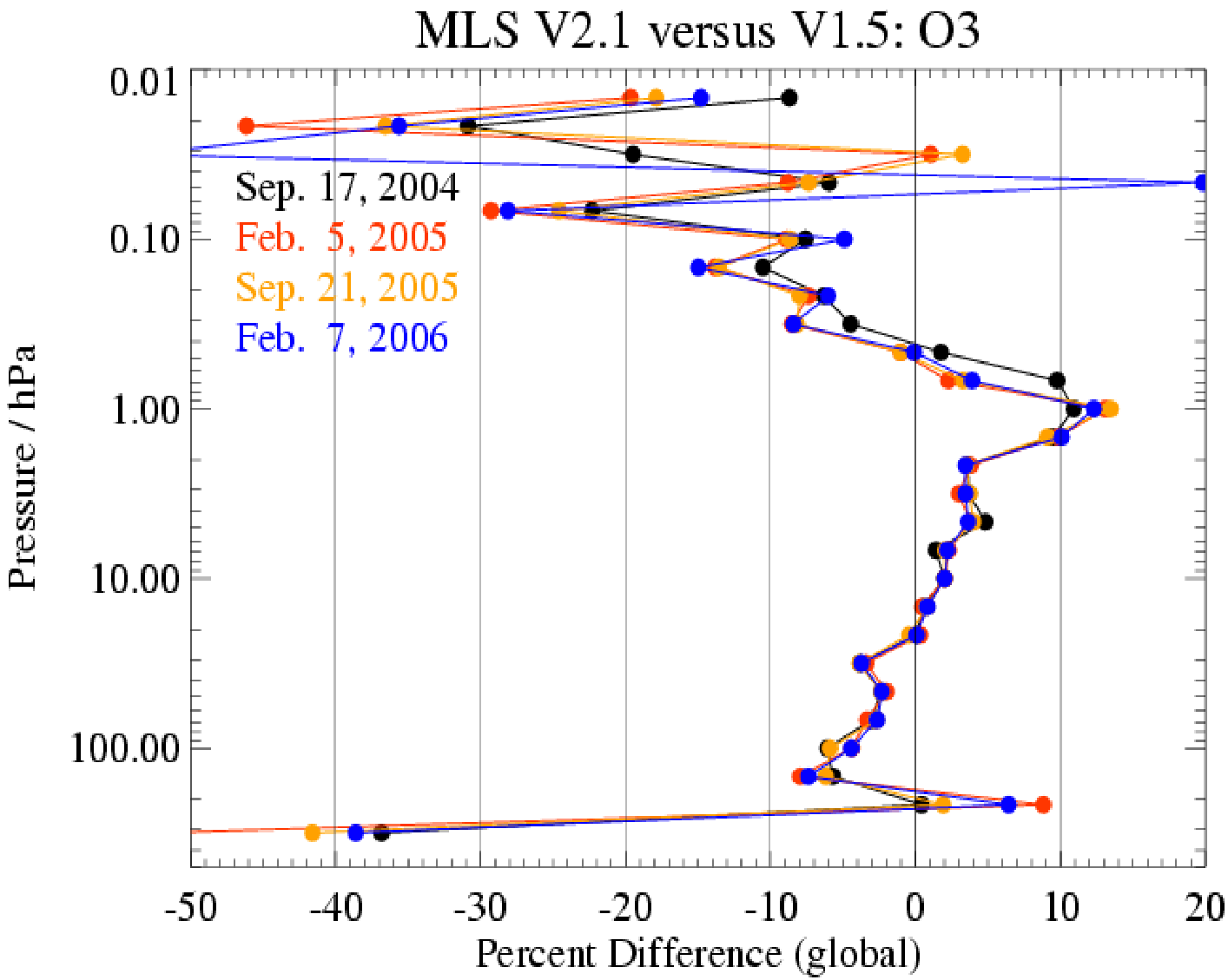
➢ mainly because of changes to Temperature and P_{tan}

➢ global average profiles change typically by ~ 5 to 10% in the stratosphere

➢ column O_3 (above 100 to 315 hPa): v2.1 avgs. ~ 0.5% to 2% lower (and σ ~ 4%)

➢ precision (estimated uncertainty and scatter in the data): v2.1 and v1.5 very similar

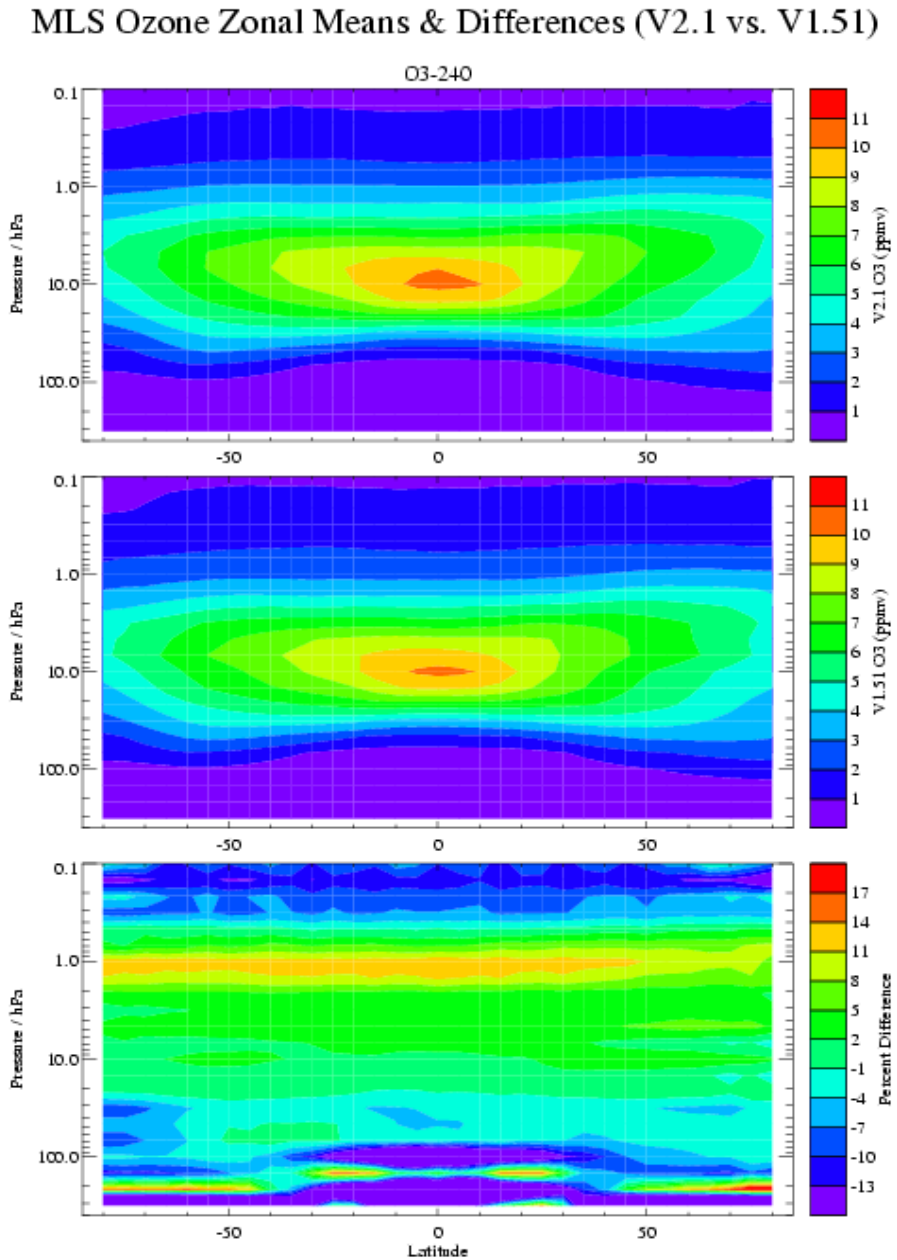
MLS provisional version 2.1 data: O_3



The ozone differences (global averages) from V1.5 to V2.1 are quite reproducible from day to day and over more than 1 year

- based on a few days that have been reprocessed

MLS provisional version 2.1 data versus version 1.5 data: O_3



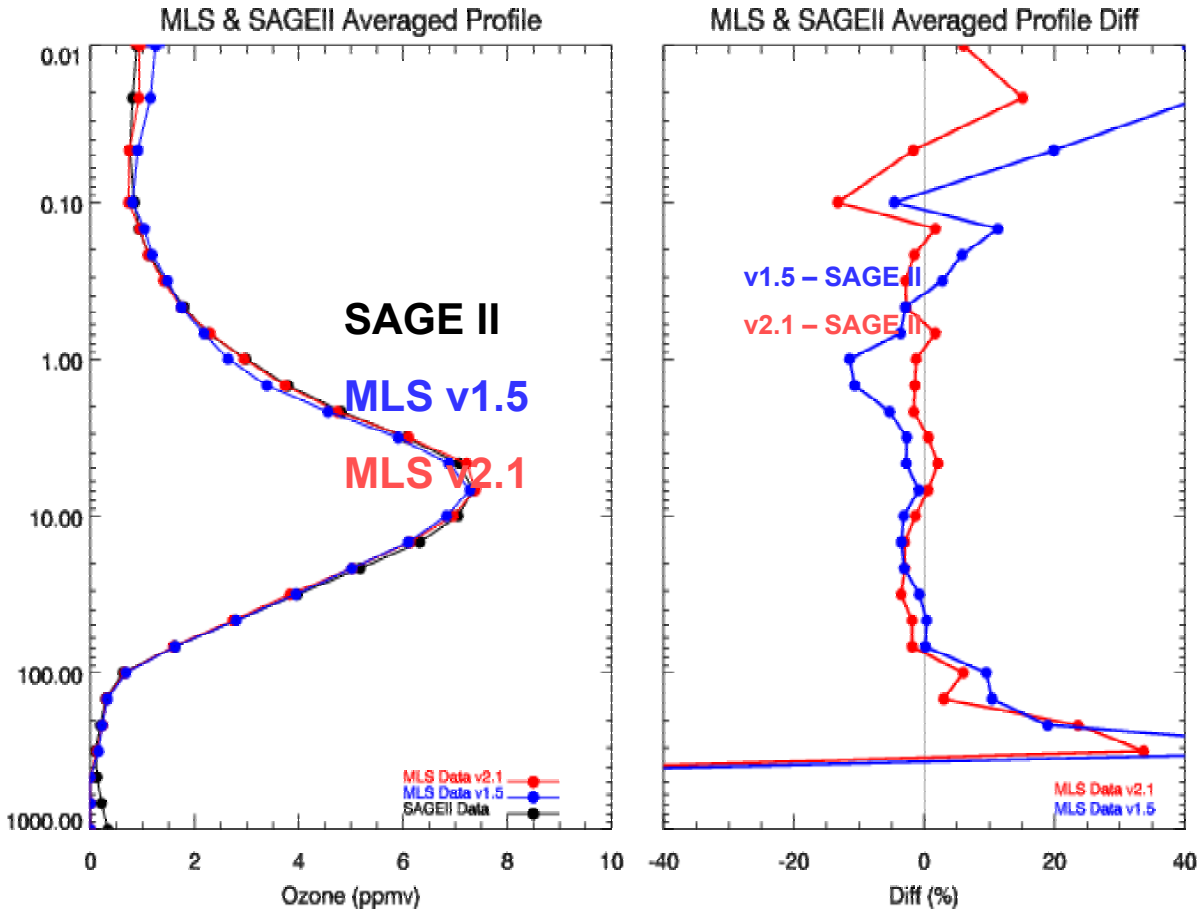
The differences (V2.1 – V1.5) are fairly constant (systematic) with latitude.

percent differences shown here
- based on 17-day averages, from available v2.1 MLS data

Changes to MLS ozone in v2.1: impact on comparisons

Satellite Data (some examples)

17 days (~ 200 profiles) of MLS coincidences with SAGE II (72S to 49N, with gaps)



The comparison versus SAGE II is generally improved for v2.1

- stratospheric and mesospheric differences are reduced

- within ~5% from 150 to 0.15 hPa (for these profile averages)

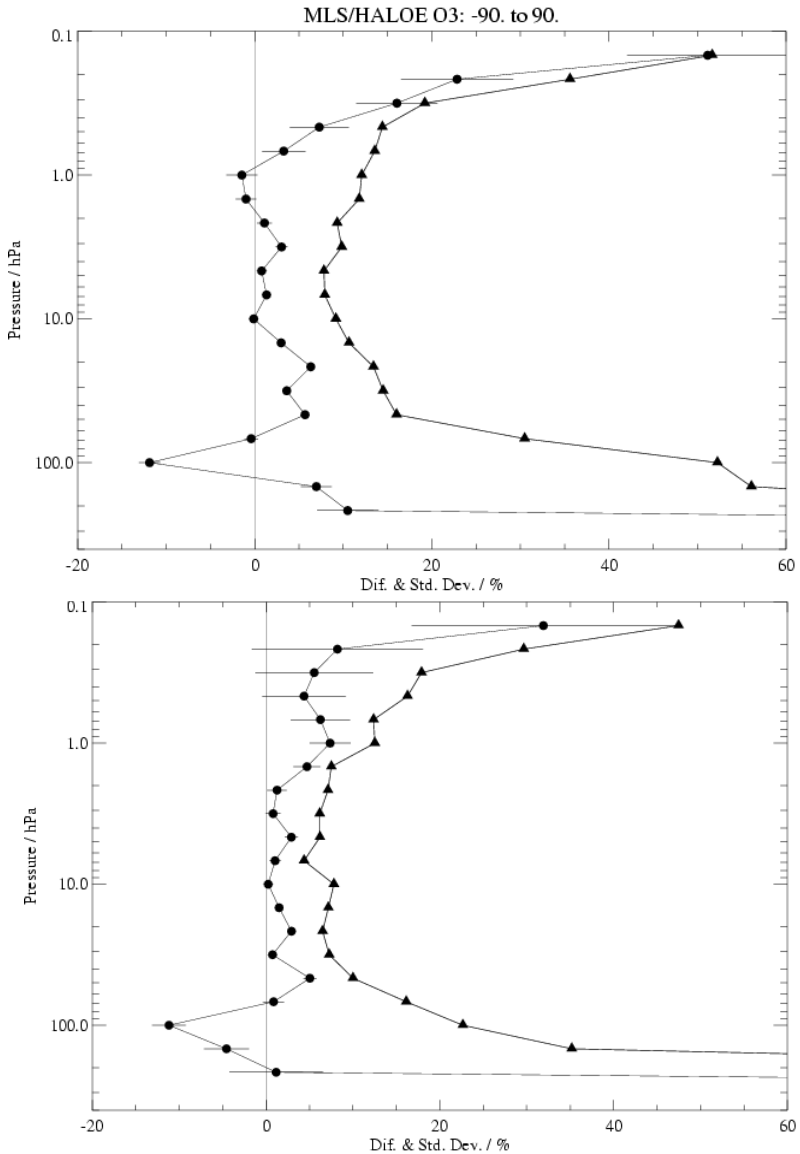
- also seems better at 315 hPa

- will await more (v2.2) data for more analyses vs latitude (and time)

The small positive change in slope versus height is of the right sign and magnitude to reduce the negative slope that was (often) found in ozone comparisons for MLS v1.5 data.

Changes to MLS ozone in v2.1: impact on comparisons

Satellite Data (cont.): HALOE and MLS Ozone comparisons



The comparison of MLS vs HALOE is also changed slightly for v2.1

- Use 17 days of MLS data here

- dots are average diffs. (MLS-HALOE) in percent, with est. precision as error bar

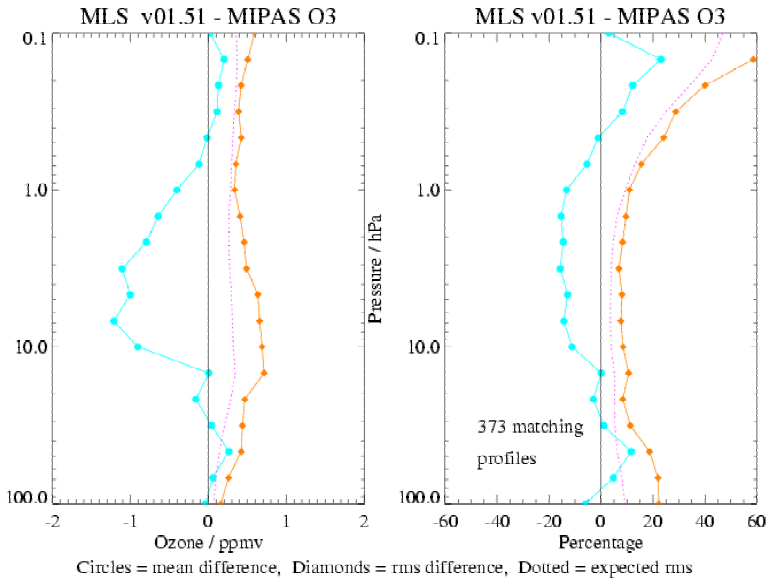
- triangles are std. deviation of differences

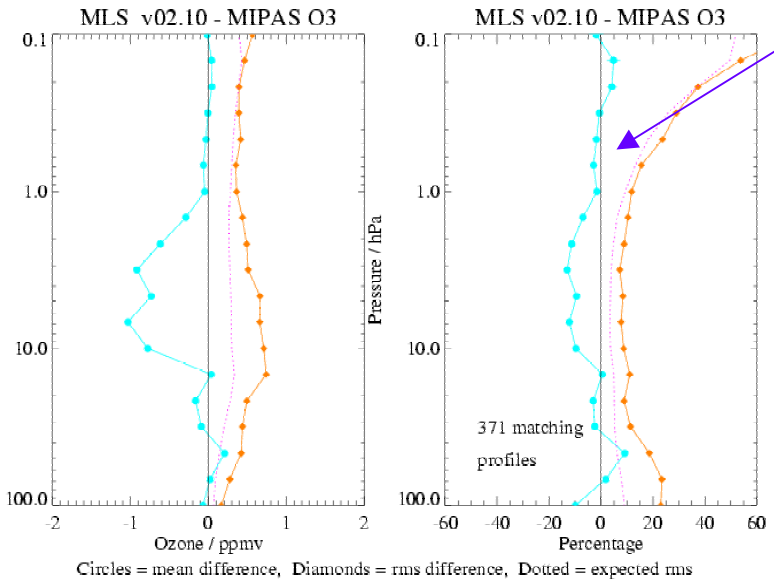
In stratosphere, agreement is typically within a few percent

In lower mesosphere, up to 0.2 hPa, get ~ 4 to 8% agreement (better than in v1.5 comparison)

Changes to MLS ozone in v2.1: impact on comparisons

Satellite Data (cont.): MIPAS ozone (courtesy C. Waymark, Oxford Univ.) vs MLS

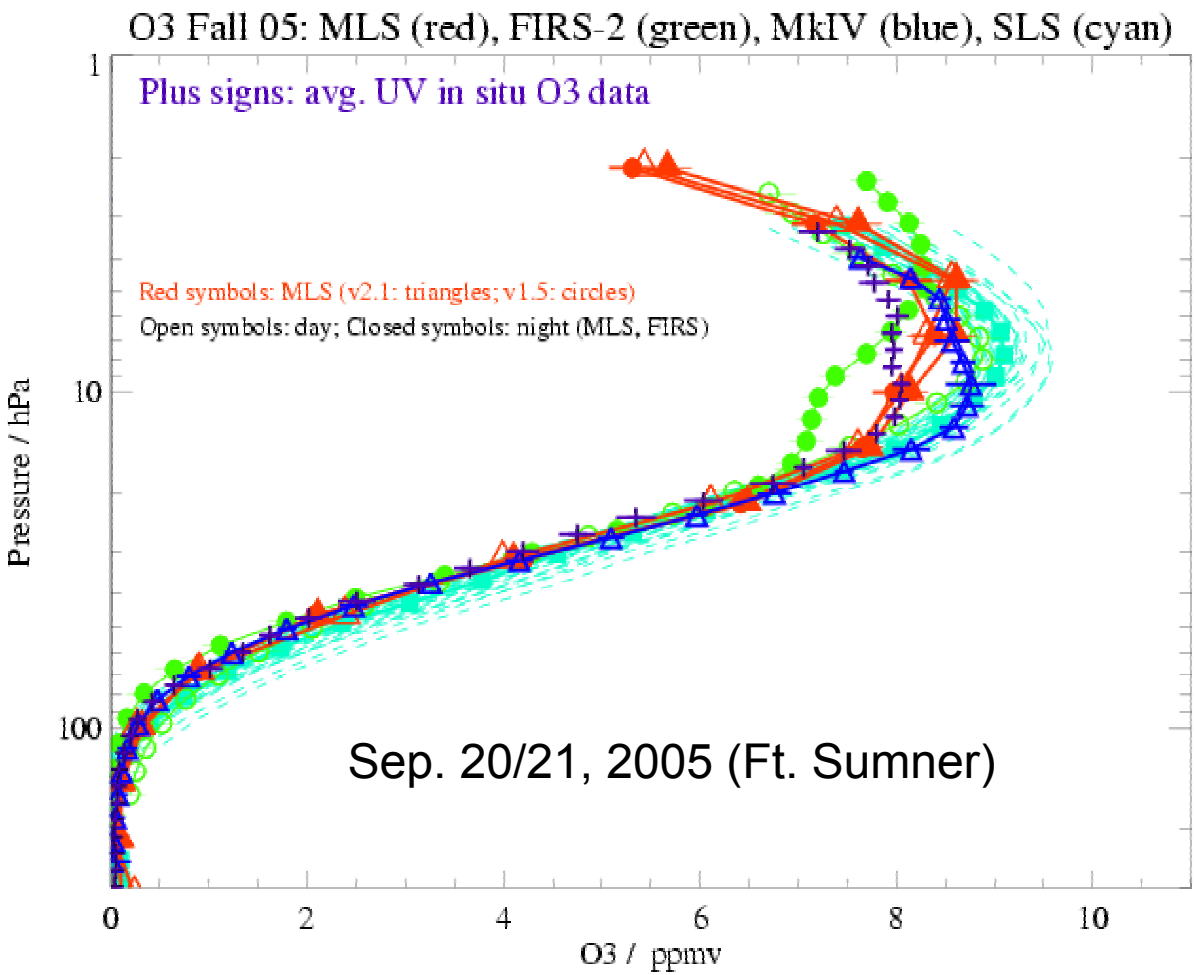




This comparison versus MIPAS (Jan. 28, 2005) data (a few orbits) gives a smaller average difference for V2.1 MLS data in the upper stratosphere and lower mesosphere.

Changes to MLS ozone in v2.1: impact on comparisons

Balloon Data



Good comparison overall versus balloon O_3 data for Sep. 2005

- The MLS v2.1 changes (from v1.5) are smaller than the differences and/or variability seen in the balloon data

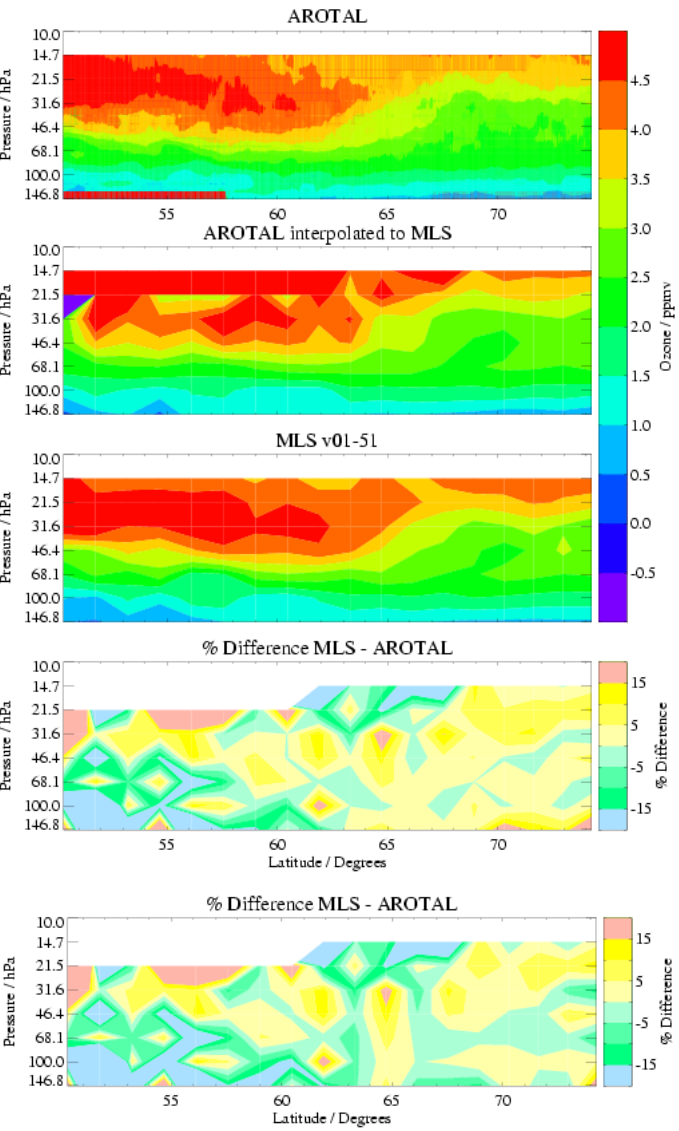
- The change in slope near 15 hPa in UV in situ data is captured fairly well by MLS (although not seen in exactly the same way by the satellite and balloon profiles)

Note: There is an issue with some FIRS-2 profiles [per K. Jucks] (e.g., night profile shown here)

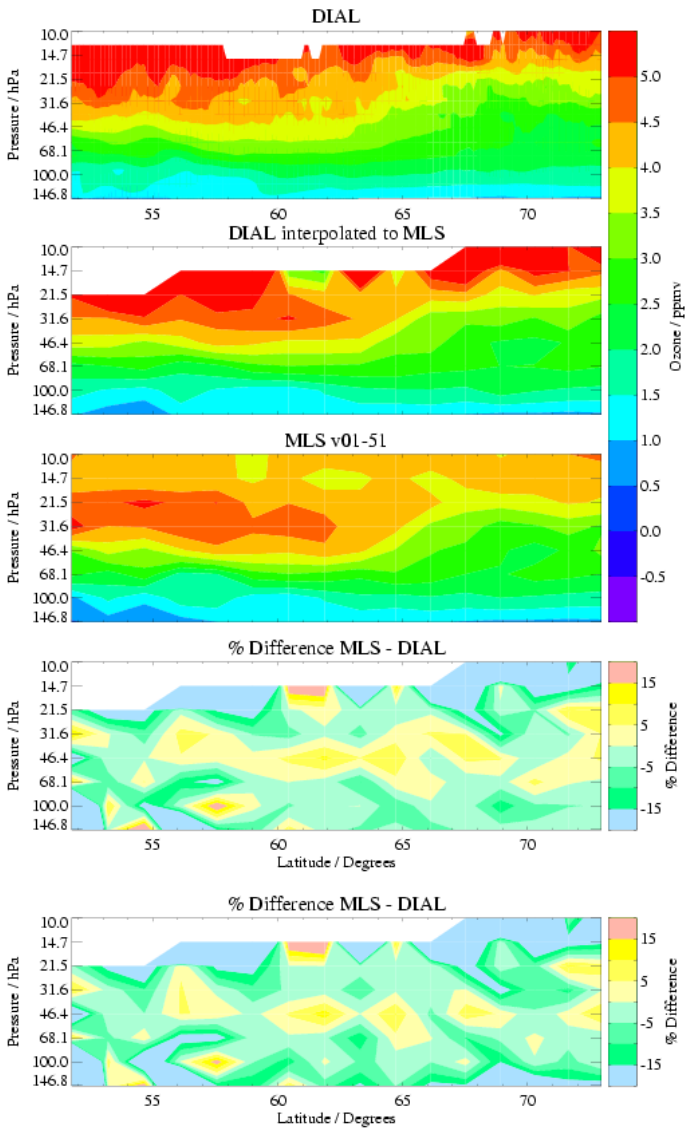
Changes to MLS ozone in v2.1: impact on comparisons

Aircraft Lidar Data (Polar AVE campaign, Jan./Feb. 2005)

MLS and AROTAL data for January 27, 2005 (2005d027)



MLS and DIAL data for January 27, 2005 (2005d027)



Differences vs lidar data (degraded in spatial resolution) were typically within ~5 to 10%

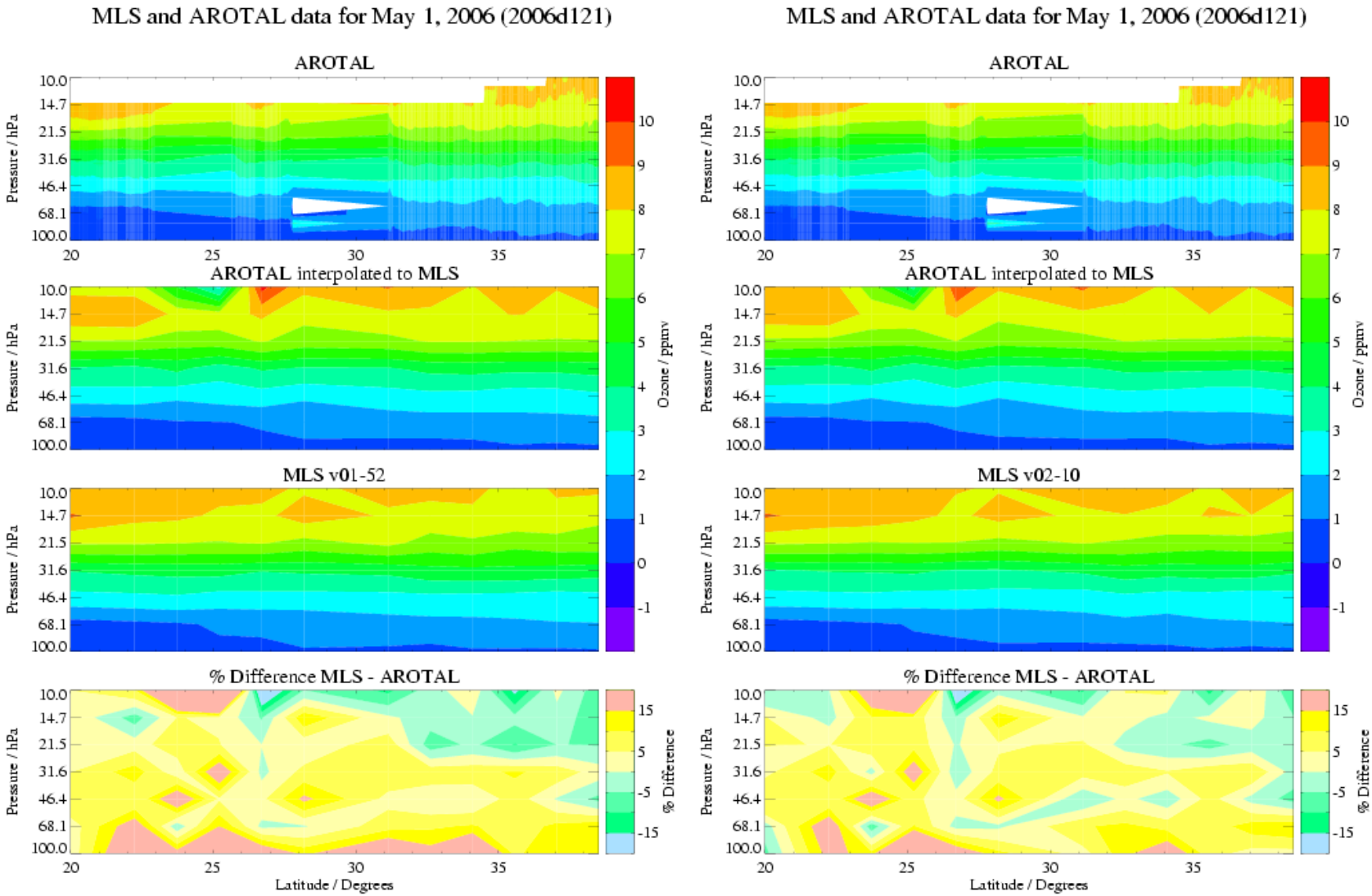
v2.1 MLS data match at least equally well

v1.5 MLS – lidars (%)

v2.1 MLS – lidars (%)

Changes to MLS ozone in v2.1: impact on comparisons

Aircraft Lidar Data (INTEX-B campaign; May 1 transit flight from Hawaii to Alaska)



Here, MLS is biased ~5 to 10% high vs AROTAL; v2.1 results are not much different from v1.5.

- compared to previous slide, however, both measurement systems track the different regimes

Validation plans/needs, validation special issue (MLS O_3)

- **Planned JGR validation paper *(L. Froidevaux et al.)* on MLS strat. (and mes.) O_3**

  - Satellite data: Plan to expand on comparison results using v2.2 MLS data (e.g., show diffs. versus latitude) vs SAGE II (+ add SAGE III), HALOE, ACE, POAM III + maybe more
  - Balloon data
  - Aircraft data. Lidar PAVE, INTEX-B

  + in situ AVE, CR-AVE (but maybe in planned *Livesey et al.* MLS paper on UT O_3).

  - Include detailed tabulation/plots of <u>error estimates</u> (accuracy especially)
  - Are the comparisons and the error estimates compatible?
  - See also *Yibo Jiang et al.* work on ground-based data comparison (sondes, lidar, microwave) [separate paper planned for special issue]

- **Other related work led by other investigators?**

  MLS team is aware of some (most?) of these based on ongoing work, and Sep. 05 Aura meeting (although not all presenting in 2005 are presenting in 2006)

  - *Klemens Hocke et al.* (microwave Bern O_3 data)
  - *Thierry Leblanc et al.* (lidar data, TMF and Hawaii)
  - Also, *Sergey Rozanov et al.* (Moscow microwave data; SPIE)
  - Stratospheric O_3 column work (CAFS vs MLS; *Rick Shetter, Irina Petropavlovskikh et al.)*
  - Others using MLS stratospheric column data + OMI data (*several*)
  - Others? – e.g., campaign data work ? [TBD]

  > Please let MLS team (L. Froidevaux) know if you plan to submit related validation O_3 work to the JGR special issue on Aura validation so we can coordinate, iron out any differences, and eliminate unnecessary duplication of effort (+ as a courtesy) [before Feb./March, 2007]

- **Validation needs (short-term) ?** Nothing extra needed for general stratospheric O_3 validation (except for wider geographic distr. of O3 sonde files on AVDC – see *Jiang et al.* presentation)

Summary: MLS Stratospheric Ozone

- MLS version 2.1 Ozone Data
  - profiles have a slight slope change ('lifting' of profiles) versus v1.5; this reduces the sloping differences versus several other datasets (satellites and also sondes and lidars – per *Y. Jiang et al.* work); product also seems improved in mesosphere.
    > mainly as a result of changes in retrieved temperature & tangent pressure
  - e.g., within ~ 5% of SAGE II profiles from 150 to 0.15 hPa (17 days of v2.1 data)
  - other satellite comparisons + balloon, aircraft data → generally very good results
  - strat. O_3 columns are ~ 0.5% to 2 % smaller than v1.5 data (with σ ~ 4%)

- V2.2 stratospheric O_3 data might change very slightly
  (probably << than v1.5 to v2.1)

- Validation Plans (near-term, JGR special issue)
  - Expand on such results for version 2.2 (production) MLS data validation
  - *L. Froidevaux et al*.: strat. (and mes.) MLS O_3 vs satellite datasets
    + detailed error characterization
  - *Y. Jiang et al*.: comparisons versus sondes + some lidars, maybe others.
  - *N. Livesey et al*.: focused mostly on UT MLS O_3 data validation.
  - Other collaborations ? (please contact MLS team for further coordination)
- Longer-term Plans
  - should rely more on sondes & NDACC (NDSC) data to look at stability versus time
  - how to connect to past long-term satellite data record?