OMPS Limb Profiler – Level 2 Products Update

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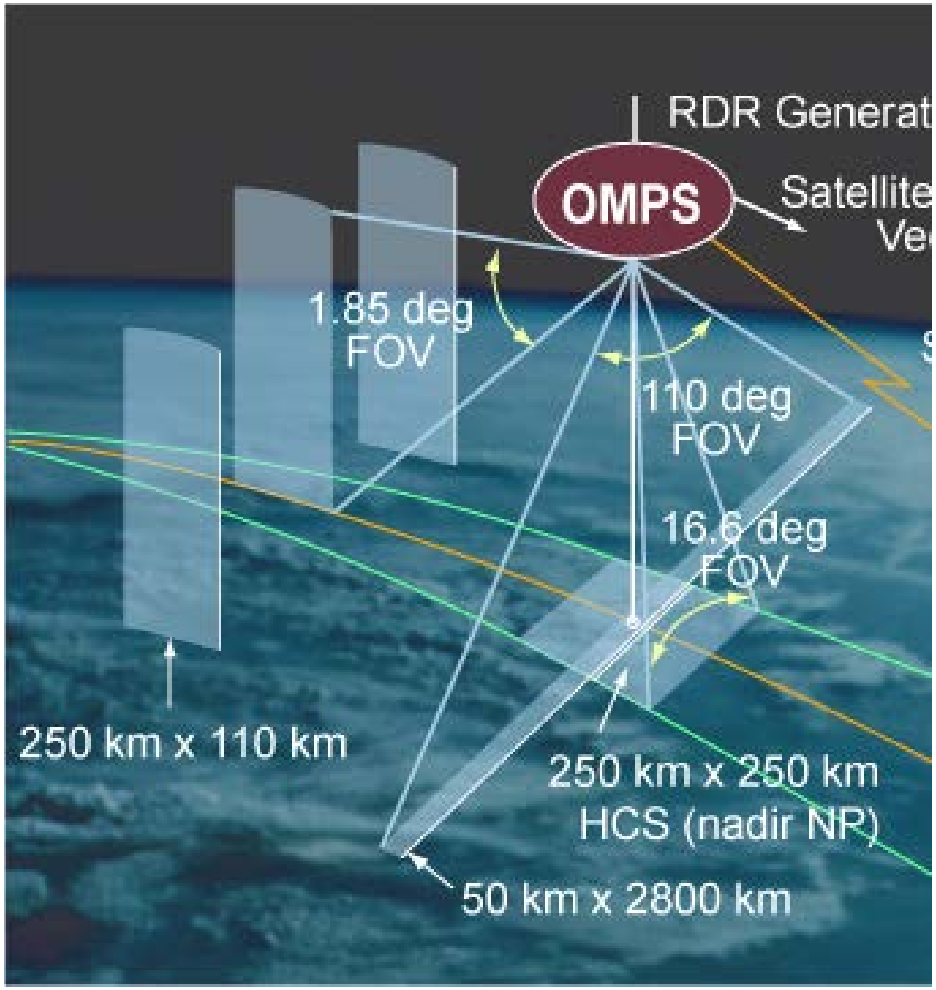
LP Instrument Review

- LP makes limb scattering measurements viewing backwards along orbit.
- Wavelength range = 290-1000 nm, with variable resolution (1-25 nm).
- Altitude range = 0-80 km, 1 km sampling.
- Collect radiance spectrum simultaneously at each altitude.
- Specify (programmable) sample table of CCD pixels that are downloaded to meet data rate limits.



Major LP Data Products

- Gridded radiances (Level 1)
  - L1B pixels have variable wavelength, altitude sampling across CCD.
  - Interpolate radiances to regular grid for use in L2 retrievals.
- Ozone profile (UV wavelengths)
  - Retrieved profile covers stratosphere and lower mesosphere (28-60 km).
- Ozone profile (visible wavelengths)
  - Retrieved profile covers lower stratosphere (cloud top to 30-35 km).
- Aerosol extinction coefficient (visible, near-IR wavelengths)
  - Retrieve profiles at 5 wavelengths between 514-865 nm.

Processing Status

- Release 1 products (L1G radiances, center slit ozone profiles) initially released October 2012.
- Release 2 L1G processing completed (up to present) April 2014.
- Ozone reprocessing completed 12 May 2014. Evaluation in progress to support archival of data set at DAAC for public release.
- Aerosol reprocessing now in progress. Estimate completion by end of May 2014.

L1 Changes from Release 1

- Implement intra-orbit "dynamic" tangent height adjustment through OPF. Also implement additional 500 m "static" adjustment.
- Revise wavelength gridding in L1G product to use fixed grid for all events.
- Revise reference wavelength scale to use better data set.
- Implement intra-orbit and seasonal wavelength scale adjustments for each event.
- Eliminate merging of multiple gain/aperture values for determining radiance at each pixel.
- Prioritize data selection to use high gain sample for $\lambda < 500$ nm, low gain sample for $\lambda > 500$ nm.
- Revise ancillary data selection to use GMAO products for temperature, pressure, density. Profiles extended to 80 km with constant temperature lapse rate.

L2 Changes from Rel. 1 [1]

- Implement new ozone *a priori* data set created from 2012 MLS data.
- Implement SUSIM data for UV portion of high-resolution solar irradiance spectrum.
- Exclude OH emission wavelengths (306.5-311 nm) from UV ozone profile retrieval.
- Add 1% instrument error term to SNR noise term for retrieval.
- Modify VIS retrieval to use 510 nm and 673 nm as "guard" wavelengths for triplet formation, 549-633 nm as range to sample Chappuis band.
- Turn off explicit aerosol correction in ozone retrieval.

L2 Changes from Rel. 1 [2]

- Provide ozone retrieval data from all three slits.
- Limit altitude range of ozone product to z_{max} = 60.5 km.
- Report UV and VIS ozone retrieval results as separate products, in addition to combined profile.
- Combined ozone profile uses UV retrieval values from 60.5 km down to 27.5 km, uses VIS retrieval values from 26.5 km down to retrieval cutoff.
- Create mixing ratio ozone profile product on regular pressure grid for every event.
- Generate separate aerosol product data set using current retrieval algorithm.

Evaluation of GMAO vs. MLS

- LP retrieval algorithm uses GMAO FP-IT Np profiles for temperature and pressure (derived from geopotential height), interpolated to event location and time, as ancillary data.
- Compare zonal mean products with MLS data for selected days to evaluate accuracy and variability.
- Temperature profiles generally agree to ±5 K between 10-60 km.
- Pressure profiles generally agree to ±2% between 10-60 km.

GMAO vs. MLS – Temperature

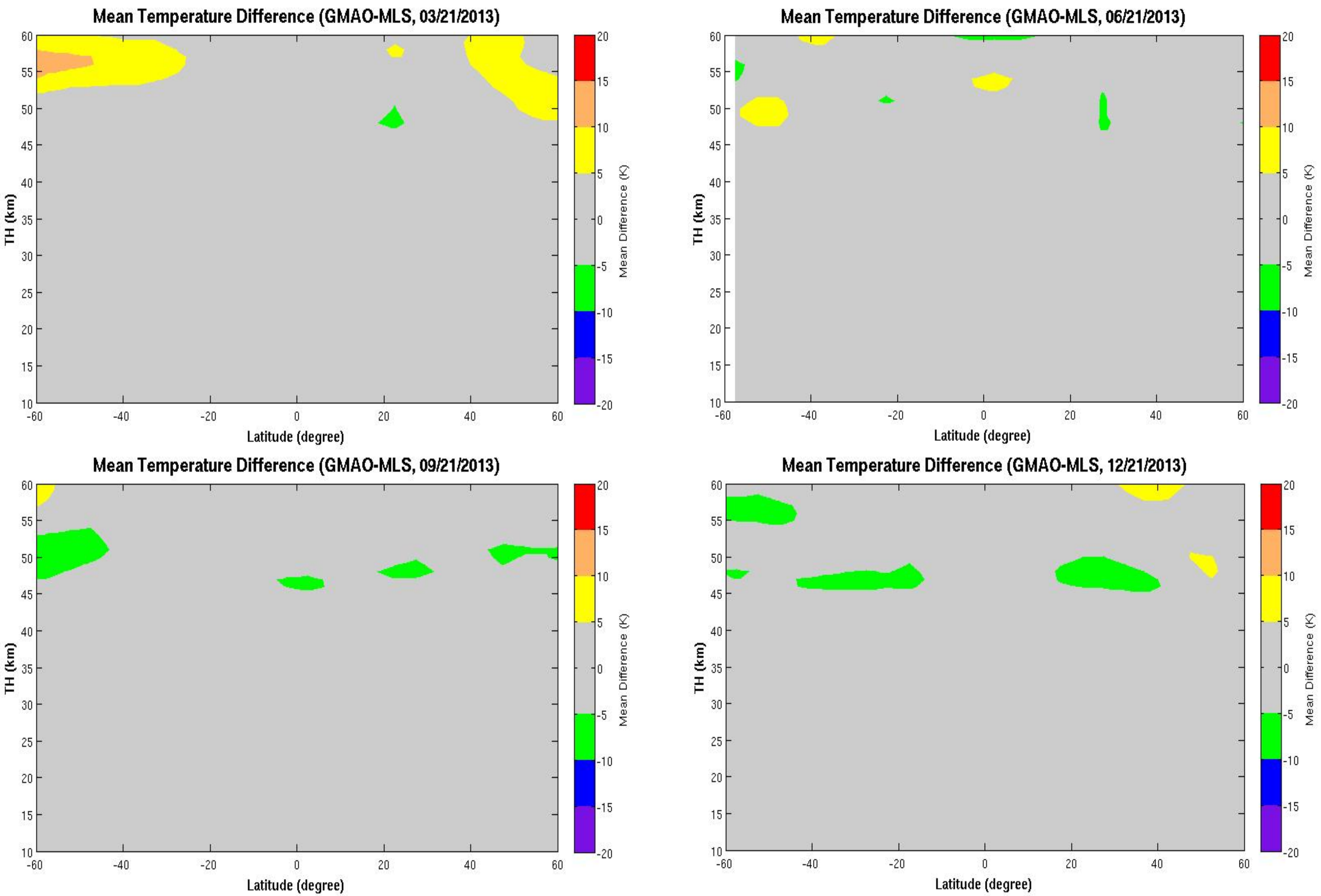


Figure courtesy of Philippe Xu

GMAO vs. MLS – Pressure

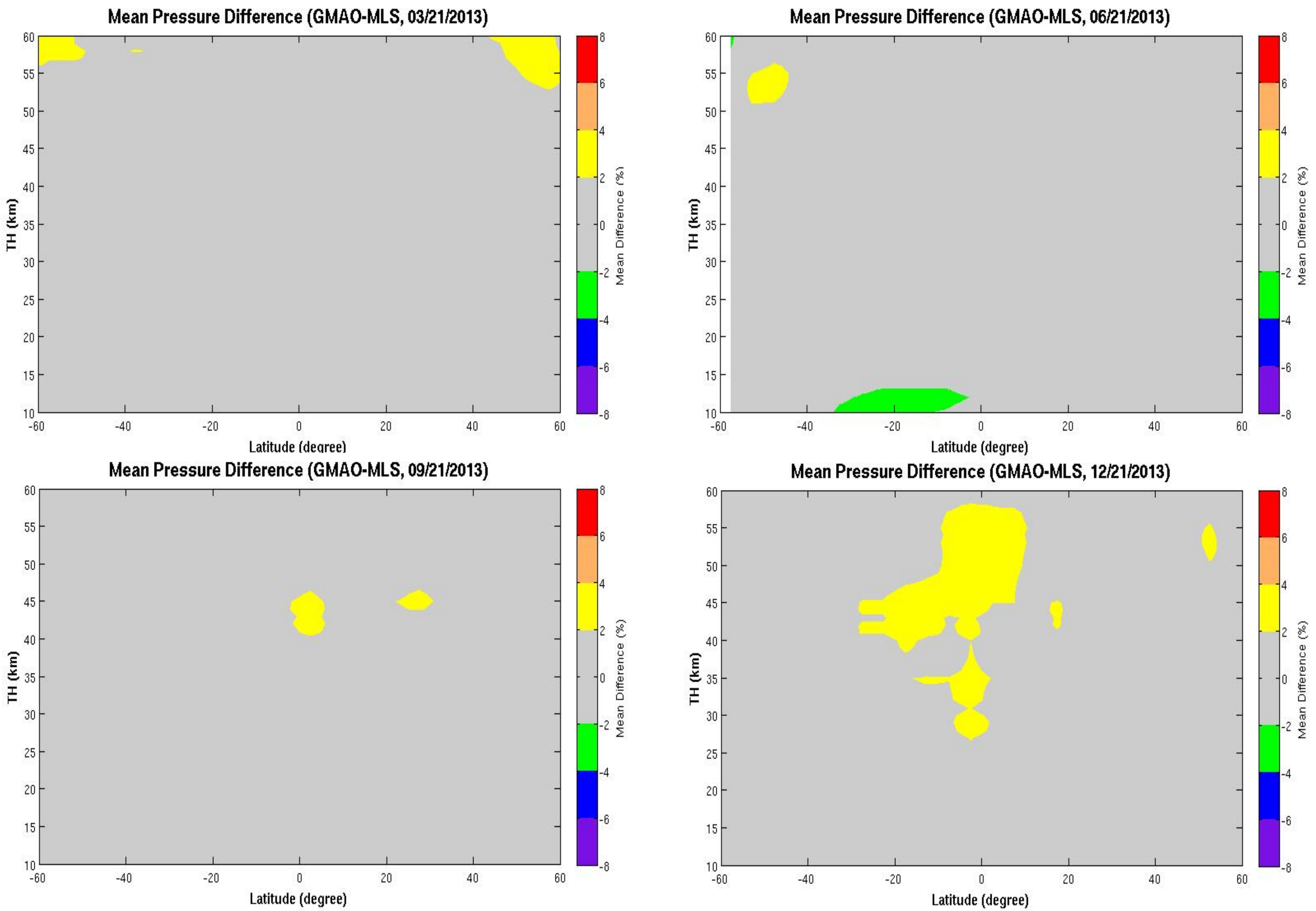


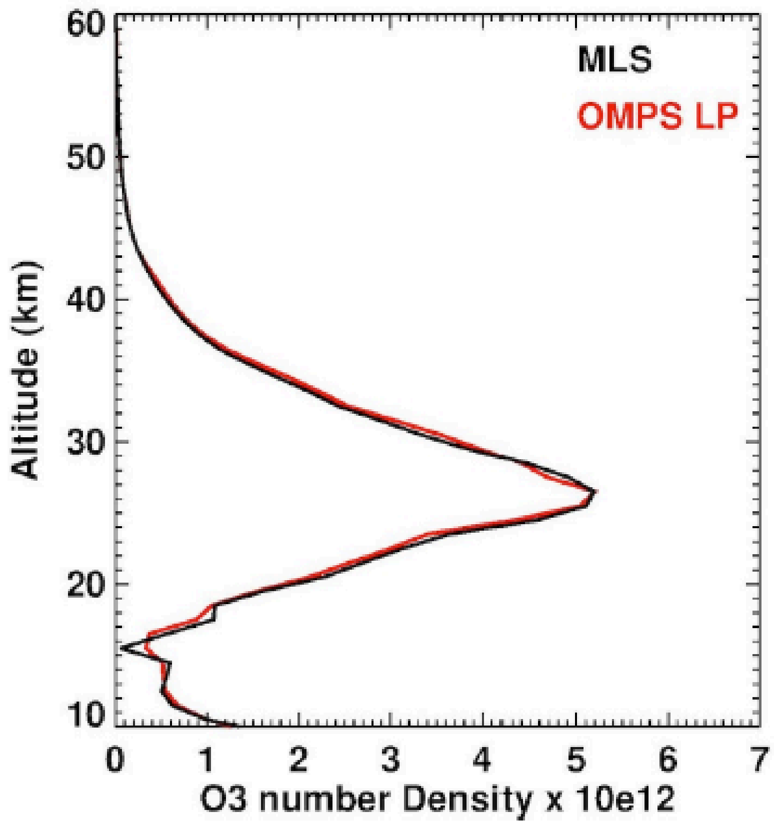
Figure courtesy of Philippe Xu

Ozone Products

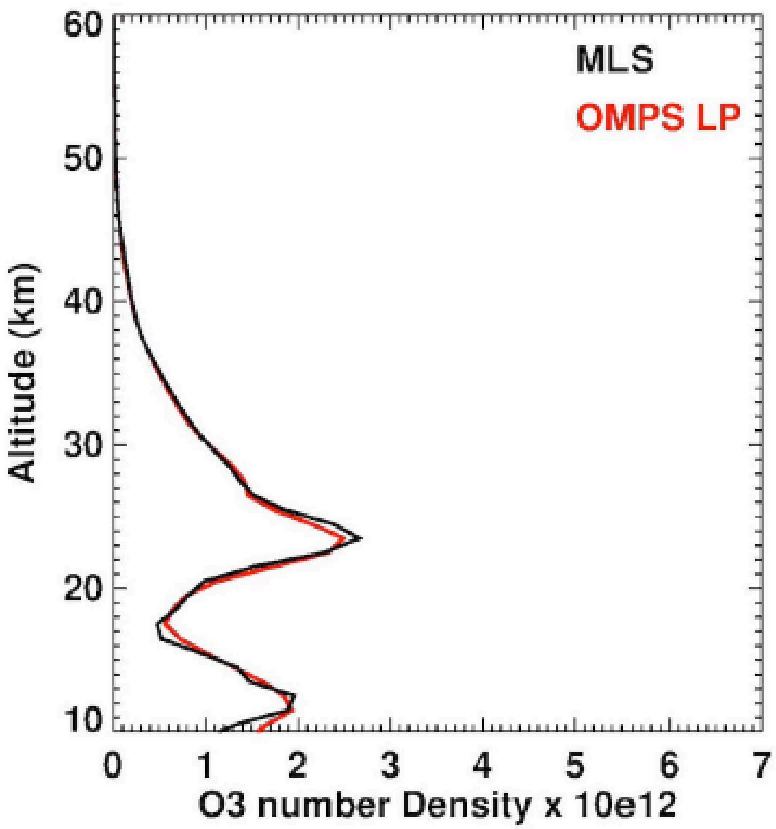
- Combined ozone density profile uses visible ozone retrieval for cloud top-27 km, UV retrieval for 28-60 km. No merging or adjustment at transition altitude.
- Mixing ratio profiles also created for user convenience.
- Development testing results shown here utilized set of 38 “golden days” during April-December 2012, where NPP orbit is closely aligned with Aura satellite (and MLS instrument).

Sample LP Profiles vs. MLS

2°S



76°S



LP vs. MLS - All Sample Orbits

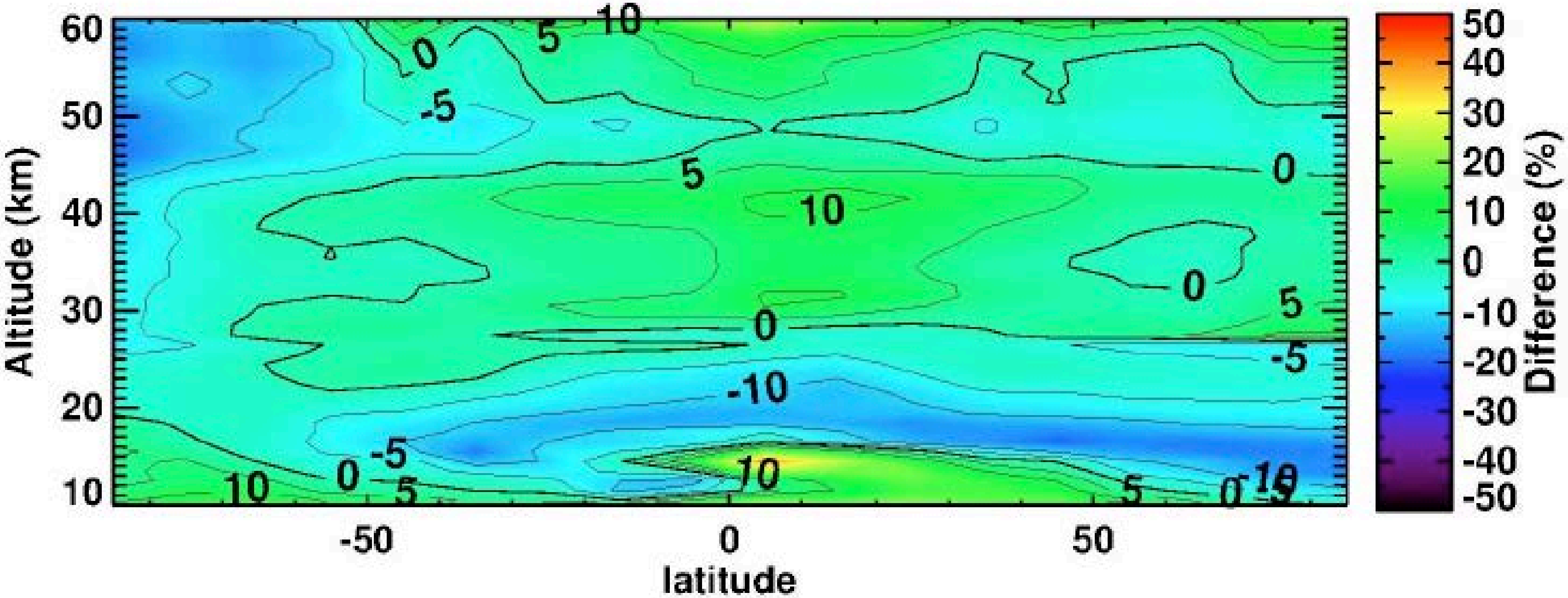
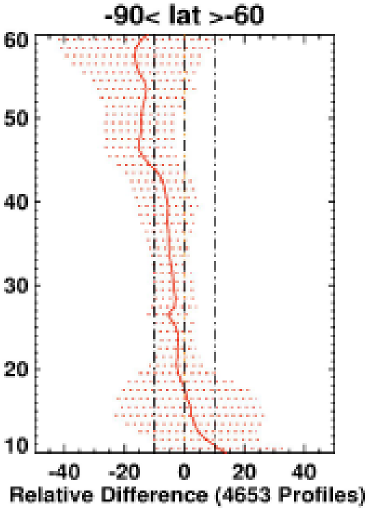
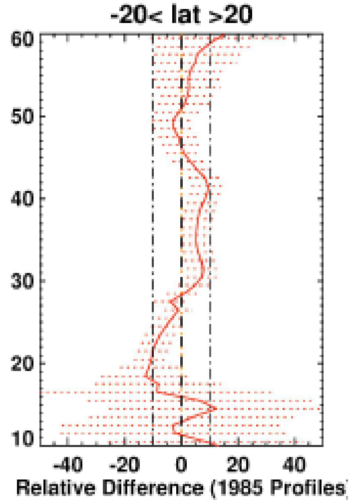
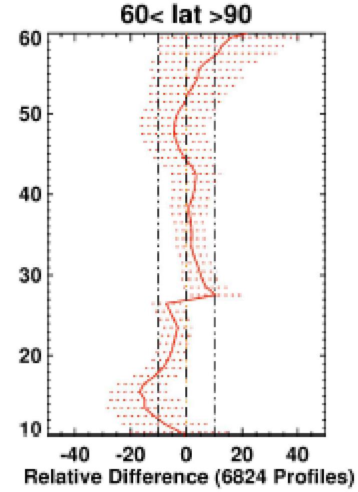


Figure courtesy of Ghassan Taha

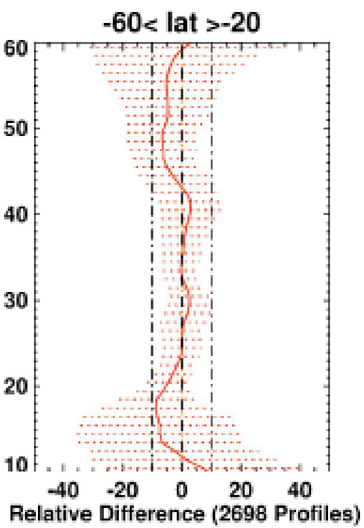
LP vs. MLS – Zonal Means

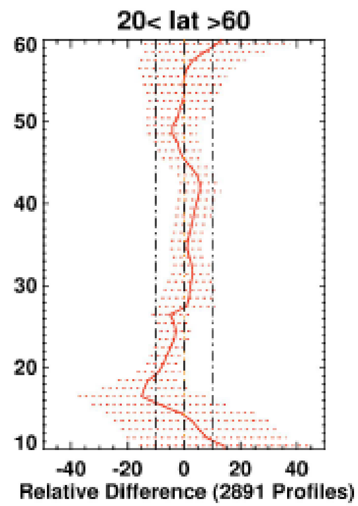






Southern Hemisphere

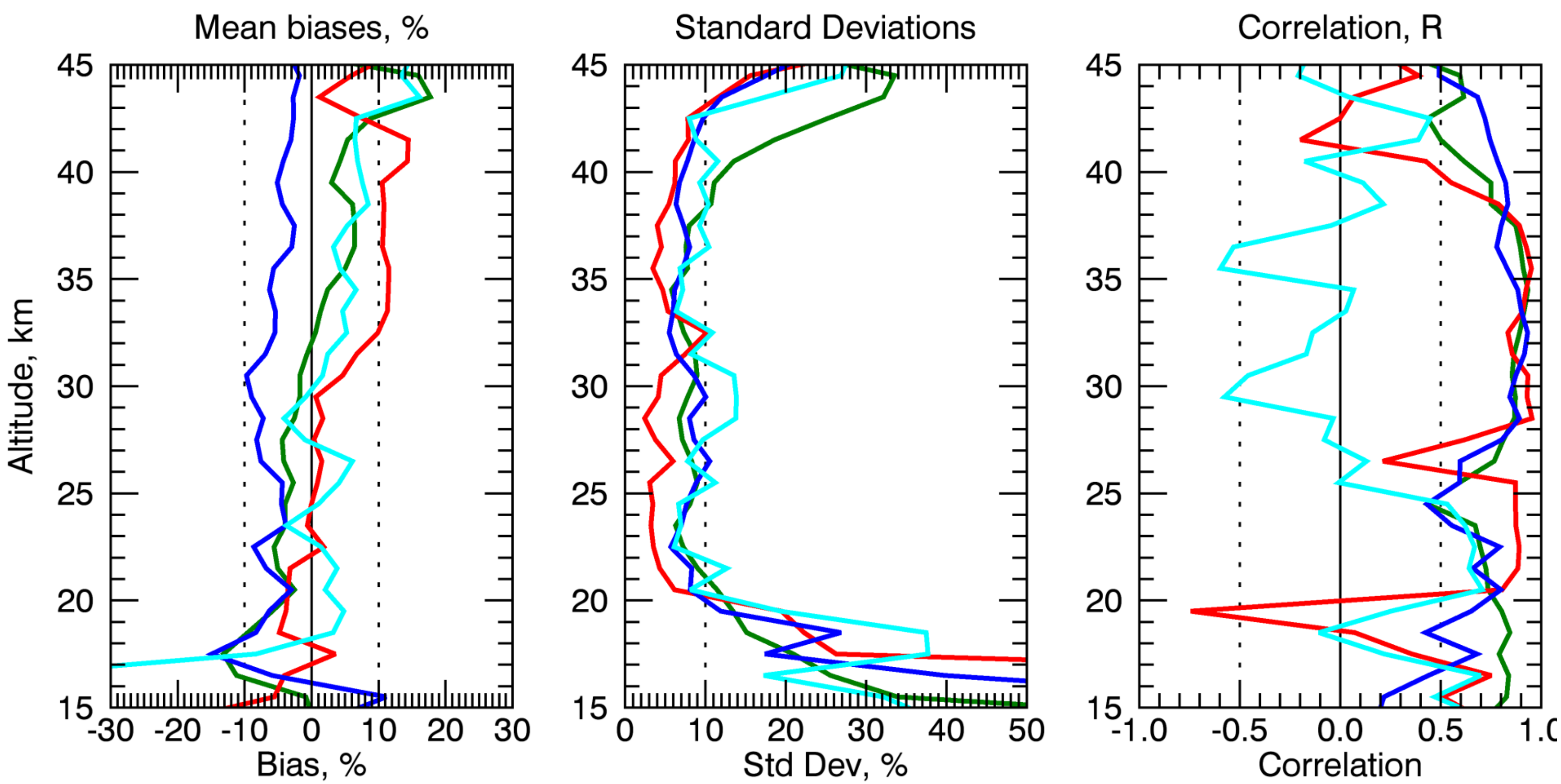




Northern Hemisphere

Figure courtesy Ghassan Taha

LP vs. Lidar - Overpass



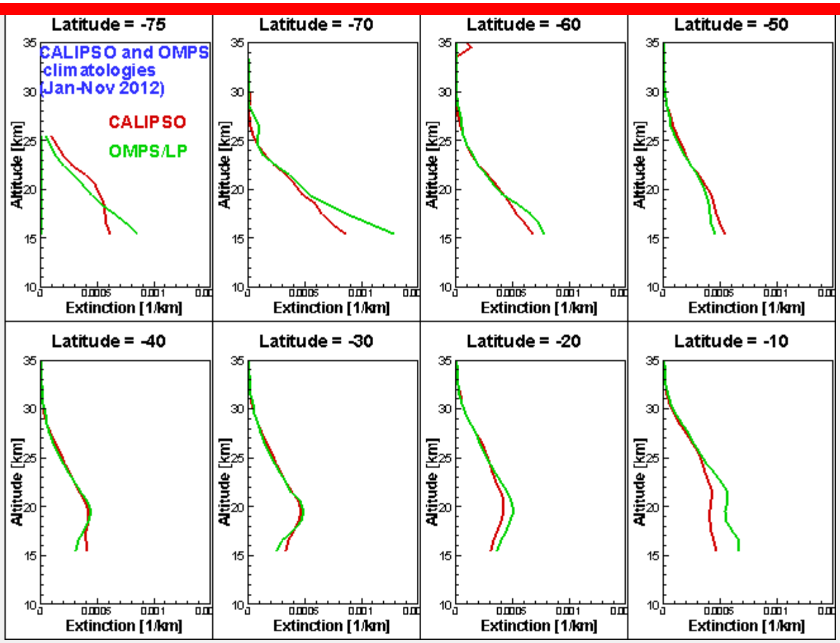
Haute Provence 31 Mauna Loa 10 Hohenpeissenberg 23 TableMount 13

[44N,5.7E]; [20N, 155W]; [48N,11E]; [34N, 118W]

Figure courtesy Natalya Kramarova

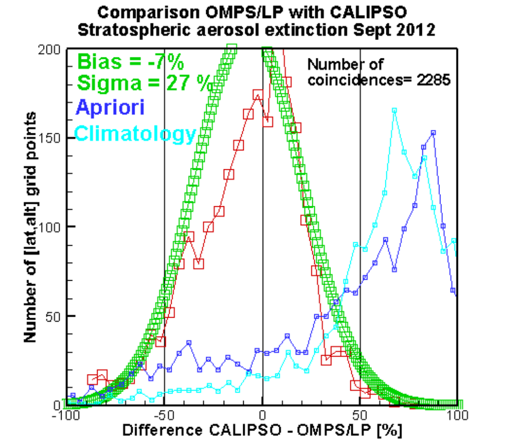
LP Aerosol Product

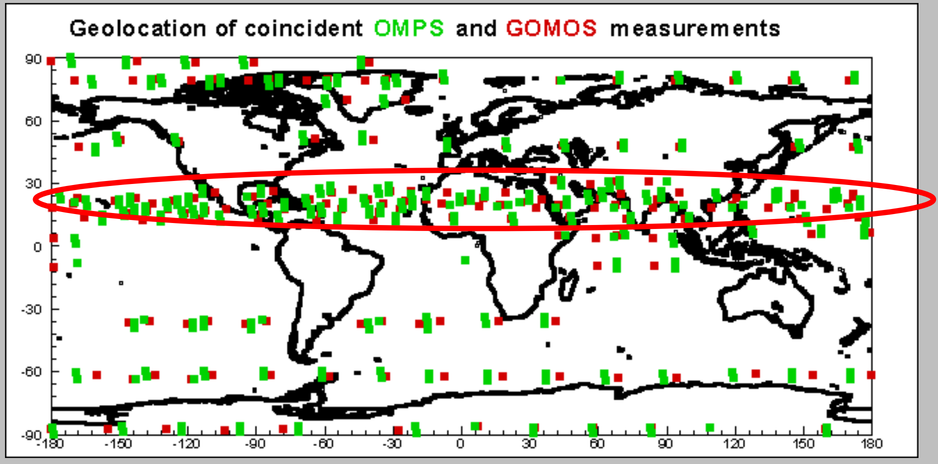
Comparison with CALIPSO and GOMOS



Comparison with CALIPSO

Bias < 7%, Variance = 27 %





Comparison with GOMOS

Bias < 10%, Variance = 30 %

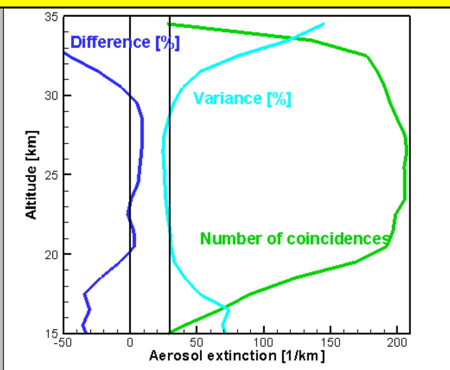


Figure courtesy Didier Rault

LP Aerosol Product

Evolution over NPP mission

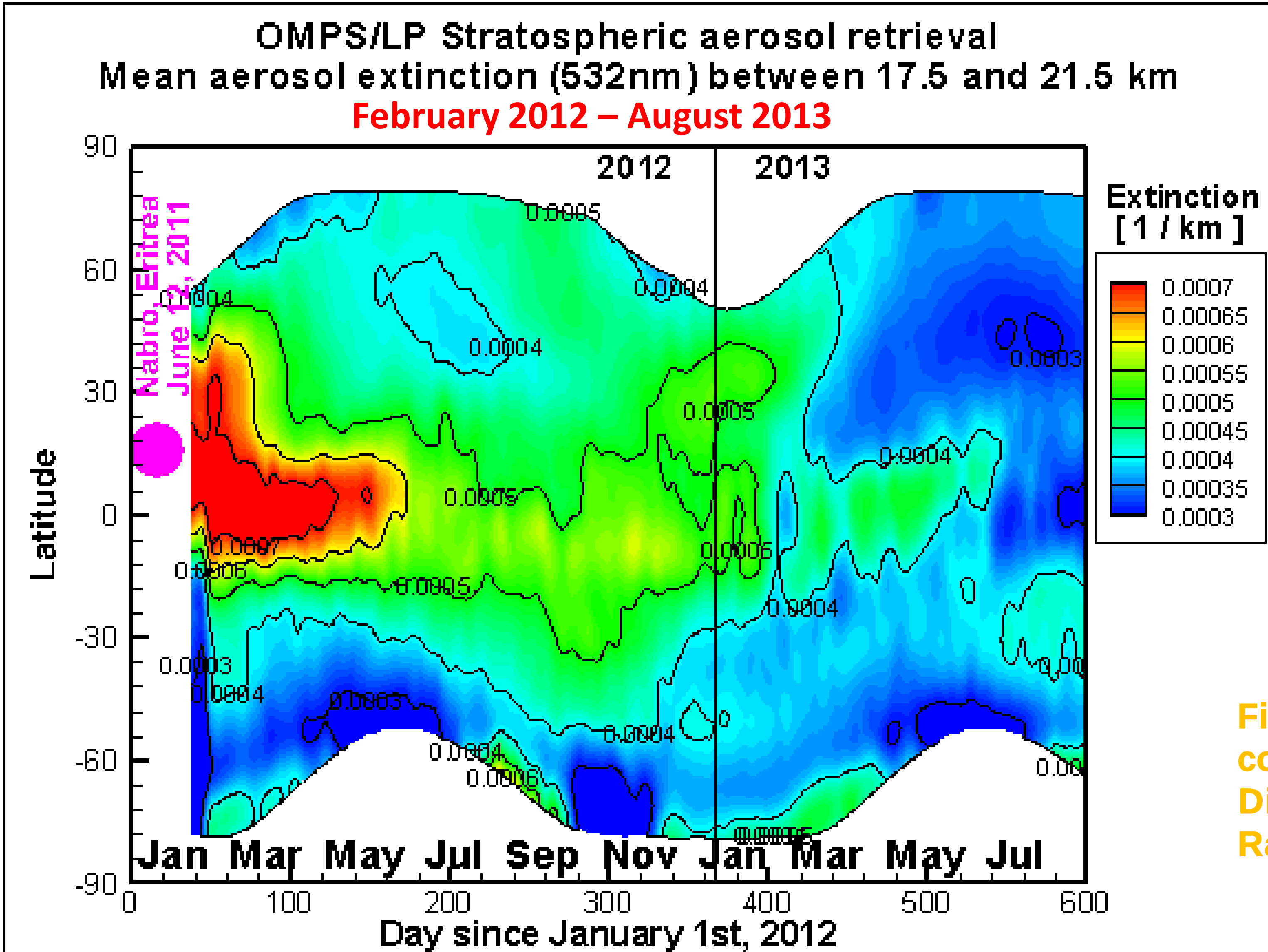
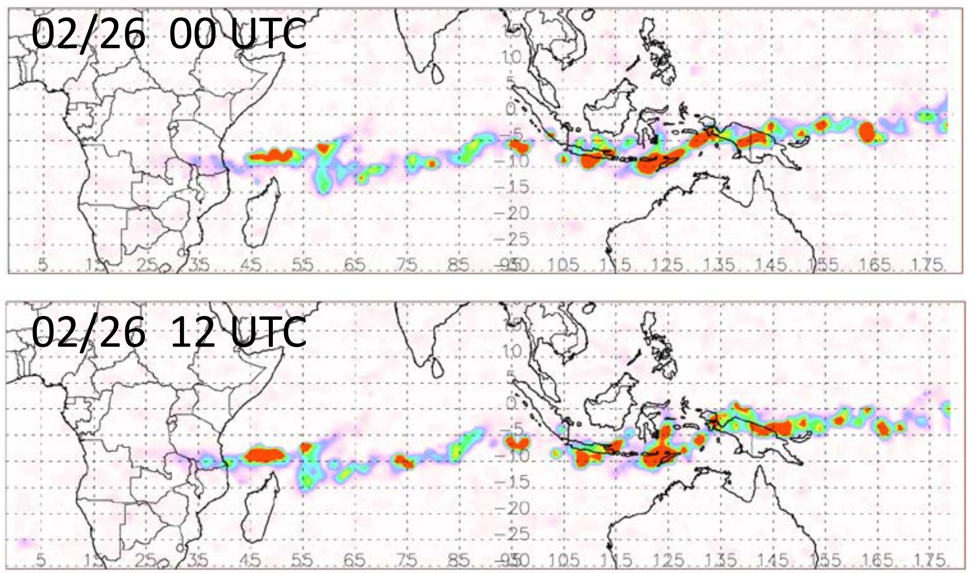


Figure courtesy Didier Rault

LP Aerosol – Kelut Volcano

LaRC Forecast 26 Feb 2014 (Duncan Fairlie)



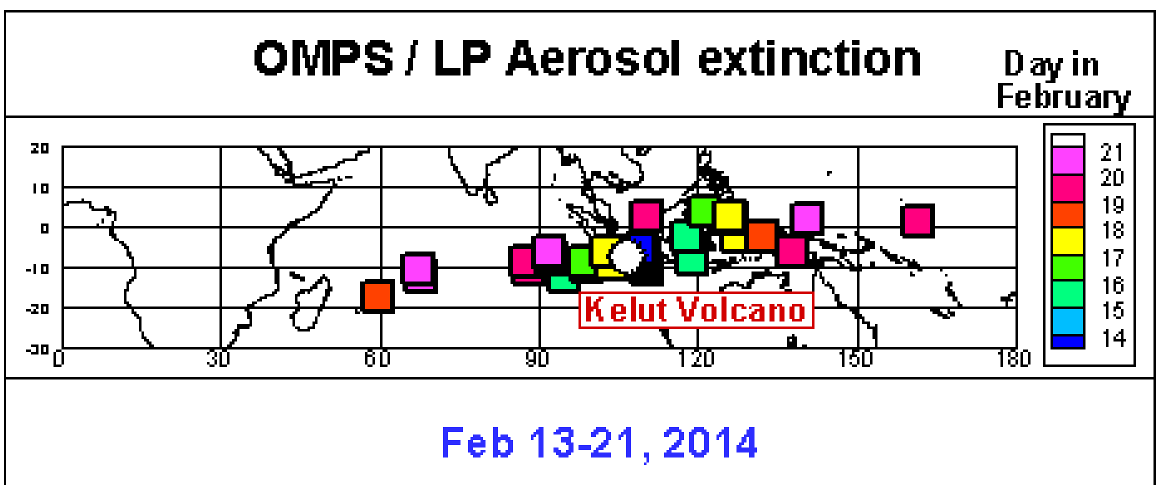
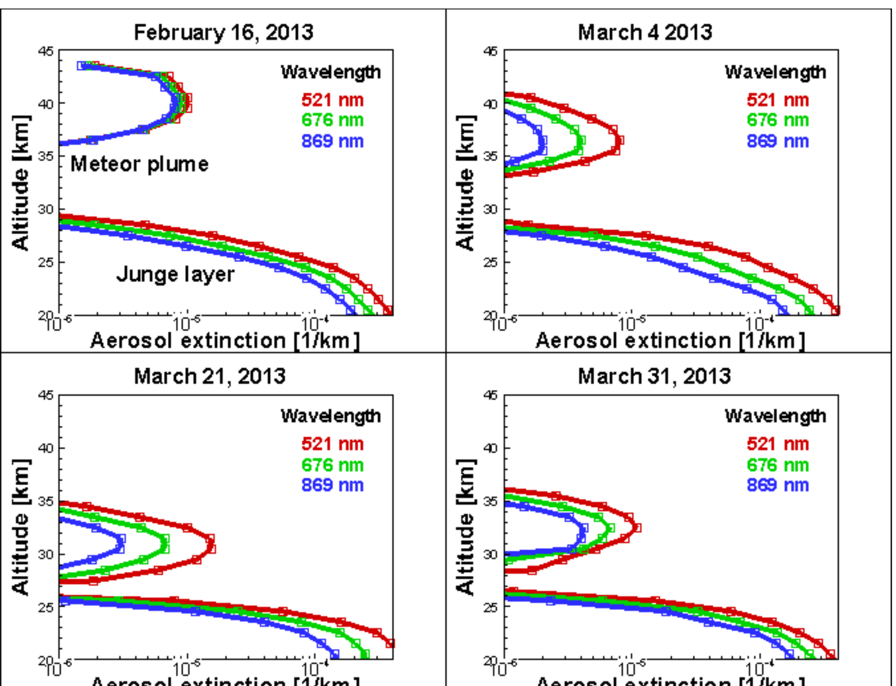


Figure courtesy Didier Rault

LP Aerosol – Chelyabinsk bolide

20 m diameter, 10,000 metric tons, 18.6 km/s
Explosion at 23.3 km with energy release = 30 x Hiroshima; Dust plume rose to > 55 km



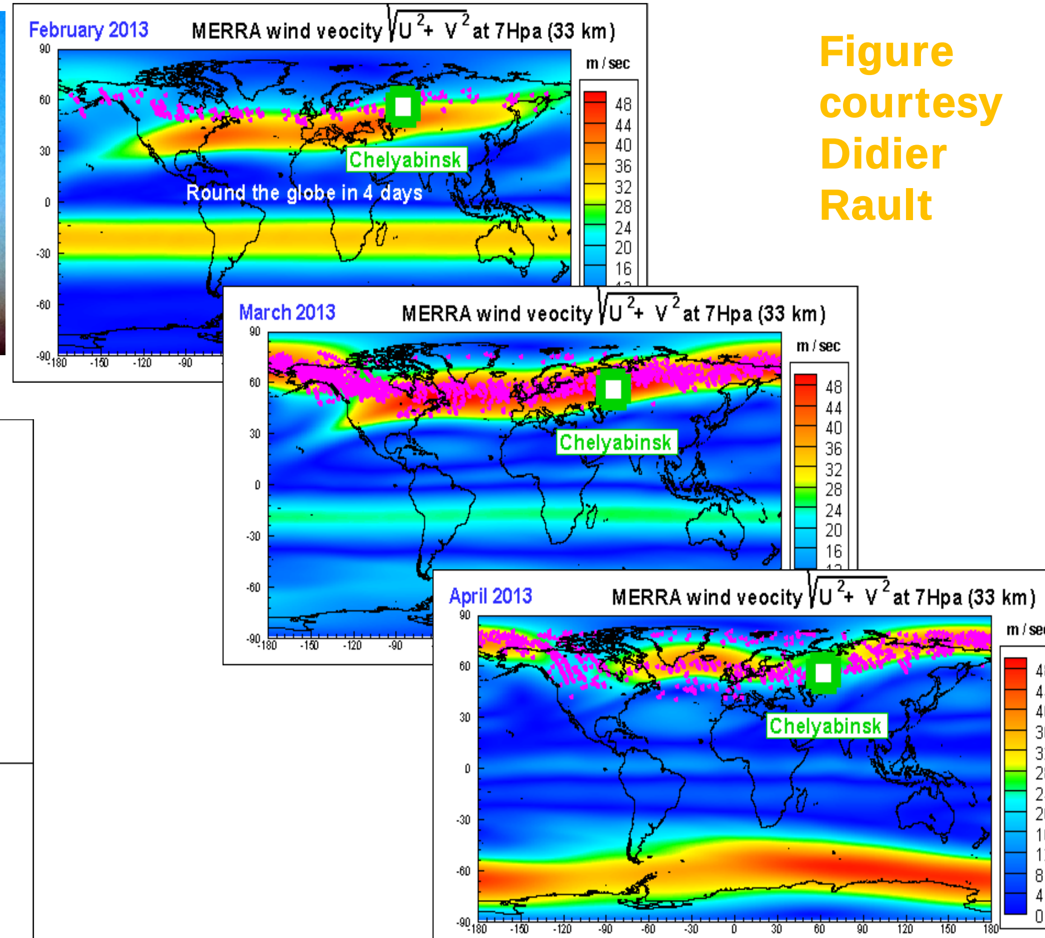


Figure courtesy Didier Rault

"New stratospheric dust belt due to the Chelyabinsk bolide", Gorkavyi, Rault, Newman, da Silva, Dudorov, *GRL*, doi:10.1002/grl.50788 (5 Sep 2013)

Unresolved Issues

- Accuracy of geopotential height profiles in mesosphere (60-80 km)
  - GMAO data currently extrapolated to 80 km with linear lapse rate for ancillary data.
  - MLS team claims 400 m uncertainty in both MLS and GMAO products at this altitude.
- Tangent height registration error along orbit
  - Stratospheric radiance values are very sensitive to tangent height location ($dI/dz \approx -14\%/\text{km}$).
  - Current analysis suggests remaining errors are ±300 m or less, but results from different techniques are not yet consistent.

Future Work

- Aerosol correction
  - Need to be consistent with current "clean" environment, accommodate local variability.
  - Need capability to handle future change in conditions.
- Polar mesospheric cloud (PMC) correction
  - Layers of ice crystals at 80-85 km during polar summer.
  - Affects radiance signal at lower altitudes due to LP viewing geometry.
  - Flagging approach in place for Release 2. Correction will be more complex to develop.
- Extend retrieved ozone profiles into troposphere.
- Derive improvements to GMAO profiles above 40 km using LP data.