Extending the Satellite PMC Data Record with OMPS

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Science Systems and Applications, Inc. (SSAI)

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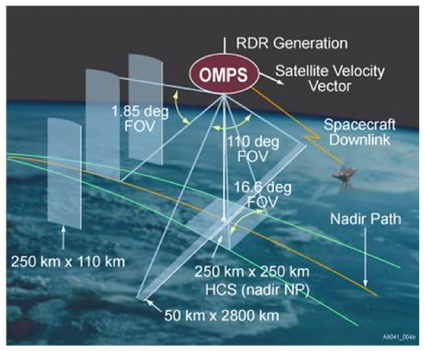
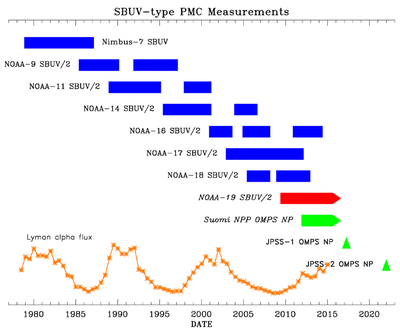
Ozone Mapping and Profiler Suite (OMPS)

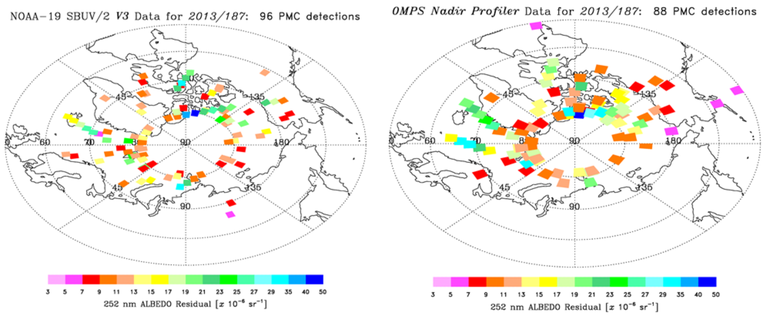




- OMPS instruments are designed to continue long-term monitoring of ozone. Launched on Suomi National Polar-orbiting Partnership (NPP) satellite on 28 October 2011. All sensors use hyperspectral CCDs.
- **Nadir Mapper (NM)** measures total ozone using backscattered UV. 2800 km swath, 50 km x 50 km pixels (adjustable), spectral range = 300-380 nm.
- **Nadir Profiler (NP)** measures stratospheric profile ozone using backscattered UV. 250 km x 250 km footprint, spectral range = 250-310 nm.
- **Limb Profiler (LP)** measures profile ozone and aerosols using limb scattering in UV/VIS/IR. Altitude coverage = 0-80 km, spectral range = 290-1000 nm.

Nadir Profiler (NP)

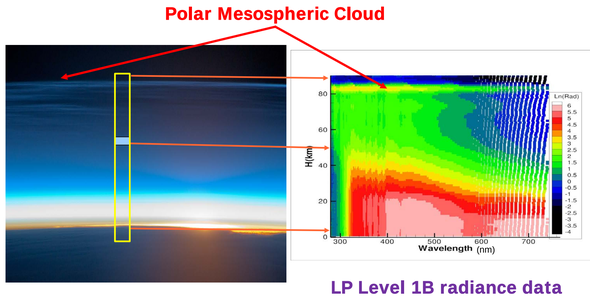
- Designed to replicate SBUV/2 functionality (similar viewing geometry and spectral range) for measuring stratospheric ozone profiles.
- Hyperspectral measurements maintain ability to use legacy SBUV PMC detection algorithm, but also allows for testing of other options (*e.g.* use more or different wavelengths).
- Current results are consistent with concurrent NOAA-19 SBUV/2 data.
- Next NP instrument on JPSS-1 satellite (planned launch in early 2017) will conduct normal operations with 50 km x 50 km pixels within current footprint → more ability to detect fine structure.
- NOAA plans to operate additional NP instruments through 2040, which would extend SBUV-type PMC record to 60+ years.



NOAA-19 SBUV/2 and S-NPP OMPS NP PMC detection results for 6 July 2013

Limb Profiler (LP)

Overview of Measurements



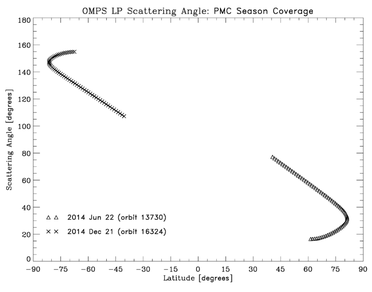
LP slit on Earth limb

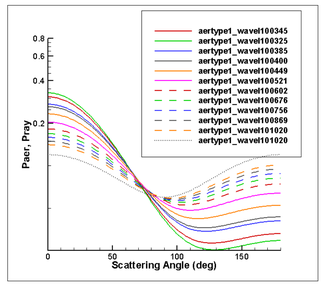
LP Level 1B radiance data

- LP limb scattering measurements give snapshot of atmosphere over 0-80 km (Δz = 1 km) and 290-1000 nm (Δλ = 1-30 nm) every 19 seconds (~125 km separation between profiles).
- Three parallel slits look backward, oriented along-track and 4.25° (~250 km) to each side.
- Center slit observes same atmospheric region as NP instrument approximately 7 minutes later throughout every orbit → <u>Continuous "common volume" observations</u>.

Operational Constraints

- Maximum altitude coverage varies between slits, along orbit, and during season. Southern Hemisphere measurements typically capture full PMC vertical extent, Northern Hemisphere measurements may not capture PMC peak (*see examples below*).
- Scattering angle covers large range along orbit (high in SH, low in NH). Ice phase function varies by factor of ~30 at UV wavelengths over LP observation range → Observed PMC signal will vary substantially between hemispheres (similar to SME and SNOE).
- SH PMC analysis is affected by South Atlantic anomaly (SAA) effects on CCD pixels, since tangent point is ~26° southward of satellite at mid-latitudes.

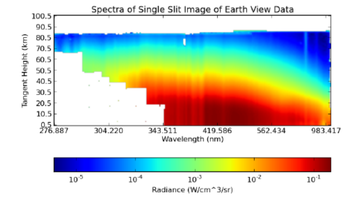




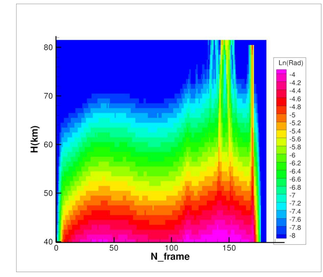
Ice phase function for 325-1020 nm (r = 45 nm, σ = 1.4)

Identification of PMCs in LP Data

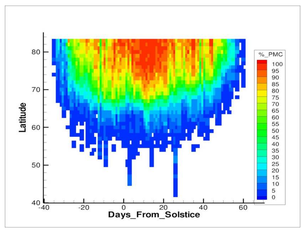
- A cloud located at 80-85 km can be seen in LP radiances down to 50 km (sometimes lower) due to line-of-sight viewing effects.
- LP Level 2 ozone processing generates forward model radiance profile (no cloud) for every event, but only up to 80 km.
- Residual difference between observed and calculated radiance (> 20%, evaluated at 65 km) provides a very sensitive indicator of PMC presence.



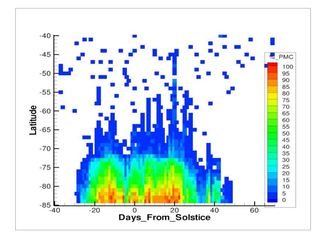
LP radiance data for single event (interpolated to regular spectral and altitude grid)



LP radiance data for single orbit at 353 nm

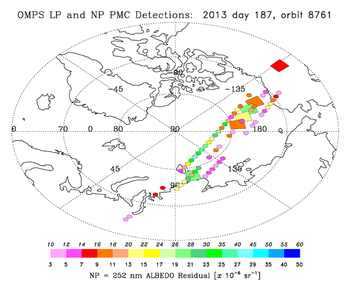


LP PMC occurrence frequency (residual test), NH 2013



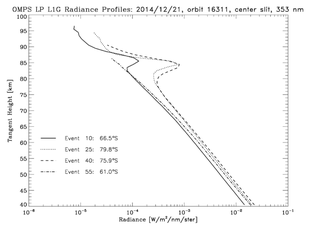
LP PMC occurrence frequency (residual test), SH 2012-2013

- Early tests based on LP radiance peak detection demonstrated consistency between LP and NP PMC observations.

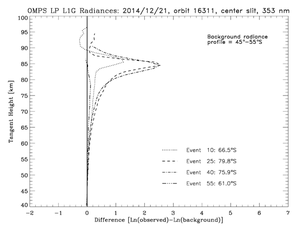


Characterization of PMCs in LP Data

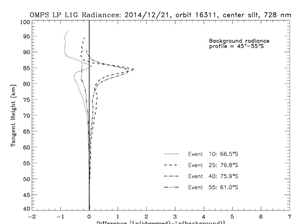
- Current LP stray light correction is less accurate at high altitude, longer wavelengths → Subtracting calculated radiance is problematic for quantitative analysis.
- Determine background by averaging non-cloud observed profiles at lower latitudes, normalizing to observed profile below PMC signal.
- Calculate difference to estimate strength of PMC signal.



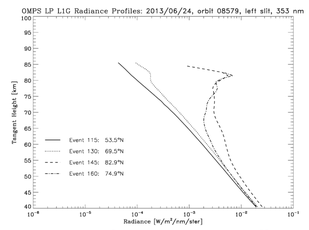
SH raw data, 353 nm, C slit



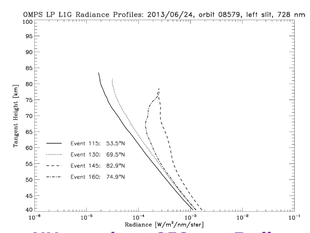
SH difference, 353 nm



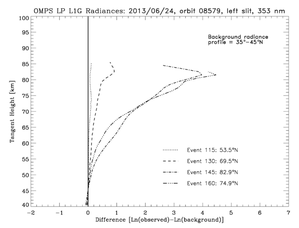
SH difference, 728 nm



NH raw data, 353 nm, L slit



NH raw data, 353 nm, R slit



NH difference, 353 nm

Future Work (*lots!*)

- Create seasonal processing code for NP data and compare 2012-2015 results to NOAA-19 data.
- Incorporate OMPS NP data in long-term trend analysis.
- Evaluate changes in NP PMC detection results when different wavelength selections are used.
- Refine background determination and application for LP observations.
- Implement calculation of PMC peak intensity (parabolic fit?).
- Create seasonal processing code for LP data.
- Begin common volume studies.
- Note that LP instrument is not manifested on JPSS-1 satellite, but is planned for JPSS-2 satellite (launch ~2022).