Variations in Polar Mesospheric Clouds (PMCs) in Aura OMI Data

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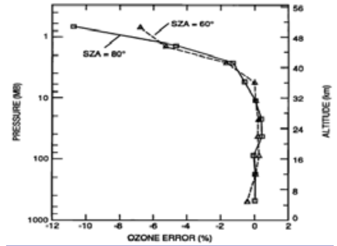
Why Study PMCs?

- PMCs are a sensitive indicator of water vapor and temperature in a region that is difficult to observe directly.
- Expected climate change in lower atmosphere (stratospheric warming due to greenhouse gases, methane buildup) is predicted to give mesospheric effects.
- Long-term changes in PMC properties, such as those observed by SBUV instruments, may indicate that these changes are occurring.
- Presence of PMC in field of view may bias stratospheric ozone profile retrieval from BUV instruments *(see below)*.

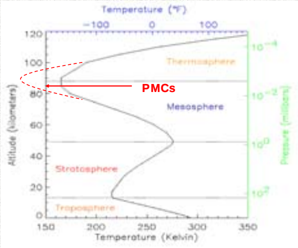


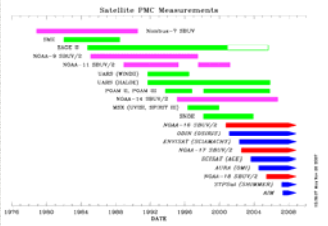
Estimated Error in Ozone Profile due to a PMC

Thomas et al. [1991]

Polar Mesospheric (Noctilucent) Clouds

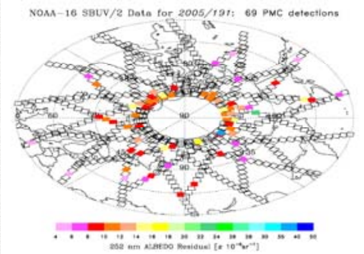
- Thin layers of ice crystals formed at 80-85 km in summer hemisphere at temperatures < 140 K.
- Normally observed only above 50° latitude.
- Observed visually from ground after sunset or before sunrise (*noctilucent* = "night shining") since 1880s.
- Regular satellite measurements available since 1970s.





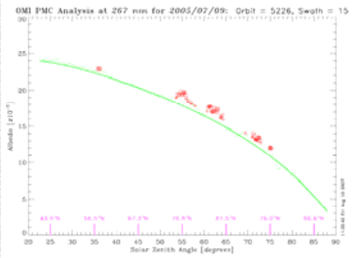
Typical SBUV/2 Results

- PMCs identified as spectrally dependent (250-290 nm) albedo increase above Rayleigh background.
- SBUV/2 detects brightest 15% of overall PMC population.
- Large field of view (170 km x 170 km) averages together complex spatial structure, reduces amplitude of signal.
- Stratospheric ozone variations complicate detection of weak clouds with this technique.



OMI PMC Detection

- Adapt basic SBUV/2 algorithm. Use 267 nm as shortest wavelength for adequate signal-to-noise.
- Use all pixels, 5 wavelengths (same number as SBUV/2). Interpolate spectra to 0.5 nm grid, average 3 bins to reduce noise.
- Process each swath independently (neglects residual cross-track variations, ice phase function effects).
- Raw albedo data show clear along-track structure (*nadir swath shown*). Retrieved PMC brightness is higher than seen by SBUV/2.

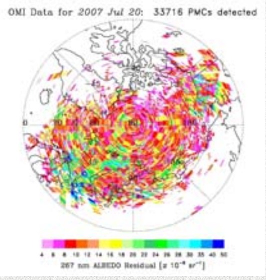


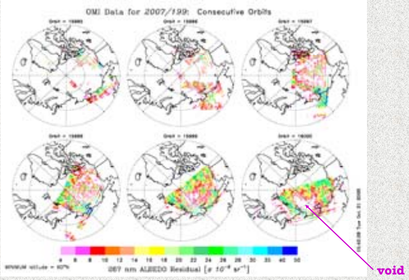
OMI Advantages for PMC Studies

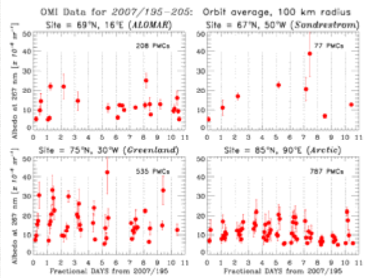
- Smaller pixels (13 km x 48 km nadir in UV1 data) increase chance of being filled with PMC → more contrast to background.
- Cross-track observations can show horizontal structure over large geographic regions.
- First regular polar measurements (up to 90° latitude).
- Overlapping measurements at high latitude allow study of short-term (orbit to orbit) variability, planetary waves.
- Spectral information with each pixel holds potential to address particle size questions.
- Many more opportunities for coincidence analysis with ground-based data.

Initial OMI PMC Results

- Single day produces 200-300 times more PMC detections than SBUV/2 instrument due to geographic coverage, smaller pixels, improved sensitivity.
- Predicted increase of PMC occurrence frequency at higher latitude extends to North Pole.
- "Void" regions with no clouds emerge and grow within highly populated areas, consistent with AIM results.
- Overlapping swaths allow direct analysis of local time dependence at all latitudes > 65-70°. Significant longitudinal variations are seen (*tidal effects?*).







Coincidence Analysis

- Low latitude NLC (< 50º) detections increasing in frequency, but still rare. Would like quantitative evaluation of these clouds with satellite data.
- NLC and SBUV-type PMC observations not simultaneous by definition, but useful coincidence windows can be specified.
- SBUV/2 orbit tracks are far apart at mid-latitudes (25º longitude = 1000 km) → limited coincidence opportunities for ground-based observers.
- Work in progress to examine 2003-2005 seasons using Canadian-American NLC network and SBUV/2 data.
- OMI cross-track coverage and smaller pixels will allow tighter windows on geographic, temporal coincidence tests.
- OMI can also detect more faint PMCs → more opportunities for comparison.

2005 July 12-13 SBUV/2 PMC detections and North American NLC reports. Note agreement between satellite tracks and NLC observer locations.

Courtesy of J. Barker-Tvedtnes and M. Taylor [Utah State Univ.]

Status and Future Work

- Determine most useful wavelength set for PMC detection.
- Produce comparisons with concurrent SBUV/2 and AIM data for validation.
- Evaluate how small spatial structure behaves using OMI data, and how it affects SBUV/2 PMC detections.
- Investigate persistence and magnitude of local time dependence at many locations.
- Determine impact of PMCs on retrieved upper stratospheric ozone profiles.
- Compare OMI PMC results with MLS temperature and relative humidity measurements.