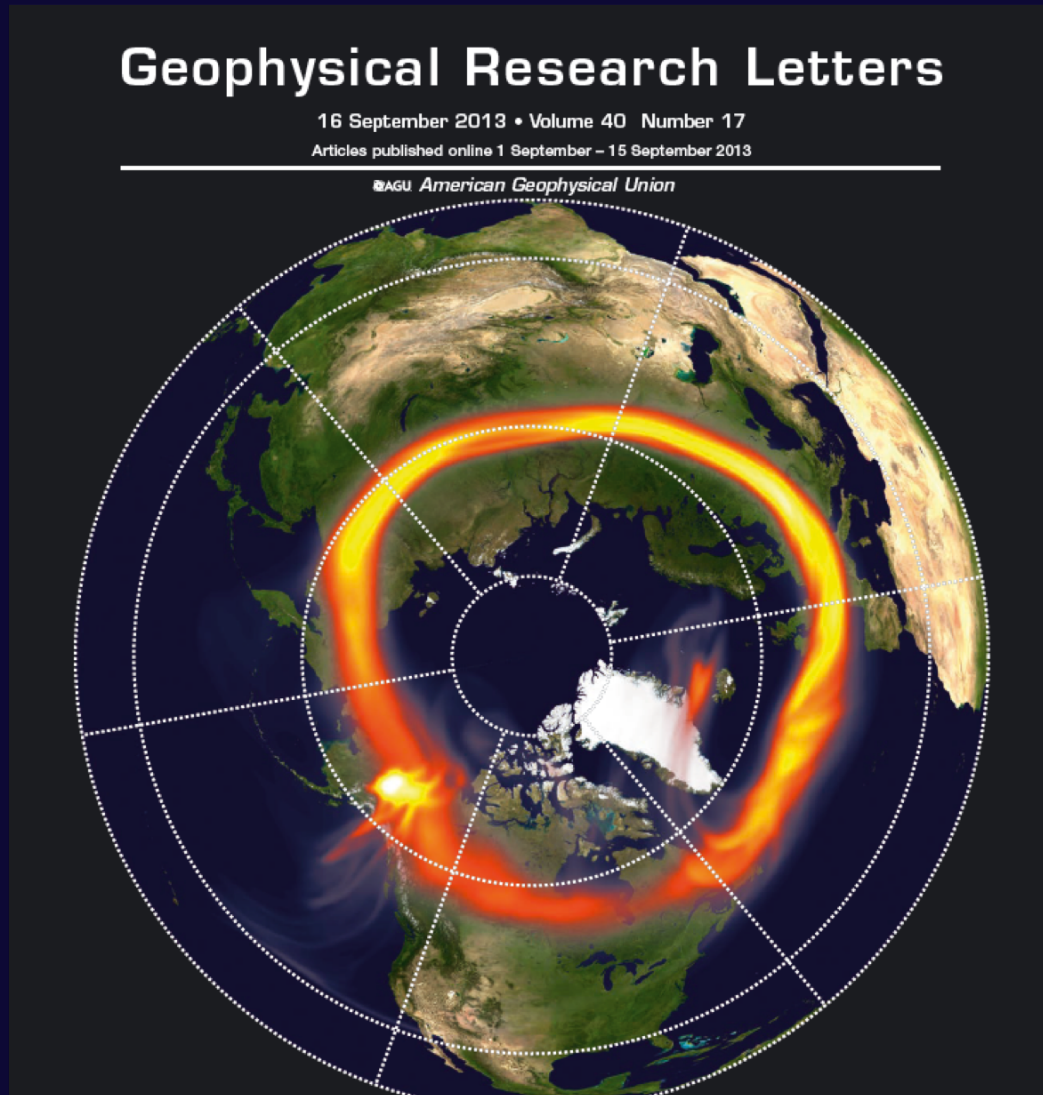


Improving the Performance of the OMPS Limb Profiling Instrument in Monitoring Aerosols in the Post-Pinatubo Stratosphere



P. K. Bhartia, Robert Loughman, Zhong Chen & Ernest Nyaku

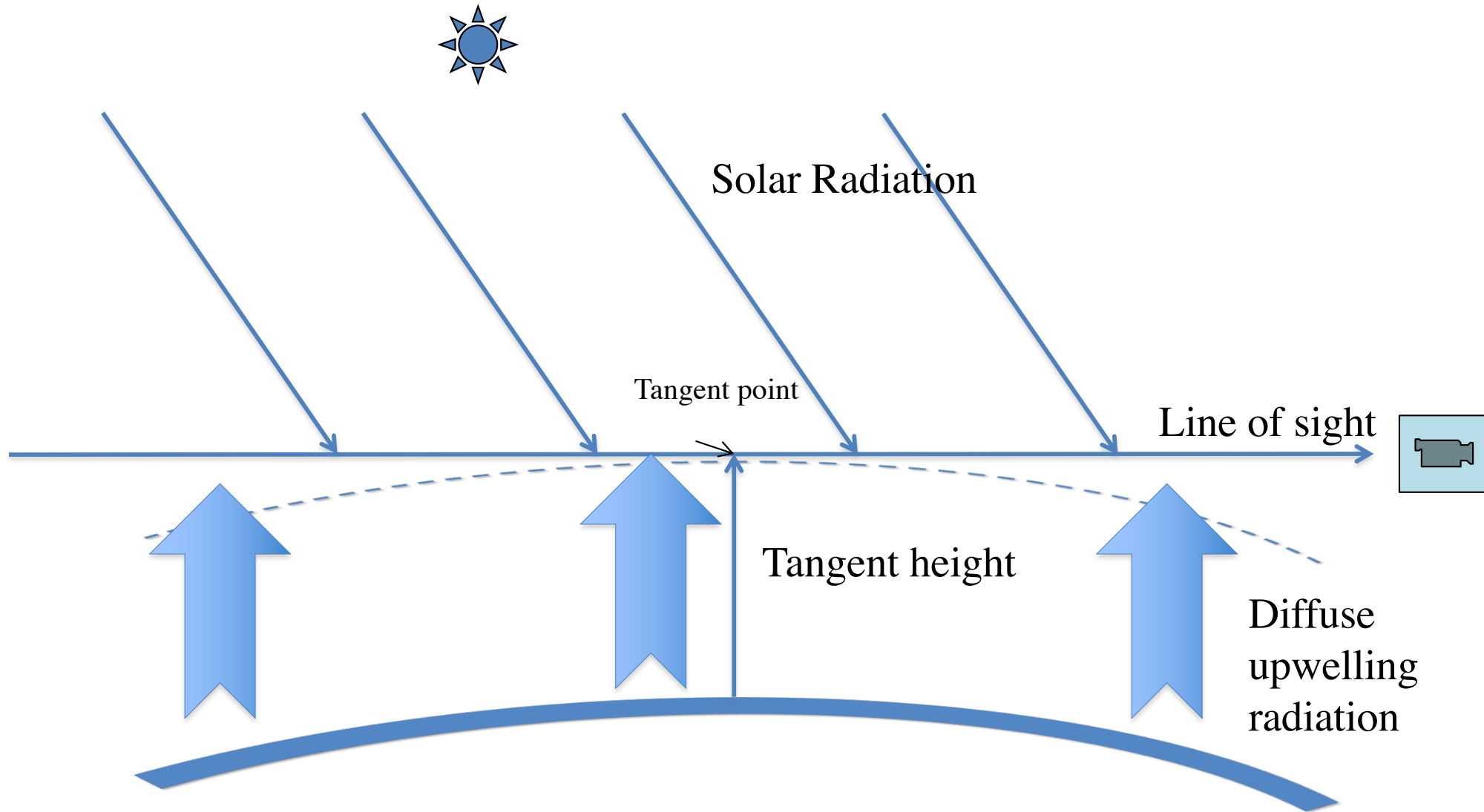
Strat Dust Belt on March 22, 2013 due to Chelyabinsk Bolide

Limb Scattering Instruments

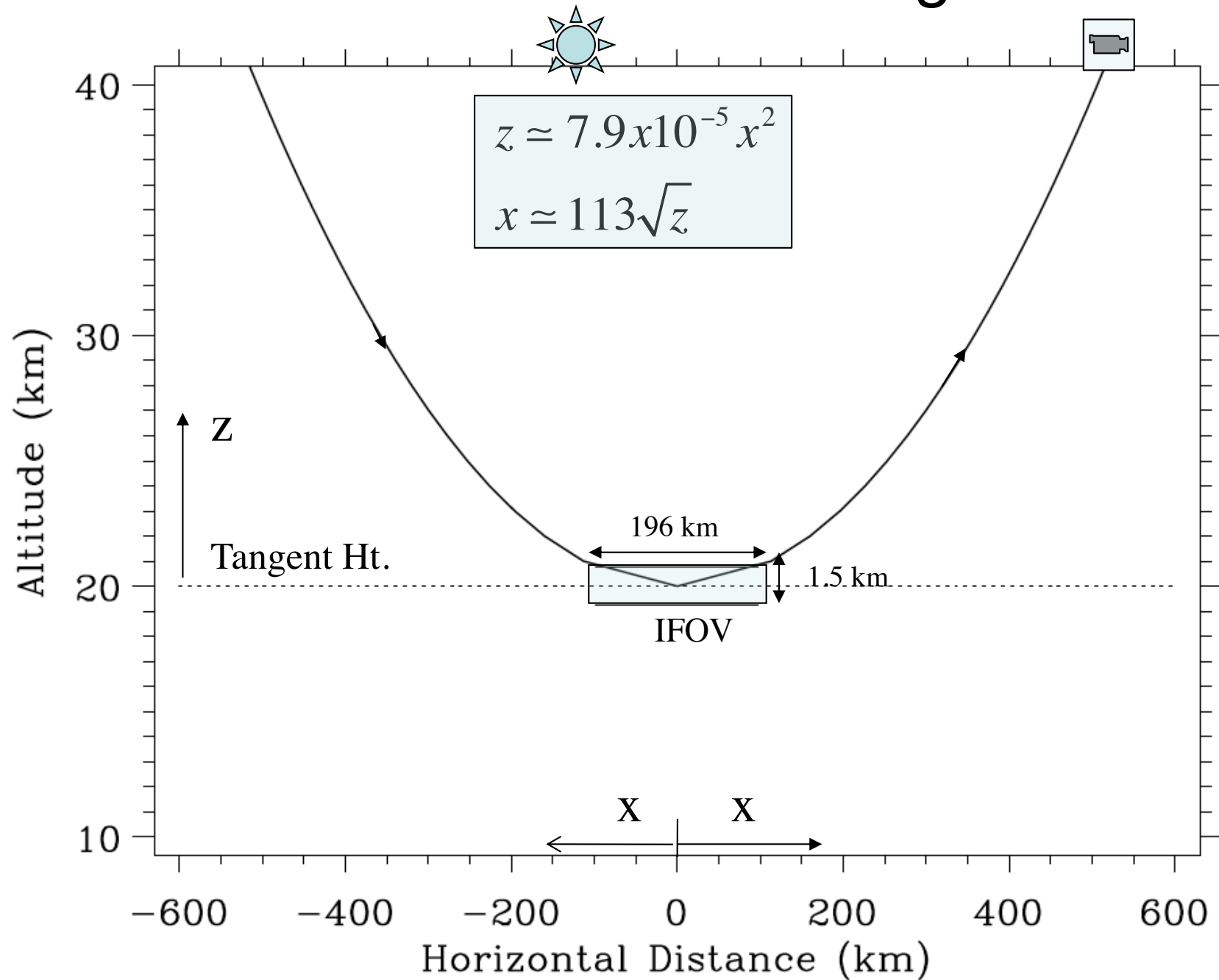
- SME: 1982-1988
- SOLSE/LORE: 1997
- SAGE III: 2002-2005, 2017-
- SCIAMACHY: 2003-2011
- GOMOS: 2003-2011
- OSIRIS: 2002-
- OMPS: 2012-

Also flown on MARS missions

Limb Scattering Technique

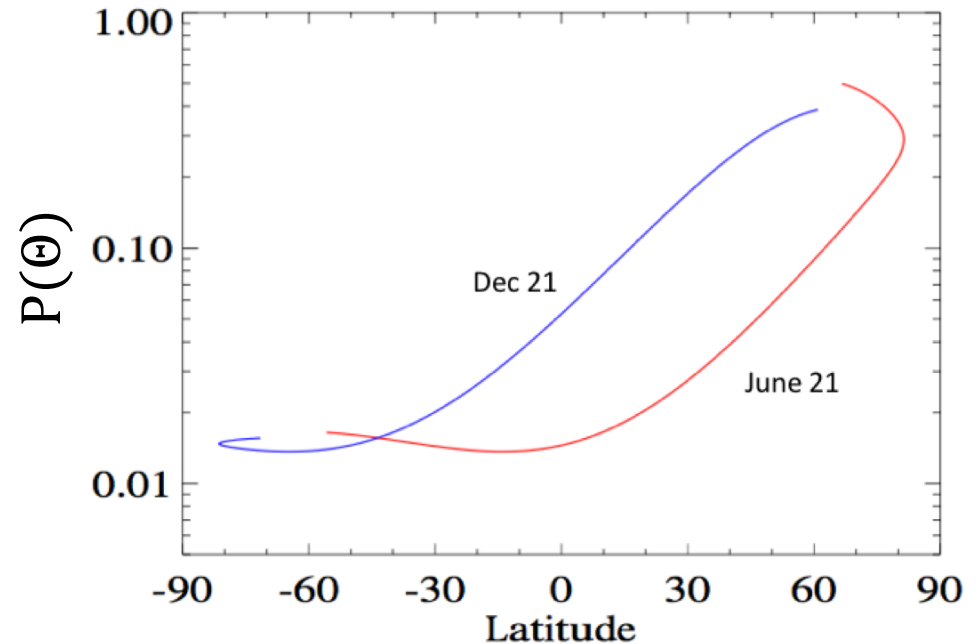
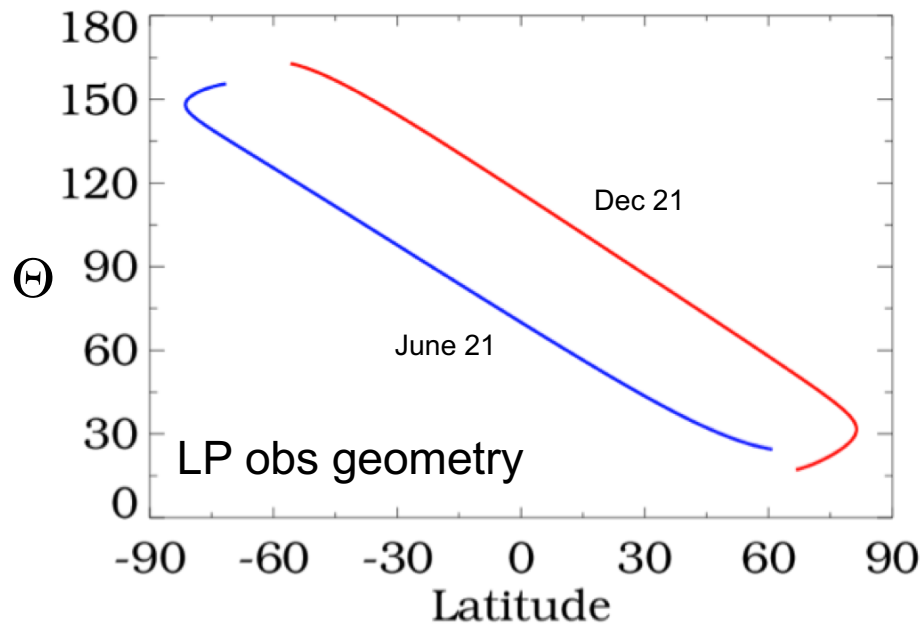


Altitude vs. Distance Along LOS



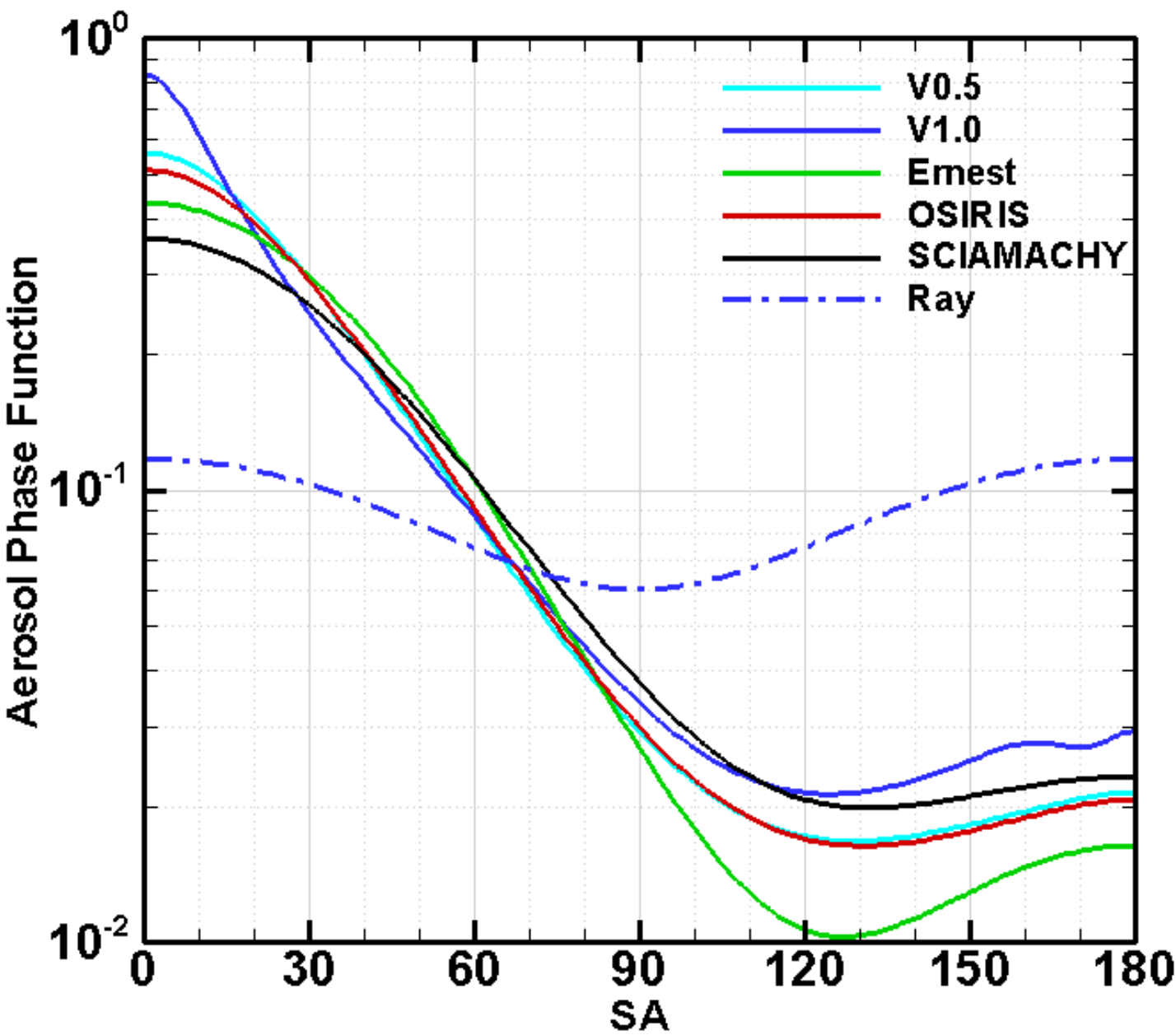
LS Aerosol Signal in SS Approx.

$$\Delta I = \frac{1}{4} \varpi P(\Theta) \tau_a - O(\tau_a \tau_R)$$

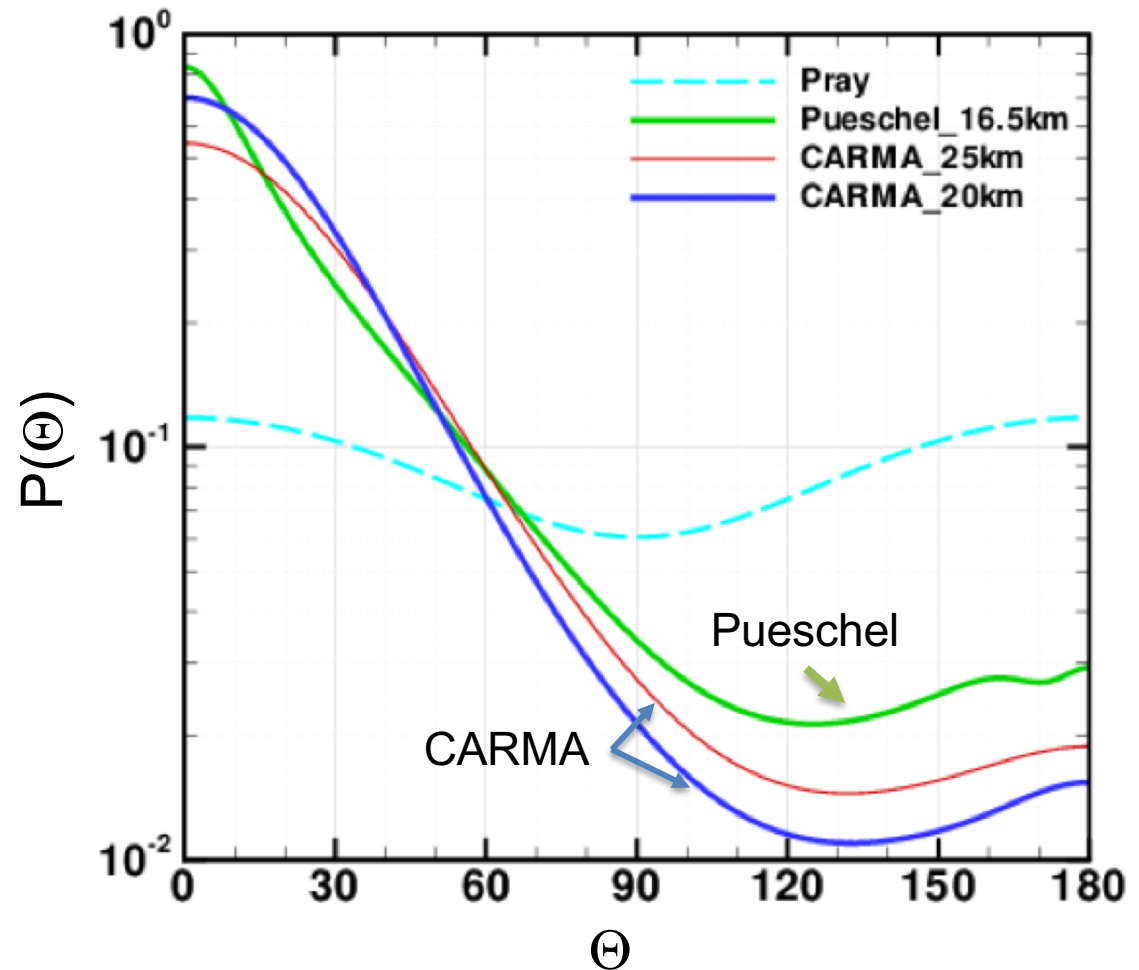
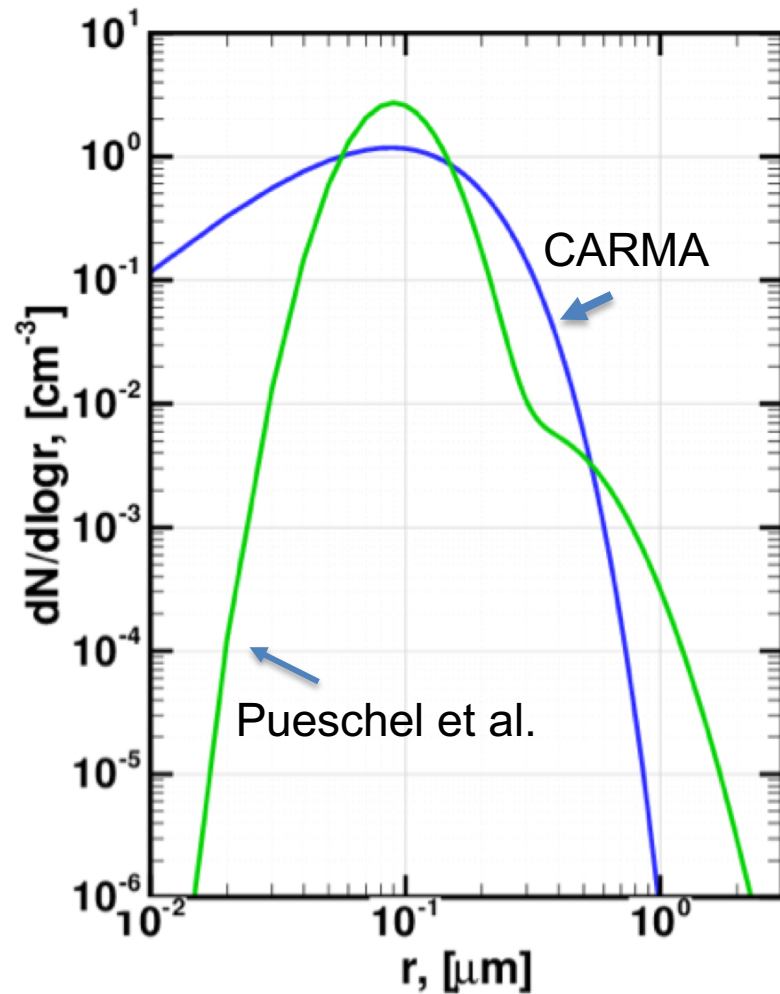


- The 2nd term can cause ΔI to go to zero when $P(\Theta)$ is small and τ_R is large.
- At any given λ , Θ and clouds determine the lower altitude cutoff. At 675 nm the cut-off varies from ~ 13 km in SH mid/high lat to cloud top in the tropics & NH.
- Multiple scattering reduces the effect of phase function error.

Phase function comparison



Gamma vs Bimodal lognormal Size Distribution



- $0.1 \mu\text{m}$ particle density seem to matter most for determining the phase function. Bimodal lognormal distributions tend to overestimate it when there are no measurements below $0.15 \mu\text{m}$.
- Gamma distribution seems to produce more reliable results.

Key Conclusions

- Based on a broad range of metrics the simple Gamma model does a better job for deriving aerosol scattering phase function than the bimodal lognormal model.
- Unimodal lognormal works reasonably well, but it too over-predicts aerosol density below ~ 0.1 micron.
- Gamma phase function and AE are well correlated, effectively making it a one parameter model for PF calculations.
- The modified Gamma distribution may be needed if there are many coarse model particles.

Synergy with ISS/SAGE III (Launched Feb 2017)

- SAGE III measures aerosol extinction directly during solar/lunar occultation
 - Comparison with LP can provide phase function information, which can then help tie down aerosol size distribution
- SAGE III can also measure limb scattering between occultations at varying local times
 - LS + occultation can better constrain aerosol size distribution, similar to AERONET DS + Almucentar data.
- High spatial and temporal sampling from LP provides context to interpret SAGE data

Relevant References

- OMPS Limb Profiler Version 1 Aerosol Extinction Retrieval Algorithm: Theoretical Basis
 - Loughman, Bhartia, Chen, Xu, Nyaku, and Taha.
 - AMT Discussions (pending final review, publicly available).
- Impact of aerosol size distribution on extinction and spectral dependence of radiances measured by the OMPS Limb profiler instrument
 - Chen, Bhartia, Loughman, and Colarco.
 - AMT discussions (under review, publicly available)
- The sensitivity of the stratospheric aerosol phase function to aerosol size distribution models
 - Nyaku, Loughman, Bhartia, Deshler, Chen, and Colarco.
 - T. Deshler has recommended reanalysis using recently released data.