Improved Modeling Approaches Towards the mm SLR

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Atmospheric Loading (ECMWF)

Difference in the RMS of fit of weekly arcs of LAGEOS SLR for 2001 & 2006 and four Atmospheric loading treatments (one being NO loading)

Test Case	Points (weeks)	Mean	Median	RMS	Std Deviation
ΔRMS v0-NO*	52	3.4	2.7	4.45	2.87
ΔRMS v1-NO	104	2.9	2.1	4.31	3.16
ΔRMS v2-NO	52	2.7	1.7	4.09	3.08
ΔRMS v1-v0	*52*	*0.4*	*0.0*	*0.92*	*0.82*
ΔRMS v2-v1	*52*	*1.7*	*1.4*	*2.58*	*1.96*

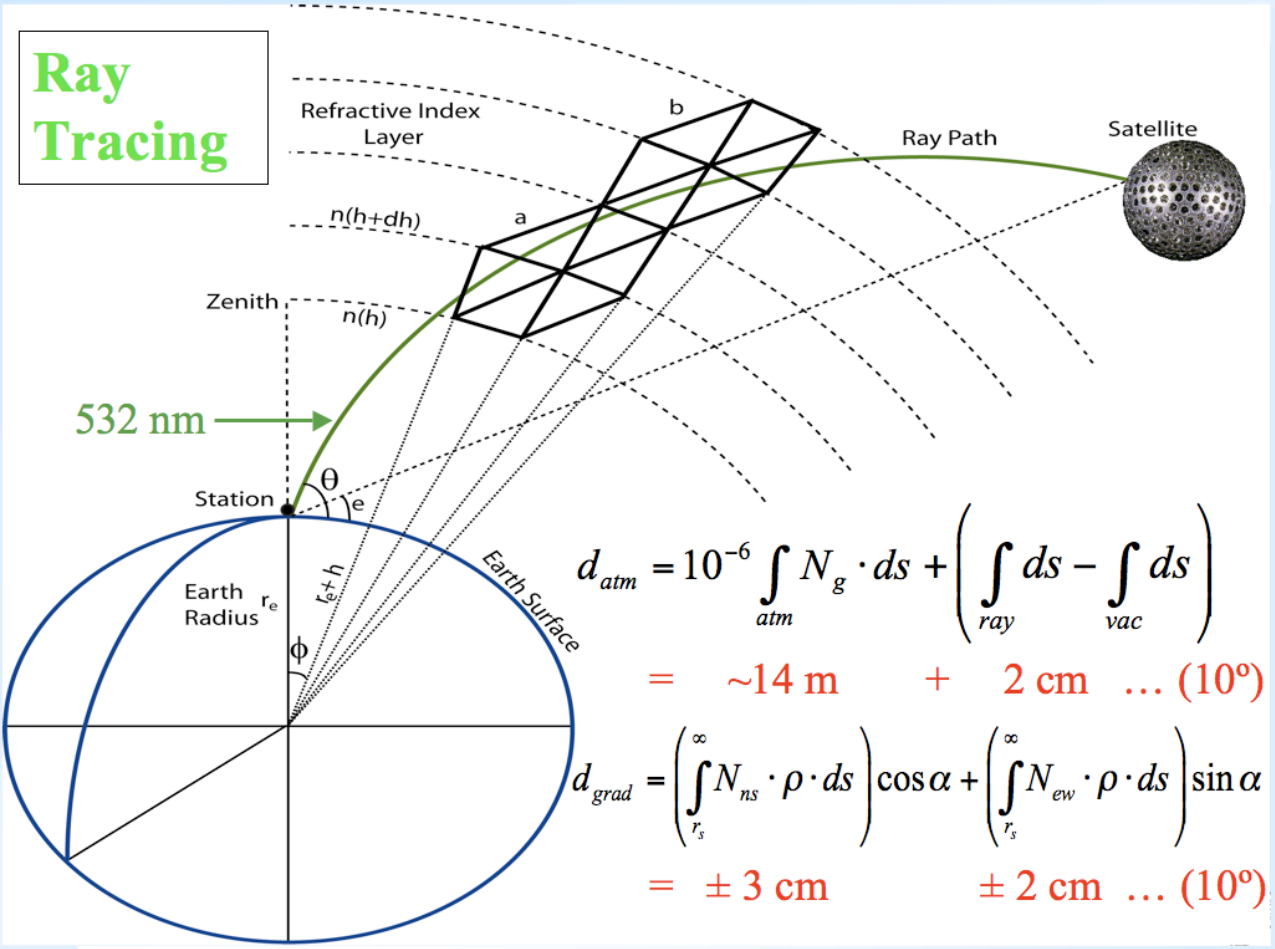
*NO indicates no atmospheric loading modeling

"v0": 1970/01 - 2002/08: ECMWF Reanalysis (ERA40), with a spatial resolution of 1.125 degrees

"v1": 2000/12 - 2006/12: ECMWF Operational, with a spatial resolution of about 0.350 degrees

"v2": 2005/10 - now: ECMWF Operational, with a spatial resolution of about 0.250 degrees

3D Atmospheric Ray Tracing (ART)



$$d_{atm} = 10^{-6}\int_{atm} N_g \cdot ds + \left(\int_{ray} ds - \int_{vac} ds\right)$$

$$= \sim 14\ \text{m} + 2\ \text{cm} \quad \ldots (10^{o})$$

$$d_{grad} = \left(\int_{r_s}^{\infty} N_{ns} \cdot \rho \cdot ds\right)\cos\alpha + \left(\int_{r_s}^{\infty} N_{ew} \cdot \rho \cdot ds\right)\sin\alpha$$

$$= \pm 3\ \text{cm} \quad \pm 2\ \text{cm} \quad \ldots (10^{o})$$

Hulley, G. C. and E. C. Pavlis, (2007), A ray-tracing technique for improving Satellite Laser Ranging atmospheric delay corrections, including the effects of horizontal refractivity gradients, *J. Geophys. Res.*, 112, B06417, doi:10.1029/2006JB004834, 2007.

Pavlis, E. C., V. Mendes and G. Hulley, (2008), Tropospheric Model: Optical Techniques, in *IERS Conventions 2003*, G. Petit and B. Luzum *eds.*, IERS Technical 32, online version: http://tai.bipm.org/iers/convupdt/convupdt.html, Paris, France, 2008.

Gradient-corrected SLR Residuals Statistics

Method	ΔBias (mm)	$\Delta\sigma^2$ (%)
AIRS		
RT_{grad}	0.3 ± 0.3	14.0
RT_{3D}	0.9 ± 1.1	24.8
ECMWF		
RT_{grad}	0.1 ± 0.5	10.8
RT_{3D}	0.6 ± 1.2	22.5