Refraction Study Group
Summary

- Zenith Delay uncertainty due to
  - refractive formula uncertainty <5E-8, translates (assuming n=1.00029) into a relative zenith delay accuracy of (5E-8/(n-1))=0.17E-3.
    For ZD=2.4m this gives an uncertainty of 0.4mm (2.3mm @ 10 deg)
  - Accuracy limit in dispersion measurement (delta n) is 1E-9 (Velsko (1986)), about 15 times better than refractivity.

- Mendes-Pavlis zenith delay assessed by raytracing through radiosonde data (180 Radiosonde stations with 2 launches per day, 1 year data span):
  - gives rms for zenith delay prediction of 0.6mm which is quite close to the measurement uncertainty in refractivity under controlled laboratory conditions.
  - the projected zenith delay rms is 3.5mm at 10 deg elevation
  - this is a long term average.
  - effect of 0.1hPa pressure change leads to less than 1.4mm refraction delay change at 10 degree elevation
  - effect of .1K temperature change leads to less than .1mm refraction delay change at 10 degree elevation
  - Group delay concept applicable ?
    Yes, ...if there is no adjacent absorption line.
    The group velocity concept is applicable for 10ps fourier limited pulses and atmospheric propagation distances < 40km (very conservative statement).

Refraction Study Group
Summary (2)

- Possible problems:
  - This is the utmost we can do using onsite meteorological data only.
  - the meteorological conditions at the sounding sites might not represent those at which SLR observations are taken. Do we need to measure the water vapour lapse rate at the stations as indicated in V.B.Mendes,E.C.Pavlis,"High-accuracy zenith delay prediction at optical wavelengths" ?
  - How much "horizontal gradient effect" is included in the radiosonde data ?
  - In reality mapping function depends on wavelength, Mendes mapping function does not, but chromatic error for the discussed wavelengths does not exceed 1 part in 10000 (i.e.1.3mm) at 10 deg elevation.
  - due to horizontal refractivity gradients 1mm accuracy only can be achieved at high elevations, depending on the site topography.
  - Horizontal Refraction Gradients are a real problem.
    The Northpole-Equator Temperature Gradient approx 0.01K/km
    causes about 1cm refraction change at 15 degree elevation.
  - Raytracing through Numerical Weather Prediction Data seems to be the only global available possibilty to retrieve these gradients.
  - Two Colour Laser Ranging can be used for validation.