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Determination of the reference frame scale with VLBI

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We investigate the systematic errors that contribute to the scale of the VLBI reference frame. There are bias and rate scale errors as well as seasonal scale errors. These systematic errors include unmodeled antenna thermal deformation, unmodeled (or mismodeled) mass loading, and tropospheric path delay mismodeling. Scale error due to troposphere mismodeling is about 0.1 ppb. Without modeling mass loading or antenna thermal deformation, the VLBI scale has an annual amplitude of about 0.5 ppb. This is reduced by about 30% if mass loading is applied. We consider systematic effects due to the non-uniform geographical distribution of VLBI antennas, especially the predominance of Northern Hemisphere VLBI sites. To understand these effects, we analyze results from simulated networks with different global distributions. Finally, we compile an error budget of systematic effects to provide an upper bound on the VLBI scale error. In the recently developed International Terrestrial Reference Frame, ITRF2005, there is a scale bias between VLBI and SLR of about 1 ppb. Comparison of recent VLBI solutions yields scale agreement with ITRF2000 at the level of 0.26 ppb and 0.02 ppb/yr where both VLBI and SLR determined the scale and agreement with ITRF2005 at a level of 0.08 ppb and 0.02 ppb/yr, where the scale was taken from VLBI. We discuss the extent to which our VLBI scale error budget resolves the scale discrepancy between VLBI and SLR.