

VLBI Scale Error

D. S. MacMillan

NVI, Inc.

NASA Goddard Space Flight Center

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Systematic Errors Contributing to VLBI Scale

- Antenna Thermal Deformation
- Pressure Loading and Hydrology Loading
- Atmospheric Delay Modeling
- Radio source structure

Antenna Thermal Deformation

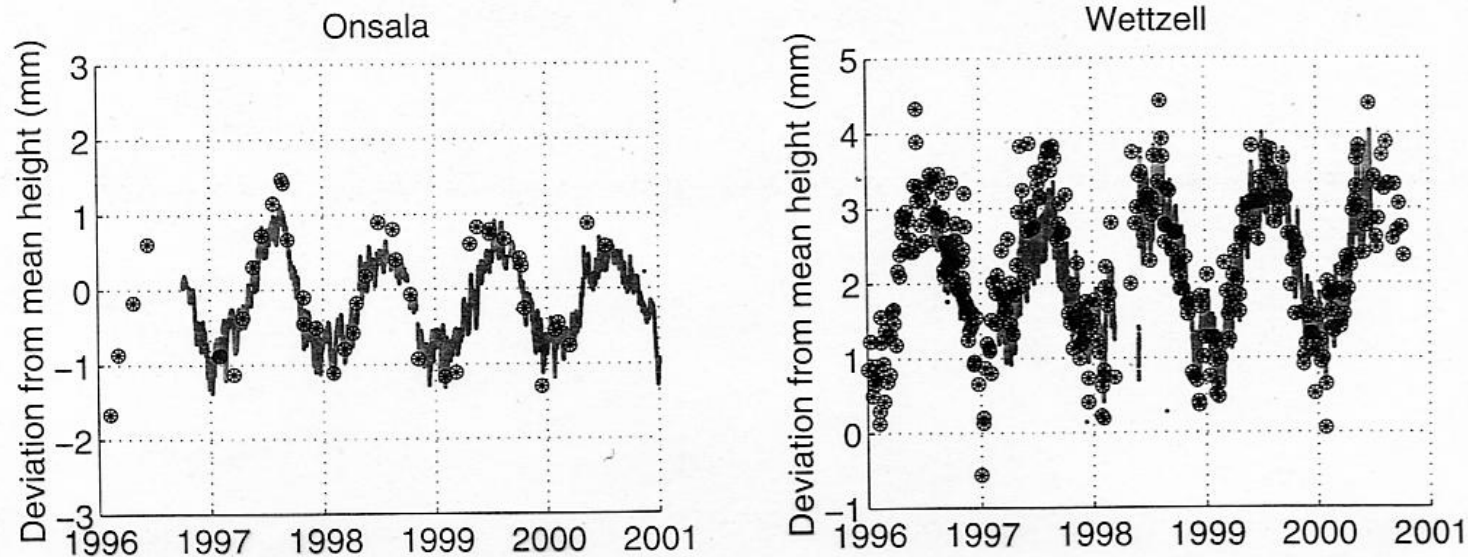


Figure 13: Vertical height changes of the VLBI radio telescopes at Onsala and Wettzell: solid lines - measured by the invar rod measuring systems; stars in circles - modelled with a simple model based on daily mean temperature from the VLBI data base, thermal expansion coefficient, and the telescope dimensions.

$$\text{Vertical} = \text{Expan. Coef} * \text{Hgt} * (T - T_{\text{ref}}) \sim 0.2 \text{ mm}/^{\circ}\text{C} * (T - T_{\text{ref}})$$

Average vertical bias due to not modeling antenna deformation
 $\Rightarrow 0.04 \text{ mm} \sim 0.01 \text{ ppb}$

Atmospheric Delay Modeling

- Errors in atmospheric modeling at low elevations
- Scale dependence on elevation cutoff

10° - 5° elevation cutoff solutions

=> -0.01 ± 0.005 ppb/yr

=> -0.13 ± 0.05 ppb

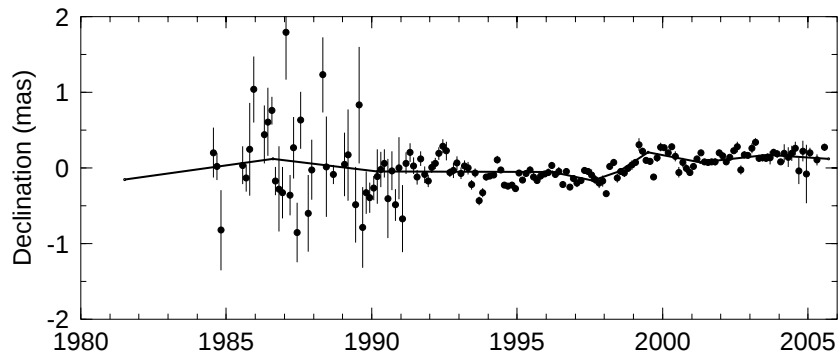
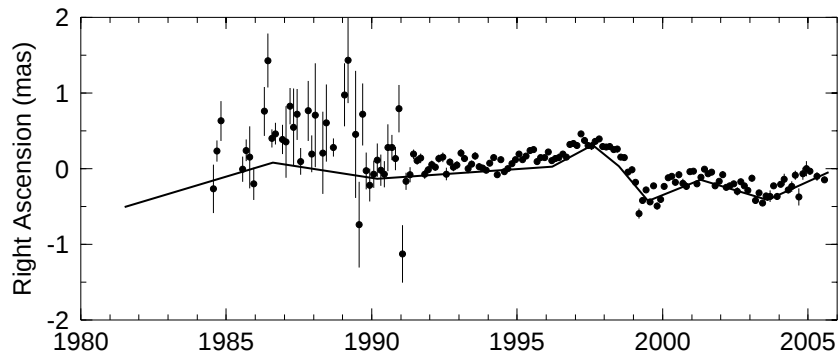
- Mapping function error

VMF – NMF => bias ~ -0.1 ppb

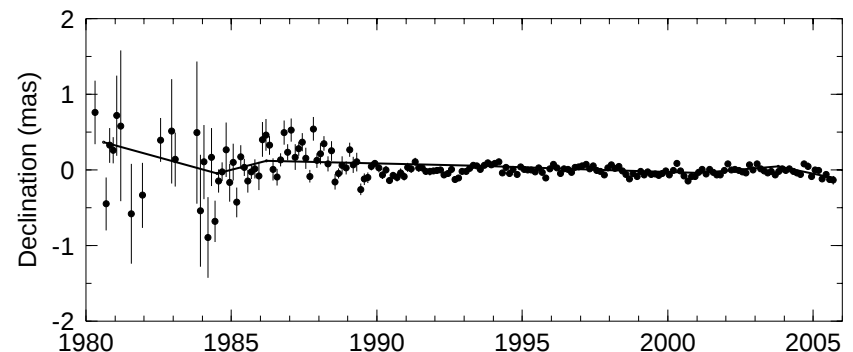
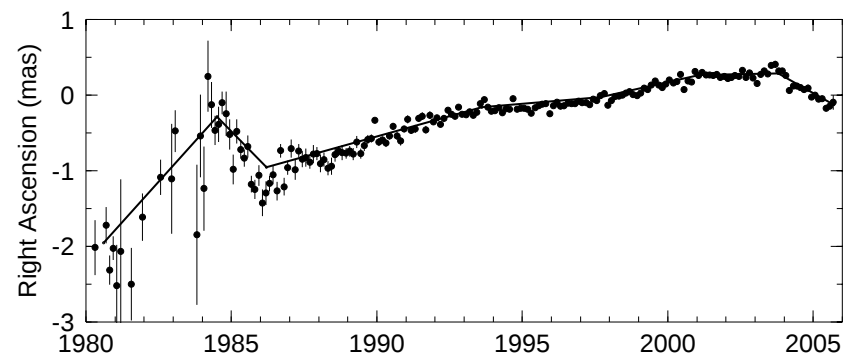
seasonal amplitude ~ 0.1 ppb

Radio Source Instability

- Radio source position estimates can have large rates or even nonlinear variation
- Identified sources with unstable position time series from among the most frequently observed (geodetic) sources



Radio source 2145+067



Radio source 4C39.25

Scale Error Budget

Error Source	Annual ppb	Rate ppb/yr	Bias ppb
Thermal deformation	0.1	< 0.01	- 0.01
Loading (hydrology,pressure)	0.14	0.01	- 0.05
Troposphere delay model	0.1	- 0.01	- 0.13
Radio source instability	---	0.01	- 0.02
Total	0.34	0.01	- 0.21