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Thermal deformation of VLBI antennas

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Geodetic VLBI is one of the major space geodetic techniques that contributes to the International Terrestrial Reference Frame (ITRF). Error contributions due to atmospheric propagation effects, loading phenomena and technical reasons have been minimized during the last years. The accuracy of geodetic VLBI results is today on the sub-cm level. For further improvements in accuracy also the thermal deformations of the radio telescopes have to be taken into account in the analysis of geodetic VLBI data.

Thermal deformation effects can reach several millimeters in particular for the vertical position of the antenna reference point. The magnitude depends on the design of the antenna structure, the material, and environmental influences. The variations typically have seasonal and daily signatures.

Two radio telescopes, Onsala (Sweden) and Wettzell (Germany), are equipped with measurements systems that are based on invar rods or invar wires and provide direct observations of the vertical variation of the telescope reference points. Based on these measurements we developed models that can be used to model thermal deformations as a function of environmental temperature observations. These thermal deformation models can also be applied to other radio telescopes that are not equipped with invar measurement devices.

We present direct observations of thermal deformation of the radio telescopes at Onsala and Wettzell, we also discuss the corresponding models for thermal deformation and the possibility to apply them to other radio telescopes. The application of directly measured thermal deformations and thermal deformation models in the VLBI data analysis and the corresponding effects on the geodetic VLBI results will be addressed.