GRACE
Science
School

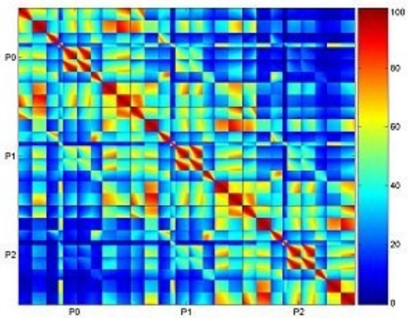
GNSS - FROM OBSERVATIONS TO PRECISE POSITIONING

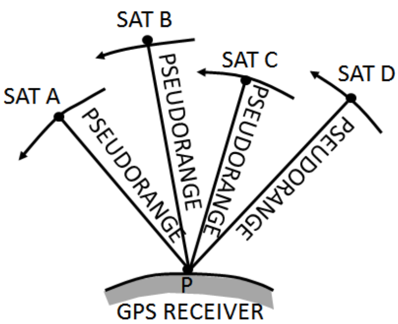
Date: May 03 and May 11, 9:45 - 13:00

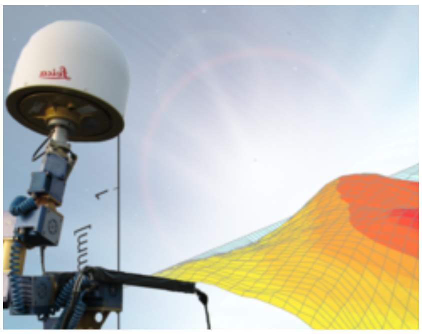
Place: Room 318, Building 10.81

Lecturer: Prof. Dr.-Ing. Steffen Schön, Gael Kermarrec

Credits: 0.5







Content

Global navigation satellite systems (GNSS) are a basis for precise positioning, navigation and timing for both everyday life and specialized, high precision scientific investigations. GNSS observations enable a large variety of applications from geodetic positioning at the mm level for deformation monitoring to atmospheric sounding or weather forecast. Thanks to a sampling rate of up to 100Hz high frequency phenomena can be studied such as vibrations or atmospheric fluctuations.

In a first part, after a general overview of GNSS systems, the basic concepts of GNSS based precise positioning are addressed and illustrated with precise point positioning and relative positioning. The GNSS uncertainty budget will be explained with examples and methods to reduce systematic effects such as double differencing or linear combinations presented. We will show and discuss that every error source for GNSS positioning is a valuable signal for new applications especially in environmental sciences.
The functional model that describes the relationship between observations and estimates is quite well understood. However the stochastic model - which is a prerequisite for sound interpretation of the obtained results - is still improvable.

The second part will be devoted to the deeper study of the stochastic model of GNSS observations that describes the statistical dependency of the measurements. After a short introduction to the underlying statistical concepts of variance and covariance that are used to describe the stochastic model, the basics of least-squares estimation will be shortly reviewed. Next, different variance and covariance models from simple cosine to the fuzzy logic models proposed in literature will be presented and their characteristics compared. As only a correct or well estimated stochastic model allows to derive optimal parameters from the least-squares estimation, the impact of miss-specified stochastic models will be introduced. In a last section, we describe in details how a physically derived covariance function for GNSS phase measurements can be built. Based on the concept of turbulence theory, it is shown how variations of the refractivity index due to turbulent activity in the atmosphere impact the phase measurements. Underlying concepts such as the eddies, the energy cascade or Taylor frozen hypothesis will be explained. These concepts are not only useful for GNSS but also to further observations like INSAR or optical measurements. Applications show that the final covariance model describes adequately correlations between GNSS phase observations and yields more realistic quality measures for the estimated parameters.

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