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Investigations and approaches for modeling GNSS clocks in a global network

Global Navigation Satellite Systems (GNSS) are one of the most important techniques for positioning, navigation and the realization of the International Terrestrial Reference Frame (ITRF), which forms the basis for many coordinate-related applications in the geosciences. The basic principle of GNSS is to measure the time difference between the transmission of a microwave signal at the satellite and its reception at the ground station. For this reason, clock information is required on both sides.

The quality of the clocks used varies strongly and ranges from highly stable atomic clocks on board of the satellites (e.g. hydrogen masers) to less stable quartz oscillators, which are built into most GNSS receivers. To compensate for the resulting synchronization errors, current GNSS analysis models generally introduce epoch-wise clock biases into the observation equations. The often-made assumption of a pure white noise behavior for the estimated clocks leads to negative effects in the results, especially to high correlations between the clocks and other geodetic parameters. Modeling the clock behavior to reduce the number of unknowns can be a solution to this problem, but requires a high degree of stability for the corresponding clocks.

We present our comprehensive investigations into the clock quality within the station network of the International GNSS Service (IGS). Those IGS ground stations, that are connected to an external H-maser clock, are considered in a global network analysis over a period of one year. The generated clock products are used to compare the frequency stabilities within the station network, as well as with the mean behavior of different satellite blocks. Additionally, the results of first modeling approaches are shown.

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