Combination of precise GNSS orbit and clock solutions in a multi-constellation, multi-frequency environment

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Precise GNSS orbit and clock solutions are essential for the generation of the Terrestrial Reference Frame (TRF) and required for a broad variety of applications. Over the last decades the combination products of the International GNSS Service (IGS) have become the standard for all kinds of GNSS applications requiring highest accuracy.

The emerging new GNSS constellations Galileo, BeiDou and the QZSS as well as the modernization of the already established GPS and GLONASS constellations will stimulate a new development in the GNSS data processing in order to gain be best benefit from the new signals and systems for geodetic and geodynamic applications. This introduces the question regarding the influence of this development on the orbit and clock products. What are the consequences for the consistency of the contributions from the Analysis Centres (ACs) of the IGS and how does the combination procedure need to react on his development?

Another set of questions is related to the expected scenario in which not all IGS ACs will likely include all GNSS. The algorithm for the orbit and clock combination needs to be adapted for a multi-system combination to keep on one hand the internal consistency between the GNSS during the combination procedure but also consider the differences in the expected orbit qualities between the satellite systems (e.g., due to the number of satellites or network coverage).

To investigate these questions ESOC and AIUB have agreed on a joint research fellowship for three years. The objective of this research is to analyse the capabilities and challenges when combining hybrid multi-GNSS solutions and to develop a concept, which compares and combines orbit and clock contributions to come up with a consistent, reliable, truly combined multi-GNSS combination product.

Well-defined test scenarios shall be constructed and analysed based on the GNSS data processing software packages in the two institutions, namely "NAPEOS" and "Bernese GNSS Software". The presentation will show selected results from the on-going research, to address the impact of several key elements, on the potential combination, which will ultimately give the criteria for the weighting scheme undertaken in the combination.