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## The benefits for ITRF2020 from multi-technique combination at the observation level (COOL) processing

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For the previous ITRF calls for participation ESOC reprocessed the historic data from the IDS, IGS, and ILRS. Our three solutions were computed with a single software package (NAPEOS), running on the same machine and using, as far as possible, identical settings. Any systematic differences between the technique dependent reference frame solutions must therefore be caused by the techniques themselves, and not because of model differences or errors. Our three technique dependent solutions gave us a good understanding of the technique dependent effects, helping us to improve our models.

At ESOC we have now made a significant step forward by including all satellite geodetic techniques (SLR, DORIS and GNSS) into one solution. This allows us to combine the ILRS, IDS and IGS reference frames by using "space ties". Of course these space ties are not perfectly known but they still allow for a rigorous combination of the different reference frames. Furthermore, and very important for the GNSS technique, they allow for the direct estimation of the GNSS satellite transmitter phase centre offset. We solve not only for integer ambiguities of the GPS satellites but also for those of the LEO satellites, which is also providing GPS phase observations on two frequencies.

Our poster presents an overview of this multi-technique combination approach at observation level (COOL). We have included all observations provided by the following satellites in a single parameter estimation process: GNSS, JASON, SPOT, Sentinels, GRACE, LAGEOS and Etalon satellites. We demonstrate the benefits of such a rigorous approach compared to processing the various space geodetic techniques separately.