

Multi-technique combination of space geodesy

observations

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Study Context

Multi-technique combination: simultaneous use of observations of the different space geodesy techniques (DORIS, GNSS, SLR, VLBI) to derive geodetic parameters

 \rightarrow allows to combine the technique advantages while mitigating their weaknesses

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Ground ties / local ties: necessary in order to obtain a homogeneous multitechnique reference frame

Some restrictions: low number, poor distribution, precision varying with sites, discrepancies with space geodesy estimates (37% at > 1cm, [Altamimi et al.,



Space Ties

- Multi-technique satellites : co-✤ Advantages: location sites in space
- Idea: tying the techniques by using the space ties found on multi-technique satellites such as Jason-2
- Densified co-locations
- > Inter-technique calibration
- > Allows external validation of local ties

But the ST values are not always well known... \rightarrow Re-evaluation needed?



- ♦ Over the period 20/05/2011 03/12/2011, we derived: ➢ GPS-only, DORIS-only and SLR-only solutions Multi-technique solutions with Jason2 as space tie Processing strategy:
 - ➢ GINS software
 - ➢ GRGS AC standards
- Presented results:

Outline

- > Impact on ground station positions
- > Re-evaluation of Jason2 space ties



Impact on station positions

We derived different series of weekly terrestrial frame solutions in order to study the impact of the Jason2 observations and of the multi-technique combination on ground station position estimates:

- > GPS_only (Go): Ground GPS observations only
- ➢ GPS+Jas2 (GJ2): Ground + Jason2 GPS observations
- > SLR_only (So): SLR observations to Lageos 1/2
- > SLR+Jas2 (SJ2): SLR observations to Lageos 1/2 and Jason 2
- > DORIS_only (Do): DORIS observations to Envisat, Cryosat-2, SPOT 4/5 and Jason2
- > comb: multi-technique solution with Jason2 as space tie (no local ties, NNR constraints on the GPS network)

We compared each series of weekly terrestrial frames with the weekly solutions submitted to **ITRF2014** (IGS repro2; ILRSA v61; IDS 09).

The figures below show the **WRMS [mm]** of the residuals from weekly 7-parameter Helmert comparisons





Helmert parameters w.r.t. ITRF2014P: Translations [mm], scale [ppb]



GPS week GPS week GPS week

Time series of weekly estimated space tie parameters:

Small bias on TZGPS, ~3mm.

Signal on TXGPS directly correlated with Jason-2 beta angle. Smaller beta-related signals seem also present in TYGPS and TZGPS.



- We stacked our multi-technique combined weekly solutions into a long-term solution including:
 - > Station positions + velocities.
 - > Constant range biases for the SLR stations tracking Jason2.
 - Constant Jason2 space ties.
- Different constraints were used to define the long-term frame:
 - Positions: NNR on the GPS network, NNR+NNT on the 3 techniques, NNR+NNT+NNS on the 3 techniques.
 - > Velocities: NNR on the GPS network, strong constraints on ITRF2014P.

Our combined solutions are of equivalent quality to the GRGS AC solutions.

- The addition of Jason2 observations seems to slightly degrade the North component of the GPS and SLR station position estimates.
- **Our multi-technique combination with Jason2 as space tie has marginal impact** when comparing the combined solutions with the technique-only (+Jason2) solutions.
- **The addition of Jason2 observations improves the T_x and T₇ parameters of GPS, but** the observation period is too short to conclude about geocenter motion.
- The multi-technique combination has little effect on Helmert parameters. The technique scales are in particular unaffected.

- Only the TZDORIS seems affected by adding NNS constraints w.r.t. the ITRF2014P, because of its link with the DORIS network scale.
- Orbits and stations positions were estimated by taking into account the newly estimated values for the Jason-2 space ties. The effects on orbits and stations positions are negligible.
- Space ties increments are absorbed mostly by other parameters such as laser range biases, frequency biases, clock parameters, ambiguities on Jason-2 etc.

Extend study period

Perspectives

- Use a constellation of multi-technique satellites
- Track down the orbit modeling errors that contaminate some of the weekly space tie estimates
- Re-evaluate technique-specific biases simultaneously with space ties:
 - > GPS satellite phase center offsets
 - ➤ SLR range biases
 - DORIS frequency biases