Analysis of the Signal Content in the Coordinate Time Series of the DORIS Stations

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Abstract

In the context of ITRF2014, the Combination Center (CC) **of the International DORIS Service (IDS) delivered to the IERS weekly SINEX files containing DORIS stations positions from January 1993 to December 2014. The IDS series is the combination of multi-satellite weekly SINEX solutions from the six IDS Analysis Centers** (ACs)**. Since ITRF2014, all the series were extended to December 2015 and the associated cumulative DORIS position and velocity solutions were computed by stacking all the weekly solutions.**

The objective of this study is to analyze the signal content of the station position residuals (difference between the coordinate time series and mean velocities) of the 71 DORIS sites from the seven solutions (6 ACs + 1 CC**). Amplitudes of annual, semi-annual and draconitic periods of the DORIS satellites will be investigated. Furthermore, annual and semi-annual estimates will be compared with displacements due to atmosphere and hydrology as well as with the coefficients deduced from the ITRF2014 solution from IGN.**

DORIS Series

In addition to the IDS contribution to the ITRF2014 (IDS combined series IDS 09), we analyze 6 IDS AC individual solutions: ESA 10, GOP 43, GRG 40, GSC 26, IGN 15 and INA 10. Note that the first five solutions were included in the IDS 09 combined series. Instead of using the former INA solution (INA 08), which was included in the IDS 09 series, we opted for the new INA 10 series as it makes use of the DORIS ground antenna phase laws (as the other series).

Methodology

For each series, the estimation of the signal content of the DORIS coordinate time series consisted in 6 steps:

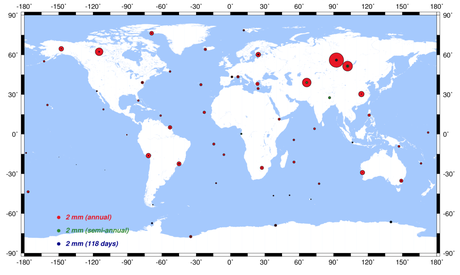
1. **Construction of the DORIS position and velocity cumulative solution over the time period 1993.0-2015.0.** The position discontinuities and velocity constraints are the same as in Moreaux et al. (2016).
2. **Estimation of the DORIS station position residuals (differences between the coordinate time series and the mean velocities).**
3. **Selection of the residuals from Jason-2 including (2008/06/20).**
4. **Gathering of residuals per DORIS site.**
5. **Rejection of sites with less than 120 weeks or with mean time interval larger than 10 days.**
6. **Estimation of the top 25 periodic signals w.r.t. S/N ratio larger than 2. Software: FAMOUS from Mignard (2005).**

Atmosphere and Hydrology

Atmospheric and hydrologic loading at the DORIS sites was modeled using weekly averages of products derived from the ECMWF ERA Interim reanalysis (http://loading.u-strasbg.fr/**). After combination of these two loading displacements, the time series were injected into step 5 of the Methodology to obtain the signal content.**

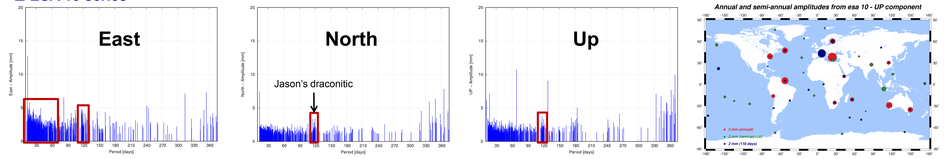
As expected and as depicted by the next figure, the largest displacements are in the up component and are of an annual period. The most impacted sites are: Yellowknife, Badary, Kitab and Krasnoyarsk. We also observe smaller annual amplitudes in South America (Cachoeira, Kourou and Santiago) and in Australia (Mount-Stromlo and Yarragadee).

Annual and semi-annual amplitudes from ERA inHyd - UP component

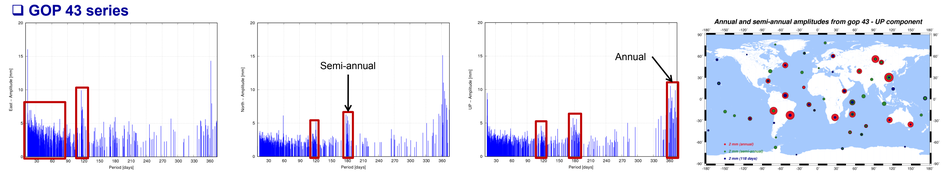


Signal Content of the DORIS Coordinate Time Series

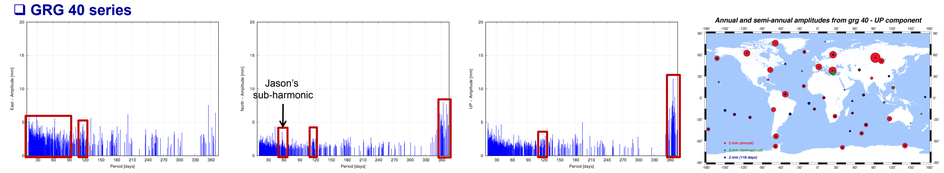
❑ **ESA 10 series**



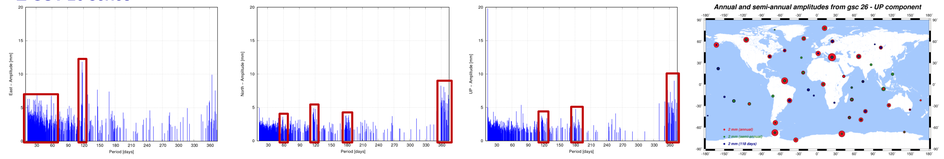
❑ **GOP 43 series**



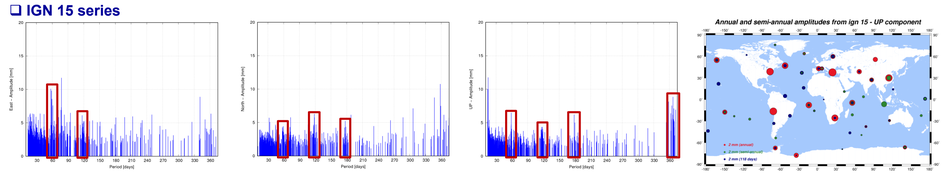
❑ **GRG 40 series**



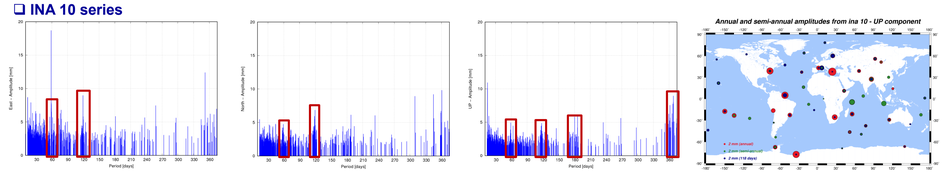
❑ **GSC 26 series**



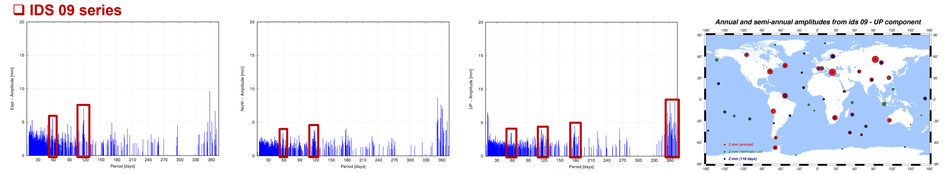
❑ **IGN 15 series**



❑ **INA 10 series**

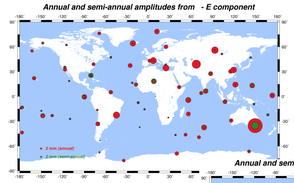


❑ **IDS 09 series**

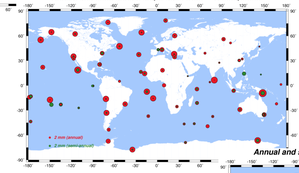


ITRF2014 Annual and Semi-annual Signals

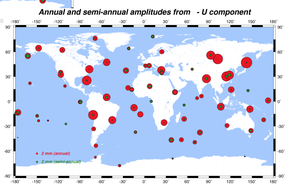
Annual and semi-annual amplitudes from - E component



Annual and semi-annual amplitudes from - N component



Annual and semi-annual amplitudes from - U component



Preliminary Conclusions

❑ **The IDS NEU coordinate time series show annual, semi-annual and 117.3-day (Jason satellite draconitic) periodic signals.**

❑ **Overtones (58.7 days, 29.3 days) of the Jason draconitic period are also observed in the three components (NEU).**

❑ **The Jason draconitic is most likely explained by mismodeling of the solar radiation pressure, however errors in the DORIS measurement model could also contribute at some level.**

❑ **The East component shows higher amplitudes at lower frequencies. This is most likely a consequence of the orbit configuration for the DORIS satellite constellation.**

❑ **Maps of the amplitudes of the periodic signals show geographic regional coherences** (North America, West Eurasia, Europe)**.**

❑ **The smallest amplitudes are obtained for the stations situated on islands.**

❑ **Coherence between IDS 09 and atmosphere and hydrologic annual signals in Yellowknife, Badary, Kitab and Krasnoyarsk. Higher amplitudes for IDS 09 in Cachoeira, Kourou, Santiago and Hartebeesthoek may be explained the South Atlantic Anomaly sensibility of SPOT-5, Jason-1 and Jason-2 Ultra Stable Oscillators.**

❑ **Differences with ITRF2014 estimations may reflect differences in the time span as well as in the estimation strategy. In ITRF2014, annual and semi-annual signals are estimated at the combination level. Part of the differences may be in the IDS 09 geocenter motion.**

Acknowledgment

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References

Moreaux, G., Lemoine, F.G., Argus, D.F., et al., 2016. Horizontal and vertical velocities derived from the IDS contribution to ITRF2014, and comparisons with geophysical models. *Geophys. J. Int.*, 207, 209-227, doi: 10.1093/gji/ggw265.

Mignard, F., 2005. FAMOUS, frequency analysis mapping on usual sampling. Technical report. Obs. de la Cote d'Azur Cassiopé, Nice, France.

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