Are there detectable common aperiodic displacements at ITRF co-location sites?

Maylis de La Serve[1], Paul Rebischung[1], Xavier Collilieux[1], Zuheir Altamimi[1], and Laurent Metivier[2]

[1]Université de Paris, Institut de physique du globe de Paris, CNRS, IGN F-75005 Paris France
[2]Université Paris Diderot,Institut De Physique Du Globe De Paris,Institut national de l'information géographique et forestière

November 26, 2022

Abstract

Nowadays, the time evolution of ITRF station positions is described by piece-wise linear models extended with exponential and logarithmic functions to account for post-seismic displacements. The ITRF2020 will also account for seasonal deformation by means of annual and semi-annual sine waves. However, part of the Earth's surface deformation is not captured by those deterministic functions, such as inter-annual hydrological loading deformation, or high-frequency atmospheric loading deformation. To account for such aperiodic displacements, a reference frame in the form of a time series could be considered. This would require aperiodic motions of the different space geodetic stations to be tied in a common frame by means of co-motion constraints. The relevance of such constraints is however debatable. Indeed, common aperiodic movements between co-located space geodetic stations have thus far not been evidenced. This presentation describes the comparison of station position time series from the different space geodetic techniques in order to highlight whether or not common aperiodic movements can be detected at co-location sites. Those time series are extracted from the solutions provided by the techniques international services for the ITRF2014. They are first carefully aligned to a common reference frame in order to minimize differential network effect. Then, they are cleaned from linear, post-seismic and periodic signals (including seasonal deformation and technique systematic errors). Residual time series from co-located stations are finally confronted with each other.

Posted on 26 Nov 2022 — The copyright holder is the author/funder. All rights reserved. No reuse without permission. — https://doi.org/10.1002/essoar.10509118.1 — This a preprint and has not been peer reviewed. Data may be preliminary.

Are there detectable common aperiodic displacements at ITRF co-location sites ?

G55C-0267

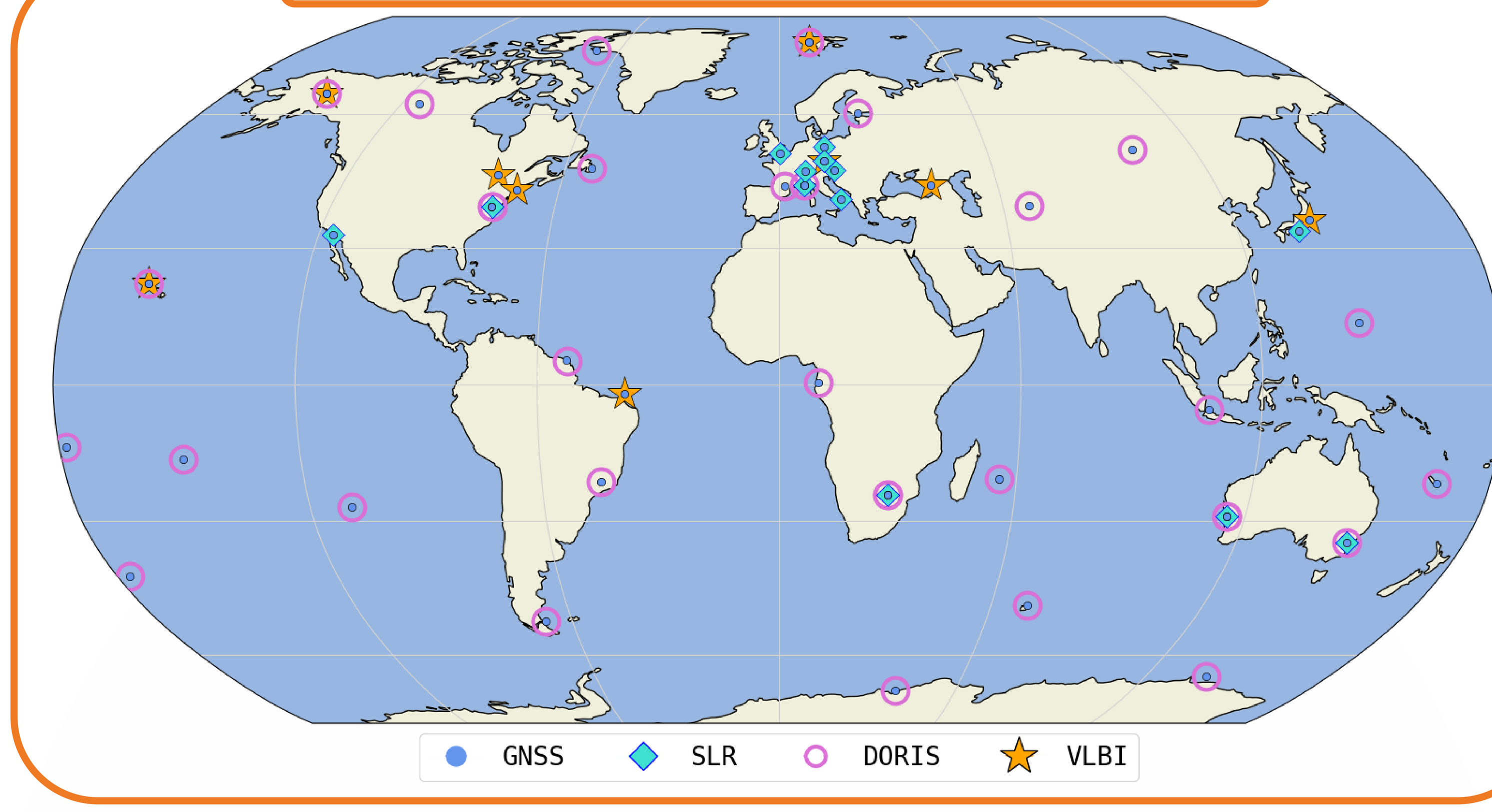
Maylis de La Serve[1,2] , Paul Rebischung[1,2] , Xavier Collilieux[1,2], Zuheir Altamimi[1,2], Laurent Métivier[1,2] email : teyssendier@ipgp.fr

[1] Université de Paris, Institut de physique du globe de Paris, CNRS, IGN, F-75005 Paris, France [2] ENSG-Géomatique, IGN, F-77455 Marne-la-Vallée, France

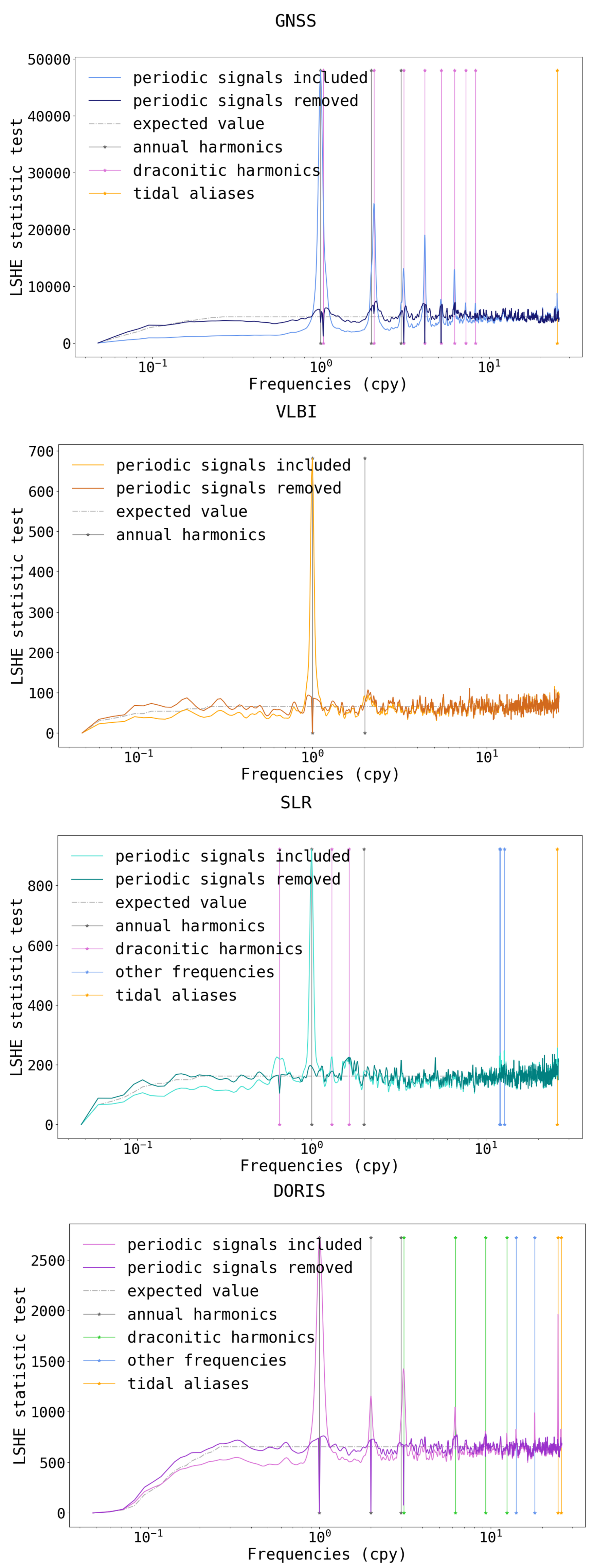
A – Introduction

- Part of the Earth's surface deformation is not captured by the deterministic functions of the current ITRF model, such as inter-annual hydrological loading deformation, or high-frequency atmospheric loading deformation.
- To account for such aperiodic displacements, a reference frame in the form of a time series could be considered. This would require aperiodic motions of the different space geodetic stations to be tied in a common frame by means of co-motion constraints.
- However **common aperiodic movements, other than post-seismic deformations, between co-located space geodetic stations have thus far not been evidenced at a global scale.**
- This poster describes the comparison of station position time series from the different space geodetic techniques in order to highlight whether or not common aperiodic movements can be detected at co-location sites.

D – Selected colocation sites



C – Spectral analysis

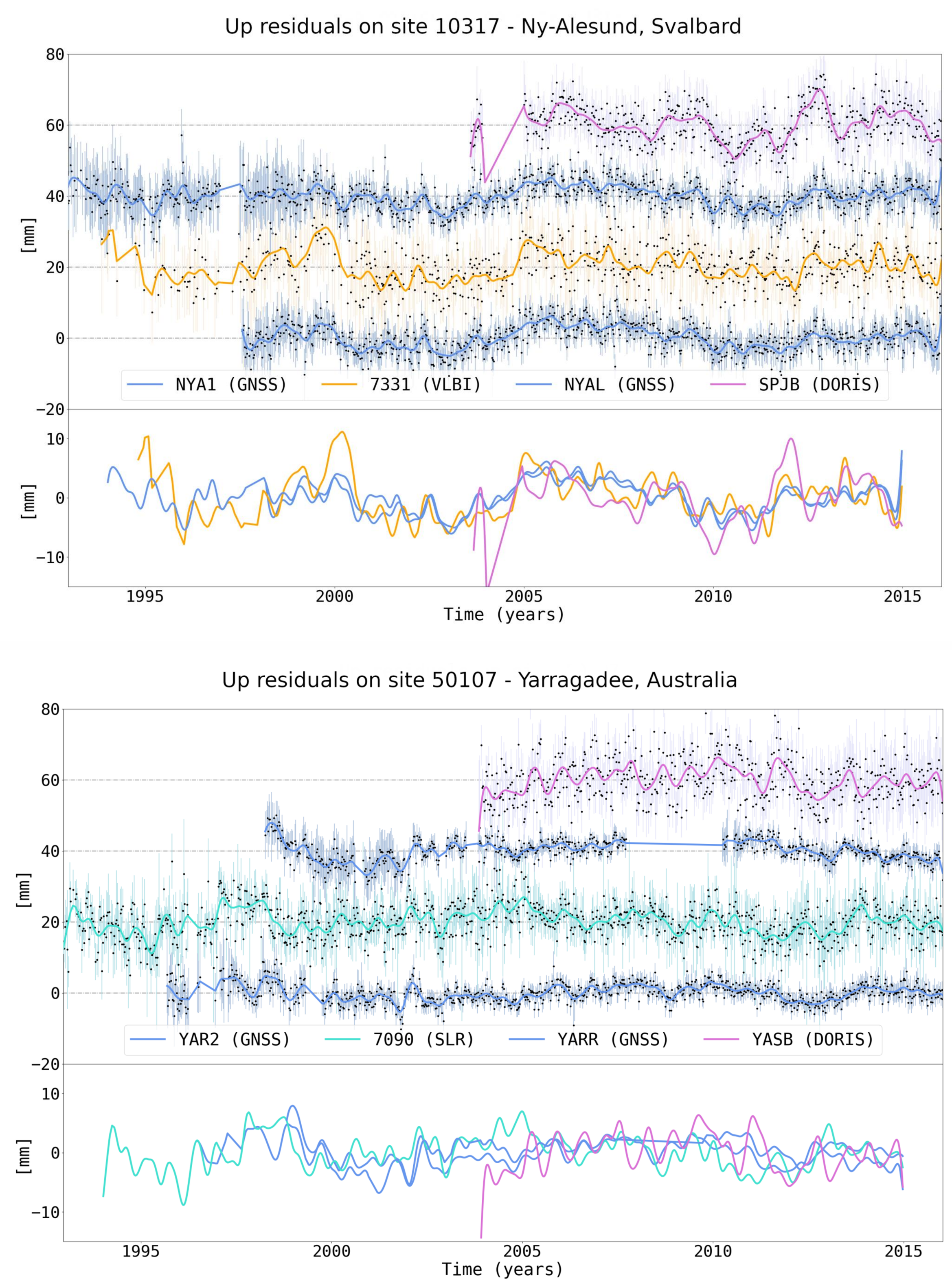


We analyze the spectral content of the position time series in order to clean them from seasonal signals and technique-specific periodic errors (e.g., GPS draconitics). We use the statistical method LSHE – Least Square Harmonic Estimation [2] - to test for the significance of potential periodic signals, and iteratively remove the most significant ones.

B – Data and processing

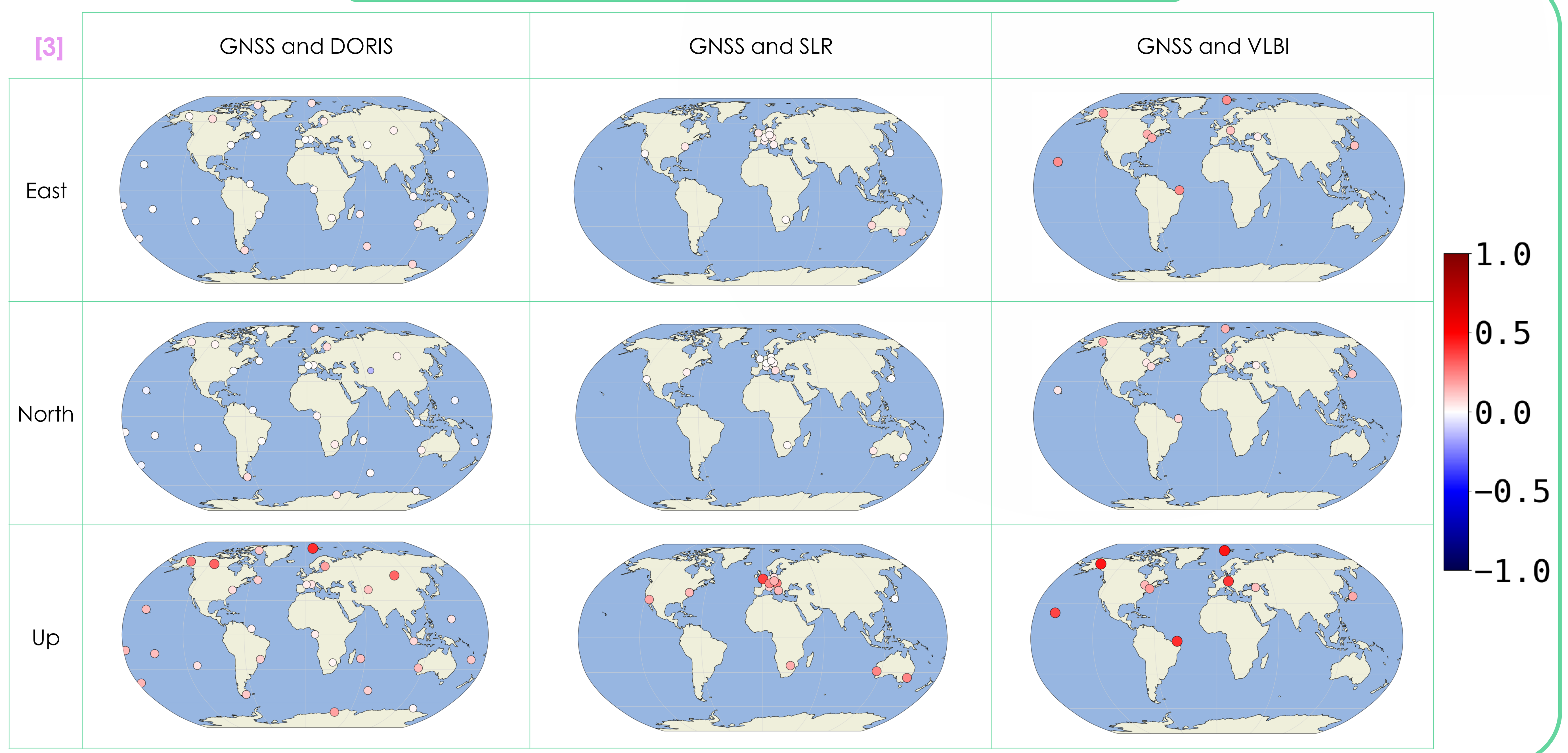
- The station position time series are extracted from the solutions provided by the technique services for the ITRF2014 [1] and sampled at a weekly basis.
- They are first carefully aligned to a common reference frame. In order to minimize technique related network effect, the solutions of the other techniques are aligned to the GNSS solution of the same week.
- Then, they are cleaned from linear, post-seismic and periodic signals, including seasonal deformation and technique systematic errors - see C.
- Residual position time series from a selection of co-located stations - see D - are finally confronted with each other - see E and F.

E – Residual position time series



The curves are Vondrak-filtered residuals with a 2 cpy cutoff frequency.

F – Concordance correlation coefficient of the residuals



G – Conclusions and perspectives

- Modest correlations are observed between GNSS residual position time series and the other space geodetic techniques, mostly in the vertical component.
- Are these correlations broadband, or do they pertain to particular frequency bands? ⇨ Compute frequency-dependent inter-technique correlations.
- How much of these correlations is explained by loading deformation? ⇨ Repeat the study with loading-corrected time series.
- Unfortunately, this work is limited by the heterogeneity of the space geodetic techniques data : difference in precision, global coverage and amount of data.

H – References

[1] Z. Altamimi, P. Rebischung, L. Métivier, et X. Collilieux, « ITRF2014: A new release of the International Terrestrial Reference Frame modeling nonlinear station motions », Journal of Geophysical Research: Solid Earth, vol. 121, no 8, p. 6109-6131, 2016, doi: 10.1002/2016JB013098.

[2] A. R. Amiri-Simkooei, C. C. J. M. Tiberius, et P. J. G. Teunissen, « Assessment of noise in GPS coordinate time series: Methodology and results », Journal of Geophysical Research: Solid Earth, vol. 112, no B7, 2007, doi: https://doi.org/10.1029/2006JB004913.

[3] L. I.-K. Lin, « A Concordance Correlation Coefficient to Evaluate Reproducibility », Biometrics, vol. 45, no 1, p. 255-268, 1989, doi: 10.2307/2532051.