Call for space geodetic solutions corrected for non-tidal atmospheric loading at the observation level

Background:

Crustal motion related to non-tidal atmospheric loading (NT-ATML) has been detected in station position time series from space geodetic techniques *(van Dam and Herring, 1994; van Dam et al., 1994; Magiarotti et al., 2001; Otsubo et al., 2004)*. Several models of station displacements related to that effect are currently available. At the moment, NT-ATML models are not yet considered as Class-1 models by the International Earth Rotation and Reference Systems Service (IERS) *(Petit and Luzum 2011)* indicating that they are currently not recommended for data reduction.

Up to the latest realization of the International Terrestrial Reference System (ITRS), namely ITRF2008, contributed solutions were requested not to include NT-ATML models. Attempts have been made to consider non-tidal loading corrections as a posteriori corrections to construct a multi-technique combined reference frame *(Collilieux et al., 2010)*. However, the improvement, while conclusive at some stations, has not been widely observed. Atendees to The Unified Analysis Workshop 2011 (Zurich) have recommended that the community evaluate space geodetic solutions for the period 2006-2011 with loading corrections applied at the observation level and a posteriori. Participants are requested to use the same loading model, i.e. that delivered by the Global Geophysical Fluid Center (GGFC) of the IERS.

The objective of this test is to evaluate the impact of atmospheric loading corrections on Terrestrial Reference Frame (TRF) and Earth Orientation Parameters (EOP). Compared to previously published studies, this call is an opportunity to assess the impact of atmospheric loading corrections to all technique solutions using the same loading model. Solutions with and without NT-ATML corrections will be compared. The issue of applying mean daily/weekly NT-ATML corrections to solution (a posteriori corrections) versus using the loading model a priori in the data processing will be also revisited for the four space geodetic techniques. Finally, the impact of NT-ATML on the International Terrestrial Reference Frame (ITRF) will be carefully studied.

Contributions

The objective of this call is to collect and evaluate space geodetic solutions (daily or weekly) spanning the period 2006.0-2011.0, as well as to assess the NT-ATML impact on an ITRF-like combination. A contribution consists of two sets of solutions:

- one without non-tidal atmospheric loading corrections applied at the observation level (called *standard* solution in the following);
- and one with atmospheric loading applied at the observation level (called *load-corrected* solution). The specific model used in this test will be delivered by the GGFC.

If the participants wish to use another NT-ATML model, they are welcome to submit a third solution. In this case, they are requested to deliver the full model time series for every station over the whole period of time at the highest resolution.

It is important that the NT-ATML two solutions differ only by the application of the non-tidal loading corrections. Any submission that does not fulfill this requirement will not be considered. More details about the contribution requirement are provided in the next section.

Description of the requested solutions

Geodetic data:

- Submitted Solutions should be individual solutions either from DORIS, GNSS, SLR and VLBI

Sampling rate of the solutions:

- session-wise for VLBI

- daily or weekly for GPS. Daily solutions are favored if possible.

- weekly for SLR and DORIS

Handling of tidal loading:

Atmospheric tidal loading should be applied according to *Ray and Ponte (2003) (IERS, 2011)* for BOTH solutions. These corrections should be expressed in the Center of Mass frame for the solid Earth + load (CM) for satellite techniques.

Handling of non-tidal loading geometric effect:

- Up to now, there is no recommended interpolation method to interpolate NT-ATML corrections. You may use the method that you think the best.

Handling of non-tidal loading gravitational effect for satellite techniques:

For consistency, it is recommended to model gravitational variations due to mass flux within the atmosphere in the *load-corrected* solution. These mass transfers also generate a modification of the gravitational potential due to the deformation of the solid Earth.

The Earth and mass load models used to derive the adopted model of the atmosphere effect on the potential should be the same as those used to derive the geometrical effect. Thus, GGFC also provides the g=stokes coefficients of the atmosphere contribution to the geopotential into a series of spherical harmonics up to degree 50/50. The impact of the gravitational effect on the estimated satellite orbits depends on the satellite altitude, so it is up to the technique services to adopt the most suitable truncation degree of the potential model depending of the satellites they use. This model can also be used in the *standard* solution (solution without geometric load corrected) if necessary: for example *Lemoine et al., 2010* have shown that the modeling of atmospheric gravity variations modify the Jason-1 satellite position by up to 4 mm annually in the radial component and improves the orbit fit. In this case, the technique services might proceed to a test solution considering only

gravitational effect of the atmosphere over 1-2 years to verify if this correction is necessary in the *standard* solution.

Processing strategies:

- Homogeneously processed solutions are required.
- A global network of stations is requested for GPS in order to assess the Terrestrial Frame.

File format:

The solutions should be supplied as SINEX files that follow the SINEX Version 2.0 format standard. They should contain at least the following sets of parameters:

- Station positions
- Earth Orientation parameters

The following parameters would be also appreciated:

- Troposphere parameters (Zenithal tropospheric delays). Troposphere parameters can be supplied in separated files if they are not included in the SINEX files.
- GNSS antenna phase center offsets

Solutions should be given as:

- Solutions with removable constraints
- Loosely constrained solutions (constraint level: s > 1 m)
- Solutions with TRF minimum/inner constraints
- Free normal equations

A fully-updated summary file, as traditionally supplied by the technique service analysis centers, has to be given for both solutions.

Loading model

The loading model will be available on request at the following FTP site: http://geophy.uni.lu/users/tonie.vandam/

All station position time series will be supplied in the center of mass frame of the Earth (solid Earth + atmosphere) (CM).

The gravity field contribution includes coefficients up to degree and order 50.

The NT loading model is derived using 6 hourly NCEP surface pressure data provided at 2.5 x 2.5 degree spacing over the Earth. The surface pressure data have been filtered for all periodic signals with periods less than 26 hours. The 3-d surface displacements have been

determined by convolving Farrell's Green's functions, transformed into CM, with the filtered surface pressure.

Analyses and Results

The submitted solution will be analyzed within the activity of the IAG working group "Modeling environment loading effects for Reference Frame", GGFC and the ITRF Product Center.

- Solutions with and without NT-ATML corrections will be compared for station positions, EOPs and troposphere parameters;

- Mean daily NT-ATML a posteriori corrected solutions (computed by the study group from the non-corrected solutions) will be compared to a priori corrected solutions that have been submitted. Whereas a posteriori corrections are known to be less rigorous in principle, their use could be more flexible if they are shown not to degrade significantly the solution;

- ITRF-like combinations will be operated using the three types of solutions so that the impact of NT-ATML on the ITRF will be carefully evaluated.

Instructions

The Technique Centers and individual Analysis Centers that intend to contribute their time series of SINEX files should submit these series by July 1st, 2012 at the latest. Earlier submissions are most welcome and very much encouraged.

To submit a time series of SINEX files please send an e-mail to:

ITRF PC: itrf@ign.fr

and

IERS Central Bureau: central_bureau@iers.org

The e-mail should contain the detailed instructions on where the solutions can be downloaded, their present naming convention, etc. The submitted SINEX files will be archived in the IERS information and database system and the ITRF PC.

References

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