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Jet Propulsion Laboratory
California Institute of Technology
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Assessment of the ITRF2000 accuracy for the DORIS tracking network and implication for the Jason Precise Orbit Determination

Pascal Willis (IGN+JPL/Caltech), John C. Ries (CSR/U. Texas), Bruce J. Haines (JPL/Caltech), Laurent Morel (ESGT)

Context:

The DORIS network has several advantages for Precise Orbit Determination (geographical distribution, long-term observation).
Precise and reliable station coordinates are mandatory for POD.
ITRF2000 cannot be used as such as it has several known deficiencies:

- •New stations do not appear in ITRF2000
- •Some DORIS problems (antenna tilts, station discontinuities in the geodetic time series) were not known at the time of the ITRF2000 computation (Willis and Bar-Sever, 2003)

ITRF2004 is in preparation but may not be available for several months.

Scientific objectives:

•Provide a Terrestrial Reference Frame of DORIS stations (positions in 1997.0 and velocities), based mainly on the latest ITRF2000 realization for Precise Orbit Determination (POD).

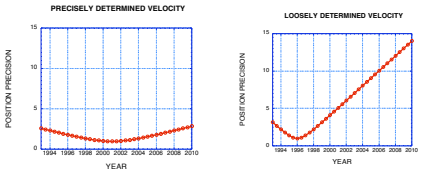
•Assess the quality of this frame for POD applications. In some cases, recommend to use these coordinates and velocities with caution (down-weigthing of the data) or not to use them at all during specific period of observation.

Conclusions

We studied the accuracy of the current ITRF2000 stations.
A method has been proposed to test the accuracy and the reliability of Terrestrial Reference Frame for Precise Orbit Determination
For each DORIS stations we have proposed coordinates and velocities at epoch 1997.0
We also propose a classification of the DORIS stations, specifically suited for Precise Orbit Determination.
Such a classification could be used as a basis of a possible DORIS core network

References
Altamimi, Z.,P. Sillard, C. Boucher (2002), ITRF2000, a new release of the International Terrestrial Reference Frame for earth science applications, J. Geophys. Res., 107(B10), 2214.
Melbourne, T.I. And F.H. Webb (2002), Precusory transient slip during the 2001 M-w= 8.4 Peru earthquake sequence from continuous GPS, geophys. Res. Lett., 29921), 2032.
Morel, L., and P. Willis (2002), Parameter sensitivity of TOPEX orbit and derived mean sea level to DORIS station coordinates, Adv. Space Res., 30(2), 255-263.
Willis, P. and Y.E. Bar-Sever, DORIS time series elaboration with the Gipsy/Oasis software,IDS Analysis Workshop, February 20-21, 2003, http://lareg.ensg.ign.fr/IDS/events/prog_2003.html
Willis, P. and M. Heflin (2004), External validation of the GRACE GGM01C gravity field using GPS and DORIS positioning results, Geophys. Res. Lett., 31(13), L13616.

Epoch of reference, epoch of minimum variance, epoch of comparison



The epoch of reference of the frame is totally conventional. For our study, we used 1997.0 to express coordinates of all DORIS stations at the same epoch.
Due to the imprecision of the velocity (estimated parameter), the position precision degrades with time and possesses a minimum that is close to the mean observation epoch. In the case of DORIS, this epoch is in fact more recent, as the weekly precision of the DORIS results increases with time with the number of available satellites (Willis and Heflin, 2004). This epoch is called the epoch of minimum variance and is different from station to station, depending on the observation and on the number of available data.
In our study, we have compared coordinates of all station at a specific epoch of comparison, depending on the nature of the station (2010 for active stations and the end of the observation for non-active stations).

Description of the method:

In a first step we have analyzed the published ITRF2000 coordinates by comparing the ITRF2000 position at the epoch of comparison to the position obtained through a more recent DORIS realization IGN04D02 done at JPL (1993 to 2004.5). For active DORIS stations, the test was done by interpolation to 2010 and the threshold used for the test was 10 cm as such a difference would not affect the radial component of the orbit nor the derived Mean Sea Level (Morel and Willis, 2002).

In a second step, we have extended the ITRF2000 realization by computing coordinates of new DORIS beacons installed on ITRF2000 sites using local ties. The same tests were conducted also on these coordinates at the epoch of comparison.

In a last step, for stations that were not in the original ITRF2000 submission or that failed the tests discussed above we have estimate a DORIS position and a DORIS velocity. In some cases, we had to adopt a plate tectonic model when only few DORIS observations were available. We have tested these coordinates and velocities with other realizations as provided by John C. Ries (CSR/U. Texas) and F. Lemoine (NASA/GSFC).

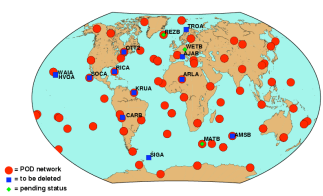
In some cases, we were able to distinguish 2 types of classifications: excellent and good stations (from the point of view of the POD analysis). Good stations may not have a precisely determined velocity due to a limited DORIS data set of observation. Some stations were also declassified as "good" when discontinuities were found in the geodetic time series (Willis and Bar-Sever, 2003) or when special events occurred to the station (antenna tilt or instability).

FINAL RESULTS: POD NETWORK PROPOSAL

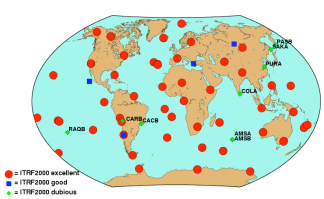
Stations with a pending status = Stations for which we provide coordinates and velocities. However, these information could not be fully tested using a sufficient amount of DORIS data. It is recommended that POD group use these coordinates and velocities with caution either by down-weighting the DORIS data or by putting a large a priori standard deviation on these coordinates.

Acronym	DOMES	Station	
MATB	30031 3S003	Marion island	Too few DORIS data to verify position derived from local tie
REZB	10202S003	Reykjavik	No DORIS data available to verify a priori position derived from local tie
WETB	14201S042	Wettzell	No DORIS data available to verify a priori position

Table 1: Stations with pending status



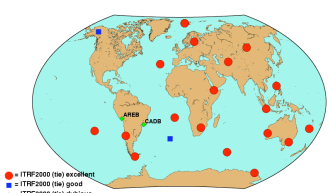
STEP ONE: validating the ITRF coordinates and velocities



Acronym	DOMES	Station	
AMSA	91401S001	Amsterdam Island	Antenna tilt at AMSB not detected during the ITRF2000 computation
AMSB	91401S002	Amsterdam Island	Antenna tilt at AMSB not detected during the ITRF2000 computation
CACB	41609S001	Cachoeira	ITRF2000 velocity was not precise enough creating errors for CADB prediction in 2010
CARB	41710S001	Cariquima	Very few DORIS data available in ITRF2000
COLA	23501S001	Colombo	Problem with velocity in ITRF2000
PASB	12339S001	Kouriles	Velocity in ITRF2000 very loose (16 weeks of observation)
PURA	21604S003	Purple Mountain	ITRF2000 velocity was not precise enough
RAQB	92403S001	Rapa	Very few DORIS data available in ITRF2000
SAKA	12329S001	Sakhalinsk	Several discontinuities in the geodetic time series creating problems with the velocity estimation

Table 2: stations published in ITRF2000 that did not pass the test and are considered as dubious. Coordinates and velocities need to be improved..

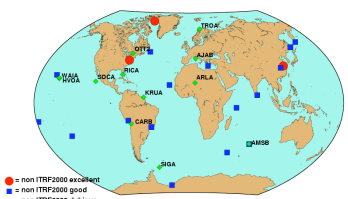
STEP TWO: validating the new ITRF coordinates and velocities (using local tie information) = new DORIS station in an old DORIS site



Acronym	DOMES	Station	
AREB	42202S006	Arequipa	The velocity after the 2003 Earthquake is different (Melbourne and Webb, 2004)
CADB	41069S002	Cachoeira	Problem with CACB ITRF2000 velocity (during the first months of CACB observation)

Table 3: Stations that were not in the ITRF2000 release but could be connected to ITRF2000 using local tie but which did not pass the test. Coordinates need to be improved

STEP THREE: Computing ITRF2000 coordinates for additional DORIS stations



Acronym	DOMES	Station	
AJAB	10077S002	Ajaccio	Insufficient number of DORIS observations
AMSB	91401S002	Amsterdam island	Antenna tilt (several cm during several months)
ARLA	33710S001	Arlit	Insufficient number of DORIS observations
CARB	41710S001	Cariquima	Very few DORIS data available in ITRF2000
HVOA	40476S001	Hawaiian Volcano	Insufficient number of DORIS observations
KRUA	97301S005	Kourou	Insufficient number of DORIS observations
OTT2	40102S007	Ottawa	Insufficient number of DORIS observations
RICA	40499S015	Richmond	Insufficient number of DORIS observations
SIGA	30607S001	Signy Island	Insufficient number of DORIS observations
SODA	40503S003	Socorro island	Volcano depletion
TROA	10302S010	Tromso	Insufficient number of DORIS observations
WAIA	40475S001	Waimea	Insufficient number of DORIS observations

Table 4: Stations that should not be used by Precise Orbit Determination