Preliminary results on the sensitivity to radiations of the back-up DORIS/Jason oscillator

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Context:

A problem has been detected on the JASON/DORIS oscillator when the satellite crosses the South Atlantic Anomaly (SAA) region.
On June 29, 2004, the back-up DORIS receiver (Jason-2) has been turned on

Goals and method:

The goal of this study is to verify if the new DORIS oscillator is also sensitive to radiations over the SAA. We have analyzed time series of DORIS weekly stations coordinates to look for erroneous velocities created by the SAA effect and try to compare the velocity before and after June 29, 2004.

Conclusions:

Unfortunately the new DORIS/Jason receiver is also sensitive to radiations over the SAA. This does not affect the current Precise Orbit Determination (POD) results but it totally forbids any use for geodetic applications. Present results (computed using only 2 months or data) show that the amplitude of the effect has an opposite sign but is smaller by a factor of two.

References:

J.-M. Lemoine,R. Biancale, A model of DORIS frequency correction for Jason in relation to the SAA, presented at the COSPAR meeting, Paris, France, July 2004.
P. Willis, B. Haines, Y. Bar-sever, et al., TOPEX/Jason combined GPS/DORIS orbit determination in the tandem phase, Adv. Space Res., 31(8), 1941-1946, 2003.
P. Willis, B. Haines, J.-P. Berthias, et al., Behavior of the DORIS/Jason oscillator over the South Atlantic Anomaly, CR Geosci, 336(9), 839-846, 2004.

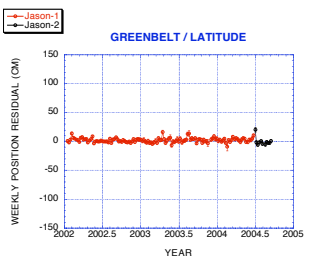
First step
Analyzing time series of stations coordinates on a station by station basis

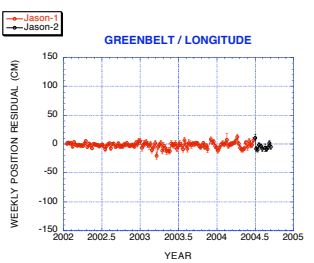
Method:

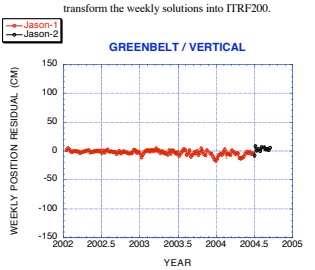
We compare for each week and for each station the position obtained using the weekly DORIS data with a recent cumulative DORIS solution IGN04D02 (position + velocity).
Stations inside and around the SAA where not used to transform the weekly solutions into ITRF200.

Greenbelt

(USA/MD) is far from the SAA.
Results are not affected by the SAA effects.
Residuals show a 2-3 cm coherence from week to week.
The velocity is totally explained by global velocity model derived using all DORIS satellites for the 1993-2004.5 period.





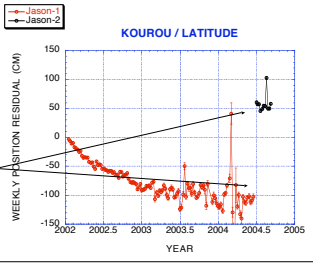


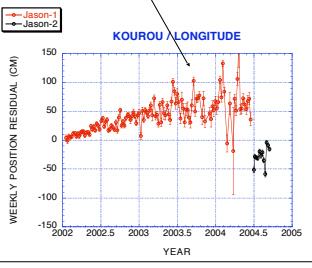
The last Jason-1 results (around June 2004) are more noisy because more and more DORIS data are rejected during the pre-processing phase at CNES

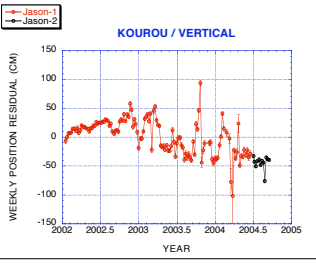
NB: to transform stations coordinates into ITRF2000 (using a standard 7-parameter transformation), stations inside the SAA or close by were not used to estimate the transformation. However, their coordinates were estimated using the derived transformation.

Kourou

(French Guyana) is inside the SAA region.
Results are affected by the SAA.
Errors are mostly in latitude as predicted by a simple model (Willis, 2004)
The second DORIS receiver (black dots) is also affected by the same effect, but with an opposite sign and a smaller amplitude (latitude and longitude).



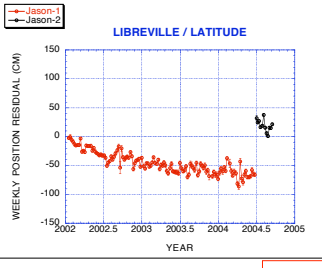


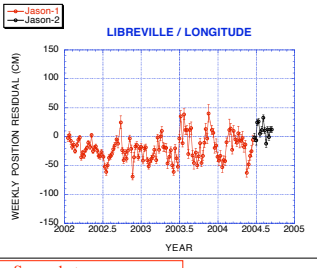


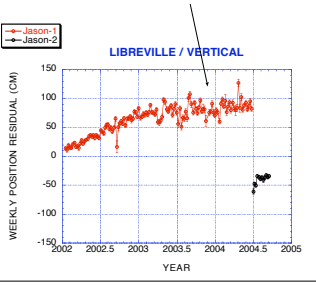
It must be noted that the effect on the height was up to 1 m even if the DORIS station was not inside the SAA.

Libreville

(Gabon) is outside the SAA but in its close periphery.
Geodetic results are also affected by the SAA effect (mostly the altitude).
The second DORIS receiver (black dots) is also affected by the same effect, but with an opposite sign and a smaller amplitude (all 3 components).

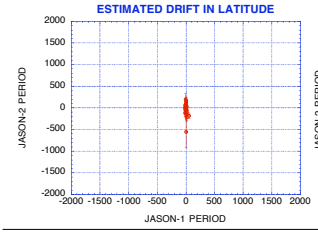




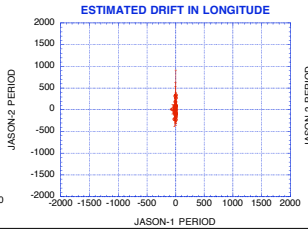


Second step
Analyzing apparent residual velocity per station and per DORIS receiver

ALL SATELLITES (EXCEPT JASON)



ALL SATELLITES (EXCEPT JASON)



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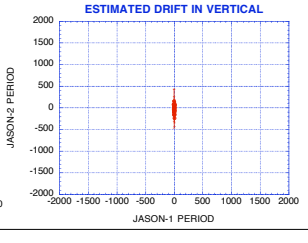
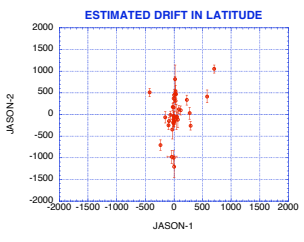


Analyzing multi-satellite solutions

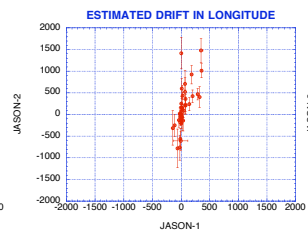
For each station, we have divided the DORIS times series in two consecutive data sets (before and after June 29, 2004).
For each data set and each station, we have estimated an apparent drift in all components (latitude,longitude,altitude) as well as its estimated precision. The plate tectonic effect has previously been removed.
Each point of the plot correspond to a unique station
X = estimated drift before June 29, 2004
Y = estimated drift after June 29, 2004
Units are in mm/year

No erroneous velocity can be detected. Sigma in Y are very large as the secular drift is computed using only 2 months of data.

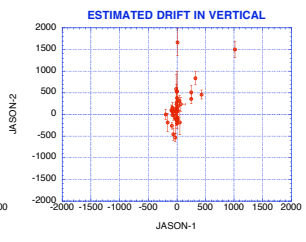
JASON - ONLY



JASON - ONLY



JASON - ONLY



Analyzing Jason-only solutions

The same analysis done with Jason-only results shows some significant outliers. These are abnormal velocity detected during the fist 2 years of the DORIS/ Jason-1 that can directly linked to the SAA effect on the DORIS clock.
By comparing the mean slope Y/X we could get an idea of the difference of sensitivity to the radiation between the two DORIS instruments.
However, the first 2 months of operation do not seem to be sufficient to derive any reliable estimate of this value.
One solution would be to impose that the effect should be 0 in December 2001 (launch of the satellite) but plots above also show that the error does not have a truly linear behavior.