TIME SERIES STATISTICS OF THE DORIS AND GPS COLOCATED OBSERVATIONS

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The study

The DORIS and GPS global networks have a number of collocated stations for which time series of coordinates are available.

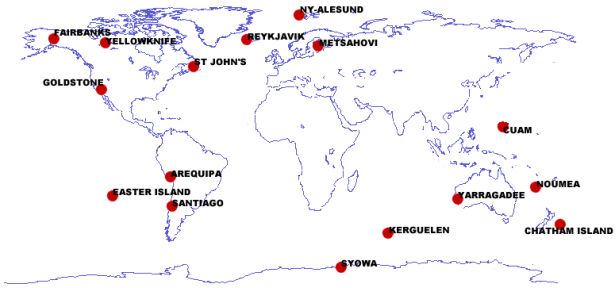
The parallel statistical analysis of these time series allows to discriminate various noise sources, e.g. :

- analyst noise (analysis strategy, weighting, alignment,…)
- technique specific noise (models, network,…)
- geophysical noise.

The analysis makes use of the Allan variance. It is an estimator of the stability of a time series with regular steps. This statistical tool is standard for characterizing the stability of the atomic clock.

The data

We choose 16 stations among the GPS-DORIS collocation sites :



The time series considered are the following :

- for DORIS :

  - LCA1 series : LEGOS/CLS solution computed with GINS/DYNAMO software. Monthly solutions over 1993-2001. Toulouse station and EOP are fixed (http://ids.cls.fr);
  - LCA2 series : LEGOS/CLS solution computed with GINS/DYNAMO software. Free-network monthly solutions aligned on ITRF2000 over 1993-2001 (ftp://cddisa.gsfc.nasa.gov/doris/products/sinex_series/lcamd);
  - IGN/JPL series : computed by GIPSY/OASIS software the free-network monthly solutions cover the period 1993-2002 (ftp://cddisa.gsfc.nasa.gov/doris/products/sinex_series/ignmd);

- for GPS :

  - IGS series : weekly solutions over 1999-2002, aligned on ITRF2000 (ftp://macs.geod.nrcan.gc.ca);
  - JPL series : daily free-network solutions over 1993-2002, aligned on ITRF2000 (ftp://sideshow.jpl.nasa.gov/pub/mbh/point).

Allan Variance

If $x_i, i = 1, n$ are the measurements and T the sampling time, the mathematical expression of the Allan variance is :

$$\sigma^2(n,T) = \frac{1}{2} < (x_{i+1} - x_i)^2 >, where < . > represents the average.$$

Let a temporal process which has a spectral density D proportional to f : $D(f)=h_\alpha f^\alpha$, where the α parameter characterizes the type of noise :

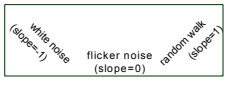
- α=0 for white noise,
- α=-1 for flicker noise,
- α=-2 for random walk.

With the Allan variance, we can specify a noise in a time series thanks to the relation :

$$\log \sigma^2(2,T) = \mu \log T, for\ T = T_0, 2T_0, 4T_0, ...$$

where T is the tabular interval of the time series.

- μ=-1 corresponds to white noise,
- μ=0 to flicker noise,
- μ=1 to random walk.



An important characteristics of the Allan variance analysis is that it is insensitive to the deterministic content of the analyse signal (e.g. bias, linear slope, sine component,…).

We show the Allan variance graphs for each station and each analysis centre. The graphs give in log-scale the change of the Allan variance as a function of the sampling time.

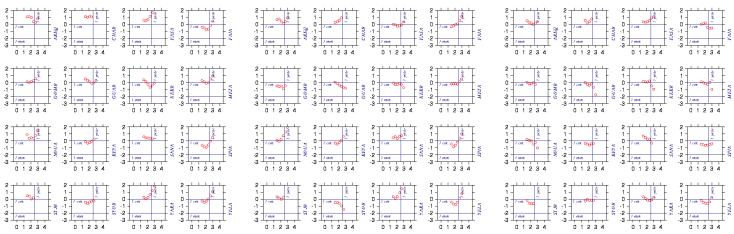
Future work

The combination of series in a three-corner-hat process will allow to separate the measurement noise spectrum from the geophysical one.

Reference :

Allan, D. W. 1966, Proc IEEE, 54, 221

Allan variance plots - DORIS East | Allan variance plots - DORIS North | Allan variance plots - DORIS Up

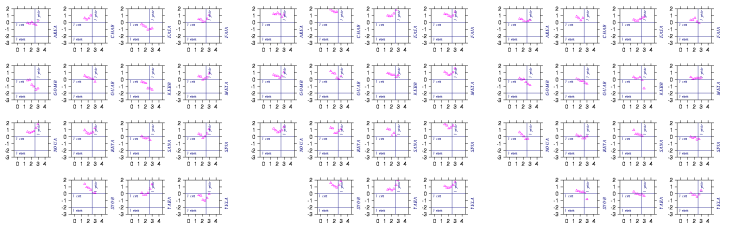


LCA1 series :

Horizontal motion : some stations show flicker noise for sampling times up 2.5 years, while other show random walk after a couple of months.

Vertical motion : most stations have quasi-flicker noise, while some have white noise.

Allan variance plots - DORIS East | Allan variance plots - DORIS North | Allan variance plots - DORIS Up

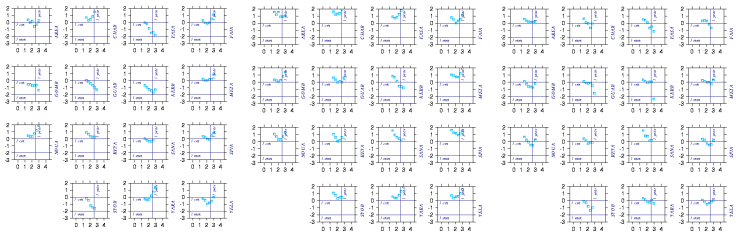


LCA2 series :

Horizontal motion : there is different type of noise for each station : white noise, flicker noise or random walk.

Vertical motion : most stations have random walk.

Allan variance plots - DORIS East | Allan variance plots - DORIS North | Allan variance plots - DORIS Up

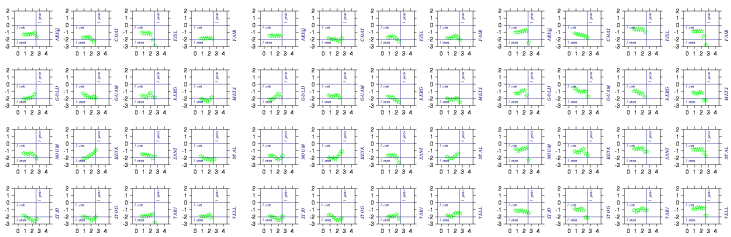


IGN/JPL series :

Horizontal motion : stations have the three different noises but for the North component, most of them show random walk.

Vertical motion : stations have either white or flicker noise.

Allan variance plots - IGS East | Allan variance plots - IGS North | Allan variance plots - IGS Up

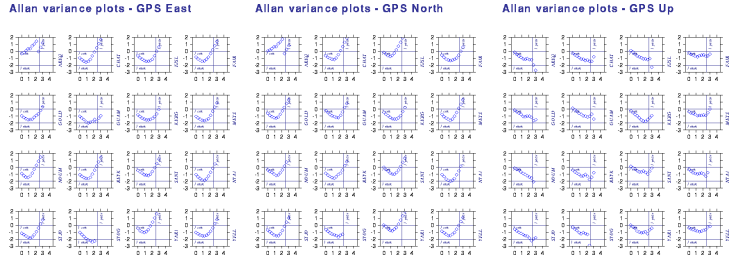


IGS series :

Horizontal motion : most stations have flicker noise but some stations have a random walk.

Vertical motion : stations principally show flicker noise.

Allan variance plots - GPS East | Allan variance plots - GPS North | Allan variance plots - GPS Up



JPL series :

Horizontal motion : every stations show random walk, it may be due to the alignment method.

Vertical motion : stations have flicker or white noise.