

# Drift ?

Long term stability (♣change of sensitivity): Drift vs. noise.

Which frequency band (or period) ?

What might be drifting:

- electronics, acquisition, clock
- sensors
- instrument
- ground (or wall) coupling
- site (building, gallery, cavern...)
- Earth crust

Causes :

- temperature (direct or thermo-elastic stress)
- humidity
- rain (load)
- air pressure (local or regional)
- aging (mechanical, radiations,...)
- contamination (dust, impurity, chemicals)
- water table, pore pressure, ground water motion
- power supply
- non tidal loading (river, lake...)
- post glacial rebound
- crustal movement

# Drift ? (cont.)

What is a signal, what is not ?

For instance: Seasonal variation = signal

Local temperature = signal if affects the magnet position but not if it perturbs the electronic or the instrument or its coupling to the ground

Suggestion:

- Test electronics (aging, direct thermal effect, power supply etc...)
- Test sensor
- Test instrument in quiet location

Why not :

- record the signal from a sensor alone (in situ) ?
- install few simple (two vessels) systems one the ground, close to the girders, at tidal sensitivity?

# Drift ? (cont.)

Feel more comfortable when have long records and hence a knowledge of the « normal » behavior of the site, instrument, coupling etc...

Instrumental drift is expected to be smooth (linear, exponential...)

By the way, it has been shown that tiltmeters usually do not agree outside the tidal band and the (micro)seismic band (see ref.)

# Some references

- **Agnew, D.C.** , Stainmeters and Tiltmeters, *Reviews of Geophysics*, vol 24 N°3, pp 579-624, **1986**
- **Baumont C., J. Berger**, An Analysis of Tidal Strain Observations from the United States of America: I. The Inhomogeneous Tide, *Bull. Seismol. Soc. Am.* , vol 65, pp 1613-1629, **1975**
- **Beavan J., R. Bilham**, Thermally Induced Errors in Fluid Tube Tiltmeters, *Journ. Geoph. Res.*, vol 82, N° 36, pp 5699-5704, **1977**
- **Berger J.**, A Note on Thermoelastic Strains and Tilts, *Journ. Geoph. Res.*, vol 80, pp 274-277, **1975**
- **Berger J., C. Baumont**, An Analysis of Tidal Strain Observations from the United States of America: II. The Inhomogeneous Tide, *Bull. Seismol. Soc. Am.* , vol 66, N° 6, pp 1821-1846, **1976**
- **Bilham R.G., R.J. Beavan, K. Evans**, Long Baseline Fluid-Tube Tiltmeter Geometry and the Detection of Flexure and Tilt, *Proc. of 9<sup>th</sup> Int. Symp. On Earth Tides*, New-York, pp 85-94, **1983**
- **d'Oreye N.**, Long and short-base tiltmeters for active area monitoring, *Comptes-Rendus of the 86th Journ. Lux. De Géodyn.*, pp 12-17, **1999**
- **d'Oreye N.**, *Inclinomètre à niveaux hydrostatiques de haute résolution en géophysique*, PhD thesis, UCL, Belgium, **2003** (available on the web)
- **Harrison J.C.**, Cavity and Topographic Effects in Tilt and Strain Measurements, *Journ. Geoph. Res.*, vol 81, N° 2, pp 319-328, **1976**
- **Harrison, J.C.**, Tilt Observations in the Poorman Mine near Boulder, Colorado, *Journ. Geoph. Res.*, vol 81, pp 329-336, **1976**
- **Harrison, J.C., K. Herbst**, Thermoelastic Strains and Tilts Revisited, *Geophys. Res. Lett.*, vol 4, pp 535-537, **1977**
- **Jentzsch G., A. Weise, J. Kääriäinen**, Comparison of Tilt Measurements at Neighbouring Stations, *Bull. Inf. Marées Terr.*, N° 115, pp 8493-8497, **1993**
- **Meertens C., J. Wahr**, Topographic Effects on Tilt, Strain and Displacement Measurements, *Journ. Geoph. Res.*, vol 91, N° B14, pp 14.057-14.062, **1986**
- **Rabbel W., J. Zschau**, Static Deformations and Gravity Changes at the Earth's Surface due to Atmospheric Loading, *Journ. of Geophys.*, vol 56, pp 81-99, **1985**
- **Wyatt F.**, Displacements of Surface Monuments – Horizontal Motion, *Journ. Geoph. Res.*, vol 87, pp 979-989, **1982**
- **Wyatt F.**, Measurements of Coseismic Deformation in Southern California: 1972-1982, *Journ. Geoph. Res.*, vol 93, B7, pp 7923-7942, **1988**

# Some references (cont.)

- **Wyatt F., J. Berger**, Investigations of Tilt Measurements Using Shallow Borehole Tiltmeters, Journ. Geoph. Res., vol 85, pp 4351-4362, **1980**
- **Wyatt F., S.T. Morrissey, D. Agnew**, Shallow Borehole Tilt: A Reprise, Journ. Geoph. Res., vol 93, N° B8, pp 9197-9201, **1988**
- **Wyatt F., G. Cabaniss, D. Agnew**, A Comparison of Tiltmeters at Tidal Frequencies, Geophys. Res. Lett., vol 9, pp 743-746, **1982**
- **Wyatt F., R. Bilham, J. Beavan, A.G. Sylvester, T. Owen, A. Harvey, C. Macdonald, D.D. Jackson, D.C. Agnew**, Comparing Tiltmeters for Crustal Deformation Measurements: a Preliminary Report, Geophys. Res. Lett., vol 11, pp 963-966, **1984**
- **Zadro M., C. Braitenberg**, Measurements and interpretations of Tilt-Strain Gauges in Seismically Active Areas, Earth-Science Reviews, vol 47, pp 151-187, **1999**
- **Zürn W., D. Emter, E. Heil, J. Neuberg, W. Gruninger**, Comparison of Short and Long-Baseline Tidal Tilts Proc. of 10<sup>th</sup> Int. Symp. On Earth Tides , Madrid, pp 61-70, **1986**