Long Term Site Movements at the ESRF

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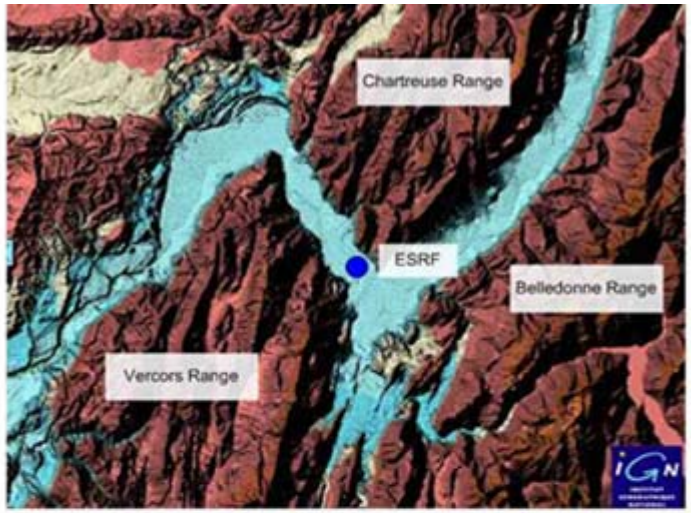
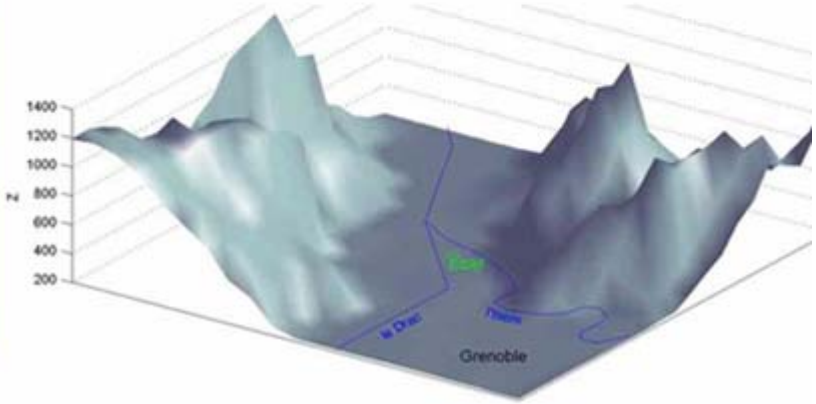
Outline

- Introduction
- Measurements and Uncertainty
- Vertical Movement Signatures
- Horizontal Movement Signatures
- Summary

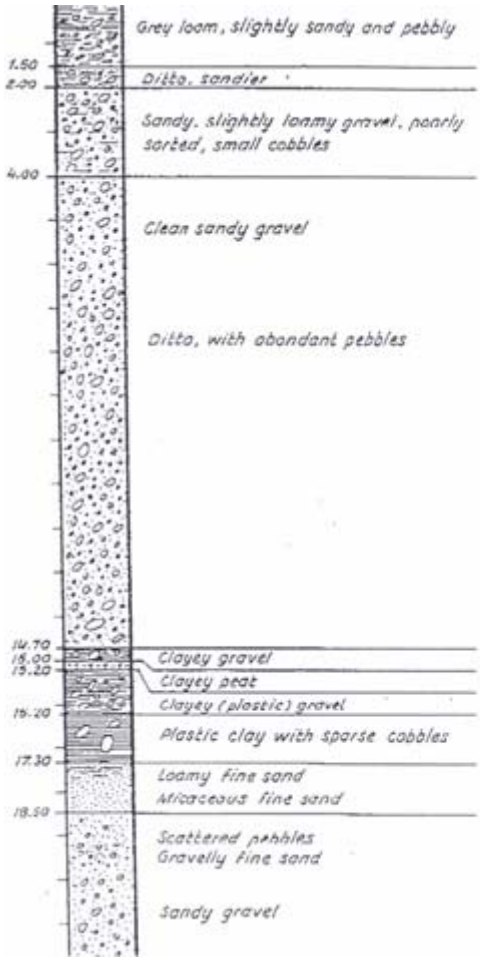
Introduction

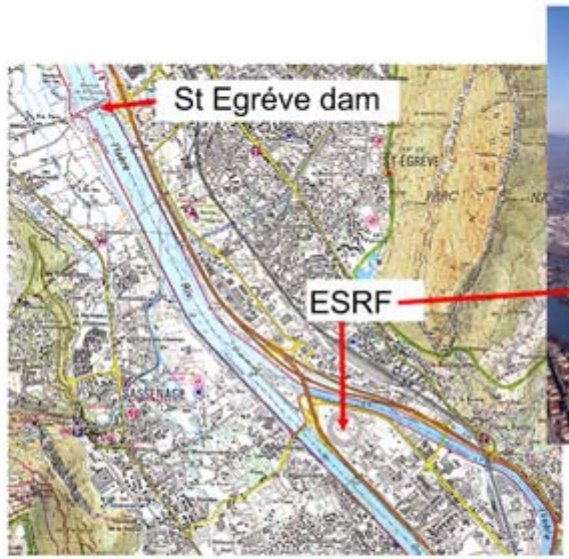




The ESRF is located on the confluence of the Drac and Isère Rivers. The area is surrounded by mountains up to 1000m above the site altitude of 200m.

Introduction





- The valley geology is composed of a glacial deposit to a depth of at least 200 m (possibly up to 500 m) topped with alluvial material.
- A dam is located approximately 4 km downriver of the site.

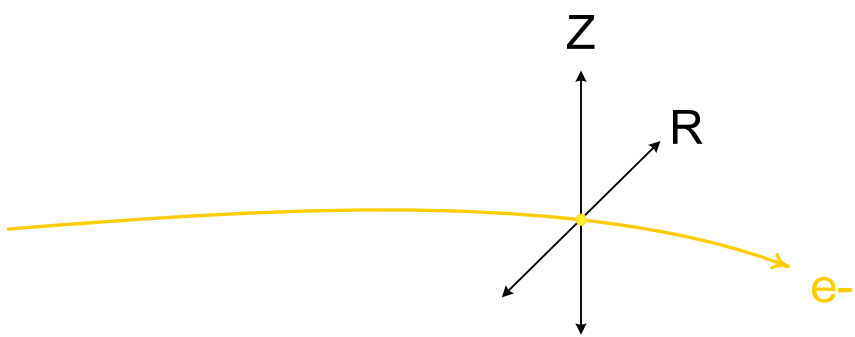
Introduction

The ESRF Storage Ring (SR) altimetric and planimetric networks consist of 32 cells :

- 32 pillars and 32 wall brackets
- 10 machine stations two each at the entrance and exit of the G10, G15, G20, G25 and G30 magnet supports

Introduction

- The sensitive directions in the SR are perpendicular to the travel of the beam.
- We refer to these directions as R and Z– the radial or horizontal, and vertical directions.



Measurements

- All leveling is made with the DiNi 12 electronic level.
- HLS measurements are used to follow the height evolution of the site in real time.
- All planimetric measurements are made with the TDA5005 robotic total station (RTS).

Levelling Measurements

N3 (1990 to 1998)	**DiNi 12 (1998 to present)**
845 m complete run of storage ring tunnel	
3 level stations per cell	2 level stations per cell
96 double height stations	64 double height stations
704 observations in a level run	
Estimated point uncertainty at 2σ 0.156 mm	**Estimated point uncertainty 2σ 0.079 mm**

Levet N., Martin D. *Optimization of the ESRF Storage Ring Level Survey Network* in *Seventh International Workshop on Accelerator Alignment*, 2002 SPRING-8 Japan.

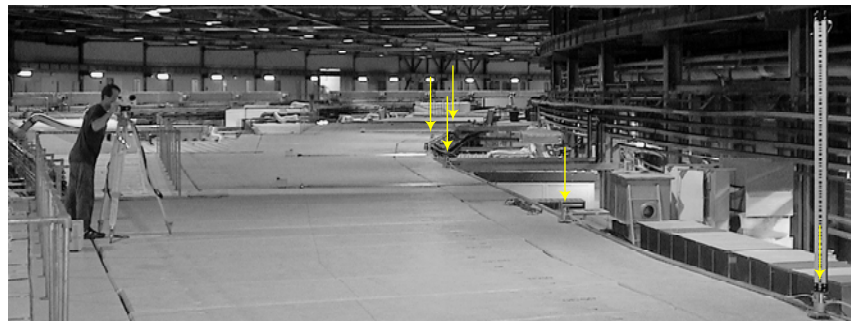
Planimetric Measurements

	Distinvar Ecartometer (1990 to 1998)	**TDA5005 RTS (1998 to present)**
Total No. Measures	1904	3456
No. Parameters (x,y)	778	992
Redundancy	1126	2464
Semi-major Semi minor axes	0.285 mm 0.143 mm	0.099 mm 0.066 mm
dR envelope peak to peak; 2σ	**1.66mm 0.53mm**	**0.65mm 0.19mm**

Martin, D. *Instrumentation and Survey Networks at the ESRF* in Eighth International Workshop on Accelerator Alignment, 2004 CERN Geneva Switzerland.

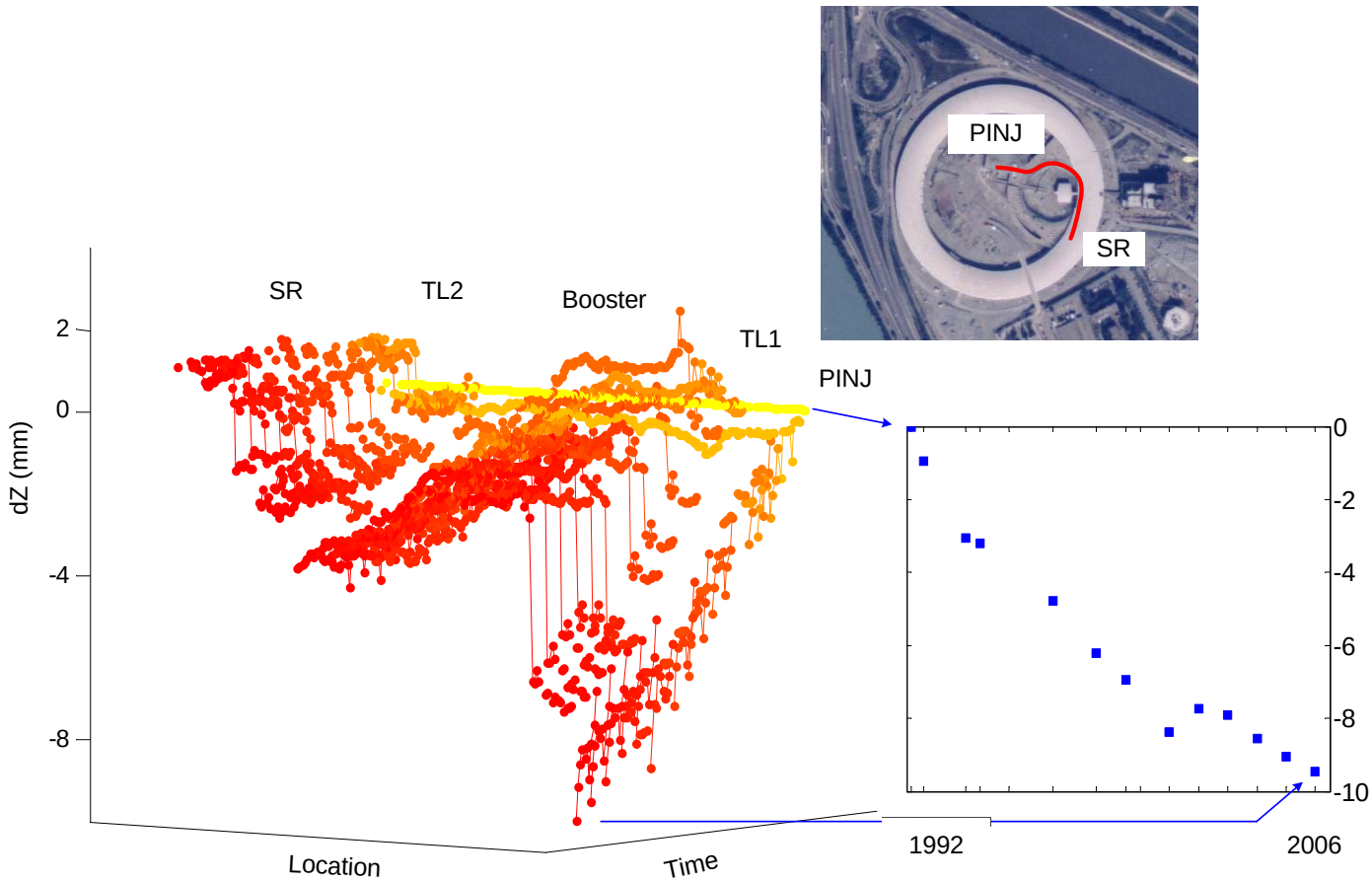
HLS Measurements

Comparisons between high precision leveling and the 850 m ESRF roof HLS system installation over a three year period show agreement to better than 40µm*.



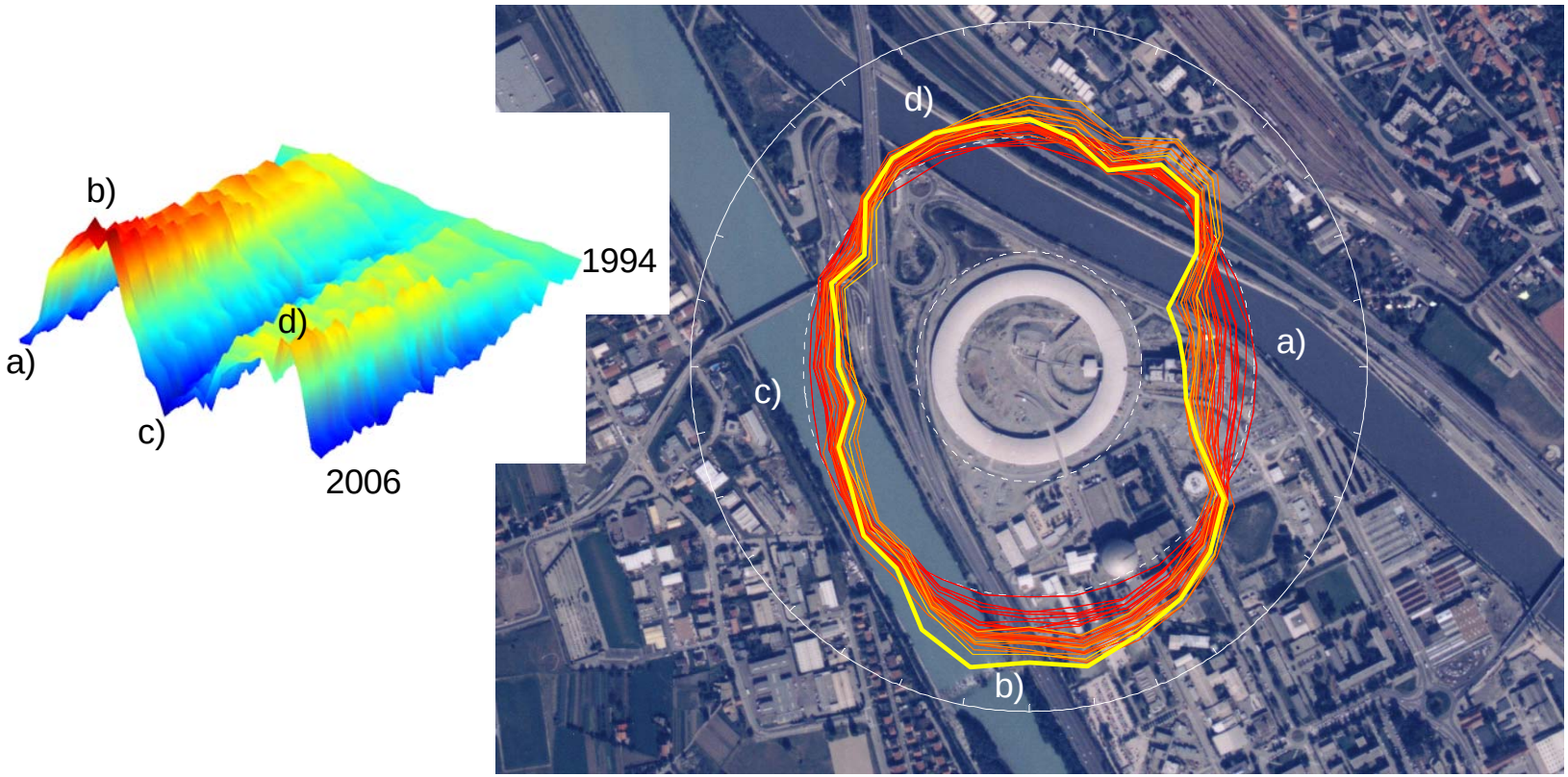
*Martin, D. *Some Reflections on the Validation and Analysis of HLS Data*, in Eighth International Workshop on Accelerator Alignment, 2004 CERN Geneva Switzerland.

Vertical Movements



It has been known for some time the center of the ESRF site is sinking relative to the SR

Vertical Movement

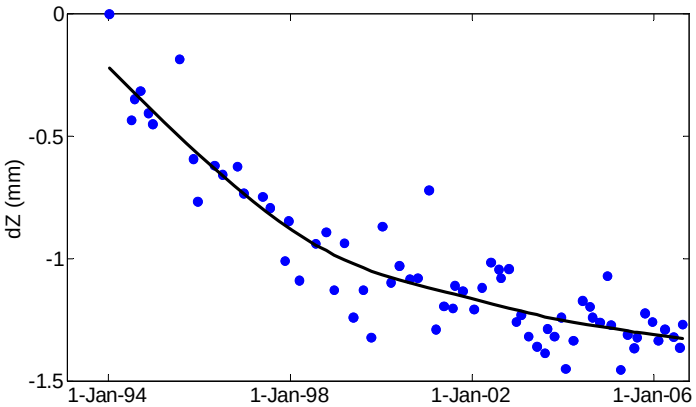


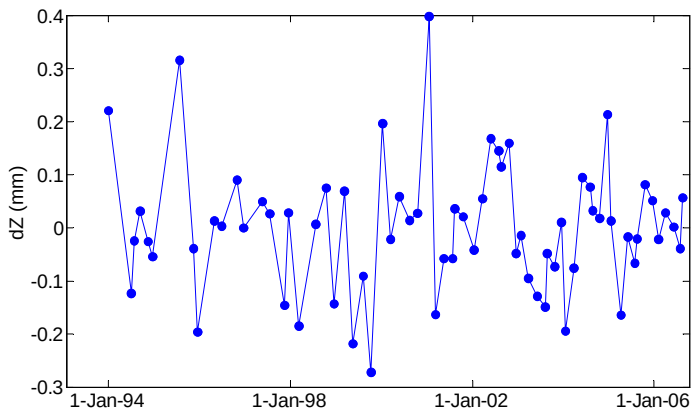
This is confirmed by successive leveling campaigns of the SR. Peak to peak movements are -1.75 to 2.0 mm

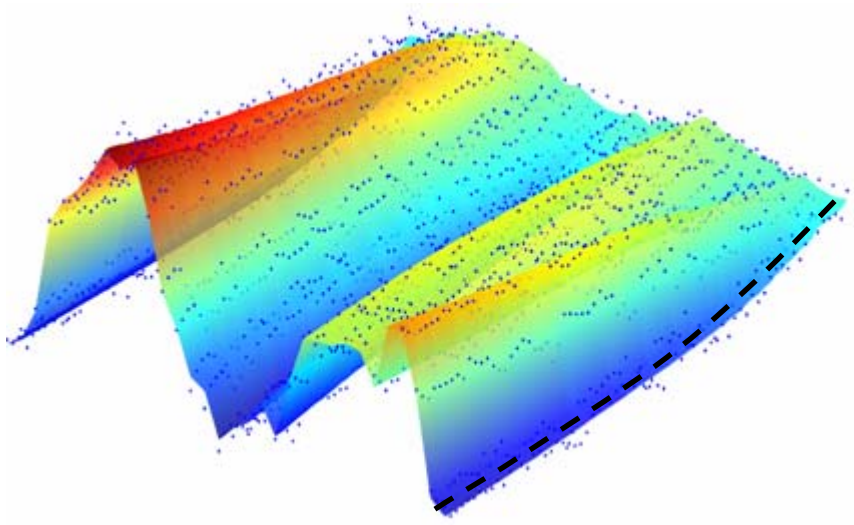
Vertical Movement

- Between 1992 and 2005 these movements reached nearly 1cm!
- In 2006 shims were installed under the booster girders to provide sufficient alignment stroke for the future.

Vertical Movements

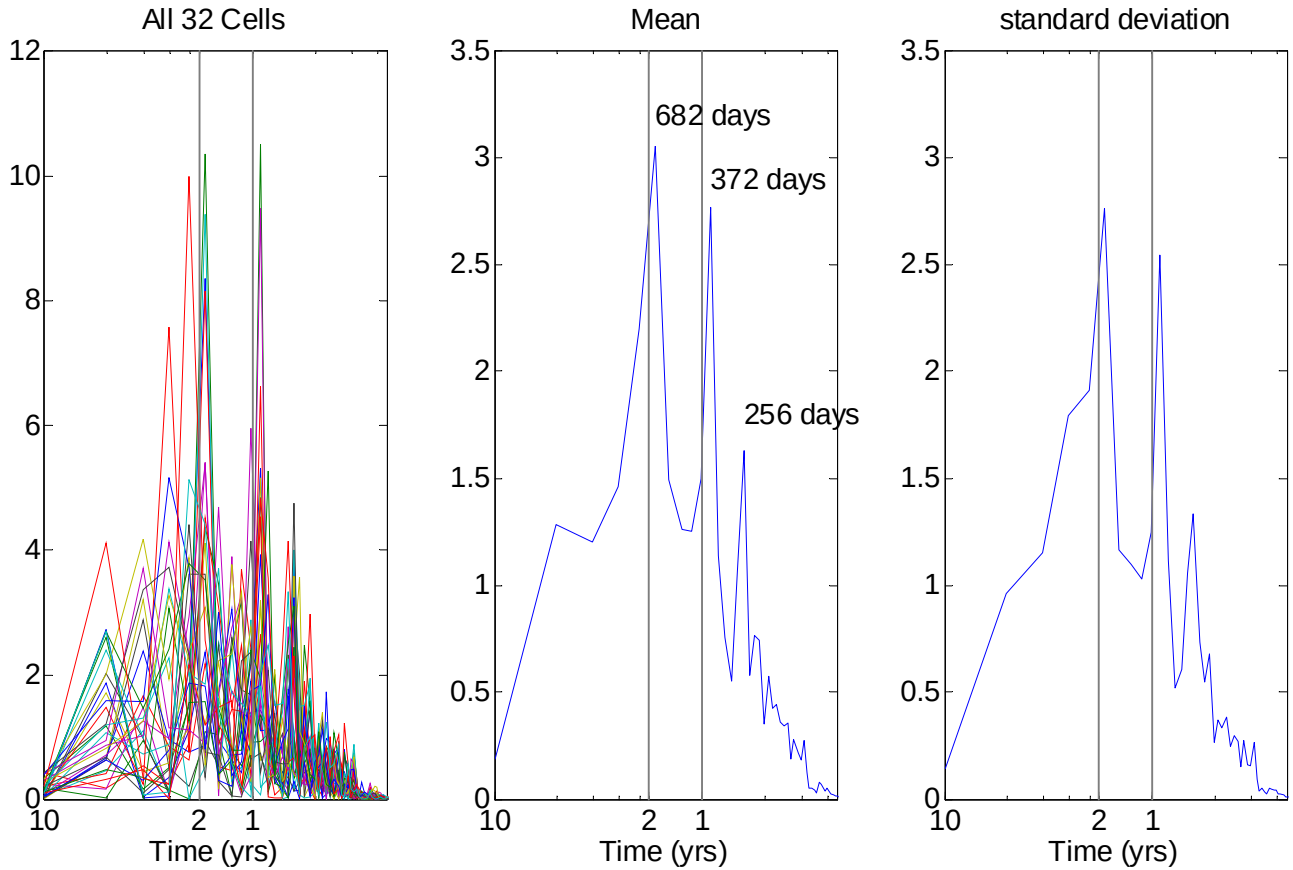






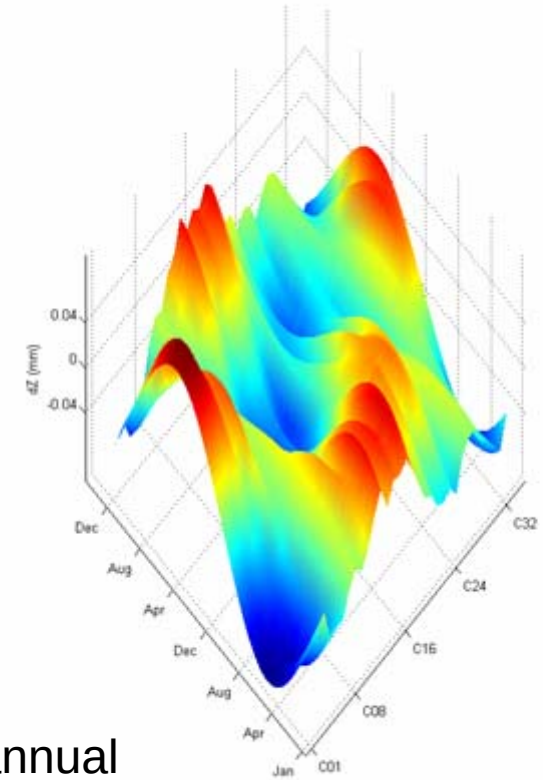
To estimate an annual component one must first remove the underlying long term trend. Any annual systematic trend in the data will be present in the residuals.

Vertical Movements

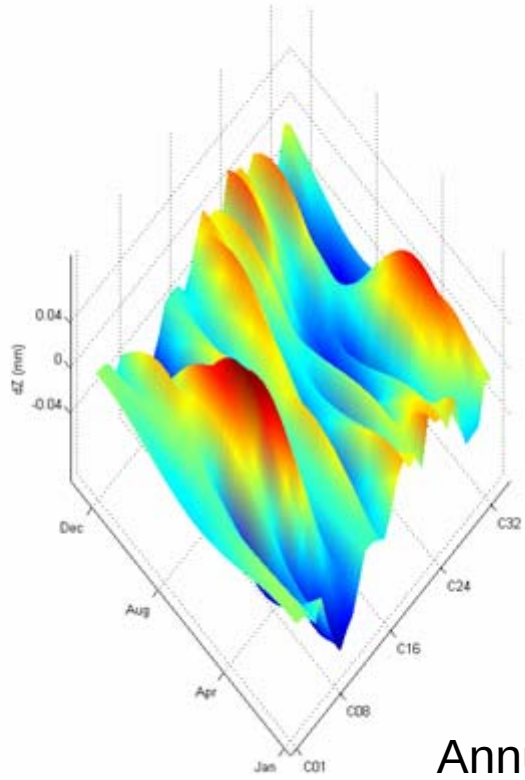


One can perform a spectral analysis on the residuals.

Vertical Movements



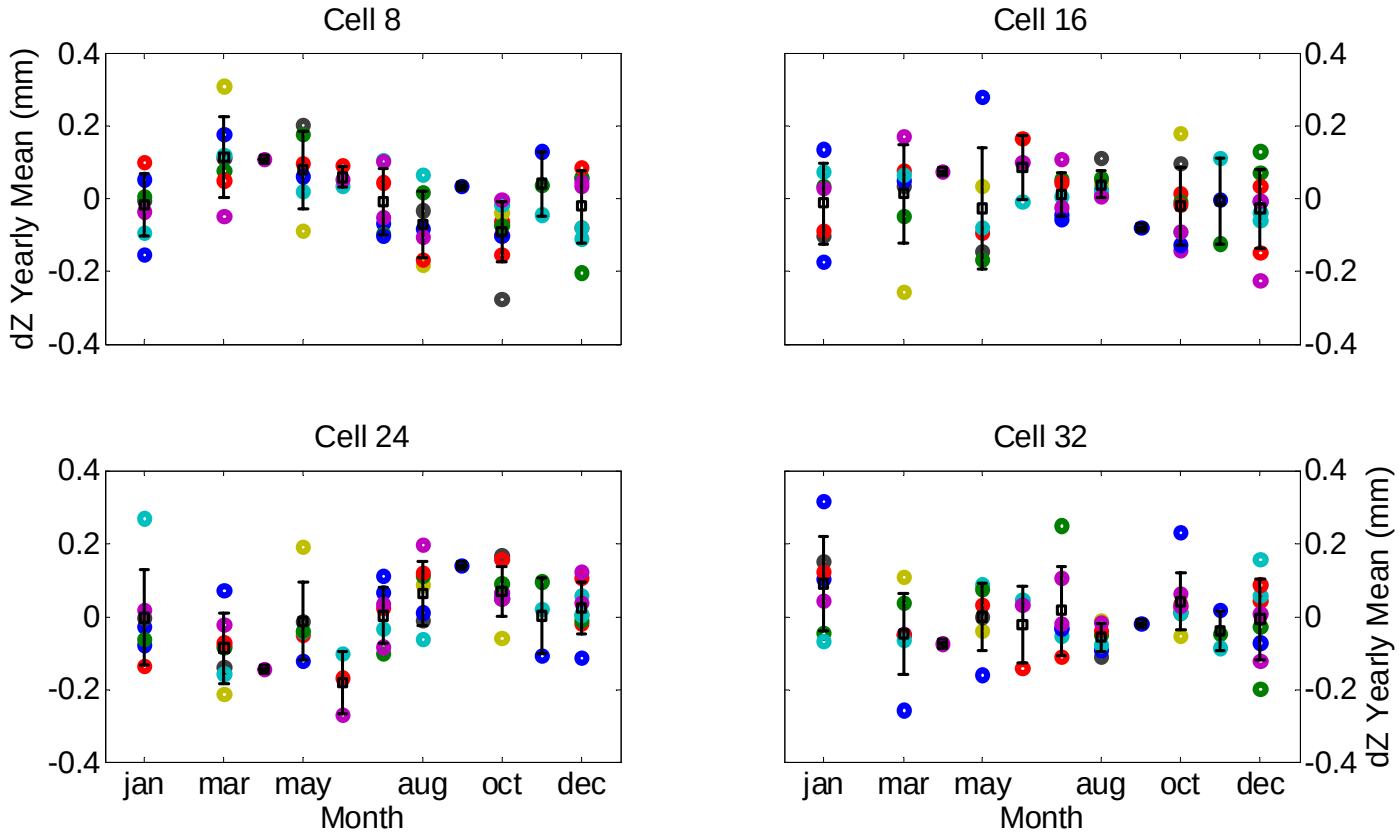
Bi-annual



Annual

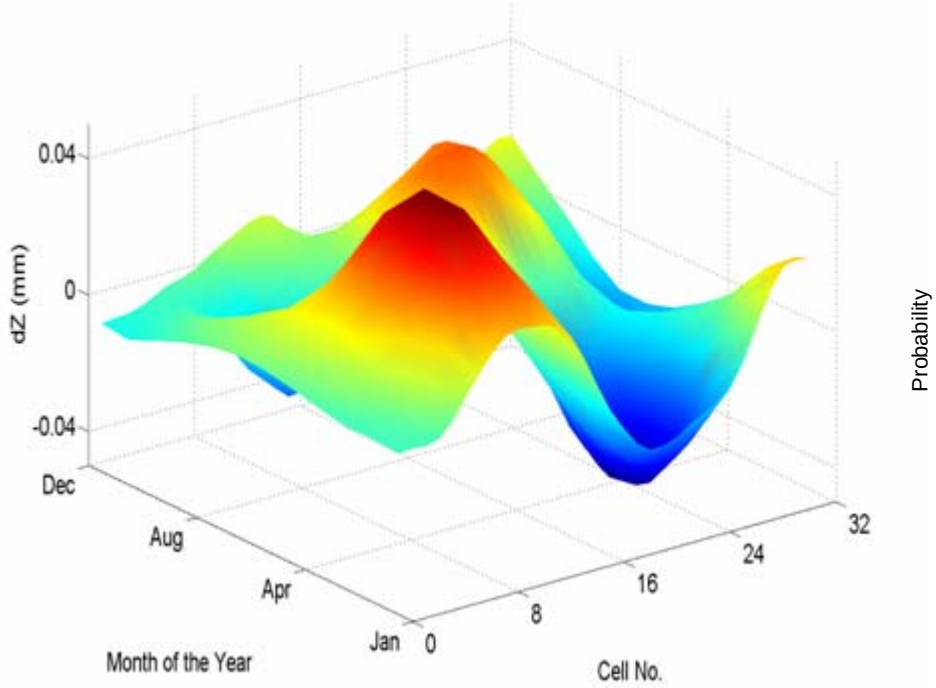
It is not entirely clear how to interpret these results.

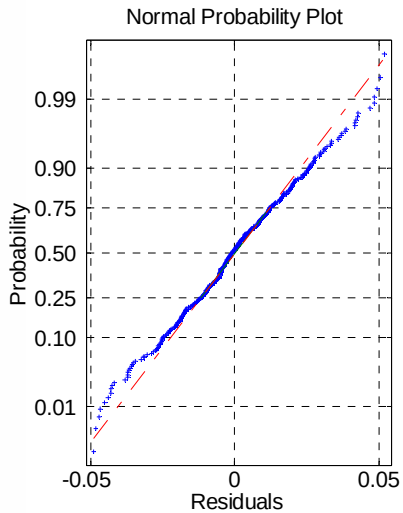
Vertical Movements

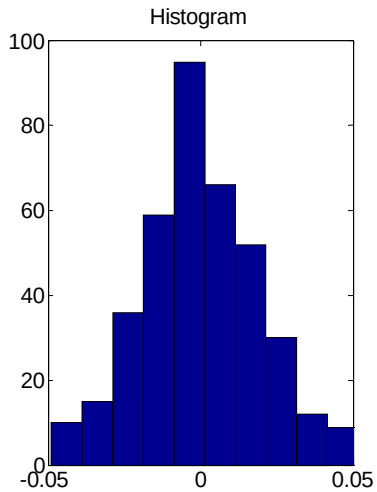


Another way to look at the data is to classify the residual for each month of the year and then take the mean monthly value of the 13 years for each pillar.

Vertical Movements

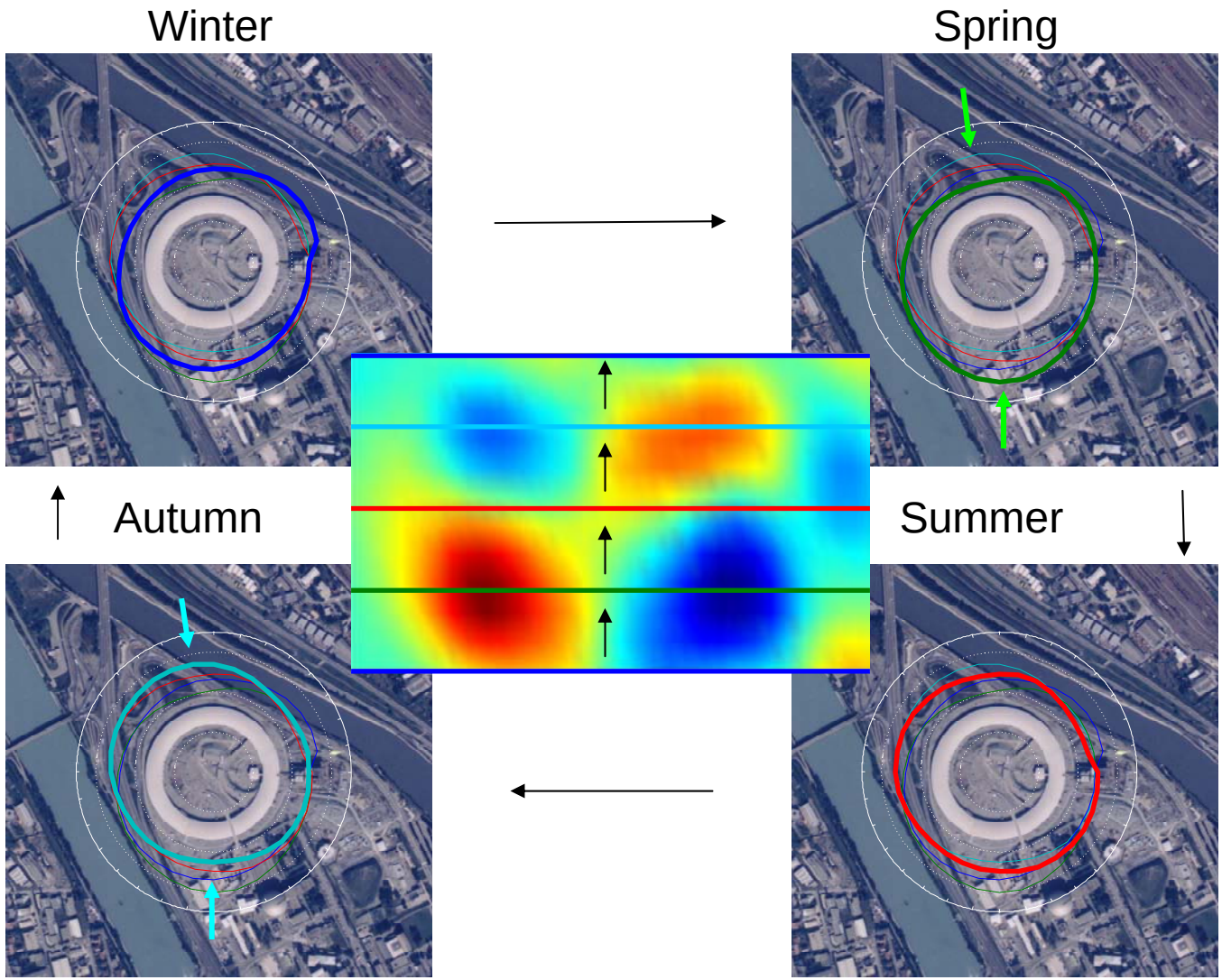




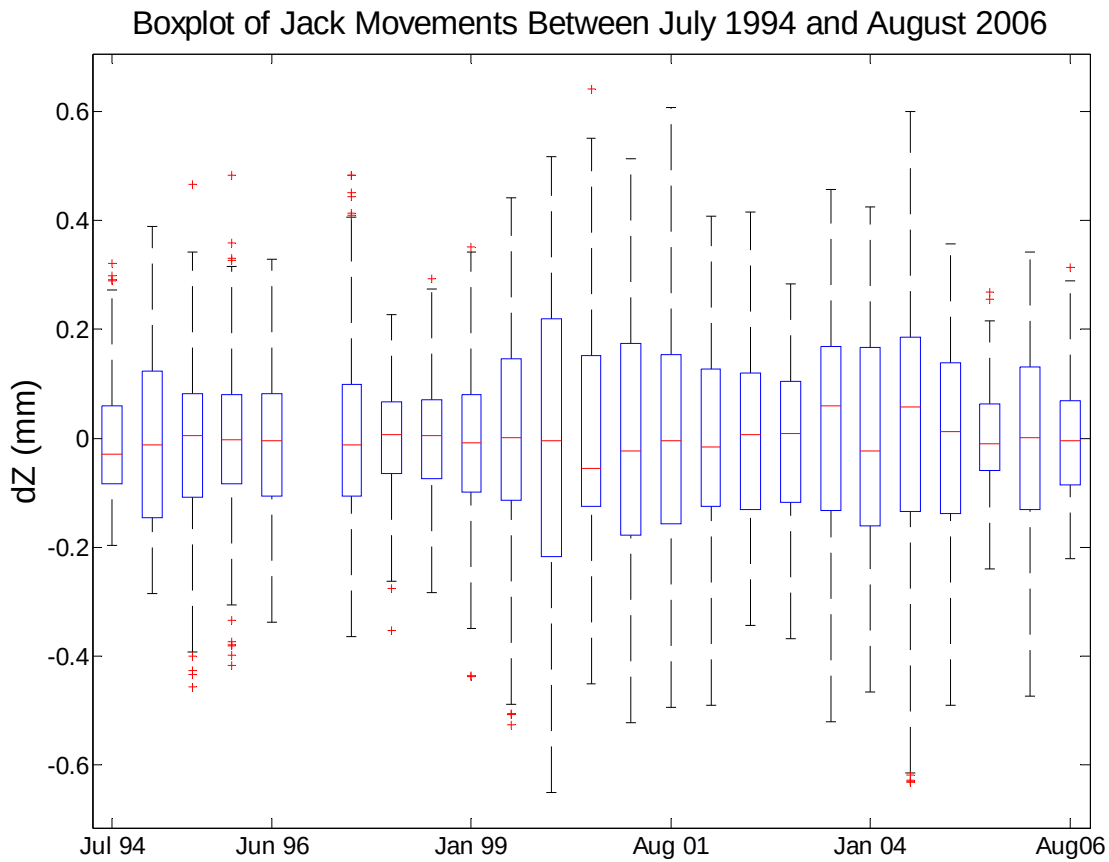


Plotting these values and creating a smooth surface shows small variations of ±50µm over the year. This represents a rocking motion.

Vertical Movements

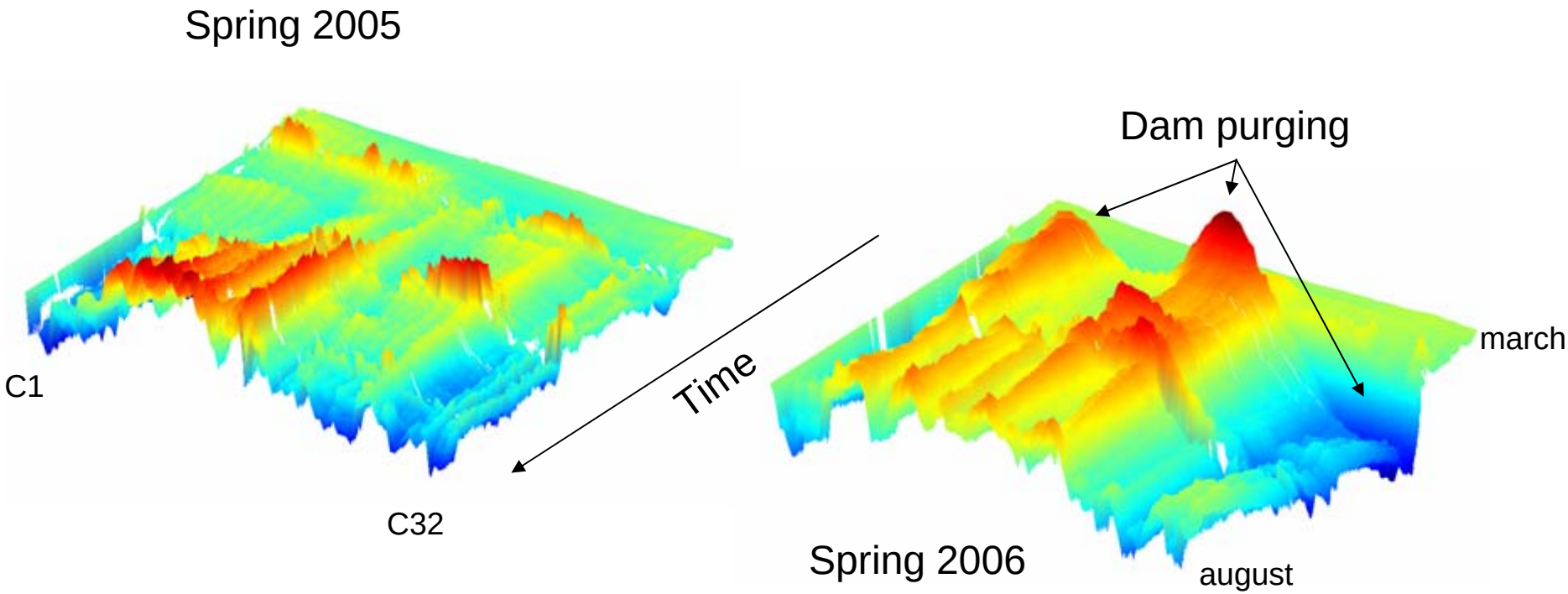


Vertical Movements



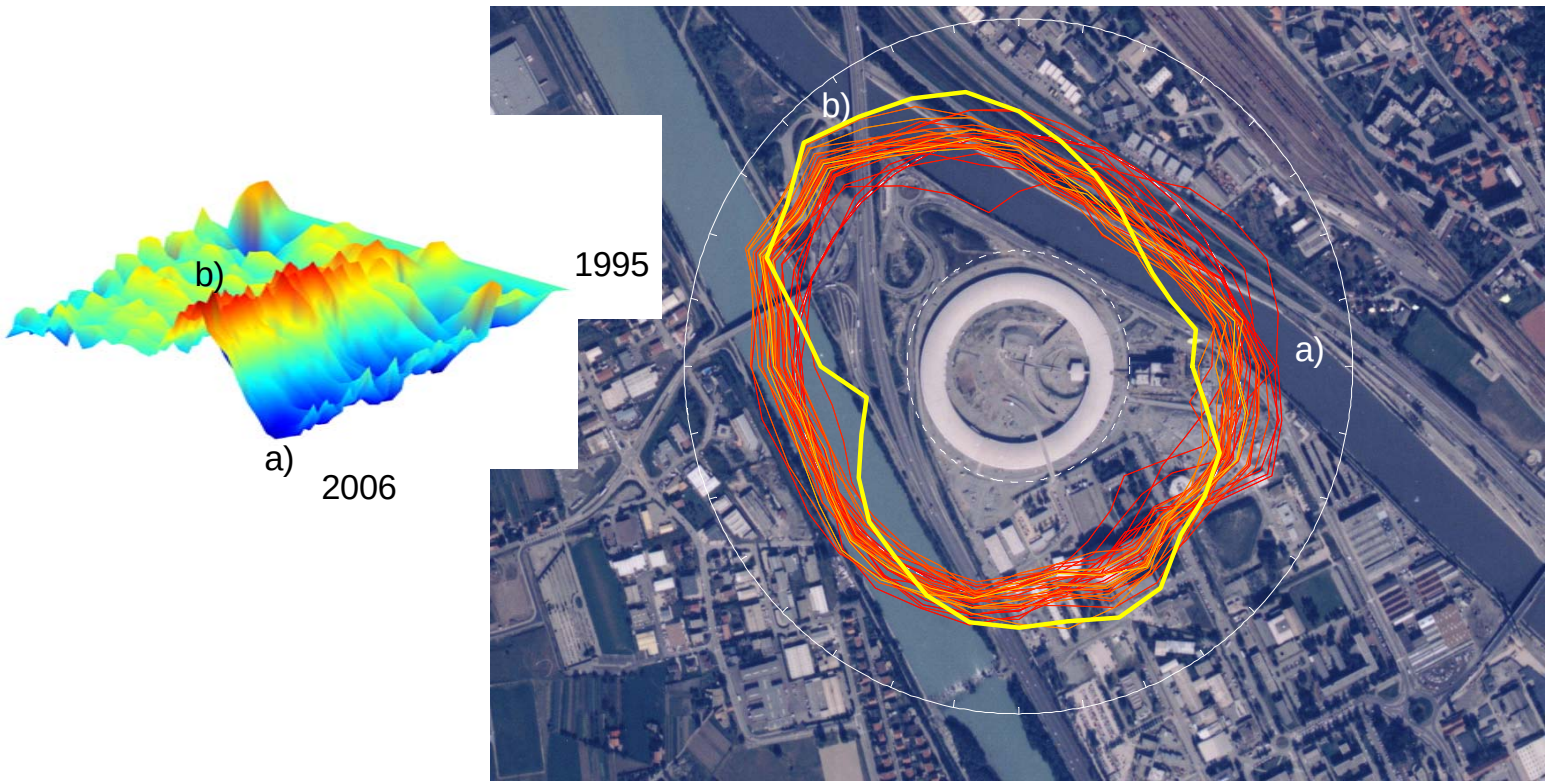
These annual trends represent between 20% and 25% of the overall observed vertical movements.

Vertical Movements



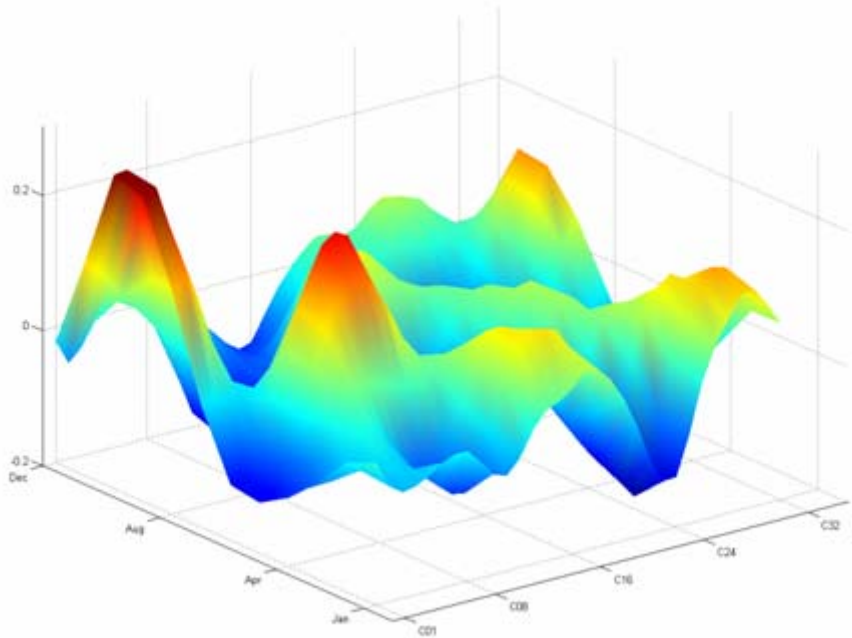
The rest of the motion is less predictable as shown in these roof HLS plots.

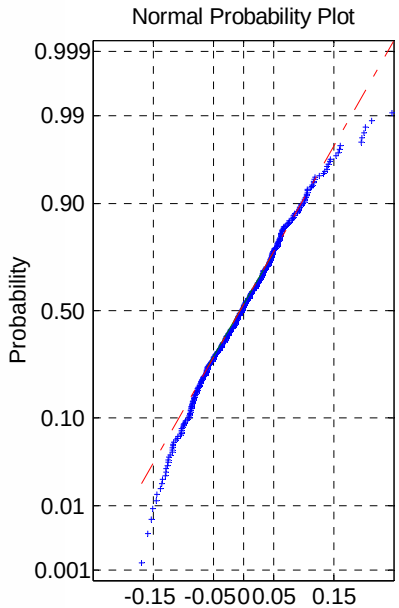
Horizontal Movement

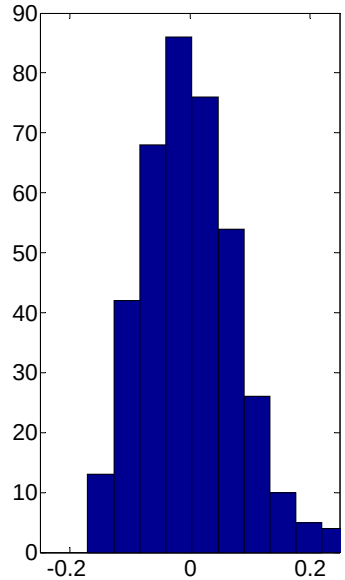


As with the vertical, there is a planimetric evolution of the machine. Peak to peak movements are -1.3 to 1.7 mm

Horizontal Movements

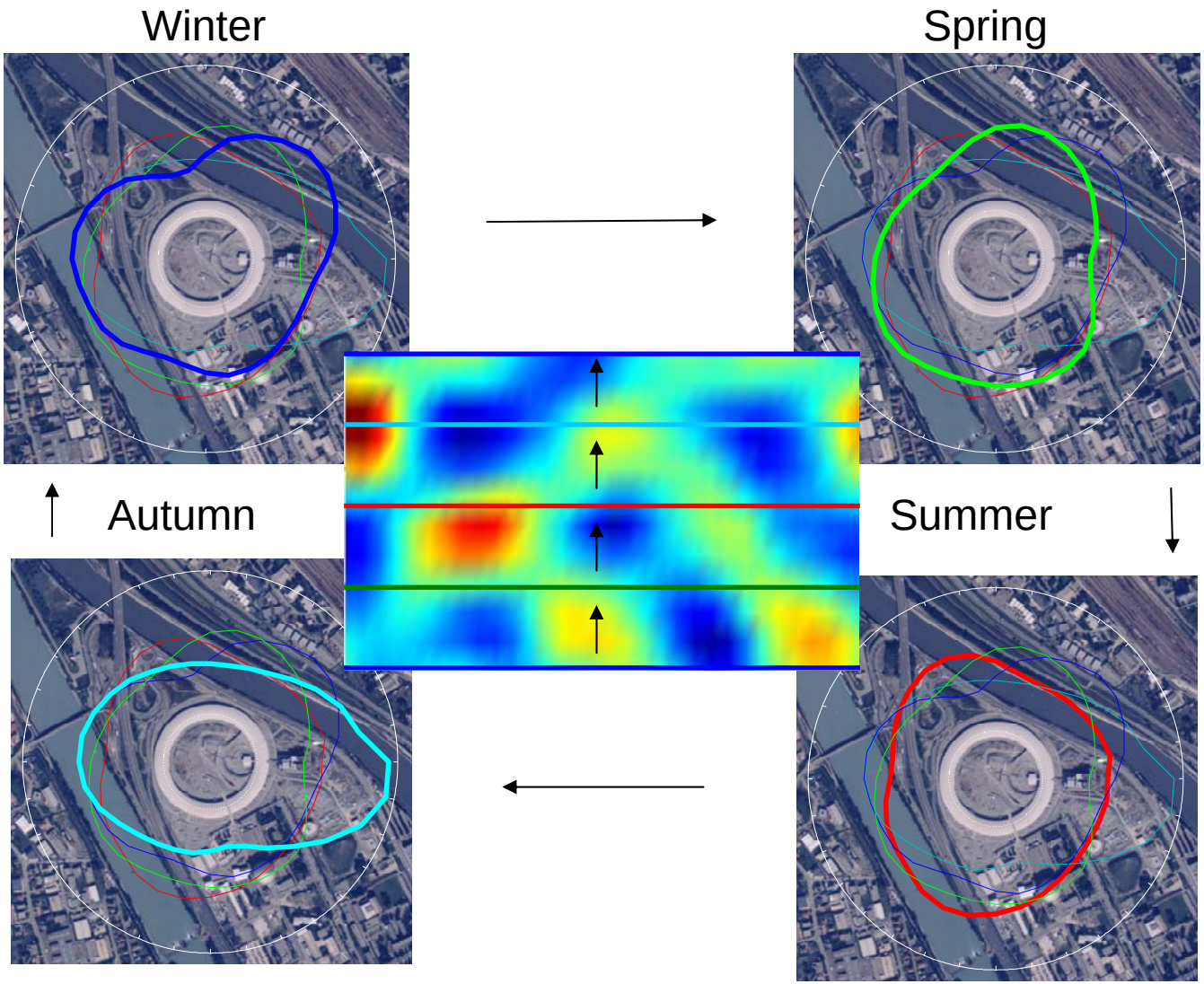






As with the vertical annual movements, horizontal annual trends can be estimated. They are considerably larger and more complex that the vertical annual movements

Horizontal Movements



Summary

- For the most part movements are smooth.
- Both horizontal and vertical long term movements are systematic.
- Vertical annual movements manifest themselves as a rocking motion of ±50μm.
- Horizontal annual movements are both larger ±200μm and more complex.