Long term stability of DORIS and GPS station coordinates Some examples

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IDS Plenary Meeting

Monday 3rd and Tuesday 4th May 2004

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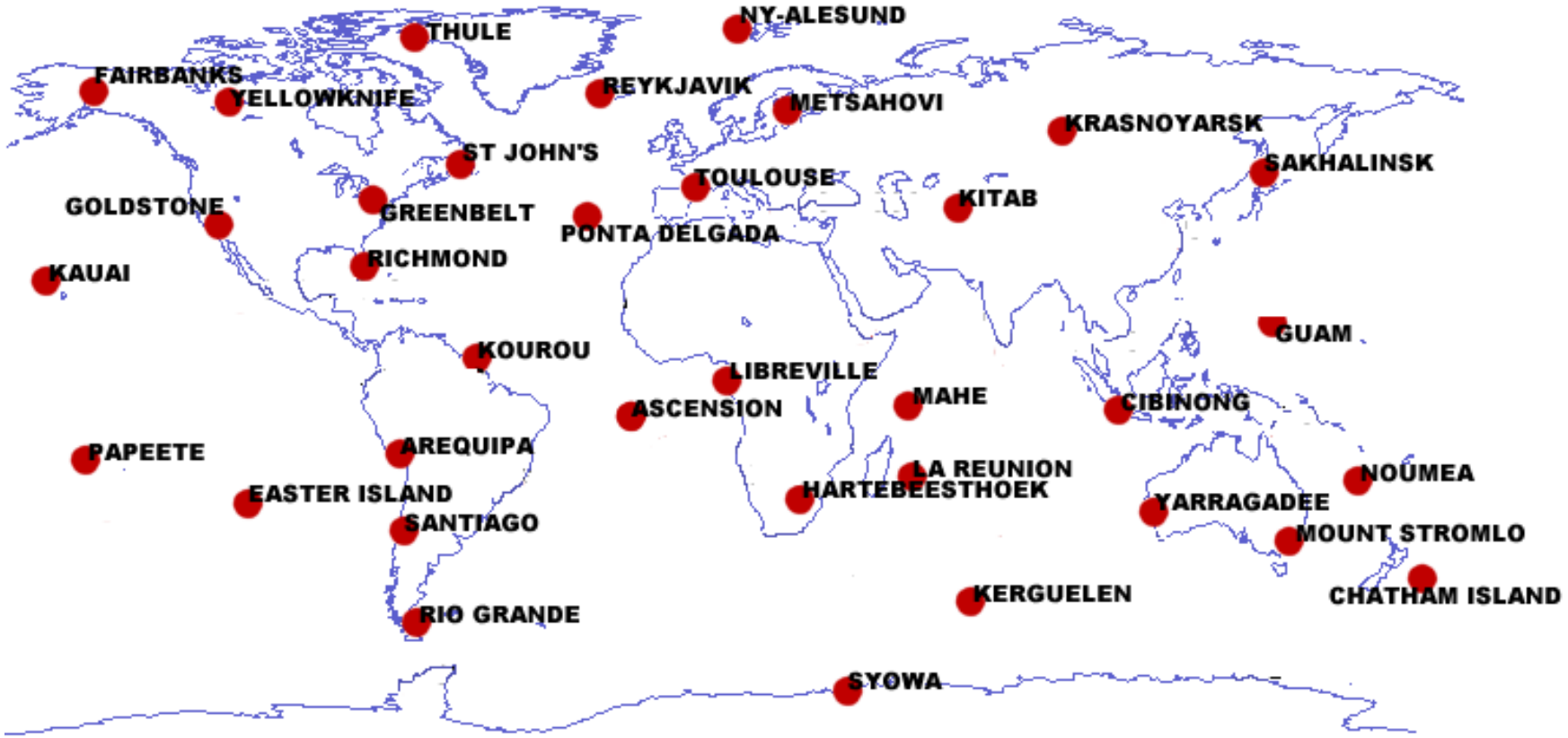
DORIS-GPS collocated sites



- 35 collocated sites

The data

- Time series of ENU residuals in Reykjavik

	Source files (from)	Processing (by)	TRF reference
IGN-JPL	Weekly IGN-JPL SINEX files (Pascal Willis)	CATREF (Zuheir Altamimi)	ITRF2000
LCA	Monthly LCA SINEX files (Laurent Soudarin)	CATREF (Jean-Jacques Valette)	ITRF2000
CODE	Weekly CODE SINEX files	IGS (Rémi Ferland)	Cumulated IGS

The Reykjavik times series

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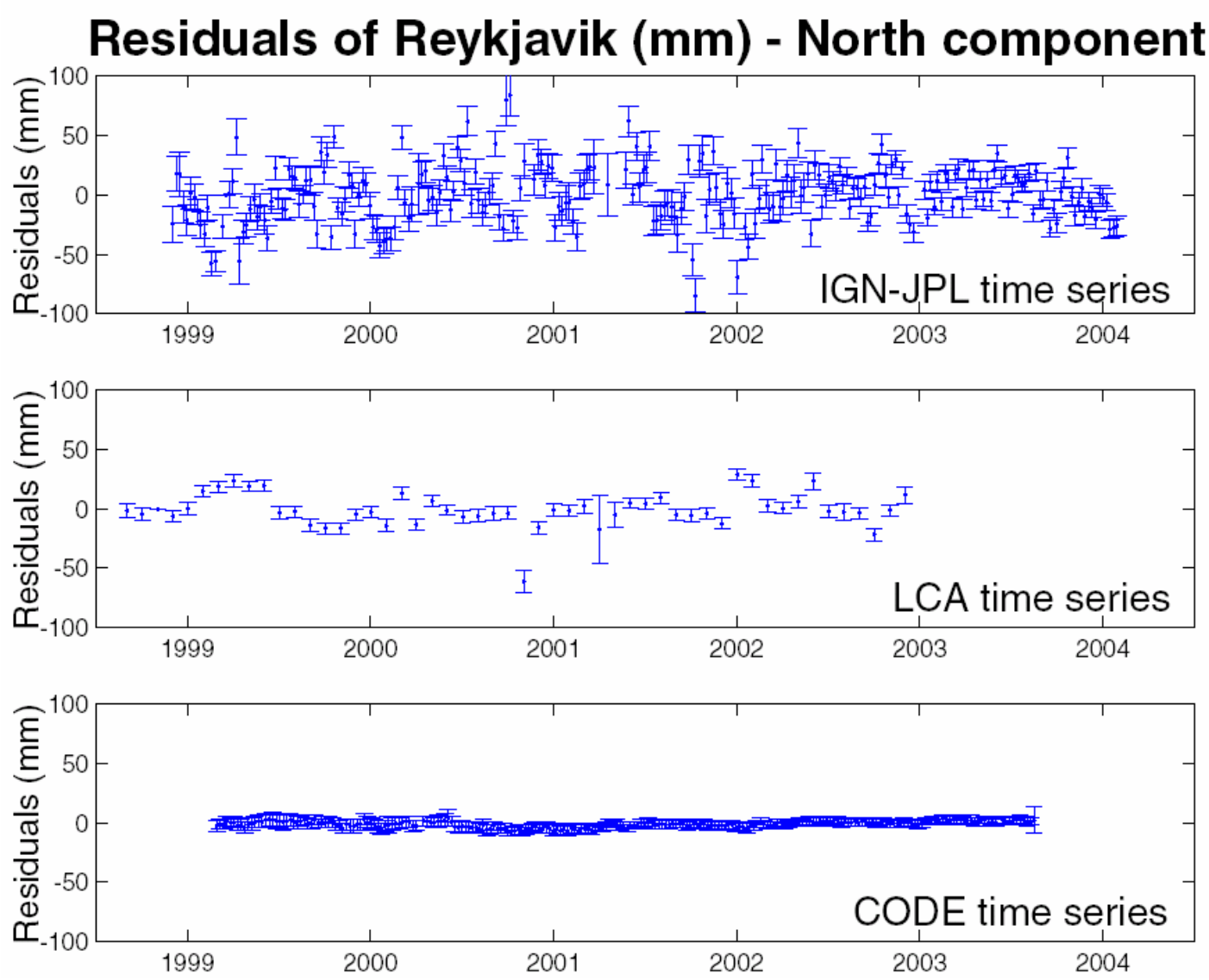

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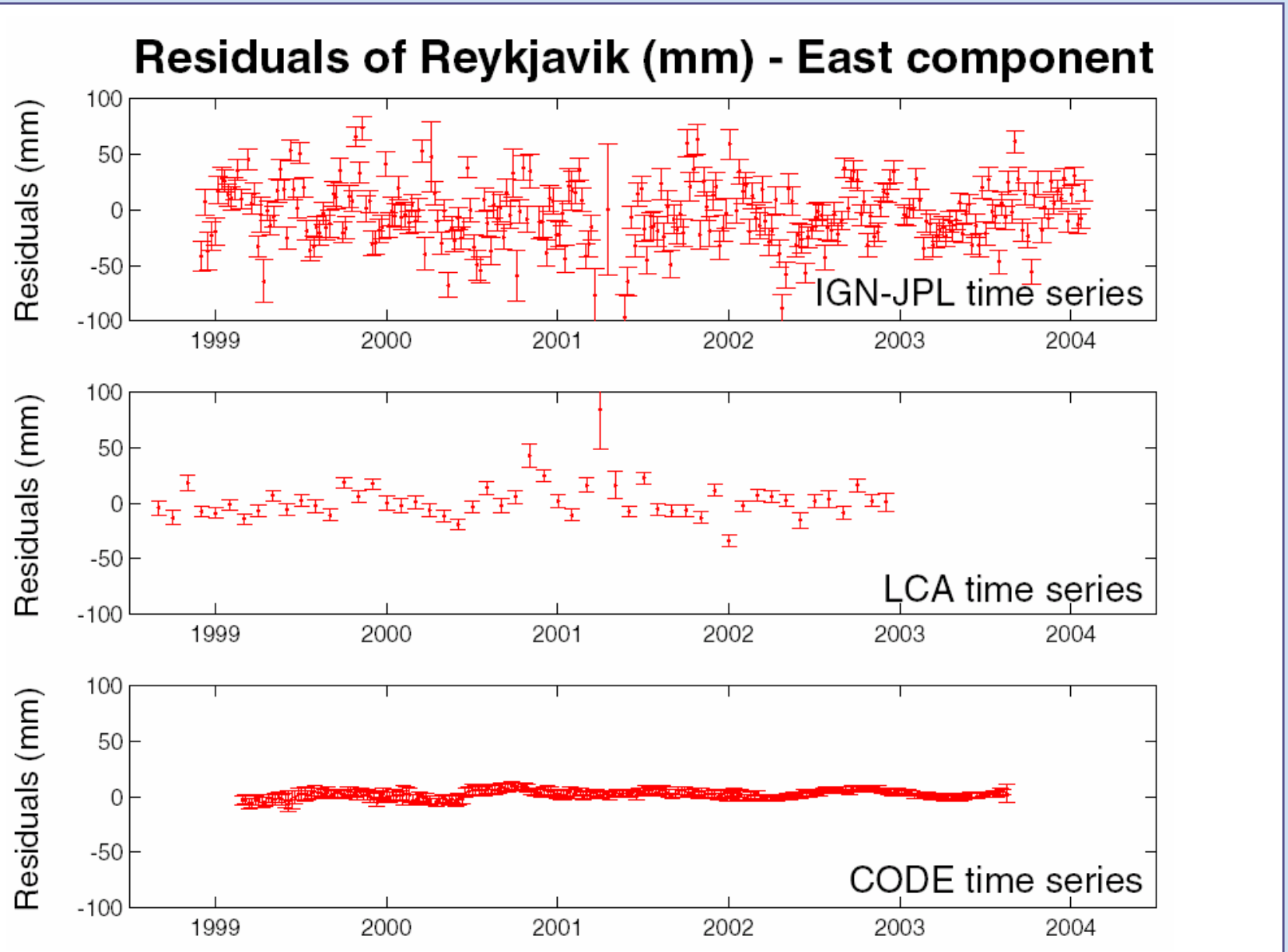

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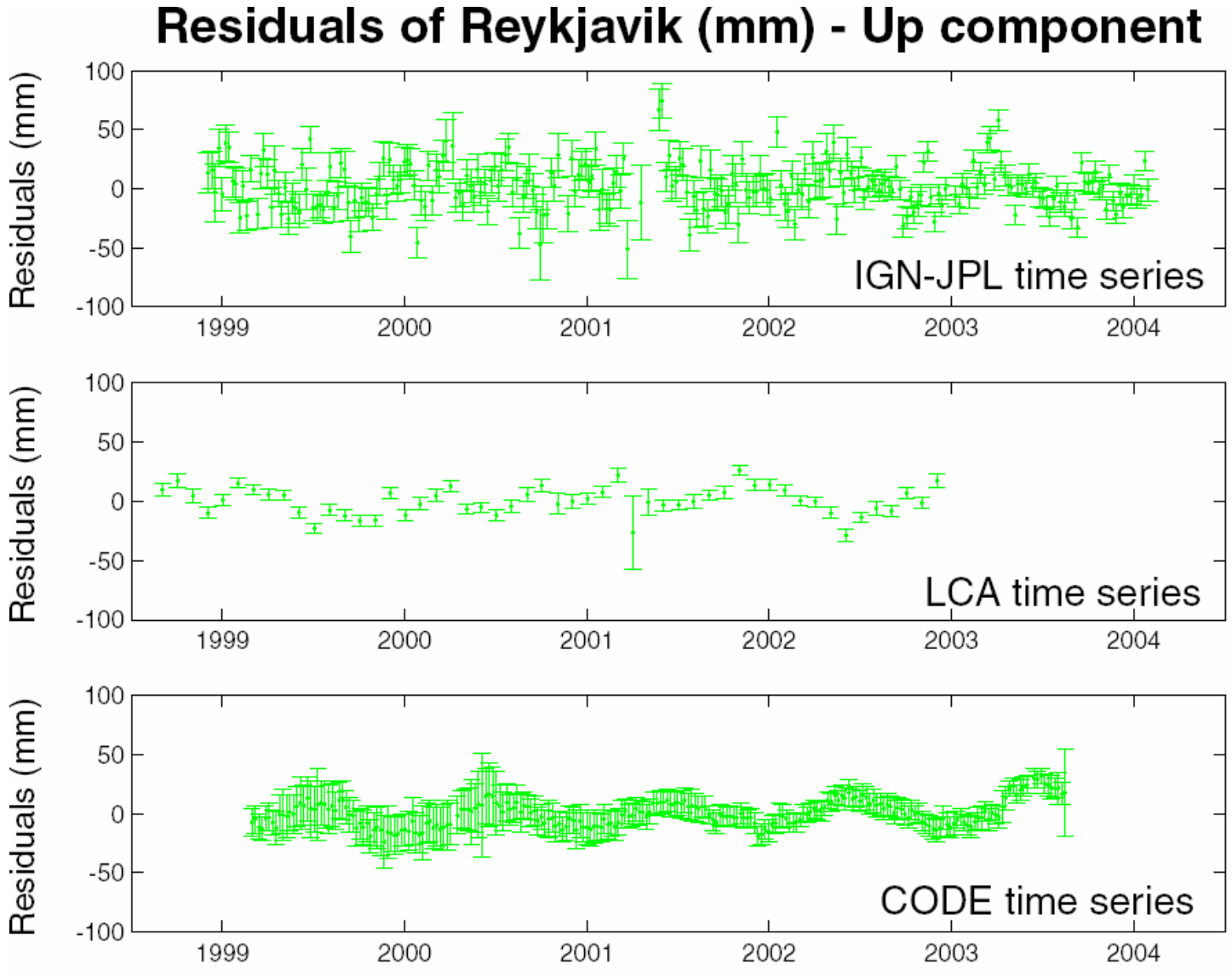

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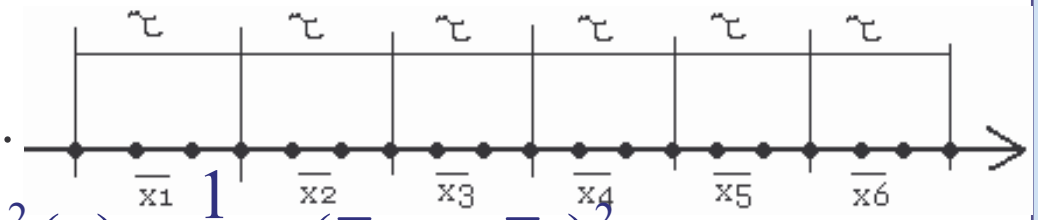
Allan Variance

$(x_j)_{j\in I}$ are the studied measu - rements, τ is the sampling time.



- Allan Variance : $\sigma_x^2(\tau) = \frac{1}{2} < (\bar{x}_{k+1} - \bar{x}_k)^2 >$
- Allan variance representation:

$$\log(\sigma^2(\tau)) = \mu \log(\tau), \; pour \; \tau = \tau_0, 2\tau_0, 4\tau_0, \ldots$$

- Let's $S_y(f) = h_\alpha f^\alpha$ the spectral density of the process :

$$\sigma_x^2(\tau) = \frac{1}{card(I)\tau_0} \sum_{i\in I} S_x(f_i) \frac{2\sin^4(\pi\tau f_i)}{(\pi\tau f_i)^2}$$

- Noise characterization :
  - $\alpha = 0 \quad \Leftrightarrow$ white noise $\Leftrightarrow \quad \mu = -1$
  - $\alpha = -1 \quad \Leftrightarrow$ flicker noise $\Leftrightarrow \quad \mu = 0$
  - $\alpha = -2 \quad \Leftrightarrow$ random walk $\Leftrightarrow \quad \mu = 1$

White noise | Flicker noise | Random walk

Two different applications of the Allan variance

- Individual time series

  With respect to a linear drift

- The three time series together

  Elimination of a common geophysical signal

  $\Rightarrow$ The three-cornered hat method

Three-cornered hat method

- Let's assume each studied time series is the sum of two terms :

$$x_i = S + \varepsilon_x^i$$

where S is the geophysical term and ε_x^i the noise.

- Three time series at the same dates
- Assume statistical independence of errors
- Elimination of the common signal S by means of the differences :

$$\begin{cases} \sigma^2(x-y) = \sigma^2(\varepsilon_x) + \sigma^2(\varepsilon_y) + 2\,\mathrm{cov}(\varepsilon_x, \varepsilon_y) \\ \sigma^2(x-z) = \sigma^2(\varepsilon_x) + \sigma^2(\varepsilon_z) + 2\,\mathrm{cov}(\varepsilon_x, \varepsilon_z) \\ \sigma^2(z-y) = \sigma^2(\varepsilon_z) + \sigma^2(\varepsilon_y) + 2\,\mathrm{cov}(\varepsilon_z, \varepsilon_y) \end{cases}$$

Reykjavik Allan variances

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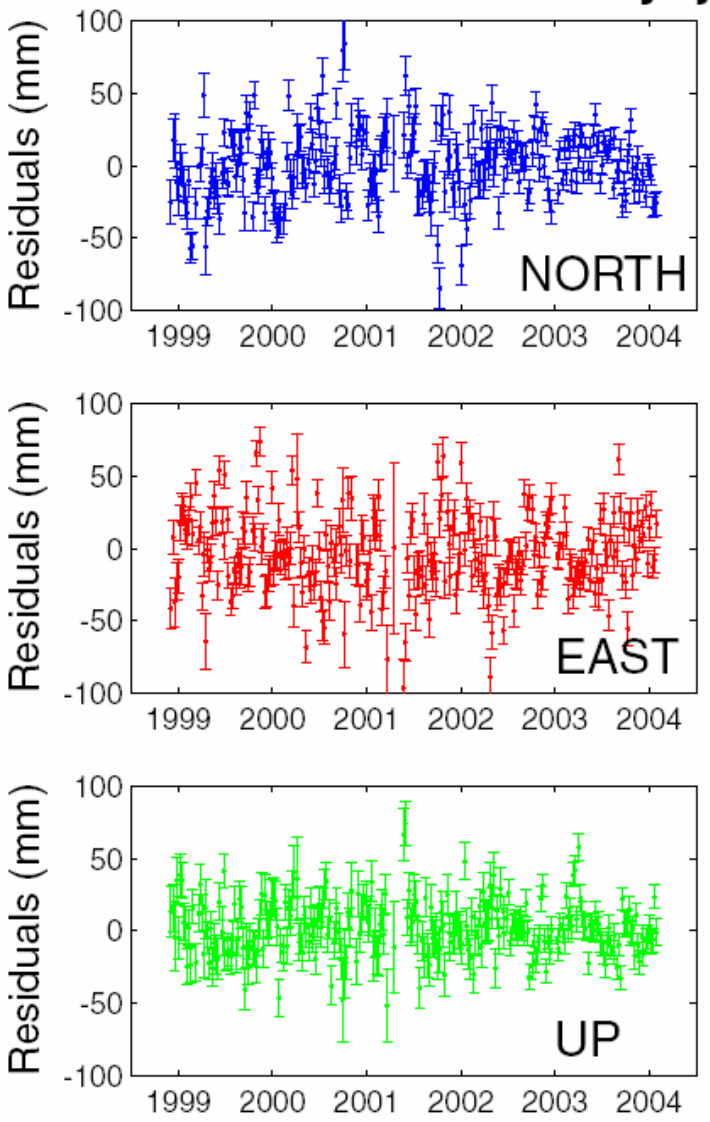
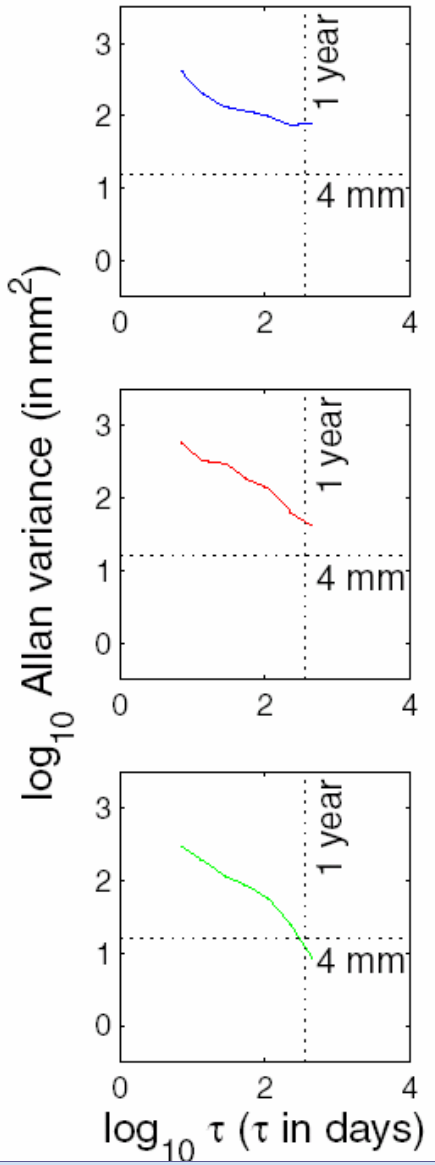
IGN-JPL time series - Reykjavik



Allan variance



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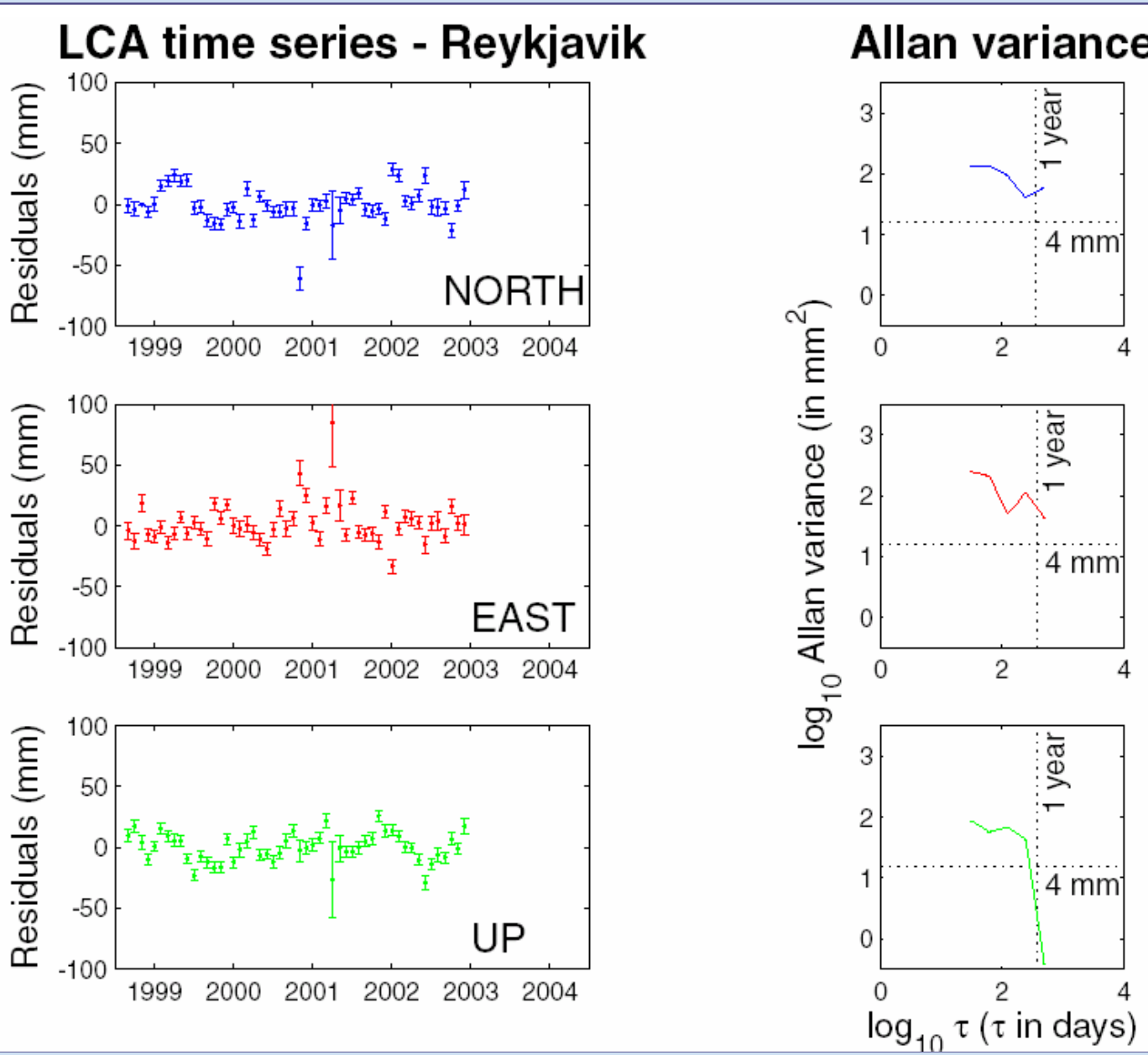

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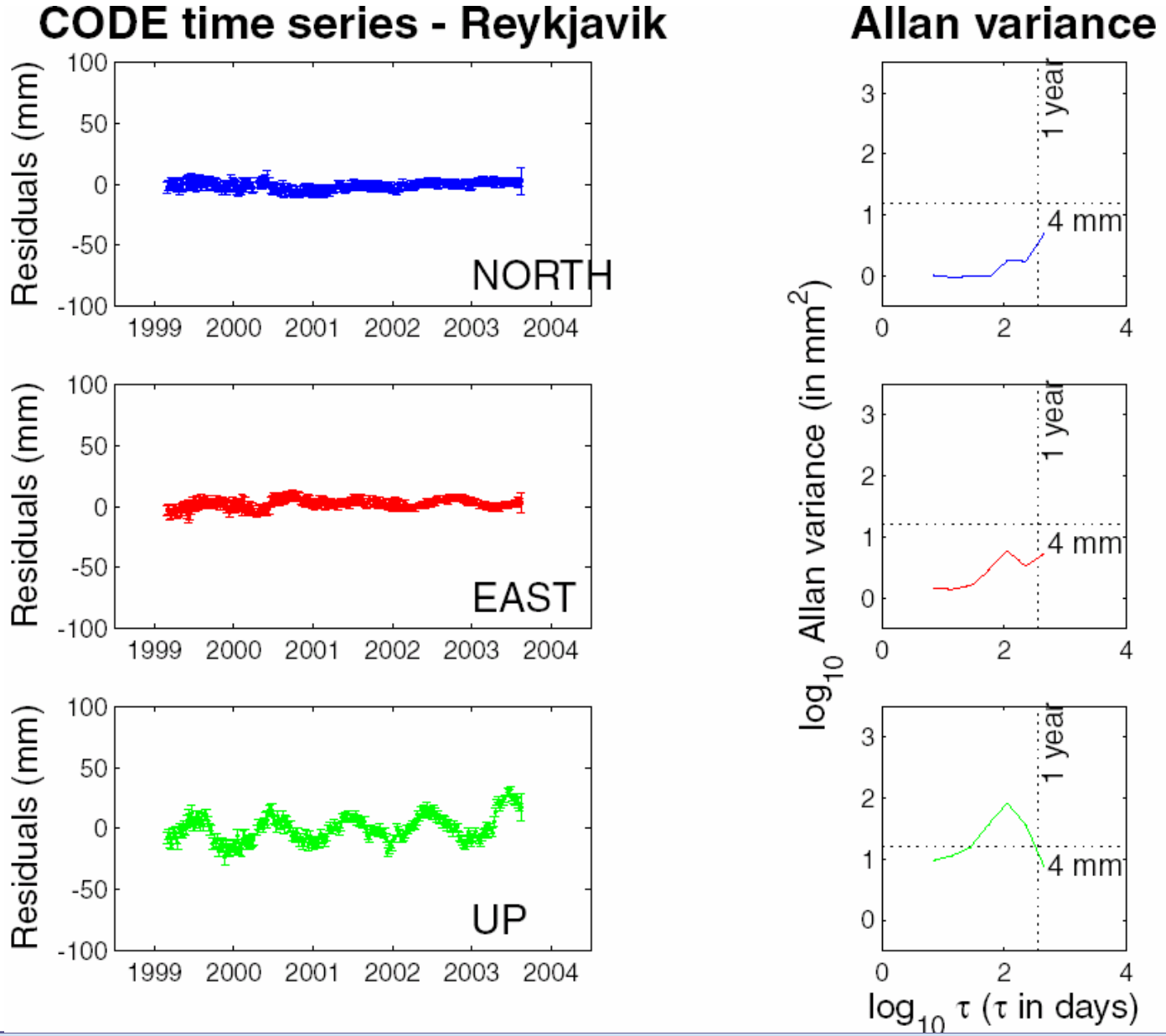

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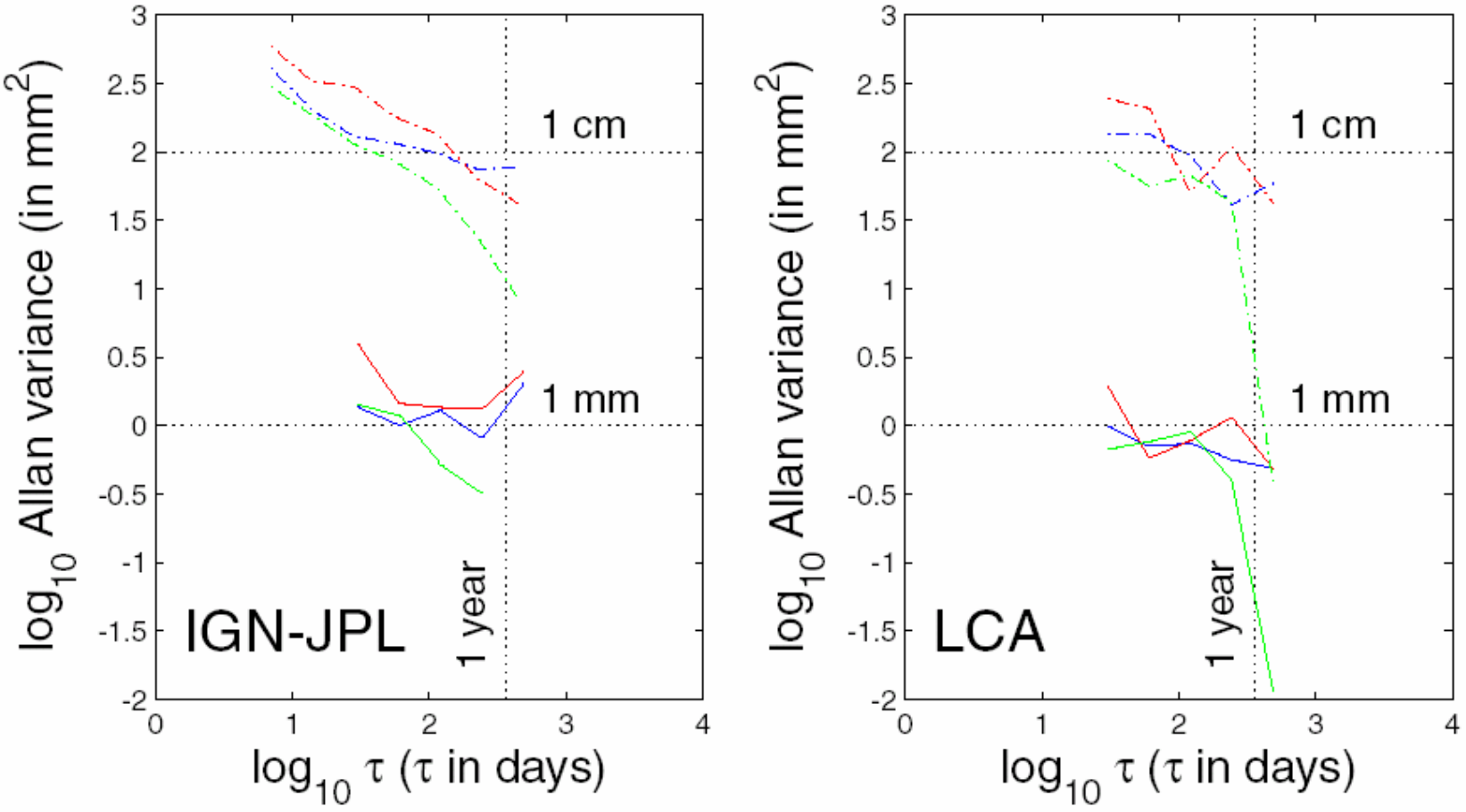
Reykjavik Allan variances by the three-cornered hat method

Solid line : three-cornered hat method

Dashed line : direct method



North (blue) - East (red) - Up (green)

Comments

• REYK follows the general characteristics (see the poster)

• DORIS has white noise and gets closer to GPS

• Important discrepancies between the direct method and the three-cornered hat method
• Short time series because of bad continuity of the observations

THE END…

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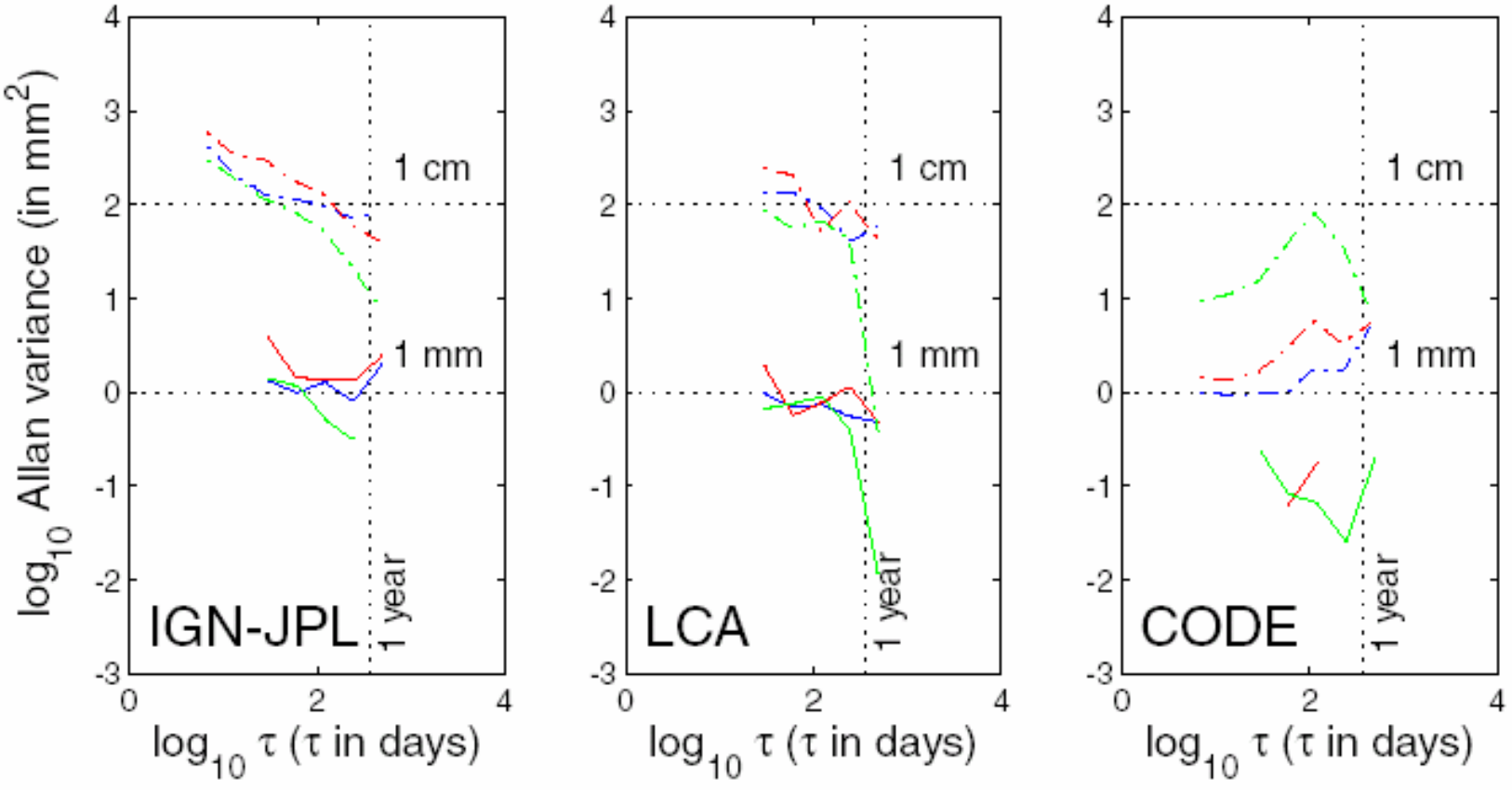
Solid line : three-cornered hat method
Dashed line : direct method



North (blue) - East (red) - Up (green)