

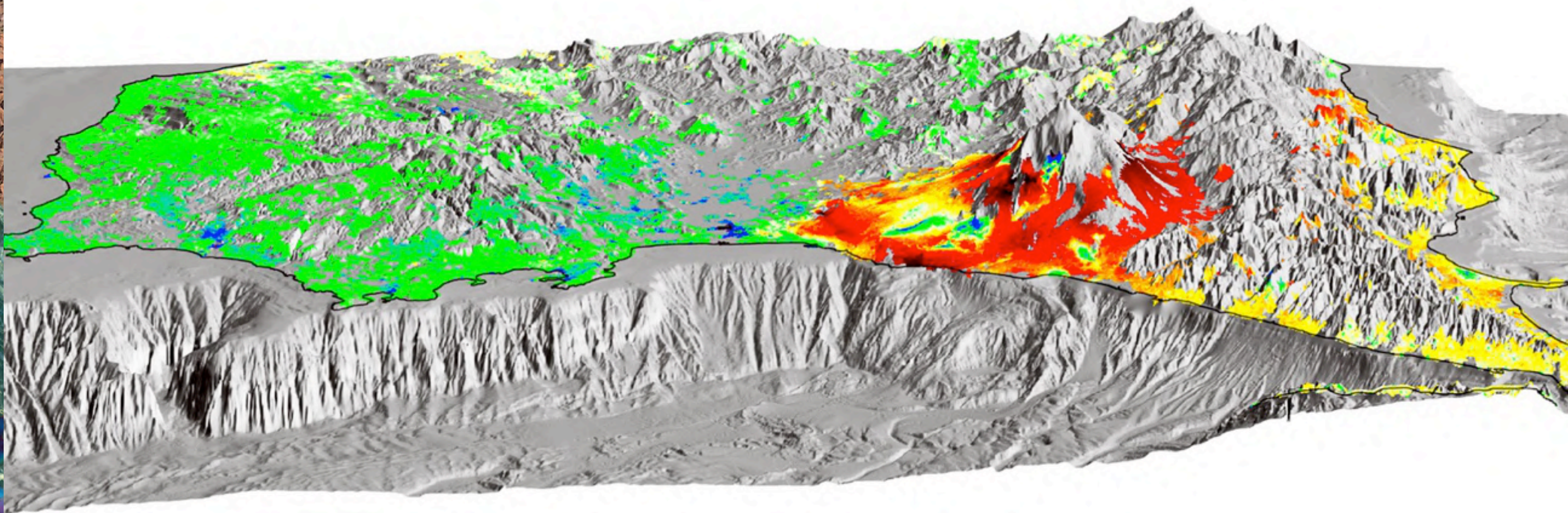
Pseudo-3D ground deformation map of Sicily derived from Sentinel-1 InSAR time-series

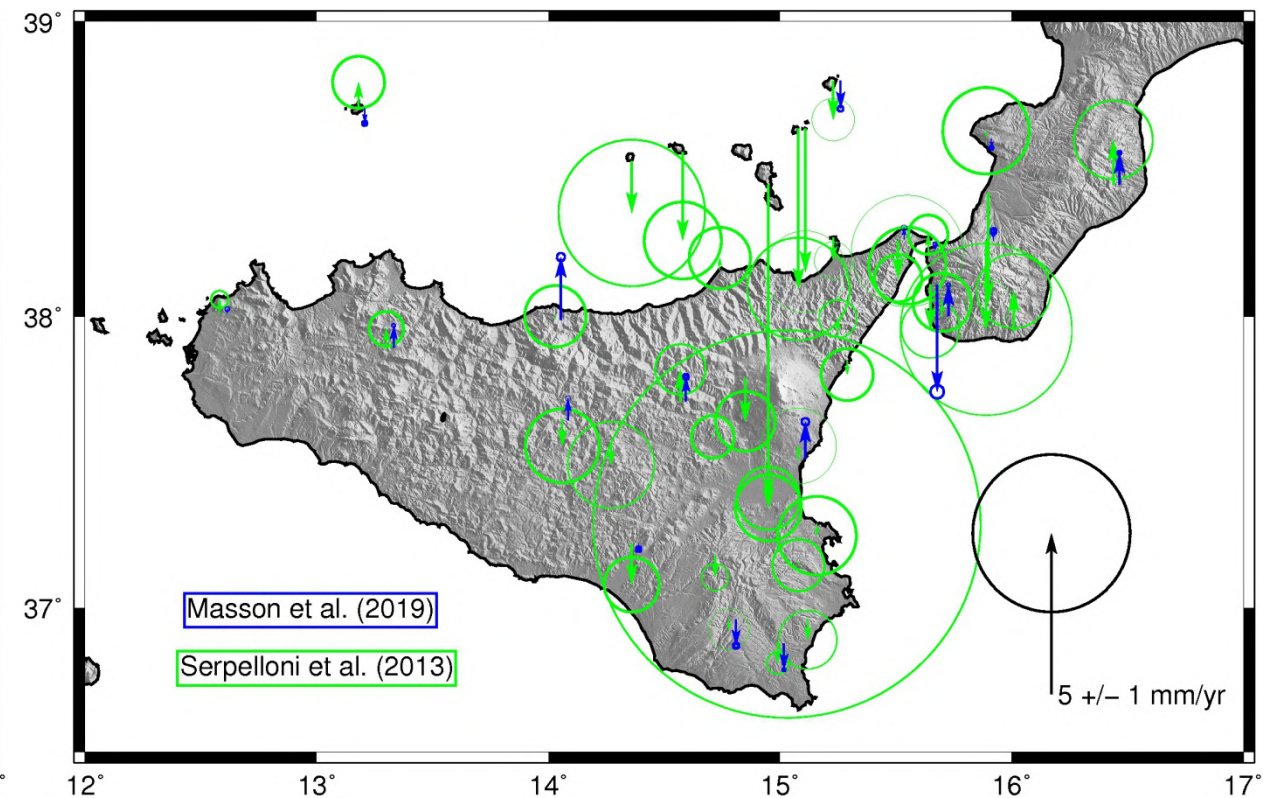
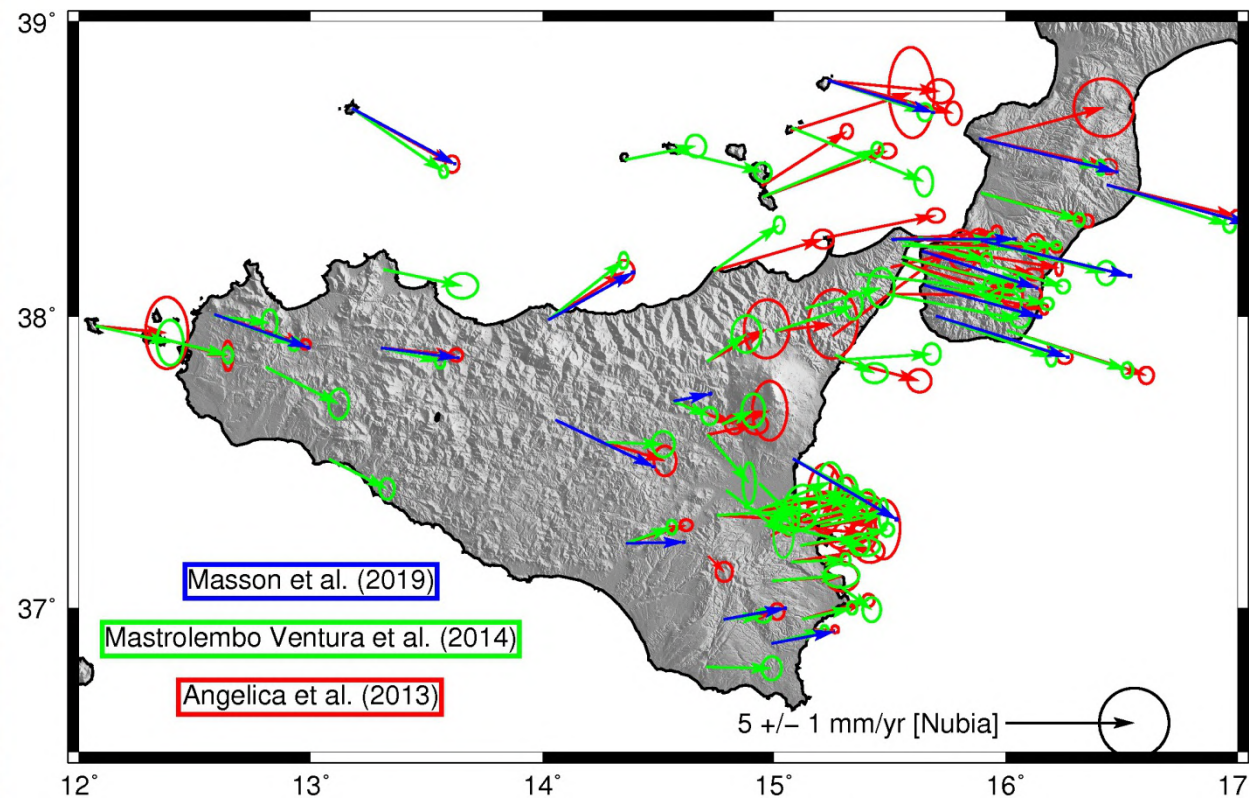
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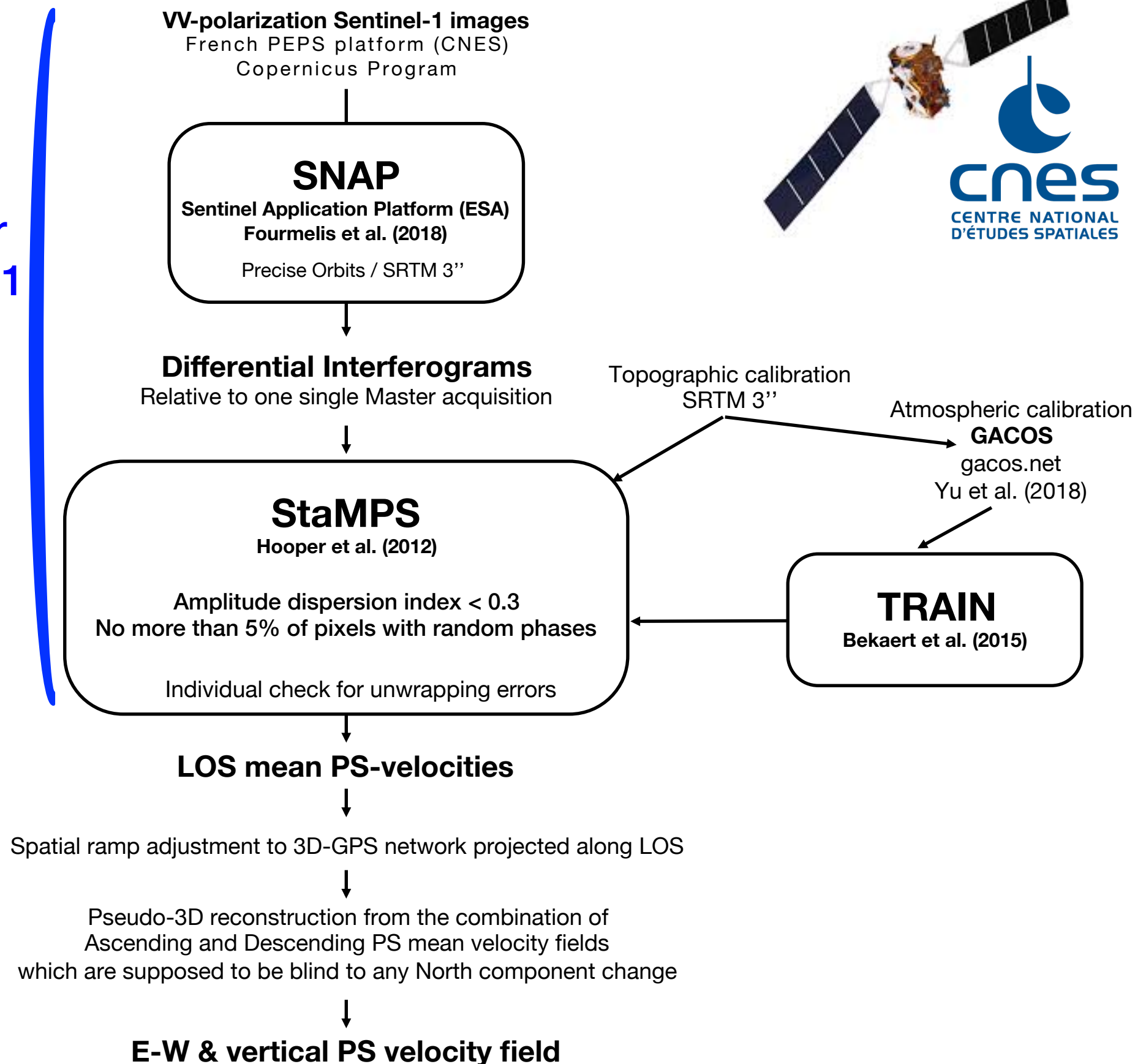
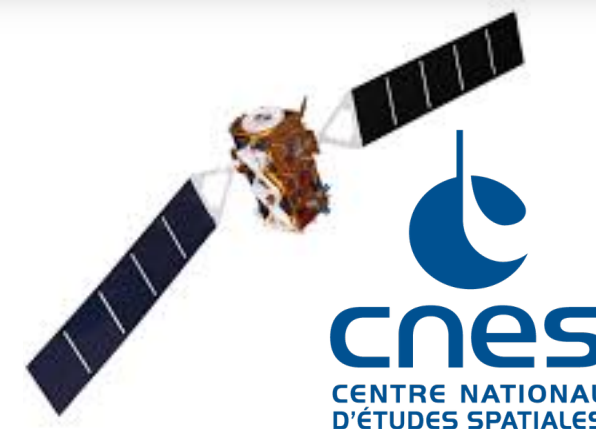
GPS kinematics

- *Heterogeneous spatial density and variable quality of the time-series*
- *Vertical velocities at the resolution limit (~ 1 mm/yr)*

InSAR – Study objectives

IMPROVE OUR KNOWLEDGE OF THE CURRENT SURFACE KINEMATICS OF SICILY BY PROVIDING THE FIRST VERTICAL VELOCITY FIELD DERIVED FROM MULTI-TEMPORAL INSAR

Persistent Scatterer Analysis of Sentinel-1 InSAR time-series

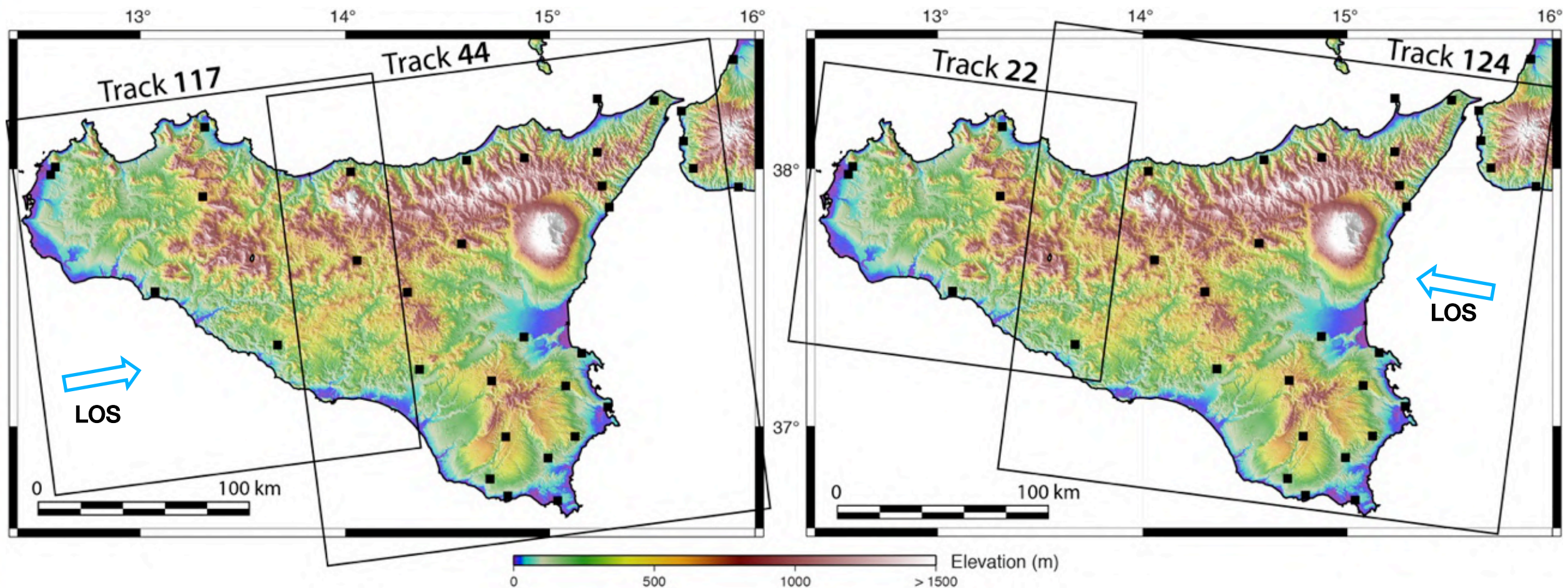


From LOS to
Up and East

Sentinel-1 SAR time-series from 01/2015 to 01/2020
 (12d interval before 09/2016 & 6d since then)

Ascending pass

Descending pass



West: track 117 – 216 images
East: track 44 – 196 images

West: track 22 - 205 images
East: track 124 - 215 images

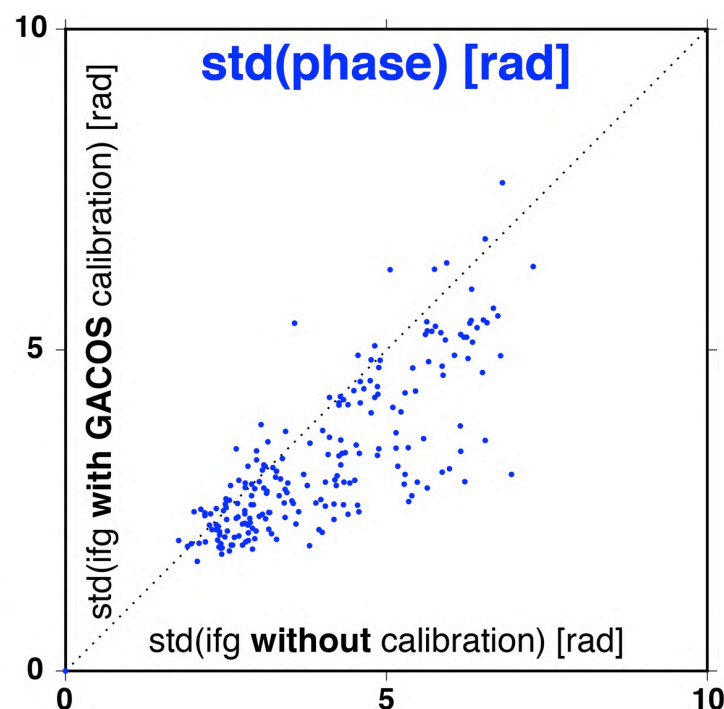
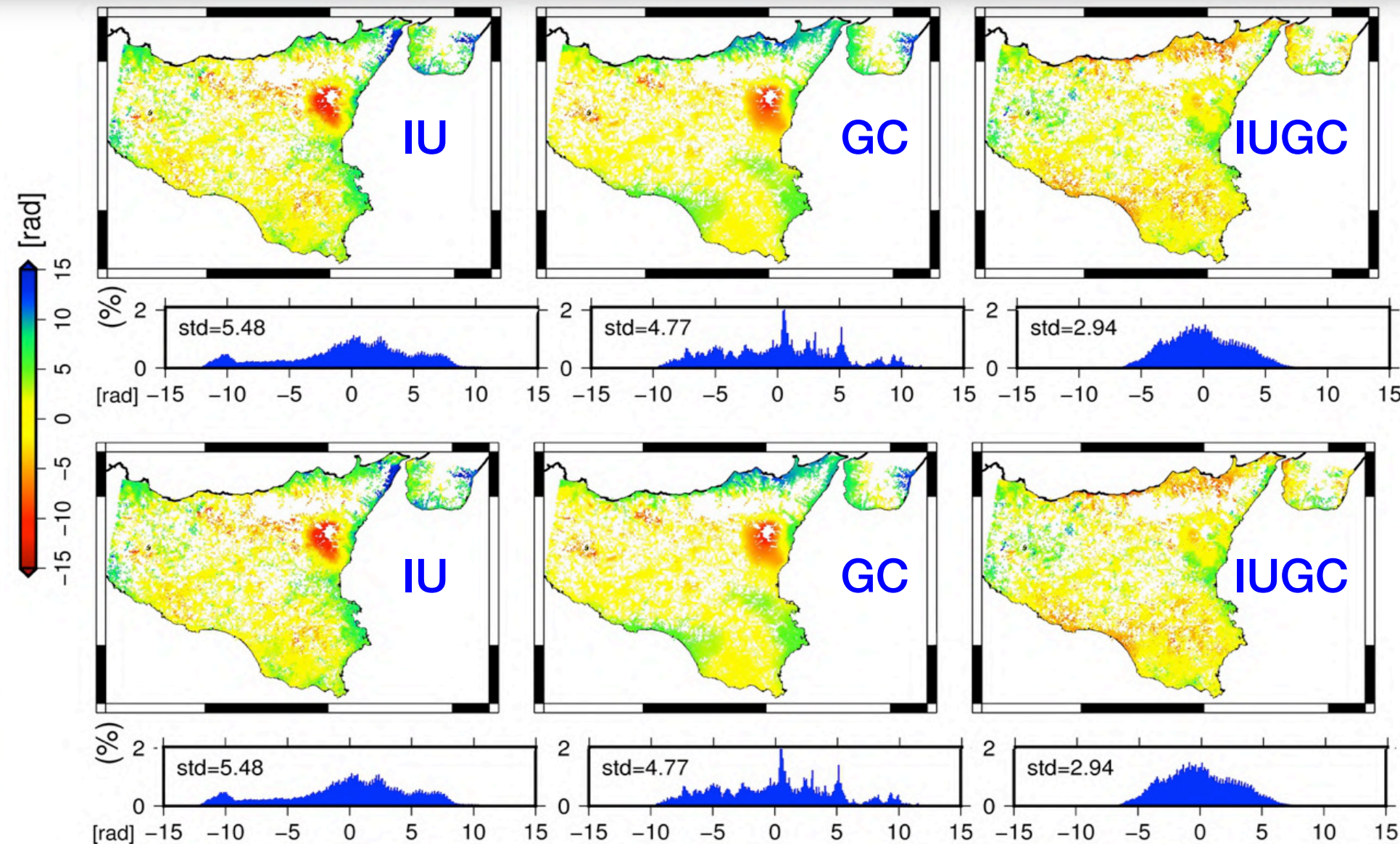
■ Selected GPS data from **MAGNET** time-series (Nevada Geodetic Lab)

Desc pass - Eastern Sicily

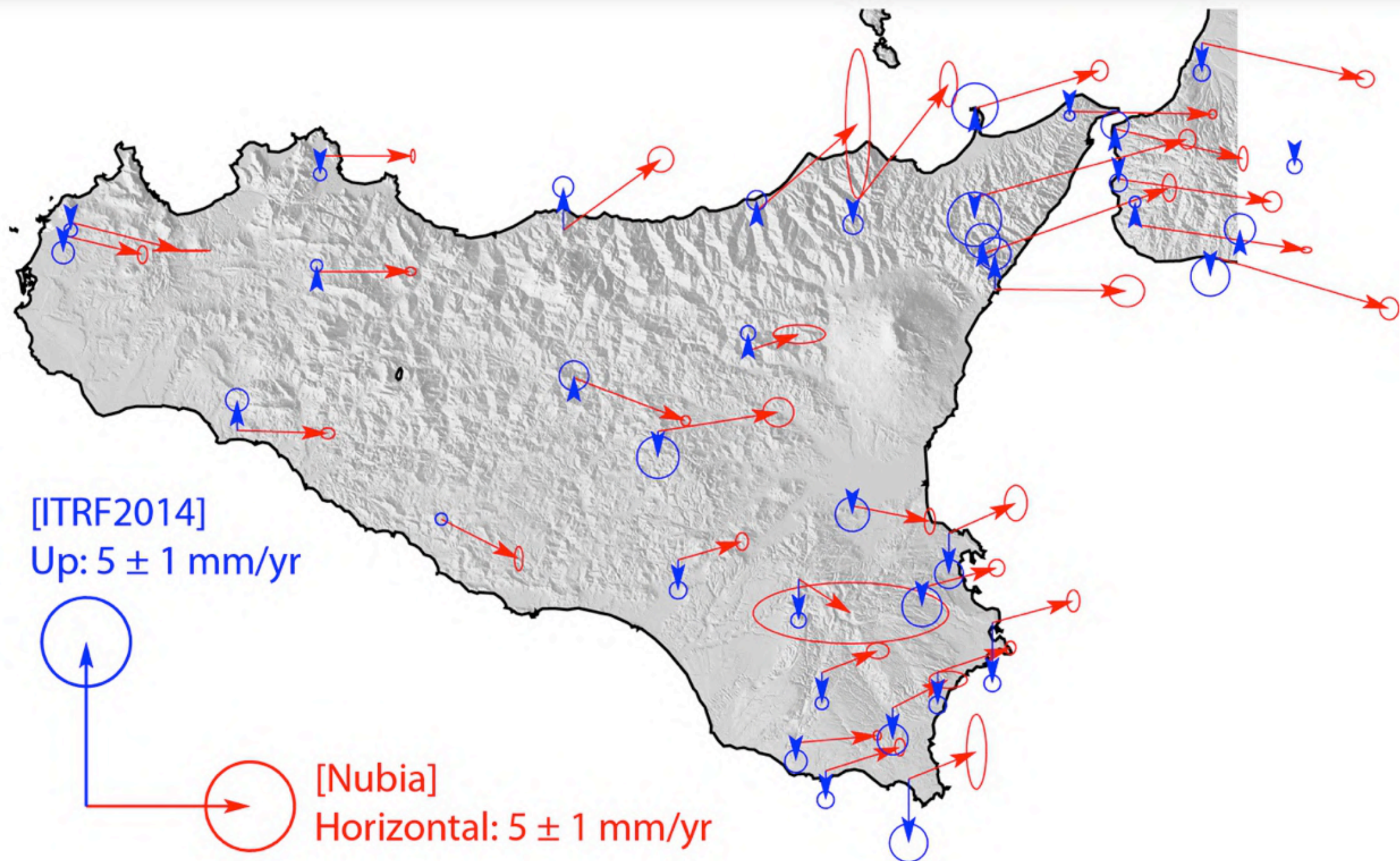
Example: Ifg 32

IU = unwrapped Ifg
 GC = GACOS calibration
 IUGC = Ifg + calibration

Example: Ifg 28



- **GACOS** stratified and turbulent **tropospheric calibration** based on HR-ECMWF model at **0.1°** and **6h** resolutions.
- **Interferometric phase standard deviation is significantly reduced**, notably over Mt Etna, the Peloritani range and Calabria. Their time persistence induces biases in PS velocity if not taken into account.
- Unmodelled turbulent tropospheric signals are removed by **spatio-temporal filtering** of PS time series.

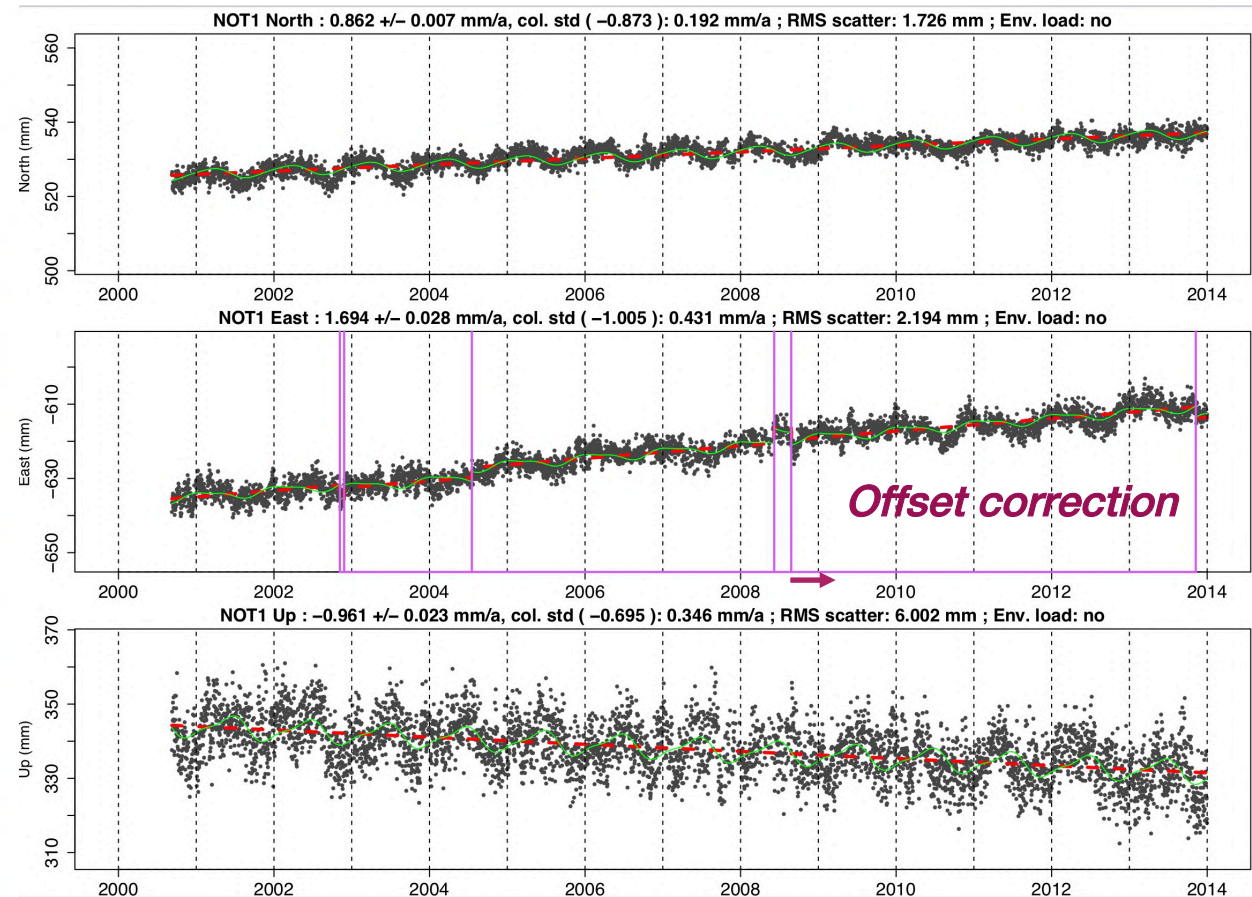


- Our selection from a **re-analysis of MAGNET time-series** (Nevada Geodetic Lab).
 - Quality check of the GPS time-series: large gaps, offsets, duration...
 - Consistency between GPS and PS time-series: same period? PS density around the GPS station? Artefacts vs local effects?

Example of good quality time-series

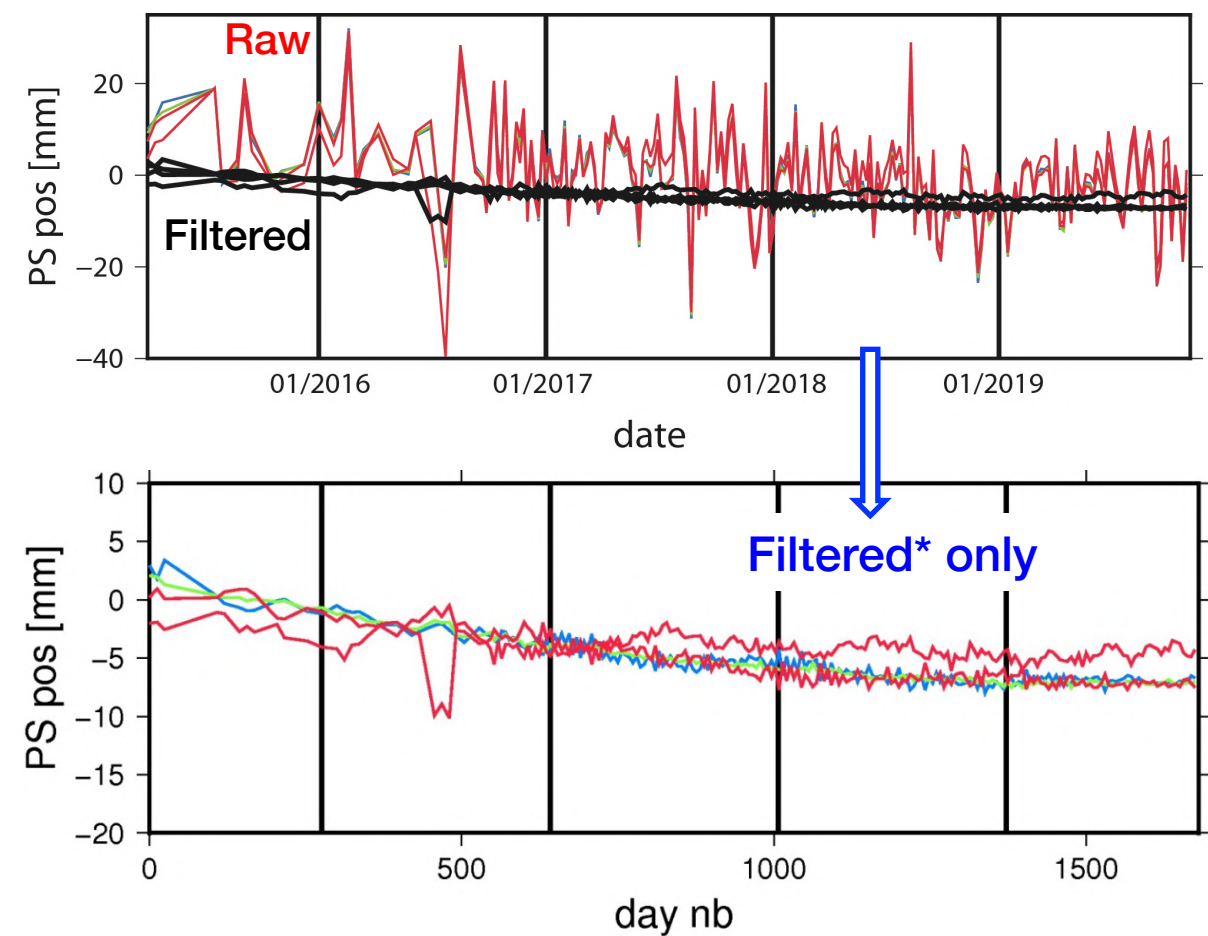
NOT1 station (Noto, SE Hyblean Plateau)

GPS time-series



--- linear trends ~ modeled annual variations

PS time-series



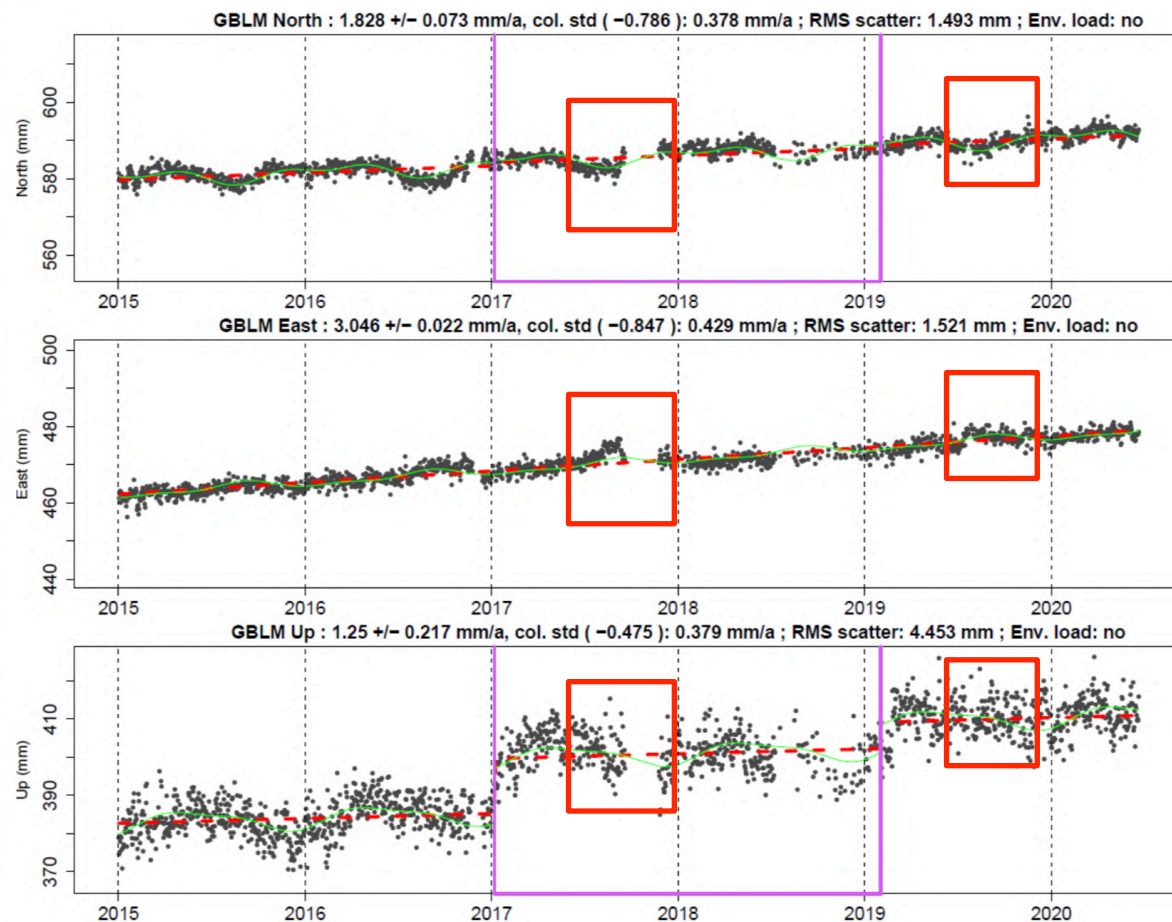
*spatio-temporal filtering: 100m/1yr

- Good quality GPS time-series + clear linear trends >> robust estimation of mean velocities.
- No evidence of any significant transient deformation >> good estimation of mean PS velocities.
- Very steady PS and GPS time-series over time >> reliable velocities for PS adjustment to GPS

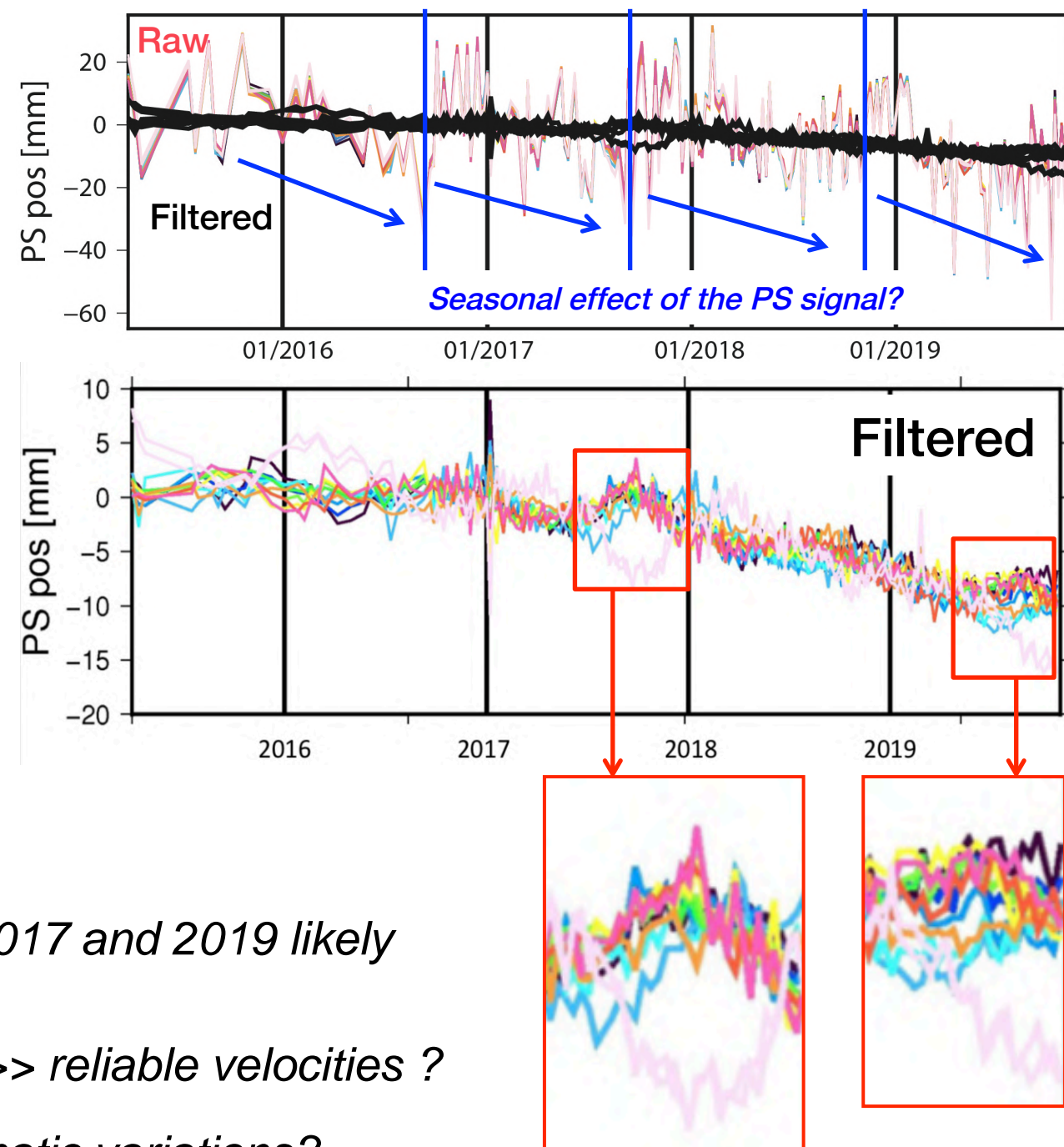
Example of doubtful time-series

GBLM station (Cefalu, Northern coast)

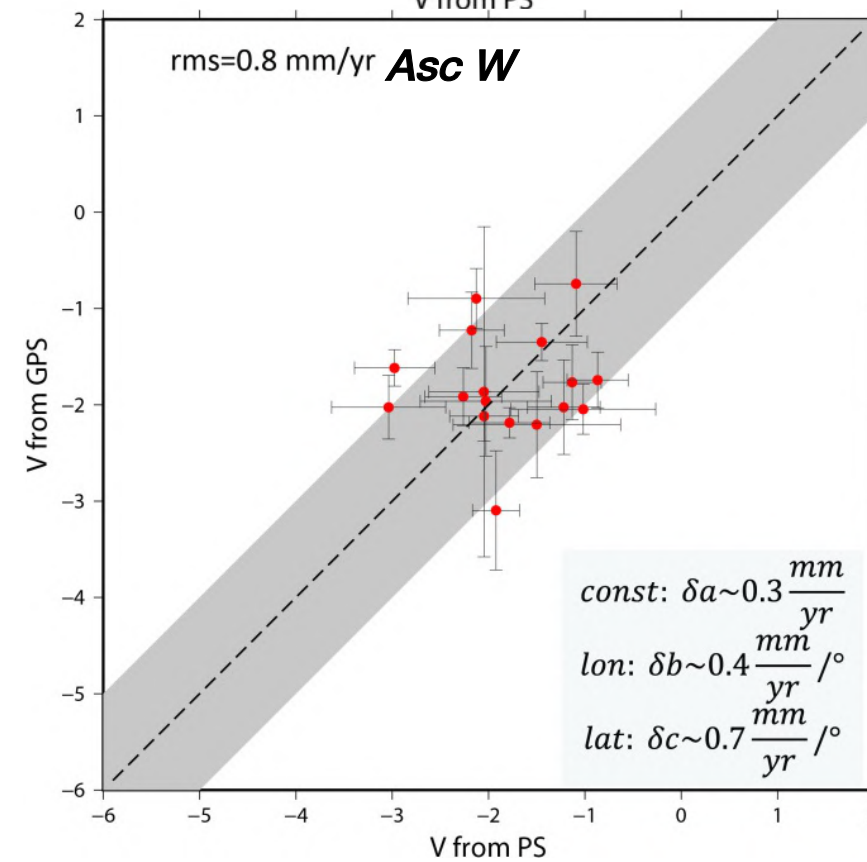
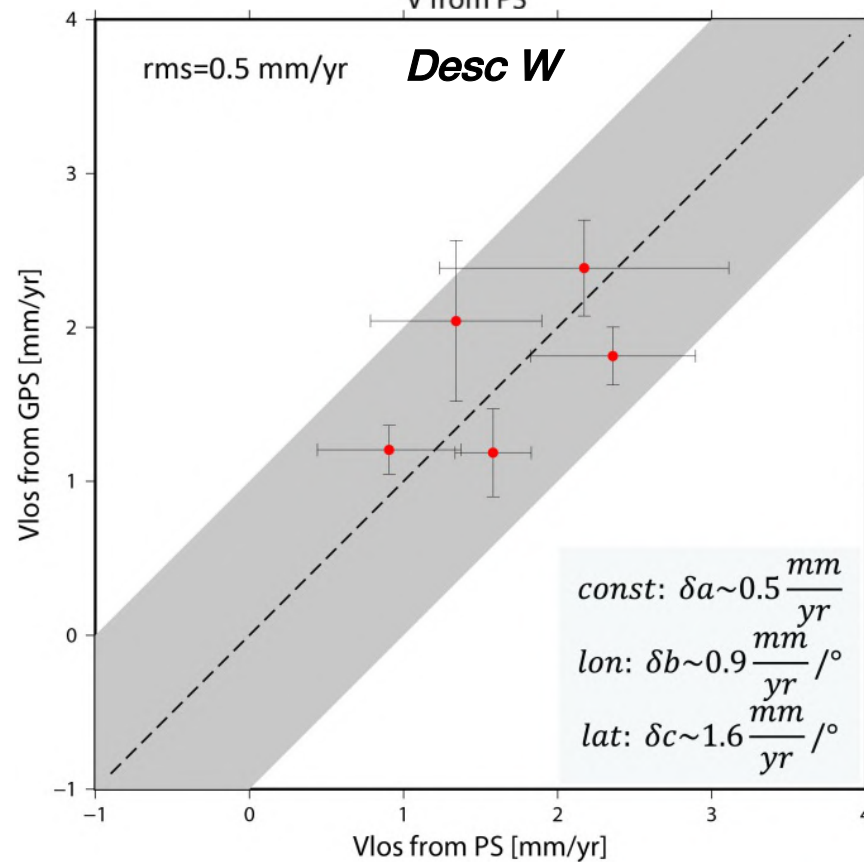
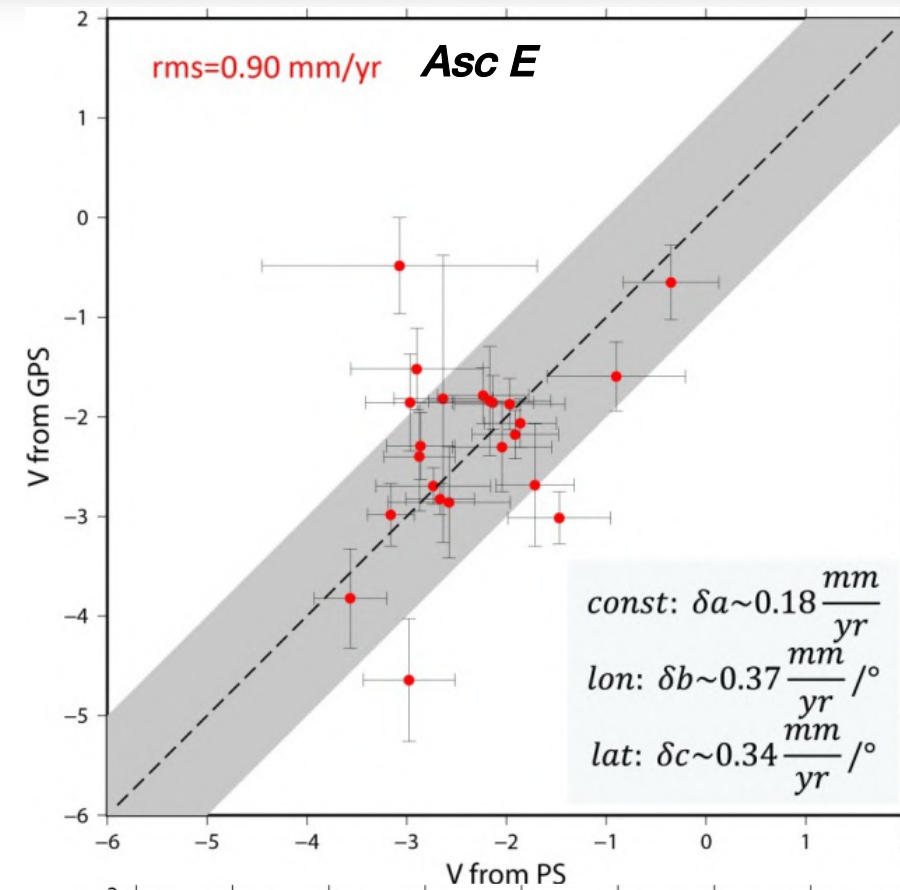
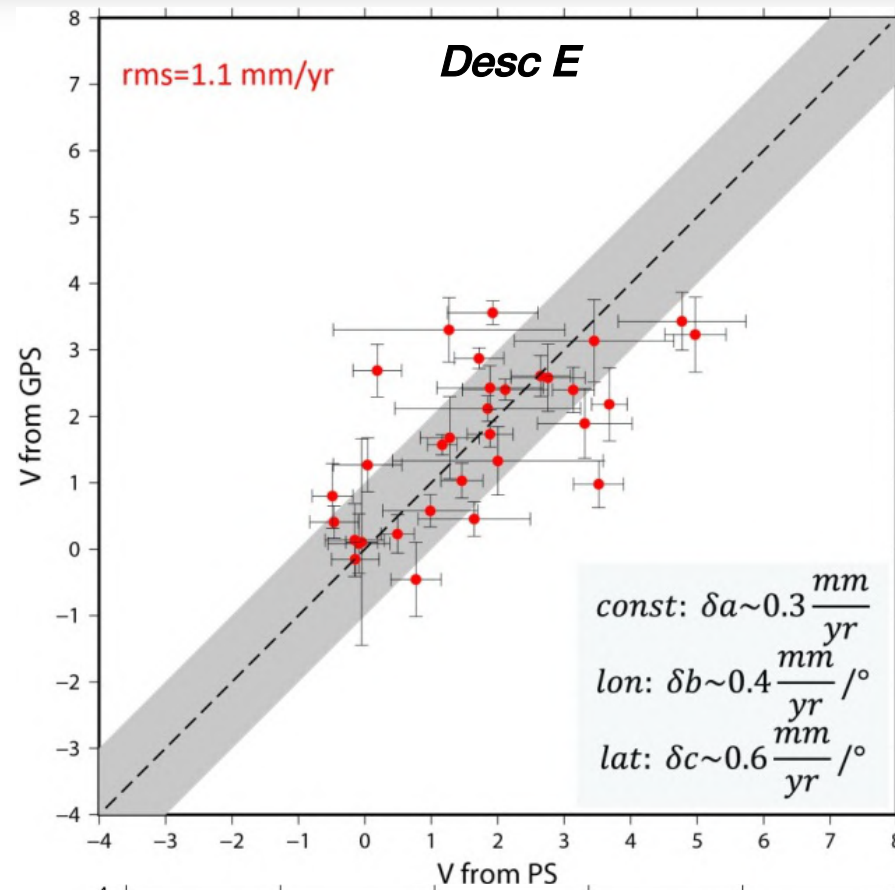
GPS time-series



PS time-series



- Poor quality GPS time-series
- Anti-correlated PS displacements during fall 2017 and 2019 likely associated to GPS artefacts (at least 2017)...
- Unsteady PS and GPS time-series over time >> reliable velocities ?
- Is it a local gravitational slide controlled by climatic variations?
 >> **Specific investigations are carried out on such cases!**

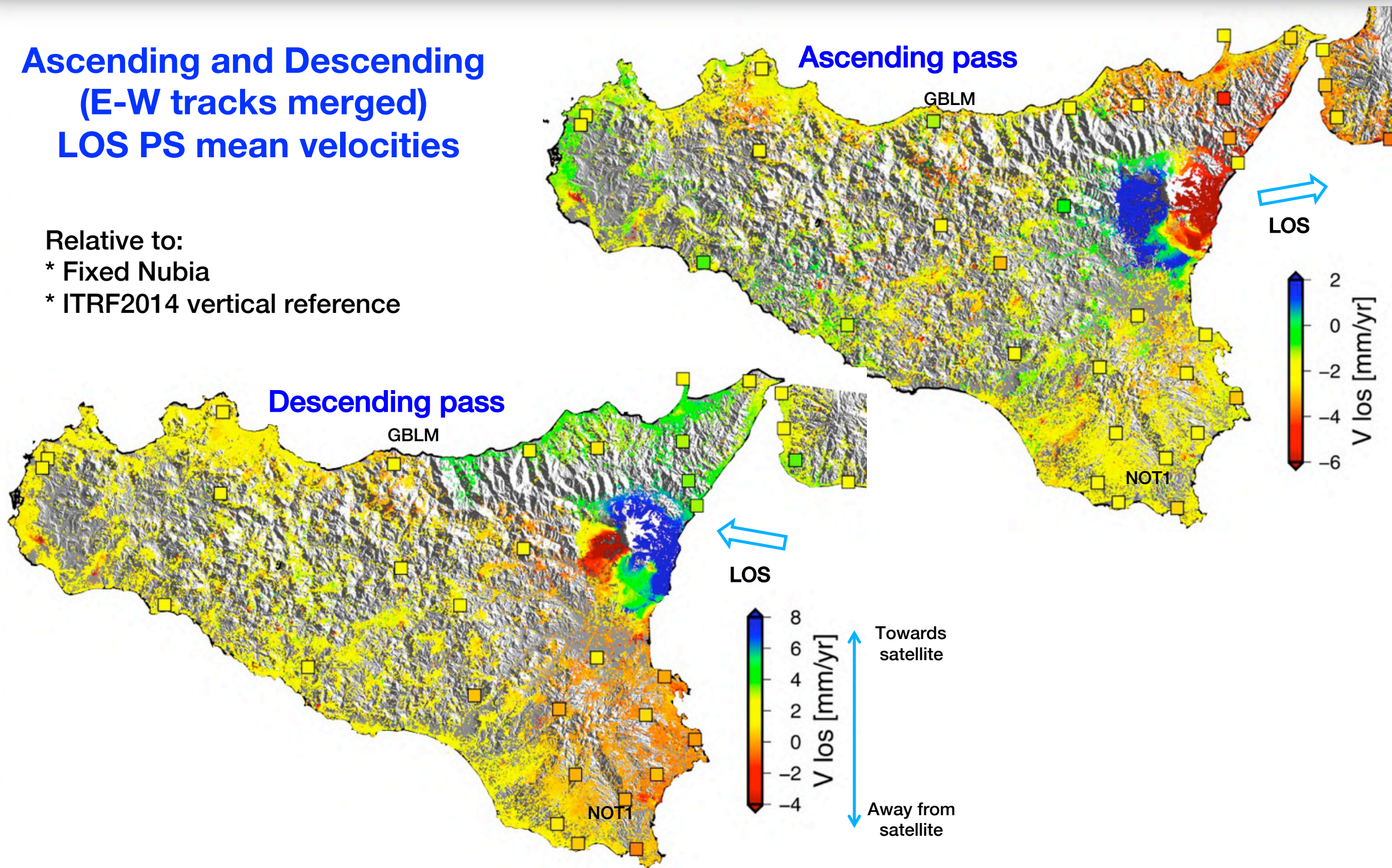


- All tracks: excellent $\text{rms} \leq 1.1 \text{ mm/yr}$

Ascending and Descending (E-W tracks merged) LOS PS mean velocities

Relative to:

- * Fixed Nubia
- * ITRF2014 vertical reference



Pseudo-3D: LOS Asc/Desc to East/Up component

*N-component neglected
(< 0.5 mm/yr along the LOS)*

$$\begin{pmatrix} v_e \\ v_{up} \end{pmatrix} = -[P'^t \cdot S \cdot P']^{-1} P'^t \cdot S \begin{pmatrix} v_{asc} \\ v_{desc} \end{pmatrix}$$

> P matrix of the coefficients of projection along LOS

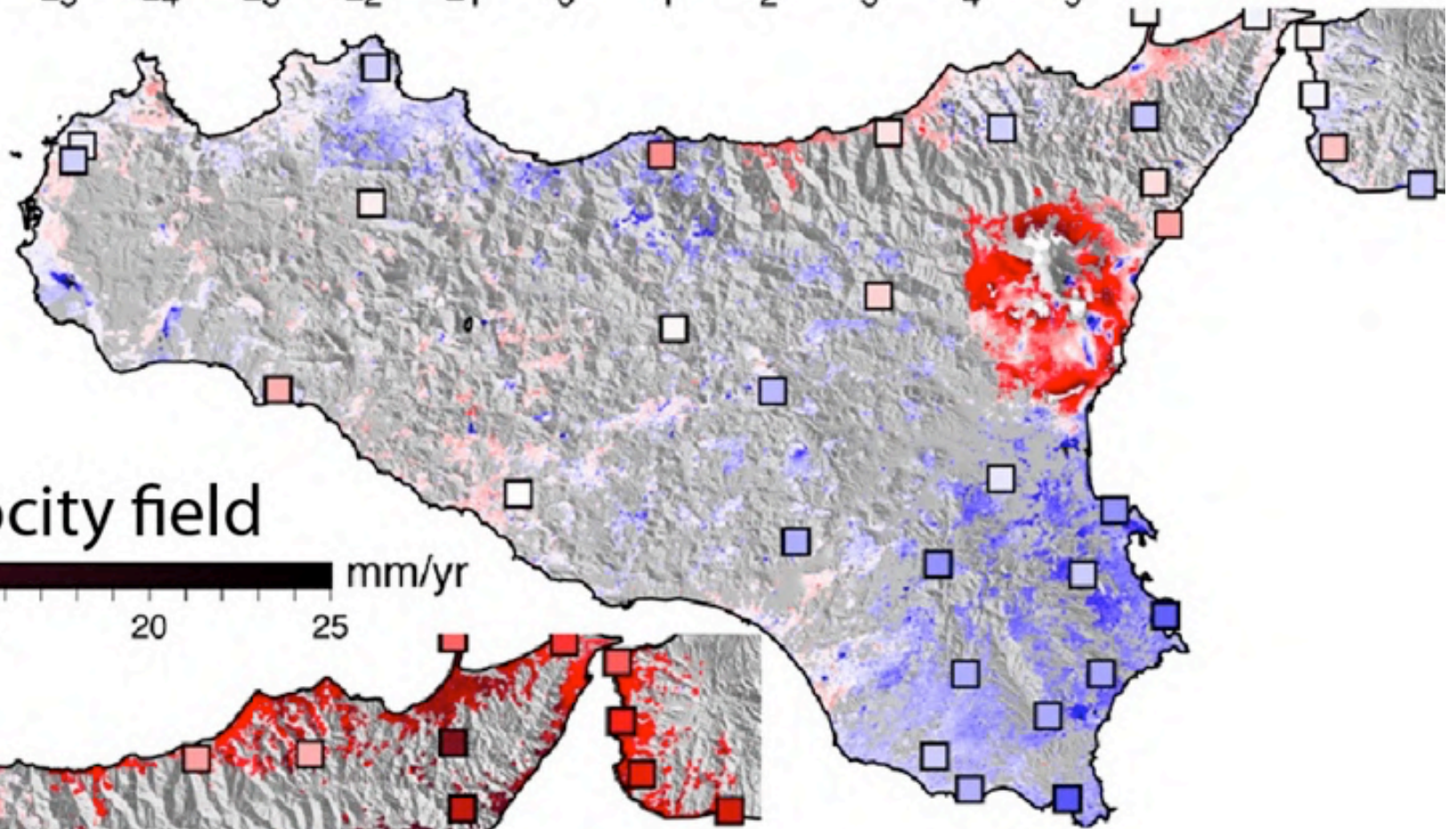
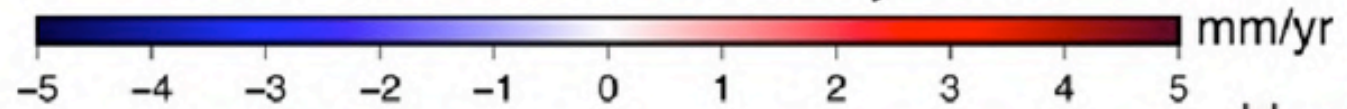
> S⁻¹ is the covariance matrix of the PS velocity measurements.

Relative to:

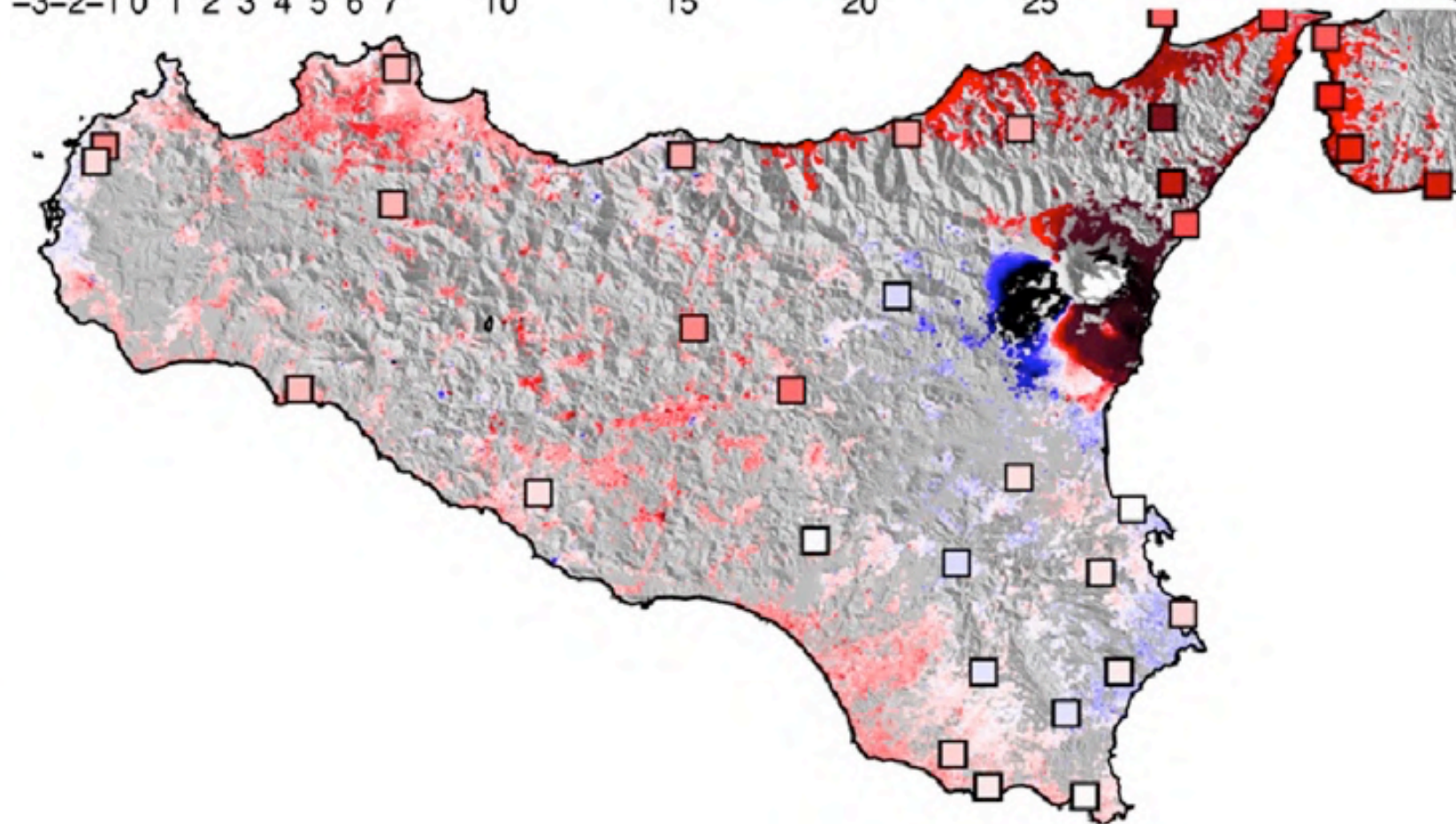
* Fixed Nubia

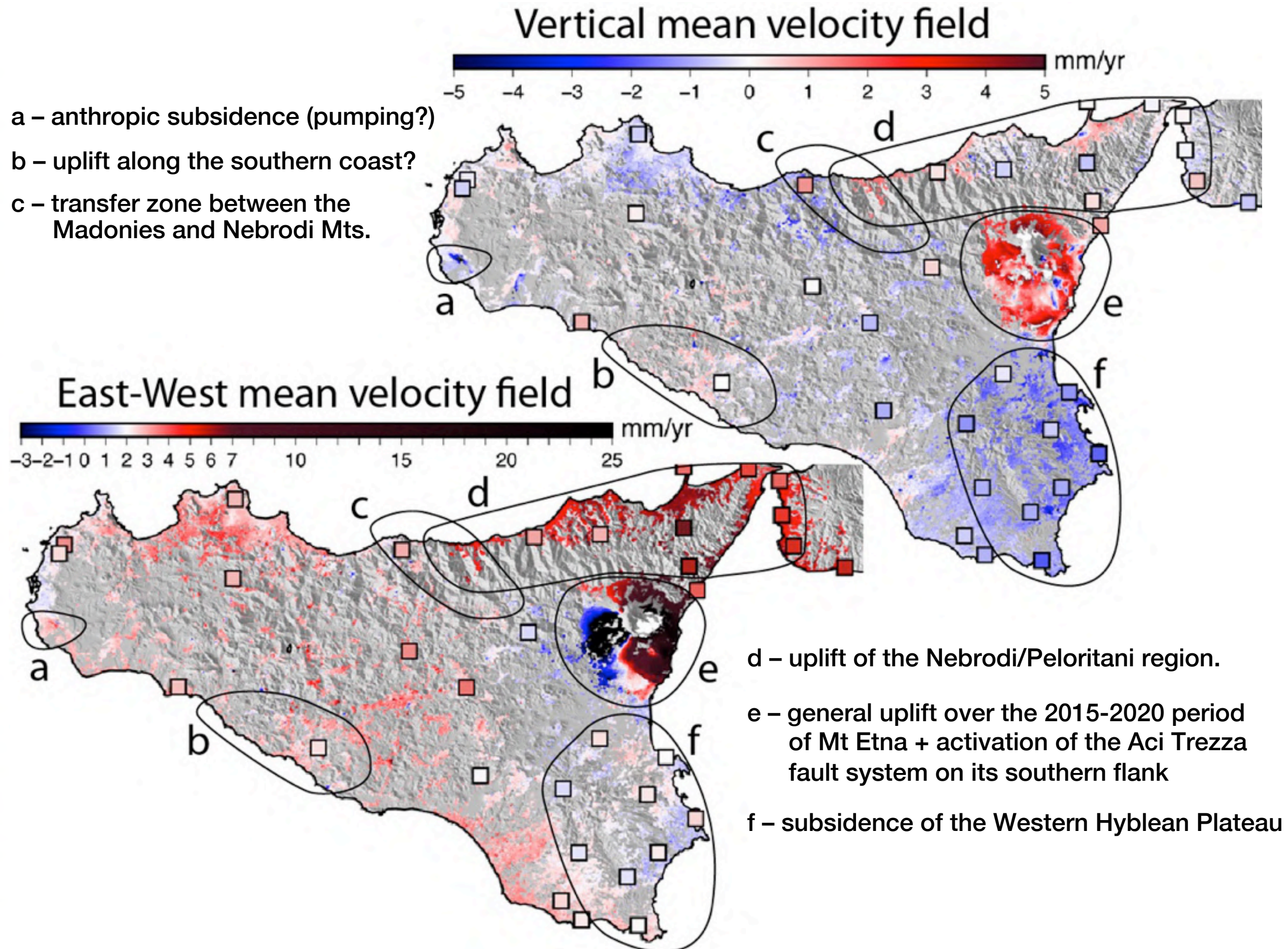
* ITRF2014 vertical reference

Vertical mean velocity field



East-West mean velocity field





Take home messages

- PS approach: large and dense spatial coverage (+ transient deformations)
- First regional scale mean PS velocity field of Sicily at the order of ~ 1 mm/yr
- Careful check of the GPS time-series and of the atmospheric delays are mandatory
- PS adjustment to 3D GPS time-series still in progress
- Preliminary results confirm known active processes in Sicily, such as the uplift of the Peloritani and the dynamics of Mt Etna. But, original tectonic patterns are also revealed: the relative subsidence of the Western Hyblean Plateau, the potential transfer zone between the Madonie et Nebrodi Mts, the relative uplift of the southern coast.

Thank you for your attention!