Towards a new generation of Generic Atmospheric Correction Online Service (GACOS)

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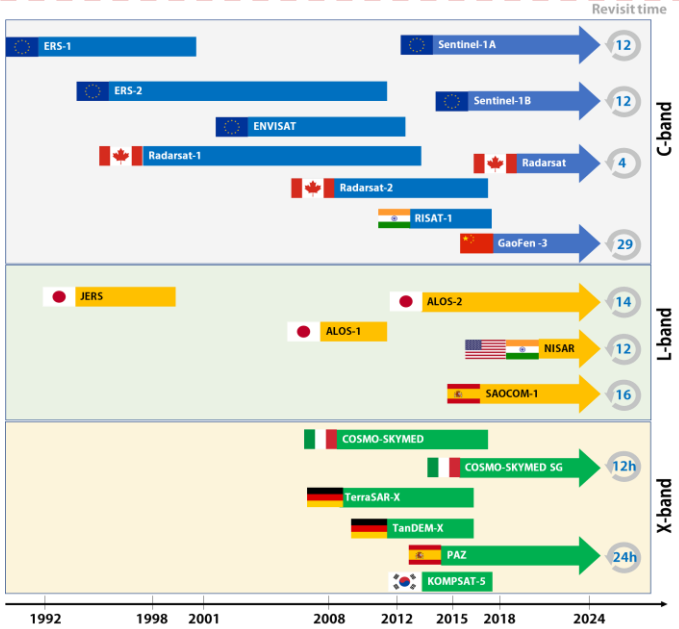
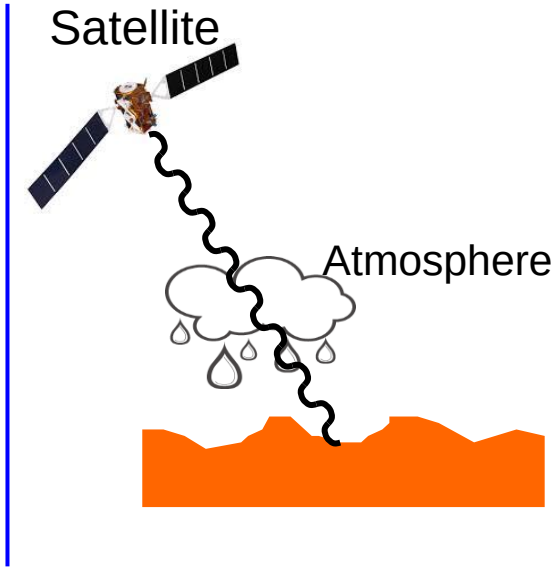
Earth Observation & Atmospheric delay

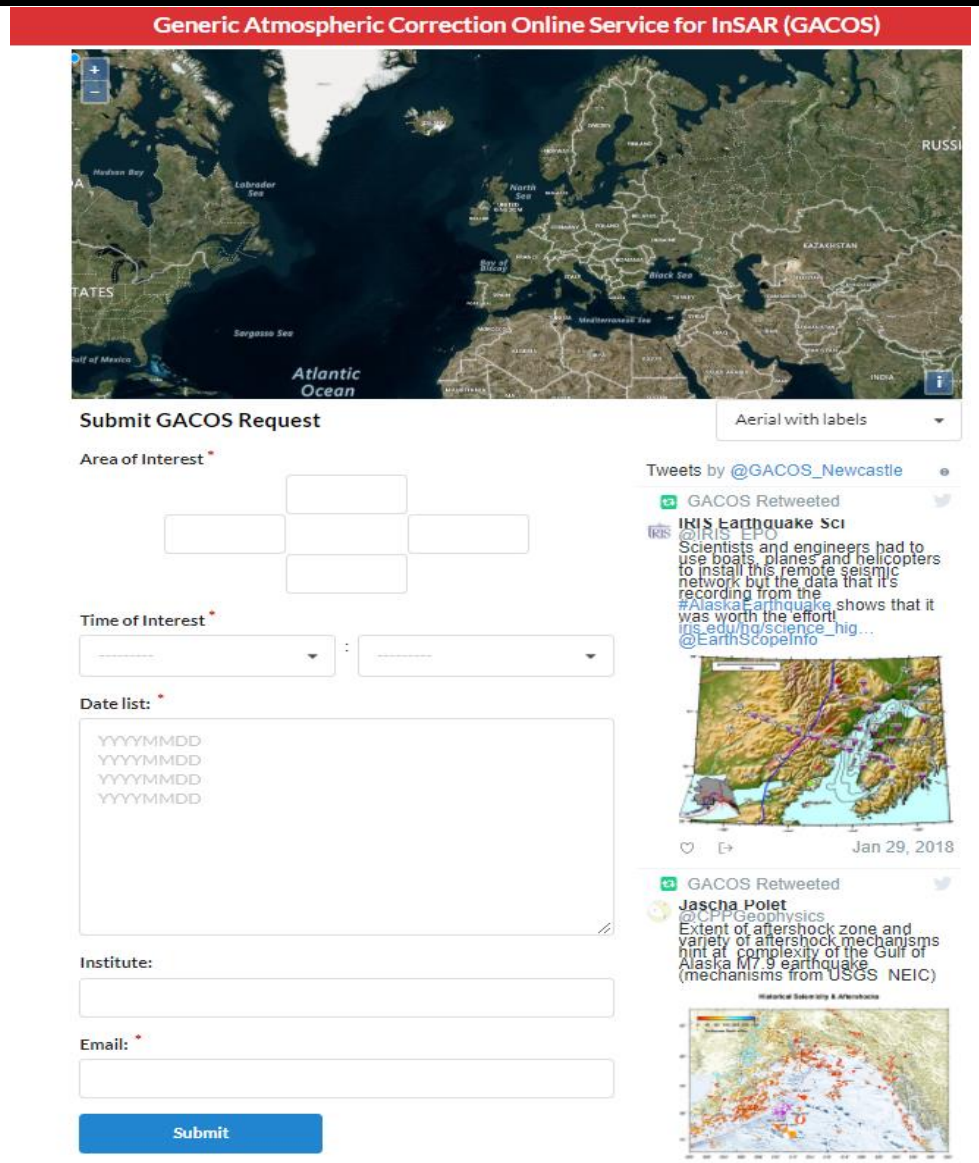


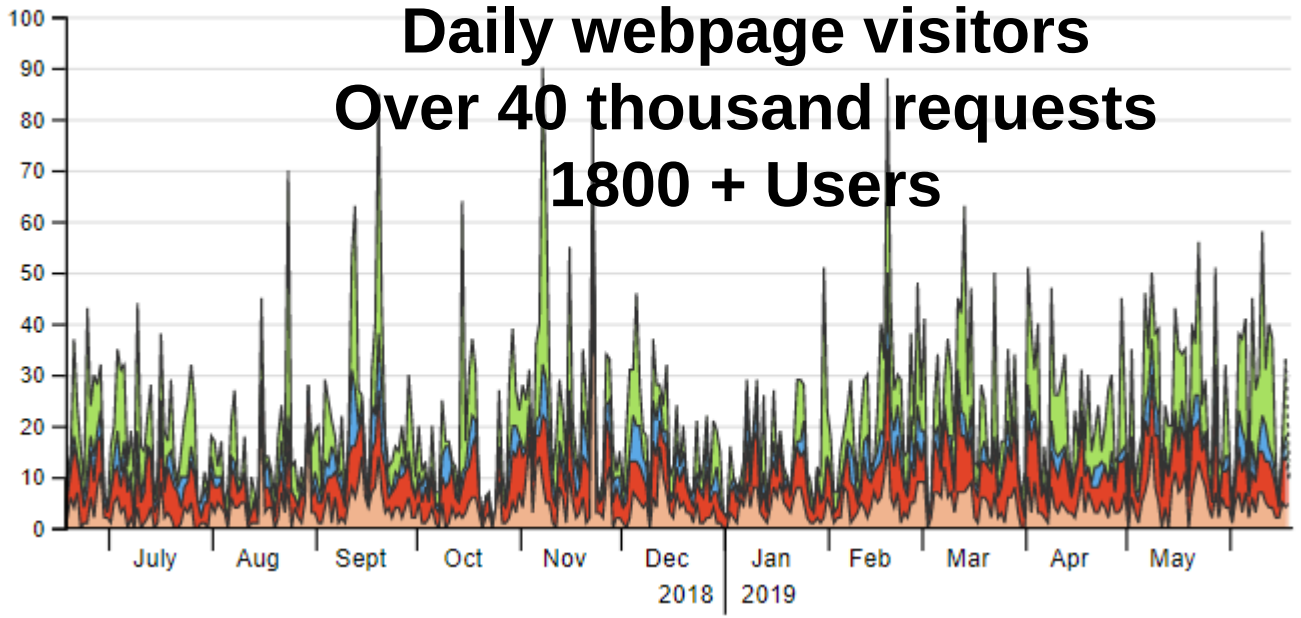


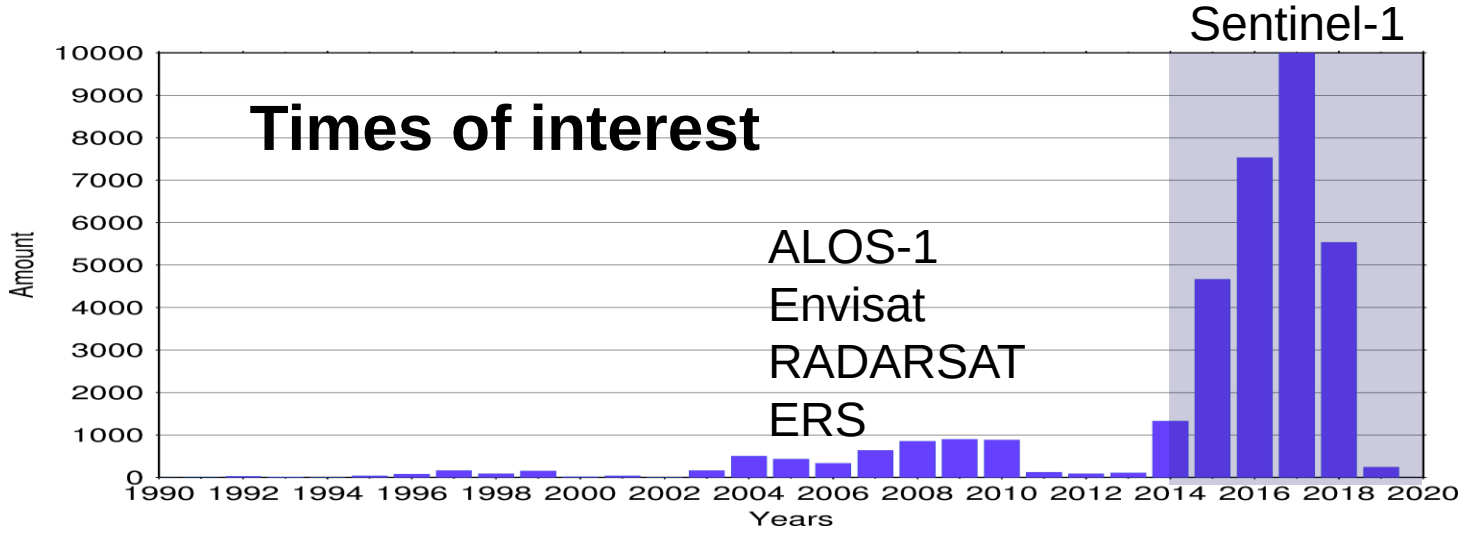
- Atmospheric delay is a major error source in GNSS positioning
- Spatiotemporal variations of water vapour represent one of the major limitations of InSAR
- Satellite altimetry (Sentinel – 3)

A common error source for most Earth Observations (EO)

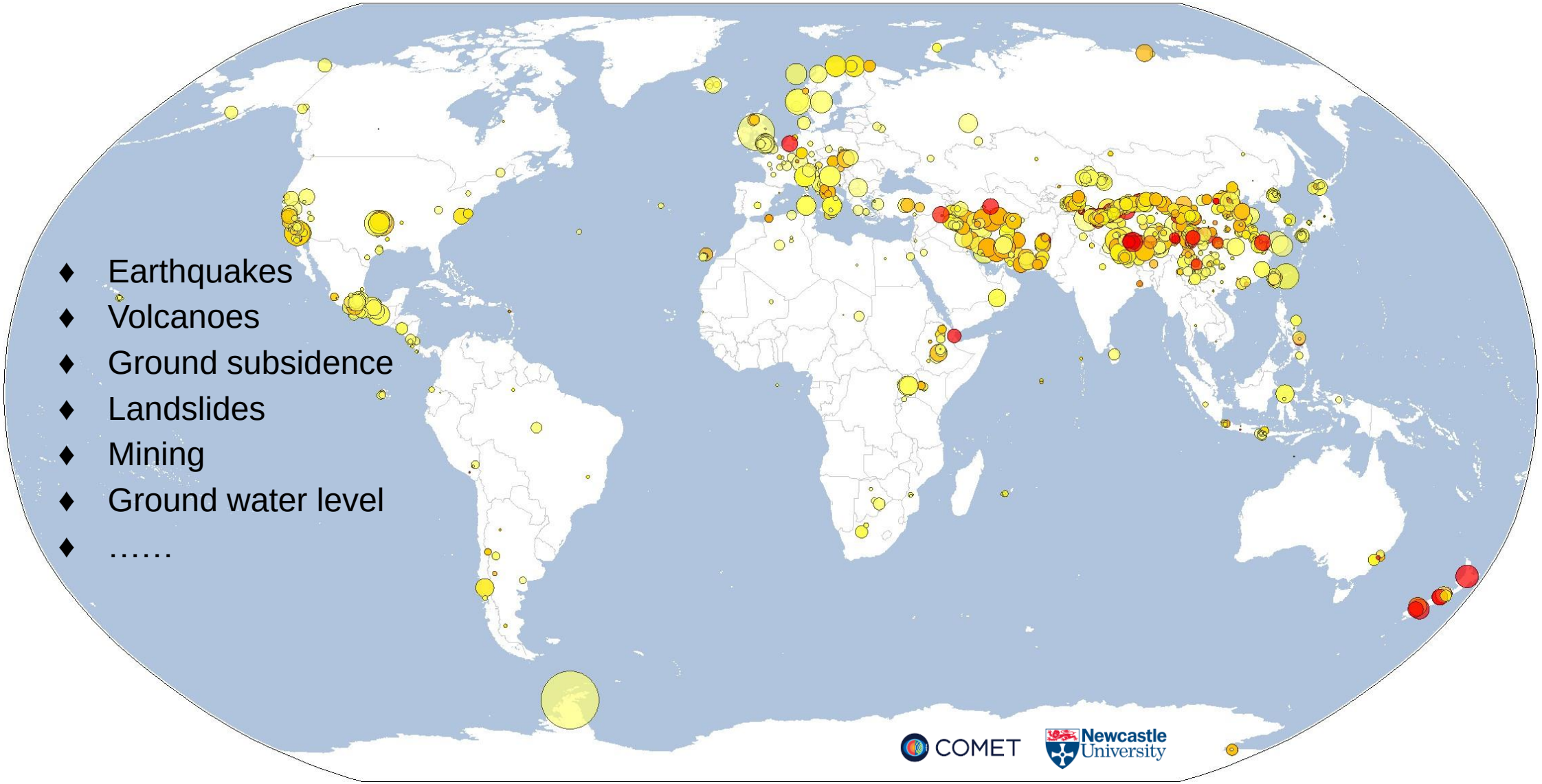
GACOS – Current status







GACOS – Areas of interest



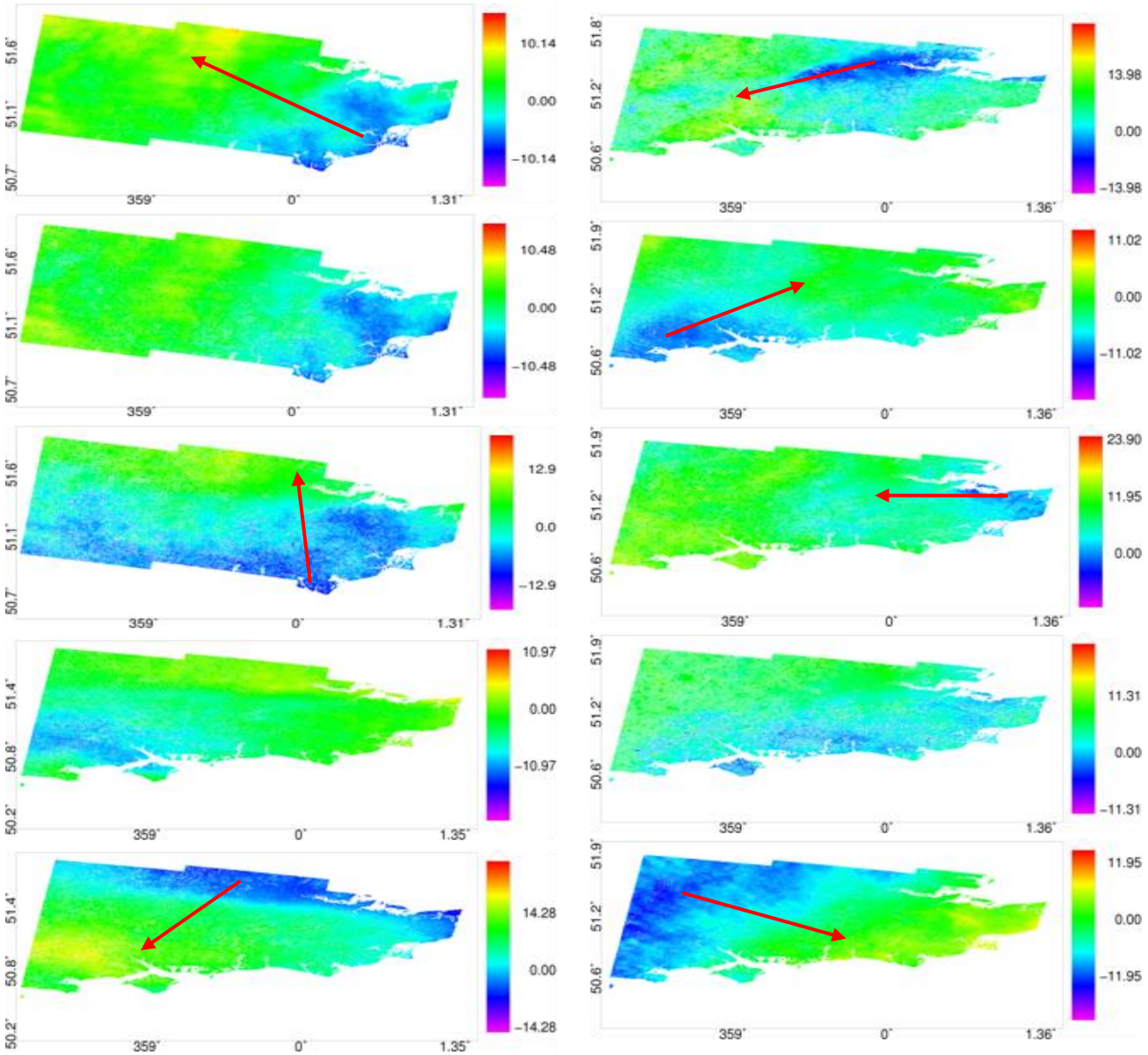
New challenges for InSAR

- Large spatial extent
  National, continental …

- Full time series
  Seasonal/semi-seasonal signals

- Computational costs
  Sophisticated APS models/filters

Highlight - Long wavelength ramps

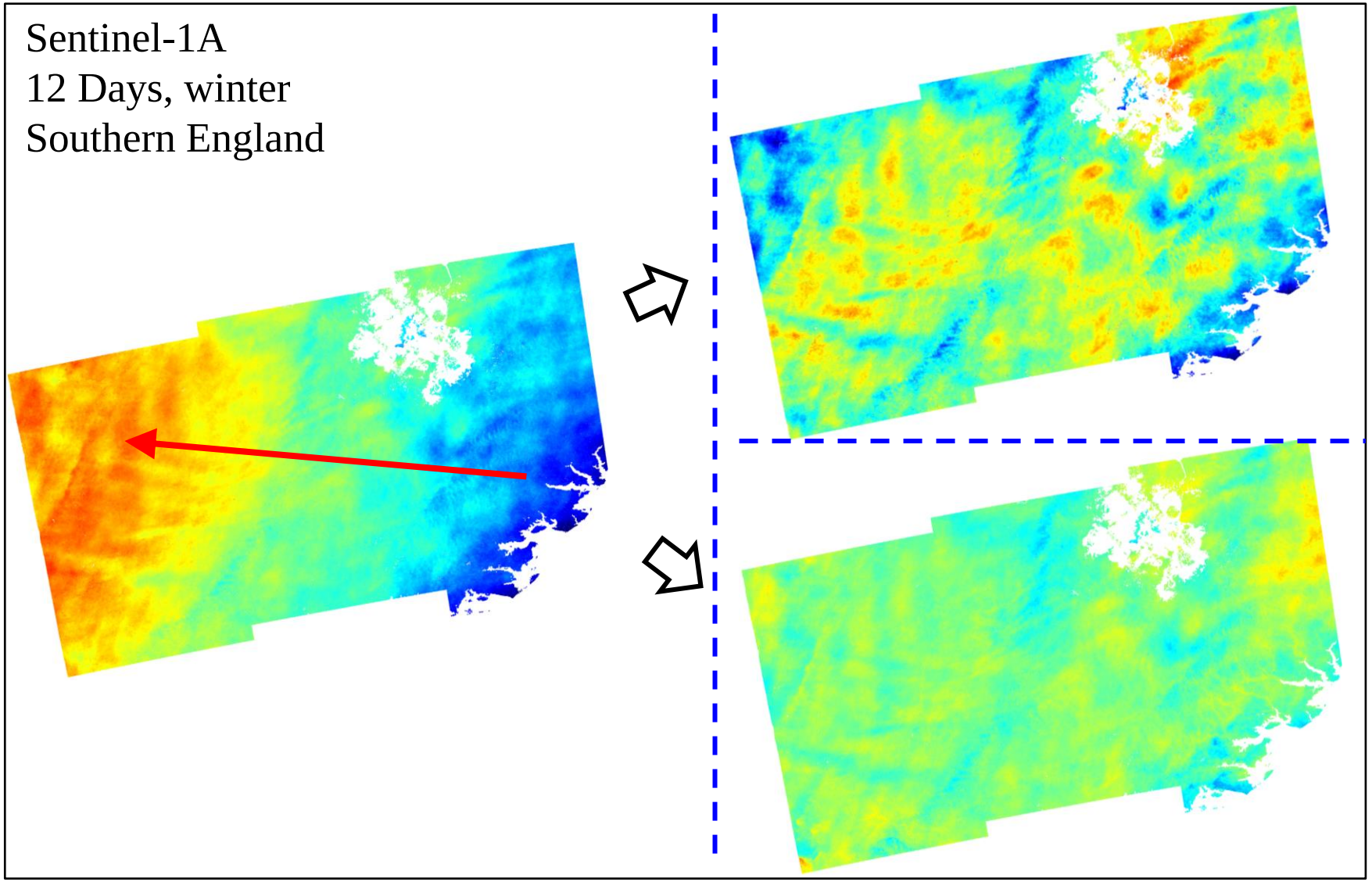


- The spatial pattern of atmospheric delay can be complicated
- Coupled with potential orbital ramps
- Atmospheric delays are not purely consist of long wavelength components, even in large spatial extents

Highlight - Long wavelength ramps

Original IFG

Corrected IFGs

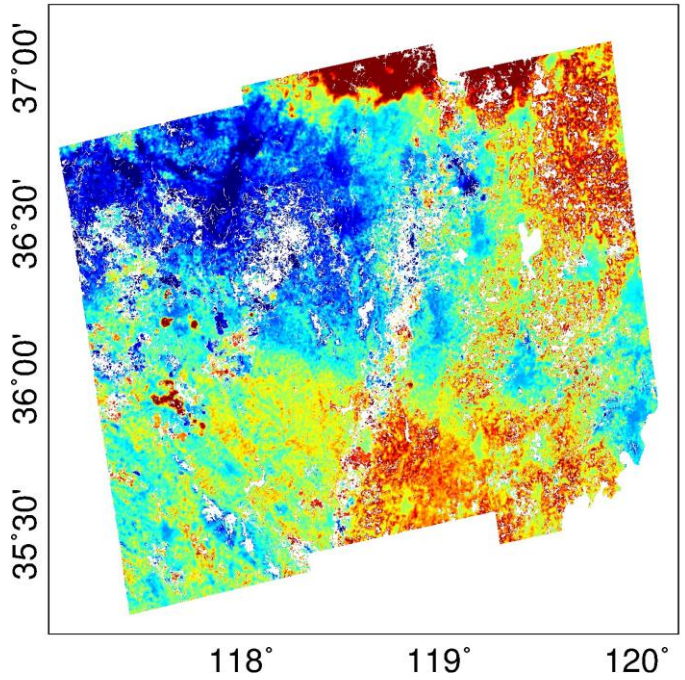


Ramp removal
ax + by +c

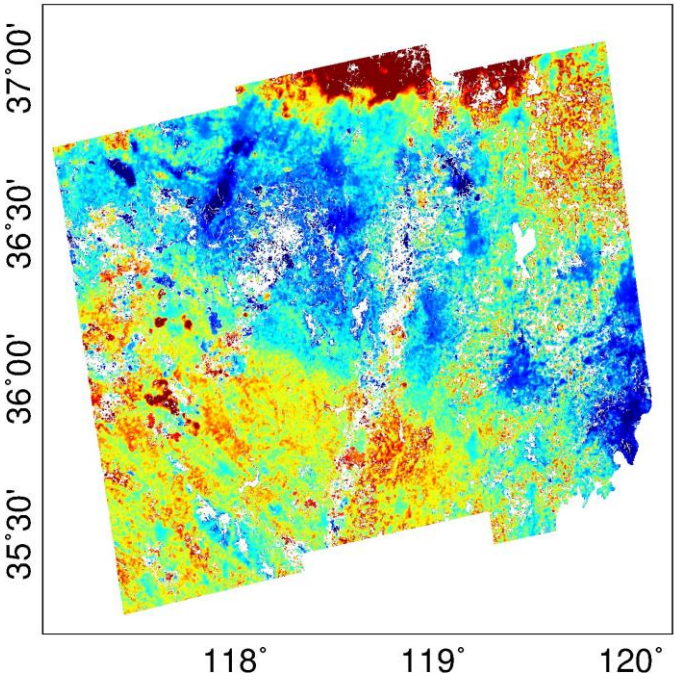
GACOS correction

Highlight - Long wavelength ramps

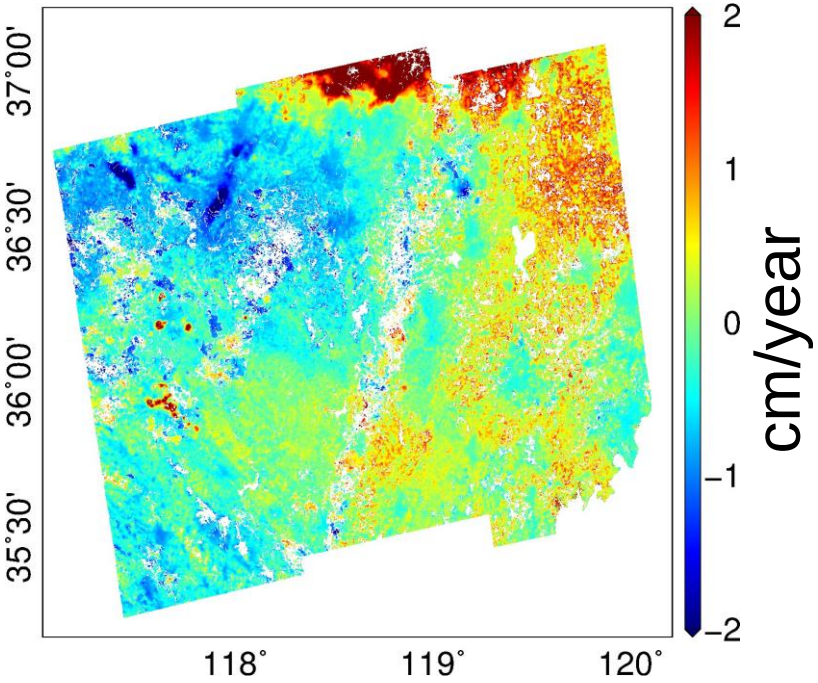
Original Velocity map

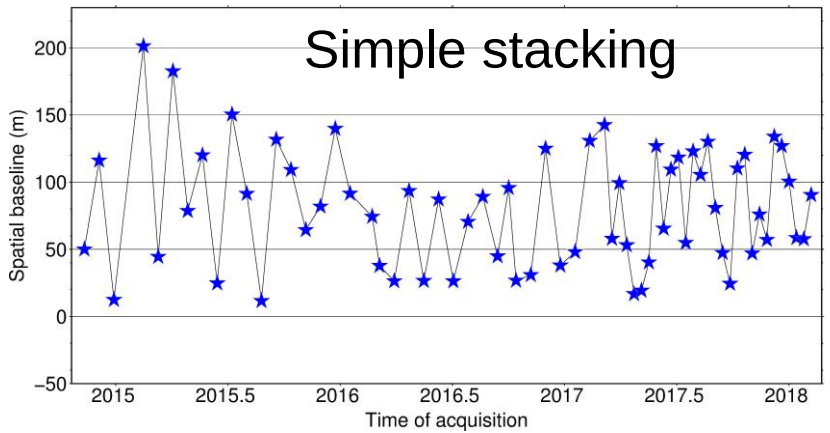


By ramp removal



By GACOS correction





- The best-ft plane improves, to some extent, a single interferogram.
- However, it does not help much on velocity mapping

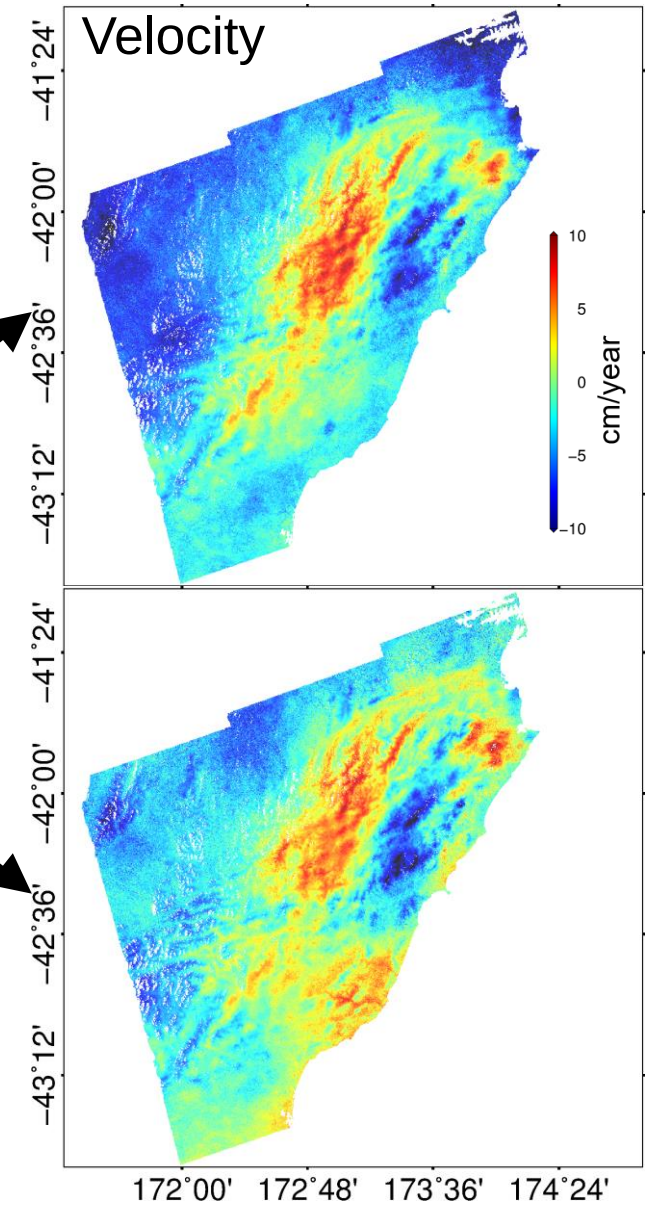
Highlight - Long wavelength ramps

- Least square estimation assuming logarithmic velocity

$$\Delta\rho = \mathrm{A} \cdot \log(t - t_0) + \varepsilon$$

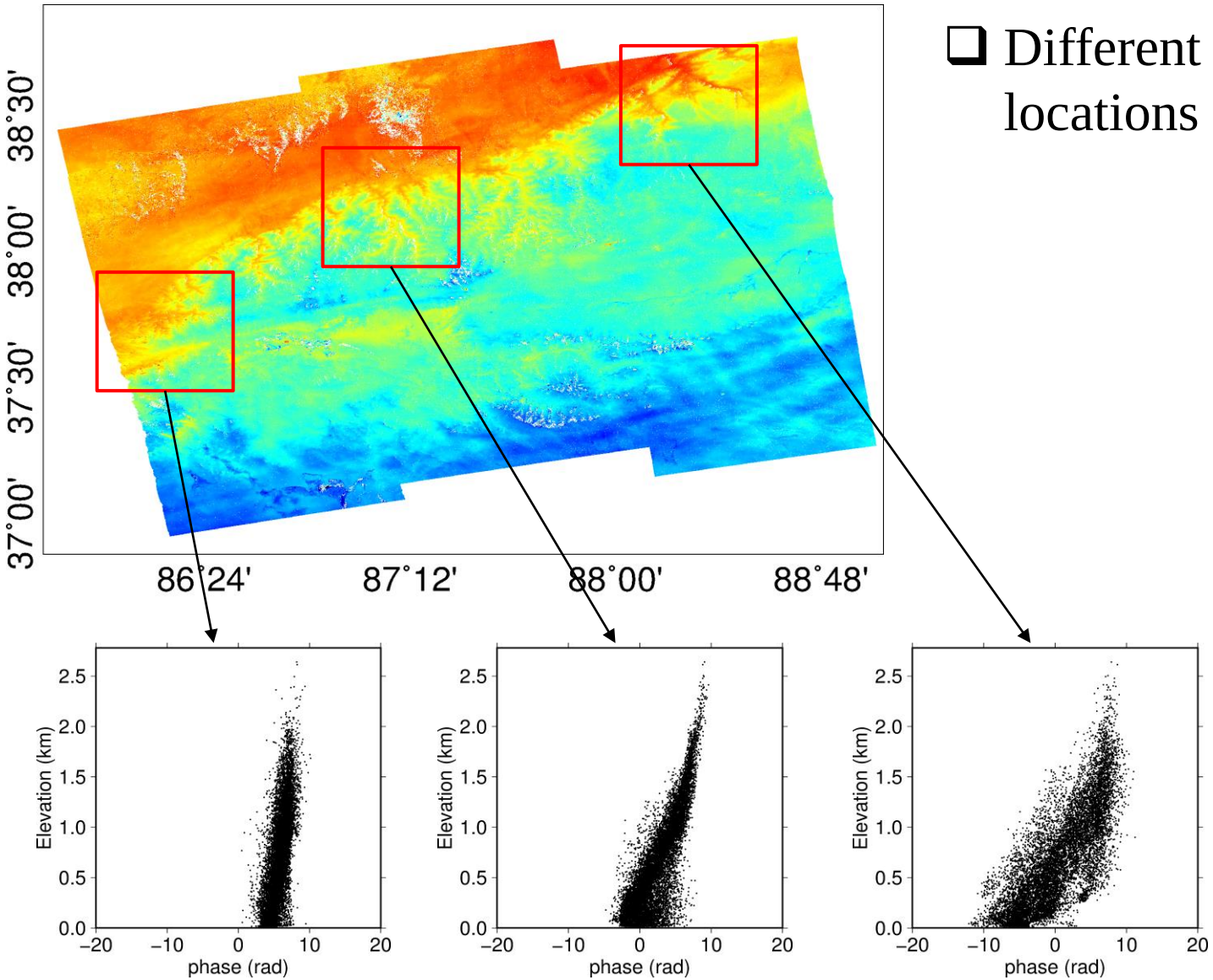
Strategy 1:
- Network based ramp removal (Biggs et al., 2007)
- No atmospheric correction

Strategy 2:
- No ramp removal
- GACOS atmospheric correction



- A further refinement can be done by an APS filter

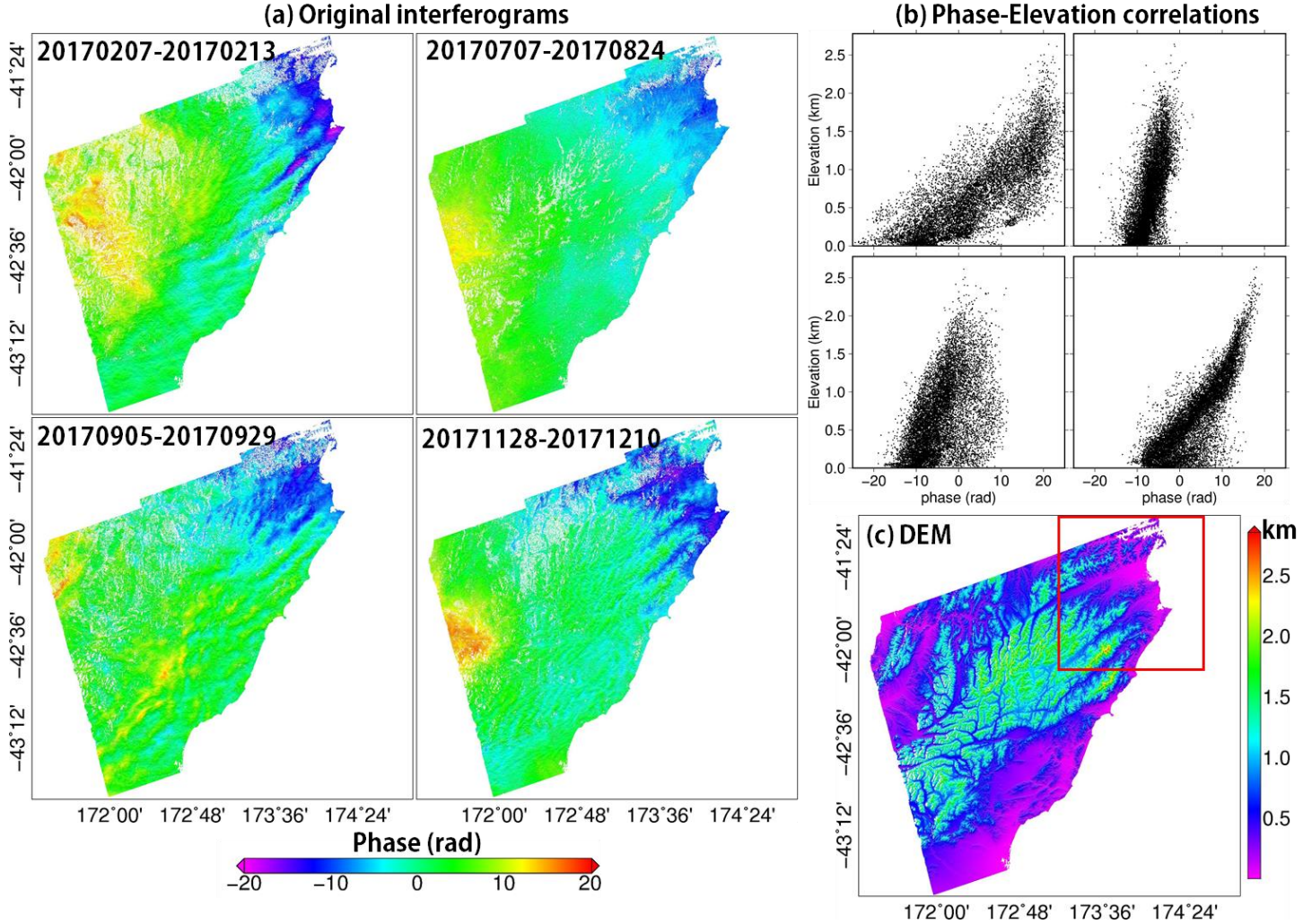
Highlight – Temporal correlations due to topography



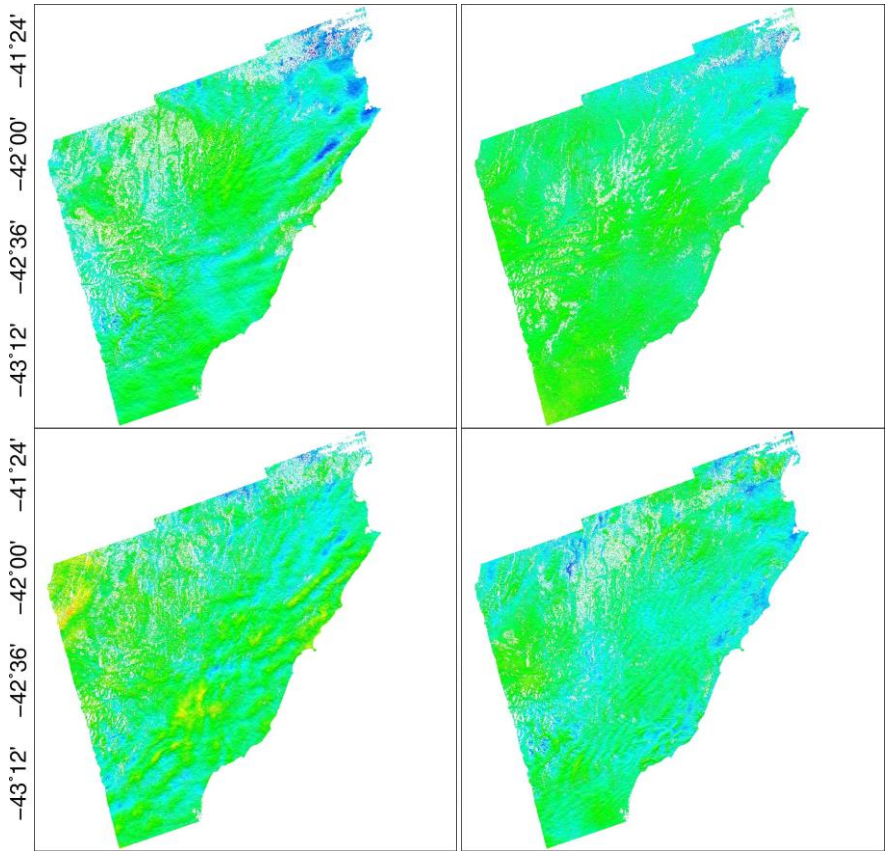
- Different correlation patterns at different locations and over different window sizes

Highlight – Temporal correlations due to topography

IFGs collected at different periods

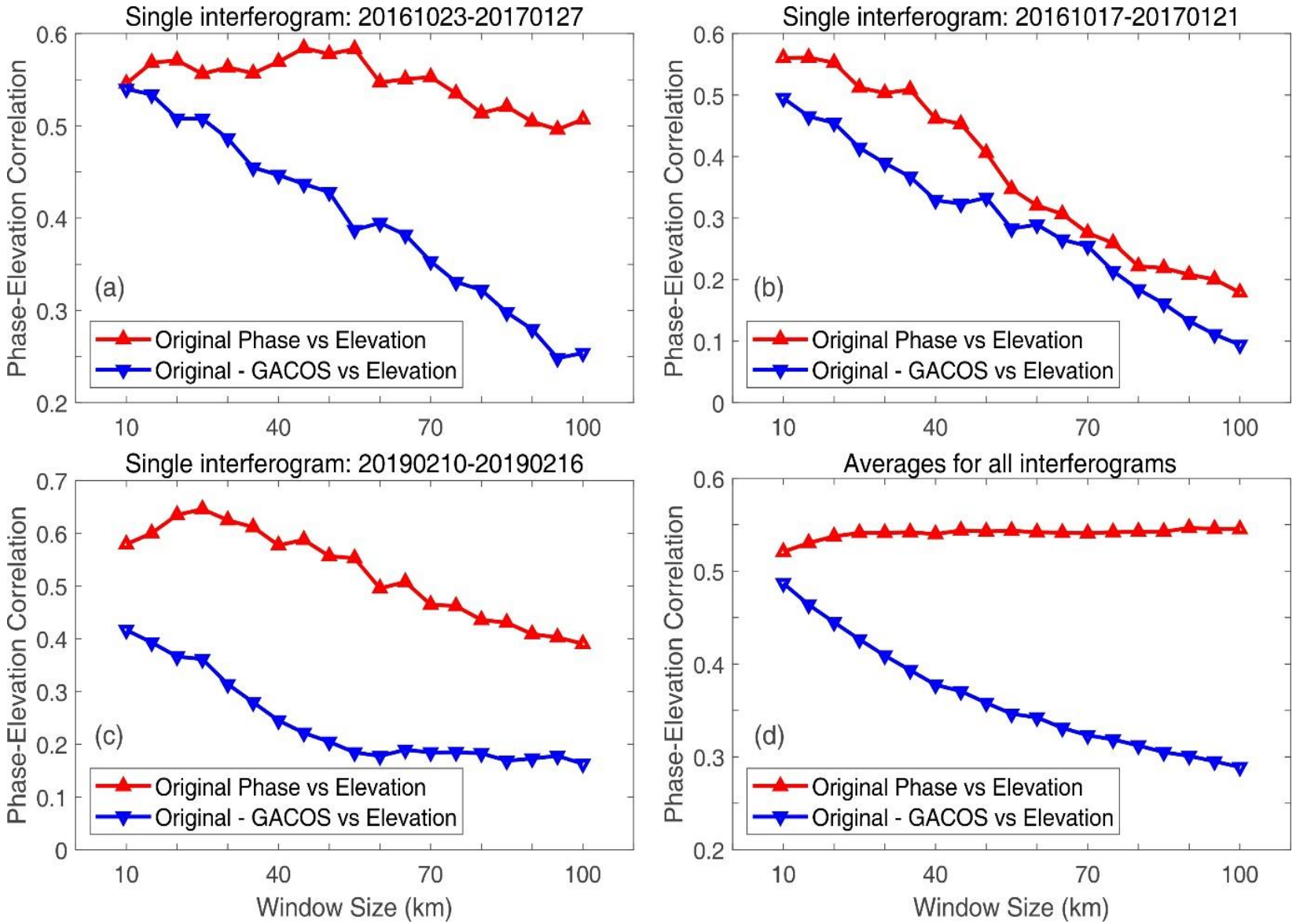


After correction



Reduce temporal correlation

Highlight – Temporal correlations due to topography



- Reduction of the topographic related error over different window sizes.

Large-scale automatic deformation monitoring

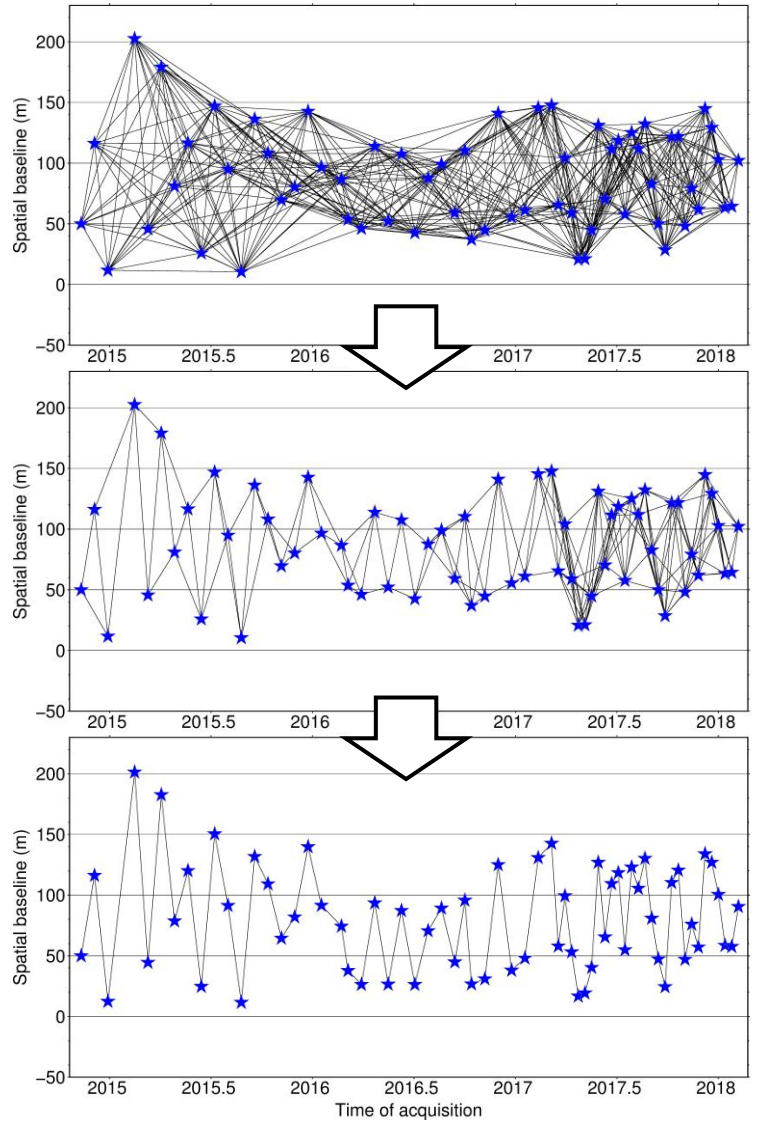
- Implications for large scale automatic deformation monitoring

After atmospheric correction:

- Simpler network
- More randomized error
- More efficient spatial-temporal filters

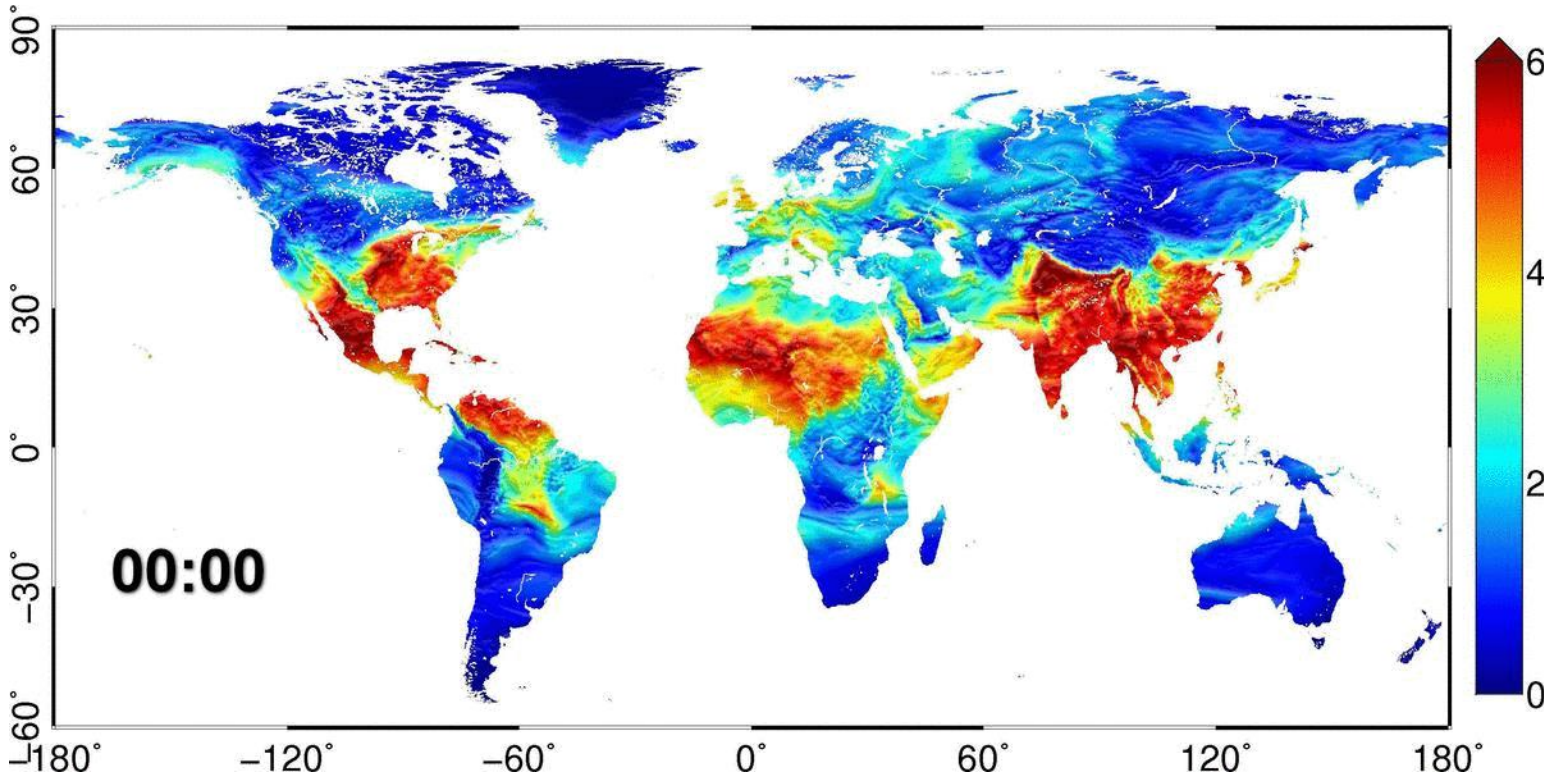
When a significant deformation area is detected:

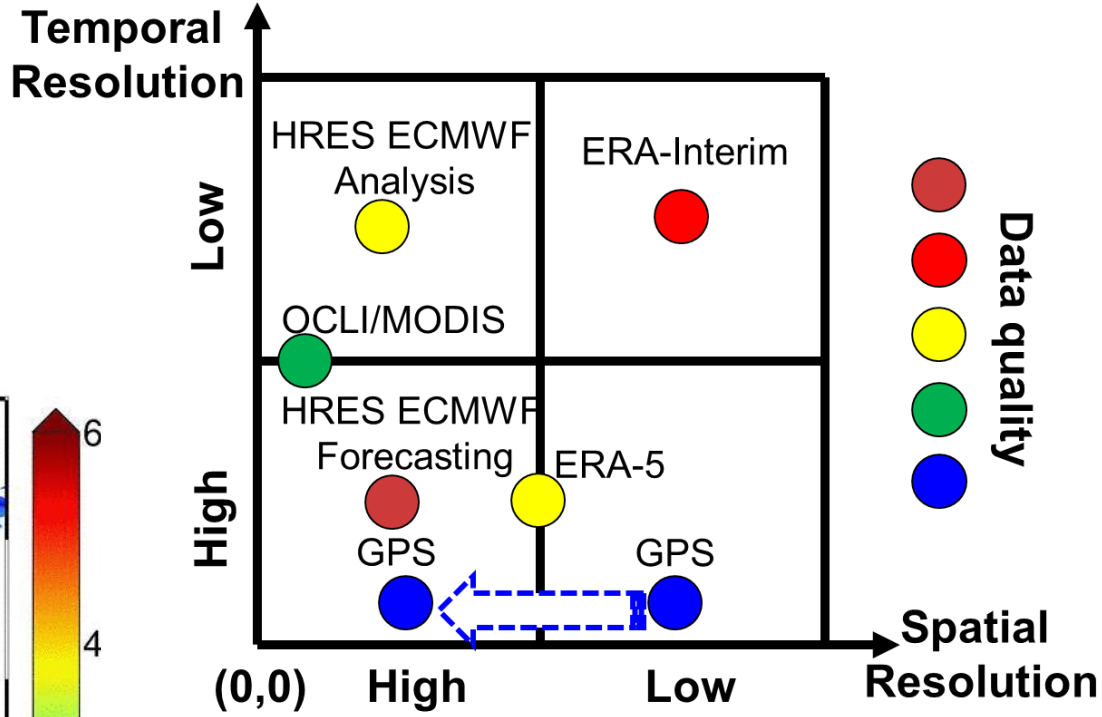
- More sophisticated time series analysis can be utilized



Future work –GACOS 2.0

- New data to improve temporal resolution
  - GNSS (5 minutes)
  - ERA5 (1 hour)





Future work –GACOS 2.0

- New data to improve temporal resolution
  - GNSS (5 minutes)
  - ERA5 (1 hour)

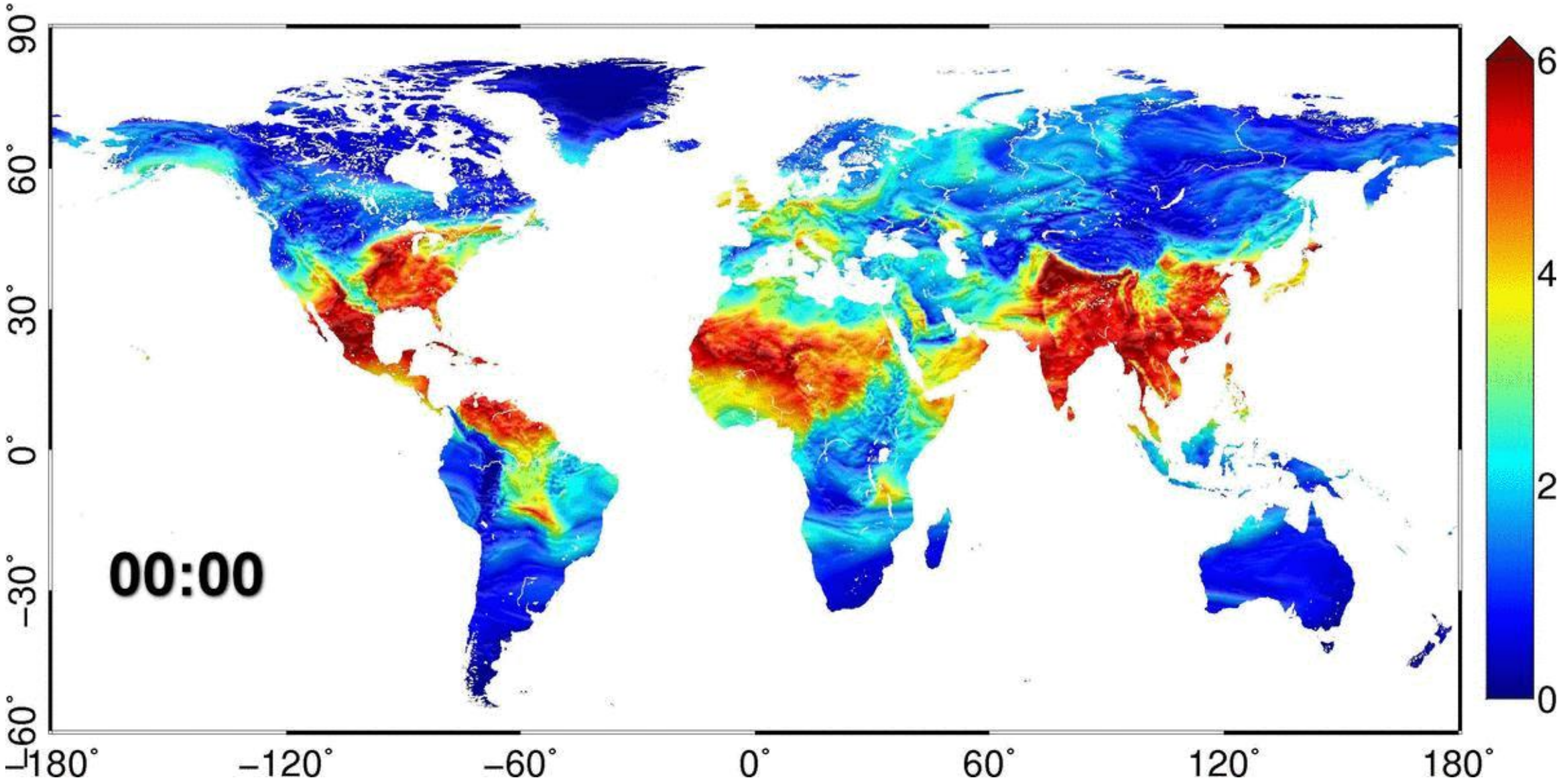
- New stream to improve efficiency
  - Localization for Sentinel-1
  - API (slow process due to university policies)
  - Cloud server

- Time series tool

- Enhanced regional service
  - Local GNSS networks
  - Regional numerical weather models

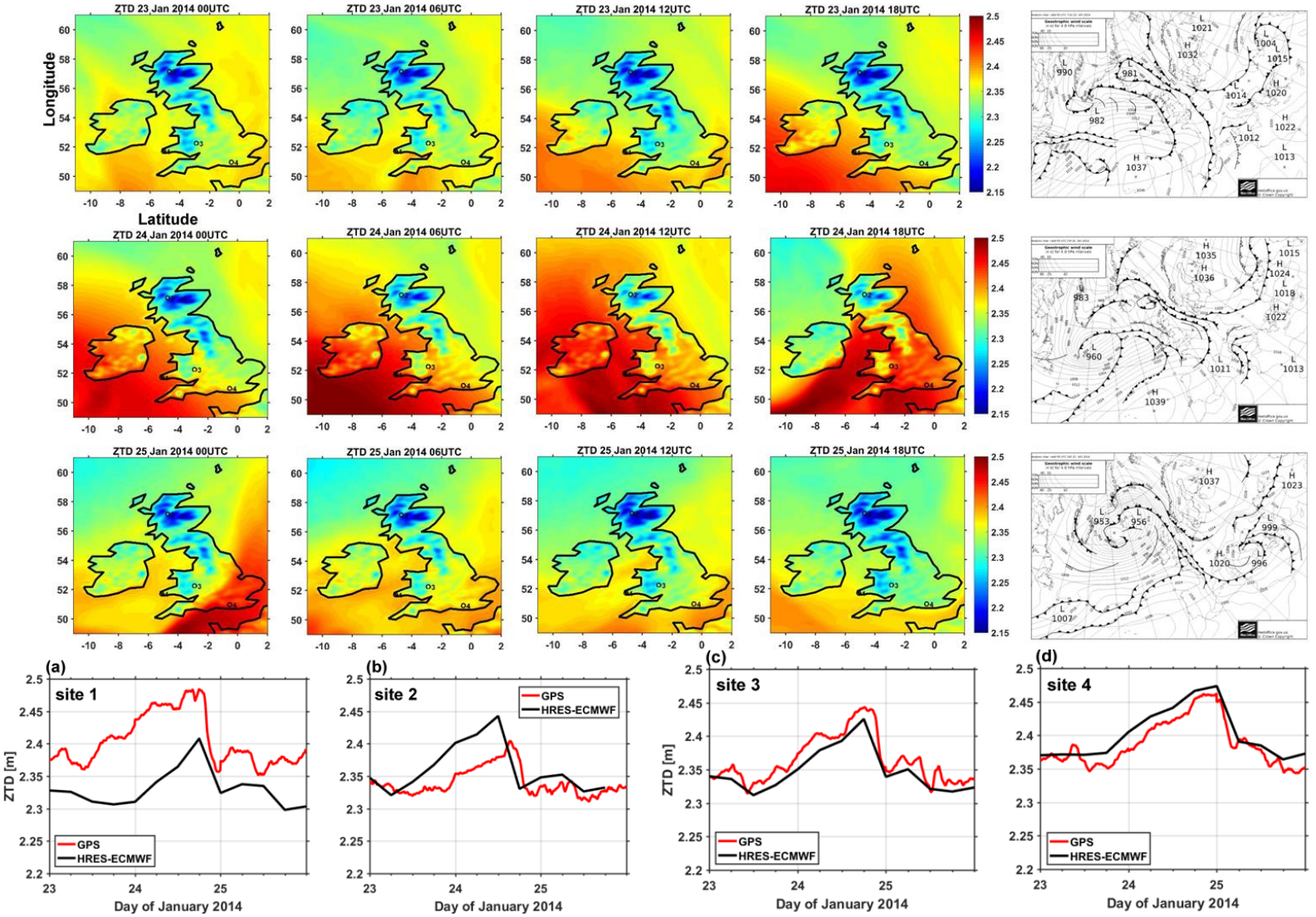
Newcastle University

GACOS 2.0 – Improving temporal resolution



GACOS 2.0 – Improving temporal resolution

UK winter storm January 2014



Future work –GACOS 2.0

Conclusions

- GACOS is efficient at reducing long wavelength and topographic related atmospheric errors.
- Large-scale automatic deformation monitoring can be simplified once GACOS is applied.
- GACOS 2.0 is due to publish with improved efficiency (with API).
- Regional enhanced GACOS service.