The accumulated seismic moment of the locked Húsavík-Flatey fault, North Iceland, derived from an interseismic model using GPS and InSAR

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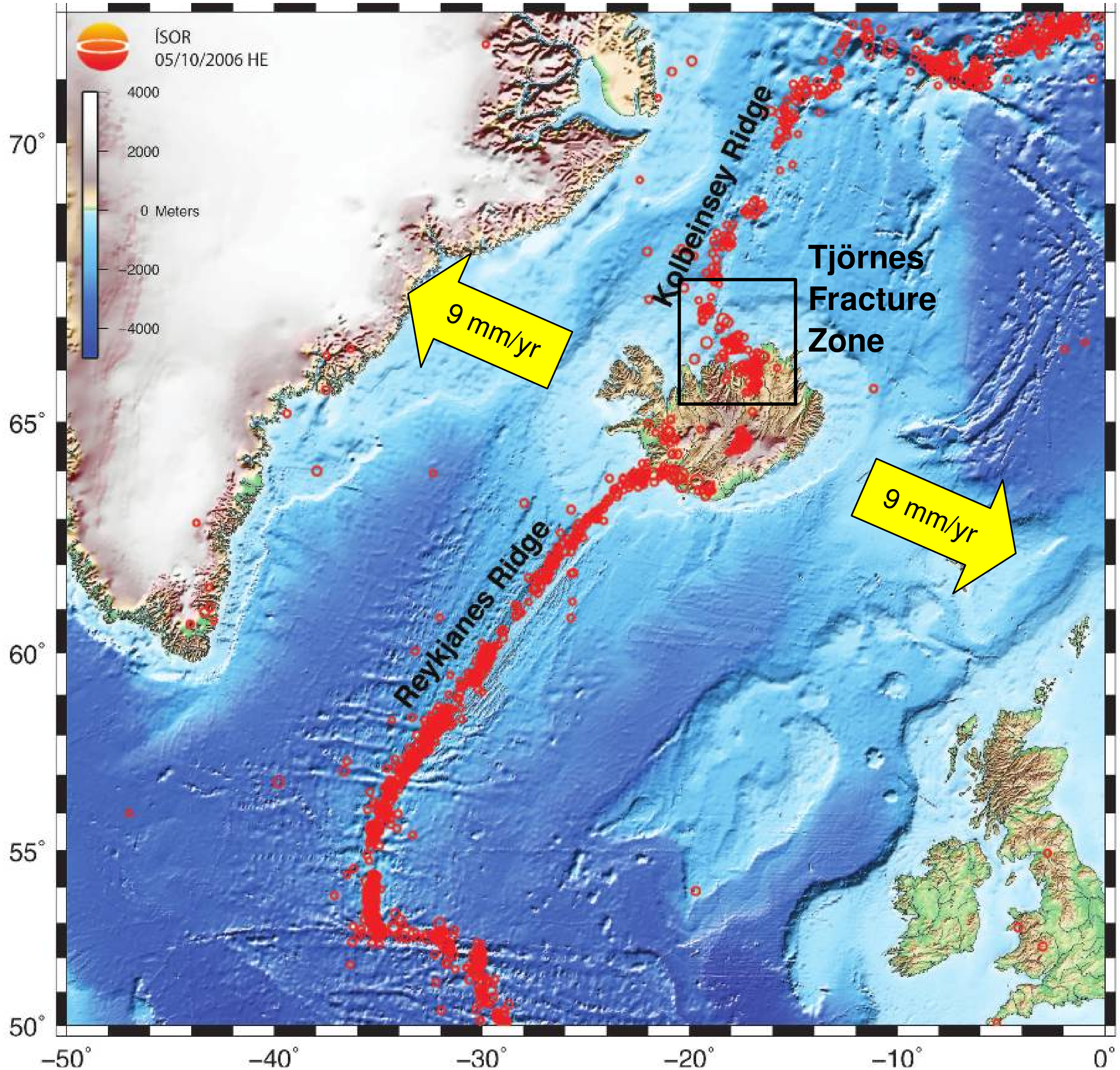
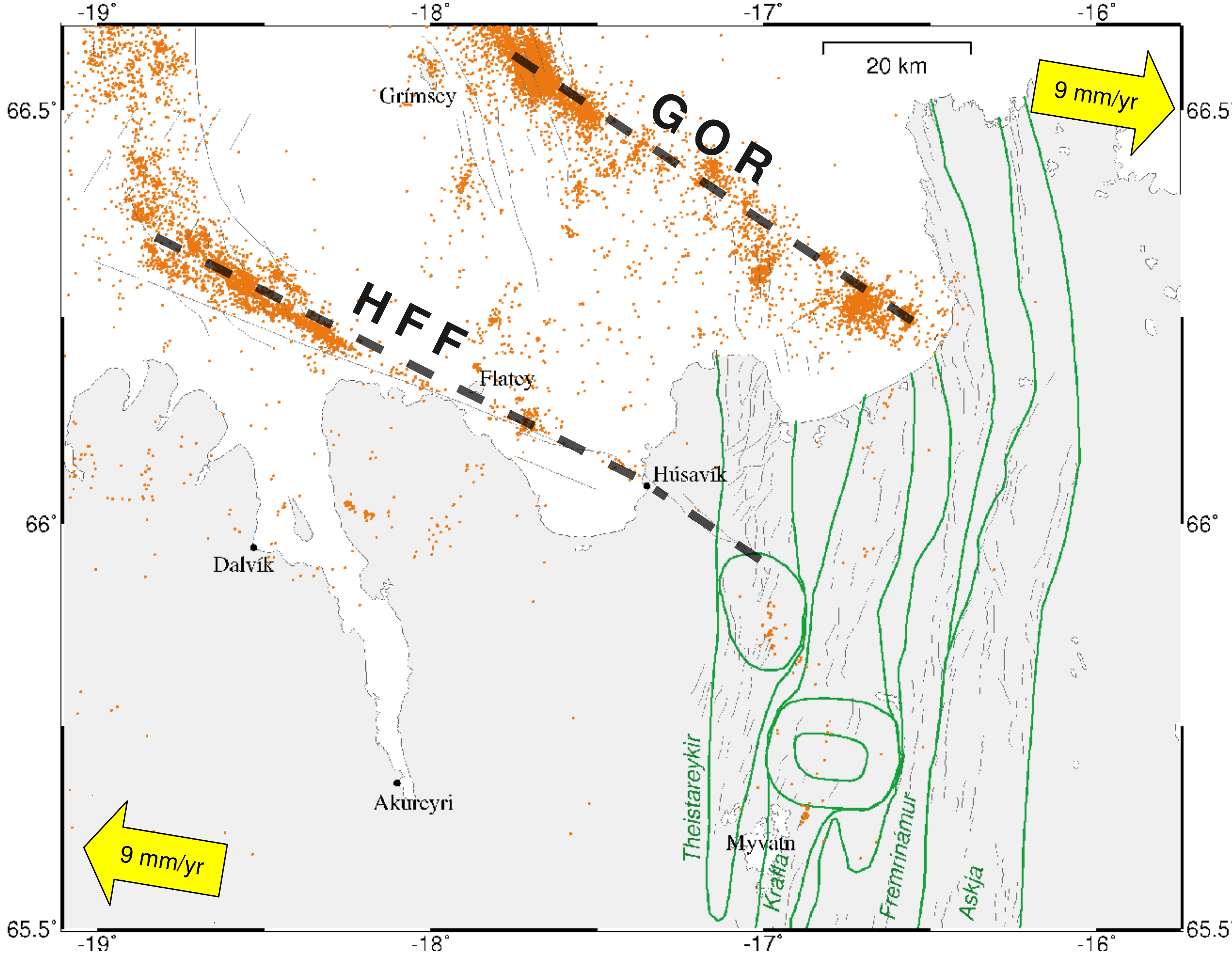
Seismicity defines the plate boundary

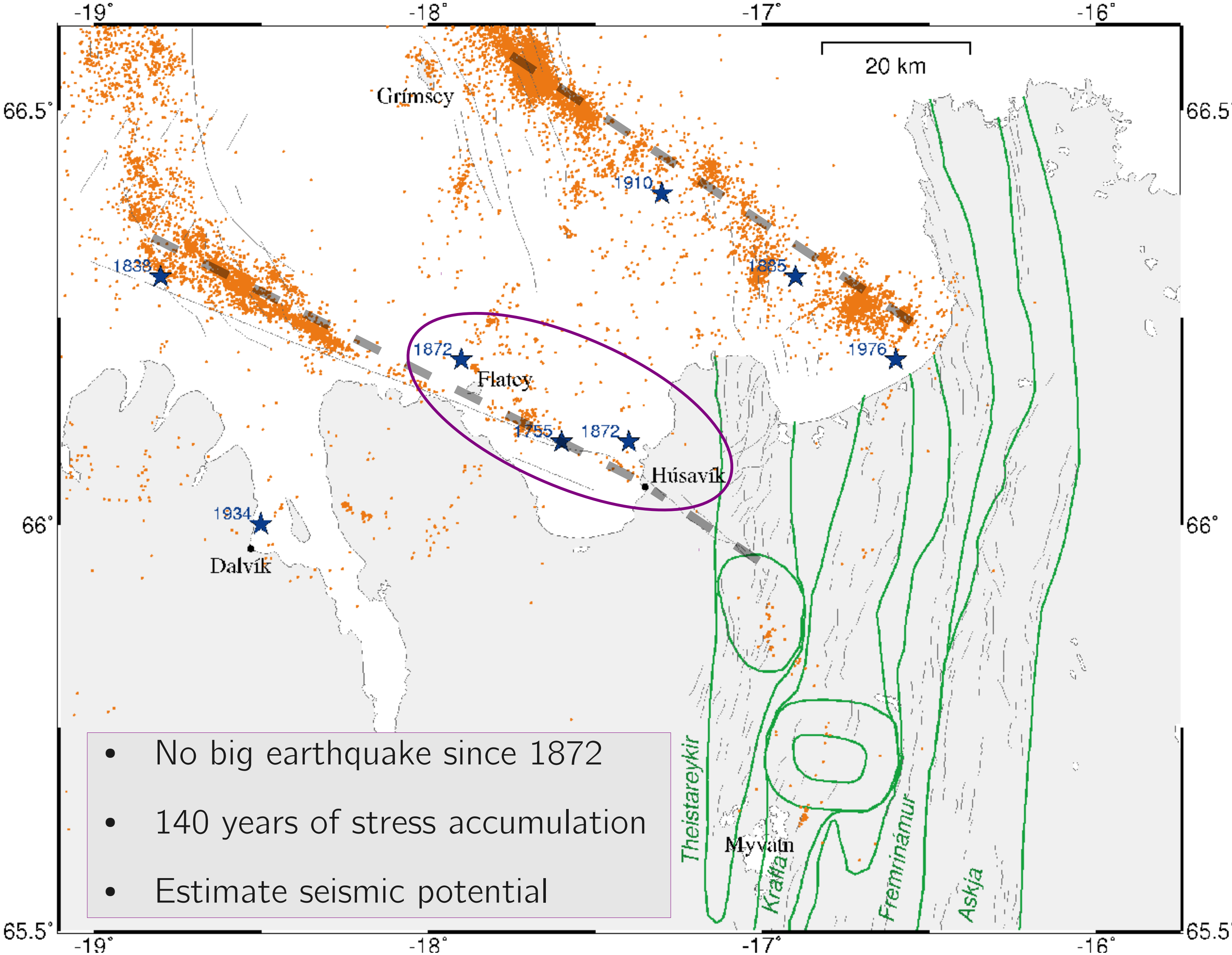


Einarsson, Jökull, 2008

Seismicity defines the plate boundary

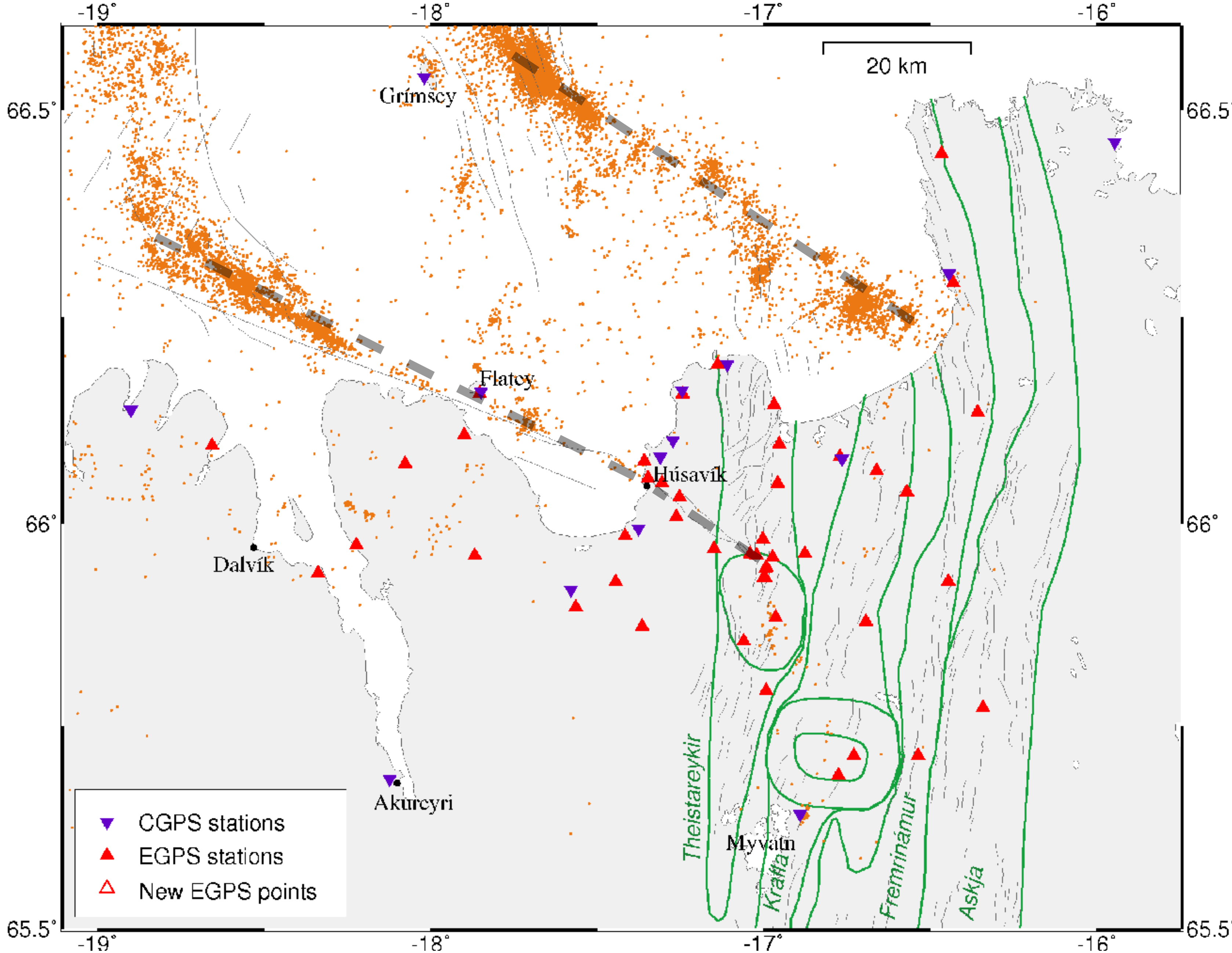


Historical seismicity



- No big earthquake since 1872
- 140 years of stress accumulation
- Estimate seismic potential

GPS network North Iceland



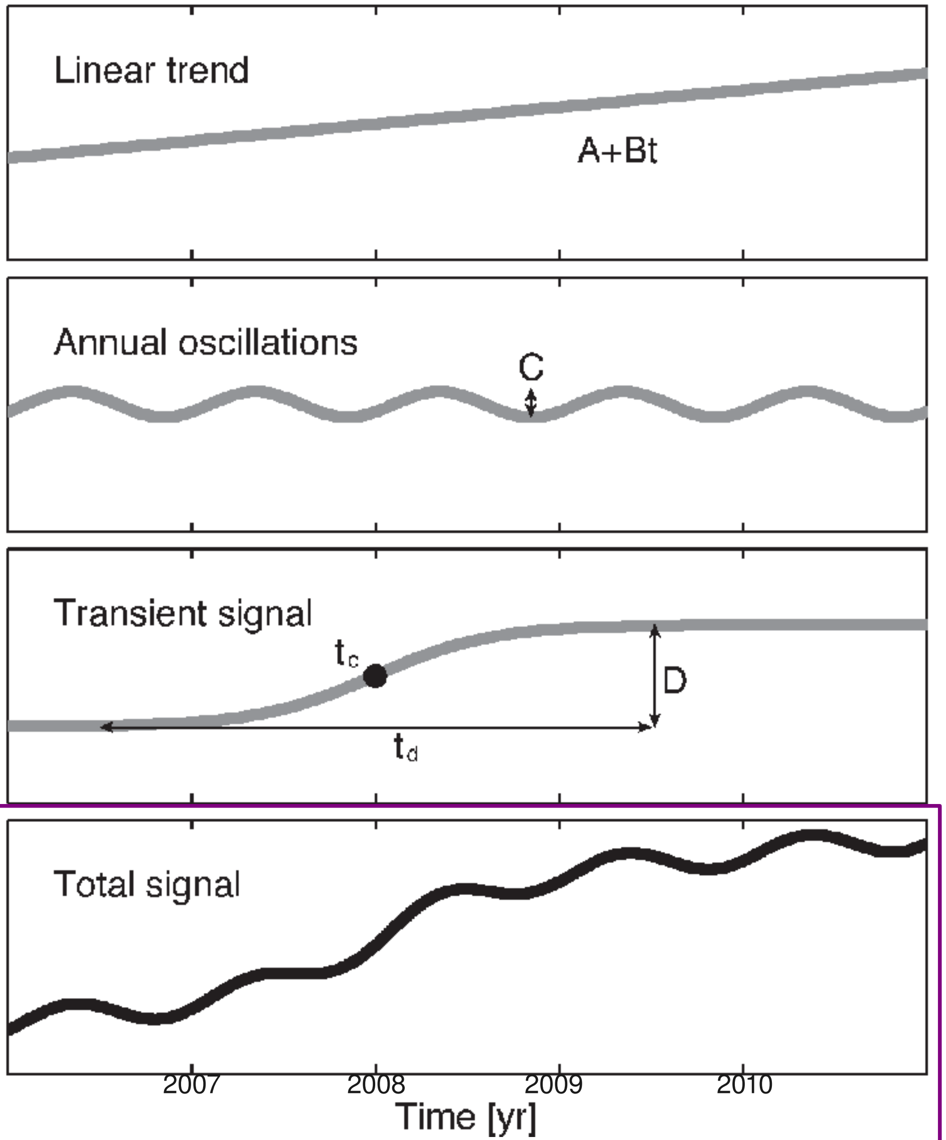
How to estimate steady-state deformation?

The GPS time-series contain

1) steady-state velocity (plate motion)
2) annual oscillation (permafrost?)
3) transient signal (volcanic uplift@Theistareykir)

⇒Estimate transient and oscillatory signal

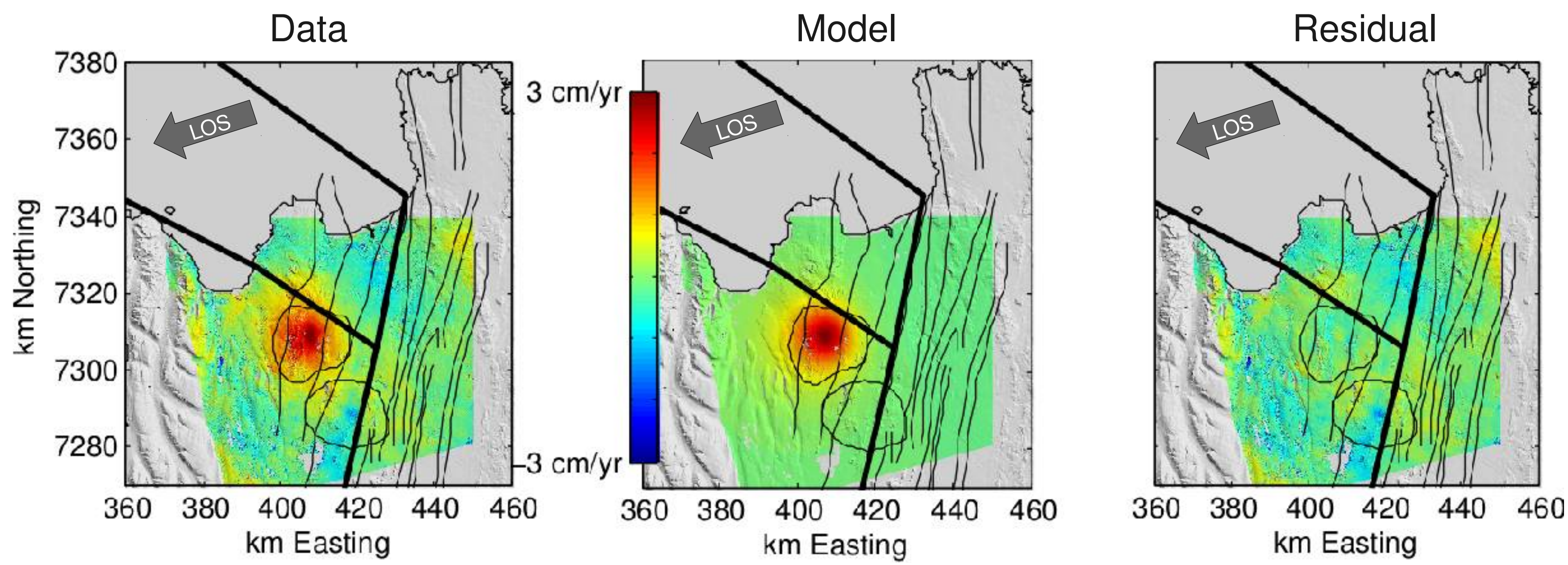
⇒ Extract steady-state velocities



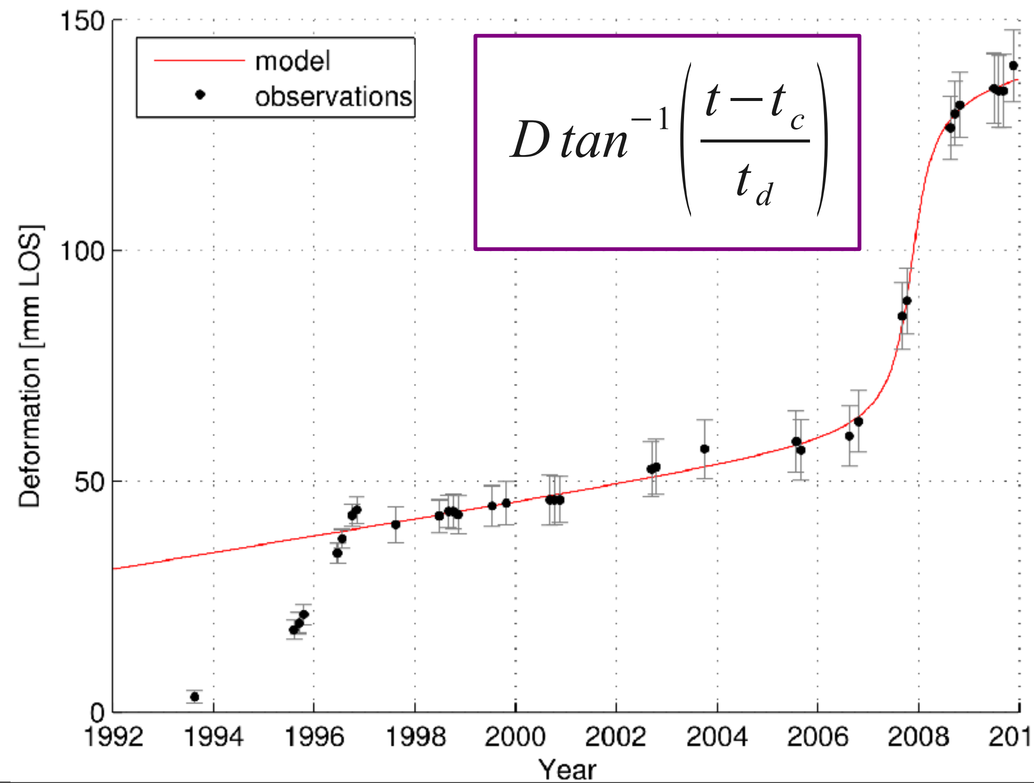
$$A + Bt + C\cos(2\pi t + \Phi) + D\arctan\left(\frac{t - t_c}{t_d}\right)$$

Inflation at Theistareykir volcano

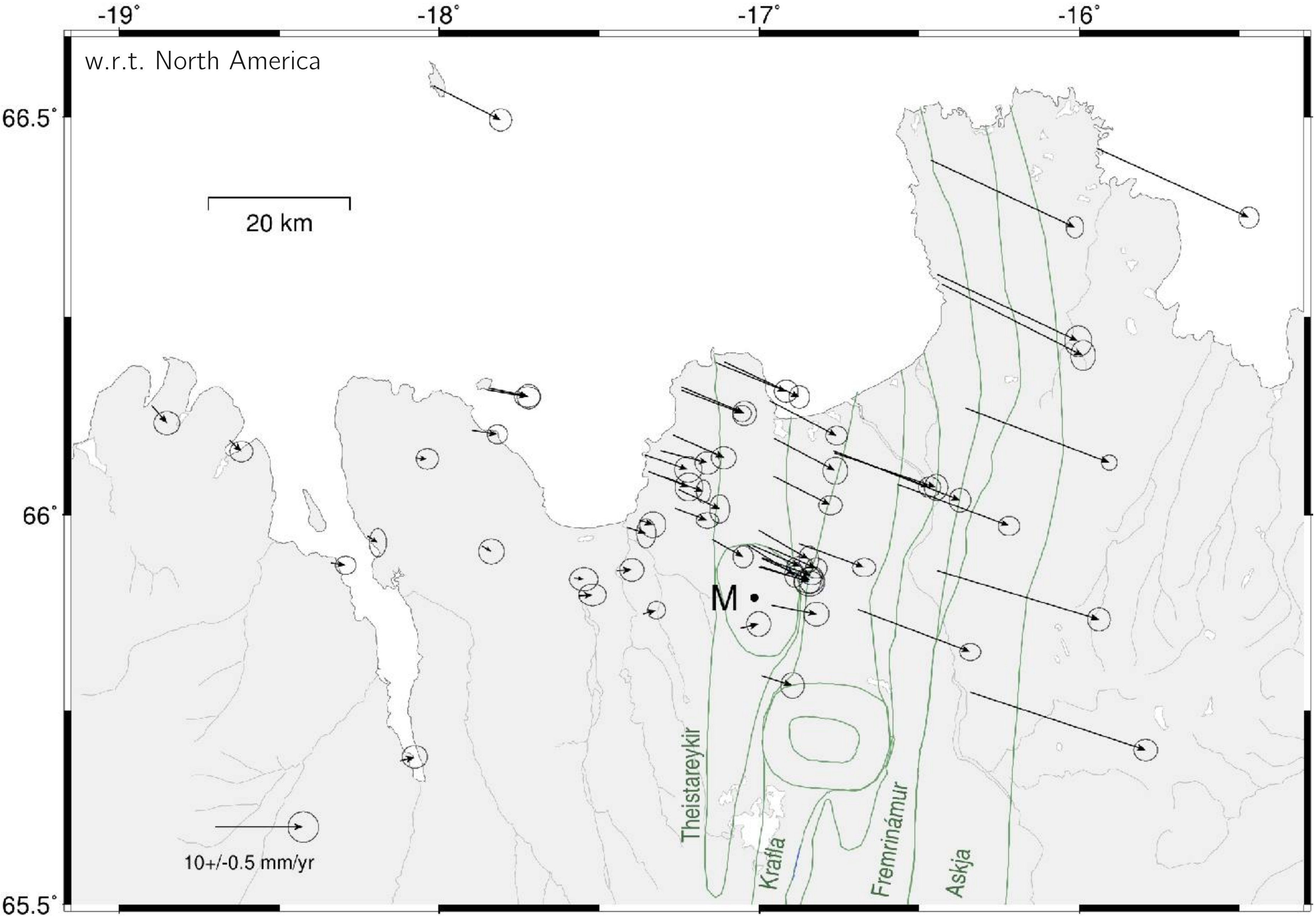
1-yr interferogram
(Metzger et al., 2011)



- Mogi model and InSAR data
- Location: Theistareykir volcano
- Duration of inflation: 2007-2009
- Absolute volume change: 25 x 10^6 m^3
- Depth: 8.5 km
- Absolute uplift: 8 cm

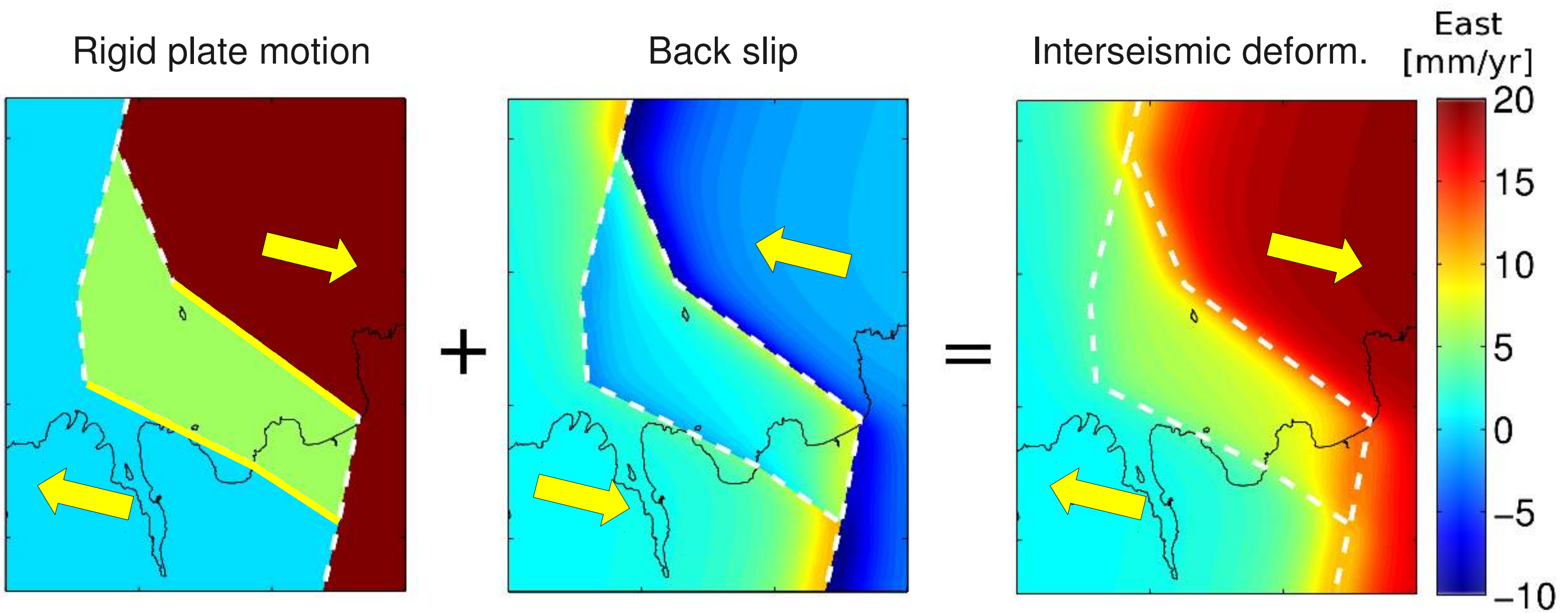


Steady-state velocities



Model concepts

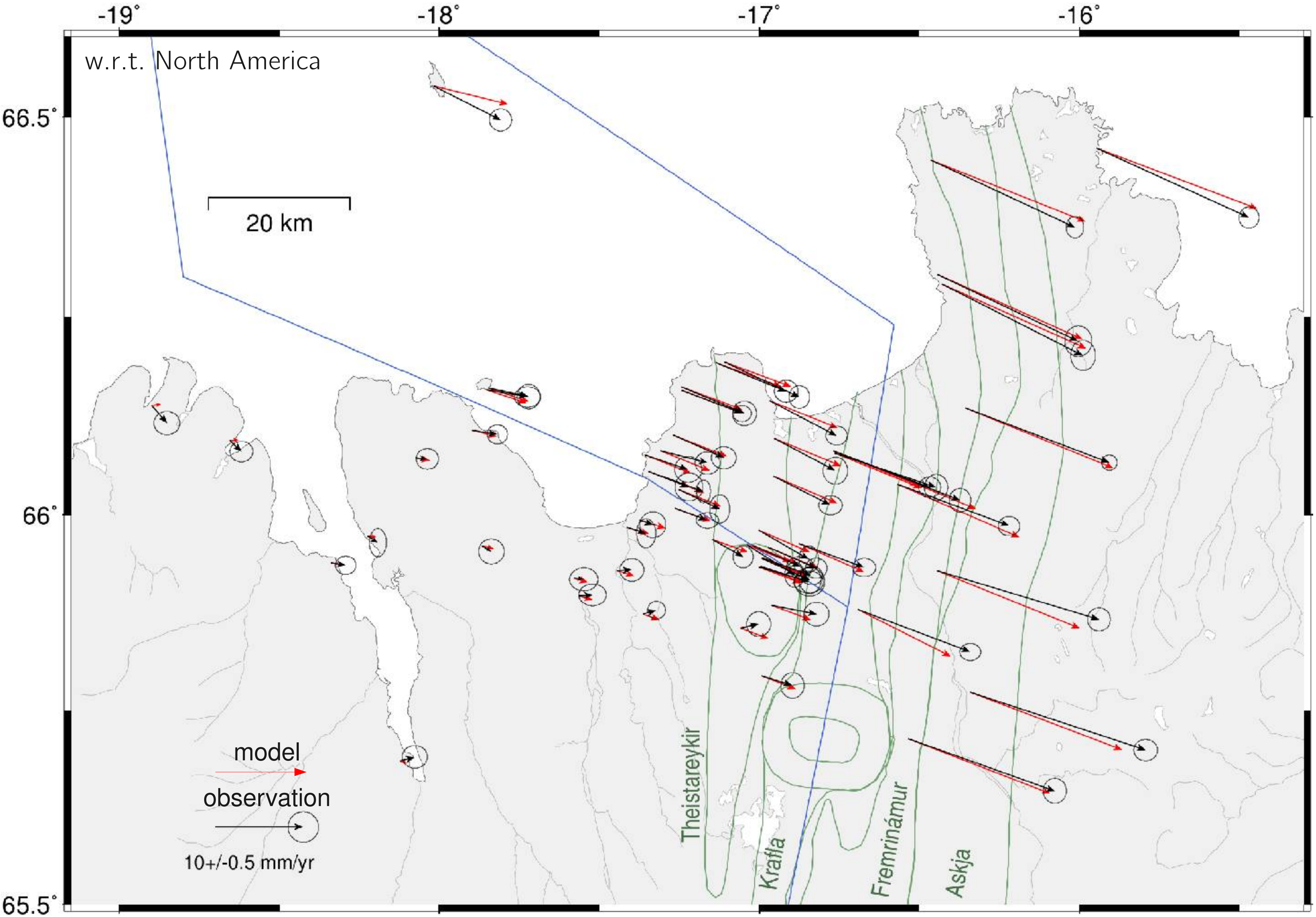
- Nine dislocation segments in an elastic half-space (Okada, 1985)
- Superposition of two signals:



Metzger et al. 2011

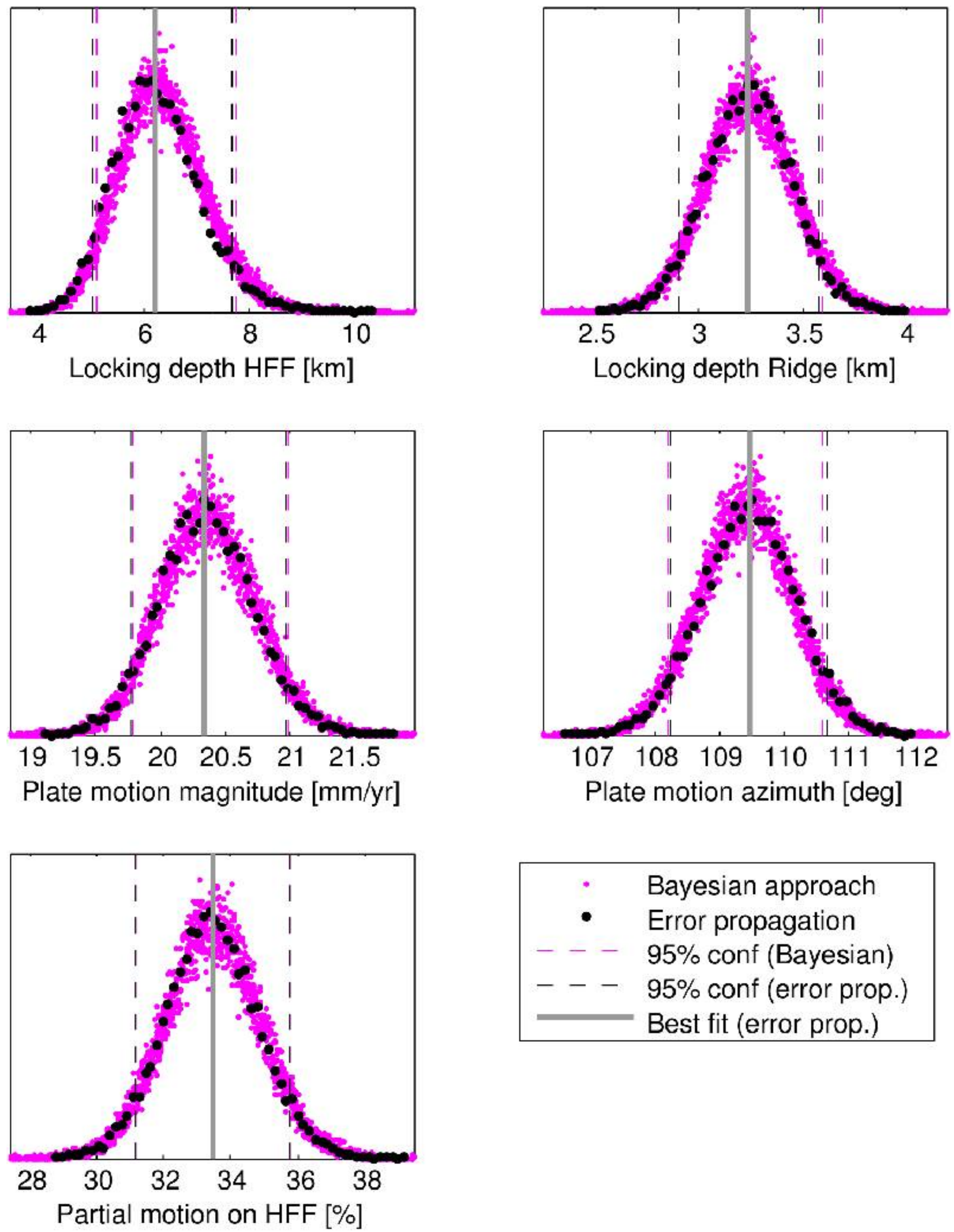
- Fixed geometry, no dip-slip etc. → only seven free parameters, e.g.,
  - **Locking depth**
  - Total plate motion + motion partition between HFF/GOR → **Slip-rate**
- Find best-fit parameters and estimate parameter uncertainties

Data and best-fit model



Uncertainty estimation

- How well defined are best-fit model parameters?
- Compare two independent methods
  1) <u>“Error propagation”</u>
     Perform statistics with “perturbed” input data
  2) <u>Bayesian approach</u>
     estimate uncertainties from a posterior probability density function
- Both methods are in good agreement and support each other



Model results in review

	This study	Metzger et al. (2011)	Rögnvaldsson et al., 1998
Data points	58 GPS points	14 GPS points	offshore seismicity
Locking depth HFF [km]	$6.2^{+0.8}_{-0.7}$	$6.3^{+1.7}_{-1.2}$	10 – 12
Partial motion HFF [%]	33.4 ± 1.4	$33.9^{+3.1}_{-3.2}$	

→ Locking depth varying along the fault?

- Best parameters confirmed and better constrained, **but:**
- The model uncertainties/assumptions now probably **outweigh** data uncertainties
- The accumulated seismic moment of the Húsavík-Flatey fault corresponds to a **M6.8 ± 0.1** event

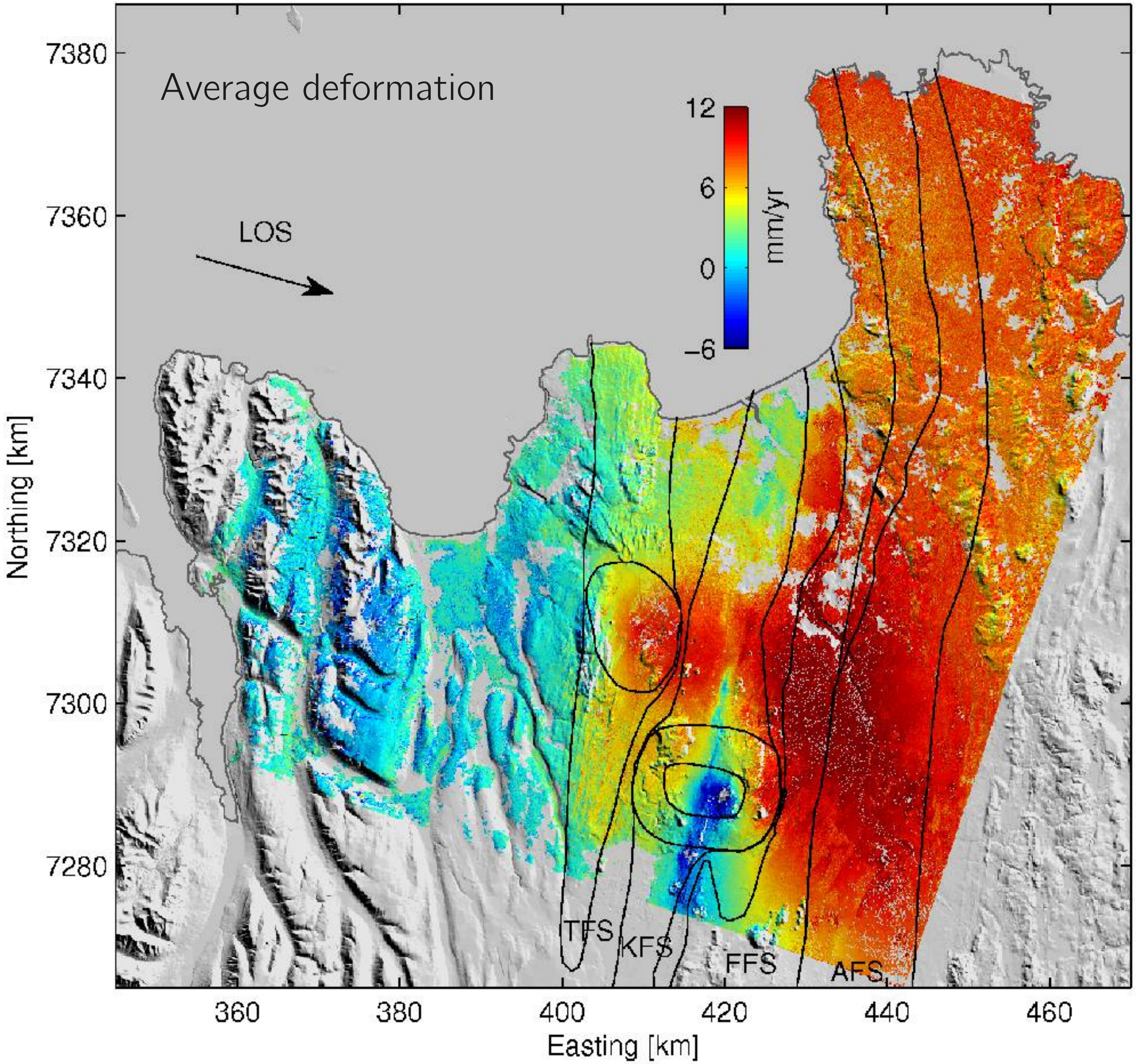
Assumptions

- Complete stress-release in 1872
- Steady stress-accumulation and slip-rate
- Complete rupture along the whole fault

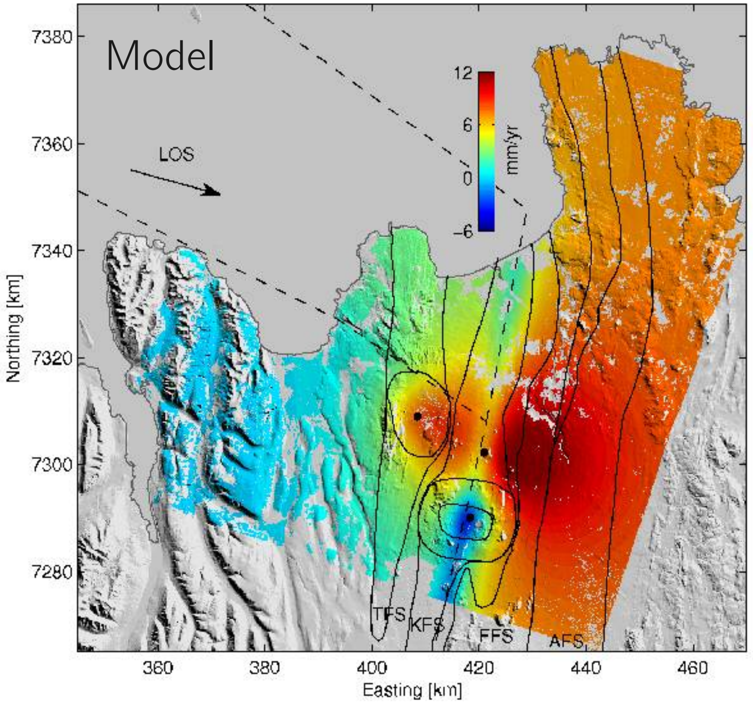
Conclusions

- We use GPS and InSAR time-series to describe the deformation of the North Icelandic plate boundary with a **kinematic model**
- Assuming complete stress-release in 1872 and steady stress accumulation since then, **the seismic potential** of the Húsavík-Flatey fault is equal to a **M6.8±0.1** event
- Offshore Earthquake relocations suggest a **varying fault locking depth**
- Additional campaign GPS data confirm our earlier results and decreases the error boundaries of the best-fit model parameters significantly → **uncertainties caused by model assumptions probably now outweigh the data uncertainties**

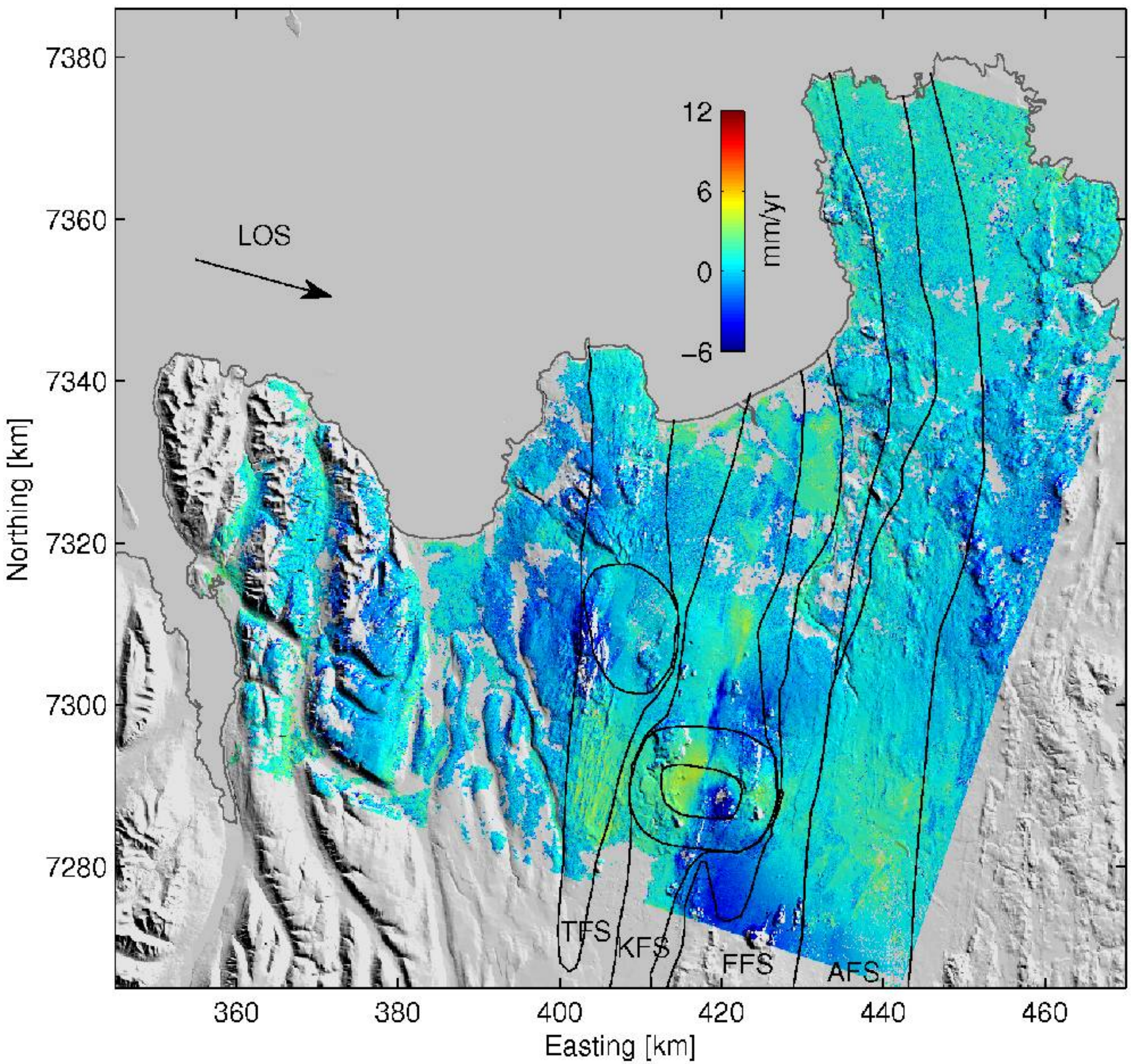
InSAR time-series analysis



- Steady-state plate extension
- Remains of the Krafla rifting episode 1975-1984 (de Zeeuw-van Dalfsen, 2004)
- Theistareykir inflation

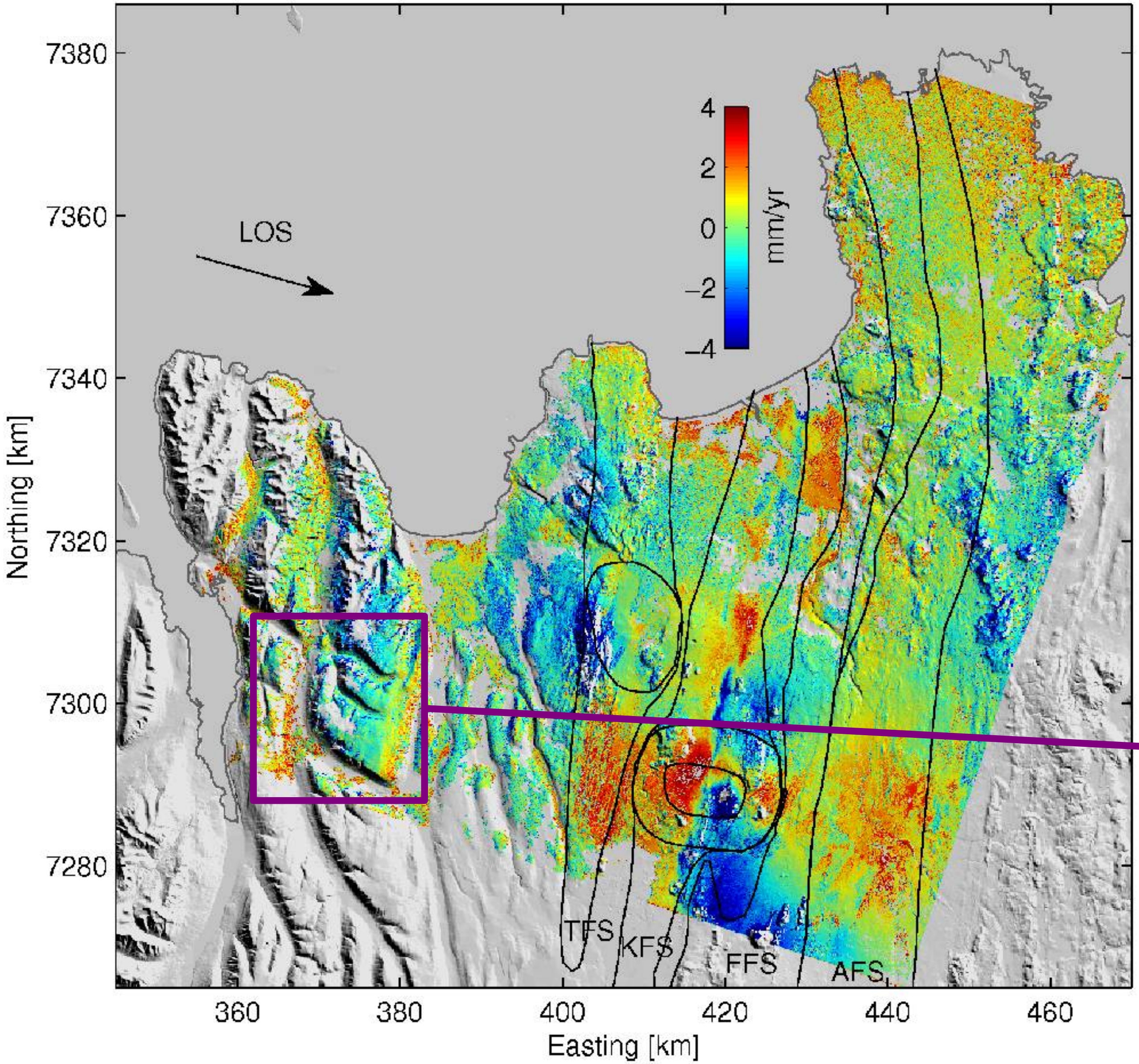


Residuals

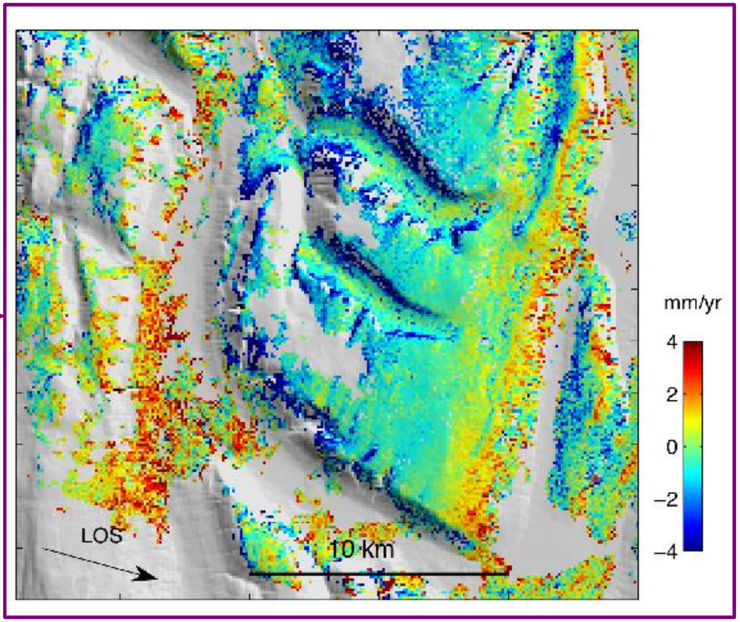


- Average RMS < 1.5 mm/yr

Residuals



- Average RMS < 1.5 mm/yr
- Residual tectonic deformation
- Non-tectonic residuals, e.g. gravity-driven slope motion?




Thank you!