TU Delft

On the use of InSAR observations for data assimilation

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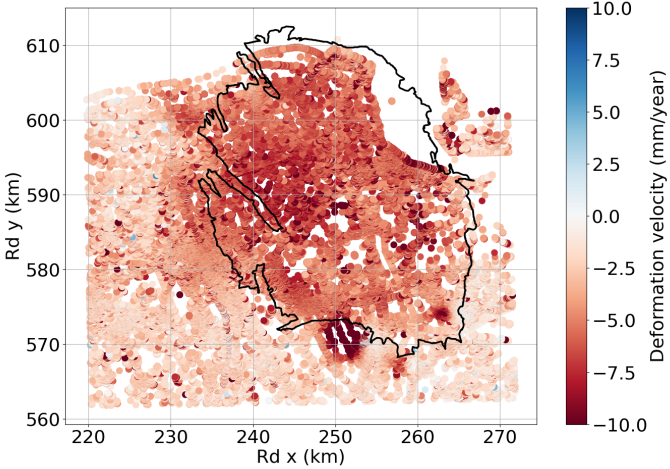
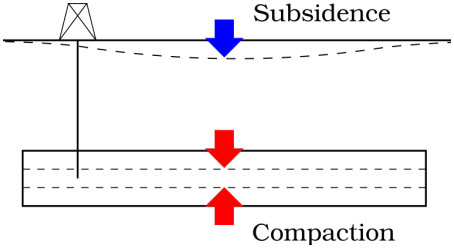
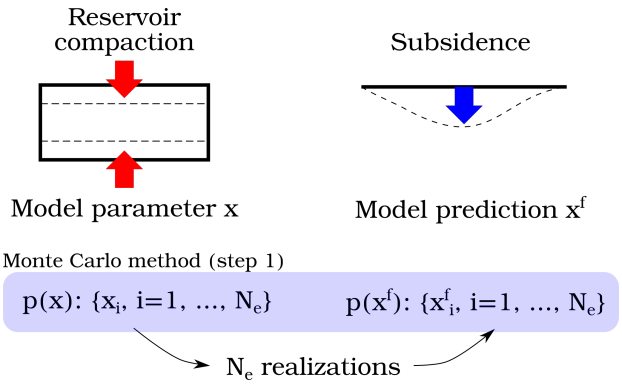

610
600
590
580
570
560
Rd y (km)
220
230
240
250
260
270
Rd x (km)
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Deformation velocity (mm/year)


Subsidence
Compaction

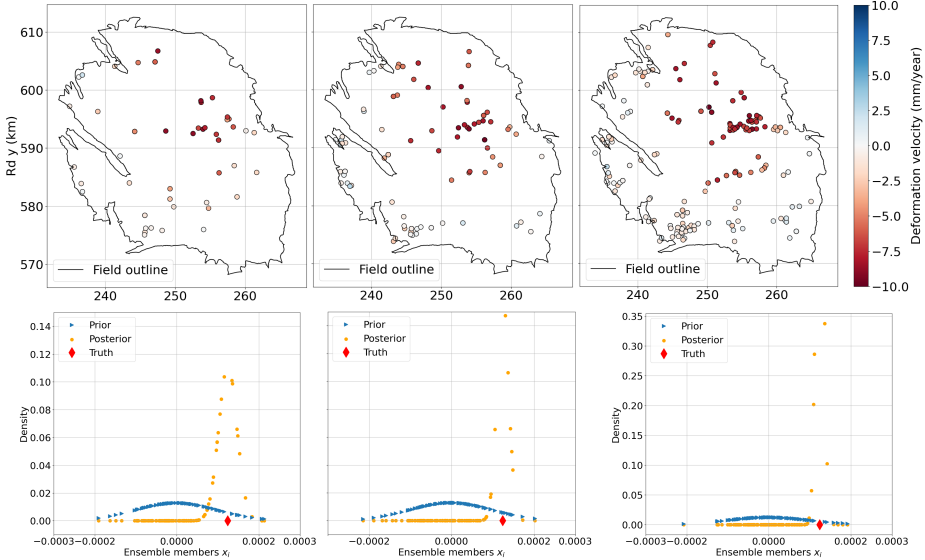
Particle method for subsidence estimation

A question of performance



1. Probabilistic method: Monte Carlo
   - Prior knowledge on model parameters, $p(x)$
   - Ensemble size = number of realizations N_e
   - Prior distribution of model prediction, $p(x^f)$
2. Assimilate data, y
3. Create a **posterior weighted distribution** $p(x|y)$

Posterior $p(x|y)$ = "How each realization x_i gives a model prediction close to the observations"

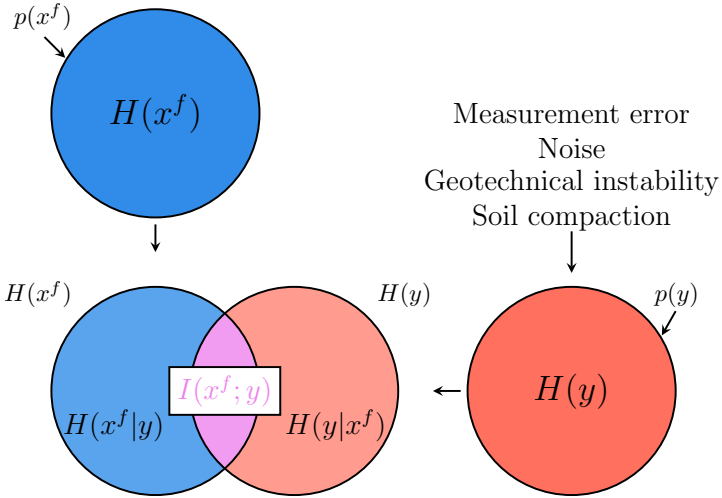


The particle method performance depends on the quality of the posterior → Ensemble size.

Entropy

Quantifying the information introduced in the system

- H is the uncertainty (reciprocally the information) on a variable: deformation velocity, y
- *"Can we know what signal is contained in the observations?"*
- Assimilate this information to estimate model parameters, x

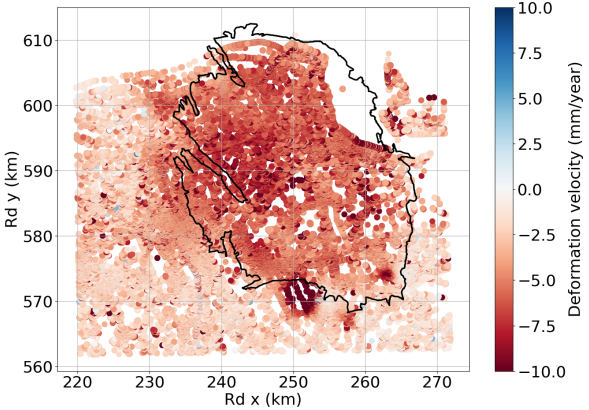


Reduction of the number of observations

Step 1: entropy in InSAR dataset

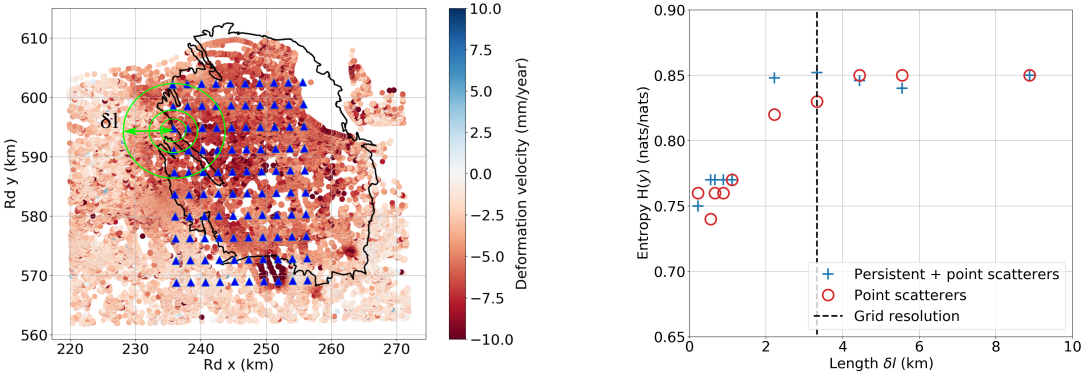
Distributed scatterers: averaged points

Point scatterers: 1 single measurement



	Full dataset (Distributed + point scatterers)	Reduced dataset (Point scatterers)
Dimension	1.5M	662 965
Entropy $H(y)$	0.48	0.49

Step 2: averaging and spatial correlation (100 observations → $N_e = 10^6$)



Redundancy is characterized by an increasing entropy: convergence to a Gaussian distribution that does not represent the signal in the full dataset.

Conclusions

- Particle method performance decreases with an increasing dimension of the observational space

- Information content of reduced InSAR data:

  1. **Point scatterers**: conserve the same amount of information but reduces the number of observations from 1.5 million to 600 000
  2. **Optimal length** δl: with an observation grid of 0.03 degrees (~ 3 km) we show that $\delta l < 2\,\text{km}$ represents the best the information content in the full dataset

Thank you

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