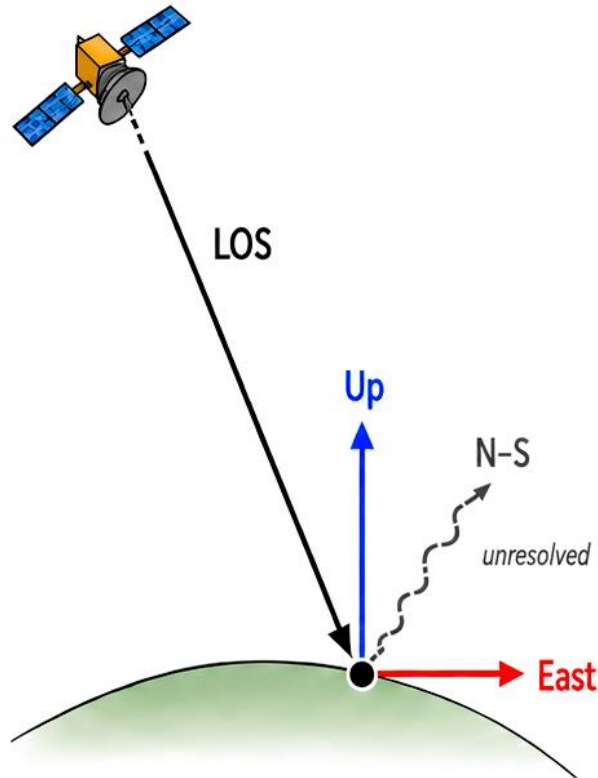


Multi-track InSAR Datum Alignment and 3D Displacement Estimation Using a Subsidence-Aware Strapdown Approach for Jakarta.

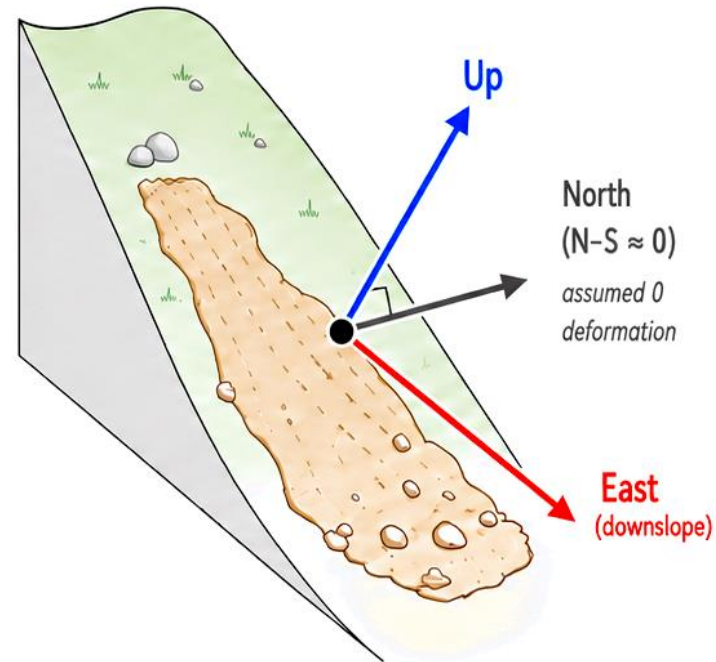
FRINGE- 15-19 June 2026

A. Lapadat, W. Brouwer, R. Hanssen

LOS geometry is selective



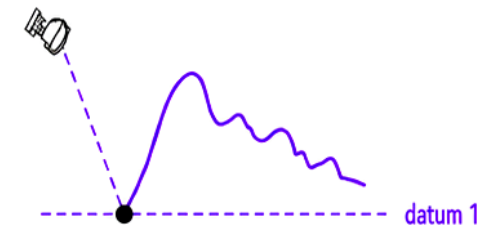
Physical constraints help
move beyond East-Up



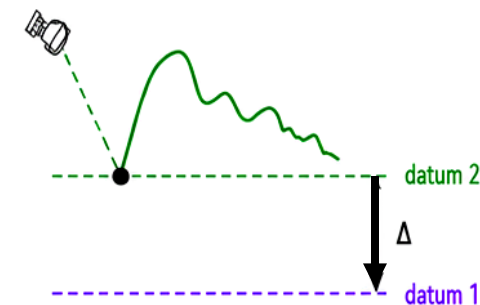
Tracks must share a common datum

Internal datum alignment during decomposition

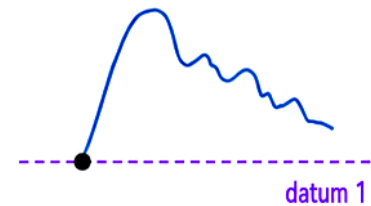
Track 1



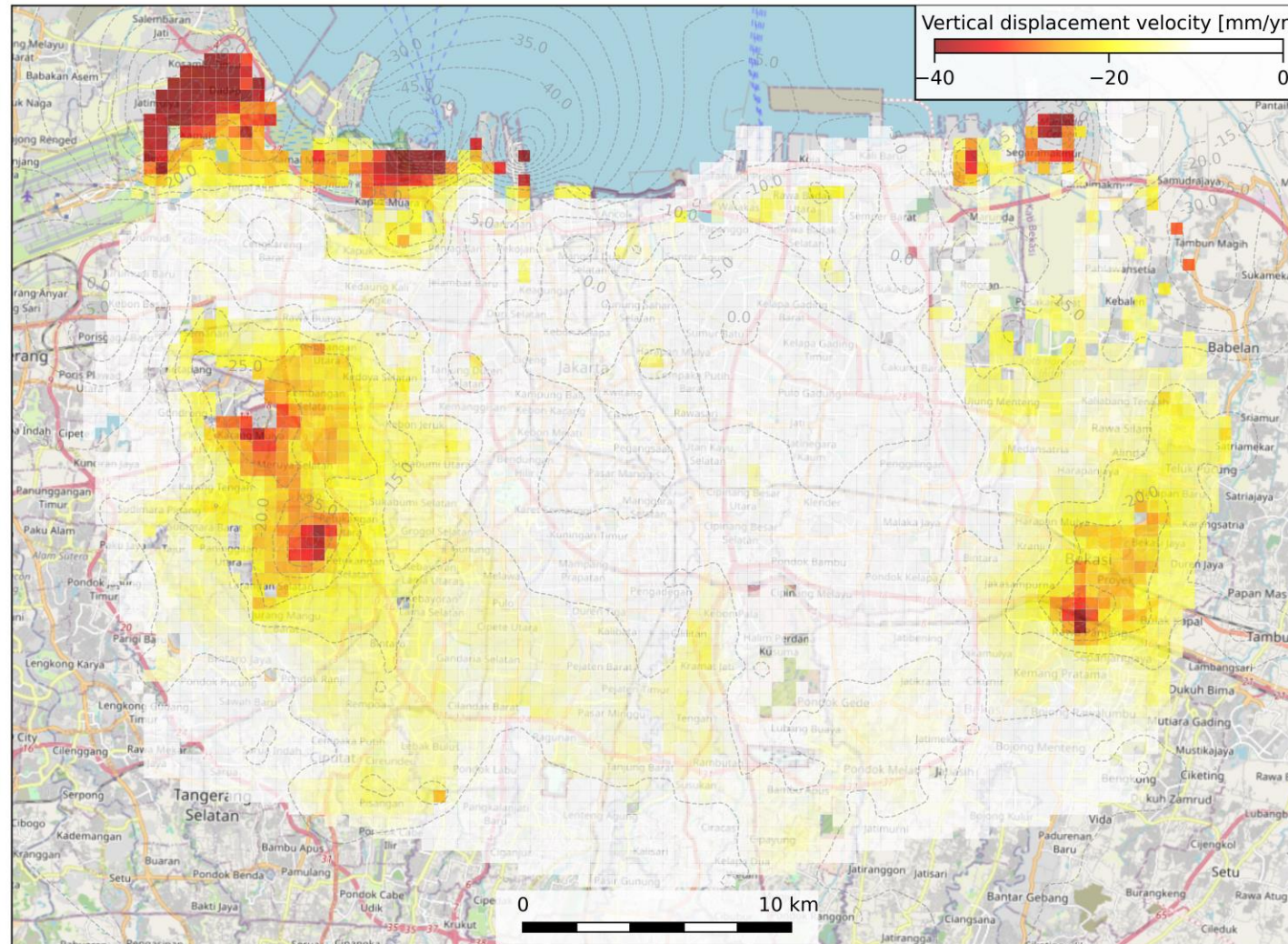
Track 2



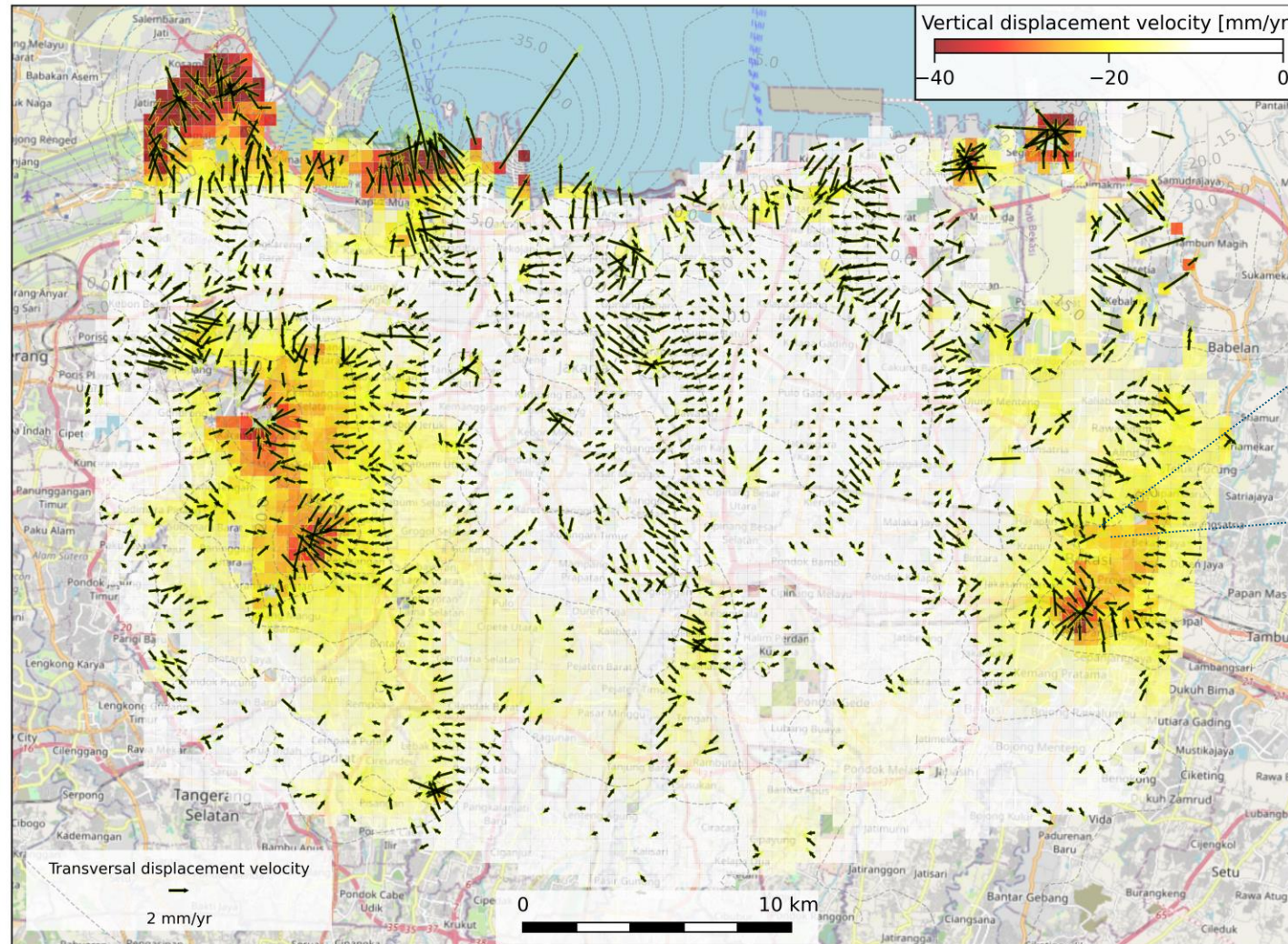
Reconstructed
3D displacement



Can we estimate 3D motion and internally align the LOS tracks at the same time?



Recovering horizontal motion with quantified uncertainty

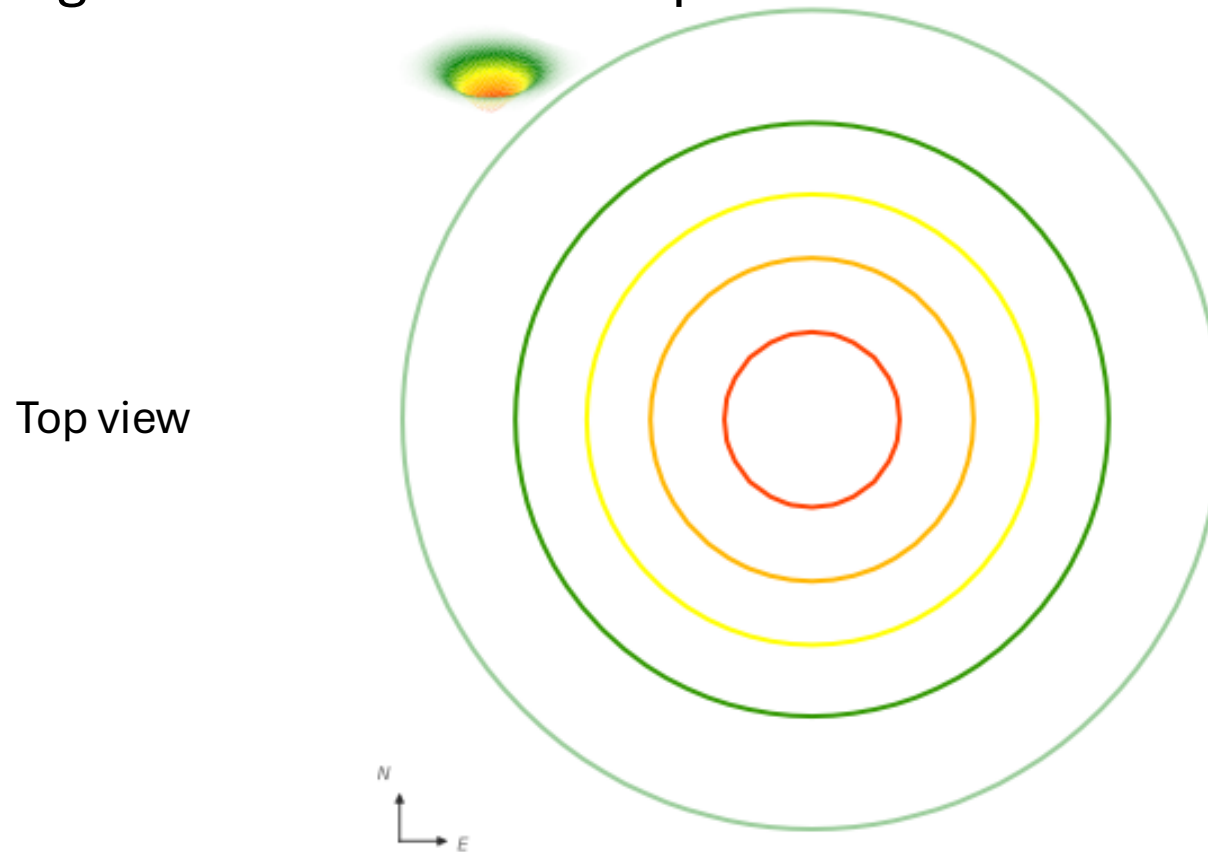


Each cell accompanied by **quality description 2σ**

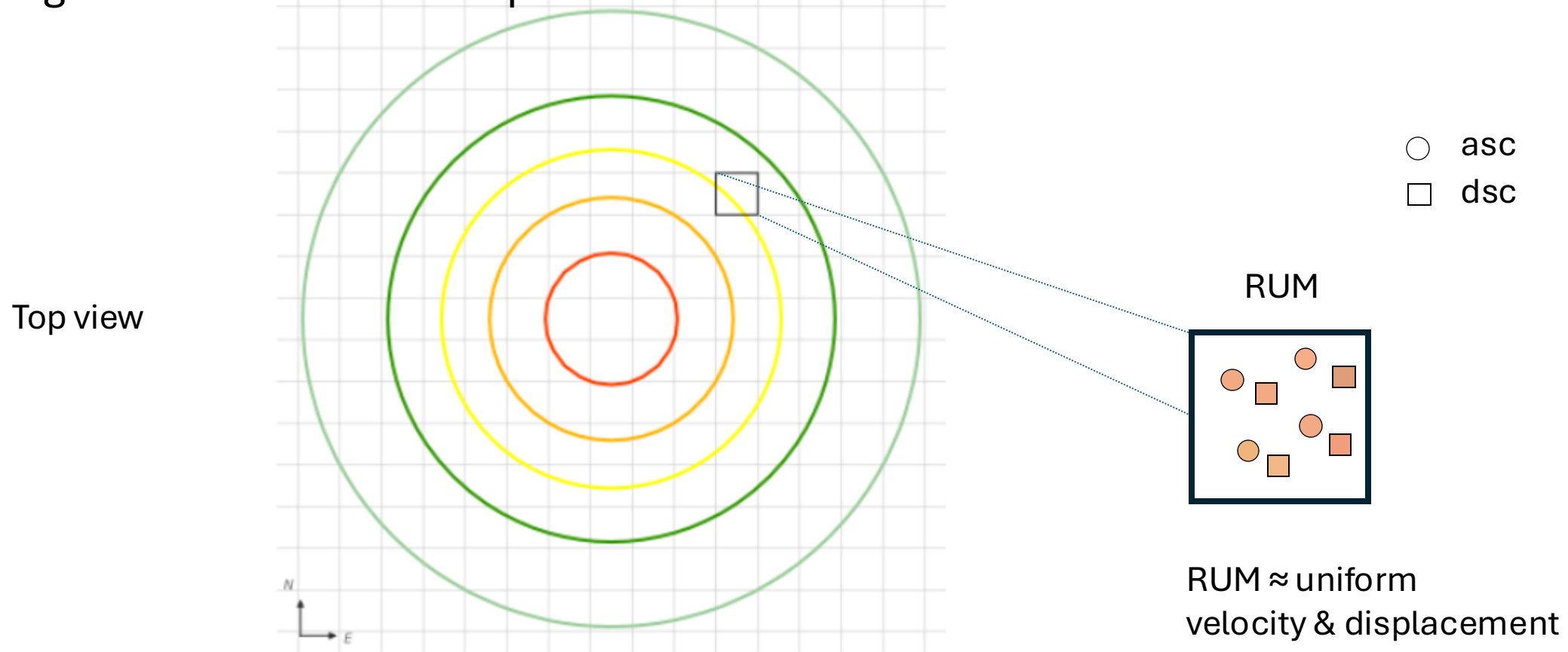
Significant ($>2\sigma$) horizontal motion, including **north-south direction!**

First step is to introduce **physical assumptions** in the decomposition

Decomposing InSAR LOS into 3D Displacement for Subsidence Bowls



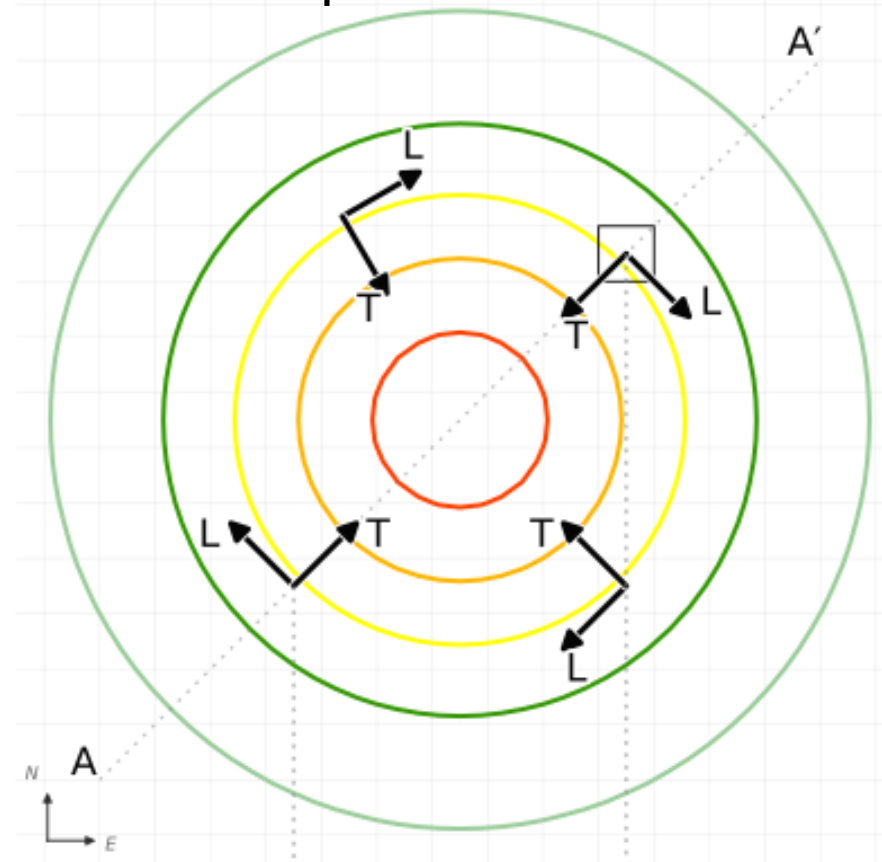
Decomposing InSAR LOS into 3D Displacement for Subsidence Bowls



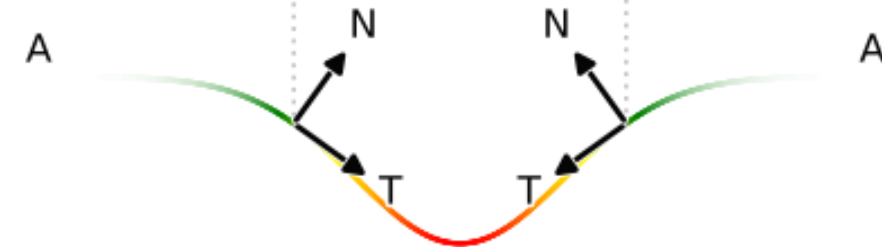
Divided the ground-surface in **Regions of Uniform Motion (RUM)**

Decomposing InSAR LOS into 3D Displacement for Subsidence Bowls

Top view



Side view



Strapdown method



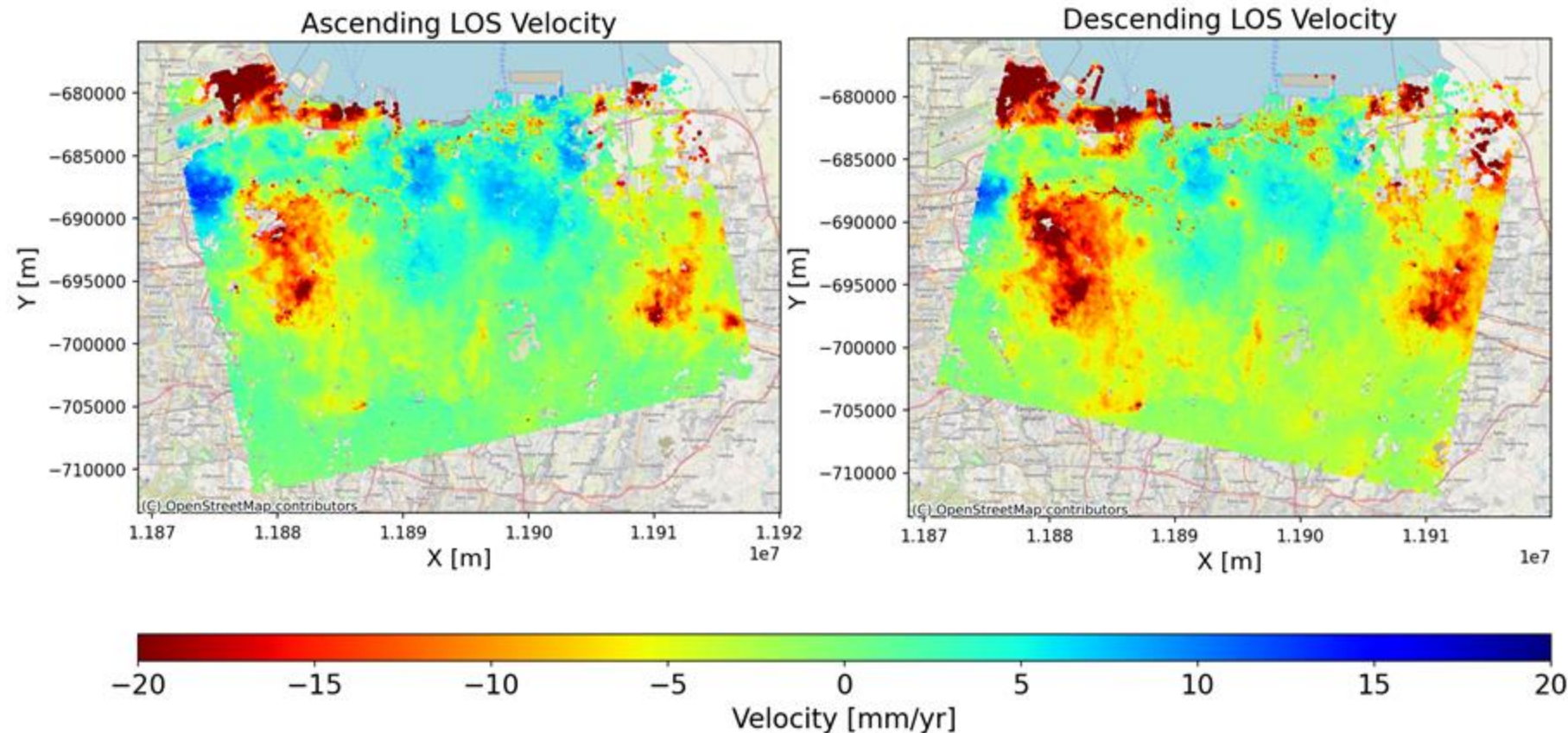
Brouwer & Hanssen, Journal of Geodesy, 2024,
doi: 10.1007/s00190-024-01918-2

In a subsidence bowl, **positive horizontal velocity** is directed **down-slope**.

LoS velocity into transversal and normal components to the iso-displacement lines.

InSAR Line-of-Sight (LOS) Velocity as input

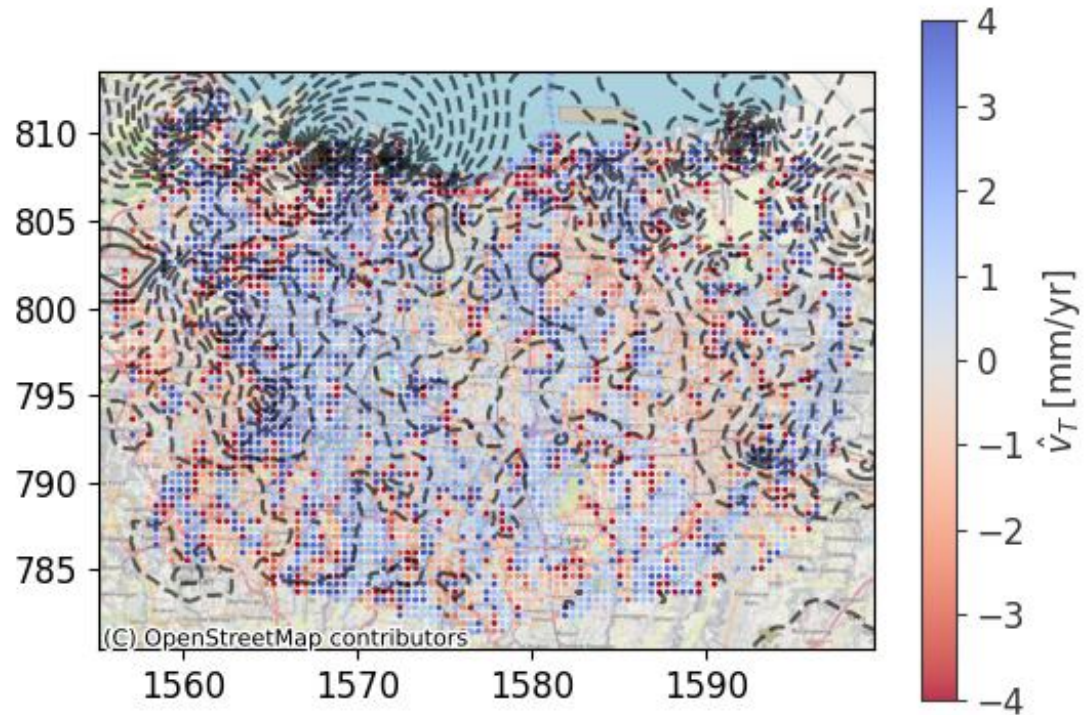
Jakarta City & Metropolitan area



Apparent color differences may reflect datum misalignment

Impact of inter-track datum misalignment on 3D decomposition

What we obtain

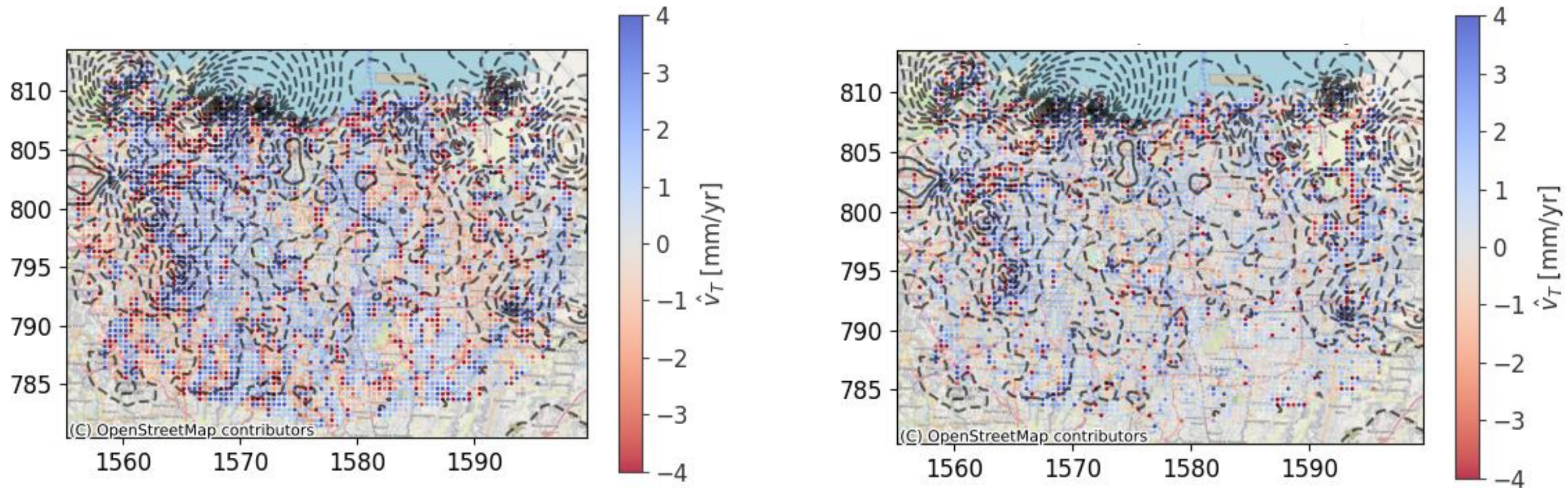


transversal velocity vectors

negative, biased direction outwards the bowl

Impact of inter-track datum misalignment on 3D decomposition

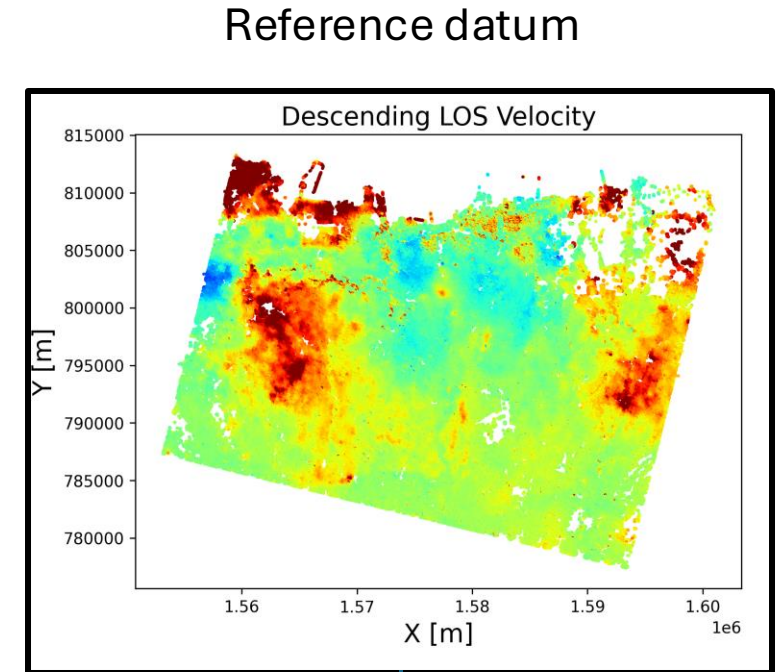
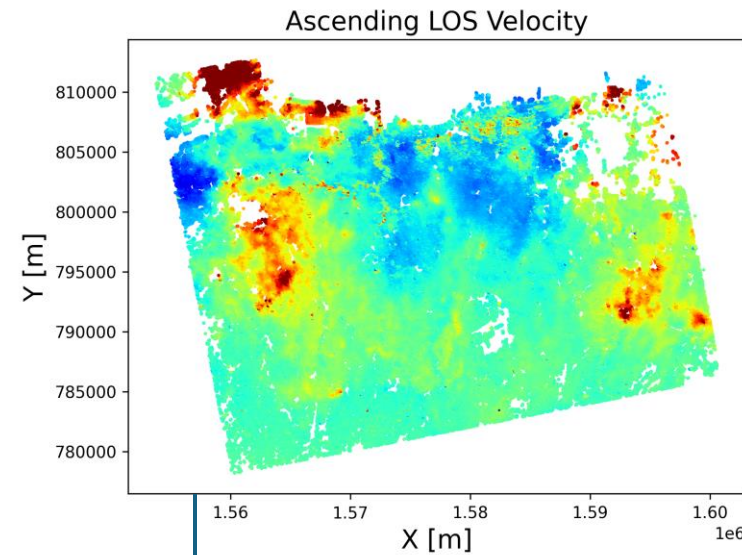
What we aim for



transversal velocity vectors

positive, directed inward, towards bowl center

Datum alignment within the strapdown: fixing a reference



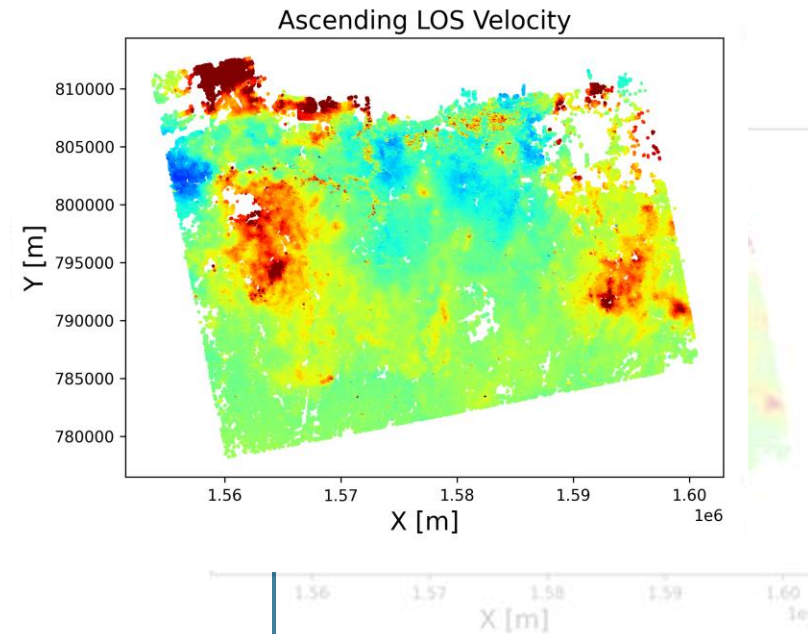
Strapdown method

Normal & Transversal velocities $\hat{d}_{N_i}$, $\hat{d}_{T_i}$

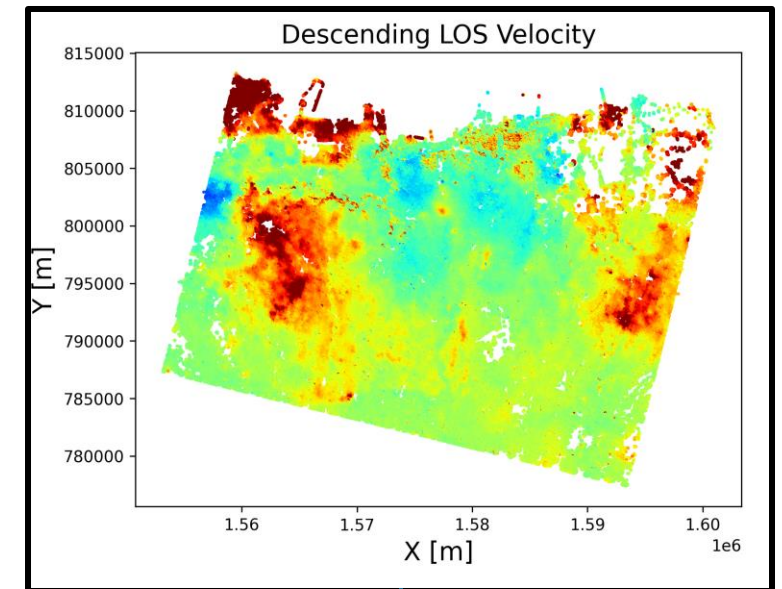
Datum alignment within the strapdown: iterative correction

Iteration 1

0.1 mm/y +



Reference datum

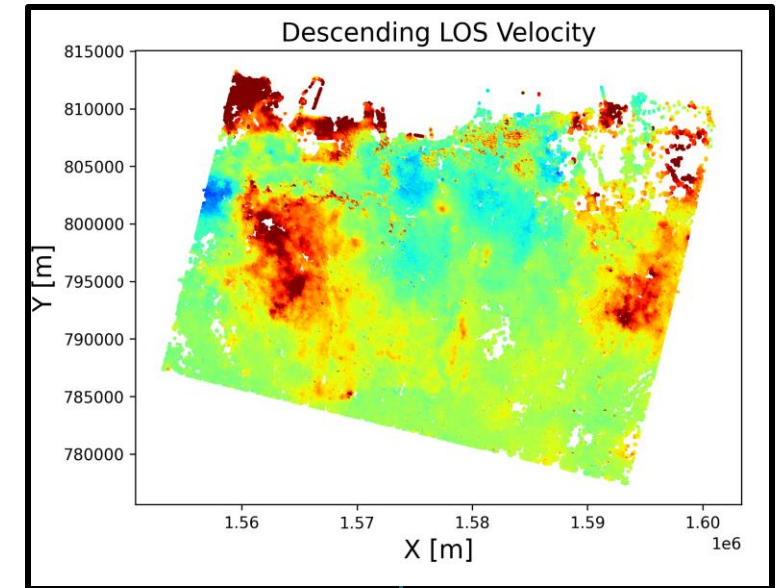
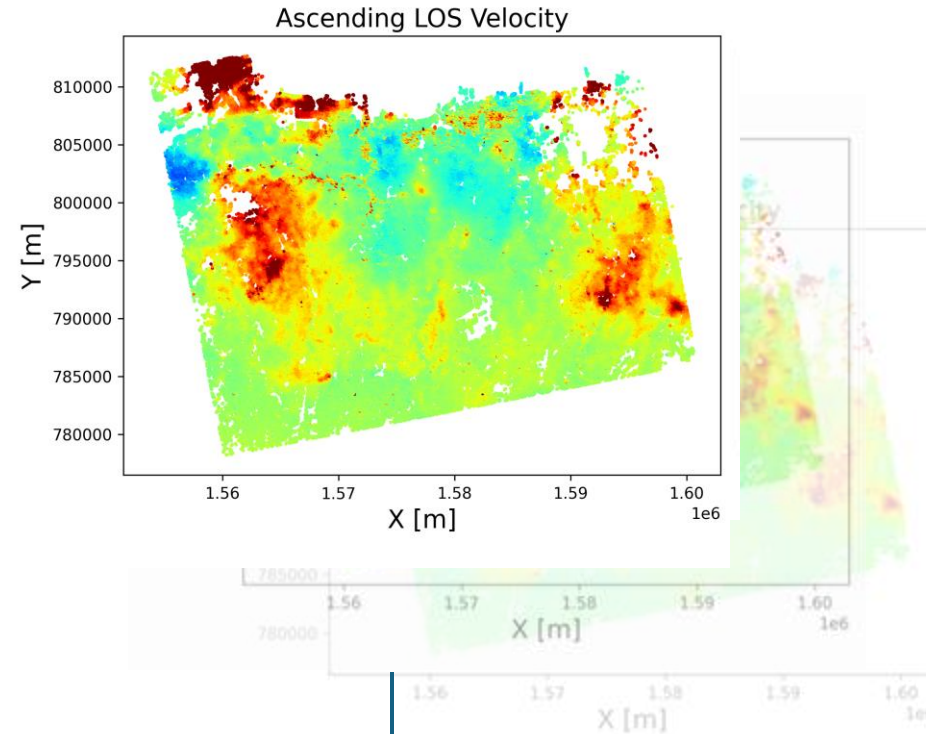


Sampling TLN solution space

Strapdown method

Datum alignment within the strapdown

Iteration 2
 0.1 mm/y +
?
until when



Sampling TLN solution space

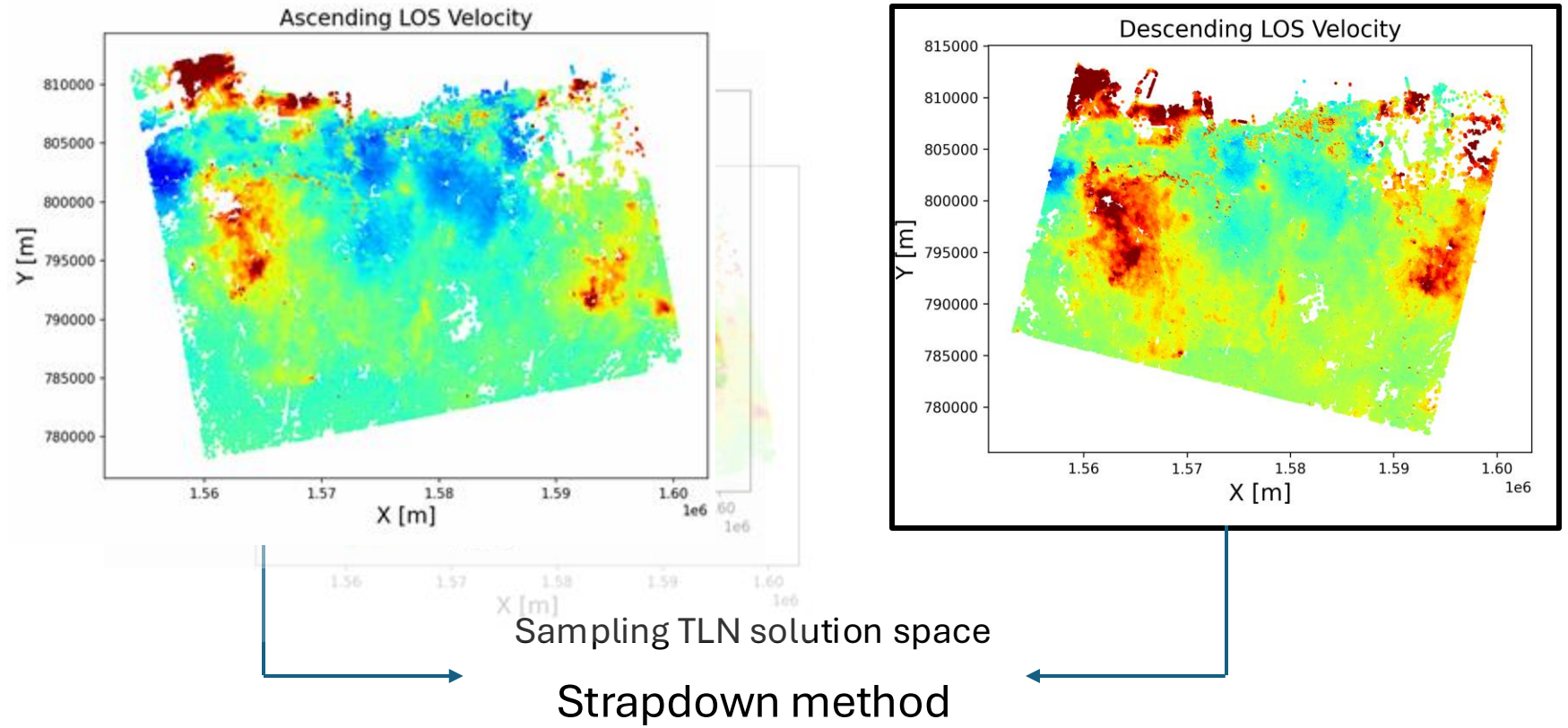
Strapdown method

which correction gives the most physically consistent decomposition?

Datum alignment within the strapdown: minimization objective

Iteration n

0.1 mm/y +



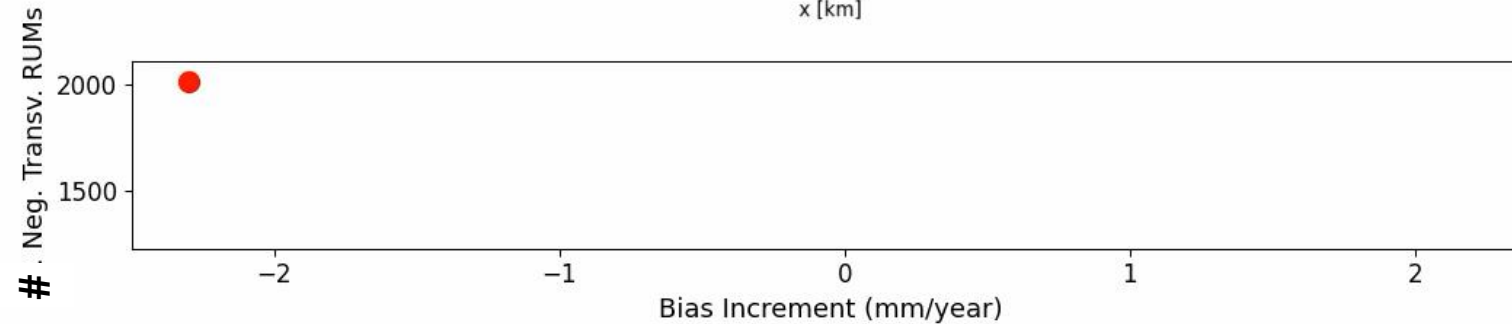
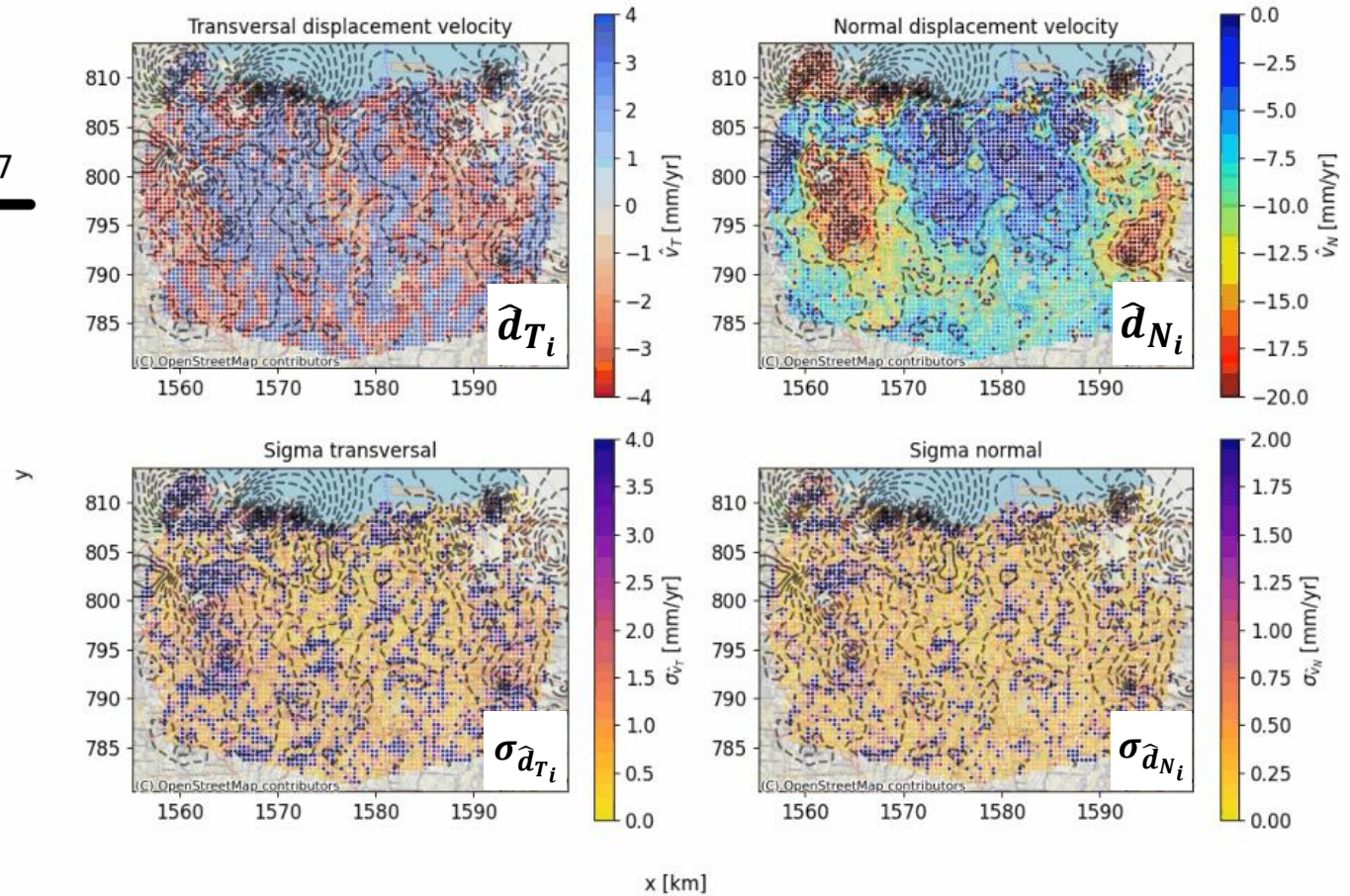
Objective: minimize number of RUMs with
negative transversal velocity

Asc Bias Increment: -2.30 mm/year

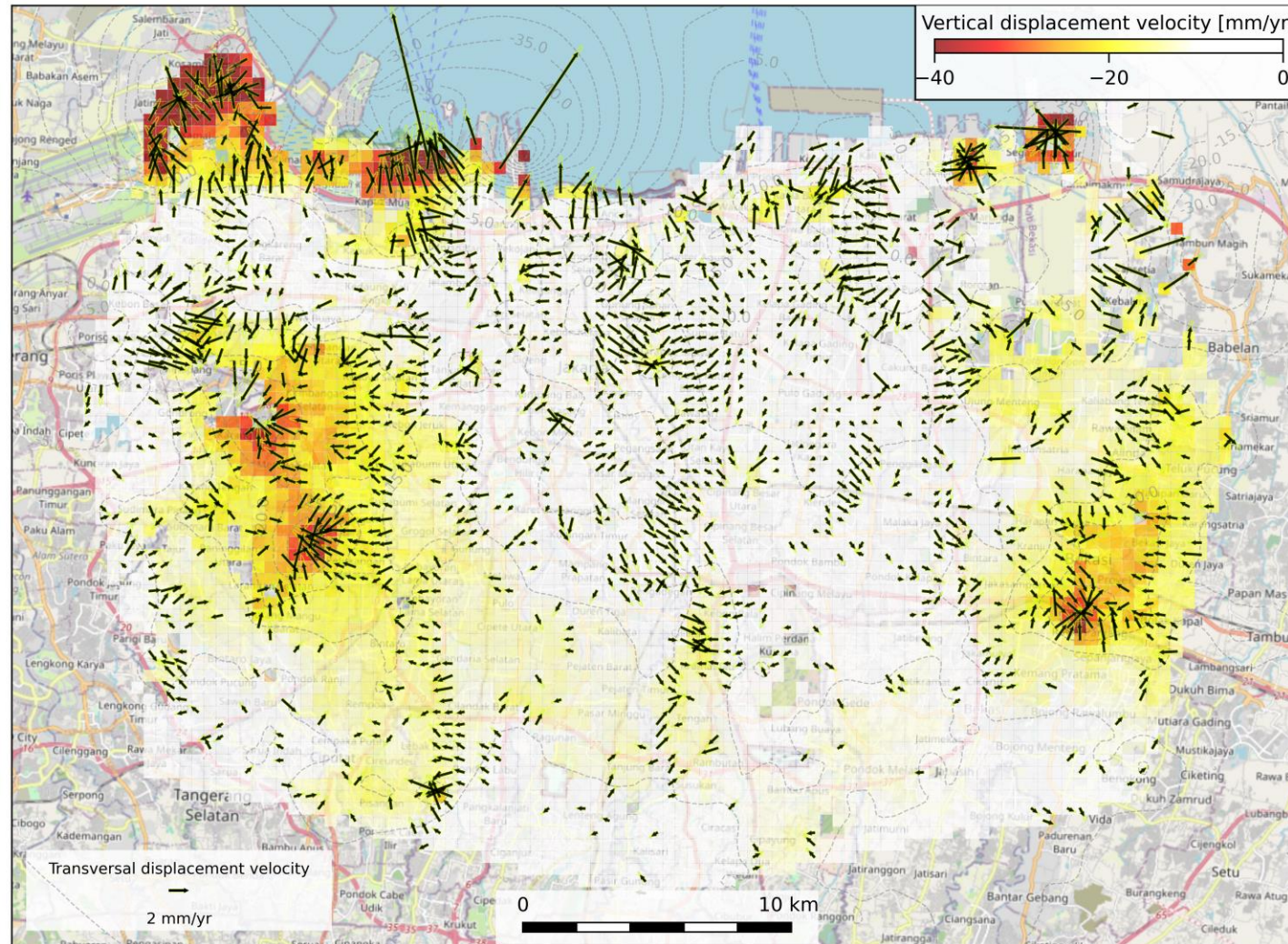
-2.3 mm/yr

dsc t047

asc t098



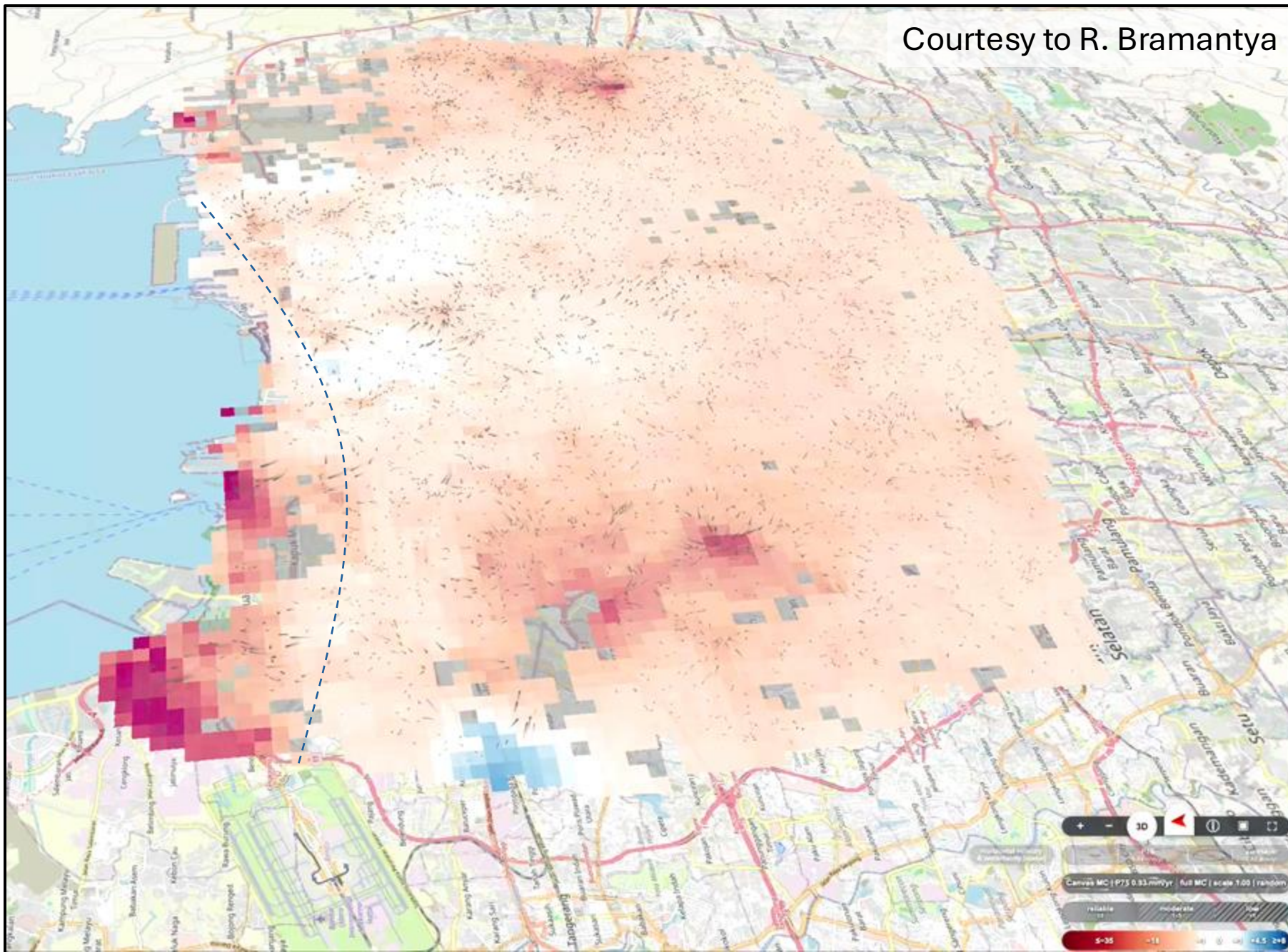
Jakarta 3D subsidence kinematics with 2σ quality description (2014–2025)



-0.9 cm/y



Courtesy to R. Bramantya



Conclusions

- Strapdown InSAR decomposition recovers 3D land motion, including the North component, with 2σ quality information.

Conclusions

- Strapdown InSAR decomposition recovers 3D land motion, including the North component, with 2σ quality information.
- Joint **datum alignment** within the strapdown decomposition prevents inter-track offsets from biasing the recovered 3D motion.

Conclusions

- Strapdown InSAR decomposition recovers 3D land motion, including the North component, with 2σ quality information.“
- Joint datum alignment within the strapdown decomposition prevents inter-track offsets from biasing the recovered 3D motion.
- In Jakarta, **six major subsidence bowls** dominate the land-motion kinematics, with motion up to -7 cm/yr vertically and 1.5 cm/yr horizontally.

Conclusions

- Strapdown InSAR decomposition recovers 3D land motion, including the [North component](#), with 2σ [quality information](#).
- Joint [datum alignment](#) within the strapdown decomposition prevents inter-track offsets from biasing the recovered 3D motion.
- In Jakarta, [six major subsidence bowls](#) dominate the land-motion kinematics, with motion up to -7 cm/yr vertically and 1.5 cm/yr horizontally.

Manuscript
Pre-print



Dataset

