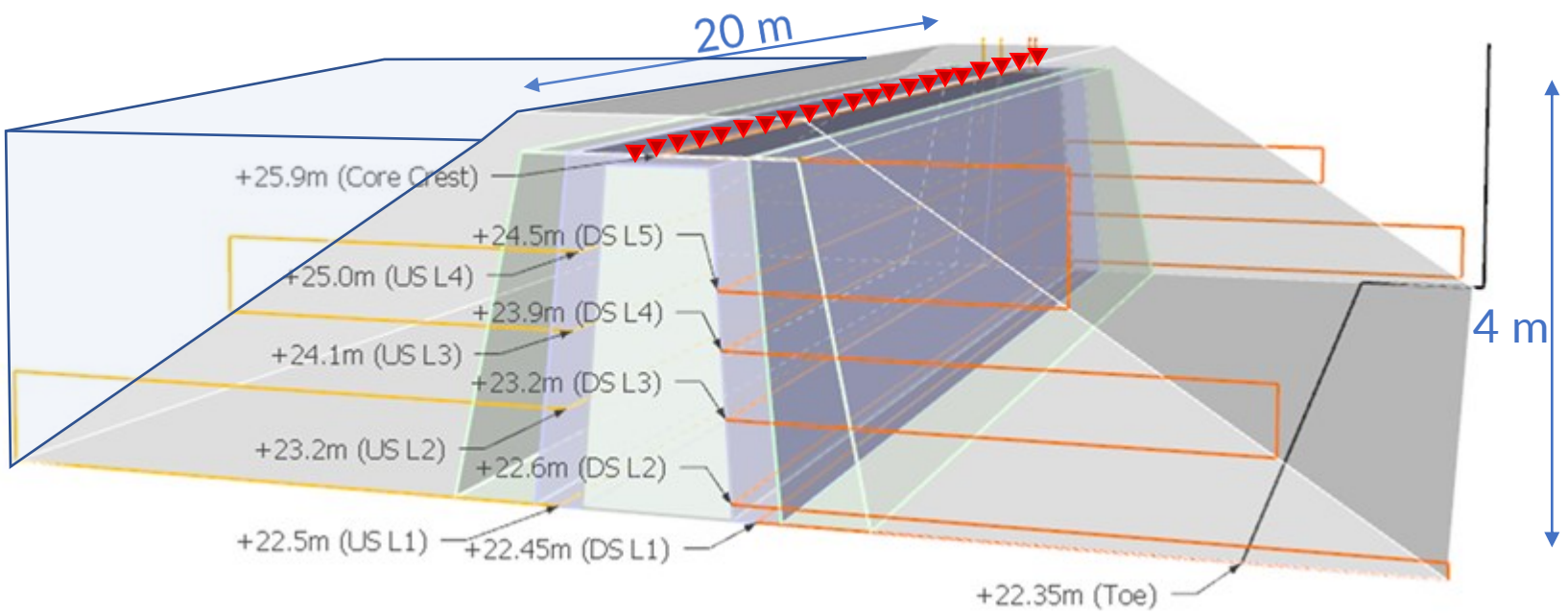
Detecting earthen dam defects using seismic interferometry monitoring on Distributed Acoustic Sensing data

Aurelien Mordret, Anna Stork, Sam Johansson, Anais Lavoue, Sophie Beaupretre, Romeo Courbis, Ari David, and Richard Lynch

23 May 2022

Experimental setup



- 3 months continuous records April-May-June 2020
- Gauge length 3 m
- Channel spacing 50 cm
- Sampling Freq 250 Hz

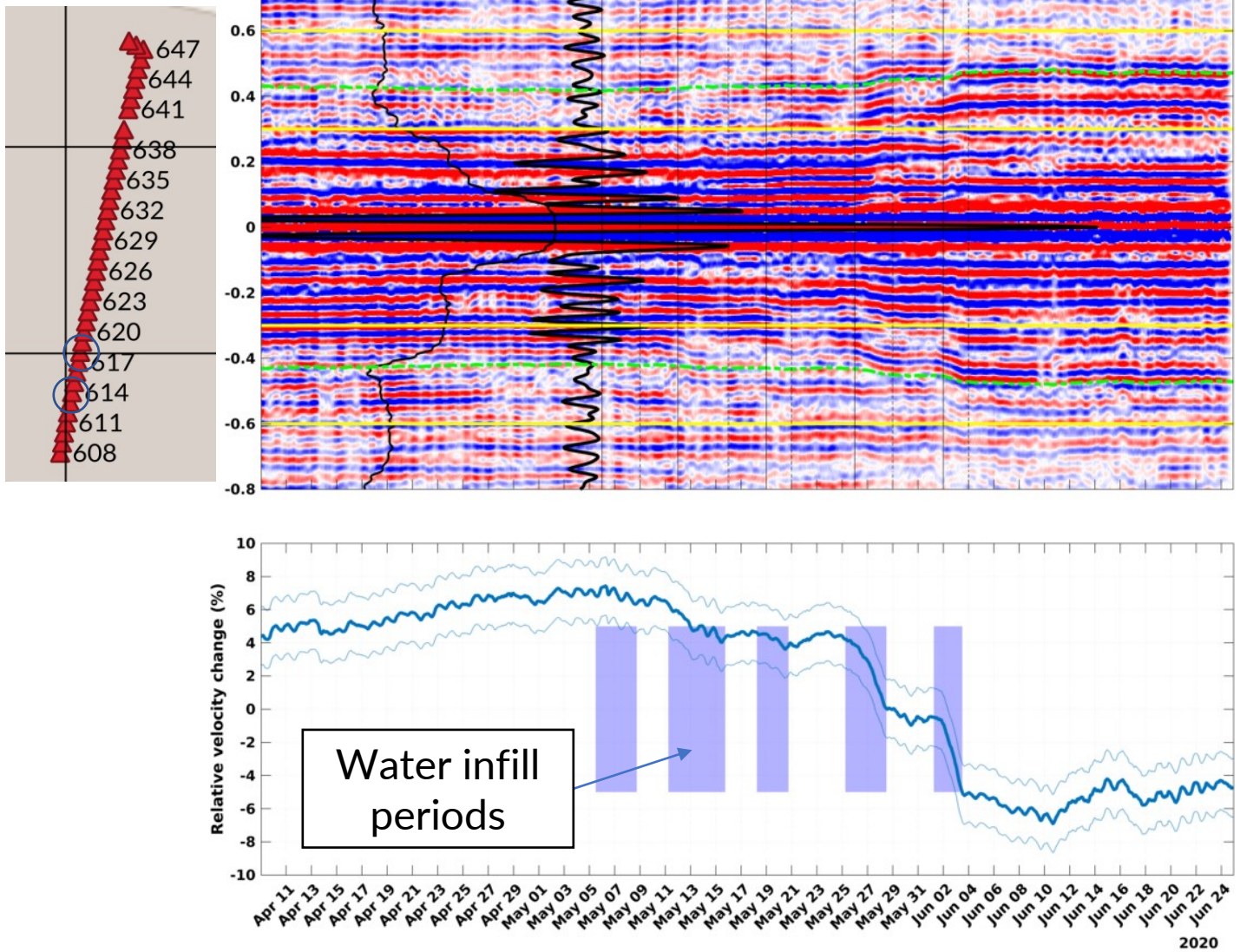
- Crest fiber
- Channel every 1 m
- Correlation of every 2 channels with 1m step = 19 correlations

- Water-level increased by steps during May

Build-in defects:

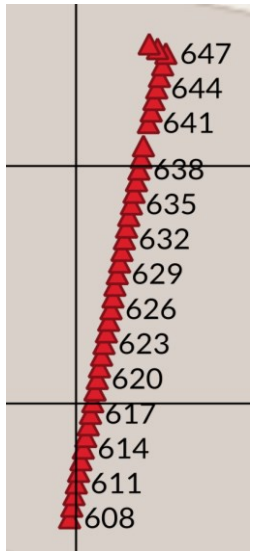
1. Cavity in the core (wood cube 0.4 m × 0.4 m × 0.4 m).
2. Horizontal permeable zone passing through the core (rectangular cross section 0.1 m high and 0.5m wide).
3. Vertically loose zone (elongated zone with square cross section with side 0.3 m).
4. Lump of concrete or large stone (cube 0.5 m × 0.5 m × 0.5 m).
5. Permeable horizontal zone at side (0.1 m x 0.1 m).
6. Filter defect on the upstream side.

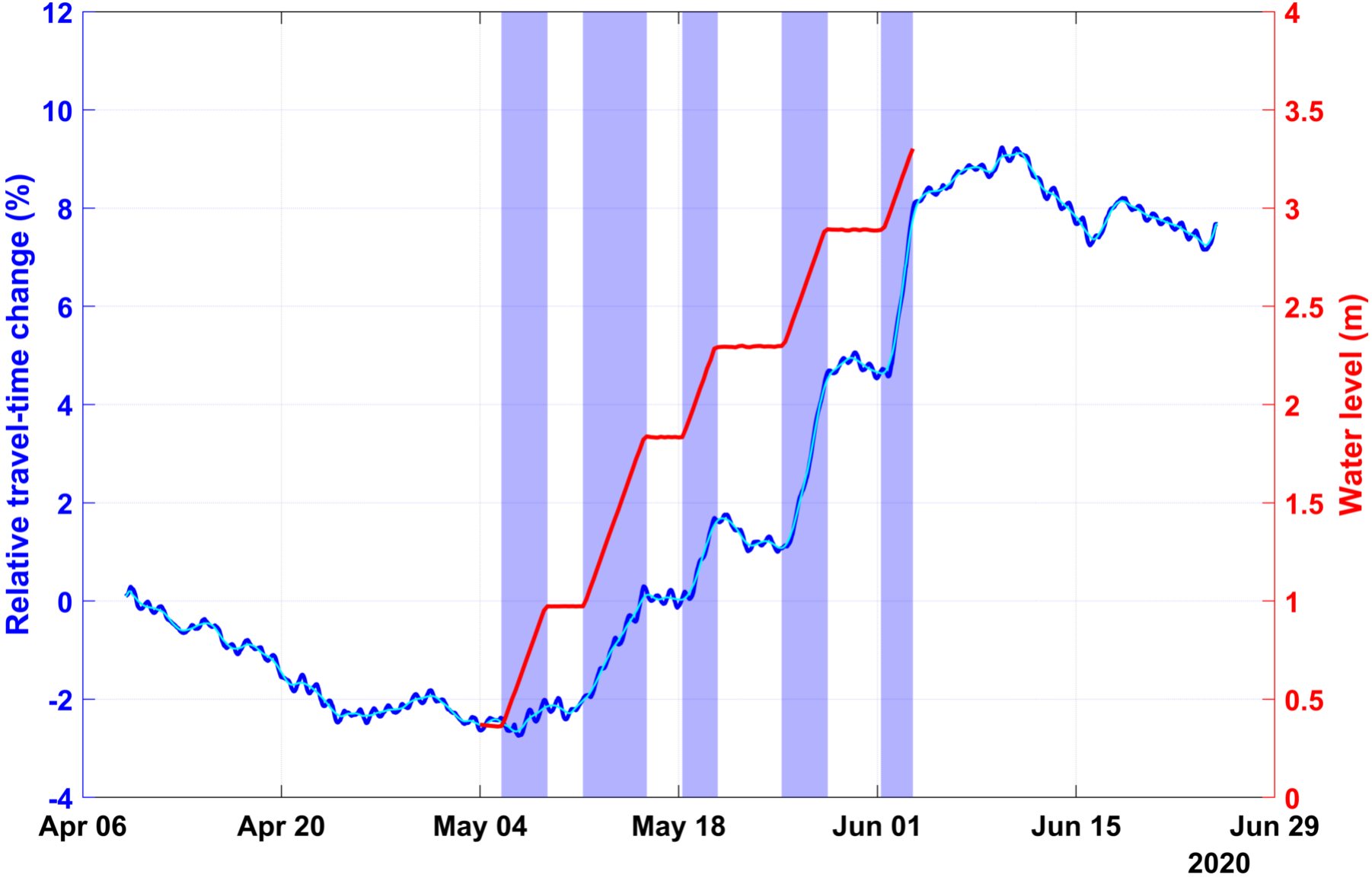
Results at one pair of channels



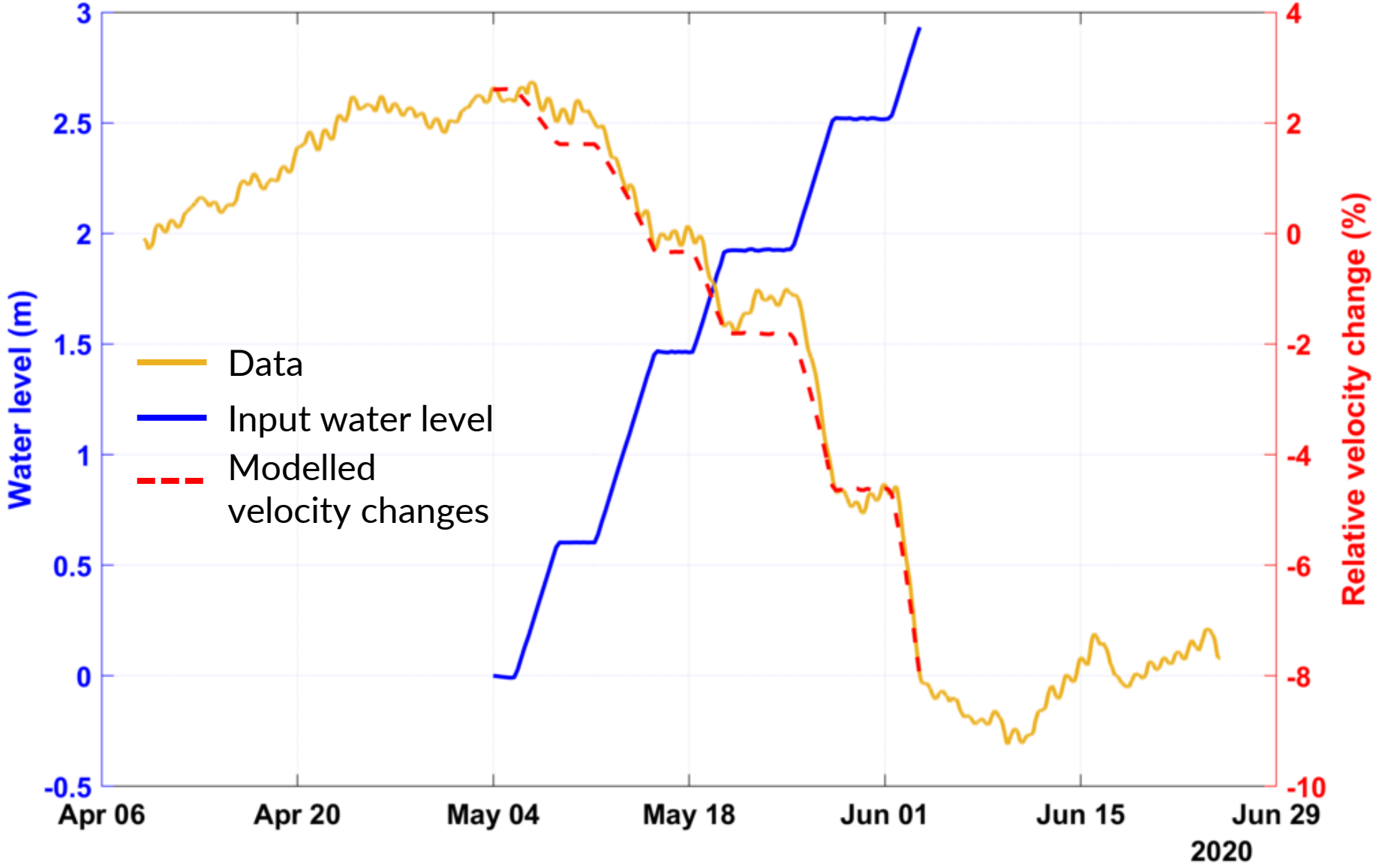
- Large velocity changes (±10%) create difficulties to accurately follow phases with standard methods
- Full inversion of pair-wise dv/v able to measure velocity changes more accurately removing cycle-skipping issues

Average result for the whole dam





Modelling the average velocity change

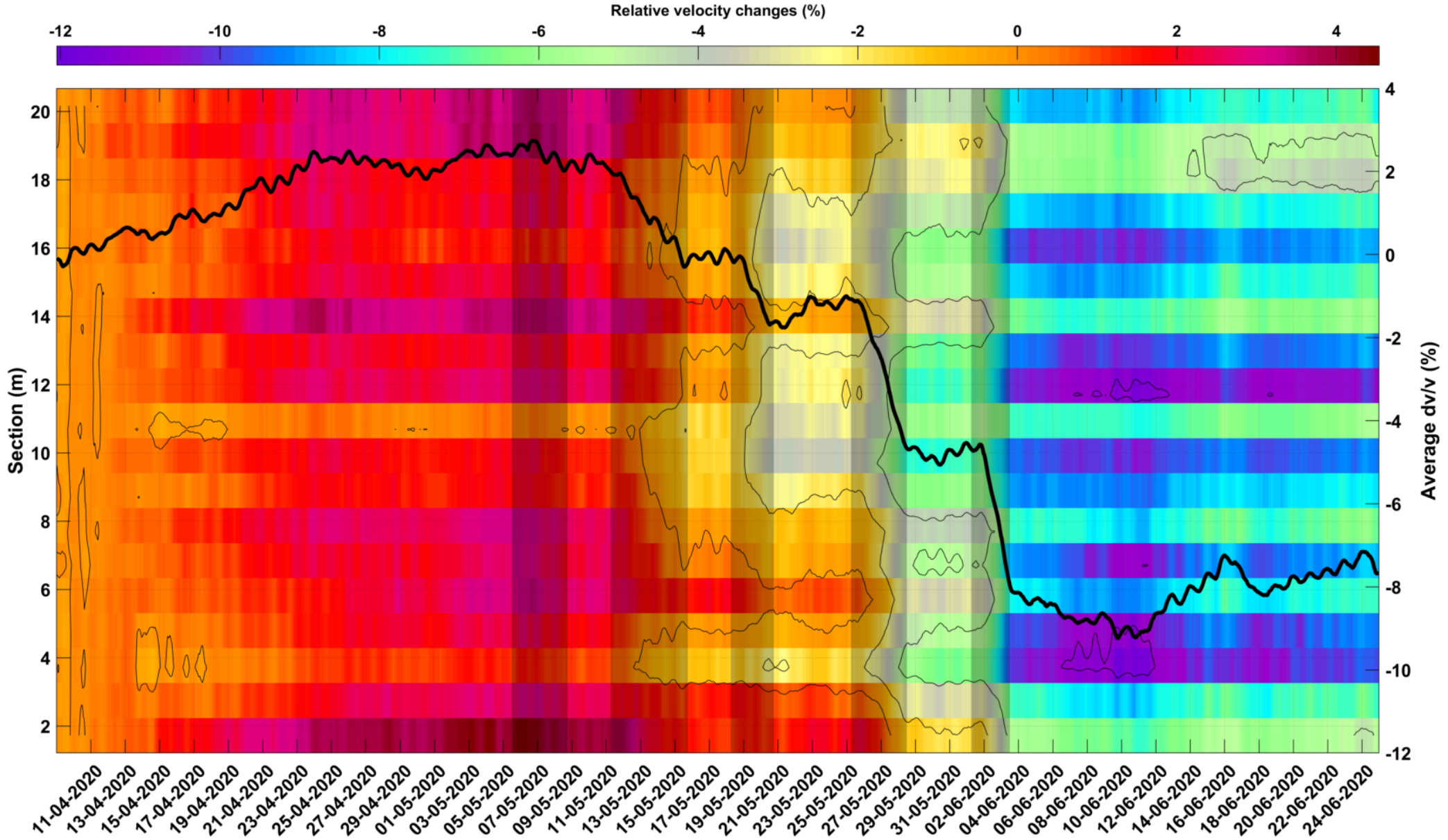


Model based on the increasing sensitivity of velocity changes to increasing water level

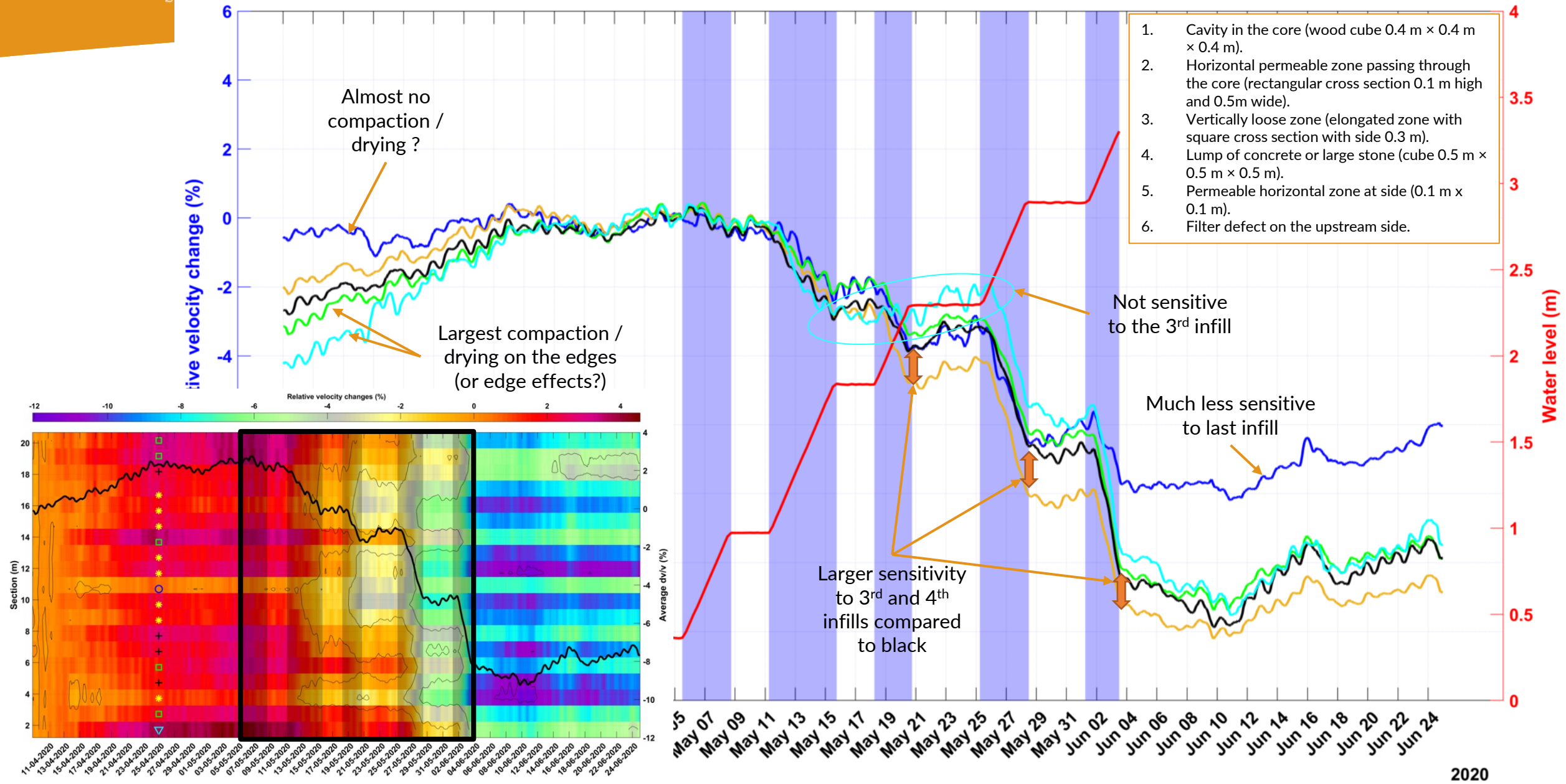
= First order variations

SISPROBE by egis

Spatialized results



Clustering: Interpretations



Conclusions

- Ambient noise correlation monitoring on DAS data
- High spatial and temporal resolution
- Sensitive to water saturation in the bulk of the dam

- Transfer function between water-level and dv/v follows a simple decreasing exponential with depth
- Dv/v lateral variations might be associated with the presence of dam defects and their nature *(true location and nature of defects will be disclosed to us in June…!)*

- DAS + ambient noise monitoring is a promising tool for assessing the health of earthen embankments