

Raster Representation of Ground Motion Service Data and Automated Hot-Spot Detection



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Motivation:

Ground motion processes interest many disciplines and should be presented as intuitively as possible.

Presentation of the data from Ground Motion Service Germany [1] → Persistent Scatterer Interferometry (PSI) data

Point Representation

- Persistent scatterers (PS) are distributed very heterogeneously
- Point representation in uniform spacing appears unintuitive

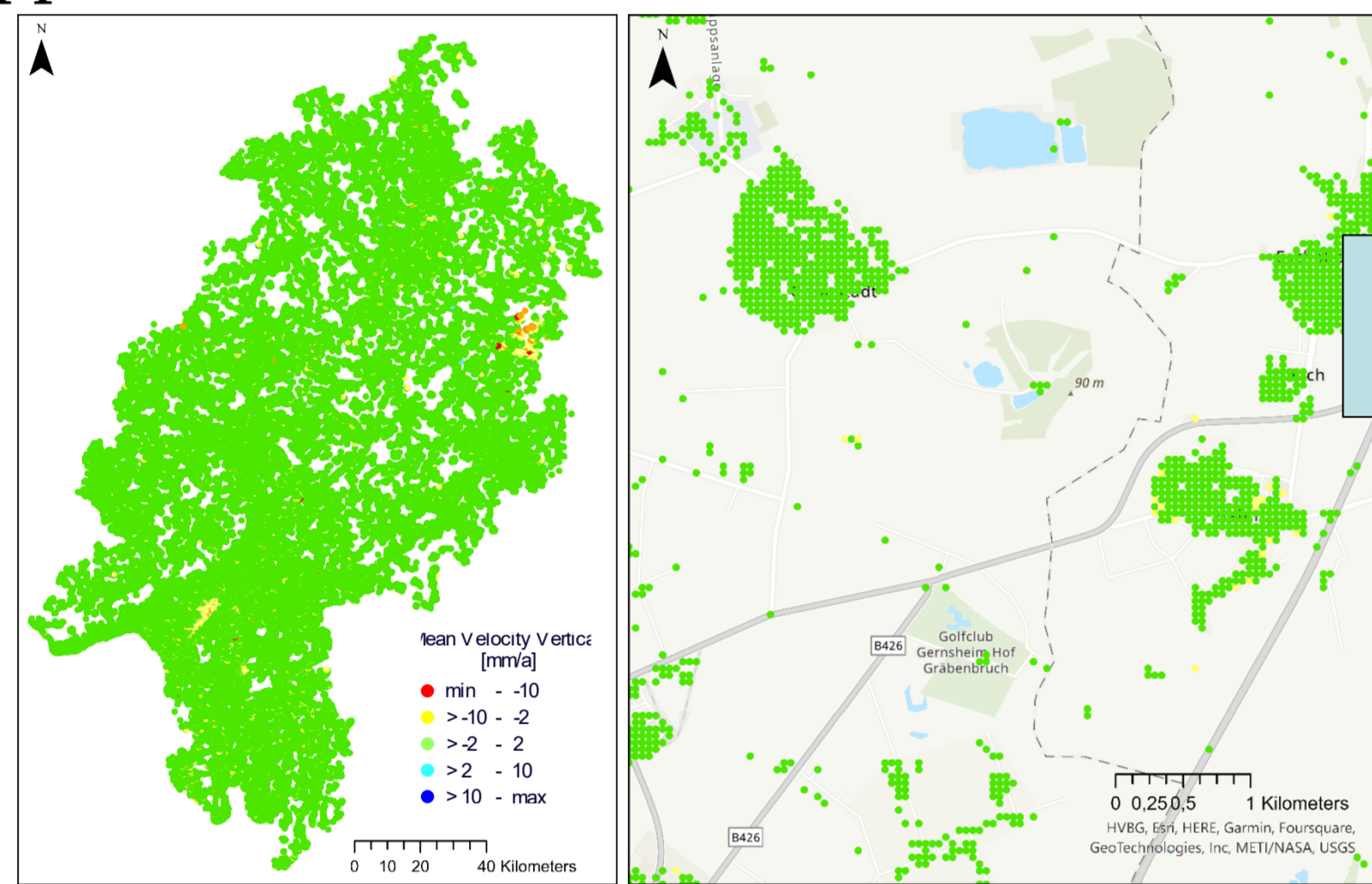


Figure 1: Ground Motion Service Data (a) for the State of Hesse (b) for the location Crumstadt

Raster Representation

- The representation over a larger grid size shows an overall smoothed result of the data on which large-scale patterns are well recognizable

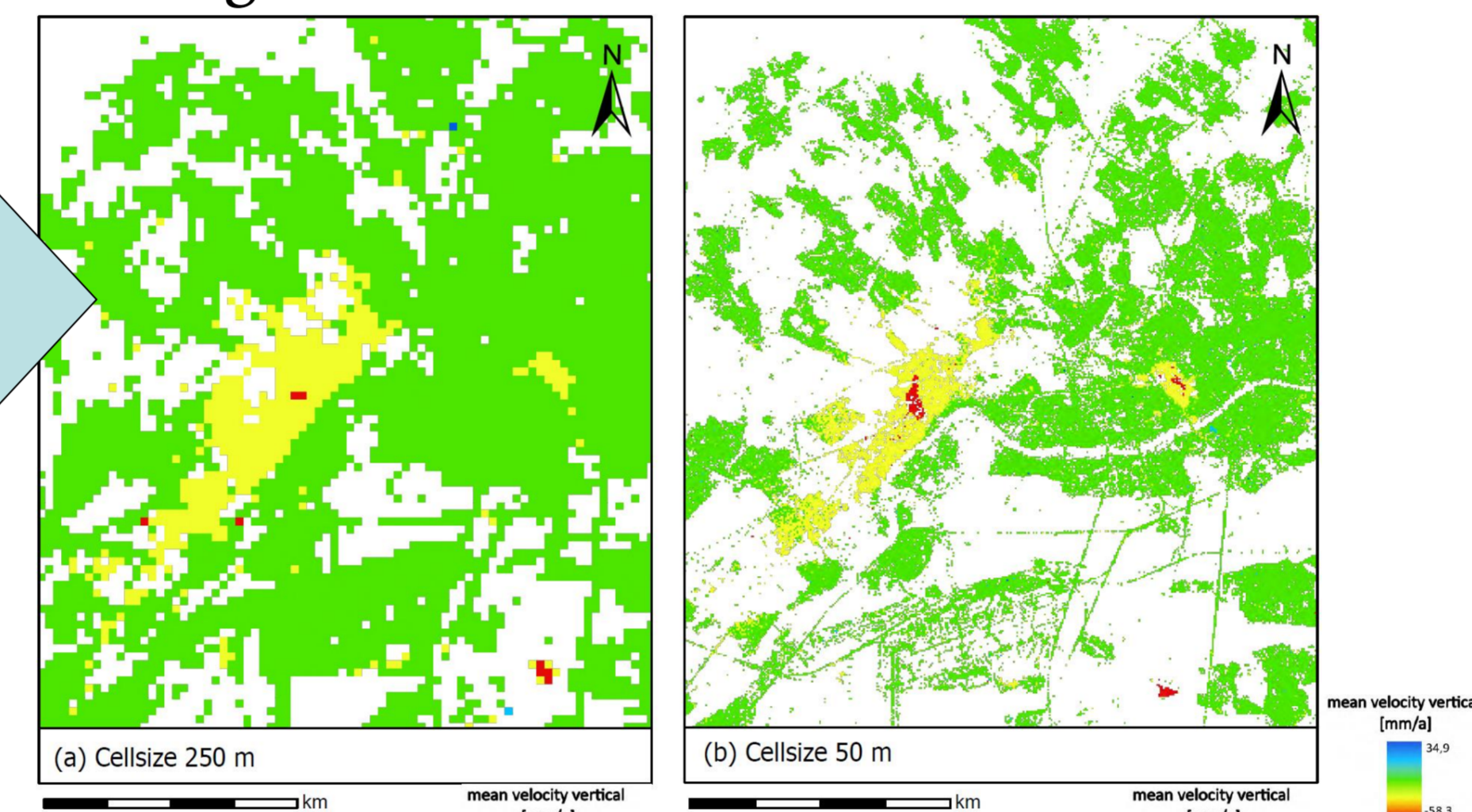


Figure 2: Raster representation of the Ground Motion Service Data for Frankfurt am Main, Germany with (a) cellsize 250 m and (b) cellsize 50 m.

Hot-Spot Detection

- The Ground Motion Analyser (GMA) focus on motion hot-spot areas
- It combines the **amount** of vertical motion measured from the PSI data with the **number** of PSI in a cell that indicate motion

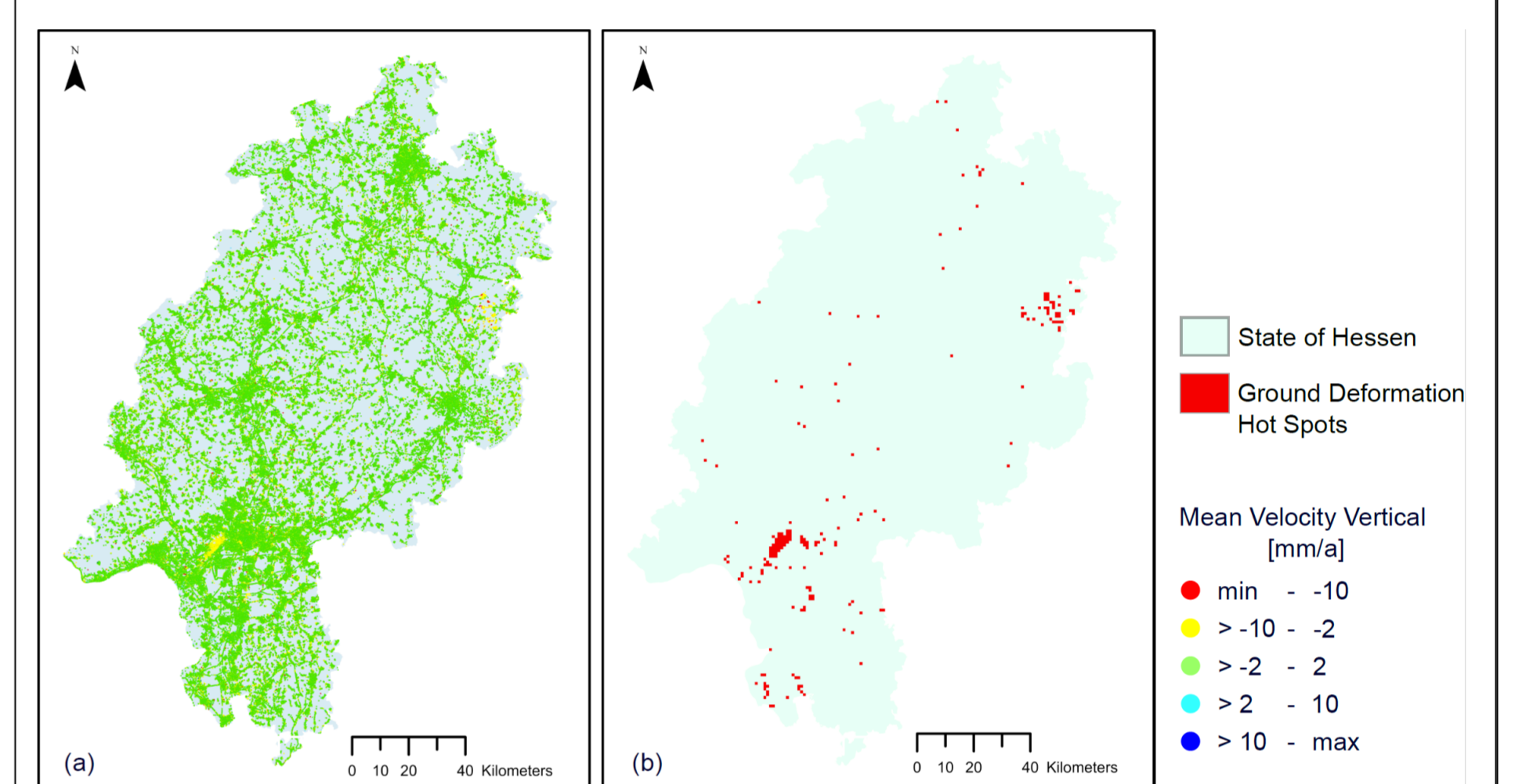


Figure 3: (a) Visualization of the PS in Hesse (b) ground deformation hot spots detected by the Ground Motion Analyser (GMA) using a threshold.

The duration and the course of the PSI data can indicate the cause of the ground motion

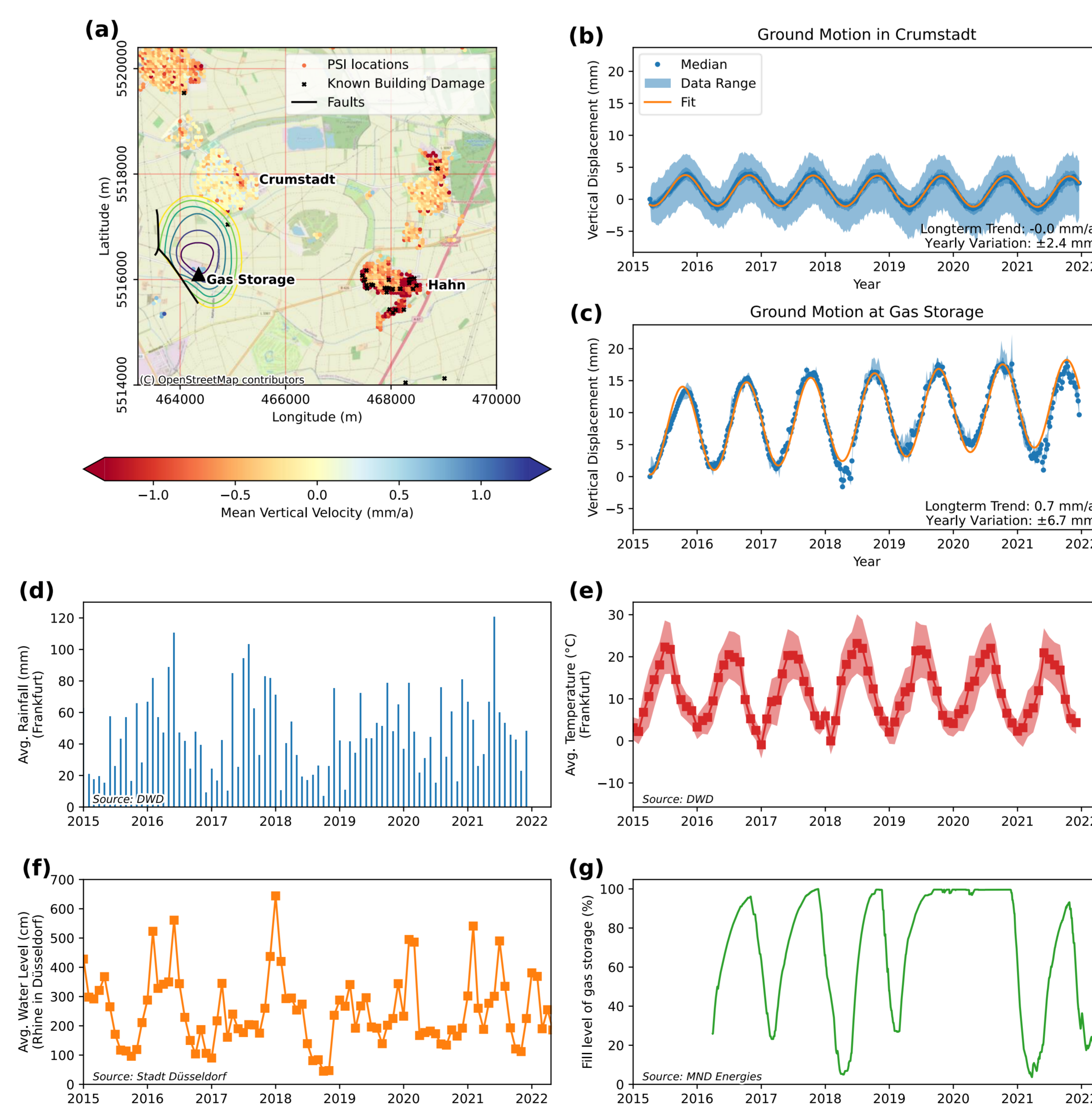
Case Study

In addition to the search for hot-spot areas, we want to analyze in our project to what extent we can derive the cause of movement from the time series of the PSI data.

Crumstadt is located on an old river bank, the soil is composed of sediments and peat. Near to the location there is an underground gas storage.

d) Average rainfall in Frankfurt [2].
→ **Precipitation can cause swelling and shrinking of the soil. Is this the cause of the ground motion?**

f) Average water level of the Rhine river in Düsseldorf [3].
→ **The groundwater level is approximated by the water level in the river. Correlates rather poorly.**



(b) Simple time series analysis of vertical displacement for Crumstadt.
→ **We can see a clear seasonal trend in the Ground Motion Service data.**

(c) Simple time series analysis of vertical displacement for vicinity of the gas wells.
→ **The seasonal trend becomes stronger near the gas storage facilities.**

(e) Monthly averages and range of temperature in Frankfurt [2].
→ **The seasonal trend correlates strongly with the average temperature.**

(g) Fill level of the gas field [4].
→ **The gas reservoir may be the cause of the ground movement, but it is probably not the only cause.**

Outlook:

- For identified hot-spots, provisions can be made (for example, InSAR zoom products with TerraSAR-X and Tandem-X)
- To fill the spatial gap, a fusion of PSI data with ALS data of several epochs is tested

[1] BGR. Bodenbewegungsdienst Deutschland. Available at <https://bodenbewegungsdienst.bgr.de/>.

[2] DWD. Klimadaten Deutschland - Monats- und Tageswerte (Archiv). German. Nov. 2022.

URL: <https://www.dwd.de/DE/leistungen/klimadatendeutschland/klarchivtagmonat.html>.

[3] Landeshauptstadt Düsseldorf. Tägliche Wasserstände des Rheins bei Düsseldorf in den Monaten seit 1996.

German. Feb. 2020. URL: <https://opendata.duesseldorf.de>.

[4] MND Energy Storage Germany GmbH. Inventory Turnover Data. Downloaded from Website on 07. Nov. 2022.

2022. URL: <https://www.mnd-energystorage.de/ugs-portal/inventory-turnover-data>.

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