

Competence Center Global System Science (GSS)

Recent Projects in 2021/22

Lead: Marko Djuric and Kilian Türk



COVID-19

Motivation: The understanding of the impact of Non-pharmaceutical interventions (NPIs) on demand for intensive care units (ICUs) is vital during the COVID-19 pandemic.

Objective: Support political decision-making by predicting COVID-19-related ICU needs. The simulation model will be adjusted accordingly based on the current pandemic progression.

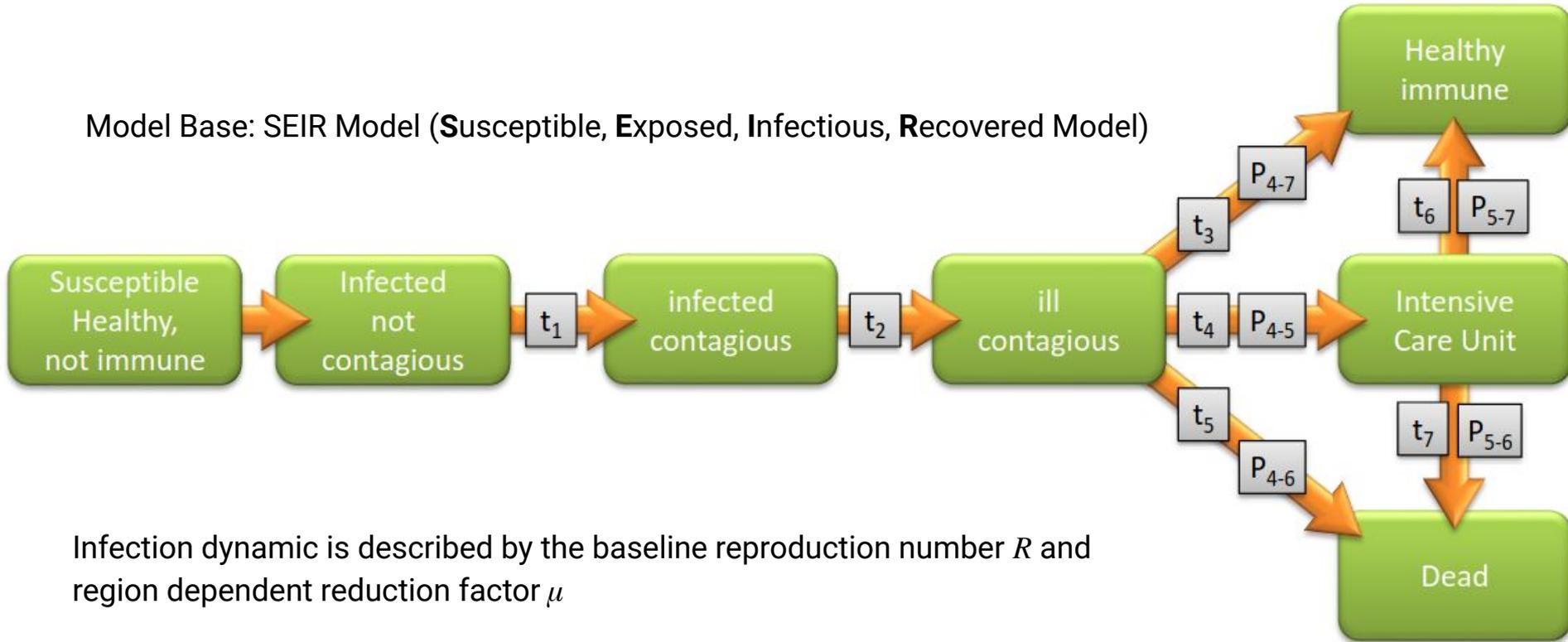
Methods: Implementation of a spatial age-structured microsimulation model of the COVID-19 pandemic

Support: Connection between ministry of interior and modelling and HPC-specialists, providing HPC infrastructure for regular simulation runs



COVID-19

Model Base: SEIR Model (Susceptible, Exposed, Infectious, Recovered Model)

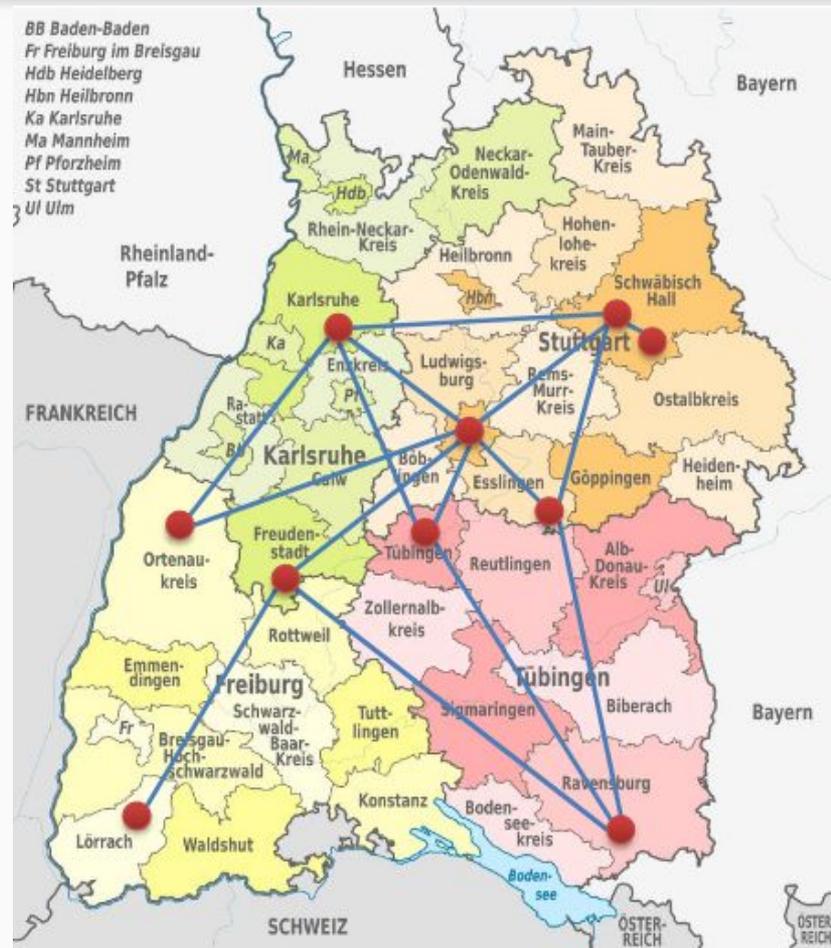


Infection dynamic is described by the baseline reproduction number R and region dependent reduction factor μ

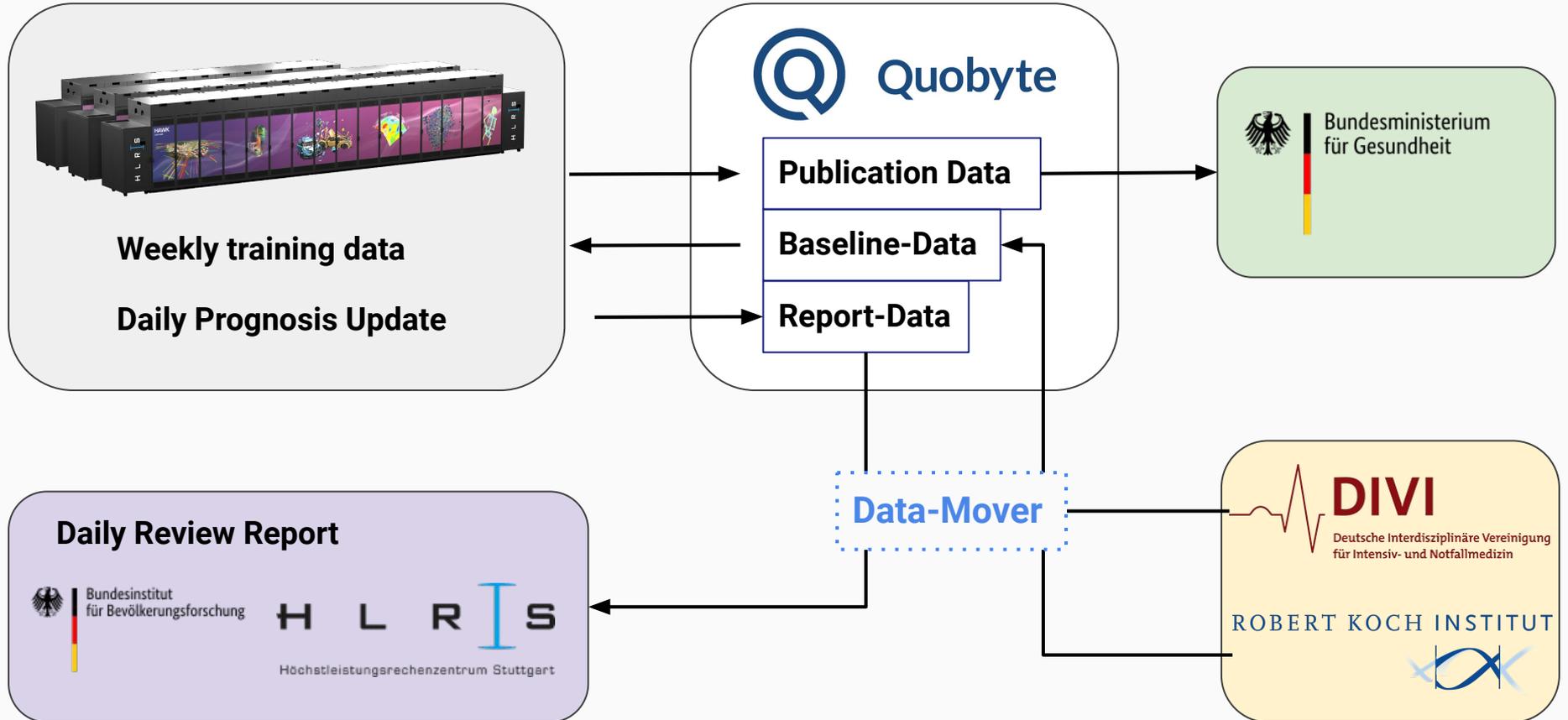
Individuals interact, i.e. infect each other on microscale based on their location

Location takes into account:

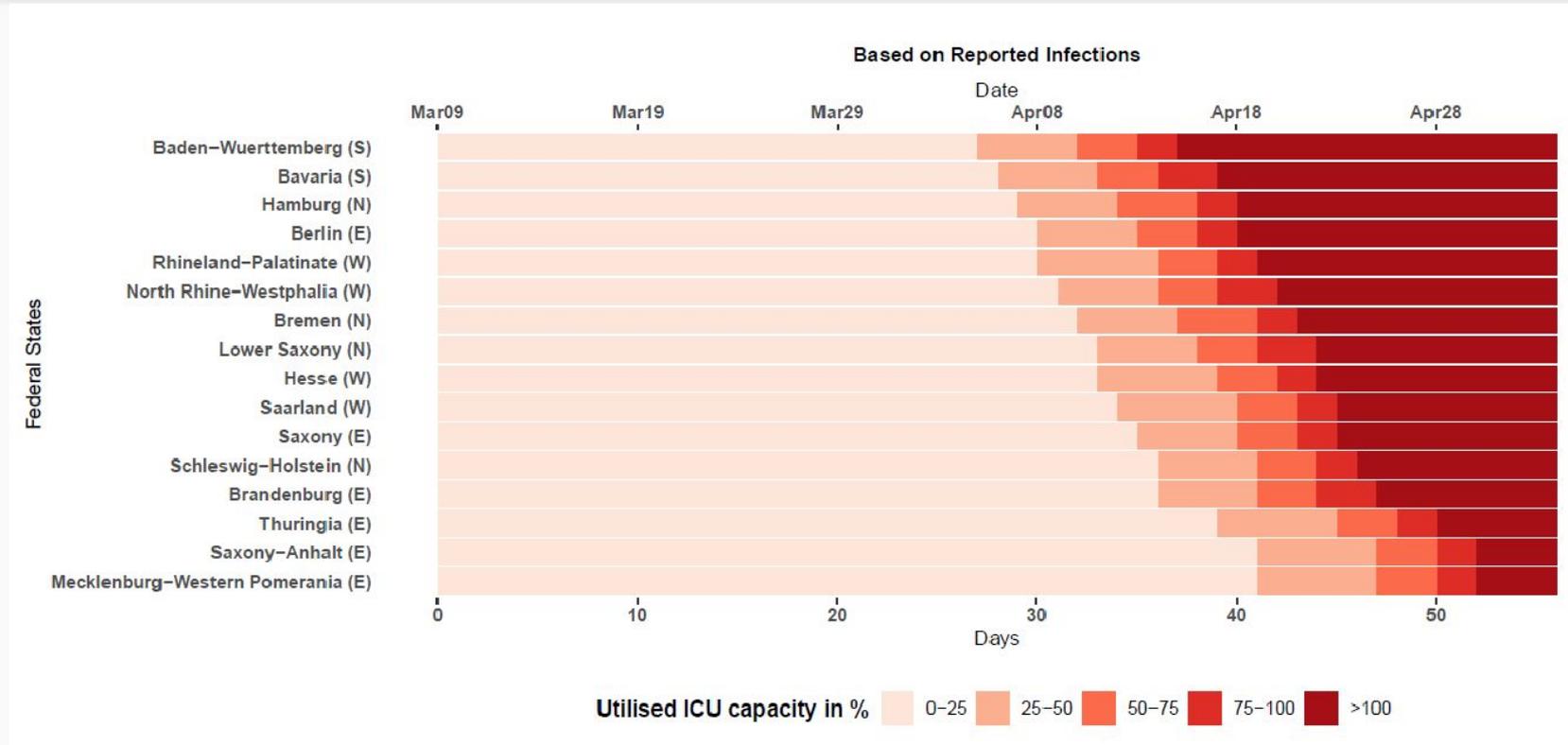
- Residency
- Location of Work
- Change of location determined by commuter matrix



Automatic Forecasting



COVID - Simulated effect of an uncontained first COVID-19 wave on related ICU



Source: RKI, German Federal Employment Agency, Federal Statistical Office of Germany, own calculations.

MPAS

Motivation: Researchers at the Institute of Physics and Meteorology, University of Hohenheim, are using HLRS's Hawk supercomputer for multiscale Earth systems simulations that are helping to predict the potential effects of climate change more accurately.

Result: Earth atmosphere simulation containing air temperature at ground level, rain number concentration, air flow, atmospheric pressure, etc.

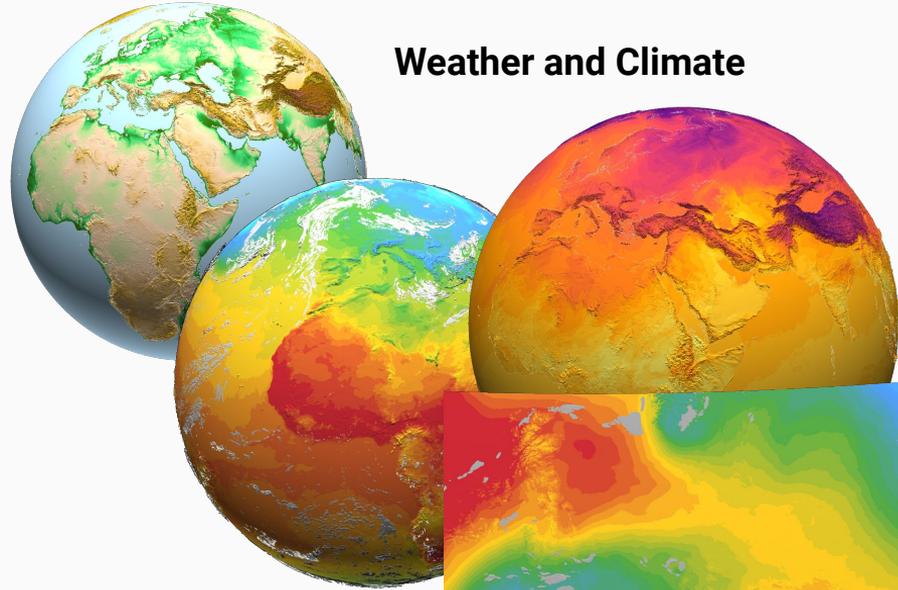
Support: Distributed Parallel Visualization from HPC-Cluster, provide resources



MPAS - Model for Prediction Across Scales

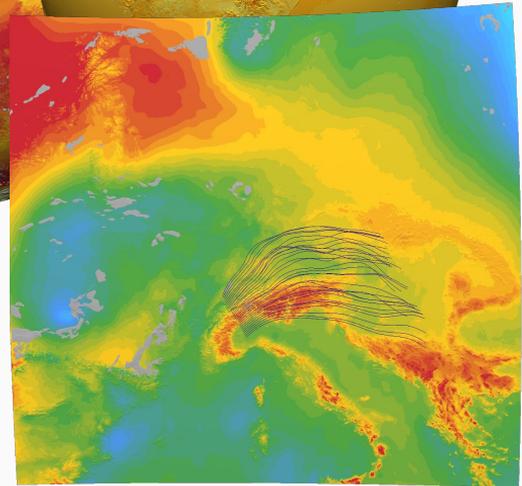


Voronoi-Mesh



Weather and Climate

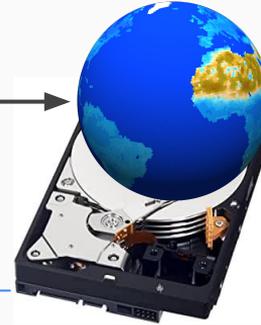
**up to 1.5 km
Resolution**



MPAS - Support



Simulate

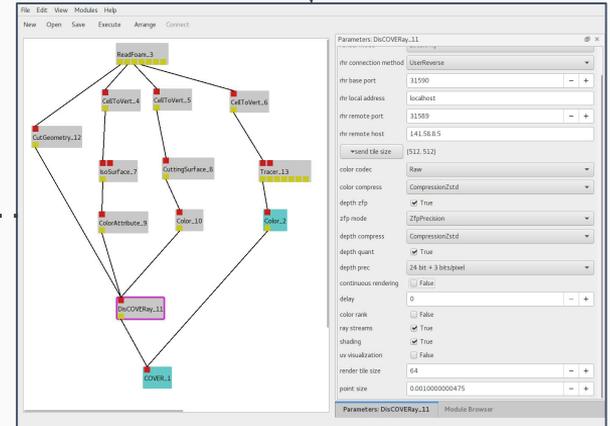


Read Data in Vistle

Support



Streaming



HiDALGO

Motivation: Several simulations were created in the EU-funded project HiDALGO (HPC and Big Data Technologies for Global Systems) aimed for developing algorithms and software for HPC to accurately model and simulate complex processes.

Use cases: urban air quality, social networks, COVID-19 and migration streams

Support: Provide resources and support for connecting with state offices, visualize urban air quality in use case of Stuttgart in digital twin



Urban Air Pollution

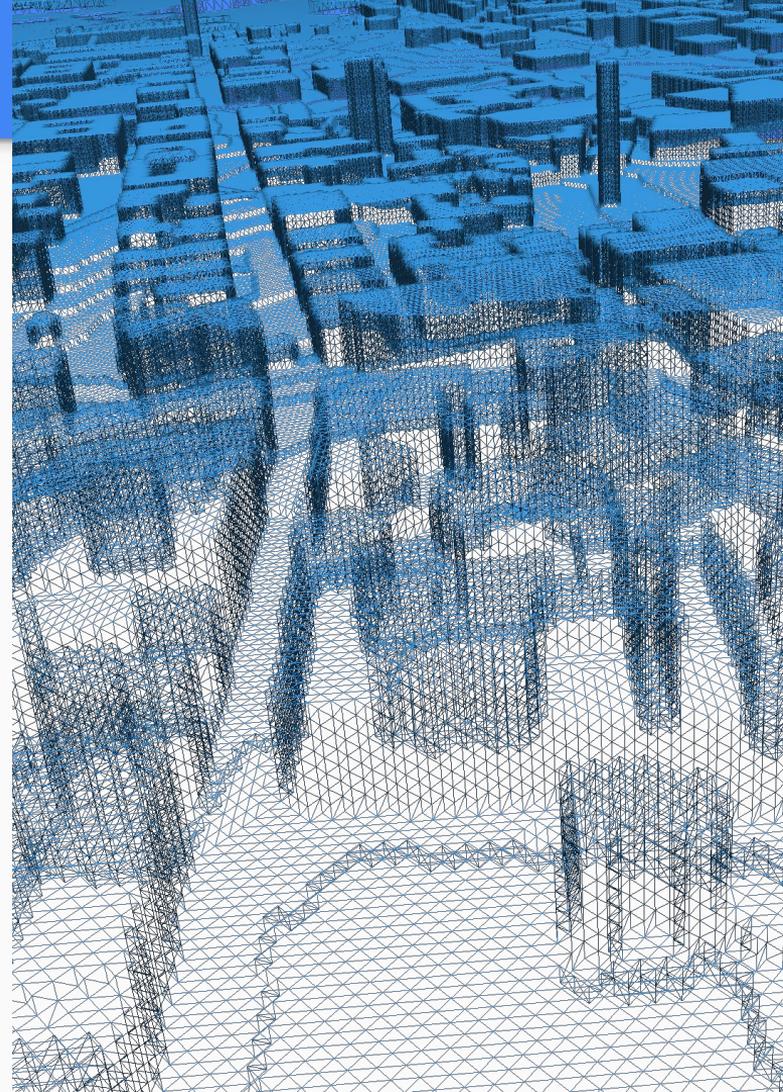
Details:

- 3D simulations (CFD)
- high-resolution (1-2m)
- air flow and pollutant distribution
- input from traffic, weather and air quality data

Support

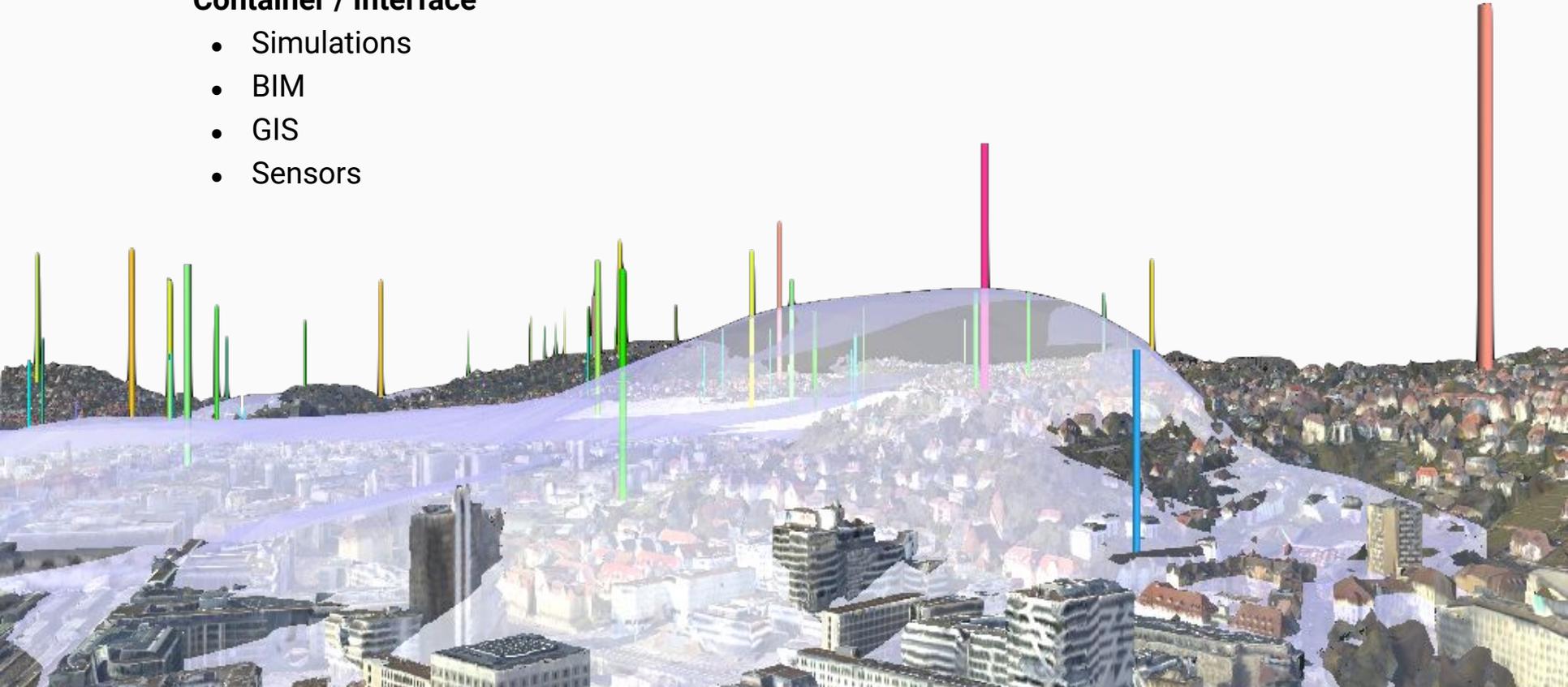
Aims for visualization:

- low-threshold **accessibility**
- results in **context**
- interactive, **real-time** analysis



Container / Interface

- Simulations
- BIM
- GIS
- Sensors



Donzdorf

Motivation: Donzdorf had to deal with flooding after heavy rain events in the past. Especially certain areas of the communal infrastructure like bridges and the sewerage system itself were critical spots.

Objective: Heavy Rain simulation for different scenarios at critical spots, automate the workflow to ensure transferability



Methods: Construction of a 3D city model, 1D - 3D flooding simulation, weather simulation, VR, Digital Twin

Support: connect municipal administration and simulation experts, simulation and visualization at HLRS

