Project FloWKar

Using high-resolution data from vehicle sensors to improve operational weather products

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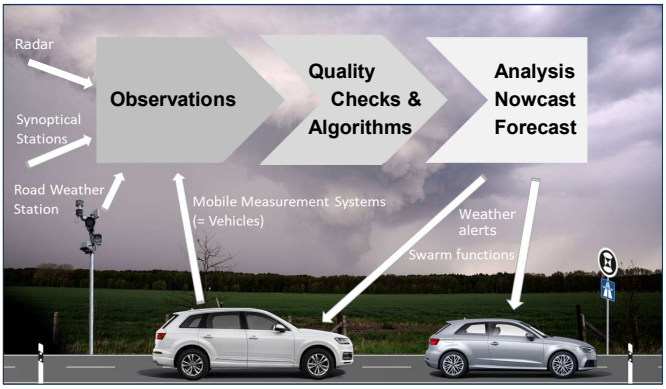
Motivation & Goals

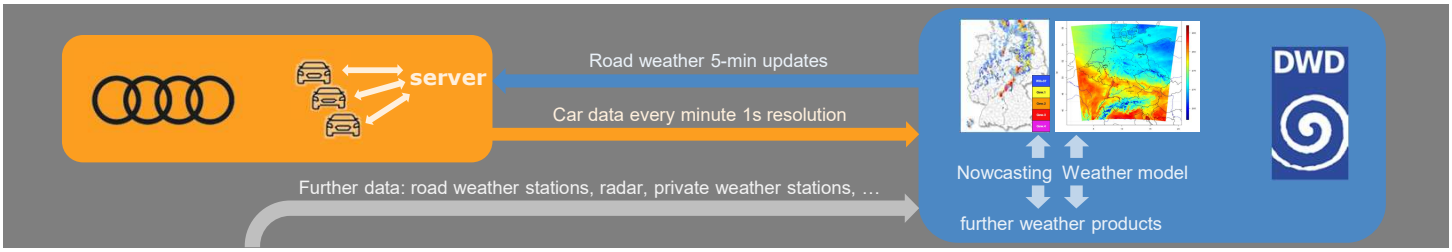
- **Fill gaps** between existing in-situ observations and remote sensing data
- Increase **spatial and temporal resolution** of meteorological observations within the boundary layer
- Improve **nowcasting near ground**
- Optimize **model performance near ground**
- Improve existing meteorological methods in the area of **road weather services**
- Generate **real-time weather maps**
- Enable functions in the field of **automated driving**



Concept of combining vehicle data with existing sources of meteorological data. Crowdsourcing data from cars include air pressure, air and road temperature, relative humidity, precipitation intensity, global radiation.

Approach

- Use moving vehicles as measurement stations
- Compare vehicle data with existing meteorological surface data from, e.g., Synop Stations, Road Weather Stations (RWS), COSMO-D2 model
- Determine quality of car sensor data
- Develop quality checks and postprocessing for data from vehicles
- Combine vehicle data with in-situ data and remote sensing data (radar)
- Develop data assimilation methods
- Take advantage of large number of car sensors (statistics)
- Generate swarm functions for weather alerts to enable automated driving functions



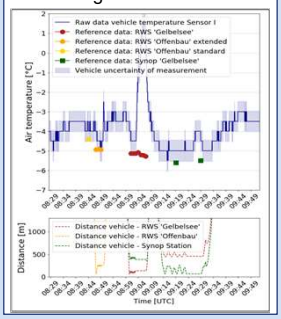
Project activities – Cooperation between DWD and Audi

Observations / measurement campaigns

Measurement vehicle next to synoptic station (↑) and mobile weather station (↓)

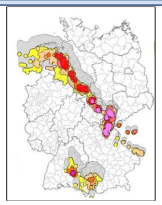
Quality check and correction of vehicle data

- Identification and correction of faulty measurement data, but leaving local effects unchanged



Nowcasting

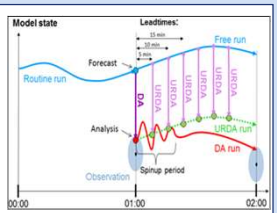
- Benefit from vehicle data near the ground in high spatial and temporal resolution
- Temperature and humidity information for near-ground hydrometeor classification
- Support of near-ground precipitation estimates



Automated thunderstorms warnings.

Model

- New technique for real-time weather: ultra-rapid data assimilation (URDA)
- Refresh rate + forecast every 5/10/15 min over 1 hour on COSMO-D2 fields
- Highly innovative internationally
- Great potential for reduced computational costs, faster and almost in real time forecasts



Comparison of newly developed URDA (green) with other model outputs

Swarm functions

- Long term: enabling functions for safe automated driving
- Short term: improve local hazard warnings in advance, caused by severe weather conditions (e.g., aquaplaning)

Exemplary implementation of warnings for driver

Challenges and main considerations

- **Privacy** and General Data Protection Regulation (GDPR) vs. free flow of data
- **Real-time exchange of data** between commercially available vehicles and weather service
- **Missing and different standards** for data as well as incomplete documentation of reference data slow down data analysis
- Proper assessment of the car sensor data quality according to weather service standards, car sensors as "**Black Box**"
- Modelling the dependency between **meteorological state** and car-microclimate
- Developing **correction algorithms** for vehicle sensor data with respect to environmental and dynamical influences by the vehicle (speed, motor heating)
- **How to verify benefits** for operational forecasts from incorporating high spatially and temporally resolved car data
- **Coordination of measurement campaigns** with weather service equipment on vehicles: timing, rain on moving platform, mobile reception gaps hinder data transfer
- **Aggregate Lagrangian data** for use in existing meteorological applications (adapt time resolution, generate point data and gridded 2D data)

Bundesministerium für Verkehr und digitale Infrastruktur

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