Smart Air Quality Network, the measurement network for the future

Session: Urban Planning and City Solutions for Clean Air

Room: Venue Room 12, BCCK Rooms 10 &11, BCCK

Date: 15.11.2018, 9.00 – 10.30 Uhr

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GRIMM Aerosol Technik Ainring GmbH & CO.KG

SmartAQnet - Motivation

- The Air Quality means today more than ever the Life Quality and is one of the biggest challenges of the modern cities and developing countries of our time.
- For many regions and cities, it is difficult to take any proper and timely decisions and efficient actions for improvement of the air quality for there is no fine-meshed and profound database.
- Although the required basic data and the measurement principles are available, a common platform for connection, combination and evaluation of the measurement data is missing.
- The Smart Air Quality Network is a pragmatic and data driven concept, in which all available data (from the high precision measurements to the low-cost sensors) are for the first time combined with the mobile measurements into an integrated measurement strategy

- **Meteorological data** and **city development plans**
- **Sensors at Buildings** (HVAC and shading systems)
- **Remote sensing data** (aerial photography, satelite observation)
- **New mobile Measurement concepts** (public trafic + Ultra-low-cost-sensors)
- Use of **Scientific Scouts** and **existing stationary AQMS**
- Ad hoc Measurements with **UAV**

SmartAQNet - Target

Future measurement networks do not only limit observation, but also data generation for active control systems.

- **Realtime Traffic Control** (virtual and dynamic low emission zones, navigation, etc.)
- **Source Apportionment** and Clean Air Strategies
- **Autonomous driving**
- Integration in **Telematic- and Navigationssystems**
- **Open Source Data** for other industrial partners, researchers and public
- **Public Information** and Behaviour Recommendation (individual scalable)
- **Alarmsystems**

Regions and cities have difficulties to take the right action regarding air quality in mobility, residential or working areas. **No fine-meshed database is available** (regarding time and region)

- ➢ New and dynamic way of generating data
- ➢ New platforms for data acquisition, analyzing and prognosis (IoT / big data, etc.)
- ➢ Valuable data for fine-grid modelling

SmartAQnet – Project Phases & Tasks

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Project Phases

Create infrastructure

- data platform
- defining test region
- devices + tests
- defining SOP’s

Test campaign

Test analysis

- data platform
- Algorithms
- Devices
- correcting SOP’s

Defining corrections

Finalize grid

- data integration
- modelling
- prototype devices
- Going live

Availability

GRIMM has the task to develop a suitable, reliable and smart *Indicative Ambient Particulate Monitor*

Device Phase 1 – EDM80NEPH

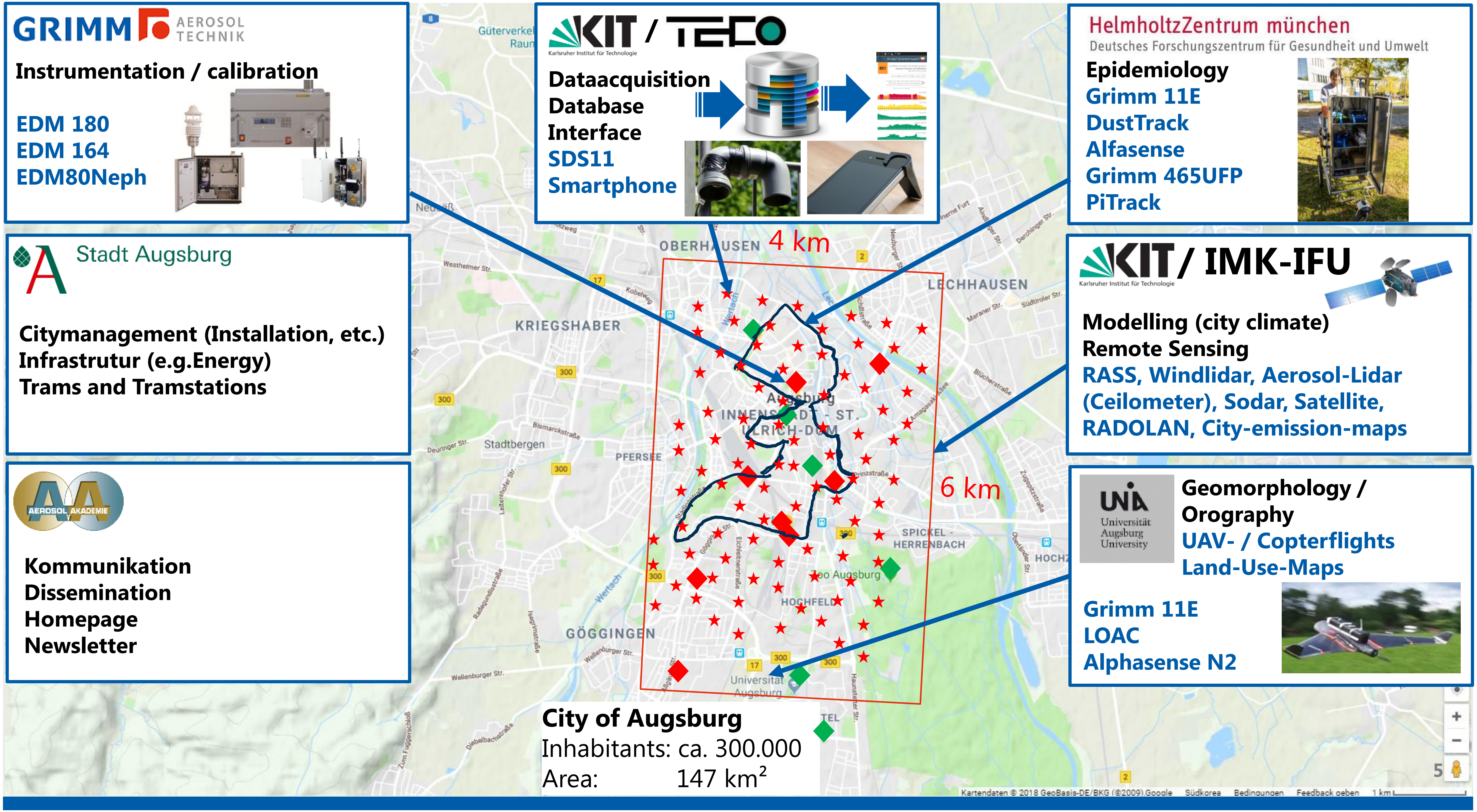
- available components
- control and test software; algorithm
- calibration process
- laboratory and long-term field tests

Defining prototype specs

Device Phase 2 (Prototype)

- Development of prototype
- Optimization of control software
- calibration process
- algorithm and autom.calibration

Prototype System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Instrumentation / calibration
EDM 180
EDM 164
EDM80Neph
KIT / TECO
Karlsruher Institut für Technologie
Dataacquisition
Database
Interface
SDS11
Smartphone
HelmholtzZentrum münchen
Deutsches Forschungszentrum für Gesundheit und Umwelt
Epidemiology
Grimm 11E
DustTrack
Alfasense
Grimm 465UFP
PiTrack
Stadt Augsburg
Citymanagement (Installation, etc.)
Infrastrutur (e.g.Energy)
Trams and Tramstations
KIT / IMK-IFU
Karlsruher Institut für Technologie
Modelling (city climate)
Remote Sensing
RASS, Windlidar, Aerosol-Lidar (Ceilometer), Sodar, Satellite, RADOLAN, City-emission-maps
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Geomorphology / Orography
UAV- / Copterflights
Land-Use-Maps
Grimm 11E
LOAC
Alphasense N2
4 km
6 km
OBERHAUSEN
LECHHAUSEN
KRIEGSHABER
Augsburg
INNENSTADT - ST. ULRICH-DOM
Stadtbergen
PFERSEE
SPICKEL - HERRENBACH
Zoo Augsburg
HOCHFELD
GÖGGINGEN
Universität Augsburg
City of Augsburg
Inhabitants: ca. 300.000
Area: 147 km²
Kartendaten © 2018 GeoBasis-DE/BKG (©2009),Google Südkorea Bedingungen Feedback geben 1 km

Challenges / general Experiences:

- **Coordination** of all partners for IOP (Intensive Obeservation Period)
- It is a **learning process** for an **inter disciplinary team**, that not only the individual contribution and scientific focus is prior
- **General definitions are important** like data interfaces, time stamps, time resolution, GPS-data, quality classes, etc. is very time consuming, intensive and needs much comunication
- **Definition of clear SOP's** (Standard Operating Proceedures) is mandatory. E.g. device location, device inter comparison, device installation (location / height / etc.)
- Availability of **power supply**
- **How to transfer the data** (City-WiFi / GSM / others?)
- Etc.

SmartAQnet – Workpackage GRIMM:

1. **Development** of a **Smart Indicative Ambient Particulate Monitor** within two phases.
   Phase 1:
   - Prototype out of market available components
   - Improve their accuracy and compensate rH / Temp / drift (avoid dust contamination)
   - Investigate the sensor market
   - Define specifications for the device Phase 2; Decision Photometer vs. OPC

   Phase 2:
   - Develop device according the specifications of Phase 1
   - Equipe the test region with these devices according to the experiences of Phase 1

2. **How many background stations are nescessary** for a proper adjustment of the low cost devices?

3. **Development** of a **calibration SOP** for such networks

First results and outlook instrumentation (Neph based)

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- \- **None of the** market **available sensors were** originally **made for ambient air monitoring** and with this correspond with the dedicated challenges (humidity / temp / aerosol composition / bioaerosols / etc.)
- \- **Inter comparison** of the sensors **very week** (partly +- 200%) ➔ preselection (we >50%)
- \+ **Temp and Humidity sensitivity** ➔ with algorithm to compensate (information is mandatory)
- \+ **Detection sensitivity** mainly starts above 20 µg ➔ can be improved with signal interpretation
- +- **Drift based on contamination** ➔ no pump, only fan or diffusion; no self cleaning effects; 0-point calibration extends lifetime, but is limited and needs reliable reference point; **drift starts depended on dust levels latest after 2-3 weeks**
- \- **Size information** ➔ all available sensors operate with factors they fail with changing aerosol composition; no size information, only indicative information possible
- \- **Life time** ➔ depended on dust levels 3-6 month under ambient conditions, **not satisfying**
- +- **Accuracy** ➔ only satisfying with local calibration and enough reference units in the field! No defined and controlled laser intensity

➔ No stand alone networks; always enough reference units are necessary in the field
➔ No size information with nephelometry at all (due to technology)
➔ Only OPC can give size information

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Thank you for your attention!

References and Pictures

GRIMM Aerosol Ainring GmbH & CO.KG, Wikimedia Commons, University of Augsburg, KIT-TECO, Open Street Map, World Air Quality, Google Maps, Helmholtz

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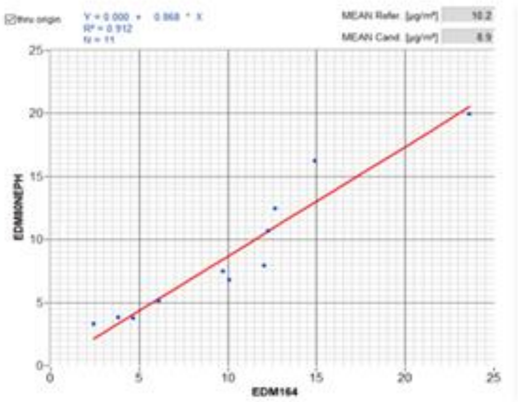
$PM_{2.5}$ comparison EDM80NEPH and 164-Reference (5 Min-readings)

(one local calibration at 08.03.2018, then continuous measurements for 10 days)



$PM_{2.5}$ comparison EDM80NEPH and 164-Reference (24h-readings)

(07.05.-07.06. 2018, 30 days, no local calibration)