Acquisition and Representation of Knowledge for Atmospheric New Particle Formation

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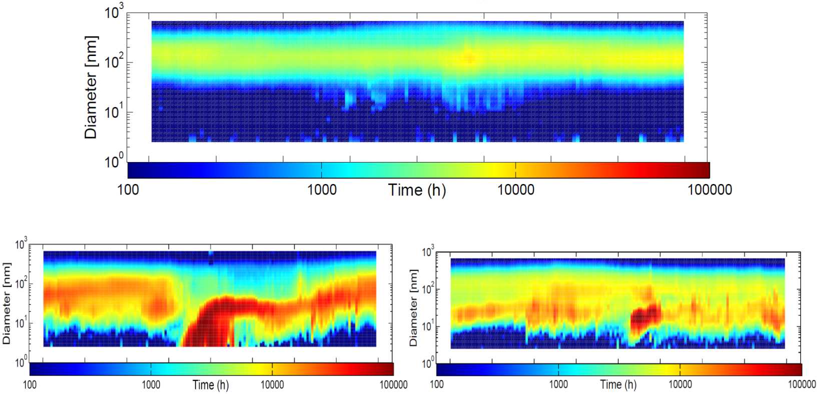
ISESS 2013, Neusiedl am See, Austria
October 10, 2013

Introduction
New Particle Formation (NPF)

- Atmospheric phenomenon
- Formation and growth of aerosol particles [nm]
- Occurs over the course of a day
- Regional spatial extent
- Relevance
  - Scattering of sunlight
  - Human health
- Studied by aerosol scientists
  - Includes manual NPF identification

Introduction
Visualizing NPF

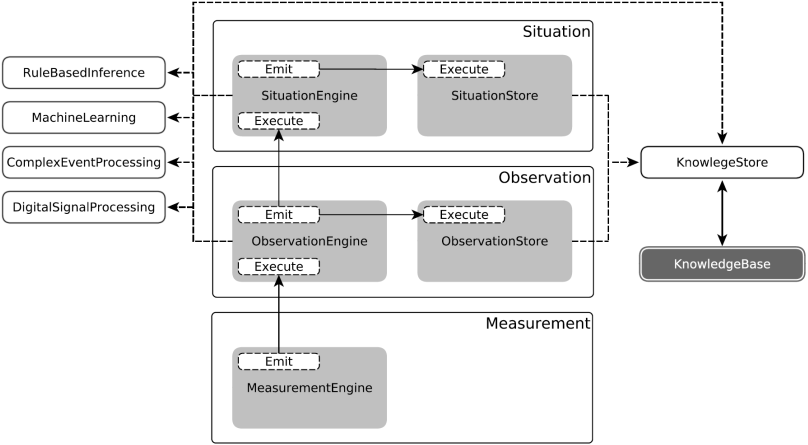


Hamed et al.: Nucleation and growth of new particles in Po Valley, Italy. Atmos. Chem. Phys., 7, 355-376

Aims

1. Automate the representation of knowledge for NPF events
    - Includes knowledge acquisition
    - Use machine learning to identify and characterize NPF
        - Process daily data to classifiable vector
        - Use expert labels to train and validate classifiers
2. Use Wavellite to implement the application
    - Software framework for the interpretation of sensor data
    - Ontology based
        - Semantic Sensor Network (SSN) ontology
        - Situation Theory Ontology (STO)

Implementation
Wavellite Architecture



Discussion
Classification

- Classification performance
  - NPF identification: 73%
  - NPF characterization: 54%
- Not sufficient for automation
- Sufficent to support experts (manual review)

Discussion
Wavellite

- Automated organization and interpretation of sensor data
- Abstraction from (sensor) data to (situational) knowledge
- Generic, hence applicable to various domains
- Implement applications by ontology and class extensions
- Representation (persistence) of computation results
- Processing of historical and real-time data
- Earth and environmental science as target domain

Discussion

Wavellite

- Use semantic web technogies, motivations
- Reuse of existing ontologies (SSN, STO, and others)
  - Ontologies have greatly inspired the design of Wavellite
  - Typically only "trivially" extended in applications
- Experts and wavellite commit to shared terminology
- Support for potentially interesting features (e.g. inference)
- Test technologies other than RDBMS

Related Work

- Architectures for representation of knowledge acquired from sensor data [1, 2, 3]
- Development of ontologies for sensor networks, sensor data, situational knowledge [4, 5]
- Work that uses the SSN ontology and STO [6, 7, 8, 9]
- Use ML, CEP, DSP on sensor data
- *Ad hoc* software systems that organize/interpret sensor data (Smart-SMEAR)

Conclusions

- Experts use visualization to identify and characterize NPF
- We investigated machine learning for this purpose
- The problem (generally): organize and interpret sensor data
- We propose the Wavellite software framework
- We implemented the use case as Wavellite application
- Results show that Wavellite can support experts
- Use case shows that Wavellite can serve concrete applications

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