Evaluation and improvement of the parameterization of aerosol hygroscopicity in global climate models using in-situ surface measurements

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AeroCom/AeroSAT meeting – 10rd October, 2017

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Outline:

- Introduction: Aerosols and Hygroscopicity in GCM's
- Field Observations and Previous Work
- DoE Project: Goals, Sites and Database
- Work Package 1 and Planned AeroCom activities

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Aerosols and Climate

- Size, composition and RH determine the amount of water that a particle will take up

- Aerosol optical properties, such as the scattering coefficient, will vary

- Relevance of hygroscopic growth to:
  - Calculate radiative forcing
  - Validate remote sensing data
  - Improve Climate Models

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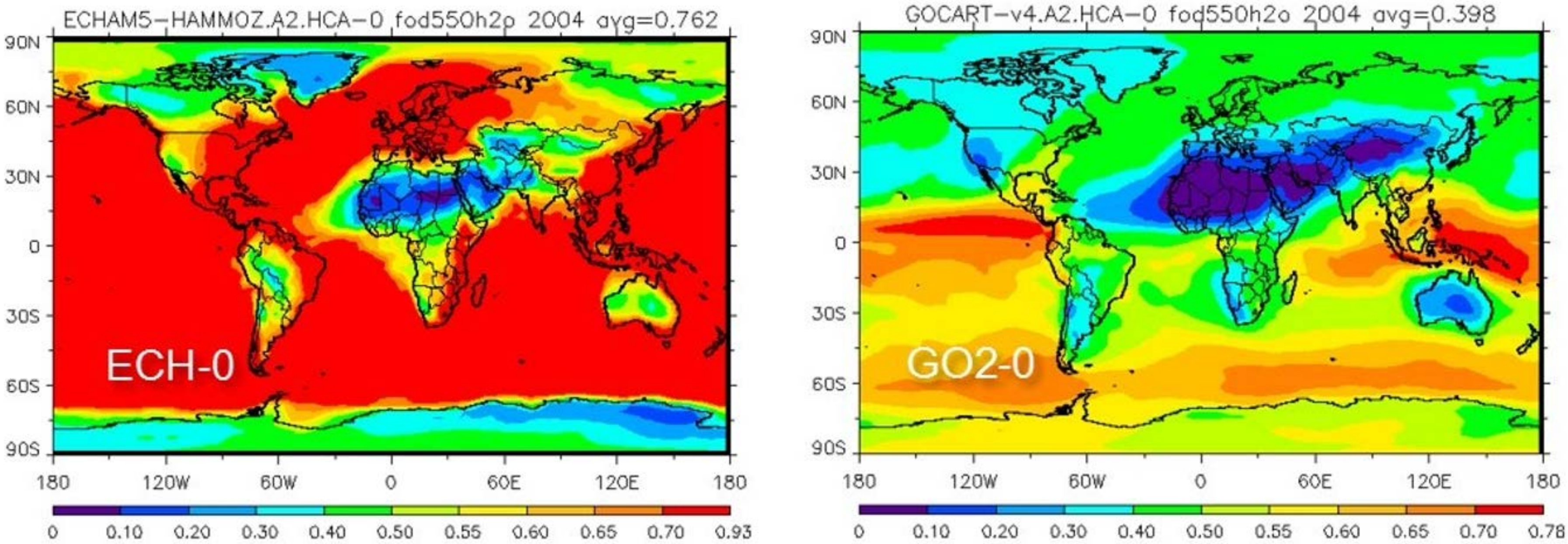
Hygroscopicity in GCM's



Figures from Mian Chin (NASA Goddard)

Fraction of aerosol optical depth (AOD) due to water in different models

Global annual average:
ECHAM5 -> 76%
GOCART -> 40%

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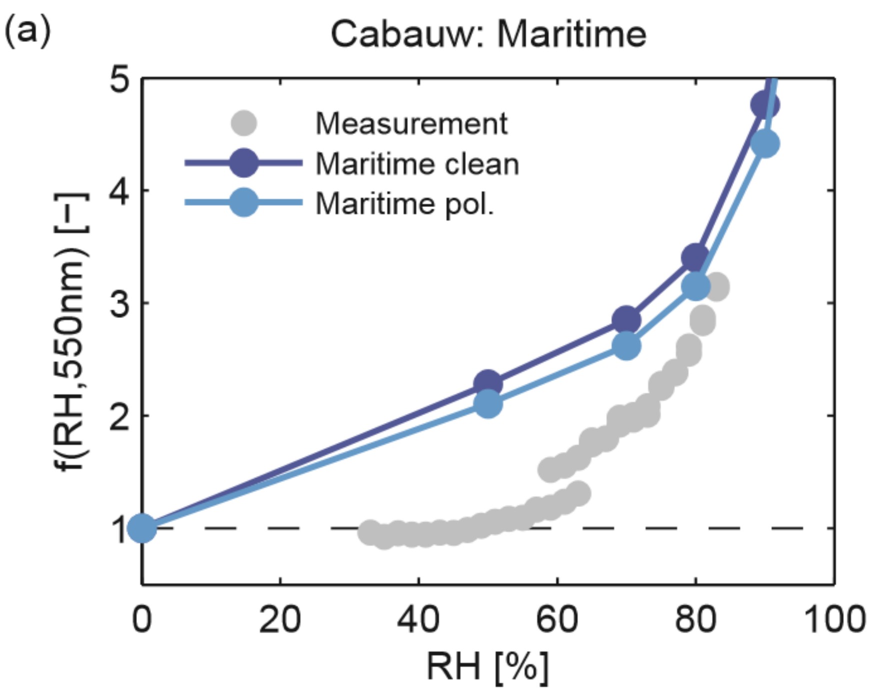
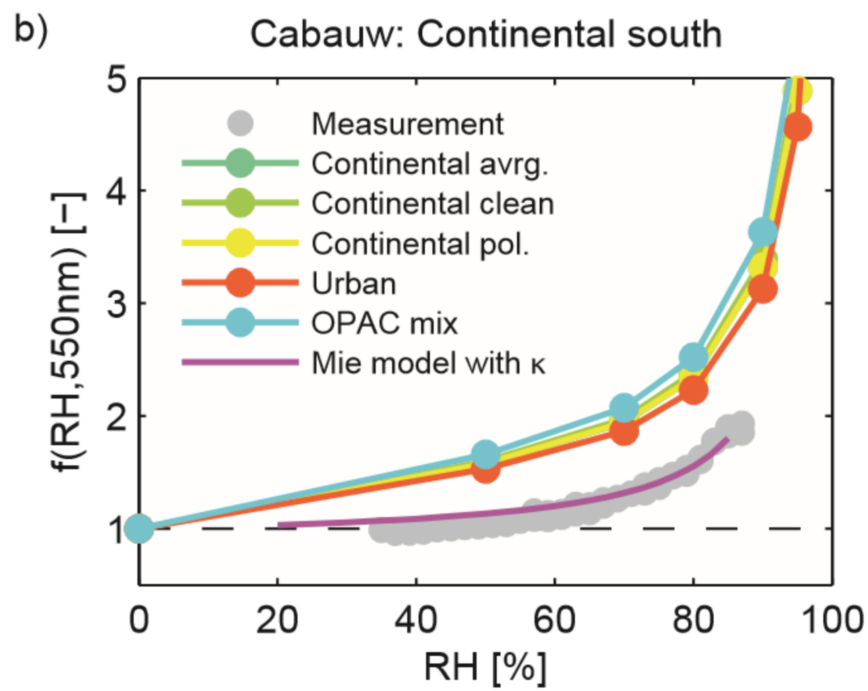
Hygroscopicity in GCM's

OPAC: Optical Properties of Aerosol and Clouds *(Hess et al., 1998)*

- Modular database of microphysical and optical properties of aerosols and clouds

Figures from Zieger et al., 2013





- OPAC generally higher than measurements especially for low-medium RH
- Reason: Growth factors too high for sea salt and sulfate components

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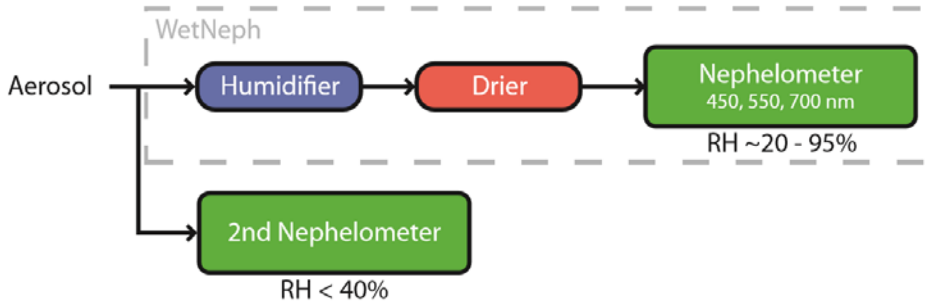
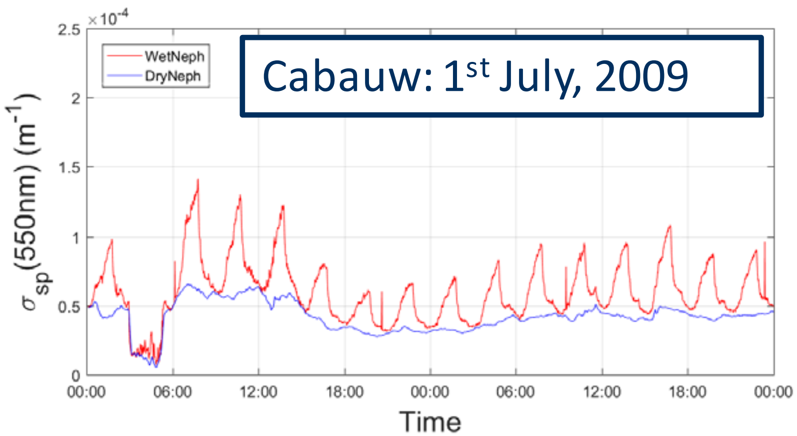
Tandem Humidified Nephelometer

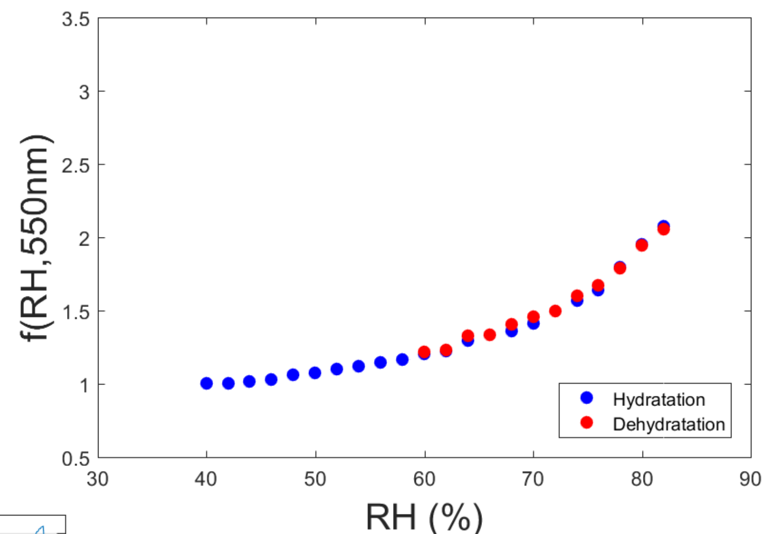


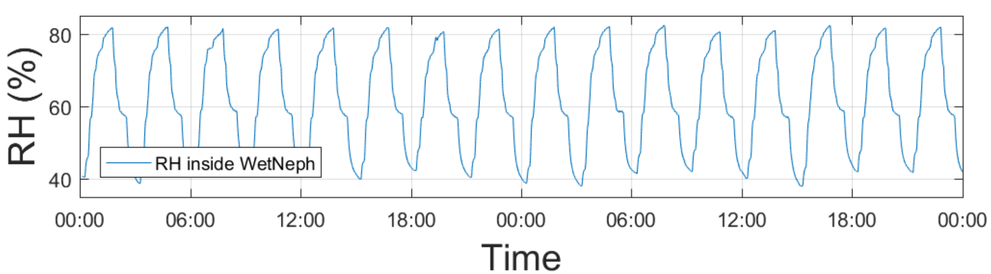
Fierz-Schmidhauser et al. (2010)

SCATTERING ENHANCEMENT FACTOR

$$f(RH,\lambda) = \frac{\sigma_{sp}(RH,\lambda)}{\sigma_{sp}(RHdry,\lambda)}$$

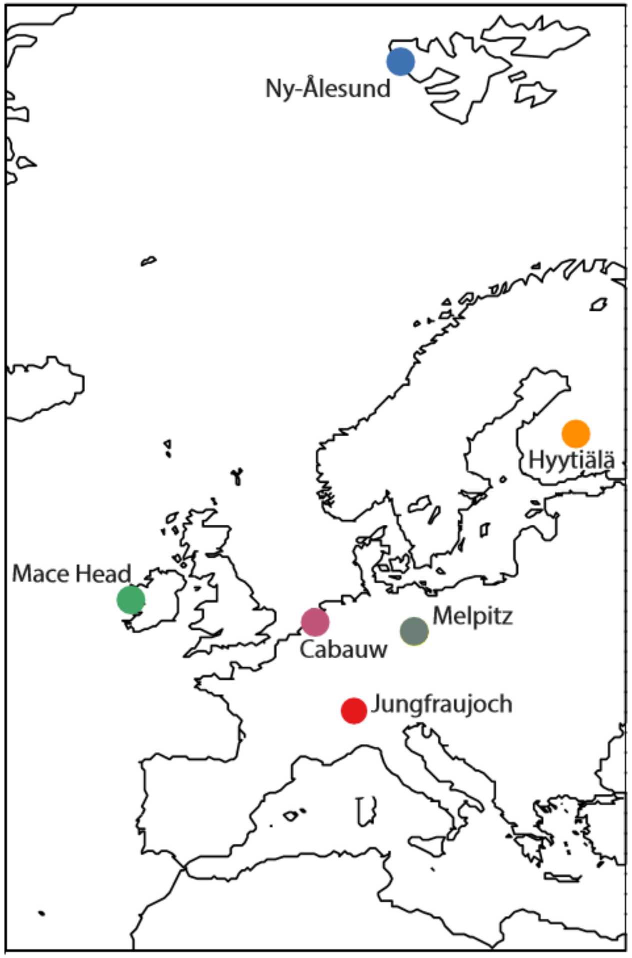


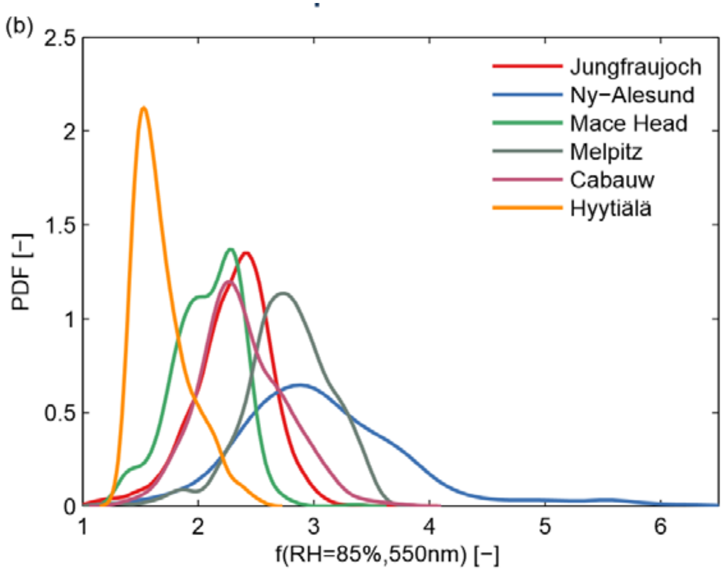




Previous work

Zieger et al.: Effects of relative humidity on aerosol light scattering: results from different European sites, Atmos. Chem. Phys., 2013





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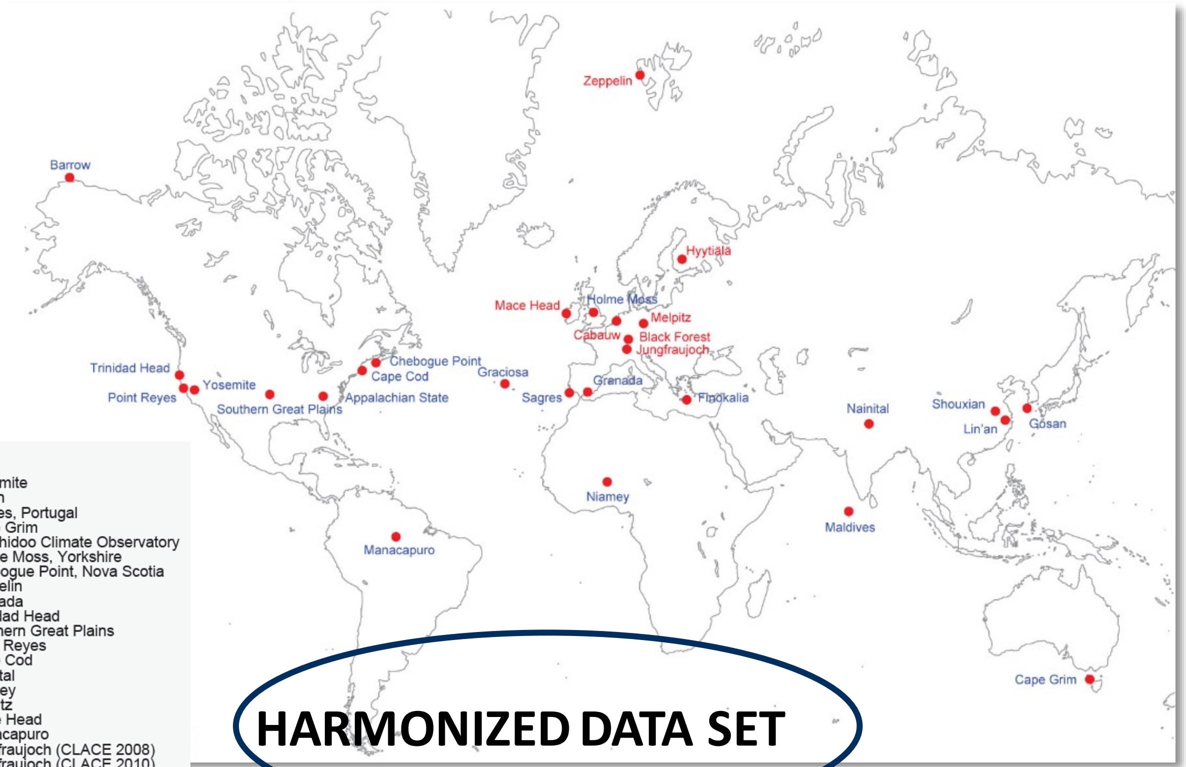
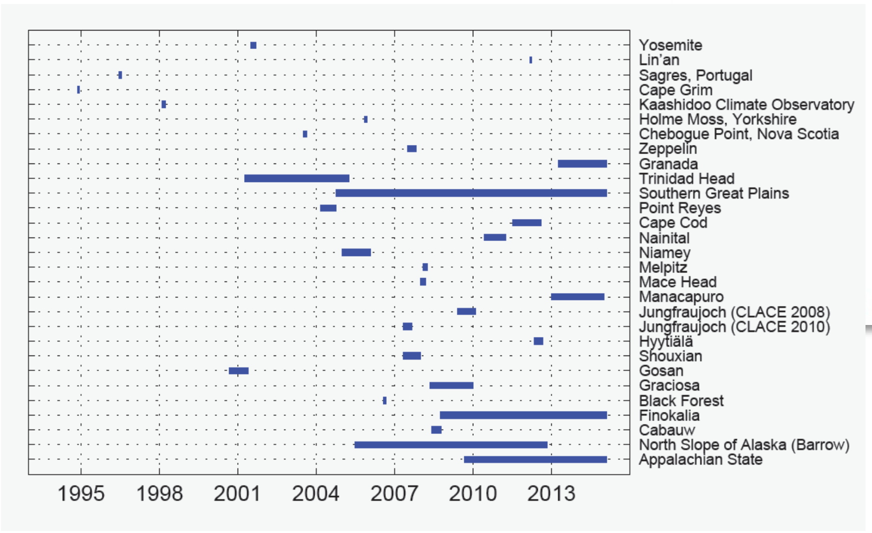
DoE project:
"Evaluation and improvement of the parameterization of aerosol hygroscopicity in global climate models using in-situ surface measurements" (2016-2019)

- Global spatial coverage
- All type of aerosols





HARMONIZED DATA SET

compare with GLOBAL CLIMATE MODELS

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Project Goals

1) Can a **climatology of humidity-dependent aerosol properties** be developed as a function of aerosol type and/or source región?

2) Can a **simplified parameterization of aerosol growth** be formulated for all common aerosol types using aerosol optical properties or other measurements as proxies for f(RH)?

3) **How well do climate models represent aerosol hygroscopic growth** and do observed biases suggest improvements in parameterization choices to improve climate simulations?

2017

WP1: Data harmonization and reliability

2018

WP2: Climatology and analysis

2019

WP3: Model evaluation and recommendations

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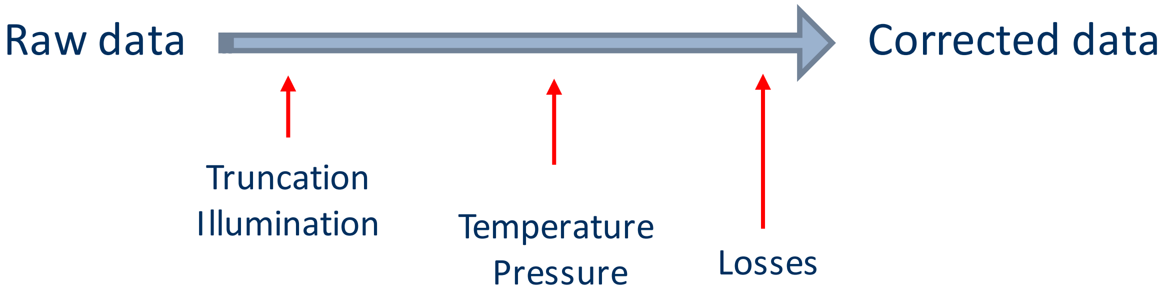
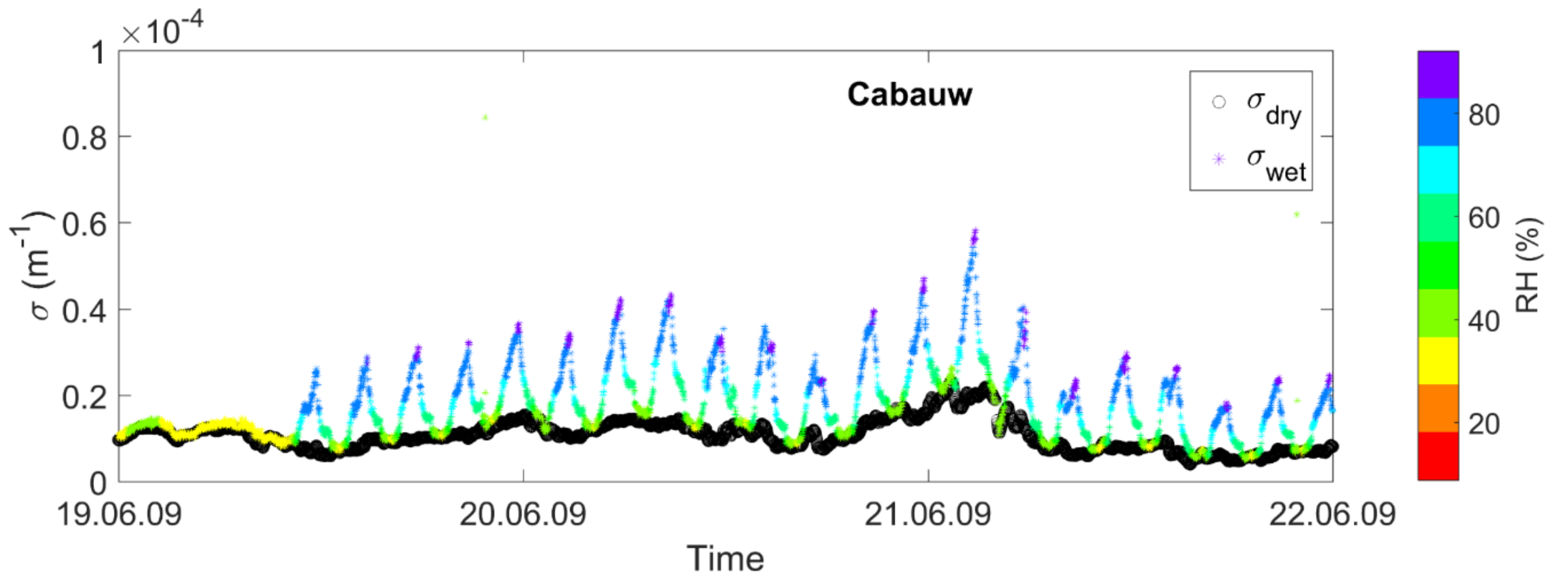
WP1: Data harmonization and reliability

- Data treatment:





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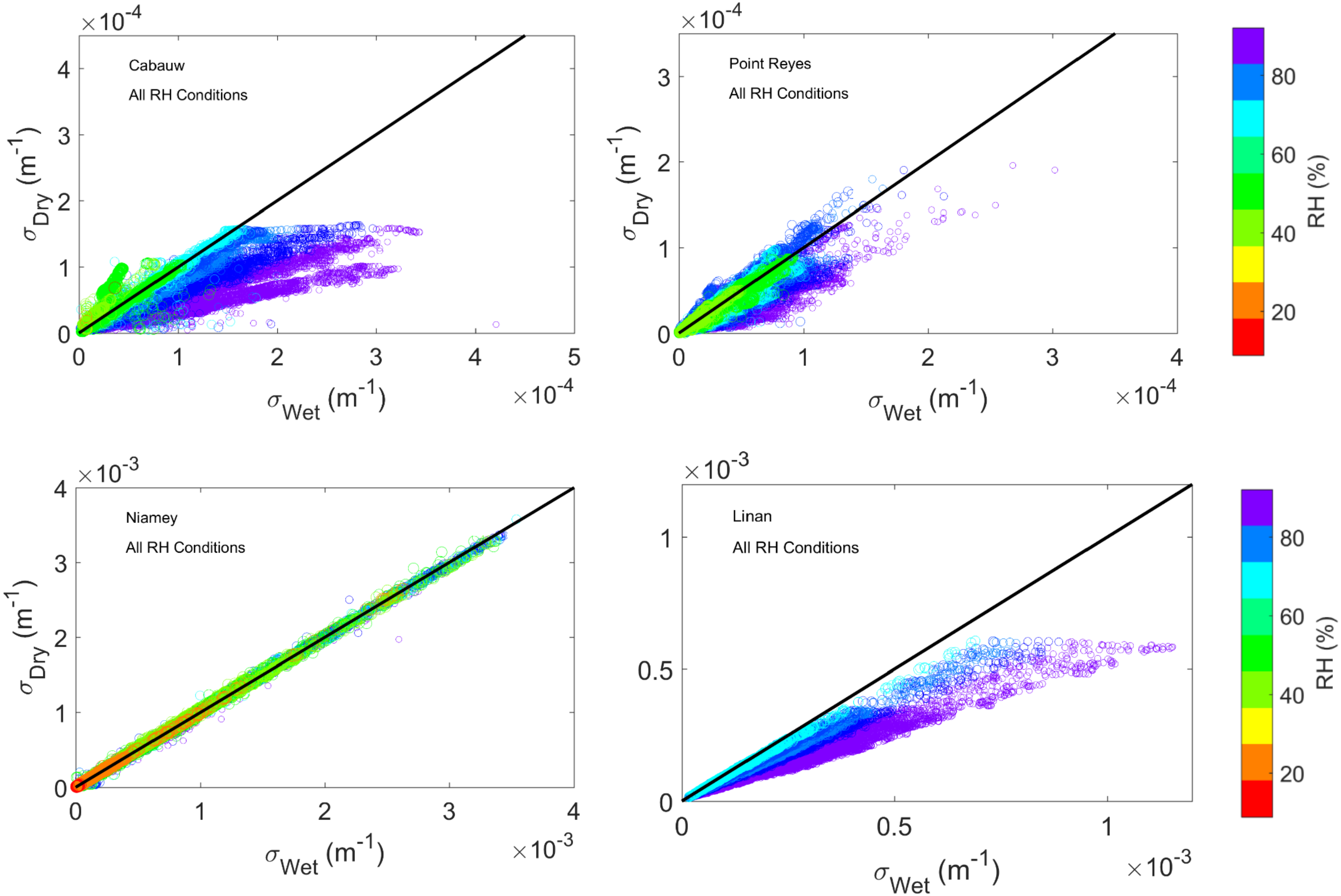

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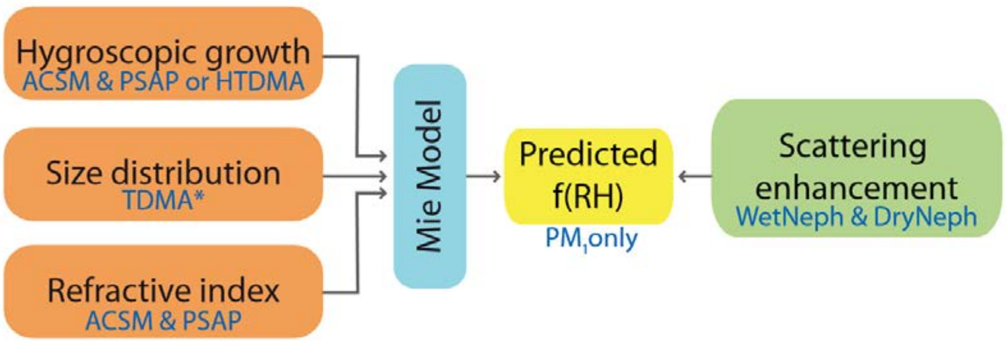
We have been working on a **harmonized and reliable database** composed of measurements from more than 25 sites around the world…

After studying the **RH for dry and wet** conditions and how the **scattering coefficient** changes as a function of RH…

Next Steps…

- Optical closure studies will help us to check for consistency in measurements:



- WP2: Climatology and Analysis: Extract information from the data set in order to compare with simulated data

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Planned AeroCom activities...

WP3: Model evaluation and recommendations

1. Intercomparison of model predictions of σ (scattering coefficient) across the globe:

a. Objective: quantify diversity among models

b. Necessary to understand different assumptions and choices of individual models

2. Combined analysis of model and measurement data

a. Quantify how well models do at simulating observed hygroscopicity

b. Diagnose whether discrepancies/patterns are attributable to assumptions about hygroscopicity or other issues

Planned AeroCom activities...

WP3: Model evaluation and recommendations

Questionaire to AeroCom modelling community to collect metadata and a description of growth parameterization

Variables requested:

- Aerosol extinction, 550 nm, 40%, 55%, 65%, 75%, 85% RH + ambient
- Aerosol absorption, 550 nm, 40%, 55%, 65%, 75%, 85% RH + ambient
- AOD speciated

Years of simulation/emission:

- 2010
- Optimal: 2000-2014

⇨

Please participate!
Description of data request can be found at:

https://wiki.met.no/_media/aerocom/INSITU_AeroComPIII_description.pdf

We encourage you to provide model data!!

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THANKS for your ATTENTION!

Related posters:
- Andrews P01
- Zieger P02

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