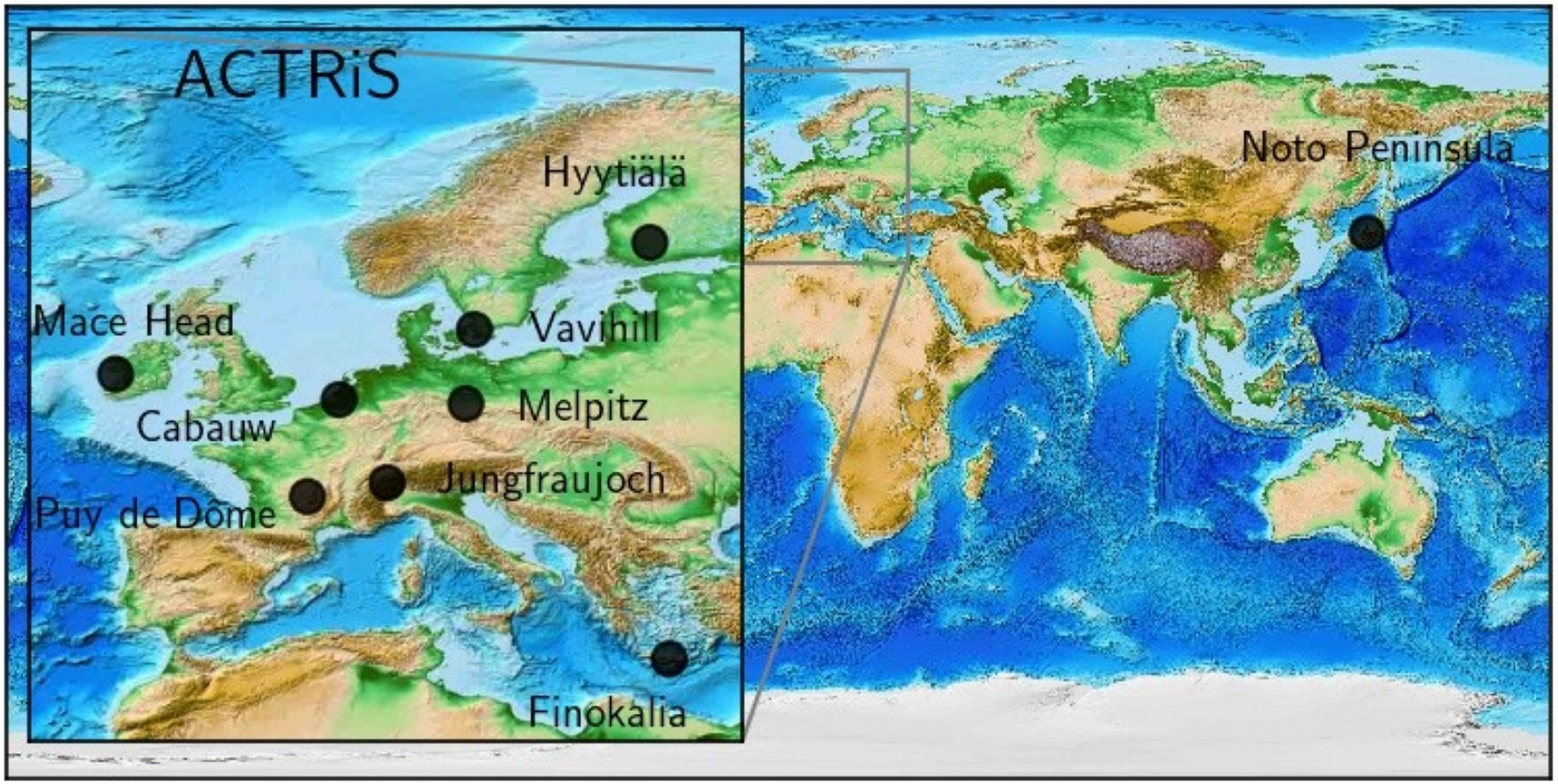
Robustness of global CCN simulations and implication for droplet formation: A BACCHUS and AEROCOM intercomparison

George S. Fanourgakis et al.

Environmental Chemistry Processes Laboratory,
Department of Chemistry, University of Crete, Heraklion, Greece;

Observational data for model evaluation



Datasets of CCN, particles number concentrations and particle chemical compositions measured at one observatory in Japan and eight Aerosols, Clouds, and Trace gases Research InfraStructure (ACTRIS) atmospheric observatories in Europe (Schmale et al., Atmos. Chem. Phys. Discuss, 5194(August), 2017–7982017)

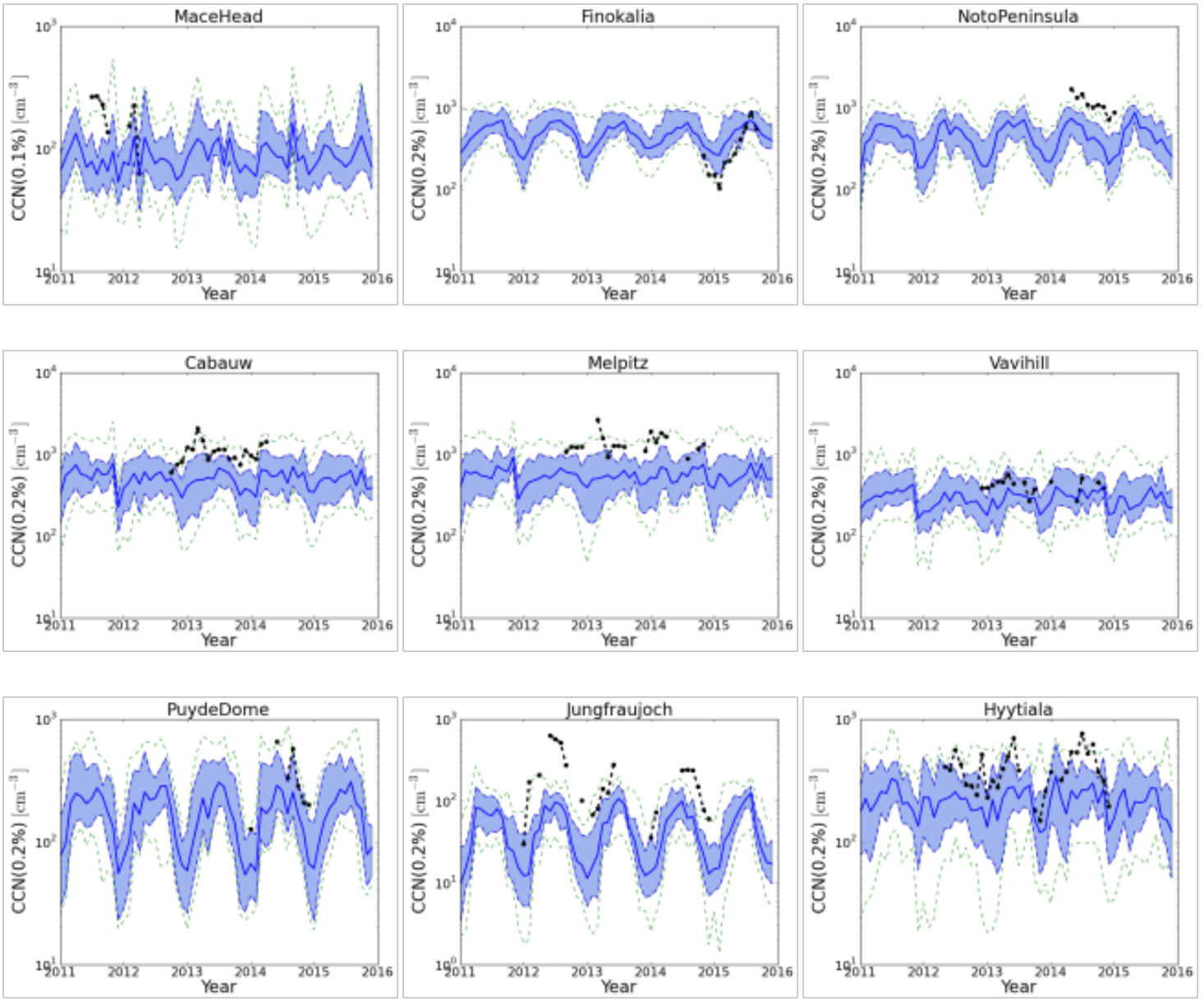
Models

- CAM5-chem-APM
- CAM5-chem-ATRAS2
- CAM5_MAM3
- CAM5_MAM4
- CAM5.3-Oslo
- ECHAM5.5-HAM2-ELVOC_UH
- ECHAM6-HAM2
- ECHAM6-HAM2-AP
- GEOS-Chem-APM
- GEOS-Chem-TOMAS
- GISS-E2.1-MATRIX
- TM4-ECPL
- TM5

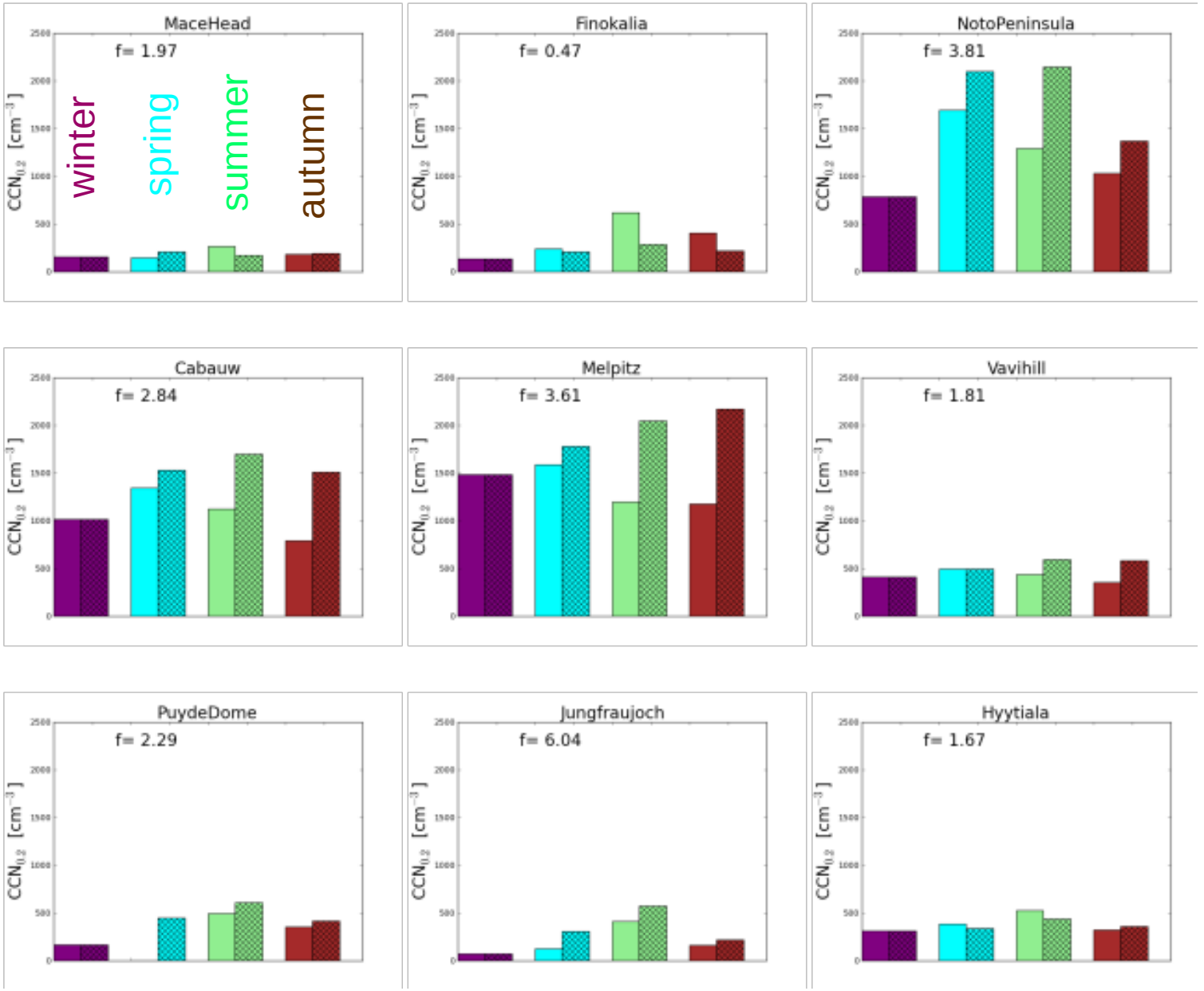
- In total 13 models participated in the present model intercomparison
- Models differ on the spatial resolution, meteorology, emission inventories. All models describe both the particle size and the mass distributions using either a number of size bins (sectional models) or log-normal distributions (modal models).
- Simulations were performed for the years 2010-2015 (2010 was taken as speed-up)
- Hourly values for CCN (at various super saturation ratios) particles numbers and mass compositions were provided for comparison with observations
- The geometric mean of the central-2/3 models (9 models) were used at each time instance for comparison with observations

Seasonal variations of the $CCN_{0.2}$ at the location of stations

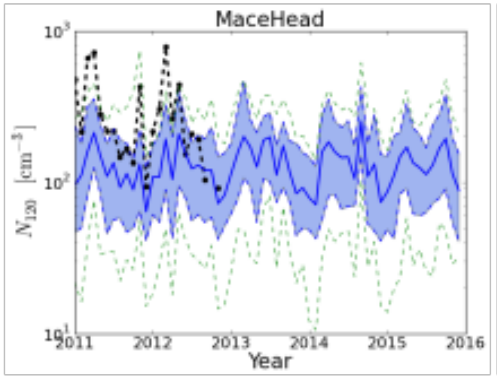
Monthly averages

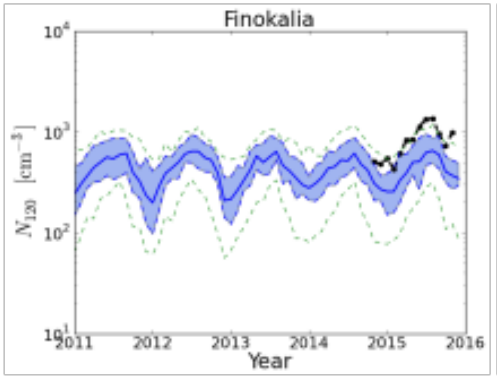


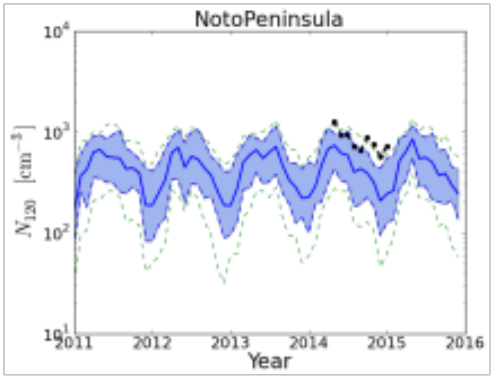
Variability of $CCN_{0.2}$ during year-seasons

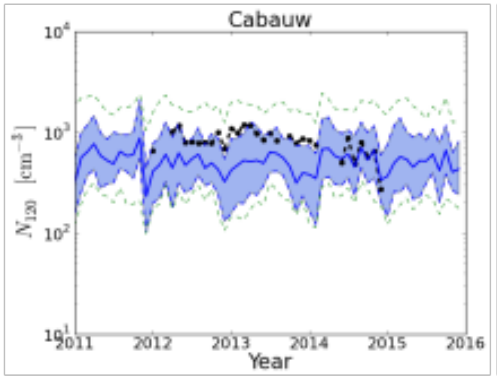


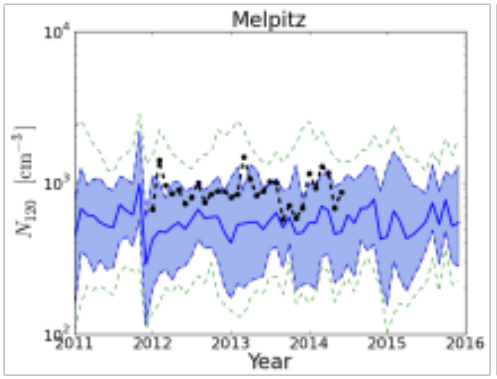
Particles numbers N_{120}

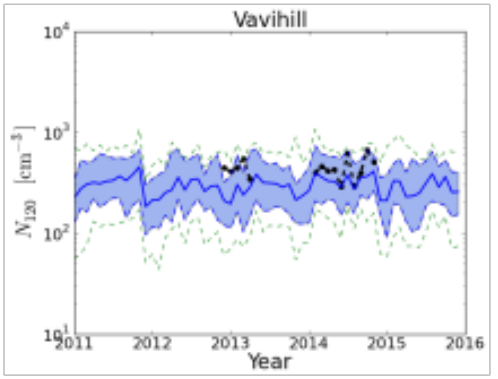


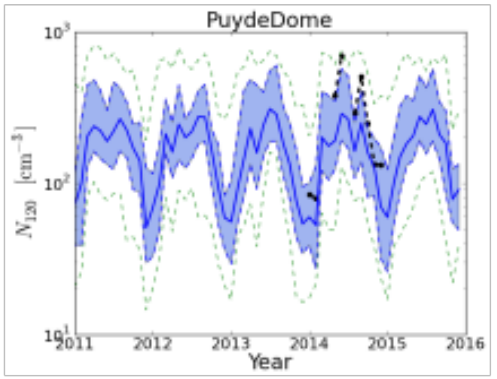


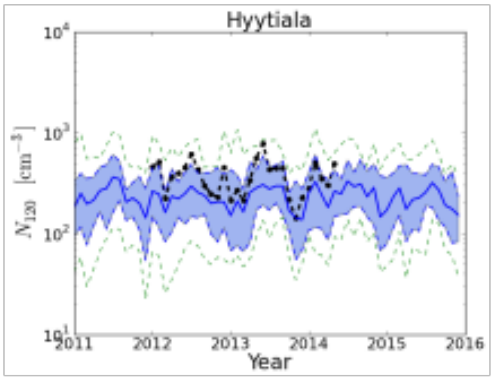




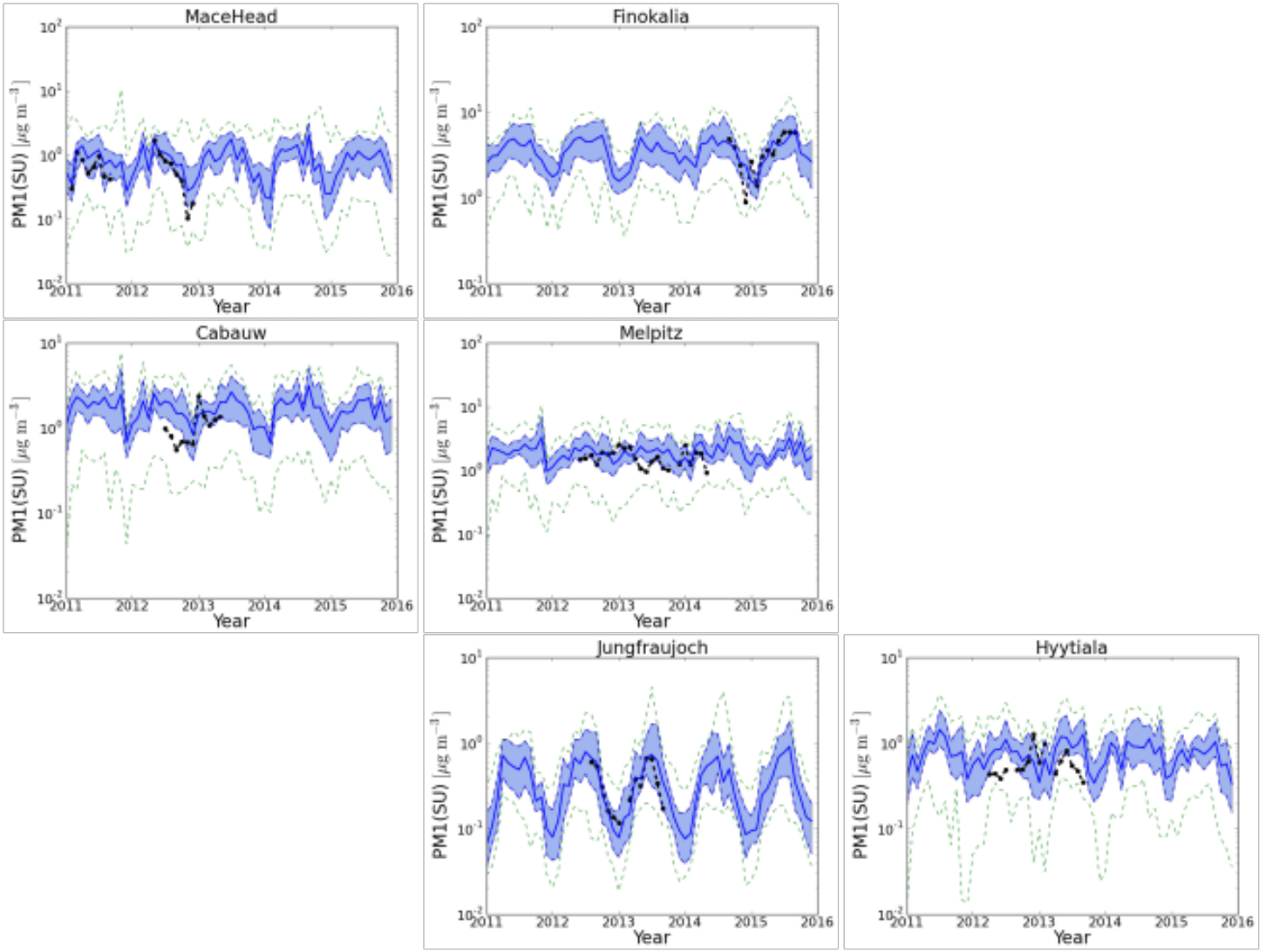




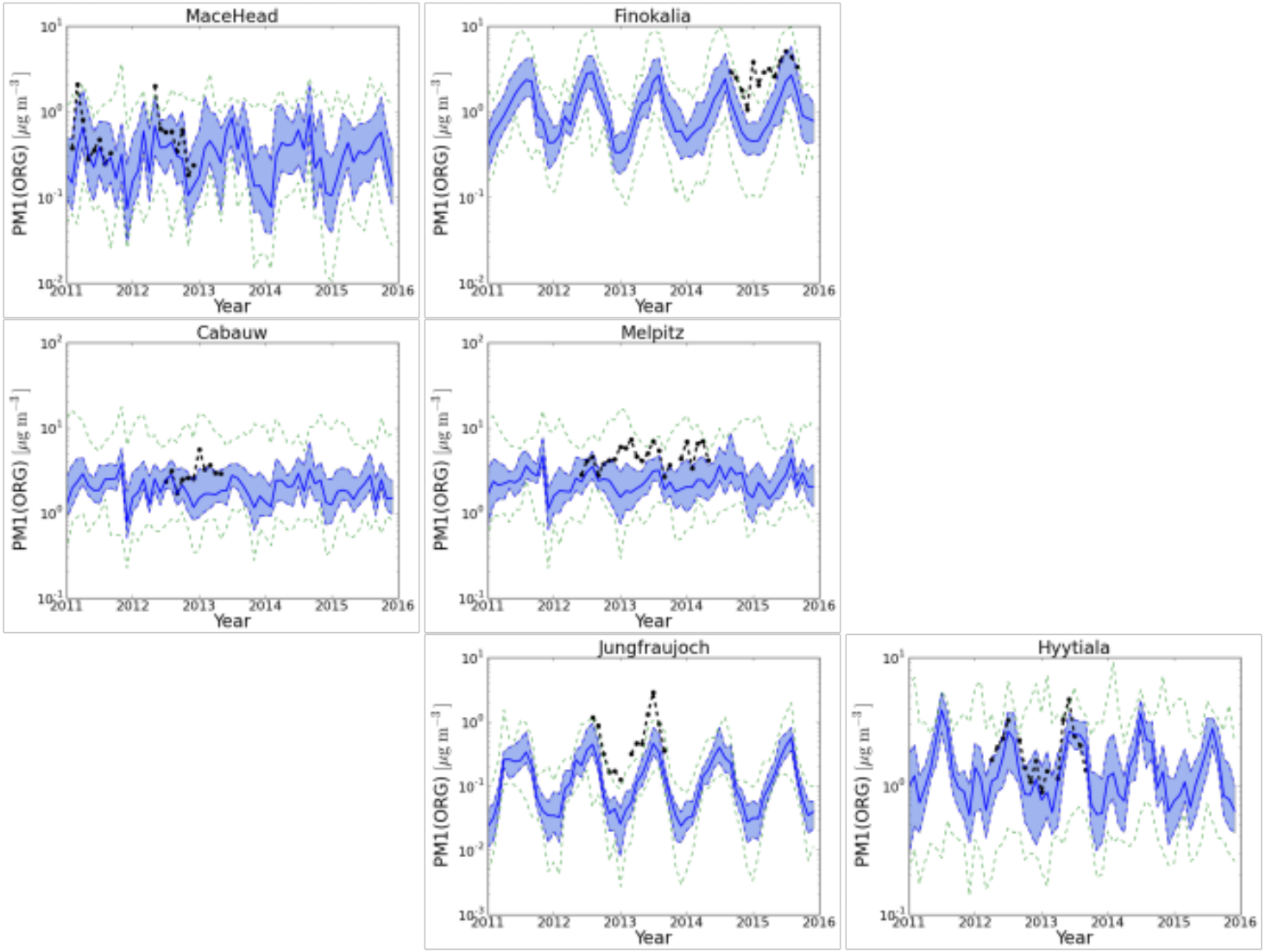




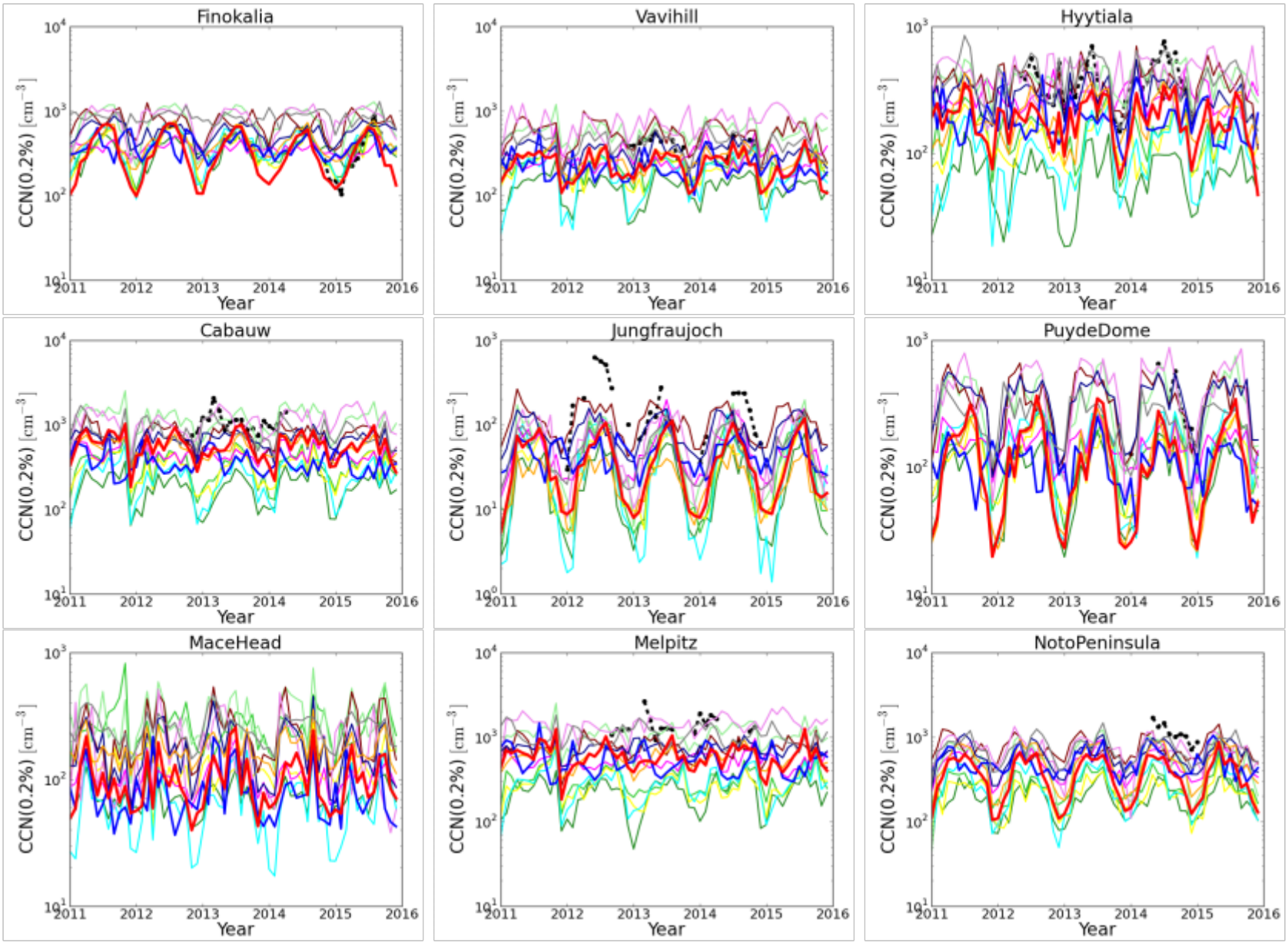
Particles Composition (Sulphate)



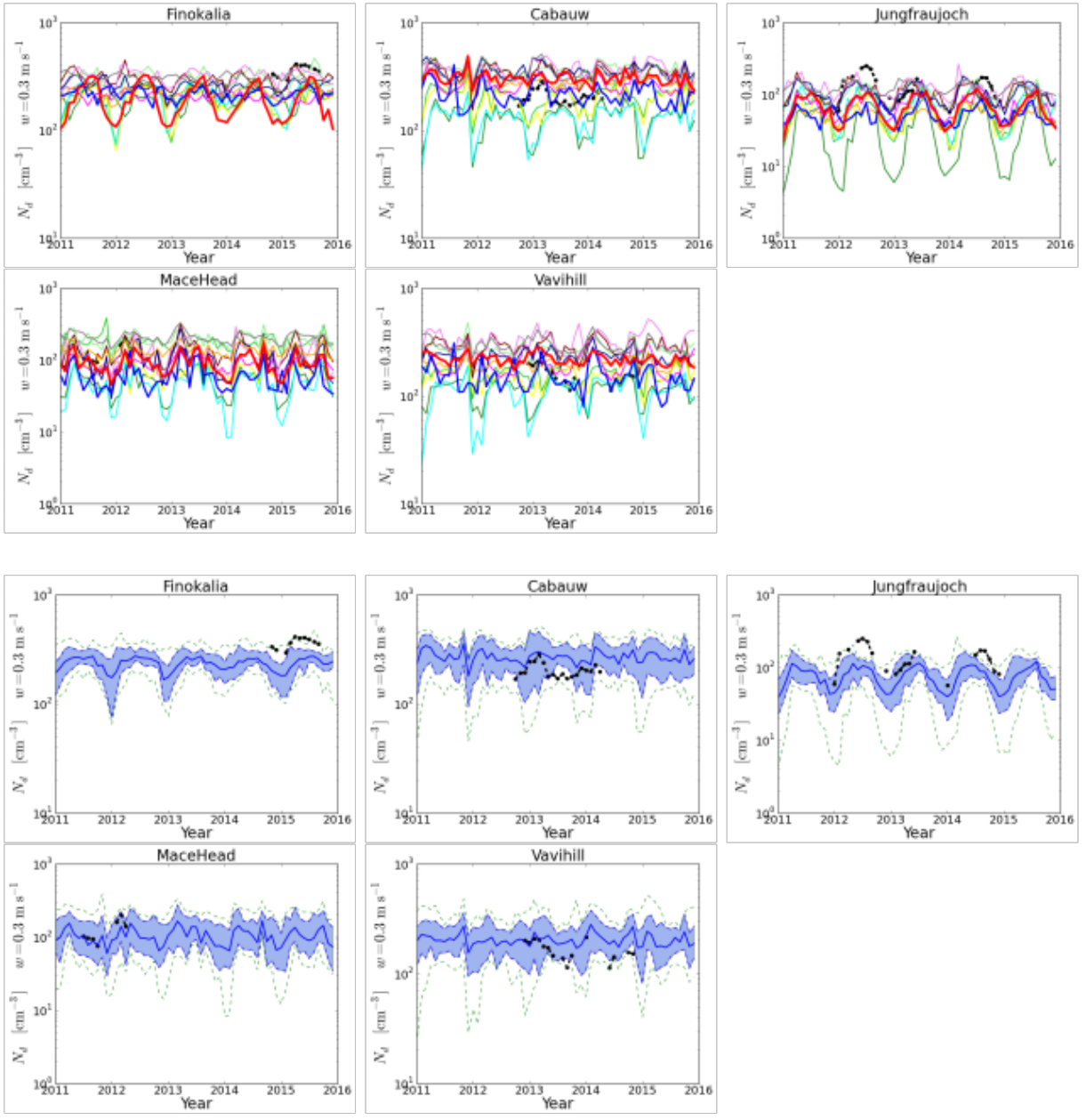
Particles Composition (Organics)



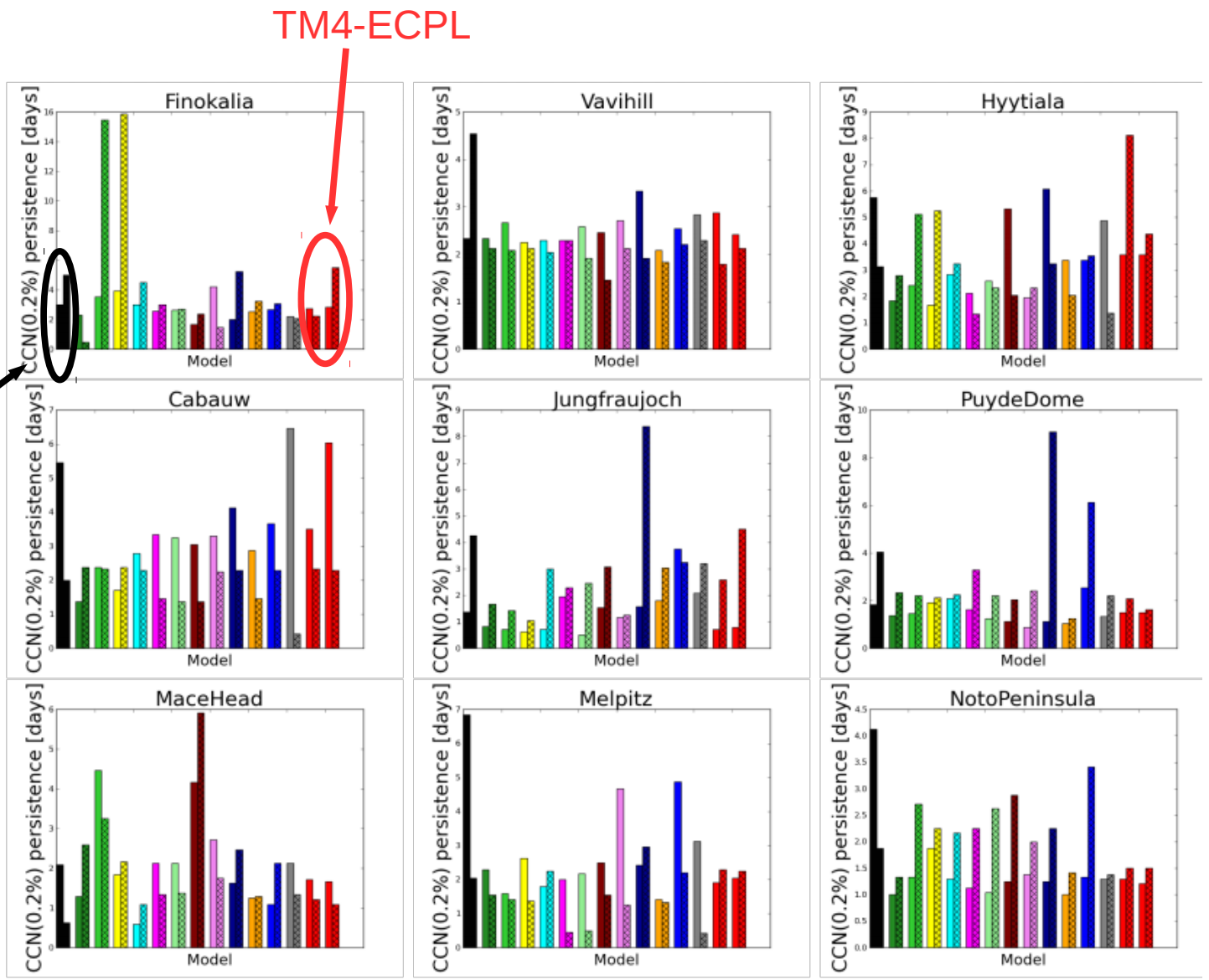
Model intercomparison for the $CCN_{0.2}$



Cloud droplets number concentrations

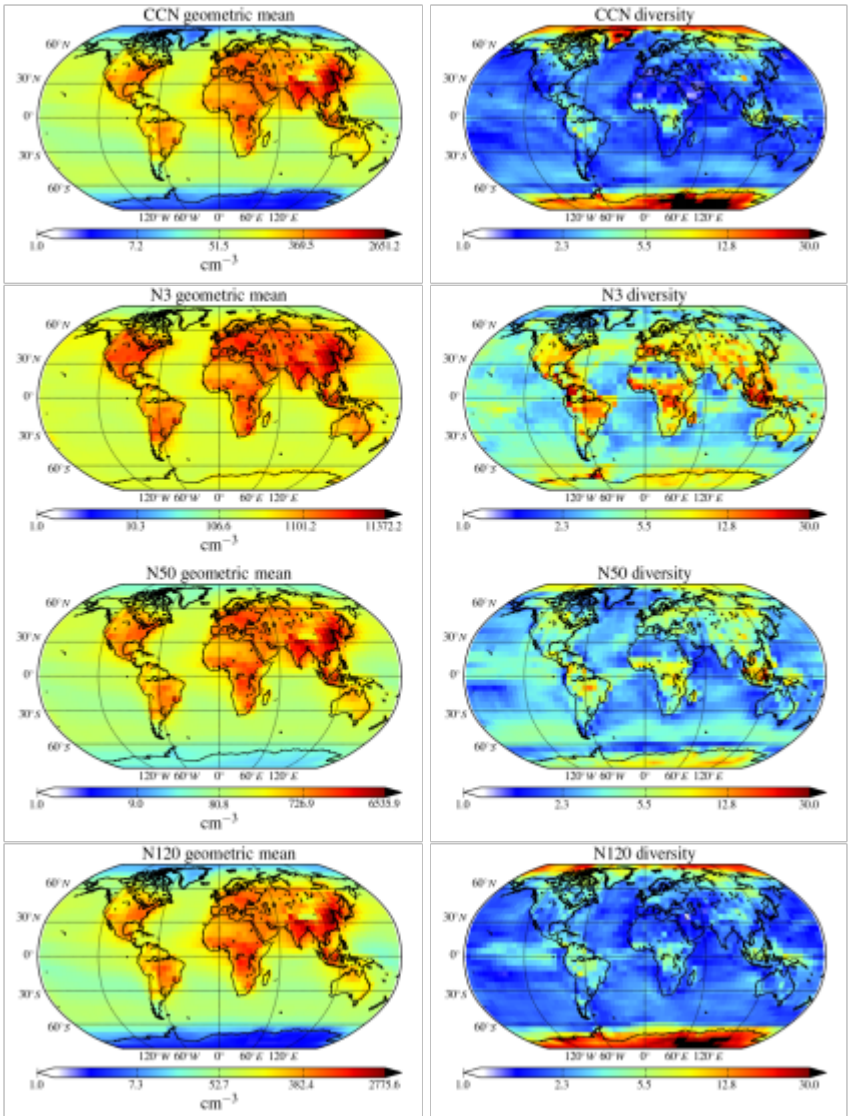


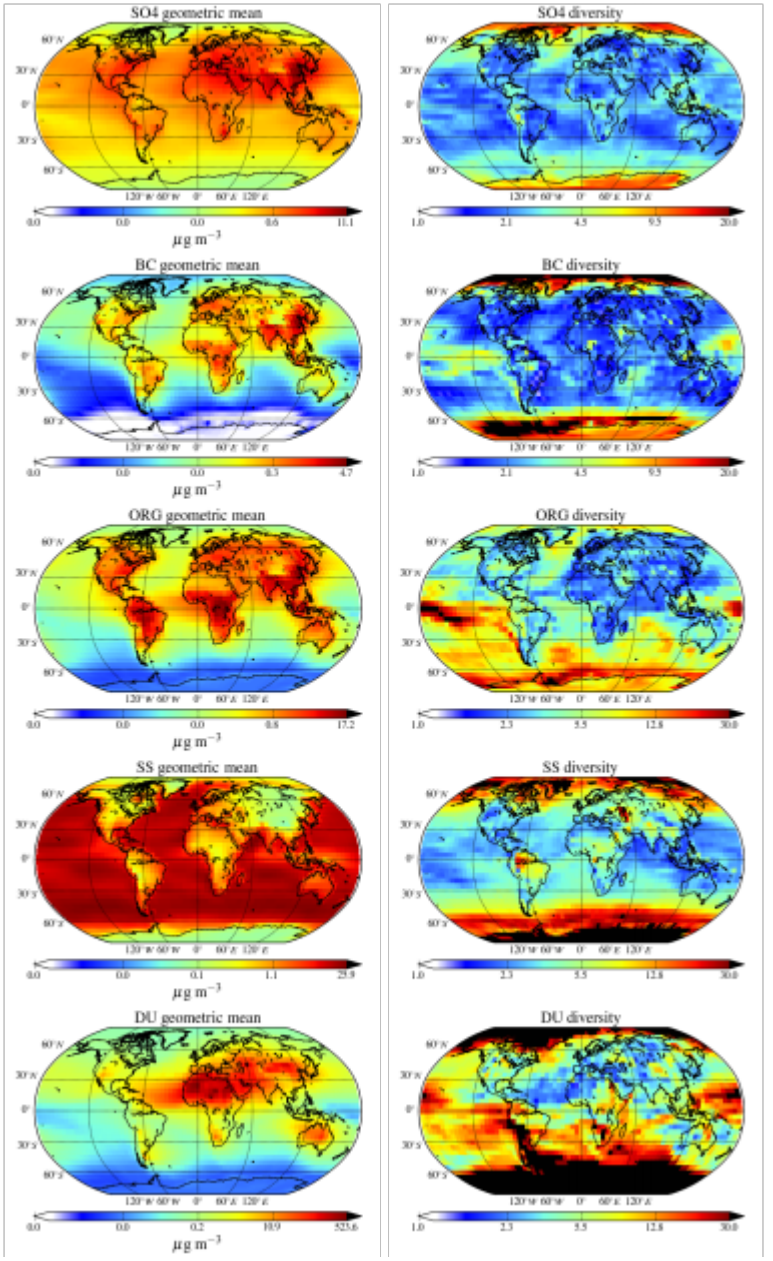
Persistence times of $CCN_{0.2}$



Persistence times during: winter (Left bar) and summer (Right bar)

Surface distribution of particles and composition





Conclusions

- High diversity of model results in the prediction of particle numbers, composition, and CCN at the station location and globally.
- The models on average underestimate CCN and particles number concentration.
- Sulphate and Organic masses are significantly underestimated.
- Models are able to capture seasonal variability of aerosol particles and CCNs
- Models show reasonable agreement with observations in the short-time (< 1 week) dynamic behavior of particles, that varies from few hours up to one week. In several cases, they are able to predict correctly the relative winter/summer order of persistence times.

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