Chasing large climate model uncertainties:

Aligning experimental and model perspectives on atmospheric nanoparticle growth

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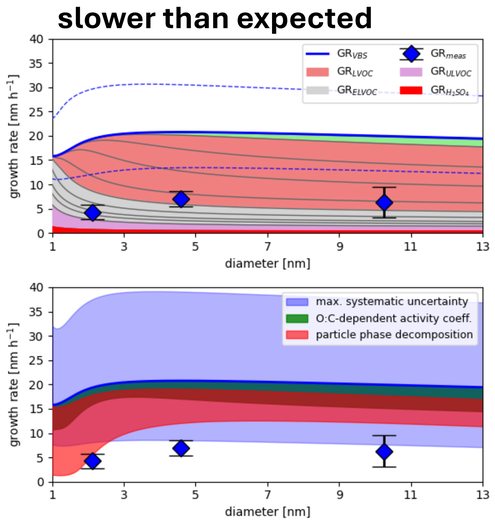
Experiments:

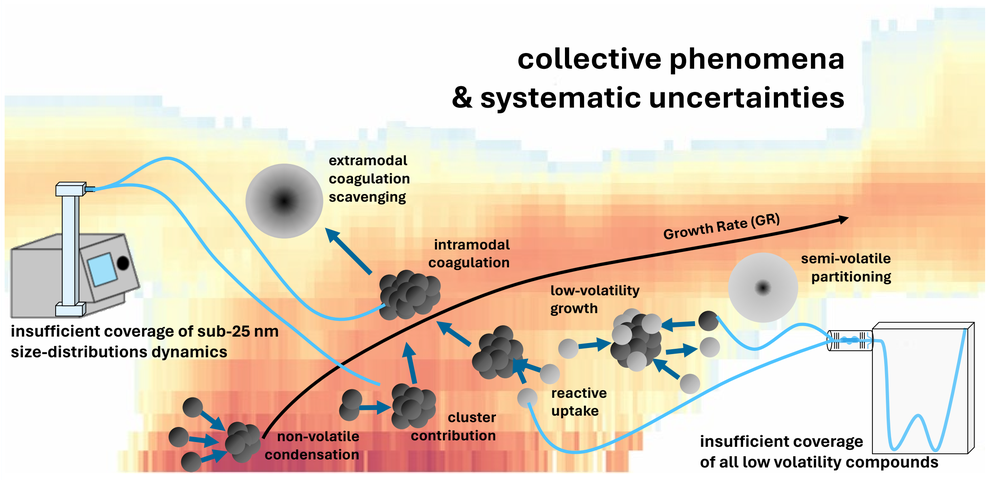
Limited experimental understanding of nanoparticle growth processes in the atmosphere:

- Wide range of vapors (up to 10000 organic molecules with unknown vapor pressures) and processes (condensation, chemical reactions and collective phenomena) potentially contributing to nanoparticle growth
- State-of-the-art box models can fail to predict nanoparticle growth rates from gas-phase measurements of condensable vapors
- Observations show little variation in growth rates, while condensable vapor concentrations span 3 orders of magnitude

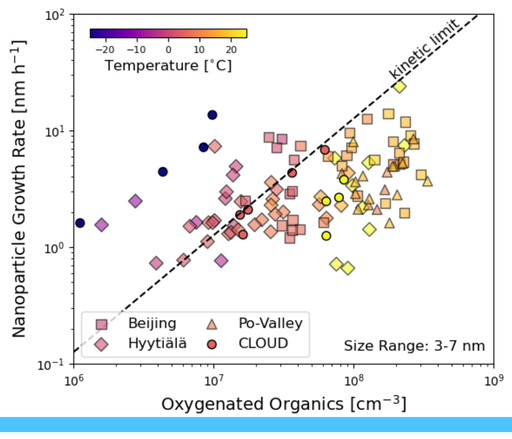
nanoparticles can grow slower than expected



collective phenomena & systematic uncertainties

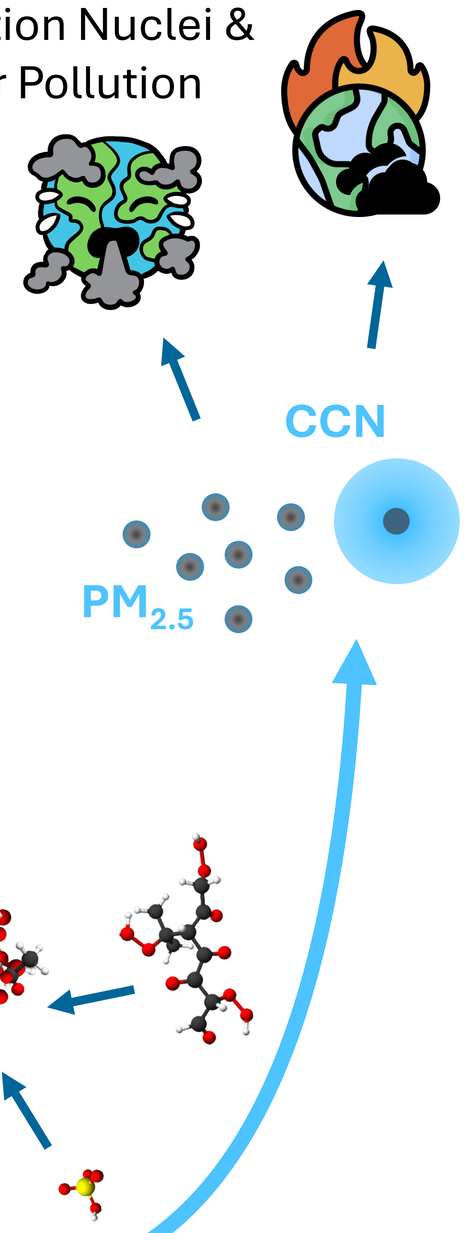


limited variability of observed growth rates



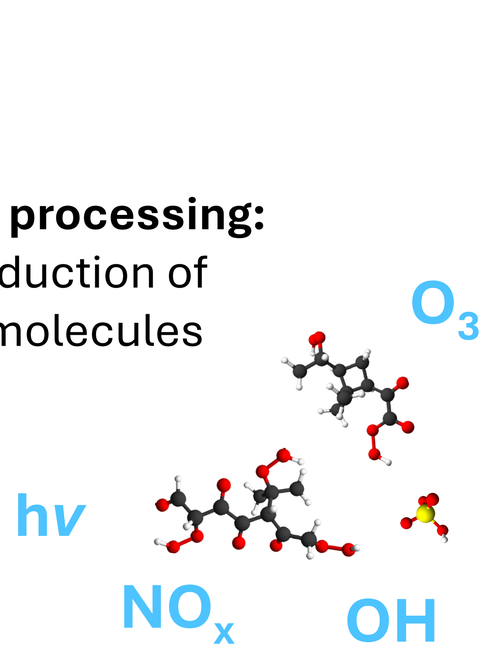
Environmental Impact:

Cloud Condensation Nuclei & Particulate Matter Pollution



Atmospheric processing:

Chemical production of low volatility molecules



Phase transition – New Particle Formation:

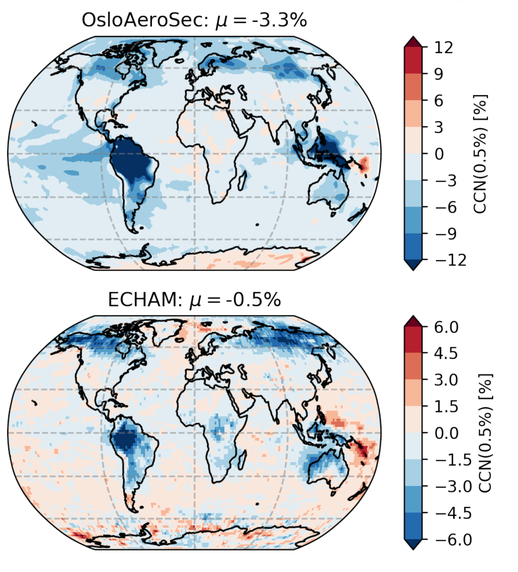
Nucleation and Clustering needs to be followed by fast nanoparticle growth

Large-scale models:

Over-simplifications are responsible for too low secondary organic aerosol levels in air quality models and too low sensitivity in global climate models:

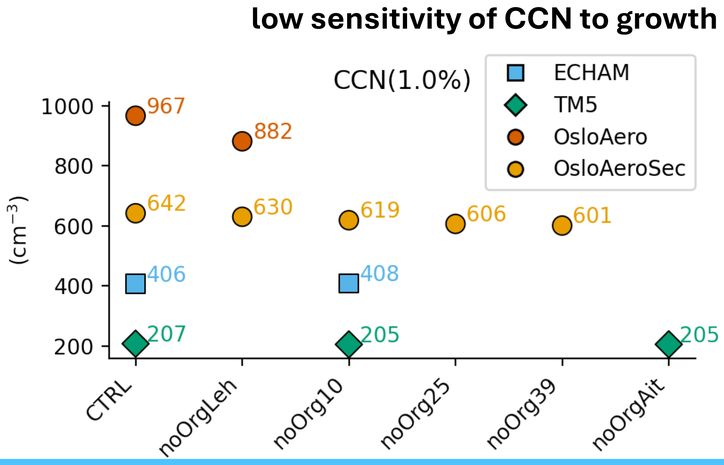
- Comparison of 4 Earth System Models from CMIP6 show little sensitivity of CCN to the inclusion of organics in growth
- Single particle growth is assumed in the models using a limited subset of condensable vapors only: Low NPF over oceans buffers global effect
- Aerosol dynamics schemes are highly-simplified and apparently do not reproduce atmospheric nanoparticle growth: Inclusion of a sectional scheme for growth changes CCN by more than 30%

limited subset of condensable vapors



single-particle growth model and simplified dynamics

low sensitivity of CCN to growth



Emissions:

Volatile gases are emitted from the bio- and anthroposphere

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