

# From Sulfur to Organics: Regional Modeling of Arctic New Particle Formation

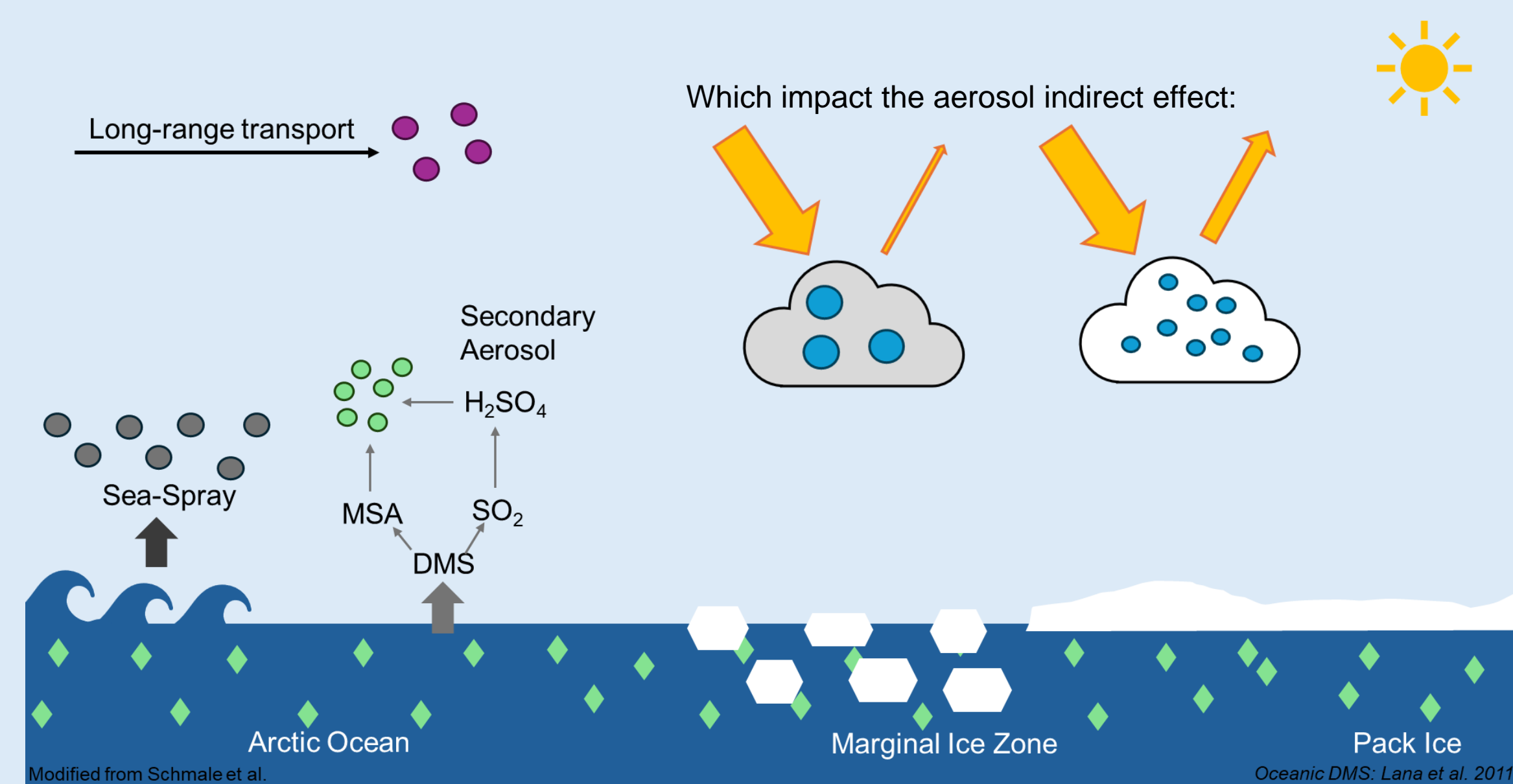
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## 1. During polar day Arctic aerosols are influenced by:



## 2. We use GEOS-Chem-TOMAS to simulate the ARTofMELT field campaign during May and June 2023.

### GEOS-Chem-TOMAS (v12.9.3)

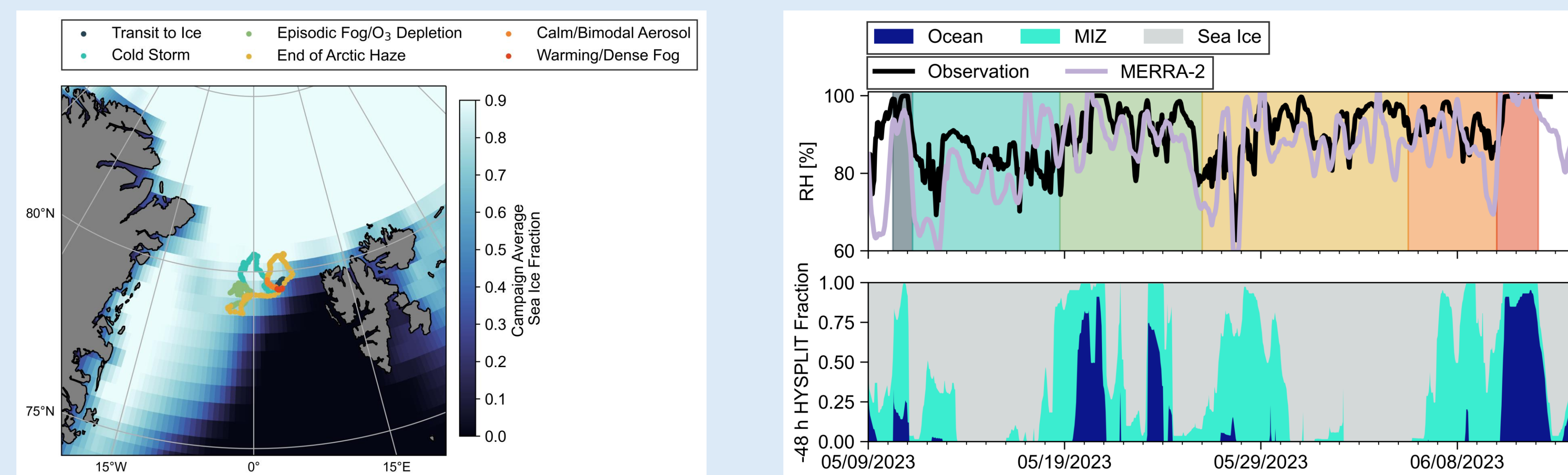
- MERRA-2 Reanalysis Meteorology
- TOMAS
  - Tracks number and mass of aerosols in 15 size bins
- Represents emissions, deposition, condensation, coagulation, nucleation
- DMS Chemistry follows Tashmim et al. 2024
- Global Simulation (for boundary conditions): 2°x2.5°
- Nested Simulation: 0.5°x0.625°

### During ARTofMELT:

- What influences model biases of marine sulfur species?
- What influences model biases of aerosol size and composition?

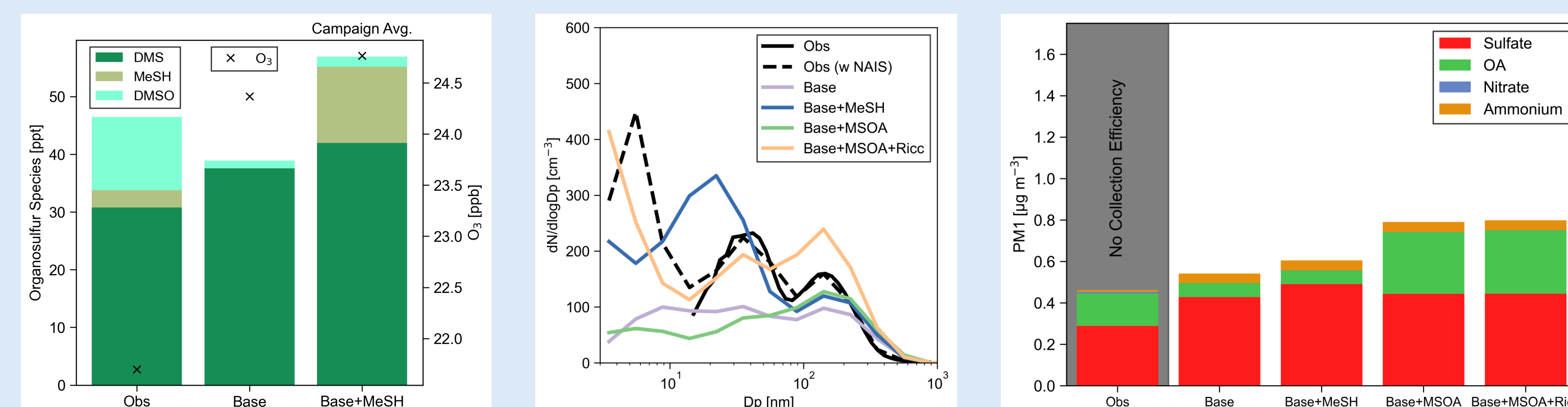
Simulations	MeSH Chemistry	Additional Marine SOAP Emission	Riccobono Nucleation
Base	Off	Off	Off
Base+MeSH	On	Off	Off
Base+MSOA	Off	On	Off
Base+MSOA+Ricc	Off	On	On

## 3. We analyze the ARTofMELT campaign in six time periods based on meteorology.



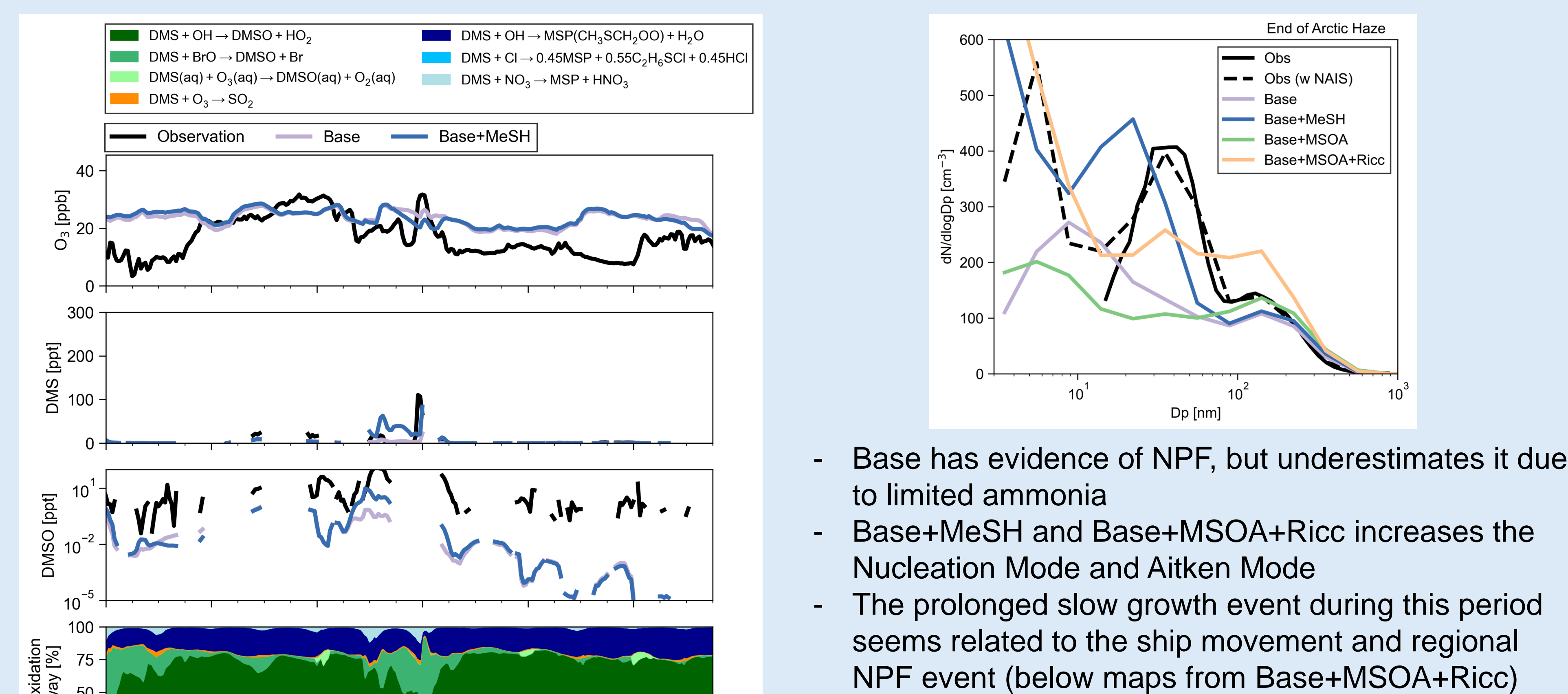
- ARTofMELT was on the icebreaker, *Oden*, in the Fram Strait from May 9 to June 13, 2023.
- We use measurements from the AMS, CIMS, DMPS, and NAIS to make comparisons between gas-phase organosulfur species, aerosol composition, and aerosol size distributions.

## 4. Campaign Average Comparisons:

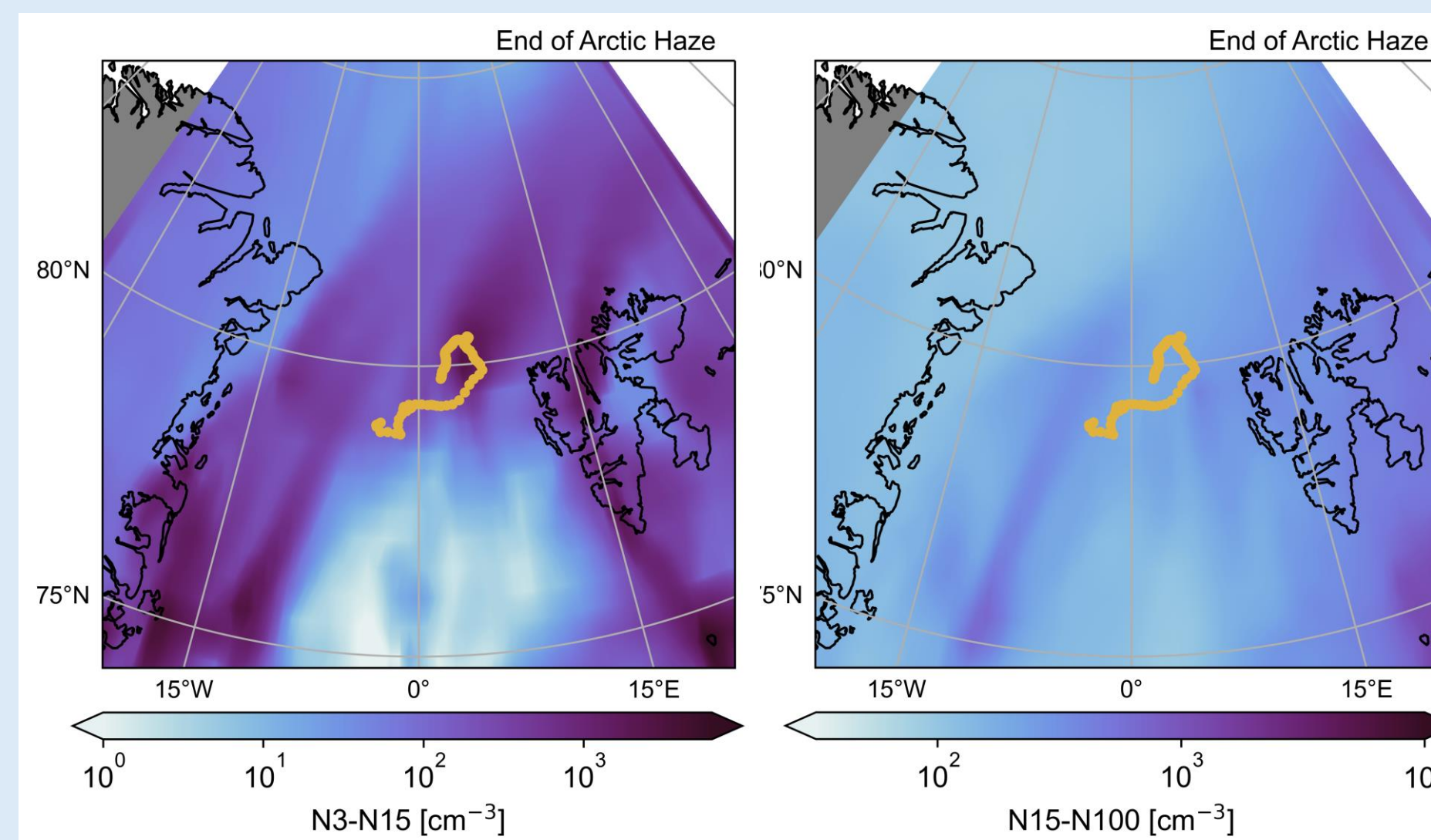


- DMSO is underestimated
- DMS has a slight overestimate
- Including MeSH increases the sulfur species in the model
- Biases are potentially related to wet deposition & halogens
- Base and Base+MSOA do not capture the bimodal structure
- Base+MSOA+Ricc increases the number across all sizes
- Base+MeSH increases nucleation
- AMS measurements are not well quality controlled
- Base and Base+MeSH have too high a fraction of sulfate
- Adding MSOA emissions improves the agreement of fractional OA

## 5. End of Arctic Haze (Yellow on plots in 3.): Observed an extended period of elevated NPF and growth, and some ozone depletion.

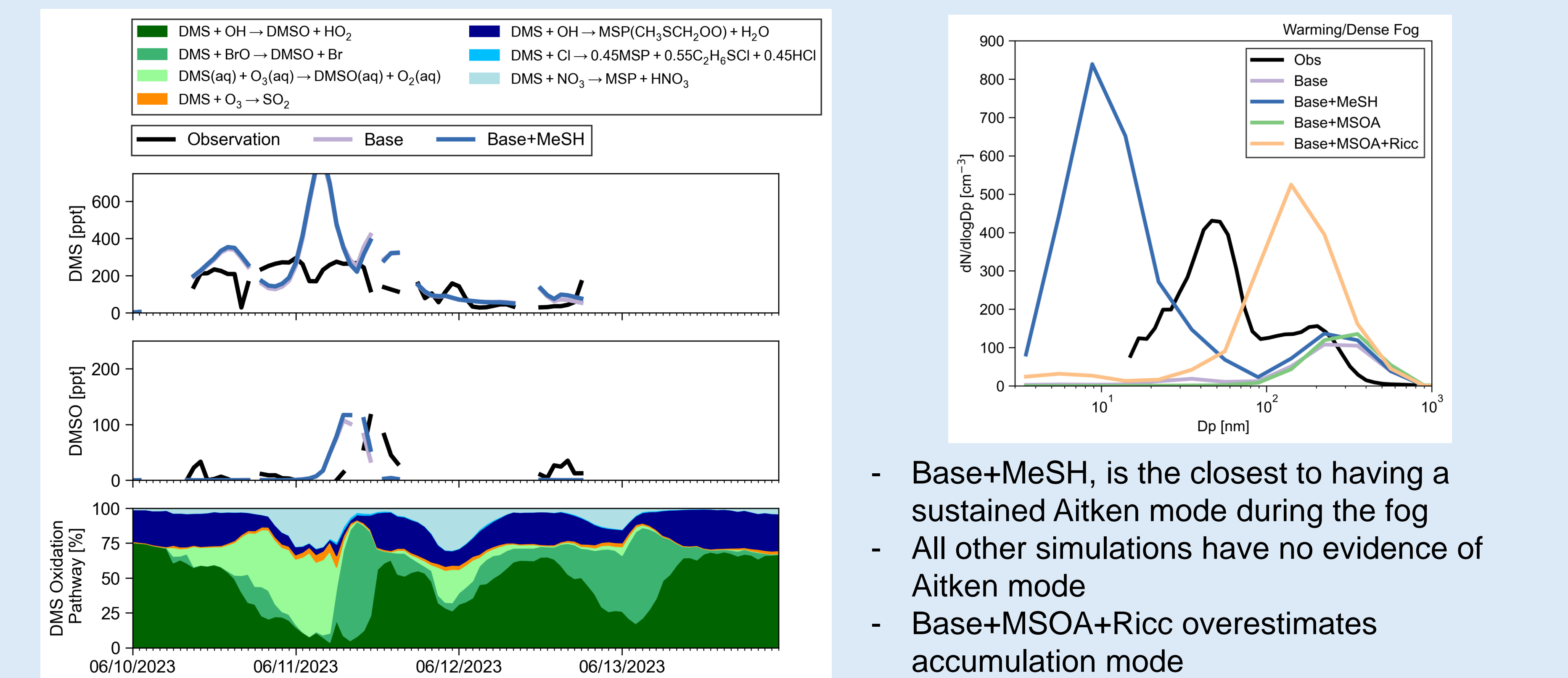


- DMSO being underestimated by more than an order of magnitude is associated with a high bias in ozone
- The BrO oxidation path increases in relative importance during many of these times
- Underestimates in bromine could be influencing lack of modeled ozone depletion events and DMSO formation

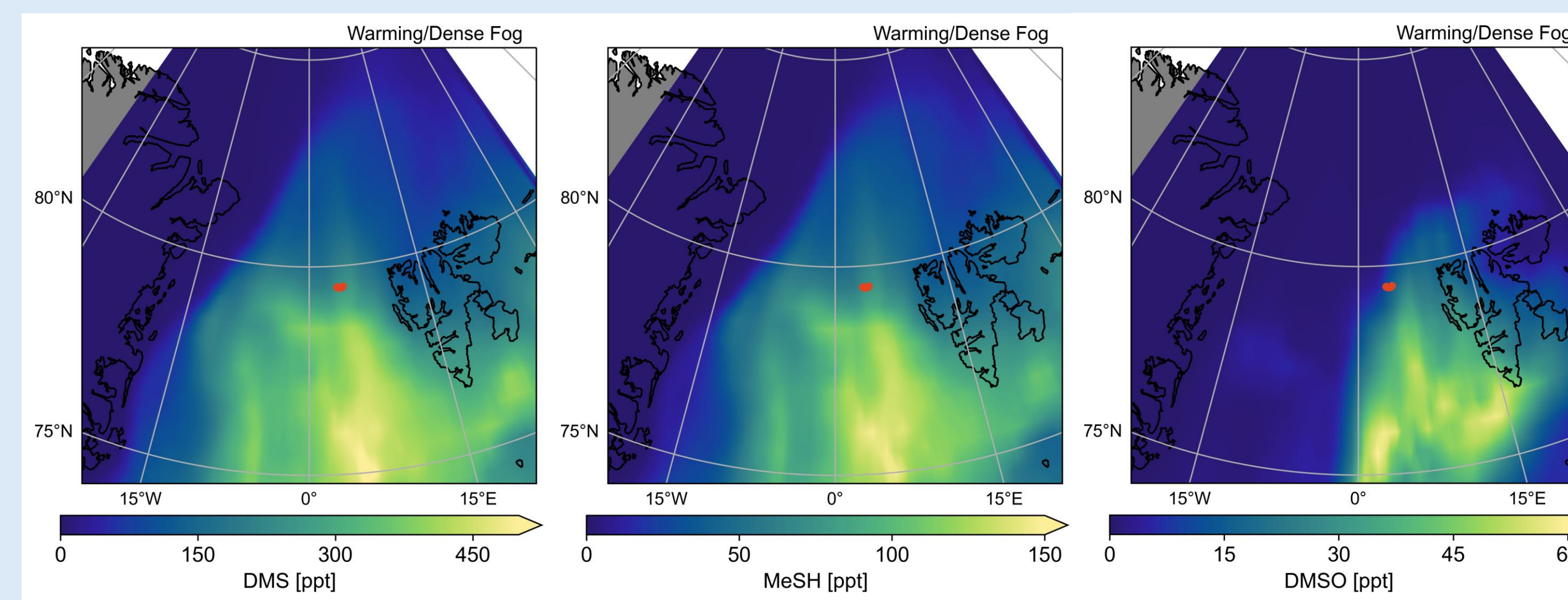


- Base has evidence of NPF, but underestimates it due to limited ammonia
- Base+MeSH and Base+MSOA+Ricc increases the Nucleation Mode and Aitken Mode
- The prolonged slow growth event during this period seems related to the ship movement and regional NPF event (below maps from Base+MSOA+Ricc)

## 6. Warming/Dense Fog (Red on plots in 3.): Observed the highest concentration of organosulfur species in the campaign and a sustained Aitken mode.



- Base+MeSH, is the closest to having a sustained Aitken mode during the fog
- All other simulations have no evidence of Aitken mode
- Base+MSOA+Ricc overestimates accumulation mode
- This is the only period with elevated DMSO that the model comes close to capturing
- The dominance of the aqueous pathway, direct marine influence, and overall regional elevation are likely contributing to why we can represent this event in the model
- HYSPLIT trajectories during this time were all from the South, just east of 0°, which the model has elevated DMS, MeSH, and DMSO (below maps from Base+MeSH)



## 7. Next steps of analysis:

- Bromine emissions from blowing snow and sea ice have previously been shown to help capture ozone depletion events in other parts of polar regions
- Implement the Luo et al. 2019 Wet Deposition scheme with TOMAS
- Connect MSA to TOMAS as done in Hodshire et al. 2019
- Implications of model updates on the Aerosol Indirect Effect