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# Improvements to the WRF-Chem model for quasi-hemispheric simulations of aerosols and ozone in the Arctic

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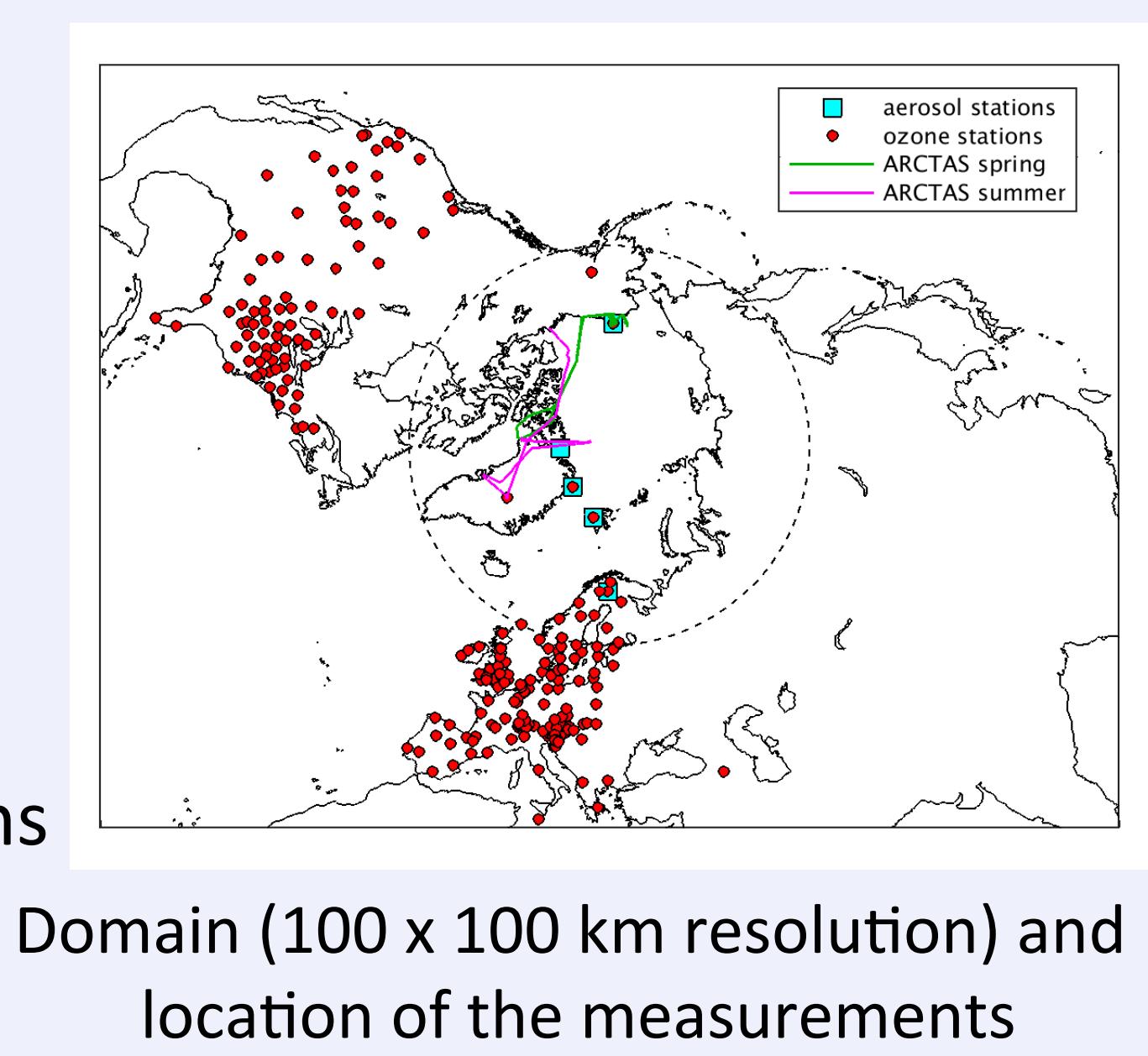
## Motivations

- Improve WRF-Chem's performance compared to recent intercomparisons (AMAP, 2015) in order to study aerosols and ozone in the Arctic (long-range transport, local sources).
- We identify missing processes in WRF-Chem 3.5.1, update the model, and evaluate the corrected model in the Arctic.

## WRF-Chem model setup

WRF-Chem 3.5.1 simulations, 1 March 2008 to 1 August 2008

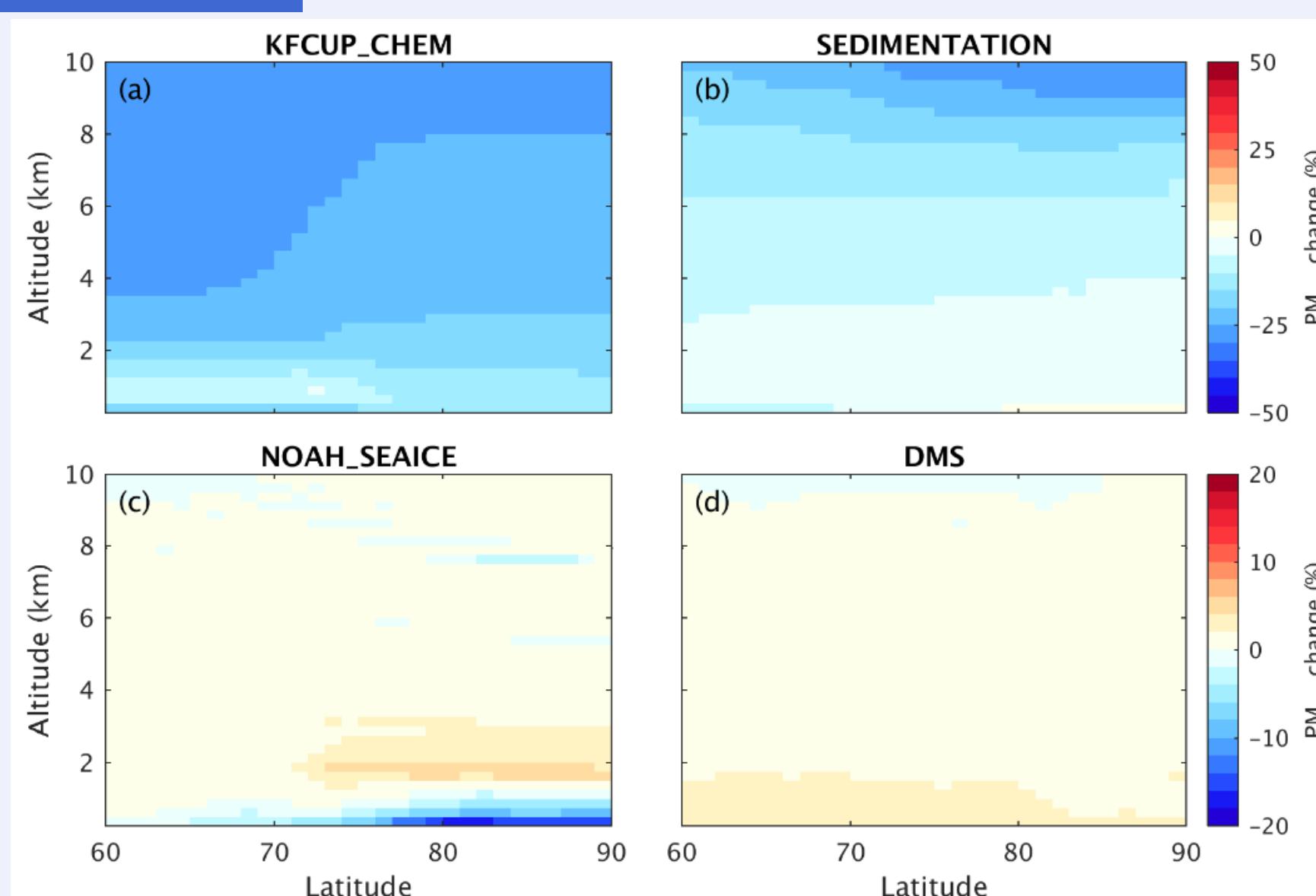
- MOSAIC aerosols (cloud chemistry and SOA), SAPRC-99 gas-phase chemistry
- Morrison 2-moment microphysics
- KF-CuP cumulus parameterization
- Noah Land Surface Model
- MOZART boundary and initial conditions
- Nudging to NCEP FNL



## Results - aerosols in the Arctic

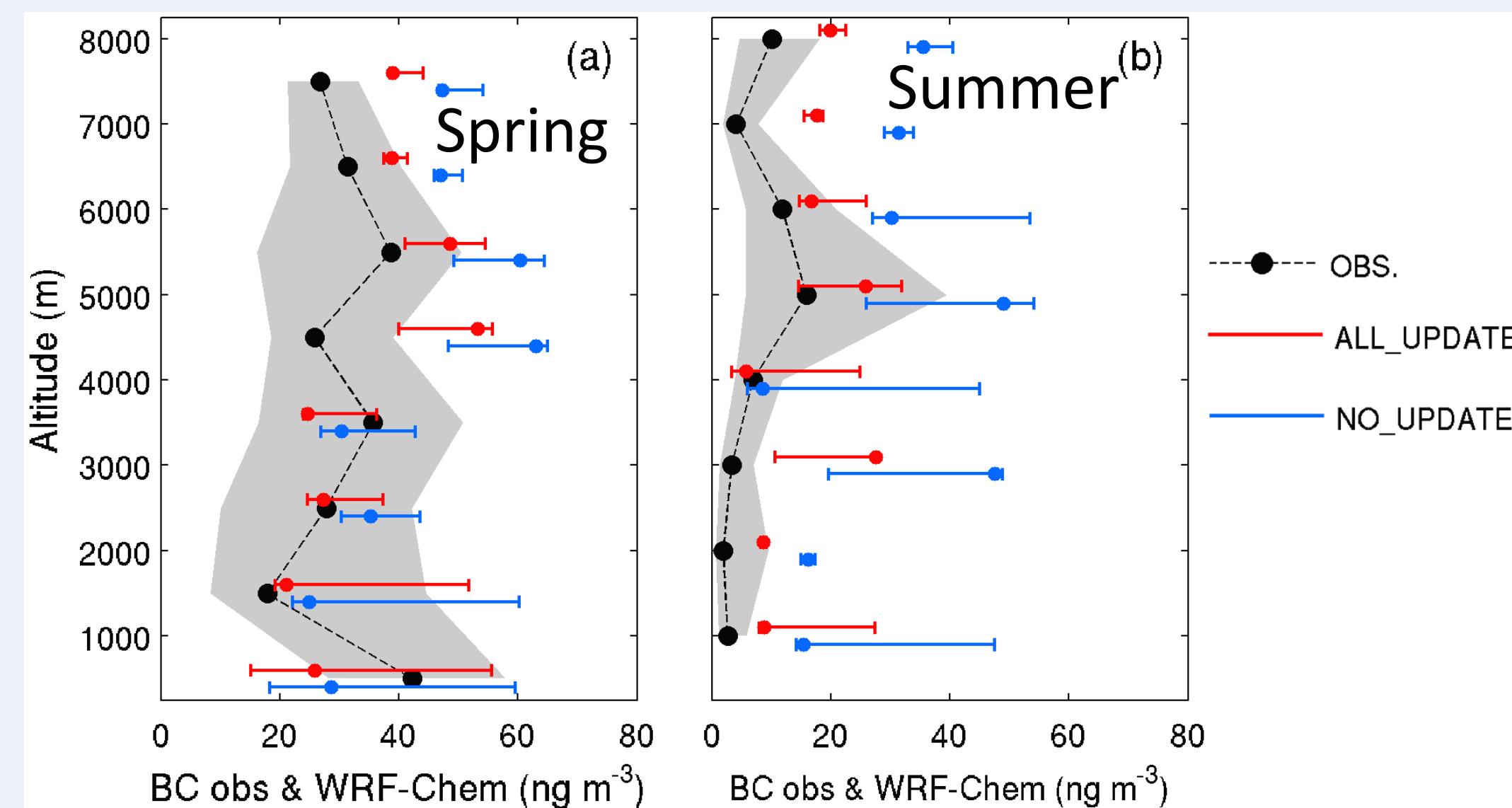
### Effect of the updates on zonal mean PM<sub>10</sub> in the Arctic (60°N – 90°N, April-July average)

- KFCUP\_CHEM decreases are mostly due to increased wet removal by cumuli
- NOAH\_SEAICE reduces sea ice skin temperatures, increasing stability over sea ice, reducing vertical mixing.

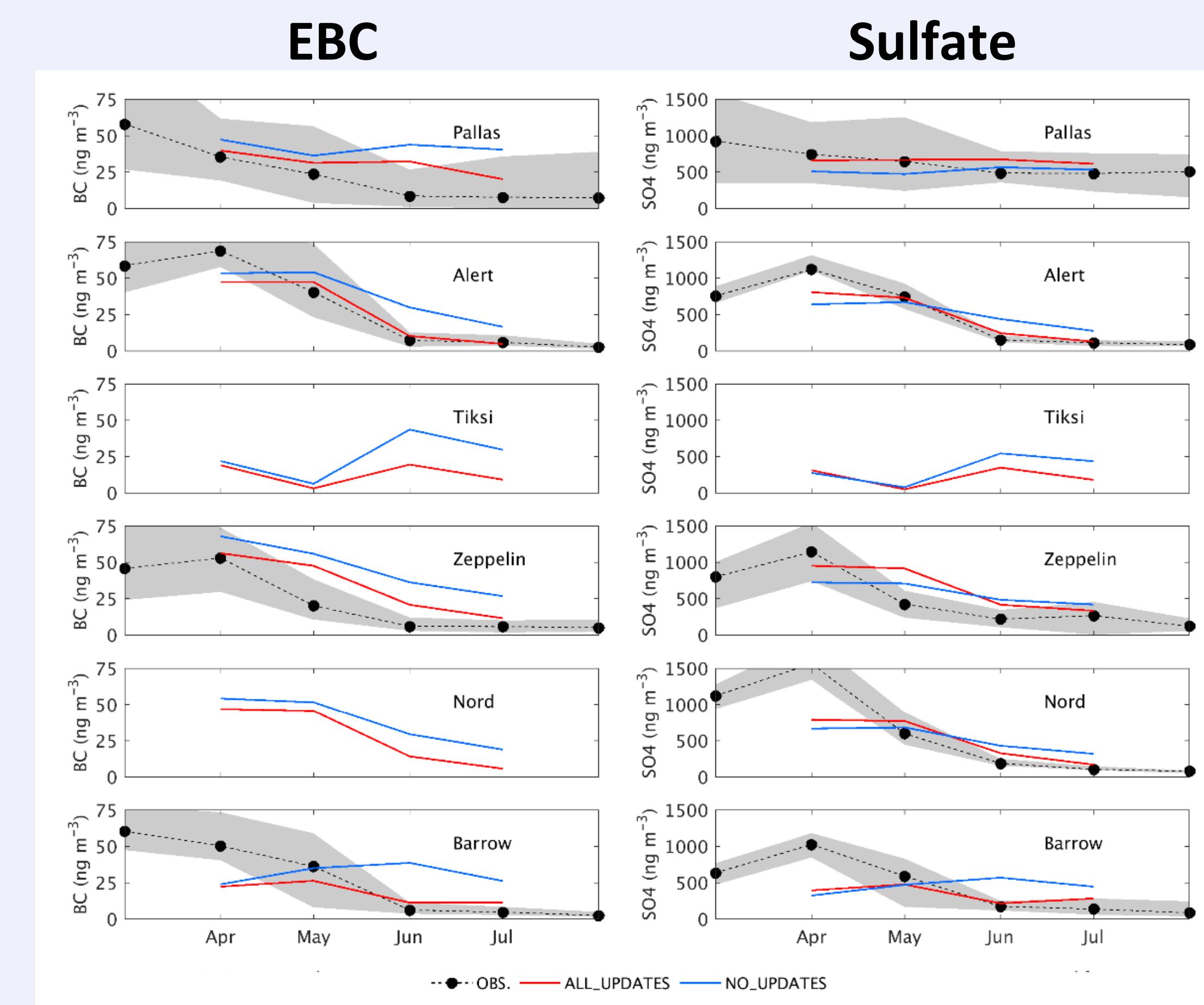


### Evaluation against mean rBC profiles from the ARCTAS campaigns (2008)

- BC RMSE reduced by 28 % (spring) and 50 % (summer), due to KFCUP\_CHEM.



### Evaluation against surface measurements in the Arctic

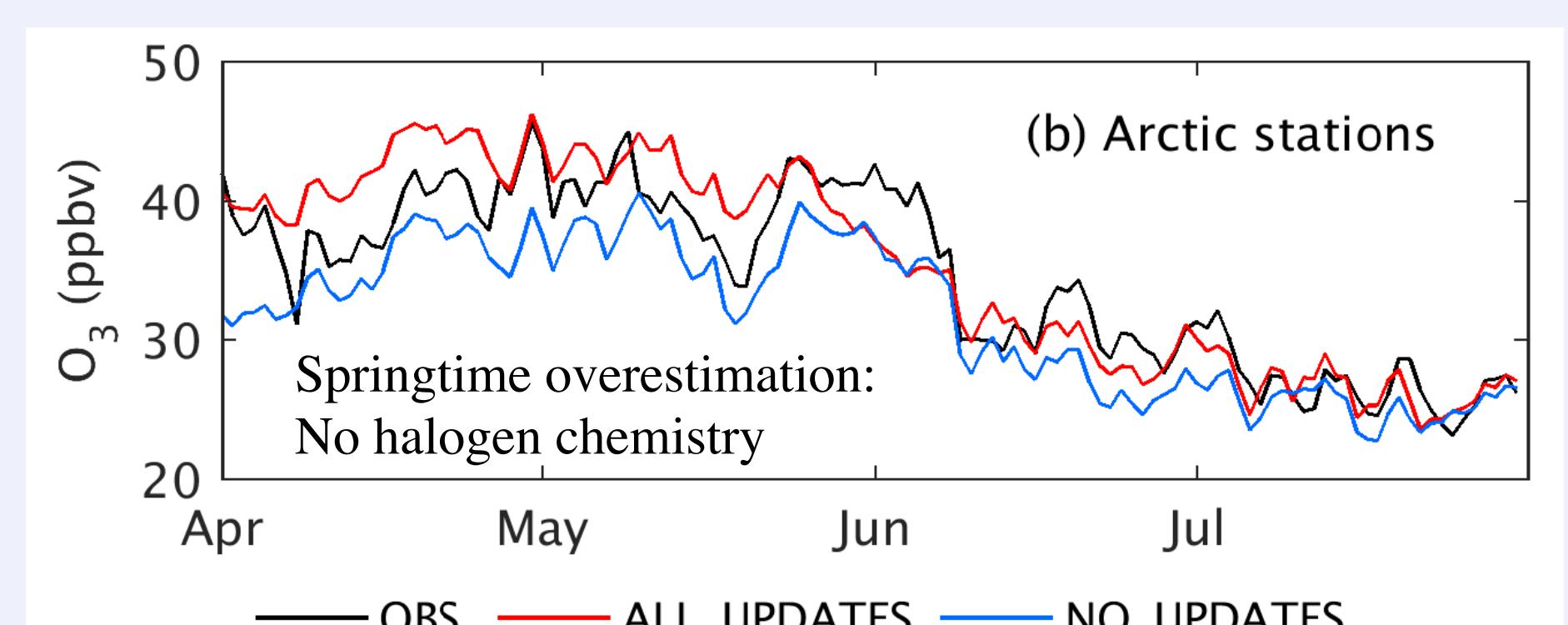
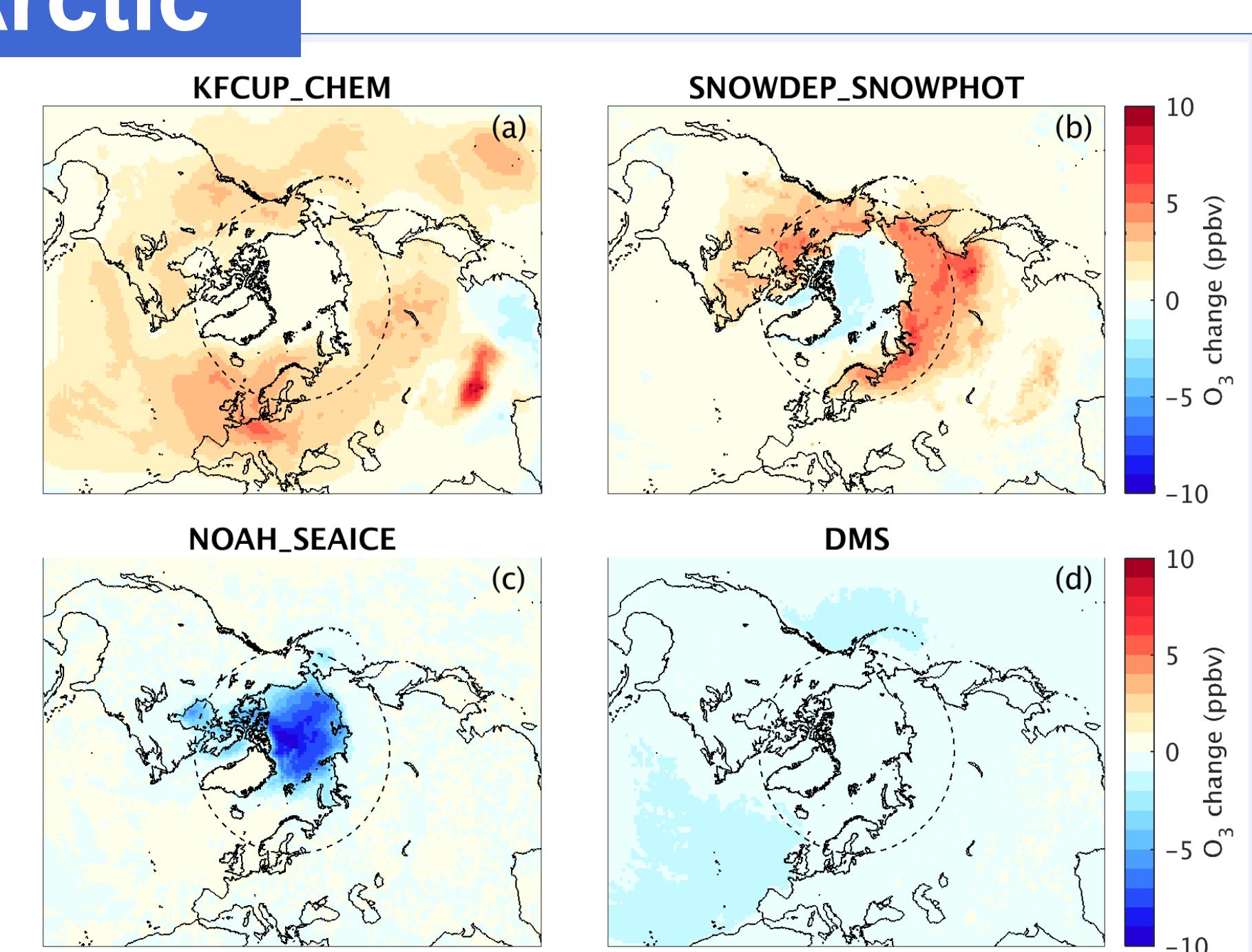


- BC RMSE reduced by 38 %, sulfate RMSE by 21 %.
- KFCUP\_CHEM and NOAH\_SEAICE have the largest impact
- DMS improves RMSE at all stations except Zeppelin

## Results - ozone in the Arctic

### Effect of the updates on surface O<sub>3</sub> (April-July average)

- KFCUP\_CHEM: increased vertical mixing of O<sub>3</sub> and precursors, higher surface O<sub>3</sub>
- NOAH\_SEAICE: reduced vertical mixing, lower surface O<sub>3</sub>
- SNOWDEP & SNOWPHOT: reduced dry deposition and increased photolysis rates, higher O<sub>3</sub>.



## Main conclusions

- Model updates reduce RMSE significantly (-10 % to -50 %) for all datasets. Large improvements for BC, especially during summer.
- NOAH\_SEAICE (improving skin temperatures over ice and stability) and KFCUP\_CHEM (Including cumulus cloud interactions with aerosols and gases) have the largest effect on aerosols.
- Improved deposition and photolysis over snow (SNOWDEP & SNOWPHOT) have a large effect on ozone.
- Halogen chemistry and detailed DMS gas-phase chemistry, as well as higher resolutions are needed to improve results further.

## References:

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