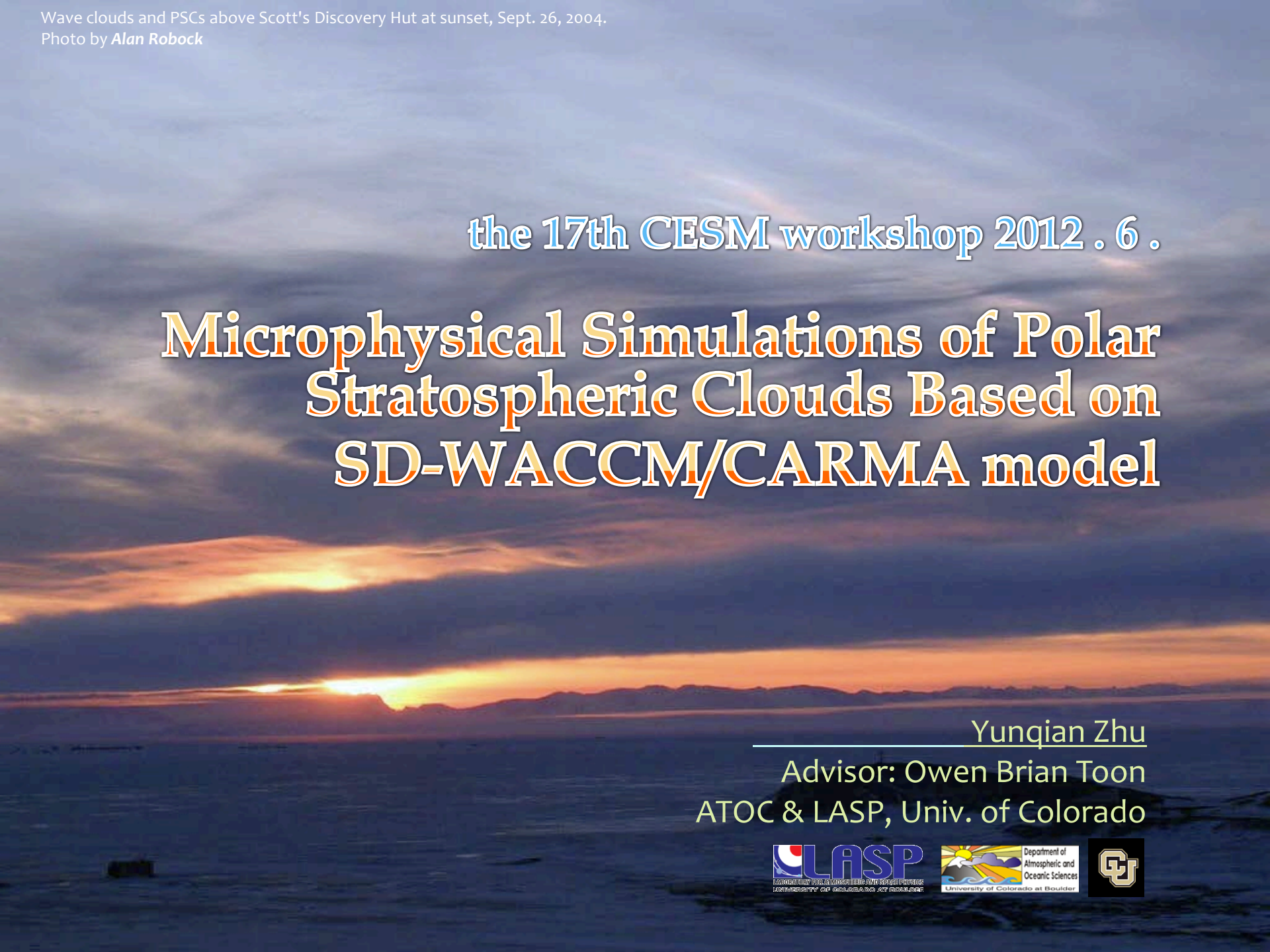


the 17th CESM workshop 2012 . 6 .

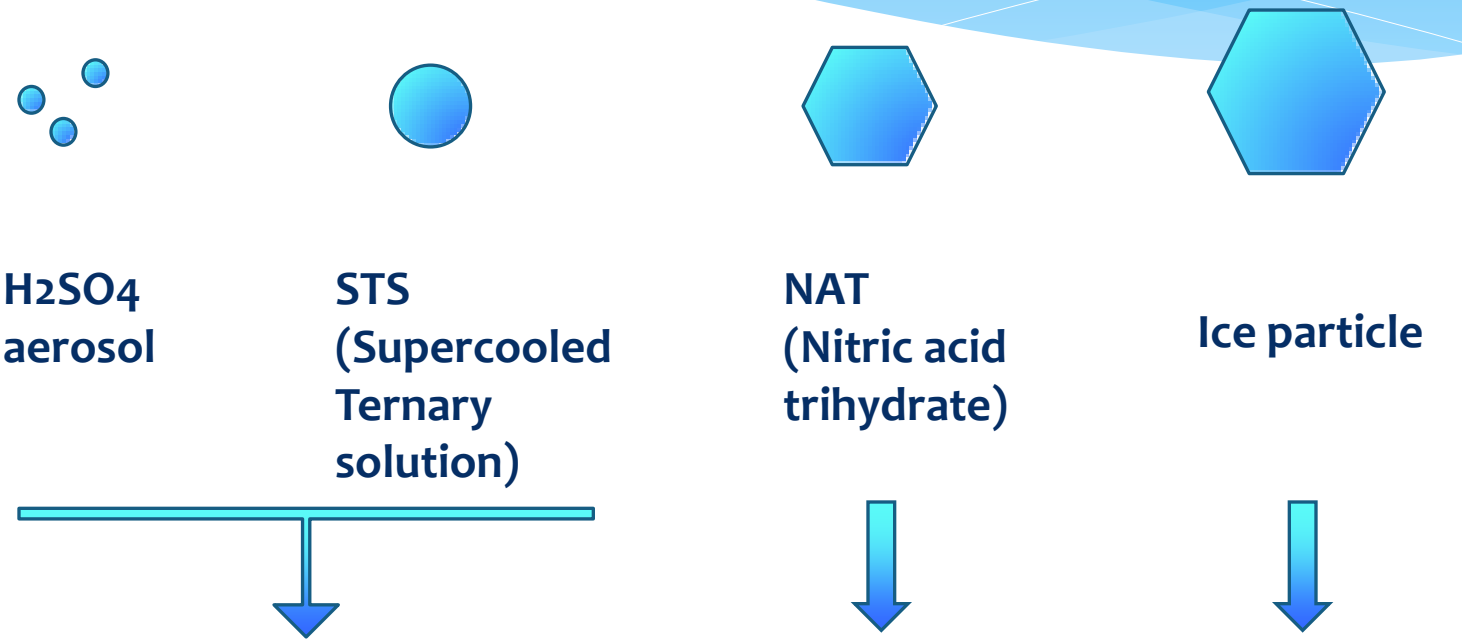
Microphysical Simulations of Polar Stratospheric Clouds Based on SD-WACCM/CARMA model

Yunqian Zhu

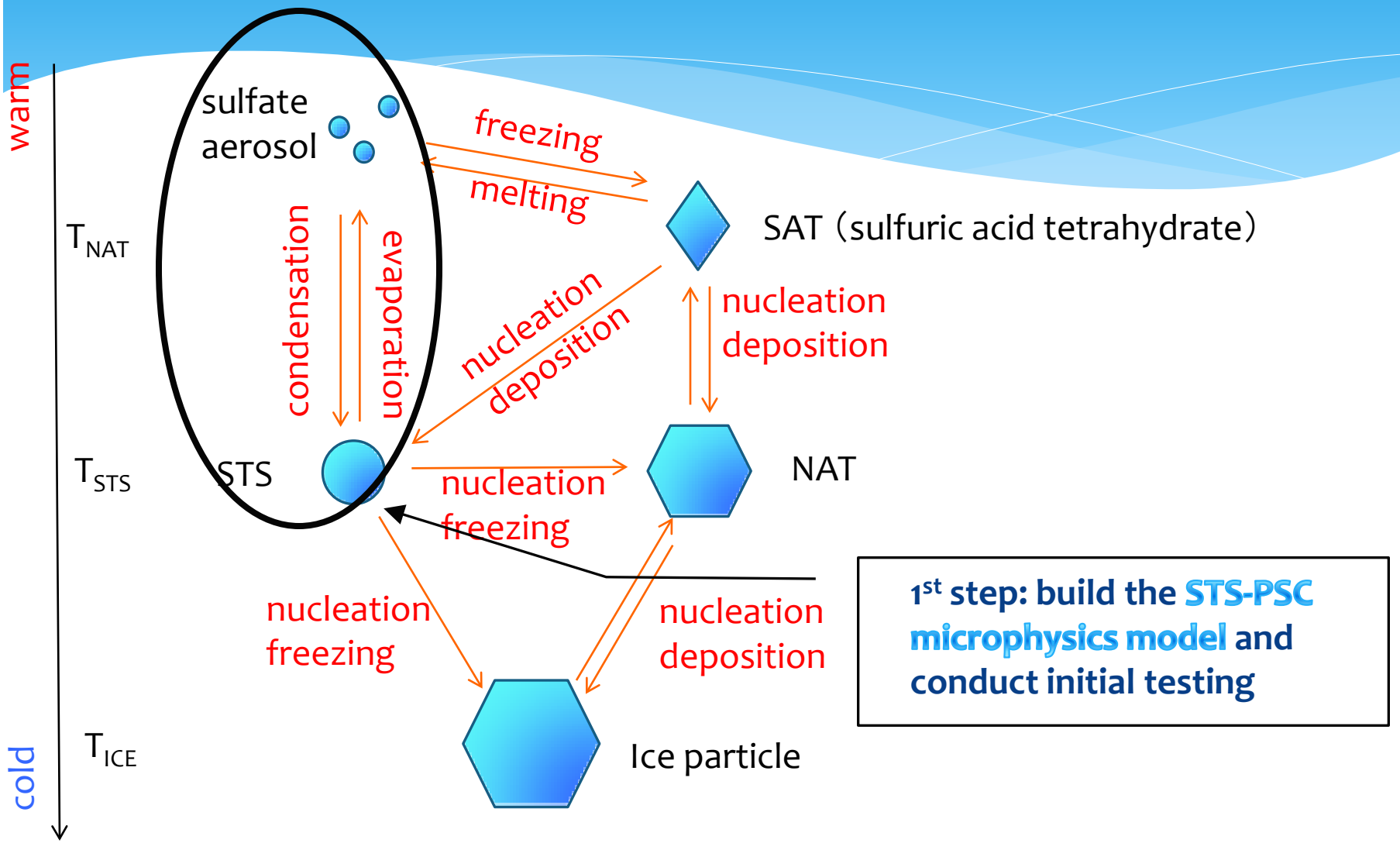
Advisor: Owen Brian Toon

ATOC & LASP, Univ. of Colorado

What are PSCs and what do they do?



How do different types of PSCs convert to each other?

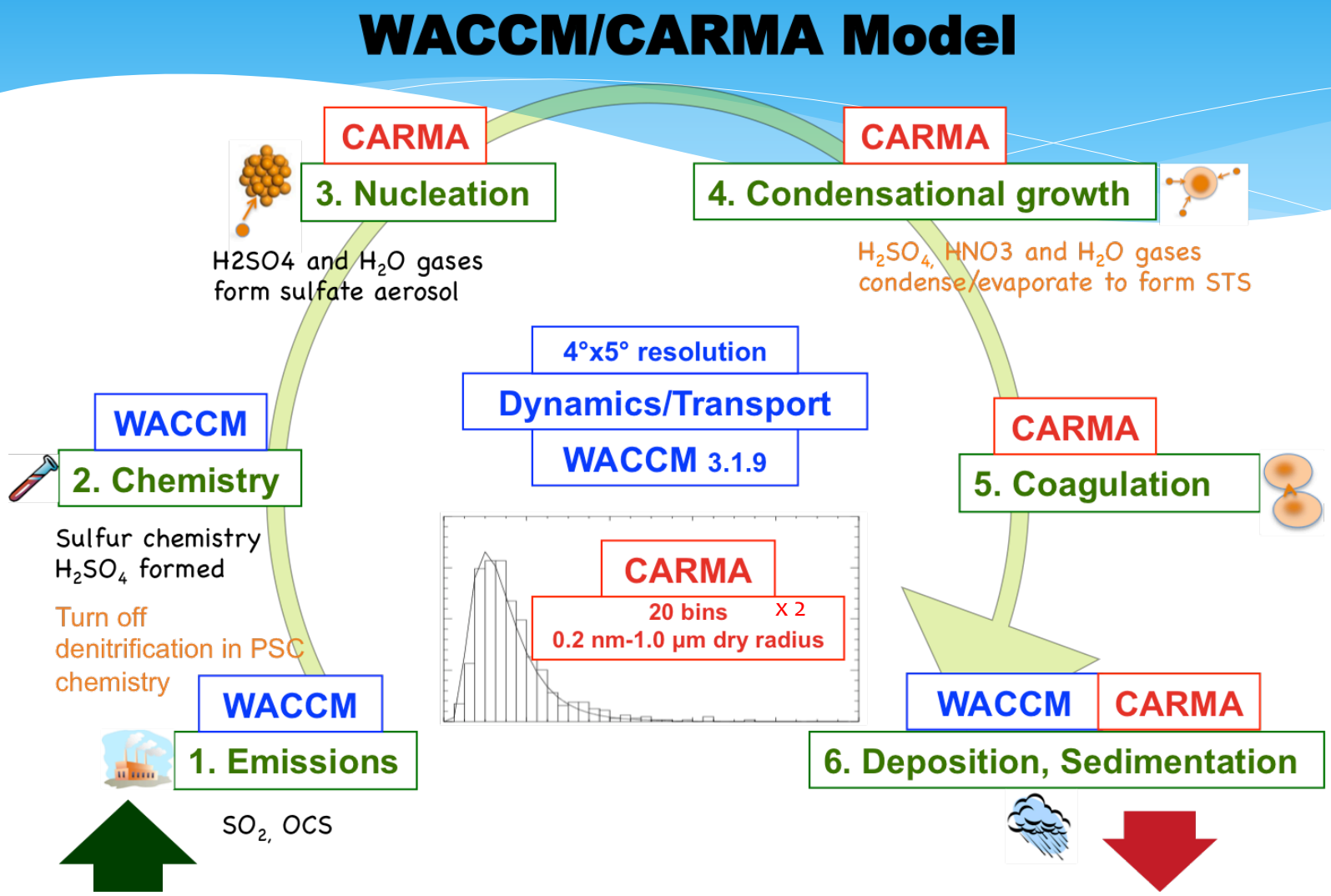


1st step: build the STS-PSC microphysics model and conduct initial testing

STS-PSC Model testing: driven by model meteorology

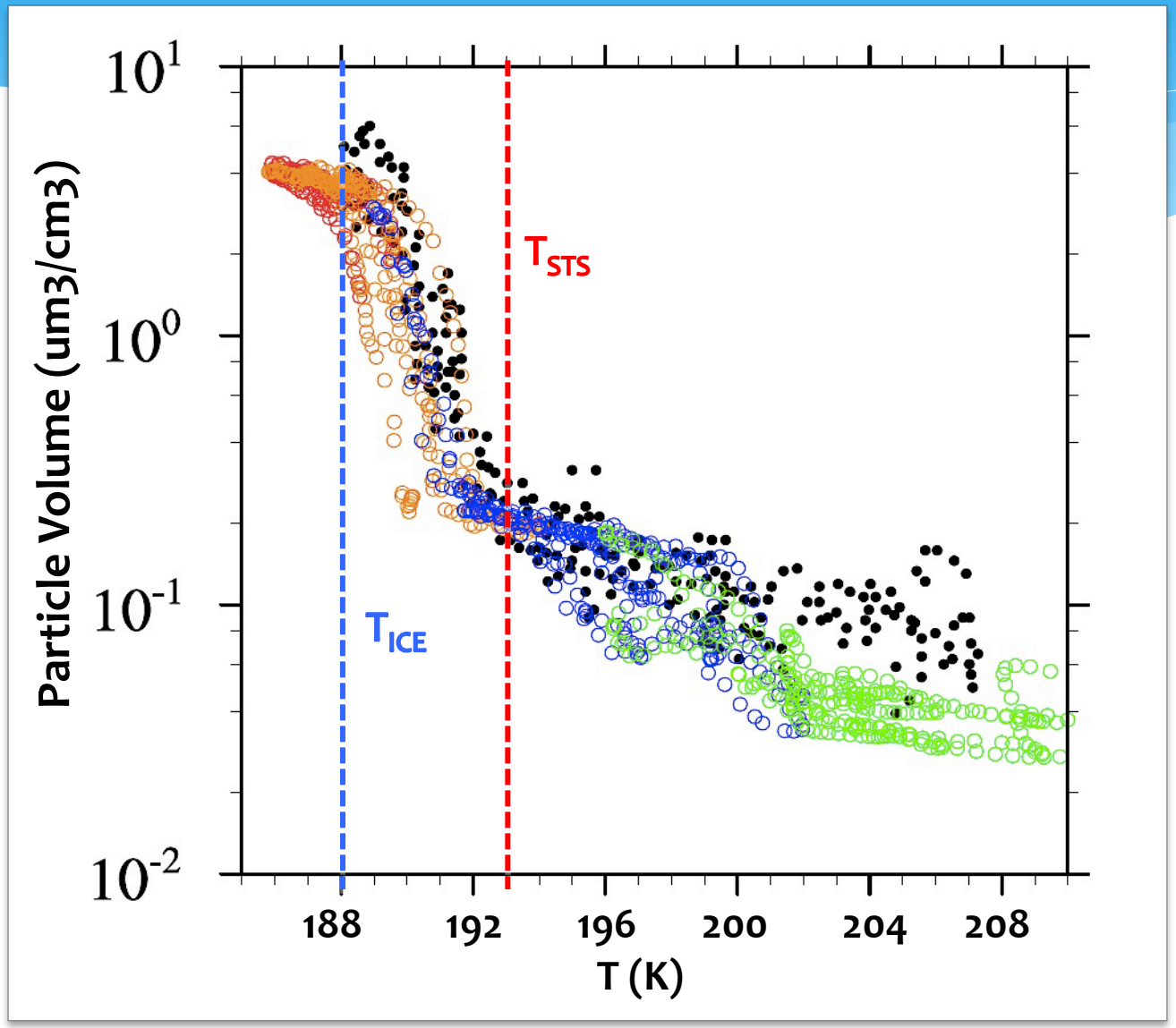
WACCM 3.1.9
CARMA 2.3
4x5 resolution

The STS-PSC model in WACCM/CARMA



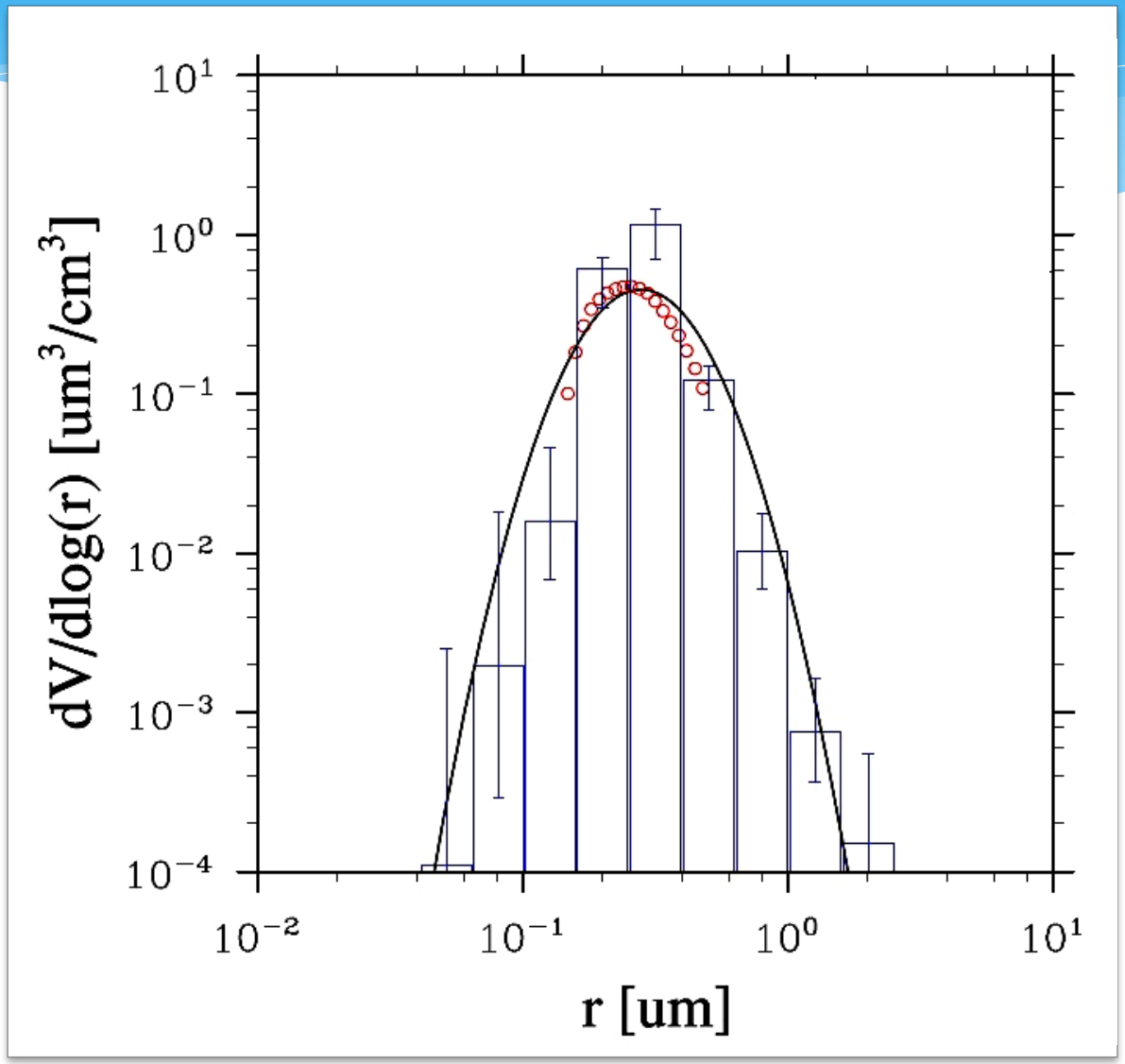
Particle volumes compares well with aircraft observations at 55 mbar

Obs (Dye, 1992) ●
90°S - 86°S ○
82°S - 78°S ○
74°S - 70°S ○
66°S - 62°S ○



Size distribution at 24 mbar compares well with satellite and balloon data

ACE
Balloon
Model



SD-WACCM results: 2010-2011 winter

CESM 1.0.4
CARMA 3.0
1.9x2.5 resolution

Partial column HNO_3 compares with MLS and WACCM results

- MLS shows 30% of HNO_3 is removed over the winter.
- Some permanent denitrification is due to dynamics and chemistry.

Total HNO_3

STS-PSC ——

STS-PSC - - - - -

turn off sedimentation

Gas phase HNO_3

STS-PSC ——

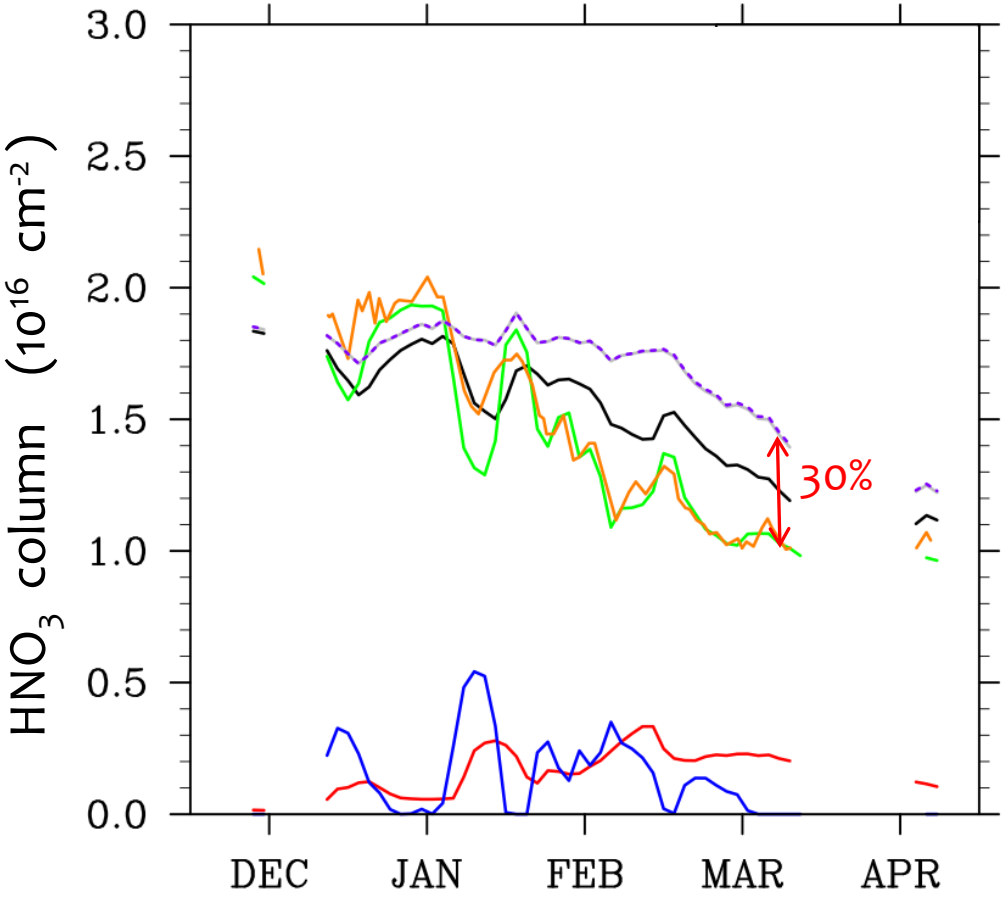
MLS ——

WACCM ——

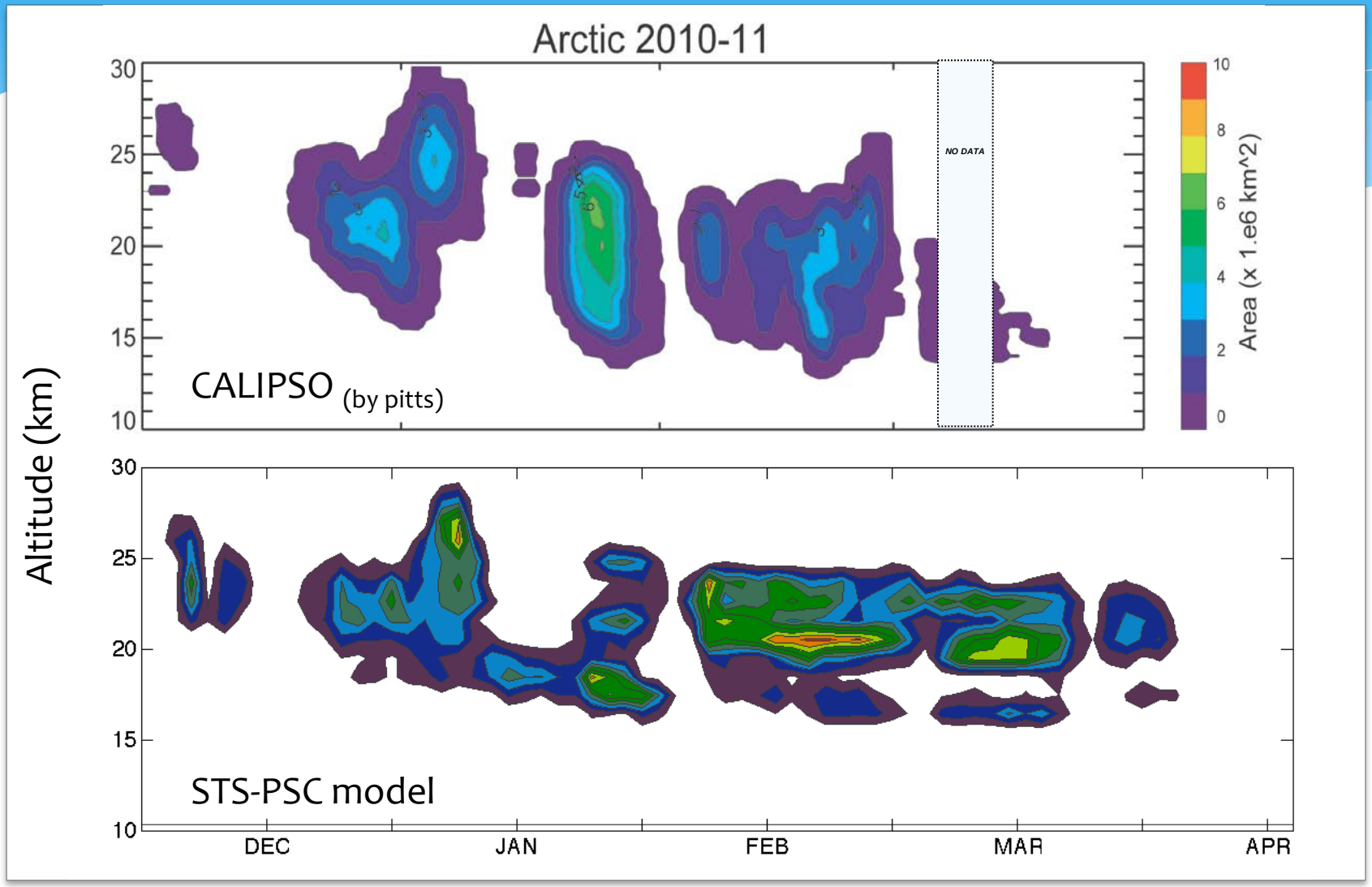
Condensed phase HNO_3

STS-PSC ——

WACCM ——

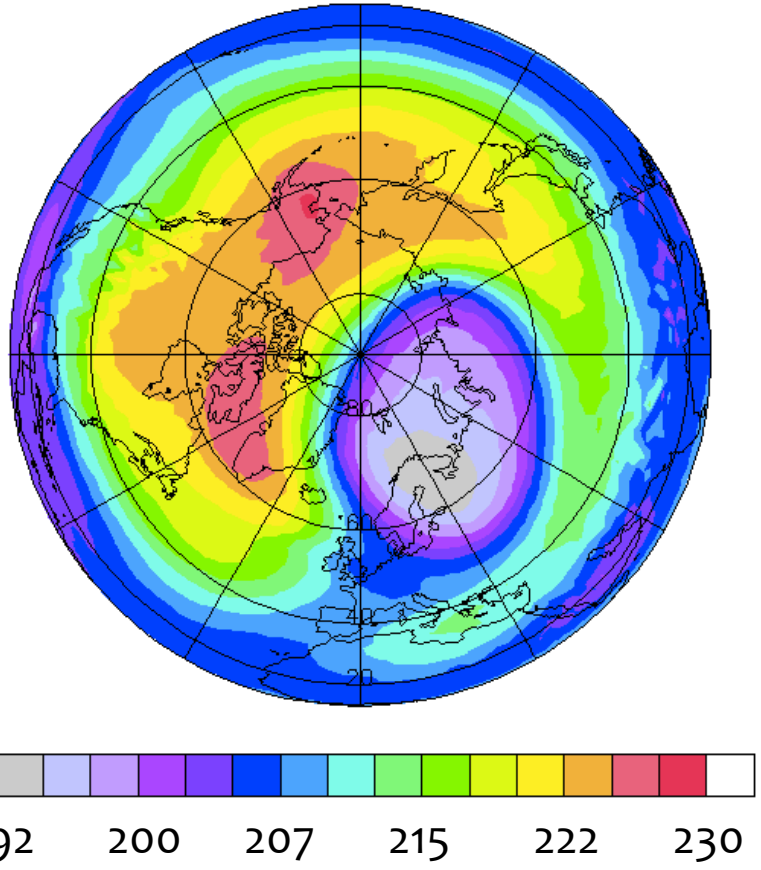


Simulated cloud coverge agrees well with CALIPSO data, but clouds persist too long due to low denitrification.



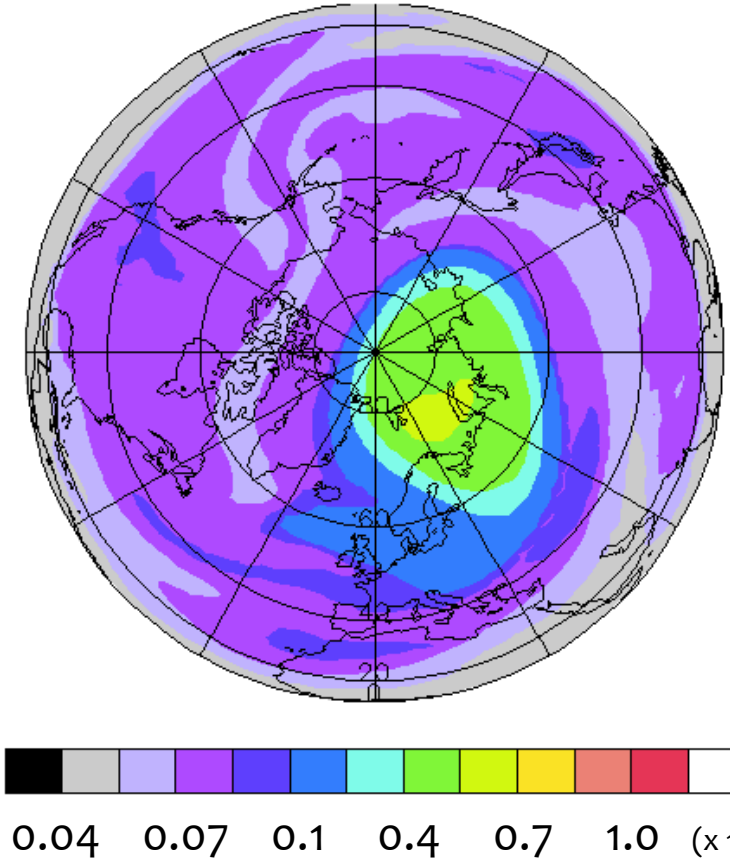
Temperature pattern explains why PSCs haven't disappeared in the model in April.

T(K) 52mbar, Apr 01



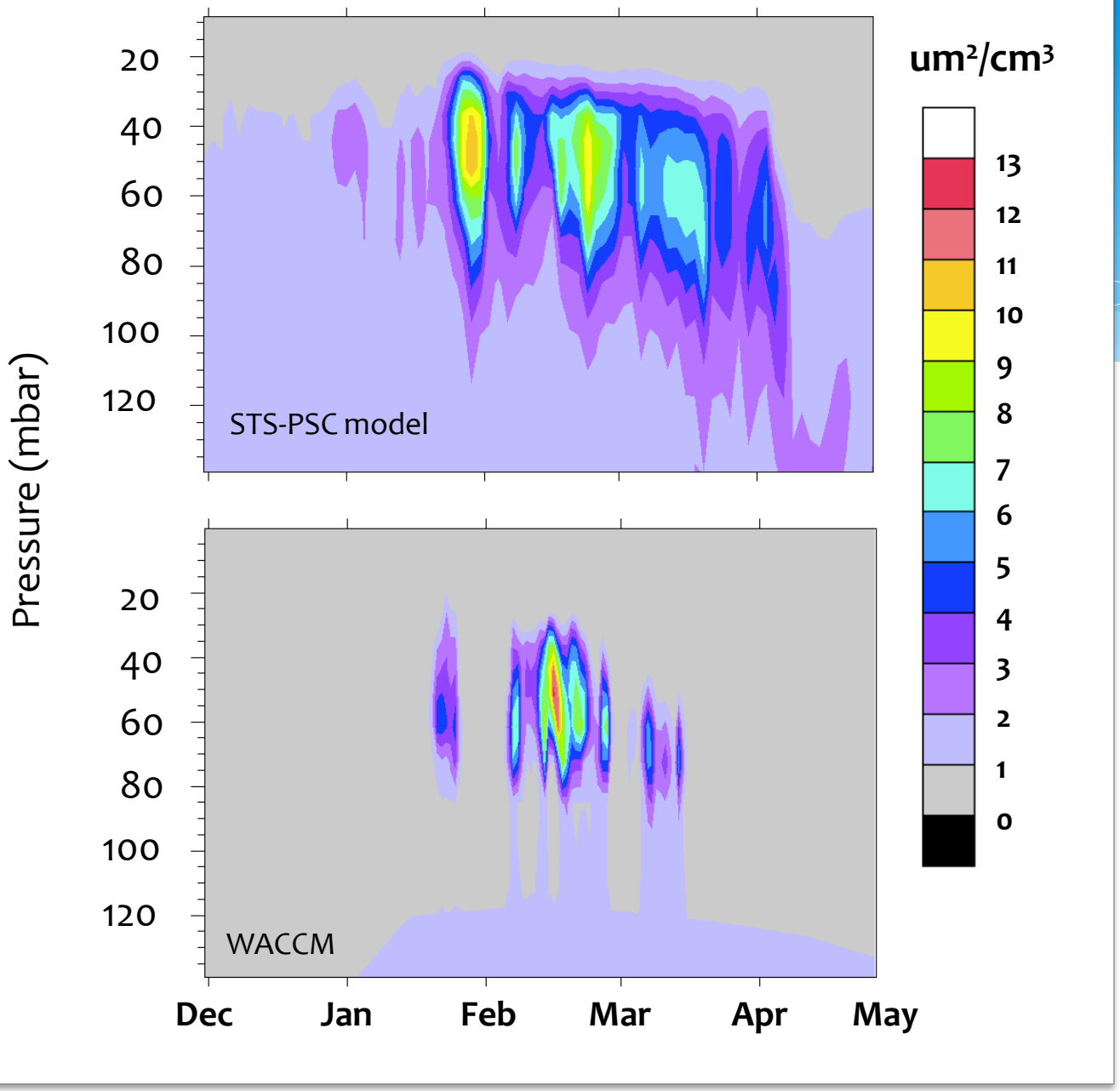
192 200 207 215 222 230

Condensed HNO_3 (g/cm^3) 52mbar, Apr 01



0.04 0.07 0.1 0.4 0.7 1.0 (x $1e^{12}$)

Surface area density



WACCM and CARMA shows the same magnitude of surface area density around the same height.

However, CARMA clouds last longer due to the lack of denitrification.

Conclusion

* STS-PSC model in WACCM/CARMA catches the microphysics features (size distribution and particle volume) very well.

* About 30% of HNO_3 inside the vortex in 2010-2011 spring removed by NAT and ice particles, which are missing in STS-PSC model.

* The cloud coverage in STS-PSC model compares with CALIPSO data indicating the good treatment of growth and evaporation in STS-PSC model.

* SD-WACCM-MOZART and SD-WACCM-CARMA show the similar magnitude of surface area density in Jan and early Feb.

Future work

* Develop full PSC model: consider freezing processes. Add SAT, NAT to the model; add ice particles as a third step.

* Do more complete comparisons with observations on 2010-2011 winter.


Photo by *Alan Robock*
Thank you!