Wave clouds and PSCs above Scott’s Discovery Hut at sunset, Sept. 26, 2004.
Photo by Alan Robock
What are PSCs and what do they do?

- **H2SO4 aerosol**
- **STS (Supercooled Ternary solution)**
- **NAT (Nitric acid trihydrate)**
- **Ice particle**

**Processes:**
- Chlorine activation
- Denitrification
- Dehydration
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

WACCM/CARMA Model

1. Emissions
   - SO₂, OCS

2. Chemistry
   - Sulfur chemistry
   - H₂SO₄ formed
   - Turn off denitrification in PSC chemistry

3. Nucleation
   - H₂SO₄ and H₂O gases form sulfate aerosol

4. Condensational growth
   - H₂SO₄, HNO₃ and H₂O gases condense/evaporate to form STS

5. Coagulation
   - 4°x5° resolution
   - Dynamics/Transport
   - WACCM 3.1.9
   - CARMA
   - 20 bins x 2
   - 0.2 nm-1.0 µm dry radius

6. Deposition, Sedimentation
   - WACCM
   - CARMA
Particle volumes compare well with aircraft observations at 55 mbar.

Obs (Dye, 1992)

- $90^\circ$S - $86^\circ$S
- $82^\circ$S - $78^\circ$S
- $74^\circ$S - $70^\circ$S
- $66^\circ$S - $62^\circ$S

Particle Volume ($\mu$m$^3$/cm$^3$)

- $T_{\text{ICE}}$
- $T_{\text{STS}}$

Temperature ($T$ (K))
Size distribution at 24 mbar compares well with satellite and balloon data.
SD-WACCM results: 2010-2011 winter

CESM 1.0.4
CARMA 3.0
1.9x2.5 resolution
Partial column HNO₃ compares with MLS and WACCM results

- MLS shows 30% of HNO₃ is removed over the winter.
- Some permanent denitrification is due to dynamics and chemistry.
Simulated cloud coverage 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.
WACCM and CARMA show 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 HNO₃ 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.
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.
Thank you!