Studies of PSC Coverage and Composition Using CALIOP Data

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Outline

• PSC detection and areal coverage
• PSC composition
  – Classification scheme
  – Comparison with MIPAS
  – Seasonal evolution
  – Thermodynamic verification using Aura MLS HNO$_3$ & H$_2$O data
• Case study of NAT formation
• RECONCILE
• PSCs are detected as statistical outliers in scattering ratio (total/molecular backscatter) or $\beta_\perp$ at 532 nm.

• Successive horizontal averaging (5, 15, 45, & 135 km)
  
CALIOP PSC Areal Coverage

Antarctic 2006

Antarctic 2007

Antarctic 2008

Arctic 2006-07

Arctic 2007-08

CALIPSO PSC Volume

2006-07

2007-08
Pitts et al., 2009, *Atmos. Chem. Phys. Discuss.*, 9, 8121-8157
CALIPSO vs MIPAS PSC Composition

- Different approaches: lidar vs. IR limb emission/scattering (12-13 μm)
- Approximately 3000 coincident (<6hr,<200km) PSC observations in Antarctic in 2006-2007
- Good agreement overall, especially between MIPAS NAT and CALIPSO Mix1/Mix2 (90%)
- Höpfner et al., 2009, JGR (accepted)
The values have been normalized by the total PSC area to show the relative coverage of each composition class as indicated by the color bars.
PSC Occurrence Relative to $T_{\text{NAT}}$

Antarctic 2006-2008
Onset of PSCs in May 2007
Onset of PSCs in May 2007

NAT Cloud (Mix2)

5-day Back Trajectories

NAT Cloud

Temperature History

STS Cloud

21 May

26 May
RECONCILE

• Four-year (2009-2013) EU project: “Reconciliation of essential process parameters for an enhanced predictability of Arctic stratospheric ozone loss and its climate interactions”

• We are an invited Associated Partner (Work Package 2: PSC Microphysics and Heterogeneous Chemistry, led by Prof. Thomas Peter, ETH-Zurich)
  – Intensive field campaign in Kiruna, Sweden, January-March 2010 (two separate deployments, 30 days apart)
  – M55-Geophysica high-altitude aircraft with full instrument suite, many flights targeting in-situ measurements in PSCs
  – Match campaign with balloon-borne O₃, H₂O, and backscatter measurements
CALIPSO and RECONCILE

- CALIOP expedited browse images used to identify PSC regions for flight planning purposes
- Possible direct aircraft underflights of CALIPSO, as well as coordination of Match balloon launches with CALIPSO overpasses
- Quick-look comparison of CALIOP PSC data products with aircraft and balloon-borne data during field mission, more comprehensive comparisons during extended post-campaign data analysis phase
- Monitoring of PSC activity between two separate phases of field campaign
- Use multi-year Antarctic and Arctic CALIOP PSC database to expand studies beyond limited scope of field campaign
BACKUP SLIDES
CALIOP PSC Composition
Inter-hemispheric Differences

Antarctic 2006-2008

Arctic 2006/07-2007/08
PSC Area versus $T<T_{\text{NAT}}$ Area

Equilibrium $T_{\text{NAT}}$ values calculated using Hanson and Mauersberger (1988) relationship with cloud-filtered Aura MLS HNO$_3$ and H$_2$O mixing ratio measurements.
Seasonal Evolution of Aura MLS
HNO₃ and H₂O Mixing Ratio

PSC Occurrence Relative to $T_{NAT}$

Antarctic 2006-2008

June 14 km

July 14 km

August 14 km

September 14 km

October 14 km