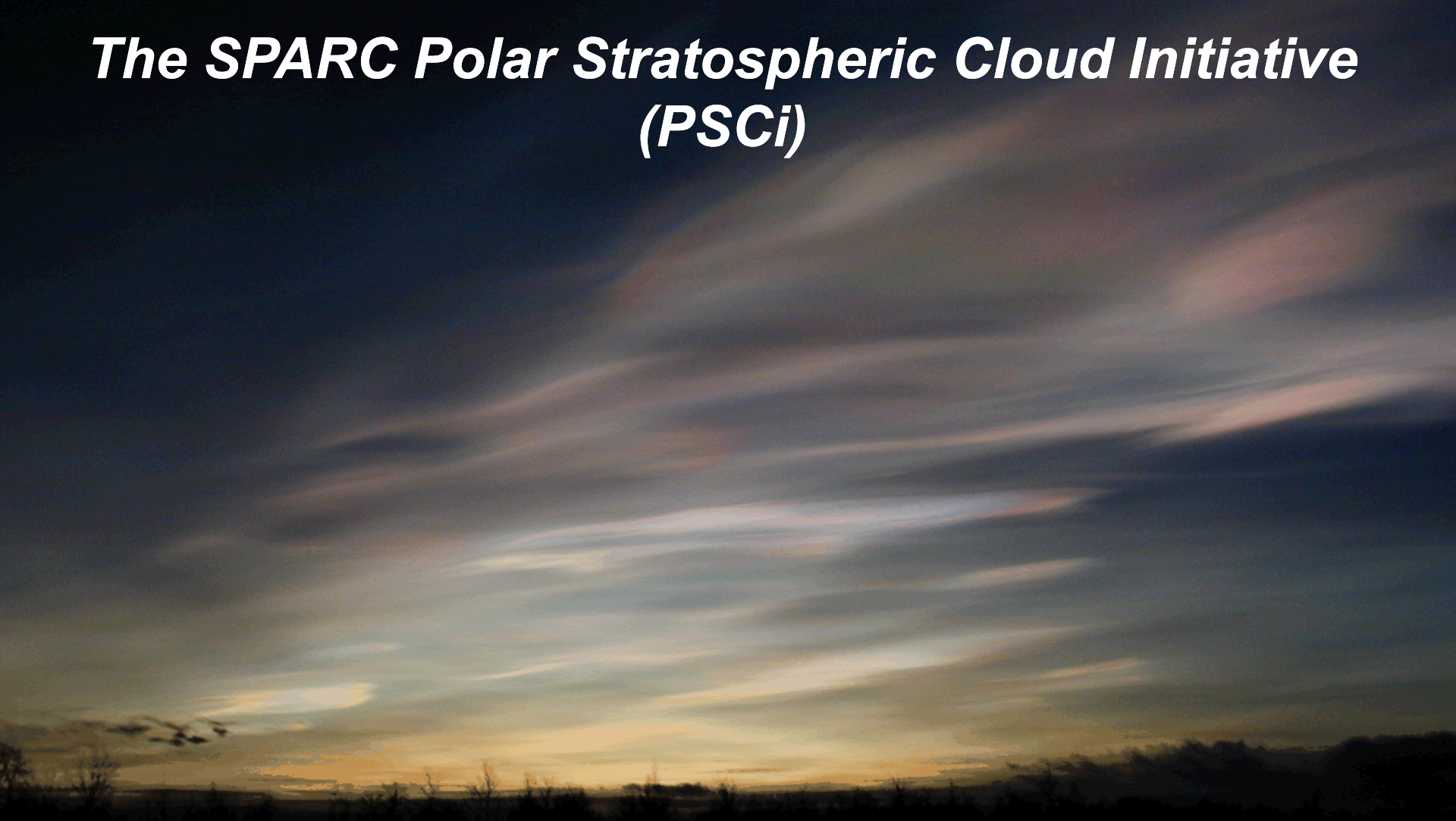
The SPARC Polar Stratospheric Cloud Initiative (PSCi)



Michael Pitts[1], Lamont Poole[2], Ines Tritscher[3], Reinhold Spang[3], Michael Höpfner[4], and the PSCi Team

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POLAR 2018

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What are Polar Stratospheric Clouds (PSCs) and why are they important?

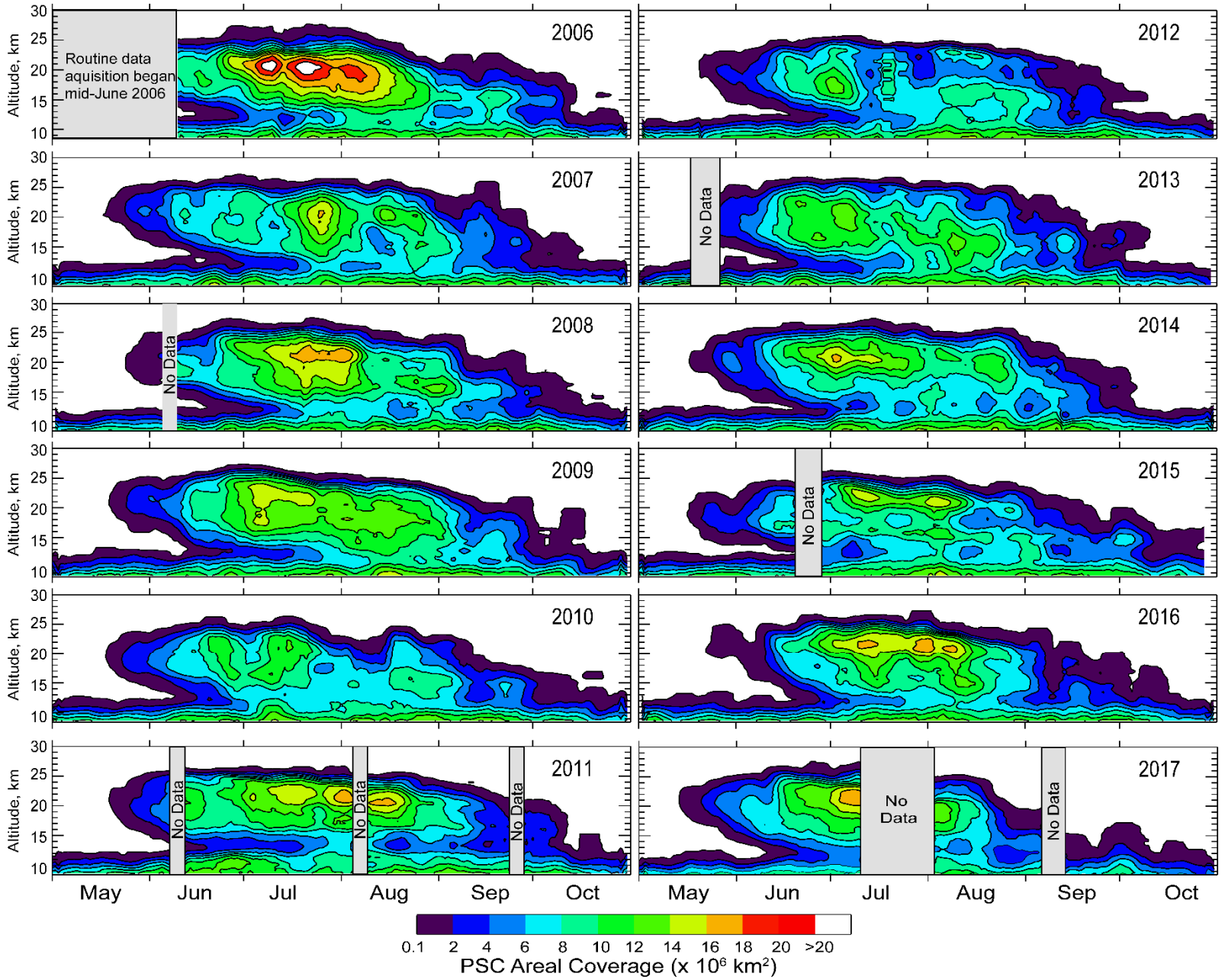
- PSCs form in the Antarctic and Arctic stratosphere at temperatures below ~195 K
- Three known particle compositions: liquid super-cooled ternary solution (STS) H_2SO_4-HNO_3-H_2O droplets, nitric acid trihydrate (NAT) crystals, and H_2O ice
- PSCs play key roles in chemical depletion of ozone at high latitudes
  - Heterogeneous (mixed-phase) reactions on PSC particle surfaces convert inactive chlorine reservoirs (HCl and $ClONO_2$) to active (ozone-depleting) chlorine radicals
  - Sedimentation of large NAT particles irreversibly removes odd nitrogen (denitrification), which delays chlorine deactivation and prolongs ozone depletion
- Significant gaps in knowledge still exist
  - Large solid particle formation and their denitrification potential (NAT rocks)
  - Extent of chlorine activation on cold background stratospheric aerosol
  - Limit our ability to accurately represent PSCs in global models and call into question our predictions of ozone recovery in a changing climate
- CALIPSO PSC observations helping to fill these gaps

Polar Stratospheric Cloud initiative

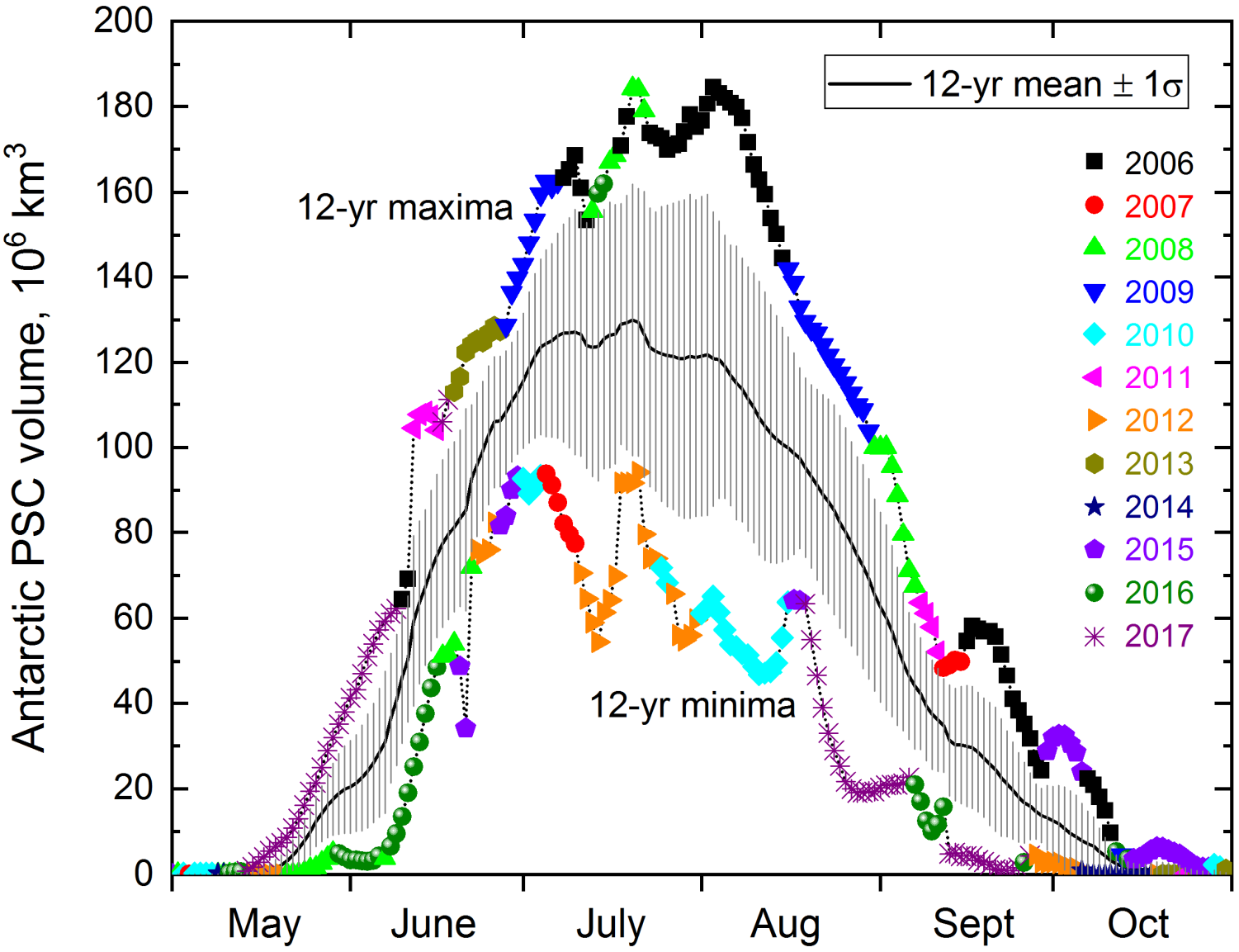
http://www.sparc-climate.org/activities/polar-stratospheric-clouds/

- PSCi began as a new SPARC activity in November 2015
  - Leads: Michael Pitts, Ines Tritscher, Lamont Poole, and Thomas Peter
- Main objectives:
  - Assess recent research developments related to PSCs
  - Compare remote and in situ datasets to identify their strengths and limitations
  - Identify the key PSC characteristics required by global models that can be estimated from measurements
  - Synthesize new datasets into a state of the art PSC climatology
  - Identify remaining open science questions
- Will ultimately lead to improved representation of PSC processes in global climate models
- Deliverables
  - Reference PSC data records (to include SAD & VD)
  - Comprehensive review paper on state of PSC science

CALIOP Antarctic PSC Data Record

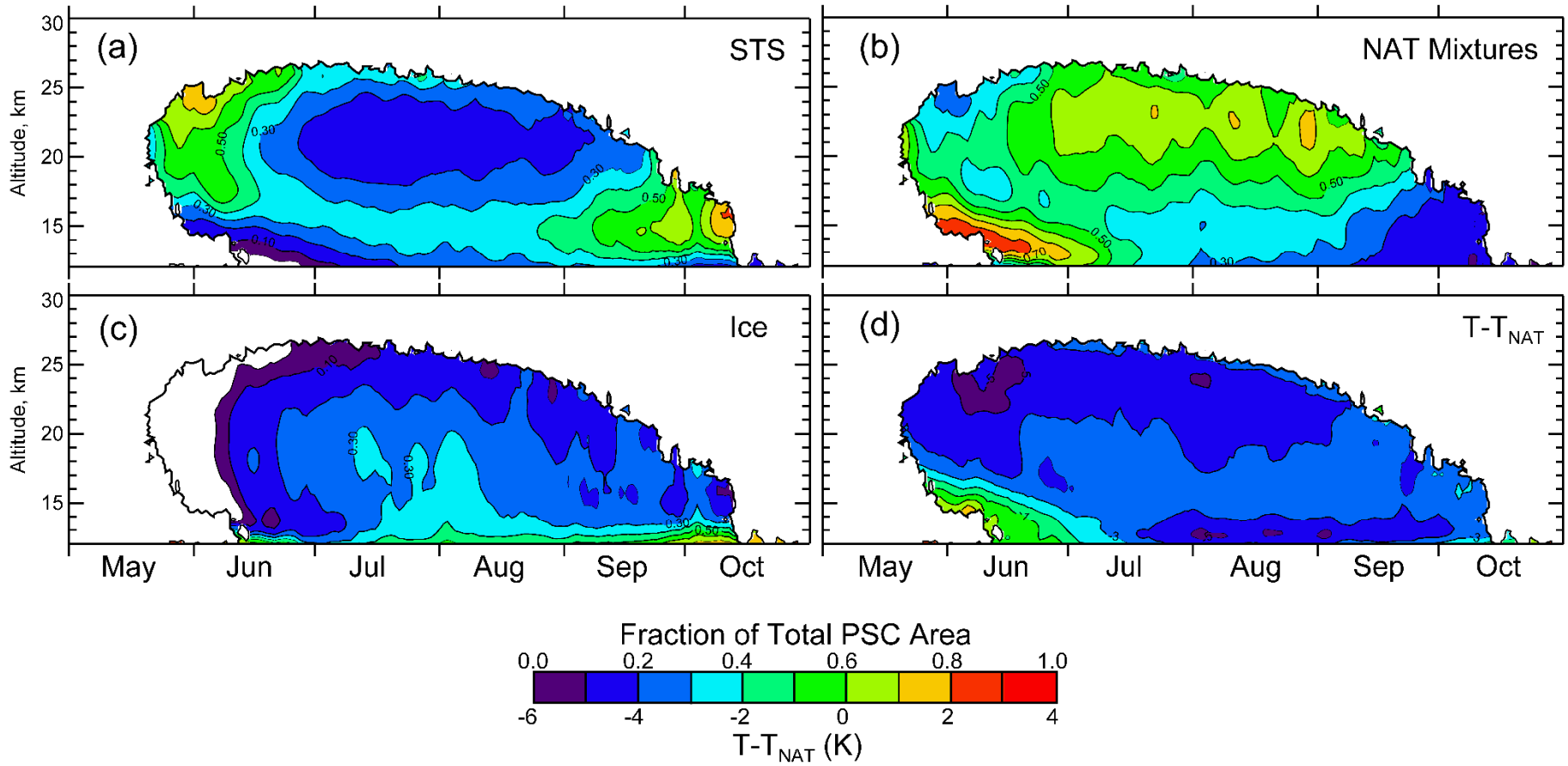


Antarctic PSC Interannual Variability



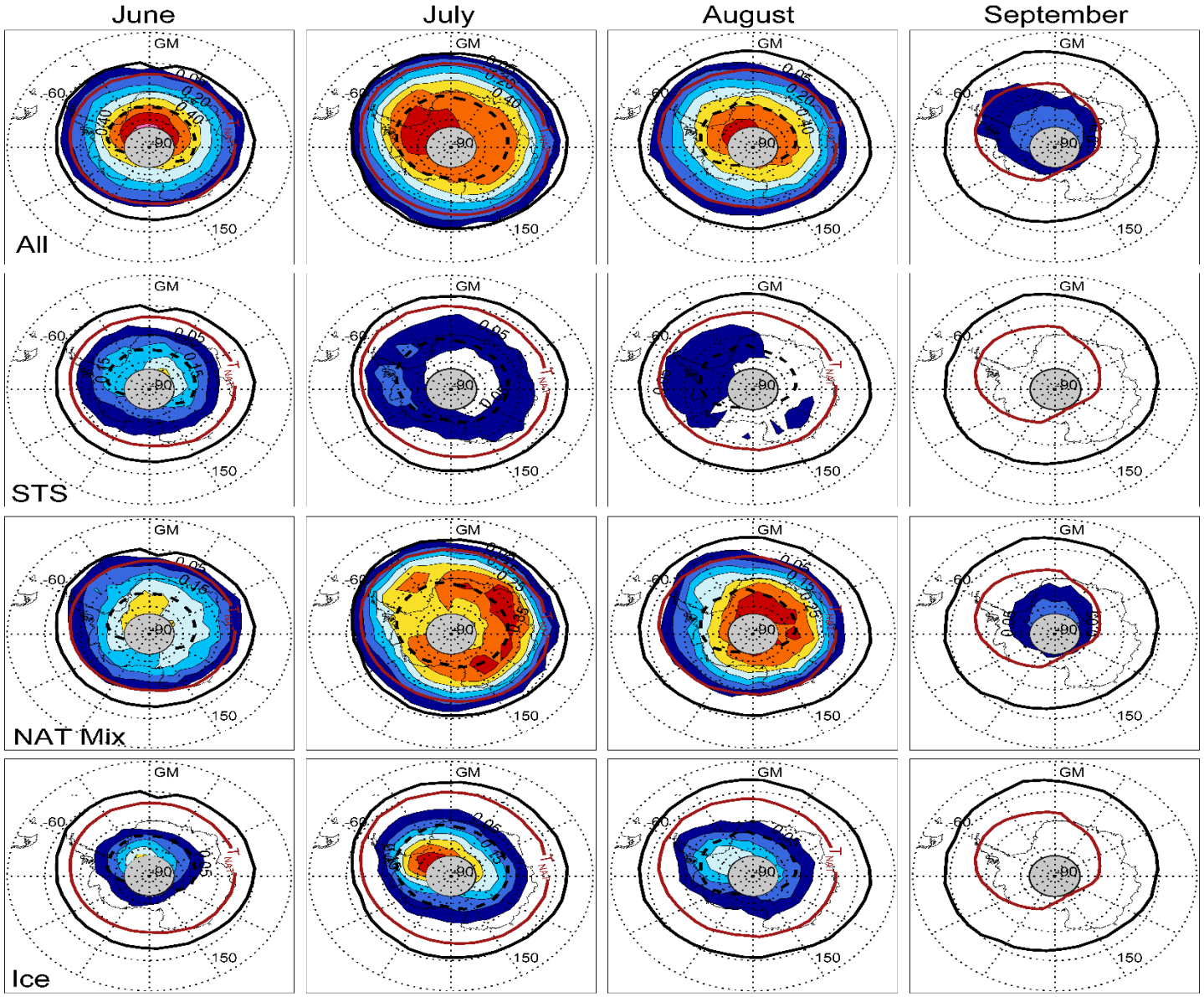
Antarctic PSC Area Fraction by Composition

Vortex Average: 2006-2017

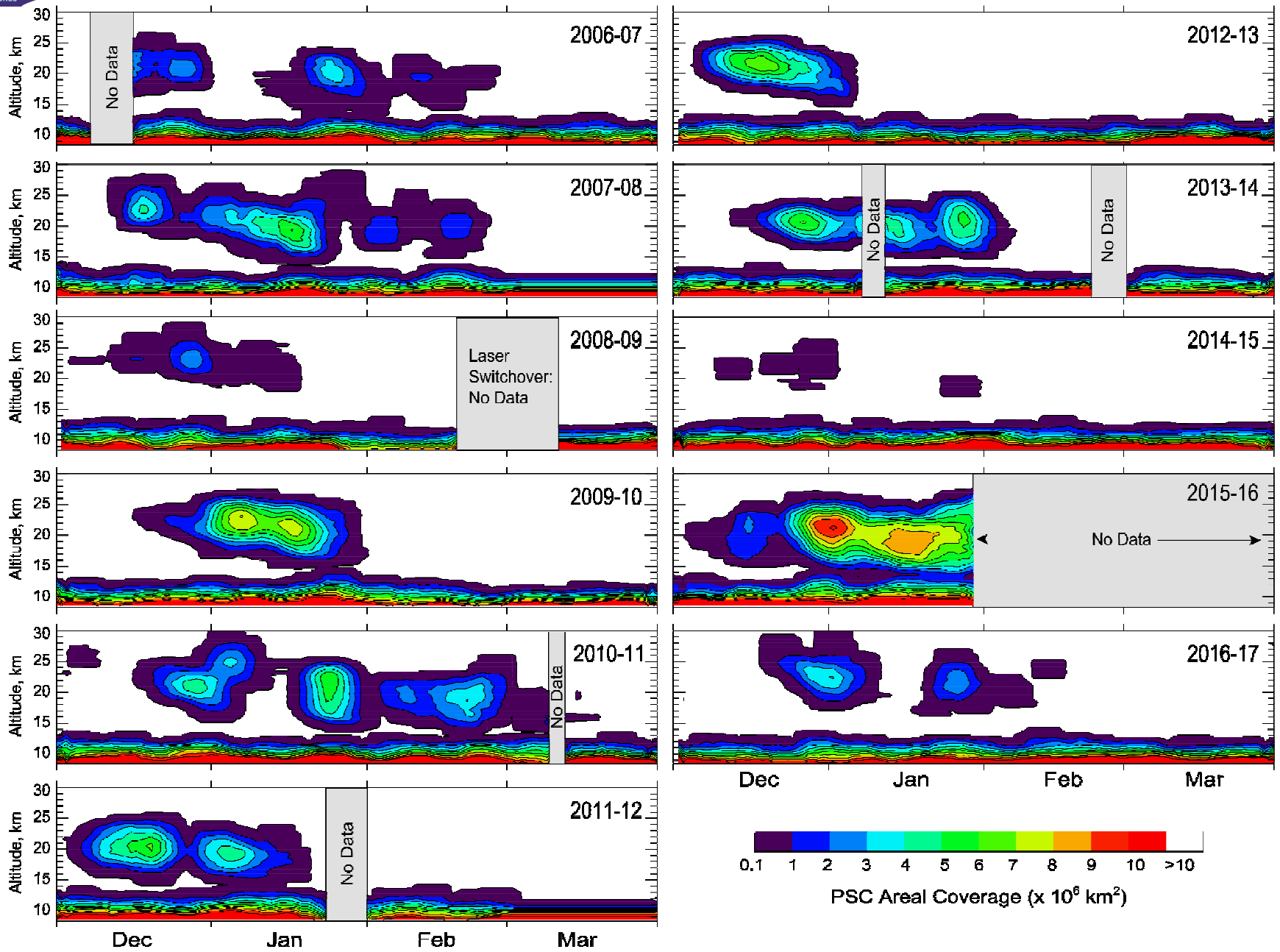


- STS is predominant composition early and again late in the season
- NAT Mixtures are widespread during middle of season and predominate at lower altitudes throughout most of season
- Ice peaks in July/August

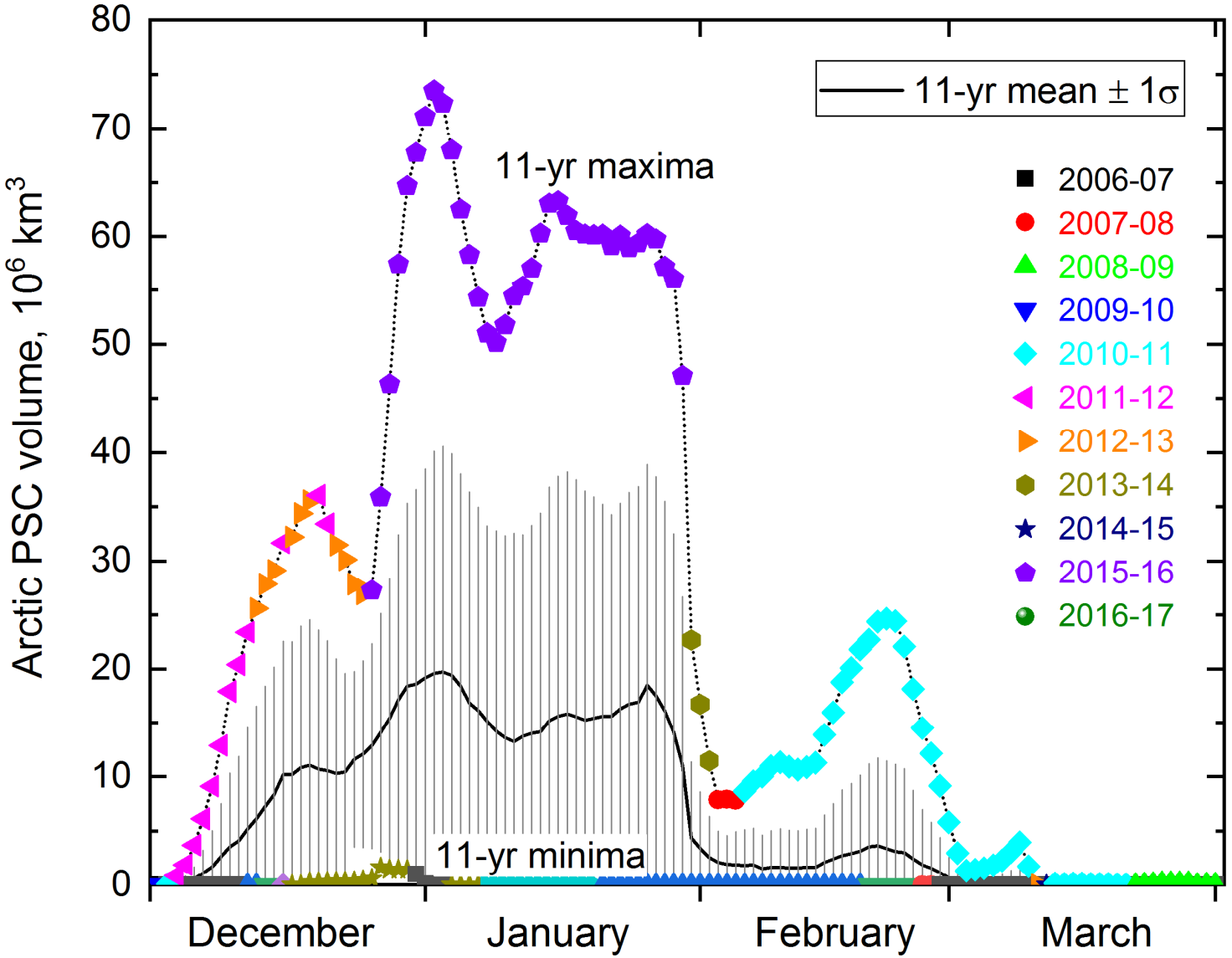
Antarctic PSC Spatial Distribution



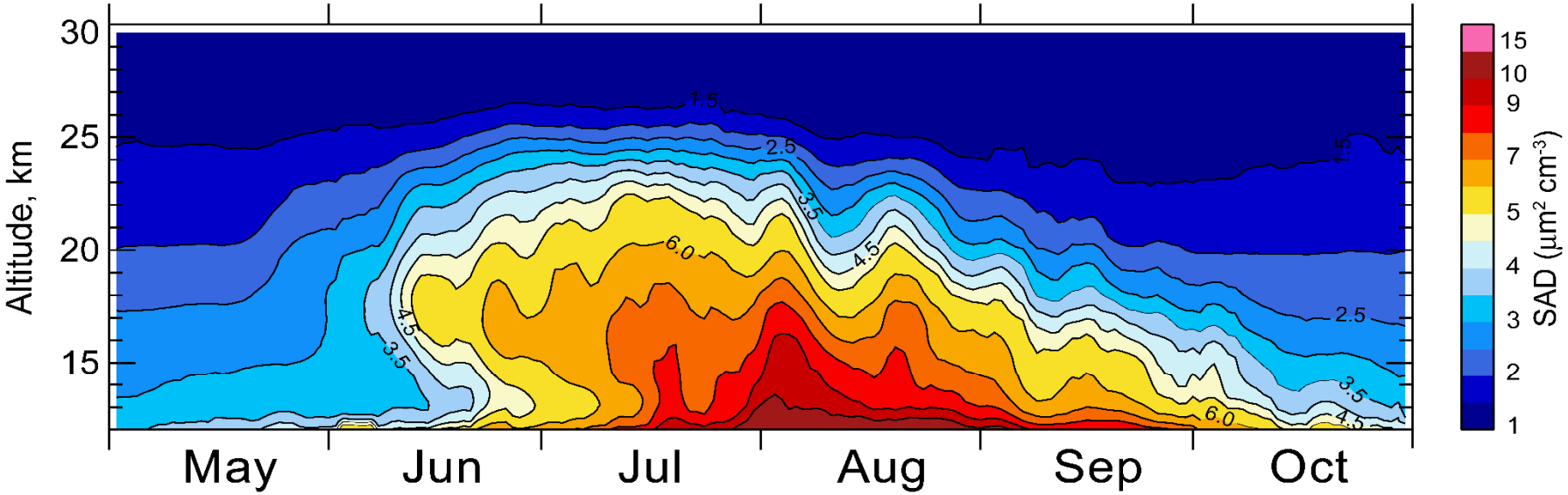
CALIOP Arctic PSC Data Record

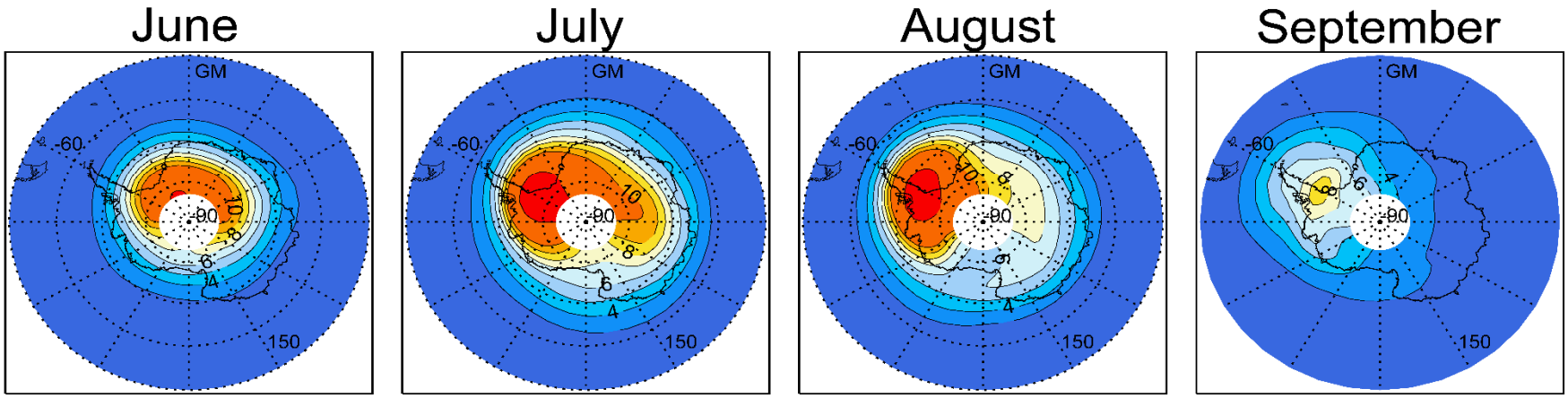


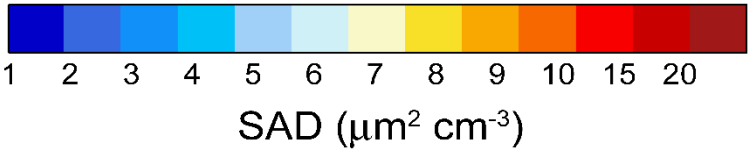
Arctic PSC Interannual Variability



Mean Antarctic SAD Distributions (2006-2017)







Summary and Outlook

- CALIOP is providing a wealth of information on PSC characteristics on unprecedented spatial scales
- Version 2 detection and composition classification algorithm incorporates major enhancements
  - Improved detection sensitivity using less conservative thresholds
  - Improved discrimination between ice and NAT mixtures under denitrified/dehydrated conditions
  - Retrieval of “unattenuated” backscatter and extinction to estimate surface area density and optical depth
- CALIOP 10-year data record has captured primary aspects of the seasonal and multi-year variability of PSCs in Antarctic and Arctic
  - Small interannual variability in Antarctic: Multi-year averages fairly representative
  - Large interannual variability in Arctic: Each Arctic winter is unique
- SPARC Polar Stratospheric Cloud initiative (PSCi) activity is ongoing
  - Reference PSC data records based on CALIOP, MIPAS, MLS, and other datasets
  - Review paper on state of PSC science