STRATOSPHERIC AEROSOL MEASUREMENTS BY THE SAGE SERIES OF INSTRUMENTS: 1975 TO 2005

Larry Thomason

NASA Langley Research Center

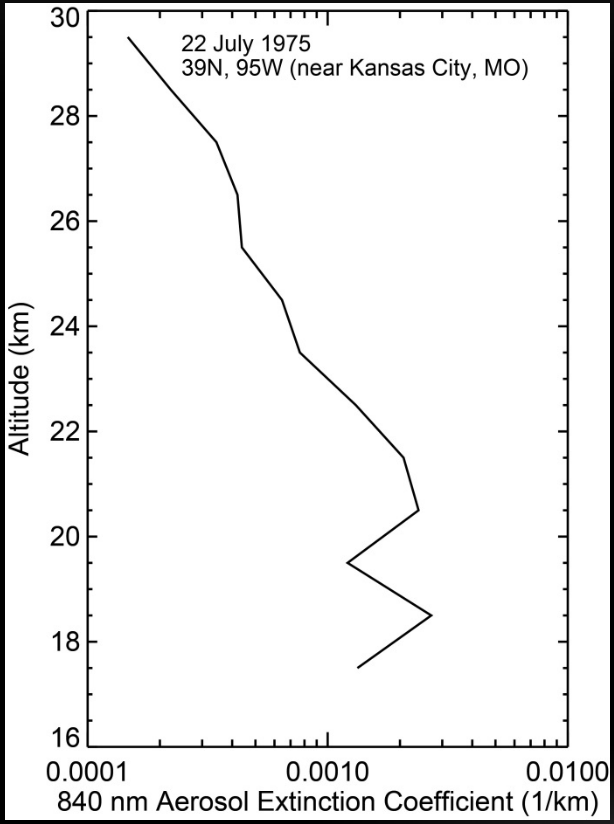
Hampton, VA USA

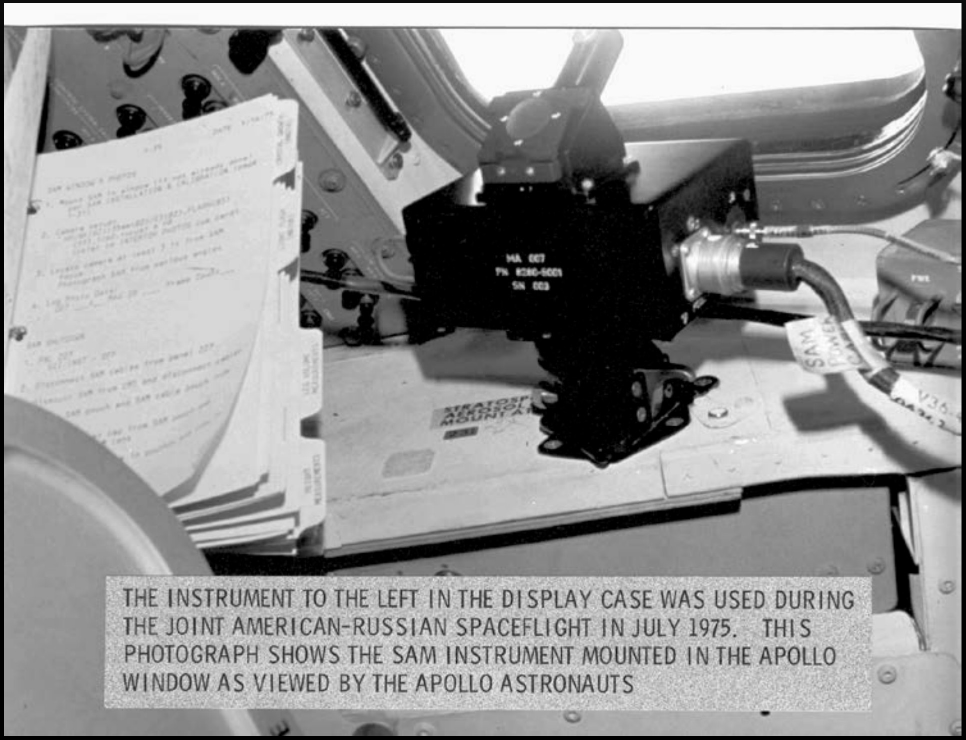
THE SAM/SAGE SERIES

Instrument	Platform	Mission Period	Aerosol Measurements
Stratospheric Aerosol Measurement	Apollo 17 (Apollo-Soyuz Experiment)	1975	840 nm
Stratospheric Aerosol Measurement (SAM II)	Nimbus 7	1978-1993	1000 nm
Stratospheric Aerosol and Gas Experiment (SAGE I)	Atmospheric Explorer Mission (AEM-2)	1979-1981	385, 450, 1000 nm
SAGE II	Earth Radiation Budget Satellite (ERBS)	1984-2005	386, 452, 525, 1020 nm
SAGE III	Meteor 3M **ISS**	2002-2005 **2015-Onwards**	385, 449, 521, 601, 676, 755, 868, 1020, 1545 nm

- Five instruments span a 30-year period with a reemergence in 2015
- SAGE II 21-year lifetime
- Last major instrument redesigned (SAGE III) occurred in the late 1980s
- A dominant theme for the ensemble data set is 'maintaining relevance in an era of substantial science requirement creep' including
  - Trends in the non-volcanic component
  - Derived products (surface area density)
  - Tropospheric applications

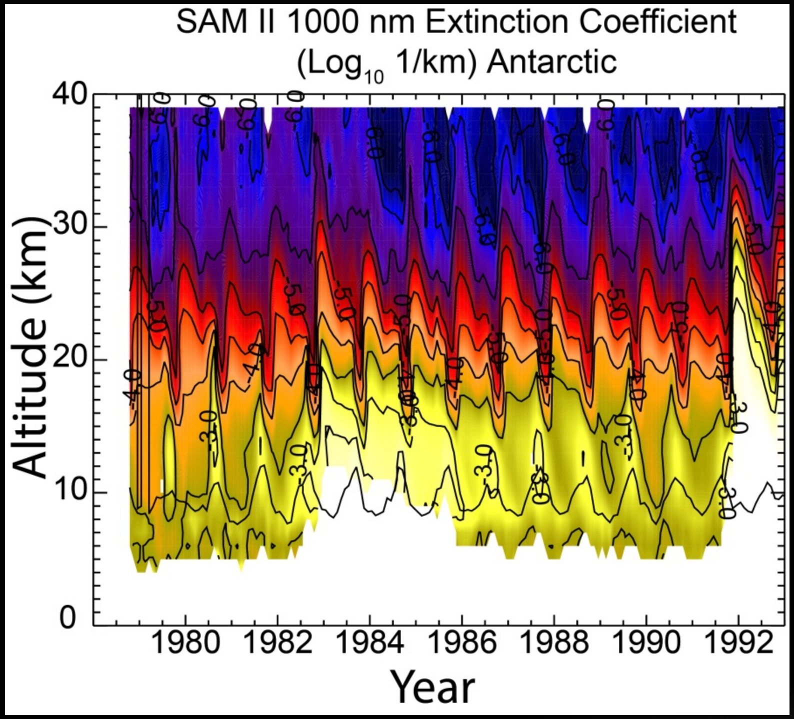
THE STRATOSPHERIC AEROSOL MEASUREMENT: THE APOLLO-SOYUZ MISSION (1975)

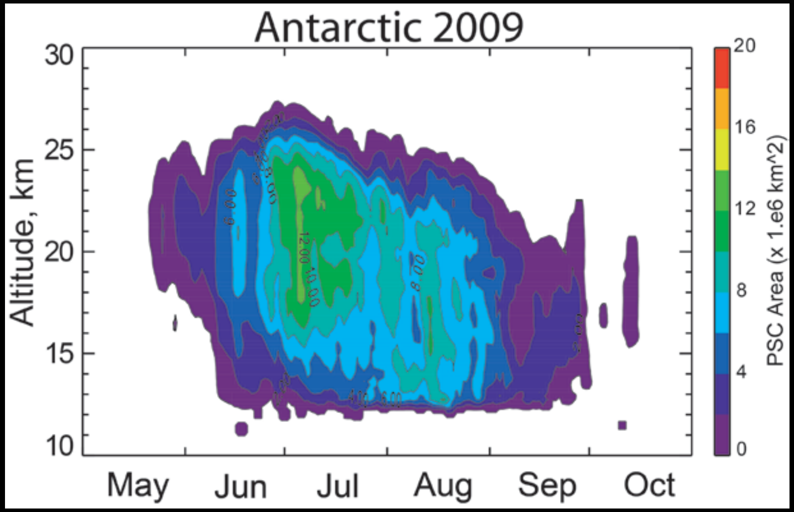




(operated by Deke Slayton)

SAM II: POLAR STRATOSPHERIC CLOUDS AND THE POLAR VORTEX

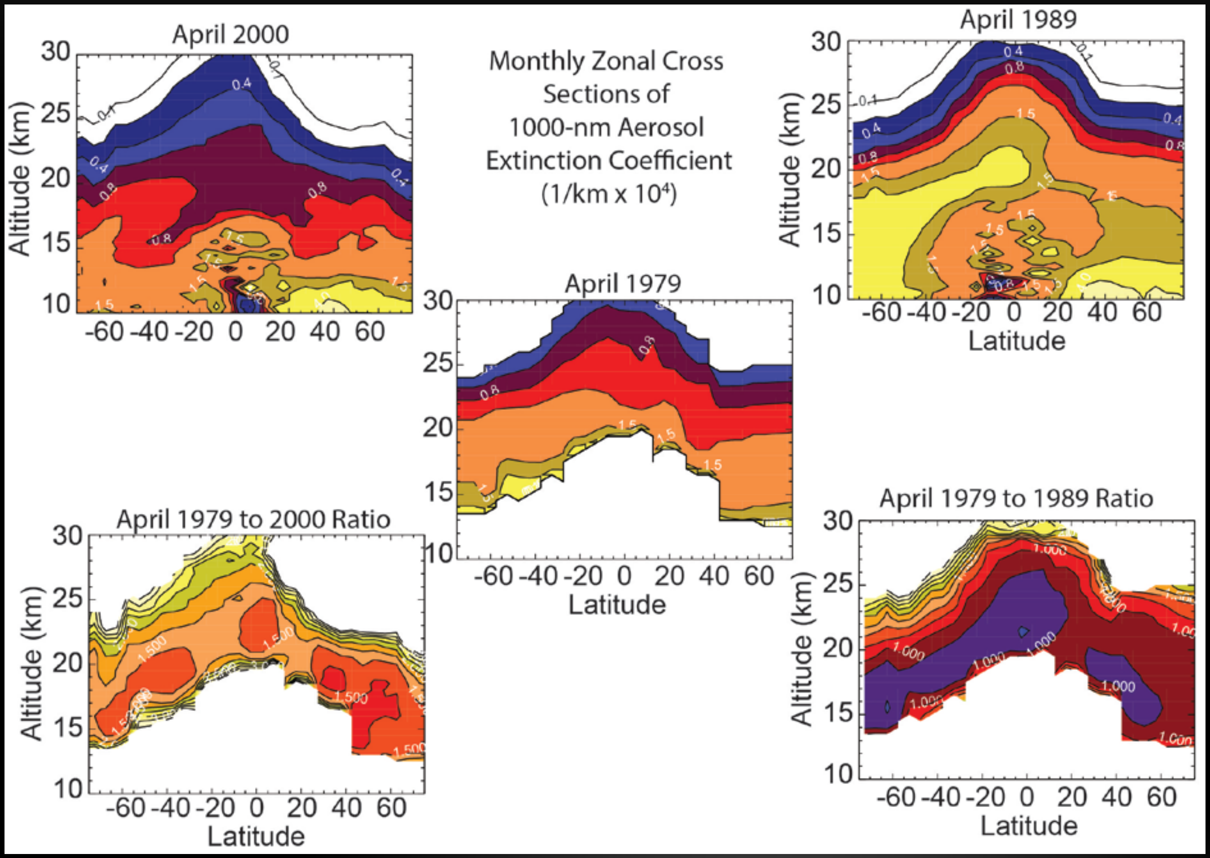




To some extent, the SAM II PSC record has been supplanted by CALIPSO

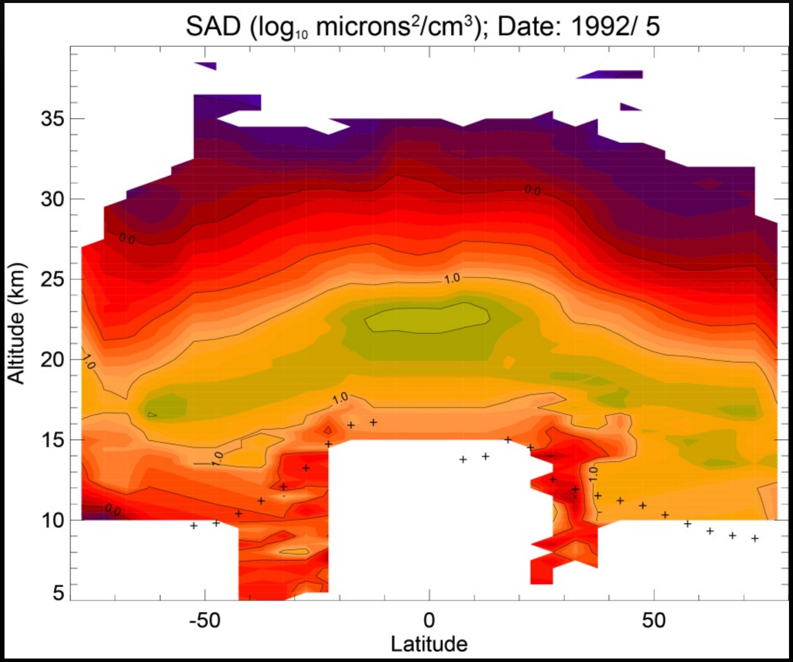
New version is expected in 2015; 1st since 1985

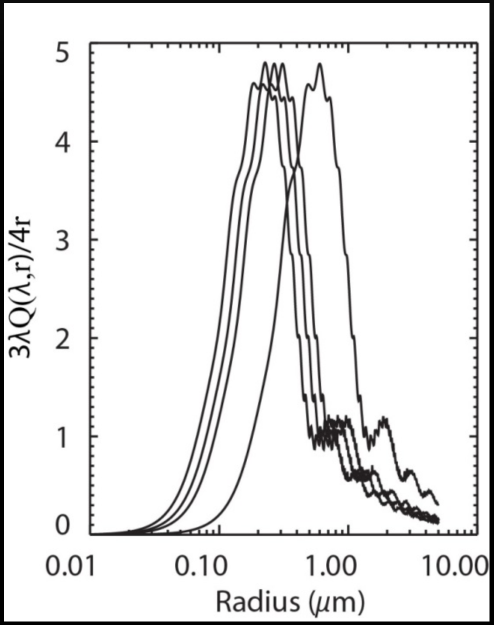
SAGE I, SAGE II AND THE STRATOSPHERIC BACKGROUND



- 1979 typically considered the nominal non-volcanic background (NVB)
- Former candidate for the SAGE II NVB is 1989 which is ~25 to 50% higher 1979
- Early 2000s have the lowest observed levels in the entire SAGE data set and approximately 50% less than 1979 levels
- New SAGE I version expected by 2015

SAGE II AND DERIVED AEROSOL PRODUCTS (1)

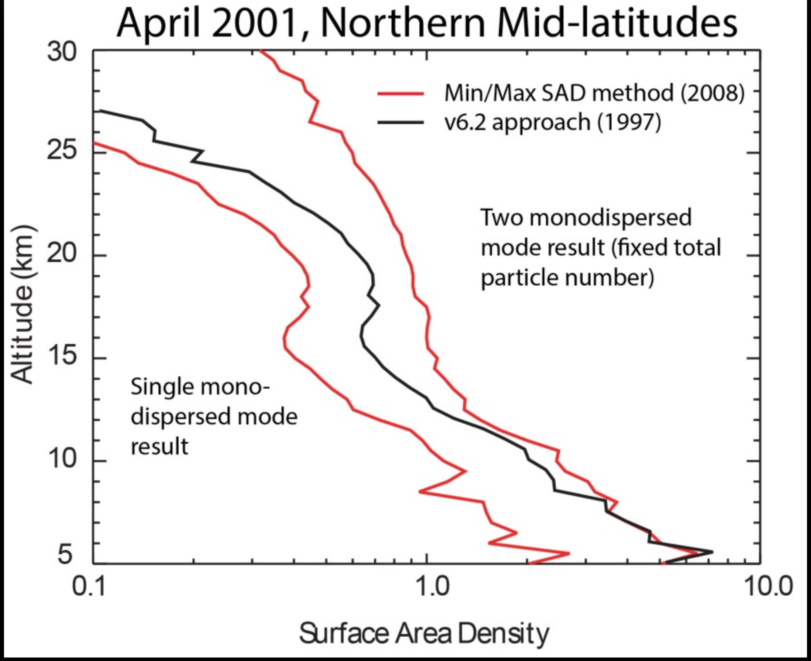




SAGE II's 21-year record of aerosol ext. coeff. measurements is an important climate resource. Derived aerosol products remain key to climate modelling.

SAD estimates are limited by a low sensitivity to small particles and all the things that must be assumed to get values out: composition, form of the size distribution, etc.

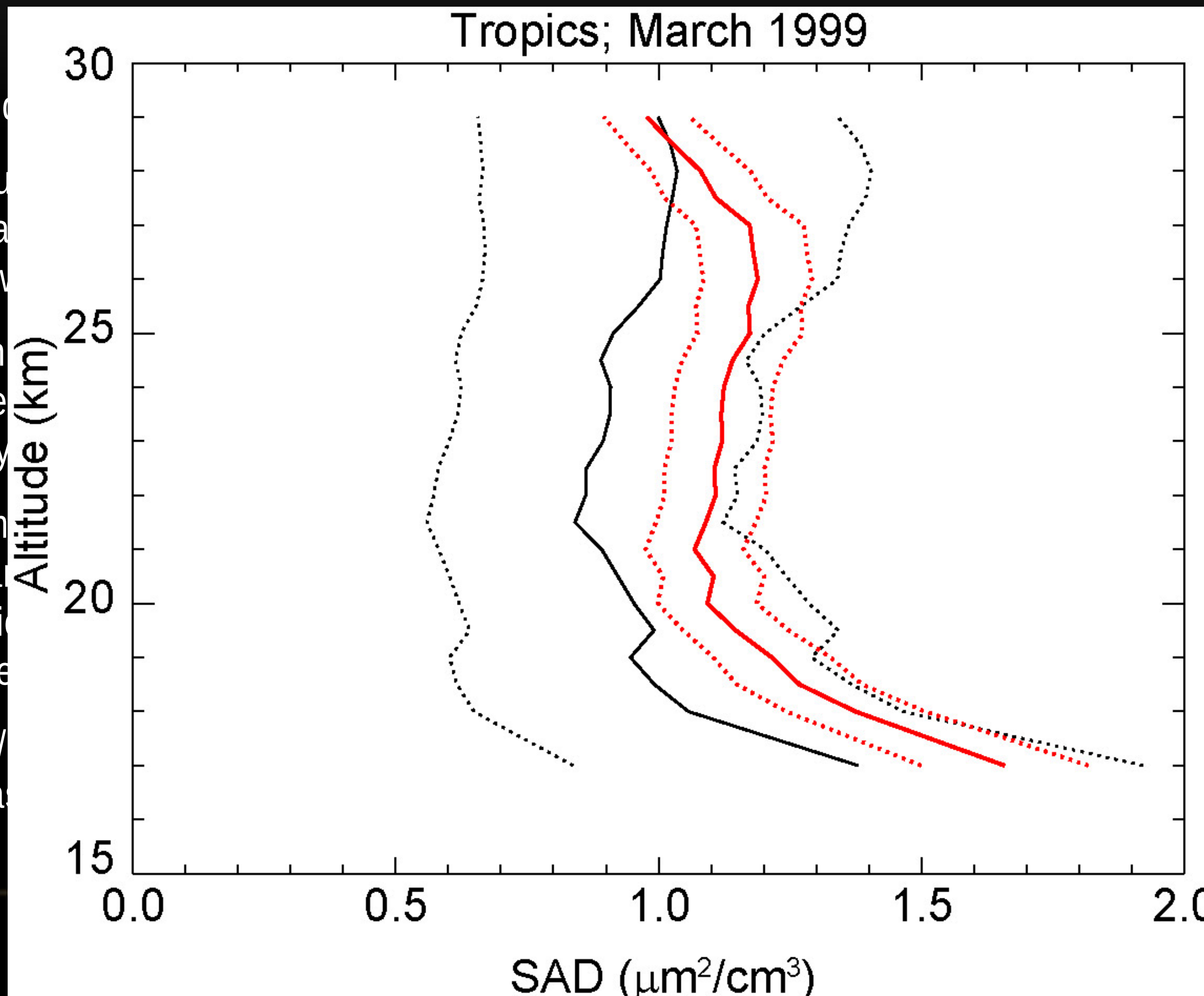
SAGE II AND DERIVED AEROSOL PRODUCTS (2)

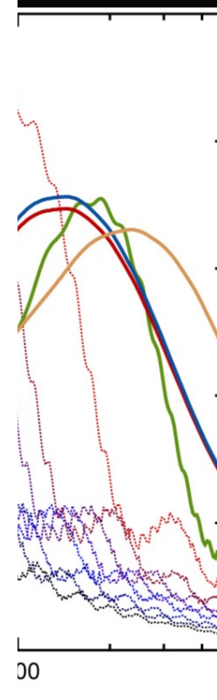


- New 'Min/Max' method tries to minimize the impact of size distribution models with the goal of bounding estimates of SAD *(not restrained by too much science)*
- Uses a pair of monodispersed modes to fit the observed spectra
- Minimum SAD is real (assuming composition is sulfate)
- Maximum SAD is bounded by setting the total particle number density to 20 cm^{-3}
- Typically a spread of a factor of 3 to 4 in clean periods; ~25% in heavily loaded periods

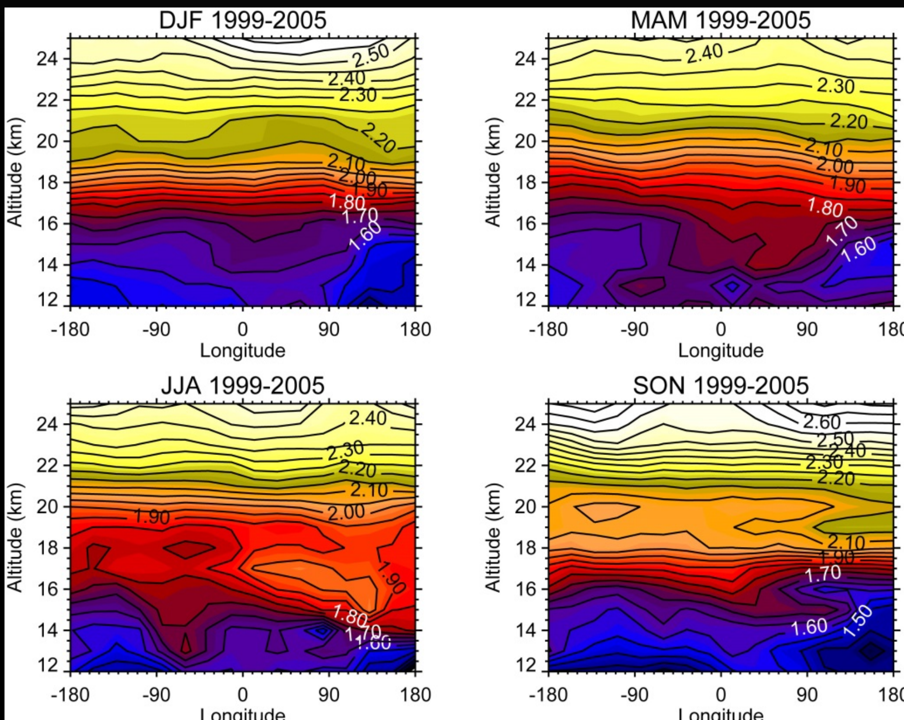
SAGE II AND DERIVED AEROSOL PRODUCTS (3)

- To what
  mitigated
- Key issu
  small pa
  shorter w
- Solution
  coefficie
  primarily
- Problem
  the IR a
  absorptio
  measure
- HALOE/
  this “fea

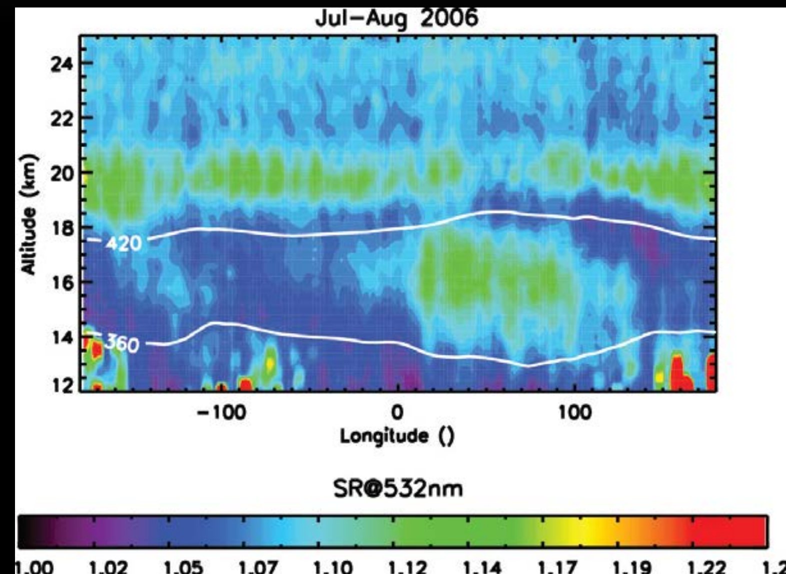




SAGE II AND THE ASIAN TROPOPAUSE AEROSOL LAYER



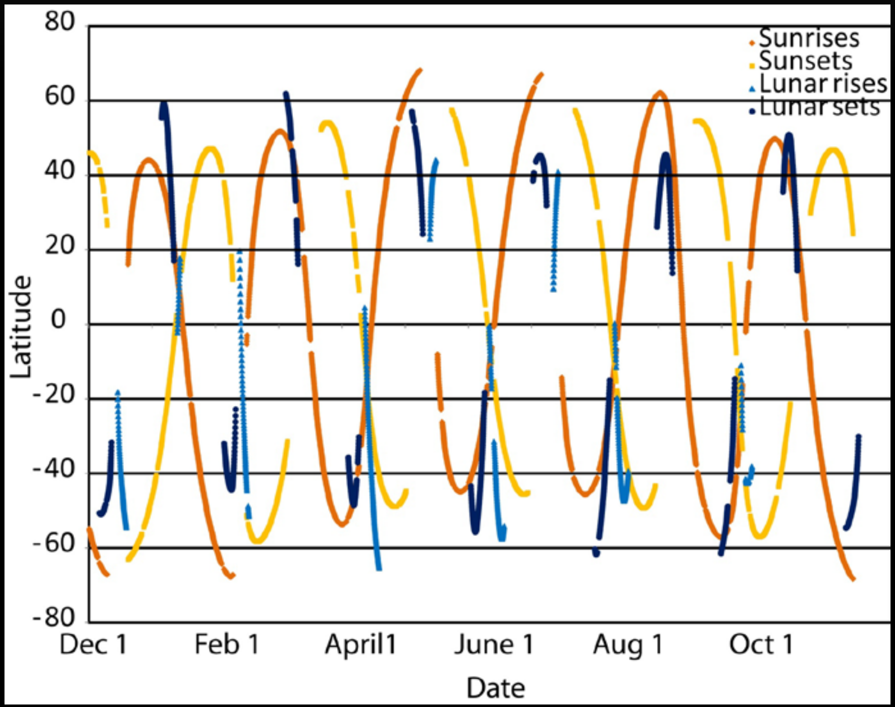
SAGE II Aerosol to Total Extinction Ratio
15 to 45N



CALIPSO Backscatter Ratio
15 to 45N

SAGE III ABOARD THE INTERNATIONAL SPACE STATION

- SAGE III is scheduled to fly aboard the International Space Station in early 2015 (51^{o} inclination orbit)
- The instrument is virtually identical to the instrument that flew aboard the Russian Meteor 3m platform 2002-2006 (solar/lunar occultation; limb)
- Significant refurbishment of the instrument is on-going including the hexapod (pointing) and a replacements of the solar attenuator
- Validation planning is underway; the collegial component will be critical



BEYOND SAGE III

- What are the science requirements that would drive a SAGE III follow-on?
  - Climate continuity requirements:
    - Maintain the SAGE ozone profile record
    - Maintain the aerosol extinction coefficient record
  - Improved science value
    - The SAGE series lacks a tracer
    - Need to reduce uncertainty in aerosol derived products
- Design alternatives
  - Target climate continuity with a SAGE II+ design (low-cost, low risk mission)
  - Add IR element (out to ~4 mm) to add IR aerosol measurements, CH_4 & N_2O

THE 2008 MODEL FOR SAD ESTIMATES