The Atmospheric Chemistry Experiment (ACE): Mission Overview

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Science Priority 1

- Measurement of regional polar O_3 budget to determine the extent of O_3 loss. This will require measurements of O_3, tracers (CH_4 and N_2O), and meteorological variables (pressure and temperature).
- Measurement / inference of details of O_3 budget by detailed species measurements (for O_3, H_2O, NO, NO_2, N_2O_5, HNO_3, HNO_4, HCl, $ClNO_3$, ClO) and modelling.
- Measurement of composition, size and density of aerosols and PSCs in the visible, near IR and mid IR (climate change).
- Comparison of measurements in the Arctic and Antarctic with models to provide insight into the differences, with emphasis on the chlorine budget and denitrification.

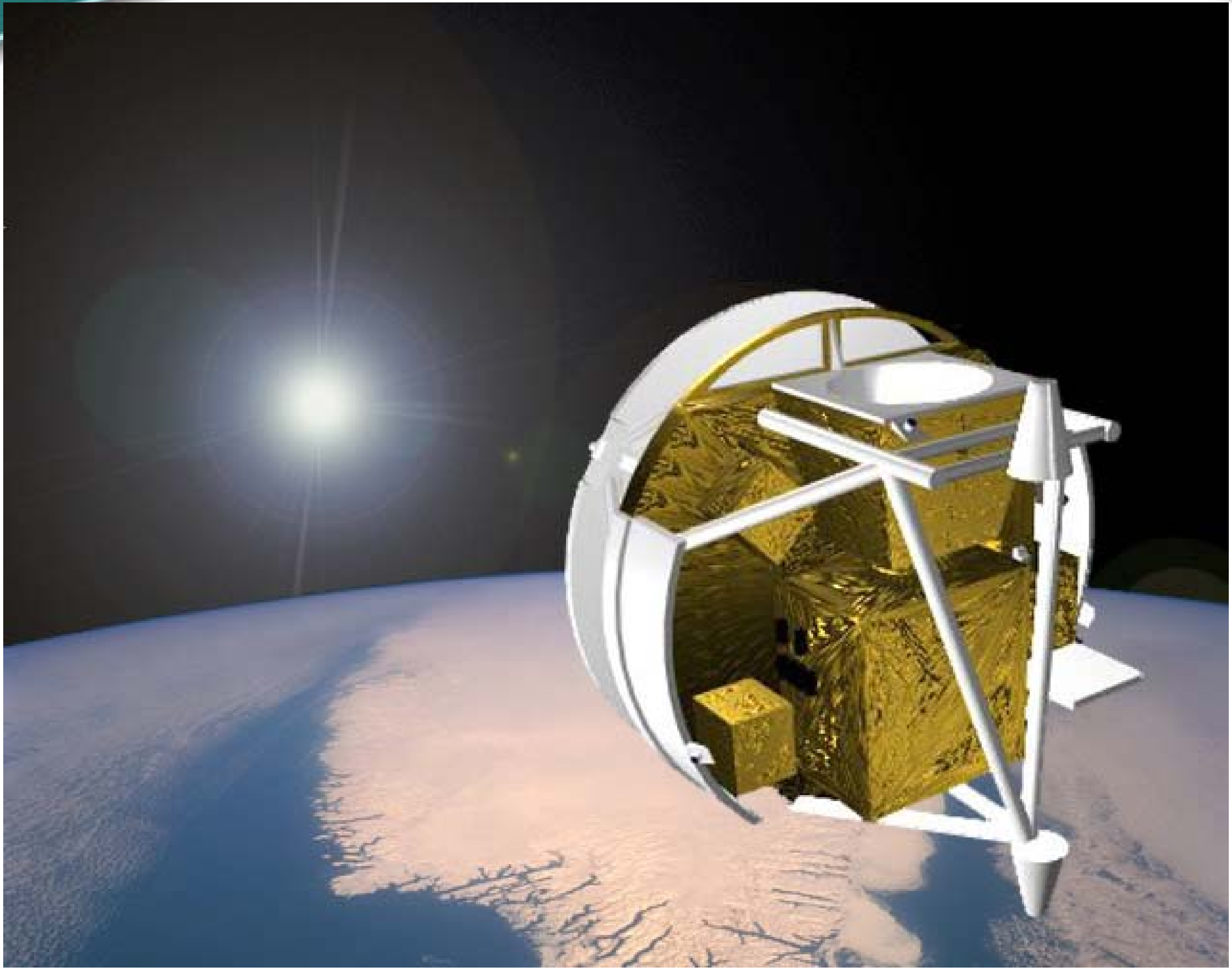
Science Priority 2

- Mid latitude O_3 budget.
- Measurement of Arctic vortex descent.
- Atmospheric dynamics- strat.-trop. exchange- H_2O, HDO, O_3.
- Study of upper tropospheric chemistry- effects of biomass burning and industrial activity.
- Monitoring of CFCs, CFC substitutes and greenhouse gases.
- Climate-chemistry coupling (Arctic O_3 hole?).

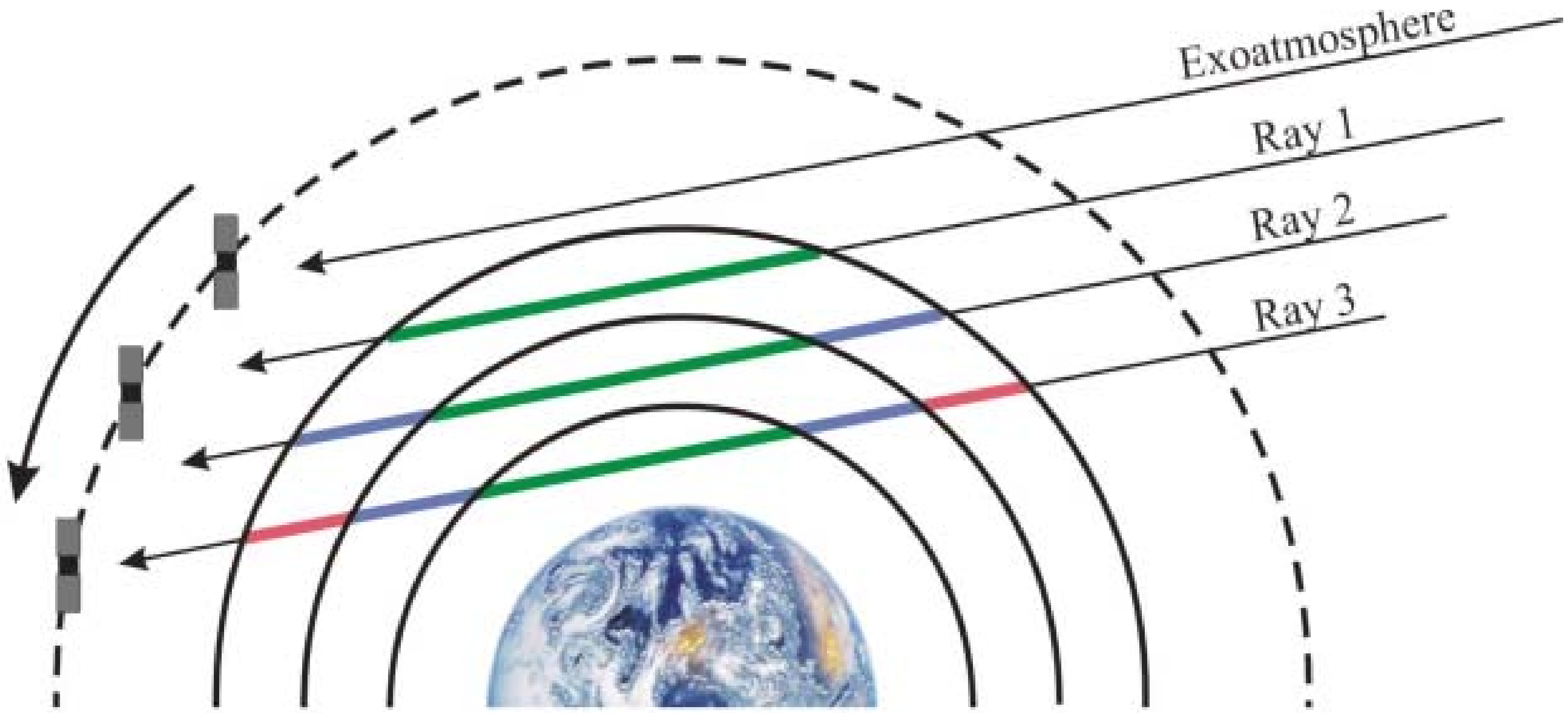
University of Waterloo

CSA ASC

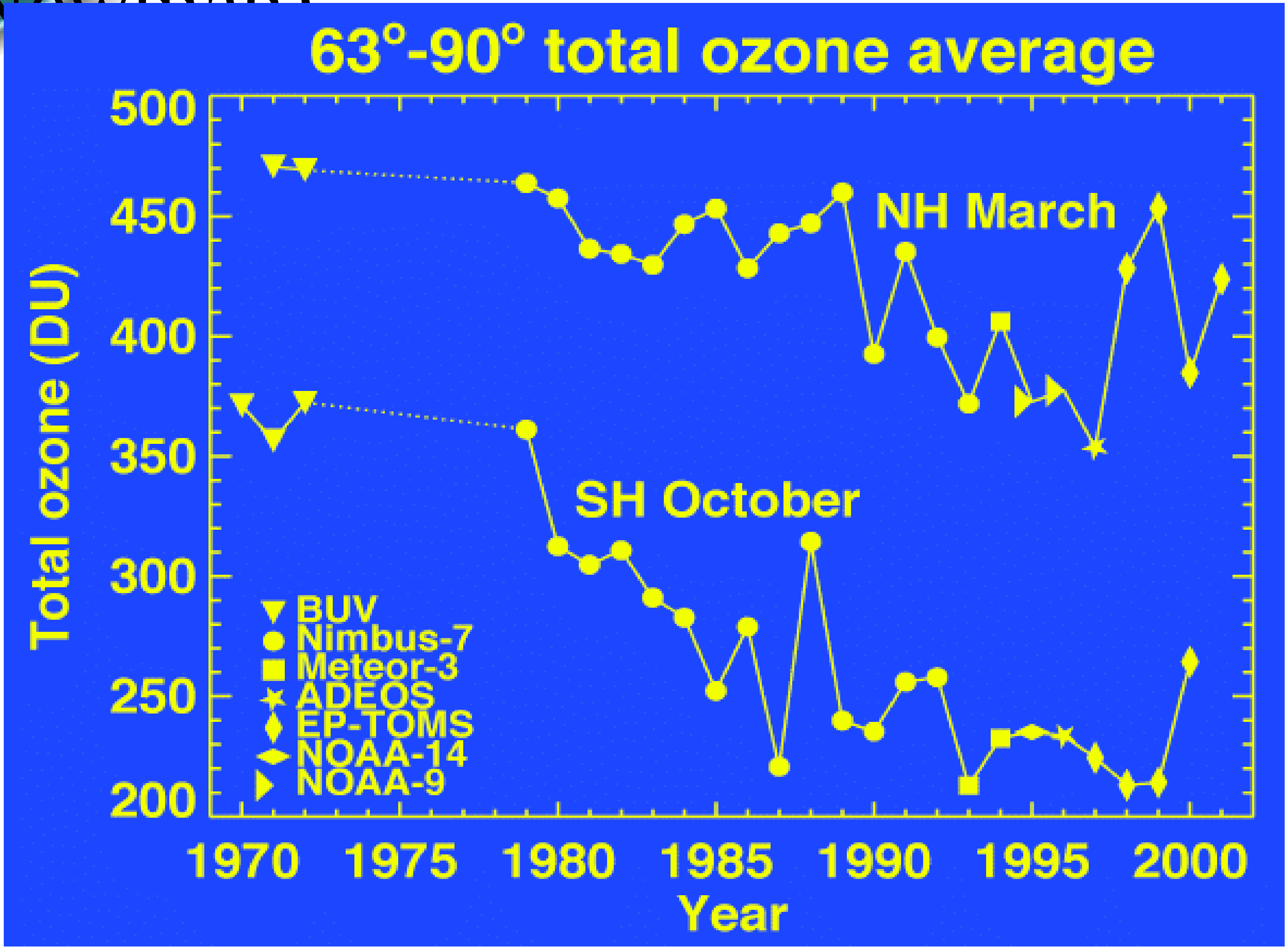
ACE Satellite



Solar Occultation

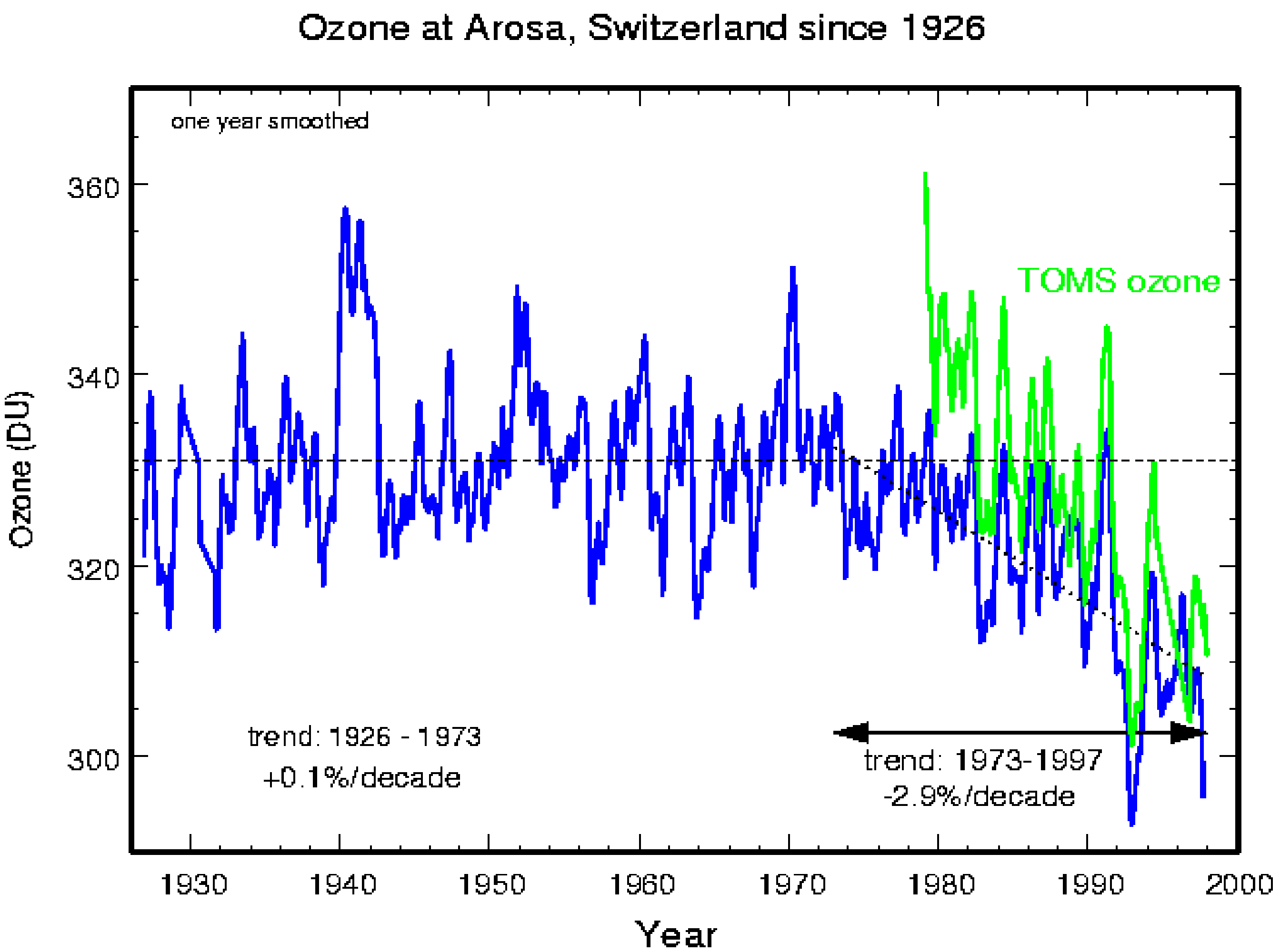


Polar Ozone (DeCola and Newman)

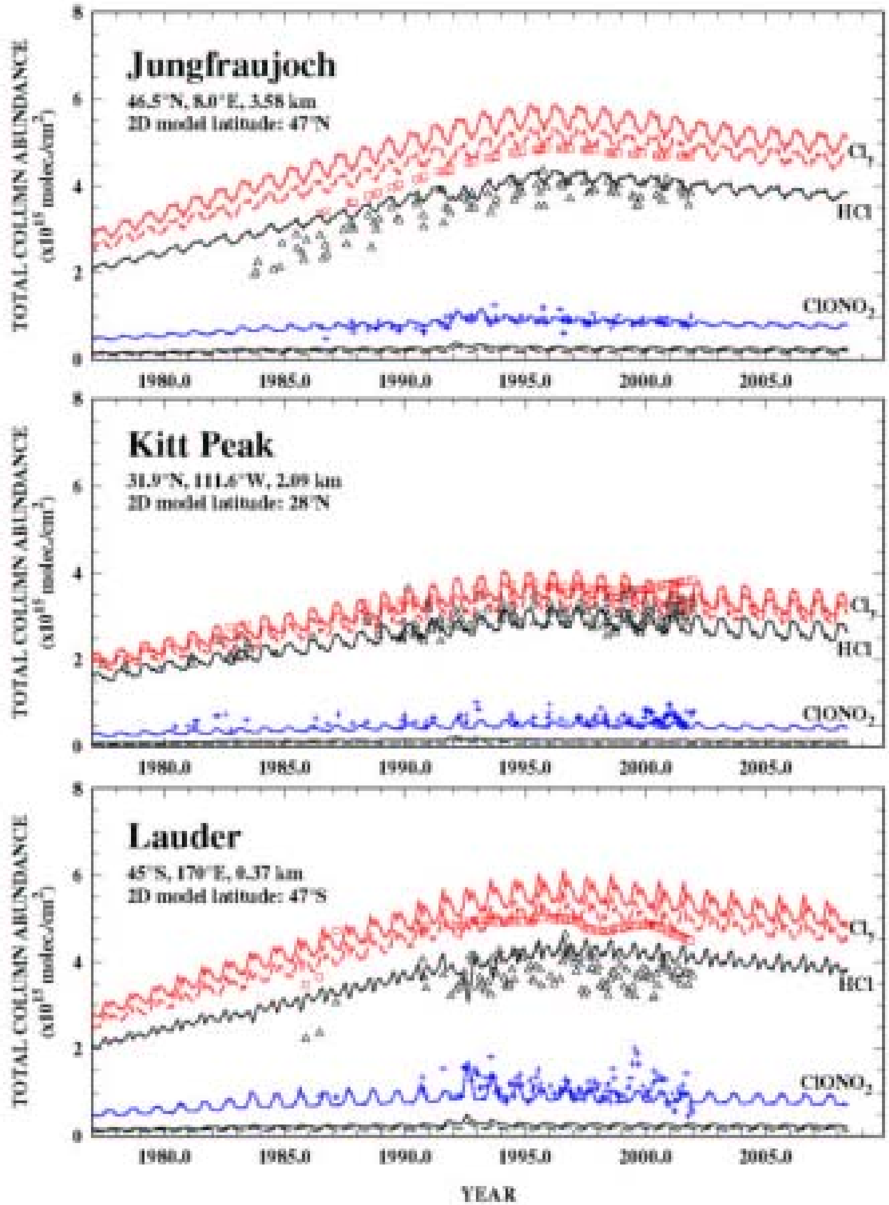


Mid-latitude Ozone Decline

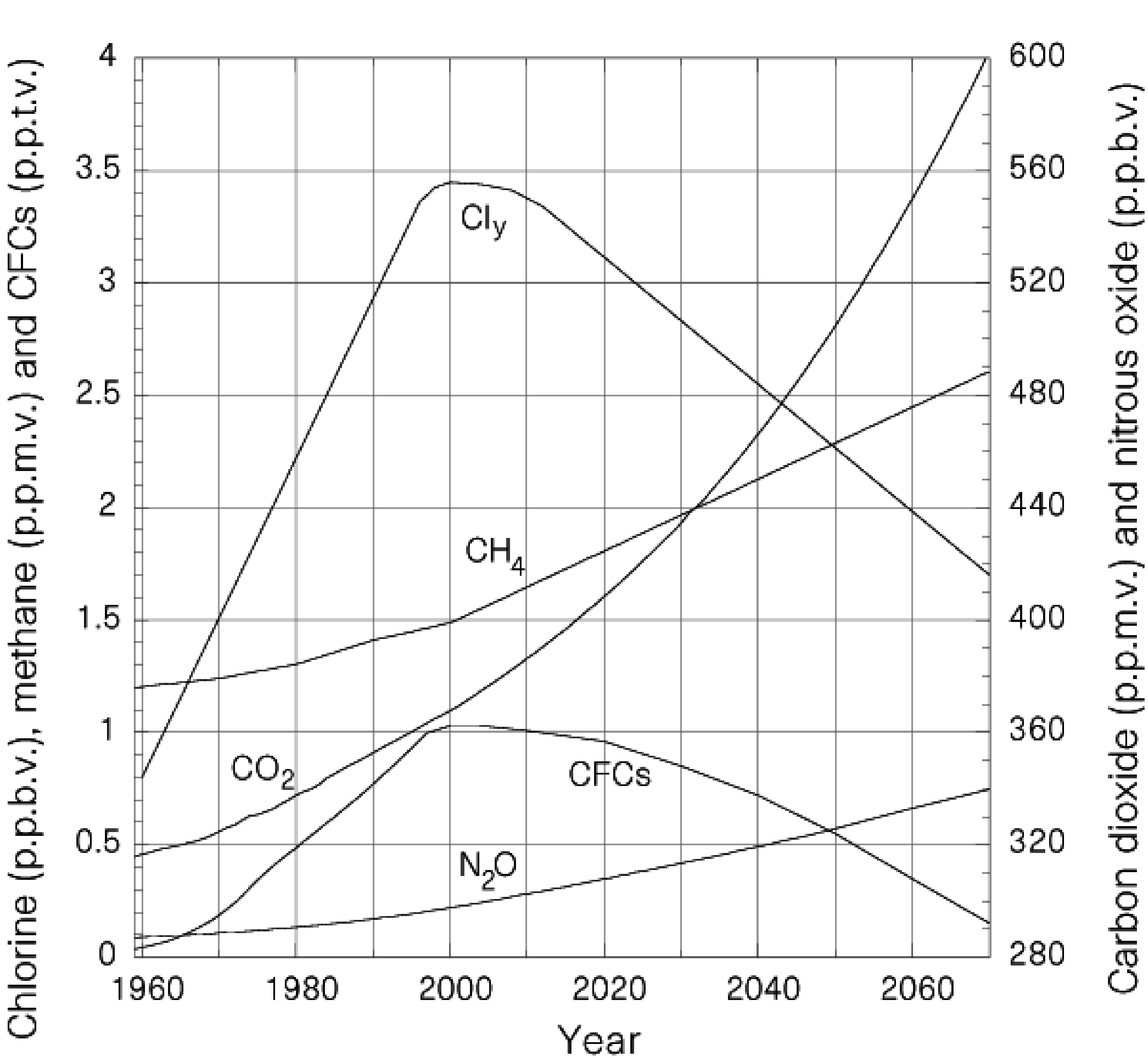
McPeters May 1, 1998



HCl and $ClONO_2$ Trends (Rinsl



Trace Gas Prediction (Shindell)

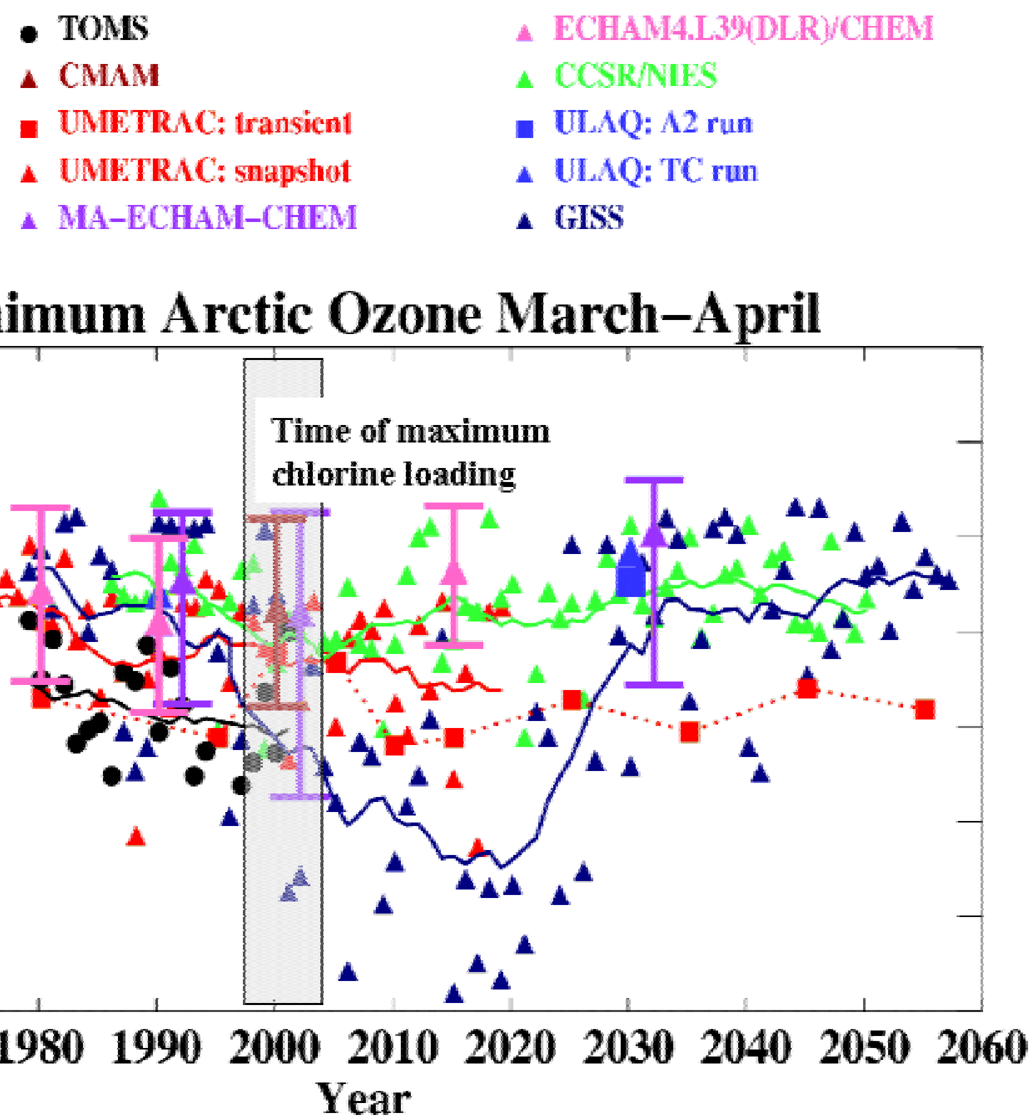


Climate-Chemistry Coupling

- D. Shindell *et al.* Predict that increasing greenhouse gases and ozone depleting halogens will cause an Arctic ozone hole in the 2010 to 2020 timeframe.
- These species cause warming of the Earth's surface and radiative cooling of the stratosphere.
- This will create a much more stable Arctic vortex with significantly colder lower stratospheric temperatures leading to dramatically increased ozone depletion.
- In spite of the global CFC reduction programs, up to two thirds of the Arctic ozone column may be lost in the early spring.

Arctic Ozone Predictions

Model Assessments 1960-2050



Austin et al., Uncertainties and assessments of chemistry-climate models of the stratosphere, Atmos. Chem. Phys., 3, 1 - 27, 2003

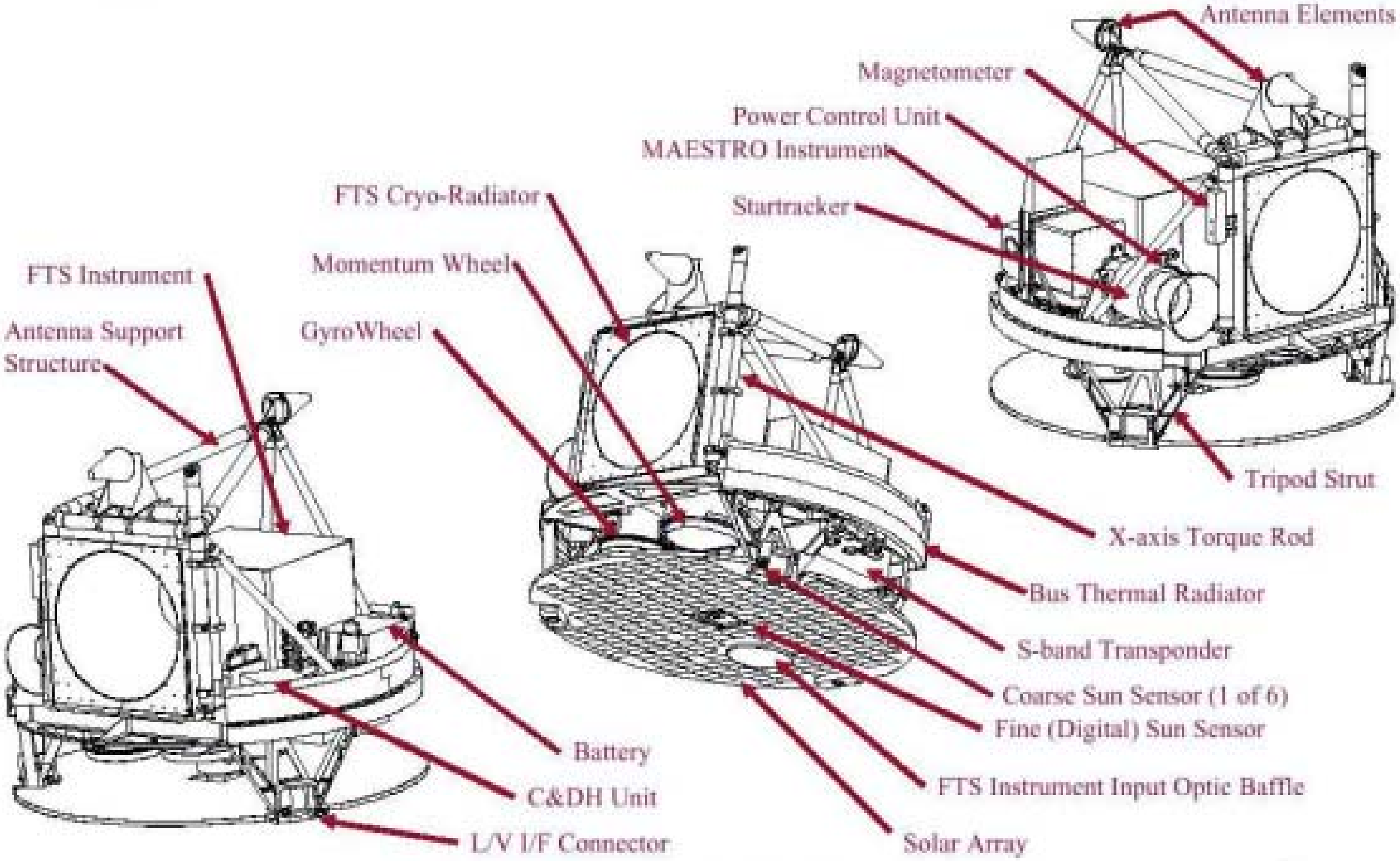
Instruments

- Infrared Fourier Transform Spectrometer operating between 2 and 13 microns (750-4100 cm^{-1}) with a resolution of 0.02 cm^{-1}
- 2-channel visible/near infrared Imagers, operating at 0.525 and 1.02 microns (c.f., SAGE II)
- Suntracker keeps the instruments pointed at the sun's radiometric center.
- UV / Visible spectrometer (MAESTRO) 0.285 to 1.03 microns, resolution ~1-2 nm
- Startracker

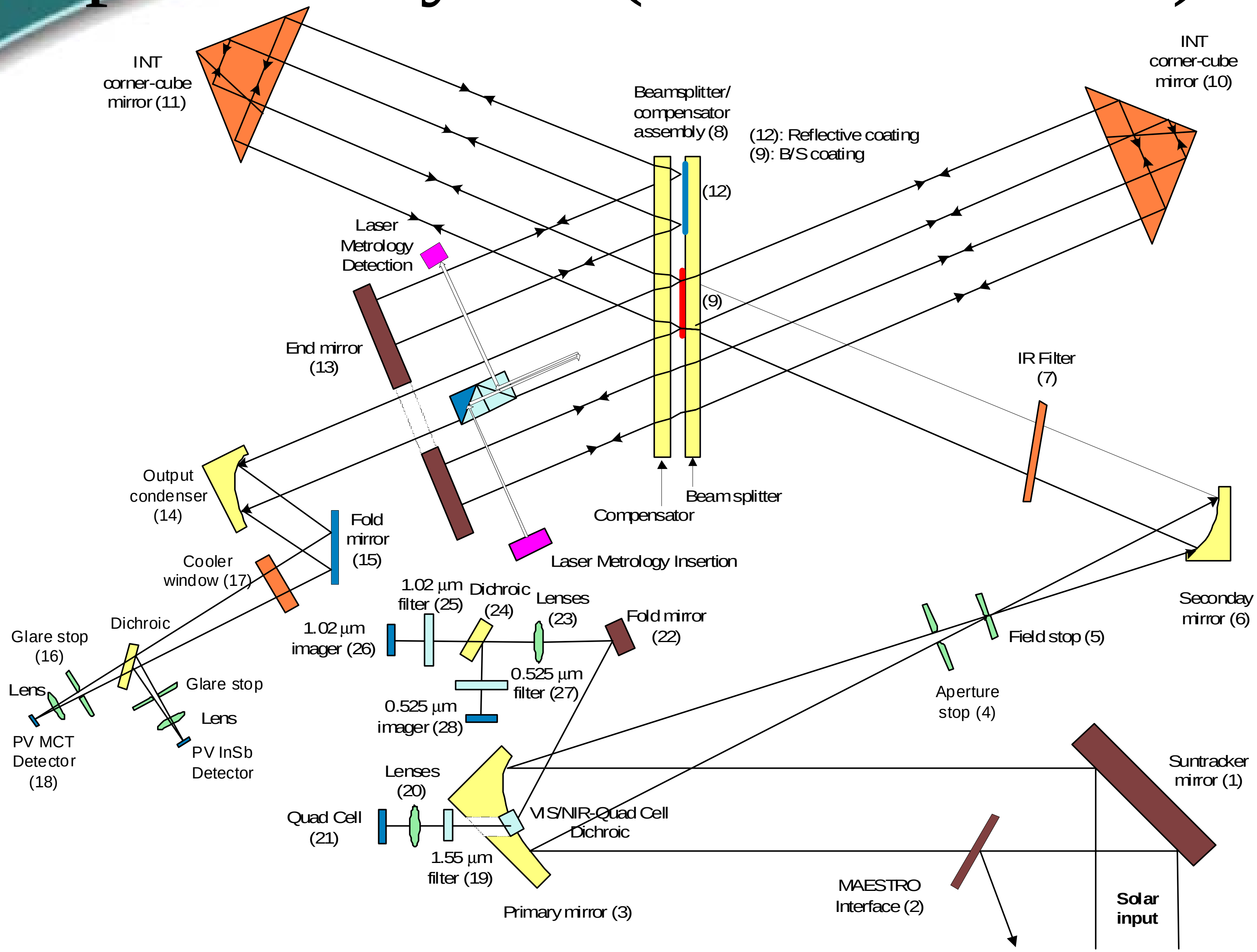
Timeline

- Jan. 1998 Proposal to CSA
- Feb. 2001 FTS and Imager CDR
- Mar. 2001 MAESTRO CDR
- Jun. 2001 Bus CDR
- Sept. 2002 S/C integration & test
- Mar. 2003 Instrument test (Toronto)
- May 2003 Final integration (DFL)
- July 2003 Launch

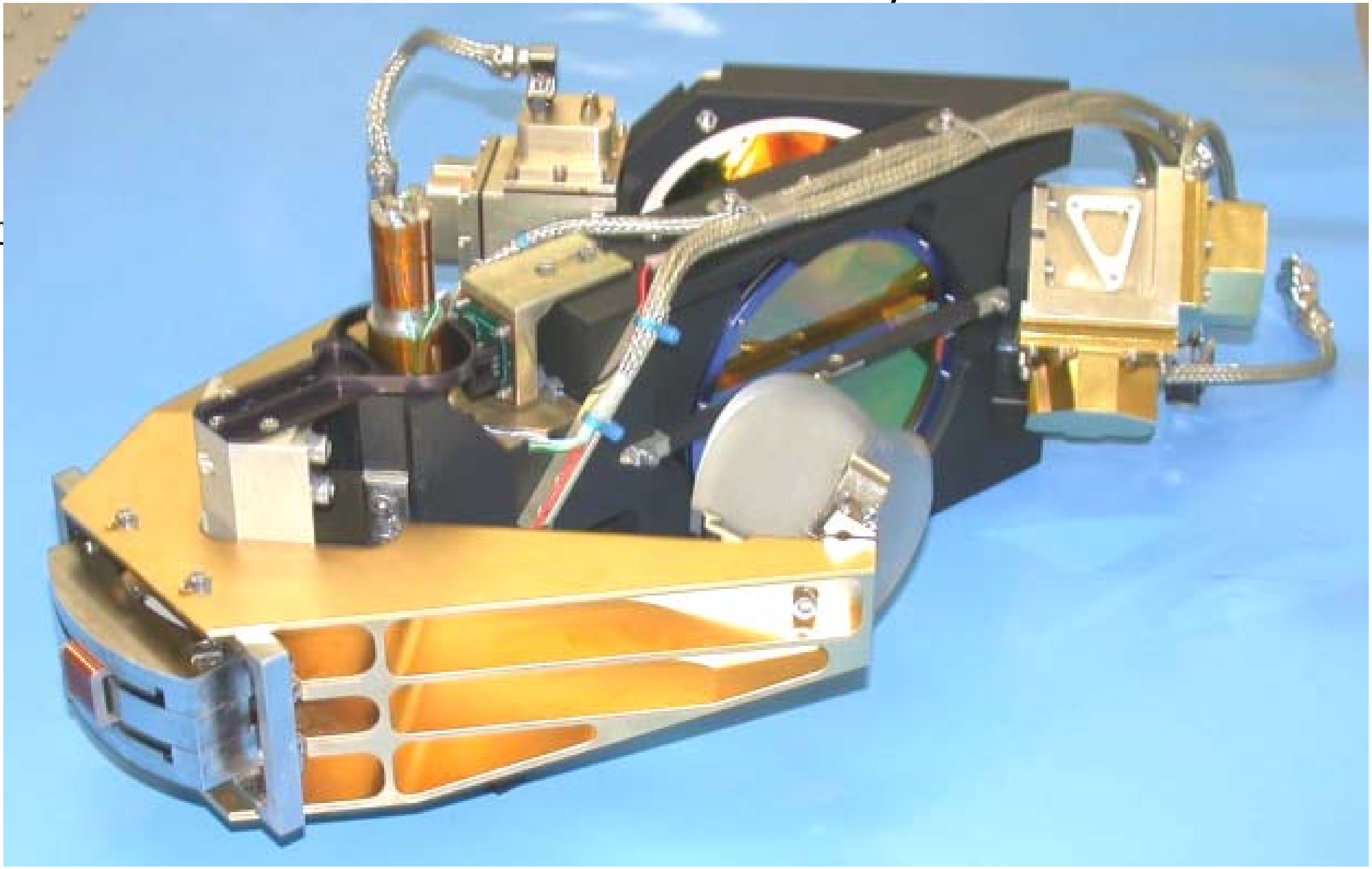
ACE Payload


Antenna Elements
Magnetometer
Power Control Unit
MAESTRO Instrument
FTS Cryo-Radiator
Startracker
FTS Instrument
Momentum Wheel
Antenna Support Structure
GyroWheel
Tripod Strut
X-axis Torque Rod
Bus Thermal Radiator
S-band Transponder
Coarse Sun Sensor (1 of 6)
Fine (Digital) Sun Sensor
Battery
C&DH Unit
FTS Instrument Input Optic Baffle
L/V I/F Connector
Solar Array

Optical Layout (ABB-Bomem)



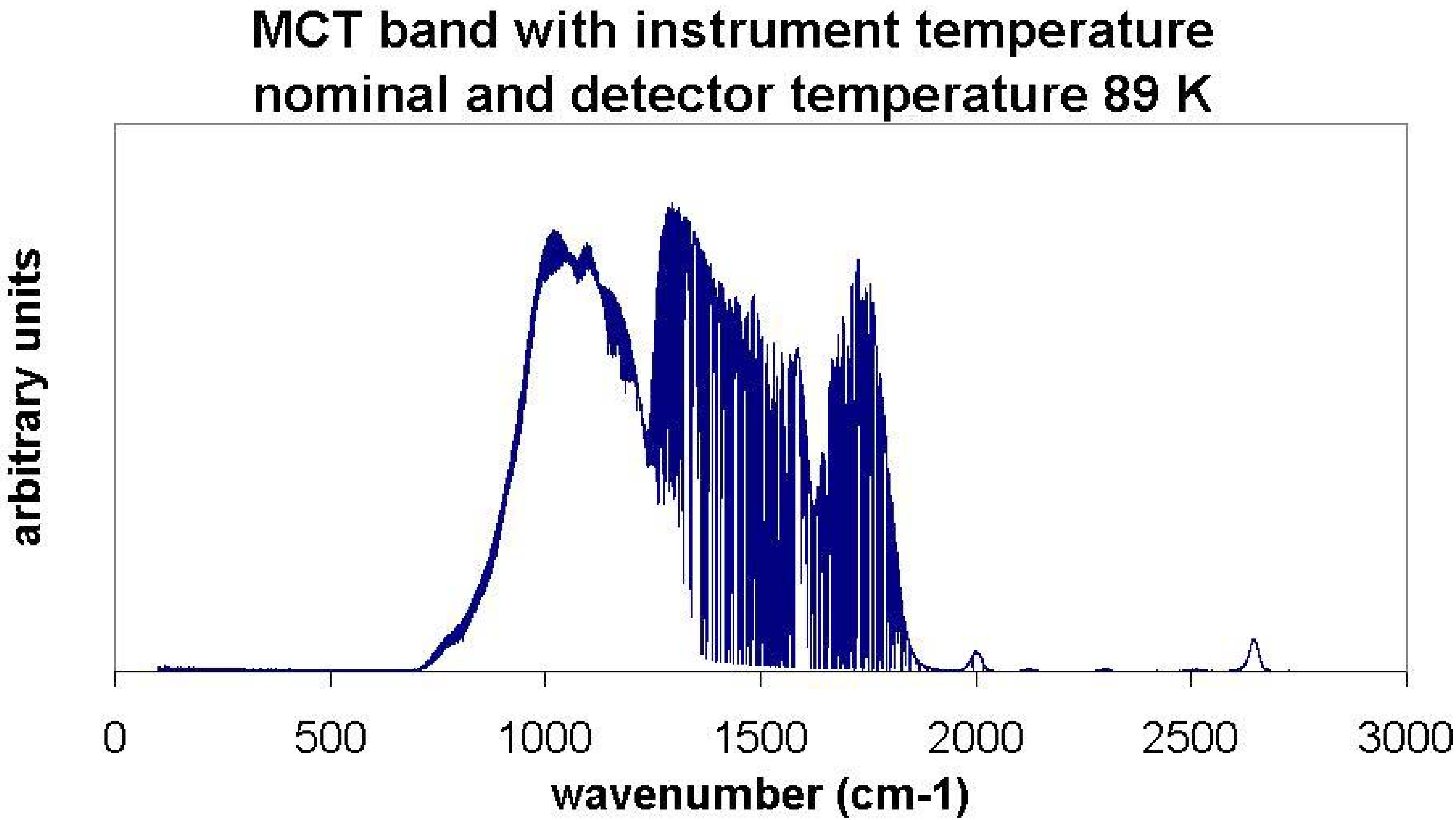
Interferometer Sub-system



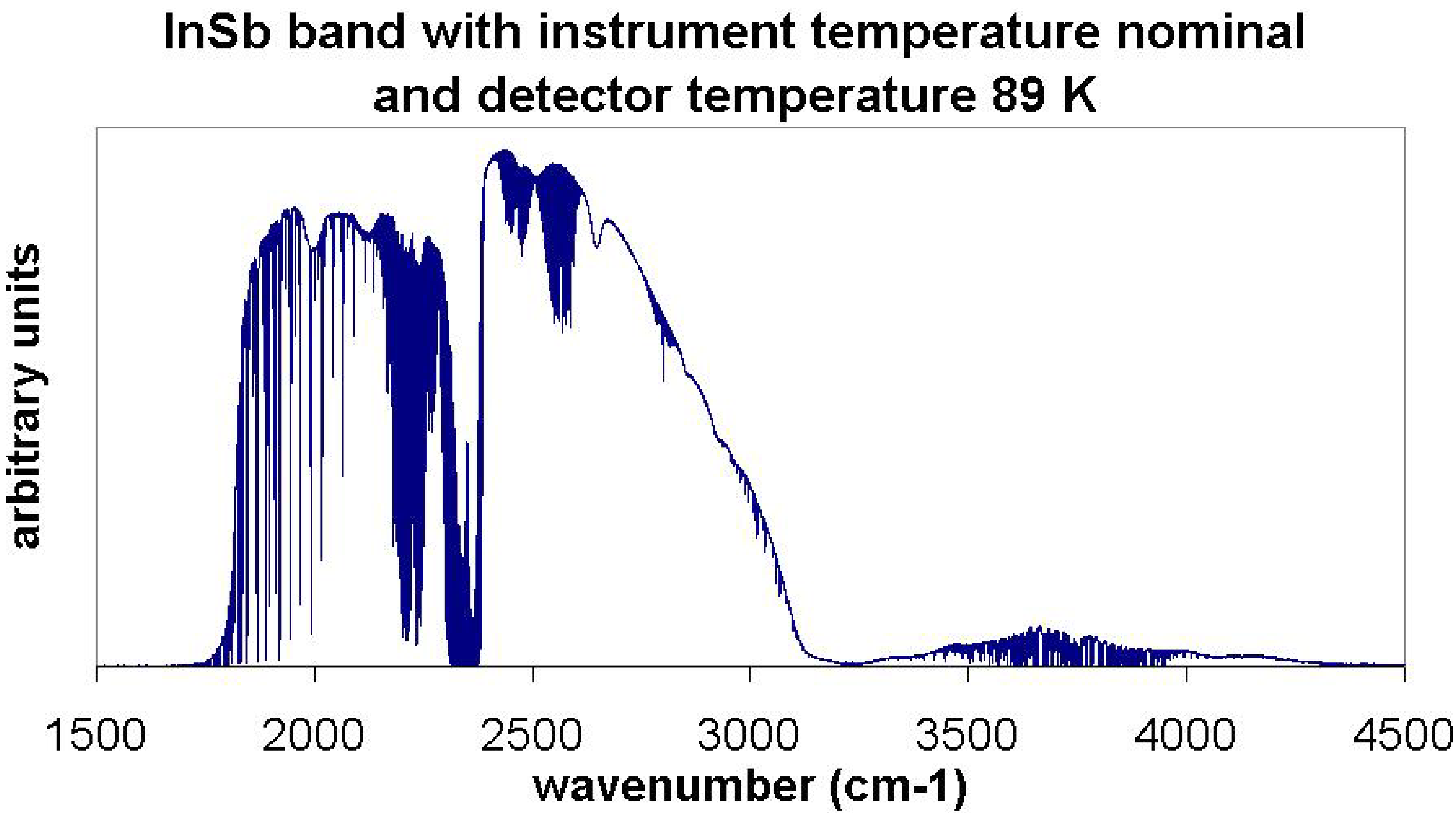
ACE-FTS

Integration to S/C Bus

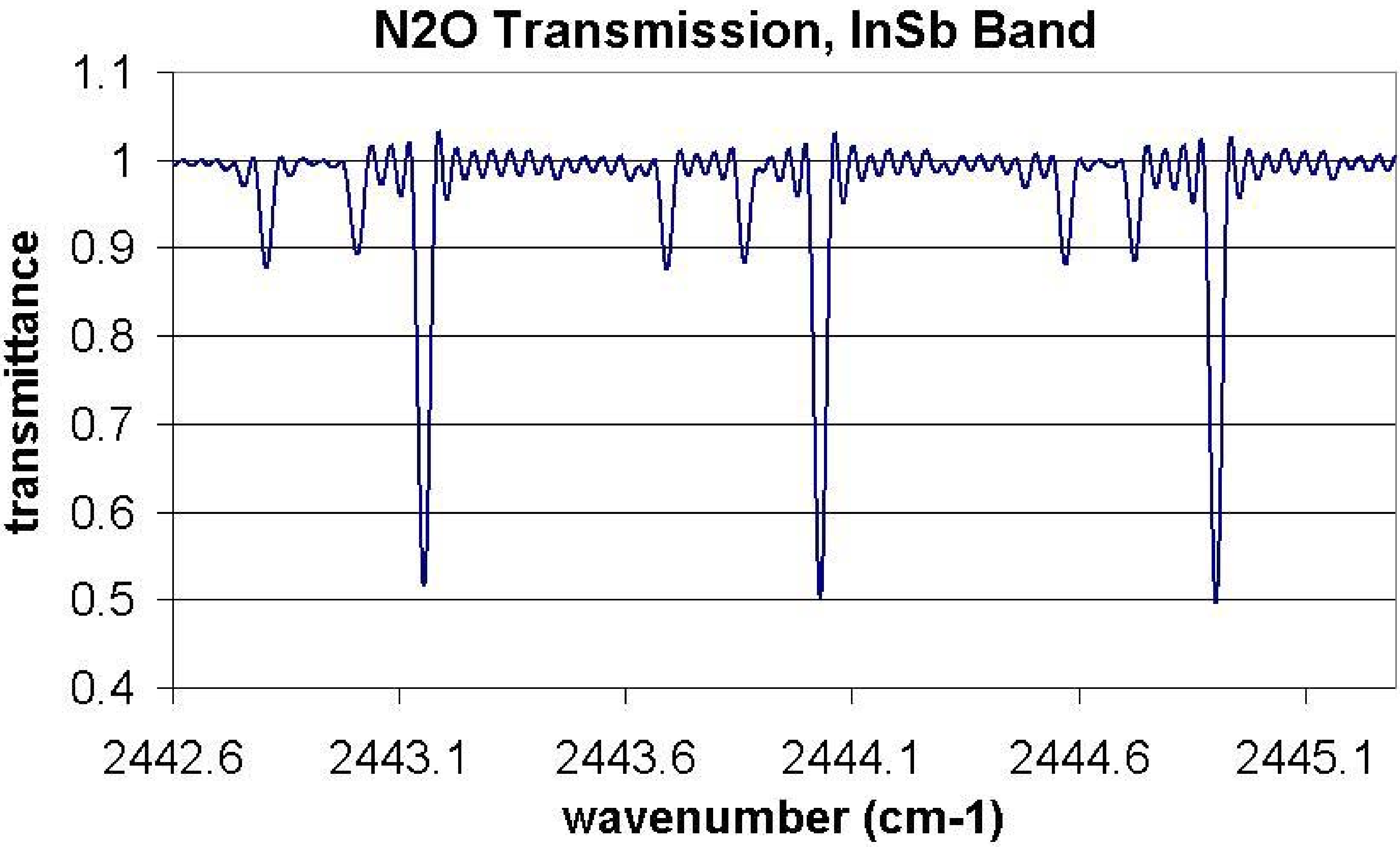
ACE-FTS: MCT Spectra



ACE-FTS Spectra: InSb channel



ACE-FTS InSb Spectra



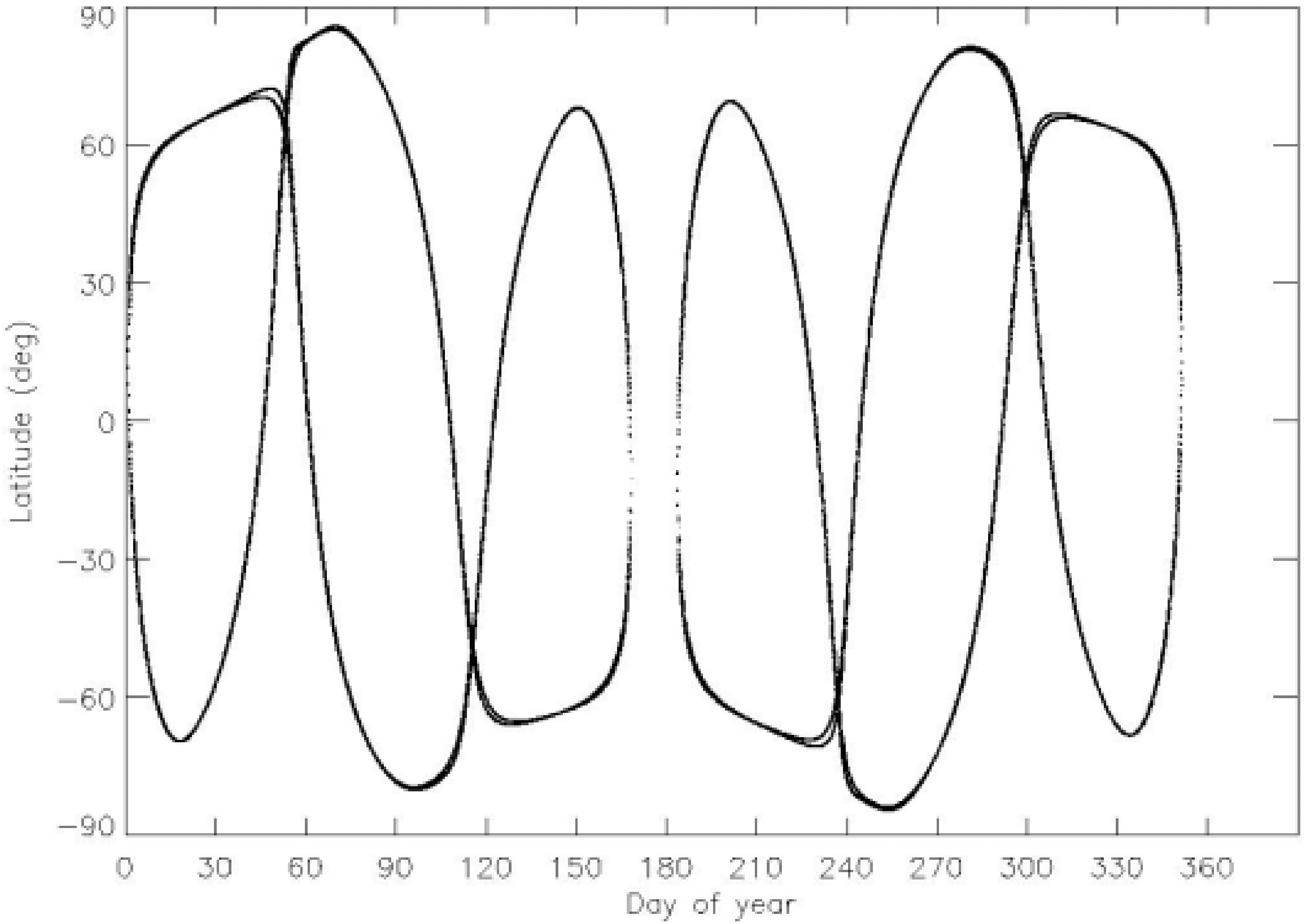
FTS Species

MINOR GASES	CO_2, CO, H_2O, O_3, N_2O, CH_4
TRACE GASES	
Nitrogen species	NH_3, NO, NO_2, N_2O_5, HNO_2, HNO_3, HO_2NO_2, HCN
Hydrogen Species	H_2CO, H_2CO_2, HDO, $H_2{}^{17}O$, $H_2{}^{18}O$
Halogens	CCl_3F (F11), CCl_2F_2 (F12), CH_3CCl_3, $CHClF_2$ (F22), CH_3Cl, CCl_4, SF_6, HF, HCl, CF_2O, $ClONO_2$, HOCl
Sulfur oxides	OCS, SO_2
Other species	C_2H_2, C_2H_4, C_2H_6, CH_3D

As well as aerosols and PSC IR spectra

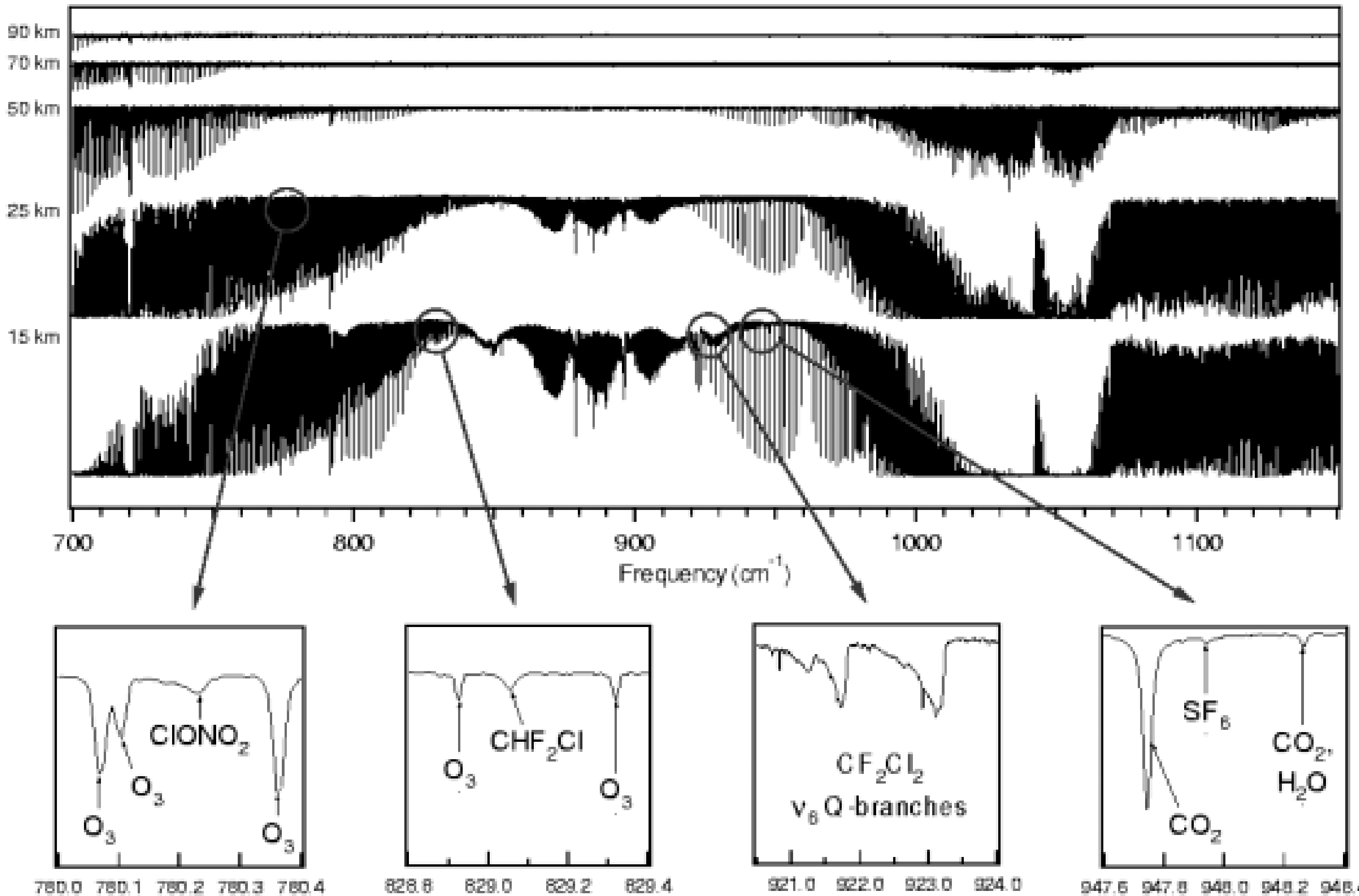
Pegasus XL Launch Vehicle

ACE Orbit (RAAN 144°)



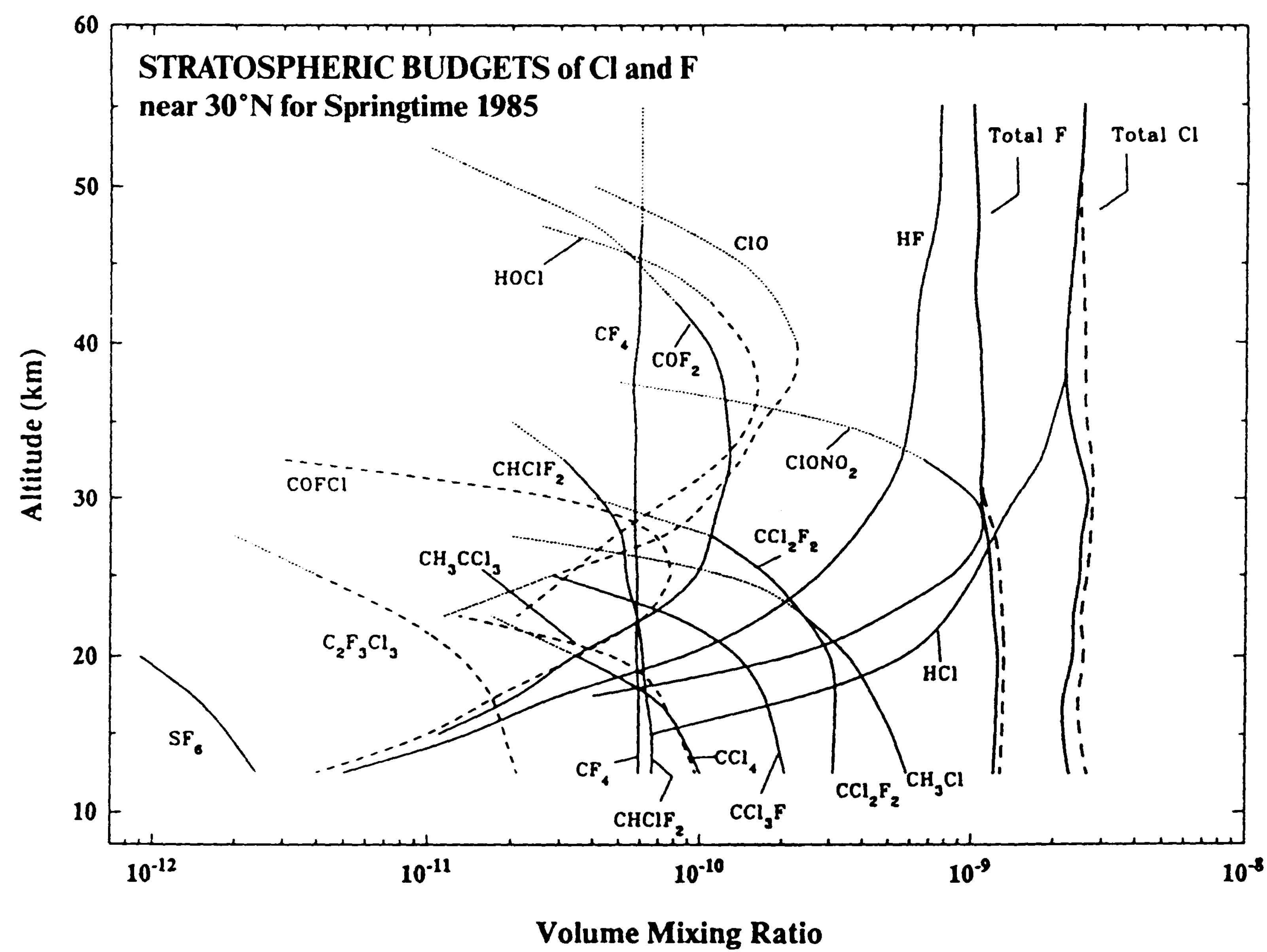
650 km, 74° inclined circular orbit

ATMOS Spectrum

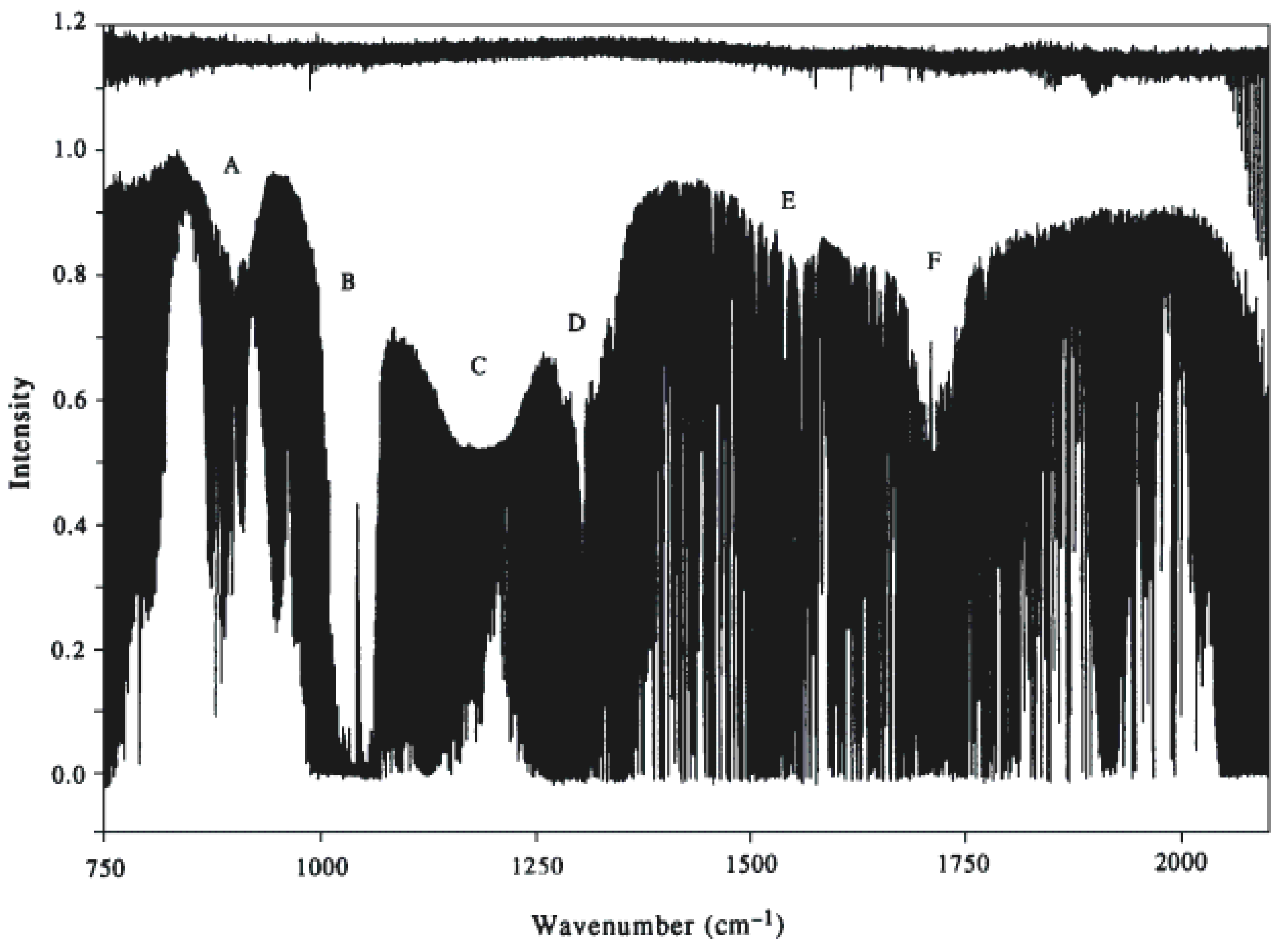


Infrared transmission at tangent altitudes between 15 and 90 km and between frequencies of 700 and 1100 cm^{-1} (recorded using the ATMOS interferometer onboard the space shuttle, Feb. 1992)

ATMOS F and Cl Budget

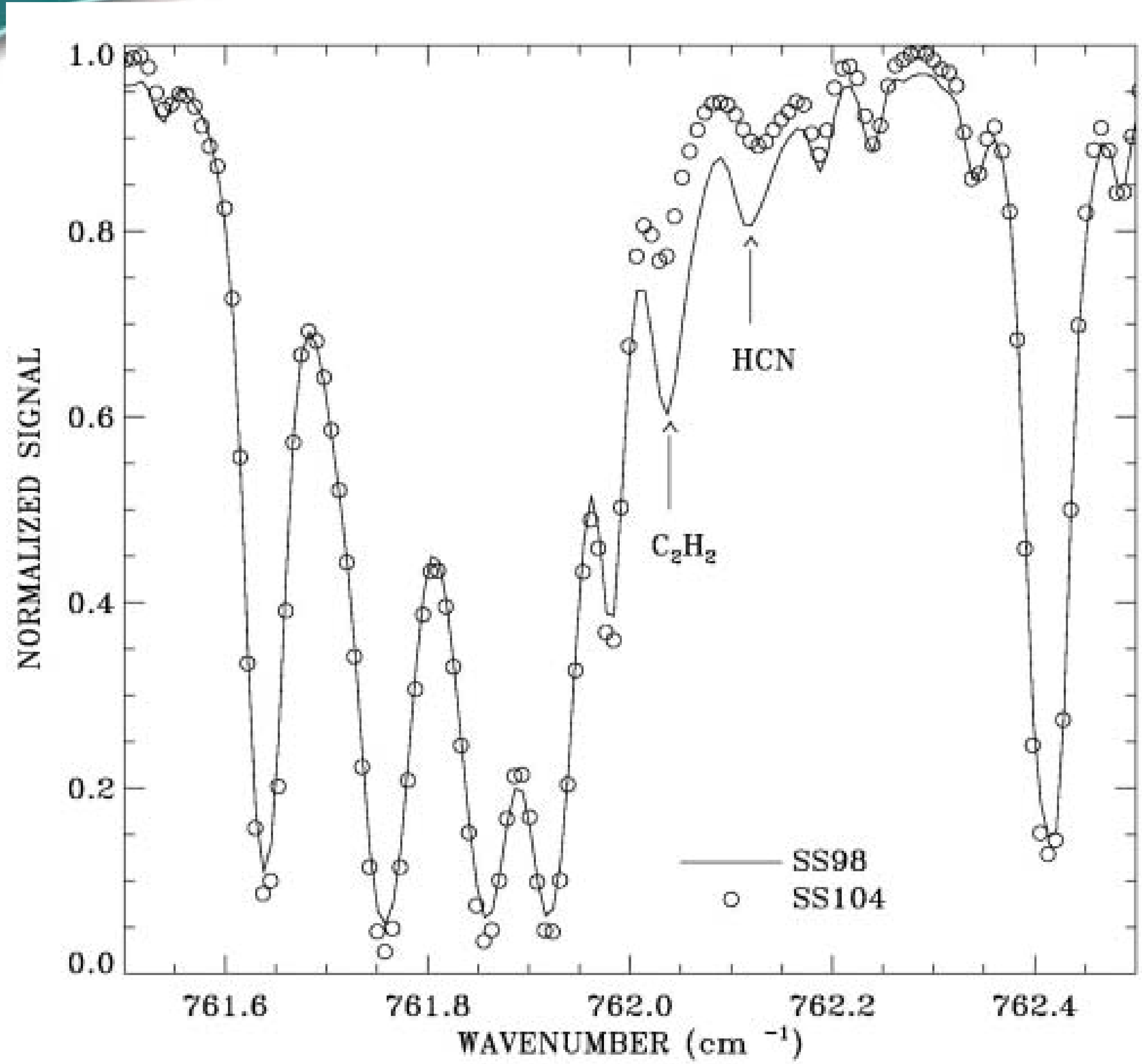


ATMOS (after Pinatubo)



Biomass Burning

ATMOS in Troposphere



FTS Data Analysis

- Processing to occur at the University of Waterloo (along with that for MAESTRO and the Imagers)
- Fitting selected microwindows
- Global Fit approach for retrievals of P/T and of volume mixing ratios (VMRs)
- Operational processing (a new set of data every ~48 minutes)

International ACE Partners

- USA- NASA will launch ACE and C. Rinsland (NASA-Langley) funded to help with algorithms and cal/val.
- Belgium- R. Colin (ULB) and M. DeMaziere (IASB) and co-workers supplied CMOS imager chips, spectroscopic data, cal/val and algorithms.
- France- C. Camy-Peyret (Paris) cal/val
- Japan- M. Suzuki (NASDA) cal/val

ACE Participants:

Mission Scientist
- Peter Bernath, University of Waterloo

MAESTRO Principal Investigator
- Tom McElroy, MSC

Instrument Test
- Jim Drummond, University of Toronto

ACE Instrument Support (FTS, MAESTRO, Imagers)
- Pierre Tremblay, Université Laval
- Jim Drummond, University of Toronto
- David Turnbull, U.of Western Ontario

Science Operations Center, U. of Waterloo
- Mike Butler, Manager
- Chris Boone, ACE scientist
- Sean McLeod, Computer Support
- Kaley Walker, Cal/Val
- Debbie Loney, Admin. Assistant

Additional Canadian Univ. Participants
- Wayne F. J. Evans, Trent University
- Ian Folkins, Dalhousie University
- Ted Llewellyn, Univ. of Saskatchewan
- Bob Lowe, Univ. of Western Ontario
- Ian McDade, York Univeristy
- Jack McConnell, York University
- Diane Michelangeli, York University
- Jim Sloan, University of Waterloo
- Kim Strong, University of Toronto

Instrument Contractor, ABB-Bomem
- Marc-Andre Soucy, Project Manager

Bus Contractor, Bristol Aerospace
- Ian Walkty, Project Manager

MAESTRO Contractor, EMS / MSC
- Andrew Bell, EMS, Project Manager
- Tom McElroy, MSC, Project Manager

Main International Partners

Belgium:
- Reg Colin, Univ. Libre de Bruxelles
- Paul Simon, IASB

France:
- Claude Camy-Peyret, LPMA CNRS

USA:
- Curtis Rinsland, NASA Langley

Canadian Space Agency
- Glen Rumbold, ACE Manager
- Randolph Shelly, Bus
- Victor Wehrle, FTS and Science Team
- Marie Yelle-Whitwan, MAESTRO
- Dennis Ewchuk / Dan Showalter, Ground Segment

Sunset over Kitt Peak, AZ