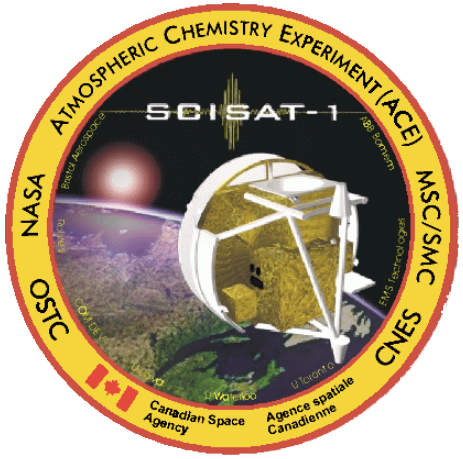

Twelve Years of the Atmospheric Chemistry Experiment (ACE) Satellite: Mission Status and Recent Results

Kaley A. Walker[1,2], Patrick E. Sheese[1], Chris Boone[2], Peter Bernath[3,4], and C. Thomas McElroy[5]

[1]Physics, University of Toronto; [2]Chemistry, University of Waterloo;
[3]Chemistry and Biochemistry, Old Dominion University;
[4]Chemistry, University of York (UK);
[5]Earth and Space Science and Engineering, York University

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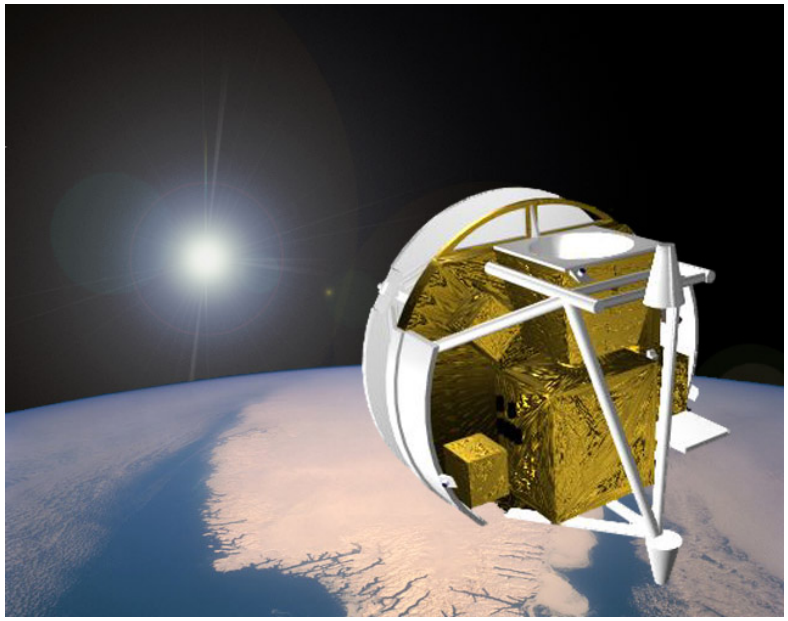
ACE on SCISAT-1

Atmospheric Chemistry Experiment (ACE) Satellite Mission:

Mission to measure atmospheric composition: profiles of trace gas species, cloud and aerosol extinction and temperature/pressure



Launch date: 12 August 2003

Orbit: 74° inclination at 650 km

Measurement mode: solar occultation

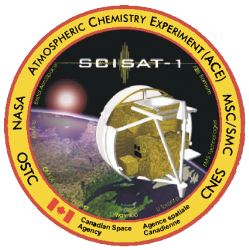
ACE-FTS:

- FTIR spectrometer, 2-13 microns at 0.02 cm^{-1} resolution
- 2-channel visible/NIR imager, 0.525 and 1.02 microns

MAESTRO:

- dual UV / visible / NIR grating spectrophotometer, 285 to 1030 nm at ~1-2 nm resolution

Pointing: suntracker in ACE-FTS

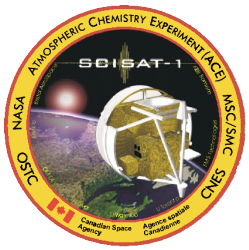


ACE Mission Status

- Now completing 12th year in orbit – designed for 2 year lifetime
  - Starting to see some degradation in ACE-FTS performance and MAESTRO continues to "age gracefully"

- Since launch, satellite and instrument operations nominal
  - Routine operations began on 21 February 2004
  - On 1 July 2015, SCISAT will complete its 64,000th orbit!
  - ~50% of occultations occur in polar regions (> 60 degrees)

- CSA conducted review of ACE during the first half of 2014
  - Based on the positive response from the panel, CSA has approved operation of SCISAT until end of March 2018



ACE Data Products

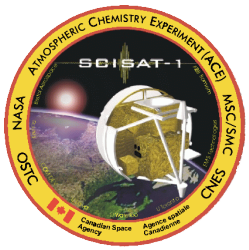
- ACE-FTS profiles (current version 3.5; previous v2.2+updates/2.5):
  - Tracers: H_2O, O_3, N_2O, NO, NO_2, HNO_3, N_2O_5, H_2O_2, HO_2NO_2, N_2
  - Halogen-containing gases: HCl, HF, $ClONO_2$, CFC-11, CFC-12, CFC-113, COF_2, $COCl_2$, COFCl, CF_4, SF_6, CH_3Cl, CCl_4, HCFC-22, HCFC-141b, HCFC-142b
  - Carbon-containing gases: CO, CH_4, CH_3OH, H_2CO, HCOOH, C_2H_2, C_2H_4, C_2H_6, OCS, HCN and pressure / temperature from CO_2 lines
  - Isotopologues: Minor species of H_2O, CO_2, O_3, N_2O CO, CH_4, OCS
  - Research species: ClO, acetone, PAN (peroxyacetyl nitrate), etc.
- MAESTRO profiles (current version 3.12.1; validated version 1.2):
  - O_3, NO_2, optical depth and aerosol (water vapor research version)
- IMAGERS profiles (current version 3.5; validated version 2.2):
  - Atmospheric extinction & aerosol extinction at 0.5 and 1.02 microns

ACE-FTS v3.5/v2.5 Update

Fix for processing issue from October 2010 onward:

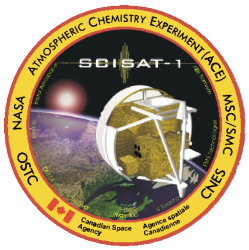
- Versions 2.2 and 3.0 results should not be used because of problems with pressure and temperature information obtained from the Canadian Meteorological Center.

- New processing versions (starting with v3.5, then v2.5) are being completed to provide corrected results for the affected time period (October 2010 onward).
  - *Version 3.5* will include research products for high altitude CO, C_2H_6, HCFC-22, polar N_2O
    - There is also a new "research" product for CH_4
  - This version will be released in "batches" with the first made available in Sept. 2014 – we are working on completing the second batch for release in the coming months



Version 3.5 Release

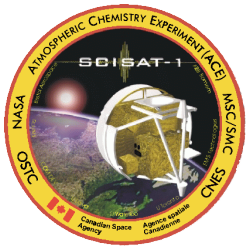
- The "preliminary" release of version 3.5 includes:
  - ACE-FTS & ACE-Imager profiles for this version
  - Also, geolocation information along the measurement path is available for the 1-km and tangent grid data
  - New data flagging has been developed for ACE-FTS profiles
  - Derived Meteorological Products (DMPs) are available
- Also, we have identified multiple periods with missing data so we are going back to "rescue" occultations as processing continues for v3.5
  - Ensure those processed in v2.2 and 3.0 are present in v3.5
- Also with the v3.5 ACE-FTS release, a new version of ACE-MAESTRO has been released (v3.12.1)



Data Flagging for v3.5 Profiles

- Developed to provide better guidance to teams for use of ACE-FTS profiles
  - To provide more quality advice than the Data Issues List and fitting error ranges for removing outliers
  - Employing a better way to deal with outliers when data distributions are not symmetric
- Uses two step process using 1-km grid dataset
  - For given height and latitude region, calculate "expected" density distribution (Gaussian mixture distribution)
  - For each day, using 15-day running median filter with±10 times the median average deviation (MeAD)

P. E. Sheese et al., AMT, 8, 741-750 (2015).

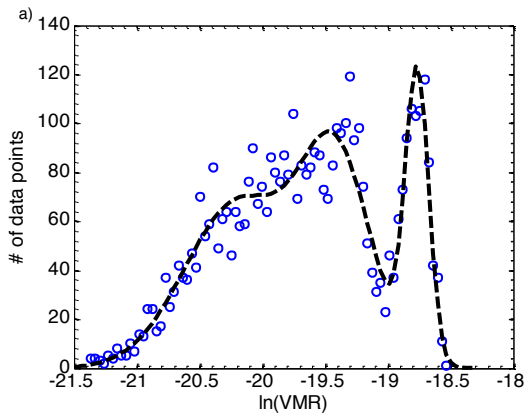


Examples for Antarctic SR

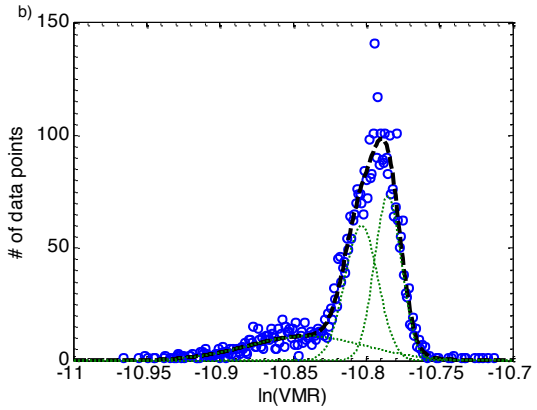
First Step - PDFs Calculated

- For 30 degree latitude ranges, type of observation and each altitude (on 1 km grid)

NO_2 at 30.5 km



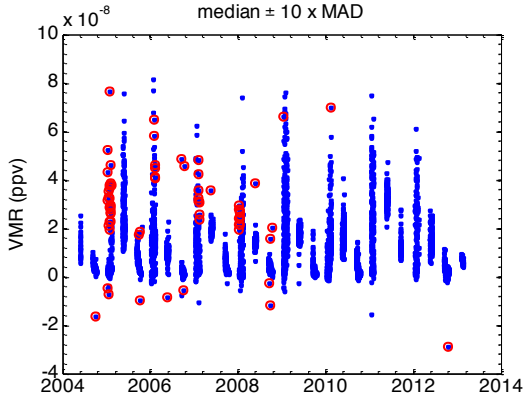
O_3 at 30.5 km



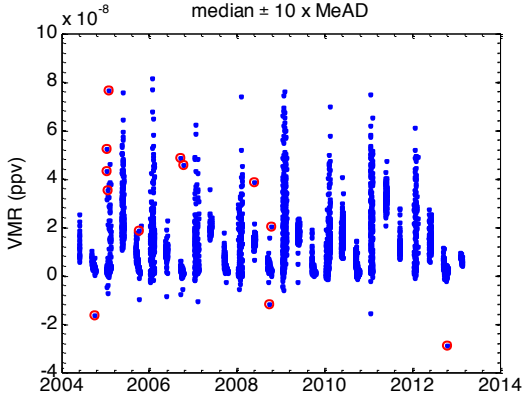
Second step – 15-day filter

- Used 15-day running median filter with±10 times the MeAD rather than MAD (median absolute deviation) for efficacy
- Shown for N_2O at 35.5 km

MAD – med($|x_i - med(x_i)|$)
Insensitive to "outliers"



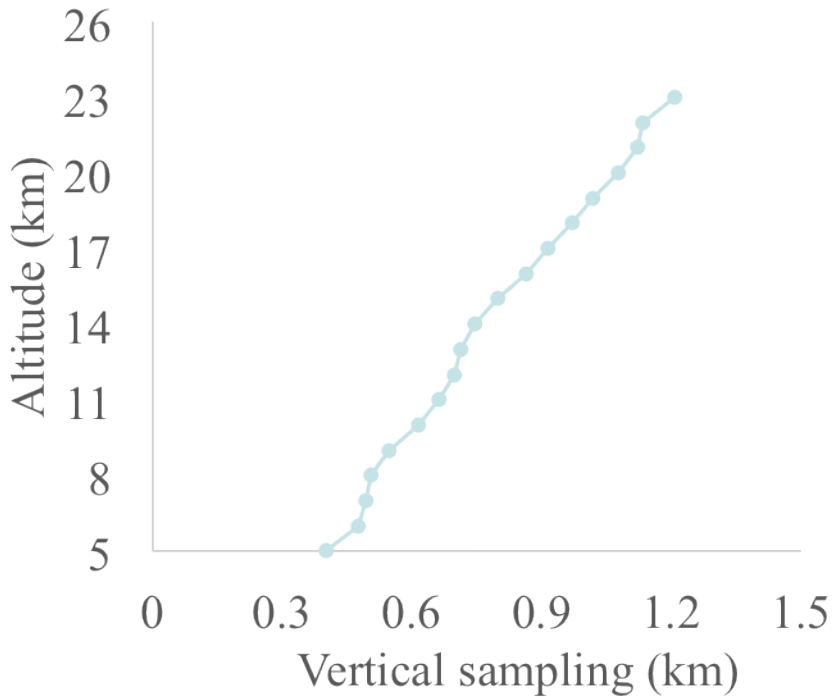
MeAD – mean($|x_i - med(x_i)|$)
A statistical Goldilocks



P. E. Sheese et al., AMT, 8, 741-750 (2015).

MAESTRO "Research" H_2O

- Match observed differential optical depth (DOD) in the ~940 nm band with simulated DOD using iterative retrieval (i.e. Chahine-updating of VMR profile) [Sioris et al. Adv. Space Res., 2010]
- Retrieval errors calculated by perturbation - Smallest relative errors in mid-trop (5 km)
- Vertical resolution of water vapour profile approaches vertical sampling
- WAVAS-II validation shows few issues: e.g., 1 ppm dry bias in Antarctic in summer
- 2004-02 to 2013-03 available

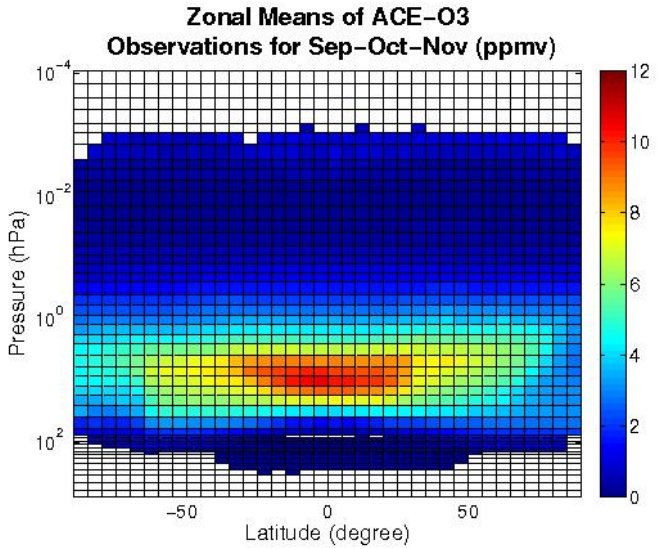


C. Sioris et al., in preparation

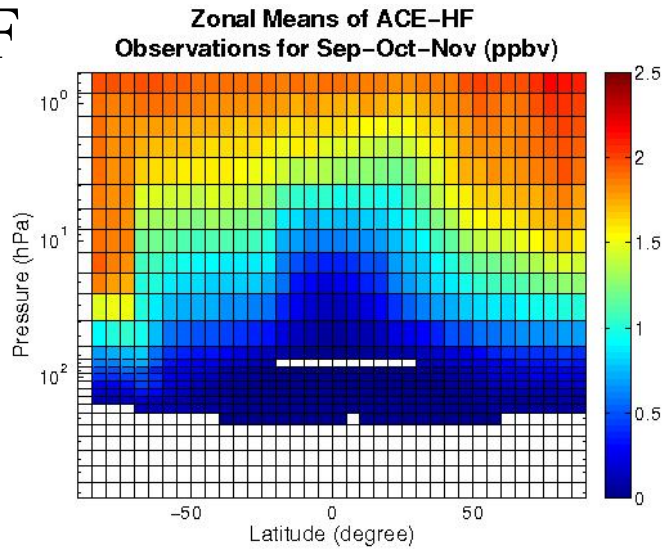
New ACE-FTS v3.5 Climatology

- Building on work by Jones et al., ACP (2011) and that done for SPARC Data Initiative
- Using quality filtered ACE-FTS v3.5 profiles from Feb. 2004 – Feb. 2013 (was 2004-2009)
- O_3, H_2O, CH_4, N_2O, CO, NO, NO_2, N_2O_5, HNO_3, HCl, HF, $ClONO_2$, CFC-11 and CFC-12
  - C_2H_6, C_2H_2, HCN, OCS, HCOOH, CH_3OH, H_2CO
  - 45 levels up to 0.0001 hPa as data available (was 0.1 hPa)

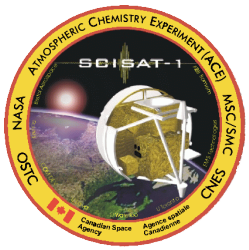
O_3



HF



J.-H. Koo and A. Jones

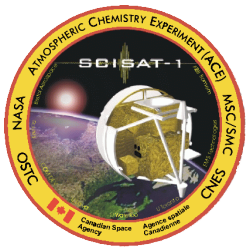


Summary

- ACE Instruments and satellite are continuing to function nominally and produce excellent results
  - v3.5 to fix processing issue released with new data flags
- Data being used for scientific and validation studies
  - Reprints available from http://www.ace.uwaterloo.ca
  - Climatological datasets and atlases available from website
  - Validation results published in *Atmos. Chem. Phys.*: http://www.atmos-chem-phys.net/special_issue114.html

Funding for ACE and this work provided by:

- Canadian Space Agency (CSA)
- Natural Sciences and Engineering Research Council of Canada
- Environment Canada
- Natural Environment Research Council (NERC)



Joint Science Team Meeting

- This fall we will be holding a joint SCISAT-Odin Science Team Meeting in Toronto, Canada (19 – 21 Oct. 2015)
  - All are welcome to attend and present at the meeting
  - We are interested in developing new collaborations so come and learn more about ACE and Odin
  - Let me know if you would like to be on the mailing list for the meeting!