

Ozone related activities at the Canadian Space Agency

- ∴ Thomas Piekutowski
- ∴ Seventh Meeting of the Ozone Research Managers, Geneva, 19-21 May 2008



Summary

The Canadian atmospheric science community has a long-standing interest and expertise in ozone. This is reflected in two of the CSA's current science missions: SCISAT-ACE and OSIRIS on Odin.

The CSA invests in spaceborne atmospheric remote sensing, in production & validation of high quality data, and in interactive chemistry-climate modeling.

The CSA is likely to continue investing in atmospheric science missions that help us to understand ozone recovery and the processes linking ozone and climate.

The CSA places great value in partnerships:

- with Canadian scientists, government departments and industries;
- with international organizations;
- with other space agencies.



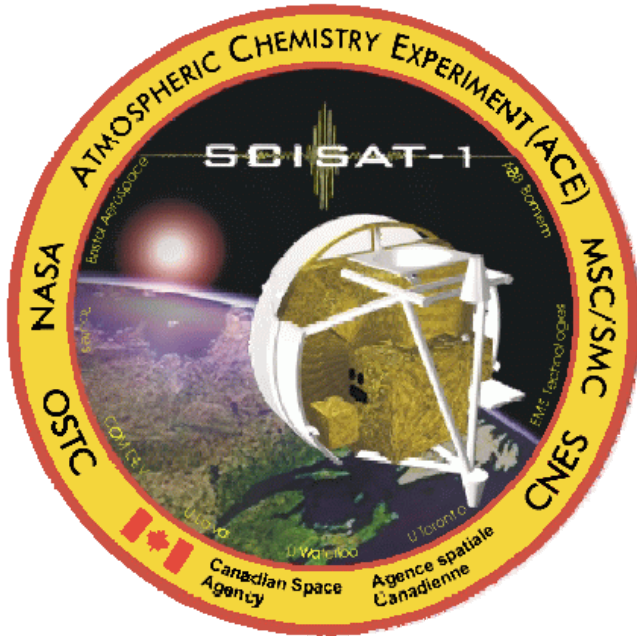


Outline

- Current Missions
- Validation and Modeling
- Future Missions
- Partnerships



SCISAT – ACE: Instruments



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

Launched August 2003

Routine operations since February 2004

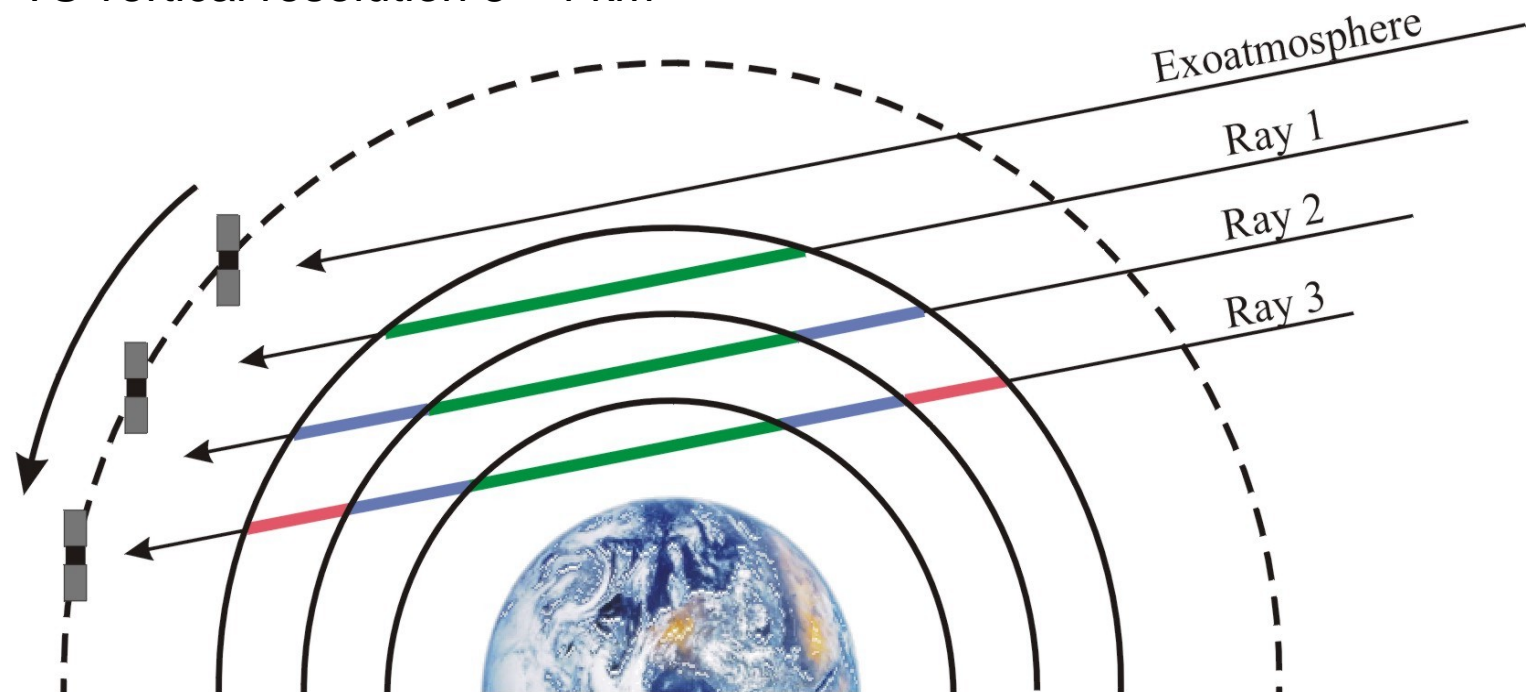


SCISAT – ACE: Solar Occultation

A powerful technique for acquiring self-calibrating, very high resolution spectra

Vertical profiles from cloud tops to about 150 km

- MAESTRO vertical resolution 1 – 2 km
- FTS vertical resolution 3 - 4 km





SCISAT – ACE: Measurements

Profiles of 18 molecules were derived after launch. Profiles of over 34 molecules are derived now.

The extremely high signal-to-noise permits retrieval of weak spectra.

Baseline species (version 2.2):

H_2O , O_3 , N_2O , CO , CH_4 , NO , NO_2 , HNO_3 , HF , HCl , N_2O_5 ,
 ClONO_2 , CCl_2F_2 , CCl_3F , as well as pressure and temperature
from CO_2 lines

Other routine species:

COF_2 , CHF_2Cl , CF_4 , CH_3Cl , C_2H_6 , SF_6 , OCS , HCN

Research species:

CCl_4 , HOCl , H_2O_2 , HO_2NO_2 , $\text{CCl}_2\text{FCClF}_2$, CH_3CClF_2 , ClO , C_2H_2 ,
 CH_3OH , HCOOH , N_2 and additional isotopologues





SCISAT – ACE: Usefulness

- The high precision and accuracy of solar occultation makes ACE useful for monitoring changes in atmospheric composition and the validation of other satellite instruments including MIPAS, HIRDLS and MLS.
- ACE is uniquely able to monitor all important chlorine- and fluorine-containing molecules in the stratosphere. ACE has determined a global inventory of atmospheric chlorine and fluorine that was included in the WMO's report *Scientific Assessment of Ozone Depletion: 2006*. ACE found that the average total stratospheric chlorine concentration is significantly higher than the accepted value.
- ACE is able to monitor all of the main components involved in activated polar chlorine chemistry: O_3 , HCL, $ClONO_2$, ClO, HNO_3 , H_2O and polar stratospheric clouds (PSCs).





SCISAT – ACE: Additional Information

ACE website at the University of Waterloo

<http://www.ace.uwaterloo.ca/>

- ACE Validation Special Issue of Atmospheric Chemistry and Physics (14 papers)
- International ACE Symposium, June 9-11, 2008, University of York, York UK

SCISAT-ACE is an ESA Third Party Mission

<http://eopi.esa.int/esa/esa>





OSIRIS

Optical Spectrograph and InfraRed Imaging System

on the Odin spacecraft
routine operations since 2001



Limb radiance profiles of scattered sunlight from 270 nm to 810 nm.

The profiles, which are constrained to the sunlit section of the orbit, have a height resolution varying between 1 and 2 km.

Primary data products: O_3 , NO_2 and aerosols

Science products: BrO , NO_3 , mesospheric OH and H_2O

Validation shows OSIRIS ozone agreement with ACE-FTS and SAGE II better than 3% over the altitude range 18 km to 53 km. The OSIRIS observations can be used to extend the SAGE instruments data sets.





OSIRIS: Additional Information

OSIRIS products and retrieval techniques have aided algorithm development associated with the OMPS instrument on NPP.

OSIRIS has both sufficient sensitivity and spatial-temporal coverage to measure global ozone transport across the troposphere on a weekly basis.

OSIRIS website at the University of Saskatchewan

<http://osirus.usask.ca/>

Odin is an ESA Third Party Mission

<http://eopi.esa.int/esa/esa>





Science Operations Centres

CSA supports the science operations of ACE-FTS, MAESTRO and OSIRIS through contracts to the Universities of Waterloo, Toronto and Saskatchewan. These contracts support:

- Instrument monitoring and operations
- Data processing and data product generation
- Algorithm development and re-analysis
- Data validation
- Data distribution and archiving



Validation and Modeling Activities

CSA has supported intensive ACE validation campaigns at PEARL each polar sunrise period since 2004. The Polar Environment Atmospheric Research Laboratory (PEARL) is a thoroughly instrumented facility at Eureka, Nunavut (80N, 86W) managed by CANDAC (Canadian Network for the Detection of Atmospheric Change) <http://www.candac.ca/>

CMAM, the Canadian Middle Atmosphere Model, has been developed with the support of CSA research grants. CMAM and its associated Data Assimilation System will be coupled to Environment Canada's GCM to perform ensembles of transient simulations addressing the policy-relevant question of the link between ozone recovery and climate change. These simulations will provide key Canadian contributions to the 2010 WMO/UNEP Ozone Assessment and the 2012 IPCC Climate Change Assessment Report. <http://www.atmosp.physics.utoronto.ca/C-SPARC/>

CSA also contributes to support of the SPARC International Project Office at the University of Toronto.





Committee on Earth Observation Satellites



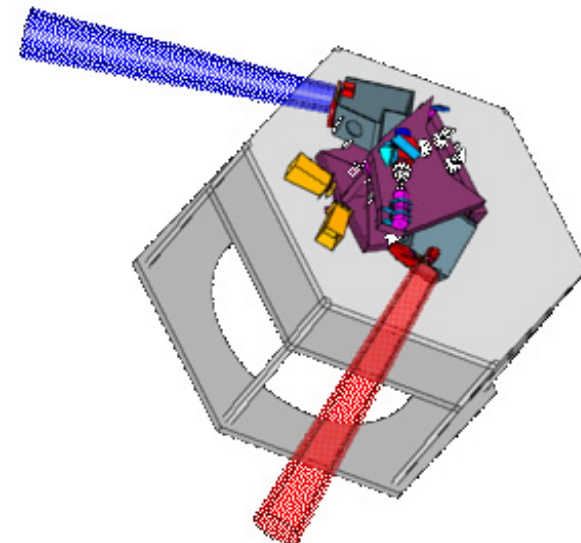
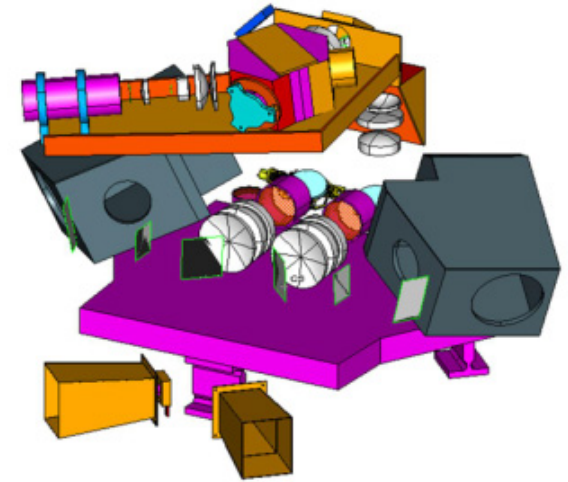
CSA participates in the CEOS:

- Atmospheric Composition Constellation pilot project
- Working Group on Calibration and Validation –
Atmospheric Composition Sub-Group



Future Missions: SWIFT

Stratospheric Wind Interferometer For Transport studies (SWIFT) is a satellite instrument designed to measure stratospheric winds and ozone concentration to improve our knowledge of the dynamics of the stratosphere, and the global distribution and transport of ozone. It is being considered as the primary instrument on the Chinook Mission. The limb viewing SWIFT instrument is an imaging, field-widened Michelson interferometer and the measurement technique is known as Doppler Imaging Michelson Interferometry.



Future Missions: Concept Studies

Three Mission Concept studies addressing ozone and relevant atmospheric gases are starting. These resulted from a request for proposals to the Canadian science community for missions to address Atmospheric Processes of Climate and its Change:

1. SOAR (Solar Occultation for Atmospheric Research): an ACE follow-on mission with next-generation performance.
2. STEP (Stratosphere-Troposphere Exchange Processes) mission to retrieve information of unprecedented spatial resolution on the photochemistry, dynamics and radiative properties of the Upper Troposphere and Lower Stratosphere: O_3 , H_2O , NO_2 , CO , HNO_3 , ClO and aerosols
3. A multi-instrument climate and air pollution mission that would include measurements of NO_2 , O_3 , $HCHO$, SO_2 , BrO and glyoxal in the troposphere.



Partnerships

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- with international organizations;
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Cost effectiveness through collaboration...