Status report on the current and future satellite systems by the Canadian Space Agency

Presented to CGMS-40 plenary session, agenda item [III.2] by Guennadi Kroupnik
### Overview - CSA current and future Atmospheric Composition satellite systems

<table>
<thead>
<tr>
<th>Year</th>
<th>MOPITT on Terra</th>
<th>OSIRIS on Odin</th>
<th>SCISAT/ACE</th>
<th>CASS</th>
<th>TICFIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MOPITT on Terra**
- Nadir column: CO

**OSIRIS on Odin**
- Limb Scatter vertical profiles: O3, NO2, BrO, aerosols

**SCISAT/ACE**
- Solar Occultation vertical profiles: over 37 gas species, aerosols

**CASS**
- Solar Occultation & Limb Scatter vertical profiles: over 37 gas species, aerosols

**TICFIRE**
- Nadir and Limb Far IR emission: polluted thin ice clouds
CURRENT LEO SATELLITES

- Radarsat - 1: launched in 1995 and still going strong!
- Radarsat – 2: launched in 2007. PPP with MDA.
CURRENT R&D SATELLITES

- MOPITT – launched in 1999 (on Terra). Nadir, column CO
- OSIRIS – launched in 2001 (on Odin). Limb Scatter, vertical profiles: O3, NO2, BrO, aerosols

Extensively used by atmospheric science and climate communities:
- ESA and NASA-led activities to generate Essential Climate Variable products for Ozone and Aerosols
- WCRP/SPARC activities related to ozone trends and chemistry-climate model evaluations

MOPITT, OSIRIS and SCISAT are operating well beyond their design lives:
- CSA intention is to operate them as long as they produce quality observations
FUTURE LEO SATELLITES

- Radarsat Constellation Mission: ensuring continuity in SAR-C data.
- Launch - 2016
FUTURE HEO SATELLITES

Polar Communications & Weather (PCW) Mission.

2 satellites in HEO to provide:

- Continuous GEO-like imagery above $50^\circ$ N (refresh rate 15 minutes)
- 24/7 High data rate communication services in Ka-band and X-Band, (addition of UHF services is being considered)
- Continuously collected space weather data
FUTURE HEO SATELLITES – Status update

PCW Accomplishments:
- Users Requirements Document (URD v. 6.1) - released
- Mission Requirements Document (MRD Rev. C) – available via CSA web
- Reference system conceptual design (Phase A) - complete
- PHEOS instruments (3) conceptual design (Phase A) - complete
- Preliminary Procurement Business Case (PPP vs. MCP) - complete
- Socio-Economic Benefits Study Report - October 2012
- Preliminary Investment Business Case – October 2012
- Service Requirements Document (Initial Release) – October 2012

PCW Work in Progress:
- UHF Requirements and Feasibility study (CSA/DND/CRC) – March 2013
- Critical Technologies development – July 2014
- PHEOS technologies development – March 2014
- Bi-lateral and multi-lateral international collaboration scenarios
- Targeted entry in operations 2018.
FUTURE R&D SATELLITES

- CASSIOPE – launch 2013. ePOP space weather payload comprises a suite of eight scientific instruments, including plasma imagers, radio wave receivers, magnetometers and cameras.
- M3MSat – launch 2013. AIS and LDR communication payloads, capable to pick-up low power signals from in-situ sensors
- CASS (Chemical and Aerosol Sounding Satellite) - will respond to needs for vertical profile observations of ozone, ODSs, GHGs, aerosols and precursors as identified by GCOS/CEOS. Planned launch -2016
- TICFIRE – Nadir and Limb Far IR emissions: polluted thin ice clouds. Launch-2017
To be considered by CGMS:

- PCW is open for international Collaboration
  - Definition and validation of User’s needs and Requirements,
  - Launch capabilities,
  - Meteorological Payload or its subsystems/core components
  - Spacecraft subsystems and/or critical components,
  - Enhanced communications capabilities,
  - Secondary payload and its data processing or service delivery:
    - Ground segment (Back-up TT&C, Data processing and applications).
- CSA is looking for an opportunity to partner on CASS mission.
- Potential use of M3MSat AIS and LDR capabilities for in-situ measurements
Back-up
MOPITT: Measurements Of Pollution In The Troposphere

Launched in 1999 on NASA’s Terra satellite

Instrument operations are performed at the University of Toronto

- Measures concentration of carbon monoxide in the troposphere
- Observes sources, transport and diffusion of this product of incomplete combustion
- Links with CO2 and ozone
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$_2$O
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 are being used to extend the SAGE instruments data sets.
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)
- UV / Visible spectrometer (MAESTRO) 0.285 to 1.03 microns, resolution ~1-2 nm
- Suntracker keeps the instruments pointed at the sun’s radiometric center.

Launched August 2003
Routine operations since February 2004