



# ACE/OSIRIS Arctic Validation Campaign at Eureka

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Pierre Fogal, Kaley Walker, Kim Strong

and the ACE/OSIRIS Arctic Campaign Team

U. Toronto, Dalhousie U., U. Saskatchewan, U. Western Ontario,  
York U., Environment Canada and LATMOS/CNRS

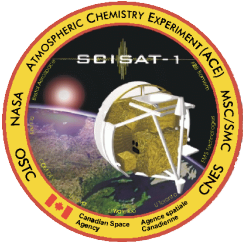
NDACC IRWG – June 2015 – Toronto, Canada



# Campaign Motivation

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- As of 21 February 2015, the ACE mission has been making routine measurements of the Earth's atmosphere for 11 years.
  - With a focus on high latitude & Arctic measurements
- Ground-based measurements provide critical data for the validation of satellite retrievals of trace gases and for the assessment of long-term stability of these measurements.
- In particular, validation comparisons are needed for ACE and OSIRIS during Arctic springtime to understand better the measurements of species involved in stratospheric ozone chemistry.

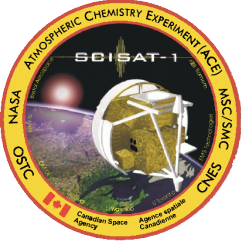


# ACE/OSIRIS Arctic Campaign 2015

Location: Polar Environment Atmospheric Research Laboratory (80°N)

ON-SITE INSTRUMENTS (location)	CAMPAIGN INSTRUMENTS
<ul style="list-style-type: none"> <li>• <b>EC DIAL (PEARL)</b></li> <li>• EC ozonesondes (weather station)</li> <li>• EC Brewers (Ridge Lab.)</li> <li>• CANDAC Bruker 125HR FTS (Ridge)</li> <li>• CANDAC grating spectrometer (Ridge)</li> <li>• <b>CANDAC E-AERI (0PAL)</b></li> </ul>	<ul style="list-style-type: none"> <li>• U of Toronto PARIS FTS</li> <li>• EC/York SPS-G</li> <li>• U of T grating spectrometer (UT-GBS)</li> <li>• LATMOS/CNRS SAOZ</li> </ul>

- Pre-campaign phase: 8 – 25 February
  - Setup and testing of the SPS and further work on testing the DIAL
- Intensive phase: 26 February – 18 March
  - Measurements by all 10 instruments with daily ozonesondes
- Extended phase: 19 March – April 1
  - Repair of E-AERI and continued measurements with all instruments at PEARL/0PAL and weekly ozonesonde flights



# Instrument Repairs & Upgrades

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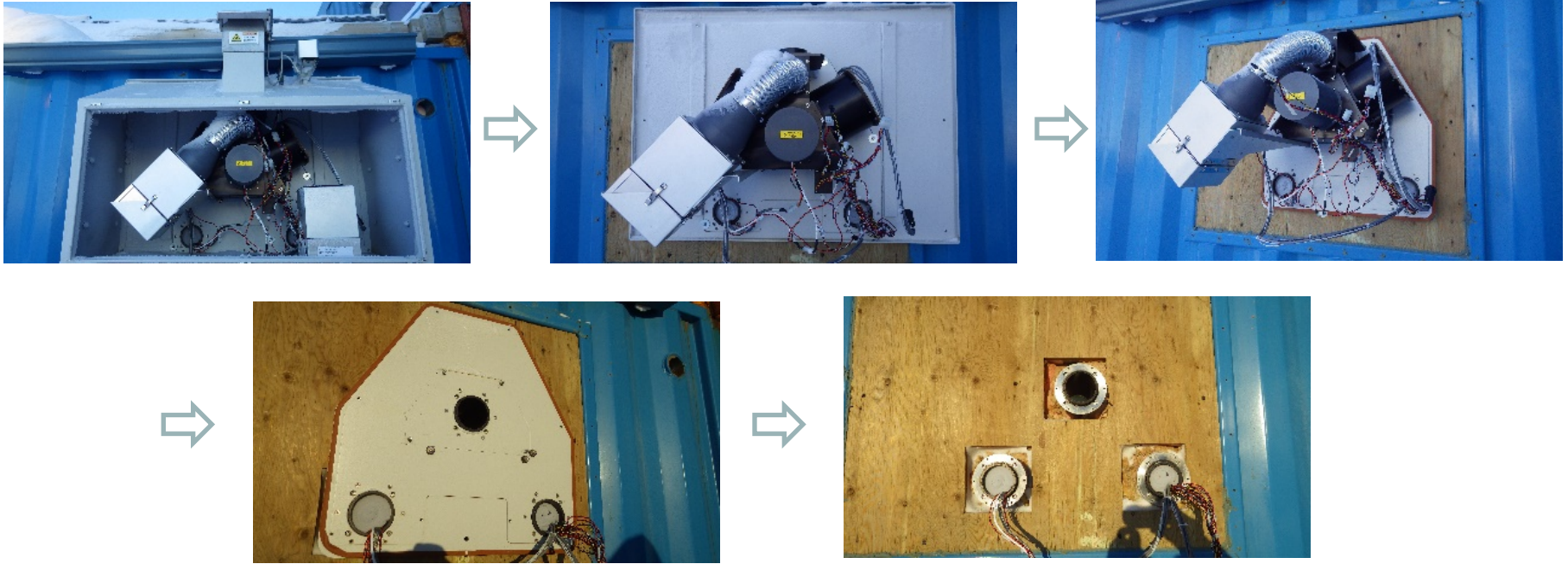
This was the year for more instrument repairs and upgrades than a typical campaign! The main ones were:

- In November, E-AERI (IR emission radiometer) had cooler issues and radiometer and two blackbodies were shipped back to ABB for assessment
  - Failed Sterling cooler was replaced and instrument reinstallation and calibration were planned for campaign
- After loss of excimer laser for the DIAL at the end of 2009 campaign, laser was replaced – however issues remained that required more detailed work
  - Pre-campaign phase was used to continue refurbishment and testing of the instrument – obtained atmospheric signals



# Dismantling and re-assembling E-AERI for indoor tests

Outside the shelter:



Inside the shelter:

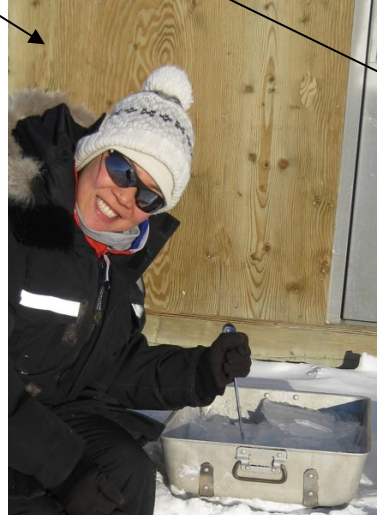


**Sophie Tran**

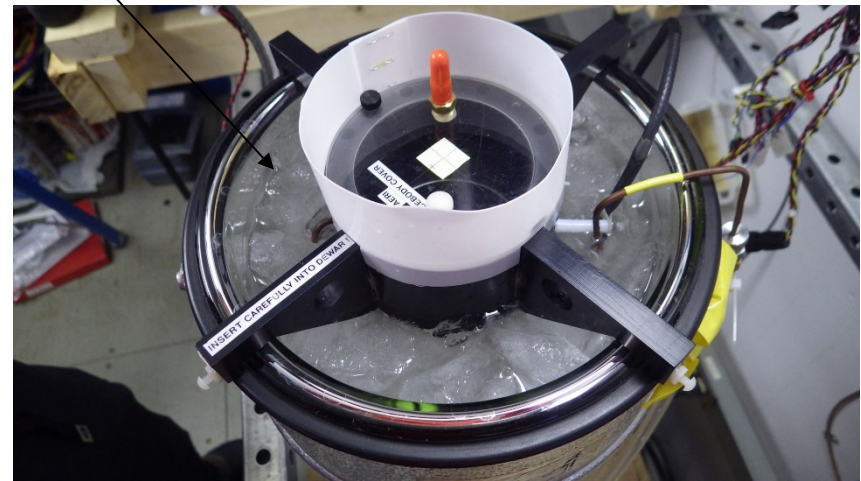
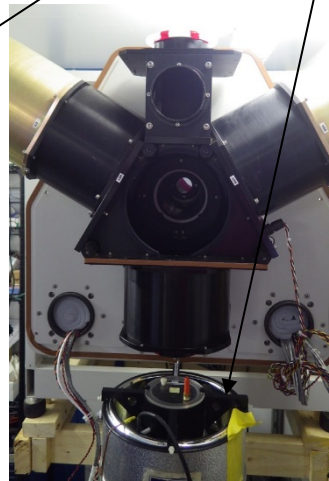
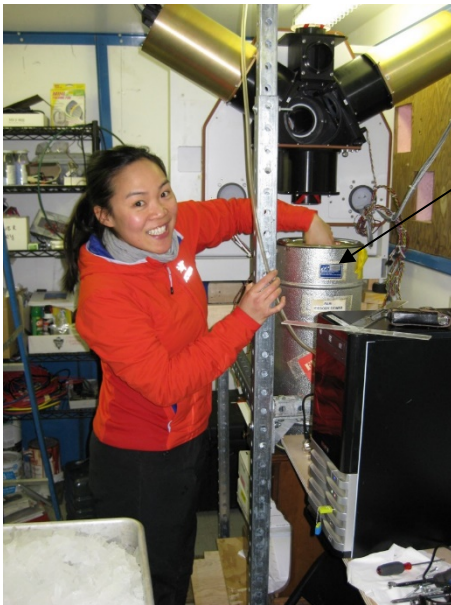


# Preparation for the ice body test

Making pure crushed ice



Preparation of the icebody

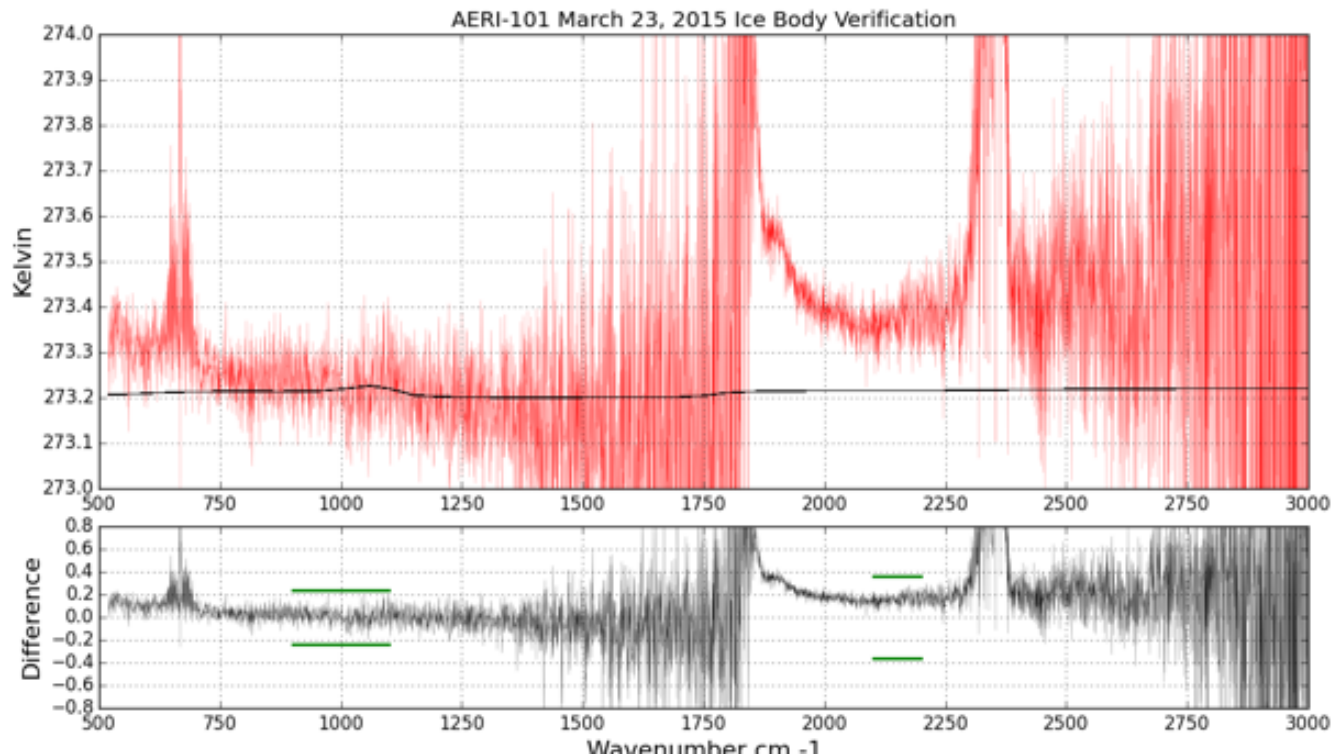


Sophie Tran

# E-AERI Radiometric Calibration

Radiometric calibration absolute accuracy shall be  $< 1\%$  of ambient blackbody radiance

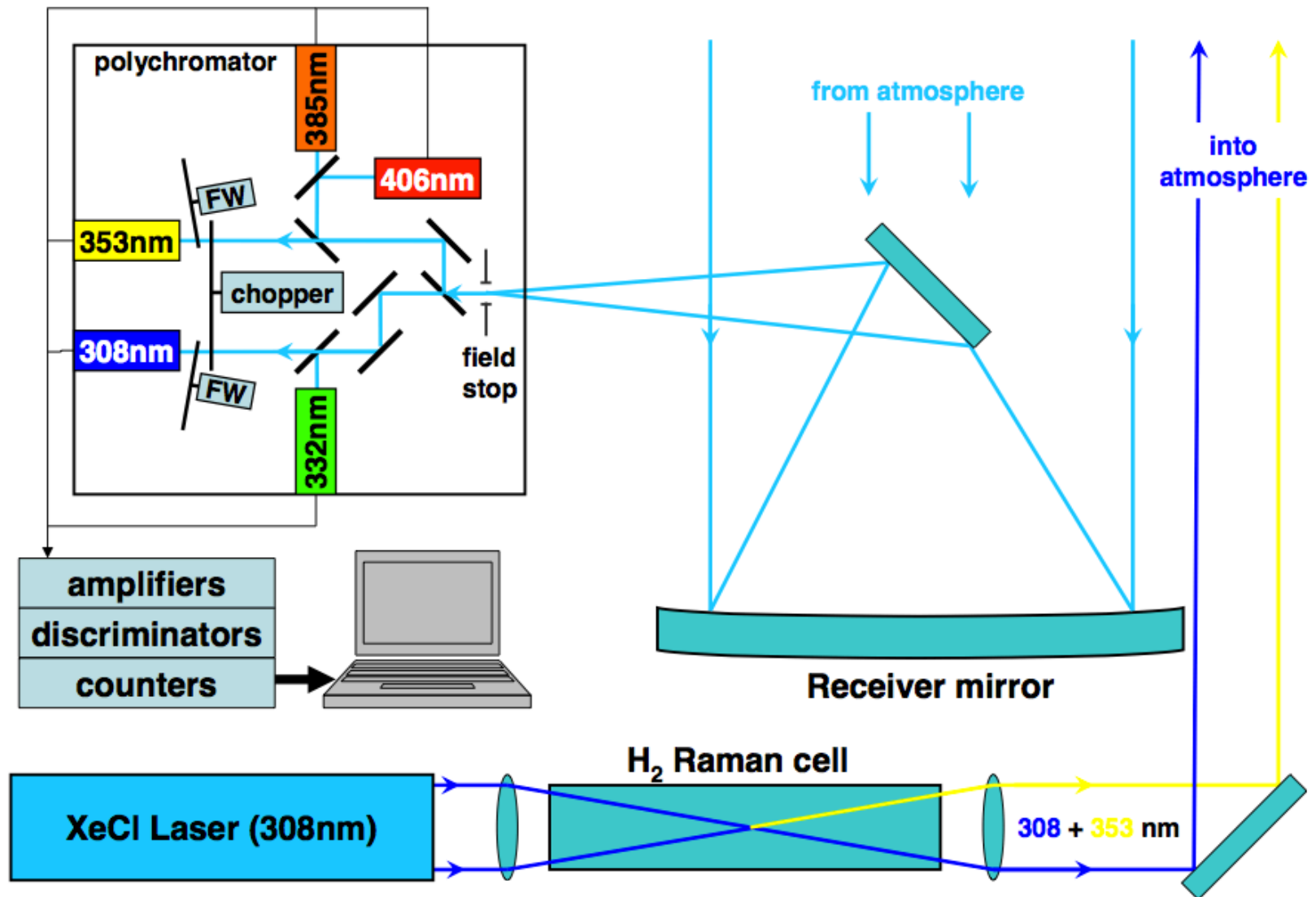
Results for the icebody test



AERI-101 observed blackbody brightness temperature for ice body test compared to predicted value. Green bars indicate the certification test criteria.

Sophie Tran

# DIAL schematic

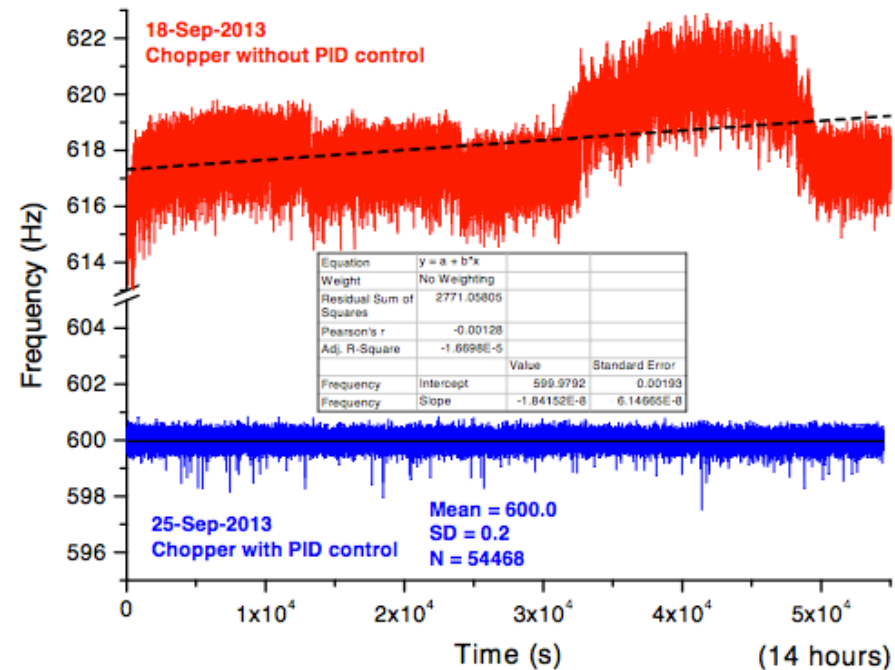
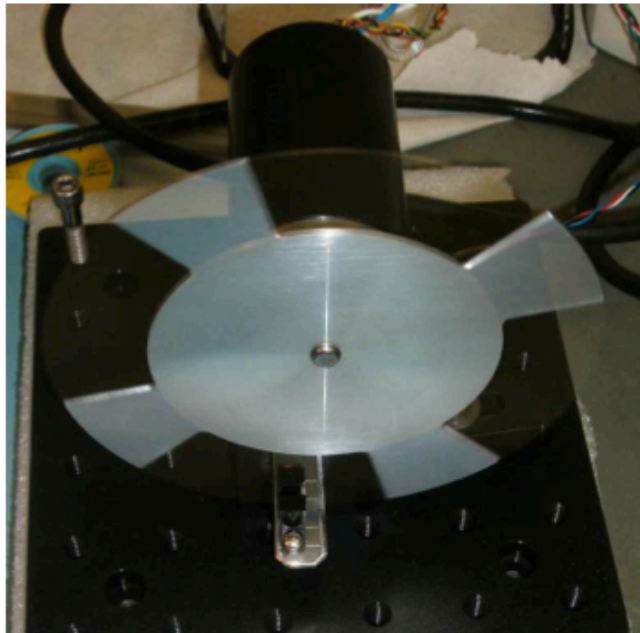


Alexey Tikhomirov

# DIAL chopper replacement



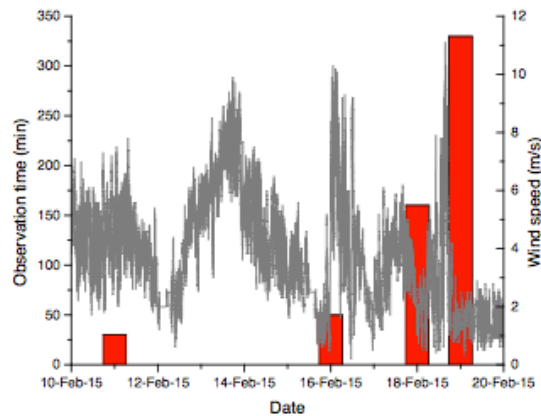
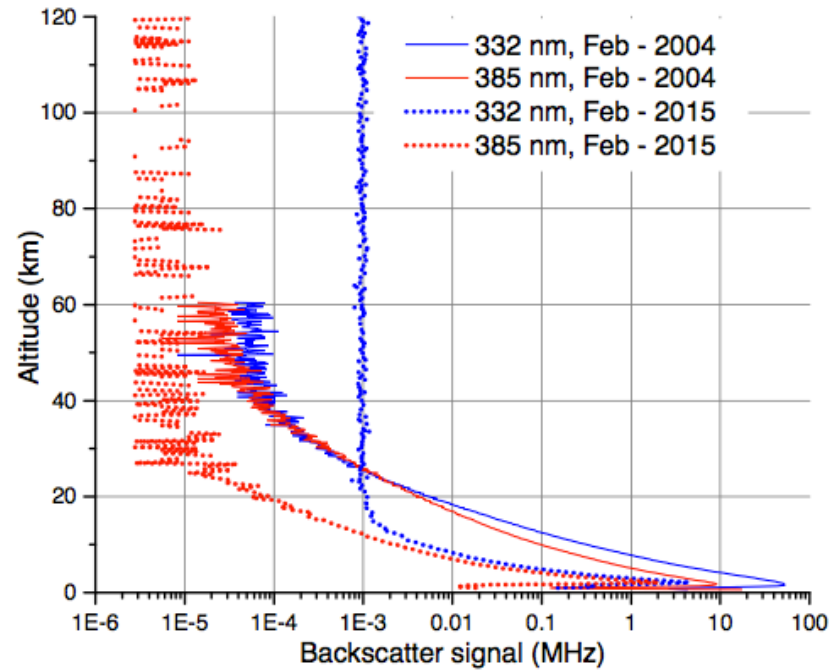
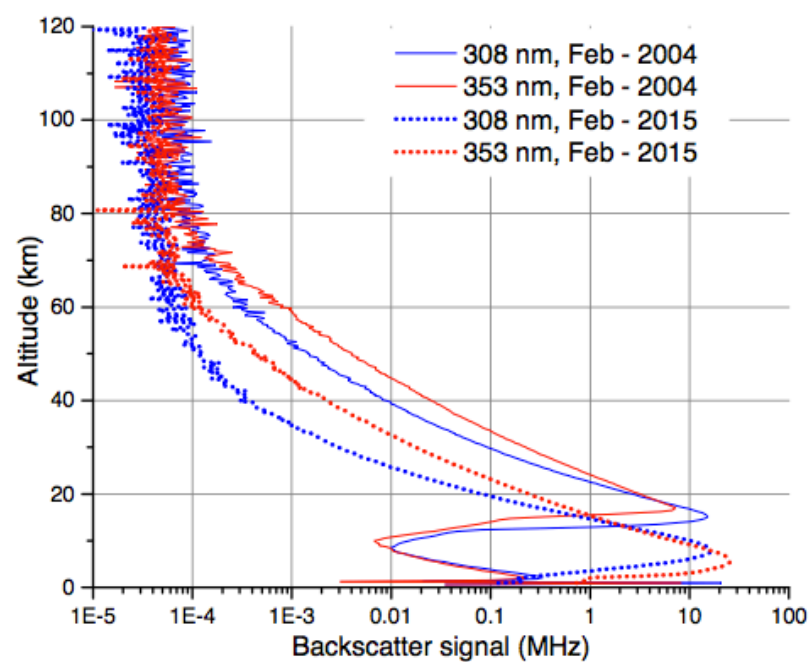
Specification	Old chopper	New chopper
Blade	2-slot	4-slot
Motor	Brushed DC	Brushless DC
Speed	9000 rpm	9000 rpm
Frequency	300Hz	600Hz
Laser triggering	300Hz	200Hz (every 3d slot)
Control	N/A	PID



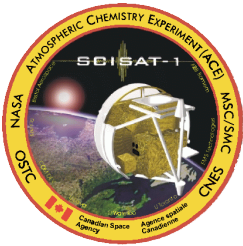
Alexey Tikhomirov



# DIAL RESULTS

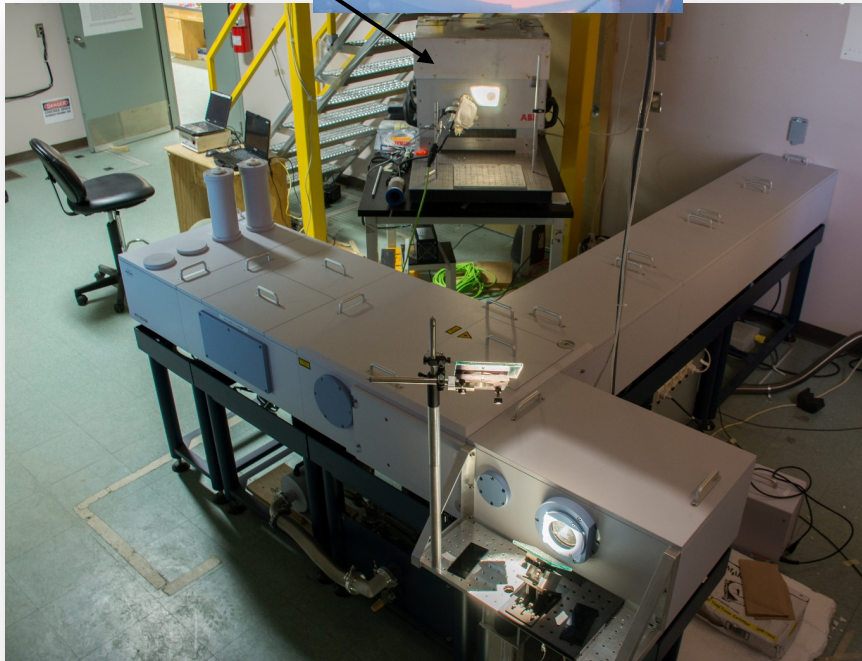


Alexey Tikhomirov



# FTS Measurements

PARIS-IR



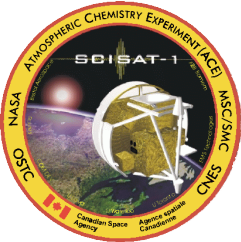
Bruker FTS

Two ground-based solar absorption FTS instruments were in operation throughout the campaign:

- **PARIS:** U. Toronto  $0.02 \text{ cm}^{-1}$  res. (terrestrial version of ACE-FTS)
- **Bruker IFS125HR:** CANDAC  $0.00245 \text{ cm}^{-1}$  res., in place since July 2006

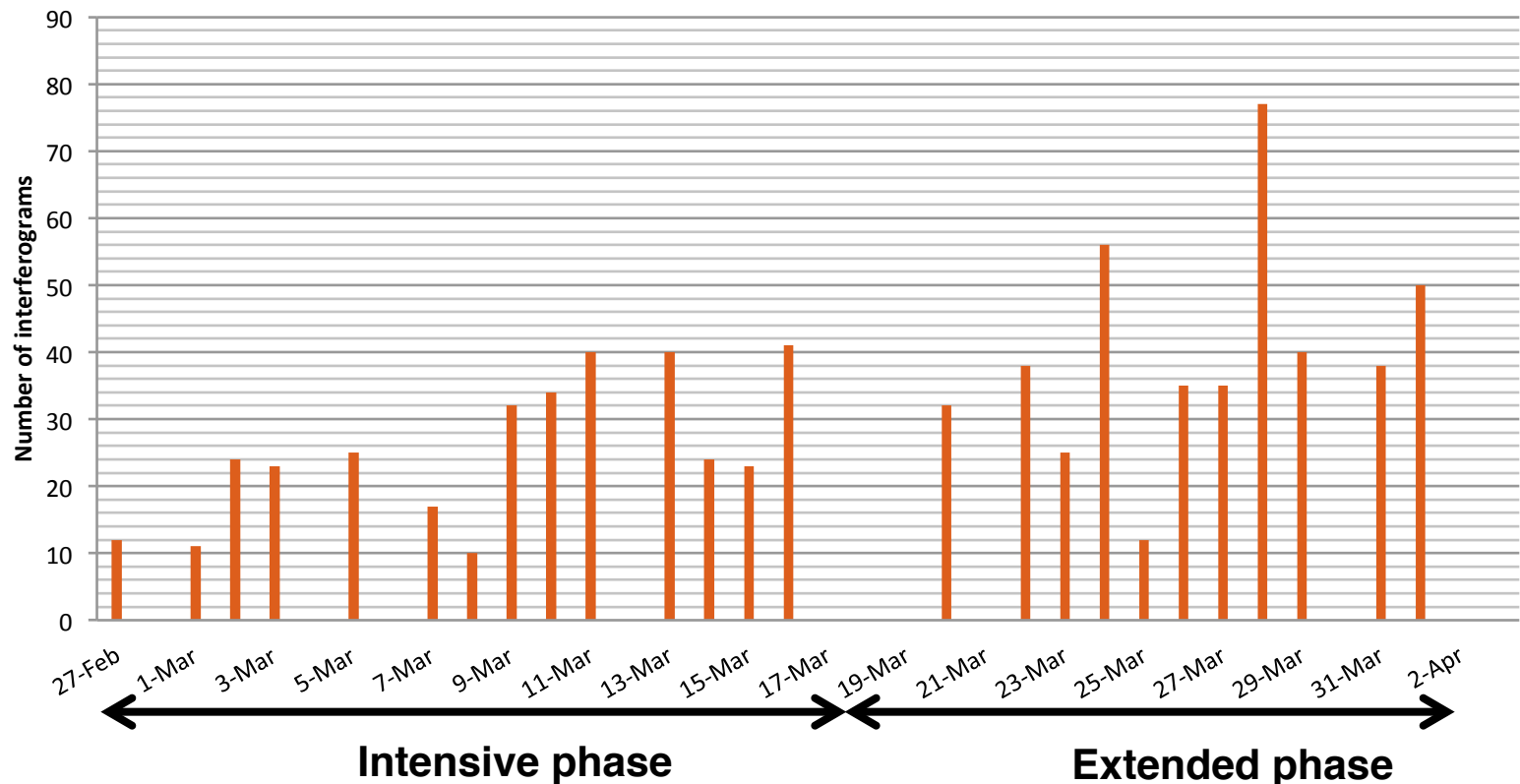
The instruments operated by sharing the solar beam –remote operation, suntracker installed that allows filling of both instruments' field-of-view fully. Both measured continuously as weather conditions allowed.

Debora Griffin, Joseph Mendonca, Sebastien Roche and Dan Weaver



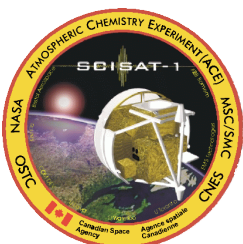
# PARIS-IR Measurements

- Collected **782 solar measurements** during 2015 ACE campaign over **25 days** between 27 February and 01 April.
- Only few days of measurements missed – reasonable weather



Debora Griffin

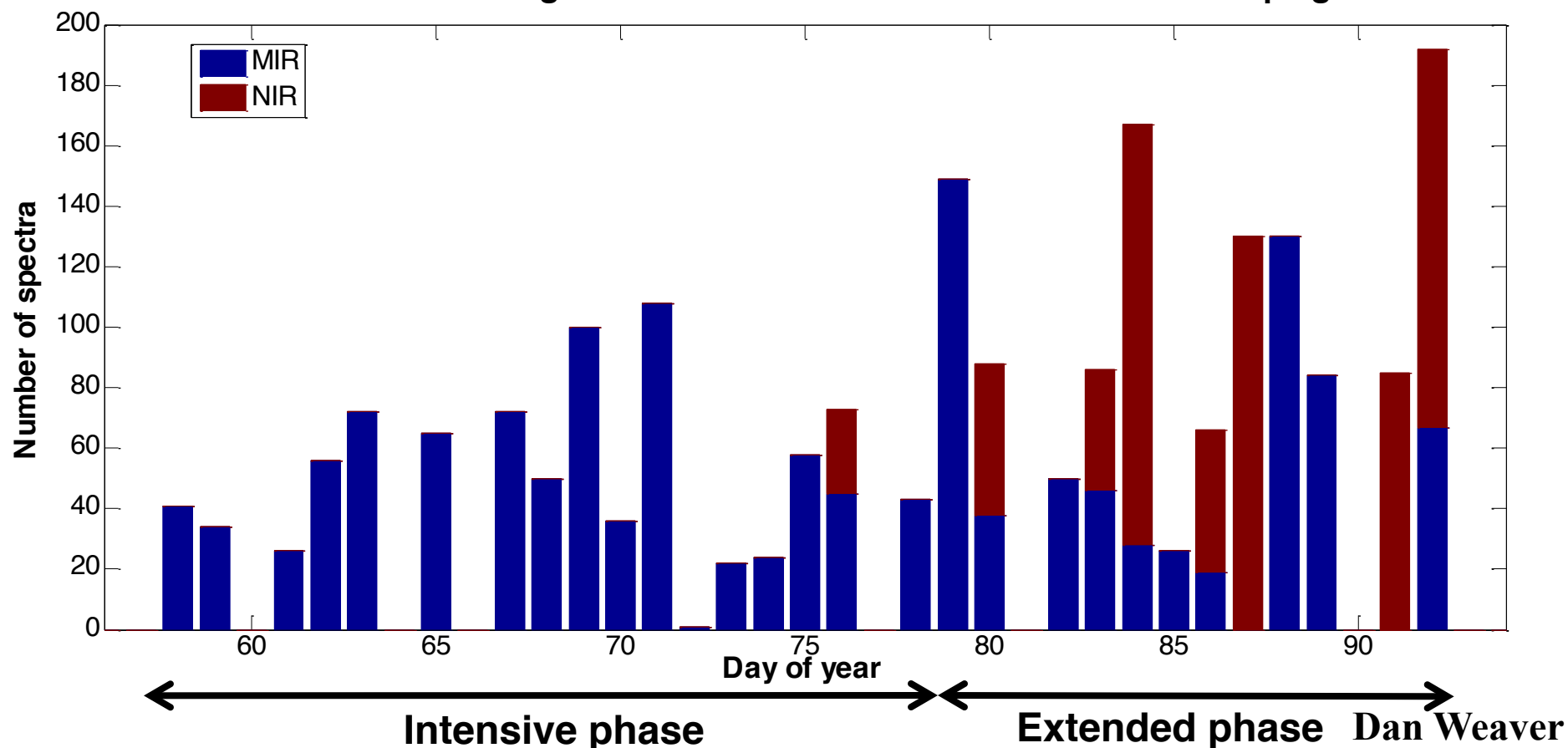




# CANDAC Bruker FTS

- Collected 2134 solar measurements during 2014 ACE campaign over 29 days between 27 February and 01 April.
  - 644 NIR (8 days) and 1490 MIR (27 days)

Measurements during the 2015 Eureka ACE/OSIRIS Validation Campaign



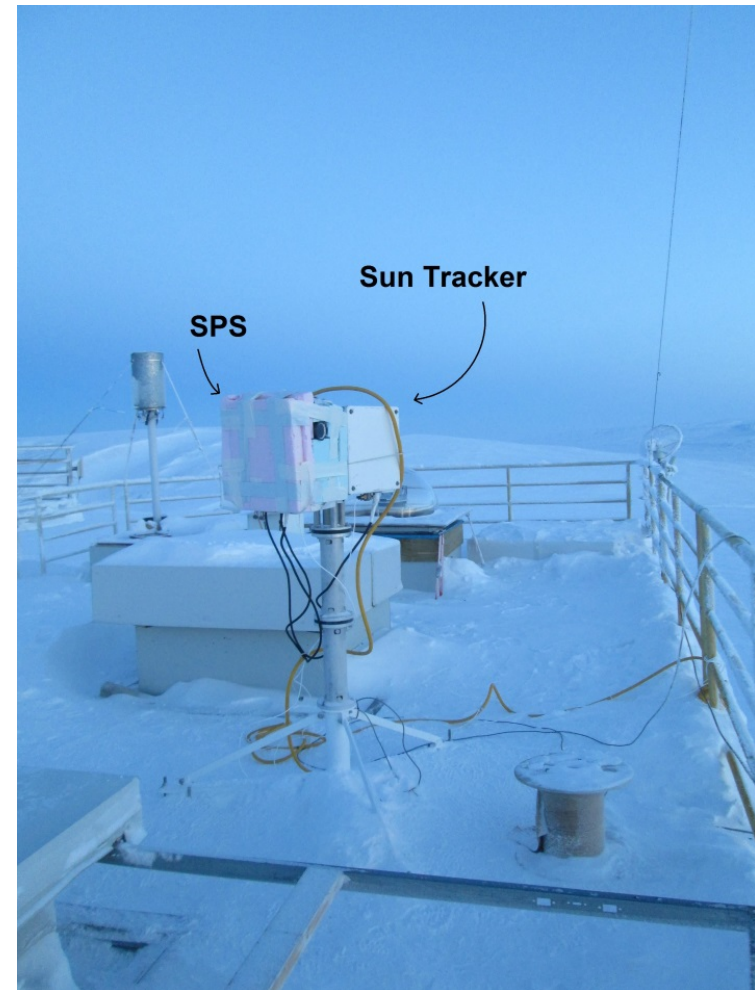


# SPS Data Collected for Campaign

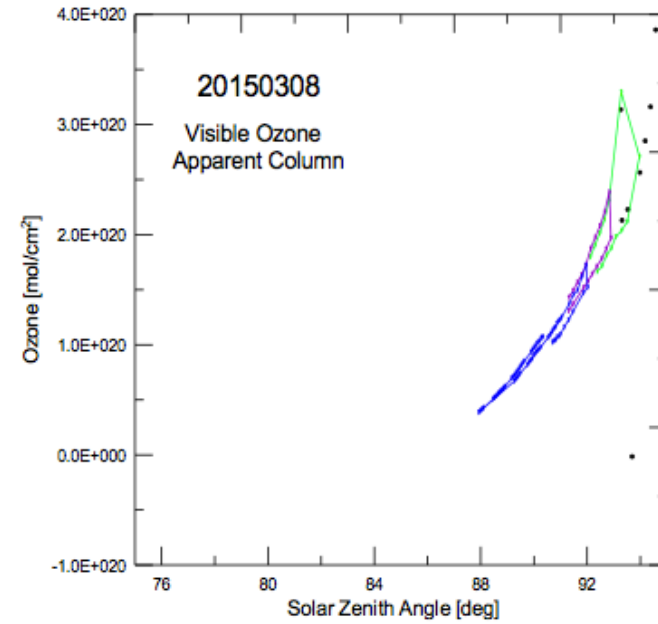
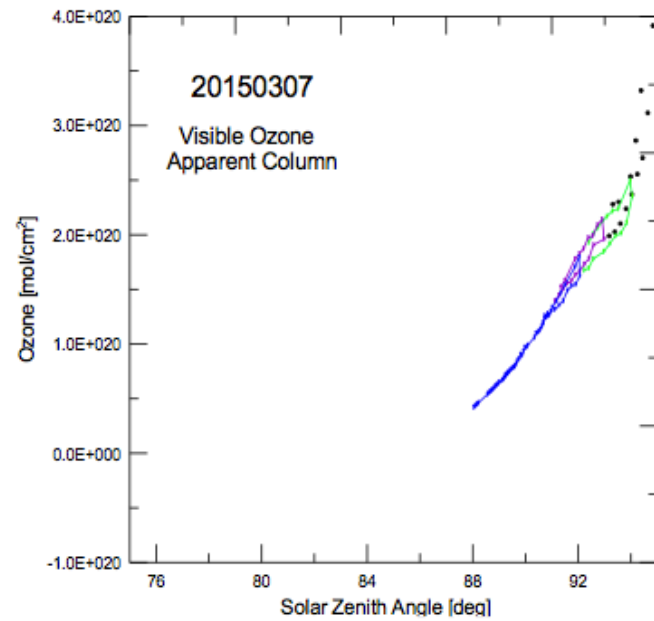
- 33 days from 16/2/2015 to 1/4/2015
- Issues with the tracker and SPS computer reduced our data to only zenith sky mode.
- Sunrise at Noon



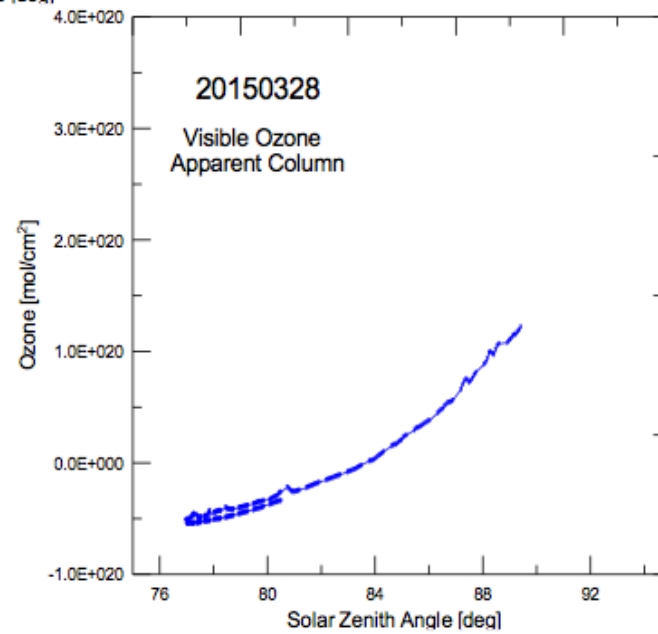
SPS and the Sun-Tracker on the roof of PEARL



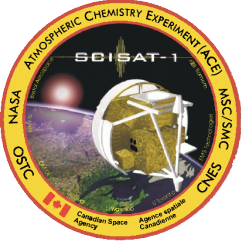
**Zahra Vaziri Zanjani, Tom McElroy**



**Ozone**



**Zahra Vaziri Zanjani, Tom McElroy**



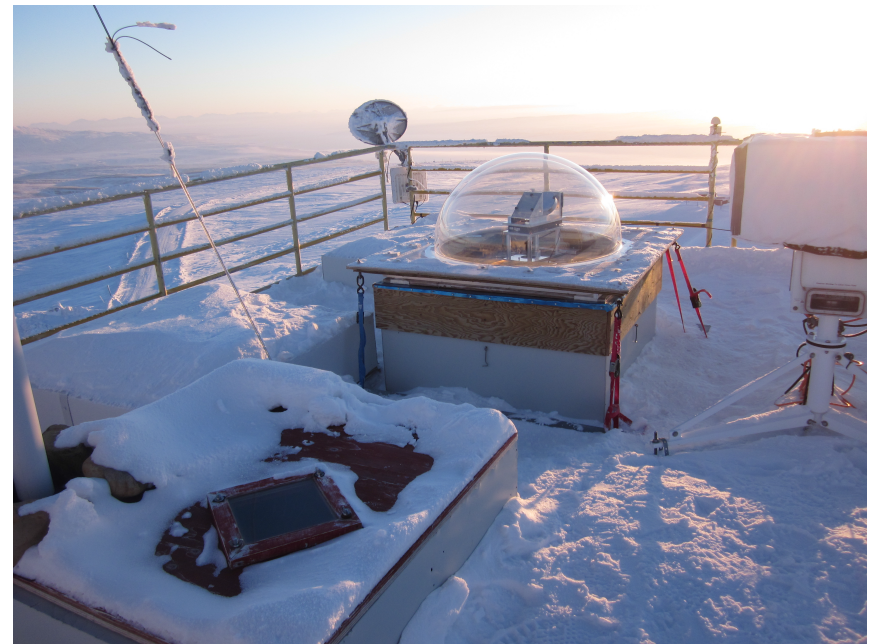
# Ground-based Spectrometers

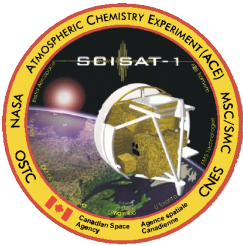
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Two UV-visible triple-grating spectrometers with cooled CCD detectors with different viewing modes (PEARL-/UT-GBS)

- Zenith-sky: primarily stratospheric species measured.
- MAX-DOAS: tropospheric species measured.
- Direct-sun: stratospheric and tropospheric partial columns (not done this year because of filter wheel issues).

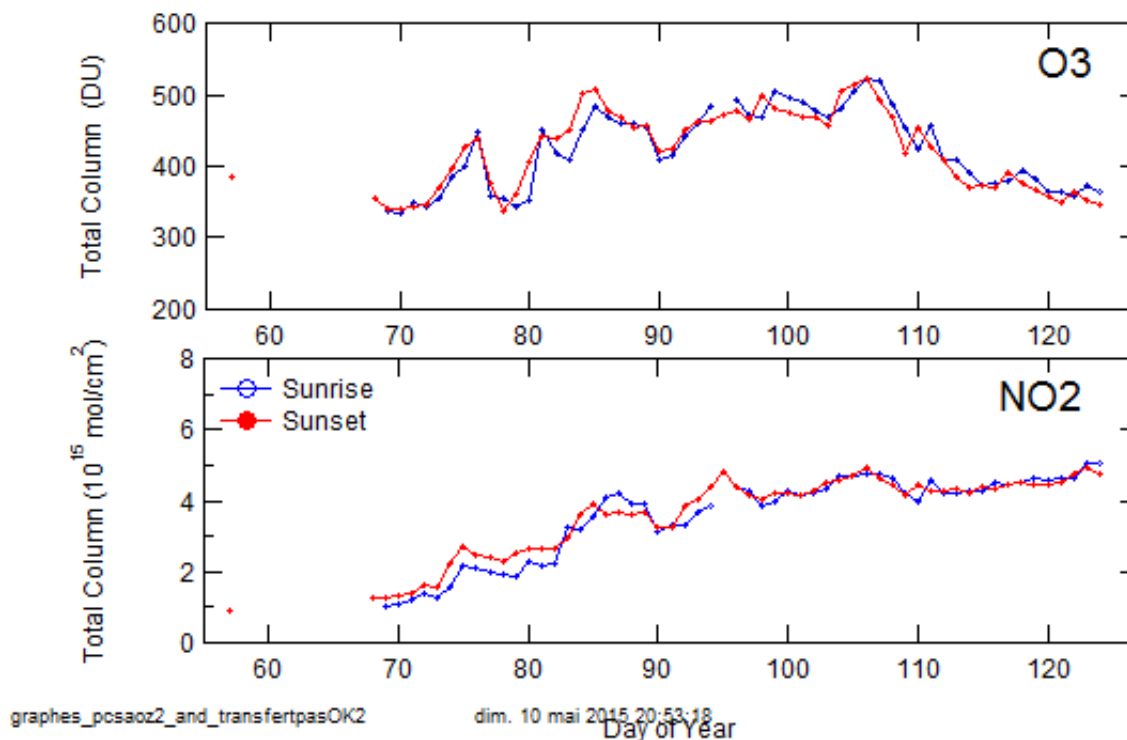
New dome installed for PEARL-GBS in Fall 2014 to allow measurements lower on horizon in MAX-DOAS mode (“negative angle” from tracker base)





# SAOZ at Eureka – 2015

## Real-Time V3

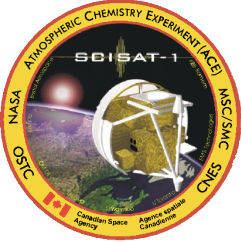


## O<sub>3</sub> and NO<sub>2</sub>

Processed with:

- Reference spectrum 06/05/2011; SZA 63.22
- NDACC recommended cross sections
- NDACC recommended adjusted daily O<sub>3</sub> AMF
- NDACC recommended adjusted daily NO<sub>2</sub> AMF

Florence Goutail / Andrea Pazmino

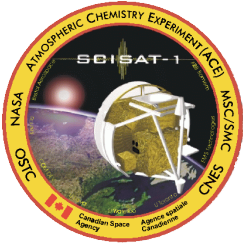


# Summary

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- 2015 ACE/OSIRIS Arctic Campaign was very successful
  - Quite consistent observing conditions with main challenges being instrument repairs!
    - Very good progress made in returning instruments to operation and upgrading components
  - Post-campaign meeting was held in mid-May
    - Preliminary results are available for some instruments and coming soon for others
  - Looking forward to continuing usage of data set and expanding on validation and science results
  - Campaign measurements continue to be of value to ACE and OSIRIS for assessing instrument results





# 2015 Campaign Team

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## ACE/OSIRIS Validation Team Co-Leaders

- Kimberly Strong, U. Toronto
- Kaley Walker, U. Toronto

## Co-Investigators

- Doug Degenstein, U. Sask.
- James R. Drummond, Dalhousie U.
- C. Thomas McElroy, York U.
- R. J. Sica, U. Western Ontario

## Collaborators

- Florence Goutail, LATMOS/CNRS
- Andrea Pazmiño, LATMOS/CNRS
- David Tarasick, Env. Canada

## Team Members

- Jonathan Franklin, Dalhousie U.
- Debora Griffin, U. Toronto
- Emily McCullough, U. Western Ontario
- Joseph Mendonca, U. Toronto
- Sebastien Roche, U. Toronto
- Alexey Tikhomirov, Dalhousie U.
- Sophie Tran, U. Toronto
- Zahra Vaziri Zanjani, York U.
- Dan Weaver, U. Toronto
- Xiaoyi Zhao, U. Toronto

## ACE/CANDAC Operators

- Paul Loewen
- Pierre Fogal
- Mike Maurice



# Acknowledgements

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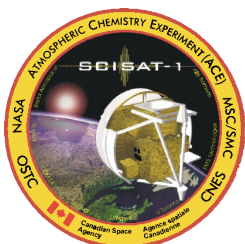
Funding and support for this work was provided by:

- Canadian Space Agency
- Environment Canada
- Natural Sciences and Engineering Research Council Canada
- Northern Scientific Training Program
- Centre National d'Etudes Spatiales
- Canadian Network for Detection of Atmospheric Change  
(funding partners: ARIF, AIF/NSRIT, CFCAS, CFI, CSA, EC, GofC IPY, NSERC, OIT, ORF, INAC, and PCSP)

Special thanks to:

- Eureka Weather Station staff for their support during our twelve spring campaigns





# ACE Arctic Campaign 2015

Campaign Location: PEARL at Eureka, Nunavut (80°N, 86°W)

- Intensive phase: 26 February – 18 March (full team on site)
- Extended phase: 19 March – 1 April (operator on site)

Instrument	Type	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EC DA8 FTS	IR FTS	✓	✓	✓	✓	✓	*						
U. Toronto PARIS-IR	IR FTS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CANDAC Bruker FTS	IR FTS				✓	✓	✓	✓	✓	✓	✓	✓	✓
CANDAC E-AERI	IR FTS						✓		✓	✓	✓	✓	
EC Ozone DIAL	Lidar	✓	✓	✓	✓	✓	✓	**					****
CANDAC RMR	Lidar								✓	✓	✓	✓	
EC MAESTRO-G	UV/Vis	✓	✓	✓	✓	✓	✓	✓	***	✓	✓	✓	***
EC SPS-G	UV/Vis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CANDAC UT-GBS	UV/Vis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EC Brewer Spectrom.	UV/Vis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SAOZ	UV/Vis		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CANDAC PEARL-GBS	UV/Vis				✓	✓	✓	✓	✓	✓	✓	✓	✓
EC Ozonesondes	Balloon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Abbreviations for spectral regions are: IR: infrared; UV: ultra-violet; Vis: Visible; Colours show year instr. added

\* Following extensive intercomparisons with Bruker FTS, DA8 FTS was removed in February 2009

\*\* Laser failed at end of 2009 campaign and repair / rebuilding of lidar is currently on-going

\*\*\* On balloon campaign in Kiruna during spring 2011 / preparing for balloon campaign in summer 2015

\*\*\*\* Testing of rebuilt lidar undertaken in February 2015