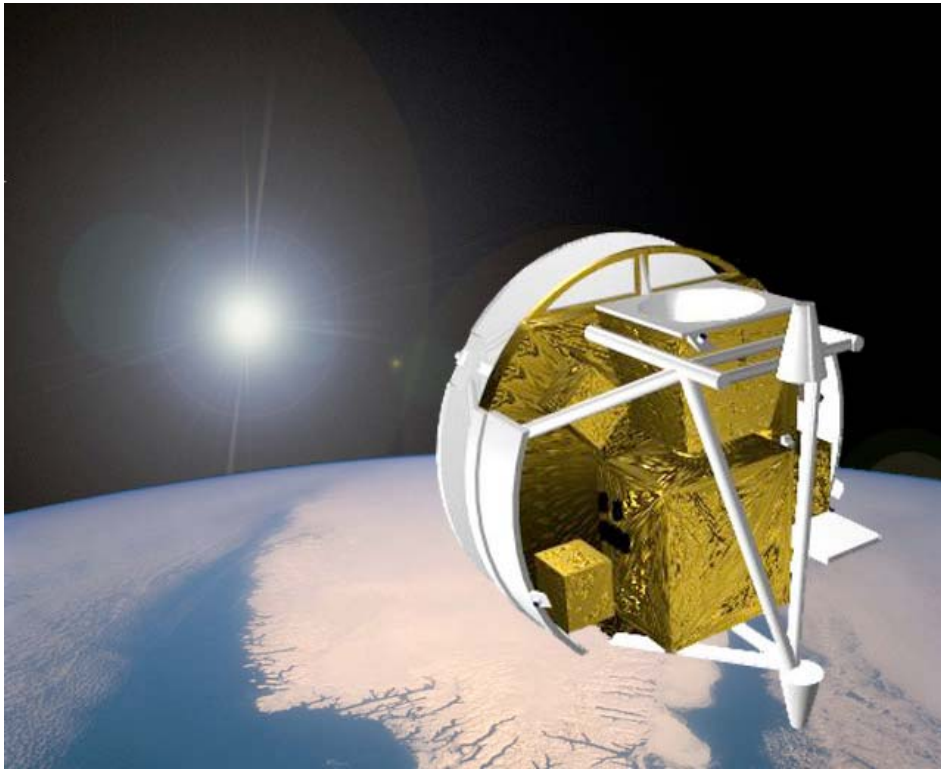


The Canadian Arctic Validation Campaigns for the ACE satellite mission at Eureka

Kaley Walker, Kim Strong,
and the Canadian Arctic ACE Validation Team
Department of Physics, University of Toronto
ARC-IONS Data Workshop - 7 January 2009

Atmospheric Chemistry Experiment (ACE)

Goal: to investigate chemical and dynamical processes that control the distribution of ozone in stratosphere and upper troposphere



Size: 1.12 m dia. x 1 m

Total mass: 152 kg

Total power: 70 W
(from single solar panel)

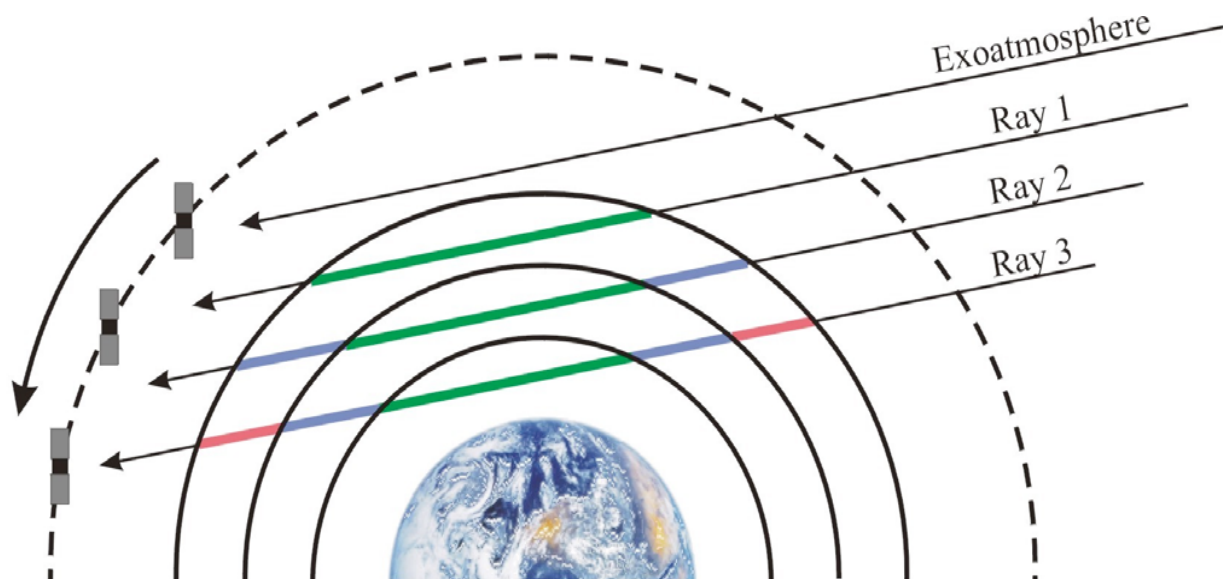
Launch date: August 12, 2003

Launch vehicle: Pegasus XL
(provided by NASA)

Orbit: 74° inclined circular orbit at
650 km

Solar Occultation Measurements

- Use solar absorption instruments to obtain atmospheric profiles of over 30 species, temperature and atmospheric extinction
 - **ACE-FTS**: a high resolution (0.02 cm^{-1}) infrared Fourier transform spectrometer operating between 2-13 microns
 - **ACE-MAESTRO**: dual UV / Visible / NIR spectrometer measuring from 0.285 to 1.030 microns, resolution $\sim 1\text{-}2 \text{ nm}$



Where the ACE Campaign story begins...

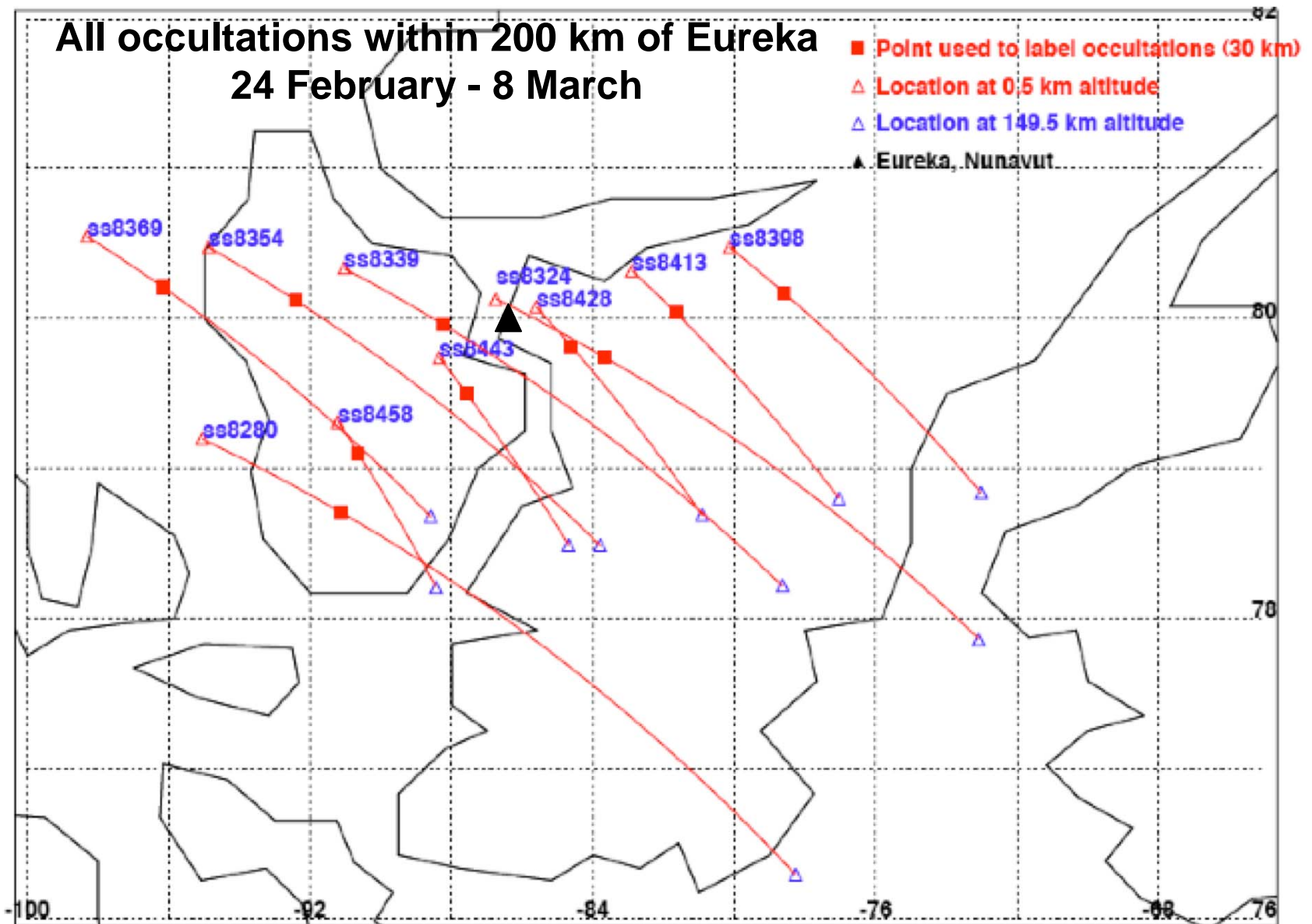
- In developing the ACE Validation Plan in 2001-2003, we found that there were very few measurement sites in northern Canada that monitor trace gases
 - Only Environment Canada upper air stations and AStrO lab
- So, a dedicated Canadian Arctic ACE Validation campaign at Eureka was proposed to the Canadian Space Agency (CSA) in Summer 2003
 - Campaign was funded for February-April 2004 by CSA and Environment Canada
 - Re-proposal funded for 2005-2006 and then we were funded to continue through IPY (2007-2008)

PEARL at Eureka

- Polar Environment Atmospheric Research Laboratory
 - Formerly Env. Canada's Arctic Stratospheric Ozone Observatory (AStrO) on Ellesmere Island (80°N, 86°W)
 - Run by the Canadian Network for Detection of Atmospheric Change (CANDAC) since August 2005
 - Three facilities: PEARL ridge lab, ØPAL, and SAFIRE



ACE Occultation Ground Tracks - 2005



ACE Arctic Validation Campaigns

Campaign Goals

- To obtain validation measurements for ACE in the Canadian Arctic (Eureka, Nunavut – 80°N, 86°W) from February to April 2004 - 2008 for all 14 ACE baseline species
- To provide spectral, as well as trace gas, measurements from ground-based versions of ACE-FTS and MAESTRO
- To make daily measurements at high temporal resolution to give context to the sparse (in time and space) ACE occultation measurements
- To maintain the continuity of measurements from the NDACC- validated FTIR at Eureka, which have been made since 1993

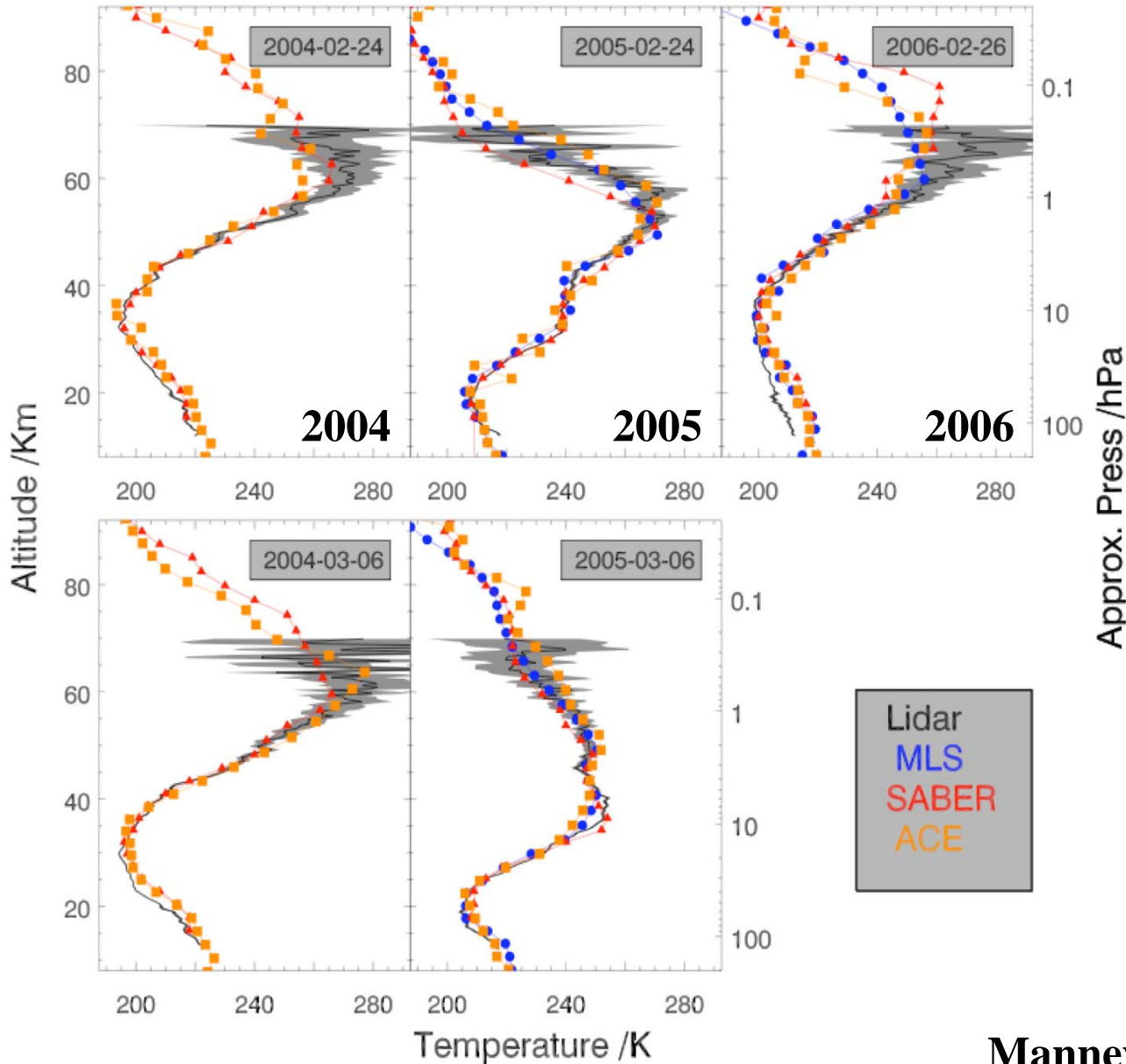
ACE Arctic Campaign Details

Location: Eureka, Nunavut - PEARL / AStrO

ON-SITE INSTRUMENTS (location)	CAMPAIGN INSTRUMENTS
<ul style="list-style-type: none">• EC DA8 FTS (PEARL)• EC/CANDAC DIAL (PEARL)• EC ozonesondes (weather station)• EC Brewers (weather station)• EC Brewer (PEARL)• CANDAC 125 HR FTS (PEARL)• CANDAC grating spectrometer (PEARL)	<ul style="list-style-type: none">• U of Waterloo PARIS-IR FTS• EC MAESTRO-G• EC SPS-G• U of T grating spectrometer (UT-GBS)• Service d'Aeronomie SAOZ

- Intensive phase: ~February 19 – March 10
 - Measurements by all 12 instruments with daily ozonesondes
- Extended phase: March 11 – ~ early-mid April
 - Continue measurements by as many instruments as possible at PEARL and weekly ozonesonde flights (all in 2007-08)

Year-to-year Changes in Temperature

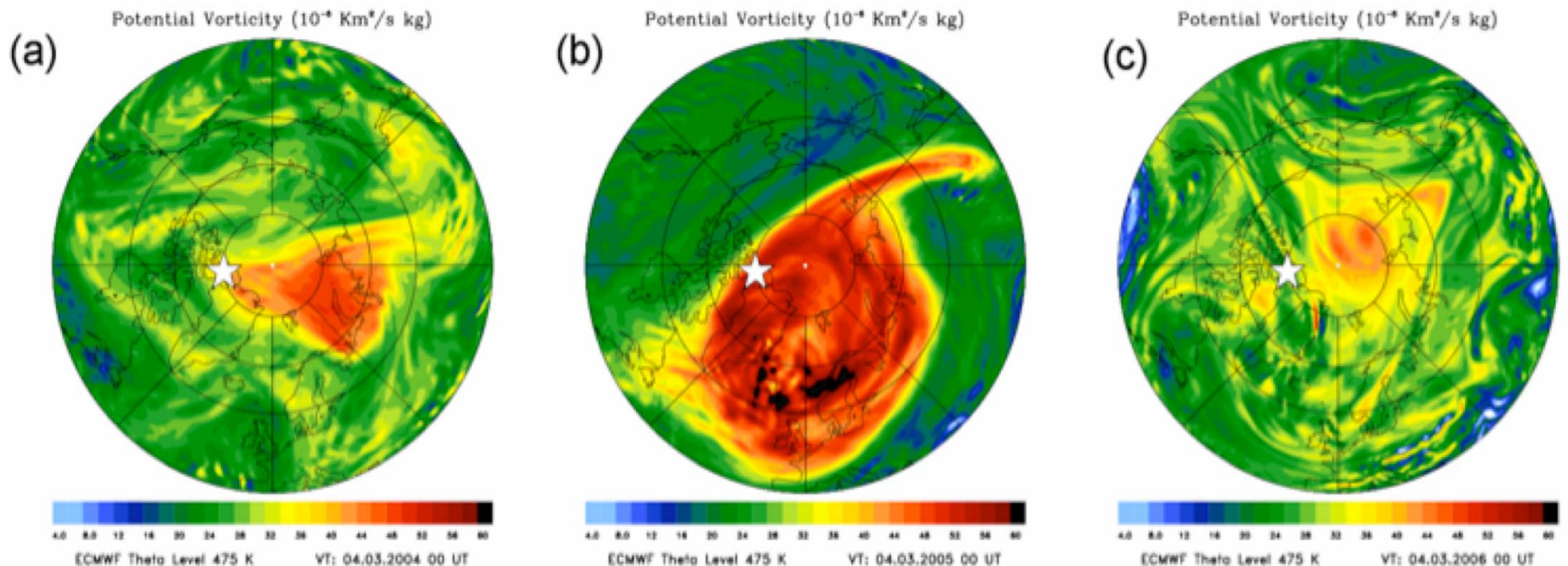


Impact of meteorology

- differences between years due to sudden stratospheric warming events in 2004 and 2006

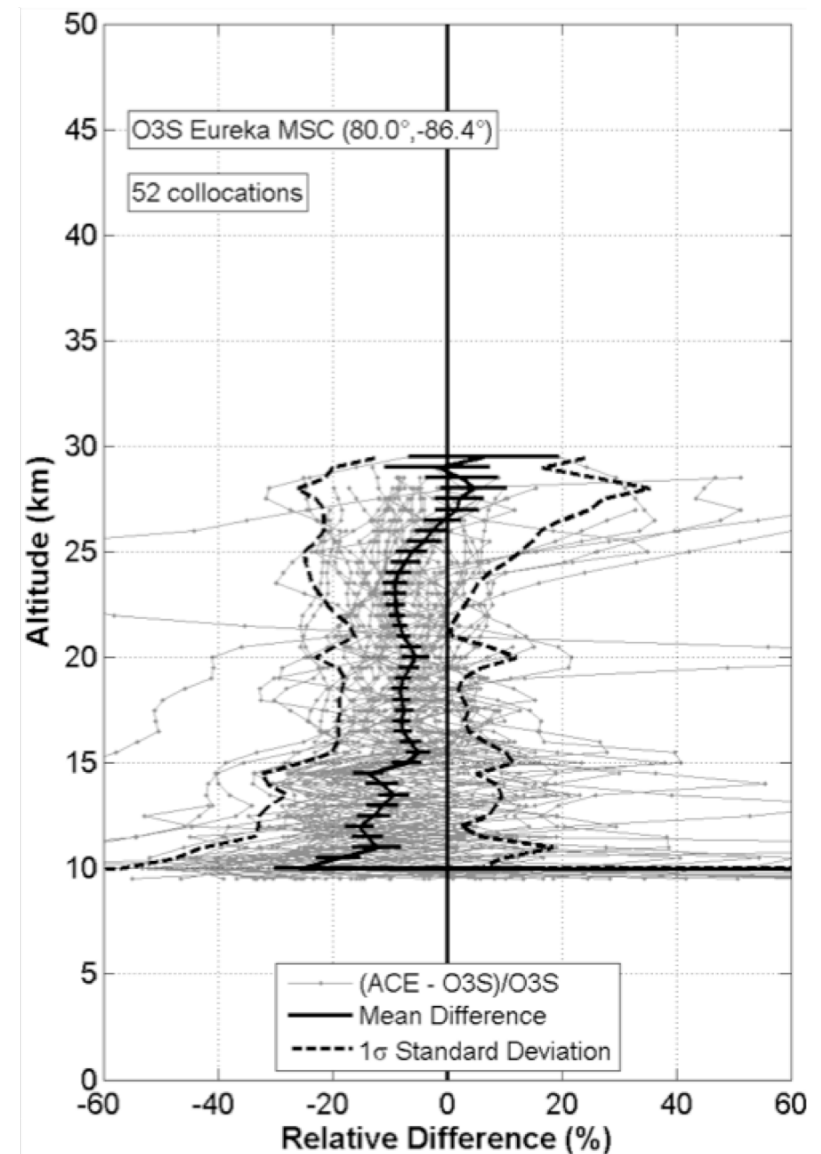
Location of Polar Vortex

- Strength and location of vortex changes throughout winter / spring and can vary significantly from year to year
- Example: March 4 in (a) 2004; (b) 2005; (c) 2006



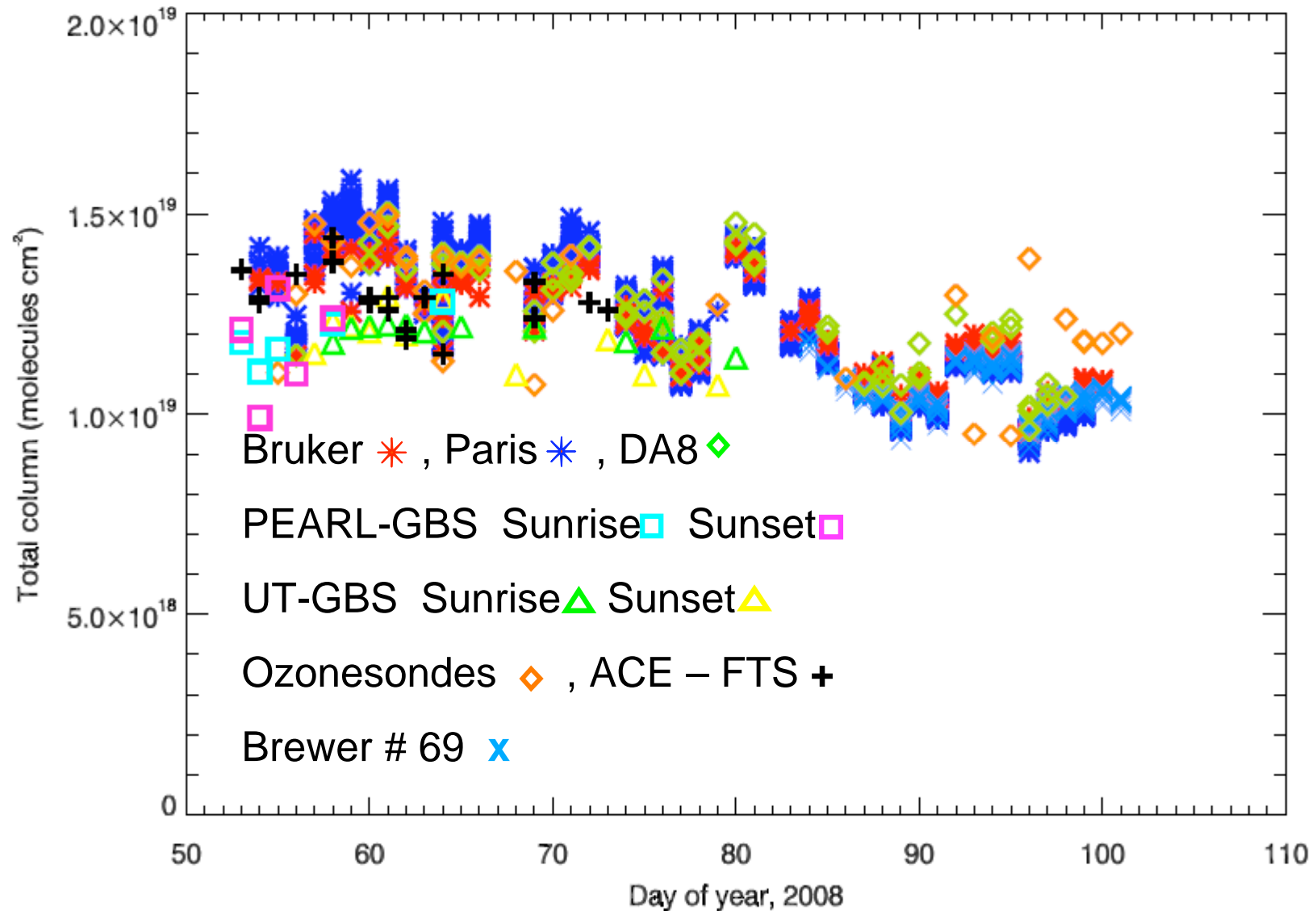
ACE-MAESTRO – Ozonesondes

- Measurements from Eureka ozonesondes (primarily during 2004-2006 ACE Arctic campaigns)
- Coincidence criteria: 500 km and ± 12 hours of sonde launch
- $\sim -7\%$ difference between satellite instrument and ozonesondes



Dupuy et al., ACP (accepted)

Campaign Ozone Comparison 2008



Summary

- Canadian Arctic ACE Validation Campaign project (2004-2008) has been very successful
 - Creating a time series of measurements with consistent set of instruments throughout the life of SCISAT
 - Understanding differences between instruments has improved data processing and comparison techniques
 - Used profile information for development/refinement of T retrievals for ACE instruments
- Looking forward to continuing measurements in 2009-2010
 - Campaign planning is underway

2004 - 2008 Campaign Team

ACE Validation Team Co-Leaders

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

ACE Mission Scientist

- Peter Bernath, U. Waterloo

Campaign Co-Investigators

- James R. Drummond, Dalhousie
- Hans Fast, EC
- C. Thomas McElroy, EC
- Richard Mittermeier, EC
- Kevin Strawbridge, EC

CANDAC/AstrO Operators

- Suzy Bingham, U. Toronto
- Ashley Harrett, U. Toronto
- Paul Loewen, U. Toronto
- Keith MacQuarrie, U. Toronto
- Oleg Mikhailov, U. Toronto
- Matt Okraszewski, U. Toronto

Team Members

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- Hongjiang Wu, U. Toronto

PEARL Facility Manager

- Pierre Fogal

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- Canadian Space Agency
- Environment Canada
- Northern Science Training Program, INAC
- Centre for Global Change Science, U. Toronto
- Centre National d'Etudes Spatiales
- Canadian Network for Detection of Atmospheric Change
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Special thanks to:

- PEARL/AStrO operators and Eureka Weather Station staff
for their support during our spring campaigns

Using ACE and ACE Campaign Data

If you are interested in using ACE or Arctic Campaign data...

- Please let me know - we welcome collaborations:

kwalker@atmos.physics.utoronto.ca

- ACE data are available to IPY projects like ARC-IONS

- Via signup at:

- <http://www.ace.uwaterloo.ca/polaryear.html>

- Validation results published in *Atmos. Chem. Phys.*:

- http://www.atmos-chem-phys.net/special_issue114.html

- For campaign measurements, please contact Kaley or Kim!