

The Canadian Network for the
Detection of Atmospheric Change
(CANDAC)

and

The Polar Environment Atmospheric
Research Laboratory (PEARL)

James R. Drummond

And the CANDAC team

The CANDAC Team

- Jim Drummond, Toronto
- Tom Duck, Dalhousie
- Jim Sloan, Waterloo
- Kim Strong, Toronto
- William Ward, New Brunswick
- Norm O'Neill, Sherbrooke
- Alan Manson, Saskatchewan
- + about 30 other Canadians

CANDAC

- The Canadian Network for the Detection of Atmospheric Change
- CANDAC is attempting to
 - Provide a unifying forum for remote sounding and similar atmospheric science in Canada (“our kind of science”)
 - Provide opportunity for atmospheric research, particularly in the Arctic
 - Act as an expertise and training pool for researchers
 - Provide data for atmospheric research
 - Requires extensive collaboration
 - Requires pooled resources
 - Requires quality control

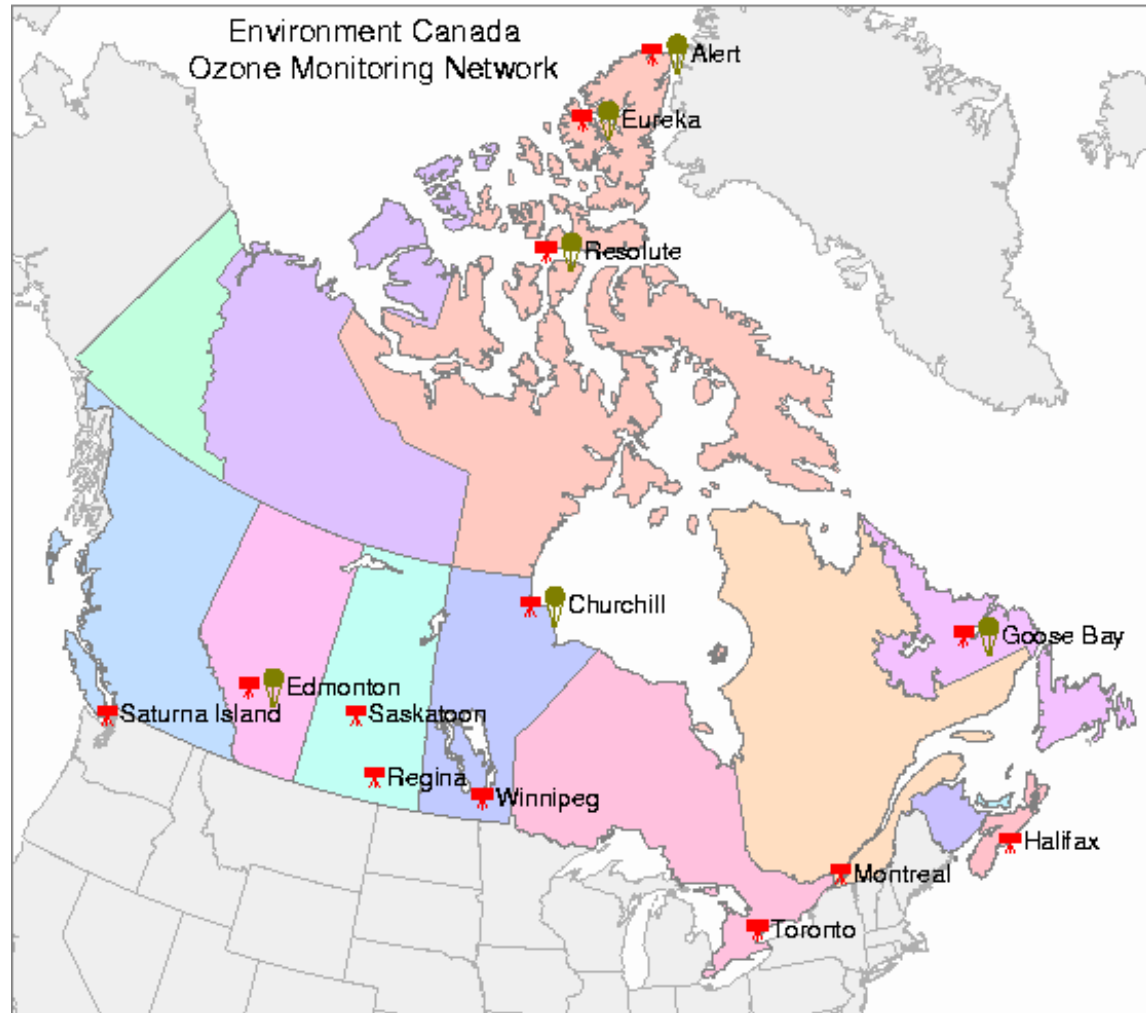
PEARL

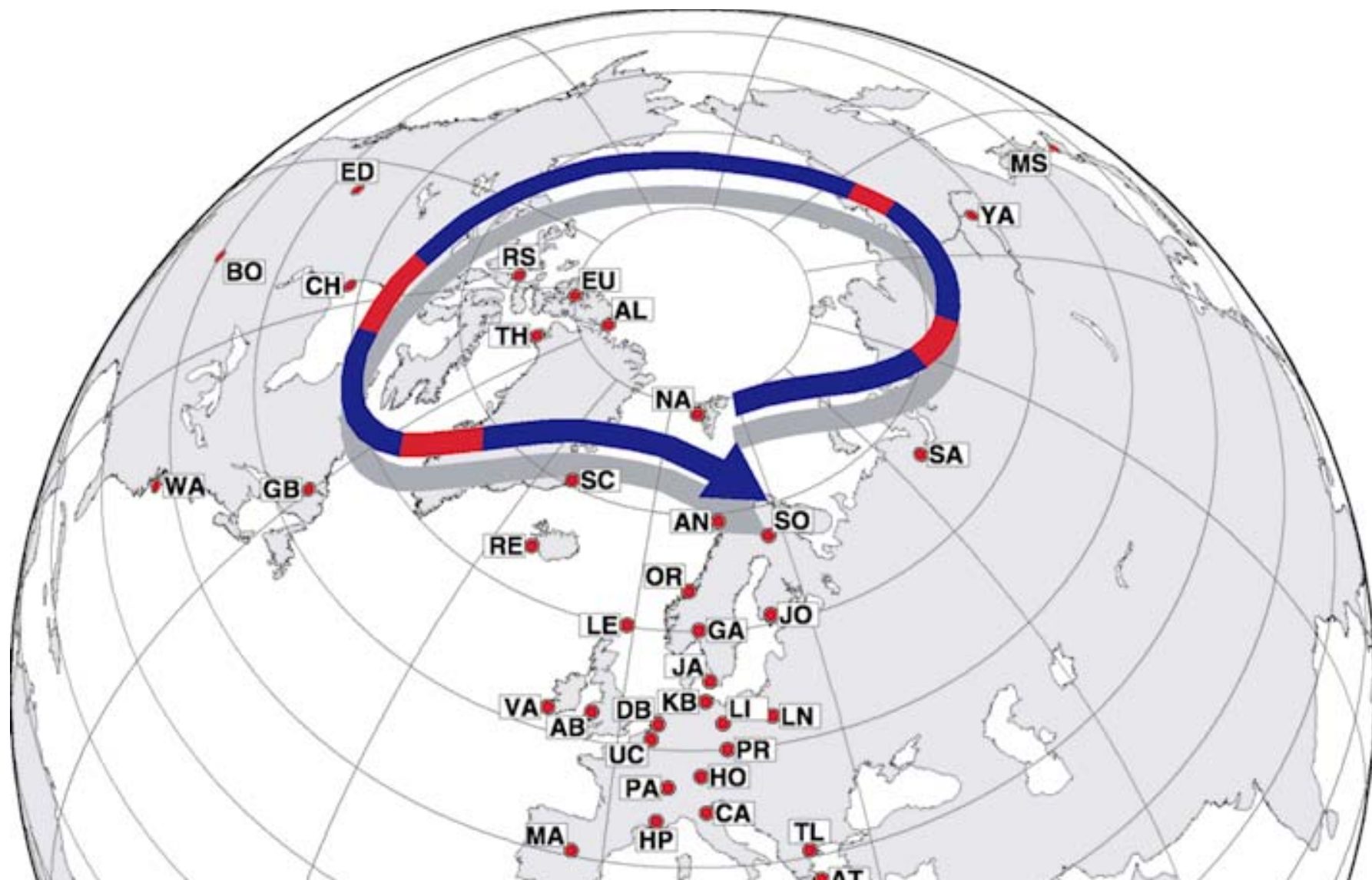
- PEARL was conceived as a necessary part of the atmospheric research strategy of CANDAC
- PEARL will be located at Eureka, Nunavut
- Building previously housed the ASTRO laboratory for ozone studies
- It is a fully equipped laboratory with “all the usual facilities”
- It is in the high Arctic
- It is practically unique as a resource

PEARL Objectives

- PEARL is
 - located at 80N 86W
 - At various times “within and without” the polar Arctic vortex
- Aim of the measurement program
 - To measure the atmosphere in the range 0-100km as comprehensively as possible
 - Deploy the best research-grade equipment
 - Develop new instrumentation and observing strategies

Location of Eureka

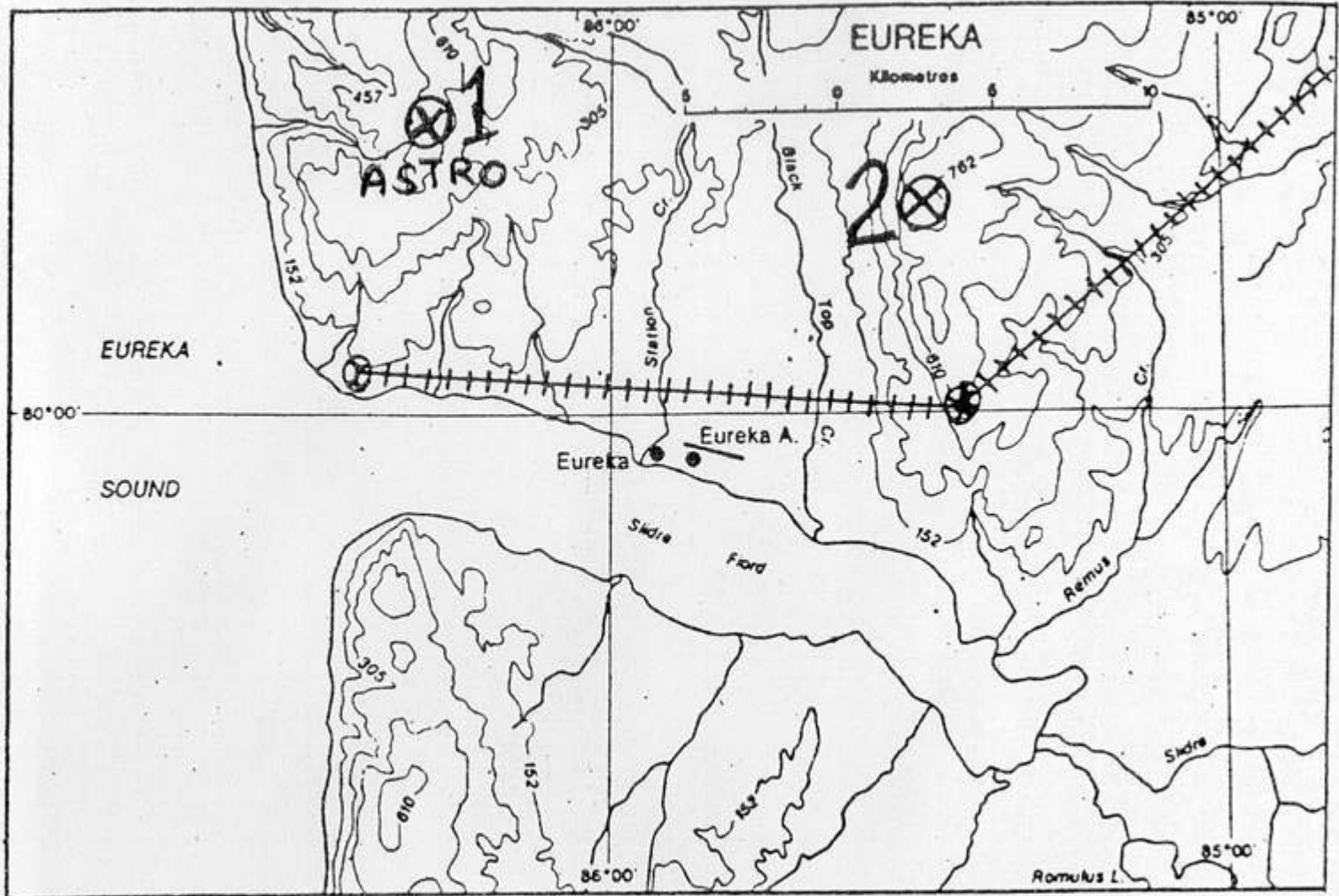




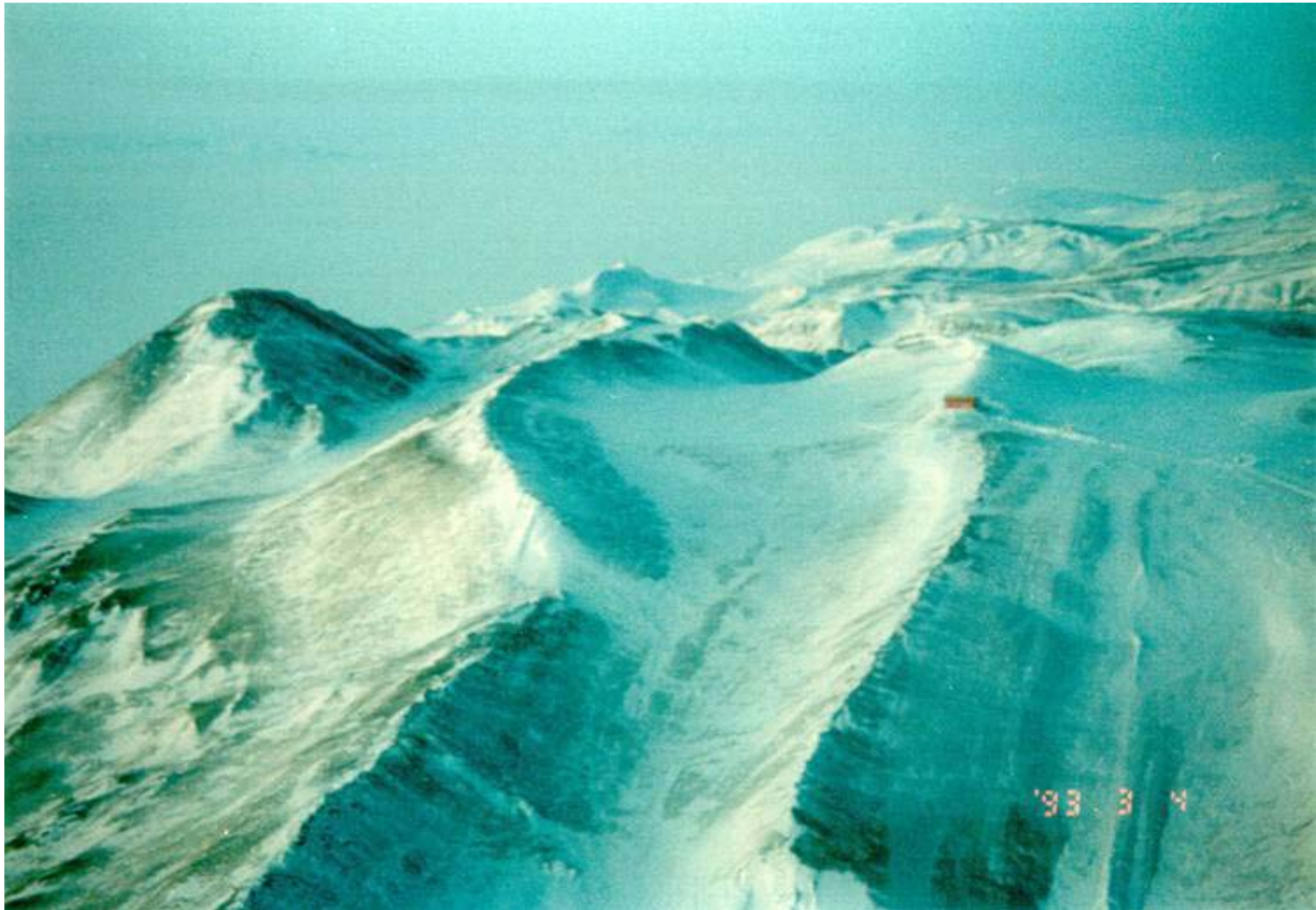
Work Horse of the Arctic



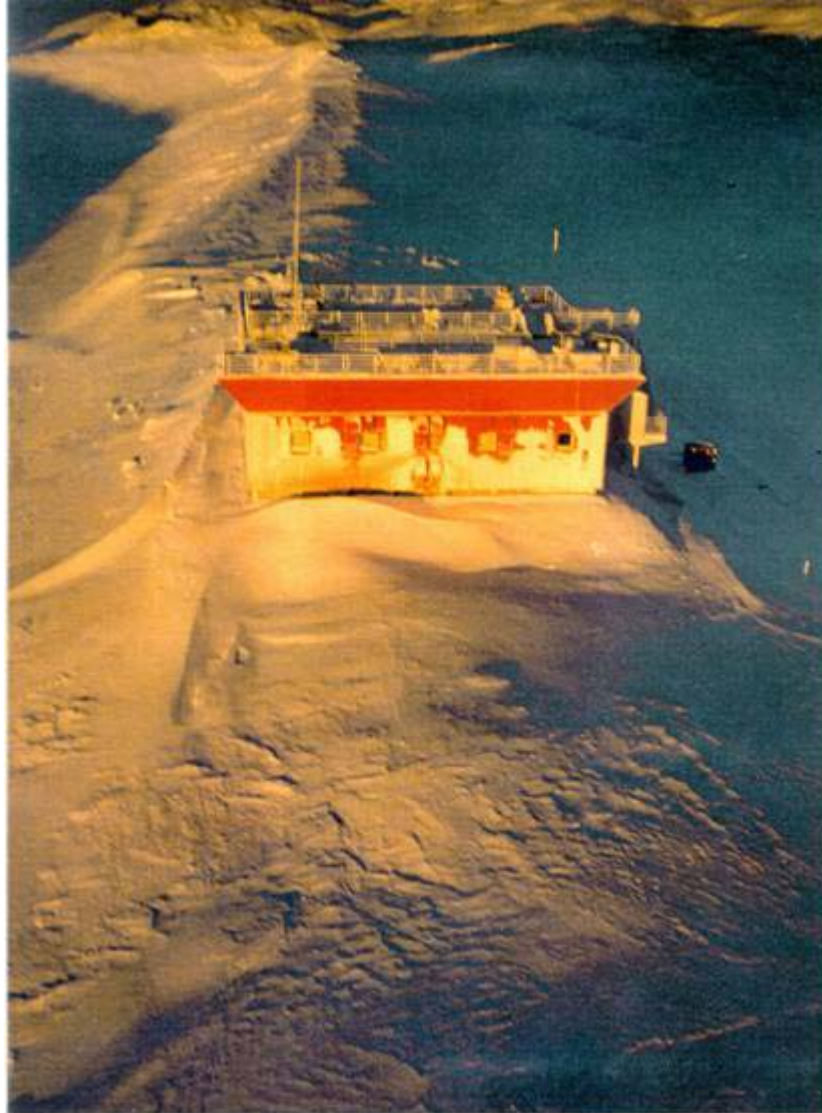
Map of Eureka



PEARL from Afar



PEARL Up Close



Eureka Weather Station



Upper Paradise Communication



What We Have Done

- 2001 – CFCAS workshop on atmospheric networks
- April 2003 – CANDAC first workshop
- May 2003 – CFI application for PEARL
- July 2003 – LOI Application to NSERC RNG
- August 2003 – Trip to Eureka with SEARCH
- September 2003 – NSERC RNG LOI refused
- March 2004 – CFI application to PEARL successful
- May 2004 – CFCAS LOI submitted
- July 2004 – CANDAC second workshop
- July 2004 – OIT matching funding approved
- July 2004 – CFCAS LOI accepted
- September 2004 – Application to NSERC for an MFA grant
- October 2004 – CANDAC Third Workshop
- November 2004 – CFCAS application
- 2005 – OIT matching funding

Current Complement

Ozone Lidar – MSC / Canada

O₃ Profiles

Temperature Profiles

Aerosol Profiles

H₂O Profiles

Aerosol Lidar – Japan

Aerosol Profiles (Arctic Haze, PSCs)

FTIR (Atmospheric Absorption) – MSC / Japan

Column: HCl, HF, O₃, CH₄, N₂O, CO, HNO₃, ClONO₂, ClO,...

Zenith Sky Spectrometer – U. of Toronto / Canada

O₃, NO₂, BrO, and OClO

Brewers – MSC (relocated to weather station)

Column O₃

Ozonesondes - MSC / Europe / Japan

O₃ Profiles

PEARL INSTRUMENTATION

| Instrument | Measured Quantities | Day/night Operation |
|--|---|---|
| Nd: YAG-based Rayleigh Mie / Raman Lidar | Cloud / aerosol / NLC backscatter ratio/ depolarization / extinction / volume, middle atmosphere temperatures / gravity waves, tropospheric water vapour | Day / night Cloud Measurements, night for others |
| VHF Radar (Wind Tracker) | Winds and turbulence 0.4-15 km, meteor winds (80-100km), summertime PMSE | Day / night |
| Spectral Imaging Interferometer (SATI) | Mesopause temperatures and gravity waves (O ₂ @ 94 km, OH @ 87 km) | Night |
| Airglow imager | OH airglow intensity | Night |
| Michelson Wind Interferometer (ERWIN) | Airglow winds (OH @ 87 km, O ₂ @ 94 km, OI green line @ 97 km) | Night |
| High resolution Fourier transform infrared spectrometer (FTIR) | Columns / profiles of Ozone, HC1, HF, NO, NO ₂ , C1ONO ₂ , HNO ₃ , CH ₄ , N ₂ O, CFC-11, CFC-12 | Day |
| UV-visible grating spectrometer | Columns of ozone, NO ₂ , BrO, elevated OC10, and NO ₂ profiles | Day |
| Brewer spectrometer | Ozone column | Day |

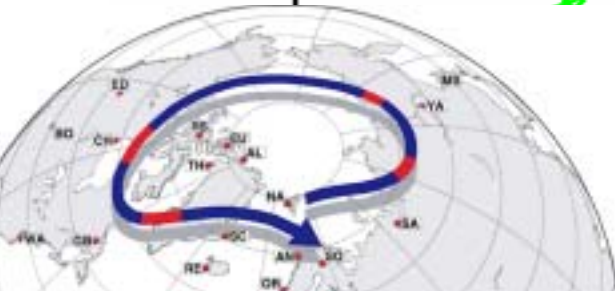
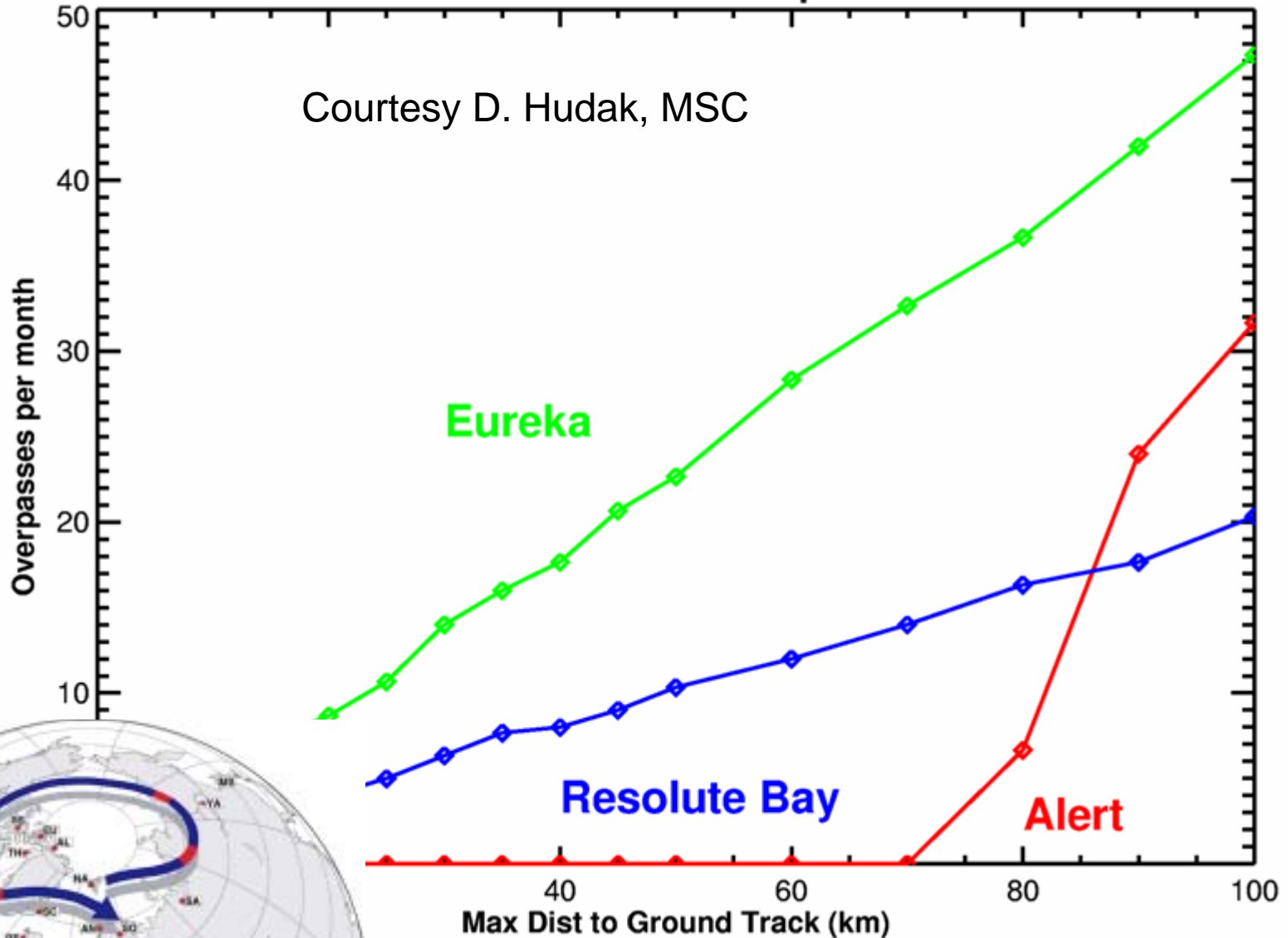
PEARL Instrumentation

| Instrument | Measured Quantities | Day/night Operation |
|--|---|----------------------------|
| Millimeter cloud radar (35 Ghz) | Cloud reflectivity, vertical velocities, etc. | Day / night |
| Atmospheric Emitted Radiance Interferometer (AERI) | Cloud absolute infrared spectral radiance | Day / night |
| Star photometer | Aerosol optical thickness and Angstrom type indices of particle size | Night |
| Sun photometer and sky radiometer | Aerosol optical thickness, size distribution, single scattering albedo, water vapour column | Day |
| Particle counter | Ground level aerosol Number and size distribution | Day / night |
| Aerosol Mass Spectrometer | Chemical composition, number and size distribution of ground level particulate matter | Day / night |

Overpasses at Eureka

CloudSat Arctic Overpasses

Courtesy D. Hudak, MSC



Current PEARL Issues

- Negotiation with Meteorological Service of Canada (MSC) for lease of facility
 - Ongoing – no great issues foreseen
- Funding for operations (paying the electric bill!)
- Start-up of organisation
 - Employ people
 - Begin program
- Communications with the laboratory
 - More bandwidth
 - Less cost!

What Happens Next

- Assuming that we are successful
 - First instrument deployment early 2005
 - Collaboration with SEARCH group
 - Permanent presence, April 2005 onwards
 - Possible to be in a position to support Cloudsat validation in mid-2005
 - Need radar installation and commissioning
 - Full operation by International Polar Year in 2007-2008

What We Need

- Community support
 - Use of facility
 - Use of data from facility
 - “Talk it up”
 - Letters of support from Canada and abroad:
 - WMO-GAW
 - SEARCH
 - IANABIS
 - NDSC
 - CSA
 - MSC
 - ????

MILLIMETER CLOUD RADAR

- Vertically pointing, 35 GHz Doppler radar measuring
 - Reflectivity
 - Doppler velocity
 - Spectral width
- Will detect more than 90% of the radiatively significant ice clouds and > 70% of the water clouds.
- The radar would not suffer significant attenuation for the majority of precipitation rates typically encountered in Arctic regions.
- Macroscopic variables that can be extracted directly from the data include
 - cloud geometric profiles
 - cloud top
 - cloud thickness
 - cloud type
 - precipitation occurrence
 - precipitation rate and type (light to moderate precipitation only), .
 - liquid water content
 - ice water content
 - cloud phase
 - effective radius
- The unit will be purchased from ProSensing, Amherst Massachusetts.