Polar Communications & Weather (PCW) Mission

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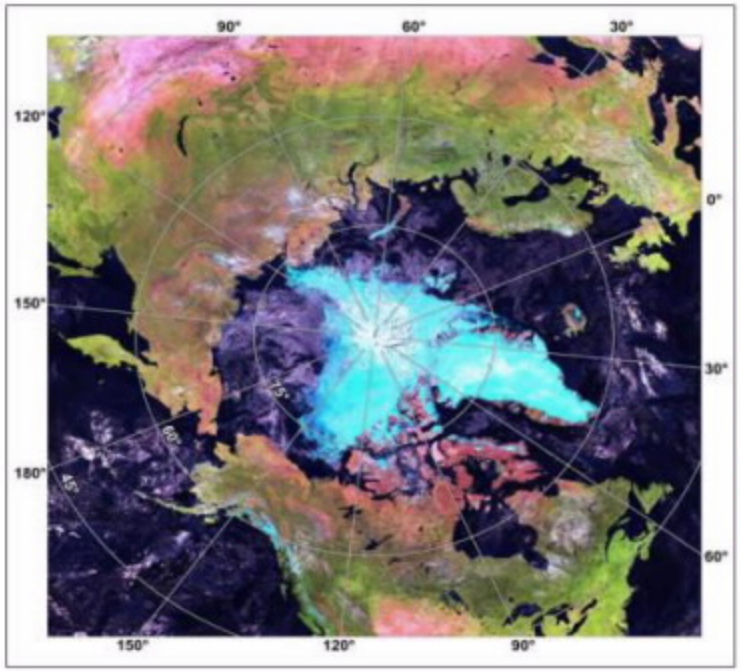
Presentation to CGMS-39

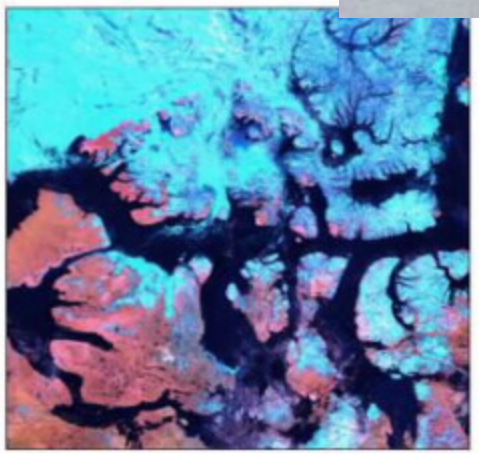
Outline

- Introduction
- Phase A accomplishments
  - Orbit trade-off
  - URD
  - Industrial contract close-out
  - MRD
- Ongoing activities
- Next steps
- Opportunities for international collaboration
- Conclusion

Why the Arctic?

- Canada is an Arctic nation
- Increasing economic activities, marine and air traffic
- Acceleration of climate change
- Air pollution transport

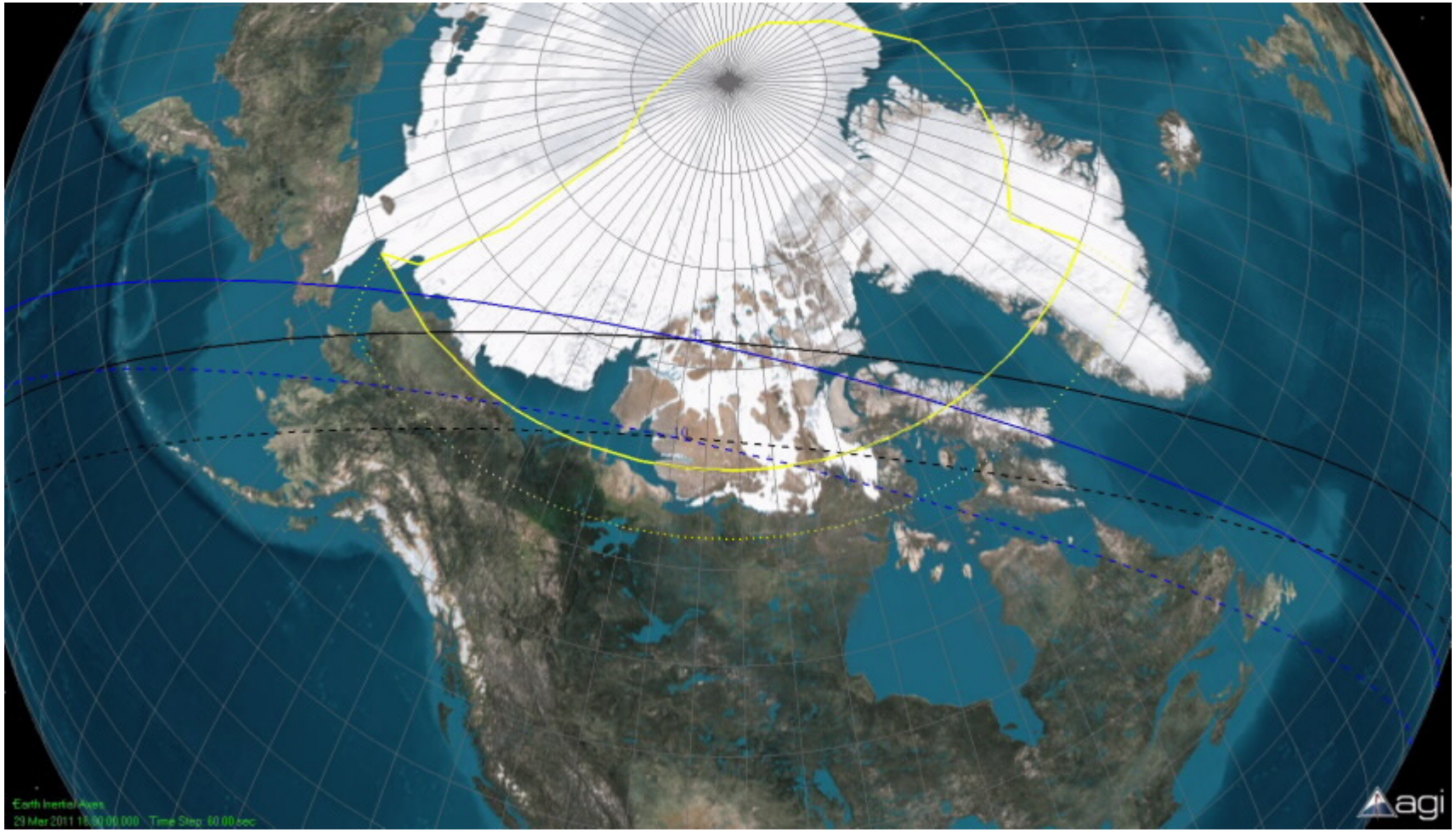




Opening of NW passage
September 2007
From Modis 250-m imagery

Courtesy: Canada Center
For Remote sensing

Gap in Broadband Coverage



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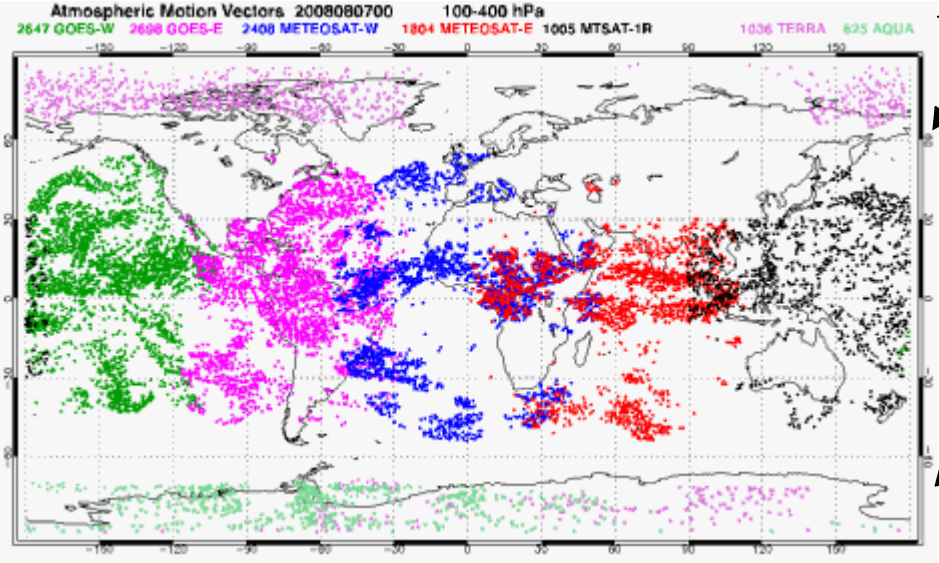
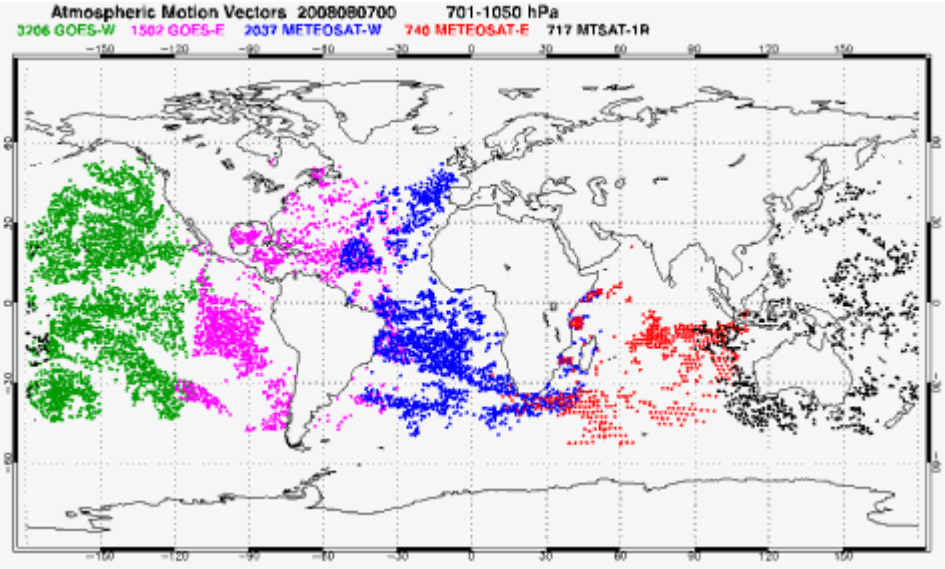
Gap in Meteorological Coverage



Example of 07 Aug 2008 00 UTC AMV availability

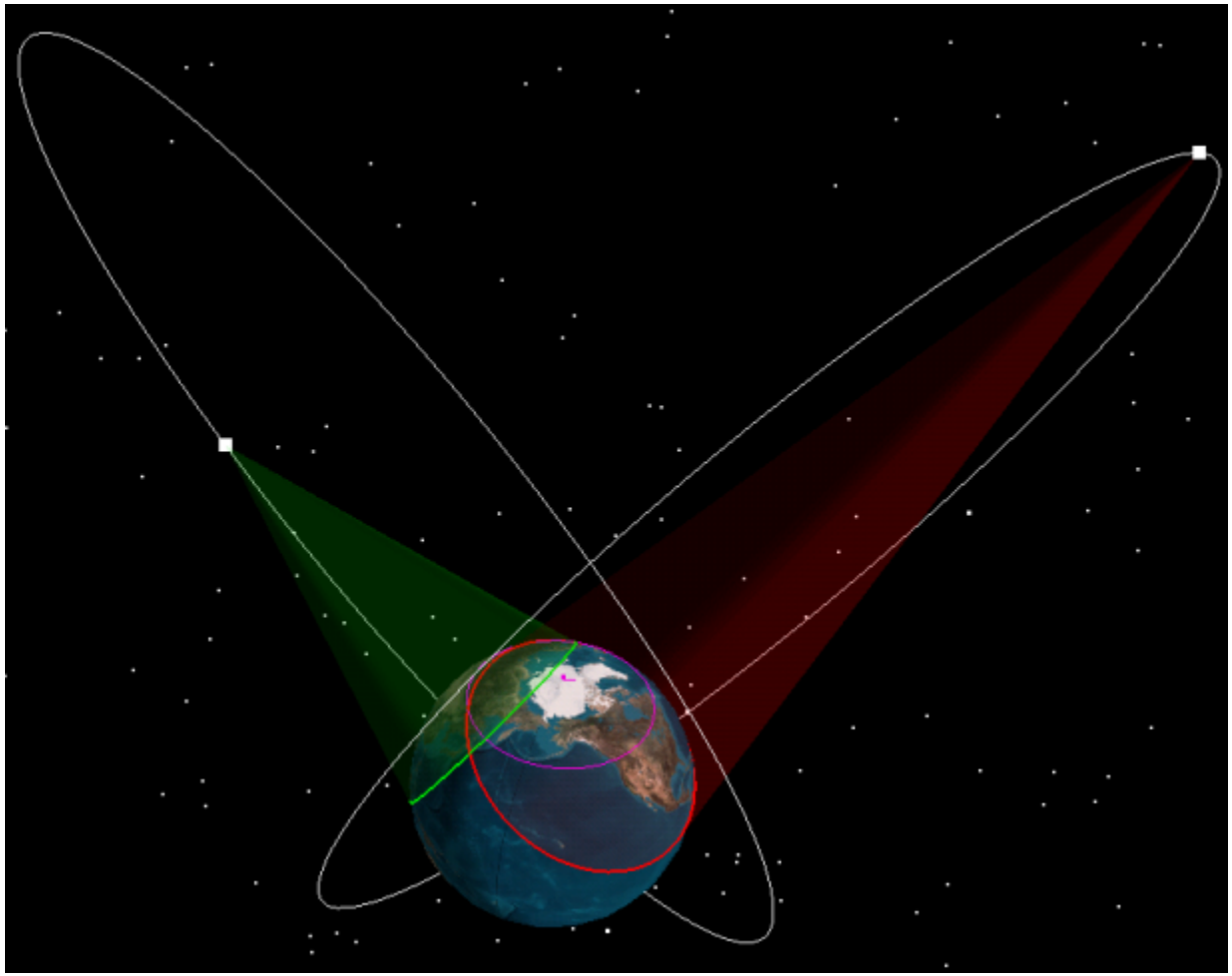
100-400 hPa
Recognized availability gap 55-65 N/S
Terra/Aqua AMVs



700 hPa to surface
No AMVs above 55 N/S

Required features to serve this application:
- High temporal sequences
- Simultaneous retrievals
- Stereo views

PCW Mission Overview



One of the highest priorities of the CSA

2 satellites in HEO to provide:

Continuous GEO-like imagery above 50º N (refresh rate 15 minutes)

24/7 High data rate communication services in Ka-band and X-Band

Continuously collected space weather data

Phase A Accomplishments

- Extensive analyses of HEO options
- Canadian and International Sections of the Users & Science Team revised the Users Requirements Document taking into consideration HEO options analyses and released URD version 6.0
- All the objectives of the Phase A contract with the Industrial Team led by MDA were met and the contract was closed with a successful Preliminary Systems Requirements Review on March 31, 2011
- Based on the URD v.6.0 and the outcomes of the Industrial contract, the CSA, in close collaboration with Other Government Departments, elaborated and released the Mission Requirements Document (MRD)
- Mission Requirements were validated by feasible technical solutions for different HEO options (Molniya, Tundra, and TAP)
- Different procurement strategies were considered (Major Crown Project vs. Private Public Partnership (PPP)). Further elaboration of the PPP option is required.

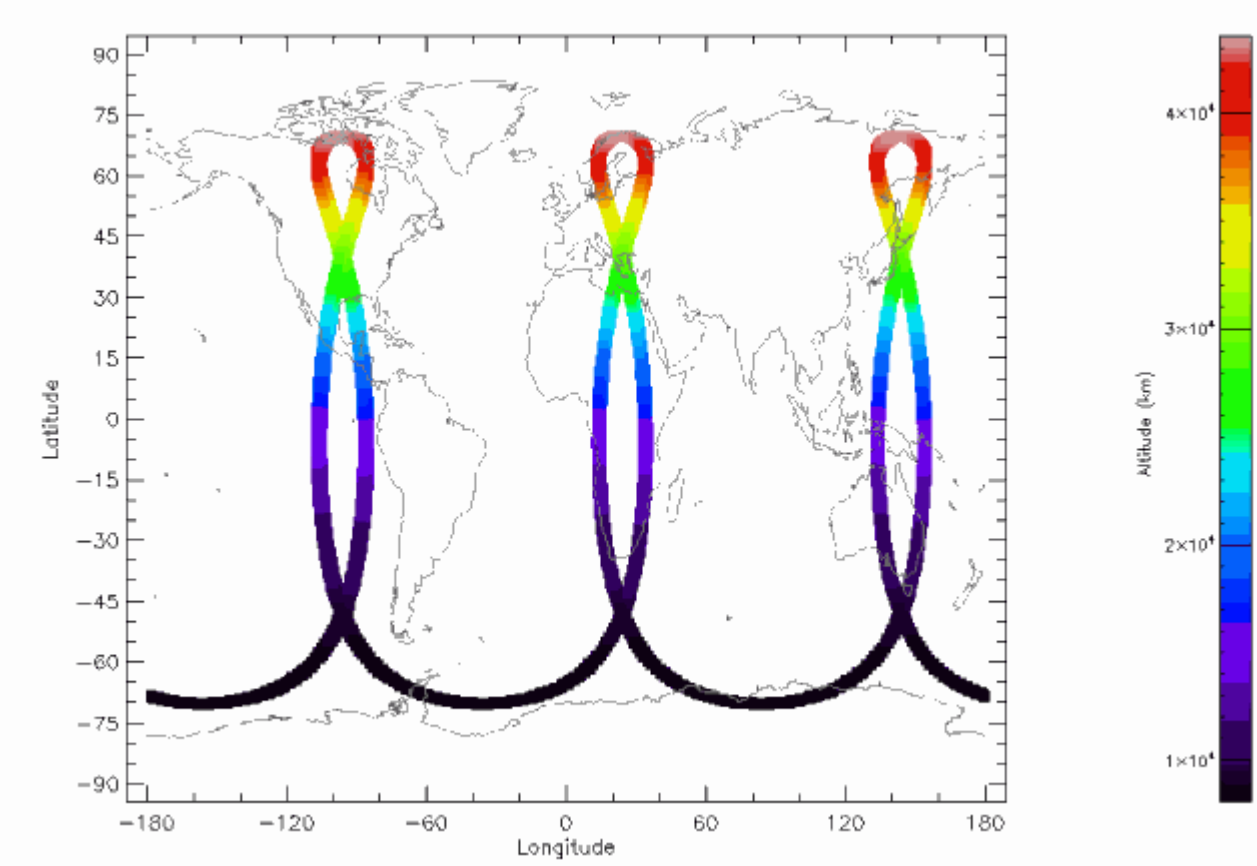
HEO Options

- 12hrs HEO provides for superior imaging conditions:
  - Two satellites in 1 orbital plane (6hrs apart) with 63.4^0 inclination, i.e. 4 apogee points: 95^0W, 175^0E, 85^0E, 5^0W;
  - Critical inclination makes apogee location stable

$$\dot{\omega} = \frac{3}{4} J_2 n \left(\frac{r_E}{a}\right)^2 \frac{5\cos^2 i - 1}{\left(1 - e^2\right)^2}$$

  - Rate of change for the argument of perigee 0
  - Radiation environment in this orbit is the most difficult
- 24hrs HEO provides for superior spacecraft longevity:
  - Two satellites in 1 orbital plane (2 apogees)
  - Non-critical inclination is possible to improve Arctic coverage
  - Rate of change for the argument of perigee in non-critical inclination is much smaller than for 12 hrs orbit
  - Radiation environment in this orbit is comparable to GEO
- 16 hrs HEO provides for potential compromise between imaging conditions and spacecraft longevity

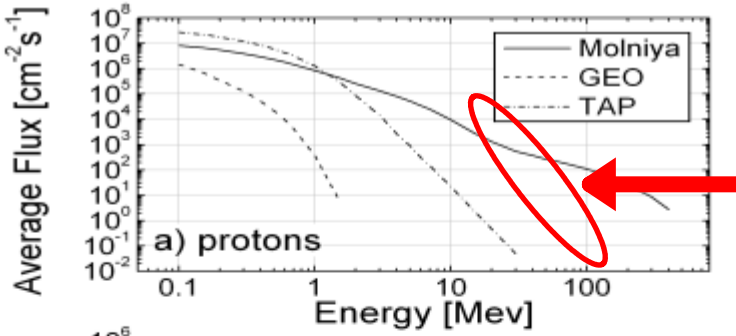
16hrs HEO



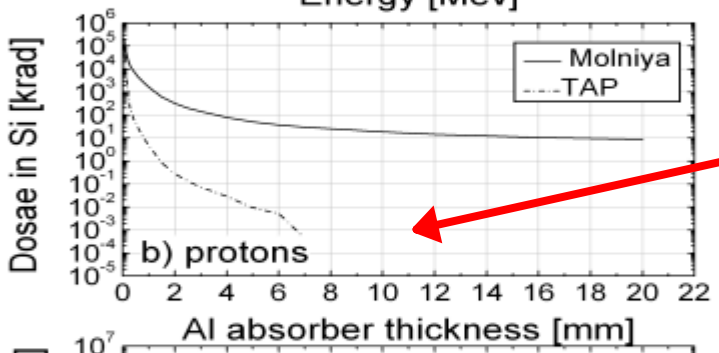
Three APogee (TAP) orbit

Suggested apogees: 95^{0}W; 25^{0}E, 145^{0}E

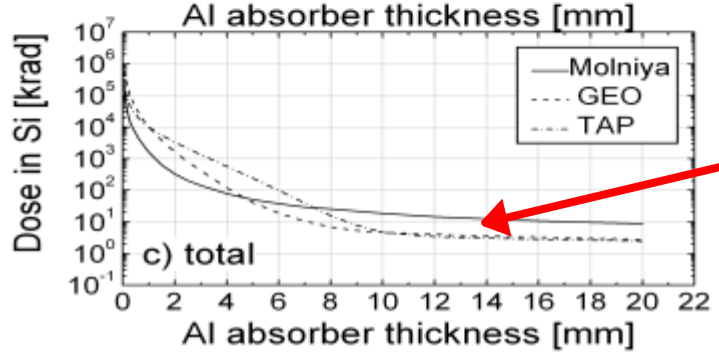
Comparison of Radiation Environment



3-4 order of magnitude smaller flux of high energy trapped protons



trapped protons flux essentially vanishes after 7mm AL shielding



after 9mm AL shielding TAP orbit becomes similar to GEO

Ongoing Activities

- Three Phase A contracts for science instruments (space weather and atmospheric science) to contribute to the PCW enhanced mission has been awarded in May-June 2011.
- As a follow-up to the RFP published last year, 3 contracts for Critical Technologies development (bus and metpayload) are being negotiated with contract award planned for the end of October, 2011
- In collaboration with Public Works and Government Services Canada's National Centre of Expertise in PPP, a contract for Preliminary Business Case Study is being negotiated with the contract award planned for mid-October, 2011
- RFP for Socio-Economic Benefits study is closing this week with the contract award planned for the end of October, 2011.
- Extensive consultations with potential Private Partners via Request For Information mechanism is being prepared with planned kick-off this fall.

Next Steps (Under Review.TBC)

- Close-out of Phase A contracts for science instruments – Apr. 2012
- Preliminary Business Case Analyses – Apr. 2012
- Socio-Economic Benefits Analyses - May 2012
- Final Business Case Analyses - Oct. 2012
- Budget and Authorities - Feb. 2013
- PPP Procurement
  - RFQ - June 2013
  - RFP - Sept. 2013
- PPP Agreement - Oct. 2014
- Beginning of data and services delivery - 2018

Venues for International Collaboration

- Definition and validation of User's needs and Requirements,
- Launch capabilities,
- Spacecraft/core payloads subsystems and/or critical components,
- Enhanced communications capabilities,
- Secondary payload and its data processing or service delivery:
  - GNSS,
  - ATM,
  - Science,
  - Technology demonstration,
  - Other?
- Ground segment (Back-up TT&C, Data processing and applications).

Conclusion

- PCW represents an exciting opportunity to close the gap in global broadband communication services and meteorological observation coverage in the Arctic
- PCW is an engine for development of new technologies, applications and capabilities.
- The mission is open for international collaboration. Interesting opportunities have been identified and actively pursued.
- The Phase A outcomes clearly demonstrated merits of the PCW mission for Canada and in the international context.
- The technical feasibility of the PCW system is well established.
- The Canadian Space Agency is working with Other Government Departments and Private Sector to optimize the procurement strategy