Update on status and plans for the Arctic Observing Mission (AOM) and Terrestrial Snow Mass Mission (TSMM)

Presented to CGMS-51 Plenary session, agenda item CGMS-51-ECCC-WP-01

Executive summary of the WP

- The Arctic Observing Mission (AOM) and the Terrestrial Snow Mass Mission (TSMM) will fill important observation gaps over the Arctic for weather, greenhouse gas, air quality, space weather and snow
- Both missions are aligned with *Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation*, released in early 2022, which describes how Canada will take full advantage of the unique vantage point of space to address climate change and other key challenges of our time
- AOM will complete pre-formulation study activities in late 2024, that will refine the options for mission architecture and inform what is required for the design, implementation and operational phases of the mission
- Canada is continuing engagement on AOM and welcomes new partnerships from the international community, to strengthen the mission's business case to seek funding
- Activities are in progress to advance technical and scientific readiness for TSMM ahead of a potential funding ask

Resourceful, Resilient, Ready:
Canada's Strategy for Satellite Earth Observation (SEO)

Economy | Press Release

Canada Announces Strategy for Satellite Earth Observation

Twenty-one Canadian organizations receive funding to make innovative use of Earth observation data LONGUEUIL, QC, Jan. 20, 2022 /CNW/

OBJECTIVE #1

Ensure the benefits of satellite EO are maximized

OBJECTIVE #2

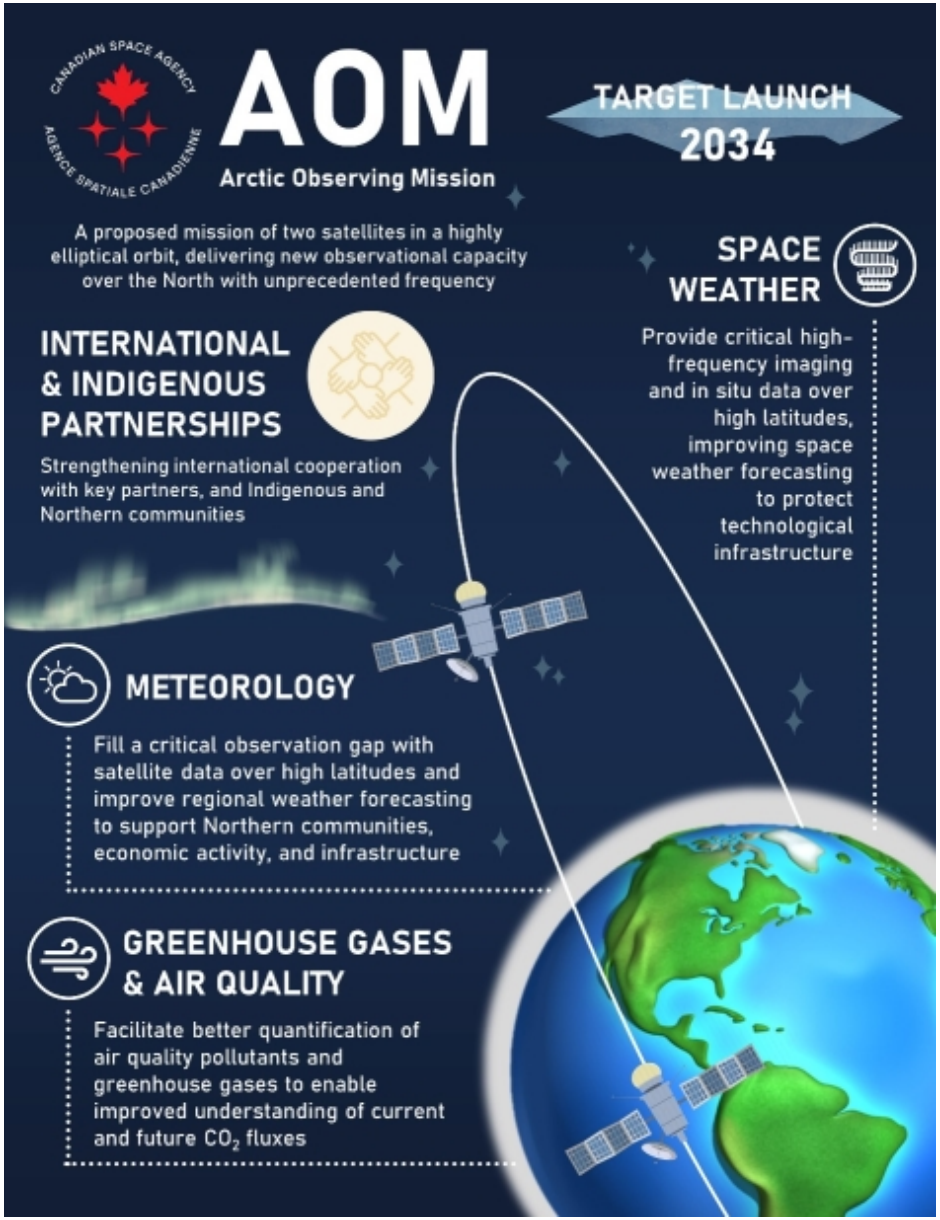
Harness satellite EO to tackle climate change and issues that matter to Canadians

OBJECTIVE #3

Strengthen delivery of critical services to keep Canadians healthy, safe, and informed

OBJECTIVE #4

Inspire satellite EO skills and capacity development for the next generation



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The Arctic Observing Mission

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Mission Status and timeline:

- AOM started a 2.5-year pre-formulation study in 2022 that will refine the options for the mission architecture and inform what is required for the design, implementation and operational phases of the mission
- Key elements of the pre-formulation study include:
  - Mission Design Contract (Kick-off meeting June 2023)
  - Socio-Economic Benefits Study (To be completed June 2023)
  - Space Technology Development (RFP evaluation June 2023)
  - Science/Application Studies (Ongoing)
  - GHG Capability Demonstration (Balloon campaign August 2022)
  - International engagement and partnership development (Potential partner contributions to be finalized in 2024)
    - AOM's International Expert Team includes members from NOAA, NASA and EUMETSAT, with ESA as an observer
- The pre-formulation study is scheduled for completion in October 2024 with the outputs to be incorporated into AOM's business case, to inform future budget ask for end-to-end mission funding

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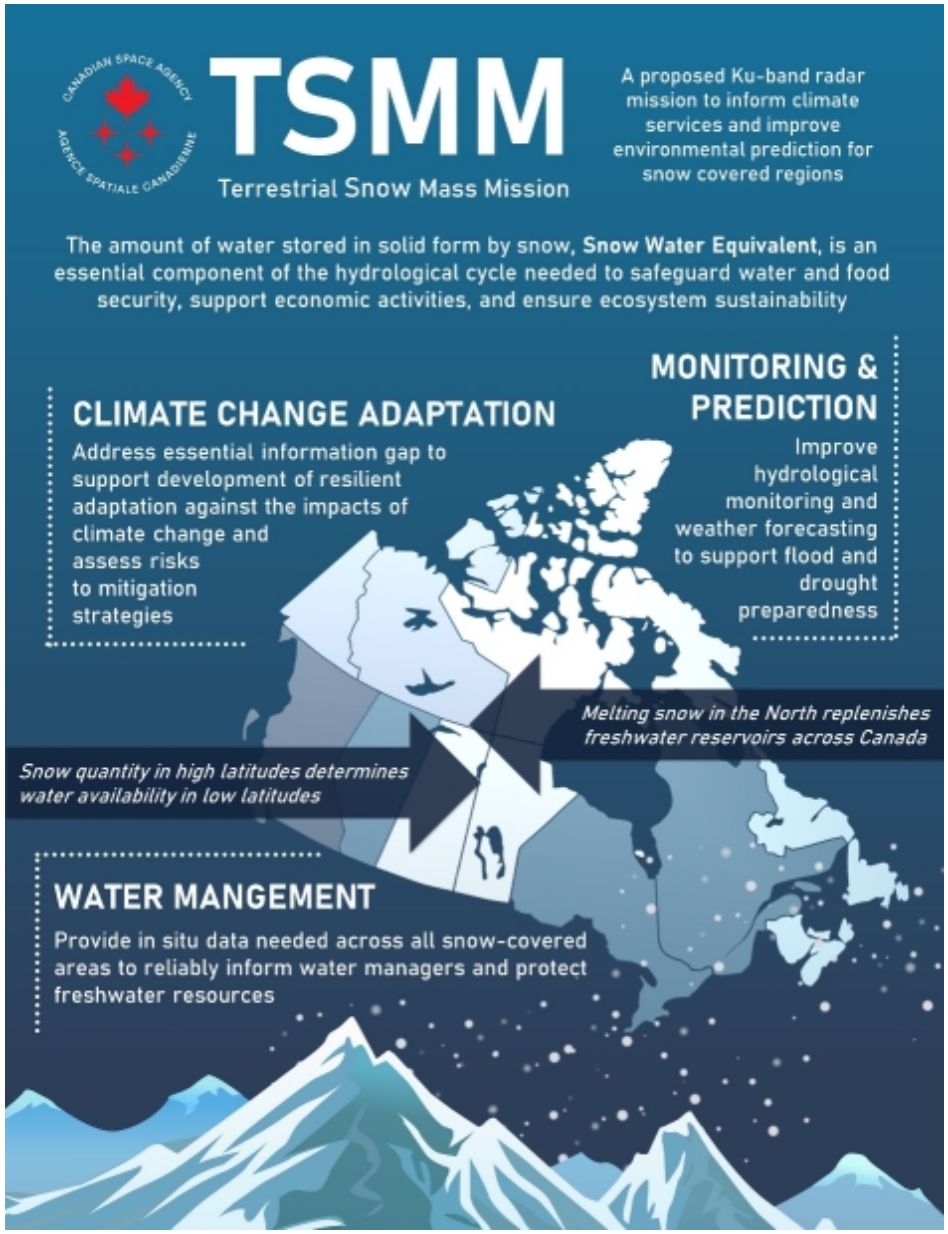

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The Terrestrial Snow Mass Mission:

Environment and Climate Change Canada
Environnement et Changement climatique Canada

A Canadian Ku-band radar mission to inform climate services and improve environmental prediction for snow covered regions

Mission Driver: Snow mass information is required to safeguard water/food security, support economic activities, ensure ecosystem sustainability, and protect from flood risks

Gap: Snow is the only water cycle component with no dedicated EO mission; current satellite snow mass products have critical weaknesses; surface networks are insufficient

Need: Snow mass at moderate resolution with hemispheric coverage and rapid revisit for climate services and operational environmental prediction to:

- Quantify the amount, distribution and variability of terrestrial snow mass and feed prediction services (NWP, hydro) that require improved snow mass estimates
- Understand how much water is stored as seasonal snow and how it varies in space and time, as well as understanding the contribution of snow to the water cycle and how well we can predict it

Technical solution:

- **500m resolution** Ku-band radar measurements (**13.5 and 17.25 GHz**) covering NH snow covered areas
- **250 km swath** = coverage of Canada every **5-7 days**
- **50 m stripmap mode** across 30 km swath

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The Terrestrial Snow Mass Mission:

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TSMM Mission Status:

- Under development as a partnership between Environment and Climate Change Canada and the Canadian Space Agency, guided by an international science team
- TSMM is in a pre-formulation study phase at CSA for potential future implementation as a pathfinder mission

Technical readiness led by CSA:

- Canadian industry continues to advance Ku-band radar hardware; mission simulator in development

Science readiness led by ECCC:

- Snow and radar modeling, algorithm development, preparation for land surface data assimilation, experimental radar measurements

Programmatic development:

- Open data policy to facilitate broad community uptake
- Mission team is open to potential science and programmatic partnerships
- Minimal requirements for satellite tasking during NH summer means there is capacity to address additional objectives

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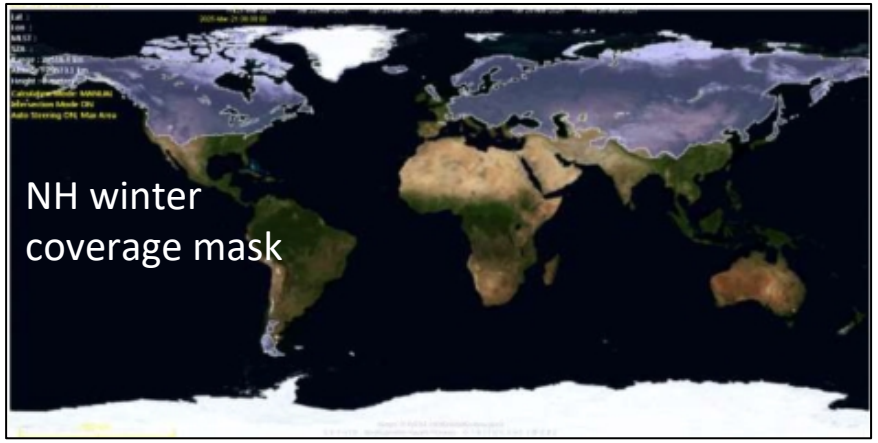
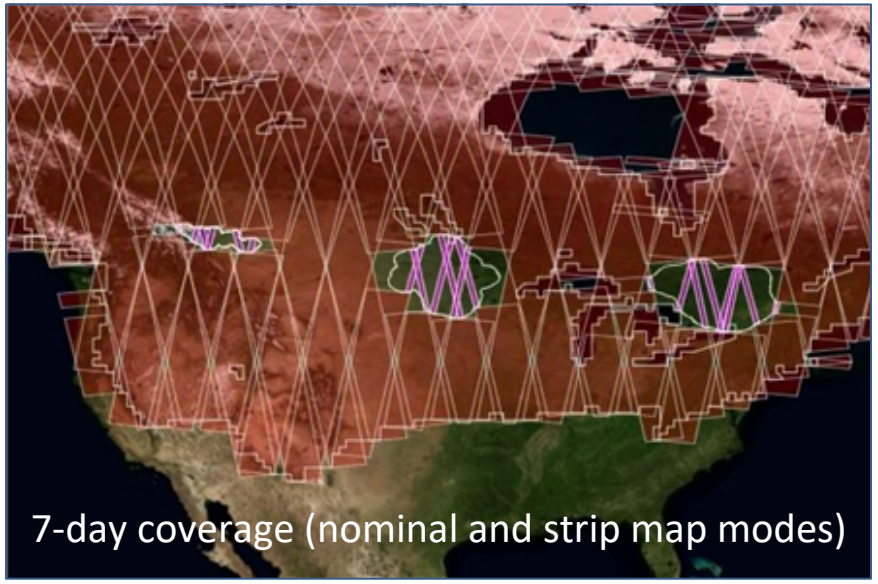
Key issues of relevance to CGMS

- Both TSMM and AOM have been identified as priority SEO initiatives for Environment and Climate Change Canada (ECCC) who continues to work with the Canadian Space Agency (CSA) to advance these mission concepts
- If advanced, these missions will fill observation gaps over the North and contribute to the international pool of satellite data which enables the world-class science and operations needed to protect populations from the impacts of climate change and improve the quality of life in Northern communities, including for indigenous peoples
- As AOM's pre-formulation study activities progress, Canada welcomes further collaborations with foreign national space and meteorological agencies and are happy to engage in such discussions
- Programmatic positioning for TSMM continues to be strengthened, including the development of partnerships with Canadian universities and collaborations with international organizations

ANNEX SLIDES

Characteristic	Mission Design	Comments
Frequencies	13.5 and 17.25 GHz	Maximize SWE retrieval capability
Polarizations	VV; VH	Dual-pol mitigates effects of snow stratigraphy; cross-pol facilitates non-snow applications
Nominal resolution	500 x 500 m	Notable improvement over current satellite snow mass products
Stripmap resolution	50 x 50	For targeted imaging of high impact events
Number of Looks	>4	Multi-looking to enhance radiometric quality
Incidence Angle Range	25° - 55°	Optimal range for SWE retrieval performance
NESZ – 13.5 GHz	<-26 dB (VV & VH)	Low NESZ for sensitivity to SWE (dry snow), and detection of wet snow cover with weak backscatter
NESZ – 17.2 GHz	<-25 dB (VV & VH)	
Azimuth and Range DTAR	<-20 dB	Typical DTAR to control ambiguities
Radiometric stability	<0.5 dB	Temporal consistency requirement
Radiometric accuracy	1 dB	Enables accurate retrieval of SWE
Duty cycle	~25%	Determined from analysis of mass, power, and heat dissipation budgets
Mission duration	3 winter seasons	Minimum requirement





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