CSQ-22 Summary

Question	Knowledge Advancement Objectives	Geophysical Observables	Measurement Requirements	Tools & Models	Policies / Benefits
What are the cycles of variability for cryosphere essential variables, and how large are they?	Determine what the cycles of variability are for cryosphere essential variables.	● Measurements of all Polar climate data records, including sea ice extent and thickness, ice speed, ice surface elevation change, ice shelf basal melt, surface mass balance, calving front location, permafrost area, etc.	Fine temporal resolution (weekly), with enough sensitivity to measure change Multi-decadal record of change required over last 30-40-years, updating continuously in NRT High (100 m) spatial resolution for all components.	EO satellite datasets. Auxiliary data including bed topography.	Improve future projections of ice mass loss, which remain the greatest uncertainty in future sea level rise projections.
	Quantify the magnitude of variability, e.g. diurnal, weekly, monthly, seasonal, annual and decadal	As above.	As above.	As above.	

CSQ-22 Narrative

Historically, the remote location of the Polar regions and the constraints on downlinking high volumes of satellite data, has meant that image acquisitions over the global cryosphere have been limited to annual (or even less frequent) sampling, since the 1990's. The revolution in high temporal frequency and high spatial resolution satellite observations acquired by the EC-ESA Copernicus missions, enables the cycles of variability for all essential cryosphere variables to be studies in depth for the first time. The development of new data analysis techniques, such as deep learning and AI, enables the full exploitation of these satellite datasets to generate measurements of new climate variables in an automated way. Furthermore, these new methods combined with the use of High-Performance Computer facilities, allows the full archive of satellite data to be processed routinely. Now that our capacity to acquire and process the full archive of satellite observations has been realized, this enables essential cryosphere measurements to be made at the finest spatial and temporal resolution. This is already delivering new high impact science results, such as measurements of summer sea ice thickness in the Arctic by using AI to distinguish between altimetry waveform returns over leads and melt ponds in the sea ice (Landy et al., 2021). On the Antarctic Peninsula, previously undocumented seasonal ice speed variations have been observed, where glaciers are flowing 22 % faster in the summer vs the winter time (Wallis et al., 2023). These methods and approaches can be extended and applied to other cryosphere parameters, improving our knowledge about the cycles of variability in these important variables.

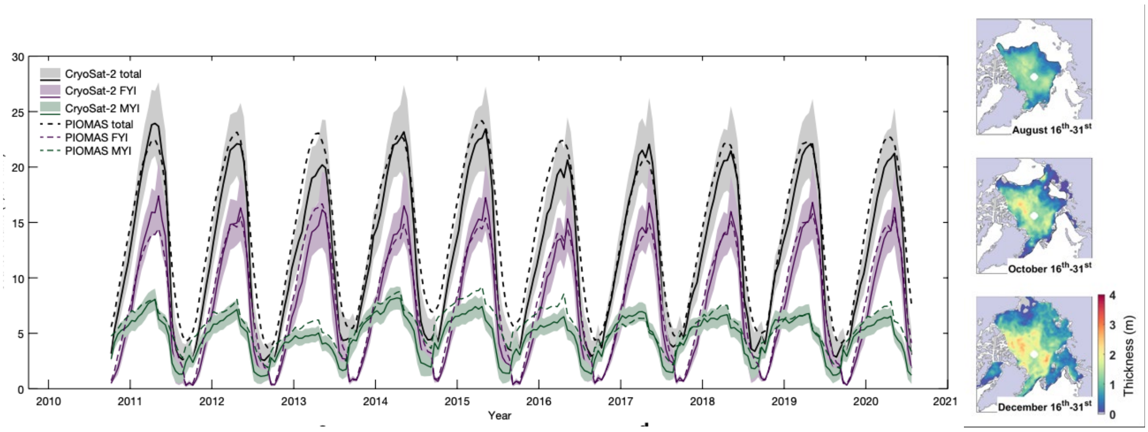

Fig. 3: Time series of SIV derived from CryoSat-2 compared with reanalysed predictions of ice volume from PIOMAS. Sea ice volume from CryoSat-2 is presented with uncertainty envelopes for the entire Arctic and separated into zones of predominantly FYI and MYI (using the NSIDC sea-ice-age dataset43). The CryoSat-2 sea ice volume uncertainties are derived from the total ice thickness uncertainty (Methods) multiplied by the ice area. Maps of sea ice thickness shown alongside. From Landy et al., 2022.

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