An aerial photograph of a vast, flat, white frozen landscape, likely a snowfield or ice sheet, extending to a clear blue horizon. The surface shows subtle textures and patterns, possibly from wind or ice movement.

**CRYOSPHERE IN A CHANGING CLIMATE:  
A GRAND CHALLENGE OF CLIMATE SCIENCE**

# Motivation

- the prospect of an **ice-free Arctic Ocean**;
- the fate of mountain glaciers providing **fresh water** to hundreds of millions of people worldwide;
- the strength of positive feedbacks between the warming climate and **natural emissions of GHGs** from the thawing permafrost (both terrestrial and sub-sea);
- the role of ice-sheet dynamics in amplification of Greenland's contribution to the **global SLR**.

These issues are getting increasing attention in the international scientific research community and relate directly to societal needs for information about climate change and its impacts.

These and other processes, in which components of the cryosphere play a central role, remain an important source of uncertainty in projections of future climate change, and so improved understanding of the cryosphere in a changing climate (CCC) clearly is a “Grand Challenge” (GC).

# Expected results

- ✓ Increased confidence in climate models and their predictions/projections of cryosphere changes including those on regional scale;
- ✓ Improved information regarding future changes in the cryosphere, with a specific focus on information relevant for impact assessment and adaptation decision-making, such as the timing of the Arctic multiyear sea ice disappearance, the fate of mountain glaciers, etc.;
- ✓ More comprehensive, quality-controlled observational, observationally-based, and proxy datasets of cryospheric variables suitable for a range of research and model evaluation activities;
- ✓ Better quantitative understanding of processes involved in cryosphere/climate interactions and better representation of these processes in global and regional climate predictions from months to decades ahead, as well as longer-term projections, particularly with respect to the effect of the carbon sequestered in the terrestrial and sub-sea permafrost on the atmospheric, the role of ice sheet dynamics in SLR, etc.

# Ways in which WCRP can contribute

- ✓ Providing fora for improved communication between those involved in cryospheric observations and process studies and those involved in development and application of global and regional climate models and predictions.
- ✓ Promoting and facilitating targeted analysis of the CMIP and CORDEX results, and seasonal hindcasts in the CHFP database, focusing on the cryosphere and polar regions.
- ✓ Promoting detection and attribution studies of the cryosphere change (i.e. quantification of the interplay of its forced and unforced aspects) and evaluation of the ability of the state-of-the art climate models to reproduce the observed or reconstructed cryosphere behaviour as a part of the broader Earth system, with as full as possible accounting of cryosphere-climate processes, interactions and feedbacks.

# Ways in which WCRP can contribute

- ✓ Promoting more coordinated evaluation and perhaps consolidation of cryospheric data sets (e.g. those derived from satellite remote sensing) so as to better inform and guide those using such data in research and model evaluation activities. A closely related activity is the development of more robust and revealing metrics to quantitatively evaluate model performance using these data sets.
- ✓ Developing relevant international mechanisms.
- ✓ Enhancing connections between various sub-disciplines and region-specific research programs and coordinating bodies.
- ✓ Enhancing connections with the palaeo community. There are a number of key issues associated with the CCC that can be (or are already) addressed by this community.

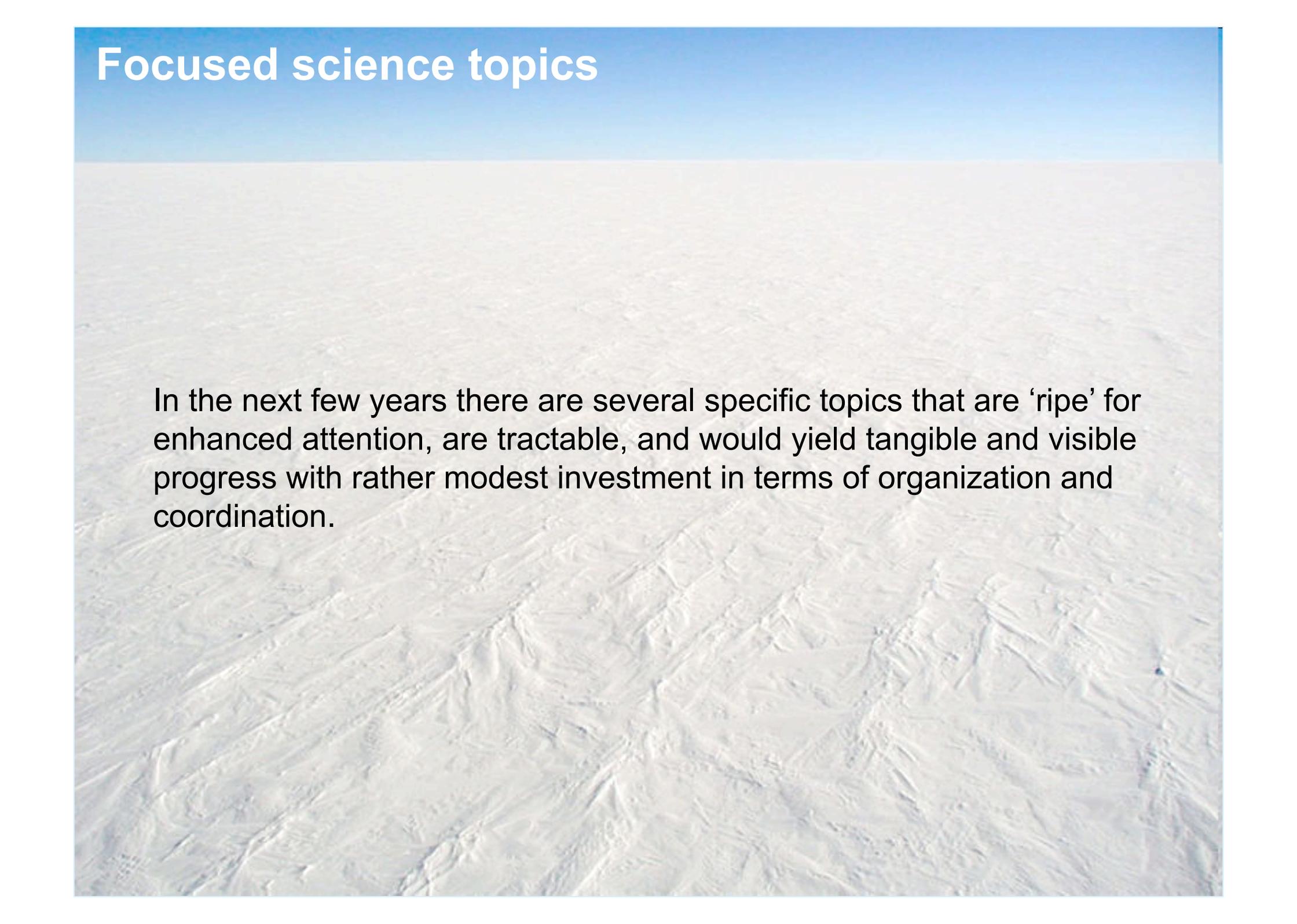
# Imperatives

Within WCRP, there is also a need to enhance communication and collaboration between projects, particularly for CCC, which connects intimately to the atmosphere, ocean and land surface, and to the global water, energy and carbon cycles.

There is also a need to make better connections with those involved in the delivery of climate services, some of which directly the cryosphere (e.g. prediction of sea-ice conditions in support of Arctic shipping; prediction of glacial meltwater availability to support drinking water and agricultural irrigation, etc.).

CliC should serve as the focal point for such efforts and there is a need to take this on as a high-profile activity in collaboration with WGSIP and WGCM.

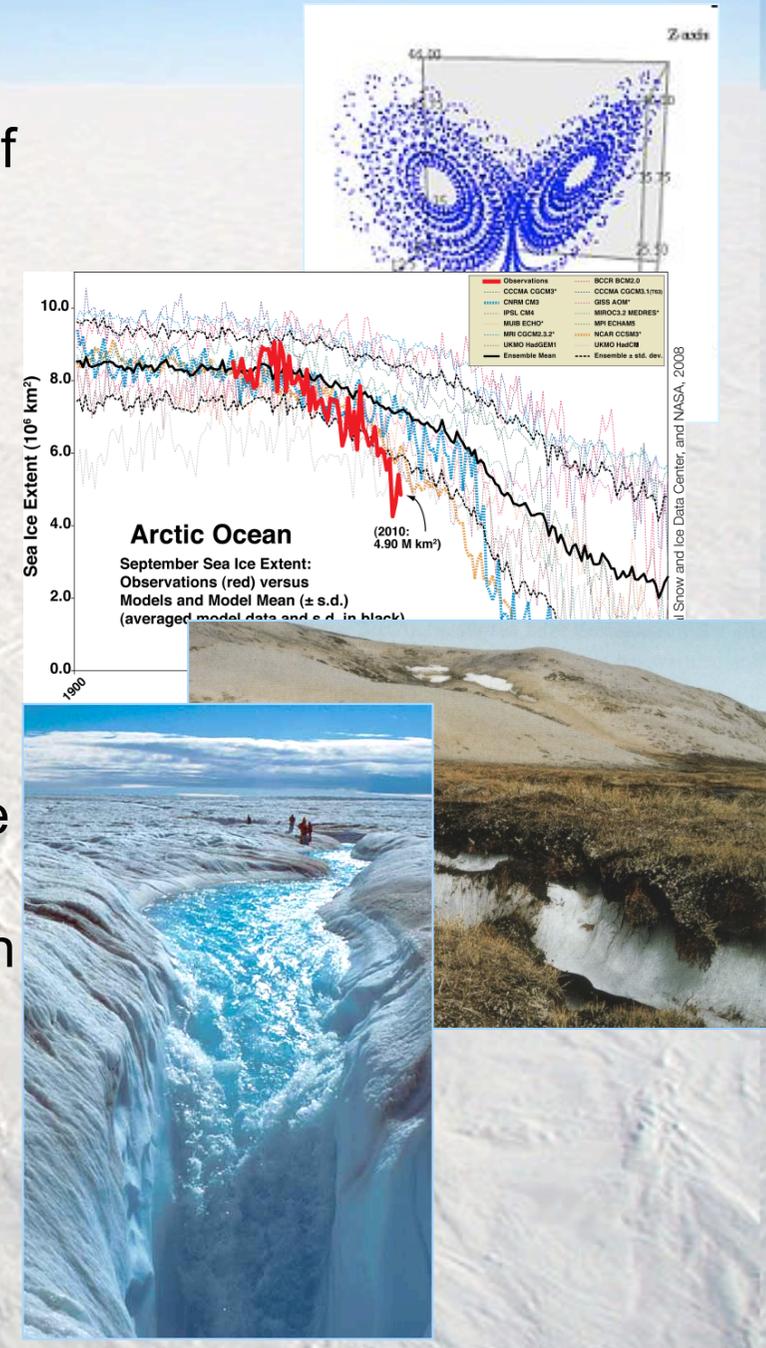
# Focused science topics

The background of the slide is an aerial photograph of a vast, flat, light-colored landscape, likely a salt flat or a desert. The terrain is mostly uniform in color but shows subtle textures and patterns, possibly from wind erosion or mineral deposits. The sky is a clear, pale blue, occupying the top portion of the image. The overall scene is bright and open.

In the next few years there are several specific topics that are 'ripe' for enhanced attention, are tractable, and would yield tangible and visible progress with rather modest investment in terms of organization and coordination.

# Focused science topics

- ✓ A coordinated focus on seasonal, interannual and longer-term predictions and projections of polar climate and the role of cryosphere in climate predictability
- ✓ A more focused analysis of model intercomparison results aimed specifically at understanding and attributing model biases and shortcomings related to cryosphere
- ✓ A focused effort on improving the representation of permafrost and high-latitude land surface, including wetlands, in climate models, with specific emphasis on their role in the global carbon cycle
- ✓ A focused effort on developing ice sheet models, with specific emphasis on the role of ice sheet dynamics on the rate of the SLR



The Cryosphere is a multi-faceted component of the climate system and so does not lend itself to a 'single-issue' approach.

We presented here a set of GCs targeted at components of the cryosphere and the different time scales of the corresponding processes.

However, each of these "sub-GCs" meets the GC criteria, and so we suggest pursuing a grouping of related and societally relevant themes.

# CCC and Major international Initiatives

International Polar Initiative

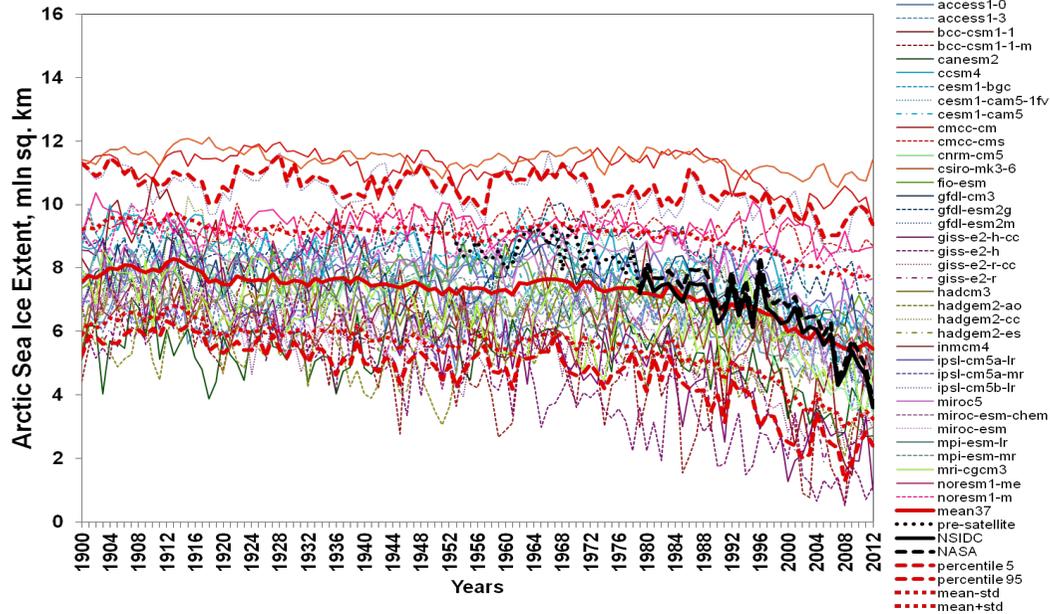
Global Cryosphere Watch

Global Integrated Polar Prediction System

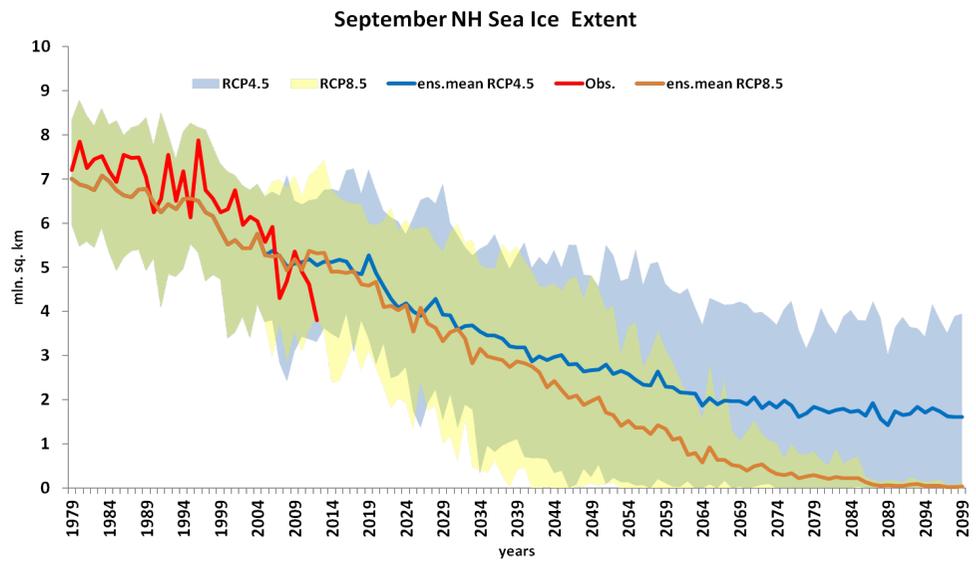
WCRP Polar Climate Predictability Initiative

WWRP Polar Prediction Project

# Sea ice (CMIP5)



CMIP6?



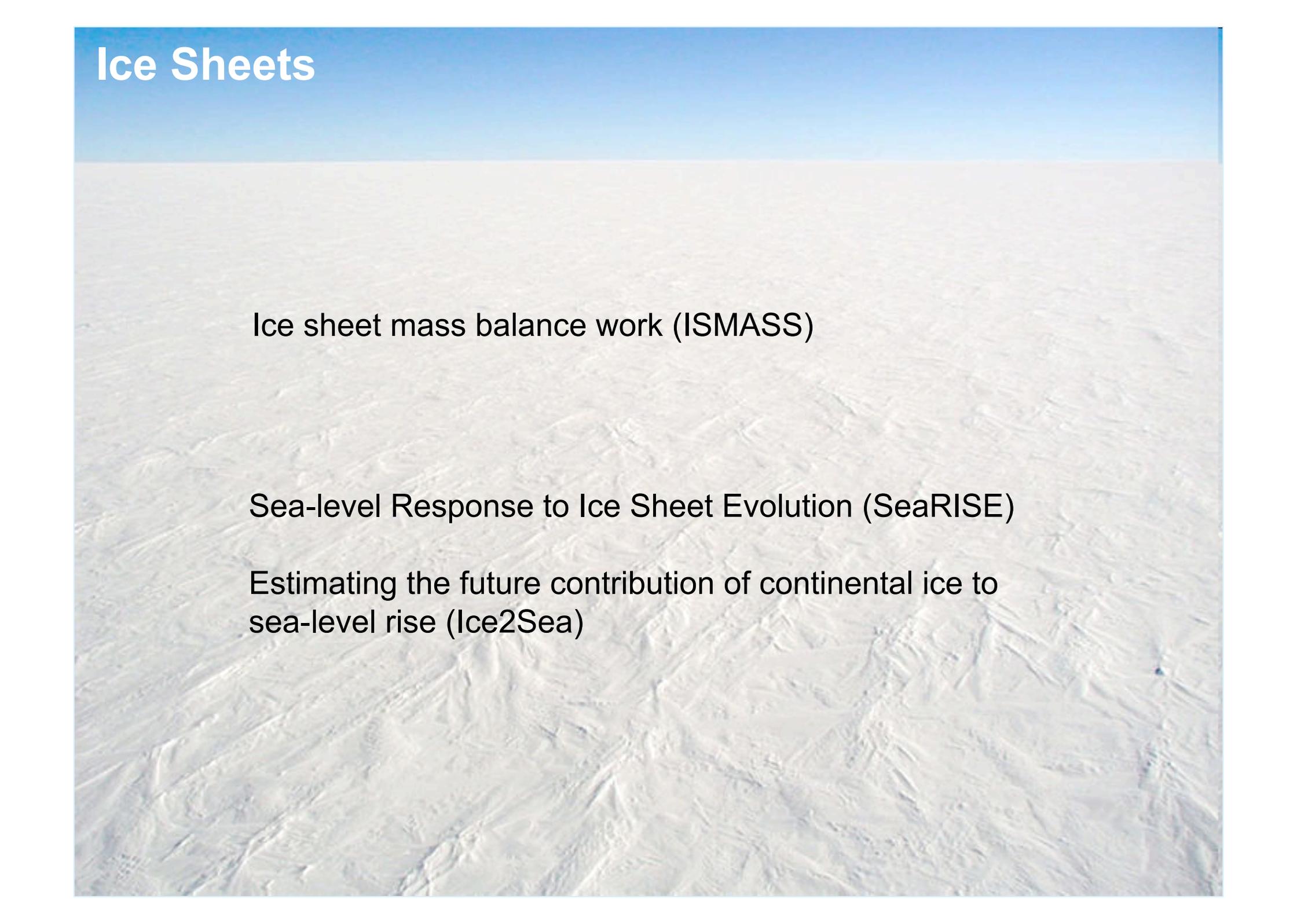
# Carbon and Permafrost (CAPER)

By now, at least four national/international large scientific projects are active and implementing the ideas that were developed by CliC through its CAPER initiative. The four projects where CliC plays various roles are:

- 1) Vulnerability of Permafrost Carbon Research Coordination Network (RCN)
- 2) Changing Permafrost in the Arctic and its Global Effects in the 21st Century (PAGE21)
- 3) Centre for Permafrost dynamics in Greenland (CENPERM)
- 4) Next-Generation Ecosystem Experiments (NGEE Arctic)

A major role for CliC is to help to coordinate interaction between these projects

# Ice Sheets

An aerial photograph of a vast, flat, white ice sheet, likely Antarctica, extending to the horizon under a clear blue sky. The ice surface shows subtle textures and patterns, possibly from wind or ice flow.

Ice sheet mass balance work (ISMASS)

Sea-level Response to Ice Sheet Evolution (SeaRISE)

Estimating the future contribution of continental ice to sea-level rise (Ice2Sea)

# Future of Mountain Glaciers

satellites  
+  
CORDEX?

# Relevant meetings and the kick-off

Permafrost Carbon Network Meeting (May 16-17, 2013)  
Florida

CliC Sea Ice Modeling and Observation Workshop (June 05-06, 2013)  
Fram centre, Tromsø



An aerial photograph of a vast, flat, light-colored landscape, possibly a salt flat or a desert, under a clear blue sky. The terrain is covered in a dense, repeating pattern of small, irregular, light-colored shapes, likely salt crystals or sand dunes. The horizon is a straight line separating the light-colored ground from the clear blue sky.

**THANK YOU!**

# Meanwhile...

Firefox | BBC News - Russia to evacuate Arctic sta... | +

← → ЯНДЕКС | www.bbc.co.uk/news/world-europe-22640512

Яндекс | Почта | Карты | Маркет | Новости | Словари | Видео | Музыка | Диск | Часто посещаемые | Начальная стр

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23 May 2013 Last updated at 14:49 GMT 1.2K Share    

## Russia to evacuate Arctic station over melting ice



RUSSIAN MINISTRY OF NATURAL RESOURCES AND ECOLOGY

An icebreaker is being sent to evacuate the station

A Russian drifting Arctic research station is to be evacuated

Windows taskbar:          

# 1. Scientific context

“The cryosphere collectively describes elements of the Earth System containing water in its frozen state and includes solid precipitation, snow cover, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost, and seasonally frozen ground. The presence of frozen water in the atmosphere, on land, and on the ocean surface affects energy, moisture, gas and particle fluxes; clouds; precipitation; hydrological conditions; and, atmospheric and oceanic circulation. Elements of the cryosphere also contain important records of past climate, providing benchmarks for interpreting modern climate change.”

# A Grand Challenge is...

The following criteria were suggested by CLIVAR for a Grand Challenge:

- A Grand Challenge is both **highly specific and highly focused** identifying a specific barrier preventing progress in a critical area of climate science.
- This focus enables the development of **targeted research efforts** with the likelihood of significant progress over 5-10 years, even if its ultimate success is uncertain.
- It should thus enable the implementation of effective and **measurable performance metrics**.
- By being transformative, a Grand Challenge should bring the **best minds** to the table (voluntarily), **building and strengthening communities of innovators that are collaborative**, perhaps also extending beyond “in-house expertise”.
- It can **capture the public’s imagination**: teams of world-leading scientists working to solve pressing challenges can offer compelling storylines to capture the interest of media and the public.

# Retrospective

## **TERRESTRIAL PERMAFROST CARBON IN THE CHANGING CLIMATE (2009) (CliC white paper)**

*V. Kattsov, K. Hibbard, A. Rinke, V. Romanovsky, D. Verseghy*  
Reviewers: *T.R. Christensen, P. Kuhry, D. Lawrence, D. McGuire*

## **RAPID LOSS OF SEA ICE IN THE ARCTIC (2010) (WCRP white paper)**

*V. Kattsov, V. Ryabinin, C. Bitz, A. Busalacchi, J. Overland, M. Serreze, M. Visbeck, J. Walsh*

## **SEASONAL TO MULTI-DECADAL PREDICTABILITY OF POLAR CLIMATE (2011) (Report on WCRP Workshop, Bergen, Norway, 25-29.10.2010)**

*T.G. Shepherd, J.M. Arblaster, C.M. Bitz, T. Furevik, H. Goosse,  
V.M. Kattsov, J. Marshall, V. Ryabinin, J.E. Walsh*

# Meanwhile...

The screenshot shows a Firefox browser window with the following details:

- Address Bar:** [www.nsr.ru/en/ceii\\_funktсии/](http://www.nsr.ru/en/ceii_funktсии/)
- Page Header:** Includes logos for the Ministry of Transport of the Russian Federation and the Federal Agency of Maritime and River Transport. Navigation links include "PVC/ENG" and "Site map".
- Main Banner:** Features the Russian coat of arms and the text "FEDERAL STATE INSTITUTION THE NORTHERN SEA ROUTE ADMINISTRATION" over a map of the Arctic region with a red dotted line indicating a shipping route.
- Navigation Menu:** A horizontal bar with buttons for "HOME", "OFFICIAL INFORMATION", "CURRENT INFORMATION", "CONSIDERATION OF APPLICATIONS", "THE ICEBREAKER ASSISTANCE AND ICE PILOTAGE", "WEATHER INFORMATION", and "CONTACT".
- Content Area:**
  - Section Header:** "Object of activity and functions of NSRA"
  - Text:** "The Federal State Institution 'Administration of the Northern sea route' was established according to the Order of the Government of Russian Federation № 358-p (March,15,2013), Federal law act № 81 (April,30,1999) p.3 art. 5.1 'The merchant shipping code of Russian Federation ', to organize navigation on the water area of the Northern sea route."
  - Text:** "The main targets of the Institution are ensuring safe navigation and protection of marine environment from the pollution on the water area of the Northern sea route."
  - Text:** "The main functions are the following:"
  - List:**
    - Obtaining and considering the submitted applications and issuing the permissions for navigation through the Northern sea route;
    - Issuing the certificates of the ice conventional pilotage on the Northern sea route;
    - Researching weather, ice, navigational and other conditions on the Northern sea route;
    - Coordination of installation of navigational aids and harmonization of regions to carry out hydrographic surveys operations on the Northern sea route;
- Search Box:** Located on the right side of the content area, with the text "Поиск" and a button "ИСКАТЬ".

The Windows taskbar at the bottom shows the system clock as 22:28 on 27.05.2013, along with various application icons.