The Arctic Observing Summit

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Outline

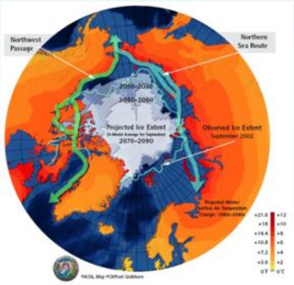
- **Context**
- **Arctic Observing Summit**
- **AOS 2018 Recommendations**
- **Perspectives**

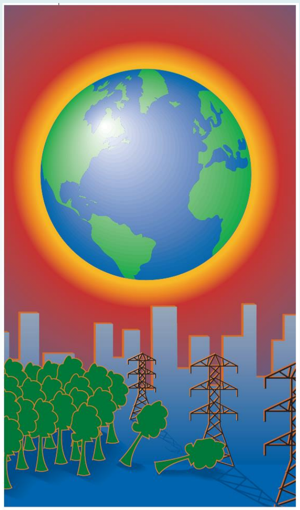
SAON
SUSTAINING ARCTIC
OBSERVING NETWORKS

ARCTIC OBSERVING SUMMIT
AOS

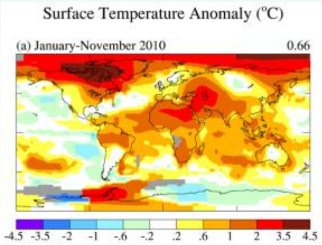
Context

- We have entered the Anthropocene, i.e., a unique era with a cascade of fast accelerations …
- Virtually all physical, chemical, biological, socioeconomic, and sociocultural systems of our planet are on non-sustainable paths
- Some subsystems are close to or have exceeded critical thresholds (Planetary Boundaries/Constraints)
- We are experiencing changes of the Earth System on extremely short time scales
- This represents biggest challenge for humankind for foreseeable future



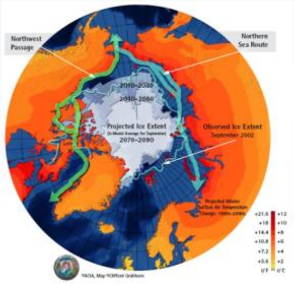


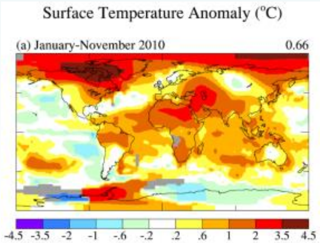
NATURE|VOL 415|3 JANUARY 2002|www.nature.com



Context

- Next to the low Lying Island Nations (AOSIS), the Arctic Region is showing the strongest impacts of global change
- Changes in the Arctic occur early and with amplified amplitudes
- Even the best scenarios presently discussed (Paris Accord; IPCC SR 15) will lead to a temperature increase of ca. 3.5 to 5C in the Arctic
- As the Arctic system is already responding to the change in a mode of self-adaptation, strategic decision making informed by pan-Arctic observations is more urgent than ever
- Responses to changes rely on complete picture of the evolution of the Arctic system
- Such a picture relies heavily on a comprehensive Arctic Observing System





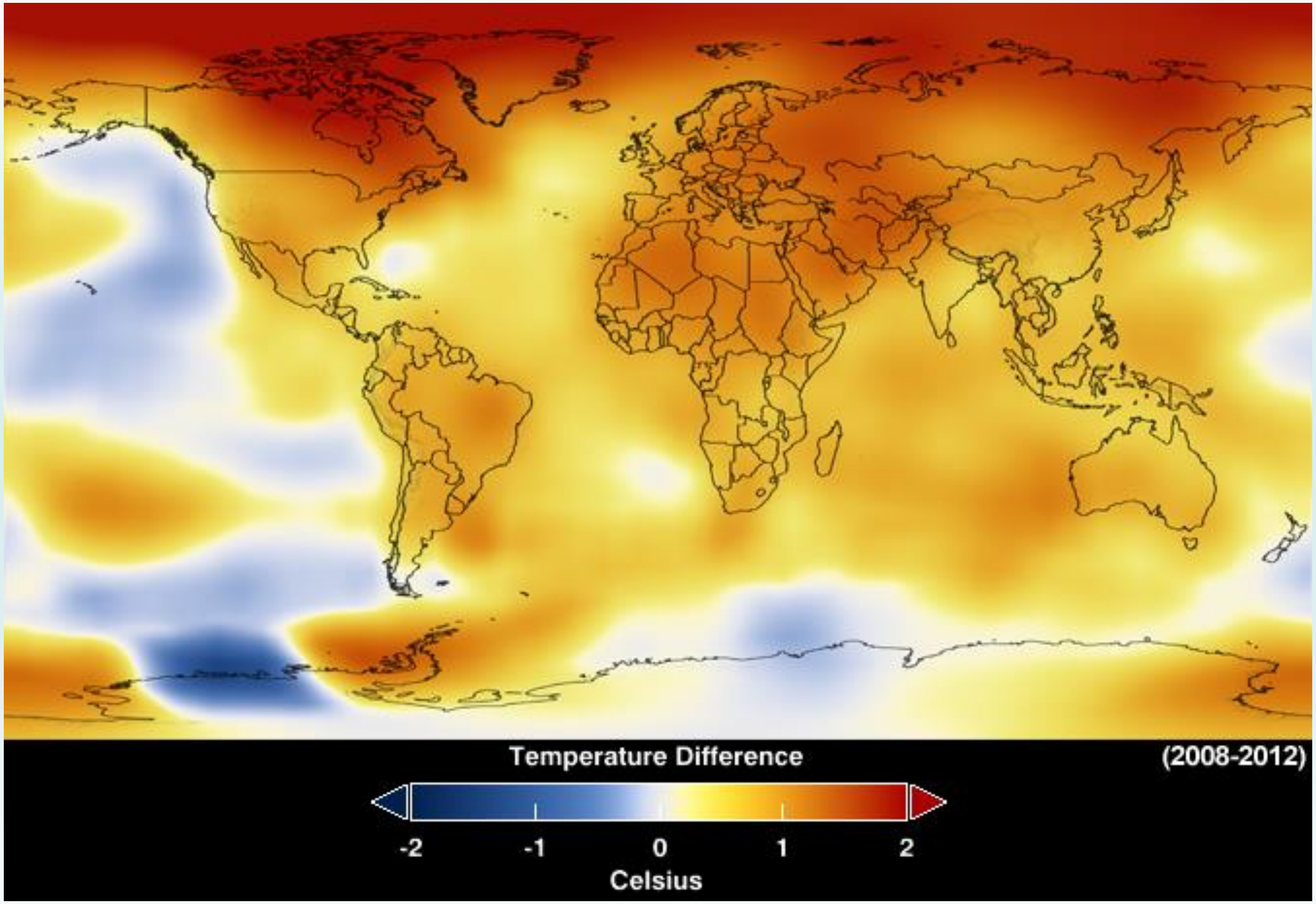
Global Warming: Amplified

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased (see Figures SPM.1, SPM.2, SPM.3 and SPM.4). {2.2, 2.4, 3.2, 3.7, 4.2–4.7, 5.2, 5.3, 5.5–5.6, 6.2, 13.2}

"Because of a variety of positive feedback mechanisms, the Arctic is likely to respond rapidly and more severely than any other area on Earth, with consequent effects on sea ice, permafrost, and hydrology."

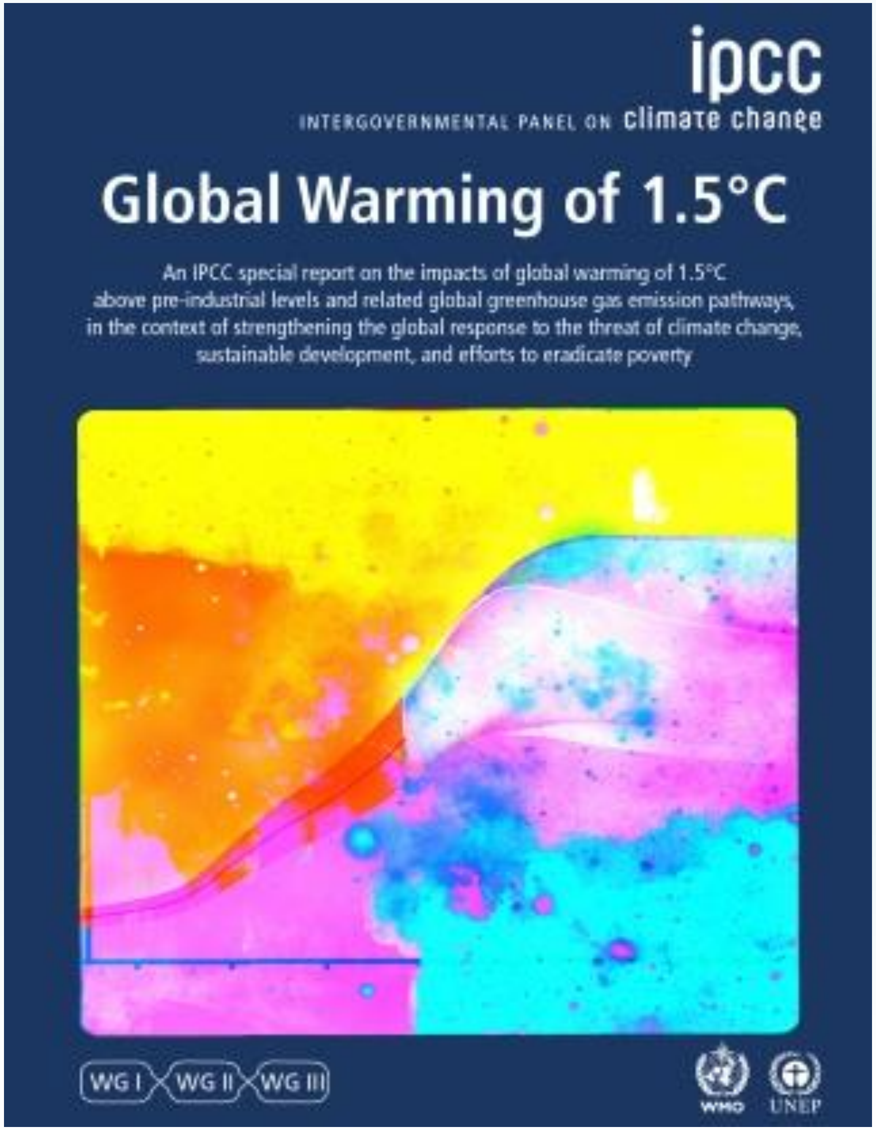
IPCC 2001 (Technical Basis p. 807)

Global Surface Temperature

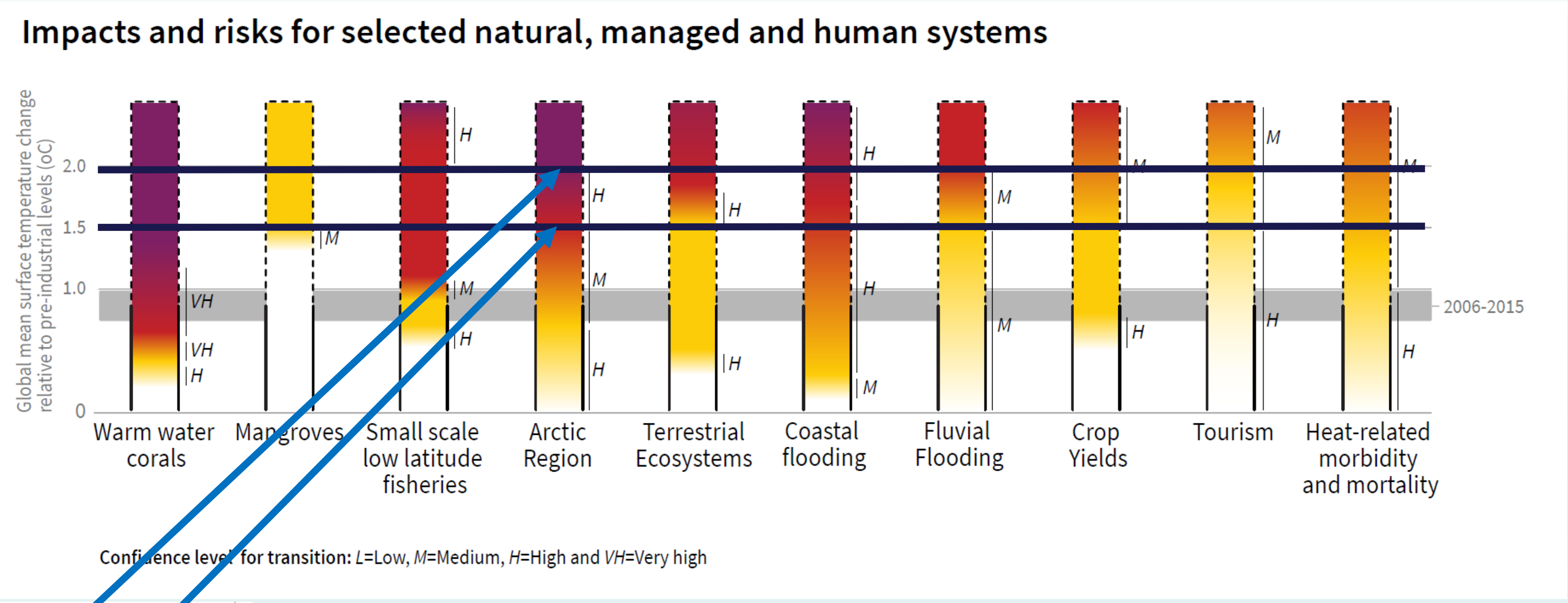


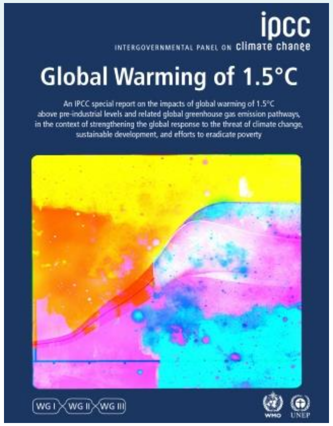
NASA GISS
http://www.nasa.gov/topics/earth/features/2012-temps.html

IPCC SR 15: 1.5 Degree Report



IPCC SR 15: 1.5 Degree Report





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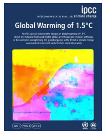
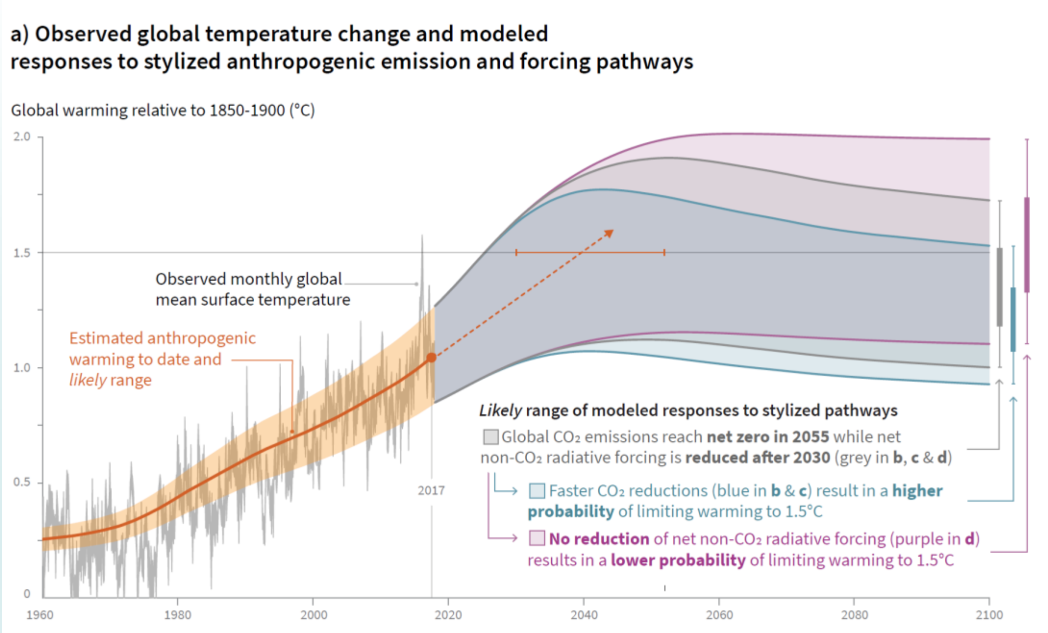
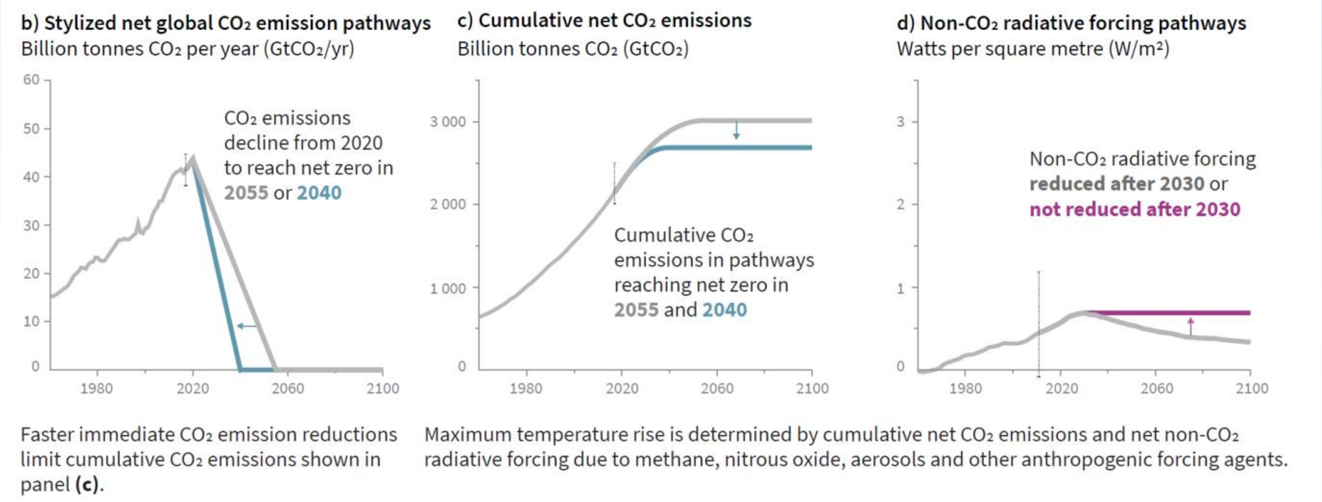


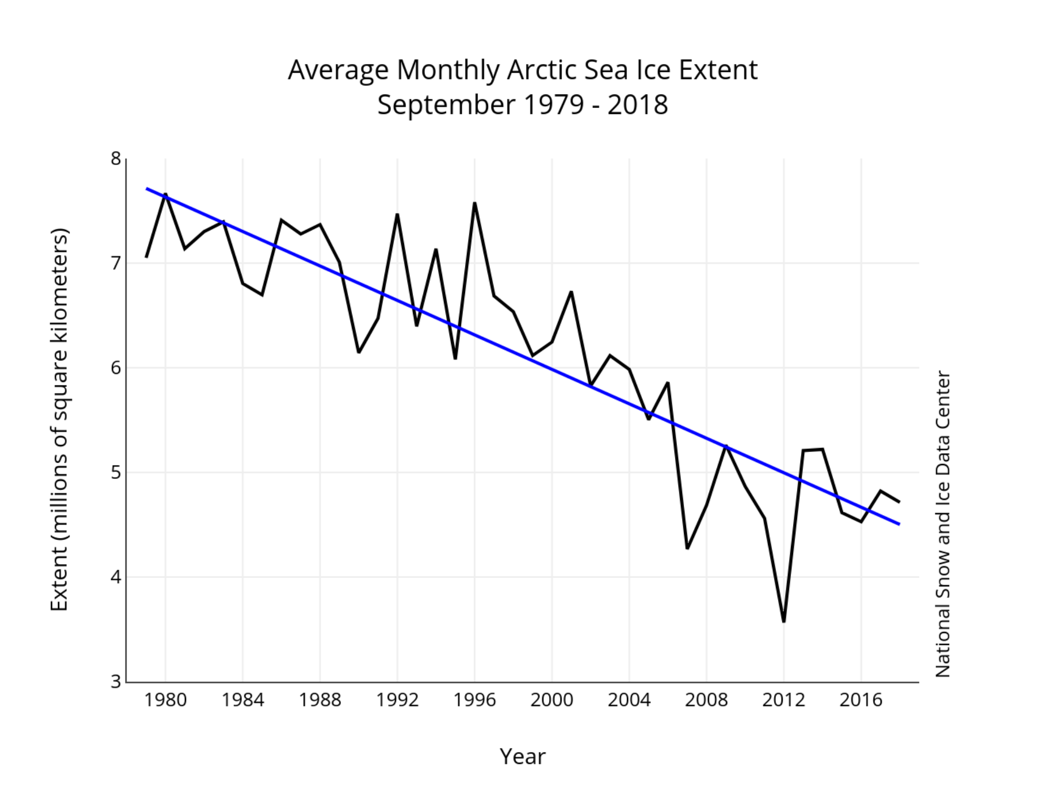
Time Scale for Response:
Ca. 1 decade





Sea-ice trends: ice extent

2007: Minimum sea ice extent
2008: Record-low sea ice volume
2012: New sea ice extent minimum



http://nsidc.org/arcticseaicenews/files/2018/10/Figure3.png

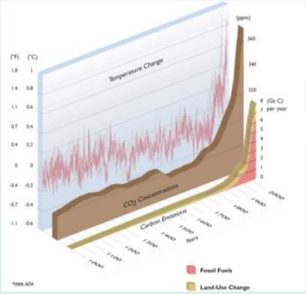
ca -13% per decade

Nature of Arctic Ocean is changing dramatically at present – changes will be more fundamental in a 2C world

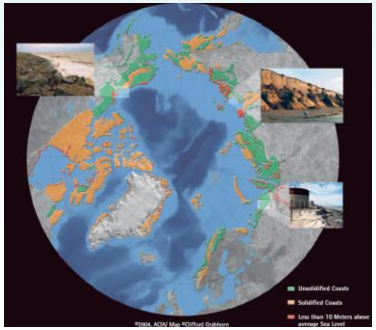
Impacts

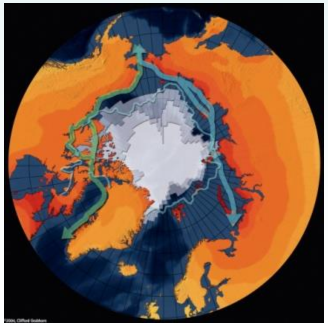
The observed changes have large impacts on Arctic:

- **Fisheries**
- **Land cover**
- **Erosion**
- **Infrastructure**
- **Vegetation zones, forest fires**
- **Socioeconomic/Sociocultural systems**



These impacts translate to more urgency in solving the scientific questions underlying the observed changes





Arctic Science Ministerial (ASM II)

- **Strengthening, integrating and sustaining Arctic observations, facilitating access to Arctic data, and sharing Arctic research infrastructure;**
- **Understanding the regional and global dynamics of Arctic change;**
- **Assessing the vulnerability and building resilience of Arctic environments and societies.**

- **Arctic Observing Summit directly addresses topic 1 of Arctic Science Ministerial II**

Arctic Observing Summit (AOS)

- **SAON Task**
- **Biennial gathering, workspace and forum:**
  - **GOAL:** Design, implementation, coordination & sustained operation of international, pan-Arctic observing system

    - Network: Arctic observing system of systems
    - Comprehensive: cross-disciplinary
    - Community-driven
    - Science-based guidance

  - Planning and development led by **ISAC and partners (IASC, SAON, others)**

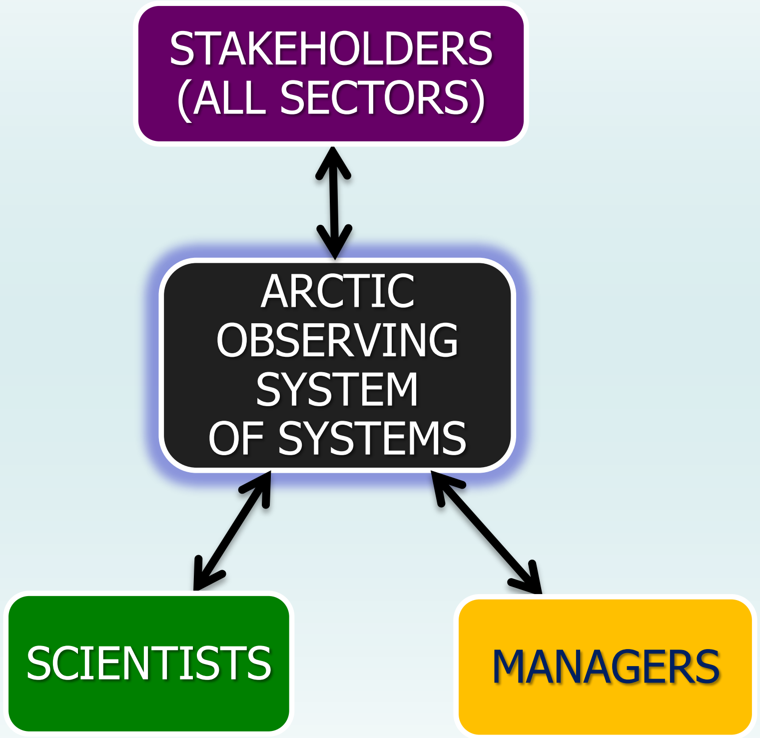
www.arcticobservingsummit.org

The Arctic Observing Summit (AOS)

- **PLATFORM:** address urgent & broadly recognized needs of Arctic observing across all components of the Arctic System

- **FORUM:** optimizing resource allocation, minimizing gaps; avoiding duplication.

- **WORKSPACE:** develop solutions, recommendations, and make tangible contributions for operation



Arctic Observing Summits

- 1st: AOS **2013: Vancouver**, B. C. Canada
- 2nd: AOS **2014: Helsinki**, Finland (with ASSW 2014)
- 3rd: AOS **2016: Fairbanks**, USA (with ASSW 2016)
- 4th: AOS **2018: Davos**, Switzerland (with POLAR 2018)

XXXV SCAR Biennial Meetings
Arctic Science Summit Week 2018 &
IASC Business Meetings
SCAR/IASC Open Science Conference
2018 Arctic Observing Summit

AOS 2018 Theme

The Business Case for a pan-Arctic Observing System

- *Propose to the highest levels of government, the business case for a comprehensive pan-Arctic observing system." (AOS Conference Statement 2016)*
- The AOS 2018 focused on pressing issues in the implementation and support of sustained observations that can be addressed through a business-case lens.

AOS 2018 Recommendations

- Since the AOS-2016 (Fairbanks, Alaska, USA), analytical advances, in a series of efforts that emerged from the first Arctic Science Ministerial (ASM1), have provided quantitative and qualitative valuation methods to support informed decisions drawing on the societal benefits of sustained observing systems and accessible data. Case studies for selected Arctic challenges have shown positive return on investment, motivating our call for action to coordinate and extend sustained observations.

AOS 2018 Recommendations

- Compared to other, more populated parts of the globe, Arctic observations rely heavily on research projects, rather than operational infrastructures and initiatives. There is an urgent need to progressively shift key observing system components – including community-based observations – from short-term research funding to sustained, operational infrastructure support. The operational infrastructure of the Arctic Observing System must target key variables that capture the Arctic system's main features. It has to be augmented by observing a broader set of variables required for addressing topical problems through research projects. Such a system also serves a critical function as information infrastructure in support of global services derived from the Arctic system.

AOS 2018 Recommendations

- A properly resourced, comprehensive effort is needed to identify strengths and gaps in the current set of systems, sensors, networks, and surveys used to observe the Arctic. A knowledge map connecting these observations to societal benefits can then guide new observations, data management needs, and development of products and services, leading to a much-needed roadmap for Arctic system observing. Support for an international and local team of experts to complete these tasks under the auspices of SAON will greatly increase the benefits derived from Arctic observing activities and is deemed critical for successful deployment and sustained operation of an Arctic Observing System.

AOS 2018 Recommendations

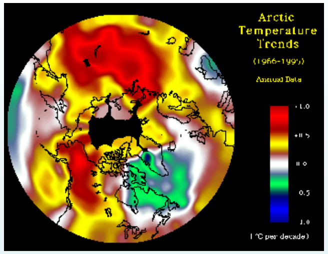
- Observing and data systems, at different spatial and temporal scales, have to emerge from co-design, co-production, and co-management processes with relevant stakeholders and rights-holders embracing free, ethical, and open data sharing, adhering to the "FAIR" data principles (Findable, Accessible, Interoperable, Reusable) are essential.

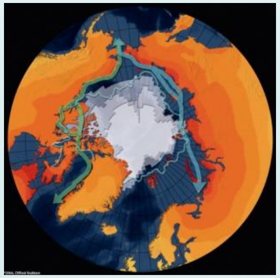
AOS 2018 Recommendations

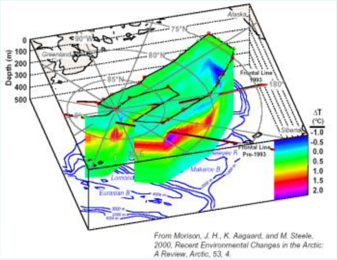
- To build an Arctic Observing System that is comprehensive, coordinated, sustainable, and fills current observational gaps, all existing assets and activities, including Indigenous knowledge, must be leveraged to the greatest extent. Such a system needs to span the full range of spatial and temporal observation scales. This is achievable by combining multiple observational methods and technologies, including Indigenous knowledge, community-based monitoring and citizen science, and by linking all relevant data systems.

Perspectives

- **Need for Arctic Observing System has been firmly established**
- **Components of the system are being implemented in a network fashion**
- **Multi-Stakeholder nature of system well established**
- **International contributions are growing**
- **International collaboration is increasing**
- **Long-term support still a problem**
- **Danger of gaps in emerging time series**
- **ASM can play a critical role in securing implementation and operation of a comprehensive, long-term Arctic Observing System**







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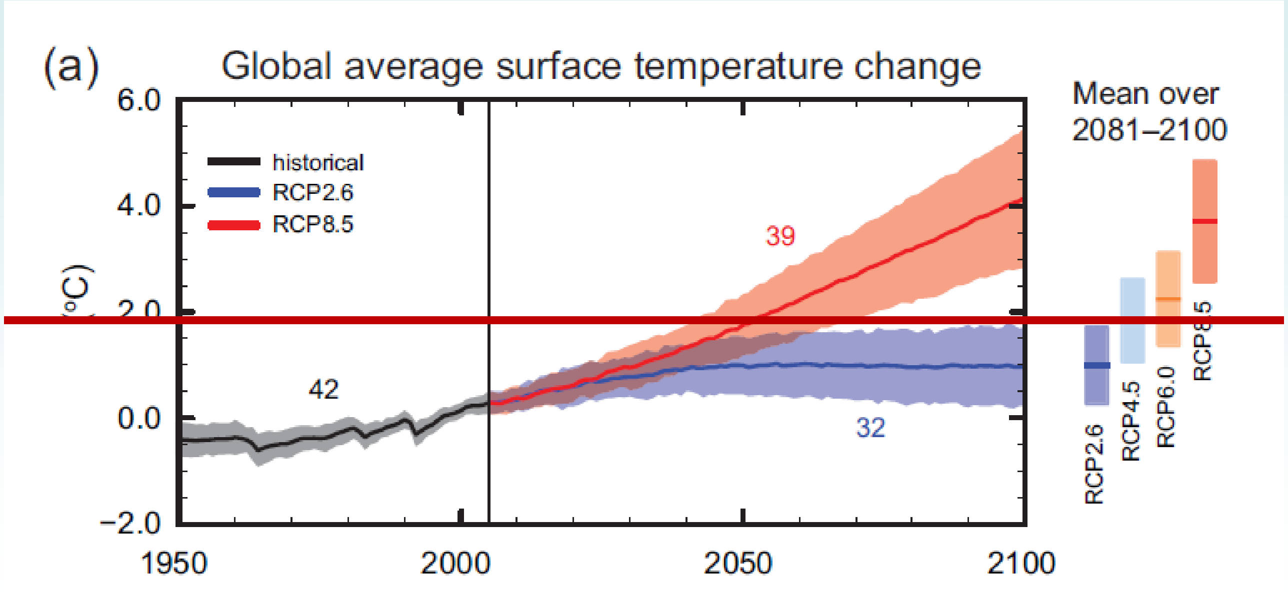
Arctic System on Trajectory to New, Seasonally Ice-Free State

IPCC AR5: Projections

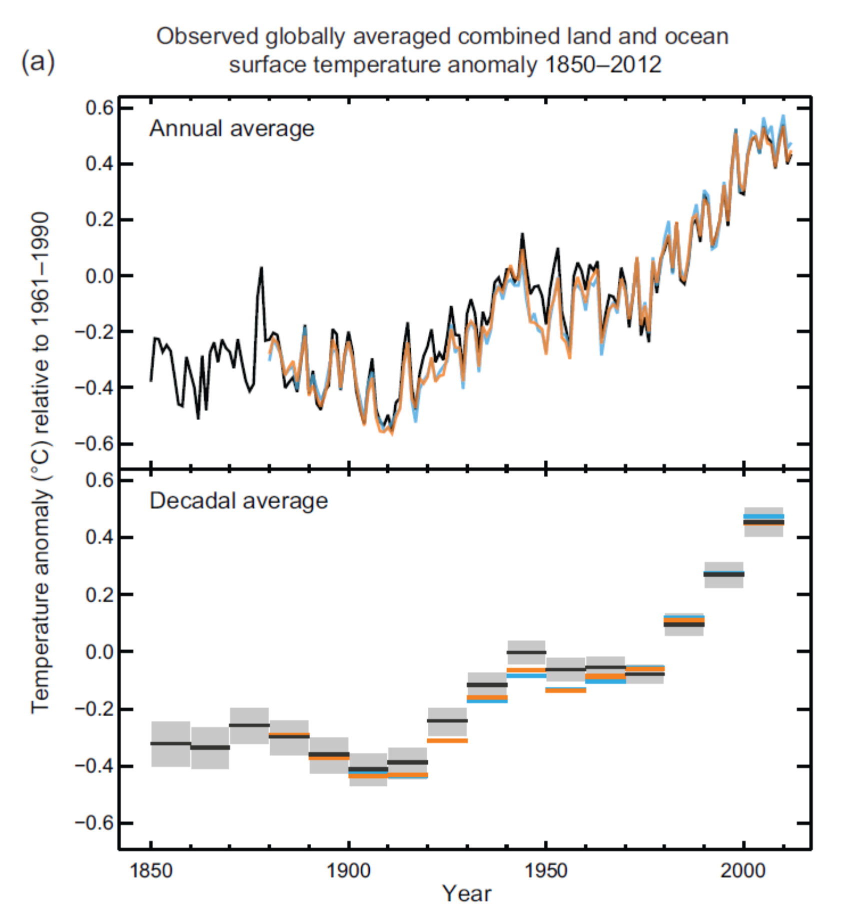
Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. {6, 11–14}

Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is *likely* to exceed 2°C for RCP6.0 and RCP8.5, and *more likely than not* to exceed 2°C for RCP4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Warming will continue to exhibit interannual-to-decadal variability and will not be regionally uniform (see Figures SPM.7 and SPM.8). {11.3, 12.3, 12.4, 14.8}

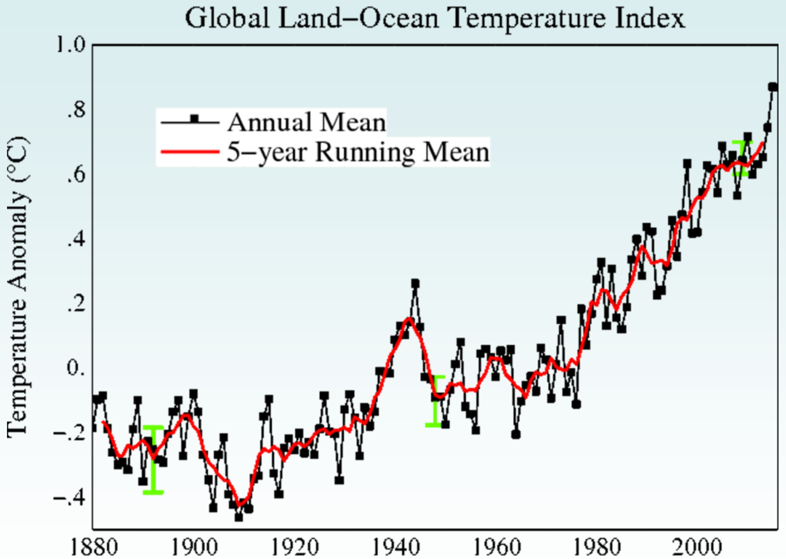


IPCC 2013: Global Surface Temperature

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 (see Figure SPM.1). In the Northern Hemisphere, 1983–2012 was *likely* the warmest 30-year period of the last 1400 years (*medium confidence*). {2.4, 5.3}



Global ΔT: **0.85 [0.65 to 1.06] °C**, over the period 1880 to 2012. ('It is **virtually certain** that globally the troposphere has warmed since the mid-20th century'.)



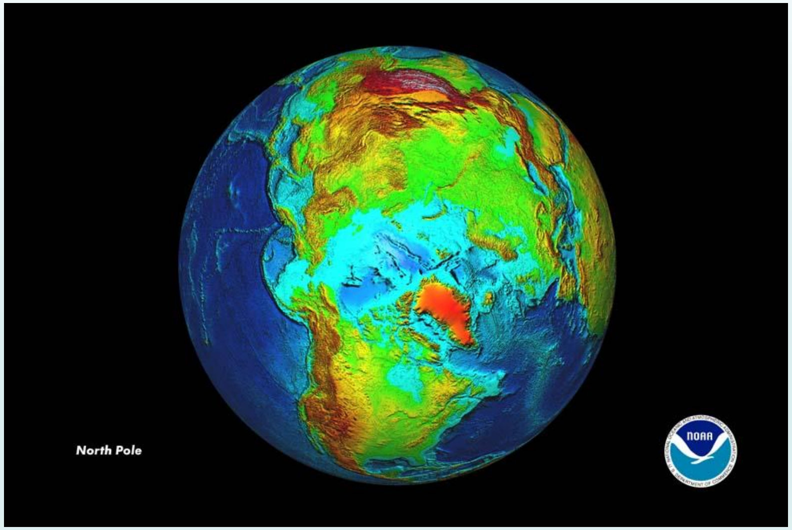
http://data.giss.nasa.gov/gistemp/graphs_v3/Fig.A2.gif

AOS 2018 Sub-Themes

The Business Case for a pan-Arctic Observing System

1. **The Need for the Observing System**
2. **Implementing and Optimizing a Pan Arctic Observing System**
3. **Leveraging Observing Systems and Networks**

The Arctic in the Earth system:
remote, pristine, exotic vs changing rapidly



- Gateway between Pacific and Atlantic
- Land-locked ocean, ice-covered
- Large ice masses on land
- Permafrost
- Vulnerable ecosystems
- Long and rich culture

IPCC AR5: Projections

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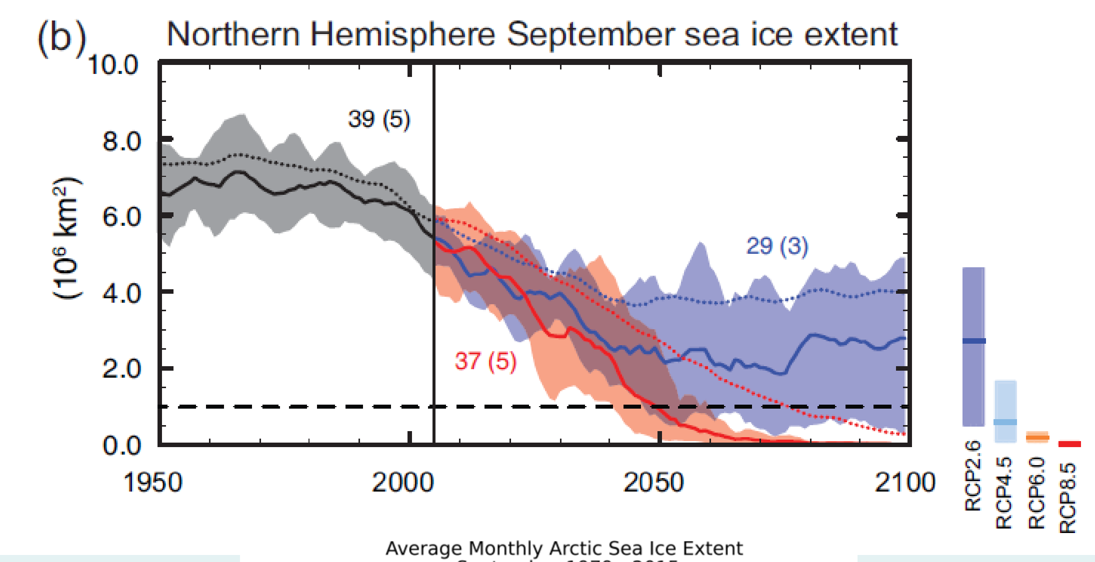
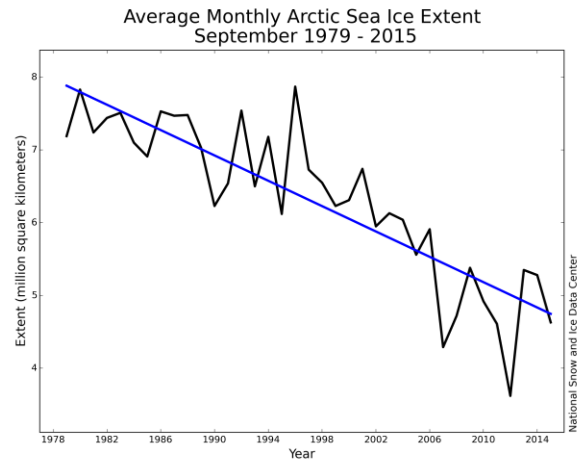
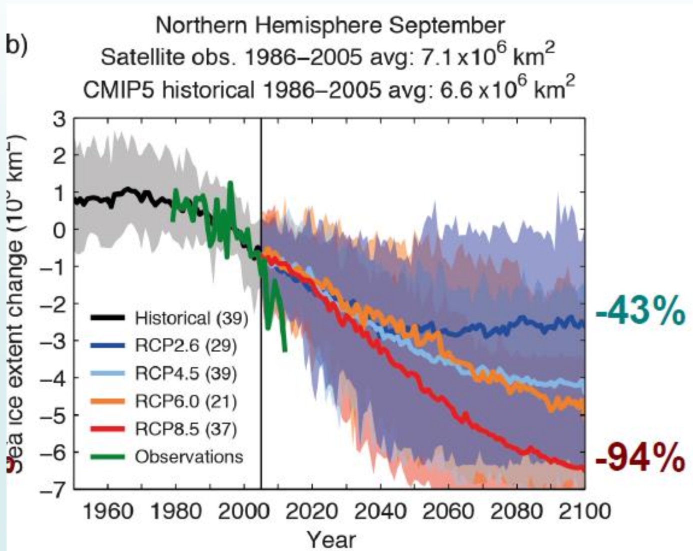
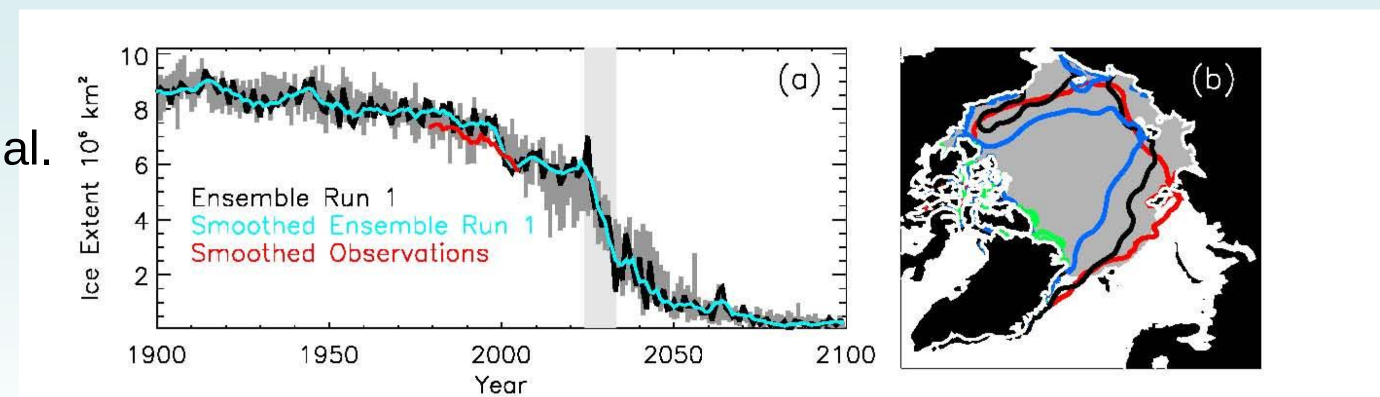




Sea-ice trends: Simulations



Holland et al. 2006



Models simulate abrupt changes

(b) The Run 1 (black) and observed (red) 1990s averaged September ice edge (50% concentration) and Run 1 conditions averaged over 2010–2019 (blue) and 2040–2049 (green). The Arctic region used in our analysis is shown in grey.

AOS Goals

- To provide community-driven, science-based guidance for the design, implementation, coordination and sustained long-term (decades) operation of an International Network of Arctic Observing systems that serves a wide spectrum of needs
- To create a forum for coordination and exchange between researchers, stakeholders, and funding agencies involved in long-term observing activities.

AOS Objectives, Products, Audience

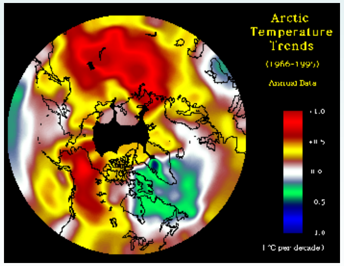
- **Engage academia, government agencies and other Arctic stakeholders (e.g. local communities, industry, non-governmental organizations).**
- **Assess the scientific basis for the Arctic observing activities.**
- **Synthesize network design options and observing priorities into recommendations for decision makers.**
- **Identify network issues that require SAON attention.**

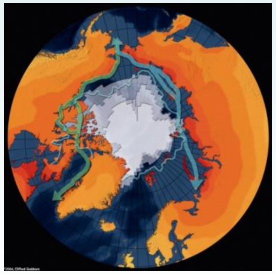
Academia’s New Challenge

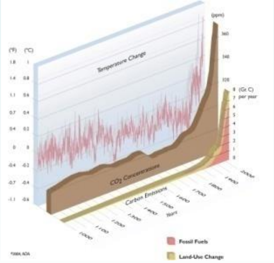
- The industrial revolution can be seen as the starting point of a cascade of accelerations in human development and use of resources that push the planet towards the limits of its capacity
- The Industrial Revolution changed Academia fundamentally
- In order to respond to these challenges that are a real threat to global society academia has to become more proactive and has to change its structures and pace of knowledge generation and translation into the solution and implementation domains
- Earth Science has to position itself in this new context
- Besides the curiosity-driven, ‘basic’ research, it has to accept new roles in ‘applied’, solution-oriented research that directly addresses societal challenges
- This has to occur in close collaboration with other disciplines

Earth System under Stress

- During the past three centuries the world population increased by a factor of about 10
- The energy use increased by a factor of ca. 16 in the 20th century causing increases of CO_2 and SO_2, among other effects.
- The use of fossil fuels and agriculture led to increases in the concentration of the greenhouse gases CO_2 und Methane by ca. 40 and 100 %, respectively.



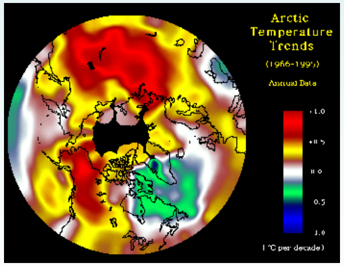


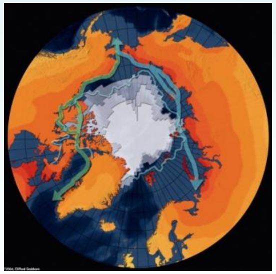


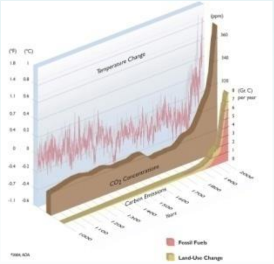
Crutzen, Nature, 2002

Earth System under Stress (2)

- Ca. 30–50% of the Earth surface is used anthropogenically
- More than half of Earth's freshwater is used anthropogenically
- The amount of nitrogen fertilizer used in agriculture is larger than the nitrogen naturally fixed by all global ecosystems.
- ...







Crutzen, Nature, 2002

Anthropocene

- So far, these effects were caused by only ca. 25 % of the world population
- Consequences include global warming, acid rain, or smog.
- The role of humans in the Earth system is so large that a new geological unit of time, the 'Anthropocene' has been proposed (for example: Crutzen, Zalasiewicz)

NATURE | VOL 415 | 3 JANUARY 2002 | www.nature.com

IPCC AR5: Projections

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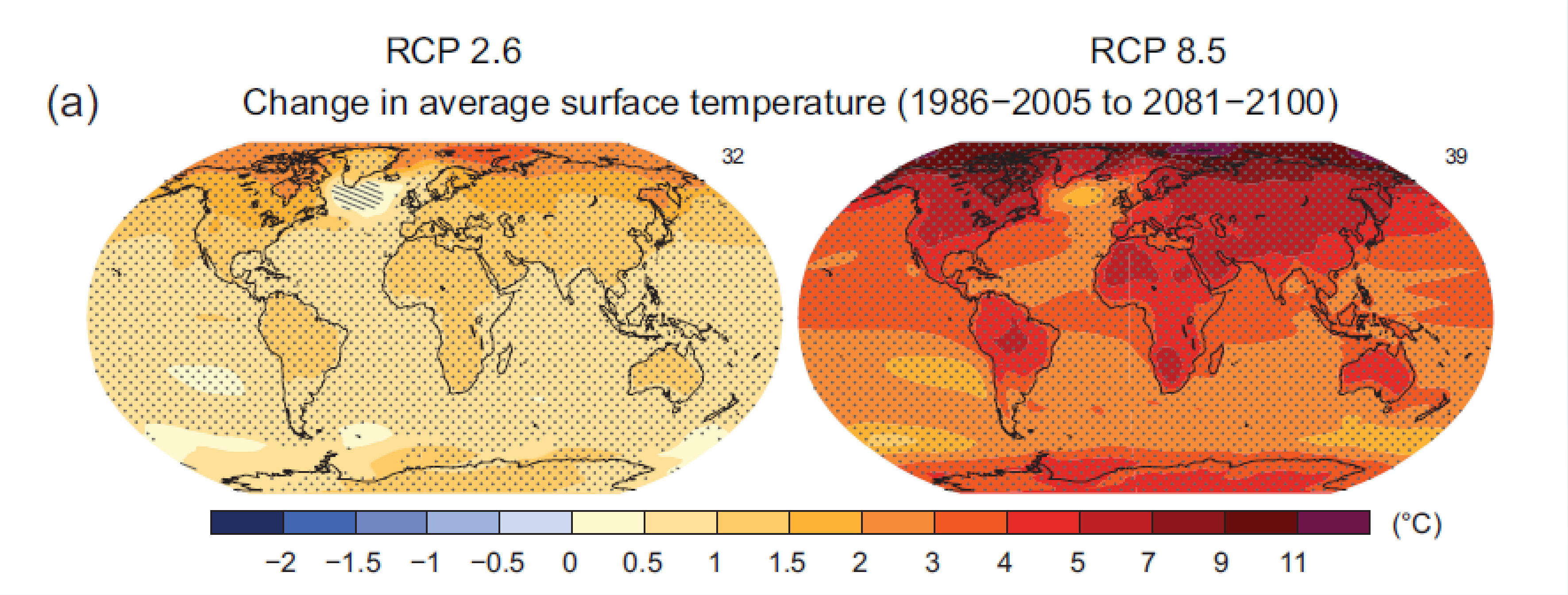
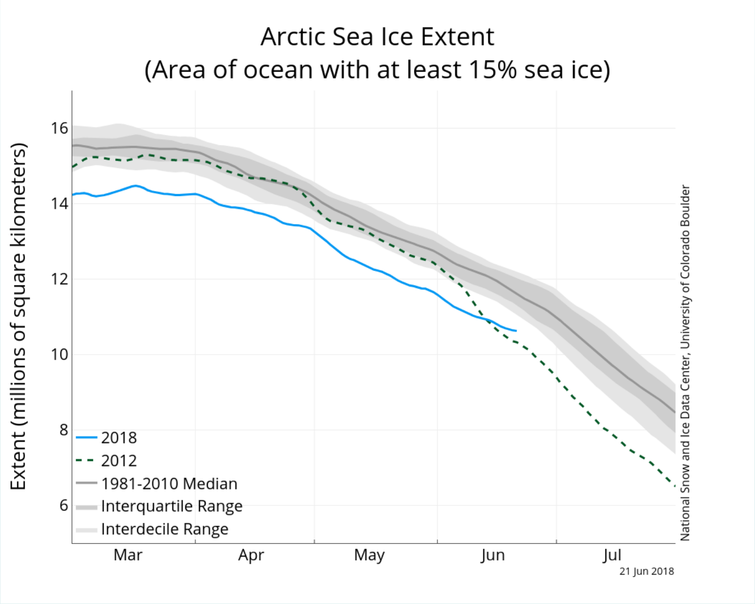


Sea Ice Trends: Ice Extent



http://nsidc.org/arcticseaicenews/

Transition to new State

EOS
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VOLUME 86 NUMBER 34
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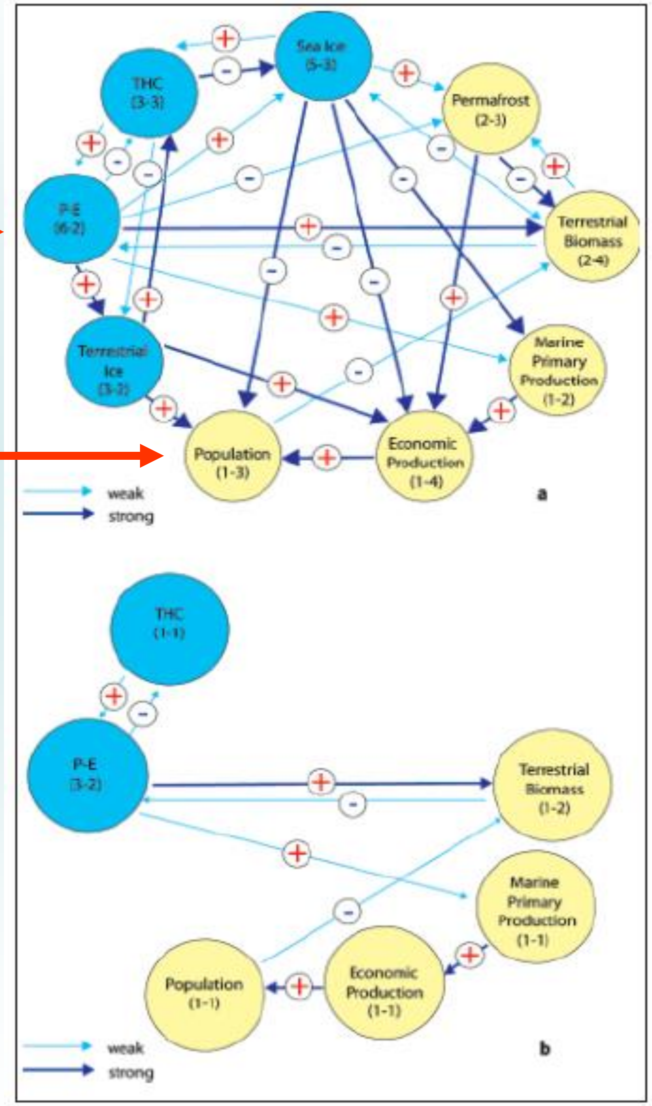
PAGES 309–316

Arctic System on Trajectory to New, Seasonally Ice-Free State

Driver

‘Recipient’



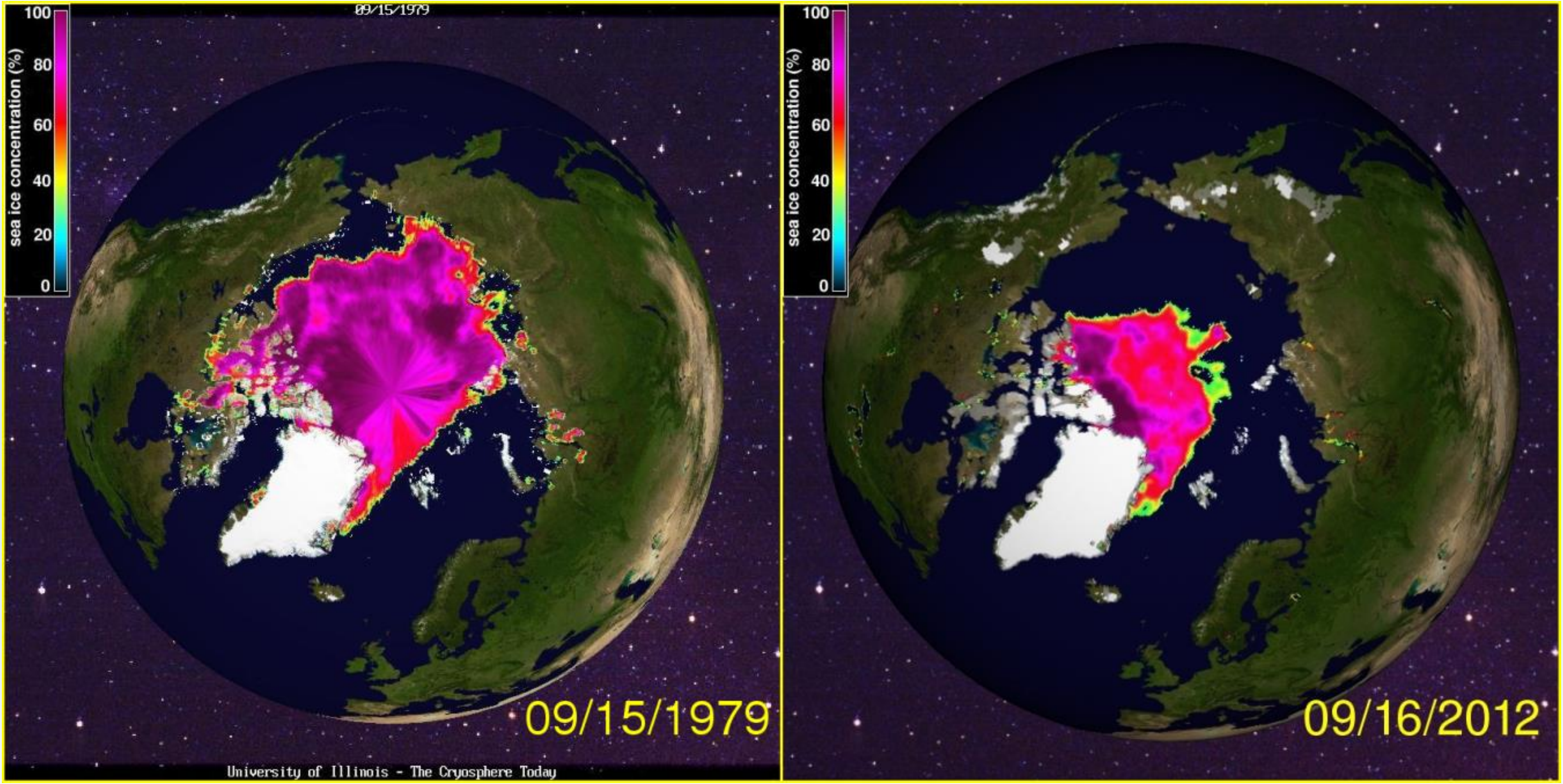
Big Sky meeting, 2003

20 plus scientists from diverse backgrounds

Need for Complex systems theory and modeling

Fig. 2. (a) Schematic of the essential components (or hubs) of the present Arctic system. The main interactions between hubs are denoted by arrows: Single or double arrowheads indicate one- or two-way interactions. Interaction strength is designated by arrow thickness, and the sign (plus or minus) indicates whether a change in one component produces a change in another of the same (plus) or opposite (minus) sign. Numbers in parentheses within each hub indicate the number of interactions going out of, and coming into, that hub. Driver hubs are blue; recipient hubs are yellow. (b) The Arctic system in the future after loss of substantial permanent ice.

Sea Ice Trends: Ice Extent



http://igloo.atmos.uiuc.edu/cgi-bin/test/testimage.2.sh?first=19790915.png&second=20120916.jpg

Global warming projections

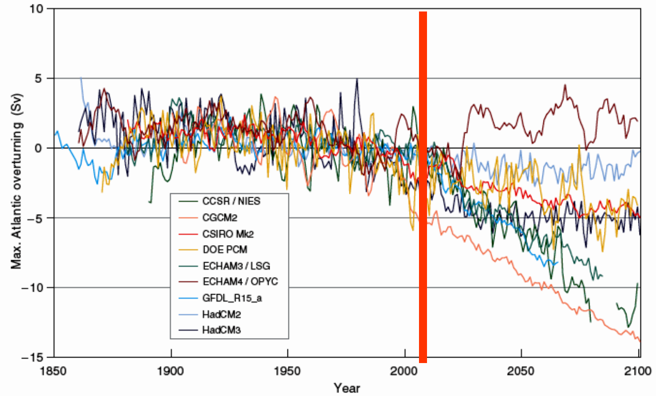


Figure 9.21: Simulated water-volume transport change of the Atlantic "conveyor belt" (Atlantic overturning) in a range of global warming scenarios computed by different climate research centres. Shown is the annual mean relative to the mean of the years (1961 to 1990) (Unit: SV, $10^6\ m^3s^{-1}$). The past forcings are only due to greenhouse gases and aerosols. The future-forcing scenario is the IS92a scenario. See Table 9.1 for more information on the individual models used here.

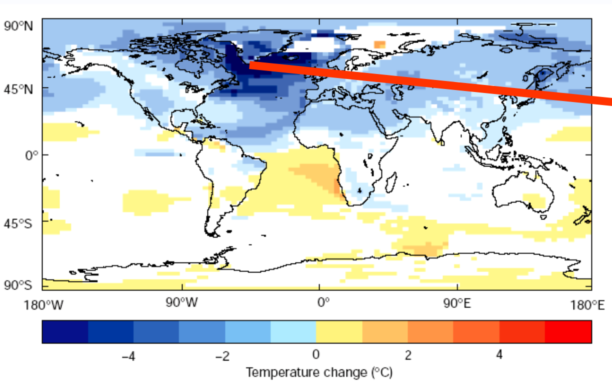


Figure 1 Changes in surface air temperature caused by a shutdown of North Atlantic Deep Water (NADW) formation in a current ocean–atmosphere circulation model. Note the hemispheric see-saw (Northern Hemisphere cools while the Southern Hemisphere warms) and the maximum cooling over the northern Atlantic. In this particular model (HadCM3)[7], the surface cooling resulting from switching off NADW formation is up to 6 °C. It is further to the west compared with most models, which tend to put the maximum cooling near Scandinavia. This probably depends on the exact location of deep-water formation (an aspect not well represented in current coarse-resolution models) and on the sea-ice distribution in the models, as ice-margin shifts act to amplify the cooling. The largest air temperature cooling is thus greater than the largest sea surface temperature (SST) cooling. The latter is typically around 5 °C and roughly corresponds to the observed SST difference between the northern Atlantic and Pacific at a given latitude. In most models, maximum air temperature cooling ranges from 6 °C to 11 °C in annual mean; the effect is generally stronger in winter.

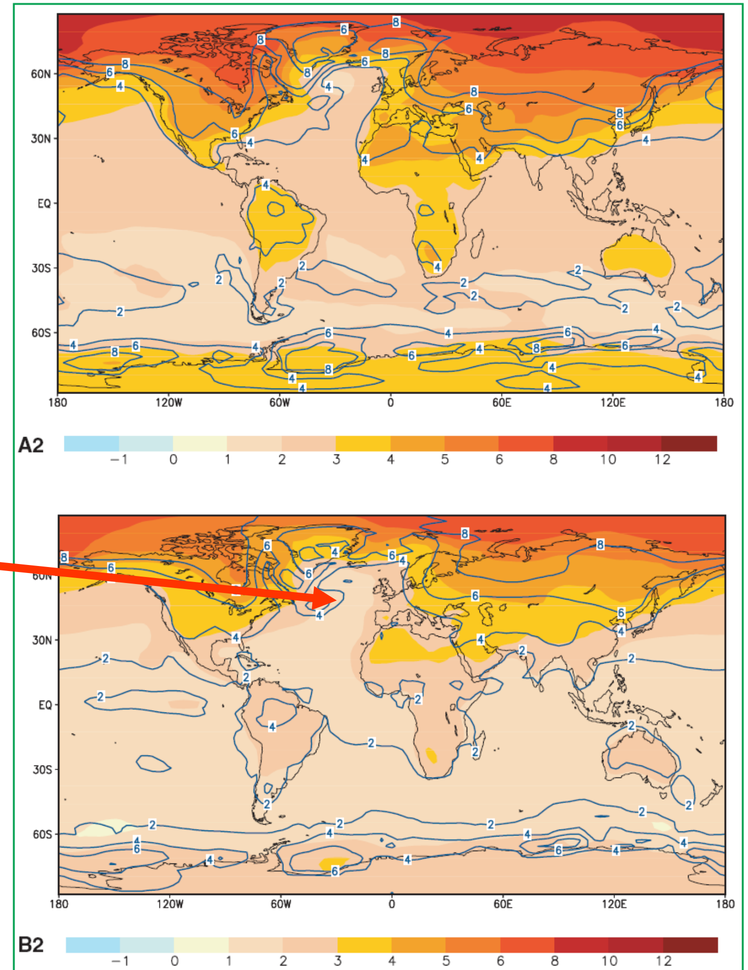


Figure 20: The annual mean change of the temperature (colour shading) and its range (isolines) (Unit: °C) for the SRES scenario A2 (upper panel) and the SRES scenario B2 (lower panel). Both SRES scenarios show the period 2071 to 2100 relative to the period 1961 to 1990 and were performed by OAGCMs. [Based on Figures 9.10d and 9.10e]

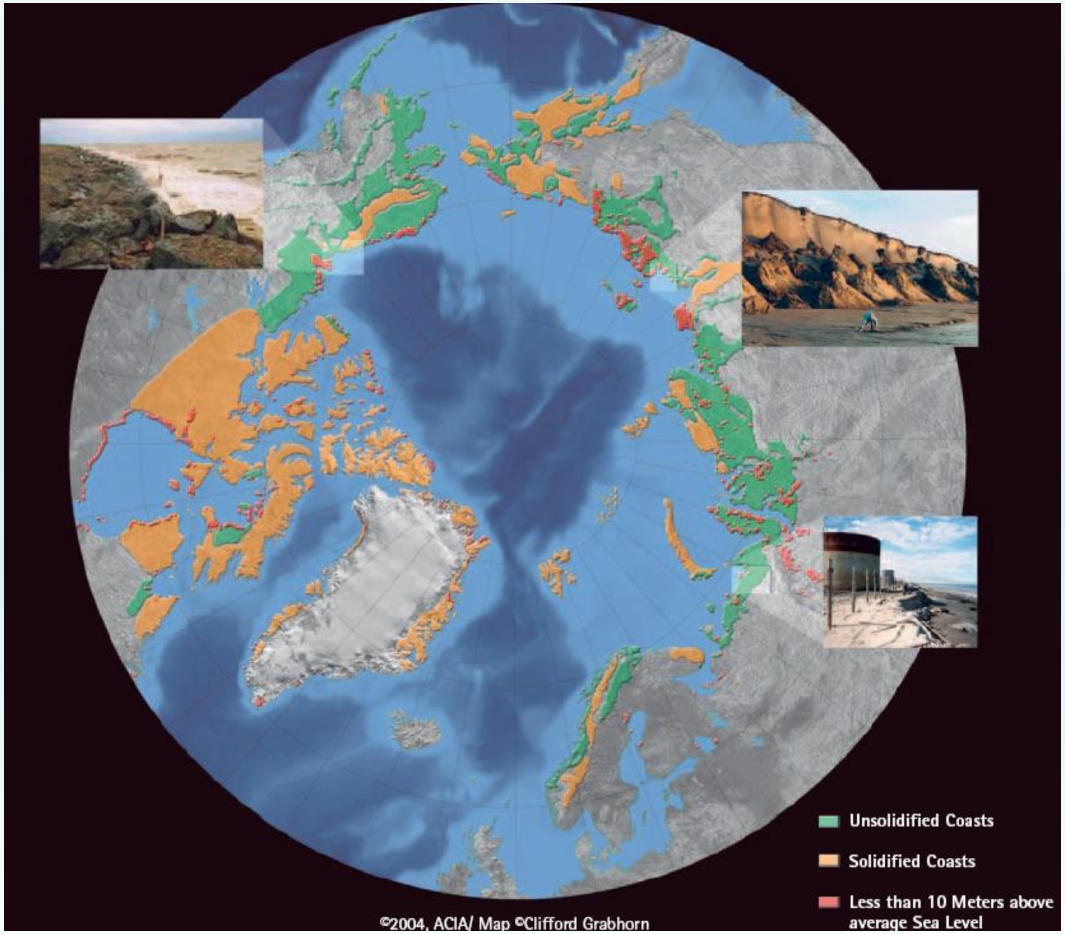
IPCC, TAR, 2001

Ocean circulation and climate during the past 120,000 years

Stefan Rahmstorf

Potsdam Institute for Climate Impact Research, PO Box 601203, 14412 Potsdam, Germany

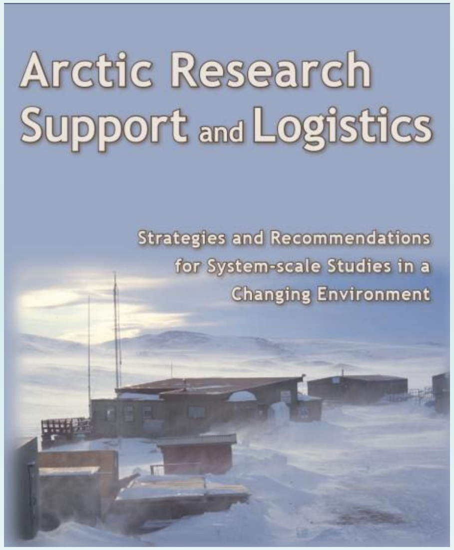
Impacts: coastal erosion



ACIA

http://cires.colorado.edu/science/features/thawingalaska/

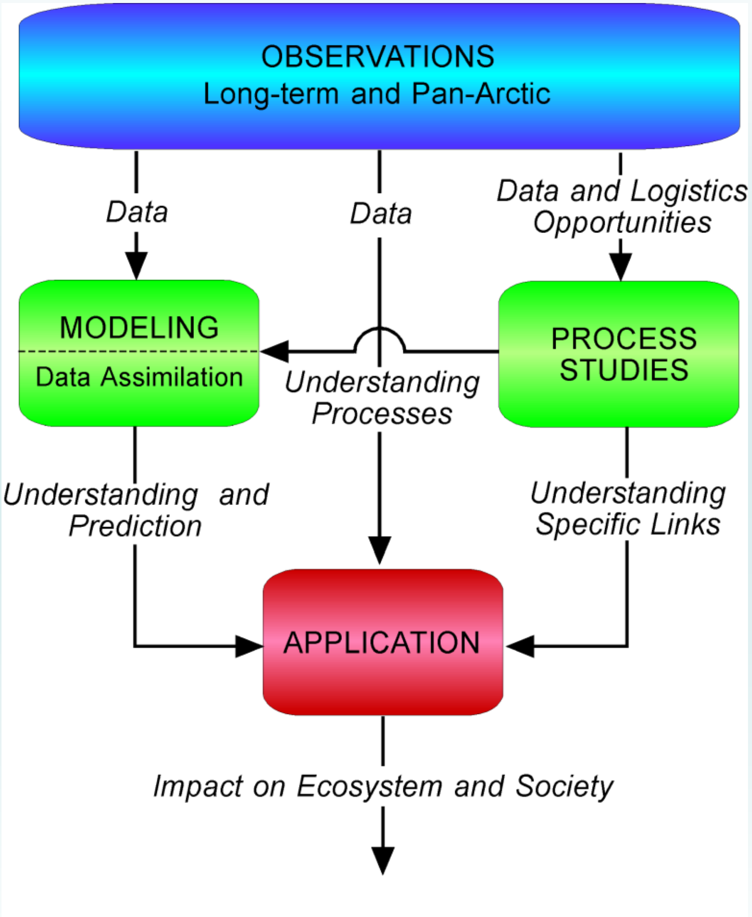
Need for Arctic Observing System

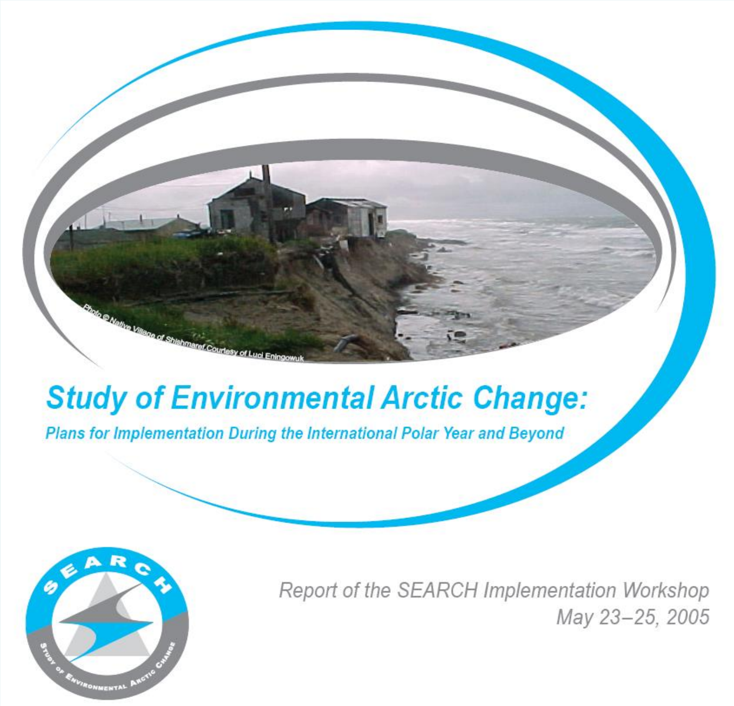


RSLWG report, 2003
http://www.arcus.org/Logistics/ArcticLogistics_10_03.pdf

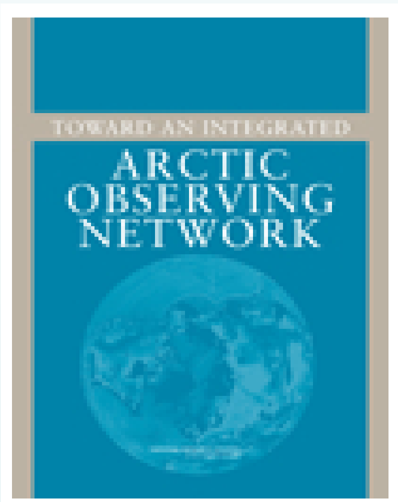
1. **Supplying critical components for development of a pan-arctic Perspective**
   - *Plan, implement, and support an arctic observing network.*
   - *Facilitate access to distributed systems of hardware, software, information bases, and automated aids for data management, synthesis, interpretation, and modeling.*
   - *Improve communication and data transmission capabilities, remote field power options, and access to satellite observations.*
2. **Supporting the infrastructure for safe and efficient research**
3. **Maximizing resources and cooperation**
   - *Facilitate international coordination and cooperation.*
   - *Pursue interagency collaborations.*
   - *Enhance communication and partnerships with arctic communities.*
   - *Maintain and disseminate arctic expertise and train the next generation of arctic field experts.*

SEARCH


OBSERVATIONS
Long-term and Pan-Arctic
Data
Data
Data and Logistics Opportunities
MODELING
Data Assimilation
Understanding Processes
PROCESS STUDIES
Understanding and Prediction
Understanding Specific Links
APPLICATION
Impact on Ecosystem and Society

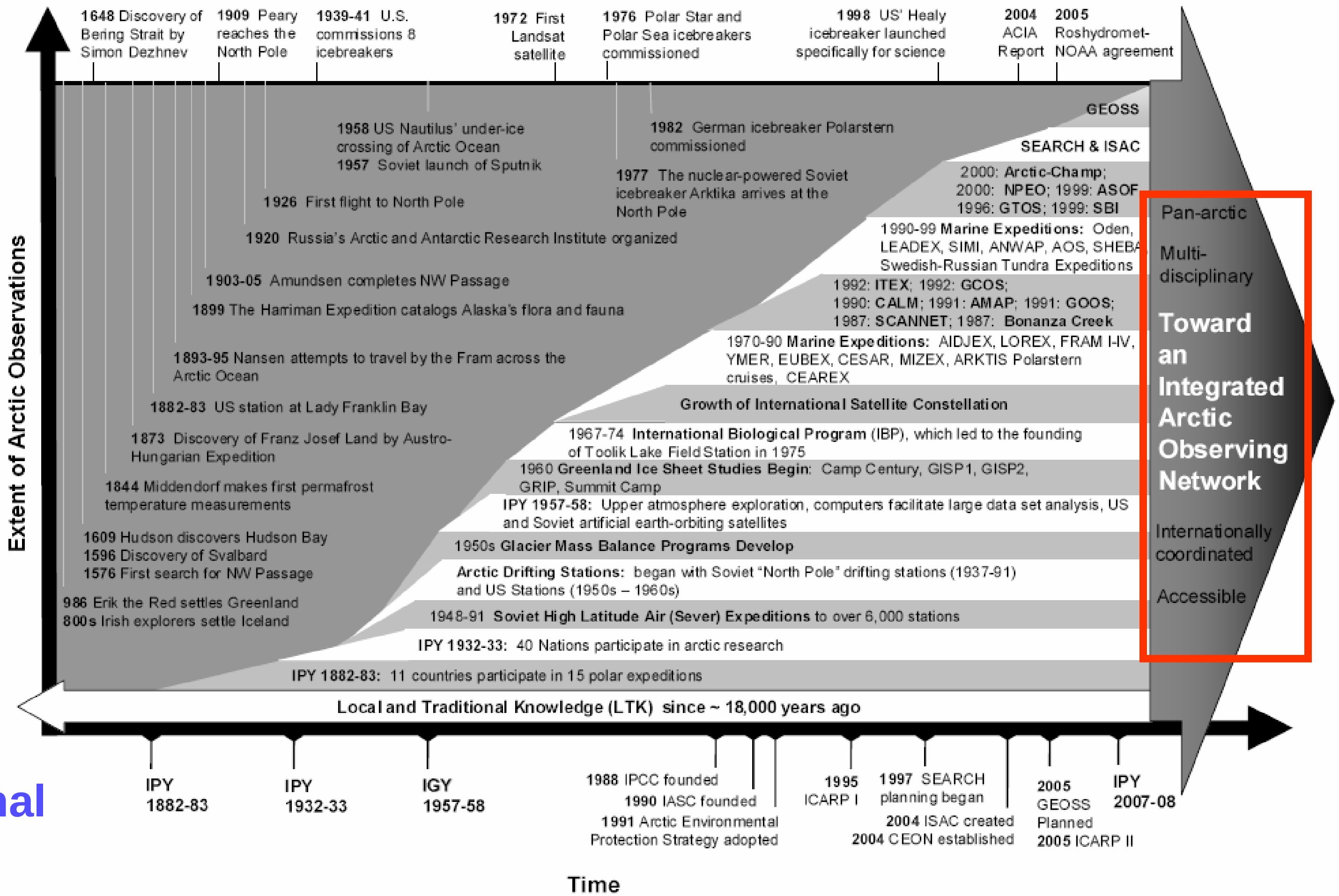

Study of Environmental Arctic Change:
Plans for Implementation During the International Polar Year and Beyond
SEARCH
Study of Environmental Arctic Change
Report of the SEARCH Implementation Workshop
May 23–25, 2005

Pan – Arctic observing systems



U.S. PRB:
AON report; 2006

Local and traditional knowledge



International Partnerships; e.g.:
SEARCH, DAMOCLES, ArcticNet, ISAC, SAON

Features of an Arctic Observing System/Network

- Pan-Arctic
- Multi-Domain
- Long-Term, Sustained
- Multi-Stakeholder (science and solution space)
- Network (System of Systems)
- Internationally coordinated
- Flexible Design
- Empirical Approach
- Optimization – OSSE

Pan – Arctic Observing Systems

ISAC

A Pan-Arctic Observing System must be:

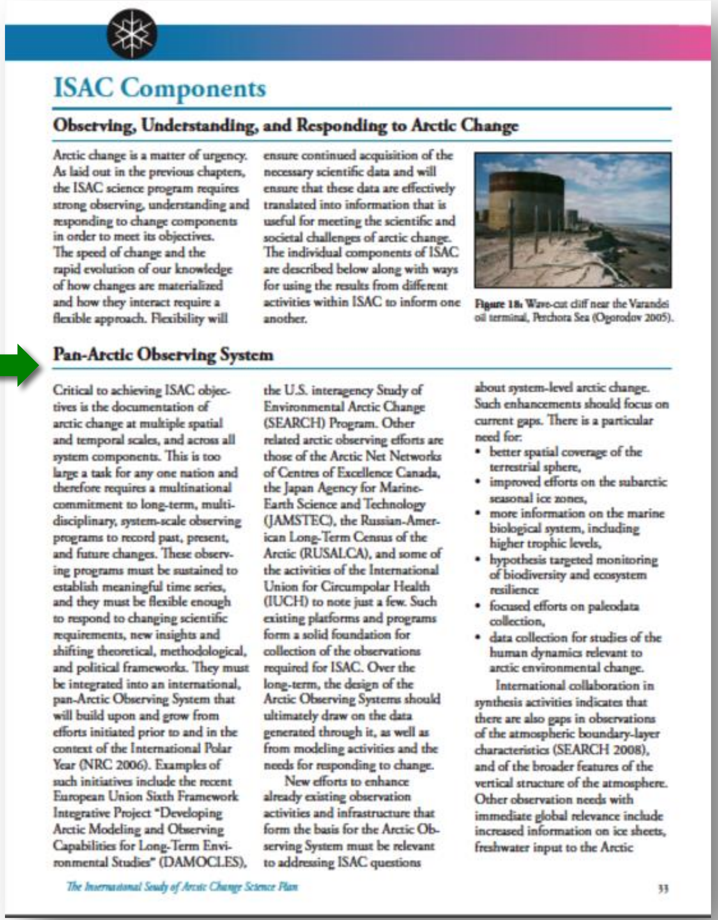
- **integrated** one allowing for merging of data streams
- **focused** around central science questions and societal needs
- **relevant** to people's lives, decision making and policy

Observing System Design:

- is **critical**
- the system should be **responsive** to arctic system change
- responsive to needs for improved **understanding** and **adaptation** to and **mitigation** of change.

The AOS must be **connected** with global observing systems.

(from: ISAC Science Plan 2010)



ISAC Components

Observing, Understanding, and Responding to Arctic Change

Arctic change is a matter of urgency. As laid out in the previous chapters, the ISAC science program requires strong observing, understanding and responding to change components in order to meet its objectives. The speed of change and the rapid evolution of our knowledge of how changes are materialized and how they interact require a flexible approach. Flexibility will ensure continued acquisition of the necessary scientific data and will ensure that these data are effectively translated into information that is useful for meeting the scientific and societal challenges of arctic change. The individual components of ISAC are described below along with ways for using the results from different activities within ISAC to inform one another.

Figure 18: Wave-cut cliff near the Varandei oil terminal, Perchora Sea (Ogorodov 2005).

Pan-Arctic Observing System

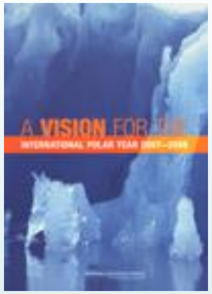
Critical to achieving ISAC objectives is the documentation of arctic change at multiple spatial and temporal scales, and across all system components. This is too large a task for any one nation and therefore requires a multinational commitment to long-term, multi-disciplinary, system-scale observing programs to record past, present, and future changes. These observing programs must be sustained to establish meaningful time series, and they must be flexible enough to respond to changing scientific requirements, new insights and shifting theoretical, methodological, and political frameworks. They must be integrated into an international, pan-Arctic Observing System that will build upon and grow from efforts initiated prior to and in the context of the International Polar Year (NRC 2006). Examples of such initiatives include the recent European Union Sixth Framework Integrative Project "Developing Arctic Modeling and Observing Capabilities for Long-Term Environmental Studies" (DAMOCLES), the U.S. interagency Study of Environmental Arctic Change (SEARCH) Program. Other related arctic observing efforts are those of the Arctic Net Networks of Centres of Excellence Canada, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), the Russian-American Long-Term Census of the Arctic (RUSALCA), and some of the activities of the International Union for Circumpolar Health (IUCH) to note just a few. Such existing platforms and programs form a solid foundation for collection of the observations required for ISAC. Over the long-term, the design of the Arctic Observing Systems should ultimately draw on the data generated through it, as well as from modeling activities and the needs for responding to change.

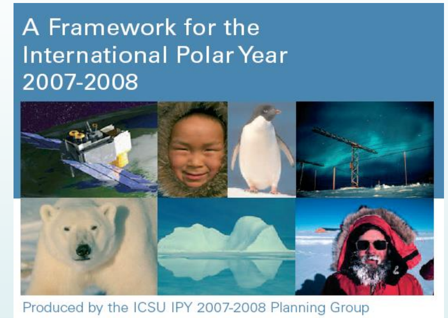
New efforts to enhance already existing observation activities and infrastructure that form the basis for the Arctic Observing System must be relevant to addressing ISAC questions about system-level arctic change. Such enhancements should focus on current gaps. There is a particular need for:

- better spatial coverage of the terrestrial sphere,
- improved efforts on the subarctic seasonal ice zones,
- more information on the marine biological system, including higher trophic levels,
- hypothesis targeted monitoring of biodiversity and ecosystem resilience
- focused efforts on paleodata collection,
- data collection for studies of the human dynamics relevant to arctic environmental change.

International collaboration in synthesis activities indicates that there are also gaps in observations of the atmospheric boundary-layer characteristics (SEARCH 2008), and of the broader features of the vertical structure of the atmosphere. Other observation needs with immediate global relevance include increased information on ice sheets, freshwater input to the Arctic

IPY 2007 – 2008



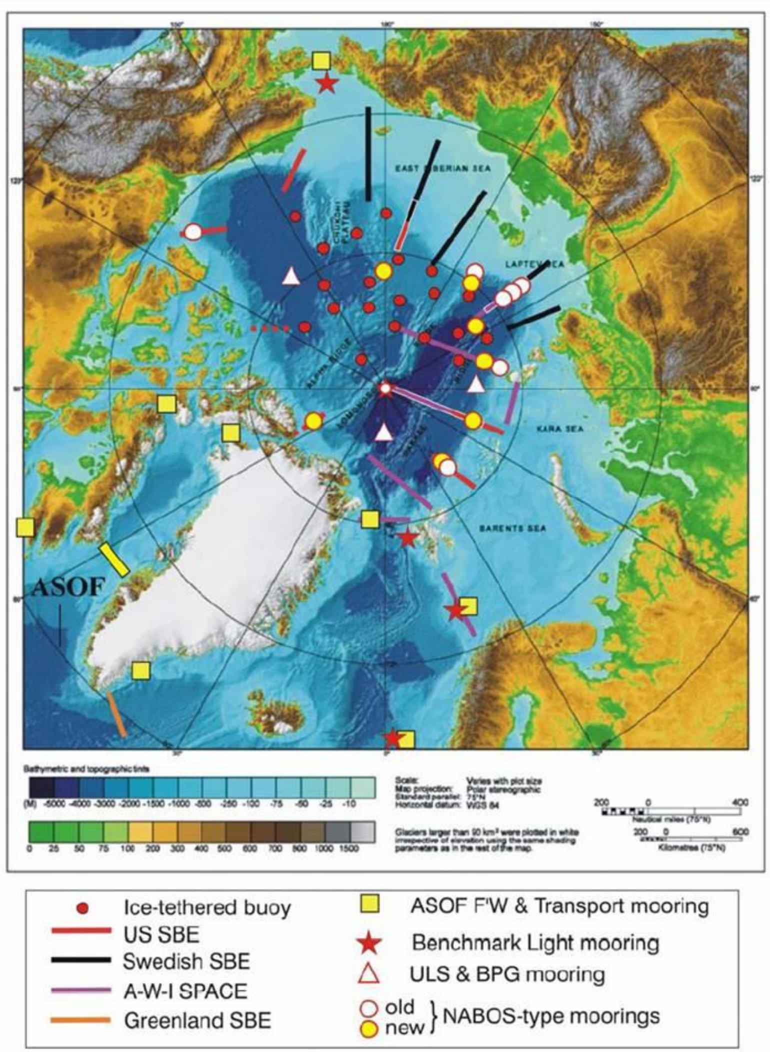


Scientific Challenges

IPY 2007-2008 is an opportunity to deepen our understanding of the physical, biological, and chemical processes in the polar regions and their global linkages and impacts, and to communicate these insights to the public. Five broad scientific challenges provide a framework for organizing IPY activities:

- Assessing large-scale environmental change in the polar regions, with questions looking at both the physical and human dimensions of change and its impacts.
- Conducting scientific exploration of "new" frontiers, whether these are once inaccessible places such as the seafloor, or areas of inquiry that are now open because of advances in technology, such as how the tools of genomics now allow exploration of previously unanswerable questions about biological adaptation.
- Observing the polar regions in depth, with adequate coverage of the vast and challenging landscape, to provide a description of current conditions and allow for better future understanding of variability and change.
- Understanding human-environmental dynamics in a region where the connections are intimate and where the impacts of change are clear.
- Creating new connections between science and the public, using these regions that are inherently intriguing.

IAOOS



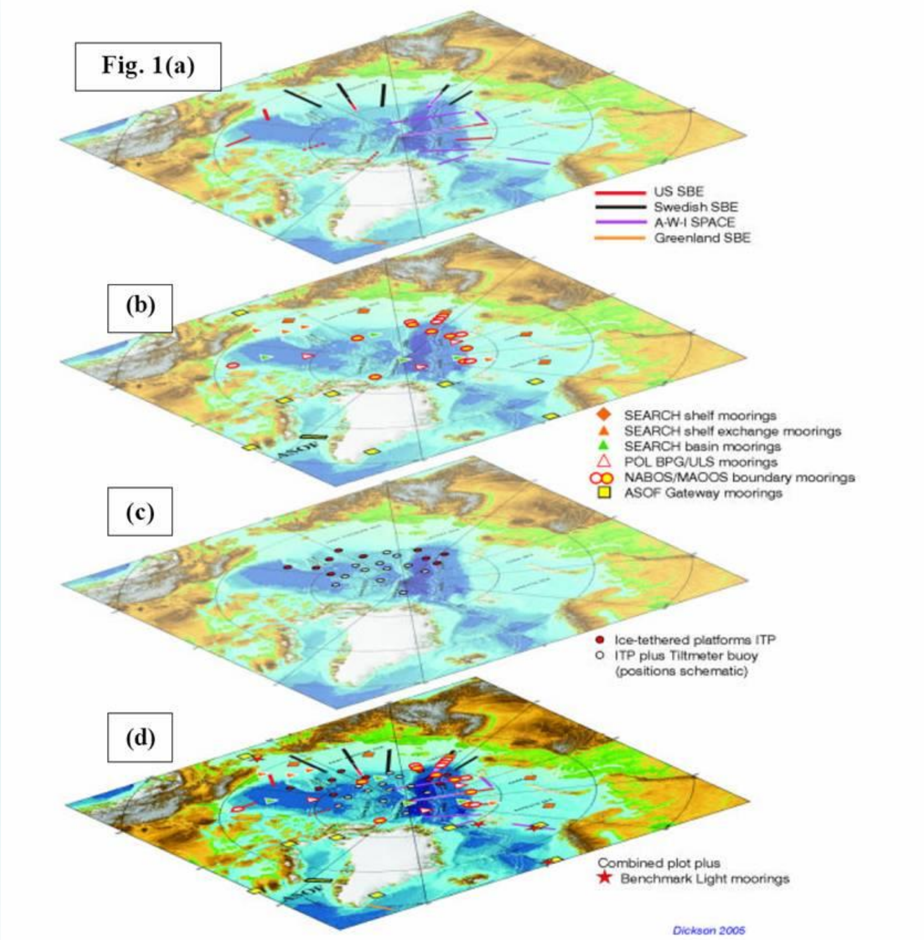
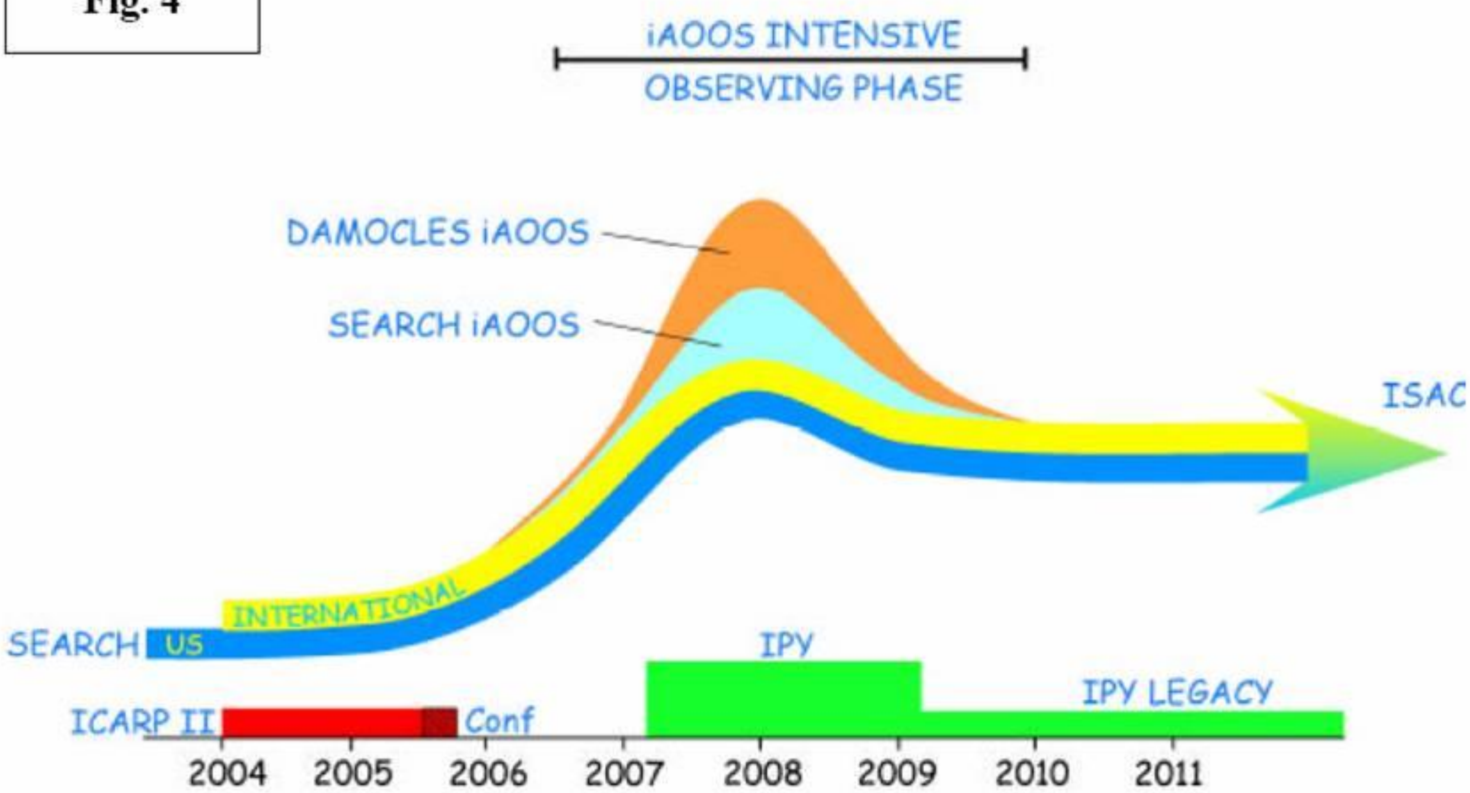


Figure 1. The elements of an integrated Arctic Ocean Observing System showing a) the ship-based Shelf Basin Exchange transects, b) the proposed mooring system for Shelf, Slope, Basin and Gateways c) grids of Ice-Tethered Platform and Tiltmeter Buoys (positions figurative) and d) the full combined deployment.

Dickson et al., 2006

IAOOS

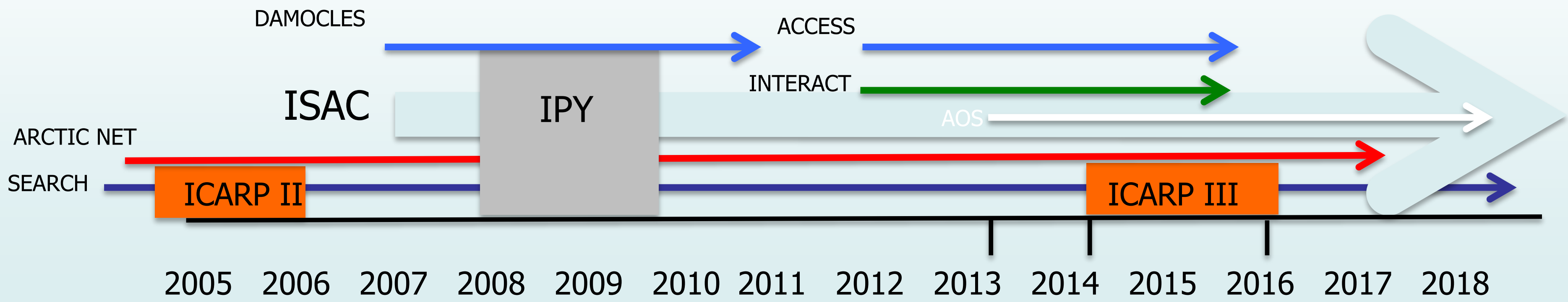
Fig. 4



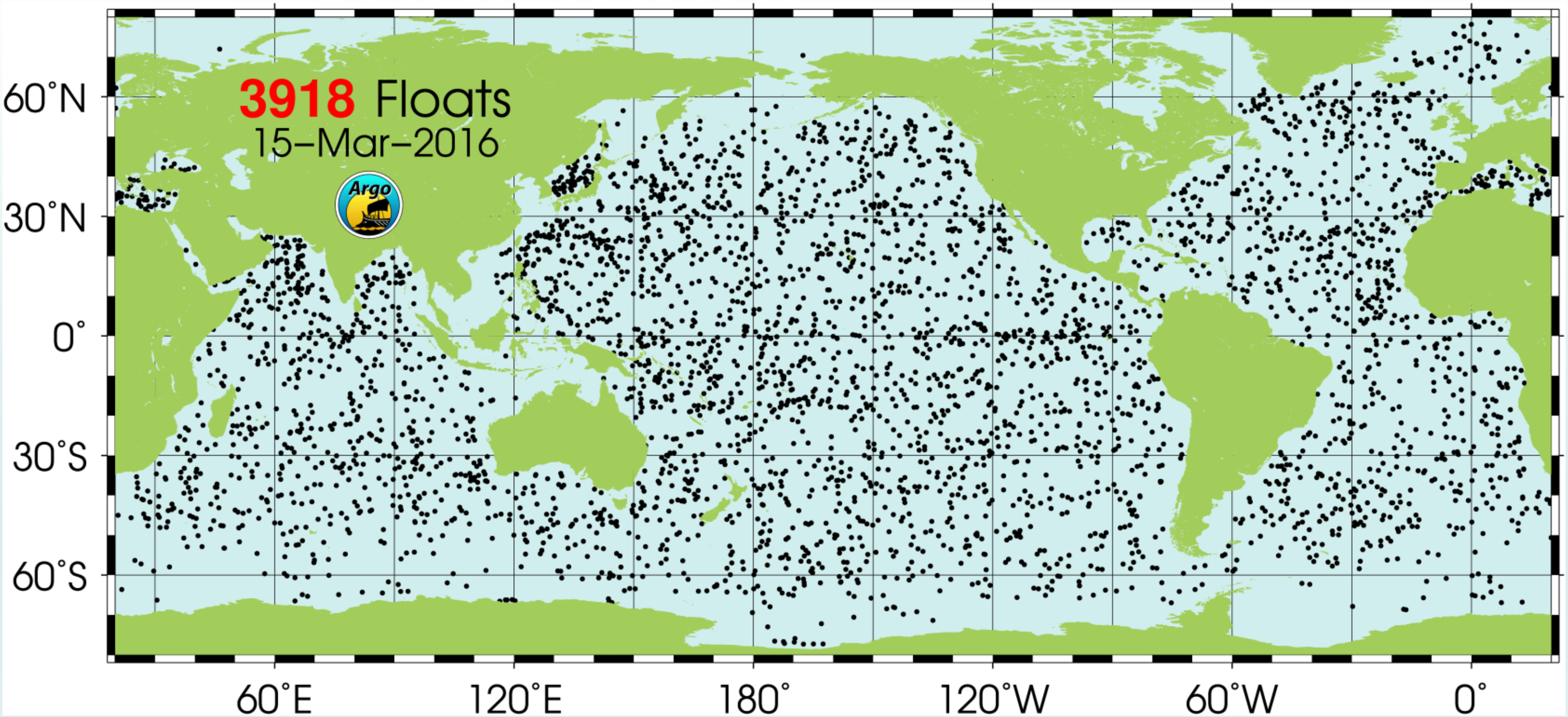
The integrated Arctic Ocean Observing System (iAOOS) in relation to ICARP, IPY and the multidecadal SEARCH and ISAC studies of Arctic change.

Dickson et al. 2006

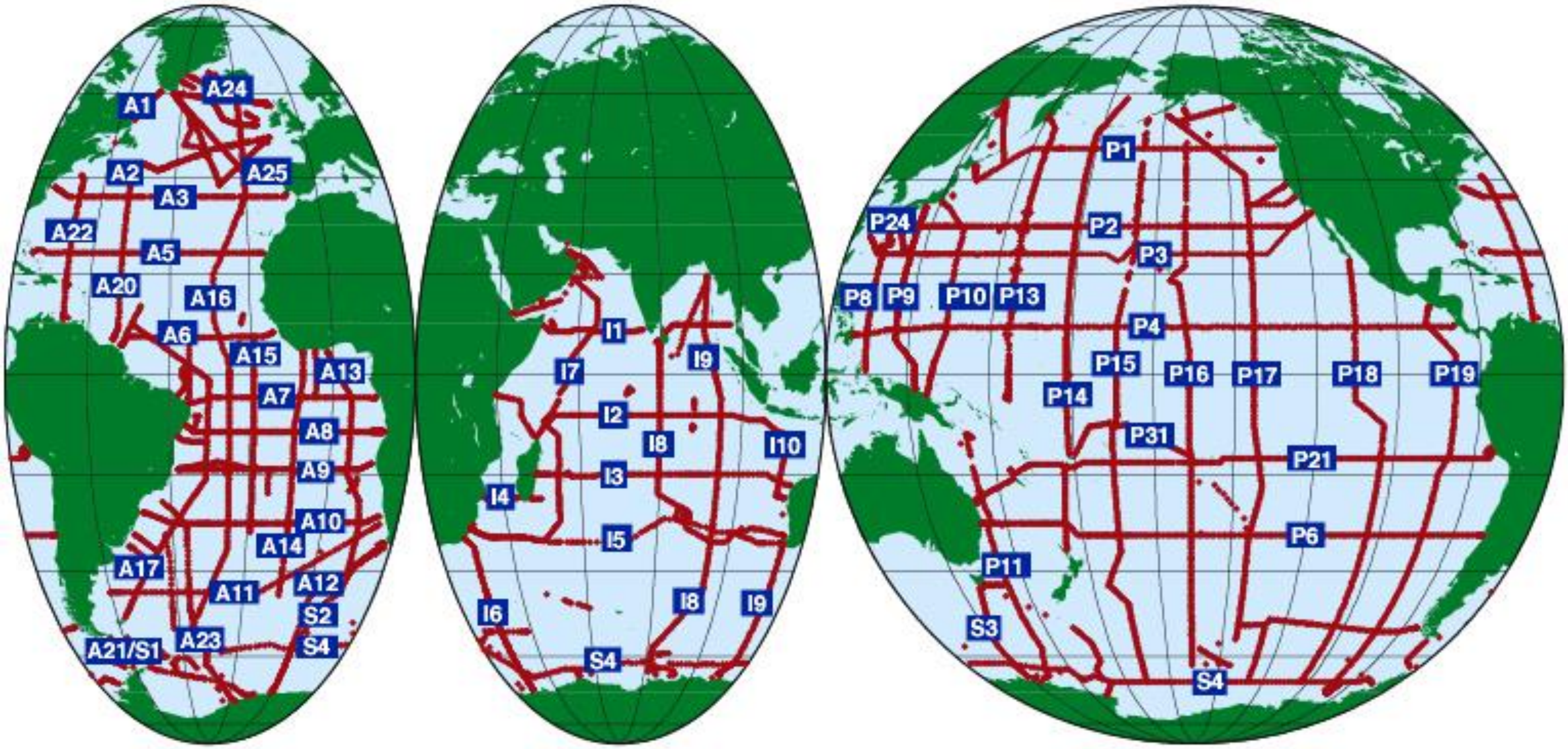
Long-Term Stability



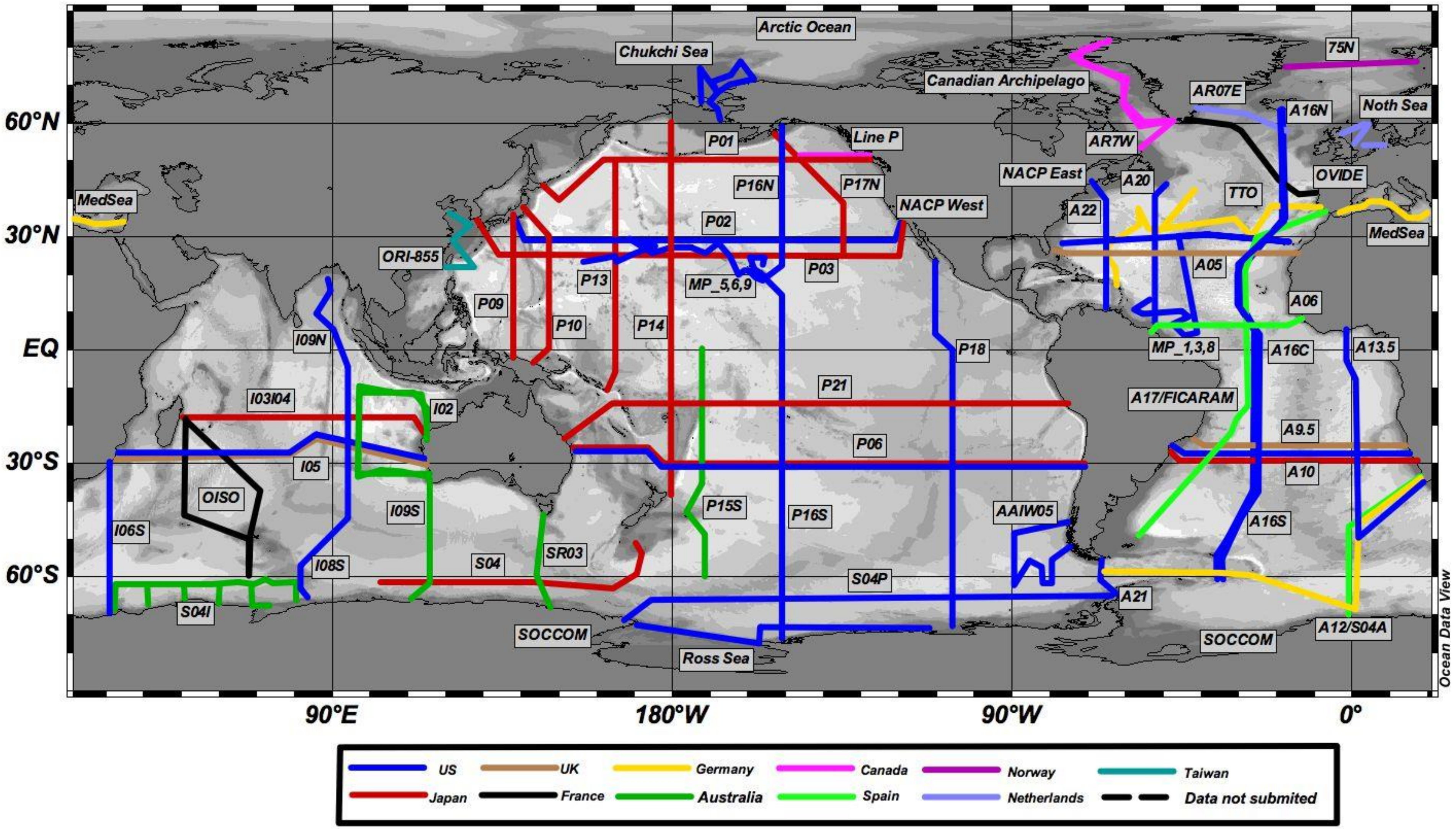
Global Float Array (ARGO)



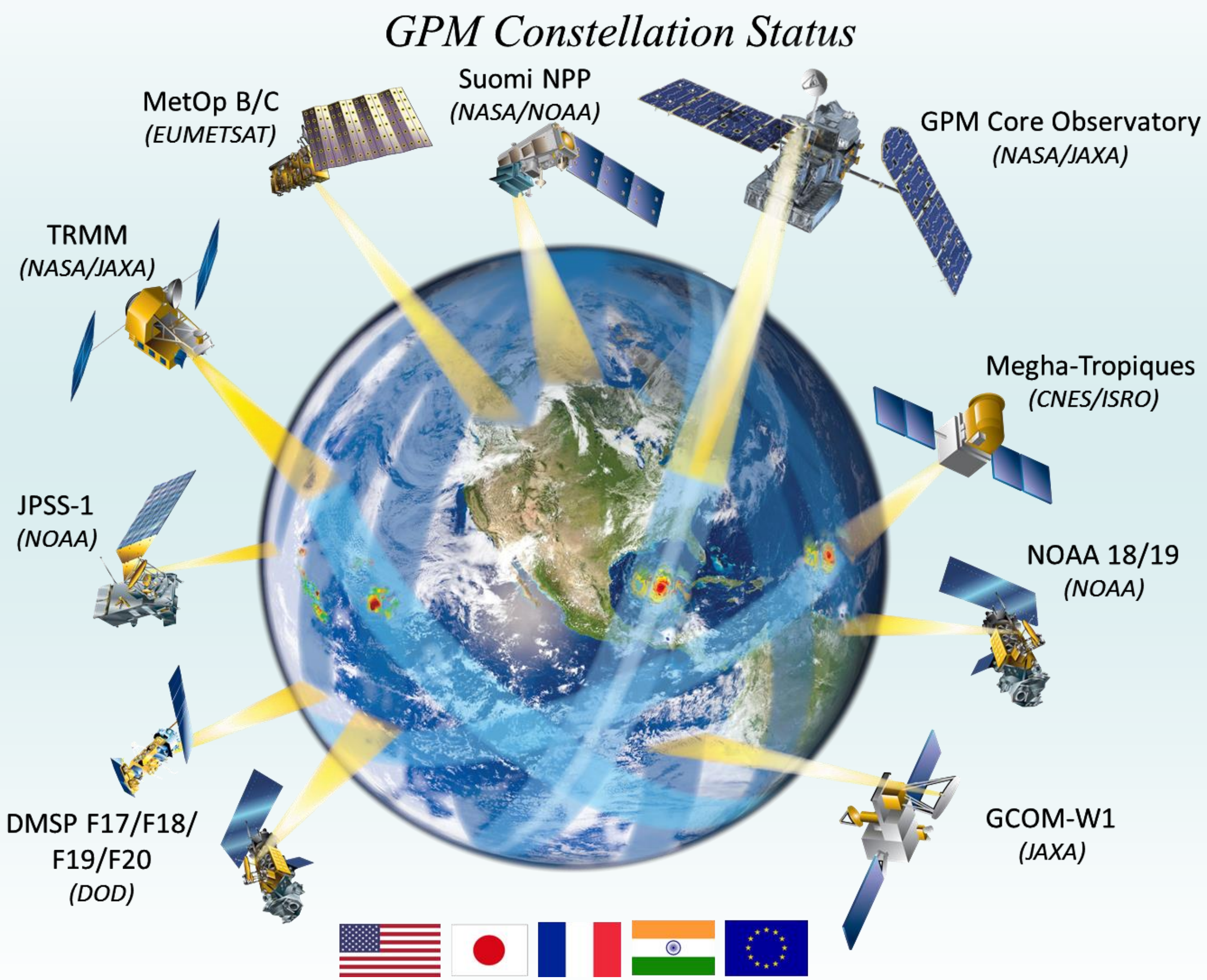
World Ocean Circulation Experiment



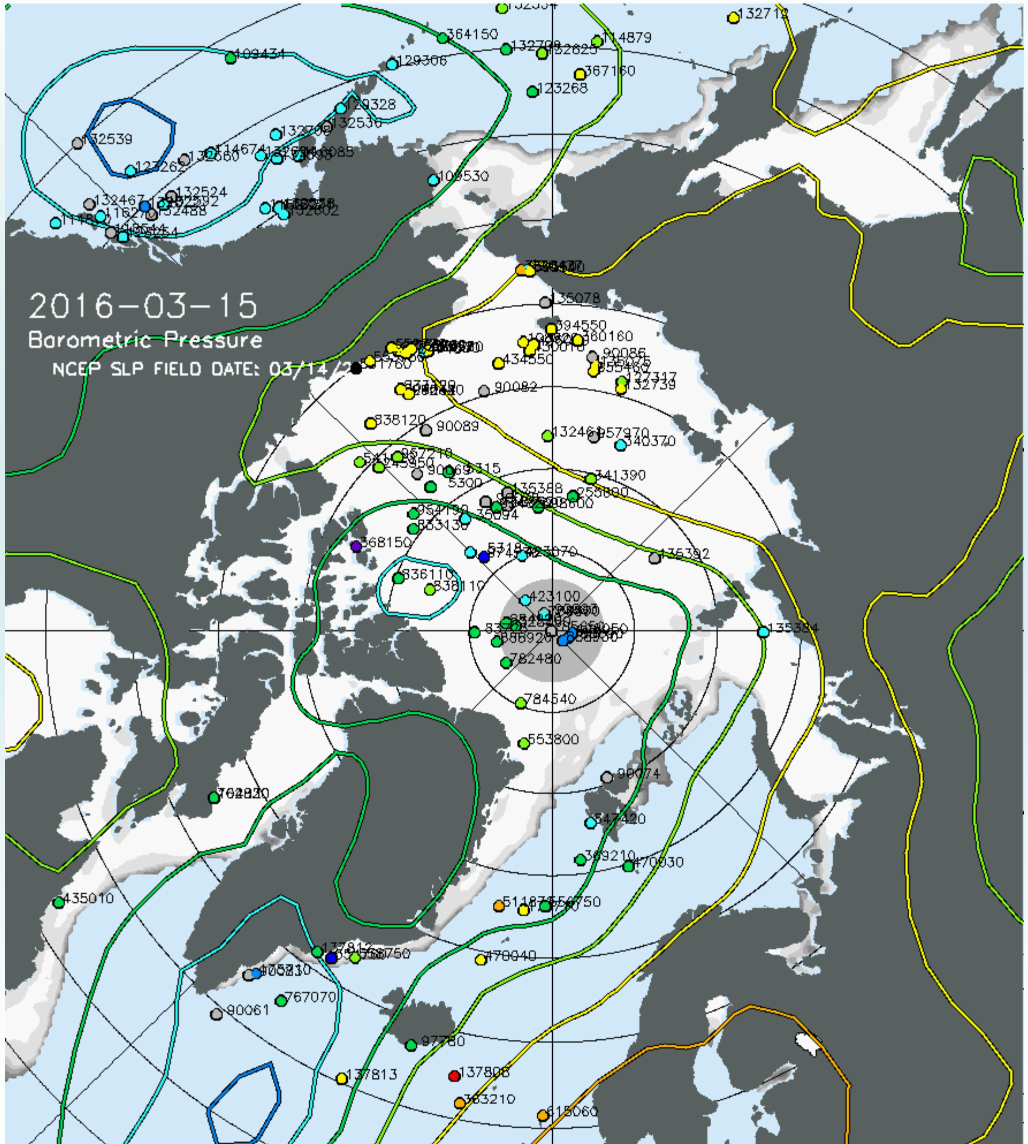
Global Repeat Hydrography



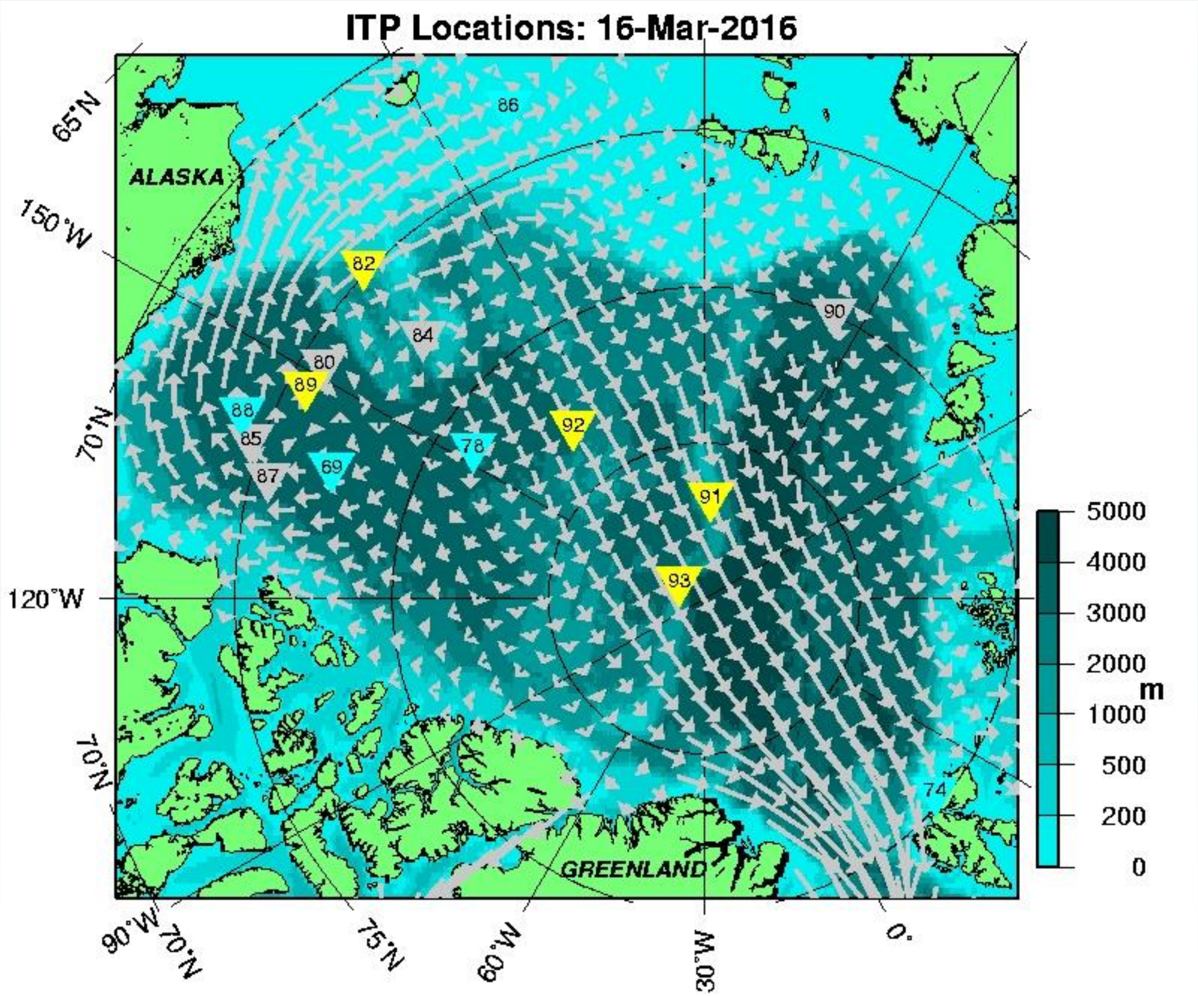
Remote Sensing



International Arctic Buoy Project

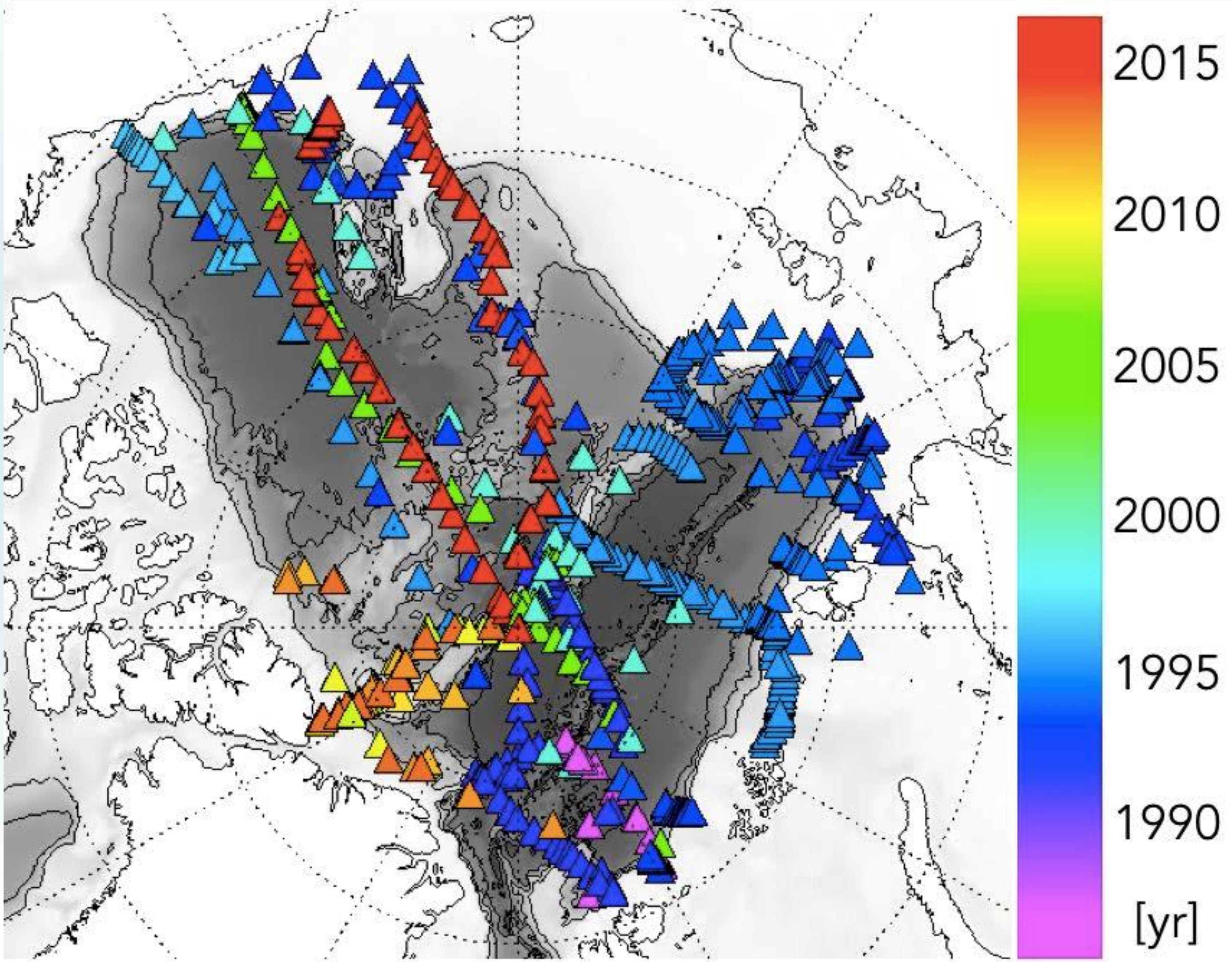


Ice Tethered Platforms

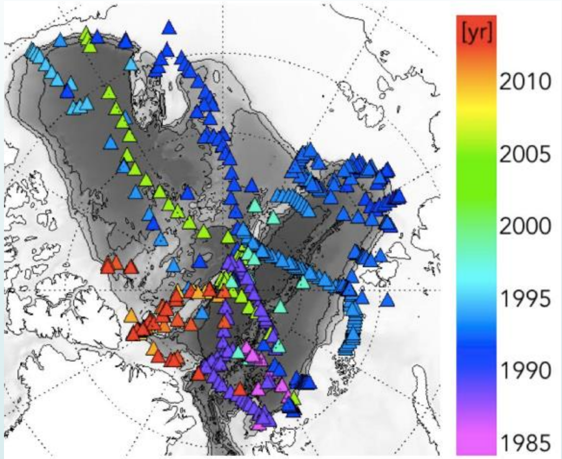


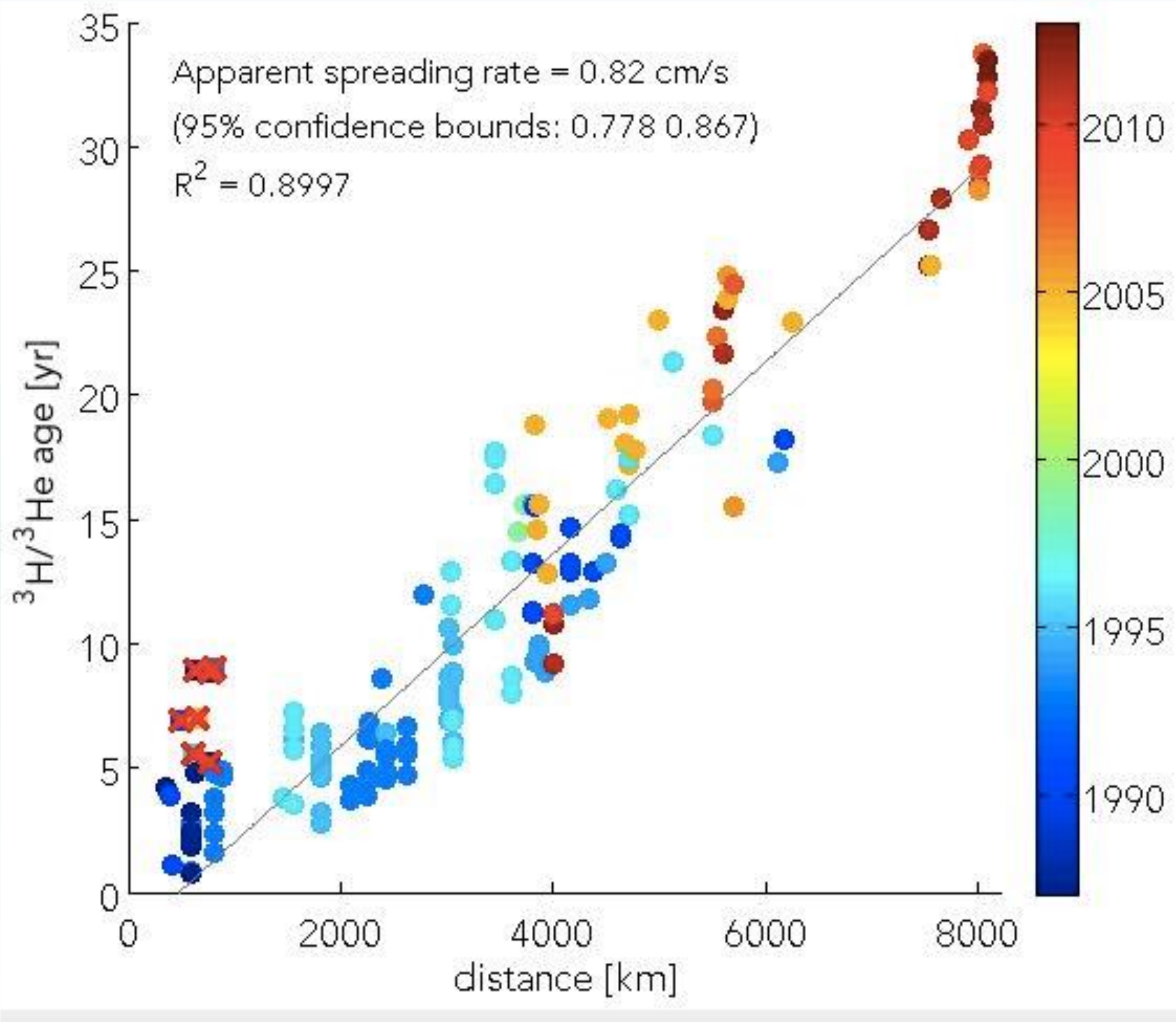
Hydrographic Sections

18 cruises
621 stations



Age Structure of AW

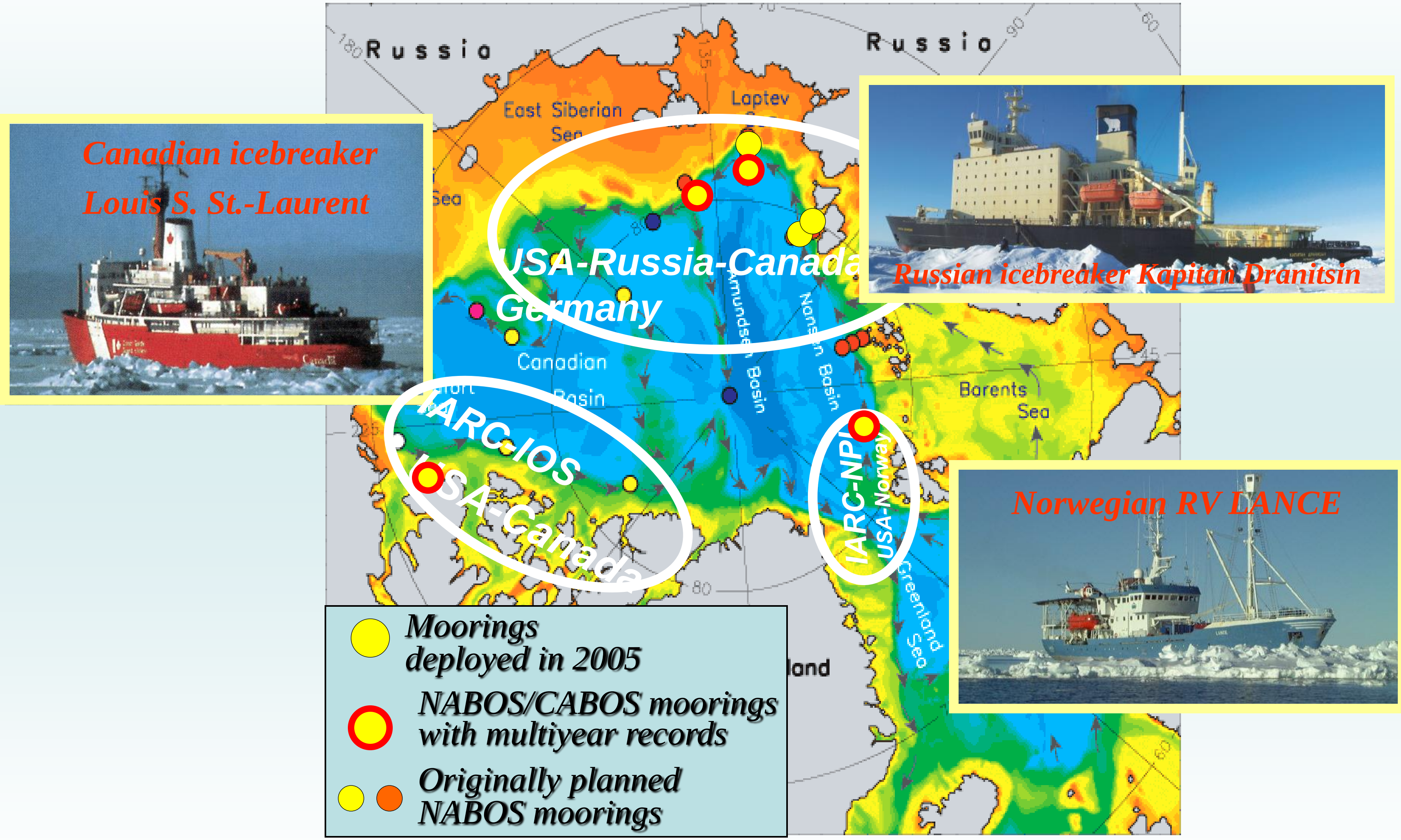




230 stations
ca. 1300 data points

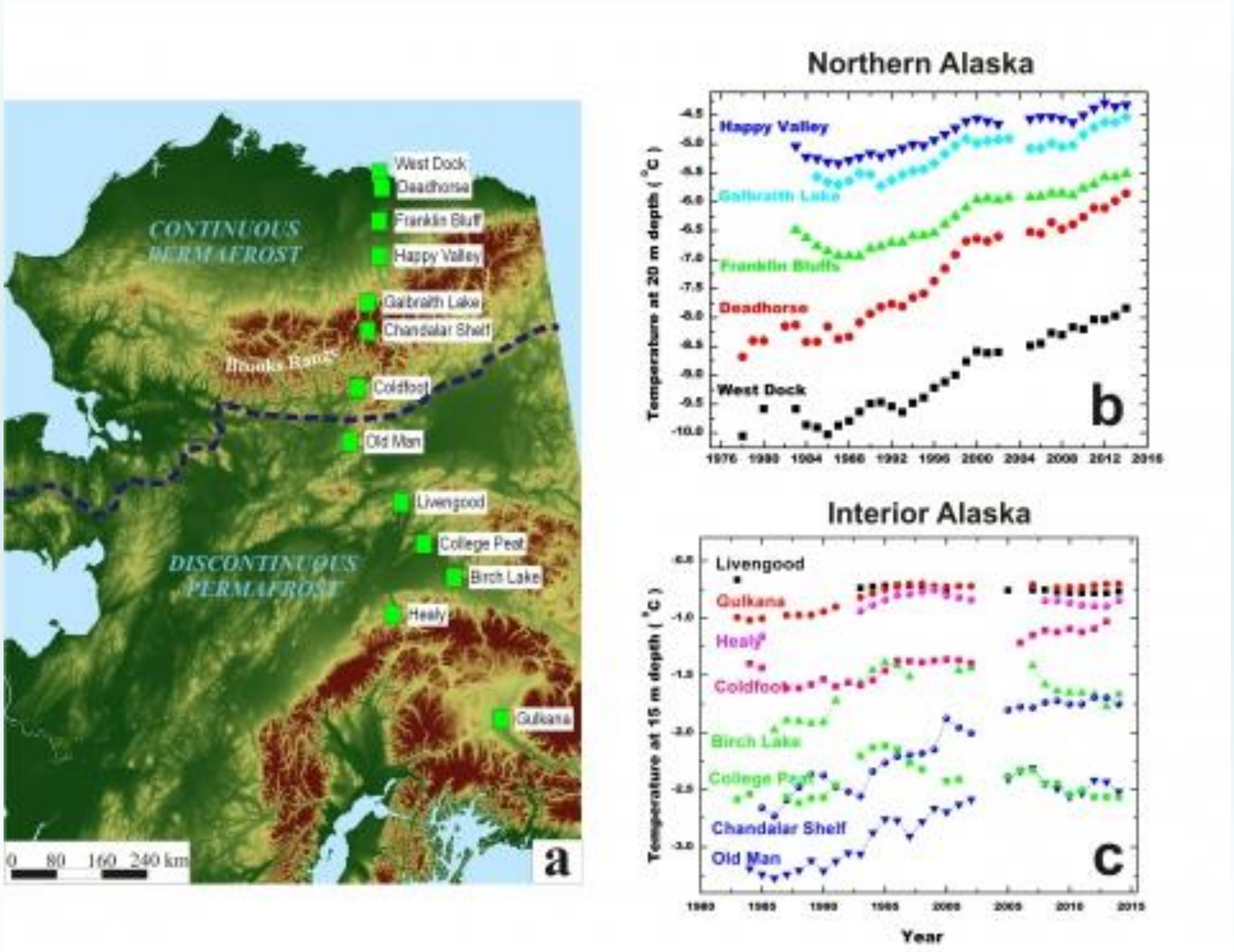
Pasqualini/Schlosser
Unpublished data

Multi-Ship Operations



NABOS program, Polyakov et al.; IARC

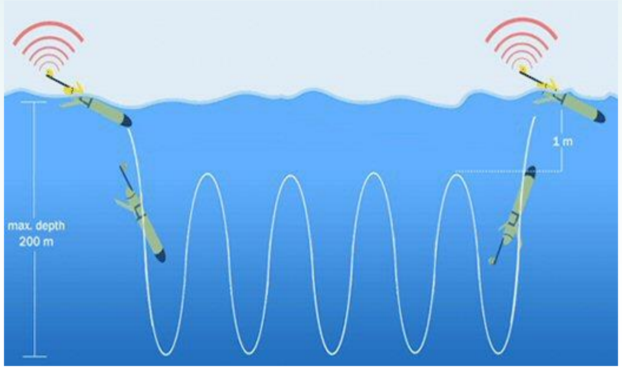
Permafrost



CONTINUOUS PERMAFROST
DISCONTINUOUS PERMAFROST
Brooks Range
West Dock
Deadhorse
Franklin Bluff
Happy Valley
Galbraith Lake
Chandalar Shelf
Coldfoot
Old Man
Livengood
College Peat
Birch Lake
Healy
Gulkana
0 80 160 240 km
a
Northern Alaska
Happy Valley
Galbraith Lake
Franklin Bluffs
Deadhorse
West Dock
Temperature at 20 m depth (°C)
b
Interior Alaska
Livengood
Gulkana
Healy
Coldfoot
Birch Lake
College Peat
Chandalar Shelf
Old Man
Temperature at 15 m depth (°C)
Year
c

Key role for new technology

- Reaching remote areas
- Operation under ice
- Continuous measurements
- Adjustable data collection patterns
- Real time data delivery
- Cost effective
- …



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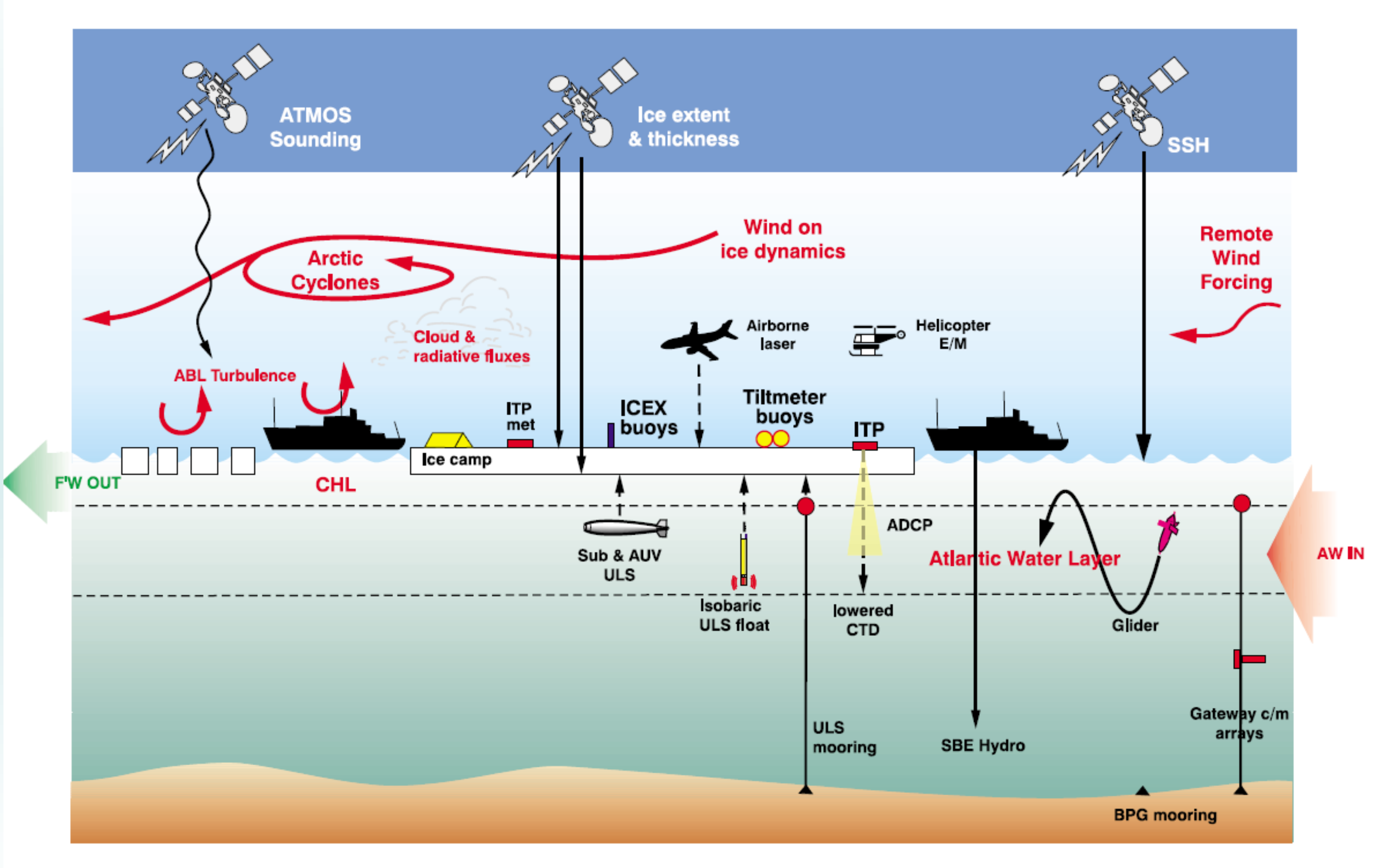
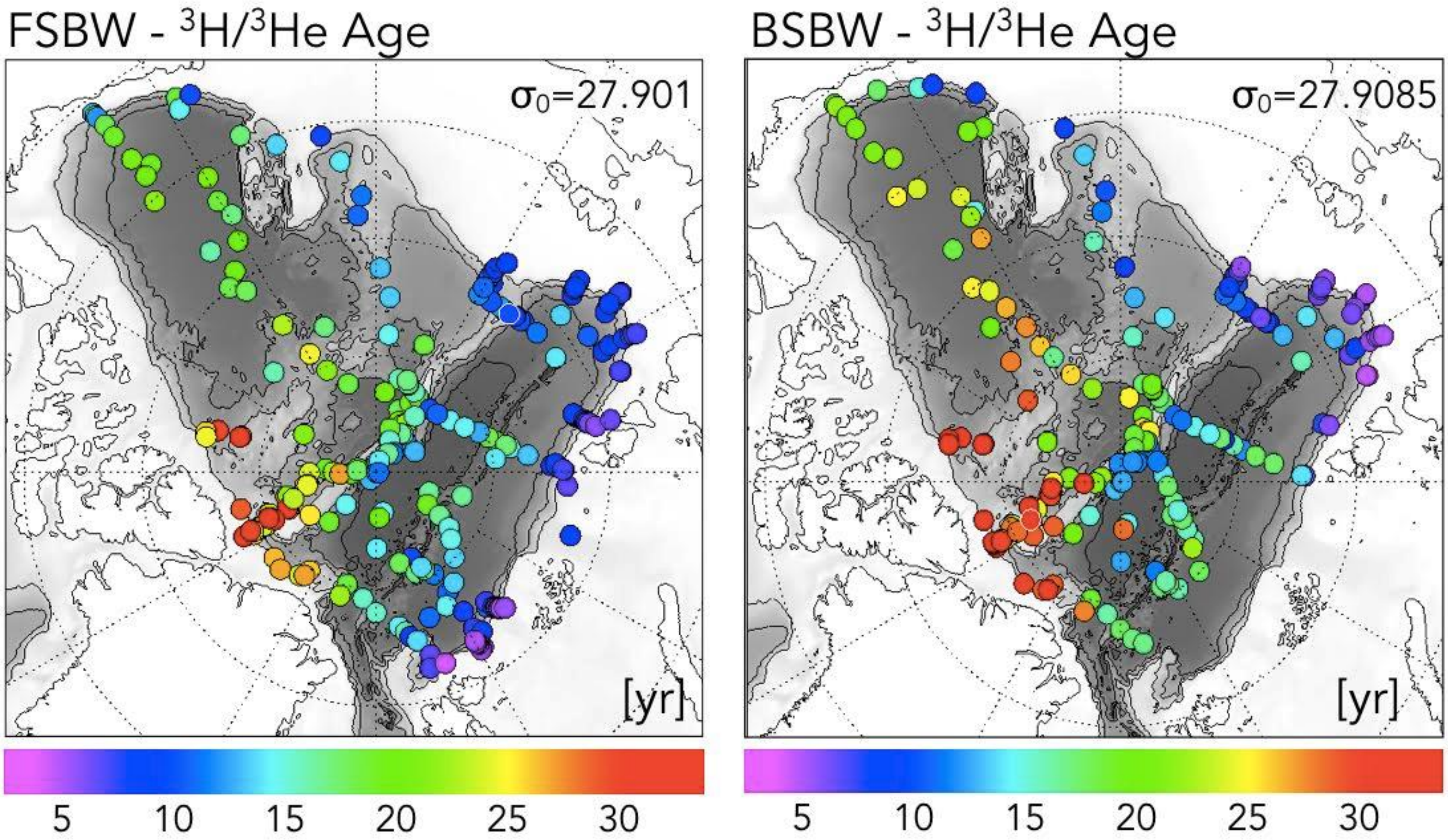


Dickson et al. 2006

Circulation Patterns



$27.866 \le \sigma_0 \le 27.936$
stations with age data: 230

$27.95 \le \sigma_0 \le 28.02$
stations with age data: 234

A 5°C Arctic in a 2°C World

CHALLENGES AND RECOMMENDATIONS FOR IMMEDIATE ACTION FROM THE JULY 21-22, 2016 WORKSHOP

Briefing Paper for Arctic Science Ministerial

September 20, 2016

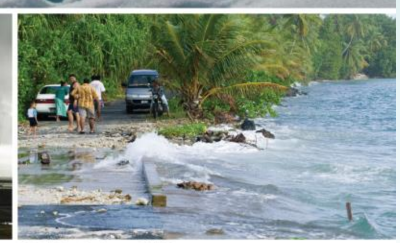
Staffan Widstrand / WWF

Global Warming Images / WWF

Alexander Evgrafov / WWF-Russia

Jürgen Freund / WWF

Global Warming Images / WWF



Global Warming Images / WWF

International Arctic Research Center, University of Alaska Fairbanks — IARC

MEOPAR — Marine Environmental Observation Prediction & Response Network

future ocean — Kiel Marine Sciences

POLAR PARTNERSHIP

Arctic Institute of North America 1945

5C2W Briefing Paper

(a) Enhance and support research in projecting which future states of the Arctic are possible in principle, under which conditions they can be reached, and which impact they would have.

(b) Design, initiate, and support a platform for a broad stakeholder dialogue on which future state of the Arctic we should strive for, drawing on existing local and regional platforms. The outcomes of the continuing dialogue have to inform decision-making processes in the context of the evolving Arctic trajectory.

(c) Expedite research on adaptation of the Arctic to ongoing and expected environmental changes and provide resources for implementation of science-based adaptation strategies.

(d) Ramp up technical and financial support for Arctic societies needing strategic adaptation solutions—including relocation and soft infrastructure support (building codes, zoning, and others).

(e) Complete and sustain the emerging Arctic Observing System, augmented by early warning components and enhanced Arctic system models to closely track key components of the changing Arctic.

(f) Unify the voices of the Arctic Nations and those global actors interested in the future of the Arctic in support of the science needed for immediate upscaling of efforts in global decarbonization and negative emissions schemes.

(g) Deploy measures for deep decarbonization of the global energy system and accelerate the upscaling and deployment of technologies for negative carbon emissions. Unify the efforts for allocating resources to master this historic challenge.