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Ocean Observations and Services
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**GOOS Major Accomplishments 2000-2010:**

1. **Global Climate Observations:** The ocean observing system for climate is 60% complete. Reporting to the UNFCCC (via GCOS) ensures high visibility. Ocean inputs into the development of a Global Framework for Climate Services is ensured. *Understanding of global climate change has been substantially enhanced.*

2. **Societal Benefits:** Relevant components of the GOOS are increasingly available in real time, enabling coastal inundation warnings (storm surges, tsunami). Regional seasonal products derived from ocean observations are also starting to become possible (eg ENSO, Monsoon, drought, flooding and fire regime forecasts)

3. **Standard Setting:** TEOS-10 Equation of State Adopted.
Recent and Upcoming Publications
Initial Global Ocean Observing System for Climate
Designed for detection and attribution. Reporting to UNFCCC.

Milestones
Surface Driters 2005
Argo Floats 2007
VOSClim 2007

System % complete

Original goal: Full implementation in 2010
Why monitor the Arctic Ocean?

Services to society from a sustained ocean observing system
The Arctic is experiencing rapid environmental and social change

*In the last few months:*

- The third lowest sea ice extent on record.
- The first commercial supertanker navigates the Northern Sea Route.
- Cairn Energy strikes oil off Greenland.
- Inuit protests block oil exploration in Lancaster Sound, Canada.
- Tens of thousands of walrus come to shore in mainland Alaska due to a lack of sea ice.
- Russia reiterates its claim to the Lomonosov Ridge.
The Arctic is changing fast and under-sampled.

Environmental, social and economic impacts are substantial.

Report of the SAON-IG, 2009

Alverson, EOS, 2008

Sustained Arctic Observation: A Legacy of the Polar Year
The Arctic is a significant gap in the Global Ocean Observing System.

An Arctic Ocean observing system must be created... ...and sustained.
The Argo network has achieved its initial design target. Sustaining the network remains a major challenge.
Observing networks 100% - Argo network density
Realtime tidegauge data underpin the climate record and regional coastal services ...
Evolution of the GLOSS tide gauge network 1999-2009
Evolution of the GLOSS tide gauge network 1999-2009
Sustaining the system

• The observing system must provide distinct services to society.
• The number of potential users for an observing system is growing:
  – Conservation and natural resource management
  – Shipping
  – Global climate science
  – Indigenous peoples
  – Industry and economic development
  – Other: Military?
Conservation and natural resource management

• One of the most pristine ecosystems on Earth.
• Iconic species such as polar bear, walrus, narwhal.
• Economically important fish stocks.
• Tourism.
• Food security and culture of coastal indigenous peoples.
• Carbon regulation.
• Nutrient transformation.
Conservation and natural resource management

Ocean observing services:

• Monitoring species numbers and distributions.
• Monitoring contaminants in the ocean and the food chain.
• Monitoring commercial fish stocks, and the impacts of commercial fishing.
• Seasonal monitoring of ocean acidity and carbon.
• Baseline data and monitoring of protected areas.
Salmon Fishing
Climate Feedback on Ocean Acidification

• Globally water saturated by >300%, considered suitable for coral growth, vanishes by 2070.
• Aragonite undersaturation <100% is projected to occur in the Arctic within a decade.
• Climate change (sea ice retreat and freshening) amplifies the decrease in Arctic saturation and pH by >20%

Biological Response to Recent Pacific Area Sea Ice Retreats
To detect, measure, and track the combined effects of changing oceanographic conditions on the ecosystem, scientific approaches need to be holistic, integrating measurements of basic oceanographic variables with data on species and trophic level interactions, from primary producers to marine mammals.

Grebmeier et al, EOS 91:18 2010
Shipping

- Shipping in the Arctic includes commercial ships, tourist cruises, research ships, coastguard ice breakers and fishing fleets.
- Commercial vessels carry goods for arctic communities and industry.
- Northwest Passage and Northern Sea Routes predicted to open.
- Ships are both vulnerable and a potential hazard.
Shipping

Ocean observing services:

• Reports on weather and sea state.
• Reports on ice cover, thickness and movement.
• Mapping and monitoring currents through the sea routes.
• Information for port design, construction and operation.
• Monitoring the impacts of shipping.
• Coordination of research ships.
Global Climate Science

- The Arctic Ocean is a key indicator and driver of global climate change.
- 75% of ice volume and mass has been lost in last 30 years.
- Major role in the Earth’s ocean circulation system.
- Positive feedback mechanisms in the region’s atmospheric and oceanic dynamics enhance climate change at global scales.
- Contribution to sea level rise, particularly through the melting of Greenland’s ice cap.
Ocean observing services:

- Monitoring the extent of arctic sea ice.
- Monitoring the velocity and direction of ocean currents, and the temperature and salinity of sea water.
- Monitoring methane release from permafrost in the arctic sea bed.
- Monitoring arctic sea levels.
- Monitoring the impact of sea temperature on glacier dynamics.
climate change is amplified in the Arctic ...
Indigenous peoples

- 4 million people live in the Arctic, about one-third are indigenous peoples.
- Many live on the coast, and depend on the ocean for food and transportation.
- They are resilient and adaptable, and are actively responding to change.
- Indigenous knowledge systems can provide important information.
- They should be active partners in research and monitoring processes.
- Special attention is needed to adapt research activities and communication strategies to indigenous needs.
Indigenous peoples

Ocean observing services:

• Weather and ice reports.
• Ecosystem monitoring.
• Prediction and monitoring of storm events for village erosion and inundation.
• Protection of Arctic cultural heritage.
• Community-based monitoring programmes.
Coastal Communities
Industry and economic development

• The Arctic holds an estimated 90 billion barrels of undiscovered oil reserves.
• Approximately 84% occur in offshore areas.
• The Arctic will remain hostile for industrial operations.
• Oil spill clean-up would be hampered by ice, storms and seasonal inaccessibility.
• An oil spill in cold biologically inactive waters would take many years to biodegrade.
• Deepwater Horizon disaster showed the importance of a robust ocean observing system.
Industry and economic development

Ocean observing services:

• Assessing the implications and monitoring impacts of oil and gas extraction (inc. cumulative impacts).

• Forecasts and real-time information on sea state, ice and weather for construction, operation and spill response.

• Development of infrastructure that can withstand sea ice movement.

• Developing clean-up strategies for oil spills.
Adaptation strategies and Sustainable Development in the Arctic will require observing systems are maintained within the context of a broad interdisciplinary approach, tapping UNESCO’s strengths in Science, Culture, Education and Natural and Cultural World Heritage.
Conclusion

• There is a clear need for a sustained Arctic Ocean observing system.
• By providing services to user groups the observing system will become central to efforts to adapt to climate change in the Arctic.
• Adaptation is fundamentally a social issue.

This is an interdisciplinary activity.