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**Climate Change  
and Arctic Sustainable Development :  
scientific, social, cultural and educational  
challenges**

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## **ABSTRACT: OCEANS, ICE AND ATMOSPHERE**

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### **Observatories for understanding Arctic change**

The Arctic Ocean is probably the least explored ocean basin in the world. Rapid changes in the extent, thickness and characteristics of the sea ice cover are already occurring. The ventilation of the deep ocean, surface gas exchange, ocean circulation and physical conditions for marine life are expected to change with changes in the ice cover. The Arctic and sub-Arctic region will be the first to experience ocean acidification in deep waters as well as surface waters. Several recent analyses suggest that a state change has occurred in response to atmospheric forcing. A return to ice-ocean conditions of previous decades may be unlikely even if accounting for responses to natural variability in atmospheric forcing.

Recent measurements and process studies allow improved understanding of vertical mixing in the Arctic Ocean and the role of ocean heat and sea ice melt water in the future evolution of the ice cover. However process understanding is still limiting our ability to make future projections. Complexities not only in the ocean circulation and ice-ocean interaction but also concerning the stable atmospheric boundary layer are not well described. In order to remedy this situation and provide a basis for development of improved global climate models, there is a need for dedicated observatories which not only monitor the evolution over time and produce consistent data sets but also allow in-depth studies of the interacting media.

### **Recommendations:**

- Establish Arctic ocean-ice-atmosphere observatories which combine long-term reference measurements of core variables and ground truth for satellite observations with excellent working conditions for in-depth studies of geophysical and biogeochemical processes.
- Integrate long term observatories with satellite data and assimilation in models through regional mechanisms which are tightly linked to global

counterparts, like the Arctic Regional Ocean Observing System (Arctic ROOS), a component of the Global Ocean Observing System and GEOSS.

- Integrate studies of the present day physical climate system processes with studies of the past climate evolution and with biogeochemistry emphasising urgent topics like ocean acidification and seafloor gas exchange.