New developments in our observational capabilities present an unprecedented opportunity to make significant progress towards an integrated ability to address scientific issues of both the ocean and ice components of the Arctic Ocean system. In the coming decade, data from gravity satellites (GRACE and GOCE), and polar-orbiting altimeters (e.g., Envisat, IceSat, and upcoming CrySat-2, ICESat-2, and SWOT) will provide basin-scale fields of gravity and surface elevation. Together with an optimally designed in-situ hydrographic observation network, these data sets will have the potential to significantly advance our understanding of the ice-ocean circulation, interaction and mass variations of the Arctic Ocean. Recent work has demonstrated the combined use of GRACE and bottom pressure recorder (BPR) data for understanding the Arctic circulation, and the use of high precision altimeters for documenting recent decline in sea ice thickness. We describe several topics of particular interest in the use of in-situ observations in the top 200 m within 200 km of the Pole are also shown.

**Satellite altimetry (sea/ice surface height) Mean Dynamic Topography**

Comparison of modeled mean dynamic topography (MOT) with that derived from satellite altimetry. (Top) MOT from PIPS (left) and MOCOM (right) for the period 1995-2003 (PIPS average is for March only). Unit: cm. (Bottom) Low-pass filtered MOT from remote sensing. MOT from MSS with AncGP geoid (left) and EIGEN-GL4C (right). Unit: cm.

**Hydrographic sampling network**

Sampling Array to complement spaceborne observations

Moorings (left) and mooring, tide gauge and bottom pressure recorder (BPR) approximate locations to provide in-situ sustained observations in the Arctic Ocean to complement and validate space-borne measurements of ice thickness and sea surface heights in the Arctic Ocean.

Ideally, a network designed to systematically monitor sea level and ocean circulation should be guided by an objective strategy. For example, a set of Observing System Simulation Experiments (OSSE) could be employed to identify optimal in-situ observing site locations required measurement accuracy and frequency, and acceptable levels of uncertainty. The long-term goal of the combined Arctic in-situ and satellite monitoring system should address the need for sufficient data to validate Arctic SCMs so as to provide the interpolation of subsurface changes in the Arctic between the necessarily sparse elements of the in-situ arrays.

**Conclusions**

Results from current work that combines satellite and in-situ observations illustrate that significant improvements in our understanding of the Arctic Ocean are about to be realized with existing and forthcoming satellite data sets. Furthermore, the use of these data sets in conjunction with a well-designed in-situ hydrographic sampling network— with judiciously deployed ocean instrument technologies—would ensure the most accurate quantification of the sea level, circulation and mass changes of the Arctic Ocean. Together, a new observational network that includes satellite remote sensing, in-situ data acquisition, and ice-ocean components considered in companion white papers (Breivik et al., 2009; Calder et al., 2009; Lee et al., 2009), will undoubtedly contribute to a new understanding of the Arctic Ocean and its impact on global climate.

Breivik et al., Remote sensing of sea ice, OceanObs’09 Venice, Italy, 21-25 September 2009.


Lee et al., Autonomous platforms in the Arctic Ocean, OceanObs’10 Venice, Italy, 21-25 September 2009.


Lee et al., Remote sensing of sea ice, OceanObs’09 Venice, Italy, 21-25 September 2009.

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