Geophysical Research Abstracts
Vol. 17, EGU2015-453-2, 2015
EGU General Assembly 2015

Sea ice, erosion, and vulnerability of Arctic coasts

Katherine Barnhart (1,2), Irina Overeem (1), Jennifer Kay (3,4), Robert Anderson (1,2)

(1) Institute for Arctic and Alpine Research, University of Colorado at Boulder, Boulder, United States (katy.barnhart@gmail.com), (2) Department of Geological Sciences, University of Colorado at Boulder, Boulder, United States, (3) Department of Atmospheric and Oceanic Sciences, University of Colorado at Boulder, Boulder, United States, (4) Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder, Boulder, United States

Coasts form the dynamic interface between the terrestrial and oceanic systems. In the Arctic, and in much of the world, the coast is a zone of relatively high population, infrastructure, biodiversity, and ecosystem services. A significant difference between Arctic and temperate coasts is the presence of sea ice. Sea ice influences Arctic coasts in two main ways: (1) the length of the sea ice-free season controls the length of time over which nearshore water can interact with the land, and (2) the location of the sea ice edge controls the fetch over which storm winds can blow over open water, resulting in changes in nearshore water level and wave field. The resulting nearshore hydrodynamic environment impacts all aspects of the coastal system.

We first combine satellite records of sea ice with a simple model for wind-driven storm surge and waves to estimate how changes in the length and character of the sea ice-free season have impacted the nearshore hydrodynamic environment along Alaska's Beaufort Sea Coast for the period 1979-2012. This region has experienced some of the greatest changes in both sea ice cover and coastal erosion rates in the Arctic and is anticipated to experience significant change in the future. The median length of the 2012 open-water season along this stretch of coast, in comparison to 1979, expanded by 1.9 x. At the same time, coastal erosion rates increased from 8.7 m yr^{-1} to 19 m yr^{-1}. At Drew Point, winds from the northwest result in increased water levels at the coast and control the process of submarine notch incision, the rate-limiting step of coastal retreat. When open-water conditions exist, the distance to the sea ice edge exerts control on the water level and wave field through its control on fetch. We find that the extreme values of water-level setup at Drew Point have increased consistently with increasing fetch.

We then extend our analysis of the length of the open water season to the entire Arctic using both satellite-based observations and global coupled climate model output from the Community Earth System Model Large Ensemble (CESM-LE) project. This model ensemble uses a 1-degree version of the CESM-CAM5, historical forcing for the period 1920-2005 and RCP 8.5 forcing from 2005-2100. It has 30 ensemble members that differ only by round-off differences in their initial atmospheric states. Complementing the transient ensemble members, a control model run with constant pre-industrial (1850) forcing characterizes internal variability in a constant climate. The CESM-LE model simulations are well suited to constrain the uncertainty in Arctic ocean properties due to internal climate variability. Finally, we compare observations and model results to identify locations of observed and expected rapid sea ice change. Based on satellite observations, the median length of the 2012 open-water season expanded by between 1.5 and 3-fold relative to 1979 by Arctic Sea region. This allows for open water during the stormy Arctic fall. CESM-LE results indicate that the duration of open water continues to increase into the future under the RCP 8.5 scenario, with some areas experiencing a shift to less inter-annual variability in the length of the open water season.