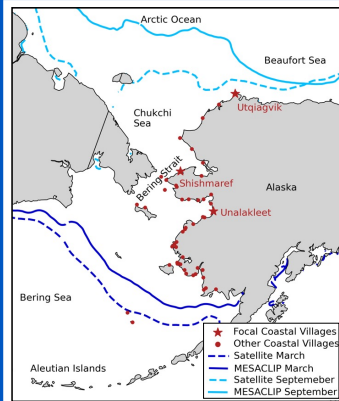


USING MESACLIP TO INVESTIGATE COMMUNITY RELEVANT CHANGES IN THE BERING STRAIT REGION, ALASKA



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Motivation

The RVCC Alaska hub is working with communities in the Bering Strait region of Alaska. Our community partners' deep knowledge of their region and concerns have helped us identify priority research areas. Changes to sea ice, storms, and erosion are major threats to traditional ways of living that our partners have raised.

Here, we show results from work using the high resolution MESACLIP ensemble to investigate localized environmental change in the Bering Strait Region relevant for community planning and subsistence activity safety.

Figure 1: Bering Strait Region including our partner communities (Focal Coastal Villages) and other coastal villages. We also show the historical (1979-2020) average March (dark blue) and September (light blue) sea ice edge from MESACLIP and satellite observations.

Trend in Sea-Ice Season Duration (days/yr) (1979-2024)

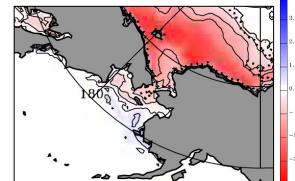


Figure 2: Satellite observed trend in sea ice season duration from 1979-2024. Red indicates less sea ice coverage over the year. Figure: Sharon Stammerjohn.

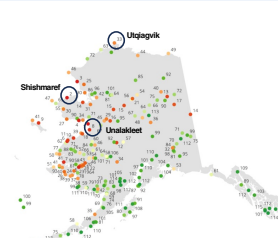


Figure 3: Ranking (numerical with reds highest and greens lowest) of Alaskan Communities at greatest overall risk of flooding, erosion, and permafrost thaw as identified in the Statewide Threat Assessment prepared for the Denali Commission (2019).

Funding

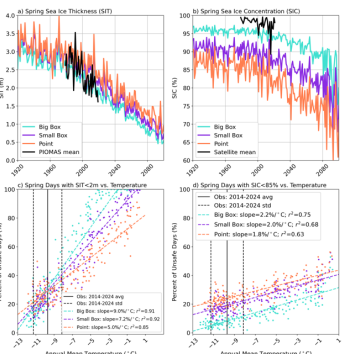
The National Center for Atmospheric Research is a major facility sponsored by the National Science Foundation (NSF) under cooperative agreement 1852977. Rising Voices, Changing Coasts (RVCC) Hub is a coastal research project that brings together university-trained scientists and traditional knowledge-holders to study the interactions between natural, human-built, and social systems in coastal populated environments. RVCC is supported through the NSF Coastlines and People (CoPe) program award #2103843.

Subsistence Hunting

Many Alaskan communities rely on subsistence hunting to meet food needs. In Utqiagvik, Spring (Apr./May) whaling activities depend on stable, shore-fast sea ice to camp on, launch boats from, and land harvested whales for processing.



Figure 4: Whaling camp on sea ice. Photo from Alaska Eskimo Whaling Commission



Sea ice thinning rates depend on resolution, with a standard grid size reaching unsafe thicknesses (SIT < 2m) almost 2x earlier than a high resolution grid cell. Potentially unsafe sea ice concentrations (SIC < 85%) do not have the same resolution dependent response.

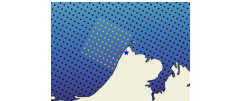


Figure 5: MESACLIP mean springtime a) sea ice thickness (SIT) and b) concentration (SIC), and Annual mean temperature vs. annual whaling day frequency based on c) SIC, and d) SIT. We show values near Utqiagvik for the single grid cell (red), small box average (orange), and large box (-1°) average (yellow) from the MESACLIP ice/ocean grid near Utqiagvik.

Erosion



Figure 8: Erosion in Shishmaref. Photo from New York Times

Coastal villages are vulnerable to coastal erosion from large ocean waves. Erosion is generally worse in Autumn (Sept./Oct./Nov./Dec.) when sea ice has not yet frozen to provide a protective barrier. This problem is becoming worse due to a longer ice-free season. Recent major flooding and episodic erosion events have caused damage, and in 2016 Shishmaref residents voted to relocate due to this threat.

Erosion models developed with data from Drew Point, Alaska along the Beaufort Sea for ice-free conditions require wave height and period, water temperature, and presence/absence of sea ice.

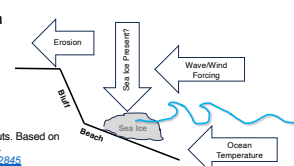


Figure 9: Schematic of Erosion Model Inputs. Based on data from Barnhart et al. 2014. <https://doi.org/10.1002/2013.JE002845>

Flooding

Autumn (Sept./Oct./Nov./Dec.) storms with southwesterly winds cause large storm surges and dramatic flooding for Bering Strait Region communities, including Unalakleet. Compound hazards occur when storm surge is combined with high precipitation rates or high tides.

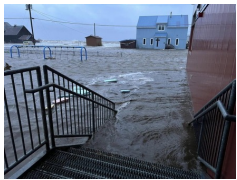
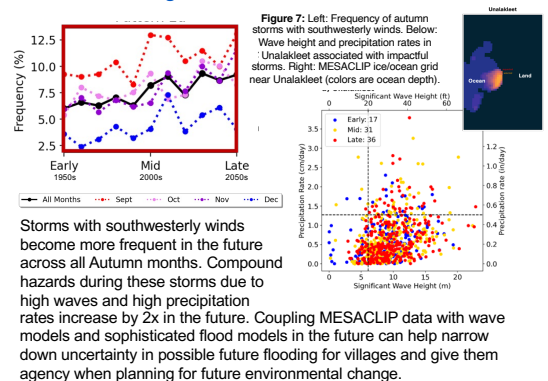
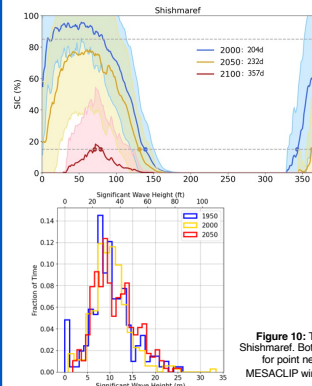


Figure 6: Flooding in Golovin (near Unalakleet). Photo from Alaska Public Media



Storms with southwesterly winds become more frequent in the future across all Autumn months. Compound hazards during these storms due to high waves and high precipitation rates increase by 2x in the future. Coupling MESACLIP data with wave models and sophisticated flood models in the future can help narrow down uncertainty in possible future flooding for villages and give them agency when planning for future environmental change.



During Autumn months, we use empirical methods to relate wind speed and ocean waves and attenuate waves when there is sea ice present. We find that the average wave heights tend to be larger in later decades, partly due to the lack of sea ice to damp waves. Coupling MESACLIP with sophisticated wave and erosion models in the future can provide projections the communities can use to plan for projected change.

Figure 10: Top: Sea ice season near Shishmaref. Bottom: Significant wave height for point nearest Shishmaref using MESACLIP winds and sea ice conditions.