Development of Climate Change Model Layers: Downscaling for Alaska’s Coastal Seas

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Project objectives

• Deliver (to AOOS database) high-resolution spatial fields of temperature, precipitation and wind for the Alaskan coastal and offshore regions

• Develop downscaled future scenarios for 21\textsuperscript{st}-century timeslices

• Address the potential impacts of these changes in the context of a changing sea ice cover

Relevant to ongoing and future changes in

-- marine ecosystems
-- marine navigation
-- coastal vulnerability (flooding, erosion)
Projections based on global climate models

- A set of 20+ models are compared with data (1958-2000) for surface air temperature, sea level pressure, and precipitation.

- Root-mean-square error (RMSE) evaluated over seasonal cycle to select the best-performing models for Alaska.

- These models provide future scenarios: A2, A1B, B2, RCP’s,…

- Downscale coarse-resolution model output to fine resolution.
Two downscaling methods

• Delta method:
  -- future changes from global models (coarse resolution) are added to high-resolution present-day climatology
  -- removes model biases
  -- used with monthly or seasonal averages
  -- SNAP has implemented this method for Alaskan land areas (temperature, precipitation, pressure)

• Bias-Correction Spatial Disaggregation (BCSD)
  -- each quantile of model-derived distribution is given an adjustment which is difference between model-simulated quantile value and corresponding value from observed distribution for recent decades
  -- can be used with daily values
  -- enables capture of changes in entire distribution, including extremes
Projected Change - Average Annual Temperature

Projected Increase: degrees F
High : 8.3
Low : 3.7

Projected increase calculated from difference between baseline temperatures (1961-1990 annual average) and modeled future temperatures (2051-2060 annual average). Five general circulation climate models selected for their optimized fit to the Arctic.


NOTES: IPCC AR4 Emissions Scenario A1B; Five GCM composite; Average of 1961-1990 is baseline.
PRISM July $T_{\text{max}}$ (1961-1990)
(deep red = 70s °F, blue = 40s °F)
January Temperatures

1961-1990 (PRISM climatology)  2070-2090 (ECHAM5)

- Temperature (°F)

-20  -4  +12  +28  +44

January
1961-1990 climatology

January
2070-2090 ECHAM5
Temperature projections for Point Hope

[from SNAP – Scenarios Network for Alaska Planning]
Precipitation projections for Kenai

[from SNAP – Scenarios Network for Alaska Planning]

Historical and Projected Average Monthly Precipitation for Kenai

Mid-range emissions (A1B)

This graph shows average values from projections from five global models used by the Intergovernmental Panel on Climate Change. Due to variability in a natural climate system, such graphs are useful for examining trends over time. For more information on SNAP, including derivation, reliability, and variability, visit www.snap.uaf.edu. For information regarding the affects of climate change in Alaska, visit the Alaska Cooperative Extension Service at http://www.uaf.edu/ces/
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Quantile mapping used in BCSD downscaling approach
What is new in this STAMP subproject?

• Extension to offshore region (+ coastal station sites)

• Extension to daily data and model output → extreme events

• Downscaling of winds (storm events)

• New generation of global climate models (CMIP5)

• Availability of sea ice database to enable assessment of changes in occurrence of coastal flooding/erosion events
Domain of North American Regional Reanalysis
Progress to date

• Evaluation and selection of global modes

• Retrieval of model and NARR output + station data

• Testing of BCSD downscaling algorithms for extreme events (wind events)