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

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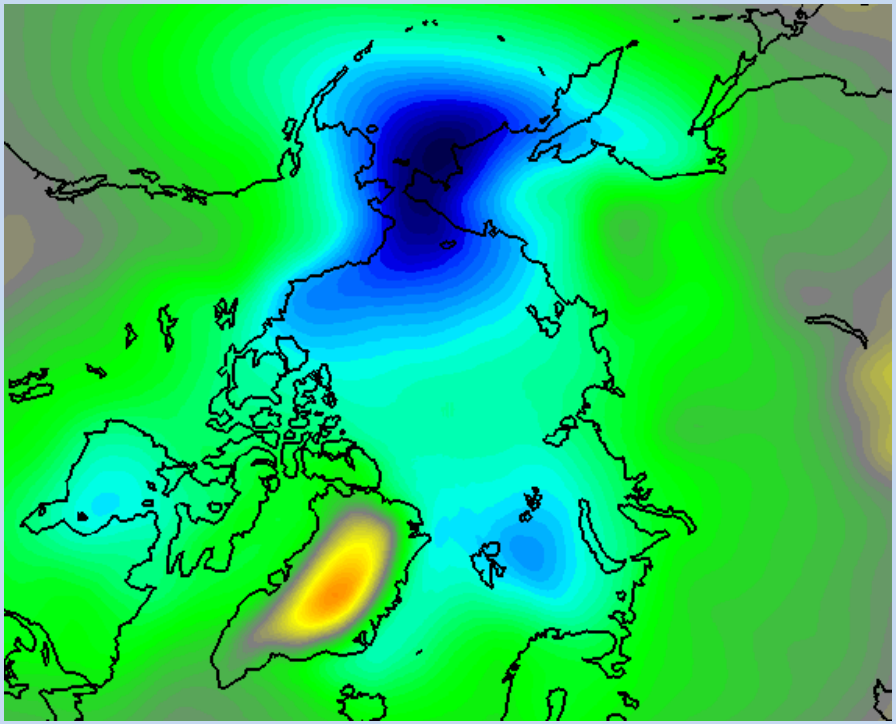


STAMP presentation, 6 April 2012

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 21st-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

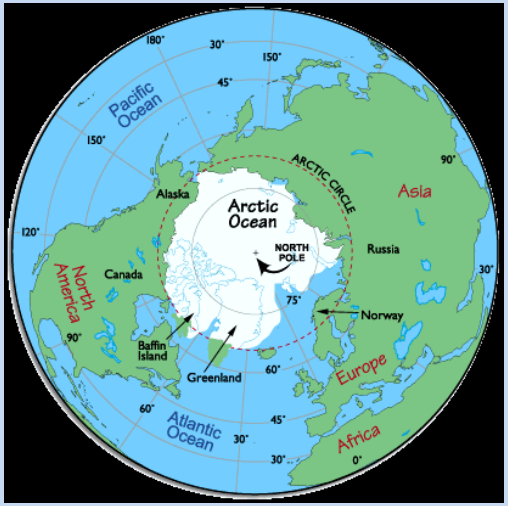
-- marine navigation

-- 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**

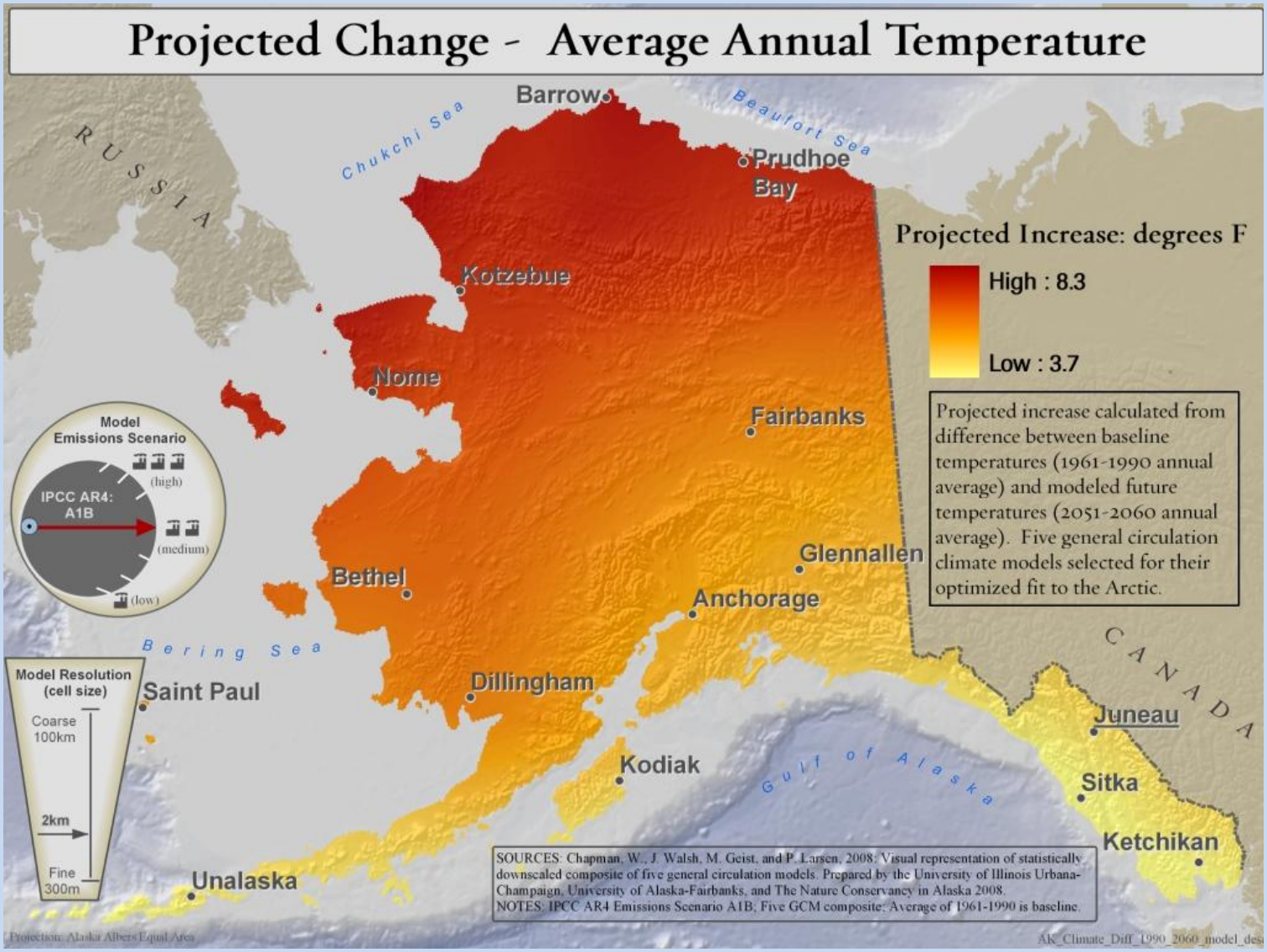
Two downscaling methods

- **Delta method:**

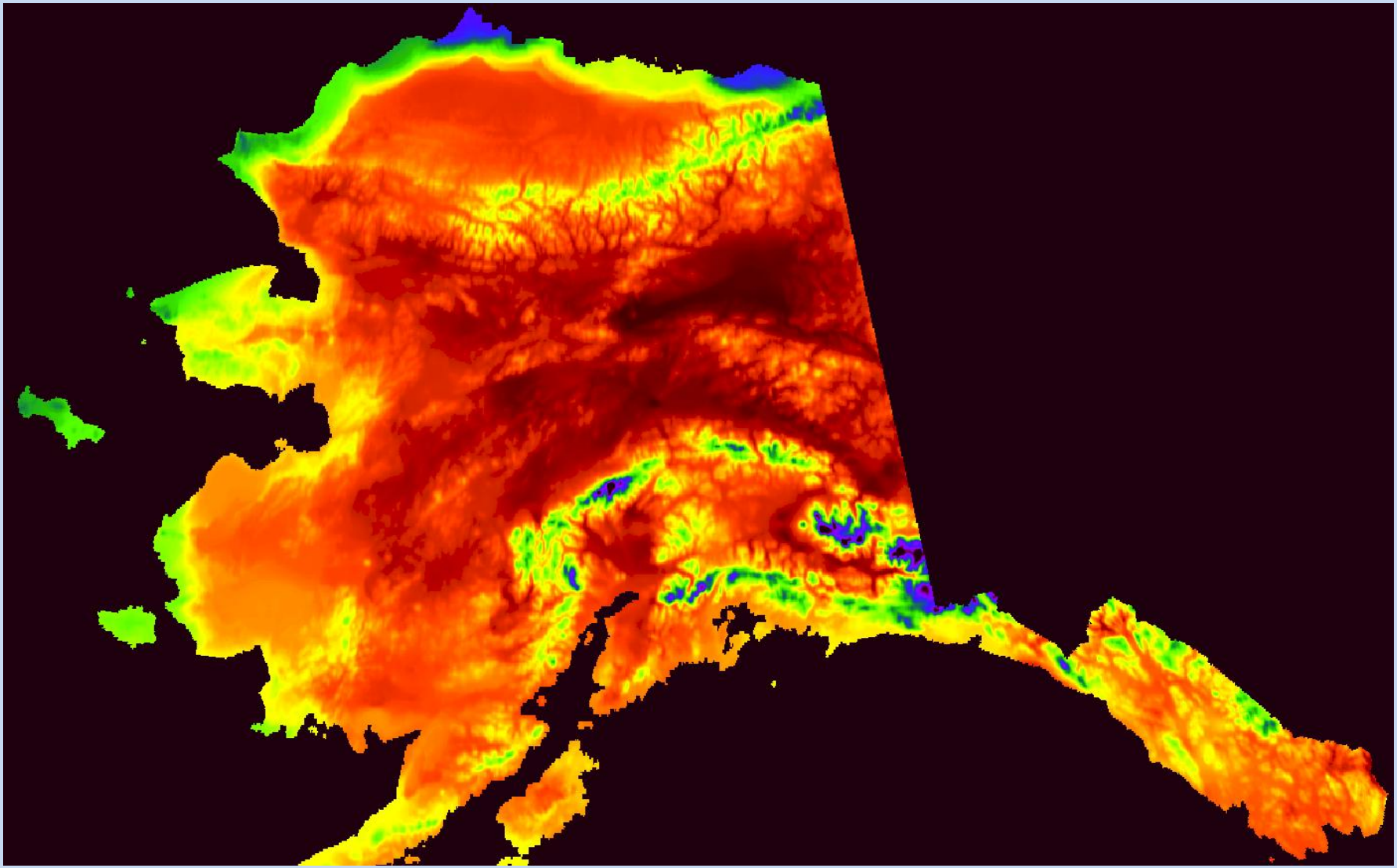
  -- future changes from global models (coarse resolution) are added to high-resolution present-day climatology
  -- removes model biases
  -- used with monthly or seasonal averages
  -- SNAP has implemented this method for Alaskan land areas (temperature, precipitation, pressure)

- **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
Barrow
Chukchi Sea
Beaufort Sea
Prudhoe Bay
RUSSIA
Kotzebue
Nome
Fairbanks
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.
Model Emissions Scenario
(high)
IPCC AR4: A1B
(medium)
(low)
Glennallen
Bethel
Anchorage
Bering Sea
CANADA
Model Resolution (cell size)
Coarse 100km
2km
Fine 300m
Saint Paul
Dillingham
Juneau
Kodiak
Gulf of Alaska
Sitka
Ketchikan
Unalaska
SOURCES: Chapman, W., J. Walsh, M. Geist, and P. Larsen. 2008. Visual representation of statistically downscaled composite of five general circulation models. Prepared by the University of Illinois Urbana-Champaign, University of Alaska-Fairbanks, and The Nature Conservancy in Alaska 2008.
NOTES: IPCC AR4 Emissions Scenario A1B, Five GCM composite. Average of 1961-1990 is baseline.
Projection: Alaska Albers Equal Area
AK_Climate_Diff_1990_2060_model_des

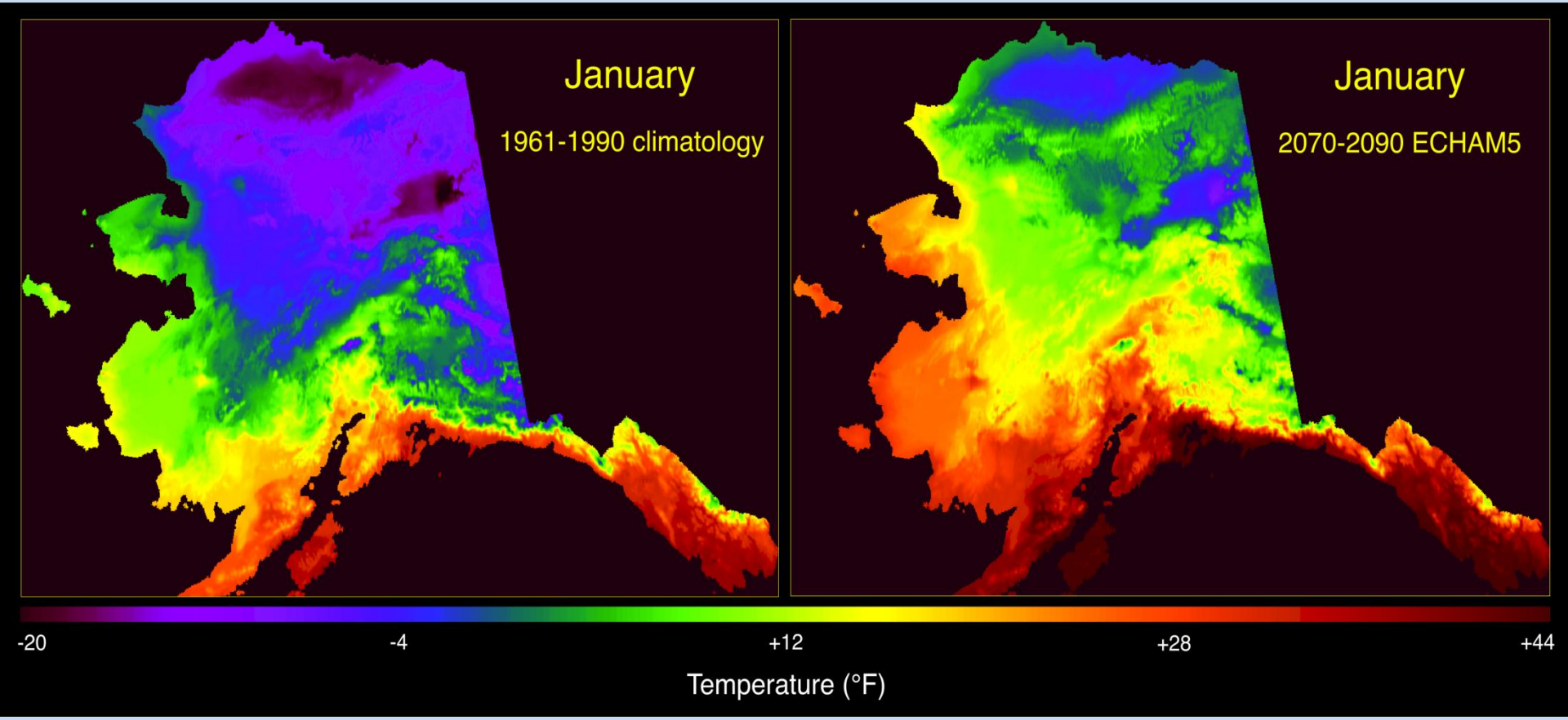
PRISM July T_{max} (1961-1990)
(deep red = 70s °F, blue = 40s °F)



January Temperatures

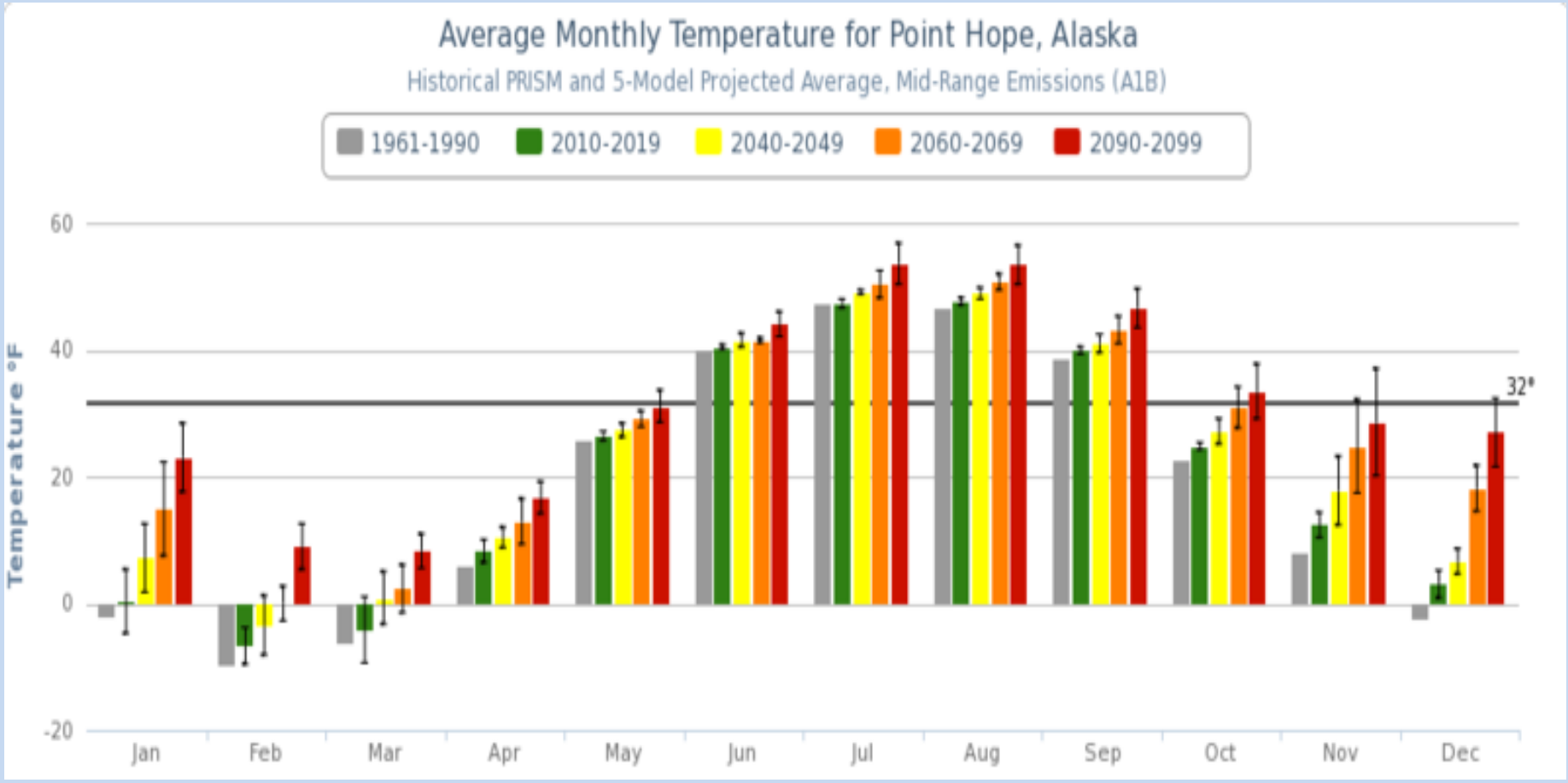
1961-1990 (PRISM climatology)

2070-2090 (ECHAM5)



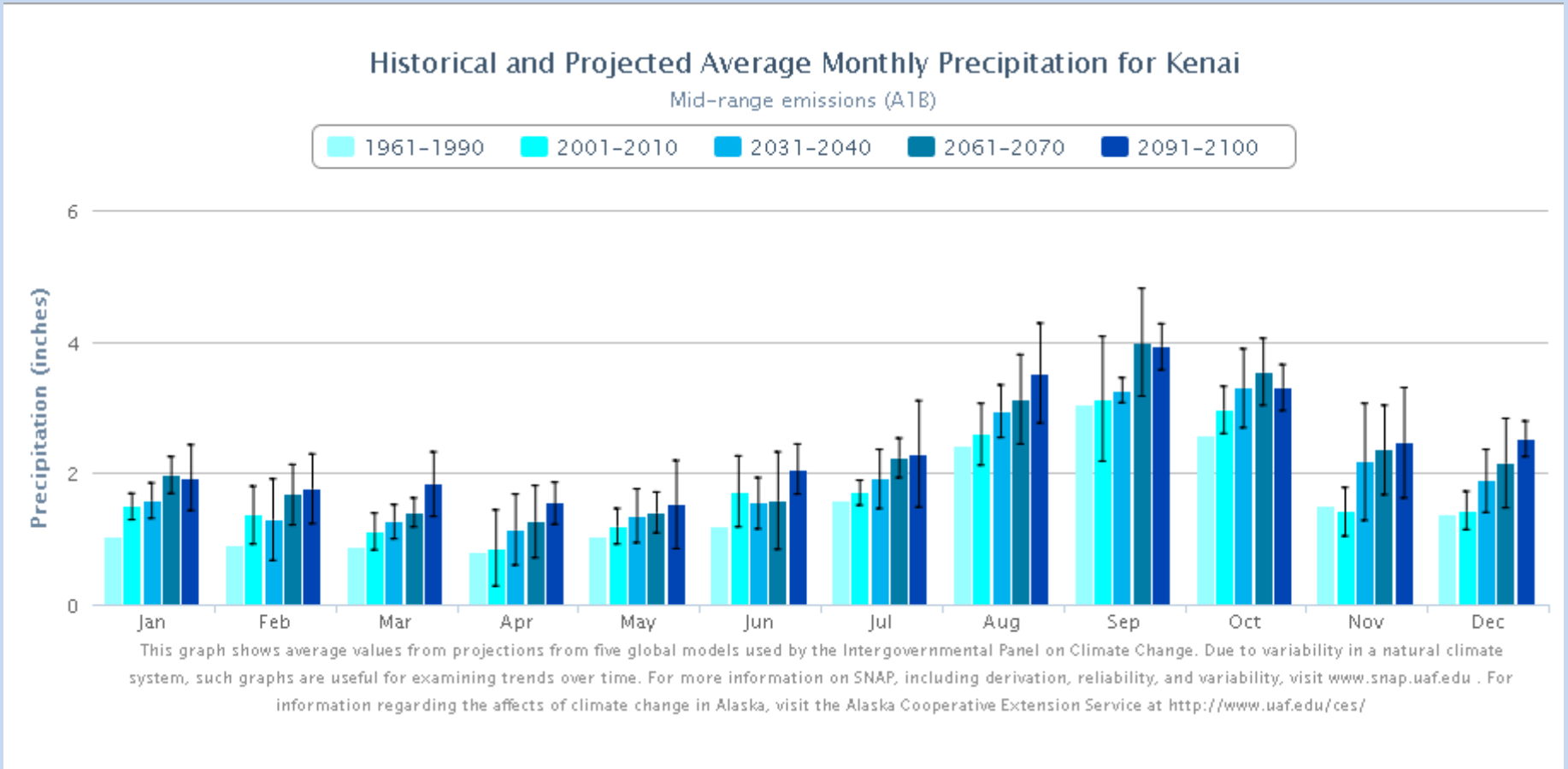
Temperature projections for Point Hope

[from SNAP – Scenarios Network for Alaska Planning]



Precipitation projections for Kenai

[from SNAP – Scenarios Network for Alaska Planning]



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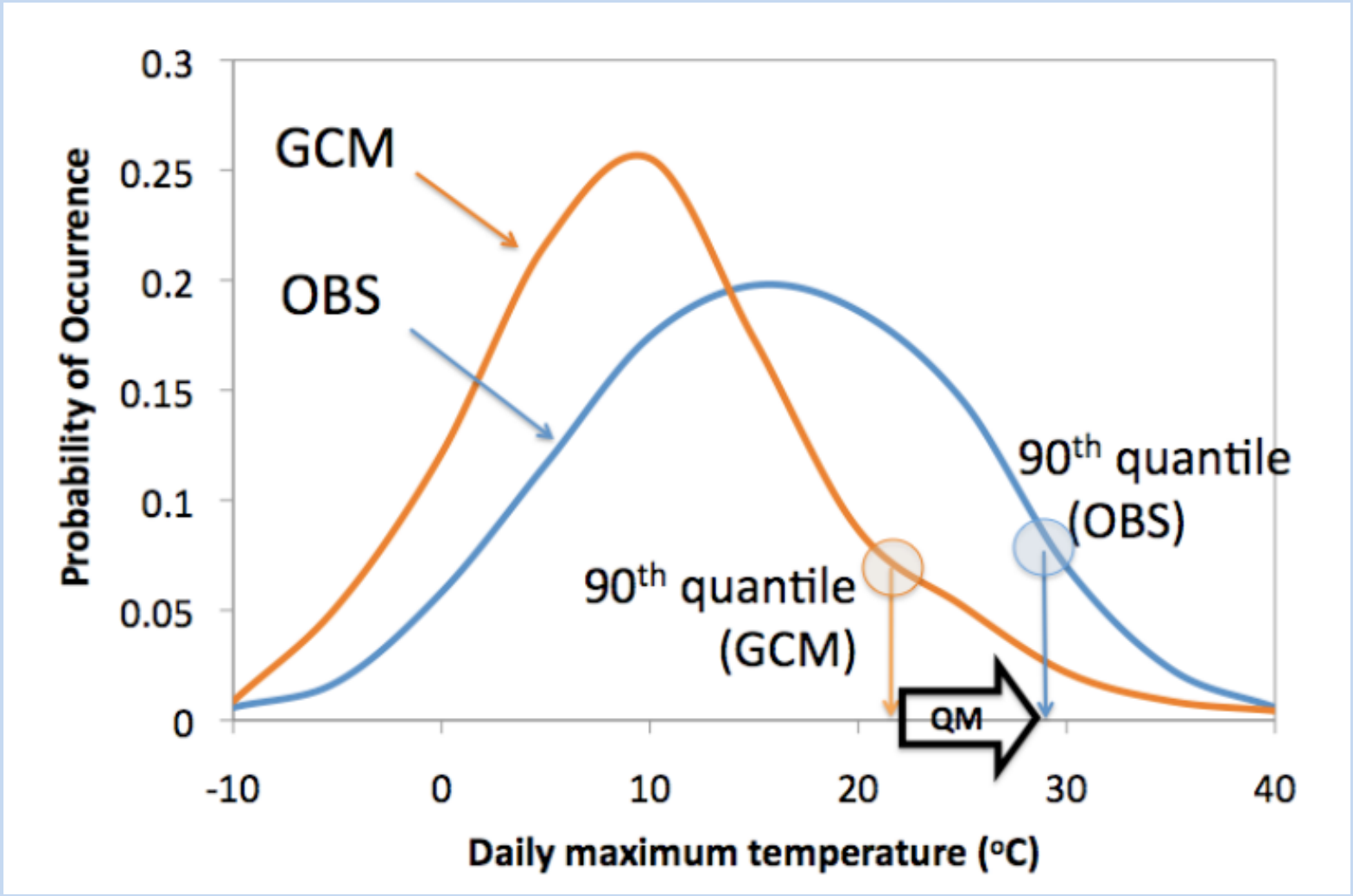
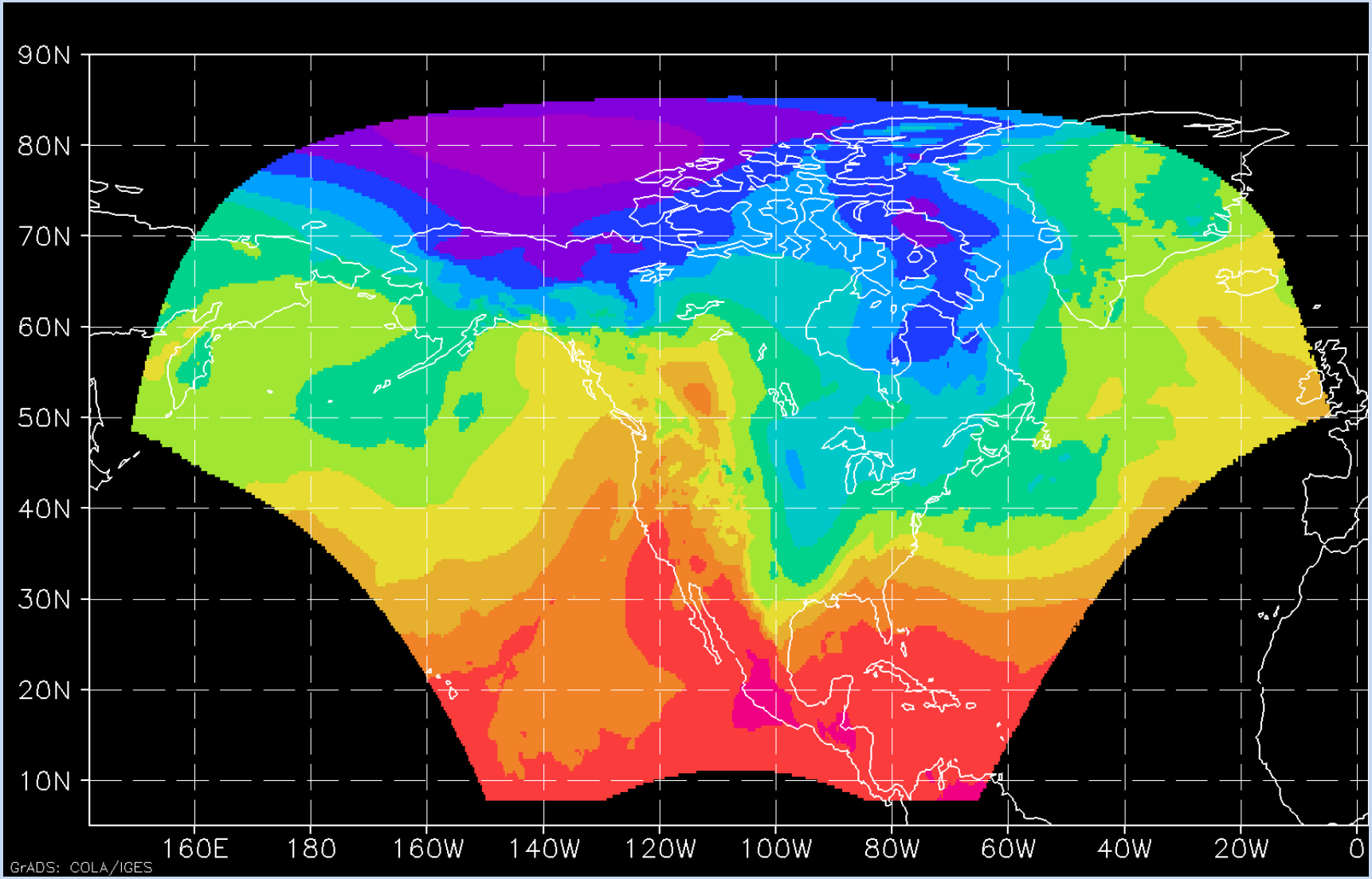
Quantile mapping used in BCSD downscaling approach



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)**