



# On North American Decadal Climate for 2011-2020

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# **Factors Relevant for North American Decadal Climate Predictability**

1. Sensitivity to external radiative forcing
2. Sensitivity to sea surface temperature/sea ice variation that are internal to the system
3. Contribution from atmospheric internal variability to decadal means

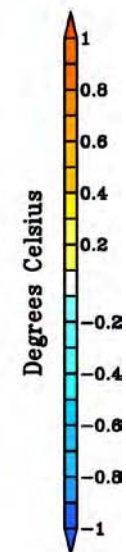
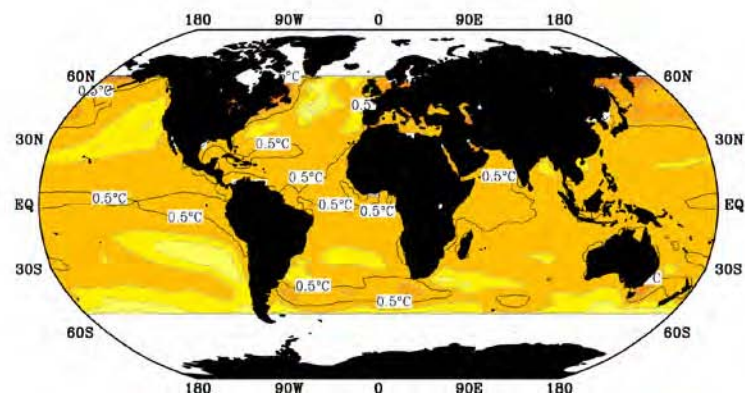
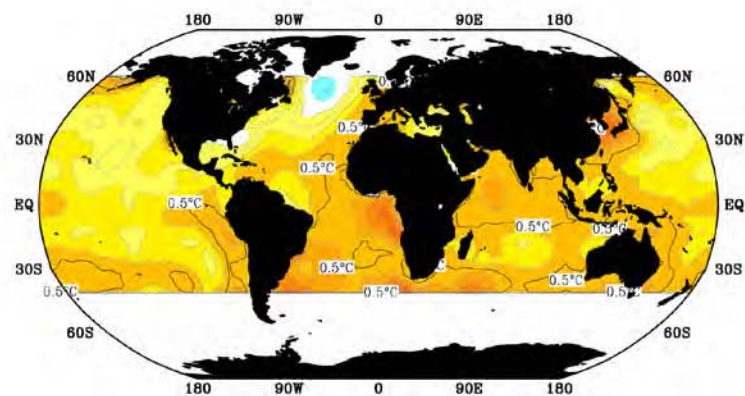
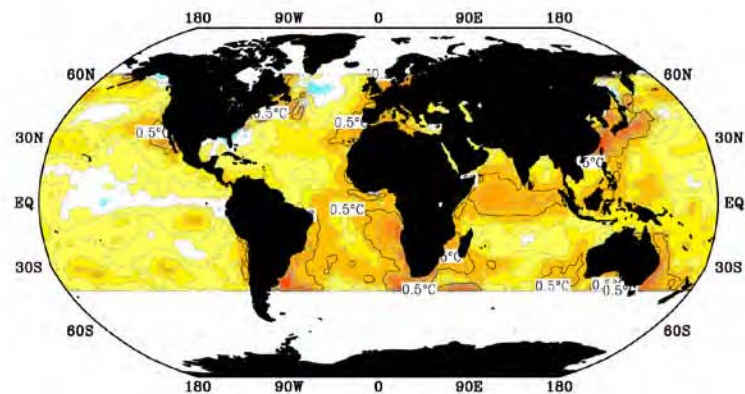
# Methods for Predicting Decadal Climate

- **Uninitialized CGCM methods** → *driven by specified evolving, or current committed, external forcing (CMIP3/CMIP5)*
- **Initialized CGCM methods** → *various initialization procedures (CMIP5)*
- **Empirical methods** → *persistence; extrapolation of observed trends and/or decadal modes*
- **Hybrid Empirical/AGCM methods** → *GCMs driven by specified surface boundary forcing using scenario-based predictions of SST/sea ice.*

# Deriving the SST Scenarios for 2011-2020

- **Method of temporal optimal detection (Ribes et al. 2010)** applied to observational data → *temporal patterns of sfcT are derived from CMIP3 simulations for 1900-2020, and the observed SSTs are regressed upon the ensemble temporal pattern to derive the 2011-2020 SST anomaly.*
- **Observationally-driven scenarios** → *NOAA ERSST and Hurrell SST for 1900-2009*
- **CMIP3 SST projections for 2011-2020** → *ensemble average SST anomaly from A1B scenario runs of 22 different CMIP3 models*

# Sea Surface Temperature Anomaly Scenarios 2011–2020

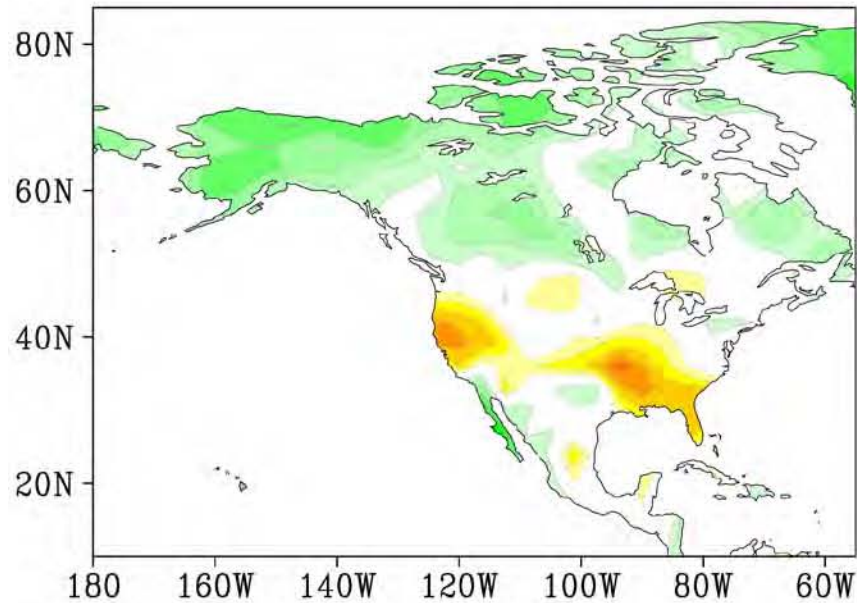


# Experimental Design for our 2011-2020 Outlooks

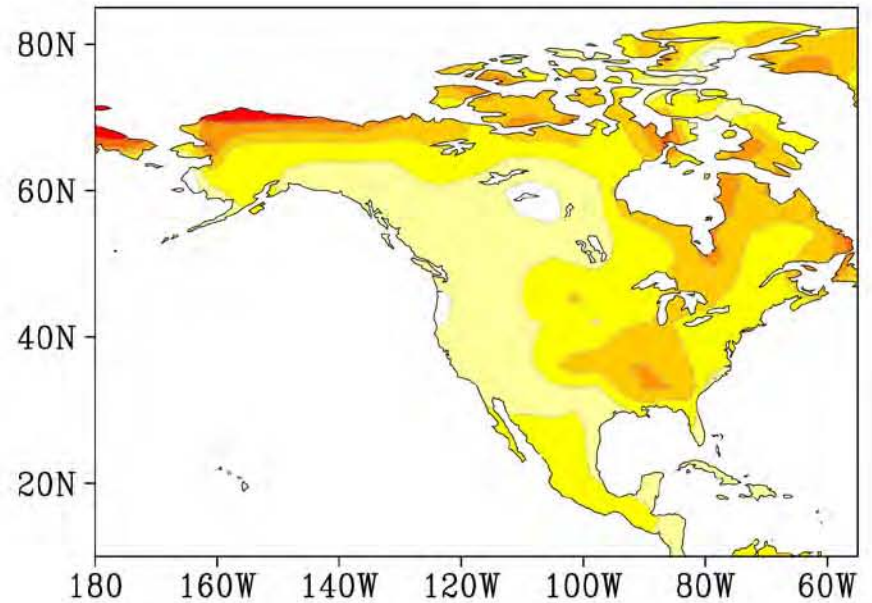
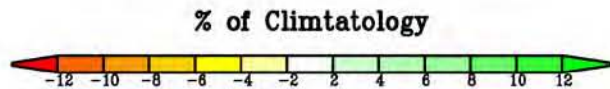
- © **Atmospheric GCMs forced by specified 2011-2020 decadal mean SST/sea ice anomaly scenarios** → *3 different SST & one sea ice scenario.*
- © **Multi-model approach using 3 different AGCMs** → *same models for which 20<sup>th</sup> Century AMIP simulations are also available.*
- © **50-yr integrations** → *time slice experiments for the impact of 2011-2020 surface boundary condition forcings*
- © **2011-2020 decadal anomalies relative to 1971-2000 reference** → *control runs using 1971-2000 mean SST/sea ice conditions for each AGCM.*

**For the atmosphere it is only the SST that matters!!**

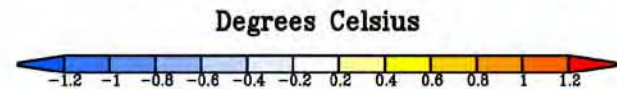
2011–2020  
Multi-Model Response to SST/Sea Ice Scenario



PCPN

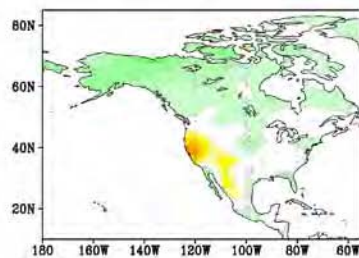


TEMP

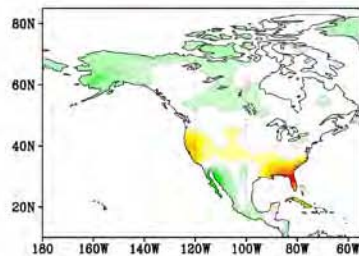




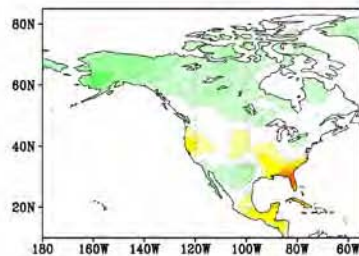
## Precipitation



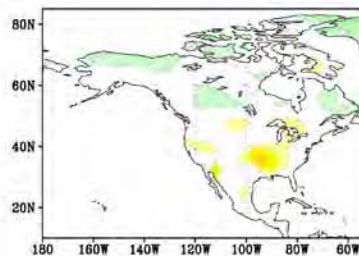
CMIP SST



Hurrell SST

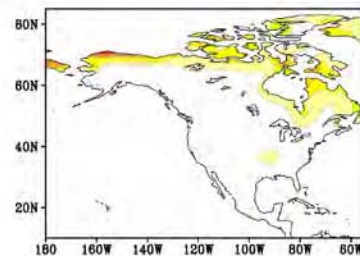
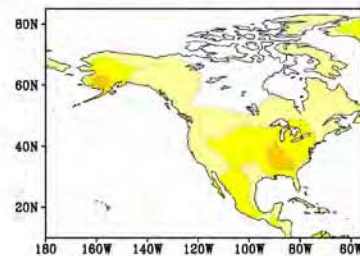
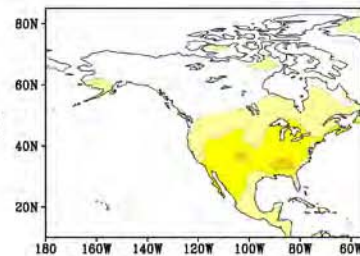
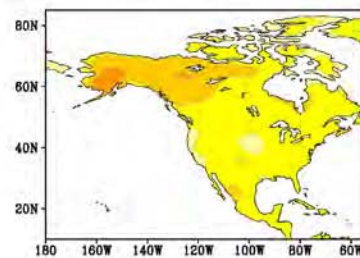


NOAA SST



Sea Ice

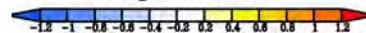
## Temperature



% of Climatology

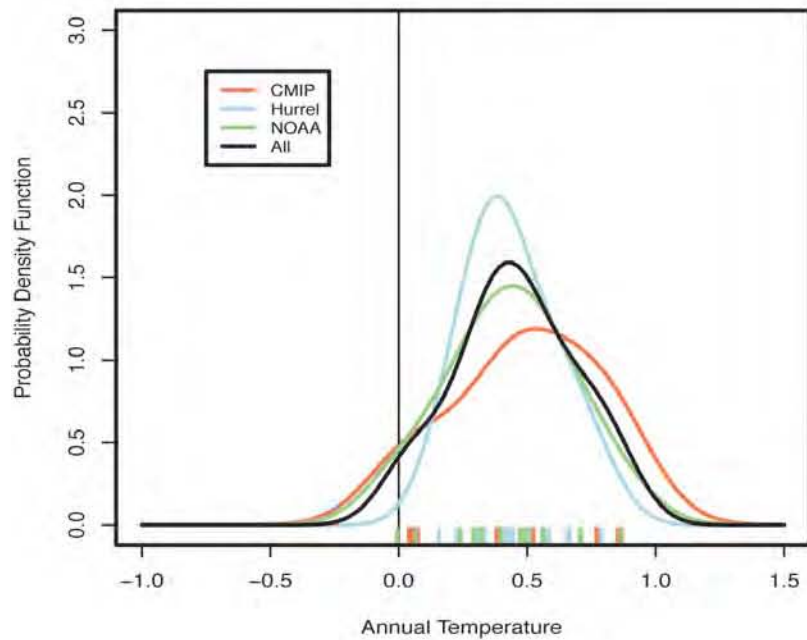


Degrees Celsius

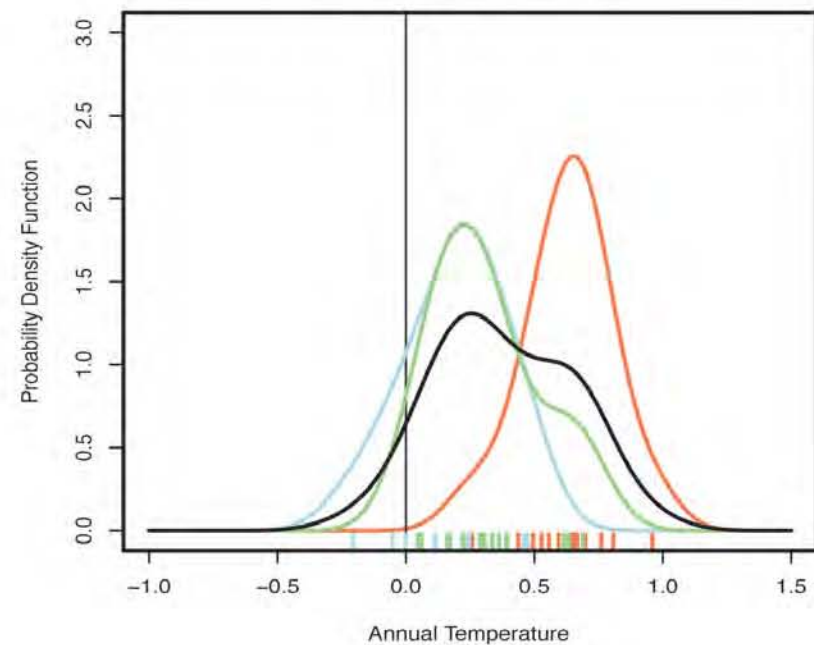




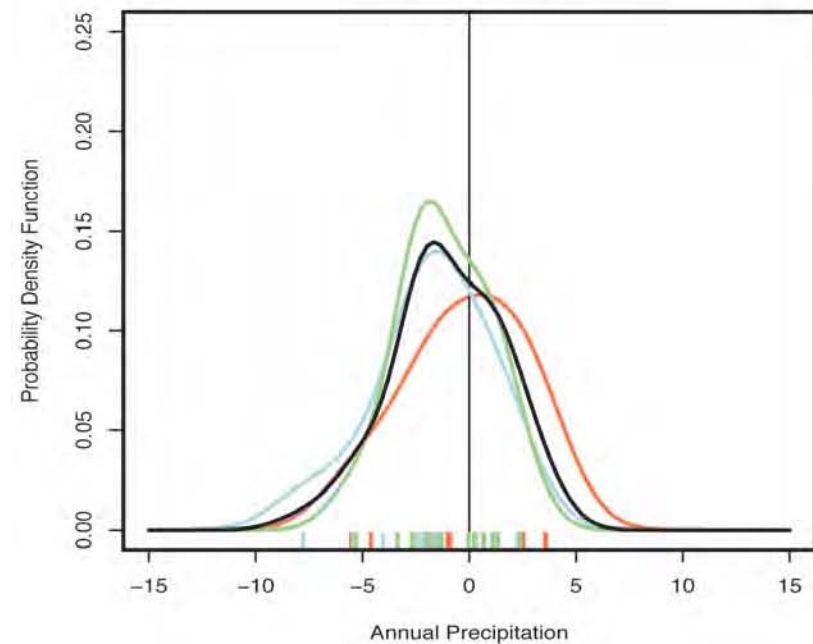
United States: 2011\_2020



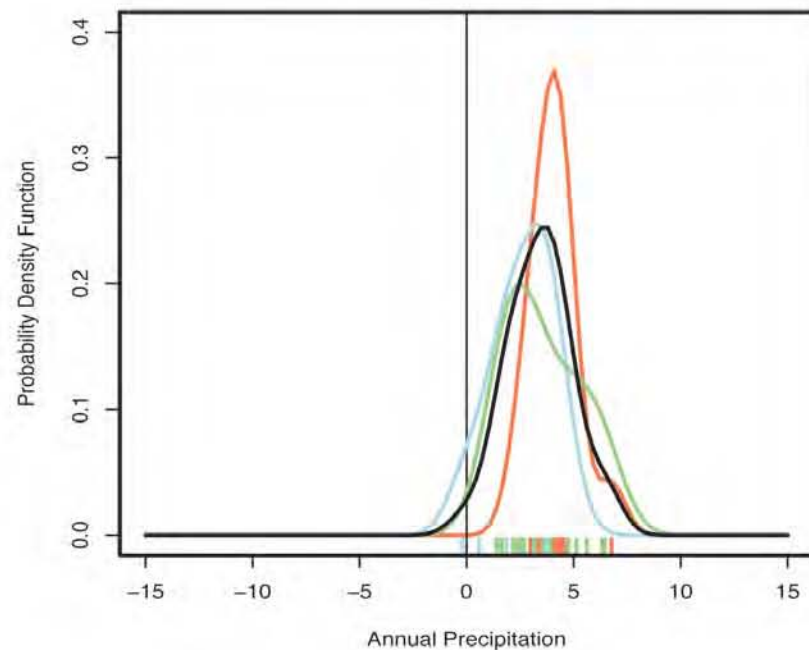
Canada/Alaska: 2011\_2020



United States: 2011\_2020



Canada/Alaska: 2011\_2020

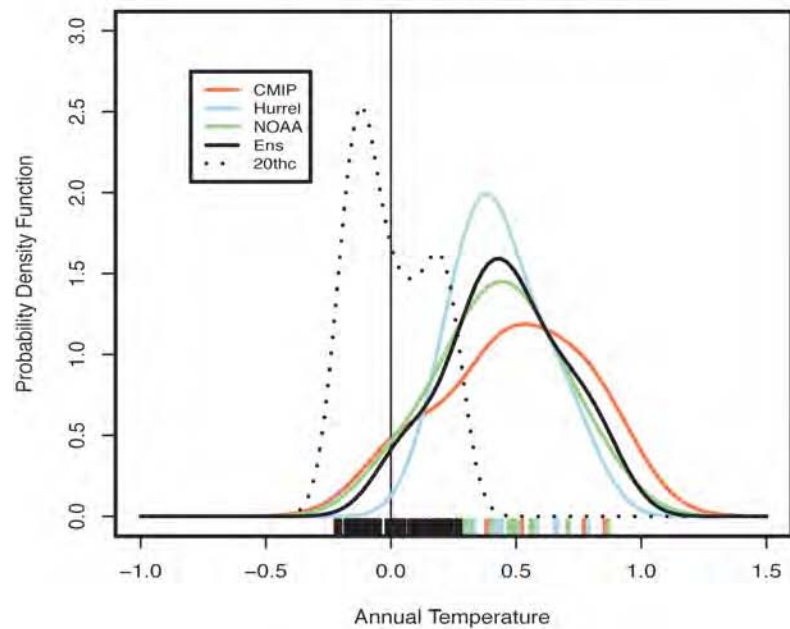




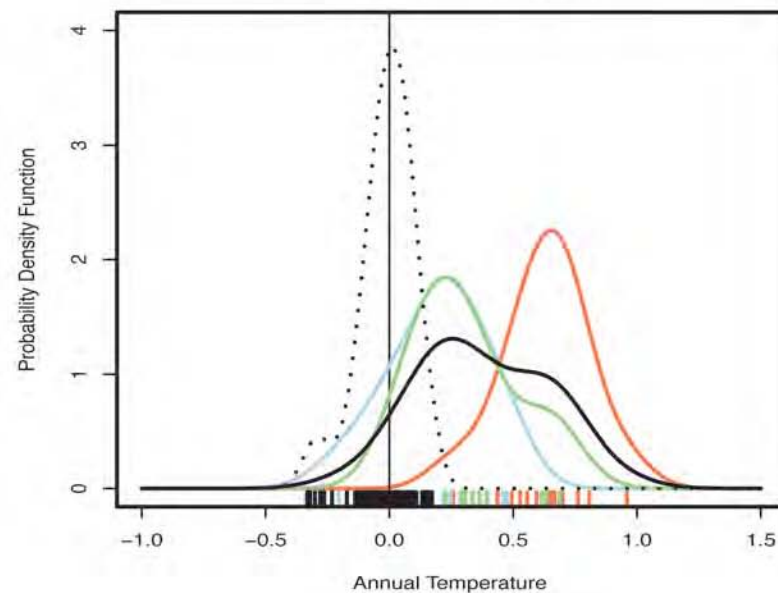
# **Factors Relevant for North American Decadal Climate Predictability**

1. Sensitivity to external radiative forcing (e.g., what might be different SST scenarios for next decade)
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3. Contribution from atmospheric internal variability to decadal means

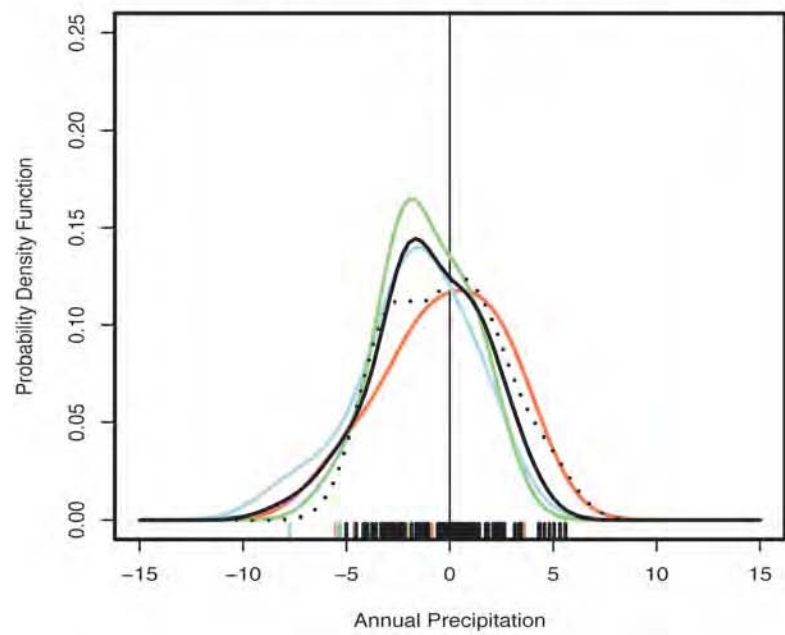
United States: 2011\_2020



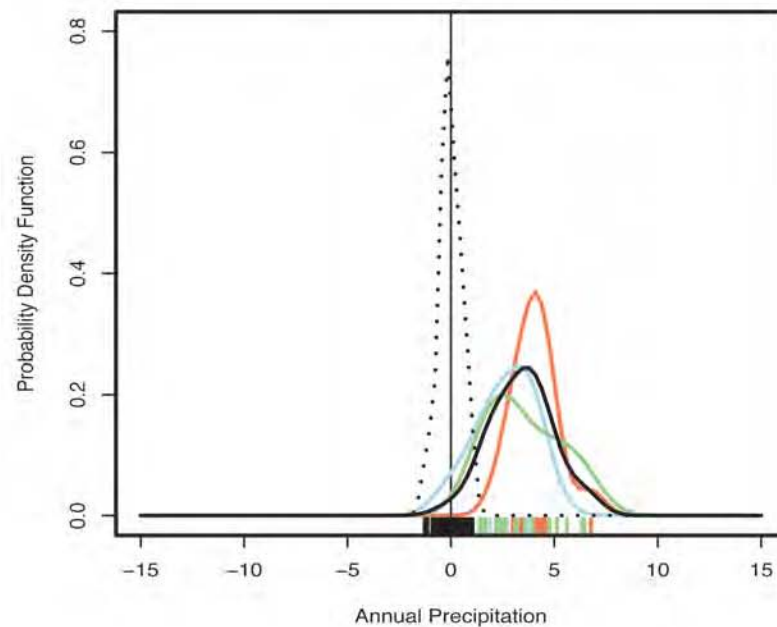
Canada/Alaska: 2011\_2020



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AMIP



Preindustrial  
CMIP



# Conclusions

- © **A hybrid empirical/AGCM method for predicting 2011-2020 North American decadal climate has a merit given that:**
  - I. Much of the external radiative forcing of NA decadal climate is physically linked to the SST/sea ice response to that forcing.*
  - II. Removes the potentially negative impact of the substantial biases in SST climatologies occurring in coupled model (Shin and Sardeshmukh 2010).*
  - III. Facilitates diagnosis of the factors affecting predictability.*
- © **Outlook for 2011-2020 North American climate, constrained by scenarios of the changes in SST/sea ice resulting from AG forcing, show:**
  - I. Widespread warming of the continent ( +0.5 C relative to 1971-00)*
  - II. Increased precipitation over Canada/Alaska (+4% of climo)*
  - III. Decreased precipitation over the contiguous US (-2% of climo)*
- © **A probabilistic outlook was generated by convolving the impact of the scenarios of SST/sea ice change with the statistical impact of natural decadal SST/sea ice variability during the 20<sup>th</sup> Century.**