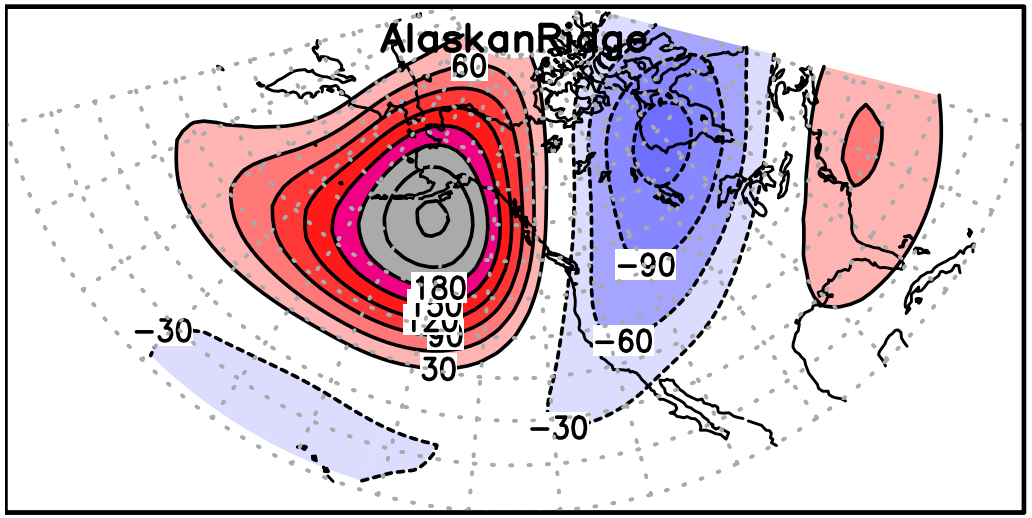
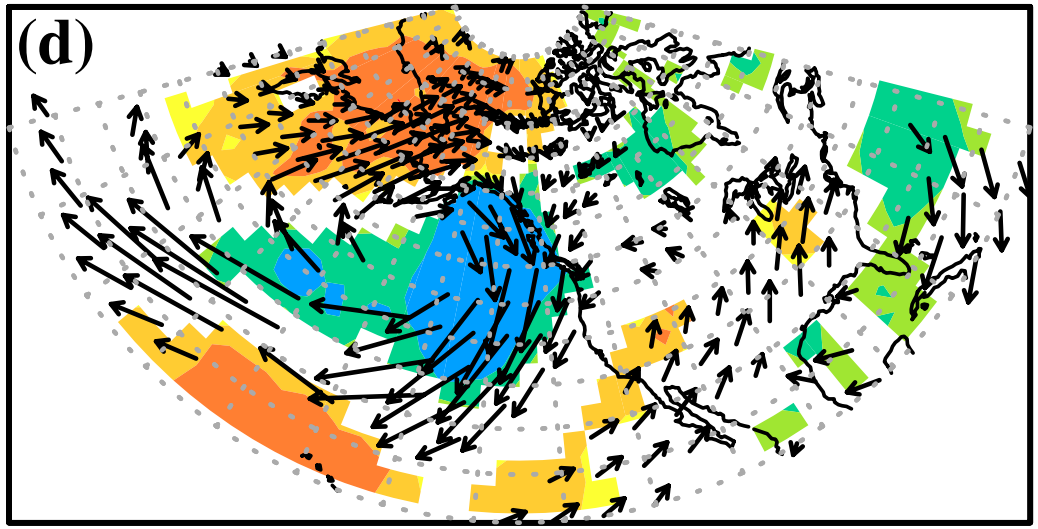
Ensemble Prediction and Predictability of Extreme Weather via Circulation Regimes





David M. Straus and Kathy Pegion

Acknowledging the work of Dr. Sara Amini

George Mason University, Dept of Atmospheric, Oceanic, and Earth Sciences
Center for Ocean-Land-Atmosphere Studies

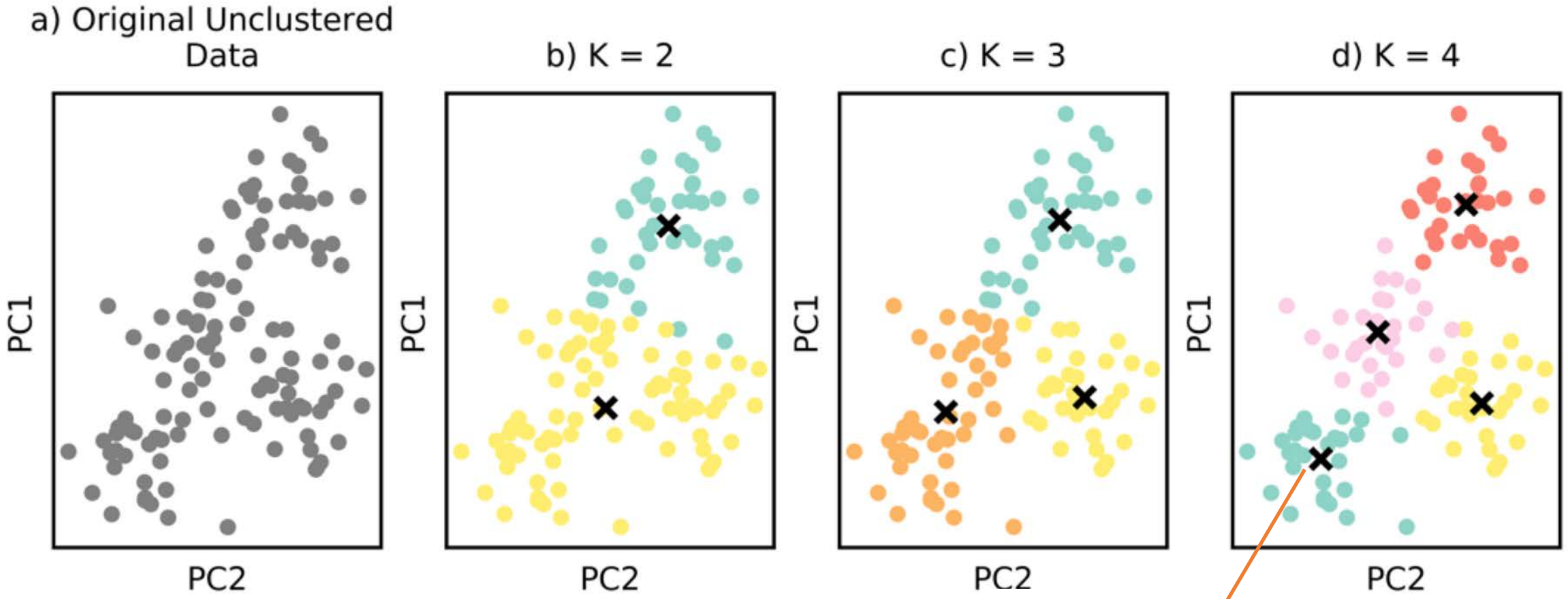
- Precipitation is one of the most poorly simulated and predicted quantities
- Models are generally skillful in simulating and predicting the large-scale large-scale circulation regimes.
- Patterns of storminess and extreme weather may be directly linked to circulation regimes

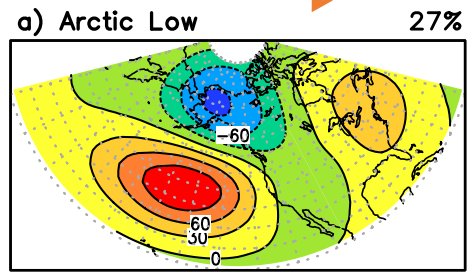
Can we use circulation regimes to extend predictions of extreme weather into the S2S time scales?

Circulation Regimes

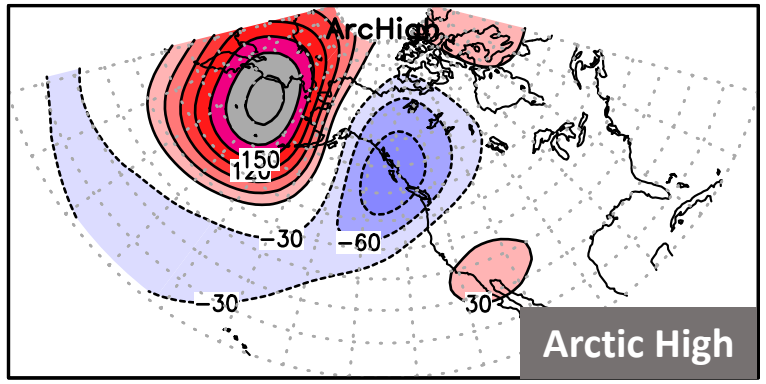
- 500 hPa geopotential height
- k-means cluster analysis to group all states so that each 5-day running mean is assigned to one of the groups
- Each group of states is then associated with a characteristic map, called a circulation regime
- Principal Component Space (12 PCs) ~80% of the total space-time variance

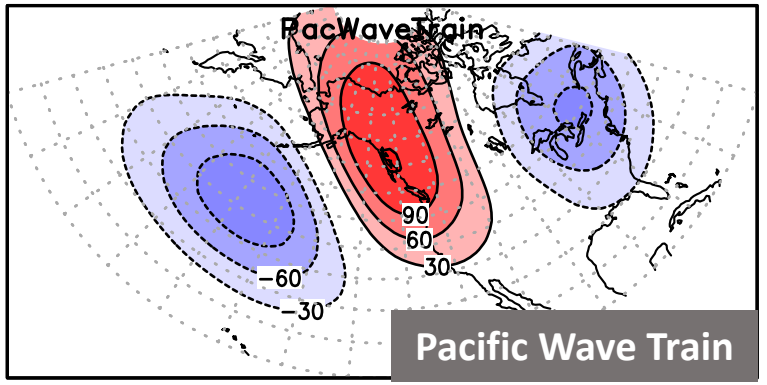
Example: Applying k-means algorithm

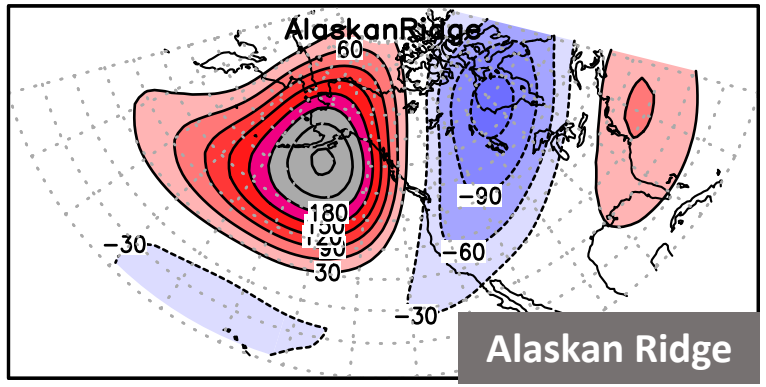


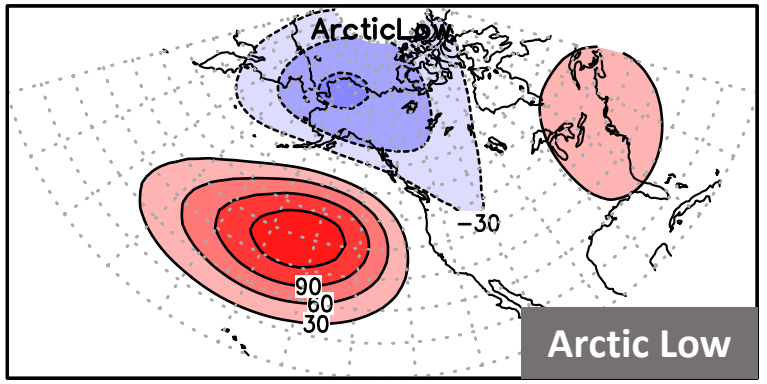


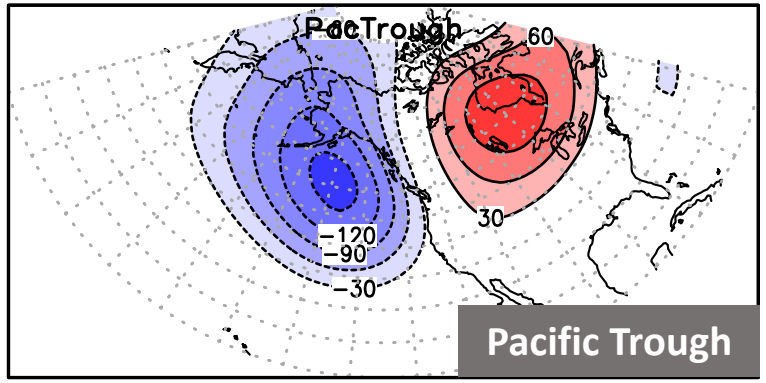
Circulation Regimes Pacific – North America Region







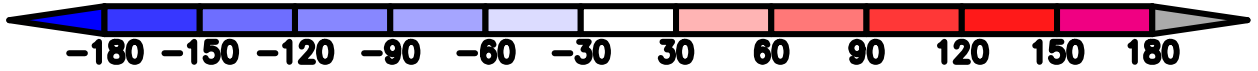




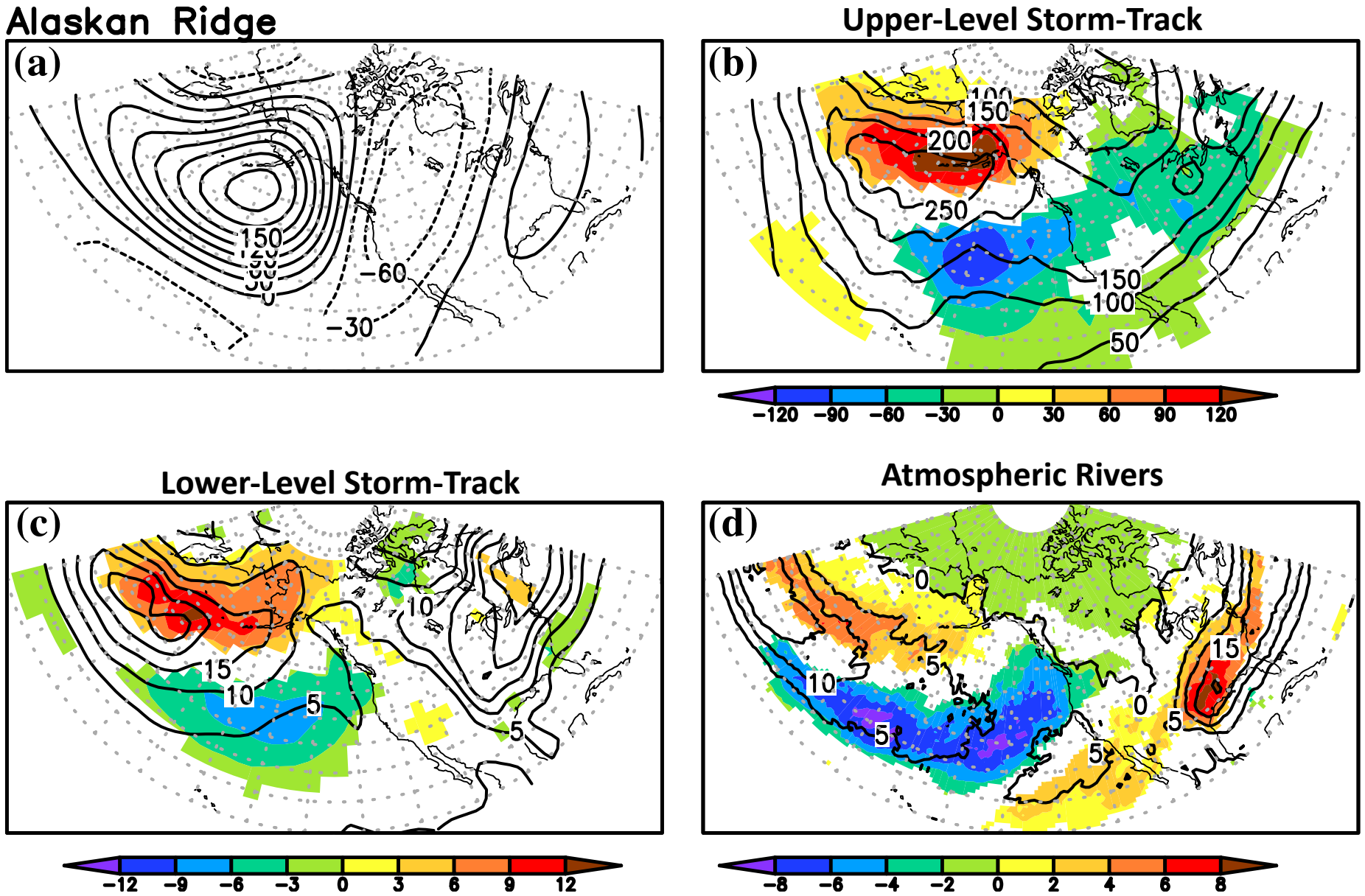
Cluster Centroids

ERA–I 1980–2015 DJF

Z500 12_pcs (units: meters)

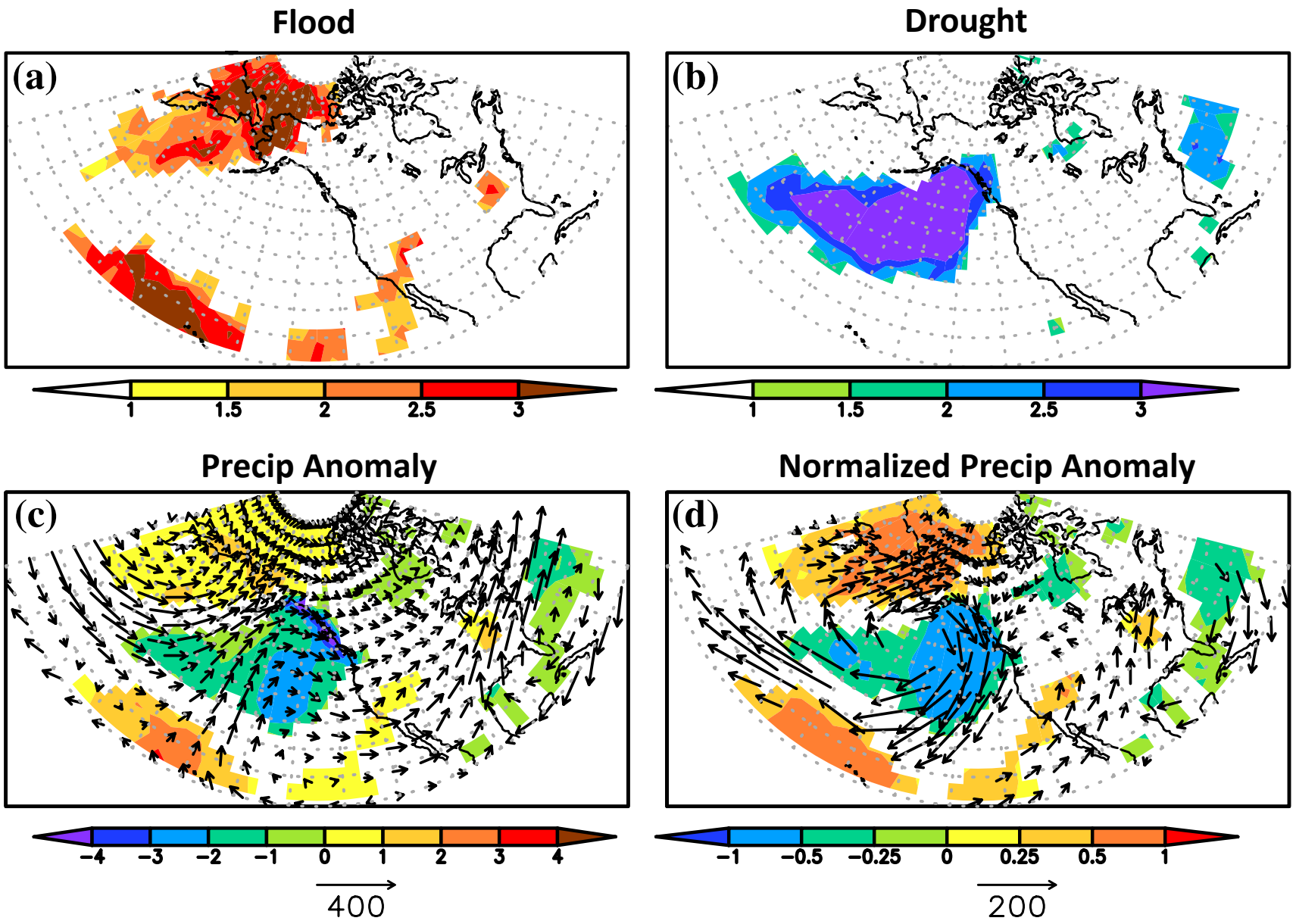


Relationship of Circulation Regimes to Storminess and Extreme Weather



From Amini, S. and Straus, D.M., 2018: Climate Dynamics

Relationship of Circulation Regimes to Storminess and Extreme Weather



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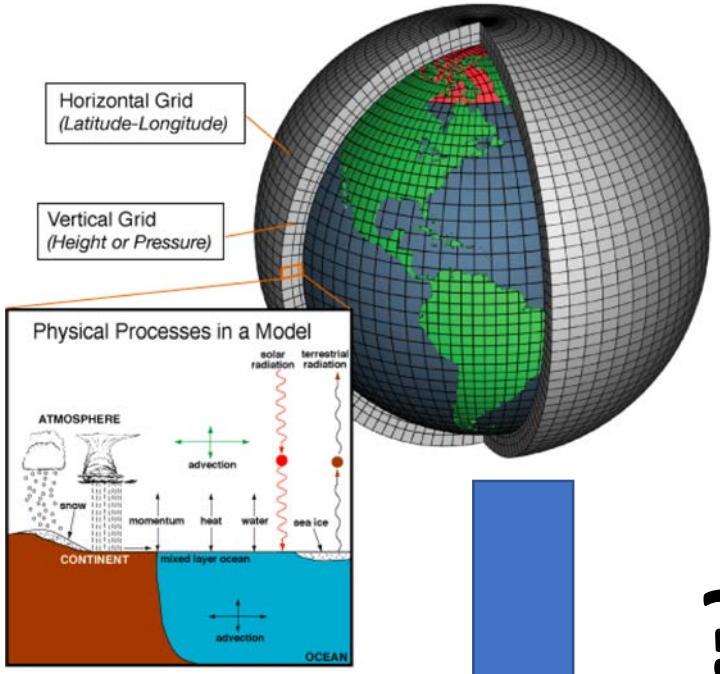

Are circulation regimes predictable?

Are extreme precipitation and storminess predictable based on regimes?

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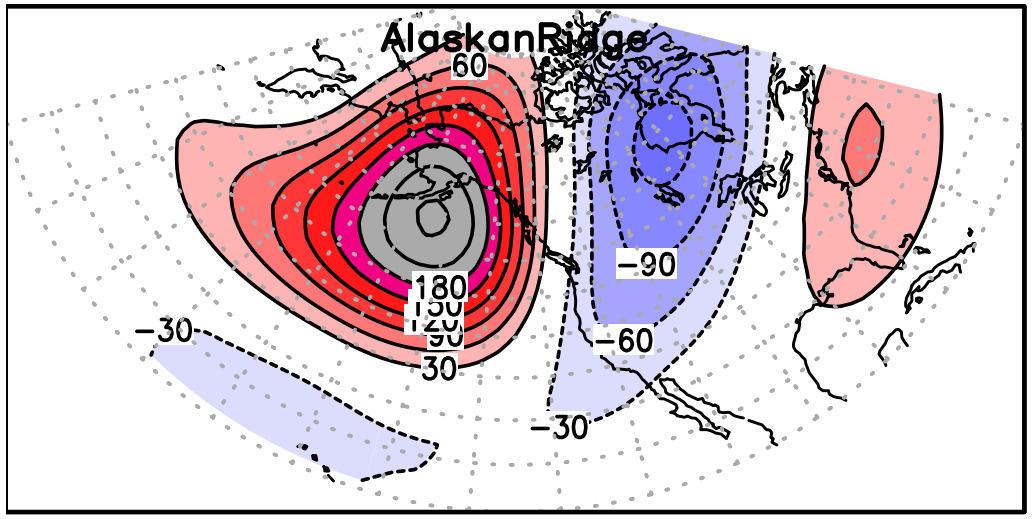

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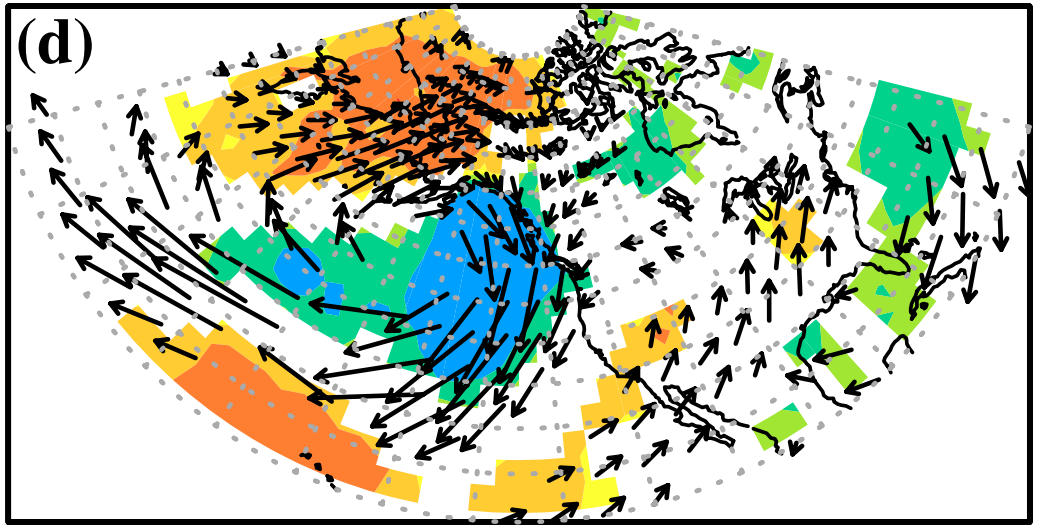


Are Circulation Regimes Predictable?

Examples from S2S ECMWF reforecasts with 11 members: 1995-2014

Method:

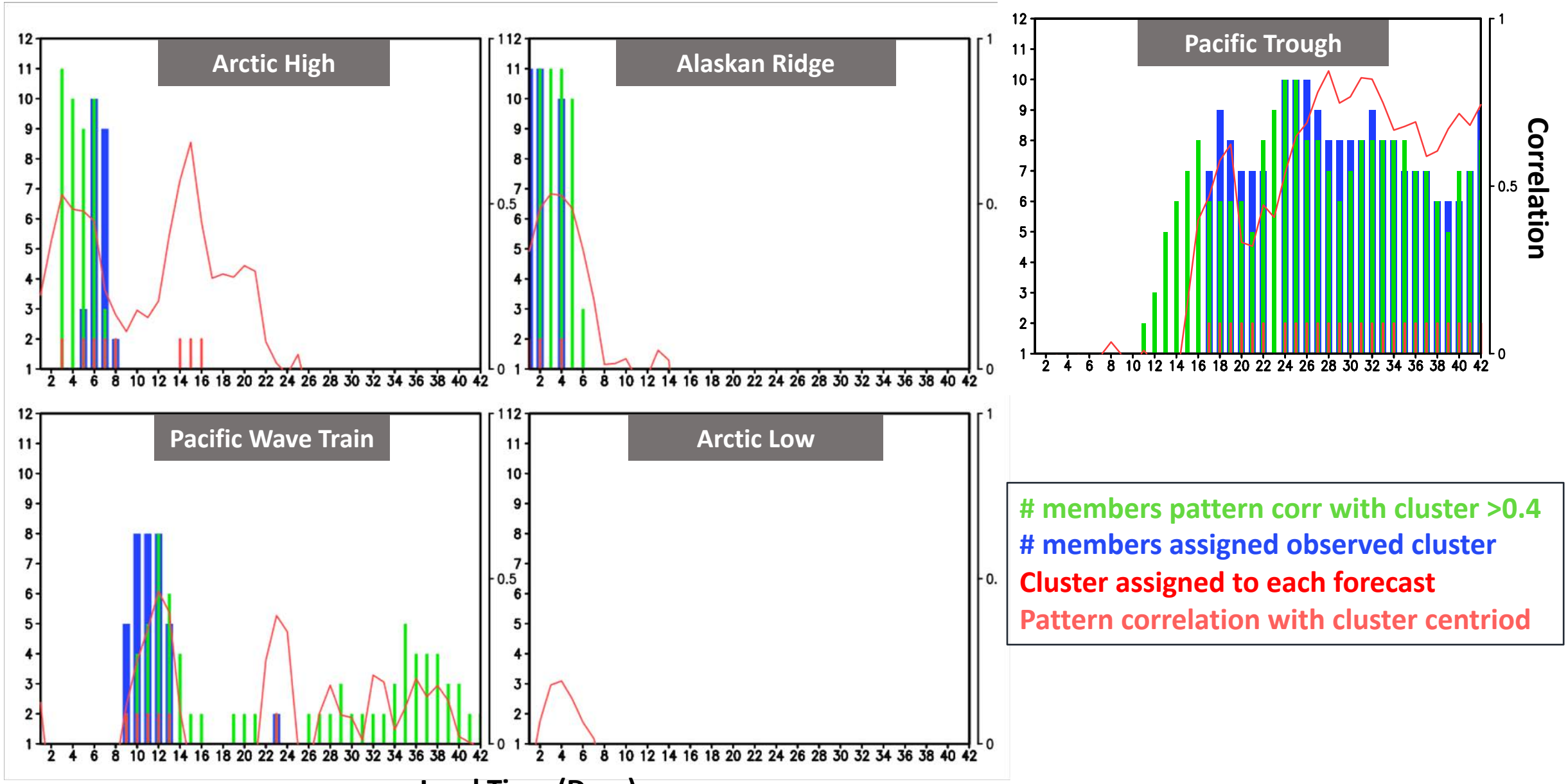
- **Project Forecast Z500 anomaly onto leading 12 EOFs from ERA-Interim for the appropriate period**
- **In PC space, assign each forecast day to one of the 5 cluster centroids shown previously, using one of two methods:**

(1) Match the forecast with the regime closest to its using Euclidean distance in PC space (same measure used to define clusters)

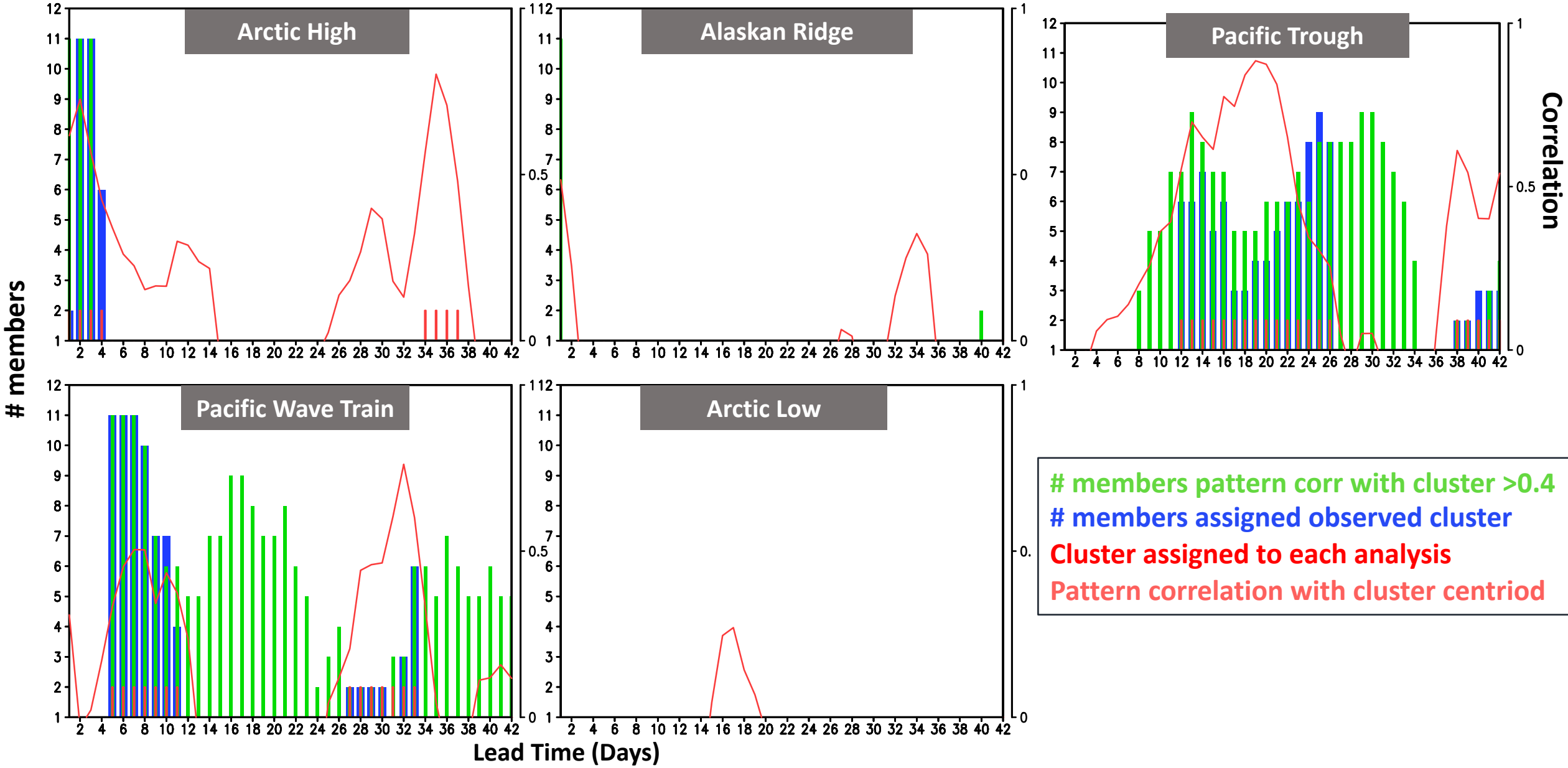
(2) Match the forecast with any regime with which it has a pattern correlation exceeding 0.40. (*Caveat:* A forecast may be matched to more than one regime).

On any given day, how many ensemble members are assigned the correct (verifying) circulation regime?

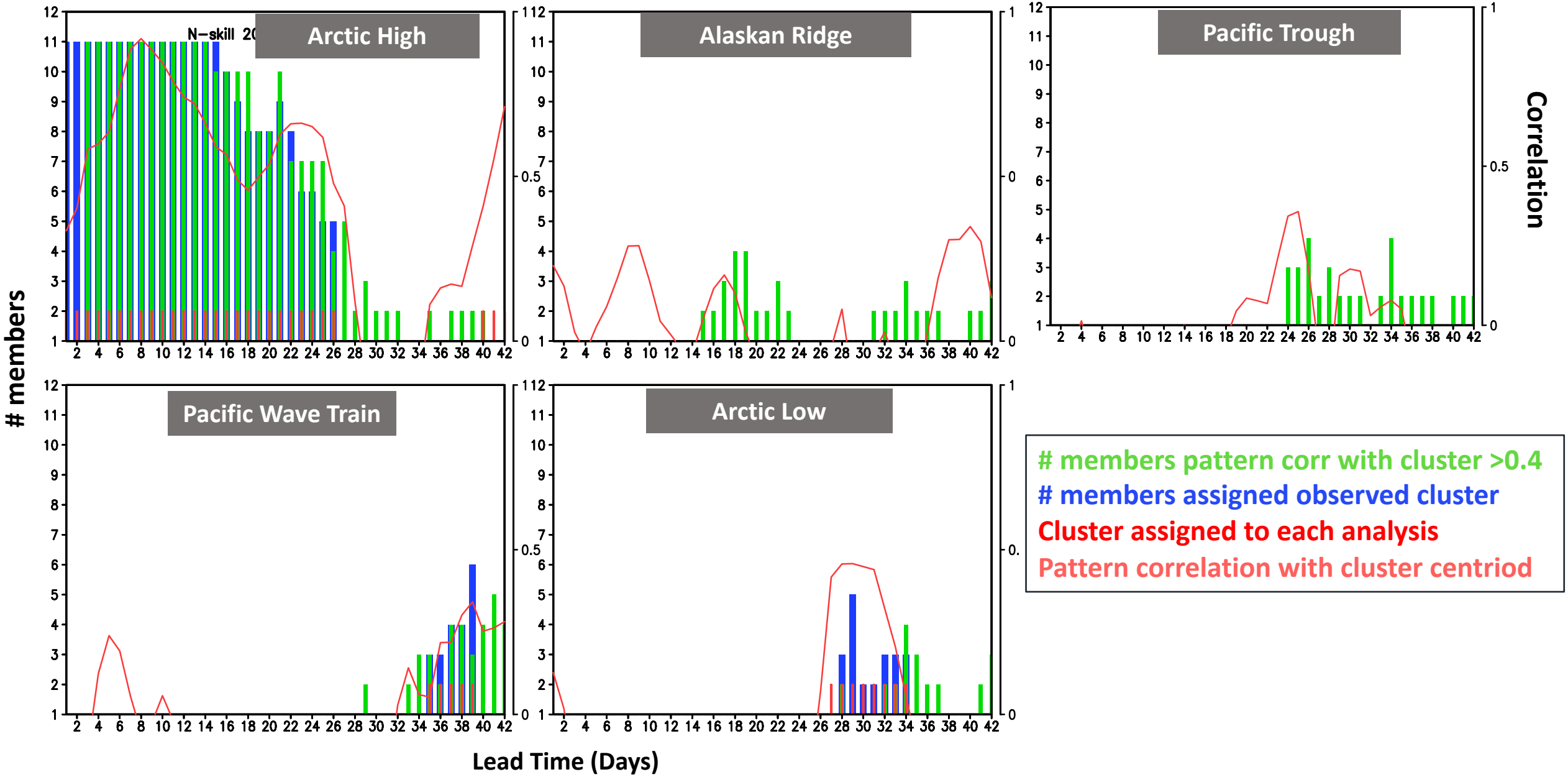
Forecasts Initialized: Dec 03 1997



Forecasts Initialized: Dec 31 2009



Forecasts Initialized: Dec 3 2010



Conclusions

- PNA Circulation regimes are related to extreme weather and storminess
- Evidence that ECMWF model can predict circulation regimes for some specific cases

Future Work

Advance the predictive capability of extreme weather on the S2S timescales, over the Euro-Atlantic and Pacific-North American regions, using reforecasts and forecasts from S2S, SubX, NMME