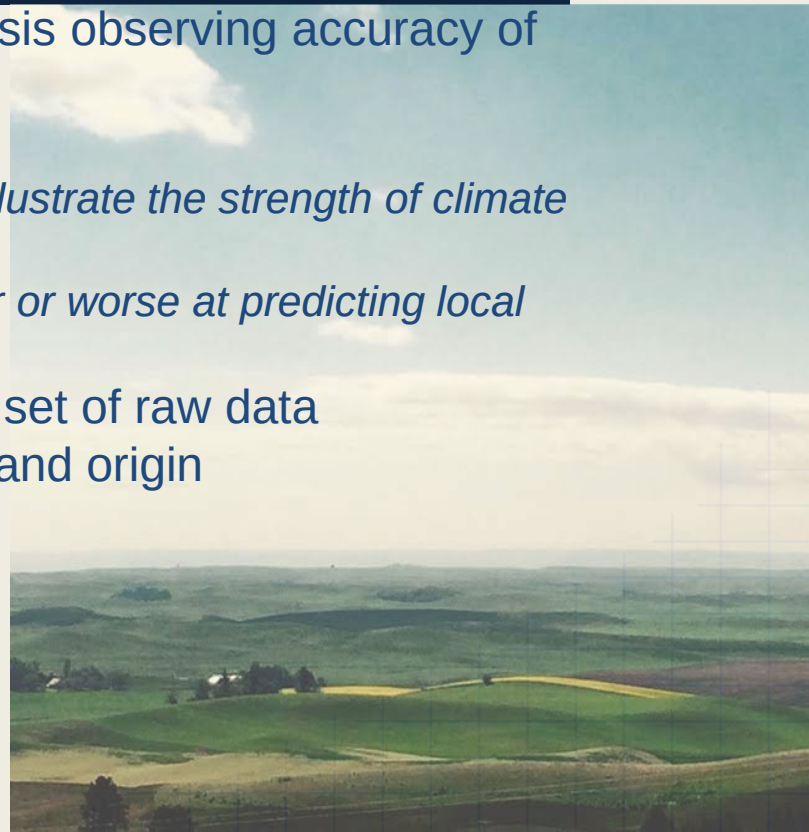
REACCH
Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Assessing the skill of seasonal climate prediction for inland northwest Agriculture

Blaise DeFranco

Project Description

- Primary objective: to conduct a statistical analysis observing accuracy of seasonal predictions for the REACCH region
- Research questions:
  - *What are different metrics that can be used to illustrate the strength of climate hindcasts?*
  - *What causes some forecast models to be better or worse at predicting local climate?*
- Research conducted comparing a single ‘truth’ set of raw data to three different ‘test’ models of varying scale and origin

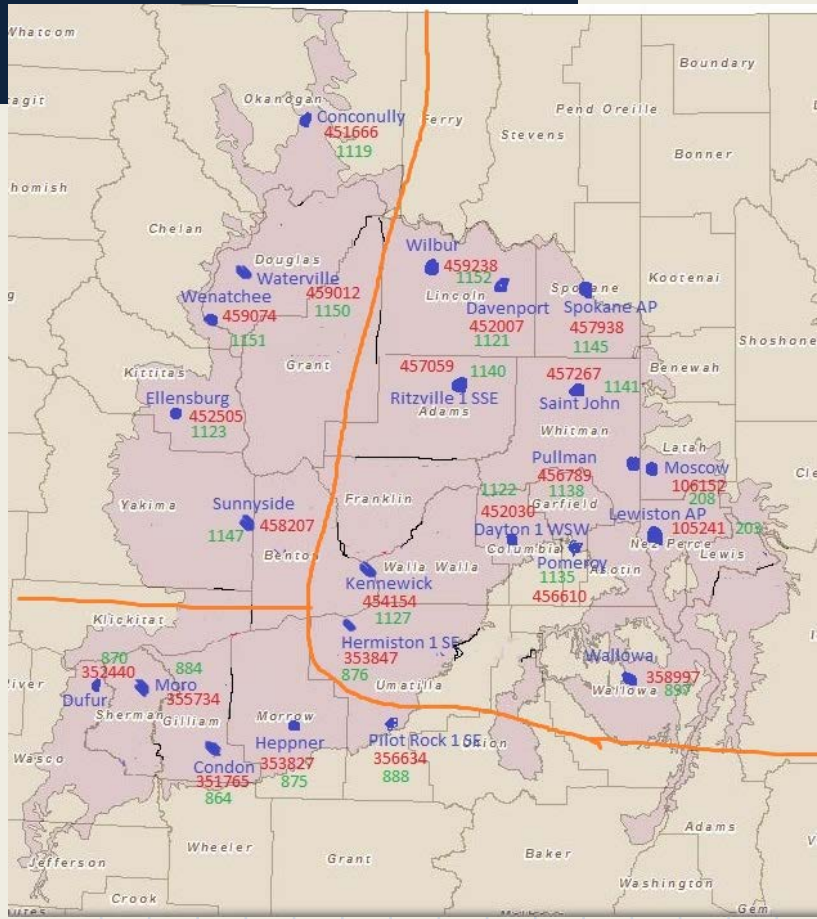


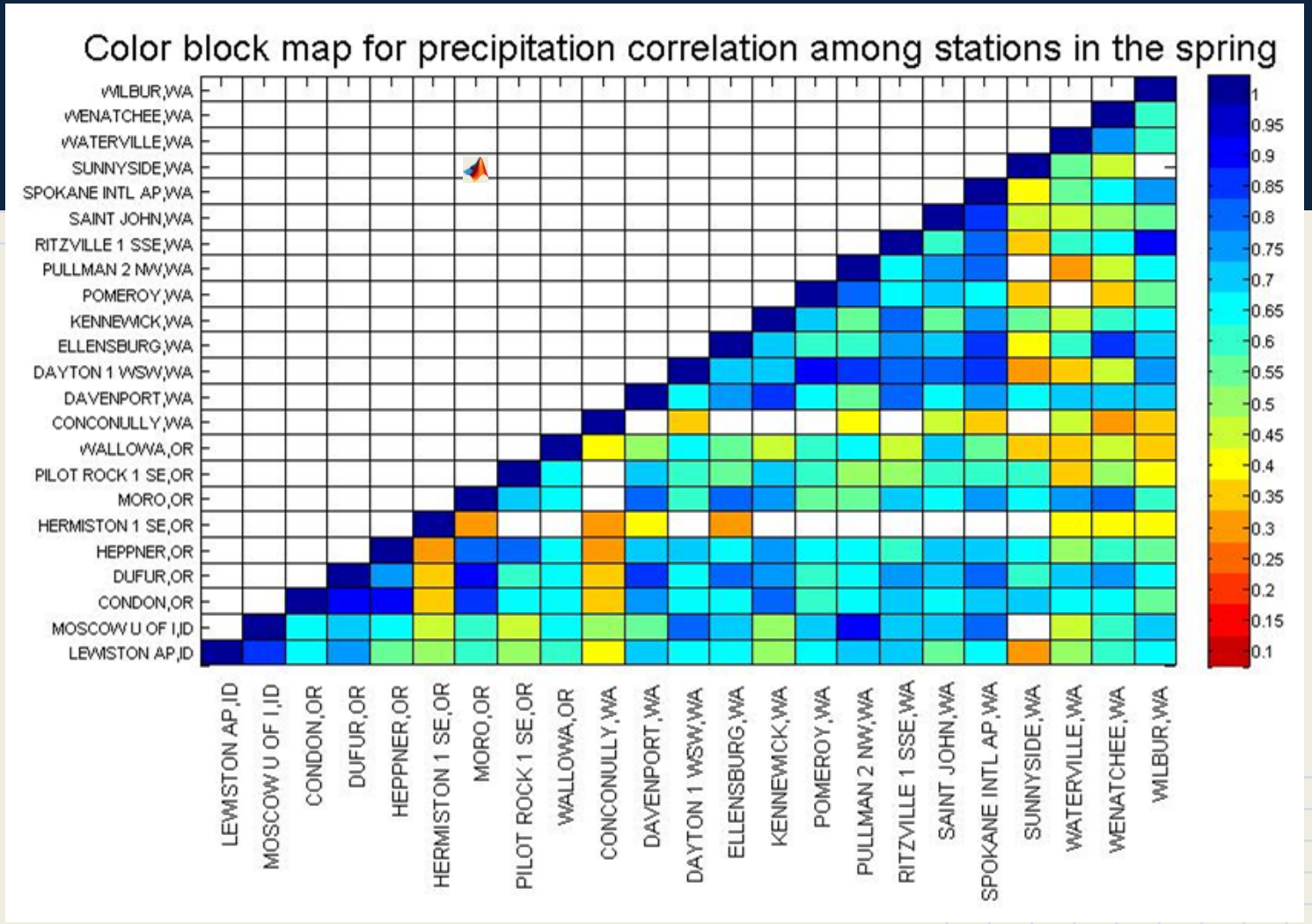
Extension

- Climate forecasts directly affect local farmers and growers
  - Can play a role in land management decision-making
  - Stronger forecast models can be used to help adapt growing practices for each year
- Possible development using this research could be a culmination or more localized seasonal forecast database
  - Could account for micro-climates within the inland northwest
  - Forecasts can be customized based on needs of stakeholder

GHCN station data

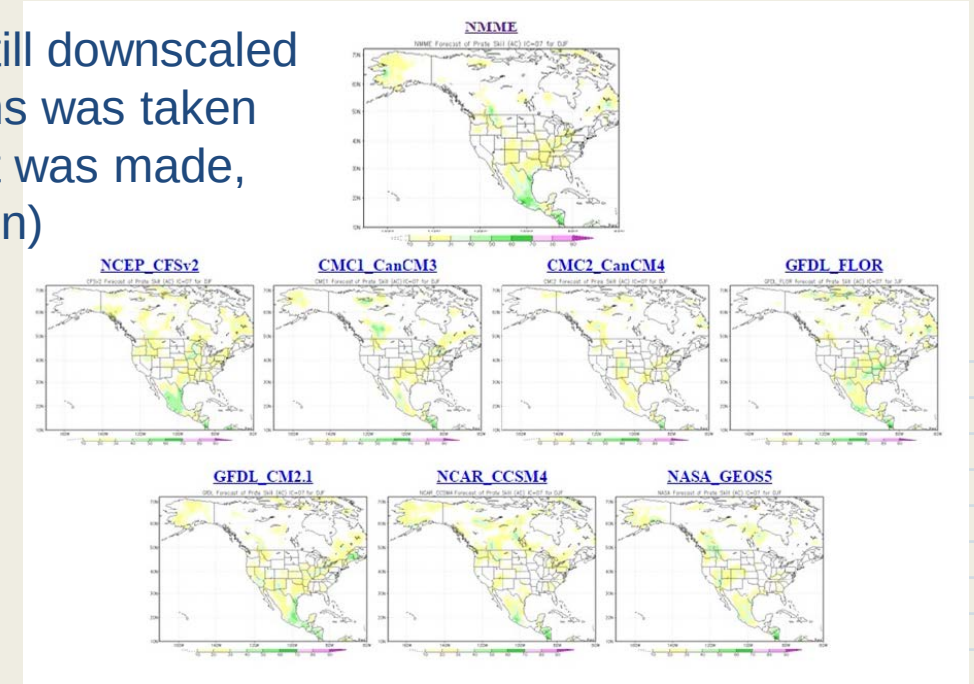
- GHCN (Global Historical Climatology Network) is a database of global land surface weather stations
- 23 individual stations were chosen that best encompassed REACCH region (average temp and precip values)
- Based on variability observed within the region, stations were split into 3 subregions
- This was done using correlation analysis



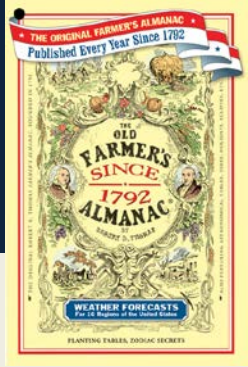

Color block map for precipitation correlation among stations in the spring
WILBUR,WA
WENATCHEE,WA
WATERVILLE,WA
SUNNYSIDE,WA
SPOKANE INTL AP,WA
SAINT JOHN,WA
RITZVILLE 1 SSE,WA
PULLMAN 2 NW,WA
POMEROY,WA
KENNEWICK,WA
ELLENSBURG,WA
DAYTON 1 WSW,WA
DAVENPORT,WA
CONCONULLY,WA
WALLOWA,OR
PILOT ROCK 1 SE,OR
MORO,OR
HERMISTON 1 SE,OR
HEPPNER,OR
DUFUR,OR
CONDON,OR
MOSCOW U OF I,ID
LEWISTON AP,ID
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1

North American Multi-Model Ensemble (NMME)

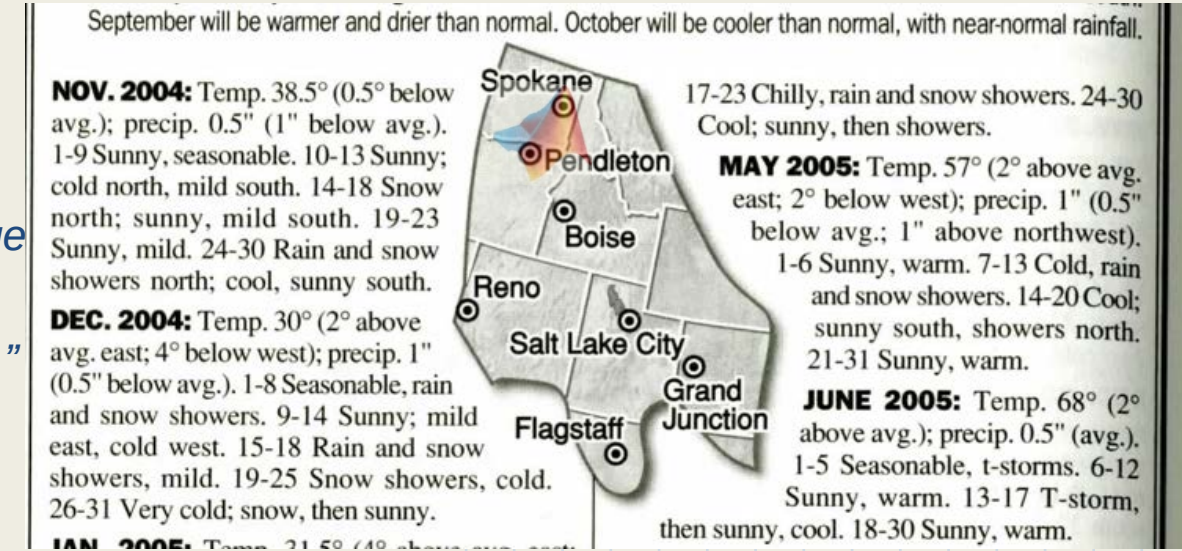
- Comprised of 6 climate models including NOAA, NASA, NCAR, Canada's CMC
- Spatial scale larger than GHCN, but still downscaled
- Forecast data from selected 23 stations was taken
- Data in sorted by year, month forecast was made, station, and lead month (month of prediction)



Old Farmer's Almanac



- All data was hand-recorded from hard copies of back editions
- Long-term forecasts are split into geographic regions
- Rather vague about how predictions are made…
  - *"We derive our weather forecasts from a secret formula that was devised by the founder of this Almanac, Robert B. Thomas, in 1972…"*
  - *"We employ three scientific disciplines to make our long-range predictions: solar science… climatology… and meteorology…"* (*OFA*, 2010 ed.)
  - Temp and Precip. normals taken from NCDC


September will be warmer and drier than normal. October will be cooler than normal, with near-normal rainfall.

NOV. 2004: Temp. 38.5° (0.5° below avg.); precip. 0.5" (1" below avg.). 1-9 Sunny, seasonable. 10-13 Sunny; cold north, mild south. 14-18 Snow north; sunny, mild south. 19-23 Sunny, mild. 24-30 Rain and snow showers north; cool, sunny south.

DEC. 2004: Temp. 30° (2° above avg. east; 4° below west); precip. 1" (0.5" below avg.). 1-8 Seasonable, rain and snow showers. 9-14 Sunny; mild east, cold west. 15-18 Rain and snow showers, mild. 19-25 Snow showers, cold. 26-31 Very cold; snow, then sunny.

Spokane
Pendleton
Boise
Reno
Salt Lake City
Grand Junction
Flagstaff

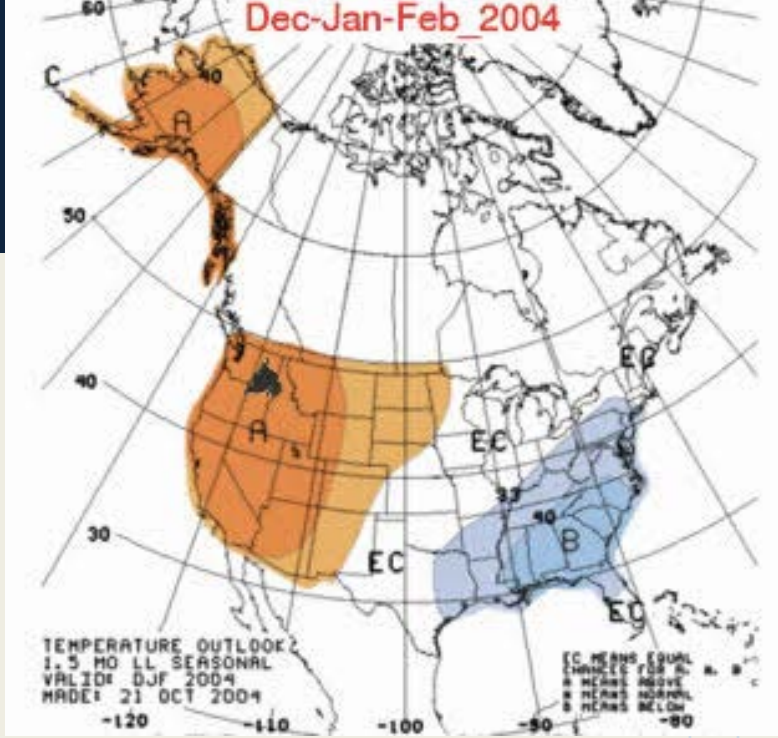
17-23 Chilly, rain and snow showers. 24-30 Cool; sunny, then showers.

MAY 2005: Temp. 57° (2° above avg. east; 2° below west); precip. 1" (0.5" below avg.; 1" above northwest). 1-6 Sunny, warm. 7-13 Cold, rain and snow showers. 14-20 Cool; sunny south, showers north. 21-31 Sunny, warm.

JUNE 2005: Temp. 68° (2° above avg.); precip. 0.5" (avg.). 1-5 Seasonable, t-storms. 6-12 Sunny, warm. 13-17 T-storm, then sunny, cool. 18-30 Sunny, warm.

Climate Prediction Center

- CPC issues 1-13 month seasonal climate outlooks (each month)
  - As well as short-term outlooks (1-2 weeks)
  - Predicts temp and precip. as well as soil moisture, UV index and drought
- Probabilistic forecasts were used (available from October 1995-present)
  - Probabilities of temperature and precipitation departing from normal
- Could only be recorded as binary data points



Tested Datasets

- All forecast predictions made in October for November-May (1.5-8.5 lead time)
- Split into 3 intervals: November-March, December-February (winter), March-May (spring)
- Time span: NMME (1982-2010), *OFA*
  (1981-2010 excluding ‘82 and ‘84), CPC (1995-2015)

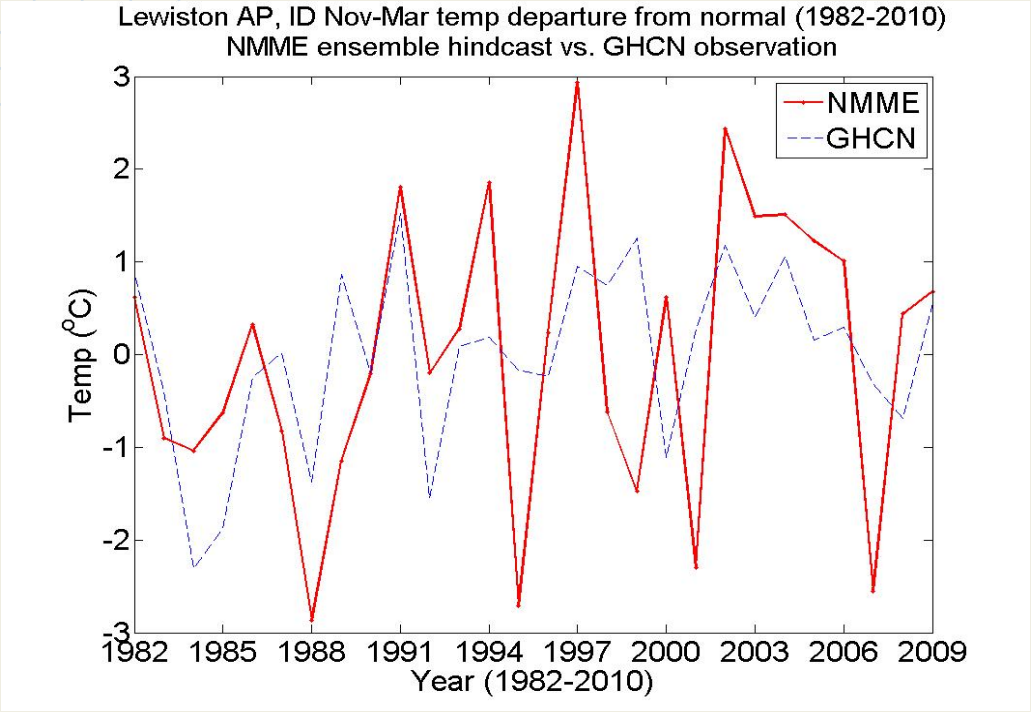
Metrics

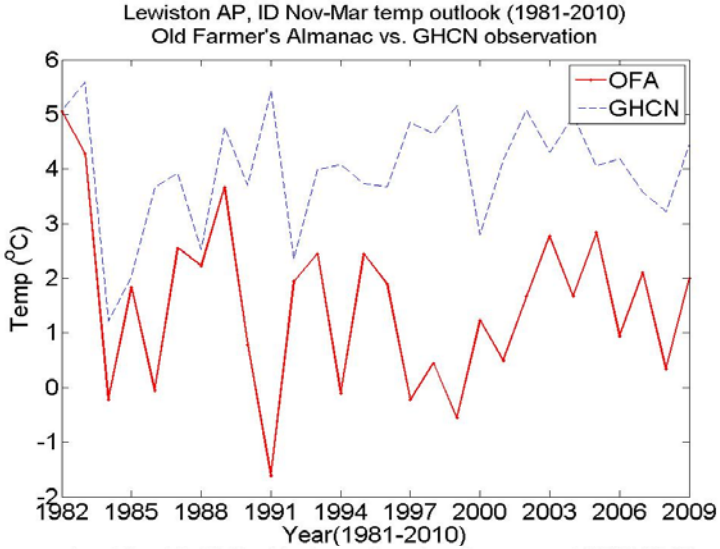
- 3 metrics generated: Normalized Root Mean Square Error (NMME & *OFA*), Correlation analysis(NMME & *OFA*), Heidke Skill Score (all three)
  - RMSE compares difference between predicted forecasts to observed data
  - Correlations compare changes in values and similarities in trends
  - HSS observes whether or not a predicted event occurred (probabilistic)
- Bias corrections:
  - Temperature departures were compared (Celsius)
  - Precip. was found as a percent of normal (mm to %)

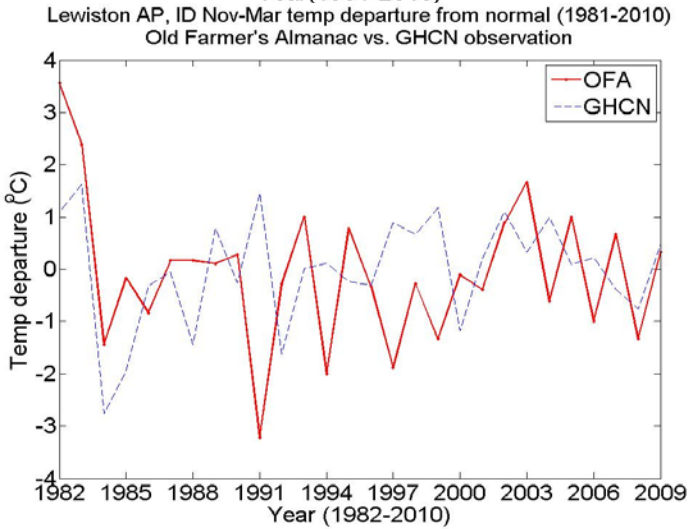
$$\mathrm{RMSD} = \sqrt{\frac{\sum_{t=1}^{n} (\hat{y}_t - y)^2}{n}}.$$

$$HSS = 100 * \frac{(H - E)}{(T - E)}$$

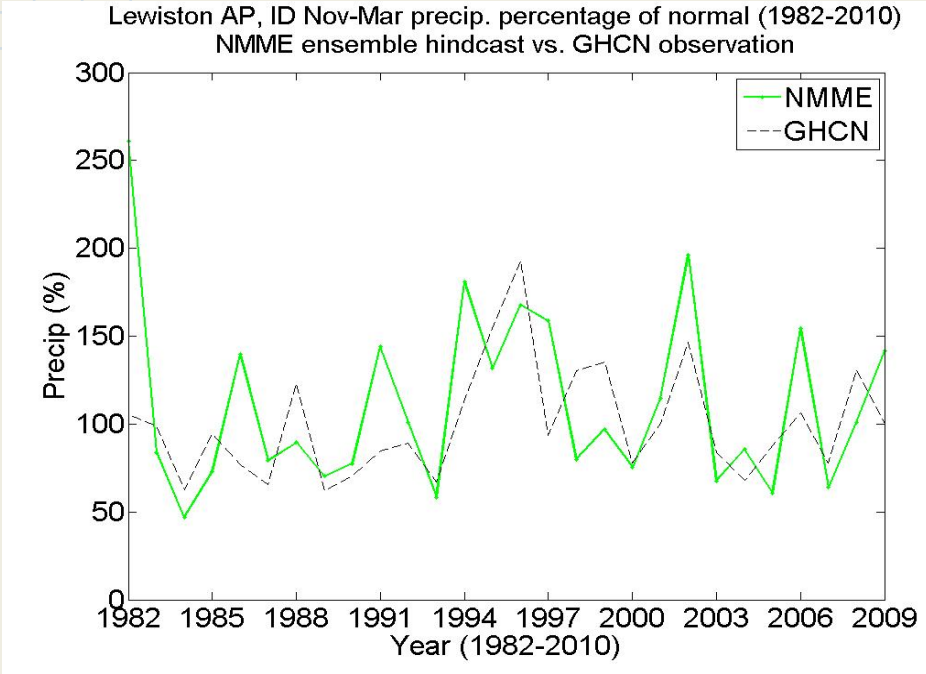
Temp (NMME & *OFA*)

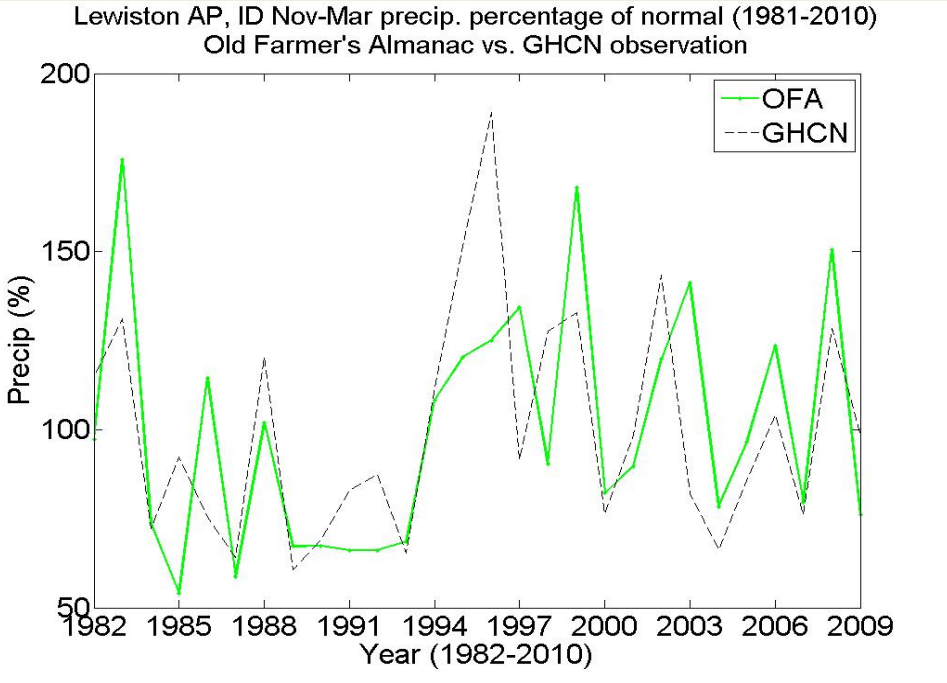






Precip. (NMME & *OFA*)

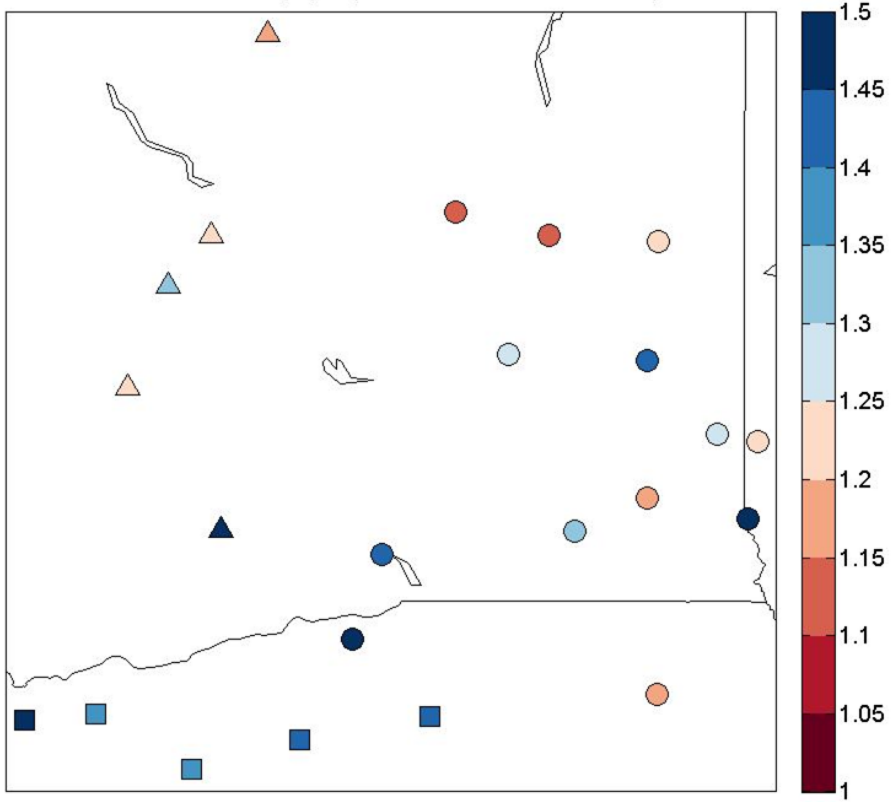




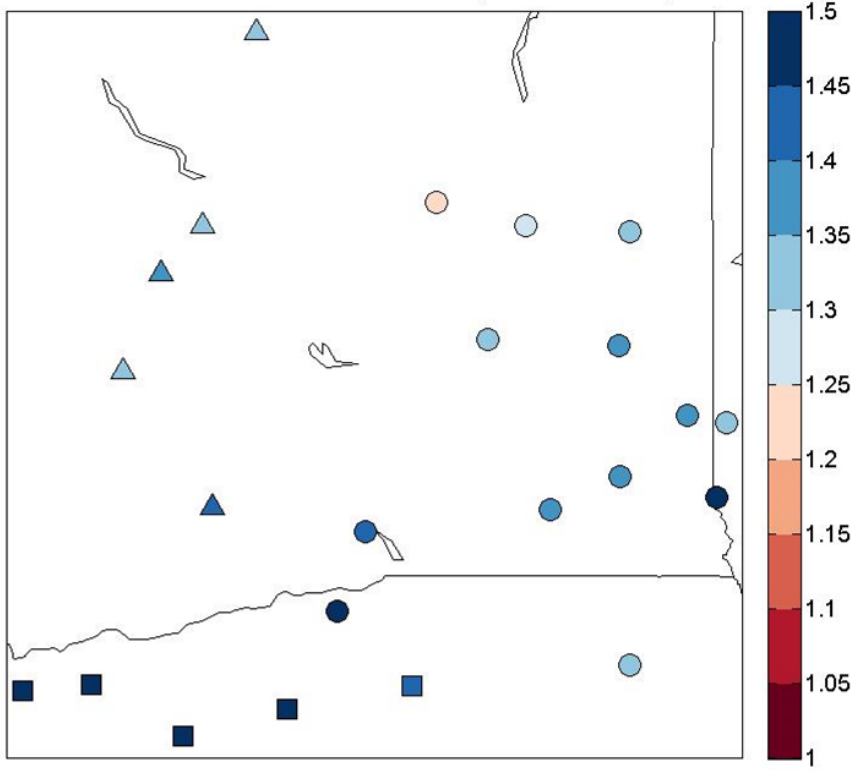
Results (RMSE)

Temperature

November-March Temp(°C) RMSE of NMME (1.5-5.5 lead)

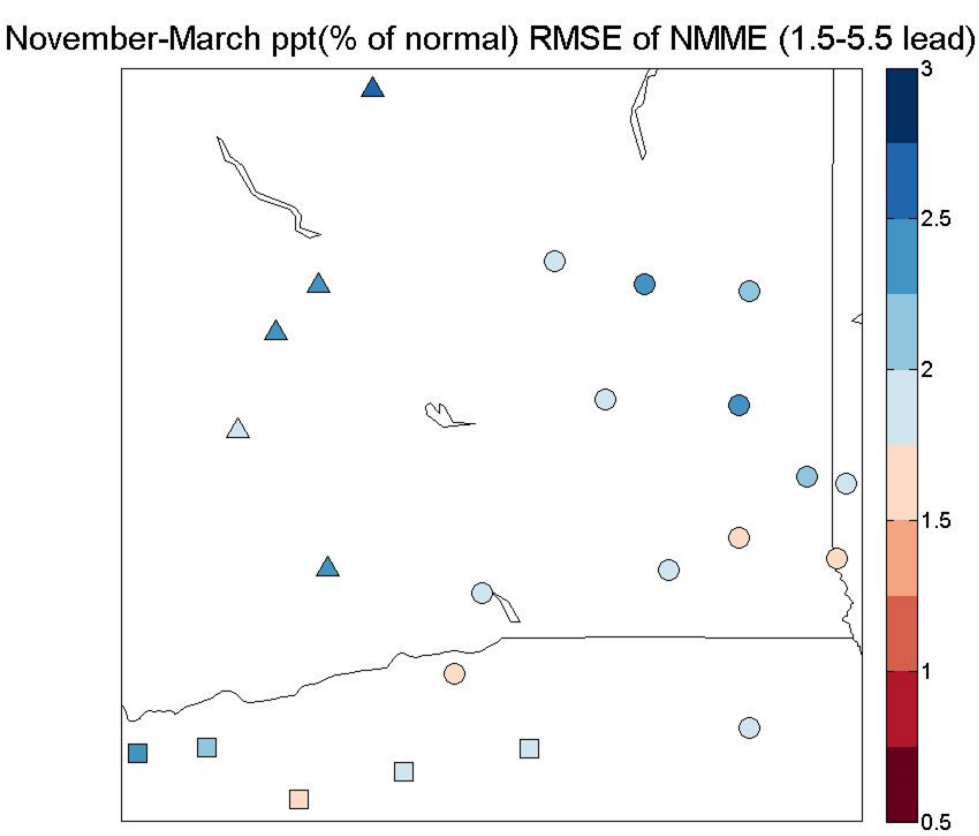


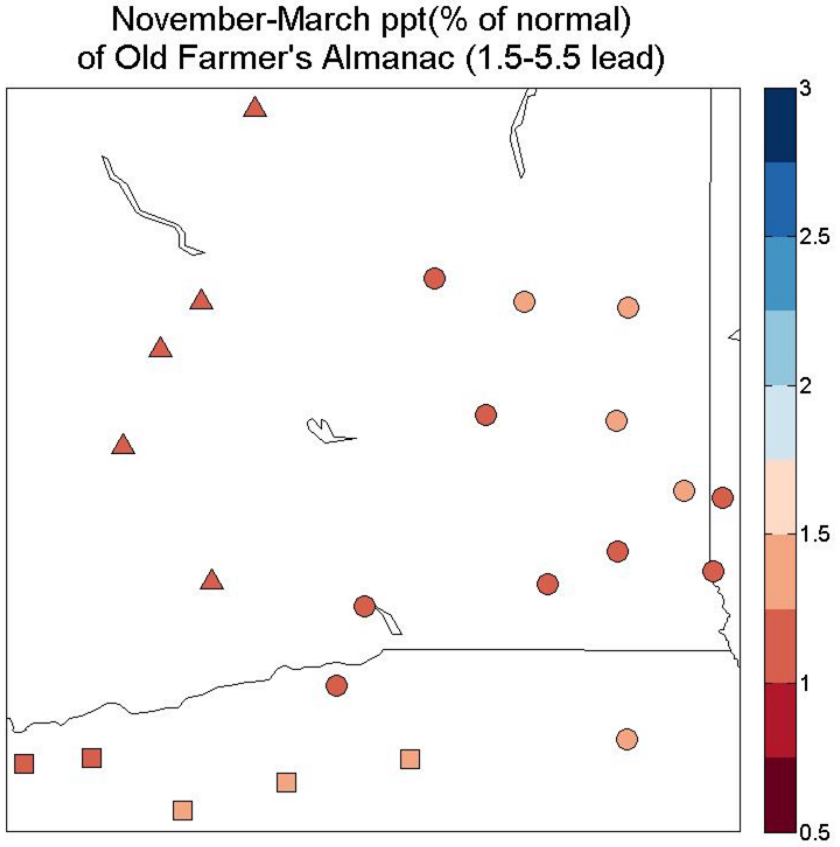
November-March Temp(°C) RMSE of Old Farmer's Almanac (1.5-5.5 lead)



RMSE cont'd

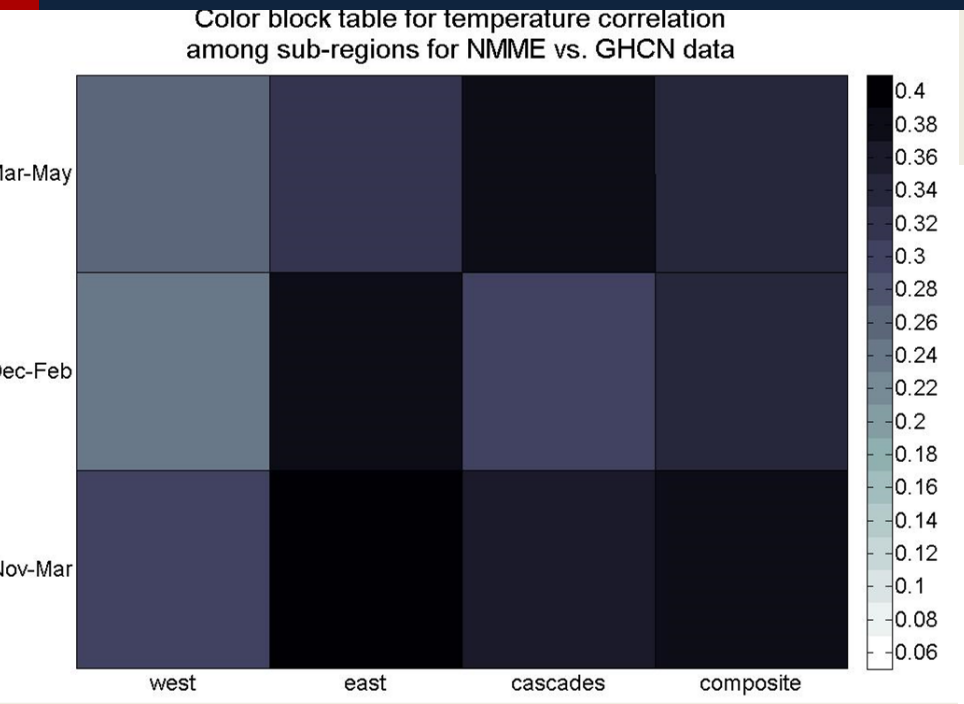
Precipitation

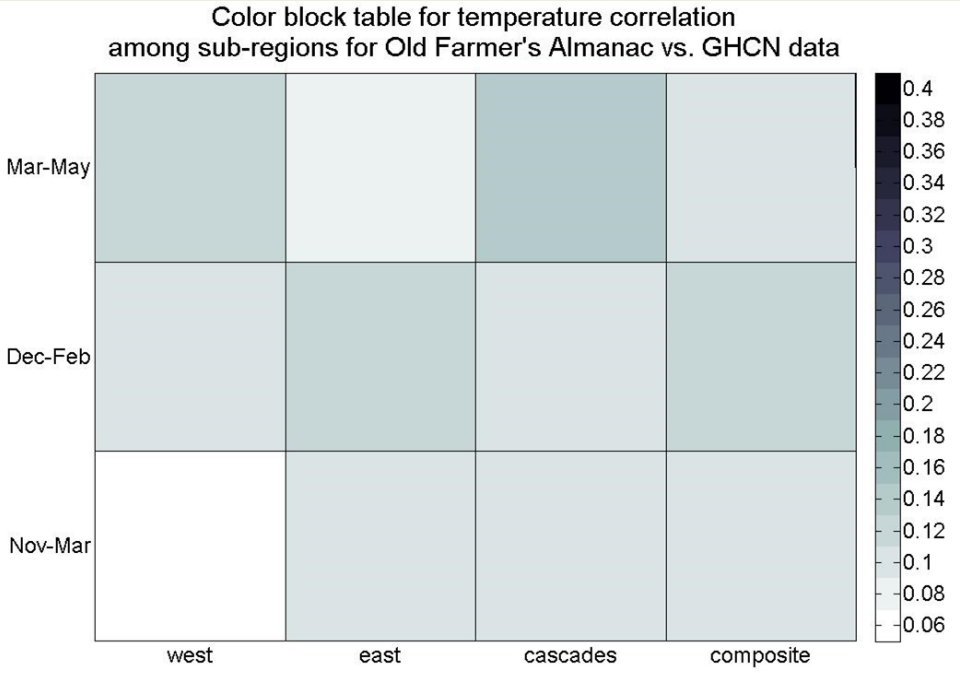




Correlation Analysis

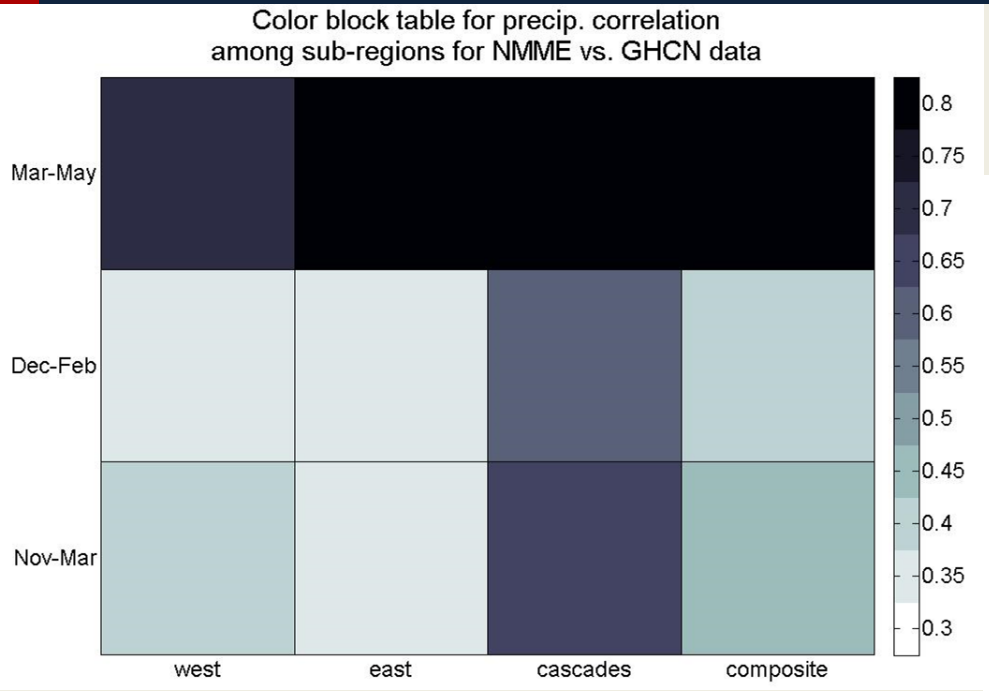
Temperature

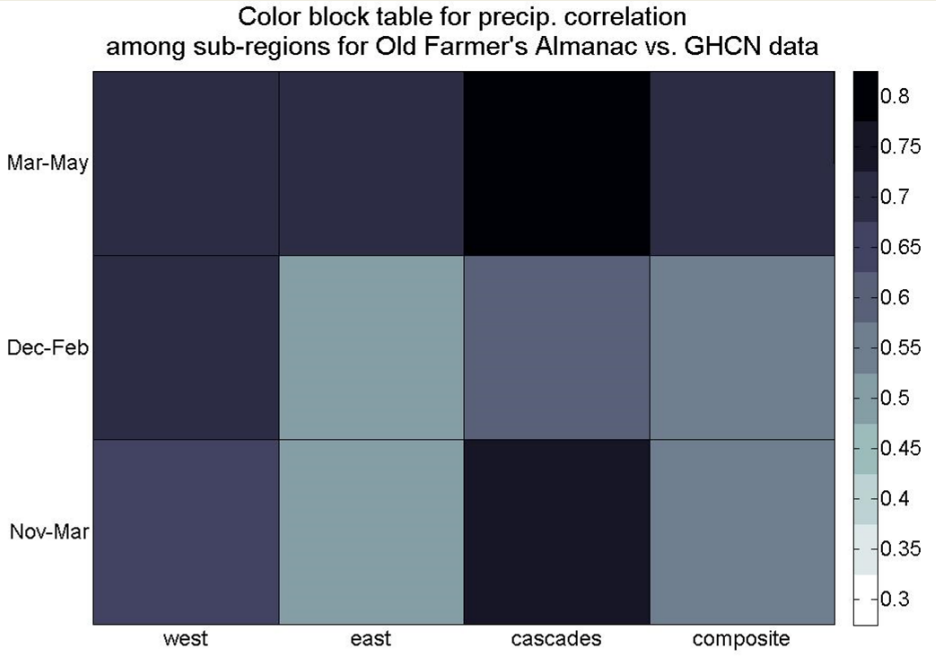




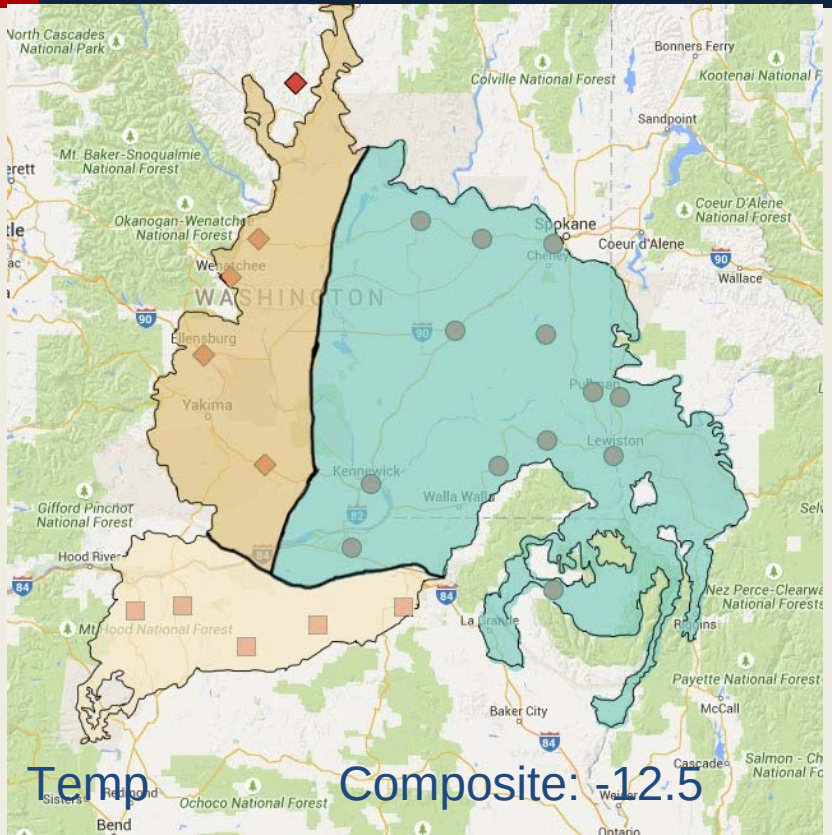
Correlation Analysis cont'd

Precipitation

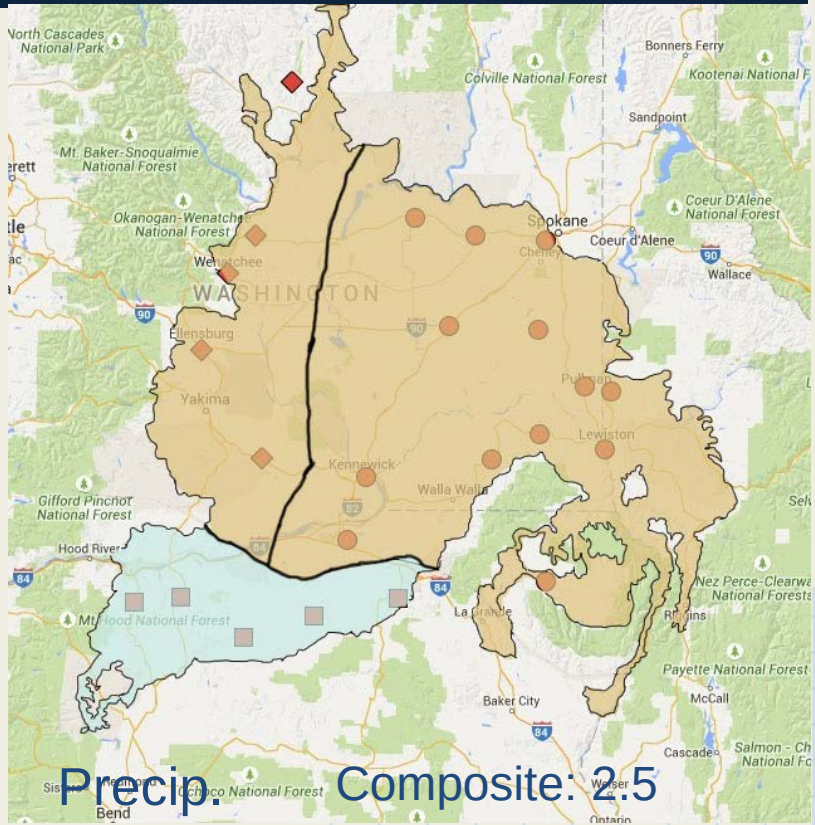




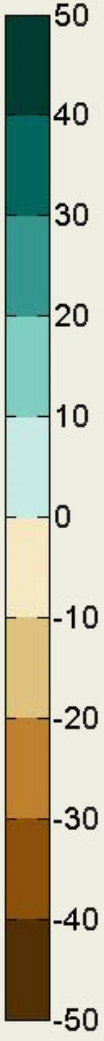
Heidke Skill Score for CPC data (Nov-Mar)



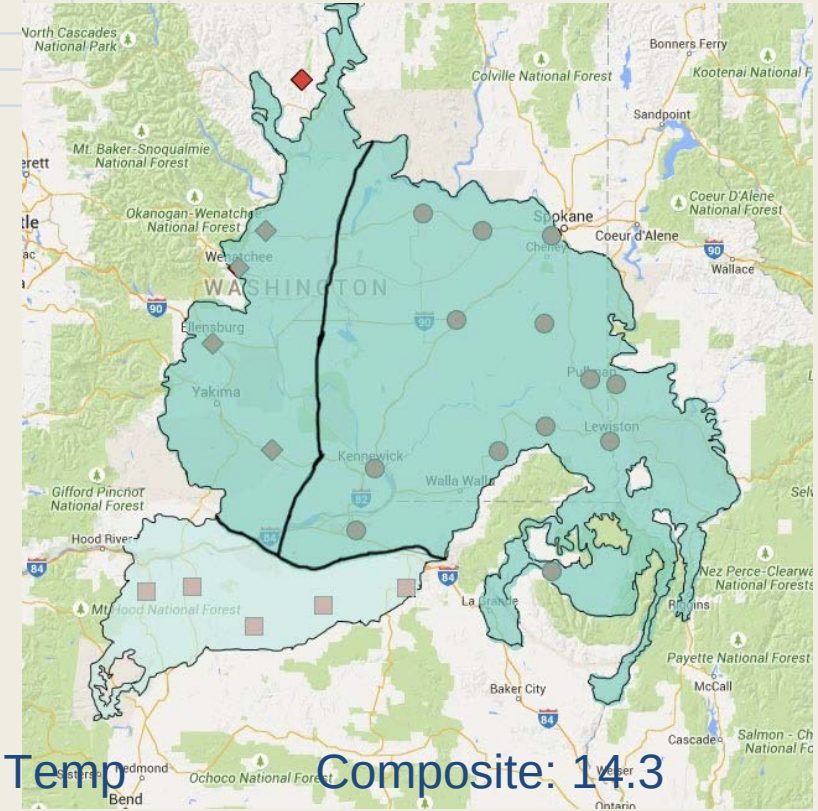
Temp Composite: -12.5



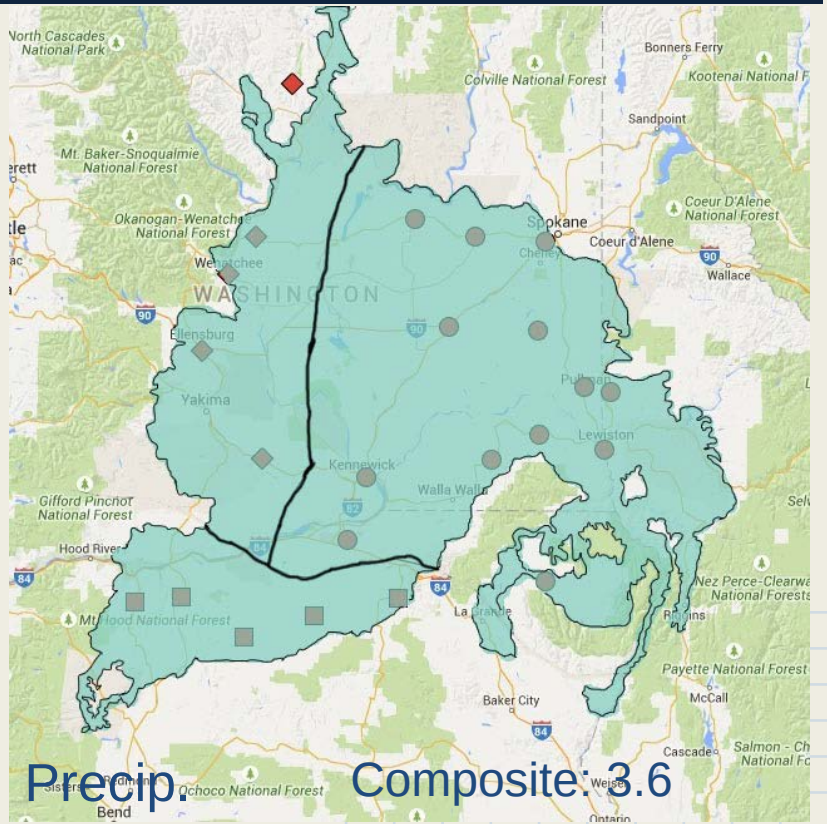
Precip. Composite: 2.5



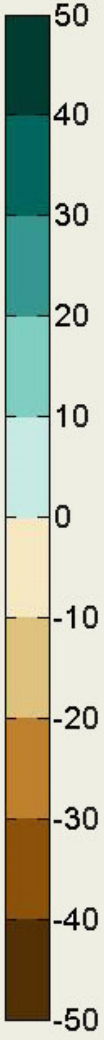
Heidke Skill Score for NMME data (Nov-Mar)



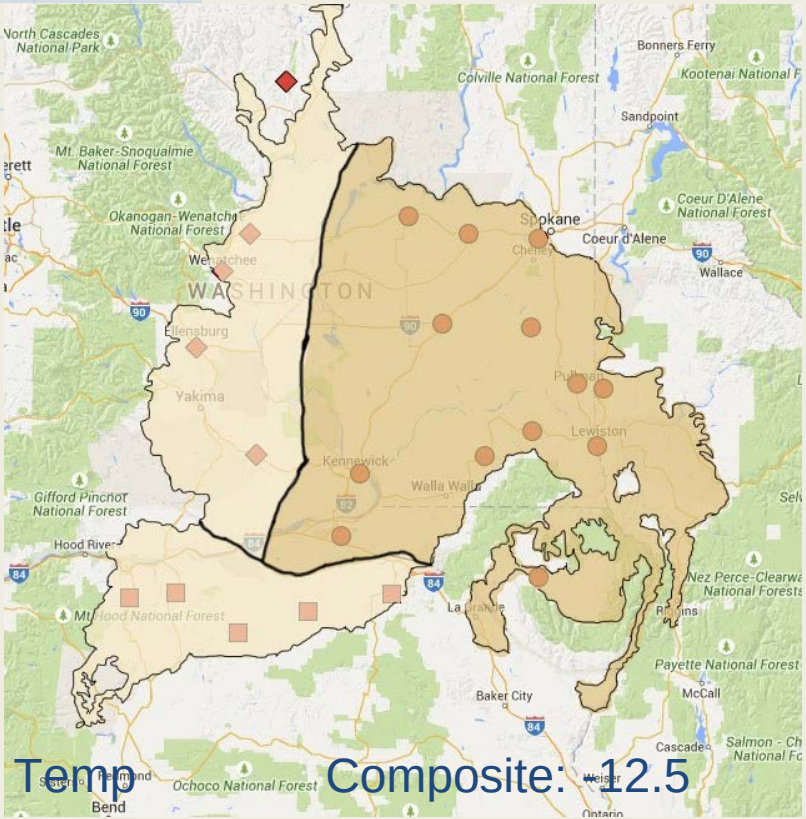
Temp Composite: 14.3



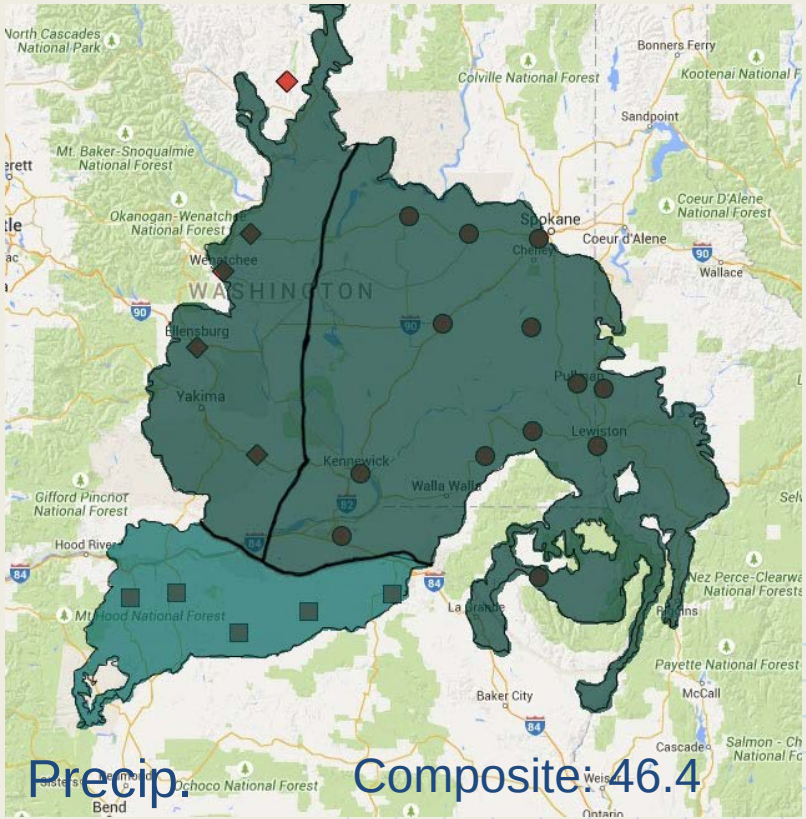
Precip Composite: 3.6



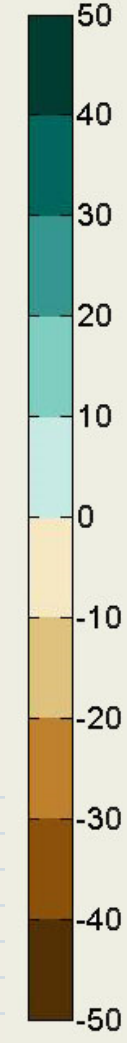
Heidke Skill Score for OFA data (Nov-Mar)



Temp Composite: 12.5



Precip. Composite: 46.4



Conclusions

- Overall, NMME had stronger skill
  - Exhibited some weaker results than expected
  - *Old Farmer's Almanac* was not phenomenally inaccurate.
- Recommendations:
  - Would not recommend CPC (not good for local climate)
  - Would not recommend *OFA* (also too broad of a region, but could be useful for precip.)
  - Using a localized variation of NMME data would be one's best bet
- Limitations/sources of error:
  - Data availability and recording data
  - Spatial scope of each model varied

Acknowledgements

- Dr. John Abatzoglou- mentor
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- Marijka Haverhals- transportation/coordinator
- Models and databases:
  - NOAA National Centers for Environmental Information (NCEI)
  - NOAA Climate Prediction Center (CPC)
  - MATLAB (2011)
- Pertinent literature:
  - *Old Farmer's Almanac* (1981-1015 editions)(U of I library)
  - *Statistical Methods in the Atmospheric Sciences*, Daniel S. Wilks (3rd ed.)

all hail matlab