

# WRF-ARW on Farber

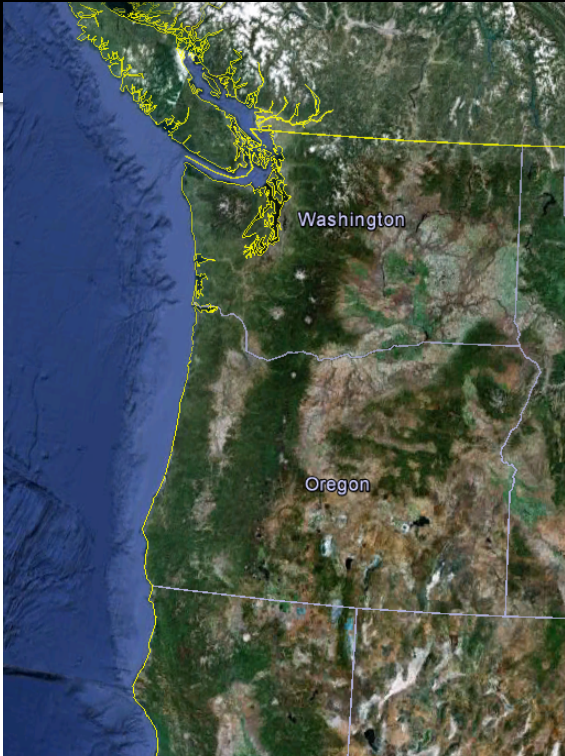
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HPC Workshop

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# Research and Applications



## Research Interests:

- Pacific Northwest regional climate
- Western US water resources
- Regional Climate Modeling
- Decadal-scale Ocean Variability

## Tools:

- WRF-ARW Regional Climate Model
- Observational Climate Data

## Current work:

- How does the Pacific Decadal Oscillation affect winter precipitation in the Cascades?
- Which of WRF's cloud microphysics options provides the best simulation of winter precipitation in the complex terrain of the Pacific NW?

# Research and Applications

Pacific Decadal Oscillation (PDO)

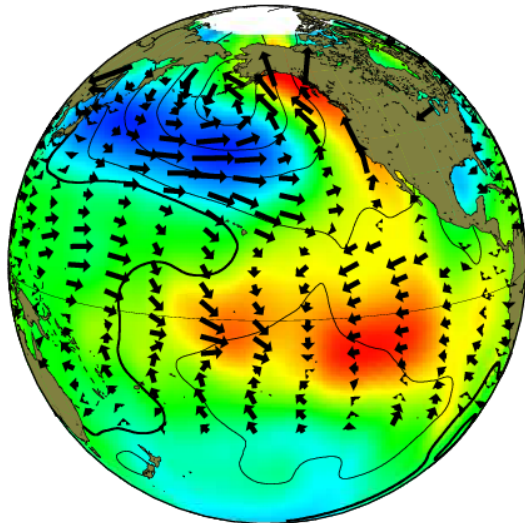
North Pacific Sea Surface Temperature variability

One regime typically dominates for about 30 years

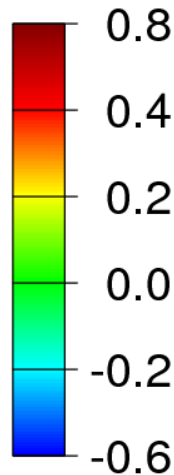
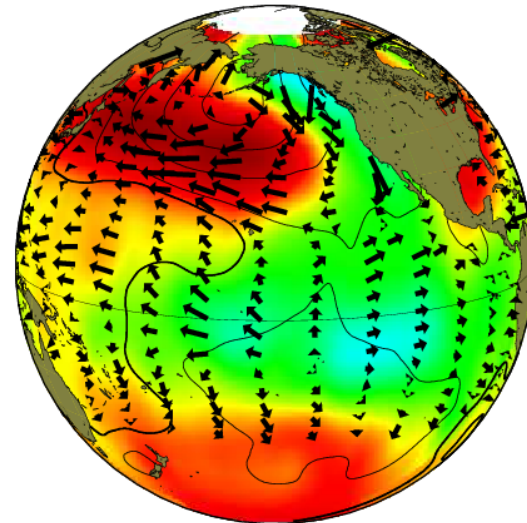
Affects western US weather

Can interact with ENSO

**positive phase**



**negative phase**



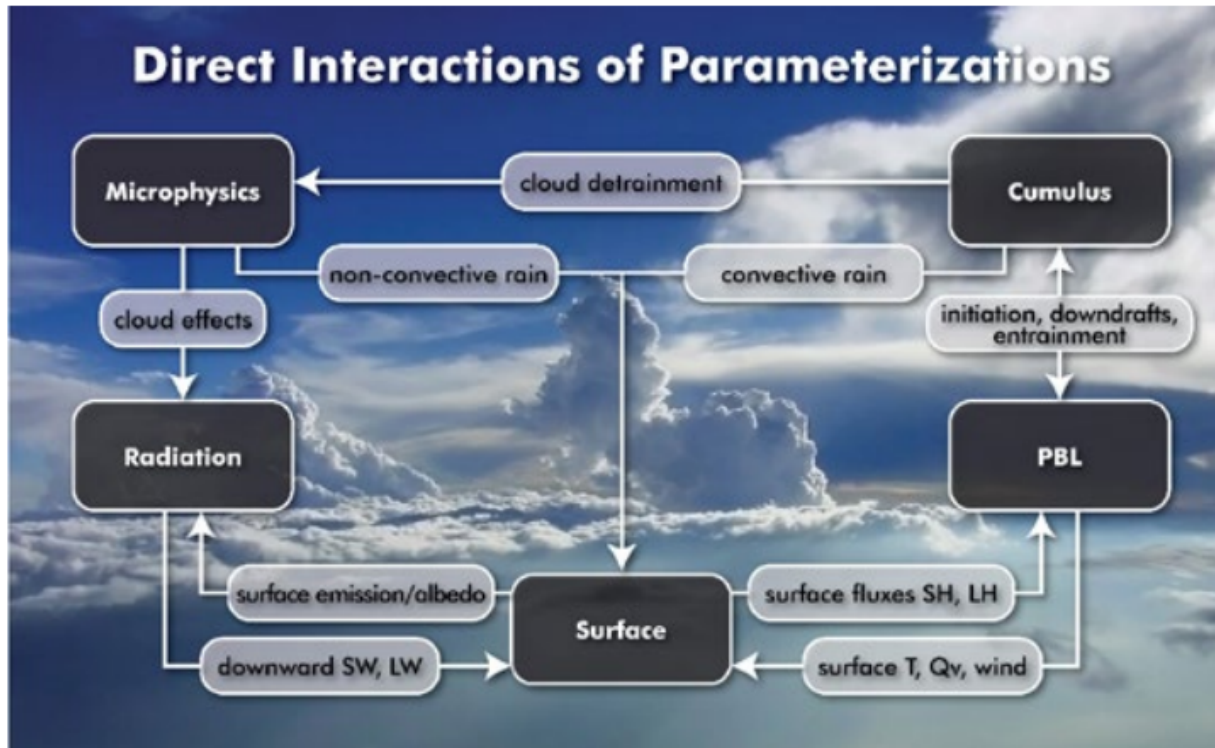
# WRF-ARW

- Highly customizable – user can specify between many physics submodels for cloud processes, radiative transfer, land surface processes, etc.
- Cloud Microphysics (MP) Options
  - Single-moment: includes only mixing ratio (g/kg)
  - Double-moment: includes mixing ratio and number concentration ( $\#/m^3$ )



# Physics options in WRF-ARW

- WRF has a variety of parameterizations for cloud microphysics (MP), turbulence and fluxes in the planetary boundary layer (PBL), radiative transfer, and land surface processes



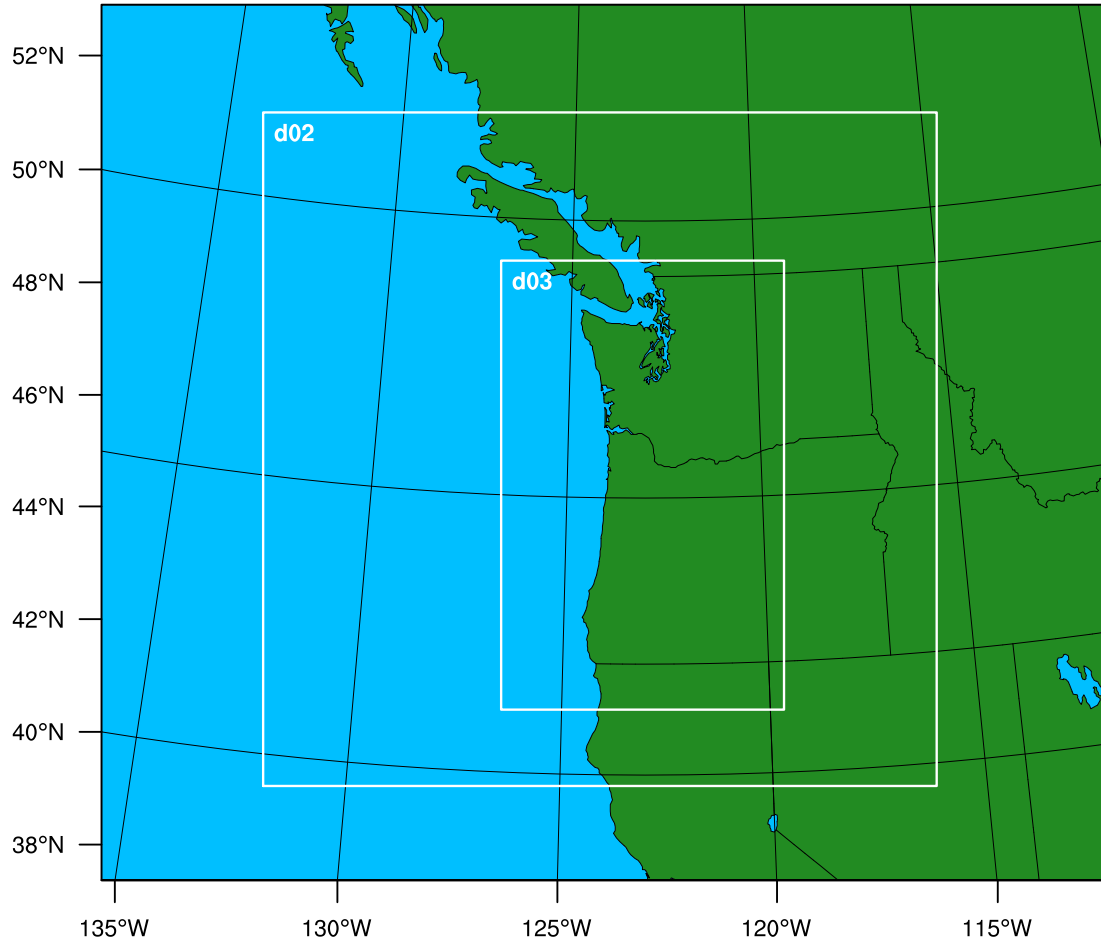
WRF model physics chart showing direct interactions of parameterizations.

Image source:  
Developmental Testbed Center

# Test Runs Completed on Mills

- Research Question:
  - Do different cloud microphysics (MP) and planetary boundary layer (PBL) parameterizations lead to differences in simulated total precipitation in the Pacific Northwest?
  - 5-day simulation in January
- Completed on Geography Dept node
- 12 processors

# Test Runs Completed on Mills



Horizontal resolution:

3 nested domains:

□ d1: 27 km

□ d2: 9 km

□ d3: 3 km

Vertical resolution:

30 vertical levels

Simulated 00Z on

January 1, 1996 through

21Z on January 5, 1996

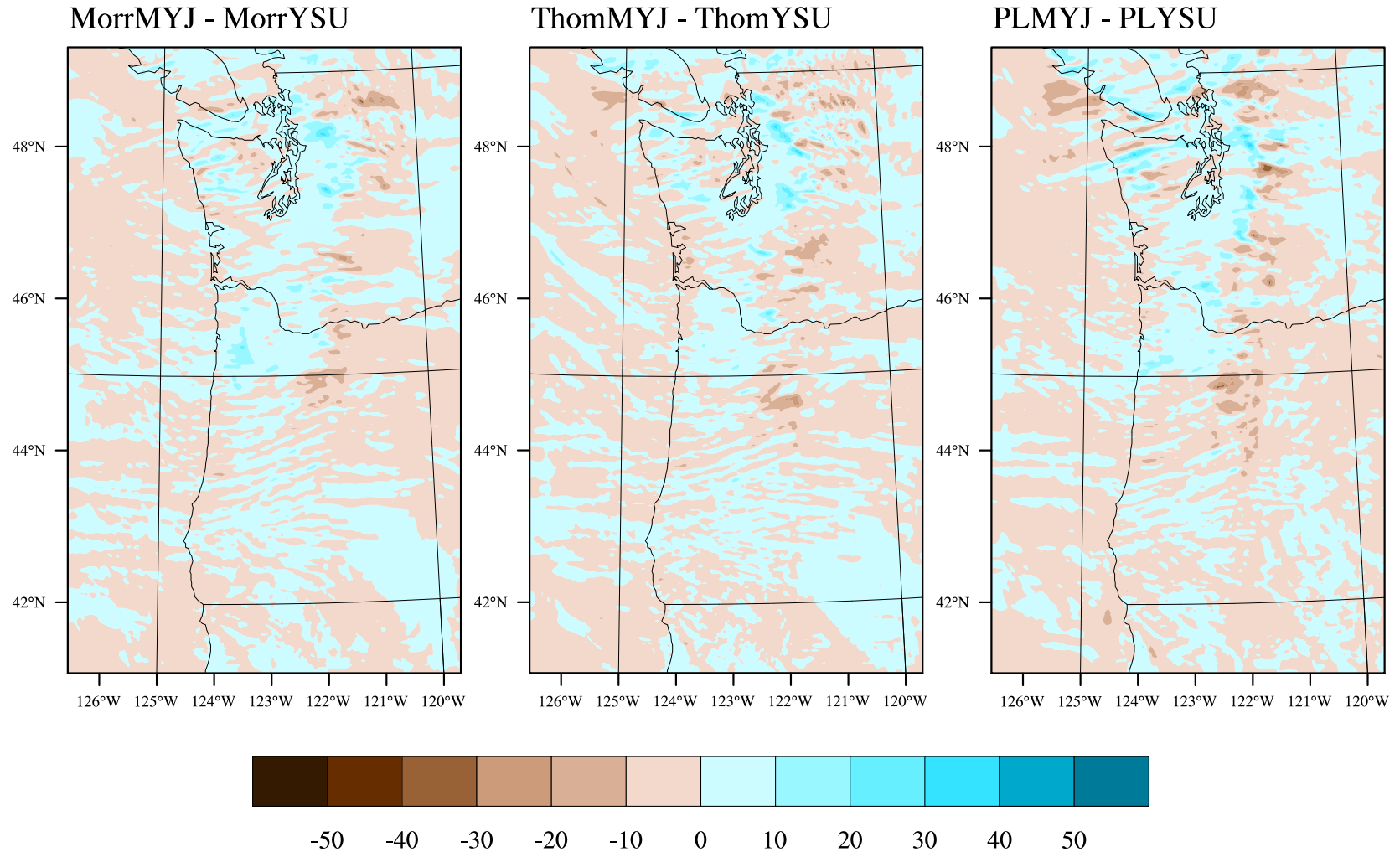
Input Data: North

American Regional

Reanalysis (NARR)

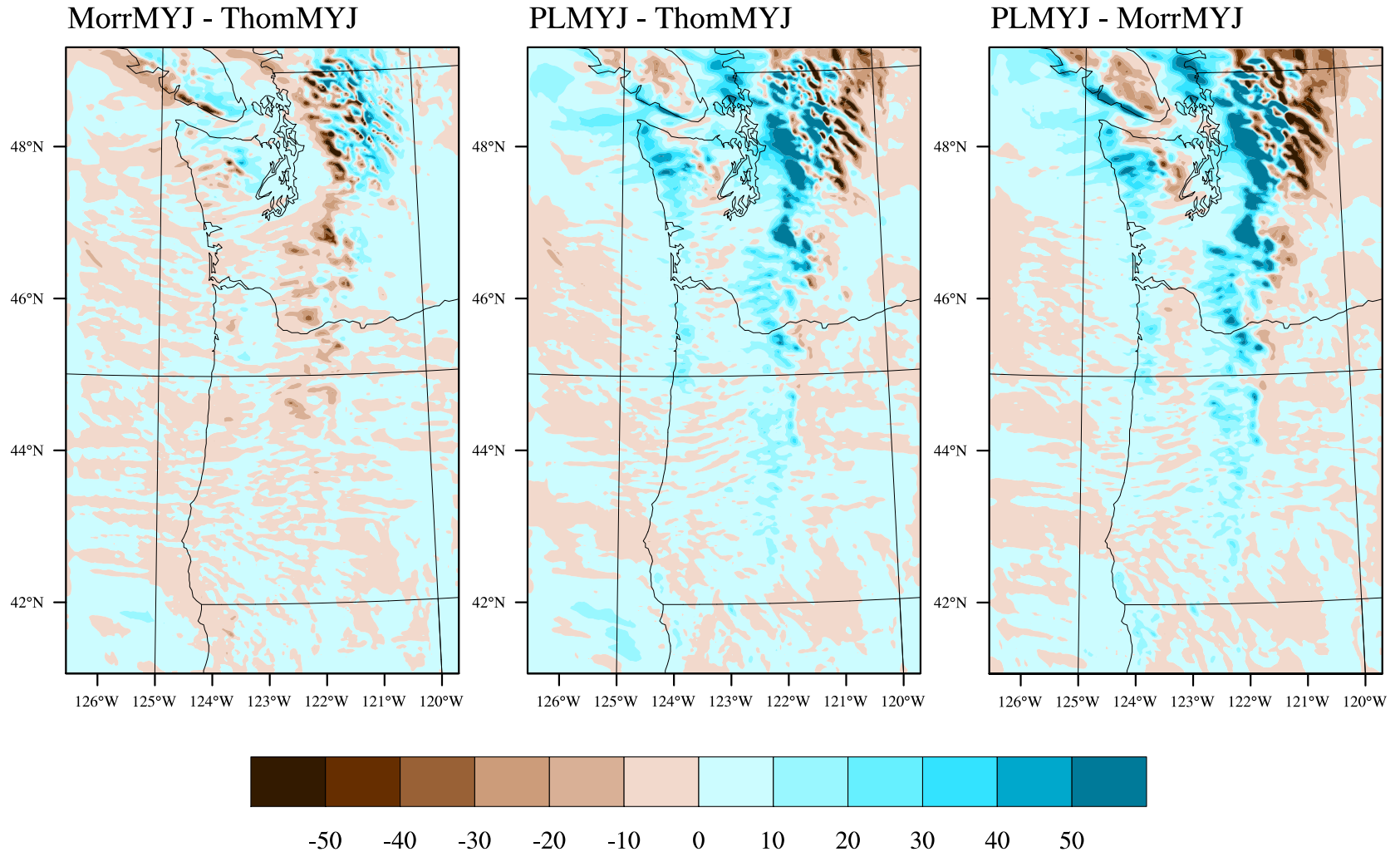
# Test run results – PBL Comparison

Total Precipitation Difference (mm)



# Test Run Results – MP Comparison

Total Precipitation Difference (mm)



# WRF-ARW Setup on Farber

- VALET packages used:
  - openmpi/1.8.2-intel64
  - netcdf/4.1.3-intel64
  - NCL (for analysis of results)
- Compiler changes
  - Intel instead of PGI
- Changes to WRF configuration
  - Thanks, IT!!
- Need to specify memory requirements



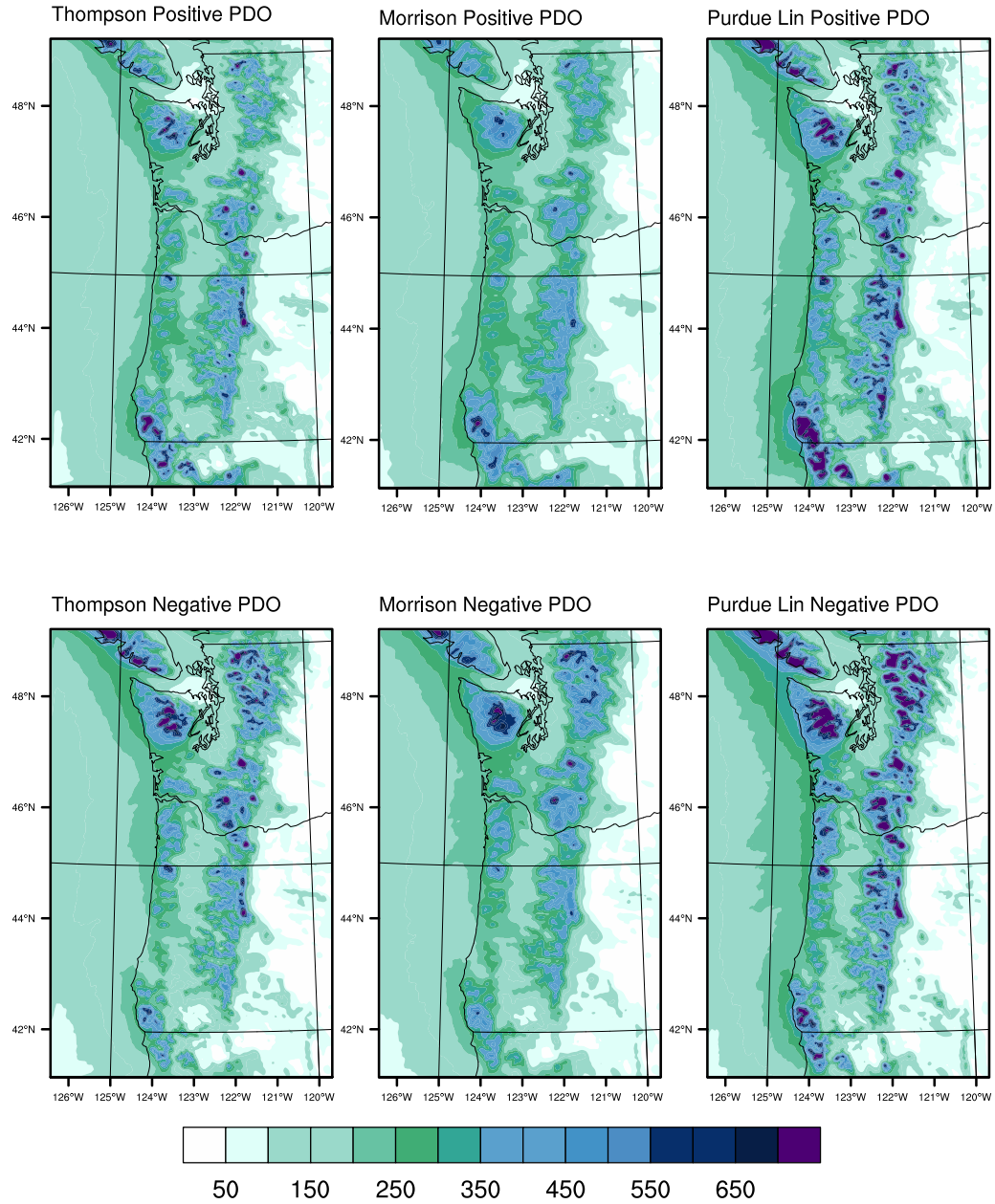
# Running WRF on Farber

- Completed on Rauscher workgroup nodes
- 12 processors
- 5 GB memory per processor
- Write output to /lustre/scratch
  - Lustre storage is faster than NFS storage used on /home/work

# Dissertation Research on Farber

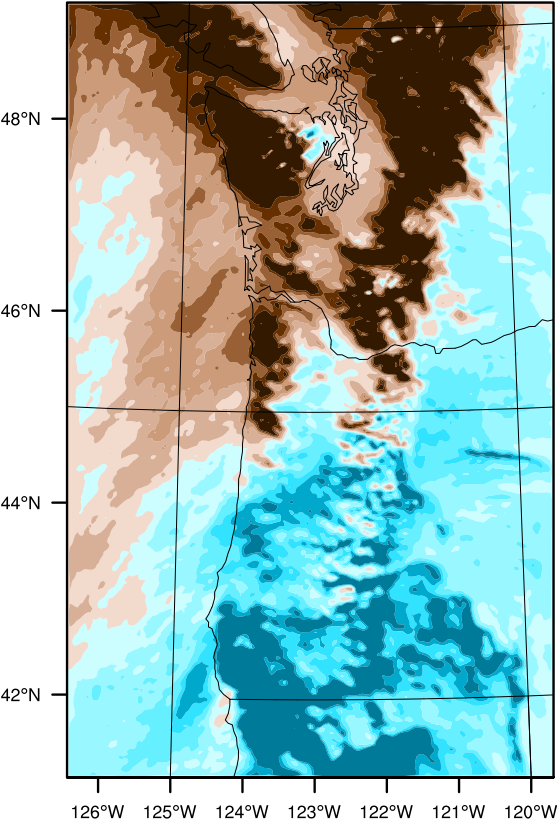
- Research Question:
  - How does PDO phase affect winter precipitation in the Pacific NW, especially the Cascades?
- Model runs completed on 4/21
- Month-long simulations (month of January)
  - 10 positive PDO years, 10 negative PDO years
  - 3 MP options for each year

# Total Precipitation (mm)

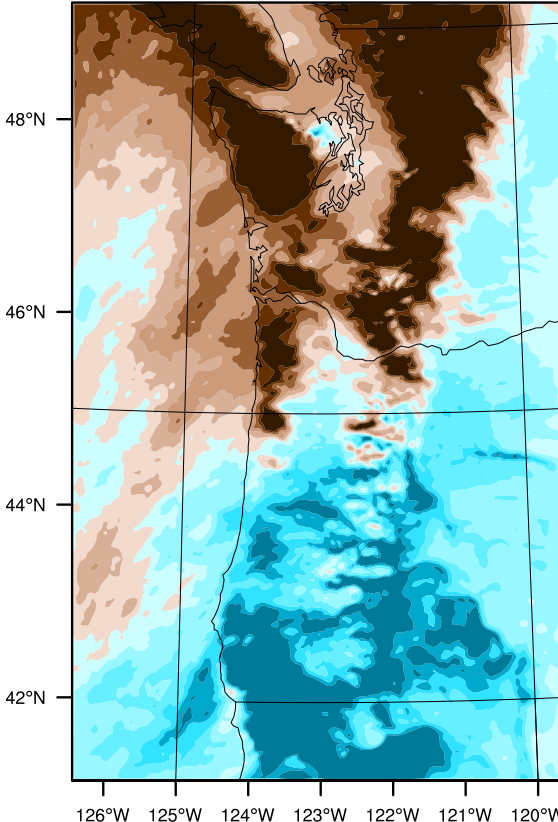


# Total Precipitation Difference (Positive - Negative) (mm)

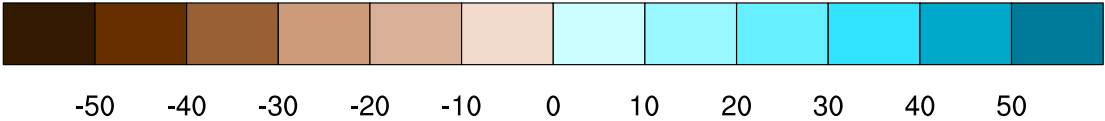
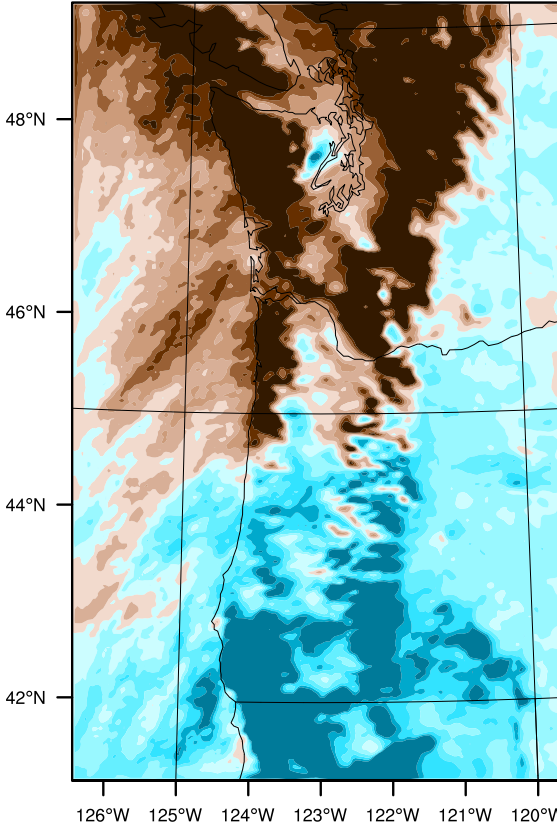
Thompson



Morrison



Purdue Lin



# Summary and Future Work

- Preliminary results indicate that a Positive PDO Index leads to lower January precipitation in WA and higher January precipitation in OR
- Future work:
  - Compare to observational data
  - Other affects on precipitation: elevation, variability, intensity, etc.

# Final Thoughts

- Thank you to the HPC group for your help!
  - Do not be afraid to ask questions
- Addition of NCO on Farber is helpful
  - NetCDF Operators
  - For analysis of gridded data
    - Compute statistics, calculate ensemble averages, pull out specific variables or times, manipulate metadata
- Climate Modeling – storage is the limiting factor



# Thank you!

- Dissertation Committee:
  - Dr. Brian Hanson, Geography
  - Dr. Dana Veron, Geography
  - Dr. Sara Rauscher, Geography
  - Dr. Tobias Kukulka, POSE
  - Dr. Michael O'Neal, Geology
- Computing Resources:
  - UD HPC, Mills and Farber computing clusters