

# Regional Climate Simulations over the US and the role of Surface Water in Atmospheric Predictability

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# Introduction and Framework

Land-surface parameters (i.e., **soil moisture** and **snow cover anomalies**) can play an **important role** in influencing the atmosphere on time-scales from seasonal to interannual. This is especially true for **summer**, when the influence of tropical SSTAs over continental climate is reduced while **land-atmosphere interactions are enhanced**.

The **forcing** associated with land surface processes is **complex**: surface heat and water fluxes influence circulation of the overlying atmosphere through convection, evapotranspiration, radiation balance, the amount of energy partitioned into latent and sensible heat fluxes, etc.

A **comprehensive understanding** of the feedbacks between land and atmosphere **is yet to be reached**. Observational data of surface and sub-surface properties are often very scarce (e.g., for soil moisture an observation network over large areas is lacking).

Numerical results may differ depending on the specification of surface parameters provided to land-surface models.

## Motivation and Issues of this study

- What is the influence of surface water (i.e., **soil moisture** and **snow cover**) on the atmospheric predictability at regional scale?
- What are the spatial and temporal scales of surface water variability in relation to atmospheric variability (at interannual, intraseasonal and diurnal scales) over North America?

# Model Description and Setup (1/2)

Long-term climate simulations (January 1979 - December 2004) are being conducted with the Experimental Climate Prediction Center's (ECPC) Regional Spectral Model (RSM)/CVS

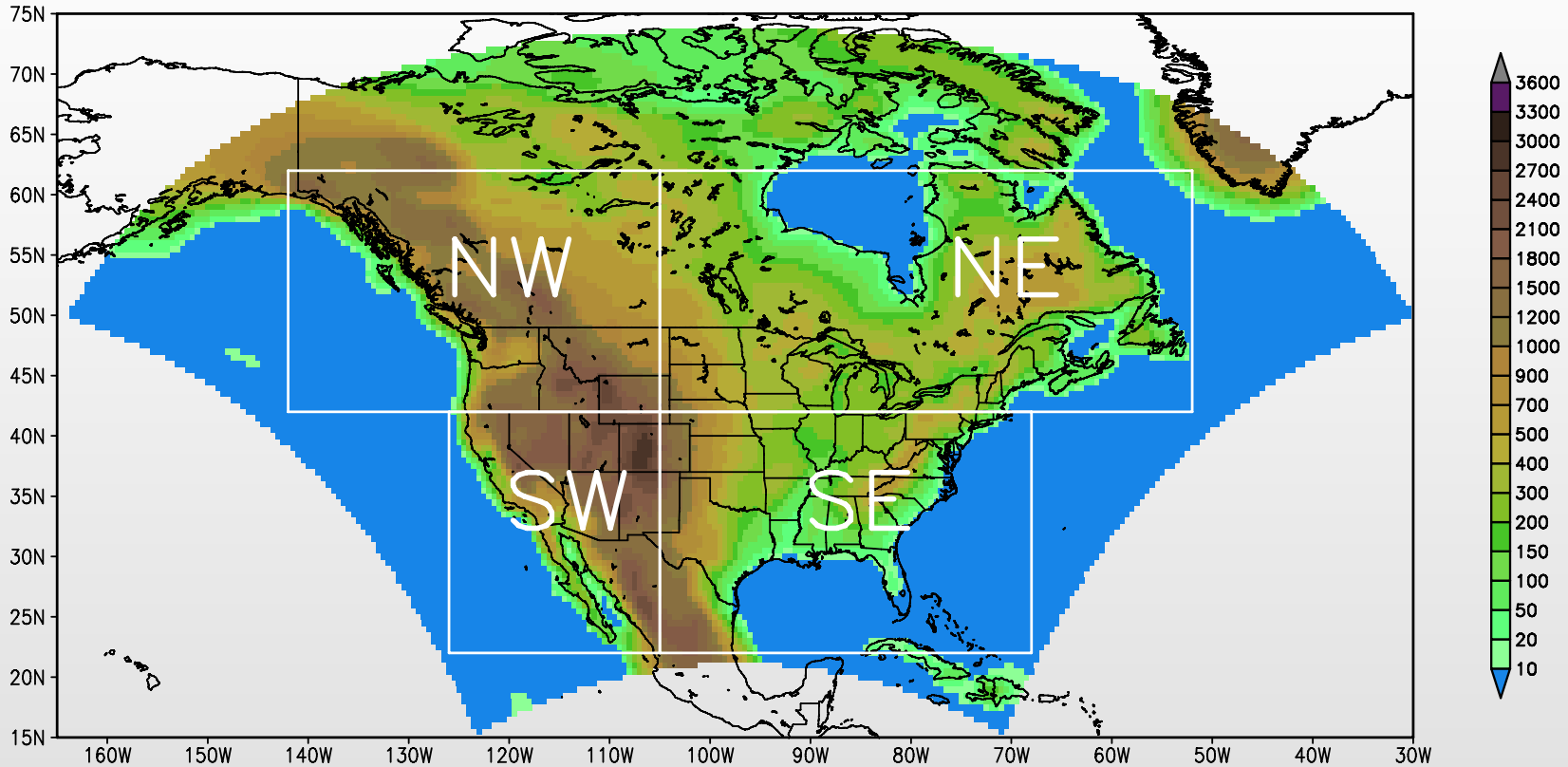
- Resolution of 50 km, 28 vertical levels
- Covering North America [for comparison purposes as similar as possible to other regional model's domains (e.g., NARCCAP Experiment 0.0)]
- new NOAH LSM (4 soil layers)
- Boundary conditions provided every 6 hours by NCEP/DOE Reanalysis II
- Daily-observed SST from ERA-40
- Output data every three hours

*Computational time: 1 year of run ~1.5 day*

Status: (started end of Jan 2005, CTL running)

# Model Description and Setup (2/2)

Domain: 161x130 points – Time interval: 120 sec



Model domain and orography (m). The white rectangles represent four sub-regions where area-average values are computed (in addition to continental US).

# Experiments Design

- 1 CTL: control run ( => *soil hydrology interacts with the atmosphere*)
- 2 CLIM\_SW: every day, predicted **soil moisture** and **snow cover** are replaced with the 25-yr climatology derived from CTL ( => *soil hydrology decoupled from atmosphere*)
- 3 OBS\_PREC: every 3 hrs, predicted **precipitation** is replaced with observed precipitation from the North American Regional Reanalysis ( => *soil moisture close to reality*)
- 4 ANOM\_SW: shorter simulations with climatological soil moisture and snow cover only during **limited** and **significant periods** ( => *persistence of anomalies and response time*)



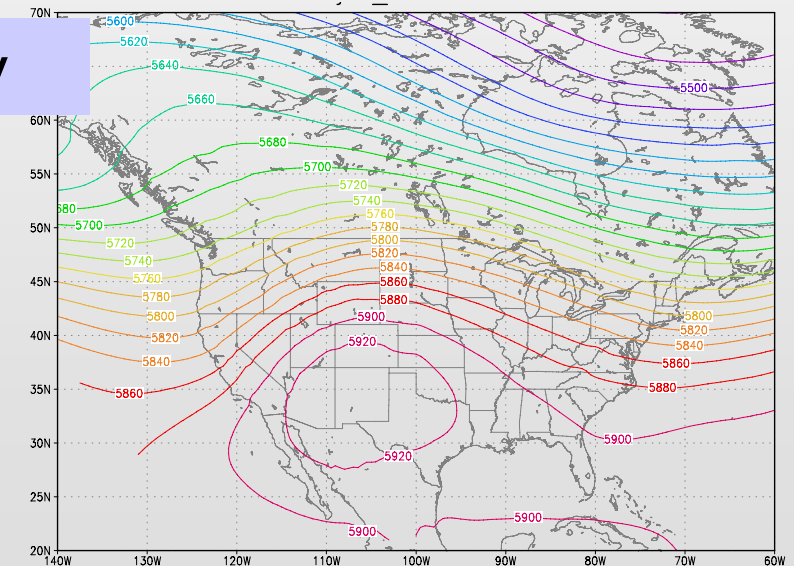
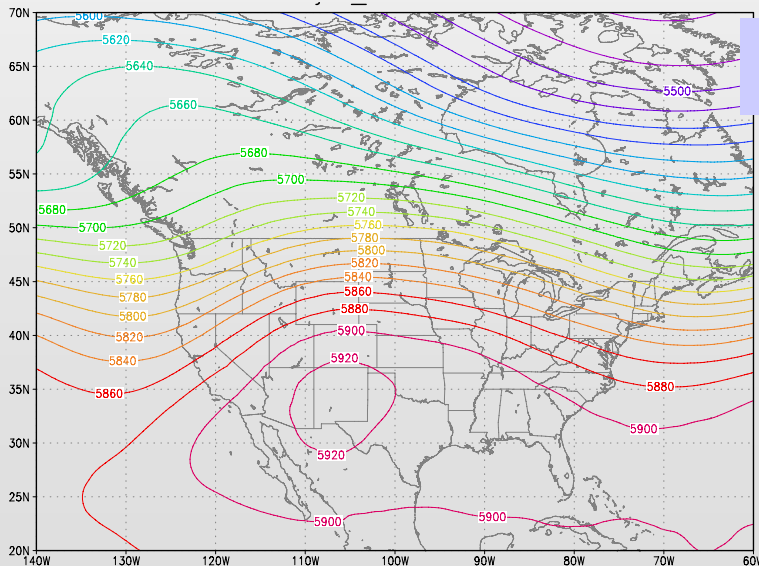
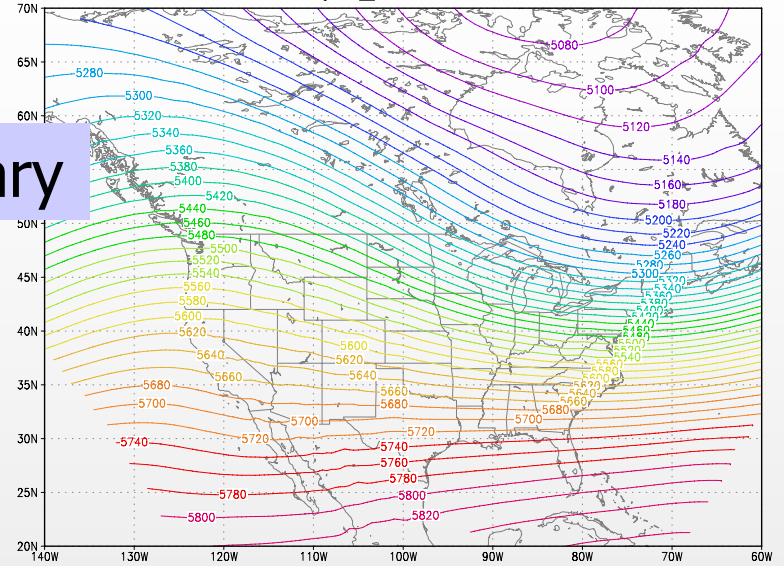
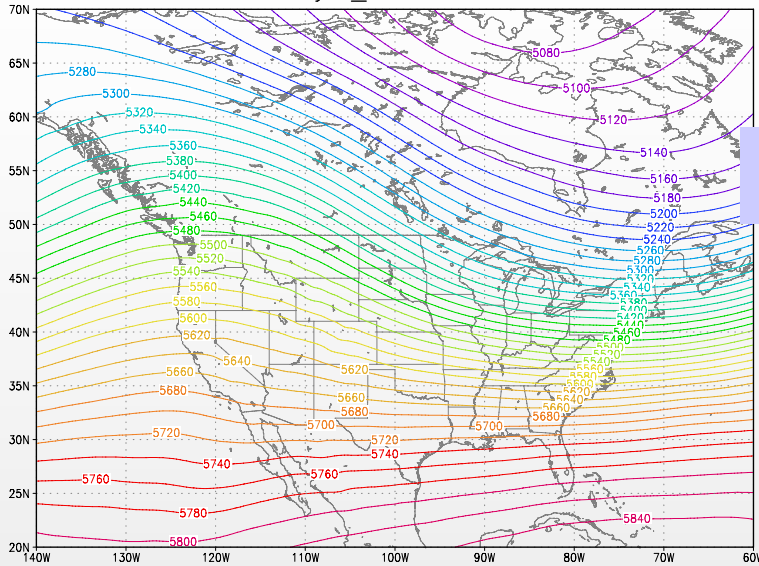
# Preliminary results

NARR

RSM

January

July

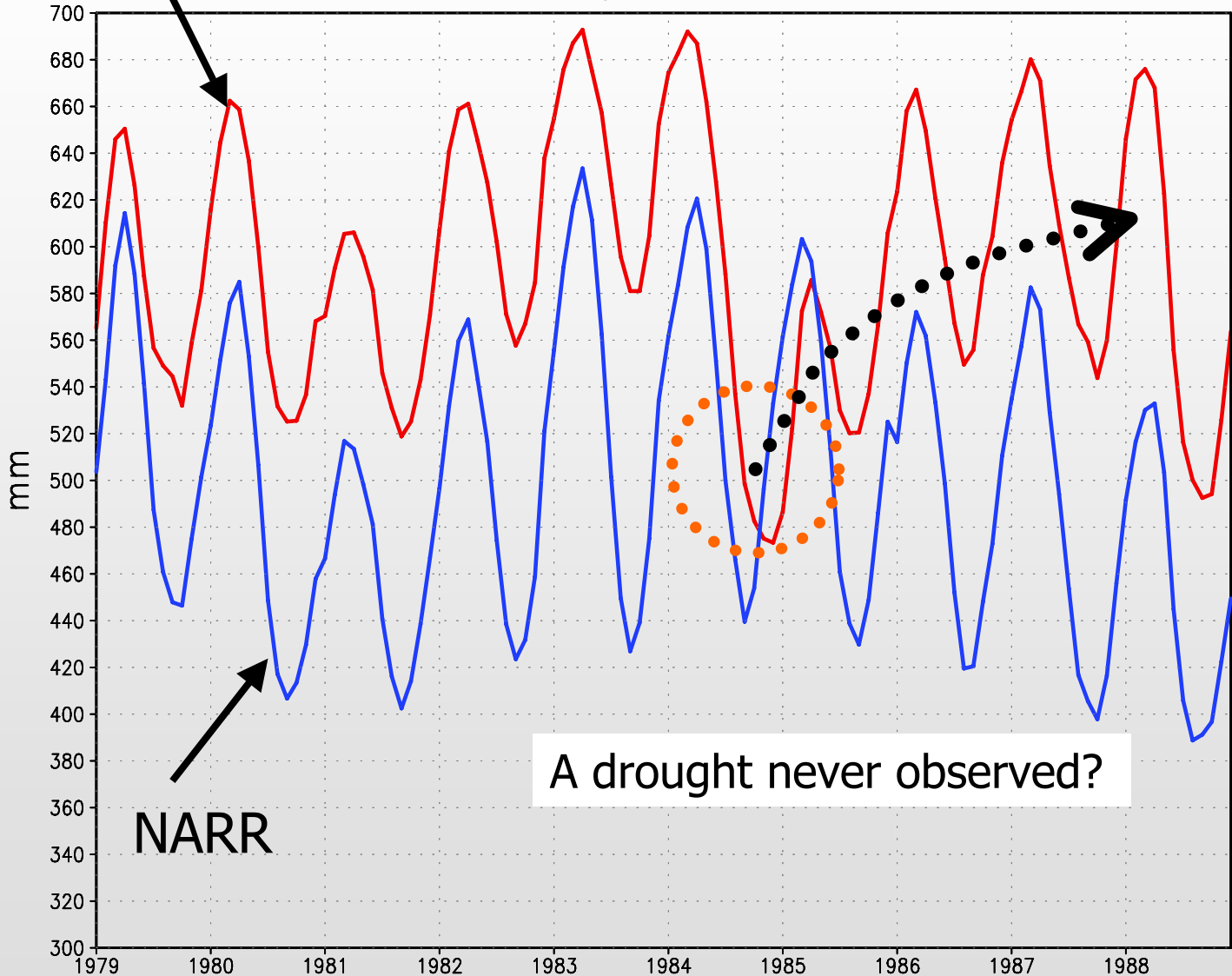


Geopotential height at 500 mb (1979-1983 average)

# Variation of soil moisture

RSM

CTL – Soil Moisture  
Continental US: jan 1979 to dec 1988



NARR

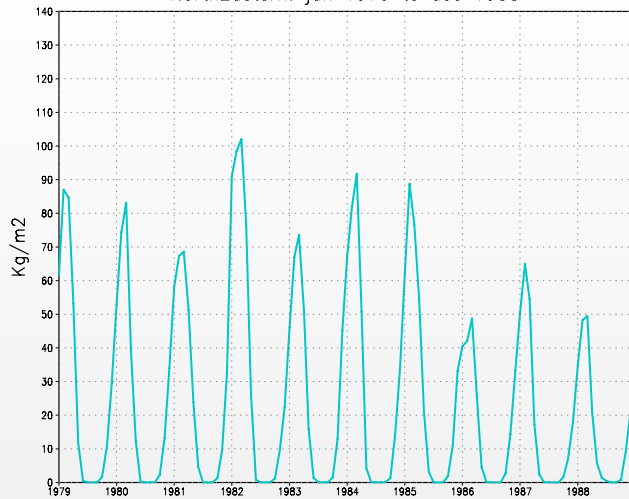
A drought never observed?



# Variation of snow depth

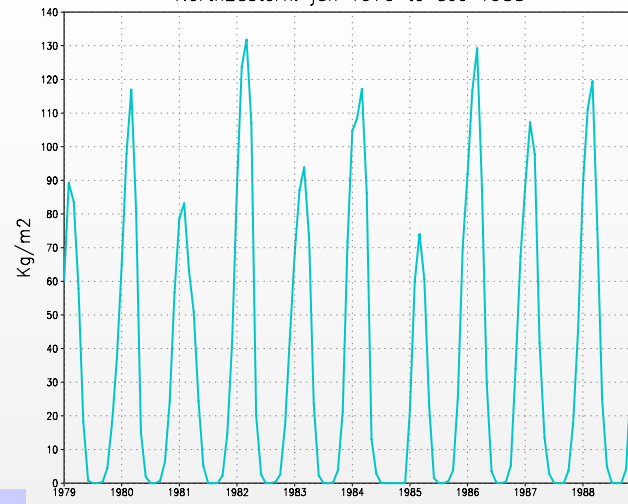
NARR

NARR - Snow Depth  
NorthEastern: jan 1979 to dec 1988

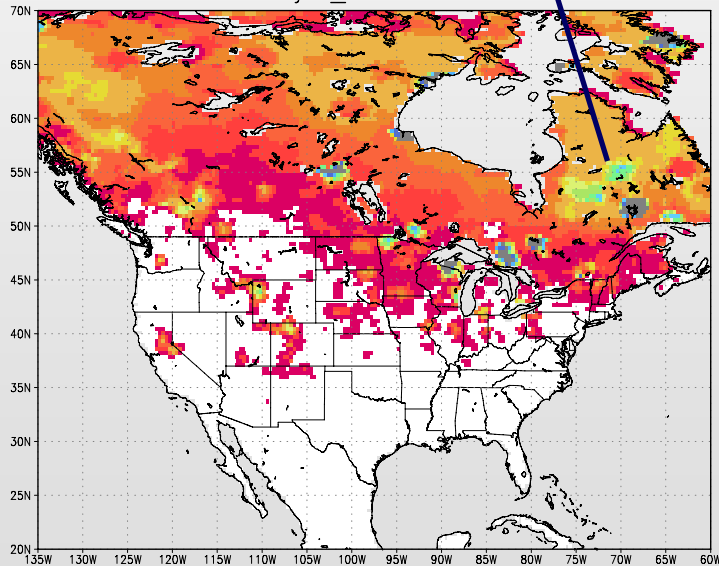


RSM

CTL - Snow Deg  
NorthEastern: jan 1979 to dec 1988

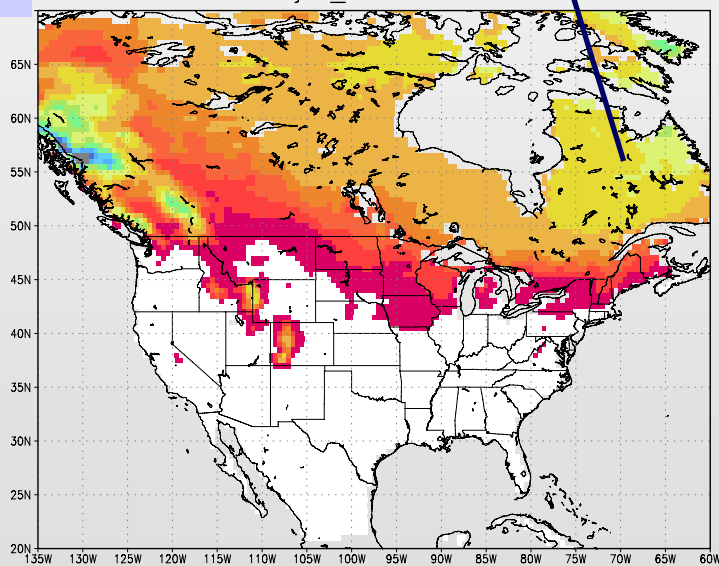


1979jan\_dec month: 3



March

1979jan\_dec month: 3

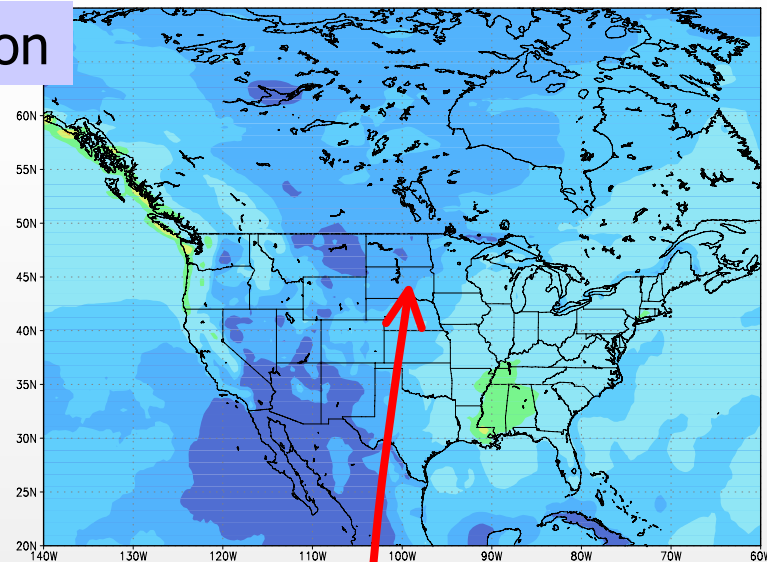
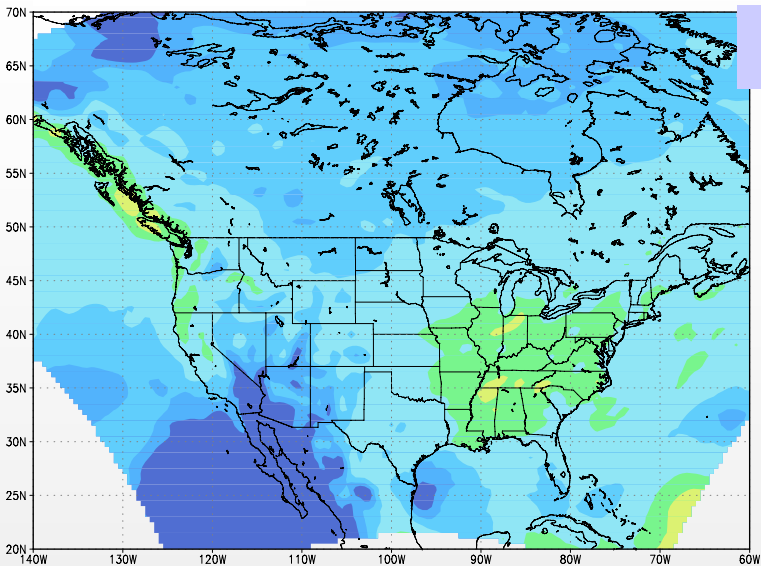


# Soil moisture and precipitation

NARR

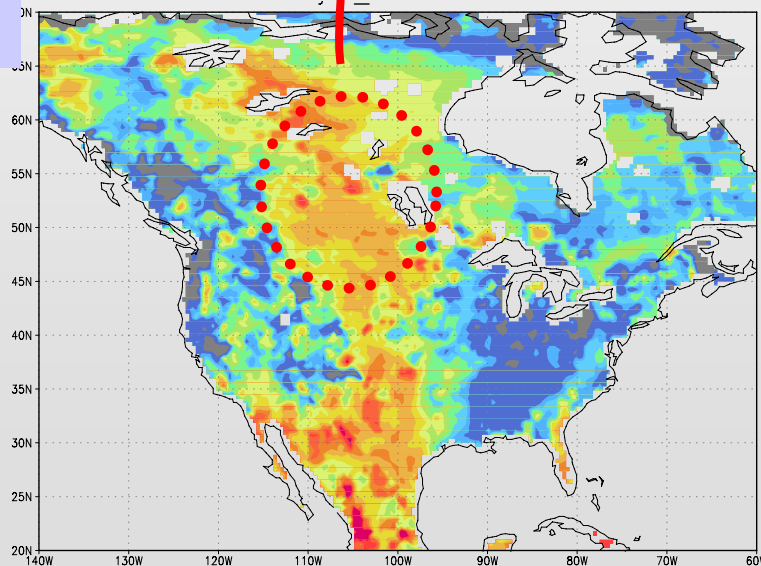
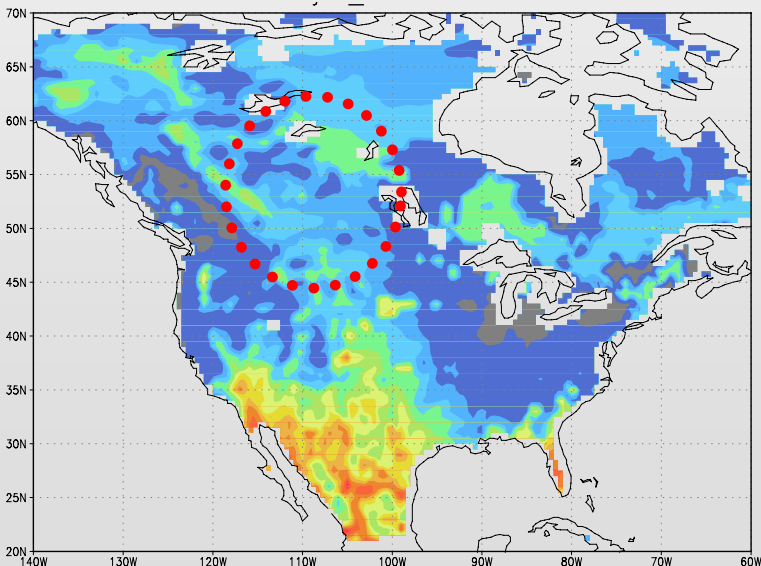
RSM

Precipitation



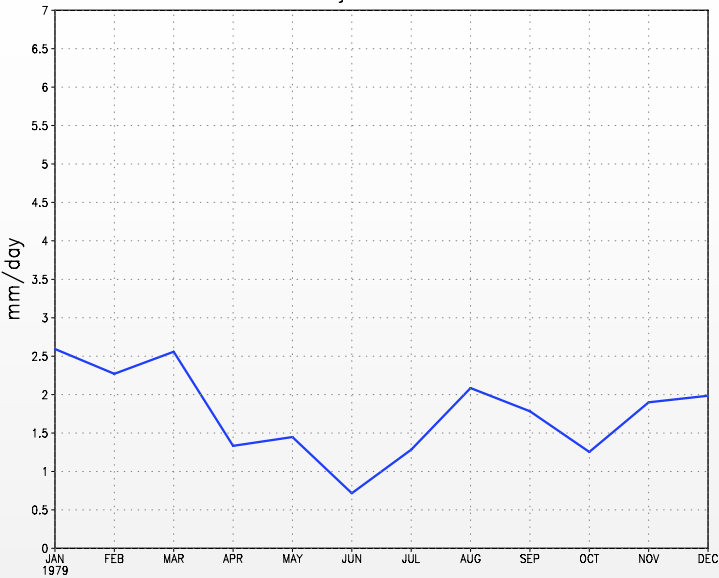
Average (1979-1983) precipitation (mm/day) and soil moisture (mm, 0-200 cm average) for April.

Soil M.

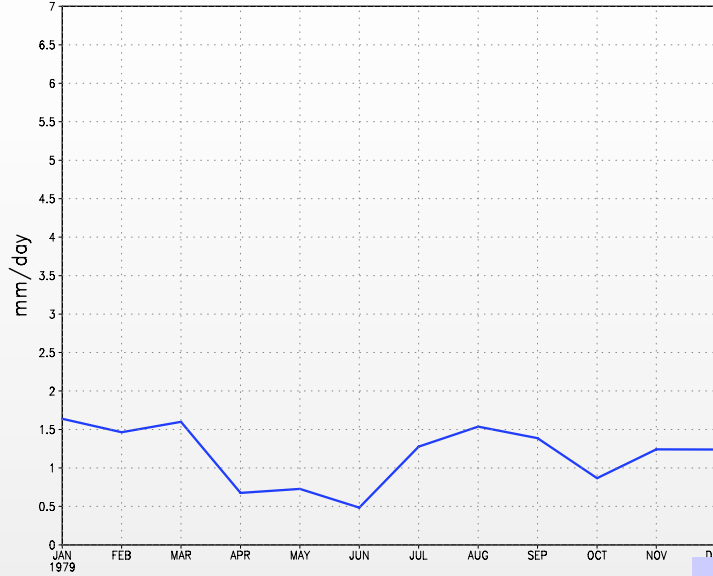


# The annual cycle

CTL - Precipitation  
SouthWestern: jan 1979 to dec 1979

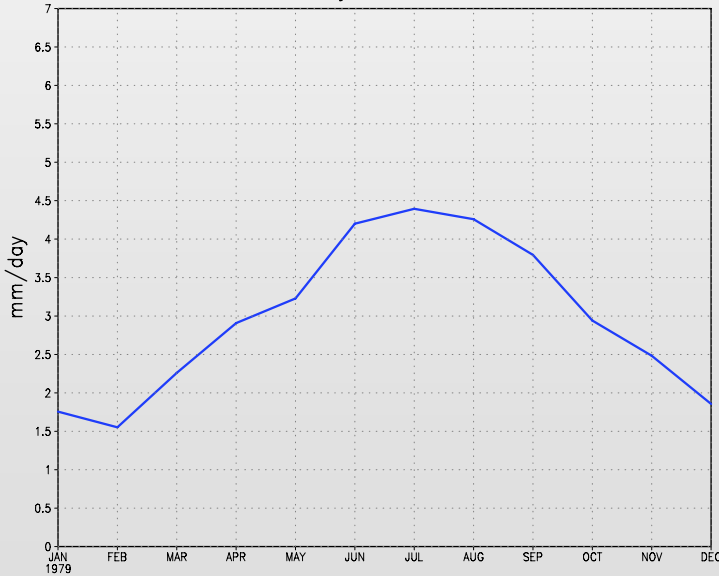


NARR - Precipitation  
SouthWestern: jan 1979 to dec 1979

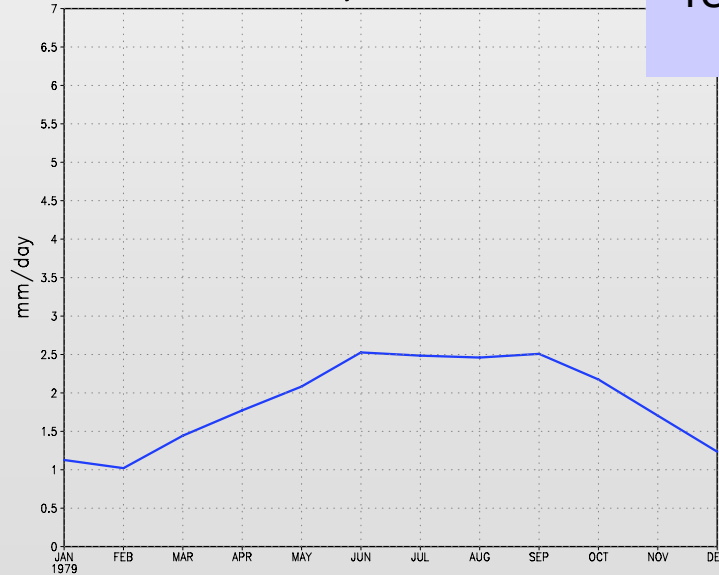


Average (1979-1983)  
precipitation (mm/day)

CTL - Precipitation  
NorthEastern: jan 1979 to dec 1979



NARR - Precipitation  
NorthEastern: jan 1979 to dec 1979



Variations very well  
reproduced, amounts  
~ 1.5 times

## Contribution to CEOP goals

*... "To understand and model the influence of continental hydroclimate processes on the predictability of global atmospheric circulation and changes in water resources" ...*

- Use of Reference Site data in validating model results
- Influence of soil moisture on the diurnal cycle
- Intraseasonal and interannual characteristics of the hydrological cycle over the US and the impact of soil moisture anomalies