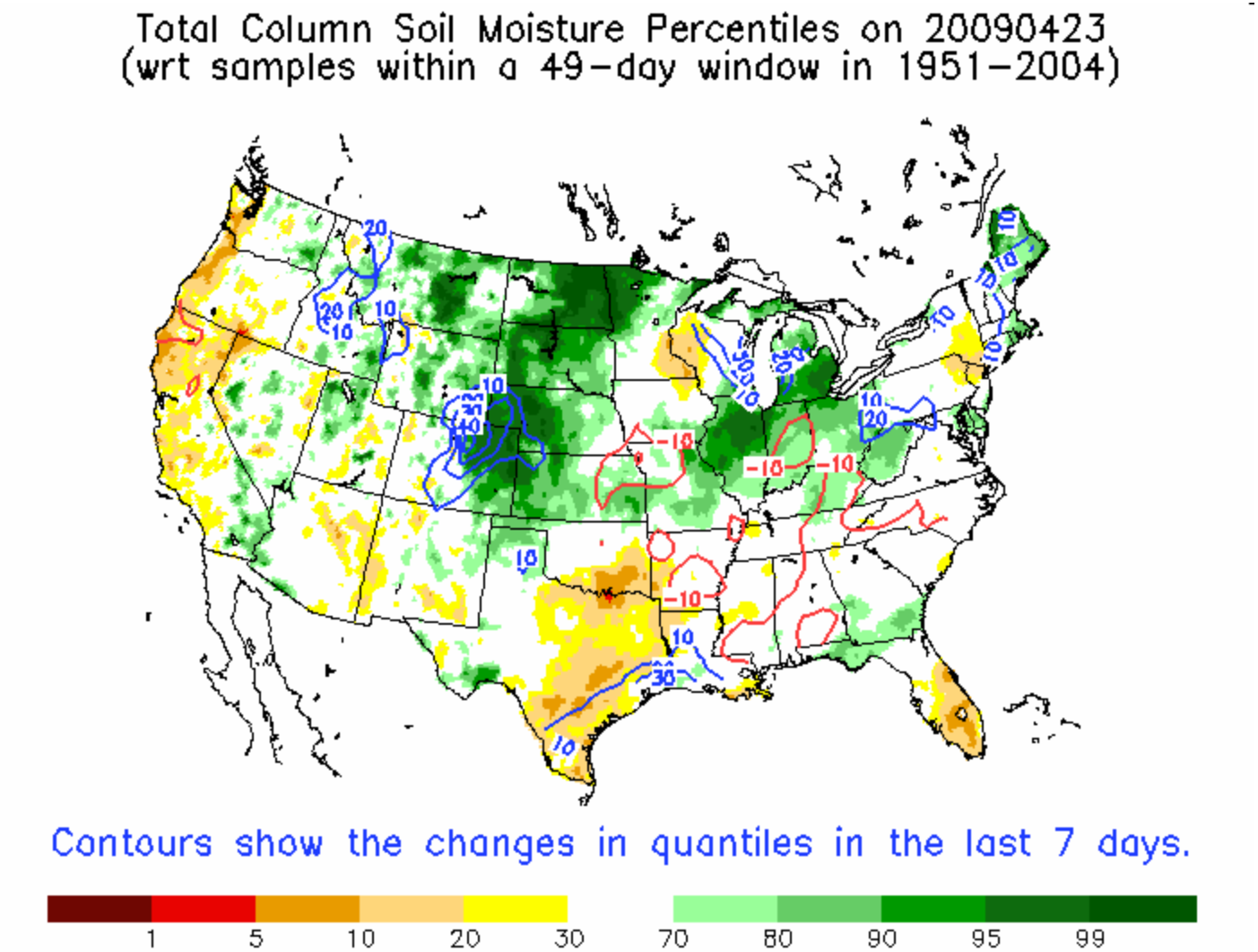
Land data assimilation products and their applications in drought monitoring and forecast

Eric F Wood
Princeton University

Presented at the
DRI Precipitation and Drought Indices Workshop
Environment Canada, Toronto
April 30, 2009

Princeton University

Princeton Drought Monitor (April 23, 2009)



Development of the Drought Index

1) Retrospective Simulation

Forcings → **VIC LSM** → **Retrospective Soil Moisture**

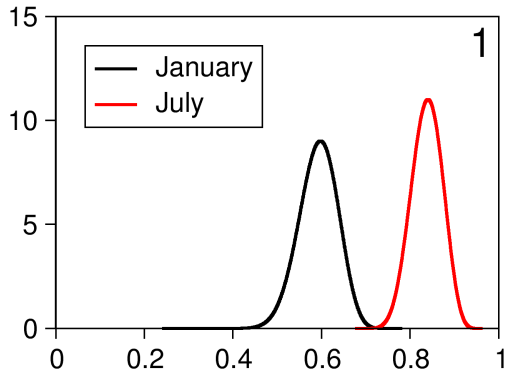
2) Calculate Soil Moisture Index

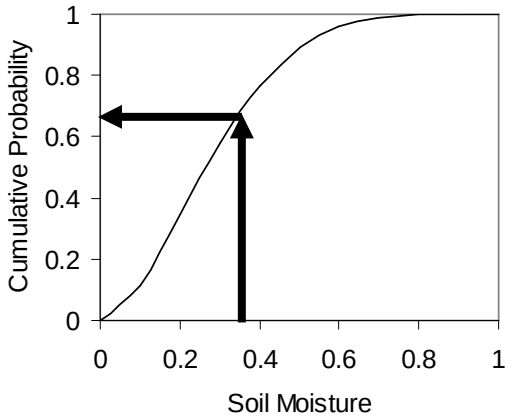
L-Moments → **Fit beta distribution** → **Calculate Index**

$$L_{mean}(\mu_s) = \lambda_1$$

$$L_{CV}(\sigma_s / \mu_s) = \frac{\lambda_2}{\lambda_1}$$

$$L_{skew}(\gamma_s) = \frac{\lambda_3}{\lambda_2}$$

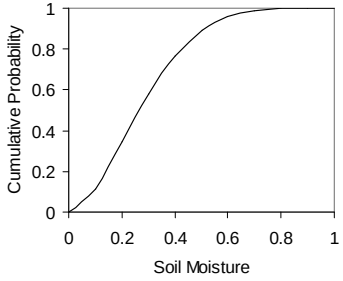


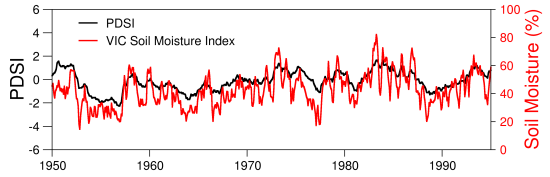


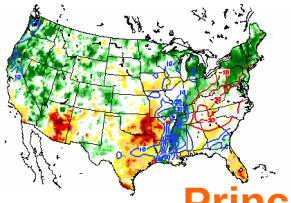
3) Drought Analysis

Historic soil moisture

Realtime soil moisture





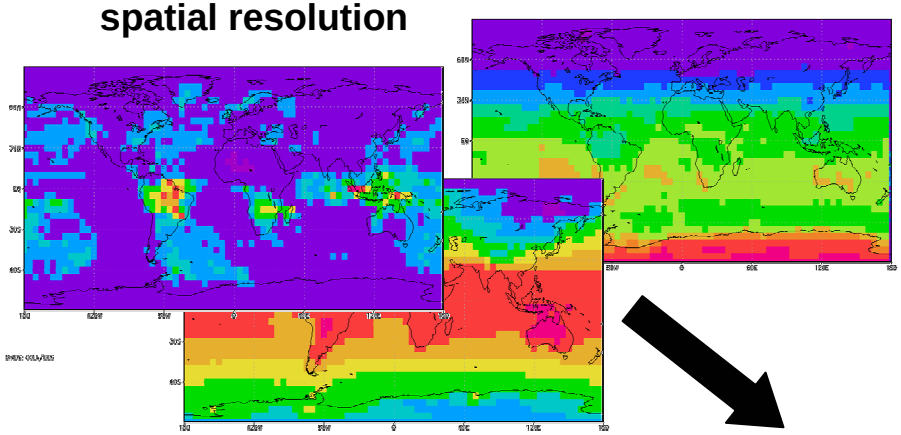


Princeton University

Global Meteorological Forcing Dataset

Reanalysis

High temporal/low spatial resolution



Observations

Generally low temporal/high spatial resolution

CRU
19
P,

GPCP
199
P

UW
197
P

TRMM
200
P

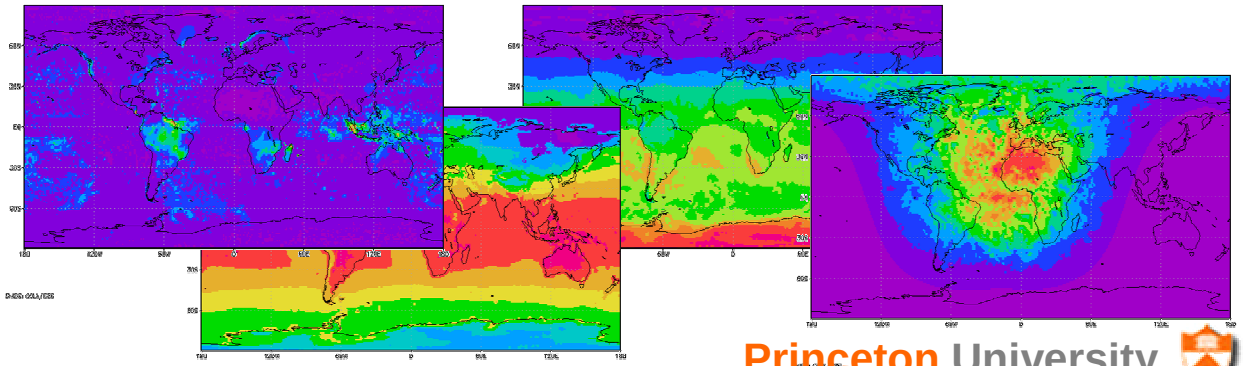
SRB
1985-2000, 3hr, 1.0deg
Lw, Sw

Bias Correct and Downscale

- corrected rainday statistics, gauge undercatch
- removal of biases in monthly P, T, DTR, SW, LW
- removal of spurious trends in SW
- adjustment for elevation effects
- downscale in time and space

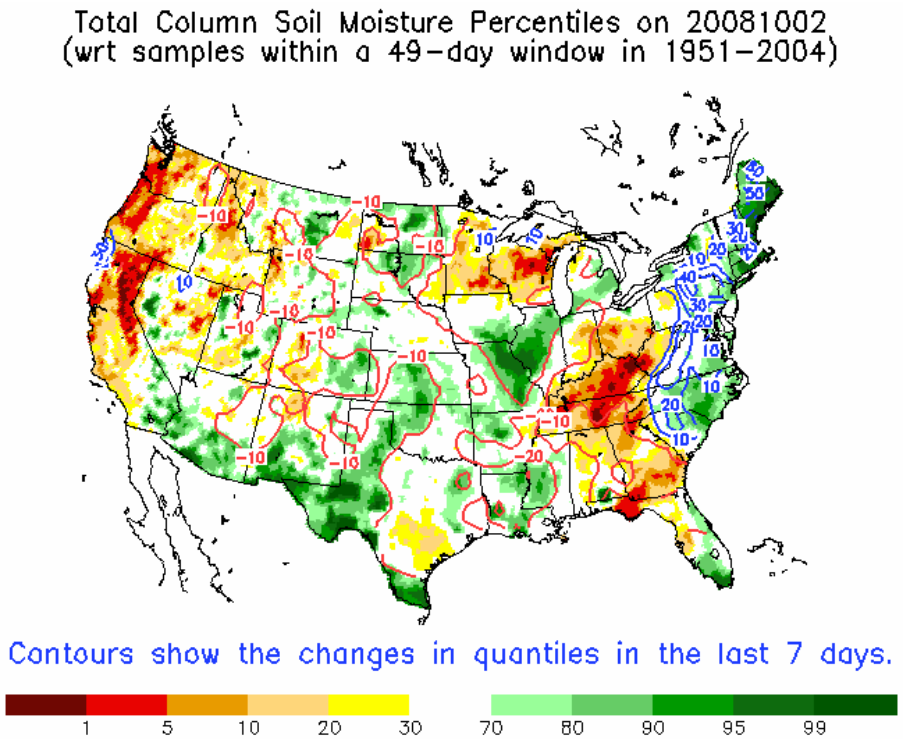
Global Forcing Dataset

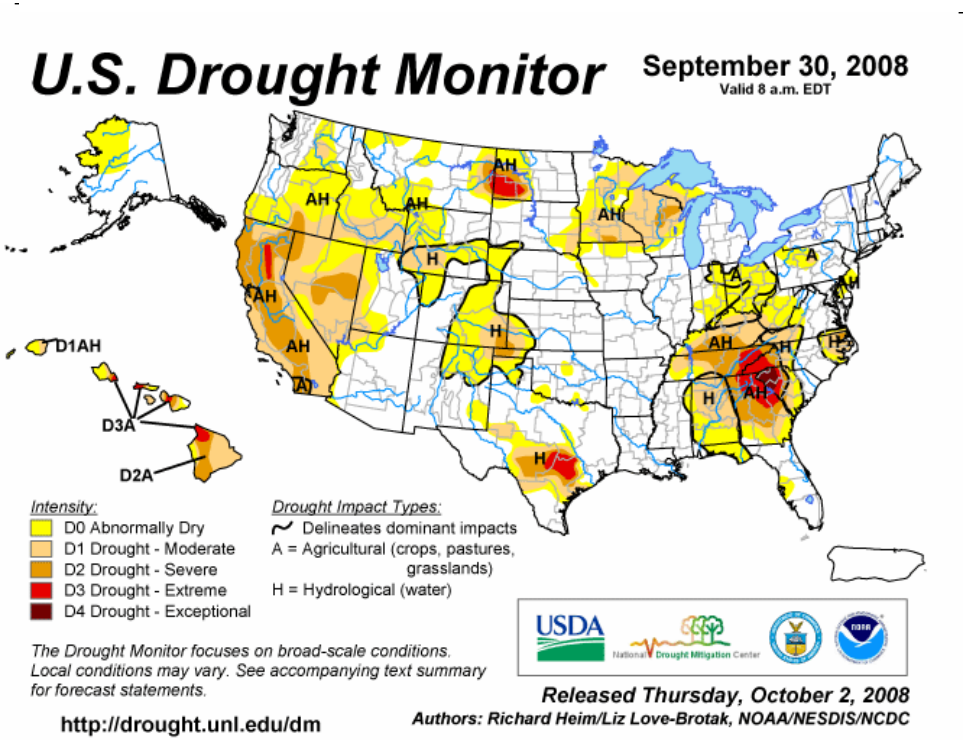
High temporal/high spatial resolution, bias corrected, trend corrected, etc…



Princeton University

Realtime Drought Monitoring
(Oct 2, 2008 assessment)



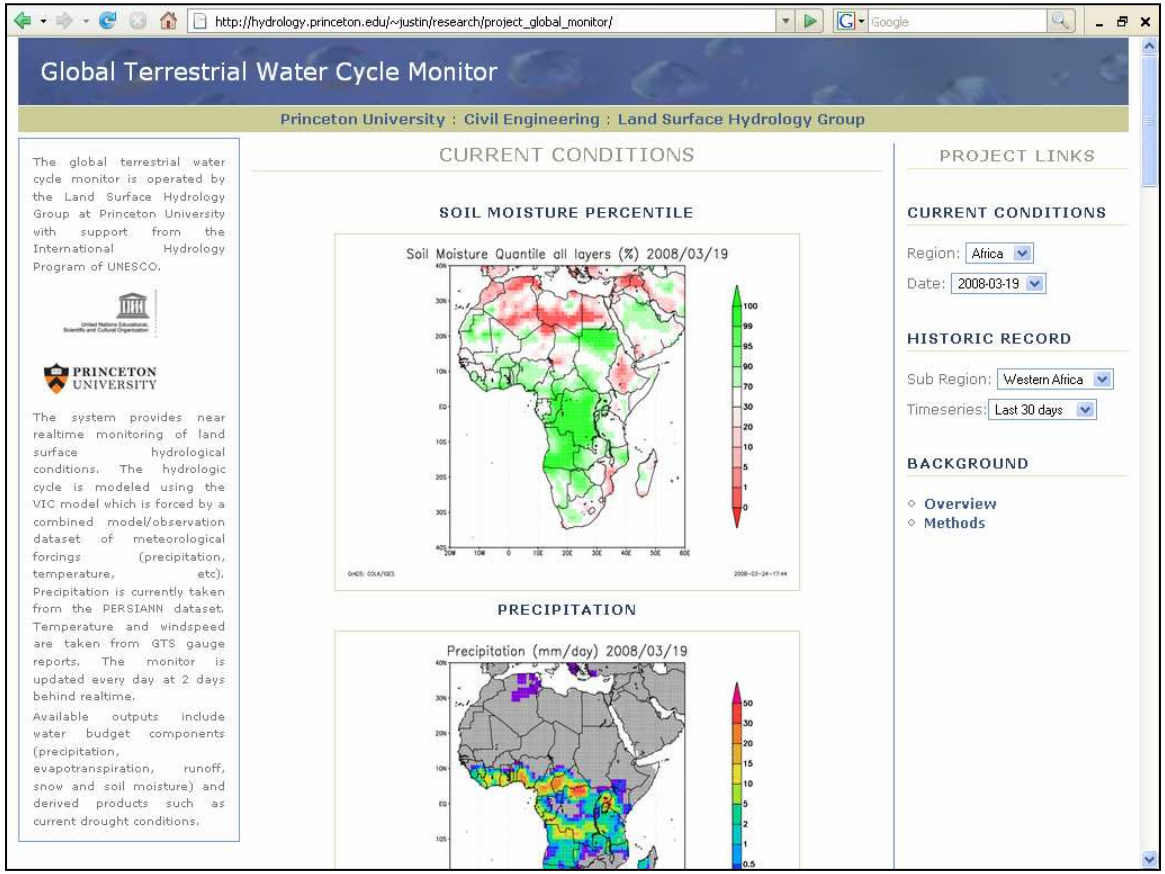


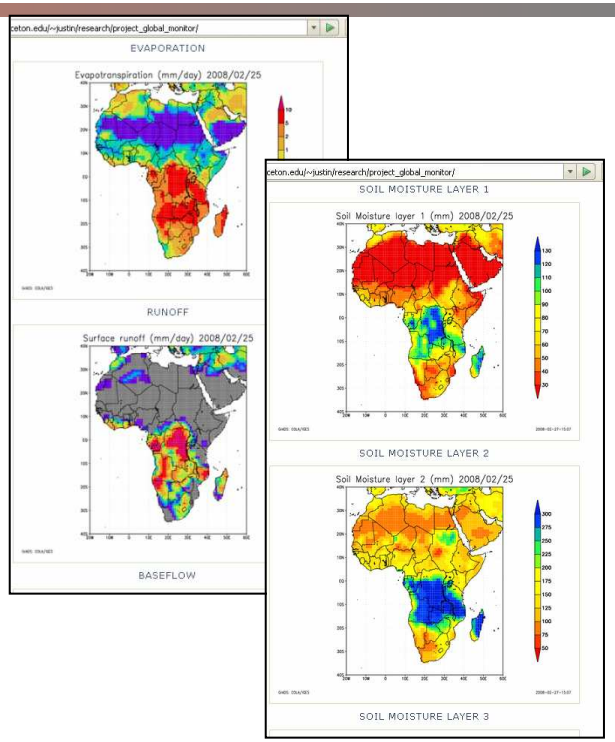
Based on running our VIC LSM forced with real-time NLDAS data. Index is the total column soil moisture, (as a percentile) – objective, can be used in forecasting.

Based on a variety of field information and significant human interpretation – subjective, can't be used in forecasting..

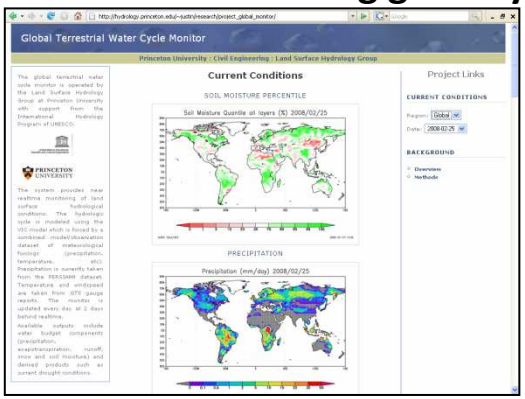
Water Cycle and Drought Monitoring

http://hydrology.princeton.edu/monitor





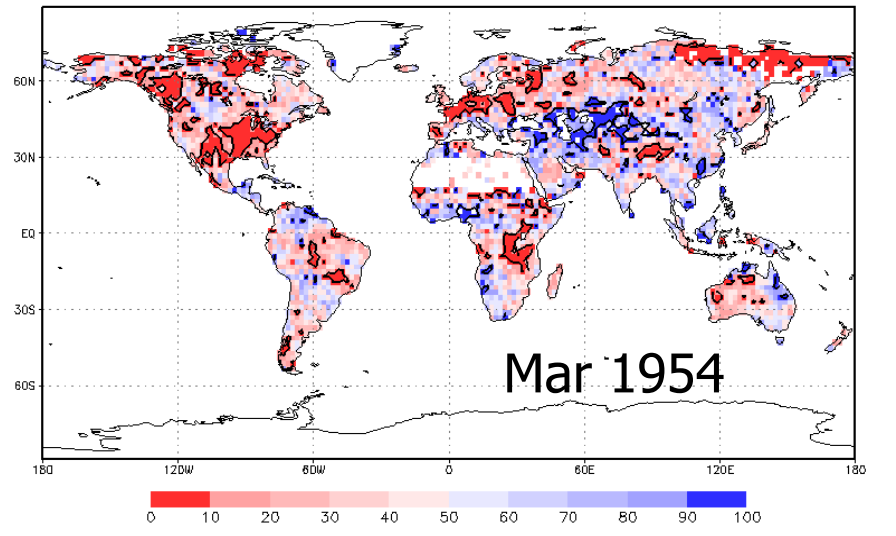
We are also monitoring globally…

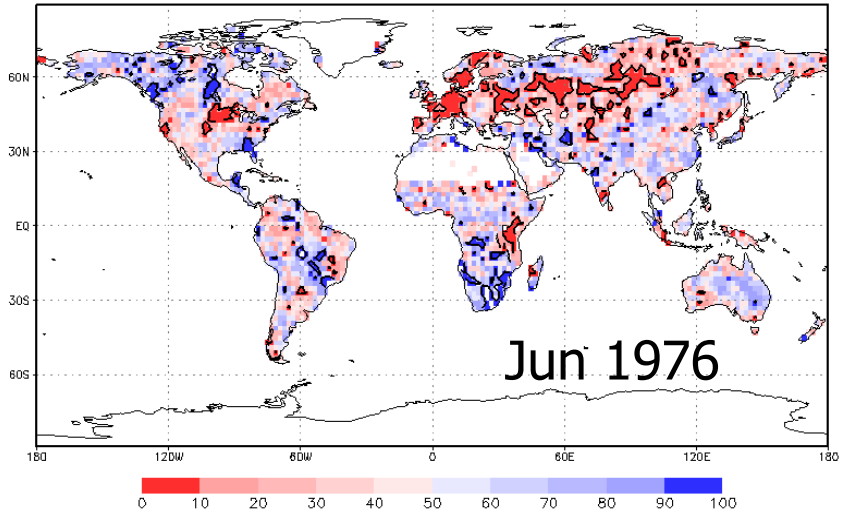


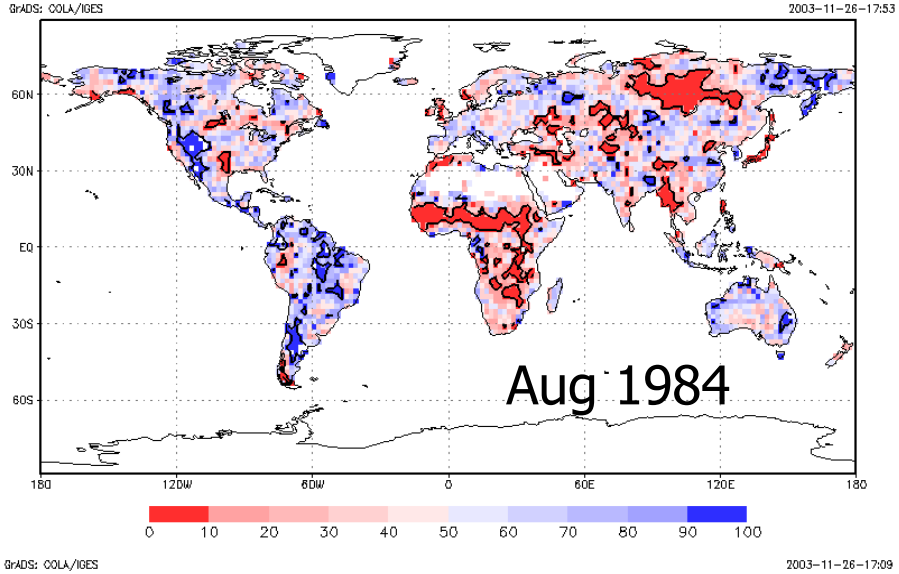
Terrestrial water cycle (evaporation, runoff, soil moisture, snow) simulated using the VIC land surface model, forced by observed and remotely sensed precipitation and temperature

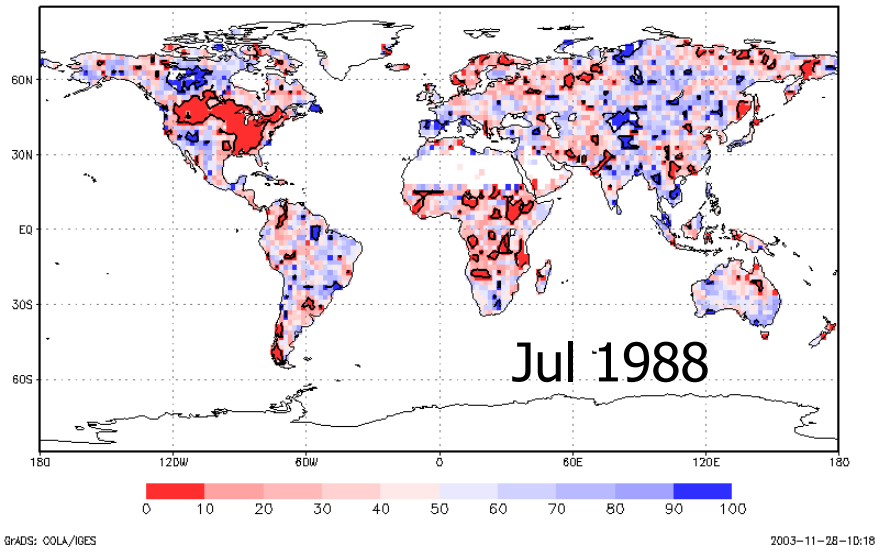
Princeton University

Historical Drought Quantiles



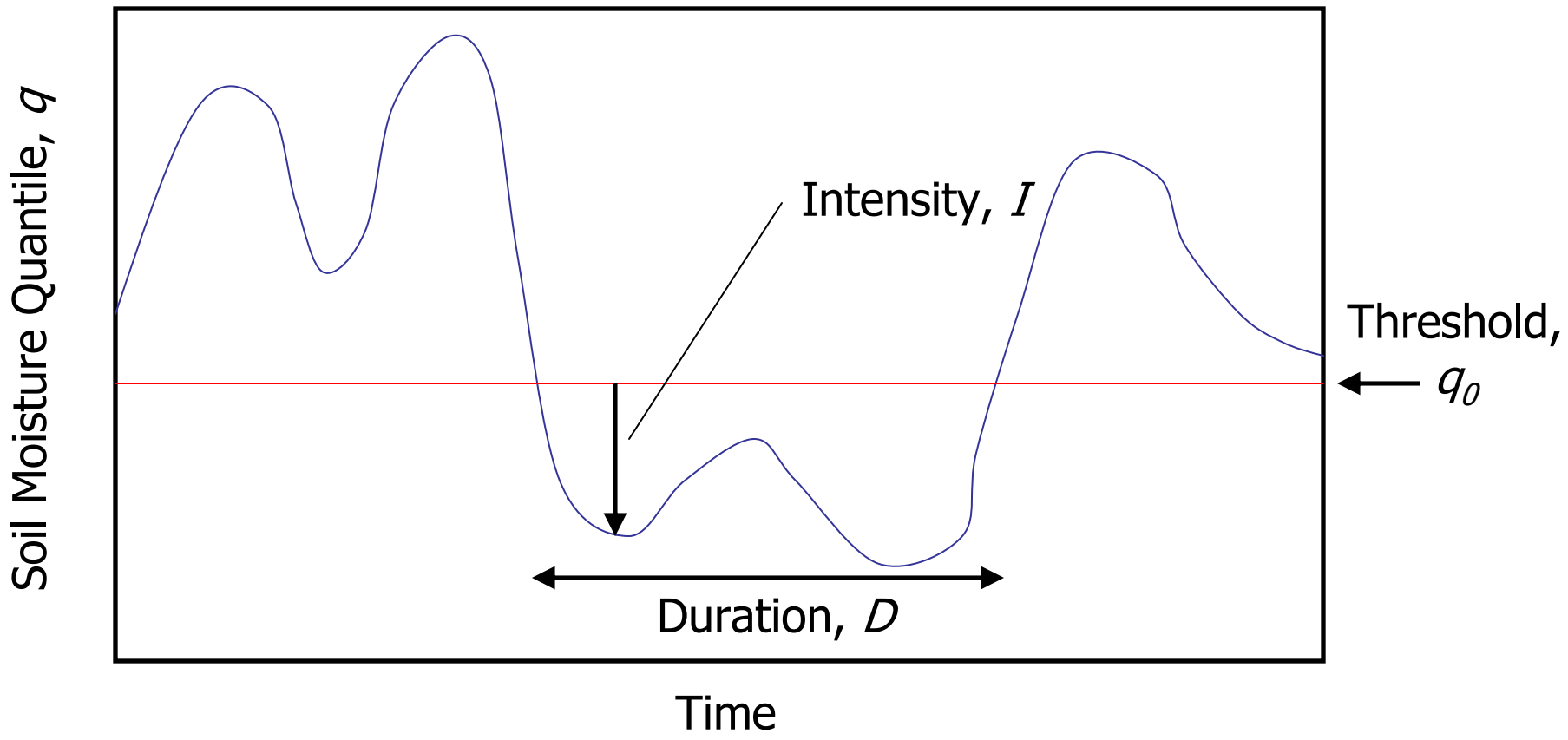






Princeton University

Severity-Area-Duration (SAD) Analysis

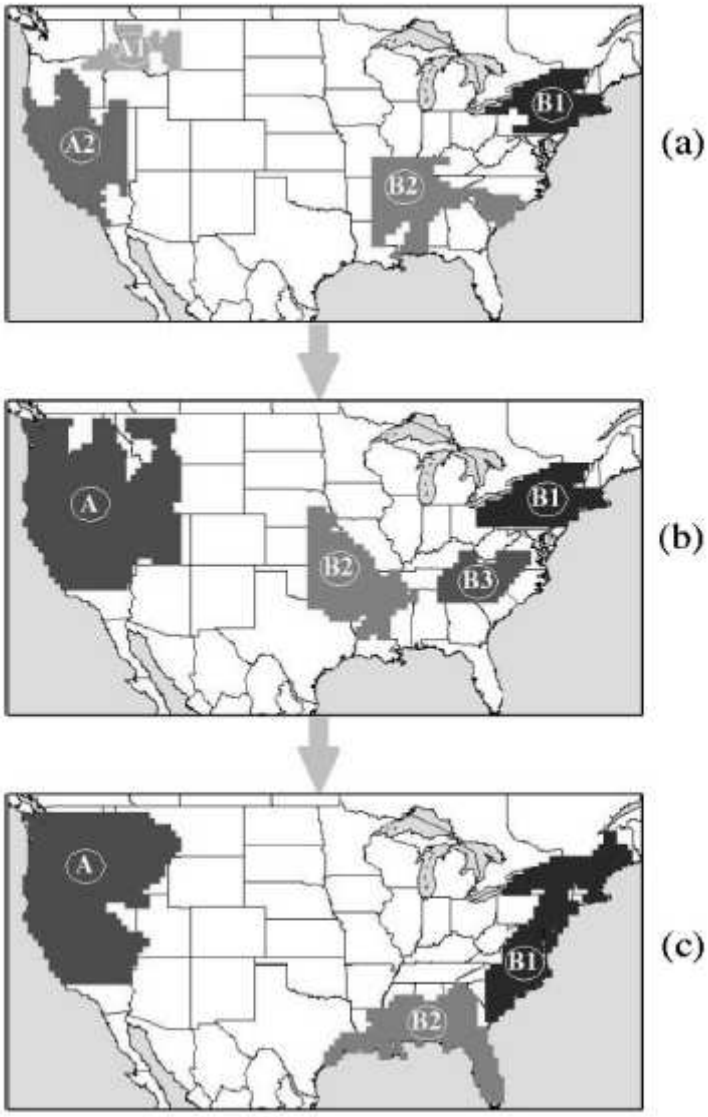


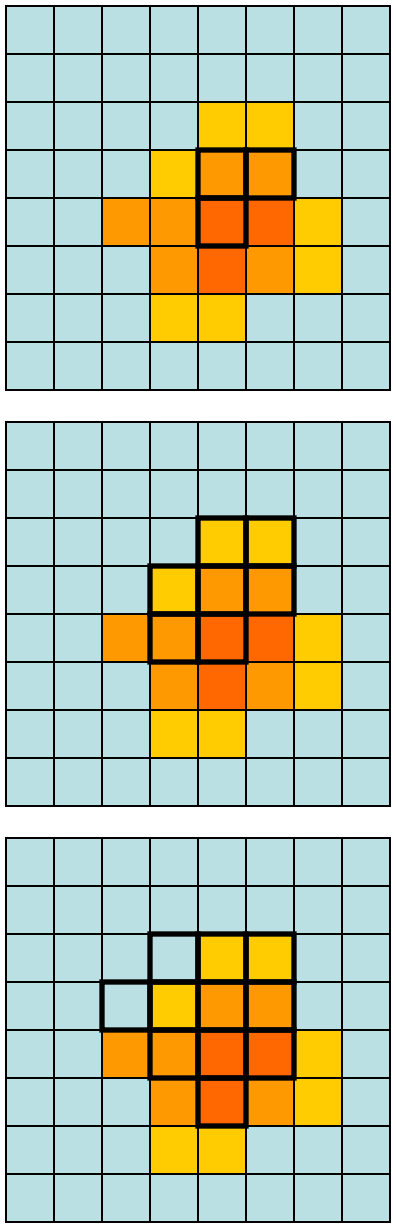
Severity, $S = D \times I$

Extent, A = area in drought (perhaps contiguous)

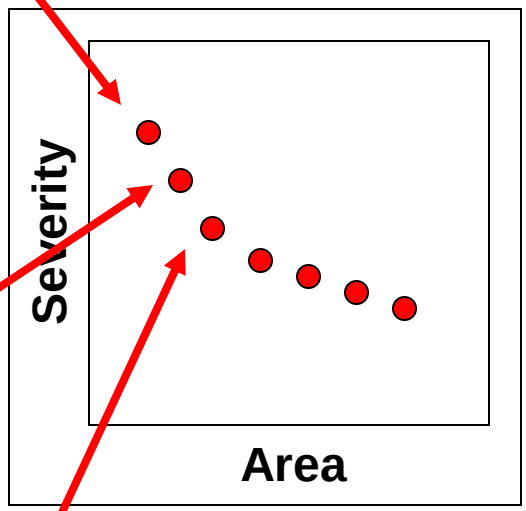
Severity-Area-Duration (SAD) Analysis

Cluster Analysis





SAD Analysis for a Single Event

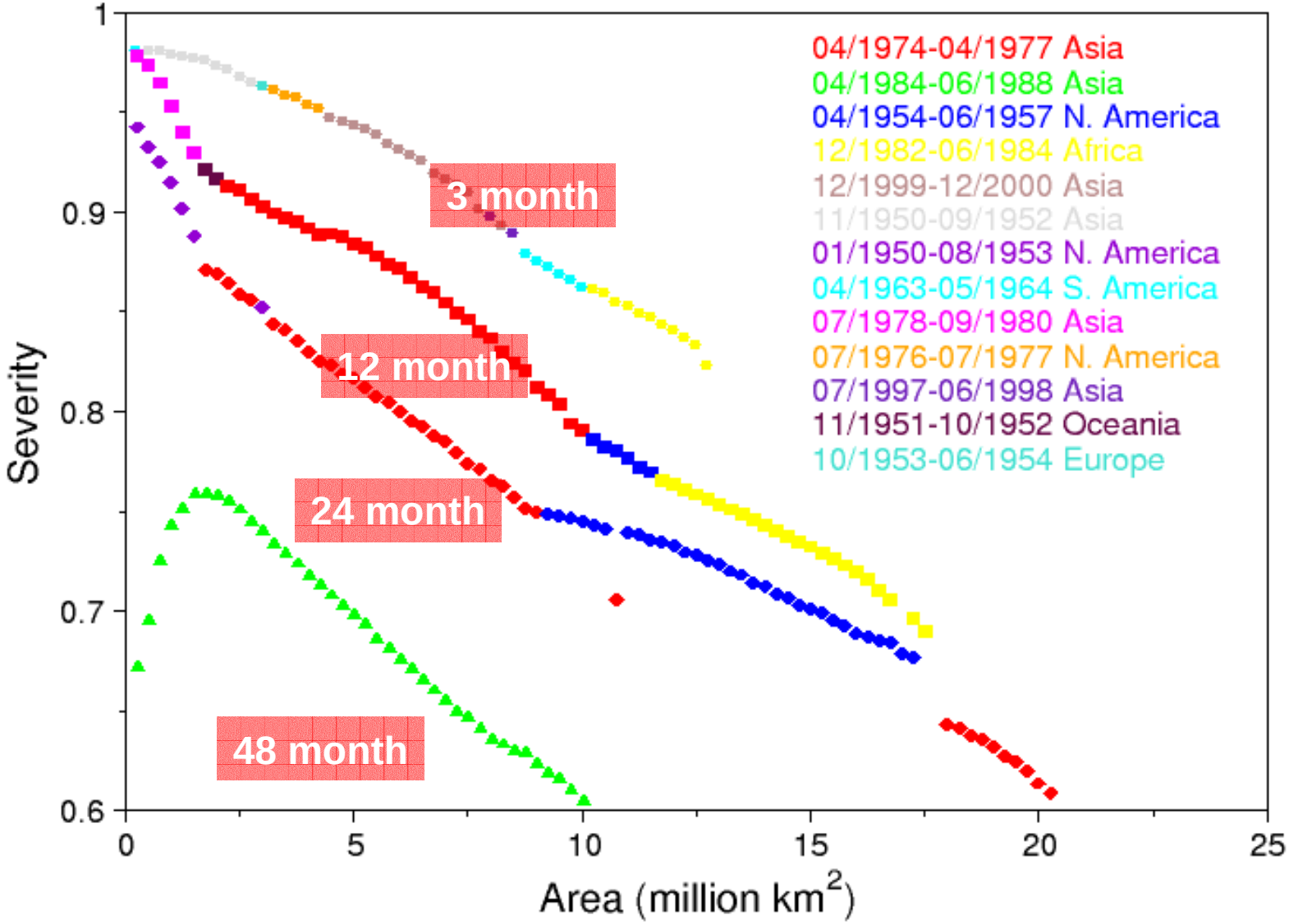


Envelope of SAD curves for all drought events shows which are the most severe events for each combination of duration and area.

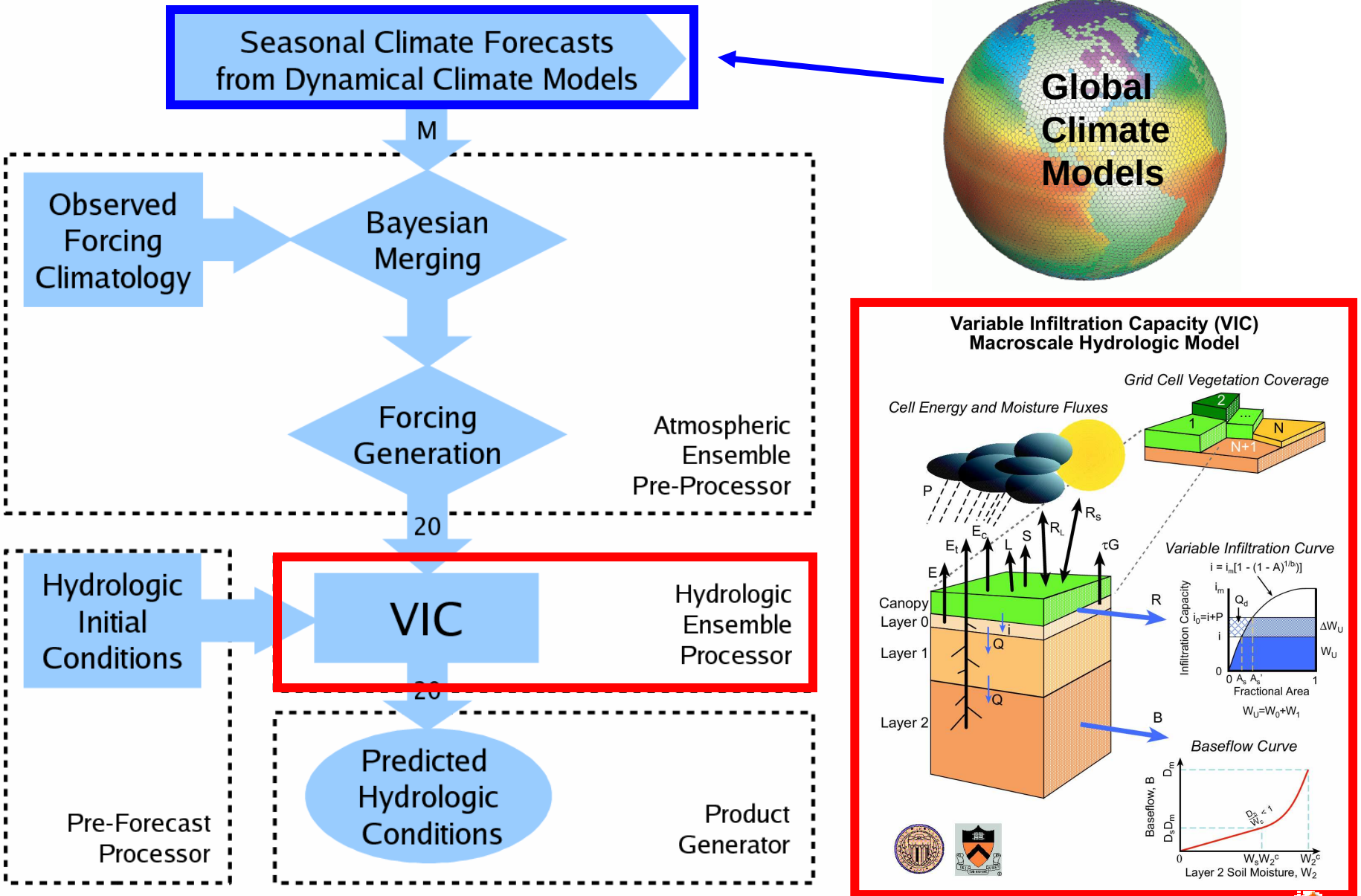
Princeton University

SAD Analysis

Most Severe Events Globally, 1950-2000

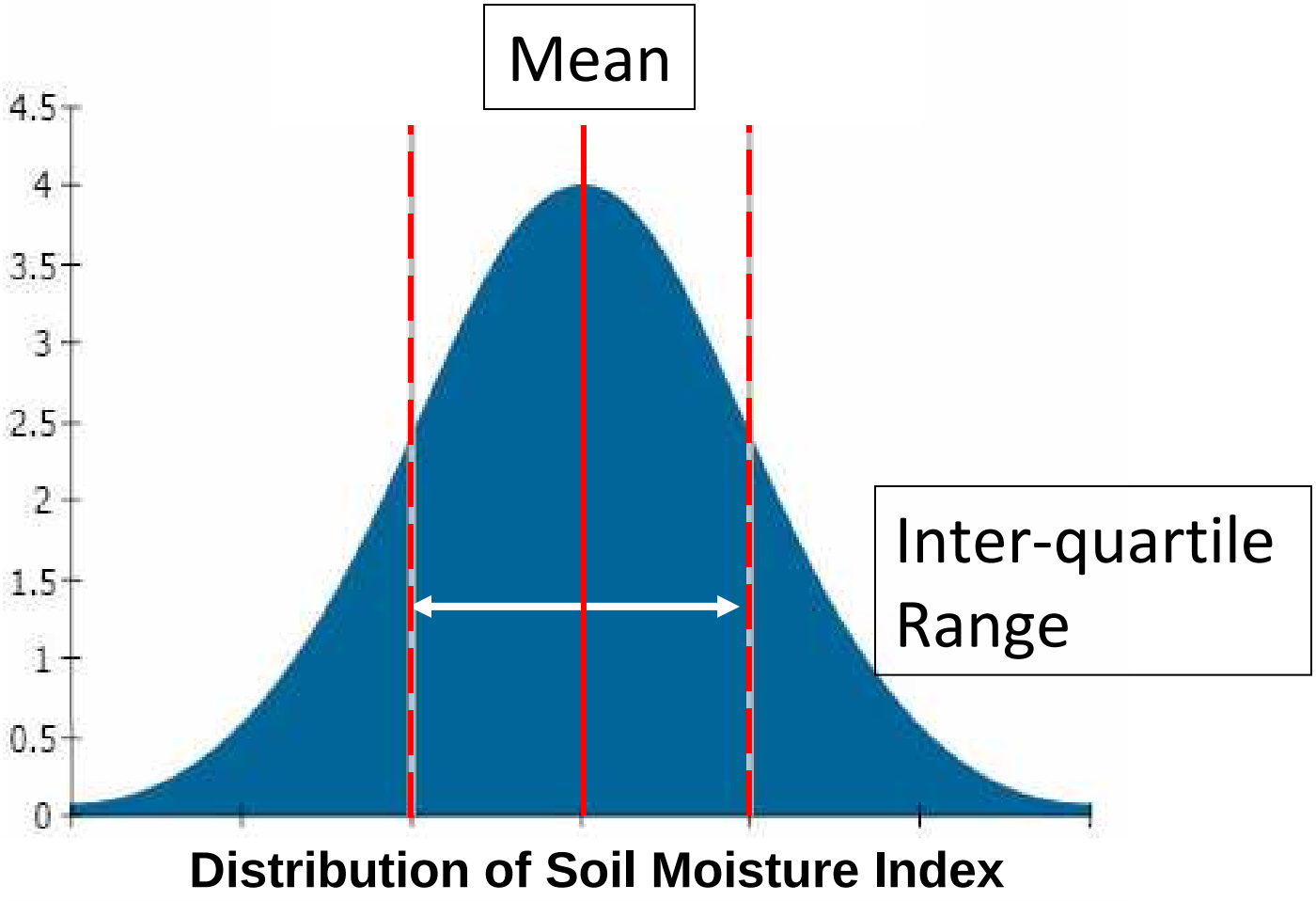


Princeton Seasonal Hydrologic Prediction System

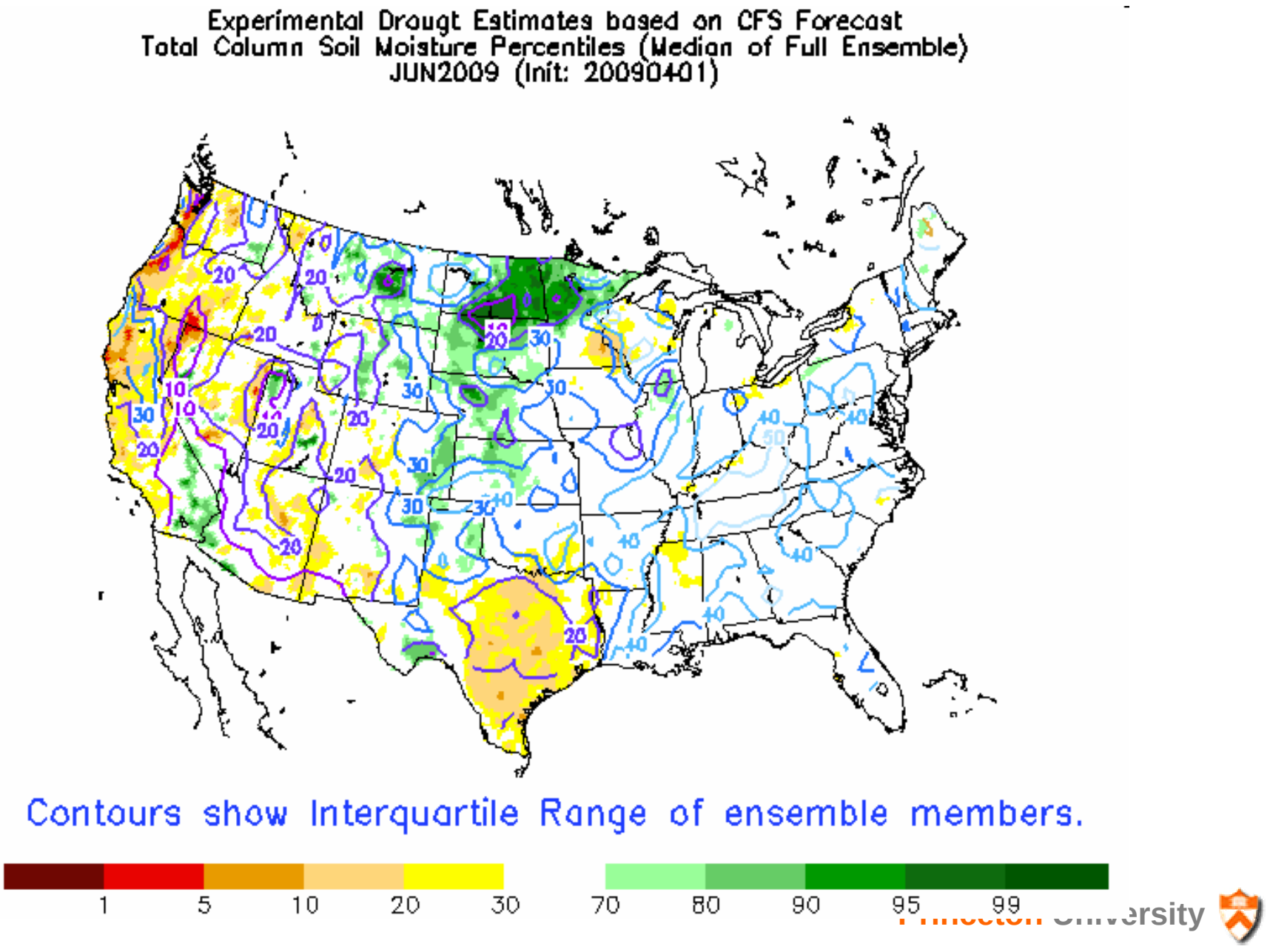


Princeton University

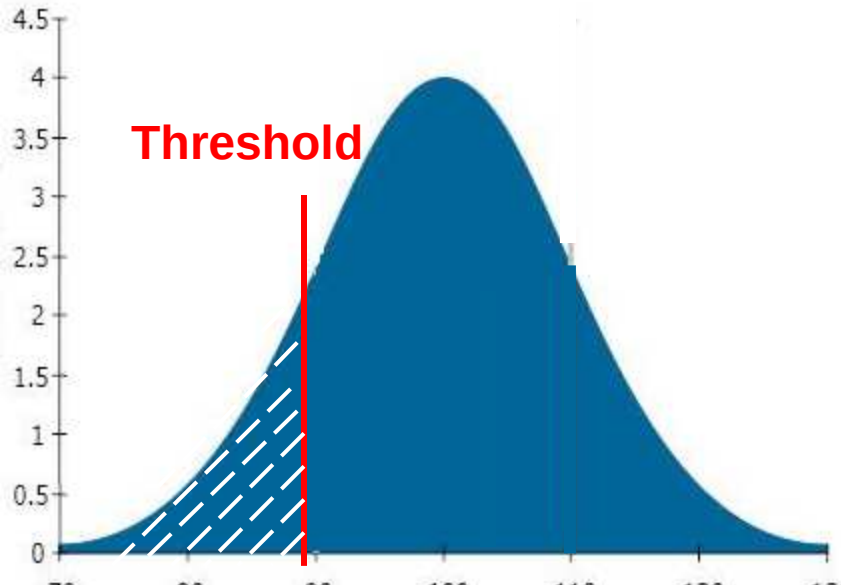
Drought Forecast Ensemble Distribution



CFS Drought Forecast (Ensemble Median and IQR)

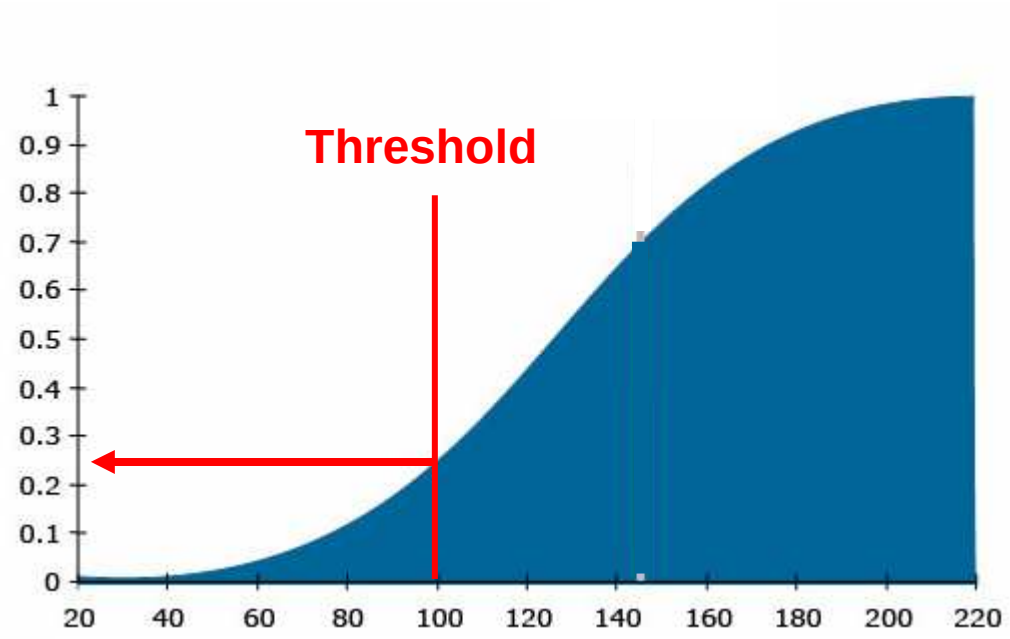


Distribution of Soil Moisture Index



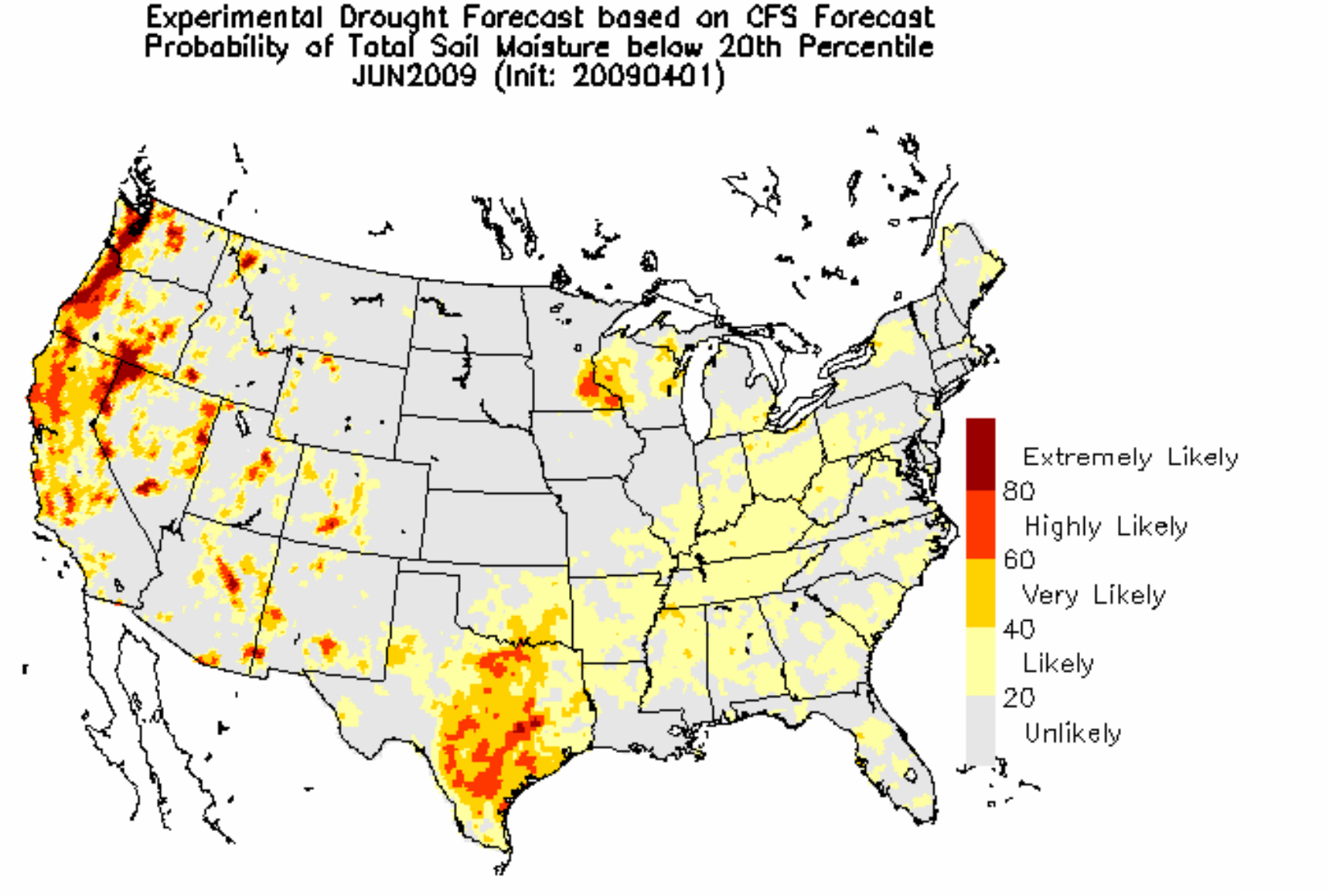
Distribution of Soil Moisture Index

P { SM < threshold}



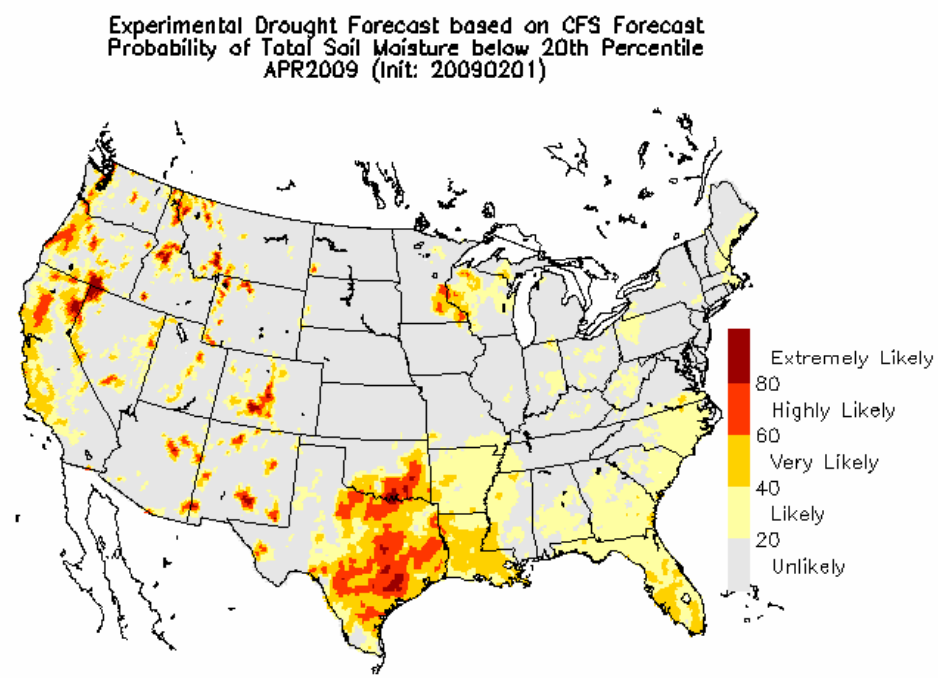
Distribution of Soil Moisture Index

CFS Drought Forecast (Probability Map)

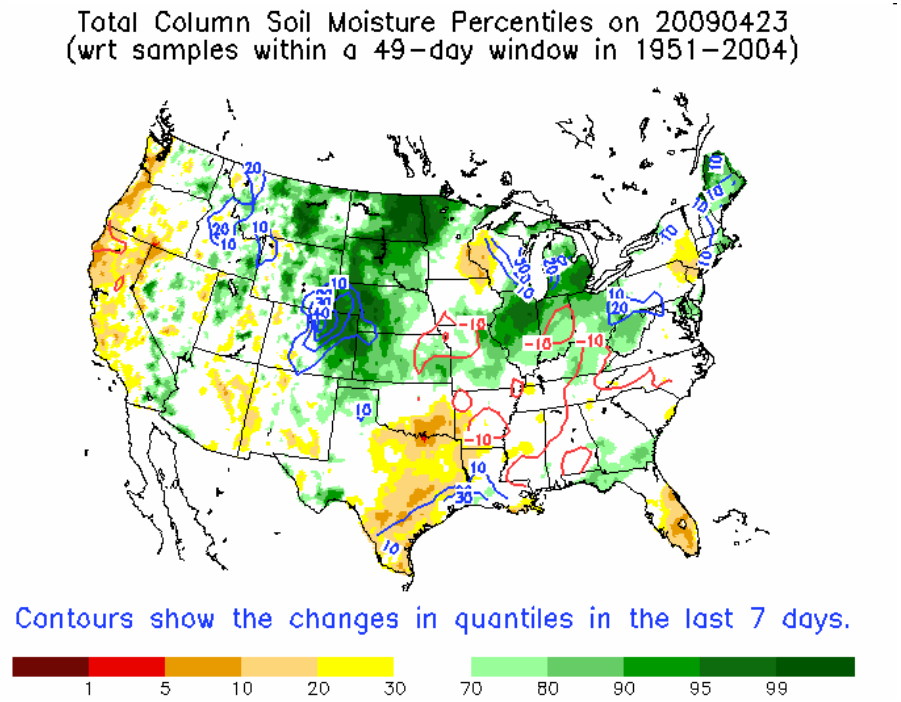


Drought Forecasts and Verification

April forecast, initialized 2009-02-01



April 23, 2009 VIC, Drought Monitor



Conclusions

A drought index based on soil moisture distributions from a land surface model (LSM) offers an object index for both monitoring and forecasting.

Thank you – Questions?