An Intercomparison of North American LDAS Soil Moisture Fields

John Schaake[5], Qingyun Duan[5], Kenneth Mitchell[2], Paul R. Houser[3], Eric F. Wood[4], Dennis Lettenmaier[6], Alan Robock[1], Brian Cosgrove[3], Dag Lohmann[2], Lifeng Luo[1], Justin Sheffield[4], Wayne Higgins[7], Rachel Pinker[8], and Dan Tarpley[9]

[1]Department of Environmental Sciences, Rutgers University

[2]NOAA/NWS/NCEP/EMC

[3]Hydrological Sciences Branch, NASA/GSFC

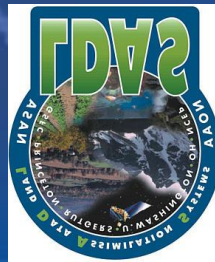*[4]Department of Civil Engineering, Princeton University*

[5]NOAA/NWS/OHD

[6]Department of Civil and Environmental Engineering, University of Washington

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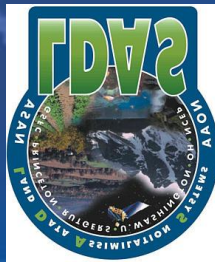*[8]Department of Meteorology, University of Maryland*
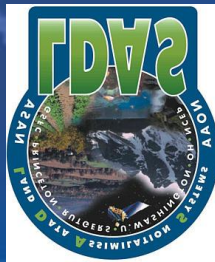
[9]NOAA/NESDIS/ORA

Questions

- How similar are soil moisture fields from different LDAS LSMs ?

- Can the soil moisture field from one LSM be used to initialize another LSM?

- How long should the model spin-up period be ?

Strategy

- **Investigate the space-time correlation between soil moisture fields from different LDAS LSMs:**

  – *Mean statistical properties*

  – *Spatial statistical properties*

  – *Statistical properties of temporal changes*

- **Investigate if and how the soil moisture field from one LSM can represent that of another LSM using statistical methods**

Data

- **Snapshots of soil moisture fields from different days are assembled:**

    - *Beginning October 1, 1996*

    - *Ending September 30, 1999*

    - *1st and 15th day of month*

    - *Entire LDAS domain available for analysis*
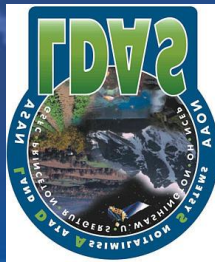
Maximum Soil Water Capacity

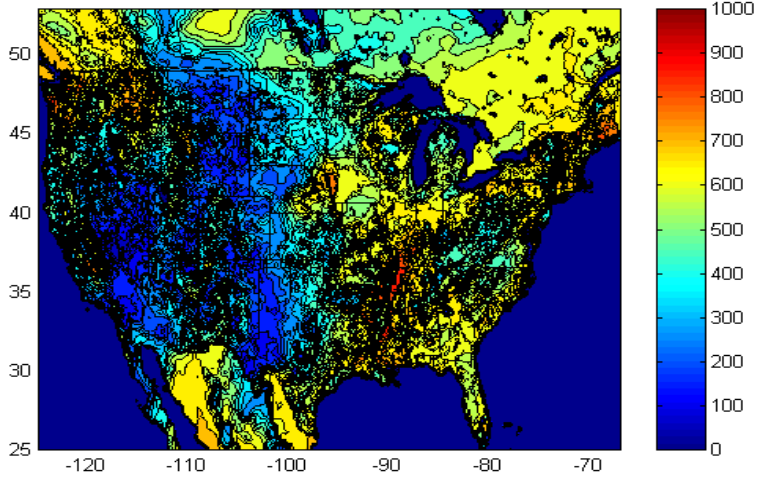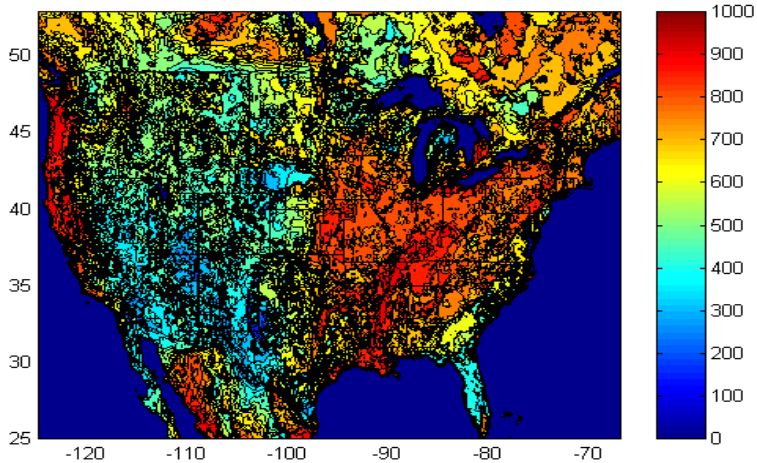Sacramento Model Maximum Water Content

NOAH Model Maximum Water Content
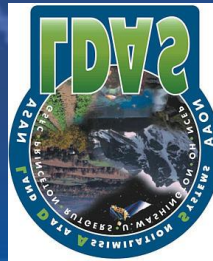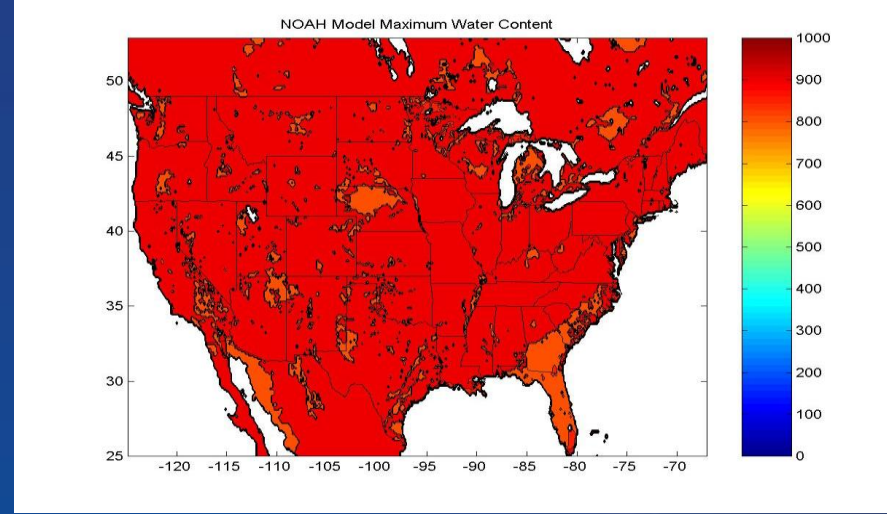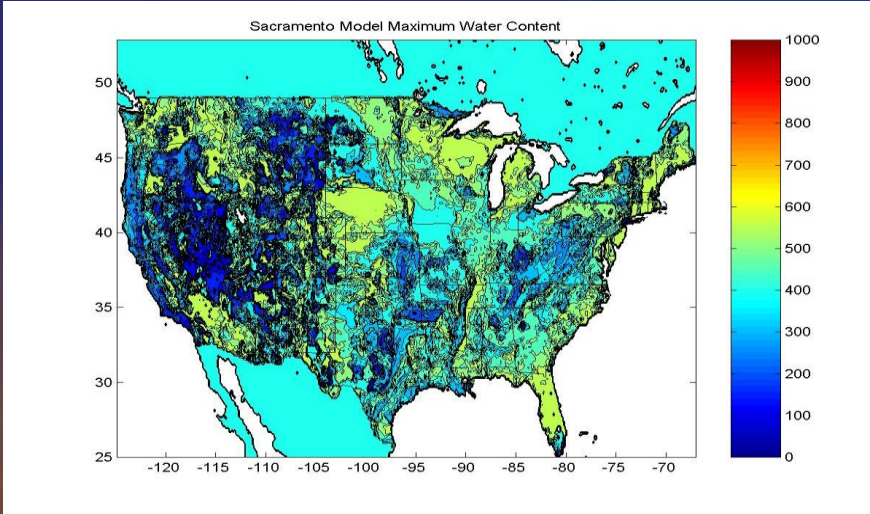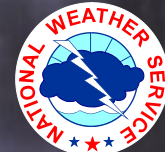
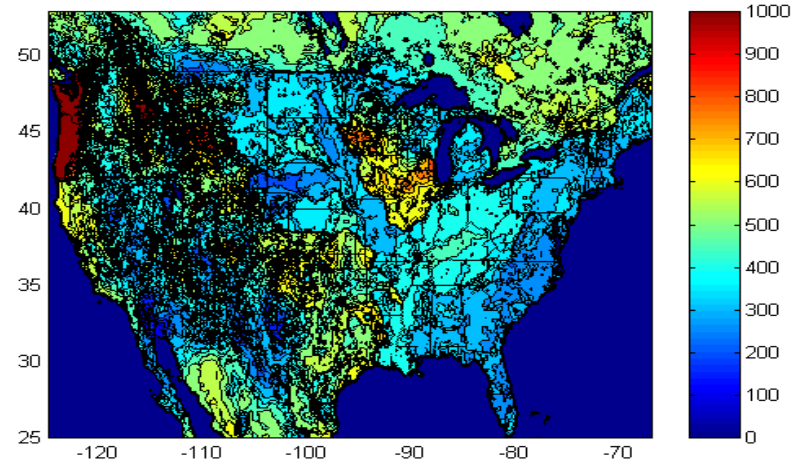# Minimum Soil Water Content

Sacramento Model Minimum Water Content
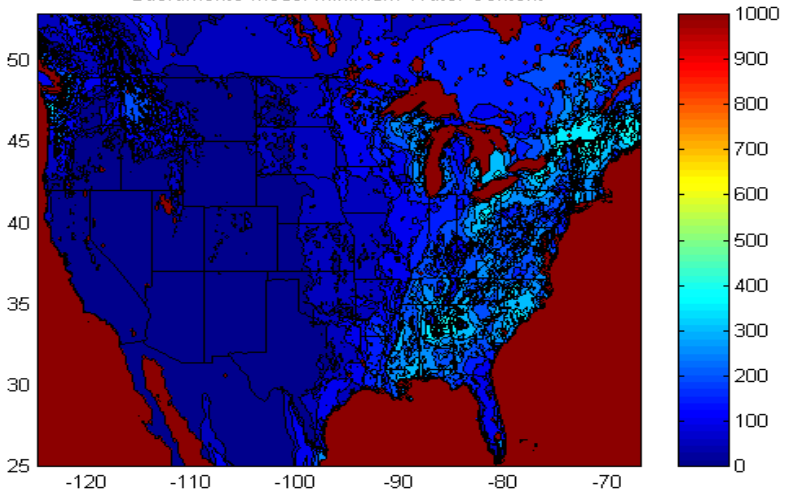
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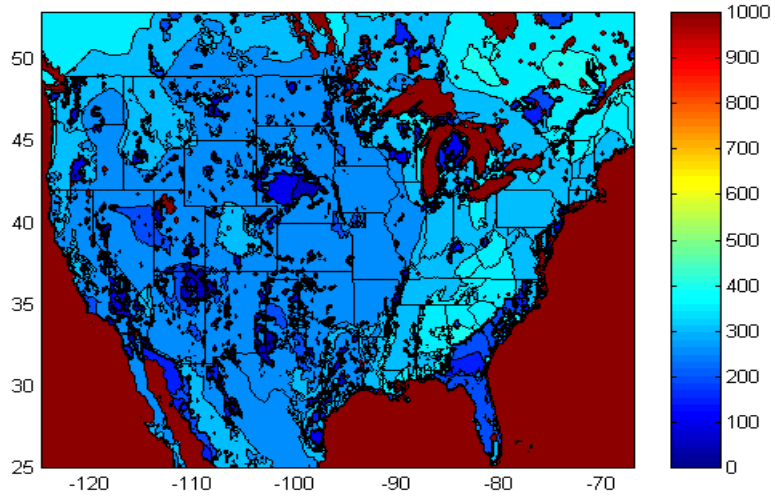
Mosaic Model Minimum Water Content
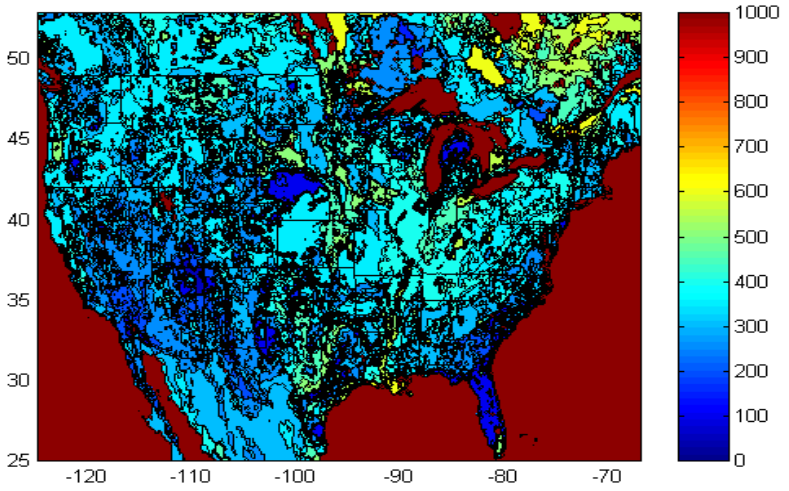
VIC Model Minimum Water Content
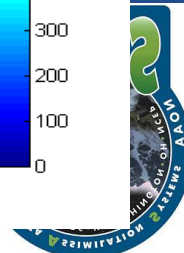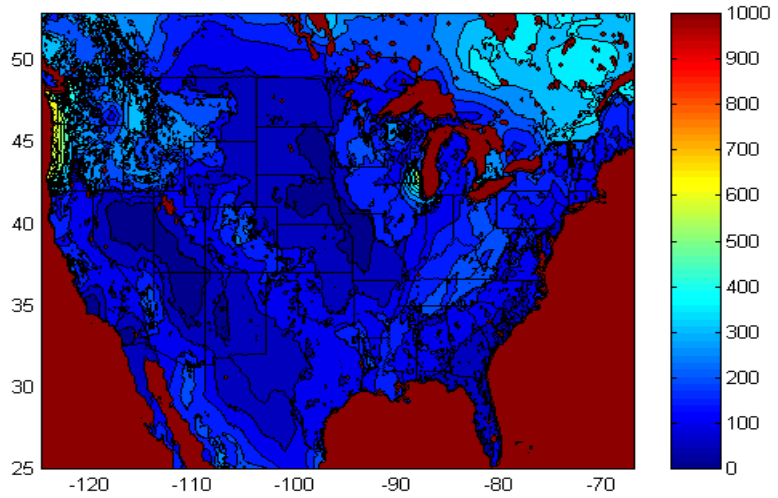
Maximum Soil Water Content

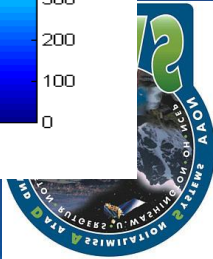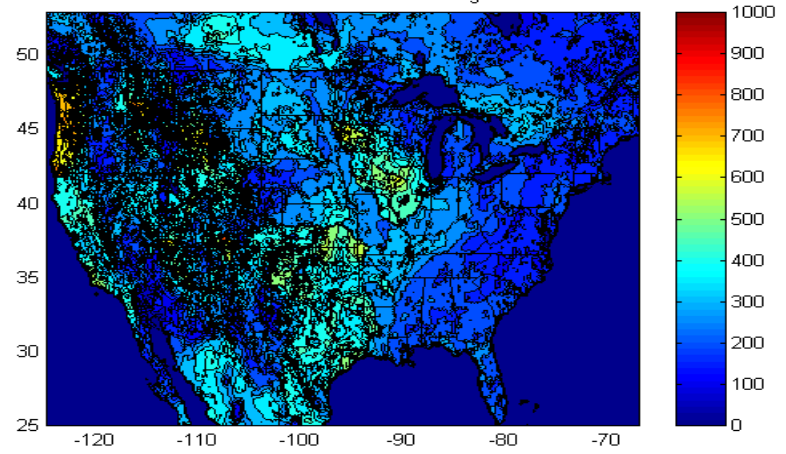# Maximum Range of Soil Water Content

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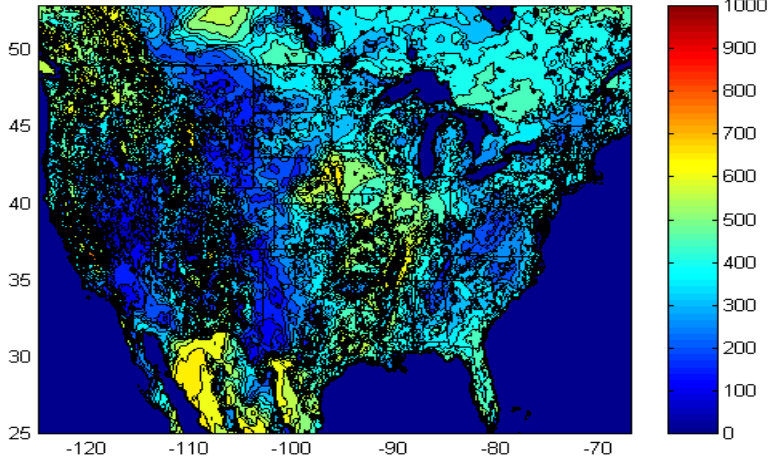
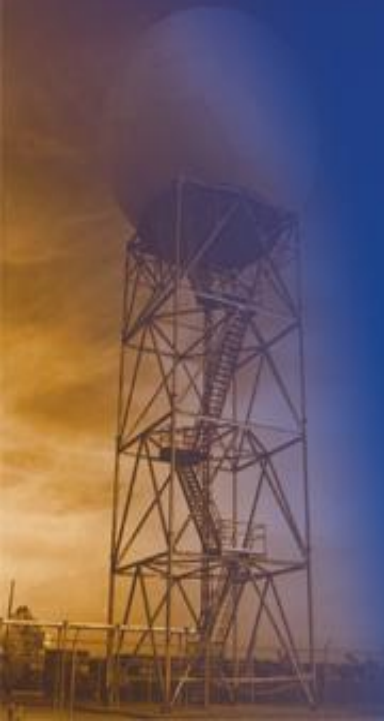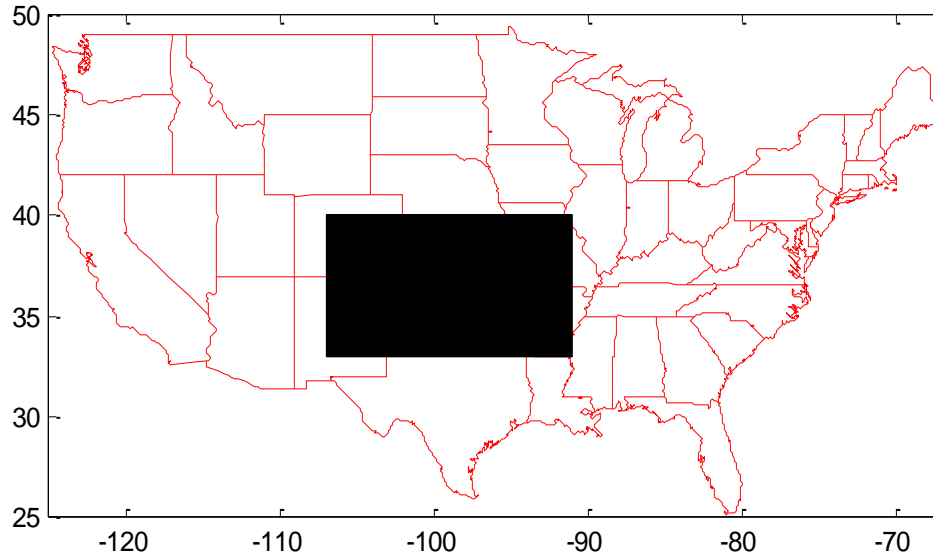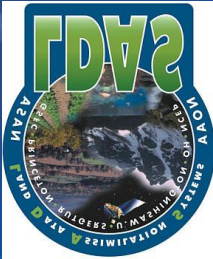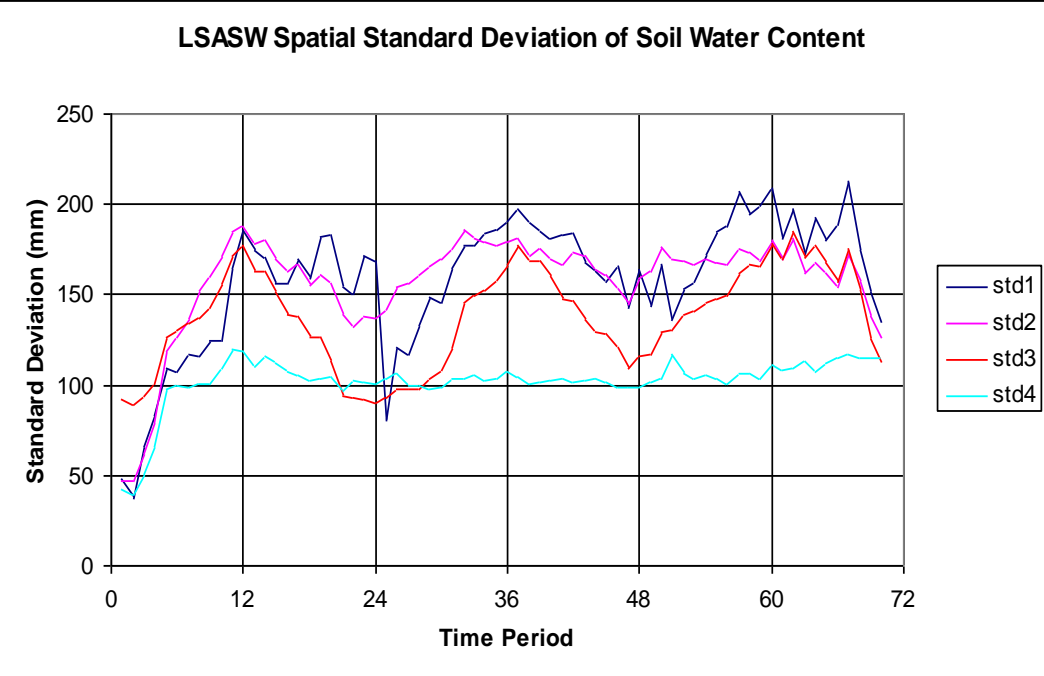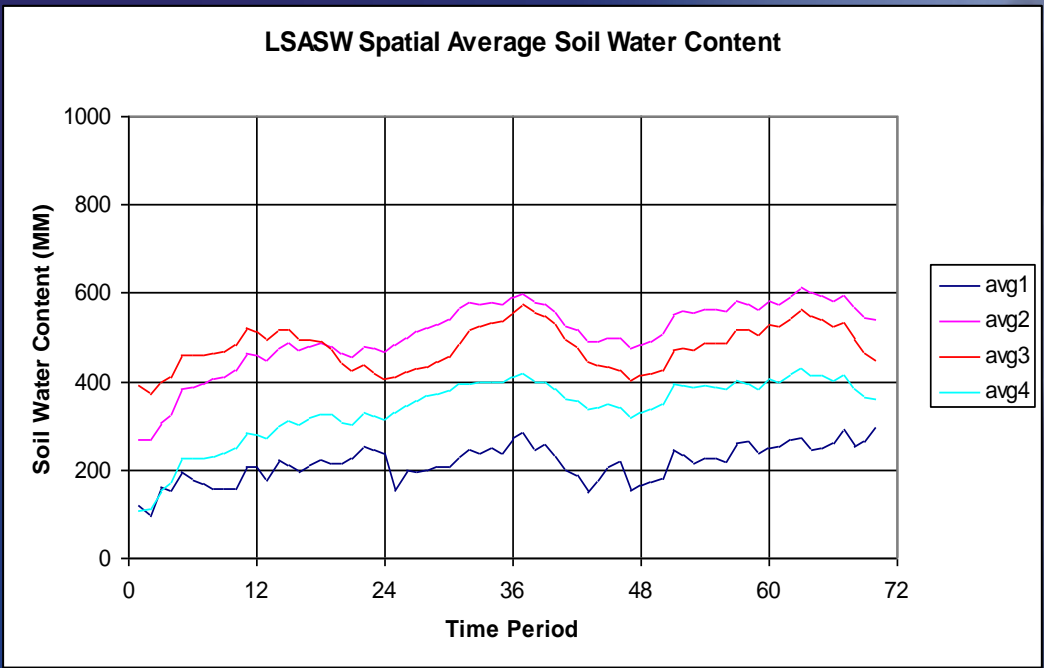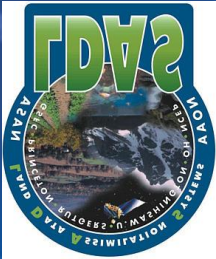NOAH Model Water Content Range
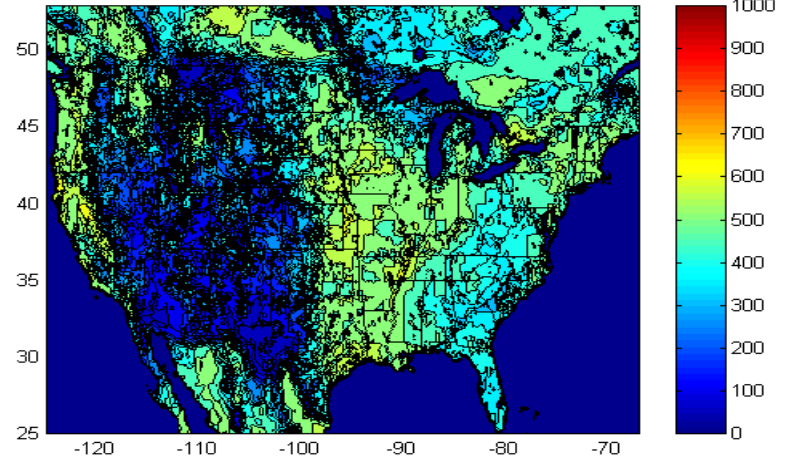
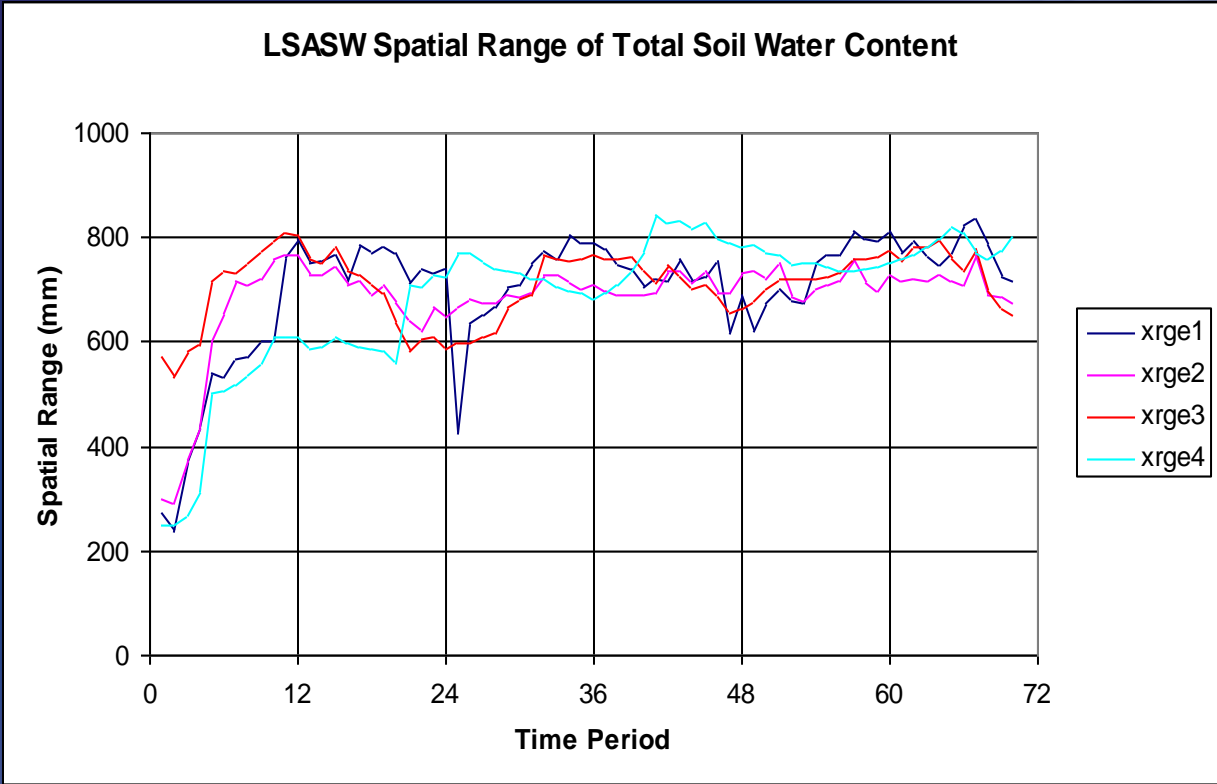Mosaic Model Water Content Range
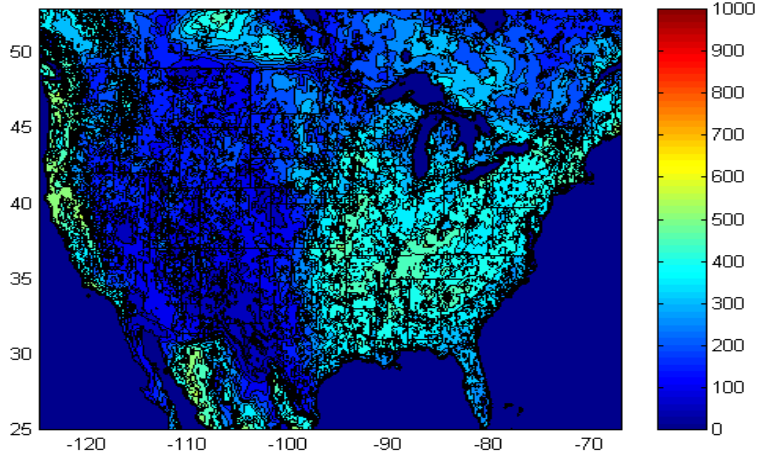
VIC Model Water Content Range

Location of LSASW Study Area

LSASW Spatial Average Soil Water Content

LSASW Spatial Standard Deviation of Soil Water Content
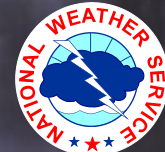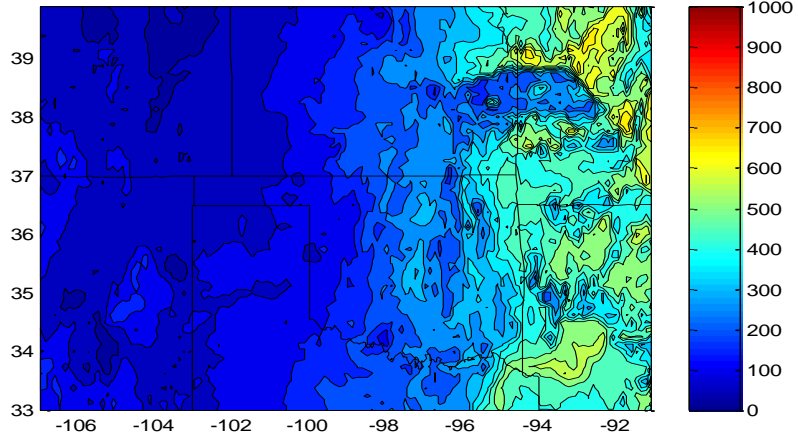
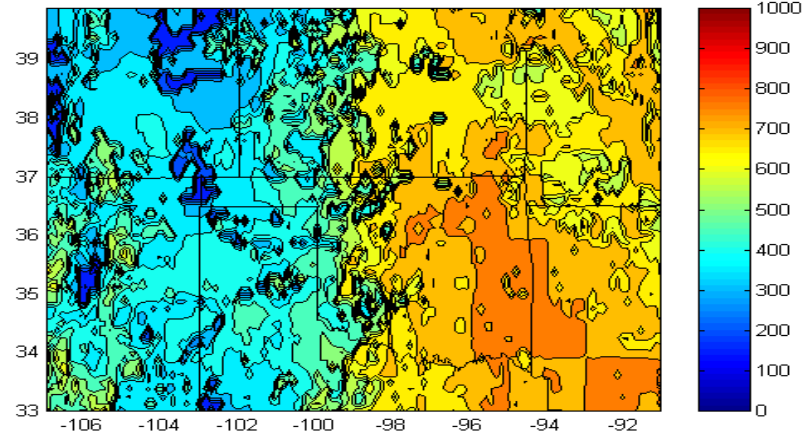LSASW Spatial Range of Total Soil Water Content
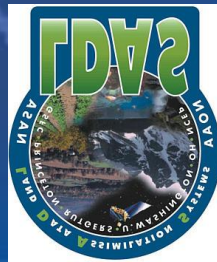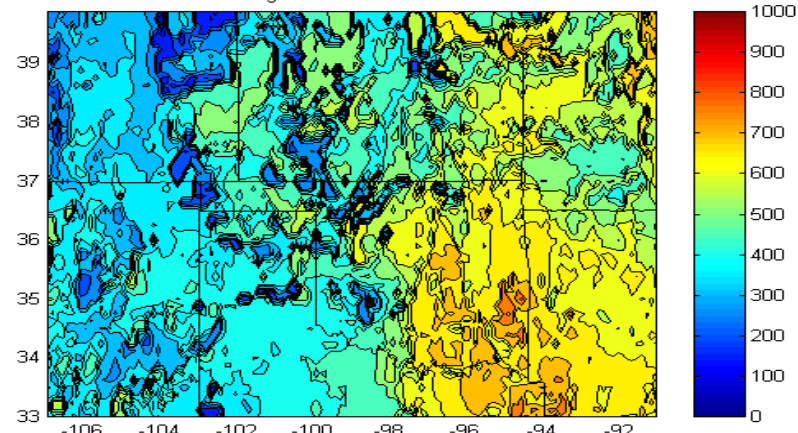
LSASW Average Soil Water Content
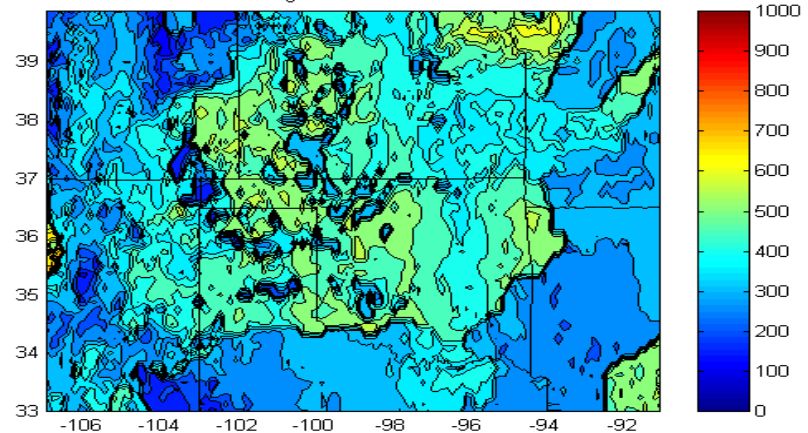

Average Soil Water - SAC

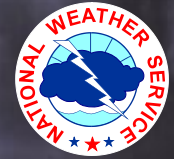

Average Soil Water - NOAH

Average Soil Water - Mosaic

Average Soil Water - VIC

LSASW Standard Deviation of Soil Water Content
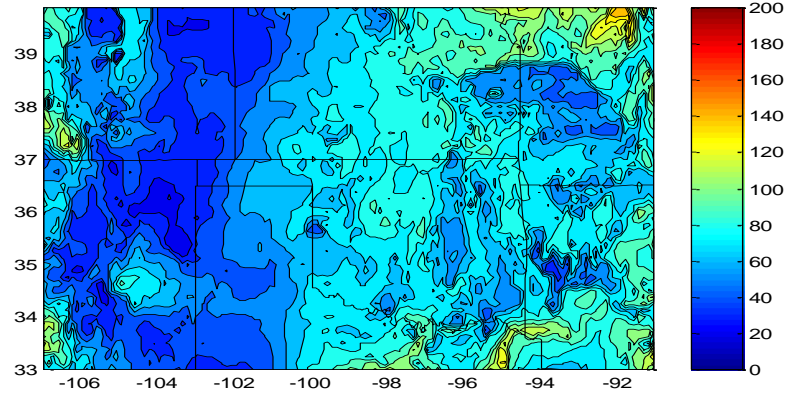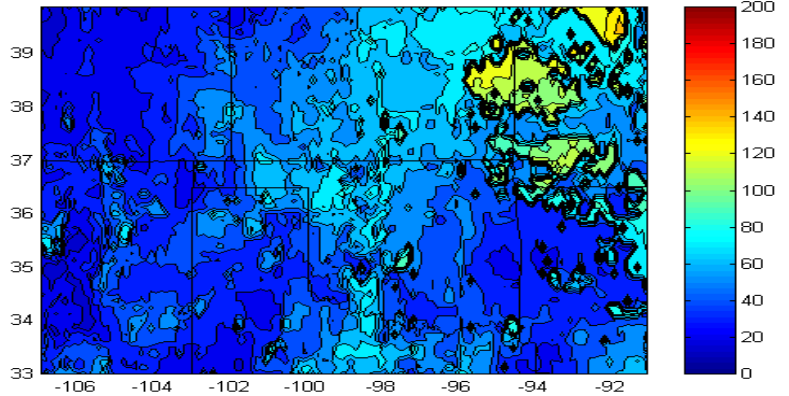
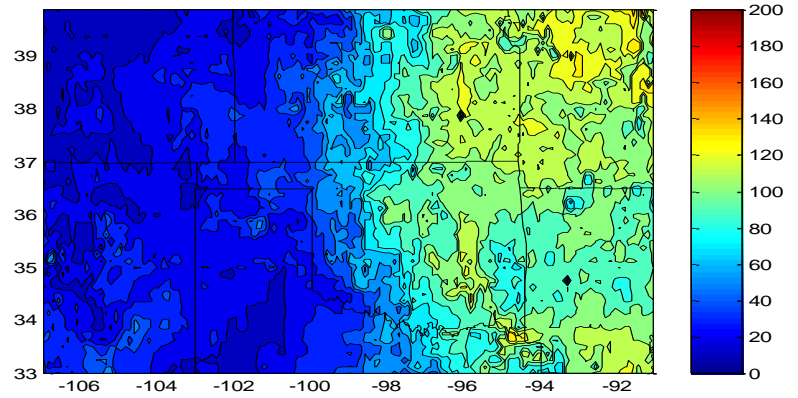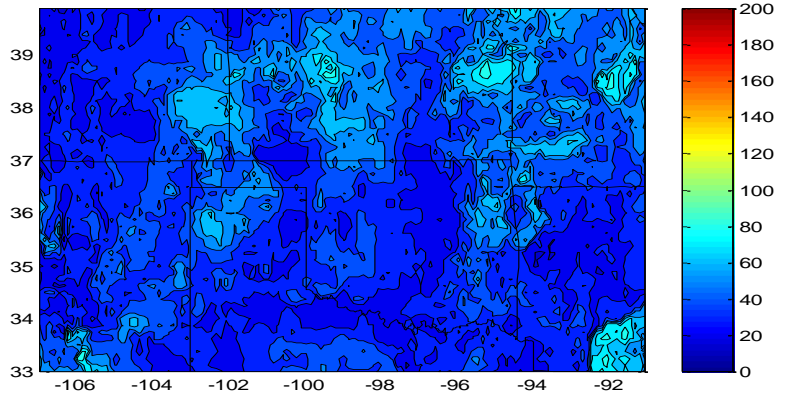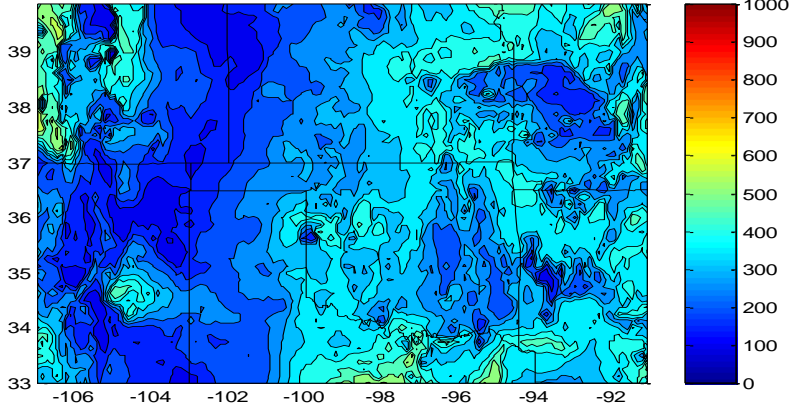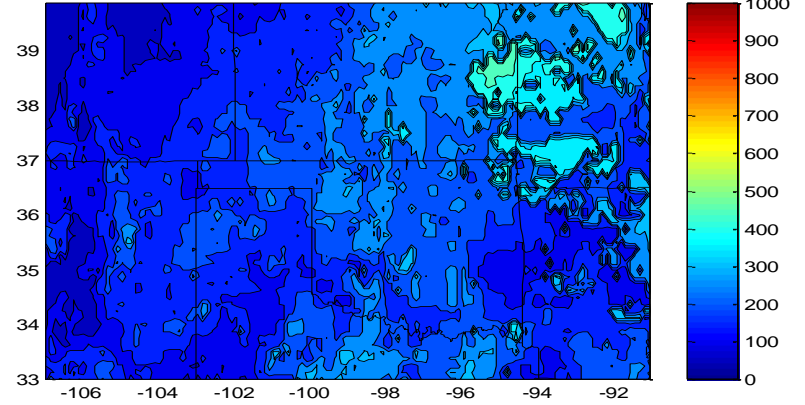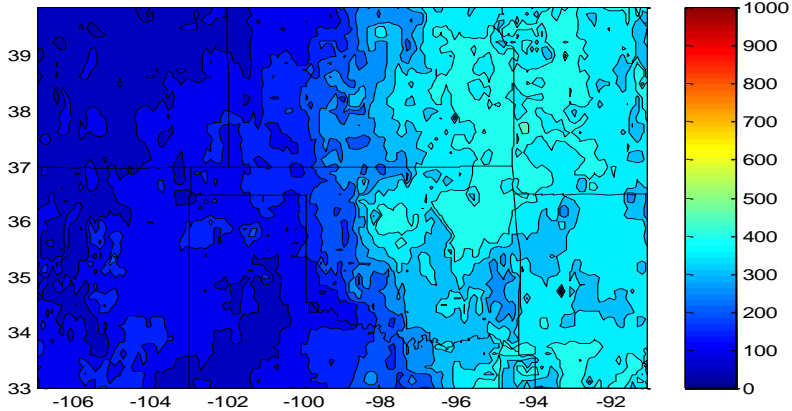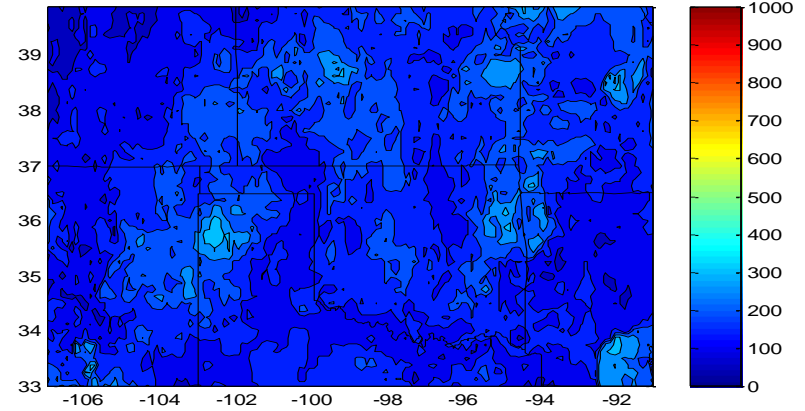# LSASW Range of Soil Water Content

Maximum Range in Total Soil Water - SAC

Maximum Range in Total Soil Water - NOAH

Maximum Range in Total Soil Water - Mosaic

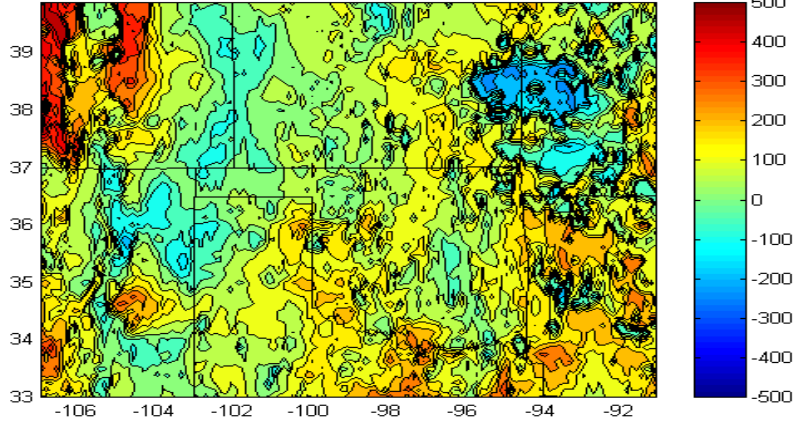Maximum Range in Total Soil Water - VIC
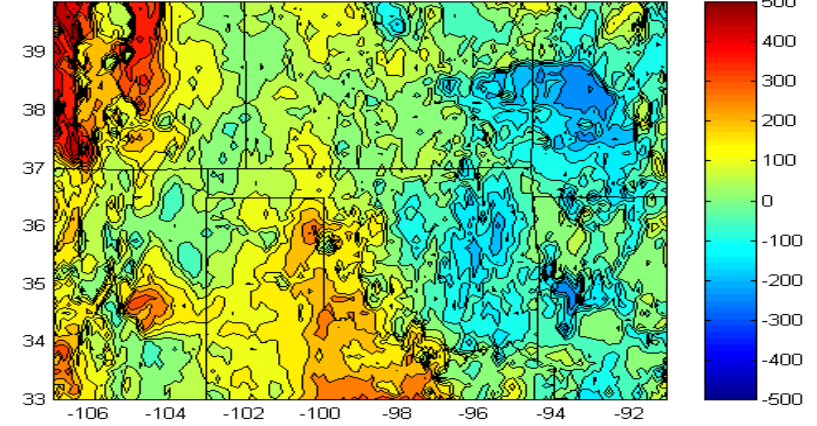
LSASW Range Difference with SAC

SAC - NOAH

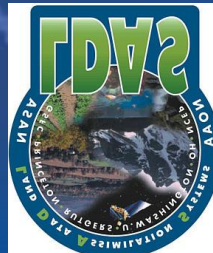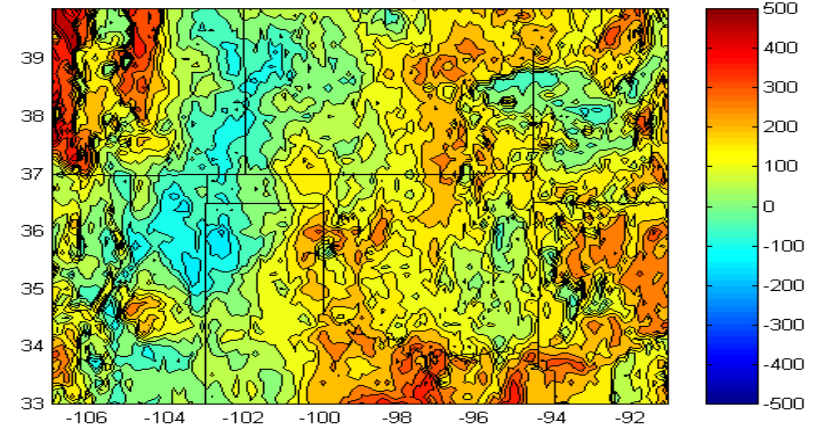
Difference in Maximum Ranges (SAC - NOAH)

SAC - Mosaic

Difference in Maximum Ranges (SAC - Mosaic)
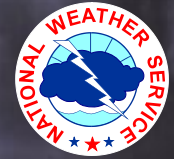
SAC - VIC
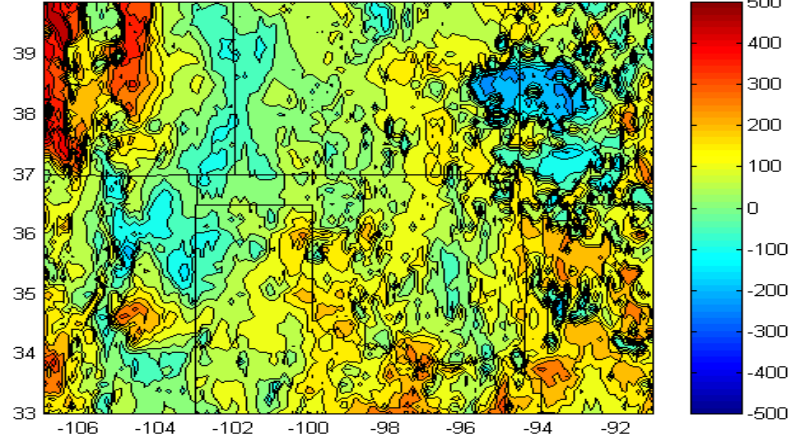

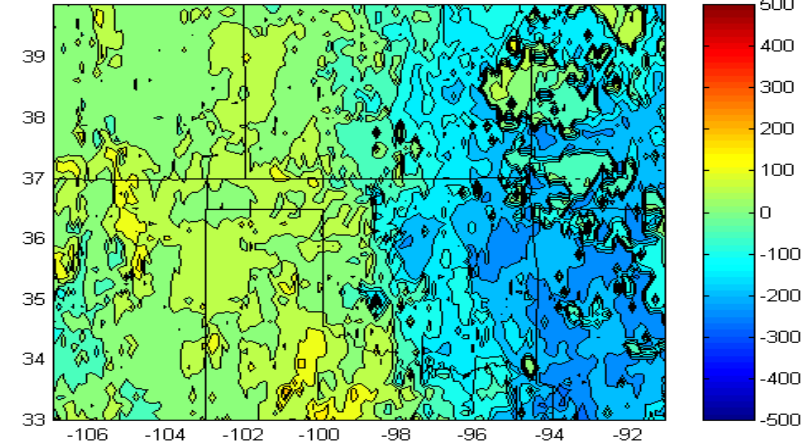Difference in Maximum Ranges (SAC - VIC)

LSASW Range Difference with NOAH

SAC - NOAH

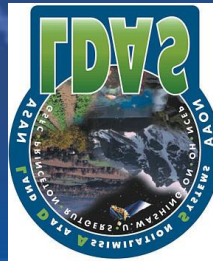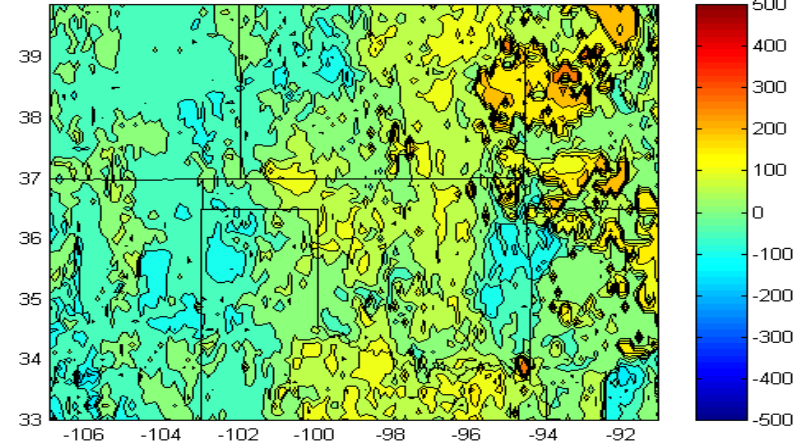

Difference in Maximum Ranges (SAC - NOAH)

NOAH - Mosaic

Difference in Maximum Ranges (NOAH - Mosaic)

NOAH - VIC
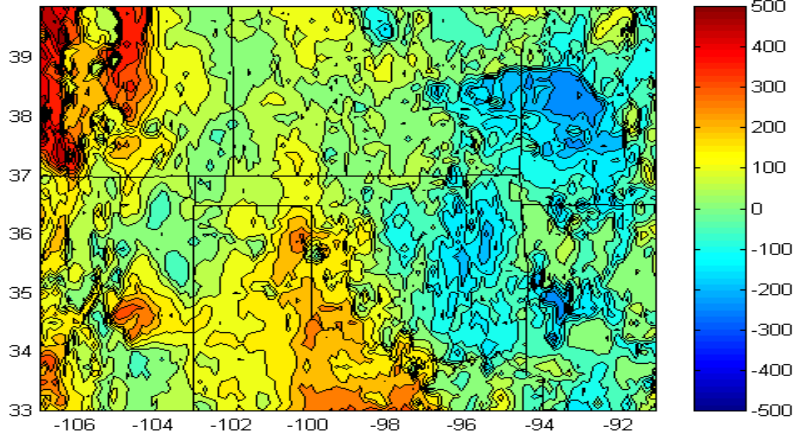

Difference in Maximum Ranges (NOAH - VIC)
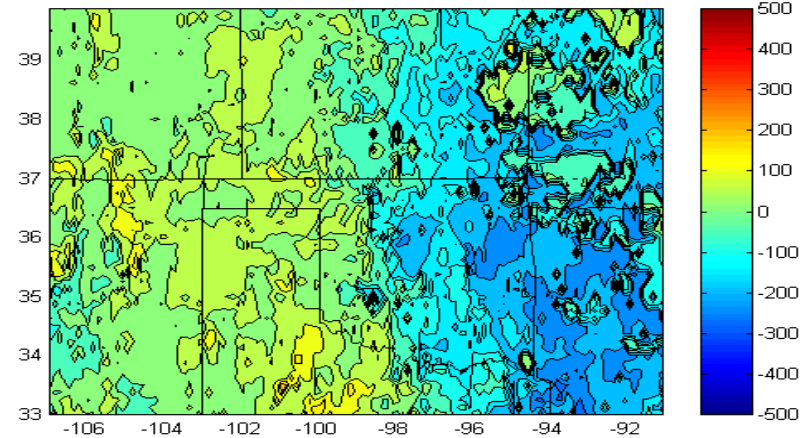
LSASW Range Difference with Mosaic

SAC - Mosaic

Difference in Maximum Ranges (SAC - Mosaic)
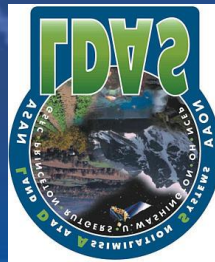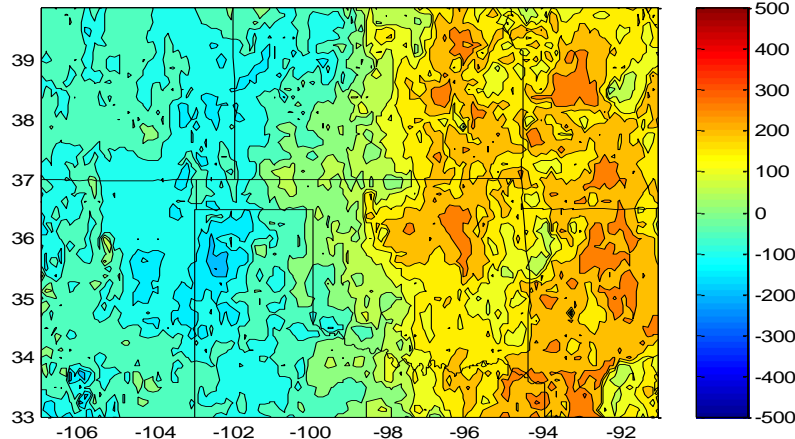
NOAH - Mosaic

Difference in Maximum Ranges (NOAH - Mosaic)

Mosaic - VIC

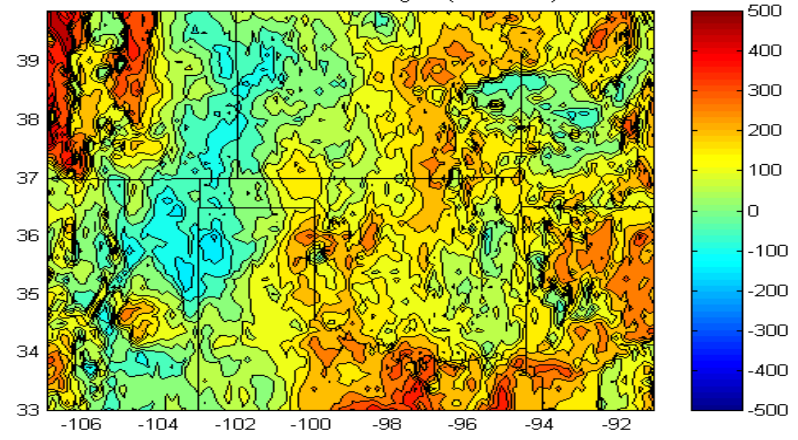Difference in Maximum Ranges (Mosaic - VIC)
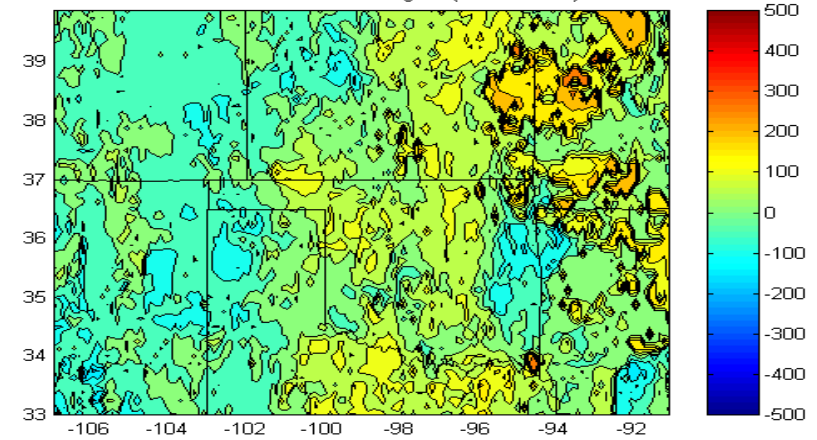
LSASW Range Difference with VIC

SAC - VIC

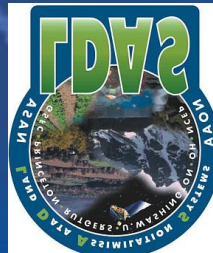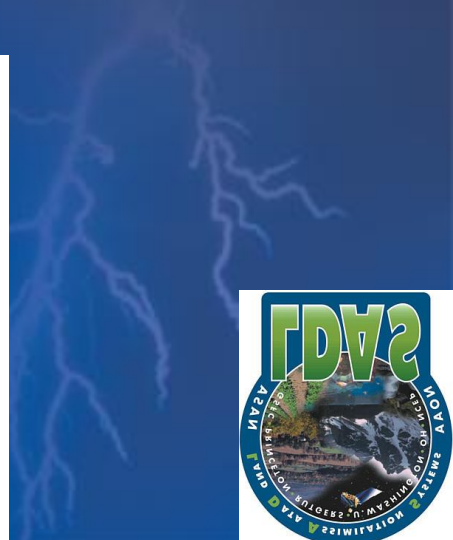Difference in Maximum Ranges (SAC - VIC)
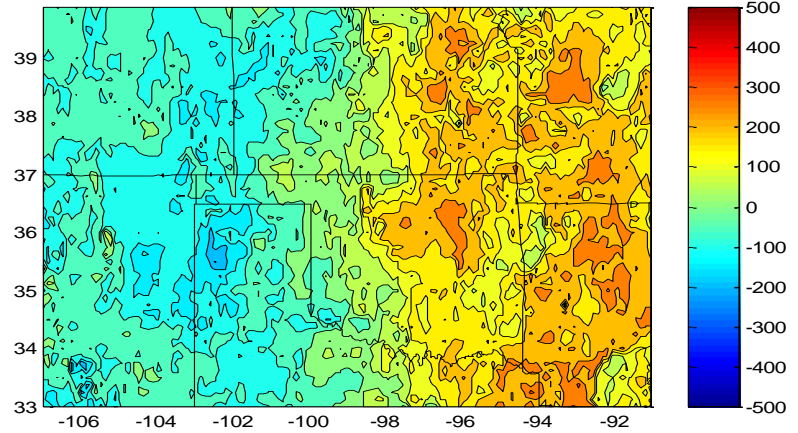
NOAH - VIC

Difference in Maximum Ranges (NOAH - VIC)

Mosaic - VIC

Difference in Maximum Ranges (Mosaic - VIC)
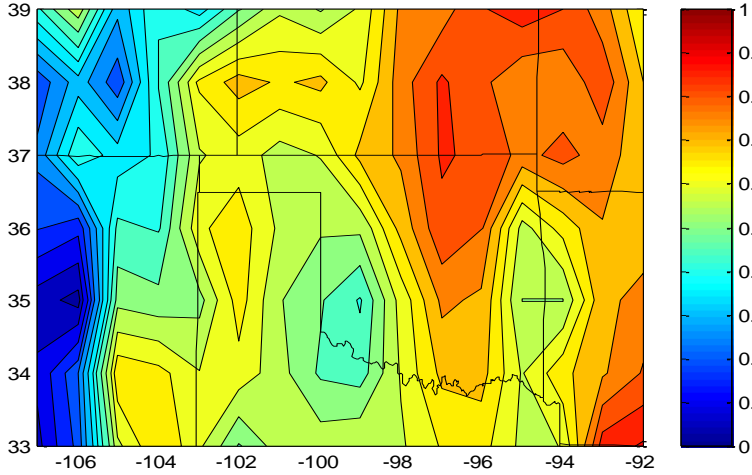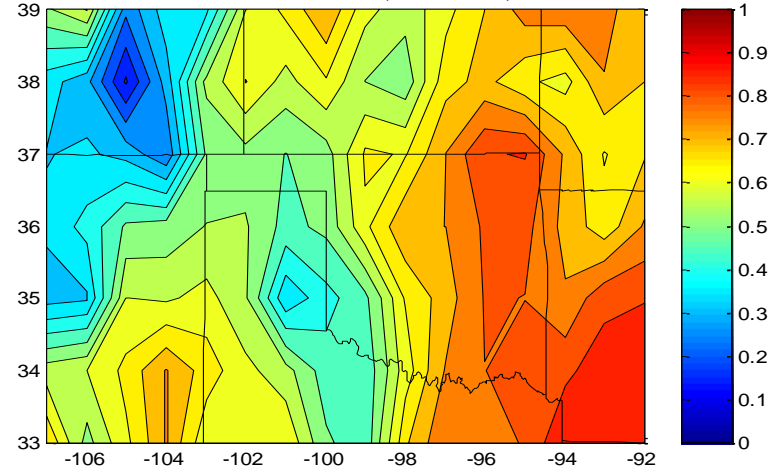
LSASW Correlation with SAC

NOAH

Mosaic

VIC

LSASW Correlation with NOAH

SAC

Correlation Coefficient (SAC-NOAH)

Mosaic

Correlation Coefficient (NOAH-Nosaic)

VIC

Correlation Coefficient (NOAH-VIC)
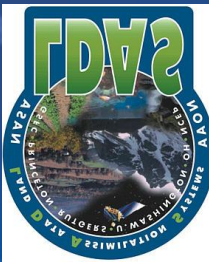
LSASW Correlation with Mosaic

SAC

NOAH
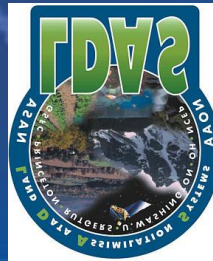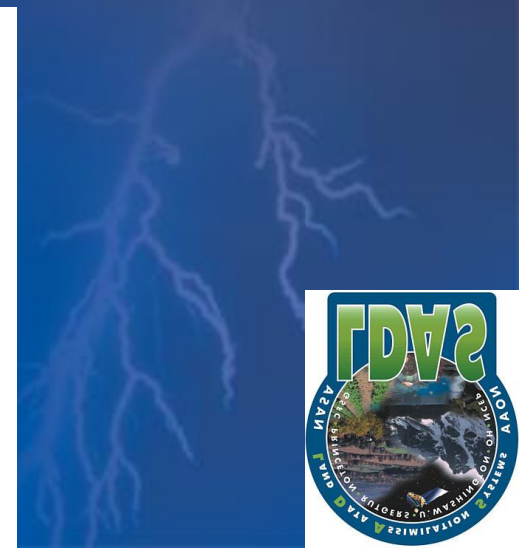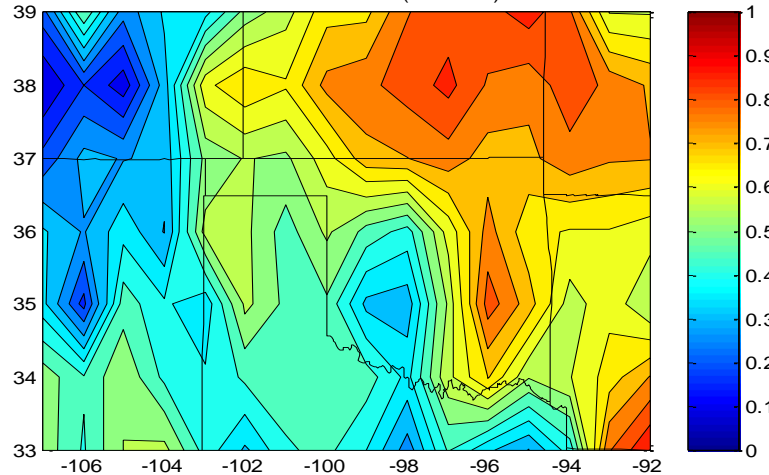

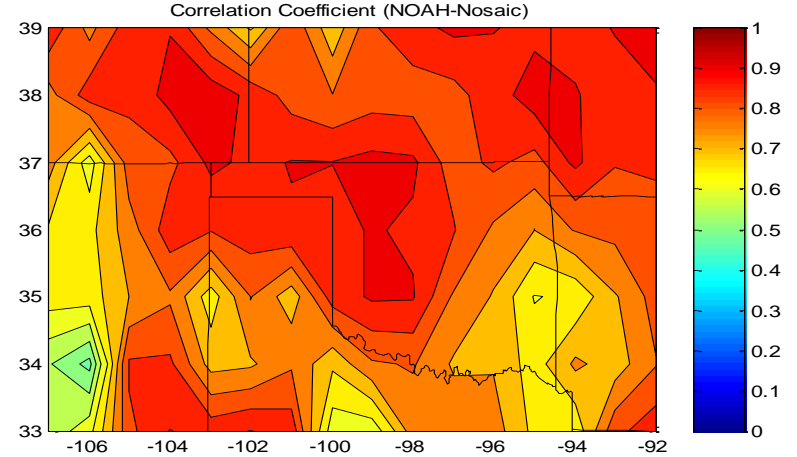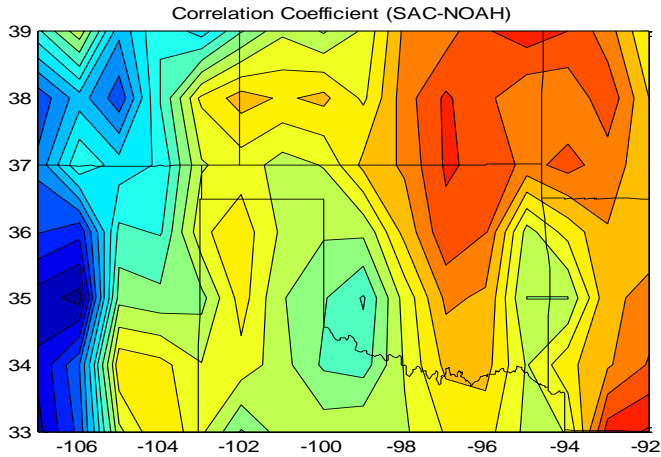Correlation Coefficient (SAC-Mosaic)

Correlation Coefficient (NOAH-Nosaic)

VIC

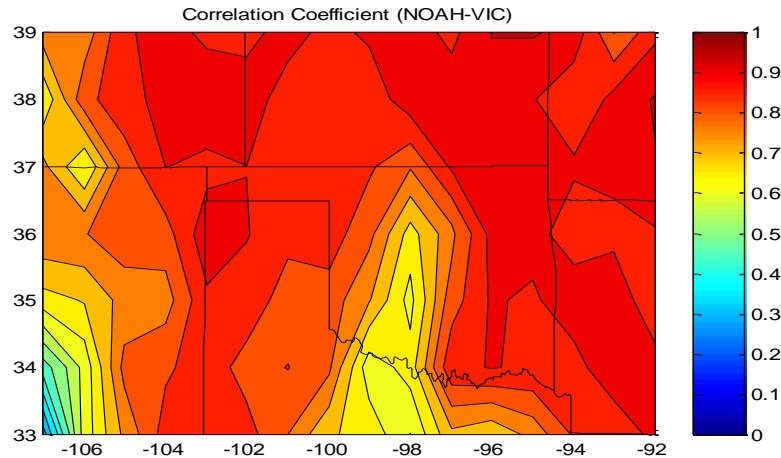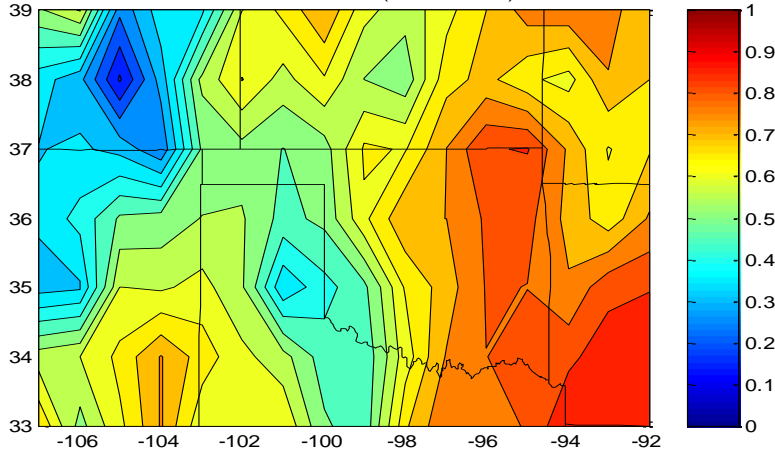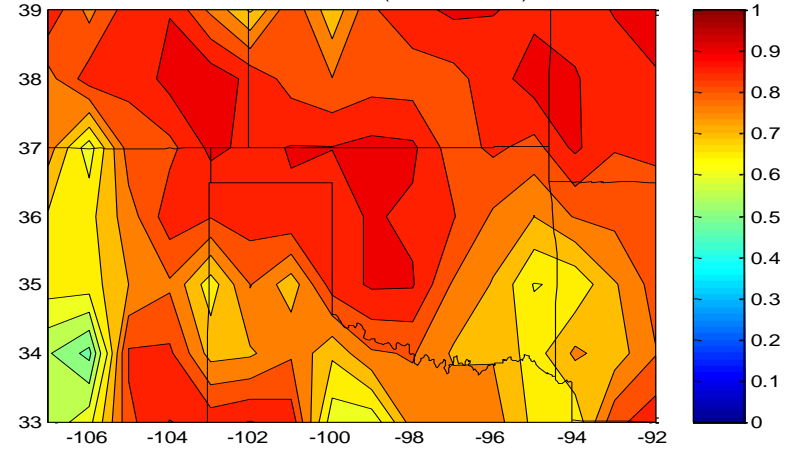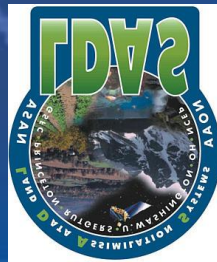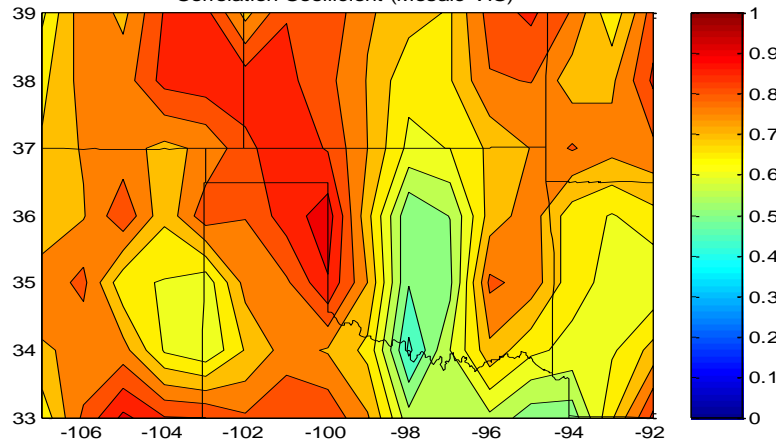Correlation Coefficient (Mosaic-VIC)

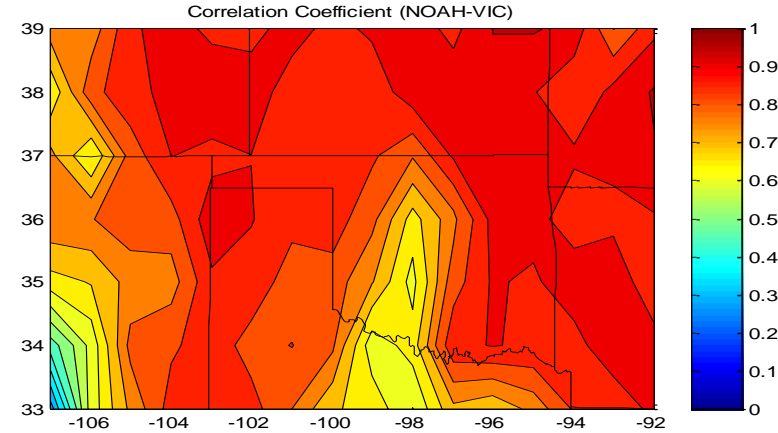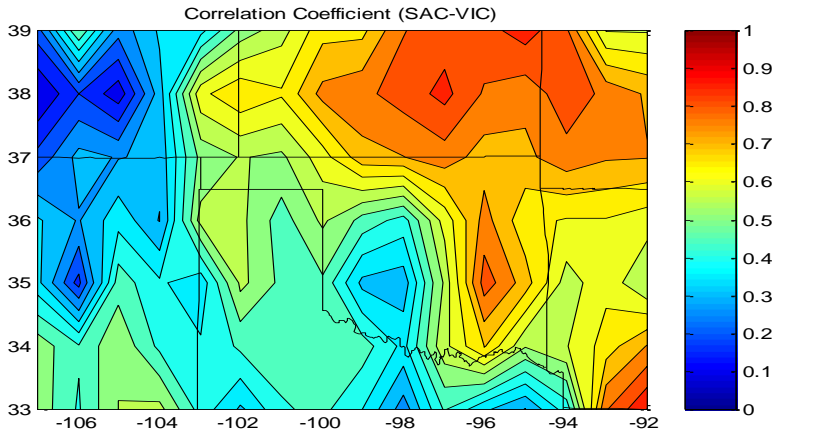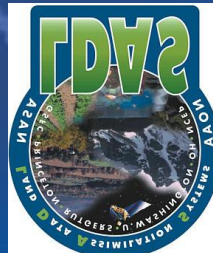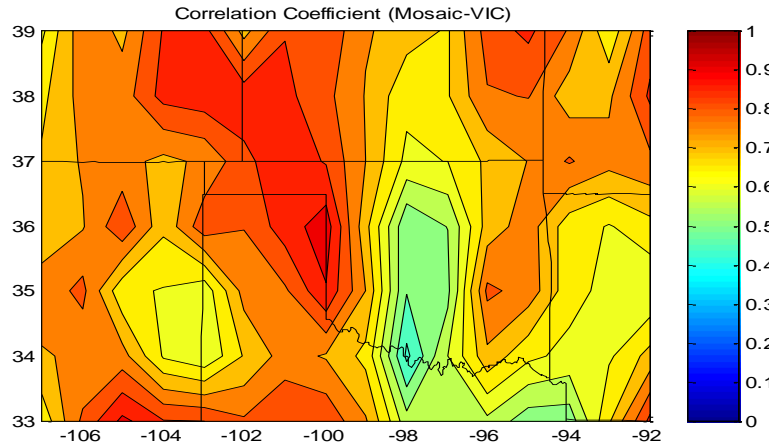# LSASW Correlation with VIC
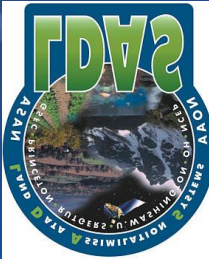
Fraction of Total Variance Accounted for by 1st Principal Component

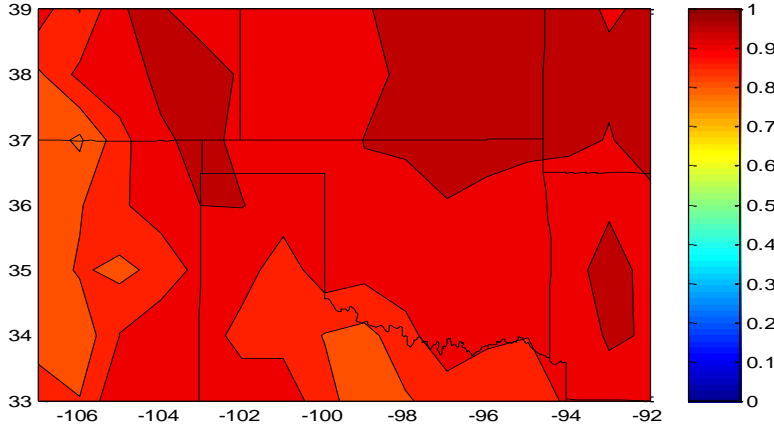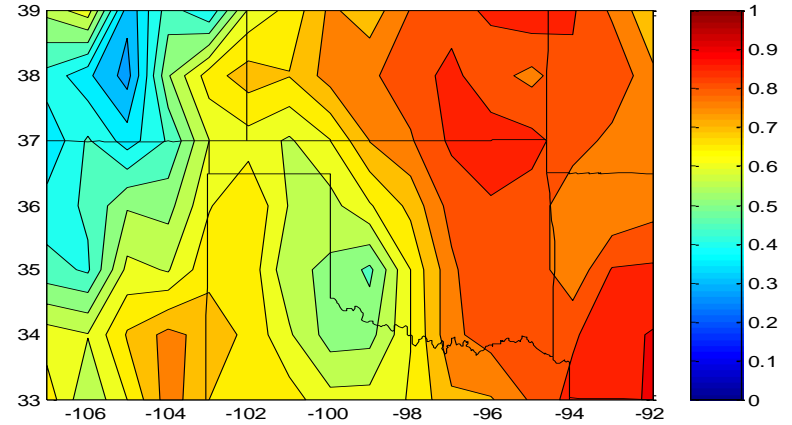Fraction of Joint Variance - 1st Component
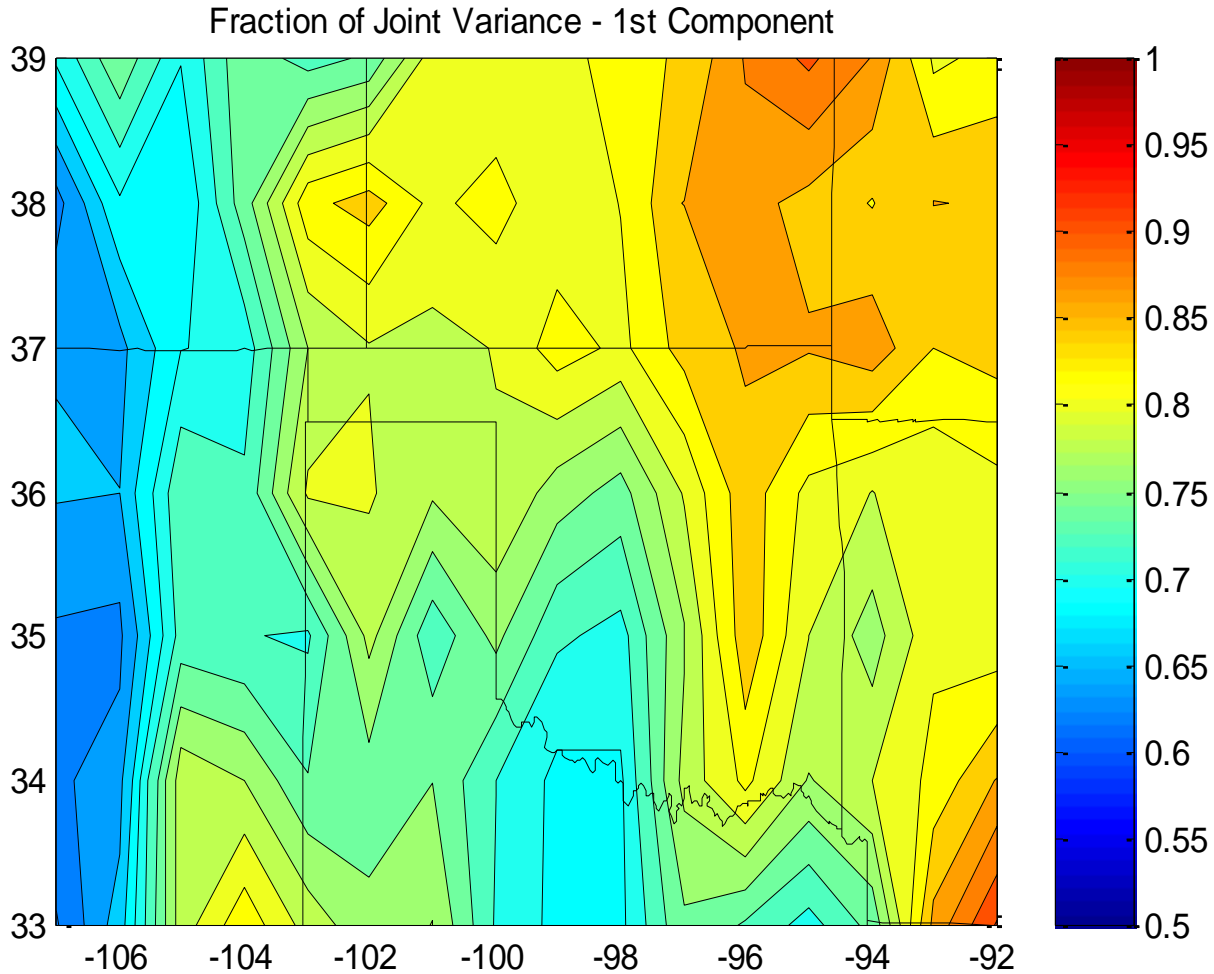
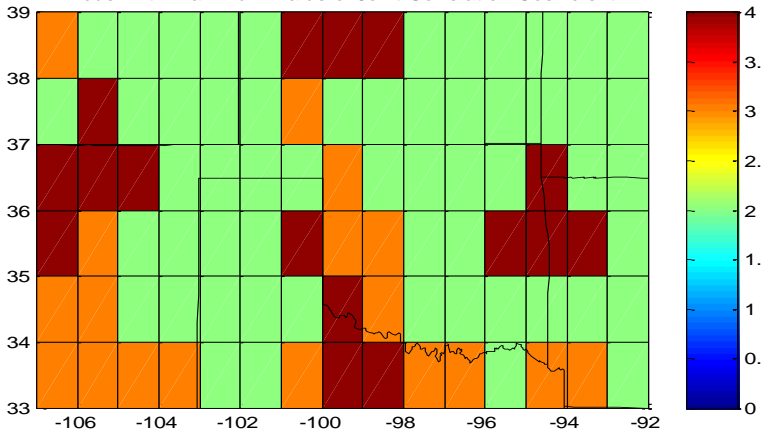# Maximum/Minimum Joint Correlation Coefficient

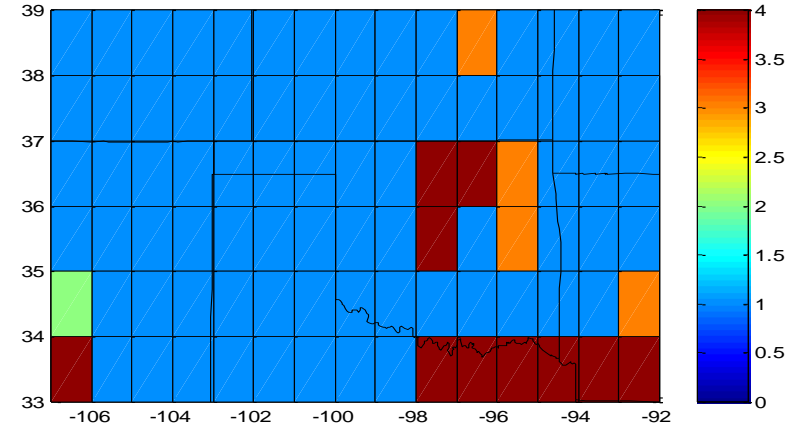Maximum Value of Joint Correlation Coefficient

Minimum Value of Joint Correlation Coefficient

Model with Maximum Value of Joint Correlation Coefficient

Model with Minimum Value of Joint Correlation Coefficient

Conclusions

- Some "useful" correlation between model values of total soil water content, but clearly different models behave differently

- Sacramento model is most different from the other models

- Model spin-up strongest for first 6-months, but lasts for about 1-year

- GRACE satellite mission to measure large-scale total water storage changes should help discriminate between models at continental scale
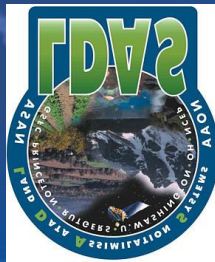
Thank you!
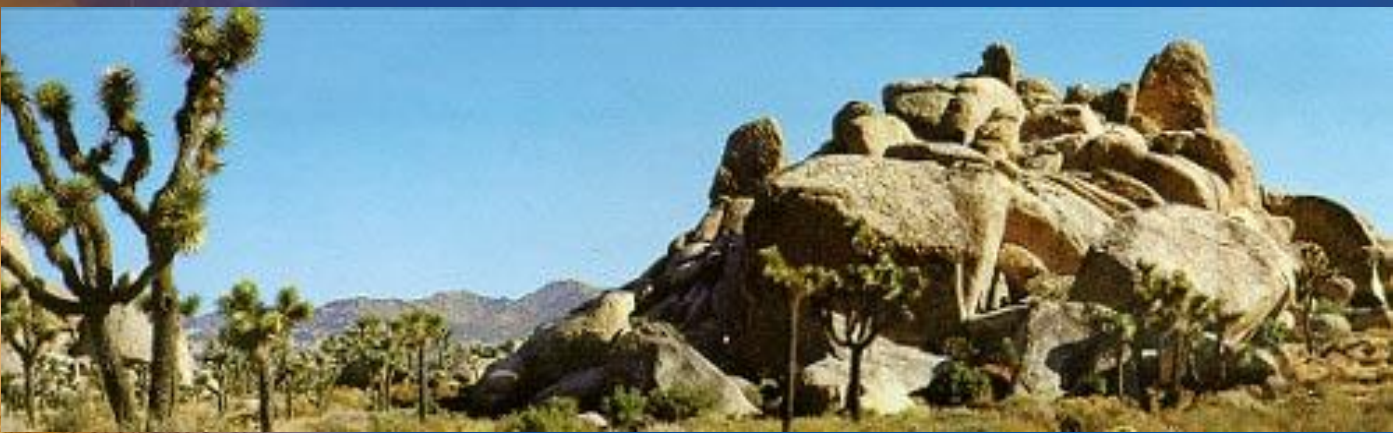
Background

- **Four LSMs running in LDAS:**

  - *NOAH, MOSAIC, VIC and SAC*

- **Forced by the same real-time data**

- **Each LSM was initialized on October 1, 1996 from similar initial conditions**