ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
INSTITUTE FOR ATMOSPHERIC AND CLIMATE SCIENCE

Assessing the large-scale spatial representativeness of soil moisture over the United States

Nadine Nicolai-Shaw, Martin Hirschi, Heidi Mittelbach, and Sonia I. Seneviratne
contact: nadine.nicolai@env.ethz.ch

Satellite Soil Moisture Validation & Application Workshop 2014

Motivation

Soil moisture is crucial for environmental science

Insight into the spatial variability of soil moisture can provide a basis for up-scaling in-situ soil moisture station data, network improvement and climate model validation

Several studies on the spatial-temporal variability of soil moisture

Research question:

What is the spatial representativeness of temporal soil moisture dynamics, i.e the spatial footprint?

Data and Method

Data

Soil moisture data sets:

- **In-situ** measurements
  - International Soil Moisture Network (ISMN)
  - North American Soil Moisture Database (NASMD)
- **Satellite derived**
  - ESA Climate Change Initiative soil moisture project (ECV-SM, 1979-2010)
- **Land-surface model estimates**
  - ERA Interim/Land (ERA, 1979-2010)

Location:

- North America

Period investigated:

- April-September 2003-2010

Temporal resolution:

- Daily absolute values
- Daily inter-annual anomalies

Data

Soil moisture data sets:

- **In-situ** measurements
  - International Soil Moisture Network (ISMN)
  - North American Soil Moisture Database (NASMD)
- **Satellite derived**
  - ESA Climate Change Initiative soil moisture project (ECV-SM, 1979-2010)
- **Land-surface model estimates**
  - ERA Interim/Land (ERA, 1979-2010)

Location:

- North America

Period investigated:

- April-September 2003-2010

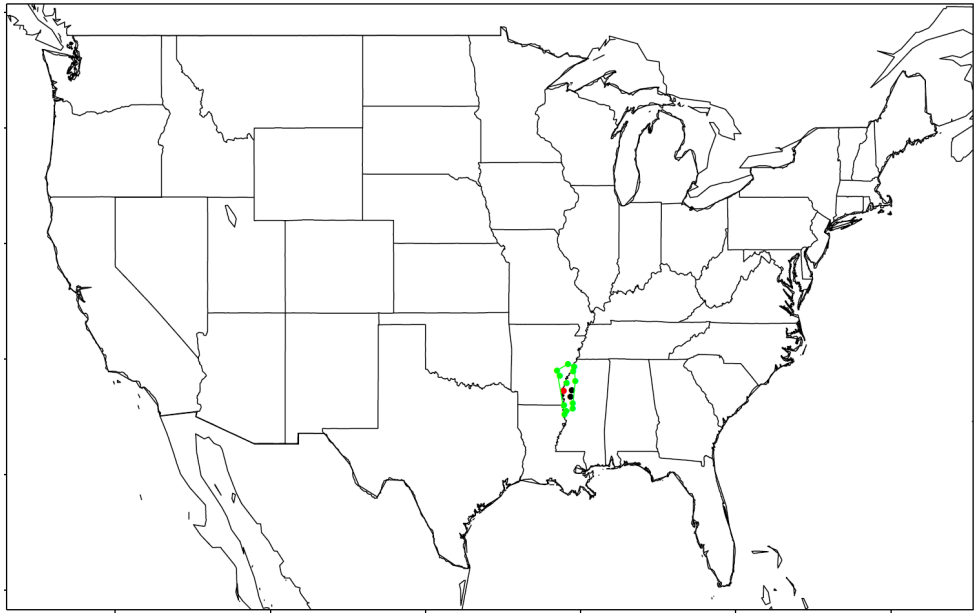
Temporal resolution:

- Daily absolute values
- Daily inter-annual anomalies

Method

Spatial representativeness:

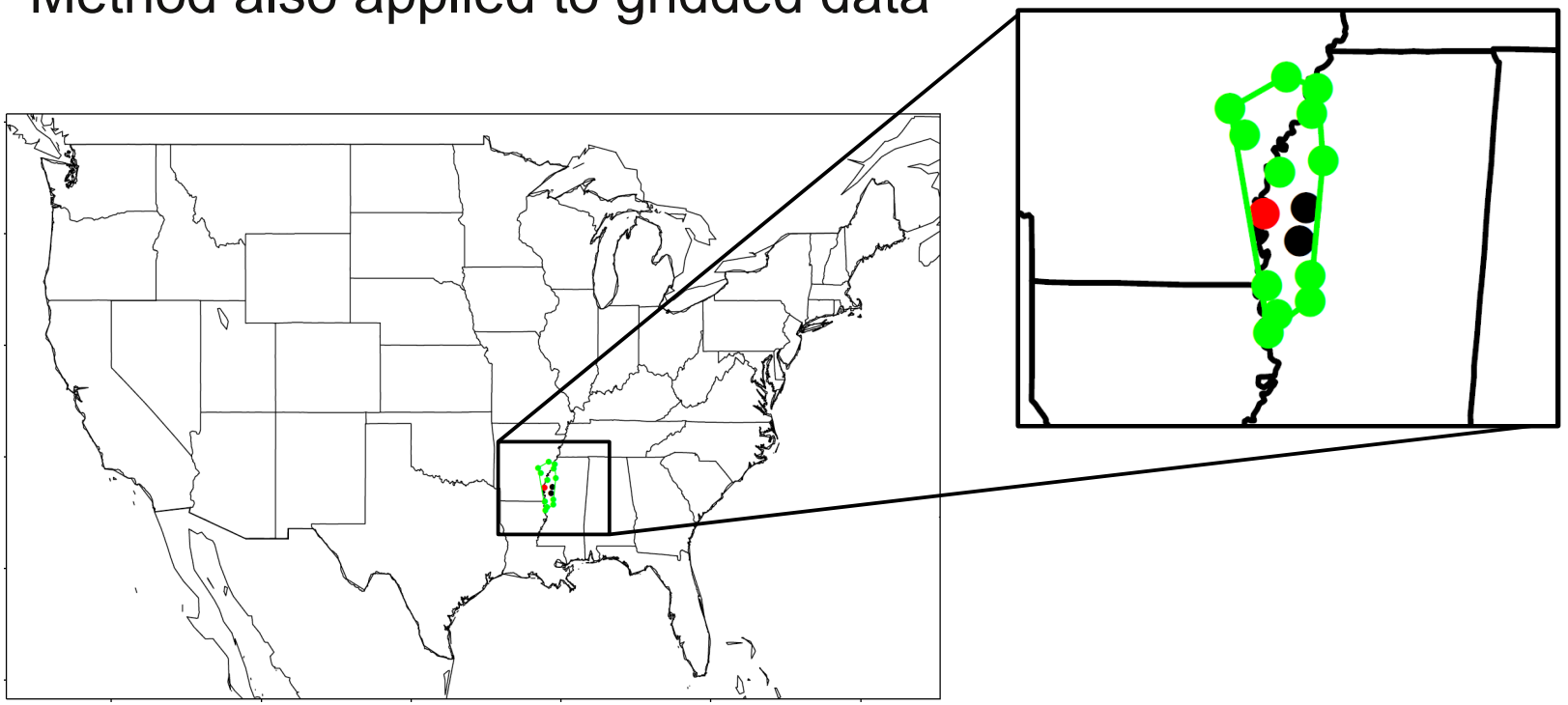
- Area surrounding a station in which other stations exhibit similarity above a predefined cut-off
  → definition of convex hull area = footprint of station
- Similarity is based on rank correlation
- Method also applied to gridded data



Method

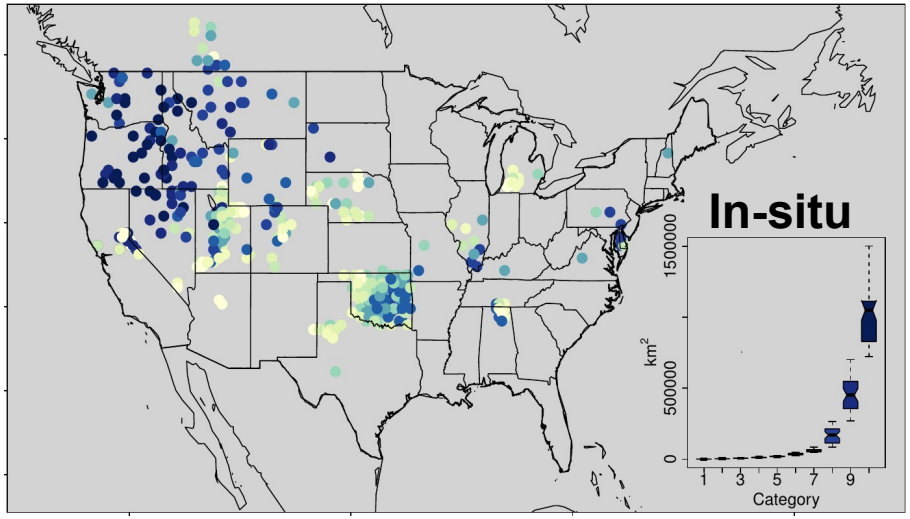
Spatial representativeness:

- Area surrounding a station in which other stations exhibit similarity above a predefined cut-off
  → definition of convex hull area = footprint of station
- Similarity is based on rank correlation
- Method also applied to gridded data

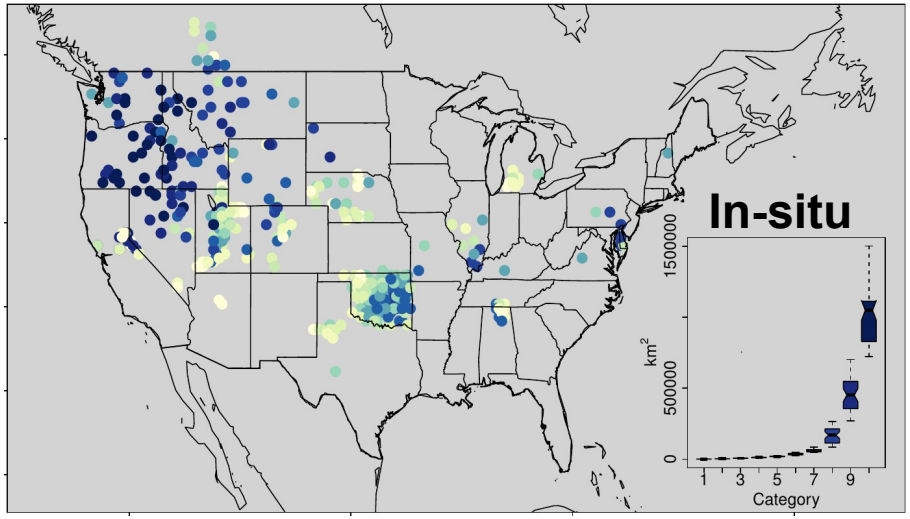


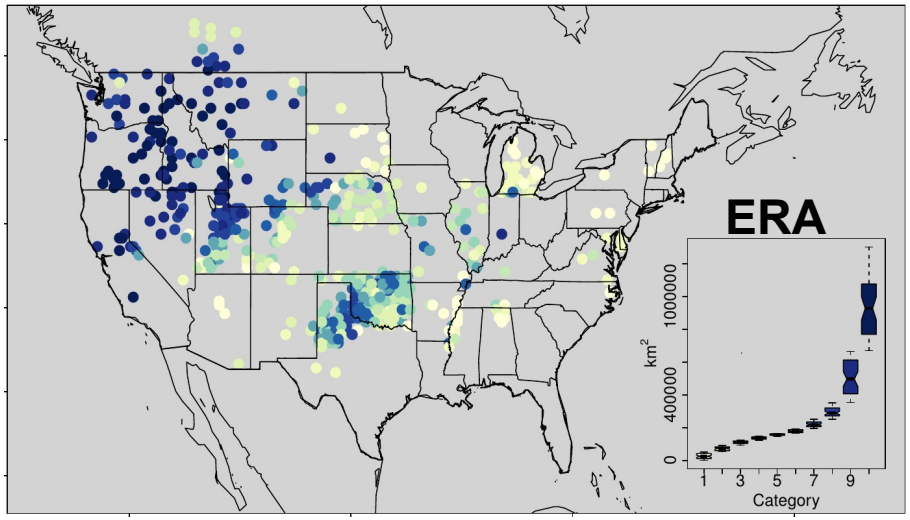
Results

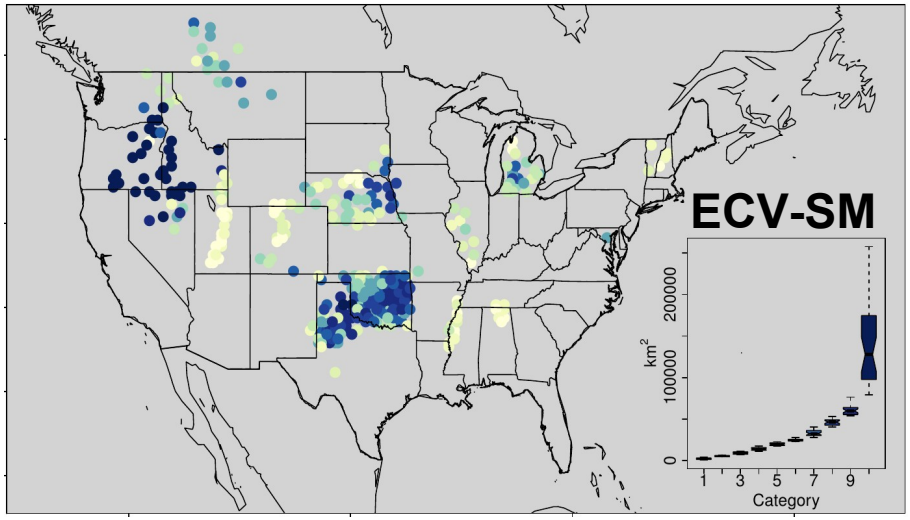
Spatial Representativeness Absolute Values



Spatial Representativeness Absolute Values

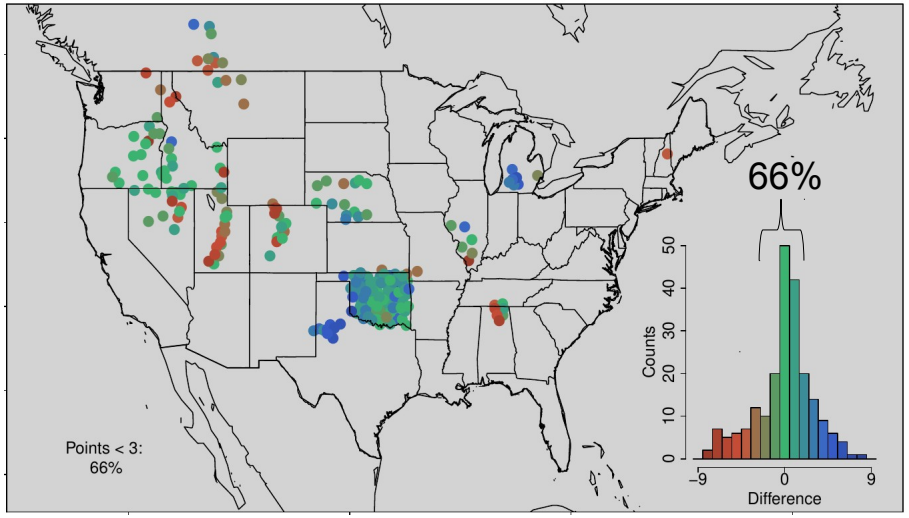




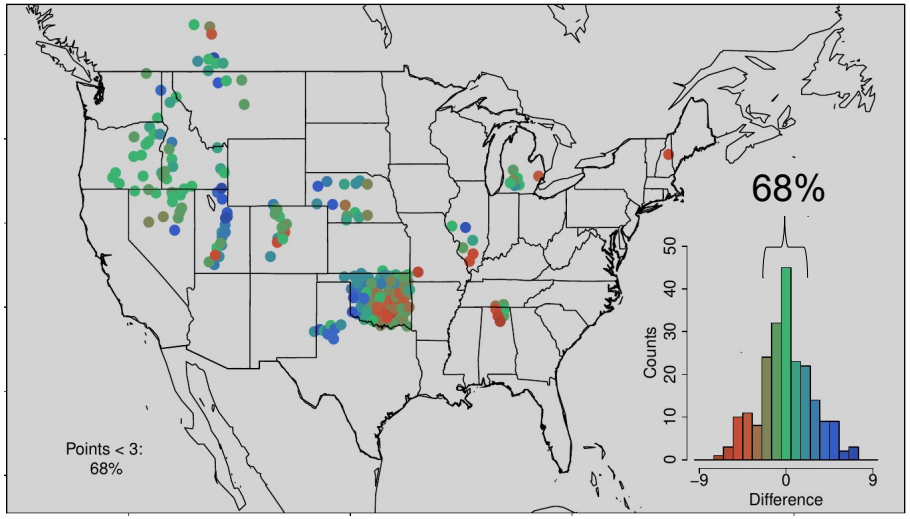


Differences in Spatial Representativeness

ECV-SM - In-situ

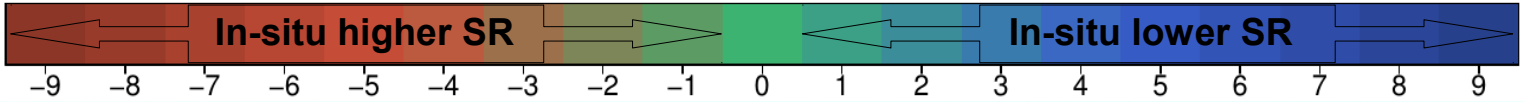


ERA - In-situ



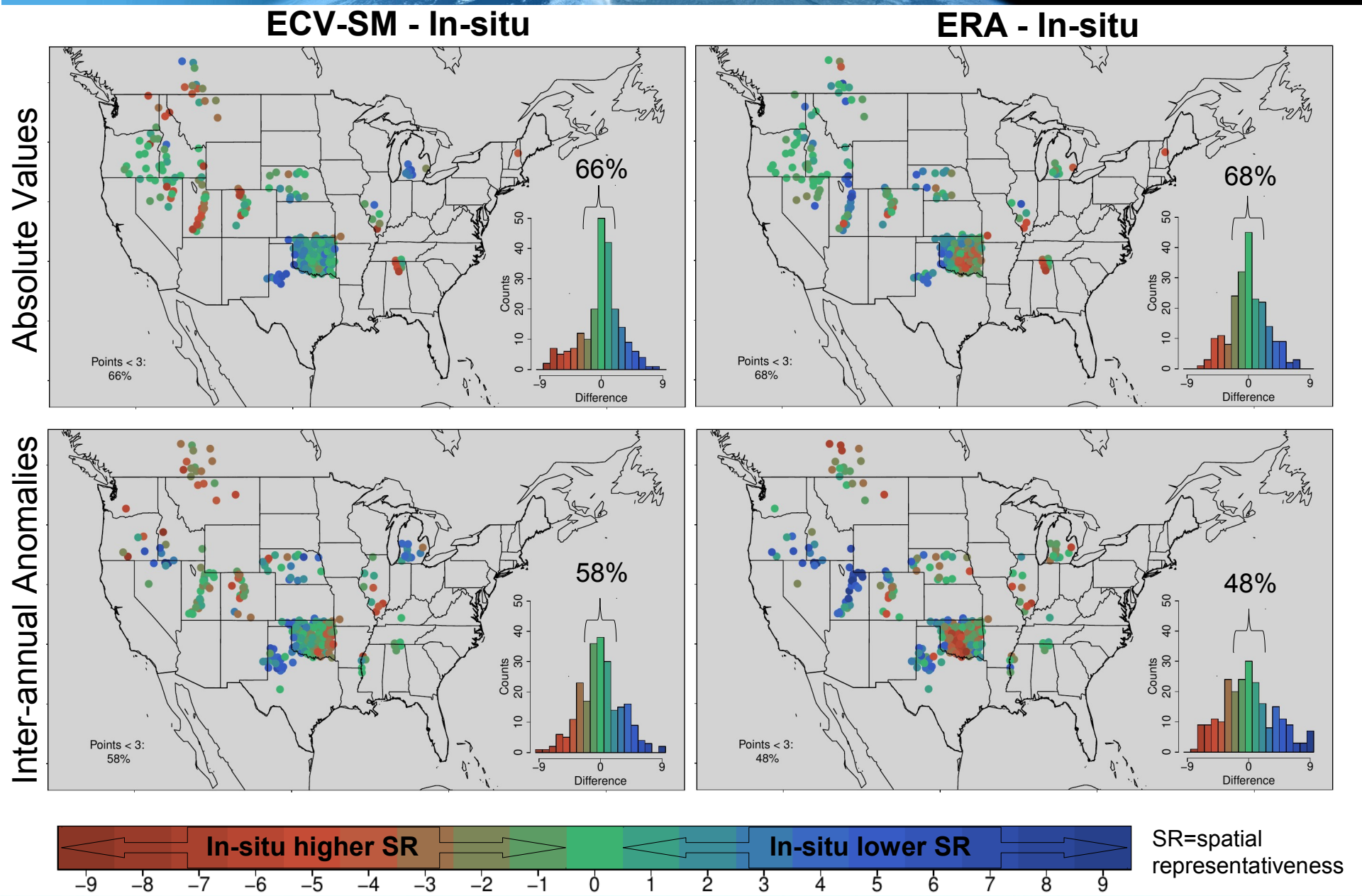
Absolute Values

Inter-annual Anomalies

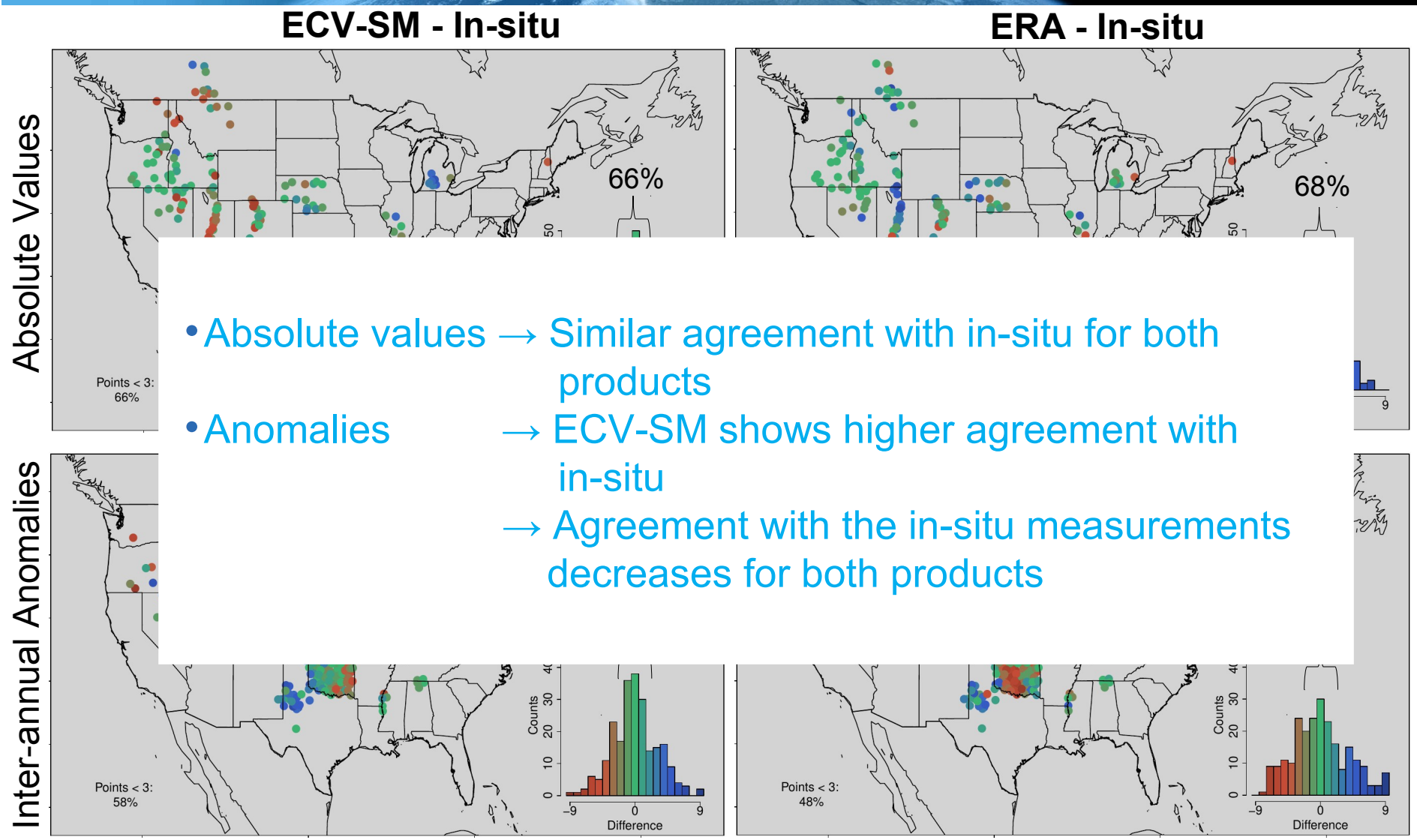


SR=spatial representativeness

Differences in Spatial Representativeness



Differences in Spatial Representativeness



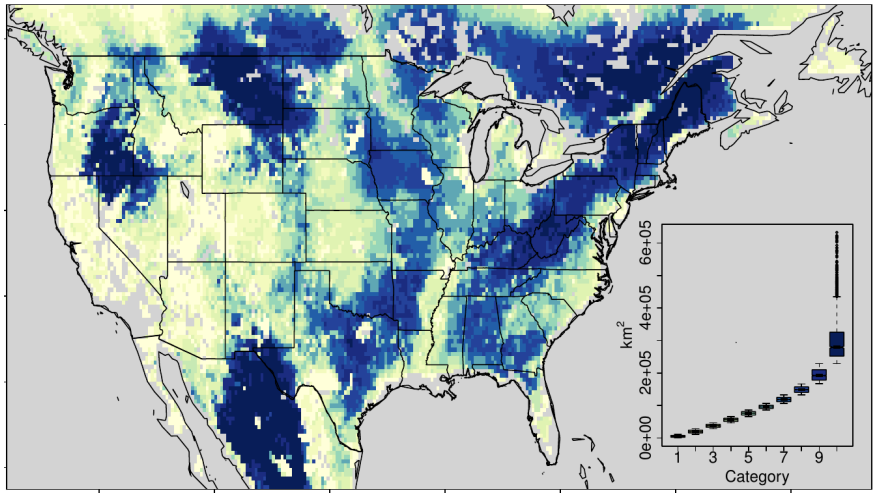
- Absolute values → Similar agreement with in-situ for both products
- Anomalies → ECV-SM shows higher agreement with in-situ
  → Agreement with the in-situ measurements decreases for both products

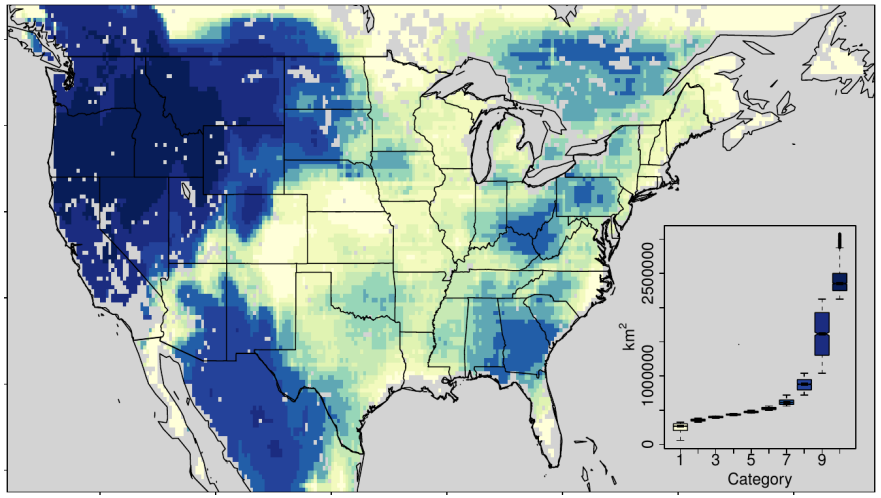
SR=spatial representativeness

Spatial Representativeness

ECV-SM | **ERA**

Absolute Values

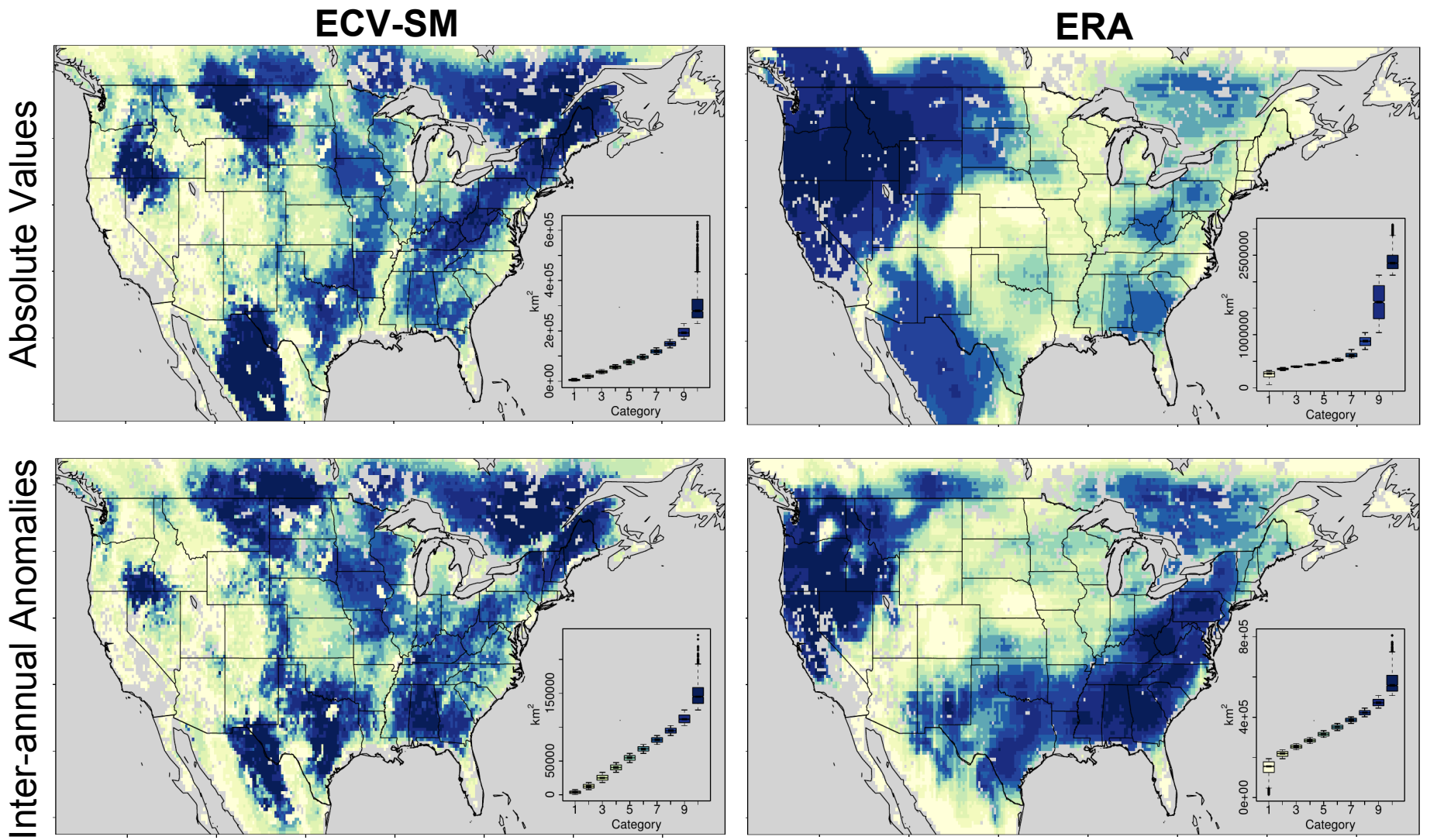




LOW **HIGH**

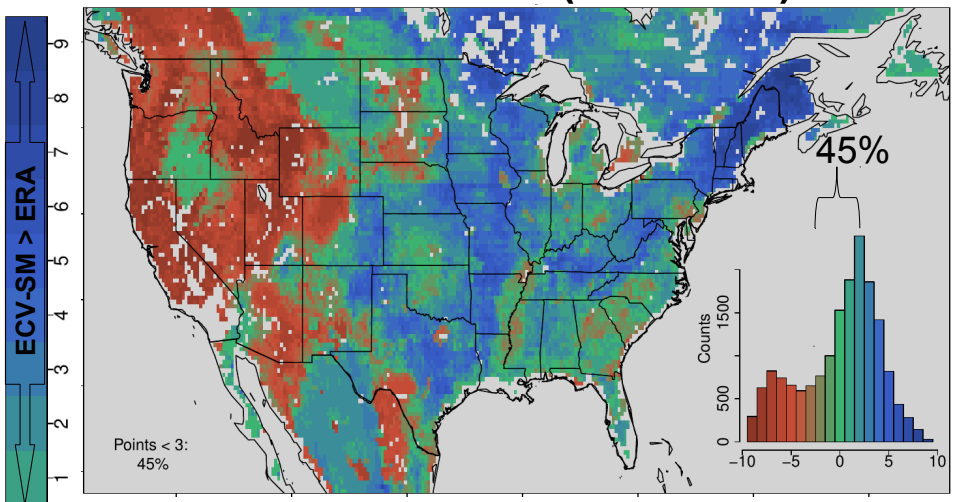
1 2 3 4 5 6 7 8 9 10

Spatial Representativeness

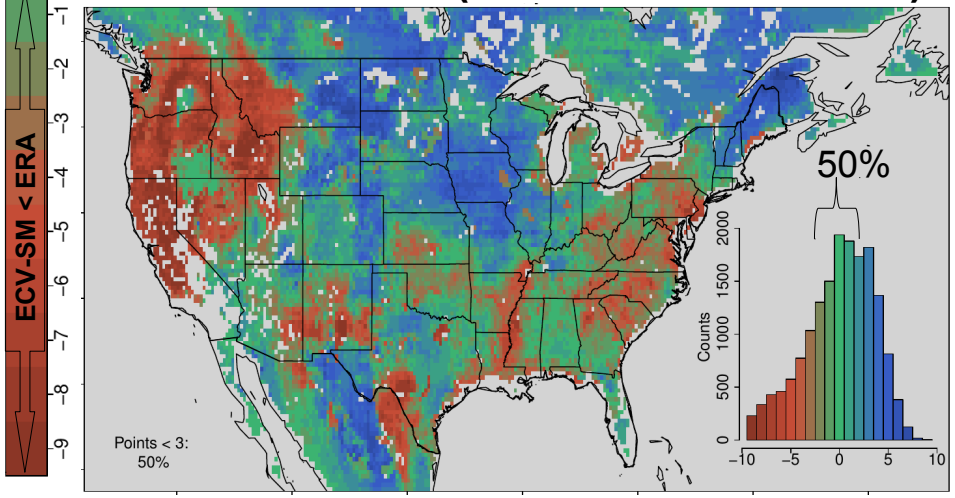


Differences in Spatial Representativeness

ECV-SM - ERA (Absolute)

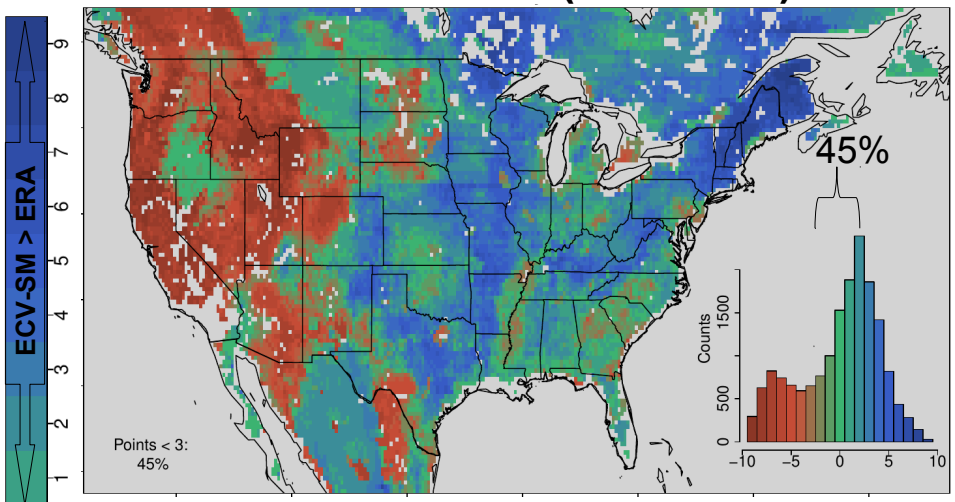


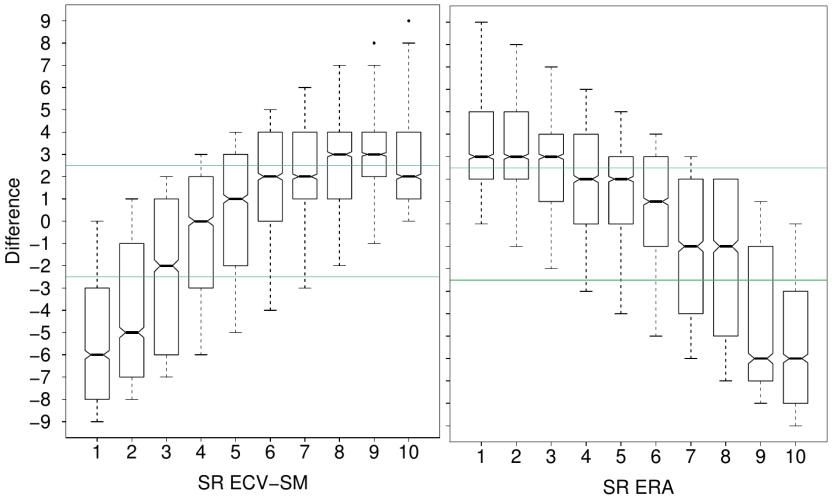
ECV-SM – ERA (Inter Annual Anom.)



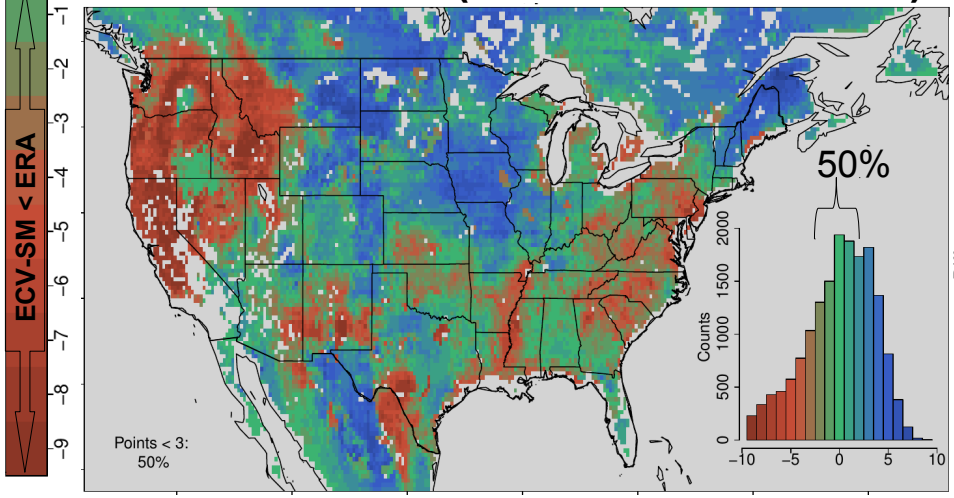
Differences in Spatial Representativeness

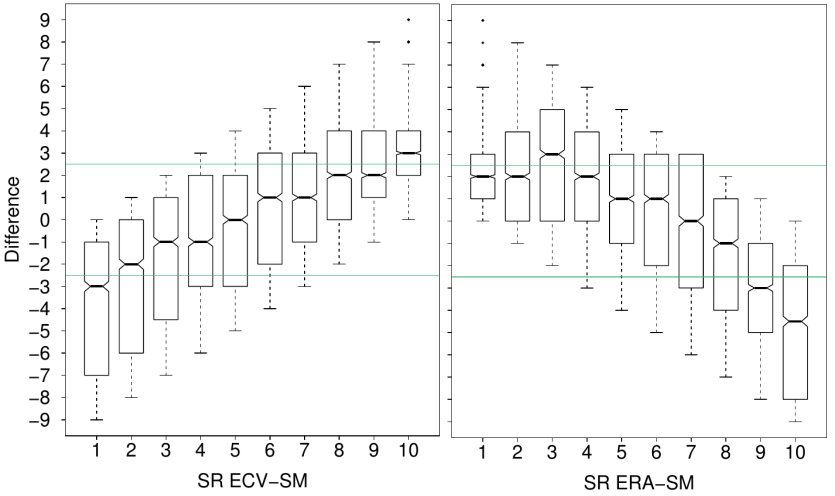
ECV-SM - ERA (Absolute)





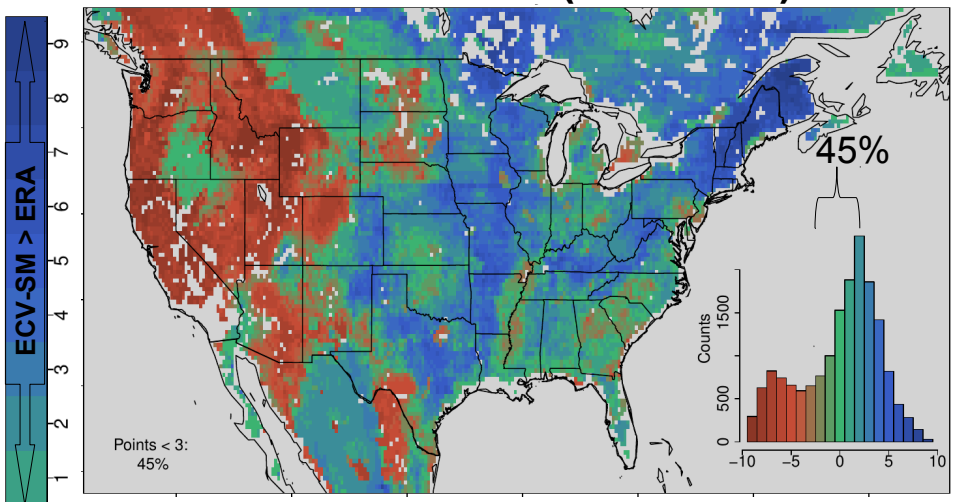
ECV-SM – ERA (Inter Annual Anom.)

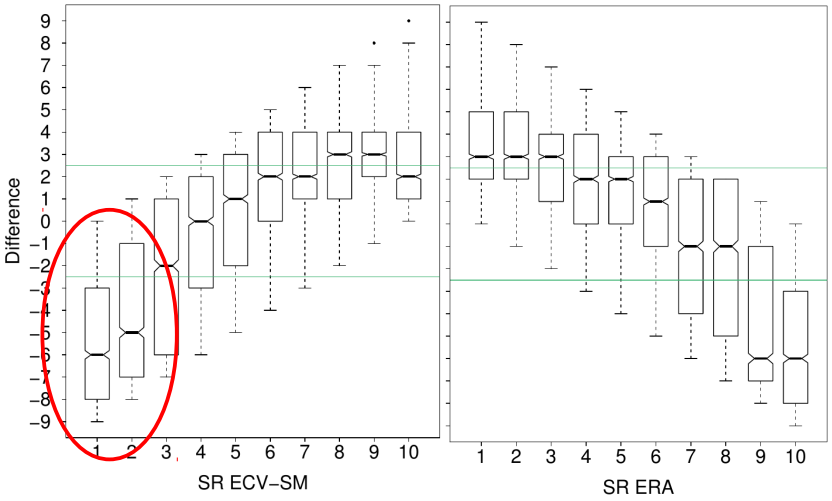




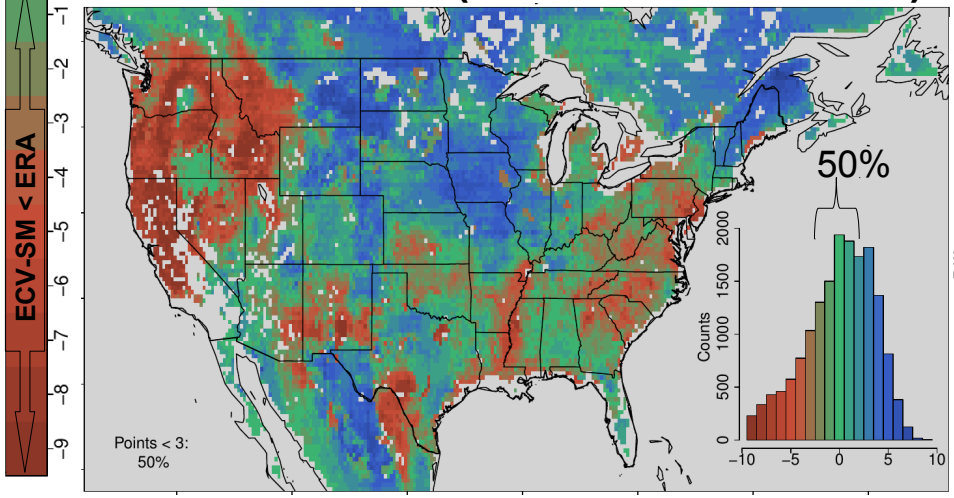
Differences in Spatial Representativeness

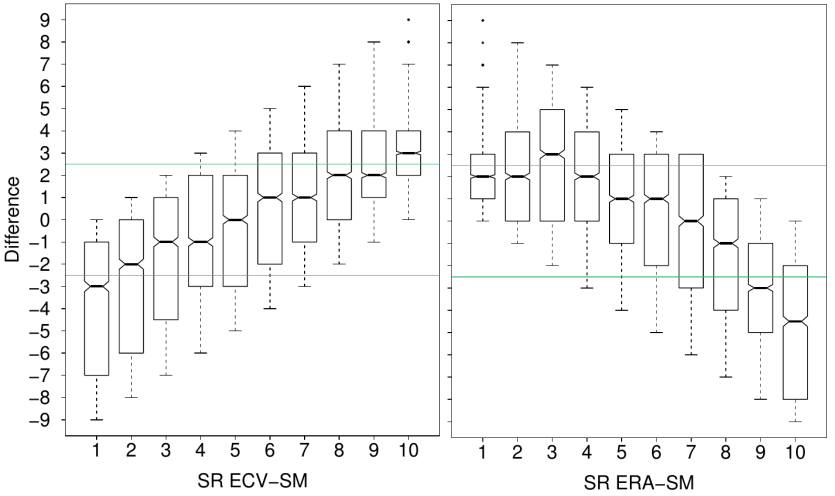
ECV-SM - ERA (Absolute)





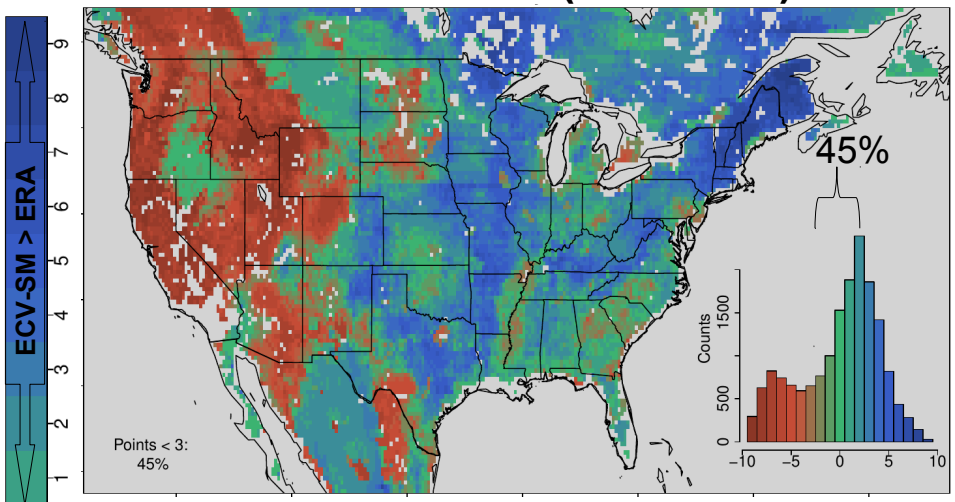
ECV-SM – ERA (Inter Annual Anom.)

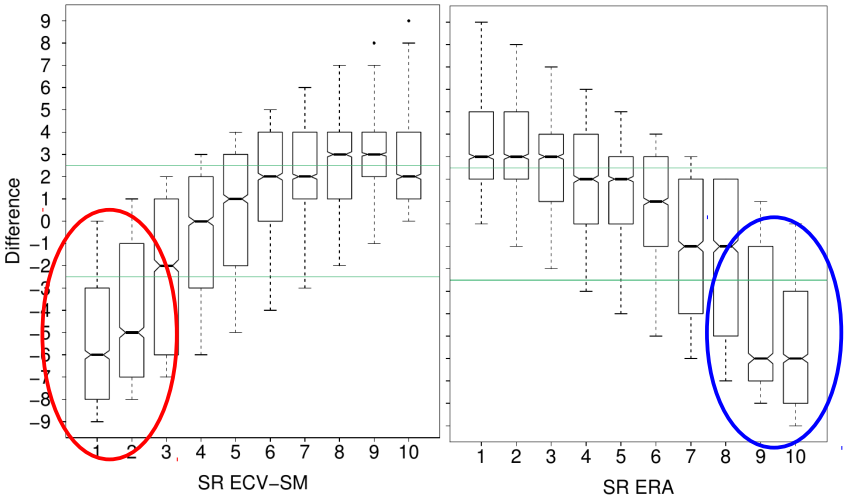




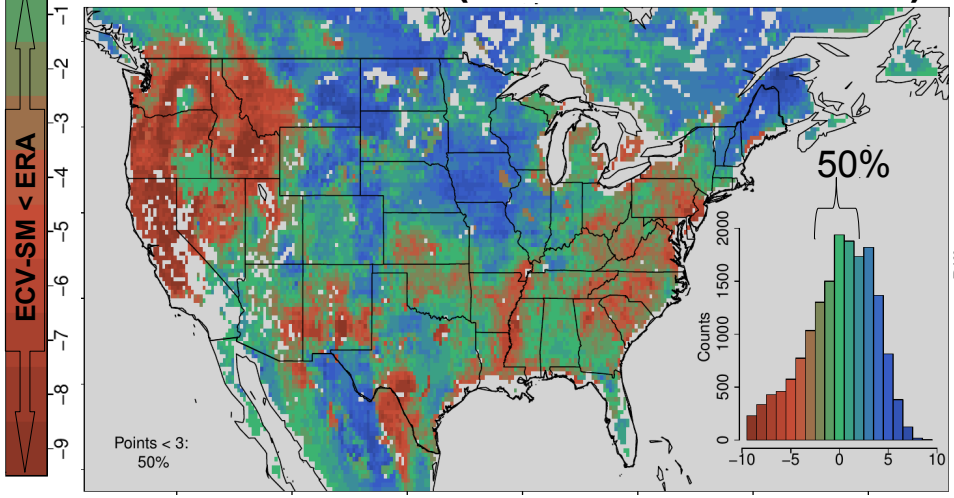
Differences in Spatial Representativeness

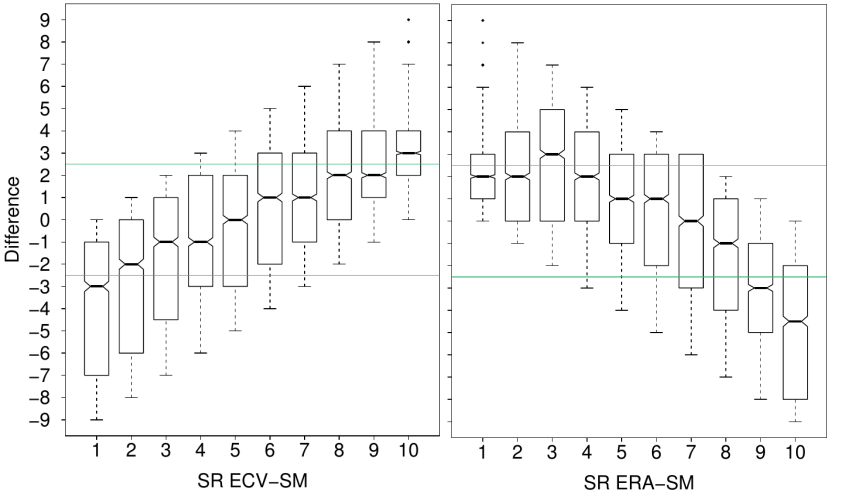
ECV-SM - ERA (Absolute)





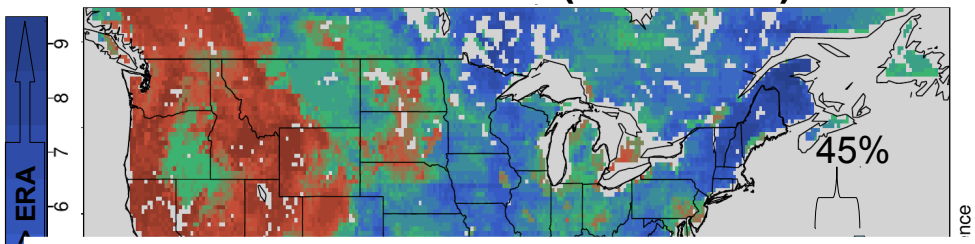
ECV-SM – ERA (Inter Annual Anom.)



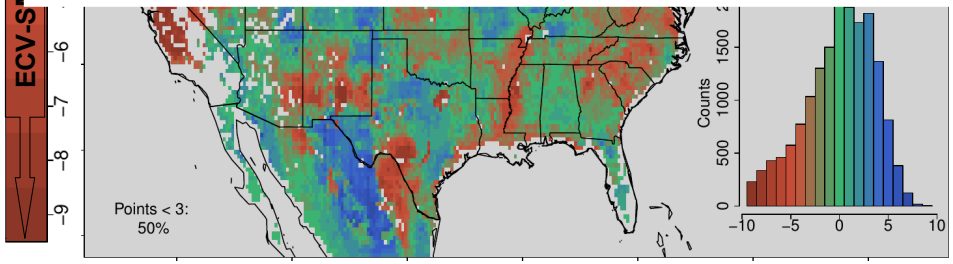


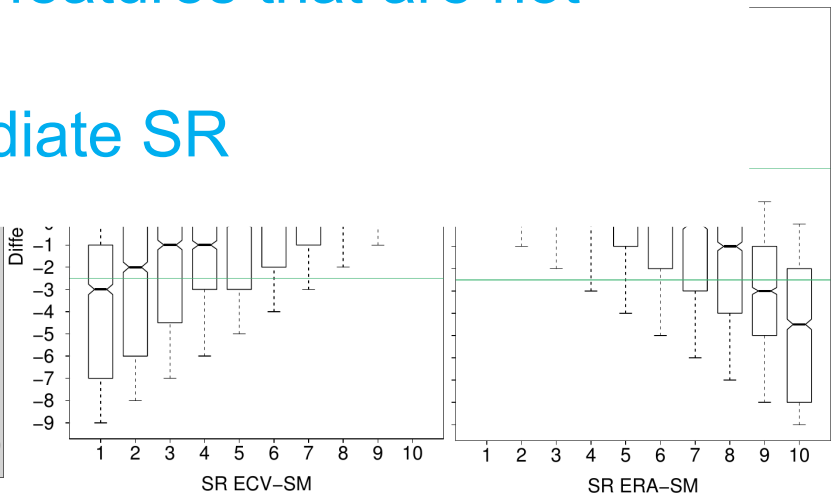
Differences in Spatial Representativeness

ECV-SM - ERA (Absolute)



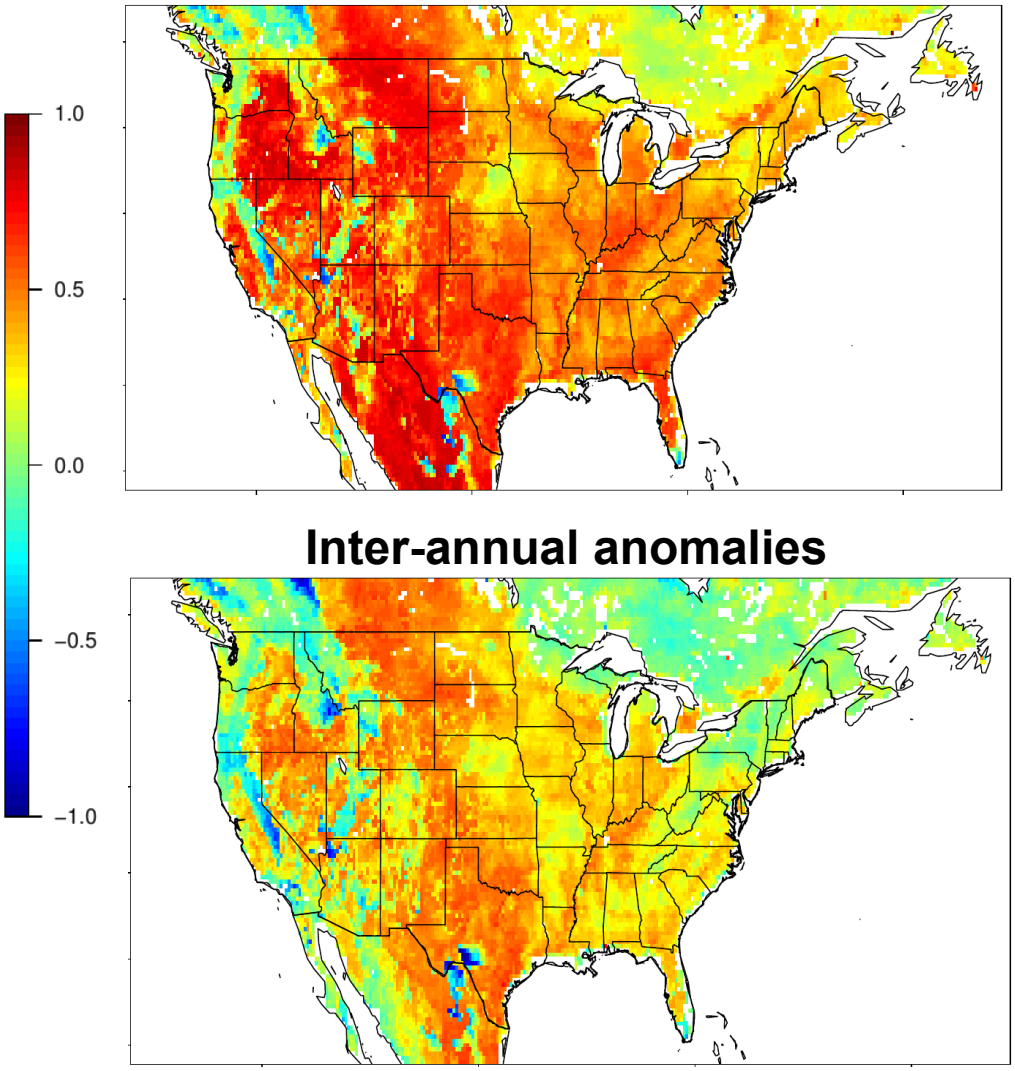
- Approximately 50% of the data is ≤ 2 categories apart
- ECV-SM shows small scale features that are not captured by ERA Land
- ERA Land shows large scale features that are not captured by ECV-SM
- Most similarity in the intermediate SR





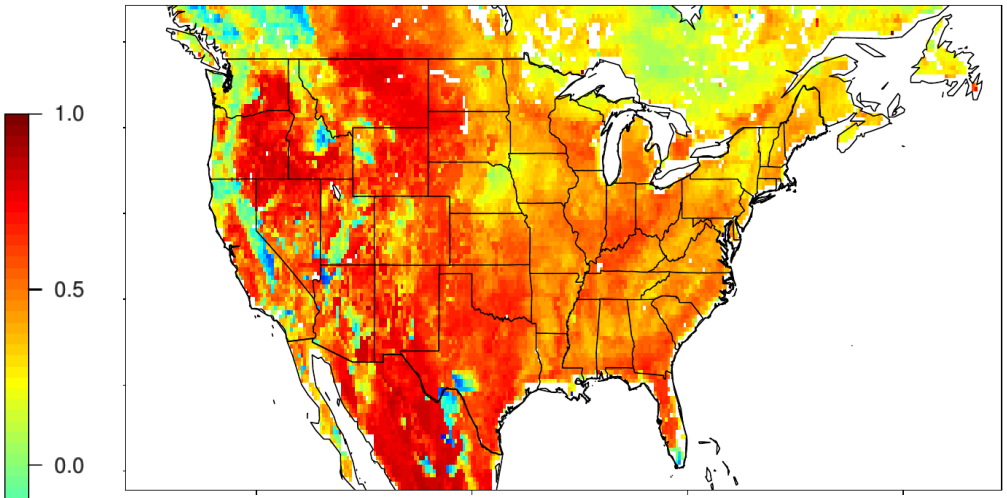
Correlation ECV-SM and ERA Land

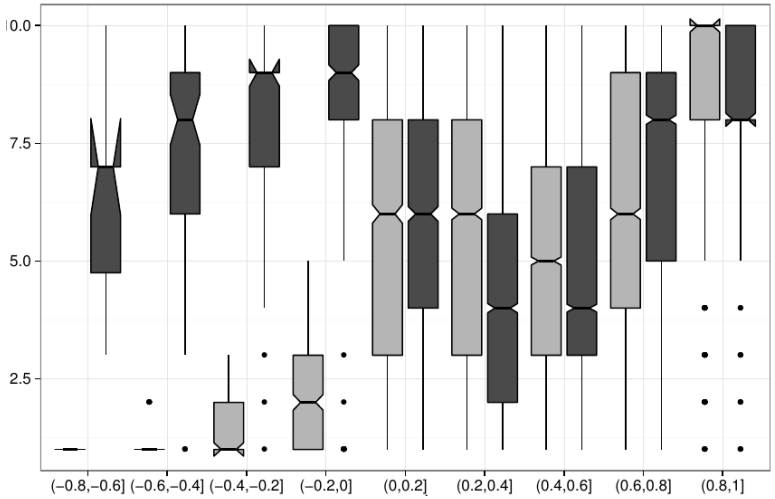
Absolute



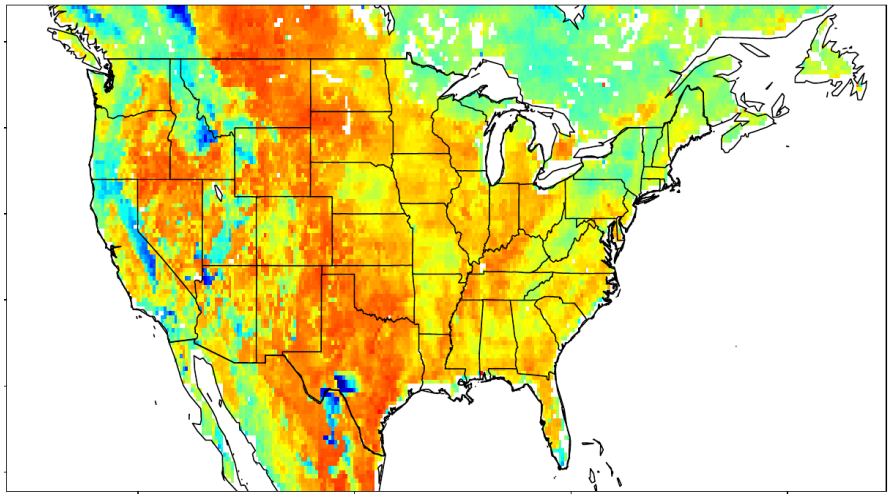
Correlation ECV-SM and ERA Land

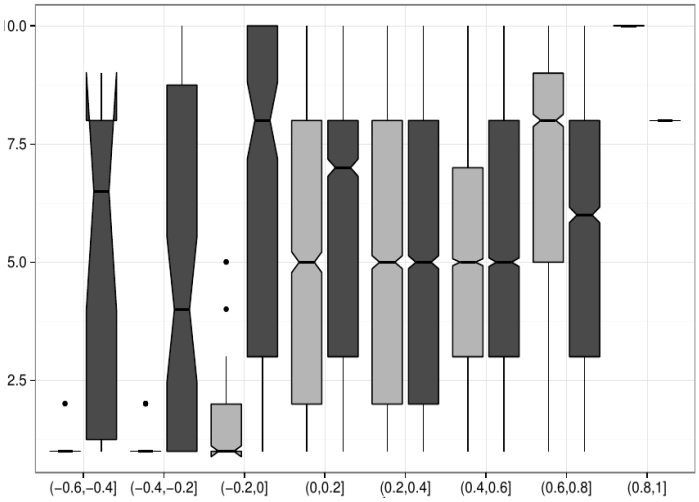
Absolute





Inter-annual anomalies

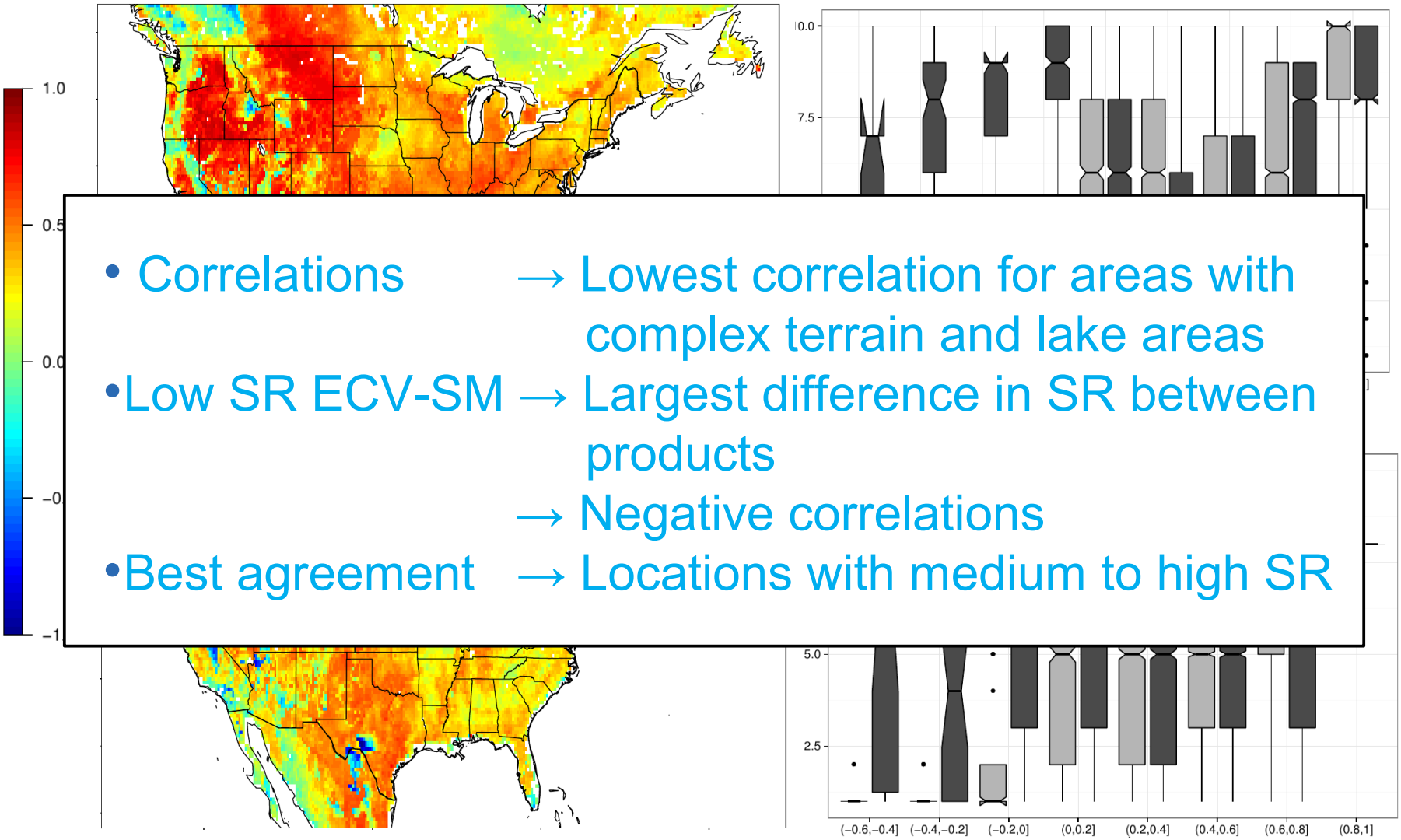




ECV−SM
ERA

Correlation ECV-SM and ERA Land

Absolute



- Correlations → Lowest correlation for areas with complex terrain and lake areas
- Low SR ECV-SM → Largest difference in SR between products
  → Negative correlations
- Best agreement → Locations with medium to high SR

Conclusions

Conclusions

Large-scale spatial representativeness of soil moisture:

- **Compares better for absolute soil moisture then for anomalies**
- **Gridded data showed good agreement with reference point scale data**

Conclusions

Large-scale spatial representativeness of soil moisture:

- **Compares better for absolute soil moisture then for anomalies**
- **Gridded data showed good agreement with reference point scale data**

Thank you for your attention!