

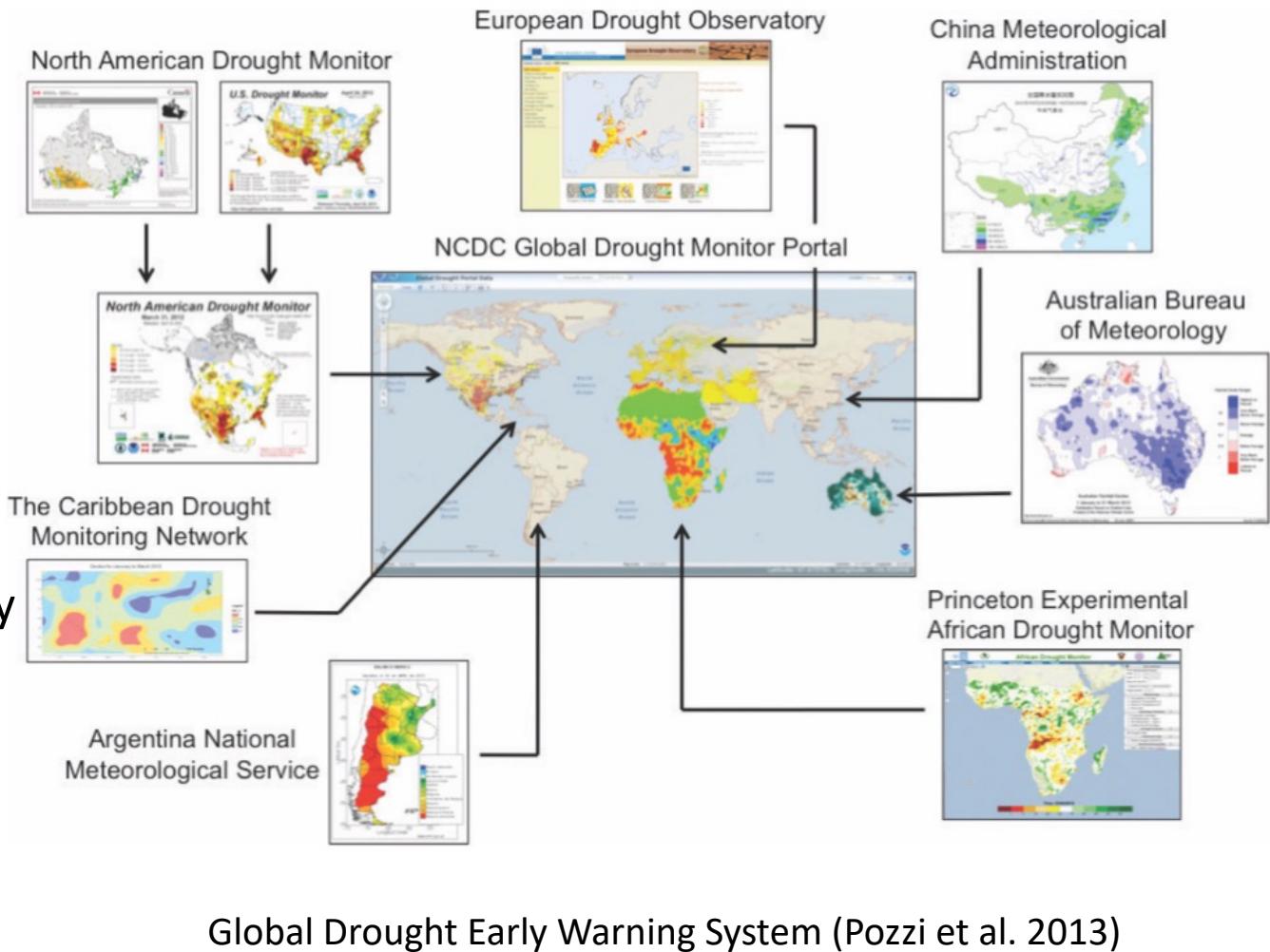
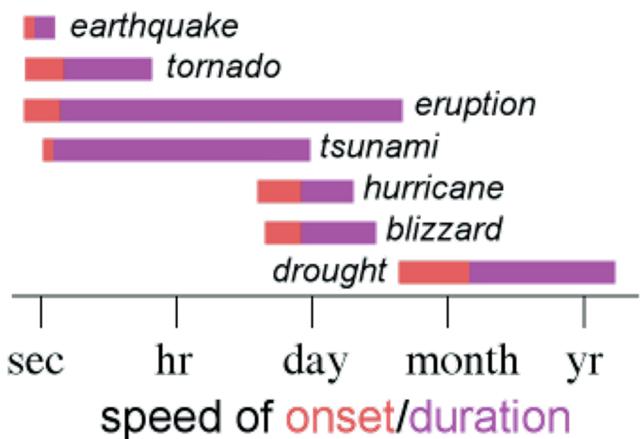
Drought nowcasting based on a spatiotemporal prediction algorithm in US

Xin HUANG

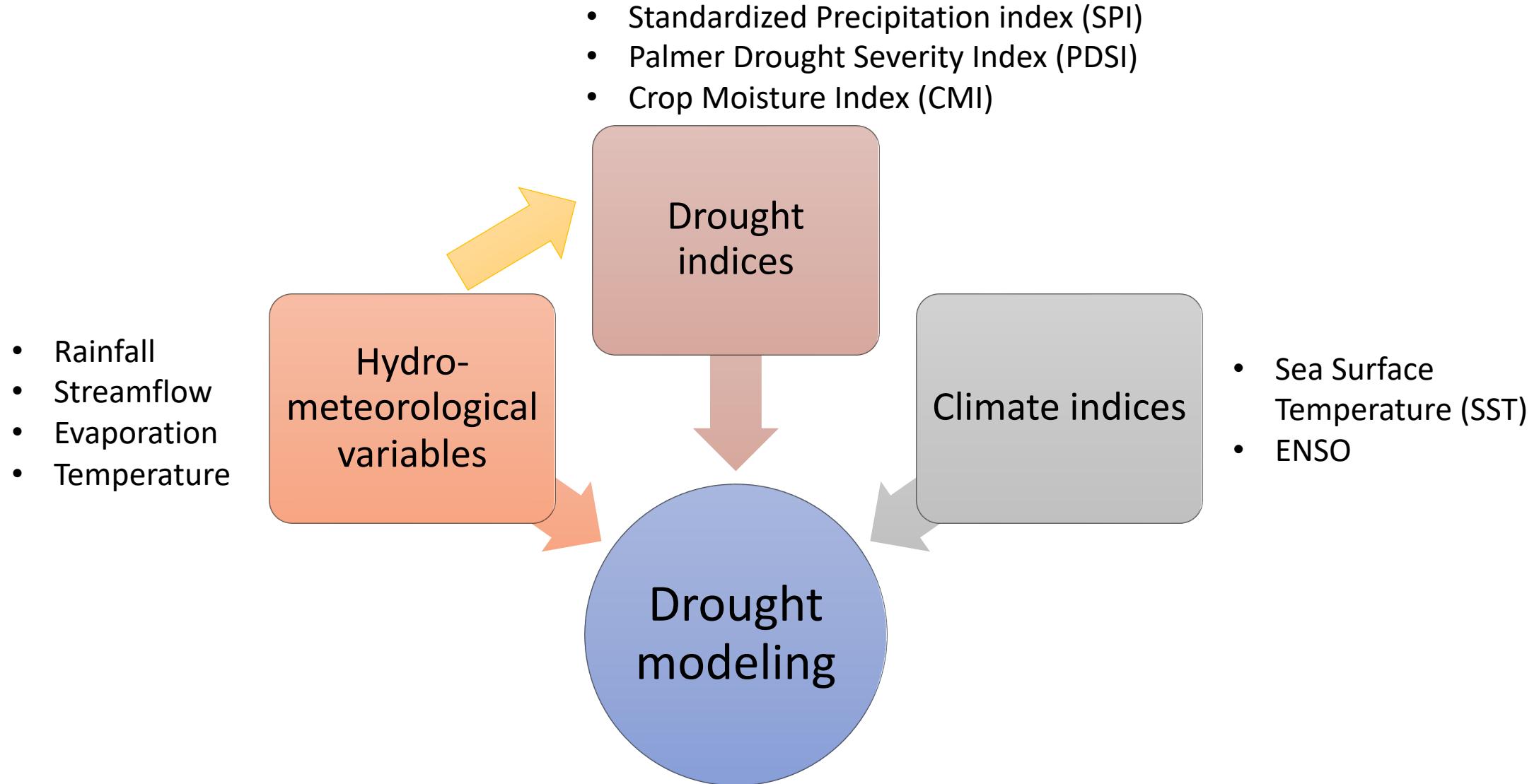
April 23th, 2019

Drought

- Hazard profile
 - Slow onset
 - Prolonged duration
 - Widespread
- A major challenge is to develop the predictability of the onset points
 - The basis of other drought analysis
 - Inability to predict droughts accurately



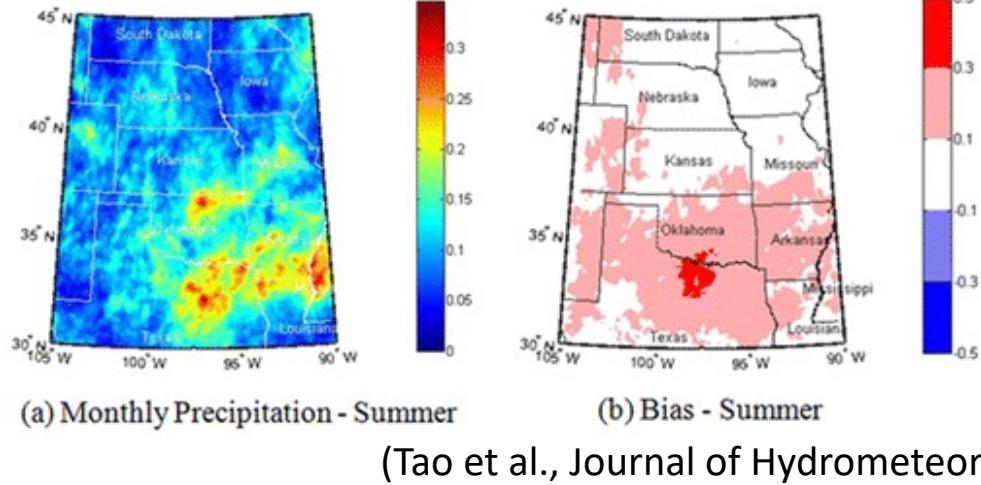
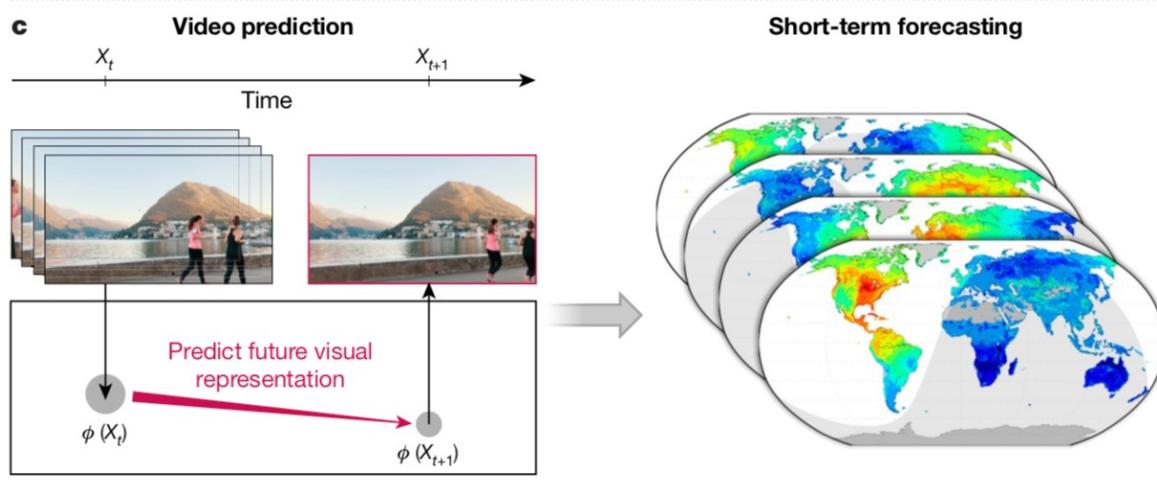
Drought forecasting



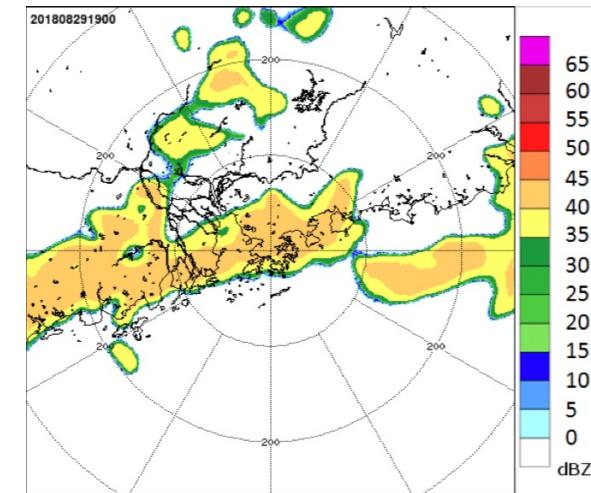
Drought forecasting methodology

Category	Examples	Advantages	Disadvantages
Regression analysis	Multivariate linear regression (Liu et al, 2001)	Quantitative; widespread	The assumption of linearity; lack causal
Time series analysis	Autoregressive Integrated Moving Average (ARIMA) (Han et al., 2010)	Capability of identification, estimation and diagnostic checks	Linearity
Probability models	Markov chain models (Moreira et al, 2006)	Quantify uncertainty	Hard to estimate transition probability
Artificial neural network models	Feed-forward network (Morid et al, 2007)	Nonlinear, flexible	Black box nature, overfitting
Hybrid models	Linear+ANN(Mishra et al, 2007)	Extract individual advantages	Too many candidates
Global climate models	Balling et al, 2007	Long-lead forecasting	Many parameters; Regional droughts change in terms of spatial and temporal variations

Deep learning for drought forecasting



hydro-climatic variables are periodic in nature and this characteristic can be explored further for drought prediction



(Shi et al., Conference on Neural Information Processing System, 2017)

Data Flow

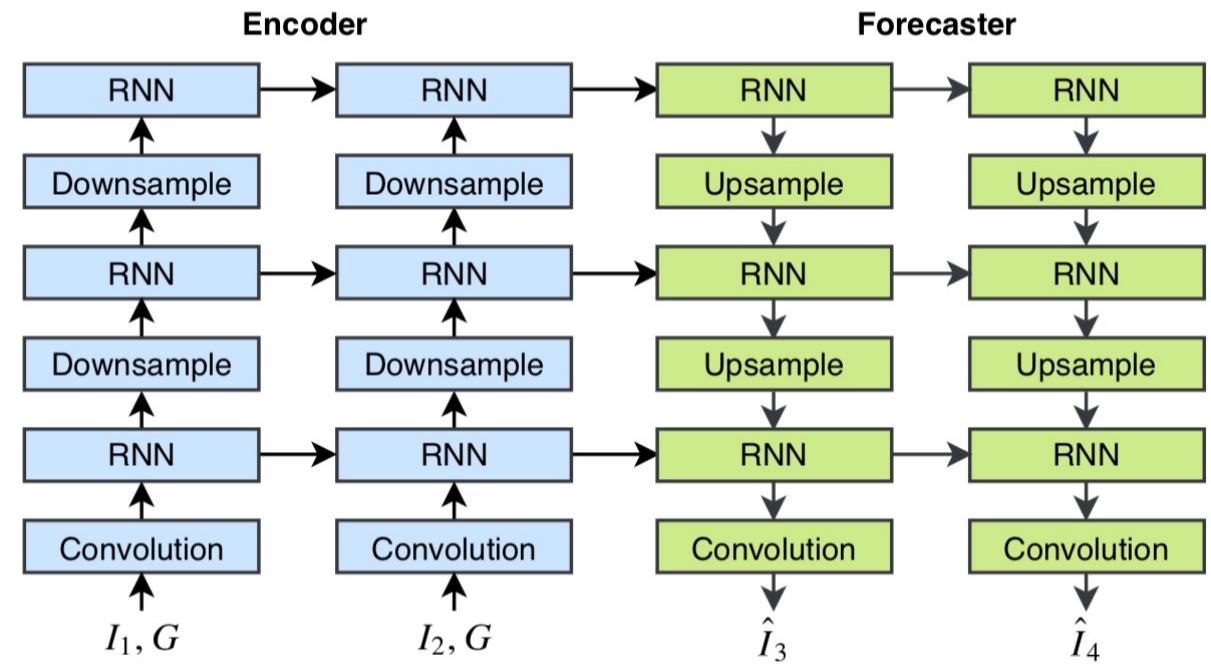
I_i Data format

[nSeq, Batch_size, nChannel, Height, Width]

Train: 1901-2010, 2013-2015

Validation: 2011

Test: 2012



Predict the following 2 months based on the past 2 months

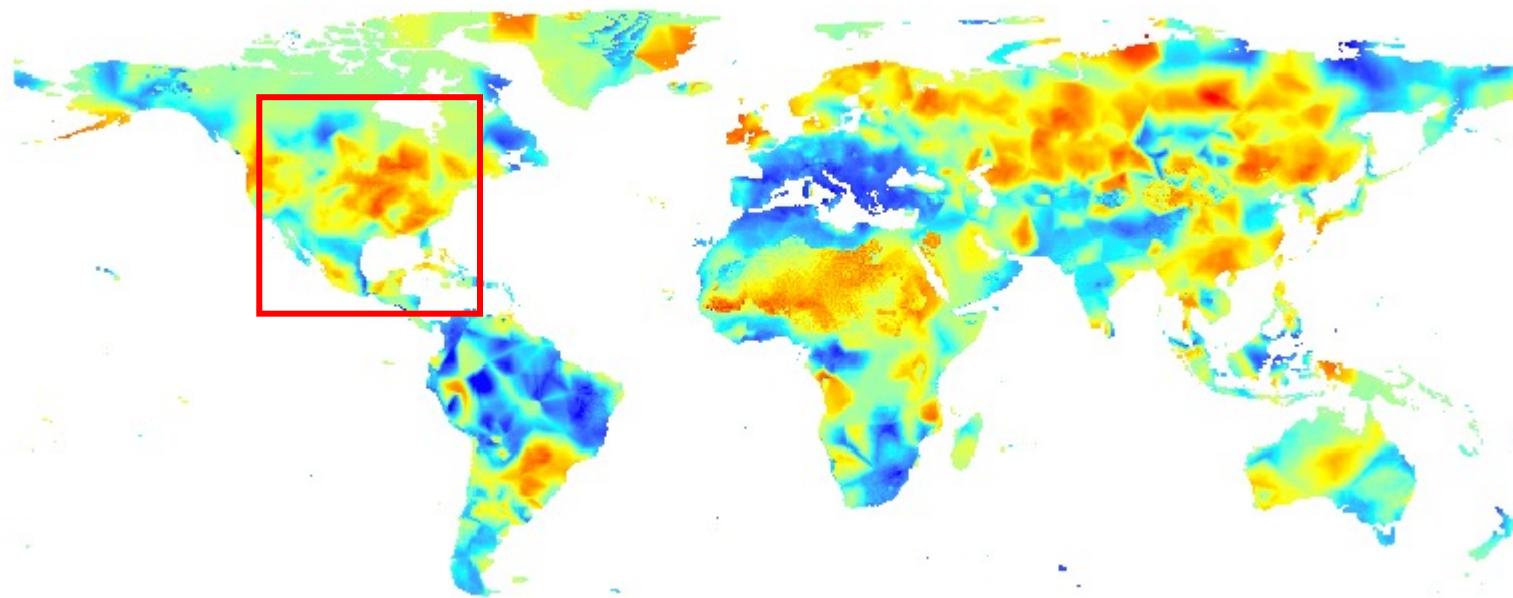
Data

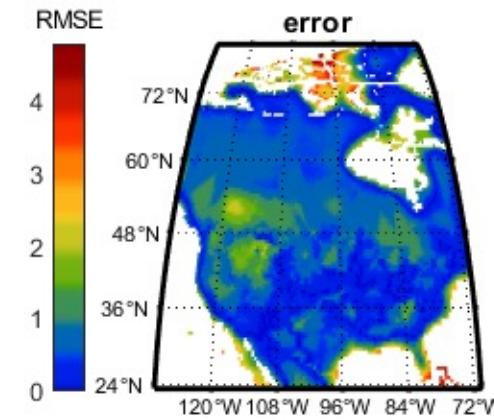
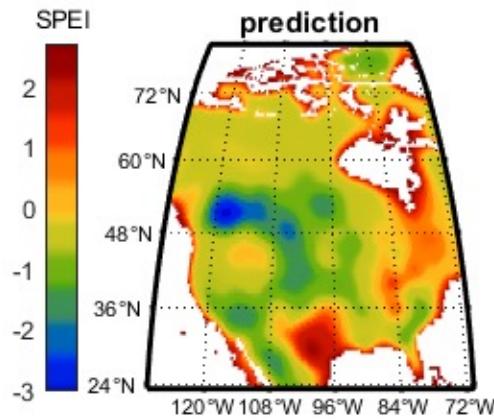
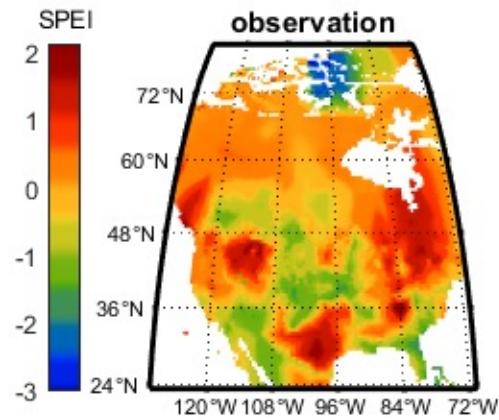
The **Standardised Precipitation-Evapotranspiration Index (SPEI)**
<https://digital.csic.es/handle/10261/153475>

0.5° spatial resolution -> $9\text{km} \times 9\text{km}$ grid

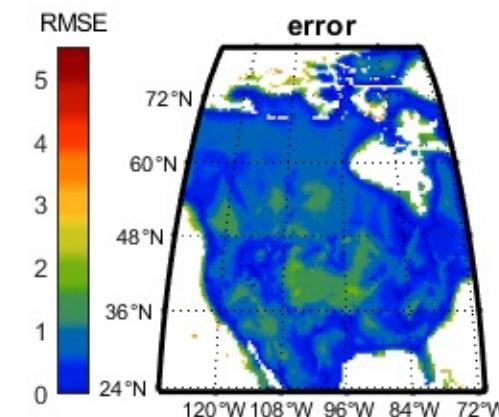
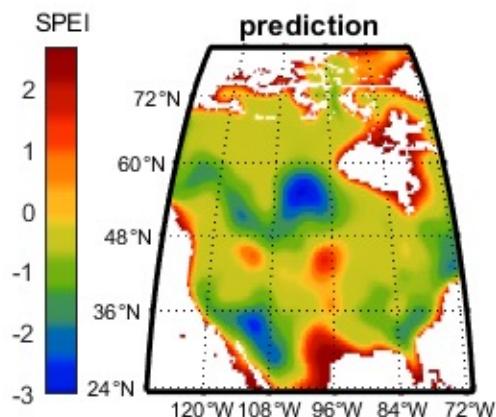
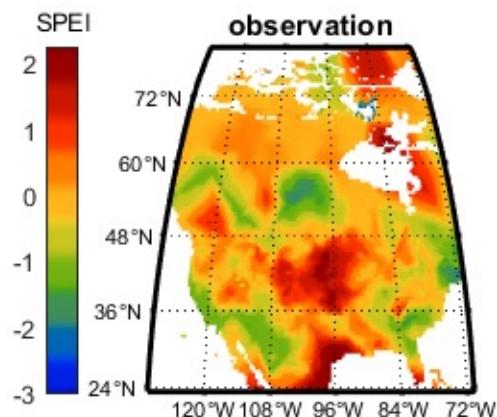
1901-2015, monthly

SPEI values	Flood/Drought category
≥ 0.5	Wet
-0.49 -- 0.49	Near normal
-0.99 -- -0.50	Mild drought
-1.49 -- -1.00	Moderate drought
-1.99 -- -1.50	Severe drought
≤ -2.0	Extreme drought

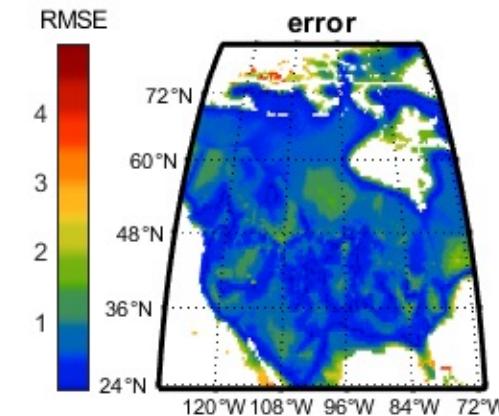
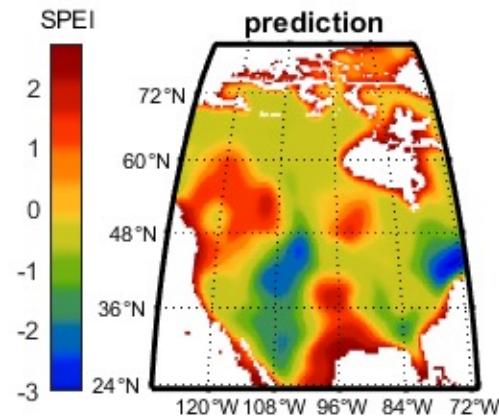
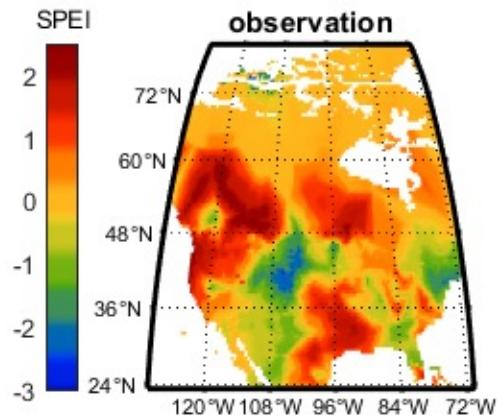




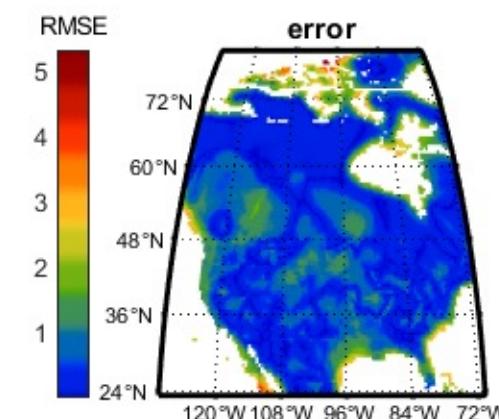
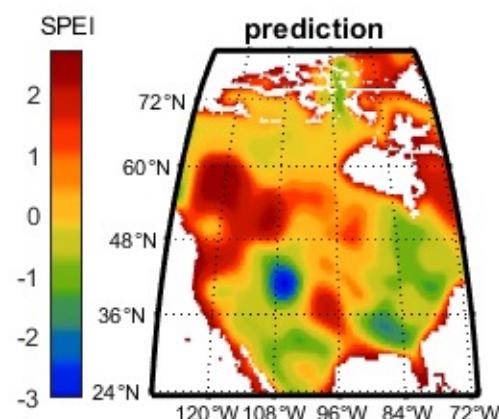
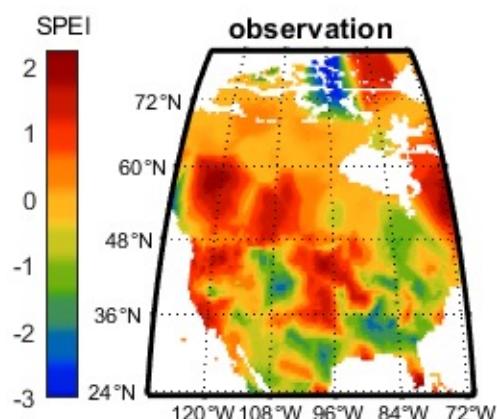
January-
2012



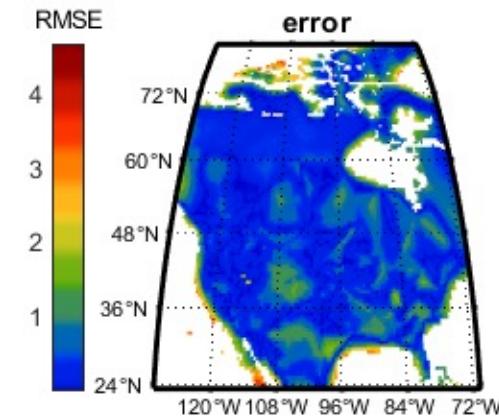
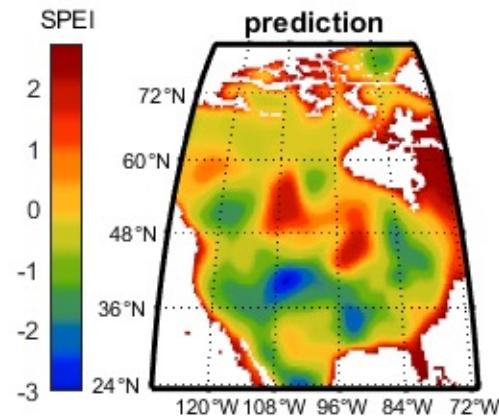
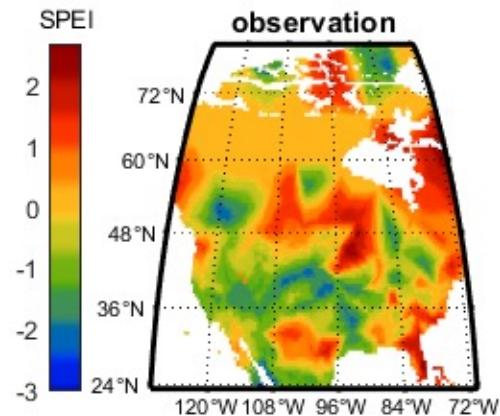
February-
2012



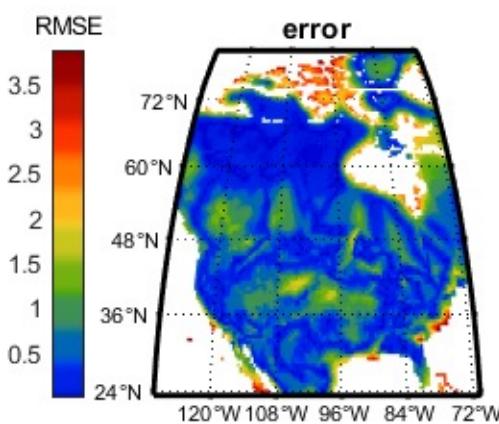
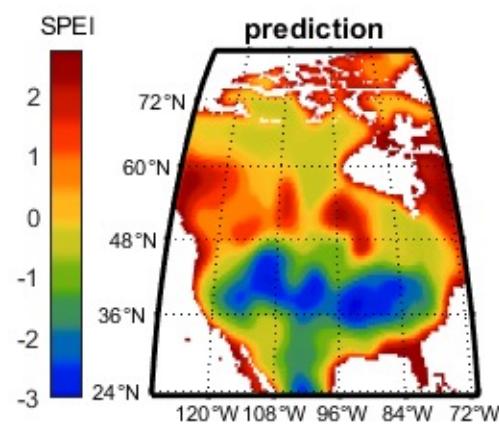
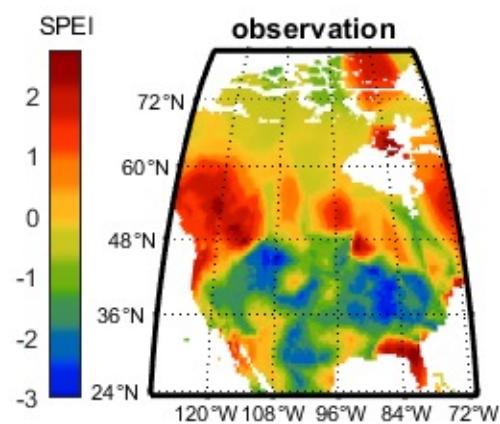
March-
2012



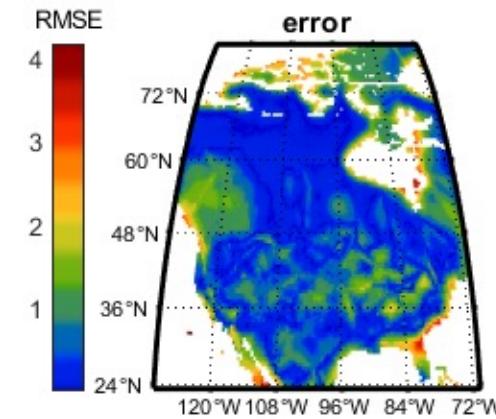
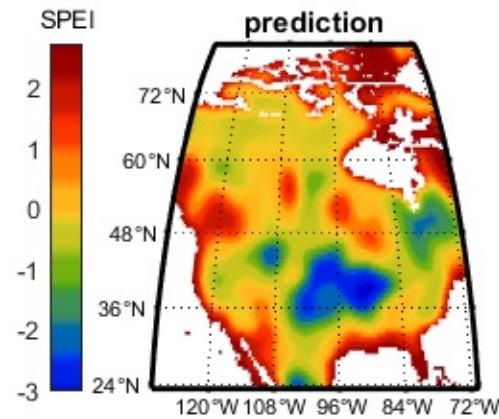
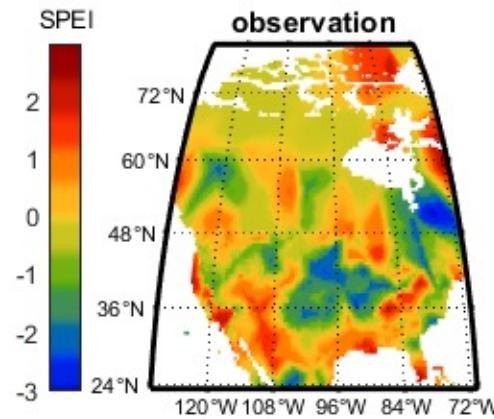
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2012



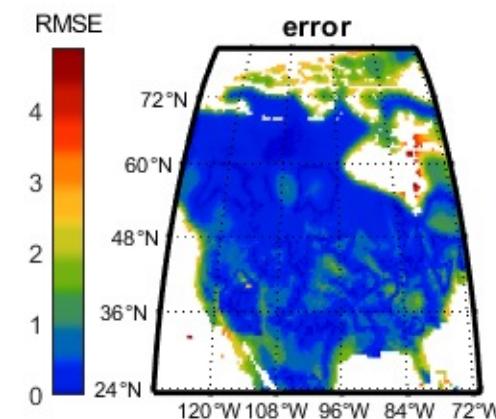
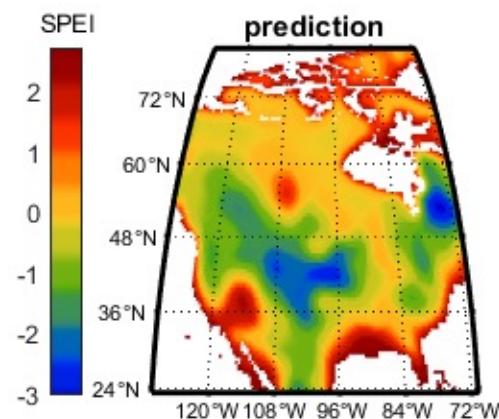
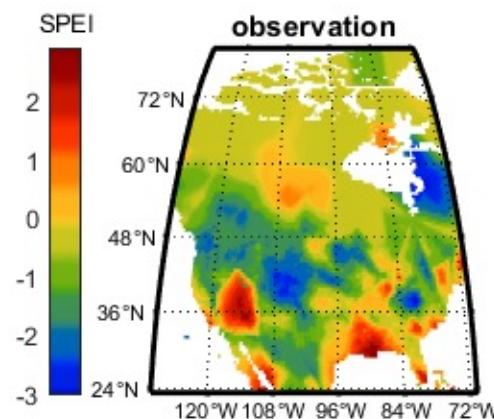
May-2012



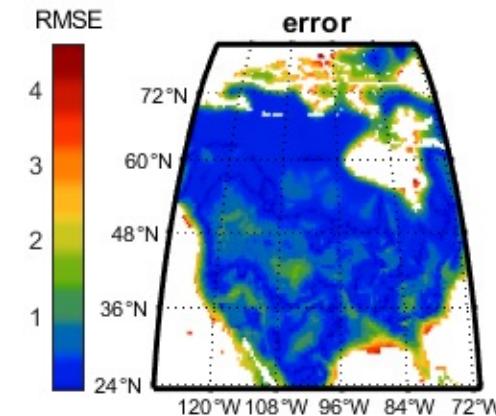
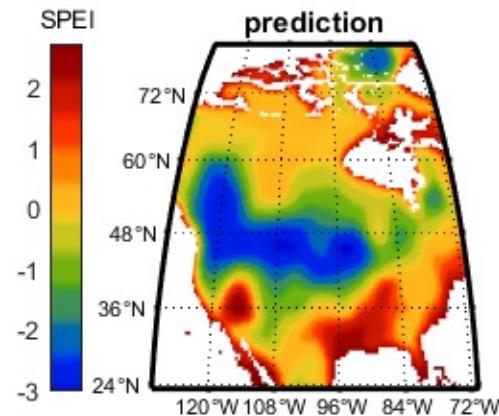
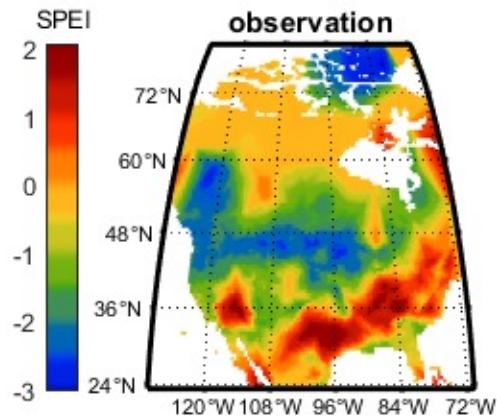
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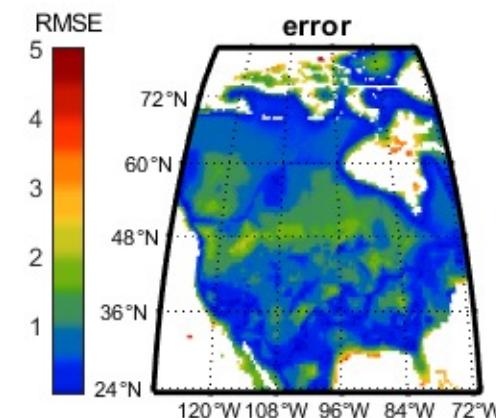
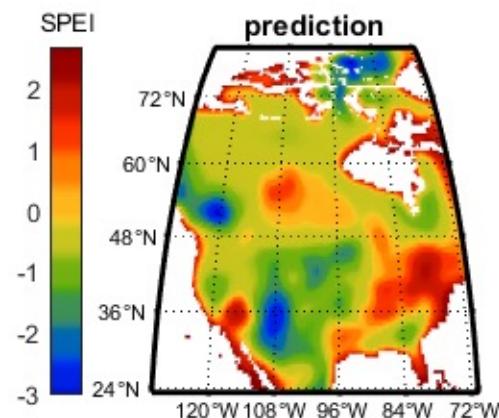
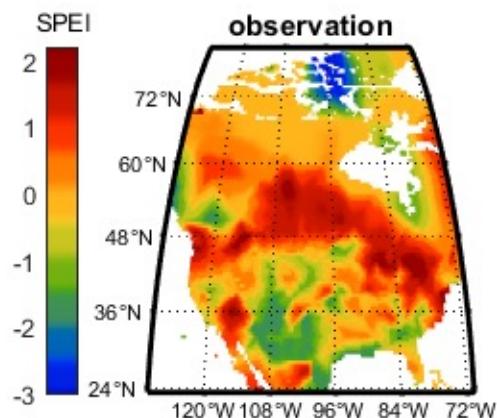
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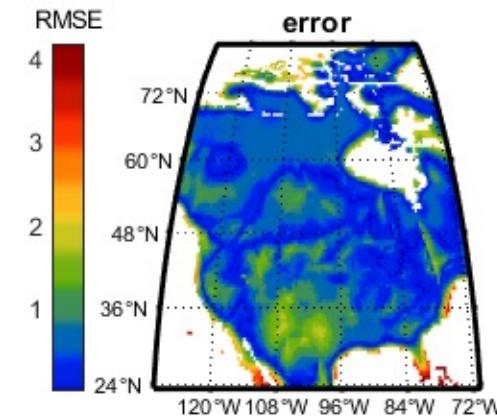
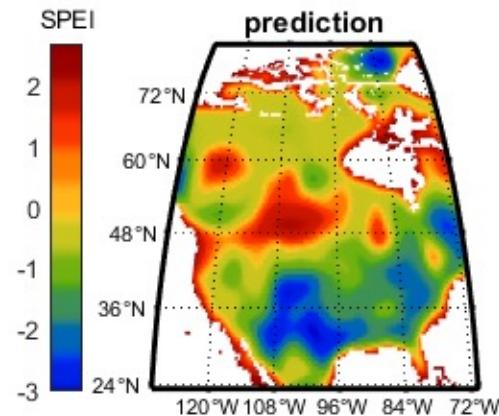
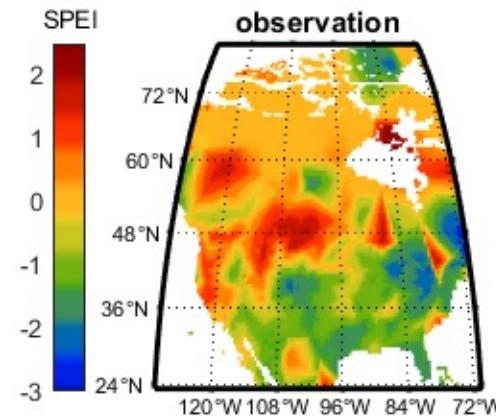
August-
2012



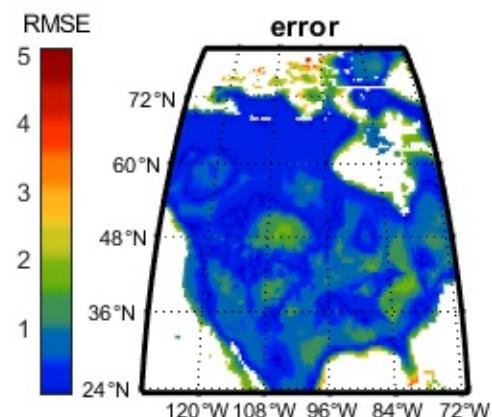
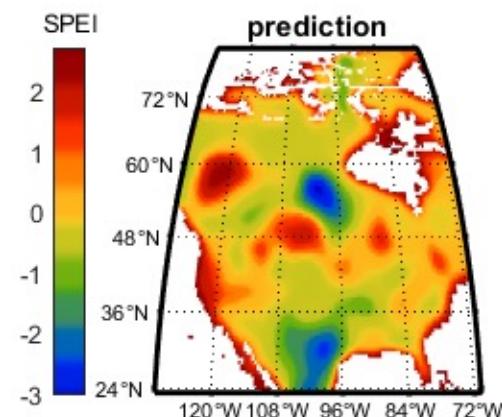
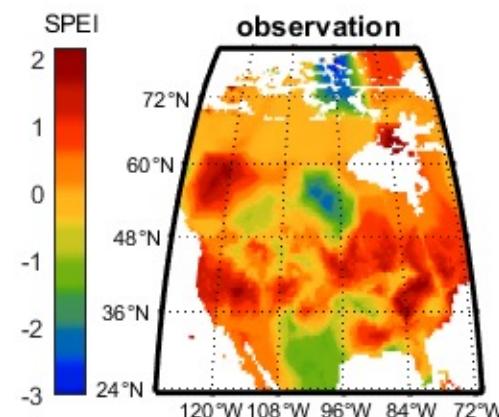
September-
2012



October-
2012

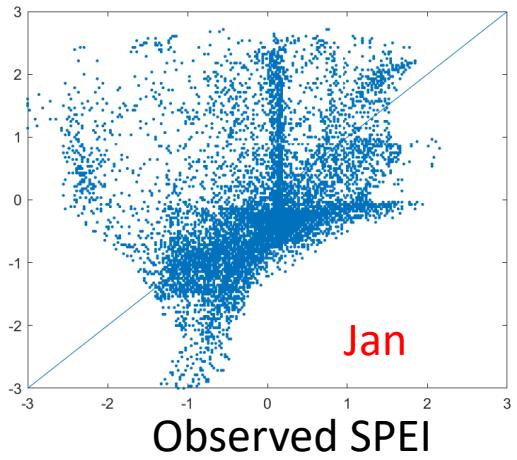


November-
2012



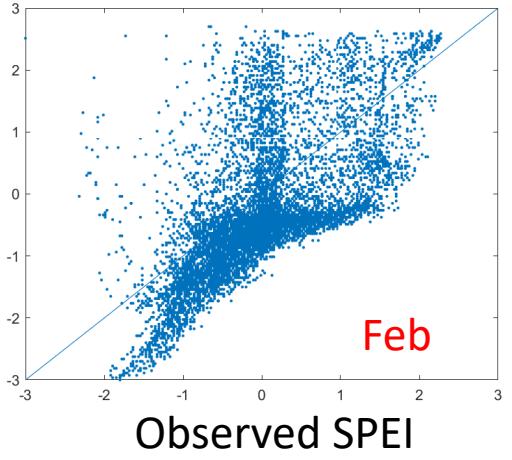
December-
2012

Predicted SPEI



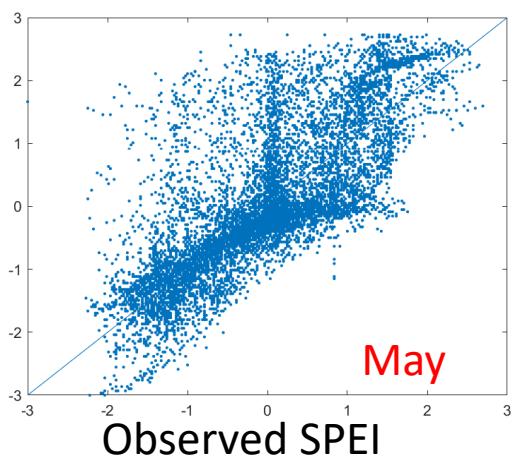
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Predicted SPEI



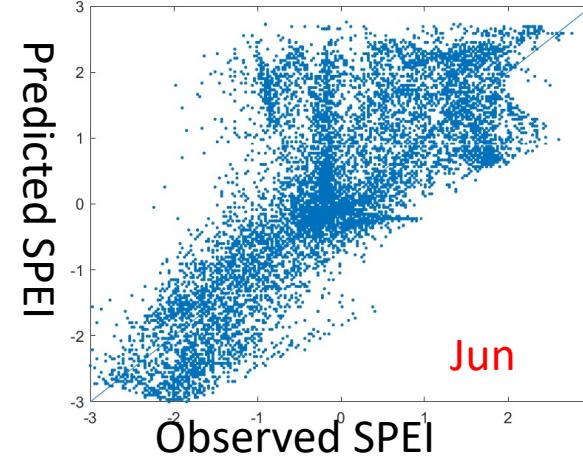
Feb

Predicted SPEI



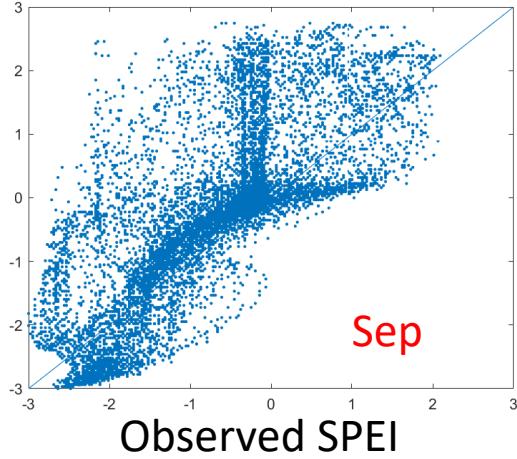
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Predicted SPEI



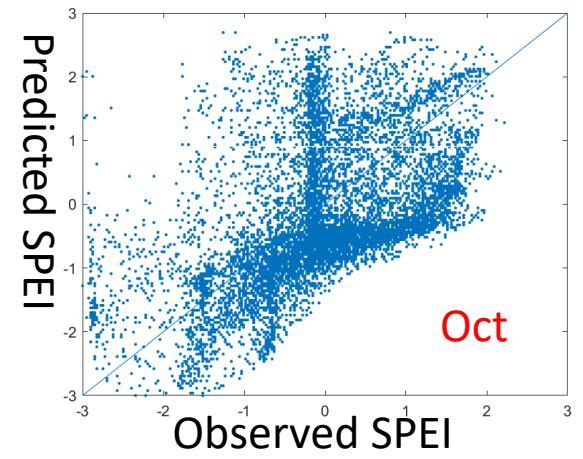
Jun

Predicted SPEI



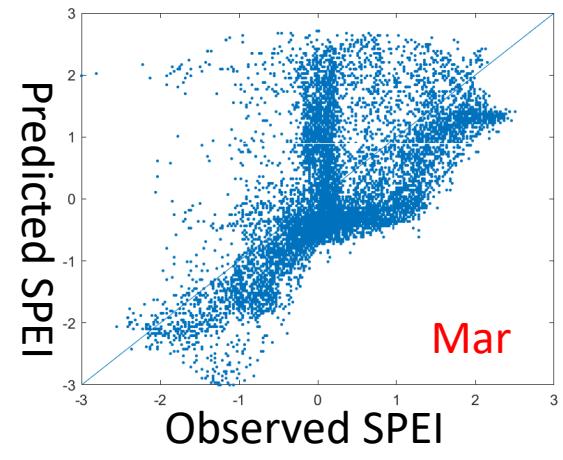
Sep

Predicted SPEI



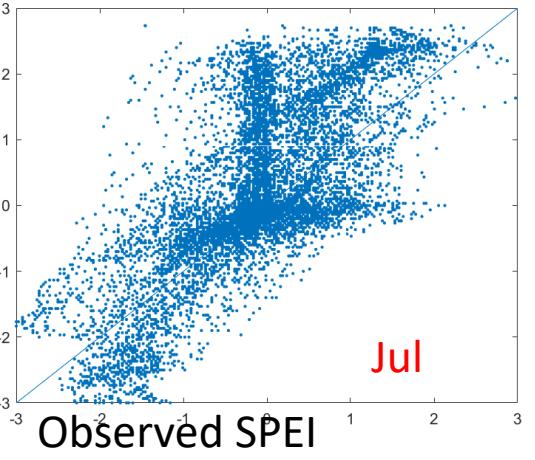
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Predicted SPEI



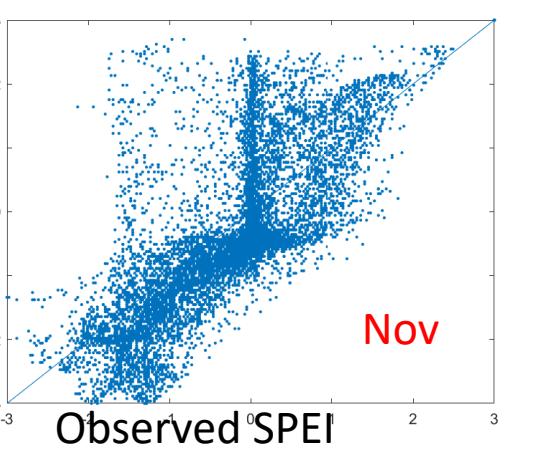
Mar

Predicted SPEI



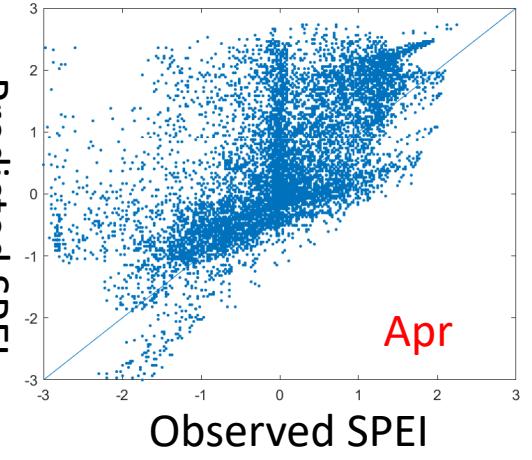
Jul

Predicted SPEI



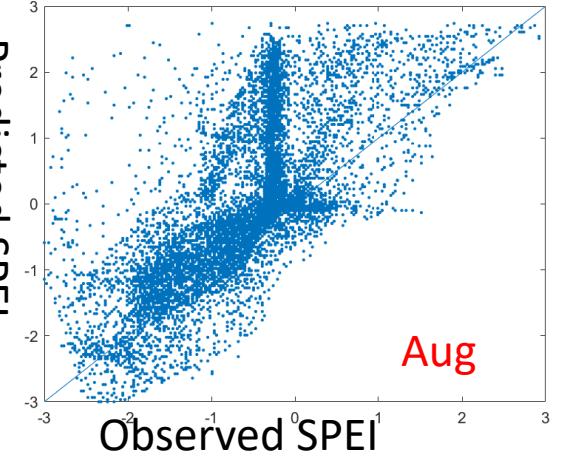
Nov

Predicted SPEI



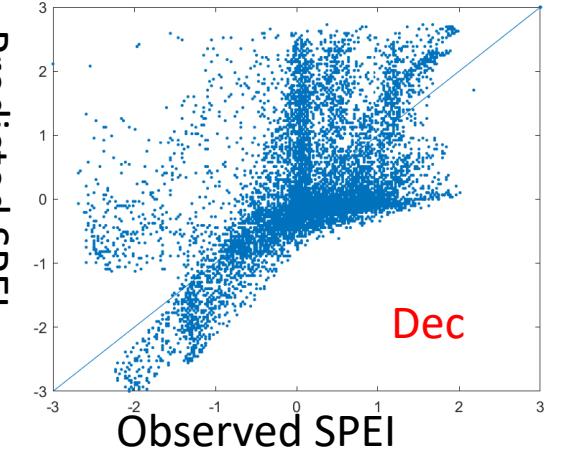
Apr

Predicted SPEI



Aug

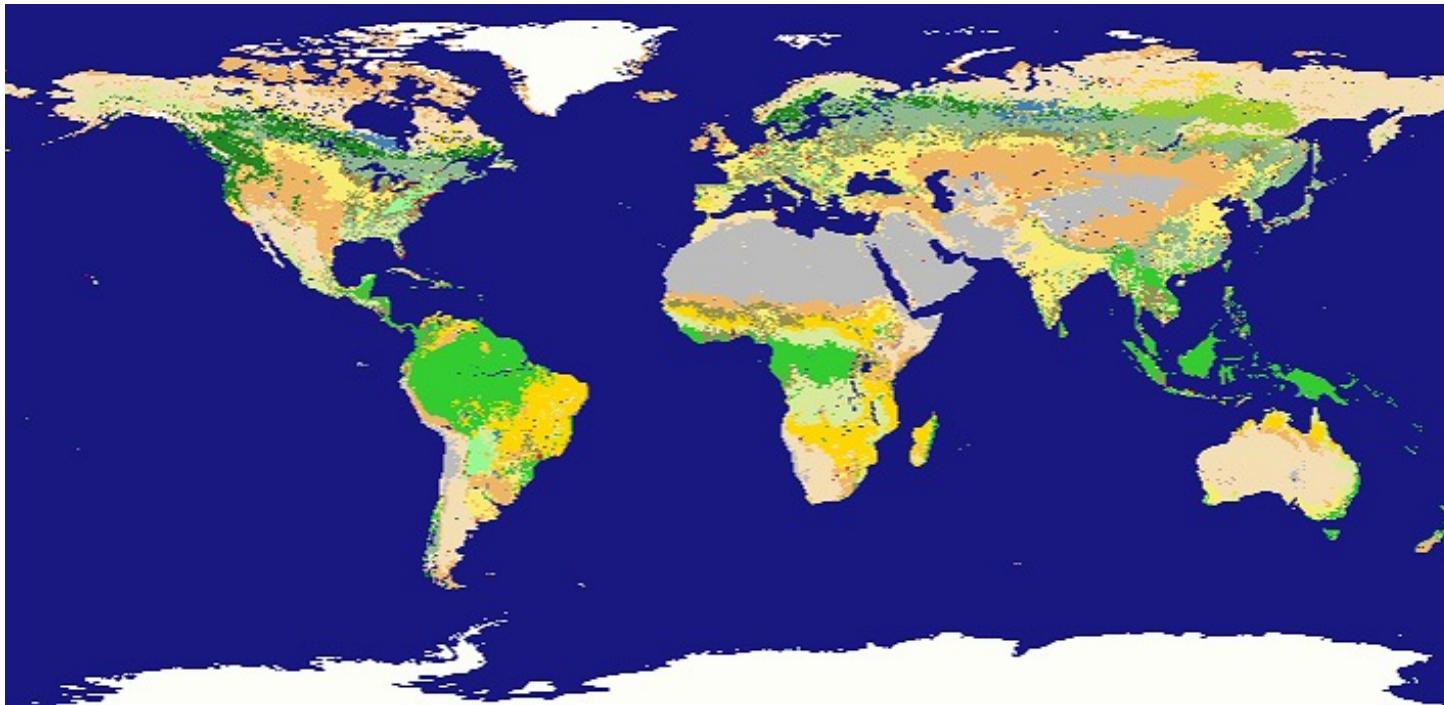
Predicted SPEI



Dec

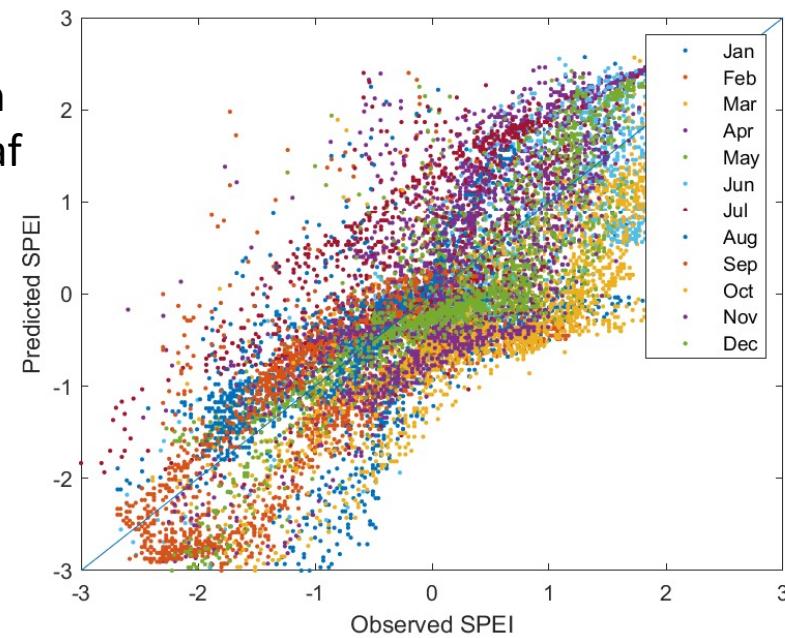
Predicted SPEI

Evaluate based on biome classification

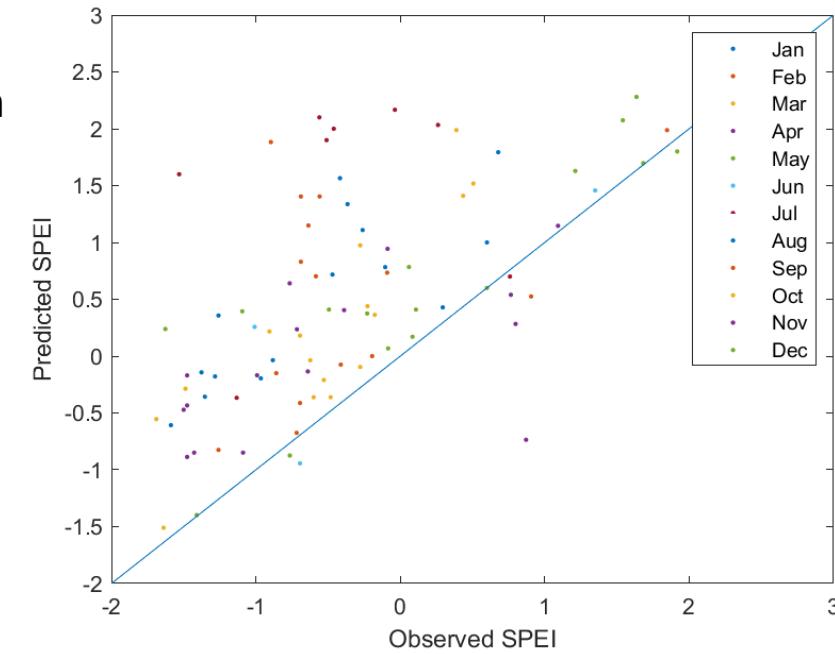


The MODIS Land Cover Classification data set (2011) categorize land surface into 17 categories: 9 classes of natural vegetation, 3 classes of developed lands, 2 classes of mosaic lands, and 3 classes of non-vegetated lands (snow/ice, bare soil/rocks, water).

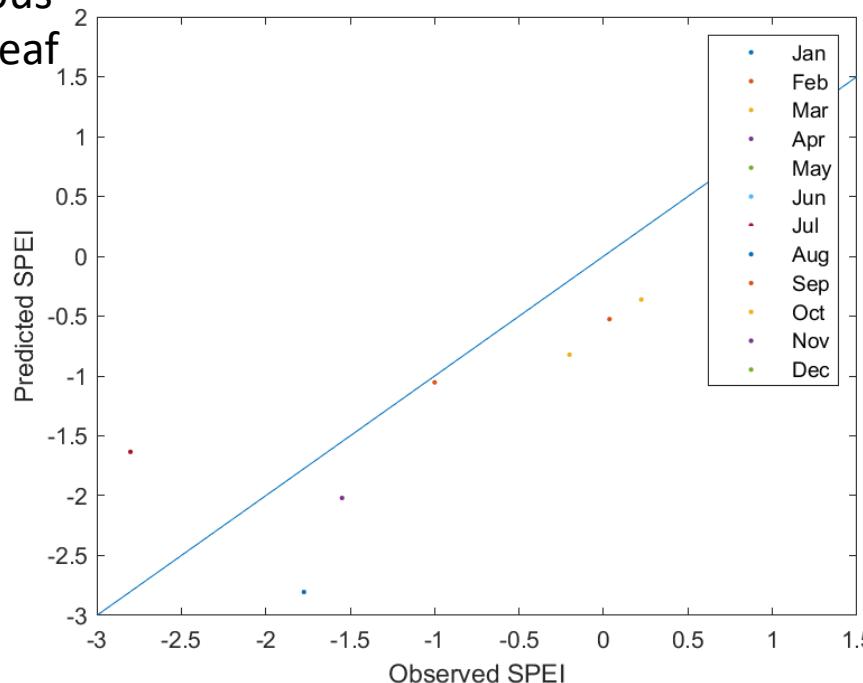
**Evergreen
Needleleaf
Forests**



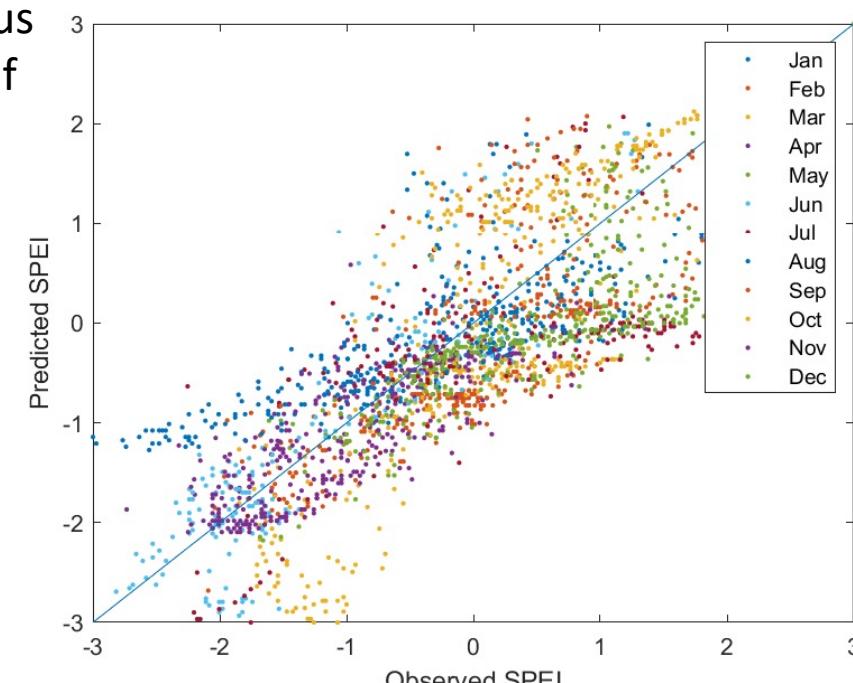
**Evergreen
Broadleaf
Forests**



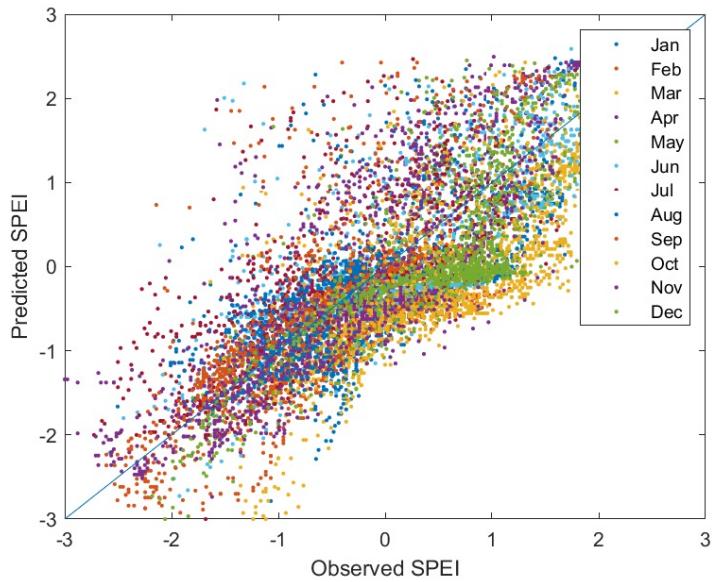
**Deciduous
Needleleaf
Forests**



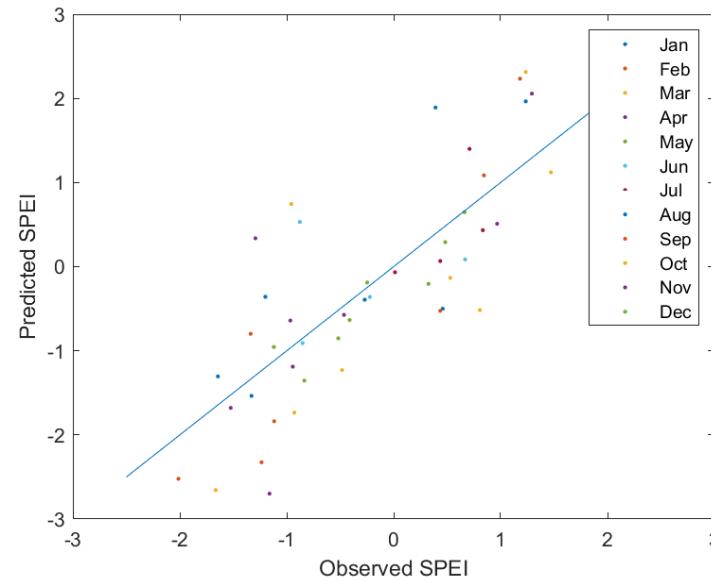
**Deciduous
Broadleaf
Forests**



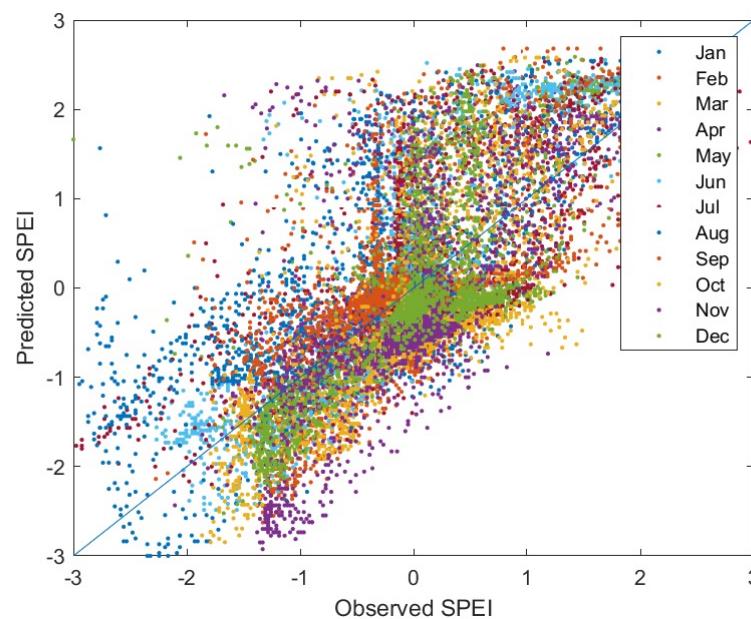
Mixed Forests



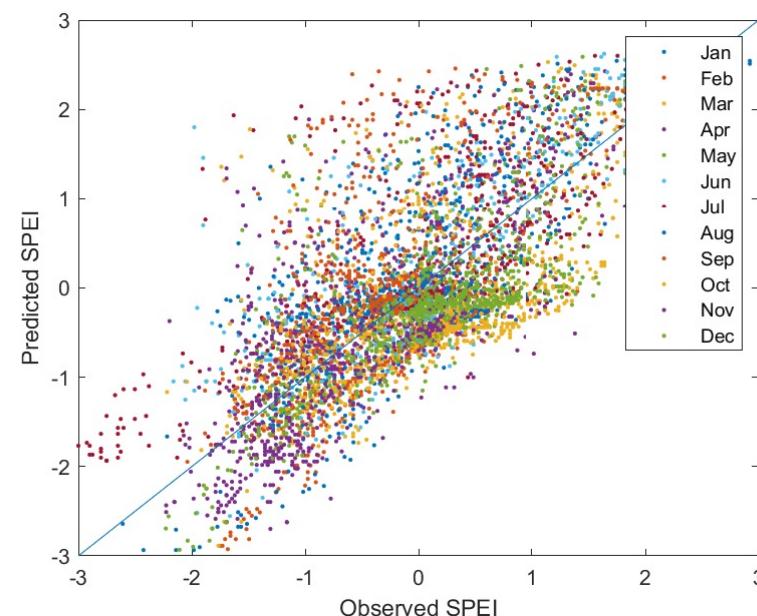
Closed Shrublands



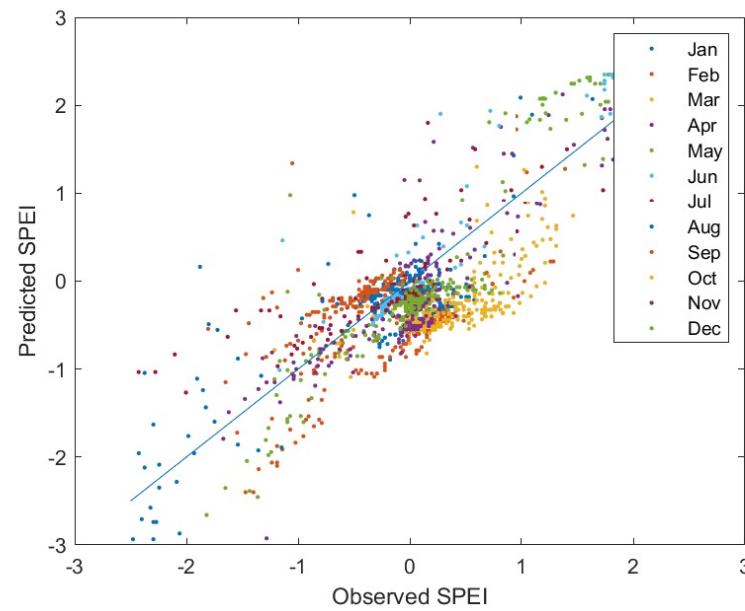
Open Shrublands



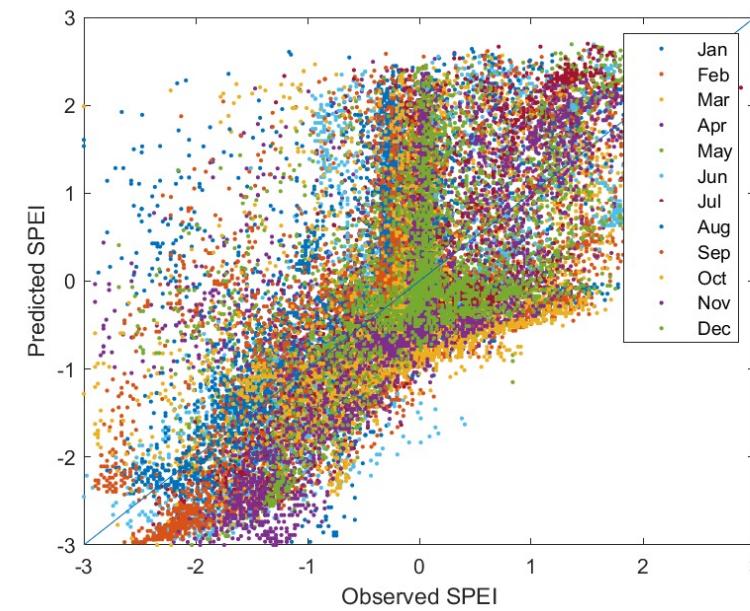
Woody Savannas



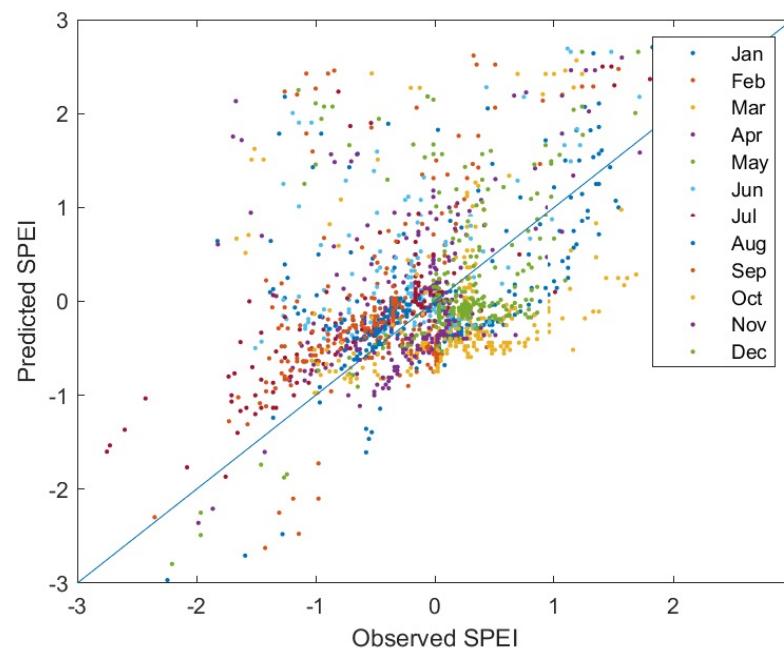
Savannas



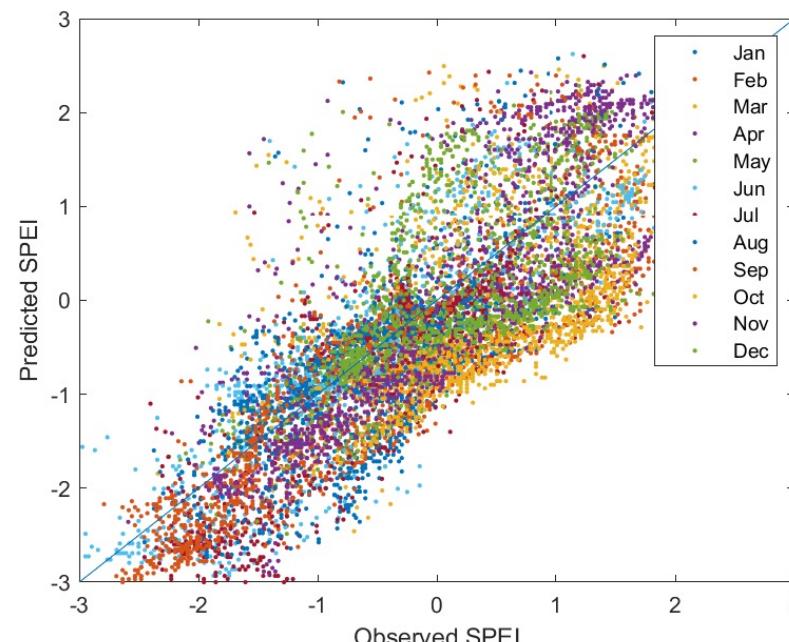
Grasslands



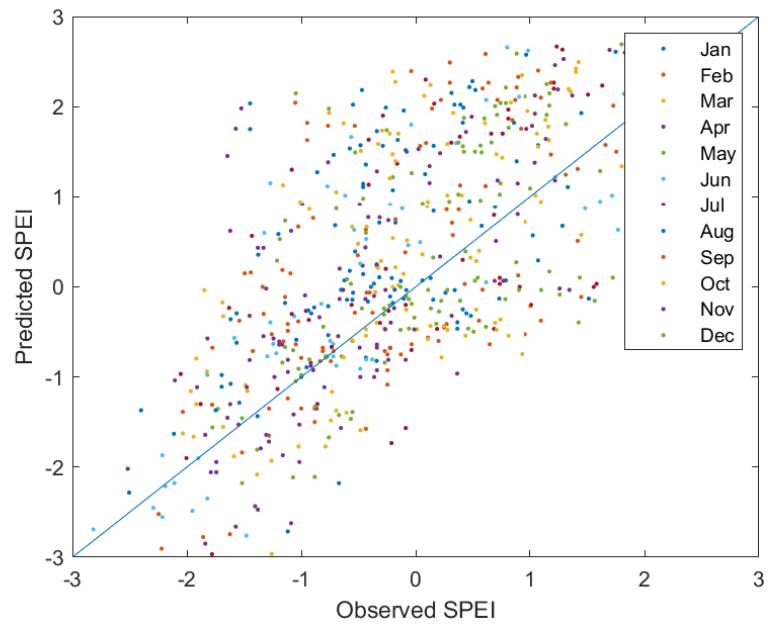
Wetlands



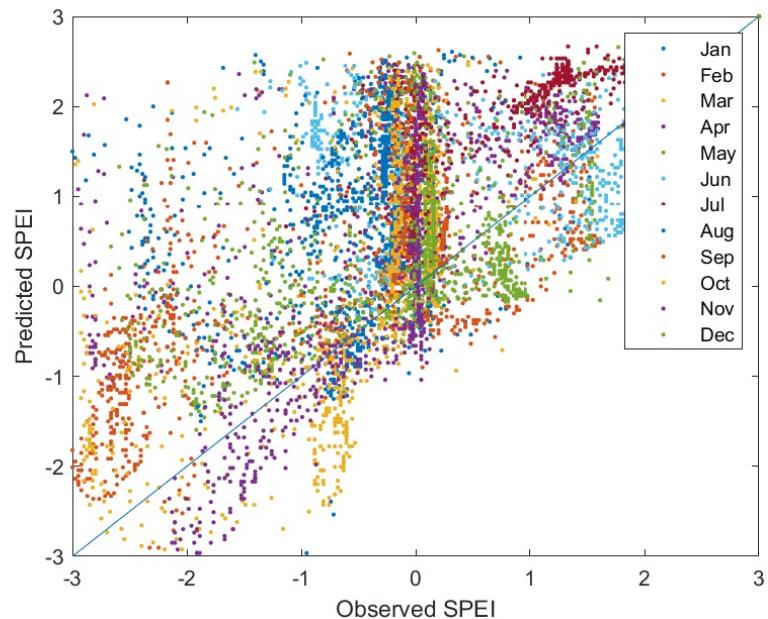
Croplands



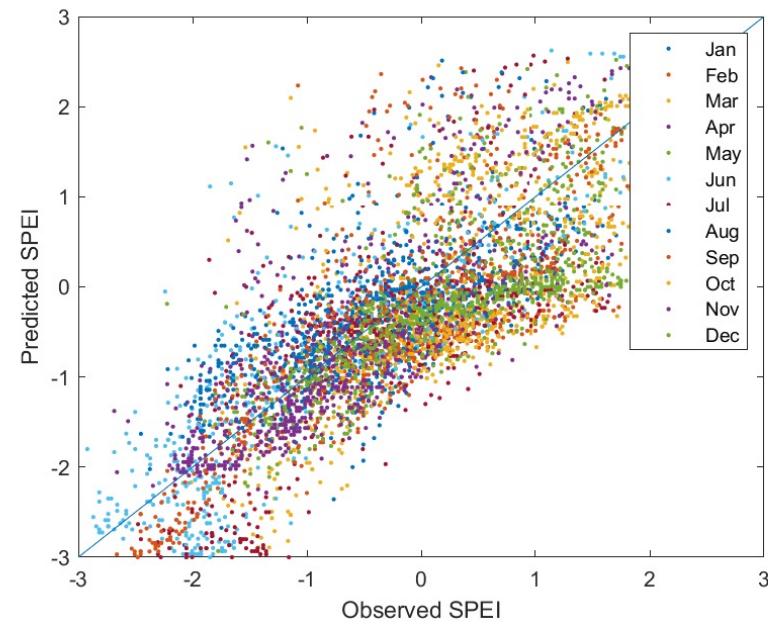
Urban and
Built-up
lands



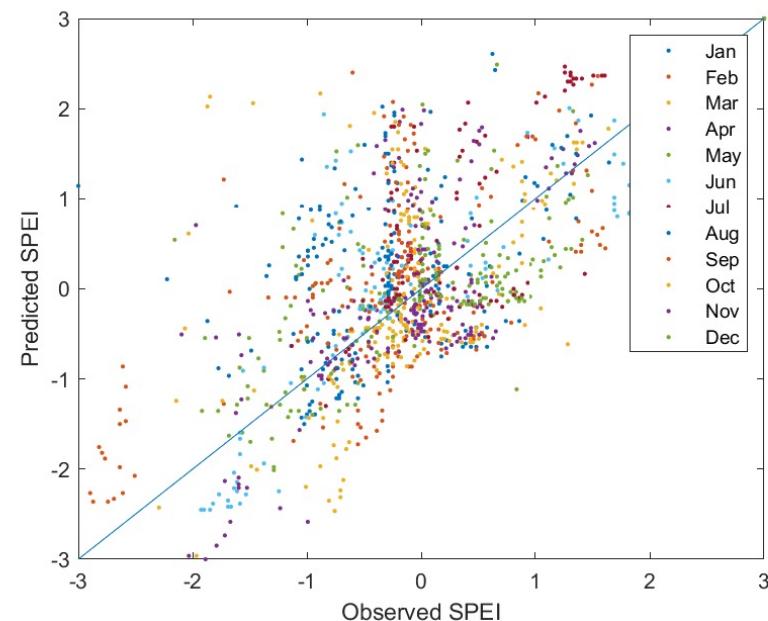
Snow and
ice

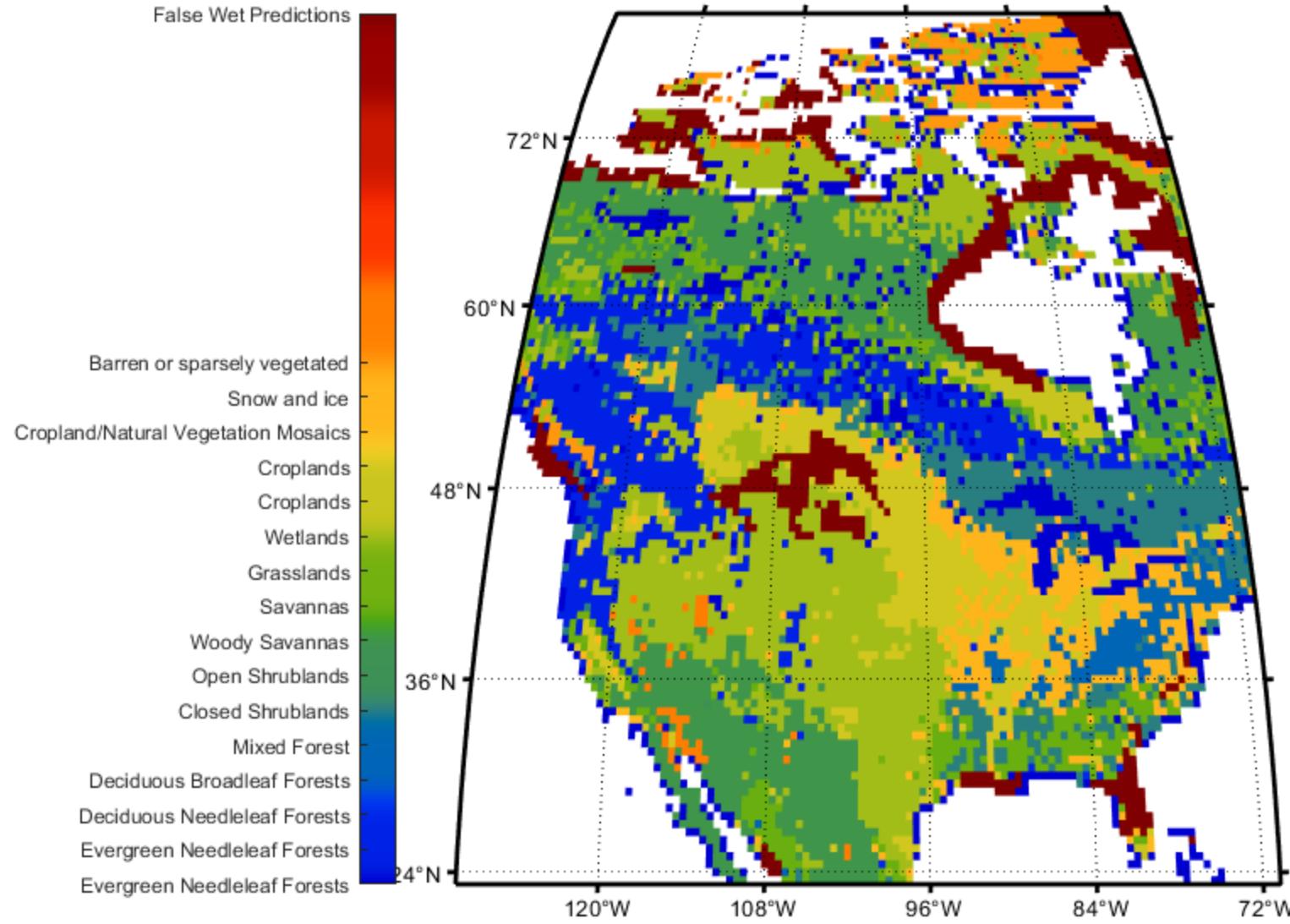


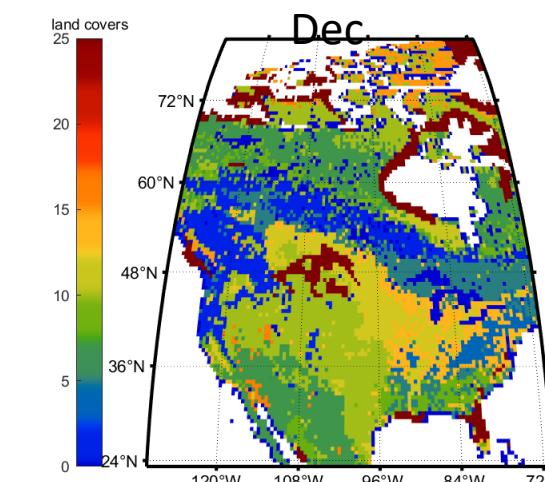
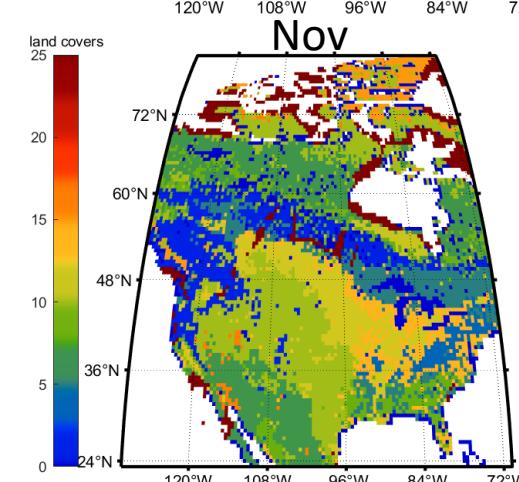
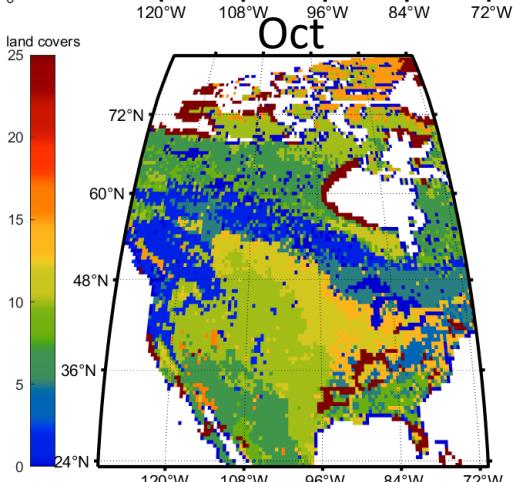
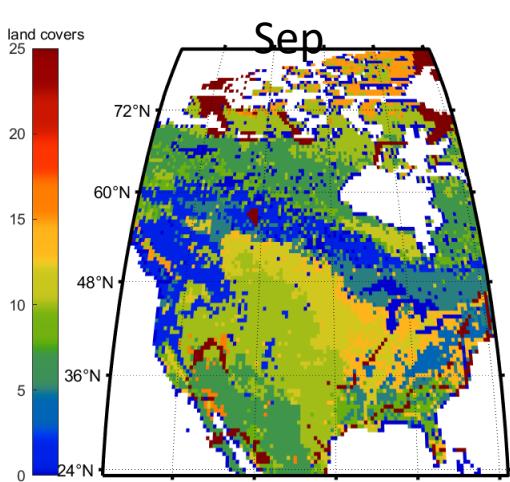
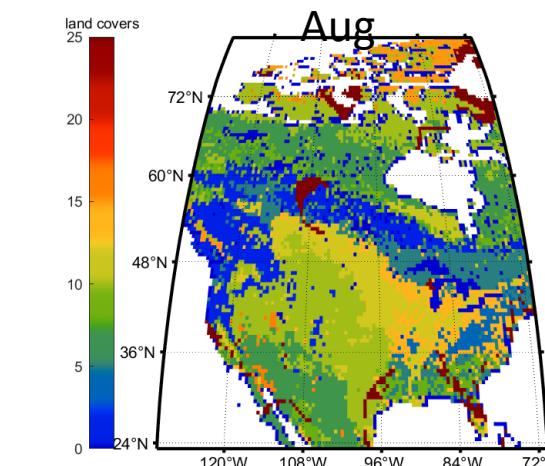
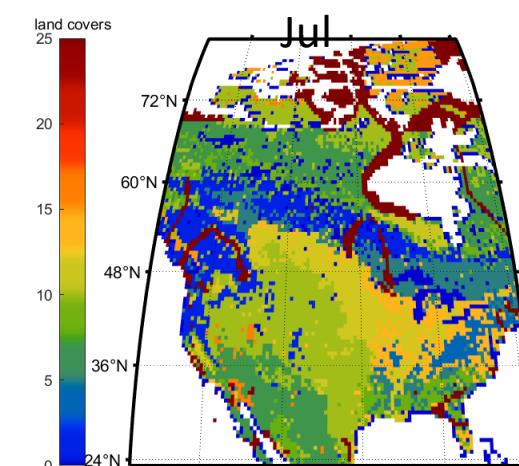
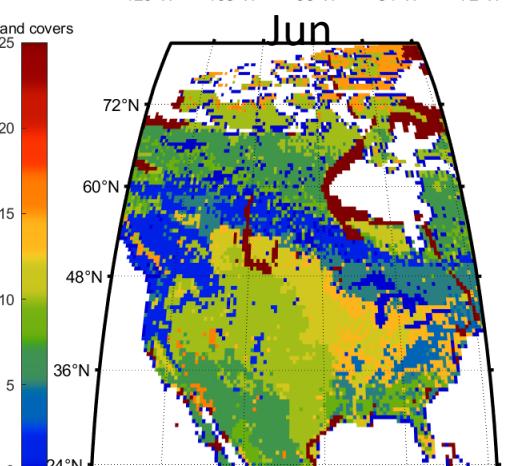
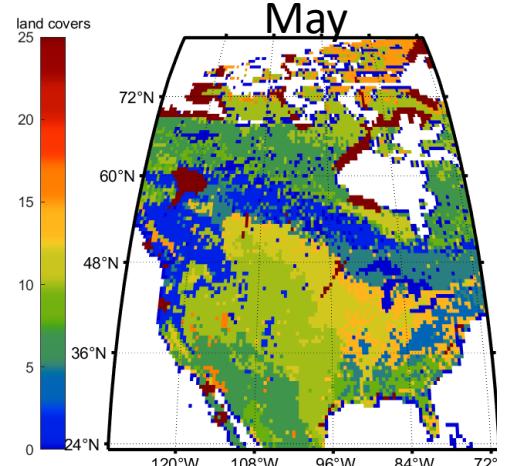
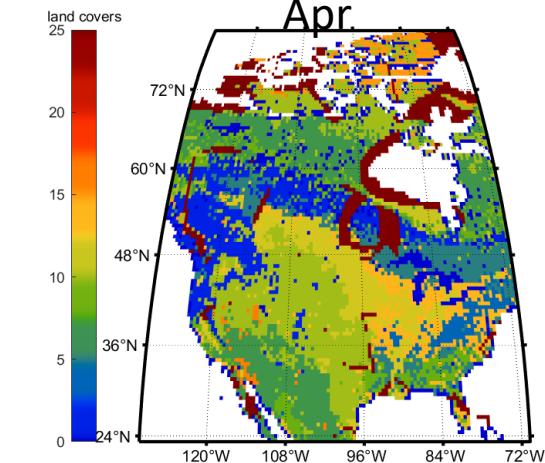
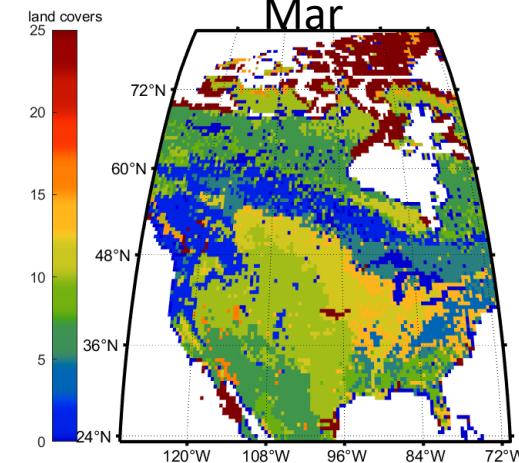
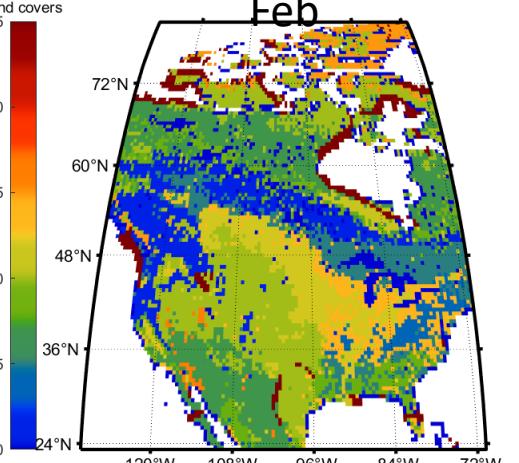
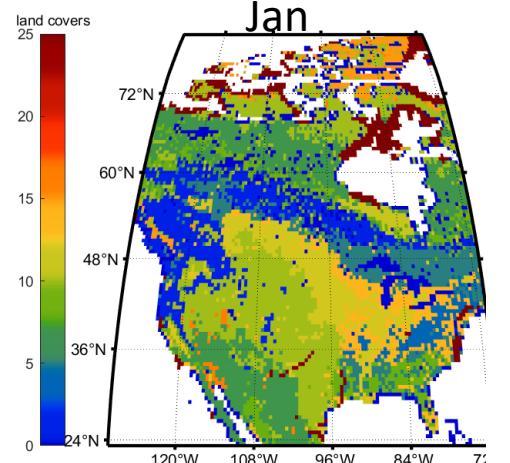
Cropland/
Natural
Vegetation
Mosaics



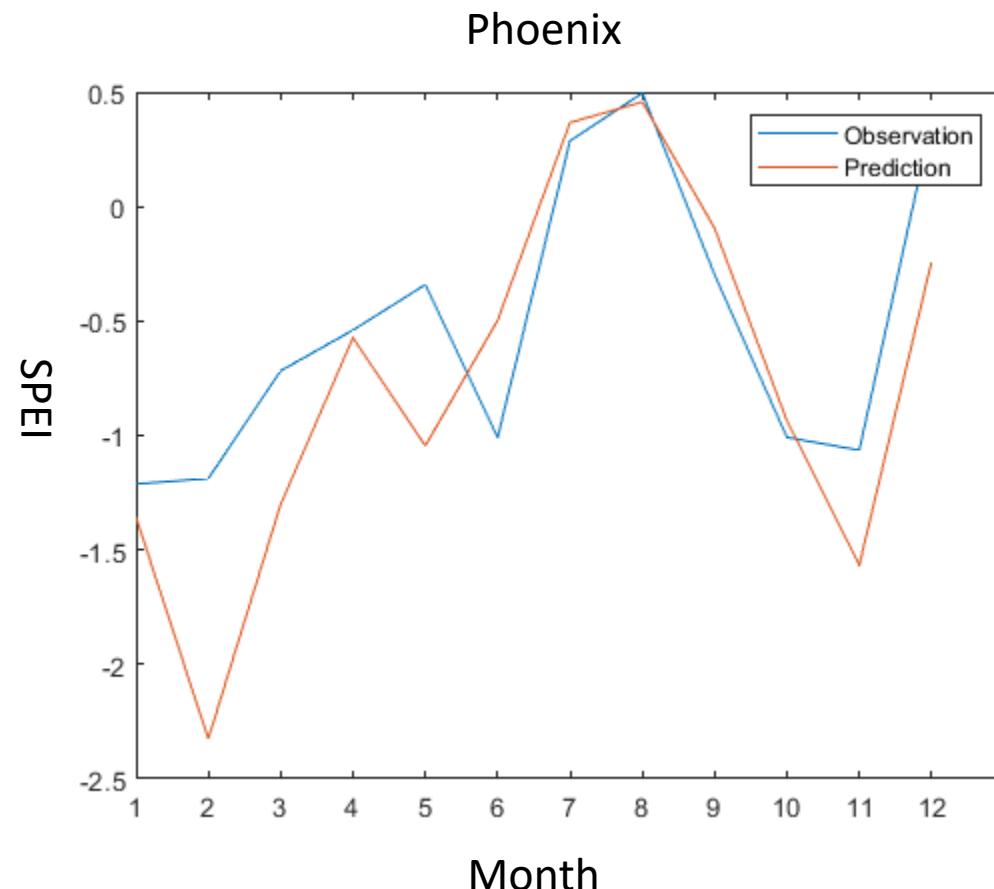
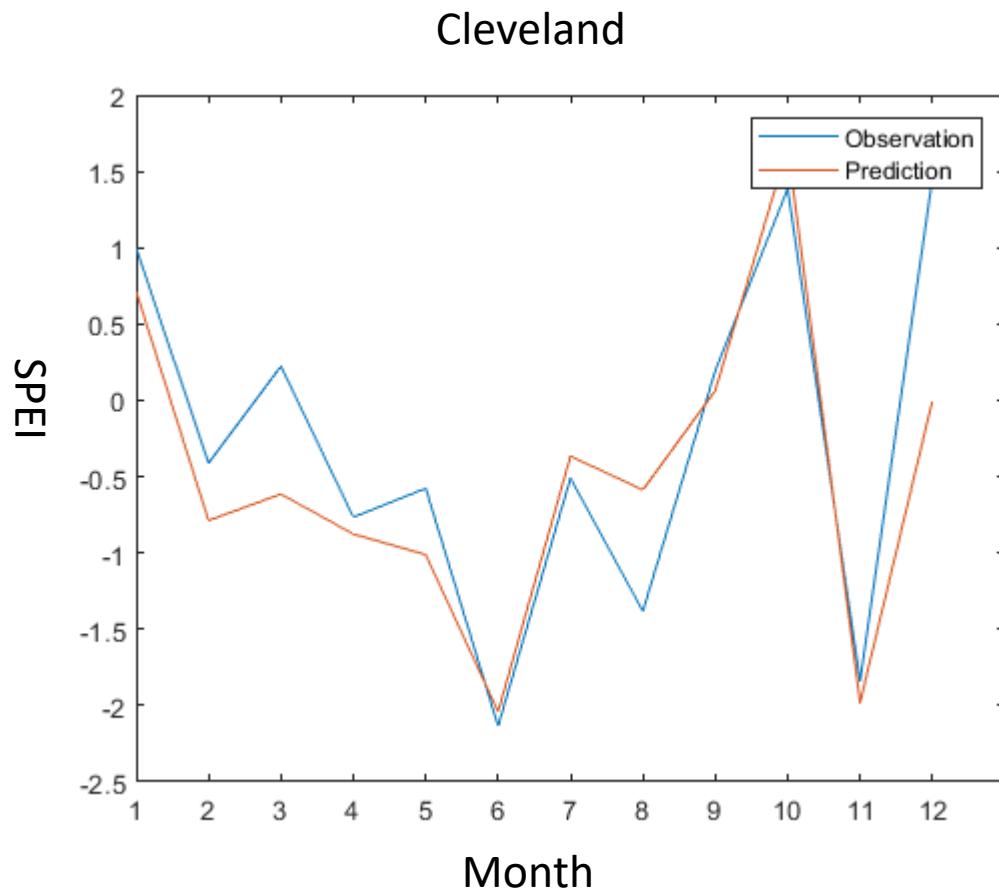
Barren or
sparsely
vegetated







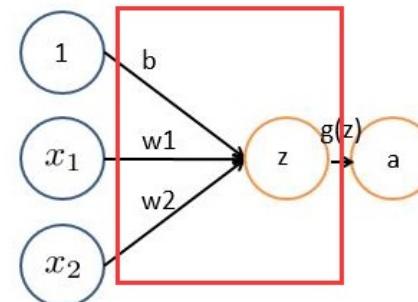
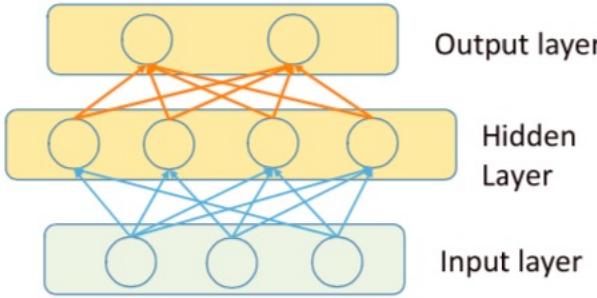
Results in local regions



Thank you

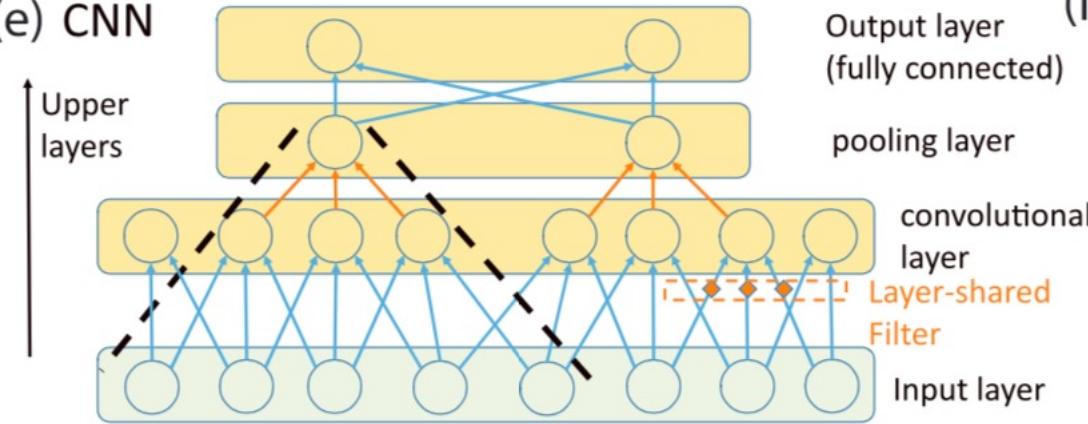
Deep learning basics

(a) MLP

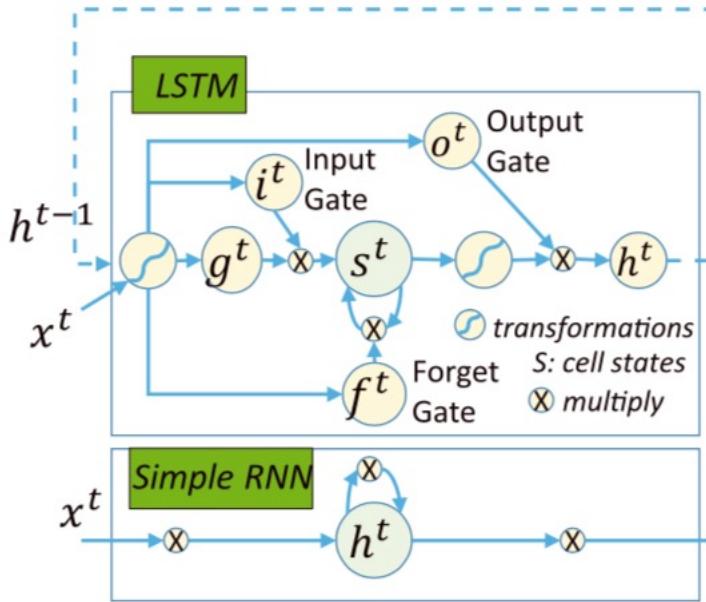


- Tensor
- Activation functions
- gradient descent
- error back-propagation (BP)
- batch-normalization

(e) CNN



(f)



This study adopts **convLSTM** method which combines convolution and LSTM