A Multi-Index Multivariate Drought Monitoring Framework

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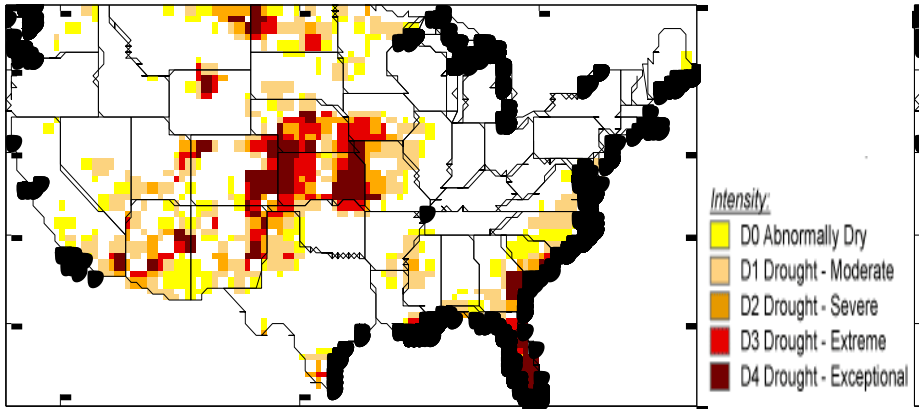
Multi-Index Drought Monitoring

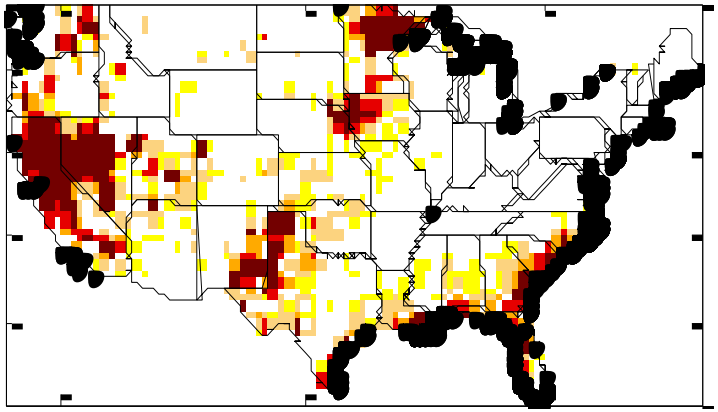
Different drought indices based on different climate variables (e.g., Precipitation, soil moisture):

- Standardized Precipitation Index (SPI)
- Standardized Soil Moisture Index (SSI)
- Standardized runoff Index (SRI)
- Palmer Drought Severity Index (PDSI)

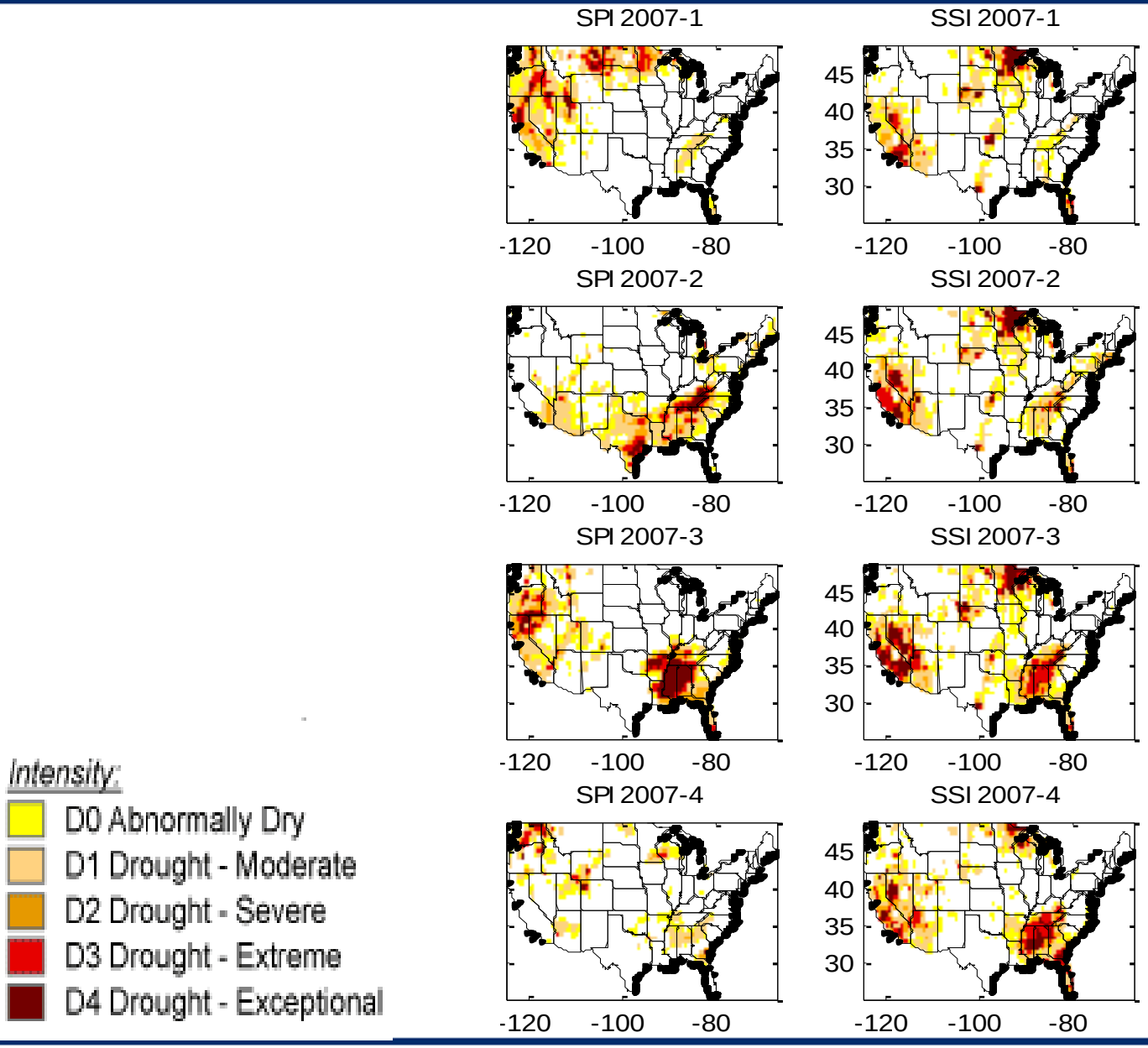
SPI 2012-1



SSI 2012-1

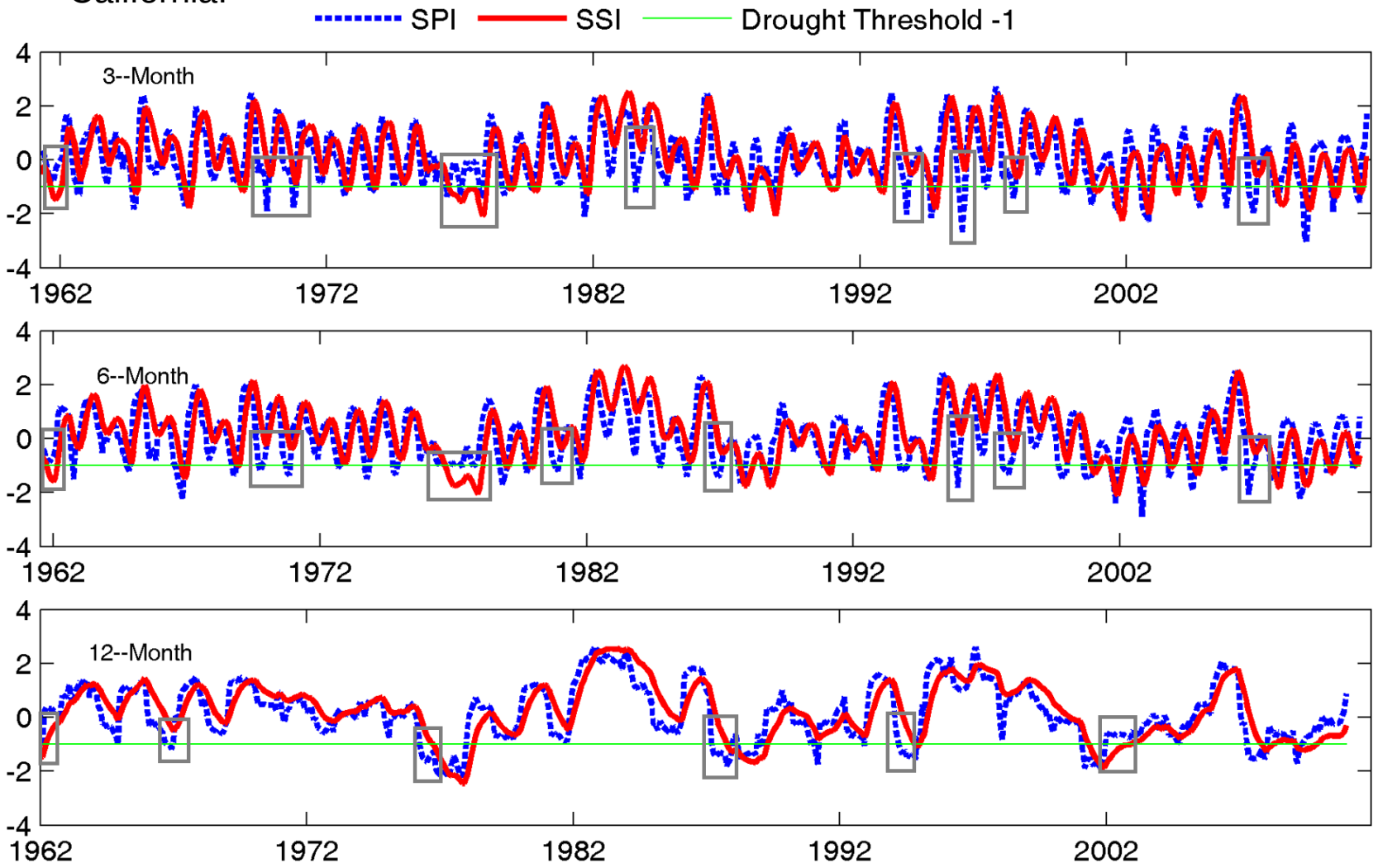


Multi-Index Drought Monitoring



Multi-Index Drought Monitoring

3-, 6- and 12-month drought conditions based on Standardized Precipitation Index (SPI) and Standardized Soil Moisture Index (SSI) for Climate Division 3 in California.



A Multi-Index Approach Using a Joint Distribution Function

$$p = P(X \le x, Y \le y)$$

$$p = C[F(X), G(Y)]$$

C is the copula and F (X) and G (Y) are the marginal cumulative distribution functions of precipitation (X) and soil moisture (Y), respectively

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Multivariate Standardized Drought Index (MSDI)

$$MSDI = \phi^{-1}(p)$$

where ϕ is the standard normal distribution function.

Deriving the Joint Distribution of Precipitation and Soil Moisture

$$p = C\left[F(X), G(Y)\right]$$

Non-Parametric Models

Yue et al., 1999

$$P(X \le x, Y \le y) = \left(\sum_{i=1}^{k} \sum_{j=1}^{k} n_{ij} - 0.44 \right) (m + 0.12)^{-1}$$

where n is the length of the observations; and nij is the number of occurrences of the pair (x_i, y_i) for $x_i \le x_k$, $y_i \le y_k$ with $1 \le i \le k$.

Deriving the Joint Distribution of Precipitation and Soil Moisture

$$p = C\left[F(X), G(Y)\right]$$

Parametric Models

Nelson 2006; Joe 1997; AghaKouchak 2010

$$C_{v,\rho}(u_1, u_2) = t^2_{v,\rho}(t^{-1}_{v,\rho}(u_1), t^{-1}_{v,\rho}(u_2))$$

$$t^2_{v,\rho}(x) = \frac{1}{\sqrt{\det \rho}} \frac{\Gamma(\frac{v+n}{2})}{\Gamma(\frac{v}{2})(\pi v)^{n/2}} \int_{-\infty}^{x_1} \int_{-\infty}^{x_2} \frac{dx}{(1+\frac{x' \rho^{-1} x}{v})^{(v+n)/2}}$$

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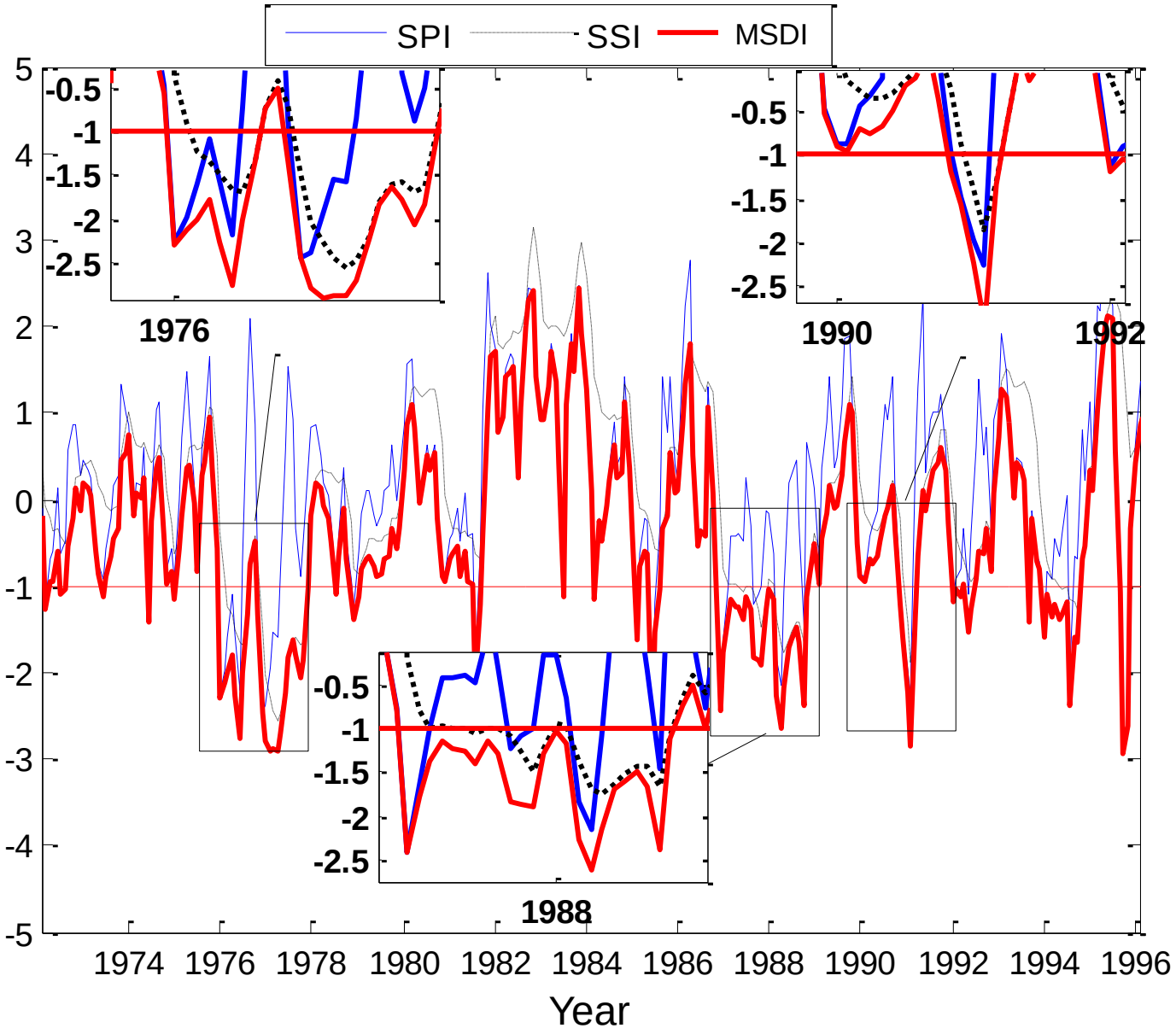
Multi-Index Drought Monitoring

Monthly precipitation and soil moisture from 1/1932 to 12/2010

Precipitation : NCDC
Soil Moisture: CPC

3-month SPI, SSI, MSDI for Climate Division 3 in California.



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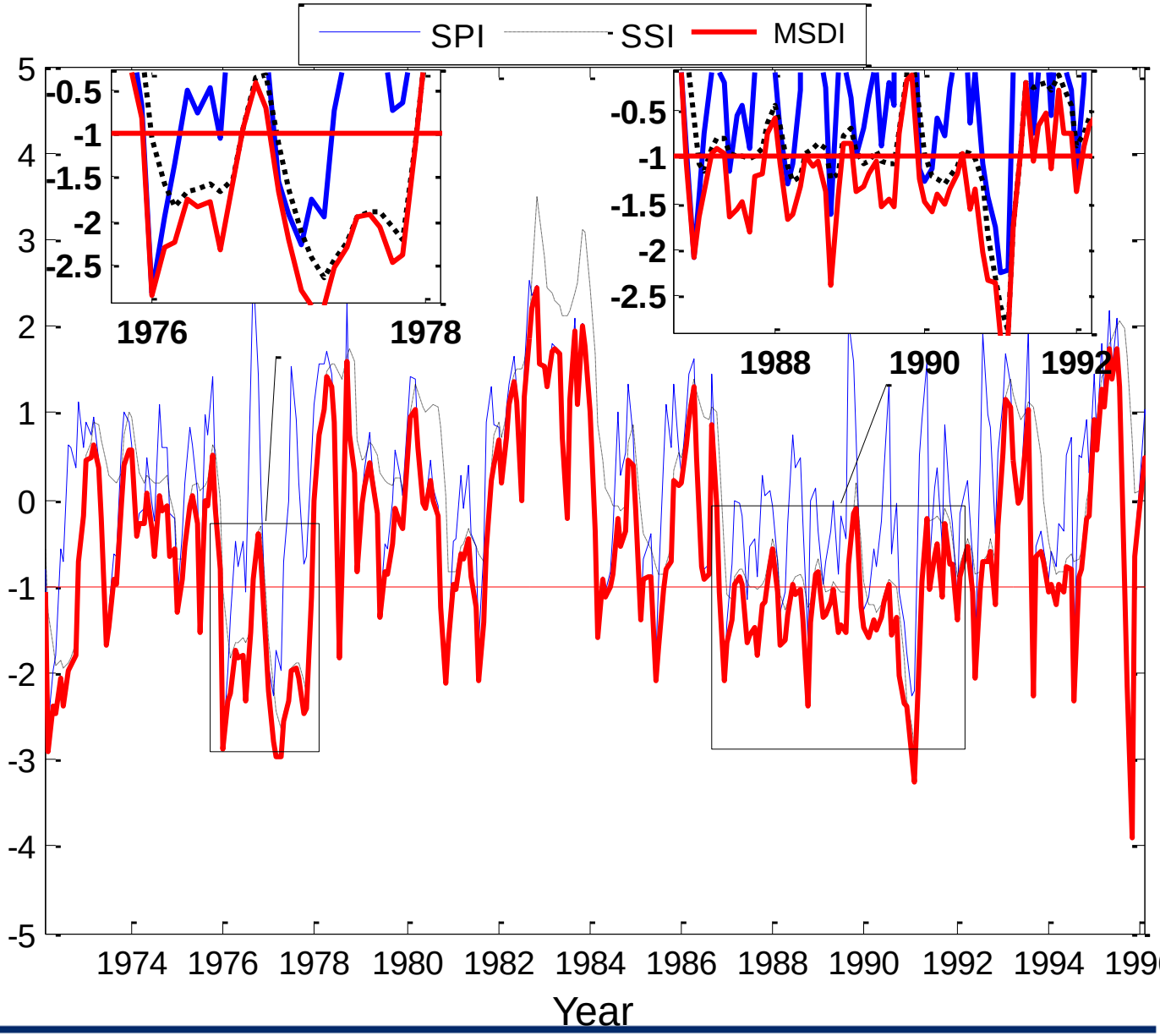
3-month SPI, SSI, MSDI for Climate Division 5 in California.

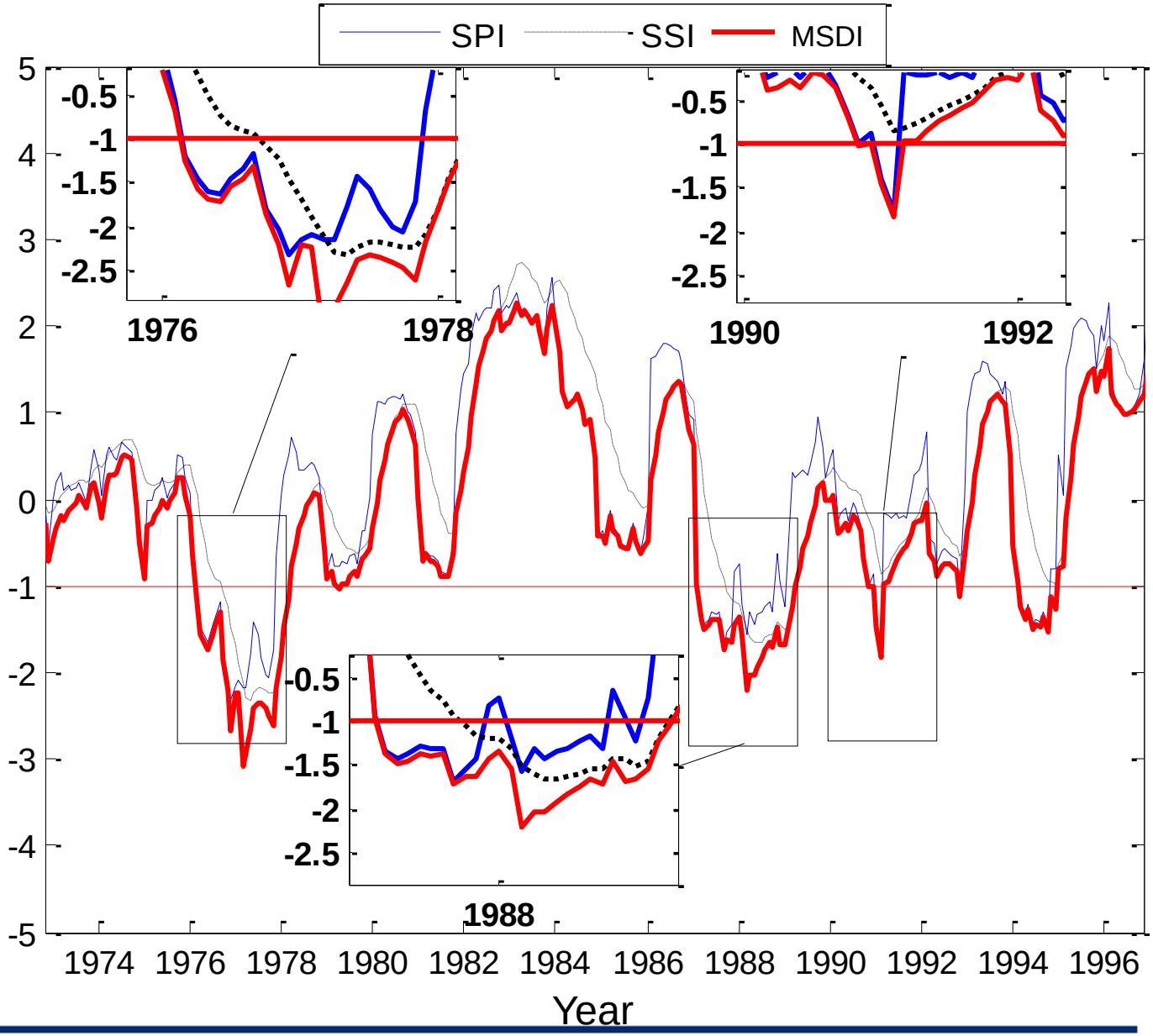


Multi-Index Drought Monitoring

Monthly precipitation and soil moisture from 1/1932 to 12/2010

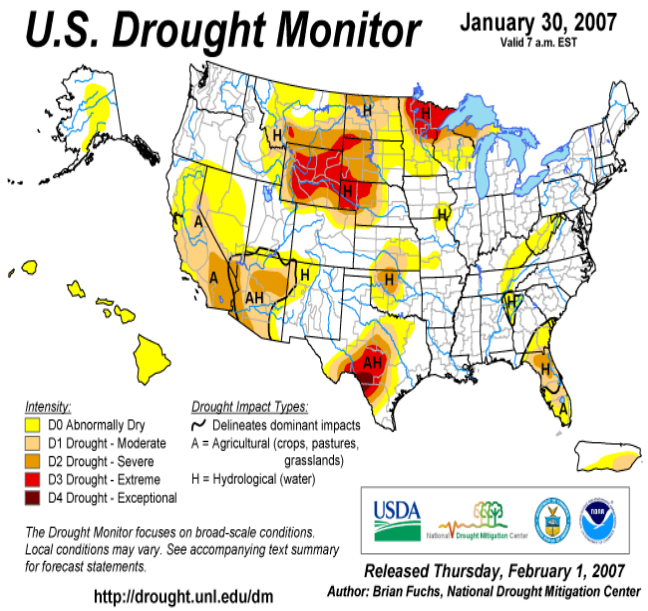
Precipitation : NCDC
Soil Moisture: CPC

6-month SPI, SSI, MSDI for Climate Division 3 in California.

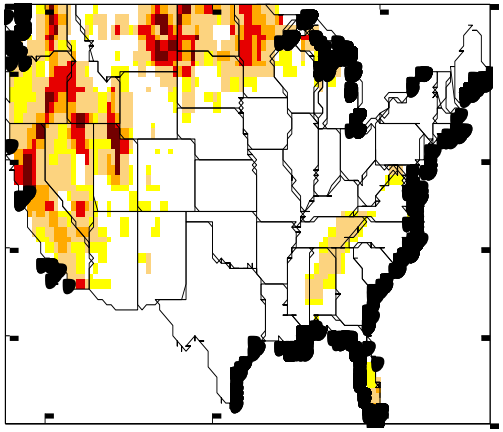


Multi-Index Drought Monitoring

1-Month SPI and SSI Derived Using NASA MERRA-LAND Precipitation and soil moisture Data.



SPI 2007-1



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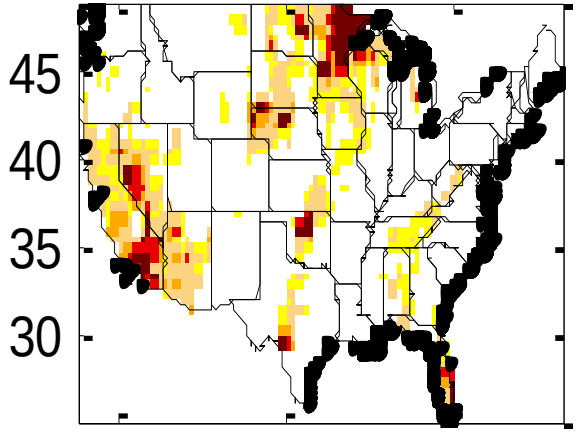
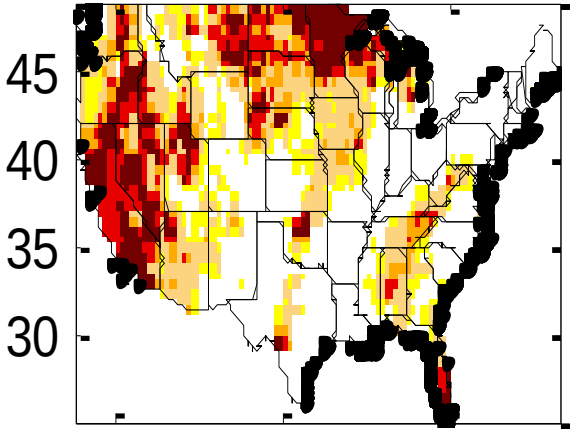


MSDI 2007-1



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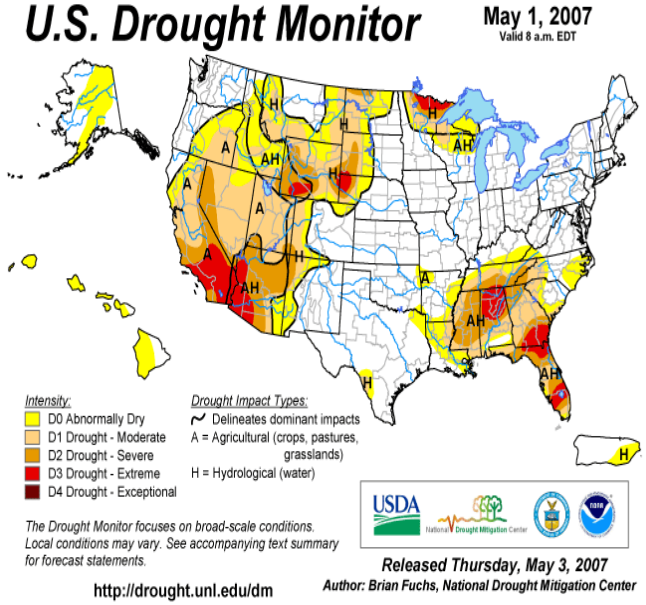
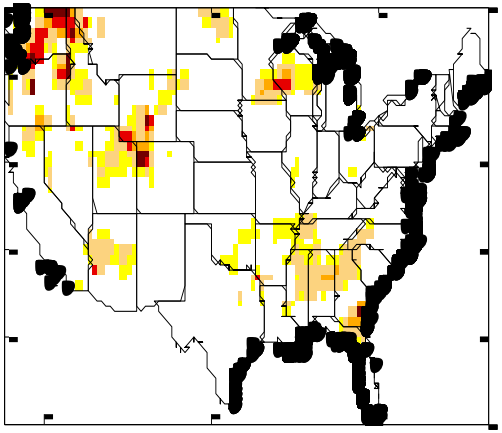


SPI 2007-4



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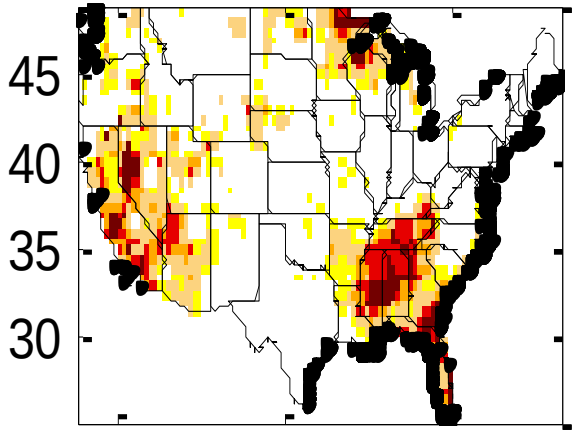

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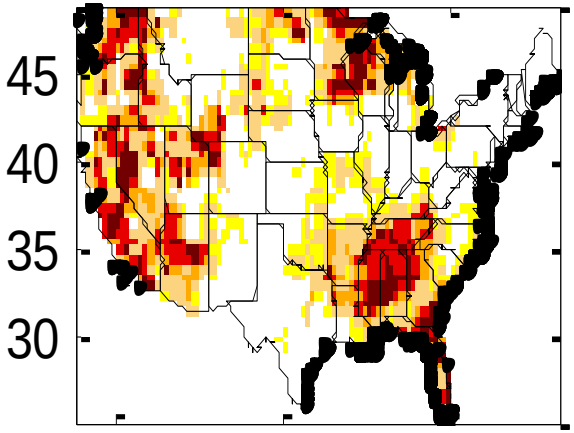

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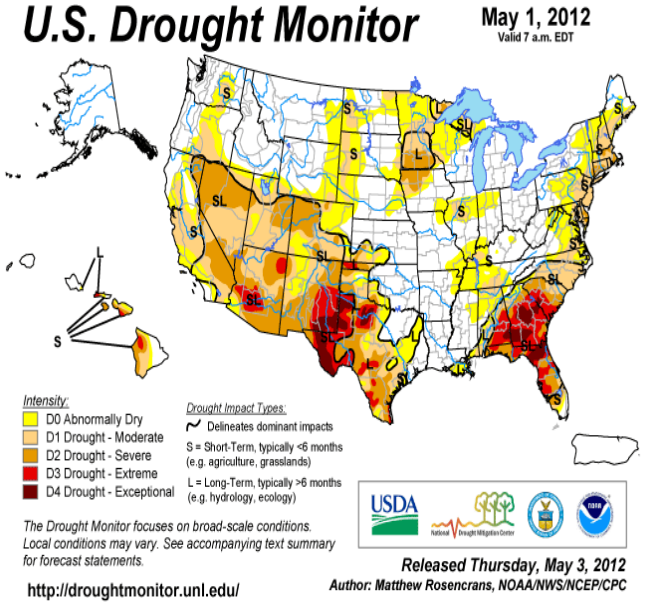
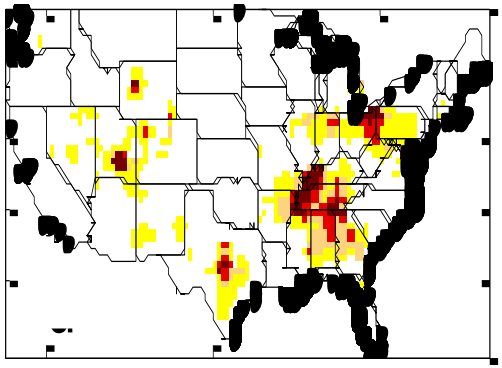


SPI 2012-4



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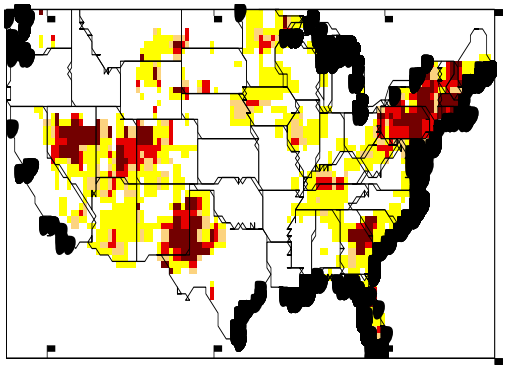

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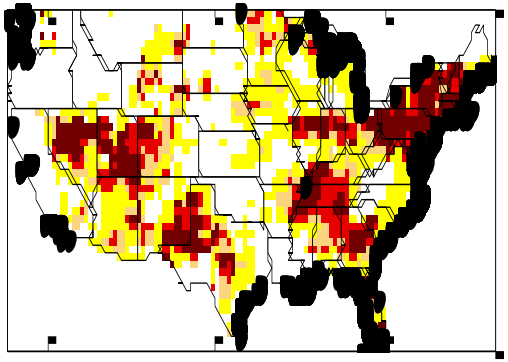
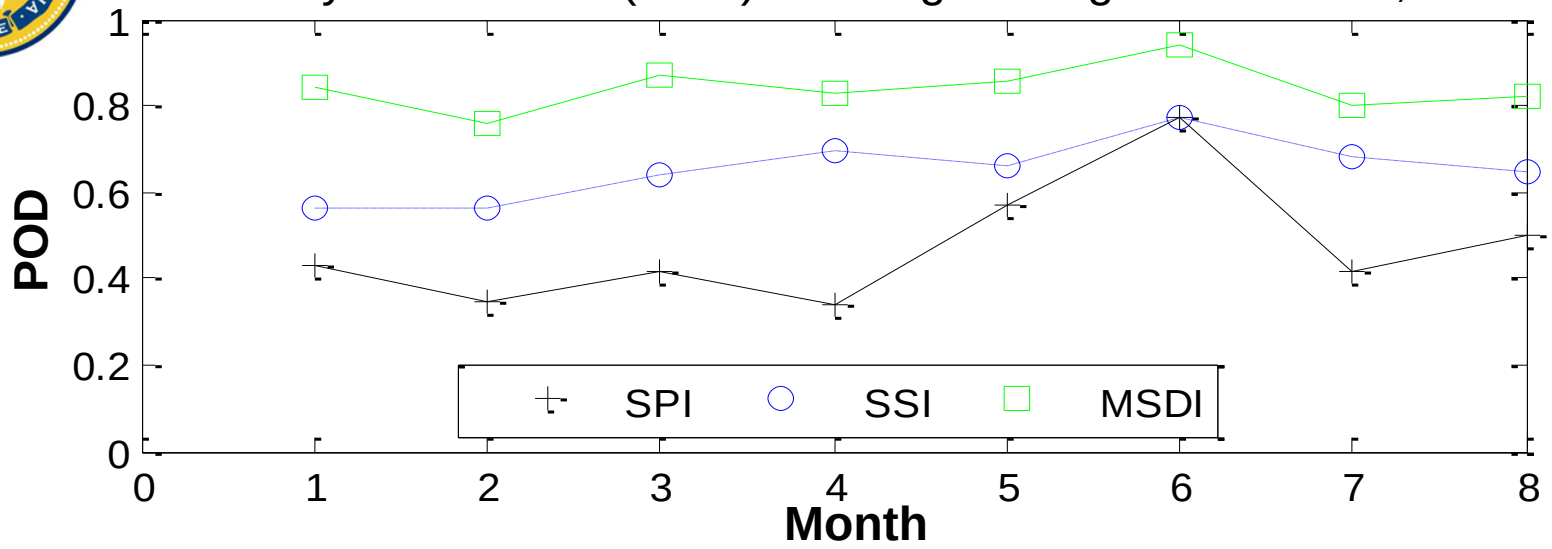
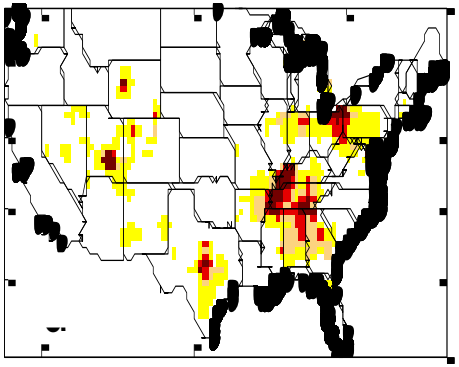


Multi-Index Drought Monitoring

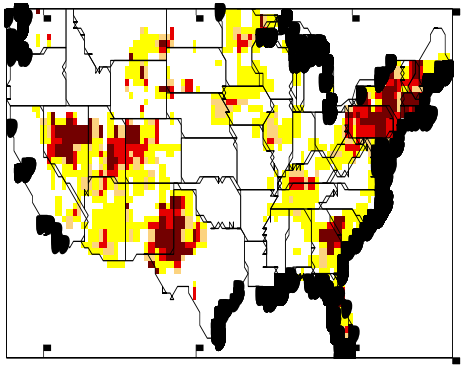
Probability of detection (POD) of drought using 1-month SPI, SSI and MSDI



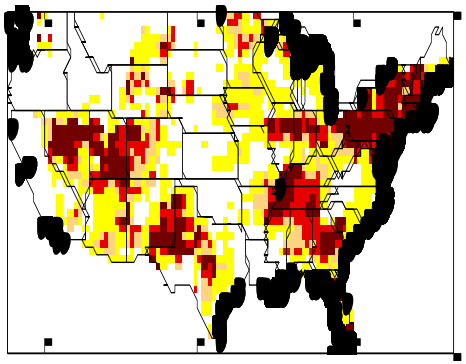
SPI 2012-04

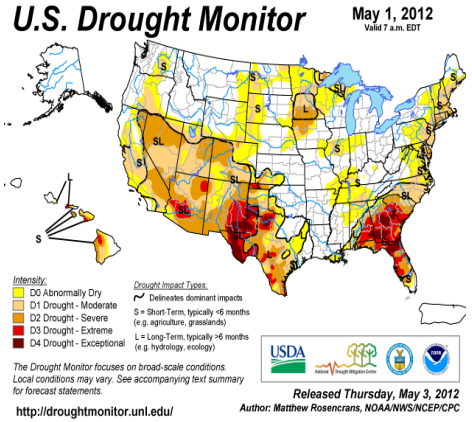


SSI 2012-04



MSDI 2012-04





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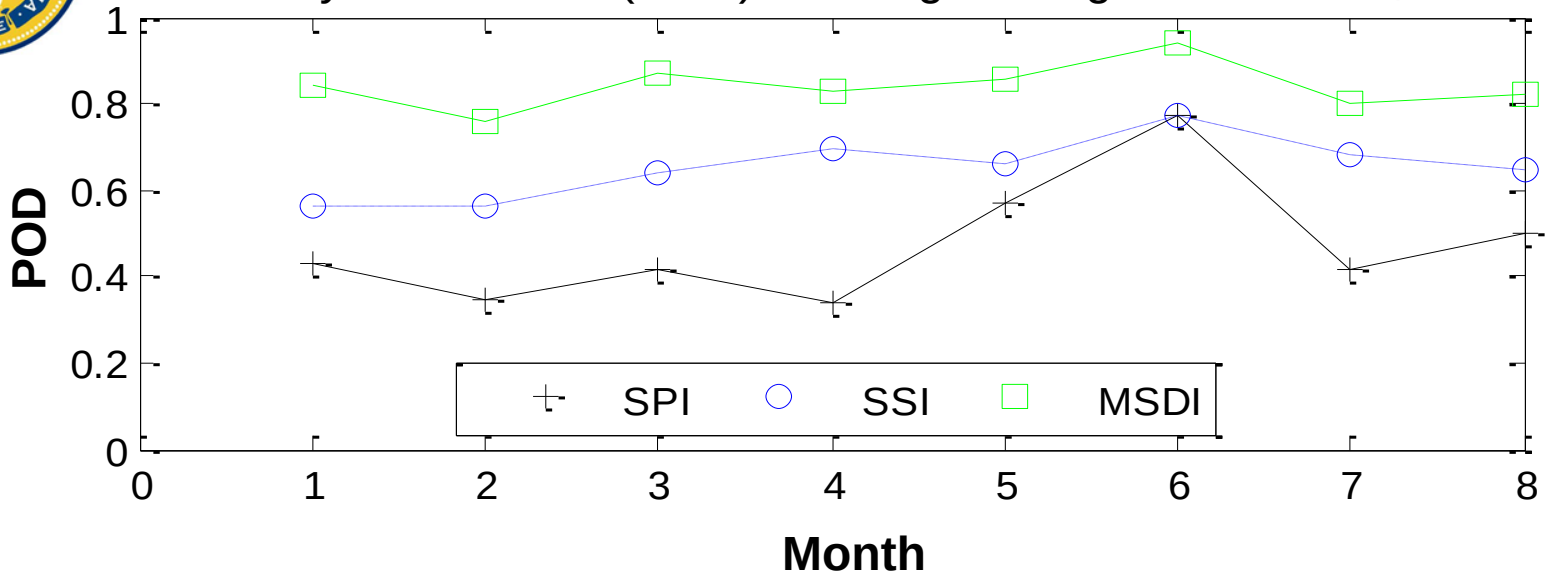
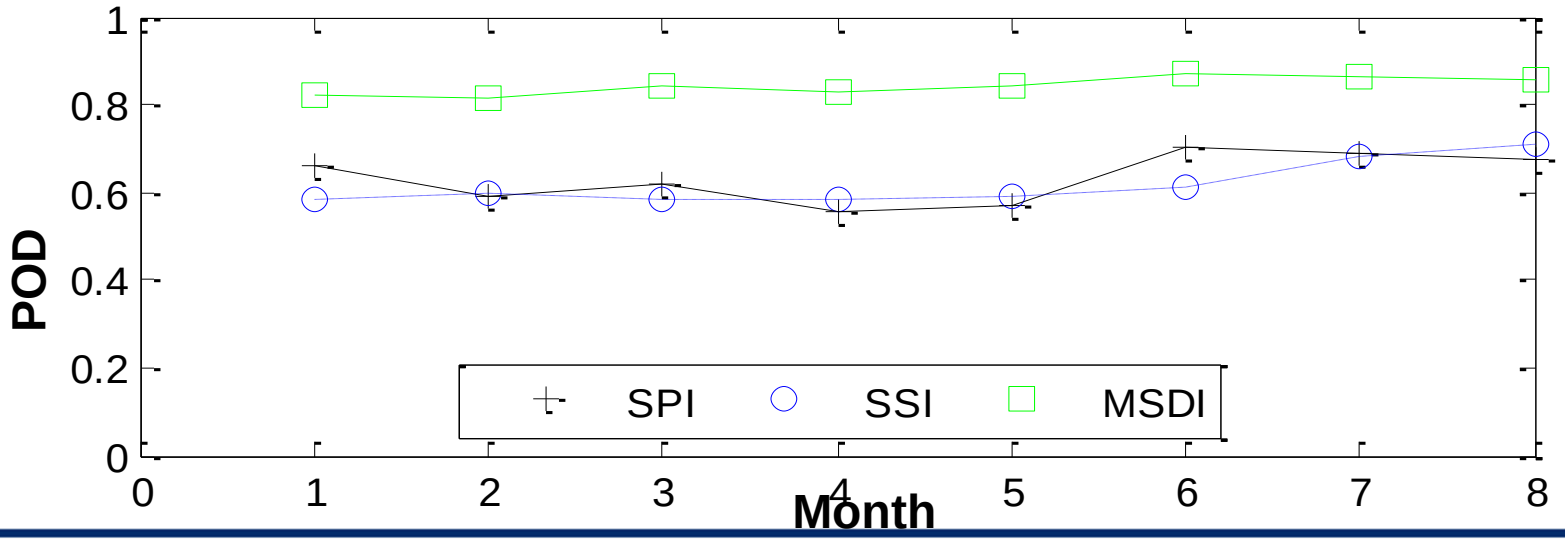


Probability of detection (POD) of drought using 6-month SPI, SSI and MSDI



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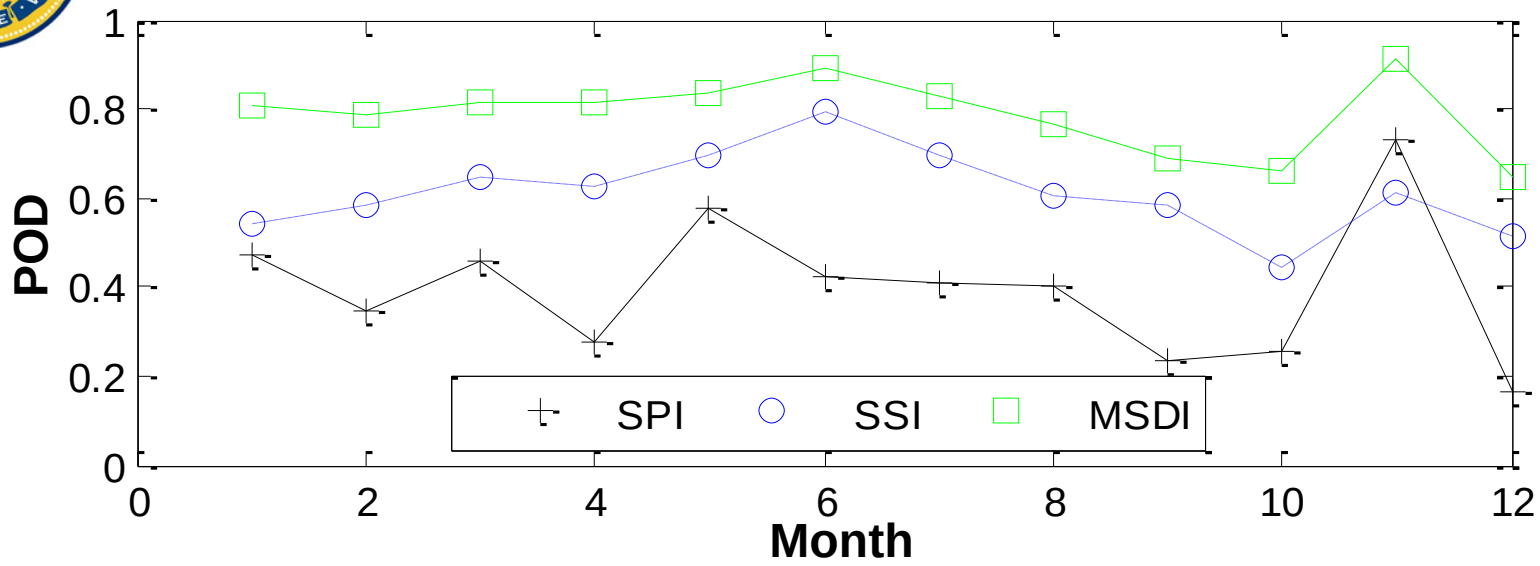
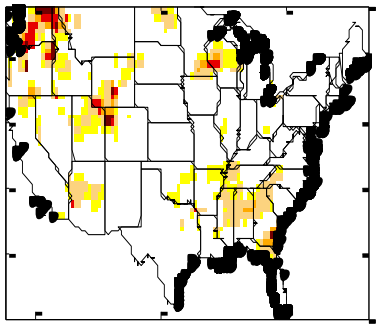


SPI 2007-4



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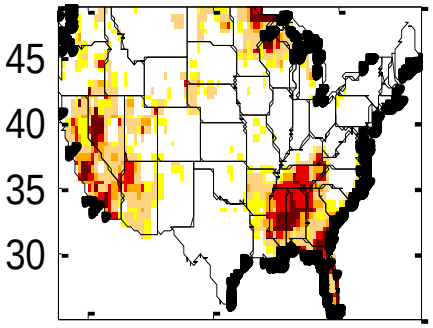

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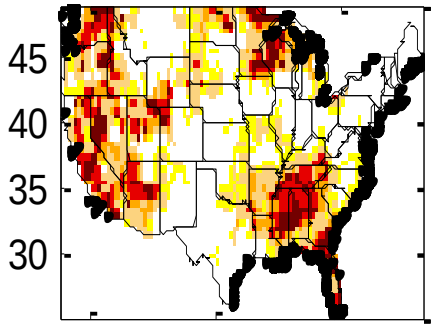

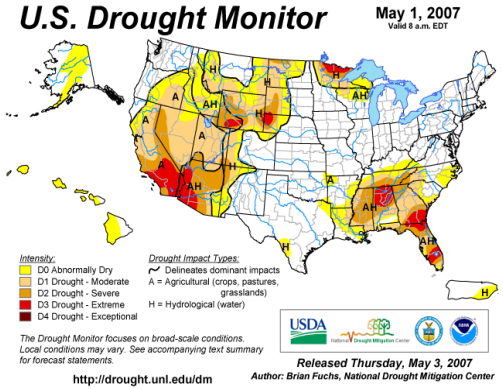

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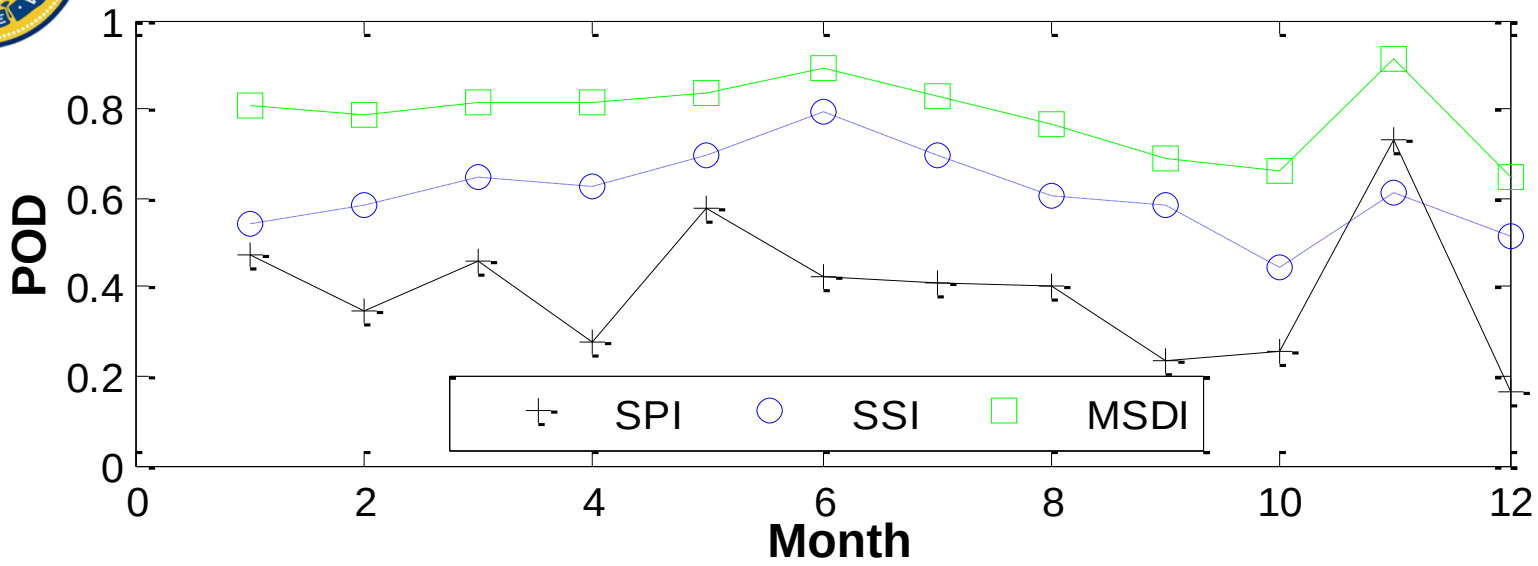
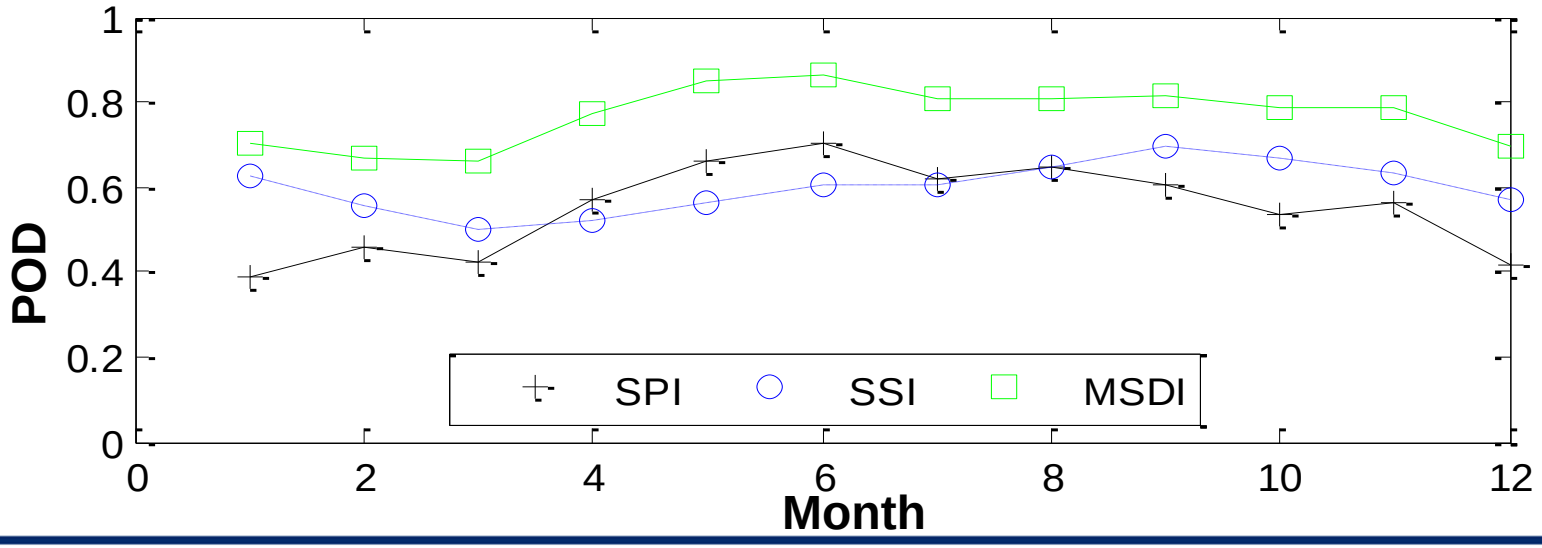
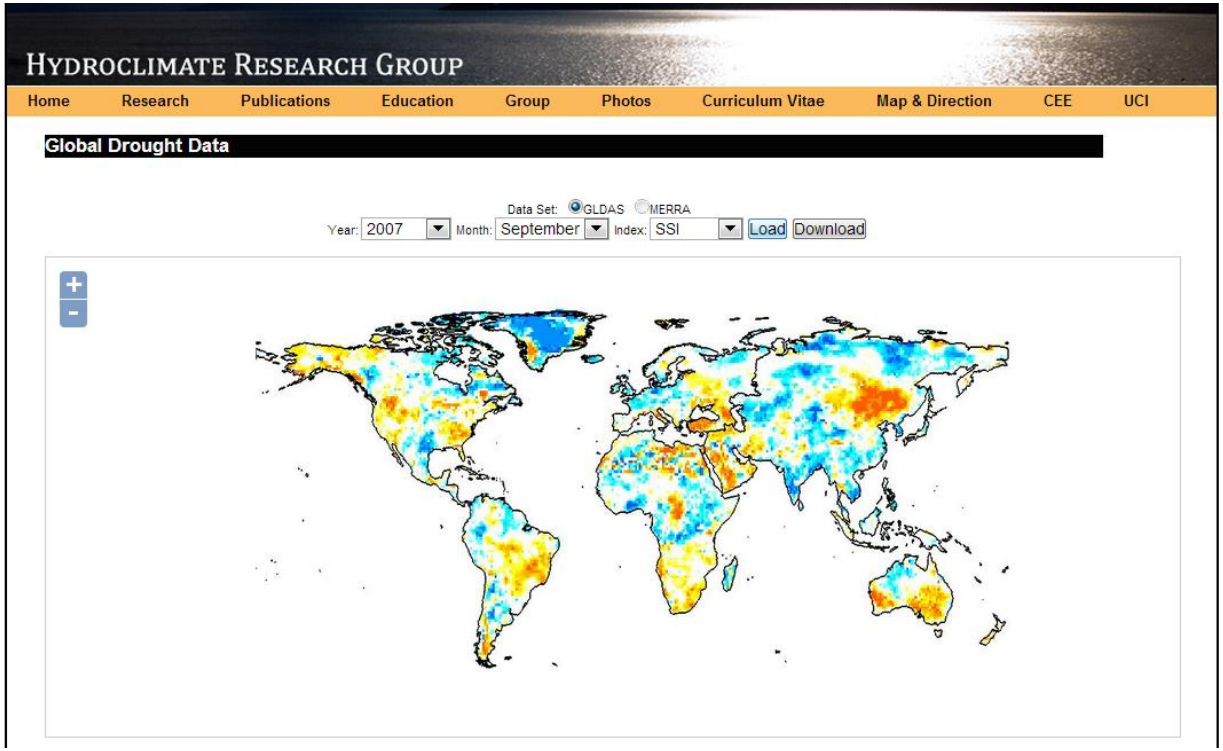


Probability of detection (POD) of drought using 6-month SPI, SSI and MSDI



Multi-Index Drought Monitoring

Data Distribution System



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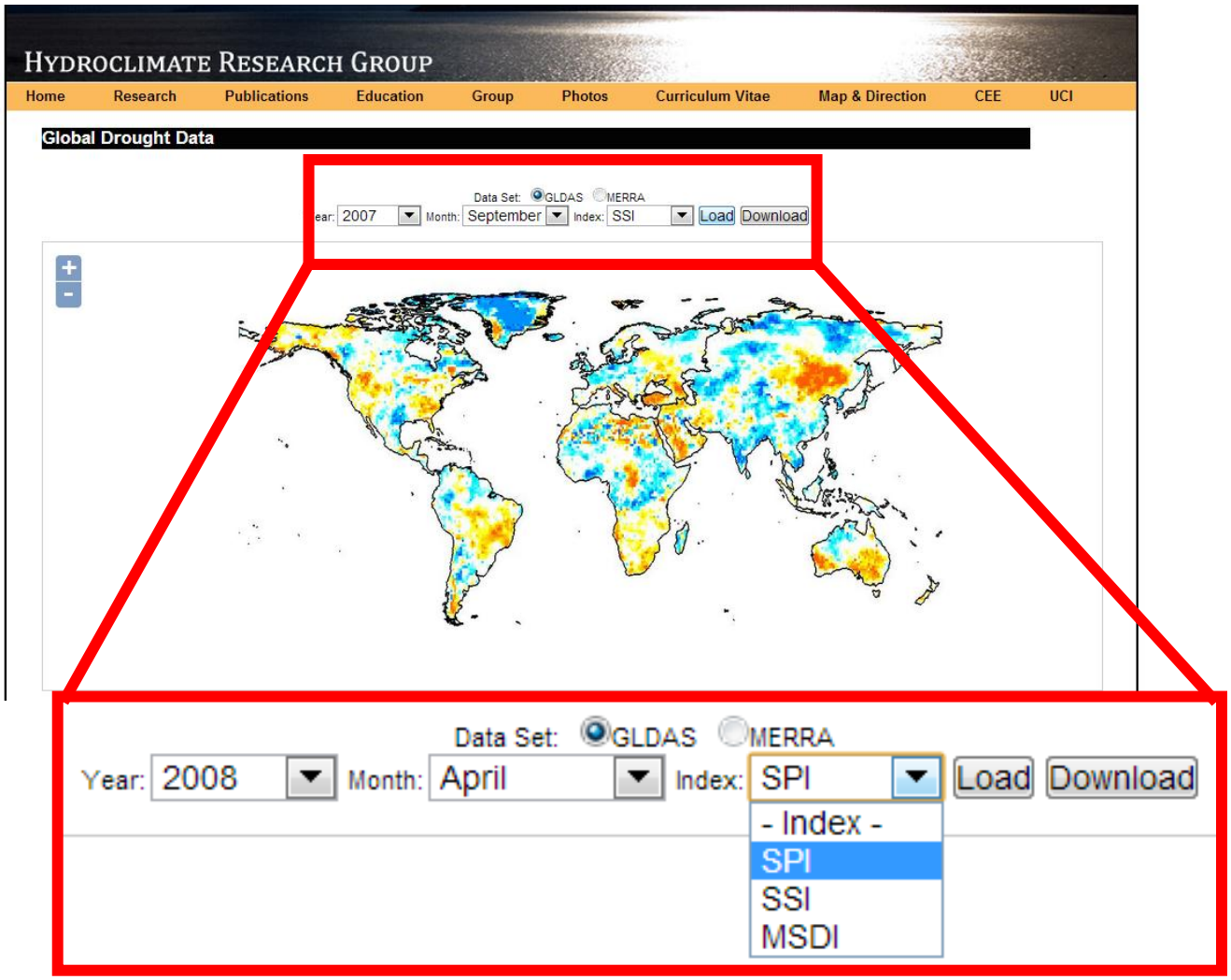

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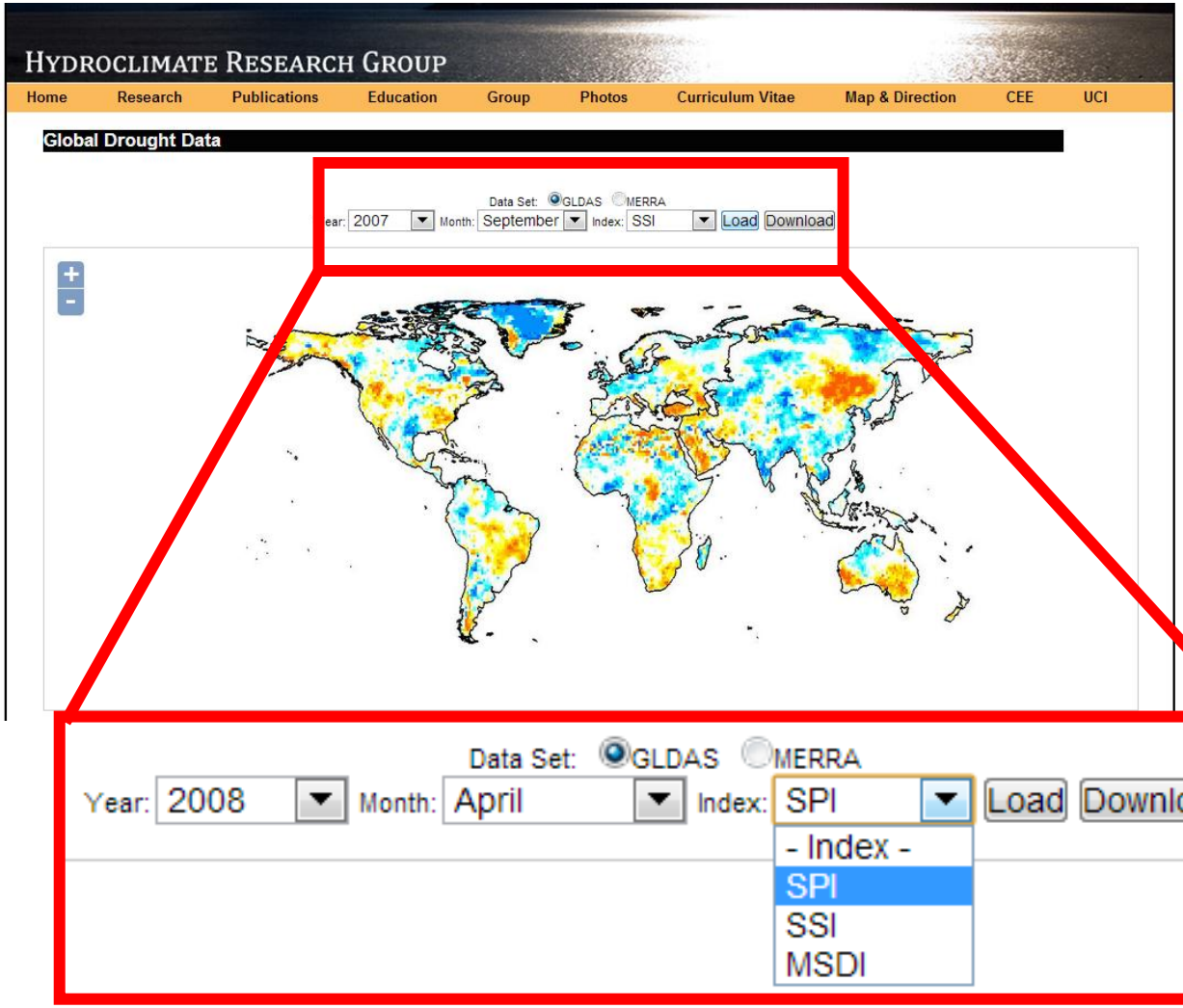

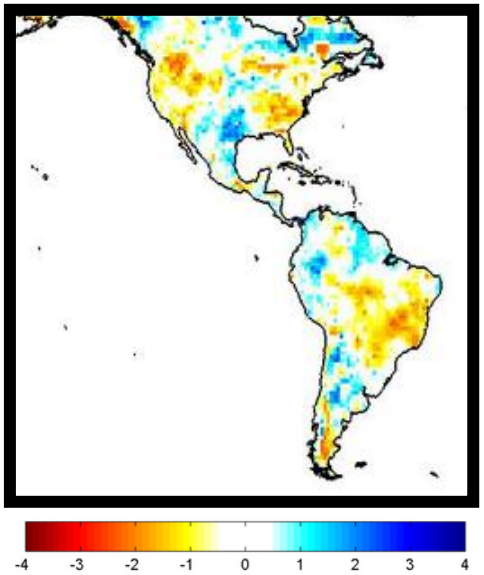

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