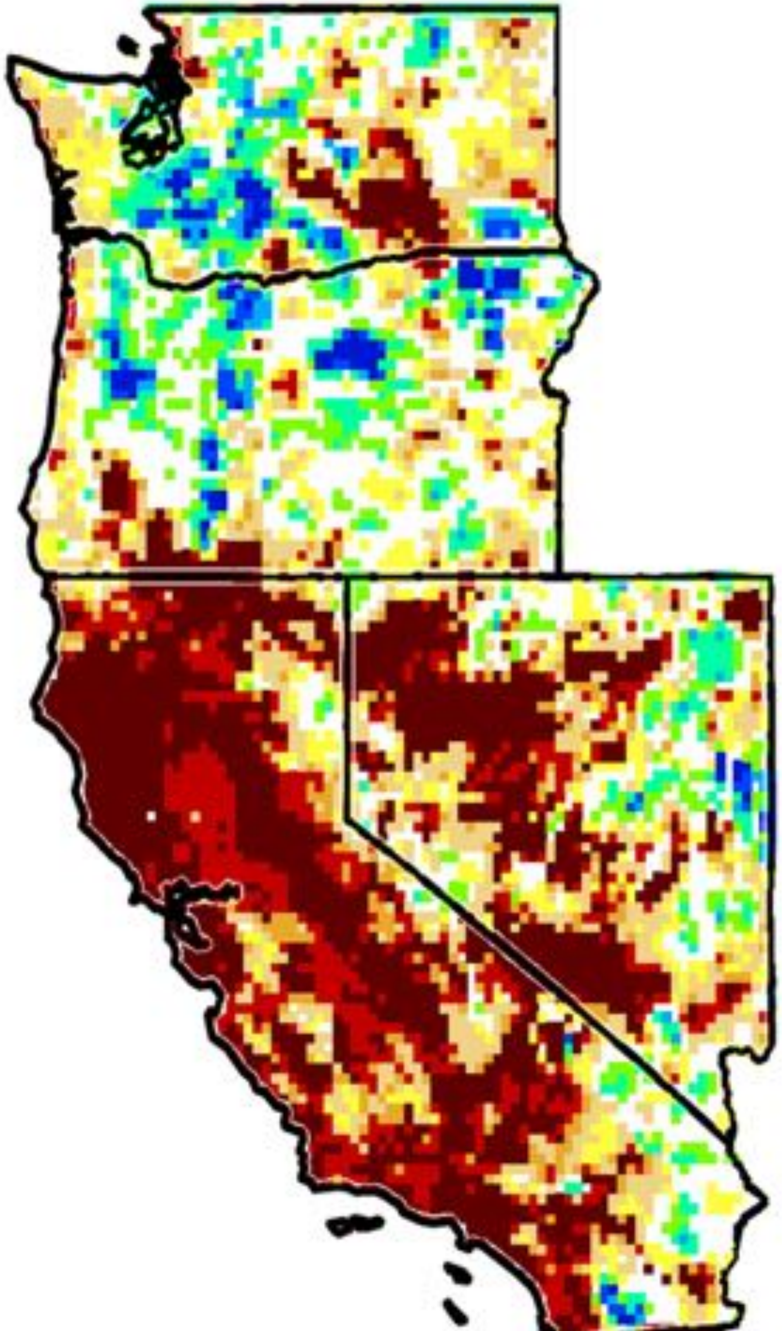


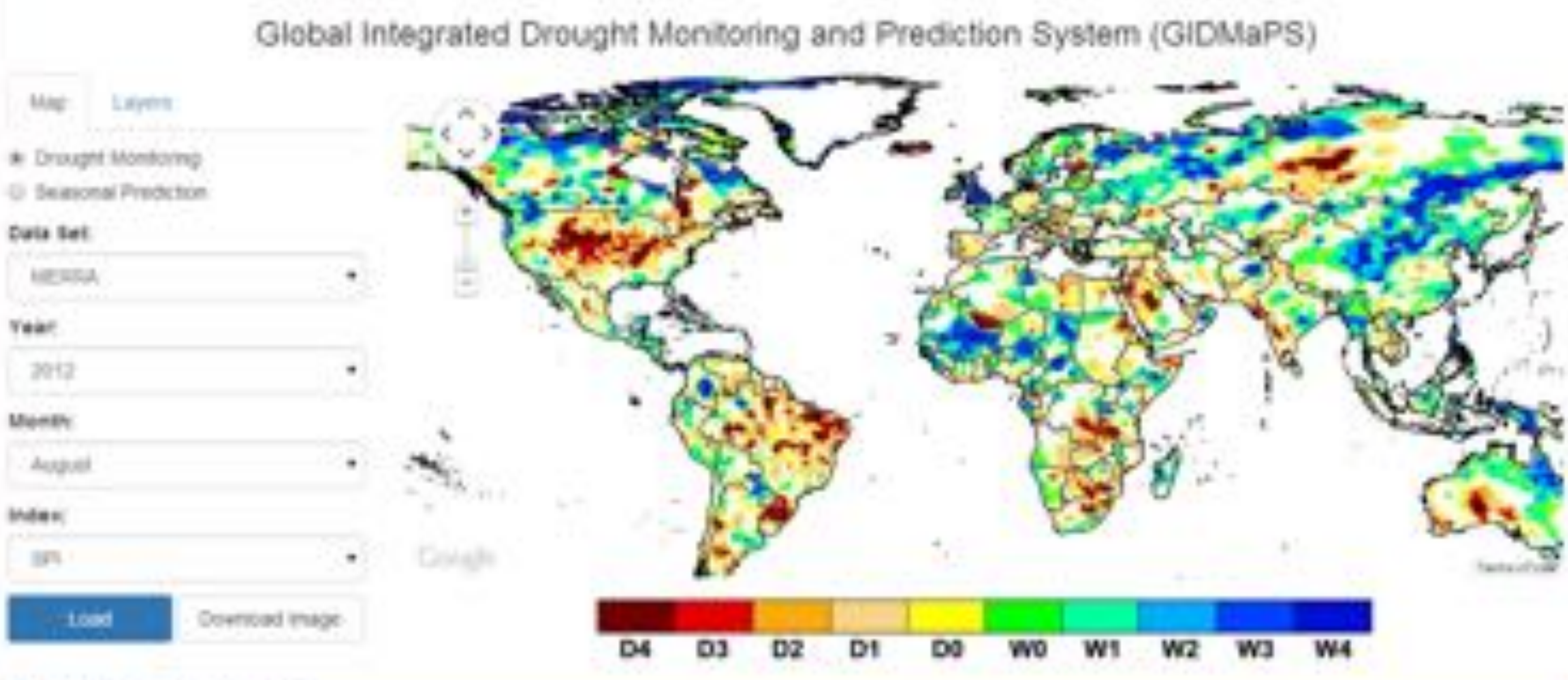
A probabilistic framework for linking drought information to impact on agricultural production

Amir AghaKouchak

University of California, Irvine

GIDMaPS: Global Integrated Drought Monitoring and Prediction System

http://drought.eng.uci.edu/



Hao Z., AghaKouchak A., Nakhjiri N., Farahmand A., 2014, Global Integrated Drought Monitoring and Prediction System, *Scientific Data*, 1:140001, 1-10, doi: 10.1038/sdata.2014.1.
http://www.nature.com/articles/sdata20141

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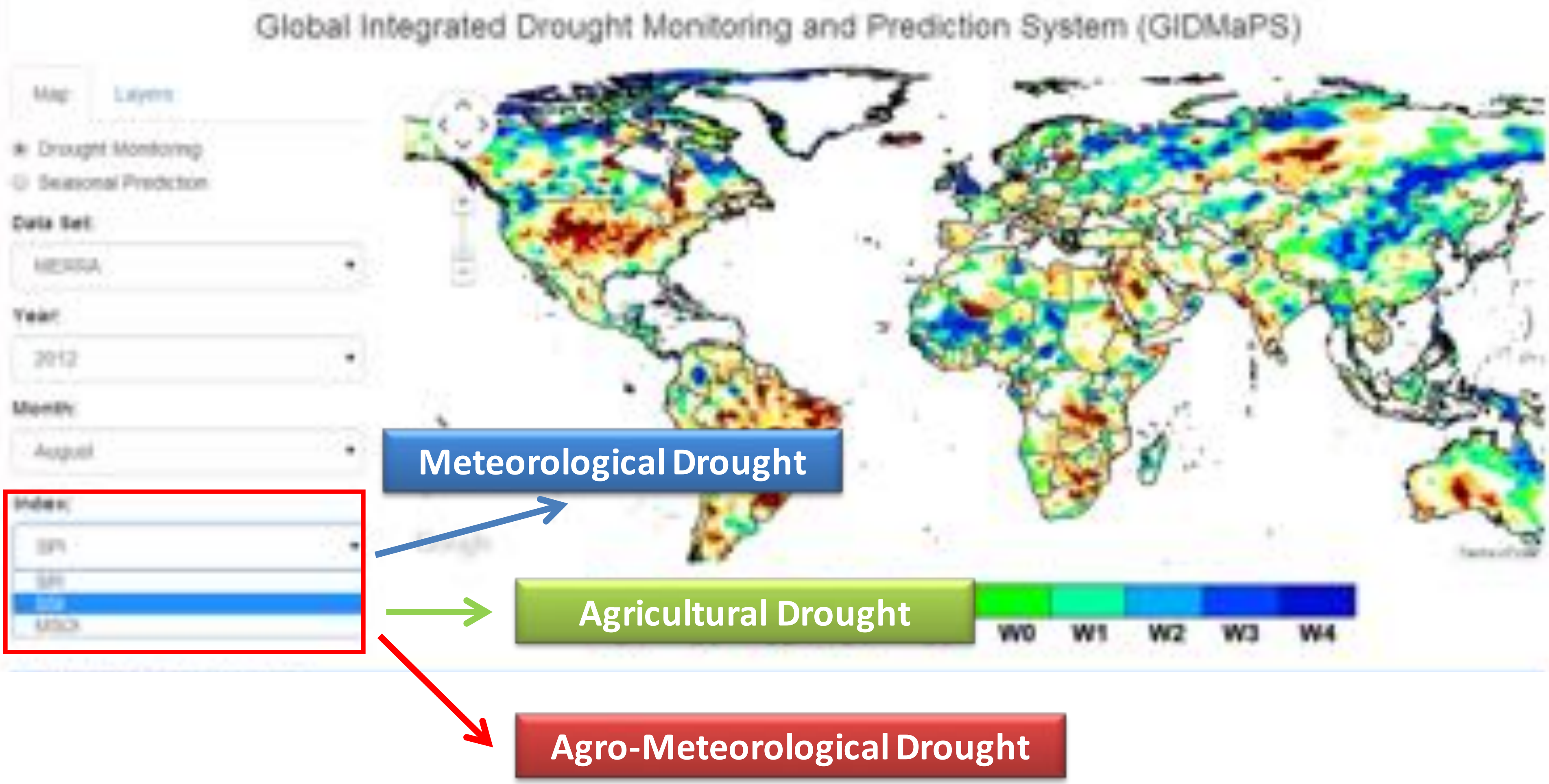
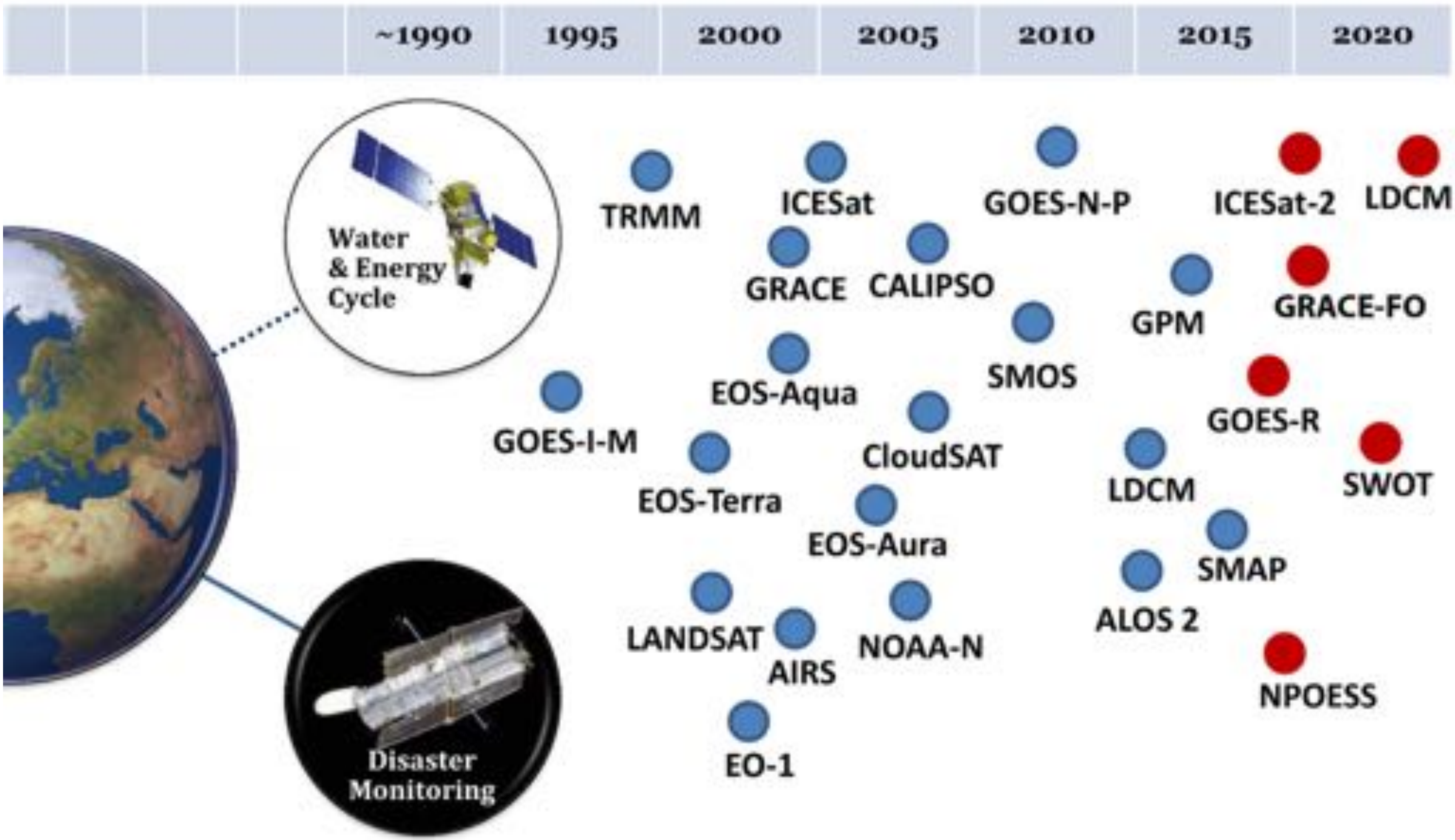
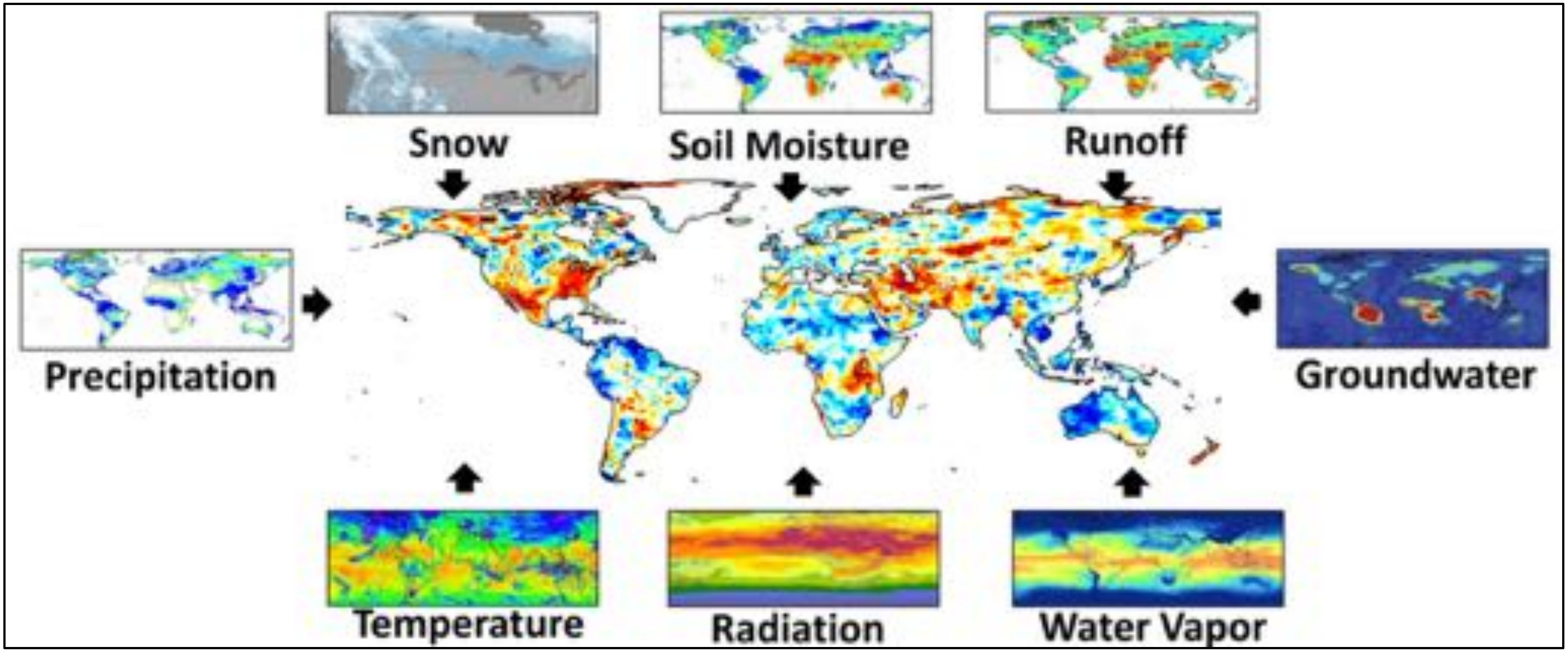


Hao Z., AghaKouchak A., Nakhjiri N., Farahmand A., 2014, Global Integrated Drought Monitoring and Prediction System, *Scientific Data*, 1:140001, 1-10, doi: 10.1038/sdata.2014.1. http://www.nature.com/articles/sdata20141

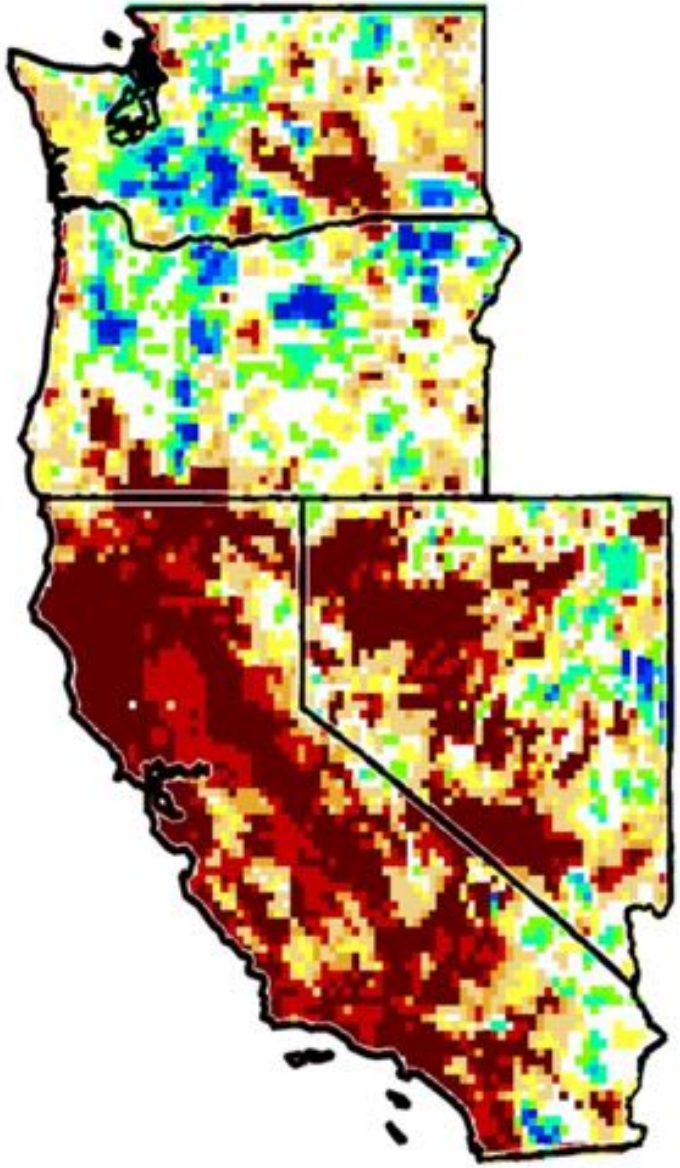
Remote Sensing of Drought

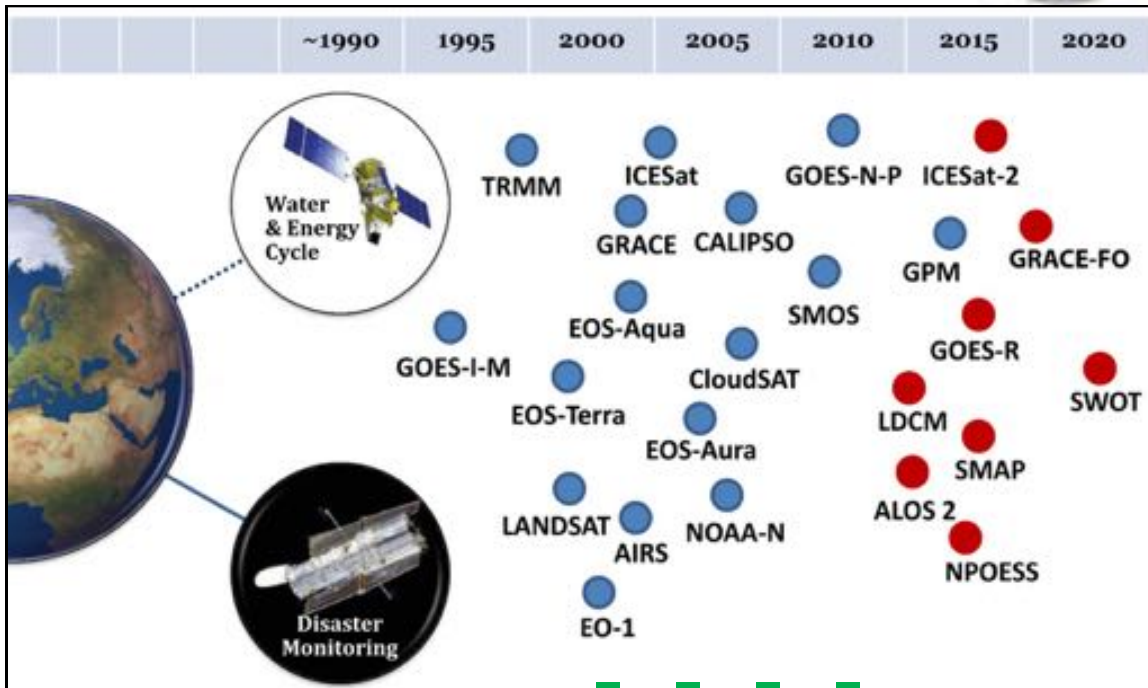


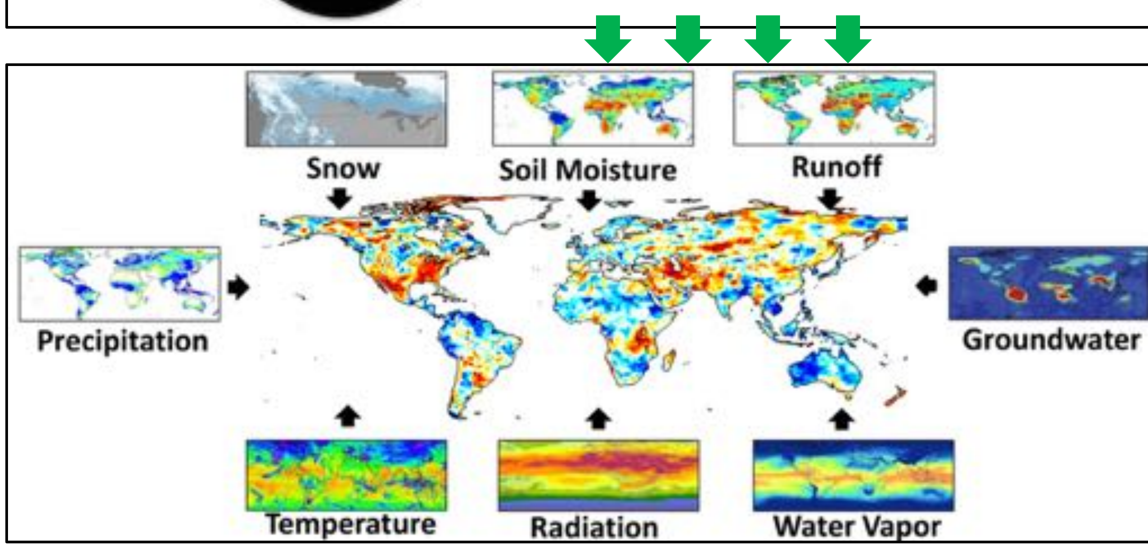


Multi-sensor (multi-index) composite drought monitoring using remote sensing observations

Remote Sensing of Drought



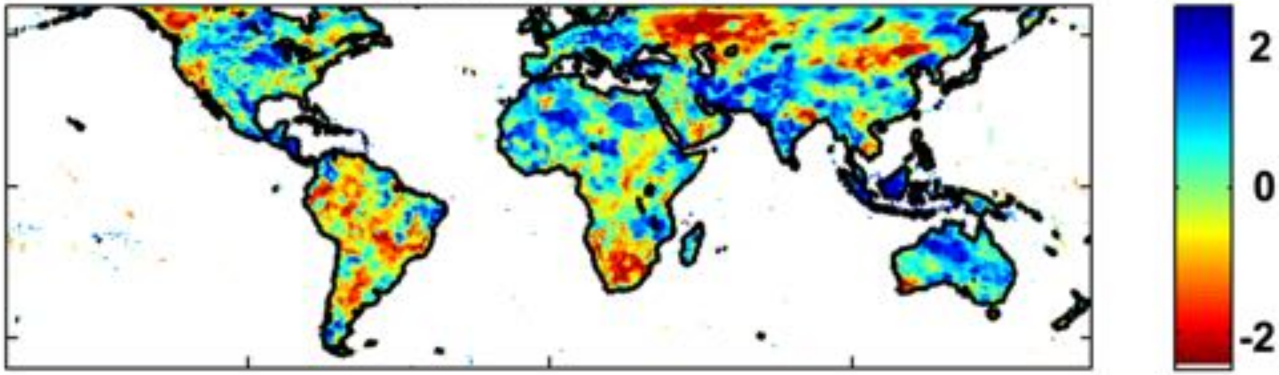




Integration of AIRS Data into GIDMaPS

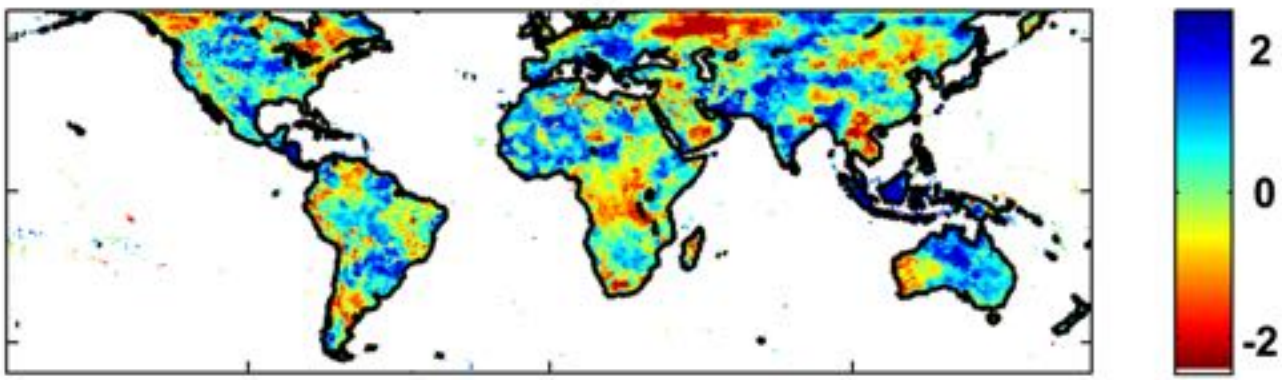
Precipitation (MERRA)

3-month SPI August 2010



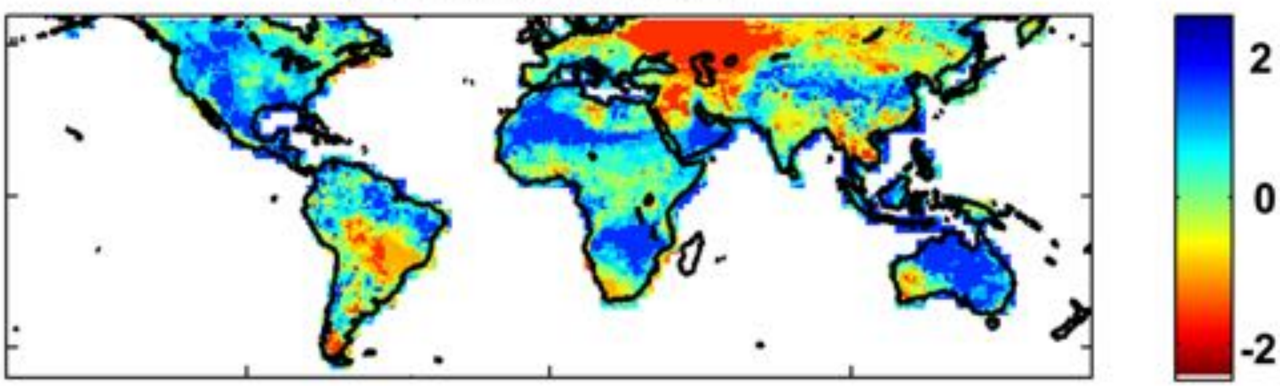
Soil Moisture (MERRA)

3-month SSI August 2010

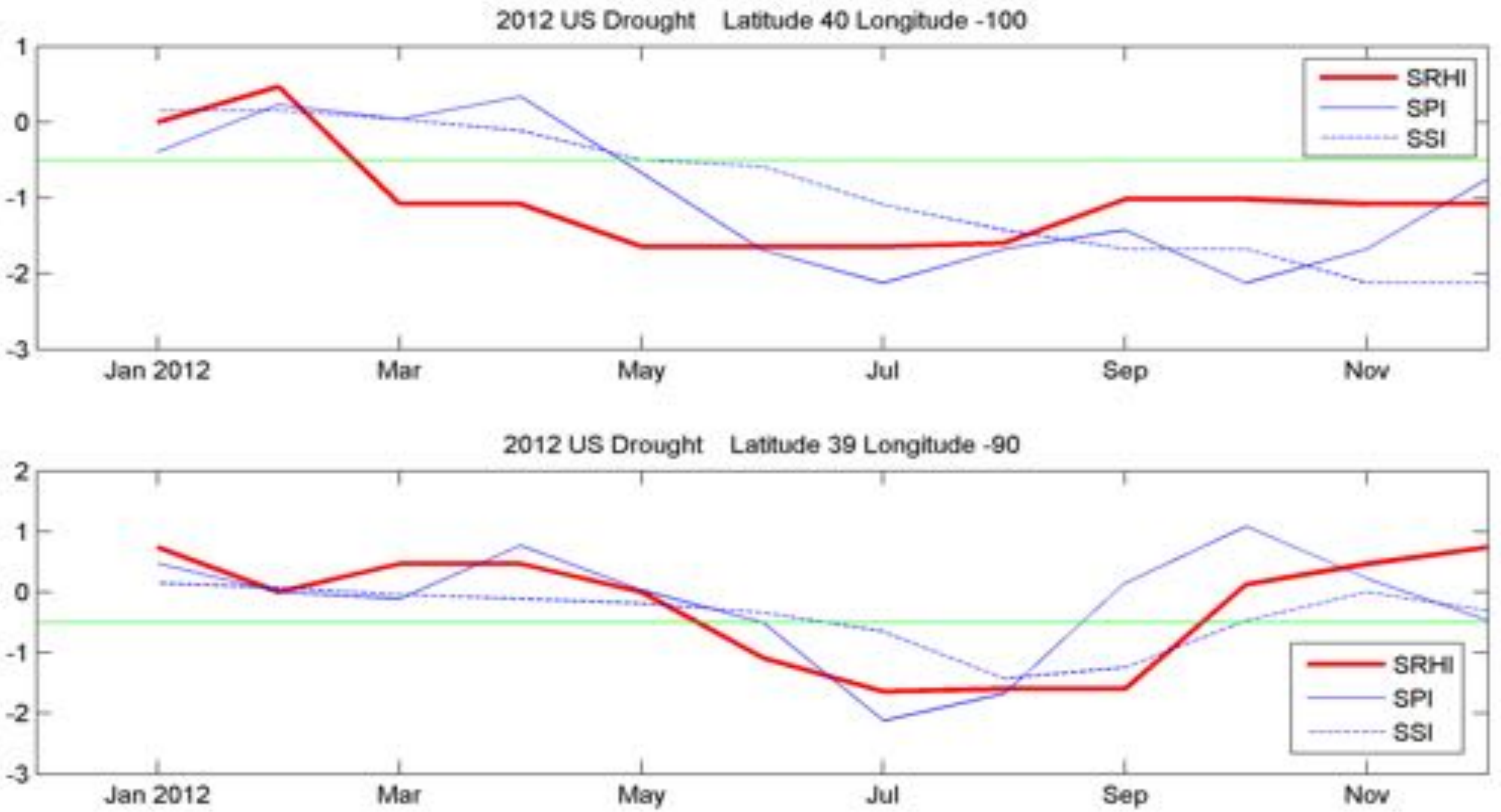


Relative Humidity (AIRS Data)

3-month SRHI August 2010

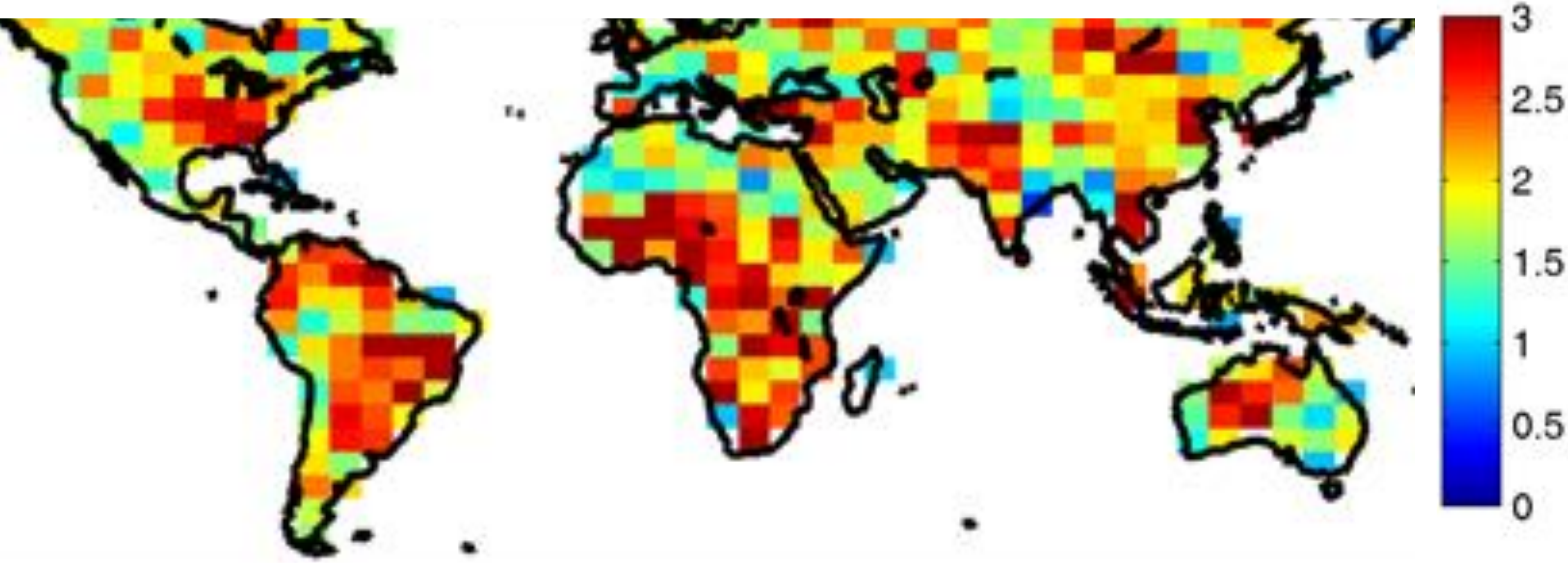


Integration of AIRS Data into GIDMaPS



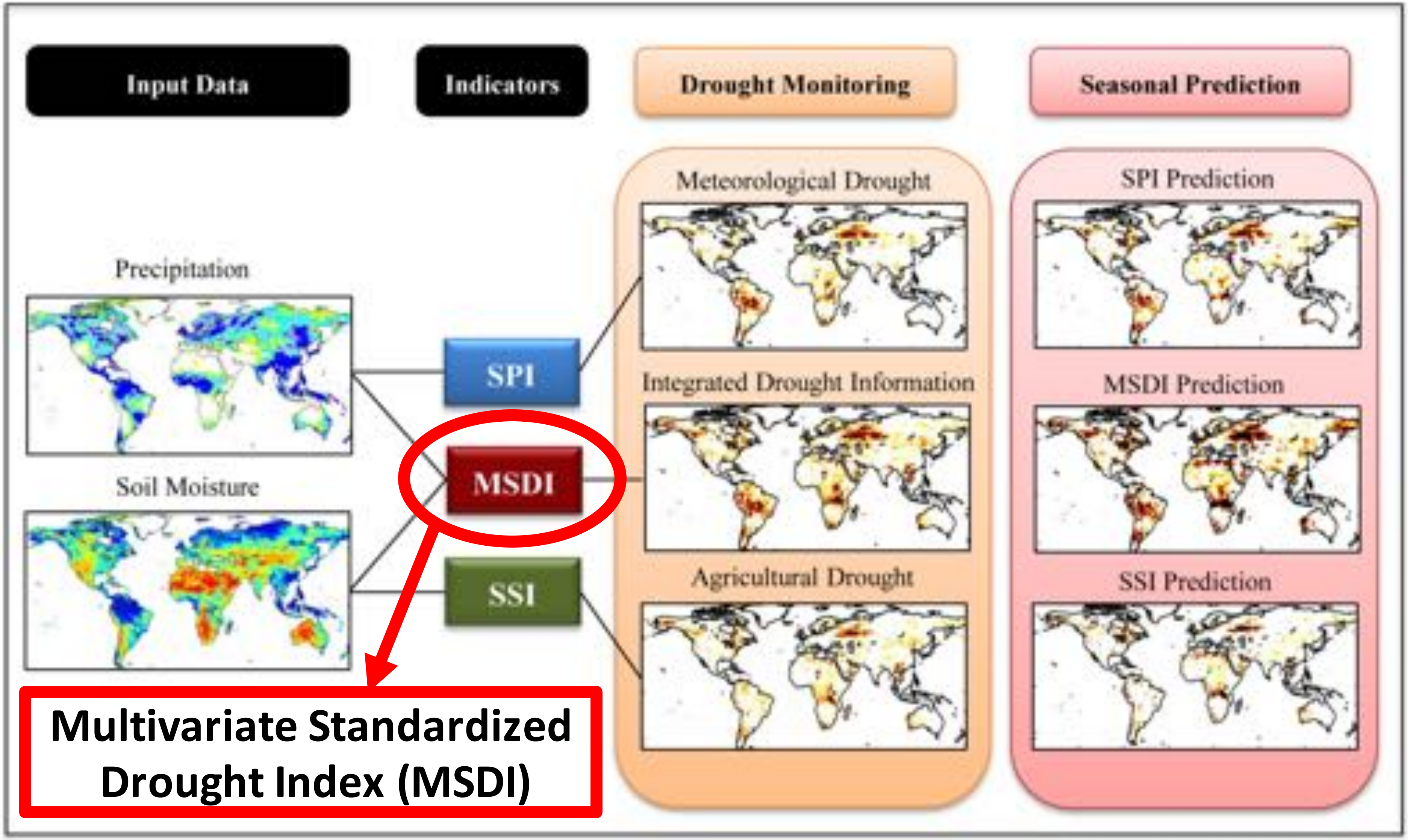
Farahmand et al. 2015; http://www.nature.com/srep/2015/150225/srep08553/full/srep08553.html

Mean lead time based on satellite relative humidity data relative to precipitation (months)

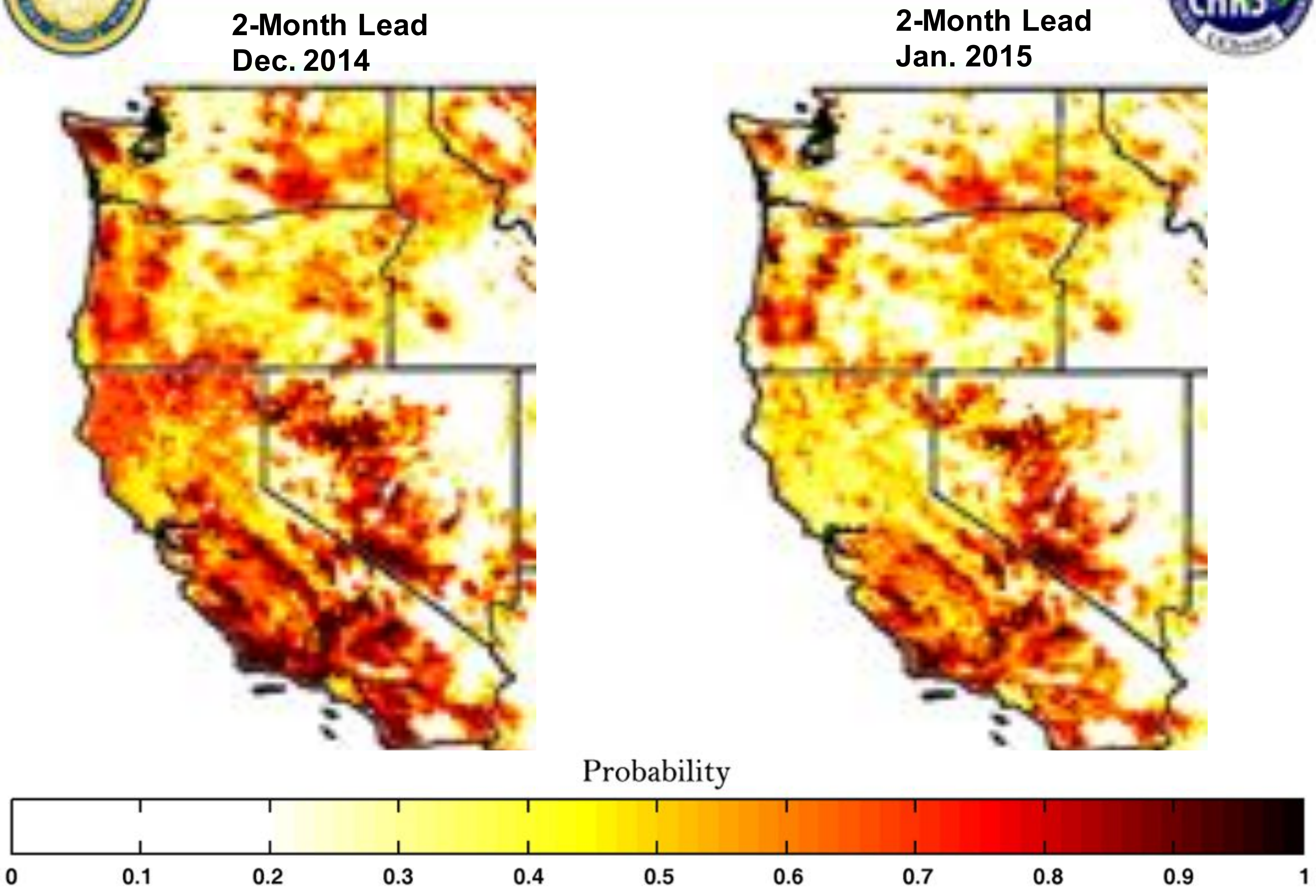


Farahmand et al. 2015; http://www.nature.com/srep/2015/150225/srep08553/full/srep08553.html

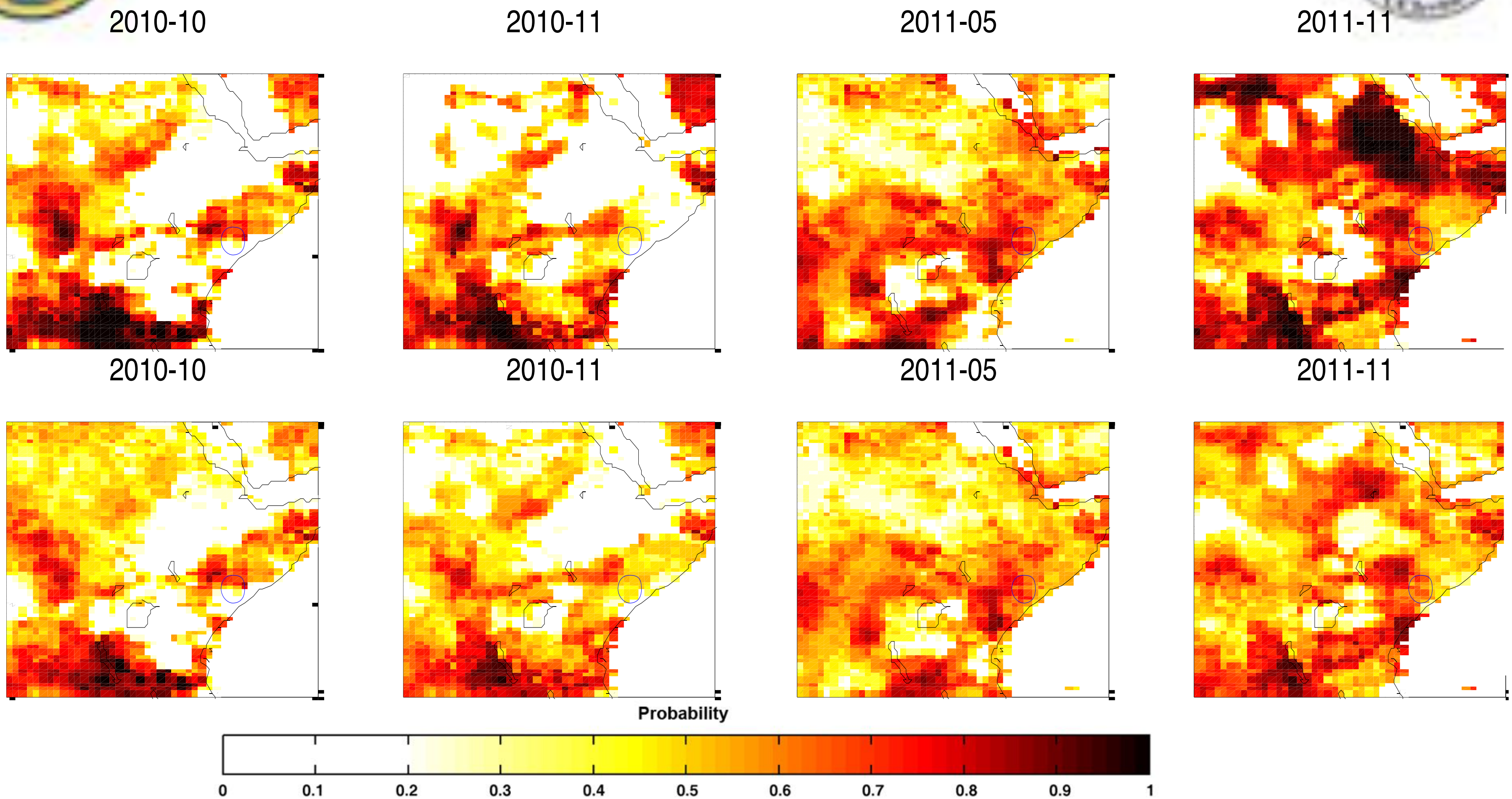
GIDMaPS: Global Integrated Drought Monitoring and Prediction System



Probabilistic Drought Prediction

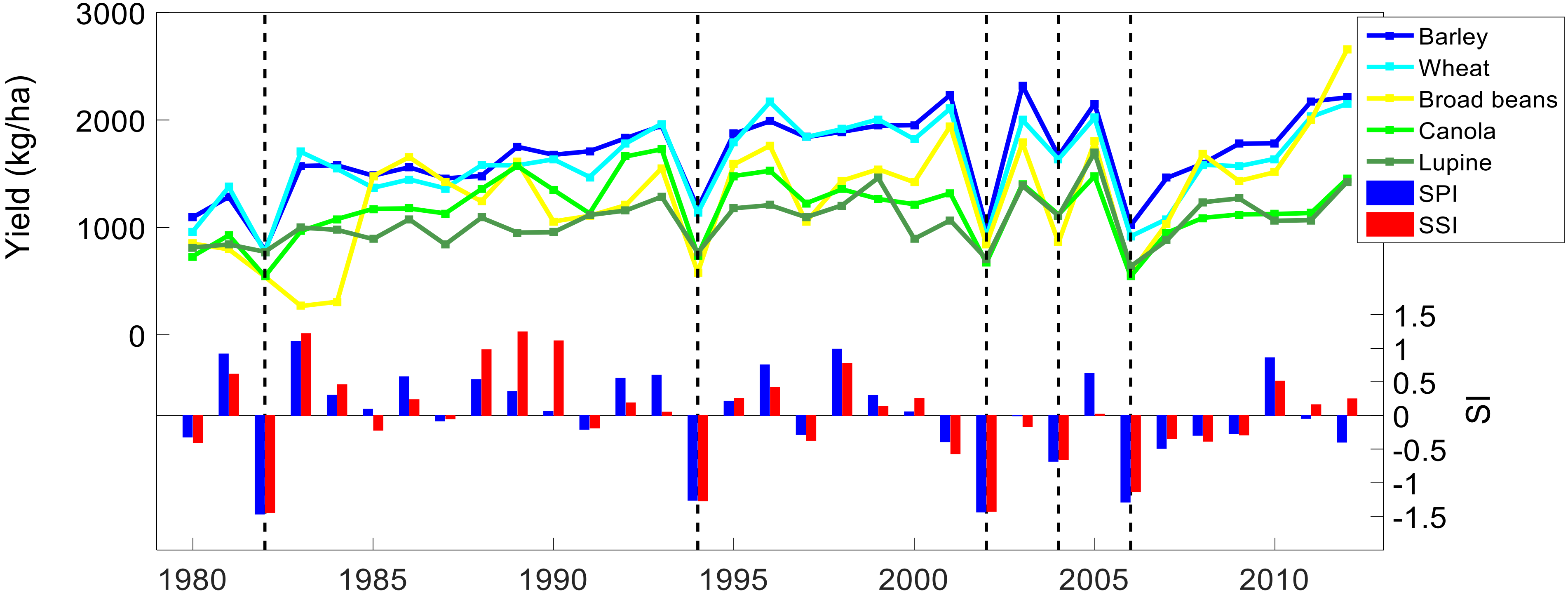


GIDMaPS: Global Integrated Drought Monitoring and Prediction System



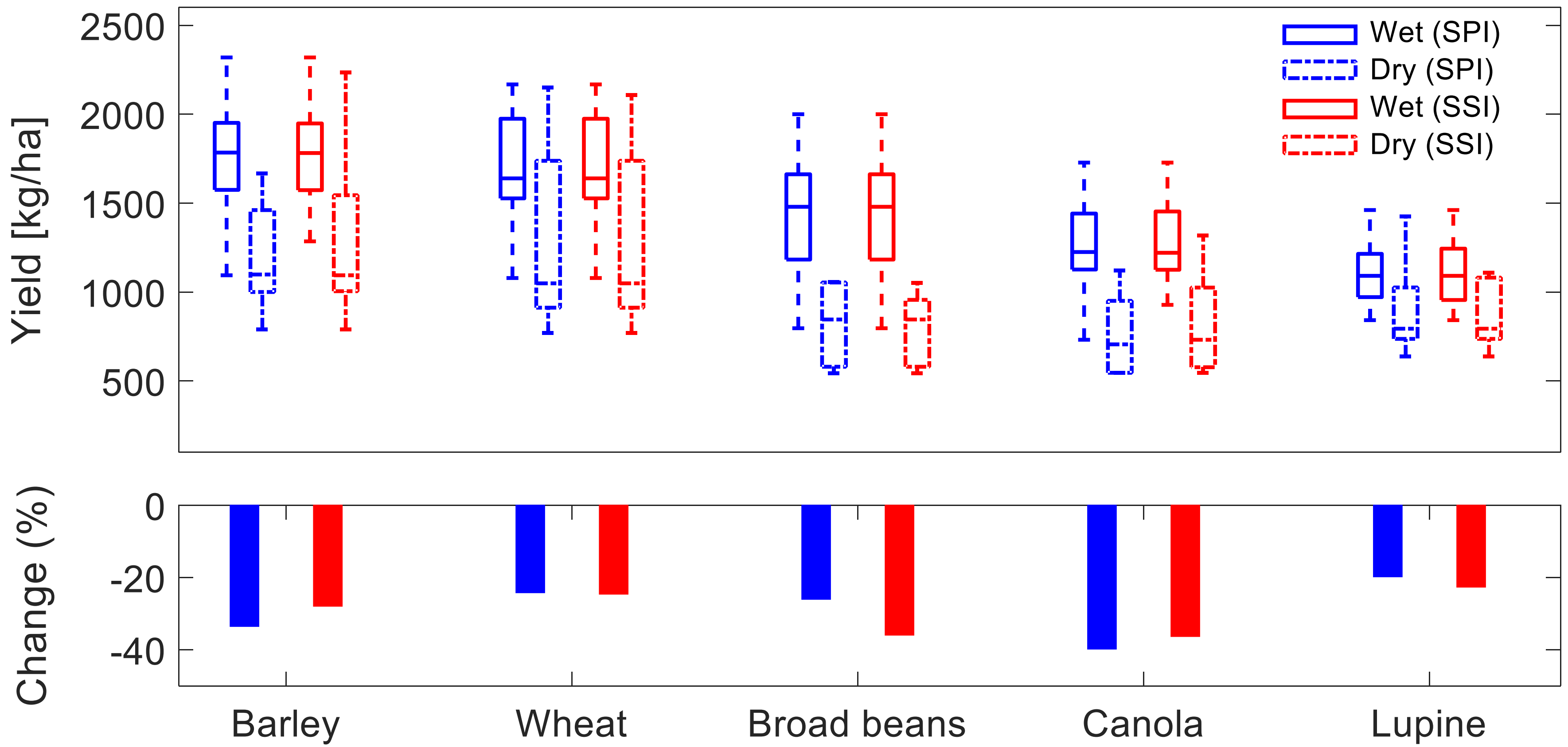
3- and 4-month lead predictions of the ensemble median (top two rows), and their corresponding drought probability (bottom two rows) for a number of time-steps throughout the event. Based on a UNDP report, the first official warning was received December 2010. Our results show high probability of drought 3 to 4 months prior to October 2010 (top left panel).

Linking Drought Information to Crop Yield



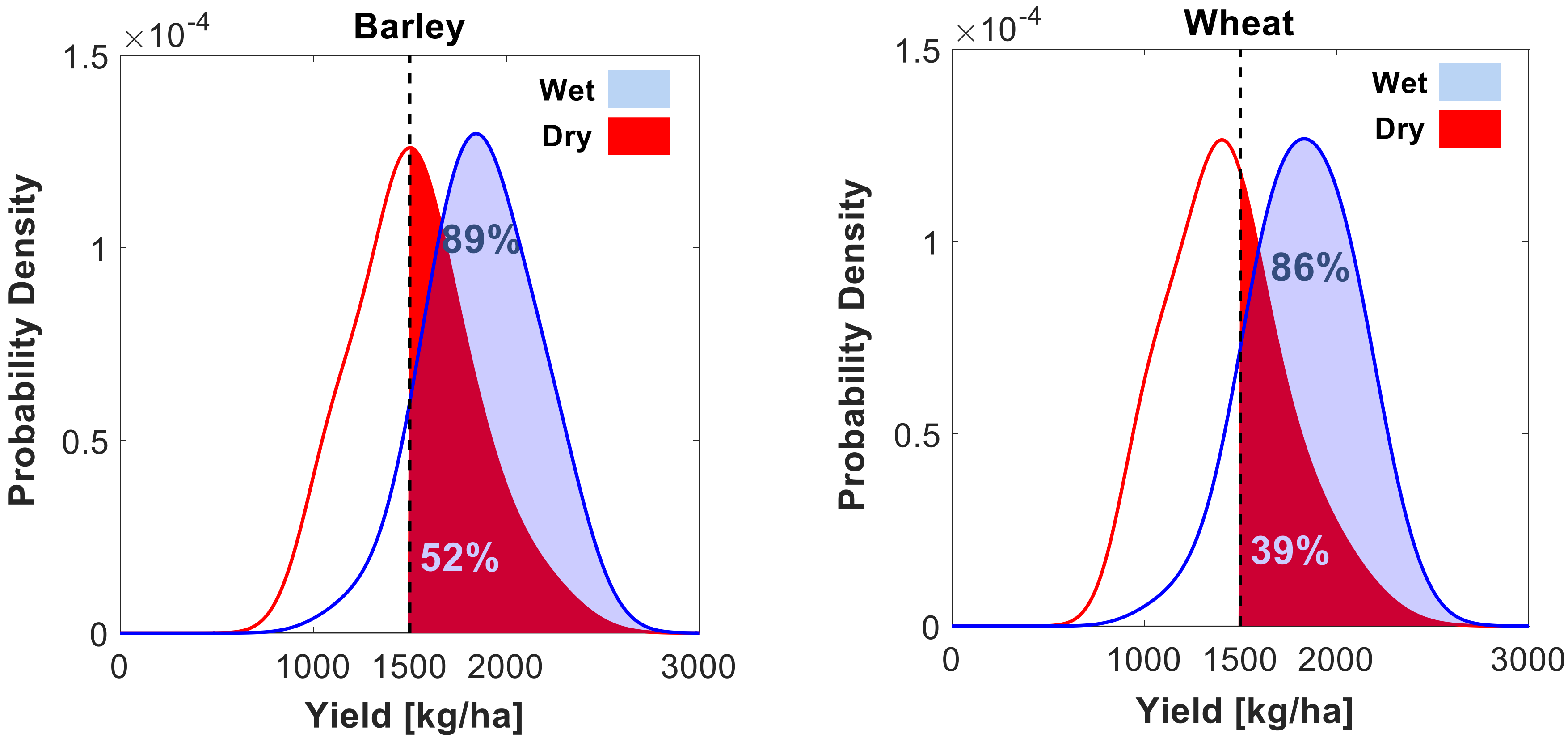
Variation of rain-fed crop yields in Australia versus SPI (blue bars) and SSI (red bars) during 1980-2012. The grey vertical dash lines associate the driest years with their corresponding annual yields.

Linking Drought Information to Crop Yield



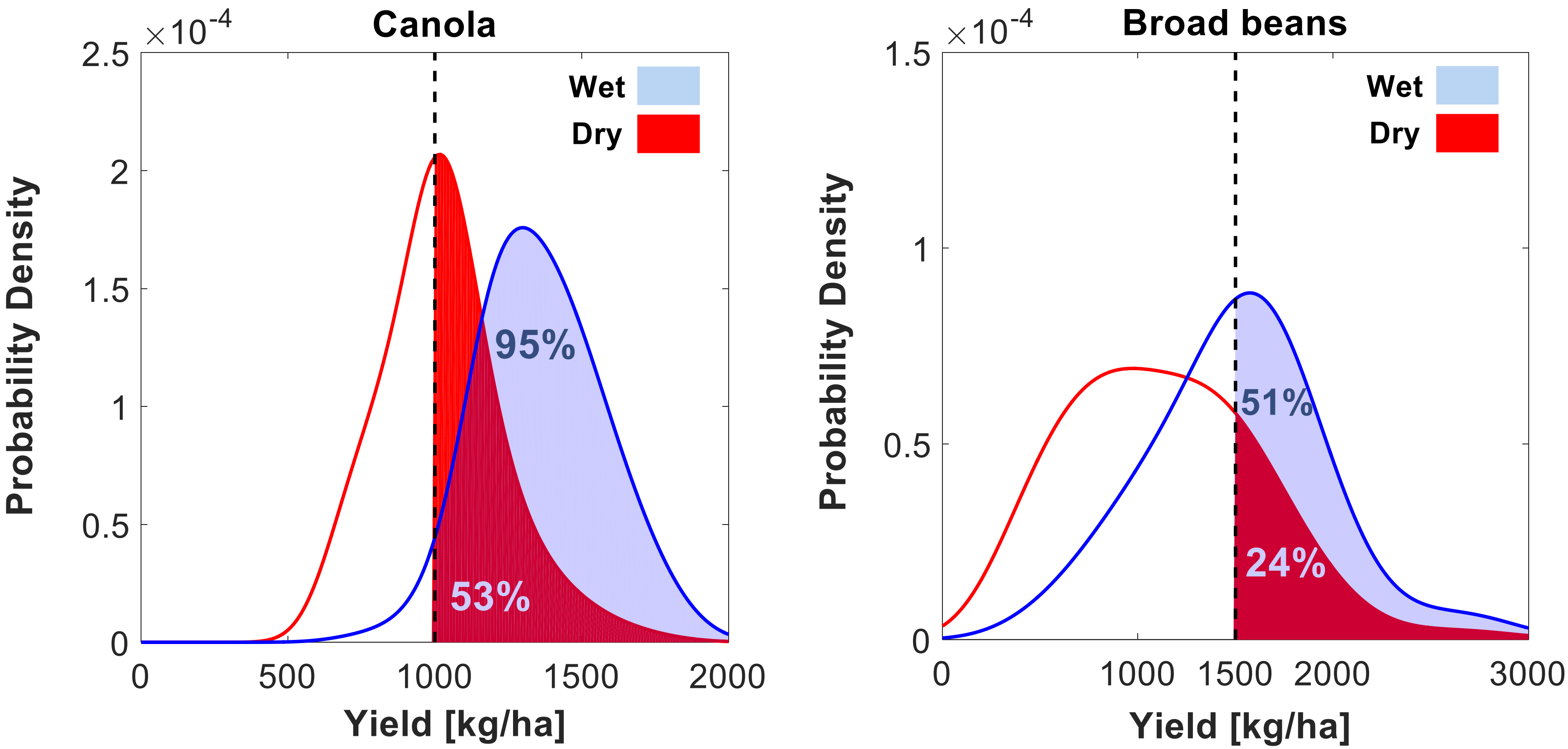
Crop yield distributions for different drought conditions based on SPI (blue boxes and bars), and SSI (red boxes and bars). The solid and dash-lined boxes are associated with wet/normal ($SI > -0.4$) and dry ($SI < -0.4$) conditions, respectively. The bars on the bottom indicate the average change of annual crop yield (in percent) in dry conditions ($SI < -0.4$) relative to wet/normal conditions ($SI > -0.4$) defined based on either SPI (blue) or SSI (red).

Linking Drought Information to Crop Yield



Conditional probability distribution of different crop yields at dry (red curves) and wet (blue curves) conditions. The shaded area and associated numbers indicate the probability (in percent) of annual crop yield exceeding its annual average (vertical dash line). The conditional probabilities are defined as $\Pr(\text{Yield} > y \mid \text{SPI} = \text{x})$

Linking Drought Information to Crop Yield



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Linking Drought Information to Crop Yield

$$F_{XY}(x,y) = C[F_X(x), F_Y(y)]$$

$$F_{Y|X}(Y > y \mid X)$$

Copula	Function	Domain
Gaussian	$C(u_1,u_2)=\int_{-\infty}^{\Phi^{-1}(u_1)}\int_{-\infty}^{\Phi^{-1}(u_2)}\frac{1}{2\pi(1-\rho^2)^{\frac{1}{2}}}\exp\left\{-\frac{x_1^2+x_2^2-2\rho x_1 x_2}{2(1-\rho^2)}\right\}dx_1\,dx_2$ $u_1=\Phi(x_1)$, $u_2=\Phi(x_2)$ ρ : Linear correlation coefficient Φ : Standard normal cumulative distribution function	$x_1, x_2 \in R$
t	$C(u_1,u_2)=\int_{-\infty}^{t_v^{-1}(u_1)}\int_{-\infty}^{t_v^{-1}(u_2)}\frac{1}{2\pi(1-\rho^2)^{\frac{1}{2}}}\exp\left\{1+\frac{x_1^2+x_2^2-2\rho x_1 x_2}{v(1-\rho^2)}\right\}^{-(v+2)/2}dx_1\,dx_2$ $u_1=t_v(x_1)$, $u_2=t_v(x_2)$ ρ : Linear correlation coefficient t_v : Cumulative distribution function of t distribution with v degree of freedom.	$x_1, x_2 \in R$
Clayton	$C(u_1,u_2)=\left(u_1^{-\theta}+u_2^{-\theta}-1\right)^{-1/\theta}$ θ : Measure of dependency between u_1 and u_2.	$\theta \in [0,\infty)$
Frank	$C(u_1,u_2)=-\frac{1}{\theta}\ln\left[1+\frac{(e^{-\theta u_1}-1)(e^{-\theta u_2}-1)}{e^{-\theta}-1}\right]$ θ : Similar to Clayton copula.	$\theta \in R$

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