# AIRS drought application and beyond: Opportunities, challenges, and future direction

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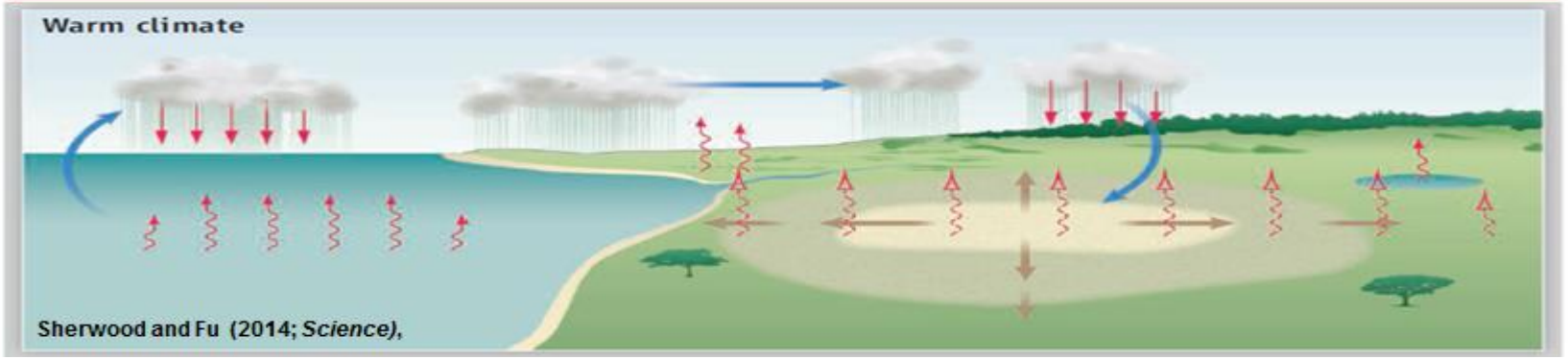
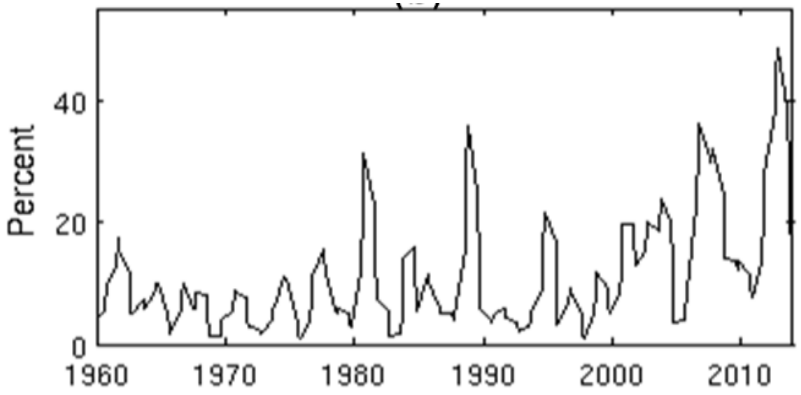
# Why AIRS is important ?

The key factor in drying over land is that land surfaces (and the air just above them) warm, on average, about 50% more than ocean surfaces (M. M. Joshi *et al*. 2008).




**(VPD= $e_s$-e) will increase**

Time series of percent area of CONUS in which 3-month standardized VPD is more than 1.25 standard deviation above normal.

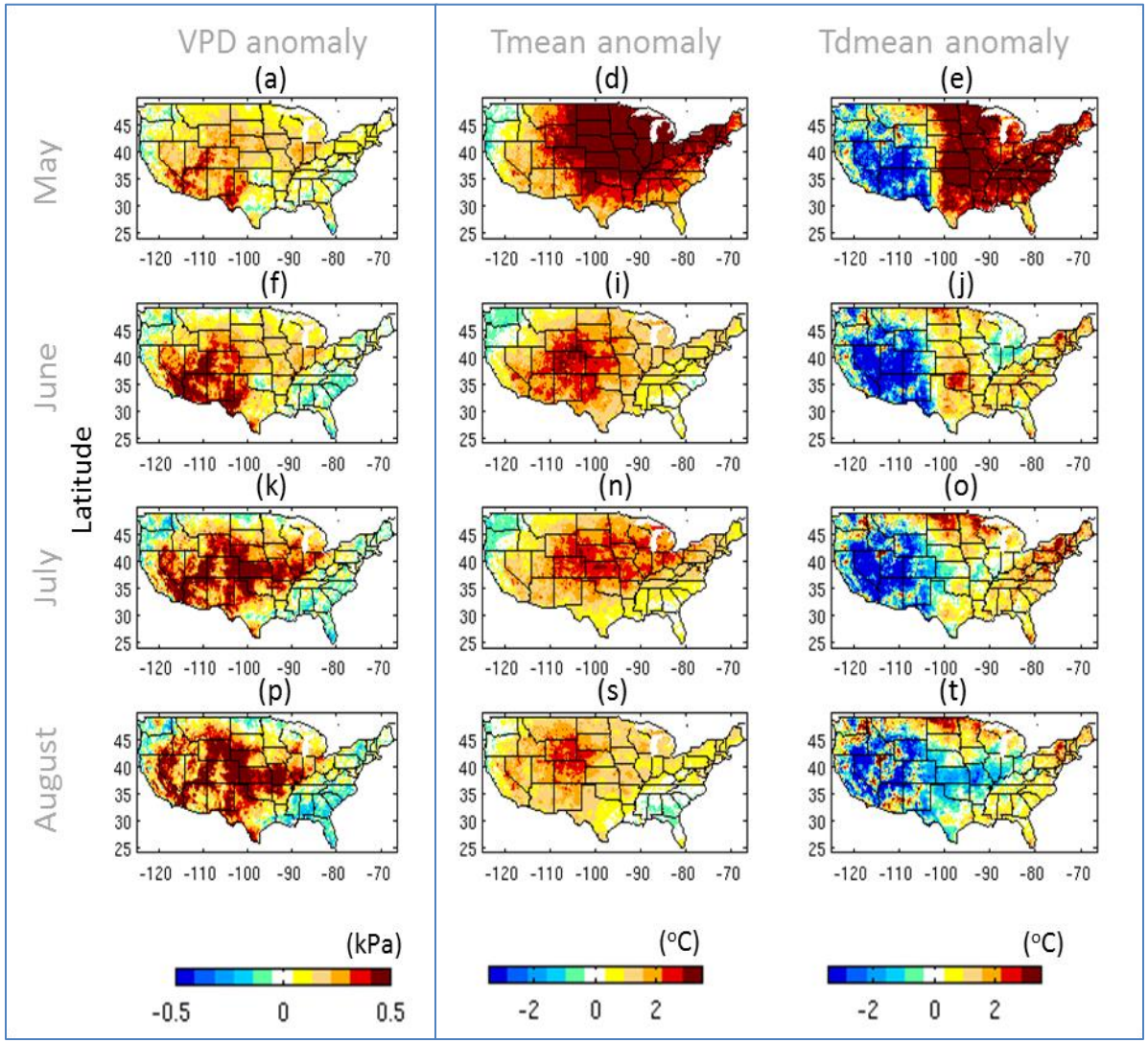



- The analysis of recent observational data shows that associations of ENSO and PDO with U.S. drought have weakened over time (Kam et al. 2014).

- Droughts are becoming less associated with oceanic variability (Kam et al. 2014) [ and more with atmospheric variability]

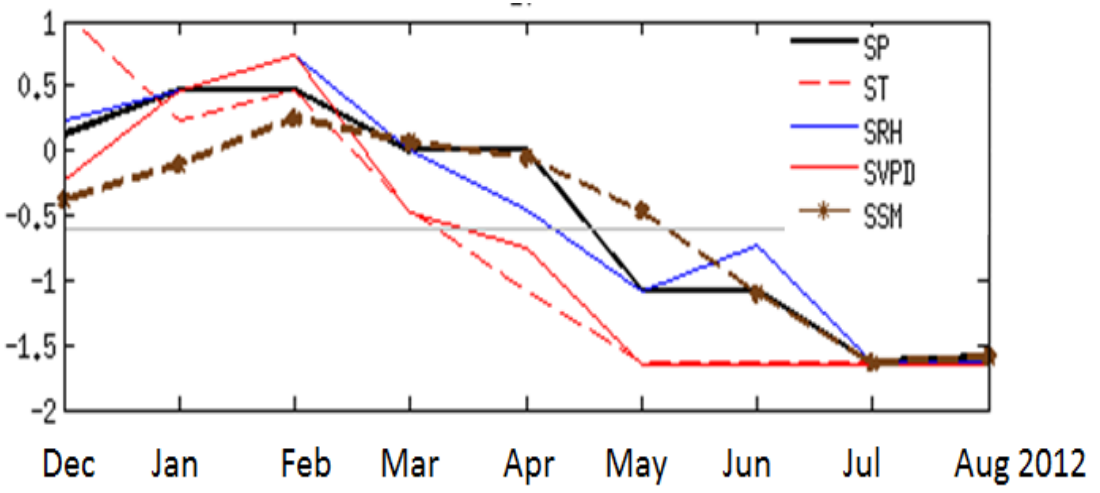
# AIRS help understand drought development processes

## 2012 drought



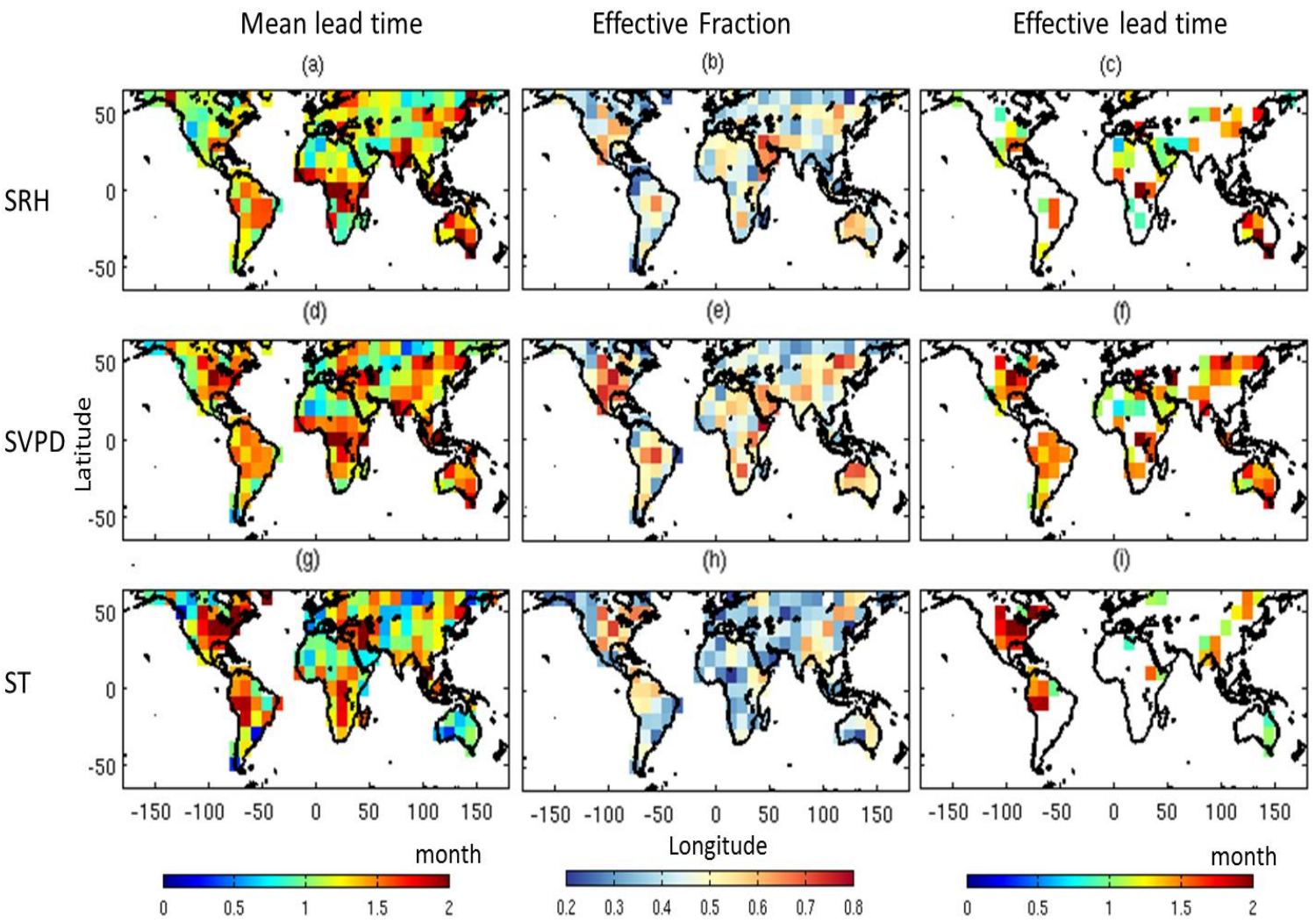

Behrangi, A., P. Loikith, E. Fetzer, H. Nguyen, and S. Granger, 2015: Utilizing Humidity and Temperature Data to Advance Monitoring and Prediction of Meteorological Drought. *Climate*, **3,** 999-1017.

# Early detection of drought onset




Time series of corresponding SP, SRH, SVPD, ST, and SSM for a grid box (latitude 38.5$^{o}$N, longitude 103.5$^{o}$W) at the central US during the 2012 drought. SSM is calculated from MERRA and the rest of the indices are calculated from PRISM.

# Early detection of drought onset

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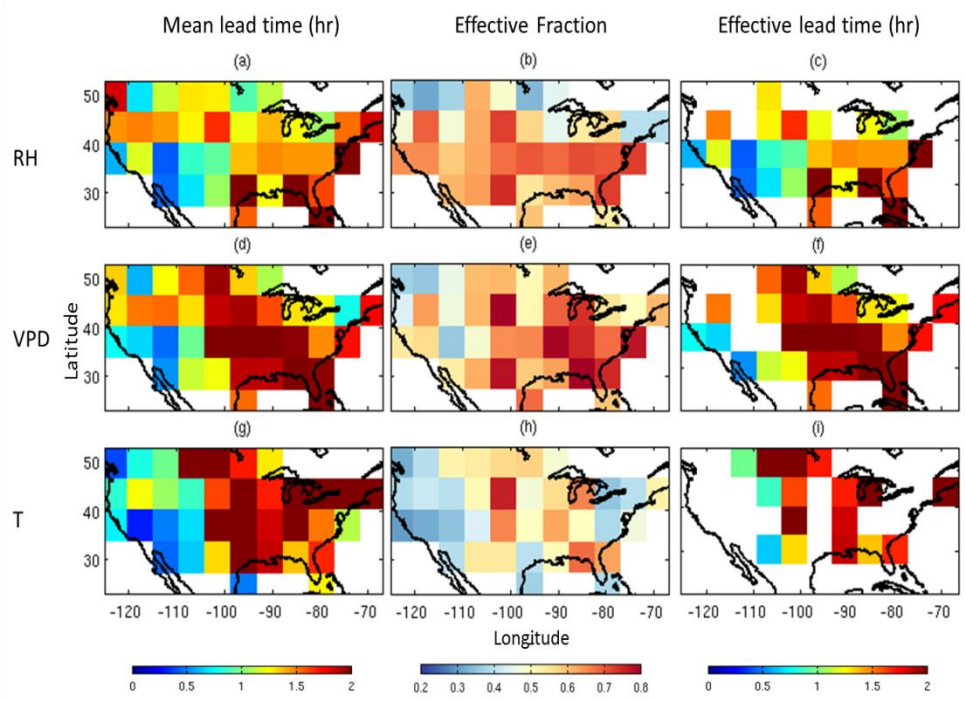
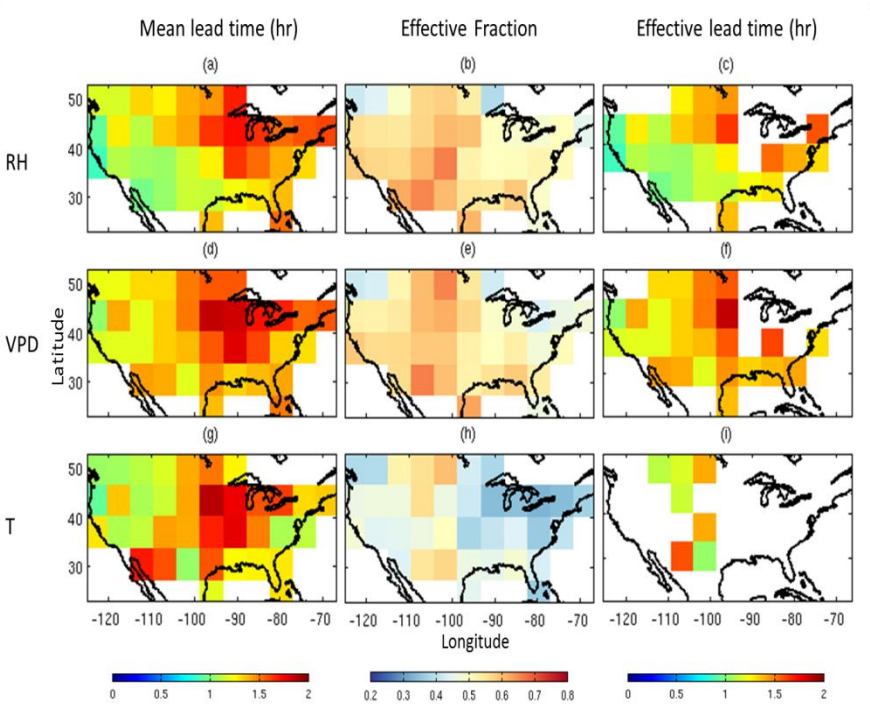
# The length of data record matters

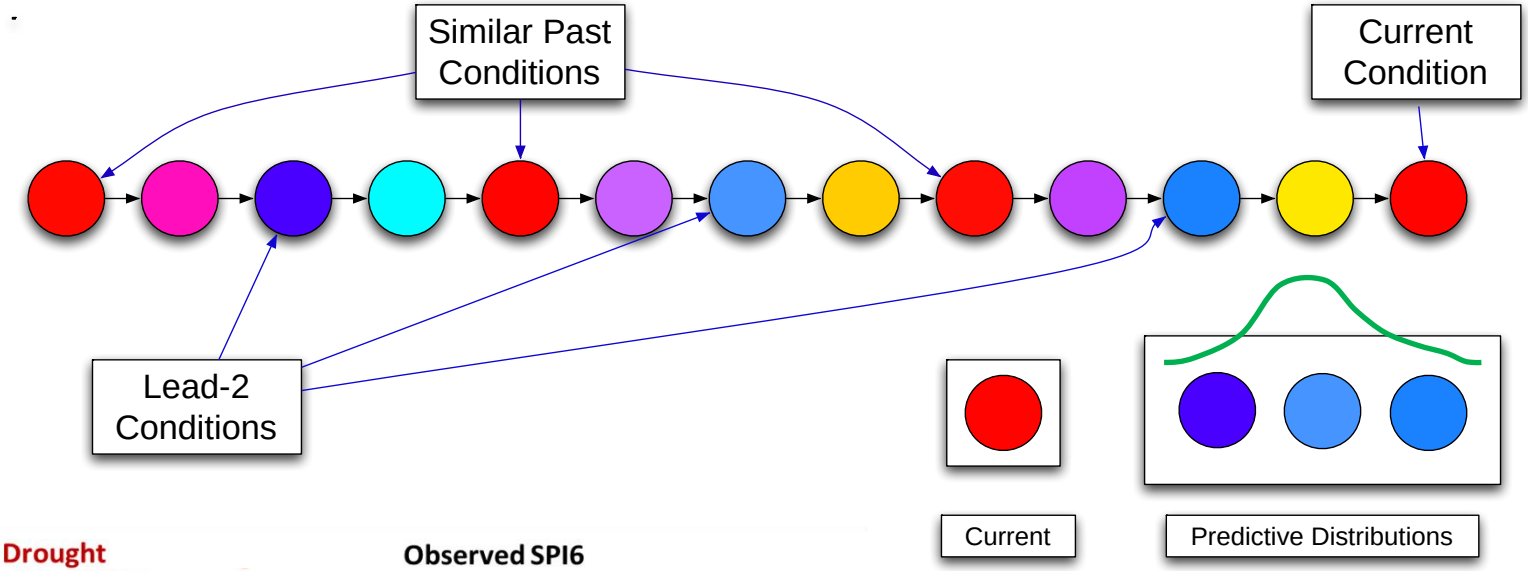


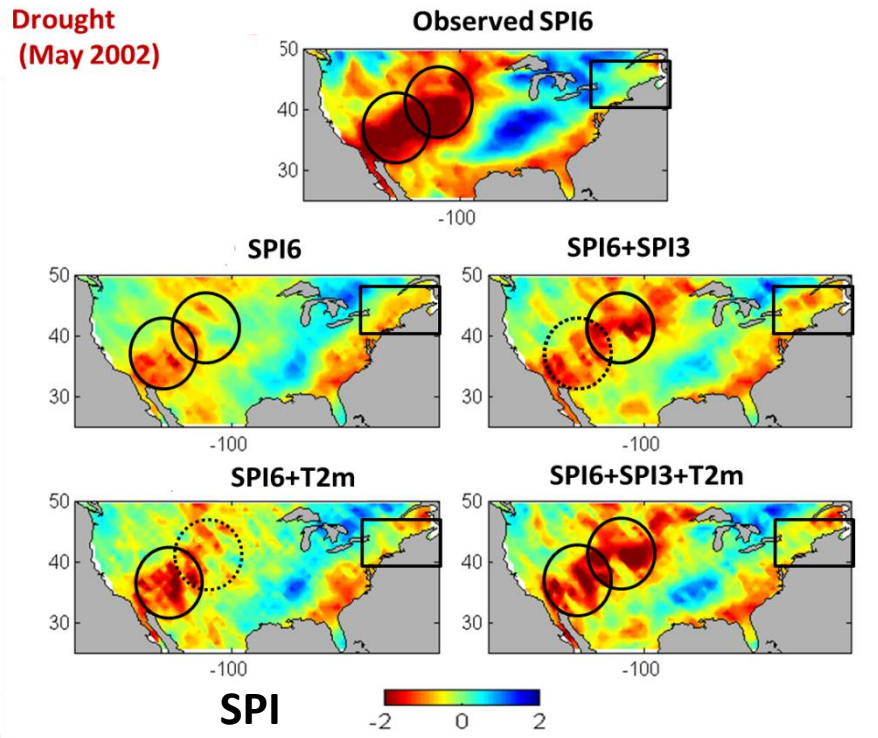

Constructed from 12 years (2003-2014) of PRISM data.




Similar to figure at left, but constructed from 65 years (1960-2014) of PRISM data.

# Temperature is important for Seasonal precipitation forecast




**3 month lead** predictions based on initial conditions in February 2002

Behrangi, A., H. Nguyen, and S. Granger, 2015: *Probabilistic Seasonal Prediction of Meteorological Drought Using the Bootstrap and Multivariate Information*. Journal of Applied Meteorology and Climatology, **54,** 1510-1522.

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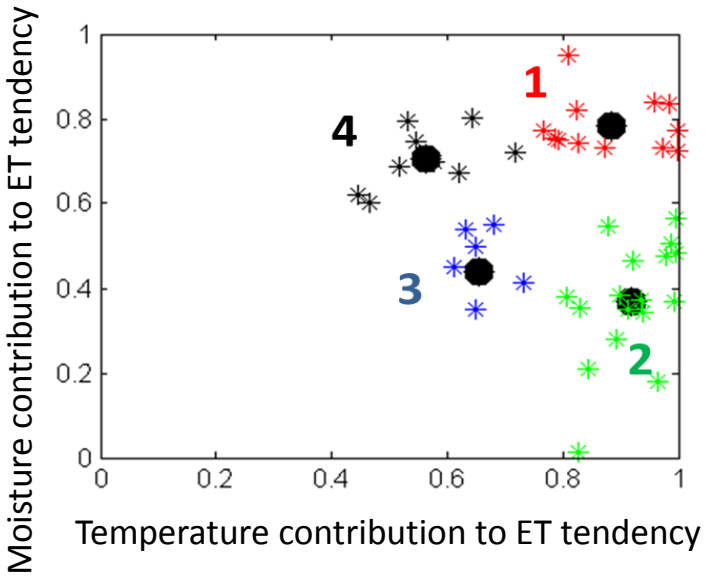
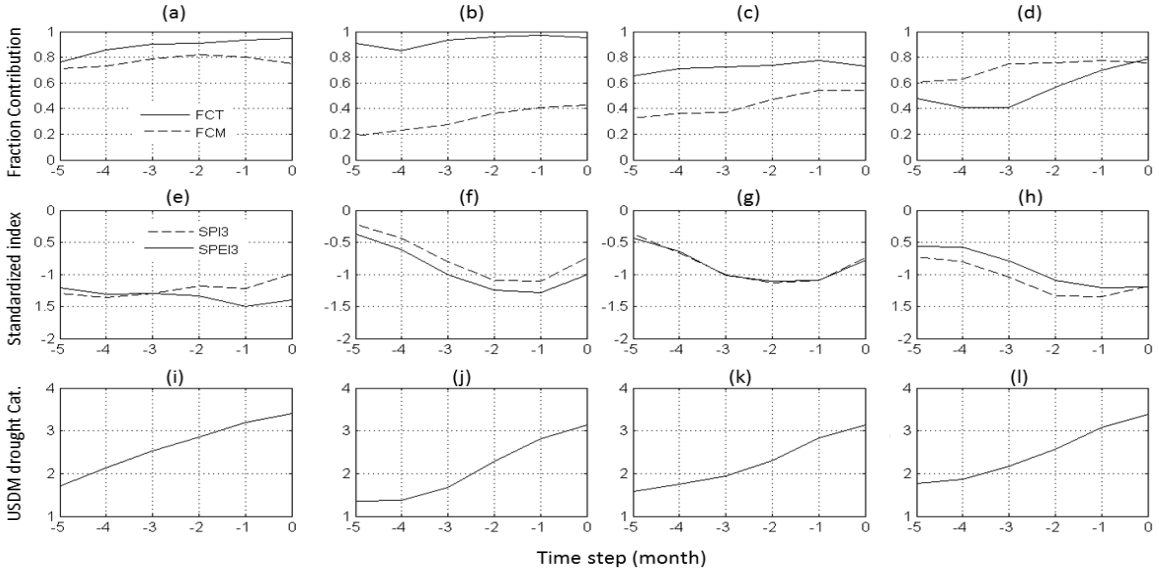
# AIRS to understand the environment of drought




SPI/SPEI

USDM

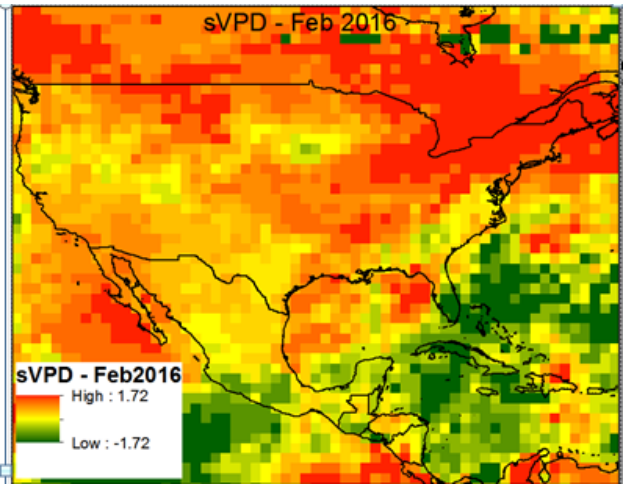


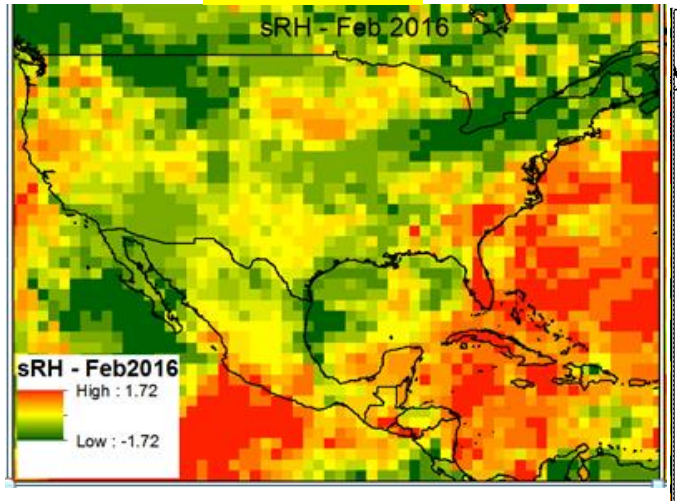

Behrangi, A., P. Loikith, E. Fetzer, H. Nguyen, and S. Granger, 2015: Utilizing Humidity and Temperature Data to Advance Monitoring and Prediction of Meteorological Drought. *Climate*, **3,** 999-1017.

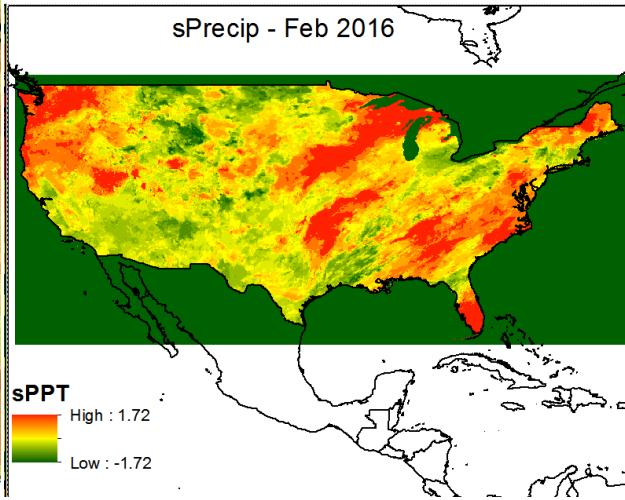
# Application :
# Opportunities and challenges

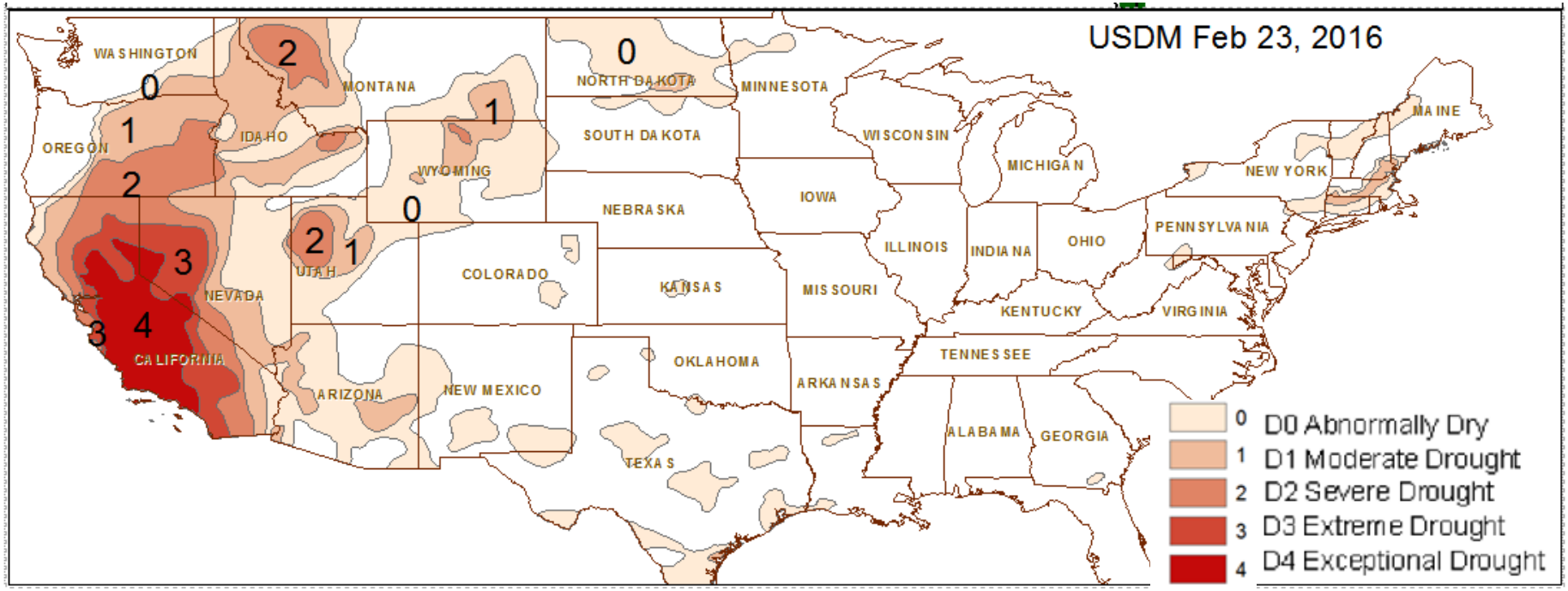
# AIRS and US drought monitor (USDM )

**Feb 2016**



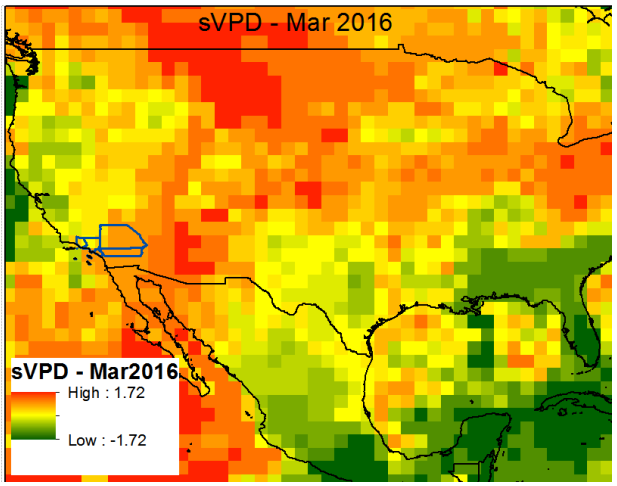



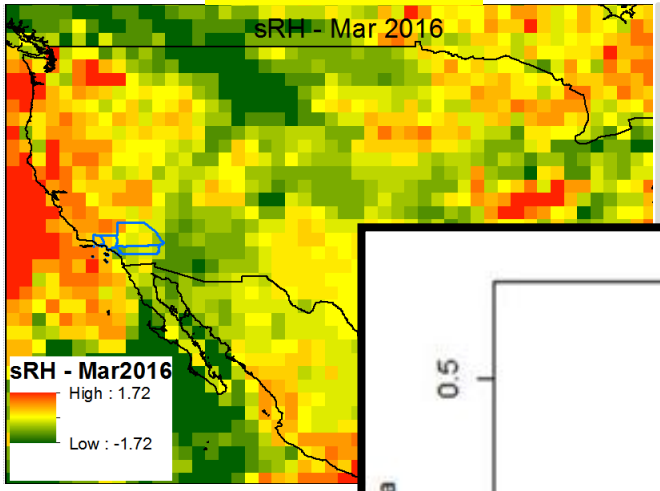



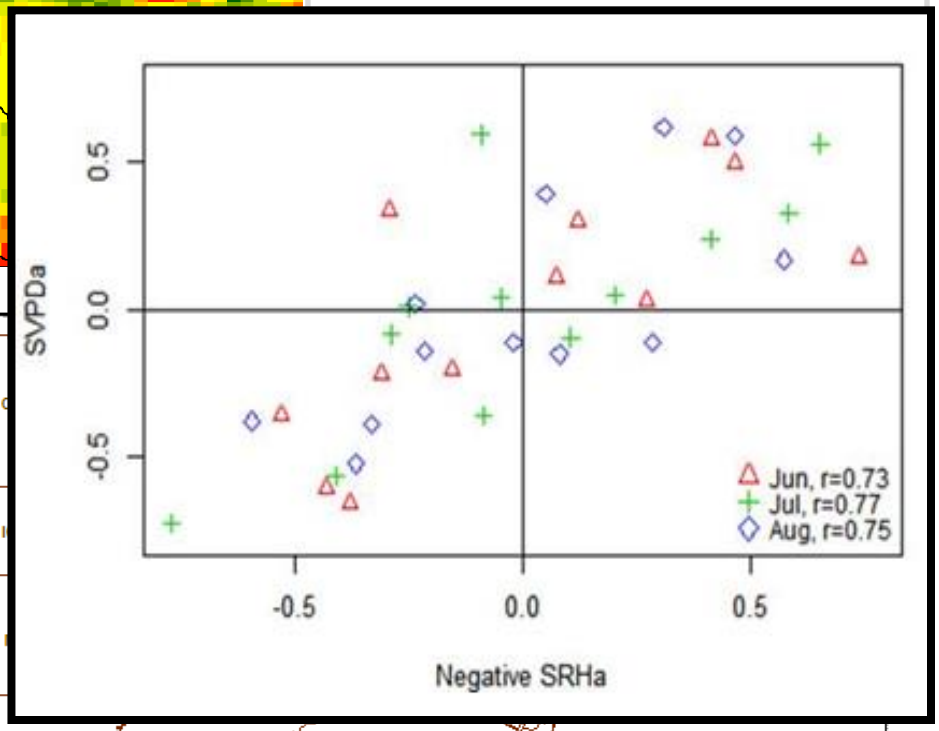
# AIRS and US drought monitor (USDM )

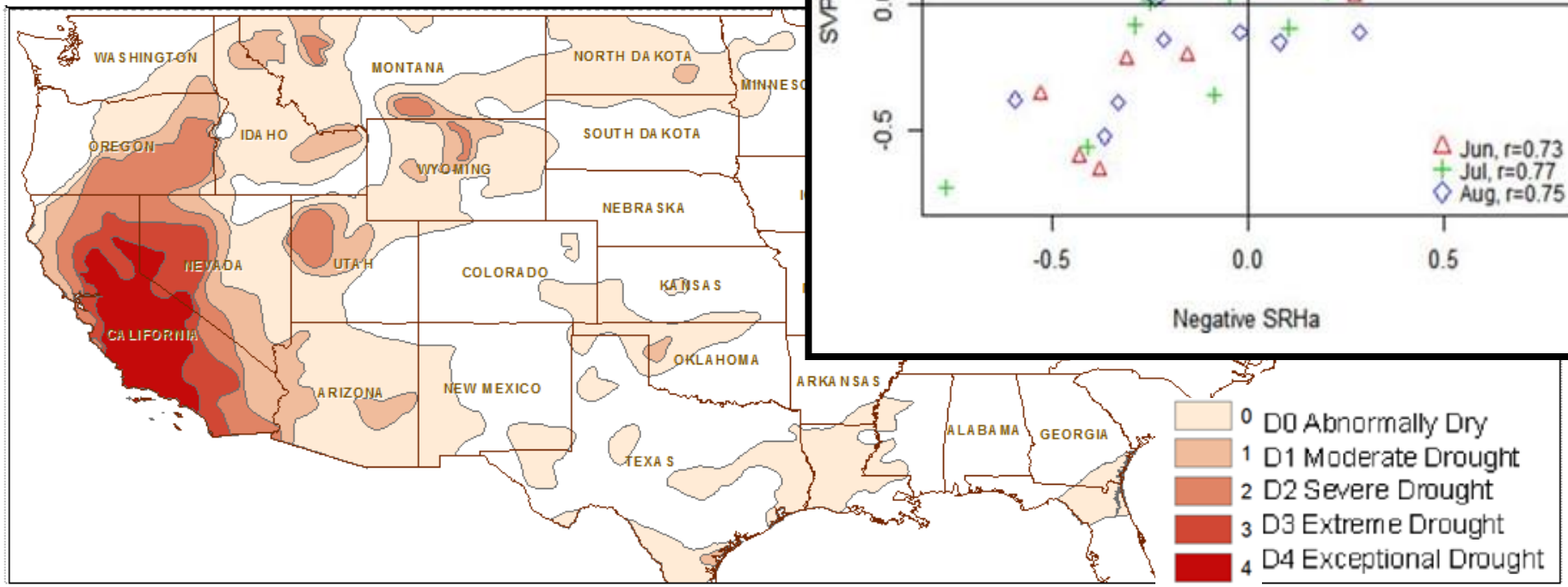
March 2016 precip.
Not available yet

**March 2016**

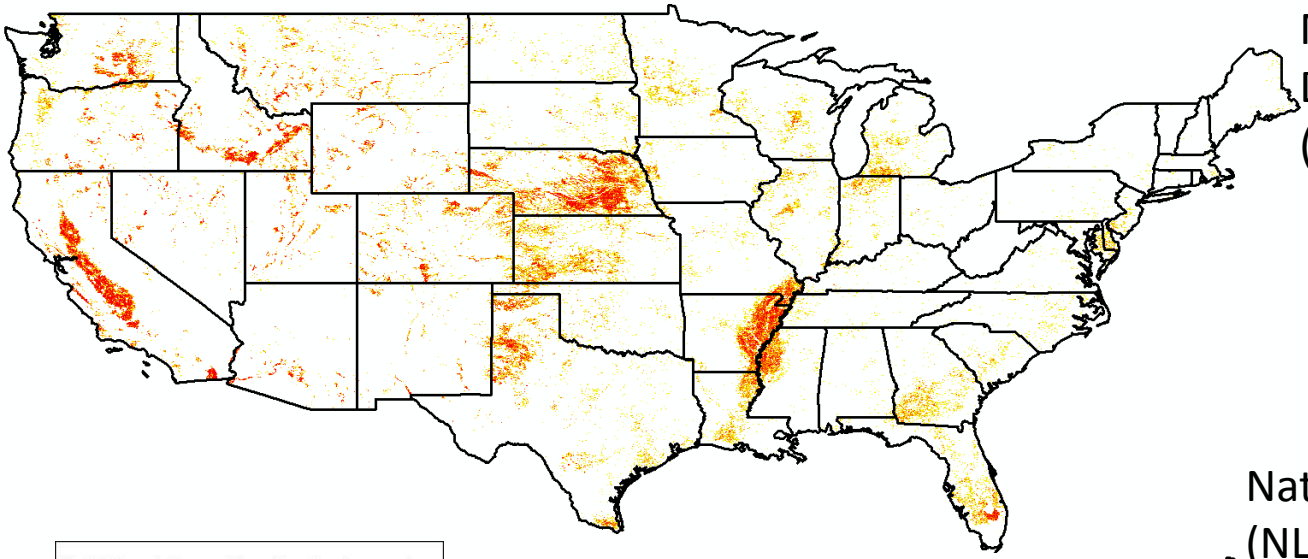


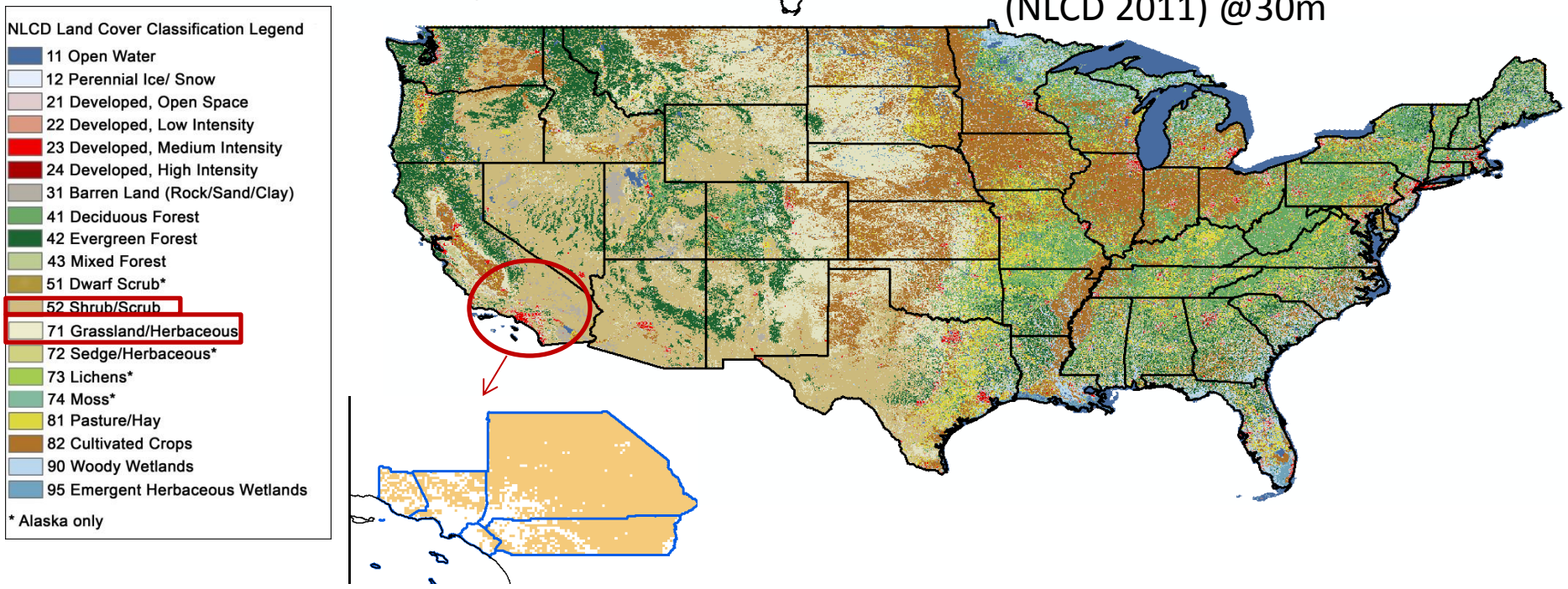



# Human impact: Irrigated and non-irrigated regions

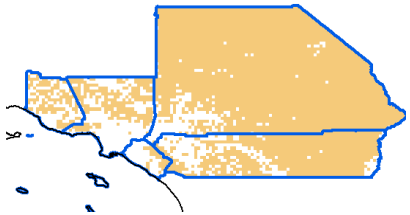


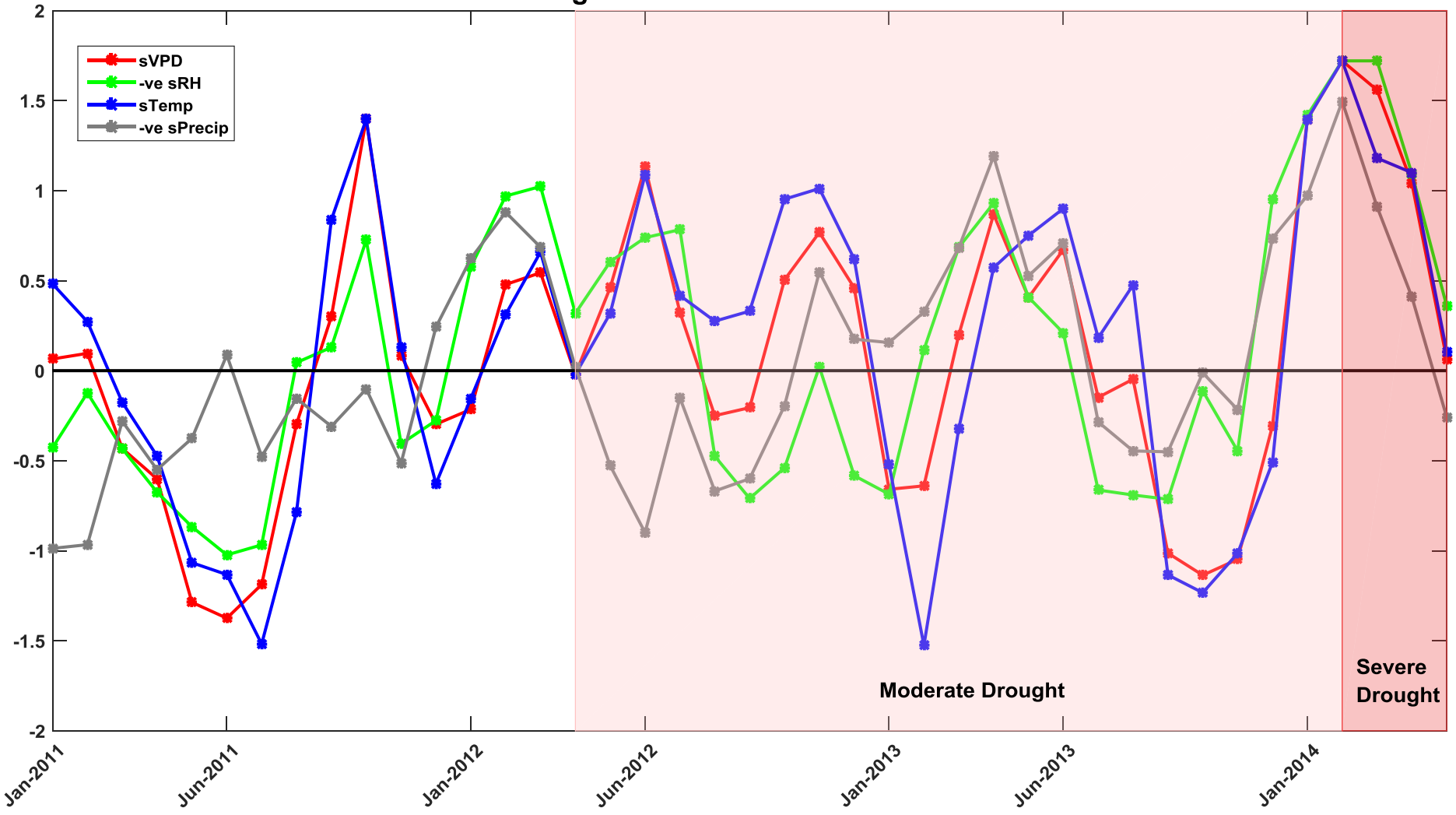
MODIS Irrigated Agriculture Dataset for the U.S. (MIrAD-US 2012) @250m,1km

National Land Cover Dataset (NLCD 2011) @30m

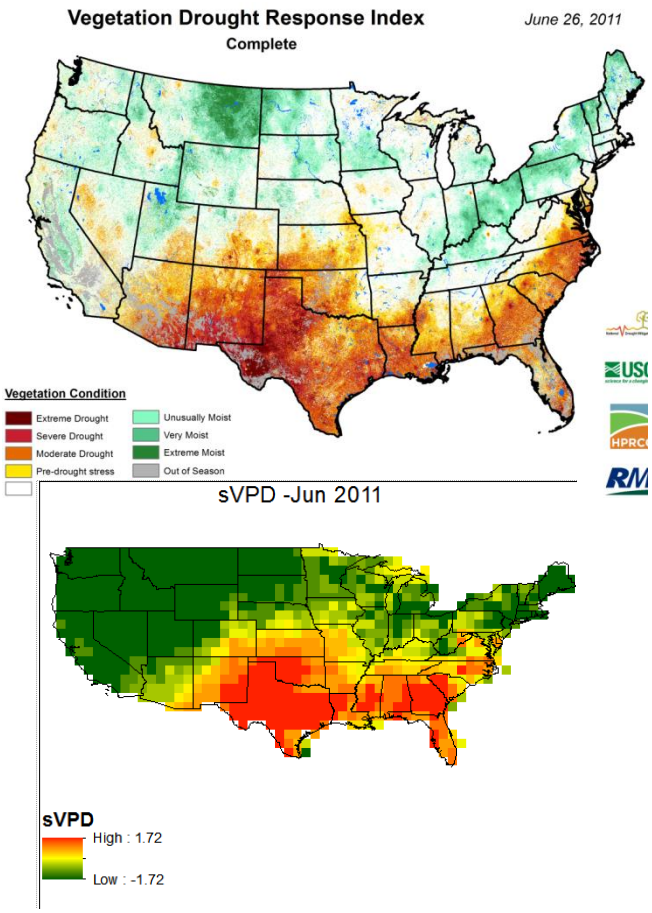


# AIRS should contribute to USDM

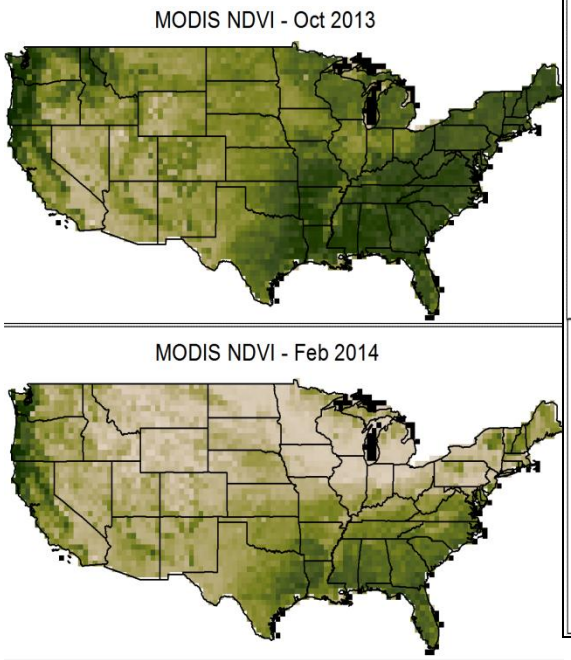




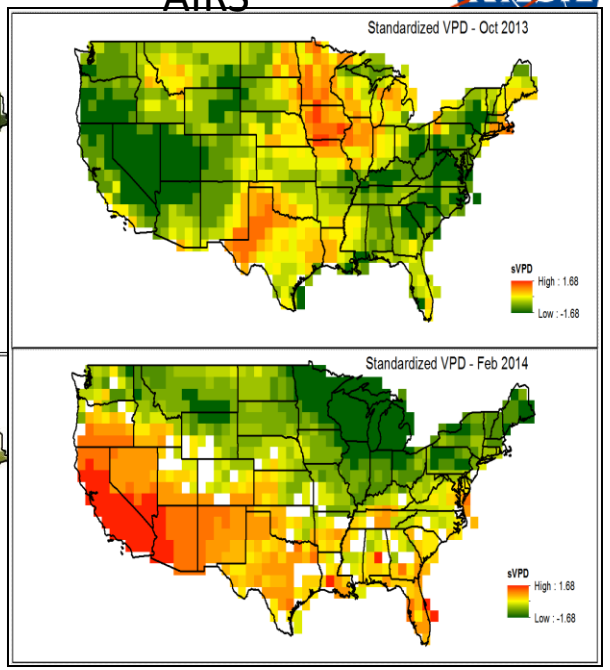
# Impact on vegetation dryness




Annual burned forest area *v.* mean March–August VPD in SW forest area during 1894–2013. The figure is from Williams et al. (2014a)



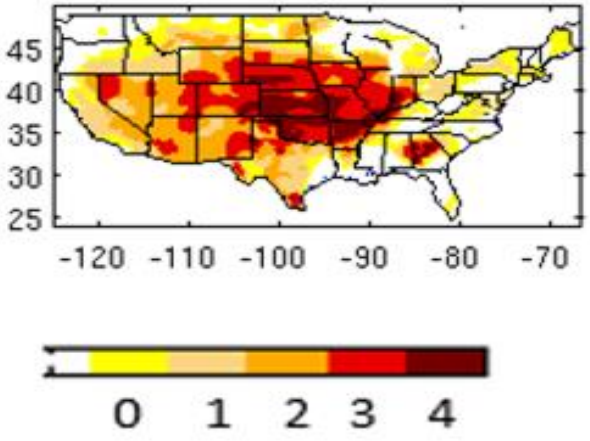

AIRS



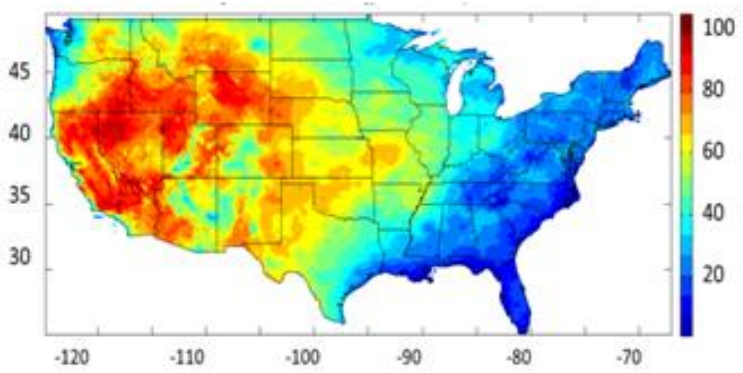
# VPD and Fire danger

August 2012

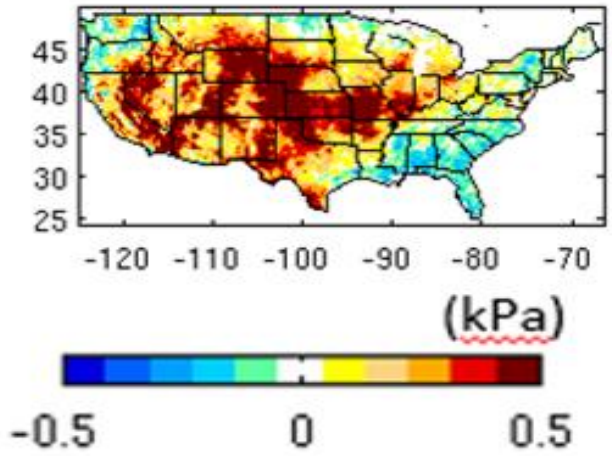
USDM drought category



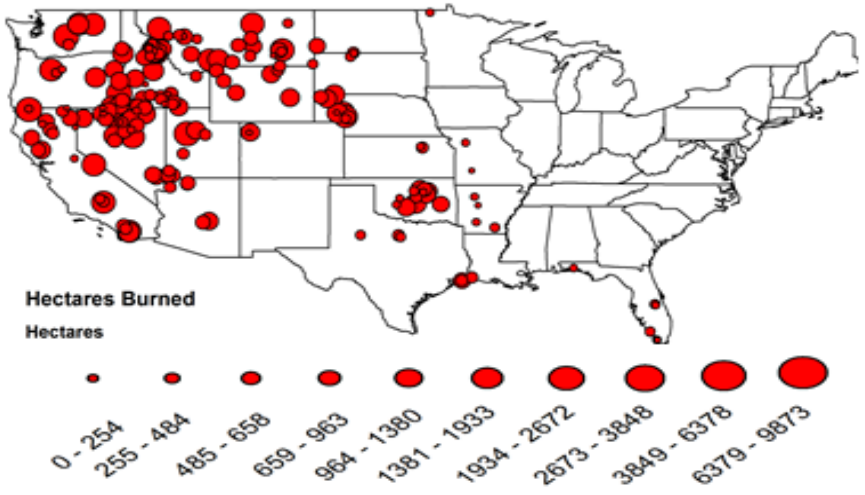

The **national fire danger rating system (NFDRS)** energy release component (ERC)




VPD anomaly




Fire occurrence : hectares burned

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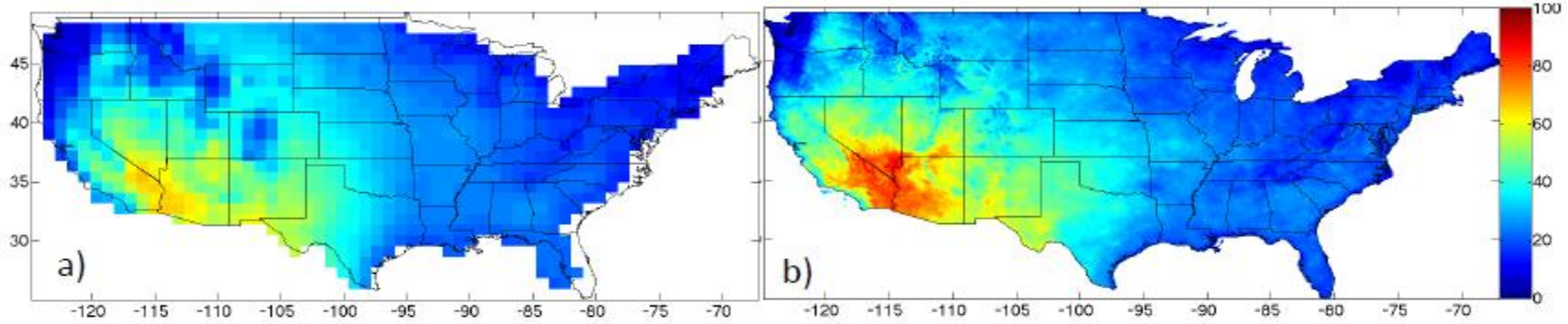
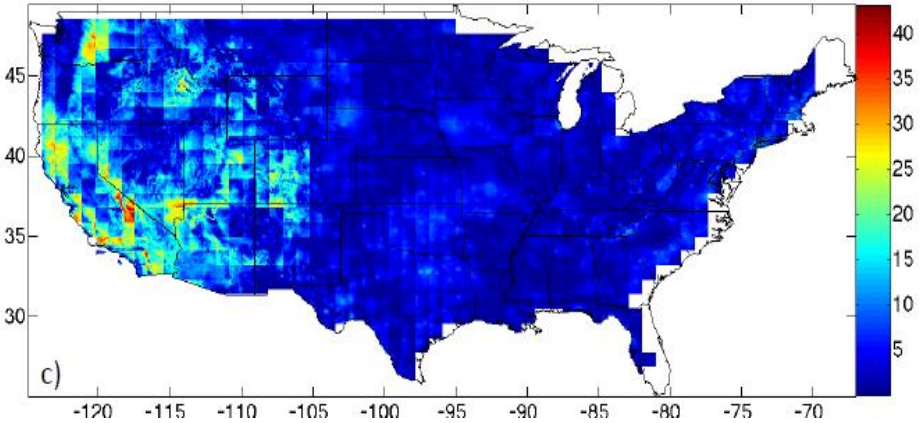
# VPD and Fire danger

ERC using AIRS surface T and RH

ERC using Reanalysis data (U of Idaho)




The absolute difference between mean ERC of AIRS and reanalysis

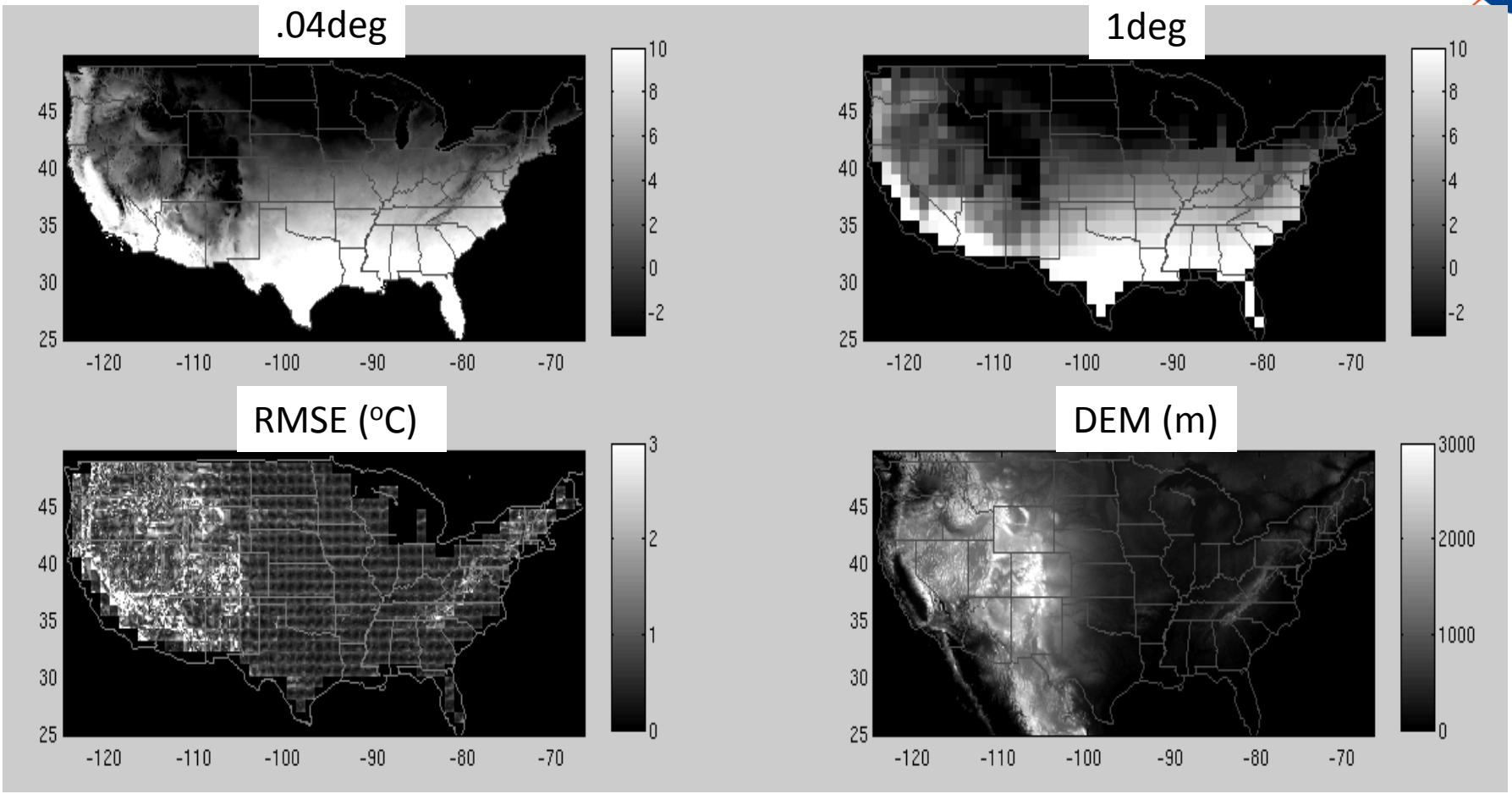



Natasha Stavros

d) Weather stations

e) Topography

# Moving from 4km to 100 km grid can cause >3 °C temperature difference




Summer (2010-2012)

More than 3 °C in temperature is easily seen due to the spatial scale issue:
**Suggestion : higher resolution data ?**

# AIRS and Heat index (human comfort)

**NOAA's National Weather Service**

**Heat Index**

**Temperature (°F)**

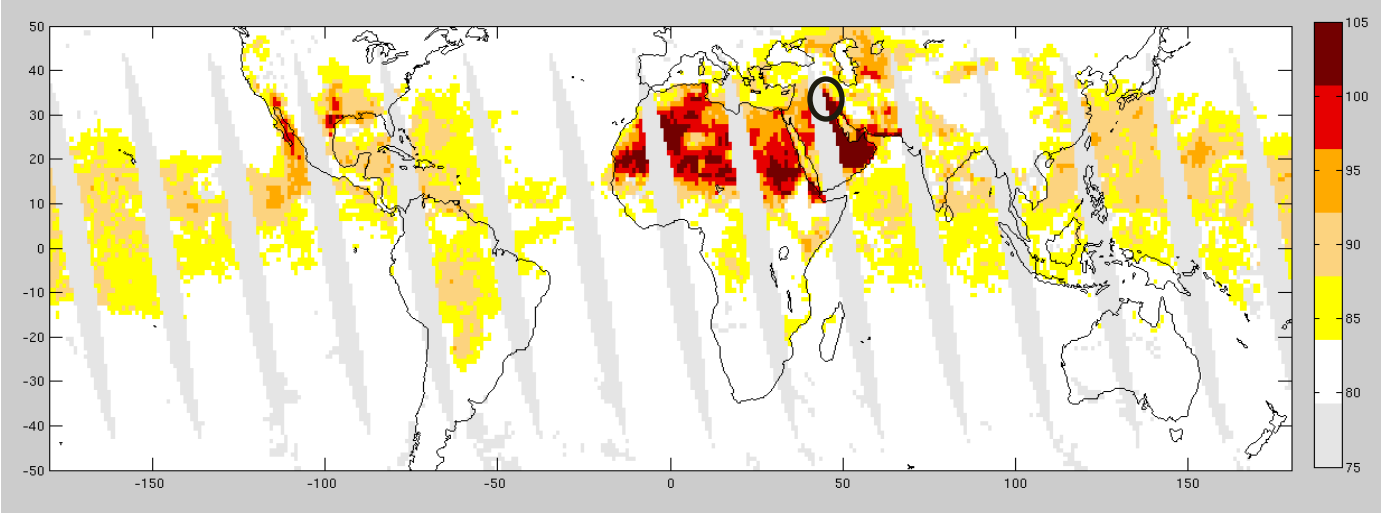
| Relative Humidity (%) | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 94 | 96 | 98 | 100 | 102 | 104 | 106 | 108 | 110 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 80 | 81 | 83 | 85 | 88 | 91 | 94 | 97 | 101 | 105 | 109 | 114 | 119 | 124 | 130 | 136 |
| 45 | 80 | 82 | 84 | 87 | 89 | 93 | 96 | 100 | 104 | 109 | 114 | 119 | 124 | 130 | 137 | |
| 50 | 81 | 83 | 85 | 88 | 91 | 95 | 99 | 103 | 108 | 113 | 118 | 124 | 131 | 137 | | |
| 55 | 81 | 84 | 86 | 89 | 93 | 97 | 101 | 106 | 112 | 117 | 124 | 130 | 137 | | | |
| 60 | 82 | 84 | 88 | 91 | 95 | 100 | 105 | 110 | 116 | 123 | 129 | 137 | | | | |
| 65 | 82 | 85 | 89 | 93 | 98 | 103 | 108 | 114 | 121 | 128 | 136 | | | | | |
| 70 | 83 | 86 | 90 | 95 | 100 | 105 | 112 | 119 | 126 | 134 | | | | | | |
| 75 | 84 | 88 | 92 | 97 | 103 | 109 | 116 | 124 | 132 | | | | | | | |
| 80 | 84 | 89 | 94 | 100 | 106 | 113 | 121 | 129 | | | | | | | | |
| 85 | 85 | 90 | 96 | 102 | 110 | 117 | 126 | 135 | | | | | | | | |
| 90 | 86 | 91 | 98 | 105 | 113 | 122 | 131 | | | | | | | | | |
| 95 | 86 | 93 | 100 | 108 | 117 | 127 | | | | | | | | | | |
| 100 | 87 | 95 | 103 | 112 | 121 | 132 | | | | | | | | | | |

**Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity**

Caution | Extreme Caution | Danger | Extreme Danger

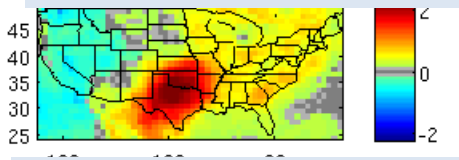
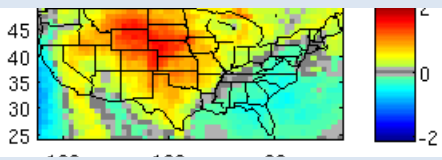
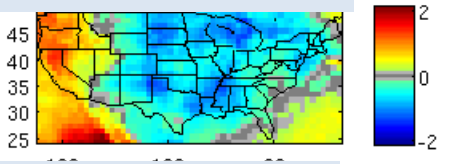
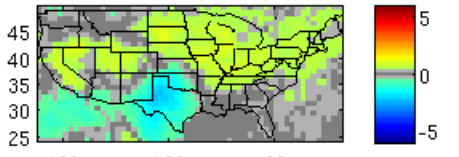
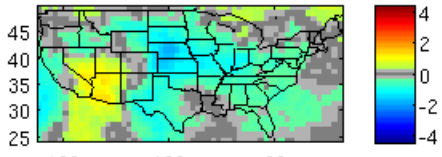
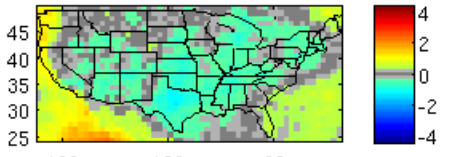
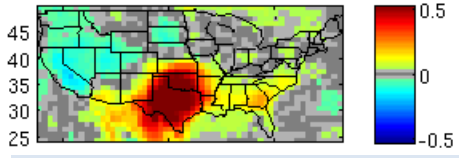
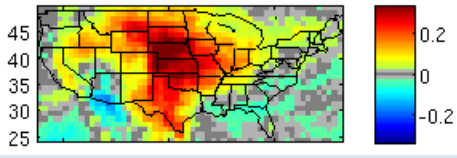
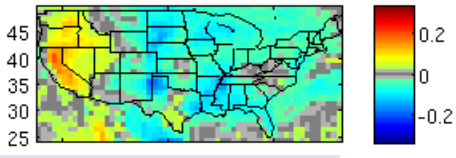
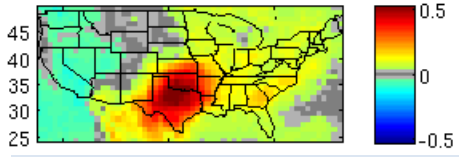
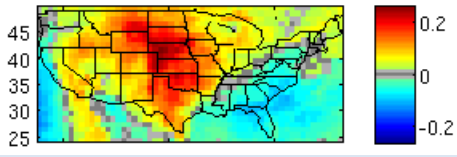
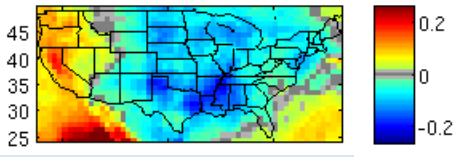
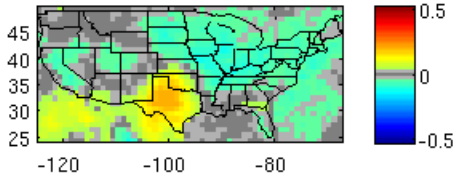
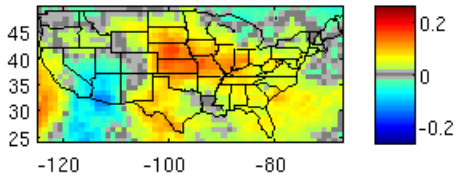
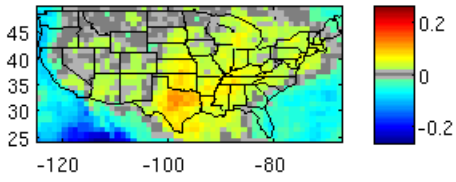
July 31 2015 (Iran Heat Index reached 165F)

AIRS ascending



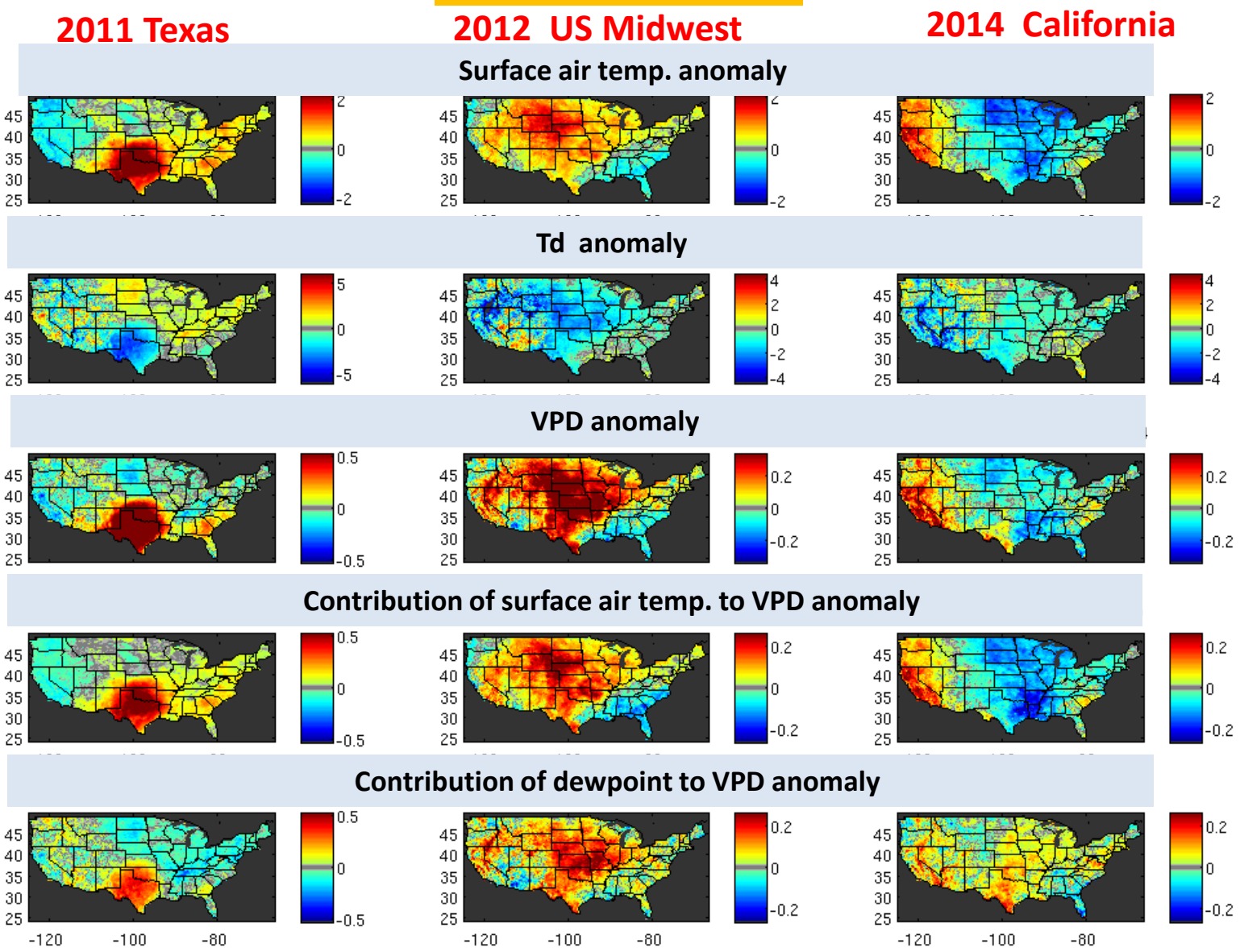
# Evaluation of AIRS product

**AIRS (2003-2013)**

| 2011 Texas | 2012 US Midwest | 2014 California |
|---|---|---|
| **Surface air temp. anomaly** | | |
|  |  |  |
| **Td anomaly** | | |
|  |  |  |
| **VPD anomaly** | | |
|  |  |  |
| **Contribution of surface air temp. to VPD anomaly** | | |
|  |  |  |
| **Contribution of dewpoint to VPD anomaly** | | |
|  |  |  |
| **JAS** | **JAS** | **AMJ** |

# Evaluation of AIRS product

**PRISM (2003-2013)**



What is needed:

- More rigorous validation of near surface temperature and humidity is needed: our case studies show that the pattern is captured fairly well, but the magnitude may not be accurate.

- Resolution is important for some applications, especially for regions with rugged topography.