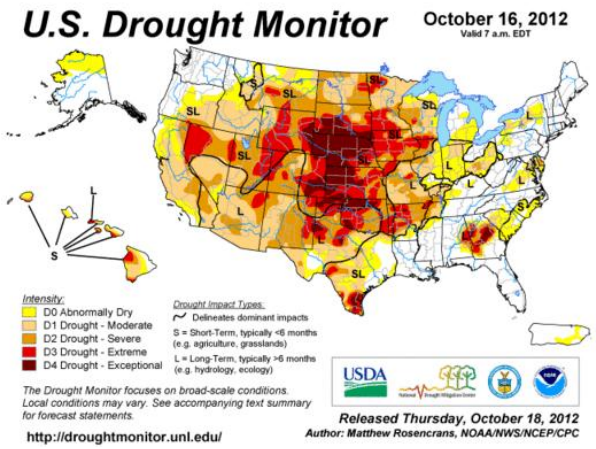
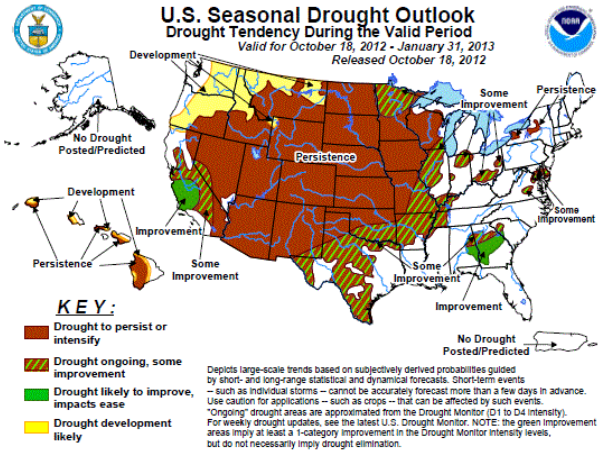
The 2011-2012 Texas drought

Kingtse Mo

Climate Prediction Center

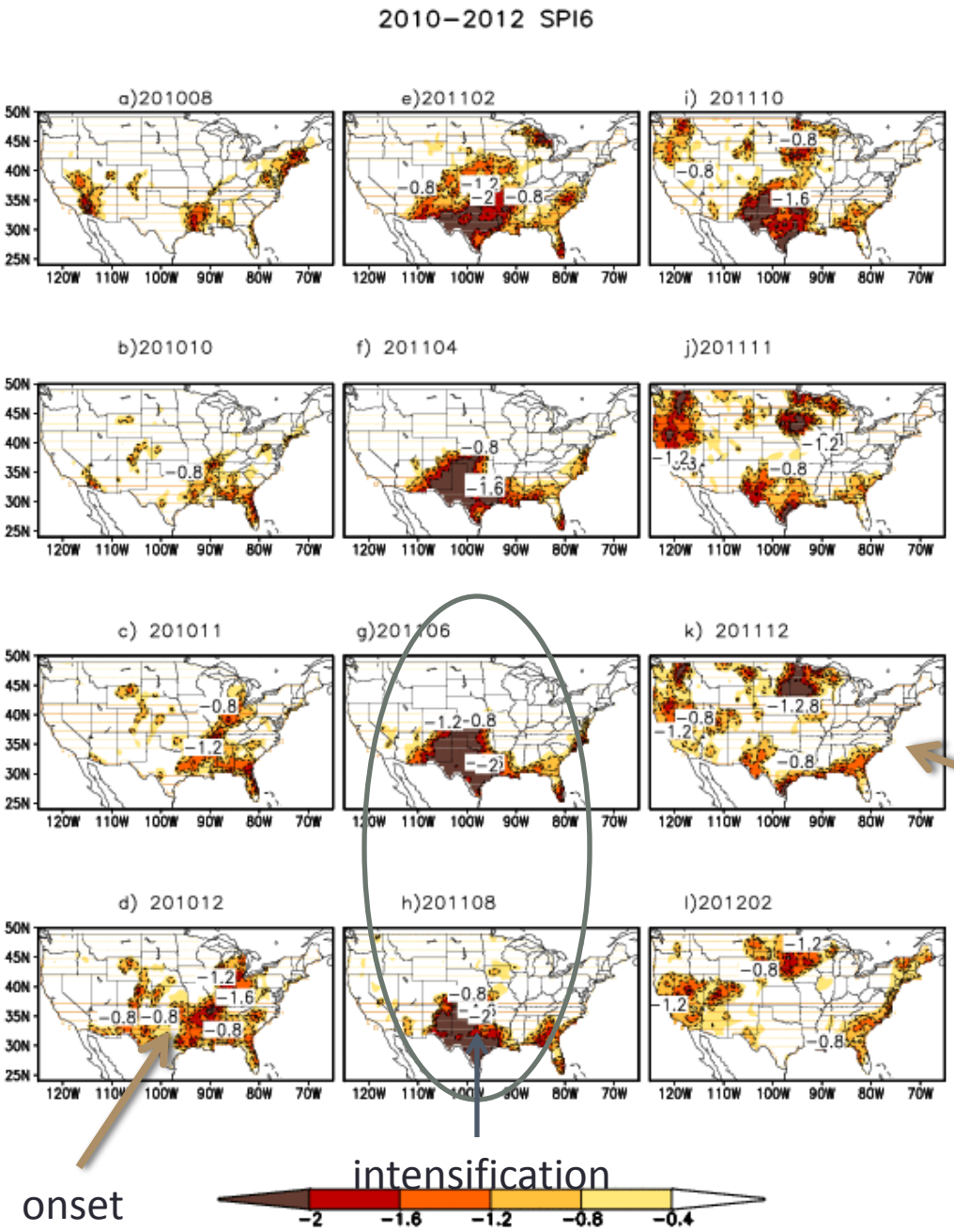
NWS/NCEP/NOAA





outline

- Evolution of the 2011-2012 Texas drought
- Climatology and historical perspective
- The 2011 drought Onset
- Feedback from soil moisture
- Demise
- Forecasts of drought



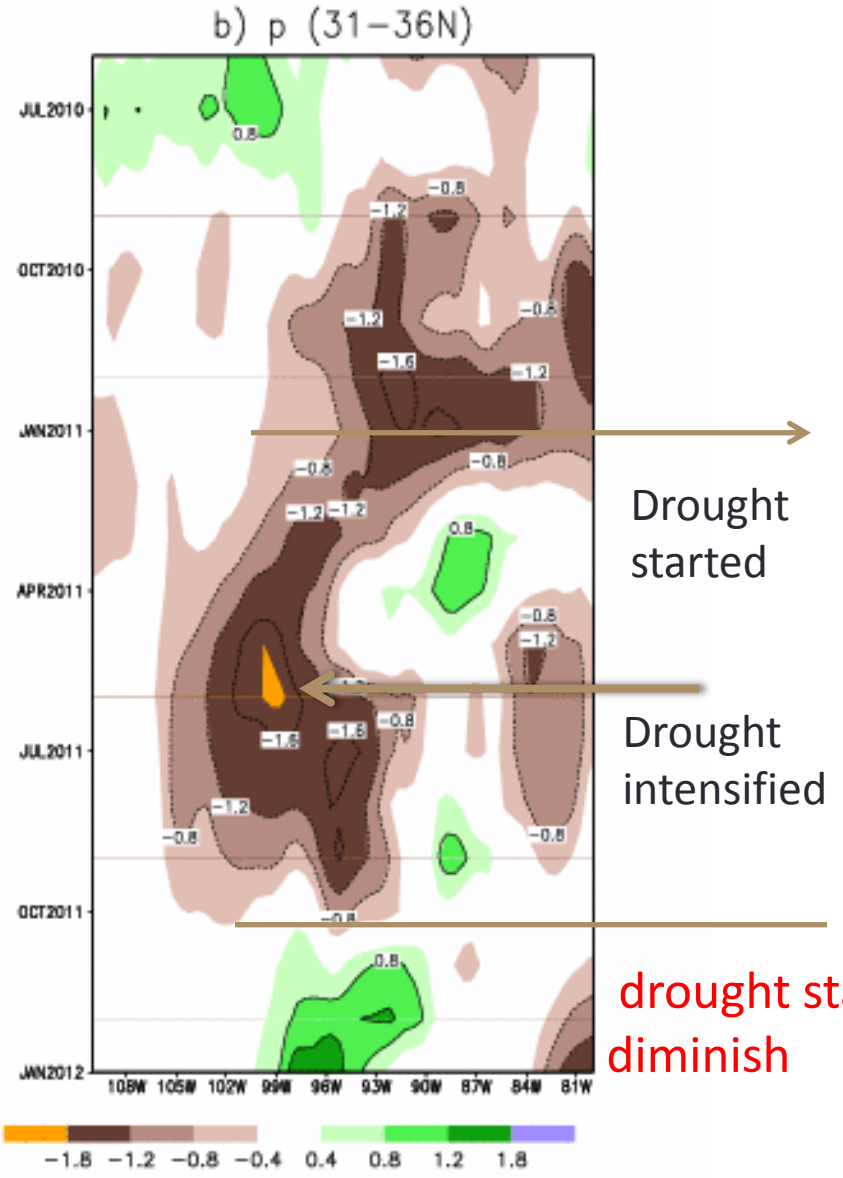
Evolution of drought over Texas 2011-2012

Initial phase: DJF 2011

Intensification: JJAS 2011

Demise: DJF 2012

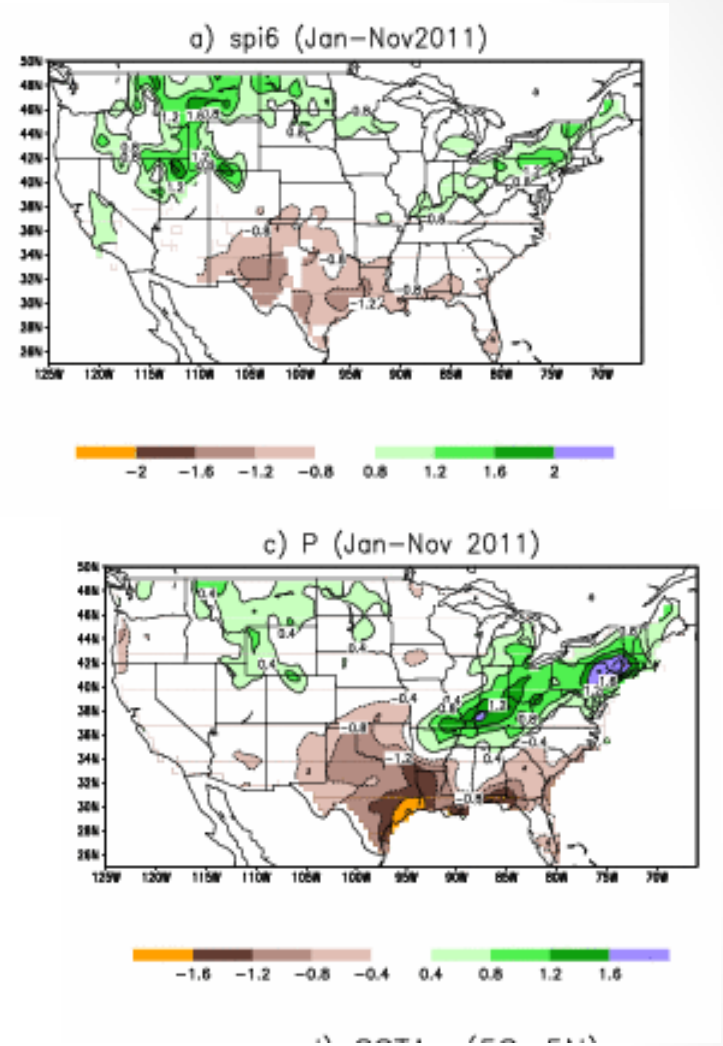
P anomaly averaged over the Texas
Lat 31-36N



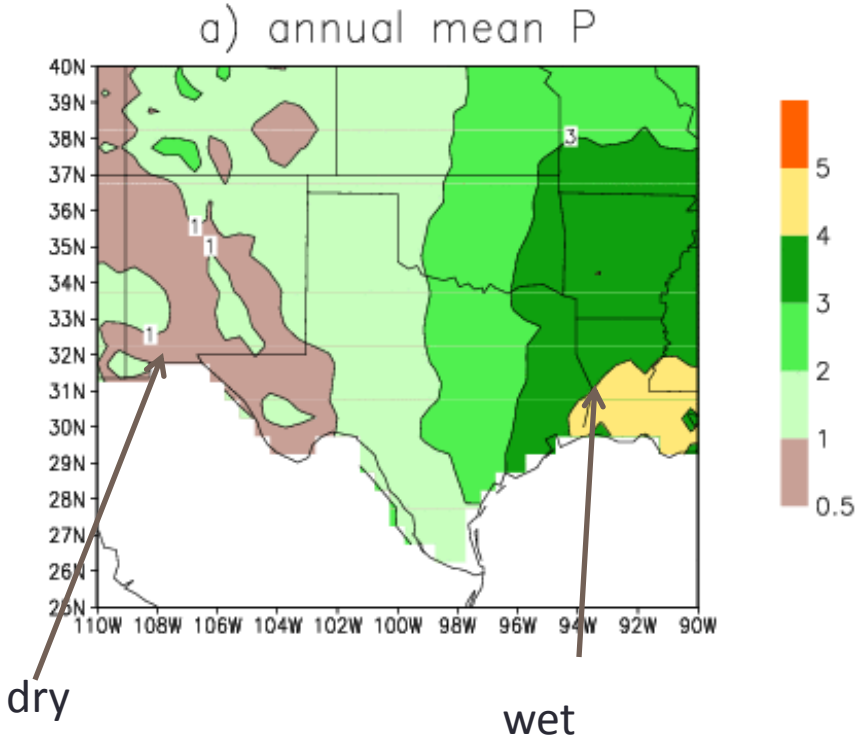
Drought started

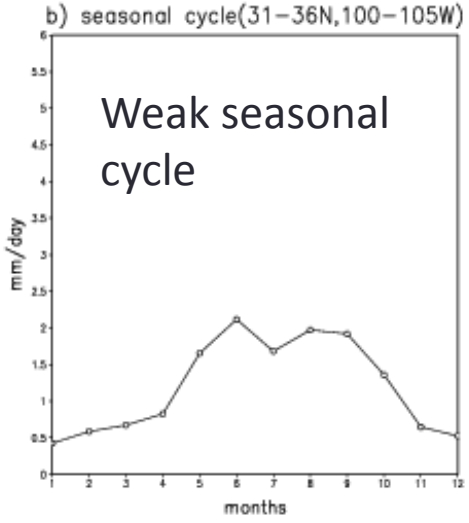
Drought intensified

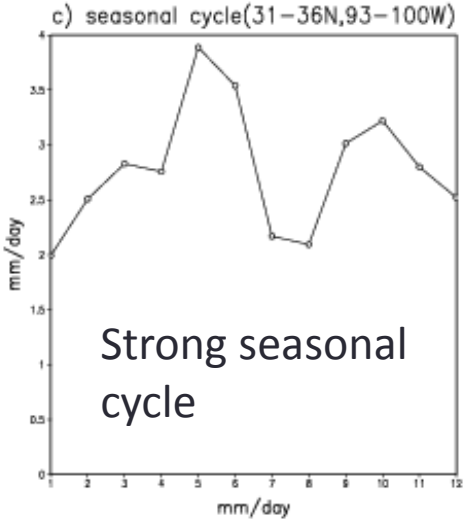
drought started to diminish



Climatology seasonal cycle





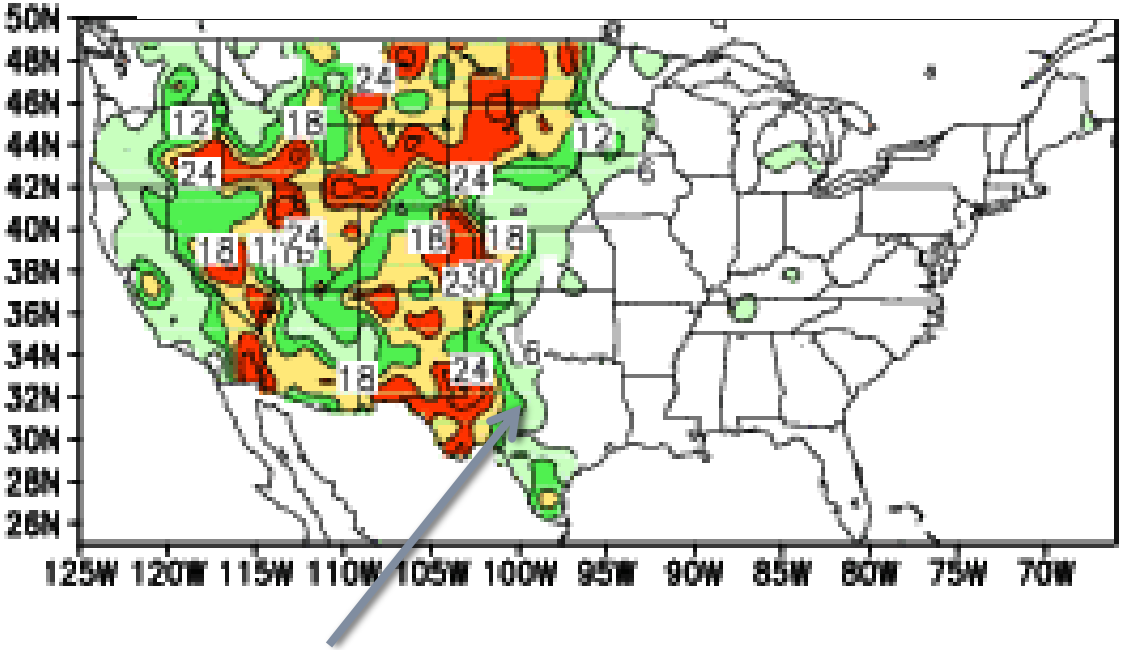


There is a rainfall gradient over Texas:
East Texas is wet with rainfall more than 3 mm/day,
West Texas is relatively dry, about 1.-1.5 mm/day
For the eastern Texas
There are two rainfall maxima:
One in spring and another in fall

Also in vegetation _wells talk yesterday

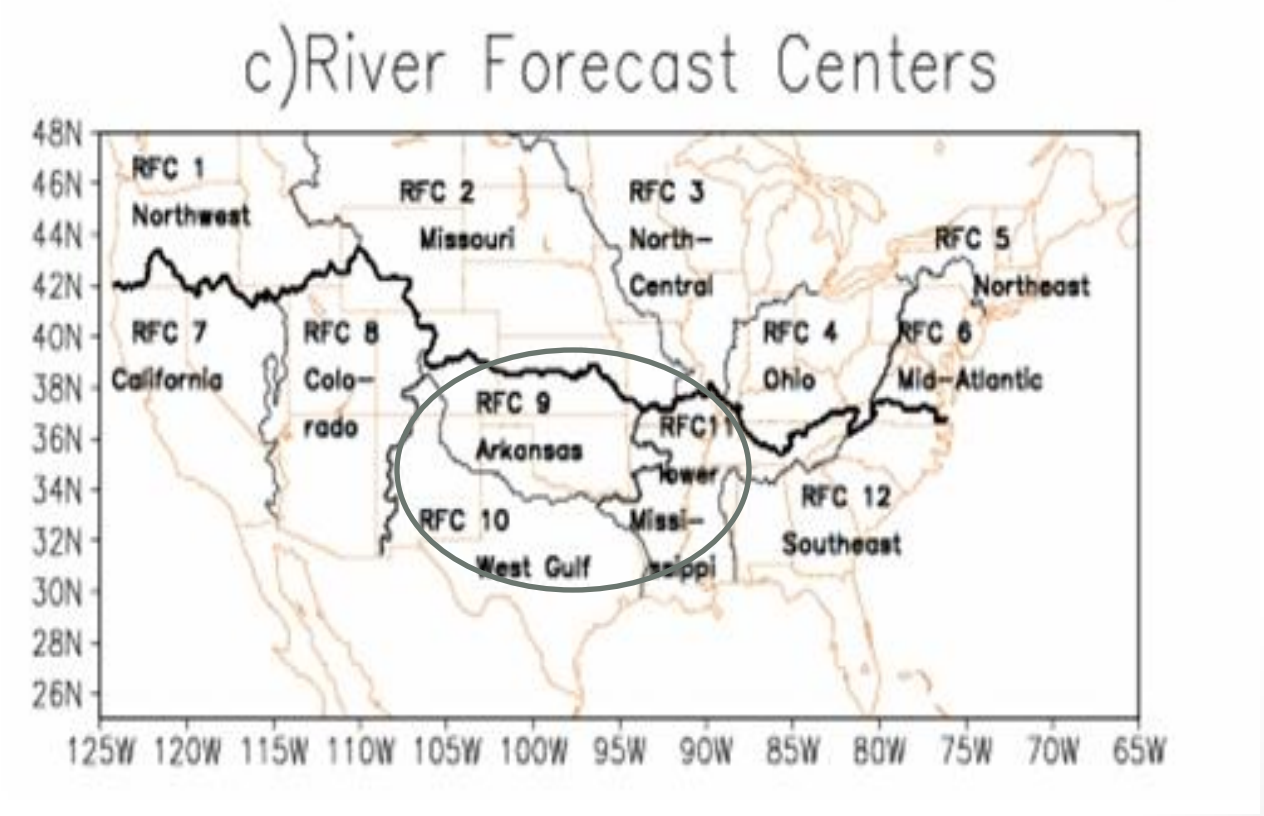
Reason that the western Texas drought lasted longer

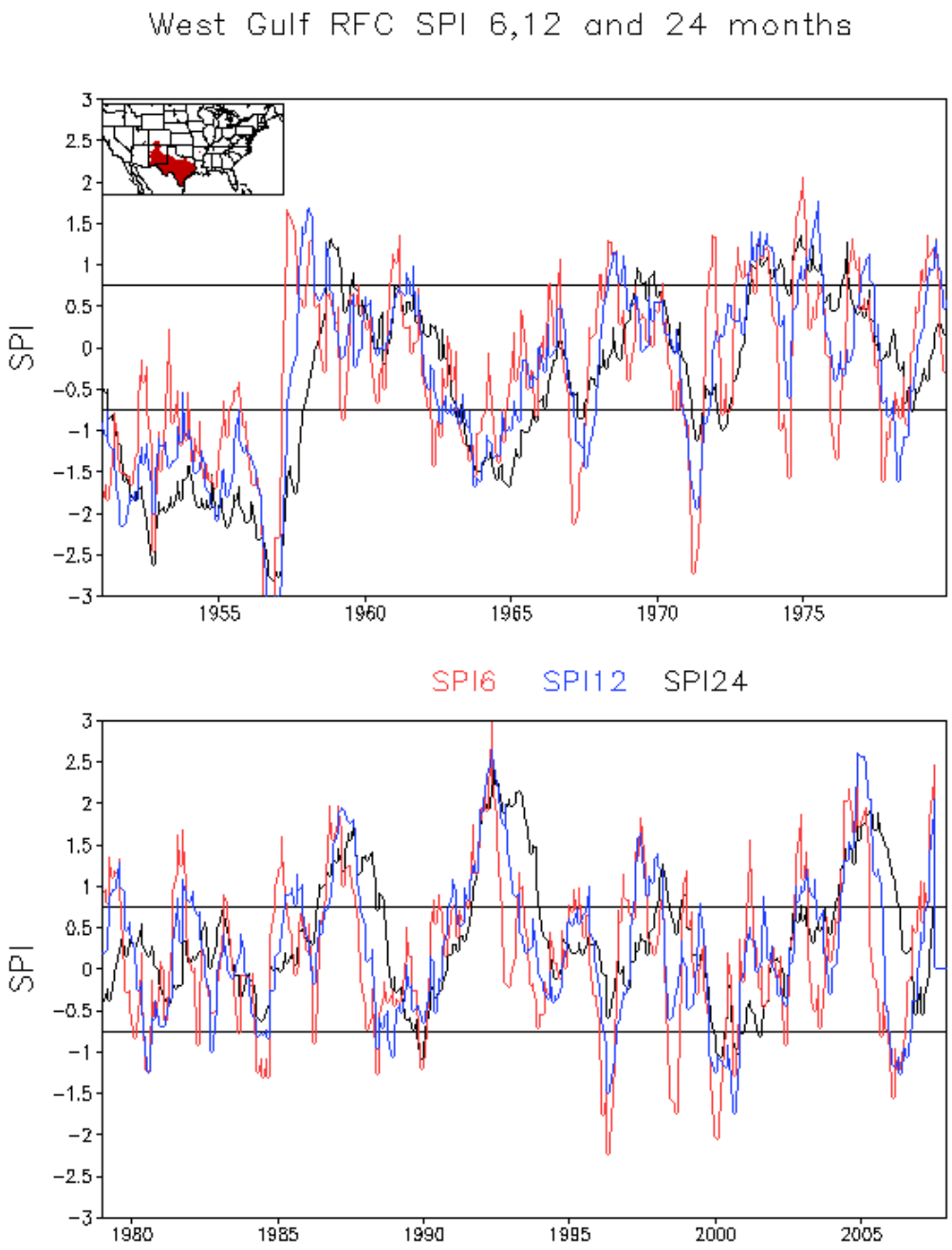
Characteristic time To



SM has high persistence over the western region

SSTAs and drought over Texas





Historical perspective

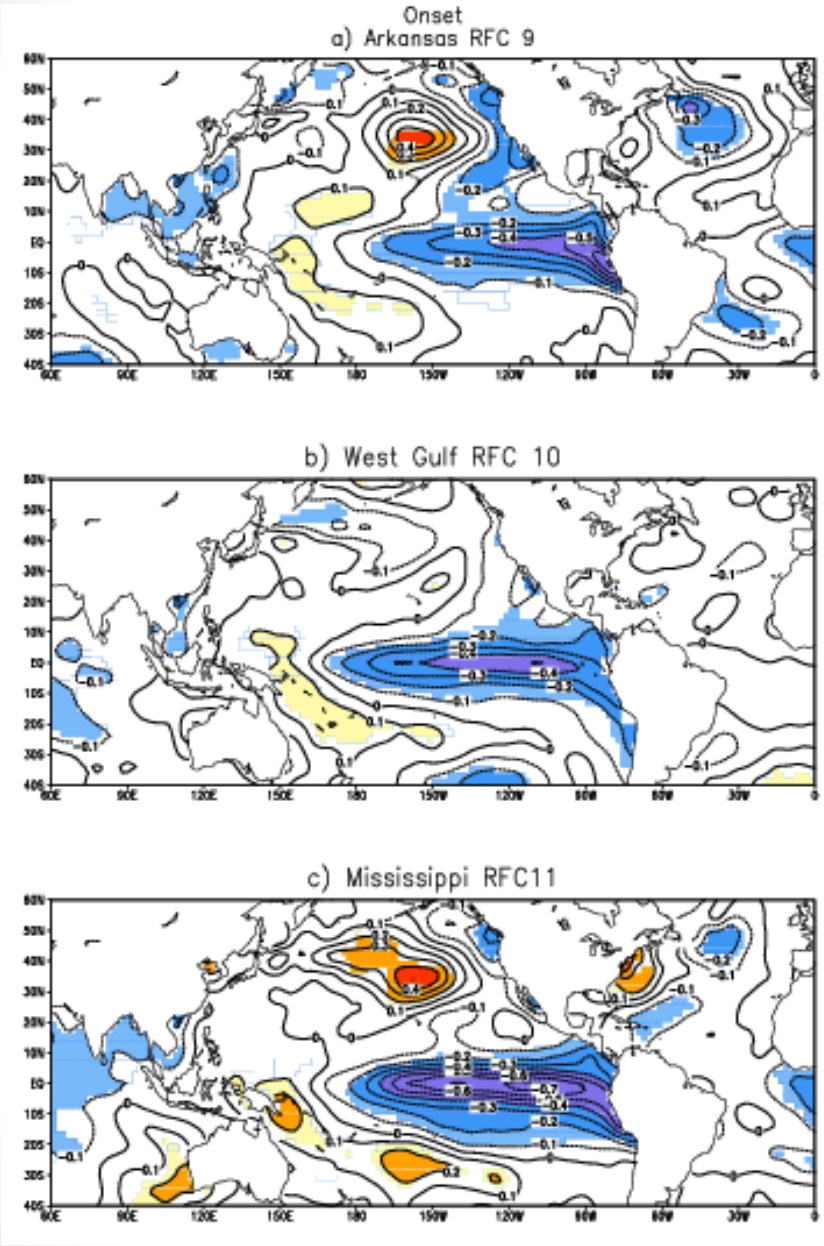
Wetness over west Gulf RFC

Select drought events:

SPI< -0.8 and last more than 6 months

Dr, Maidment asked for 6-18 month forecasts of drought:
May be the ENSO fcst is an answer

SSTA composites one season before onset



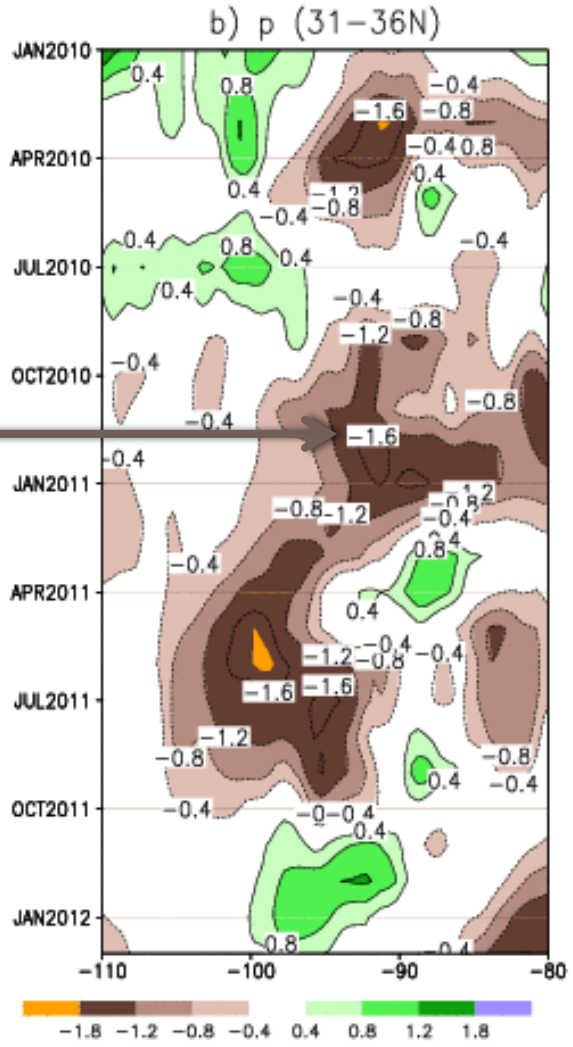
Cold ENSO sets up one season before the beginning of droughts over the Southern Plains and the Mississippi basin

All Drought over Texas occurred during the cold events

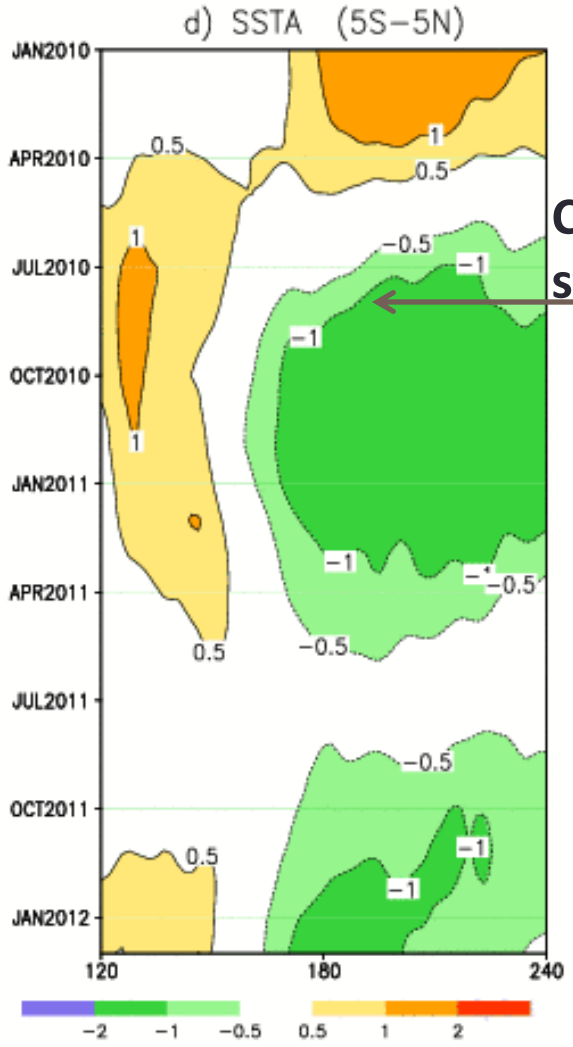
No drought occurred during the warm ENSO events

Cold SSTAs were established one season before the drought onset

Ssta and current drought
Onset—triggered by cold ENSO

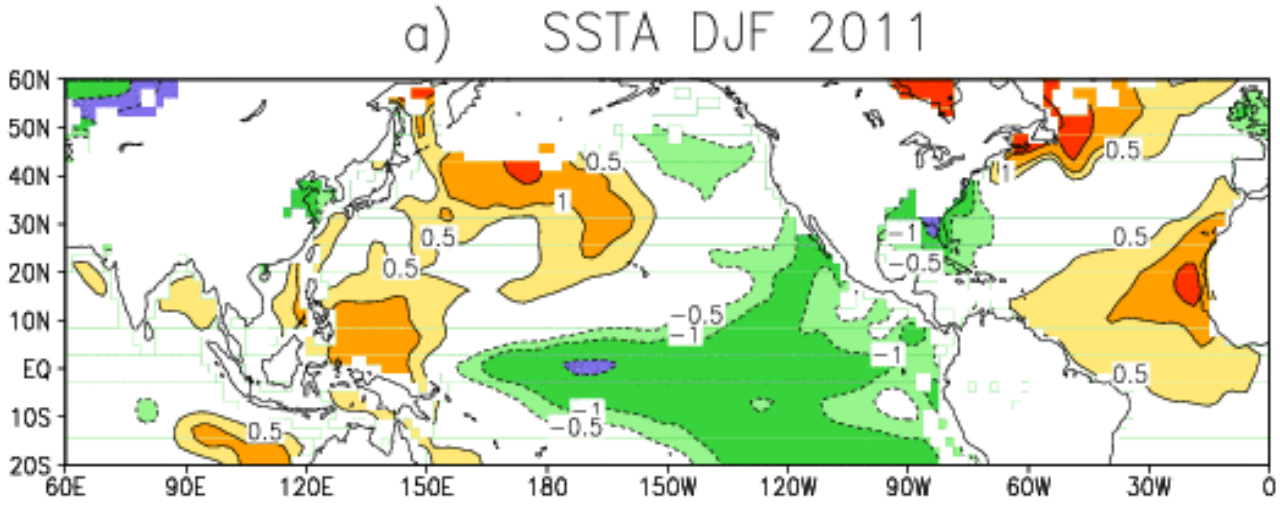


Texas drought



Cold ENSO started

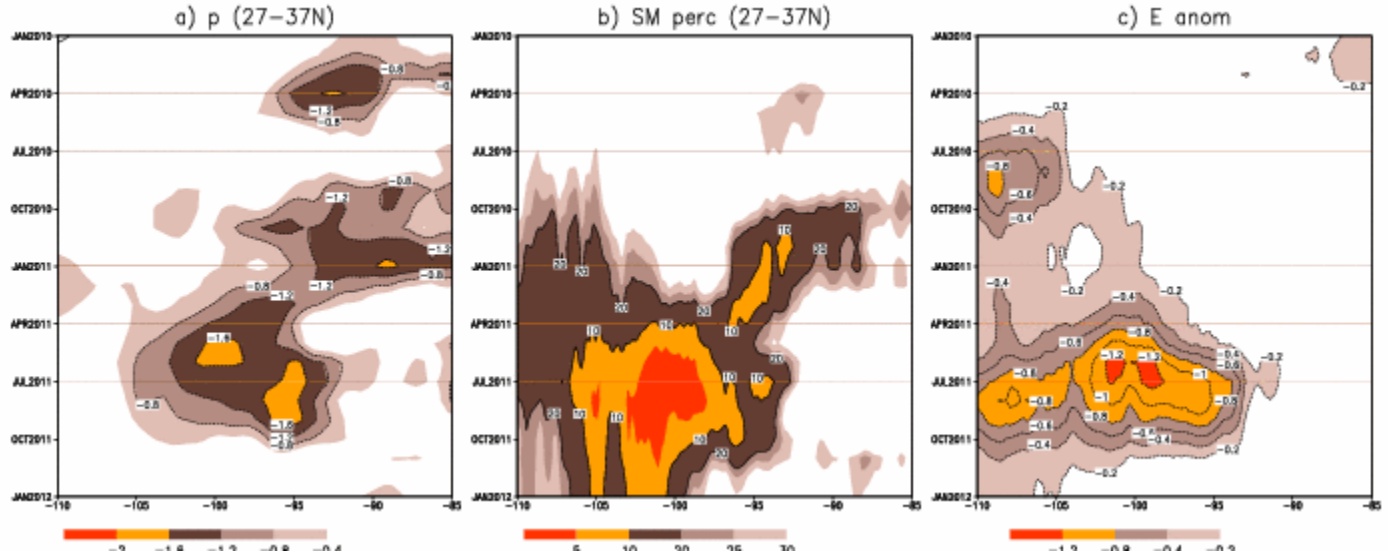
SSTAs for the 2011 winter



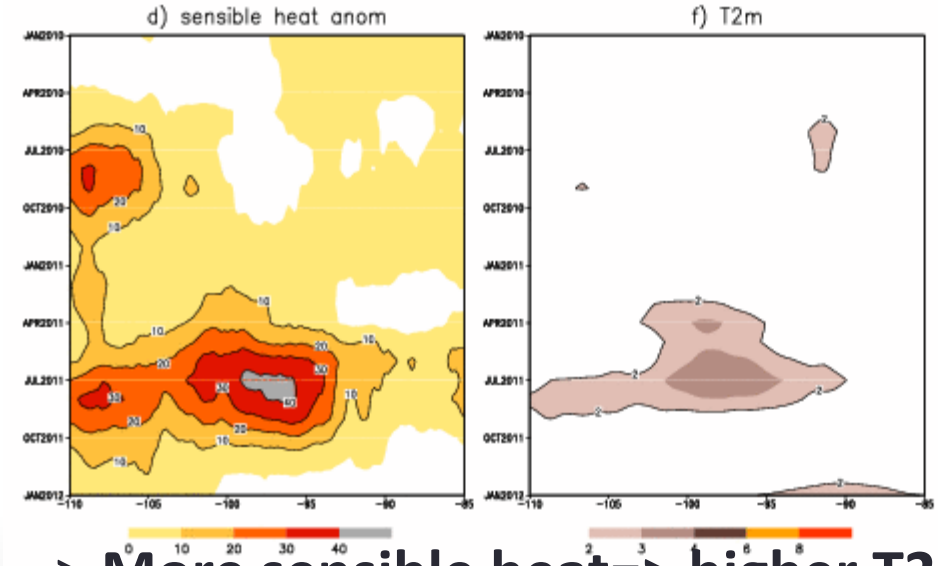
Cold ENSO had some help!!

1. The negative phase of the PDO with negative SSTAs in the west coast of the U. S.
2. a three cell pattern of SSTAs in the Atlantic with negative SSTAs along the east coast

Intensification in summer: Soil moisture influence



Less P => SM decreases (delayed) => Less E



=> More sensible heat=> higher T2m

⇒ Increase of convective inhibition

⇒ less P

=> drought intensification

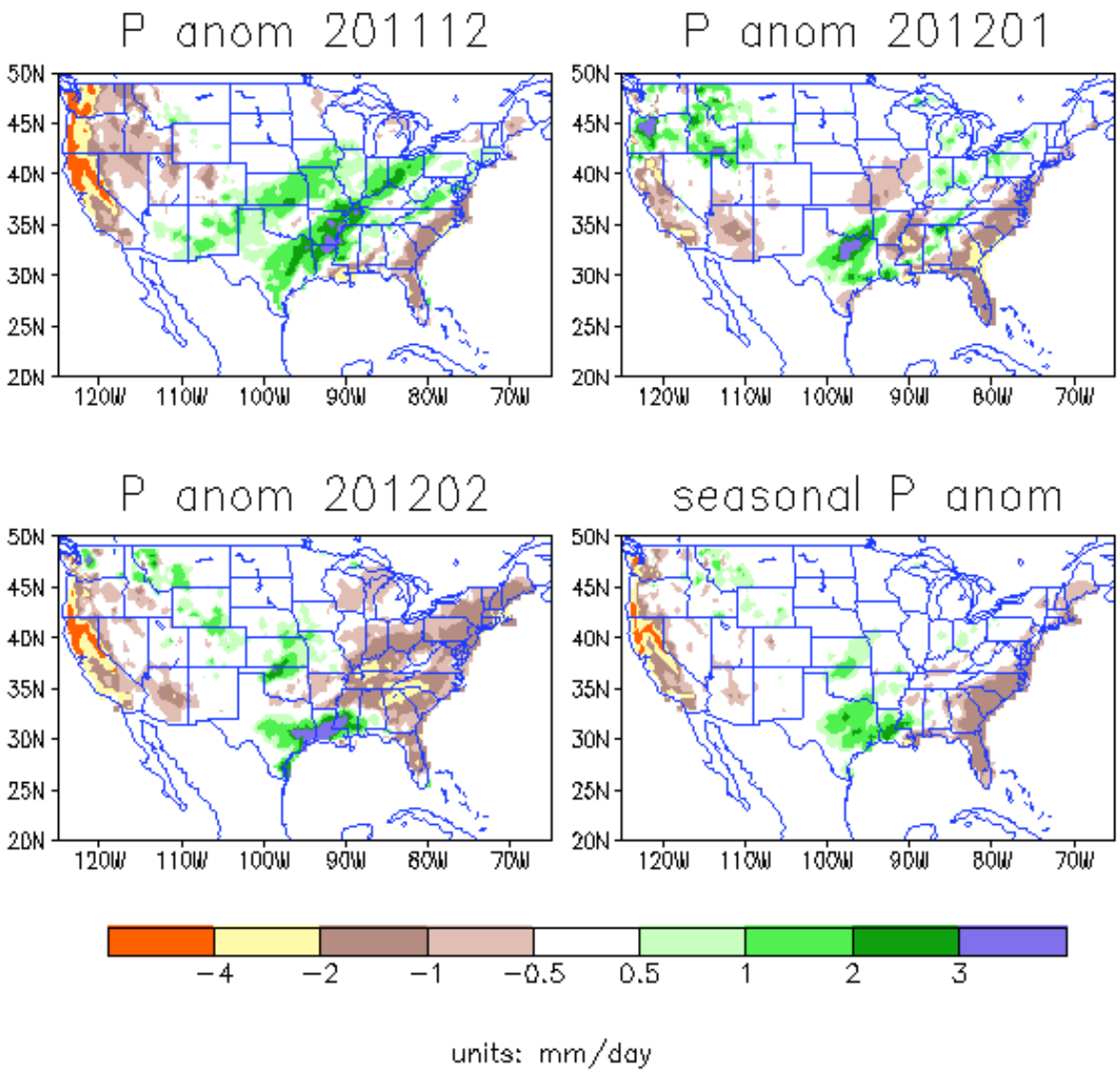
Hsu Su's talk yesterday

Feedback loop

- Less P
- => Less soil moisture in a delayed occurrence
- => Less ET during summer
- => more sensible heat to balance ET since the radiative forcing does not change much.
- => high surface temperature
- => Increase of convective inhibition (Rong Fu and D. N. Fernando)
- => less P
- => drought intensification

Demise:

P anomalies over the United States

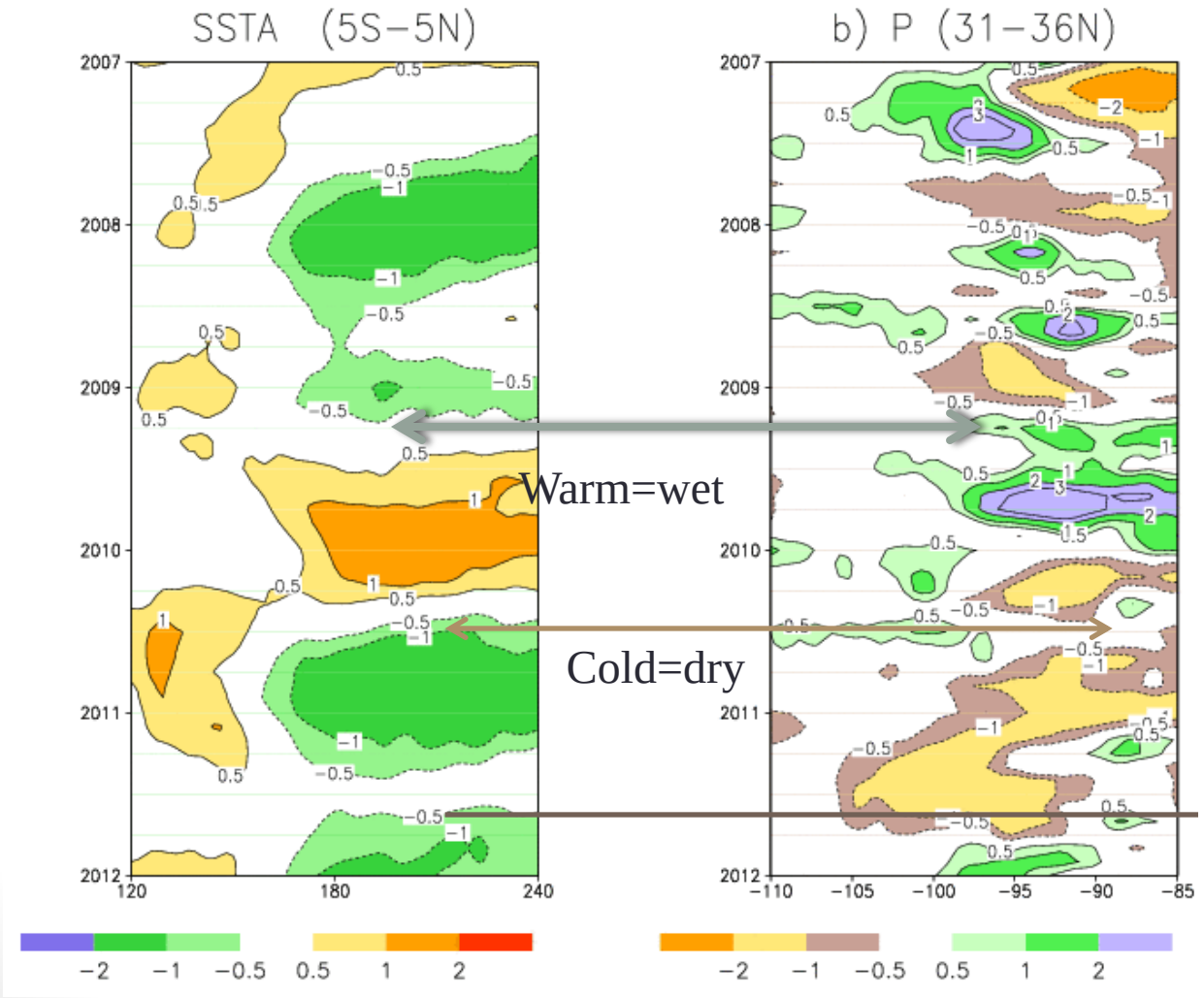


High lights:

Feb 2012

- Rainfall over Texas improved drought
- Drought over California and Arizona intensified
- Dryness continues over the Southeast and the Atlantic coast

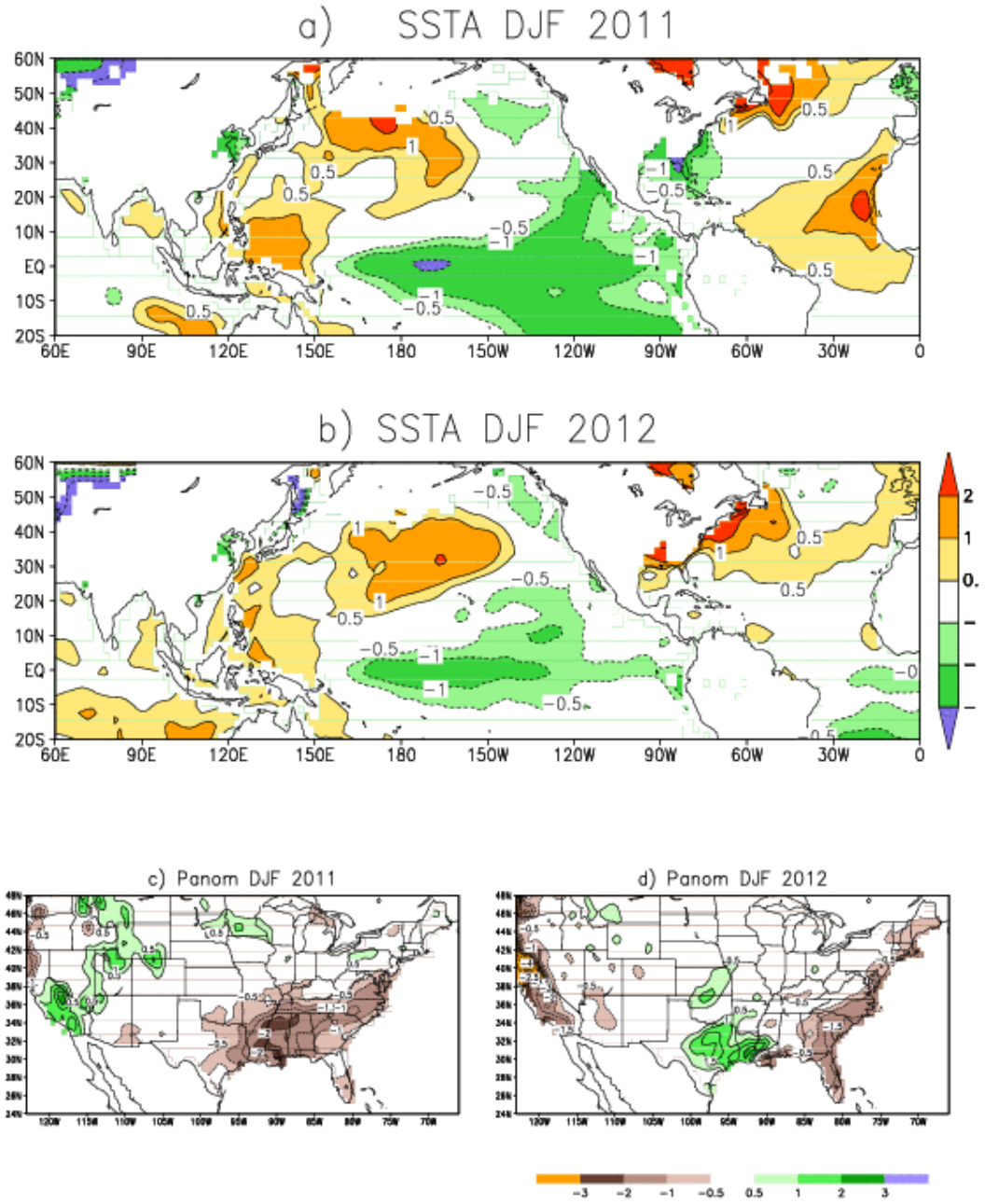
Tropical SSTa and Panom



Cold ENSO=> dry southern plains
Warm ENSO=> wet southern plains

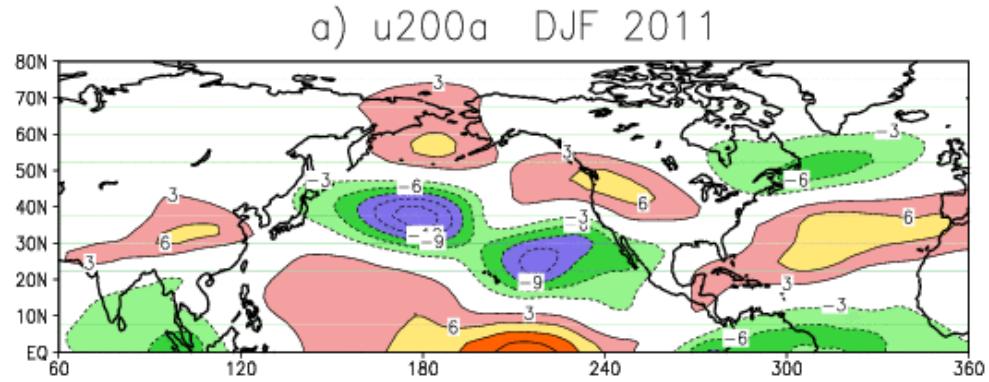
Cold but wet??

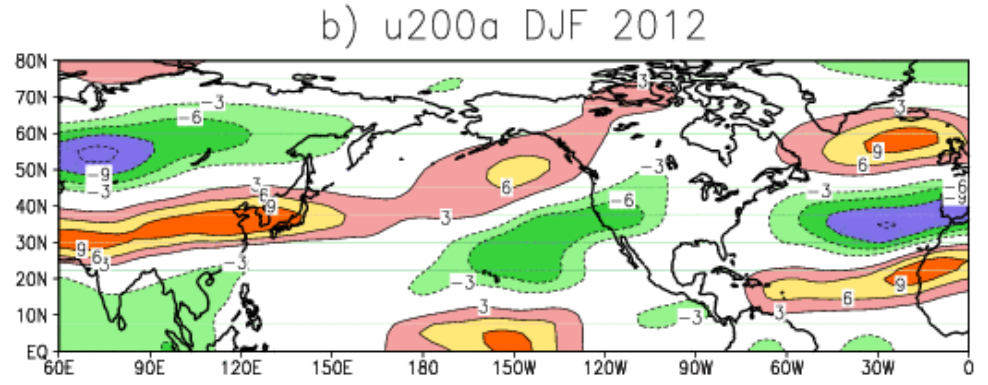
Comparison bw 2011 and 2012 winter

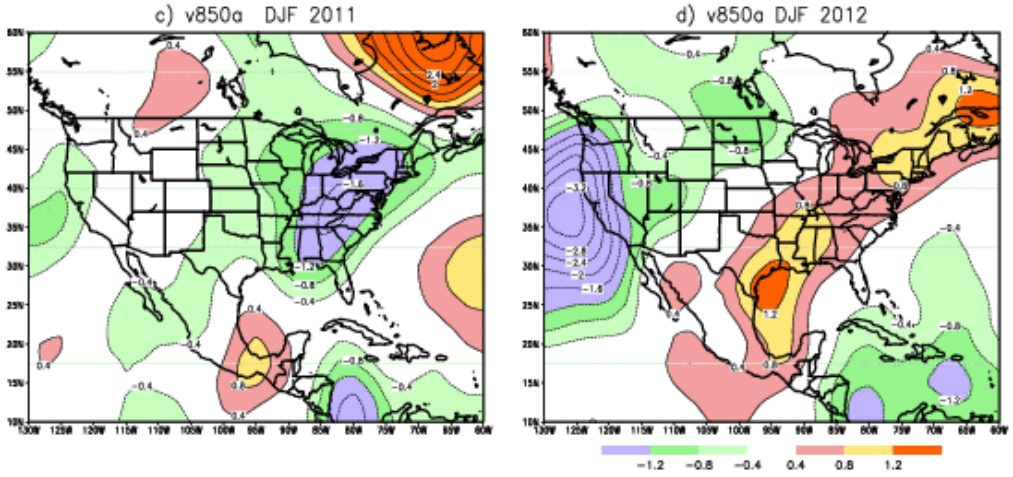


- Both winters were La Nina winters with leas than -1C SSTAs in the tropical Pacific
- Both had warm SSTAs in the North Pacific (PDO)
- The differences are in the North Atlantic (suggested by Dr. Rong Fu)
  - For DJF 2011, there is the three cell SSTA pattern with cold SSTAs close to the east coast of the US
  - For DJF 2012. warm SSTAs in the North Atlantic

Upper level jet stream and low level winds







The Pacific jet shows the northward displacement for both winters (U200a)
The differences are in the u200a in the Atlantic
For V850 (colored) DJF 2011 , the low level flow is weak but the low level flow for DJF 2012 was strong. That brought moisture to the southern Plains

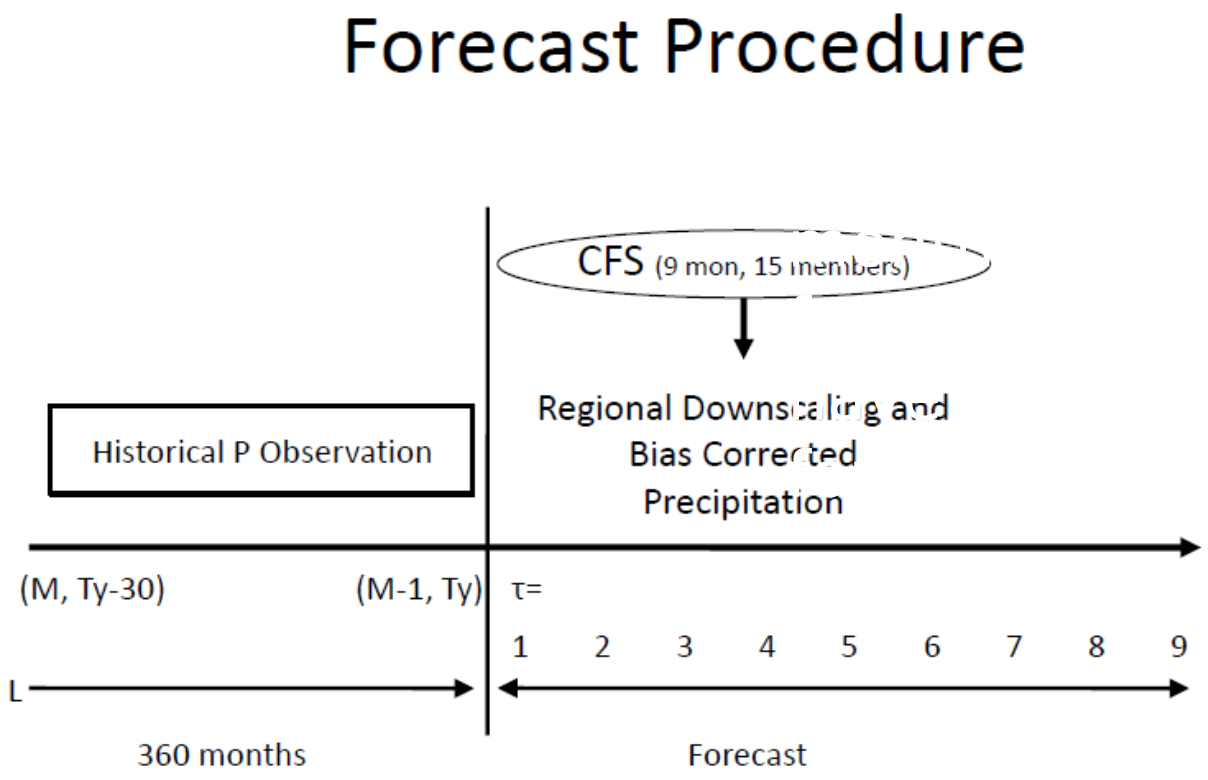
Conclusions

- Onset due to SSTAs :the cold ENSO event, three cell pattern in the Atlantic and a negative PDO phase
- Intensification : Soil moisture feedback _ high surface temperature– CIN – Less P (negative impact to make drought intensify).
- Demise: Due to the Atlantic SSTAs changing phase

Forecasts used for drought

- Seasonal SPI prediction
- Ensemble Streamflow Prediction (ESP)
- CFS based hydroclimate forecasts : Error correction and bias correction of Precip and Tsurf from the global CFS and use them to derive forcing to drive a land_surface VIC model to set Soil moisture and runoff
-

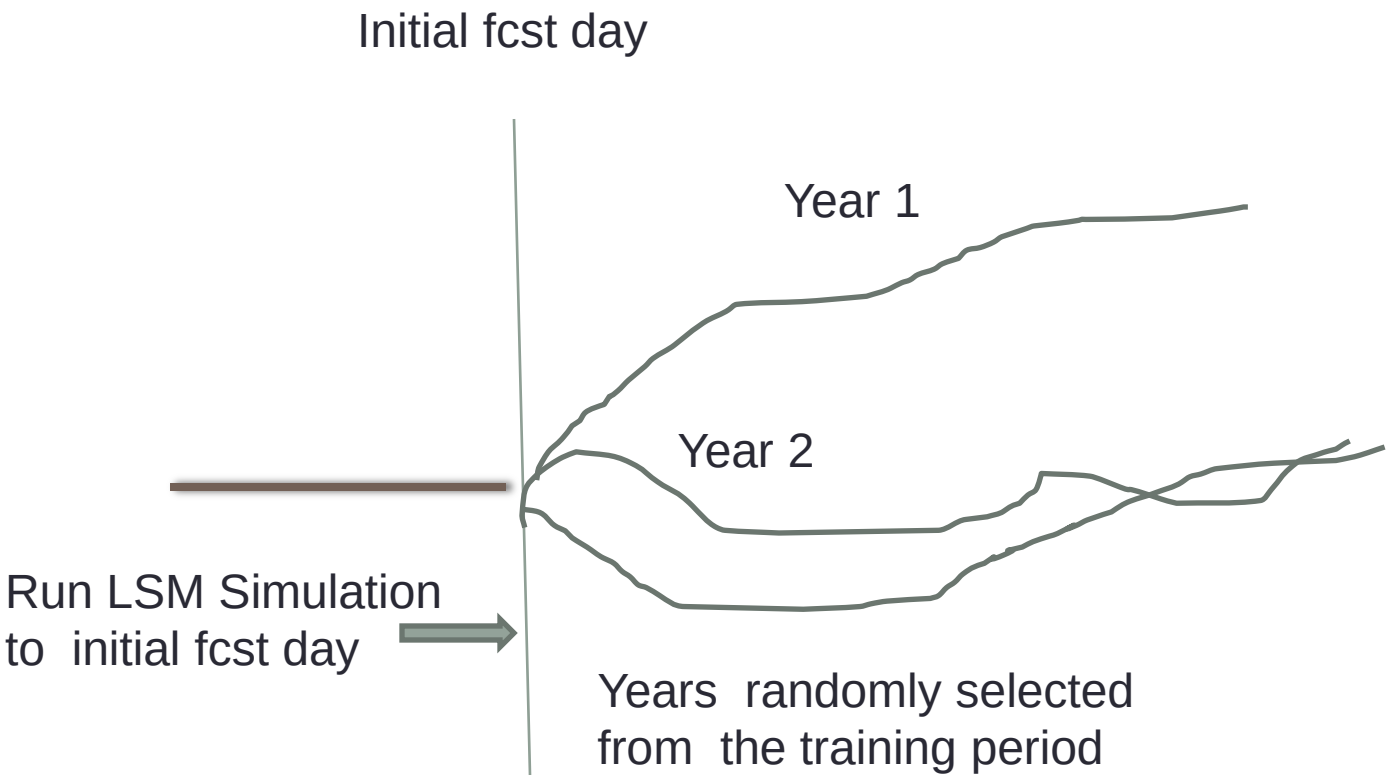
SPI forecast



If drought is in the observations before the fcst date, it has better chance for a successful fcst

Ensemble Streamflow Forecasts (ESP)

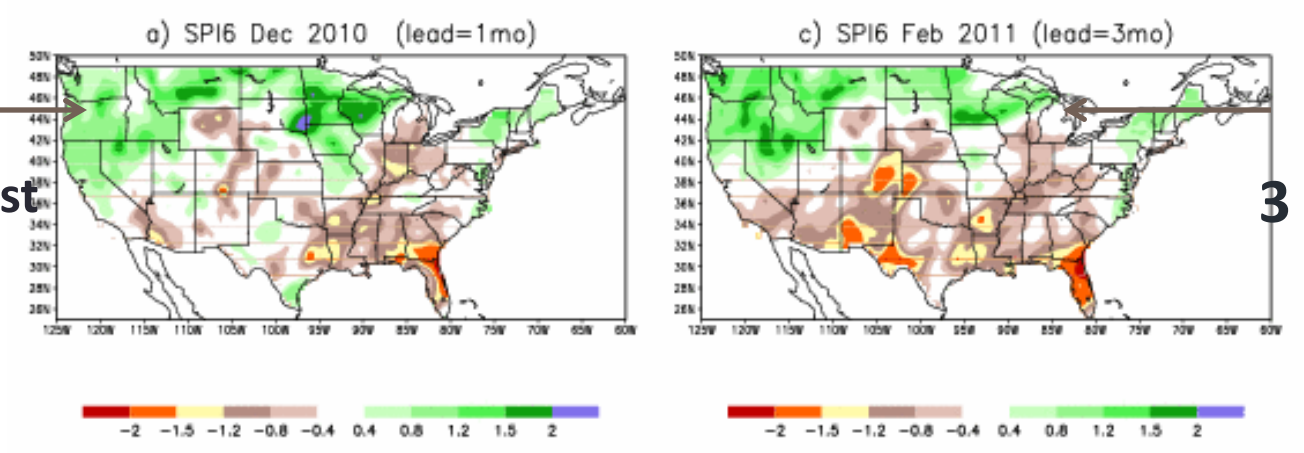
Know initial conditions and climatology



Daily P and Tsurf were randomly selected from the training period. They are used to derive forcing

SPI forecasts based on CFSv2 for drought onset

Ics= 2,3 DEC 2010

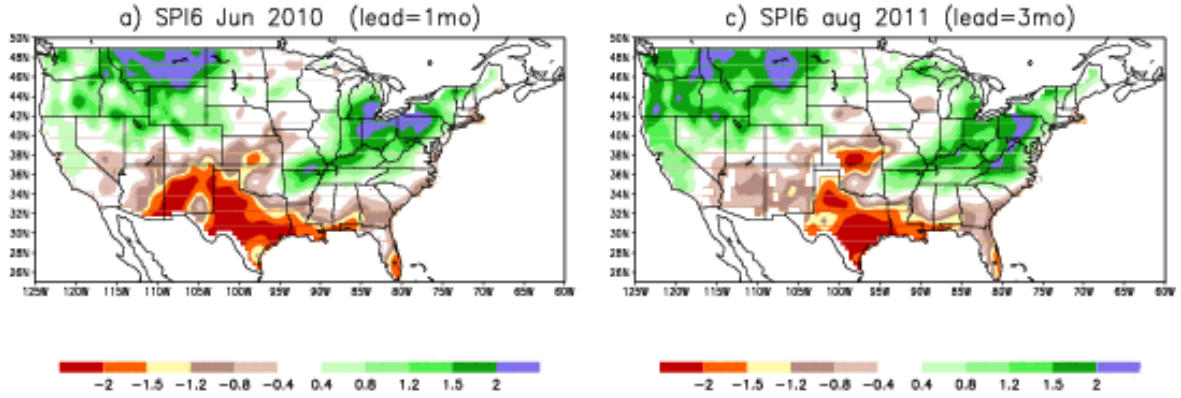


1mo fcst

3 mo fcst

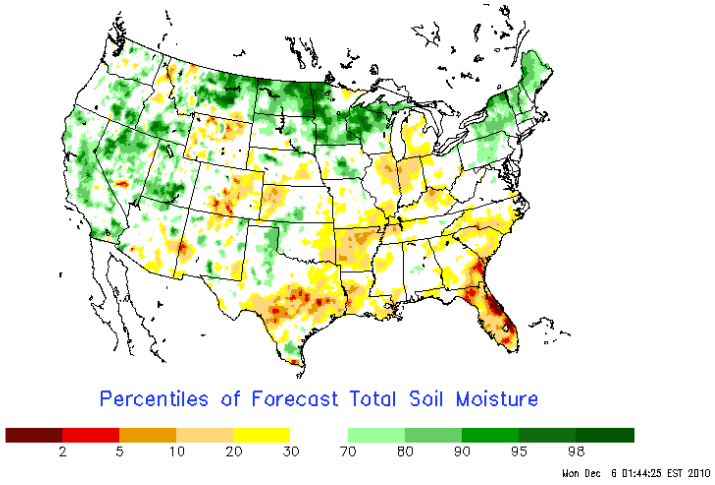
intensification

Ics= 3,4 Jun 2011

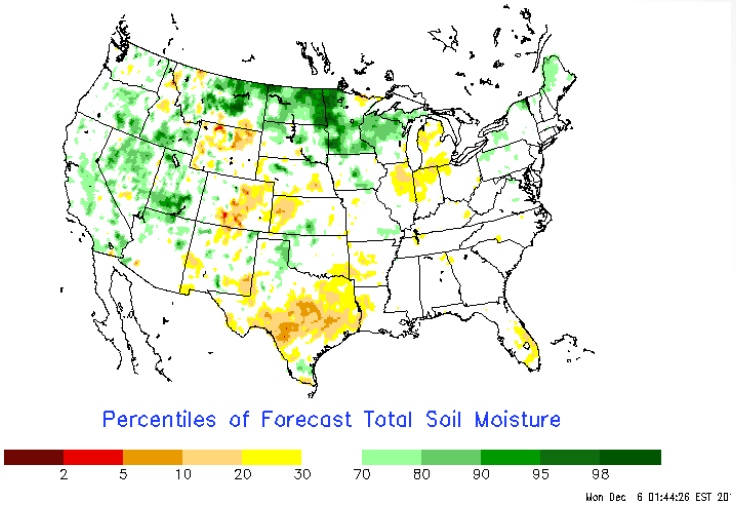


The EMC/Princeton system Forecasts initialized in December (Youlong Xia)

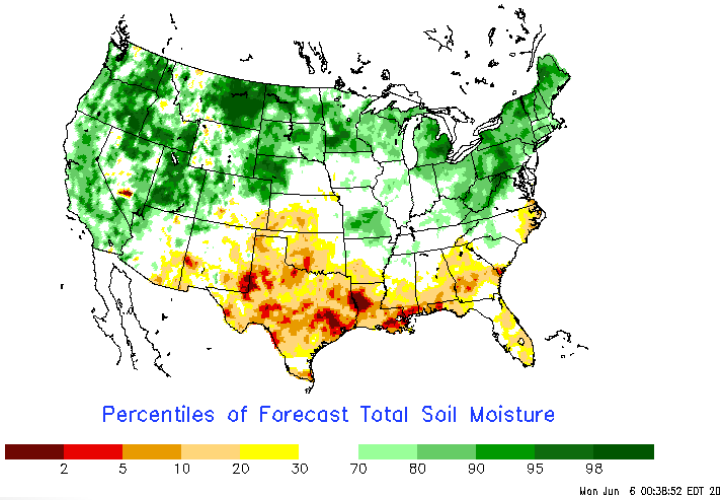
Onset Ics= Dec 2011

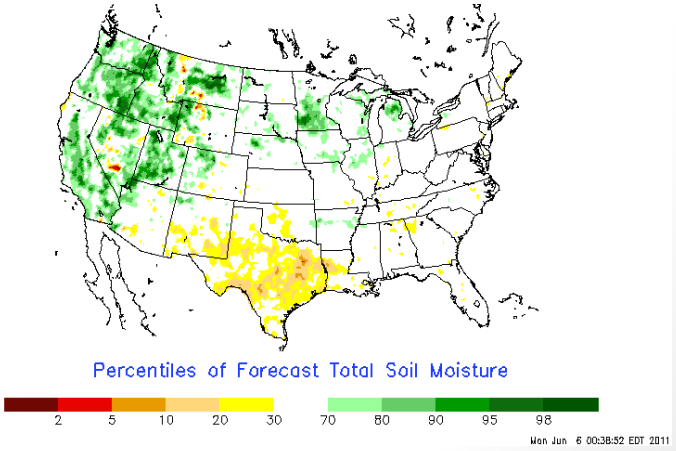


3 month fcst



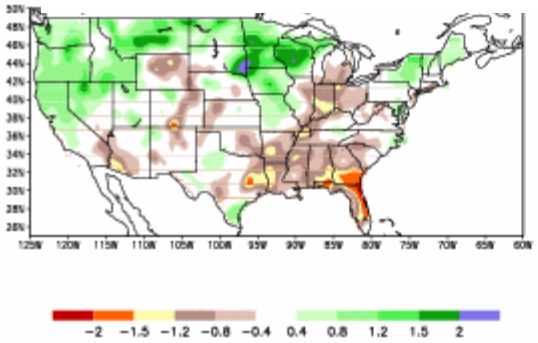
Intensification Ics=Jun 2011



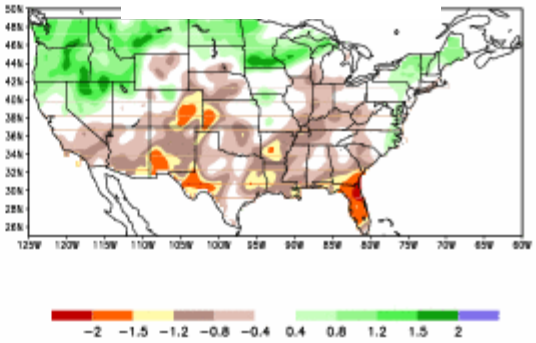


Demise-difficult to fcst

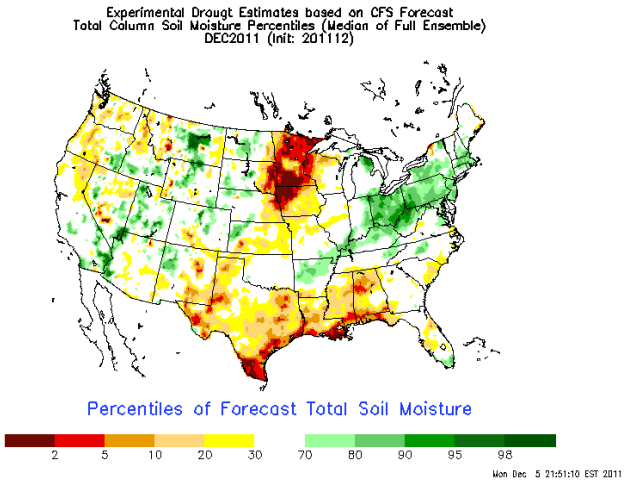
Spi6 201112

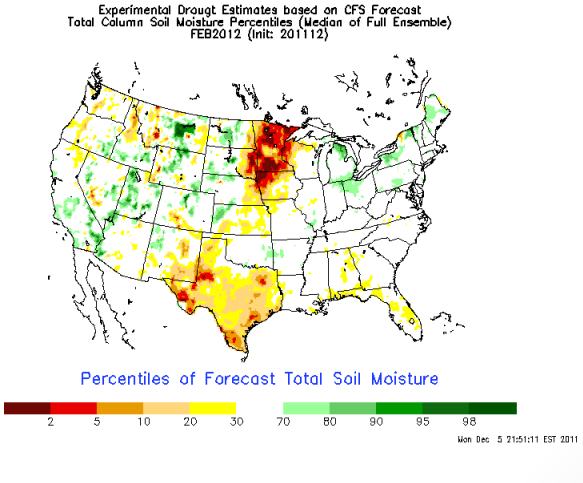


SPI6 201202



EMC_Princeton fcsts





Forecasts

- SPI prediction does well if the signal is in the initial conditions.
- ESP beats persistence of soil moisture, but it works better over the western interior region. Over the southern plains where the interaction between land-atmosphere is large, ESP does not work well. It does not have the dynamical guidance.
- CFS based forecasts works well ONLY if the precipitation forecasts are skillful

Recommendations

- 1. There is a strong relationship between the establishment of the cold ENSO event and the occurrence of the Texas drought. Usually the cold ENSO starts one season before the onset of drought (watch out for ENSO)
- 2. Intensification – The southern Plains is the place that the atmosphere-land coupling is strong in late spring and summer. If the drought is already established, then there is a possibility that drought will increase the strength due to the soil moisture feedback. (monitoring the low level jet and precipitation)
- Demise of drought is very difficult to forecast. A few rainfall events will end drought. (no magic)

Two questions

1. Are there any drought products that you would like to have in addition to these already provided?
2. Can you identify any gaps in drought research that we should emphasize?