

Drought and Persistent Wet Spells over the United States and Mexico

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Objectives

- To identify regions over the United States and Mexico that the drought and wet spells are most likely to occur and persist.
- Understand the reasons for the regional preference.

Data set used

- Palmer Drought Severity Index (PDSI) based on climate division data from the NCDC (1900-2004)
- Standardized Precipitation Index (SPI) based on the gridded P data (1948-2004)
- Precipitation (1948-2004) (Higgins et al. 2000)
- Regional reanalysis (1979-2004)
- CDAS 1 (1948-2004)

Preferred regions for drought

The droughts and wet spells were identified based on the PDSI from 1900 to 2004. The ratio between the months that drought or wet spell occurred and the total records (Figure 1) indicate that

① The interior western United States (west of 90-95W) is more prone to droughts or wet spells. Once drought (wet spells) occur, they are more likely to persist.

② Droughts (wet spells) are less likely to occur and persist over the eastern United States including the Ohio Valley, the East Coast and the central southeastern US

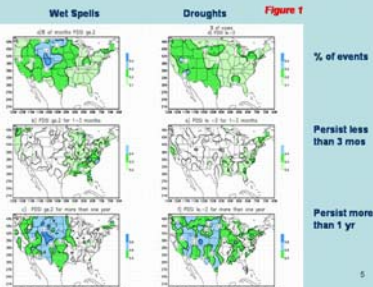


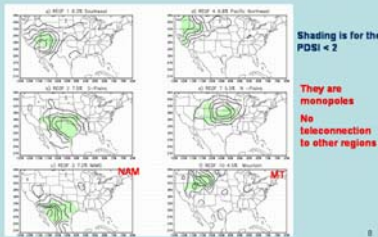
Fig. 1: Characteristic Time T_p (measures persistence)

- Long term dry or wet events are most likely to occur
- 1. over the mountain region and the northwestern Mexico.
- 2. 2nd preferred region is the Great Plains and the southwest.
- 3. T_p is small east of 90-95W.

REOFs for 6-month SPI (SPI6)

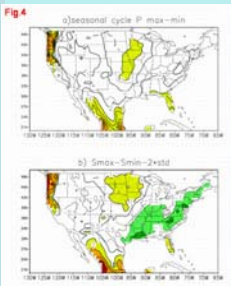
- The spatial domains for drought/wet spells are examined using the REOFs of the SPI6.
- All REOFs are monopoles (Fig.3). There is no teleconnections between the areas for droughts or wet spells even though the monthly precipitation REOFs show dipoles or three cell patterns. This means that in addition to the large scale forcing, the local influence is also important. One of the regional feature is the seasonal cycle

Fig.3 :REOFs for SPI6



Seasonal cycle

- The seasonal cycle has strong influence on the persistence of precipitation anomalies.
- It is estimated by the difference between the maximum (S_{max}) and the minimum (S_{min}) of climatological monthly means from 1948-2004 (Fig.4a).
- The uncertainties of the seasonal cycle are estimated by the standard deviations (std) of the climatological monthly means.
- If ($S_{max}-std$) is smaller than ($S_{min}+std$), then the seasonal cycle is weak and rainfall for all seasons can contribute to SPI or PDSI (Fig.4b)



Seasonal cycle

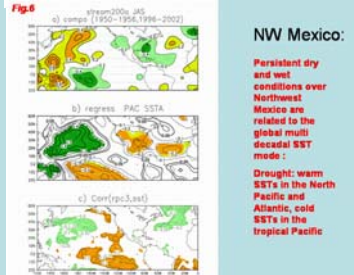
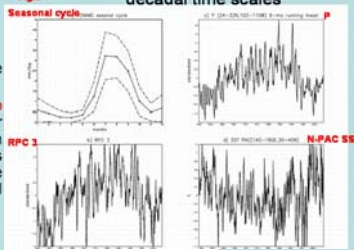
Weak seasonal cycle over the central eastern United States where drought/wet spells are least likely to occur and persist

Strong seasonal cycle over the central Plains, the northwestern Mexico and the Pacific Northwest.

Classify drought/wet spells by time scales

- Most persistent:** The Western Mountain regions and the Northwestern Mexico. They are influenced by multi-decadal modes (Fig.5-7)
- Persistent:** The Great Plains and the Southwest. Regions are influenced by interannual modes (Fig.8)
- Least persistent:** The Eastern United States, California, the Ohio Valley and the central southeastern US. Regions have weak seasonal cycle and large intra-seasonal Variability (Fig.9)

REOF 3 : Northwest Mexico decadal time scales



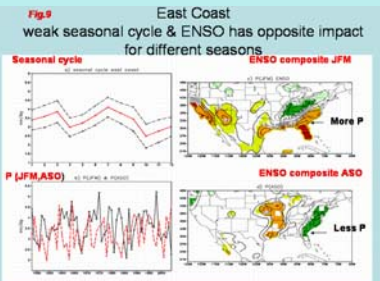
NW Mexico:

Persistent dry and wet conditions over Northwest Mexico are related to the global multi decadal SST mode

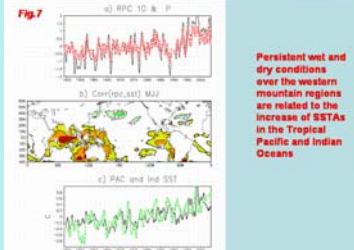
Drought: warm SSTs in the North Pacific and Atlantic, cold SSTs in the tropical Pacific

Intraseasonal time scales

- The East coast has a weak seasonal cycle so rainfall from all seasons contributes to the long term precipitation indices like the PDSI and SPI.
- ENSO often has opposite effect on rain for winter and summer. Therefore, precipitation anomalies are less likely to persist. (Fig.9)



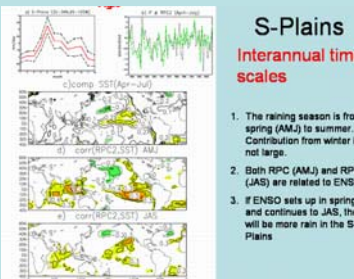
Western mountain area : decadal time scales



Persistent wet and dry conditions over the western mountain regions are related to the increase of SSTs in the Tropical Pacific and Indian Oceans

Interannual time scales

- The raining seasons over the Great Plains are spring and summer.
- Precipitation is modulated by SSTs over the Pacific for the entire raining season. An example is given in Fig.8
- For the Southwest, monsoon rainfall is modulated by both ENSO and the North Pacific SSTs which have decadal /interannual time scales.



S-Plains Interannual time scales

- The raining season is from spring (AMJ) to summer. Contribution from winter is not large.
- Both RPC (AMJ) and RPC (JAS) are related to ENSO
- If ENSO sets up in spring and continues to JAS, there will be more rain in the S-Plains

Conclusions

- The wet and dry spells are more likely to persist over the northwestern Mexico and interior western United States. They are less persistent over the areas east of (90-95 W)
- Conditions for persistent extreme events:
 - Associated with multi decadal trends or interannual modes
 - Rainfall has strong seasonal cycle

Conclusions

- Most persistent regions:** Northwestern Mexico and western mountain region
 - Strong seasonal cycle
 - Associated with multi decadal trends
- Persistent regions:** Great Plains and Southwest
 - Associated with interannual modes like ENSO or /and North Pacific SSTs
- Least persistent regions:** Central Eastern United States, East coast and the Ohio Valley
 - Rainfall has weak seasonal cycle : rainfall occurs all the time
 - ENSO has opposite impact on precipitation for different seasons.