Objective Climate Drought Monitoring over the United States

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Our Goals

- Provide users timely information and analysis on drought.
- Monitor atmospheric and hydrological conditions in support of operational Drought Monitor and Drought Outlook
- Develop regional applications in support of the NIDIS pilot project
Current status

http://www.cpc.ncep.noaa.gov/products/Drought

- Drought briefing each month to (a) bring drought forecasters and products generators together, (b) support operational Drought Monitor and Outlook
- **Current conditions:**
  - Surface conditions including soil conditions, E, P– from the ensemble NLDAS (Mitchell’s group)
  - Atmospheric conditions and budget terms: NARR
- **Forecasts:**
  - U. Washington (ESP)
  - Princeton U (downscaling from the CFS using VIC)
  - NSIPP (from NSIPP model)
Objective monitoring: Many Faces of Drought

- **Meteorological drought**: Precipitation deficit.
  Index: Standardized Precipitation Index (SPI)

- **Hydrological drought**: Stream flow or runoff deficit.
  Index: Standardized runoff index (SRI)

- **Agricultural drought**: Total soil water storage deficit.
  Index: soil moisture anomaly percentiles

*Examples are given in the next few slides based on Jun2008 conditions*
Colorado RFC

All indices pick up severe droughts

SPI – high frequency and will pick up shorter duration dry events

SM – drought lasts longer

For the eastern United States (east of 90W), all three indices are more likely to pick up same drought events.
Example: Jun 2008

1. Heavy flooding over Iowa, Mo, & Illinois in June
2. Dryness over the Southeast & Texas and California
3. This pattern persisted from April

Kansas: western Kansas: D3 drought
Eastern Kansas: Floods
1. Rainfall over the Mississippi basin influenced all SPI indices.

2. Dry: Southeast, southern Texas and California

3. Wet: Central U. S. and the upper Missouri basin (RFC 2 area)

Meteorological drought

data source: CPC gridded P from 1950–present
Agricultural drought

**EMC/NCEP**

SM percentiles Jun 2008

**Base:** 1979-2006

They all capture basic features: Drought: SE, southern Texas and California

Wetness: great Plains, But details differ

**University of Washington ensemble:**

**Base:** 1920-2003

UW: Capture Kansas condition well.

NCEP ensemble: too weak
Western Kansas Dry,
Eastern Kansas Wet
The standardized index from 3 models capture
Wetness over the Mississippi, Upper Missouri,
Dryness over the Southeast, Texas and California

Compare well with USGS stream flow
Uncertainties of the NLDAS (compare VIC and Noah 1948-2003)

Differences are regionally dependent

- Over the areas east of 90W, differences are small.
- Over the areas west of 90W, differences are large.
- The RMS error is larger than 25%: the difference between one drought class to another

Thanks: Yun Fan and Andy Wood!!

Soil moisture percentiles
Possible Reasons:

a) SM is more persistent over the west region so SM at deeper levels plays a role. That depends on model

b) Difference in precipitation. Less stations over the western mountains and different PRISM

Corr SPI3 (VIC,noah)  RMS SPI3 (VIC,Noah)
Differences between VIC and Noah

Total SM anomaly percentile for selected River Forecast Center areas

Vic (Blue), Noah (black)

From 1950-2001

1. For RFCs east of 90-95W, VIC and Noah agree. e.g. the lower Mississippi, Arkansas RFCs.

2. There are large differences over the western region. e.g. the Missouri, Colorado RFCs.

3. VIC has more high frequency components than the Noah.
Conclusions

- We have developed objective drought monitoring at the CPC in support of the Drought Monitor.
- Drought briefing reaches out to the RFC, and NWS regional offices and network with users in the United States. For long-term drought, attributions are discussed with forecasters.
- More than one index is needed to assess different aspects of drought.
- The uncertainties of NLDAS are larger over the western region than areas east of 90W.
- Over areas east of 90W, different indices based on P, SM or runoff are likely to pick up same drought events.
- Over the west region, uncertainties are too large to select drought events for less than 3 months over small areas.
Gaps

- Large differences among the NLDAS are regionally dependent: They depend on forcing, and parameterization and record length.
- Drought is a local phenomenon. The NLDAS goes down to 1/8 degrees, but they really can not resolve features at that resolution.
- Drought is persistent deficit of Precip, SM or stream flow. Long term data sets are needed.
- We need to objectively assess uncertainties of NLDAS and communicate to forecasters.