SIMULATIONS OF U.S. DROUGHTS BY GLOBAL REANALYSIS PRODUCTS AND THE IMPLICATION IN GLOBAL DROUGHT MONITORING

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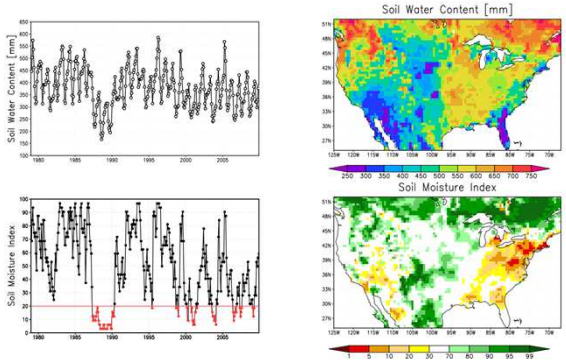
Introduction

Drought has significant impact on water resource and agriculture worldwide. Developing an Early Drought Warning System for the U.S. and other parts of the world requires a drought monitoring capability that can detect the onset , monitor the progress, and predict the recovery of drought in real-time. To achieve this, approaches based on satellite remote sensing and land surface modeling have been were explored in previous studies.

Several global reanalysis products were released to the public recently, including the NCEP CFSR (Saha et al, 2010) , NASA MERRA (Rienecker et al., 2011) and ERA-Interim (Dee, 2011). In this ongoing study, we explore the possibility of using these global reanalysis products and their real-time extensions for global drought monitoring. We compare the simulation of U.S. historical droughts by these global reanalysis products and the simulation from North American Land Data Assimilation System (NLDAS), and discuss the possible use of these global reanalysis products in real-time drought monitoring and potential issues.

SPI and Soil Moisture Index

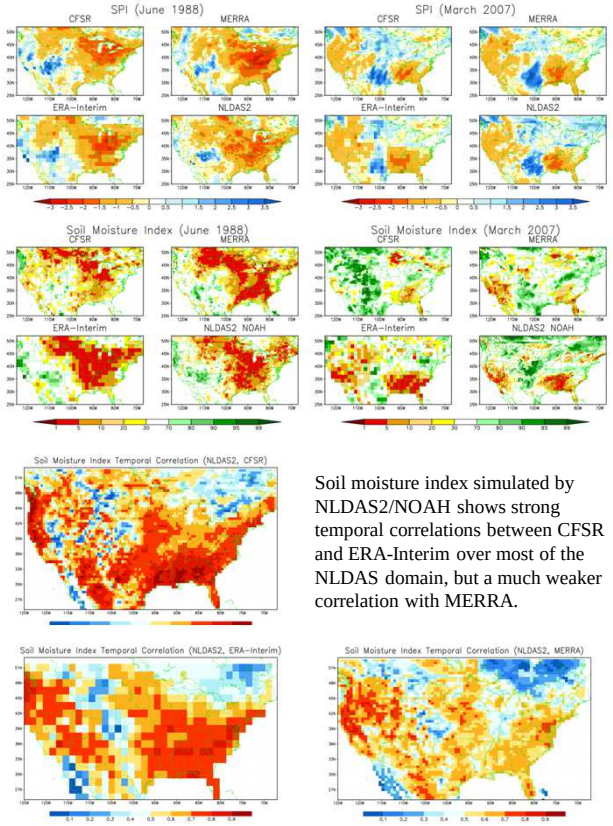
We use Standardized Precipitation Index (SPI) and soil moisture index to quantify meteorological droughts and agricultural droughts. The soil moisture index is expressed as a percentile value of the monthly (or daily) soil moisture (root-zone or top 2-meter) with respect to its climatological probability distribution. The climatological distribution at each grid is estimated from the 30-year simulation in the global reanalysis or the NLDAS2 land surface models. The following figures illustrate how soil moisture index differs from the original soil moisture values.



Previous studies have used 20th percentile as the threshold to determine whether a region is in drought. Since soil moisture index is a relative measure, regions with higher soil water content can be considered in drought while other regions with lower soil water content are not.

Simulation of U.S. Drought Events

The SPI and soil moisture index are derived for drought events over the U.S. The precipitation fields are more similar than soil moisture among all products. CFSR soil moisture index failed to reproduced the drought over California during early 2007.



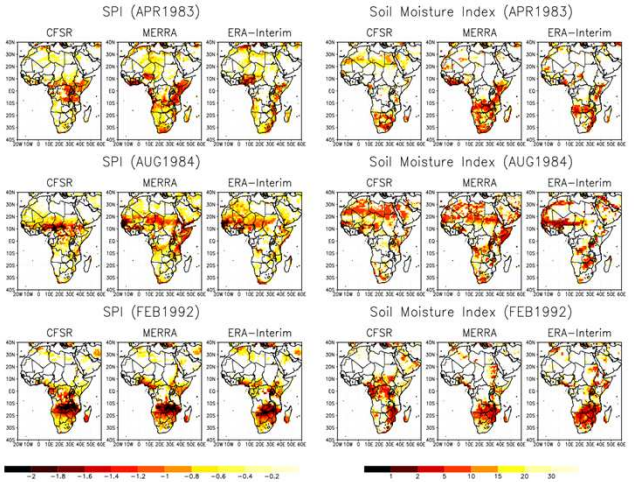
Soil moisture index simulated by NLDAS2/NOAH shows strong temporal correlations between CFSR and ERA-Interim over most of the NLDAS domain, but a much weaker correlation with MERRA.

Summary and Conclusions

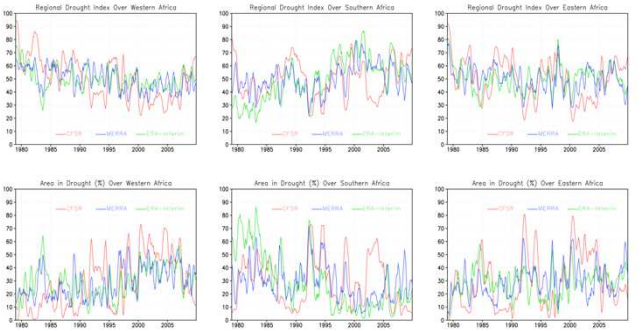
- When drought is measured SPI, the three global reanalysis products show more agreement both spatially and temporally in depicting droughts in the US.
- Soil moisture fields from global reanalysis products can be used to analysis and monitor regional to continental scale drought events. For smaller scale drought episodes, high resolution hydrological modeling is necessary.
- The disparity in soil moisture index between reanalysis can be significant. In some cases, one reanalysis can completely miss a regional drought event.
- It is necessary and beneficial to develop real-time global drought monitoring capability using the real-time extensions of multiple global reanalysis, which can potentially improve the accuracy and robustness of drought detection.

Simulation of Global Drought

Here we compare SPI and soil moisture index derived from the three global reanalysis products for selected periods when several drought events took places over parts of Africa.



The drought index based on soil moisture is used to determine the severity and areal coverage of droughts. Although most of the time the three global reanalysis products agree with each other reasonably well, there are occasions where CFSR is significantly different from MERRA and ERA-Interim, which suggests a real-time drought monitoring with multiple global reanalysis products should be more reliable.



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