NEAR-REAL-TIME GLOBAL DAILY DROUGHT DETECTION AND MONITORING

Olivier Prat[1], David Coates[1], Scott Wilkins[1], Denis Willett[1], Ronald Leeper[1], Brian Nelson[2], Michael Shaw[3], and Steve Ansari[4]

INTRODUCTION

- In many locations, a lack of timely, localized drought information, including data on the amount of precipitation that would be required to ameliorate drought conditions, makes it difficult to plan and manage drought response efforts.
- Three gridded daily precipitation datasets from satellite (CMORPH, IMERG) and in situ (NClimGrid) observing platforms are used to compute global and CONUS-wide standardized precipitation index (SPI) values for various time scales (1- to 36-month).
- Cloud-scale computing decreases computational time and allows for process optimization for daily updates of drought conditions.
- A drought amelioration module, run subsequently to the SPI, quantifies the amount of precipitation needed to alleviate drought conditions as a function of drought severity and accumulation periods.

RESULTS

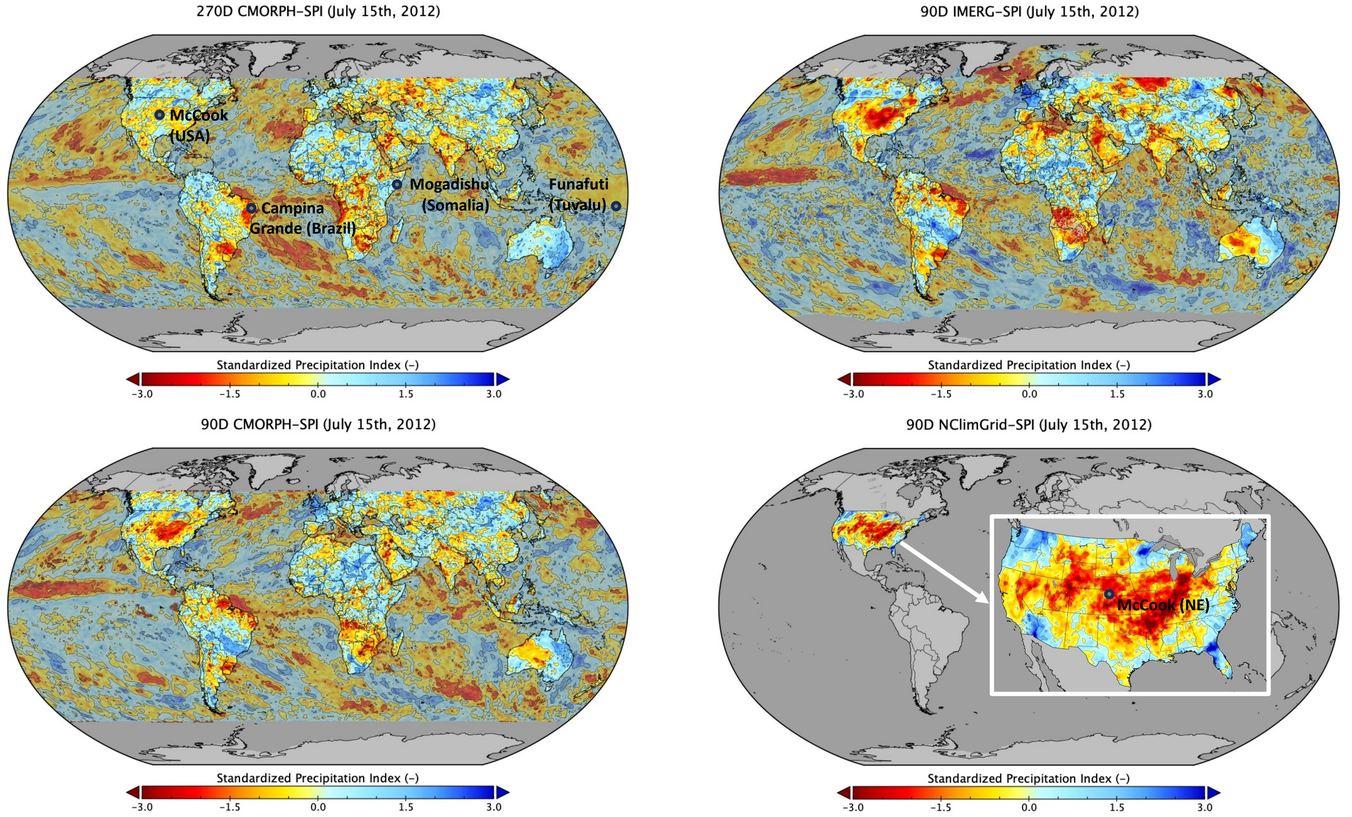
- A suite of global drought monitoring tools provides users with near-real-time, high-resolution precipitation and drought information.
- Near-real-time daily global SPI derived from CMORPH (global; 1998-present; 0.25°x0.25°) is available for operational drought monitoring (*https://www.drought.gov/data-maps-tools/cmorph-drought-indices*).
- CONUS-wide NClimGrid-SPI (CONUS; 1951-present; 0.05°x0.05°) provides 70 years of daily drought conditions and allows derivation of long-term statistics on drought occurrences, duration, and severity.
- IMERG (global; 2000-present; 0.1°x0.1°) provides a higher resolution global SPI than CMORPH-SPI (i.e., 6-fold increase).

Authors' Affiliations

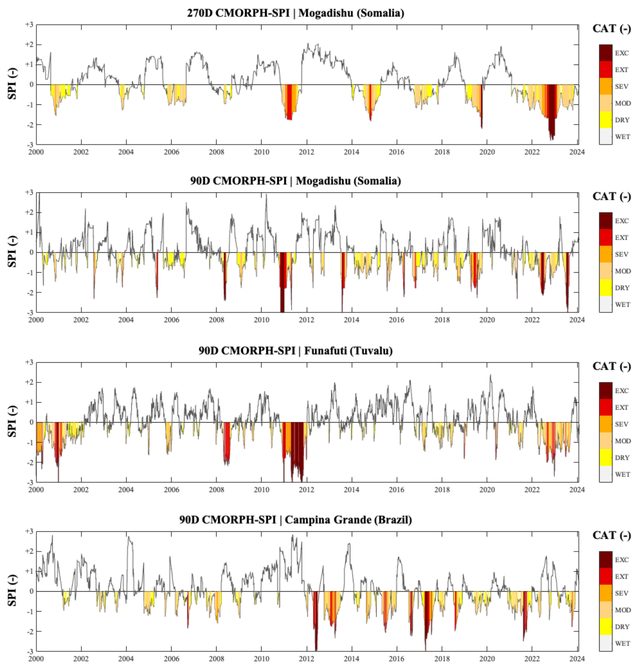
[1]Cooperative Institute for Satellite Earth System Studies (CISESS), North Carolina State University, Asheville, NC, USA. [2]NOAA/NCEI/Center for Weather and Climate, Asheville, NC, USA. [3]ISciences, L.L.C., NCEI, Asheville, NC, USA. [4]NOAA/NCEI/NIDIS, Asheville, NC, USA.

Contact information: opprat@ncsu.edu

A) DAILY DROUGHT CONDITIONS

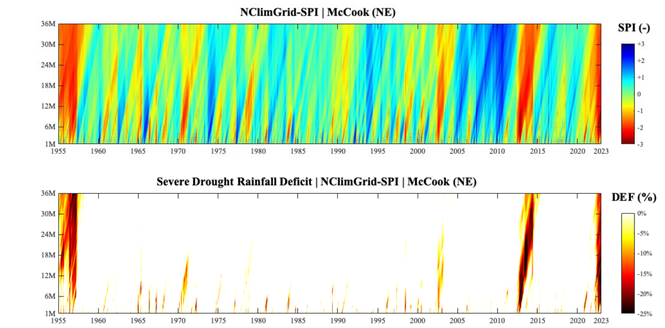


B) HISTORICAL DROUGHT CONDITIONS

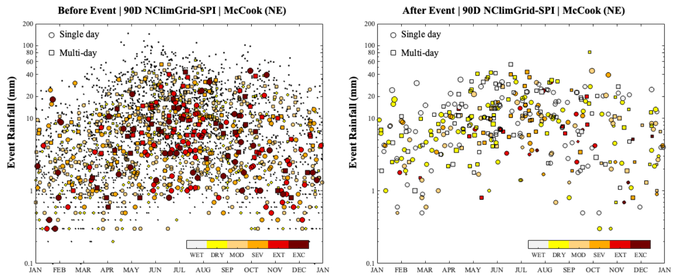


CMORPH-SPI time series for selected locations around the globe for 90-day and 270-day accumulation scales. Drought episodes are indicated as a function of their severity using the USDM classification: abnormally dry (DRY: −0.5 ≤ SPI < −0.8), Moderate (MOD: −0.8 ≤ SPI < −1.3), severe (SEV: −1.3 ≤ SPI < −1.6), extreme (EXT: −1.6 ≤ SPI < −2), and exceptional (EXC: SPI ≤ −2).

C) RAINFALL DEFICIT ESTIMATION

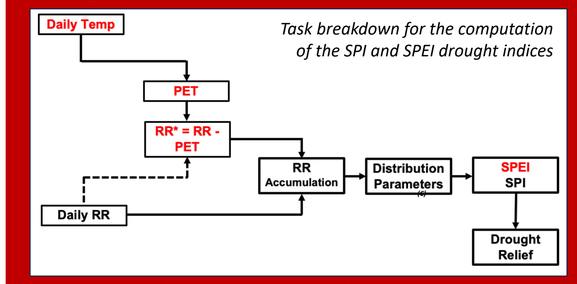


(top) NClimGrid-SPI for a continuum of accumulation scales from 1-month to 36-month for McCook (Nebraska, USA). (bottom) Rainfall deficit with respect to severe drought classification (−1.3 ≤ SPI < −1.6) expressed as percent of normal precipitation.



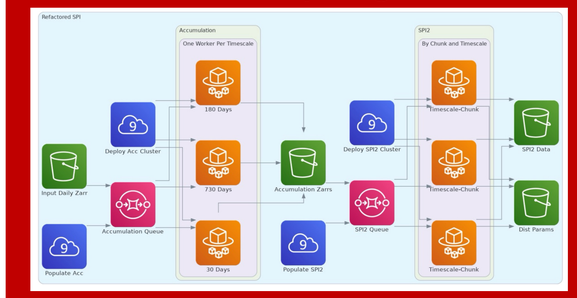
(left) NClimGrid-SPI 90-day drought conditions for McCook (NE, USA) observed before a rainfall event (single day, multi-day) as a function of the day of the year and the event total rainfall. (right) NClimGrid-SPI 90-day drought conditions observed after the rainfall event. Only the rainfall events leading to changes in the drought conditions are displayed.

Drought Index Computation Framework



Task breakdown for the computation of the SPI and SPEI indices. The process consists in the computation of multi-day rainfall accumulation, distribution parameters, and drought indices.

Cloud-based SPI Computing



Task breakdown for the SPI source code adapted to the Amazon Web Services (AWS) cloud. The computational process is divided into three phases: file preparation (pre-processing), drought indices computation (accumulation periods, distribution parameters, SPI and SPEI computation), and output files finalization (size reduction, retiling, concatenation).

POLICY MESSAGES

- **Assessing Near-real-time Drought Conditions:** The global-scale, high-spatial-resolution SPI and near-real-time updates provide more localized and timely information on drought onset and amelioration.
- **Estimating Rainfall Deficit:** The drought relief module estimates rainfall deficits with respect to drought classification. The visualization of drought propagation across a continuum of accumulation scales (1- to 36-month) allows to evaluate the likelihood of any deviation from normal rainfall conditions evolving into long-term drought.
- **Optimizing Computing Process:** The serverless pipeline developed leveraging AWS cloud computing resources makes it possible to calculate near-real-time global daily drought conditions and monitor drought evolution at an unprecedented pace.
- **Transitioning from Research to Operation:** The near-real-time global CMORPH-SPI has been transitioned from research to operation. Other drought products (NClimGrid-SPI, IMERG-SPI) will be integrated into NOAA's drought portfolio.
- **Extending Drought Monitoring Capabilities:** The flexible framework can be extended to other datasets (satellite, radar, in situ), drought indices (agricultural, hydrological), and rainfall model predictions (sub-seasonal, seasonal) for drought forecasting.