CPC Global Drought Early Warning System For Food Security : An Application Case of GEFSv12 and NMME

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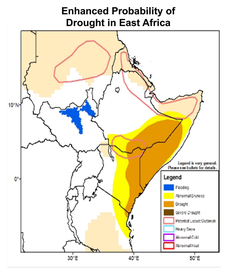
ABSTRACT

Drought is a major focus of the Climate Prediction Center (CPC) International Desks (ID) for the global Famine Early Warning Systems Network (FEWS Net). Objective drought monitors and accurate subseasonal-to-seasonal (S2S) drought forecasts are essential for drought early warning system (DEWS) for food security. To address United States Agency for International Development (USAID) and other international stakeholder's needs, NOAA CPC international desk (ID) has been actively conducting research and development to improve its global drought monitor and forecast products and capability. Currently, in the CPC we have established a near real-time drought monitor system cover the whole globe based on the different drought aspects, i.e., meteorological drought, agriculture drought and hydrological drought. However, the capability for drought forecast is still relative weak and need further ongoing development, in particular the probabilistic S2S drought outlooks. Current objective drought forecasts are heavily relying on dynamical model NCEP GEFSv12 and NMME forecast, and the drought forecast skills are limited by the performance of current forecast systems. Based on the GEFSv12 forecast, we have developed the objective drought forecast, including Standardized Precipitation indies (SPIs), Standardized Precipitation-Evaporation Indices (SPEIs) and Evaporative Demand Drought Indices (EDDIs). These drought monitor and forecast products consist of the key components of CPC global drought service capability. In this presentation, we will discuss current major issues and challenges we use the NCEP S2S forecast system. For any improving in future S2S forecast systems, i.e. GEFSv13 and SFS, will be greatly advance the global drought early warning capability at CPC.

OBJECTIVE

Background on CPC International Desks

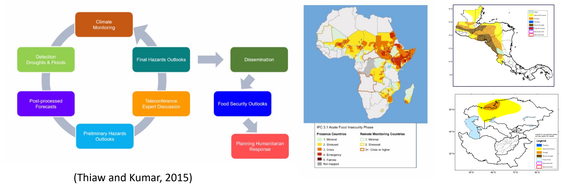
- The CPC African Desk was established in 1994 at CPC to provide support for the prolonged drought in the Sahel.
- The CPC International Desks were an evolution of the African Desk services to the rest of the developing world including central Asia, and central America in order to meet needs of the United States Agency for International Development (USAID).



Food Security Early Warning

FEWS NET
Famine Early Warning Systems Network

Integrating weather, climate, and land information to inform humanitarian response planning.



(Thiaw and Kumar, 2015)

- CPC International Desk issues hazards outlooks that integrate weather, climate, land surface information and global model forecasts.
- Drought is one of the dominant natural hazards that could devastate many economic sectors, especially in the developing world.
- Drought monitors and outlooks are primary input for the FEWS NET food security outlooks that help decision makers plan for and respond to humanitarian crisis

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DROUGHT MONITORS

Drought：Convergence of Evidences

- Meteorological drought
  - Precipitation deficient (anomalous, anom. percent etc.) at multiple time scale, from 1week to 2 years
  - Multiple data source: gauge based, satellite retrieval etc.
  - Standardized Precipitation Indices (SPIs), from 1,3,6,12 to 24 months accumulated Prcp
  - Standardized Precipitation-Evapotranspiration Index (SPEI) (Vicente-Serrano et al. 2010)
- Hydrological Drought
  - Standardized Runoff Indices (SRIs)
- Agricultural Drought
  - Soil Moisture anomalies and tendencies
  - Soil Moisture Percentile (SMP)
- Evapotranspiration related drought indices
  - Evaporative Demand Drought Index (EDDI): (Hobbins et al. 2016)
  - Evaporative Stress Index (ESI)
- Vegetation Health Index (VHI)

Objective Drought Categories

Category	Description	Possible Impacts	Ranges: Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Objective Drought Indicator Blends (Percentiles)
D0	Abnormally Dry	Going into drought: • short-term dryness slowing planting, growth of crops or pastures Coming out of drought: • some lingering water deficits • pastures or crops not fully recovered	-1.0 to -1.9	21 to 30	21 to 30	-0.5 to -0.7	21 to 30
D1	Moderate Drought	• Some damage to crops, pastures • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested	-2.0 to -2.9	11 to 20	11 to 20	-0.8 to -1.2	11 to 20
D2	Severe Drought	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed	-3.0 to -3.9	6 to 10	6 to 10	-1.3 to -1.5	6 to 10
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions	-4.0 to -4.9	3 to 5	3 to 5	-1.6 to -1.9	3 to 5

The same as the NDMC standard, but without exceptional drought (D4) due to observational records limitation.

Drought Impacts for food security

D0 - Abnormally Dry
- Short-term dryness slowing planting, growth of crops or pastures.
- Some lingering water deficits
- Pastures or crops not fully recovered

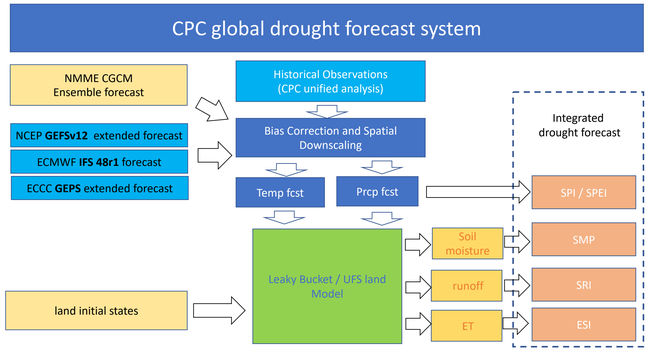
D1 - Moderate Drought
- Some damage to crops, pastures
- Streams, reservoirs, or wells low, some water shortages developing or imminent
- Voluntary water-use restrictions requested

D2 - Severe Drought
- Crop or pasture loss likely
- Water shortages common
- Water restrictions imposed

D3 - Extreme Drought
- Major crop/pasture losses
- Widespread water shortages or restrictions

D4 - Exceptional Drought
- Exceptional and widespread crop/pasture losses
- Shortages of water in reservoirs, streams, and wells creating water emergencies

DROUGHT OUTLOOKS



Global Sub-seasonal drought outlooks

Based on **GEFSv12 extended forecast** (00Z initial daily, 31 ensembles, forecast up to 840h)

Driven Leaky Bucket Model

1. Soil Moisture Percentile (SMP) forecast
2. SPI1,SPI3,SPI6 forecast
3. SPEI1, SPEI3,SPEI6 forecast
4. SRI1 and SRI3 forecast
5. ESI1 and ESI3 forecast

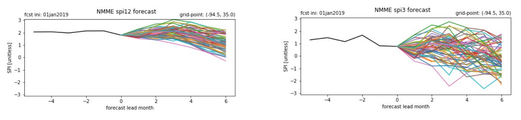
Focus on the flash drought (rapid onset drought) and monthly drought outlook

Soil Moisture Percentile (SMP) forecast

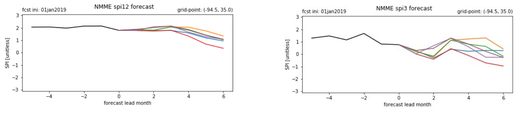
Regions:	Week1	Week2	Week3	Week4	Week5
Africa					
Central_America					
Central_Asia					
South_Asia					
Southeast_Asia					

SPI Forecast plumes

60 ensemble members

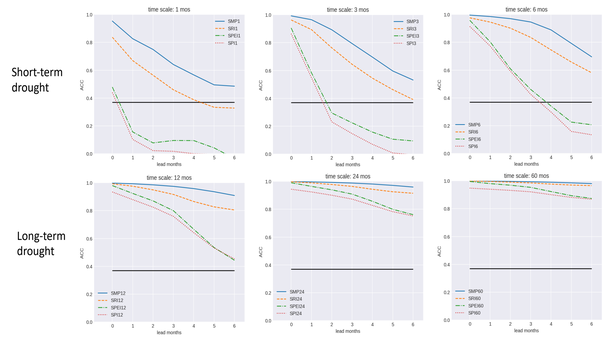


6 model mean

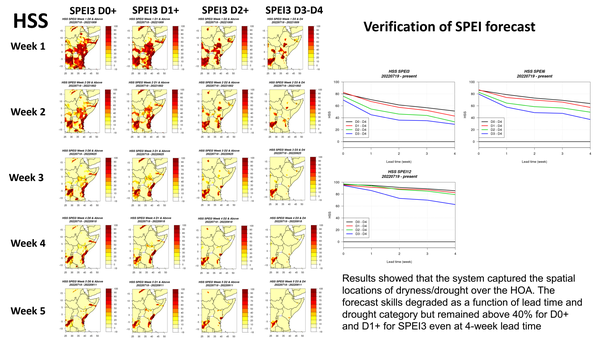


PERFORMANCE EVALUATION

Lead 0-6 months drought forecast : Jan IC for 1991-2020 CONUS mean ACC

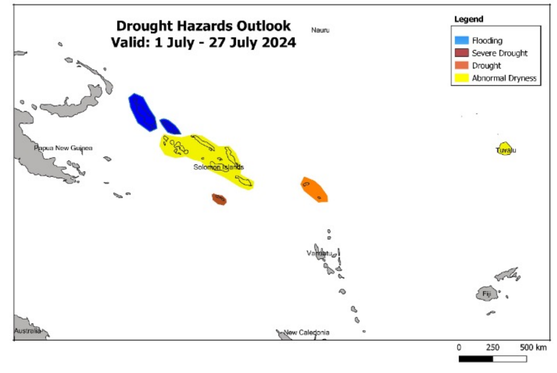


Skills of S2S prediction: SMP > SRI > SPEI > SPI



Results showed that the system captured the spatial locations of dryness/drought over the HOA. The forecast skills degraded as a function of lead time and drought category but remained above 40% for D0+ and D1+ for SPEI3 even at 4-week lead time

PREPARE PACIFIC EARLY WARNING WORKSHOP



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