Implementation of subseasonal drought monitoring from NCMRWF Extended Range Prediction System

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1. Background

Drought is a natural phenomenon characterized by an extended period of abnormally dry weather conditions, resulting in a significant water shortage. Consequently, drought poses a significant threat to water resources, including surface water and groundwater reserves resulting in a deficit water supply for irrigation, drinking water, and industrial use with heavy consequences for the local population. Hence, drought planning and management is essential to developing early warning systems, and drought response strategies that can enhance resilience and aid in proactive decision-making. The countries like India where the livelihood of 60% of the population depends on agriculture, drought is one of the most feared natural calamities as it impacts food production, economy, and morale of millions of farmers in the country. More importantly, recent studies stressed on flash droughts are characterized by rapid onset and intensification, unfolding on sub-seasonal to seasonal (S2S) time scales. To monitor and assess drought conditions, various tools and indices are used, including the Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI) etc. The SPI was designed to quantify the rainfall deficit to monitor drought conditions on a range of time scales. This temporal flexibility allows SPI to be useful in short-term agricultural and long-term hydrological applications. Therefore, we strategically started the drought monitoring system using the SPI estimated based on National Centre for Medium Range Weather Forecasting (NCMRWF) Extended Range Prediction (NERP) System. The following section discusses briefly the NERP modelling system.

2. NCMRWF Extended Range Prediction System

The NERP model configuration is based on the UK Met Office GloSea5 seasonal prediction system in Global Coupled 2.0 configuration (GC2.0; documented in Williams et al., 2015). The model is a fully global coupled S2S ensemble system consisting of Global Atmosphere 6.0 (GA6.0) and Global Land 6.0 (GL6.0), GlobalOcean 5.0 (GO5.0) and Global Sea Ice 6.0 (GSI6.0) (Walters et al., 2017; Gupta et al., 2019 and references therein). The atmospheric model is non-hydrostatic and fully compressible with semi-implicit semi-Lagrangian discretization to solve equations of motion. The model has a terrain-following hybrid-height coordinate system with a horizontal resolution of $0.833^{\circ} \times 0.556^{\circ}$ having 85 vertical levels covering up to 85 km. The NERP operational model has 16 ensemble members obtained from the lagged initial conditions of 4 consecutive preceding days with 4 physically perturbed members generated for each day. The first lagged daily initial condition begins every Sunday and continues until Wednesday every week (Figure 1). The model is integrated into a forecast length of 36 days.

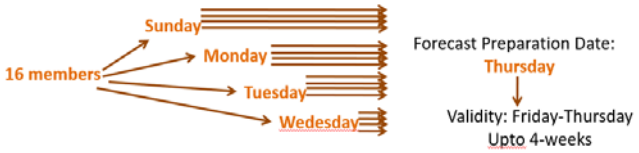

Figure 1 *Schematic representing the forecast generation from NERP operational model*

3. Multiscalar SPI Drought Outlook

The SPI is calculated by fitting a gamma distribution to the historical precipitation record at each grid location, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero (McKee et al., 1993). The positive SPI and negative values represent wet and dry conditions, respectively. The 16-member ensemble mean rainfall is used for computing the SPI drought on weekly/multi-weekly scales. A sample chart of the multi-scalar SPI drought chart released on May 04, 2023, is shown in Figure 2. The drought severity is labelled based on the classification defined by the World Meteorological Organization (WMO). The drought chart indicates the spatiotemporal evolution of drought on weekly scales to multi-week scales that are updated every Friday on www.ncmrwf.gov.in -> Products ->Drought.

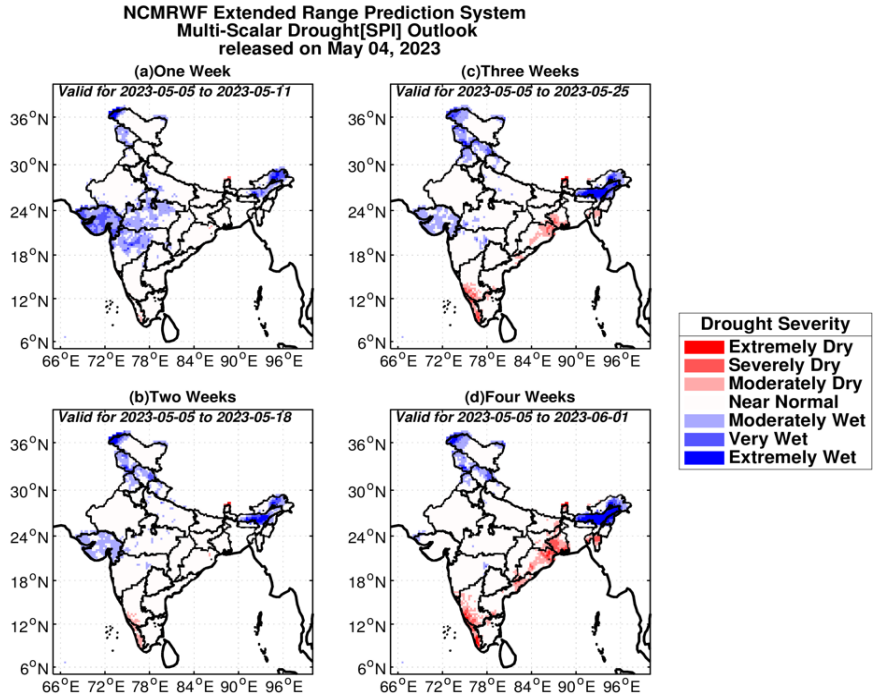

Figure 2 *Multi-scalar SPI drought index computed using the NCMRWF extended range prediction system. The climatological distribution is obtained from the India Meteorological Department (IMD) gridded data*

4. References

[1]. Williams, K. D., Harris, C. M., Bodas-Salcedo, A., Camp, J., Comer, R. E., et al. (2015), The Met Office Global Coupled model 2.0 (GC2) configuration, Geosci. Model Dev., 8, 1509–1524, https://doi.org/10.5194/gmd-8-1509-2015

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