IAHS2022-254, updated on 01 Feb 2023
https://doi.org/10.5194/iahs2022-254
IAHS-AISH Scientific Assembly 2022

Multiscale analysis of soil moisture variability for a typical semi-arid Mediterranean ecosystem

Roberto Corona[1], Nicola Montaldo[1], and Gabriel G. Katul[2]
[1]Department of Civil Engineering, Environmental and Architecture, University of Cagliari, Italy (roberto.corona@unica.it)
[2]Department of Civil and Environmental Engineering, Duke University, Durham, North Carolina, USA

Soil moisture content influences the partitioning of net radiation into latent and sensible heat fluxes that, in turn, affect the dynamics of the atmospheric boundary layer depth and concomitant generation of precipitation. The interactive effect between soil moisture and precipitation has been found to be stronger in areas where soil moisture temporal variability is enhanced such as in arid and semiarid regions, and in transitional regions between dry and wet climate. For this reason, variability in soil moisture at multiple time scales continues to draw attention in climate science and hydrology. In this work, the soil moisture variability at multiple scales for a typical Mediterranean ecosystem, has been quantified using the spectrum of soil moisture.

The case study is the Orroli site in Sardinia (Italy), a typical semi-arid Mediterranean ecosystem which is an experimental site for the ALTOS European project of the PRIMA MED program.

The spectrum of root-zone soil moisture content for this Mediterranean ecosystem is analyzed using 14-years of half-hourly measurements. A distinguishing hydro-climatic feature in such ecosystems is that sources (mainly rainfall) and sinks (mainly evapotranspiration) of soil moisture are roughly out of phase with each other. For over 4 decades of time scales and 7 decades of energy, the canonical shape of the measured soil moisture spectrum is shown to be approximately Lorentzian determined by the soil moisture variance and its memory but with two exceptions: the occurrences of a peak at diurnal-to daily time scales and weaker peak at near annual time scales. Model calculations and spectral analysis demonstrate that diurnal and seasonal variations in hydroclimate forcing responsible for variability in evapotranspiration had minor impact on the normalized shape of the soil moisture spectrum. However, their impact was captured by adjustments in the temporal variance. These findings indicate that precipitation and not evapotranspiration variability dominates the multi-scaling properties of soil moisture variability consistent with prior climate model simulations.