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Investigating temporal field sampling strategies for site-specific calibration of three soil moisture - neutron flux interaction models

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Soil moisture is an important state variable in land-atmosphere interaction and hydrological processes. The novel Cosmic-Ray Neutron Sensor (CRNS) can be used to determine soil moisture at the sub-kilometre scale, which is relevant to these processes. The CRNS is usually calibrated with soil moisture samples taken on a single day. We investigated whether using data from only one day can be sufficient and, if not, how many days would be needed to obtain a reliable calibration. Therefore temporal sampling strategies for calibration of three widely used soil moisture - cosmic-ray neutron interaction models were investigated for three distinct sites: an arid site in Arizona (USA), a temperate humid grassland and a temperate humid spruce forest, both located in Germany. First, the effects of the number of sampling days on the calibration results were analysed and the effects of different soil wetness conditions of the sampling days on the quality of the calibration results were then investigated. Independent point-scale (TDT) soil moisture measurements from a sensor network were used as input to all three models. Simulated neutron intensity was then compared against measurements from cosmic-ray sensors at all sites. It was found that, if wetness conditions were not taken into account, collecting soil moisture samples on more than one day is needed to obtain a reliable calibration result, regardless of which model is used. We typically find that two to four days are normally sufficient. Sampling on days or combinations of days with appropriate wetness conditions for specific sites can reduce the needed number of sampling days. What appropriate wetness conditions are, differs between sites and different soil moisture – cosmic-ray neutron interaction models.