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Spatial analysis of sunshine duration by combination of satellite and station data

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Sunshine duration can exhibit rich fine scale patterns associated with special meteorological phenomena, such as fog layers and topographically triggered clouds. Networks of climate stations are mostly too coarse and poorly representative to resolve these patterns explicitly. We present a method which combines station observations with satellite-derived cloud-cover data to produce km-scale fields of sunshine duration. The method is not relying on contemporous satellite information, hence it can be applied over climatological time scales. We apply and evaluate the combination method over the territory of Switzerland.

The combination method is based on Universal Kriging. First, the satellite data (a Heliosat clear sky index from MSG, extending over a 5 year preiod) is subjected to a S-mode Principal Component (PC) Analysis. Second, a set of leading PC loadings (seasonally stratified) is introduced as external drift covariates and their optimal linear combination is estimated from the station data (70 stations). Finally, the stochastic component is an autocorrelated field with an exponential variogram, estimated climatologically for each calendar month.

For Switzerland the leading PCs of the clear sky index depict familiar patterns of cloud variability which are inhereted in the combination process. The resulting sunshine duration fields exhibit fine-scale structures that are physically plausible, linked to the topography and characteristic of the regional climate. These patterns could not be inferred from station data and/or topographic predictors alone. A cross-validation reveals that the combination method explains between 80-90% of the spatial variance in winter and autumn months. In spring and summer the relative performance is lower (60-75% explained spatial variance) but absolute errors are smaller. Our presentation will also discuss some results from a climatology of the derived sunshine duration fields.