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Reliable Averages and Risky Extremes - Analysis of spatio-temporal variability in solar irradiance and persistent cloud cover patterns over Switzerland

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With the perspective of Switzerland's phase-out from nuclear energy, solar energy potential may take a leading role for the country's future in renewable energy. Unlike nuclear power stations, photovoltaic (PV) production is prone to intermittency as it depends on the immediate solar irradiance, which fluctuates in space and time. If a large percentage of Switzerland's electricity was to be derived from solar radiation, stochastic fluctuations pose a risk to the robust supply and healthy function of the electricity network. For most efficient PV planning and siting, it is hence imperative to understand and quantify this variability in solar radiation, in order to anticipate average production as well as worst-case scenarios.

Based on 12 years of satellite derived, spatially distributed data of daily average surface incoming shortwave radiation (SIS) this work analyses standard statistics, spatial correlation patterns and extreme conditions of cloud cover over Switzerland. Having compared different irradiance products, we decided to use the SIS product captured on the Meteosat Second Generation satellites, because it provides the most reliable snow/cloud discrimination, which is essential for spatial analysis over alpine terrain. Particularly in regions with high elevation differences, correlation between cloud cover and elevation undergo an annual cycle. In winter more clouds are found in the valleys, while in summer convective clouds dominate at higher elevations.

The highest average irradiance values occur in the southern parts of the country, and make the cantons of Vallais, Tessin and Grison ideal candidate locations for PV installations. Simultaneously the Tessin shows a higher risk of periods with long lasting cloud cover, which would discourage from relying too much on solar power in that area. However looking at the question of suitability by studying spatial and temporal correlations of extremes, we see that the Tessin appears to be comparably decoupled from the rest of the country, and leads us to believe that this zone plays a valuable role in compensating temporary deficits in solar production from other regions of the country.
This is just one of many example that highlight the complexity of spatio-temporal variability in solar irradiance and its implications for a reliable electricity supply in a future renewable Switzerland.