



## Wind shear enhances soil moisture influence on rapid thunderstorm growth

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Convective storms can develop rapidly, creating hazards to local populations via intense precipitation, strong winds and lightning. The large-scale environment in which thunderstorms develop is often well-captured in forecast systems yet predicting where individual storms will initiate remains a fundamental challenge. It is known that differential heating driven by soil moisture patterns creates atmospheric circulations which favour convective initiation over drier soils, whilst wind shear between low and mid-levels can enhance upscale storm growth.

Here we show that the most explosive initiations are especially favoured over soil moisture contrasts via an interaction with wind shear. Analysing 2.2 million afternoon convective initiations across Sub-Saharan Africa identified from Meteosat Second Generation imagery for the period 2004-2023, we find that stronger low-level directional wind shear systematically enhances the sensitivity of convective initiations to underlying soil moisture gradients (as identified by combining ERA5 wind fields, MSG land surface temperature and Advanced Scatterometer soil moisture). We detect 68% more initiations classed as extreme given favourable (versus unfavourable) soil conditions, with the most rapidly deepening clouds occurring where soil moisture-induced circulations oppose the direction of mid-level cloud displacement. We propose this configuration promotes wider, more resilient updraughts capable of overcoming shear-enhanced entrainment. Furthermore, where mid-level wind opposes the low-level flow, we find subsequent rainfall to be strongly correlated with locally drier soils as developing rainy clouds follow the mid-level wind direction. Whilst such shear conditions are particularly common over Tropical North Africa, the effect favours negative soil moisture-precipitation feedbacks globally. The combination of soil moisture heterogeneity and wind shear provides a potentially important source of predictability for where deep convection develops, particularly for the most rapidly-developing thunderstorms.