Accounting for non-rainfall moisture and temperature improves litter decay model performance in a fog-dominated dryland system

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Historically, ecosystem models have treated rainfall as the primary moisture source driving litter decomposition. In many arid and semi-arid lands, however, non-rainfall moisture (fog, dew, and water vapor) plays a more important role in supporting microbial activity and carbon turnover. To date though, we lack a robust approach for modeling the role of non-rainfall moisture in litter decomposition. We developed a series of simple litter decay models with different moisture sensitivity and temperature sensitivity functions to explicitly represent the role of non-rainfall moisture in the litter decay process. To evaluate model performance, we conducted a 30-month litter decomposition study at 6 sites along a fog and dew gradient in the Namib desert, spanning almost an eightfold difference in non-rainfall moisture frequency. Litter decay rates in the field correlated with fog and dew frequencies but not with rainfall. Including either temperature or non-rainfall moisture sensitivity functions improved model performance, but the combination of temperature and moisture sensitivity together provided more realistic estimates of litter decomposition than relying on either alone. Model performance was similar regardless of whether we used continuous moisture sensitivity functions based on relative humidity or a simple binary function based on the presence of moisture, although a Gaussian temperature sensitivity outperformed a monotonically increasing Q(10) temperature function. We demonstrate that explicitly modeling non-rainfall moisture and temperature together is necessary to accurately capture litter decay dynamics in a fog-affected dryland system and provide suggestions for how to incorporate non-rainfall moisture into existing Earth system models.
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