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Atmospheric water vapor as driver of litter decomposition during rainless seasons

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Litter production in many drought-affected ecosystems coincides with the beginning of an extended season of no or limited rainfall. Because of lack of moisture litter decomposition during such periods has been largely ignored so far, despite potential importance for the overall decay process in such ecosystems. To determine drivers and extent of litter decay in rainless periods a litterbag study was conducted in Mediterranean shrublands, dwarf shrublands and grasslands. Heterogeneous local and common straw litter was left to decompose in open and shaded patches of various field sites in two study regions. Fresh local litter lost 4-18% of its initial mass over about 4 months without rainfall, which amounted to 15-50% of total annual decomposition. Lab incubations and changes in chemical composition suggested that litter was degraded by microbial activity, enabled by absorption of water vapor from the atmosphere. High mean relative humidity of 85% was measured during 8-9 h of most nights, but the possibility of fog deposition or dew formation at the soil surface was excluded. Over 95% of the variation in mass loss and changes in litter nitrogen were explained by characteristics of water-vapor uptake by litter. Photodegradation induced by the intense solar radiation was an additional mechanism of litter decomposition as indicated by lignin dynamics. Lignin loss from litter increased with exposure to ultraviolet radiation and with initial lignin concentration, together explaining 90-97% of the variation in lignin mass change.
Results indicate that water vapor is a driver of litter decay which has been ignored so far. Water-vapor absorption presumably enables microbial degradation, which, together with solar radiation and litter quality, controls decomposition and changes in litter chemistry during rainless seasons. Warmer and drier conditions as a consequence of climate change will result in enhanced drying of litter layers also outside currently classified drylands. In addition, land-use change, e.g. logging, and fire open up plant canopies and significantly enhance dehydration of litter. With a large part of the land area affected by climate change, land-use change and/or fire, drying of litter layers is probably already a common phenomenon and might be more so in the future. Therefore, absorption of water vapor might play a role in decomposition and nutrient cycling in an increasing number of ecosystems.