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Effects of solar dimming on soil moisture trends

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Soil moisture variations depend principally on variations of the two main surface forcings, precipitation and solar radiation. While much attention in the past has been paid to precipitation variations, only recently have solar radiation data sets allowed analysis of their effects. Using the longest soil moisture data set in the world, 47 yr of April-October in situ observations for the Ukraine, 1958-2004, we previously noted that an upward trend in summer soil moisture for the first half of the period cannot be explained simply by precipitation trends for the region. Recent observations of solar insolation in the region have discovered a phenomenon labeled "solar dimming," a downward trend in incoming solar radiation due to the effects of tropospheric aerosol pollution on direct solar radiation and indirectly on cloud properties. The observed time series of solar radiation is a mirror image of the soil moisture curve, and also matches an observed downward trend in pan evaporation. To investigate how strong this effect may be on soil moisture, we conducted off-line simulations with the Noah land surface model over the domain, 22-40˚E, 46-52˚N. A control run using a standard forcing data set, which did not explicitly include solar dimming effects due to aerosols, did not produce the observed trends. We then modified the standard forcing by imposing downward trends on the incoming solar radiation for the first half of the period to simulate solar dimming. The results produce an improved simulation of the observed soil moisture trends and serve to quantify the effects of solar radiation trends on land surface hydrology.