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Semi-direct dynamical and radiative effect of North African dust transport on lower tropospheric clouds over the subtropical North Atlantic in CESM 1.0

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This study uses a century length pre-industrial climate simulation by the Community Earth System Model (CESM 1.0) to explore statistical relationships between dust, clouds and atmospheric circulation, and to suggest a semi-direct dynamical, rather than microphysical, mechanism linking subtropical North Atlantic lower tropospheric cloud cover with North African dust transport. The length of the run allows us to account for interannual variability of dust emissions and transport downstream of North Africa in the model. CESM's mean climatology and probability distribution of aerosol optical depth in this region agrees well with available AERONET observations. In addition, CESM shows strong seasonal cycles of dust burden and lower tropospheric cloud fraction, with maximum values occurring during boreal summer, when a strong correlation between these two variables exists downstream of North Africa over the subtropical North Atlantic. Calculations of Estimated Inversion Strength (EIS) and composites of EIS on high and low downstream North Africa dust months during boreal summer reveal that dust is likely increasing inversion strength over this region due to both solar absorption and reflection. We find no evidence for a microphysical link between dust and lower tropospheric clouds in this region. These results yield new insight over an extensive period of time into the complex relationship between North African dust and lower tropospheric clouds over the open ocean, which has previously been hindered by spatiotemporal constraints of observations. Our findings lay a framework for future analyses using different climate models and sub-monthly data over regions with different underlying dynamics.