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Multi-decadal rise in evapotranspiration due to increased transpiration

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Evapotranspiration (ET) is the process by which liquid water becomes water vapor and energetically this accounts for much of incoming solar radiation. If this ET did not occur temperatures would be higher, so understanding ET trends is crucial to predict future temperatures. Here we used a well validated diagnostic model to show that ET has increased by 0.54 $\pm$ 0.31 mm per year^2 during 1981–2012. In addition, we analyze for the first time the multi-decadal trends in the three main ET components: the transpiration from vegetation (E_t), the direct evaporation from the soil (E_s) and the vaporization of intercepted rainfall from vegetation structures (E_i). We show that the rise in ET is owed to the significant increase in E_t of 0.72 $\pm$ 0.23 mm per year^2 and E_i of 0.14 $\pm$ 0.07 mm per year. Conversely, we find a strong negative trend of -0.32 $\pm$ 0.07 mm per year^{2}in E_s. These contrasting trends are primarily driven by the different response of E_t, E_s and E_i to the vegetation greening trend in northern mid- and high-latitudes associated with CO_2 fertilization and global warming, afforestation and forest protection and increased productivity in croplands. Coupled Model Intercomparison Project phase 5 (CMIP5) climate models do not seem to reproduce these trends accurately. Therefore, our findings highlight the importance of realistically representing vegetation changes in earth system models for predicting future changes in the energy and water cycle.