Global and regional variations in temperature and precipitation are key parameters affecting our economy and ecosystems. In order to better predict their future variations, it is essential to understand how they have evolved in the past and why. In our study, we quantify the transient atmospheric sensitivity to individual time-varying external forcings during the period 1870-2005, and discuss the physical processes and feedbacks involved. We use the atmospheric global climate model ECHAM5-HAM at resolution T42 and T63, which distinguishes itself through sophisticated aerosol treatment and cloud microphysics. Among the investigated forcings are observed sea surface temperatures (SSTs), transient aerosol emissions (from NIES, the National Institute for Environmental Studies, Japan) and greenhouse gas emissions. Extended ensembles of transient experiments (3 to 13 members per ensemble) are run, and a whole series of sensitivity experiments with different forcings are conducted. We show that on decadal timescales, SSTs (encapsulating other forcings) are the dominant forcing driving the global land temperature and precipitation variability. On top of this SST forcing, we find the steadily increasing aerosol emissions to gradually reduce global land precipitation between 1930 and 2005, by up to 30 mm/year. Our results suggest that this drying occurs primarily via the impact of aerosols on the radiative balance, which potentially affects the atmospheric stability and suppresses convection. In conclusion, our results quantitatively demonstrate a continuously increasing effect of aerosol emissions on the climate system (on top of SST related decadal variability) since at least 1870.