

**Atmospheric Circulation Trends, 1950-2000: The Relative Roles of Sea Surface
Temperature Forcing and Direct Atmospheric Radiative Forcing**

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Abstract

We examine the relative roles of direct atmospheric radiative forcing (due to observed changes in well-mixed greenhouse gases, tropospheric and stratospheric ozone, sulfate and volcanic aerosols, and solar output) and observed sea surface temperature (SST) forcing of global atmospheric circulation trends during the second half of the 20th century using atmospheric general circulation modeling experiments. We find that SST forcing and direct atmospheric radiative forcing drive distinctive circulation responses that contribute about equally to the global pattern of observed circulation trends. We further decompose the SST-induced circulation response into natural and anthropogenic components. We conclude with some recent results on attribution of the widening trend of the tropics from the perspective of the lapse-rate tropopause.