Changes in the stratospheric mean meridional circulation due to the increased CO2 - Radiation and SST induced effects

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Mechanisms of changes in the stratospheric Brewer-Dobson circulation (BDC) due to the increased CO_2 are investigated through atmospheric GCM experiments. The total effects of increased CO_2 on the BDC are separated into the radiation-induced effects (direct effects) and the SST-induced effects (indirect effects). The total effects enhance the BDC in both winter and summer hemispheres. In winter hemispheres, both direct and indirect effects enhance the NH BDC much more than the SH one, since stationary waves are more active in the NH upper stratosphere than those in the SH. In the NH during winter, though the direct effects do not affect tropospheric waves, they suppress lower-stratospheric stationary waves and enhance upper-stratospheric ones. The indirect effects, in contrast, suppress stationary waves in the troposphere and lower-stratosphere. Despite this, the indirect effects enhance upper-stratospheric stationary waves. Probably stronger westerlies in the mid-latitude lower stratosphere reduce stationary wave activities in the lower stratosphere but enhance them in the upper stratosphere, since both the direct and indirect effects enhance the mid-latitude westerlies in the lower stratosphere. In the summer stratospheres, the indirect effects enhance the BDC, consistent with the enhanced transient waves. Only the indirect effects enhance the mid-latitude westerlies in the summer hemispheres. Hence the vertical wave propagation property may be affected by the enhanced mid-latitude westerlies in the upper-troposphere and stratosphere.