



The Paradoxical Negative Greenhouse Effect and Radiative Forcing over Antarctica

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A paradoxical negative greenhouse effect has been found over the Antarctic Plateau, which indicates that greenhouse gases enhance energy loss to space. Using 13 years of NASA satellite observations, we verify the existence of the negative greenhouse effect and find that the magnitude and sign of the greenhouse effect varies seasonally and spectrally. A previous explanation attributes the negative greenhouse effect solely to stratospheric CO₂. However, we find that the negative greenhouse effect is predominantly caused by tropospheric water vapor. A novel principle-based explanation provides the first complete account of the Antarctic Plateau's negative greenhouse effect indicating that it is controlled by the vertical variation of temperature and greenhouse gas absorption. Our findings indicate that unique climatological conditions over the Antarctic Plateau, such as a strong surface-based temperature inversion, scarcity of free tropospheric water vapor, and warmer stratospheric temperatures relative to the surface, cause the negative greenhouse effect. Additionally, we find that the unique temperature profile over the Antarctic Plateau also induces a paradoxical negative instantaneous radiative forcing over Antarctica when CO₂ is increased.