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An estimate of the impact of transient luminous events on the atmospheric temperature

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Abstract. We present an order of magnitude estimate of the impact of sprites and other transient luminous events (TLEs) on the atmospheric temperature via ozone changes. To address the effects of expected TLE-ozone changes of at most a few percent, we first study the linearity of the radiatively driven response of a stratosphere-mesosphere model and of a general circulation model (GCM) to a range of uniform climatological ozone perturbations. The study is limited to Northern Hemisphere winter conditions, when planetary wave activity is high and the non linear stratosphere-troposphere coupling can be strong. Throughout most of the middle atmosphere of both models, the radiatively driven temperature response to uniform 5% to 20% ozone perturbations shows a close-to linear relationship with the magnitude of the perturbation. A mid-latitude stratopause ozone perturbation is then imposed as an idealised experiment that mimics local temperature gradients introduced by the latitudinal dependence of TLEs. An unrealistically high 20% magnitude is adopted for the regional ozone perturbation to obtain statistical significance in the model response. The local linearity of the radiatively driven response is used to infer a first order estimate of TLE-induced temperature changes of the order of 0.015 K under typical conditions, and less than a peak temperature change of 0.3 K at 60–70 km height in coincidence of extraordinarily active TLE-producing thunderstorms before horizontal mixing quickly occurs. In the latter case, dedicated mesoscale modelling is needed to study the relevance of regional non linear processes which are expected to impact these radiatively driven responses.

Full Article in PDF (PDF, 354 KB)

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