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## Three-dimensional modeling of the $O_2(^1\Delta)$ dayglow and implications for ozone in the middle atmosphere.

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Future space missions dedicated to measuring  $CO_2$  on a global scale can make advantageous use of the  $O_2$  band at  $1.27 \mu m$  to retrieve the air column. The  $1.27 \mu m$  band is close to the  $CO_2$  absorption bands at  $1.6$  and  $2.0 \mu m$ , which allows a better transfer of the aerosol properties than with the usual  $O_2$  band at  $0.76 \mu m$ . However, the  $1.27 \mu m$  band is polluted by the spontaneous dayglow of the excited state  $O_2(^1\Delta)$ , which must be removed from the observed signal.

We investigate here our quantitative understanding of the  $O_2(^1\Delta)$  dayglow with a chemistry-transport model. We show that the previously reported  $-13\%$  deficit in  $O_2(^1\Delta)$  dayglow calculated with the same model is essentially due to a  $-20$  to  $-30\%$  ozone deficit between  $45$ - $60$  km. We find that this ozone deficit is due to excessively high temperatures ( $+15$  K) of the meteorological analyses used to drive the model in the mesosphere.

The use of lower analyzed temperatures (ERA5), in better agreement with the observations, slows down the hydrogen-catalyzed and Chapman ozone loss cycles. This effect leads to an almost total elimination of the ozone and  $O_2(^1\Delta)$  deficits in the lower mesosphere. Once integrated vertically to simulate a nadir measurement, the deficit in modeled  $O_2(^1\Delta)$  brightness is reduced to  $-4 \pm 3\%$ . This illustrates the need for accurate mesospheric temperatures for a priori estimations of the  $O_2(^1\Delta)$  brightness in algorithms using the  $1.27 \mu m$  band.