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# Inferring the photolysis rate of $NO_2$ in the stratosphere based on satellite observations

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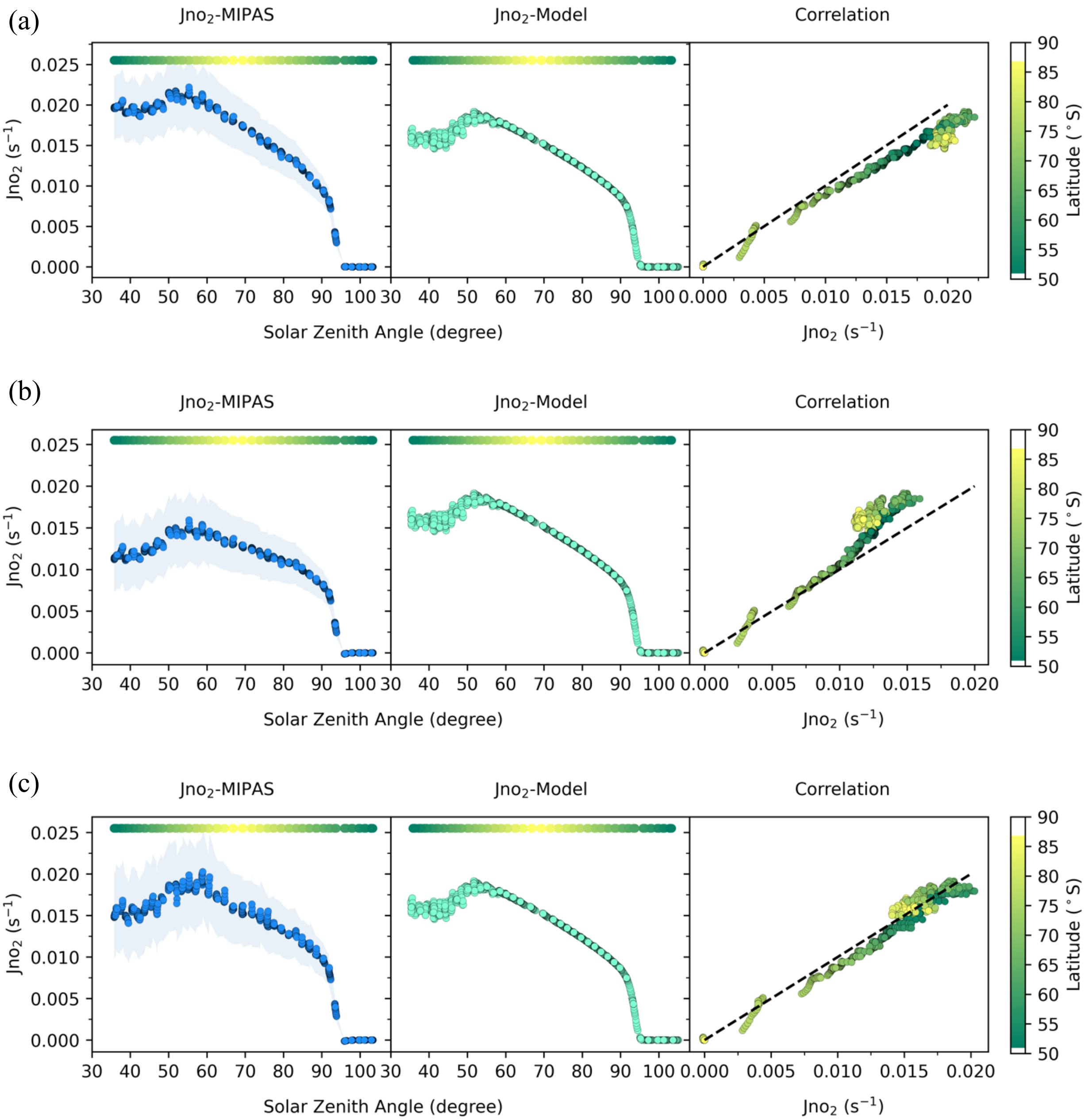


Figure S1. The $J_{NO_2}$ in 50° S -90° S from MIPAS and model considering different species at 38 km. (a) Only the reaction of NO with $O_3$ and the photolysis of $NO_2$ are considered. (b) In addition to the reactions in (a), the reaction of O with $NO_2$ is considered. (c) In addition to the reactions in (a), the reaction of O with $NO_2$ and the reaction of ClO with NO are also considered. Model data is for the same time and location as the satellite data. The color strip represents the latitude source of data points at the same solar zenith angle. In the correlation plots, the abscissa is $J_{NO_2}$-MIPAS and the ordinate is the $J_{NO_2}$-Model. To ensure clear visual distinction for each point, black outlines are applied around them.

In order to better understand which species will have a significant impact on NOx chemistry, $J_{NO_2}$ calculated by considering different species at 38 km is shown in Figure S1. When only the reaction of NO with $O_3$ and the photolysis of $NO_2$ are considered, the calculated $J_{NO_2}$ value from satellite data is significantly higher than the model values. After considering the reaction of O with $NO_2$, the $J_{NO_2}$ value calculated by satellite data has changed substantially, which indicates that O has a large influence on NOx chemistry. When the reaction of ClO and NO is also considered, the calculated $J_{NO_2}$ value matches well with the model data, which also indicates that ClO should be considered in NOx chemistry at 38 km. It is worth noting that at other altitudes, due to the different profiles of each species, the importance to NOx chemistry is also different. When the altitude is lower than 35 km, the concentrations of ClO and O are very low, and hardly affect NOx chemistry. Moreover, the satellite data error of ClO is very large, so ClO should be ignored in such calculations when the altitude is lower than 35km to avoid introducing unnecessary error. When the altitude is higher than 40km, the concentration of $HO_2$ increases, so $HO_2$ can have a large impact on NOx chemistry at higher altitudes than those considered here. $HO_2$ data can't be measured by MIPAS, so the $J_{NO_2}$ at an altitude higher than 40 km is not included in this work.