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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Intercontinental transport of nitrogen oxide pollution plumes" *by* M. Wenig et al.

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Addressing the questions about the treatment of lightning NO_x production: We used the LIS dataset in order to get information about the lightning activity in the analyzed area. The number of flashed has been multiplied by the production rate of 6.7 10^{25} molecules/flash for intracloud flashes and 6.7 10^{26} molecules/flash for cloud-to ground flashes given by Jourdain et al.. We assumed 5% cloud-to-ground flashes according to the very high flash rates and using the formula IC/CG=2.7 $F^{1/2}$ given by Rutledge et al. Pickering et al., 1998 (see paper) states that tropical systems, particularly those over marine areas, tended to have a greater fraction of intracloud flashes. For the FLEXPART lightning simulation the NOx tracer particles had been released between 5 and 10 km height.

LIS is not observing the area permanently, so we scaled the resulting number of NOx molecules by a factor of 250, assuming the thunder storms to last 12 hours. This

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resulted in 10% of the lightning induced NOx compared to the total amount of NOx from the FLEXPART simulation. The exact fraction of lightning NOx can be seen in Table 1. The high values in column 3 come from the fact that in early stage of the transport the industrial plume has not yet reached the ocean. Because of the referee's and A. Richter's comment, we increased the scaling factor (time scaling factor=500 corresponding to 2 overpasses per day with 90 seconds viewing time respectively, production rate 6.7 10^{25}*0.95+6.7 10^{26}*0.05 molecules/flash). The fraction of lighting induced NOx increased to approximately 25% (see Table2). The uncertainties are still very high, so the main conclusion of the paper is that the plume reaching Australia consists of both, industrial NO2 emitted in South Africa, and lightning NO2 produced over the Indian Ocean near South Africa. This can be confirmed by a comparison of the shapes of the plumes produced by lightning and industrial emissions, since there are areas, dominated by lightning NOx and areas dominated by industrial NOx, all seen by GOME, especially the areas not covered by clouds (see Fig.3).

Addressing the referee's question about the differences between our algorithm to estimate the tropospheric fraction of NO2 and other algorithms: We are using an algorithm to separate the stratospheric and tropospheric fraction of the total vertical NO2 column seen by GOME which is utilizing several assumptions about the spatial distribution and temporal variance of the Stratosphere and the Troposphere. In comparison to the reference sector method from Andreas Richter et al., our algorithm is using more information than one Orbit per day so that we can also resolve zonal variations, but we are using only one spectral window (430-450nm), whereas Andreas Richter et al. is additionally using the additional wavelength band 345 - 359 nm (see for example "Quantification of Tropospheric Measurements from Nadir Viewing UV/vis Instruments", TROPOSAT (EUROTRAC-2 subproject) Task Group 1, by Andreas Richter, Folkard Wittrock, Annette Ladstätter-Weißenmayer, John P. Burrows and Thomas Wagner). Martin et al. combines GOME measurements with model results, which we can not do, since we are using the comparison of the GOME measurements with model results to validate both. The first version of our algorithm is described in Leue et al. (2001) and the new

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version is described in detail in Wenig 2001. There, also comparisons with in-situ data is shown.

Table 1: FLEXPART lightning NOx in percentage of total FLEXPART NOx (industrial+lightning)

Date/whole area seen in fig3(paper)/ocean only		
05/04/1998	0.00945	0.3939
05/05/1998	1.60451	21.2381
05/06/1998	5.41546	65.9199
05/07/1998	10.35070	21.9508
05/08/1998	8.60432	10.9591
05/09/1998	8.60928	9.6072
05/10/1998	8.46404	8.8824
05/11/1998	9.99398	10.2958
05/12/1998	10.00680	10.2544
05/13/1998	9.35731	9.8777
05/14/1998	8.28894	10.5325

Table 2: FLEXPART lightning NOx in percentage of total FLEXPART NOx (industrial+lightning) with new scaling factor

Date/whole area seen in fig3(paper)/ocean only		
05/04/1998	0.0274	1.13375
05/05/1998	4.5154	43.8828
05/06/1998	14.2397	84.87
05/07/1998	25.0840	44.9219
05/08/1998	21.4464	26.3045
05/09/1998	21.4570	23.5602
05/10/1998	21.1452	22.0396
05/11/1998	24.3574	24.9725

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05/12/1998	24.3837	24.8885
05/13/1998	23.0399	24.1187
05/14/1998	20.7673	25.451

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