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Ship emitted NO₂ in the Indian Ocean: comparison of model results with satellite data

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Abstract. The inventory of NO_x emission from international shipping has been evaluated by comparing NO₂ tropospheric columns derived from the satellite instruments SCIAMACHY (January 2003 to February 2008), GOME (January 1996 to June 2003), and GOME-2 (March 2007 to February 2008) to NO₂ columns calculated with the atmospheric chemistry general circulation model ECHAM5/MESSy1 (January 2000 to October 2005). For both measurements and model consistently the tropospheric excess method was used to obtain mean NO₂ columns over the shipping lane from India to Indonesia, and over two ship free regions, the Bay of Bengal and the central Indian Ocean. The long-term data set from SCIAMACHY yields the first monthly analysis of ship induced NO₂ enhancements in the Indian Ocean. Comparison of data from the three instruments and in addition OMI reveals differences between the datasets which are discussed with respect to the diurnal cycle of NO₂ and the increase in shipping traffic over the time period studied.

In general, the model simulates the differences between the regions affected by ship pollution and ship free regions reasonably well. Minor discrepancies between model results and satellite data were identified during biomass burning seasons in March to May over India and the Indochinese Peninsula and August to October over Indonesia. We conclude that the NO_x ship emission inventory used in this study is a good approximation of NO_x ship emissions in the Indian Ocean for the years 2002 to 2007. It assumes that around 6 Tg(N) yr⁻¹ are emitted by international shipping globally, resulting in 90 Gg(N) yr⁻¹ in the region of interest when using Automated Mutual Assistance Vessel Rescue System (AMVER) as spatial proxy. A second model run using lower ship emissions estimates of 3–4 Tg(N) yr⁻¹ globally results in poorer agreement with the satellite data.

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