

Interactive comment on “Rapid intercontinental air pollution transport associated with a meteorological bomb” by A. Stohl et al.

A. Stohl et al.

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We thank the reviewer for his positive and very constructive review.

1) We completely agree that the NO_x tracer alone does not allow quantitative calculations of the impact of the event on tropospheric chemistry. However, that was not what we intended to do, as the satellite observations allow a much better quantification of how much NO_x was transported than even use of a chemistry transport model would allow. We encourage others to quantify the impact of this event (and other, similar, ones) on tropospheric chemistry using global chemistry transport model, but it is beyond the scope of the present paper to do so.

The reviewer's suggestions 1a-1b are well received and will be changed accordingly in the final version of the paper. However, to us it is not clear how suggestion 1c could improve our estimates. The fraction of NO_x exported varies with both meteorological

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and chemical conditions. Assuming that a fixed fraction of the emitted NO_x "survives" the export to the free troposphere would replace our assumption of a 2-day lifetime, but it is not obvious to us that this will actually improve the estimate. However, we will cite the Liang et al. paper and briefly discuss "export efficiency" of NO_x.

2) We will add the following paragraph in section 1.2: Strong filamentation of pollution plumes normally takes place during ICT. The large surface/volume ratio of filaments increases the probability of mixing of the polluted air with the surrounding cleaner air-masses. If this process is fast enough for NO_x to be still contained in the plume, the efficiency of O₃ production (i.e., the number of molecules of O₃ produced per molecule of NO_x available) increases (Lin et al., 1988), because of a higher hydrocarbon/NO_x ratio in the mixed airmass (note that sufficiently high levels of hydrocarbons, e.g., methane, are contained in "background" air).

3) Several case studies of forecast failures during specific bomb events have been done, but to our knowledge no comprehensive study exists that systematically compares forecast quality for normal cyclones and bombs. However, we only used analysis, not forecast, data, and therefore this problem is minimized (although it may also be present to some extent in the analyses over regions with sparse observation data). Furthermore, in our case the bomb was quite big, and therefore well resolved by the ECMWF model, which is not the case for all bombs.

4) A very good point, and true also for less extreme conditions. Perhaps the community should take some action to convince ECMWF, NCEP and other major meteorological centers to archive their data with hourly resolution. In a past initiative we have indeed succeeded in convincing ECMWF to store their ERA-40 data every 3 hours (ERA-15 data are available only every 6 hours). Maybe it is time to push again for higher temporal resolution.

5) We agree that a more systematic study would be valuable, but at present we did what we could with the data we have available.

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6) We will add a remark as suggested.

7) We will mention this in the final version.

Figure 2: We will try to improve the figure's quality. However, it will occupy a full page in ACP and will, thus, be of better quality.

Technical corrections: We will take all into account, except for replacing "lysis" with "disappearance". Lysis is quite commonly used in the meteorological literature (e.g., cyclolysis, frontolysis are well established terms).

Additional lightning study: After our presentation at the EGU conference in Nice, the question was raised whether lightning in the hurricane could have produced the observed NO_x. To rule out that possibility, we have now released lightning tracers at the hurricane's approximate location on 2, 3, and 4 November. None of these tracers was transported in the express highway. They all remained south of the highway.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 2101, 2003.

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