Correction of results from meteorological composite analysis

Achim Zien

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Further investigations have revealed that our implementation of the composite analysis of meteorological condiditions leading to the emission of long-range tranport events included a software bug that would include only meteorological data from 2007, omitting data from 2008 to 2011. This lead to improper, overly strong pronounced anomalies.

The problem has been amended and the implementation double-checked to make sure that the updated implementation operates as described in the paper.

We are sorry for this misleading mistake.

1 Programming error

Our implementation of the composite analysis for meteorological and chemical data was implemented in such a way that the groups of data associated to the emission of a long-range tranport plume and non-associated data were not consistent.

- The associated data only contained data from the first contiguous period of observed long-range tranport events.
- The non-associated data contained data from all 5 years which were not included in the associated data.

This means that the associated group contained only a very small number of data points. For DJF statistics, these were limited to plumes observed in January or February 2007. For JJA statistics, plumes from June to August 2007 were included.

The small amount of data points in this group led to very sharp contours, which was visible especially over Europe. Also, statistical deviations from the true distribution are very likely.

The less significant error was that in the non-associated group (or meteorological mean) data that was indeed associated to long-range tranport events was still included, which would lead to a further diminishing of the real composite signal.

2 Updated Results

The updated data set differs strongly from the data set used for the initially submitted paper.

The analysis of the South African region (Fig. 1) does no longer show an identifiable pattern suggesting a typical cyclone crossing South Africa and lifting NO_2 from the Highveld plateau up. This is no proof against this type of long-range tranport emission scenario, it is just no further evidence.

For the tropospheric NO_2 VCD (Fig. 2, original: Fig. 22), the expected pattern is retained in this updated analysis. There is an elevated NO_2 VCD south-east of the Highveld plateau

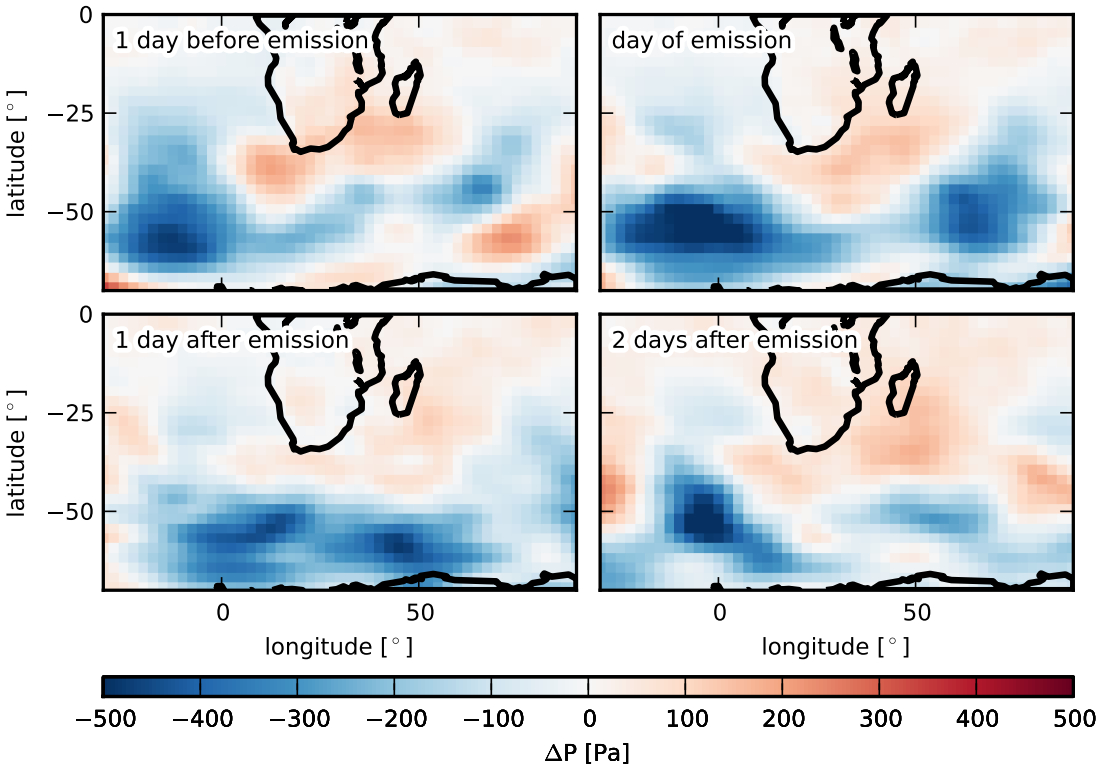

Figure 1: Updated composite analysis of the mean sea-level pressure for long-range tranport plumes emitted from the South Africa region. A clear low-pressure pattern as in the inital figure (Fig. 21) in the paper is no longer visible.

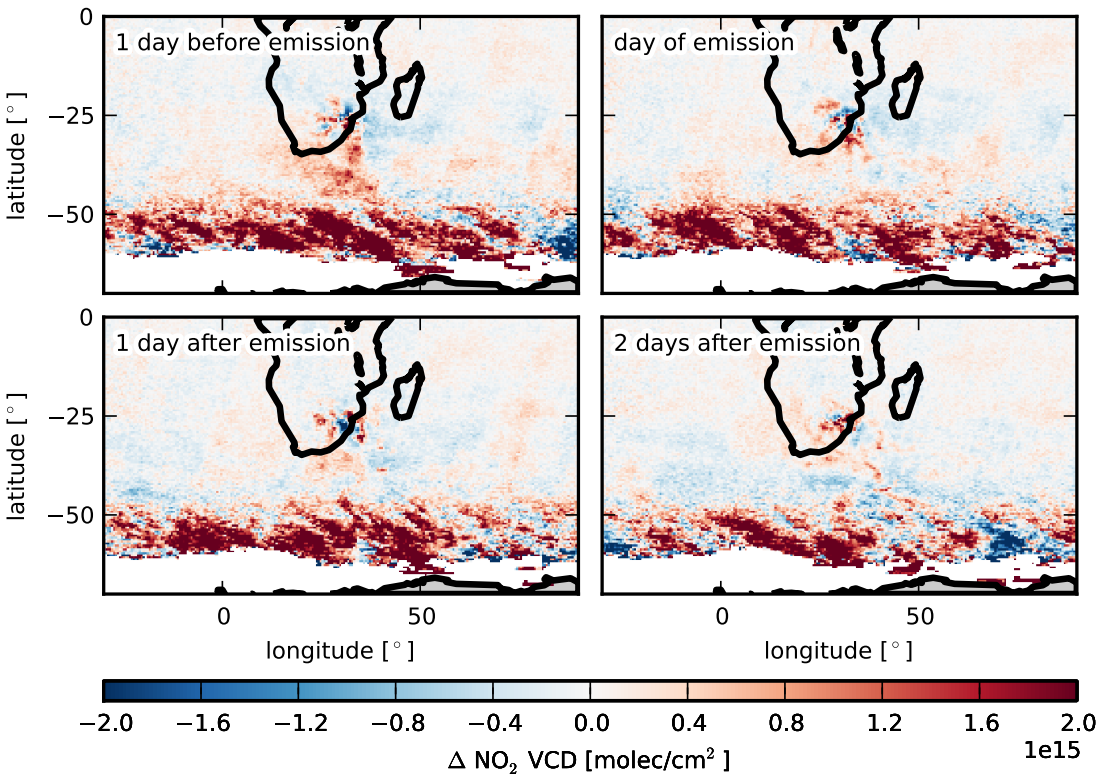

Figure 2: Updated composite analysis of the NO_2 VCD for long-range tranport plumes emitted from the South Africa region. An outflow pattern is still visible in this data.

on the day of emission, indicating an outflow pattern. The day after emission there is a low-anomaly of NO_2 in the area of the Highveld plateau, indicating quick removal of NO_2, as would be expected from a transport event.

Over Europe, the pattern of mean sea-level pressure anomalies has decresed significantly in amplitude and drastically changed its shape. The updated data set (Fig. 3, original data set Fig. 23 in the initial paper submission.) has a much smoother and broader pattern as should be expected from an average over more than 100 days of meteorological data.

In this data set, a low-pressure anomaly moves from Greenland toward Central Europe over the course of the long-range tranport event. This confirms that cyclones traveling on typical routes could be the meteorological cause for NO_2 long-range tranport events in Europe and is consistent with the given case study in October 2010.

The strong signal in the case of Europe can probably be attributed to a typical storm path.

The anomaly of elevated FRESCO+ cloud fraction east of the Beijing area for plumes emitted from China is no longer visible in the updated data set. This passage has been removed from the paper.

We also removed the significance contour lines as these are dependent on the number of observations included in the dataset which will vary from region to region. This, among other reasons, makes the contours misleading.

These results will be included in the revised paper.

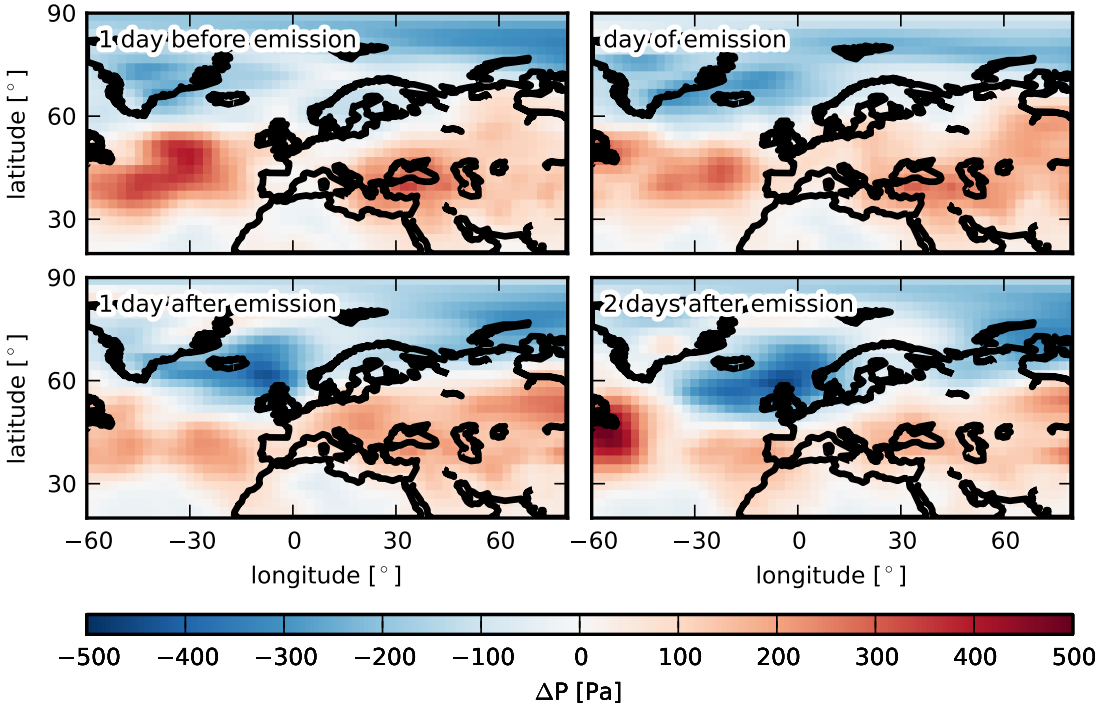

Figure 3: Updated composite analysis of the mean sea-level pressure for long-range tranport plumes emitted from the European region. A clear low-pressure pattern can be seen which is indicative of cyclones leading to the emission of NO_2 plumes in the course of a long-range tranport event. The very strong patterns from the original figure are no longer visible.