Correction of results from meteorological composite analysis

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Further investigations have revealed that our implementation of the composite analysis of
meteorological conditions leading to the emission of long-range transport 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 im-
plemented in such a way that the groups of data associated to the emission of a long-range
transport plume and non-associated data were not consistent.

- The associated data only contained data from the first contiguous period of observed
  long-range transport 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 transport 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\textsubscript{2} from the Highveld plateau
up. This is no proof against this type of long-range transport emission scenario, it is just no
further evidence.

For the tropospheric NO\textsubscript{2} VCD (Fig. 2, original: Fig. 22), the expected pattern is retained
in this updated analysis. There is an elevated NO\textsubscript{2} VCD south-east of the Highveld plateau
Figure 1: Updated composite analysis of the mean sea-level pressure for long-range transport plumes emitted from the South Africa region. A clear low-pressure pattern as in the initial figure (Fig. 21) in the paper is no longer visible.
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 decreased 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 transport event. This confirms that cyclones traveling on typical routes could be the meteorological cause for NO$_2$ long-range transport 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 transport 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 transport event. The very strong patterns from the original figure are no longer visible.