Review of "Trapping, chemistry and export of trace gases in the South Asian summer monsoon observed during CARIBIC flights in 2008" by A. Rauthe-Schöch et al.

Recommendation: Requires major revisions

General Comments:

The paper contains interesting analysis of chemical measurements taken from aircraft passing through the Asian summer monsoon anticyclone and has the potential for making an important contribution towards understanding the role of that dynamical feature for transport in the upper troposphere. However, it contains serious weaknesses that make it inappropriate for publication in its present form. In particular the presentation is chaotic and often poorly worded, making it difficult to follow the logic of certain arguments. The paper includes many unnecessary descriptive details that obscure important results and analysis that fails to adequately support the conclusions drawn from it.

Sec. 3.1.2: The presentation in this section is too chaotic. Results should be better synthesized – perhaps less detail given and more focus on the logic of the results. The authors need to better explain how conclusions were drawn. Some conclusions seem overly speculative.

Sec. 3.1.3: This section contains far too many unnecessary descriptive details. It would be better to focus on the main points and important features of the figures that support your conclusions.

Sec. 3.2: The section would be more meaningful if Fig. 9 and 10 showed statistics accumulated over all flights.

Sec. 3.3.1: The analysis in this section is weak. The criterion for determining the influence of air along the flight path in receptor regions is imprecise and subject to severe sampling problems. For example, an analysis of forward trajectories cannot determine how important air from the path of the airplane is to the receptor regions because it neglects air that has sources from elsewhere, which might be much more important. Given that, once air leaves the confines of the anticyclone, prevailing winds carry transport it throughout low-latitudes, where it mixes with air that never was confined to the anticyclone, this analysis seems pointless and this section could be deleted with no loss to the integrity or impact of the paper..

Sec. 3.3.2: This analysis subsamples the flights (choosing data from 4 flights out of 14) to examine photochemical age and uses an apparently arbitrary (i.e., with no physical basis) measure of age from the trajectories (the time since the air was last

east of 95°E). In Sec. 3.2, the location at which a backward trajectory descended below 5 km was used as a source – why change that criterion now? A cynical reviewer would wonder if the sampling and analysis criteria were chosen to provide the answer that the authors wanted rather than a physically meaningful result.

Sec. 3.3.3: This section seems disconnected from the rest of the paper and is apparently has little or no scientific relevance. If this section is to be included, the authors should put more effort into justifying its existence.

Specific Comments

Page 3, line 12 and other places in the manuscript: The word 'remarkable' is too subjective and inappropriate and should be deleted throughout. Please describe the 'consistency' in a more objective and specific manner. For example, 'CARIBIC observations feature consistent north-south gradients of important chemical species … '

Page 11, line 12: The northward tilt of the anticyclone is an interesting observation and seems to be consistent with previous work (not sure which reference; probably a paper by M. Park and W. Randel). It would be good to mention this.

Page 11, lines 18-19: That 'the UTAC is observed to be furthest north during July' is probably not statistically significant. Please acknowledge the small data sample being used.

Page 12, lines 13-16: The authors need to be more careful and more precise about what patterns are distinct. I suggest putting average over all flights in Fig. 5. Also, discuss which distinct features are statistically significant and which aren't. Why not use all 14 flights in Fig. 5?

Page 13, lines 1-7 ('In the north … in-mixing of stratospheric air'): This discussion seems to be very speculative. Please provide evidence for this argument.

Page 13, lines 7-9: This is the first instance where the authors discuss filtering the data using potential vorticity. This procedure should be described in more detail and justified.

Page 13, lines 9-10: Please explain how the results are supported by Baker et al.

Page 14, lines 3-11: Please explain (briefly) why positive correlations indicate ozone formation and negative slopes indicate ozone destruction or in-mixing. Are there other processes that might cause positive correlations? How do you rule those out? Also, change 'positive slopes of correlation' to 'positive correlations' or 'positive slopes of the O_3-CO relationship'.

Fig. 8: As with Fig. 5, adding the average over all flights and quantifying which features are statistically significant and which aren't would help the analysis. Also, it is difficult to identify the specific profiles that the authors refer to (June and July).

Page 16, line 29 to Page 17, line 7: Is the 'C' Shape indicative of different source regions? If so, the trajectories might offer insight.

Page 19, line 7: Please explain why altitudes of 5 km provide relevant source regions (instead of the surface or boundary layer, for example)?

Page 25, lines 19-20: The phrase 'which is believed to be at its bottom part where pollution levels are possibly lower than a few kilometres aloft where the UTAC is even stronger' is not clear. Suggested rewording 'which is at the lower boundary of the UTAC, where pollution levels are likely to be reduced compared to a few kilometres aloft, where the UTAC is better developed'. Also, this statement needs to be explained further; for example, how can pollution levels increase with height if there is no intervening source?

Page 25 lines 23-24: The phrase 'remarkable consistency of the CARIBIC observations, where trace gas distributions show regular patterns' is too vague. What does it mean to have 'regular patterns' and what are those patterns?

Page 25, line 26 to Page 26, line 2: The authors state that 'Earlier observations from CARIBIC phase 1 in the summers 1998–2000, despite consisting of a more limited chemical dataset … also consistently show a similar development of the monsoon in terms of trace gas and aerosol particle distributions' is not worded clearly. For example, it could be interpreted as saying that limiting the number of chemical species observed is expected to make a data set less consistent. That makes no sense to me.

Page 27, lines 16-26: The paragraph should be rewritten for clarity. It makes no logical sense.

Page 28, lines 12-13: A merry-go-'round is an imaginative, but inappropriate analogy. How often does a merry-go-'rounds shed small children as it spins?

Page 28, lines 16-24: The statement 'Even going … ' does not belong in the conclusions. It refers to an artifact of the flight path and has no bearing on any physically meaningful results.

Page 28, lines 26-27: The parenthetical statement 'linearly interpolated to the year 2008 from Center for International Earth Science In- formation Network (CIESIN) data for 2000 and estimates for 2010' is unnecessary.

Selected technical details

Page 3, line 6: The wording within 'which so far has mostly been observed from satellites' is imprecise. Suggested change: 'for which few in situ observations are available'

Page 3, line 7: Awkward and imprecise wording for 'range of atmospheric pollutants were recorded e.g. carbon monoxide, total reactive nitrogen oxides, aerosol particles and several volatile organic compounds'. Suggested change: '*variety* of atmospheric pollutants (e.g. carbon monoxide, total reactive nitrogen oxides, aerosol particles and several volatile organic compounds) were recorded'.

Page 3, line 14: The sentence 'Trajectory calculations …' belongs in paragraph 2.

Page 7, line 10: Change 'measured' to 'operated' or 'took measurements'

Page 12, line 2: The past tense is used in this first sentence, but the present tense is used elsewhere. Suggested change: 'As the aircraft *moves* from south to north we *observe* …'

Page 13, line 25: Change 'critical in' to 'critical for'

Page 13, line 25: Delete 'potential'

Page 13, line 27: Change 'in particular ozone' to 'particularly ozone' or 'ozone in particular'

Page 15, line 23: Change 'where' to 'when'

Page 24, line 17: Change 'trajectories leave the *trajectory'* to 'trajectories leave the *region'*.

Page 26, line 5: Change 'of a few flights per month *only*' to '*only* a few flights per month'.

Page 27, line 23: The reference to Fig. 10 seems inconsistent with the text.

Page 28. Line 5: Change 'around' to 'approximately'.

Page 28, line 25: Awkward wording; change 'lived about 1.4 billion people in 2008' to 'had a population of approximately 1.4 billion in 2008'.

Page 29, line 8: Change 'has been' to 'was'.