

Manuscript ID acp-2017-1124 entitled 'The importance of vertical resolution in the free troposphere for modelling intercontinental plumes'.

The aim of this paper is to determine the horizontal and vertical resolution required for accurate free tropospheric plume transport. This topic is of interest and the analysis in this paper is presented clearly and precisely. The quality of the writing is excellent and there are therefore few specific comments. I recommend the paper for publication in ACPD with minor corrections.

### General Comments

1. The paper deals specifically with free tropospheric tracer transport and situations in which the vertical velocities are small (order  $1\text{cm s}^{-1}$ ). Do the results hold for different situations in which vertical velocities are larger? For example, in a convective boundary layer, A and B (eq 24) may be similar so  $B/A$  is much smaller than 500.
2. In the abstract the authors claim that 'the local surface pollution influence from the subsiding plume on intercontinental scales is also considerably increased', but on p12 say that this result is just implied, as the fv3 dynamical core does not include boundary layer physics. Can the authors justify the term 'considerably' increased as they have no quantitative estimate of this potential increase?
3. Throughout the paper the authors refer to typical horizontal plume scales of 1000km. Given that in the real atmosphere plumes sizes cover a whole spectrum how sensitive are the results to the initial plume size? The authors present sensitivity results for plumes of different initial vertical thicknesses but not different initial horizontal spreads. On a similar topic of variable resolution, I was surprised that there was no discussion of local grid refinement, grid transformation or irregular grids as alternative methods to gain numerical efficiency in the introduction.

### Specific Comments

1. Page 2 line 6: the authors use 'thick plumes of Asian ozone pollution', do they refer to optical or geometric thickness here?
2. Page 4 line 14: This sentence is a little difficult to follow. What is 'positive'?
3. Page 5 line 21: CFL acronym should be defined.
4. Page 6 line 5: 'This explains why', what is 'this'? Are the authors referring to equation 14?
5. Page 7 line 14 and elsewhere: The authors often refer to 'reviewed above', 'will be discussed', 'described below' etc. Please can the specific section numbers be used in these places?
6. Page 13 line 4: 'S' is not defined.
7. Page 14 line 6: Why is the z underlined here?
8. Page 30 figure B1: A difference plot might help to highlight deviations from the initial conditions due to numerical error more clearly.