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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Relationship between the Anticyclonic Anomalies in Northeast Asia and Severe Haze in the Beijing–Tianjin–Hebei Region" *by* Wogu Zhong et al.

Anonymous Referee #2

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Interactive comment on "The Relationship between the Anticyclonic Anomalies in Northeast Asia and Severe Haze in the Beijing–Tianjin–Hebei Region" by Wogu Zhong et al. Anonymous reviewer #2 Major Comments As noted in my initial evaluation, this manuscript presents a potentially practical index, based on synoptic-scale data, to assess the likelihood and duration for marked haze/pollution events over parts of China (the Beijing-Tianjin-Hebei region). The presentation is generally good. The paper could, however, be improved by further attention to translation from Chinese into English. In addition, there are statements regarding the influence of anomalous anticyclonic conditions (as determined by the authors' index) on local circulations and the vertical transport of pollutants that I find confusing. The statements may, in part, simply

reflect difficulties in translation. They might, however, also reflect some misunderstanding regarding the generally accepted roles that anticyclonic and cyclonic environments play in the regional accumulation of low-level pollution aerosols. Those parts of the text and figures that relate to these and a few other important issues have been highlighted using bold italics in the Specific Comments section below. The illustrations are, for the most part good, although Figure 2 could be improved by enlargement, and information (certain contours) appear to be missing in Figures 7 and 8.

Specific Comments (numbers refer to lines in the manuscript) 14. (Abstract) Replace "conductive" with "conducive," "lower" with "shallower," and add comma after "layer." 17. (Abstract) Unclear what is meant by "the horizontal direction." Also, the sentence that begins, "The AANA induced anomalous..." is unclear. This statement is directly related to the "somewhat confusing statements" in the body of the manuscript mentioned in Major Comments (above). 19. (Abstract) Add "a" before "shallower." 20. (Abstract) Replace "stable" with "persistent." 21. (Abstract) How does abundant moisture weaken turbulence? 28. It is not entirely clear what is meant by the word "haze." I suggest adding a short sentence to clarify the intended meaning (e.g., is the subject pollutant / restrictor of visual range here more akin to "smog," or is the term being used to refer to the presence of sulfate-containing aerosols that more commonly appear over eastern Asia and North America in summer; perhaps by "haze" you mean both phenomena). 29. Change "level" to "levels." 30. Change "have" to "has." 35. The assumption implied here is that the rate of occurrence continues to increase; if that is the case, replace "occurred" with "occur." 39. Not certain of meaning of "...were detected within20 days..." Do you mean "lasted about 20 days"? 43. "Cause" might be a better word choice than "reason." 57. Suggest "a weaker" instead of "the weaker;" also, I suggest introducing the acronym "EAWM" here instead of in line 62. 60. Eliminate "the" before "anticyclonic anomalies." 62. Add "have" after "studies." 69. Eliminate "the" after "study focused on." 70. Add comma after "2014-2016." 73. Is there a reason why only December (vs. other winter month) data were used? Should state why only December data were used, and consider using data from other winter months to enlarge dataset. 77. Not certain what

is meant by “vertical wind” here; if I am correct, I think you mean vertical motion (i.e., as is indicated in the parentheses, omega)? 84. Add an “s” to “polygon” and eliminate “the” after “built.” 88. Not certain of the meaning of “haze progresses.” 89. Change “remained” to “remain.” 90-91. Replace “synoptic processes” with “synoptic-scale environments.” Also in line 91, could the second use of the word “process” be better if replaced by “events”? 92 and 94. Ditto comment for lines 90-91 regarding use of the word “process.” 101. Change “pollutions” to “pollution events.” 107. “Quickly” relative to what? Assuming that it is (was) relative to the observed behavior in 2015 and 2016, add the word “relatively” before “quickly.” Also, consider replacing “lowering down” with “decreasing.” 114. Suggest replacing “the negative patterns of the” with “a relatively weak.” 115. Eliminate “the” before “mid-level” and add an “s” to “mid-level.” 119. Replace “the cold air stayed inactive,” etc., with “cold air intrusions were suppressed, and their southward movement into the BTH region decreased.” 121. Suggest replacing “wind” with “flow.” 122. What is a “meion”? Replace “in” with “over.” 123. Change middle part of line to read “...SLP over the western Pacific anomalously high” (or to something similar). 124. The mechanism by which increased southeasterly component to the low-level flow restricted the dispersion of pollutants is not immediately apparent; please briefly explain. 125. Add “the” after “brought by.” 127. Change “made the cold air activity” to “made cold-air invasions more frequent.” 130. Change “activity” to “invasions.” 135. Change “mentioned” to “aforementioned.” 137. I think what you mean to say here is that “...we evaluated the influence of AANA on the regional atmospheric environment.” 138. Add “in” before “the white box.” 139. Add “in” before “the black box.” 140. Add “in” before “the white box.” 142. Add a comma before “since.” 143. Change “the anomaly field” to “anomaly fields.” 144. Add an “s” to “circulation.” 147. Change “from the horizontal direction” to “at two pressure levels.” 151. Add an “s” to “mid-level.” Also change “From the horizontal direction, etc....” to “At the surface, the AANA could generate weak southerly winds (Figure 3a).” 153. Change “Taihang-Yanshan mountain” to “the Taihang-Yanshan mountains.” Also change “beneficial to” to “encouraged.” 154. Add an “s” to “wind.” 155. Consider indicating the location of Bohai

Bay either in the text or in Figure 3 to clarify geographical references for readers. 156. Change “aroused” to “induced.” 159. Add an “s” to “speed” and the word “a” before “drier environment.” 161. Change “special” to “unique.” Change “topography contition” to “topographical conditions.” 162. Change “wind” to “flow.” 163. Add a comma after “particles.” Well-stated; the sentence (ending in “persistent and serious”) provides a good, succinct summary of the situation. 165. Changed “verified” to “occurred” or “were focused over.” 166-167. I think you mean to say, “...the mid-level reflection of AANA stimulates anomalous ascending motion...” I am not certain what is meant by “in the rear” and “in the front.” In the rear or front of what? I think you mean “with respect to the AANA,” but consider briefly clarifying the point of reference. 170. Change “at the back” to “to the rear.” 171-172. Change “appeared to have a conflict with” to “appear to contradict.” Not sure what is meant by “the insufficient speculation;” please clarify. Eliminate “would” after “The following sections.” 174. Not sure of the meaning of “range;” do you mean that it (the anomalous ascending motion) extended through the depth of the troposphere? 175-176. I am not certain how wind anomalies “appeared as weak and narrow ascending motion...which broke the local circulation.” This is one of the “confusing statements” mentioned in the Major Comments section that should be clarified prior to publication. 177. Not certain of the meaning of “was restrained at 500-800 hPa.” “500-800” implies a fairly thick layer, not a single level. I also do not know what constitutes “confrontation” between updrafts and downdrafts. Consider re-wording this sentence; also, change “the upper level” to “upper levels.” 179. I can understand how weakening of the downward transport of westerly flow from aloft can foster the build-up of pollutants near the surface, but I not see how the presence of anomalous ascending motion in the mid and upper levels necessarily “confined” downward westerly momentum transport. What likely physical processes were involved? 183-184. Perhaps I am not cognizant of the scale of the anomalous vertical motions being discussed here. But I do not understand how synoptic-scale vertical motions — anomalous or otherwise — can impact the vertical air motions such that they overpower vertical motions that predominantly occur in response to vertical density differentials

(i.e., to the vertical stratification). It is well-known that regional inversions often arise as a result of persistent synoptic-scale subsidence, and that such inversions sometimes are associated with haze and pollution events. Ascending motions tend to destabilize stratified thermal environment, so it is a bit difficult to accept the notion given that the diagnosed ascending motions somehow "restrict" the descent of ("cold") air from higher levels of the atmosphere, thereby encouraging the build-up of pollutants. As the offered interpretation runs counter to that which is commonly understood —- and because this part of the paper is central to the overall argument being made regarding the value of the AANA index — further discussion and clarification of the ideas presented in this paragraph are warranted. 188-189. Change "the atmospheric environment capacity" to "the atmosphere's capacity for pollution aerosols." 195. What is the "normal vertical circulation" in the BTH region? 196-199. The idea that ascending motions somehow limit vertical mixing is, again, counterintuitive and requires further explanation. I might well be missing something in my reading of this section. But another interpretation of the data that occurs to me involves what might be described as the "temporal footprint" of the AANA pattern. In short, a persistent ANNA over the BTH region leaves it with a stable thermal stratification that is conducive to the build-up of pollution aerosols — namely, a shallow PBL capped by a strong inversion. The strong ascending mid-level vertical motions that appear on the "back sides" of the AANA patterns then are unable to strongly "connect" with the air that lying beneath the inversion. Similar environments can give rise to "elevated thunderstorms" (e.g., Corfidi et al. 2006), wherein boundary-layer air is unable to support deep convective development, but the arrival of strong mid-level ascent on the "back side" of a large, deep anticyclone releases convective instability that evolves at the mid-levels. I do feel that the preceding interpretation is more strongly supported by accepted synoptic- and mesoscale meteorological theory than is the notion (proffered in line 196) that "clean air in the upper atmosphere" is somehow "restricted" from descending to the surface. Another interpretation that occurs to me in reading this section is that the vertical motions resulting from vertical stratification somehow are being conflated with those that arise from AANA synoptic-scale pattern

that is the main subject of your investigation. 204. Add an "s" to "levels." 205. Not sure "generated advection inversion" means. Is it that the relatively warm oceanic air moves inland atop the shallow, cool layer based at the surface? 206. Add the word "a" before "thermal inversion." 207. Add an "s" to updrafts. 209. It is not immediately apparent why the circulation is indirect; adding a few words to support this observation would be helpful (a similar comment could be made for direct circulation noted in line 200). Also, consider rewording sentence that begins "Drier atmosphere" as "The resulting drier atmosphere..." 211. Change "stable" to "persistent" or "reliable." 214. Change "forecast" to "forecasting." 215. Change "in" to "over" before Lake Baikal. 219-220. Low-level convergence cannot "supply" water vapor. Likewise, there is no process of which I am aware by which convergence at low-levels can "motivate" (cause?) sinking motion and lower PBLHs. 222. Change "rebuilt of" to "rebuilding of a." 227. Change "the" before "cyclonic circulation" to "a." 228. Change "and then it was forced to move" to "that subsequently moved." 236. Add an "s" to "winds," an "a" before "stronger," and a comma after PBLH. 237. Eliminate "From the horizontal direction." 239. Change "updraft" to "vertical motions." 240. Change "broke" to "weakened." 241. Change "of" after "factor" to "in promoting." Also, change "ascending" to "anomalous vertical." Recall, however, in the summary you present here, the comments given above for lines 183-199. 243. Related to comment made for line 209, it is difficult to envision how a land-sea circulation is indirect without a bit more clarification. 248. Change "the" to "a" after "contrast." Also, add a comma after "non-haze day," and change "for" after "non-haze day" to "resulting in." 253. Add an "s" to "winds" and an "a" before "stronger." As a review for readers, you might consider briefly restating the relationship between the (well-known) EAWM and the AANA here. 256. Eliminate "in the horizontal direction." 257. Add "of the AANA area" after "front." 258. Add an "s" to "winds," an "a" before "Stronger," and an "a" before "shallower." 260-275. Interesting observations regarding the different statistical relationships observed. But given the relatively small number of cases involved, it is difficult to draw definitive conclusions. 262. Not sure that "indicative" is the correct word here. I'm also not sure that the word is needed; I think it could

be eliminated. 275. Add an “s” to “levels.” 276. Change “wind” to “flow.” 279. Unless I have interpreted your data section incorrectly, “the period of December 2014-2016” should be re-phrased as “the months of December in the years 2014-2016.”

Figures Fig. 1 In caption, add an “s” to lines,” and add a comma and the word “respectively” after “episodes.” Fig. 2. While the images can be enlarged for viewing with electronic media, the present images need some enlargement for print publication. Also consider somewhat thickening the underlying geographical outlines for ease of view. Fig. 6 In caption, add an “s” to “mid-level.” Fig. 7. The meaning of the green lines in parts “a” and “c” not indicated in caption. More significantly though (and forgive me here), I find this figure confusing. Parts “a” through “d” purport to show wind anomalies, but the captions for each part mention “omega.” Parts “a” and “c” purport to show contoured PBLH anomalies, but I can find no contours in either figure parts. As this figure is important to supporting the thesis of the paper, some clarification of the figure caption would improve the presentation. This figure (and the related text in the manuscript) represents one of the areas of “confusing statements” mentioned in the Major Comments section. Fig. 8. In caption, consider changing “Pressure-meridional” in parts “b” and “d” to “Pressure-longitude” to better correspond with terminology used in parts “a” and “c.” As with Figure 7, I am also somewhat confused by this one. If I understand things correctly, parts “a” and “c” depict mean profiles of the wind along a longitudinal band between 114 and 120 E. If what is shown is indeed wind, why is “omega” mentioned in the captions for both parts “a” and “c”? Further, do the orientations of the arrows indicate the directions (i.e., azimuths) of the wind? Parts “b” and “d” purport to be the mean wind along the latitudinal band between 36 and 42 N. Again, however, there is reference to “omega” in the caption for both parts. Vertical transport of westerly momentum is shown only along the latitudinal swaths given in parts “b” and “d,” but not along the longitudinal swaths given in parts “a” and “c.” Is there a reason for this? Again, as this figure also is important to the thesis of the paper, some clarification would improve the presentation.

Reference Corfidi, S. F., S. J. Corfidi, and D. M. Schultz, 2008: Elevated Convection and Castellanus: Ambiguities, Significance, and Questions. Wea. Forecasting, 23, 1280-1303)

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