

Interactive comment on “The dynamic-thermal structures of the planetary boundary layer dominated by synoptic circulations and the regular effect on air pollution in Beijing” by Yunyan Jiang et al.

Anonymous Referee #1

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Based on Lamb-Jenkinson weather typing and multiple field measurements, this study reveals the mechanisms which couple multiscale circulations, planetary boundary layer (PBL) structure and air pollution. Due to the topographic blocking during daytime, pollutants accumulate in the plain areas within different layers. The sinking divergent flows overlying on the rising convergent flows within the PBL inhibit the continuously upward dispersion of air pollutants. At night, the horizontal and vertical coupling mechanisms increase the air pollution. The large-scale wind systems and regional-scale breezes affect the air pollution directly via the horizontal coupling, which generates air pollution

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convergent zones of different directional flows. The strength of flows causes severely polluted areas from 39°N to 41°N. In addition, the multiscale circulations regulate the mixing and diffusion of pollutants indirectly via the vertical coupling, which changes the PBL dynamic-thermal structure. The warm advection caused by the upper winds overlies the cold advection caused by the lower regional breezes, generating strong wind direction shears and advective inversions. The blocking inversion and the convergent sinking motion within the PBL suppress massive air pollutants below the zero speed zone. The multilayer PBL under cyclonic circulation has no diurnal variation. Weak ambient winds strengthen the mountain breezes observably during night, the temperature inversion can reach 900 m. The nocturnal shallower PBL, consistent with the zero velocity zone between ambient and mountain winds, can reach 600 m. Otherwise, the PBL under southwesterly circulation is a mono-layer with obvious diurnal variation, reaching 2000 m during daytime. The strong circulations restrain the development of regional breezes, the zero speed zone is located at 400 m and the inversion is lower than 200 m during night. The PBL under westerly circulation has a hybrid structure with multiple air pollution layers and diurnal variation. The inversion is generated by the vertical shear of zonal winds. Clean and strong northerly winds dominate under anticyclone circulation, the vertical shear and the diurnal variation of thermal fields disappear because of strong turbulent mixing, and there is no significant PBL structure. Our results imply that the algorithms of description of atmospheric environmental capacity under synoptic circulations, such as the cyclonic type, with a multilayer PBL need to be improved. General comments The impression of the whole paper is a description of mechanisms of coupling atmospheric dynamics and air pollution levels in the North China Plain (NCP) and especially in the Beijing area. The introduction is missing the definition of objectives of the paper and maybe some hypothesis of answers for questions. The description of methods is missing an overall statement which data are required and why. It is necessary to show what is available and which data are missing. It should be explained why the data basis is complete for this study. Then the algorithms should be discussed by the same view: why you do what and why

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this way can provide the expected results or answers to the hypothesis. The chapter Conclusions is a summary. A discussion or a chapter Discussions is missing. This is necessary to provide the relation of the study results to the overall knowledge given in the Introduction. What are new results? Why at the end of the Conclusions improvements of the understanding of pollution and meteorological conditions are followed? The paper addresses relevant scientific questions within the scope of ACP. The paper presents novel concepts, ideas, tools and data. The scientific methods and assumptions are valid and clearly outlined so that substantial conclusions are reached. The description of experiments and calculations allow their reproduction by fellow scientists. The results are sufficient to support the interpretations and conclusions. The quality of the figures is good. The figure captions should be improved so that these are understandable without the overall manuscript: measurement methods and calculation methods should be given. The related work is well cited so that the authors give proper credit to related work and own new contribution. The title reflects the whole content of the paper. The abstract must be improved: It is too long and includes descriptions of processes which are from the Introduction. What are the objectives, measurement methods, data, analyses methods, new results and conclusions? The overall presentation is well structured and clear. The language is fluent and precise but must be improved in very much details. It is necessary that a native speaker is improving the manuscript. The mathematical formulae, symbols, abbreviations, and units are generally correctly defined and used. No parts of the paper (text, formulae, figures, tables) should be reduced, combined, or eliminated. The number and quality of references is appropriate. Specific Comments Sometimes air pollution and sometime aerosols are used for the same matter. Why? How the map of PM_{2.5} in Figure 4 is determined from the available network of monitoring stations? The same question is for Figure 3, 5, 7, 9. Why the vertical scale in Figure 12 and 13 from m in the figures before into hPa? Technical corrections The references are incomplete in lines 474, 497, 540, 546. Sometimes p. and sometimes pp. is used?

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