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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cold fronts – a potential air quality threat over the Yangtze River Delta, China" *by* Hanqing Kang et al.

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This paper tries to reveal impacts of synoptic process on local/regional air quality. The authors focus on cold fronts and their related weather process. This kind of large scale weather system can of course influence local air quality, during its different stage of passing the concerned site. The discussion in this paper is of scientific meaning. My major concern is on the title, since a cold front itself cannot be a threat on air quality. Usually we consider the passage of a cold front as a cleaner to local air pollutants, since stronger winds may accompany to the cold front. Therefore the title is misleading. Because of the title and related conceptual confusion, many phenomena and pro-

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cesses are not described/interpreted properly in this paper. It happens also for some concluding sentences. In addition, this is only a case study for 18 days of weather processes.

Response: Thanks for your comments. Yes, you are right, local air pollutants can be cleaned by cold front because of the stronger winds. But cold front can also bring air pollutants from upstream areas. Lin et al. (2007) suggested that long-range transport of Asian dust and upstream air pollutants by cold fronts are important environmental issues of Taiwan during the winter monsoon season. Liu (2003); Ding et al. (2009) also pointed out that frontal activity plays important roles in the long-range transport of air pollutants.

In this study, we found a series of air pollution episodes accompanied by cold frontal passage over YRD from December 2014 to February 2015 (Figure below, not shown in the manuscript, but we added descriptions to the manuscript in page 6 line 18-21.). At least 13 cold frontal cases (thicker black numbers in the figure) were found accompanied by the long-range transport of PM2.5 from NCP to YRD. During these cold frontal cases, air pollution over YRD always occurred 1-2 days later than that over NCP and PM2.5 concentrations elevated drastically along with the strong northerly winds. It is very clear that the rapid increase of PM2.5 concentrations over YRD in a short period in these cases (case 6, 7, 8, 9 and 11 are more obvious than others; in this study, we chose case 8 and the following local accumulation air pollution episode for further discussion) are attributed to cold fronts' transport rather than locally accumulation. If there are no cold frontal passage in these cases, PM2.5 concentrations over YRD would be much lower. Therefore, cold fronts are potential air quality threats over YRD. According to above discussions and conclusions, we think that the title of this paper is not misleading and the concept is clear. Note that cold front generally deteriorates air quality over YRD in a short time period, but it will finally clean the atmosphere. This study provided a new insight into the understanding of air pollution formation mechanisms over YRD.

Besides, we thoroughly revised the full text, make sure all phenomena and processes are properly described/interpreted.

Other points:

1)Page 1 line 29: "The results of this study indicate that cold fronts are potential bringers of atmospheric pollutants. . .", not exactly real.

Response: Thanks for your comment. From the result of this study and the picture below, we can conclude that cold fronts are potential bringers of atmospheric pollutants over YRD. But in other places, this conclusion may not be true.

2)Page 2 line 11: "Cold fronts are important pollutant transport pathways", what does 'pathway' mean here?

Response: We changed this sentence to "Cold fronts are important ways of pollutant transport." in page 2 line 16.

3)Page 3 line 1: " Therefore, cold fronts are a potential threat to air quality along its transport pathway", this is never a logic conclusion to previous sentences.

Response: Thanks for your comment. We changed this sentence to "Therefore, cold fronts may have significant impact on air quality along its transport pathway." in page 3 line 8.

4)Page 8 line 3: " Observations revealed that the cold front was a carrier of aerosol particles which increased PM2.5 concentration over YRD in 21 January. This finding. . .", The cold front carries the air pollutants? Or just the fact is that the air pollutants accompanies the cold front?

Response: In this cold frontal case, air pollution was formed in NCP, then transported to YRD by cold frontal intrusion. We changed this sentence to "Observations revealed that the cold front pushed polluted airmasses over NCP to YRD, which increased PM2.5 concentration over YRD in 21 January." in page 8 line 5.

5)Page 10 line 14: "Through the horizontal advection process, the cold airmass brought aerosols from the NCP to the YRD", what is the evidence?

Response: Process analysis technique can provide contributions of each physical/chemical process to PM2.5 concentrations over YRD. Contributions from horizontal advection process are positive near surface (Fig. 7a) that means PM2.5 horizontal inflows are stronger than outflows. The horizontal inflow of PM2.5 mainly comes from NCP, which can be found from the PM2.5 fluxes in Fig. 6.

6)Page 14 line 8: "Cold fronts are important PM2.5 transport pathways", Cold front is. . . transport pathway? What do you mean?

Response: We change this sentence to “Cold fronts are important ways of PM2.5 transport” in page 15 line 2.

Ding, A., Wang, T., Xue, L., Gao, J., Stohl, A., Lei, H., Jin, D., Ren, Y., Wang, X., Wei, X., Qi, Y., Liu, J., and Zhang, X.: Transport of north China air pollution by midlatitude cyclones: Case study of aircraft measurements in summer 2007, J. Geophys. Res., 114, doi:10.1029/2008jd011023, 2009. Lin, C.-Y., Wang, Z., Chen, W.-N., Chang, S.-Y., Chou, C. C. K., Sugimoto, N., and Zhao, X.: Long-range transport of Asian dust and air pollutants to Taiwan: observed evidence and model simulation, Atmospheric Chemistry and Physics, 7, 423-434, doi:10.5194/acp-7-423-2007, 2007. Liu, H.: Transport pathways for Asian pollution outflow over the Pacific: Interannual and seasonal variations, J. Geophys. Res., 108, doi:10.1029/2002jd003102, 2003.

Fig. 1. Observed surface PM2.5 concentrations (color) and wind vectors (only the wind speeds greater than 3 m/s are shown) at 14 sites from 1 December 2014 to 28 February 2015. Labels on left axis are latitudes of the 14 observation sites. Red numbers are cold frontal episodes that transport PM2.5 from NCP to YRD.

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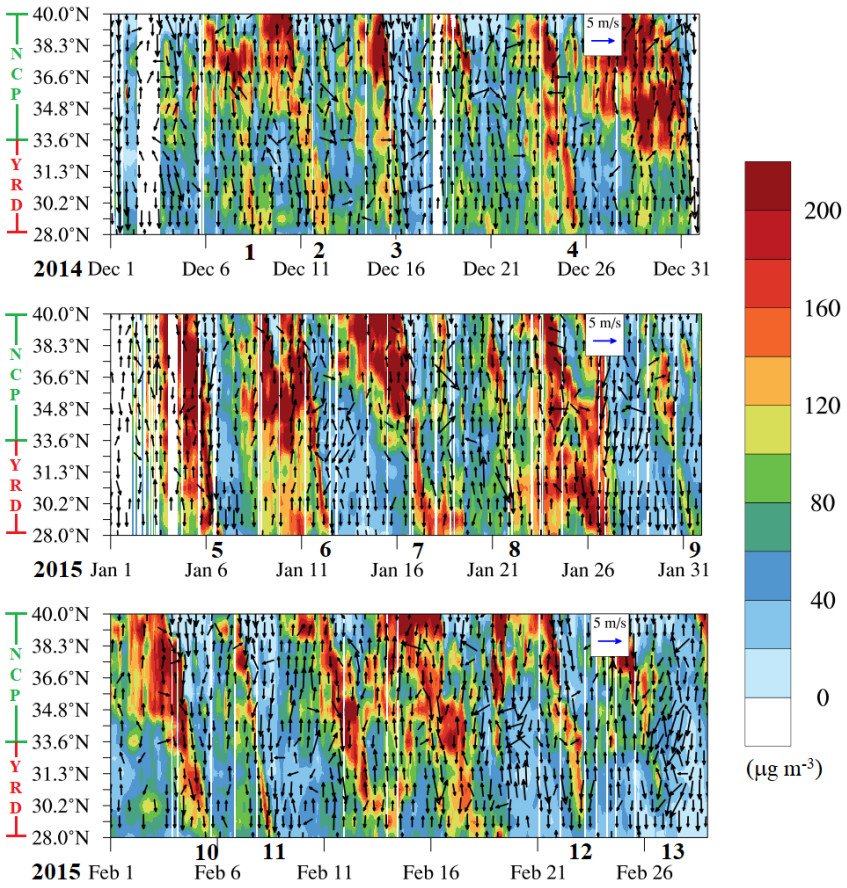

Fig. 1.

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