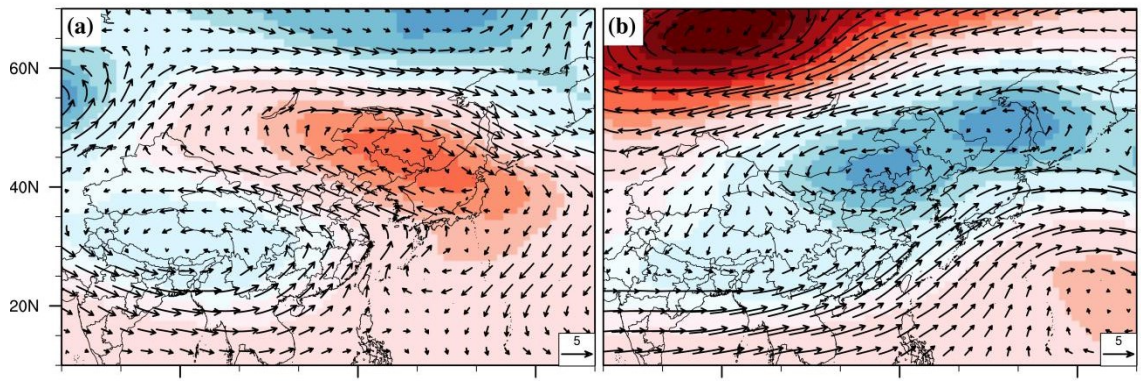
Comments from Review 3:

Response: We thank the reviewer for the thorough comments to improve our manuscript. Regarding the reviewer's concern, we have addressed all the comments shown below.

The authors identified an interesting sub-seasonal seesaw pattern of winter haze pollution in northern China, featuring high and low PM2.5 concentrations in two adjacent months. They also found that this phenomenon is related to the circulation patterns modulated by El Nino and Arctic Oscillations. In general, I think this manuscript is well structured and the topic is suitable for ACP. But I still have some concerns about the robustness of the proposed mechanism before ACP accepts this paper.

1、The analysis is based on only three super El Nino events after the 1980s. The number of cases is too few here. Does the proposed mechanism also apply to the El Nino events with smaller magnitudes and these before the 1980s? I think the readers also would like to see a figure displaying the circulation anomalies from an ensemble of El Nino events.

Response: Based on reviewer's suggestion, we now have checked the circulation patterns (i.e., 500 hPa GHT) during all the El Nino events since 1948, and found that there were no obvious seesaw patterns in the other El Nino events. The reason we selected 1948 is that the reanalysis data was only available from 1948. Only the three El Nino events (1982/1983, /1997/1998 and 2015/2016) were super strong El Nino events (peak of 3-month running SST greater than 2.0 °C), and all the other events belong to moderate or weak events. As the reviewer suggested, we added the circulation anomalies from an ensemble of El Nino events, including the super El Nino events, the moderate/small events after 1980 and the events from 1948-1980. The peak and decay of the ensemble of El Nino events were shown in Fig. S5a-f in the supporting information, which were also shown below. The results indicate that only the super El Nino events shows obvious seesaw patterns, whereas the ensembles of the others events do not show the seesaw patterns, which further implies the robustness of the seesaw patterns we discussed. This has been added in the revised manuscript (first paragraph of section 4.2).



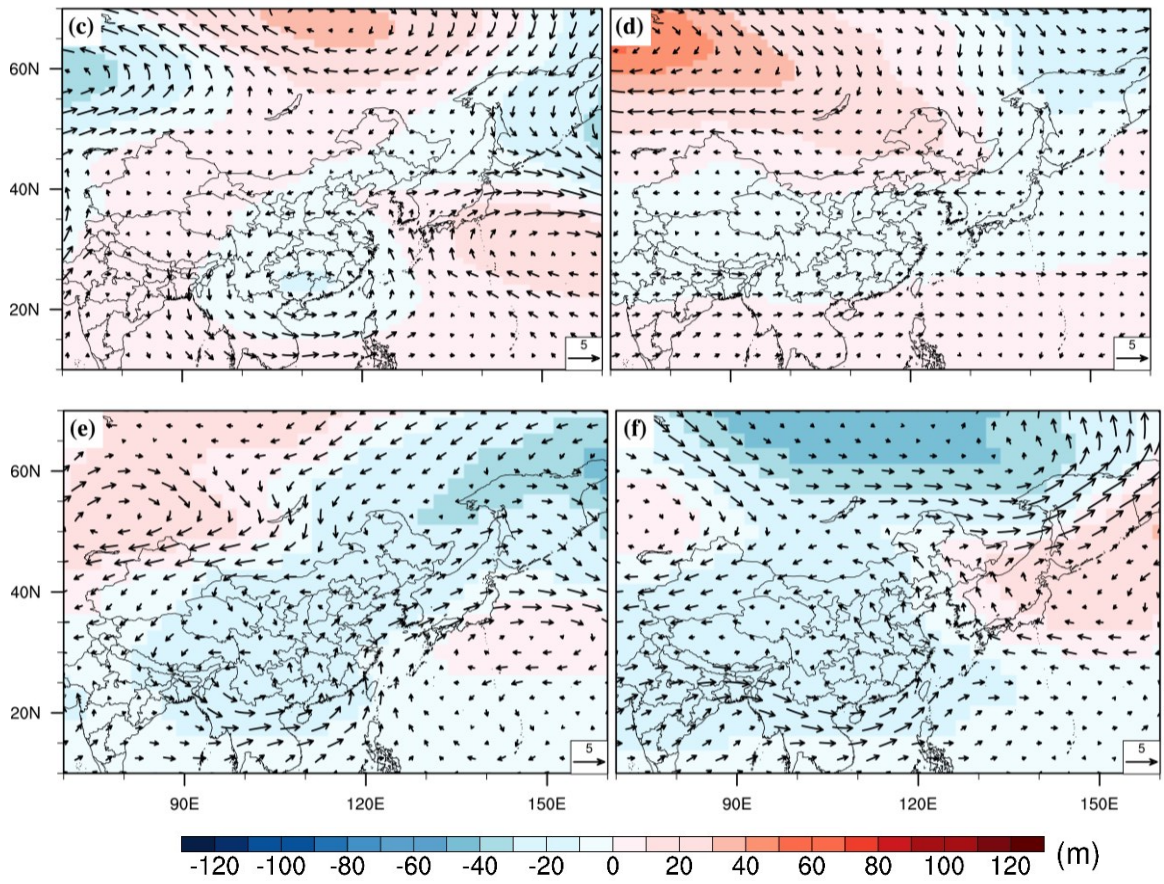


Fig. S5. Anomaly (relative to 1987-2016) of geopotential height and wind vector at 500 hPa for the ensemble mean of El Nino events, i.e., Fig. S5a (peak of super El Nino: 198301/199712/201512), Fig. S5b (the decay of super El Nino: 198302/199801/201601), Fig. S5c (peak of moderate El Nino events since 1980: 199201/199412/200211/200412/200612/200912), Fig. S5d (the decay of moderate El Nino events since 1980: 199202/199501/200212/200501/200701/201001), Fig. S5e (peak of El Nino events before 1980: 195801/196311/196511/197211/197711), Fig. S5f (decay of El Nino events before 1980: 195802/196312/196512/197212/197712)

2、If the El Nino peaks in December 2015, its effects on northern China winds may appear one or two months later due to the time spent on the wave propagation. So I am wondering whether the El Nino really causes the high $PM_{2.5}$ concentrations in December 2015. I wish the authors can have some comments here.

Response: We thank the reviewer for raising the concern regarding the impact from El Nino. The effect of El Nino on haze formation was mainly through the modulation on EAWM. Since the three month running mean SST was used, the peak of El Nino in a

certain degree has reflected a lag of one month or so. In addition, as was discussed in the conclusions, the mature phase of super El Nino was accompanied by a positive AO, and these two factors together modulate the changes of EAWM and the subsequent haze formation. Therefore, we are confident of the effect of El Nino on haze formation.