

Dear editor,

We appreciate you for carefully reviewing our manuscripts and providing the suggestion to improve the quality of it. We have carefully read your comments and revised the manuscripts as suggested. The following are our responses to your confusions point by point. We marked all relevant changes in the manuscript in red.

L22: Is this the wave propagating along the polar front waveguide or the subtropical wave guide or both? Please clarify

Response: We are sorry we didn't express our intention accurately. This wave propagated along the polar front waveguide. The sentences have been revised.

L84-86: how many stations are there? Where are they located? This is important for the Cressman interpolation below. Can you show a map of the stations?

Response: There are 3087 stations in the region from 15-55N and 70-140E. We have showed the stations in Figure 1.

L94: how were these thresholds decided? How do they compare to climatology?

Response: At present, there are two kinds of visibility thresholds for haze in the world. The value recommended by WMO is no more than 5km. Before 1948 in China, the maximum visibility of all kinds of horizontal obstruction to vision affecting visibility was less than 4 km. Clear air is a phenomenon of good atmospheric transparency (visibility ≥ 10 km). After that, the maximum visibility of haze increased to less than 10km, which is still used up to now. According to WMO's 1984 report, the relative humidity of haze is less than 80%. These thresholds are constantly updated according to actual needs, which is good compare to climatology. For example, Liu et al. (2017) and Zhao et al. (2017) used these thresholds.

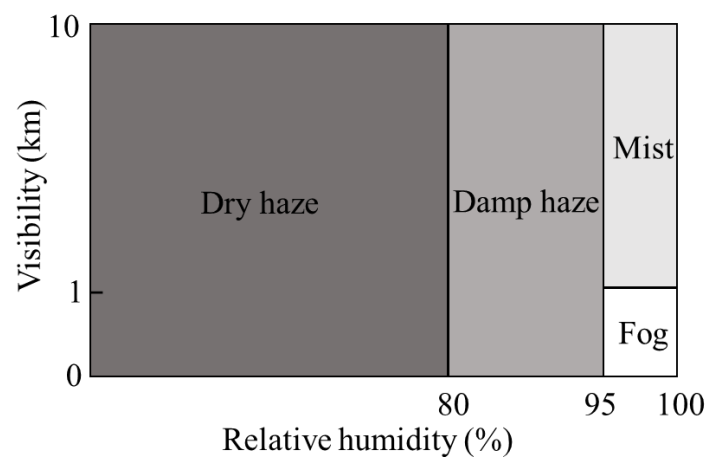


Figure 1: The conceptual model of distinguishing haze and mist or fog (Wu et al., 2018)

L98: Is Cressman objective analysis the same as Cressman interpolation method in the last sentence? please clarify

L104: how are these values chosen? Which value out of 5, 4, 3 is used for which variable? Do you show results for all three values? This needs more clarity. I could not reproduce your methods based on the level of detail given here.

Response: Yes, Cressman objective analysis is the same as Cressman interpolation method. The sentences have been revised. Cressman objective analysis is a successive corrections process using multiple Cressman interpolations.

The value of R is no more than 10, generally 1-4. The value decreases in turn, indicating the radius

of each successive corrections. There is always a subjective factor for choosing these values, generally 10, 7, 4, 2, 1. In this paper, R is 5, 4 and 3, which is more than 2 and less than 7. If Cressman objective analysis is not used, the figure is as follows, which is similar to the figure 2 in our manuscript. Compared with the figure 2a (without interpolation), the shading in figure 2 (interpolation) in our manuscript becomes smoother.

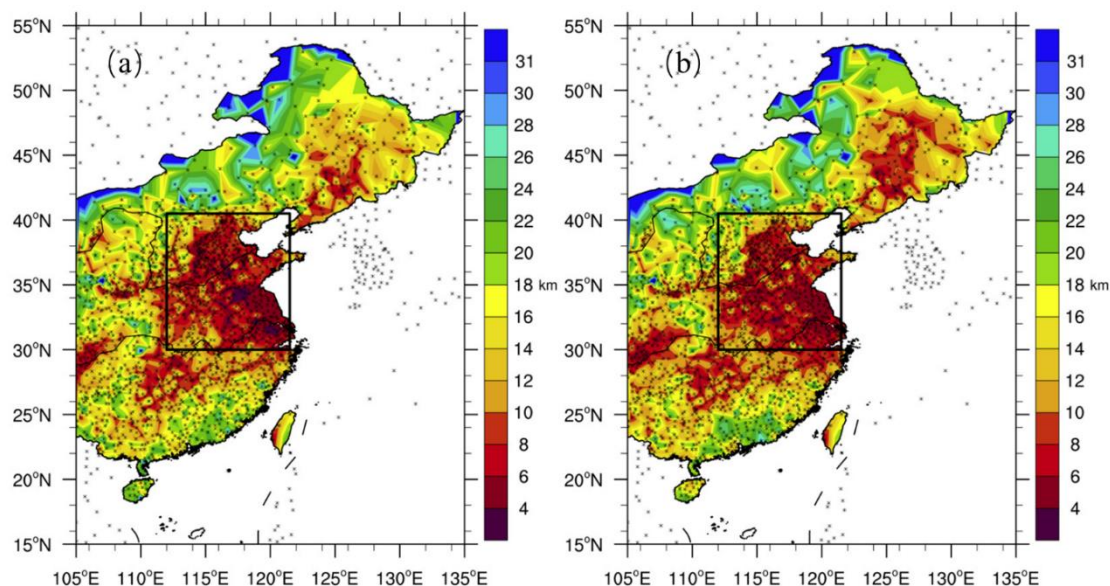


Figure 2a: Spatial distribution of monthly mean visibility (unit: km, shading) (without interpolation) in (a) November and (b) December 2015. The black box indicates the NCP (30°N-40.5°N, 112°E-121.5°E). Shading indicates the value of visibility. The black dots represent the location of meteorological stations.

L109: In the formulation of Plumb (1985) the primes in this equation are deviations from the zonal mean not the time mean state. Below in equation 10 you describe calculating the prime by taking the deviation from the time mean state. Can you clarify?

Response: Yes, the perturbation stream function is calculated according to the zonal mean flow. We mean that the geopotential height anomaly used in the calculation of the perturbation stream function is the mean relative to the climate state. The equation 10 we describe mainly refers to the calculation of other anomalies mentioned in the manuscripts. For example, figure 4 is based on the equation 10.

L176: Does the cold air induce anomalous vorticity that generates the wave? Or was the anomalous vorticity that forces the wave train already present? please clarify

Response: Yes, it is cold air that induce anomalous vorticity that generates the wave. At upper troposphere, there was a strong northerly anomaly over the European continent. The strong northerly wind intruded into the entrance of the subtropical westerly jet over the vicinity of the middle eastern Mediterranean and formed the cold air convergence (Ding and Li, 2017) (Figure 4a, Figure 5a), named as western disturbance (Syed et al., 2006). Within the subtropical westerly jet, there existed a southerly/northerly wind wave train (Li, 1988; Li and Sun, 2015; Ding and Li, 2017).

Li et al. (2015) found the Rossby wave originated from strong cold air intrusion into the subtropical westerly jet over the eastern Mediterranean. Another feature was cold advection with northerly wind over northeastern Africa (eastern Asia), coupled with upper tropospheric convergences and mid-troposphere southwest–northeast (west–east) troughs, which induced the propagation of Rossby

energy southeastward from the midlatitudes to the North African-Asian jet (Li, 1988).

L316: no I dont think it does show this directly. Instead the correlation shows that the EUI you have defined captures similar variance in the meridional wind field to the EOF.

Response: The results of EUI and empirical orthogonal function (EOF) of the 200 hPa meridional winds represent different wave trains, and their positions are obviously different. The EUI defined in our manuscripts is similar to the previous EU index, which represents the North Branch wave train (the Eurasian teleconnection), while the empirical orthogonal function (EOF) of the 200 hPa meridional winds mainly represents the South Branch wave train. There is a high correlation coefficient between EUI defined by us and the meridional wind field to the EOF, indicating that both exist when haze occurs, which is consistent with the previous results mentioned in the manuscripts.

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