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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "The combined effect of two westerly jet waveguides on heavy haze in the North China Plain in November and December 2015" *by* Xiadong An et al.

**Anonymous Referee #1**

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The combined effect of two westerly jet waveguides on heavy haze in the North China Plain in November and December 2015

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This manuscript presents an analysis of a heavy haze event in the North China Plain (NCP) in 2015, aiming to determine possible influences of the large-scale circulation on the event. It is shown that the strong haze event coincided with a wave-like pattern in the upper-tropospheric meridional wind field spanning Eurasia. It is then shown that this pattern is in fact very similar to the leading EOF of that field, and it is suggested



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Discussion paper

that this setup is vulnerable to haze events in the NCP because it is associated with (1) subsidence and increased lower-tropospheric static stability in the NCP region (forced by the polar front wave guide) and (2) additional subsidence in the NCP region resulting from ascent and diabatic heating in South China (forced by the subtropical waveguide).

This topic is of strong importance and the study helps clarify the mechanisms by which the large-scale dynamics influences local air quality in China. I do however have a number of concerns which I would like to see addressed before publication.

Main comments

- Your analysis uses mostly time-mean fields together with the Plumb stationary wave activity flux, but in the abstract you say 'The Rossby wave propagated eastward along the subtropical jet' (line 8). After reading the manuscript I am now imagining a stationary Rossby wave with an eastward group velocity (i.e. fixed ridge and trough positions, but wave activity propagating downstream), but certainly did not imagine that when I first read the abstract. Have I interpreted this correctly? Given its repeated use and importance throughout the manuscript, I wonder if there is a more precise terminology for this process? At the very least I would like to see this point clarified in the abstract and in your description of it in the manuscript.

- It is argued that it is the 'combined effect. . .of two Rossby waveguides' that leads to these conditions and is therefore responsible for the haze. Whilst this seems plausible, I struggled to see much direct evidence to support the second route, specifically the fact that ascent and diabatic heating in Sough China should lead to descent further north. Given that the 'combined effects' or both routes this makes it into the title, I would like to the see the argument made more precise.

Other comments

- L10. You say 'resulted in a stable atmosphere', but this is only true for the lower-troposphere. Please amend (I note Reviewer 2 also made this point later on in the

manuscript).

- L24-25. You say 'The latent heat released by rainfall acted as a heat source, inducing convection over South China'. I don't get the logic here. Do you distinguish between convective and non-convective rainfall? Where in the text do you justify the point that diabatic heating from non-convective rainfall leads to convection?

- L25-26. I think the conclusion that the ascending motion over South China helps maintain the descent over the NCP is too speculative to be stated in the abstract, given the evidence presented.

- L39. I wasn't familiar with the term 'haze-fog'. Please could you clarify its definition?

- L46. What do you mean by the 'contribution rate is 45%'? Is this the fraction of variance explained? Please clarify.

- L70. 'large' -> 'large-scale'.

- L95. I noted you have added the Cressman (1959) reference following a comment from Reviewer 2, but there is a typo in the author name.

- L104. What do you mean by 'anomalous propagation of Rossby waves'? I was not 100% sure of the methodology here. Is 'perturbation streamfunction' (L107) the same this as streamfunction anomaly (as defined in L117), or is it an anomaly from the zonal mean? Do you compute this from monthly mean fields? Please clarify the method.

- Eq 4. You have mis-placed the close bracket on the bottom line of the vector.

- L115. I noted you have added a definition of 'Norm' following a comment from Reviewer 2, but define sigma as the 'number of values'. Isn't sigma the standard deviation?

- L132. Your definition of 'static stability' is very confusing, given that the atmosphere is stable when this diagnostic is small, and unstable when it is large. Can you think of a more appropriate name for this variable, or else at least reverse its sign?

- L136. ‘atmosphere’ -> ‘lower troposphere’

- L152. What is ‘upward flux’?

- L166: You say the wind ‘formed a convergence of cold air in the Middle East. . .’. Would ‘led to the advection of cold air towards the Middle East. . .’ be a more accurate description?

- L174. Are you referring to Fig 4c, not 4b?

- L176. You say ‘There was a negative phase of the EU’, but have not introduced the EU pattern anywhere.

- L180. ‘atmosphere’ -> lower-troposphere’

- L213. Please state the domain used for the EOF computation (it’s stated in the caption, but should also appear in the main text). I’m assuming from the PC timeseries that these EOFs are based on the Nov-Dec average fields for each year (rather than monthly or daily values)? Please clarify.

- L215. You say ‘The mode’s variance is 25.3%’. Do you mean ‘The variance explained by this mode is 25.3%’?

- L218. Same comment.

- L240. ‘Plum’ -> ‘Plumb’

- Lines 239 to 253. You make a lot of claims regarding the interpretation of the wave activity flux plot without backing them up. E.g. ‘energy dispersion over the Siberian area, leading to a negative geopotential height anomaly in this location’. Please can you provide references explaining why this is the case. Similarly why should energy ‘dispersed within South China’ result in a ‘large amount of heavy rainfall in South China’?

- Fig 4 caption. I was confused which of the variables shown are absolute and which are anomalies (e.g. divergence in panel b). Please clarify.

- Fig 7 caption. What are the units and contour intervals in panels a and c?

- Fig 8 caption. From my understanding, the two PCs used for the regression are anti-correlated and yet the resulting patterns in panels a and b have the same signs. Have I misunderstood, or does the panel a regression use -PC1 rather than PC1?

- L480. Do you mean 'the gradient of the zonal wind with the latitude is 0'?

- Fig 9 caption. What are the units of the shaded field? Presumably this regression is again using the standardised PC1 timeseries?

- Fig 10 caption. I expected units of s-2 for the wave activity flux, given Eq 4. Please check.

- Fig 11. I find this schematic unacceptable in its current form. It shows geopotential height and meridional wind at 200 hPa, but shouldn't these be directly related via geostrophic balance? Perhaps the geopotential is shown at 500 hPa instead? In case it is correct and I have misunderstood what is shown, please clarify.

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