“Identification and characterization of foehn events in Beijing and their impact on air-pollution episodes.”

The paper introduces a novel foehn identification method for the Beijing region, emphasizing seasonal and spatial patterns influenced by local topography and meteorological conditions. The potential strength of this work lies in the simplicity of the proposed method, which relies exclusively on near surface meteorological observations, making it suitable for long-term climatological applications. However, the authors do not clearly describe and discuss this methodological innovation throughout the manuscript. While the study presents a promising approach, the manuscript would benefit from improvements in clarity, methodological transparency, and deeper discussion of the results and their implications.

The study first identifies 204 pollution episodes in Beijing based on city-wide PM2.5 concentrations exceeding 75 μg/m³. A method is then applied to detect foehn events using near surface meteorological data, considering wind direction, temperature increase, humidity drops, and no precipitation. The authors cross-reference the pollution episodes with foehn occurrences and find that 137 of them overlap. These are manually classified into two types: Type I (rapid PM2.5 decrease) and Type II (slight decrease followed by a rapid increase). The classification appears to be subjective, based on visual inspection of time series. Finally, Self-Organizing Maps (SOMs) are used to identify distinct synoptic patterns associated with each foehn type.

General comments:

1) The authors use PM2.5 time series during pollution episodes (defined by concentrations exceeding 75 μg/m³) to classify events into Type I and Type II. However, it is only between lines 382 and 401, in reference to Figure 11, that we get a clearer idea of what is meant by the “rapid pollutant concentration decreases” (Type I) and a “slight pollutant concentration decreases followed by a rapid increase” (Type II). Based on Figure 11, a “rapid” decrease seems to occur over approximately 6 hours, is that correct? I assume not all cases follow the same time window. Could the authors clarify how this visual classification was performed? Was any threshold defined? This point is particularly relevant if the method is to be applied to longer time series, where visual inspection alone may not be feasible.

2) When the authors mention that the foehn identification method was developed based on 22 representative historical cases, it is not clear whether these cases were derived from previous literature or from the same dataset used in this study. It would be helpful to clarify this point more explicitly. Were these 22 historical cases associated with pollution episodes? Were they classified as Type I, Type II or both?

3) I appreciate the use of standard meteorological data from AWS to identify foehn patterns, and this strength could be further emphasized throughout the text. While I value the simplicity of the approach, I wonder whether the authors have access to eddy covariance system data to quantify

turbulence-related variables, such as turbulent kinetic energy (TKE) or the standard deviation of vertical velocity. These metrics could provide direct evidence of turbulence intensity and offer a more detailed view of how foehn winds enhance vertical mixing and potentially contribute to pollutant dispersion.

Minor comments:

-The captions of several figures are unclear and lack essential details. I recommend that the authors carefully review each figure and revise the captions to provide complete and self-explanatory information.

Line 231: the caption of Figure 3 states: "Annual distribution of foehn days*",* but the accompanying map appears to include a Digital Elevation Model (DEM). However, there is no legend to explain the meaning of the colors used.

Line 276: A similar issue applies to Figure 5; the color shading is not accompanied by a legend.

Line 308: In Figure 7**,** what does the red square represent?

Line 342. The linear regression equation and axis labels are too small and difficult to read.

Line 378: Figure 11 illustrates a case study showing the temporal evolution of PM2.5 concentrations and foehn event occurrences during a pollution episode. While the authors refer to "phases" (Phase I, Phase II, and Phase III), these phases are not marked in the figure. The dashed vertical lines might correspond to these phases, but this is not explicitly stated. The figure caption lacks clarity and does not adequately guide the reader.

Line 398: The term "weak pressure gradients" is used, but no numerical values are provided (e.g., 1–3 hPa over 500 km?).

Line 403: Throughout the manuscript, the authors frequently omit units, symbols. For example, in Figure 12, the unit of sea level pressure is not indicated.

Line 411 – 416: The authors acknowledge the challenge of distinguishing foehn-induced warming from other non-foehn processes, such as solar radiation or warm air advection. While they suggest that this issue could be mitigated by incorporating detailed analyses of wind fluctuations and upstream–downstream consistency (in Zhang and Li, 2024), such an approach is not actually applied in the current study. As a result, the risk of misclassifying non-foehn warming as foehn, especially at downstream locations, remains unresolved. Explicitly addressing this limitation, or testing the proposed checks within the study itself, would greatly improve the credibility and robustness of the results.