Response to community reviewer

Dear Dr. Zhou,

Thanks for your constructive comments and suggestions on our manuscript (egusphere-2023-1299). We have studied them carefully and made revisions on the manuscript. These comments and the corresponding replies are listed below.

The reviewer's comments are highlighted by gray. Followed by the comments are our responses. The texts led by **"In Section xx"** are the current texts in manuscript. The added texts or ~~deleted texts~~ are colored by red.

With regards,

Shuqi Yan

Comments:

1. The authors claimed that the WRF model well simulated the atmospheric status of the fog event. But this conclusion was based only on comparison of simulated variables to the surface observations. Just surface environment well simulated is not enough. The high level atmospheric fields should also be well simulated since this study focuses on the influence of high level wind jets on the fog event. Please add such a comparison of the model with high level fields. This can gives readers more confidence to the results and conclusions.

Thanks for this suggestion. We have added the model evaluation on vertical temperature, humidity and winds within PBL by collecting data from sounding stations. The nearest sounding station to the fog area is Sheyang (SY, 120.25, 33.76, 3m).

Overall, the model reasonably simulates the temperature, humidity and wind profiles (Figure 6b). The detailed discussions are added into the manuscript.

In Section 2.1

This study focuses on the Jiangsu area, China (Figure 1), where a large-scale fog event occurred from 20 to 21 January 2020. We collected the data from 70 ground automatic weather stations (AWS) in Jiangsu Province, China. [data description……]. Additionally, the Sheyang (SY; 120.25°E, 33.76°N; 3m) station is a sounding station that used for model evaluation in the vertical direction. The sounding observations include temperature, RH, wind direction and wind speed which are sampled each second. It is conducted twice a day (00UTC and 12UTC).

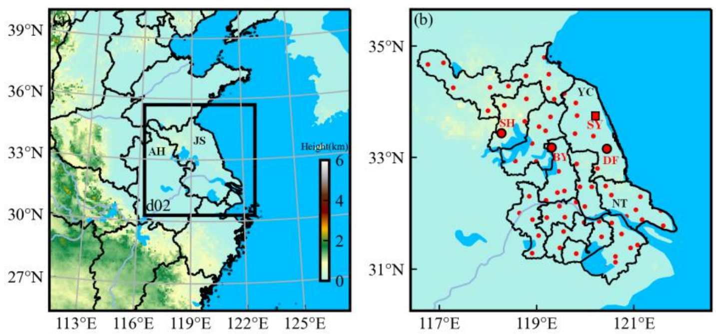

Figure 1. The parent and nest model domain. The shaded color is terrain height. The red points are automatic weather stations in Jiangsu, China. The three larger circle points are Sihong (SH), Baoying (BY), and Dafeng (DF) stations, and the square point is Sheyang (SY) sounding station. The black labels are some province or city names. (JS:Jiangsu Province; AH:Anhui Province; YC:Yanchen; NT:Nantong).

In Section 3.3

Figure 6b evaluates the model performance on temperature, RH and wind field in the vertical direction at SY sounding station. The temperature profile is simulated well by the model, with the mean bias of less than 1K. The RH bias is relatively small below about 200m, while it is a bit larger above 200m at 08:00 on 21 January. The simulated wind speed and direction are basically consistent with observation. The large winds (greater than 6m/s) at about 200m are well reproduced by the model, indicating that the model reasonably simulates boundary layer low-level jet. Studies on boundary layer low-level jet are presented in next sections.

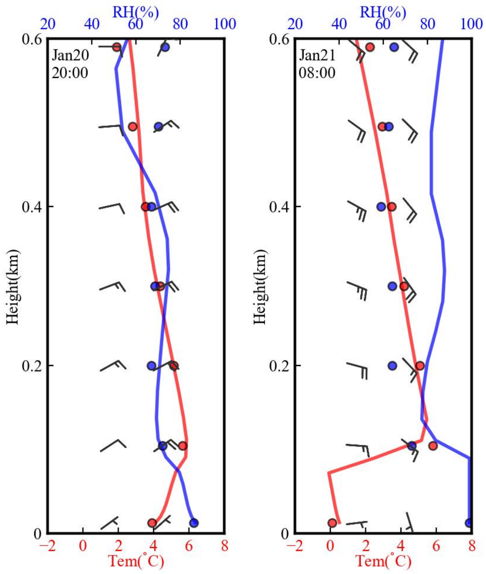

Figure 6b. The model performance on temperature (red), RH (blue) and wind (barbs) profiles at Sheyang sounding station. For temperature and RH, the observations are scatters and simulations are solid lines. For wind barbs, the left column is observations and the right column is simulations. The scatters and barbs are interpolated onto 0~600m every 100m.

2. In this study, simulated LWC was used to investigate the fog development during the fog event. The LWC equation included several important items such as condensation part, sedimentation part, vertical mixing part, etc. Then how to identify these items in the study? I don't remember there are items in WRF's output files. These items were calculated or diagnosed from the WRF outputs?

The LWC equation includes advections, condensation, sedimentation, and vertical mixing as you mentioned. These terms are already calculated by WRF physical processes, which can reasonably reflect the variation of LWC in fog events. They can be outputted by the model after modifying codes by users.

The terms controlling LWC variation have been already presented in Section 2.2.3.

In Section 2.2.3

The simulated fog is indicated by fog liquid water content (LWC). Process analysis is used to quantify the contribution of each physical process to LWC variation (Schwenkel et al., 2019; Yan et al., 2020). The variation of LWC is related to the following terms:

$$\frac{\partial \mathrm{LWC}}{\partial t} = \underbrace{-\left(u\frac{\partial}{\partial x}+v\frac{\partial}{\partial y}+w\frac{\partial}{\partial z}\right)\mathrm{LWC}}_{\mathrm{Advc}} + \left(\frac{\partial \mathrm{LWC}}{\partial t}\right)_{\mathrm{Vmix}} + \left(\frac{\partial \mathrm{LWC}}{\partial t}\right)_{\mathrm{Cond}} + \left(\frac{\partial \mathrm{LWC}}{\partial t}\right)_{\mathrm{Sedi}} + \left(\frac{\partial \mathrm{LWC}}{\partial t}\right)_{\mathrm{other}}$$

where Advc includes horizontal and vertical advection, Vmix is associated with the fog droplet vertical exchange by turbulent mixing, Cond is the vapor condensation (negative means droplets evaporation), Sedi is fog droplets sedimentation. Other microphysical processes include autoconversion, accretion and cold phase processes. They are much smaller than the previous four processes, so they can be safely ignored.

3. This study only focused on the fog event before 8:00AM due to satellite data restriction. As we know that fog may develop further after sunrise. Ignoring the evolution time after 8:00AM may loss many more important features of the fog event, or even the conclusion could be different from this study. Please clarify this concern.

Thanks for this suggestion. We agree that fog would be more complex if it develops after sunrise. We present the number of stations with fog from 07:00AM to 10:00AM (Table X1). At 08:00, the fog begins to dissipate. The number of stations with different VIS levels slightly decreases. Since 08:00, the dissipation process accelerates. At 09:00, there are 40% stations having fog and 20% stations where the VIS is lower than 200m. One hour later, fog remains at only 6 stations. All the fog disappears at 11:00.

Table X1. Number of stations with various VIS levels during 07:00~10:00 on 21 January 2020.

Local time	Number of stations	VIS<1000m	VIS<500m	VIS<200m
07:00	70	43	28	23
08:00		40	27	18
09:00		27	17	14
10:00		6	4	2

Therefore, the fog does not develop further after sunrise. It fully dissipates within 3 hours. We believe the fog evolution after 08:00AM has no significant influences on the results at nighttime.

In Section 3.2

After 07:00, the fog begins to dissipate, and it fully disappears at 11:00.

4. In the introduction section line 48: Please also add the article by Zhou and Ferrier (2008) about the role of turbulence in fog. Yes, Ye's article (2015) investigated the role of turbulence, but Ye's article is not the first but just confirmed the findings of Zhou and Ferrier in 2008.

Thanks for this suggestion. This article and other related articles have been cited.

Zhou, B. and Ferrier, B.: Asymptotic Analysis of Equilibrium in Radiation Fog, J. Appl. Meteorol, and Climatology, 47, 1704-1722, https://doi.org/10.1175/2007JAMC1685.1, 2008.

Zhou, B. and Du, J.: Fog prediction from a multimodel mesoscale ensemble prediction system, Weather and Forecasting, 25(1), 303-322, https://doi.org/10.1175/2009WAF2222289.1, 2010.

Zhou, B., Du, J., Gultepe, I., and Dimego, G.: Forecast of low visibility and fog from NCEP: Current status and efforts, Pure Appl. Geophys., 169, 895-909, https://doi.org/10.1007/s00024-011-0327-x, 2012.

In Introduction

Appropriate turbulence also facilitates fog formation and enhancement (Ye et al., 2015; Zhou and Ferrier, 2008).

In Section 2.3

Fog is hard to be simulated or predicted well (Zhou et al., 2010, 2012), which is sensitive to the choice of parameterization schemes (Steeneveld et al., 2014; van der Velde et al., 2010).