Response to the Reviewer #1

General comments:

According to literatures, the emissions from South Asia can be transported to the Tibetan Plateau (TP) as critical source regions of aerosols to TP. In this study, an assimilation system with the Himawari-8 aerosol optical thickness (AOT) into the Weather Research and Forecasting-Chemistry (WRF-Chem) model was applied for the deep study of aerosol forecasting and its radiative effects in SA and TP. In general, the study was well organized, and the findings should have some scientific contributions to related studies in future. However, the structure and English writing should be comprehensively polished for easily reading and understanding before it can be accepted. Furthermore, there are some suggestions for the manuscript as follows:

Response: We really appreciate your great efforts and positive evaluation of the manuscript. In response to your question about the structure and English writing, it has been polished by professional English speaking editors, as evidenced by the following certificate.

AJE **Editing Certificate**

This document certifies that the manuscript

Assessing the Assimilation of Himawari-8 observations on Aerosol Forecasts and Radiative Effects During Pollution Transport from South Asia to the Tibetan Plateau

prepared by the authors

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was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified native English speaking editors at AJE.

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Some concerns:

1. If the words only appeared one time, the abbreviation is not necessary, such as cloud condensation nuclei (CCN), checking for other abbreviations.

Response: Thank you for your comment. We have deleted the unnecessary abbreviations, such as CCN, GSI, ICs, ERA5.

2. Lines 35-37, references needed

Response: Done. Thank you for your comment. We have added the reference (i.e., Li et al., 2020) on aerosol transport to the Tibetan Plateau in lines 35-37.

Li, F., Wan, X., Wang, H., Orsolini, Y. J., Cong, Z., Gao, Y., and Kang, S.: Arctic sea-ice loss intensifies aerosol transport to the Tibetan Plateau, Nature Climate Change, 10, 1037-1044, https://doi.org/10.1038/s41558-020-0881-2, 2020.

3. *Lines 74-80 should be moved to the end of the above paragraph*

Response: Done. Thank you for your comment.

4. *Lines 111-116 indicated the scientific contribution of this study, it is better to move them to the end of the last paragraph.*

Response: Done. Thank you.

5. *Line 136, the emission inventory is the necessary and important input data for WRF model. According to the introduction, the inventory of 2010 was used, however, the modelled air pollution event was happened in 2018. There should be some uncertainties. Did the inventory be updated? Some explanation needed here.*

Response: Thank you for your comment. We mainly consider the impact of South Asia on the Tibetan Plateau, relatively new emission inventories such as the MEIC inventory which has 2018 but only includes the Chinese regions. The MIX Asian inventory, which includes the South Asian regions, has only recently been updated to 2010, so the 2010 MIX Asian inventory is used and there is no current 2018 MIX Asian inventory.

Changes in Manuscript:

Line 136-137:

For anthropogenic emissions, we use the MIX Asian inventory for March 2010 due to the need to include emission sources from South Asia.

6. *There are too many abbreviations in the manuscript. A list of abbreviations should be added in order to make it more clearly reading and understanding.*

Response: Thank you for your comment. We have added a list of abbreviations in Appendix A.

Changes in Manuscript:

Appendix A: The summary of the abbreviations and their corresponding full names in this study.

Abbreviation	**Full name**	**Abbreviation**	**Full name**
SA	South Asia	GOCART	the Goddard Chemical Aerosol Radiation Transport
TP	Tibetan Plateau	NCEP	the National Centers for Environmental Prediction
DA	data assimilation	AHI	Advanced Himawari Imager
AOT	aerosol optical thickness	AE	Ångström exponent
WRF-Chem	Weather Research and Forecasting-Chemistry	JAXA	the Japan Aerospace Exploration Agency
MODIS	Moderate Resolution Imaging Spectroradiometer	DT	the Dark Target
AERONET	AErosol RObotic NETwork	DB	the Deep Blue

BC	black carbon	SYN	synoptic
GOES-8	Goddard Earth Observing System-8	BIAS	mean bias
GOCI	Geostationary Ocean Color Imager	RMSE	root-mean-square error
CERES	Clouds and the Earth's Radiant Energy System	CORR	correlation coefficient
LETKF	local ensemble transform Kalman filter	PDFs	the probability distribution functions
MOSAIC	Model for Simulating Aerosol Interactions and Chemistry	DSRc	downward solar radiation under clear-sky
RRTMG	Rapid Radiative Transfer Model	DSR	downward radiation flux at the surface at the all-sky
OC	Organic Carbon	PBLH	planetary boundary layer height
$PM_{2.5}$	Particulate matter with an aerodynamic equivalent diameter of less than or equal to 2.5 micrometers in ambient air	T2	2-m temperature
PM_{10}	Particulate matter with an aerodynamic equivalent diameter of less than or equal to 10 micrometers in ambient air	RH2	2-m relative humidity
NMVOC	non-methane volatile organic compounds	q	water vapor mixing ratio
FINN	the Fire INventory from NCAR	T	temperature
MEGAN	the Model of Emissions of Gasses and Aerosols from Nature		

7. *Line 150, what's the meaning for "J"*

Response: Sorry for the unclear "J". The "J" represents the value of the cost function. Data assimilation is essentially the problem of solving "J". Since the "J" does not appear directly in the subsequent formulas, so we have removed the "*J*" to avoid confusing the reader.

Changes in Manuscript:

Line 151:

Data assimilation is essentially for solving the minimum value of the cost function.

8. *In Section 2, did the authors made the sensitivity and uncertainty analysis? The methods should be mentioned.*

Response: Thank you for your comment and question. In fact, in our previous study (Dai et al., 2021), the 4D-LETKF sensitivity experiments were conducted on different ensemble sizes (10 members, 20 members, and 40 members) for the assimilation system. The results reveal that the ensemble size has little effect on the assimilation performance. In this study, the effect of these assimilation tuning parameters is not a focus. We use 20 ensemble members and a constant multiplicative covariance inflation factor of 1.1 in all our assimilation experiments.

Dai, T., Cheng, Y., Goto, D., Li, Y., Tang, X., Shi, G., and Nakajima, T.: Revealing the sulfur dioxide emission reductions in China by assimilating surface observations in WRF-Chem, Atmospheric Chemistry and Physics, 21, 4357-4379, https://doi.org/10.5194/acp-21-4357-2021, 2021

Changes in Manuscript:

Line 201-205:

Sensitivity tests on this 4D-LETKF assimilation system with varying parameters (specifically, the ensemble members: 10, 20, and 40) have been conducted in our previous studies (Dai et al., 2021). Since the finding from ensemble size has only little effect on the assimilation performance (Dai et al., 2021), the impact of ensemble size on the data assimilation performance is not a focus of this study. We use twenty ensemble members and a constant multiplicative covariance inflation factor of 1.1 in all our following assimilation experiments.

9. *Line 269, some detailed information (for example equations) should be added for the statistical criteria, maybe in SI*

Response: Thank you for your comment. We have added the equations about the statistical criteria in Appendix B.

Changes in Manuscript:

Appendix B: Statistical criteria.

Three primary statistical metrics were employed to assess the simulation performance of observed data on model aerosol fields. These metrics include the Bias (BIAS), Root Mean Square Error (RMSE), and Correlation Coefficient (CORR). BIAS is defined as the average difference between simulated results and observed values. RMSE quantifies the standard deviation of the differences between simulated results and observed values. CORR measures the correlation between simulated results and observed values. The formulas for these three statistical metrics are as follows:

$$\mathrm{BIAS} = \frac{1}{N}\sum_{\mathrm{i=0}}^{\mathrm{N}} (M_i - O_i) \tag{B1}$$

$$\mathrm{RMSE} = \sqrt{\frac{1}{N}\sum_{\mathrm{i=0}}^{\mathrm{N}} (M_i - O_i)^2} \tag{B2}$$

$$\mathrm{CORR} = \frac{\sum_{i=1}^{N} (O_i - \bar{O})(M_i - \bar{M})}{\sqrt{\sum_{i=1}^{N} (O_i - \bar{O})^2 \sum_{i=1}^{N} (M_i - \bar{M})^2}} \tag{B3}$$

Here, N represents the total number of data points, M_i and O_i are the simulated and observed values, respectively. The symbols $\bar{M}$ and $\bar{O}$ represent the means of simulated and observed values, respectively.

10. Line 289, what's the reasons for the underestimation

Response: Thank you for your question. The underestimations do not improve well relative to the overestimations. Small values of underestimation are always associated with small values of model error. The small value of the model error leads to a larger weighting of the simulated values, so that weak underestimations are less susceptible to assimilation effects.

Changes in Manuscript:

Line 292-294:

This may because smaller underestimations are always associated with smaller model error values, resulting in larger weights of simulated values and reduced sensitivity to assimilation effects.

11. Lines 312-313, some references support needed

Response: Done. Thank you for your comment.

Changes in Manuscript:

Line 316-320:

In contrast to self-checking, the AOT analyses in DA_REON_12H are closer to MODIS than those in DA_REON_01H. The AOT analyses are interpolated to the MODIS, which is different in temporal and spatial distribution from Himawari-8. The AOT analyses in DA_REON_12H absorb the entire window of observations, and this asynchronous assimilation corrects the AOT analysis field at all times in each window (Dai et al., 2019).

12. Line 378, underestimation or overestimation?

Response: Sorry for the ambiguity of this sentence, we've corrected it..

Changes in Manuscript:

Line 386-388:

Compared to CERES observations, the underestimation occurs in eastern SA, and the overestimation occurs in western SA in FR_REON with a total domain mean bias of 10.69 W m^{-2}, which is due to the uncertainty in the aerosols and other factors such as the complex terrain processing in the model.

13. Lines 426-428, any supporting references?

Response: Thank you for your comment. We have added some supporting references.

Changes in Manuscript:

Zhang et al. (2020) and Zheng et al. (2017) pointed out that pollutants from the South Asian can be transported to the Tibetan Plateau, and the transport is much stronger and deeper along the valley.

Zhang, M., Zhao, C., Cong, Z., Du, Q., Xu, M., Chen, Y., Chen, M., Li, R., Fu, Y., Zhong, L., Kang, S., Zhao, D., and Yang, Y.: Impact of topography on black carbon transport to the southern Tibetan Plateau during the pre-monsoon season and its climatic implication, Atmospheric Chemistry and Physics, 20, 5923-5943, https://doi.org/10.5194/acp-20-5923-2020, 2020.

Zheng, J., Hu, M., Du, Z. F., Shang, D. J., Gong, Z. H., Qin, Y. H., Fang, J. Y., Gu, F. T., Li, M. R., Peng, J. F., Li, J., Zhang, Y. Q., Huang, X. F., He, L. Y., Wu, Y. S., and Guo, S.: Influence of biomass burning from South Asia at a high-altitude mountain receptor site in China, Atmospheric Chemistry and Physics, 17, 6853-6864, https://doi.org/10.5194/acp-17-6853-2017, 2017.