

Review of the manuscript “A Bias Correction Scheme for FY-3E/HIRAS-II Observation Data Assimilation (Chen and Guan, 2024)”

General comments

This paper focuses on a bias correction scheme for data assimilation of observation from FY-3E/HIRAS-II and proposes model surface skin temperature, model total column water vapor, thickness of 1000-300 hPa and thickness of 200-50 hPa as the optimal combination of air-mass predictors. It is especially noteworthy to compare effects of different air-mass predictors on analysis in data assimilation because there seems to be no paper to explore the optimal combination of air-mass predictors for hyperspectral infrared sounders while different NWP centers use different air-mass predictors. However, the paper needs polishing more in some respects. Model biases should not be corrected because the correction could cause loss of observation information and reinforce the systematic model errors (Auligné et al, 2007). Ideally, model biases should be handled explicitly by the system (e.g., weak-constraint 4D-Var). It is important to verify analysis of assimilation experiments by using conventional data and/or independent model analysis data to confirm that systematic model errors do not get larger. In some cases, model biases could be smaller against truth while the biases and the Root Mean Squared Errors (RMSEs) could be larger against own analysis when observation data is assimilated with bias correction. In section 6.3 of the paper, it is necessary to verify analysis those independent data (because I know from the author’s comment that the analysis is verified against the NCEP FNL (Final) $0.25^\circ \times 0.25^\circ$ analysis data for each experiment, not ERA5). Many descriptions in this manuscript do not follow the AMT guideline and need polishing.

Specific comments

L79: There is another paper (Liu et al., 2024) about data assimilation of FY-3E/HIRAS-II, and model total column water vapor is not used as air-mass predictors in that paper. It could be important to quote the paper to clarify the importance of this paper.

L109: In the manuscript, the observation data in clear-sky scene is selected to estimate bias correction and assimilate. There is no specific description that radiation is simulated assuming clear-sky condition, but I guess that clear-sky condition is assumed in the simulation of radiation. It is necessary to clarify about it in the manuscript. For example, the phrase ‘assuming clear-sky condition’ could be added at the end of the sentence in L109.

L117-119: The region of the training data seems to be limited by the region of FY-4A/AGRI cloud mask product. Where is the specific region when expressed by longitude and latitude?

L130-131: Why is the central FOV within each FOR selected for data thinning? Is the central FOV the best in some aspects of data quality?

L143-144: It is better to explain explicitly in section 4 in advance that the offline static correction is adopted, although section 7 includes the statement.

L174: The definitions of thickness and t_v are different from those generally used in meteorology. Please check if Eq. (4) and Eq. (5) are correct.

For your information, the definitions in meteorology are shown below.

Atmospheric thickness for dry air is defined as following according to meteorological textbooks (e.g. from Eq. (1.30) in Holton et al. (2012)).

$$\text{Thickness} = \frac{R}{g} \int_{p_2}^{p_1} t \, d \ln p \quad (p_1 > p_2)$$

The variables R , g , p_B , p_U , t and p are the gas constant for dry air ($287.0 \text{ J K}^{-1} \text{ kg}^{-1}$), the gravitational acceleration (9.8 N kg^{-1}), pressures at the bottom and the upper of an atmospheric layer, temperature and pressure, respectively.

Assume the atmospheric model has N layers.

$$\begin{aligned} \text{Thickness} &= \frac{R}{g} \sum_i^N t(i) \Delta(\ln p)_i \\ &= \frac{R}{g} \sum_i^N t(i) \ln \frac{p_B}{p_U} \end{aligned}$$

The variables p_B and p_U are pressures at the bottom and the upper of each layer, respectively. For moist air, virtual temperature t_v is generally used instead of temperature.

$$\begin{aligned} \text{Thickness} &= \frac{R}{g} \sum_i^N t_v(i) \ln \frac{p_B}{p_U} \\ t_v(i) &= [1.0 + 0.608q(i)]t(i) \end{aligned}$$

The variable is mixing ratio.

L204-206: Are the diagnostic coefficients the coefficients of determination?

Fig. 1: The assimilated channels should be listed in a table in an appendix to clarify.

L253-254: In L210-211, there is the sentence ‘Data assimilation systems generally do not assimilate strong O₃ absorption channels at present and the water vapor content in upper atmosphere is scarce, so a predictor combination including model surface skin temperature, model total column water vapor, thickness of 1000-300 hPa and thickness of 200-50 hPa is selected to correct the air-mass biases for HIRAS-II in this research.’ Why are O₃ channels assimilated in the experiments?

L265-L330: These sentences follow section 5, ‘DATA ASSIMILATION SYSTEM AND EXPERIMENTAL DESIGN’. Some people may misunderstand that these sentences explain results of data assimilation experiments. I suggest explaining these sentences in section 4 to avoid confusing.

About data availability and code availability: Authors are required to provide a statement on how their underlying software can be accessed. This must be placed as the section "Code availability" at the end of the manuscript. In the manuscript, the data corresponds to RTTOV v12.3 and WARFDA V4.4. Also, authors are required to provide a statement on how their underlying research data can be accessed. This must be placed as the section "Data availability" at the end of the manuscript. In the manuscript, the data corresponds to FY-3E/HIRAS-II Level 1 data, FY-4A/AGRI Level 2 cloud mask product, NCEP GFS forecast data and analysis data (NCEP FNL (Final) analysis data?) for verification. See the data policy page and the guideline page on the AMT website.

Minor comments

In the manuscript, many descriptions do not follow the AMT guideline. Please check the guideline.

L85: ‘... a one-month assimilation experiment.’ -> “... one-month assimilation experiments.’ because three assimilation experiments were run.

L89: ‘3041 channels’ -> ‘3041 channels (after apodization)’ to clarify the number of channels is after apodization

L98: The link has expired.

L108: A period is necessary after ‘(Saunders et al., 2018)’.

L164: Vectors should be printed in bold italics.

L175: The unit of the gas constant is J K⁻¹ kg⁻¹. Units must be written exponentially. ‘N/kg’ -> ‘N kg⁻¹’

L196 and L201: A space must be included between number and unit in each description, ‘737.5cm⁻¹, 900cm⁻¹, 1040cm⁻¹, 1279.375cm⁻¹, 1476.25cm⁻¹ and 1809.375cm⁻¹’.

Fig.1 (c) and Fig.2 (b): The spelling of the word should be consistent in the manuscript.

‘water vapour’ -> ‘water vapor’

L231 and L242: A space must be included between number and unit in the description, ‘1809.375cm⁻¹’.

Fig.2 (b): Units must be written exponentially. ‘kg/kg’ -> ‘kg kg⁻¹’

L248 and L292: In the text, equations should be referred to by the abbreviation "Eq." and the respective number in parentheses. However, when the reference comes at the beginning of a sentence, the unabbreviated word "Equation" should be used. ‘Equation (6)’ -> ‘Eq. (6)’ and ‘Equation (3)’ -> ‘Eq. (3)’

L249: Matrices should be printed in boldface, and vectors should be printed in bold italics. The multiplication sign in the second term can be omitted as well as that in first term.

L257: Coordinates need a degree sign and a space when naming the direction. The description ‘from 0°N to 60°N and from 70°E to 150°E’ does not follow the format.

L260: The period of assimilation experiments seems wrong. The period ‘17 to 31 August 2023’ -> ‘1 to 31 August 2023’

L265-266: ‘... from January 1 to January 14, 2023.’ and ‘... from January 15 to January 31 2023 ...’ -> ‘... from 1 January to 14 January, 2023.’ and ‘... from 15 January to 31 January 2023 ...’, respectively

Fig.3 and Fig.5: A space must be included between number and unit in the labels such as ‘737.5 cm⁻¹’.

L296-297: ‘From Figure 4 (a), (b) and (d), ...’ But, there is no Figure 4 (d).

L298: In the sentence ‘..., while water vapor channels with ...’, are these water vapor channels channel 1323 and 1855?

Fig.4: If the figures are between 2 pages, a caption is necessary in each page. Furthermore, it may be better to use the words ‘Observed BT’ and ‘Simulated BT’ rather than ‘Obs BT’ and ‘Bak BT’ respectively in the axis labels.

Table4: If the table is between 2 pages, the table title is necessary in each page.

L342, L343, L349 and L352: ‘O3’ -> ‘O₃’

L350 and L352: ‘CO2’ -> ‘CO₂’

L353: The sentence should be aligned left.

L368: Coordinates need a degree sign and a space when naming the direction. The description ‘0°N to 30°N’ does not follow the format.

L361: The sentence ‘..., a data assimilation experiment at 0000 UTC 7 August 2023 was...’ -> ‘..., three data assimilation experiments at 0000 UTC 7 August 2023 were ...’?

L369: ‘... is a significant.’ -> ‘... is significant.’

L362-364 and L382-384: The word colors generally include white and black. The word shading generally means not only black shading but also colorful shading. To clarify the words, ‘the colors’ -> ‘the colored dots’, ‘spatial distributions’ -> ‘spatial distributions (colored dots)’ and ‘the shading’ -> ‘the black shading’

Fig.8: Units must be written exponentially. ‘g/kg’ -> ‘g kg⁻¹’ and ‘m/s’ -> ‘m s⁻¹’

L391: ‘... from January 1 to January 31, 2023 ...’ -> ‘... from 1 January to 31 January, 2023 ...’

[References]

Auligné, T., McNally, A.P. and Dee, D.P. (2007), Adaptive bias correction for satellite data in a numerical weather prediction system. *Q.J.R. Meteorol. Soc.*, 133: 631-642.
<https://doi.org/10.1002/qj.56>

Holton, J. R. and G. J. Hakim, 2012, *An Introduction to Dynamic Meteorology*, Fifth Edition. Academic Press, 552pp.

Liu, R., Lu, Q., Wu, C., Ni, Z., Wang, F. (2024), Assimilation of Hyperspectral Infrared Atmospheric Sounder Data of FengYun-3E Satellite and Assessment of Its Impact on Analyses and Forecasts. *Remote Sensing*, 16(5), 908.
<https://doi.org/10.3390/rs16050908>

Data policy page in the AMT website: https://www.atmospheric-measurement-techniques.net/policies/data_policy.html

Guideline page in the AMT website: <https://www.atmospheric-measurement-techniques.net/submission.html>

Thanks,