

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2022-251

Anonymous Referee #1

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Referee comment on "Inverse modelling of Chinese NO<sub>x</sub> emissions using deep learning: integrating in situ observations with a satellite-based chemical reanalysis" by Tai-Long He et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-251-RC1>, 2022

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### General comments :

The article is well written and the arguments developed by the authors are supported clearly by the figures and tables that are presented. The objectives of the article are well stated. It supports the fact that deep learning models can integrate additional sources of information in a flexible environment and by doing so, improving their predictions. Also, the short time needed for these models to deliver outputs constitute an advantage for near-real time applications. Cross validation between the outputs of the model and other non physical data sources such as the C-index is a very interesting approach to qualitatively assess the model and is complementary to objective scores.

### Specific comments :

Figure 1 shows that the density of MEE networks station is highly inhomogenous. When using nearest neighbour interpolation, Stations in less dense areas will have more spatial influence in the NO<sub>2</sub> surface concentration product presented as input of the DL model. In less dense areas, the effective resolution of the product is not expected to be at 1.1° as in dense areas. Figure 7 (d) shows good correlation between DL minus TCR-2 emission difference and the density of networks as deduced from Figure 1. Have you investigated the role of the network density on the DL predictions through sensitivity tests (by lowering the number of stations used in dense areas for example) ?

It would be good to see in an exemple at what TCR-2 surface NO<sub>2</sub> concentration, MEE network surface NO<sub>2</sub> concentration and TCR-2 Nox emission field look like. It would help assess qualitatively the additional information the MEE network brings.

Line 134: can the length of the latent vector be mentioned ?

Line 135 : the description of how the information is conveyed through the LSTM cells could be improved. From Figure 2, one could understand that a latent vector is the input of a first LSTM and that the output of the first LSTM cell serve as the input of the second LSTM. But with information contained in Table 1, it seems that the input of the DL model is a sequence of 2 timesteps (T and T-1 day) \* 35 height pixels \* 46 width pixels \* 9 channels (9 variables ) and that data for T is the input of the first LSTM cell and data for T-1 days is the input of a second cell. If it is the case, it should be described more clearly in the article.

Table 1 : it is not stated that meteorological field include 2 timesteps.

Figure 2 : it could be mentioned that the DL model for stage 1 uses only 8 channels and 9 channels for stage 2.

Line 167, 'year 2020 is anomalous compared to the training set with normal years'. As industrial activity in China has dramatically increased from the 2000s in China, how is the level of Nox emission in 2020 compared to 2014 or 2005 ? It is maybe not so anomalous compared to the first years of the training set.

Line 274 : It is stated that the minimum for PRD for DL model is reached is 3days after CNY compared to 12 days. Actually, I can see on the red curve 3 minima (at 3, 13 and 17 days after CNY) in the 0-20 days after CNY period, so I don't necessarily agree with the statement. The signal from DL seems very noisy compared to the other products. Filtering it out with a moving average window would lead to different conclusions for PRD and highlight a plateau more than a global minimum on the curve.

### **Technical corrections :**

Line 25 : a word seems missing between 'changes' and 'the N02 column'

Table 1 : is it 'unit before scaling' instead of 'unit after scaling' ? because after scaling, there is no more unit.

