

Review Report on ‘MATCHA, a novel regional hydroclimate-chemical reanalysis: System description and evaluation’ by C. Roychoudhury, R. Kumar, C. He, W. Y. Y. Cheng, K. Ram, N. Mizukami, and A. F. Arellano, <https://doi.org/10.5194/essd-2025-275>.

General comments and recommendations

Roychoudhary et al. present a detailed description and evaluation of newly developed hydroclimate-chemical reanalysis, called as ‘MATCHA’. MATCHA is basically high-resolution WRF-Chem simulations after enhancing key processes on aerosol-radiation-snow and assimilating satellite-observations (MODIS AOD, MOPITT CO). Authors thus provide a large volume of data (about 100 TBs, or so) covering 17-year period. A user guide has also been made available (Kumar et al., User Guide, <https://doi.org/10.5067/CG4OT8DJX2Z7>).

Despite immense climatic significance, the High-Mountain Asia has been observationally scarce. High-resolution reanalysis using enhanced processes, as considered here, have also remained lacking. In this regard, this work is a huge effort and should be considered for publication in ESSD. The datasets can be valuable for air quality and hydroclimate studies. Data’s higher-resolution and availability for 17-year makes is also ideal for training statistical or AI/ML models for the region.

I have some comments and suggestions, which should be considered, while finalizing the manuscript for publication.

Specific Comments - Major

Figures 8, 9, 12—15: MATCHA data is shown only at observation sites. This does not exploit the actual potential of ‘high-resolution gridded data covering entire region’ produced by the authors. In fact, large areas remain blank, including parts of HMA - focus of MATCHA. I do realize that authors aimed ‘validation’, but for that they may over-plot observed values -where ever available- on the same color scale, while keeping full data fields.

Visualizing mean data fields and accordingly educating more (to potential users) on variations (+strengths, weaknesses) can make the paper ideally suiting ESSD. I did some quick visualization of MATCHA PM_{2.5} field for 1-10 April 2015, as shown below.

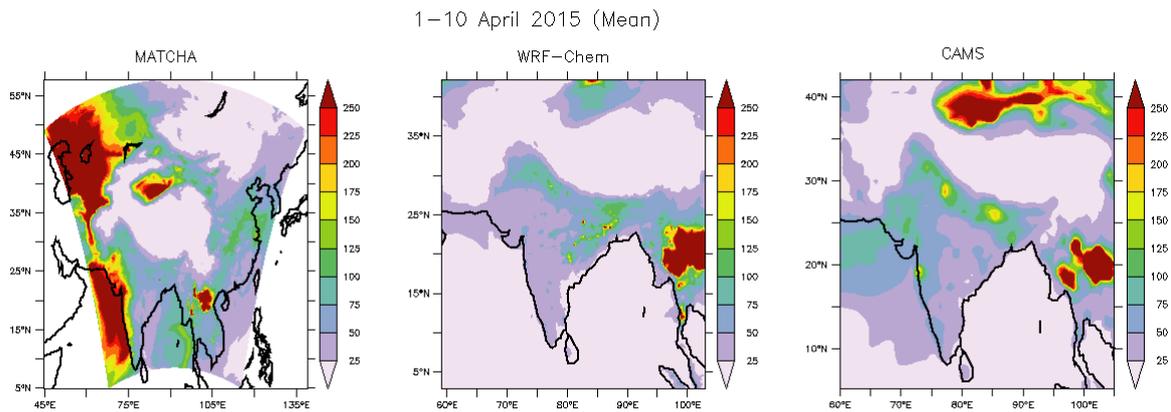


Figure: Mean distribution of $PM_{2.5}$ ($\mu\text{g}\cdot\text{m}^{-3}$) from MATCHA data (presented in this manuscript), from ‘a WRF-Chem simulation’ and CAMS reanalysis. Domains and physics/chemistry are not identical and comparison is for broad inferences.

Somehow on the western boundary of MATCHA fields, there seem anomalously high $PM_{2.5}$ (since it is a diagnostic term in model, it could be coming through one or more of its constituents). Quick look does not show such pattern in a simulation of WRF-Chem (or in CAMS reanalysis). It is possible that I am making error in understanding MATCHA data, yet it is better that this is clarified / addressed (effect of lateral boundaries in the used set up or entering through satellite-assimilation!).

Specific Comments - Minor

Abstract should be more crisp. Focus should be more on describing the data and ‘few most important’ results from evaluation. 1-2 sentence may be added to highlight the potential and applications. Other text may be reduced / optimized.

Introduction. L60: Short-lived climate forcing agents called light-absorbing particles. No. Short-lived climate forcing is a more general term, than light-absorbing aerosols. It includes scattering aerosols as well, and even tropospheric ozone [e.g., IPCC Report, 2021 – Chapter 6]. Please re-frame entire sentence.

L.84: Large uncertainty in satellite-retrievals’. OK, then how assimilating them can better the model data fields.

L.95-96: Provide supporting references and be quantitative. There are several studies analyzing CAMS, MERRA-2 over Himalaya and foothills regions.

Fig. 16: BC variability is not clearly visible, as same color (with different shades) are used for 0 to 9 $\mu\text{g}\cdot\text{m}^{-3}$.

Table 4: Surface CO. WRF-Chem has been shown to typically overestimate lower tropospheric CO, except during monsoon. However, here, we are seeing systematic underestimation (~200 ppbv) in MATCHA data across seasons. This is to be discussed.

Data archival: As said in general comments, the data has significant potential usage. However, I suggest authors to review the way data is archived. Instead of saving hourly file, they could pack key variables into monthly files, like few other chemical reanalysis. While I had accepted the review invitation on 18 February 2026, downloading many files was an issue delaying my assessment. This comment should however be seen as a general suggestion to help enhancing use of authors' data, rather than one related to quality of the work.

===== *END OF THE REPORT* =====