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Should you use a simple or complex model for moisture recycling and atmospheric water tracing?

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This paper compares three state-of-the-art atmospheric water tracing models. Such models are typically used to study the water component of the coupling between the land surface and the atmosphere: moisture recycling and the source-sink relations of evaporation and precipitation. However, the applicability of the many atmospheric water tracing methods used in this field is unclear. In this paper, the RCM-tag method uses highly accurate 3D water tracing (including phase transitions) directly within a regional climate model (online), while the other two methods (WAM and 3D-T) use *a posteriori* (offline) water vapour tracing. The methods are compared based on their basic characteristics, such as required input data and computation speed. The *a posteriori* models are faster and more flexible, but less accurate than the online model used here. In order to evaluate the accuracy of the *a posteriori* models in detail, we apply tagging to evaporated water from Lake Volta in West Africa and trace it to where it precipitates. It is found that the strong wind shear in West Africa is the main cause of errors in the *a posteriori* models. The number of vertical layers and the initial release height of tagged water in the model are found to have the most significant influences on the results. With this knowledge small improvements were made to the *a posteriori* models. It appeared that expanding WAM to a 2 layer model, or a lower release height in 3D-T, led to significantly better results. Finally, we introduce a simple metric to assess wind shear globally and give recommendations about when to use which model. The 'best' method, however, is very much dependent on the spatial extent of the research question as well as the computation power at one's disposal.