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Computing moisture sources in small river basins by lagrangian methods: the example of the Guadalquivir river (Southern Spain)

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During the last years, the use of atmospheric dispersion models originally developed to compute the transport of trace gases in the atmosphere has made possible to apply lagrangian methodologies to the study of the water vapor transport. In this method, the atmosphere is divided into a large number of "particles" and their position and water vapor content is tracked along time. By integrating the changes in the specific humidity of each particle traveling to an area it is possible to locate its water source regions. Due to the necessity of integrating the transport of a great number of atmospheric particles over the area of interest to obtain meaningful results, this method has been used to study the moisture sources of large areas as entire oceans or big river basins. However, the application of lagrangian methods to smaller areas can be problematic, as the number of the particles in consideration is reduced.

In this work we test the ability of the currently available lagrangian models to evaluate the moisture sources for the Guadalquivir basin in Southern Spain. This basin is in the limits of the spatial resolution of the model, in the order of hundreds of kilometers. The Guadalquivir basin is influenced both by the North Atlantic and the Mediterranean, but the relative contribution of these two sources had not been quantified. In addition, the importance of possible moisture sources over land had not been assessed. The improvement in the knowledge of these details of the water cycle in this highly populated and stressed area of the Western Mediterranean is especially relevant, among other reasons, in order to better understand the forecasted reduction of precipitation in most climate change scenarios for this region.

Our results suggest that for river basins of size in the scale of the model resolution, the results are consistent when the particle tracks are integrated over long periods of time in order to statistically compensate for the relative low number of particles over a region at a given time. The results show that the Atlantic is the major moisture source of the Guadalquivir basin, while the contribution of the Mediterranean water is lower than initially expected. However large seasonal changes are observed, with the Mediterranean becoming more important during spring and summer. In addition two significant land based moisture sources have been located in the Iberian Peninsula and Northern Africa with significant moisture transport.