Atmos. Chem. Phys. Discuss., 10, C9746–C9750, 2010
www.atmos-chem-phys-discuss.net/10/C9746/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Length and time scales of atmospheric moisture recycling" *by* R. J. van der Ent and H. H. G. Savenije

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Received and published: 15 November 2010

Comment by Heini Wernli and Harald Sodemann

In order to overcome the scale- and shape-dependence of regional moisture recycling ratios, a novel approach is proposed, which is based upon an empirical relationship between the precipitation recycling ratio and the distance along a streamline. The resulting scale-independent parameters are interpreted as length and time scales of atmospheric moisture recycling. However, the paper does not properly discuss the assumptions to derive these parameters and a critical assessment is missing of how these values might be interpreted. The present version of the paper might lead to the conclusion that, e.g., for precipitation over Greenland water vapor is transported over distances of more than 7000 km before precipitating. Such a conclusion is in dis-

agreement with more detailed studies in the published literature, and would be strongly misleading without detailed discussion. However, a considerable part of the relevant published literature is not considered for discussion of the results. We suggest that the following aspects need to be discussed in much greater depth:

(1) As mentioned in the review by F. Dominguez, the assumptions (and simplifications) behind the approach used in section 2.2 should be discussed in greater detail.

(2) The derivation of a length scale for moisture recycling is not very clearly presented and contains unconsolidated aspects (see review by F. Dominguez, her point 3). The added value of the parameter does not become obvious. The dimensionless recycling ratios ρ_r (and ϵ_r) are monotonously transferred into a measure of dimension [L] by dividing the quantity Δx by a rather complicated expression which only contains ρ_r (or ϵ_r). Eq. (14) describes this monotonous transformation from the quantities λ_r into λ_γ. The additional new parameter is Δx, which mainly serves to account for smaller grid box sizes with higher latitude. Why this Δx would be the "representative length of the grid cell" (pg. 21875, L. 1) is not clear without better justification. It would be insightful to provide plots of how Eq. (14) is mapping values of γ_r to values of γ_γ for the range of Δx occurring at a 1.5×1.5 deg grid resolution. Comparing Fig. 4c and 5a (or 4d and 5b) apart from the color scale does not reveal any clear differences, as would be expected from a monotonous transformation.

(3) In the abstract it is claimed that the authors present an approach to quantify the spatial and temporal scale of moisture recycling, independent of the size and shape of the region under study. However, this is in fact not explicitly demonstrated in the manuscript. To support this claim, it would be necessary to show a thorough comparison of the measures calculated for areas of different size and shape. The example in Table 2 does not suffice to make such a claim, since only two differently sized areas from two different regions are compared. Instead, several differently sized areas in the same region would have to be compared with one another.

(4) Our main point: what is the meaning of the derived length scale parameter? On p. 21877 it is written that "they have to be interpreted as the mean length over which a water particle would be recycled if all meteorological and hydrological conditions would be the same upwind". A very similar formulation is used in the caption of Fig. 5 and no further discussion is provided about the interpretation of this novel parameter. The above explanation appears to be very critical and potentially misleading:

(a) What is meant by "if all ... conditions would be the same upwind"? Does this imply that moisture recycling is assumed to be constant along the pathway of atmospheric moisture transport? Clearly, such an assumption cannot not be justified: moisture is typically transported over the ocean before reaching land, characterized by strongly differing meteorological conditions along the pathway. Also, these conditions are subject to significant synoptic-scale variations.

(b) Reference to "a water particle" suggests a Lagrangian interpretation of the length scale parameter and, e.g. for Greenland, it might imply that water vapor precipitating over Greenland has been transported on average over distances of more than 7000 km (Fig. 5a). This result would be in strong contradiction to Lagrangian studies, which are based upon comprehensive trajectory calculations considering short-term atmospheric variations as revealed by 6-hourly meteorological analyses (e.g., Sodemann et al. 2008; Gimeno et al. 2010). For Greenland precipitation, Sodemann et al. found a typical distance between ocean evaporation and rainout above Greenland of about 1000-2000 km, i.e., much less than the 7000 km found in this paper. Clearly, such a difference is highly significant since it either highlights the mid-latitude North Atlantic as the main moisture source for Greenland precipitation or a remote, potentially subtropical/tropical source. Also the study by Gimeno et al. (2010) highlights the significance of relatively short-distance moisture transport between the source and rainout areas. Although we do not claim that these trajectory-based studies are perfectly accurate, they strongly indicate that the Lagrangian interpretation of the length scale parameter given in this paper is highly questionable. Thus, the "physical meaningful" (Pg. 21880,

L. 14) claimed in the conclusions of the manuscript is not given, and instead the picture on atmospheric moisture transport becomes more blurred by this not sufficiently confounded measure.

(5) Since the paper attempts to convert information of precipitation recycling into information on the transport length of atmospheric moisture, the relevant literature on moisture transport and the respective findings on transport distances need to be taken into account and discussed. These papers, among others, and in addition to the previously mentioned ones, could include: Schicker et al. (2010) which investigates the transport distance of moisture evaporating from the Mediterranean, Sodemann and Zubler (2010), which discusses among other aspects a continental-scale recycling ratio in Central Europe from a Lagrangian moisture source diagnostic, Sodemann and Stohl (2010) which address the discrepancy of moisture transport length scales from Eulerian and Lagrangian methods, and further references mentioned in these papers.

References

Schicker, I, Radanovics, S., and Seibert, P, 2010: Origin and transport of Mediterranean moisture and air, Atmos. Chem. Phys., 10, 5089-5105.

Gimeno, L., A. Drumond, R. Nieto, R. M. Trigo, and A. Stohl, 2010: On the origin of continental precipitation, Geophys. Res. Lett., 37, L13804, doi:10.1029/2010GL043712.

Sodemann, H., C. Schwierz, and H. Wernli, 2008: Interannual variability of Greenland winter precipitation sources: Lagrangian moisture diagnostic and North Atlantic Oscillation influence, J. Geophys. Res., 113, D03107, doi:10.1029/2007JD008503.

Sodemann, H., and Stohl, A., 2009: Asymmetries in the moisture origin of Antarctic precipitation, Geophys. Res. Lett., 36, L22803, doi:10.1029/2009GL040242.

Sodemann, H. and Zubler, E., 2010: Seasonality and inter-annual variability of the moisture sources for Alpine precipitation during 1995-2002, Int. J. Climatol., 30, 947-961, doi:10.1002/joc.1932.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 21867, 2010.