Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2018-32-RC1, 2018

Earth System Dynamics
Discussions

Interactive comment on "On the origin of moisture related to synoptic-scale rainfall events for the North American Monsoon System" *by* Paulina Ordoñez et al.

E. R. Vivoni (Referee)

vivoni@asu.edu

Received and published: 2 June 2018

General Comments:

The study describes the sources of atmospheric water vapor during the North American monsoon and its dependence on the size of synoptic-scale rainfall periods. To achieve this, a particle tracking analysis of air parcels was applied using a reanalysis product in order to estimate fields of evapotranspiration minus precipitation (E-P) taken as the metric to study sources and sinks of water vapor. The authors have done a very nice job in bringing a different tool to a subject matter that is under considerable debate. Their work provides some new insights that will be useful for the community at

Printer-friendly version

Discussion paper

large to consider. Furthermore, their work is well written and illustrated. The comments below are intended for the authors to improve their work and increase its overall impact by demonstrating the solid nature of their method, results and interpretations.

Specific Comments:

1. It is important that the authors have a more in-depth explanation of the FLEXPART algorithm as it pertains to the generation of the E-P field, including the limitations therein, within the introduction and methods section. Some of the limitations are indicated subsequently in the results section, which is considered too late in the manuscript. What type of errors in E-P are expected from its estimation as dq/dt? How sensitive is the method to the selection of the ERA-Interim reanalysis fields at 1 degree, 3 hourly resolution? How realistic are these fields with respect to observations or other reanalysis products that independently estimate P and E, and from which E-P can be obtained? The reader needs to have confidence in the accuracy of E-P before it is used to make inferences on the sources and sinks of water vapor in the monsoon region.

2. It would be useful for the authors to present a justification and/or further detailed explanation for the following aspects of their methodology:

a. The coarse resolution (1 degree by 1 degree) of the meteorological fields used in the FLEXPART model, given the scale of land and ocean features in the NAM region.

b. The selection of the time period (1981-2014).

c. The boundary selected to represent the NAM region and its consistency with the tiered approach advocated by Higgins and co-authors during the North American Monsoon Experiment.

d. The use of the term anomaly when discussing differences between wet and dry days. An anomaly is formally a difference with respect to a long-term average, not a difference between extreme cases.

3. The authors should provide explanation for some of their conclusions which are hard to see from the figures, not shown by the figures, or ignored with respect to the figures:

a. Page 6, Line 3: There is an opposing behavior in this study and Bosilovich et al. (2003) with respect to the change in the recycling contribution from July to September. In this study, this contribution increases, but in Bosilovich et al. (2003), it decreases in time. Can the authors comment on why there is a discrepancy?

b. Page 6, Line 17: The description of 'all the source regions contribute with higher recharges before the synoptic-scale rainfall events' is too vague for a reader to see in the figures. Some regions have higher E-P at different days before the event, with monotonically-increasing, monotonically-decreasing or humped behaviors shown. Perhaps the authors can be more specific as to what days they are comparing?

c. Page 6, Line 31: There is an important difference between wet and dry days for the NAM region on -1 days that is not discussed. A similar difference is noted for EAST on -1 and -2 days. These could potentially be interpreted as evaporation from land surfaces that does not lead to significant rainfall.

d. Page 7, Line 3: The interpretation of difference between wet and dry days of the term E-P is quite difficult for most readers to make. (E-P)wet - (E-P)dry includes four terms, two related to E and two related to P. While the authors cannot separate these terms, it would be useful to explain to the reader why a positive anomaly means rainfall intensification and a negative anomaly means evaporation intensification, if that is the case.

e. Page 7, Line 12: The authors indicate that the NAM region has no systematic change during the wet period, but Figure 9a shows a large change in -2 days. The discussion needs to reflect this difference.

f. Page 7, Line 16: It is hard to see from the figures where the authors have conclusively shown that the northern NAM region shows a particularly important relation to the

fluxes from the Caribbean Sea.

g. Page 8, Line 14: Perhaps the authors need to remove this statement. Other studies have looked at terrestrial land sources over the entire continental land mass in North America. They might not have defined a sub-region called 'southwestern U.S.' in the same way as it is done here, but that is a minor point.

4. The authors have not shown a comparison of their E-P estimates to observational data which limits the credibility of the study. There is a mention of the observational dataset CHIRPS as being used to help specify the lifespan of 6 days through a comparison of simulated precipitation from FLEXPART to CHIRPS. It would be useful to show a comparison of FLEXPART P and CHIRPS P for the NAM region, rather than simply relying on a reference to Perdigon-Morales et al. (2017). Furthermore, the authors are encouraged to compare simulated E or simulated E-P to available observations or other reanalysis products given that the entire validity of this study relies on how well E-P is captured by FLEXPART.

5. The authors have defined precipitation recycling to be a process of local evaporation from the NAM region exceeding precipitation. It is important that the authors be more careful in this definition for a number of reasons:

a. Terrestrial evaporation from other land masses (EAST, NORTH) should also be considered precipitation recycling when it leads to precipitation in the NAM region.

b. Precipitation recycling still occurs even if evaporation does not exceed precipitation. In other words, the authors have equated E>P to recycling, but this is not necessary the case as recycling is still occurring when E<P.

6. The identification and naming of the regions should be reconsidered and perhaps more strongly justified. The names 'NORTH', 'EAST', 'ATL' and 'PAC' could be misinterpreted as these are specific to this study and not generally accepted terms. ATL is Gulf of Mexico/Caribbean Sea, PAC is Baja California and Eastern Pacific, NORTH

is southwestern U.S. and EAST is northeastern Mexico. More insightful and relevant naming would be useful. Most studies in the NAM would also include portions of the NORTH and EAST inside the NAM boundary. Other than justifying their selection by citing Hu and Dominguez (2015), the authors should further explain their choice as it is important for the overall outcomes and interpretation of their work.

Technical Corrections:

Page 1, Line 1: Suggest a change to the title as: "On the origin of atmospheric moisture related to ..."

Page 1, Line 14: Use the term 'precipitation recycling' instead of 'recycling', here and elsewhere in the manuscript.

Page 2, Line 16: The authors could cite Vivoni et al. (2008) who provide estimates of regional fractions of annual precipitation during the monsoon.

Page 3, Line 6: The authors could cite Mendez-Barroso and Vivoni (2010) and Xiang et al. (2018) to help support this statement as these studies specifically look at observed and simulated soil moisture-vegetation-precipitation recycling.

Page 3, Line 30: Replace 'freshwater' with 'water' or 'water vapor', here and elsewhere in the manuscript.

Page 5, Line 2: Geopotential and specific are misspelled.

Page 5, Line 11: The authors can indicate that water vapor gain is E>P, whereas water vapor loss is E<P.

Page 6, Line 18: The term 'water uptake' can be very confusing. Suggest to change to 'water vapor influx'. Correct here and elsewhere in manuscript.

Page 6, Line 18: The term 'recharges' is not used correctly. Suggest to change to 'water vapor influx'.

Figure 1. Please improve this figure. The bathymetry is not required. The NAM region should be labeled. This should include the overall extent of the study domain, including the sub-regions identified later. Additional information is requested: US and Mexico boundary, and state boundaries.

Figure 2. The y-axis should be labeled 'Rainfall events / month'.

Figure 5. NORTH is misspelled.

Figure 6. A legend is needed.

Figure 7. Remove the blue dashed line representing 'zero' as it is confusing.

References:

Mendez-Barroso, L.A., and Vivoni, E.R. 2010. Observed Shifts in Land Surface Conditions during the North American Monsoon: Implications for a Vegetation-Rainfall Feedback Mechanism. Journal of Arid Environments. 74(5): 549-555.

Vivoni, E.R., Moreno, H.A., Mascaro, G., Rodriguez, J.C., Watts, C.J., Garatuza-Payan, J., and Scott, R.L. 2008. Observed Relation between Evapotranspiration and Soil Moisture in the North American Monsoon Region. Geophysical Research Letters. 35: L22403, dos:10.1029/2008GL036001.

Xiang, T., Vivoni, E.R., and Gochis, D.J. 2018. Influence of Initial Soil Moisture and Vegetation Conditions on Monsoon Precipitation Events in Northwest Mexico. Atmosfera. 31(1): 25-45.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2018-32, 2018.

Printer-friendly version

Discussion paper