Referee comment of Eiras-Barca et al in Earth System Dynamics

General comments

This paper investigates the (atmospheric) moisture sources of the "atmospheric river" events. One event on the western coast of North America and another event on the western coast of Europe. The authors implement a relatively new and novel online moisture tracing tool in WRF, which allows them to question mark the apparent previous consensus that atmospheric rivers are associated with the low-level-jet of extratropical cyclones. This contribution is certainly valuable to this special issue of Earth System Dynamics, and I do not have any major comments. However, I do have quite a lot of minor comments mostly regarding readability due to imprecise use of terminology and symbols, overuse of acronyms, as well as several unclarities in the figures.

Specific comments

It would be useful if the authors could think of a name for the WRF moisture tracing tool

P1, L2-L5: "the so-called "Great Coast Gale of 2007" in the Pacific Basin, and the "Great Storm of 1987" in the North Atlantic. Results show that between 80% and 90% of the moisture advected by the ARs, as well as between 70% and 80% of the associated precipitation have a tropical or subtropical origin."
I was intrigued by this statement and wondered about the different between atmospheric moisture and precipitation, however, it seems that the percentages are quite coarsely estimated from visual inspection (numbers for Canada would be much lower) and no hard conclusions can be drawn from this. I wonder whether more deterministic percentages could be calculated for when the AR event makes landfall or for precipitation occurring within x km from the coast during x days of the AR event. Moreover, the word subtropical does not come back anywhere in the paper. Why? Is it wrong in the abstract or in the rest of the paper?

P1, L8: it makes no sense at all to abbreviate 'mean water vapor transport' with IVT, moreover, the authors are not very consequent as on page 2 it suddenly appears that IVT stands for integrated water vapor flux. Judging from the acronym a logical term would be 'integrated vapor transport' or the acronym should be changed.

P2, L17: " … West Coast"
Reference?

P2: "By calculating the water vapor budget of 200 extratropical cyclones, Dacre et al. (2014) conclude**d** that tropical moisture reaching the extratopics is only contributing to mid-level moisture, above the boundary layer."
I think the authors find something else, it would be nice if they could reflect on this statement in their conclusions.

Figures in general: Use clear headings instead of tiny names in the figure corners. The figures that show both AR events would benefit from clear titles specifying which panels are referring to the "Great Coast Gale" and the "Great Storm" respectively.

Figure 1: The source should be spelled out ERA-Interim instead of ERA-In. “SLP” appears only 2 times in the paper, thus no need to abbreviate this. A scale of the IVT vectors is missing.

P3, L1: “total water vapor”
Does the tool also track liquid water and ice and the associated phase transitions? Please elaborate on this and the consequences for the results if the assumption is that it only tracks vapor. On the other hand the authors should adjust their terminology if the tool in fact includes liquid water and ice.

P3, L3: “data and methods”
Then call section 2 data and methods instead of just methods

P3, L3: “summarize our conclusions”
After reading section 4 it appears that you give a summary and conclusions, which is different from summarizing conclusions.

P3, L16: “Iberian Peninsula”
Later you refer to damages on the British Isles, thus the AR appears to extend further than the Iberian Peninsula.

Section 2: subheadings would be helpful for readability

P4: “YSU”, “WSMC6”, “RRTM”
What do these acronyms mean? The way they appear now they are not helpful for readability.

P4, L20: “spectral nudging”
Can the authors be more specific, as there are many ways to apply spectral nudging.

Figure 3: What is (L m^{-2})? This would read as Luminous intensity per square meter according to the International System of Units, which I hardly think the authors mean. The total precipitation is shown on land only, be specific about this in the caption. LIVNEH and IBERIA02 do not have to be capitalized.

P5, L6: “[FigVALQ]”
???

Figure 4: units in the caption should NOT be italic. Is the IVT the absolute value in any direction?

P6, L6: please also refer to Arnault et al., (2016) who have developed a similar WRF tracing tool, and, if relevant, specify the differences if there are any.

Figure 5: Does the northern boundary of the red zone correspond to the northern extent of the tropics (the Tropic of Cancer)? If not, why? If yes, please specify this. Moreover, why does the red zone in Domain CS2 have a corner. And why do the domains have the crypted names CS1 and CS2?

P7, L1: "*u* and *v* represent the wind field"
There is only ***u*** in the formulas…

Equations (1)-(4): Acronyms should never be in italic as this by convention means e.g., $I \cdot V \cdot T$ which is clearly different from IVT. The "d" of the integral should be roman as well. It is not clear what "*sfc"* means. The "mixing ratio *w*", whatever it may be, is somehow only dependent on *q*, then what is its function and how should this be interpreted? I do not understand this.

P7, L8: "water vapor mixing ratio (a), and tracer water vapor mixing ratio (b)"
What are these? Do they actually represent *q* and *w*? If so, why are their names suddenly different?

P8: What is WCB? Again, I suggest the authors to moderate their use of acronyms.

P8: Some inline equations are not according to conventions regarding the use of roman and italic fonts in physics. The symbol φ is not being defined. Why is *Prec* not simply *P*? And why is "100" included in the equations? The formulas should be without 100 as they are fractions. When fractions are represented as percentages it is already implied (by calling them a percentage) that these are multiplied by 100% (not by 100 unitless).

P8, L27: "precipitation exceeded 3mm"
Per day? Per year? Per microsecond?

P8, L34-L35: "In the figure, there is evidence that the maximum of tropical moisture does not necessarily coincide with the low-level jet (LLJ), which is the maximum in wind speed at lower levels."
I am not a LJJ expert, but judging from the figure I do not clearly see that the place of the label is very different from the maximum of the integrated water vapor. Please elaborate or make the difference clearer in the figure.

Figure 6 and 7: these are certainly fascinating, probably more so when the reader would somehow be able to explore these interactively in 3D, but I am not so sure about the information content the way they are represented now. The white, blue and green colors of land and ocean are confusing with the other colors representing the water vapor mixing ratio and the cross sections blackish colors are not defined at all. Another point is that it seems that panels a-d do not correspond one-to-one with the rectangles provided at the bottom of each figure. My biggest problem is, however, with the terminology: Total water vapor mixing ratio provided in g/kg. It is not defined anywhere, but it seems this is just specific humidity (than call it specific humidity!). In any case a 'ratio' should always be unitless. Exactly the same comment applies to the tracers water vapor mixing ratio.

P9, L1: there is no Figure 8d

Figure 8: I guess this simply means the ratio of tagged water vapor to total water vapor (unitless!), but the caption provides the very cryptic description of "Tracers ratio in mixing ratio (g/kg)". There is no need to be so cryptic.

Figure 9: Here we can see some fascinating results as the tagged precipitation ratio is very different over the Iberian Peninsula. The higher elevations (Pyrenees, but also Galicia) have much higher tagged precipitation values compared to other areas. Beyond the Pyrenees in France to values have actually increased which seems counterintuitive. Does this have to do with the vertical distribution of tagged water and the rainfall generating processes which are not drawing the water specific-humidity weighted over the entire vertical column? Or does it have to do with the moment that precipitation falls? It would be great of the authors could elaborate on this.

Figure 10: How exactly is the position of the low level jet estimated?

P12, L6: "100mm"
It is daily precipitation, but it should still be mentioned whether is mm/day as one could also express daily precipitation in other units.

Figure 11: Why does the vertical axis show negative values? As mentioned before precipitation is a flux, thus cannot be expressed in mm. Please do not use computer code like "Tracers_prec", or "26_00h". An interesting question that can be raised here is whether the lack of tagged water during the initial rainfall is physical or whether it depends on the moment the simulation has started. In other words: when it started earlier, would the ratio of tagged water be apparent also during the initial precipitation?

P13, L13-L14: "It is well known that in a mature system, the water vapor store tends to be constant (e.g. Bullock and Johnson, 1971), and since the fate of tropical moisture is to precipitate sooner o**r** later, local convergence should keep the balance by lateral inflow."
What is a mature system? I cannot imagine that water vapor is constant during an extreme rainfall event. Please remove this statement or explain. Bullock and Johnson, 1971 is moreover missing from the reference list.

P14, L4: "behind or in front of the LJJ"
The maximum of tropical moisture being situated below the LJJ is seen in the figures, but where is it shown to be behind or in front of the LJJ.?

Figure A2: The LJJ estimation is missing here. Please also provide the correct unit for the latitudes in the caption.

Figure A3: I do not think this figure is referred to anywhere in the text.

Technical corrections

P1, L2: "3D Tracer tool" → 3D tracer tool

P1, L3: "Pacific Basin" → Pacific Ocean

P1, L12: Guan and Waliser (2015) **have** estimate**d** that

P1, L19: “several times of the discharge” → several times the discharge

P2, L11: Guan and Waliser (2015) **have** developed

P4, L7: “Model” → model

References

Arnault, J., Knoche, R., Wei, J. and Kunstmann, H.: Evaporation tagging and atmospheric water budget analysis with WRF: A regional precipitation recycling study for West Africa, Water Resour. Res., 52(3), 1544–1567, doi:10.1002/2015WR017704, 2016.