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Interactive comment on "Oceanic origins for wintertime Euro-Atlantic blocking" *by* Ayako Yamamoto et al.

Anonymous Referee #3

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General comments:

This paper presents an analysis of the moisture source regions of winter Northern hemisphere blocks, with a focus on those in the Euro-Atlantic region. While several previous studies have highlighted the importance of diabatic processes for blocking, the moisture source regions have not previously been characterised. It does not seem surprising that some of the air entering Euro-Atlantic blocks actually ascended in warm conveyor belts over the Pacific several days previously. However, the role of this source region in supplying low PV air to blocks is interesting.

The paper is generally easy to follow although there are many very small English language errors. Overall my comments are relatively minor.

Major specific comments:

Abstract, L15 You say that "While the particles of the Atlantic origin swiftly ascend just before their arrival at the blocking, those of the Pacific origin ascend additional few days earlier, after which they carry low PV in the same manner as dry particles." However, Fig 8 indicates that the PV for the dry particles is much higher than that for any of the moist particles.

Fig. 3 and 4 Changes in potential temperature, q and pressure are plotted in these figures for sets of particles but it's not clear how these changes are calculated. Are the values at each location mean values for changes over a timestep (of one hour as hourly data is available?) of all particles in that location at at exactly 2, 5 or 9 days before arrival in a block? Please can you clarify.

L199 You point out that previous studies have found that air ascending in WCBs tends to increase in PV below the heating region and then reduce in PV above this, entering the outflow region with similar PV values to those in the inflow. However, while your results that the WCB air arrives in the outflow region with low PV values, they don't show this increase and then decrease. Why?

Section 3.3 How do the results shown in your fig 5 and 8 compare to those shown in Fig 1 of Pfahl et al. (2015)? Your results show that, for air travelling into a block, there can be a substantial proportion of it with rather low values of PV (your moist particles) 7 days previously. This air warms substantially (by $\sim$10 K). Pfahl et al. show that air that undergoes substantial heating has PV values close to the local seasonal climatology (within 1 PVU). Given that you have the climatological PV values (shown in Fig 10), it would hopefully be straightforward to produce a plot of the same format as in Pfahl et al. The difference between the plots would presumably be mainly due to the different trajectory tools you've used (Lagrangian kinematic trajectory calculation compared to using an atmospheric

dispersion model in your study) although the definition of blocks might also have an impact. You motivate your decision to use an atmospheric dispersion model by its representation of turblence effects in section 2.3 so it would be interesting to see this comparison.

Section 4.4 I don't think we learn much in this section in addition to what is revealed by Fig 8 in section 4.3. Hence, the authors could consider omitting it.

L369 The result from Fig 13d that stronger low pressure systems are associated with stronger ascent doesn't look particularly strong. That is likely to be because WCBs tend to be strongest in strongly intensifying cyclones — deep, mature cyclones often have weak WCBs. You might find it interesting to look at this paper, https://doi.org/10.1175/JAS-D-15-0302.1, on the relationship between WCBs and cyclone intensification.

Section 4.3 Given that most moist particles arriving in blocks are identified as WCBs given a generous definition of WCBs, there is an obvious link between your work and that of Pfahl et al. (2014, https://doi.org/10.1175/JCLI-D-13-00223.1) on the moisture origins of moist conveyor belts. Please consider adding this reference.

Minor specific comments:

L37 "This transport of low PV anomalies" - it is actually the low PV valued air that is transported leading to negative PV anomalies.

L137 You need to point out that the "30–40%" range is for particles in the 3 days before their arrival in the blocking system (whereas the "60–70%" range is for the 7 days before arrival).

L138 Sentence beginning "We speculate" does not make sense - please re-write.

Does "when the direct diabatic effect tends to maximise" refer to the "immature/onset stages of blocking"?

L173 Please avoid this style of writing that compresses information using brackets ("an increase (decrease) in potential temperature is concurrent with a decrease (increase)...". It saves a few words, but it is very difficult for the reader (me at least!) to follow.

Fig 5 Here the shading around the mean is 0.5 standard deviation. I suggest instead using the standard error (the standard deviation divided by the number of particles) as a better representation of the likely error in the mean.

Fig 6 What are you normalising by to calculate the normalised difference?

Fig 7 The red contours mark the "origin locations for each grid cell". I was confused by this initially as these are backwards trajectories and previously red contours were used to indicate the particle release locations. Perhaps this description could be reworded as "particle locations at (a) 10 and (b) 20 days prior to their arrival in the blocks" or similar?

L299 Why is the Pfahl et al. reference cited here?

L321 Here you say that the difference between your finding that 10% of particles arriving in blocks are in WCBs and Madonna et al.'s finding that 0.36% of trajectories released in the lower troposphere are WCBs indicates that WCBs preferentially outflow in blocks. This conclusion doesn't follow from the two previous statements. The WCBs identified by Madonna et al. were all associated with cyclones. Thus some of those WCBs will outflow into blocks, but others (probably the majority) will instead just outflow into ridges ahead of the cyclones.

Fig 12 What period do the trajectories marked in these panels cover and when does the block occur for each case? Should we be able to see the block in the panel

for the final time for each sequence?

L396 Strictly you're giving percentages rather than fractions.

Technical errors:

There are multiple small English language errors, often associated with the use of determiners (e.g. "the"). These do not impede understanding at all, but will need to be corrected for publication. I have noted most of these from the text up to section 3 below. From section 3 onwards though I have not noted all these corrections. I encourage the authors to ask a native English speaking colleague to help them make these small corrections.

L5 Remove "an" before "atmospheric" or change "data" to "dataset".

L9 Remove "the" before "previous studies"

L10 I suggest adding "The" before "PV".

L13 Change "one-third from the Pacific" to "one third source it from the Pacific". Also, I wouldn't hyphenate "tow-thirds" on the previous line.

L15 Remove "the" before "Atlantic" and also before "Pacific" on the next line.

L17 "ascend additional a few days earlier" isn't grammatically correct. Perhaps "begin their ascent a few days earlier"?

L21 Change "Atmospheric blocking" to "An atmospheric block".

L23 Remove "the" before "extreme"

L36 Change "a blocking" to "a block" or "blocking".

L45 I suggest removing the comma after "effect".

L54 Remove "the" before "higher".

L66 Remove "the" after "amplify".

L94 Change "to manifest" to "manifests".

L115 Remove "the" from before "altitudes".

L120 and L125 Replace "at the particle's" by "to the particle's".

L121 Replace comma by "and" in "vorticity, PBL".

Fig 2 caption Change "at the wintertime" to "in the wintertime".

L189 Change "its dry" to "their dry".

L211 "particle" to "particles".

L230 Change "one-third from the Pacific" to "one third source it from the Pacific".

L316 Add "is" before "about"

L317 Change "is" to "are".

L338 Change "particles trajectories" to "particles' trajectories"

L407 Change "remains" to "remain".