

Review on “Western disturbances and climate variability: a review of recent developments” by Kieran M. R. Hunt et al. 2024

Thank you for giving me the opportunity to assess this comprehensive and well-written review article about western disturbances. I focused on the aspects related to moisture transport and isotope studies, which I found very well-summarized and inspiringly written. I have no problem with length since the well-thought-through structure helps the reader to orient efficiently. I have only few minor comments, mainly small questions on some phrasings.

Abstract:

- 1) L. 7: “Recent studies...” -> what is the time period covered in this review?
- 2) L. 8: “novel analysis techniques: mention automated tracking capabilities explicitly? Since this is mentioned in Section 2 as one of the key changes since the last review on the topic in 2015.

Introduction:

- 3) Fig. 1: add a black contour for topography? it could help to link to other Figs (such as Fig. 2).
- 4) L. 87: “a westward moving synoptic-scale trough” -> eastward-moving?
- 5) L. 136: “inexpensive” sounds a bit inaccurate to me, the simulations are just getting comparably less expensive but high-resolution model simulations are still very expensive in terms of computational costs.
- 6) L. 150: “rather **than**”
- 7) L. 159: “observed responses **in** the instrumental record”. If it’s really “observed responses to the instrumental record” that the authors mean, I don’t understand the sentence.

Section 2:

- 8) In my opinion Section 9.1 would be better placed in this section or after Section 3.
- 9) L. 179: put references in parentheses
- 10) L. 179-182: so combining early reanalyses with WD track data has been done already before 2015, right? Maybe put this sentence before the important remark of the turning point around 2015 with the start of automated tracking algorithms to keep the story chronological.
- 11) L. 195: rephrase the first sentence: yes, of course, detection depends on detection but can you say more? Detection depends on the characteristics of interest and may therefore vary among algorithms?
- 12) L. 198: which characteristics are meant here? I would be careful when using characteristics because you seem to differentiate between characteristics i.e. properties of WDs in terms of circulation vs. impacts, i.e. surface weather-related hazards.
- 13) L. 252: what is a weather distinct weather regime?
- 14) Section 2.2.: I like the bottom-up vs. top-down approach and my reading would benefit from a short introduction of these two approaches and what is meant by

- it at the beginning of the section. Is it event-based case studies (bottom up) vs. climatological composite analysis using tracking algorithms (top-down)?
- 15) Are WDs included in existing global climatologies of extratropical cyclones and cyclone-related features (i.e. WCBs)? E.g. in Wernli and Schwerz 2006 or Madonna et al. 2014.
 - 16) L. 267: IMD has not been introduced as an abbreviation yet
 - 17) L. 275: that seems also by design of most detection schemes since WDs are identified as eastward travelling, resp. the (probably very rare) westward travelling WDs are ignored?
 - 18) L. 276: "also because any system propagating eastward..." -> you mean westward here, right?
 - 19) L. 425: why "above"?
 - 20) L. 427: by compositing you mean an Eulerian analysis of the typical circulation associated with WDs and their environment? I think this ought to be clarified. Moisture sources based on trajectory-based diagnostics can also be composited using on a series of precipitation events or WD events.
 - 21) L. 430: cite Dansgaard 1964 when defining the deuterium excess
 - 22) L. 432: the delta values are deviations of the mentioned ratio from a commonly agreed-upon standards representing ocean water. How about writing "where d_2H is derived from the ratio of deuteriated water to the most abundant H_2^{16} "? Also $\delta^{18}O$ should be **\delta**.
 - 23) L. 432: both expressed as a deviation of the isotope ratio from a standard reference representing the isotope ratio of the mean ocean water.
 - 24) L. 425: missing space before reference
 - 25) L. 435: this is not entirely correct: see Thurnherr et al. 2020 for a study of ship-based measurements of dexcess in oceanic regions with different SSTs. I think for the regional setting in this paper, one important point that can be made is that the deuterium excess shows different signatures for water vapour that has undergone continental recycling vs. originates from oceanic source regions. And, furthermore, isotope signals can help partitioning land-derived sources into soil evaporation and plant transpiration (see e.g. Aemisegger et al. 2014). Rather than a reliable measure of the moisture source location, isotopes are a tracer of moisture source conditions (i.e. processes that characterise the source).
 - 26) L. 455: majority ->major?
 - 27) L. 462: Here maybe a short statement on trajectory-based moisture source detection algorithms could be made. I.e. different techniques exist including Eulerian and Lagrangian approaches with each having their own specific limitations.
 - 28) L. 490: calling for Eulerian moisture tracking methods (with numerical tracers for different sources) to be used in future studies?

Section 7

- 29) L. 1451: **of** the subtropical jet
- 30) L. 1453: and corroborates
- 31) L. 1485: misspelling of precipitation
- 32) L. 1502: remove one that
- 33) L. 1540: **E**levation-dependent warming

Section 8:

- 34) L. 1750: "... each of the moisture sources...": why "each"? Does it imply that they are a priori clear? I would remove "each".
- 35) L. 1751: "... it is known **that**..."
- 36) L. 1752: "Do different ratios... -> source ratios?"
- 37) L. 1756: is latitude really a WD impact? Or a WD property?
- 38) L. 1814: higher resolution than what? -> high resolution

Summary:

- 39) I think the concluding section should be more than just a summary. It should put the review into the current context. And with this in mind, it reads a bit strange to come back to the summary after the future research questions and challenges. One could imagine having one big Conclusion and summary section, which includes Section 8 about "Future research questions and challenges".
- 40) Section 9.1 is out of place in my opinion. This is a sort of glossary remark or definition that should probably be placed much earlier in the paper. After the summary it comes very much as a surprise to me.
- 41) I must emphasise that I really like Section 8, it is very inspiring, and I would have liked to finish reading the paper in this opening-view.
- 42) L. 1876: repetition of primarily