Review
L. Schuster et al.: Lagrangian detection of precipitation moisture sources for an arid region in northeast Greenland: relations to the North Atlantic Oscillation, sea ice cover and temporal trends from 1979 to 2017, WCD.

General comments
The author presents moisture source analysis with a focus on a specific site in Greenland. Using moisture source diagnostics and cluster analysis the sources are explored. The relationship to NAO and sea ice changes are explored. Temporal evolution is also addressed. The analysis of NAO and cluster analysis as well as the arguments for the validity of the PBL assumptions can be strengthened (see below).
The paper is a good paper, well written, clear to understand and with sufficient references. There is some work to be done in terms of framing the introduction as a classical science paper but based on the quality of the rest of the paper, this should be no problem to change.

I therefore suggest publication with major revision.

Major comments:
<u>NAO/cluster analysis</u>
It is a nice idea to use cluster analysis for moisture sources.
It is unclear whether it is reasonable to assume constant clusters throughout all seasons.
It is ok to continue with clusters based on all months, but please document using relevant numbers, that the assumption holds. Since sea ice trends are also explored later, is it reasonable to assume that the clusters are constant in time? Please document why.
Can you also add information regarding variability on the relevant timescales?

Analysis of NAO variations are also done in this manuscript.
It has been documented that NAO is important for southern/central Greenland (Vinther2010, Sodemann 2008) But is NAO really the dominant driver for this given location? Fig 9b is not strongly convincing regarding this.
There are a few ways to approach this. Either explore other weather patterns (ScB, EAtl, NAO+/-) (see e.g. Ortega et al 2014) and GBI for summer (Hanna et al. 2015) or use the already analyzed clusters and connecting circulations to document variability. Or come up with a third alternative. No matter what, it is important to argue that the chosen index (e.g. NAO) is indeed a driving circulation pattern for the location.

<u>Introduction:</u>
The introduction is interesting reading, yet not optimal in terms of structure and content for a journal paper introduction. The manuscript is about moisture sources for Greenland, with a specific focus on a single location. Please spend less text on Arctic amplification and instead use the introduction to introduce relevant literature related to this topic. Especially highlight the current knowledge gap and motivate for why your analysis is relevant and explain the regional focus of Greenland. And address why this region of interest for our science community.

<u>Uniqueness of the location - state differences and highlight benefits.</u>
The study focusses on a rather specific site on the northeastern margins of the Greenland ice Sheet. The authors refer sufficient to other studies that have explored Greenland moisture sources, but these studies have also addressed that moisture sources are not uniform over

Greenland. How this location differs from other findings due to location is underexplored in this study. It is encouraged that the authors throughout the text further motivate that their site is beneficial for Greenland studies since it is has a unique location in close proximity to areas of recent strong sea ice decline (as shown in fig 11).

Minor comments

L85 "…a model without spatial or temporal gaps…" - unclear. Just delete this sentence.
L88 It is ok to use ERA-Interim but try to address this point and potential implications briefly in the discussion rather than here.

Sec 2. The methods described are partly unclear. As a reader without prior knowledge of back trajectories, the description of how ERA-Interim and moisture source diagnostics works together is unclear. Please clearly state this and maybe consider reorganization of this section.

L110 "In the next step…" The next step of what? Are you here referring to the moisture source diagnostics?

L115 – Moisture uptakes above PBL. Be clear about why this is neglected – does Sodemann 2008 argue for this?

L121-122. The wording of why to choose Lagrangian rather than Eulerian methods is not optimal here after you have already described that you use Lagrangian methods. Please rewrite or replace.

L123 -126: Please clearly describe, where in your methods do you lift the PBL height by 1.5? Is this done on ERA-interim data or in the moisture diagnostic?
To the best of my knowledge this is have not been done for the North Atlantic before. Is the PBL height also underestimated in this region, please argue with references and please argue with numbers, what difference this have for the amount of moisture uptake in this study?
As a reader I would like to be convinced that this approach is better than the existing ones, and also clearly know what differences this makes compared earlier studies such as Sodemann 2008. Please clearly state this.

L127 – "A measure for performance of the method" Is fig 3 a measure for performance? Do we trust that moisture sources and their variability are adequate after?

L129: 52% is moisture uptake that is not accounted for? This seems like a lot. Great that this is also treated later. But what effects have 1.5 PBL on this fraction? What is the argument for only including moisture uptake below PBL rather than all moisture uptake? Please demonstrate with relevant numbers that this assumption does not strongly influence the results.

L144: Generally, there is an issue here that (at least the DJF) NAO index values for the ERA-interim are not evenly distributed. This is just nature, but please add numbers to describe the ranges for NAO+, NAO- and NAO neutral.

L163-168. If you mention this – please relate to your findings and the site of this study. The site is so north that it is only partly close to the North Atlantic storm track. But what does fig 4 show?

L167-168. Is this expected to be the case for your site? What role does increased moisture content in the air due to warmer temperatures play relative to this?

L170. Is precipitation really constant during the year? The accounted precipitation is, but not the ERA-interim precipitation. Spring/summer is clearly lower than the rest of the year. E.g. July median is roughly 3 times lower than September.

L173. How do you define "local sources" - please describe?

L170-179: Avoid the use of the word "seem". Either the sources are there or they are not.

Fig 5. There is too large of a region on the globe which is white. This makes it more difficult to look at the plot. Consider a different projection (e.g. polar stereographic) where North Atlantic/Arctic is emphasized (and apply to other relevant plots such as fig. 6). Also, fig 5 contours of z500 could be closer so it is easy to distinguish differences from month to month.

Fig. 6 – The colors on this plot looks very similar blue-toned with little contrast on my (and maybe others) printer. Please change to a color scale with stronger contrasts. The signs and meaning on the legend for 15 and 30 IVT are unclear in figure and caption, please improve this. Please add a comment on an uneven color scale on this.

Fig 6. Is figure of anomalies a better way to display this?

L211-217: This section here is unclear. Please reformulate. Are sea ice areas defined as constants throughout the year or are they changing months by months?

L278ff: This analysis is interesting and relevant, but the method and text are a bit unclear. Please reformulate to enhance clarity and clearly state relevant findings.

Sec 6 (Conclusion)
The content of the conclusion is unclear and unprecise and does currently not let the key methods and findings of the manuscript stand out. This will improve the many "skim-readers" understanding of the paper strongly. Please improve and address all key components of the manuscript.