Weather Clim. Dynam. Discuss., referee comment RC1
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Comment on wcd-2021-22

Anonymous Referee #1

Referee comment on "A 25-year climatology of low-tropospheric temperature and humidity inversions for contrasting synoptic regimes at Neumayer Station, Antarctica" by Tiago Silva et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2021-22-RC1, 2021

The manuscript “A 25-year climatology of low-tropospheric temperature and humidity inversions for contrasting synoptic regimes at Neumayer Station, Antarctica” addresses temperature and humidity inversions at Neumayer Station in Antarctica. The study aims to connect inversion properties to synoptic weather conditions, and to study inversions on different height levels. Investigation of both temperature and humidity inversions at a single station provides an opportunity to analyse inversion properties, their connection to prevailing weather conditions and affecting physical processes in detail, but unfortunately this study fails to go deep enough in those analyses. Although the manuscript is in many aspects well prepared, it has serious problems related to methods.

- My main concern is that the concept of the manuscript is based on division between “cyclonic” and “non-cyclonic” conditions at the station, defined from the synop weather codes. In practice, these weather codes used tell whether there is/has been precipitation or not. They do not indicate anything about circulation, and they should not be referred as cyclonic/non-cyclonic. If the authors want to classify circulation, they should use reanalysis/numerical model pressure fields for that or at least utilize more the wind direction information (which is also available from radiosoundings). As far as I understand the classification made in this manuscript, it practically only separates precipitation events from non-precipitation events. This leads to my second serious concern: what is the motivation to study inversion characteristics in precipitation events, when we know that radiative cooling, which is largely controlled by clouds, subsidence and horizontal advection are the main factors affecting the inversion properties? Clouds and advection can occur without precipitation. Radiative cooling, both at the surface and on the cloud tops, is almost neglected in this study (including the Introduction section), even if it is the main mechanism behind the temperature inversions. Specific humidity inversions close to the surface are largely affected by this radiative cooling, and saturation takes place in the lowermost cold layer and leads to specific humidity inversions. Formation mechanisms of inversions are not adequately taken into account in the analyses, and the authors do not utilize what is known about inversions in the other polar region, i.e. Arctic.

- Interpretation of the results is not deep in the manuscript, and it is mostly at the level of a "data report". The data analyses made do not really provide support for physical interpretation, especially because they do not give reliable estimates of the synoptic conditions/atmospheric circulation. The abstract the Discussion/conclusions section should be able to convince a reader that this manuscript has provided some new valuable results, but unfortunately this value is not clearly visible in the current version of the manuscript.
- I have two suggestions to the authors: (1) if you want to define the states based on circulation (cyclonic/non-cyclonic), define the weather states based on reanalysis/numerical model fields, and utilize those data also to address advection, or (2) if you want to limit the study to observational data, utilize more comprehensively the wind speed/direction information of radiosondes, cloud cover observations and surface radiation observations (if available). Instead of dividing the data between precipitation/non-precipitation cases, divide the data based on cloud conditions (which are known to have a large impact on the inversions), radiative fluxes at the surface, and wind direction.