**Title**

Atmospheric River Precipitation Attribution in Reanalysis Data and Comparison with ICESat-2 Altimetry Observations in Antarctica

**Author**

[van der Kleij, Sylke](https://repository.tudelft.nl/islandora/search/author%3A%22van%20der%20Kleij%2C%20Sylke%22?collection=education)

**Date**

2023-05-30

**Abstract**

Atmospheric rivers transport 90% of all atmospheric moisture in the mid-to-high latitudes, while covering only 10% of the Earth’s surface at any given time. Atmospheric rivers occur infrequently, and atmospheric river frequency in the polar areas is especially low, but they can have a large impact on the cryosphere when they make landfall. They have been linked to various processes affecting the surface mass balance, such as extreme precipitation events as well as surface melt.
This thesis addresses the importance of atmospheric rivers in the polar regions. The study aims to compare atmospheric river precipitation estimates obtained from reanalysis data with ICESat-2 satellite altimetry observations in Antarctica between 2019 and 2021, to determine whether the two different types of data sets show similar amounts of atmospheric river precipitation.
To achieve this goal, an atmospheric river detection algorithm designed specifically for polar regions was used to identify atmospheric rivers in Antarctica. All precipitation falling within an atmospheric river footprint for the first 24 hours after detection is attributed to the atmospheric river. The detection algorithm and precipitation attribution are performed to MERRA-2 and ERA5 reanalysis data. The resulting atmospheric river precipitation anomalies were then compared to ICESat-2 height change observations using correlation analysis and a metric based on variance reduction. A detailed analysis
is presented of specific drainage basins that show promising results based on the comparison of the reanalysis data and ICESat-2 observations, using time series.
The results show a high degree of correlation between the atmospheric river precipitation anomalies from reanalysis data and ICESat-2 height changes in multiple drainage basins. Variance reduction shows that atmospheric river precipitation can explain a significant part of the variance of the ICESat2 height change observations in these drainage basins. This suggests that in select locations, the atmospheric river precipitation expected based on reanalysis data is indeed observable in ICESat-2 data. A challenge is the coarse temporal resolution of ICESat-2 data. ICESat-2 data has a temporal resolution of 91 days, whereas atmospheric rivers typically last between a few hours up to a few days
at most, and occur very infrequently (up to ∼2% of the total time over the time period 2019-2021).
Nonetheless, this thesis provides a comprehensive analysis of atmospheric river precipitation in Antarctica using both reanalysis data and satellite observations, contributing to a better understanding of the impact of atmospheric rivers on the surface mass balance of Antarctica. Additionally, it suggests that as long as its limitations are taken into account, ICESat-2 data can be a valuable tool to use in addition to reanalysis data in the study of atmospheric rivers in the polar regions.