Analysis of extreme precipitation conditions near the Wilkes and Adelie Lands in Antarctica

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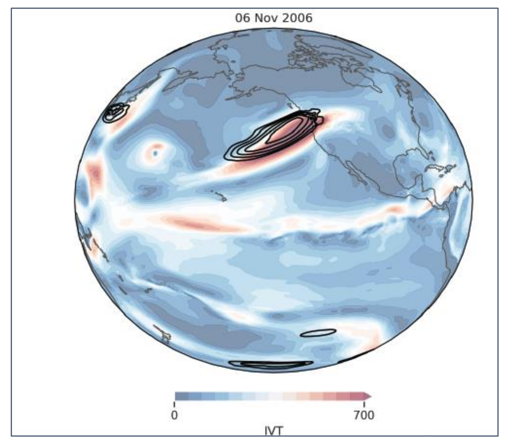
Introduction

Why study extreme precipitation in Antarctica?

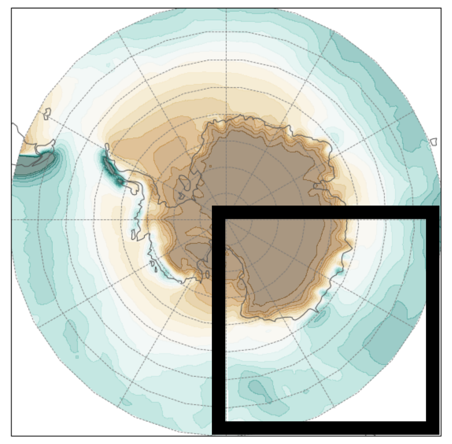
- Antarctic ice loss contributes to sea level rise (Rignot et al., 2019)
- Precipitation (snowfall) is the primary way that Antarctica gains ice (van Wessem et al., 2018)
- In Antarctica, extreme precipitation events make up 10% of precipitation days, but over 40% of total precipitation (Turner et al., 2019)

What are atmospheric rivers (ARs)? (Rutz 2019)

- ARs are long, narrow channels of water vapor transport typically connected to precipitation extremes in the mid-latitudes
- They have been attributed to specific cases of extreme precipitation in Antarctica (Gorodetskaya et al., 2014, Bozkurt et al., 2018)



Shape and water vapor content of ARs on November 6th, 2006. Figure courtesy of Ashley Payne, plotted using ERA-5 reanalysis data.



Mean precipitation over Antarctica between 1979-2019. The square shows the region studied in this work.

Why study this region?

- Some possible precipitation trends have been observed in the Wilkes and Adelie Lands in this region (Tang et al., 2018, Lenaerts et al., 2012)

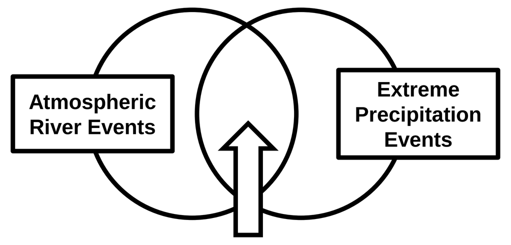
What influence do atmospheric rivers exert on extreme precipitation in this region of Antarctica?

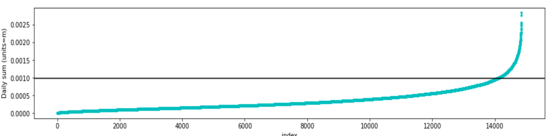
Data & Methods

Datasets

- ERA-Interim (atmospheric reanalysis data)
- Tracking Atmospheric Rivers Globally as Elongated Targets (tARget) algorithm (identified ARs) (Guan & Waliser, 2019)

Analysis Approach





Daily precipitation sums by increasing intensity. Days above the horizontal line (the 95th percentile) are considered extreme precipitation days.

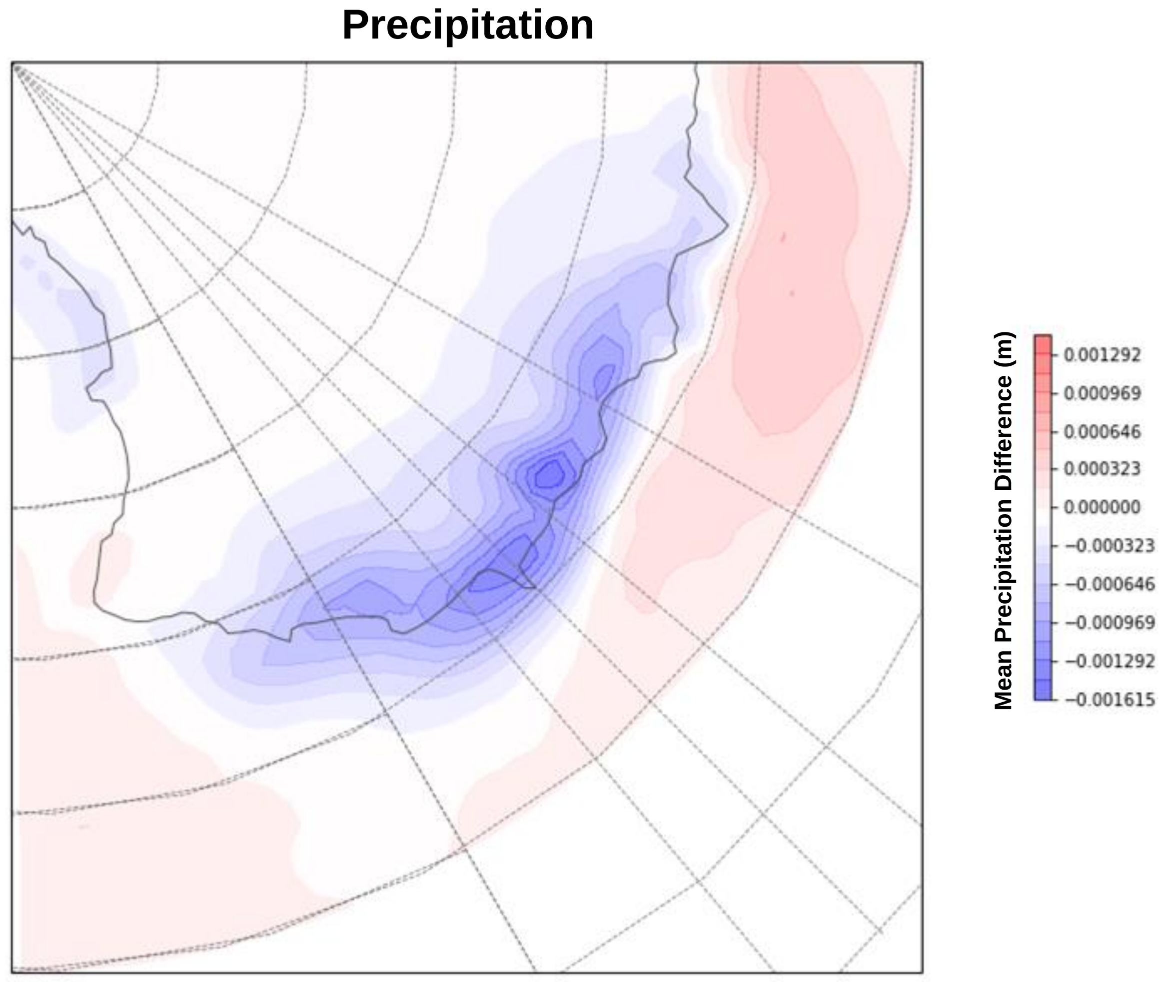
Extreme Precipitation Events	AR Events
Based on precipitation data	Based on AR land area coverage coordinates
Grouped by days	Grouped by 6h-timestep
Above the 95th percentile of precipitation	Above the 90th percentile of land area
Consecutive days form an event	Timesteps with 12 hours or less between them form an event
	Events with only one timestep are discarded

Results

These composites show the pattern of ARs with relation to extreme precipitation events.

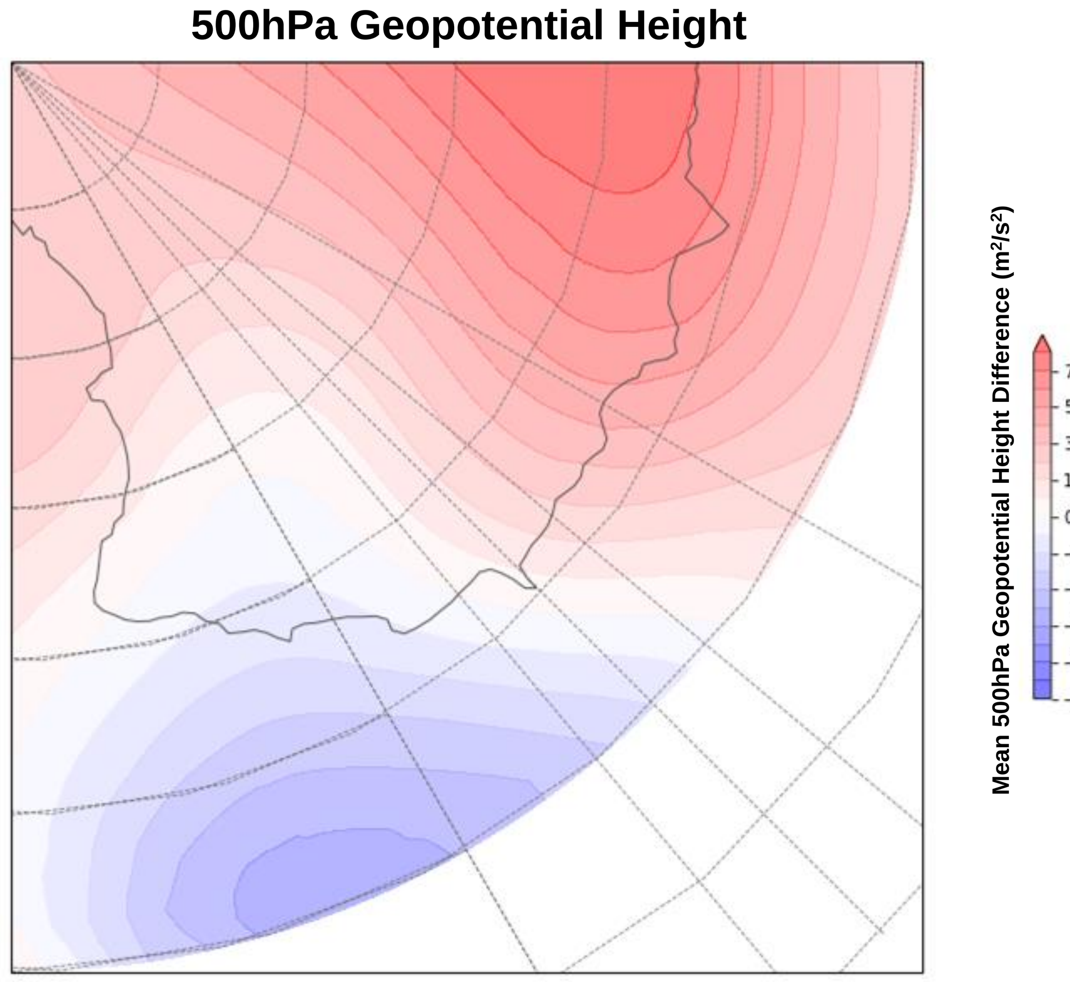
AR events average − extreme precipitation events average

Precipitation



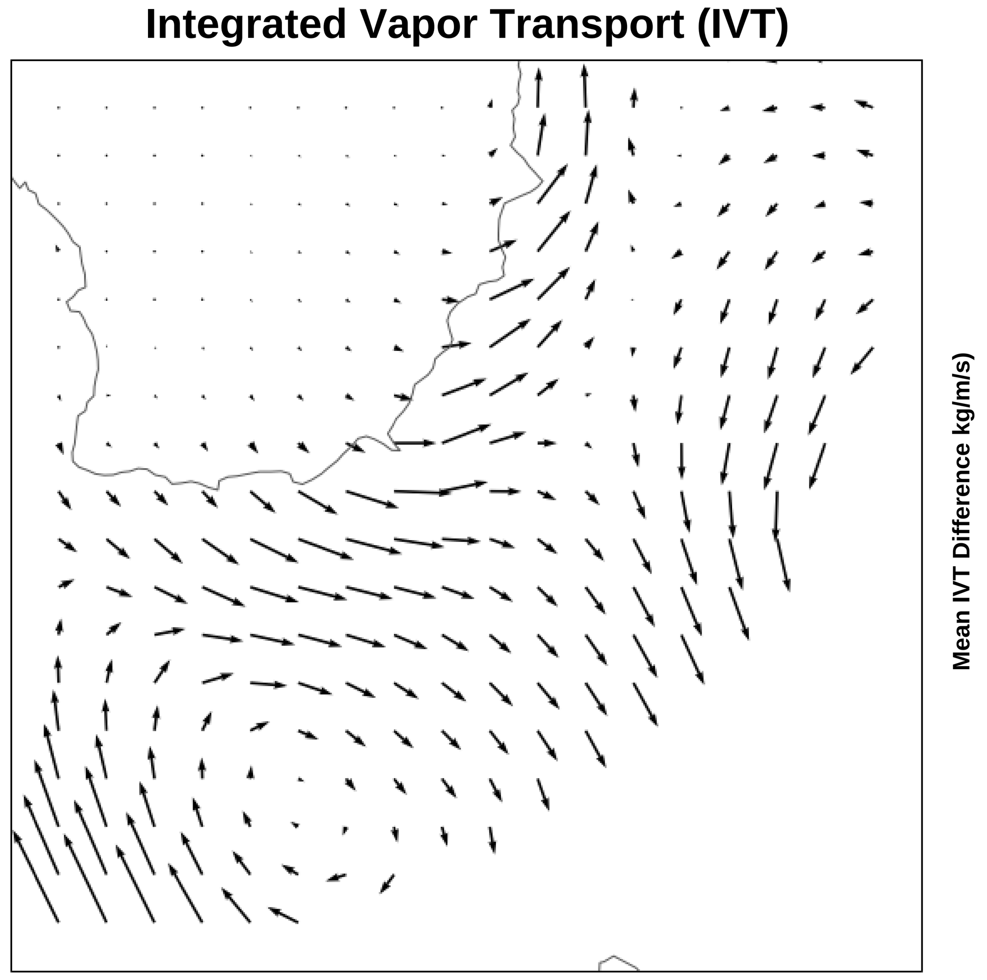
Precipitation: The total average contribution of AR events to the coastal region (defined by a land-sea mask) is less than that contributed by extreme precipitation events. On average, ARs contribute more precipitation over the oceans.

500hPa Geopotential Height



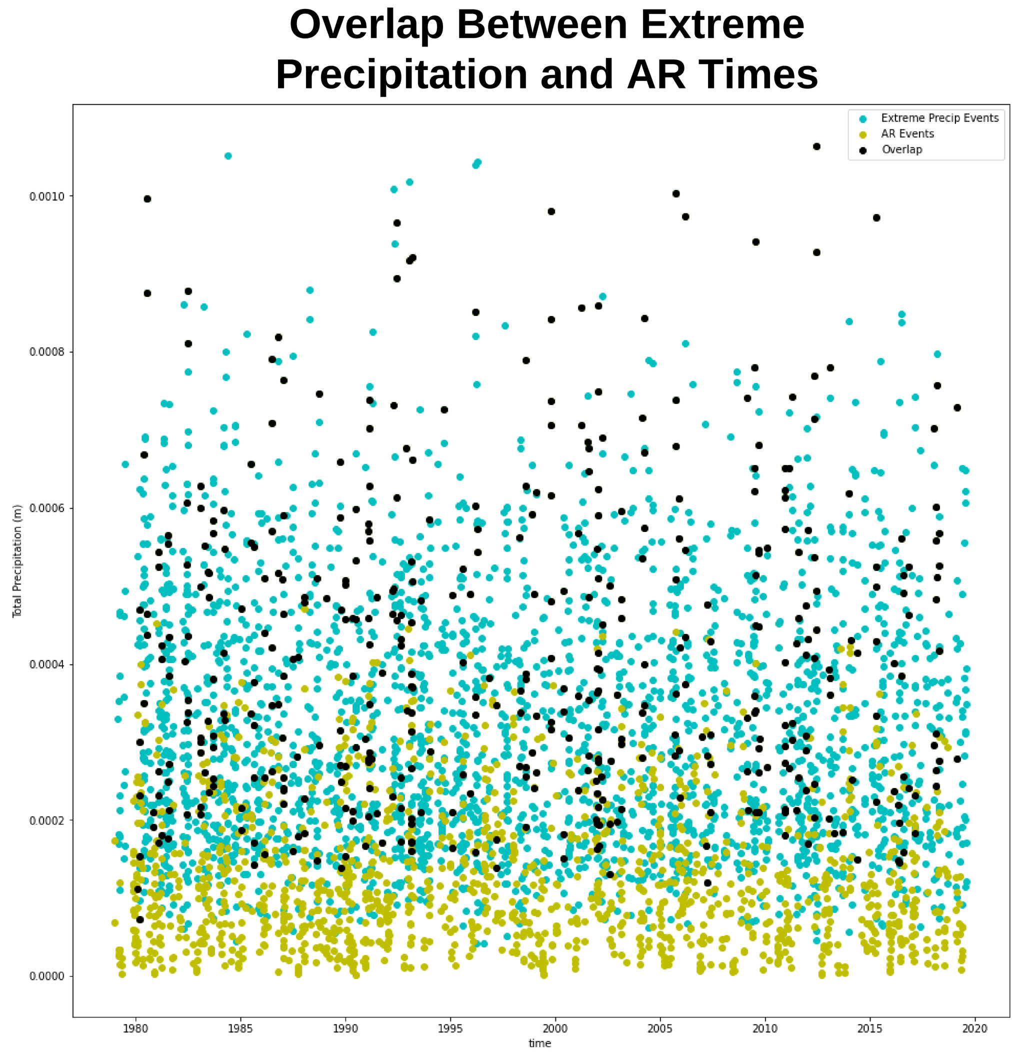
500hPa Geopotential Height: On average, the set of AR events have a higher geopotential to the west, and lower to the east, than the set of extreme precipitation events. This indicates that, relative to general extreme precipitation conditions, AR conditions typically have higher temperatures to the west (around Wilkes Land) and lower temperatures to the east (around Adelie Land).

Integrated Vapor Transport (IVT)



IVT: On average, the set of AR events has more water vapor transport towards the west than the set of extreme precipitation events.

Overlap Between Extreme Precipitation and AR Times



Overlap: Here we show the precipitation values for times when extreme precipitation occurs (in blue), times when an AR landfall occurs (in yellow), and the times in which they overlap (in black). The two sets overlap for ~ 1/4th of times.

Summary & Future Work

The differences in patterns suggest that not all AR events result in extreme precipitation. They also suggest that circulation patterns tend to differ between extreme precipitation conditions and AR conditions.

Limitations:

- The performance of reanalysis is poor over regions with few observations such as Antarctica.
- The divisions between extreme and not-extreme precipitation or AR land coverage are arbitrary (we based the thresholds for this work on past research and the need to compare similarly sized sets).

These results are preliminary but suggest two directions for future research:

- Are AR tags in the Guan and Waliser algorithm identifying physical features?
- How much overlap exists between precipitation extremes and ARs?

Acknowledgements

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