Discriminators of Antarctic Atmospheric River Environments

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Although rare, atmospheric rivers (ARs) substantially influence the interannual variability of Antarctic surface mass balance in the current climate via snowfall. The importance of ARs to the AIS mass balance, and thus global sea levels, motivates a deeper understanding of the atmospheric environments most conducive to landfalling Antarctic ARs.

Compare 3 Groups of Timesteps:

1. Landfalling AR

n = 17,418

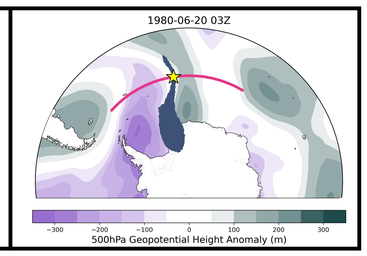


Figure 1: example of AR mask from Wille et al. (2019) AR detection algorithm applied to MERRA-2 reanalysis data (dark grey). Center of AR at 55°S (yellow star) and 500 hPa Geopotential height anomaly used to identify Analog timestep (pink).

2. Analog:

n = 17,418

Synoptic-scale environments most similar to AR timesteps but they do not feature an A**R**

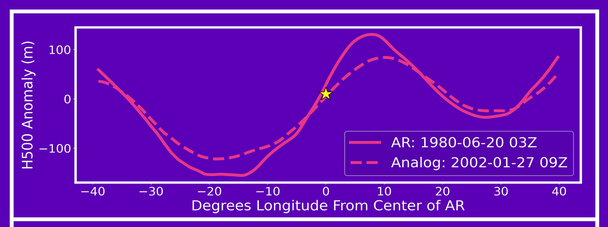


Figure 2: H500 anomaly curve for the AR timestep in figure 1 (solid curve) centered on the AR center at 55°S (yellow star) and the corresponding Analog H500 anomaly curve (dashed curve).

3. Top AR:

n = 1,742

Top 10% of timesteps with respect to snowfall intensity

Precipitation Associated with Each Group

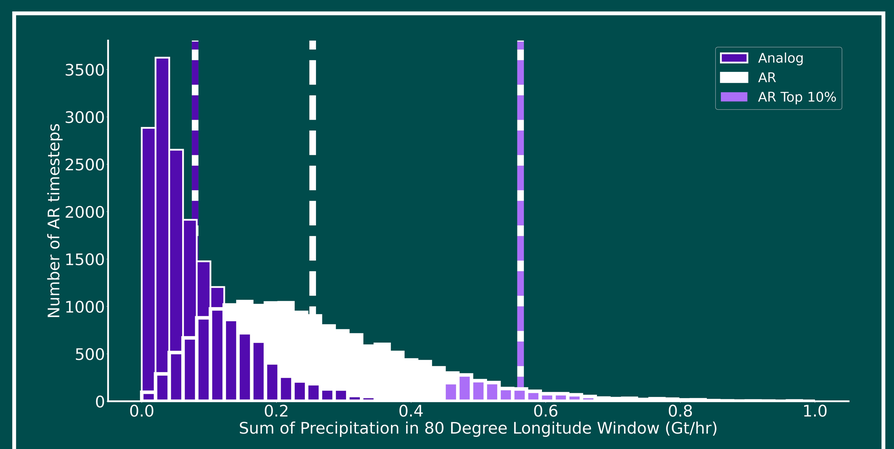


Figure 3: Distributions of snowfall intensity over the Antarctic Ice Sheet and ice shelves during Analog (dark purple), AR (clear), and Top AR (light purple) timesteps. Mean values for each group are shown with dashed lines.

What makes AR environments unique?

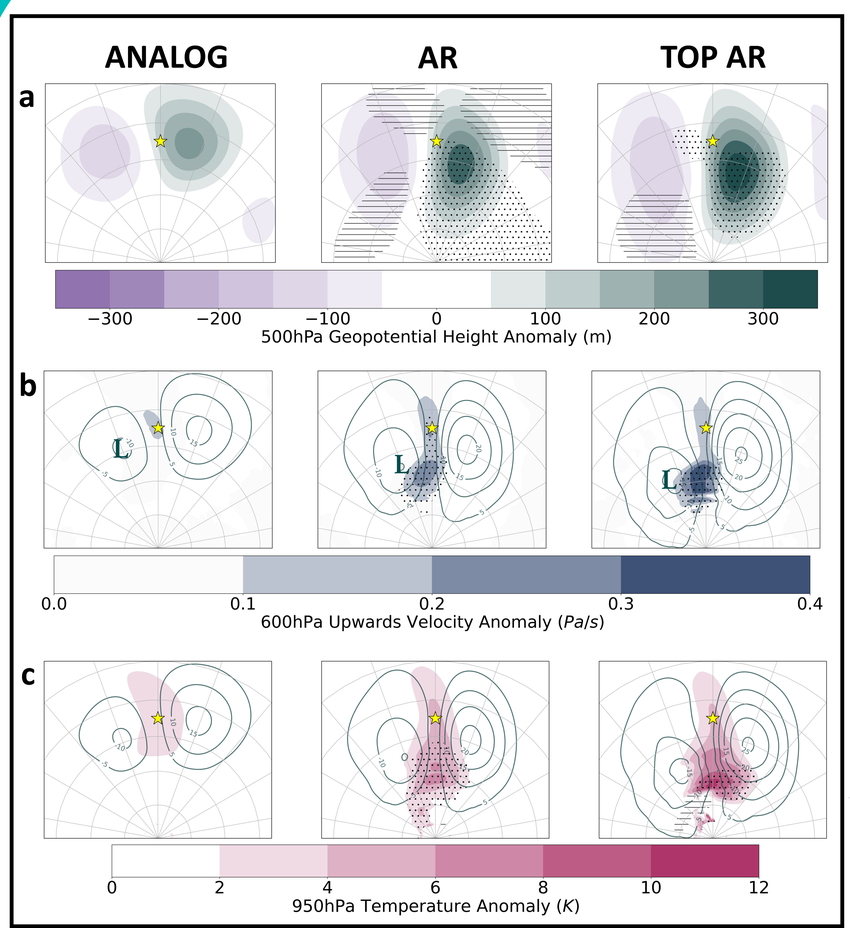
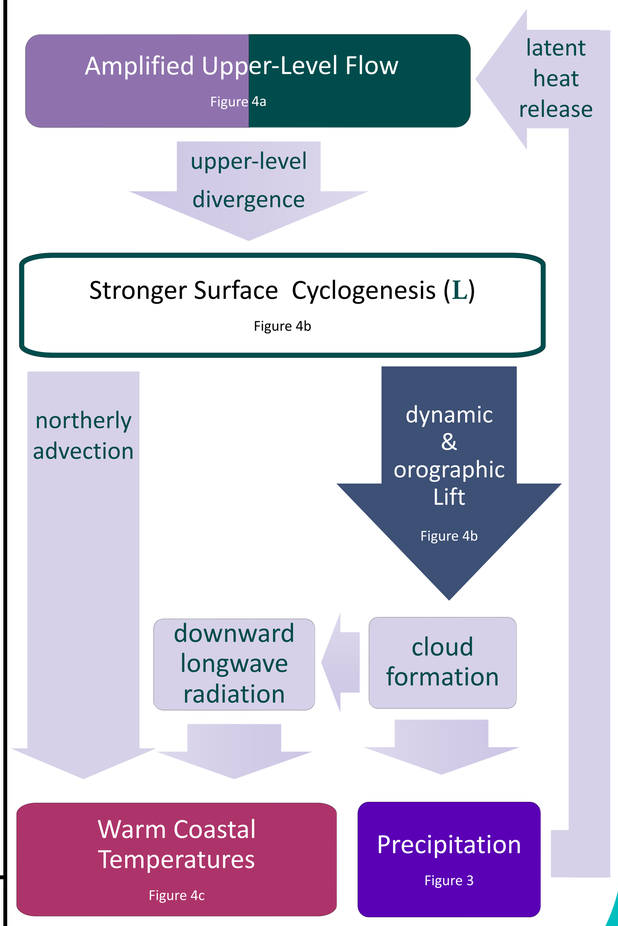


Figure 4: Composites for Analog (left), AR (middle), and Top AR (right) timesteps centered on the AR center at 55°S (yellow star). Stippling (hatching) where there is a significantly higher (lower) value in the AR group relative to the Analog group or in the Top AR group relative to AR group. **a** H500 anomalies at the time of AR landfall (green and purple shading) Significance is only considered at grid points where the difference in composite anomalies is greater than 25m. **b** 950hPa temperature anomalies (pink) and SLP (dark green contours). Significance is only considered at grid points where the difference in composite anomalies is greater than 1K. SLP anomalies (dark green contours) and 600-hPa upward vertical motion (blue). Significance is only considered at grid points where the difference in composite upward vertical motion exhibits a magnitude greater than .05 Pa/s.



What makes *Top AR* environments unique?

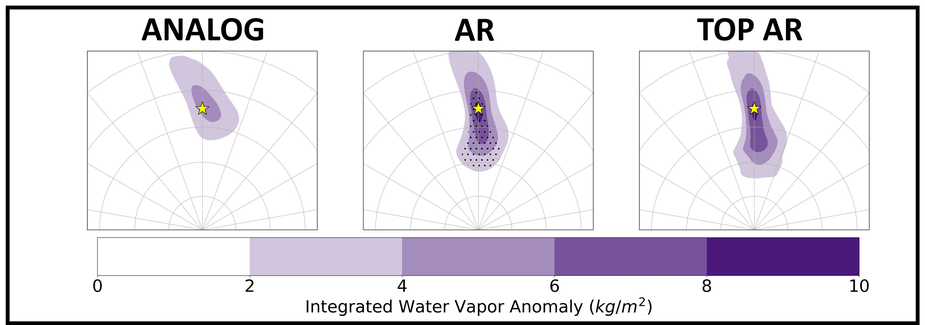
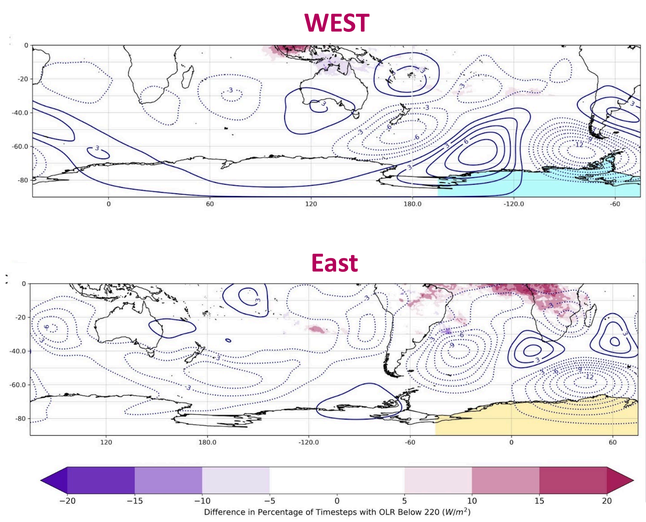


Figure 5: Composites for Analog (left), AR (middle), and Top AR (right) timesteps centered on the AR center at 55°S (yellow star). Stippling (hatching) where there is a significantly higher (lower) value in the AR group relative to the Analog group or in the Top AR group relative to AR group. IWV anomalies (purp;le shading) with stippling where there are significantly higher values in the AR group relative to the Analog group or in the Top AR group relative to the AR group. Significance is only considered at grid points where the difference in composite IWV is greater than 2 kg/m².

Top ARs **do not feature** more local moisture compared to all ARs.



Top ARs **do feature** regionally-based planetary-scale dynamics conducive to amplified flow.

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