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What are the most important contributors to Arctic precipitation: When, where and how?

Melanie Lauer[1,2], Annette Rinke[3], Susanne Crewell[1], and **Awadhesh Pant**[1,2]
[1]Institute for Geophysics and Meteorology, University of Cologne, Cologne, Germany (apant@uni-koeln.de)
[2]Earth Environmental and Planetary Sciences, Brown University, Providence, RI, USA
[3]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Potsdam, Germany

To investigate the role of synoptic systems for Arctic precipitation, Lauer et al. (2023) established a new methodology to attribute precipitation to Atmospheric Rivers (AR), cyclones, and also atmospheric fronts and tested it for two field campaigns in the Arctic North Atlantic (ANA) sector (ACLOUD, AFLUX). The results led us to hypothesize that during early summer, precipitation is mainly associated with cyclones, while during early spring, ARs and fronts are more effective. About one-third of the precipitation was classified as residual, which reduced significantly when a precipitation threshold was applied as often used to eliminate “artificial” precipitation. To investigate whether these results can be generalized we now apply the methodology of Lauer et al. (2023) to the long-term (1979-2022) ERA-5 reanalysis record over the full Arctic north of 70 deg.

When: Most precipitation falls in August as a consequence of rain peaking in July and the highest amount of snowfall in September at the time of the sea ice minimum and thus the highest evaporation from the ocean. Where: The ANA region is by far the one with the most precipitation, and the only region with significant rain outside the summer months. How: Cyclone-associated precipitation dominates in all regions, while ARs are more important for summer rainfall and, in some regions, can even bring rain in winter. We can pinpoint the high occurrence of residual precipitation over the ANA region to Marine Cold Air Outbreaks, while in the central Arctic the residual stems from very light precipitation.