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The oceanic drivers of the 2017 Maud Rise Polynya

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Maud Rise polynyas are rare events in the Weddell Sea (Atlantic sector of the Southern Ocean) that cause deep vertical mixing within the ocean column and large surface fluxes of heat with large impacts on the local Weddell gyre circulation and on the Antarctic bottom water properties. Here we use a 1/12^{o} ocean reanalysis product to assess the dominant drivers of ocean stratification leading up to the polynya event of 2016 and 2017 in Maud Rise, Weddell Sea. We carry out a potential vorticity (PV) budget to identify the dynamical components of the regional circulation responsible for changes in ocean stratification that culminated in the formation of the 2017 polynya. During 2015, an exceptionally strong (about 2x that of the previous three years) buoyancy-driven destratification led to a shoaling of the pycnocline, and the restratification at the end of 2015 remained weak. During 2016 and 2017, the buoyancy-driven destratification decreased in strength, becoming weakest during the polynya of 2017. The destratification was once again strong in 2018, but this was balanced by a stratifying forcing from the surface stress and advective components, the latter of which was associated with a transport of denser (more saline and cooler) subsurface waters from the flanks of Maud Rise. These denser subsurface waters maintained a strong stratification through 2018. These results show how interannual anomalies in local sea ice production and regional circulation can promote or inhibit the formation of polynyas in the region. Furthermore, it suggests that the Maud Rise polynya opened in 2017 following a chain of perturbations that started at least back in 2015, contrary to the common view that the polynya was initiated solely by a series of short-lived storms in 2017.