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Eddies in the marginal ice zone of Fram Strait and Svalbard from spaceborne SAR observations in winter

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In this work we investigate the intensity of eddy generation and their properties in the marginal ice zone (MIZ) of Fram Strait and around Svalbard using spaceborne synthetic aperture radar (SAR) data from Envisat ASAR and Sentinel-1 in winter 2007 and 2018. Analysis of 2039 SAR images allowed identifying 4619 eddy signatures in the MIZ. While the overall length and the area of MIZ are different in 2007 and 2018, the number of eddies detected per image per kilometer of MIZ length is similar for both years.
Eddy diameters range from 1 to 68 km with mean values of 6 km and 12 km over shallow and deep water, respectively, suggesting that submesoscale and small mesoscale eddies prevail in the record. At eddy diameter scales of 1-15 km, cyclones strongly dominate over anticyclones. However, in the range of 15-30 km this difference is gradually vanishing, and for diameter values above 30 km anticyclones start to dominate slightly.
Mean eddy size grows with increasing ice concentration in the MIZ, yet most eddies are detected at the ice edge and where the ice concentration is below 20%. The fraction of sea ice trapped in cyclones (53%) is slightly higher than that in anticyclones (48%). The amount of sea ice trapped by a single 'mean' eddy is about 40 km^2. Here we also attempt to give a first-order estimate of the eddy-induced horizontal sea ice retreat using observed values of eddy radii and amount of sea ice trapped in the eddies, and empirical mean values of ice bottom ablation and ice thickness. The obtained average horizontal ice retreat is about 0.2-0.5 $km \cdot d^{-1}$ ± 0.02 $km \cdot d^{-1}$. The spatial patterns of the eddy-induced horizontal sea ice retreat derived from SAR data suggest a pronounced decrease in MIZ area and a shift in the edge location that agrees with the observations.
The analysis of the spatial correlation between eddies, currents and winds shows that the intensity of eddy generation/observations and their detectability in the MIZ, and the width of eddy bands correlate with the intensity of northern and northeasterly winds. In some regions, e.g. along the Greenland Sea shelf break, in Fram Strait and over the Spitsbergen Bank the probability values of eddy occurrence in the MIZ seem to correlate with stronger boundary currents, while north of Svalbard and over Yermak Plateau higher eddy probability values are observed under low/moderate currents and winds.
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