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Evolution of sea ice drift, deformation and fracturing during the last decades and their role on the decline of the Arctic sea ice cover

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Using buoy data from the International Arctic Buoy Program, we found that the sea ice mean speed over the Arctic has substantially increased over the last 29 years (+17% per decade for winter; +8.5% for summer). We check that these trends were not affected by temporal or spatial sampling bias. A strong seasonal dependence of the mean speed is also revealed, with a maximum in October and a minimum in April, i.e. out of phase, lagging by 6 months with respect to the sea ice extent seasonal variability. The sea ice mean strain rate, deduced from the dispersion of buoys trajectories, also increased significantly over the period (+51% per decade for winter; +52% for summer). We check that these increases in both sea ice mean speed and deformation rate are unlikely a consequence of a stronger atmospheric forcing, as the mean wind speed over the Arctic did not increase significantly over the period. Instead, they suggest that sea ice kinematics plays a fundamental role in the albedo feedback loop and sea ice decline: increasing deformation means stronger fracturing, hence more lead opening and therefore a decreasing albedo. This accelerates sea ice thinning in summer and delays refreezing in early winter, therefore decreasing the mechanical strength of the cover and allowing even more fracturing and larger drifting speed and deformation, and possibly a faster export of sea ice through the Fram Strait. The September minimum sea ice extent of 2007 might be a good illustration of this interplay between sea ice deformation and sea ice shrinking, as we found that for both winter 2006-2007 and summer 2007, exceptionally large deformation rates affected the Arctic sea ice cover, in agreement with a much faster than expected drift of the polar schooner Tara during its journey along the transpolar current.