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Variability of surface transport pathways and how they affect Arctic basin-wide connectivity

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The Arctic Ocean is of central importance for the global climate and ecosystems. It is undergoing rapid climate change, with a dramatic decrease in sea ice cover over recent decades. Surface advective pathways connect the transport of nutrients, freshwater, carbon and contaminants with their sources and sinks. Pathways of drifting material are deformed under velocity strain, due to atmosphere-ocean-ice coupling. Deformation is largest at fine space- and time-scales and is associated with a loss of potential predictability, analogous to weather often becoming unpredictable as synoptic-scale eddies interact and deform. However, neither satellite observations nor climate model projections resolve fine-scale ocean velocity structure. Here, we use a high-resolution ocean model hindcast and coarser satellite-derived ice velocities, to show: that ensemble-mean pathways within the Transpolar Drift during 2004–14 have large interannual variability and that both saddle-like flow structures and the presence of fine-scale velocity gradients are important for basin-wide connectivity and crossing time, pathway bifurcation, and also for predictability and dispersion (the latter are covered in an associated paper [1].

The saddle-points in the flow and their neighbouring streamlines define flow separatrices, which partition the surface Arctic into separate regions of connected transport properties. The separatrix streamlines vary interannually and identify periods when the East Siberian Arctic Shelf, an important source of terragenic minerals, carbon and nutrients, is either connected or disconnected with Fram Strait and the North Atlantic. We explore the implications of this transport connectivity, with our new metric - the Separatrix Curvature Index – which in this context is arguably more informative than either the Arctic Oscillation or Arctic Ocean Oscillation indices.

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