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Eigen-glaciers: elucidating hidden features in the flow of Sermeq Kujalleq (Jakobshavn Glacier), Greenland.

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The increasing volume and spatio-temporal resolution of satellite-derived ice velocity data has created new exploratory opportunities for the quantitative analysis of glacier dynamics. One potential technique, Proper Orthogonal Decomposition (POD), also known as Empirical Orthogonal Functions, has proven to be a powerful and flexible technique for revealing coherent structures in a wide variety of environmental flows: mapping hydraulic vortex shedding patterns, the dynamics of fluidised granular beds, and the magnetohydrodynamics of sunspots.

POD exactly describes a series of snapshots from a flow field with the product of ranked spatially orthogonal Eigenfunctions, or "modes" of spatial weighting, and one-dimensional "temporal" coefficients (Eigenvectors). In many cases the variance of the flow field is well described by just a few dominant modes. The orthogonal nature of each mode, by definition, means that the relative contribution of independent forcing mechanisms on the flow can, in theory, be separated.

In this study we investigate the applicability of POD to freely available TanDEM-X/TerraSAR-X derived ice velocity datasets of Sermeq Kujalleq (Jakobshavn Glacier), Greenland. We outline the POD procedure using the singular value decomposition of a rearranged and resampled velocity matrix and investigate the factors responsible for the dominant modes. We find dominant modes interpreted as relating to the stress-reconfiguration at the glacier terminus and the development of the glacier hydrological system, but also find that the POD is sensitive to data resampling and quality. With the proliferation of publicly available optical and radar derived velocity products (e.g. MEaSUREs/ESA CCI) we suggest POD, and potentially other modal decomposition techniques, will become increasingly useful in future studies of ice dynamics.