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Unsupervised Learning Reveals Geography of Global Ocean Dynamical Regions

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Dynamically similar regions of the global ocean are identified using a barotropic vorticity (BV) framework from a twenty-year mean of the ECCO state estimate at 1° resolution. An unsupervised learning algorithm, k-means, objectively clusters the standardized BV equation, identifying five unambiguous regimes. Cluster 1 covers $43\pm3.3\%$ of the ocean area. Surface and bottom stress torque are balanced by the bottom pressure torque (BPT) and the non-linear torque. Cluster 2 covers $24.8 \pm 1.2\%$, where the beta effect balances the BPT. Cluster 3 covers $14.6 \pm 1.0\%$, characterized by a 'Quasi-Sverdrupian' regime where the beta effect is balanced by the wind and bottom stress term. The small region of Cluster 4 has baroclinic dynamics covering $6.9 \pm 2.9\%$ of the ocean. Cluster 5 occurs primarily in the Southern Ocean. Residual 'dominantly non-linear' regions highlight where the BV approach is inadequate, found in areas of rough topography in the Southern Ocean and along western boundaries.