Rossby waves and acceleration-deceleration of jets in a spherical turbulence

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http://www.gfd-dennou.org/library/spmodel/

Redistribution of angular momentum on a rotating sphere is described from the view point of Rossby waves. Numerical experiments demonstrate that, when the rotation rate of the system is large, easterly (retrograde) circumpolar jets emerge for a decaying turbulence of a two-dimensional non-divergent flow on a sphere. When the system allows surface elevation, that is, for a decaying turbulence of a shallow water system on a sphere, not a circumpolar but an equatorial easterly jet.

These robust easterly acceleration can be naively explained in the framework of the angular momentum transport associated with Rossby wave propagation on top of the local mixing of potential vorticity. When the rotation rate of the system is large and the radius of deformation is also large, low- and mid-latitudes are the area where linear term of vorticity equation dominate so that Rossby waves propagate poleward smoothly. Only the polar regions are the area where non-linear term dominates and local mixing of potential vorticity and Rossby waves absorption may act. When the radius of deformation is decreased, non-linear interaction beyond the distance of deformation radius is weakened, and consequently, mixing and wave absorption at the polar regions become obscure. The only region where the mixing may act is now the equatorial belt within the equatorial radius of deformation. Rossby waves are absorbed there, and equatorial easterly emerges.