Similar global scale motions in the atmosphere and in the ocean.

Analogies and differences between the dynamics of the atmospheric jet streams and the global equatorial undercurrent of the world ocean

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The global atmosphere and the world ocean are the two environmental sub-systems in our planetary environment that are responsible for the transportation and re-distribution of the most important physical quantities (heat, angular momentum, etc.) and substances (trace gases, dissolved materials, etc.). Although their scale-dependent motion systems show several similar features, the geometry and the driving forces are quite different for the two global "transporters". While the motions of the atmosphere are almost not constrained by the topography of the lithosphere, the world ocean is almost divided to 3 or 4 separate parts by the continents and, consequently, the motions in these ocean basins are also separated to a large extent if not totally. The last was thought in the past judging by the surface picture of currents. Surprisingly enough only in the last century it was discovered that actually this is not the case: including the abyssal circulation there exists a global conveyor belt also in the ocean, and water masses, originated from very different places mix with each other almost as efficiently, if not more efficiently as air masses in the atmosphere. Considering the driving forces, the main difference between the two media is that while the atmosphere is basically self-moving, i.e. almost does not use external momentum forcing to organize its circulation systems, the ocean is strongly driven by the moving air through wind stress. Mainly the two above features stand behind the difference between the two dynamics. It is also noteworthy, that thermodynamics of the two media, that seems to be very different at the first sight, in the reality are not so different: together with temperature and density, salinity gives the third dimension in the phase space to the equation of state for ocean water and plays a role in originating motions on every scale which is similar to the role of pressure in the atmosphere. Finally, the solar heating of the atmosphere and the ocean differs again: while the first is heated mainly from below (which is "abnormal"), the last is heated in an "ordinary way" from above.

As it is impossible to embrace even a little part of these interesting analogies and differences of the two dynamics in the frame of a short presentation, we have chosen two paramount but also relatively poorly known motion systems of the two media to give an example of comparative analysis of their dynamics. These are the jet streams in the atmosphere and the equatorial undercurrent in the ocean. The analogy of their geometries and kinematics is very interesting. Both are of global size, internally driven and represent the highest kinetic energy density among nature's global transport systems. We try to give first a short phenomenological description of these currents. Following that we analyze their dynamics "internally" as quasi-closed physical systems, finally we make an attempt to enlighten their role in the global circulation of the atmosphere and the ocean, respectively, as systems which are needed and exist in order to fulfil the global angular momentum, potential vorticity and energy balance requirements prescribed by the conservation laws.