EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-493, 2009
9th EMS / 9th ECAM

9th European Conference on Applications of Meteorology
9th EMS Annual Meeting
High resolution meteorology - applications and services

The Energy-Vorticity Adjustment (EVA) Principle of the Atmosphere

T. Schartner, P. Névir, G.C. Leckebusch, and U. Ulbrich
Freie Universität Berlin, Berlin, Germany (thomas.schartner@met.fu-berlin.de)

Total energy and Ertel‘s potential enstrophy are two fundamental global conserved quantities to characterize atmospheric motion. The adjustment between these two conserved quantities plays a decisive role for the development of low pressure systems and high impact weather. With the aid of the energy-vorticity theory, it can be shown that under adiabatic and inviscid conditions the steady-state of the atmospheric flow is characterized by a minimum of an energy-vorticity functional. At this minimum the wind blows on isentropic surfaces along the isolines of potential vorticity which coincide with the isolines of the Bernoulli streamfunction. The Dynamic State Index (DSI) reveals this energy-vorticity adjustment in practical manner, by using fields of temperature, velocity and geopotential height. The atmosphere has a local energy-vorticity minimum at a DSI value of zero. Large deviations from this state are connected with the development of low pressure systems and extreme weather events.

In our contribution we show the application of the energy-vorticity theory and the Dynamic State Index. On the basis of cases studies and statistical investigations the relationship between energy and Ertel’s potential enstrophy and the DSI concept is revealed by diagnosing the life cycles of baroclinic waves in the North Atlantic ocean. For computing the DSI, the Bernoulli streamfunction and the potential vorticity the ERA-40 dataset is used. We demonstrate that the theoretical description of the energy-vorticity adjustment (EVA) of the atmosphere is able to describe the life cycles of baroclinic waves and extreme weather events.