Home
Online Library
- Recent Papers
- Volumes
- Library Search
- Title and Author Search

RSS Feeds
General Information
Submission
Review
Production
Subscription

Volumes Contents of Volume 15

Adv. Geosci., 15, 47-56, 2008
www.adv-geosci.net/15/47/2008/

Potential-vorticity inversion and the wave-turbulence jigsaw: some recent clarifications

M. E. McIntyre
Centre for Atmospheric Science at the Department of Applied Mathematics and Theoretical Physics, Wilberforce Road, Cambridge CB3 0WA, UK

Abstract. Two key ideas stand out as crucial to understanding atmosphere-ocean dynamics, and the dynamics of other planets including the gas giants. The first key idea is the invertibility principle for potential vorticity (PV). Without it, one can hardly give a coherent account of even so important and elementary a process as Rossby-wave propagation, going beyond the simplest textbook cases. Still less can one fully understand nonlinear processes like the self-sharpening or narrowing of jets – the once-mysterious "negative viscosity" phenomenon. The second key idea, also crucial to understanding jets, might be summarized in the phrase "there is no such thing as turbulence without waves", meaning Rossby waves especially. Without this idea one cannot begin to make sense of, for instance, momentum budgets and eddy momentum transports in complex large-scale flows. Like the invertibility principle the idea has long been recognized, or at least adumbrated. However, it is worth articulating explicitly if only because it can be forgotten when, in the usual way, we speak of "turbulence" and "turbulence theory" as if they were autonomous concepts. In many cases of interest, such as the well-studied terrestrial stratosphere, reality is more accurately described as a highly inhomogeneous "wave-turbulence jigsaw puzzle" in which wavelike and turbulent regions fit together and crucially affect each other's evolution. This modifies, for instance, formulae for the Rhines scale interpreted as indicating the comparable importance of wavelike and turbulent dynamics. Also, weakly inhomogeneous turbulence theory is altogether inapplicable. For instance there is no scale separation. Eddy scales are not much smaller than the sizes of the individual turbulent regions in the jigsaw. Here I review some recent progress in clarifying these ideas and their implications.

Full Article in PDF (PDF, 332 KB)

Citation: McIntyre, M. E.: Potential-vorticity inversion and the wave-turbulence jigsaw: some recent clarifications, Adv. Geosci., 15, 47-56, 2008. Bibtex EndNote Reference Manager