# An Evaluation of Reanalysis Energy Transports between Ocean and Land

Kevin E Trenberth
National Center for Atmospheric Research

John T Fasullo
National Center for Atmospheric Research

Using atmospheric reanalyses and other observations, an examination is made of the transport of energy from ocean to land, in total and as components, as a function of season and time. The differences in warming, moisture and rainfall between land and ocean in the recent observational record, and their projected changes in the future with global warming suggest that an important diagnostic is the transport of energy between land to ocean. While reanalyses suggest that there is a net transport of energy from ocean to land globally of 2 to 3 PW, this is dominated by the hydrological cycle transports of moisture from ocean to land and hence latent energy (LE), which has a small annual cycle globally, while the dry static energy (DSE) transports undergo a huge annual cycle, with transports of 3.5 PW from ocean to land in northern winter but 3 PW from land to ocean in northern summer. The net result is a transport of energy from ocean to land of 6 PW in northern winter and about 1 PW from land to ocean in northern summer.

There are strong compensating fluctuations in DSE and LE transports over time. However, there are also large differences among reanalyses. Results also differ from the deduced energy imbalance at top-of-atmosphere from CERES measurements when compared with the total energy convergence. Hence the evidence suggests that reanalyses contain substantial biases and spurious changes over time associated with (i) the changes in the observing system; (ii) lack of conservation of energy; and (iii) lack of adequate forcing at top-of-atmosphere, such as from Mount Pinatubo and misrepresentation of greenhouse gas warming (most reanalyses suggest the planet is cooling a lot!). No reanalysis includes the signal of the Mount Pinatubo volcanic eruption in its radiation quantities although some signals are included through the effects on state variables. Transports of energy and their divergences are somewhat more robust than energy quantities from the reanalysis models. Relationships with ENSO will be explored.

**Corresponding Author:**

**Name:** Kevin E. Trenberth
**Organization:** National Center for Atmospheric Research
**Address:** Climate and Global Dynamics Division/Climate Analysis Section
P.O. Box 3000
Boulder, CO 80307-3000 USA