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Factors affecting atmospheric vertical motions as analyzed with a generalized omega equation and Open IFS model: a statistical study

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Although much weaker in magnitude than horizontal winds, vertical motions are a crucial ingredient of weather. Therefore, it is of great interest to evaluate the physical processes that stand behind them.
Here we present a statistical analysis of causes of atmospheric vertical motions in a one-year simulation with the OpenIFS atmospheric model, a version of the Integrated Forecast System (IFS) used at ECMWF for operational weather forecasting that has been made available to academic and research institutions under license since early 2013. Using hourly output data from the model as input to a Generalized Omega Equation, the vertical motions associated with vorticity advection, thermal advection, friction, diabatic heating, and an imbalance term are diagnosed. The results are then analyzed statistically, to evaluate the importance of these physical and dynamical processes for atmospheric vertical motions in different seasons and different parts of the world.
Combining the output of a state-of-the-art atmospheric model with a diagnostic tool such as the generalized omega equation gives us an opportunity to gain insight that would be difficult to obtain with reanalysis or other observation-based data alone.