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Improvement of vertical and residual velocities in pressure or hybrid sigma-pressure coordinates in analysis data in the stratosphere

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Abstract. Stratospheric vertical winds from analysis data in pressure (p) or hybrid pressure (σ - p) coordinates, for use in e.g. chemical transport models (CTMs) or trajectory models, often suffer both from excessive noise and errors in their mean magnitude, which in turn can introduce errors in important dynamical quantities like vertical mixing or constituent transport with the residual circulation. Since vertical velocities cannot be measured directly, they are inferred from other quantities, typically from horizontal wind divergence, that is the mass continuity equation. We propose a method to calculate the vertical wind field from the thermodynamic energy equation in p or σ - p vertical coordinates that substantially reduces noise and overestimation of the residual circulation. It is completely equivalent to the approach using potential temperature (θ) as a vertical coordinate and diabatic heating rates as vertical velocities, which has already been demonstrated to give superior results to the continuity equation. It provides a quickly realizable improvement of the vertical winds, when a change of the vertical variable would cause an inadequate effort (e.g. in CTMs). The method is only applicable for stably stratified regions like the stratosphere.

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