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Recent numerical developments for solving continuity equations in ACT models

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In numerical modeling of atmospheric dynamical and chemical processes a considerable number of desired properties have been formulated in the literature over the last 3 to 4 decades. These include conservation of mass, monotonicity, positive definiteness, elimination of the wind-mass inconsistency problem, computational efficiency etc. Simple examples of these properties are reviewed and demonstrated.

Recently, however, there has been focus on the property of numerical mixing, which is particularly relevant for both chemical off- and on-line modeling since – if not eliminated – numerical mixing will introduce artificial chemical reactions. To some degree this problem exists in all present models except for purely Lagrangian models.

A new numerical methodology termed the Hybrid Eulerian Lagrangian (HEL) scheme has been designed to fulfill most if not all classically defined numerical desired properties. Furthermore HEL eliminates artificial numerical mixing. A physically based mixing is introduced in HEL to represent the cascade of information to smaller and unresolved scales. It is demonstrated in both on- and off-line simulations how such mixing can be parameterized on the basis of the deformation rate of the actual flow.