Representation of Multivariate Particle Populations in Atmospheric Transport Models

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The method of moments (MOM) provides a highly efficient approach to tracking multivariate particle populations. In the case of aerosols the method is a statistically based alternative to bin-sectional and modal approaches. The moment closure problem has been largely eliminated with introduction of the quadrature method of moments (QMOM), which allows one to obtain closure under very general conditions and to compute physical and optical properties of a particle population directly from its moments. In this talk we resolve a long-standing bottleneck to the representation of aerosols and cloud droplets in atmospheric models beyond the two-moment microphysical schemes currently in use. The bottleneck is caused by the failure of higher-order advection schemes to preserve correlations between interrelated tracers during transport. The new approach applies a diffusion limiter to the basic linear scheme under the idea that achieving minimal spatial variance on an Eulerian model grid implies maximal resolution and elimination of numerical diffusion. By preserving tracer correlations and eliminating numerical diffusion, minVAR - short for minimum variance - includes the best features of the basic linear and higher-order schemes. This innovation resolves the two-moment bottleneck, a necessary step for high-fidelity, multi-moment representation of aerosols and clouds in atmospheric models.