Model complexity versus accuracy in aerosol dynamics

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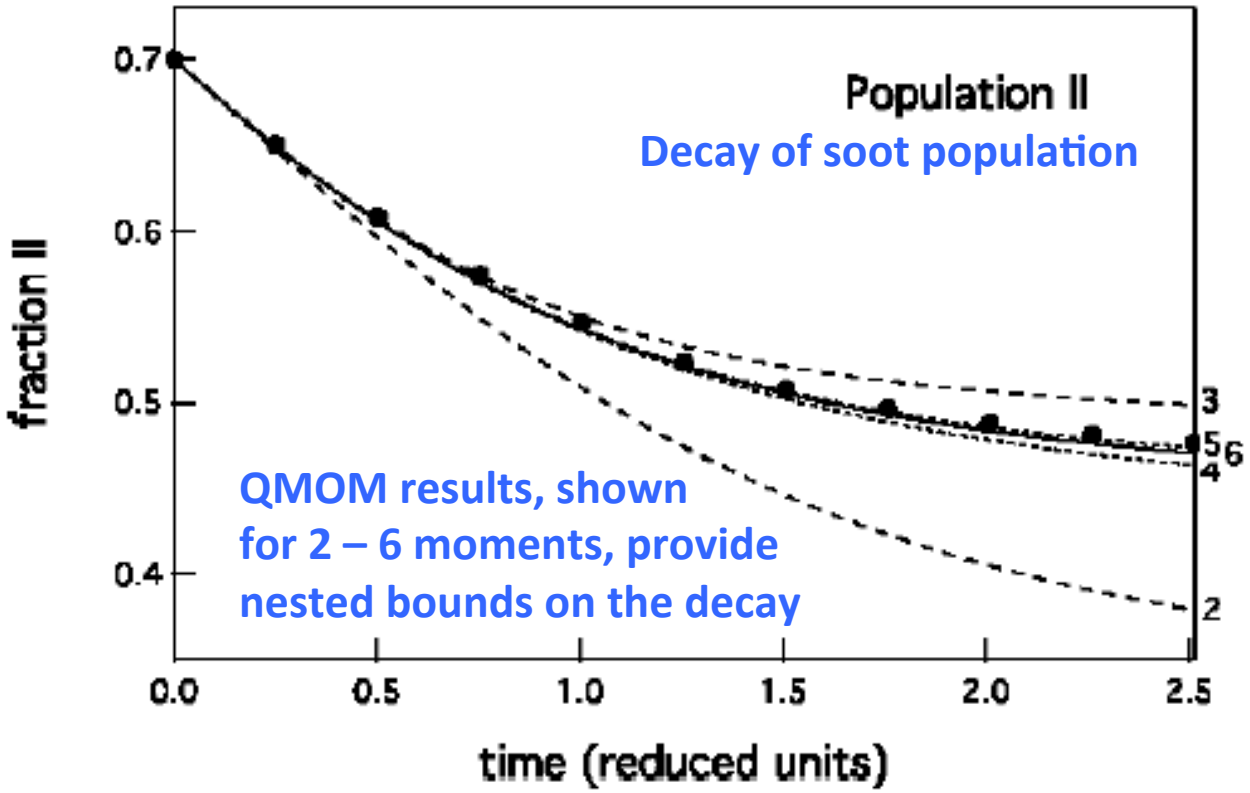
SOOT + SULFATE → MIXED PARTICLES



Validating QMOM (curves) against particle-resolved simulation (markers)

THESE EXTREMAL DISTRIBUTIONS, CONSISTING OF JUST A FEW QUADRATURE POINTS, ARE SPARSE!!!

Errors in modeling particle population dynamics can result in errors predicting CCN and optical properties but also errors in getting the dynamics right (e.g. lifetime/transport)

Optimization theory and sparse particle distributions

Min/Max: $\int_0^\infty c(r) f(r) dr \approx \mathbf{c} \cdot \mathbf{w}^{\mathbf{T}}$ *property*

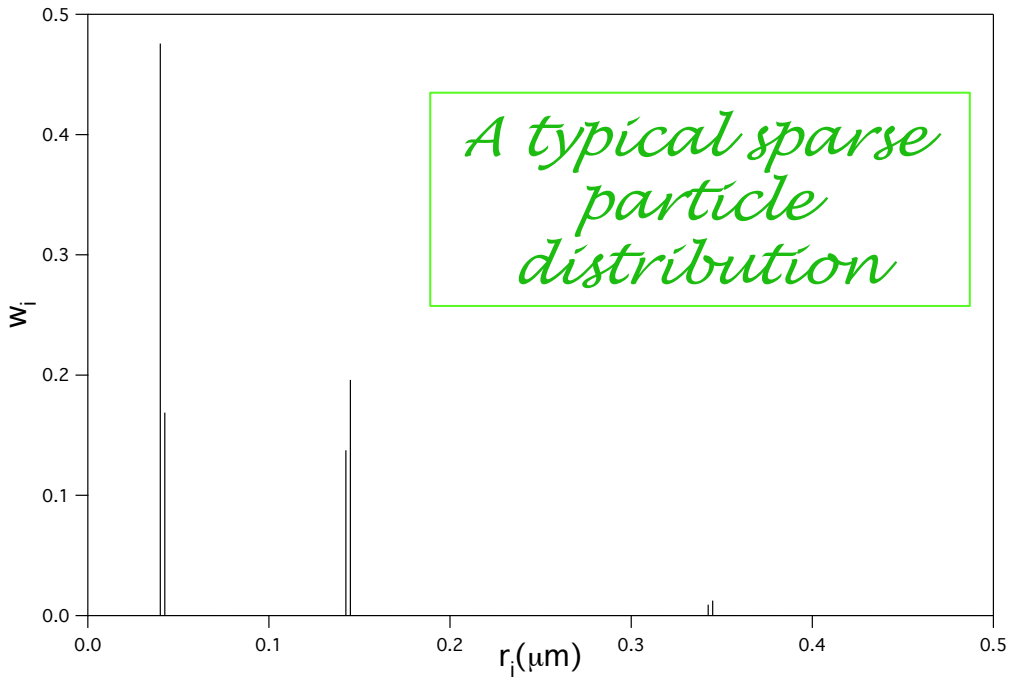
Subject to constraint list: $\int_0^\infty \sigma_k(r) f(r) dr \approx \mathbf{a_k} \cdot \mathbf{w}^{\mathbf{T}} = \mathbf{M_k}$

measurement ⋮ *model result*

Together with: $w_i \geq 0$

non-negative psd

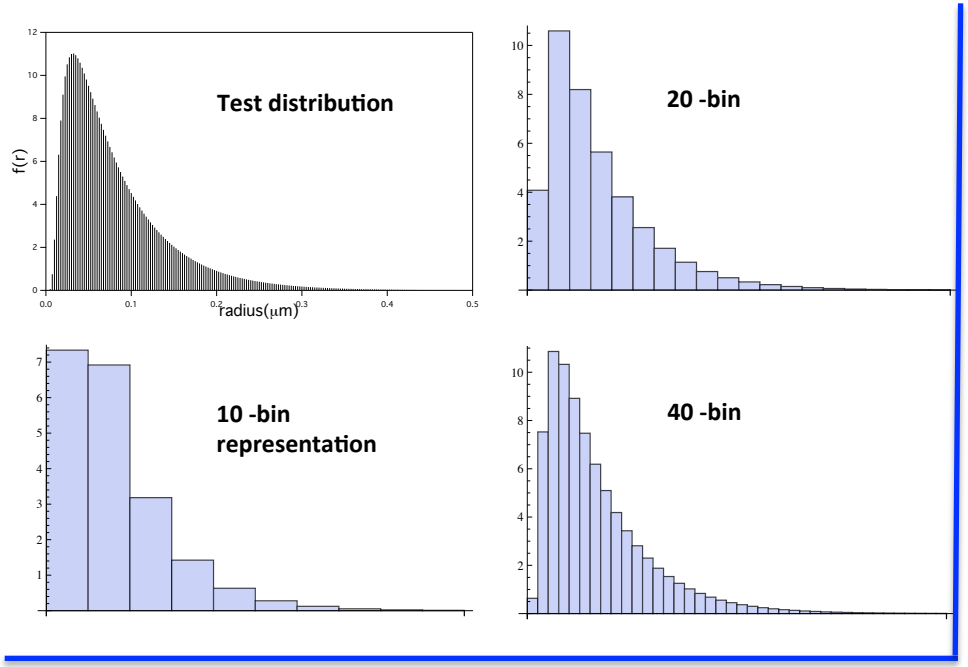
Recovery of QMOM 3-point quadrature using 6 radial moment constraints



A typical sparse particle distribution

Quantifying information content of model resolution refinement

A geometric approach



Linear Program

Min/Max: scattering extinction

Subject to: 10, 20, 40 sectional constraints

+ non-negativity constraints

Repeat for different wavelengths

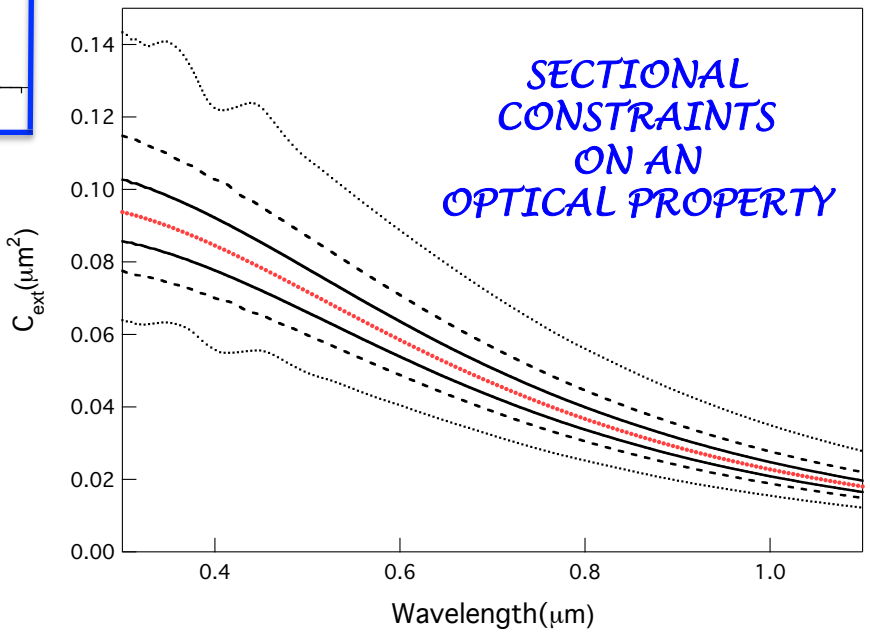
Nested Bounds

dotted curves: 10 bin constraints

dashed curves: 20 bins

solid curves: 40 bins

red curve: Test distribution



Future Directions

1. Data processing and assimilation
   (poster this meeting)
2. Metrics development

} Collaborations With FASTER

3. Adding measurement noise (sensitivity matrix from dual LP)

4. Aerosol dynamics beyond the QMOM
   - explore the tracking of more general aerosol properties: the new method is not limited to moments (QMOM is)
   - explore working on grids: these are adaptable and extendable to high dimension (the QMOM is mesh free)