Improving the representation of subgrid scale cloud variability in CAM

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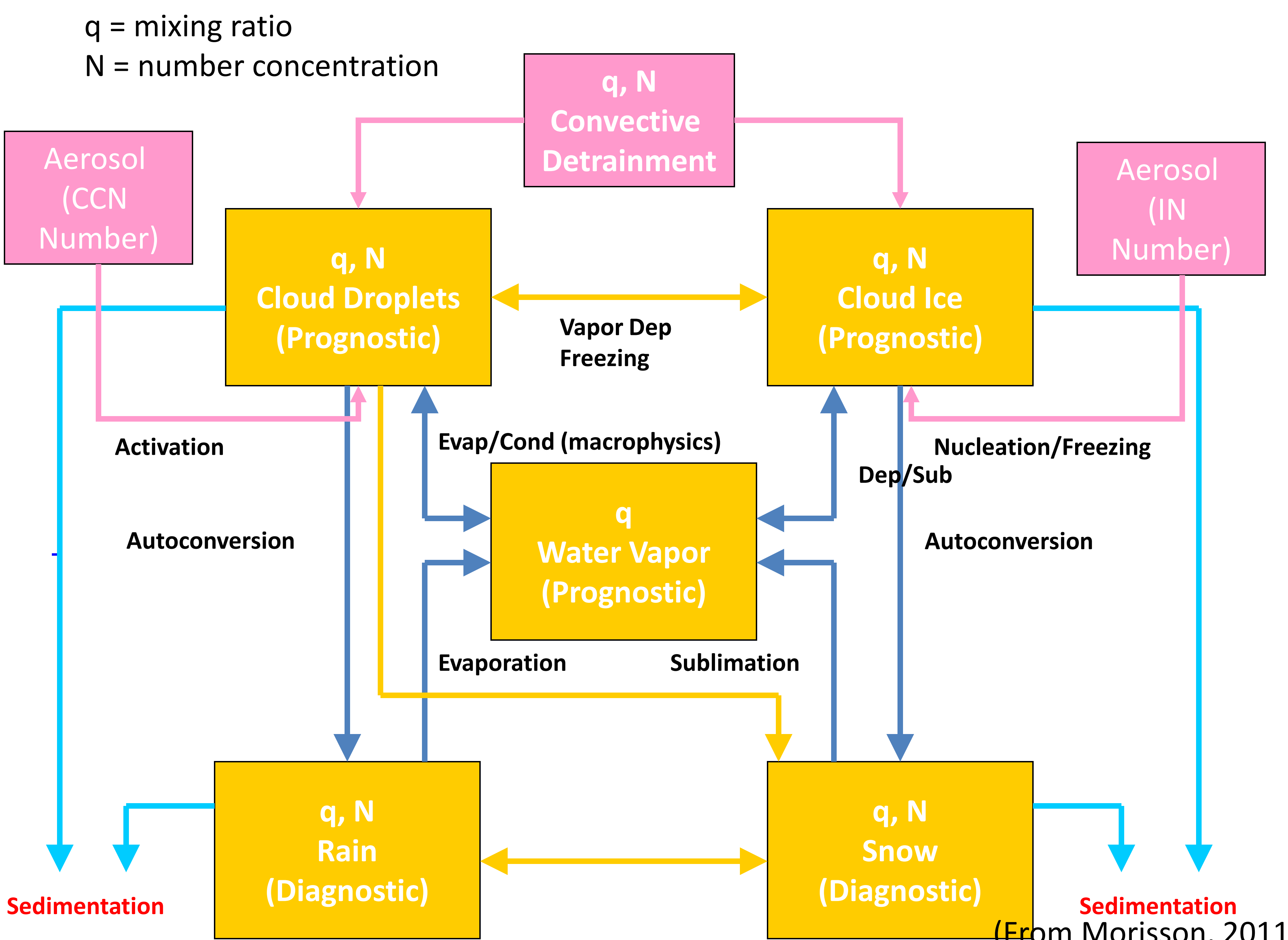


(From Morisson, 2011)

Three types of subgrid scale cloud variability

1. Cloud and precipitation particle size distributions are represented by gamma functions:

$$\phi(D) = N_0 D^{\mu} e^{-\lambda D}$$

For cloud ice, snow, and rain, $\mu = 0$.
For cloud droplets, $\mu = 1/\eta^2 - 1$ $\eta = 0.0005714N + 0.2714$

2. Subgrid scale distribution of cloud water and ice:

$$P(q_c'') = \frac{q_c''^{\nu-1}\alpha^{\nu}}{\Gamma(\nu)} e^{-\alpha q_c''}$$

$\nu = 2.0$

3. How clouds are vertical stacked.

Subgrid scale variability of the 2nd type – cloud hydrometeors

For any generic microphysical process rate given by

$$M_p = x q_c''^{y}$$

$$P(q_c'') = \frac{q_c''^{\nu-1} \alpha^{\nu}}{\Gamma(\nu)} e^{-\alpha q_c''}$$

the grid mean process rate can be expressed by

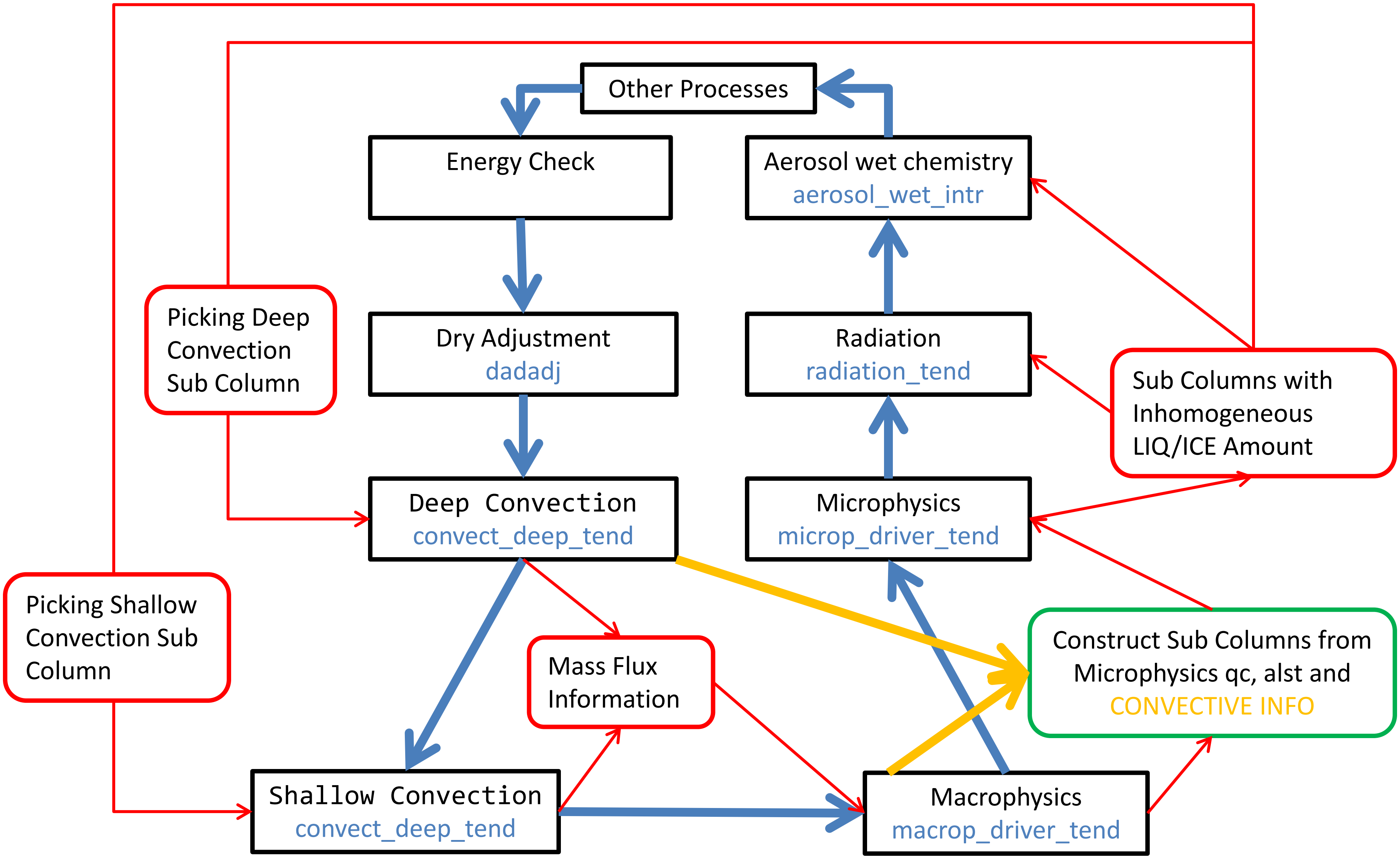
$$M_p' = x \frac{\Gamma(\nu + y)}{\Gamma(\nu)\nu^{y}} q_c'^{y}$$

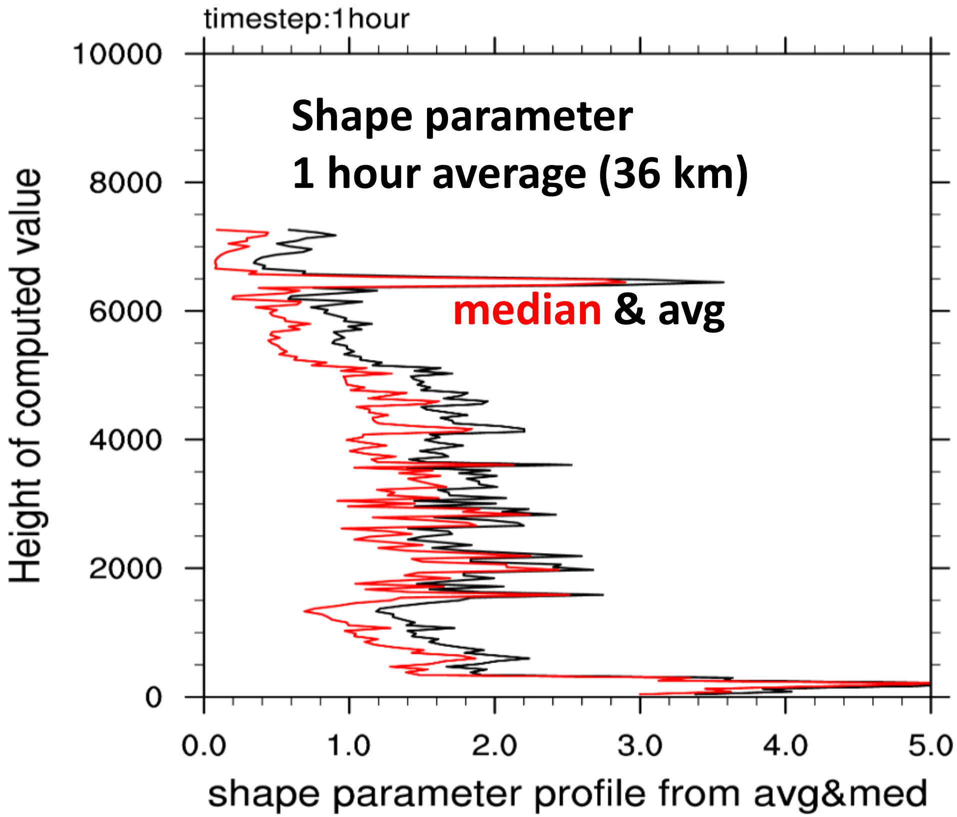
Thus, to account for sub-grid variability microphysical processes are multiplied by a factor of

$$E = \frac{\Gamma(\nu + y)}{\Gamma(\nu)\nu^{y}}$$

Default $\nu = 2.0$

(From Morrison, 2011)


Other Processes
Energy Check
Aerosol wet chemistry
aerosol_wet_intr
Picking Deep Convection Sub Column
Dry Adjustment
dadadj
Radiation
radiation_tend
Sub Columns with Inhomogeneous LIQ/ICE Amount
Deep Convection
convect_deep_tend
Microphysics
microp_driver_tend
Picking Shallow Convection Sub Column
Mass Flux Information
Construct Sub Columns from Microphysics qc, alst and CONVECTIVE INFO
Shallow Convection
convect_deep_tend
Macrophysics
macrop_driver_tend



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Shape parameter
1 hour average (36 km)
median & avg
Height of computed value
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8000
6000
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0
0.0
1.0
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shape parameter profile from avg&med

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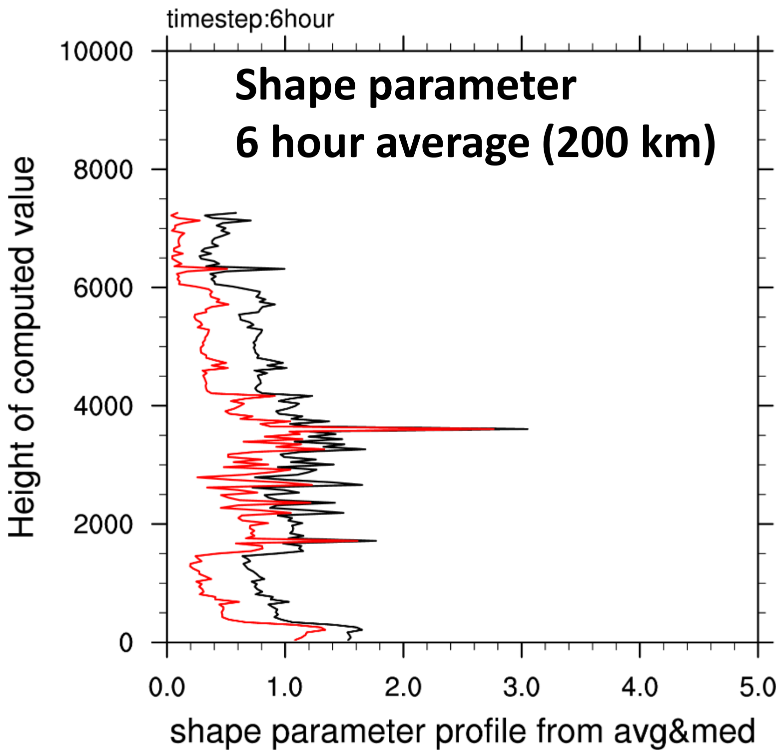
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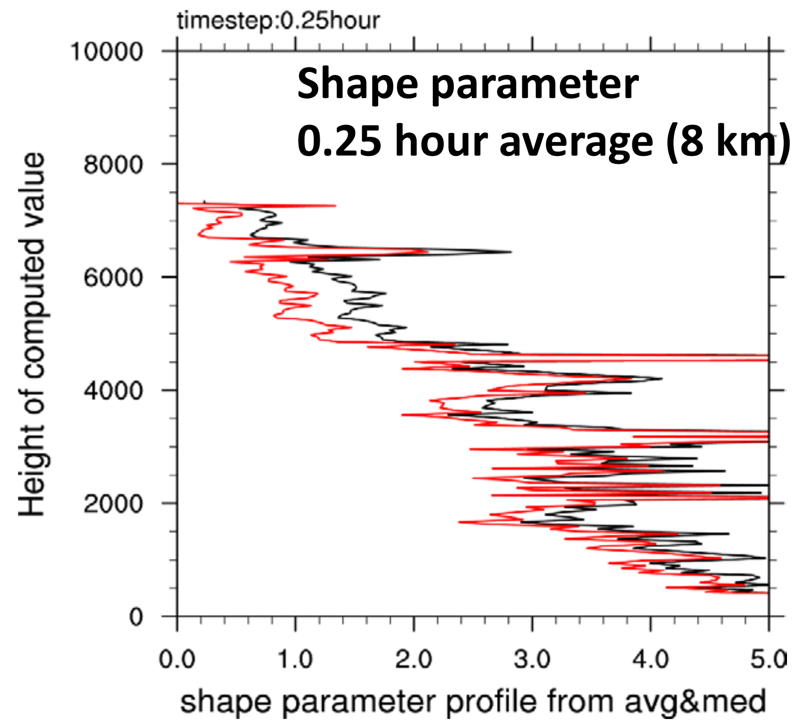
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5.0
shape parameter profile from avg&med

v