On the CCN (de)activation nonlinearities

Sylwester Arabas & Shin-ichiro Shima
University of Hyogo, Kobe, Japan
AETHON, Athens, Greece

AETHON, Athens, Greece

Dept. of Atmospheric Science

Tue., July 17, 3:10 pm, EN6085

NPG paper: Arabas & Shima 2017
Nonlinear Processes in Geophysics, 24, 2017

NPG paper: Arabas & Shima 2017
Nonlinear Processes in Geophysics, 24, 2017

phase portrait of the system: flipped Köhler curve

saddle-node bifurcation at Köhler curve maximum

bifurcations (and catastrophe) in the RH-coupled system

simple moisture budget (const T,p):

integrating in time:

new phase portrait:

regime-controlling params: RH, N

analytical estimation of the CCN activation timescale
• relevance to particle-based micromechanics (super droplets)
• corroboration with numerical integration (cusp catastrophe related hysteresis)

kappa-Köhler:

maximum at \((r_c, \text{RH}_c)\):

\[
R \approx \rho - \frac{4\pi r_w}{3\sigma_w} \frac{A}{\text{RH}}
\]

\[
\text{RH} = \text{RH}_0 - \alpha N r_w^3
\]

\[
\dot{\xi} \sim (\text{RH}_0 - \text{RH}) - \left( \frac{\text{RH}}{\text{RH}_0} - 1 \right)
\]

\[
\dot{\xi} = 2D_{\text{eff}} \frac{\rho_{vs}}{\rho_w} (\text{RH} - \text{RH}_\text{eq}(\xi))
\]

\[
\xi = r_w^2 + C
\]

\[
\xi = \frac{\text{RH}}{3} + \frac{A}{3} r_w^2 + \alpha N r_w^3
\]

\[
\text{sgn}(r') = \text{sgn} \left( \frac{\text{RH}}{3} + \frac{A}{3} r_w^2 + \alpha N r_w^3 \right)
\]