| Köhler theory | Nano-Köhler theory | Real molecular systems |
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| Describes the activation of CCN ($d_p$ > 50 nm) to cloud droplets by spontaneous condensation of water vapor. | Describes the activation of inorganic clusters ($d_p$ =∼ 1–3 nm) for growth by spontaneous condensation of organic vapor. | A distribution of clusters of varying sizes and compositions including inorganic and organic compounds can exist simultaneously at all times. |
| The condensing vapor is water vapor with typical atmospheric concentrations of $\sim 10^{17}$ cm$^{-3}$. | The condensing vapor is a water-soluble organic compound with concentrations likely ranging from $\sim 10^5$ to $10^8$ cm$^{-3}$ (Jokinen et al., 2017). | Vapor concentrations are not constant but may vary over time. |
| The seed consists of a mixture of inorganic/organic compounds and is water soluble. The seed compounds do not evaporate. | The seed consists of sulfuric acid and bases and is soluble in the condensing organic compound. The seed compounds do not evaporate but condense irreversibly on the cluster. | There is no seed in the same sense as in the theory. Both inorganic and organic compounds can condense and evaporate and may contribute to the growth. |
| Thermodynamic equilibrium between water and the seed particle is assumed. | Thermodynamic equilibrium between the organic compound, the seed cluster and water is assumed. The energy barrier width in nano-Köhler is very narrow with respect to the number of molecules compared to Köhler theory, and thus addition of only few molecules may result in overcoming the barrier. | Clusters can nucleate over barriers and they may not be in thermodynamic equilibrium before activation to growth. |
| The growing cloud droplets scavenge the available water vapor thereby limiting the activation process. | The loss rate of organic vapor is determined mainly by larger background aerosol particles and not the growing clusters. | The cluster population is affected by losses due to background particles, and cluster self-coagulation may also be important. The magnitude of external losses may vary over time. |