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Evaluating a sesquiterpene-ozone nucleation mechanism

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Nucleation events have been observed widely around the world and contribute significantly to global particle number concentrations. However, the mechanisms responsible for these events are not fully understood limiting our ability to quantify their relevance to climate. Particle formation rates generally correlate with gas-phase sulfuric acid concentrations to the power of one or two. However, the wide range of nucleation rates that have been observed suggest that other factors or chemical species are also important. A nucleation mechanism involving sulfuric acid and the reaction products of sesquiterpenes and ozone has recently been suggested. We have included this mechanism in the GLOMAP global chemical transport model which can calculate size-resolved aerosol distributions. We evaluate the mechanism using observations of total particle number from long-term surface sites around the world (from CREATE and WDCA) and vertical profiles of aerosol number over North America and the Pacific and Atlantic Oceans (from the NASA INTEX aircraft missions). This mechanism can explain the observed seasonal cycle of nucleation events, vertical profiles of aerosol number and the lack of formation events over oceanic areas. These characteristics are difficult to explain using a mechanism based solely on gas-phase sulfuric acid. We quantify the global and regional production of cloud condensation nuclei through this mechanism. Using model runs without boreal forest terpene emissions we estimate the contribution of boreal forests to global CCN concentrations. This particle formation mechanism has implications for boreal forest climate feedbacks.