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AGGREGATION AND CHARGING OF MINERAL CLOUD PARTICLES UNDER HIGH-ENERGY IRRADIATION

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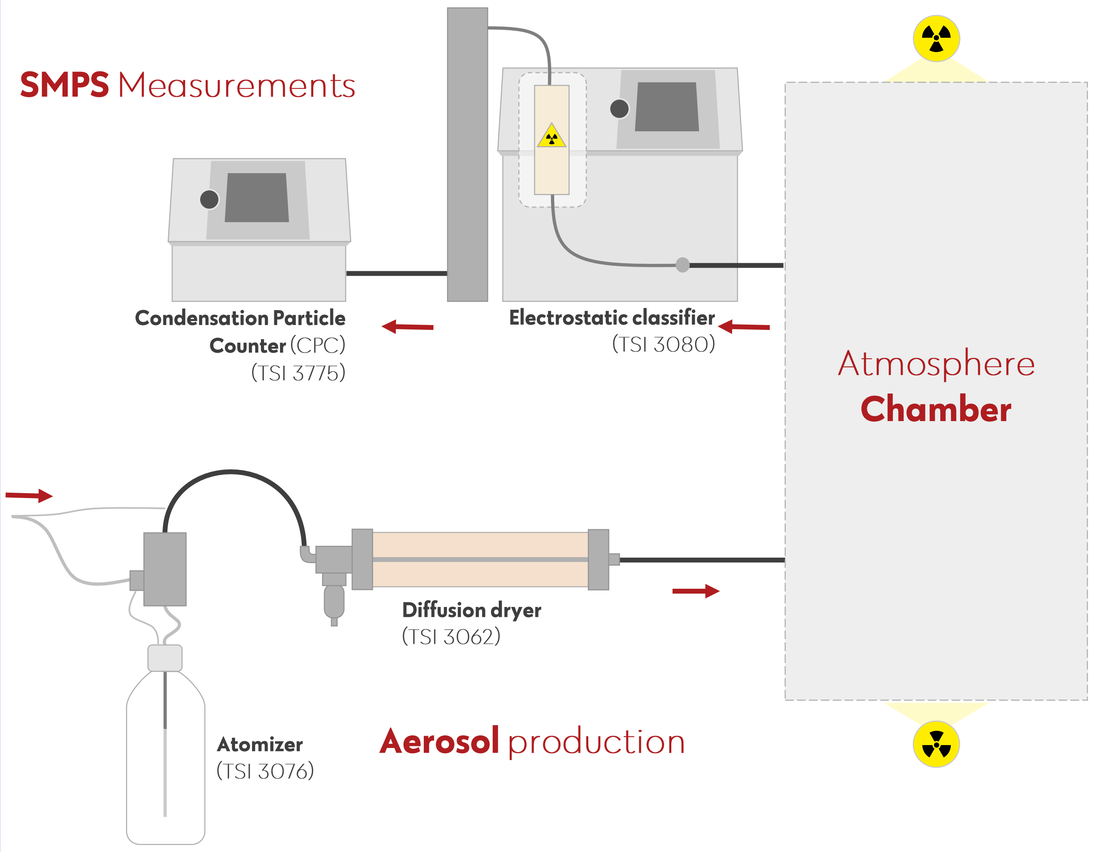


BACKGROUND AND AIM

How does high-energy radiation affect the charging and aggregation of mineral cloud particles?

Previous studies have shown that initial step of cloud formation is greatly affected by the influx of high-energy radiation, through e.g. ion-induced nucleation (Jokinen et al (2018), Wagner et al (2017), Svensmark et al, 2013, Enghoff et al (2008)).

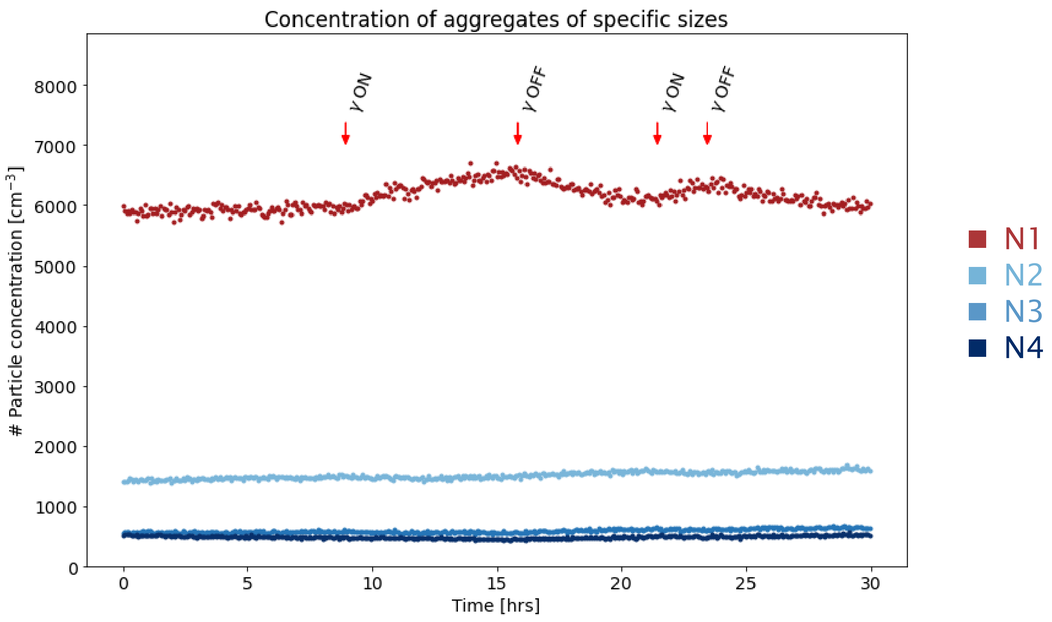
The aim of this study is to expand on previous investigations by looking at how high-energy radiation affects already nucleated mineral particles in relation to their charging and aggregation. The mineral cloud particles investigated in this study, SiO_2, are relevant both as inherent mineral cloud species on exoplanets, and as cloud condensation nuclei in Earth-like atmospheres (Lee et al, 2016).

EXPERIMENTAL SETUP

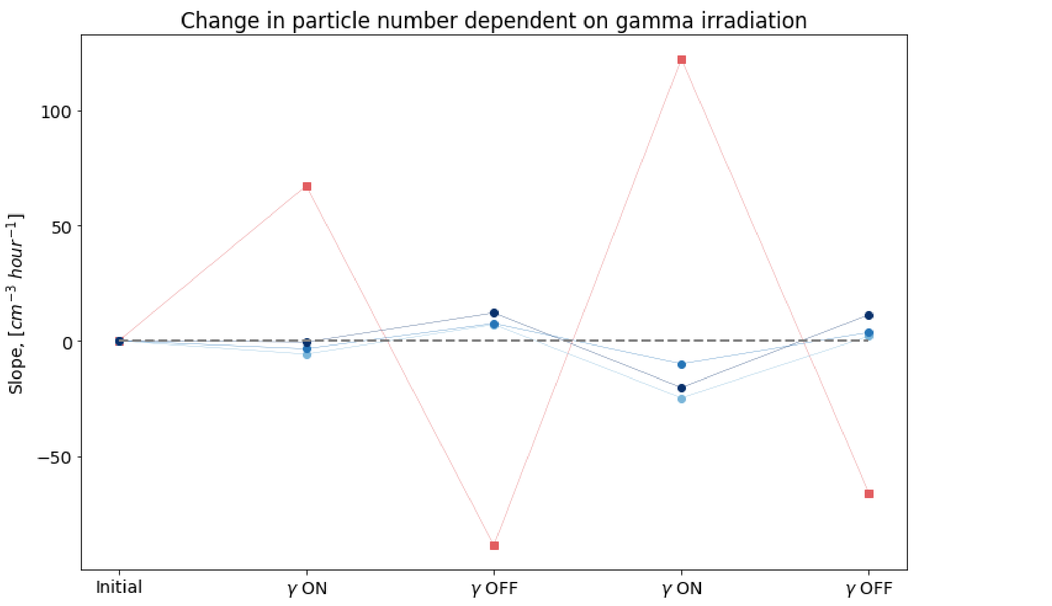
Mineral SiO_2 particles (50 nm) are released as aerosols into pure dry N_2 gas using a setup with an atomizer and diffusion dryer.
A constant flow of aerosols is introduced into an $8m^3$ atmosphere chamber, where their size distribution is measured using a Scanning Mobility Particle Sizer (SMPS). The chamber can be exposed to high-energy gamma radiation using two 27 MBq Cs-137 gamma sources.

RESULTS – AGGREGATION

We observe an aggregation of the single SiO_2 particles (N1) over time to form clusters of two, three, and four particles (N2-N4).

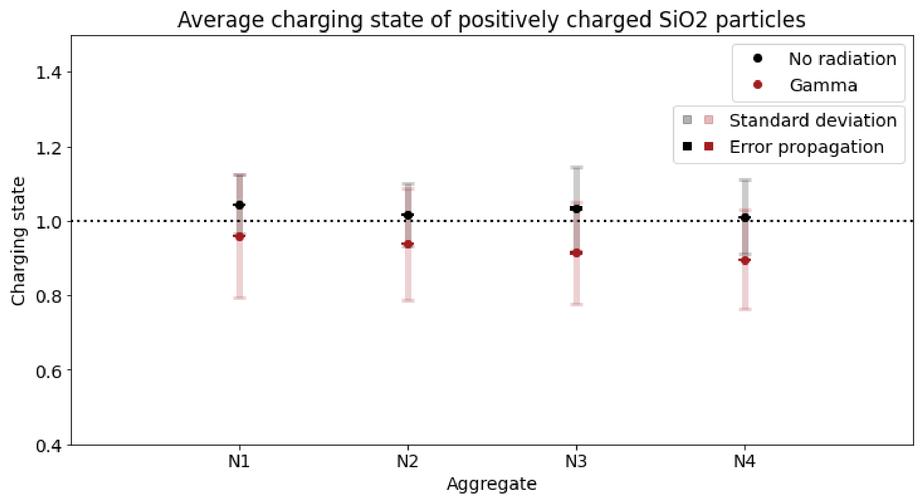


Irradiation with gamma (γ) increases the number of the N1 particles and decreases the number of larger particles, indicating that the radiation inhibits the aggregation of the particles.

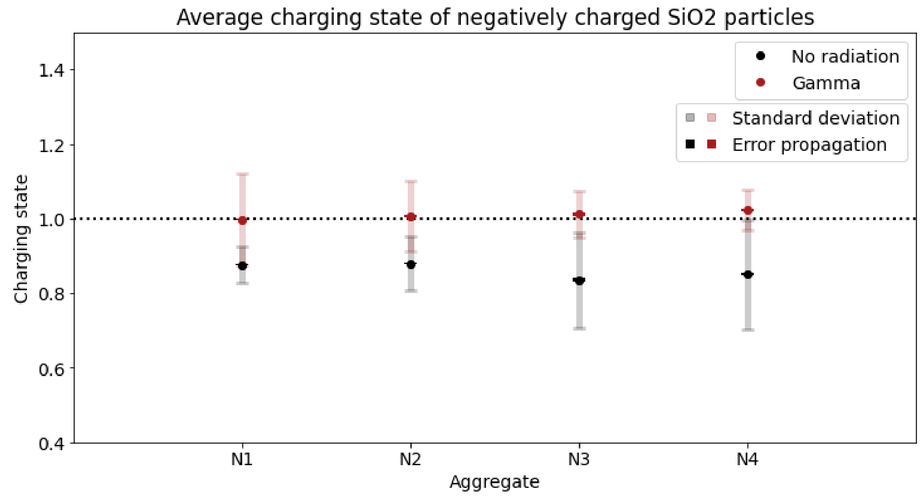


RESULTS – CHARGING

The charging state is measured as the number of charged particles in relation to a baseline charging distribution, where the charging of the particles is in equilibrium with the gas ions.



Comparing non-irradiation particles with irradiated particles, it is seen that gamma irradiation decreases the number of positively charged particles and increases the number of negatively charged particles.



SUMMARY

Mineral SiO2 particles are shown to aggregate in the atmosphere chamber.
Irradiation with gamma reduces the aggregation.
Irradiation with gamma shifts the charging distribution of the particles to become more negative.
The decrease in aggregation due to gamma radiation might lead to increased numbers of cloud particles, and thereby increased cloud formation.

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