The impact of giant aerosols on drizzle formation

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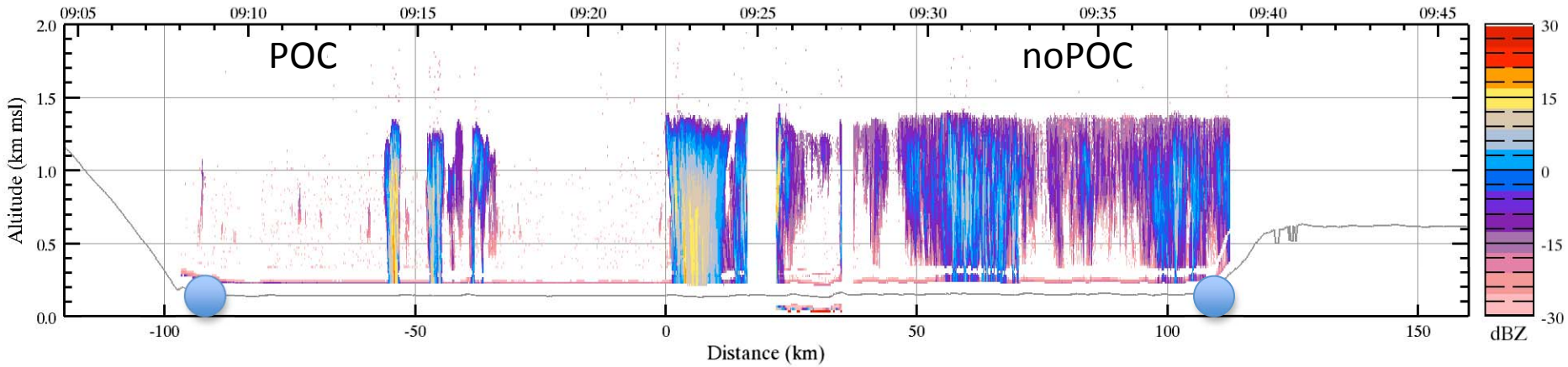
Question:

Are giant sea-salt aerosols (GNI) important for the precipitation formation?

This is relevant, as most models (and observations) focus on the total drop concentration (determined largely by smaller aerosol particles) when describing a clouds ability to precipitate by warm processes.

Giant Aerosol Slide exposures

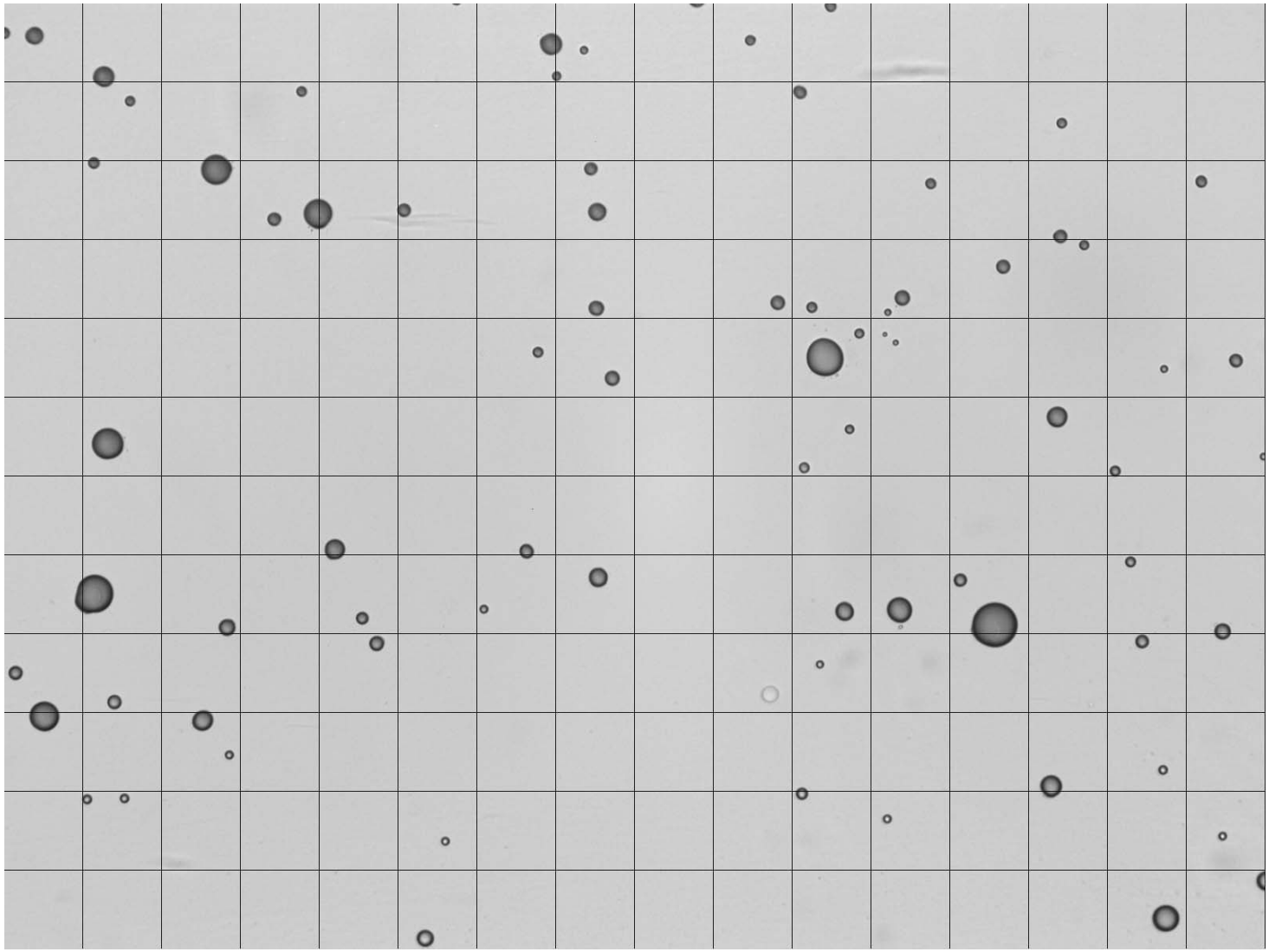


Microscope image of GNI slide

Dark lines separated by 37 micron, slide in humidified air (92% RH).

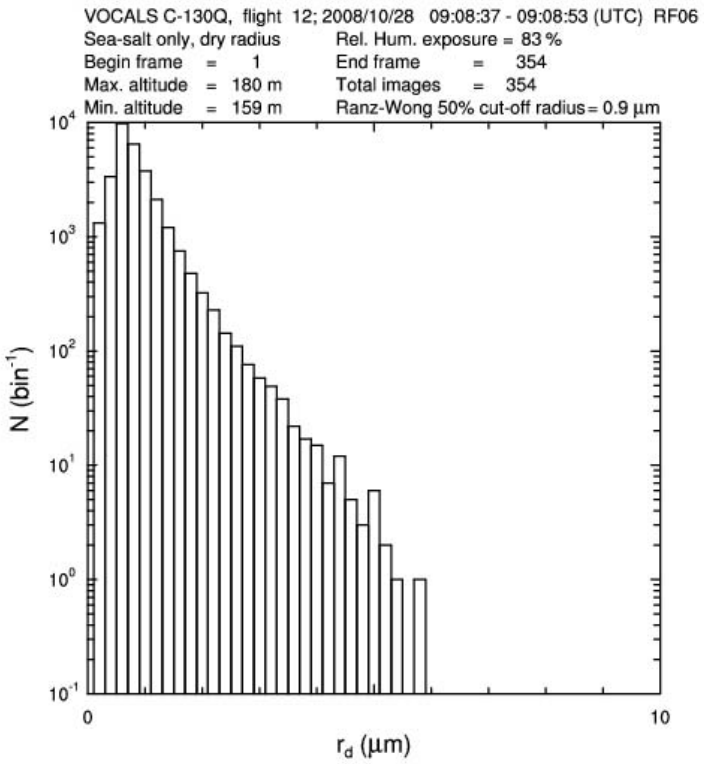
Contact-angle from side-looking camera.

Kohler theory to calculate dry salt size (assume NaCl).

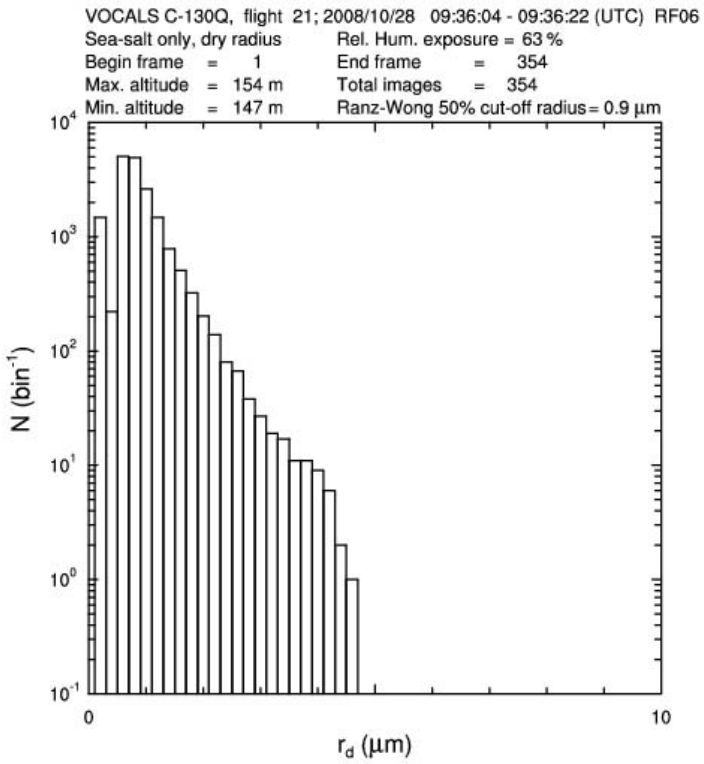


Giant aerosol measurements

POC



noPOC

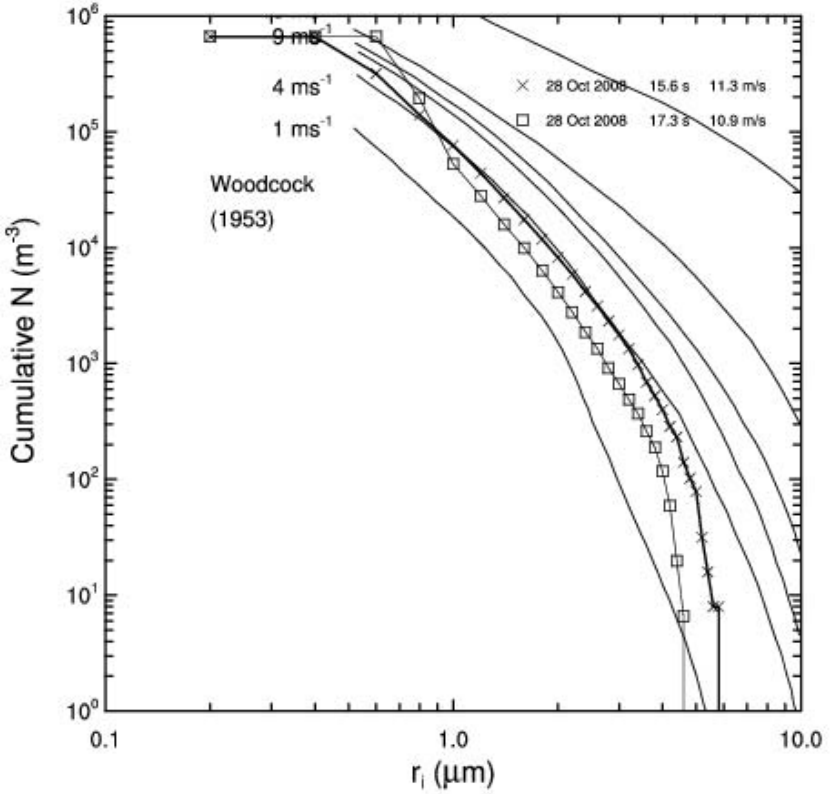


Comparison of cumulative spectra with Woodcock (1953).

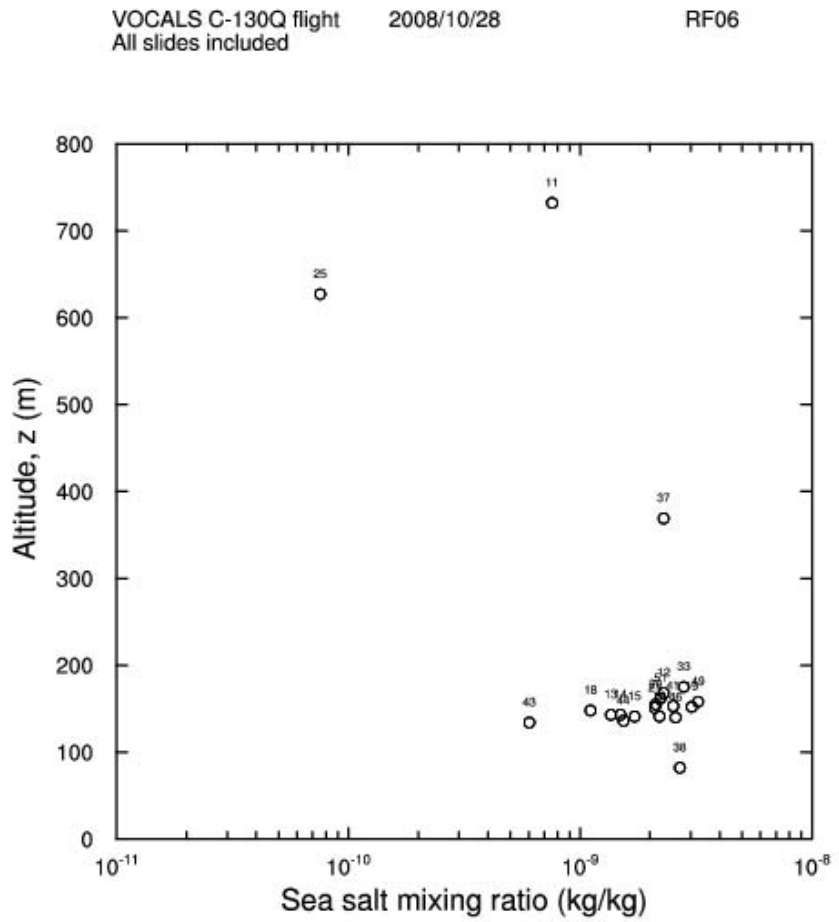
VOCALS has smaller salt particles!

- Why?
- Drizzle removal?

RF06 had surface wind speeds of 8 – 14 m/s.



Sea-Salt loading (RF06)



Gillespie (1973) Stochastic Coalescence Model

Monte-Carlo model for coalescence (no numerical broadening)

Condensation from near sea-surface (50 m) through cloud base (380 m) to cloud top (1450 m)

Initiated with particles from

- Uwyo CCN
- NCAR C-130 PCASP
- NCAR Giant Nuclei Impactor (GNI)

Use Cloud Base conditions from first RF06 POC flight

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4 cases:

POC CCN with Giant Aerosols
POC CCN without Giant Aerosols
noPOC CCN with Giant Aerosols
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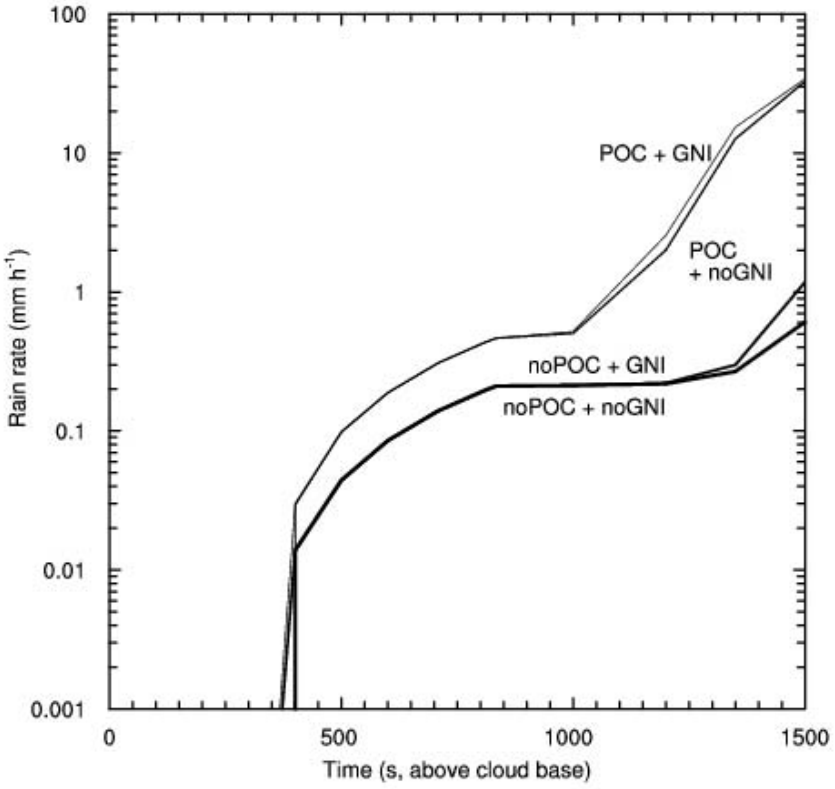
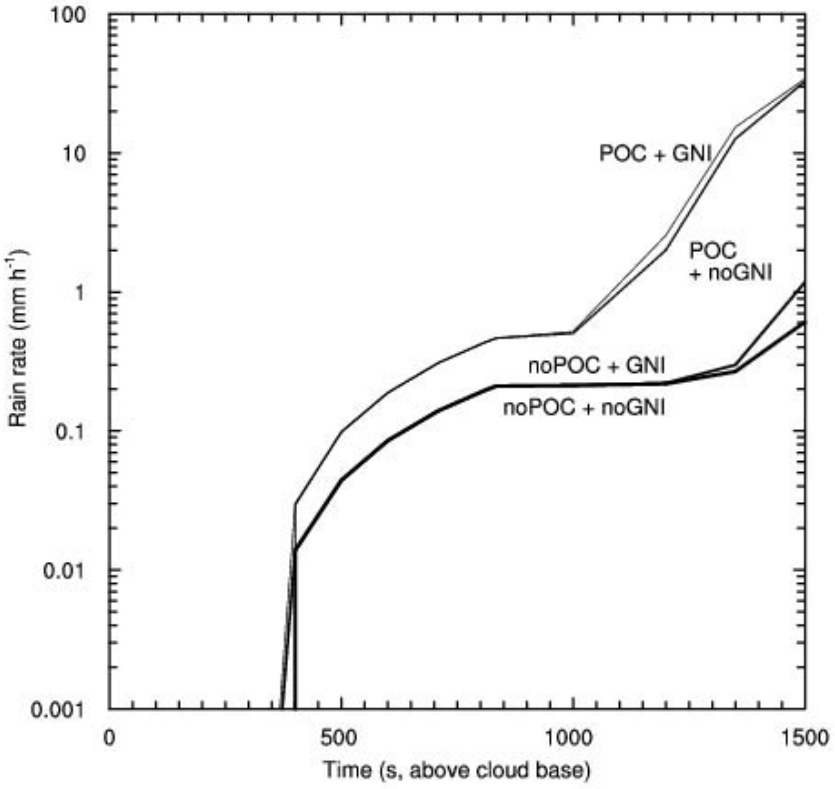


Evolution of rain rates

383s = cloud base (386 m)
850s = cloud top (1450 m,
LWC=1.8 g/m3
1500 s = stop model

2 m/s from cloud base to top,
then 0 m/s thereafter

POC has about 60 CCN/cc
noPOC has about 190 CCN/cc



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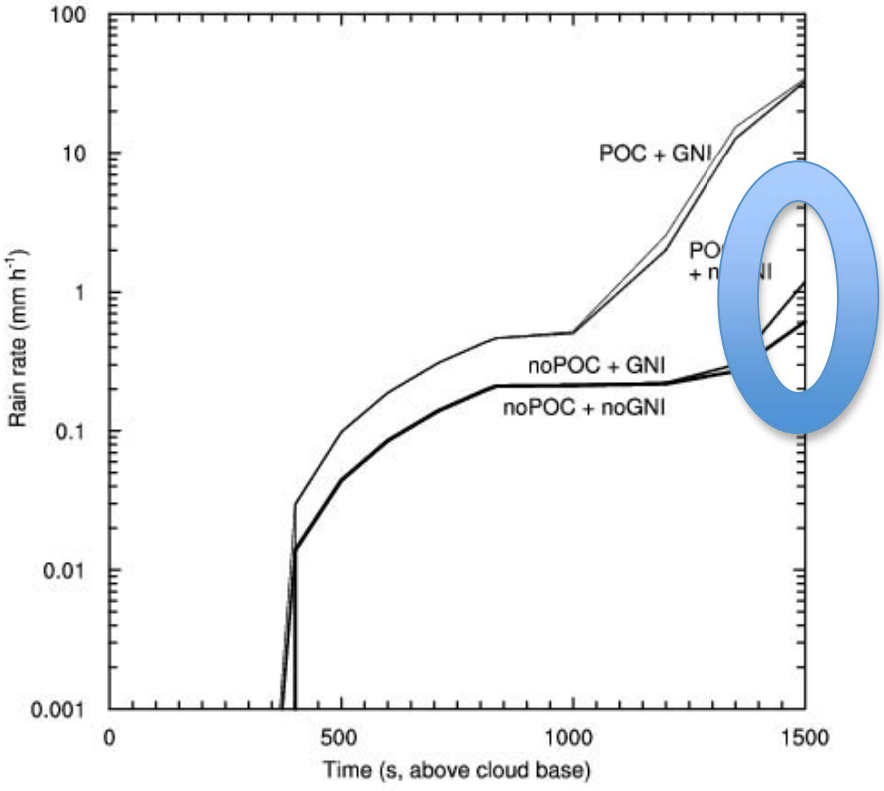

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Outside POC, giant aerosols contribute to rain rate by a factor 3 (mean radius is 16 micron)

Likely an underestimate (more time)

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Qualified yes.

Implications:

It is possible for large scale models to generate drizzle, and maybe even the correct amount of drizzle – without considering giant aerosols.

In that case, model-calculated drizzle rates may be a result of numerical diffusion in coalescence scheme or initialization scheme or other causes.

However, what happens when the GNI concentrations are different in other circumstances? - This may be a problem for GCM and other models.

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The End