

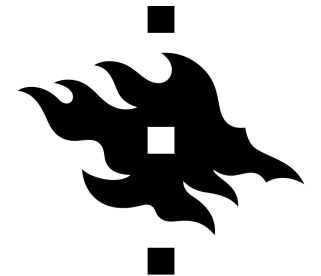


New particle formation around the globe: From laboratory experiments to the Everest Base Camp



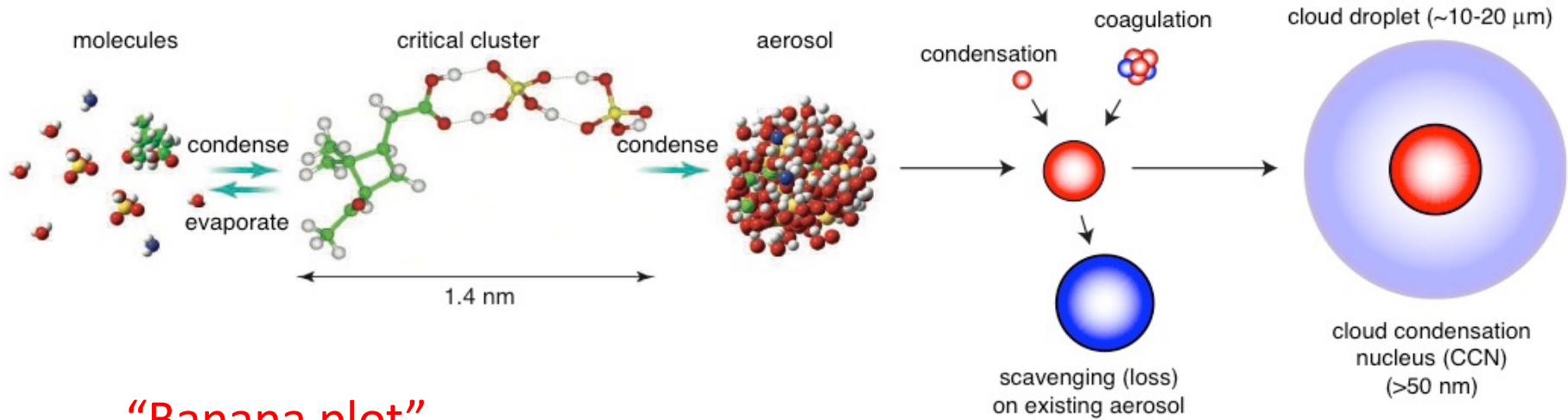
Federico Bianchi

107° Congresso SIF

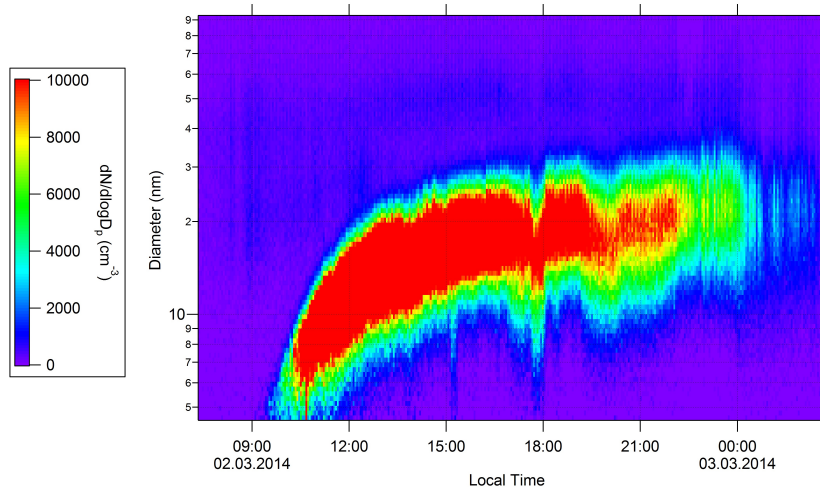


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HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

New particle formation (homogeneous nucleation)



“Banana plot”



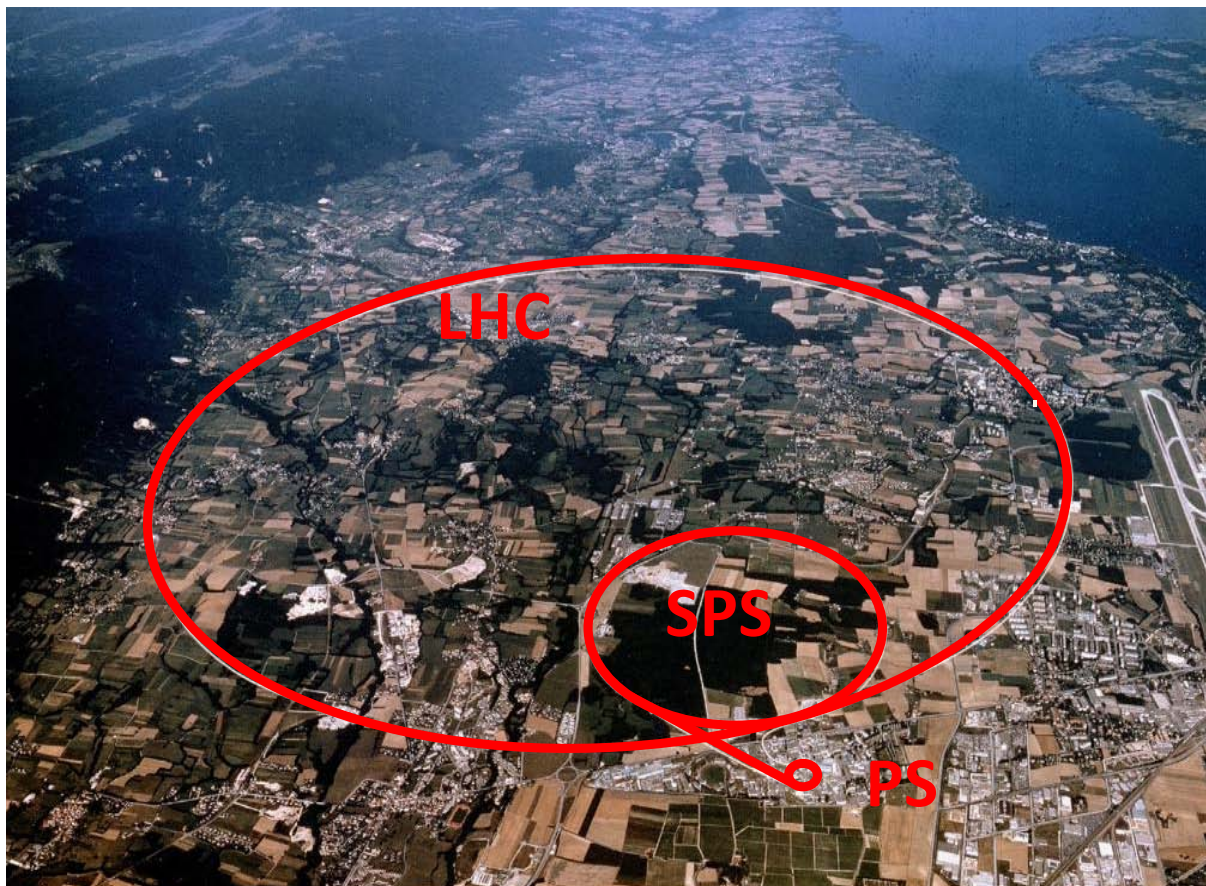
>50% of the CCN from nucleation
Cloud formation
Influence on the climate

Merikanto et al., ACP, 2009

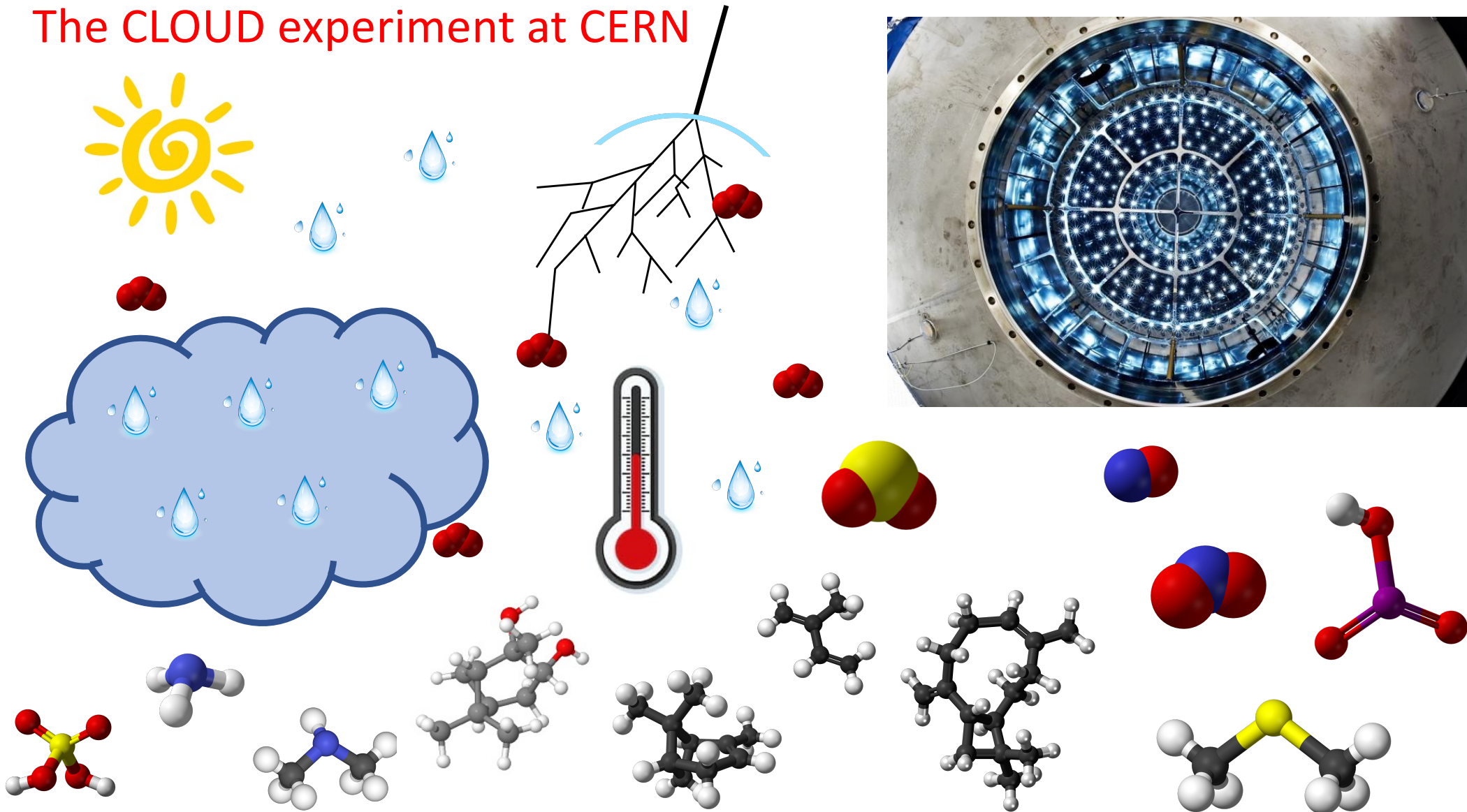
Kerminen et al., ERL, 2018

Dunne et al., Science, 2016

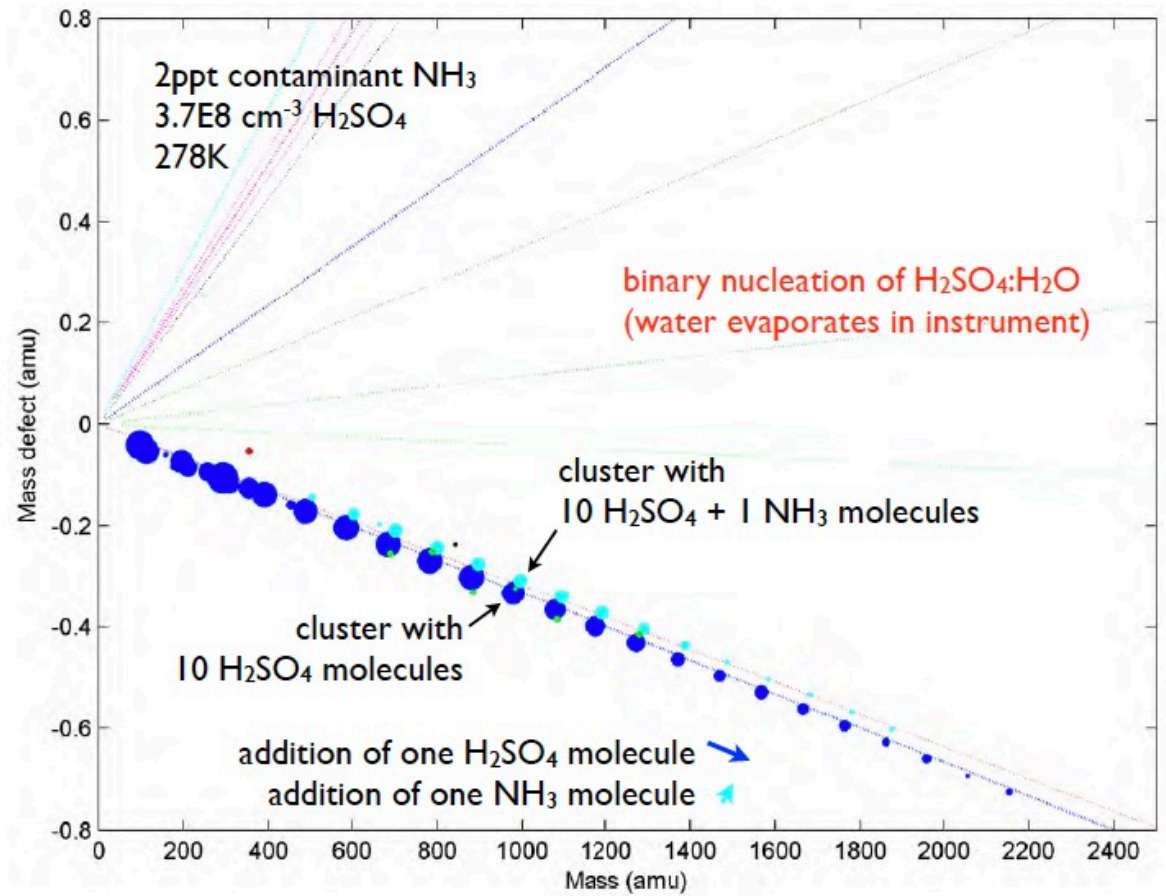
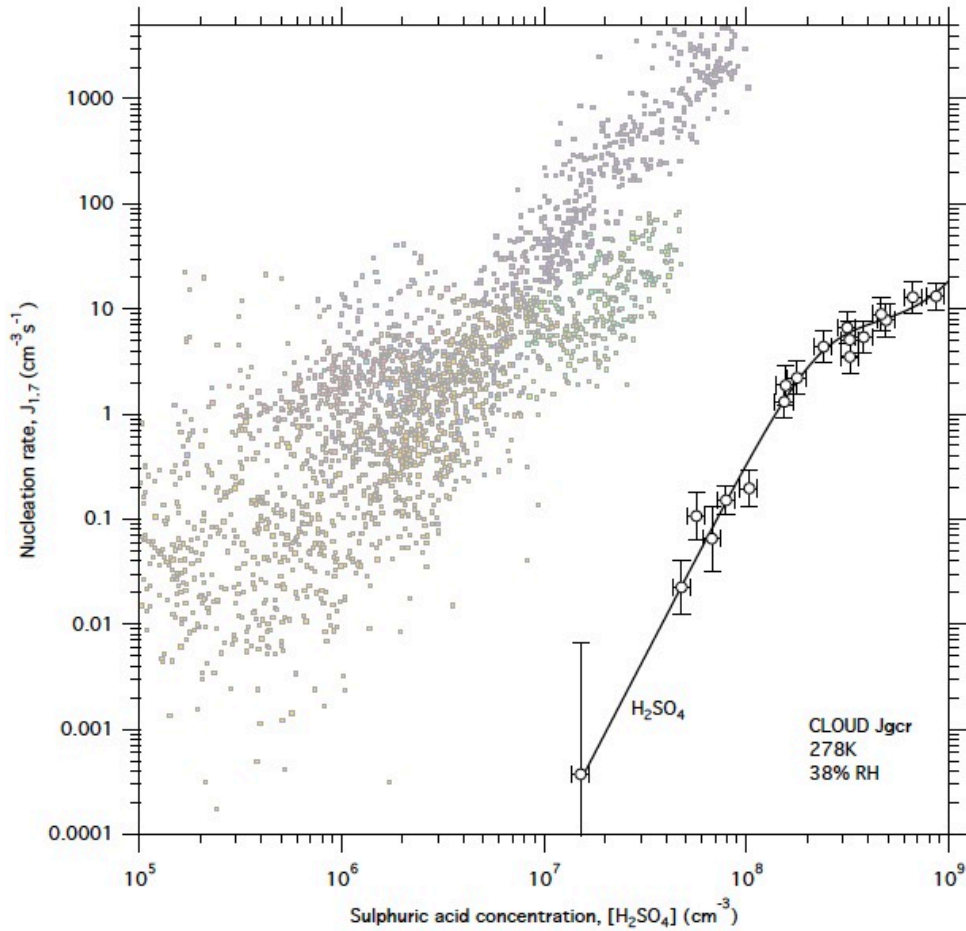
The CLOUD experiment at CERN



The CLOUD experiment at CERN



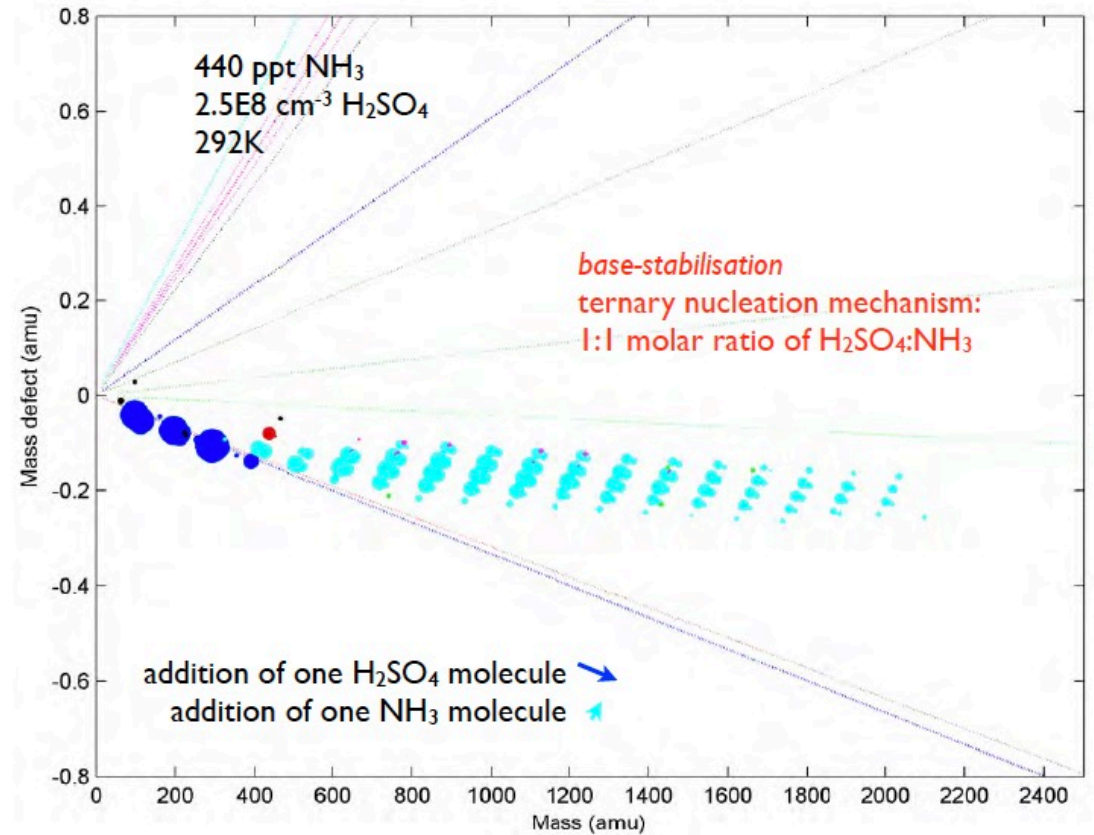
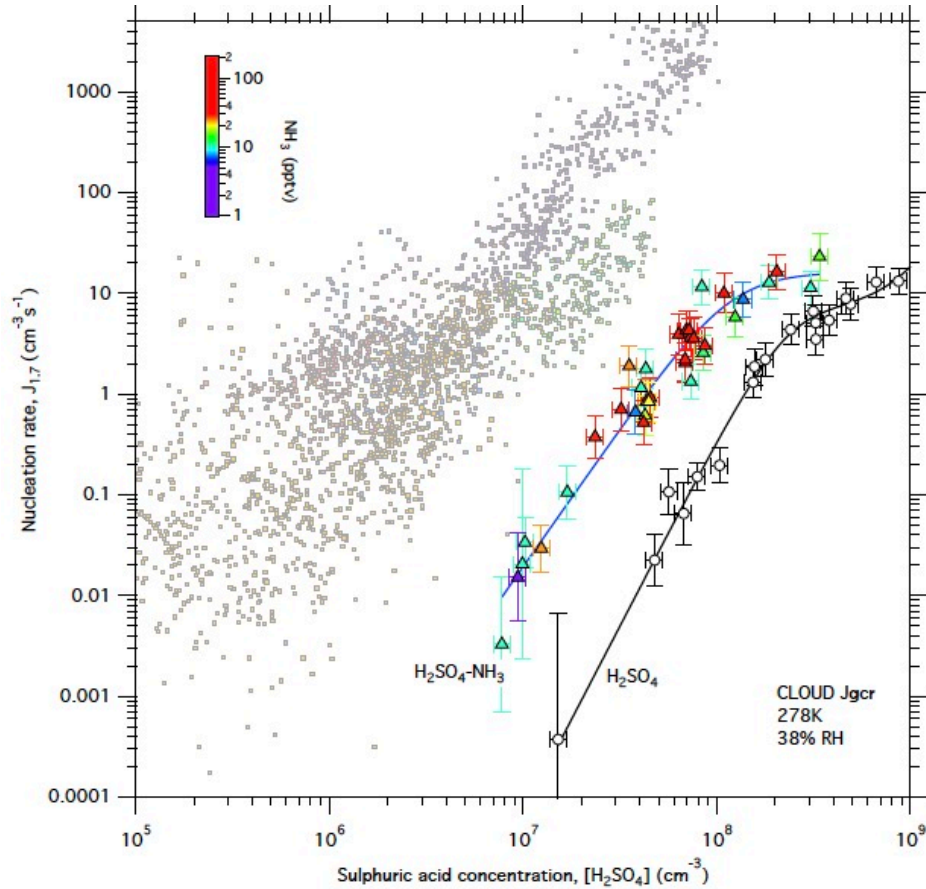
1st Sulphuric acid experiments



Courtesy of Sigi and Jasper

Kirkby et al., Nature, 2011; Duplissy et al., JGR, 2016

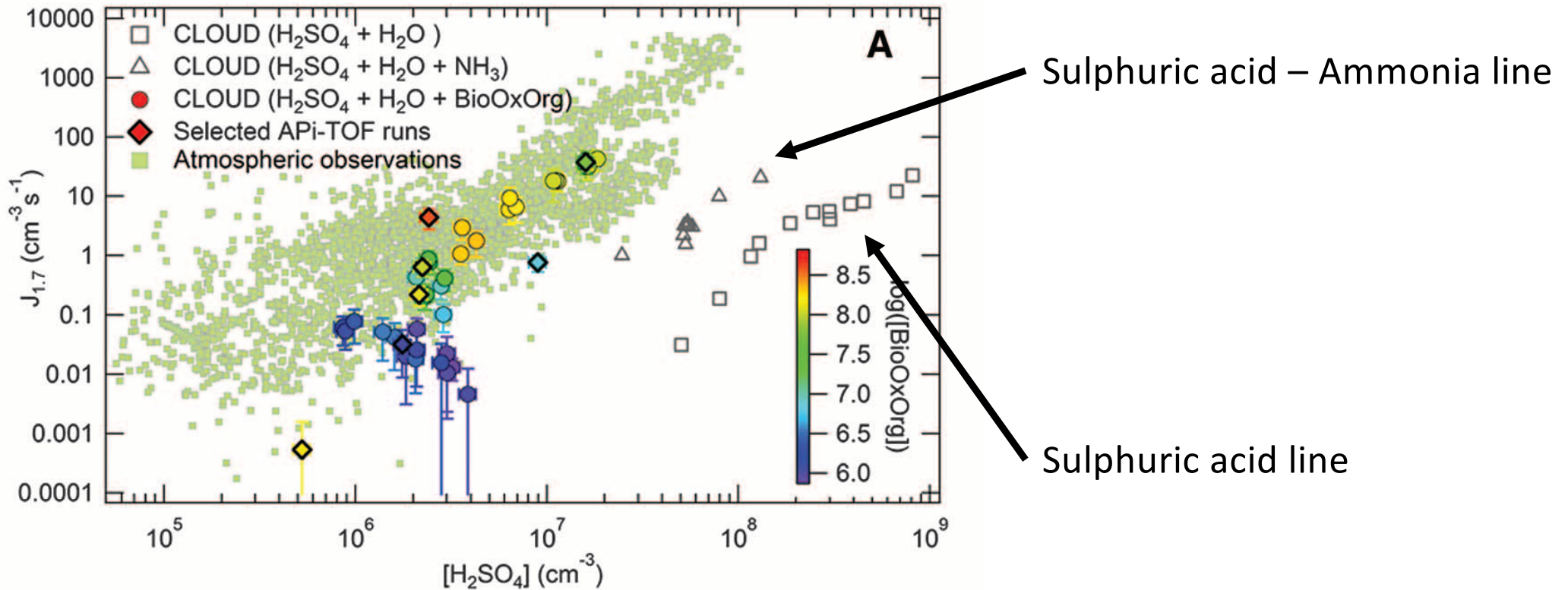
2nd Sulphuric acid – Ammonia experiments



Courtesy of Sigi and Jasper

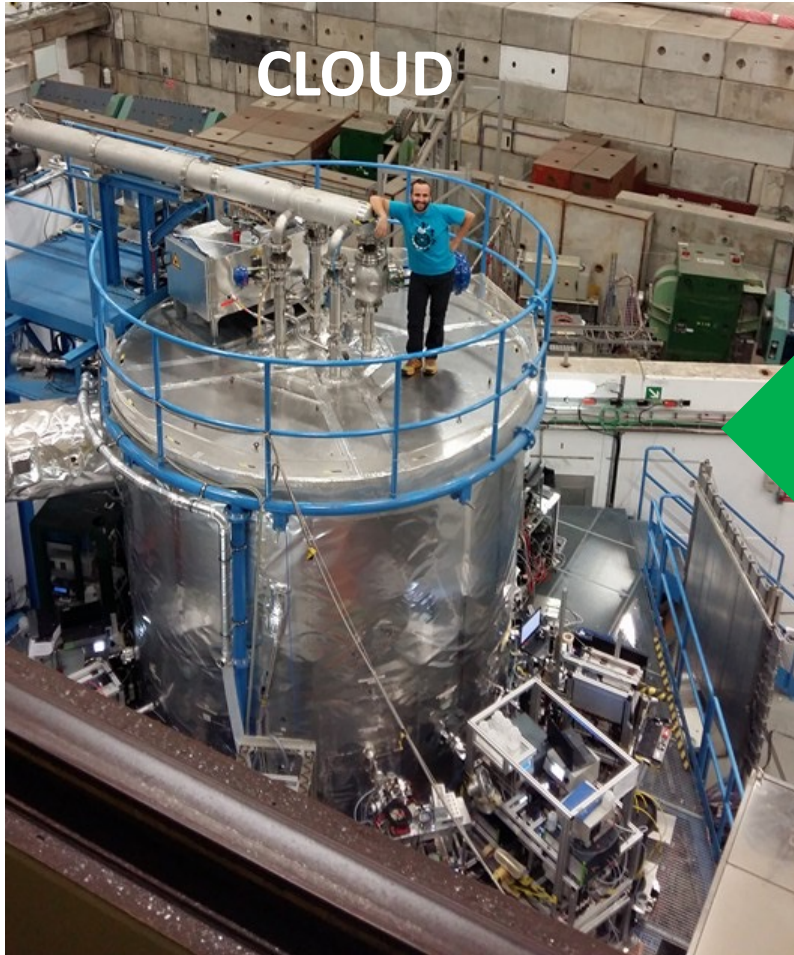
*Kirkby et al., Nature, 2011; Bianchi et al., AMT, 2012; Schobesberger et al., ACP, 2015
Duplissy et al., JGR, 2016; Kuerten et al., JGR, 2016*

Do oxidized organics compounds influence directly
new particle formation rate???



Riccobono et al., Science, 2014
Schobesberger et al., PNAS, 2013

What is missing?



New particle formation observation from high altitude sites around the globe.

The main scientific question is to understand the mechanism driving NPF in the free troposphere



Previous studies (mainly physical properties)



Studies presented here (physical and chemical properties)



Kerminen et al., ERL, 2018; Garcia et al., ACP, 2014

Atmospheric new particle formation and growth: review of field observations

Kerminen, Veli-Matti; Chen, Xuemeng; Vakkari, Ville; Petäjä, Tuukka; Kulmala, Markku; Bianchi, Federico

Environmental Research letter, 2018



New particle formation in the free troposphere: A question of chemistry and timing

- Highly-oxygenated Organic Molecules (HOM) directly participate in the NPF process
- Time window of 2-3 days after major PBL contact

Bianchi et al., Science, 2016

Tröstl et al., JGR, 2016

Frege et al., ACP, 2017



Side note: Highly oxygenated organic molecules

- Definition
- Detection
- Formation mechanism
- Properties and Fates in the Atmosphere
- Observations and Impacts

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CHEMICAL REVIEWS

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Review

pubs.acs.org/CR

Highly Oxygenated Organic Molecules (HOM) from Gas-Phase Autoxidation Involving Peroxy Radicals: A Key Contributor to Atmospheric Aerosol

Federico Bianchi,^{*,†,‡,§} Theo Kurtén,^{†,§} Matthieu Riva,[§] Claudia Mohr,^{||} Matti P. Rissanen,^{†,§} Pontus Roldin,[⊥] Torsten Berndt,^{#,§} John D. Crounse,^{∇,§} Paul O. Wennberg,^{∇,§} Thomas F. Mentel,[○] Jürgen Wildt,[○] Heikki Junninen,^{†,◆} Tuija Jokinen,[†] Markku Kulmala,^{†,‡} Douglas R. Worsnop,^{†,||} Joel A. Thornton,^{+§} Neil Donahue,^{●,§} Henrik G. Kjaergaard,^{◇,§} and Mikael Ehn^{*,†,§}

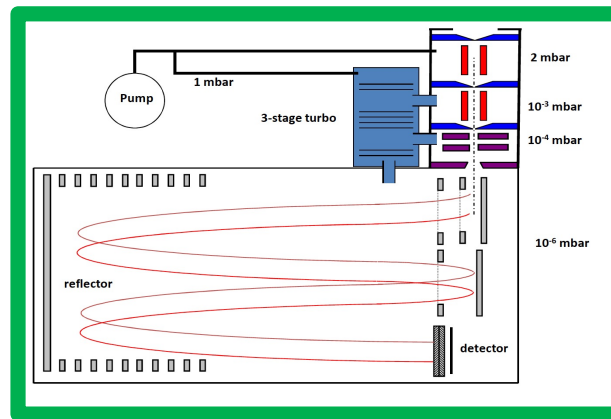
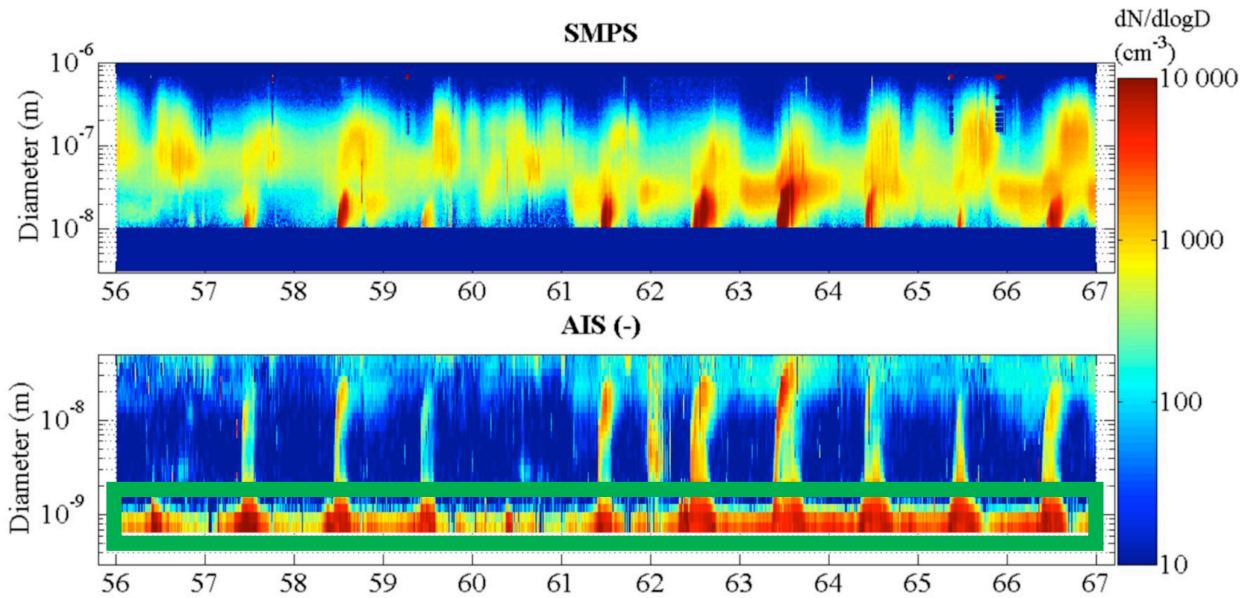
Bianchi et al., Chemical Reviews, 2019



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Nepal Climate Observatory – Pyramid 5079m a.s.l. - Everest base camp



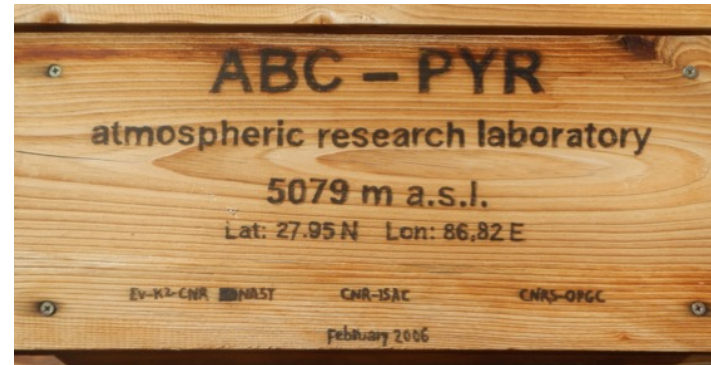
Low pressure Test



P=500 mbar



Luckla 2800 m asl



During the day

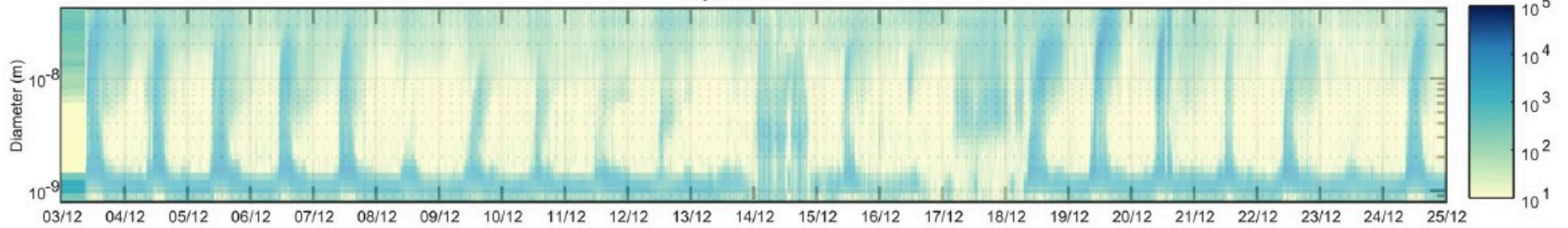


During the night

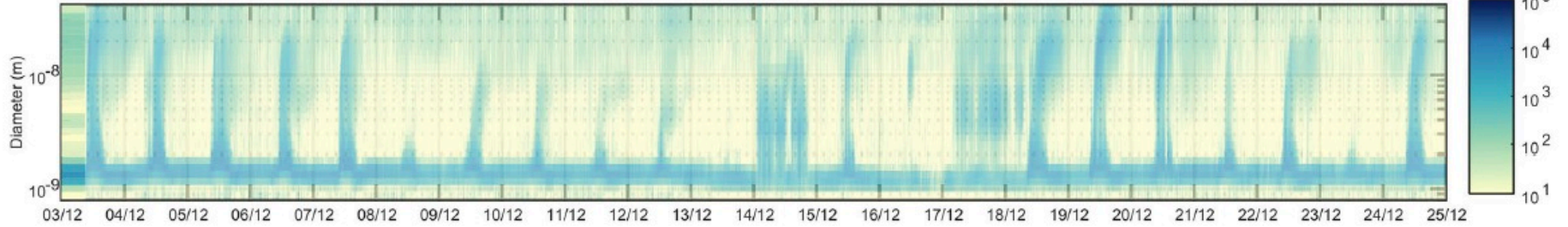


The Himalayan aerosol factory

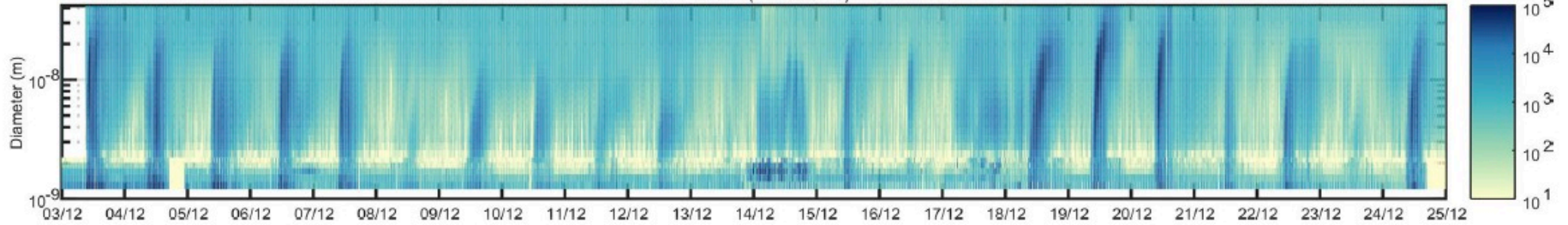
Negative ions



Positive ions

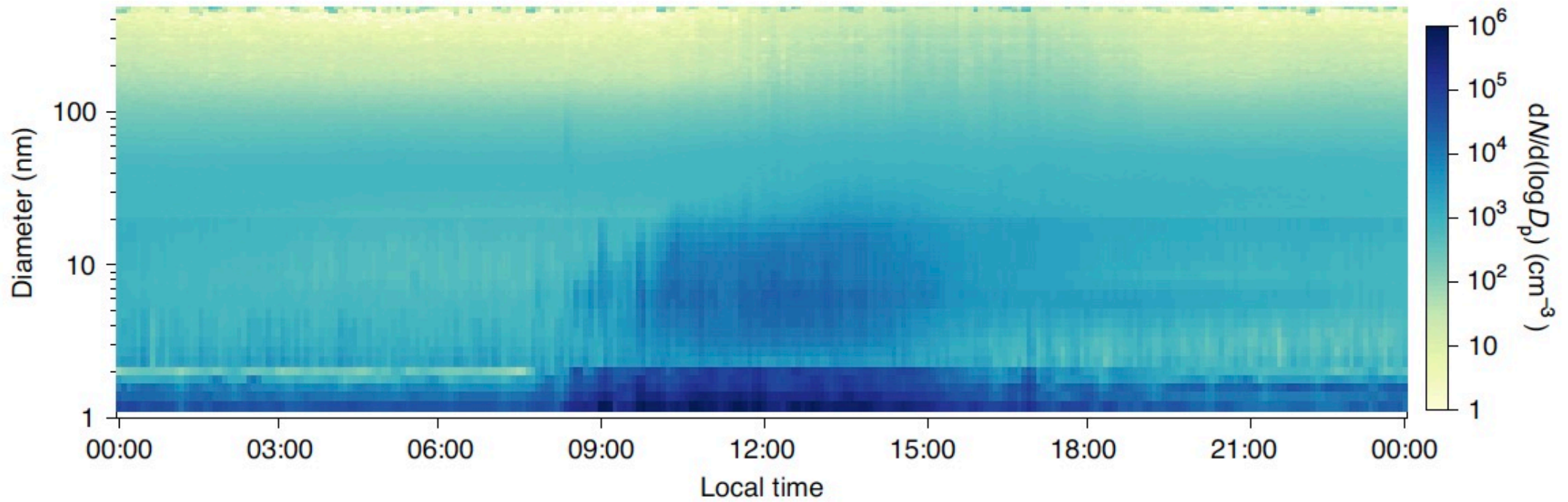


Total Particles (PSM & NAIS)

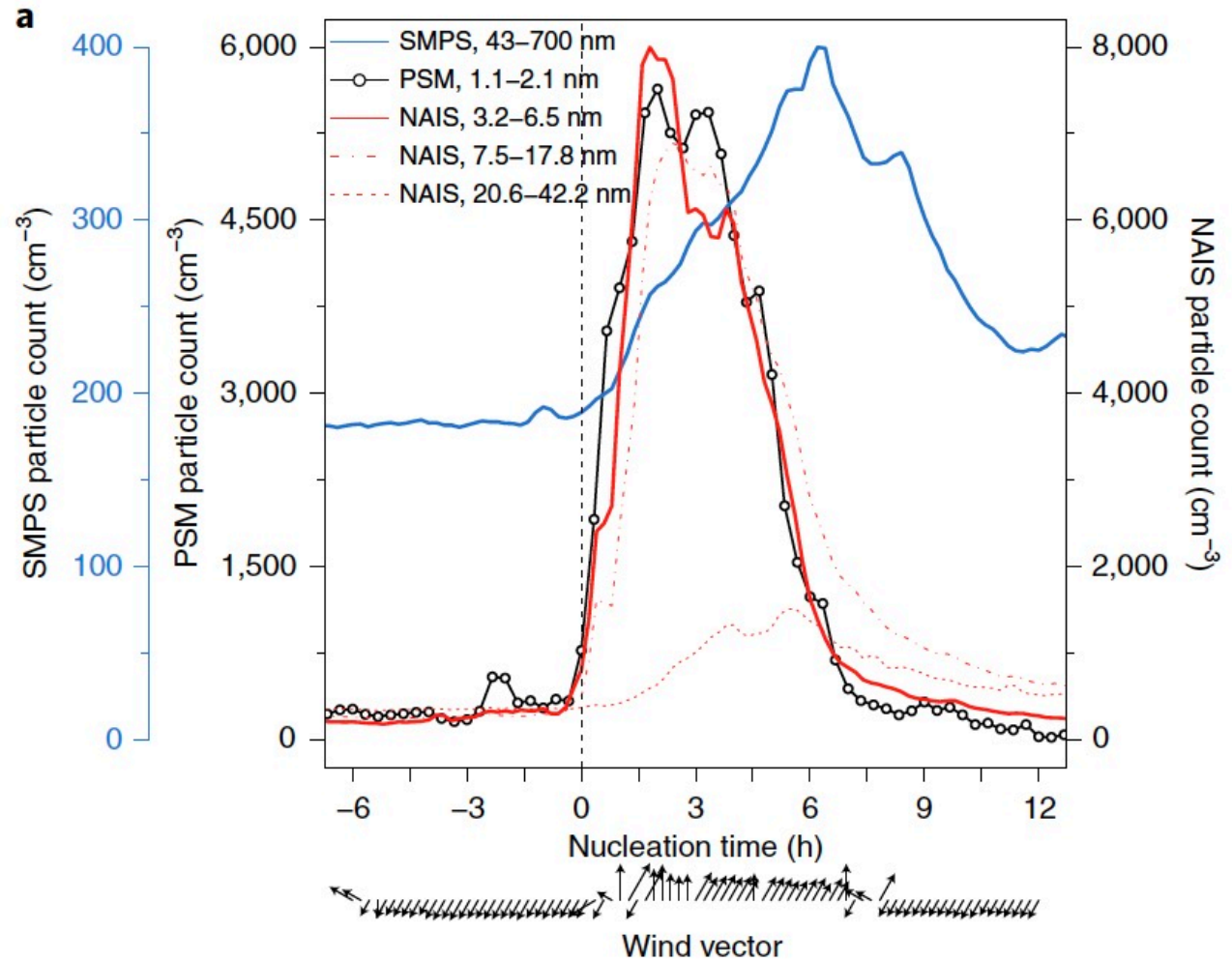
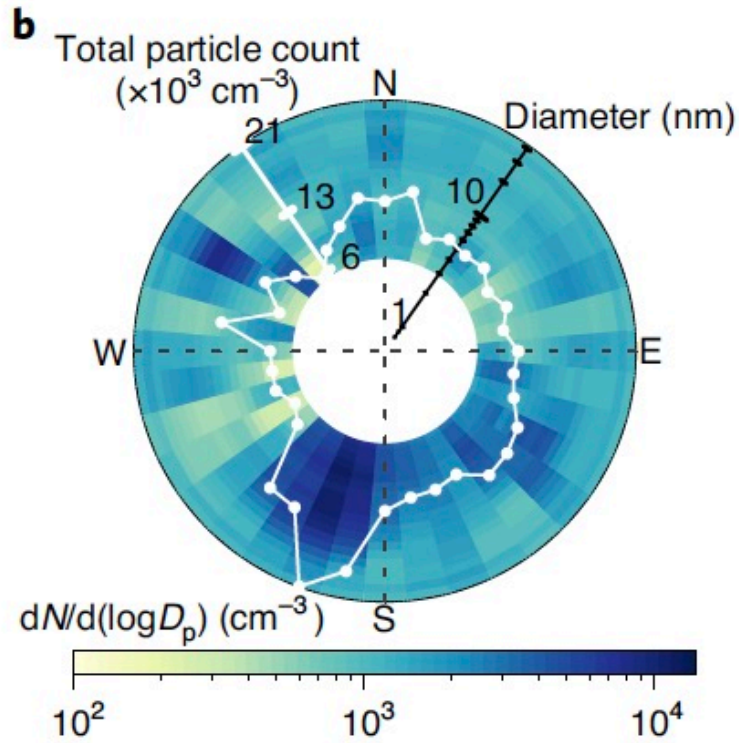


The Himalayan aerosol factory

a



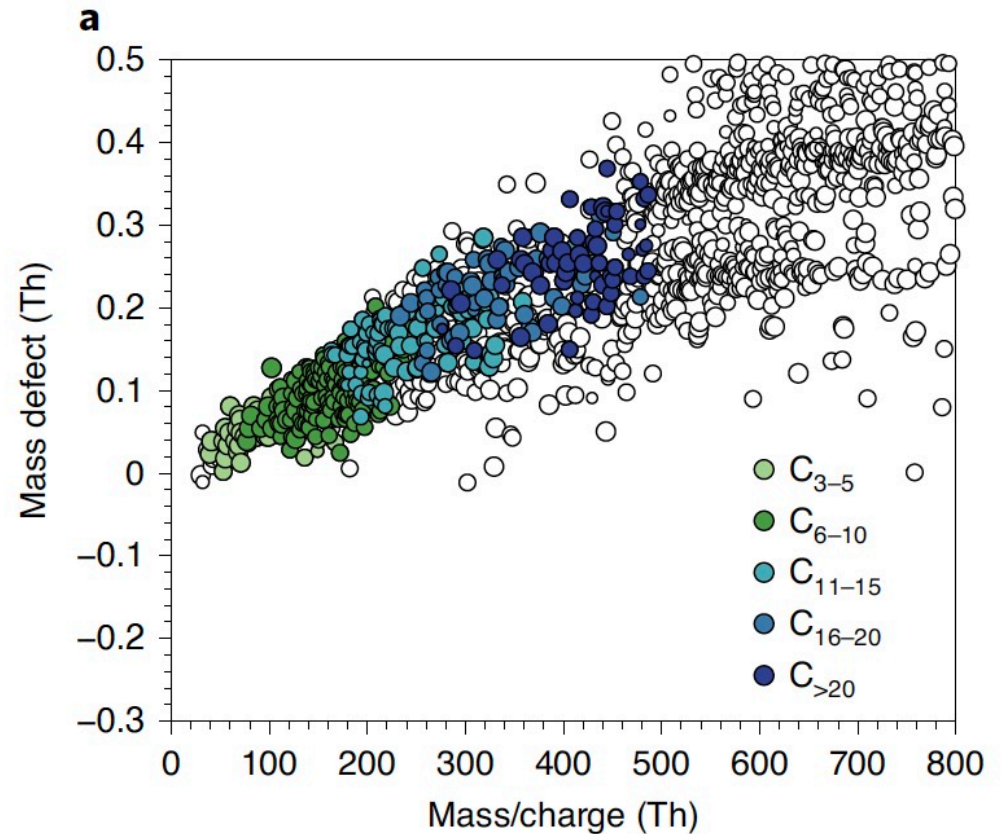
Meteorology driving new particle formation in Himalayan valley

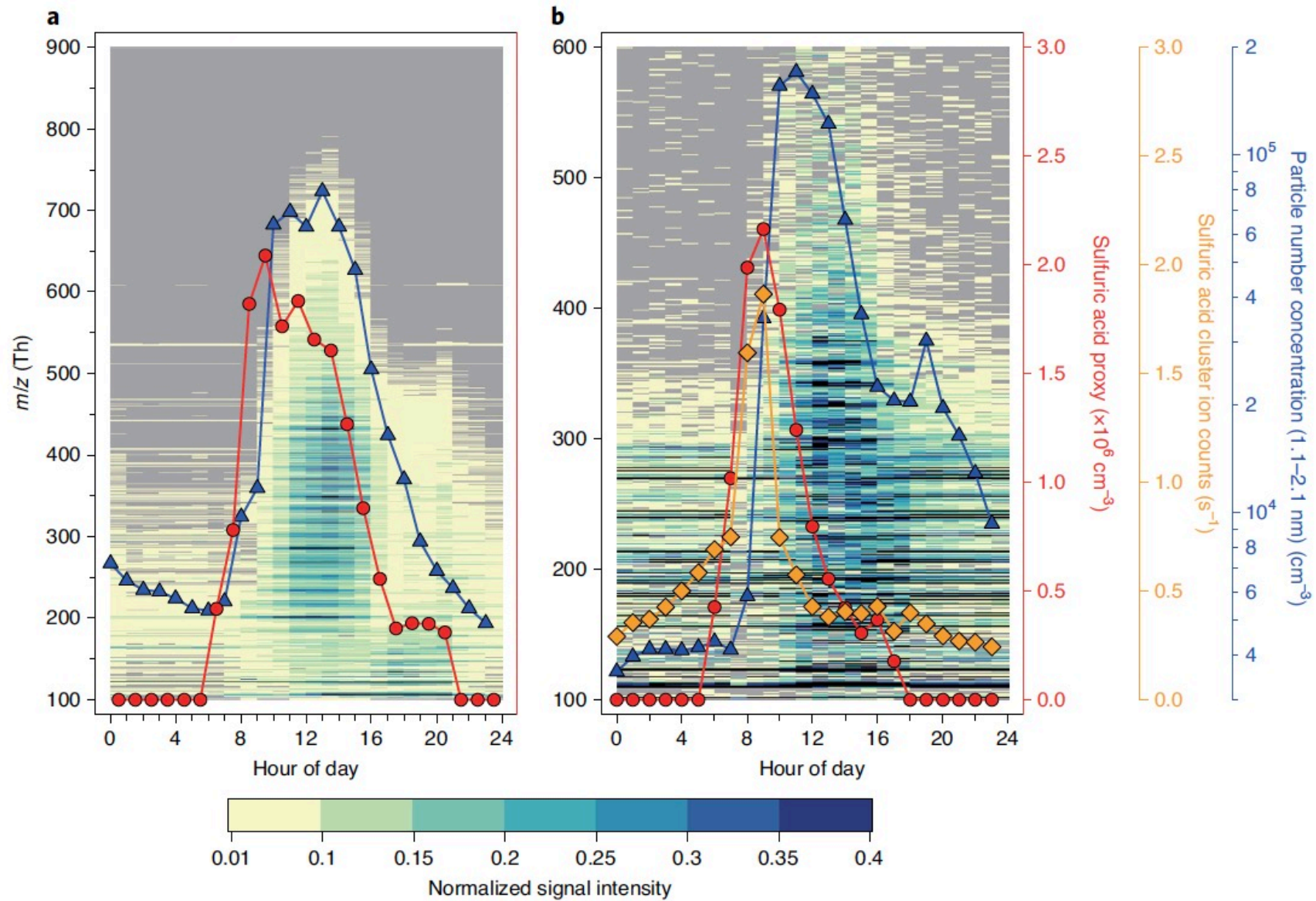


Nucleation triggered by the up-valley wind

What is the chemical composition of these clusters?

- Organic compounds (HOMs) clearly play a role on new particle formation
- Biogenic origin!





Concluding:

We think we know the physics

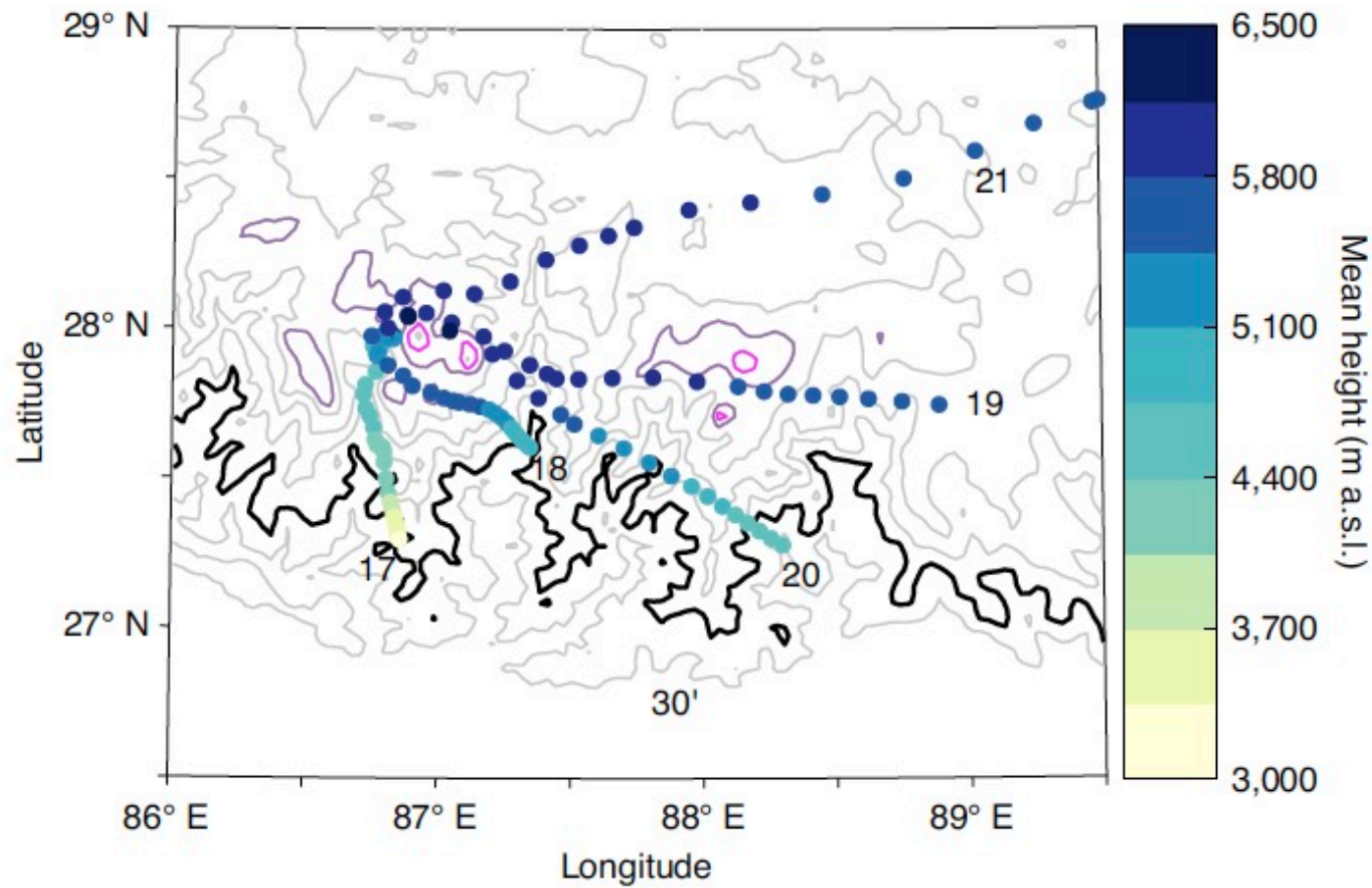
We think we know the chemistry

Are these events important for the ambient/climate?



Where do the particles go?

a

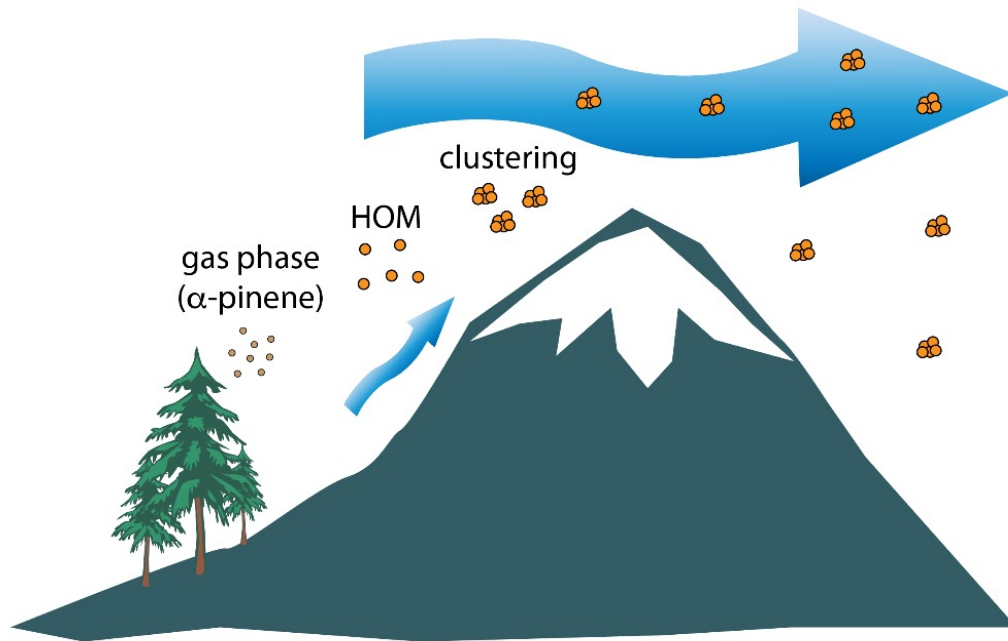


We think we know the physics

We think we know the chemistry

Are these events important for the ambient/climate?

- YES!

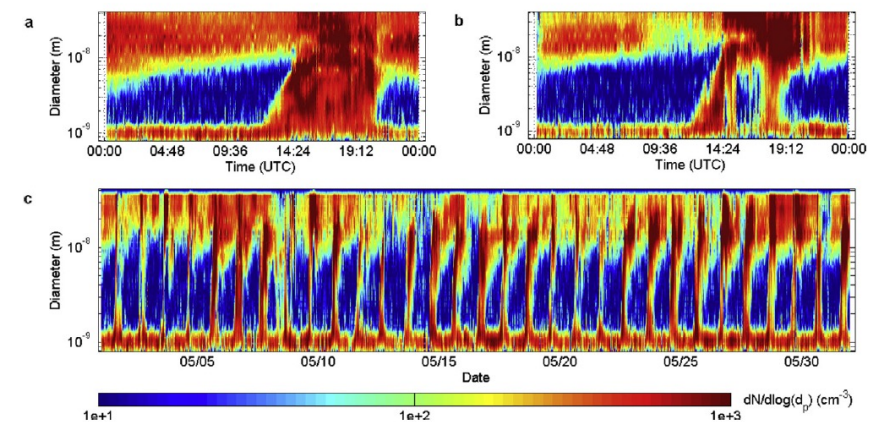


Bianchi et al., Nature Geoscience, 2021



SALTENA Campaign - Southern hemisphere high altitude experiment on particle nucleation and growth

- December 2017 – May 2018, intensive period: April 2018 – May 2018
- Chacaltaya GAW Station (CHC) - Bolivian Andes, 5240 masl



Bianchi et al., BAMS, *In press*

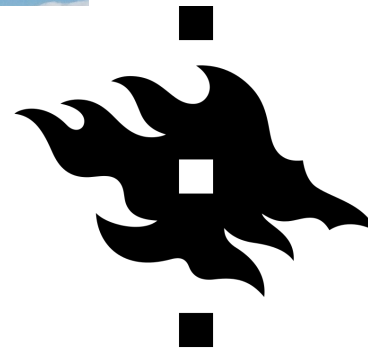


INAR

INSTITUTE FOR ATMOSPHERIC AND
EARTH SYSTEM RESEARCH



Thanks for your attention



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