



Measurement of Sulfuric Acid Vapor Concentrations using a Condensation Particle Counter

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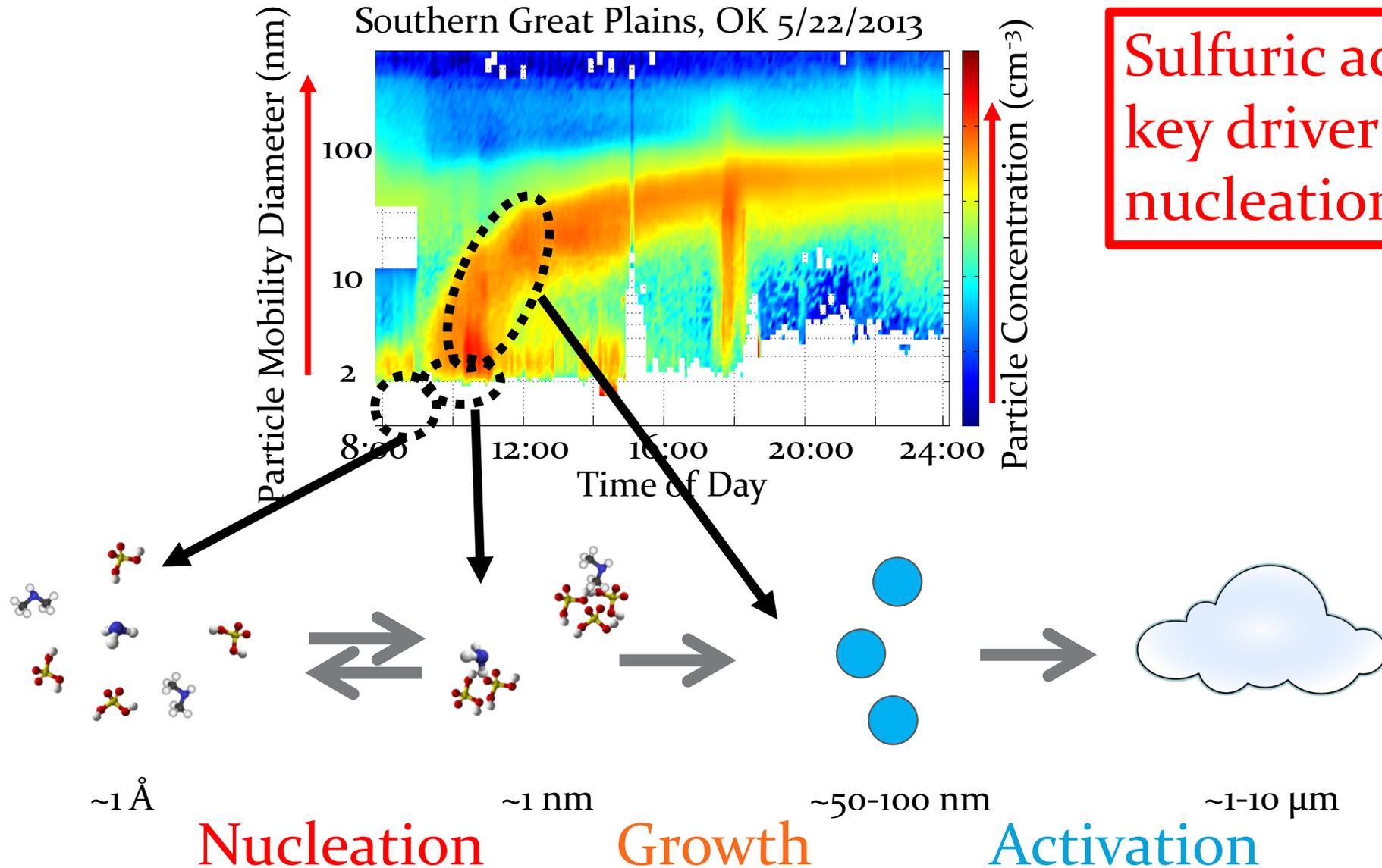
**Carnegie
Mellon
University**

Manuscript in preparation



Oct. 2022

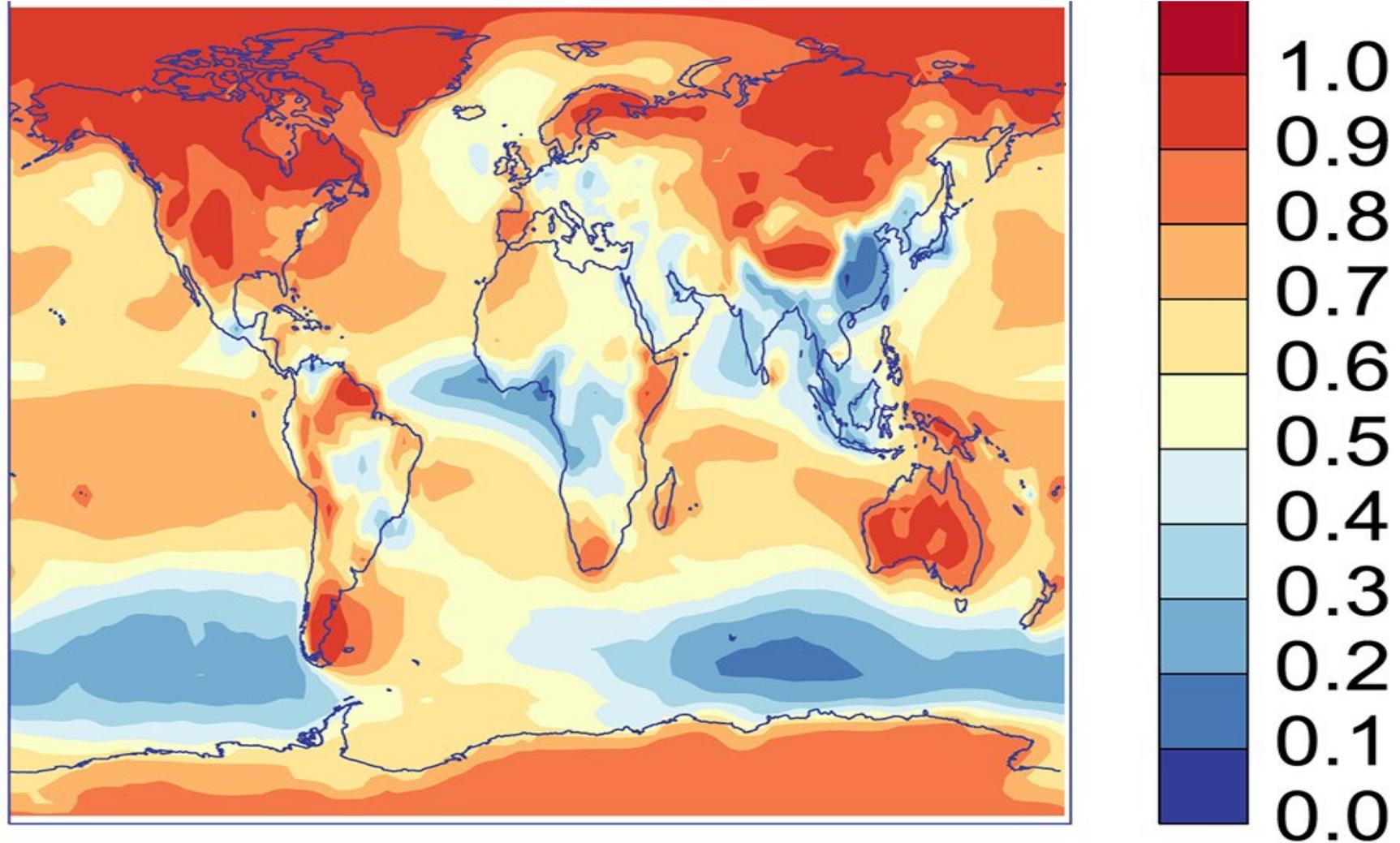
Lifecycle of a secondary atmospheric aerosol particle starts from gaseous emissions



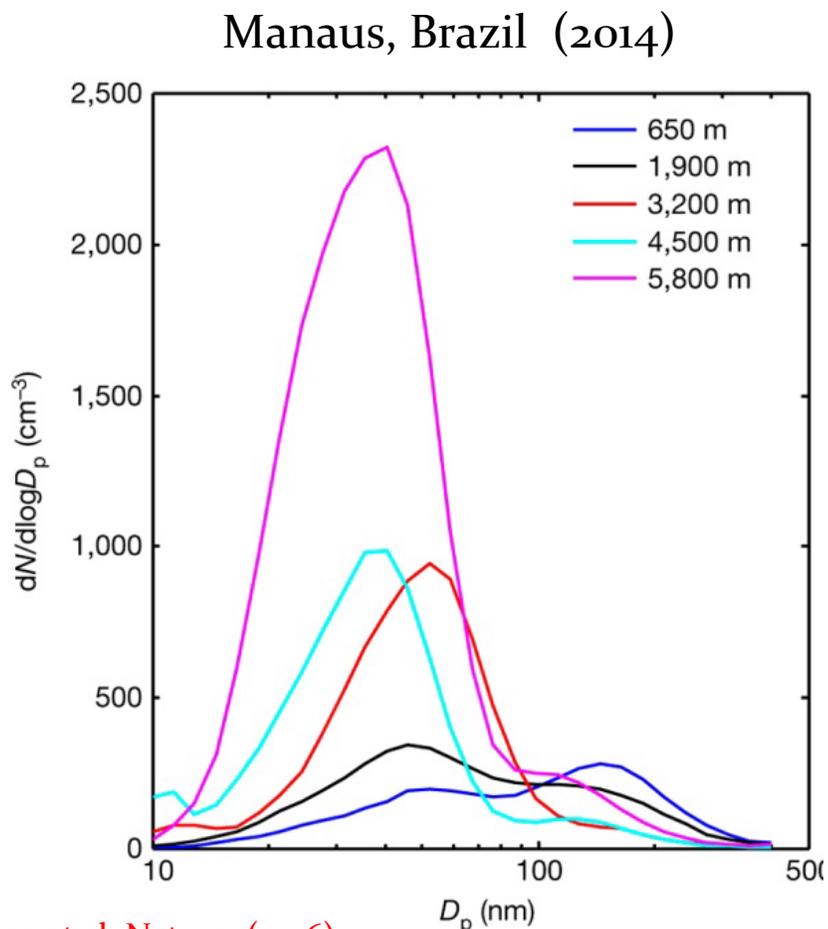


New particle formation produces ~50% of global cloud condensation nuclei (CCN, 0.2% supersaturation)

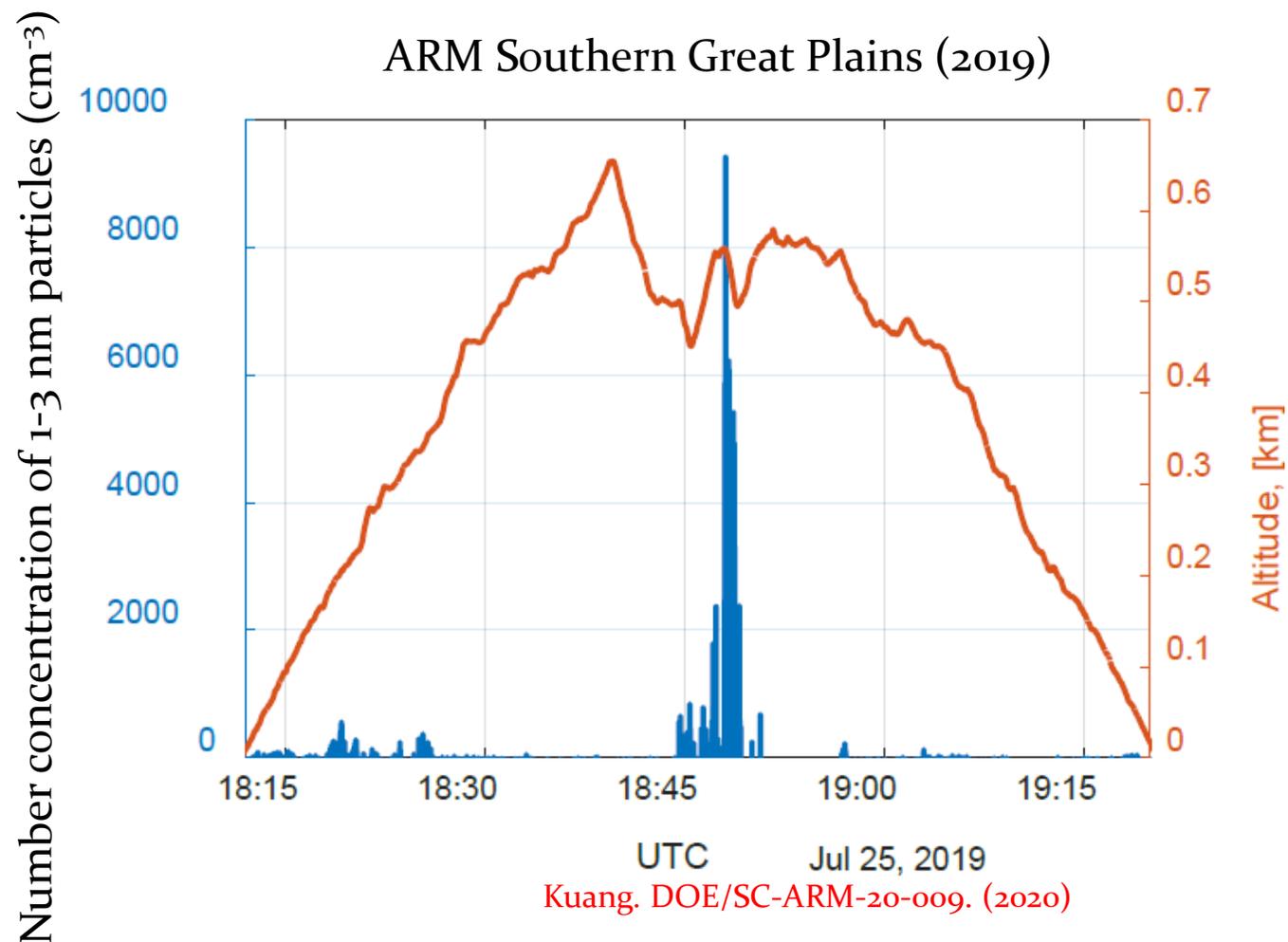
Fraction of CCN from Nucleation



Freshly formed particles observed at higher altitudes



Wang et al. Nature. (2016)

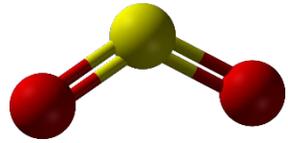


Kuang. DOE/SC-ARM-20-009. (2020)

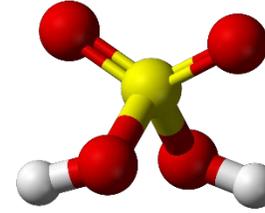
**Does sulfuric acid nucleate at higher altitudes?
Where does sulfuric acid come from?**

Inaccuracies in modeled SO₂ propagate to modeled sulfuric acid concentration

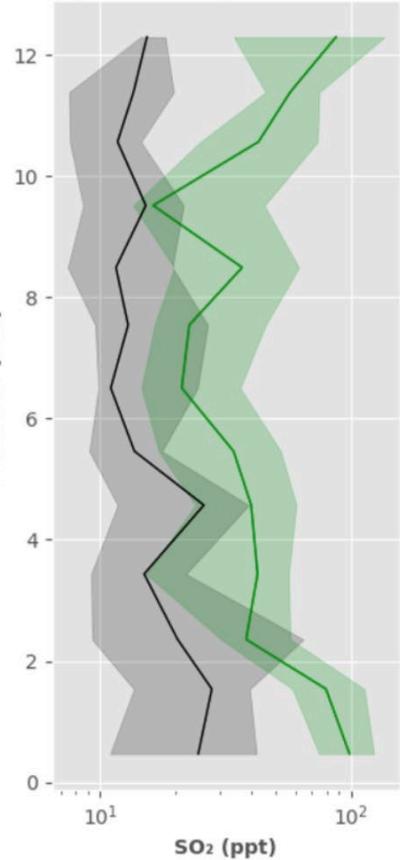
Sulfur dioxide



Sulfuric acid

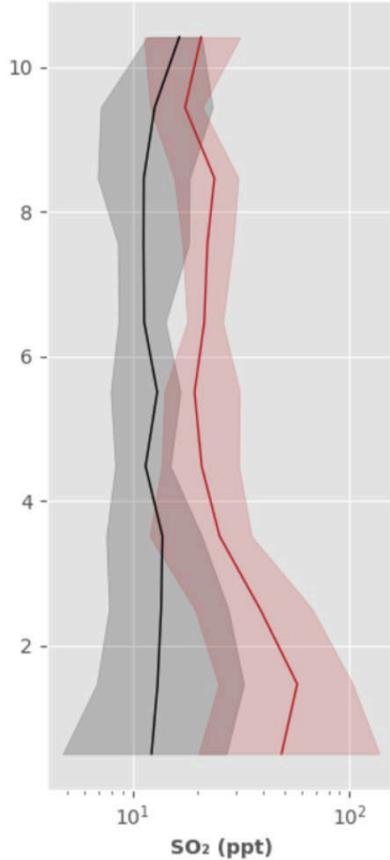


(a) Tropics



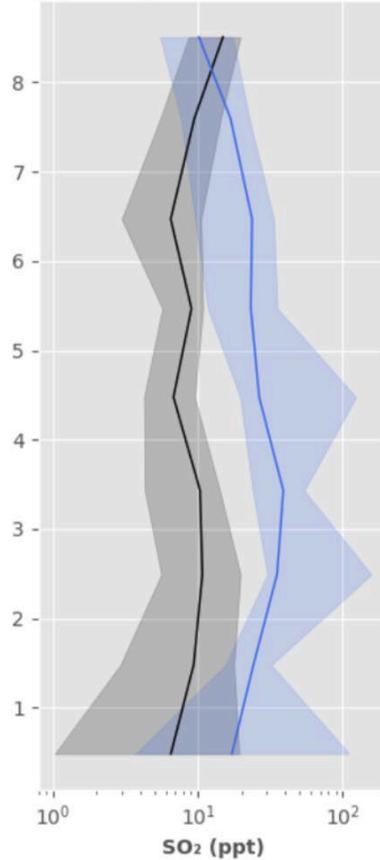
Observations (ATom4 2018)

(b) Midlatitudes



Model: UKESM1

(c) Highlatitudes



Proxy relationships

$$[H_2SO_4] \sim [SO_2]^a$$

Where a ranges from 0.4-1.1

$$\text{Nucleation rate} \sim [H_2SO_4]^{2-3}$$

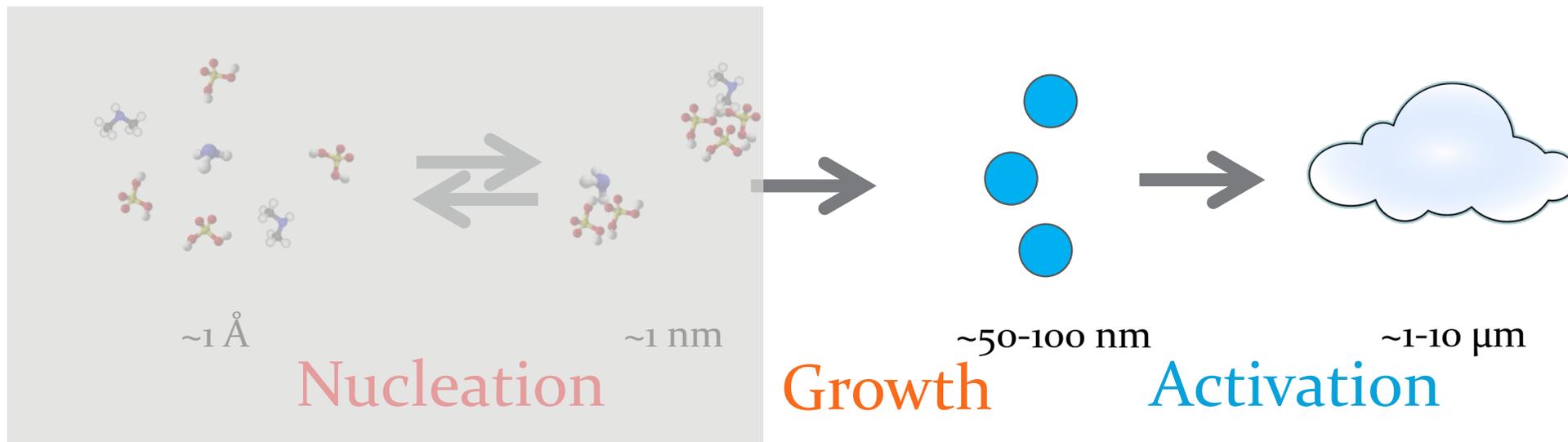
Need more sulfuric acid measurements!

Mikkonen et al. ACP. (2011)

Lu et al. ACP. (2019)

Ranjithkumar et al. ACP. (2021)

Growth and activation also depend on atmospheric sulfuric acid concentration



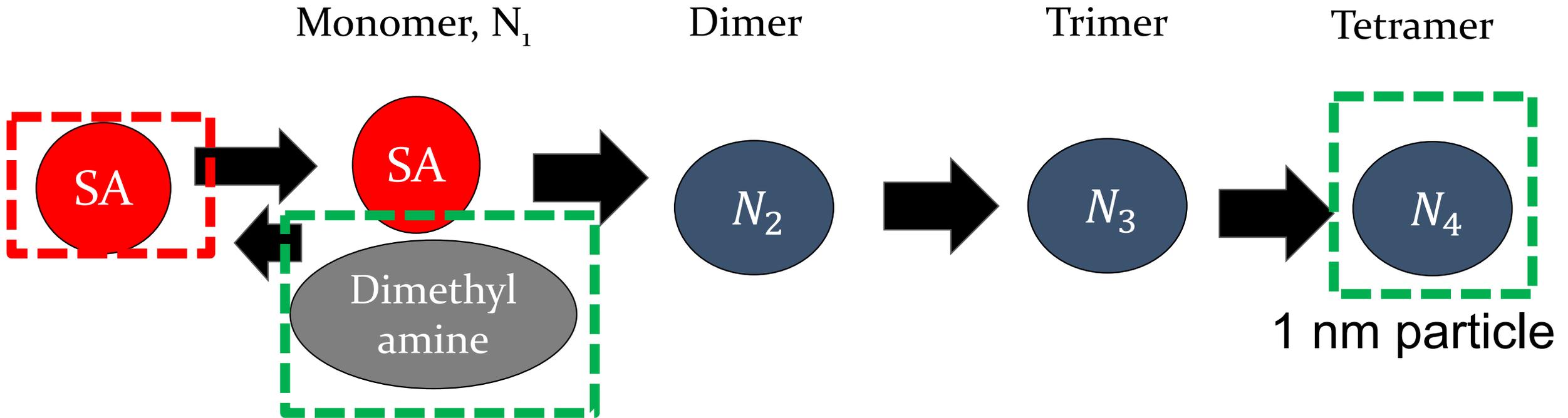
Measuring sulfuric acid requires a mass spectrometer



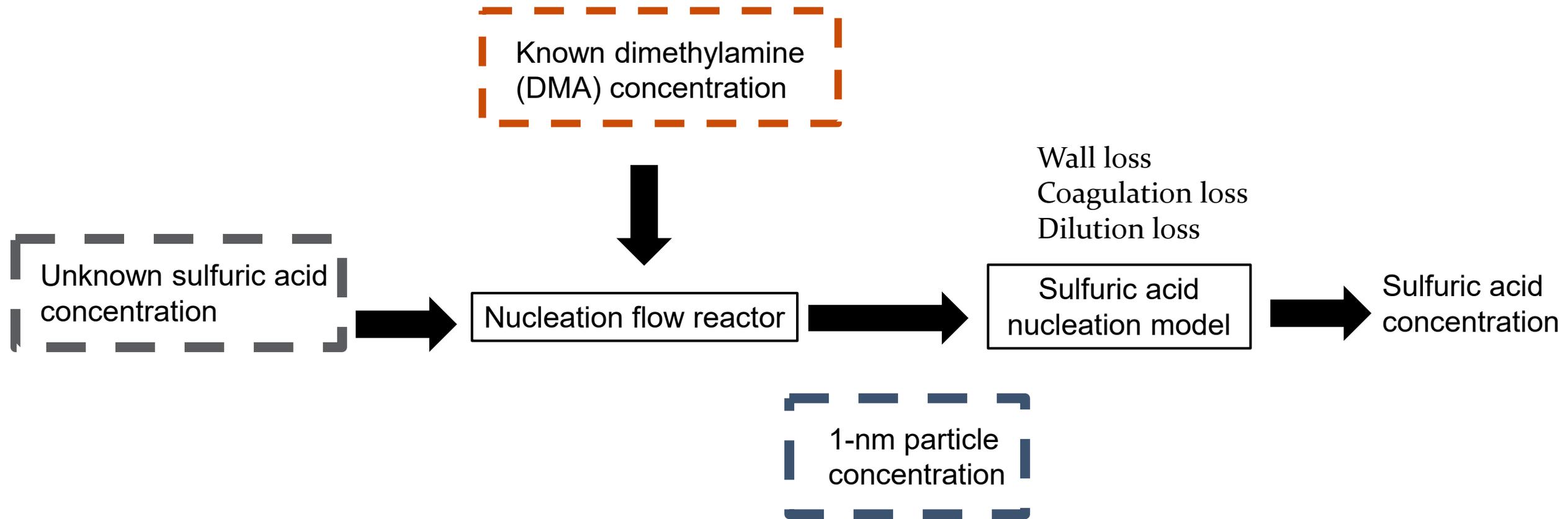
- Power intense
 - Heavy
 - Difficult to operate
 - Expensive
 - Factor of 2-3 uncertainty
-
- Poor spatial and temporal resolution measurements

GOAL: Develop a compact technique to measure atmospheric sulfuric acid

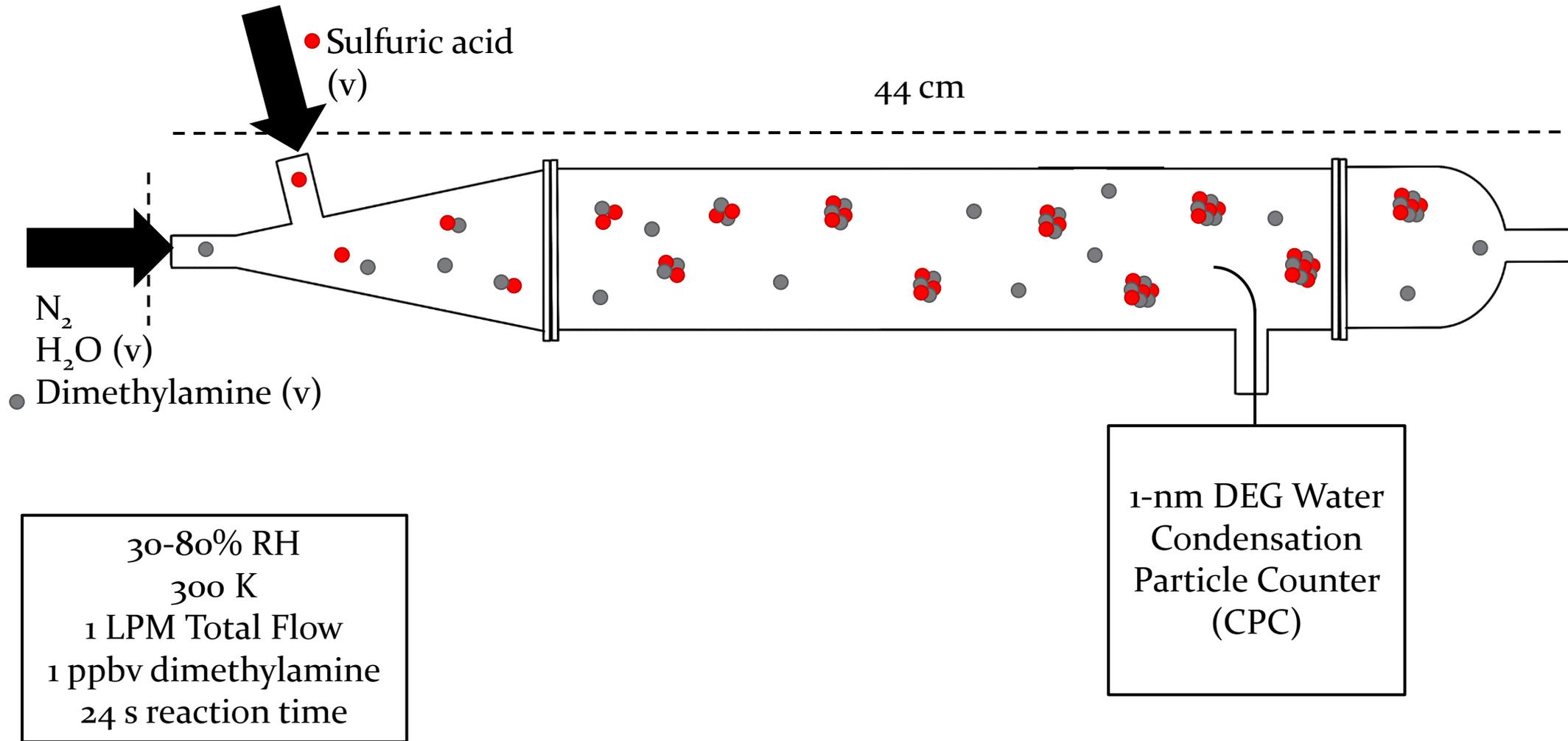
Leverage how sulfuric acid nucleates in the atmosphere to measure sulfuric acid



Sulfuric acid condensation particle counter (SA-CPC)

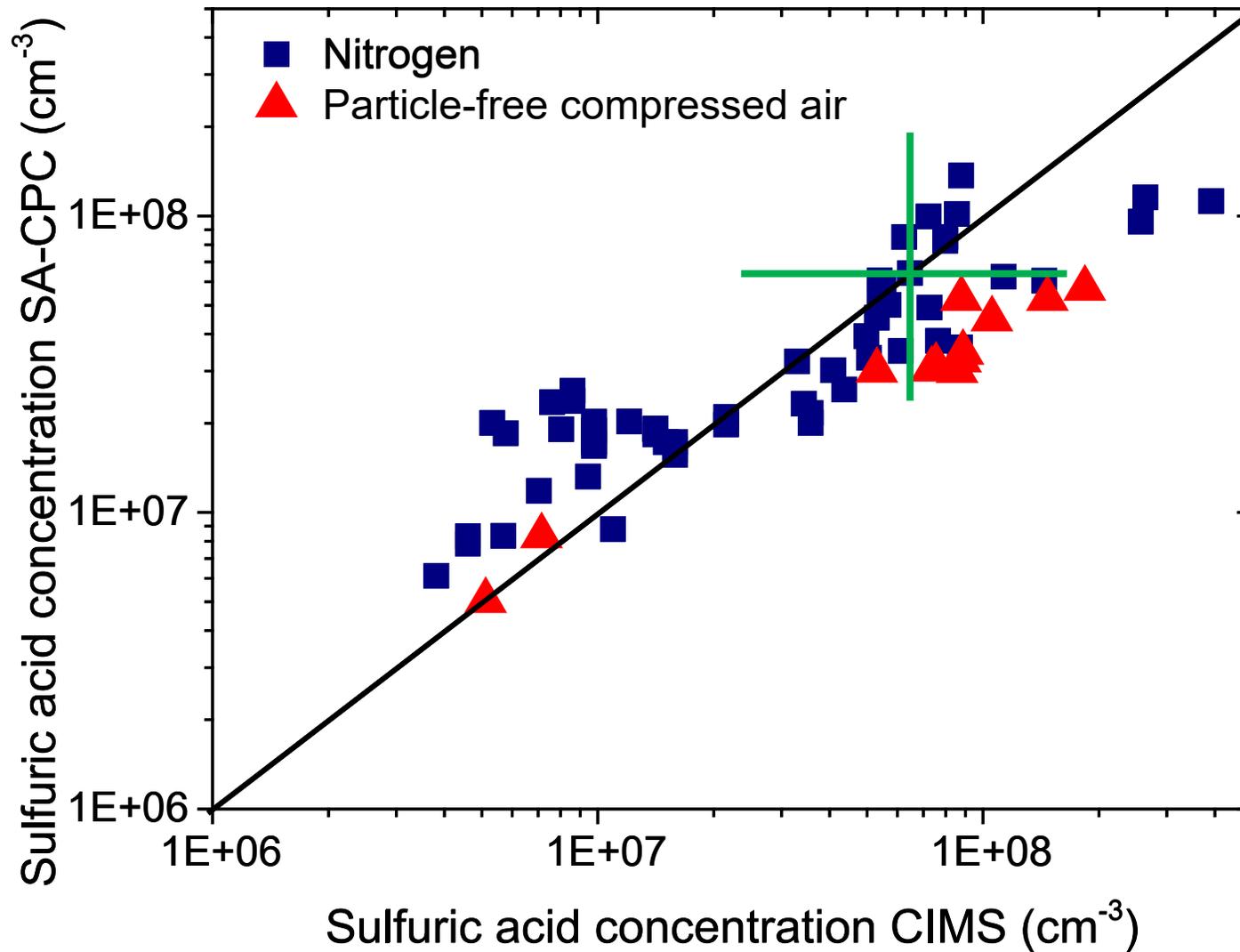


Sulfuric acid condensation particle counter (SA-CPC)

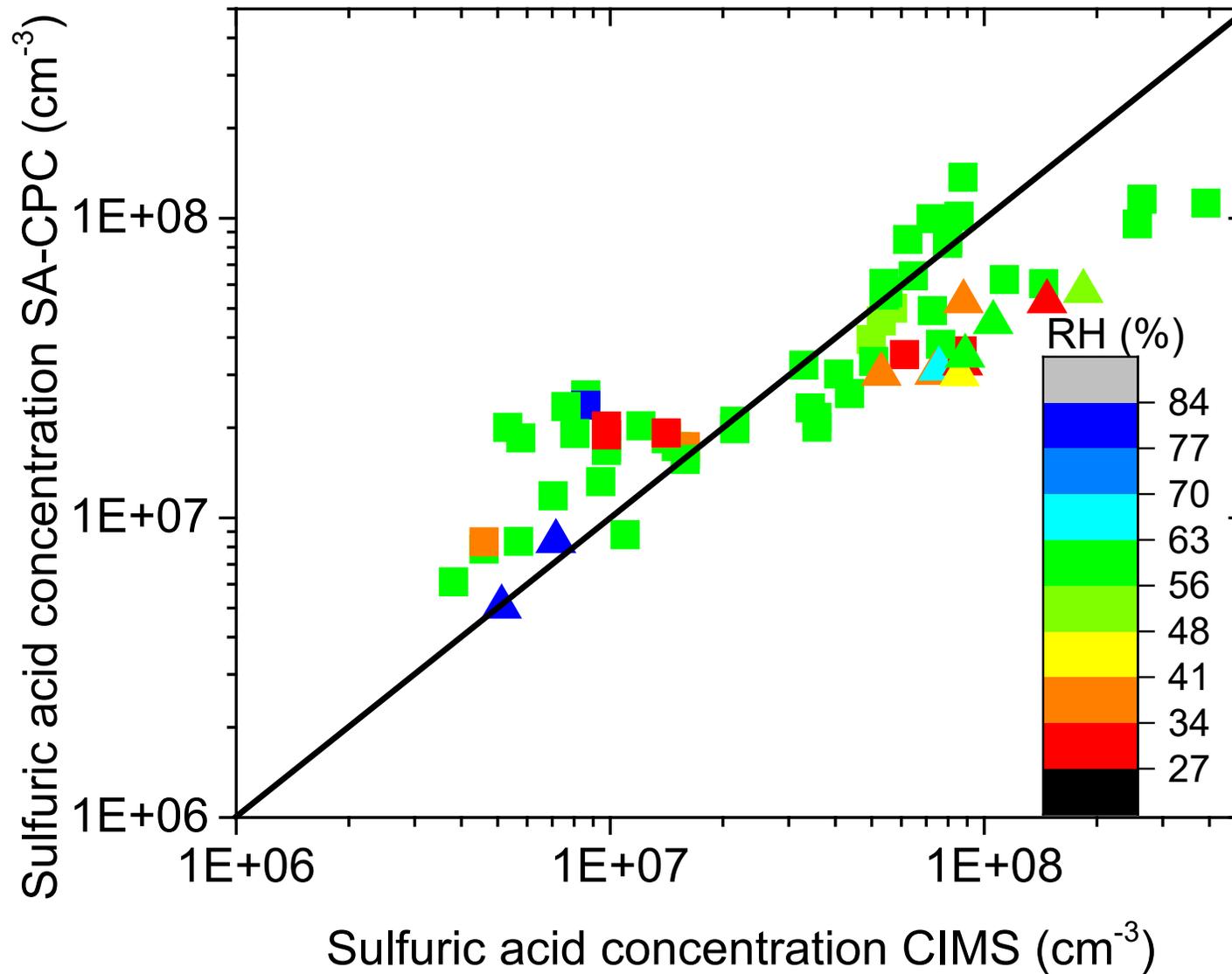




Good agreement between CIMS and SA-CPC



Minimal effects of relative humidity (RH)

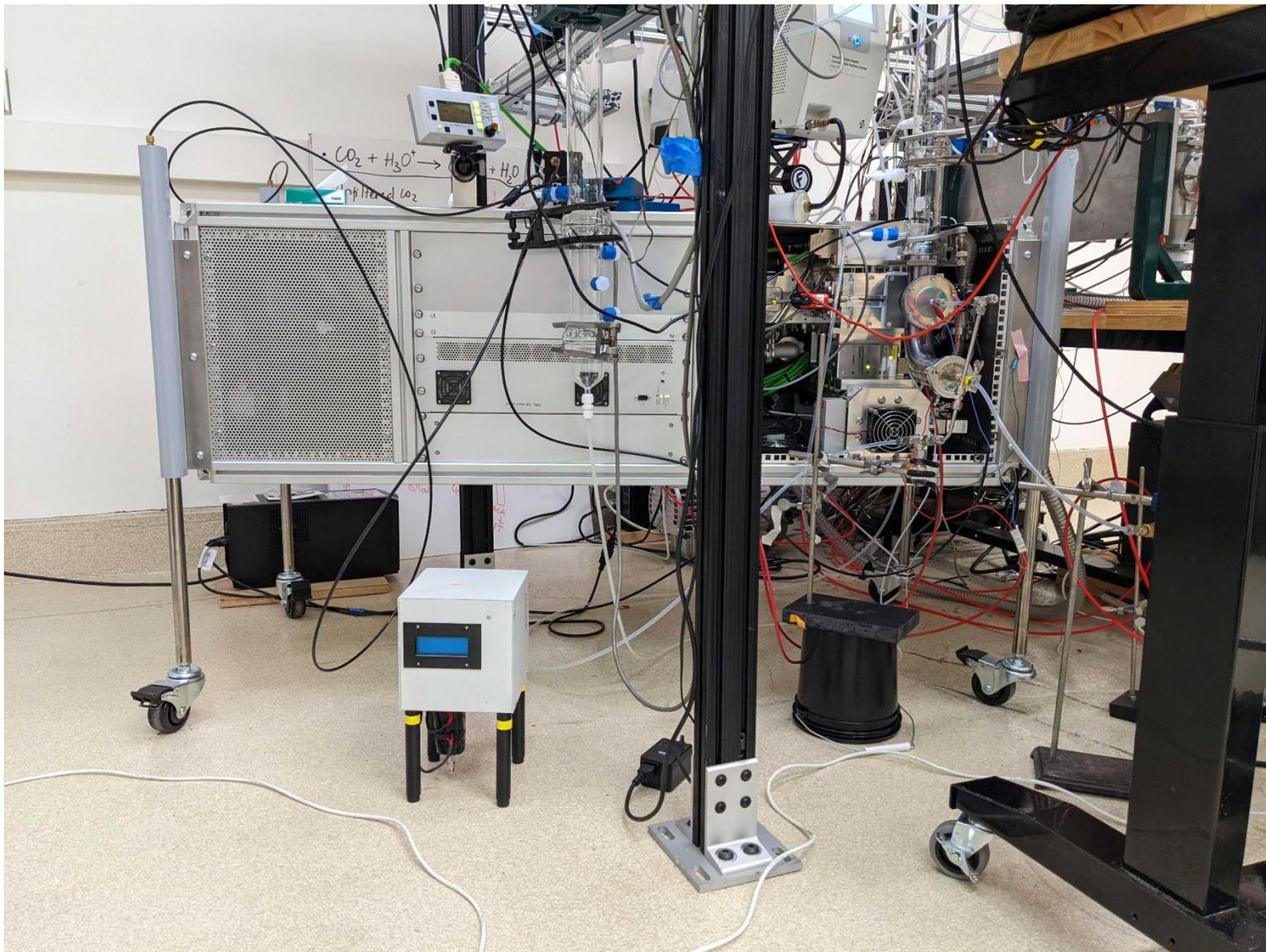


Future work: vertically resolved measurements of sulfuric acid in Pittsburgh and ARM SGP



Dexheimer. Tethered Balloon System (TBS) Instrument Handbook. (2018)

Significant Findings



Use a 1-nm condensation particle counter coupled to a dimethylamine flow reactor to measure gaseous sulfuric acid

Acknowledging my Awesome Group



Questions?

