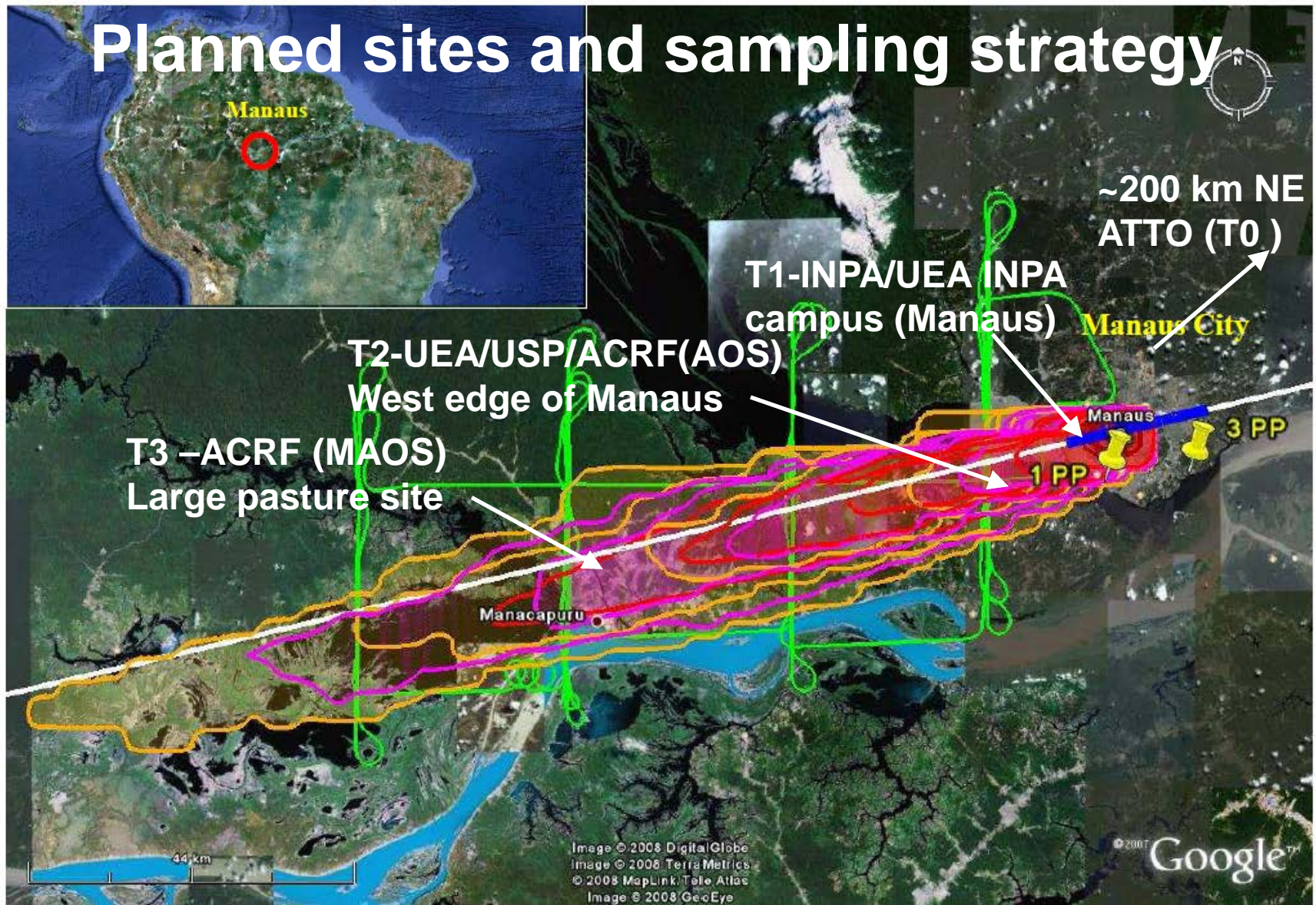




Opportunities for Addressing the ASR Working
Group Questions of the Aerosol Life Cycle

Jian Wang
DOE ASR Science Team Meeting
March 19, 2013, Potomac, MD

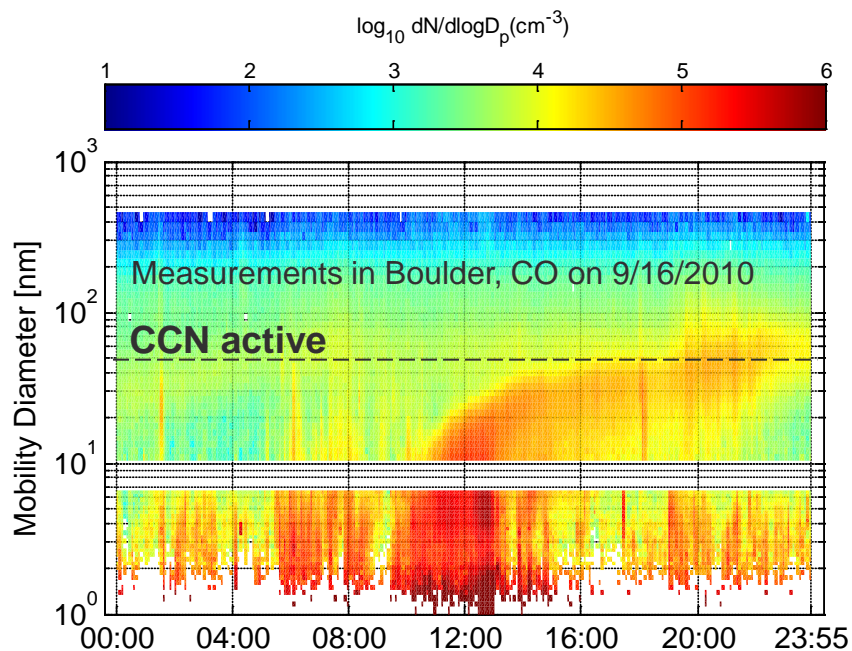
Planned sites and sampling strategy



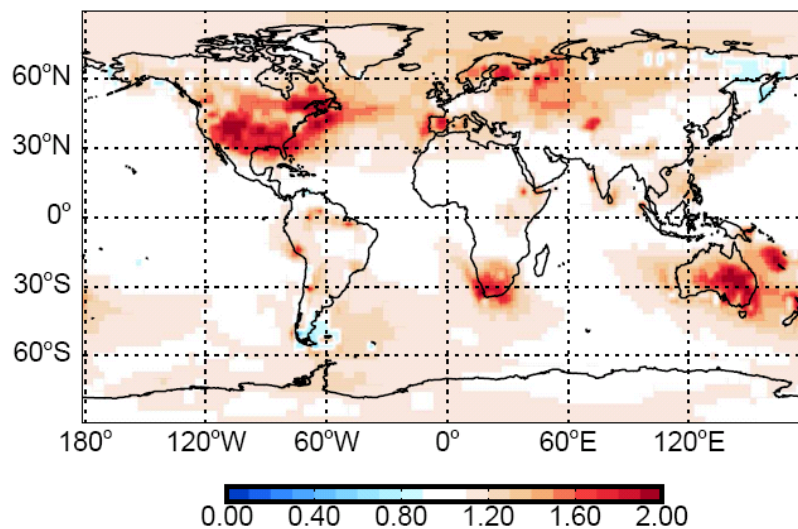
Reference: Kuhn, U.; Ganzeveld, L.; Thielmann, A.; Dindorf, T.; Welling, M.; Sciare, J.; Roberts, G.; Meixner, F. X.; Kesselmeier, J.; Lelieveld, J.; Ciccioli, P.; Kolle, O.; Lloyd, J.; Trentmann, J.; Artaxo, P.; Andreae, M. O., "Impact of Manaus City on the Amazon Green Ocean atmosphere: Ozone production, precursor sensitivity, and aerosol load," *Atmos. Chem. Phys.* **2010**, *10*, 9251-9282.

Objective: New particle formation

Motivation: Strong influence of new particle formation on CCN concentration



Fractional enhancement in CCN Conc. due to NPF



New particle formation (nucleation and initial particle growth) can increase boundary layer CCN concentration by a factor of 2.

No new particle formation observed at surface under pristine conditions in Amazon

I Small clusters and molecules

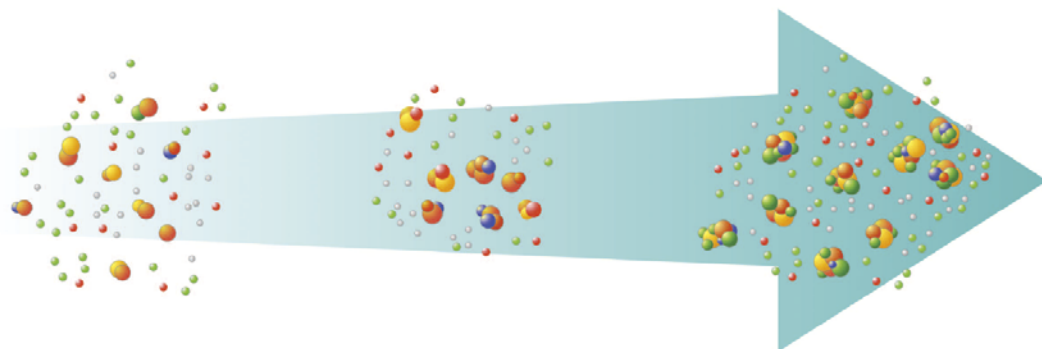
- No direct connection to NPF
- Very slow growth

II Critical size for clustering

- Sulfuric acid and amines
- Stabilizing organic compounds
- Slowly growing (<1 nm/h)
- Determines $J_{1,5}$

III Growing clusters

- Organics start to dominate
- Rapidly growing (~2 nm/h)
- Nano-Köhler
- Determines J_3



New particle formation: a two-step process:

- 1st step: sulfuric acid and amines, ammonia, or organic vapor form stable clusters
- 2nd step: organic vapor leads to enhance growth rate of the clusters to larger sizes.

Kulmala et al., 2013

Key processes:

Gas-phase reactions,
cluster formation/evaporation

Cluster stabilization

Activation of clusters for
enhanced growth

300 ... 500 amu

900 ... 2000 amu

1.1 ... 1.3 nm

1.5 ... 1.9 nm

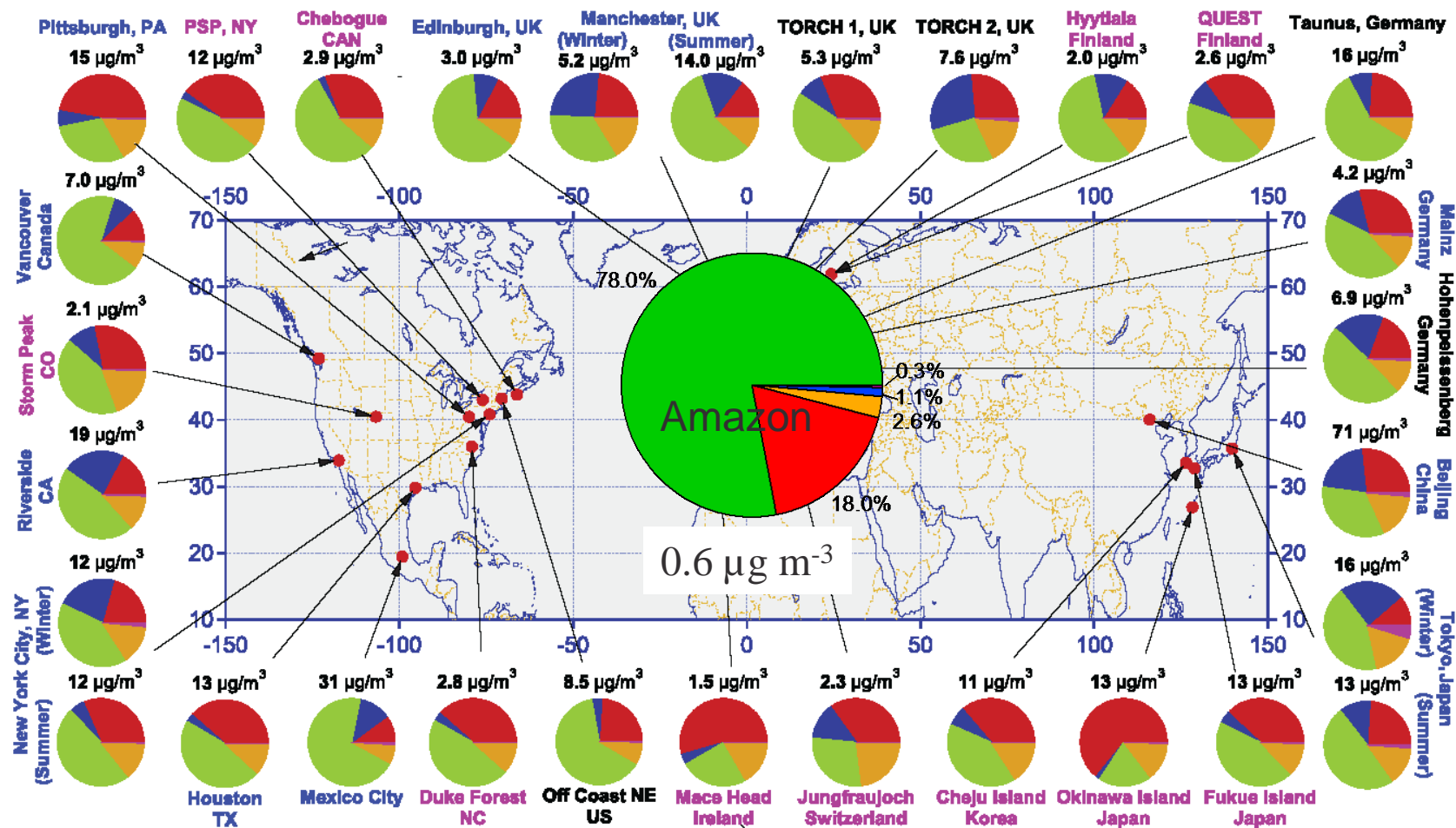
Why no new particle formation?

- Low SO_2 concentration (20-30ppt) suggests the concentration of H_2SO_4 is low
- Organic concentration may be low for the growth of stable clusters.

What is the impact of Manaus plume on NPF?

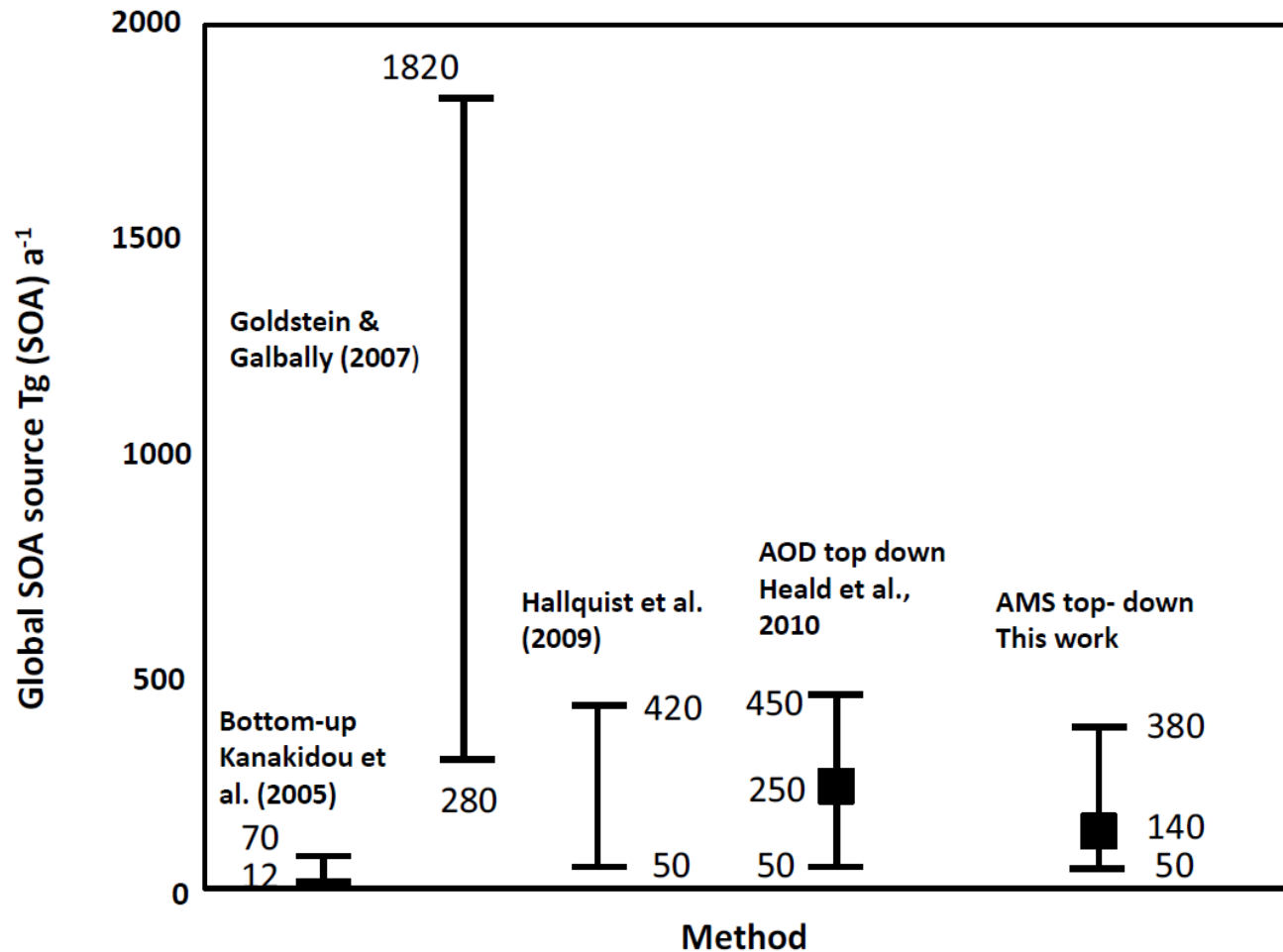
Objective: SOA formation – Interactions between biogenic and anthropogenic emissions

Motivation: Organic compounds are major component of atmospheric aerosol



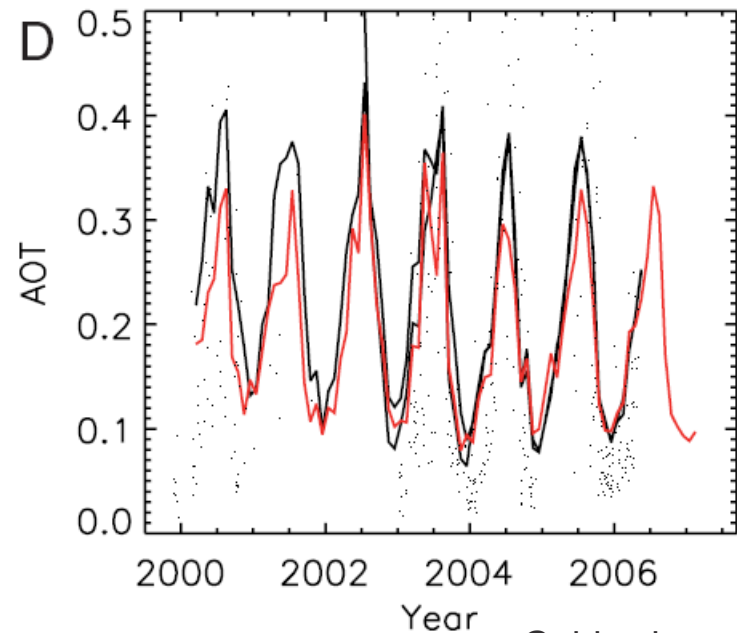
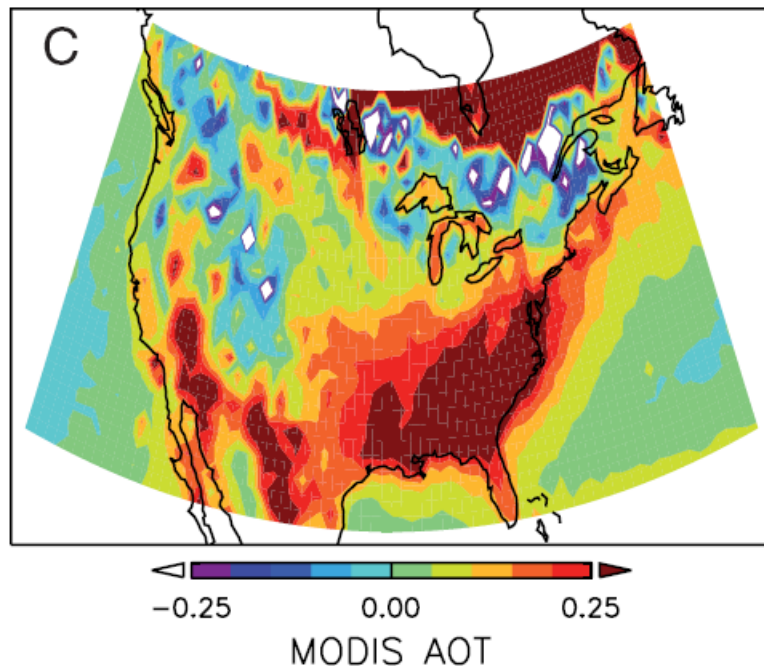
Adapted from Zhang et al., *Geophys. Res. Lett.*, 2007 and Chen et al. *Geophys. Res. Lett.*, 2009, 36, L20806.

Large uncertainty in global SOA budget



Spracklen et al., 2011

Interaction of biogenic & anthropogenic emissions

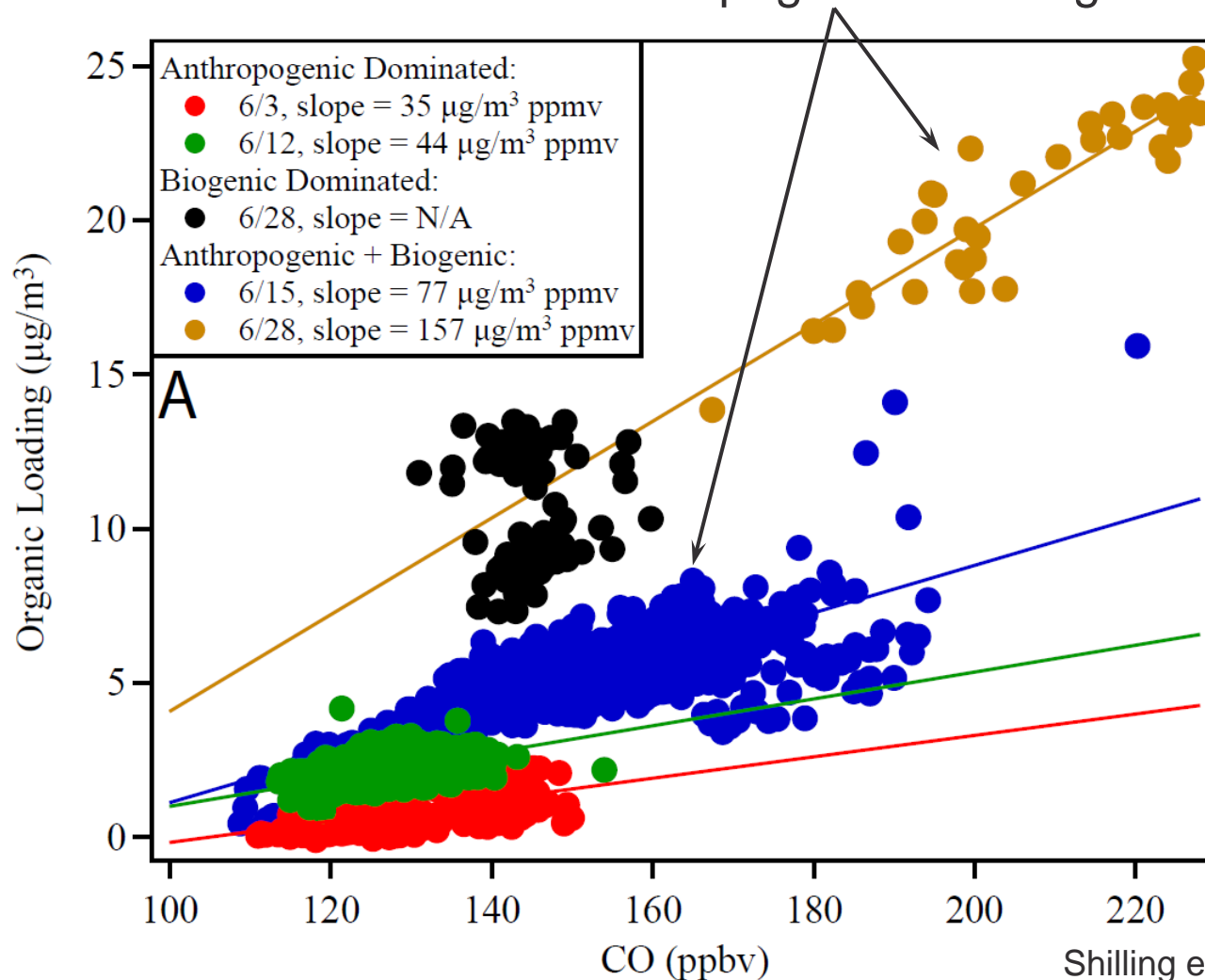


Goldstein et al., 2009

- Higher AOT during summer time (high temperature).
- Large seasonal biogenic emission leads to increased SOA during summer. However, the SOA produced in current models is too small to dominate the total AOT signal.
- >70% of the aerosol carbon is modern (i.e., biogenic origin)
- Hypothesis: The summertime maximum in AOT is due to enhanced SOA formation from biogenic VOC oxidation in the presence of anthropogenic pollutants.

Evidence of enhanced SOA formation from CARES campaign

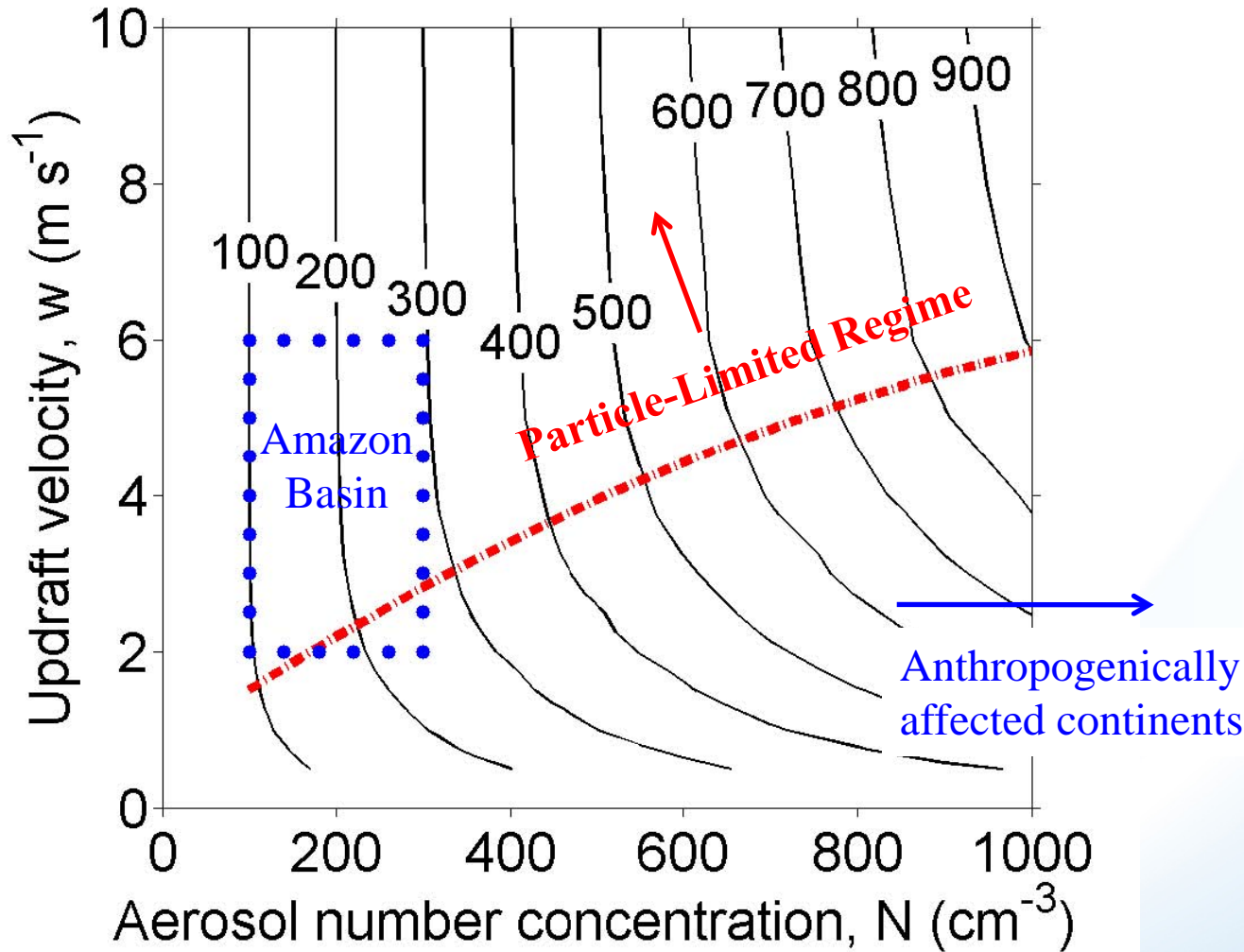
Higher OA production rates when anthropogenic and biogenic emissions mix



Shilling et al., 2013

Objective: Influence of anthropogenic activities on aerosol microphysical, CCN, and optical properties

Motivation: high sensitivity to Pollution in Pristine Regions



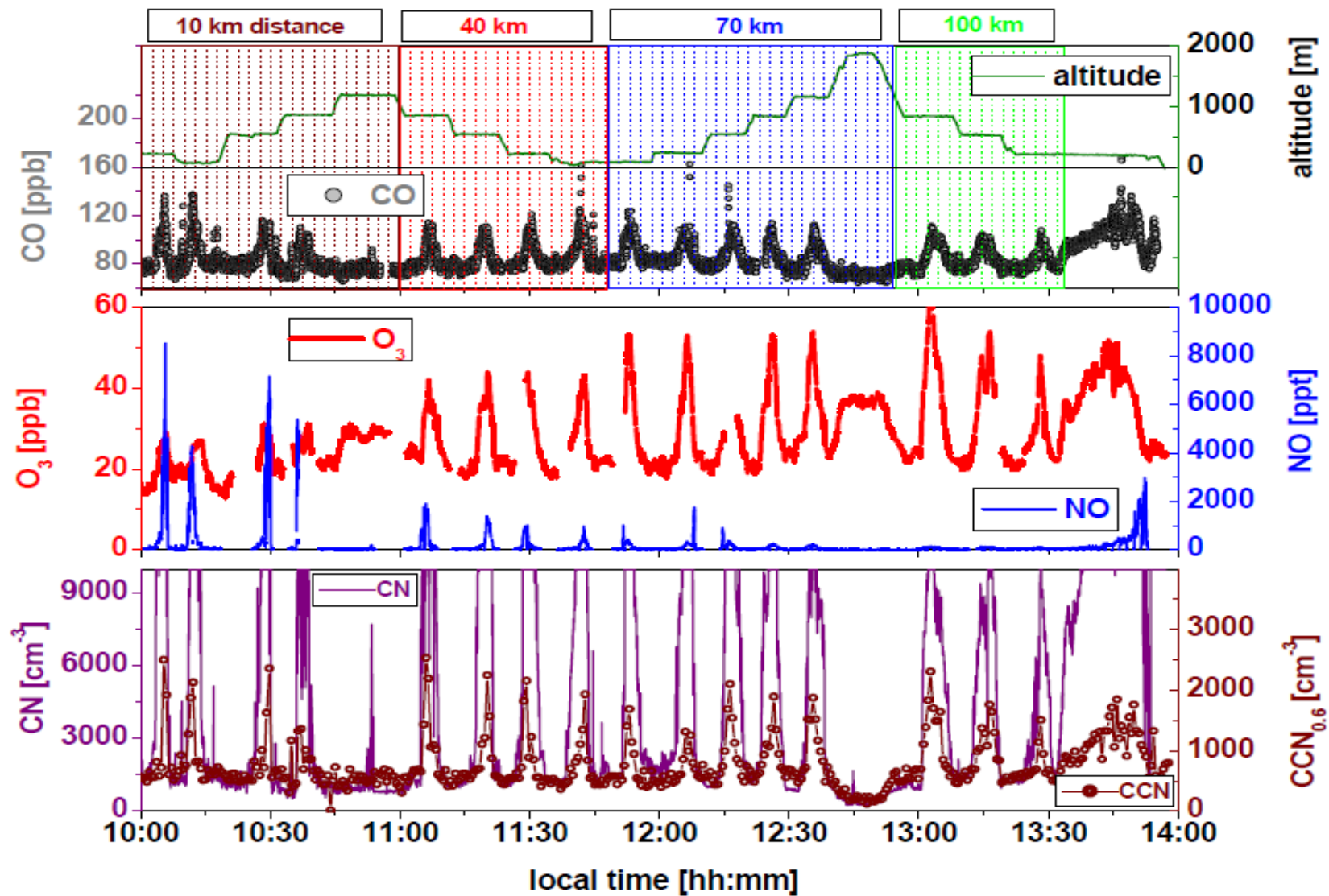
Amazon Basin:

Low aerosol number concentrations +

High water vapor concentration =

Especially susceptible.

Possibility of dramatic changes in energy flows and rainfall patterns



Reference: Kuhn, U.; Ganzeveld, L.; Thielmann, A.; Dindorf, T.; Welling, M.; Sciare, J.; Roberts, G.; Meixner, F. X.; Kesselmeier, J.; Lelieveld, J.; Ciccioli, P.; Kolle, O.; Lloyd, J.; Trentmann, J.; Artaxo, P.; Andreae, M. O., "Impact of Manaus City on the Amazon Green Ocean atmosphere: Ozone production, precursor sensitivity, and aerosol load," *Atmos. Chem. Phys.* **2010**, *10*, 9251-9282.

Influence of anthropogenic activities on aerosol properties

- What is the impact of Manaus plumes on aerosol size distribution, composition, hygroscopicity and CCN spectrum?
- The transformation (e.g., coating) of aerosol particles in Manaus plumes, and its influences on aerosol optical properties
- Impact of Manaus plumes on aerosol properties, and its variability on daily, seasonal, and annual cycles
- Impact of biomass burning on aerosol properties (Dry season)

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