Aerosol Formation and Transport within Eastern Texas

Summary of analyses responsive to questions G and H

- **G: Interactions of local and distant sources that affect PM?**
- **G: Meteorological and chemical conditions conducive to transport?**
- **G: What are background conditions and their variation?**
- **H: Effects of Texan emissions on non-attainment areas?**
- **H: Effects of non-Texan emissions on non-attainment areas?**

Preliminary findings

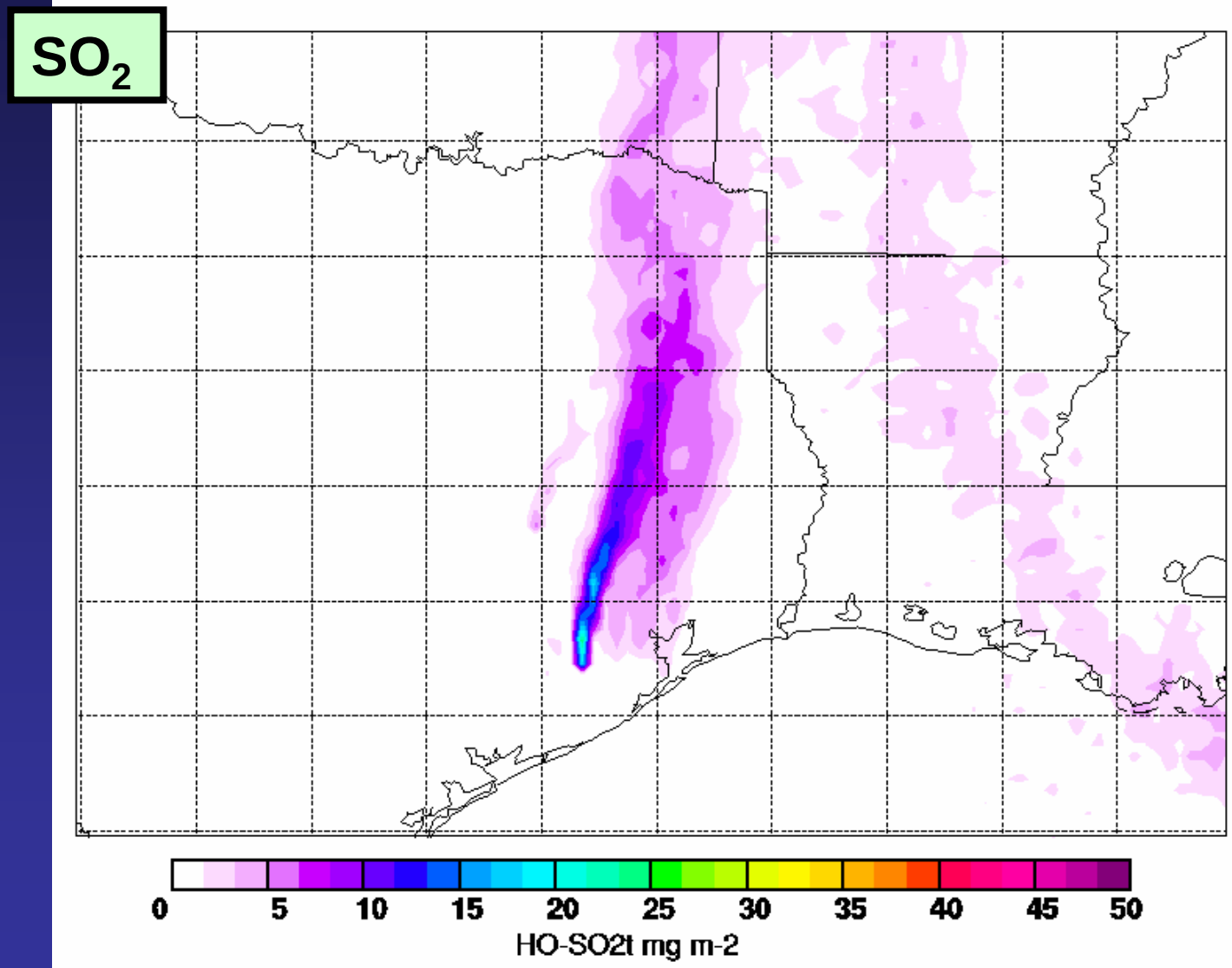
- **Plumes from Texan urban areas affect rural regions**
- **Dust events can happen and are significant**

New findings

- **Ship emissions are a major regional source of SO_2 and primary PM**
- **Organic matter is a significant fraction of emissions from ship channel**
- **Large, interstate transport events can dominate PM levels**
- **Regional and local biomass burning can significantly contribute to local PM burden**
- **Particle properties linked to O_3 through N_2O_5 chemistry**
- **Localized NH_3 sources can lead to ammonium nitrate particle formation**

Preliminary findings

➢Plumes from Texan urban areas affect rural regions



FLEXPART model, A. Stohl, NILU

Preliminary findings:

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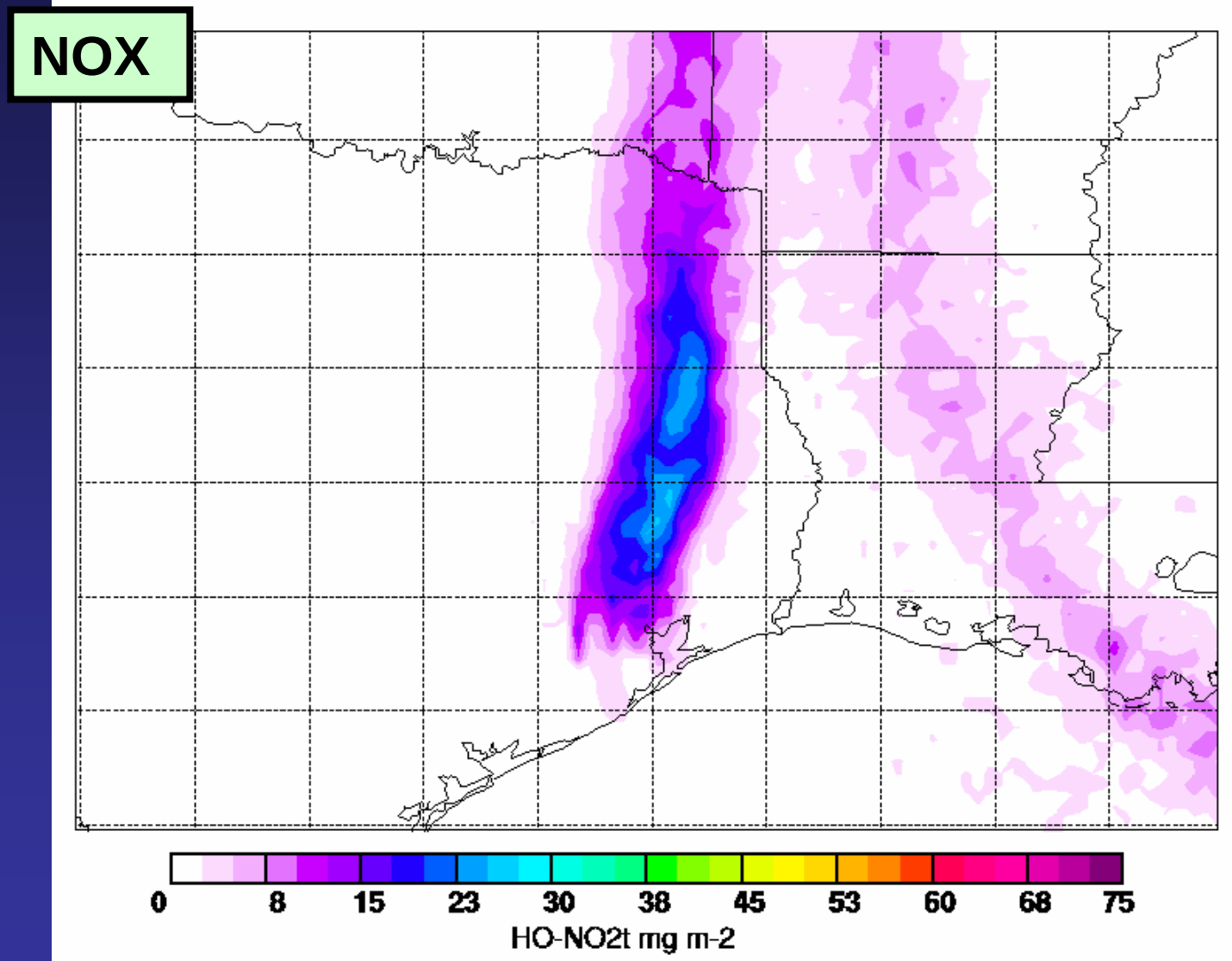

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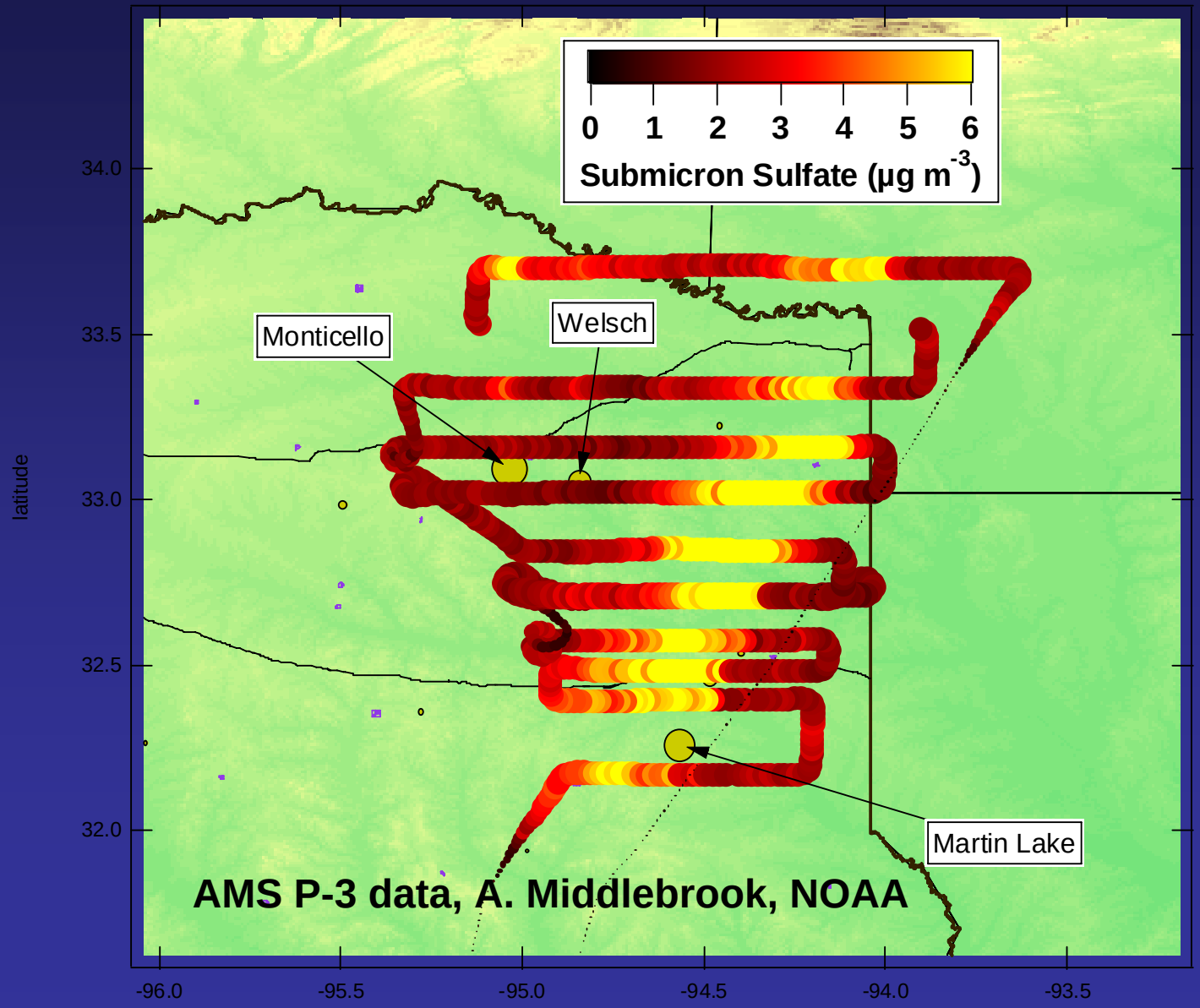

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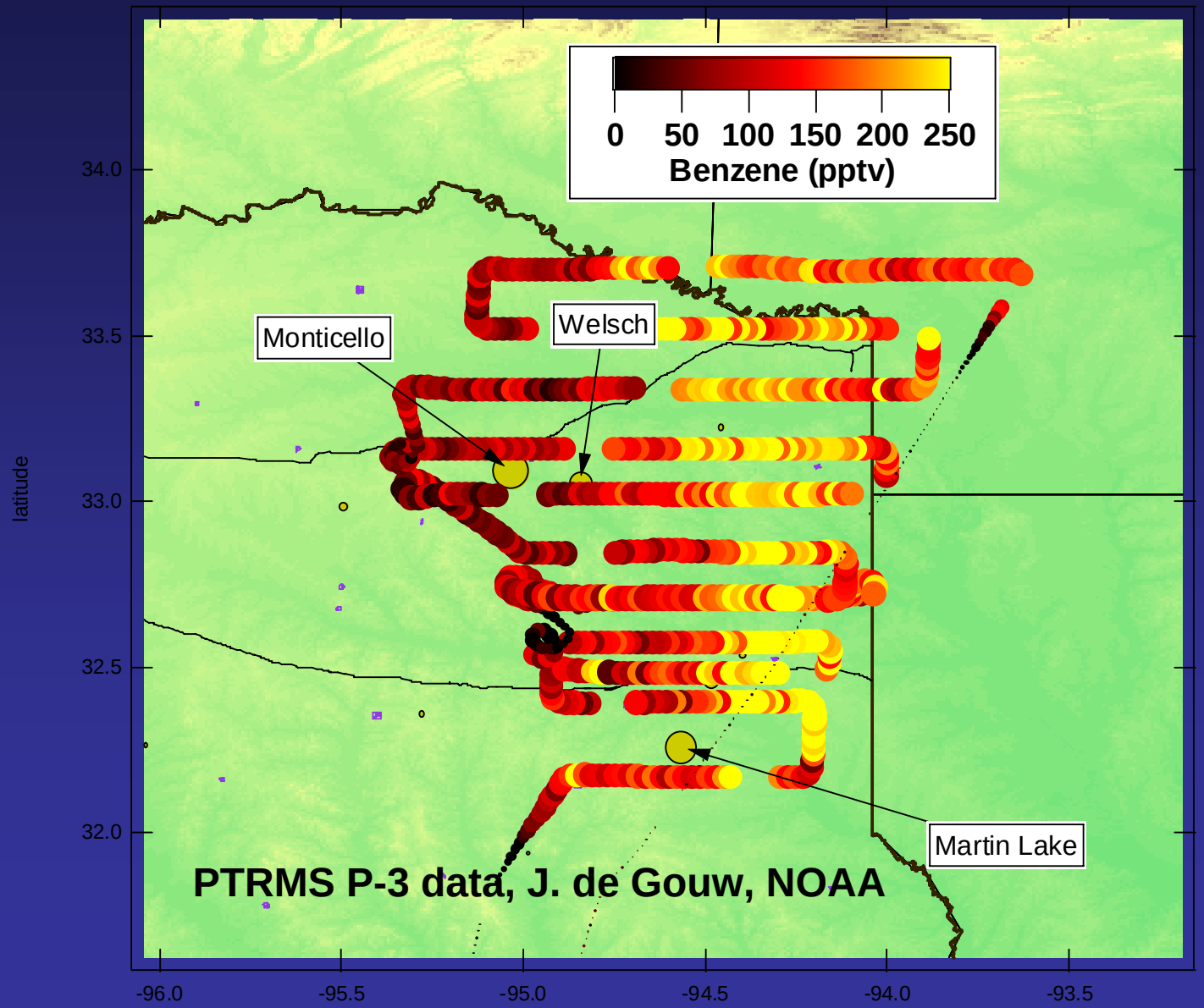

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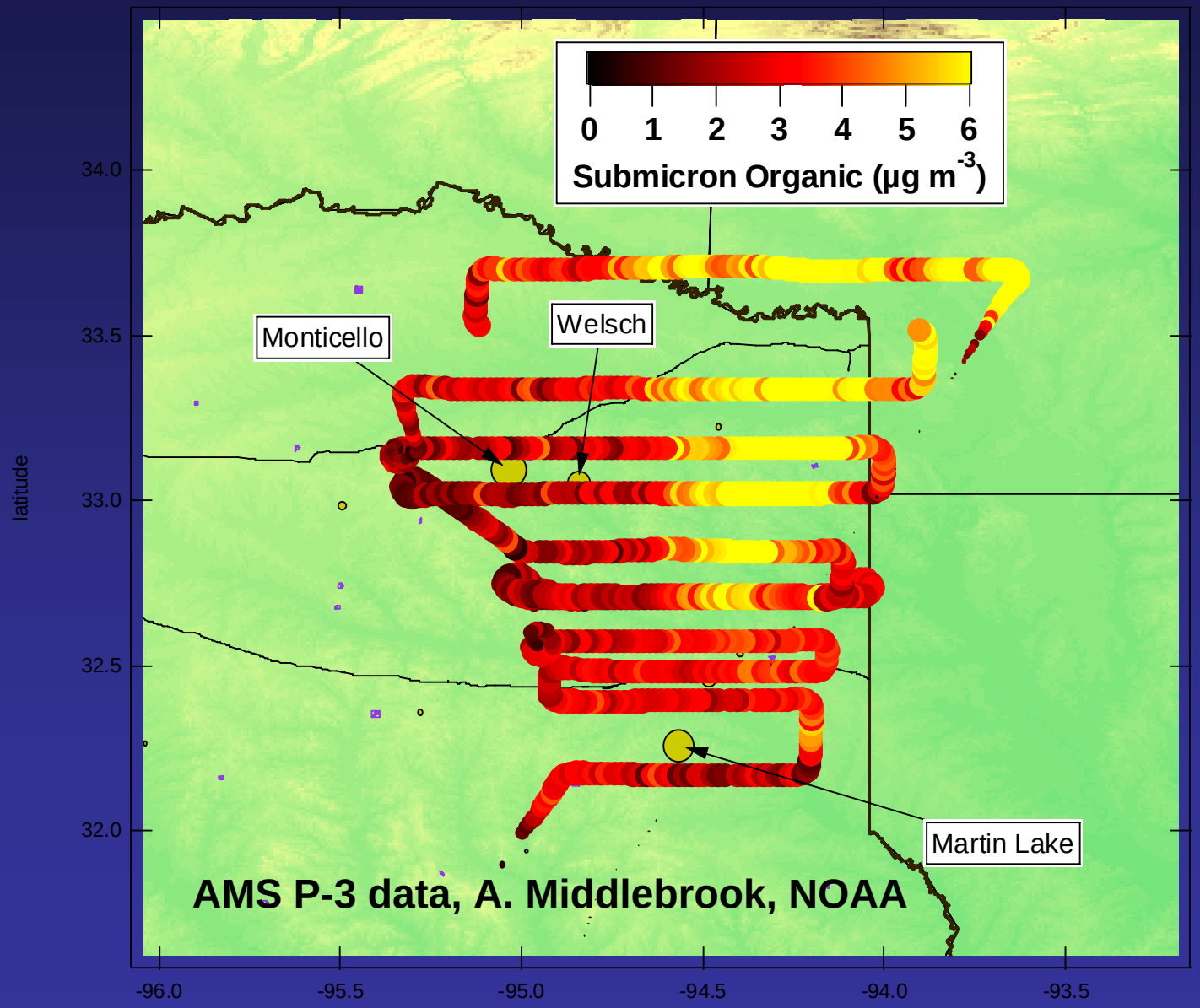
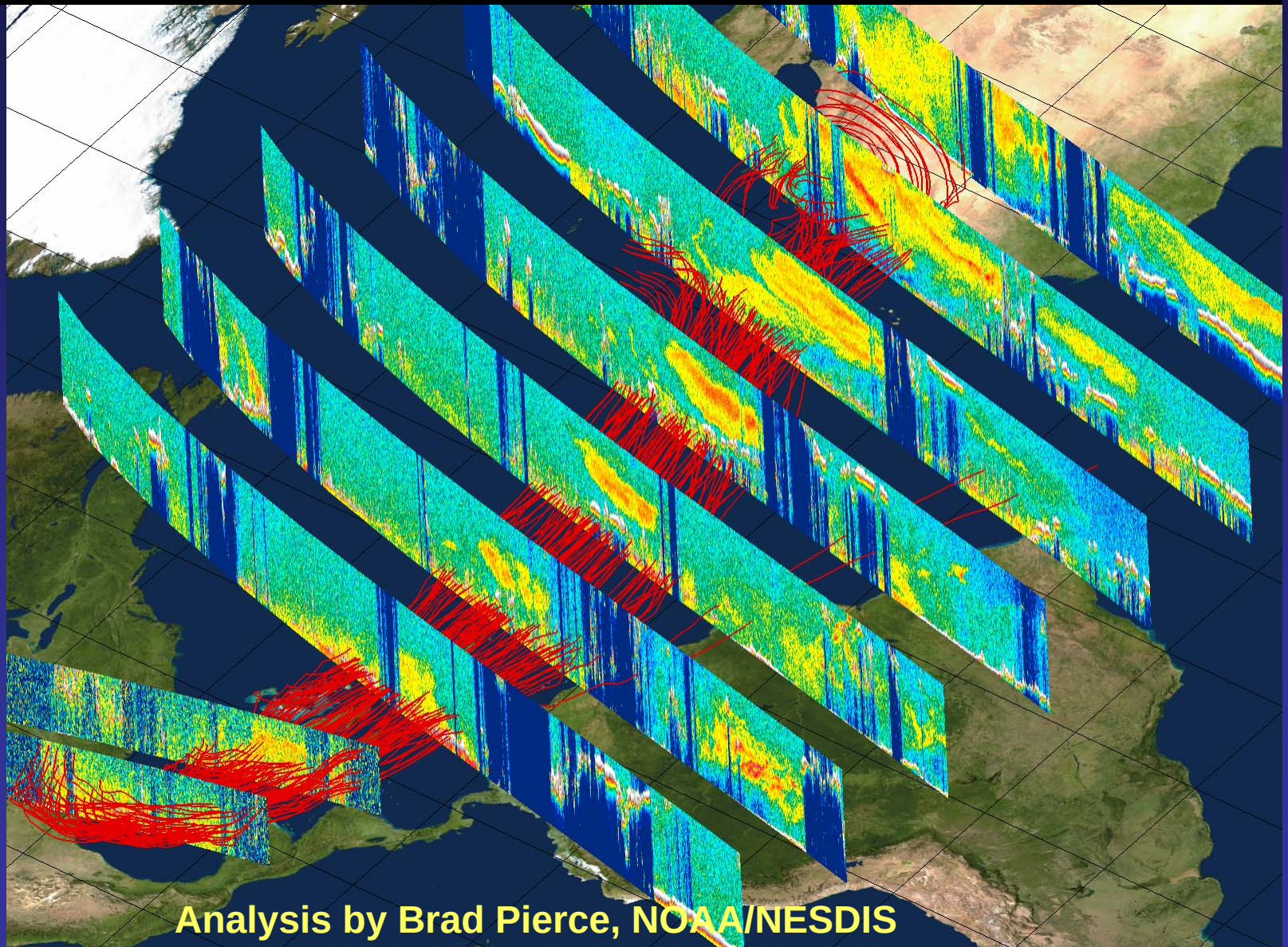


Preliminary findings

- **Dust events can happen and are significant**

CALISPO Backscatter profiles for August 17-28, 2006
Boundary Layer back trajectories from August 28 CALIPSO track shown in red



Analysis by Brad Pierce, NOAA/NESDIS

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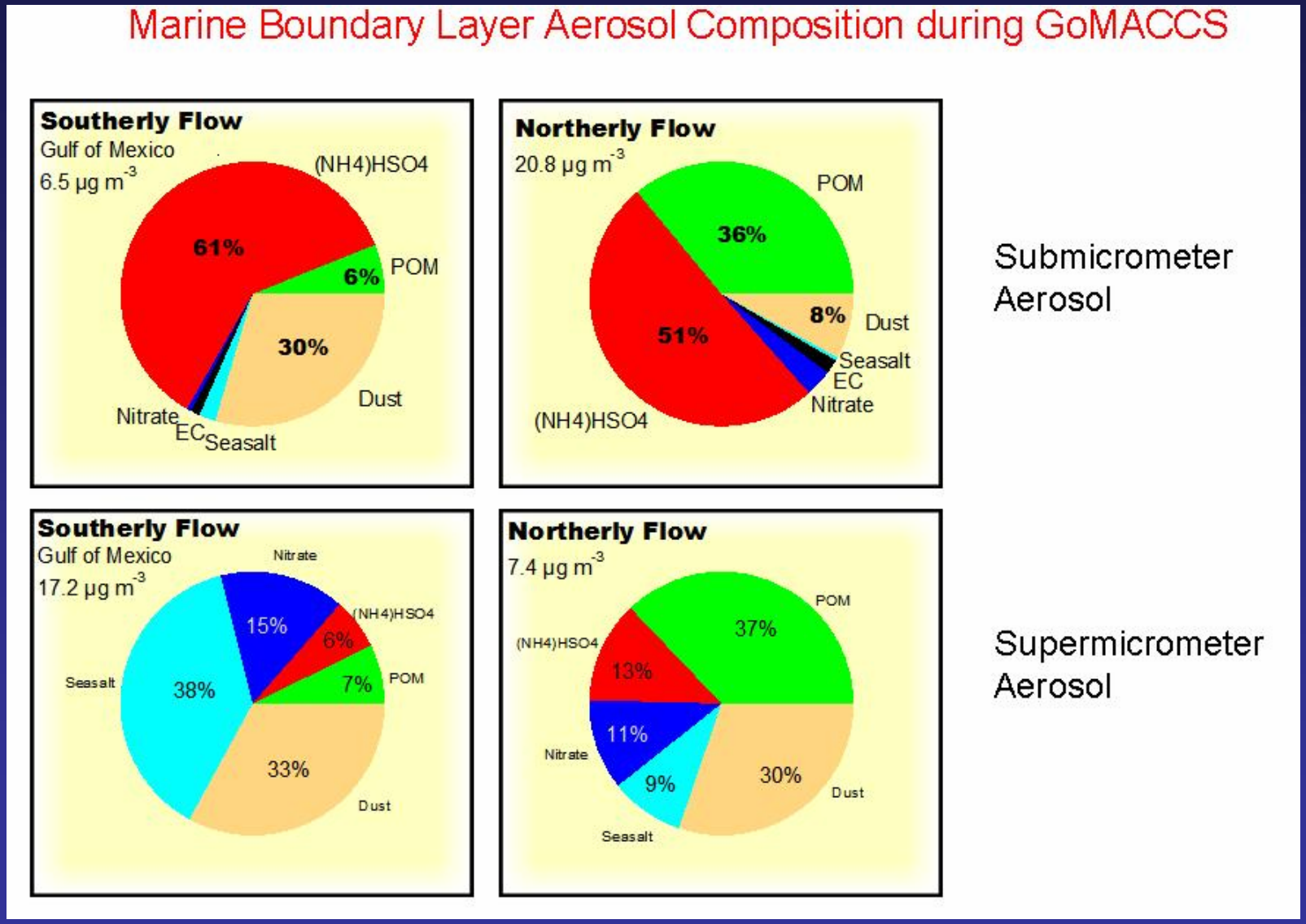

Tim Bates, NOAA/PMEL

New findings

➢**Ship emissions are a major regional source of SO_2 and primary PM**

A variety of ship types measured--116 plumes quanitified

Dan Lack, NOAA/ESRL

New findings

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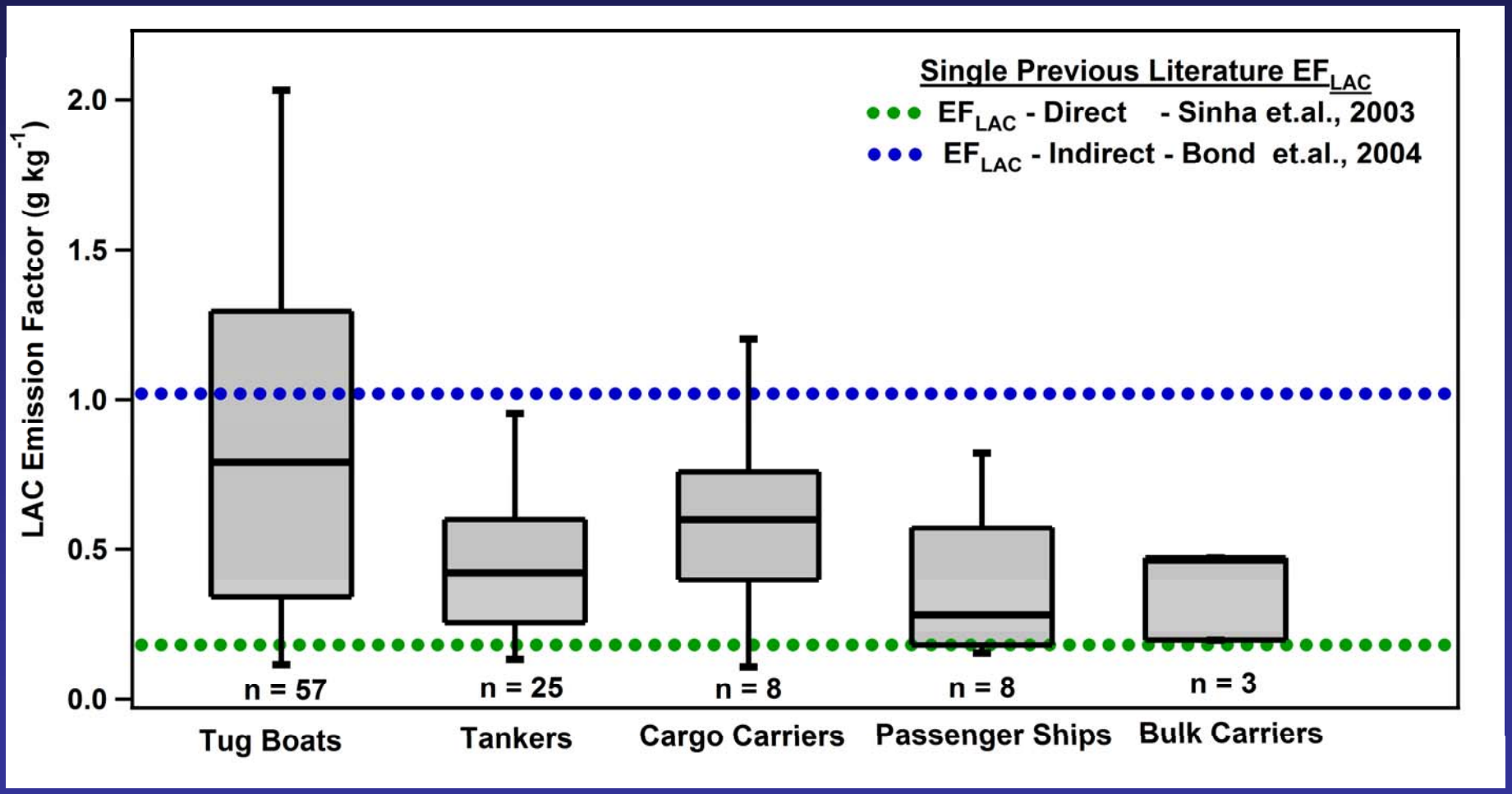
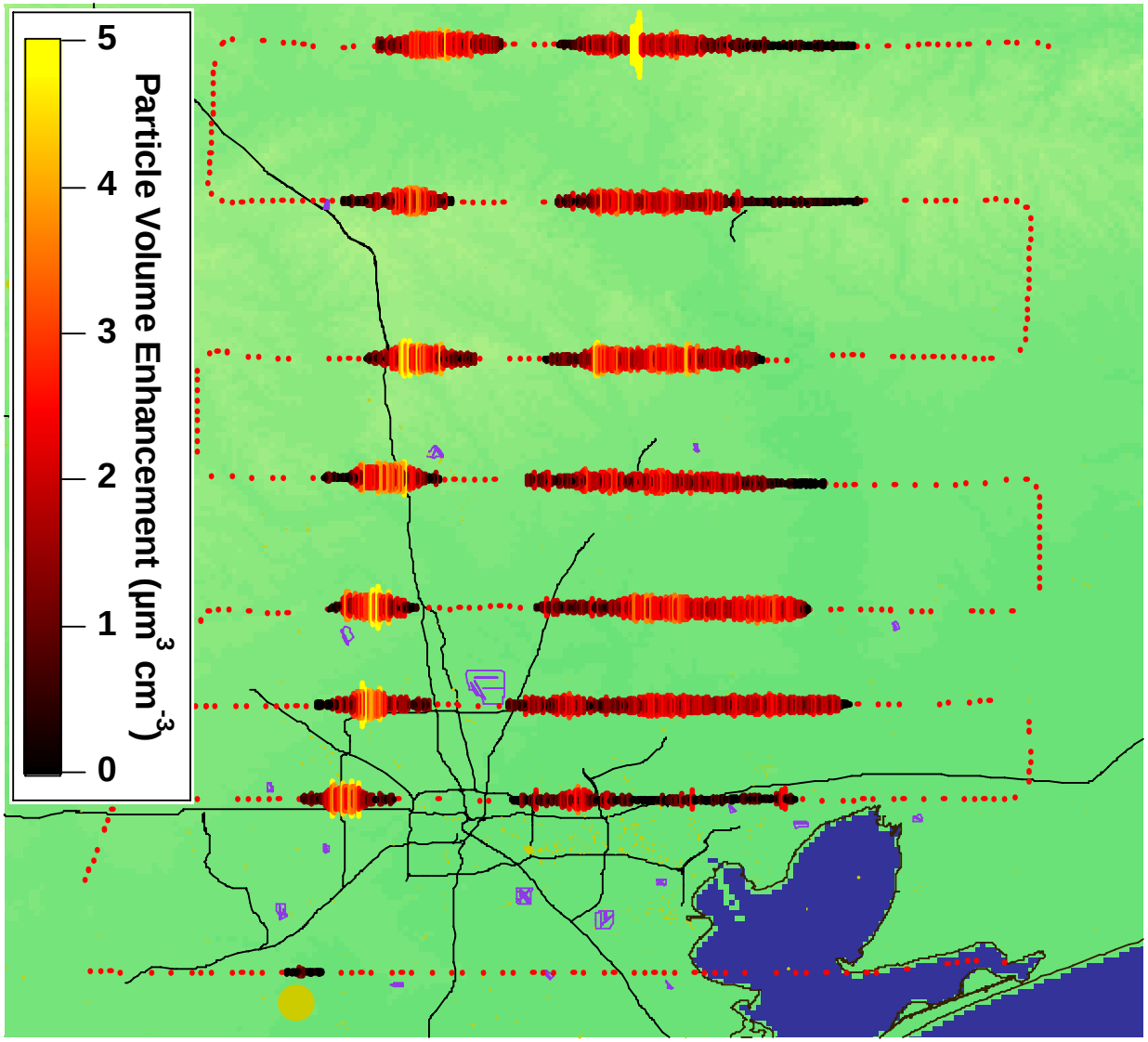


Dan Lack, NOAA/ESRL

New findings

- **Secondary organic matter is a significant fraction of emissions from ship channel**



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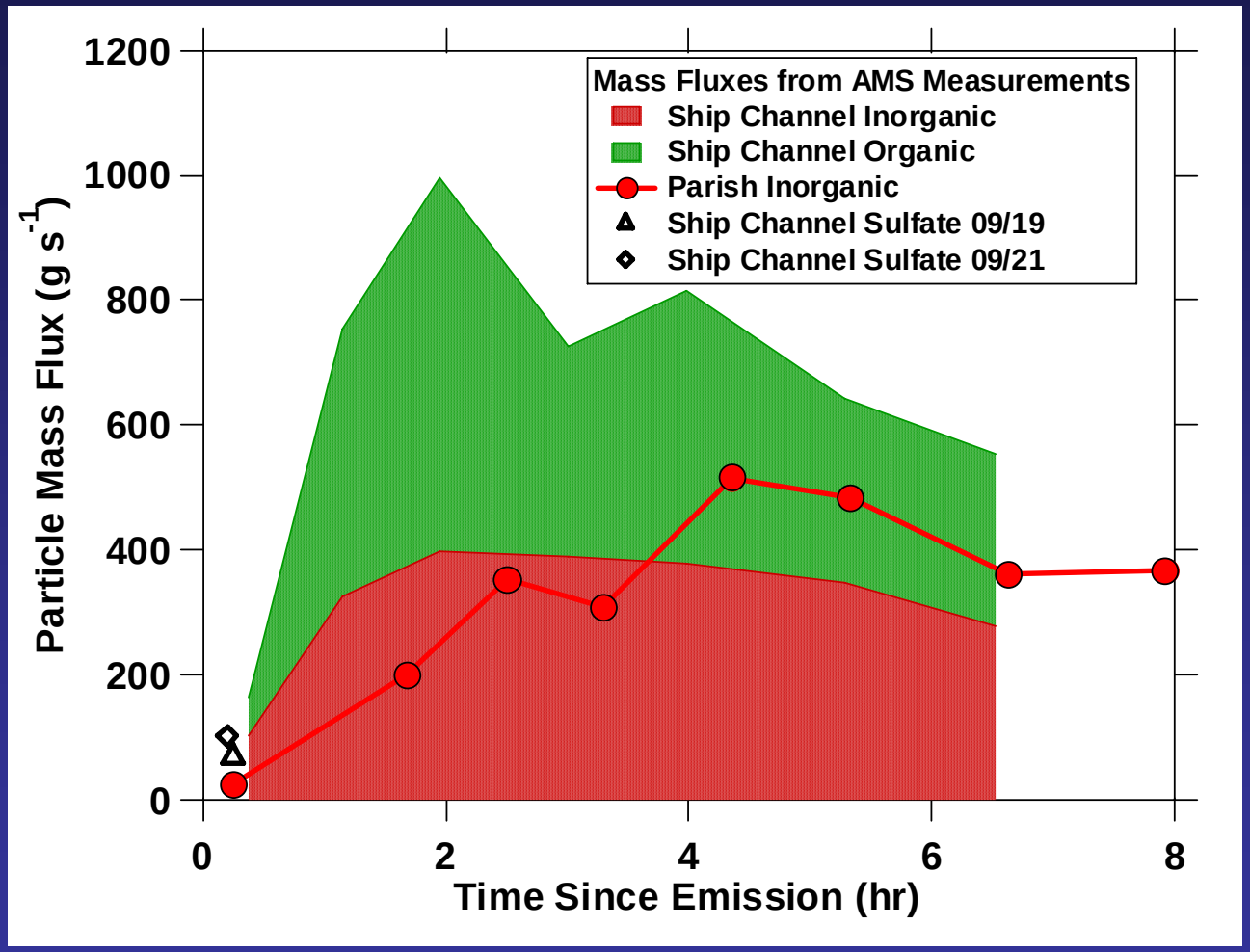


Ship channel particle mass is ~50% organic

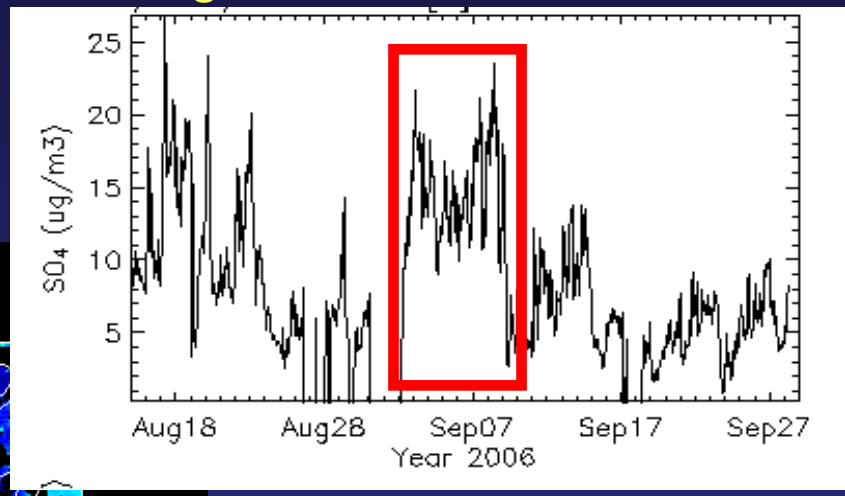
Parish plume has no significant organic component

Black carbon flux from ship channel ~10 g s^{-1} (not shown), small but not negligible

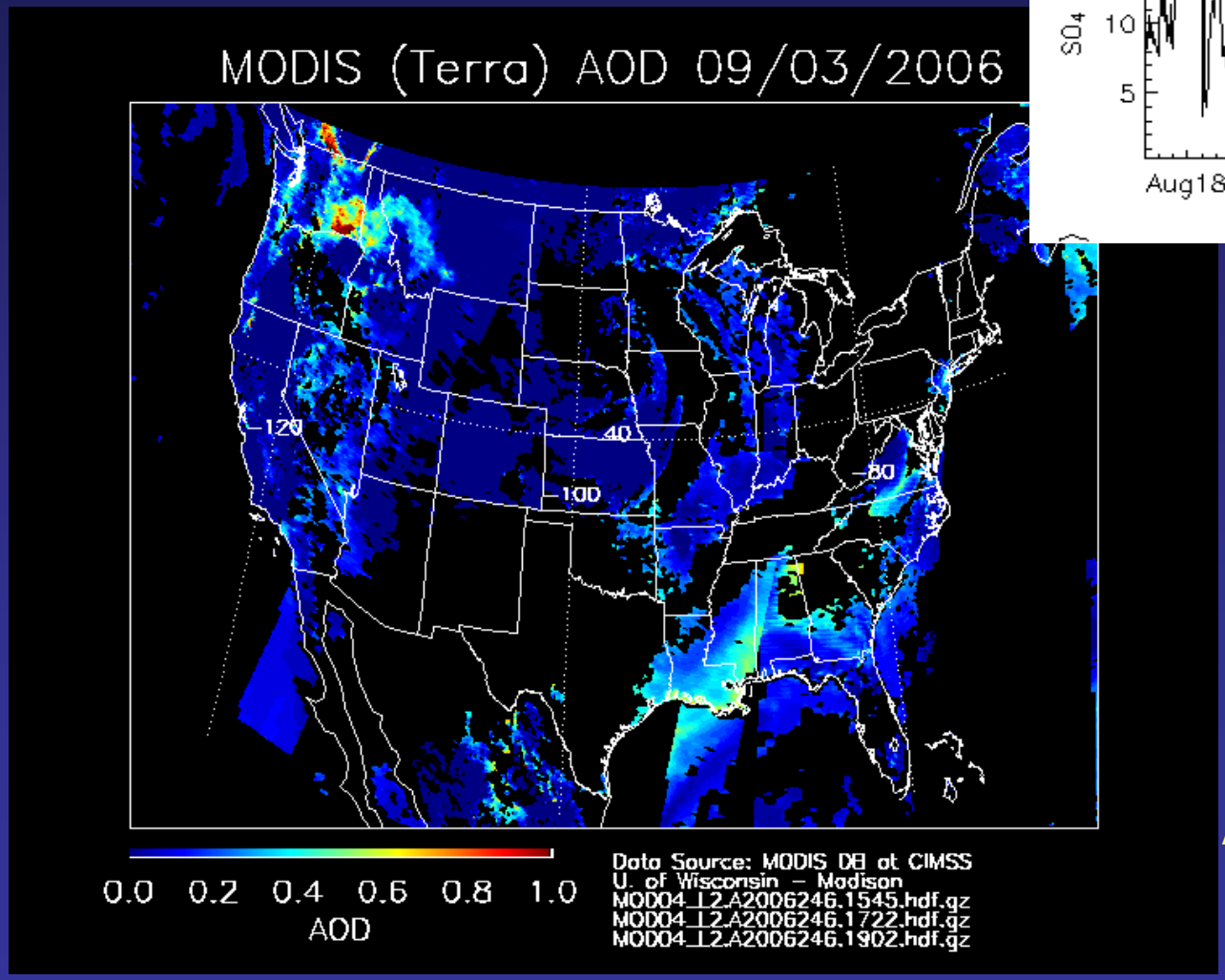
AMS data from A. Middlebrook, NOAA/ESRL

New findings

- **Large, interstate transport events can influence regional PM levels**



Deer Park CAMS site



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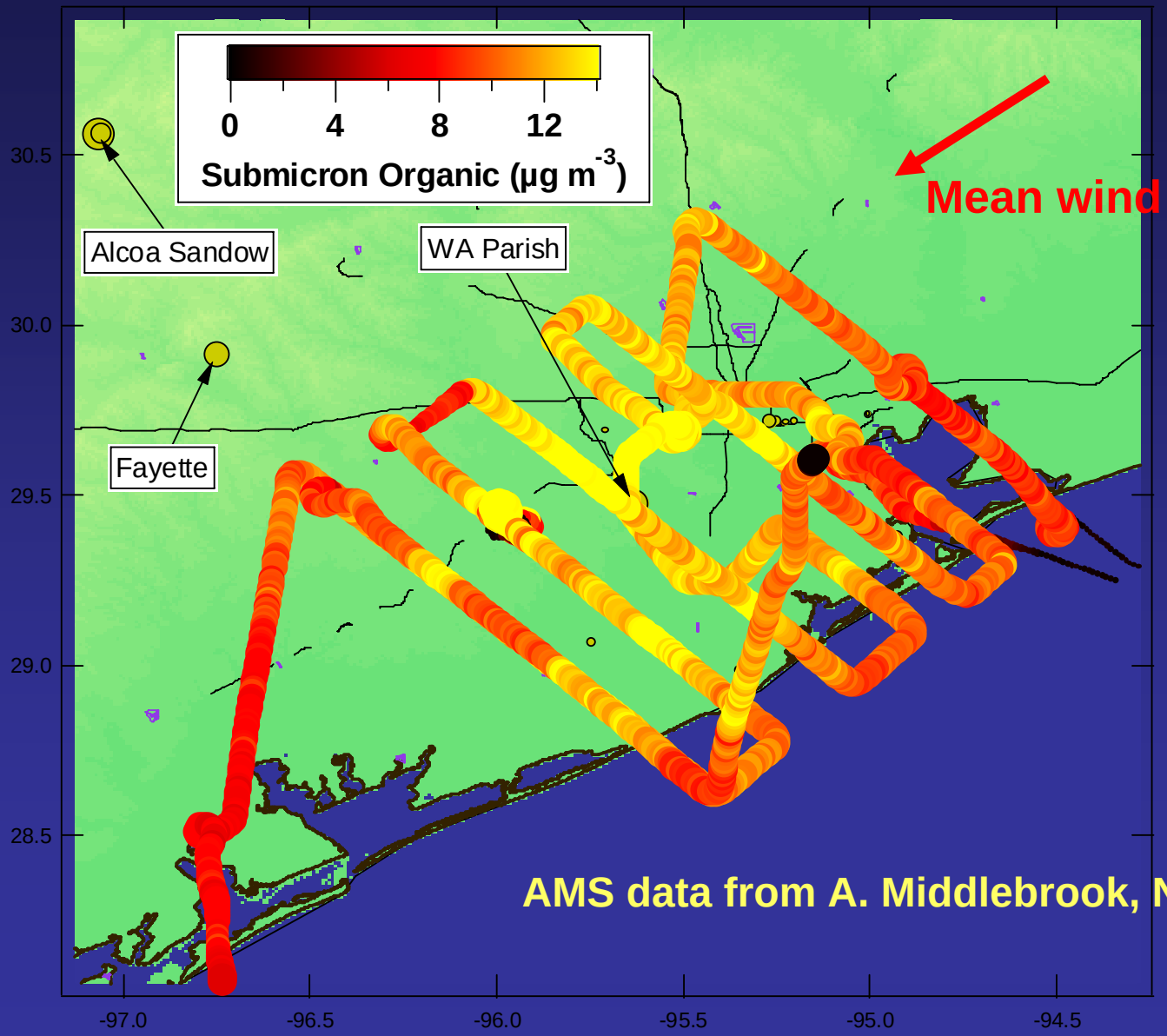
New findings

➢**Regional and local biomass burning can significantly contribute to local PM burden**



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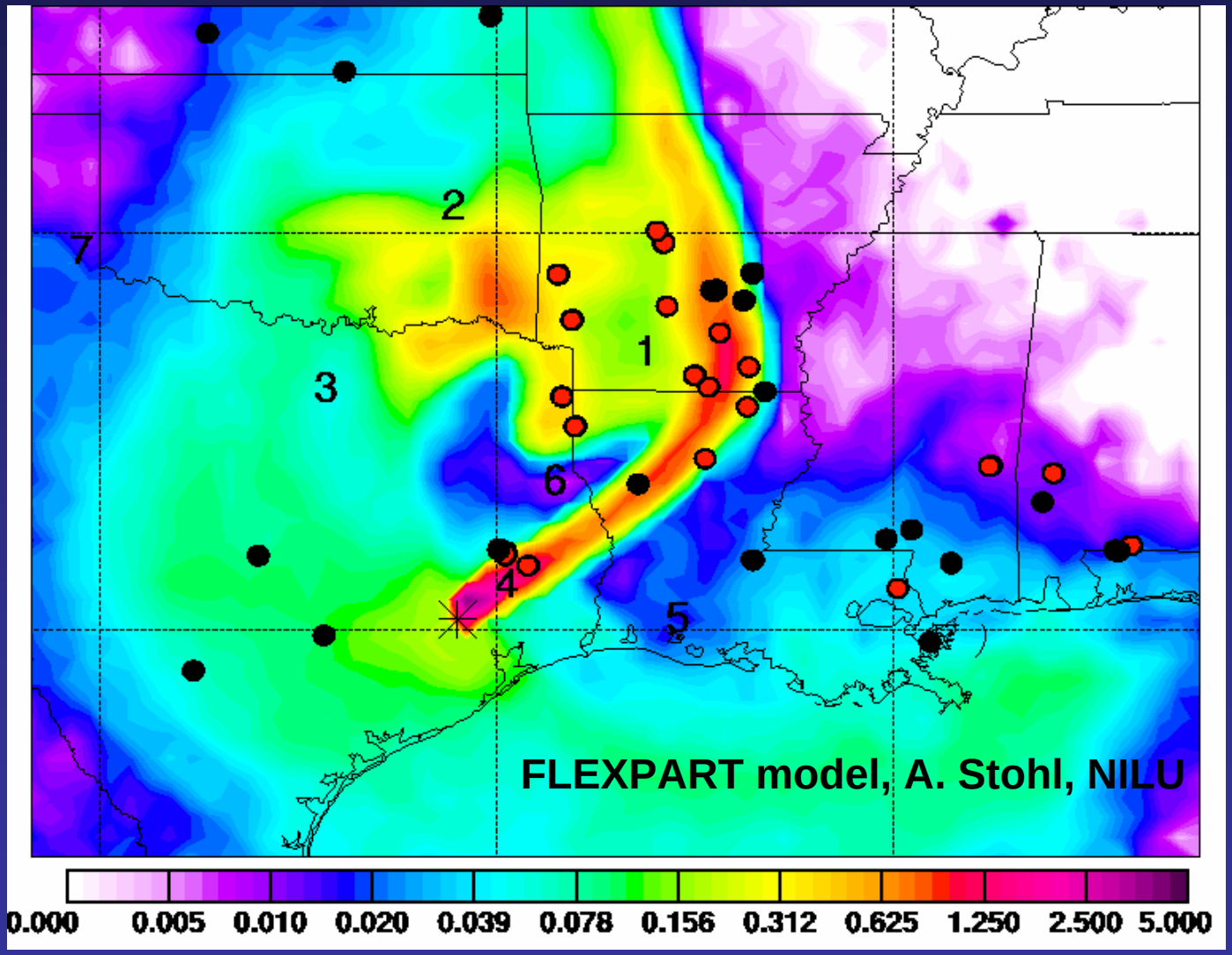
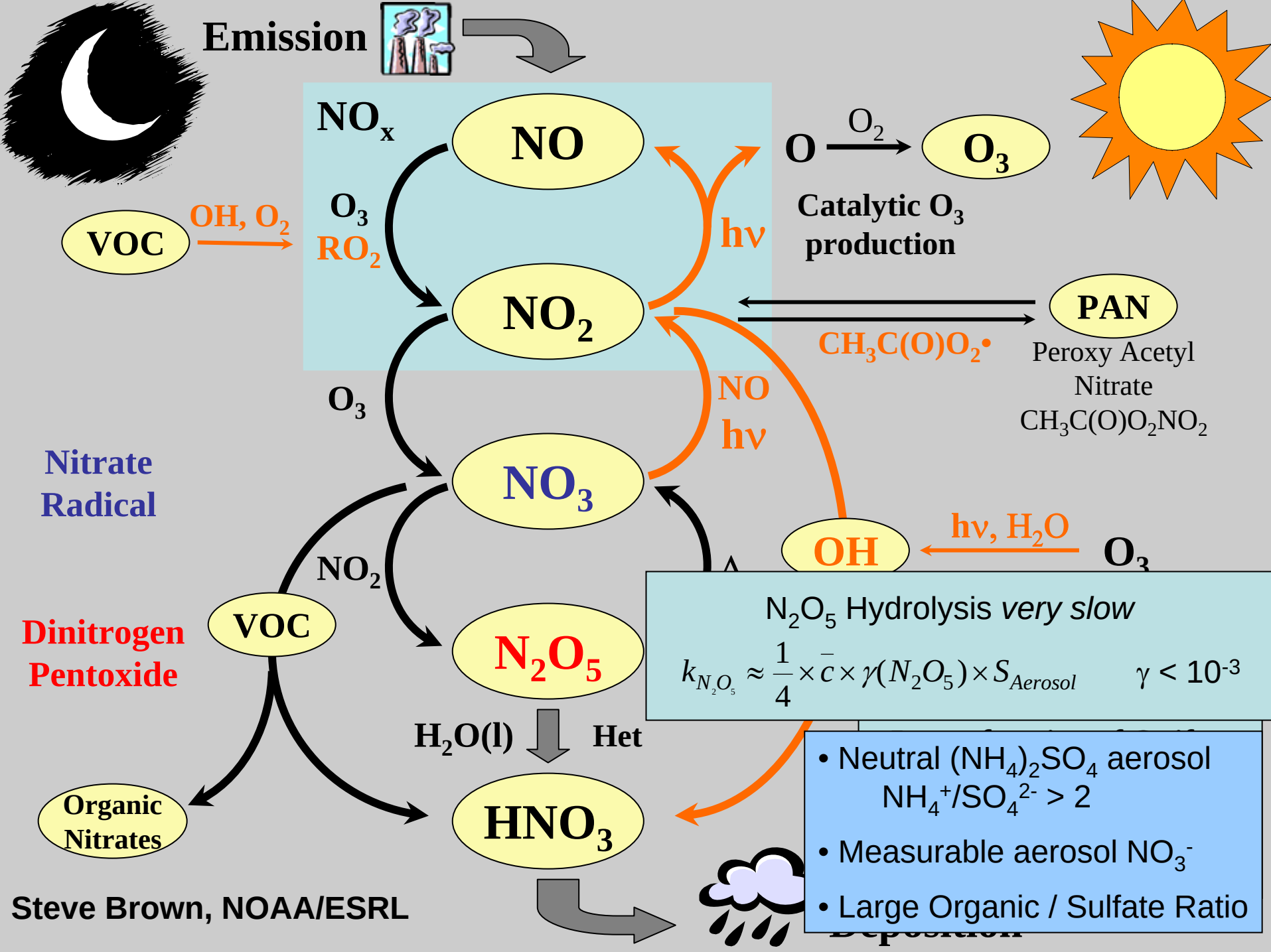


New findings

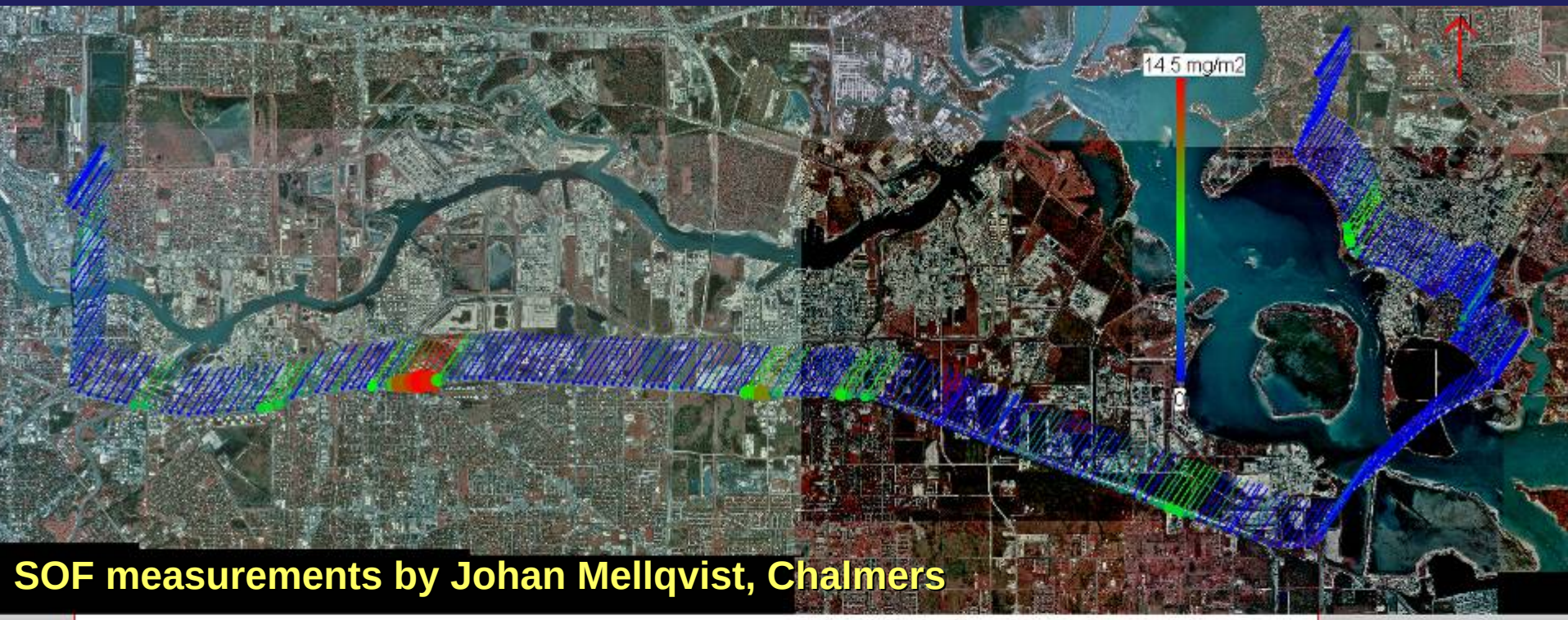
- **Particle properties linked to O_3 through N_2O_5 chemistry**
- **Important for regional redistribution of reactive nitrogen at night**
- **Linked to transport by nocturnal jets following collapse of daytime PBL**


Emission
NO_x
NO
NO_2
NO_3
N_2O_5
HNO_3
O_3
RO_2
O_3
NO_2
VOC
OH, O_2
hν
NO
hν
O
O_2
O_3
Catalytic O_3 production
PAN
$CH_3C(O)O_2$•
Peroxy Acetyl Nitrate
$CH_3C(O)O_2NO_2$
OH
hν, H_2O
O_3
Nitrate Radical
Dinitrogen Pentoxide
VOC
Organic Nitrates
$H_2O(l)$
Het
Steve Brown, NOAA/ESRL
N_2O_5 Hydrolysis *very slow*
$k_{N_2O_5} \approx \frac{1}{4} \times \bar{c} \times \gamma(N_2O_5) \times S_{Aerosol}$
γ < 10^{-3}
• Neutral $(NH_4)_2SO_4$ aerosol
$NH_4^+/SO_4^{2-} > 2$
• Measurable aerosol NO_3^-
• Large Organic / Sulfate Ratio

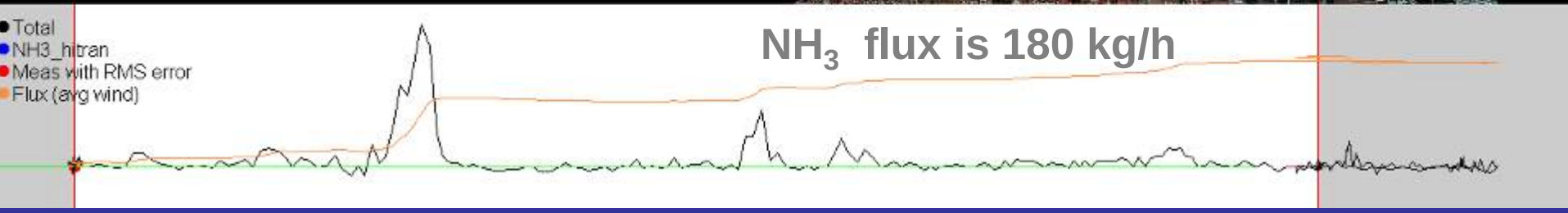
New findings

➢Localized NH_3 sources can lead to ammonium nitrate particle formation

- Solar occultation flux measurements of ammonia source in Houston ship channel on 19 September 2006
- Similar independent observations from airborne measurements



SOF measurements by Johan Mellqvist, Chalmers



Additional analyses

- Evaluate day-to-day differences in secondary particle mass growth rates as a function of OH concentrations. Is OH driving the formation of both sulfate and SOA? How does SOA growth compare to other urban areas?

- Synthesize transport information from models, satellites, lidar, and in situ data to build coherent and climatological understanding of aerosol sources

- Continue evaluation of importance of ship emissions--can this source be seen in the surface and airborne datasets?

- Continue evaluation of aerosol effects on nighttime nitrogen chemistry