Combustion Aerosol as a Source of CCN on Global Scales: Amazon Biomass Burning and other Continental Sources

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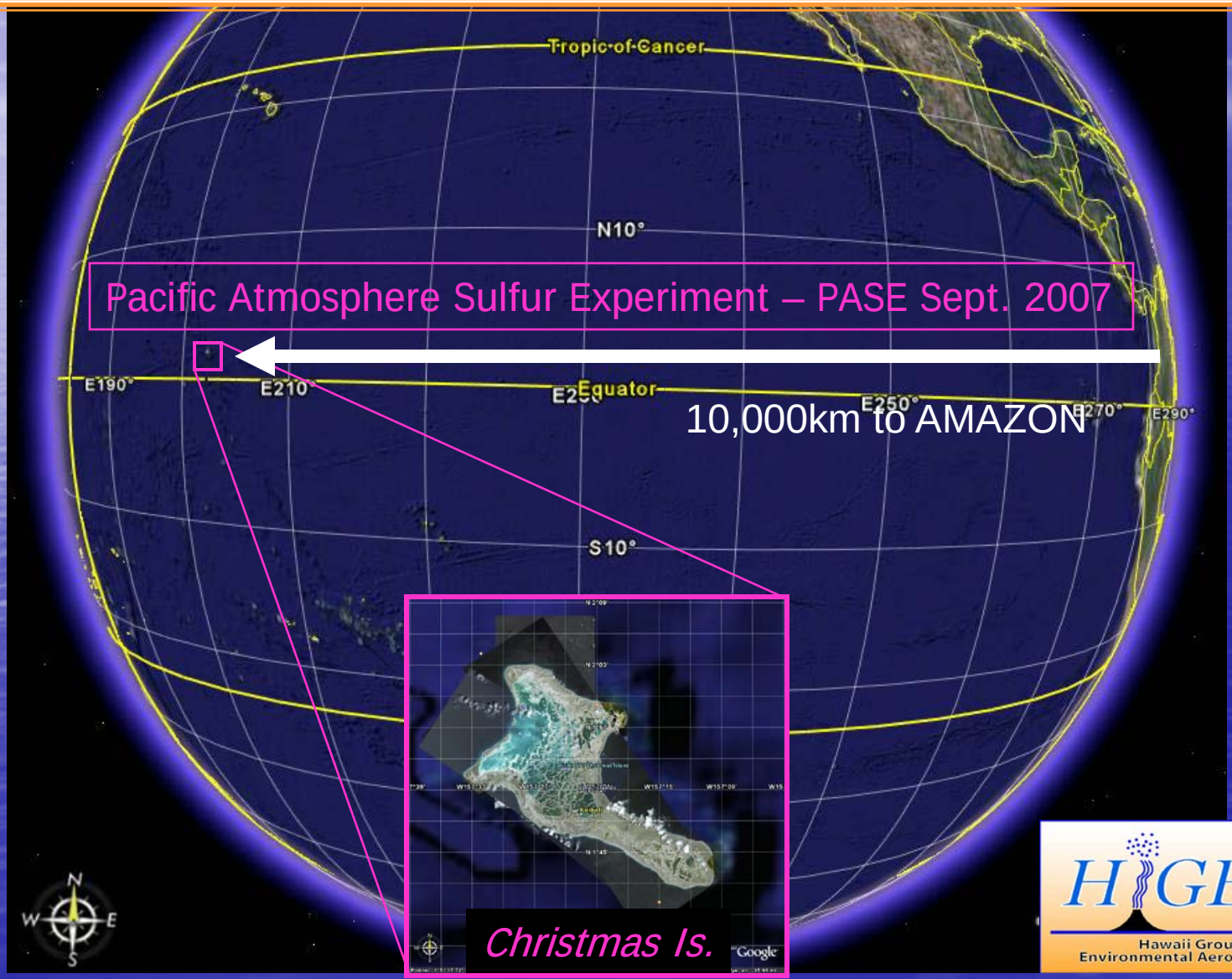

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OBJECTIVE OF PRESENTATION

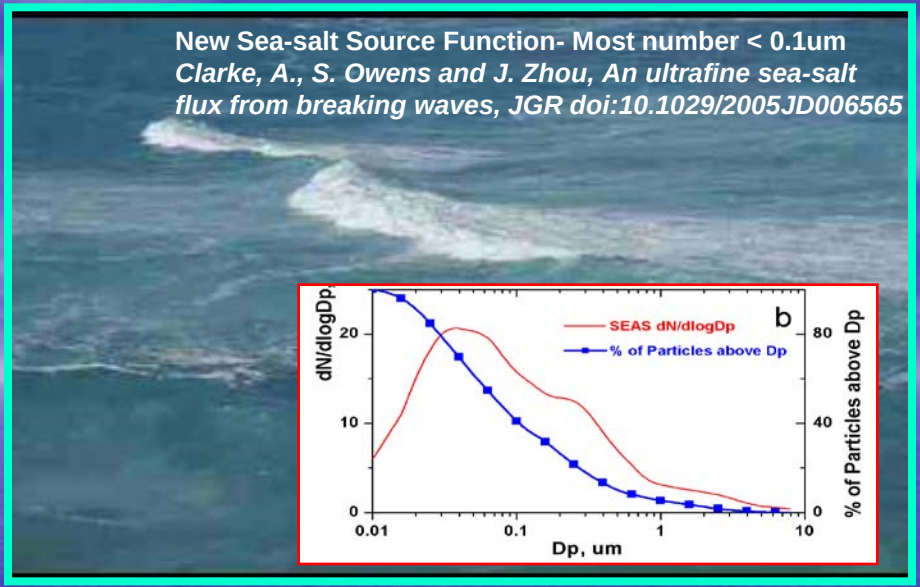
To demonstrate that after 10,000km of transport about 30% of the CCN at 0.2%S in the equatorial Pacific marine boundary layer originate as *cloud scavenged combustion* aerosol from Amazon biomass burning.

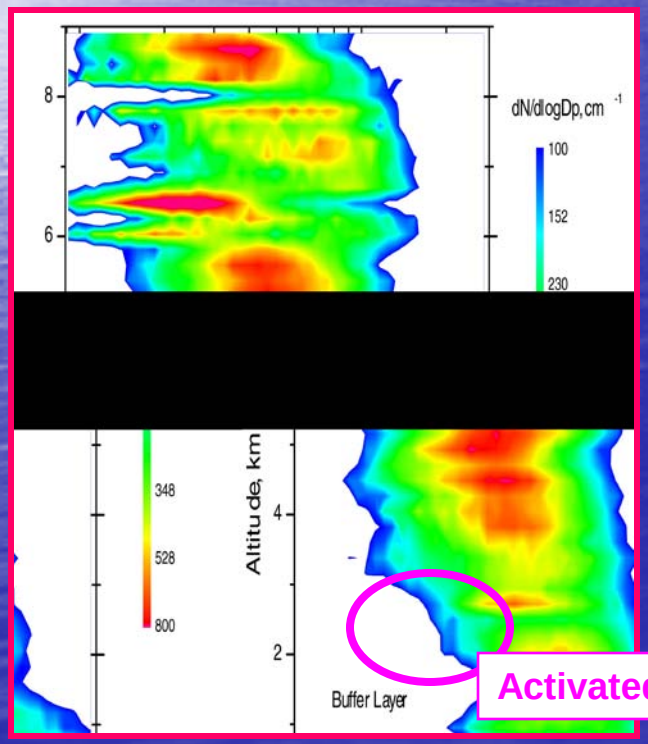
This implies similar *scavenged combustion* sources elsewhere can contribute to CCN in more complex but common transport regions.

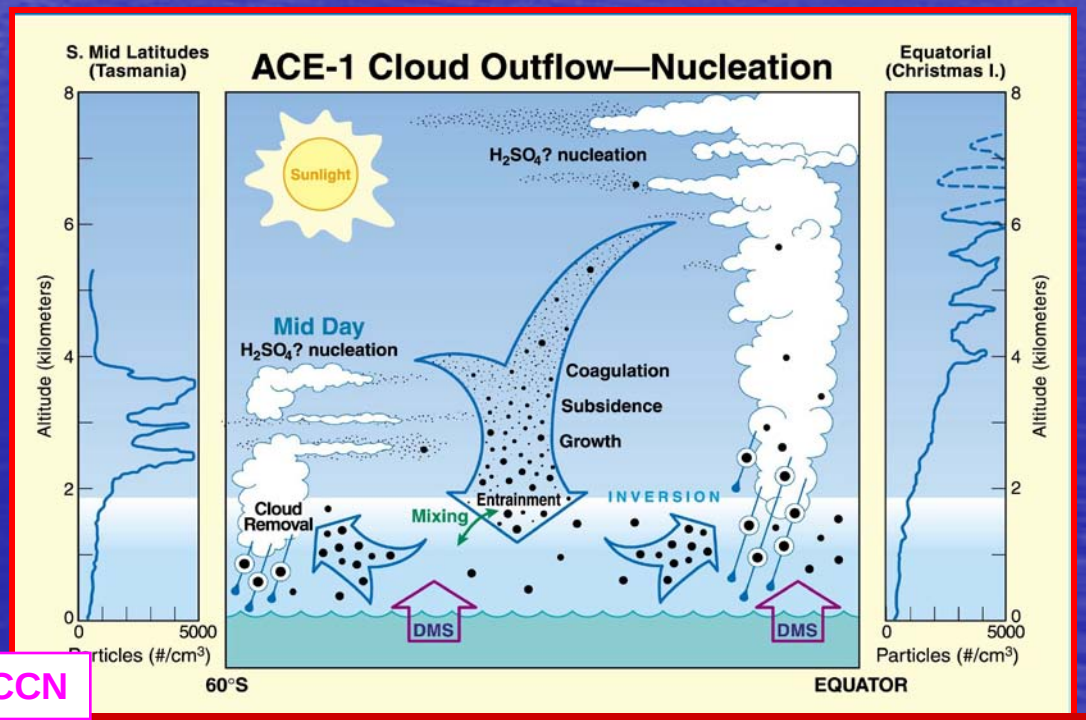
QUESTION?

What sources control the number of particles in the clean marine boundary layer and how to they influence CCN

1) Nucleation in cloud outflow
2) Sea-Salt production
3) Long Range transport

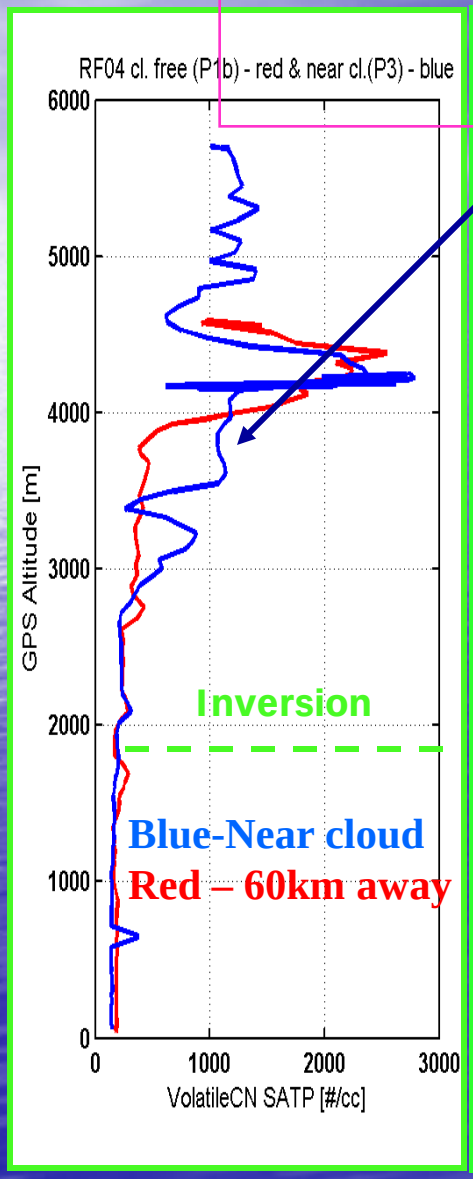


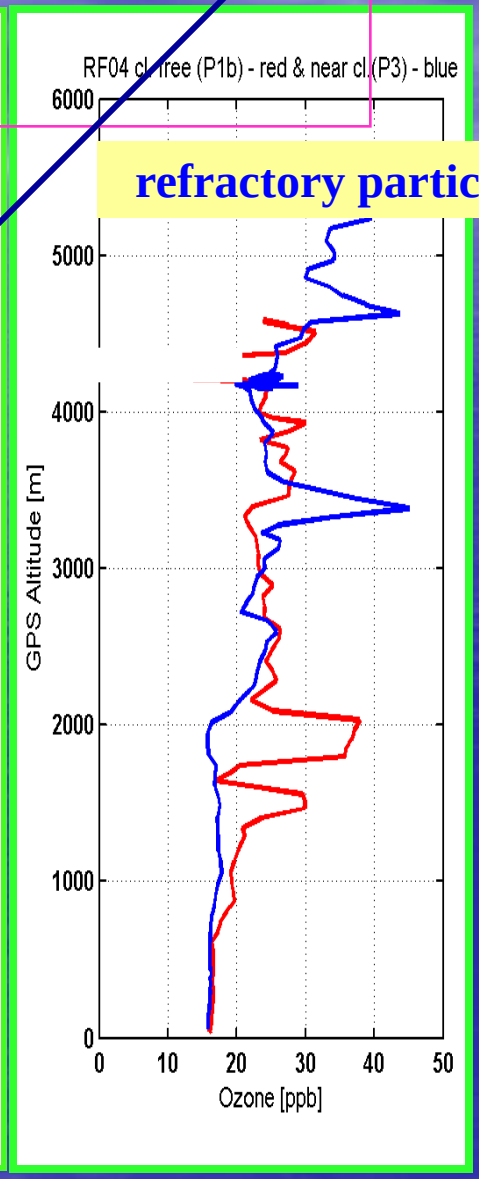


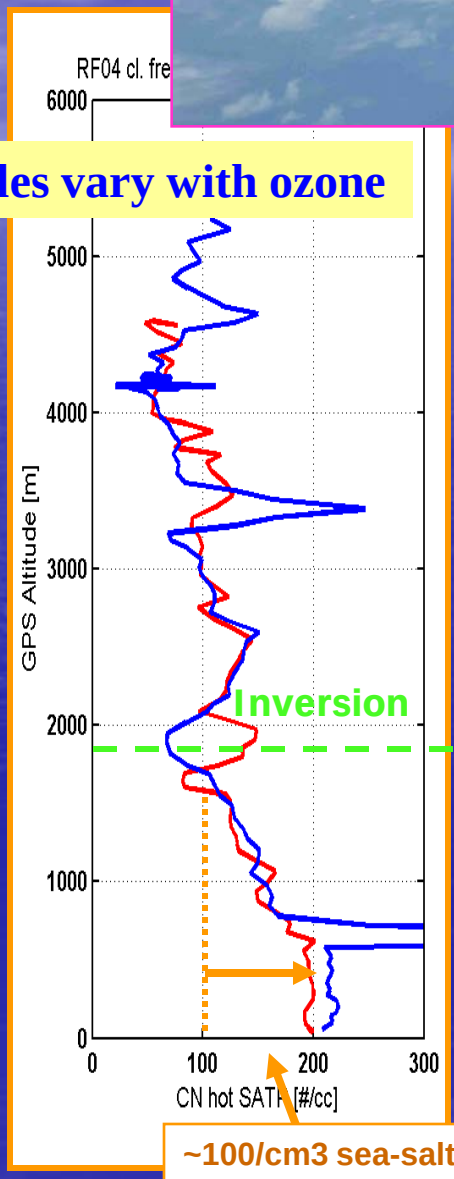


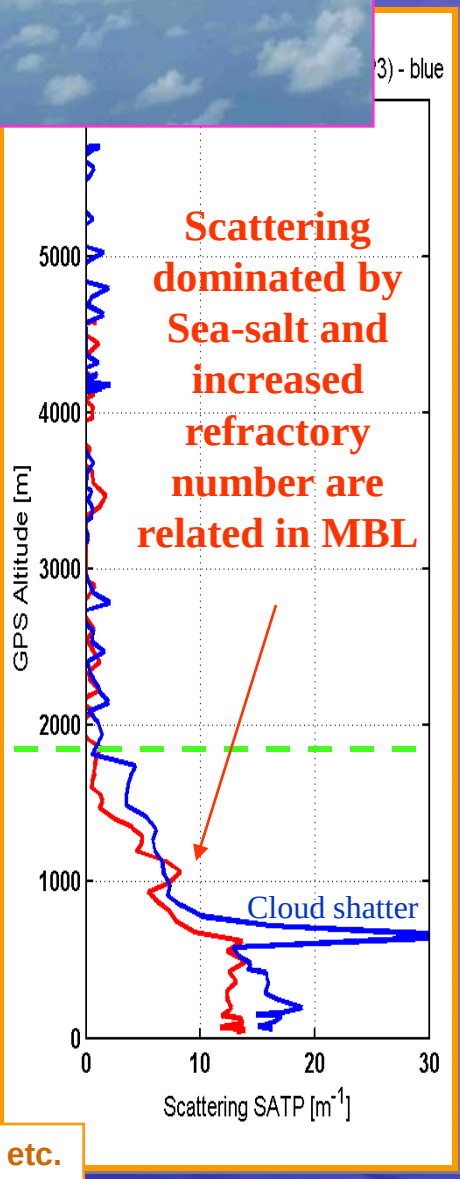
Clarke, A.D., et al., Particle production in the remote marine atmsophere: Cloud outflow and subsidence during ACE-1, Jour. Geophys, Res., 103, 1998

refractory particles vary with ozone

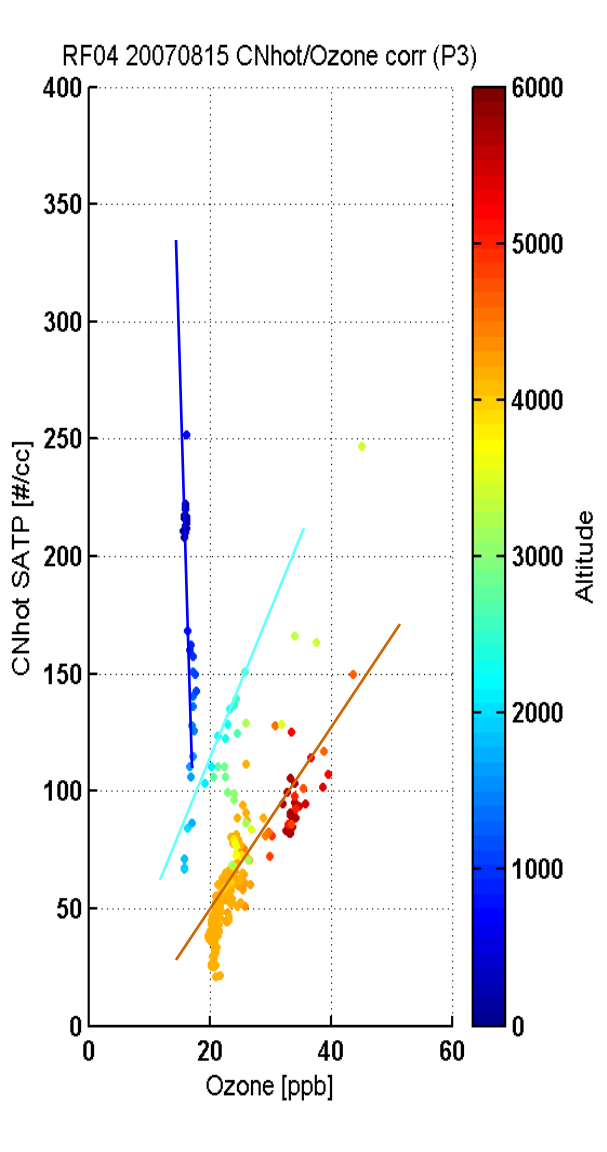


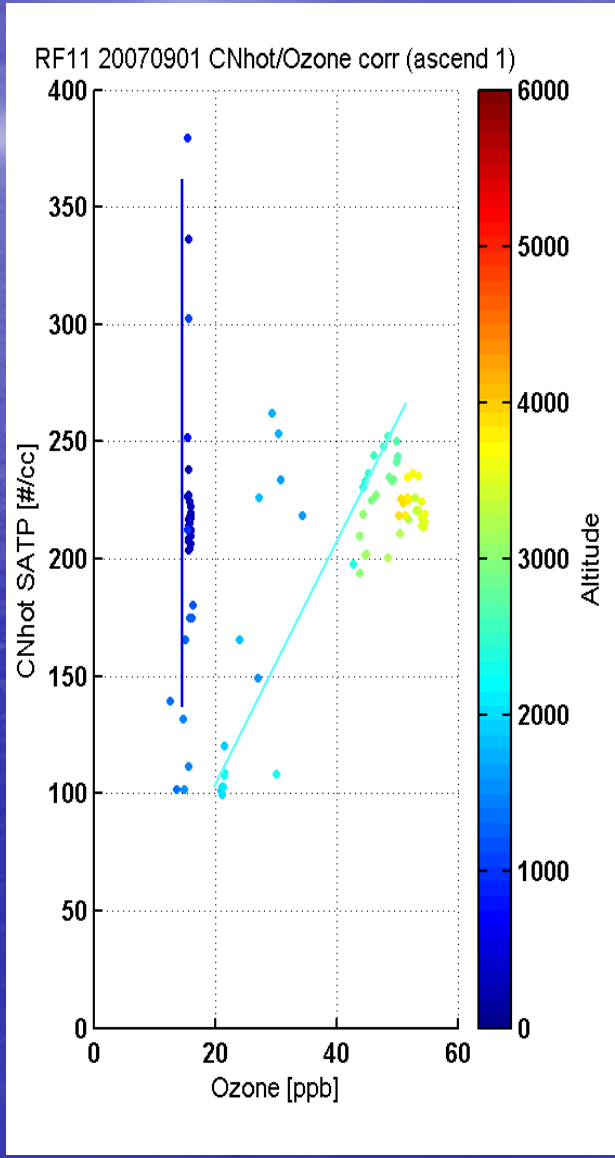


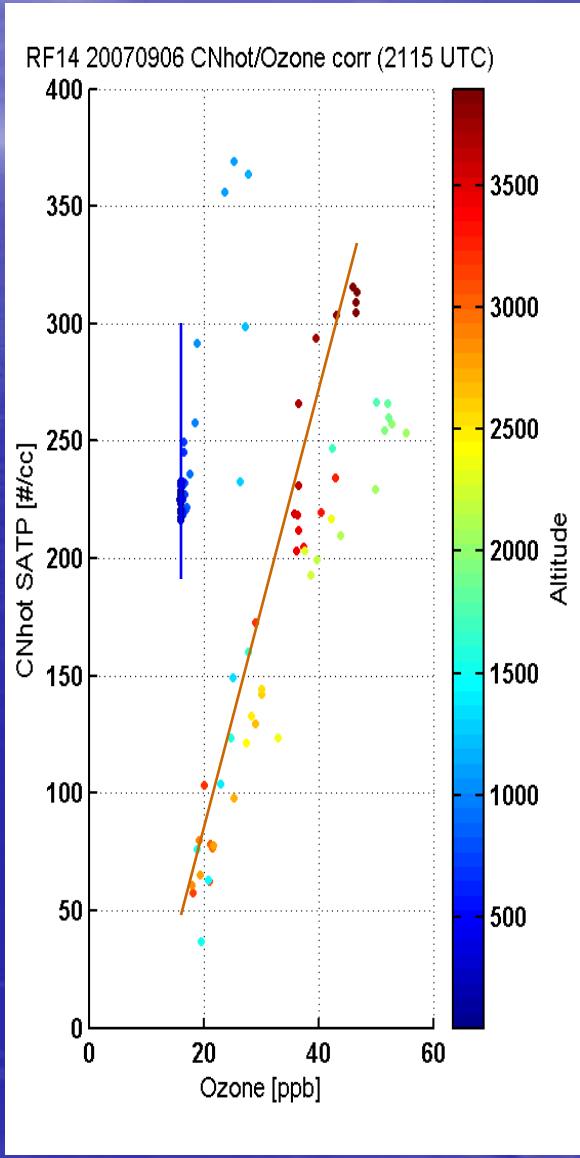




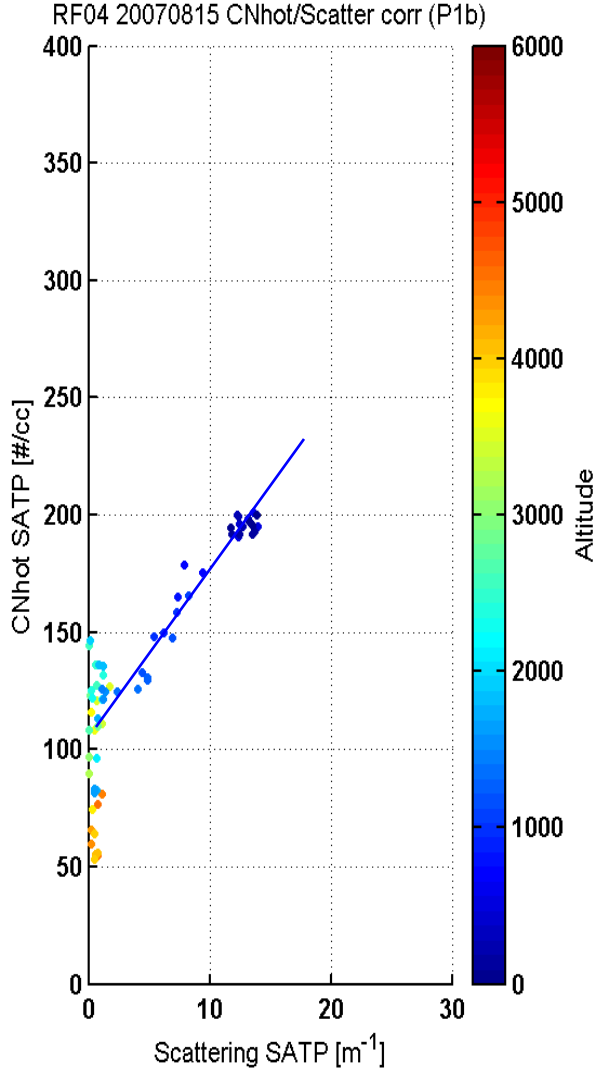
In FT the refractory aerosol varies with ozone – long range transport

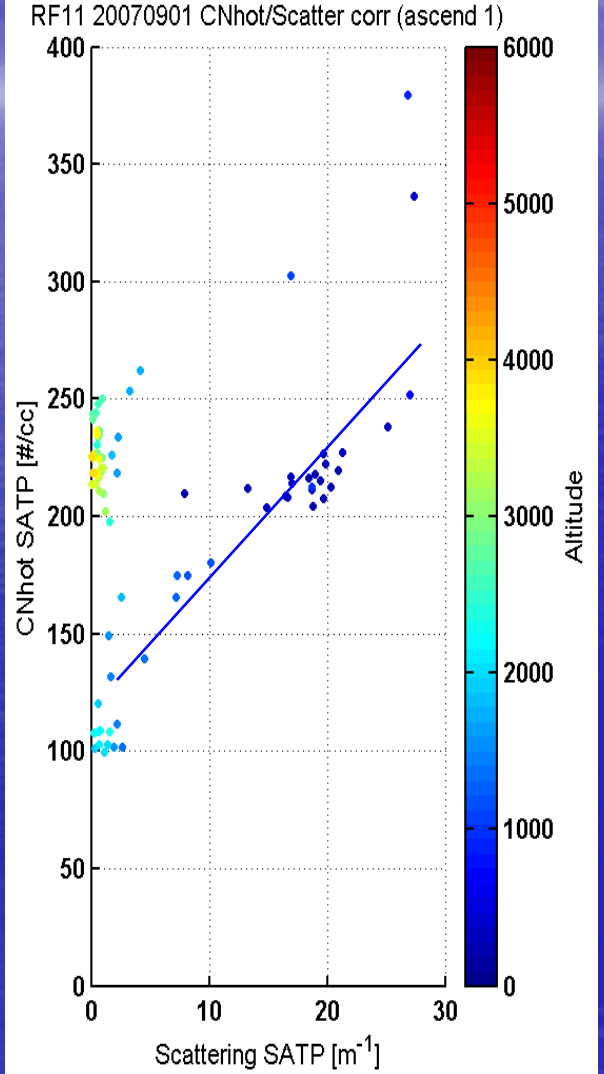


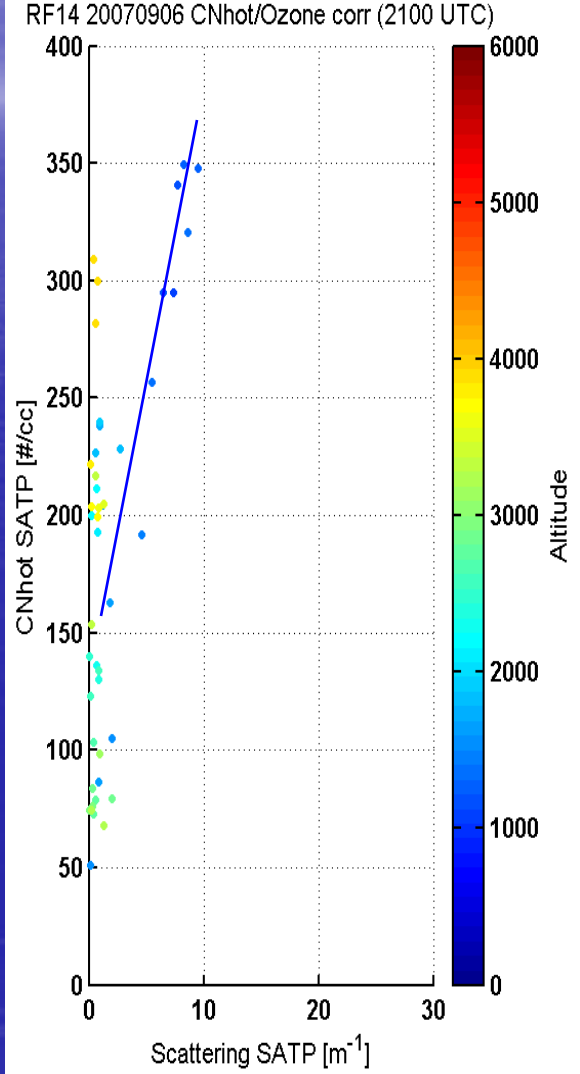




In MBL refractory aerosol vary with scattering mostly due to Sea-Salt

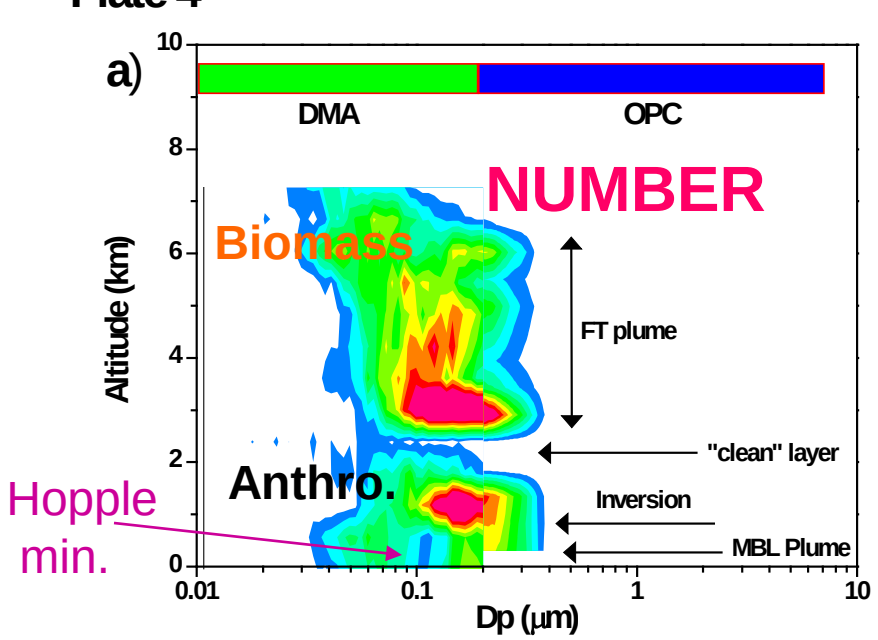


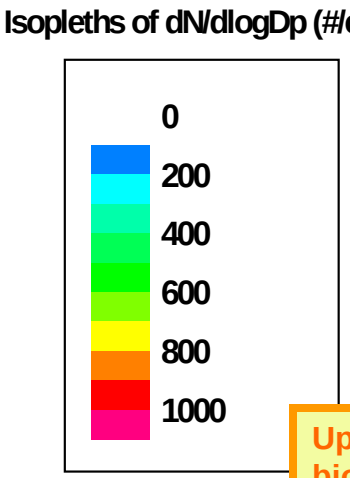




PREVIOUS DATA COLLECTED 500km off EQUADOR, (Stratus near)
Profiles: Aerosol Number & Volume over E. Pacific from S.A., PEMT 1999

Plate 4

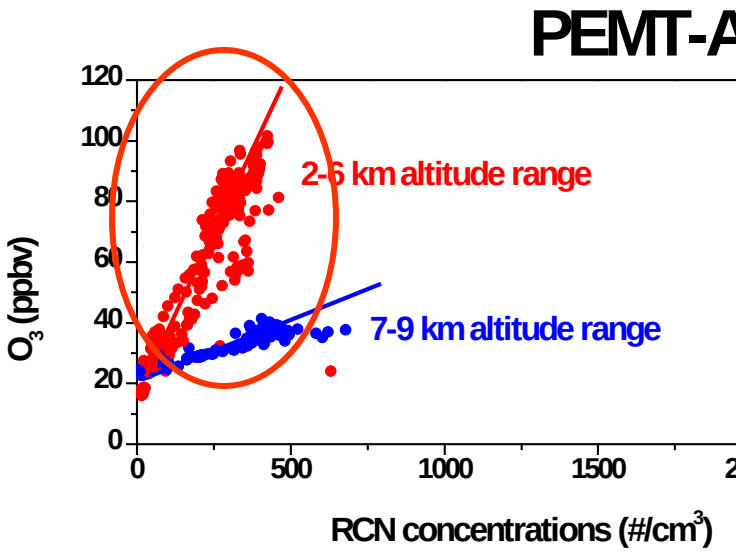


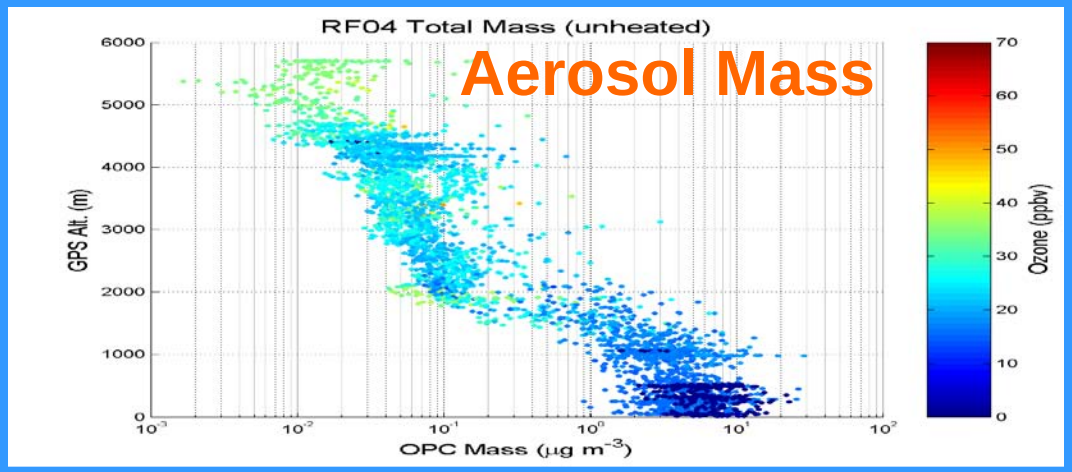


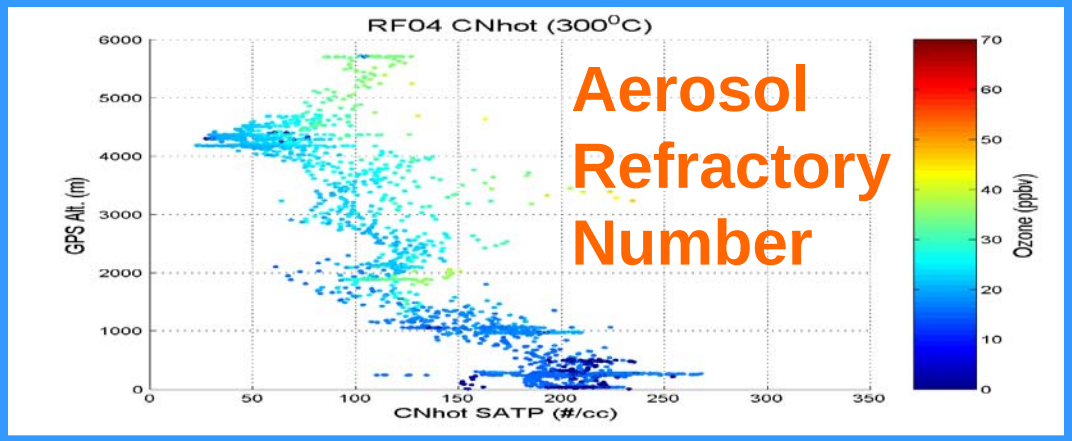
Upper layers are from Amazon biomass burning while lower layer influenced by urban coastal areas

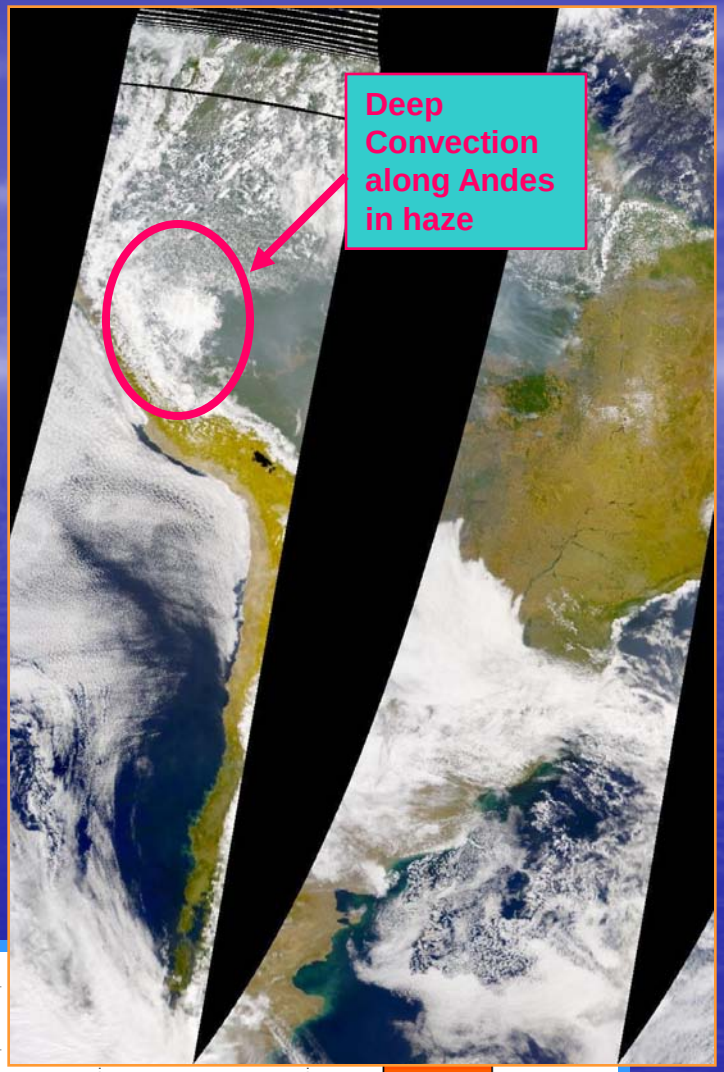
Refractory CN (300C) varies with Ozone in plume

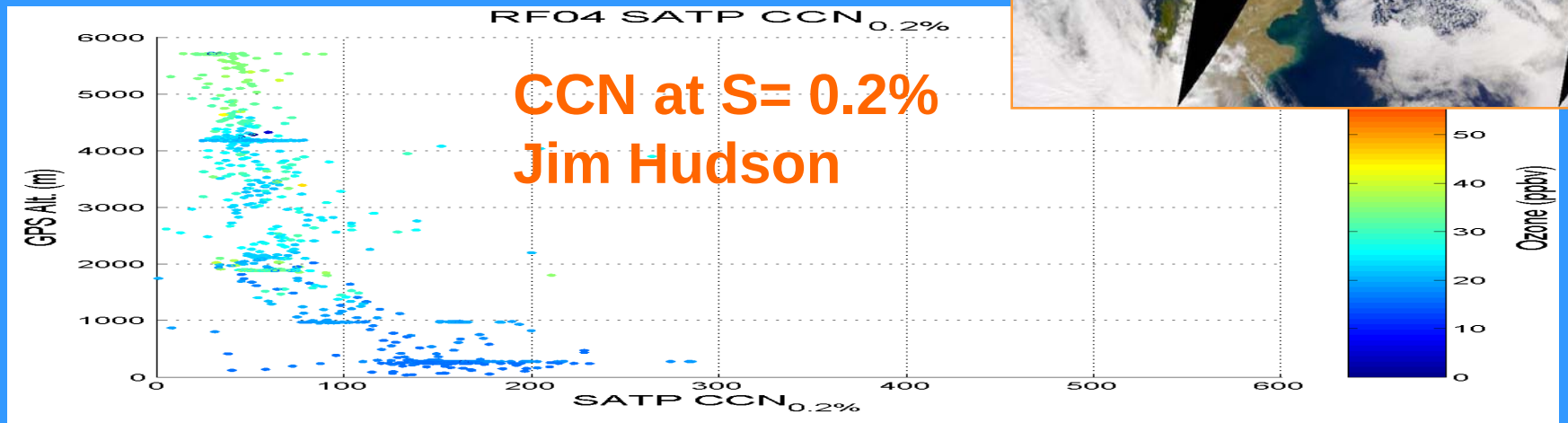
BC or refractoryOC?

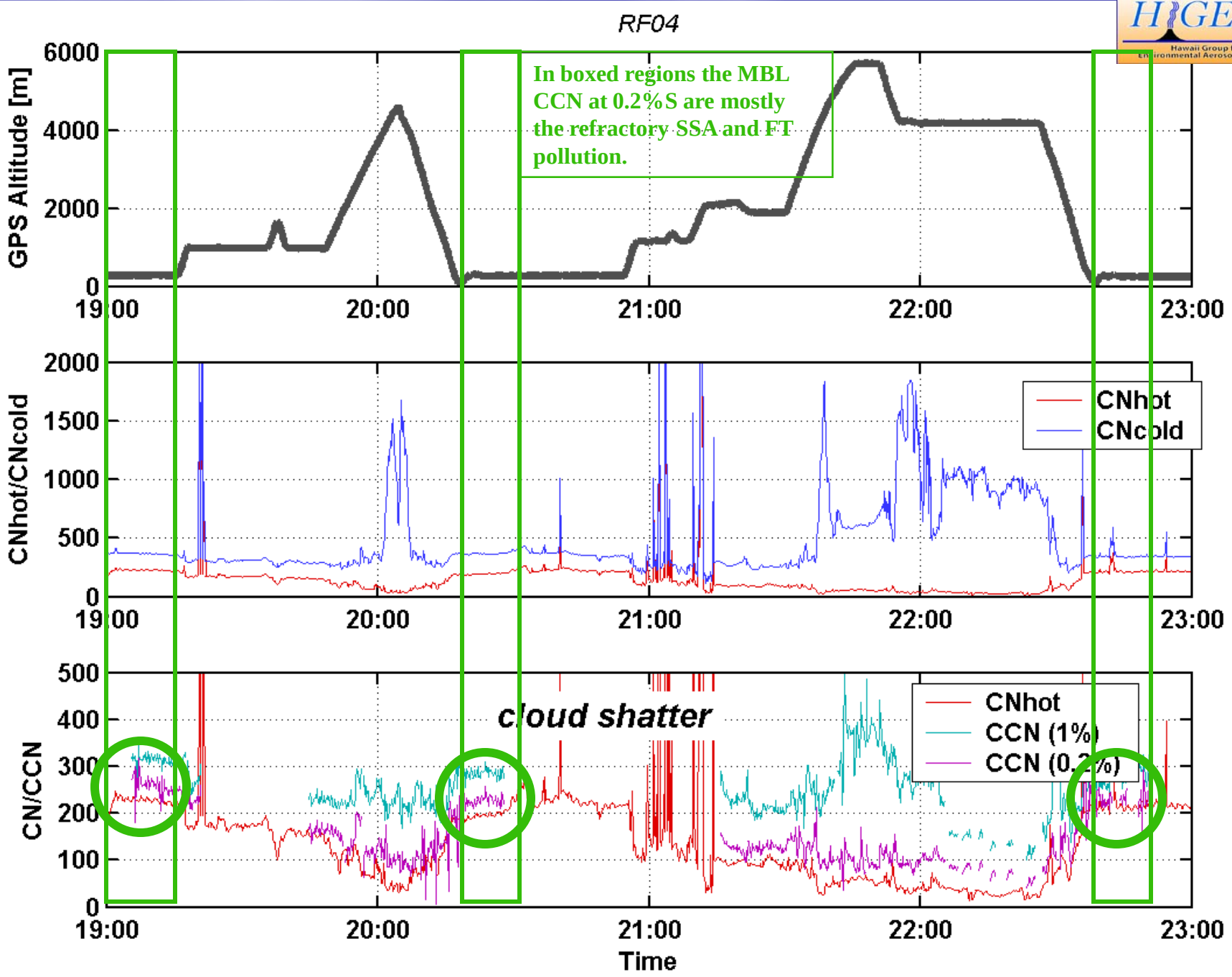



RF04 Total Mass (unheated)
Aerosol Mass
GPS Alt. (m)
OPC Mass (μg m-3)
Ozone (ppbv)

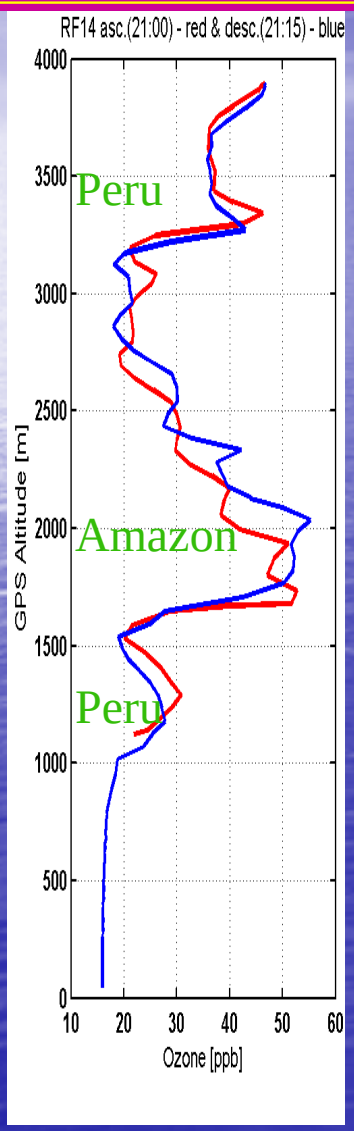

RF04 CNhot (300°C)
Aerosol Refractory Number
GPS Alt. (m)
CNhot SATP (#/cc)
Ozone (ppbv)

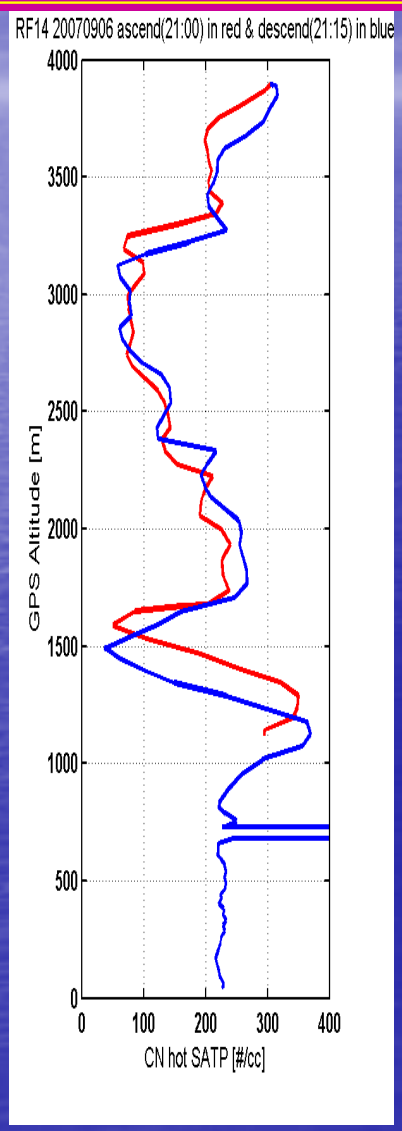

Deep Convection along Andes in haze

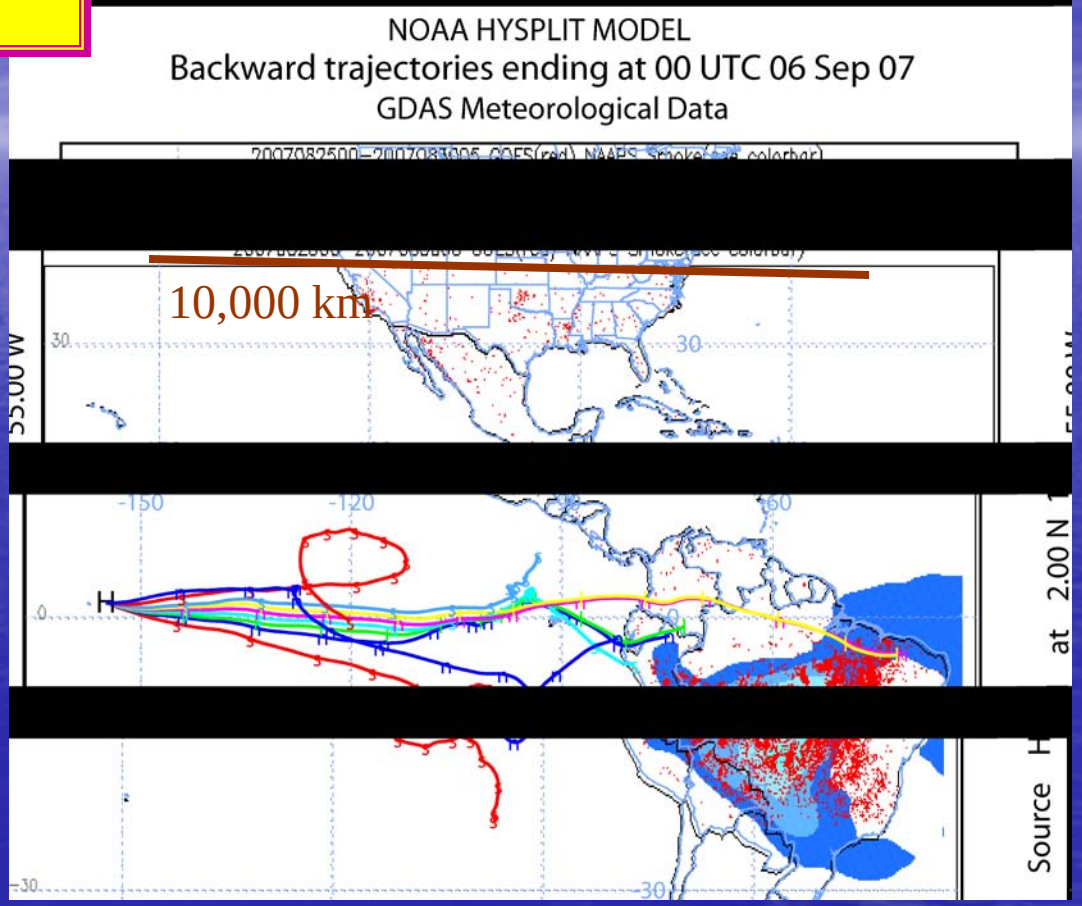

RF04 SATP CCN0.2%
CCN at S= 0.2%
Jim Hudson
GPS Alt. (m)
SATP CCN0.2%
Ozone (ppbv)


RF04
In boxed regions the MBL CCN at 0.2%S are mostly the refractory SSA and FT pollution.
GPS Altitude [m]
6000
4000
2000
0
19:00
20:00
21:00
22:00
23:00
CNhot/CNcold
2000
1500
1000
500
0
CNhot
CNcold
CN/CCN
500
400
300
200
100
0
cloud shatter
CNhot
CCN (1%)
CCN (0.2%)
Time

AMAZON Biomass Burning major source MBL CCN over 10,000km away!!!!
And how many other places??

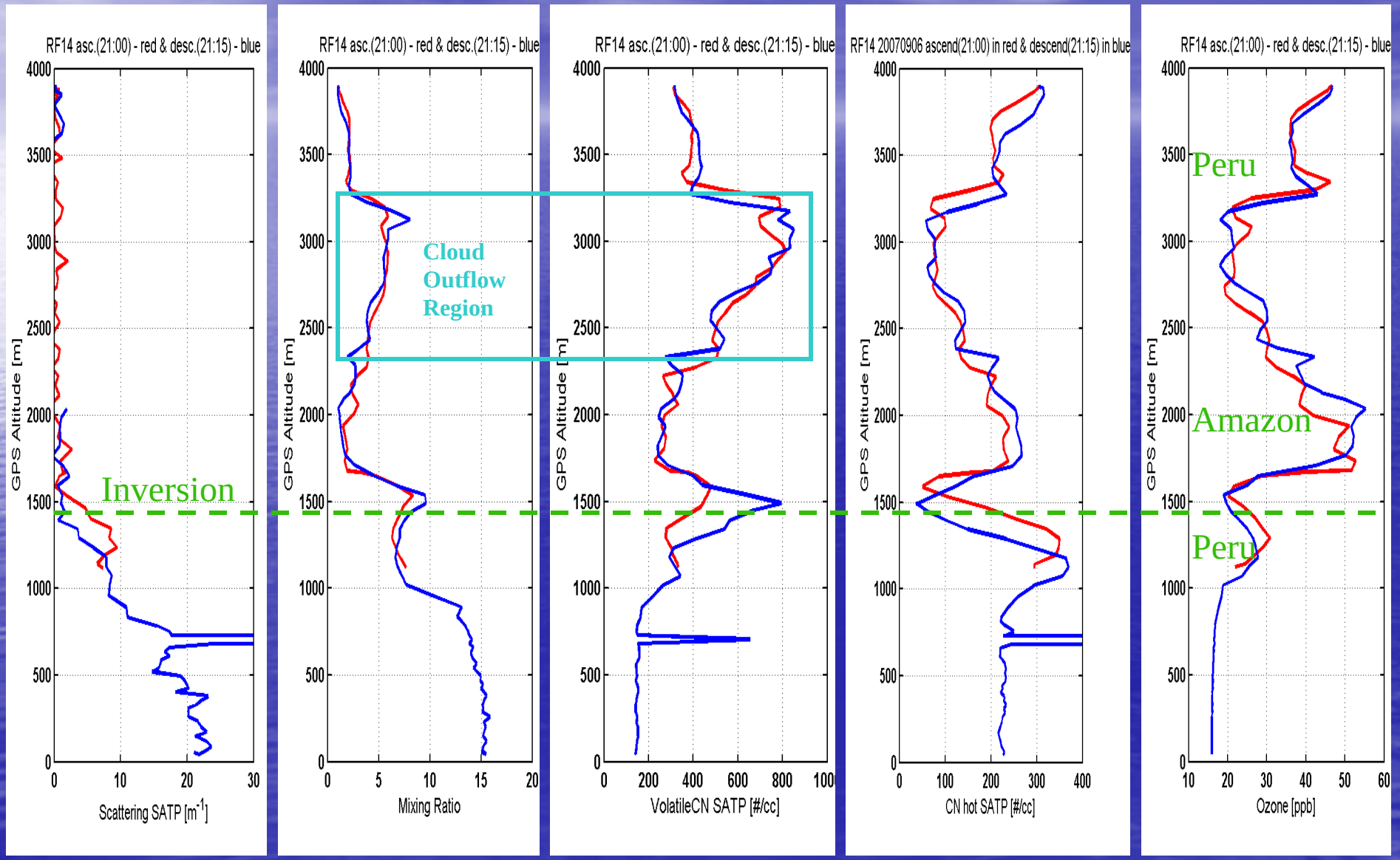




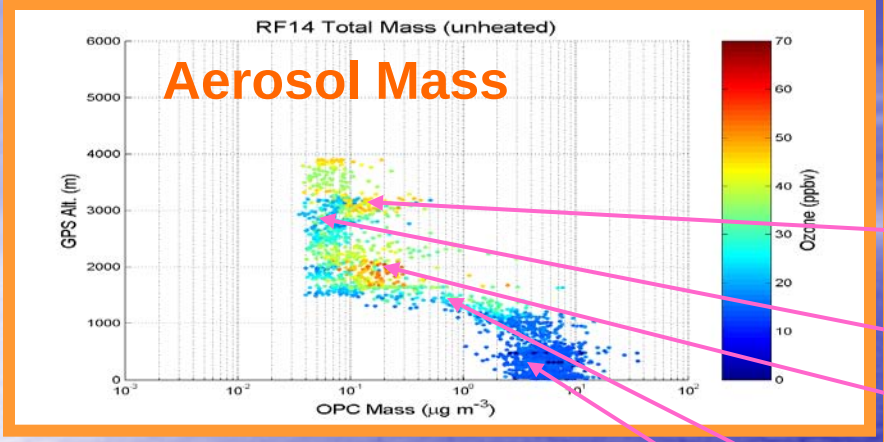


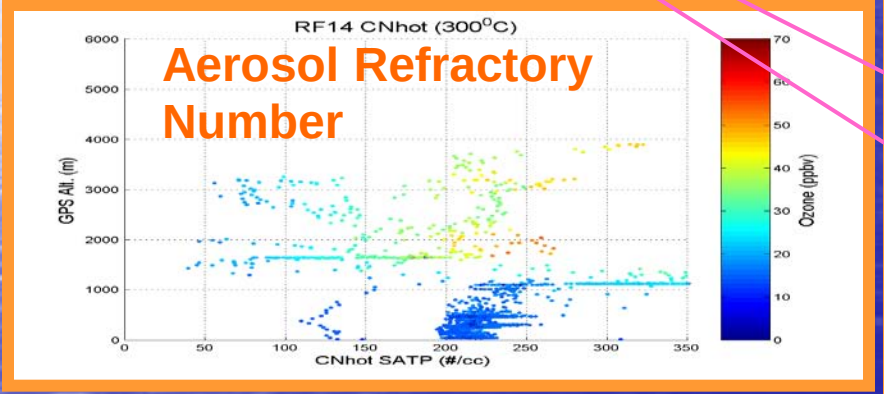
Descent rate in FT = 0.3-0.4 cm/s
Previous entrainment at CI 0.4-0.6 cm/s

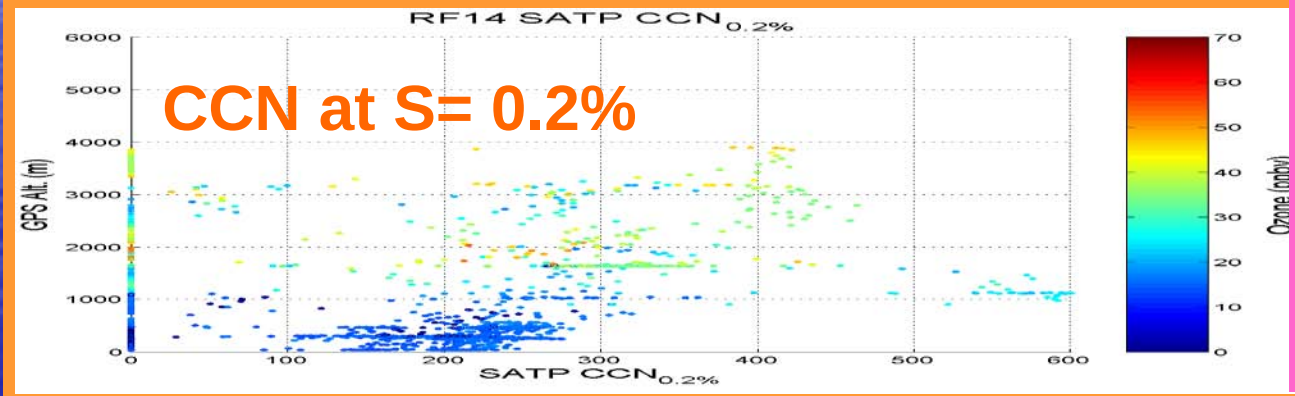
Flight 14 had enhanced ozone and refractory aerosol aloft with back trajectories reaching back to Amazon burning and some new particle formation at inversion.

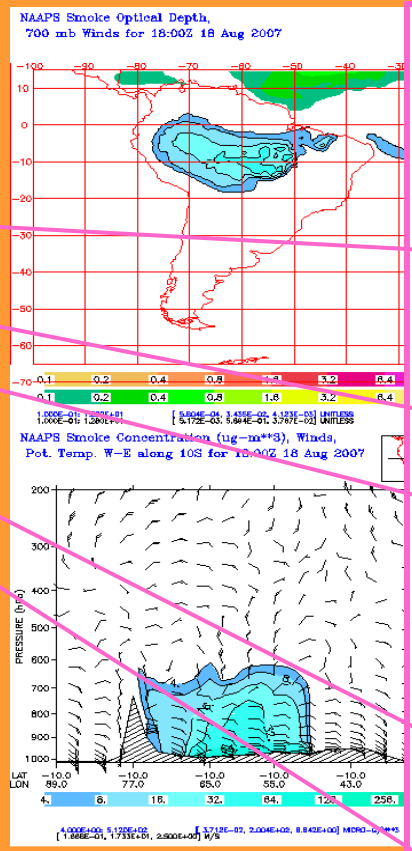


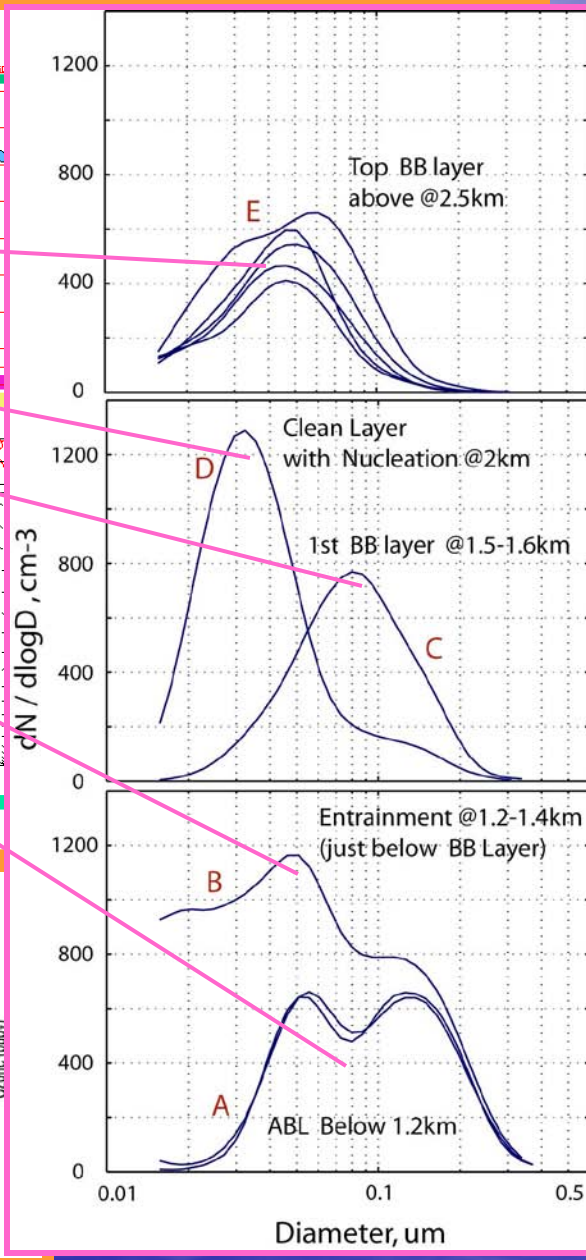
Elevated ozone over Christmas Is. linked to heavier aerosol and convection over stronger Amazon source











For 300/cc (200volatile and 100refractory per cm3)
Mixing through inversion @ 0.4 cm/s
Takes ~ 3 days to flux in 1km layer (CN=300/cc)
& acting over 2,000km assuming wind at 8m/s

Mixing and advection faster than these time scales

Rain Removal, Patchy, Episodic, hours?
Most growth in non-precip MBL clouds

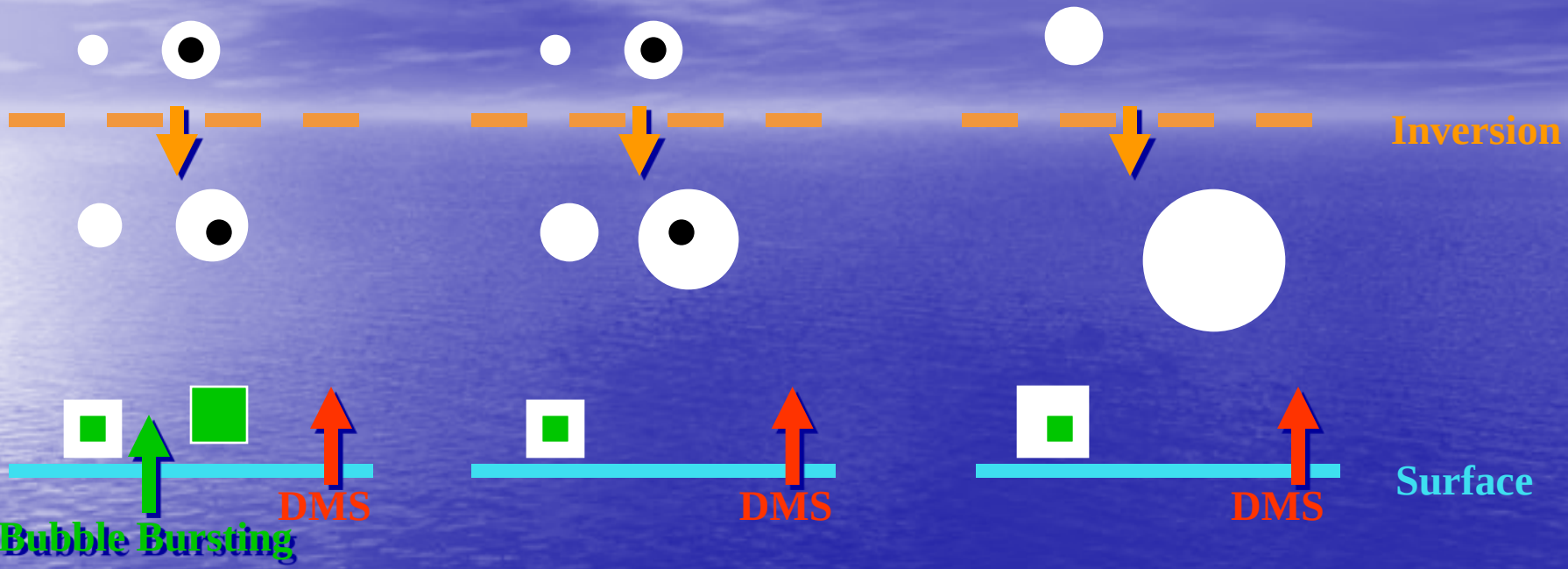
For 9m/s wind Sea-Salt Aerosol flux is about 30/cm2/s
Takes 4 days to fill 1 km layer to 100/cm3 (Direct Injection)

10 Day back trajectory from MBL inversion

Nucleation Aloft
Pollution Aloft
Moderate Wind

Nucleation Aloft
Pollution Aloft
Low Wind

Nucleation Aloft
No Pollution
Low Wind



Pollution &
Sea-salt
Dominate CCN

Pollution &
Nuclei Aloft
Dominate CCN

Nuclei Aloft
Dominate CCN

Conditions controlling MBL CCN (no scavenging)

OBJECTIVE OF PRESENTATION

To demonstrate that after 10,000km of transport about 30% of the CCN at 0.2%S in the equatorial Pacific marine boundary layer originate as *cloud scavenged combustion* aerosol from Amazon biomass burning.

This implies similar *scavenged combustion* sources elsewhere can contribute to CCN in more complex but common transport regions.