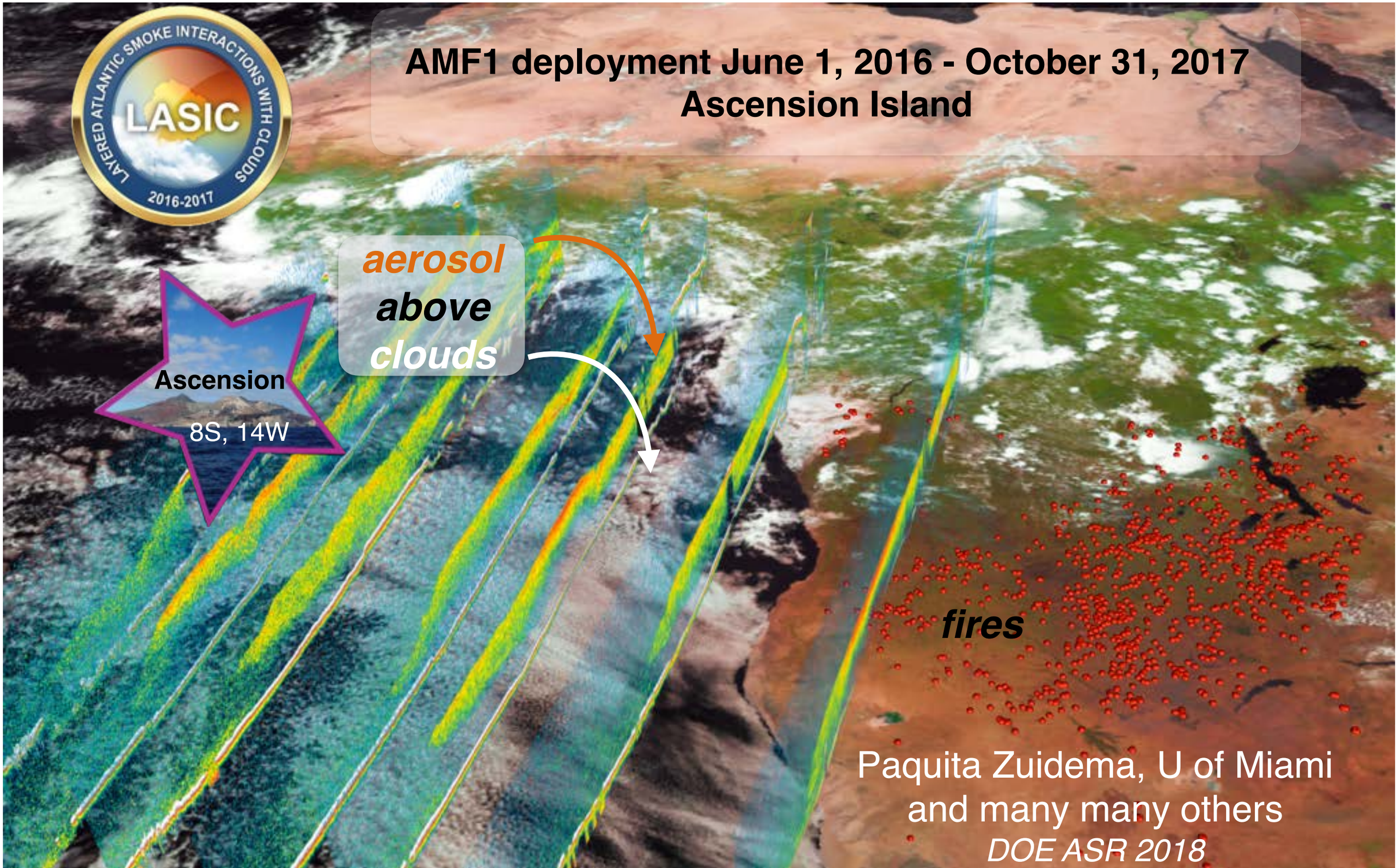
A first summary of the Layered Atlantic Smoke Interactions with Clouds (LASIC) campaign in the remote southeast Atlantic



objectives

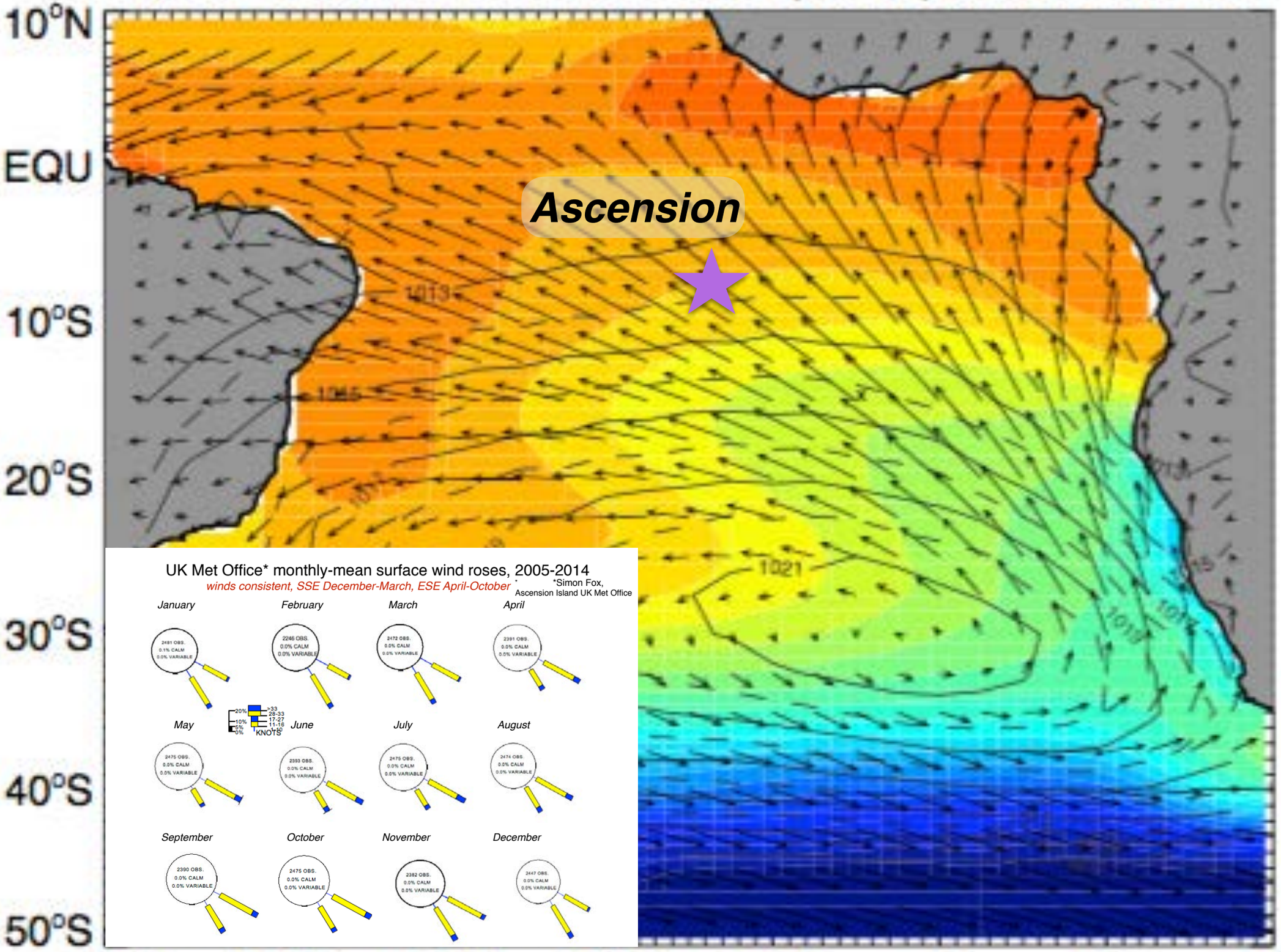
- improve knowledge of biomass-burning aerosol (BBA) properties
- characterize aerosol-cloud vertical structure
- understand cloud adjustments to BBA
    1. aerosol direct radiative effect
    2. semi-direct radiative effect
    3. aerosol-cloud microphysical interactions

- ***17-month-long campaign (two independent BBA-season samples)***
- ***radiosondes (4 or 8x/daily)***
- ***diurnal cycle***

context for the aircraft campaigns

m^{-3}

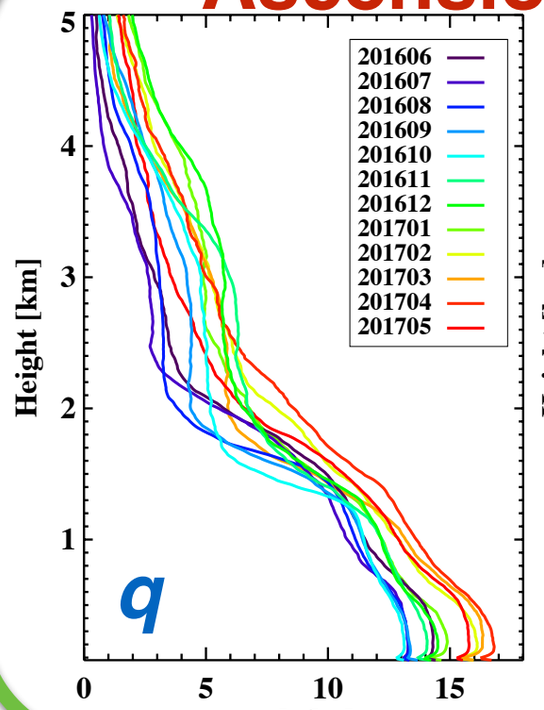
1981-2010 annual mean SST, SLP, surface winds

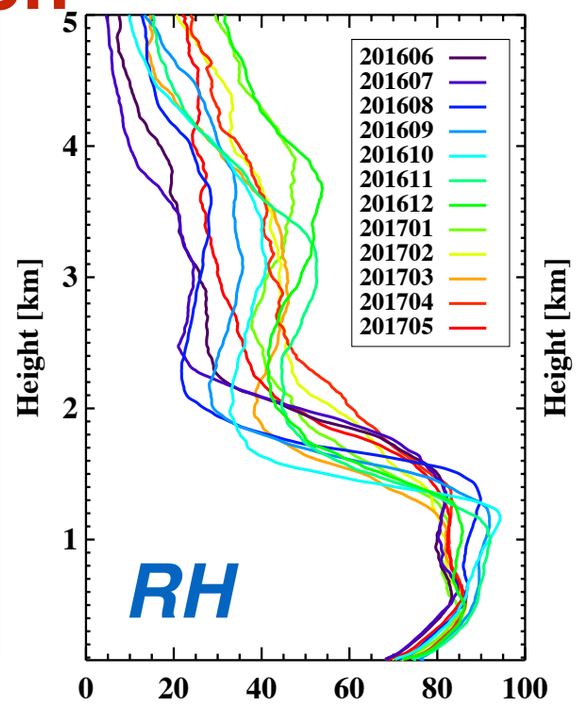


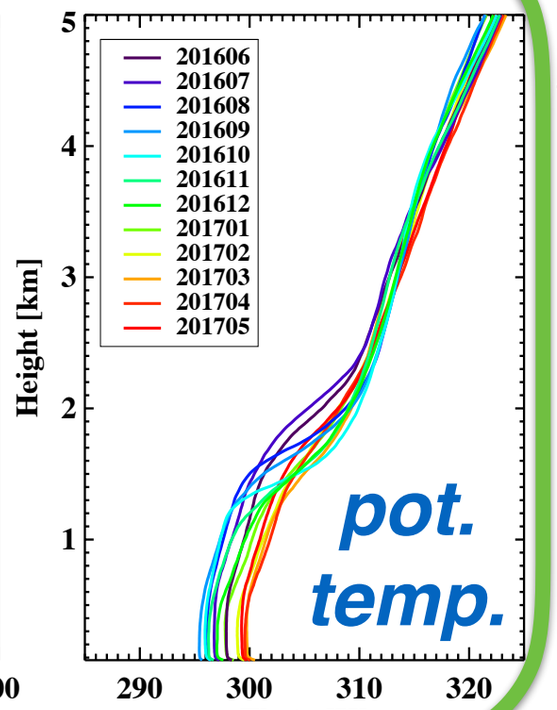
monthly-mean radiosondes

not normalized by inversion height

Ascension



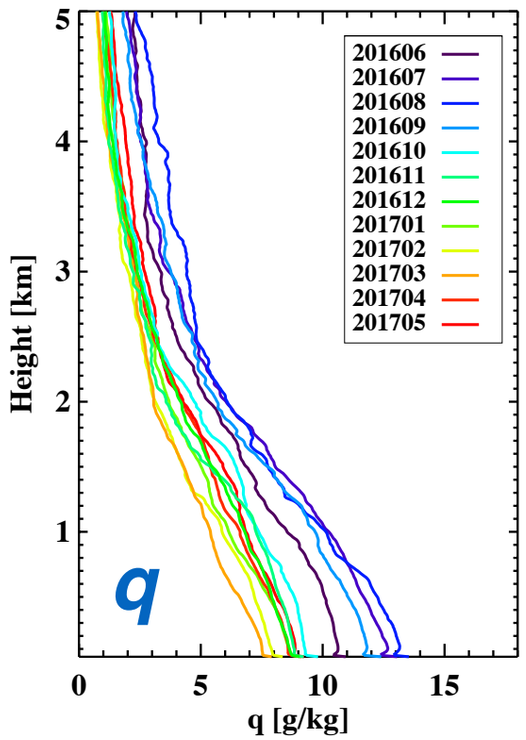


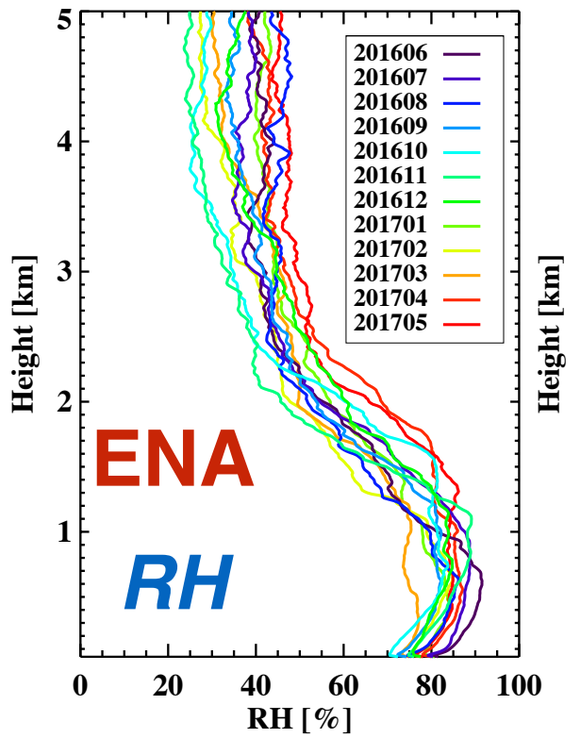


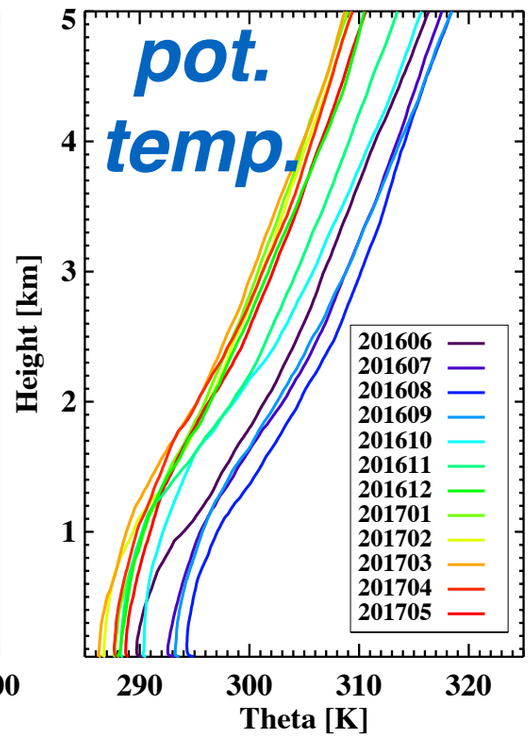
Ascension cloudy boundary layer

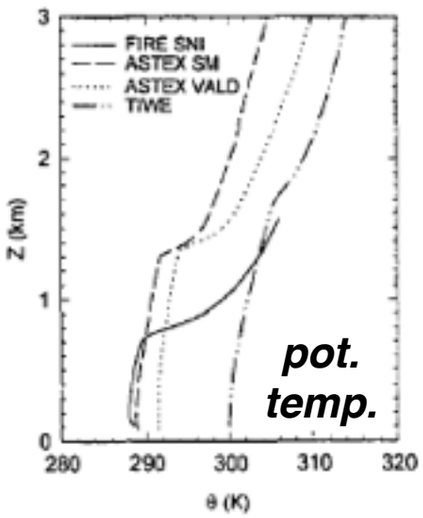
- ***warmer (by ~10K)***
- ***moister (by ~5 g/kg,)***
- ***more stable/less variable @ cloud-top***
- ***more consistently decoupled***
- ***often but not always deeper***

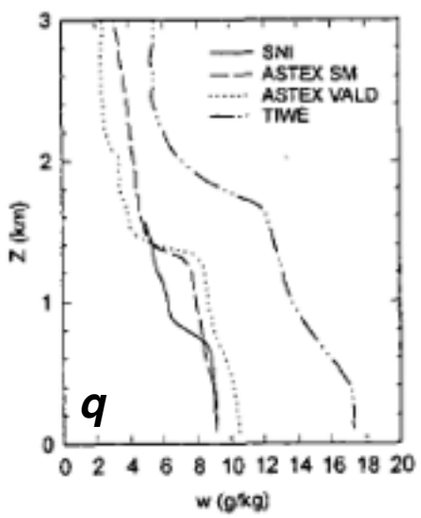
than ENA cloudy boundary layer











Albrecht et al. 1995

free troposphere slightly more moist at Ascension (by ~2 g/kg)

can't emphasize enough the capable logistics and high standards maintained at site

logistics team: Kim Nitschke, Maciej Ryczek, Amon Haruta, Heath Powers
instrument mentors: Connor Flynn, Joseph Hardin, Bradley M. Isom, Paytsar Muradyan, Art Sedlacek, Stephen Springston,Janek Uin,Alison Aiken - and more

May 17, 2016

Île de l'Ascension

North Point
English Bay
Porpoise Point
Pyramid Point
East Crater
(Broken Tooth)
226 m
North East Bay
North East Point
Hummock Point
Bates Rock
Bates Point
Clarence Bay
Tartar Rock
Sisters Peak
445 m
Catherine Point
Cross Hill
Two Boats Village
Travellers Hill
Lady Hill
329 m
Donkey Plain
Pratt Point
Boatswain Bird Island
Boatswain Bird Rock
Devil's Cauldron
Weather Post
608 m
White Hill
525 m
Letterbox
Cricket Valley
860m
The Peak
859 m
Green Mountain
Zone
Payne Point
de mouillage
McArthur Point
Devil's Riding School
Dark Crater
Spoon Crater
364 m
South East Crater
South East Bay
Whale Point
BBSS
ceilometer
MWRP
surface met
AERONET, existing
South West Bay
air runway
365m
AMF1/MAOS site
Portland Point
Crystal Bay
Unicorn Point
Coconut Bay
White Rocks
White Bluff
Pillar Bay
Wideawake Fairs
Mars Bay
South Point
Gannet Bay
prevailing wind
Océan Atlantique

N
NO
NE
O
E
SO
SE
S

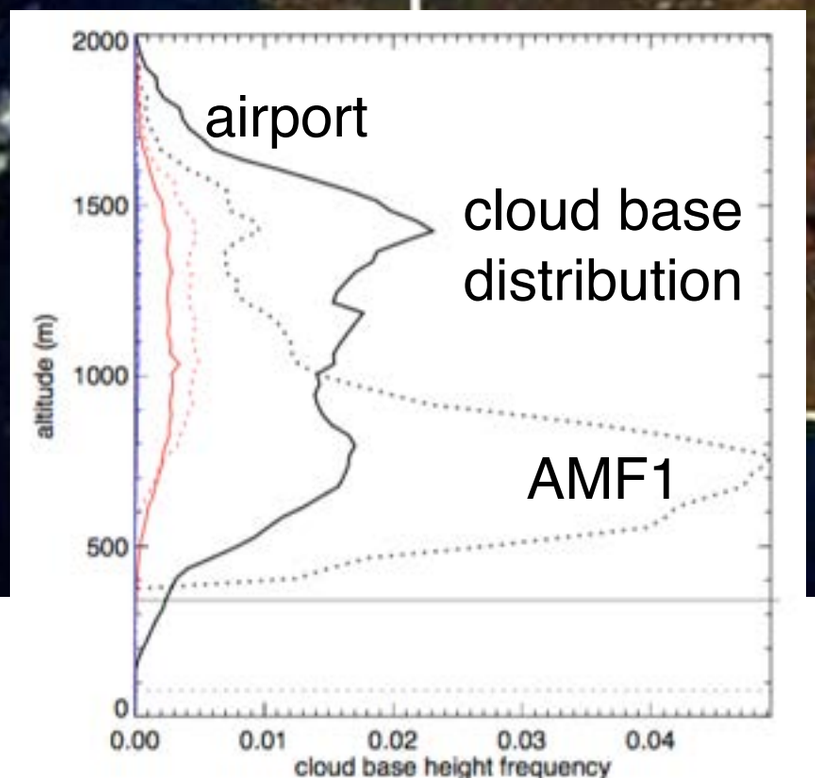
Légende:

800 m
760 m
720 m
680 m
640 m
600 m
560 m
520 m
480 m
440 m
400 m
360 m
320 m
280 m
240 m
200 m
160 m
120 m
80 m
40 m
0

AMF1 site good (excellent) for aerosol measurements, less so for vertically-pointing cloud sensors

~9 km to a side

Georgetown



ARM Mobile Facility

strong focus on July-October months b/c of maximum in continental outflow of smoke

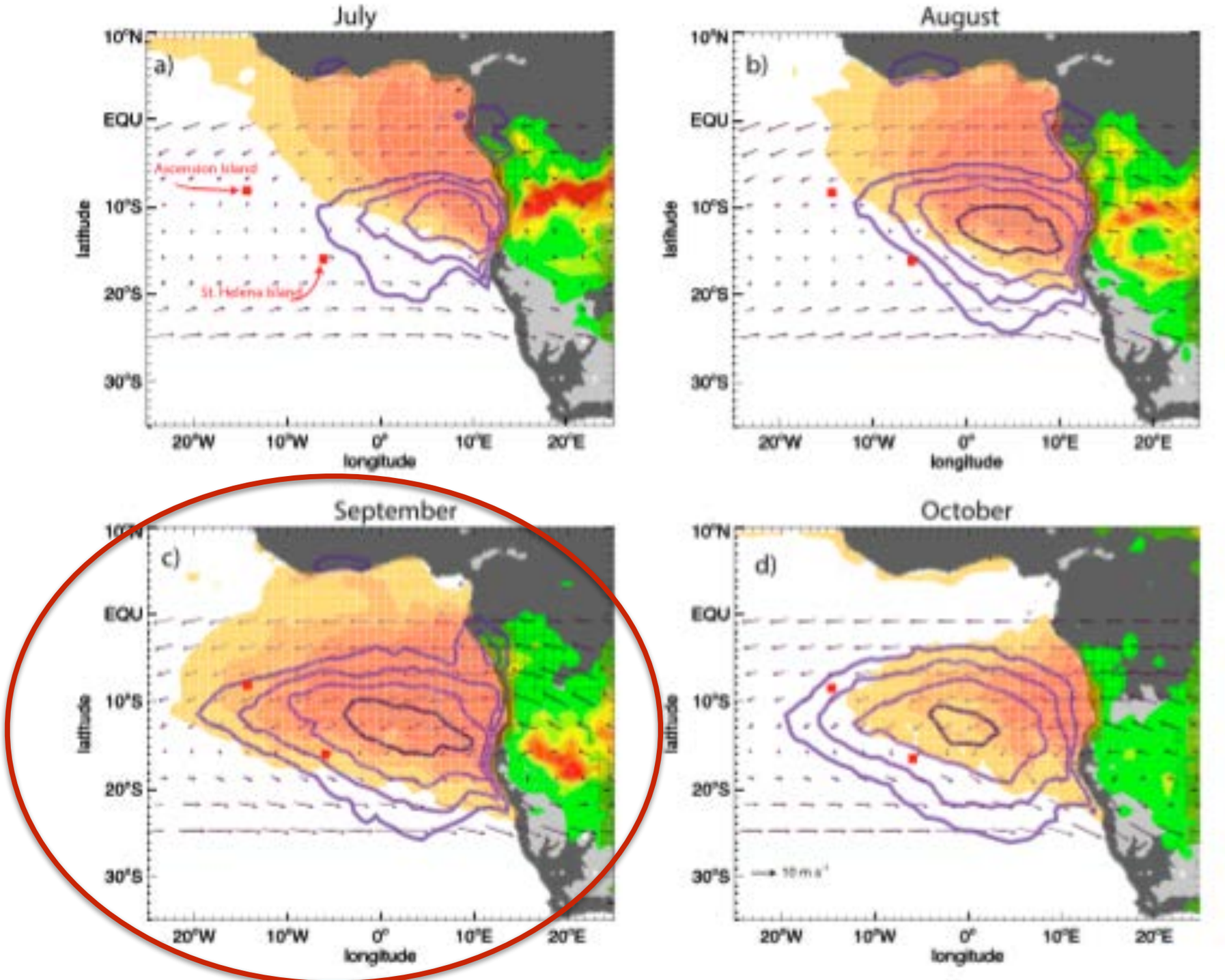
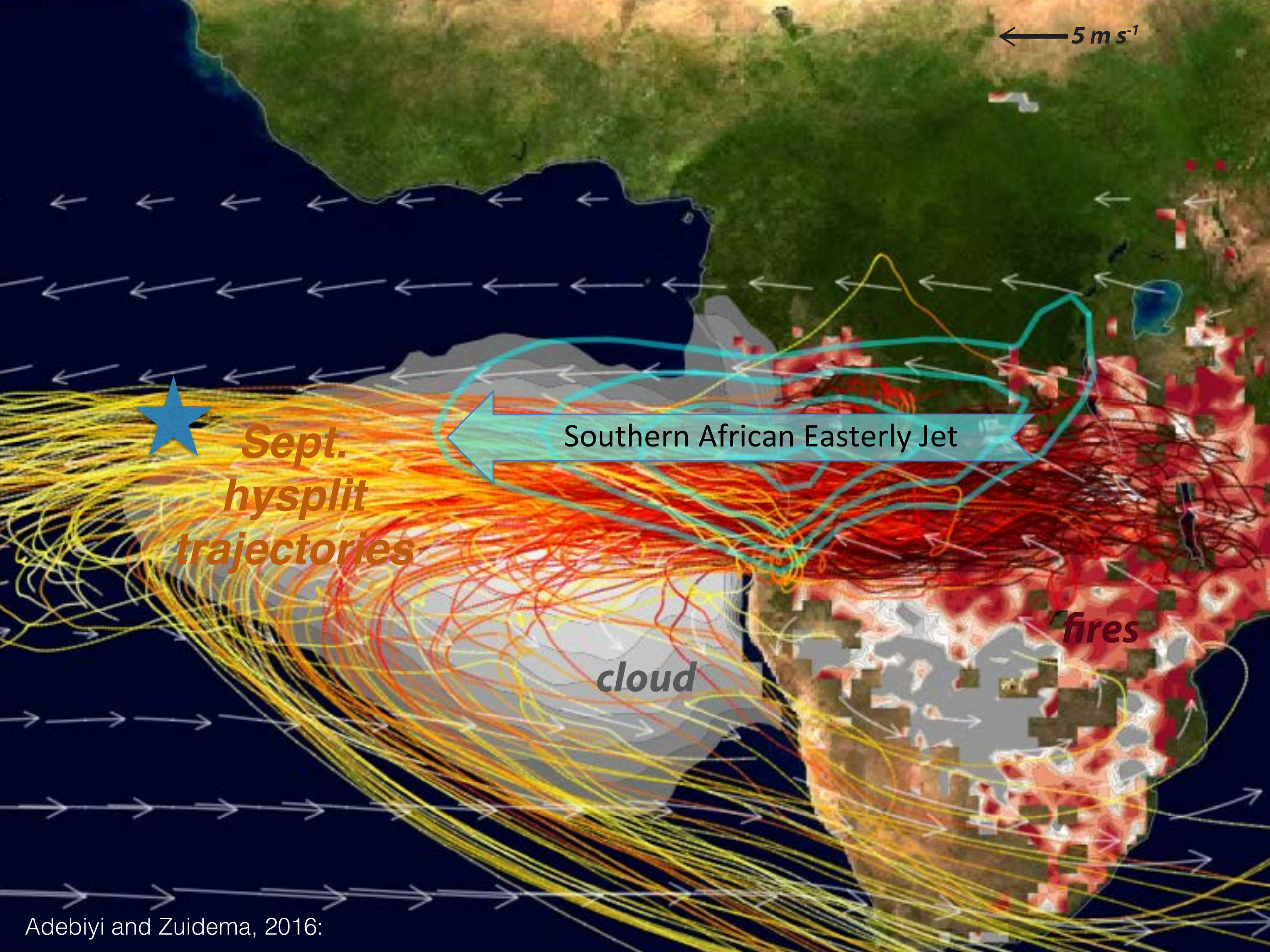


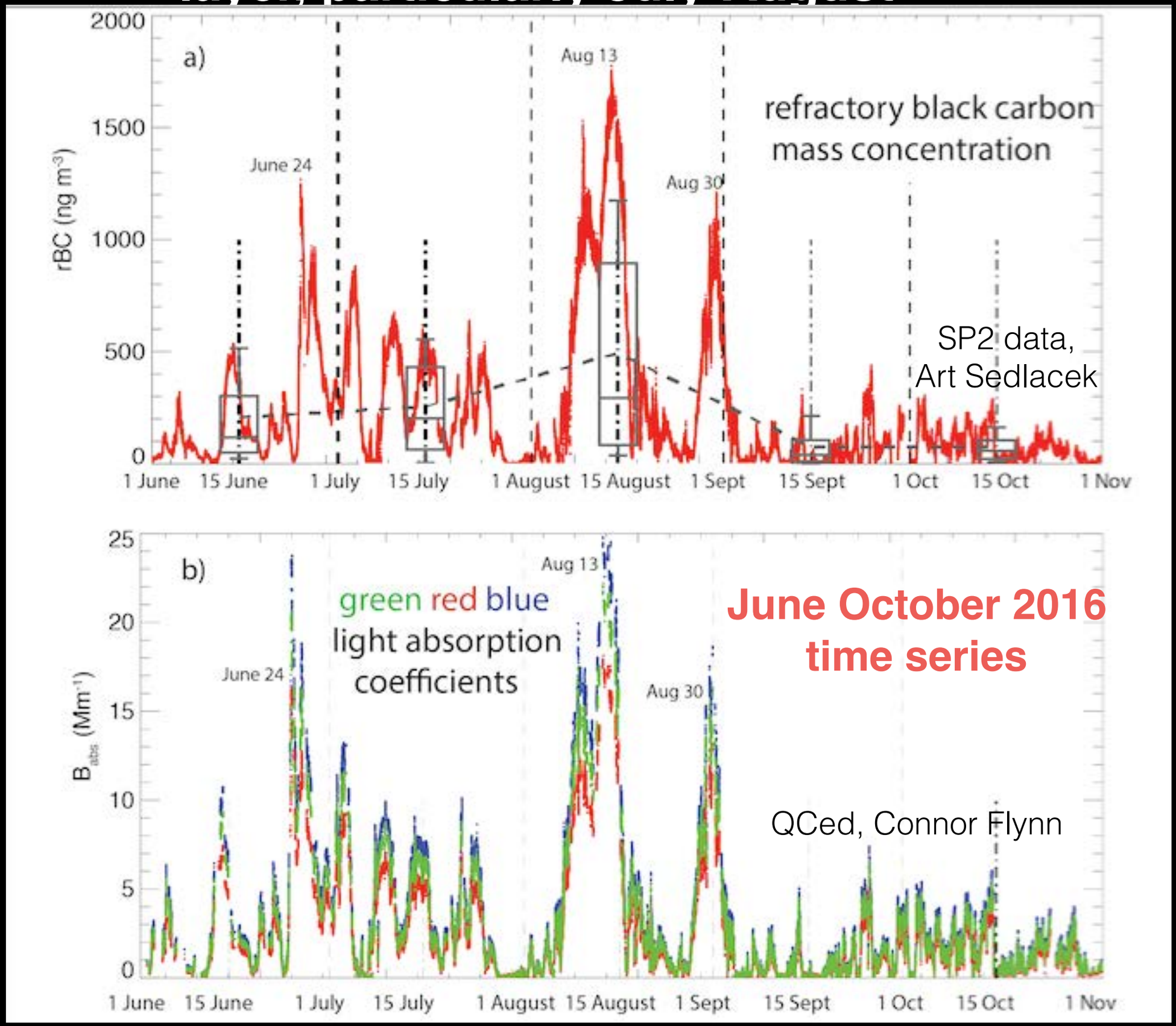
FIG. 5. (a) July, (b) August, (c) September, and (d) October MODIS mean 2002–12 cloud fraction (blue to black contours, 0.6–1.0 increments of 0.1), fine-mode aerosol optical depth (yellow-red shading indicates 0.25–0.45 in increments of 0.05 and very light black contour lines indicate 0.5–0.7 in increments of 0.1), fire pixel counts (green–red shading, 10–510 in increments of 50), and ERA-Interim 2002–12 monthly-mean 600-hPa winds. Red squares indicate Ascension Island and St. Helena Island.

Adebiyi et al., 2015 JCLIM

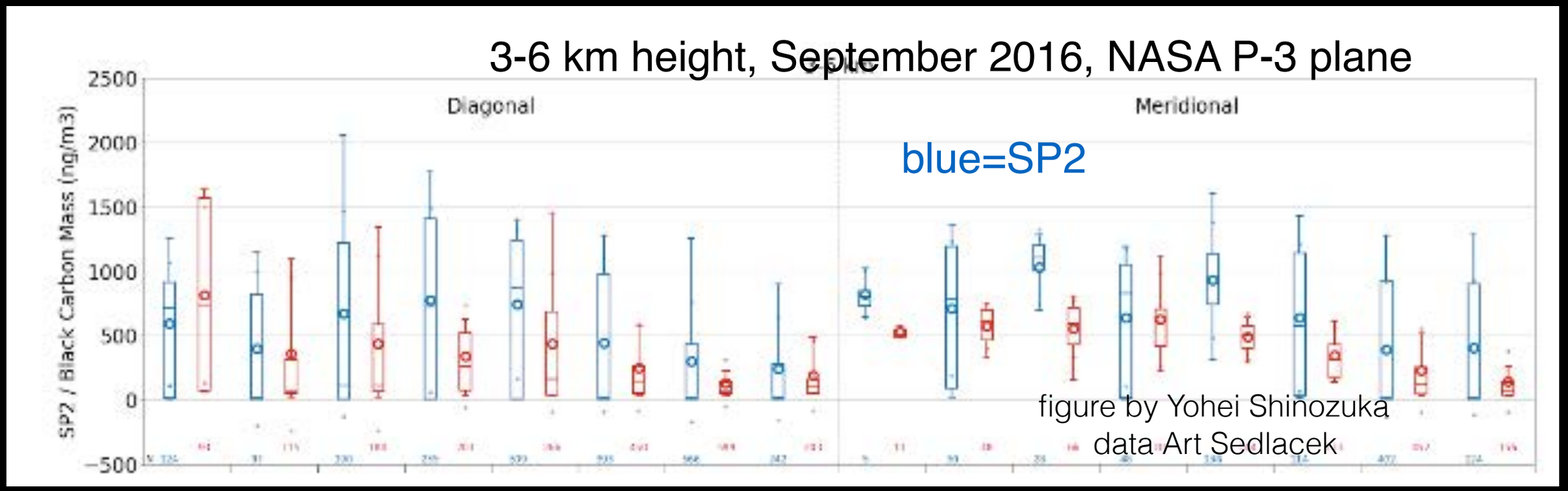


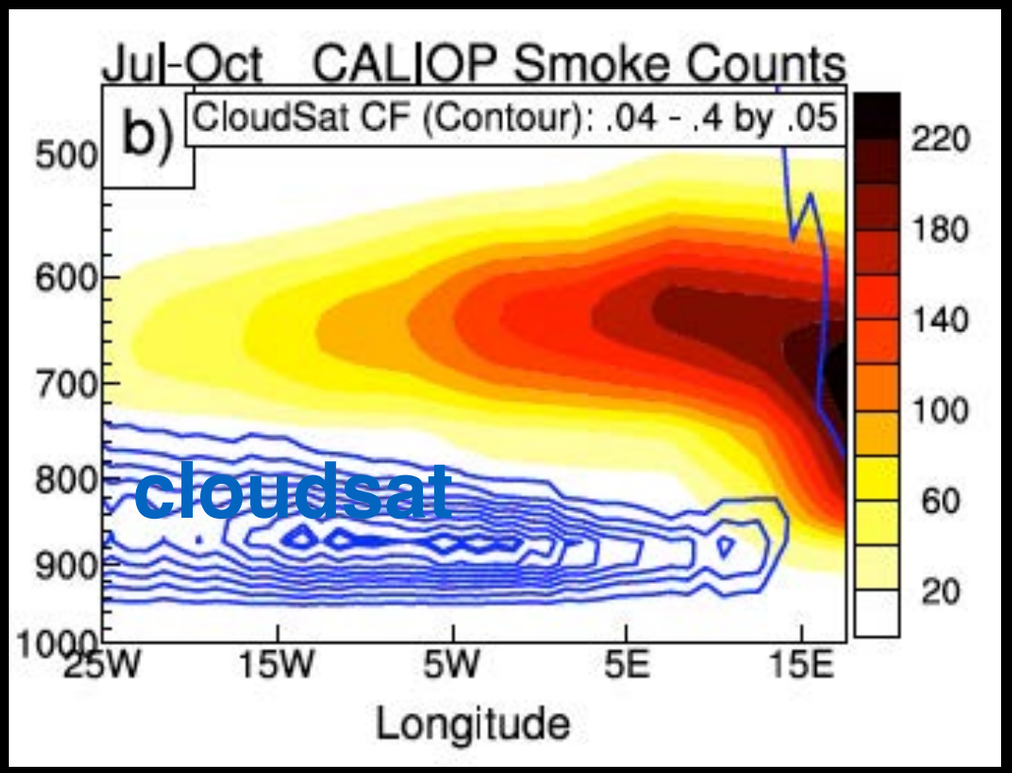
Adebiyi and Zuidema, 2016:

early data revealed smoke is often present in the boundary layer, particularly July-August



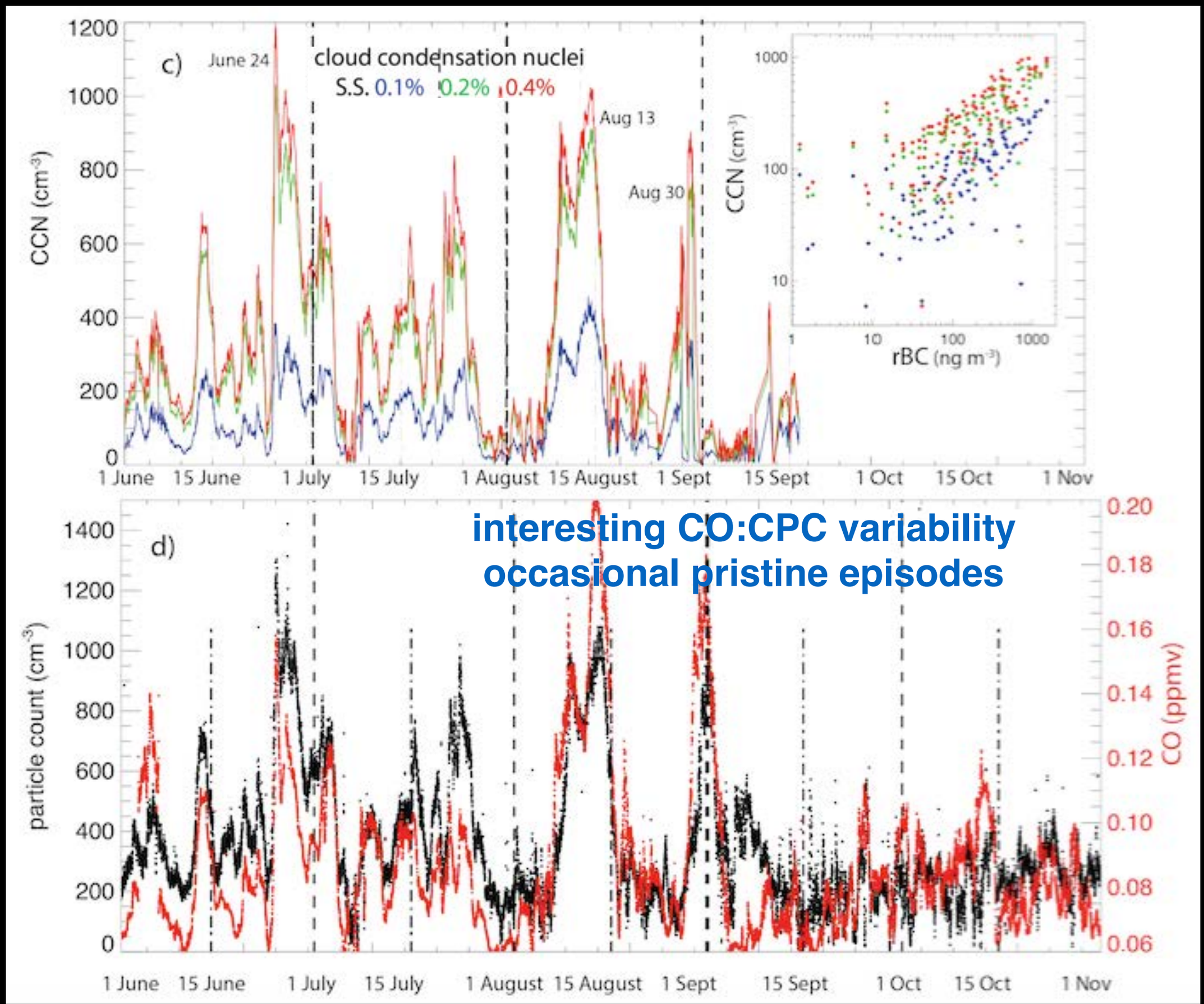
in quantities easily matching/exceeding those measured in-situ above cloud….



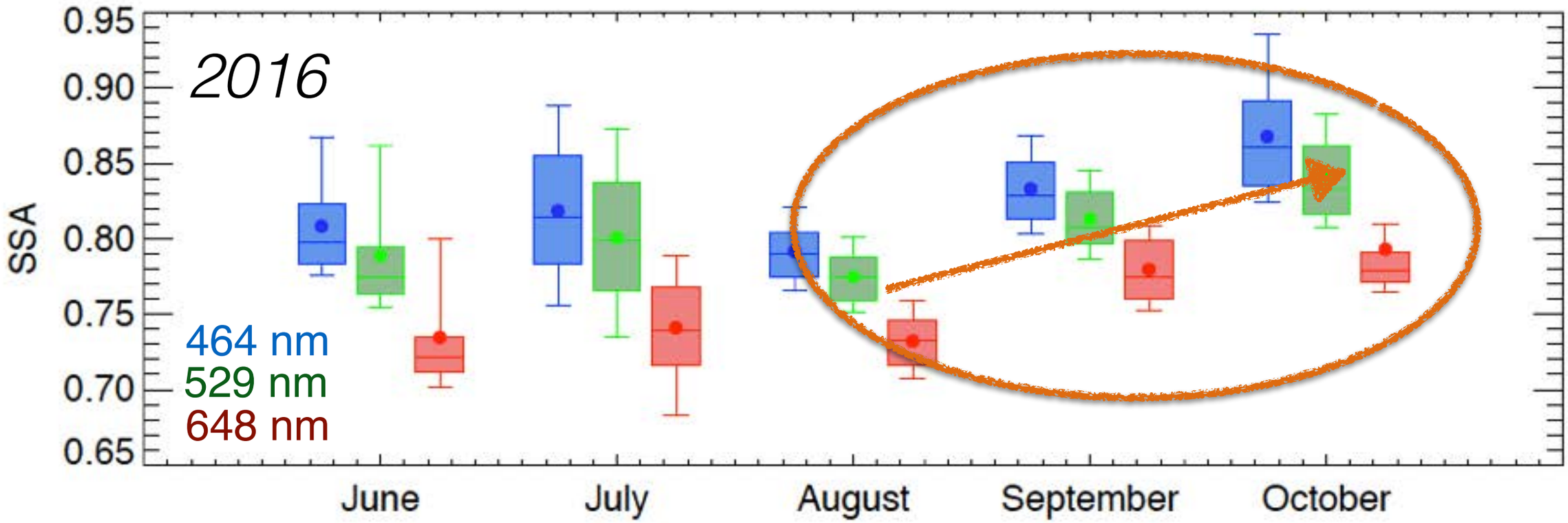


(previously we had no idea)

particles > 10 nm are readily activated into CCN



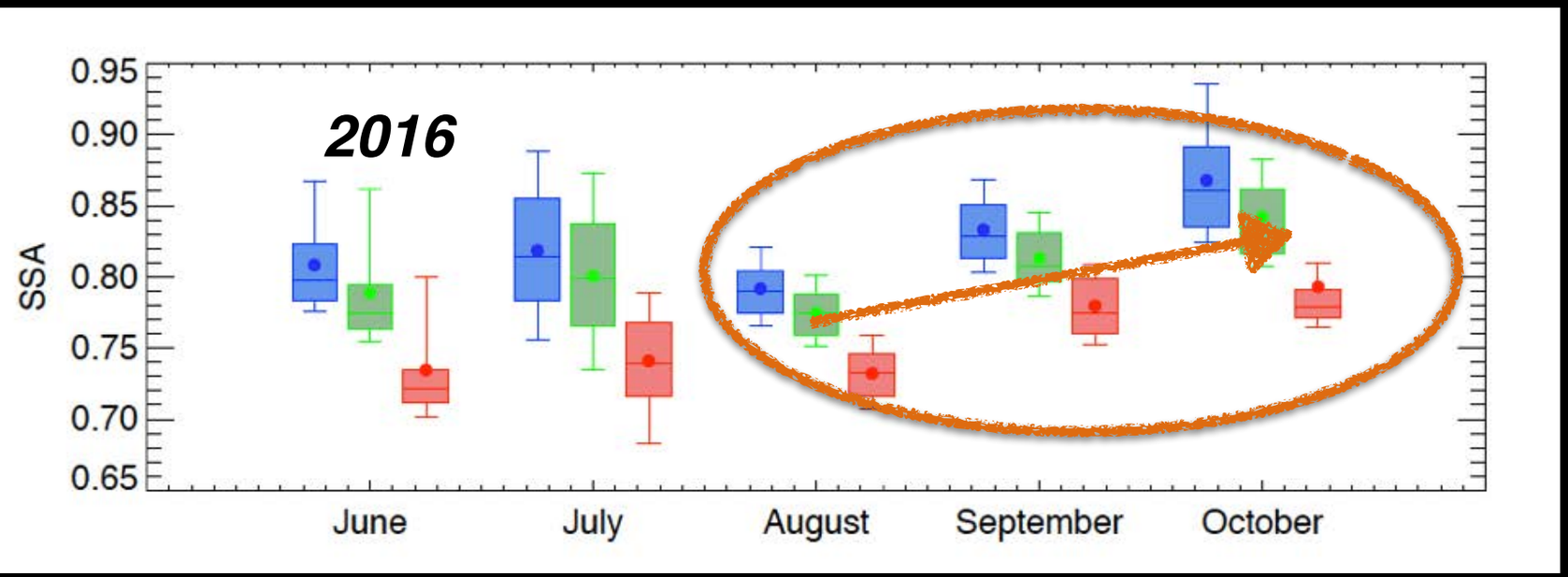
filter-based absorption estimates indicate increasing single-scattering-albedo from August through October



first noticed in AERONET retrievals over continental Africa (Eck et al., 2013)

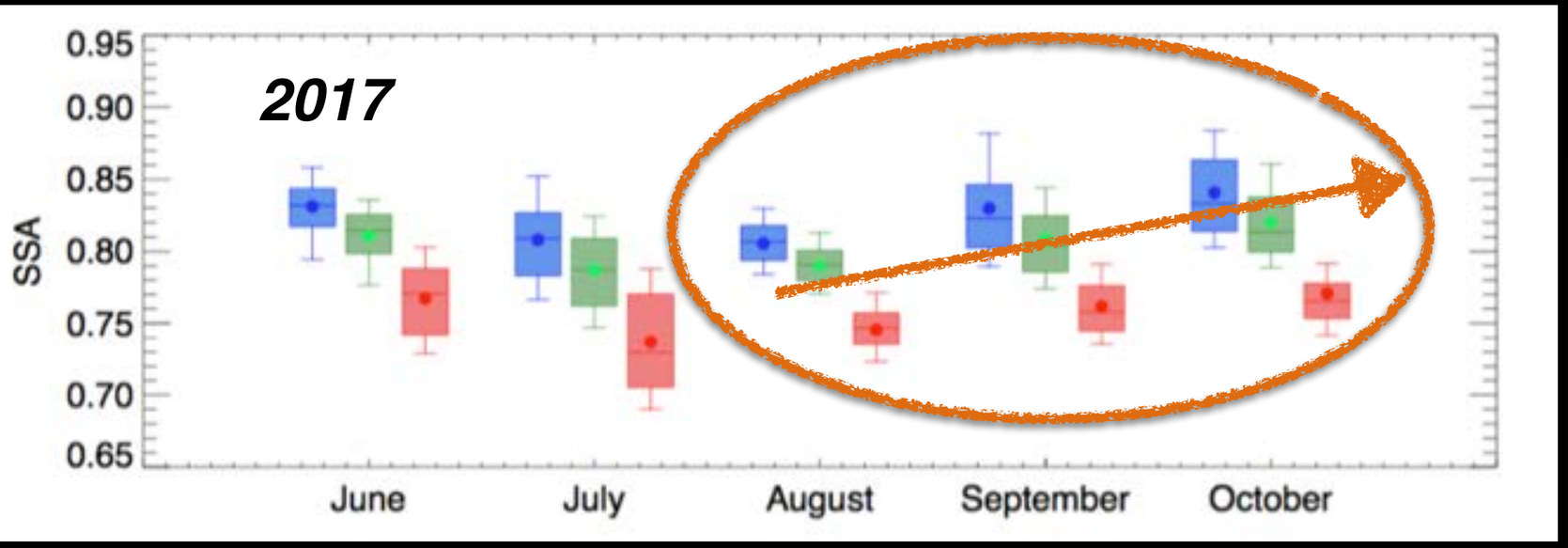
was this trend reproduced in 2017 LASIC data?

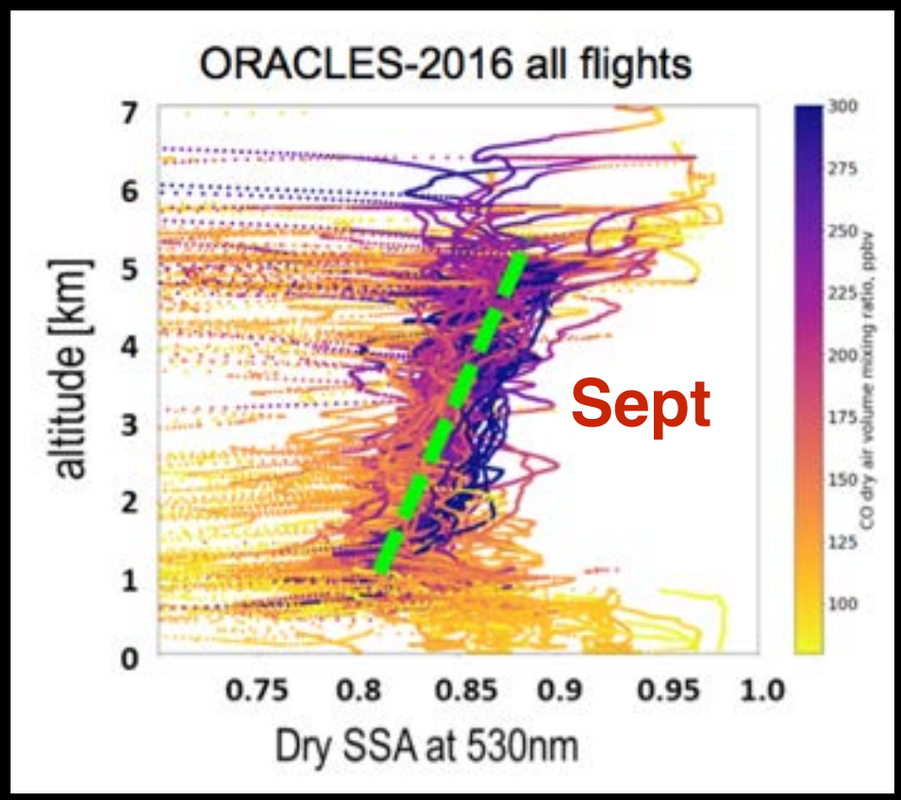
increase in single-scattering-albedo from August through October is robust across the two years



August: 0.78 +/- 0.02
September: 0.81 +/- 0.03
October: 0.83 +/- 0.03

2016/2017 means, 529 nm (green)





Howell, Freitag, Dobracki
U Hawaii

previous studies (SAFARI)
have suggested
SSA ~0.85

A synthesis of single scattering albedo of biomass burning aerosol over southern Africa during SAFARI 2000

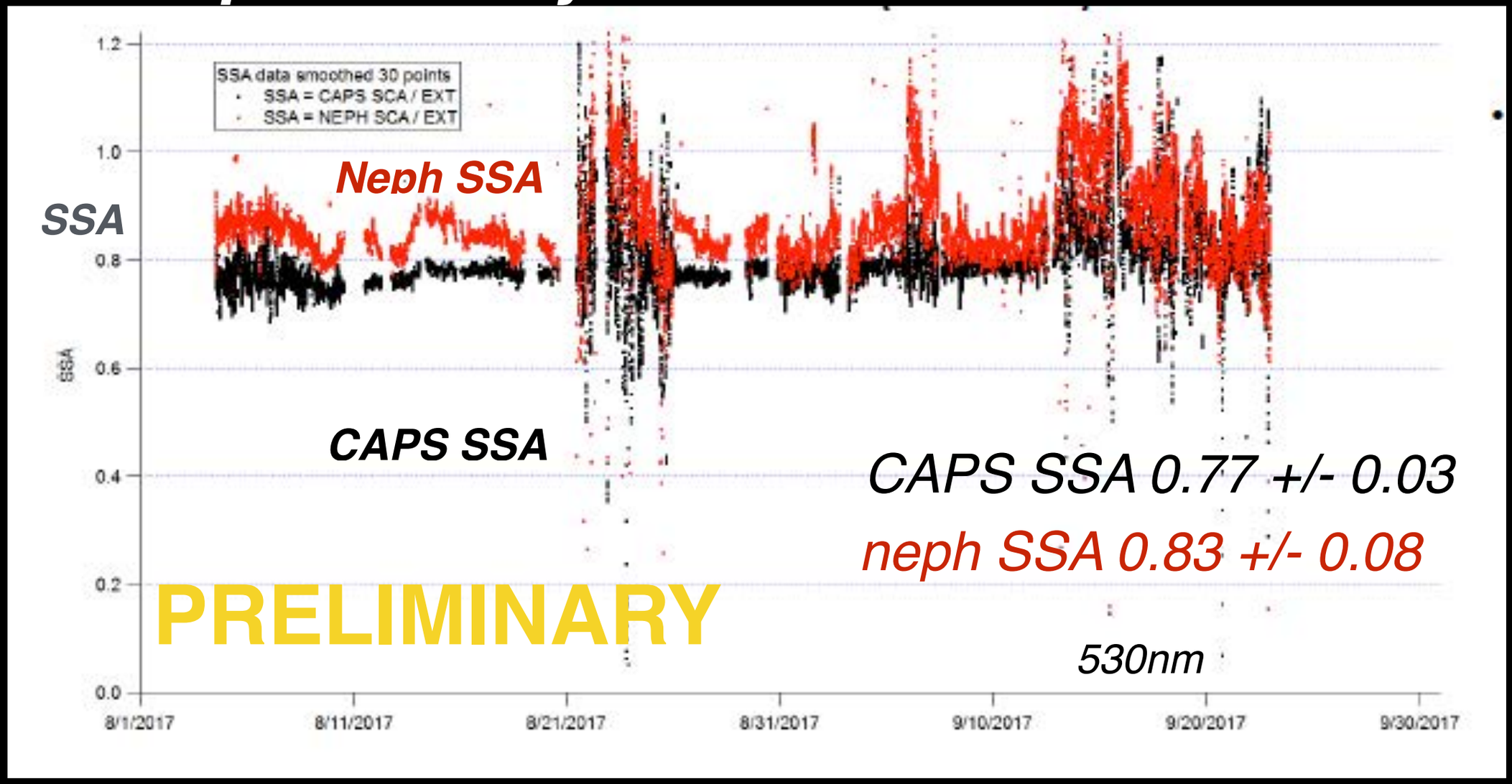
L. V. Leahy,[1] T. L. Anderson,[1] T. F. Eck,[2] and R. W. Bergstrom[3]

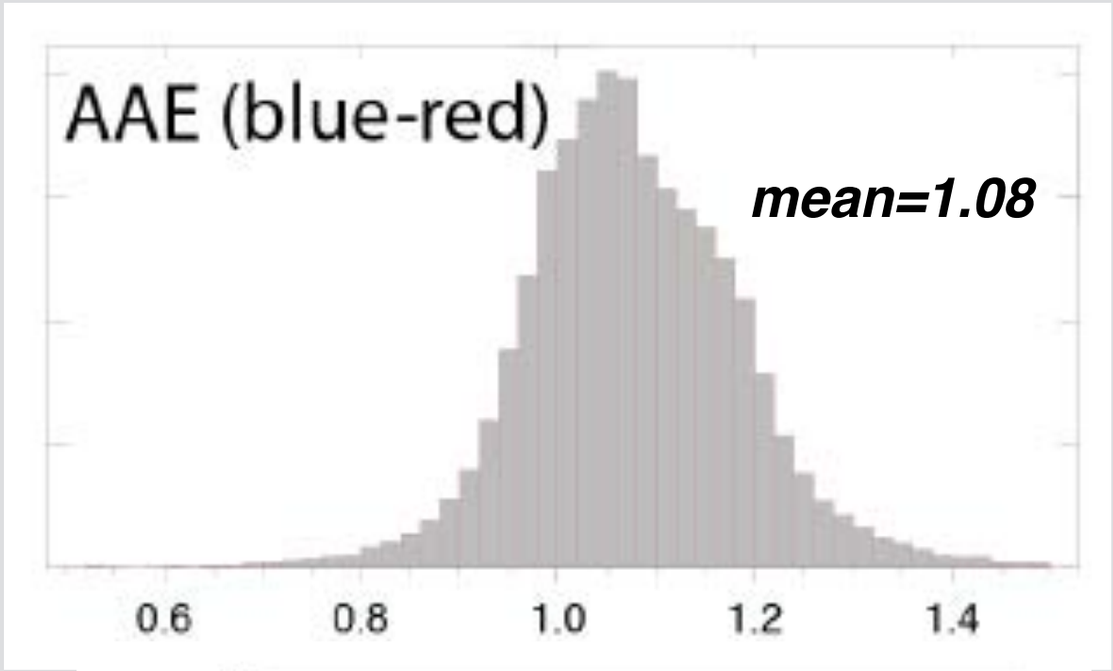
Received 15 February 2007; revised 15 April 2007; accepted 22 May 2007; published 30 June 2007.

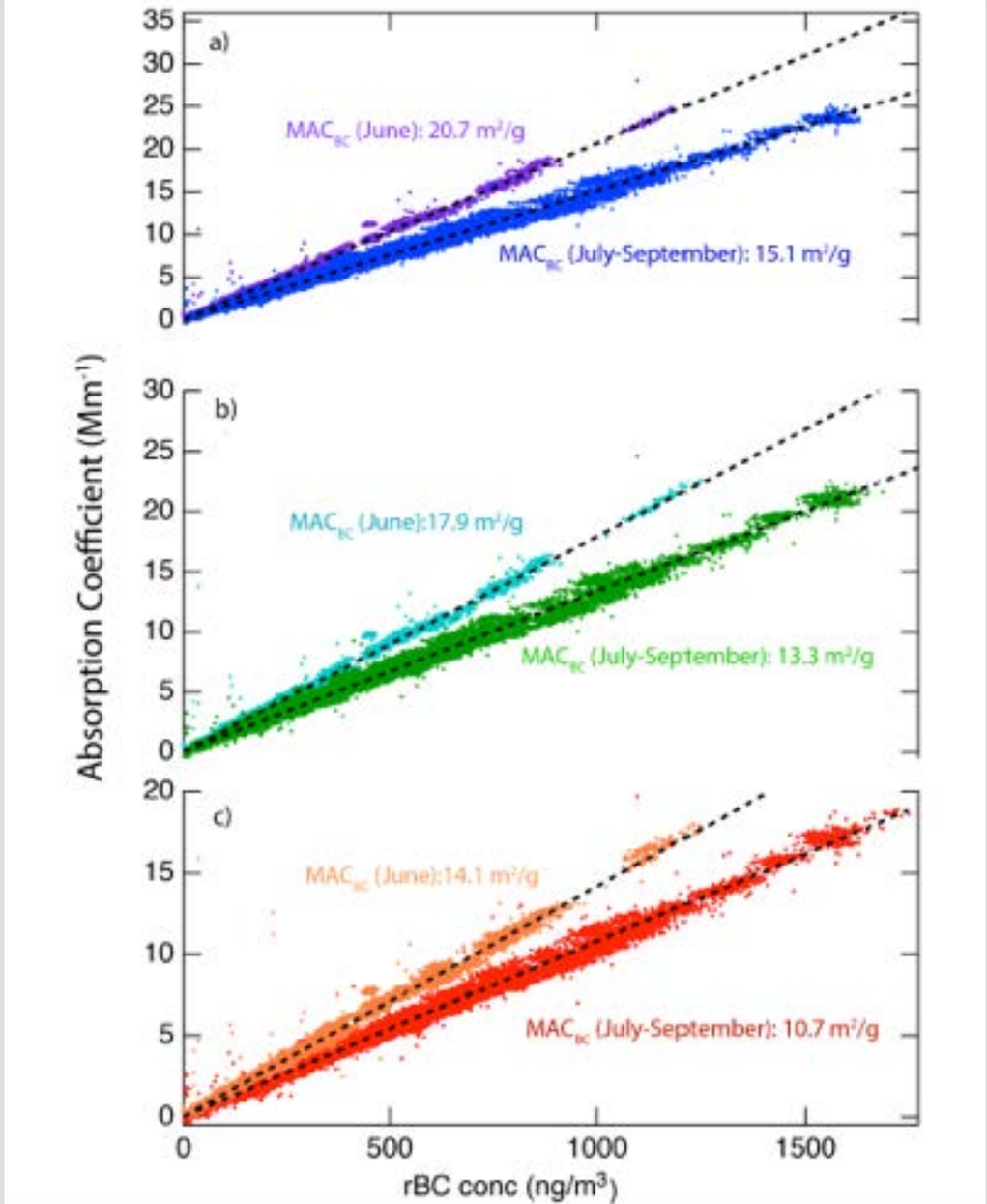
SSA-Constraint study 2017

Tim Onasch/Andrew Freedman (Aerodyne) independently assessed SSA using a CAPS-SSA, 4 Aug - 22 Sep 2017

qualitatively confirms a lower SSA







absorption angstrom exponents are spectrally-flat

filter light absorption as a function of black carbon mass conc. suggest 2x enhancement from black carbon alone

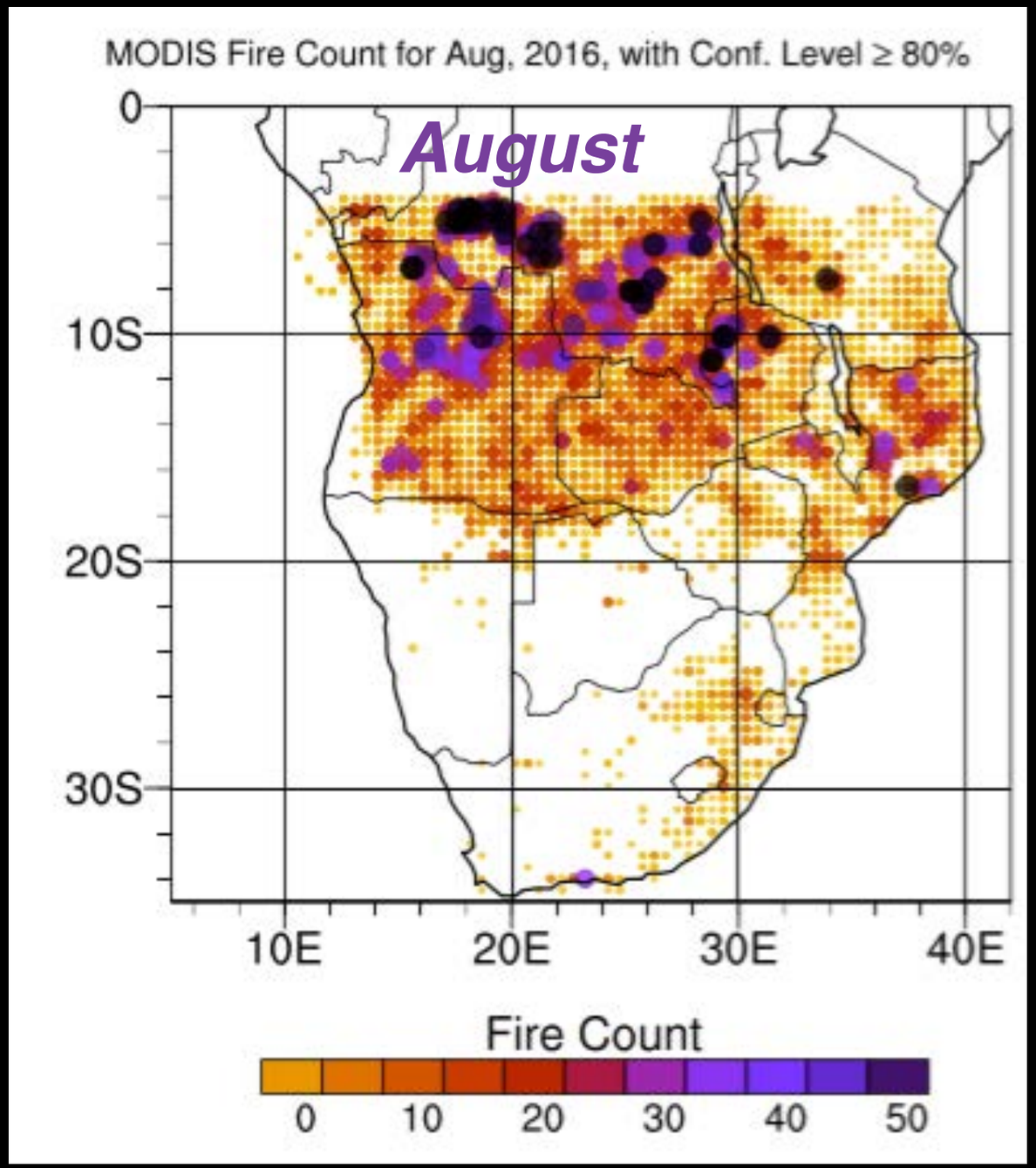
~ 15 m^2/g vs 7-8 m^2/g from lab studies of black carbon

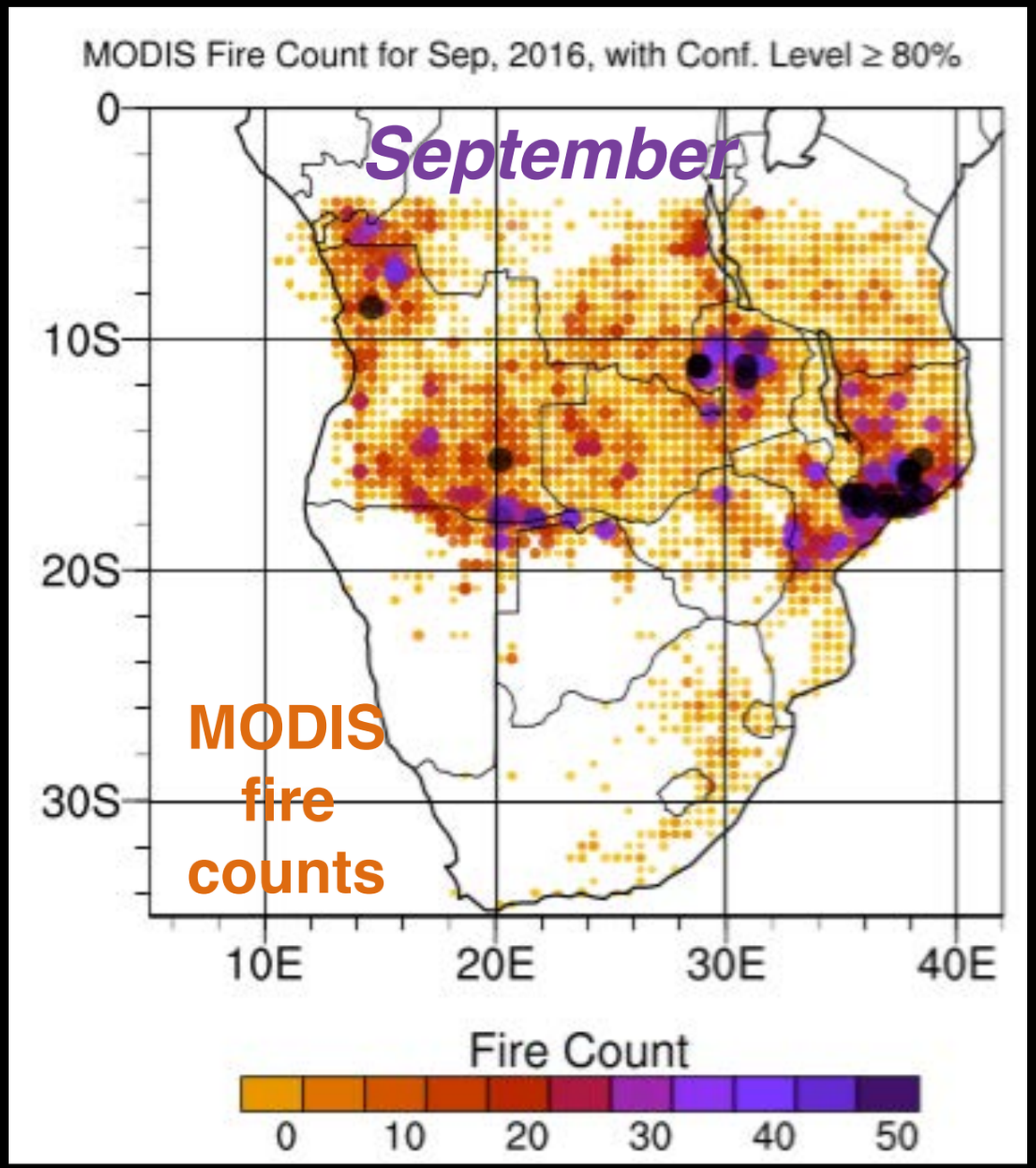
….with slightly higher values in June

low SSA/low AAE point to coated black carbon as primary light absorber, with some modification by organic aerosol, well-aged

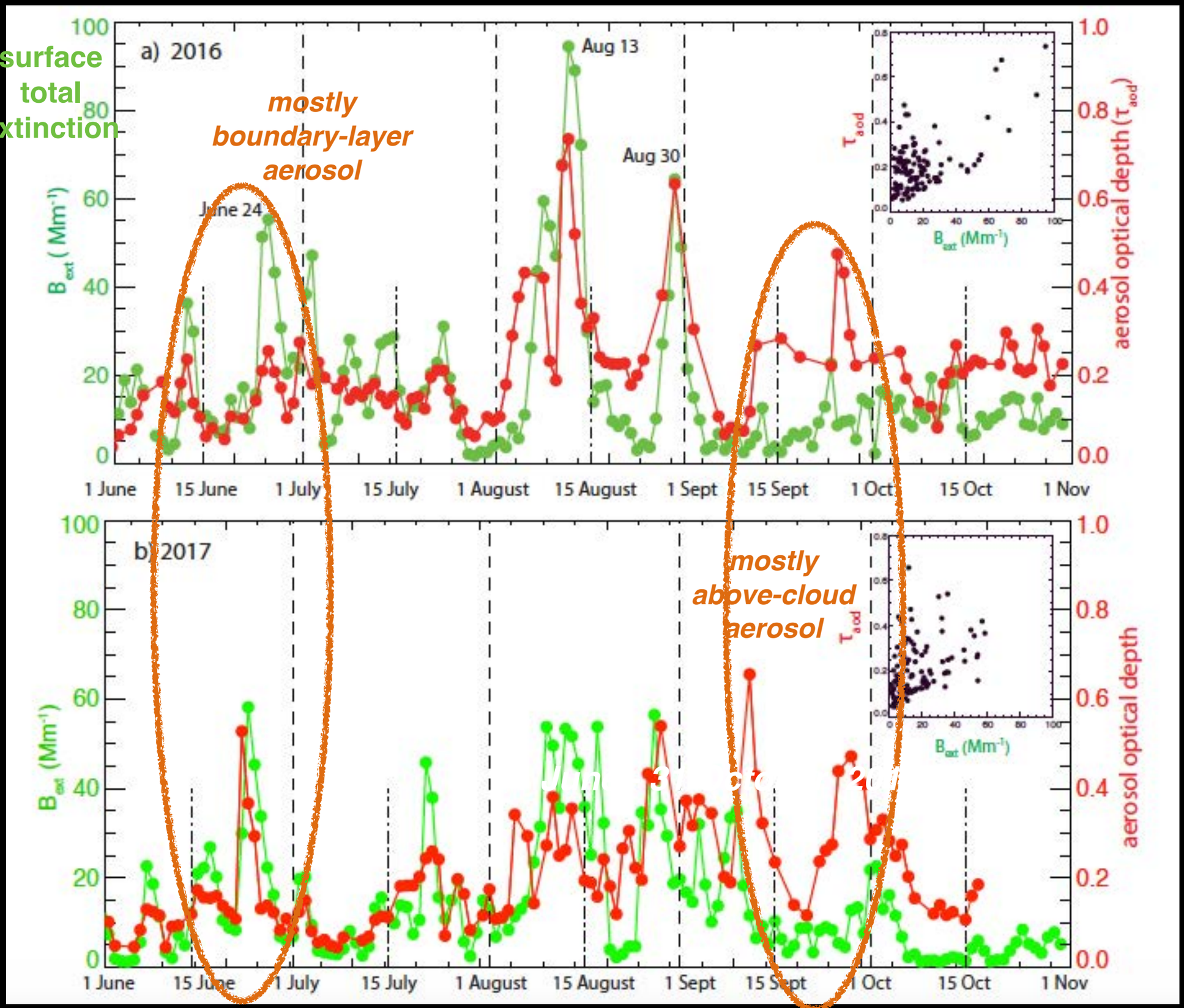
significant shift in fire spatial distribution between August to September (2016) may contribute to increasing SSA

postulated in Eck et al 2013





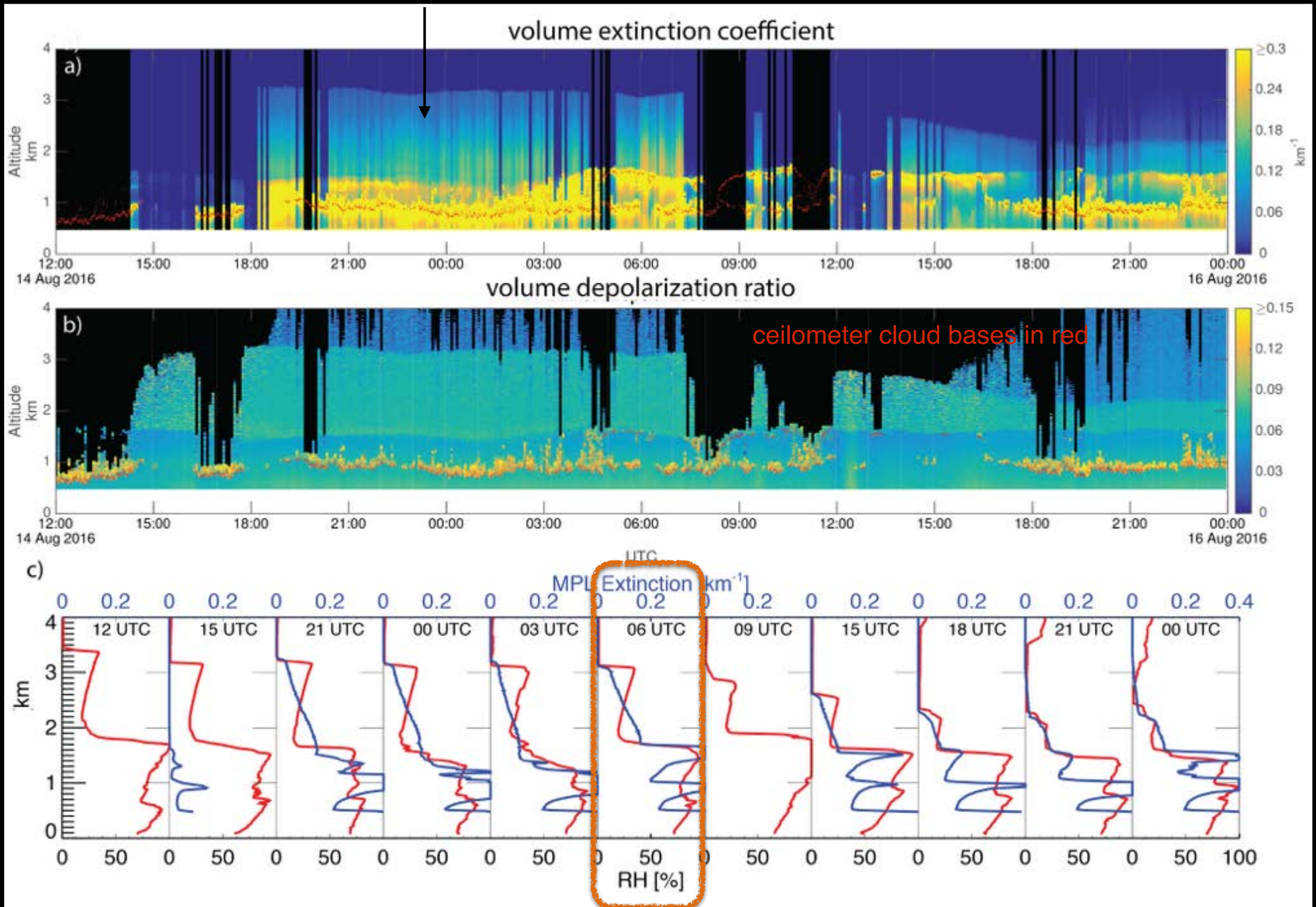
near-surface and total column aerosol not well-correlated but rather occupy ‘regimes’ that vary with ~month



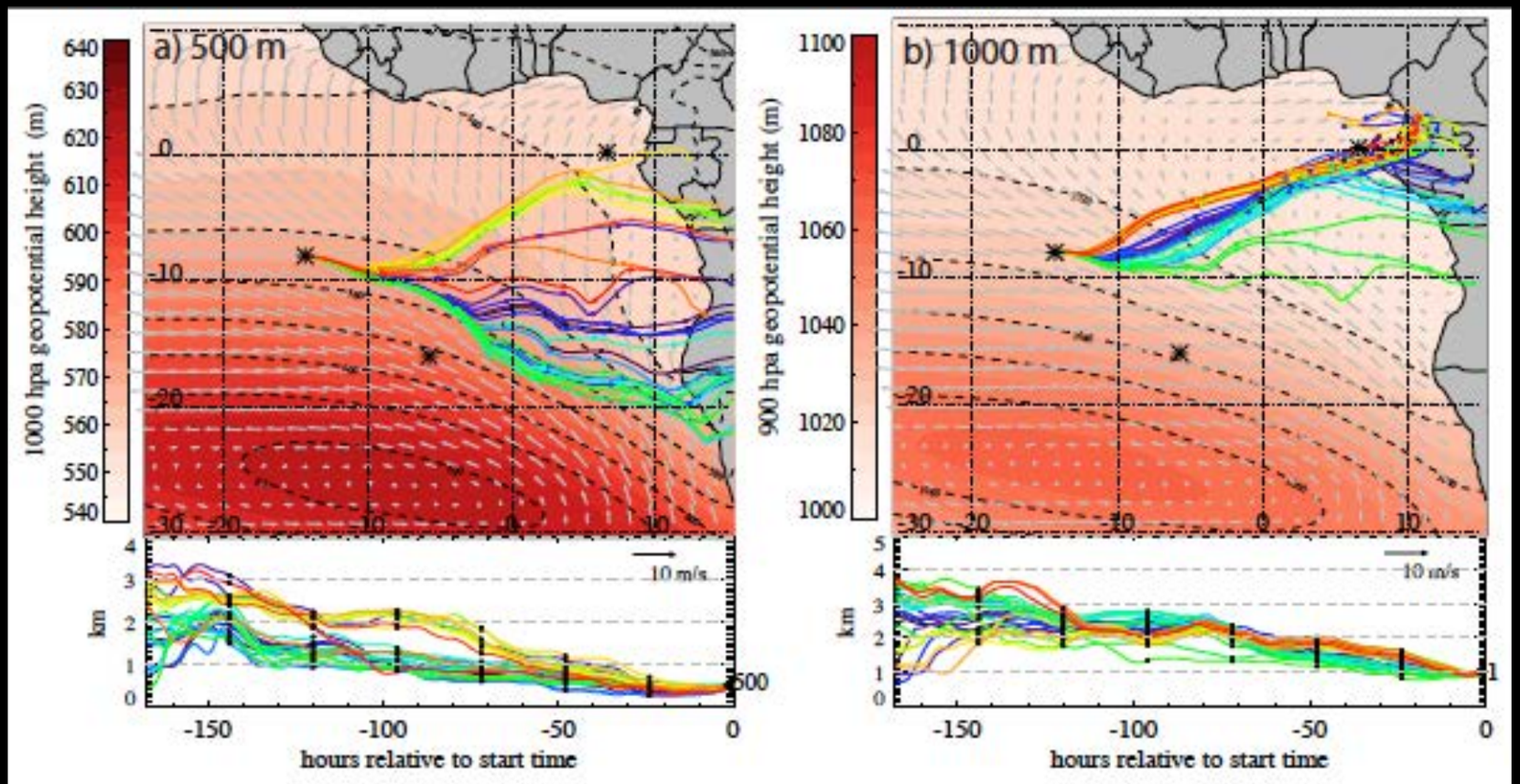
AERONET
@airport

above-cloud AOD ~0.2; total AOD ~0.43

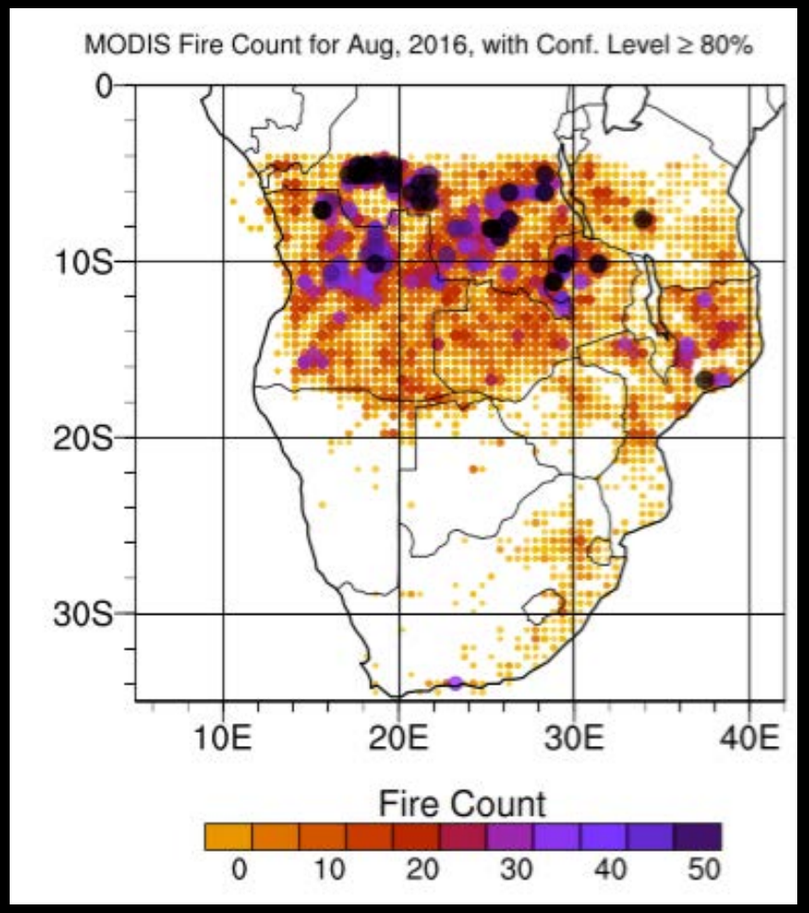
14-15 August 2016

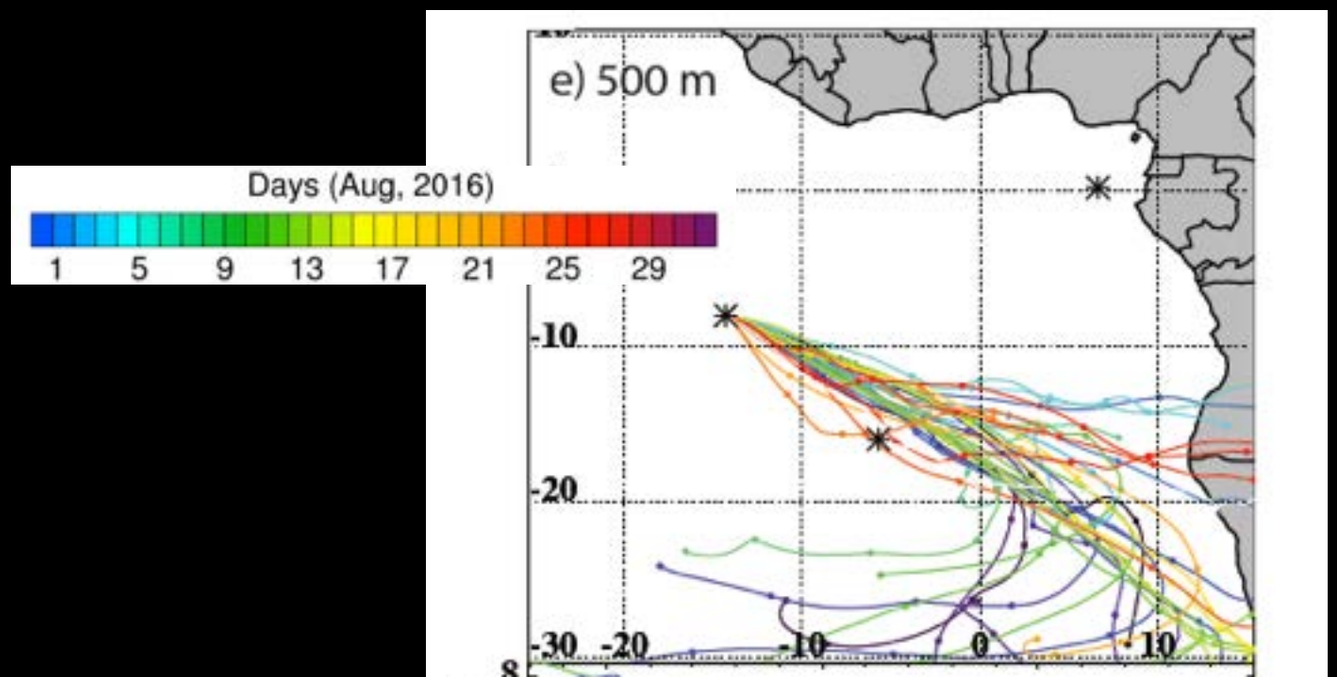


low-altitude outflow coming directly from continental fires distinguishes the smokier boundary days in August, 2016



7-day ensemble back trajectories for 13 August, 2016

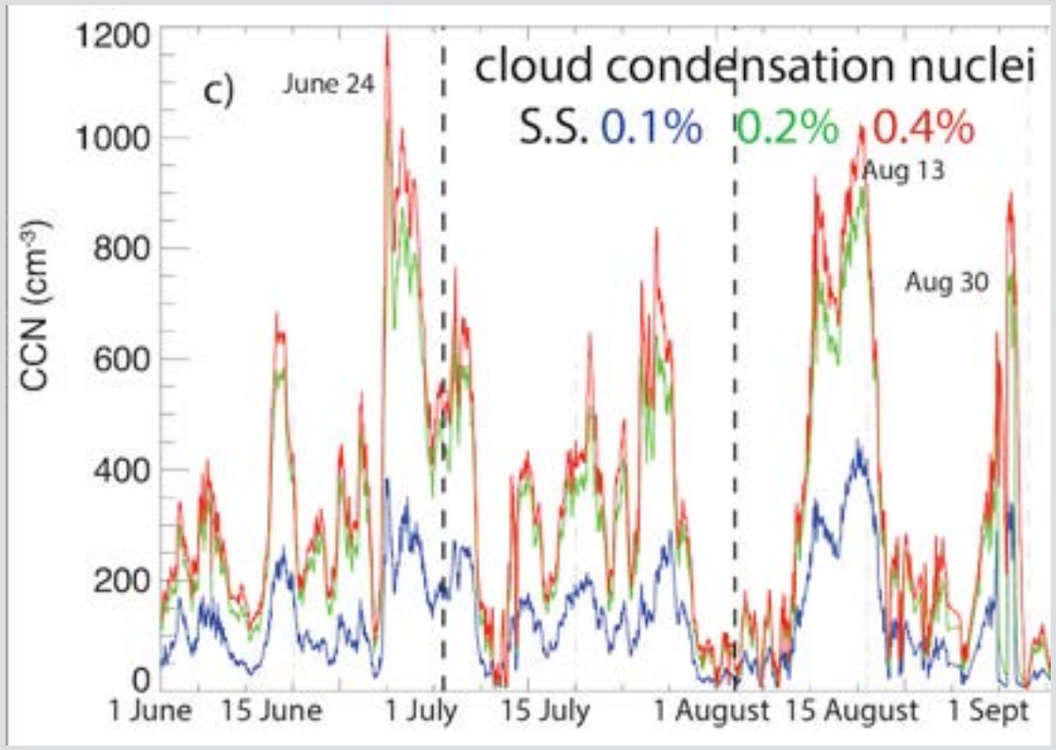


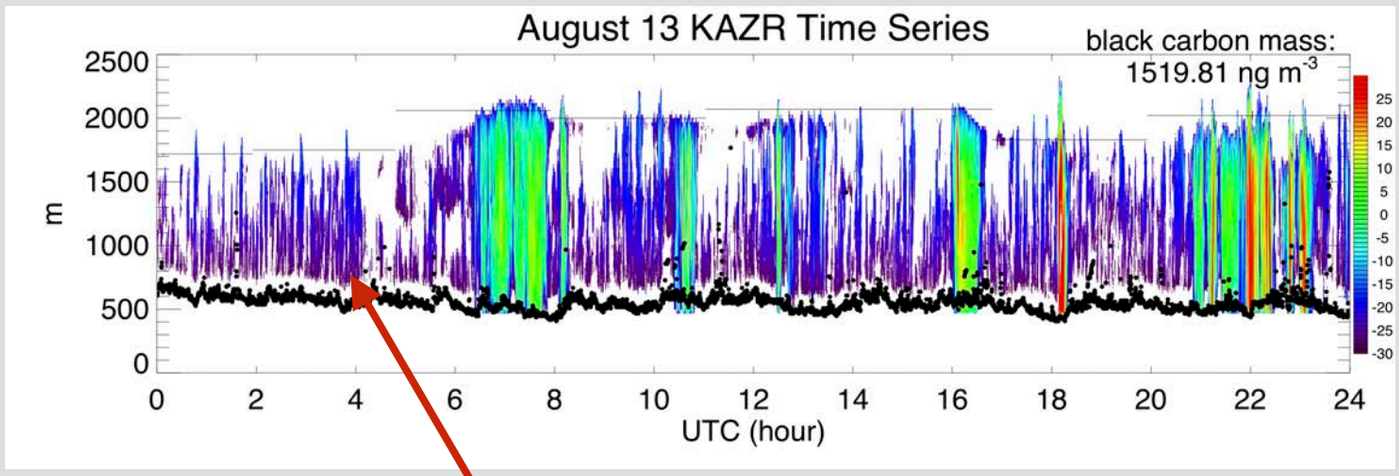


low-level flow off of continent contrasts with typical back trajectories flowing from the southeast Atlantic

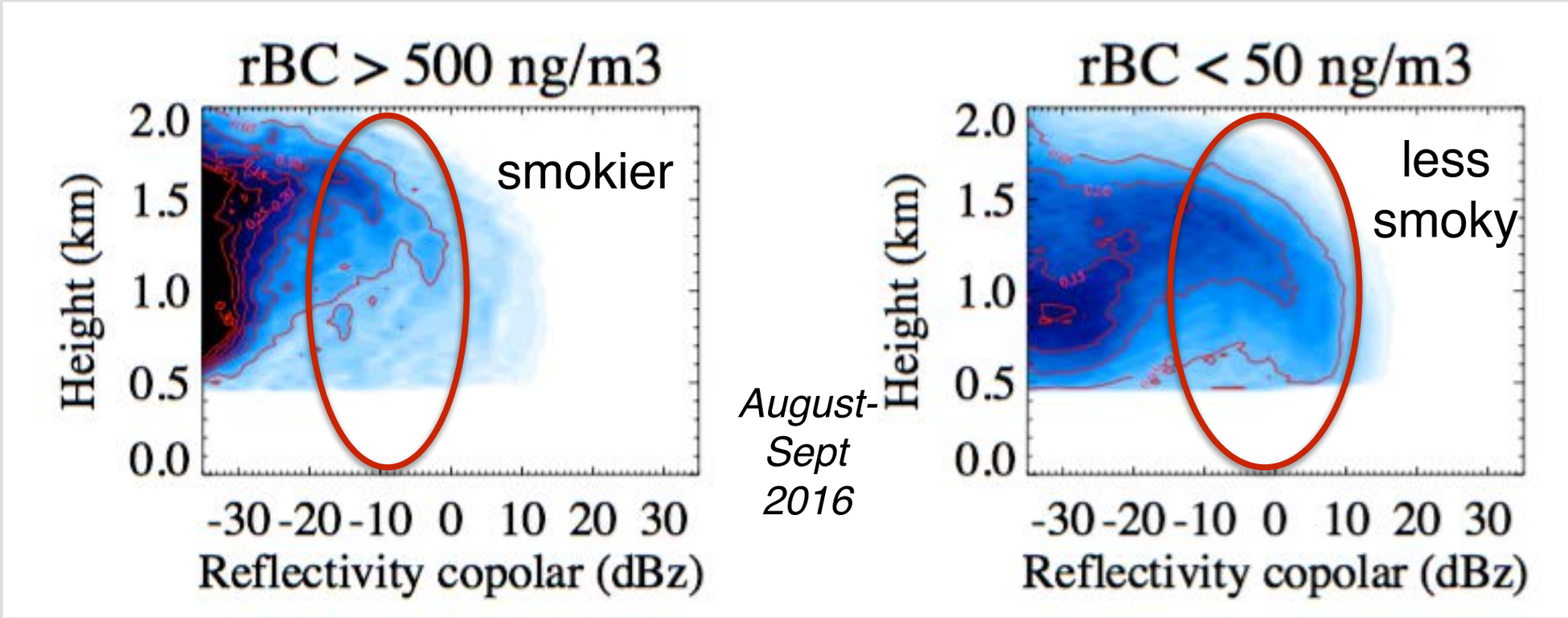
material in last few slides published in *doi:10.1002/2017GL076926*

near-surface cloud condensation nuclei concentrations elevate when smoke is present





small drops not registering at -30 dbZ;
ceilometer cloud base indicated

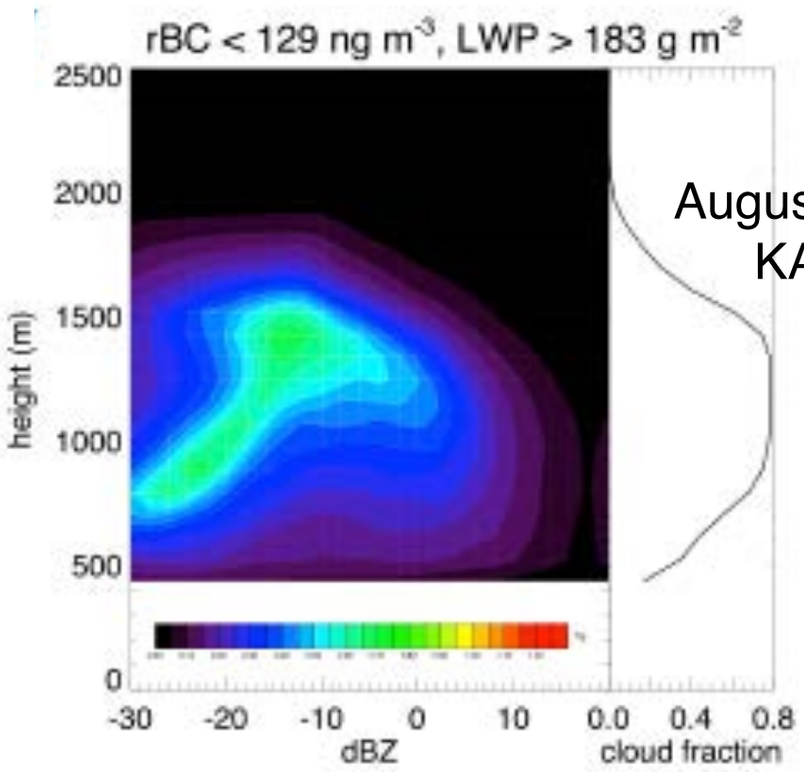


apparent signature of drizzle suppression in height-dBZ frequency distributions

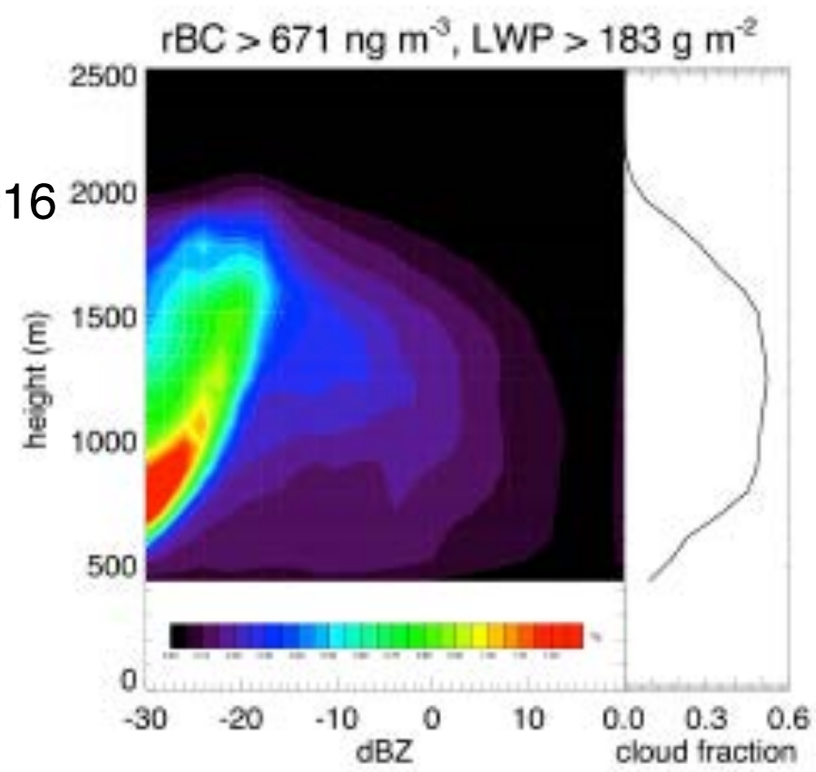
will need to use scanning radar data to robustly assess aerosol effects

compositing by both smoke and liquid water path suggests smoke can reduce overall cloud fraction consistent with cloud ‘burn-off’ (Ackerman et al.,2000)

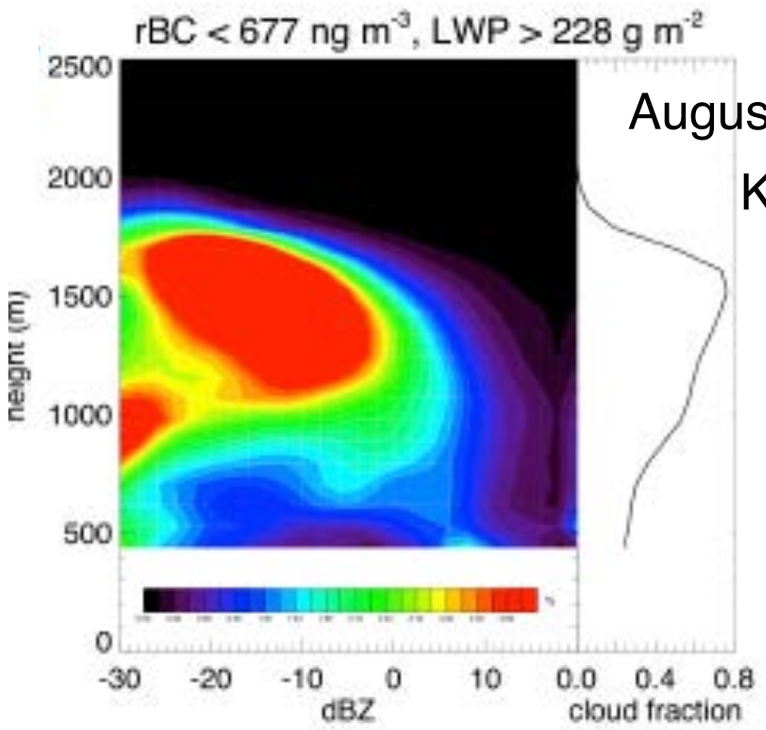
less smoky



August, 2016
KAZR



more smoky



August 13-17 2016
KaSACR

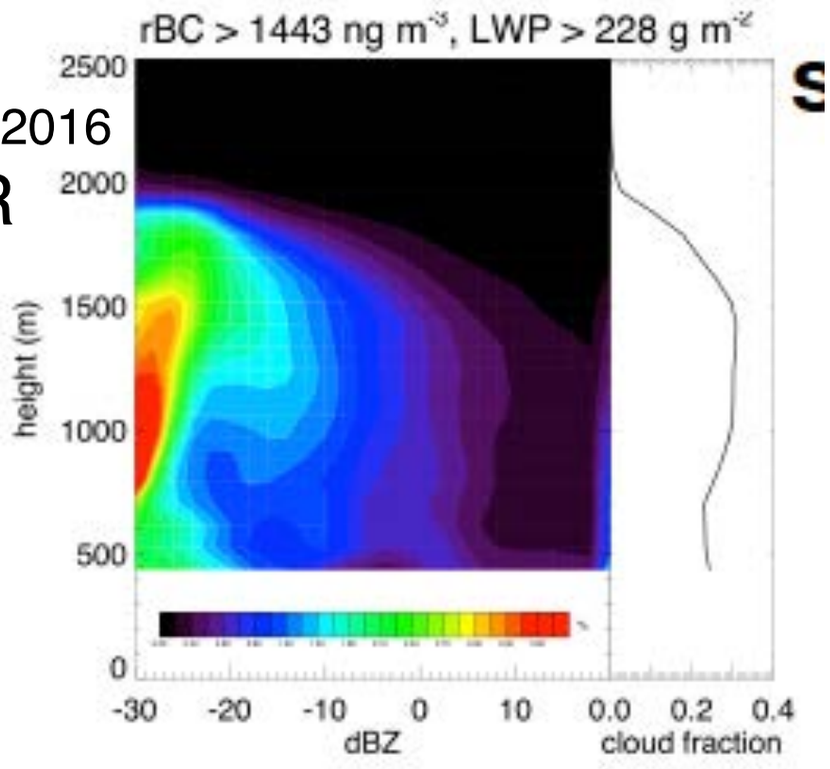
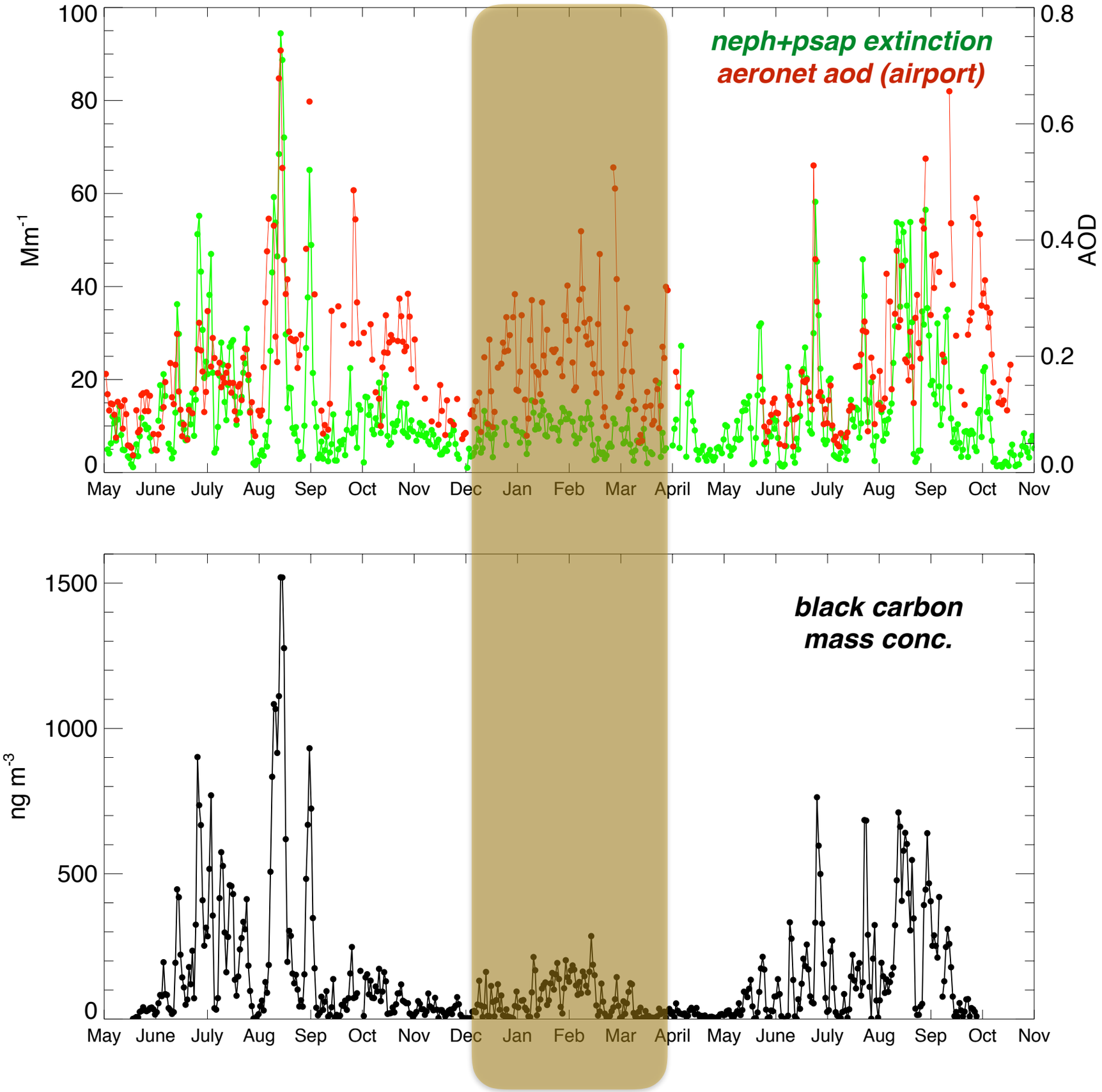


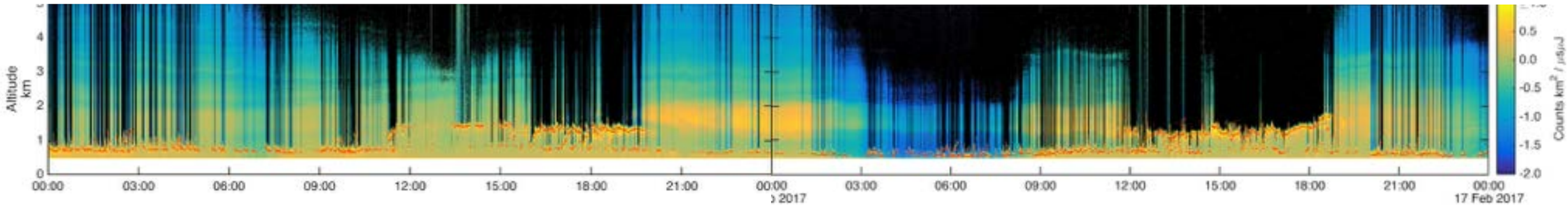
figure by Daniel Lloveras

17-month-long campaign time series reveals additional aerosol peak centered on February

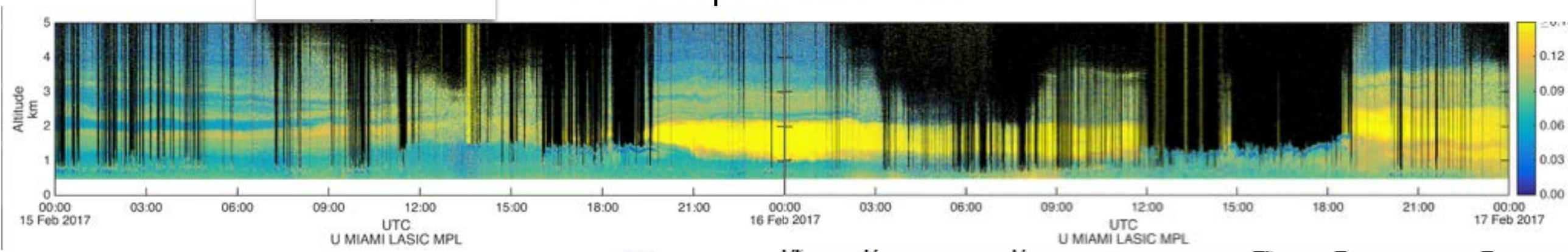


15-16 February 2017 lidar depolarization ratio suggests dust is frequent

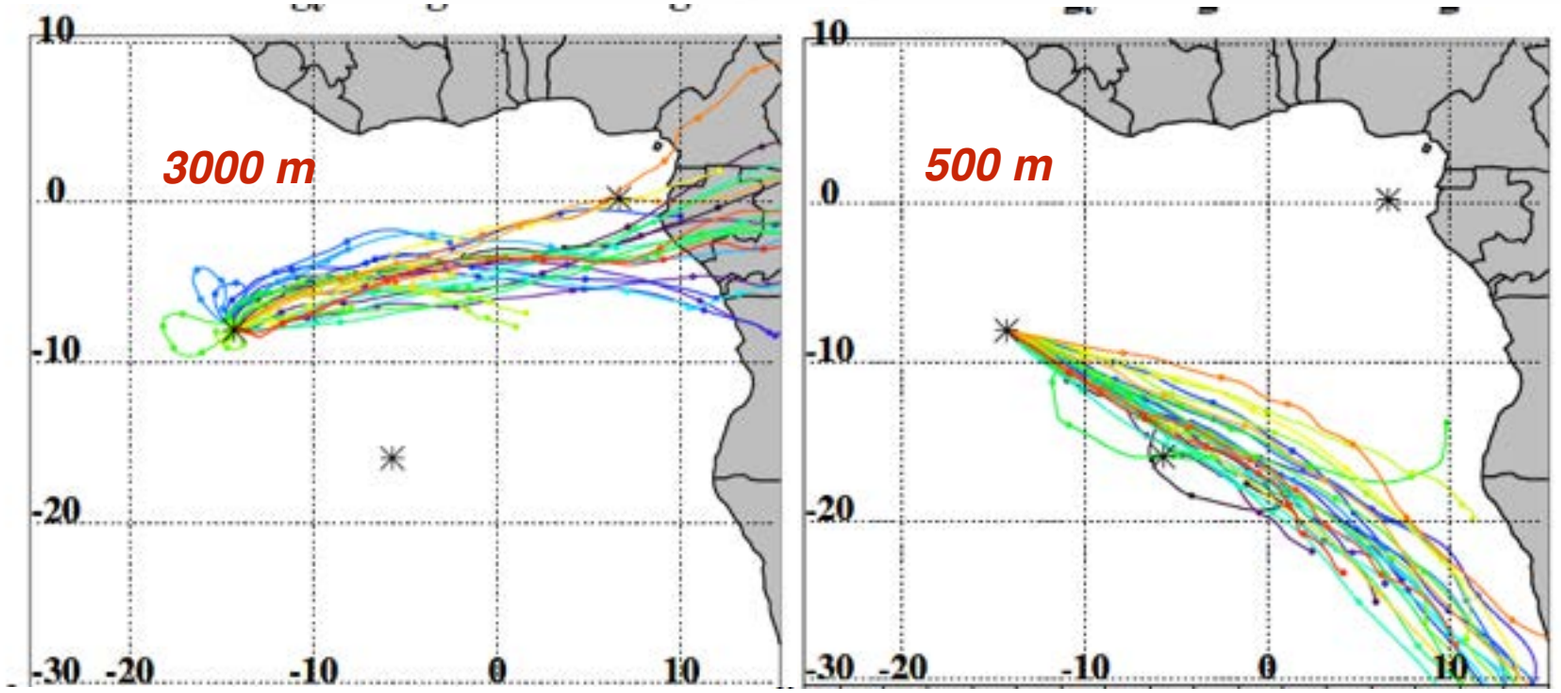
normalized relative backscattered intensity



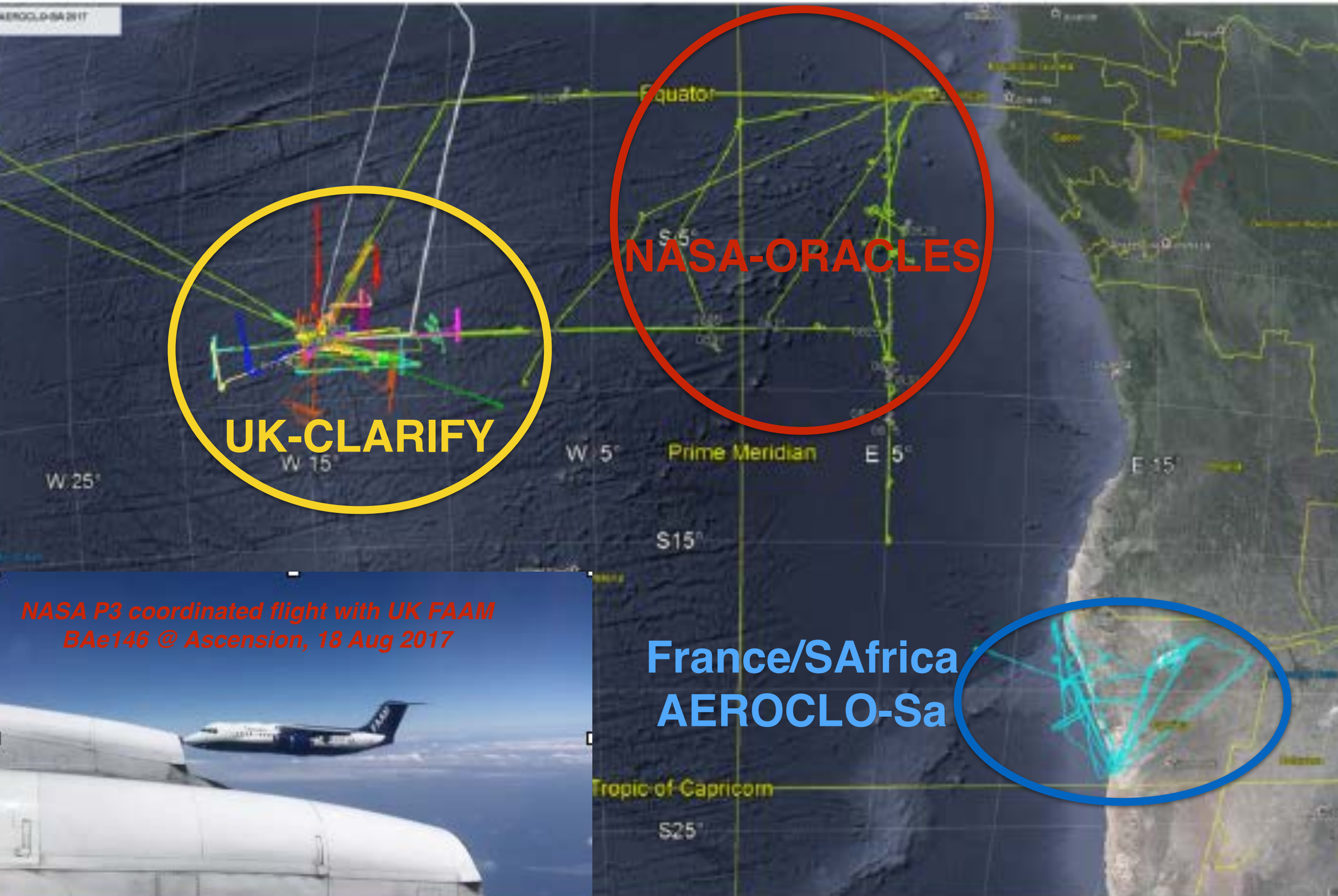
volume depolarization ratio



HYSPLIT back trajectories
not so different from
BB season -
so differences may be more
in the sources



Collaborative Aircraft Campaigns August-September 2017

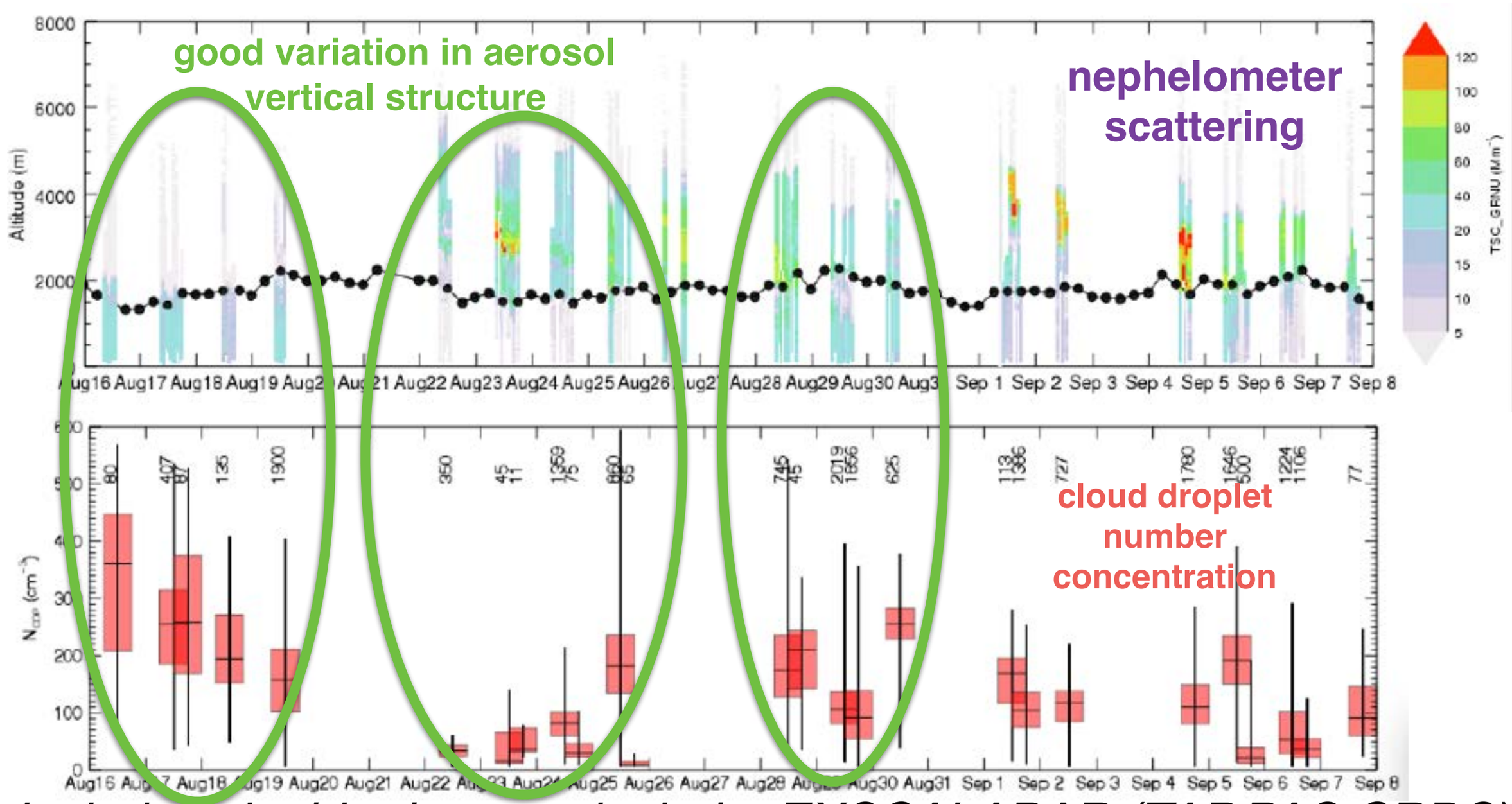


NASA P3 coordinated flight with UK FAAM BAe146 @ Ascension, 18 Aug 2017

UK Cloud Aerosol Radiation Interactions and Forcing (CLARIFY)

PI- Jim Haywood; FAAM BAe-146 plane; 16 August-8 September 2017

in-situ vertical profile measurements important for linking surface AMF1 data to atmosphere above



particularly valuable datasets include: EXSCALABAR (TAP,PAS,CRDS) measuring absorption/extinction at 3 wavelengths, blue ext. at high RH

PI Jens Redemann

ORACLES 2016: NASA P-3 & ER-2 flights from Namibia

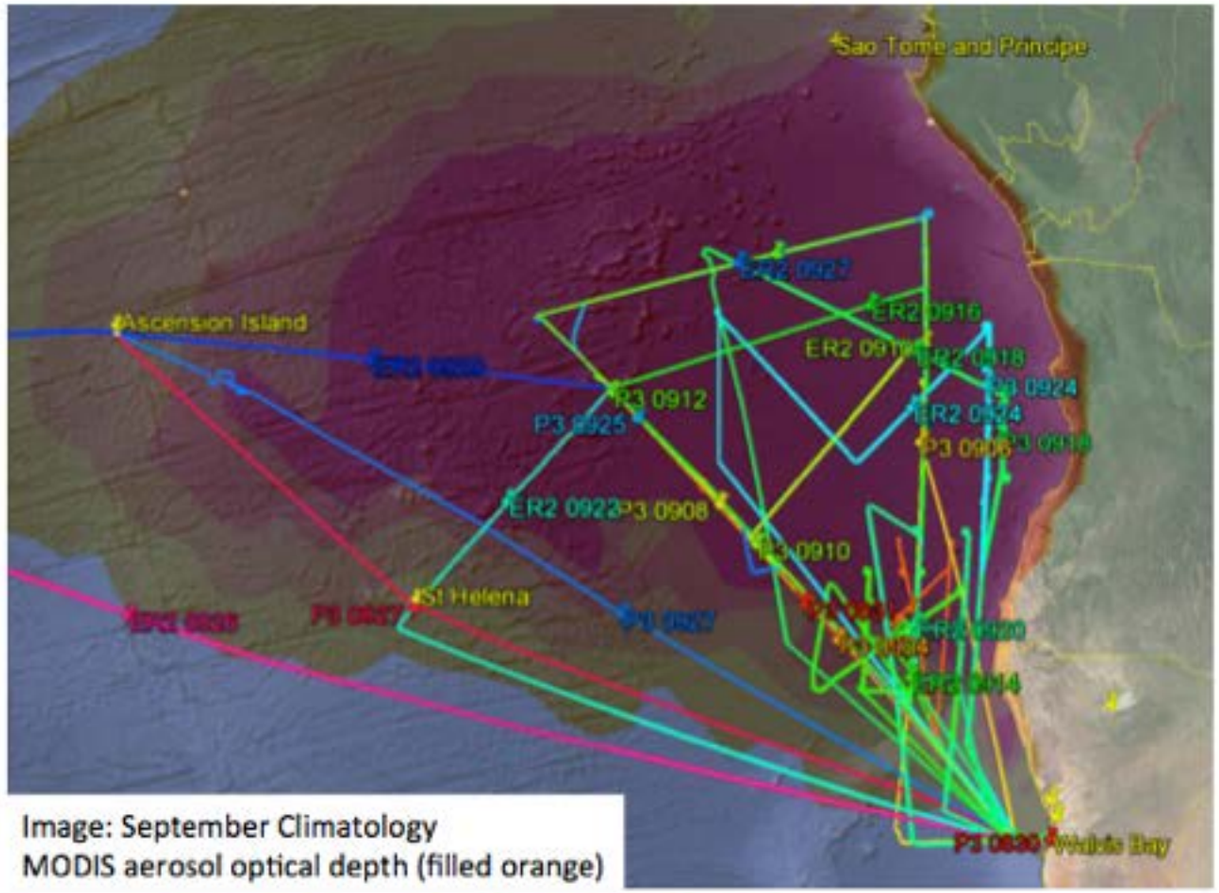


Image: September Climatology
MODIS aerosol optical depth (filled orange)

NASA ER-2
High-altitude (18km)
Remote sensing
Large spatial coverage
2016 only

NASA P-3
Profiles (0-8km)
In-situ + remote sensing
2016, 2017 & 2018

Coordinated flight segments

ORACLES 2017: Flights out of São Tomé with NASA P-3

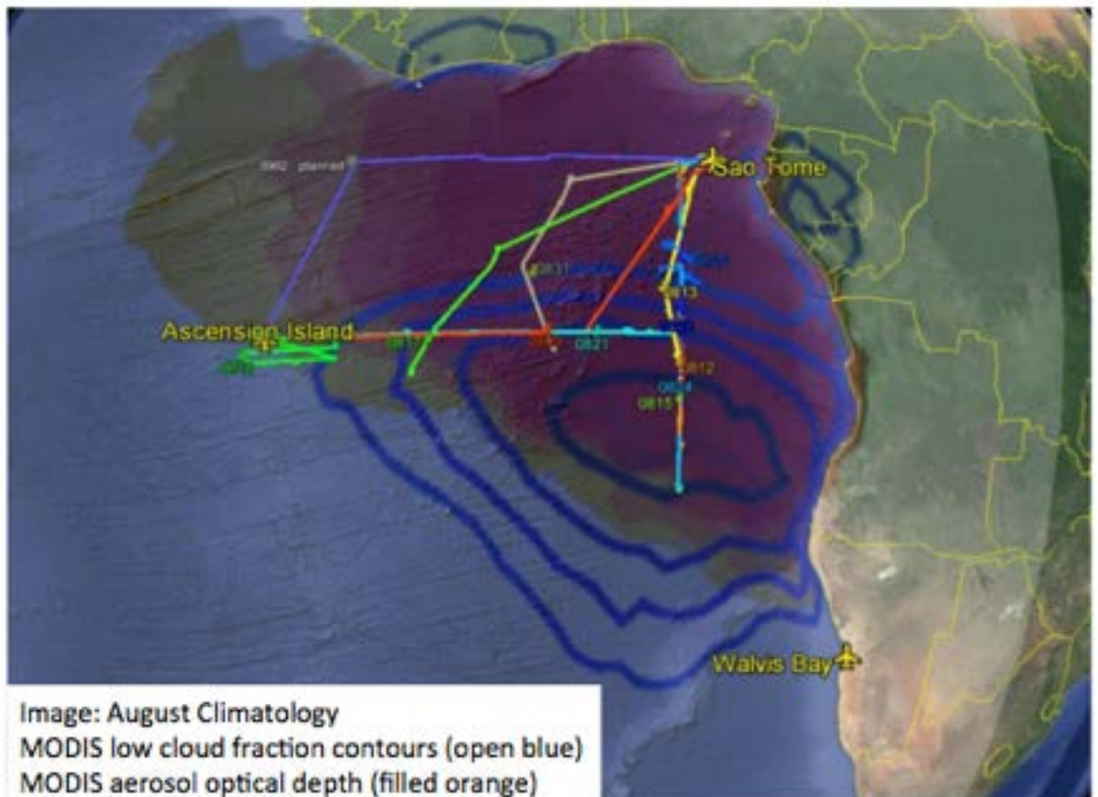


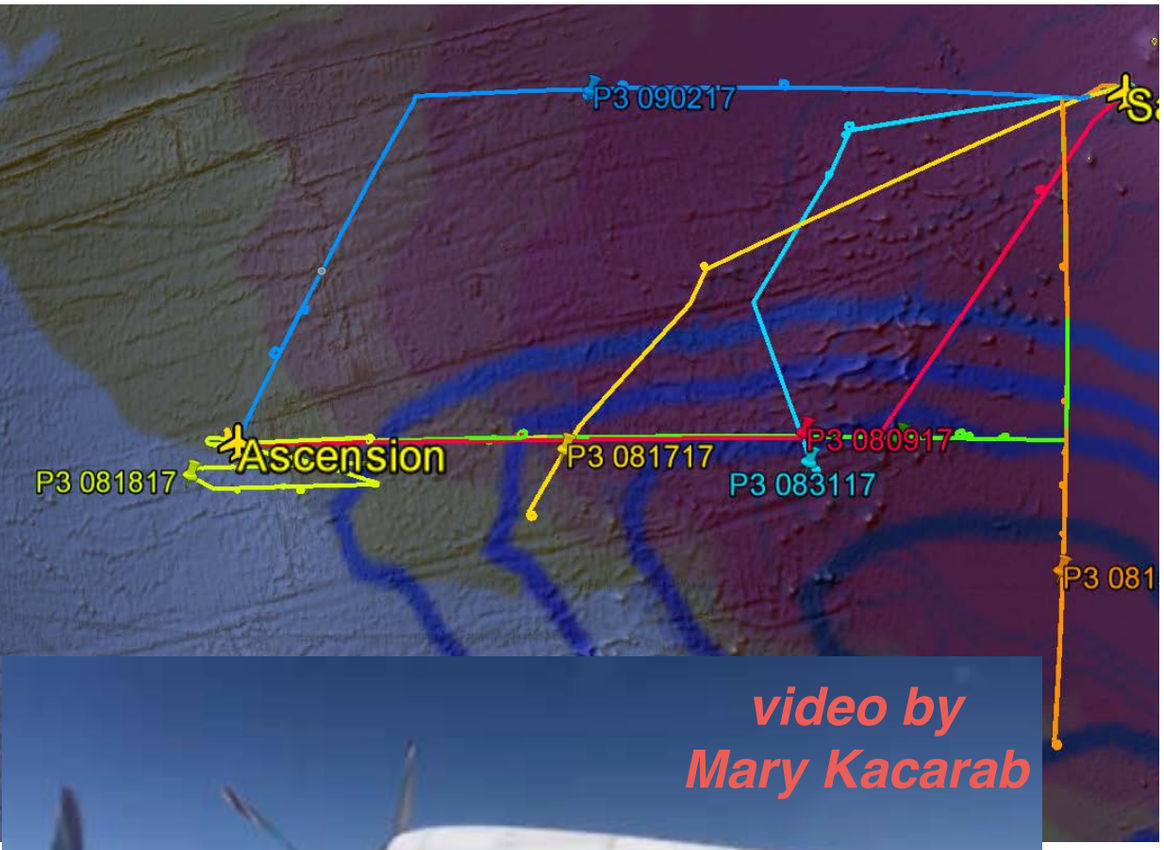
Image: August Climatology
MODIS low cloud fraction contours (open blue)
MODIS aerosol optical depth (filled orange)

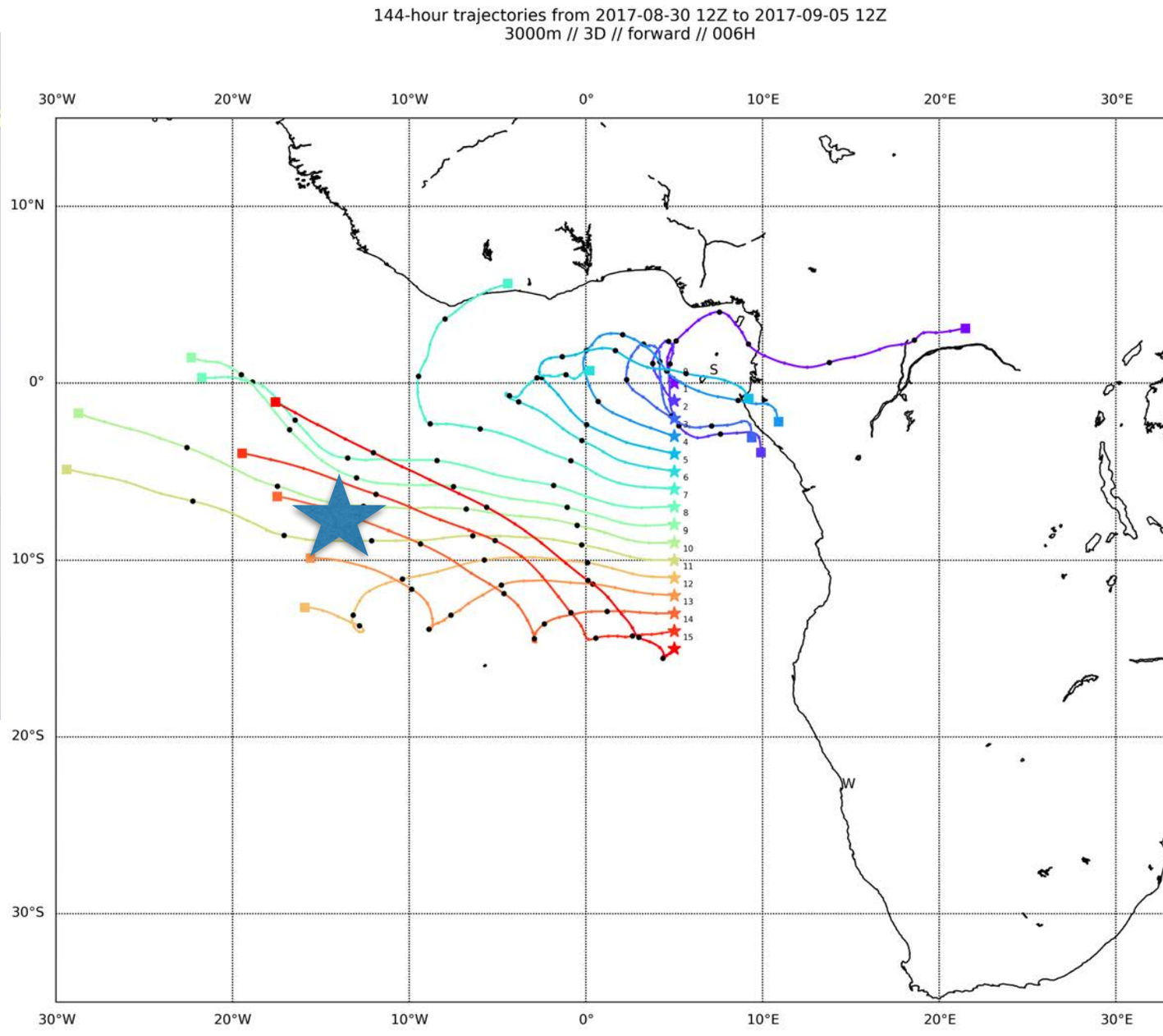
next deployment is
October 2018
also to Sao Tome

figures by Jens Redemann

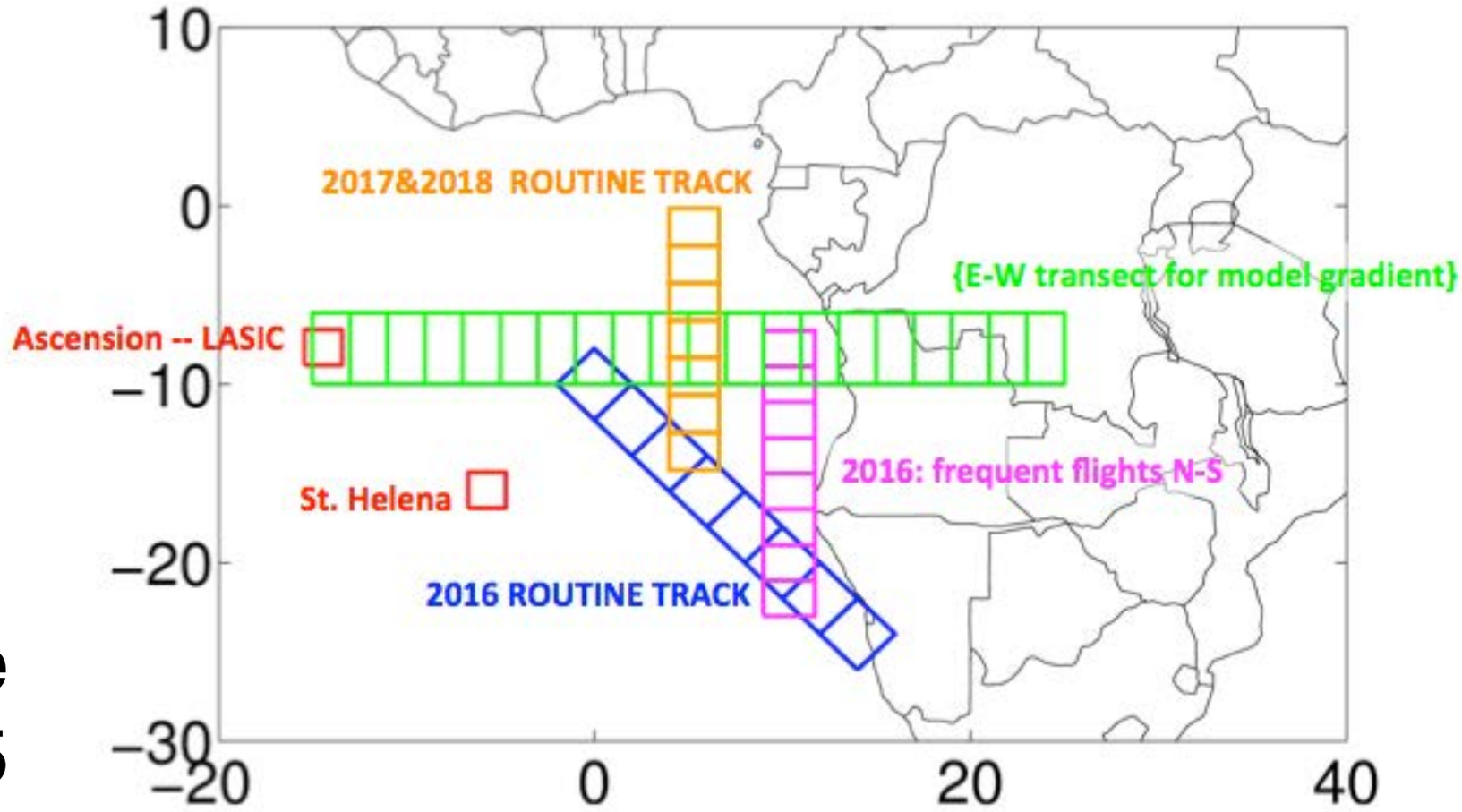
coordination between ORACLES and Ascension included
suitcase flights to Ascension 17-21 August &
transit flights both years

aerosol air mass sampled by plane on 8/30, resampled
a day later then went over Ascension

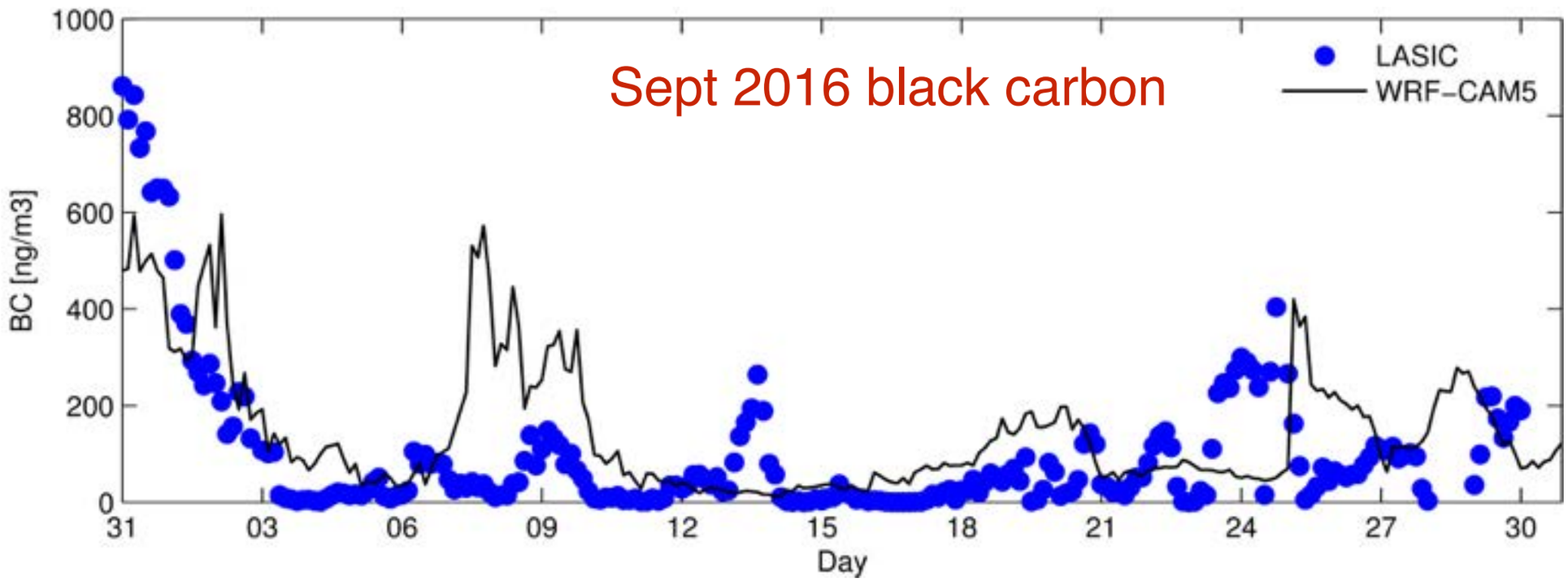




Framework for Model / observation comparisons



Pablo Saide
WRF-CAM5



LASIC breakout session 10:45-12:45 this morning
Potomac room

conveners: myself and Allison Aiken

towards defining the LASIC aerosol single-scattering-albedo: 10:45-11:30 est

1. Allison Aiken - ambient aerosols in both smoky and reference conditions
2. Art Sedlacek - refractory black carbon
3. Tim Onasch - LASIC CAPS measurements
4. Connor Flynn - perspectives on filter-based derived SSA values

discussion: what do we still need to do to come up with a 'best-estimate' SSA

other observational perspectives: 11:35-12:05 est

5. Yann Blanchard - Cloud properties from zenith-pointing and scanning cloud radars: statistics and implications
6. Ewan O'Connor - inferences on turbulence from the Doppler lidar
7. Rob Wood: ultra-clean conditions at Ascension
8. Laura Riihimaki - update on VAP status

discussion:

perspectives from modeling studies: 12:10-12:45 est

9. Tak Yamaguchi - perspectives on absorbing-aerosol-cloud interactions gained from recent modeling studies
10. Yan Feng - CAM5 simulations and the influence of meteorological conditions on aerosol long-range transport
11. Xiaohong Liu - WRF-Chem simulations of the southeast Atlantic
12. Zuidema/Saide - a community model-observational intercomparison project+assessment of WRF-CAM5 simulations using LASIC data

discussion: