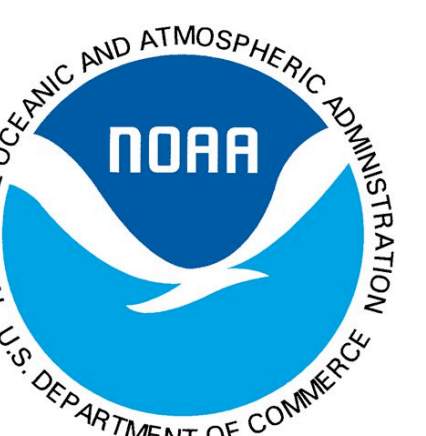


# The vertical distribution of black carbon (BC) over the continental US during the DC3 study

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## Introduction

### BC

- Is emitted by incomplete combustion of fossil and bio fuel and during biomass burning (BB).
- Absorbs shortwave solar radiation.
- Is the second most powerful climate forcer after CO<sub>2</sub>.

### MOTIVATION

- Improve model estimates of BC radiative forcing. BC impacts are sensitive to its column burden, microphysical state, and vertical distribution<sup>2</sup>.
- Reduce uncertainty associated with convective uplift or removal of BC<sup>3</sup>.

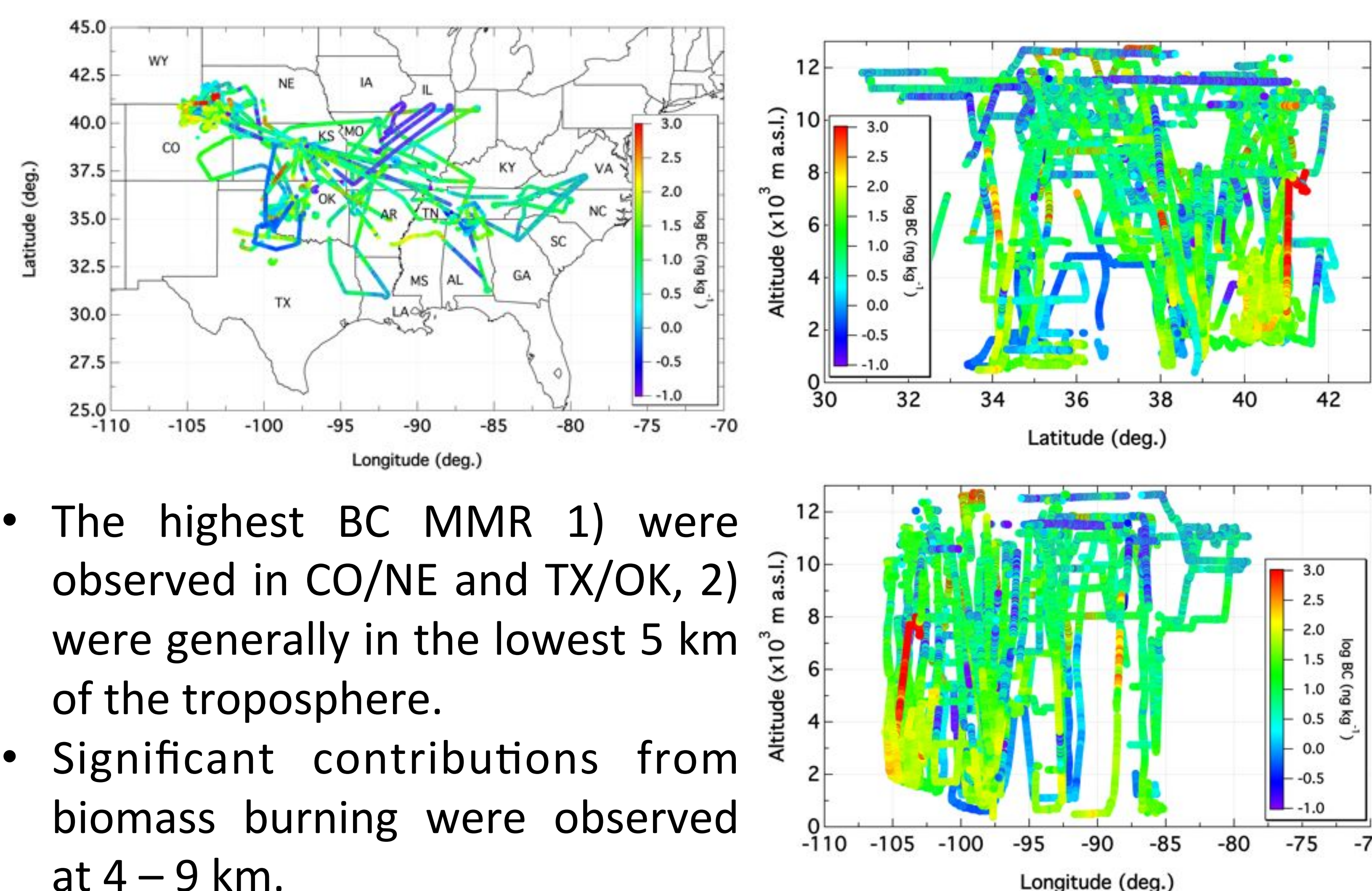
### NOAA HDSP2

- DRY and WET Single Particle Soot Photometers (SP2, DMT, Boulder, CO, USA) on the DC3.
- Measured mass, microphysical properties, and water uptake of submicron BC particles.
- BC measured in clouds has been removed from the data.



## Results and Discussion

### SPATIAL DISTRIBUTION OF BC



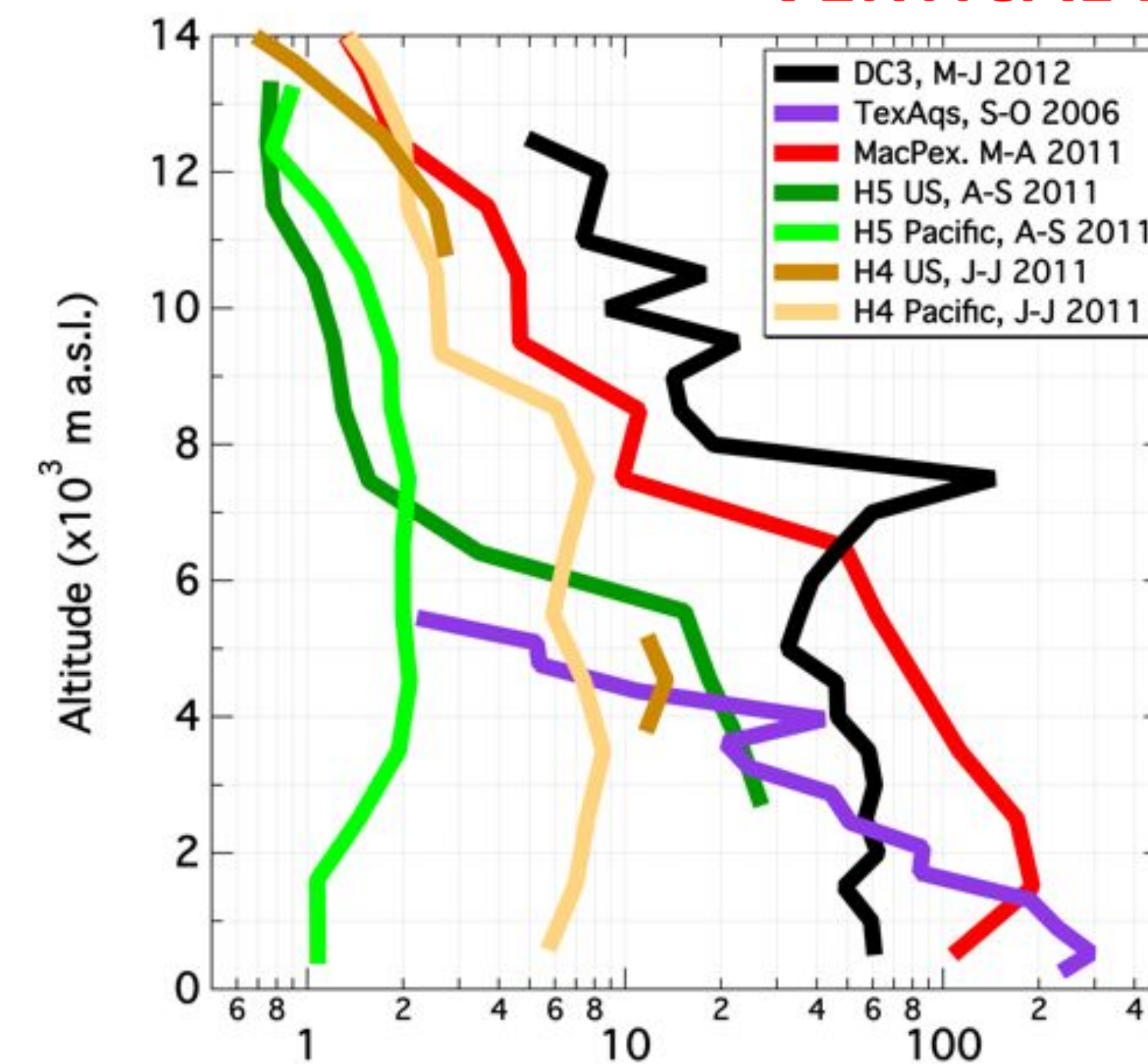
- The highest BC MMR 1) were observed in CO/NE and TX/OK, 2) were generally in the lowest 5 km of the troposphere.
- Significant contributions from biomass burning were observed at 4 – 9 km.

## References

<sup>1</sup>Bond et al., JGR, 10.1002/jgrd.50171, 2013; <sup>2</sup>Liu D., et al., ACPD, 12, 28955–28992, 2012; <sup>3</sup>Park, R. J., JGR, 110, D11205, 2005; <sup>4</sup>Speckman et al., GRL, 35, L19816, 2008;

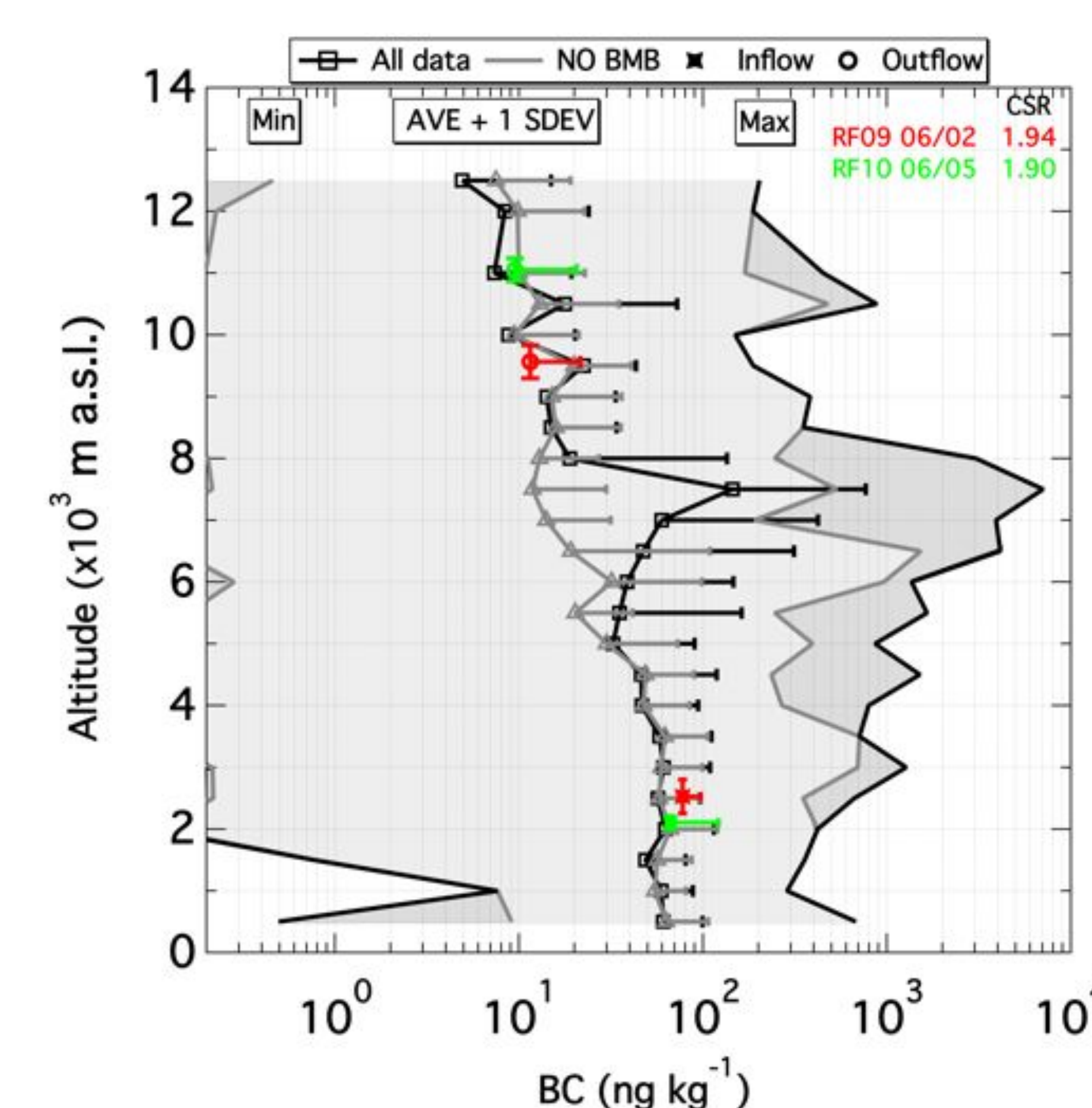
## Results and discussion

### VERTICAL DISTRIBUTION OF BC

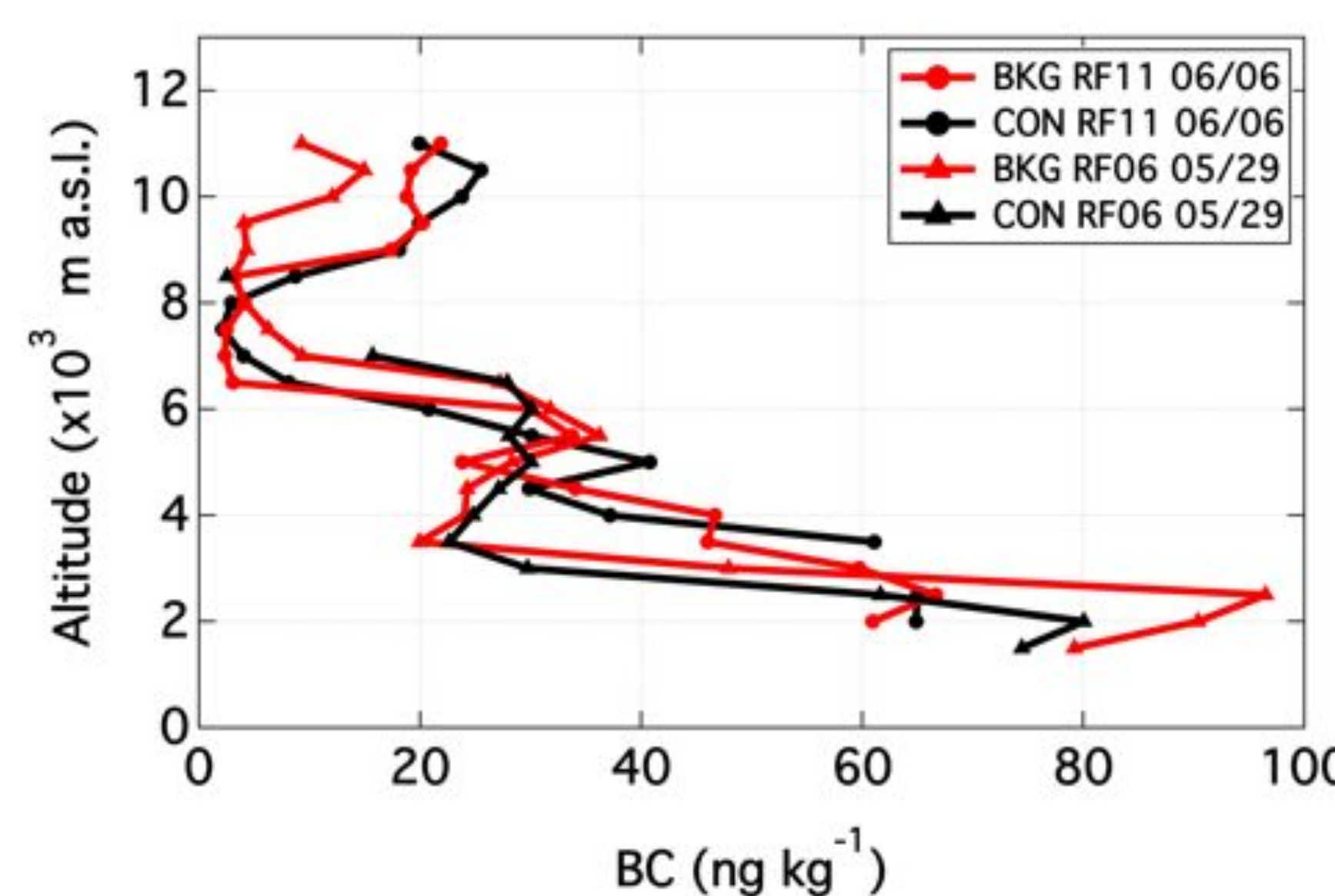


- Significantly higher BC MMR were observed in the UT/LS during DC3 perhaps due to convective processes in the region.
- BC MMR measured in the LT were slightly lower than those measured during MacPex and TexAqs due to emissions from metropolitan Houston area.

### THE EFFECT OF CONVECTION ON BC MMR



- Convection had a relatively weak effect on BC MMR in the UT/LS.
- The BC MMR observed in convective outflows during 2 flights were roughly equal to the average MMR observed at those altitudes.
- BC particles in the outflow were roughly twice as likely to be identified as coated compared to those in the inflow. This may not be the effect of convection.



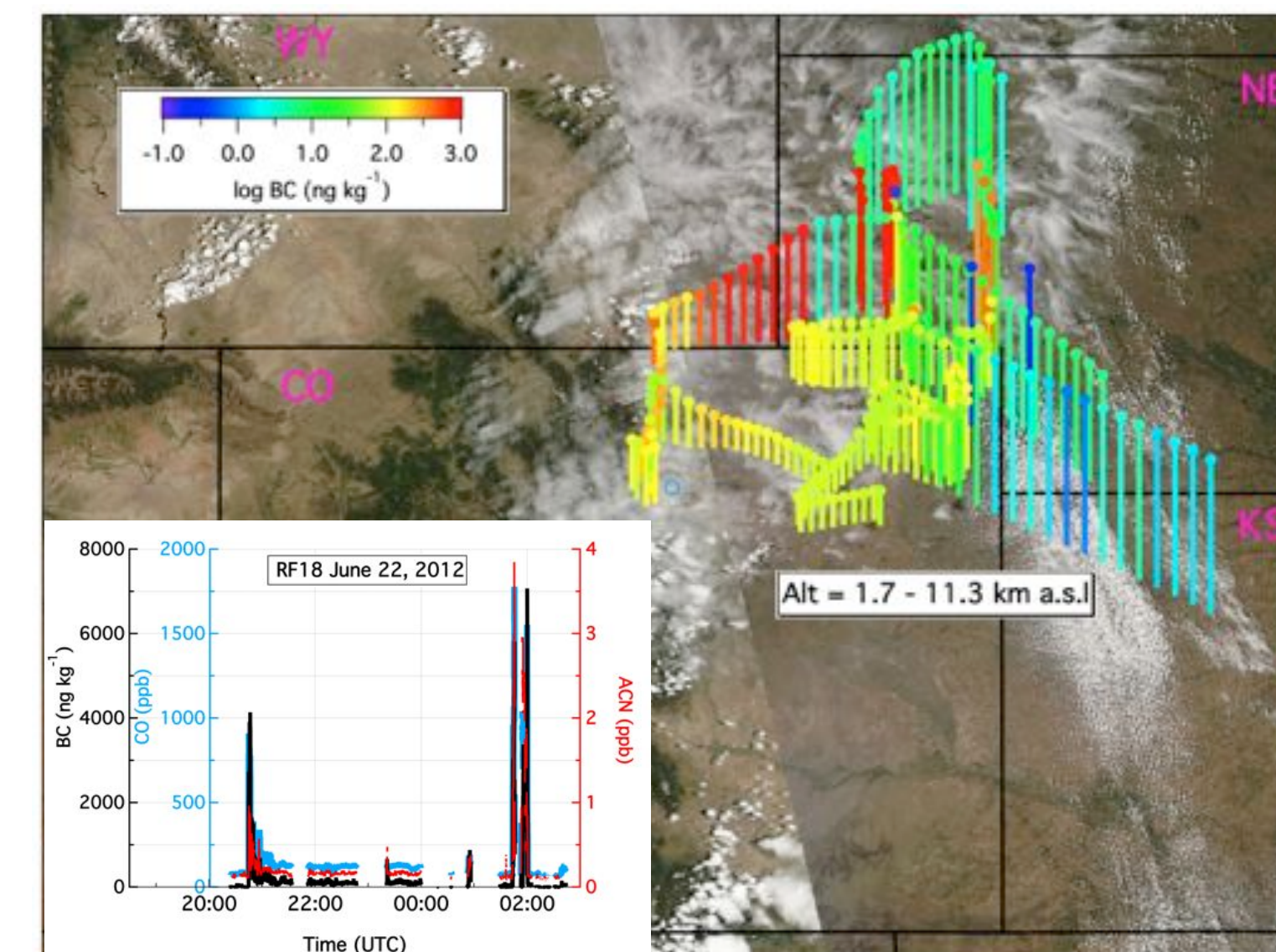
- The vertical profiles of BC and some gas tracers (ACP, NO, CO) observed during background and convection spirals on 05/29 and 06/06 were similar.
- Enhanced background levels in UT/LS - regional convective signal?

## Acknowledgements

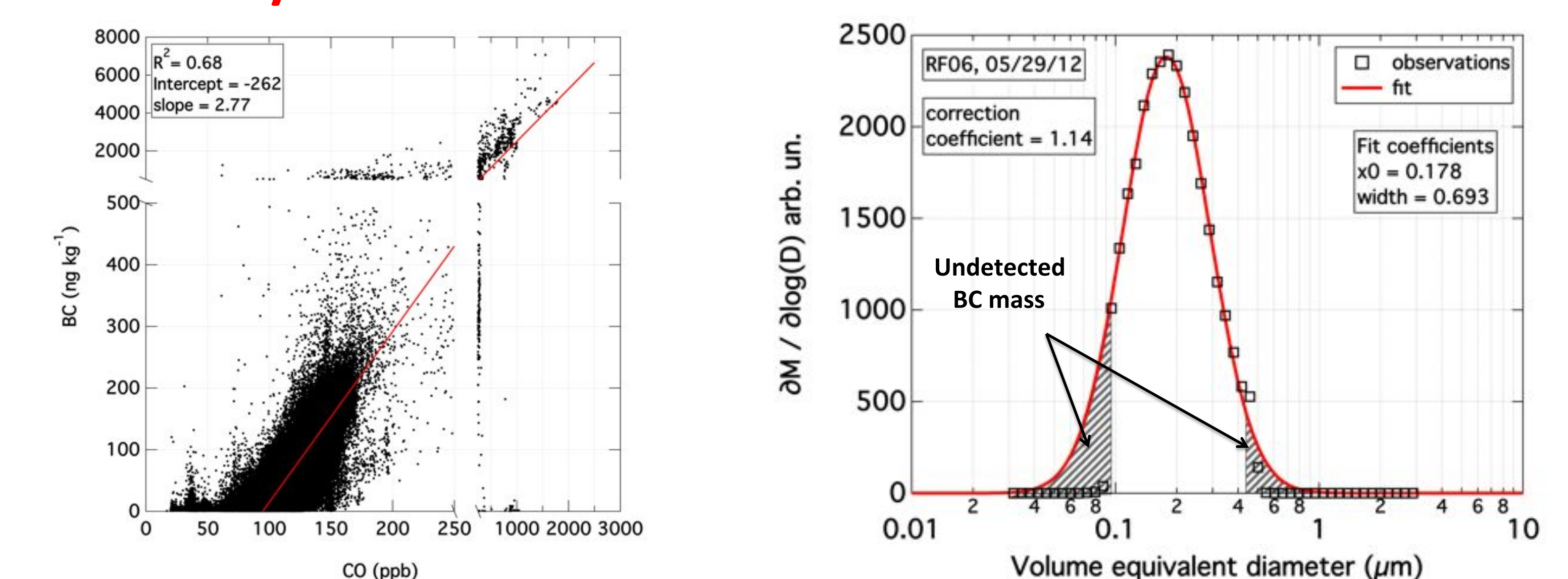


### THE EFFECT OF BIOMASS BURNING ON BC MMR

- BB had a significant impact on the BC MMR.
- BB plumes from several large fires burning in CO and NM were sampled during the campaign.
- Elevated levels of CO and acetonitrile accompanied spikes in BC MMR.



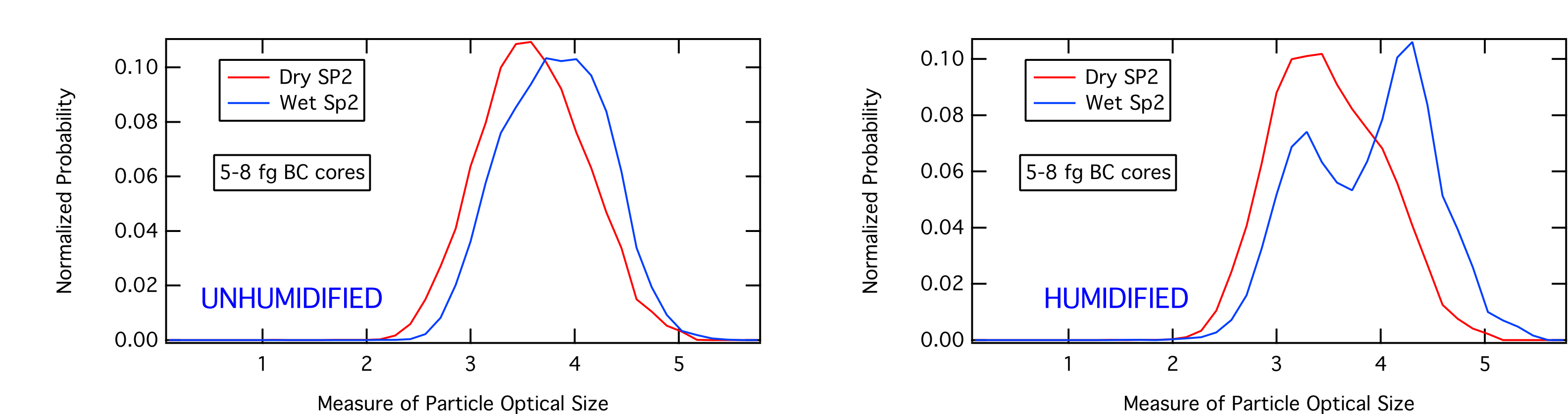
### BC/CO AND SIZE DISTRIBUTION OF BC PARTICLES



2.8 compared to 5.8 ng kg<sup>-1</sup> ppb<sup>-1</sup> during TexAqs<sup>4</sup>.

Typical size 178 nm, excellent SP2 coverage.

### WATER UPTAKE OF BC PARTICLES



- Controlled measurement of water uptake by BC-containing particles has been demonstrated for the first time on in situ aircraft. Humidification of sample air reveals a binary mixture of BC aerosol types on a flight in DC3, perhaps due to differing aerosol history.

## Conclusions

- BC MMR measured in the UT/LS during DC3 were significantly higher compared to other missions perhaps due to background regional convection.
- Compared to other chemical species, individual convection cells had a limited effect on the removal or uplift of BC.
- BB significantly affected BC MMR and increased the mission average BC MMR ~ 3 times between 5 – 8.5 km.

## Future DC3 plans

- Incorporate DLR Falcon data in the analysis
- Publish analysis on the effect of convection on BC MMR and regional BC climatology in collaboration with DLR
- Collaborate with DLR on the analysis of BC properties in BB plumes.