Aircraft Observations of the Lower Atmosphere and Surface Exchange Processes

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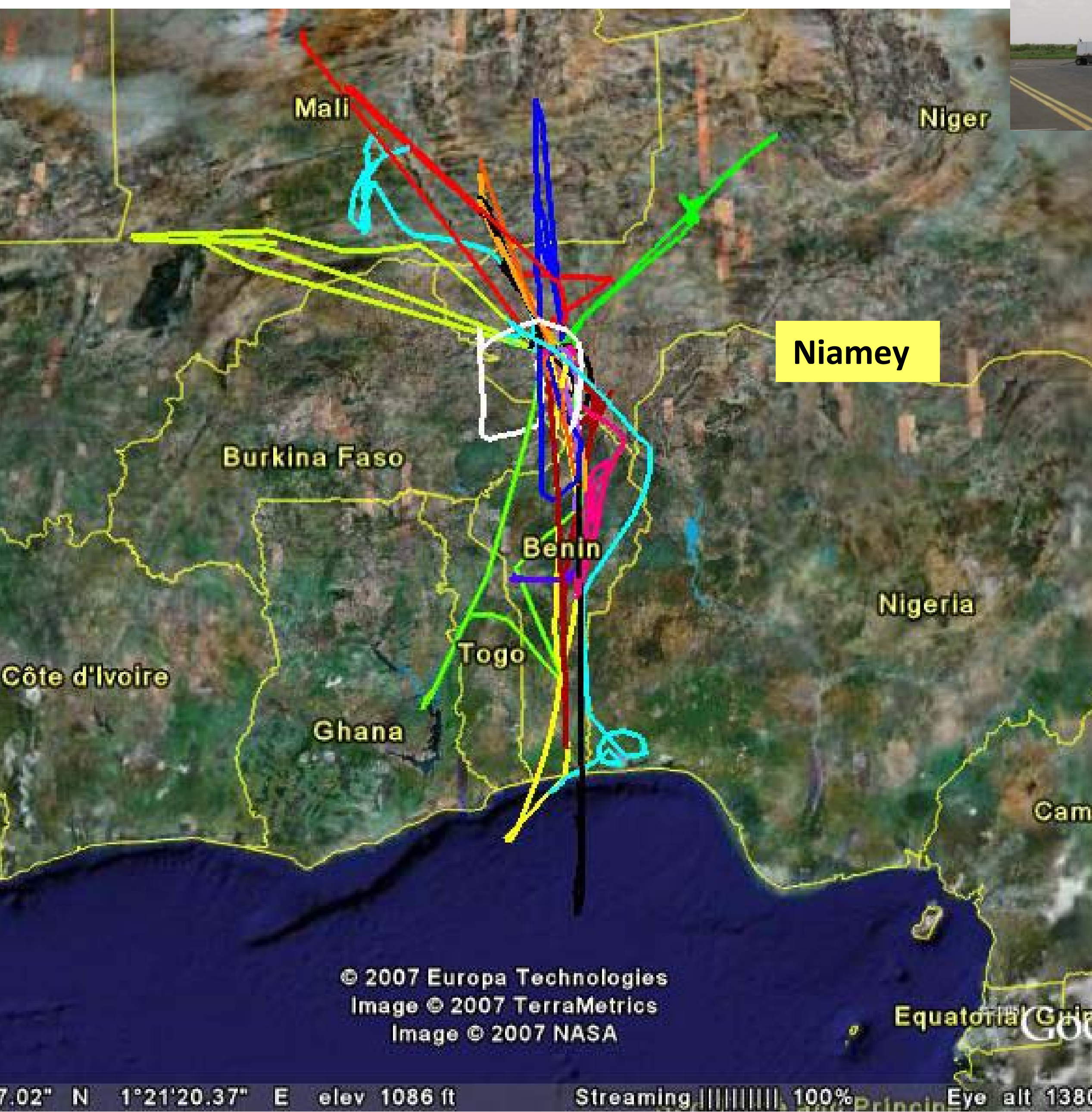
Outline

- Results from BAe-146 during AMMA
- Aircraft observations over Canada
- Existing capacity in Canadian atmospheric chemistry academic community

African Monsoon Multidisciplinary Analysis (AMMA)

AMMA-UK Flight Tracks



UK BAe-146 (FAAM)
Facility for Atmospheric Airborne Measurements

100 hours between July 15- Aug 18, 2006

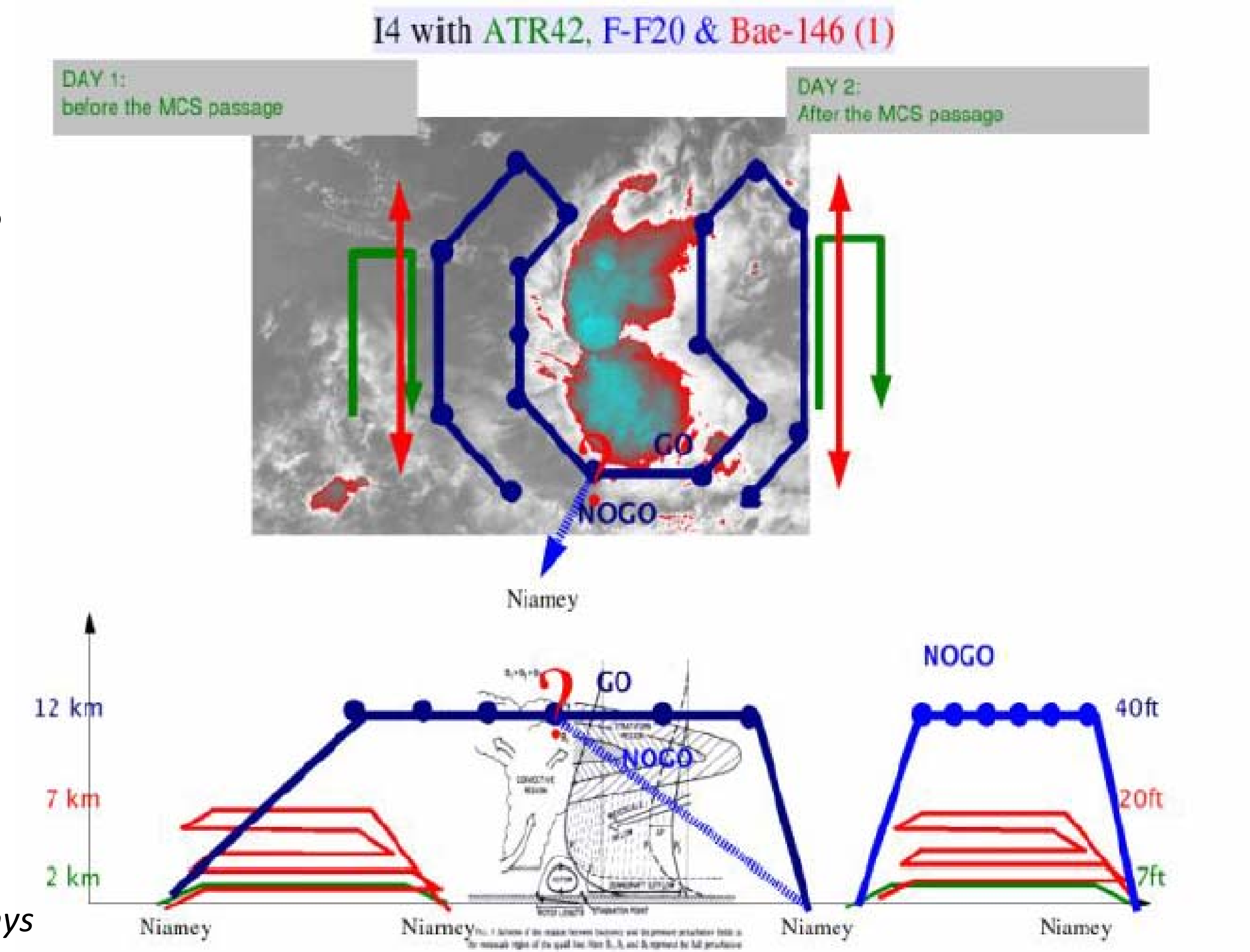
CO, O_3, NO_x
VOC (in situ and canister)
OH, HO_2, RO_2
CH_2O, ROOH
aerosol number, physical properties and composition

dropsondes

Coordinated flight plans

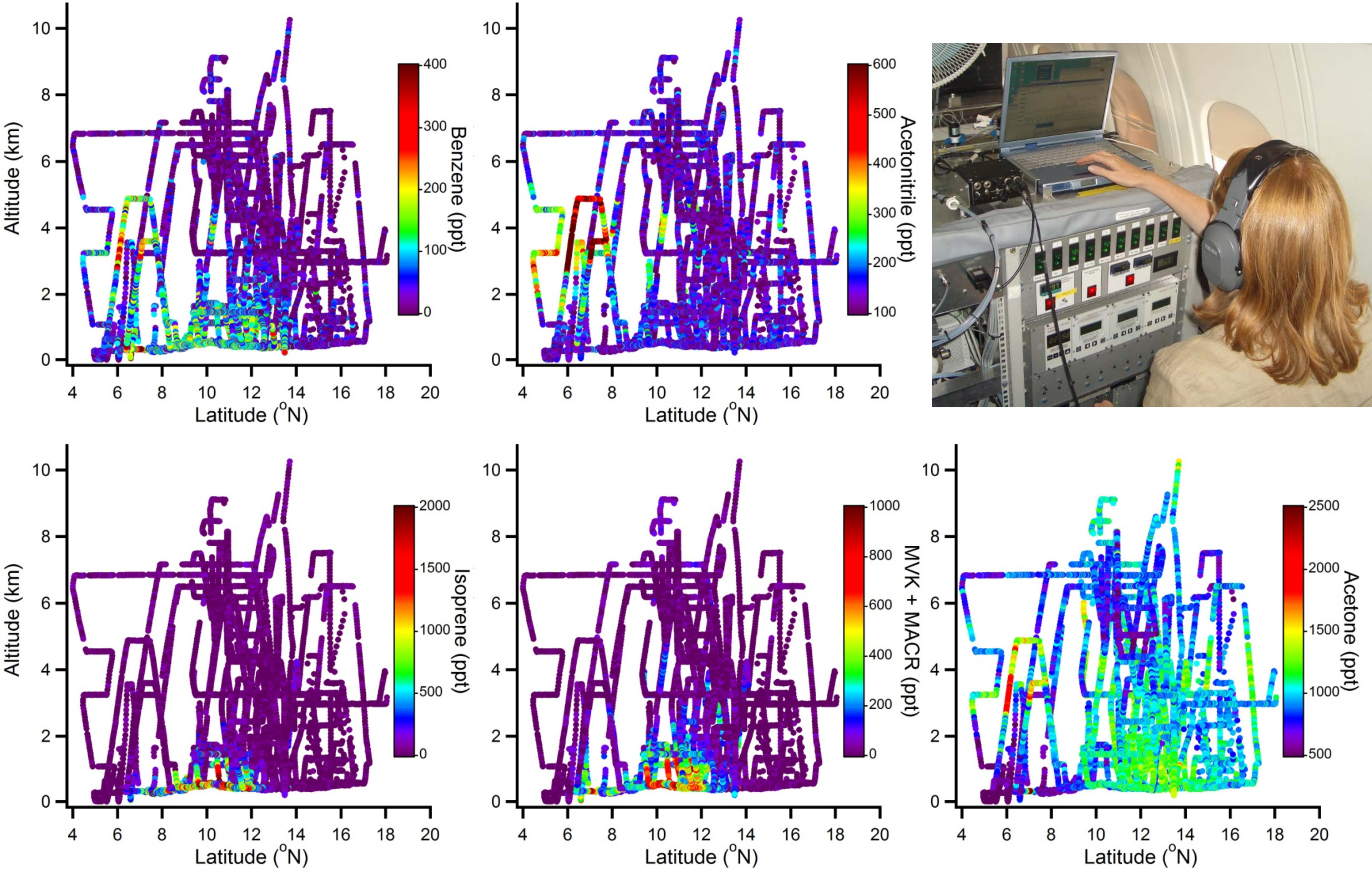
Niamey
- FAAM Bae-146
- SAFIRE Falcon
- ATR42

Ouagadougou
- DLR Falcon
- Geophysica



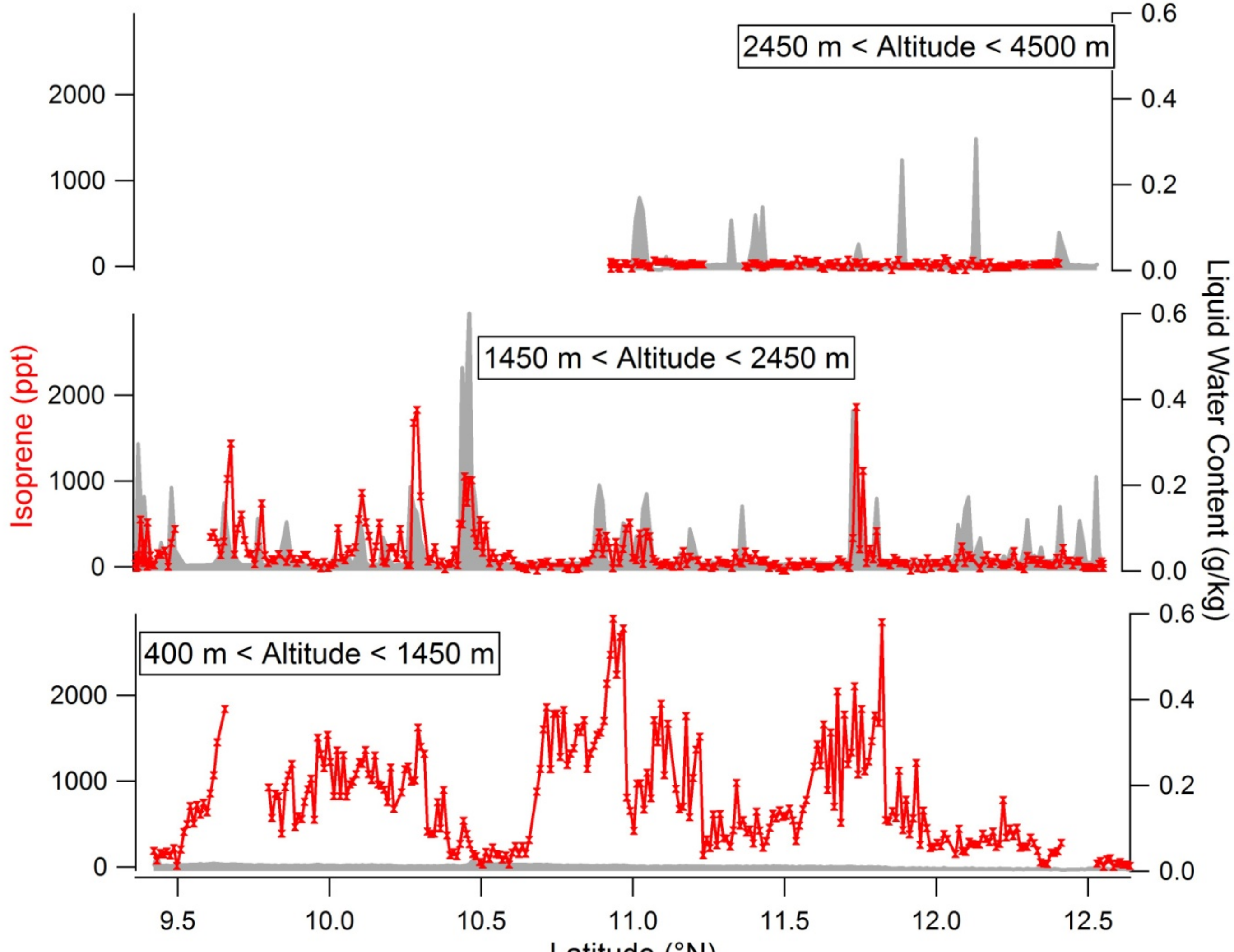
Special issue in *Atmos Chem Phys*

VOC measurements by PTR-MS



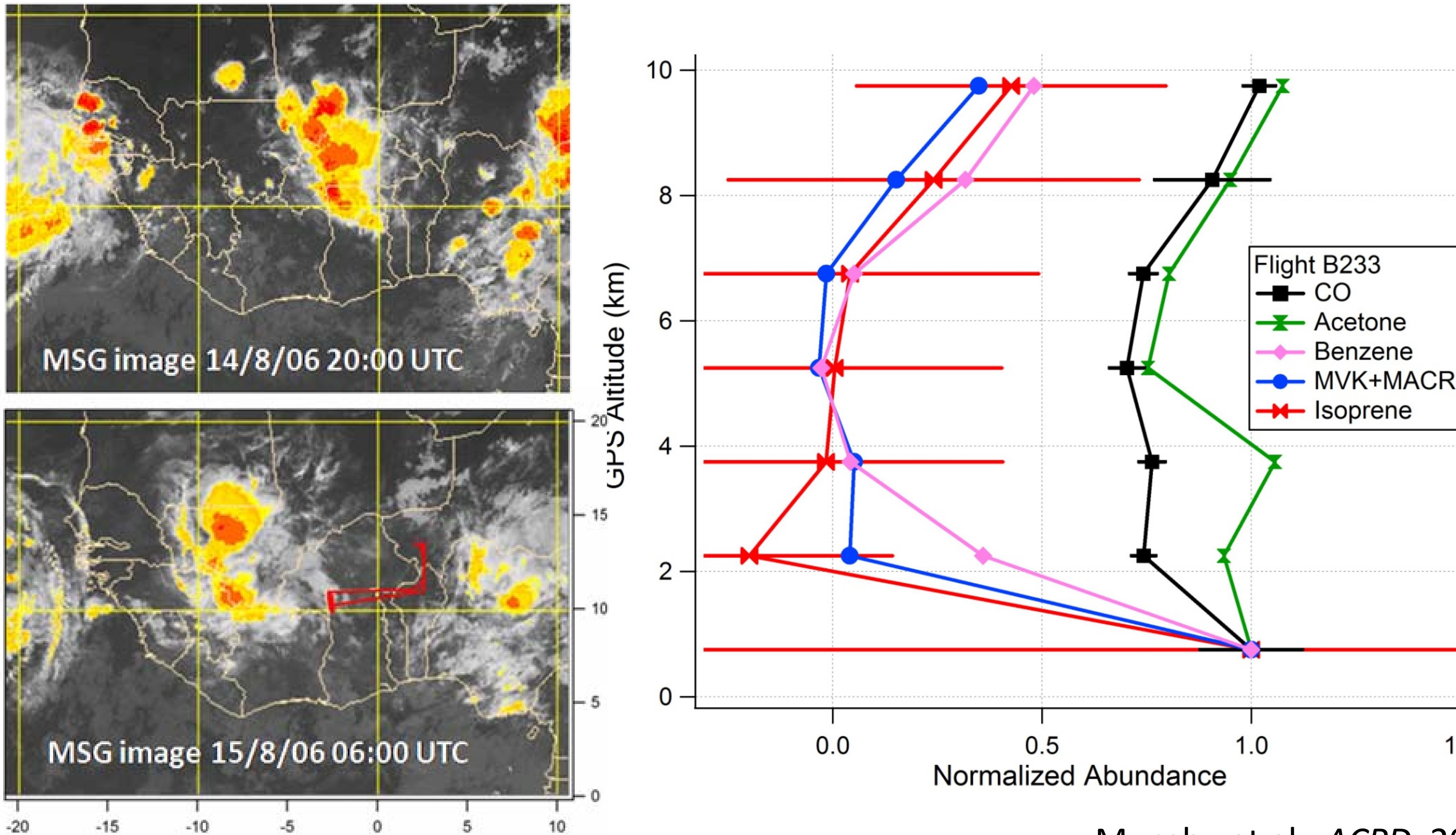
Murphy et al., *ACPD*, 2010

Coupling of Chemistry and Dynamics – Shallow Convection



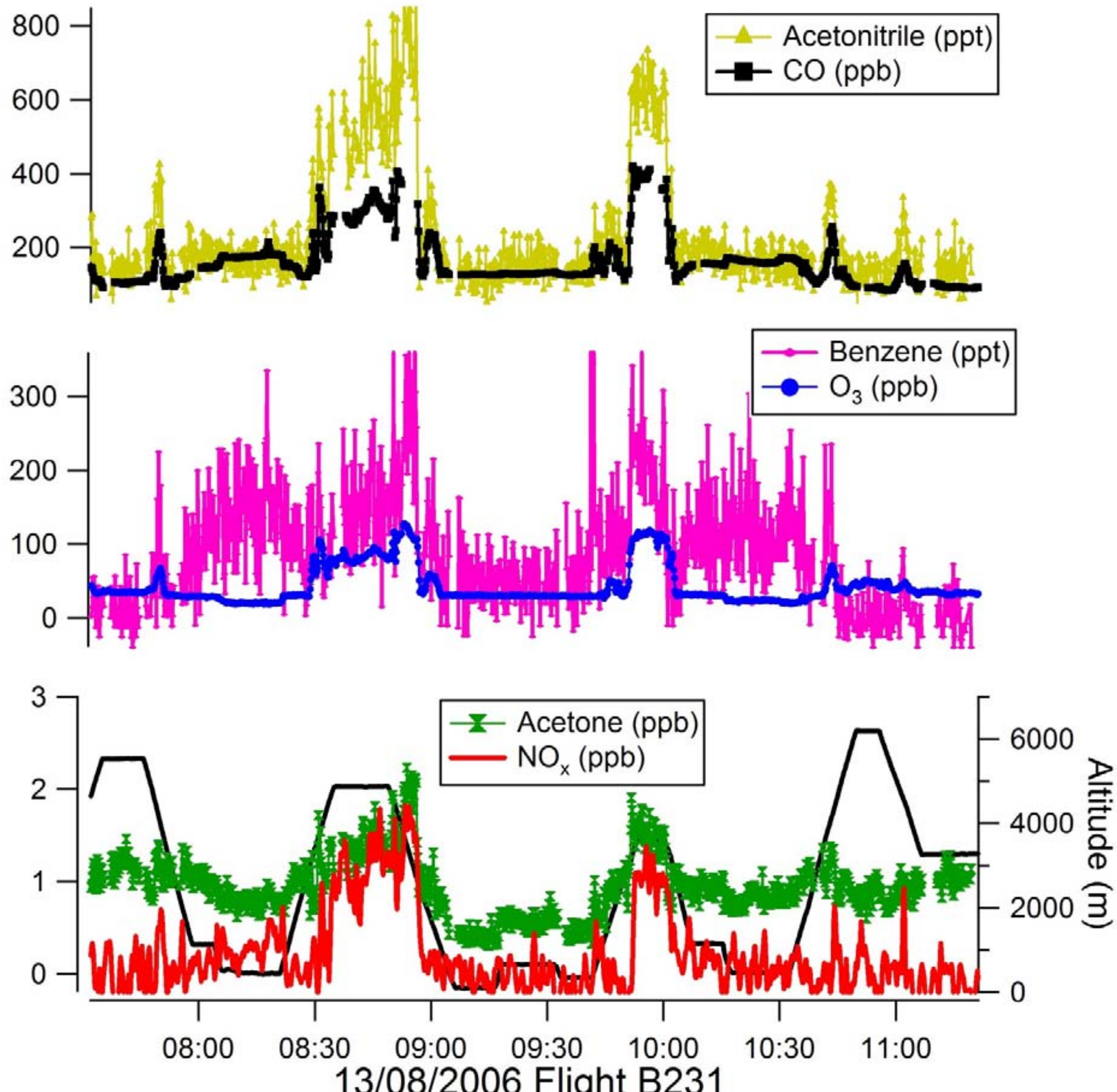
Murphy et al., *ACPD*, 2010

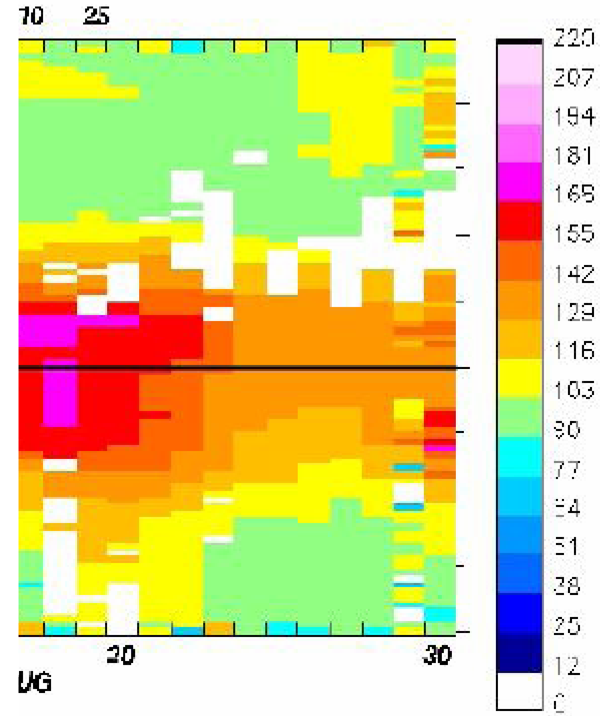
Coupling of Chemistry and Dynamics – Deep Convection



Murphy et al., *ACPD*, 2010

Coupling of Chemistry and Dynamics – Long Range Transport of Biomass Burning



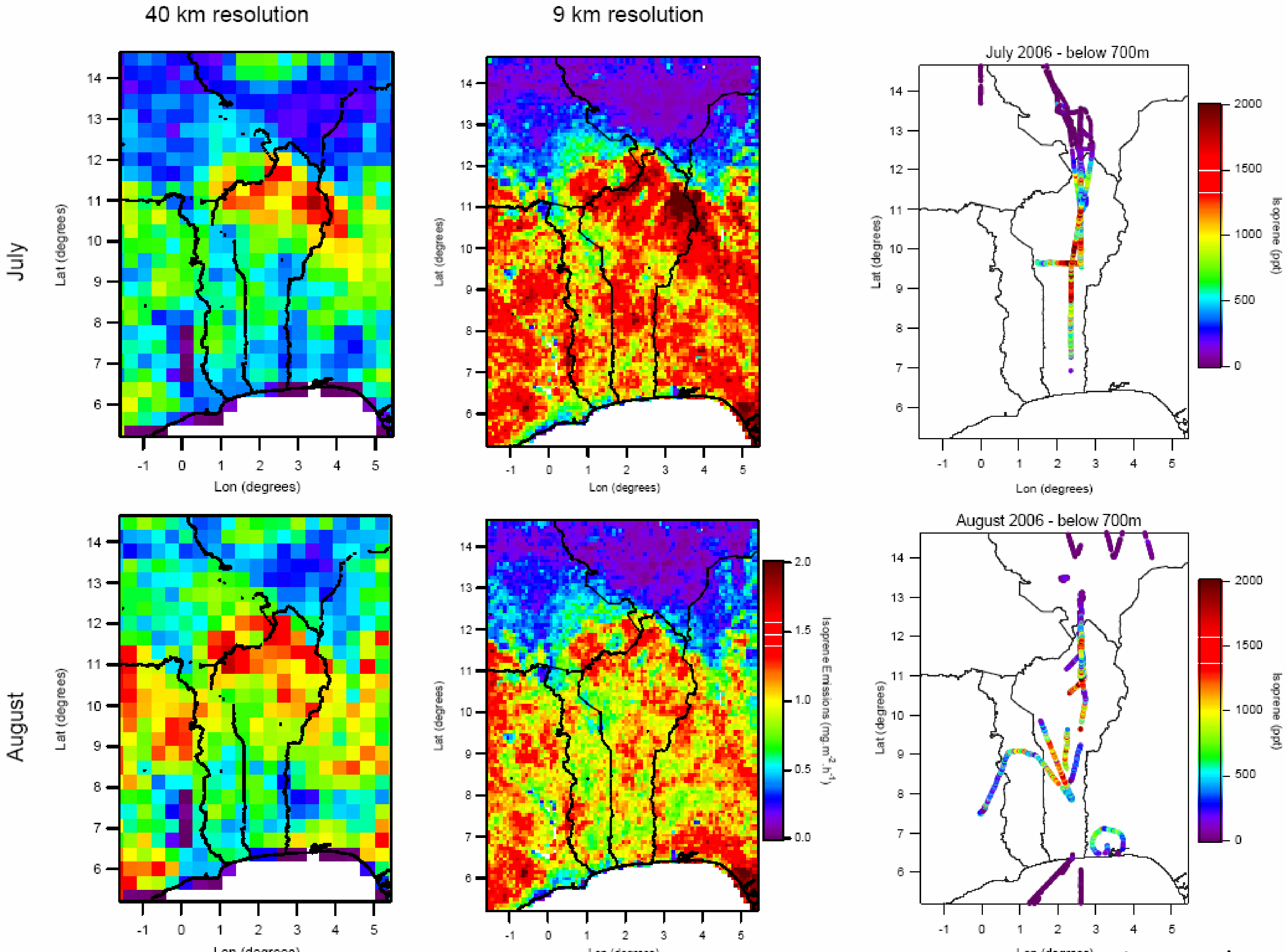


700 mb from the TERRA-
tude and time and averaged

Mari et al., *ACP*, 2008

Murphy et al., *ACPD*, 2010

Isoprene Flux Modelling using MEGAN



Fereira et al., *ACPD*, 2010

Top Down Constraints on VOC

Use satellite observations of CH_2O

To constrain modelled emission inventories of biogenic VOC

Millet et al., *JGR*, 2008

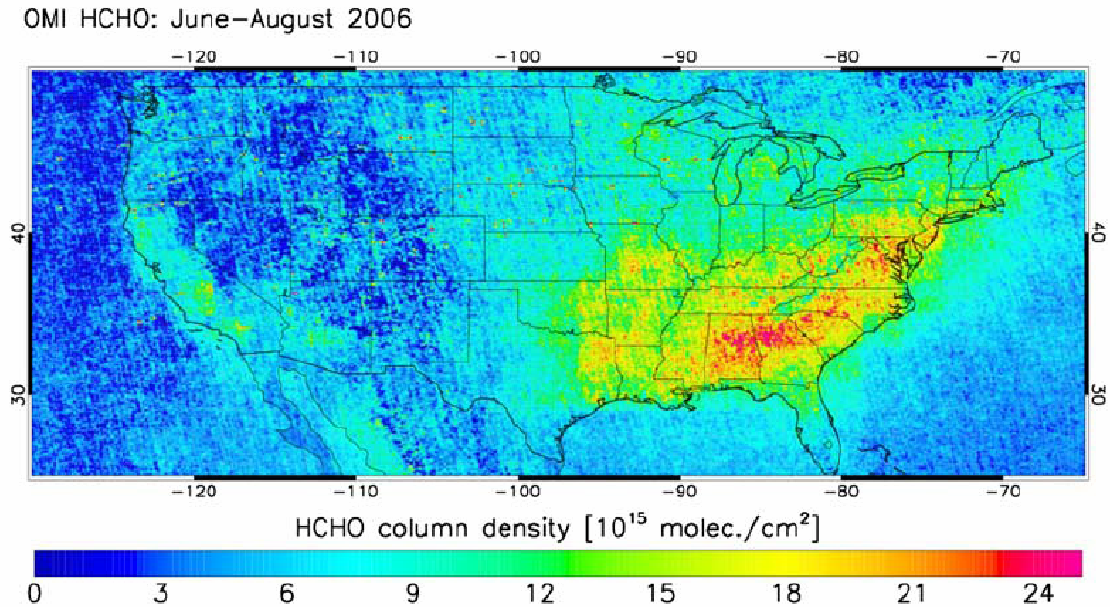
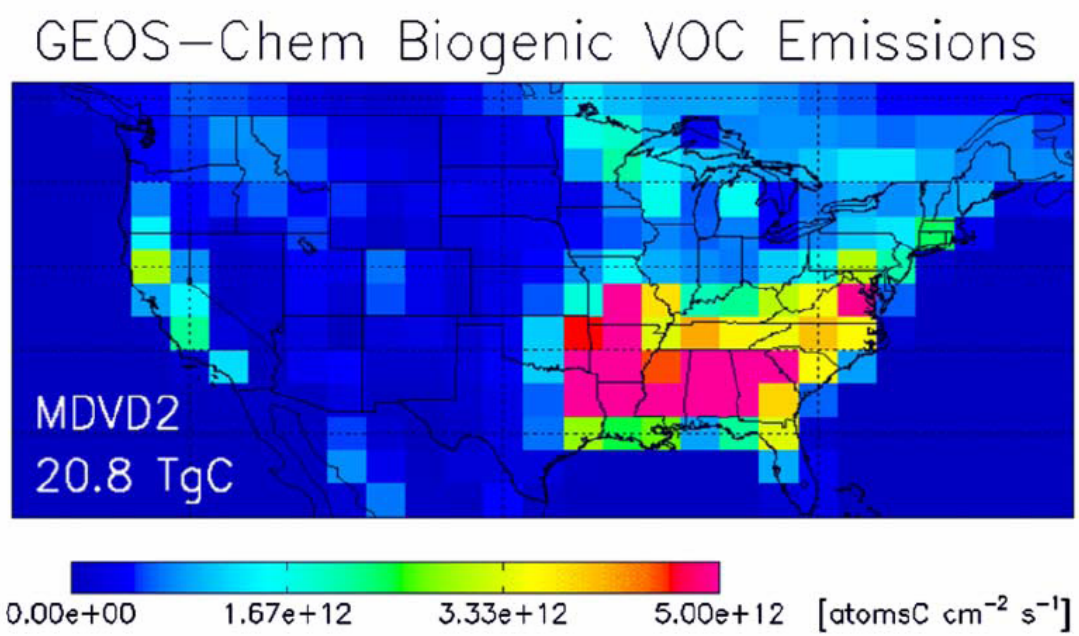
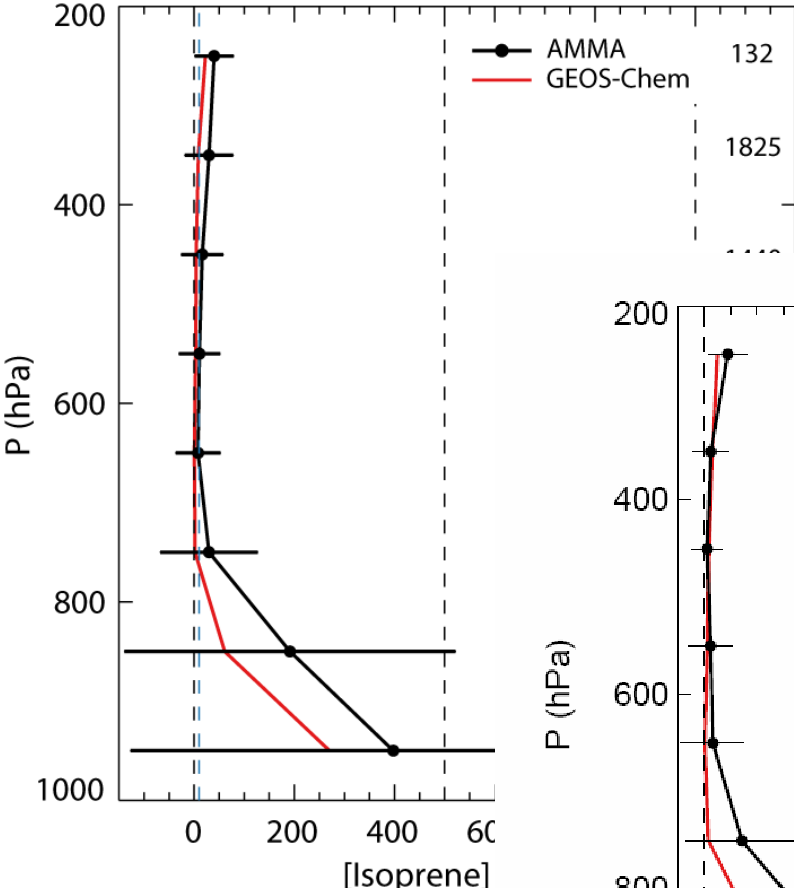
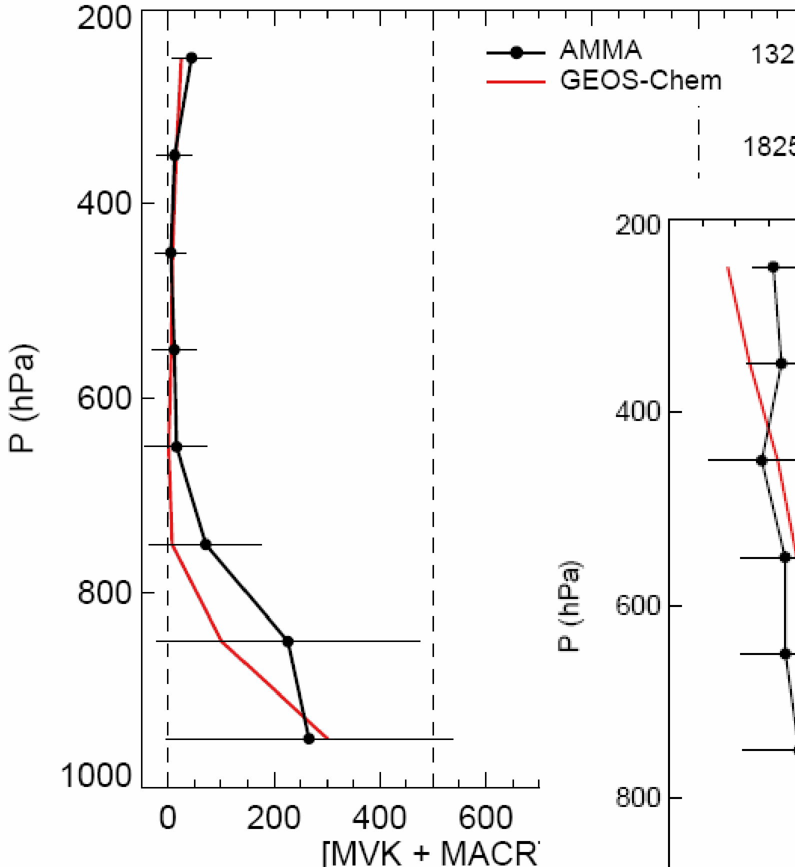


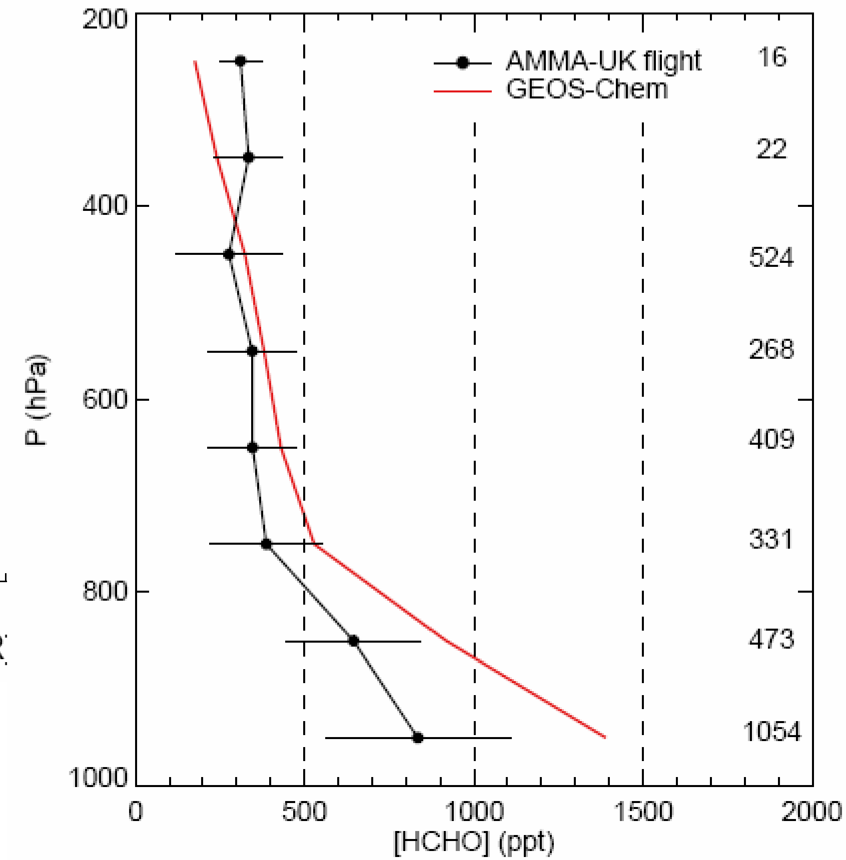
Figure 1. Mean OMI HCHO columns for June–August 2006 mapped on a 0.1° × 0.1° grid.



Vertical Profiles of VOC Oxidation

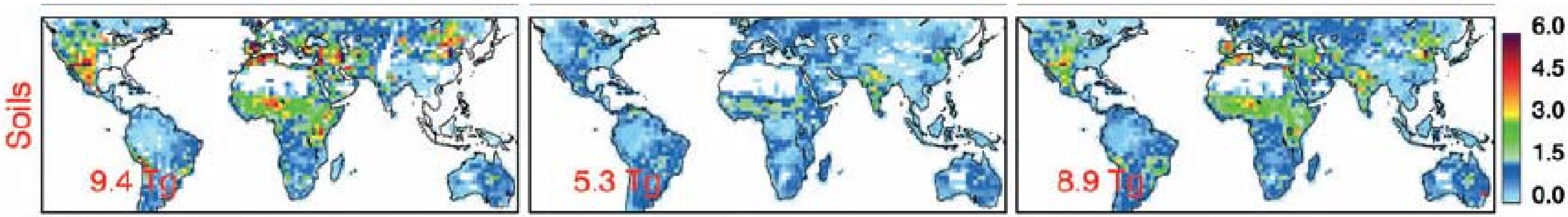


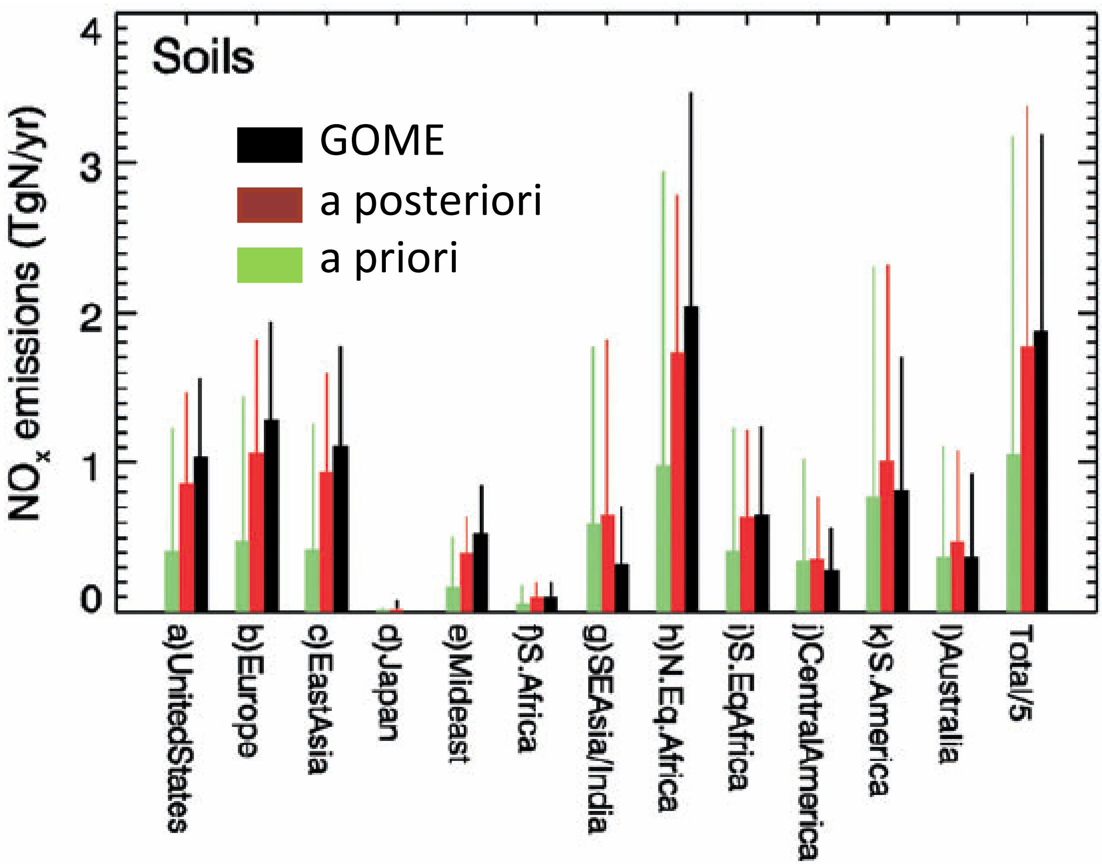




Figures from Eloise Marais, Harvard University

Top Down Constraints on NO_x

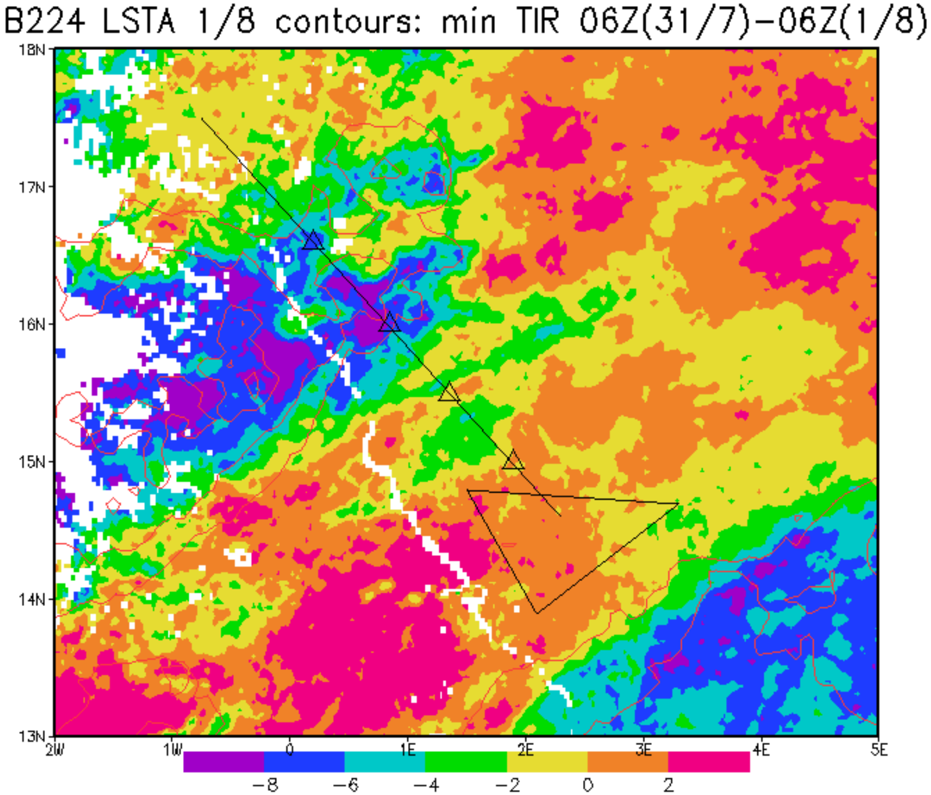




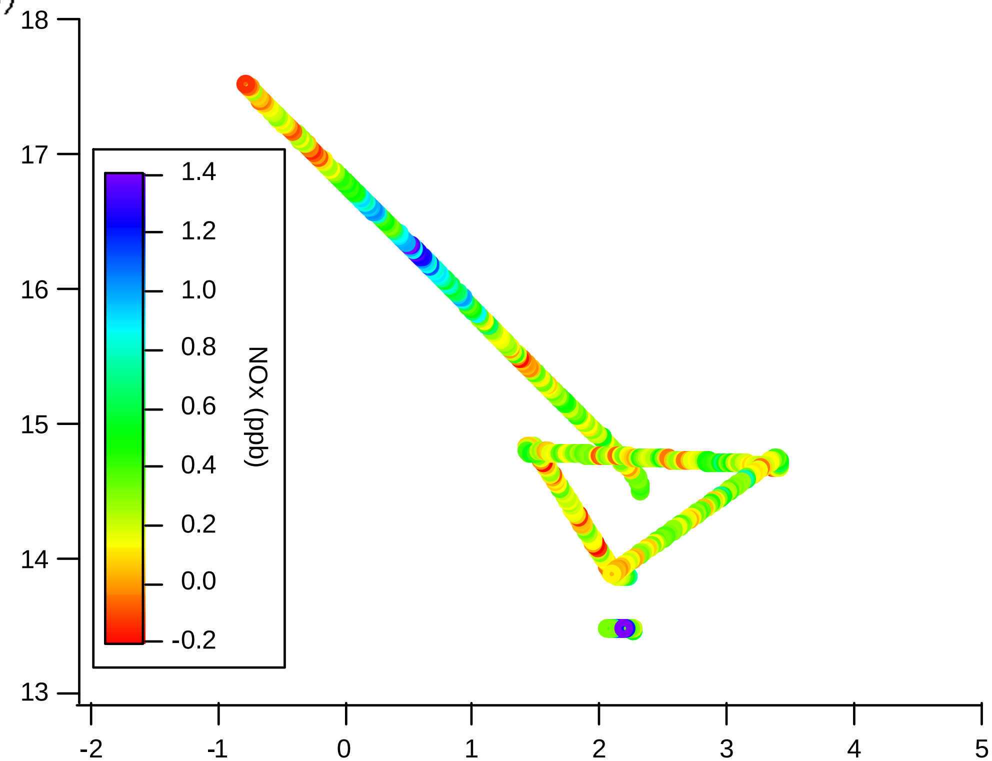
Jaegle et al., *Faraday Discuss*, 2005

Emissions of NO_x from recently wetted soils

Land Surface Temperature Anomaly



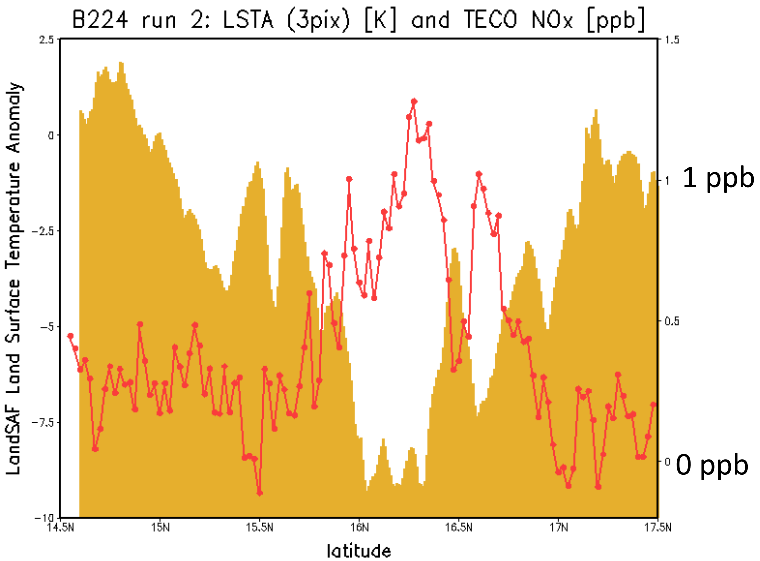
boundary layer NO_x concentration

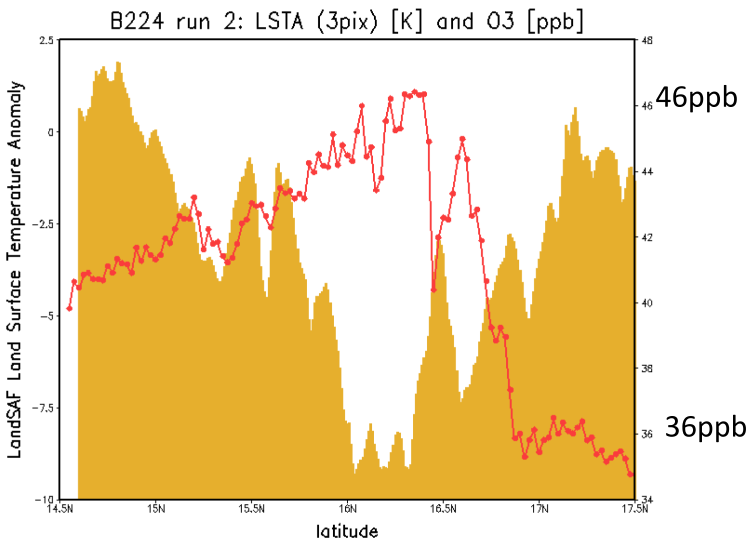


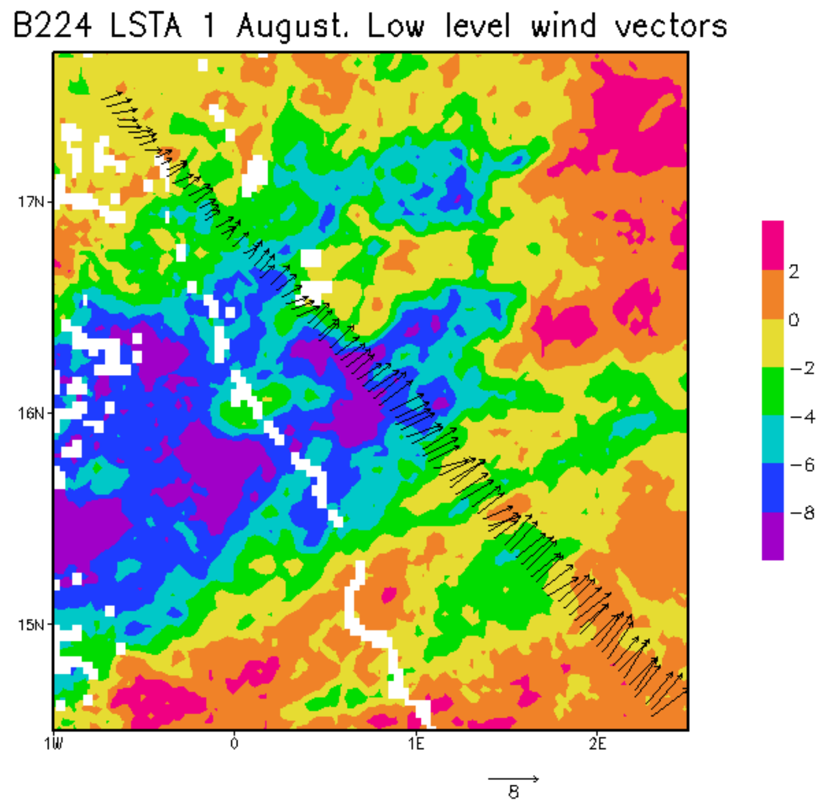
Purple = colder than usual and therefore recently wet

Stewart et al., *ACP*, 2008

Localized ozone production



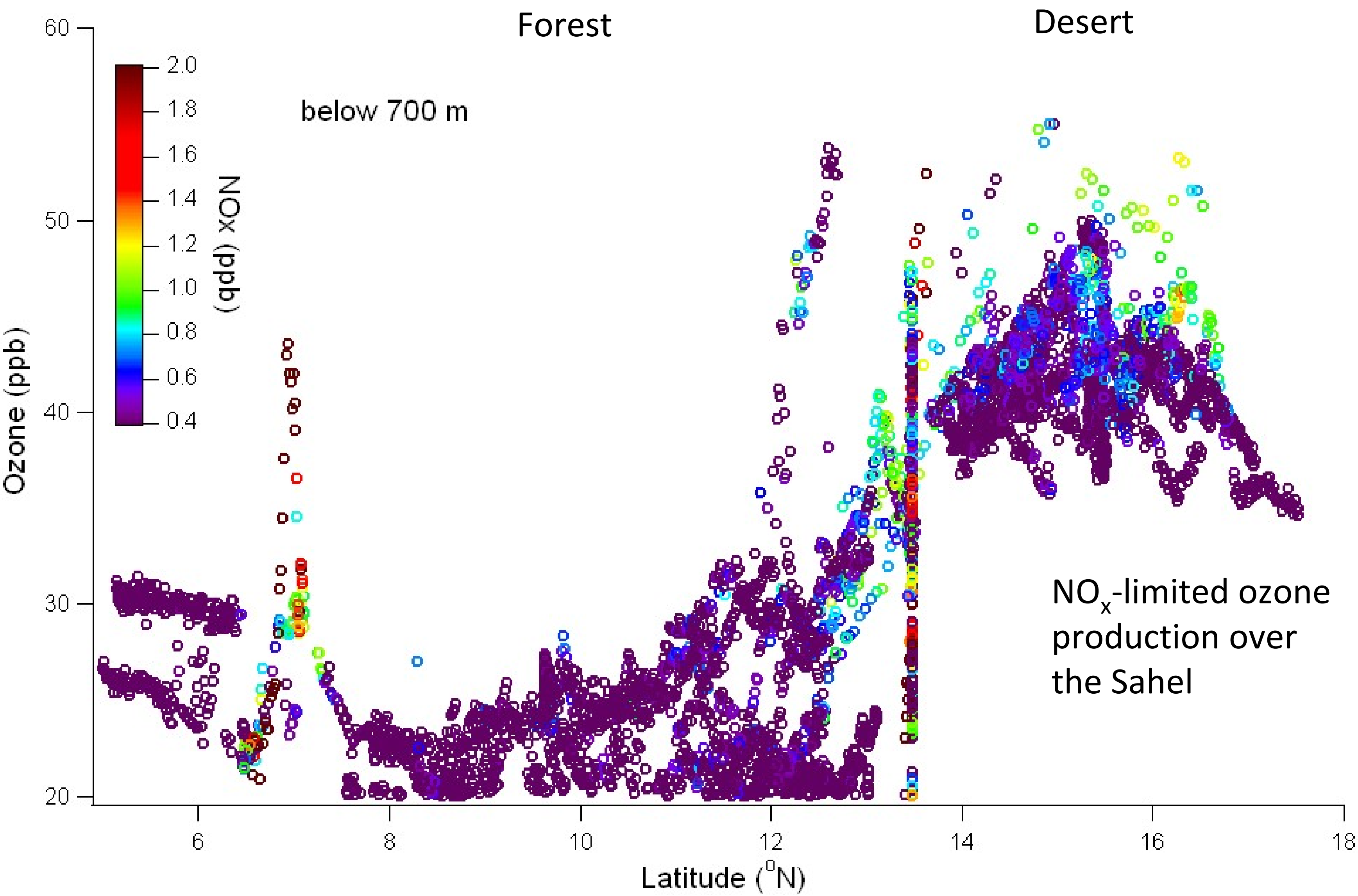




Maximum PBL ozone above storm track
Fine scale features above wet surface

Stewart et al., *ACP*, 2008

Boundary Layer Ozone:
forest is a sink, wet soil is a source of precursors

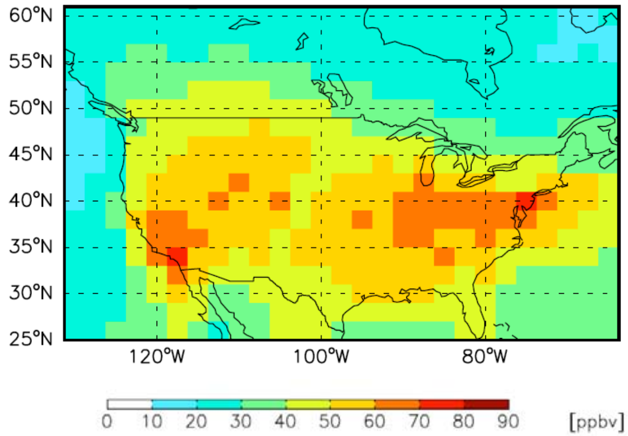


Assessing satellite constraints on boundary layer ozone

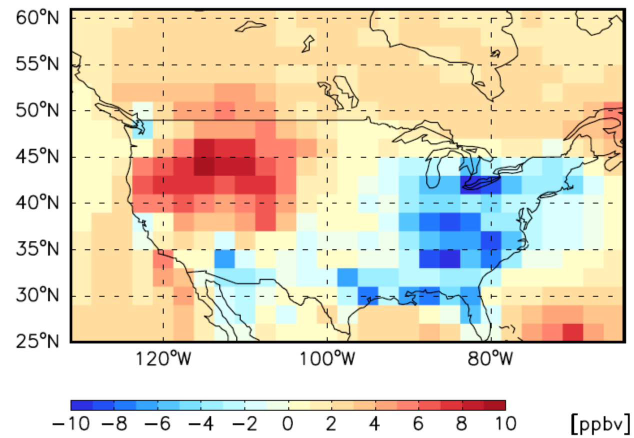
Contributed by Dylan Jones

Mean August surface O_3 (12-18 hr, local time) in GEOS-Chem

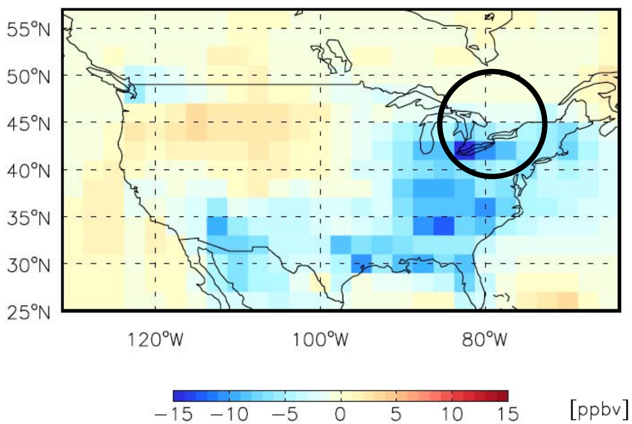
GEOS-Chem O_3 with TES O_3 assimilation and NOx and isoprene emissions based on SCIAMACHY and OMI data



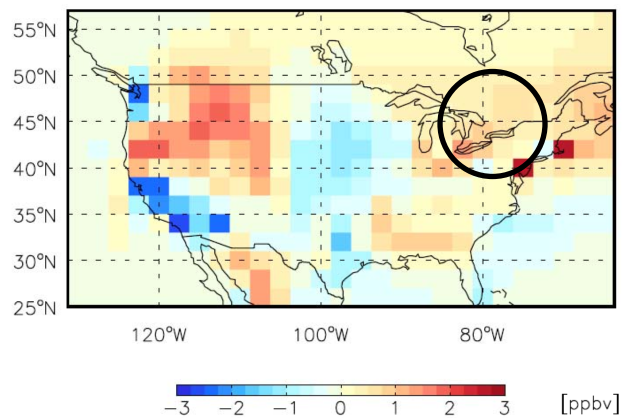
Ozone Differences:
GEOS-Chem with the satellite information minus the standard model



Ozone Differences due to NOx emissions:
Top-down NOx emissions minus the standard model



Ozone Differences due to isoprene emissions:
Top-down isoprene emissions minus the standard model

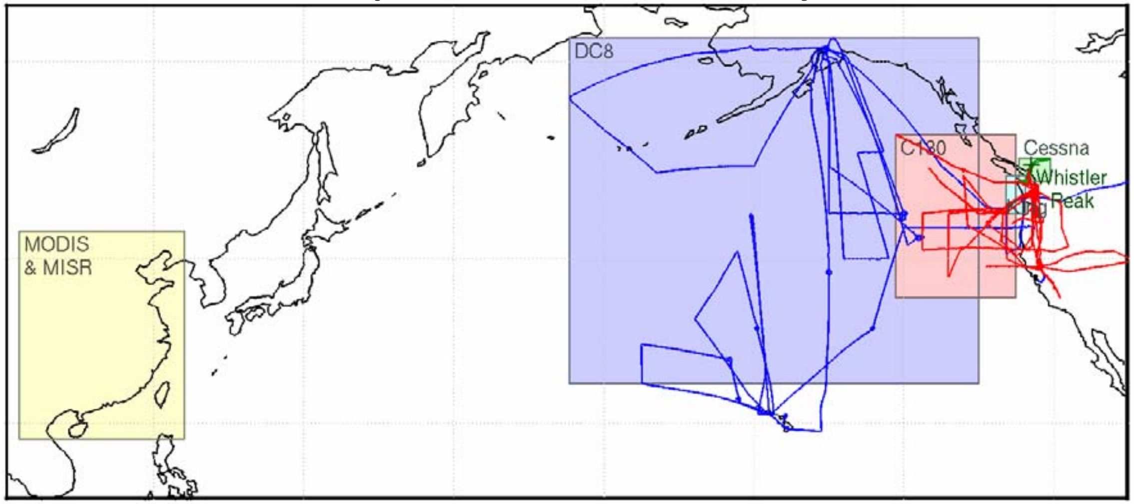


In situ observations of O_3, NO, NO_2, OH, HO_2, HCHO, etc... throughout the boundary layer and lower troposphere would be valuable for validating the changes in atmospheric composition associated with incorporating the satellite data into the model.

Other Aircraft Missions over Canada

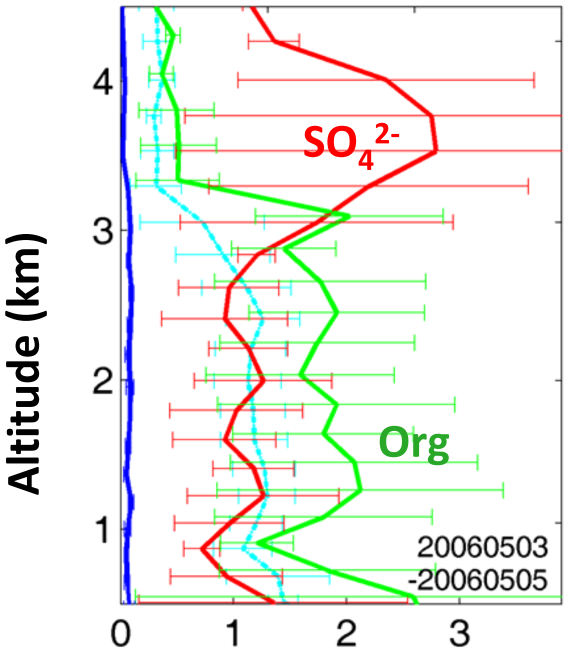
- TOPSE 2000
- ICARTT 2004
- INTEX 2006
- ARCTAS 2008
- BORTAS 2010

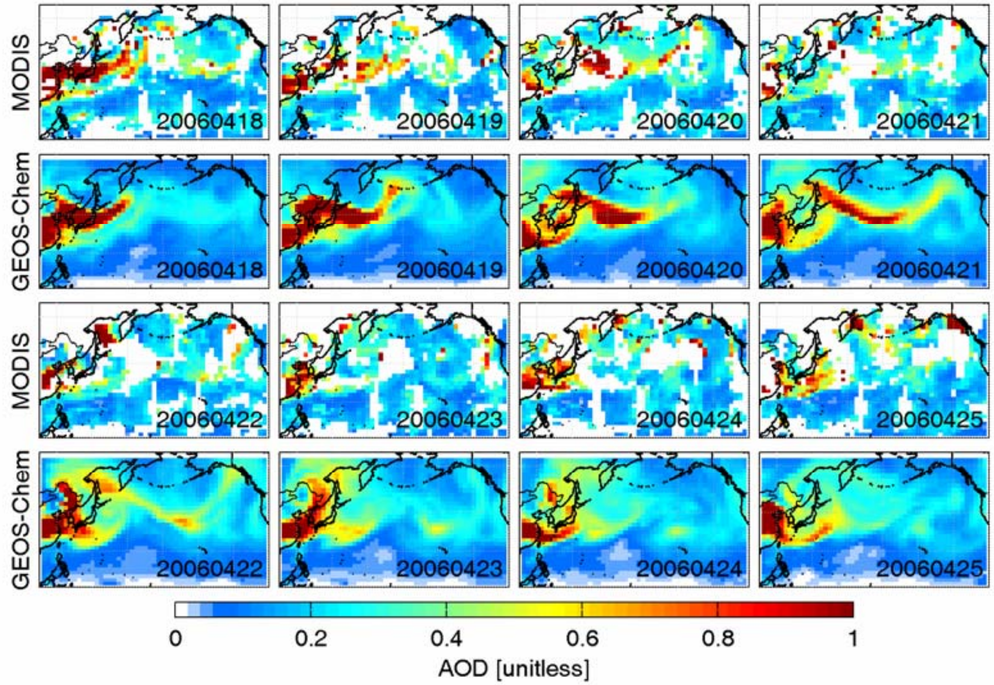
Trans−Pacific Aerosol Transport Observed by Aircraft and Satellite



Contributed by Randall Martin

Intercontinental Chemical Transport Experiment (INTEX−B)

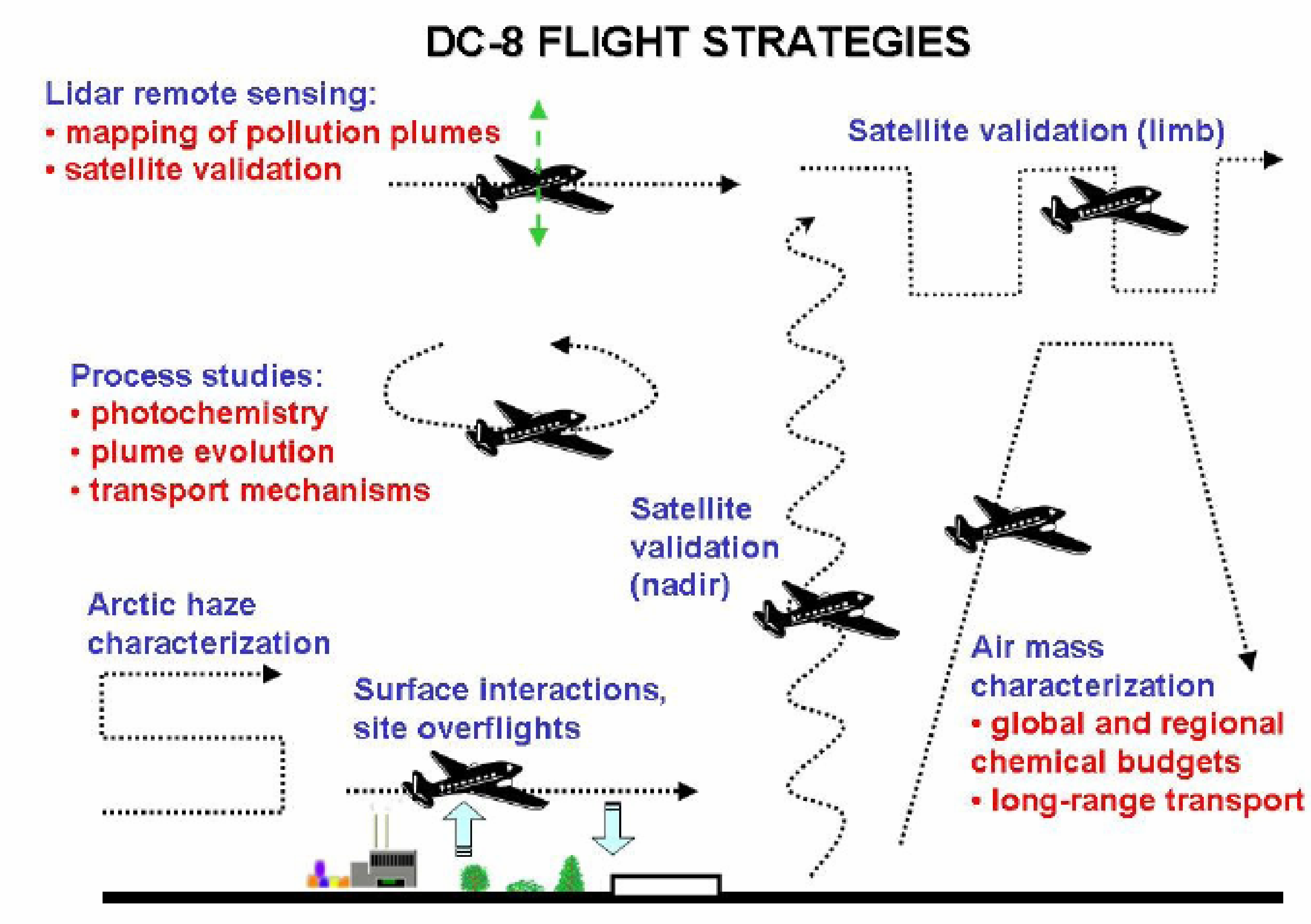




van Donkelaar et al., ACP, 2008

ARCTAS 2008

Figure from 2007 White Paper



Quantifying the impact of BOReal forest fires on Tropospheric oxidants over the Atlantic using Aircraft and Satellites (BORTAS): **Phase I** July 2010 Aircraft Mission

NATURAL ENVIRONMENT RESEARCH COUNCIL

THE UNIVERSITY of York

UNIVERSITY OF LEEDS

Composition and distribution of biomass burning outflow → O_3 production and loss within the outflow → Resulting perturbation to atmospheric chemistry in the troposphere.

International partners:
NASA, CNRS, Environment Canada, Free University of Amsterdam, Dalhousie, Washington State

BORTAS PI: Paul Palmer, University of Edinburgh

Existing Canadian Interest/Capacity in Atmospheric Chemistry Academic Community

Institution	Measurements	Modelling
U of Toronto	Murphy	Jones
	Abbatt	
York	McLaren	
Waterloo	Sloan	Lin
U of Calgary	Osthoff	
Dalhousie	Duck	Martin
		Pierce

UNIVERSITY OF CALGARY

Osthoff group
Atmospheric Chemistry

Department of Chemistry, University of Calgary, 2500 University Drive NW | Calgary, AB T2N 1N4, Canada
http://homepages.ucalgary.ca/~hosthoff/
hans.osthoff@ucalgary.ca | 403-220-8689

Instrumentation for field trace gas measurements

Chemical Ionization mass spectrometer

Target species:
PAN, PPN, APAN, MPAN, $ClNO_2$, Cl_2, Br_2

Sensitivity (1 sec data):
- PANs: better than 1 pptv
- $ClNO_2$: better than 5 pptv

Specifications:
- dimensions: w. 21", h. 52", d. 40"
- weight 250 lbs
- power requirement: 850 watt

Upgrades required for aircraft duty:
- construction of rear-facing inlet
- remount in aircraft-certified 19" rack-mount frame
- aircraft certification

Diode laser cavity ring-down spectrometer

(under construction)

Target species:
N_2O_5, NO_3

Sensitivity (1 sec data):
- better than 5 pptv

Specifications:
- dimensions: w. 21", h. 45", d. 29"
- weight: tbd (<200 lbs expected)
- power requirement: tbd (< 1kW expected)

Upgrades required for aircraft duty:
- construction of rear-facing inlet
- remount in 19" rack-mount frame
- aircraft certification

UNIVERSITY OF CALGARY
NSERC CRSNG
ALBERTA INGENUITY FUND
Canadian Foundation for Climate and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences du climat et de l'atmosphère (FCSCA)
iseee INSTITUTE for SUSTAINABLE ENERGY, ENVIRONMENT and ECONOMY