Science and Operational Highlights of the CONTRAST Campaign

Joint Western Pacific Experiments Science Team Meeting,
October 20, 2014

Laura Pan, Elliot Atlas, and Ross Salawitch

Convective Transport of Active Species in the Tropics

The GV forward Camera, CONTRAST RF05 2014-01-22

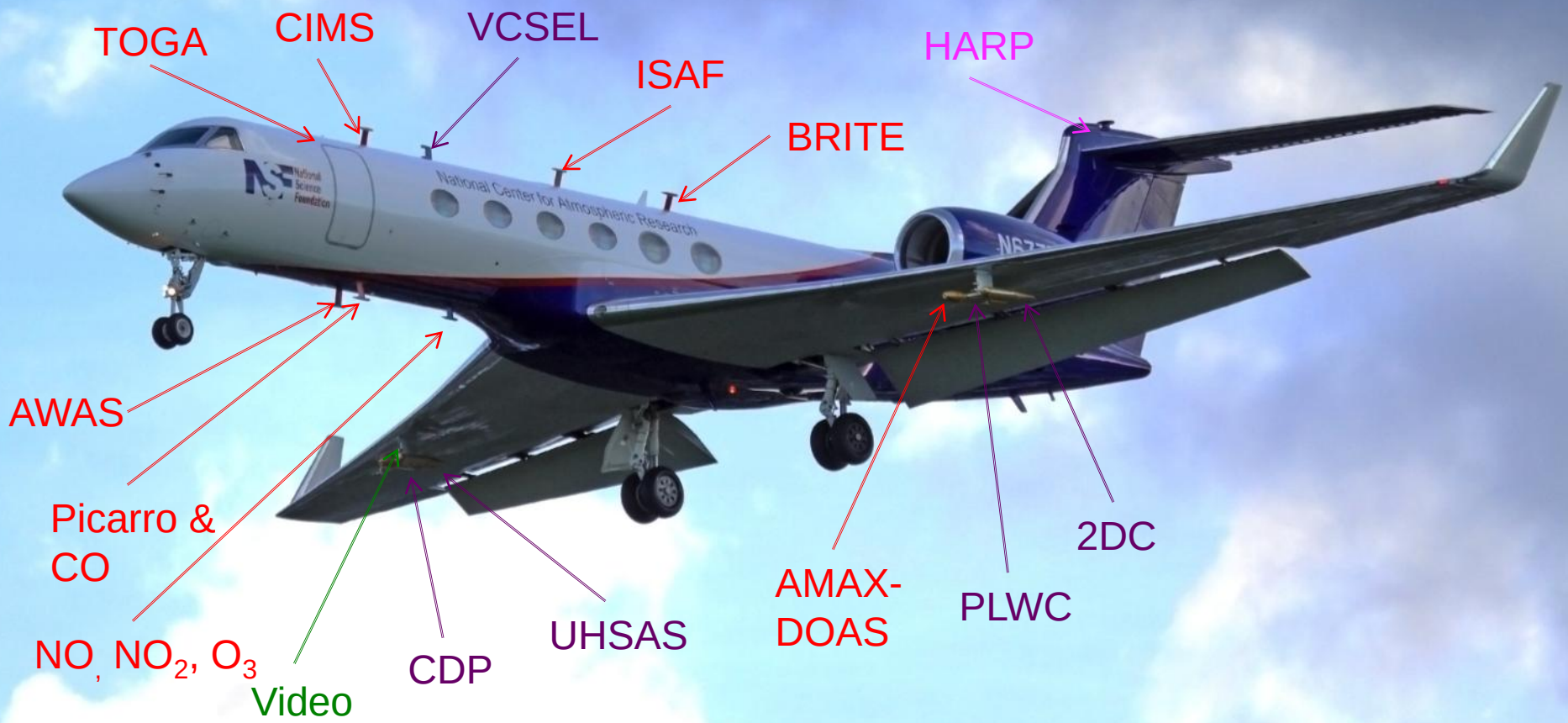
CONTRAST Science Objectives

Main Objectives

- **Characterize the chemical composition and ozone photochemical budget at the level of convective outflow over the western Pacific during the deep convective season**
- **Evaluate the budget of organic and inorganic bromine and iodine in the TTL**
- **Investigate transport pathways from the oceanic surface to the tropopause using the NSF NCAR GV coordinated flights with the BAe-146 and NASA Global Hawk.**

NSF/NCAR Research Aircraft Gulfstream V (GV)

the GV Payload for the CONTRAST Campaign



Convective Transport of Active Species in the Tropics

January 11 – March 2, 2014, Guam

CONTRAST Payload (1)

Chemistry		Investigator	GH	BAe-146
NO_x	NO, NO_2	Weinheimer/NCAR ACD	NO	YES
Fast Ozone	O_3	Weinheimer/NCAR ACD	YES	YES
VUV Carbon Monoxide	CO	Campos/NCAR ACD	YES	YES
Picarro	CO_2, CH_4	Campos/NCAR ACD	YES	YES
VCSEL Laser Hygrometer	H_2O	Jensen/NCAR RAF	YES	YES
TOGA	NMHCs, OVOCs	Apel, Hornbrook/NCAR ACD & Riemer / U Miami	NO	YES
GT-CIMS	BrO, BrCl, HOBr, ClO	Huey/GIT	NO	YES
AMAX	BrO, IO, H_2CO (remote)	Volkamer/CU	YES	NO
HAIS Advanced Whole Air Sampler (AWAS)	Trace gases	Atlas/U.Miami	YES	YES
In Situ Airborne Formaldehyde (ISAF)	H_2CO	Hanisco/ NASA GSFC	NO	NO
Inorganic Br (BRITE)	Br* (Σ BrO + Br)	Atlas/U.Miami & Flocke/ACD	NO	NO
Radiation				
HARP	Spectral Actinic Flux	Hall /NCAR ACD	YES	YES

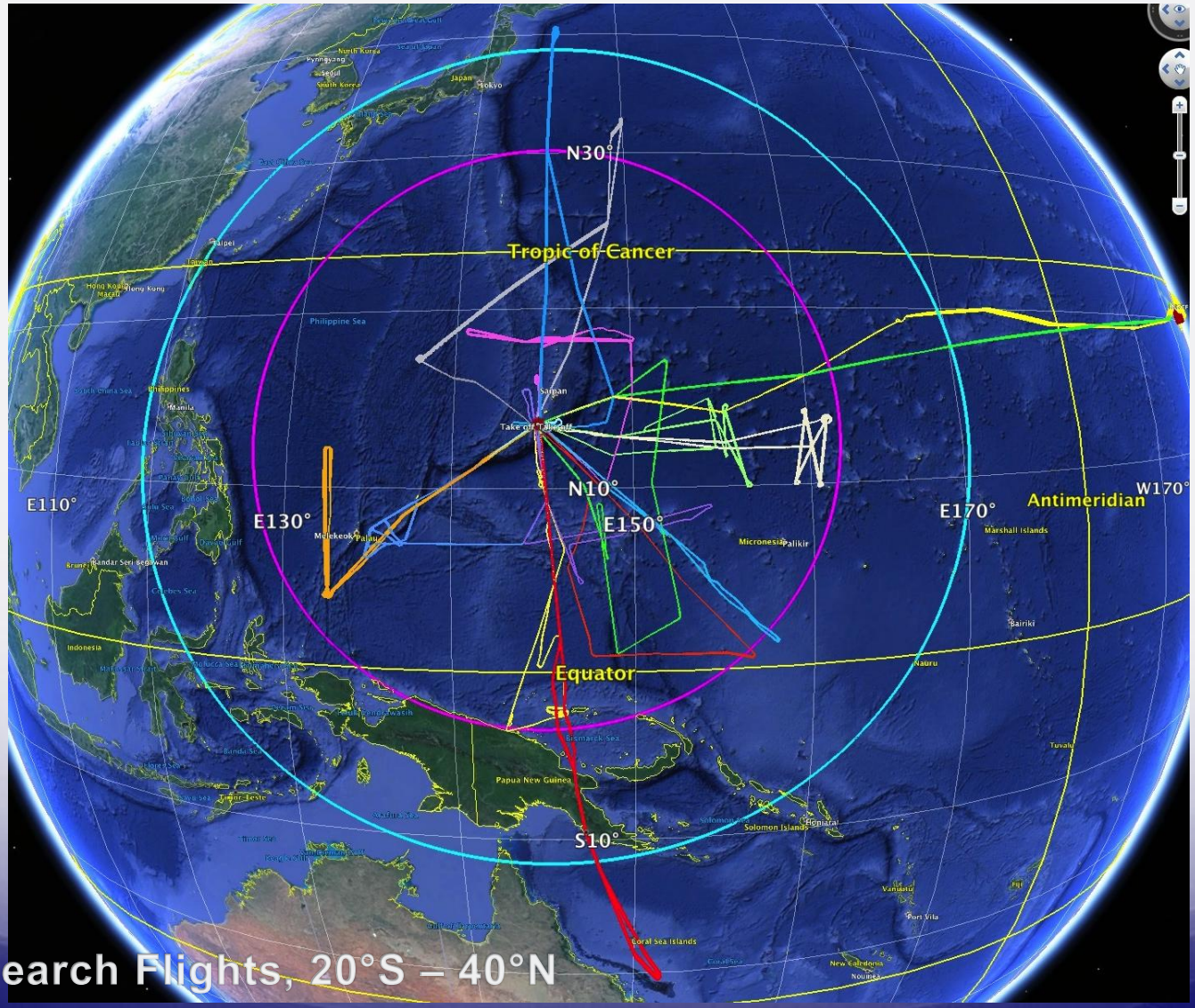
CONTRAST Payload (2)

State parameters		
State Parameters	Lat/Lon, P, T, 3D wind	Jensen/NCAR RAF
RAF Digital Video	Four Direction views	Jensen/NCAR RAF
Microphysics		
CDP Cloud Probe	2 - 50 um, water droplets, ice crystals	Jensen/NCAR RAF
2D-C Precipitation Probe	25-1600 um, ice, water	Jensen/NCAR RAF
UHSAS Aerosol Probe	0.075 - 1 um, aerosols	Jensen/NCAR RAF
WCN CN Counter	0.01 - 3 um, aerosols	Jensen/NCAR RAF


1. Observational and operational highlights
2. Active research topics

Observational and Operational Highlights (I)

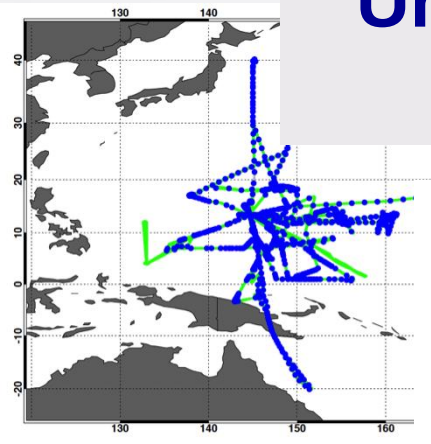
Latitudinal Range Mapped



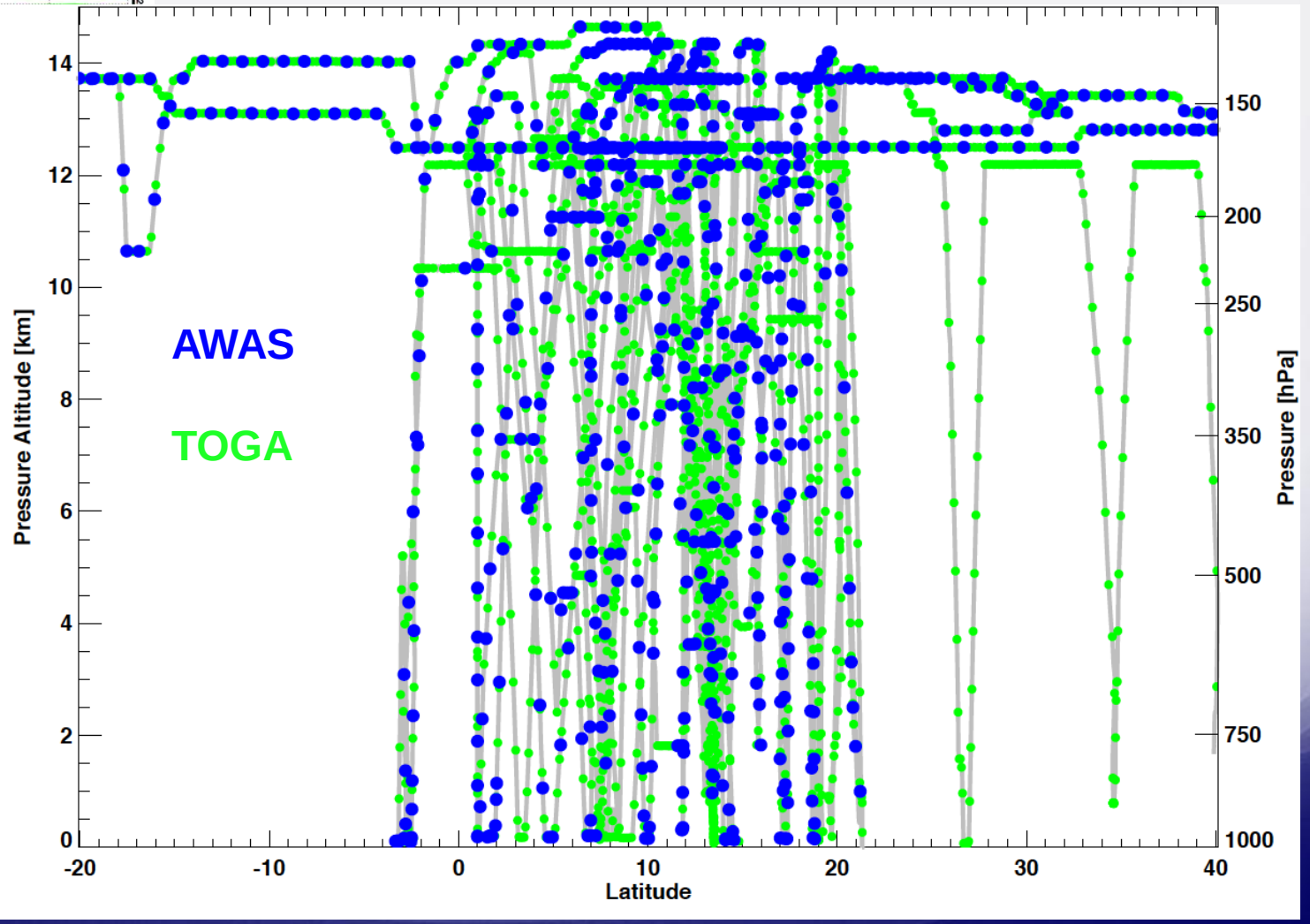
- 16 Research Flights, 20°S – 40°N
- Operated in the US, Japan, PNG and Australian airspace

Observational and Operational Highlights (II)

Unprecedented Chemical Information Content over the Western Pacific



- Over 100 complete vertical profiles
- 92 m – 15.3 km GPS altitude ASL
- θ_{max} = 384K (365K within tropics)
- P_{min} = 128 hPa



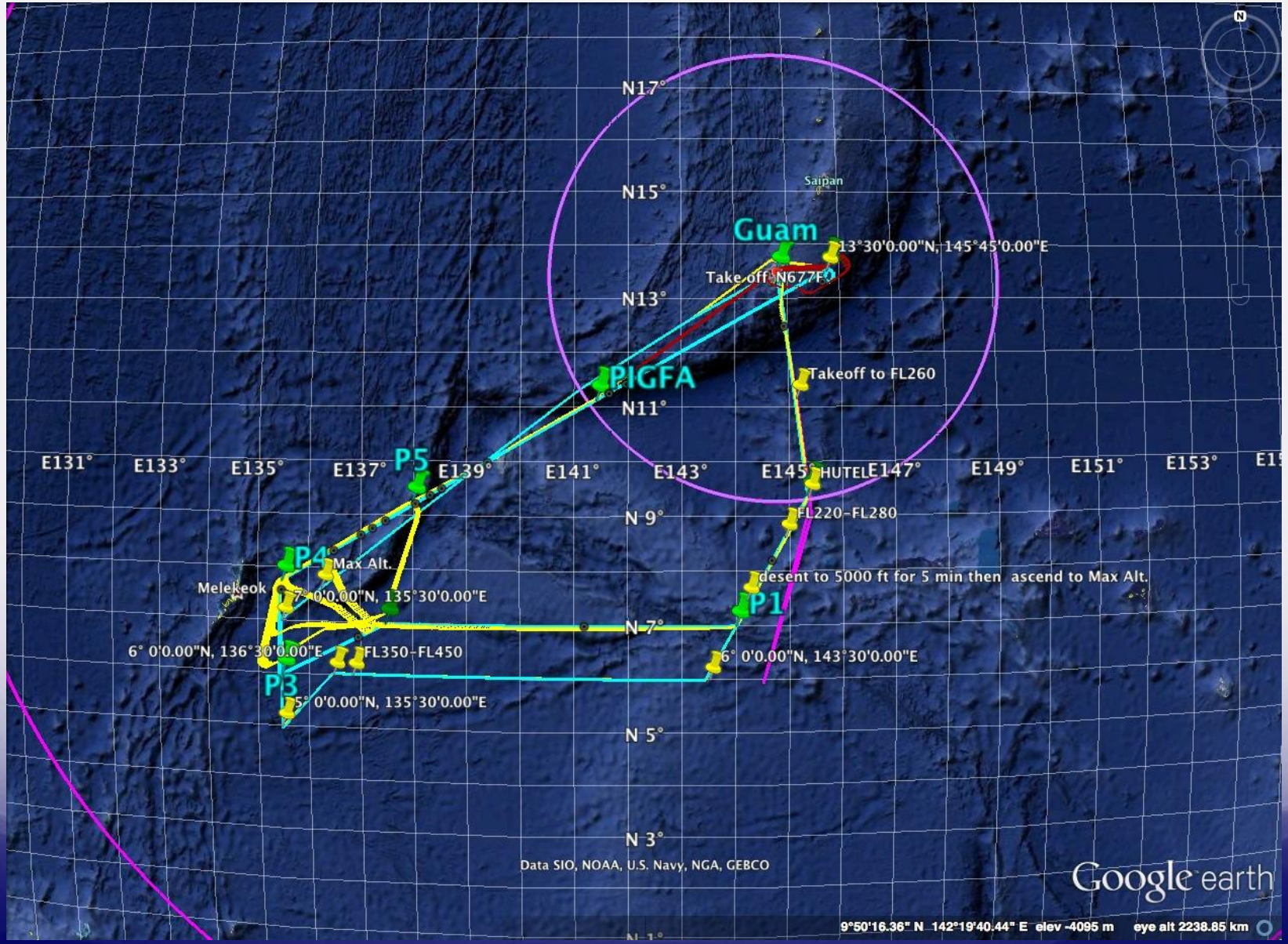
Observational and Operational Highlights (III)

Targeted a Wide Range of Chemical and Dynamical Conditions

- **Mapping regional gradients (including transit)** RF01-04, RF07
- **Sampling fresh and aged convective outflows** RF05, RF09, RF10, RF11, RF12, RF14
- **Contrasting air mass across various dynamical boundaries (crossing jet stream/equator, profiling ITCZ, frontal/shear lines)** RF06, RF10, RF14, RF15
- **Investigating photochemistry evolution (sampling the same air mass in region of near stagnation point under different solar zenith angles; Dawn/Dusk flights)** RF08, RF13
- **Targeted MBL in the region of strong gradient of oceanic biological activities** RF09
- **Co-located profiles with ozonesondes** RF11, RF12, RF14
- **GV/GH/Bae Coordinated flights** RF01, RF08, RF11, RF12

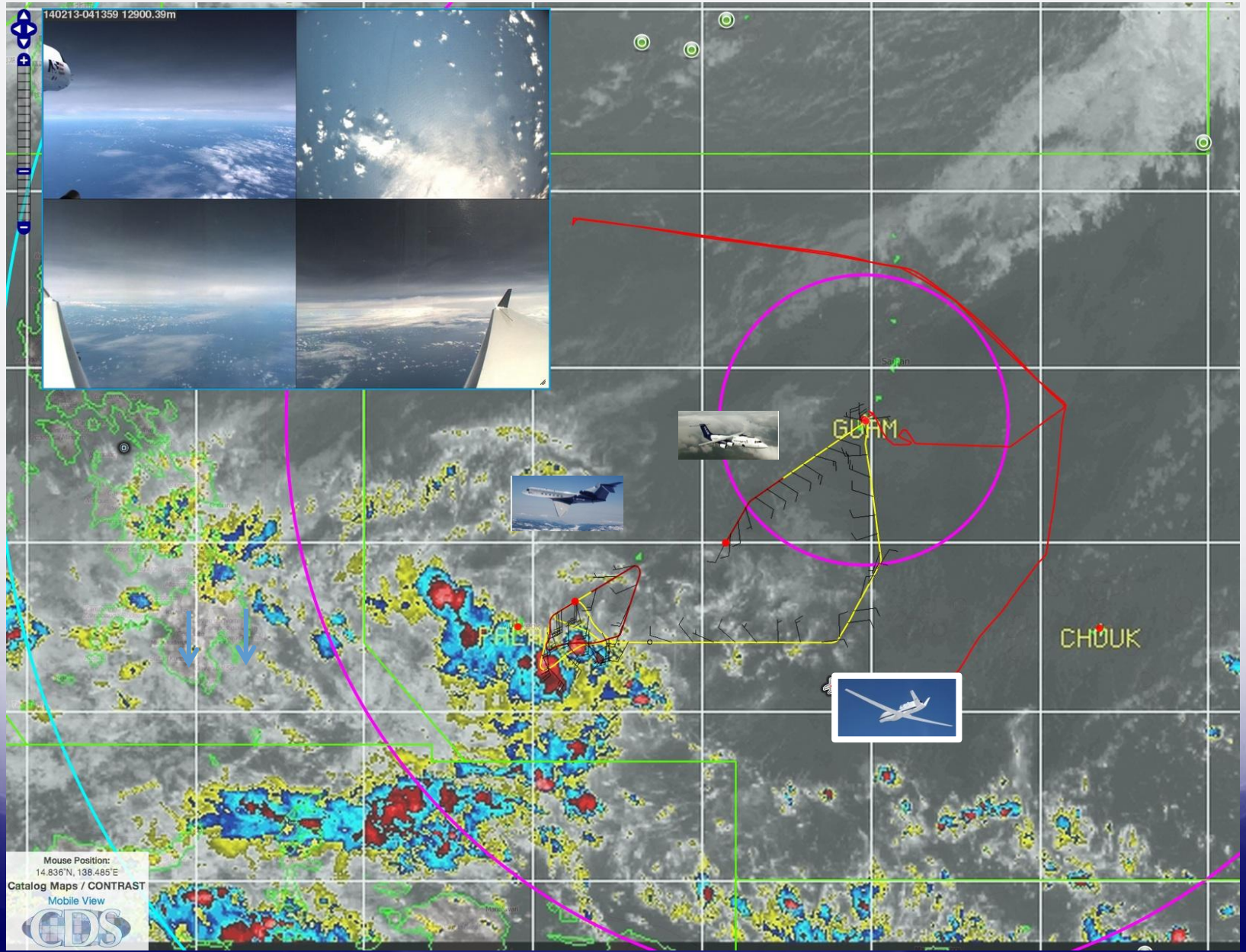
Operational Highlights:

Fresh convective outflow and coordinated flight –RF11



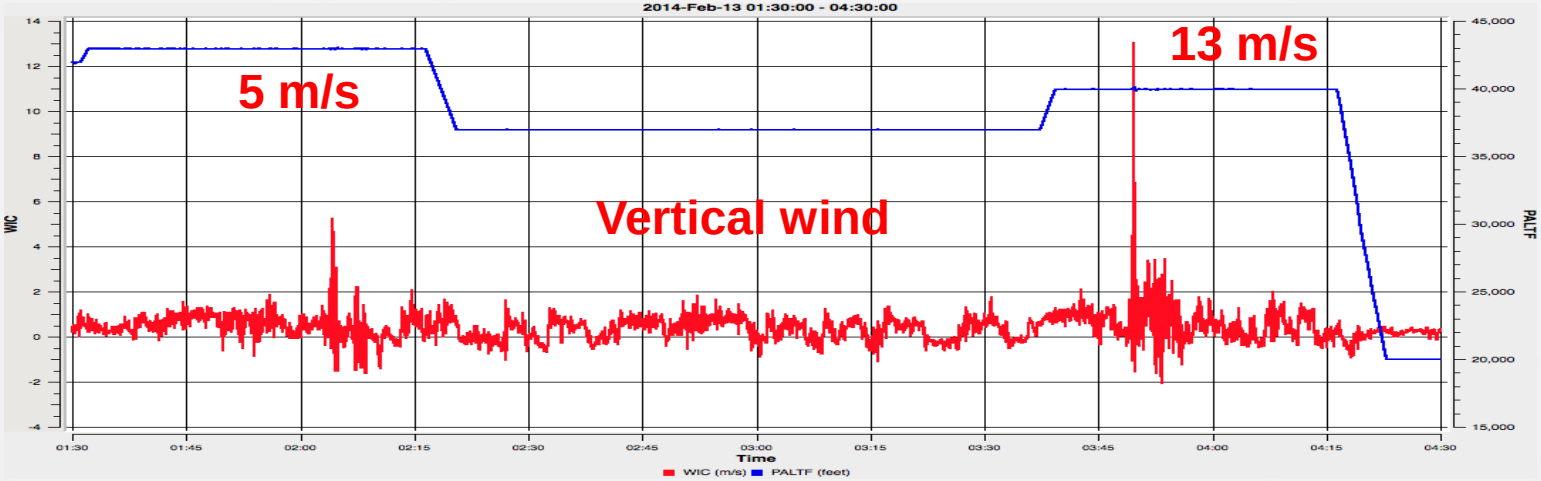
Operational Highlights:

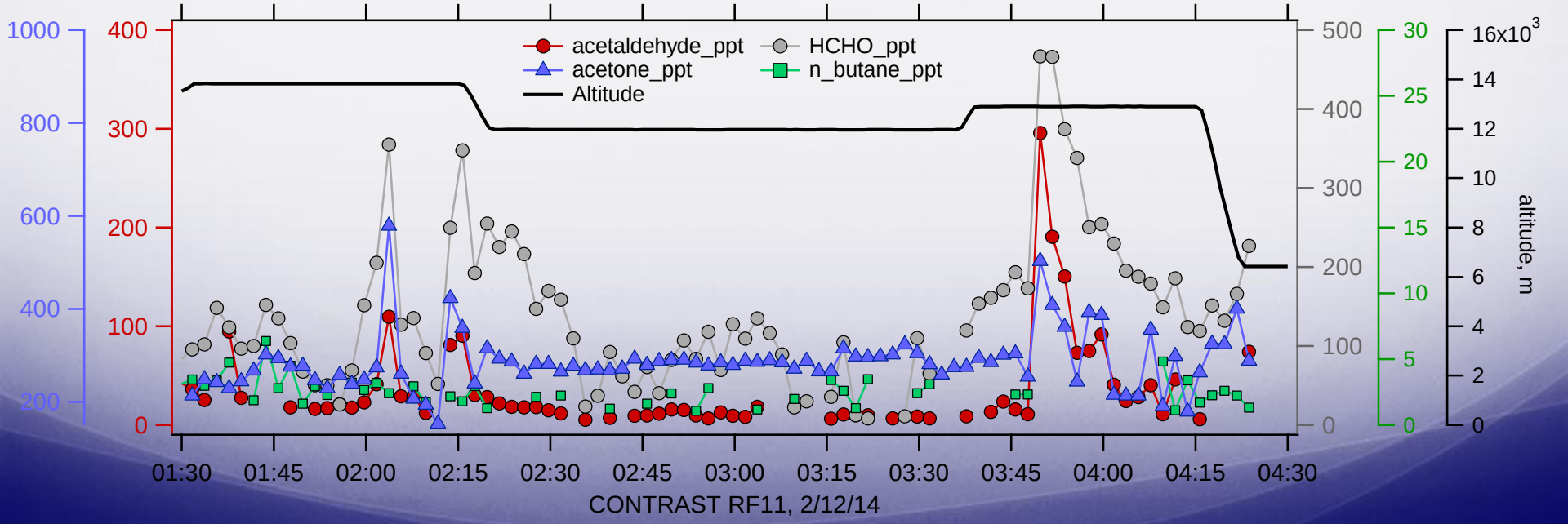
Fresh convective outflow and coordinated flight –RF11



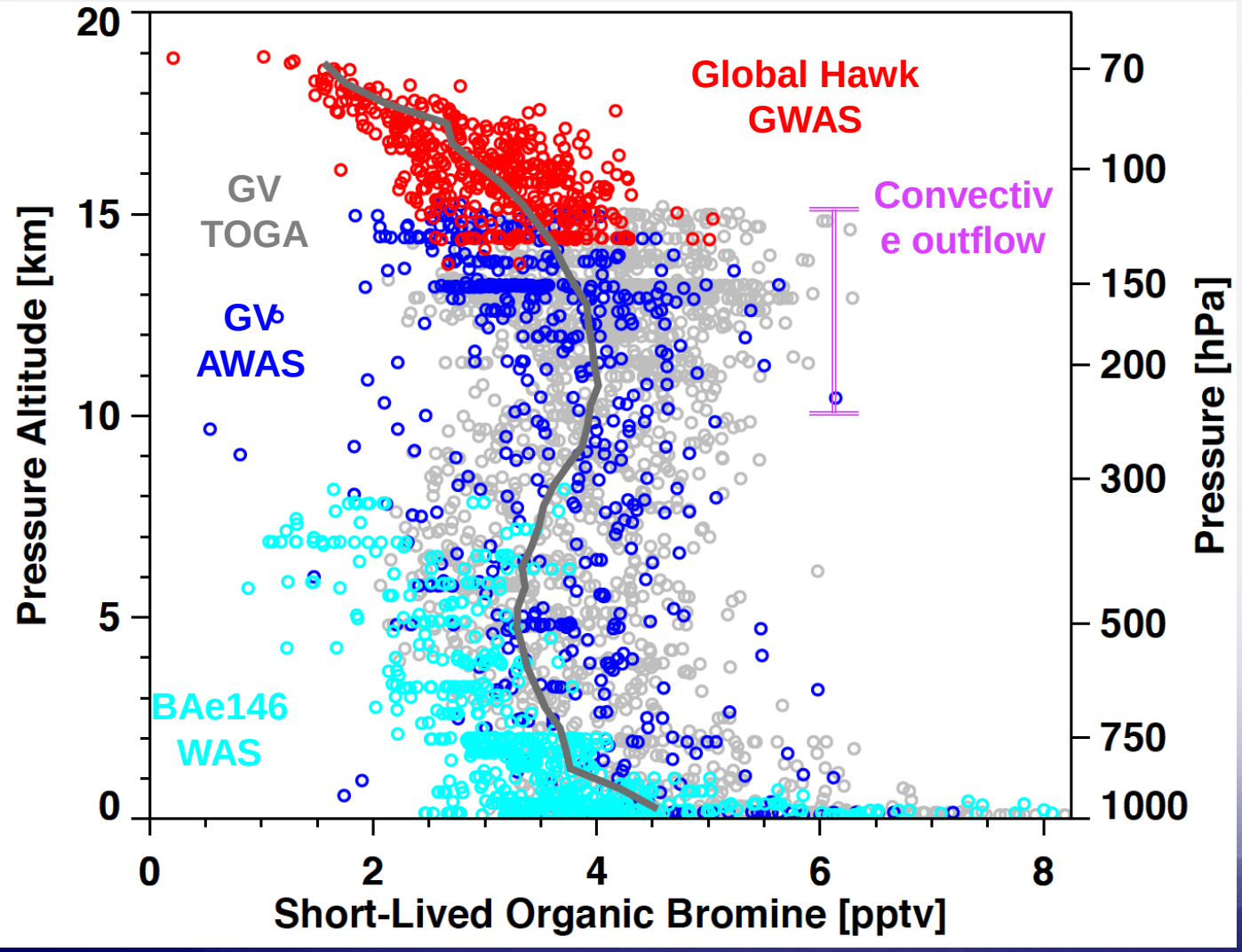
Operational Highlights:

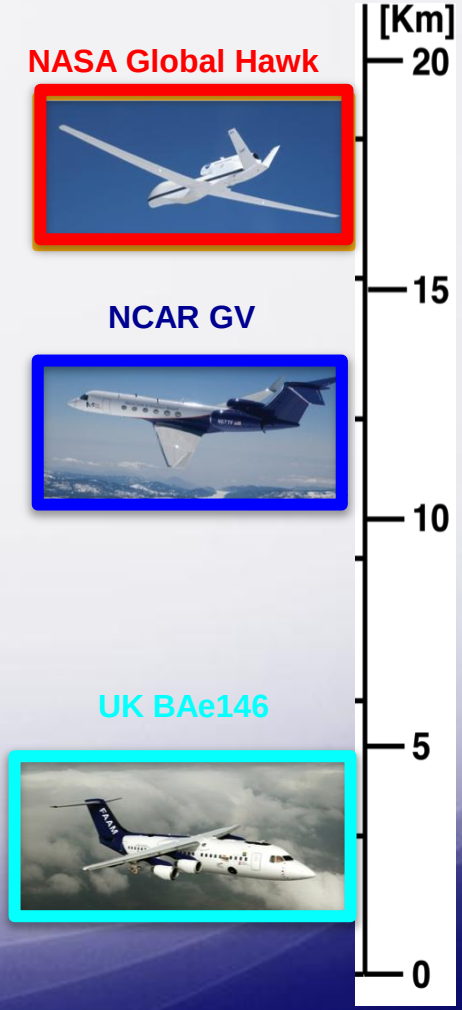
RF11: Targeting the “Fresh” Convective Outflow





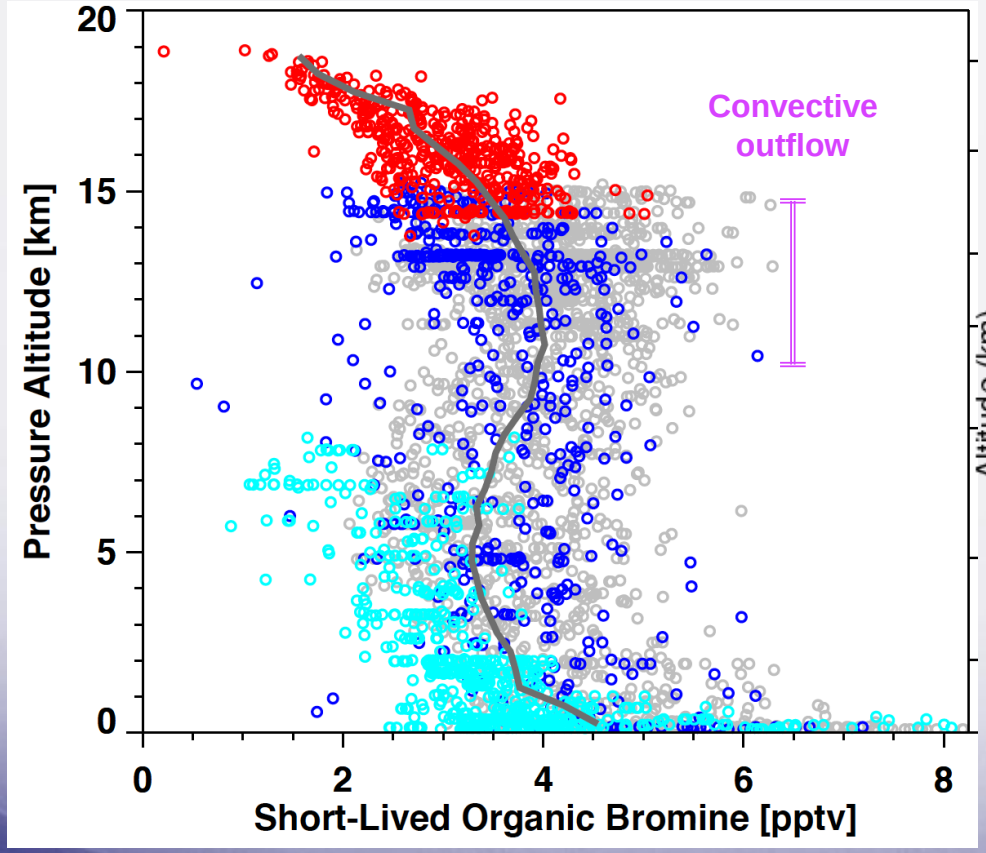
How does convection redistribute short-lived species in the tropics?

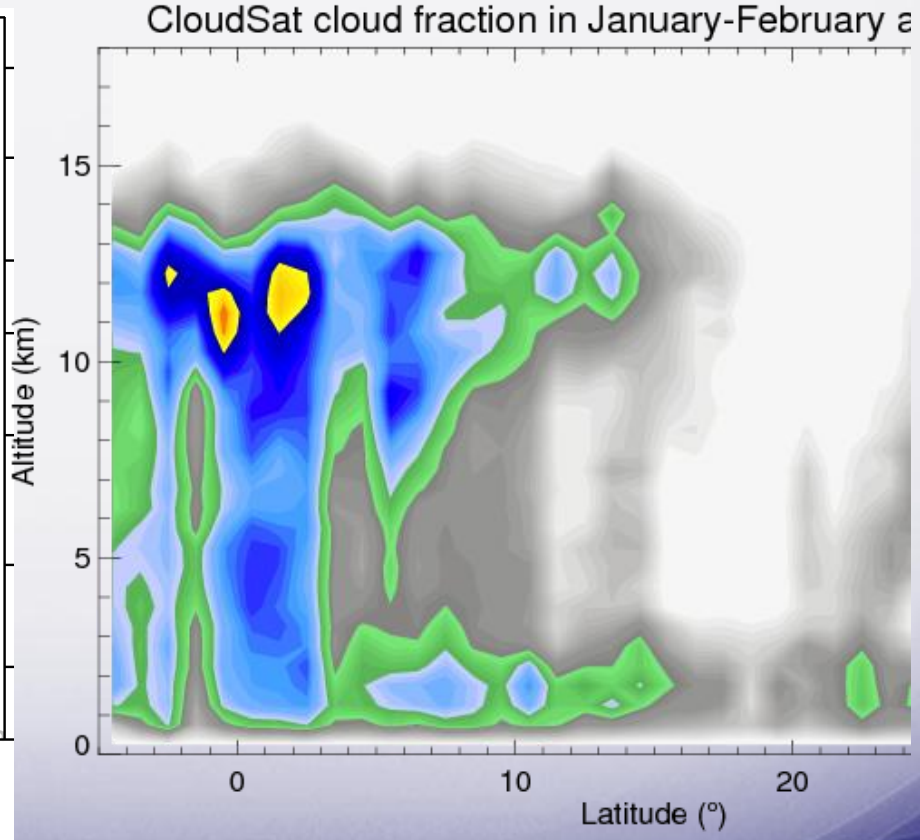




Hot Research Topics in Progress (1):

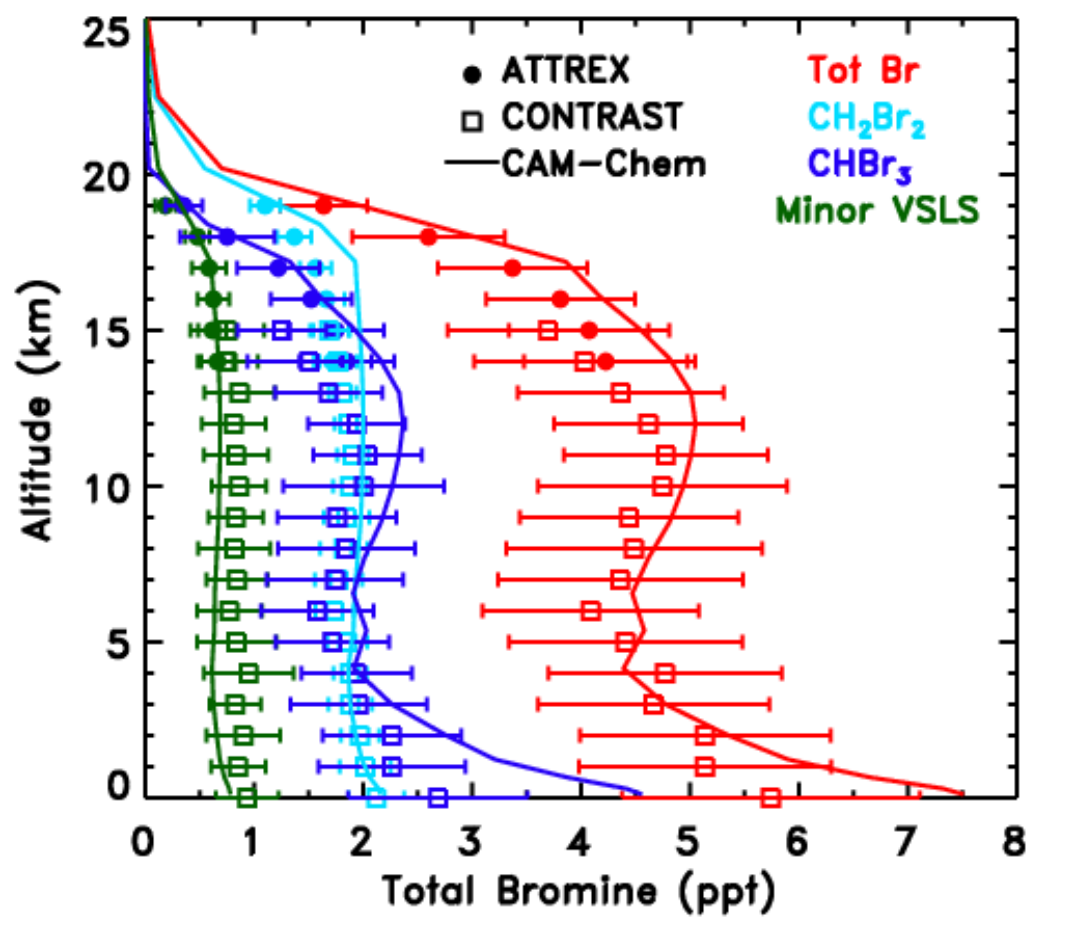
How does convection redistribute short-lived species in the tropics?





Courtesy Chuntao Liu

How well are the vertical distributions of halogenated species represented in the CCMs ?

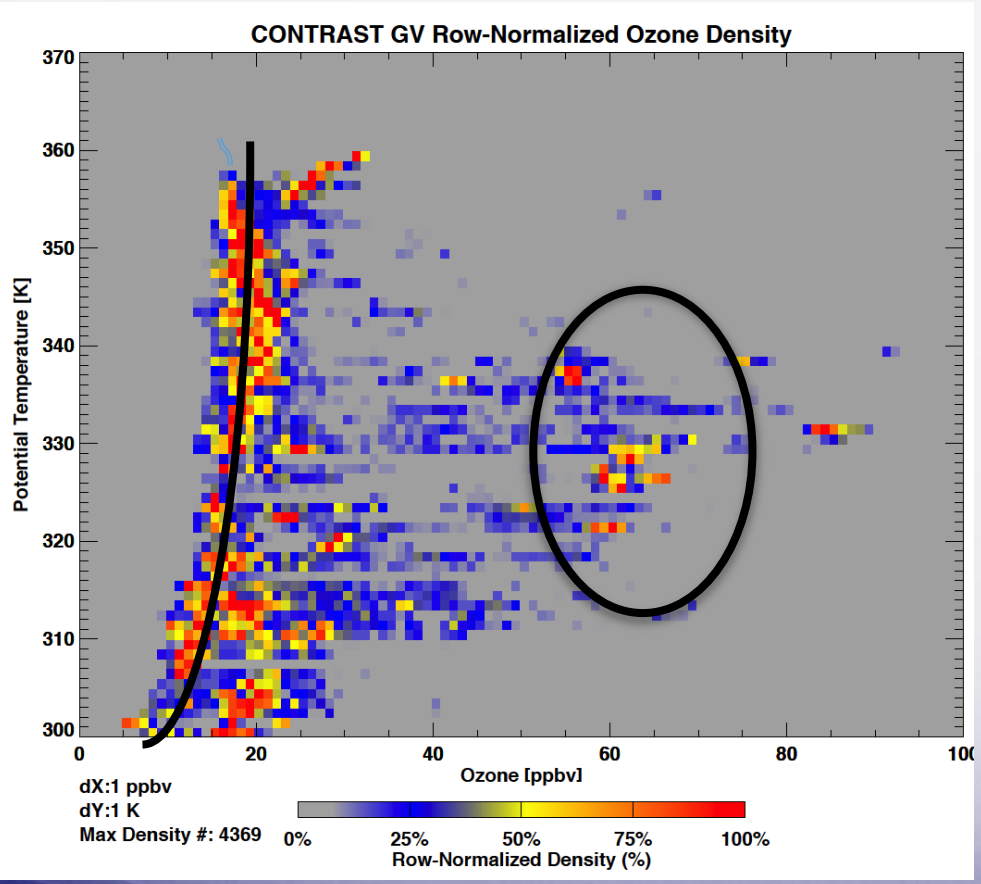


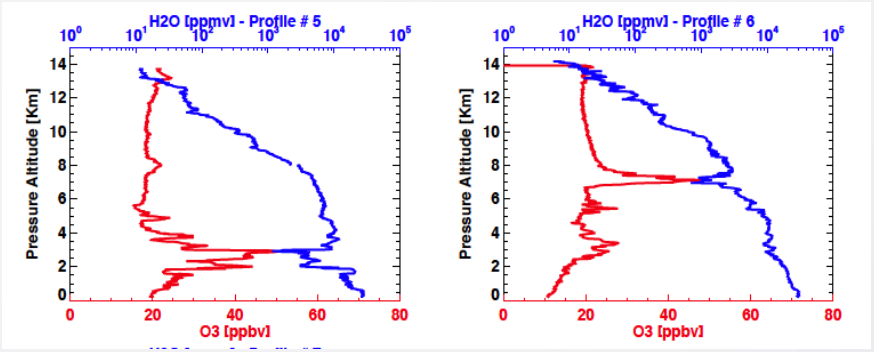
Model: CAM-Chem, Kinnison et al., (Fernandez et al., ACP, 2014)
Data: AWAS, Atlas et al.
Figure prepared by Julie Nicely, Ross Salawitch

Hot Research Topics in Progress (3):

What controls the ozone structure in the tropics?

- Is the ozone enhancement produced by dry intrusions or biomass burning?

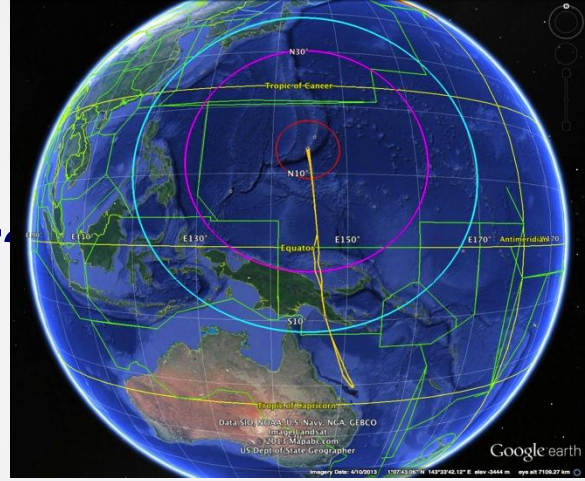




- bi-modal structure: 20 and 60 ppbv
- Enhancement was often observed as filaments anti-correlated with water vapor
- Also observed positive correlation of ozone-HCN

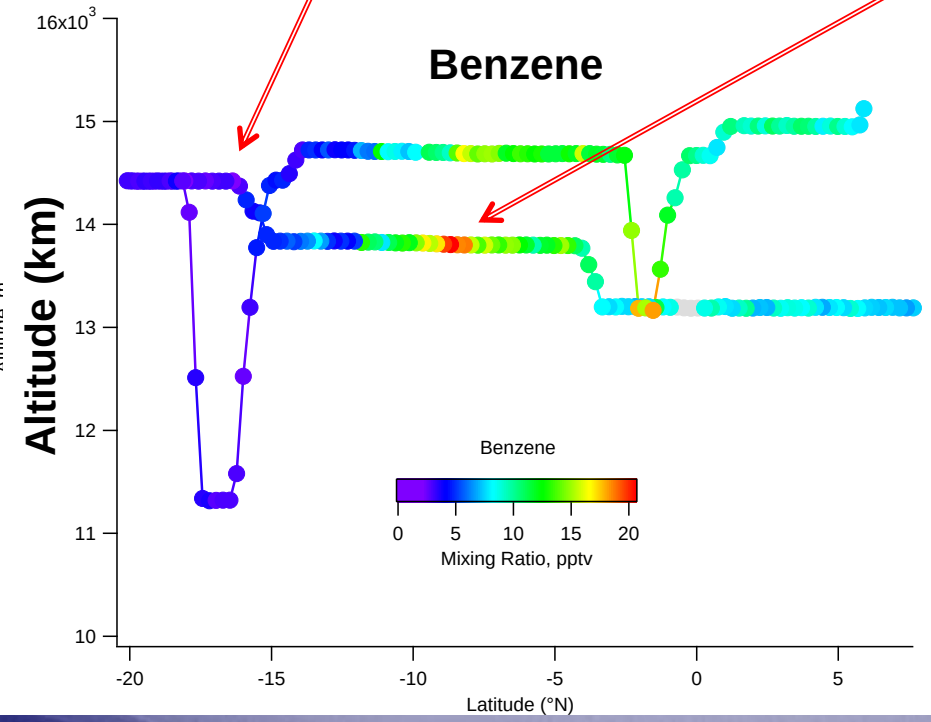
Hot Research Topics in Progress (4):

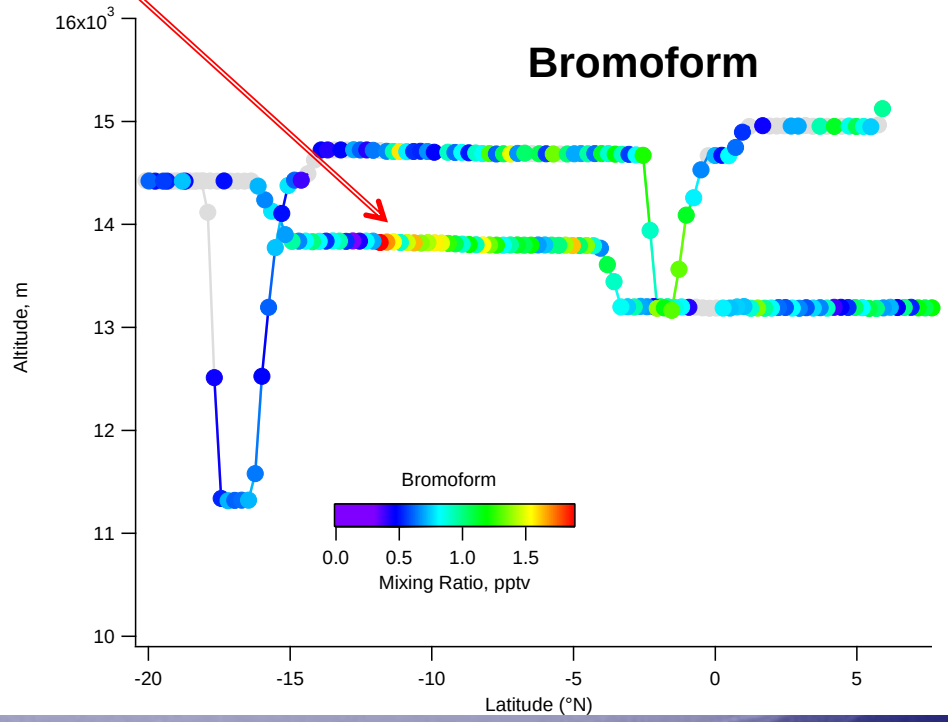
How much do we see biogenic vs. anthropogenic emission in the tropical UT



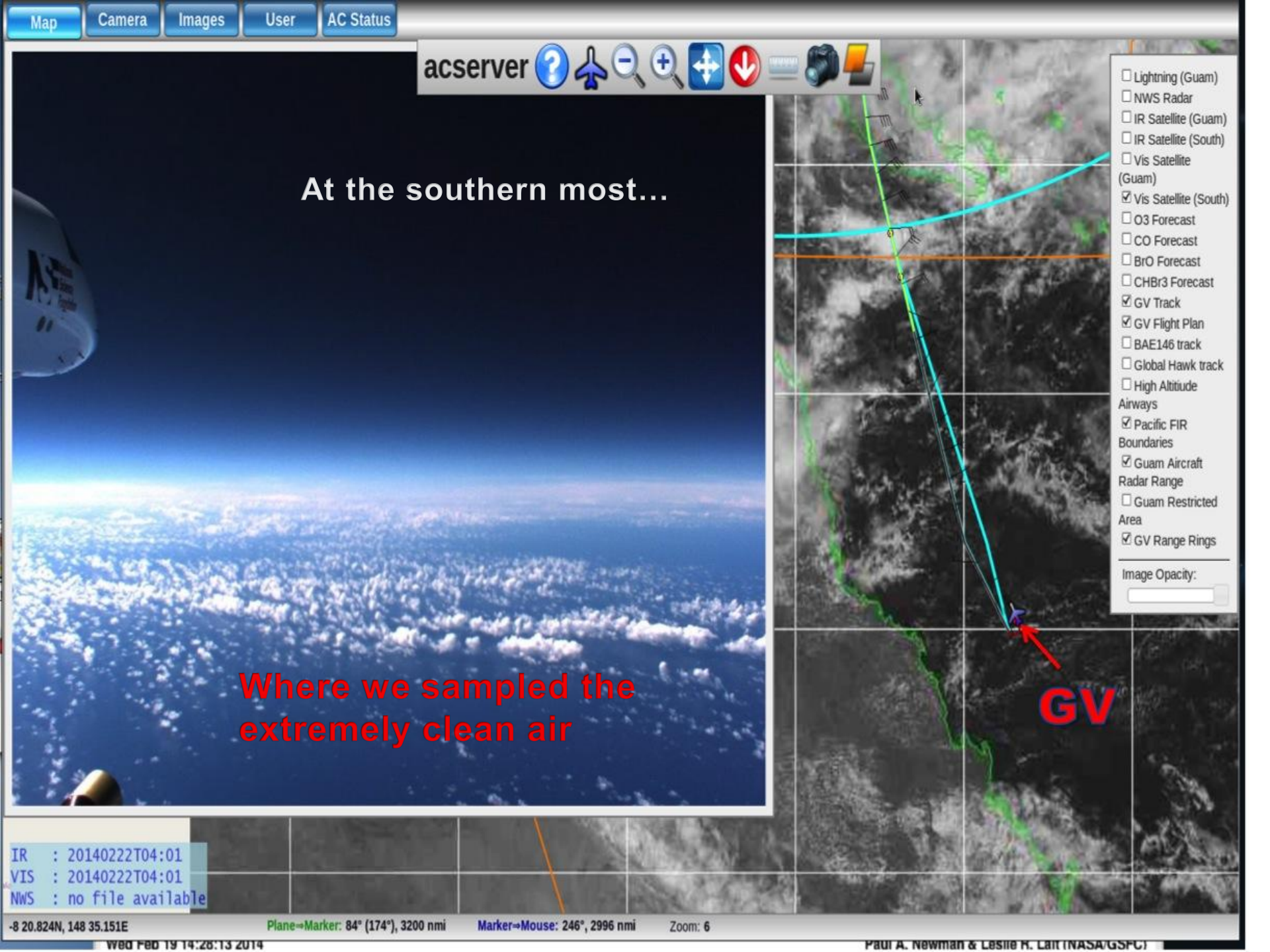
Extremely Clean Air near Australia

Clear evidence of convective influence near PNG



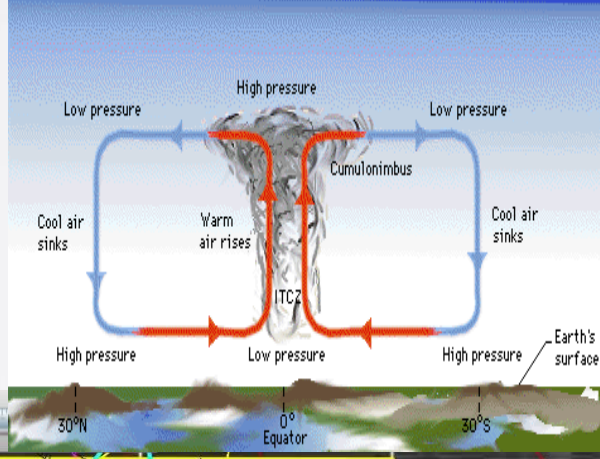


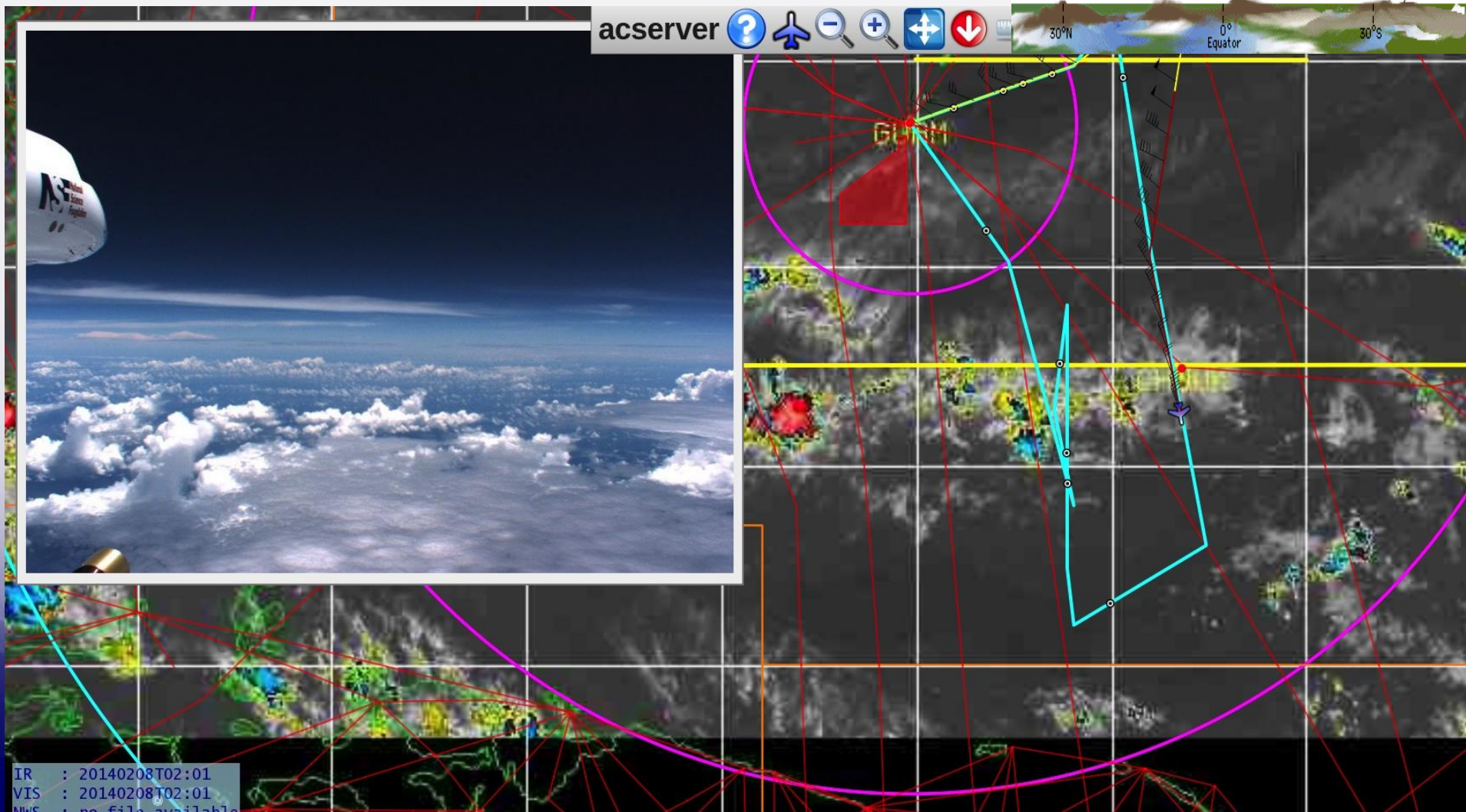
Becky Hornbrook, Dan Riemer, Eric Apel (TOGA data)


Map
Camera
Images
User
AC Status
acserver
At the southern most…
Where we sampled the extremely clean air
Lightning (Guam)
NWS Radar
IR Satellite (Guam)
IR Satellite (South)
Vis Satellite (Guam)
Vis Satellite (South)
O3 Forecast
CO Forecast
BrO Forecast
CHBr3 Forecast
GV Track
GV Flight Plan
BAE146 track
Global Hawk track
High Altitiude Airways
Pacific FIR Boundaries
Guam Aircraft Radar Range
Guam Restricted Area
GV Range Rings
Image Opacity:
GV
IR : 20140222T04:01
VIS : 20140222T04:01
NWS : no file available
-8 20.824N, 148 35.151E
Plane⇒Marker: 84° (174°), 3200 nmi
Marker⇒Mouse: 246°, 2996 nmi
Zoom: 6
Wed Feb 19 14:26:13 2014
Paul A. Newman & Leslie R. Lait (NASA/GSFC)

Hot Research Topics in Progress (5):

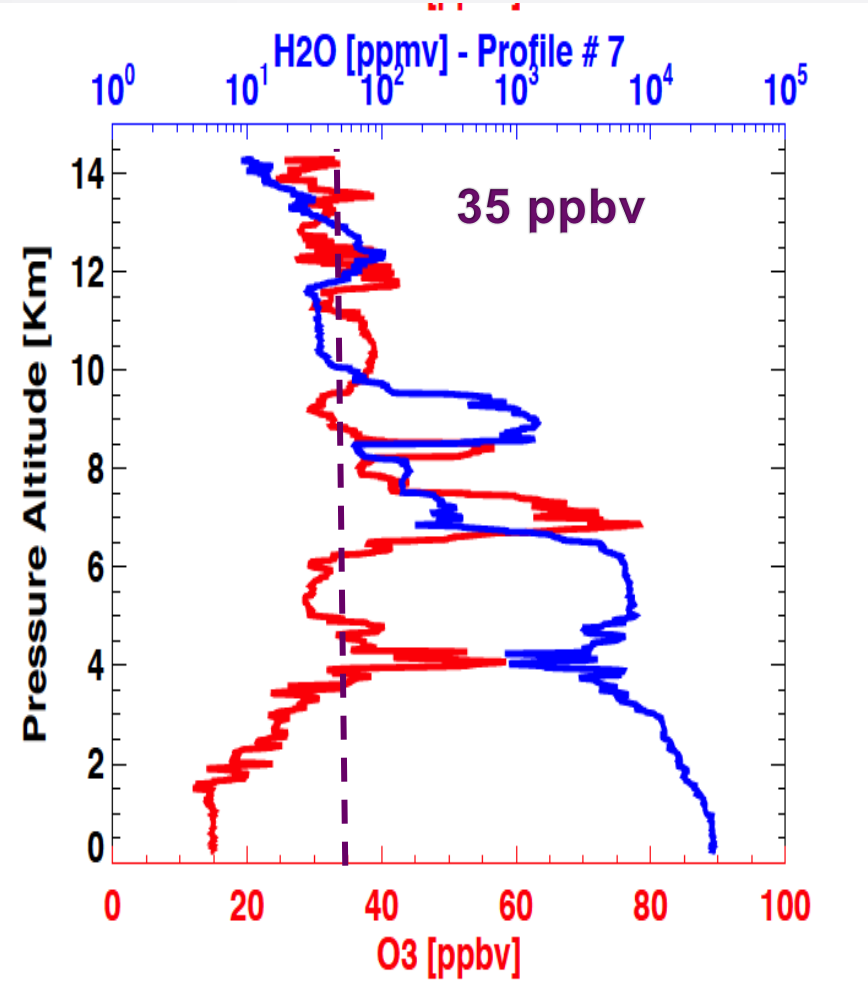
What are the chemical gradients across dynamical boundaries?



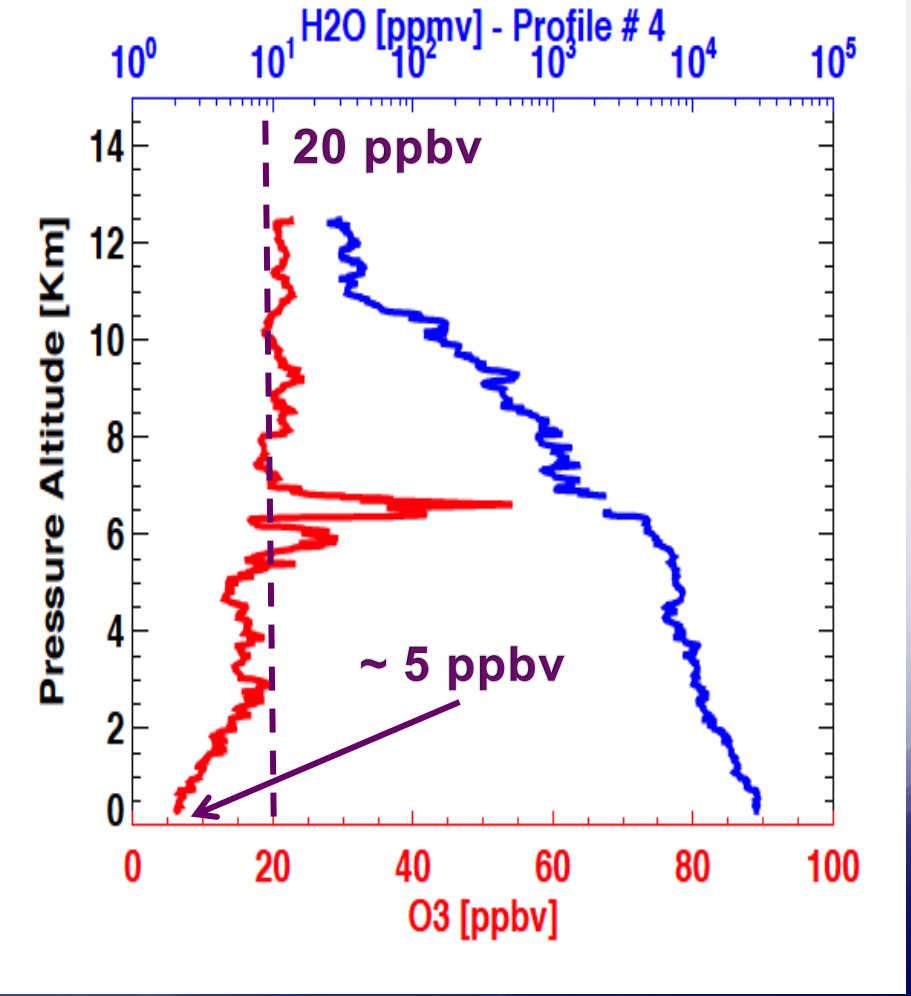


Ozone Profiles

North of ITCZ: 8-10°N



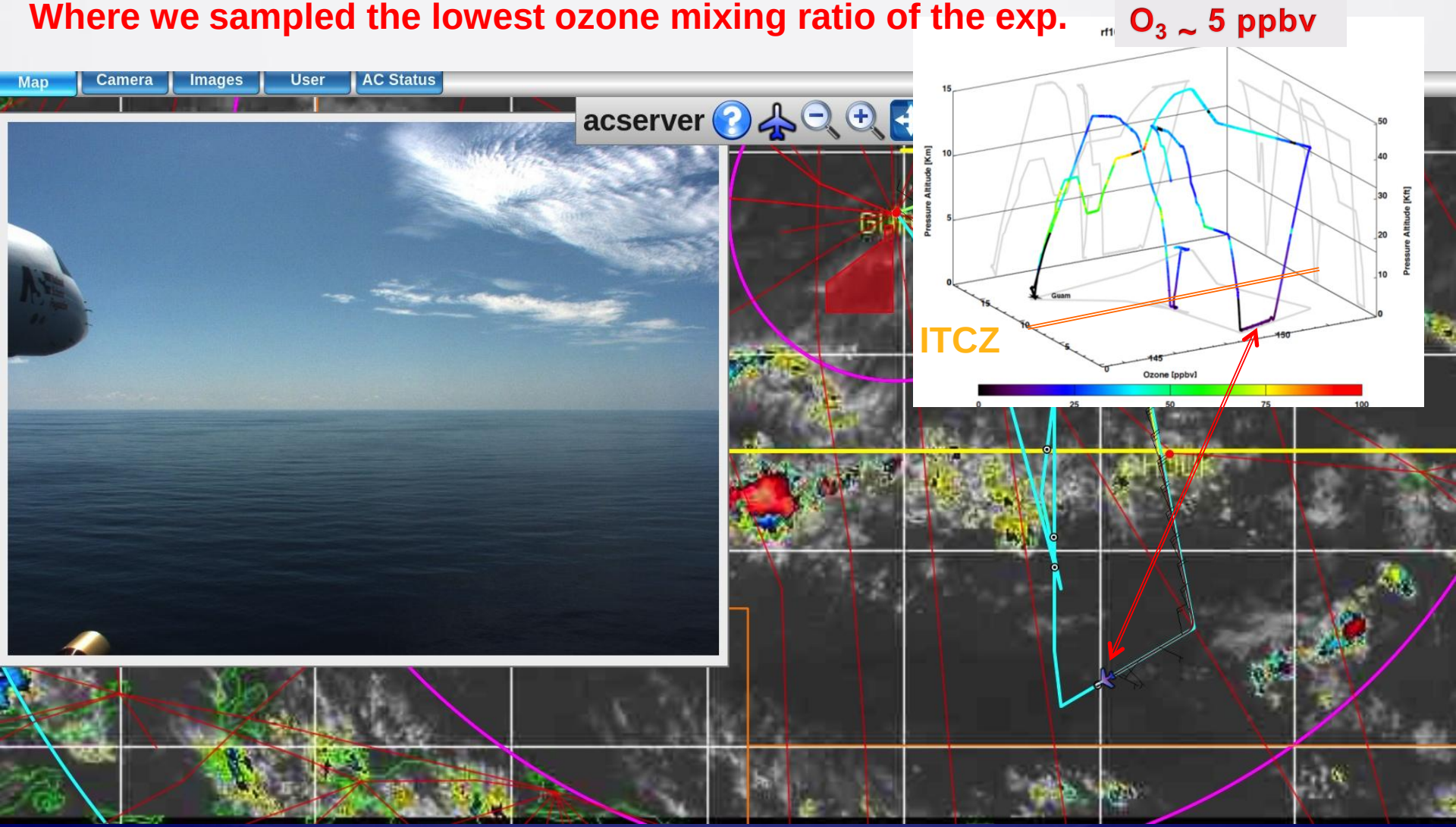
South of ITCZ: 2-4°N



Hot Research Topics in Progress (5):

What are the chemical gradients across dynamical boundaries?

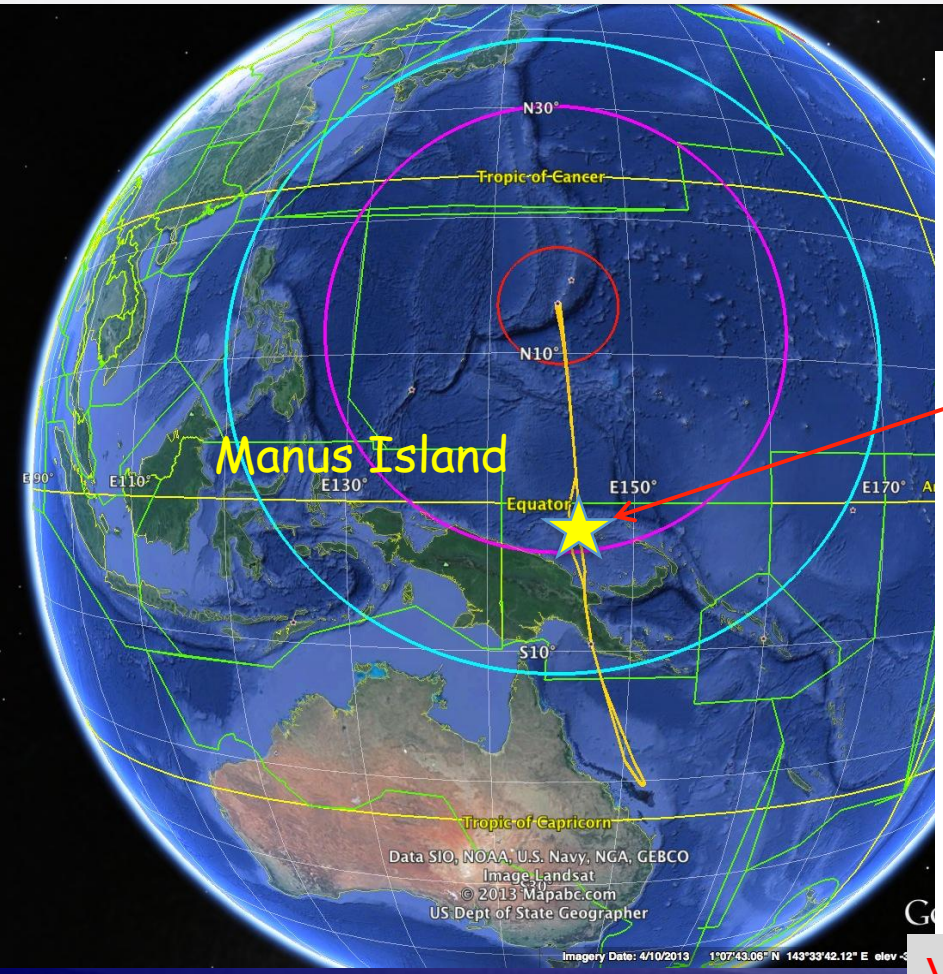
Where we sampled the lowest ozone mixing ratio of the exp.

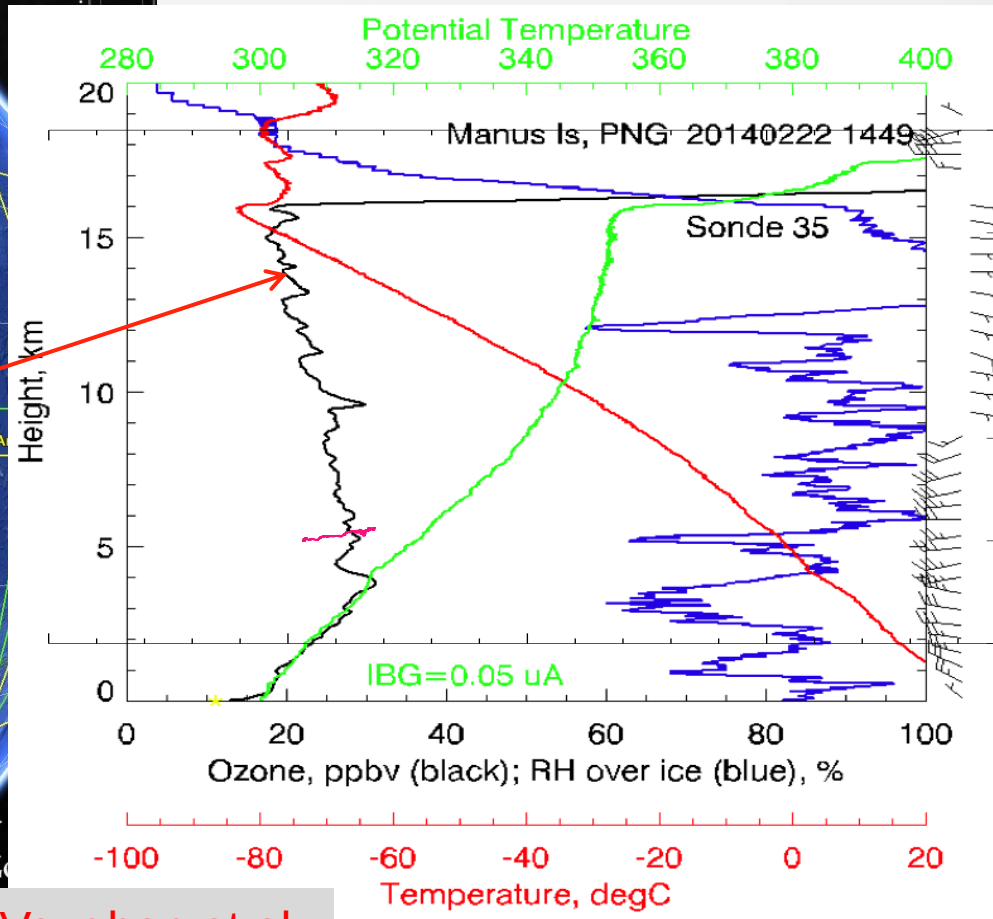


Hot Research Topics in Progress (5):

What can we learn about the uncertainty of ozonesonde measurements using co-located GV data ?

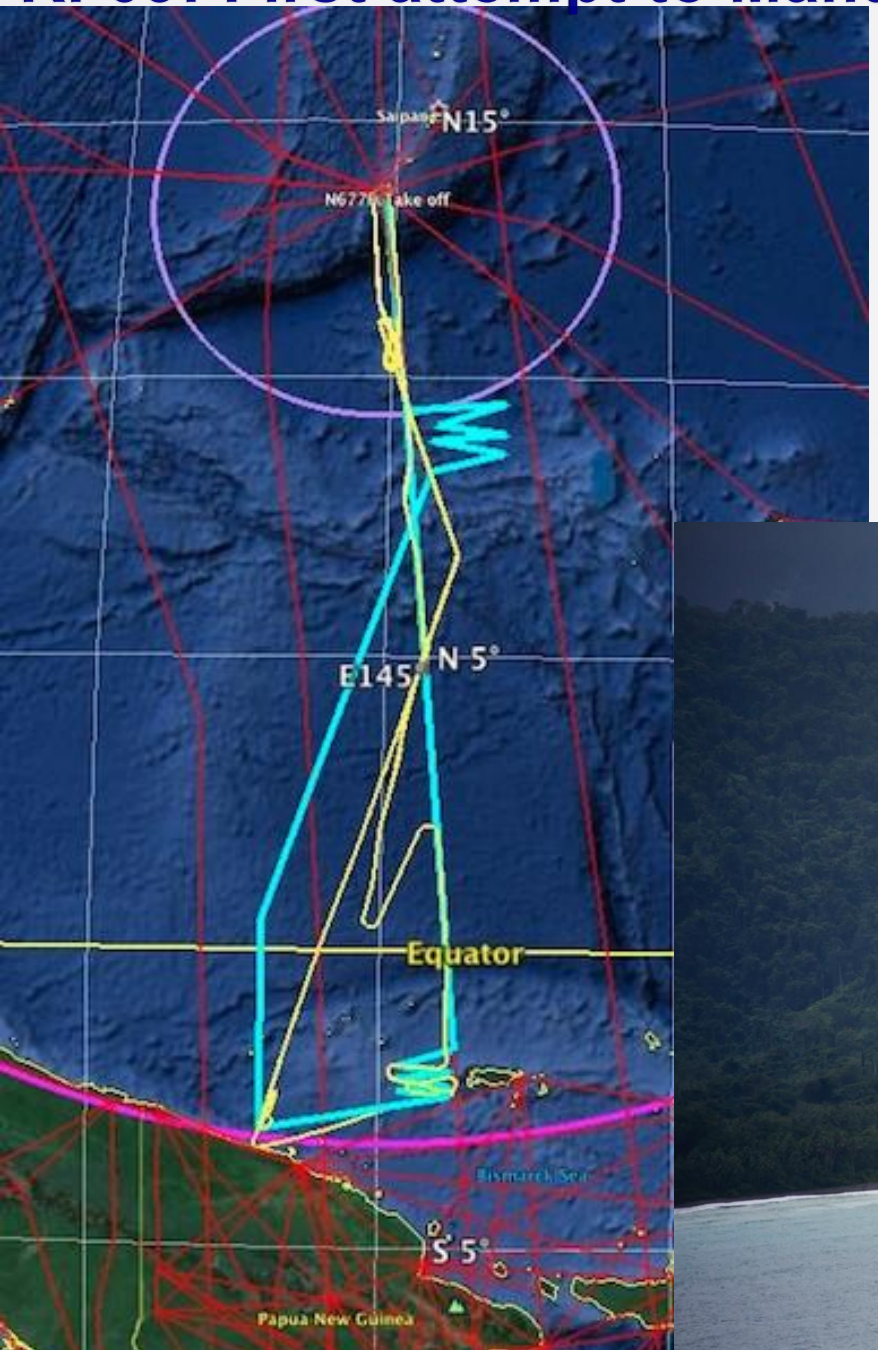
(in the environment of potentially extremely low ozone)





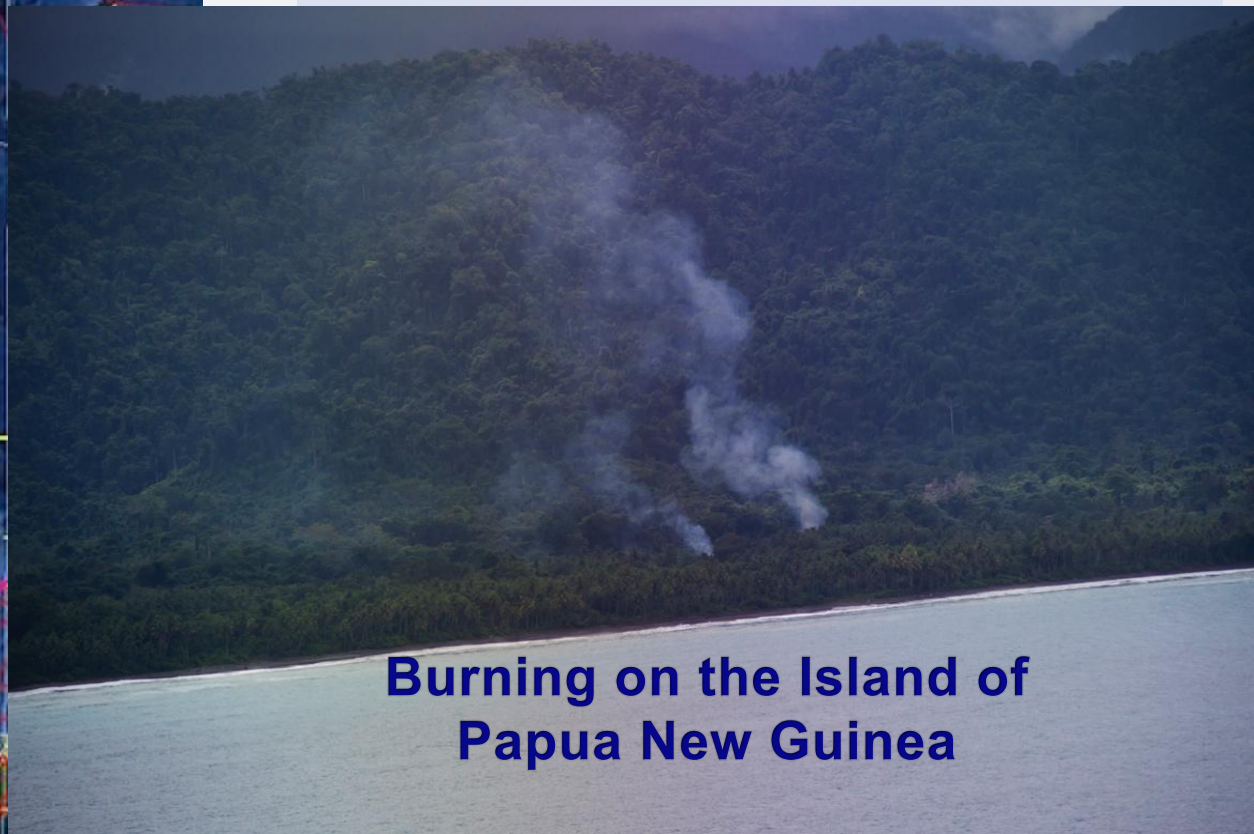
Vaughan et al.

RF09: First attempt to Manus Island over fly



300 ft ASL near the shore of PNG

MBL of strong gradient of chlorophyll

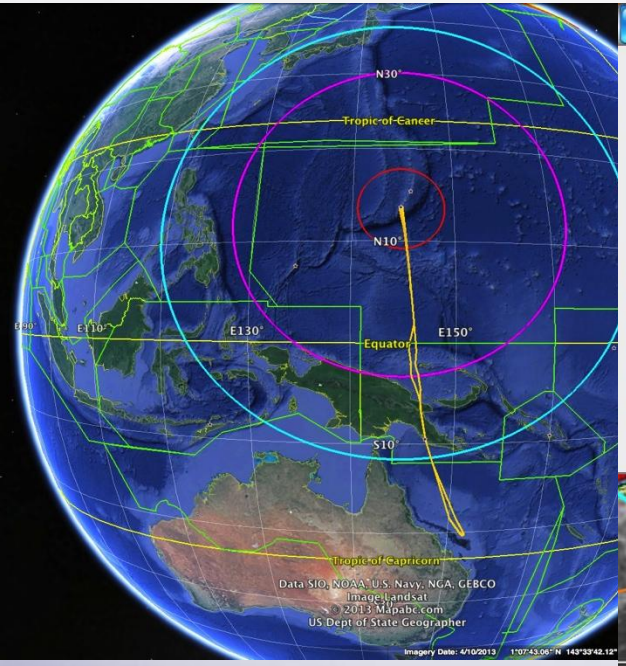


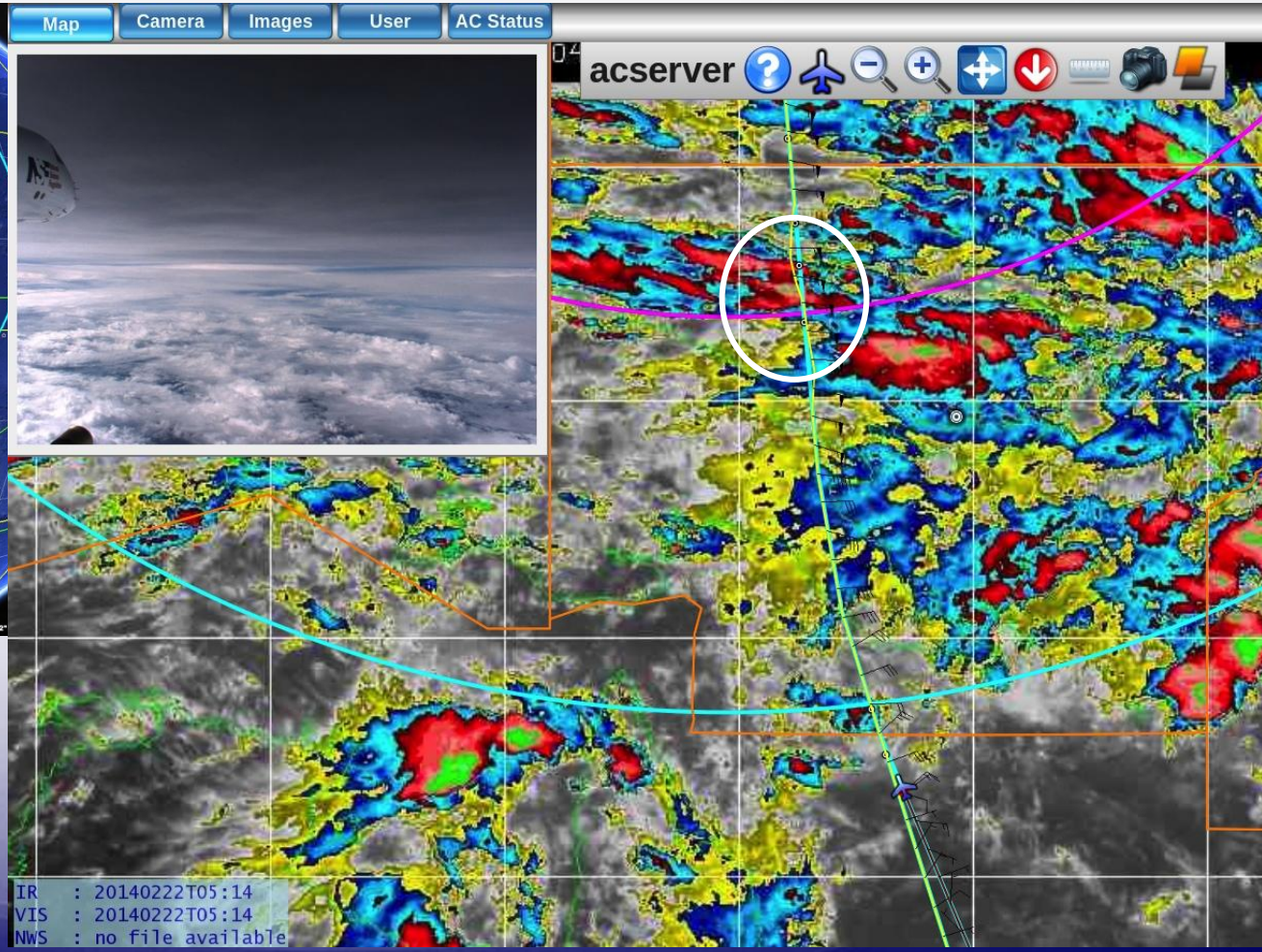
Burning on the Island of Papua New Guinea

Hot Research Topics in Progress (6):

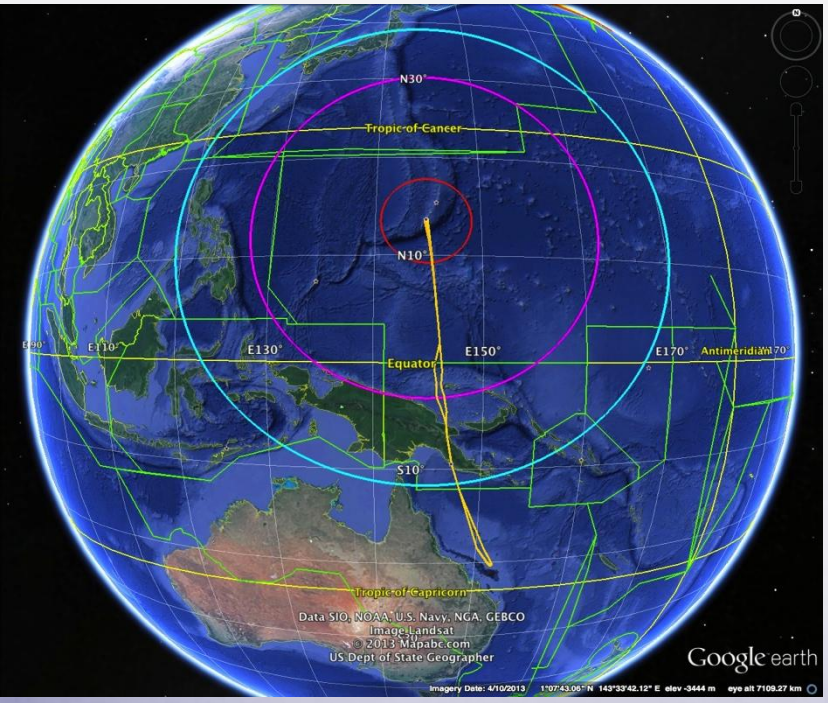
What can we learn about the uncertainty of ozonesonde measurements using co-located GV data ?

Second attempt of Manus Overfly – under active convective conditions





RF14: Co-located GV profile w. the ozonesonde profile from Manus Island



PALT

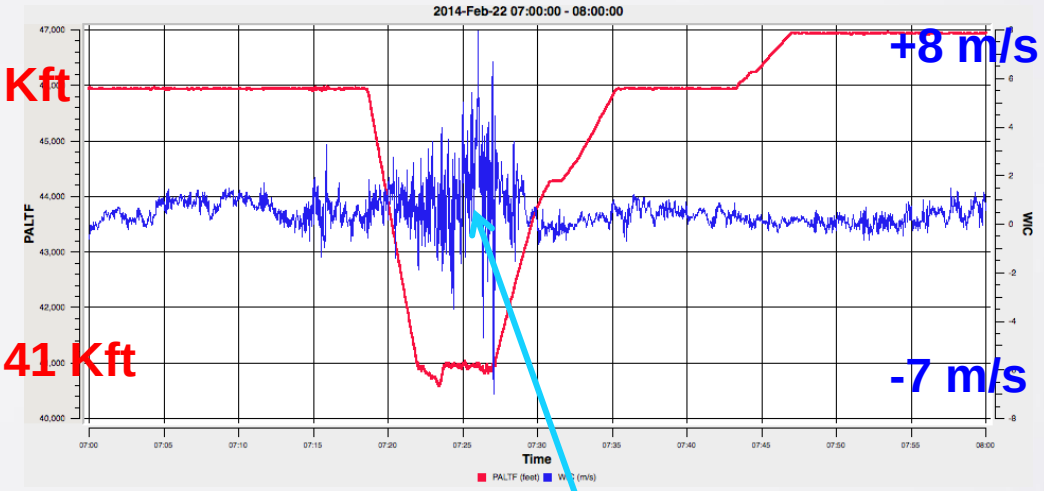
45 Kft

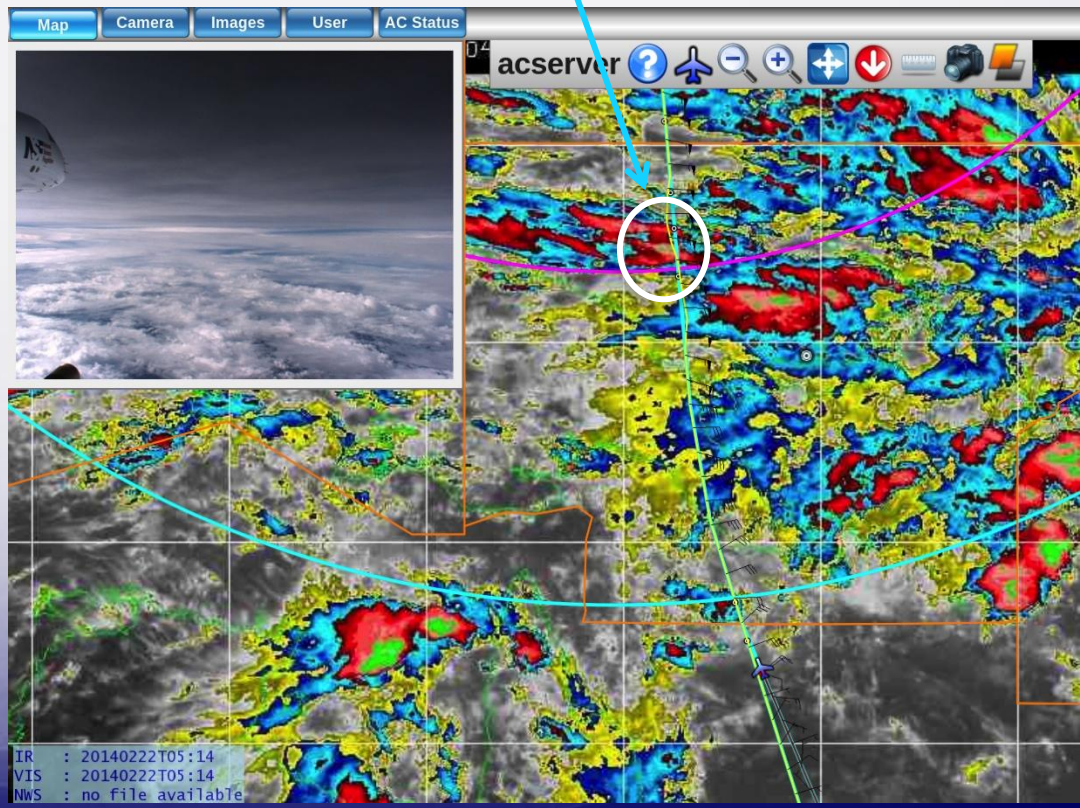
41 Kft

WI

+8 m/s

-7 m/s





We look forward to hearing all the analyses and modeling in progress…

GV fuelling before leaving Guam

Photo by Elliot Atlas

Thank You!

GV overfly Guam at 47Kft

Photo credit: Shawn Honomichl