Science Overview

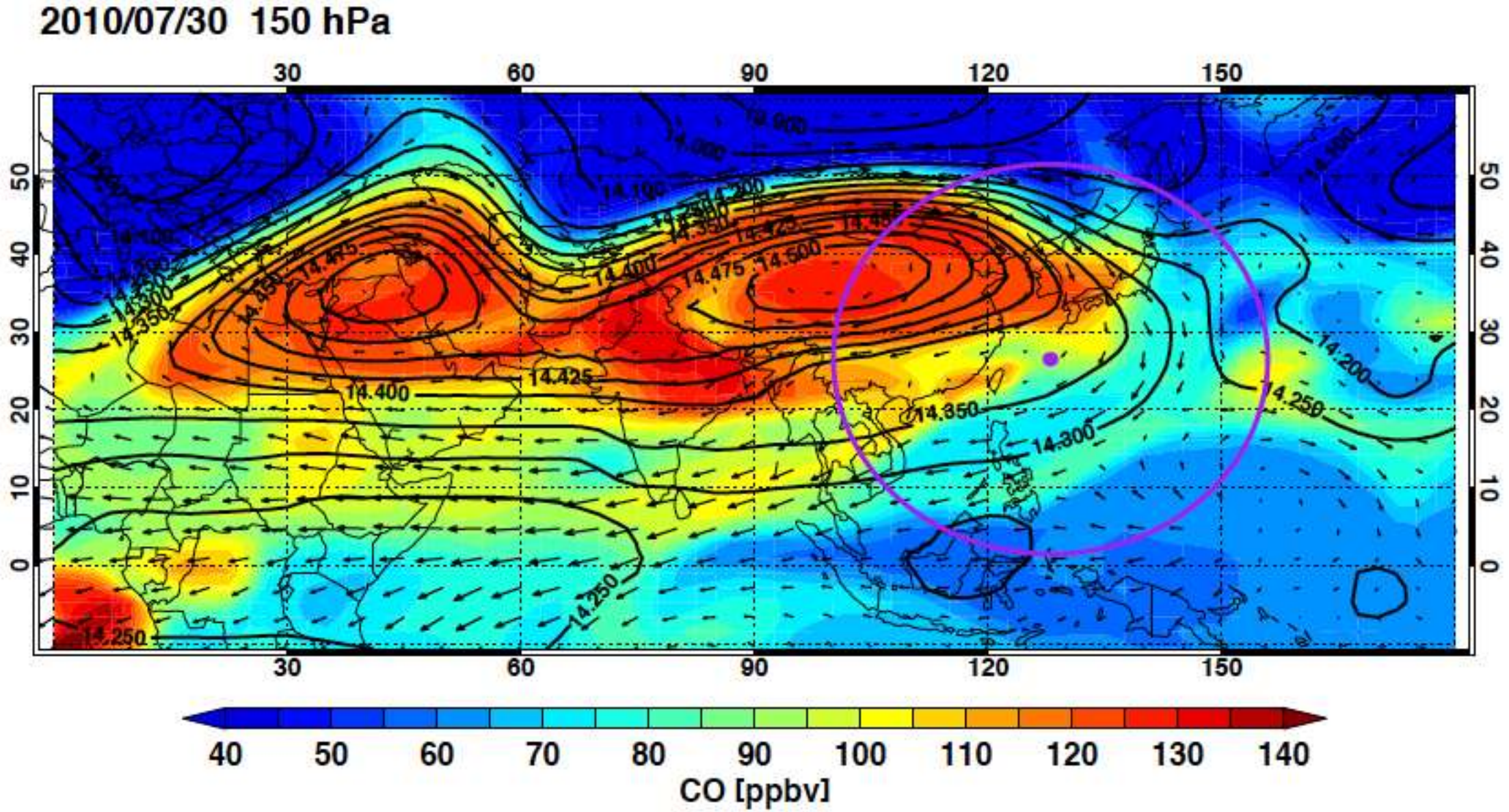
Asian Summer Monsoon Chemical and Climate Impact Project (ACCLIP)

Co-Principal Investigators: Laura Pan (NCAR), Paul Newman (NASA)
Co-Investigators: Elliot Atlas (Univ. Miami), William Randel (NCAR), Brian Toon (CU)

Location: Western Pacific (Flight Operations from Japan)
Dates: July 15 – August 31, 2019
Facilities requested: GV
(To be operated together with NASA WB-57 research aircraft)

Background of the ASM experiment planning

- SEAC4RS, 2010-2012, NASA DC-8 and ER-2 + NSF GV, Thailand Base, cancelled April 2012
- StratoClim, 2015-2017, Geophysica, Indian sub-continent base, delayed twice, back up base in the Middle East, 2017 flight TBD
- OMO campaign, HALO (DLR GV), thee bases: Oberpfaffenhofen (Germany), Paphos (Cyprus) and Gan (Maldives).


2010/07/30 150 hPa
30
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120
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14.250
14.300
14.350
14.400
14.425
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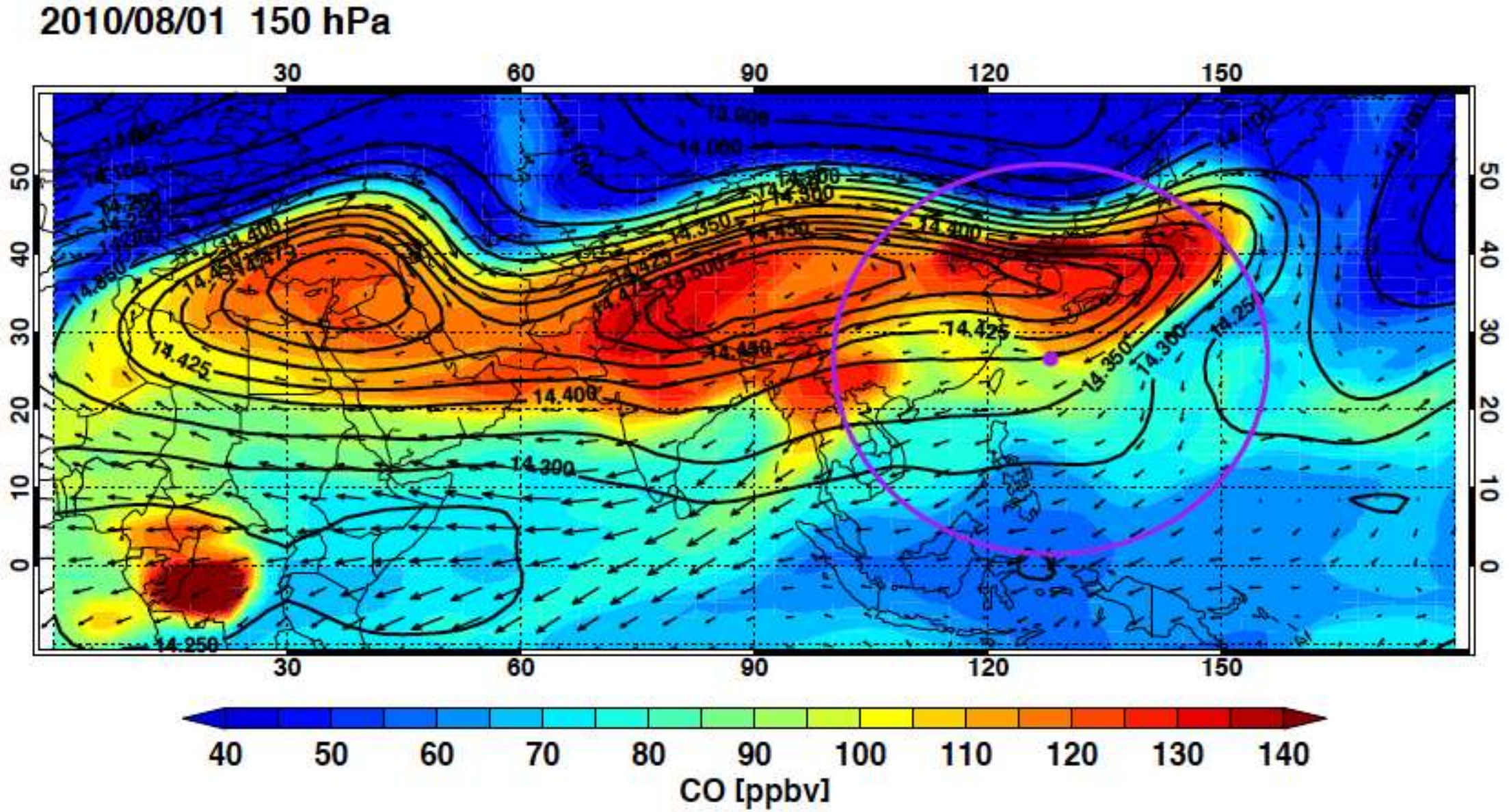
140
CO [ppbv]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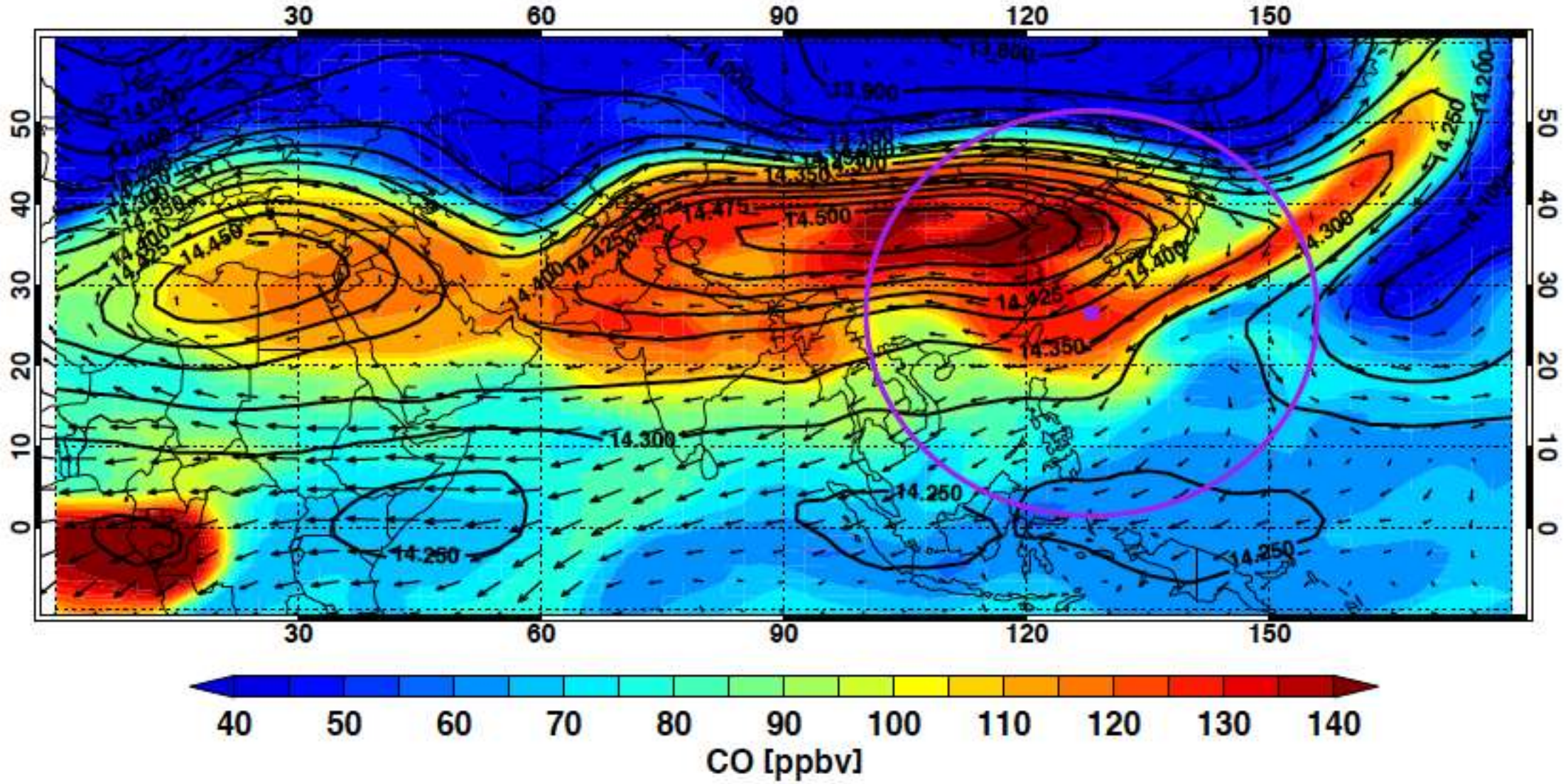
CO [ppbv]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14.500
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14.425
14.400
14.375
14.350
14.325
14.300
14.275
14.250
14.225
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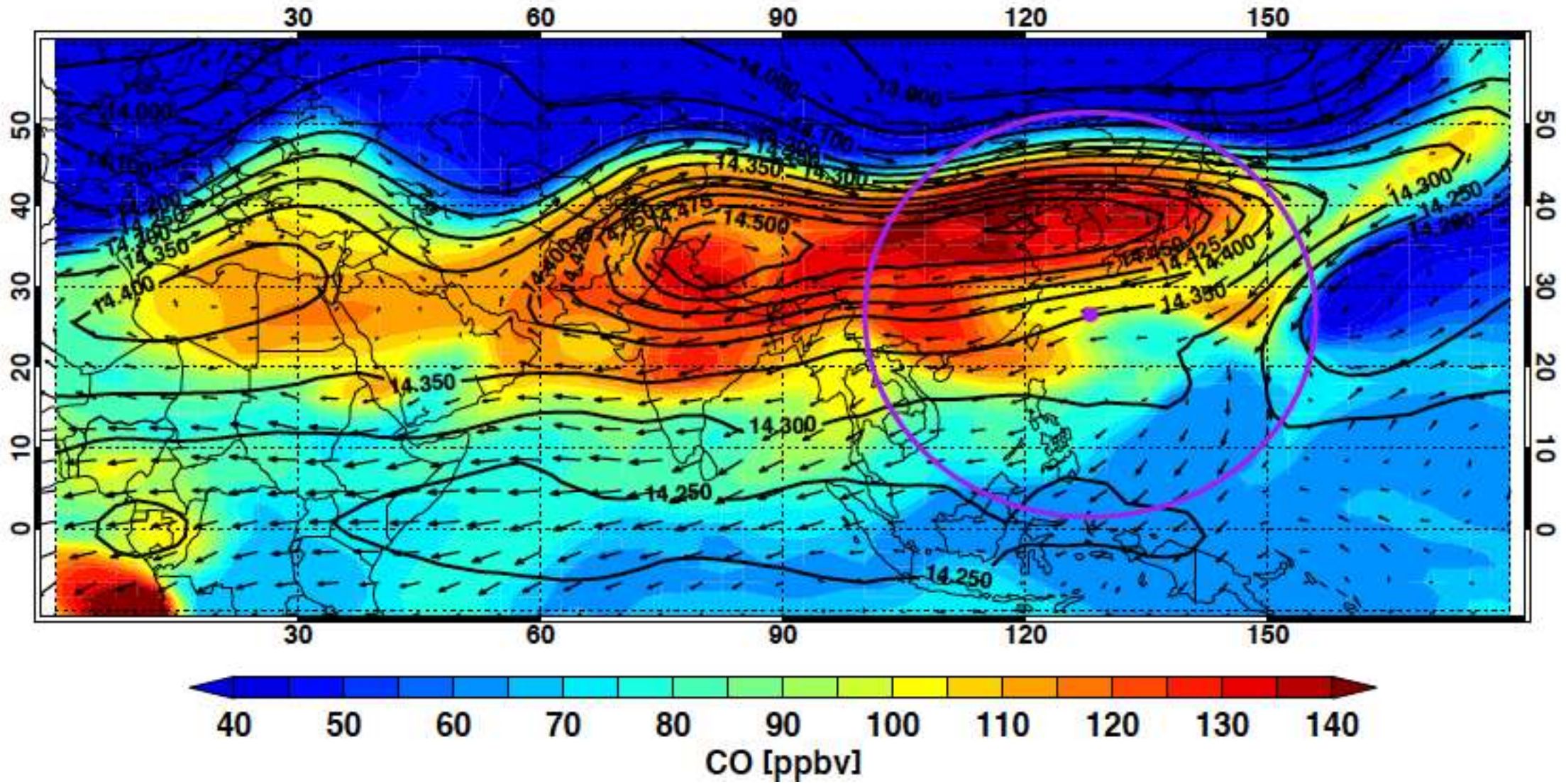
CO [ppbv]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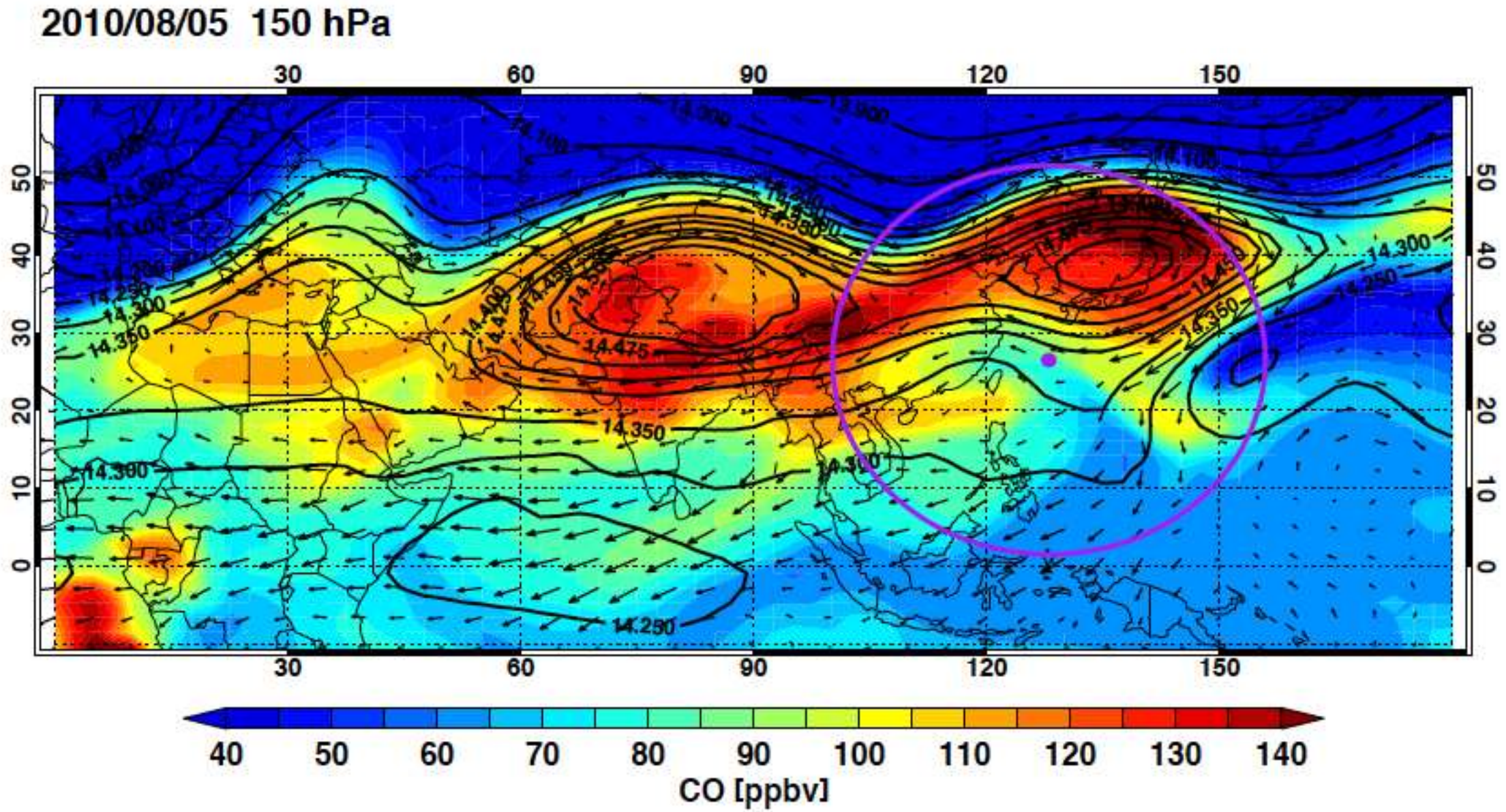
CO [ppbv]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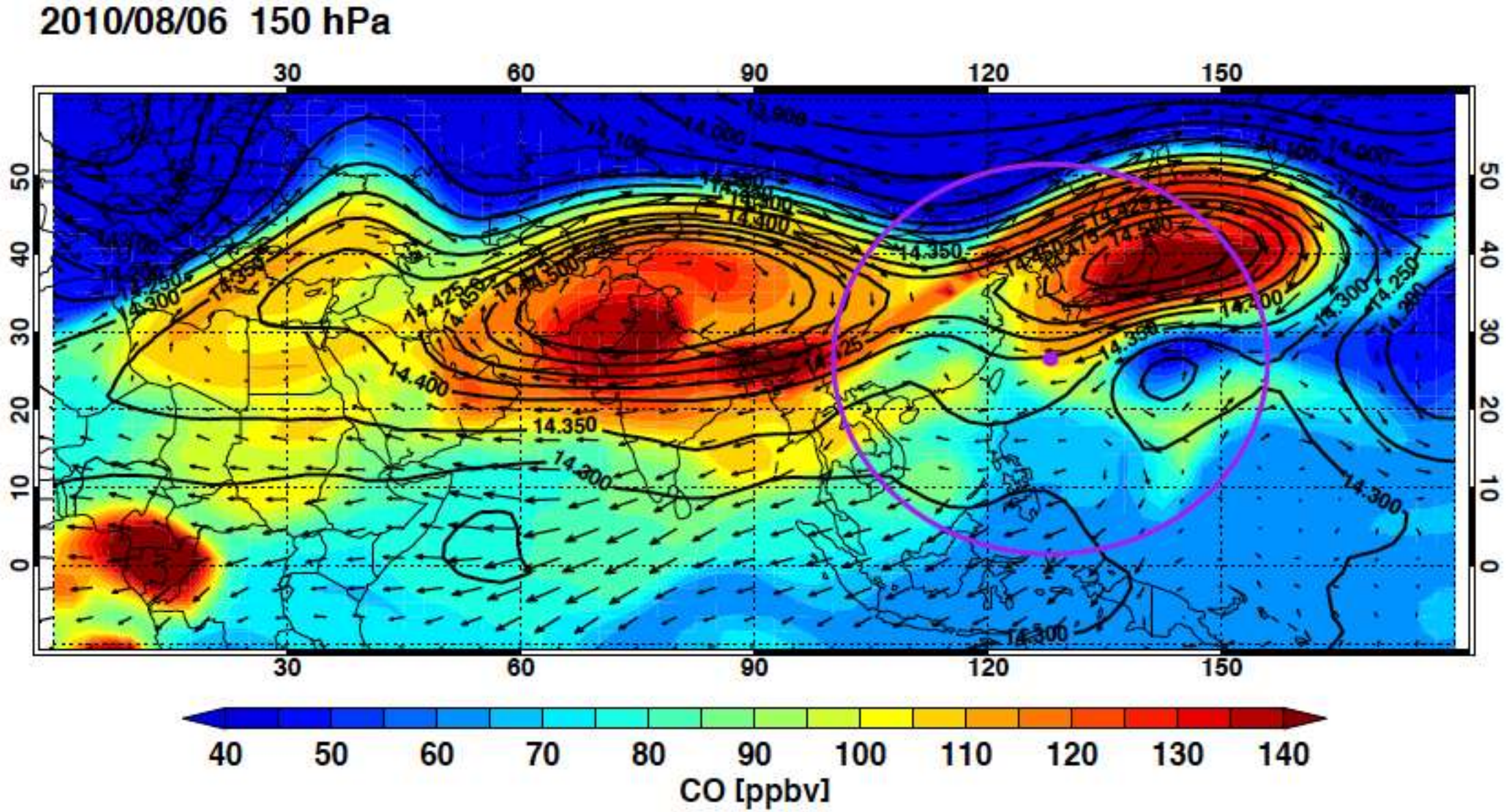
CO [ppbv]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14.350
14.400
14.300
14.250
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70
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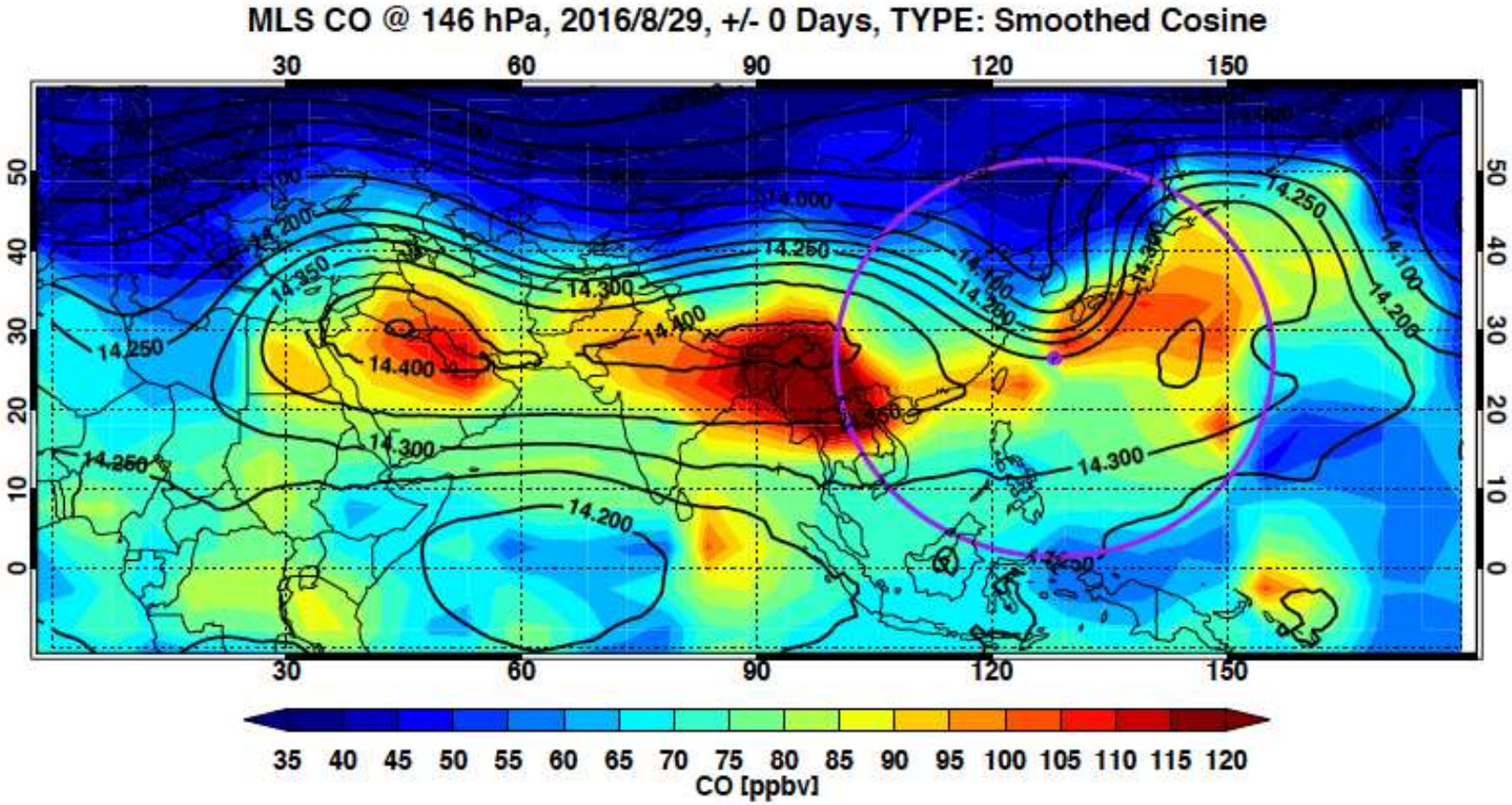
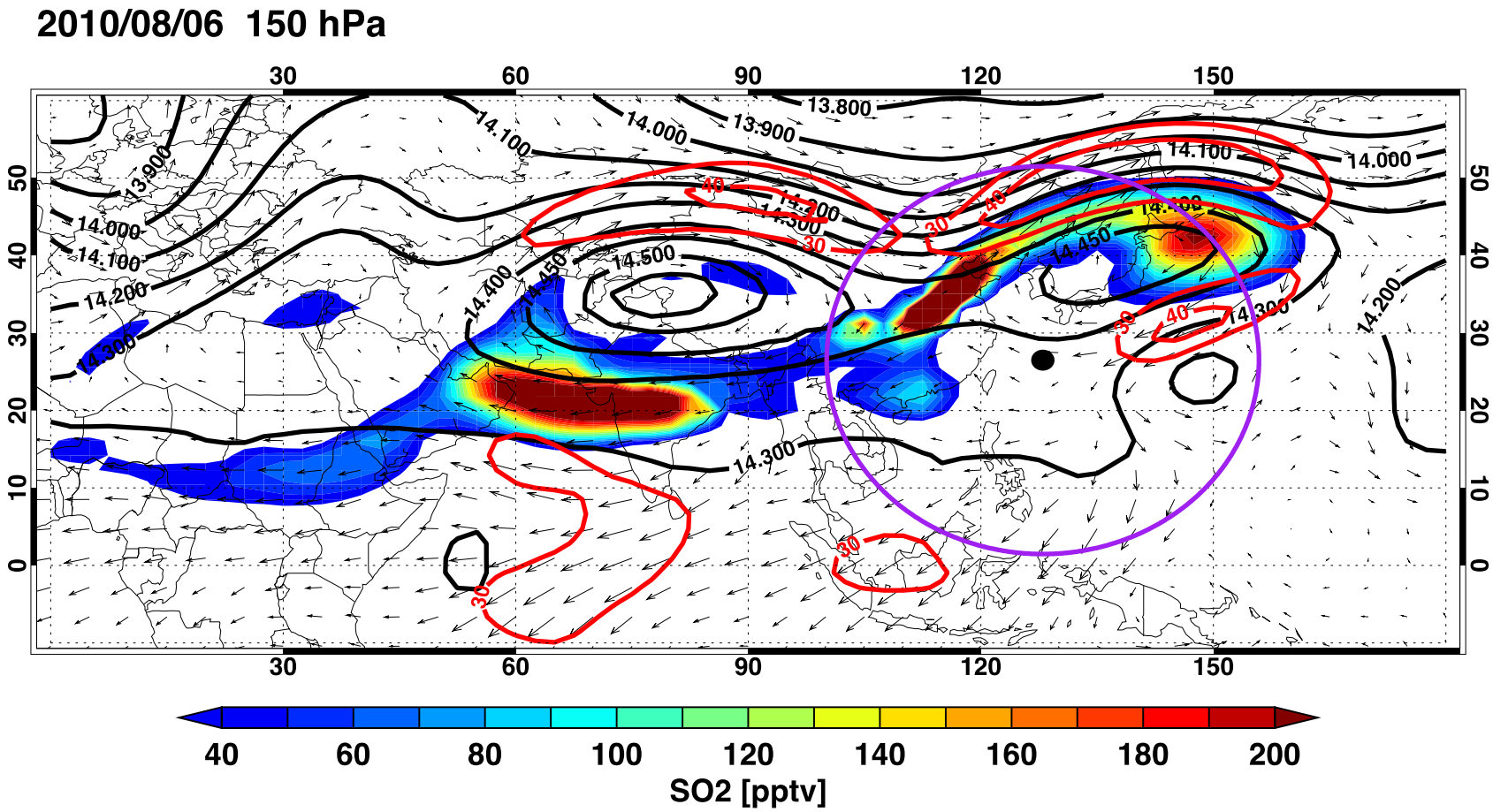
90
100
110
120
130
140
CO [ppbv]

Is the tracer signature in Western Pacific mode observed?



WACCM – SO2


2010/08/06 150 hPa
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14.450
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180
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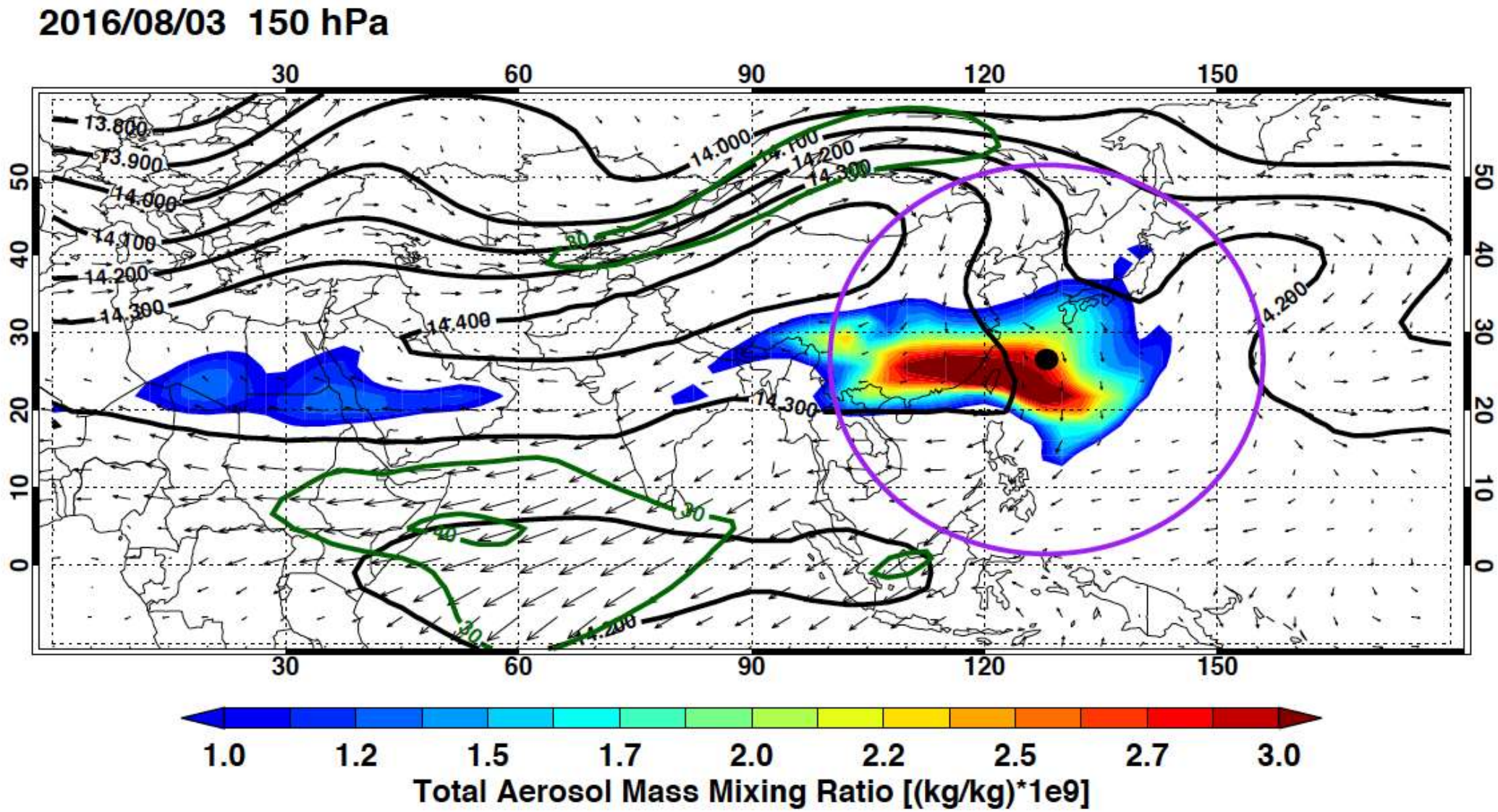
SO2 [pptv]


2016/08/03 150 hPa
30
60
90
120
150
0
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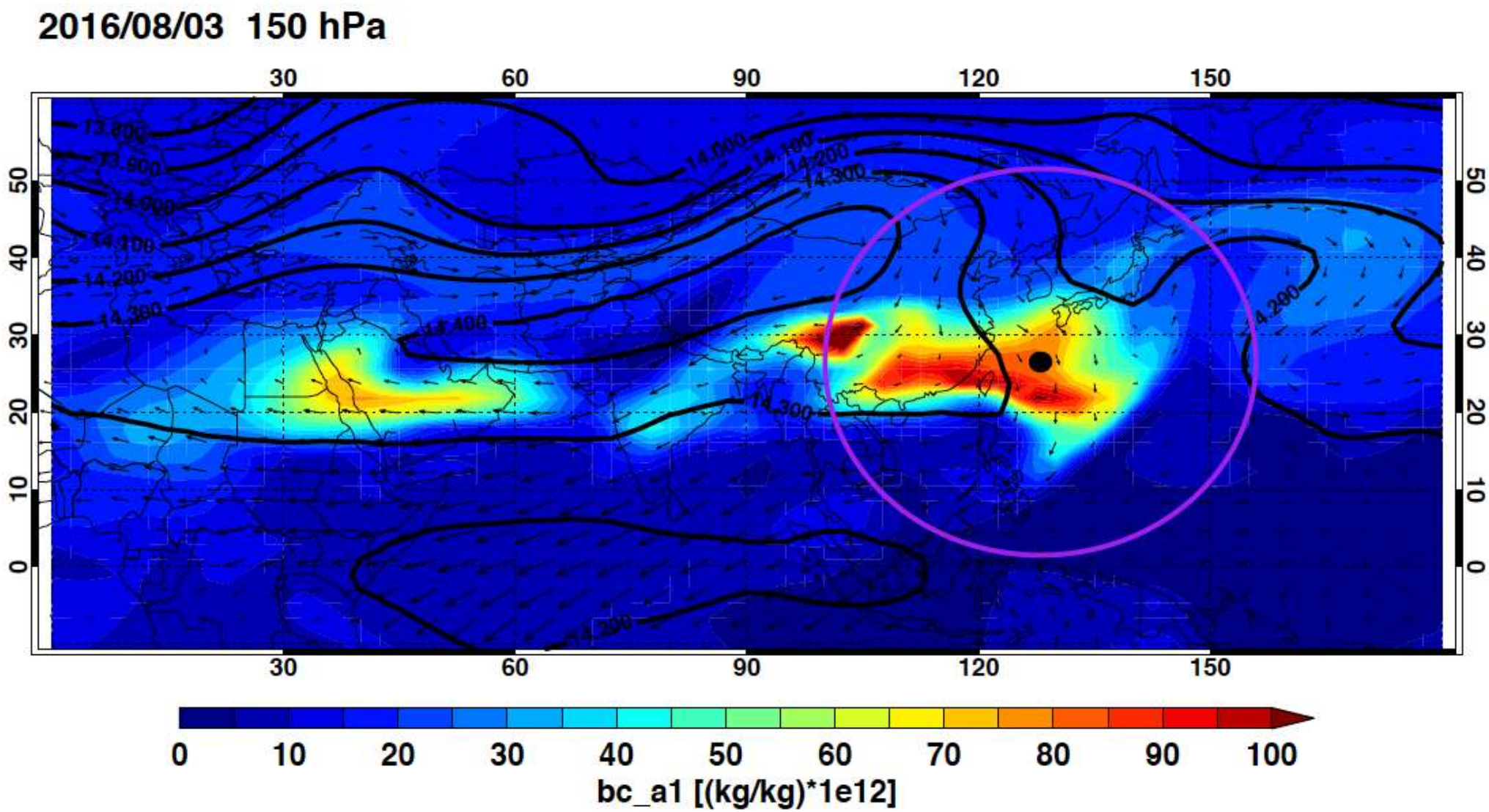
20
30
40
50
13.800
13.900
14.000
14.100
14.200
14.300
14.400
1.0
1.2
1.5
1.7
2.0
2.2
2.5
2.7
3.0
Total Aerosol Mass Mixing Ratio [(kg/kg)*1e9]


2016/08/03 150 hPa
30
60
90
120
150
0
10
20
30
40
50
13.800
13.900
14.000
14.100
14.200
14.300
14.400
0
10
20
30
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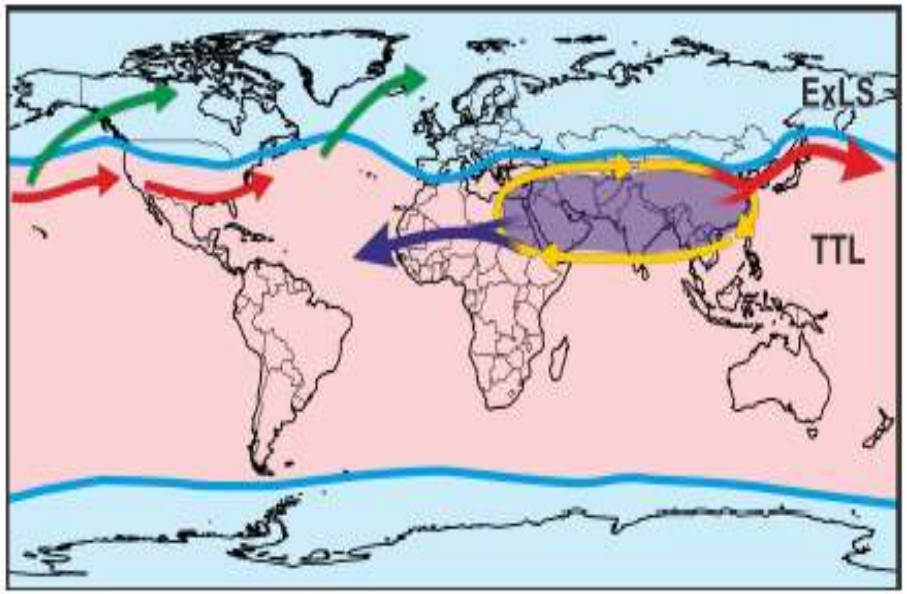
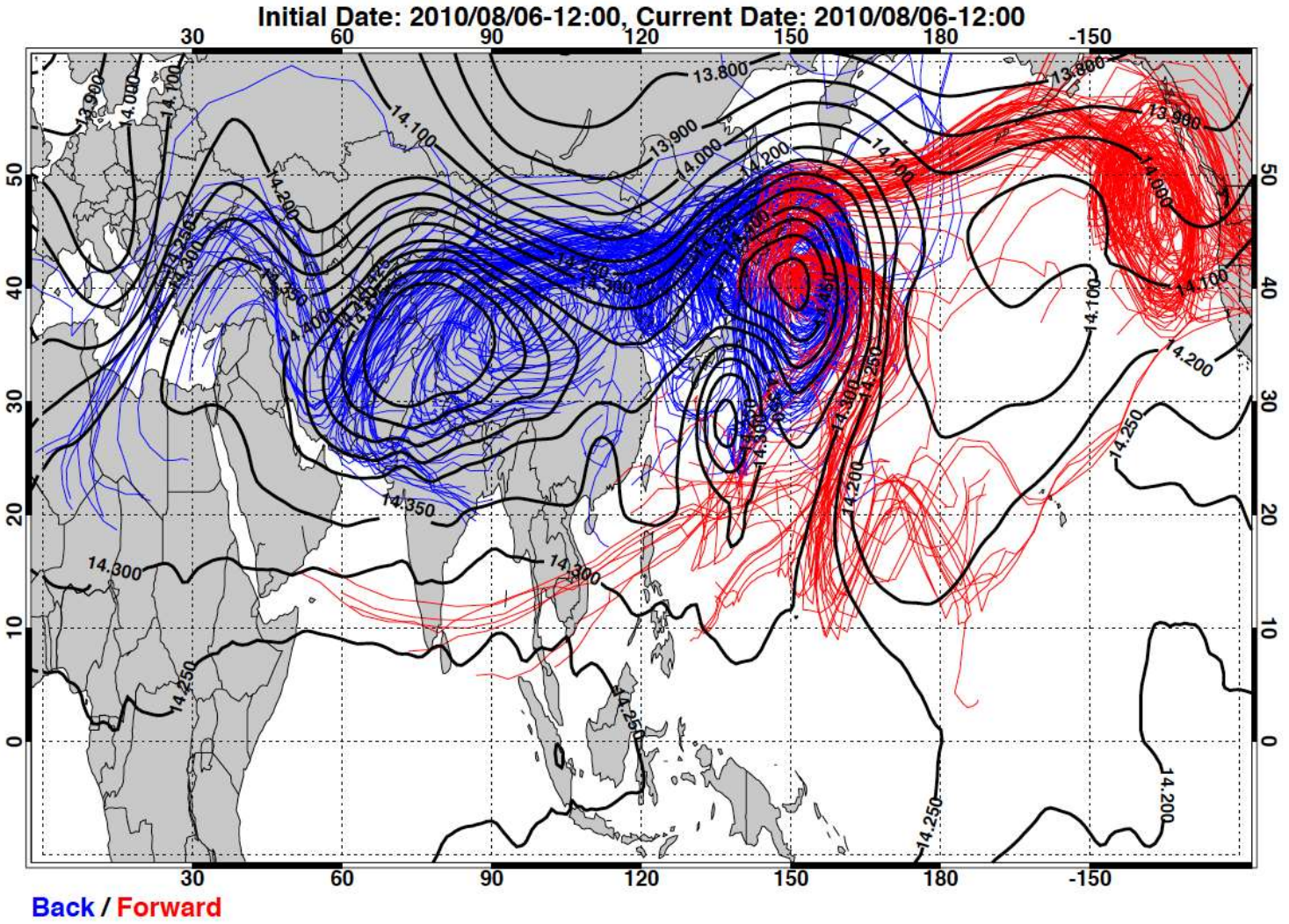
50
bc_a1 [(kg/kg)*1e12]

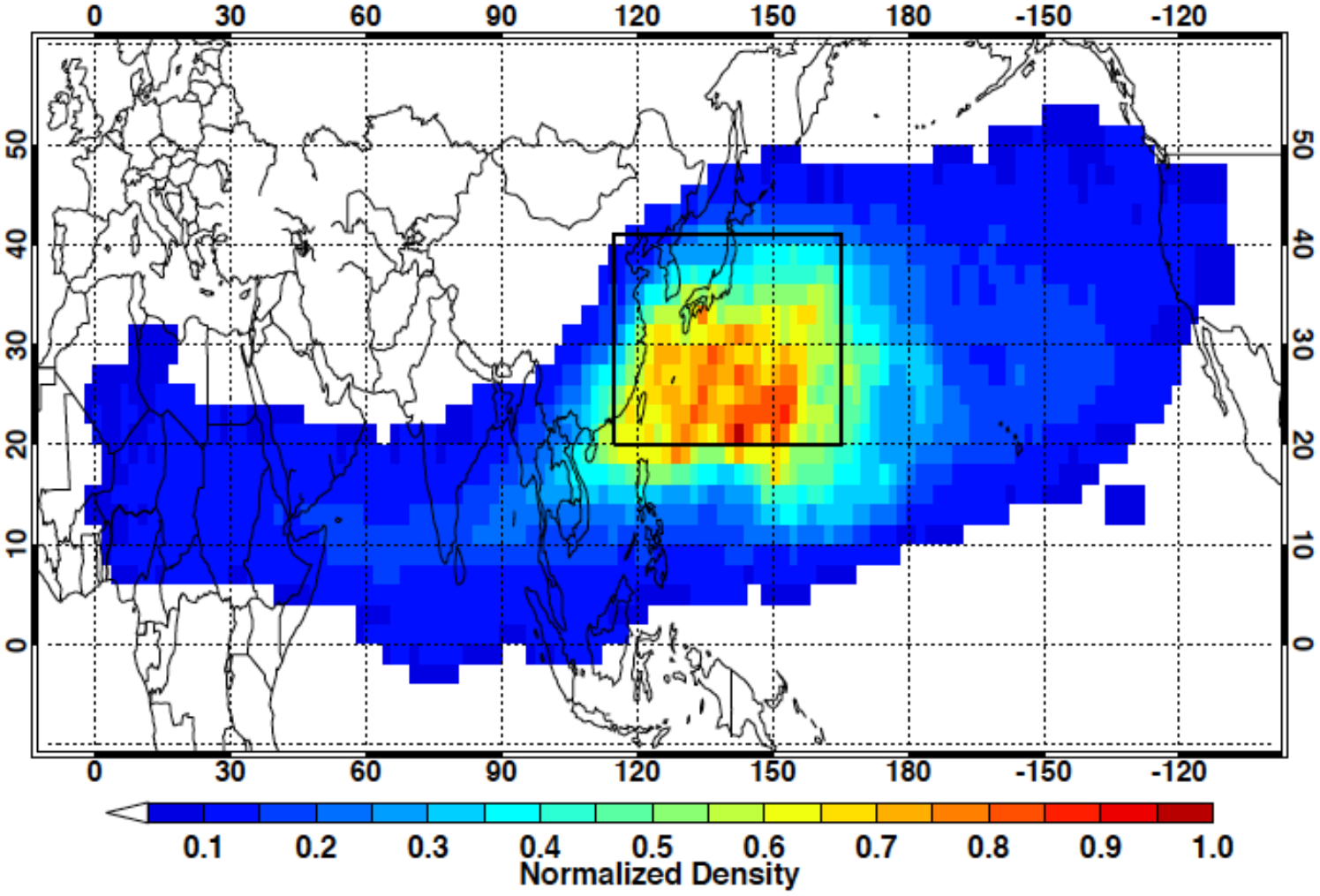
What do we target transport pathway exiting the Bonin High?



Vogel et al., 2016



“Parcel density” from 10-day forward trajectories



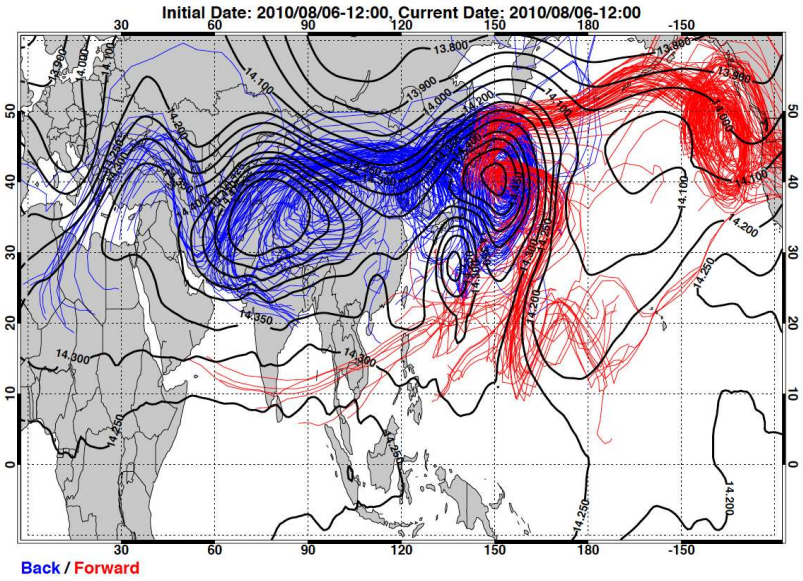
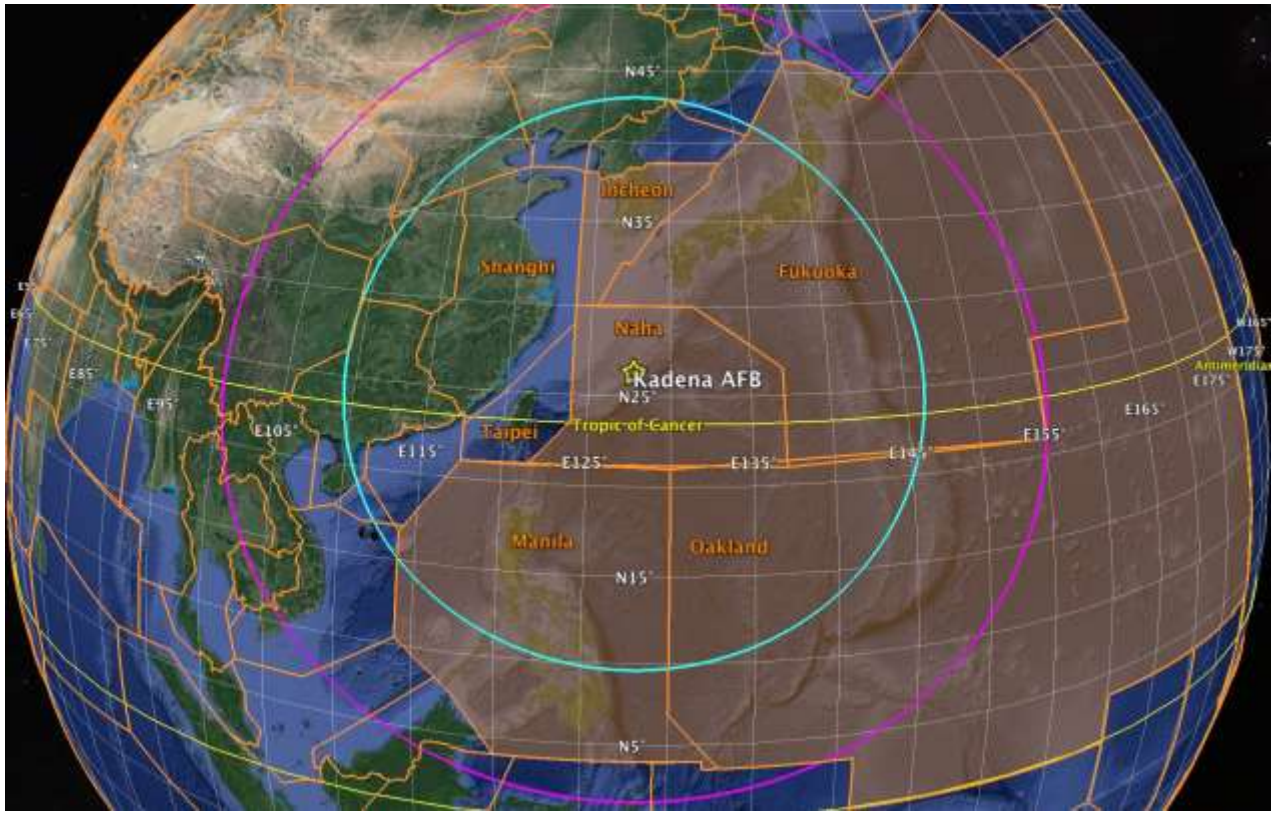


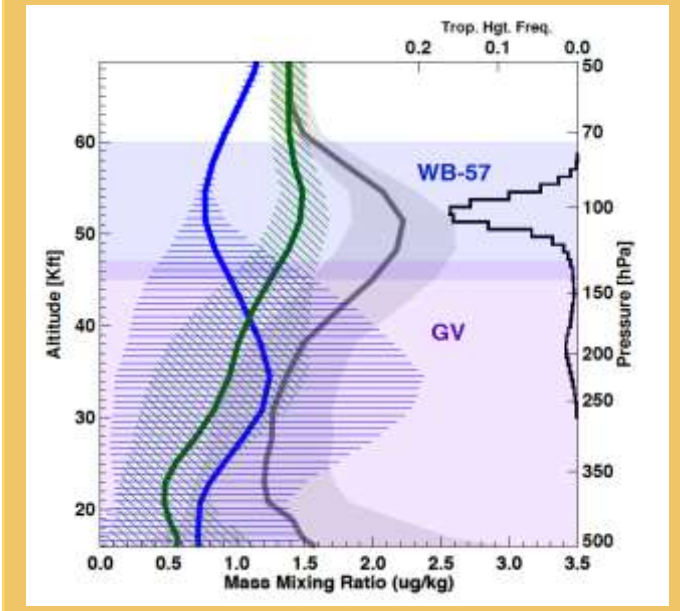
Figure 11. *10-days forward trajectory parcel density for ~ 50 cases from 2005-2016. The trajectory parcels are initiated at 150 hPa near the center of the Bonin High (all cases are initiated in the black square). The normalized density is calculated from the distributions of parcel positions at each hour for the 240 hours in 2x2 degrees latitude-longitude grids.*

Map of Operations



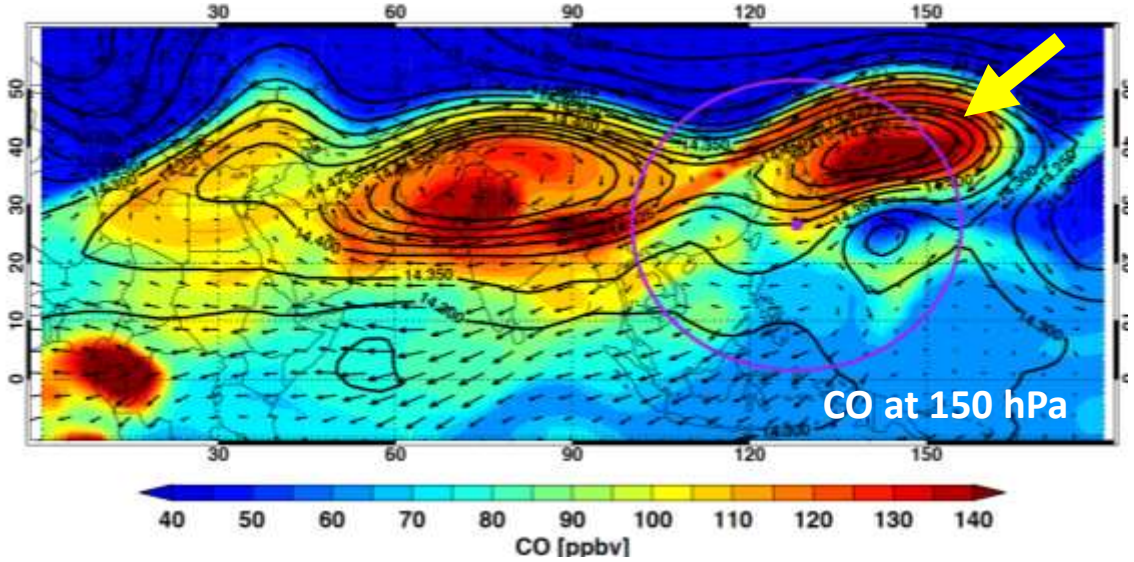
- **Okinawa is a possible base of operation. Other possible bases tbd after site surveys**
- **Five Flight Information Regions (FIRs): Naha (JPN), Fukuoka (JPN), Oakland Oceanic (USA), Incheon (KOR) and Manila (PHL).**
- **Nominal flight ranges of the GV (purple) and WB-57 (cyan)**

Conceptual roles of the two aircraft



- Aerosol mass mixing ratios from 3 model runs (colored profiles with uncertainties)
- Tropopause height distribution (right axis)
- Vertical sampling ranges of the two aircraft (shaded regions)

Example of shedding event for target sampling



Platforms and Instruments

The GV payload emphasizes:

- detailed atmospheric composition and photochemistry for gases
- the size distribution and chemical composition of the aerosols
- cloud microphysics

The WB-57 payload is comparable to the GV and is in the process of being further developed

	GV			WB-57		
Measurements	Instrument source	Requirement	Objec-tives	Instrument source	Requirement	Objec-tives
O_3	FASTO3	1 ppbv, 1 s	1, 2	UAS-O3	1 ppbv, 1 s	1, 2
NO_x	Chemiluminescence NO-NO2	<10 pptv, 1 s	1, 2	-	-	-
CO	Aero-Laser-5002 VUV (Campos)	5 ppbv, 10 s	1, 2	Picarro	3 ppbv, 10 s	1, 2
CO_2, CH_4	Picarro	0.3 ppmv; 5 ppbv, 10 s	1, 2	Picarro	0.04 ppmv; 0.25 ppbv; 2.5 s	1, 2
H_2O vapor	VCSEL	1-1000 ppmv, 1 s	1, 4	NOAA Water & DLH	1-1000 ppmv, 1 s	1, 4
Black carbon	SP2	0.5 ng/m^3, 10 s	1, 3	SP2	0.5 ng/m^3, 10 s	1, 3
SO_2	CIMS	10 pptv, 1 s	1, 3	LIF-SO2	2 pptv, 10 s	1, 3
Particle size distribution	UHSAS	0.1-1 µm	3	NMASS, FCAS, POPS	4 - 60 nm, .07 -1 mm, 0.14 - 2 µm	3
Aerosol composition	AMS, and single particle by laser ablation (ALABAMA)	<0.5 µg m^{-3} mass concentration, 30 s	3	PALMS	>1Hz at 0.1 µm^3 cm^{-3}	3
NMHC, HCFCs	AWAS	Low ppt levels	1, 2	WAS	Low pptv levels	1, 2
VOCs, OVOCs	TOGA (Apel)	Low ppt levels	1, 2	-		
HCHO	-	-		CAFE	50 pptv, 10 s	1, 2
Actinic flux	HARP	-	2	-		
State parameters	GV Facility	-	All	MMS	-	All
Cloud microphysics	2DC, CDP	-	1, 3, 4	-	-	
Temperature profile	MTP	-	1	-	-	

Project Goals, Objectives & Hypotheses

Primary Goal: **To investigate the impacts of Asian gas and aerosol emissions on global chemistry and climate via the linkage of Asian Summer Monsoon (ASM) convection and associated large-scale dynamics**

Scientific Objectives: Obtain a comprehensive suite of dynamical, chemical and microphysical measurements in the region of ASM anticyclone to address:

1) the transport pathways (vertical range, intensity, and time-scale) of the ASM uplifted air from inside of the anticyclone to the global upper troposphere and lower stratosphere (UTLS)
2) the chemical content of air processed in the ASM for UTLS ozone chemistry, and short-lived climate forcers
3) the information on aerosol size, mass and chemical composition for determining the radiative impact
4) the water vapor distribution associated with the monsoon dynamical structure

Hypotheses:

1) The western Pacific region is a major path of ASM UTLS outflow
2) The ASM outflow has a distinct chemical signature of trace gases that reflects the combination of surface sources, convective pumping and subsequent photochemical processing.
3) Air masses associated with the ASM anticyclone will have enhanced aerosol loadings with increased organic carbon and sulfate concentrations
4) The ASM anticyclone provides a pathway for air with higher moisture to enter stratosphere, bypassing the cold tropical tropopause