CSIRO Collaborative GHG Observation Programs Southeast Asia-Australia Regional Network

The 2nd International Workshop
on Atmosphere Watch in Asia
-GHG Monitoring Activities

21-22 Oct 2010
Korea

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Outline of today's talk

- CAWCR/CSIRO GASLAB background
- Importance of tropics in global (and regional) climate
- Southeast Asian – Australian regional tropical observation network
- Bukit Atur Danum Valley GAW station
- New pilot Australian Tropical Atmospheric Research Station (ATARS)

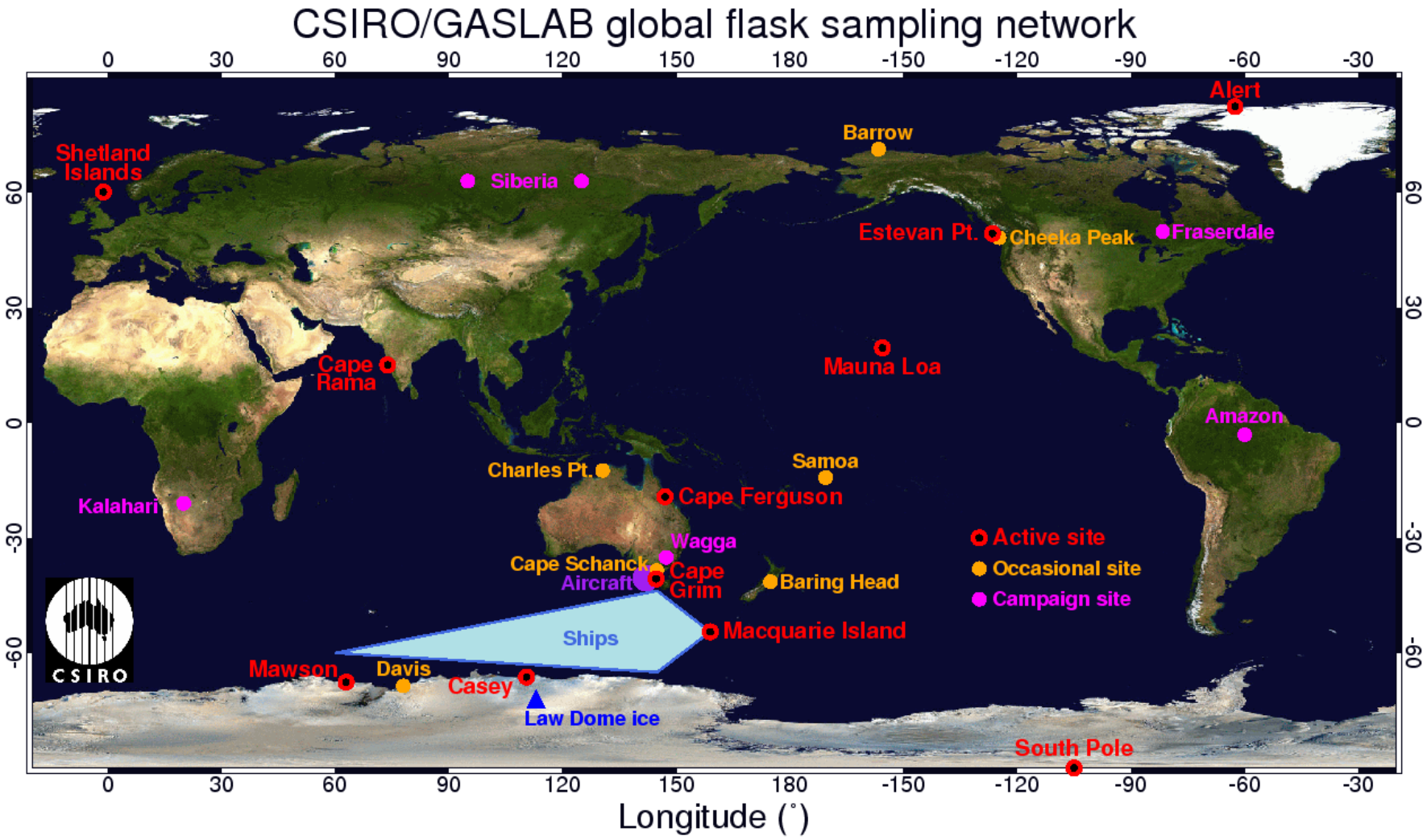
CAWCR/CSIRO Marine & Atmospheric Research - GASLAB team

- Formed 1990
- Following long term CO_2/$^{13}CO_2$ monitoring and ice core work
- Currently:
  - 4 Research scientists
  - 1 Retired fellow
  - 5 Project scientists
  - 4 Post-doctoral fellows
  - 1 PhD student
  - 3 Technical support

GASLAB research priorities

- Understand causes of atmospheric change over 10s and 1000s year time scales
- Climate forcing & stratospheric O_3 depletion
- Antarctic & Greenland ice core air, firn air (ICELAB)
- Cape Grim Baseline Air Pollution Station (GAW/AGAGE)
- Global/regional operational air sampling network
- Cape Grim Air Archive (since 1974)
- Multi gas species measurements and modelling
- Improve predictive capability (model development/validation)
- Development of next generation GHG measurement techniques (LoFlo, O_2/N_2, application of Valco PDHID universal GC detectors, application of CRDS)

CMAR GASLAB global flask sampling network



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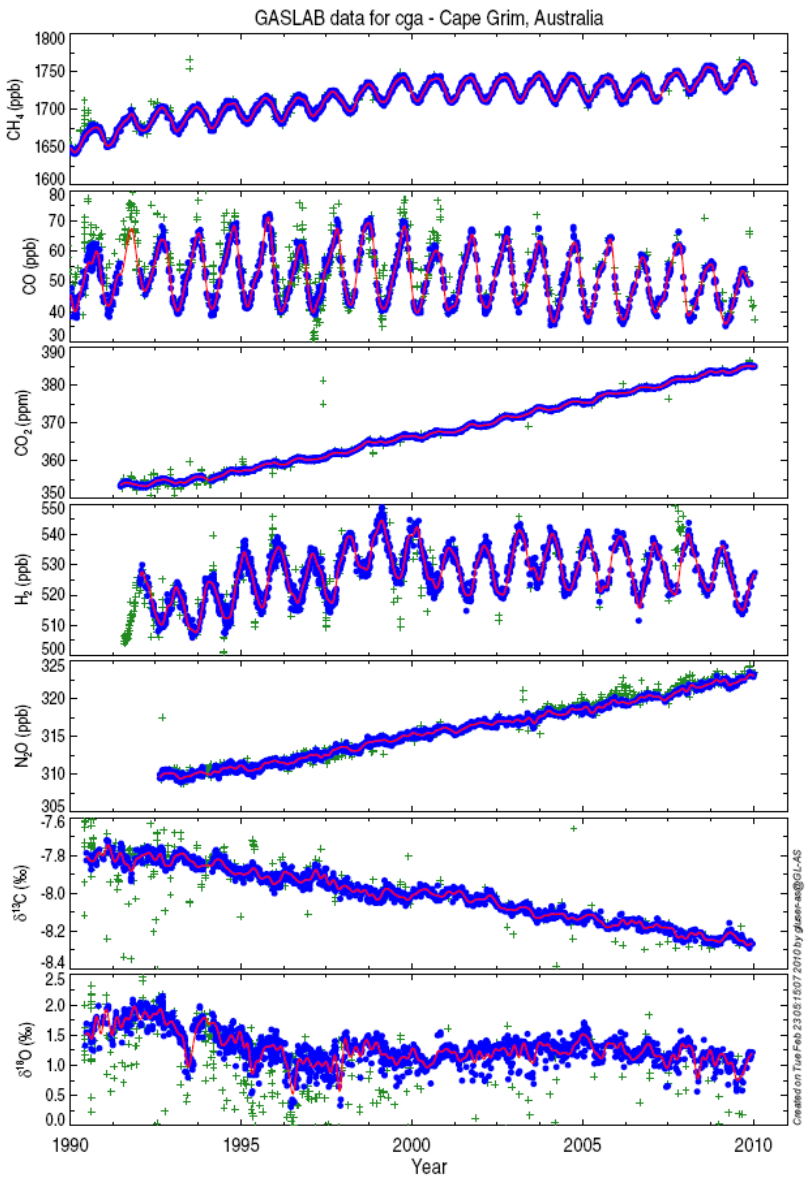
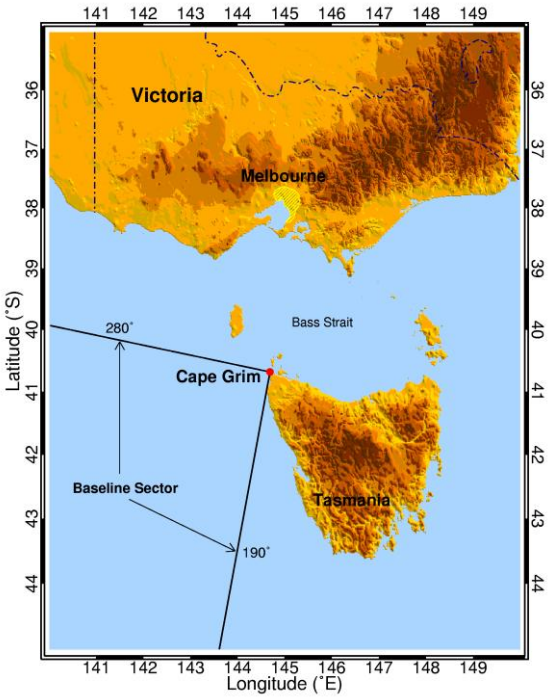
Cape Grim GAW Station





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Global Distribution of Atmospheric Carbon Dioxide

CSIRO Marine and Atmospheric Research - GASLAB

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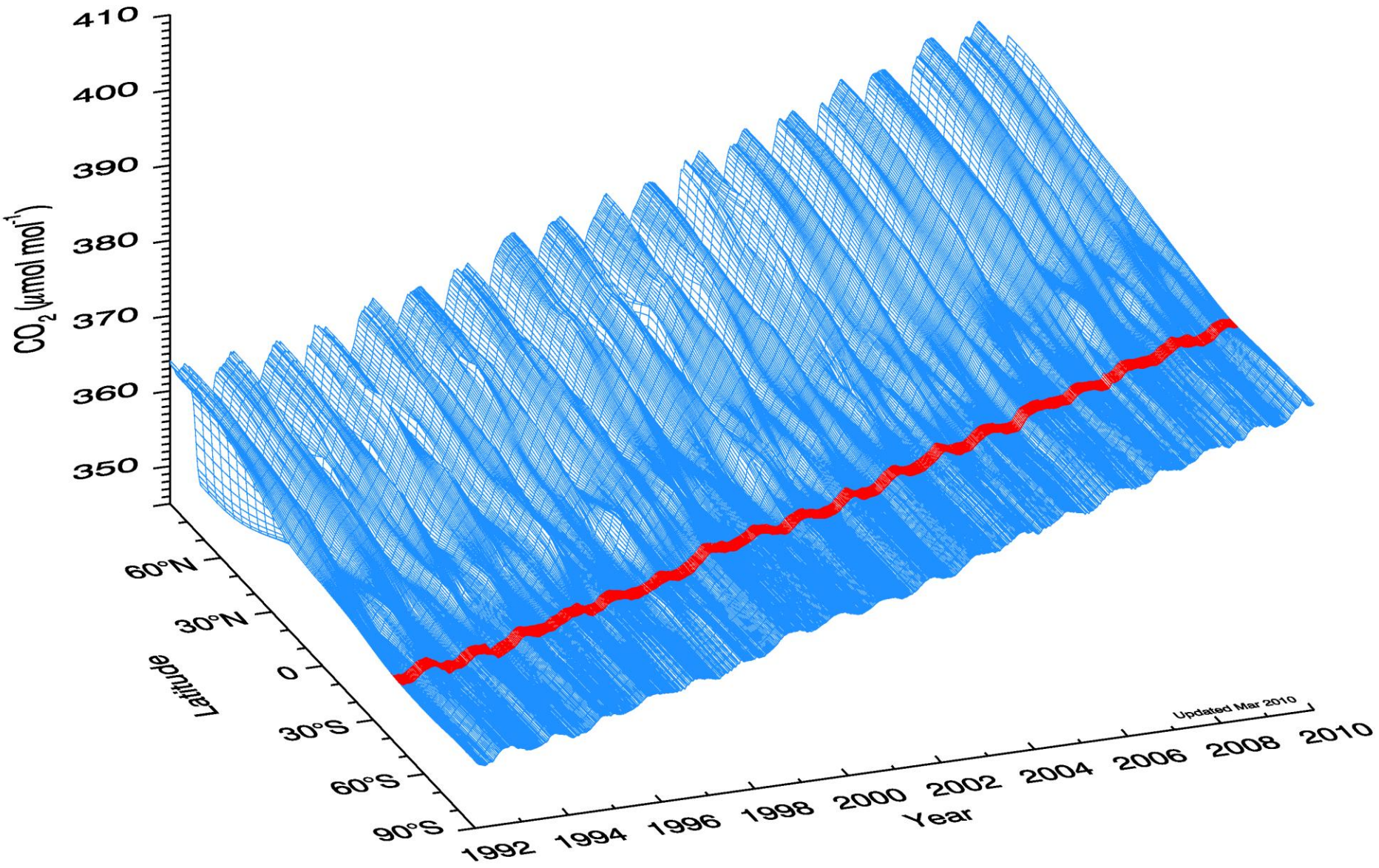


Why are tropics important?

Tropics play a major role in global climate processes (not well defined):

- Home to ~1/2 of global population & rapid development (eg. India & China)
- ~80% global biomass burning
  - 20% total global GHG emissions (mainly CO_2)
  - major source of 'anthropogenic' aerosol (global climate feedbacks)
  - ~ 13 – 40% of global CO_2 from 1997 El Nino Indonesian fires (Page, 2002) (~1Gt Carbon)
- substantial terrestrial CO2 sink (Stephens et al, 2007)
- ~50% of global wetlands
  - Indonesia alone has 4th largest peatland area in world (30-40 MHa) (~10-12% of total) (Page, 2002)
  - 50% of global sources of CH_4 (rice, wetlands, biomass burning)
- ~80% of global sources of N_2O (25% of which is from Asian tropics) *(*Huang *et al,* 2008)
- ~75% of global sources & 60% global sinks H_2 (Xiao *et al*, 2007)
- Short-lived halocarbons

- Tropics are a critically under-sampled region
  - Only 1 global tropical GAW station matches GLOBALVIEW CO2 criteria (Samoa)
  - Asian tropics unique (land-sea interactions important in SE Asia)

Some key research questions in tropics

Does biomass burning in Asian tropics influence regional climate?

- Aerosols

Why has global CH_4 increased since 2007 (after a decade of stability)?

- Boreal (likely to be very gradual) and tropics
- Increased CH_4 wetland emissions supported by CH_4 isotopes
- Dominant variability in tropics is ENSO
- OH variability possible
- Biomass burning changes unlikely as little activity since 2002

• Reduce uncertainties in sources/sinks of many climatically active constituents

- CO_2, CH_4, N_2O, H_2, halocarbons…
- Large potential feedbacks in tropical forests under stress (droughts)
  - Large droughts in Amazon (2005) caused 1.4Pg/C/yr switch from sink to source (Lewis, 2009)

Carbon cycle vulnerability in the 21st Century

Hot Spots of the Carbon-Climate System

2006

Land

- Permafrost
- HL Peatlands
- T Peatlands
- Veg.-Drought/Fire/Def

2007

Oceans

- CH_4 Hydrates
- Biological Pump
- Solubility Pump

Many Pools and Processes not in GCMs

Field and Raupach 2004
GCP 2005

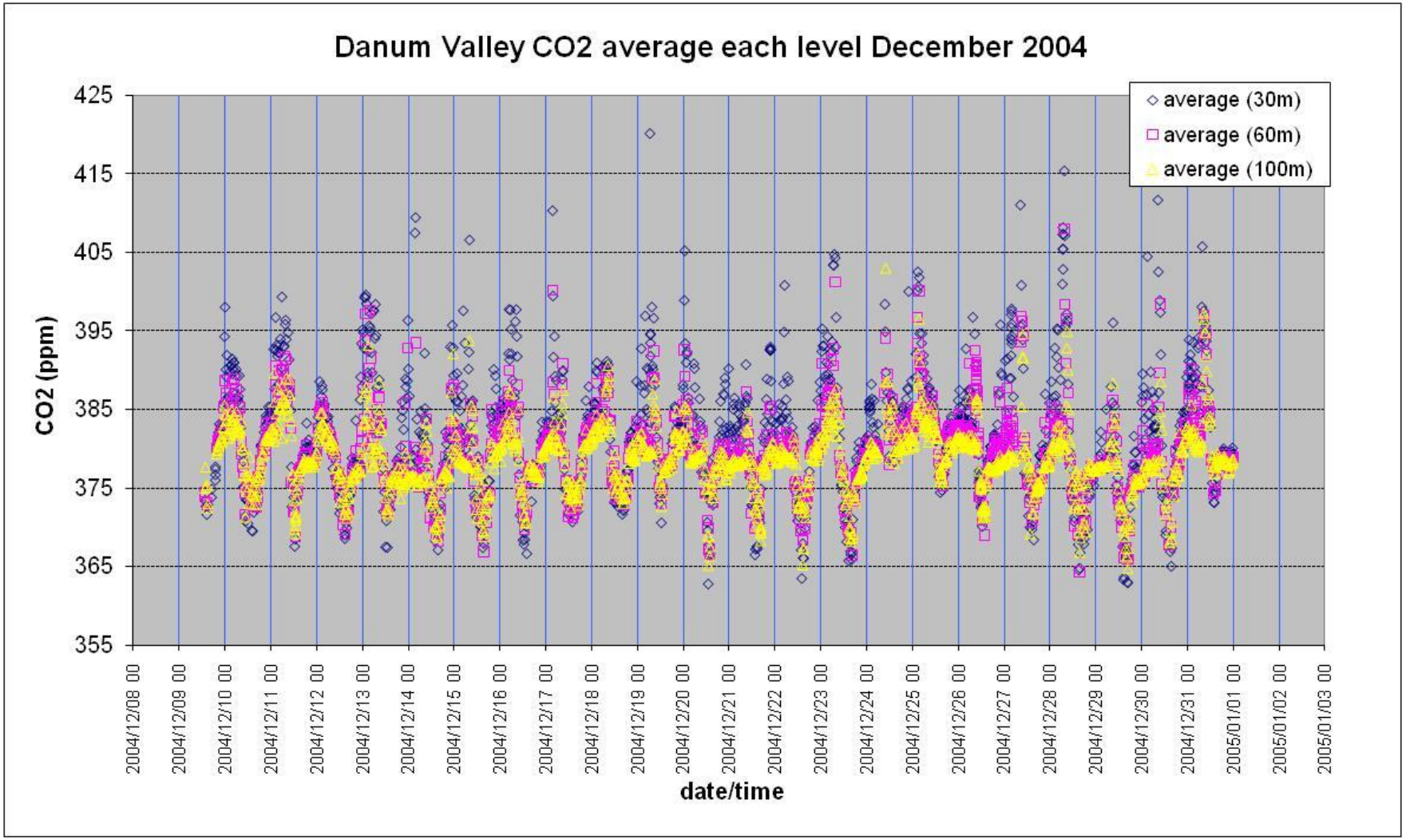
Southeast Asia-Australian Regional Network

Danum Valley (Malaysia) GAW observatory

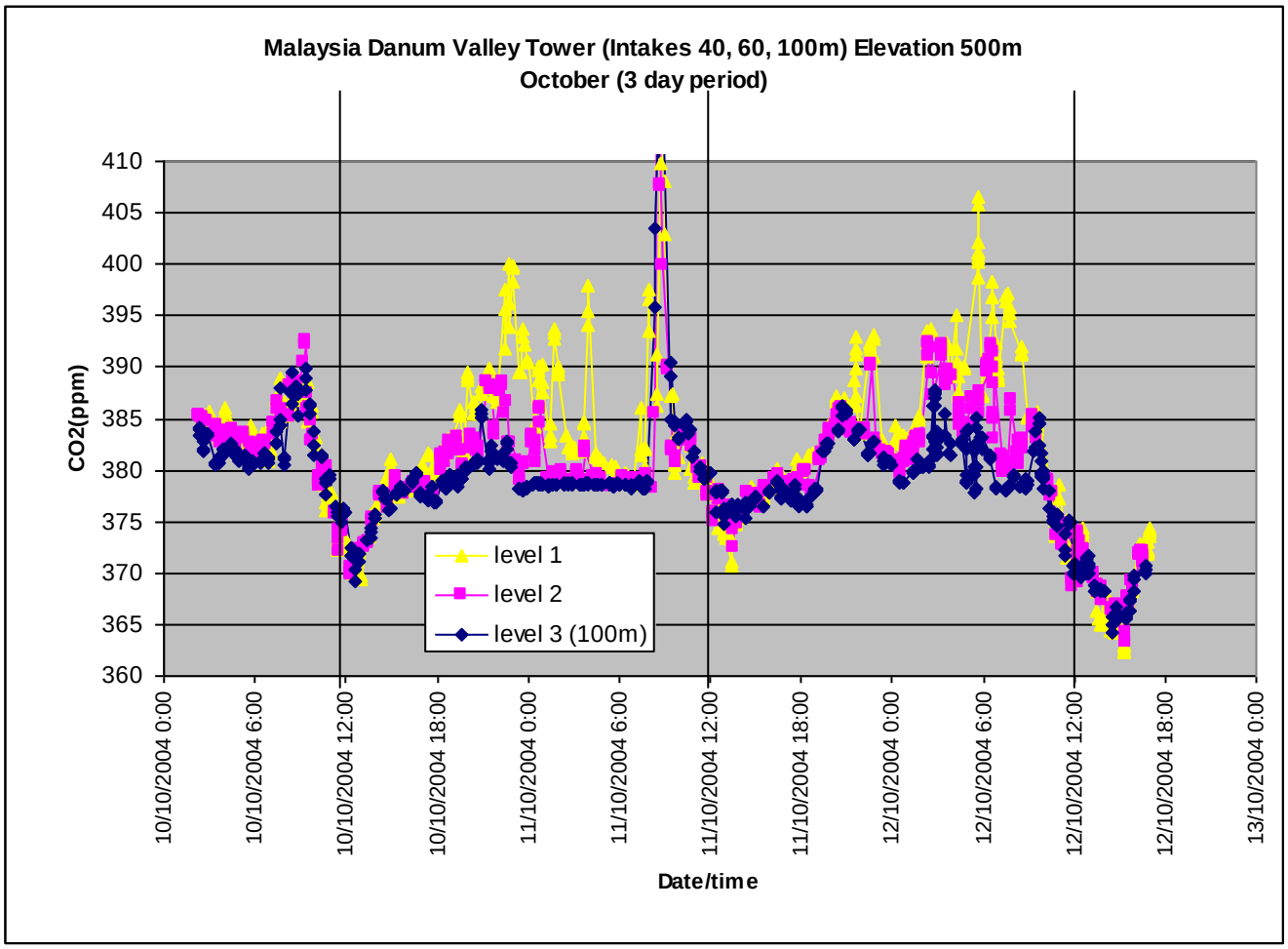
- Bukit Atur Global Atmospheric Watch (GAW) (04°58'53"N, 117°50'37"E, elevation 426m) in Danum Valley Conservation Area
- located on a ridge above the forest canopy (~70m).
- Danum Valley Conservation Area is 438 sq km Class 1 Protection Forest Reserve.
- ~ 90% is lowland dipterocarp forest (remainder is sub-montane forest).
- conservation area is surrounded by a 9500 sq km sustainably-managed natural Forest Management Area.
- CSIRO installed LoFlo CO_2 analyser system September 2004
- dual air intakes at 3 levels (100m, 60m and 30m)
  - (Future option for virtual tall tower capability & local CO_2 flux measurements)

5°N, 118°E

Danum Valley multi-level CO_2



Danum Valley: multi-level CO_2 profile



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Danum Valley existing research program

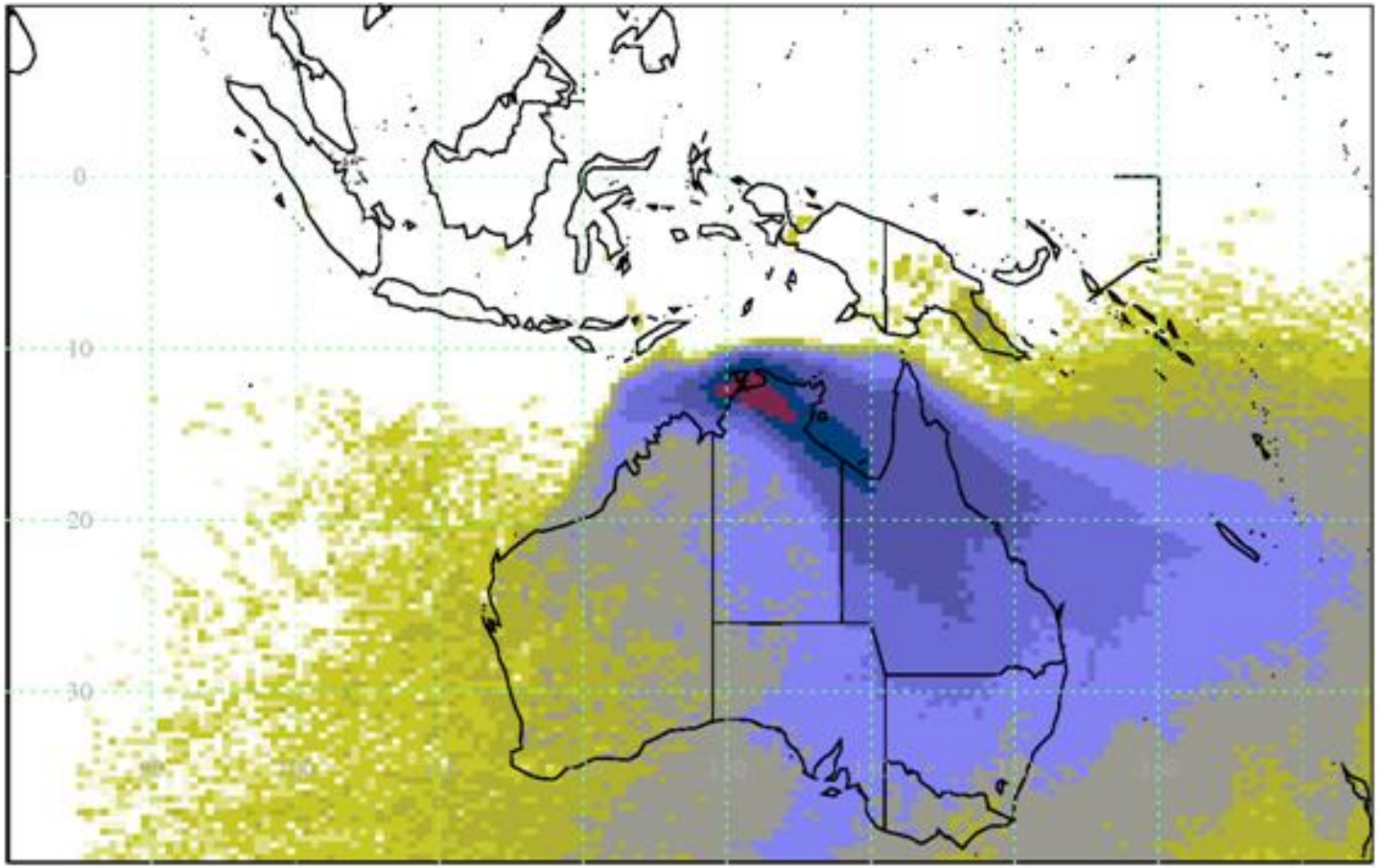
Atmospheric species	Analytical method	Intake position	Research group
Meteorological parameters	AWS (temp, RH, WS, WD, Rad)	Roof (10m)	MMD (Sep 2005)
In-situ CO_2	LoFlo (NDIR)	Tower 100m (60, 30m)	CSIRO (Aug 2004)
Particles (PM_{10})	TEOM 1400a /MAAP	Roof	IFT Leipzig (Apr 2006)
Short-lived halocarbons, C4-C12 HCs	GC-ECD	15m	University of Cambridge (2008)
Aerosols (AOD) multi wavelength optical depth	AOD Precision Filter Radiometer (Sun photometer)	Roof	PMOD-WRC (Aug 2007)
Aerosols (PM10)	Nephelometer	Roof	IFT Leipzig (Apr 2006)
Surface O_3	UV absorption (TEI 49i & 49c)	Roof	MMD (2008)
Precipitation	Rain Gauge	Roof (platform)	MMD (Sep 2005)
Multi-species OP3 campaign (Apr/June 08)	Multi	Tower (10m)	UK consortium
pH and chemical composition	wet sampler	Roof (platform)	EANET (Sep 2005)

Gunn Point (NT) - existing radar station (BoM) (Lat/Long: 12.25 S, 131.05 E)

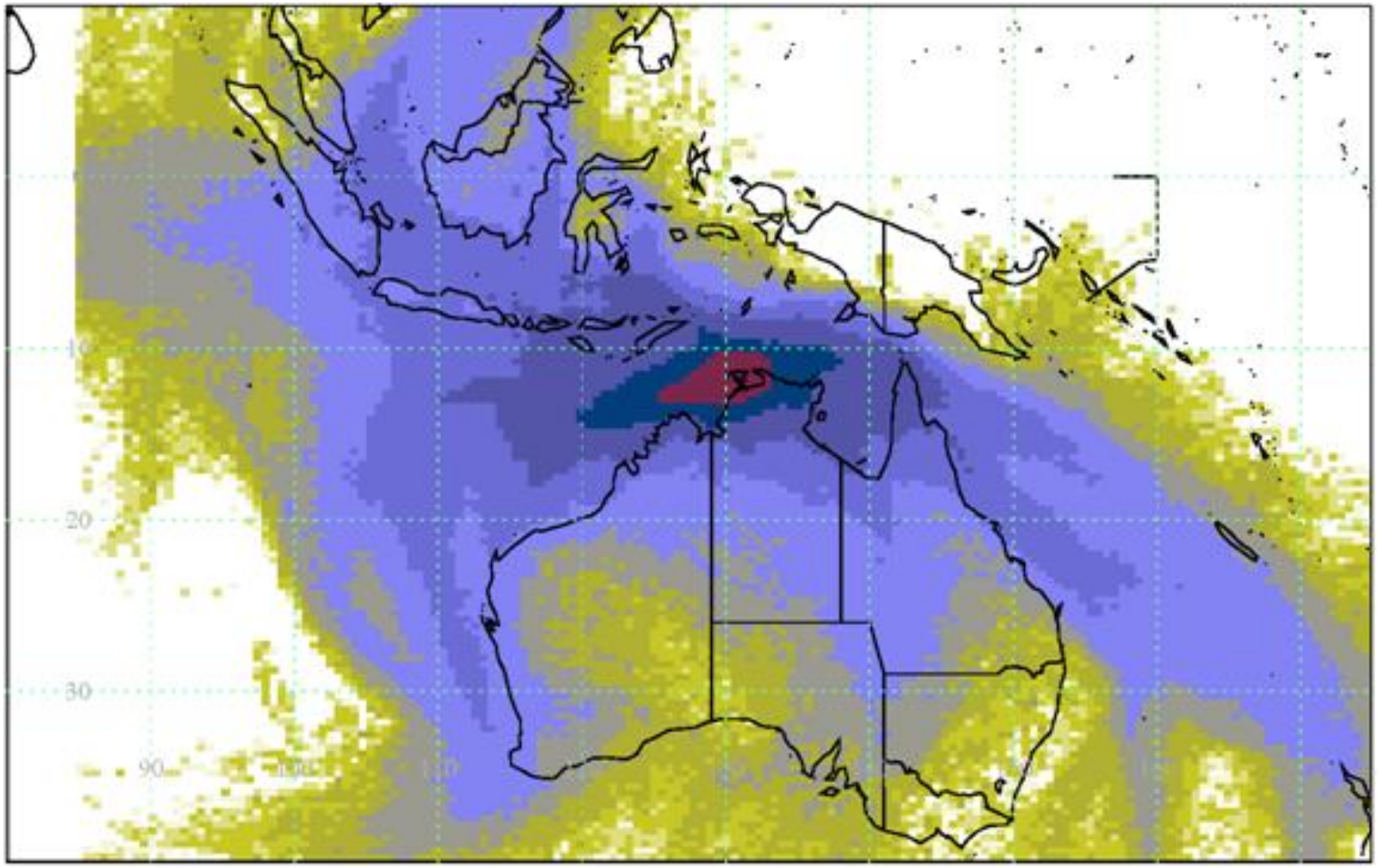
Gunn Point (NT) – New tropical Australian monitoring site

- Wet / Dry season air masses giving continental coverage with Cape Grim station, clean Indian Ocean air & SE Asian air masses
- Strategically located to reduce global scale atm. inversion CO_2 flux uncertainties
- Based at existing research radar site at Gunn Point (BoM)
- Unique opportunity to combine existing state-of-the-art **physical** atmospheric research facilities currently in Darwin (BoM / US DoE Atmospheric Radiation Measurement program) with high precision **chemical** atmospheric measurements
  - Regular field campaigns (Mctex, TRMM, Dawex, TWPICE...)
- TCCON network site at Darwin (FTS) for satellite validation (GOSAT, SCHIAMACHY) since September 2005 (University of Wollongong/Caltech)
- Extensive existing tropical ecosystem (eg Savanah) research capability (CSIRO, Charles Darwin University)

Gunn Point – DRY SEASON - Air mass origin map
(courtesy Alistair Manning UK Met Office)



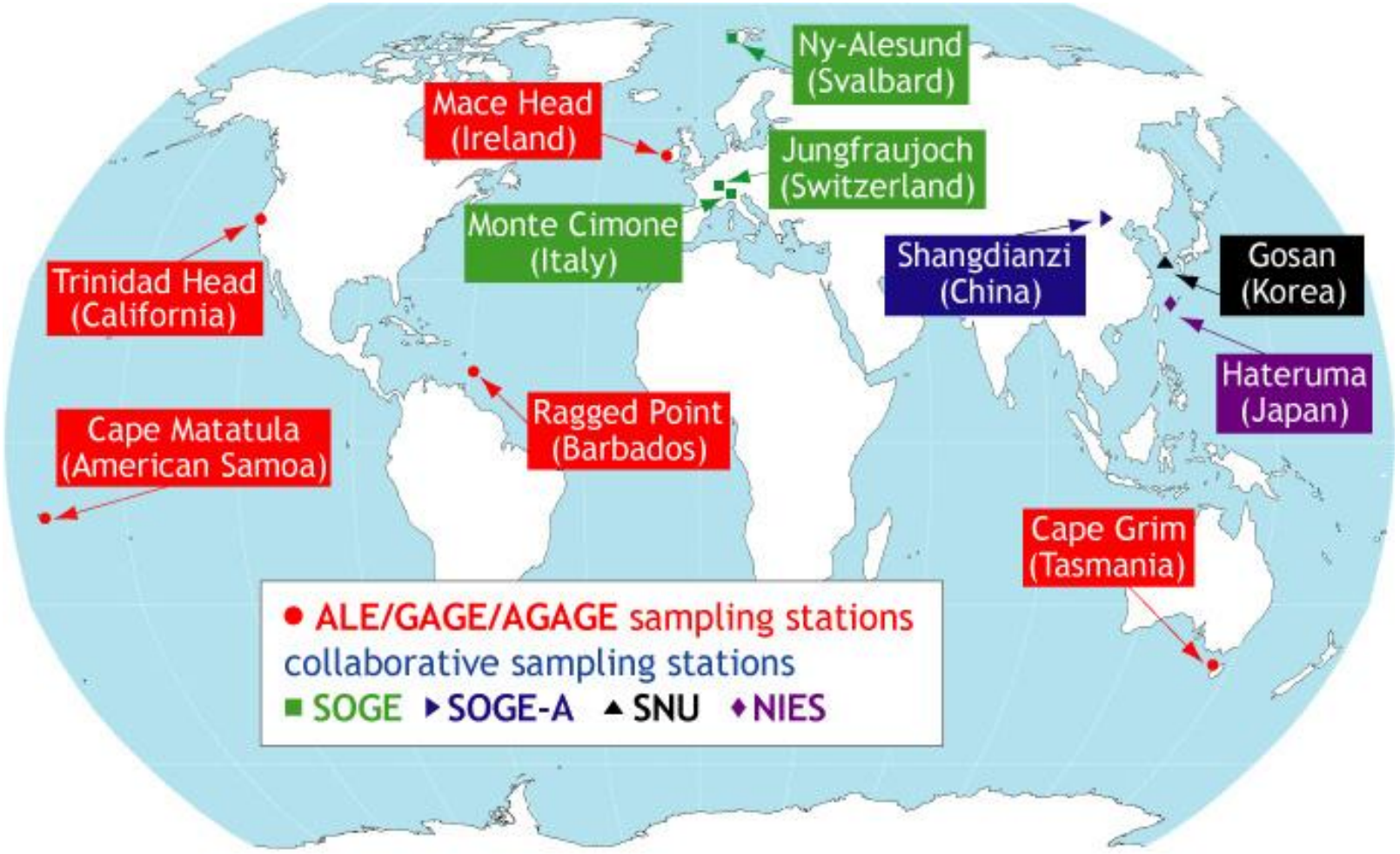
Gunn Point – WET SEASON - Air mass origin map *(courtesy Alistair Manning UK Met Office)*



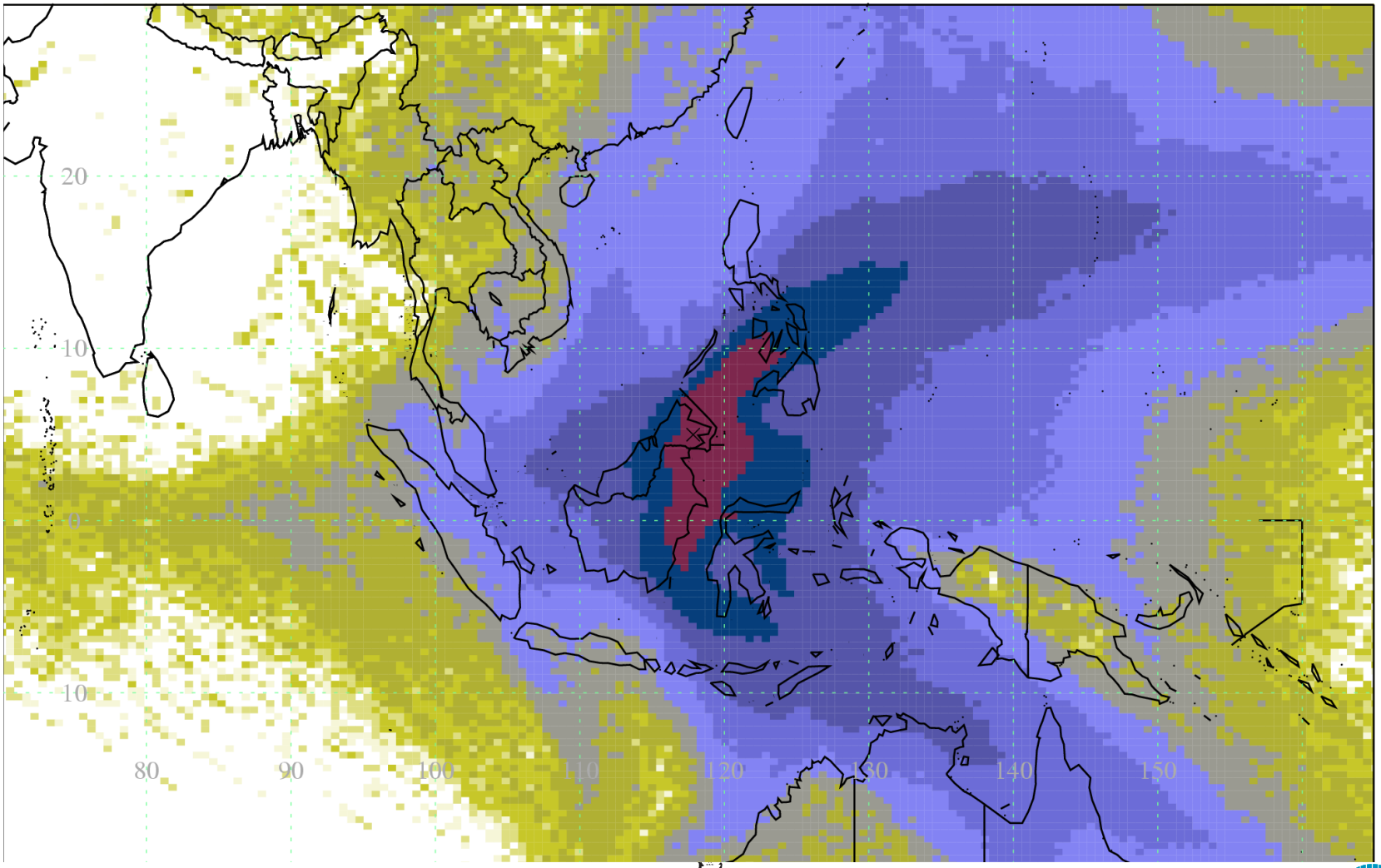
Gunn Point – atmospheric measurement program

- Proposed measurement program
  - CO_2, CO_2 isotopes: Flasks/CRDS (Picarro)/FTIR
  - CH_4: Flasks/CRDS (Picarro)/FTIR
  - N_2O: Flasks/CRDS/FTIR
  - CO, H_2: Flasks/CRDS/FTIR/GC-PID?
  - CFCs, HCFCs, HFCs, PFCs, SF_6, CH_3Br- GC-MS-Medusa
  - Short-lived halocarbons, C_4-C_{12} HCs: GC-ECD/FID/PDD (N. Harris, U. Cambridge, UK)
  - $PM_{2.5}$/PM_{10}
  - O_3
  - NO/NO_X
  - Aerosols (dry season campaign completed June 2010)

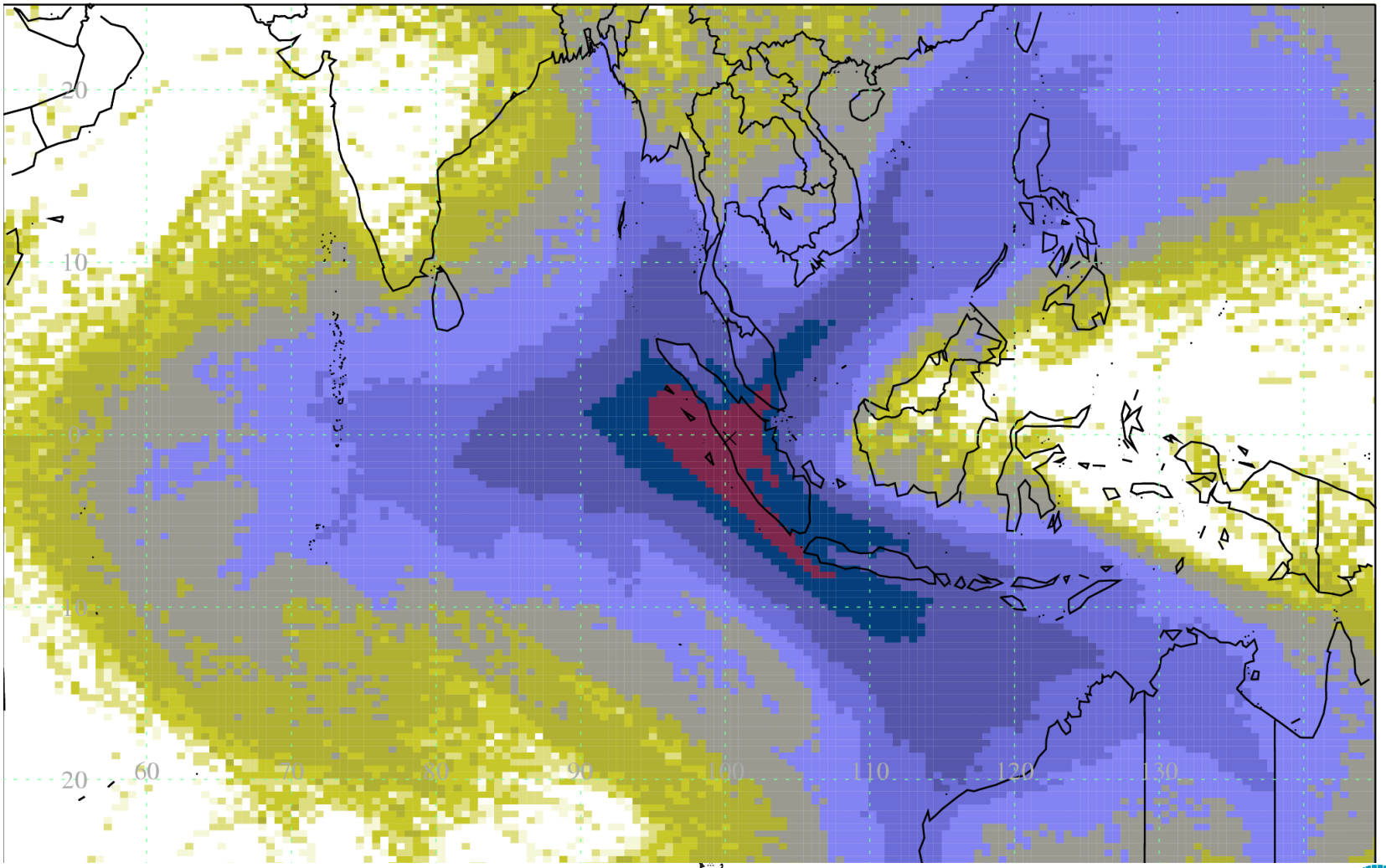
AGAGE network



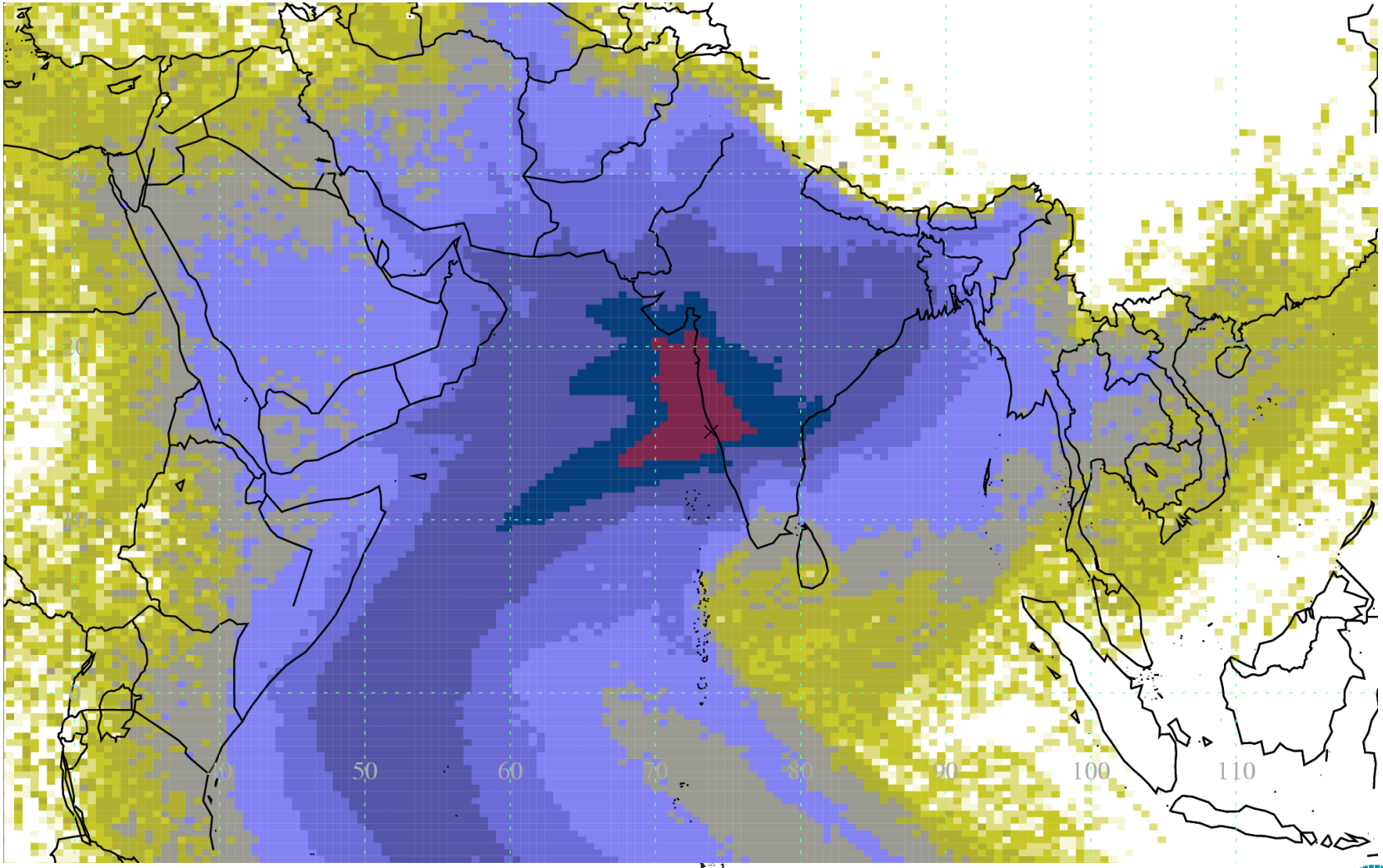
Danum Valley - Air mass origin map
(courtesy Alistair Manning UK Met Office)



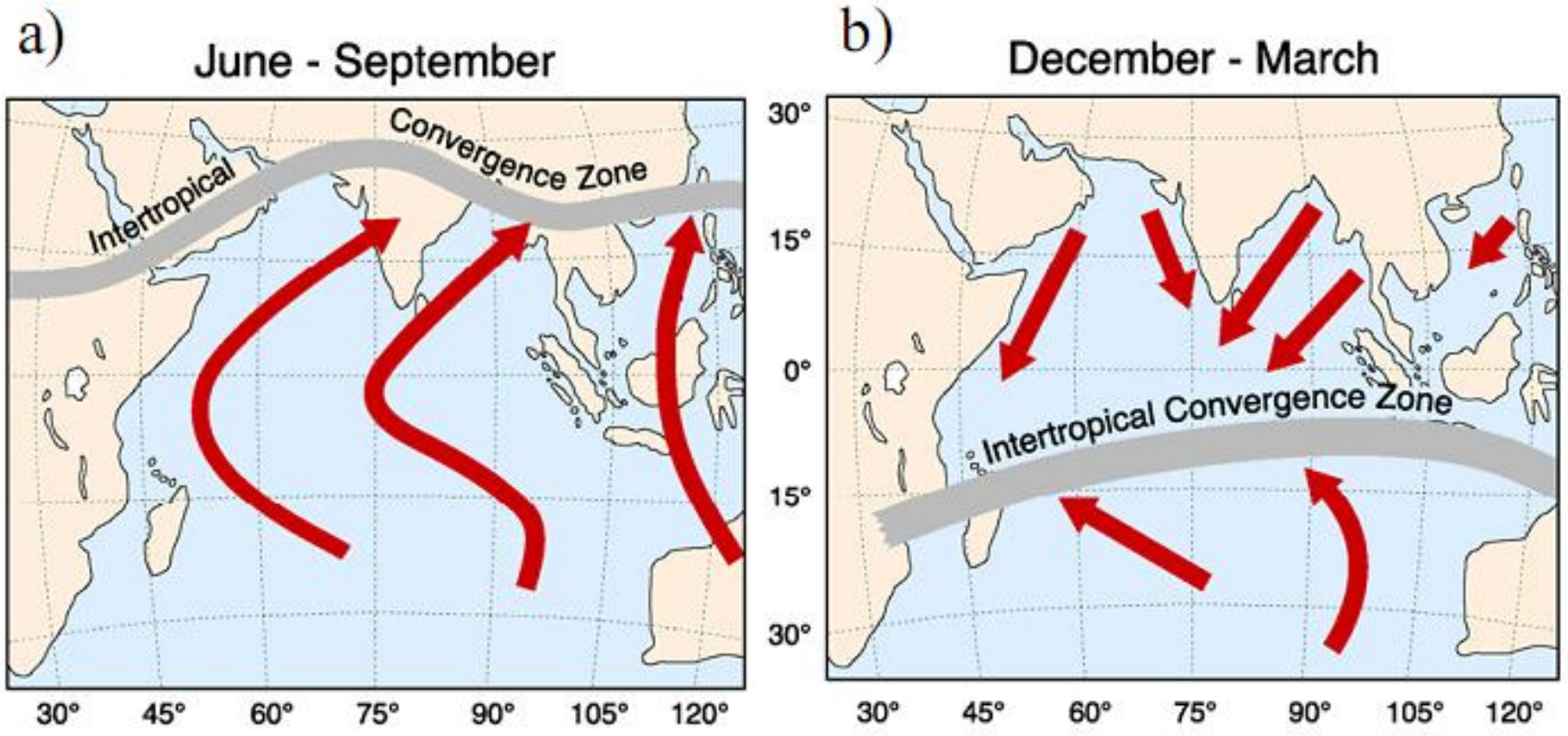
Bukit Koto Tabang - Air mass origin map
(courtesy Alistair Manning UK Met Office)



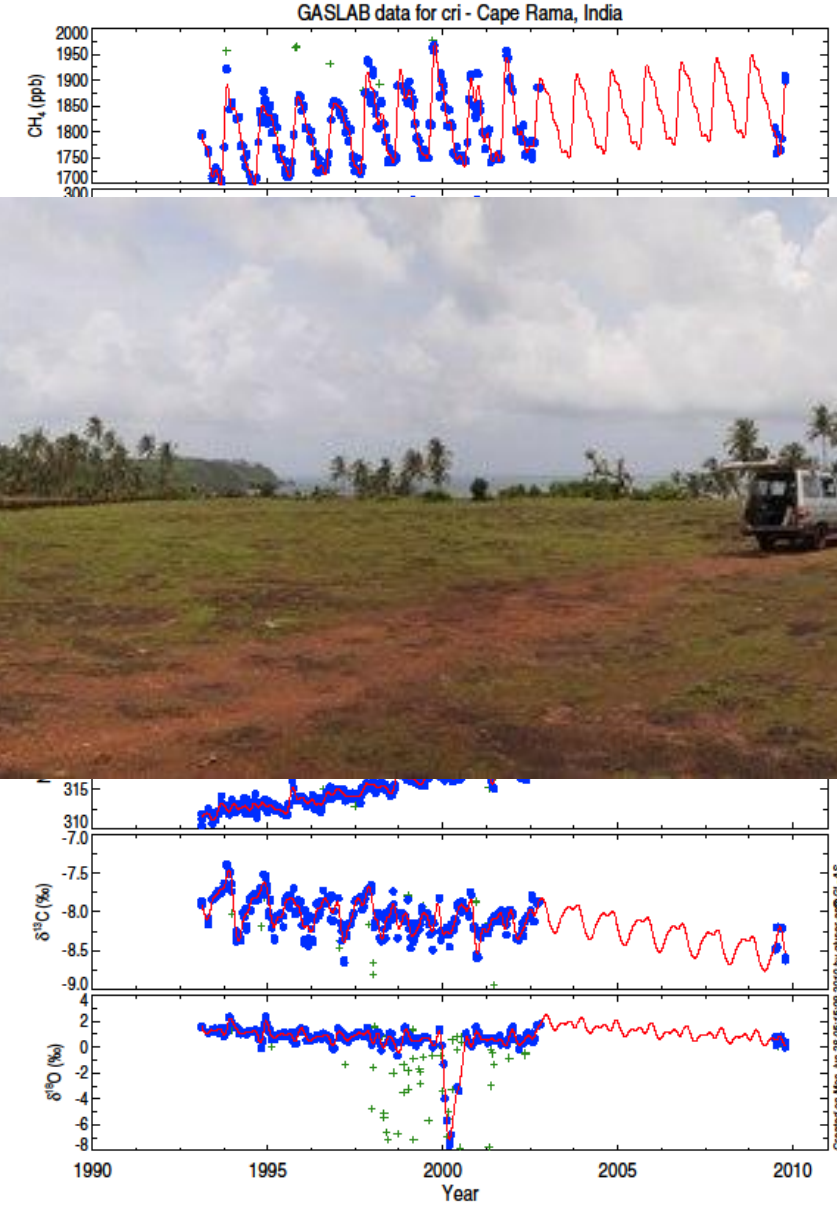
Cape Rama (India) - Air mass origin map
(courtesy Alistair Manning UK Met Office)



Asian Inter-Tropical Convergence Zone



Cabo de Rama (CSIRO/NIO)



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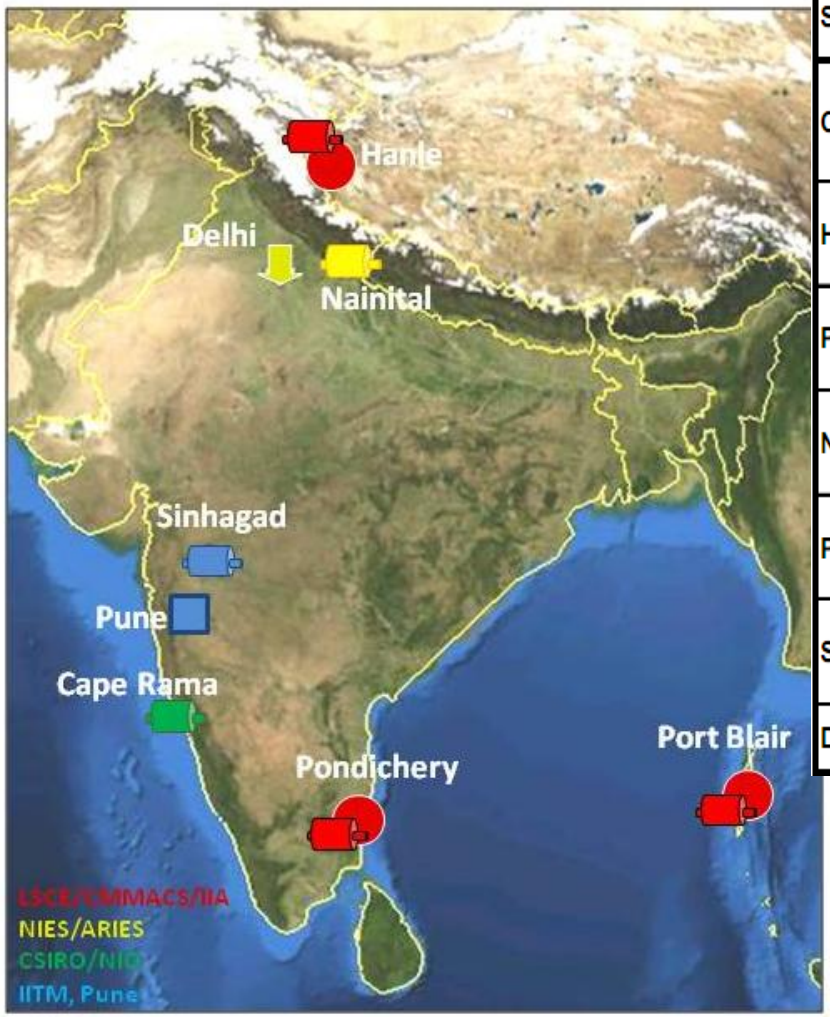
Indian GHG observation network
(courtesy M. Ramonet, LSCE, France)



Site	Code	Lat °N	Long °E	Alt m.asl	Flask	In-situ
Cape Rama	CRI	15.080	73.830	20	CMAR 1993 - 2003 2009 - ...	-
Hanle	HLE	32.779	78.964	4517	LSCE 2005 - ...	CO2 2005 - ...
Pondichery	PON	12.013	79.858	20	LSCE 2006 - ...	CO2, CH4, CO 2011 - ...
Nainital		29.400	79.500	1958	NIES 2006 - ...	-
Port Blair	PBL	11.550	92.733	10	LSCE 2009 - ...	CO2, CH4, CO 2010 - ...
Sinhagad		18.350	73.750	1400	IITM Project	-
Delhi	>> Regular vertical profiles (JAL commercial aircrafts)					

- In-situ measurements
- Flask sampling
- Airborne measurements

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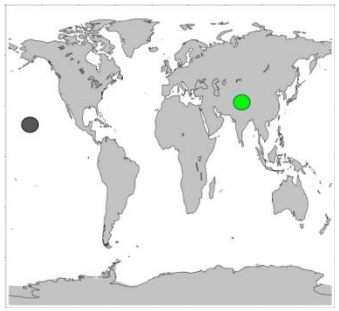
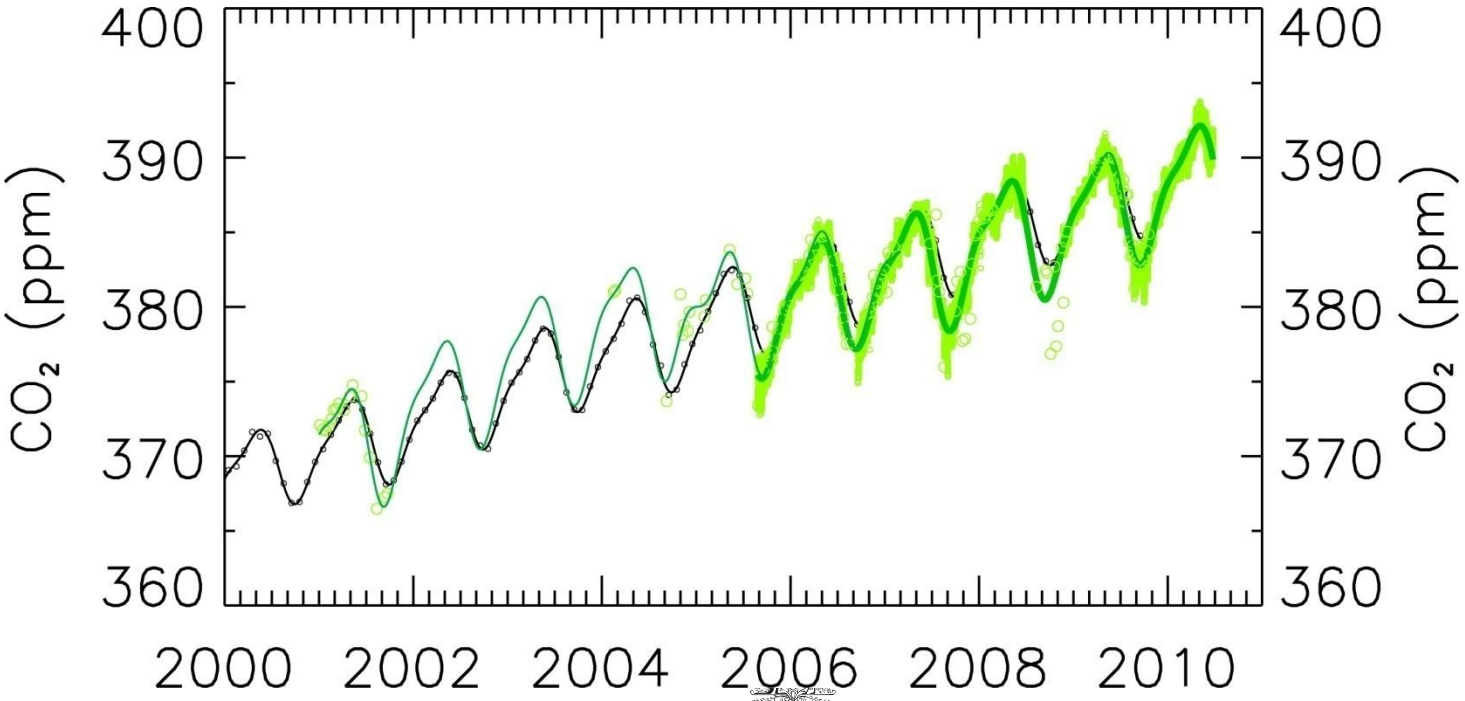
Long term observatories for background measurements *(courtesy of M. Ramonet, LSCE)*

Mauna Loa



Hanle



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