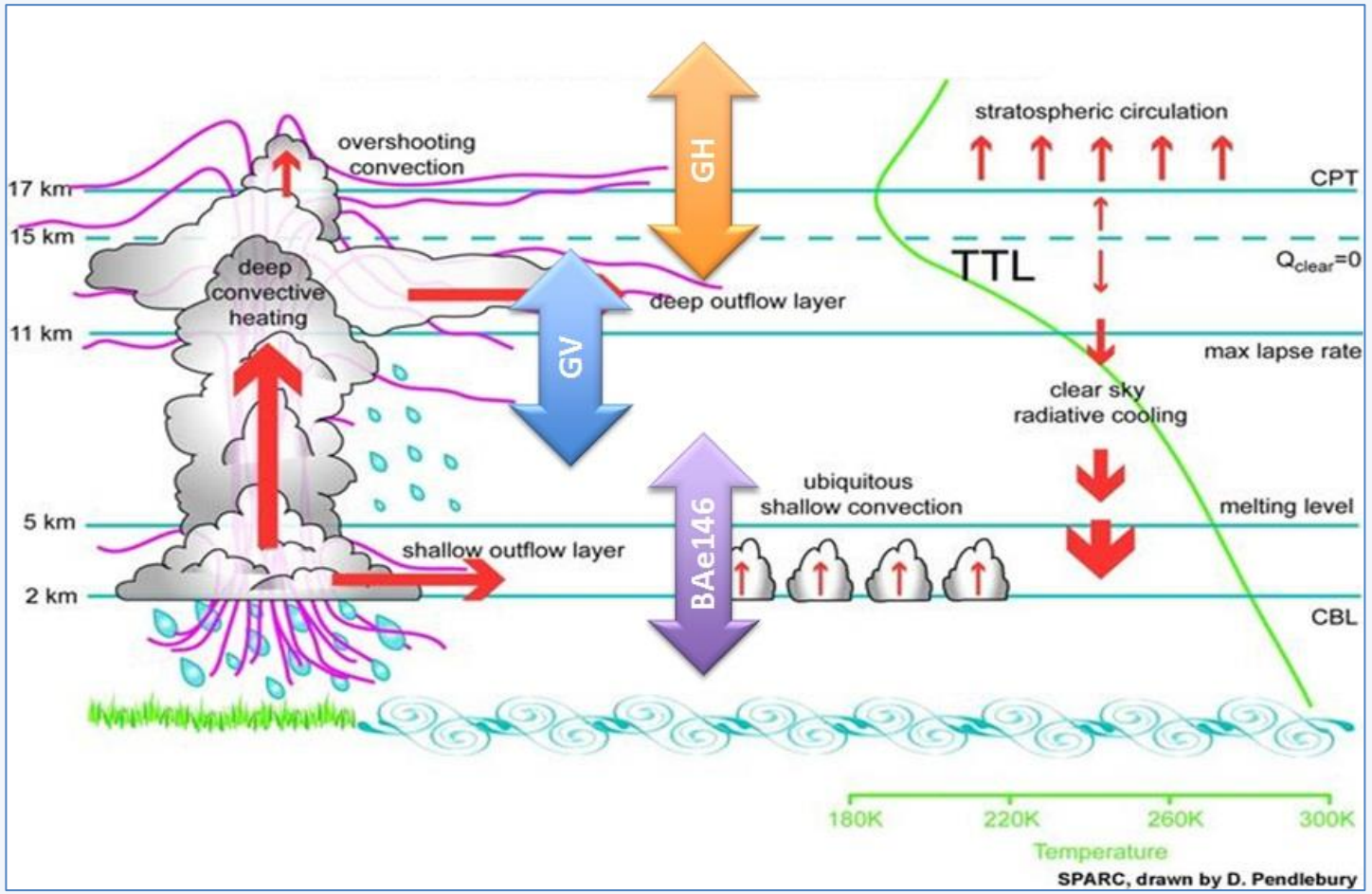
Joint flight plans - Jan-Feb 2014



Joint flight plans - Jan-Feb 2014

Challenges

1. Designing science flights whose measurements can be jointly used to address the science goals
   - Transport of trace gases in convection (inflow and outflow)
   - Transport and transformation of trace gases across the tropopause
   - Understand implications for water vapour and cirrus clouds
   - Importance of TWP region for atmospheric halogen budget and chemistry

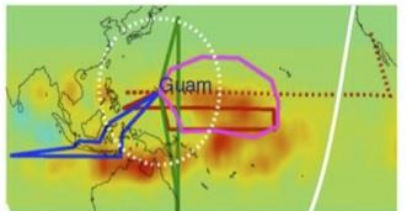
2. Ensuring that measurements on different platforms are consistent

2. Achieving the objectives
   - Keeping focus on main priorities
   - Remembering that ‘solo’ flights will also be made
   - Optimising use of ground & sonde measurements

FAAM Bae-146 Flights options (a), (b) – 1 night

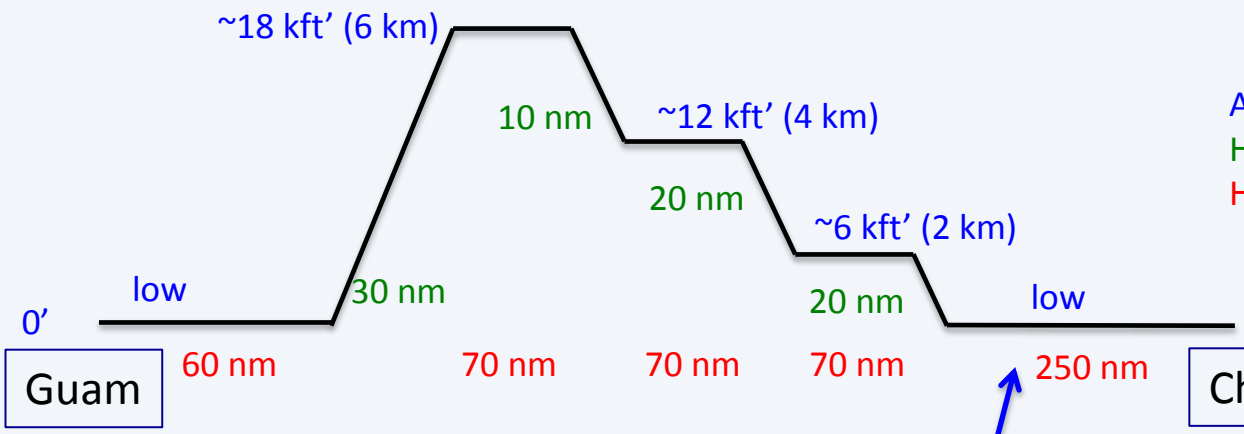
Guam 13.5° N,
145° E
Chuuk 7.5° N,
152° E

Sample at < 20 kft (6 km)
~6 sorties

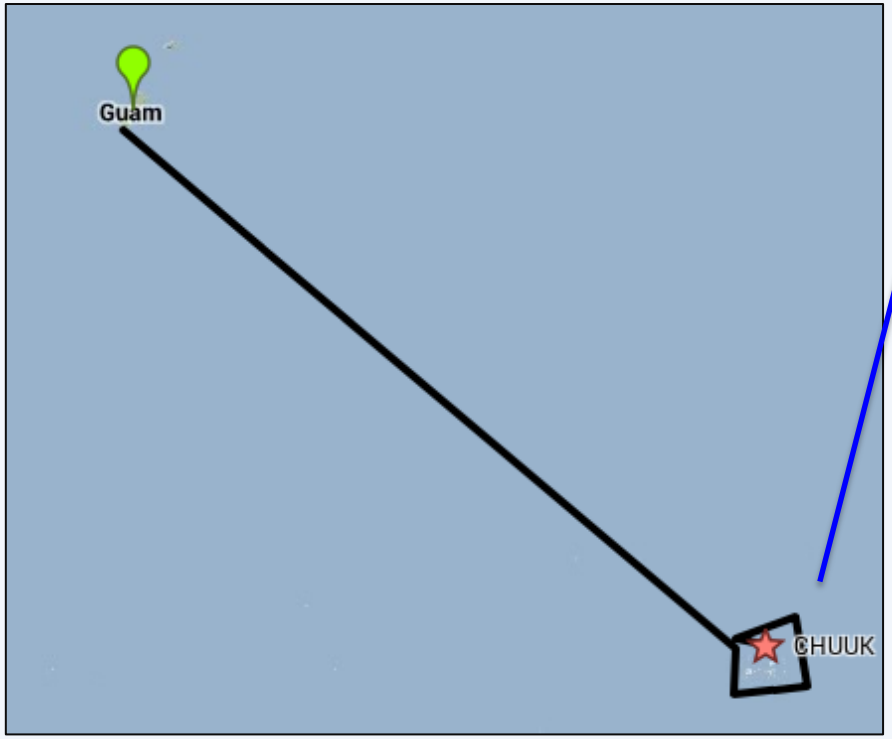


Nominal Global Hawk flights

Guam ➔ Chuuk



Altitude
Horizontal distance travelled during climb
Horizontal leg

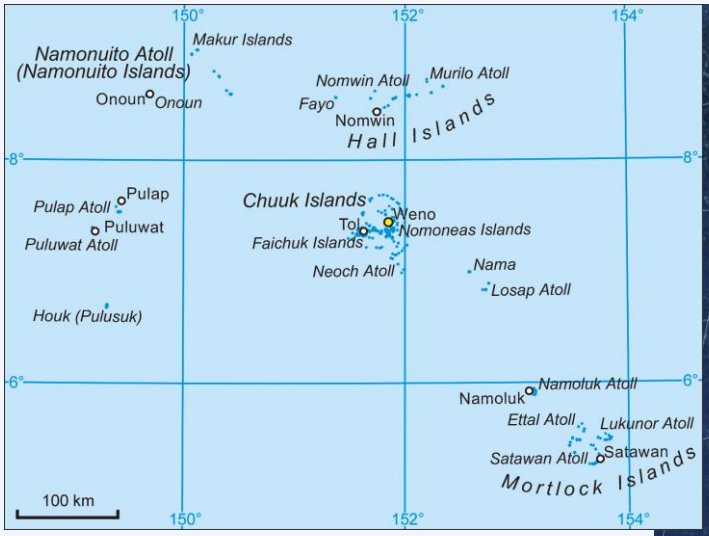


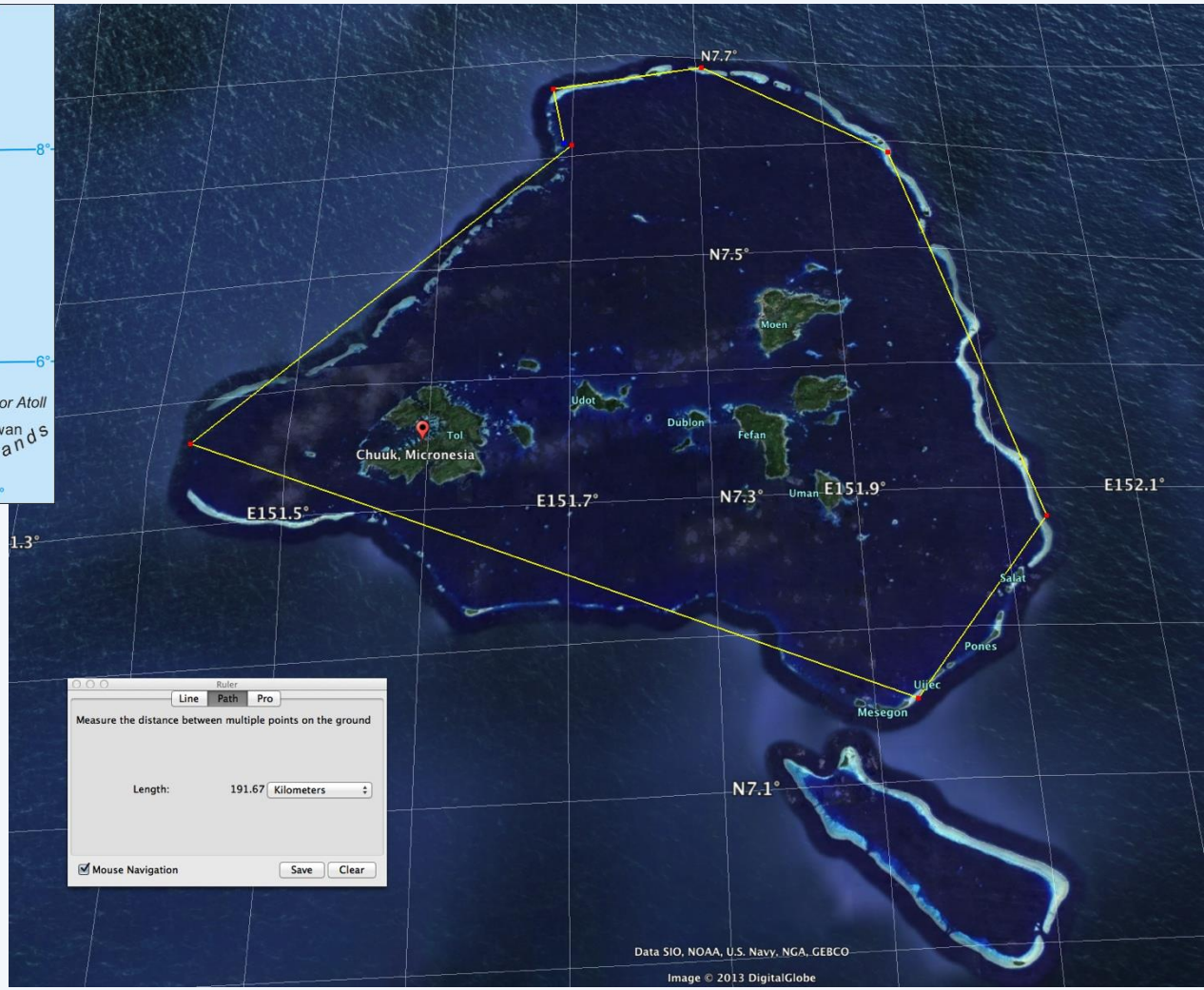
Science aims

- Survey: 13.5 to 7.5N
- Atoll emission estimates

- Total miles: 600 nm
- Leaves some time around Chuuk
- All 70 nm legs take ~20 mins so 5 GCMS samples + WAS

Guam ➔ Chuuk





Circular route round whole atoll system would be ~200km or 105 nautical miles

What is optimal route? This plus a line through the centre?

Linking GV and 146

Main roles in coordinated flights

- 146 producing measurements and climatology in inflow region
- GV measuring in main outflow region (<~13 km)
- Not aiming at linking individual events (past experience)
- Statistical approach
- Two types of GV flights of particular interest

  fresh convective outflow & Lagrangian
- Parts of others will be of interest
- Tools to use –

  Lagrangian forecasts (NAME/MetOffice, Bergman, others)

  Chemical & Tracer forecasts (CAM-CHEM, MACC, SLIMCAT, WRF?)

MACC products from ECMWF IFS (T255) + MOZART 3.5 (1.25°)

Need to define asap

Special tracers being considered:

- SE Asian boundary layer (based on CO)
- Coastal /shallow regions
- Age
- 146 operations zone
- Lightning NOx
- Stratospheric
- TTL (need definition)

http://www.gmes-atmosphere.eu/oper_info/

Linking GV and 146

Met Office forecasts

NAME traj dispersion

+5 days ahead

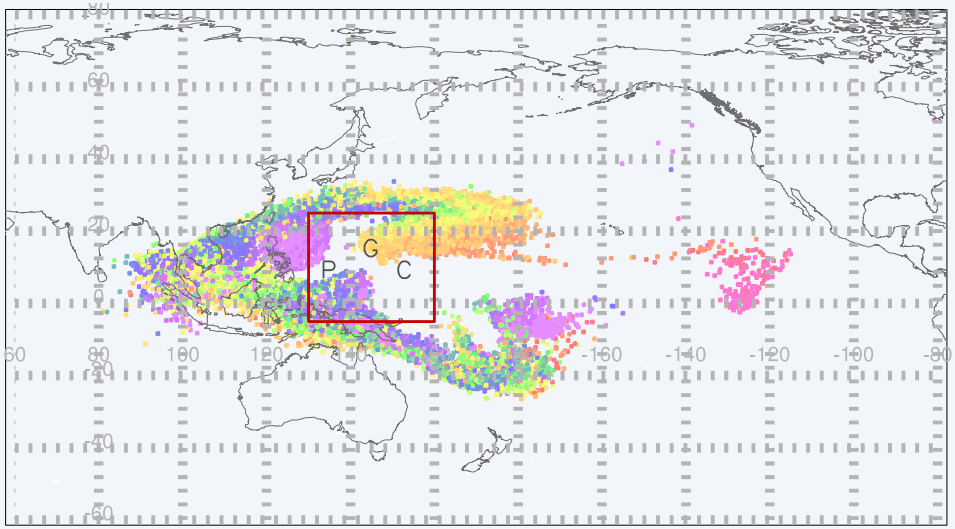
Start in region of 146

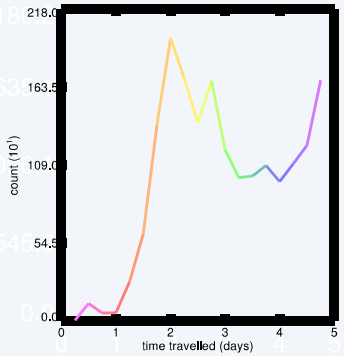
Run daily

Anticyclone clear

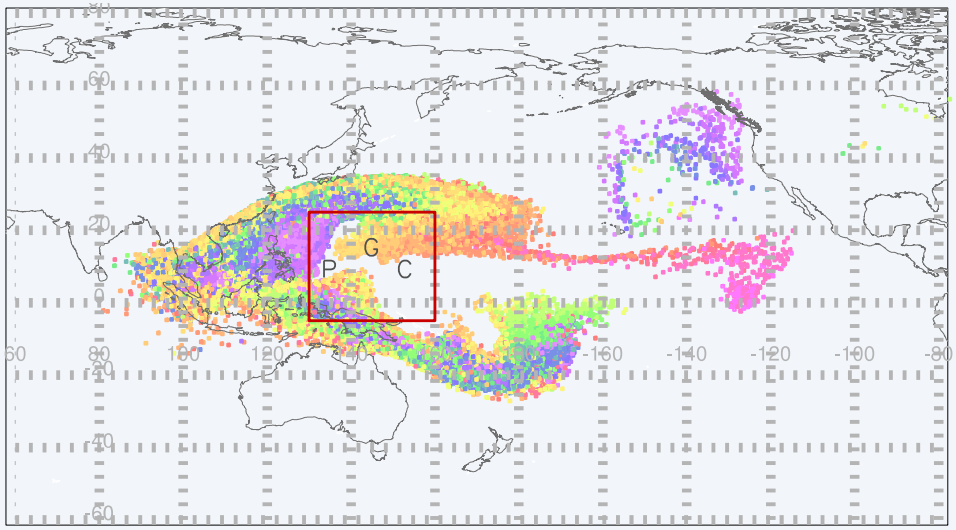
Much in range of GV

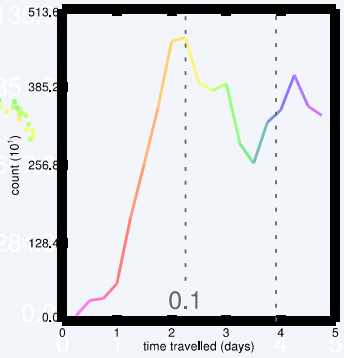
Based on Ashfold et al., 2012





Run date: 06/01/2013
Forward traj. start: 06/01/2013
Altitude range = 0-5 km
Total particles = 225000
Fraction above 13 km = 0.0825





Run date: 06/01/2013
Forward traj. start: 06/01/2013
Altitude range = 0-5 km
Total particles = 225000
Fraction above 10 km = 0.2372

Linking GV and 146

Met Office forecasts

NAME traj dispersion

+5 days ahead

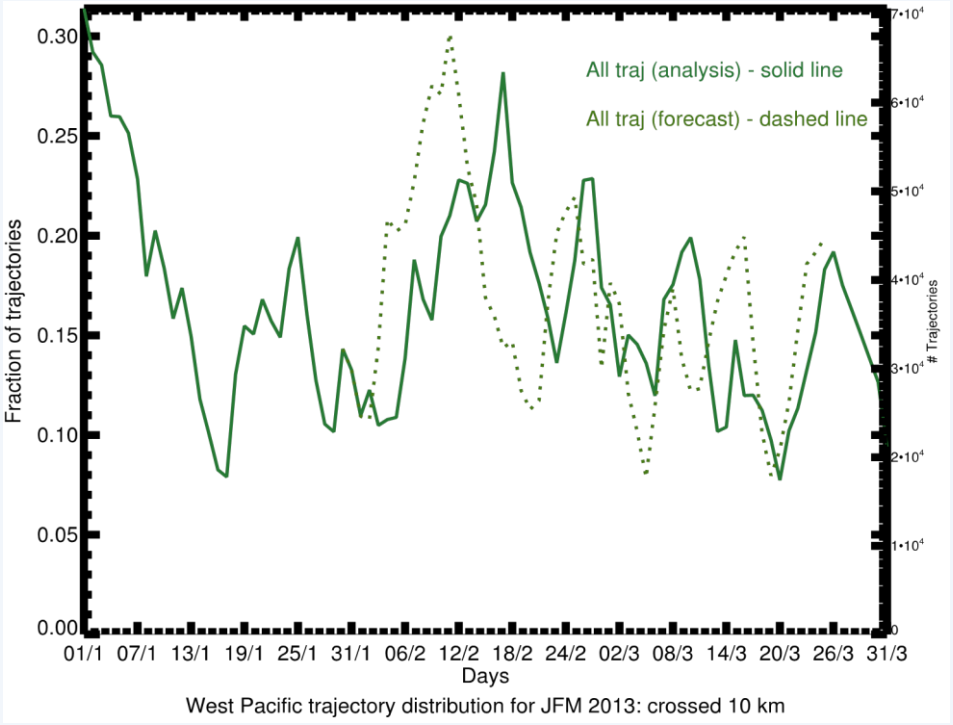
Start in region of 146

Run daily

Variation over time

Fraction of air in BL reaching 10 km

1 Jan – 31 Mar 2013



Linking GH and 146

Main roles in coordinated flights

- 146 producing measurements and climatology in inflow region
- **GV measuring in high part of outflow region (>~13 km)**
- Not aiming at linking individual events (past experience)
- Statistical approach
- **Lower parts of all GV flights are of interest (signal decreases with z)**
- Tools to use –

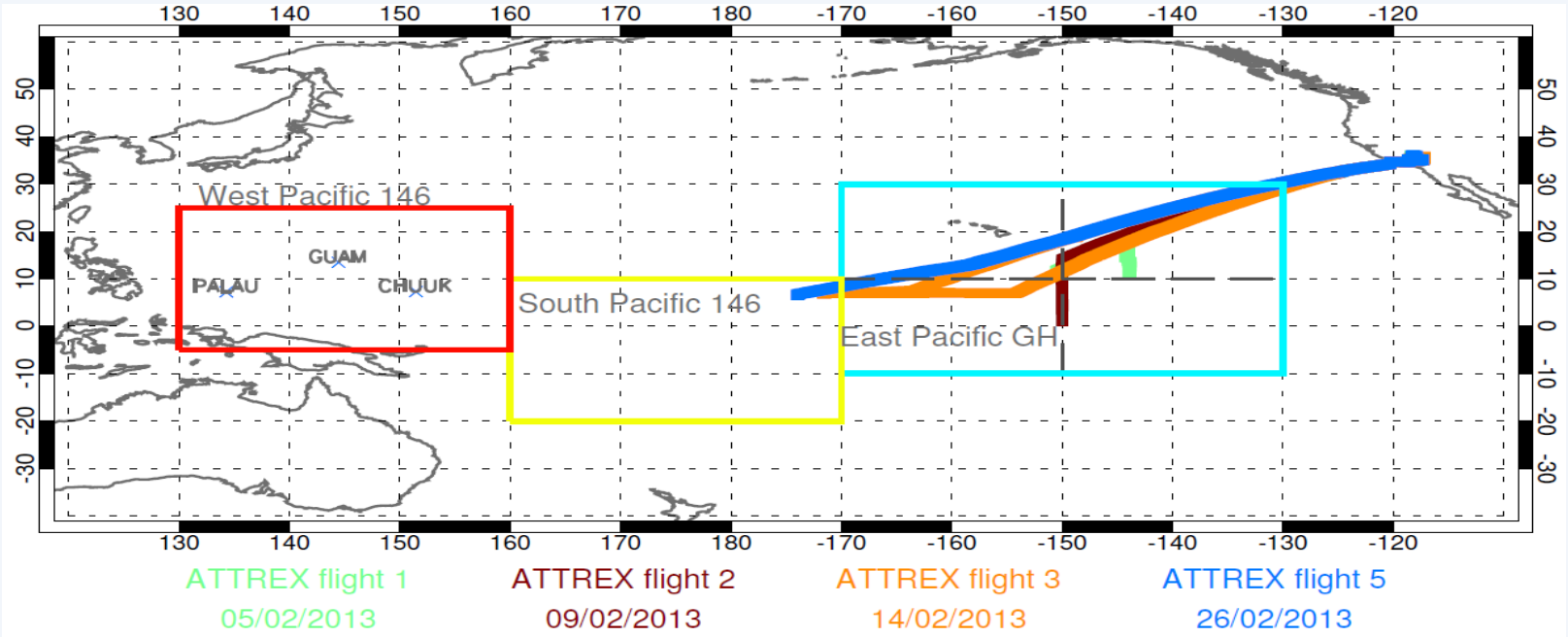
    Lagrangian forecasts (NAME/MetOffice, Bergman)

    Chemical/tracer forecasts (CAM-CHEM, WACCM, MACC, SLIMCAT, WRF?)

    Convection + Lagrangian combo

Linking GH and 146

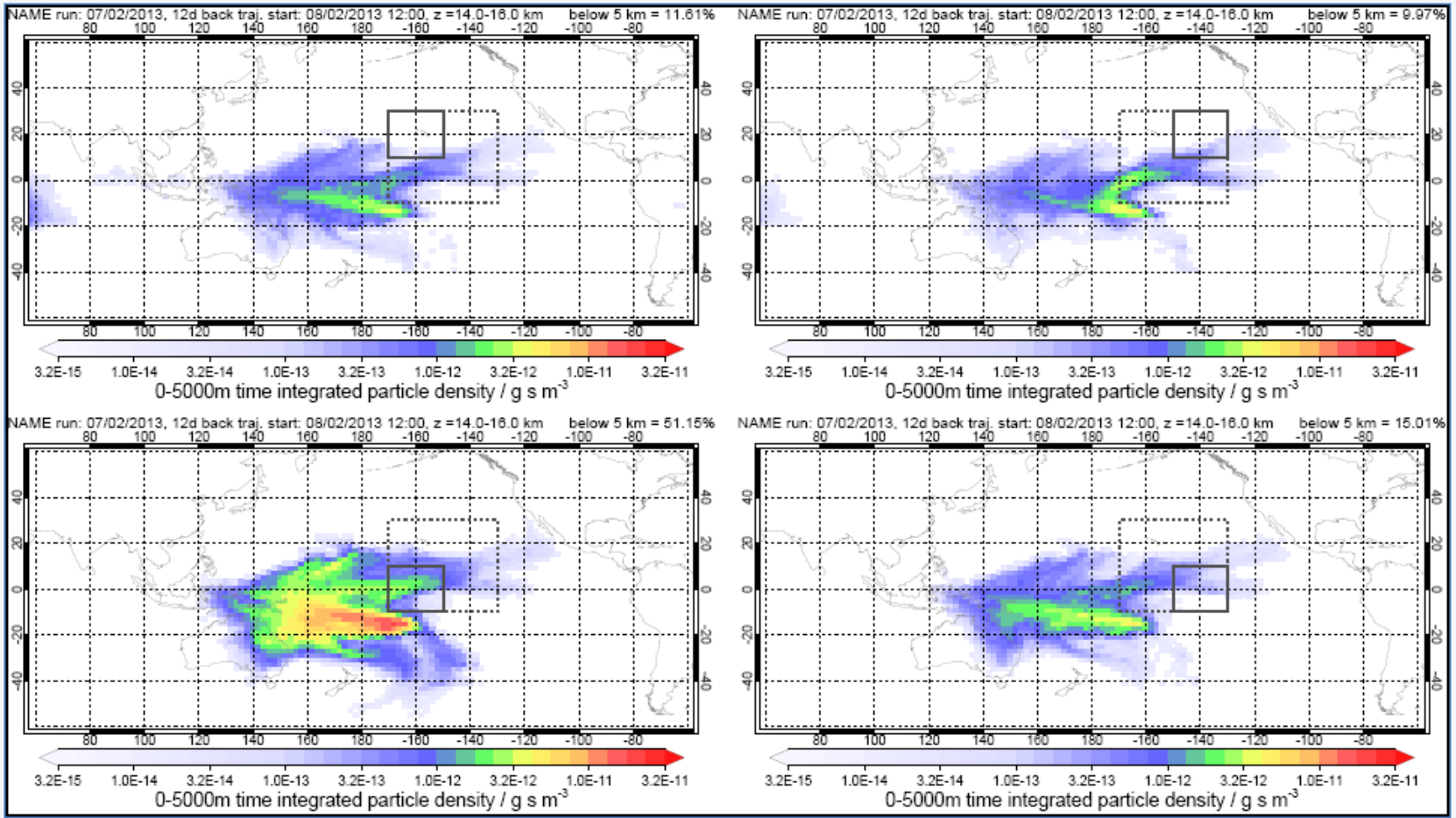
Target area	Source coordinates	Source altitude /km	Source dimensions / deg.deg.km	Density / particles/layer	NAME runs /day	Met Office forecast days
1. EAST PACIFIC GH	10°S-30°N 130-170 °W	14-16 16-18	40 x 40 x 2 (2)	80,000	12 back	1, 2, 3, 4, 5
2. SOUTH PACIFIC '146'	20°S-10°N 160°E-170°W	0-5	30 x 30 x 5	225,000	2-5 forward	0, 1, 2, 3
3. WEST PACIFIC '146'	5°S-25°N 130-160°E	0-5	30 x 30 x 5	225,000	2-5 forward	0, 1, 2, 3



Linking GH and 146

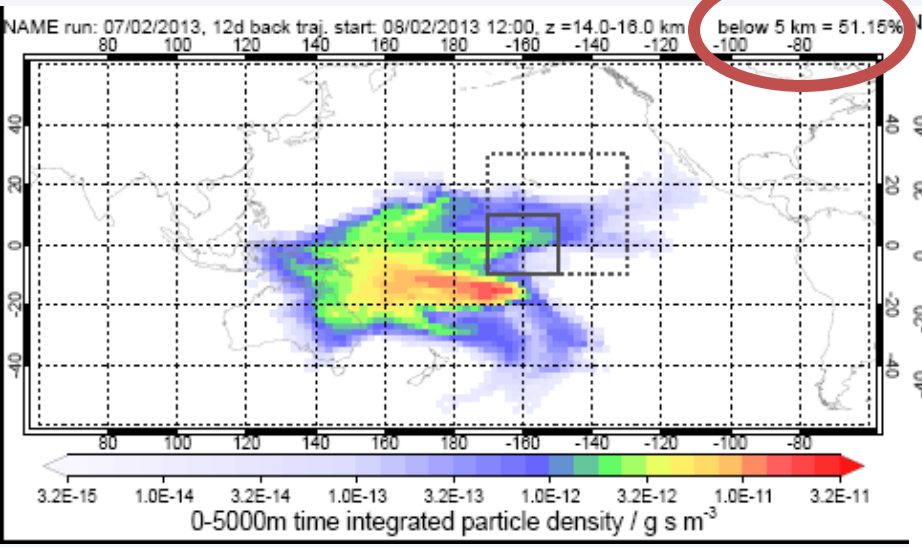
Density of particles below 5 km.
12 day back trajectories run using forecast and analysis data. Back-traj started in solid boxes

- Data representation:
  - Distribution studies: fractions crossed 1/5km
  - Air history maps
  - *Altitude vs time plots: qualitative assessment of air mass convection
  - *Meteorological maps showing weather conditions

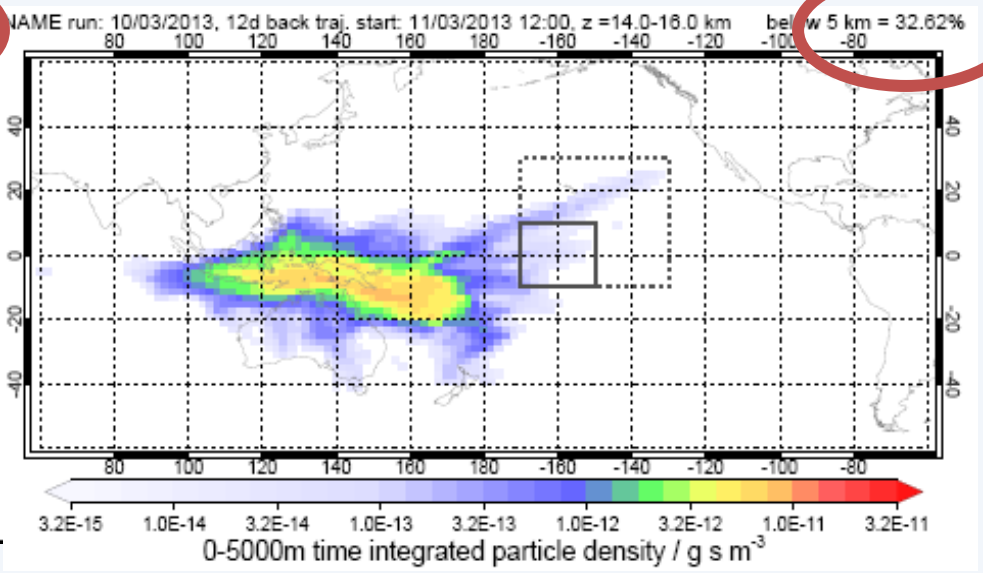


Linking GH and 146

51.15%



32.62



Linking GH and 146

Met Office forecasts and analyses

NAME traj dispersion

12 days **back**

Start at 14-16 km in East Pacific

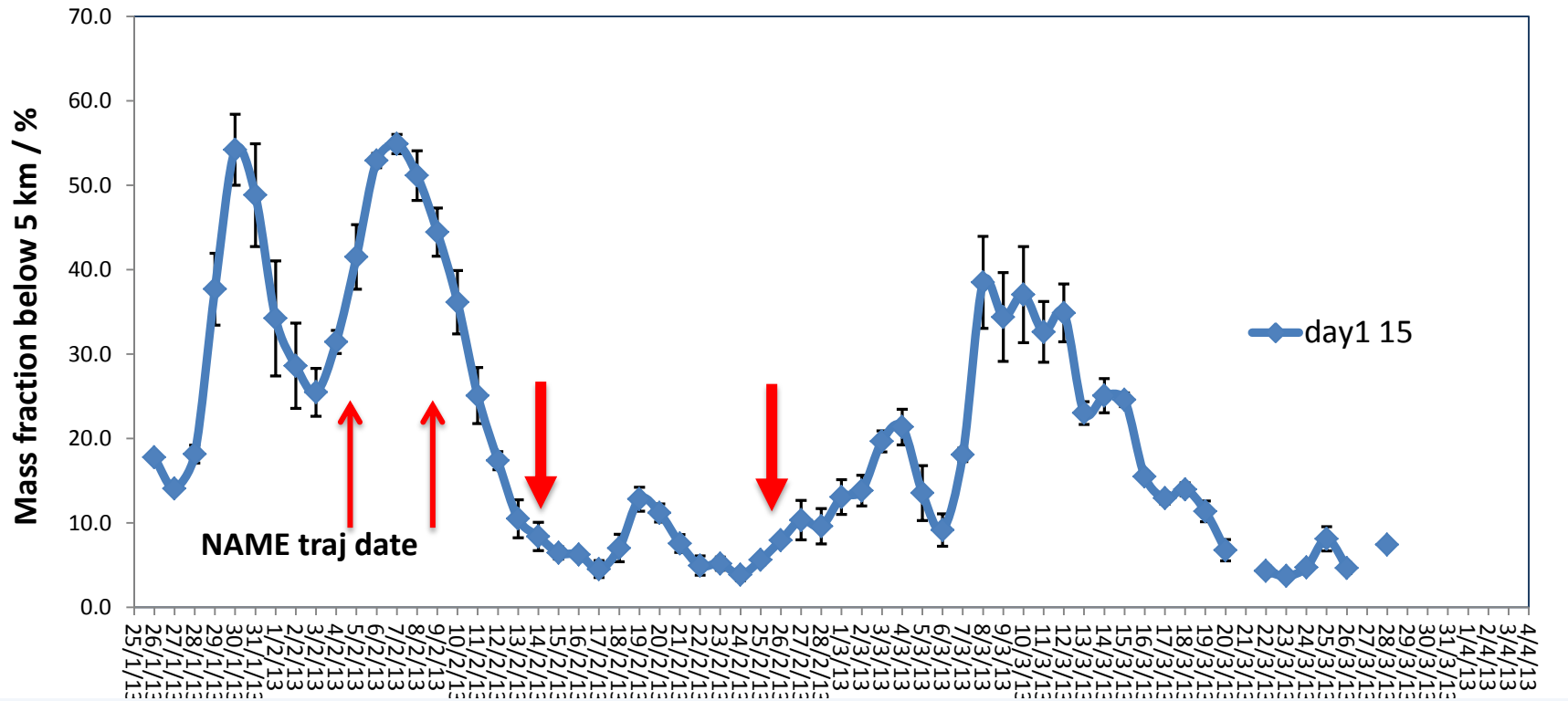
Run daily

Fraction of air at 14-16 km coming from BL

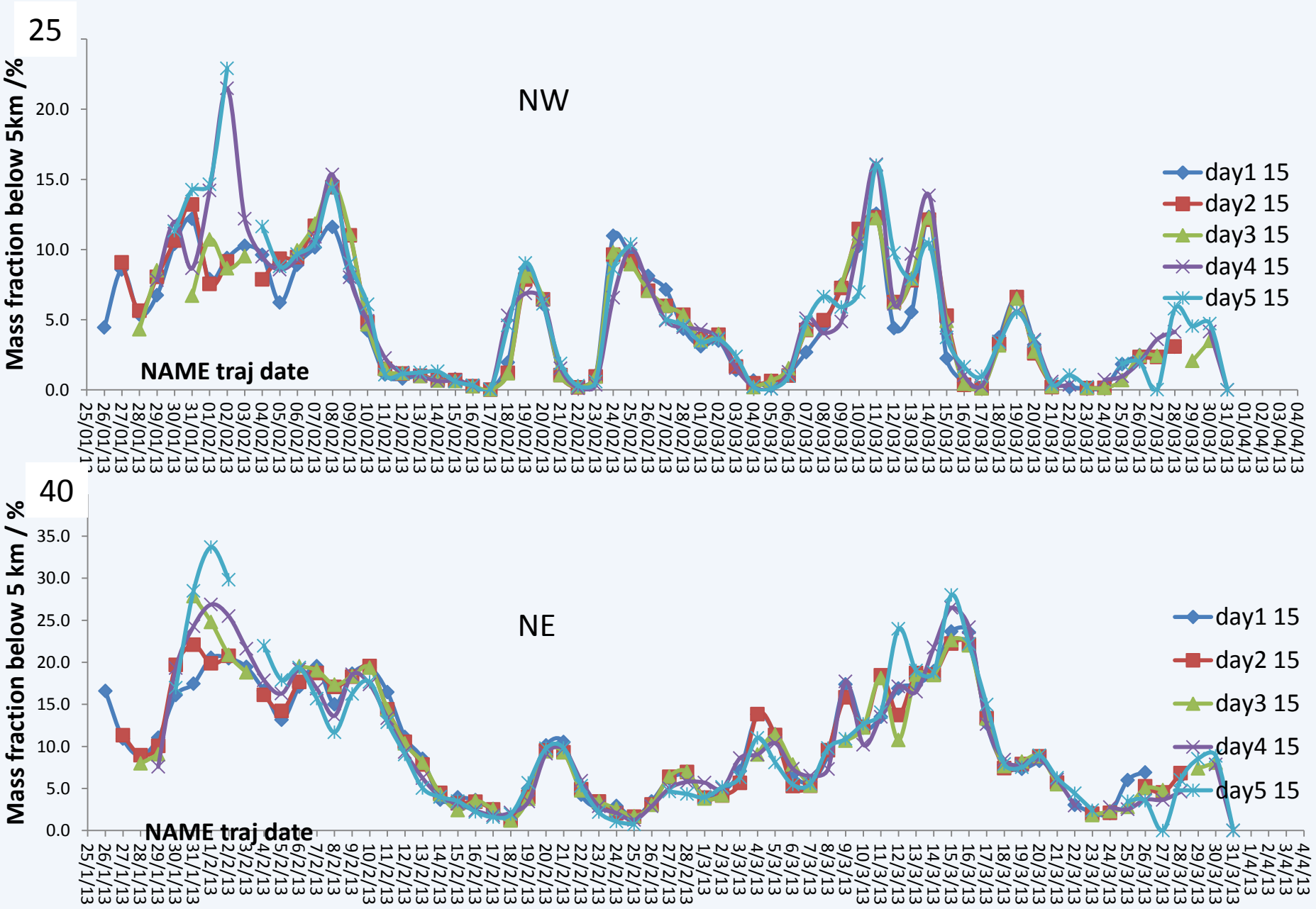
25 Jan – 29 Mar 2013

Variation over time

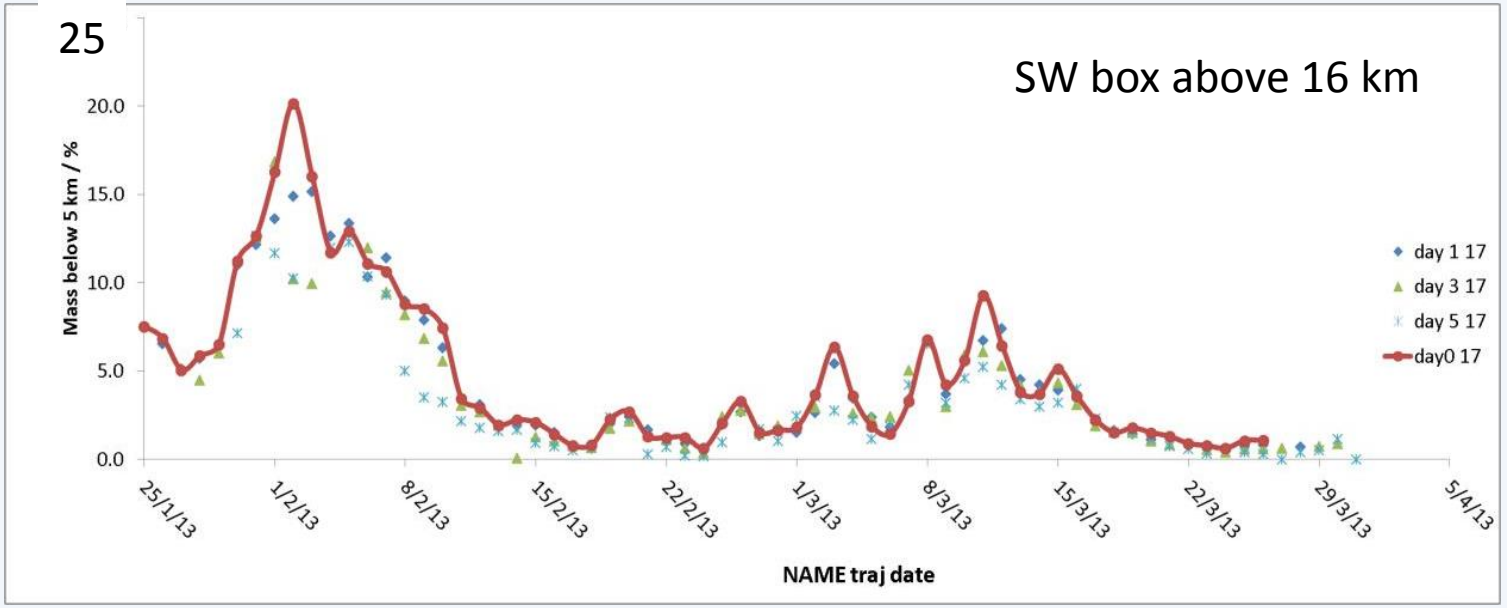
Consistency between forecasts

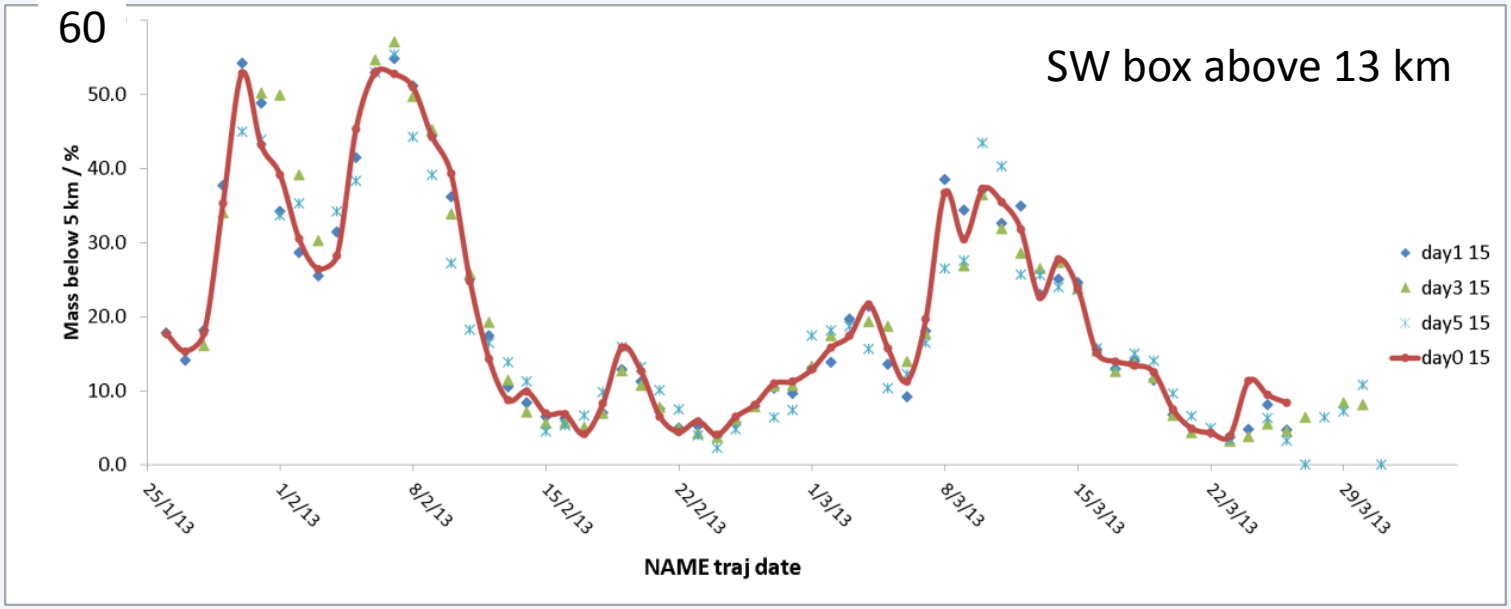


GH East Pacific NAME runs: Real variability between boxes

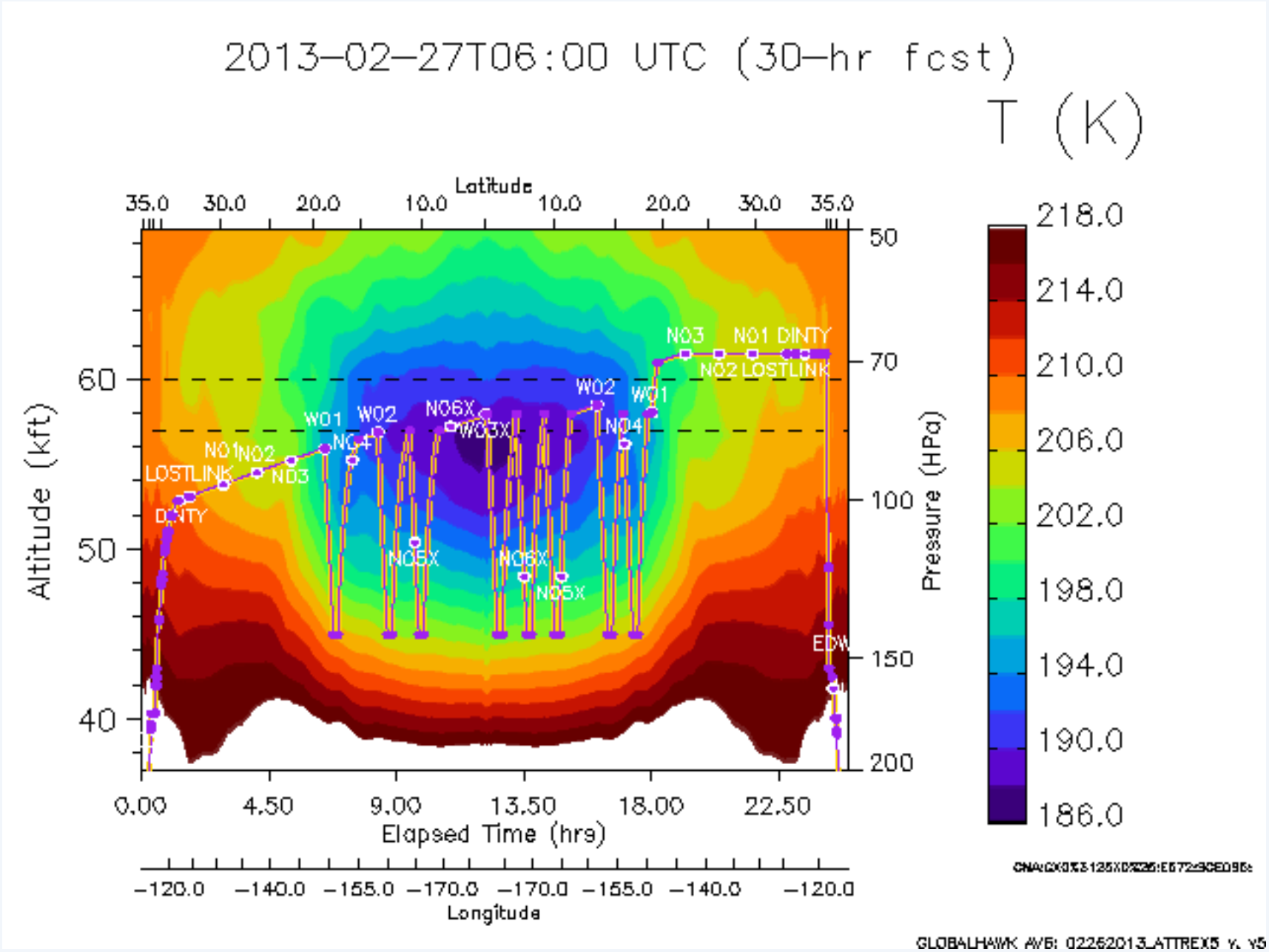


GH East Pacific NAME runs: altitude changes

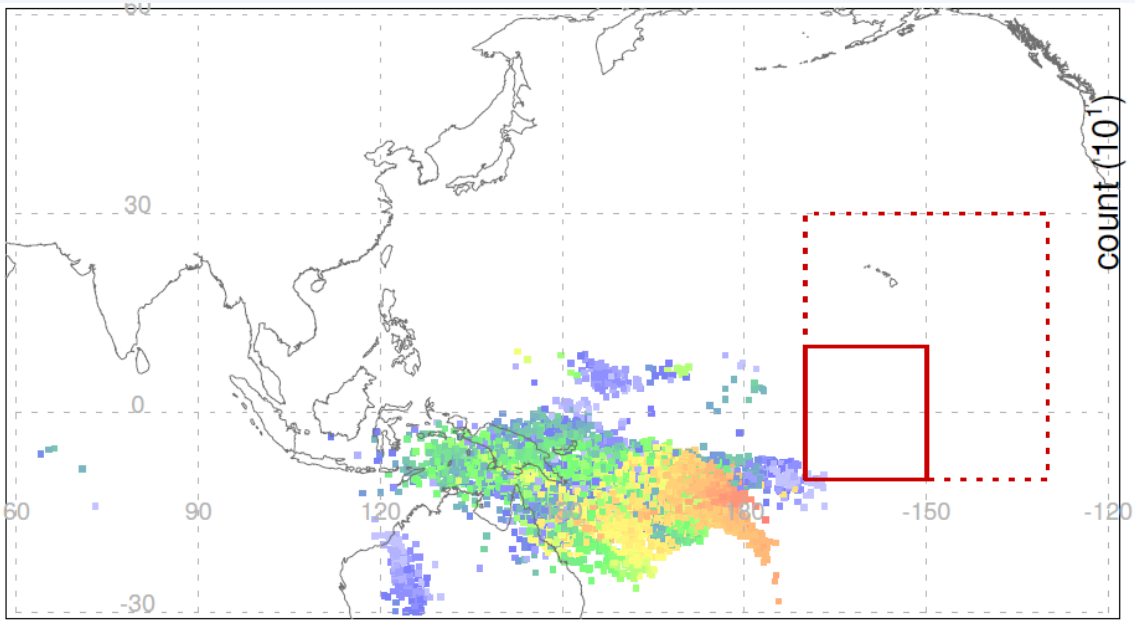


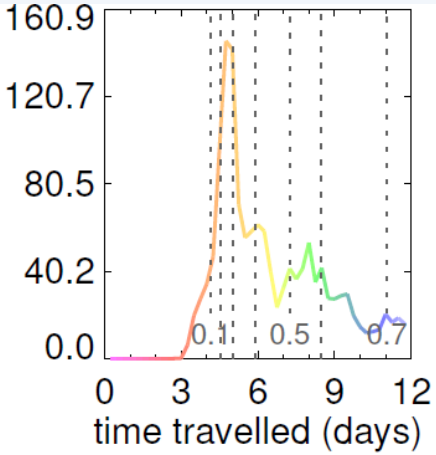


Joint flight plans - Jan-Feb 2014

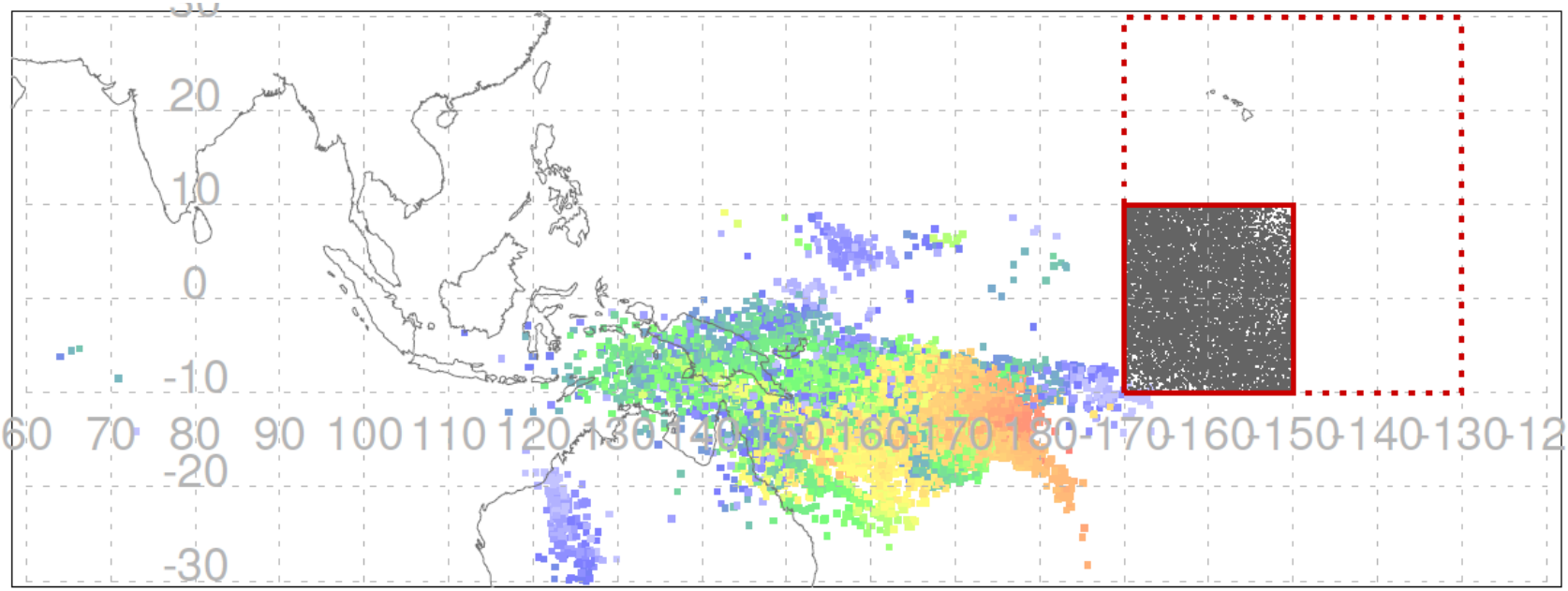


NAME – further development





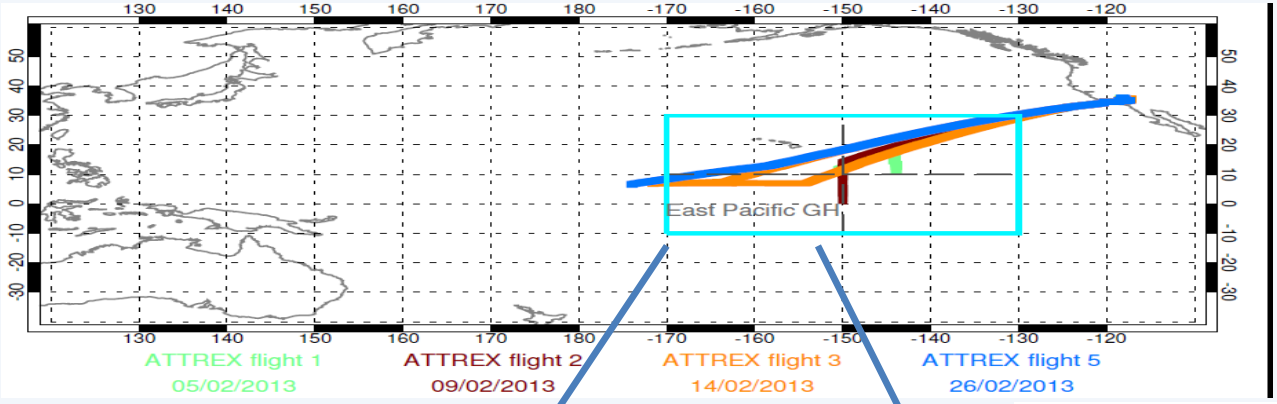
NAME run: 10/03/2013
12-day back traj. : 11/03/2013
range = 14.0-16.0 km
crossed 5 km = 0.716

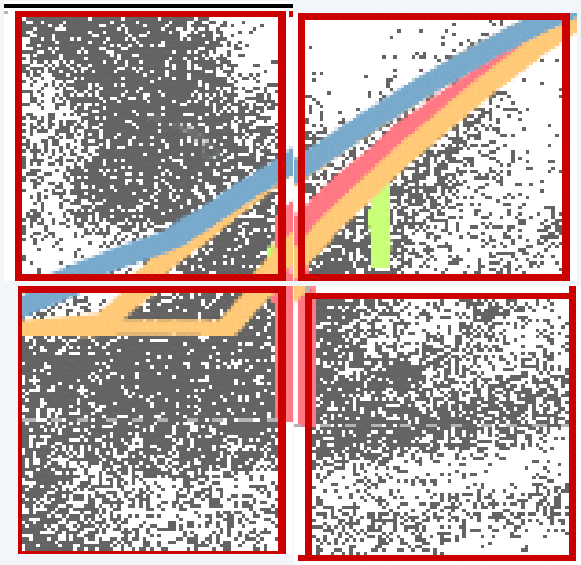


NAME run: 10/03/2013 12-day back traj. : 11/03/2013 range = 14.0-16.0 km crossed 5 km = 0.716

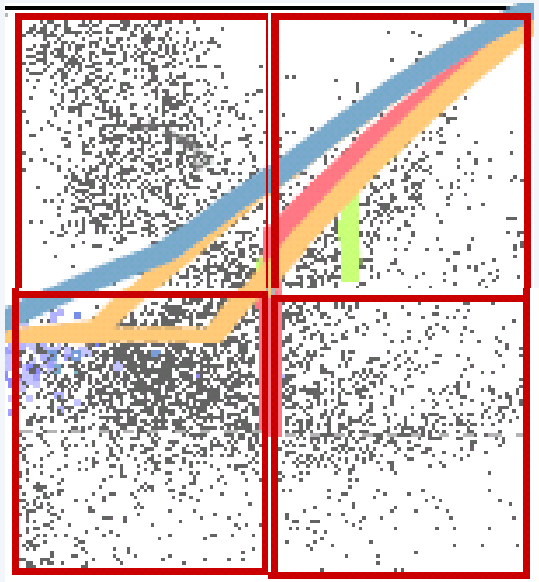
NAME – further development

- Tracer analysis: Density distribution over the boxes
- Calculations of fractions of trajectories within 0-1, 1-2, 2-3…17-18 km
- Algorithm to produce concentrations of tracers within 0-18 km
- Compare modelled results with ATTREX measurements

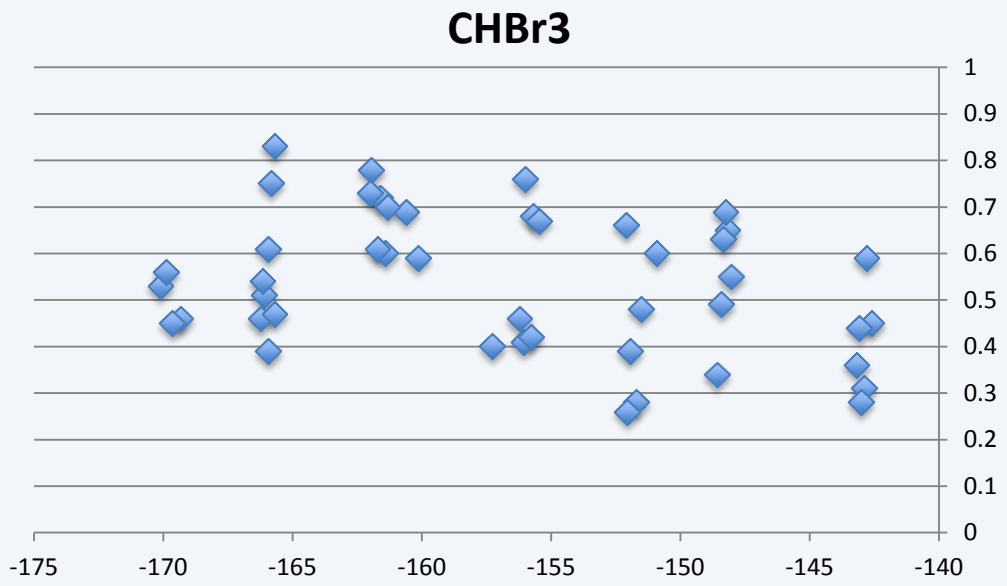




NAME run: 2013/02/25
Forecast: 2013/02/26
crossed 5 km and 1 km

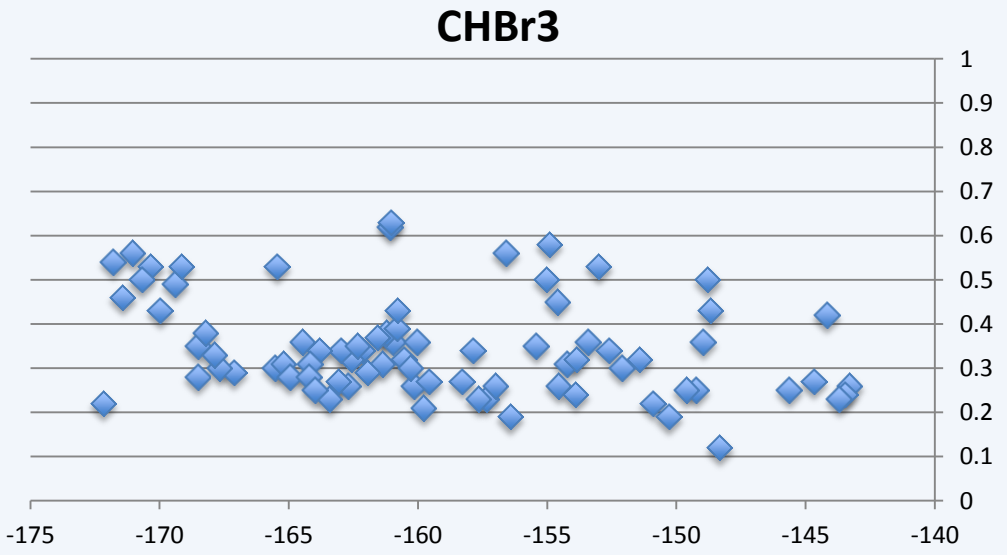


Joint flight plans - Jan-Feb 2014



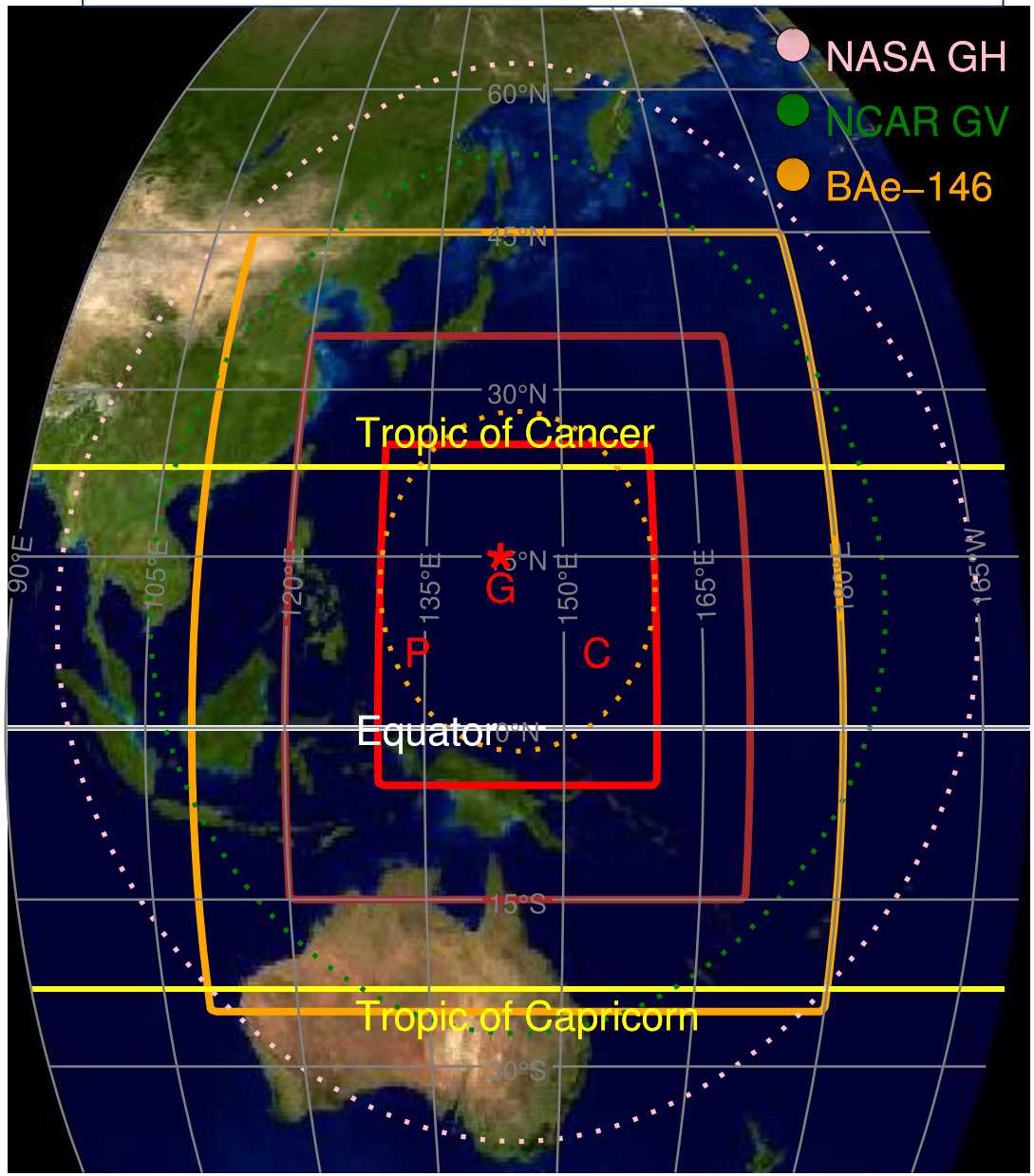
ATTREX 2013 flights

16 > z > 14 km



Z > 16 km

Joint flight plans - Jan-Feb 2014



Summary of NAME runs for CAST 2014

#	Source area	Source altitude	Density	Runs	Plots
1. WestPac "GH"	**120-180E,15S-25N** (120-140E,15S-10N 140-160E,15S-10N 160-180E,15S-10N 120-140E,10-25N 140-160E,10-25N 160-180E,10-25N)	14-16 16-18 km (GH) 8-11 11-14 km (GV)	20,000 particles per 2 km layer (instantaneous release)	12 days back trajectories starting from day +5, +3, +1	Cross location maps (5, 1 km) Air history maps Time-dependent tracer conc maps
2. WestPac "146"	**130-160E,5S-25N (G-P-EQTR-Ch-G)** (130-145E,5S-10N 145-160E,5S-10N 130-145E,10-25N 145-160E,10-25N)	0-5 km 0-1 km	150,000 particles per 5/1 km layer (instantaneous release)	X day forward trajectories from day 0, -5, -10	Cross location maps (10, 13, 16 km) Altitude vs time plots Full-length trajectory plots
3. WestPac "GB"	Single locations (d=+/- 2^{o}) Chuuk (150-154E, 5-9N) Samoa (170-174E, 16-12S) Nauru (165-169E, 2S-2N) Manus (145-149E,4S-0)	0.3-0.6 km 0.7-1.0 km	15,000 particles per hour/ 3 hours (continuous release)	15/20/25/30 day back trajectories starting at day 0, +3, +5 DJFM season covered	Back air history maps (quantified air mass origin, source and transport direction)

Joint flight plans - Jan-Feb 2014

Other things to remember

- MJO influence – plans for different phases
- Isolated convection vs mesoscale convection

Measurement comparison flights

PAYLOAD COMPARISON

Obs	Aircft	Instrument	PI	Intercomparison method
CO*	GV 146 GH	VUV Aerolaser	Campos/NCAR FAAM	Standard comparison and traceability Intercomparison flight
O_3*	GV 146	Fast ozone TE49C	Weinhemer/NCAR FAAM	Intercomparison flight
NO, NO_2	GV 146 GH	Nox AQD	Weinhemer/NCAR Lee/York	Intercomparison flight
CO*, CH_4*	GV 146 GH	Picarro Los Gatos	Flocke/NCAR FAAM + Gallagher	Standard comparison and traceability Intercomparison flight
N_2O, H_2O*	GV 146 GH	Aerodyne QCL	Gallagher/UMan	Standard comparison and traceability Intercomparison flight
BrO	GV 146 GH	AMAX CIMS MiniDOAS	Volkamer/CU Percival/UMan Pfeilsticker+Stutz	Vertical profiles of 146 and GV co-ordinated with line-of-sight of GH?
VSLS*	GV 146 GH	WAS WAS, in situ GC-MS WAS	Atlas/Miami Carpenter/York Atlas/Miami	Standard comparison and traceability Intercomparison flight WAS bottle exchange
Radiation	GV 146 GH	Spectral Actinic Flux	Hall/NCAR	Intercomparison flight

* Also ground, sonde

ATTREX/CONTRAST/CAST measurement intercomparisons

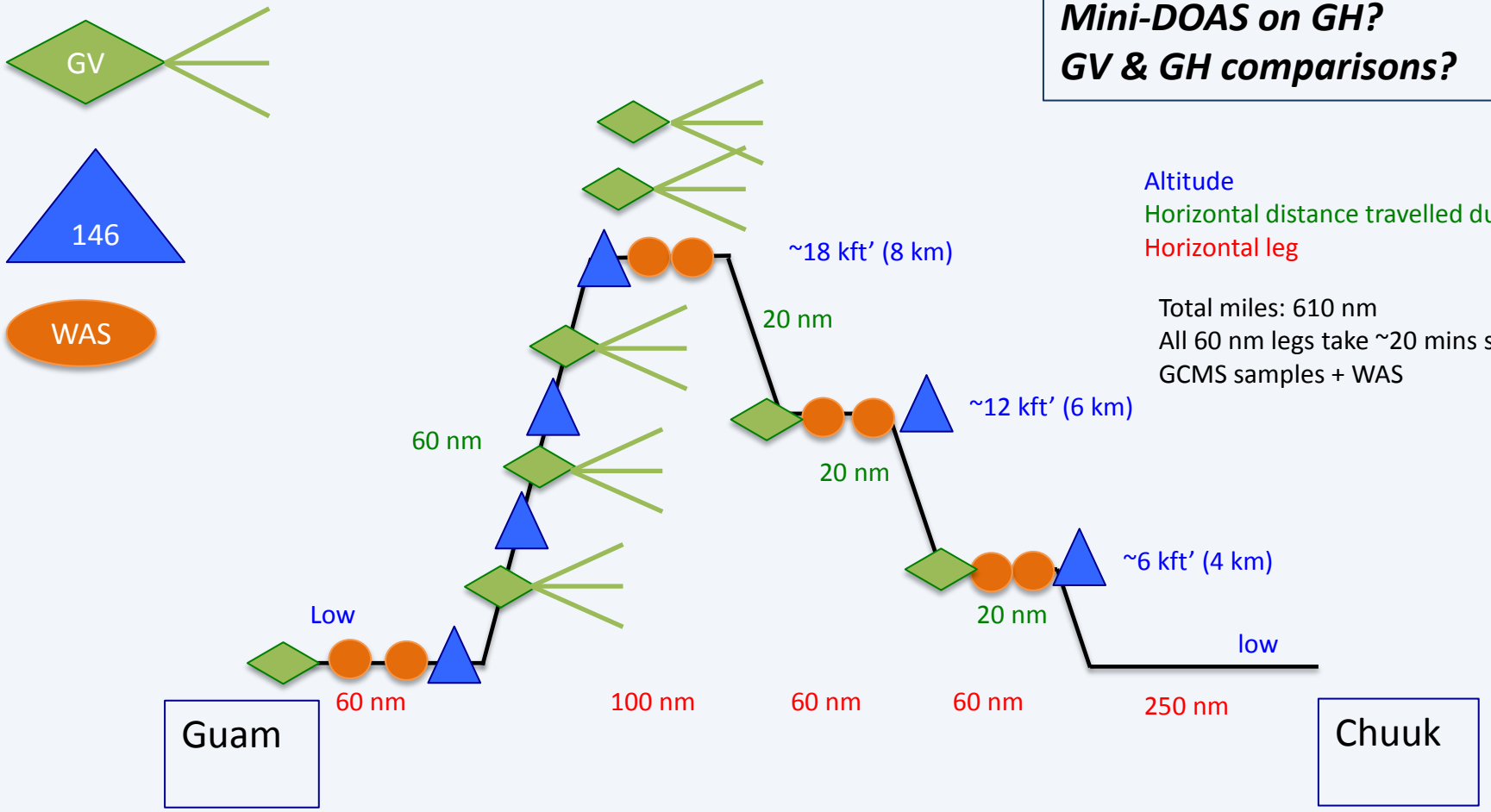
Potential Approaches

- GV and BAe146 wing-tip to wing-tip intercomparison flights
- Joint analysis of “WAS” bottle samples
- Vertical profiles of BAe146 (and GV?) along the line-of-sight of the mini-DOAS on GH
- Comparison of calibration standards
- Traceability to scales

Wing-tip to wing-tip intercomparison flights + WAS exchange

Joint GV/146 flight Guam ➔ half way to Chuuk/Palau

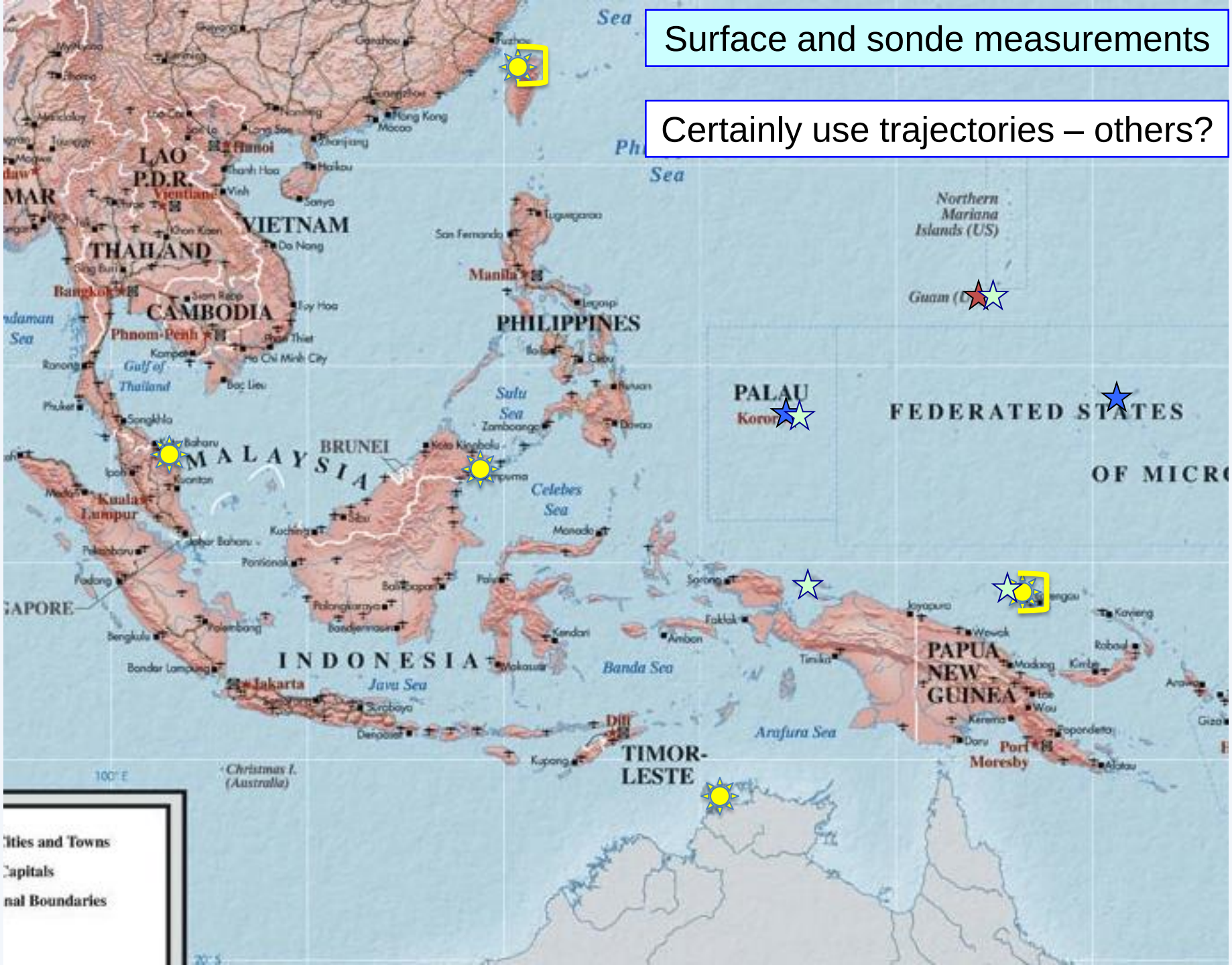
Wing-tip to wing-tip needed?
Mini-DOAS on GH?
GV & GH comparisons?



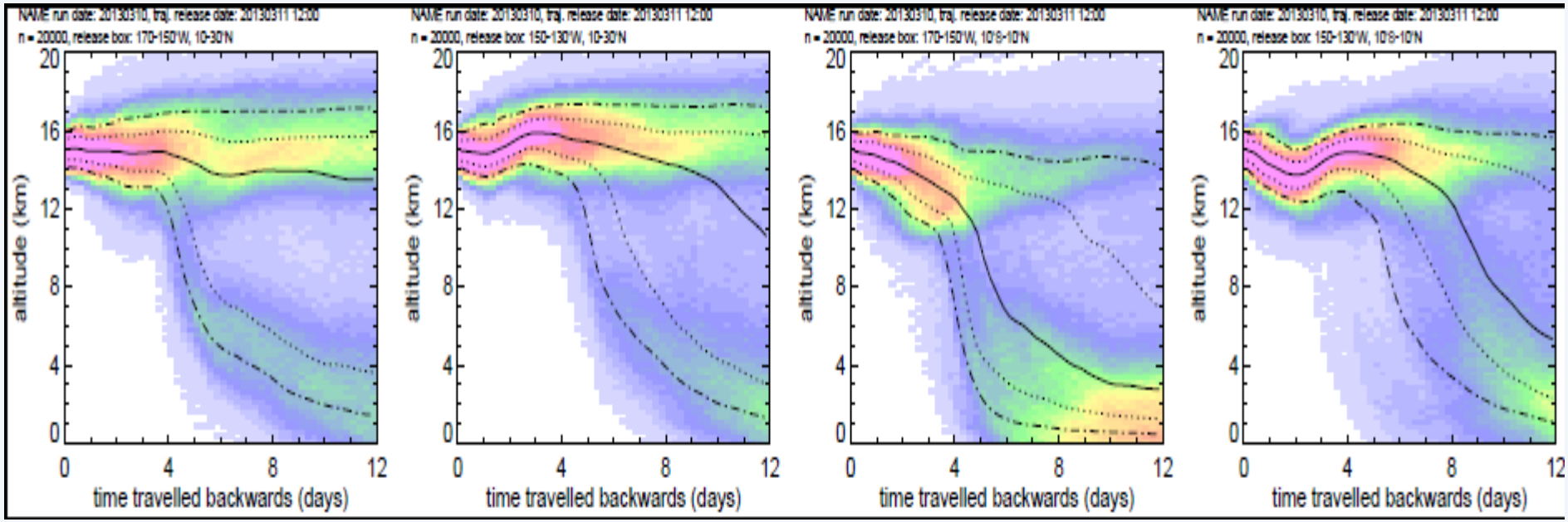
Altitude
Horizontal distance travelled during climb
Horizontal leg

Total miles: 610 nm
All 60 nm legs take ~20 mins so 4-5 GCMS samples + WAS

Linking to ground and sonde measurements


Surface and sonde measurements
Certainly use trajectories – others?
LAO P.D.R.
Hanoi
Vientiane
VIETNAM
THAILAND
Bangkok
CAMBODIA
Phnom Penh
Ho Chi Minh City
Gulf of Thailand
Andaman Sea
MALAYSIA
Kuala Lumpur
BRUNEI
SINGAPORE
INDONESIA
Jakarta
Java Sea
Celebes Sea
Sulu Sea
PHILIPPINES
Manila
Cebu
Davao
Zamboanga
Sea
Northern Mariana Islands (US)
Guam
PALAU
FEDERATED STATES
OF MICRO
Banda Sea
Arafura Sea
PAPUA NEW GUINEA
Port Moresby
TIMOR-LESTE
Dili
Christmas I. (Australia)
Cities and Towns
Capitals
nal Boundaries

Thank you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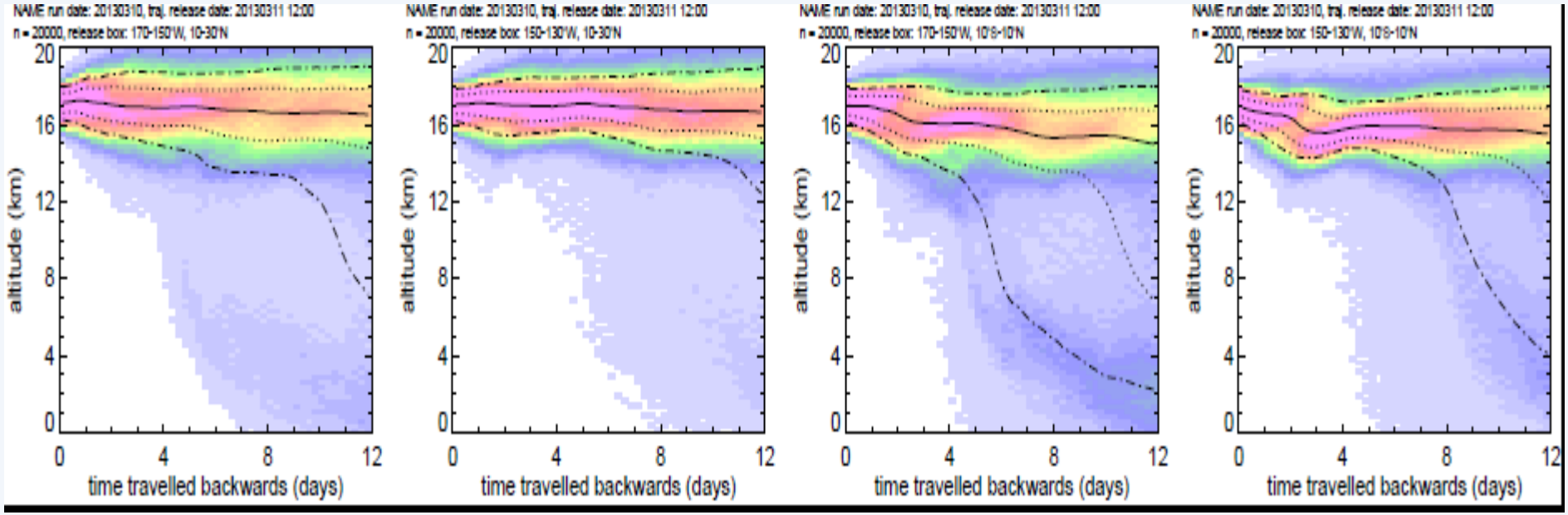
n = 20000, release box: 170-150°W, 10-30°N
NAME run date: 20130310, traj. release date: 20130311 12:00
n = 20000, release box: 150-130°W, 10-30°N
NAME run date: 20130310, traj. release date: 20130311 12:00
n = 20000, release box: 170-150°W, 10°S-10°N
NAME run date: 20130310, traj. release date: 20130311 12:00
n = 20000, release box: 150-130°W, 10°S-10°N
altitude (km)
0
4
8
12
16
20
time travelled backwards (days)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NAME run date: 20130310, traj. release date: 20130311 12:00
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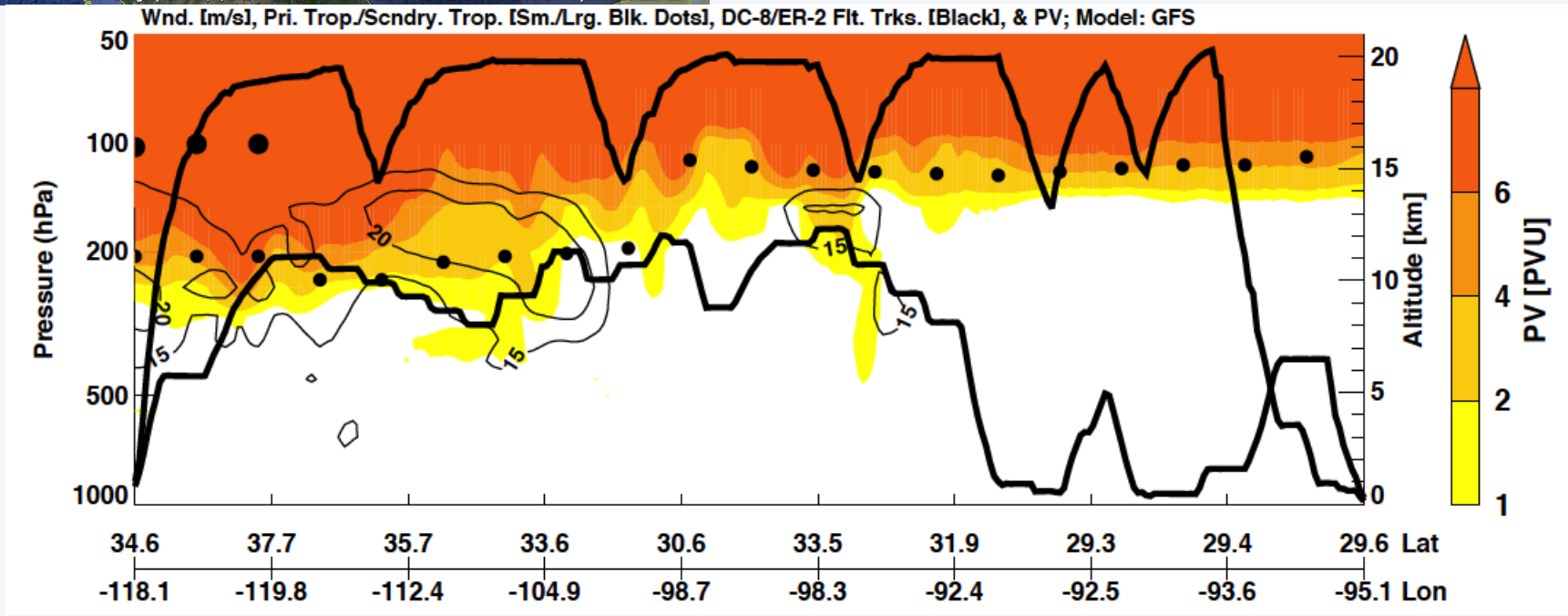
NAME run date: 20130310, traj. release date: 20130311 12:00
n = 20000, release box: 170-150°W, 10°S-10°N
NAME run date: 20130310, traj. release date: 20130311 12:00
n = 20000, release box: 150-130°W, 10°S-10°N
altitude (km)
0
4
8
12
16
20
time travelled backwards (days)

SEAC4RS
ER2 and DC8 stacked flight
Transit from Palmdale to Houston
RF02, Aug 8, 2013



CAST : BAe-146 Payload

Observation	Instrument	Investigator	Meas. Synergy
O_3	TE49C	FAAM	GH, GV
H_2O Vapor	General Eastern 1011 / Buck CR2	FAAM	GH, GV
CO	Aerolaser 5002	FAAM	GH, GV
CO_2, CH_4	Los Gatos	FAAM / Bauguitte + Manchester / Gallagher	GH, GV
N_2O, H_2O	Aerodyne QCLAS	Manchester / Gallagher	GH
VSL halocarbons[1]	Agilent GC-MS / Markes Dual TD *(in situ and WAS)*	York / Carpenter	GH, GV
NMHC, small OVOC, DMS[2]	GC-FID *(WAS)*	York / Carpenter	GH, GV
NO, NO_2	Air Quality Design	FAAM / Bauguitte + York / Lee	GV
BrO, other[3] (in situ)	CIMS	Manchester / Percival	GV
IO, I_2, OIO (In situ)	BBCEAS	Cambridge / Jones	GV (IO remote)
Black carbon	SP-2	Manchester / Gallagher	None
Aerosol	PCASP (Core FAAM)	Manchester/All	GH, GV
Winds/Turbulence/Met	AIMMS-20 (Core FAAM)	Manchester/Vaughan	GH, GV

1. $CHBr_3$, CH_2Br_2, $CHBr_2Cl$, CH_3I, CH_2BrCl, $CHBrCl_2$, C_2H_5I, CH_2ICl, CH_2IBr, CH_2I_2, CH_2Cl_2, $CHCl_3$
2. C1-C7 NMHCs (alkanes, alkenes, aromatics); small oVOCs (acetone, methanol, acetaldehyde, ethanol); DMS
3. HCOOH (formic acid), HCN, $ClNO_2$, HNO_3, N_2O_5, CH_3COOH (Acetic Acid), CH_3CH_2COOH (propanoic acid), $CH_3CH_2CH_2COOH$ (butanoic acid)

Aircraft dates

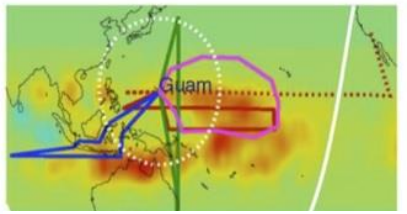
Jan 8:	depart UK
Jan 11:	arrive Guam
Jan 13 – Feb 7:	operational
Feb 9:	depart Guam
Feb 12:	arrive UK

FAAM Bae-146 Flights option (c) – 2 nights

Guam 13.5° N,
145° E
Chuuk 7.5° N,
152° E

Sample at < 20 kft (6 km)

Equator

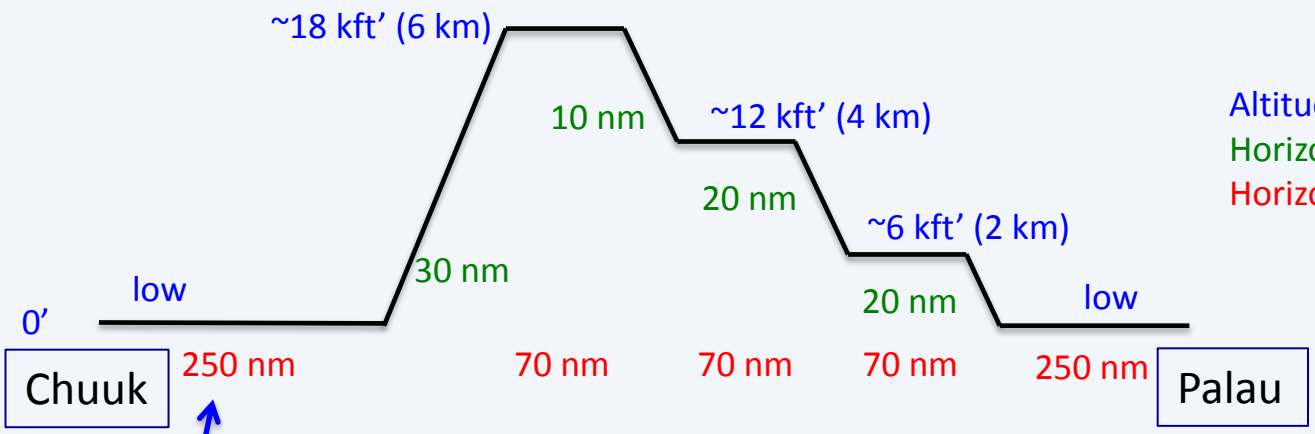


Nominal Global Hawk flights

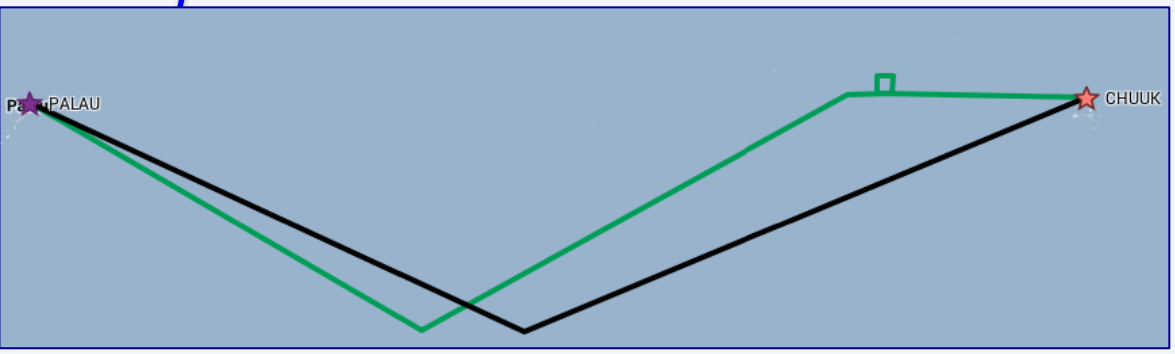
Chuuk ➔ Palau

Science aims

- Survey: 7.5 to X to 7.5N



Altitude
Horizontal distance travelled during climb
Horizontal leg

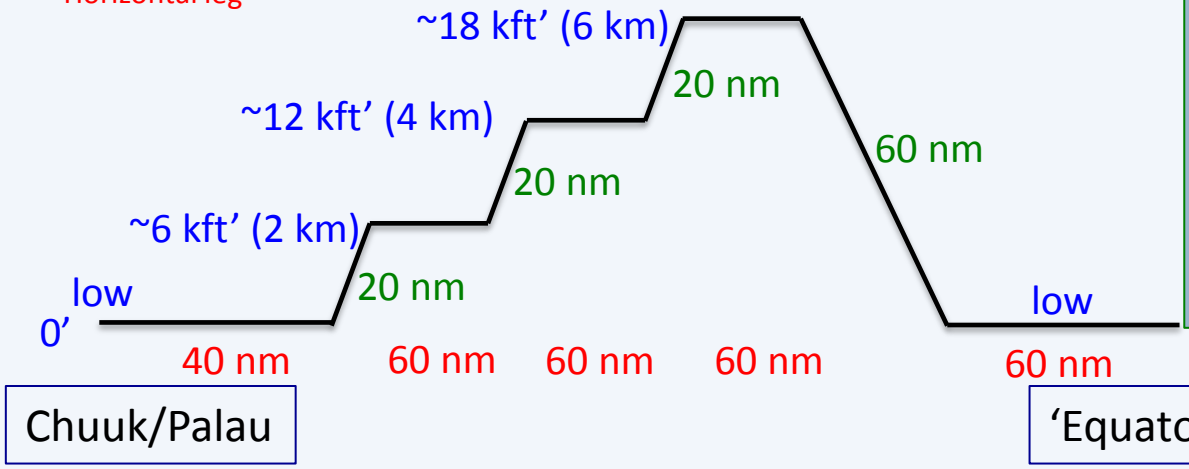


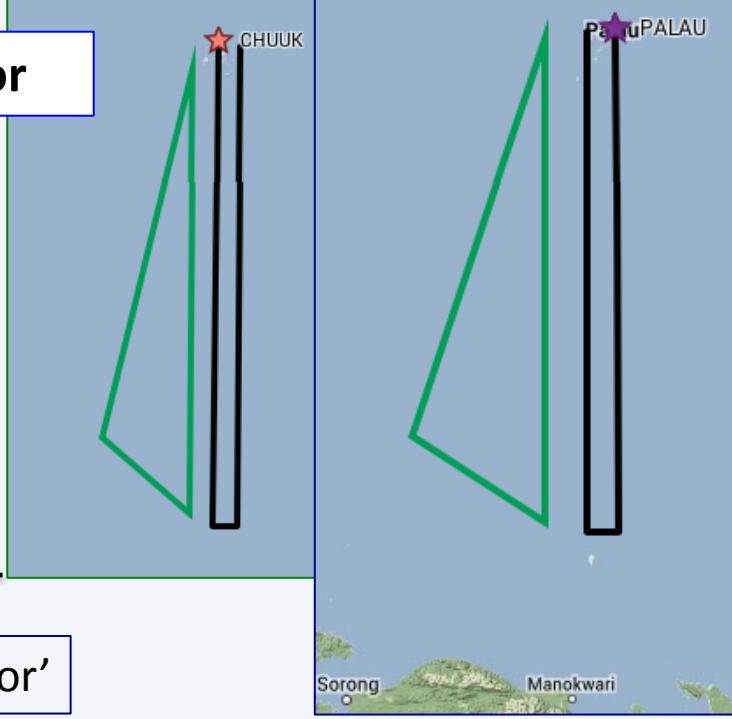
Not clear how far S we can go if we do profiles

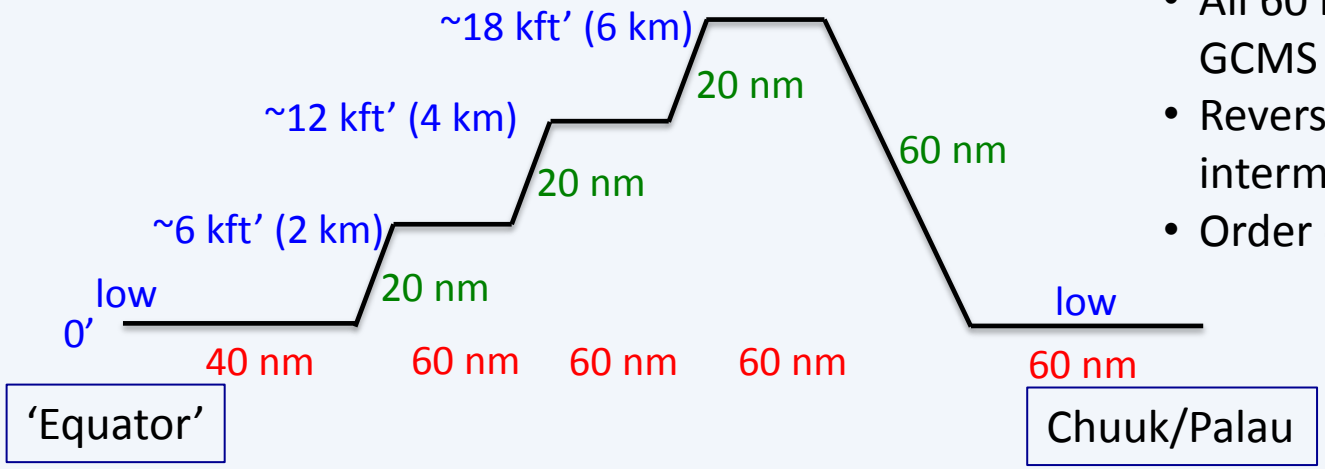
Science aim
Survey: 7.5N to equator

Chuuk/Palau ↔ equator

Altitude
Horizontal distance travelled during climb
Horizontal leg

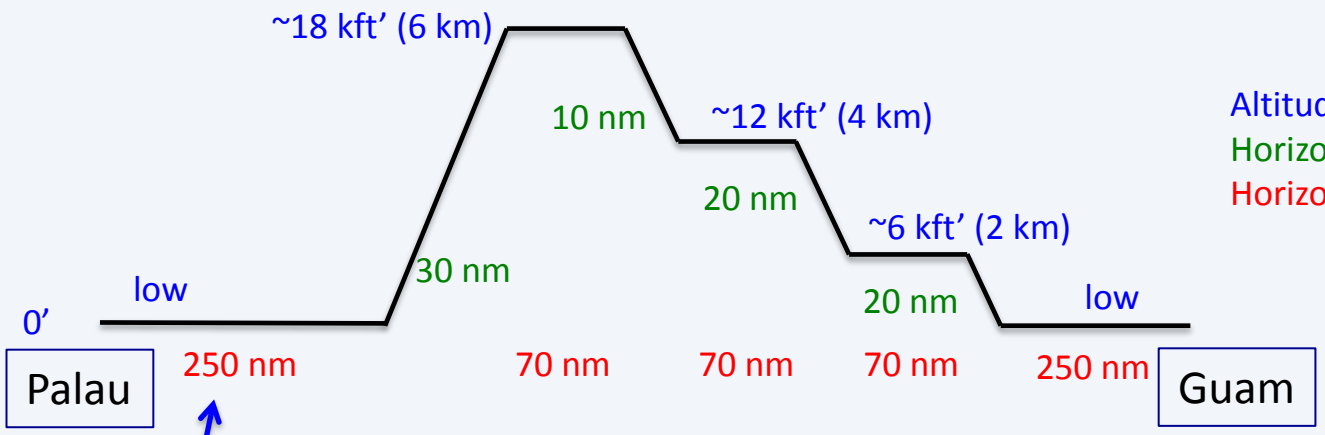




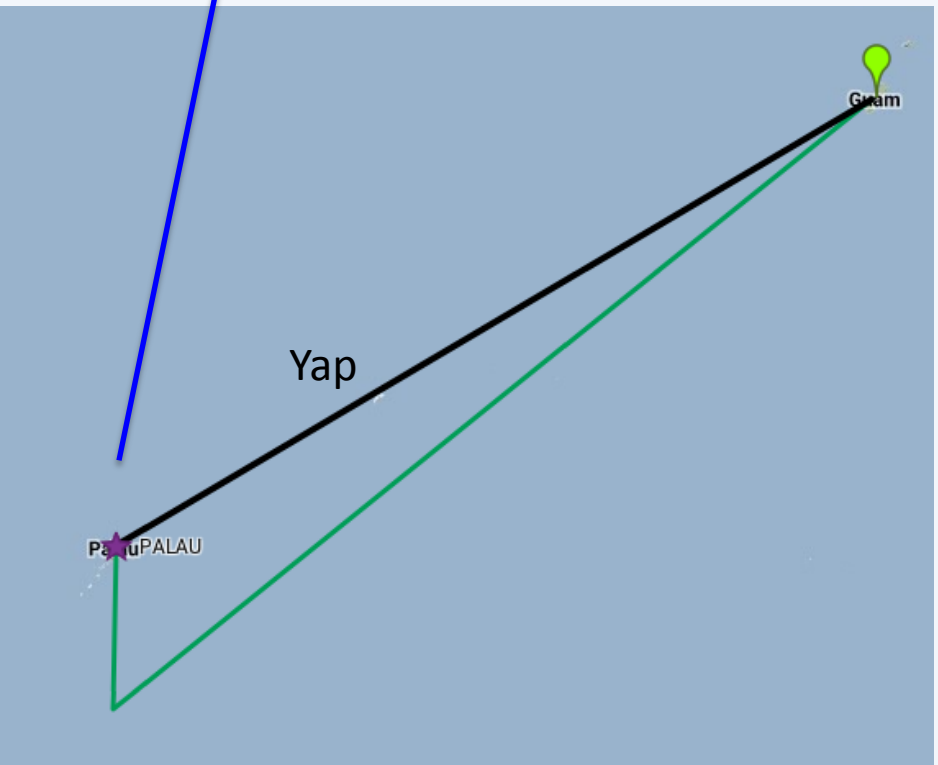


- Total miles out: 400 nm
- All 60 nm legs take ~20 mins so 5 GCMS samples + WAS
- Reverse on way back, perhaps at intermediate heights (1, 3, 5 km)
- Order of altitude legs not critical

Palau ➔ Guam



Altitude
Horizontal distance travelled during climb
Horizontal leg



Science aims

- Survey: 13.5 to 7.5N

- Total miles: 600 nm
- Leaves some time near Palau
- Could look at W side or go south
- Look at Yap?
- All 70 nm legs take ~20 mins so 5 GCMS samples + WAS

Ocean depth summary

- Guam: drops off steeply all round island
- Chuuk: 40 mile lagoon with max depth 300 ft; many little islands
- Palau: sharp drop off to E, shallower region to W
- Yap: several islands together between Palau and Guam
- Saipan/Tinian: similar except for one bay on NW side
- More islands/atolls on direct line from Chuuk to Palau (could be an option to S)