BATTREX

BAlloonsonde **T**ropical **TR**opopause **EX**periment

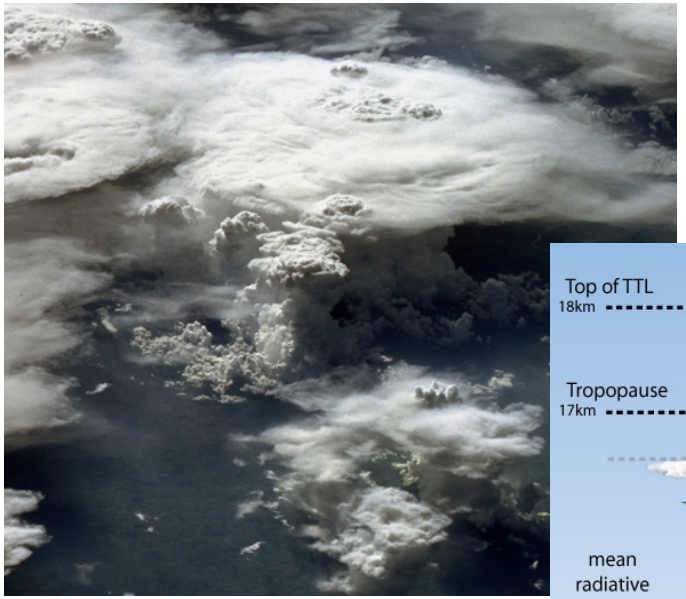
Dates: Two intensive balloon campaigns:
January/February 2014
June/July 2014

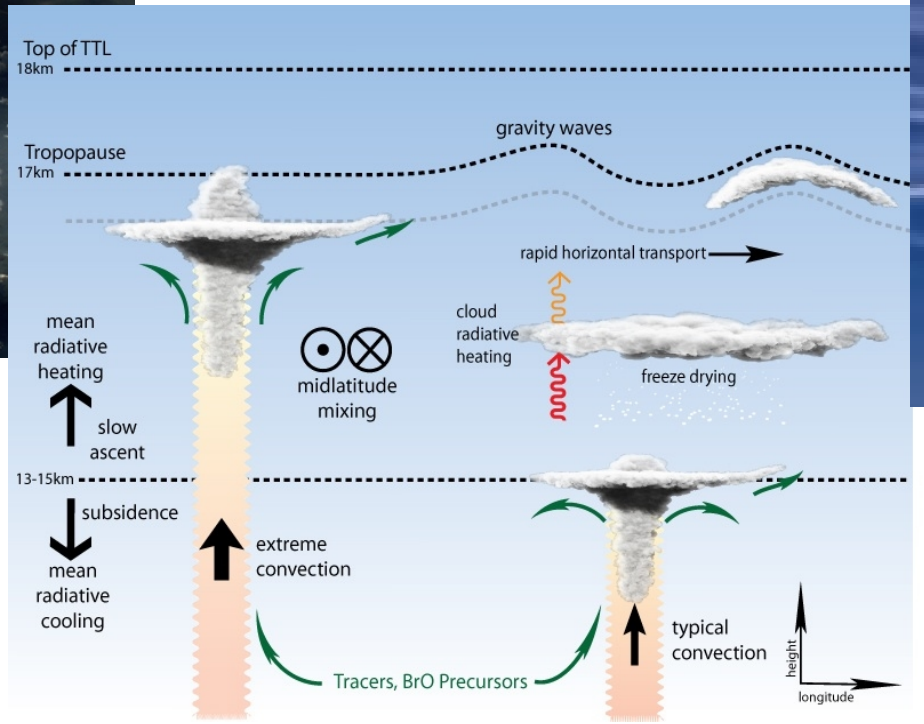
Location:
Manus Island
(2°S, 147°E)
Papua New Guinea

At the Atmospheric Radiation Measurements (ARM) program's Tropical Western Pacific site

BATTREX: Broad Objectives

Improved understanding of the interaction between:
1) Deep convection,
2) Turbulence and Waves on a variety of temporal and spatial scales,
3) Cirrus clouds, water vapor, and composition of air entering the stratosphere, and improved representation of these processes in global climate models.





Personnel

PI: Gary Morris (Valparaiso U)

Co-Is: Anne Thompson (Penn State),
Joan Alexander (NWRA),
Chuck Long (PNNL, DOE/ARM)

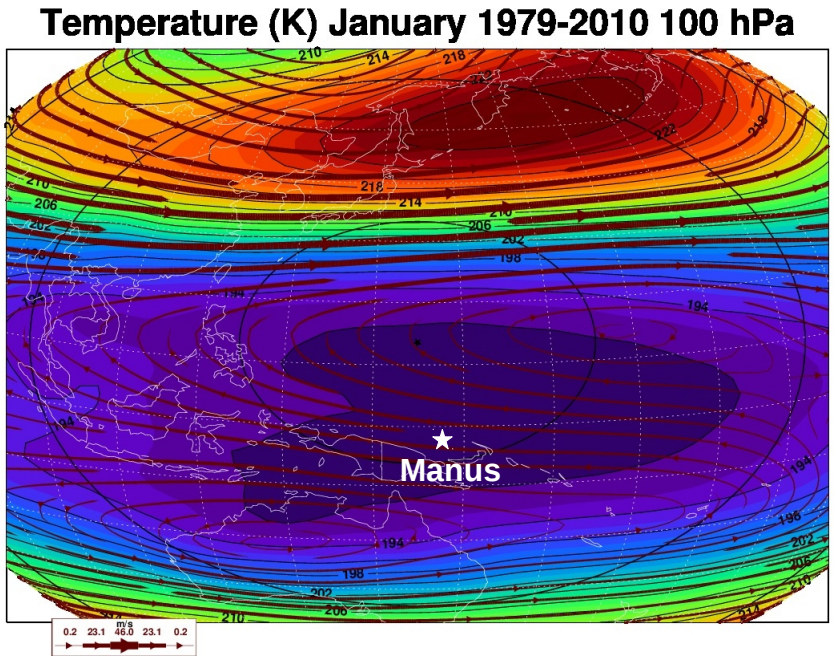
Collaborators: Rennie Selkirk (NASA),
Andrew Gettelman (NCAR),
Holger Voemel (DWD)

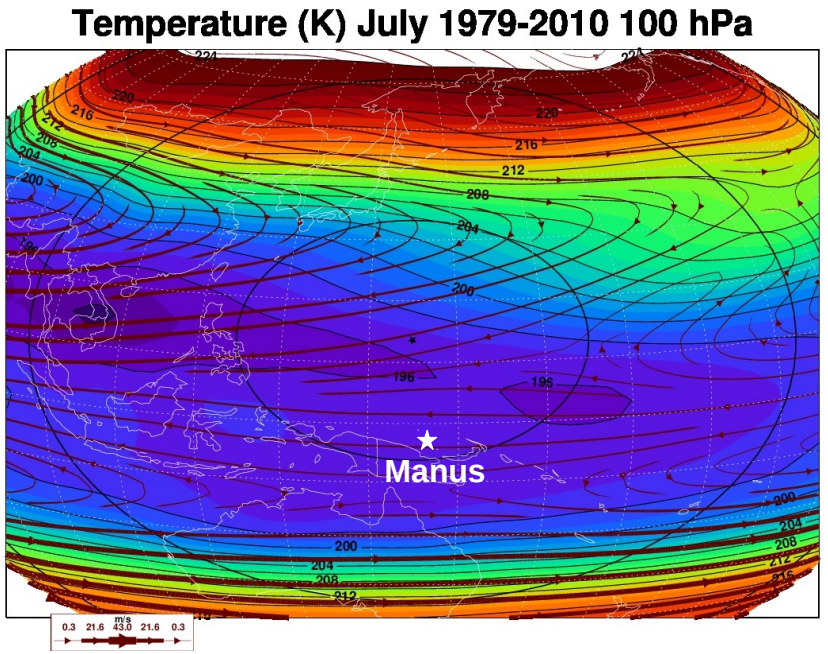
Other collaborators: M. Fujiwara, F. Hasabe, N. Harris, D. Hurst,
T. Peter, M. Shiotani, F. Wienhold

Proposal includes support for 2 graduate and 2 undergraduate students

Large Scale Context

BATTREX augments soundings from Manus to provide high-resolution profile measurements of water vapor, ozone, temperature, winds, and aerosol backscatter in the context of the large-scale phenomena that modulate stratosphere-troposphere exchange and dehydration in the western Pacific warm pool.





Climatological Temperatures January and July at 100hPa from GEOS-5

Measurement Summary

Two 36-day Intensive Observation Periods in Jan-Feb & Jun-Jul 2014

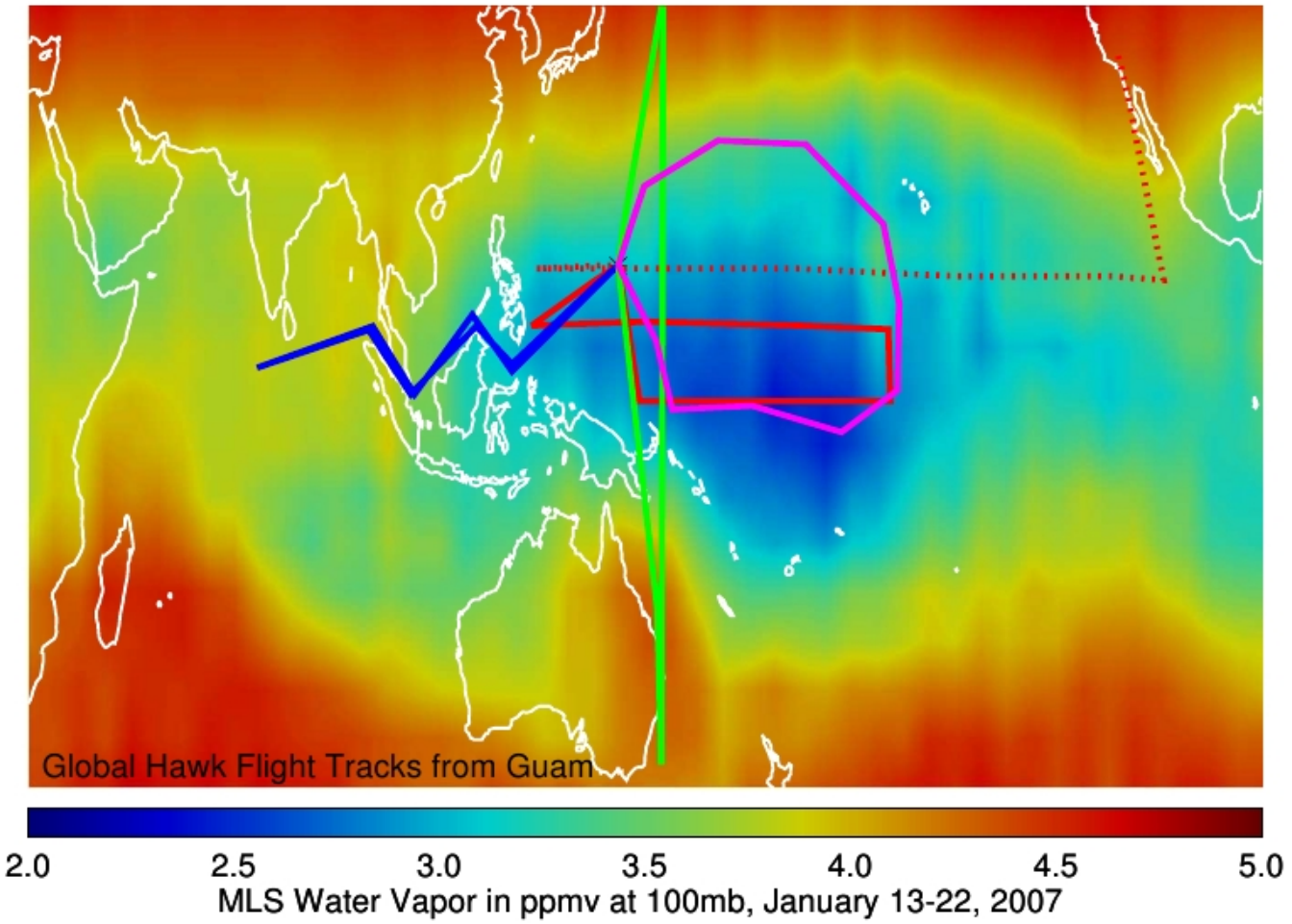
1. Balloonsonde Program. Flights planned every other day.
Payload: Cryogenic Frost-point Hygrometer (CFH)
O_3 electrochemical concentration cell (ECC)
Compact Optical Backscatter AerosoL Detector (COBALD)
Intermet radiosonde

2. Radiosonde Program. Launches 8× daily.
Vaisala RS92 radiosonde winds and temperature profiles

3. Integrate BATTREX data with data from collaborative campaigns (SOWER, CAST, ATTREX), with routine 2x daily radiosonde measurements, and with satellite measurements (AIRS, EOS-MLS, CrIS).

Coordination with ATTREX

ATTREX deployments:
Guam in Jan/Feb 2014
Darwin or Guam? Jun/Jul 2014



- High vertical and time resolution balloon measurements are complementary to ATTREX flight data
- Manus well located for ATTREX coordination for flights out of either Guam or Darwin

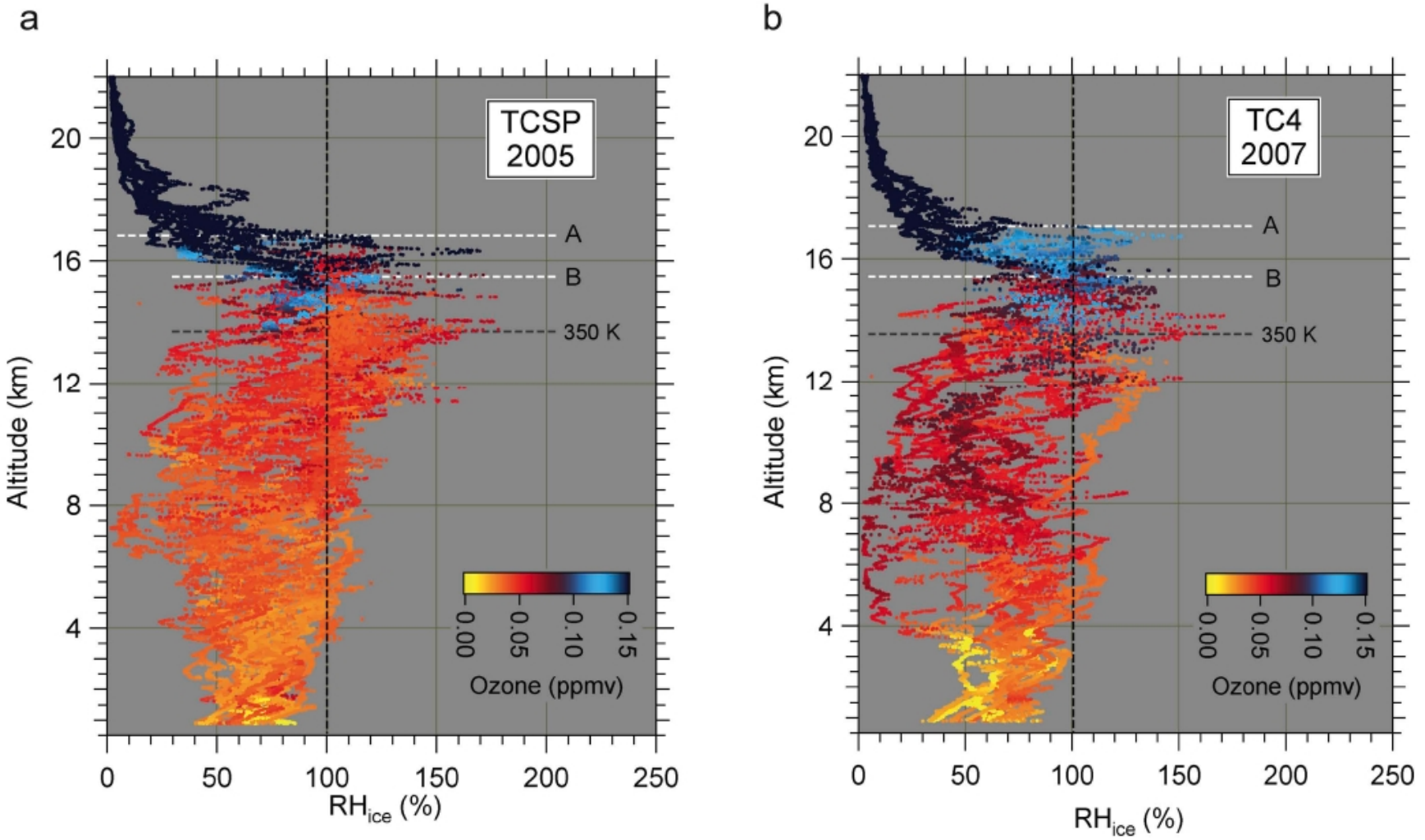
Radiosondes

PNG team launch training on Manus for AMIE campaign

Balloon Sondes

CFH/ECC photos from Costa Rica

Balloon Sondes



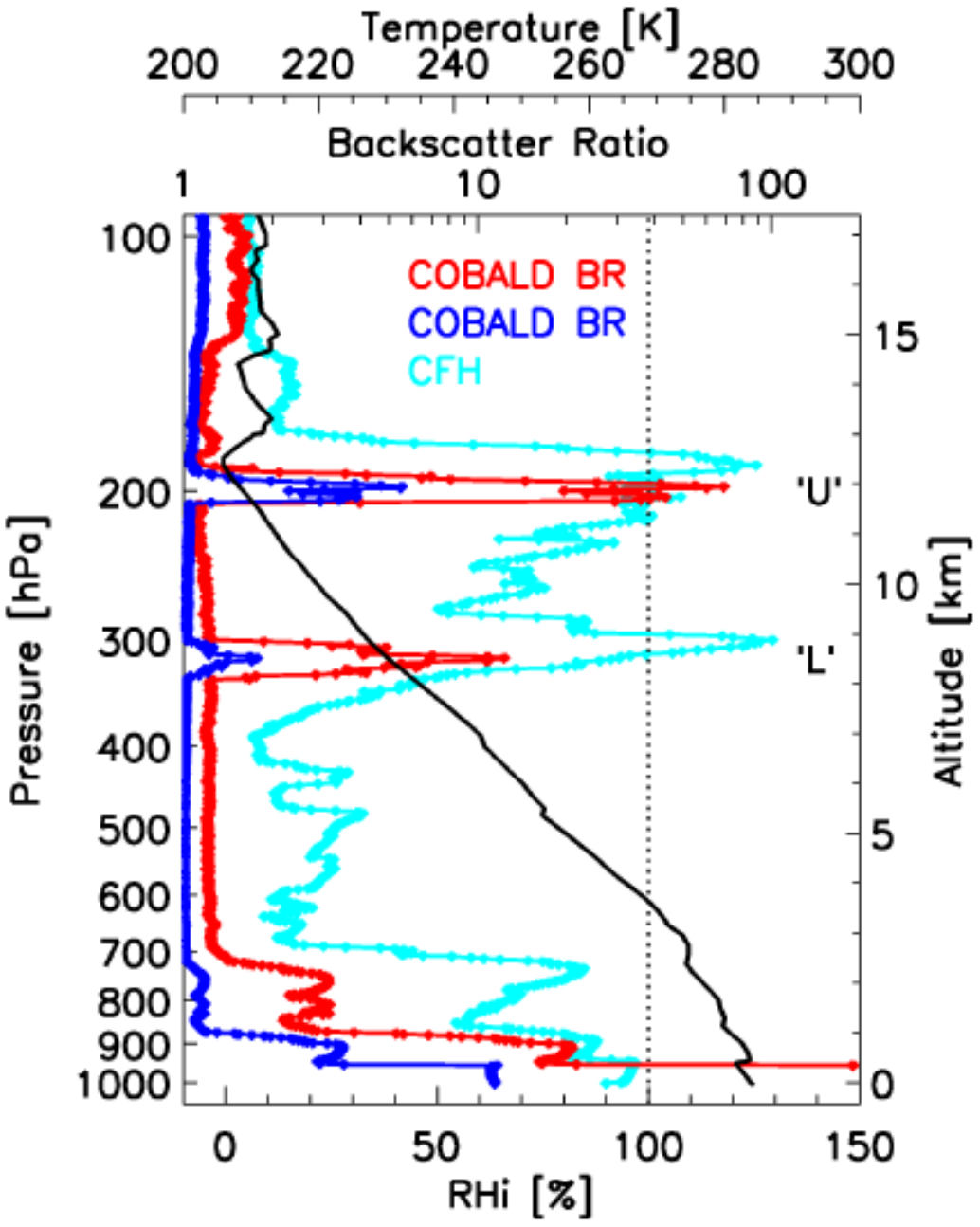
CFH and ECC at Costa Rice – NH summer

Selkirk et al 2010, Figure 4

Balloon Sondes

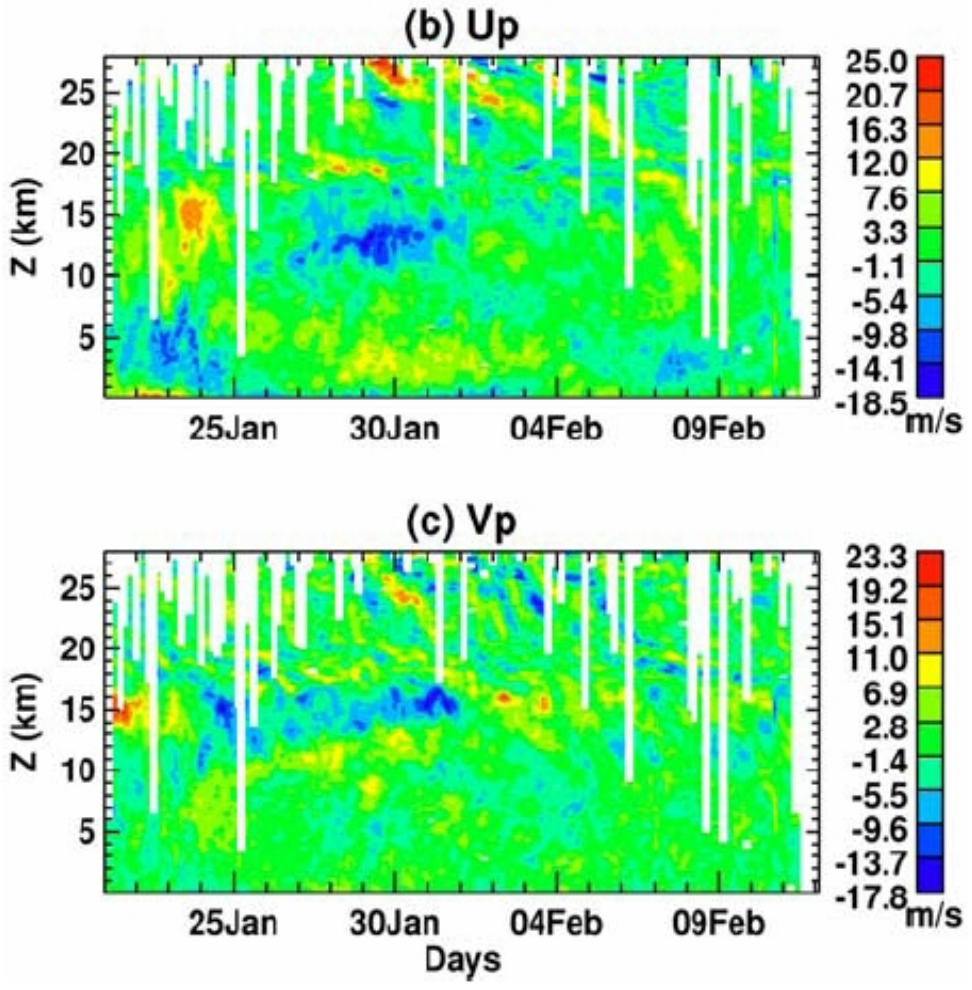
COBALD and CFH

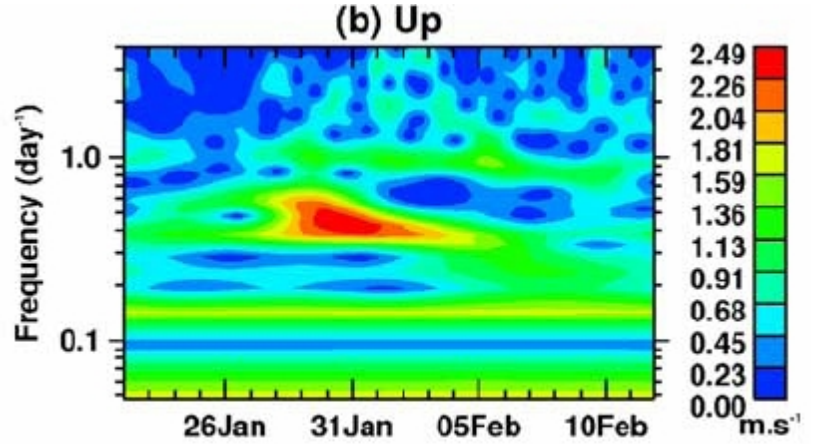
[Brabec et al. 2012]

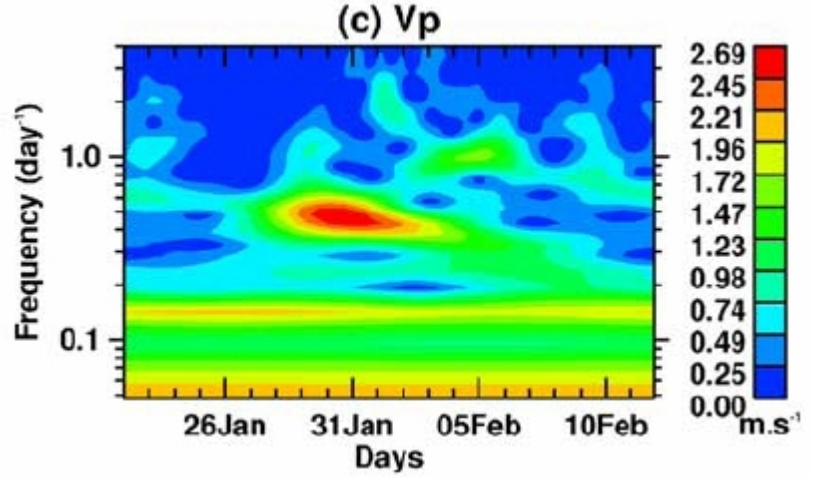


Radiosondes Waves and Wavelet Analysis in the stratosphere

8xdaily soundings from TWP-ICE
[Evan and Alexander, 2008]



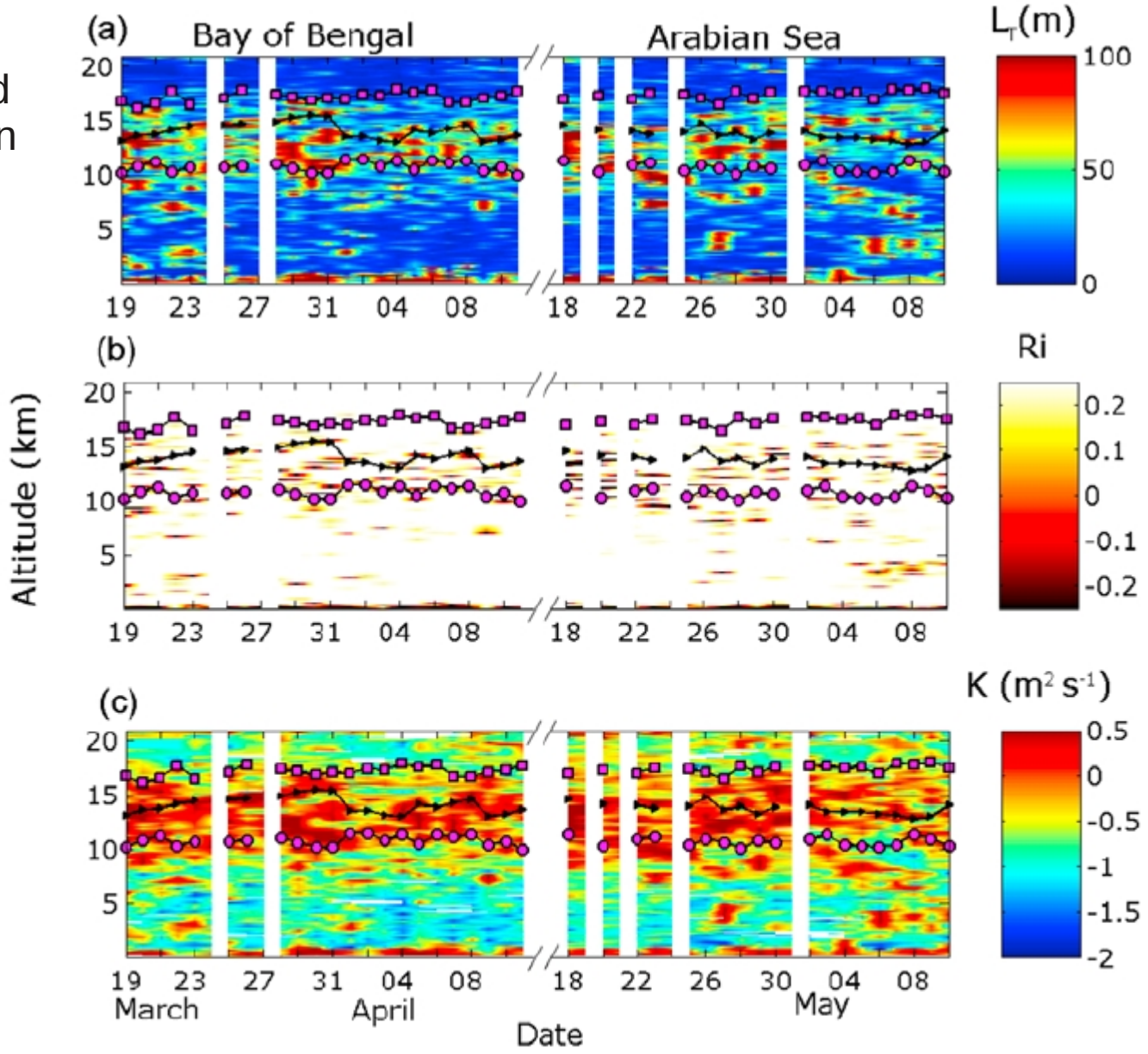




Radiosondes

Turbulence parameters

Alappattu and Kunhikrishnan 2010



Thorpe Length

Richardson Number

Eddy Diffusion

Key Science Questions

1. How important are the various processes that determine TTL?
BATTREX will quantify key variables for diagnosing convective injection, turbulent mixing, and subtropical transport and how these processes leave their mark on the vertical structure of water vapor and O3.

2. What are the characteristics of waves that determine TTL cirrus cloud occurrence and dehydration, and how well are these waves represented in global re-analyses and GCMs?
BATTREX measurements will quantify periods ranging from the slow, subseasonal waves through inertia-gravity waves, and our data are used to test and improve the representation of waves on many scales of variability in re-analyses and global models.

Program proposal submitted May 2012

White Paper Link (somewhat outdated now):
http://acdb-ext.gsfc.nasa.gov/People/Selkirk/BATTREX/BATTREX_sci_plan_14Sept2011.pdf

Mechanism (Time Scale)	Current Methods	Analysis Method (Existing Data)	BATTREX Outcome
Science Question 1: How important are the various processes that determine TTL composition?			
Convective injection and detrainment (diurnal to synoptic)	Trajectory models saturate air at cold cloud tops as defined by IR satellites	• Turbulent mixing [*Clayson and Kantha*, 2008] (AMIE) • O_3 and H_2O scatter analysis (SOWER)	6-week continuous record with time-height variations of turbulence & coincident data on origins/history of air.
Subtropical transport due to slow, large-scale wave circulation (4 days to intraseasonal)	Analysis and reanalysis systems assimilate sparse radiosonde and satellite data	• Anomalous O_3 and H_2O events (SEACIONS) • Wavelet covariance methods (operational sondes)	Origin/history of TWP air with coincident characterization of wave effects on transport
Science Question 2: What are the characteristics of waves that determine TTL cirrus cloud formation and dehydration? How well are these represented in global analyses?			
Temperature variations due to slow, large-scale waves that appear in global analysis products (4 days to intraseasonal)	Analysis and reanalysis systems assimilate sparse radiosonde and satellite data	Wavelet methods with covariance among dynamic variables [*Evan & Alexander*, 2009; *Holton et al.*, 2001] (DYNAMO)	Characterization of equatorial wave effects on H_2O and cirrus clouds in the TWP.
Temperature variations due to tropical inertia-gravity waves (< 3 days)	Random variance added to reanalysis temperatures to account for missing inertia-gravity wave spectrum	Wavelet analysis [*Evan & Alexander*, 2009] (AMIE)	Characterization of high-frequency wave effects on H_2O and cirrus in the TWP.

Concurrent Campaigns and Measurements

Campaign	BATTREX balloon sondes	BATTREX radiosondes	SOWER	ATTREX Global Hawk	CAST
Support	NSF, ARM	NSF, ARM	Japan	NASA	UK-NERC
Investigators	Morris, Thompson	Alexander	Hasebe	Jensen, Pfister	Harris, Vaughan
Measurements	CFH, O3, COBALD, iMet	RS-92 PTU	CFH, O3, PTU	Airborne in situ and remote sensing	O3, PTU
Program	18 sondes in 36 days × 2 deployments	6 days @ 4× 30 days @ 8×	~6 soundings	5 – 10 flights of 25 -28 hours each	In preparation
Jan./Feb. 2013			Tarawa, Biak, Ha Noi (10 days in Jan.)	NASA Dryden – Deep tropics, central Pacific	
Jan./Feb. 2014	Manus	Manus	Tarawa, Biak, Ha Noi (10 days in Jan.)	Guam – Deep tropics, TWP	Chuuk
June/July 2014	Manus	Manus		Darwin – Deep tropics, TWP	