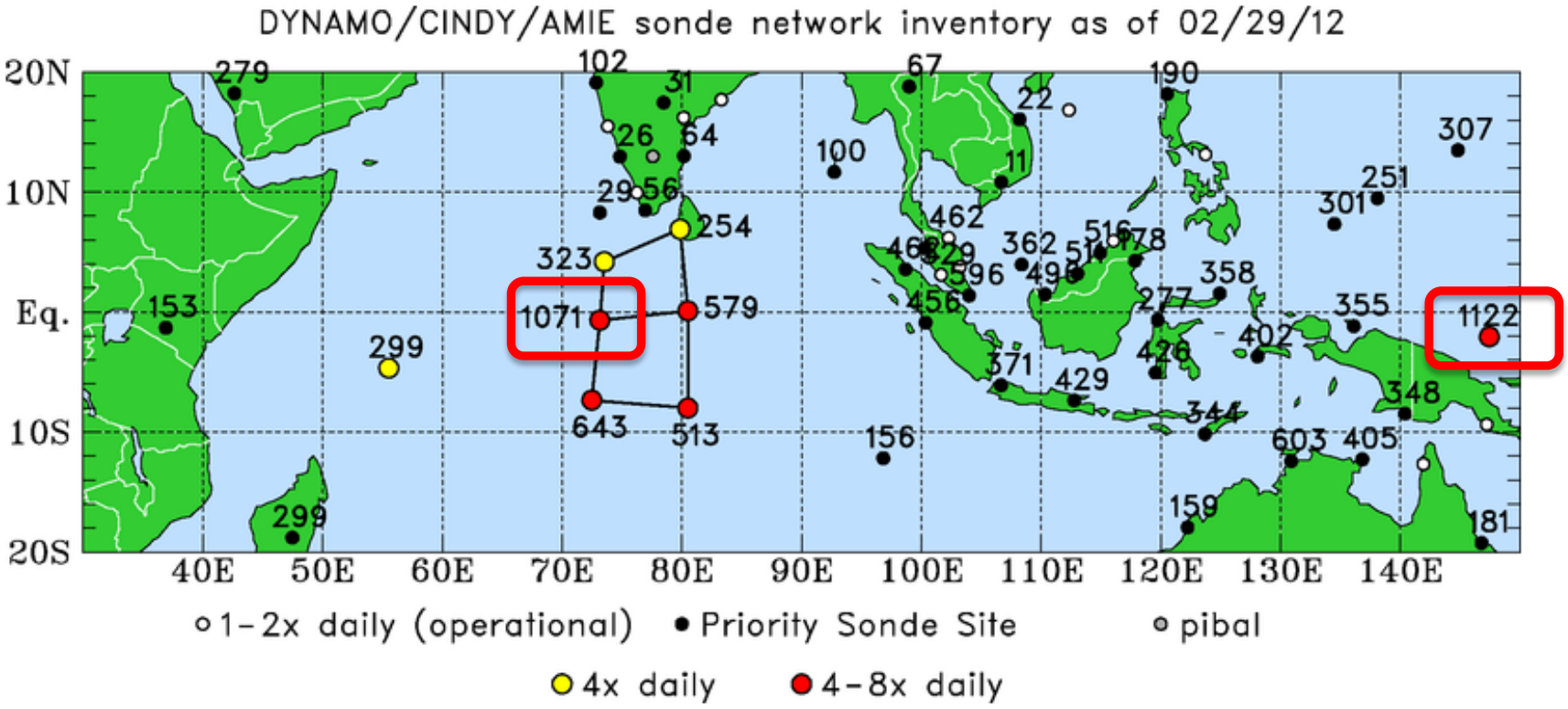
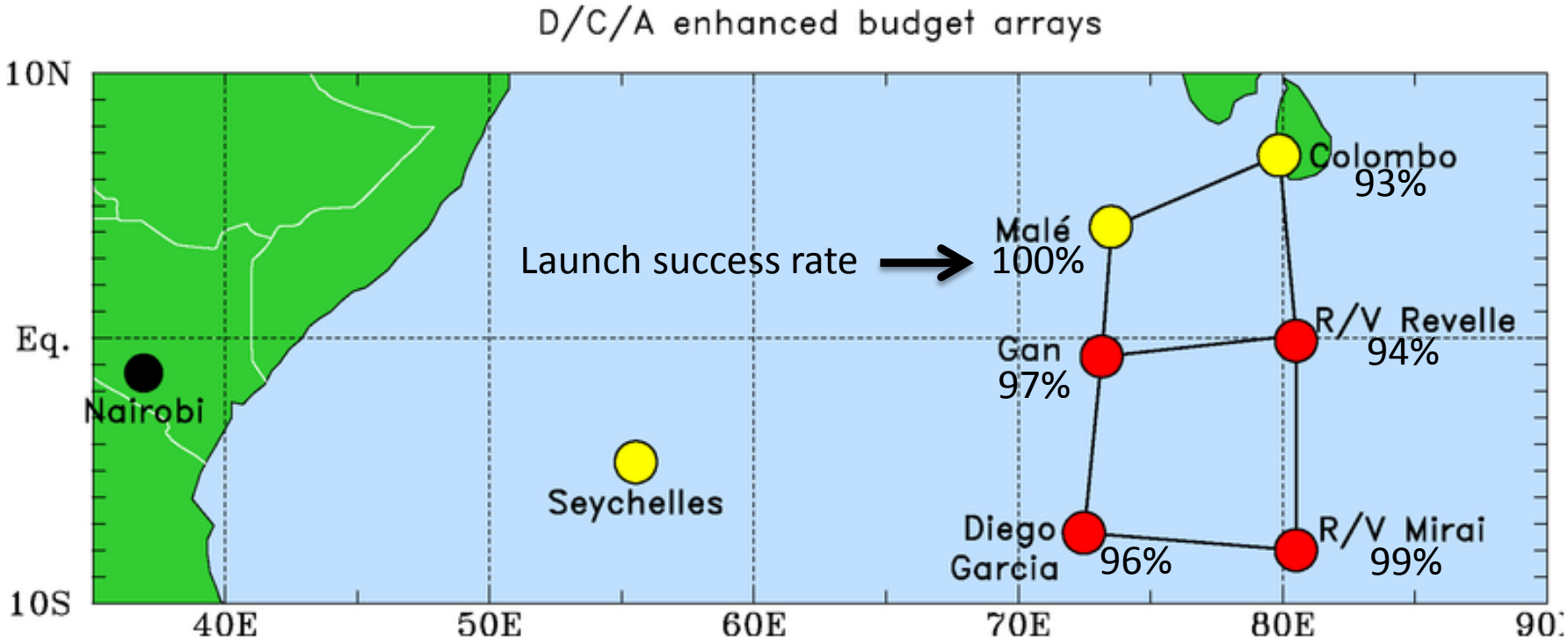
# DYNAMO/CINDY/AMIE Sonde Network Performance and Plans for Quality Control

*Paul Ciesielski and Richard Johnson*




- As of 29 February 2012, the DYNAMO/CINDY/AMIE sonde dataset is nearly 17,000 sondes and growing.
- Of this number, ~12,000 sondes are high resolution; the remainder are GTS-resolution or pibal sondes.
- Inventory covers a 152/day period; sites in India had < 1 sonde/day
- Large sonde numbers for Indonesian sites reflect 1-2 pibals/day, in addition to rawinsondes at 00 and 12 UTC.

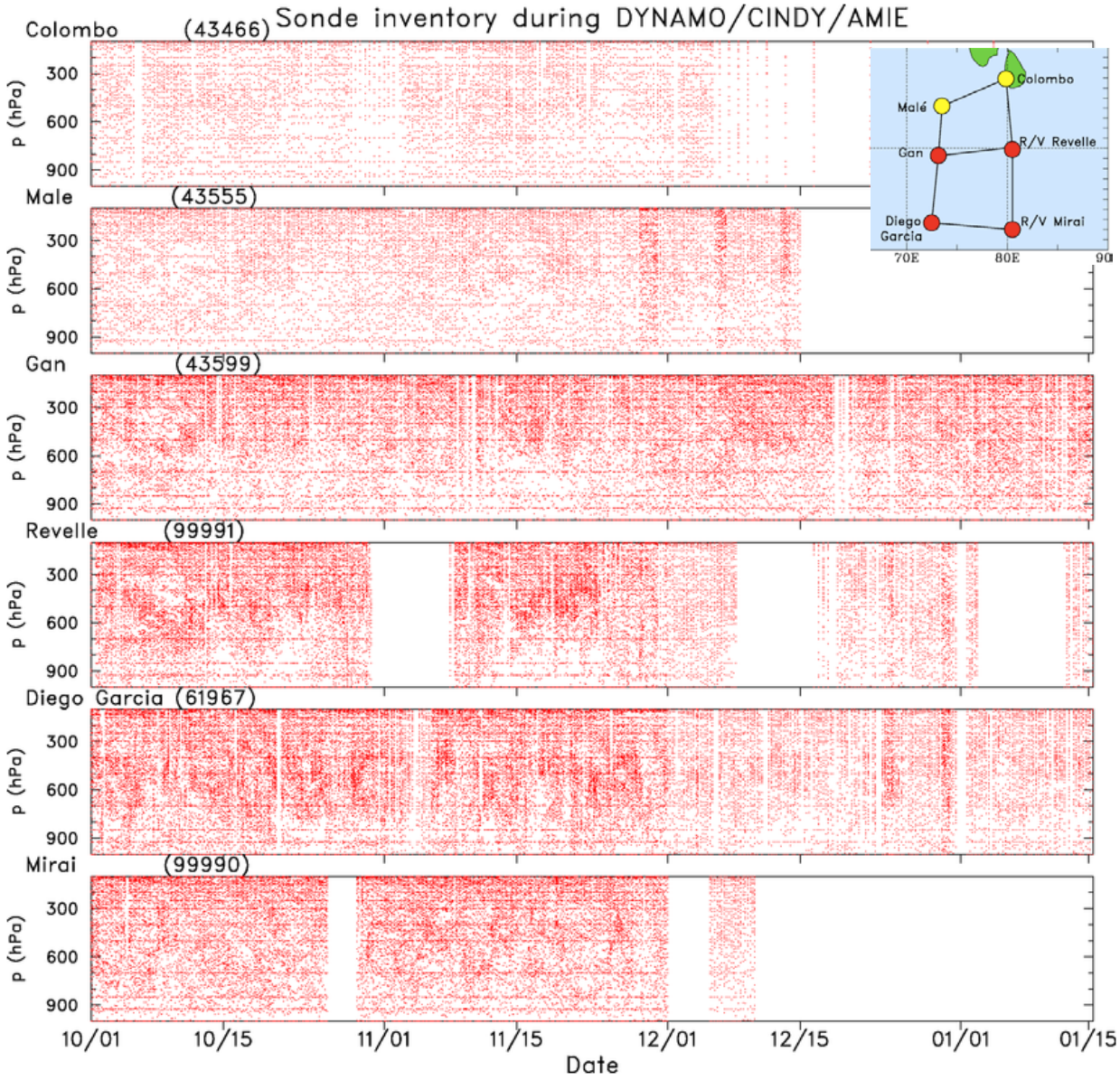



- Launch success rate = # of successful sondes / # planned

- At Manus success rate was 93%, dropsondes 99.8%, overall rate for enhanced network 96%

- Preliminary estimates indicate that over 95% of sondes were transmitted onto GTS to be used by operational centers in their assimilation process.

# Time-height Sonde Visual Inventory for IOP (each dot represents a sonde obs)

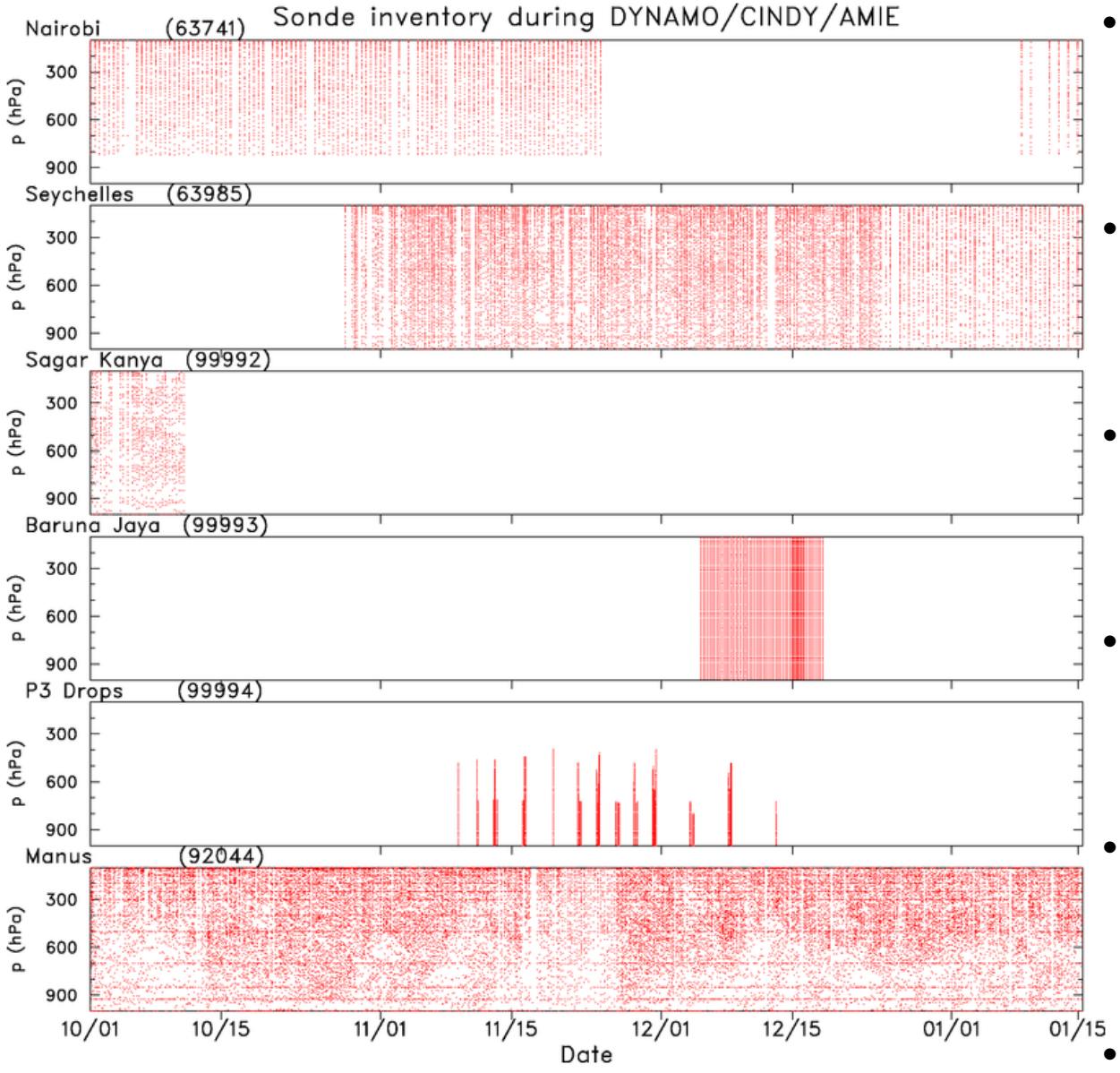



- Colombo had 4/day from 10/01 – 12/6, 1/day till 12/16
- Male had 4/day from 10/01 – 12/15 and 4 days at 8/day
- Gan had 8/day through Feb. 9
- Revelle and DG had 8/day from 10/01 to 11/30, then 4/day to 01/15
- DG operations ended on 01/15, Revelle continued at 2/day until 02/11
- Mirai had 8/day during SOP

SOP: 01 Oct – 30 Nov.

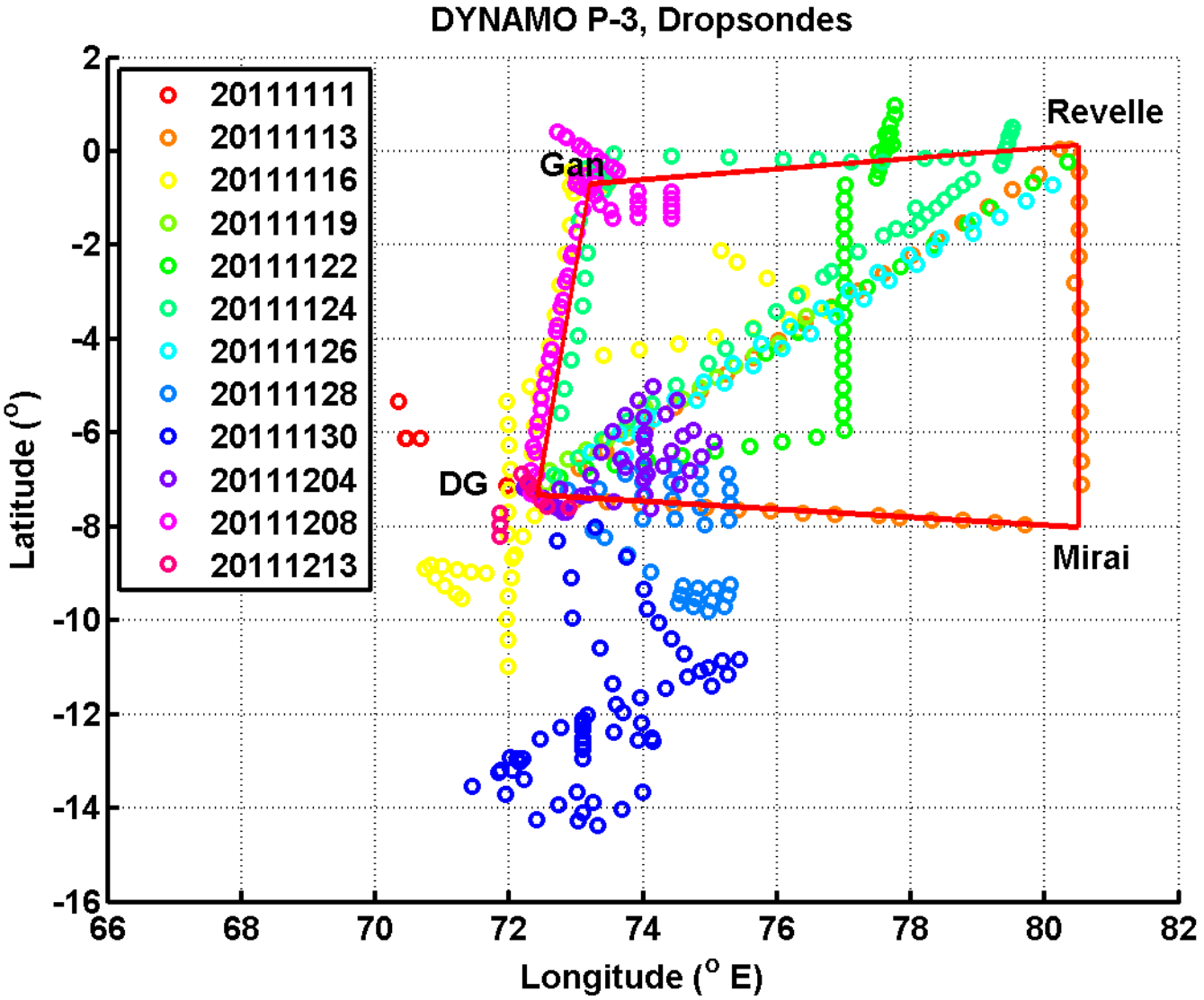
IOP: 01 Oct – 15 Jan.

# Visual Inventory continued



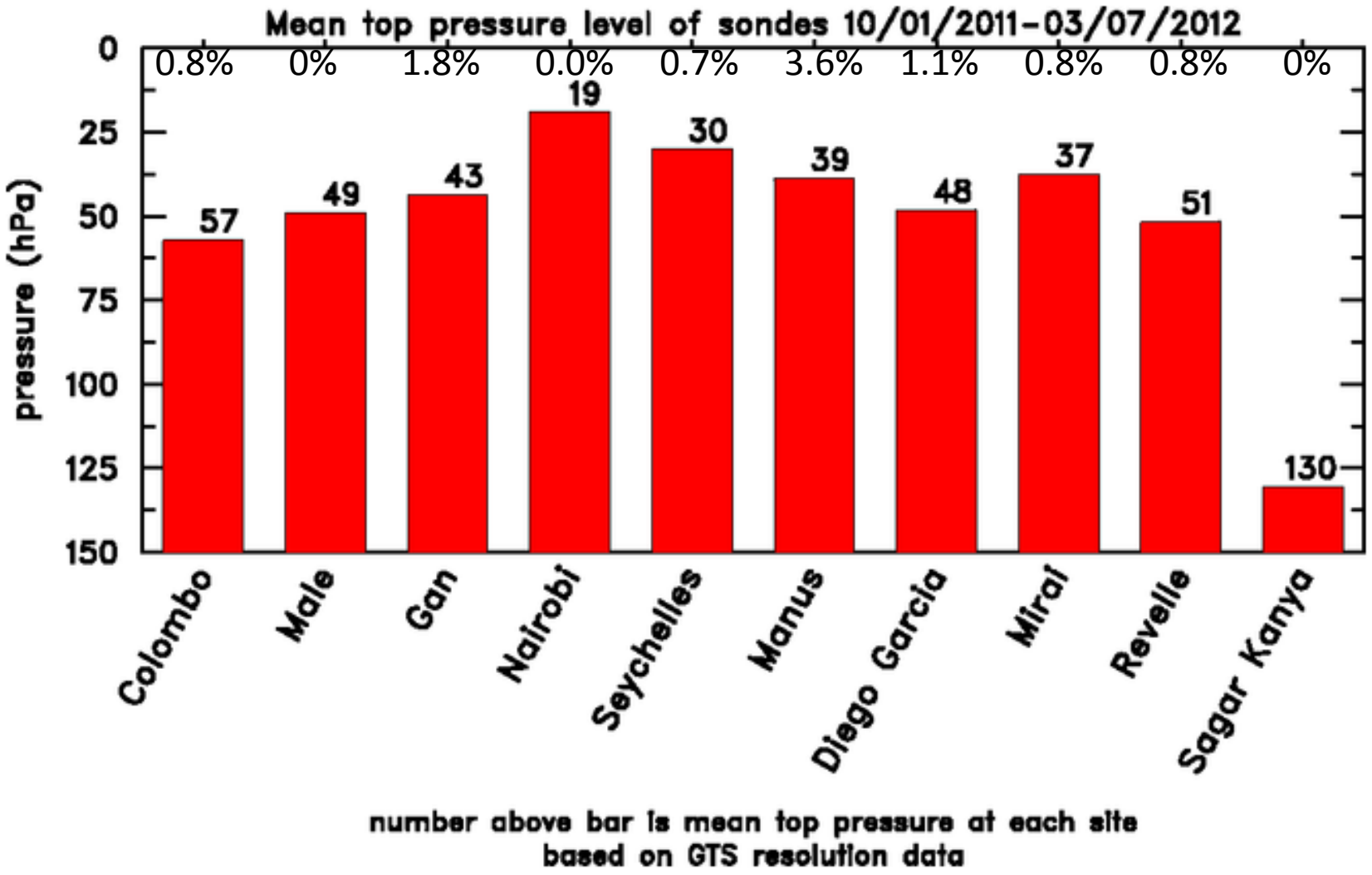

- Nairobi: 2/day sondes from 10/01 to 11/24; 1/day after 01/08
- Seychelles started on 10/28 at 4/day till 12/24, then 2/day till 01/15
- Sagar Kanya conducted sonde operations from 9/27 to 10/10 near Eq., 80E (61 sondesl)
- Baruna Jaya conducted 4/day sondes for a 2-week period in Dec near 7S, 95E (58 sondes)
- 12 dropsonde missions were conducted from 11/11 to 12/13 (469 sondes)
- Manus had 8/day throughout

# Dropsonde Measurements in DYNAMO




Total profiles: 469 from 12 flights (figure courtesy Qing Wang)

# Mean sonde termination level



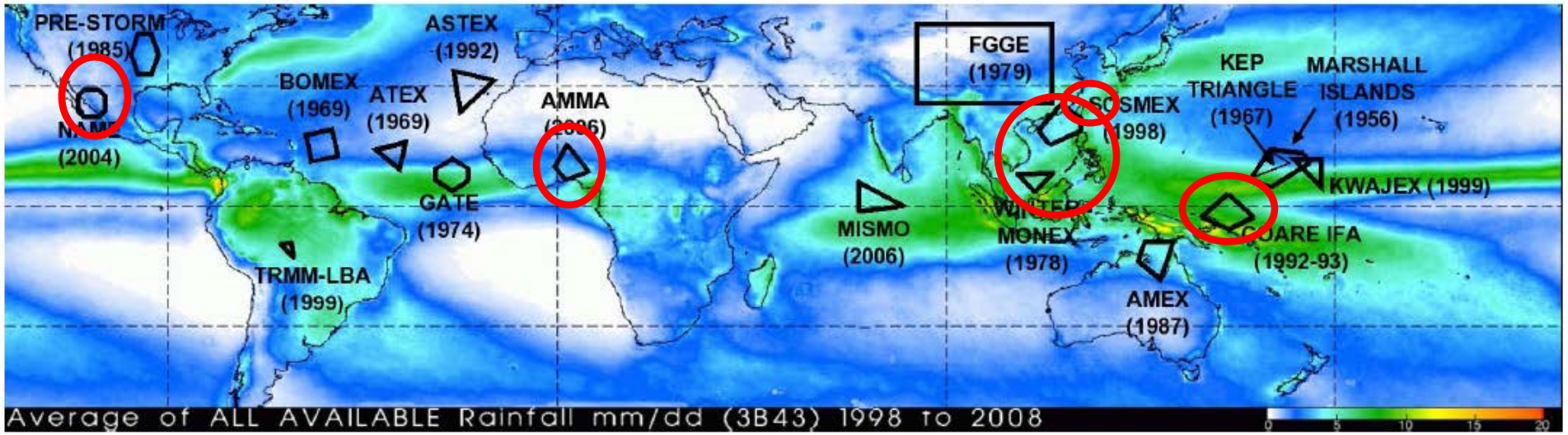

These means are decreased slightly by inclusion of a small percentage of sondes which terminated at or below the freezing level (~550 hPa) likely due to icing on the balloon.

## Seven sonde types used among 53 Priority Sound Sites:

- **27 Vaisala RS92** (Male', Gan, Manus, four R/V, DG, Seychelles, Nairobi and 17 others)
- **13 Meisei** (Colombo and 12 Indonesian sites)
- **1 Modem** (Ranai)
- **2 Graw** (Singapore and Laoag)
- **7 IM MK3** (Indian sites)
- **1 VIZ** (Guam)
- **2 Sippican Mark IIA** (Koror and Yap)

# Task before us: quality control ~17,000 upper-air sondes

**Proper QC of sonde data takes considerable time and effort**




| exp. name | dates | # snds | time* |
|---|---|---|---|
| **TOGA COARE**: | Nov. 1992 – Feb.1993 | ~14,000 | **10 yrs** |
| **SCSMEX**: | May and June 1998 | ~23,000 | **3+ yrs** |
| **NAME**: | 1 July 1 – 15 August, 2004 | ~3,000 | **4 yrs** |
| AMMA: | 1 June – 30 Sept. 2006 | ~6,600 | ???? |
| **TiMREX**: | 15 May – 25 June 2008 | ~2,300 | **1.5 yrs** |

* - time to complete corrections

**DYNAMO/CINDY/AMIE Sounding Data Workshop**

**Conducted 6-7 February 2012 at NCAR EOL**
**15 participants**

**A number of issues were identified including:**

- a nighttime moist bias of 3-4% in Vaisala RS 92 sonde
- daytime dry bias correction needs to be applied in all RS92 sondes (sites not running Digicora V3.64 software)
- High amplitude RH oscillations, related to slow ascent rates (< 3m/s) need to be identified and corrected
- Ship deck/exhaust heating effects need to be corrected on all R/V
- Independent surface data was inconsistent with sonde surface data at Male and Manus
- Correction of Meisei data using intercomparison sonde launches conducted on R/V Mirai
- Evaluate GRUAN vs Vaisala RS92 daytime dry-bias correction

# Stages to developing a research-quality sonde dataset

Convert high-vertical resolution soundings in various formats into a single easily-read format. ➠ **Level 1**

Process high resolution sondes with automated software (e.g., ASPEN) which removes unreliable data as determined by quality control (QC) checks. ➠ **Level 2**

Identify biases in data and correct them if possible (e.g. humidity biases can be reduced using a variety of methods such as intercomparison studies, statistical techniques, lab-developed algorithms, etc.). ➠ **Level 3**

Create a user-friendly dataset (uniform vertical resolution with QC flags), where flags are generated through application of objective QC checks then adjusted by visual inspection of sondes (e.g., using *xsnd* tool). ➠ **Level 4**

**Ciesielski et al. 2011 (BAMS)**

# Estimated schedule for release of different versions of dataset

| Site | Level 0 | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|
| | Hi-res, raw | Hi-res, common | Hi-res, QC'ed | Hi-res, corrected | 5-hPa, QC flags |
| Dropsondes | x | x | x | x | Summer 12 |
| Diego Garcia | x | na | na | Summer 12 | Fall 12 |
| Revelle | x | na | na | " | " |
| Gan | x | p | p | Summer/Fall 12 | Winter 12 |
| Manus | x | p | p | " | " |
| Male | x | | | " | " |
| Colombo | p | | | " | " |
| Mirai | x | | | " | " |
| Nairobi | | | | " | " |
| Seychelles | x | | | " | " |
| 13 Indonesian sites | p | | | Fall 2012 | Winter/Spring 13 |
| 7 other PS sites | p | p | p | " | " |

x – task completed, p – partially done, na – not available,

# Summary

- Atmospheric sounding effort in DYNAMO/CINDY/AMIE has been an extraordinary success in all respects

- Quality control of the dataset has begun. As different levels are completed, they will be made available on EOL data catalog:
  *http://data.eol.ucar.edu/master_list/?project=DYNAMO*

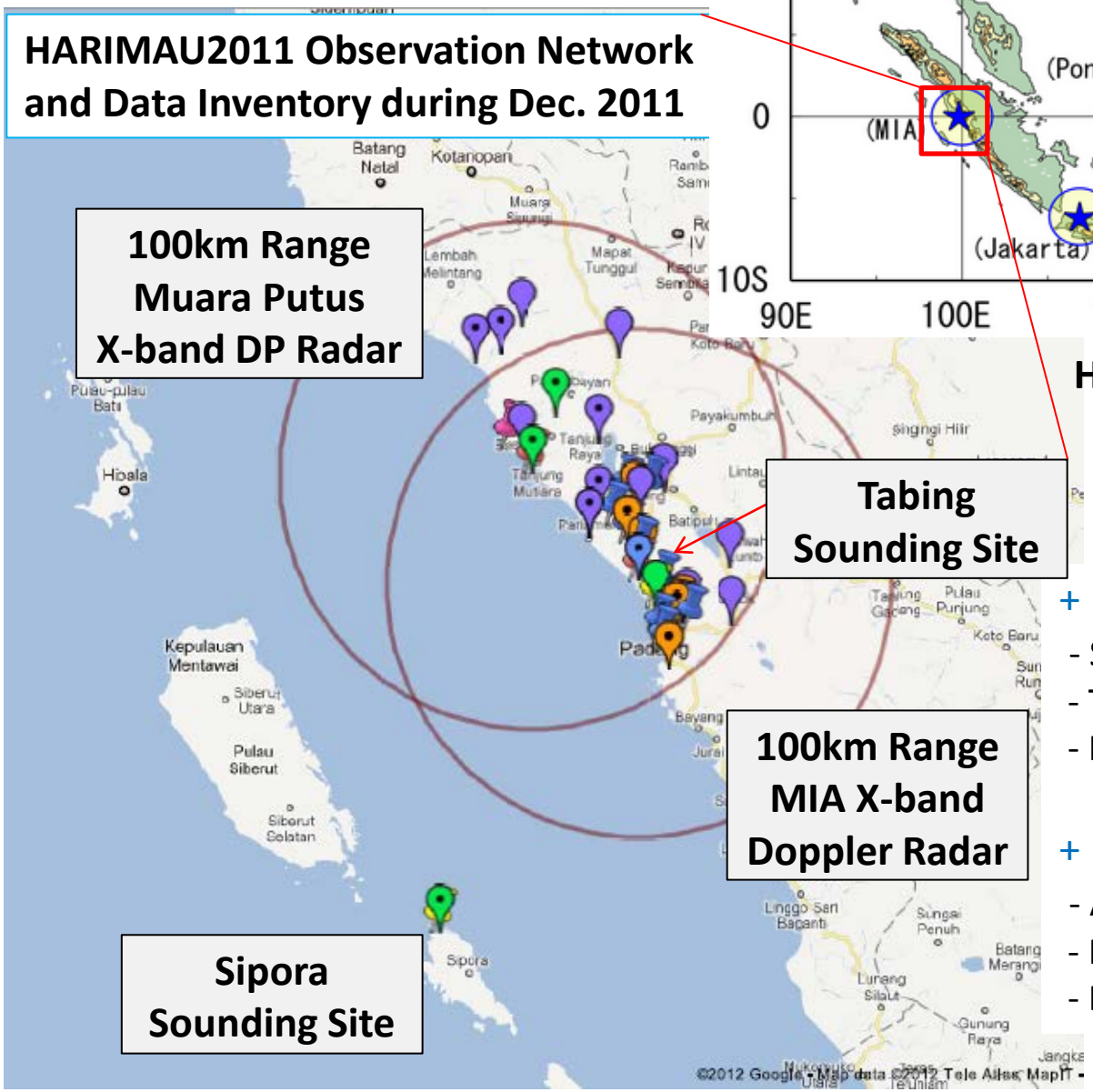
- Biases (e.g, nighttime moist bias, upper-level dry bias in RS92) and problems (e.g,, ship structure heating) are being identified and will be corrected in Level 3 products.

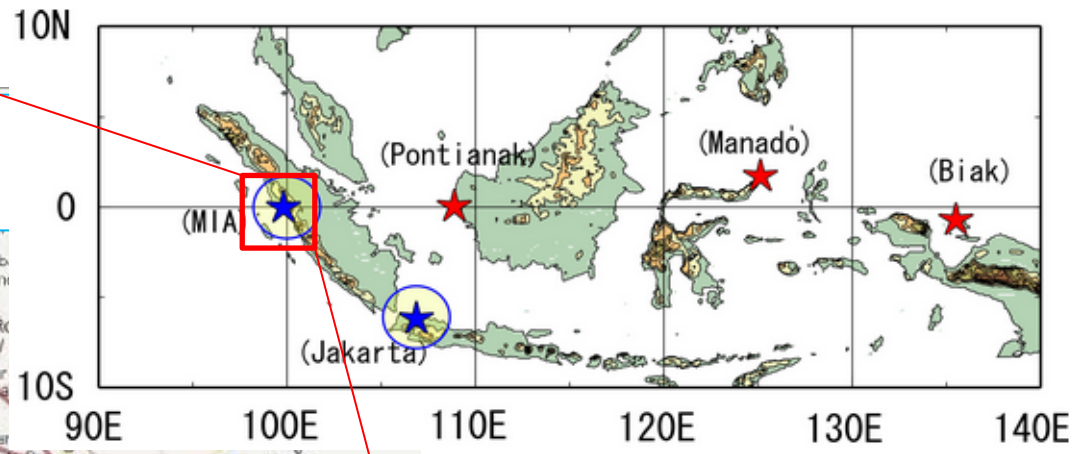
- Humidity errors in uncorrected RS92 sondes are on the order of 3-5% in column integrated sense.

- Priority of QC effort is being given to sites in the core of enhanced sonde network (i.e., central India Ocean).

# Questions

# Sounding Data Status for HARIMAU2011




**HARIMAU Radar-Profiler Network**

★ **Doppler Radar**

★ **Wind Profiler**

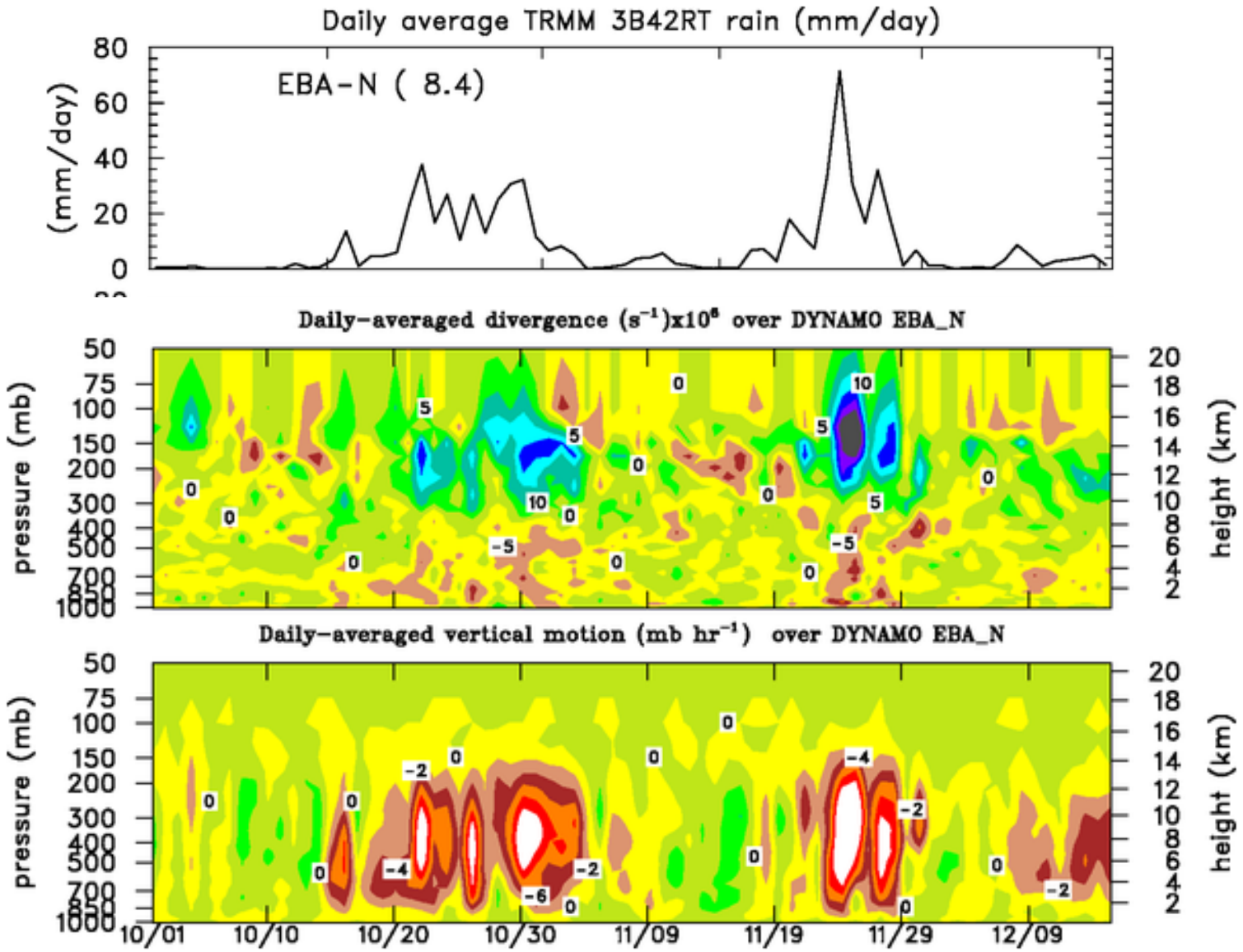
+ Intensive Sounding Stations: 3

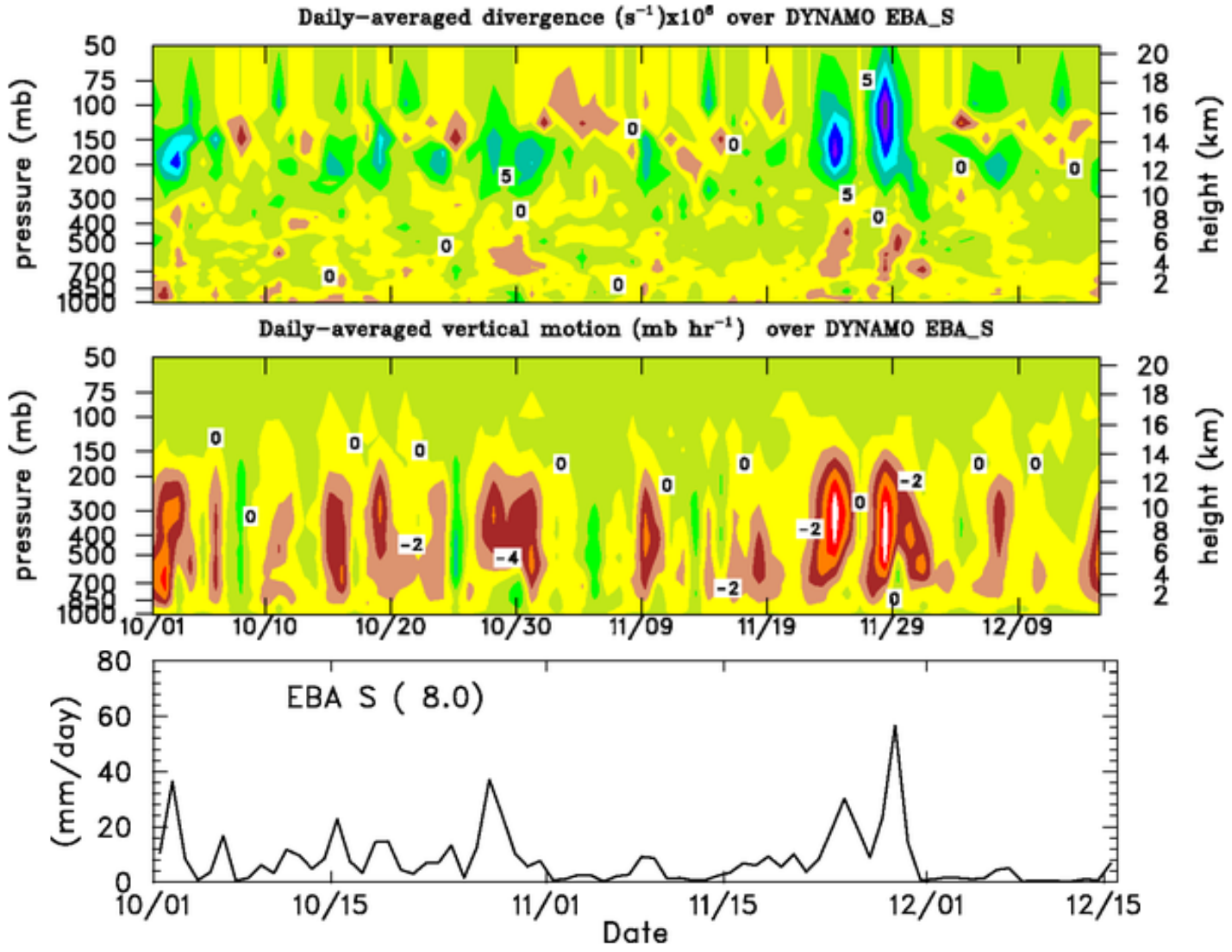
- Sipora: 3-6 hours, Vaisla RS92: 215
- Tabing: 6 hours, Meisei RS06G: 126
- Pontianak: 12 hours, Vaisala RS92:64

+ Intensive Surface Observation

- Automatic Weather Stations : 5
- Rain Gauges: 10
- Disdrometers: 2

**Figure courtesy Kunio Yoneyama**


Daily average TRMM 3B42RT rain (mm/day)
EBA-N ( 8.4)
(mm/day)
Daily-averaged divergence ($s^{-1}$)x$10^6$ over DYNAMO EBA_N
Daily-averaged vertical motion (mb $hr^{-1}$) over DYNAMO EBA_N
pressure (mb)
height (km)
10/01
10/10
10/20
10/30
11/09
11/19
11/29
12/09


Daily-averaged divergence ($s^{-1}$)x$10^6$ over DYNAMO EBA_S
pressure (mb)
height (km)
Daily-averaged vertical motion (mb $hr^{-1}$) over DYNAMO EBA_S
pressure (mb)
height (km)
10/01
10/10
10/20
10/30
11/09
11/19
11/29
12/09
EBA S ( 8.0)
(mm/day)
10/01
10/15
11/01
11/15
12/01
12/15
Date

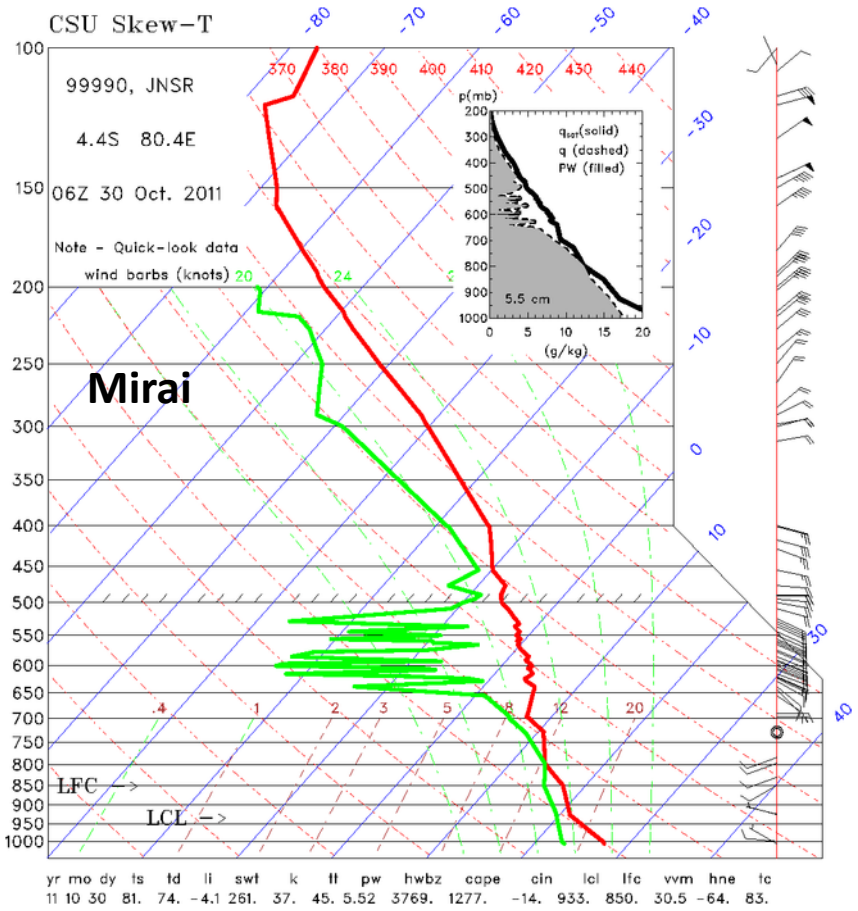
Screen shot of prelaunch data showing importance of proper sonde ventilation

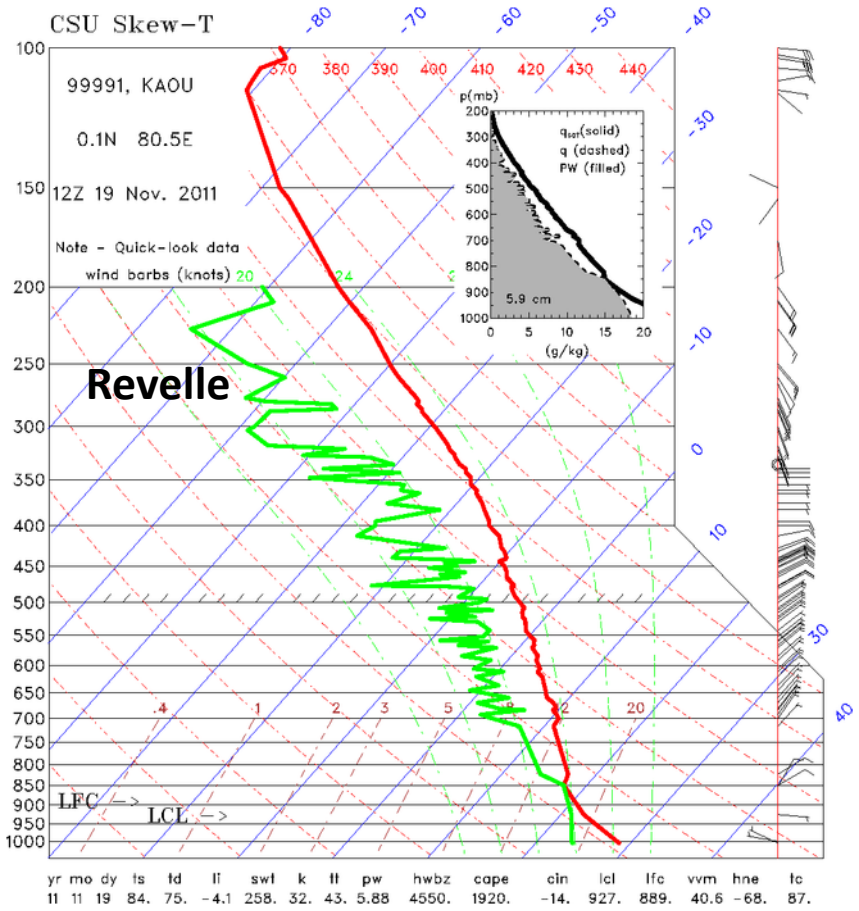



With aspirator turned off RH fluctuations of 20% are seen as dual heated RH sensor switches between sensors. With aspirator on no such fluctuations are observed.

**To avoid this problem in flight Vaisala recommends balloon ascent rate be 4-5 m/s**

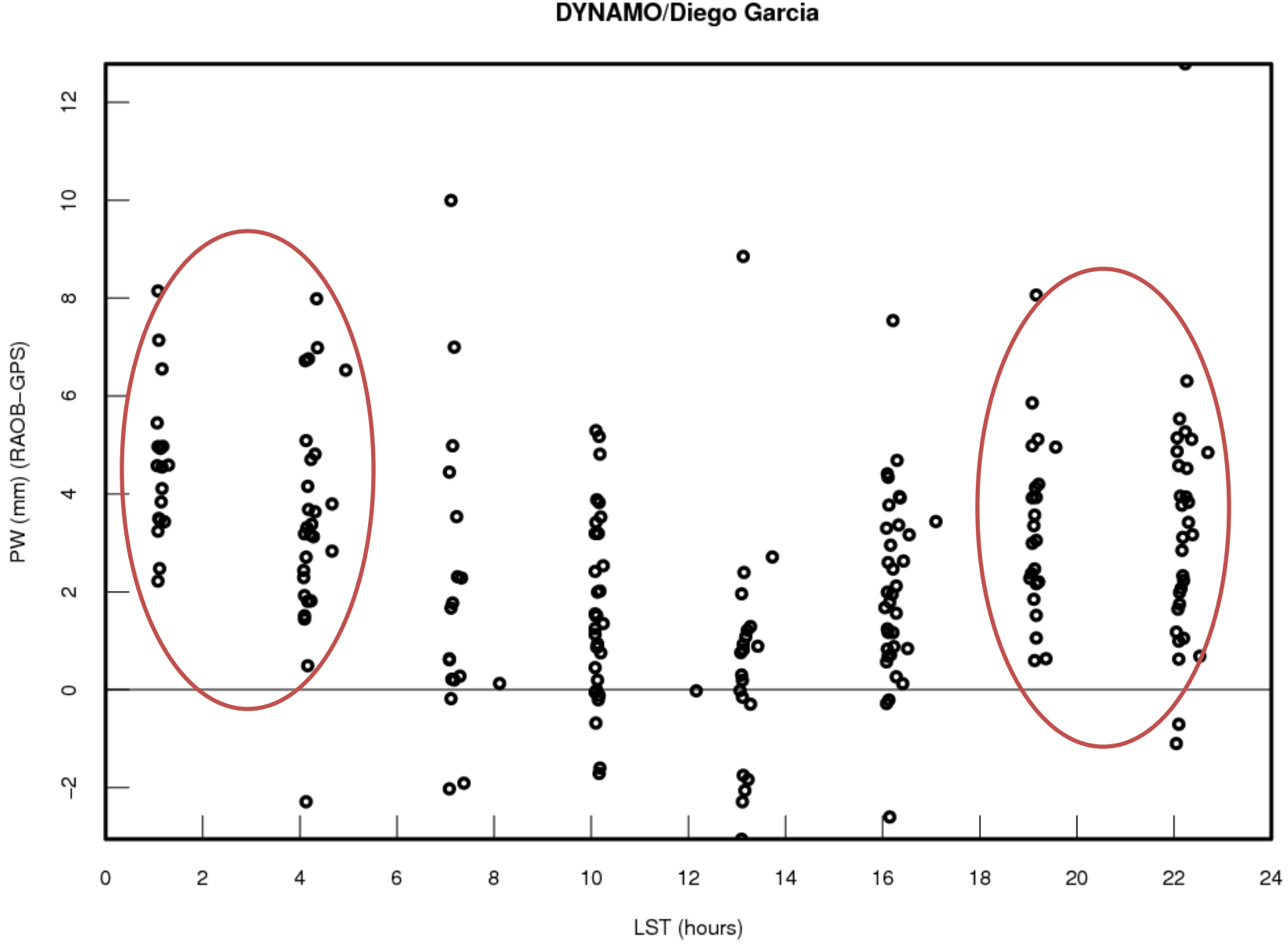
# Examples of skewTs showing suspicious humidity data possibly related to poor ventilation of the humidity sensor



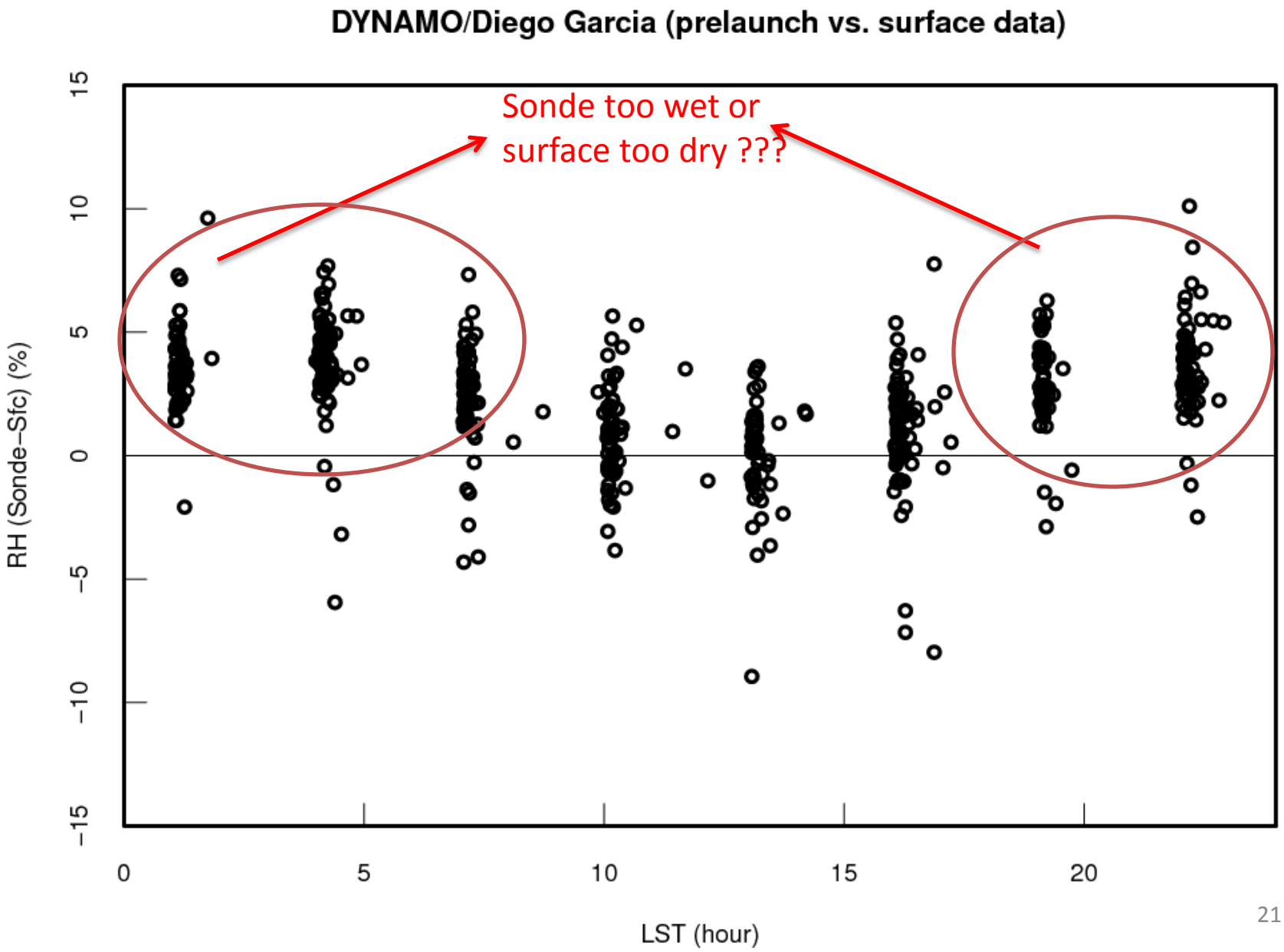




**To determine if these suspicious features are related to poor ventilation we need to examine the sonde ascent rate which is included in the high-vertical resolution data files.**

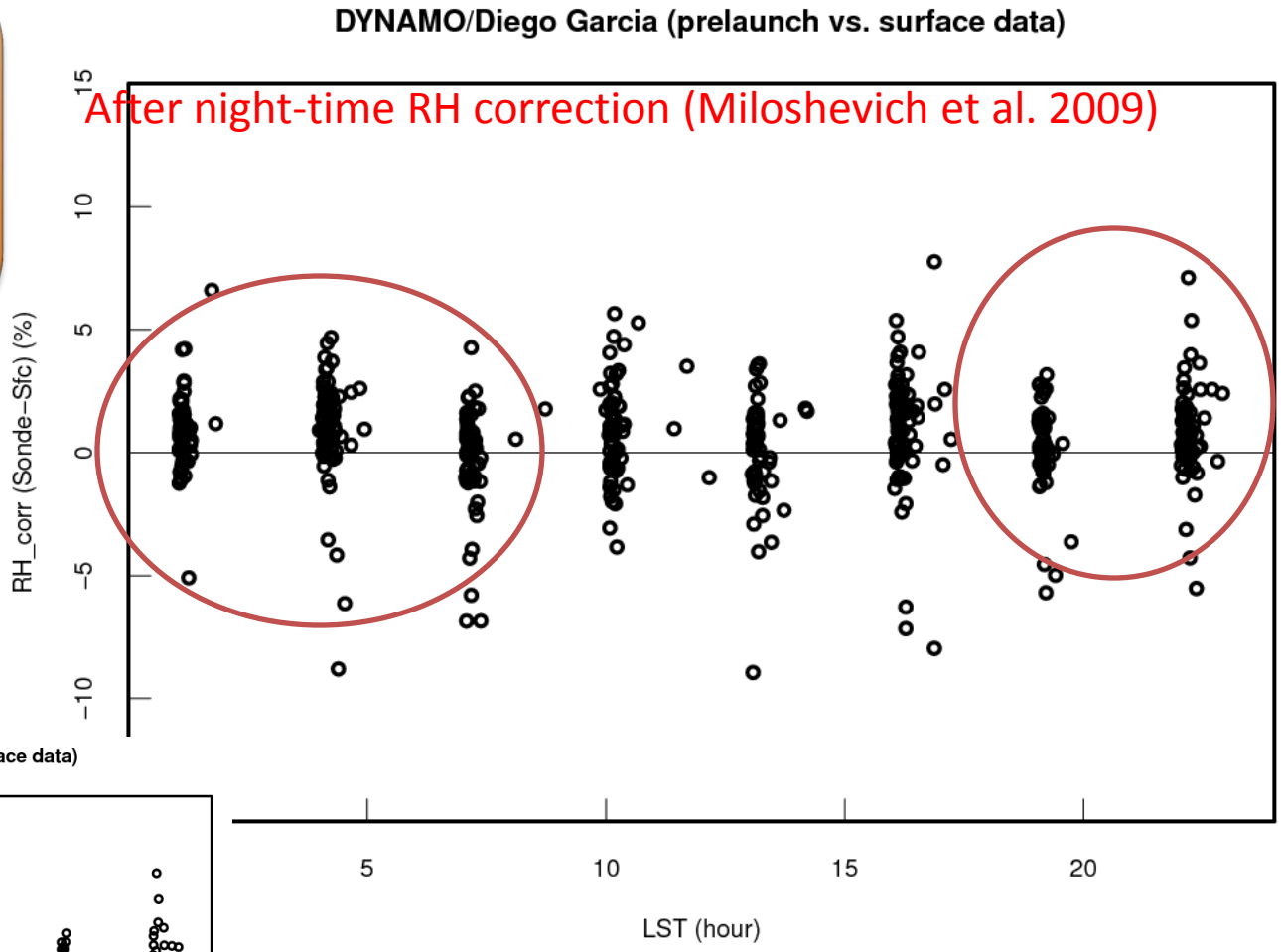
# PW comparisons between radiosonde and GPS

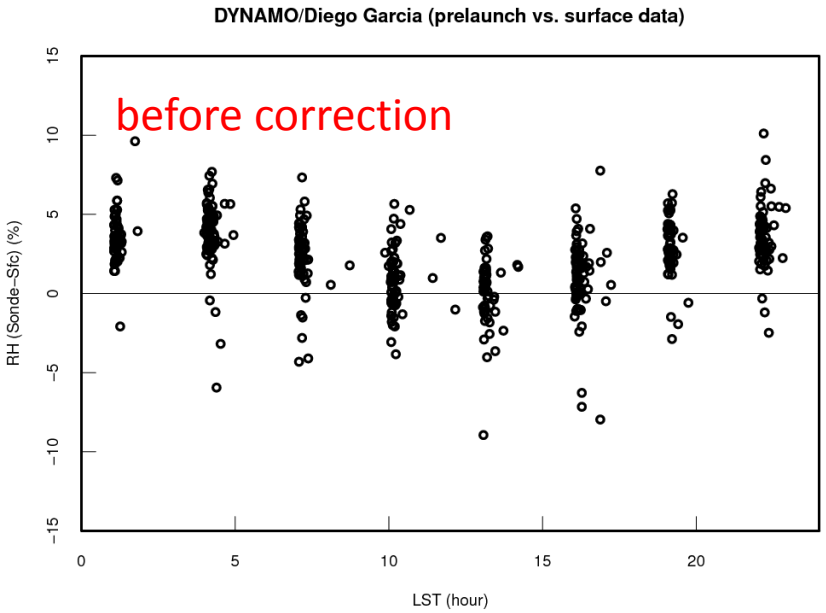


# Comparison of RH from prelaunch sonde and surface sensor



# Impact of corrections on RH_sfc




**Mainly an offset correction (~3%);**
**Can't take care of scatters.**

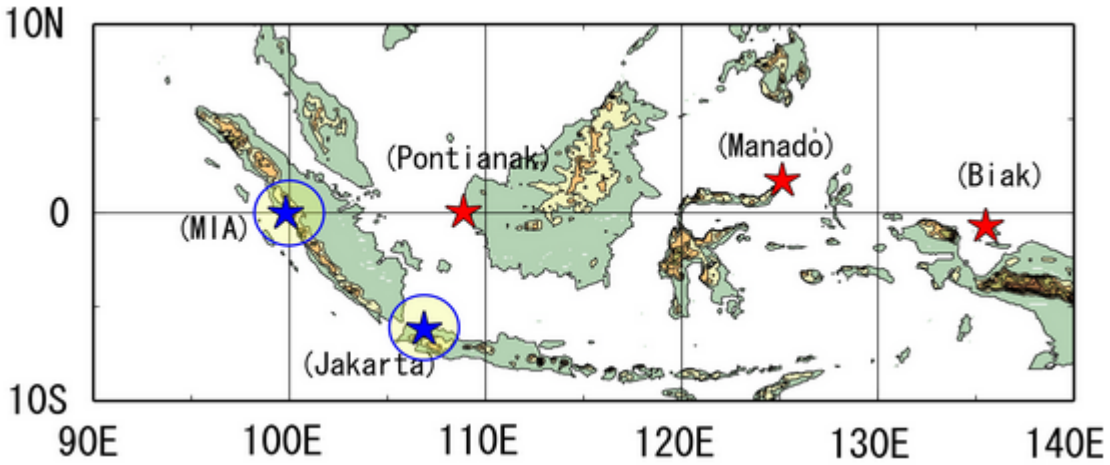
# Sounding Data Status ( 6/7 )

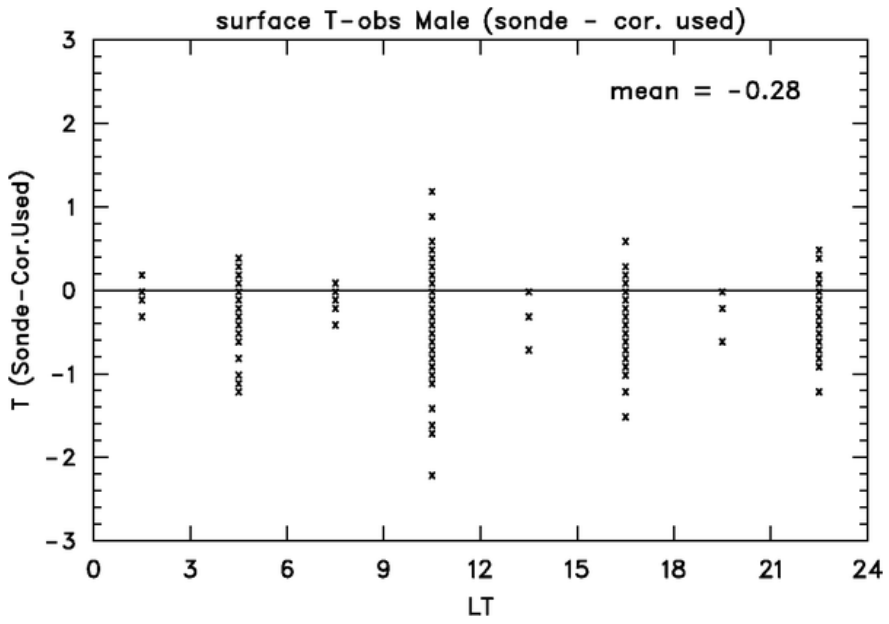
5) Indonesia (HARIMAU/SATREPS Project relevant)

* Local Main counterpart - BPPT (Agency for Assessment and Application of Technology)
* System maintenance and Data processing are done by Kyoto University.

| | | | |
|---|---|---|---|
| Pontianak | Wind Profiler | Missing period | Oct 29, Dec 1 |
| | AWS | Missing period | Nov 17 – Jan 9 |
| Manado | Wind Profiler | Missing period | Oct 14 – 18, Nov 4 – 6, Nov 17 – 18 |
| | AWS | No operational | |
| Biak | Wind Profiler | Missing period | Oct 16 – Dec 26 |
| | AWS | Missing period | N/A |

* Data are available from http://www.jamstec.go.jp/iorgc/harimau/observation.html#data

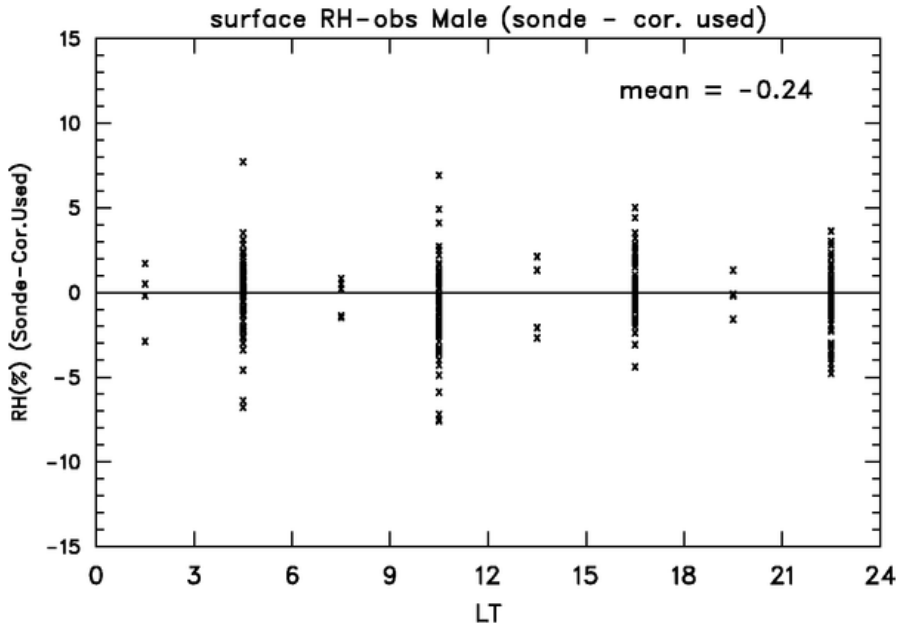





# After correction

**Temperature difference** between sonde and sfc data

- Slight sonde cool bias at all times.




**RH difference** between sonde and sfc data

- Mean bias reduced from -2.21 to -0.24.
- Sonde dry bias still largest at 1030LT (-0.98%)
- Mean bias at other times < 0.5%.

# Level 4: Uniform resolution dataset with QC flags marking suspicious data

## How is it created?

- Level 3 data is linearly interpolated to create uniform resolution

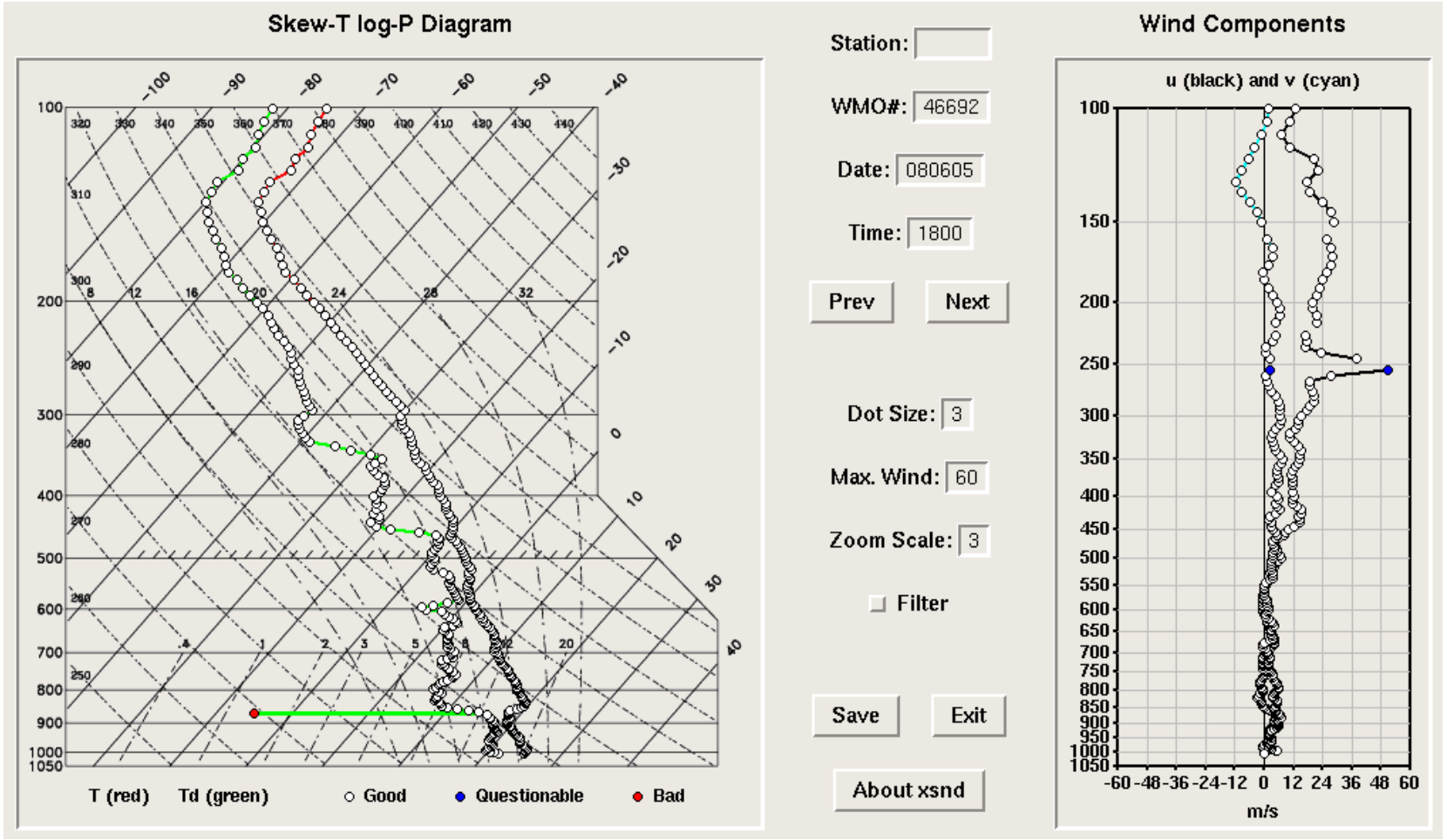
- A series of Quality-Control (QC) checks are applied which flag data as questionable or bad (for details see http://www.eol.ucar/projects/sondeqc)

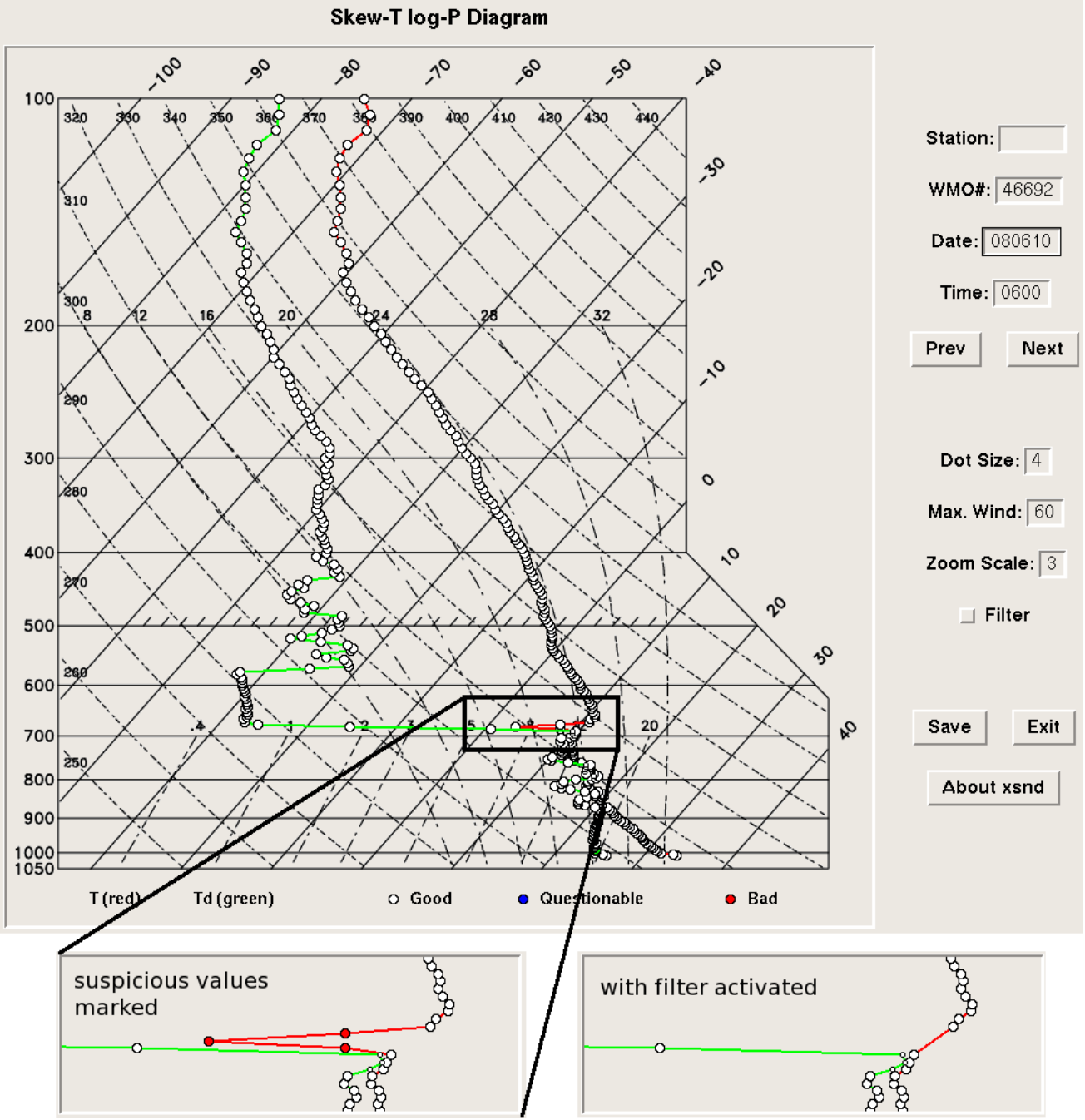
- After assigning objective QC flags, a software program (*xsnd*) is used to visually examine each sounding to subjectively adjust these flags.

- Using *xsnd* provides a mean to easily “buddy check” the data, i.e., visually compare sondes adjacent in time and in close proximity to each other for continuity of features.

Visual inspection of sondes, while tedious, is necessary to ensure a research quality dataset since subtle errors in sonde data are often difficult to detect with objective procedures.

To facilitate this processing, we've developed a software tool (its display is shown below) which allows one to visually inspect a sonde and easily flag suspicious data.












- this tool allows one to identify and mark suspicious data (e.g., a superadiabatic layer above a cloud layer.)

- marking points changes QC flags, not the data values.

- by flagging suspicious data, good data is easily retrievable with the user deciding what level of quality is acceptable for their analysis.

Tool is freely available at: *http://www.eol.ucar.edu/projects/sondeqc*

# Example of a sounding file in L4 format with QC flags

| STN | DATE | GMT | HTS | LAT | LONG | ID |
|---|---|---|---|---|---|---|
| | 080515 | 0600 | 4 | 20.70 | 116.72 | 46810 |

NLVL = 185 COMMENTS:

| P | HT | TC | TD | DIR | SPD | QP | QH | QT | QD | QW | LON | LAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1006.8 | 4.0 | 27.4 | 21.1 | 20.0 | 6.5 | 1 | 1 | 1 | 1 | 1 | 116.72 | 20.70 |
| 1005.0 | 19.8 | 24.9 | 18.8 | 56.7 | 4.9 | 1 | 1 | 1 | 1 | 1 | 116.72 | 20.70 |
| 1000.0 | 63.5 | 23.9 | 18.4 | 64.3 | 7.2 | 1 | 1 | 1 | 1 | 1 | 116.72 | 20.70 |
| 995.0 | 107.5 | 23.5 | 18.4 | 69.8 | 12.0 | 1 | 1 | 1 | 1 | 3 | 116.72 | 20.70 |
| 990.0 | 151.6 | 23.1 | 18.4 | 69.9 | 15.0 | 1 | 1 | 1 | 1 | 5 | 116.72 | 20.70 |
| 985.0 | 195.8 | 22.6 | 18.2 | 69.3 | 16.6 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.70 |
| 980.0 | 240.1 | 22.1 | 18.0 | 69.3 | 17.1 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.70 |
| 975.0 | 284.7 | 21.8 | 17.9 | 69.1 | 16.3 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.70 |
| 970.0 | 329.4 | 21.4 | 17.7 | 68.8 | 13.7 | 1 | 1 | 1 | 1 | 3 | 116.71 | 20.70 |
| 965.0 | 374.3 | 21.0 | 17.5 | 68.2 | 10.1 | 1 | 1 | 1 | 1 | 3 | 116.71 | 20.70 |
| 960.0 | 419.4 | 20.6 | 17.4 | 69.0 | 18.0 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.70 |
| 955.0 | 464.6 | 20.3 | 17.3 | 69.0 | 8.6 | 1 | 1 | 1 | 1 | 1 | 116.71 | 20.70 |
| 950.0 | 510.0 | 19.9 | 17.1 | 68.7 | 9.1 | 1 | 1 | 1 | 1 | 1 | 116.71 | 20.70 |
| 945.0 | 555.6 | 19.6 | 16.6 | 68.2 | 10.0 | 1 | 1 | 1 | 1 | 1 | 116.71 | 20.70 |
| 940.0 | 601.4 | 19.4 | 15.5 | 79.0 | 20.0 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.70 |
| 935.0 | 647.4 | 19.9 | 13.5 | 95.0 | 23.0 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.69 |
| 930.0 | 693.8 | 21.6 | 11.5 | 105.0 | 22.0 | 1 | 1 | 1 | 1 | 5 | 116.71 | 20.69 |
| 925.0 | 740.7 | 22.6 | 11.3 | 71.0 | 6.9 | 1 | 1 | 1 | 1 | 1 | 116.71 | 20.69 |
| 920.0 | 787.9 | 22.6 | 11.5 | 70.8 | 7.1 | 1 | 1 | 1 | 1 | 1 | 116.70 | 20.69 |
| 915.0 | 835.3 | 22.3 | 11.3 | 73.0 | 7.6 | 1 | 1 | 1 | 1 | 1 | 116.70 | 20.69 |
| 910.0 | 882.9 | 22.0 | 11.0 | 68.0 | 8.8 | 1 | 1 | 1 | 1 | 1 | 116.70 | 20.69 |
| 905.0 | 930.8 | 21.7 | 10.4 | 67.7 | 7.5 | 1 | 1 | 1 | 1 | 1 | 116.70 | 20.69 |

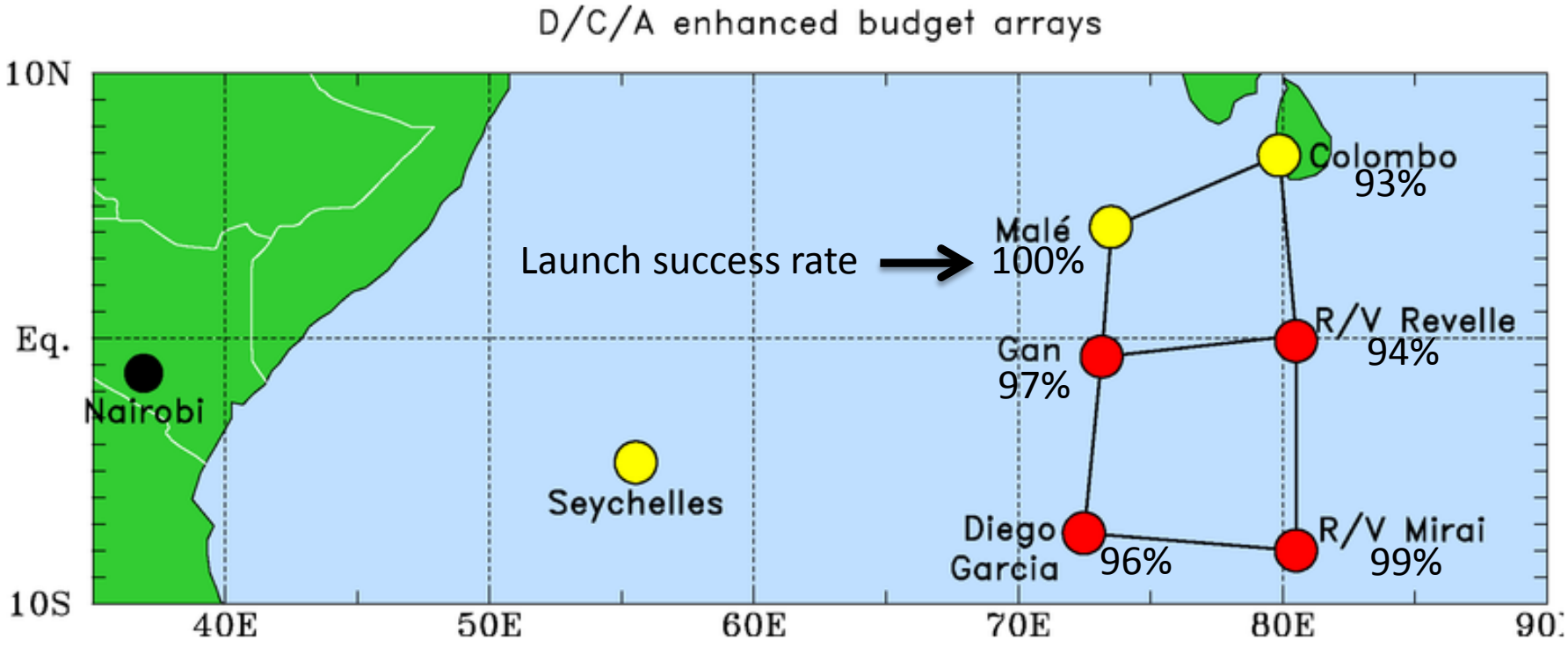
2381,47 7%

QP - pressure
QH - height
QT - temperature
QD - dew point
QW - winds

**FLAG Notation**

1 - good
2 - objective ques.
3 - subjective ques.
4 - objective bad
5 - subjective bad
6 - interpolated
7 – (available )
8 - unchecked
9 - missing

Clicking on a point in xsnd changes the value of the QC flag in the file; the data value is unchanged. **The user must decide what quality level they are willing to accept in their analysis.**




- Launch success rate at Manus was 93%, dropsondes 99.8%, overall success rate for enhanced network 96%
- Preliminary estimates indicate that over 95% of sondes were transmitted onto GTS to be used by operational centers in their assimilation process.
- Nearly 100 personnel were involved in sonde field operations including more than 30 students from US, Japan, Taiwan and Europe.