Documentation for field phase (Level 0 or L0) Male's high very resolution sonde dataset

Summary of sonde operations

Sonde set up at the Male' site began late on 28 September 2011. Launch site was at Hulhule' airport island (on Met Service grounds next to airport runway: 4.19N, 73.53E, 2 m elevation). A test launch was conducted at 12Z on 29 September and at 06 and 12Z on 30 September. Regular sonde operations commenced on 00Z 1 October 2011 and ended 00Z 15 December 2011. During this period launch frequency was 4/day except for four days at 8/day. Launch time was generally H-30min, where H is nominal launch time (00, 06, 12, 18Z).

Vaisala RS92 sondes were used. All sonde serial numbers began G18 indicating that the sondes were manufactured in the 18th week (early May) of 2011. Digicora software V3.64 was run which includes a day-time dry bias correction.

334 sondes were sent to Male'. 323 successful launches were made. There were 2 bad sondes and 9 relaunches.

Surface observations:

Ground check for pressure used a Vaisala digital barameter PTB 330.

Ground check for temperature and pressure was done using Vaisala ground check system.

   Surface data point in sounding:
- Pressure came from MMS barameter (ASL) observation

   Surface T, RH data
- 2 sources of sfc T, RH data: MMS and AWS (both were within 5 meters of sonde launch point)
- Operations began using sfc obs from MMS (Maldivian Met Service). The reading were generally taken within 5 – 10 minutes of sonde launch time when an MMS observer would read dry and wet bulb temperatures from thermometers in Stevenson screen. Values were entered into a spreadsheet formula and RH was computed.
  Starting on 3rd Oct. data from Taiwanese AWS was used for surface data . Shortly thereafter a number of cases were noted in which moisture increased with height near sfc. (Fig. 1). Because of this atypical behavior, it was suspected that the AWS values may have a dry bias. Some work was done to recalibrate the AWS using a Vaisala HMP 155 instrument brought from JAMSTEC. In comparison to this instrument the AWS showed an ~7% dry bias.

- Because of this dry bias in AWS values, after 13 October MMS obs were used exclusively for surface data. However using MMS obs, a number of suspicious looking daytime skewts at low-levels were observed (Fig. 2). These skewts seems to show noisy T_d profiles near the surface, where T_d decreases from sfc to second point then increases. This behavior was observed 39 times at Male' and always occurs at 06 and 12Z (4/5 of time at 06Z, often sfc super-adiabatic layer was present). For these 39 times the mean sonde-MMS RH difference was -4.6%.

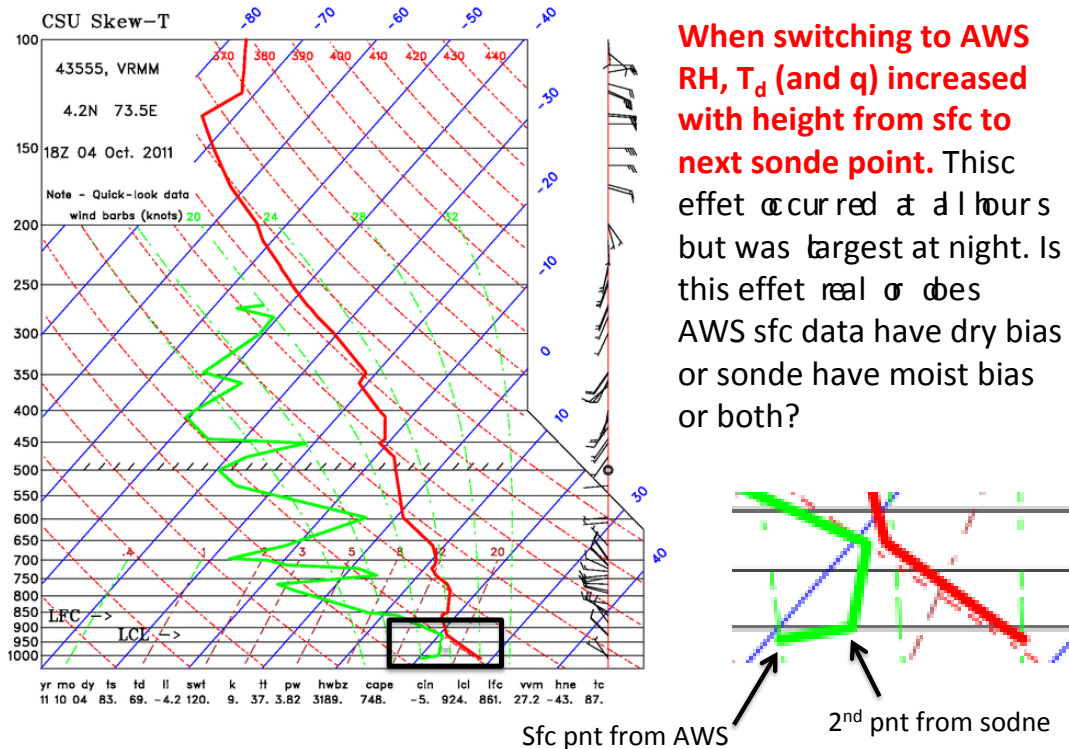## Example of issues using AWS surface data

When switching to AWS RH, T_d (and q) increased with height from sfc to next sonde point. Thisc effet occurred at all hours but was largest at night. Is this effet real or does AWS sfc data have dry bias or sonde have moist bias or both?

Sfc pnt from AWS

2nd pnt from sodne

Fig. 1 Issues with AWS surface data as shown in skewt plot on 18Z 04 Oct. 2011.

Example of issues when using MMS surface data
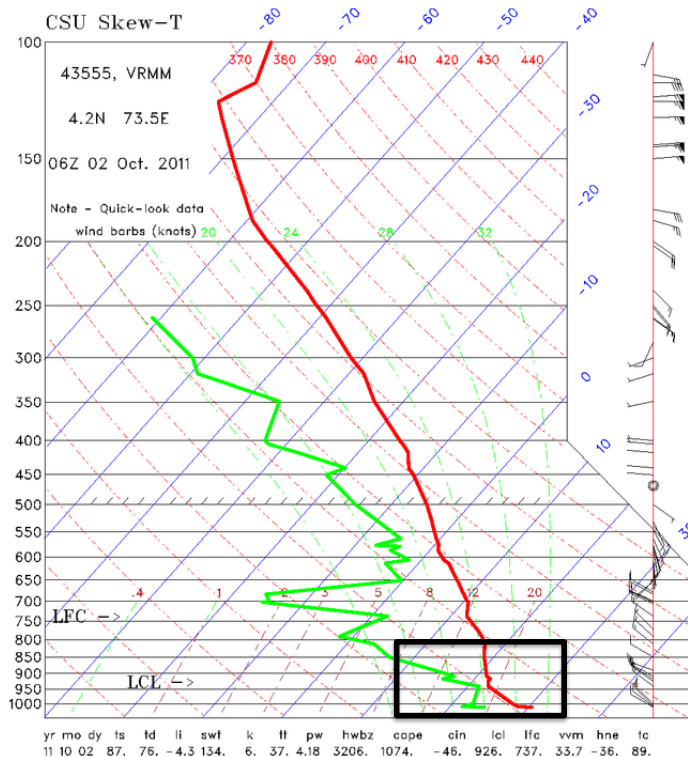
Noisy T_d & profile near sfc using MMS obs., T_d decreases from sfc to second point then increases. This behavior was observed 39 times at this site and always occurs at 06 and 12Z (4/5 of time at 06Z, often sfc super-adiabatic layer was present). For these 39 times the mean sonde-MMS RH difference was -4.6%
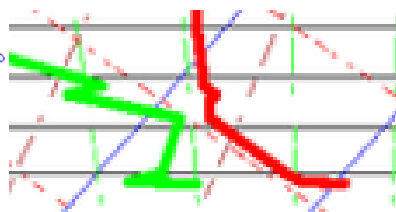
Fig. 2 Issues with MMS surface data as illustrated in skewt plot at 06Z 02 Oct. 2011.

Sonde reprocessing

Because of issues with surface data, we compared the sonde surface RH values to those from the MMS and AWS (Fig. 3). What one sees is that the sonde has a dry

bias relative to MSS and a moist bias relative to AWS. The diurnal cycle of both plots has a similar shape suggesting that part of the issue is diurnal changes in a sonde bias. Milosevich et al. 2011 found that RS92 sondes, like used in Male', have a night-time moist bias (3%) and a daytime dry bias (up to 5% in PW for solar zenith angles > 50°).
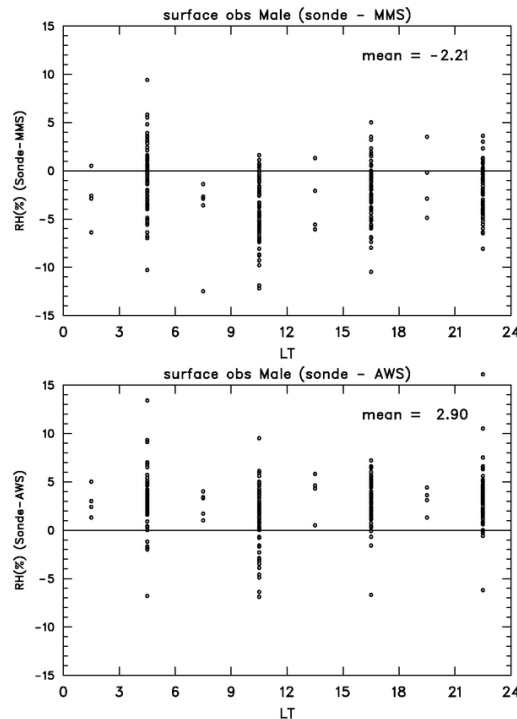
Sonde has dry bias relative to MMS, dry bias is largest (~4 percent) at 06Z.

Sonde has moist bias relative to AWS, with moist bias being ~3% at (00, 12 and 18Z) and ~1.5% at 06Z (1030LT).

Both plots have a similar shape to the diurnal cycle of the bias with largest sonde moist bias at 0430LT and largest dry bias at 10:30LT. So even though MMS and AWS have biases, they are provided us information regarding the diurnal cycle of the sonde biases.

Fig 3. Sonde RH biases relative to MMS and AWS data.

Because of the issue with the surface data, it was felt that a number of sondes needed to be reprocessed using an improved surface data. We decided to go with a corrected AWS data for the following reasons: (1) AWS data has 1-minute temporal resolution, (2) subjectively in reading MMS values and obs were generally not taken at exact time of sonde launch (usually within 5-10 minutes of launch), (3) issues regarding formula MMS used for computing RH from wet and dry bulb temperatures, (4) MMS RH has apparent moist bias. Possibly inadequate ventilation of wet bulb thermometer resulted in readings that were too high (i.e., too moist) and (5) AWS values could be corrected.

Using comparison with data from Vaisala HMP155 probe we determined the following:
- For AWS RH sensor 1: Cor_AWS RH = 1.072 *AWS RH (from 10/01 to 10/25 06Z)

- For AWS RH sensor 2: Cor_AWS RH = 1.041*AWS RH (after sensor was changed 10/25 06Z)

For example, Fig 4 gives a comparison of RH data from AWS RH sensor 2 to Vaisala HMP 155 probe. This AWS sensor has a ~4% dry bias relative to Vaisala probe.
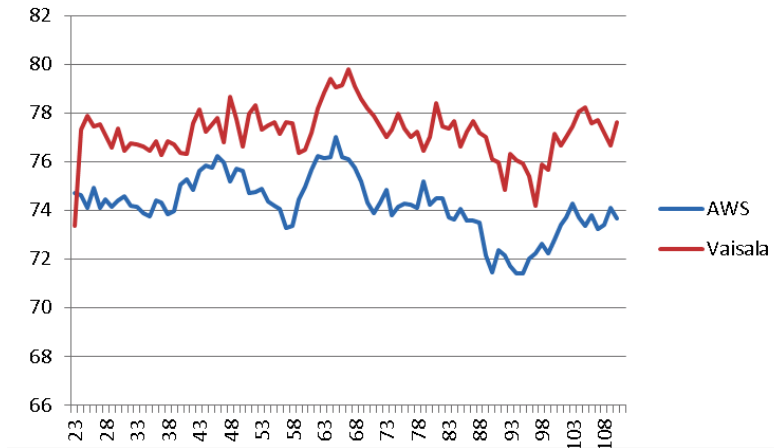

Fig. 4 Time series RH from AWS and Vaisala HMP 155 probe.

Using corrected AWS data (CorAWS) we reprocessed a number of sondes using the following criteria:

- (1) **If |RH (sonde – sfc)| > 2.5%**
- (2) **If using CorAWS RH would result in a correction > 2%**

Using these criteria, 154 out to 323 sondes were reprocessed using CorAWS T, RH. Fig. 5 shows the sonde minus sfc RH for all times (including 154 corrected and 169 uncorrected). There is still a small mean negative bias (-0.24%) with the largest sonde bias (0.98% - a sonde dry bias at 06LT).
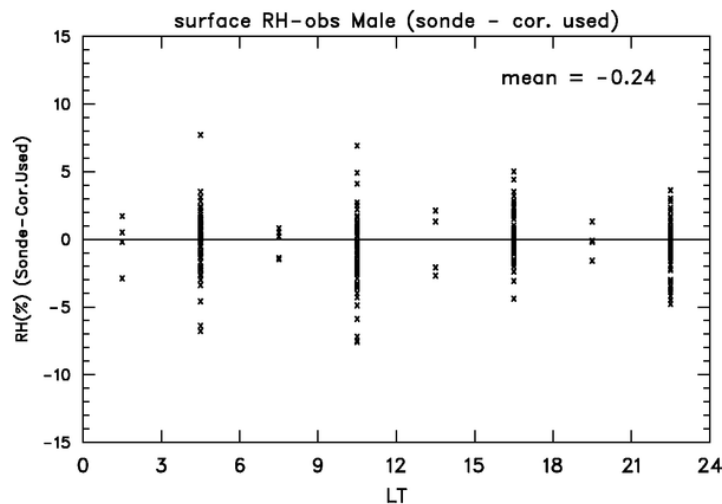

Fig 5. Diurnal cycle of sonde minus surface data (using CorAWS at 154 times).

Remaining issues

Sonde night-time moist bias still needs correcting using Miloshevich et al. 2009 correction. If GRUAN daytime correction is found to be superior to Vaisala RS92 correction, we may rerun day time sondes with GRUAN correction.

Contact information

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