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Richard Thigpen
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By e-mail

16 February 2002

Dear Mr. Thigpen;

The purpose of this letter is to provide InterMet's response to the report prepared by the UK Met Office concerning the IMS-1600 upper air station installed in Dar es Salaam, Tanzania.

As stated in the report's introduction, the purpose of the study was to establish that:

- The IMS-1600 system adequately measures winds
- The quality of the PTU from the Sippican and Modem radiosondes is of the expected quality

In addition, the test allowed the team from the UK and US to observe the Tanzanian met staff and help develop their upper-air observation skills.

Acknowledgments

InterMet Systems would like to express its appreciation to the WMO, the team from the UK Met Office, Carl Bower from the US National Weather Service and the local staff from the Tanzanian Meteorological Service. This was the first opportunity for a comprehensive test of the Universal System concept and many of the observations of the test committee have been incorporated into a new release of the iMetOS system software. We are confident the results of the study will help validate the usefulness of universal radiotheodolite type upper-air systems for tropical regions.

Operational Issues

The first section of the report describes mechanical failures experienced in the radiotheodolite during the first week. After a thorough analysis, the failure was traced to water entering the electronics cage through an improperly sealed screw hole connecting the bubble level to the azimuth unit. The manufacturing error led to a cascade of faults that were regrettable due to their impact on the test schedule. This fault should not, however, imply that the system is poorly designed, or inappropriate for the conditions in Tanzania.

InterMet data shows that IMS-1500 radiotheodolites have provided reliable sounding performance for extended periods in tropical locations. The system's MTBF is currently estimated at 1,500 hours, or roughly 1 fault for every 1,000 flights. Faults during the initial break-in period occur in approximately 15% of all installations and are quickly remedied by InterMet engineers.

The unhappiness reported on the part of the Tanzanian Meteorological Service staff was understandable given the circumstances. They had gained very little experience with the system since its August installation due to the mechanical breakdown (which unfortunately was not reported to InterMet until several weeks after its occurrence). This created a long gap between the initial training and the arrival of a high-profile international expert team. Adding to the pressure was the fact that the Dar es Salaam staff had not made upper-air observations for over ten years. These factors placed the Tanzanians into the very uncomfortable position of having to operate a new system in front of a team of experts. Considering the circumstances, they performed very well.

It became abundantly clear that the degree of training needed for the Dar es Salaam site was underestimated by both the WMO and InterMet, and that this training needed to cover every aspect of upper-air observations. The fact that the station had not been operational for ten years was not properly considered when the initial scope of the training was defined.

InterMet Africa has been following up continuously with the Tanzanian staff and they are now quite comfortable making daily flights with the system. This is consistent with our experience in other tropical locations where once the staff begin making routine flights, the skills for operating the tracking antenna are quickly established.

In summary, the mechanical fault and training deficiencies clearly impacted the schedule of the Met Office tests. A proper test of the system's durability and usability should be made over a longer period before we can draw meaningful conclusions.

Winds and PTU

Moving on to the primary questions of wind accuracy and PTU measurements, InterMet's senior systems engineer (Dr. Rod Wierenga) reviewed the Met Office report and generated a list of questions that we would like to have addressed in the report before it is formally released. The comments deal with statistical issues arising from the intercomparison data, and some procedural questions about how the InterMet system was operated during the tests. Dr. Wierenga's analysis is attached to this letter as Appendix 1.

WMO Report Coding

Mr. Bower made a complete evaluation of the WMO coded reports and uncovered numerous inconsistencies with the requirements for Region IV. We are most appreciative of Mr. Bower's efforts and have incorporated his findings into a new release of the iMetOS meteorological software that has been installed in Tanzania. Mr. Bower's observations are included in Annex A of the Met Office Report.

Conclusions

Addressing the Met Office's conclusions in order:

1. Dar es Salaam was InterMet's first installation in Region IV and Dr. Nash is quite correct that more testing should have been made to correct the WMO reporting errors before installation.

2. We will need to defer comment on wind finding until we have had a chance to discuss the Met Office findings with Dr. Nash. Please refer to comments 1 through 9 in the attached **Appendix 1**.

3. The mounting of the radiotheodolite on the roof follows normal operating procedures that have been successful in many countries. We recommend deferring any decision on moving the antenna until the local staff has become more familiar with routine observations.

4. InterMet has a long history of cooperation with Sippican and the problem with solar correction was due to a clock error rather than a lack of communications. Dr. Nash is absolutely correct that the sonde manufacturers need to keep InterMet informed about any changes in their solar correction algorithms.

5. The clock error has been corrected.

6. Additional analysis is needed on this point.

7. Message properties have been corrected for Region IV.

8. The TMS has a communications department that is familiar with sending coded messages over data lines. However, there does not seem to be a complete procedure in place for ensuring that the transmissions are made each day. This should be addressed.

9. As noted above, the scope of the training provided in Dar es Salaam was not properly defined and should have included all elements of upper-air operations. InterMet recommends that a multi-disciplinary team be employed in future installation of this type. We further recommend that the WMO consider contracting with the Met Office in future situations like this to supply the meteorological training necessary to compliment InterMet's engineering expertise.

10. Agreed.

11. No comment

Technical Comments on UK Met Office Report,
"Dar-es-Salaam demonstration test of the IMS 1600 Integrated Upper Air System," 18-30 October 2004

1. What are the plots in Fig 2 intended to show? Inspection of the plots shows that the differences between the superimposed data in each plot ranges from 2 to 5 m/s. This implies a Std Dev of no less than 1-2 m/s. As stated in the report, the plots show that the wind is quite consistent over the periods of time the flights were made. Can the differences be due to wind gusts? The plots do not show that the GPS Std Dev was around 0.3 m/s.

2. The text in Para 5.1 refers to periods where the SNR was poor and raw data was intermittent. Can more be said about these periods and when/where/how often they occurred? There are no indications on the plots.

3. It is not clear what is plotted in Fig 3. It is assumed that the RS92 data is the noisiest one? Also, what was done to get the IMS 1600 results at 3 different time resolutions? The results look like they have different amounts of smoothing, but this is not a "documented feature" of the IMS 1600 system.

   If the "Wind dTime Factor" was adjusted to get the different results, the results are unpredictable. A CAUTION in the IMS-1600 User's Manual states that it highly recommended that the default value of 250 not be changed.

4. Does "closely spaced" in the reference to Fig 4 mean closely spaced in the time between flights? The results look very smooth and nearly the same. Is being noisy or is being smooth best for the Met world? If no smoothing is done, the motion of the sonde swinging below the balloon contaminates the results. If the wind due to swinging is mostly removed, some wind gusts are smoothed as well. If there is more smoothing, the wind gusts could be mostly removed and the estimated steady (mean) wind would remain. Does the Met world want the mean wind or peak winds?

   How much smoothing does the Met world want? Has this been specified or documented by the WMO? Are not the variations seen from flight to flight in the comparison plots mostly due to wind gusts?

5. Fig 6 has an anomaly at 4 km. Was something switched in the software at that time? Was the antenna bumped or moved?

6. How were the RMS differences computed in figs 7 and 9. Was it the RMSs of differences over segments of time; was it the differences of RMSs over segments of time; or RMSs of differences at the same heights on different flights? Could the method of calculating the RMSs have introduced a bias in the data at high altitudes? The report states that the differences are caused the different amounts of smoothing. If one method filters wind gusts and the other does not, which is correct?

7. How were the times synchronized (para 5.4)?

8. Only one plot is visible in Figure 10(a). Can the Vaisala results be shown as in Figures 10(b) and 10(c)?

9. The time delay in the Modem data has been fixed. Also, the delay could have been adjusted in your analysis.

10. The wrong solar corrections were applied to the MkII in fig 13. The error in the software has been found and the fix has been implemented at InterMet. Figure 1 below shows the Fig 13 flight temperature differences (RS92-MkII) with the correction applied (difference SD = 0.31 Deg C, RMS = 0.31 Deg C). Further adjustments of the RS92 and MKII data shows that there is about a 7 second difference between the two. It is not clear which one is correct.

    Figure 2 below shows the temperature differences with a 7 second delay in the RS92 data (difference SD = 0.11 Deg C, RMS = 0.13 Deg C). Figure 3 below shows the temperatures of both versus time with the 7 second time shift. Note that the curves are essentially on top of each other. The differences seem to be due to a slighter slower response of the Mk-II.

11. Yes, it is necessary that suppliers of sondes for the universal system provide the right correction software.

12. In Fig 15, assuming that the ascent rate is 300 m/s, the altitude at 35 minutes was 10.5 km. With a 50 m error at this altitude, the pressure error would be about 2 hPa, not 1 hPa. Also, how was the error in pressure calculated? Was it the Modem calculation less the RS92 calculation of pressure? An altitude of 16 km should have occurred at 53 minutes if the ascent rate was 300 m/s. From Fig 15, the pressure error was about 25 hPa and the geopotential height should have been about 14.7 km. This would be an error of 1.3 km, not 2.5 km. Obviously, neither is good. Also, why is there a 20 m difference in altitude and a pressure difference of about 2 hPa at time zero?

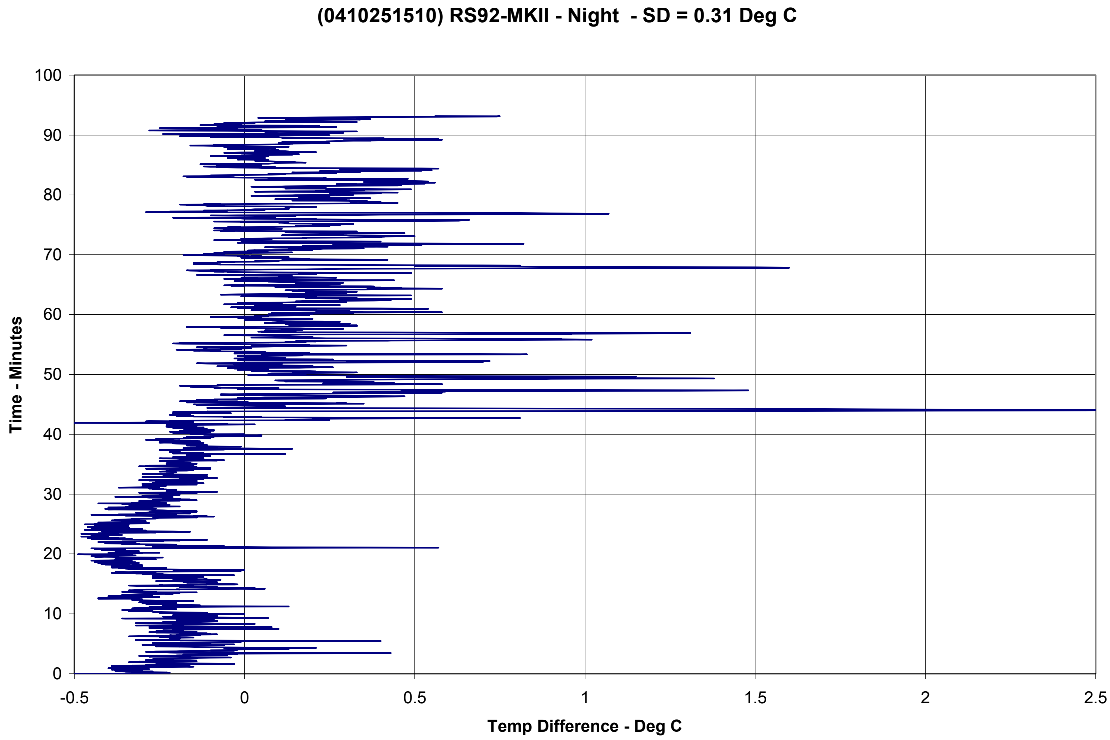

Figure 1. Temp diff with corrected solar correction

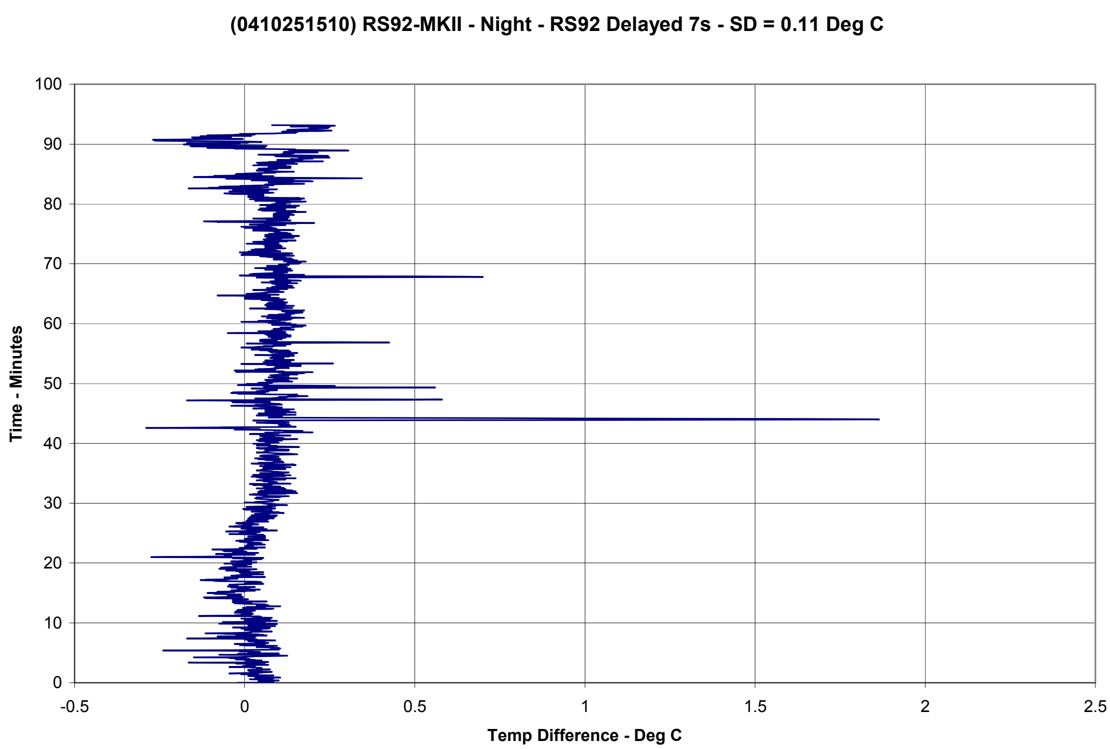

Figure 2: Temp diff with corrected solar correction and RS92 delayed 7s

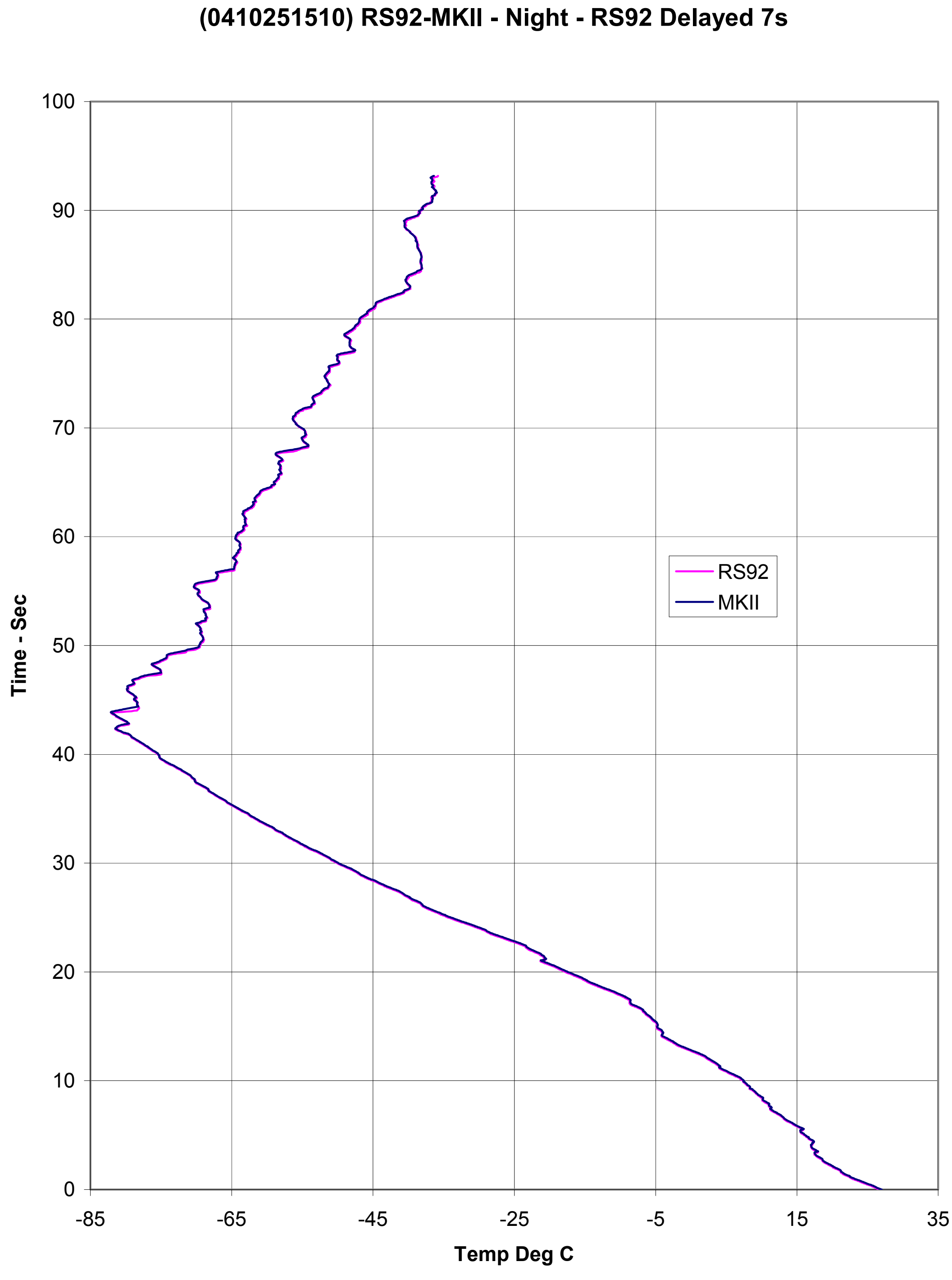

Figure 3: Temp with corrected solar correction and RS92 delayed 7s