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Atmospheric Measurement Techniques Discussions

Interactive comment on "The Development of the "Storm Tracker" and its Applications for Atmospheric High-resolution Upper-air Observations" *by* Wei-Chun Hwang et al.

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This paper introduces a newly developed, low-cost radiosonde instrument called Storm Tracker. This is a very interesting development and has a potential to be a useful tool for atmospheric science in the future. I have a few major comments and some minor comments on the current manuscript, some of which may be suggestions for future work.

Major comments:

(1) Please show some typical, individual profiles, together with the simultaneous RS41

profiles for all the variables. Here, time, rather than height, is appropriate as the independent variable. Such figures would show the actual response time, as well as possible biases, of the measurements of each variable by the Storm Tracker. For example, were the temperature inversion and the relative humidity drop at the top of the planetary boundary layer quantitatively captured? (It should be noted that relative humidity, rather than dew point temperature, should be evaluated because for both radiosondes, relative humidity should be the primary measurement.)

(2) Please show temporal changes of vertical profiles of temperature, relative humidity, and winds (for this case, zonal wind (u) and meridional wind (v) may be more appropriate) for the two campaigns. See, for example, Figures 2 and 3 of Fujiwara et al. (2003). Were the changes in the planetary-boundary-layer structure (e.g., the top inversion layer) and in the related relative humidity and wind distributions successfully captured with the series of soundings? Such figures may also show the degree of homogeneity in the production quality among individual Storm Tracker instruments; regarding this, have you made some dual soundings of two Storm Tracker instruments to evaluate the production quality homogeneity?

Specific comments:

- Page 3, line 51: A small mass radiosonde is good for reducing the balloon size. However, under turbulent conditions, the radiosonde motion relative to the balloon might become more chaotic; and this may affect the measurement quality. Attaching a kite tail might be useful for such a case.

- Page 4, line 4: Is the GPS module also used to measure the geometric height (and geopotential height and pressure)? (For the following Figures 10 and 13, please specify which height is used and how that height was calculated/obtained.)

- Page 5, line 87: It looks the Bosch BMP280 is a piezo-resistive pressure sensor. Is this sensor appropriate for the balloon sounding application, e.g., under the condition with monotonically and rather rapidly decreasing pressures from 1000 hPa to 300 hPa in about 30 minutes? This can be easily investigated by comparing with RS41 pressure measurements (from either the GPS measurements or the dedicated pressure sensor) with respect to time. (Again, is the height in Figures 10 and 13 the geopotential height calculated from the BMP280 pressure as well as measured temperature and relative humidity?)

- Page 5, line 91: The key points of the development of temperature and relative humidity sensor boom by the radiosonde manufacturers include (1) making the sensing parts as small as possible to obtain fast response, (2) coating the temperature sensor with high reflectivity material for solar radiation to reduce solar heating, (3) adding an "umbrella" for the relative humidity sensor (or adding sensor heating mechanisms) to reduce sensor icing issue, (4) extending the sensor boom upward and outward to reduce heat and water vapor contamination from the main body of the instrument (i.e., the wake effects), and (5) applying post data processing algorithms to correct for known biases. See, for example, the figures (photographs) in Section 4 of Nash et al. (2011) for (1)-(4) and Kizu et al. (2018) for (5). Therefore, the use of the HTU21D sensor, as well as the location of the sensor boom relative to the main rope and the radiosonde main body, can be a significant weak point of this instrument for upper air measurements. Direct solar heating on the sensor part should be quite significant, and longwave cooling at night could also be significant. The radiosonde body influence (e.g., heat and water vapor contamination from the body surface) can also be significant. One positive point is that this instrument is not designed for stratospheric measurements, for which the solar radiative heating issue on temperature measurements is most significant. Does the response time of 5 seconds apply for both temperature and relative humidity measurements? 5 sec for relative humidity measurements, if it is true, is probably not bad. In any case, the actual response time should be evaluated in comparison with RS41 measurements. There is a time-lag correction algorithm which can be used for both temperature and relative humidity measurements (and all other variables if necessary) (see Miloshevich et al., 2001).

- Page 5, line 99: Does this transmitter follow the national radiowave frequency regulations for the meteorological aids service? (cf. See also WMO-ITU (2017).)

- Page 5, line 107: "a 1-mm tinplate metal shield to cover the temperature and humidity sensors" – How is the airflow on the sensors? Figure 3 is not clear on this. Please show photographs from other directions as well. If the airflow is insufficient, infrared heating from the heated metal shield may contaminate the measurements significantly.

- Page 7, line 148: Please also explain the ground check and launch preparation procedures.

- Page 7, line 149, Section 3: Please see my major comment (1). Also, time should be used for intercomparisons with RS41 results.

- Page 8, line 162: "The solar radiation dry bias" – This needs a reference. Probably, Vömel et al. (2007) is an appropriate one here.

- Page 9, lines 184-205: I am confused by looking at Figure 13, top panels. The daytime results do not look different between the one with the hat and the one without the hat. This may mean that there are also other sources of heat contamination, e.g., from the main body of the Storm Tracker, or from the hat itself, or from the RS41 radiosonde body. For the last one, the dual sounding configuration shown in Figure 7 is, unfortunately, a bad one. Please see Jauhiainen et al. (2019) for better multiple sounding configurations and their reasons.

- Page 10, line 216, Section 4: Please see my major comment (2). (Also, I would be very much interested in sounding results for cloudy and rainy conditions.)

- Figure 2: The location of the battery on this photograph is very misleading.

- Figure 3: It looks the direction of the instrument is not consistent with that for Figure 2. Please also add other photographs to show the other sides of the metal shield.

- Figure 4, caption: Please add the information on the balloon size.

- Figure 7: This flight configuration would give significant heat contamination to the Storm Tracker temperature and relative humidity sensors from the RS41 body. Please see Jauhiainen et al. (2019) for much better multiple sounding configurations.

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