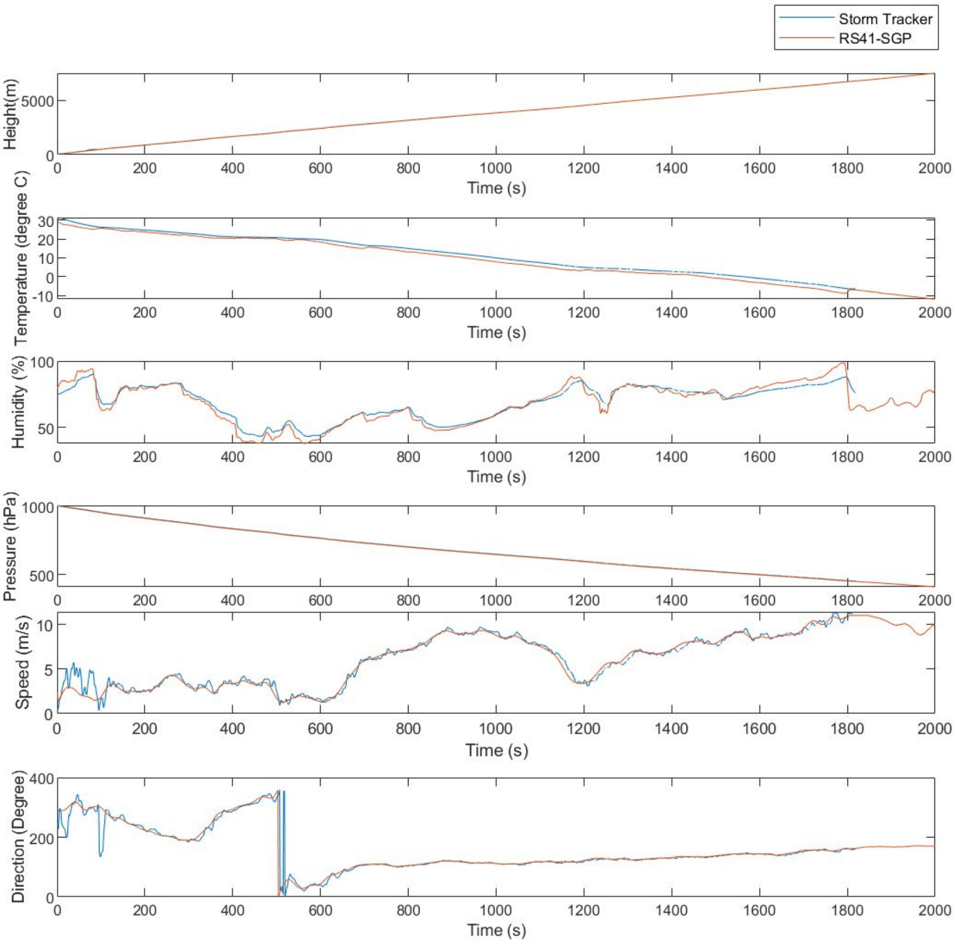
This paper introduces a newly developed, low-cost radiosonde instrument called Storm Tracker. This is a very interesting development and has a potential to be a useful tool for atmospheric science in the future. I have a few major comments and some minor comments on the current manuscript, some of which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

Thank you very much for your time and efforts in reviewing this study, Prof. Masatomo Fujiwara. We've updated our paper according to your following comments.

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.)

Thank you for the suggestions, for the response time issue, we added the section 3b to discuss the response time for humidity measurements.
Here we show all of the other variables for the StormTracker with hat co-launch on 2018/07/15 18h local time. The orange line is the RS41-SGP, and the blue line is Storm Tracker. The time lag indicates in the figure shows that the time-lag for humidity is not significant.

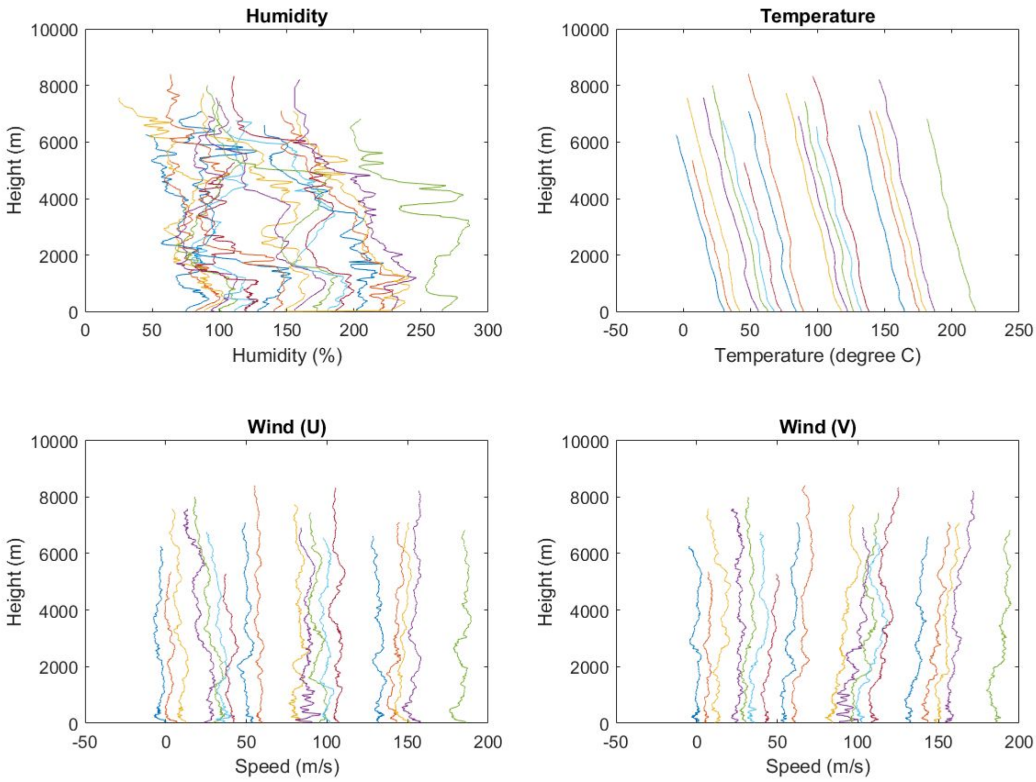
2018/07/15 18h LST



(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?

Thank you for the comments, we present the figures here. We’ve done a similar process like the reference you provided (Fujiwara et al. ,2003), by adding 2 per hour to each vertical profile. The following figures are the Storm Tracker(with hat) data during the second campaign.

temporal changes of vertical profiles



We haven’t tested dual StormTracker launch with the same configuration for temperature and humidity sensor yet, but we will add this into our future testing plan.

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.

Thank you for the suggestion, we will add this to our future plan.

- 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.)

Yes, it is used to measure geometric height. We updated Section 2 to clarified the sources of height data. But since we changed the comparison method by using time instead of height, according to your comment, Figure 10 (previously Fig 13) is now based on RS41-SGP’s altitude data.

- 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?)

Thank you for the comments, we added the section 3d to discuss the performance of pressure according to your comments. As a result, the performance is appropriate for balloon sounding usage based on the analysis of time-series data.

- 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).

Thank you for the insightful comments and the reference for the analysis.

According to the design, as shown in Figure 2, we aimed to achieve the mentioned key points by extending arm length, lower the PCB thickness and minimizing sensor areas of Storm Tracker. Finally, we added a metal shield to see if it helps to mitigate solar radiation heating. Though we haven’t tried to add coating, since the temperature and humidity sensor is the same chip, it is hard to cover the humidity sensing element and spray the coating during the production process. Note that Storm Tracker is very power efficient (in order to operate with a single AAA battery), the heating from Storm Tracker’s main body is quite minimum.

As for the response time, we add the section 3b to discuss the response time of our humidity and temperature sensors. The results suggest that the response time for humidity is a little bit more than 5 seconds, but still within about 8 seconds.

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

Although we want to follow the current frequency guideline for meteorological usage, the current production amount is not high enough for us to customize the radio module. That said, Storm Tracker's transmission circuit uses modularized design, so the radio module could be easily replaced in the future.

Note that the transmission modulation is based on Direct Sequence Spread Spectrum (DSSS), which may have some additional operation limit or limited transmission power in some regions. Though in the case for StormTracker the transmission power is about 80mW, which is way lower than most of the power limit regulations for DSSS.

- 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.

Thank you for the comments, we updated Figure 3 according to your comments.

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

Thank you for the comments, we added the discussion about the ground check and launch preparation for the field experiments in section 2c.

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

Thank you for the comments, we updated our intercomparisons calculation and the result.

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

Thank you for the comments, we’ve added the reference in our paper.

- 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.

Thank you for the comments, we also think that the hat itself might affect the sensor, according to the nighttime results.

However, the overall variance of measurements is lower. And for the future development of the correction algorithm, the effect of the hat will definitely be considered.

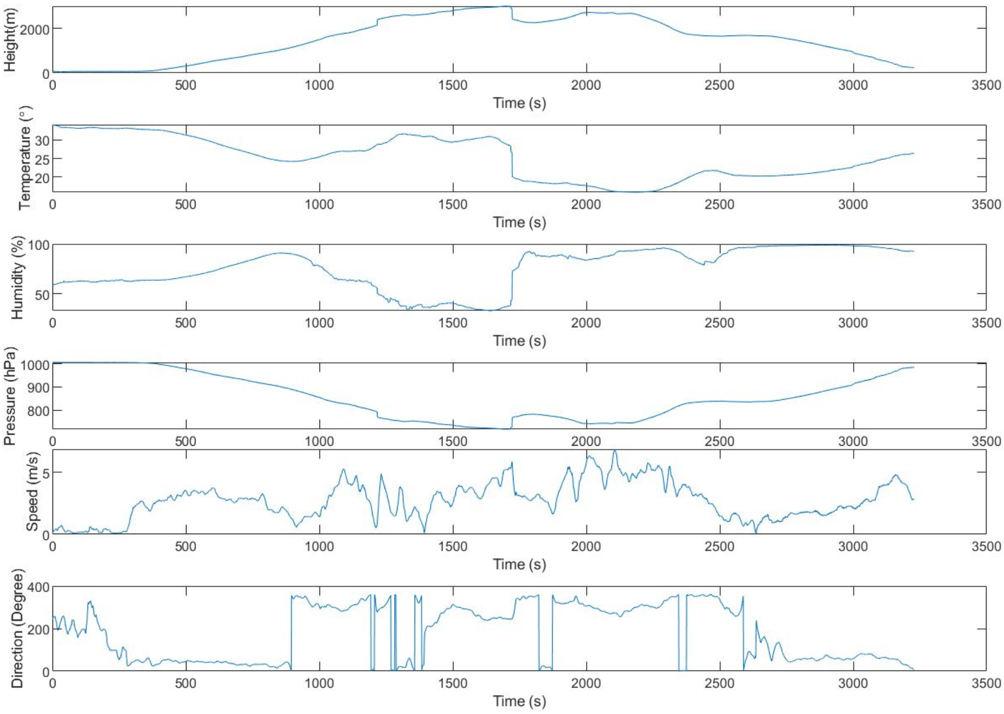
And thank you for the suggestion about the setup, we will update that in our future tests. The dual sounding setup

- 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.)

Although we have not yet co-launch with RS41-SGP under rainy conditions, we do have some testing flight during those conditions. The following figures are a test flight launch at 2017/09/08 about the time when a thunderstorm is getting close. First, we have the 3D traces (Credit to Google Earth Pro for providing the satellite image) as follows,

The StormTracker flies into the thunderstorm and then bring down by the downward wind.

And the following figure is the time-series data during the flight.



This flight data is a much extreme case whereas indicate in the time-series data, the humidity, and temperature changes rapidly, and just in time where the balloon flies into the storm, as indicated with the altitude drop. It shows that Storm Tracker is able to measure the sudden changes with the environment.

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

Thank you for the comment, Figure 2 is now updated.

- 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.

Thank you for the comment, Figure 3 is updated for this purpose.

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

Thank you for the comment, we added the information according to your comment.

- 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.

Thank you for the suggestion about the setup, we will update that in our future tests.

By Masatomo Fujiwara

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