

The editorial support team
Atmospheric Measurement Techniques
September 24th, 2025
Subject: Revision of manuscript egosphere-2024-4172

Dear Editors

Thank you for your letter and for giving us the opportunity to revise our manuscript on "Evaluation of middle atmosphere temperature and wind measurements and their disturbance characteristics by meteorological rockets" [Paper # egosphere-2024-4172]. We have carefully reviewed the comments and have revised the manuscript accordingly. Our responses are given in a point-by-point manner below. Changes to the manuscript are shown in the revised manuscript with "track changes".

Sincerely,

Yang He

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Response to Reviewer #1:

General comments:

The paper represents a rocket-borne technique for measurement of winds and temperature in the middle atmosphere between 20 and approx. 55 km.

The temperature measurement technique uses a thermistor and has been known since the early 1960th and was widely used in the last century.

Wind measurements are made by making use of the GNSS BeiDou.

Additionally, the system measures atmospheric pressure by a "silicon piezoresistive manometer". The measured data is transmitted to the ground by a built-in telemetry system. Authors claim that the density can also be derived from those measurements by using the ideal gas law: $p=nkT$, where p and T are the measured pressure and temperature, k is the Boltzmann constant and n is the number density of the ambient atmosphere. However, the density measurement results do not appear in the paper.

The paper is difficult to read because of a very specific language used alongside not commonly accepted terms. The results are clearly summarized, however not well-supported by the arguments.

After a brief introduction of the measuring instruments in Sec. 2, temperature retrieval including error analysis, is described in detail. Also, measurement error for wind soundings is addressed in this section.

After that, the paper is focused on derivation of small-scale temperature and wind fluctuations and comparison with the satellite-borne SABER measurements and MERRA 2 reanalysis data.

Response: Thank you for your understanding and recognition of our work. Without your help and advice, the manuscript would not have been significantly improved. We have carefully reviewed the comments and have revised the manuscript accordingly. Our

responses are given in a point-by-point manner below. Changes to the manuscript are shown in the revised manuscript with “track changes”.

Specific comments:

1) However, the density measurement results do not appear in the paper.

Response: Thank you for pointing out this detail. According to your suggestion, we have supplemented the comparison results of density and the corresponding discussion in the supplementary information.

L248:

Added “The vertical distribution of rocket detection density and their relative deviations with MERRA2, MSISE, and SABER are also shown in Figure A3. The density relative deviation of HJ-1 shows a significant maximum value between 40 and 50 km (the deviation can reach about 10% for the above three reference data), while the relative density deviation of HJ-2 is significantly smaller, especially with excellent consistency with the SBAER data (the relative deviation within the entire detection height range is within 5%). The large density deviation of HJ-1 in the upper atmosphere is, on the one hand, due to the significant reduction in the density itself, which makes the difference more prominent. On the other hand, it is very likely that there are other strong atmospheric disturbances causing drastic changes in density (discussed later), which have not been captured by the model and satellite data.”

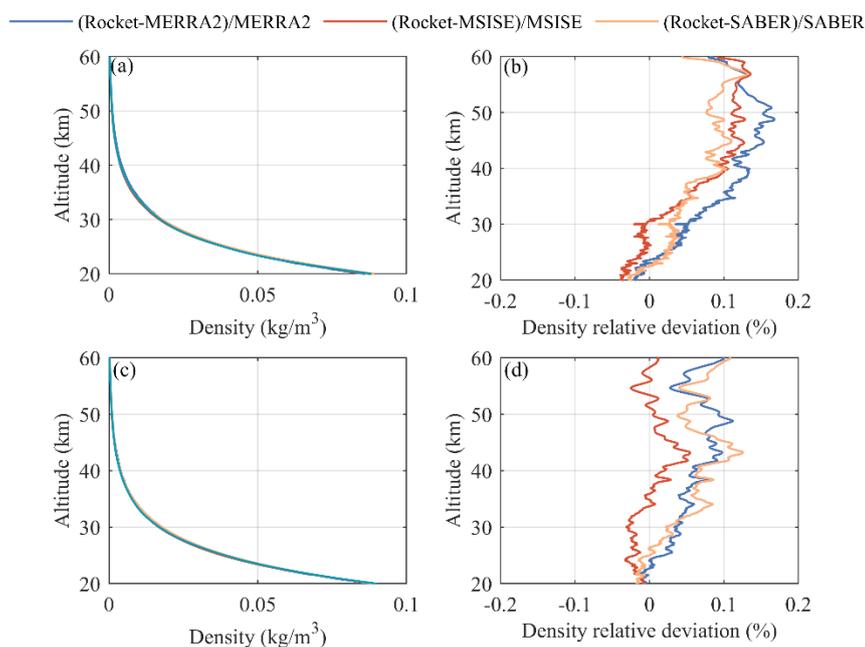


Figure A3. The vertical distribution of rocket detection density for (a) HJ-1 and (c) HJ-2. The relative deviation of rocket detection density with MERRA2, MSISE, and SABER for (b) HJ-1 and (d) HJ-2.

2) The paper is difficult to read because of a very specific language used alongside not commonly accepted terms. The results are clearly summarized, however not well-supported by the arguments.

Response: We are very sorry for the difficulty in reading caused by our lack of writing

skills. In this revision, we have further improved the expression of the full text. Of course, if necessary, after the technical issues have been resolved and modified, we will consider seeking the assistance of a professional polishing agency. In the revised version, we have focused on strengthening the support of evidence for the results.

According to your suggestion, we make the following changes to the expression:

Changed “After this treatment (linear fitting), the omitted part may correspond to the large fluctuation region of the wind field, which will also cause the loss of atmospheric disturbance information”

To “If the trajectory direction is relatively single (single-physical flow region), the linear fitting method can actually get more accurate results. However, the problem is that because many curved trajectories are rounded out after screening, the results obtained are not suitable for internal comparison. And irregularly curved trajectories may also contain important disturbance information. Compared with the best linear fitting of the single-physical flow region, the zonal or meridional projection in the multi-physical flow zone can be said to be a compromise method. Not only can more samples be retained, but also the disturbance information behind the curved/irregular trajectories can be retained.”

3) Since the manuscript is submitted to the AMT, I expected to learn more about the measurement technique itself, the instruments and data retrieval. A detailed description of the instrument is not present in the paper. In particular, which kind of sensors (thermistor, pressure sensor) were used. Either these were commercially available parts or self-made sensors. This knowledge will further help to clarify two important questions: resolution and sensitivity of the measurements. The paper by Wagner, 1961 cited in this manuscript, concludes that "Time constant and fall velocity considerations prohibit the measurement of small-scale temperature fluctuations". I accept that the new sensors can be more sensitive and much faster. However, this should be shown in this manuscript, since the main focus is made on the fluctuation measurements. Also, no information on the telemetry requirements (transmitter, receiver, bandwidth, sampling rate, etc.) appears in the manuscript.

Response: Based on your feedback, we have provided supplementary explanations regarding the information of the instrument itself. We have supplemented the detailed description of the sensor and its performance parameters in the manuscript. We have drawn the internal structure of the radiosonde so that readers can have a more intuitive understanding of the instrument information. At the same time, the information of the telemetry requirements is supplemented.

L79: The rocket radiosonde is mainly composed of temperature sensors, pressure sensors, satellite navigation and positioning modules, data acquisition circuits, transmitters, wireless remote control modules, batteries, switches, fixed frames, insulation boxes and fiberglass reinforced plastic shells, etc. The temperature sensor adopts a bead thermistor, purchased from the shelf, model MF51MP-D (Blue Crystal Electronics). The pressure sensor adopts a high-precision digital pressure sensor, purchased from the shelf, model ms5607 (Switzerland). The navigation and positioning module adopts the high-precision

accuracy	Vertical direction	5m (CEP 90%)
	Speed	0.2m/s (CEP 90%)
	Measurement range	-90°C ~ +55°C
Temperature	Static calibration accuracy of the sensor	$\leq \pm 0.2^\circ\text{C}$
	Resolution	0.1°C
	Measurement range	1060hPa ~ 5hPa
pressure	Static calibration accuracy of the sensor	$\leq \pm 0.8\text{hPa}$
	Resolution	0.1hPa

4) The main focus in the entire paper is made on the fluctuation analysis, with an attempt to demonstrate that these measurements are suitable for investigation of small-scale processes like gravity waves and turbulence. This part looks to me neither consistent nor complete.

Response: Thank you for pointing out this issue. We have further optimized and improved the structure of the text. Fluctuation analysis is carried out on the basis of reasonable and reliable measurement results, so result comparison verification and error analysis were conducted before this. And some profile difference phenomena discovered in the result comparison are believed to be closely related to the strong fluctuations at this height. Therefore, it is necessary to further verify these phenomena in the atmosphere through fluctuation analysis. We hope you could understand the efforts we have made in conducting wave analysis, as the research on it can, on the one hand, echo the previous detection results, and on the other hand, it is also an application study of rocket detection data, enhancing the theoretical and complete nature of the entire manuscript.

Of course, based on your opinions, we have made the following modifications to enhance the consistency and completeness of the context:

L61 Added “Due to the large amplitude of atmospheric waves in this height range, the momentum and energy dissipated by wave fragmentation can cause drastic changes in meteorological elements such as wind field, density and temperature in the surrounding atmosphere. Therefore, analyzing the interaction mechanism between atmospheric wave and background atmosphere has always been one of the important research directions of in-situ observational data.”

L248 Added “The large density deviation of HJ-1 in the upper atmosphere is, on the one hand, due to the significant reduction in the density itself, which makes the relative deviation more obvious. On the other hand, it is very likely that there are other strong atmospheric disturbances causing drastic changes in density (discussed later), which may be difficult to be captured by the model and satellite data.”

L286 Added “In the accuracy analysis of the two rocket detection results, we find that compared with HJ-2, HJ-1 has a more intense falling velocity disturbance, and the deviation from the reference data is larger. Profile deviation phenomena discovered in the result above are inferred to be closely related to the strong disturbance at this height. Therefore, it is necessary to further verify these phenomena in the atmosphere through

disturbance characteristic analysis. Conducting wave disturbance analysis here, on the one hand, verify the previous detection results, and on the other hand, it is also an application study of rocket detection data, enhancing the theoretical nature and completeness of the rocket data analysis results.”

5) In Sec. 5 authors focus on deviations of measurements (wind and temperature) from MERRA2, SABER, and MSIS. This makes no sense to me. The general comparison in the left panels of Figs. 5 & 6 looks very convincing and sufficient.

Response: Thank you for pointing out this issue. When we conduct rocket data analysis (more specifically, in terms of users' attention to rocket detection results), we pay attention to both intuitive trend comparisons and deviation comparisons among different data. Trends can visually compare the degree of consistency between rocket detection data and reference data, and the results also show high reliability. However, when analyzing the details, the deviation results can reflect more detailed features.

For instance, the trends of the two wind field components in Figure 5a are in good agreement. However, to visually identify which detection result deviates more from the MERRA2 data and at which height the deviation is more pronounced, Figure 5b can provide a more intuitive indication. Moreover, when analyzing the reasons for the large deviation between the detection results and the model results, the detail disturbances and extreme value regions on the deviation profile are more likely to be combined with the regions with strong atmospheric fluctuations for analysis. We would be very grateful if you could understand our presentation of the deviation results.

6) However, the next sections deal with fluctuations. Their extraction method is described in the text: 20-point sliding average, interpolated profile with 50 m interval, and fitted fifth-order polynomial to get the background profile. Additionally, high-pass filtering with a cut-off wavelength of 10 km is applied. This decomposition into background field and fluctuations needs a demonstration by proper plots, which is not shown in the paper (neither background nor fluctuations). Also, the missing data on resolution and sensitivity of the measurements would help to judge on the quality of the derived fluctuations.

Response: Thank you for pointing out this issue. According to your suggestion, we have made the following modifications:

L311: Added “Taking HJ-2 as an example, the extraction process of zonal wind and meridional wind disturbances is demonstrated (Figure A6).”

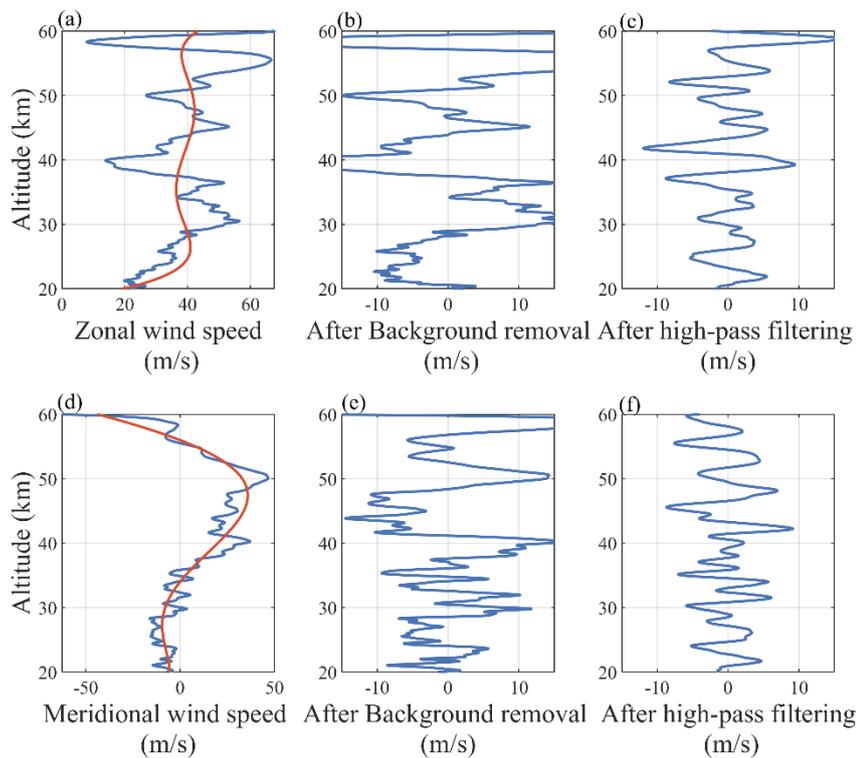
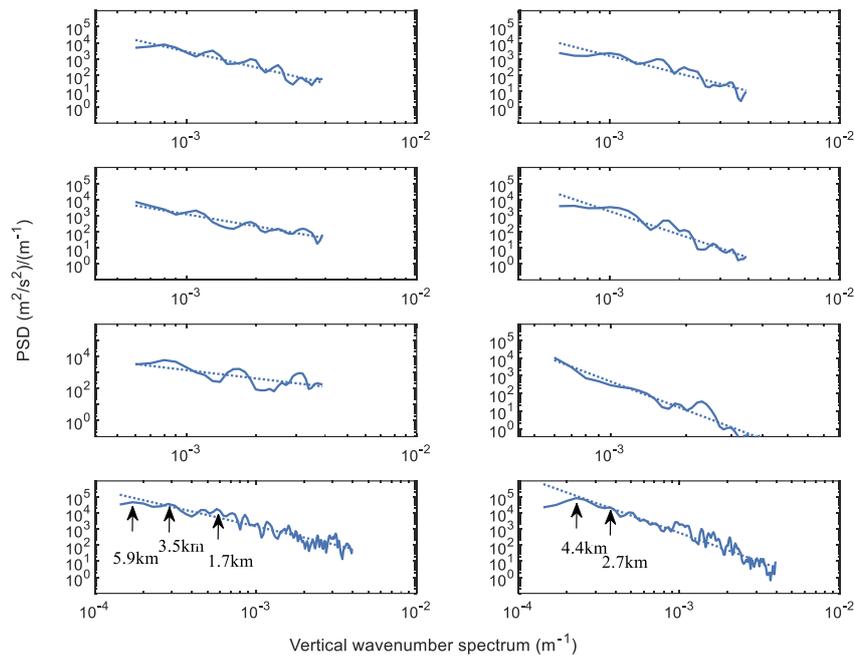


Figure A6. The disturbance extraction process of (up) zonal wind and (down) meridional wind for HJ-2

7) Next, spectral analysis is applied to the derived fluctuations. The way it is done looks strange to me. The same time series was analyzed by both the Lomb-Scargle (Fig. 10) and the Fourier (lowest panels of Fig. 11) analyzes. They should demonstrate quite similar picture, which is not the case here. It is not clear to me where such a difference comes from and why authors need the Lomb-Scargle analysis. Why, in particular, the Fourier spectra do not reveal the same dominating wavelengths as shows the Lomb-Scargle. Also, the speculations about dominating slope in the spectra do not look convincing: there are different slopes in those spectra, better pronounced in the right panel. Another question is: what the noise of the instrument itself look like? If the instrument (thermistors) reveals, e.g., red noise, the slopes in spectra demonstrated in the manuscript cannot be interpreted so directly.

Response: Thank you very much to the reviewers for pointing out this issue. By checking the programming data, we found that the reason for the difference between the Lomb-Scargle spectrum analysis and the FFT spectrum results is that the raw data processed is different. Lomb-Scargle analysis was subjected to high-pass filtering before processing (as mentioned in L311), but FFT did not perform this processing. The correction results obtained through FFT analysis of the same data are as follows:



We can see that the dominant wavelength is basically consistent with the Lomb-Scargle analysis. Considering that FFT processing may be forcibly interpolated or truncated, leading to spectral leakage or distortion of frequency components, as well as the existence of boundary effects, this may result in the dominant wavelengths in the Lomb-Scargle analysis results not being represented by FFT.

Similarly, the author also strongly agrees with your view that it is meaningless to discuss the slope in the FFT results, since there are different slopes in those spectra. At the same time, considering the existence of noise, the slopes in spectra demonstrated in the manuscript cannot be interpreted so directly.

So, based on your suggestion, we have removed the description of the FFT spectral results here because their interpretation (especially the slope) may not be entirely accurate, and the Lomb-Scargle spectral results have already achieved the author's discussion purpose: to analyze the dominant vertical wavelengths in the two detections.

8) It is also quite commonly accepted now, that the gravity waves often propagate as wave packets along very different pathways (directions, inclination angles, etc.). This leads to an observational challenge, that they rather appear in a small part of the measured altitude profile. These wave packets can better be localized by the wavelet analysis.

To my knowledge, the Stokes parameters derived in the Sec. 7.2 yield a relatively coarse description of the gravity waves in comparison with other methods. The measurements described in this paper (zonal and meridional winds and temperature) allow applying a more advance and precise analysis technique, the hodograph method.

Response: Yes, the author agrees with your point of view. Gravity waves in the real atmosphere may propagate in multiple directions and do not necessarily capture their complete wave propagation only through horizontal or vertical directions. In other words,

the existence of observational filtering would make a single detection method only capture the local features of the fluctuations (in line with the instrument observations).

Hodograph analysis (Gill, 1982) is the most widely used method. The vertical profile of wind velocity is used to obtain the detailed parameters of IGWs. However, this method is only applicable to monochromatic waves (the relative deviations of the dominant vertical fluctuations of temperature disturbance, zonal wind and meridional wind disturbance from the average wavelength do not exceed 15%). Stokes parameter method (Vincent et al., 1987) can reflect the statistical characteristics of multi-frequency wave more reasonably through the average within the wavenumber bands. The precondition of hodograph analysis is to assume that monochromatic IGWs are extracted, which may lead to large uncertainties when harmonic fitting is used. For example, some fluctuations with large frequency difference from the sinusoidal fitting will be ignored. Stokes parameter method, by contrast, is more inclined to reflect the polychromatic waves in real atmosphere based on the weighted average of perturbation on a profile.

In this paper, we need to explore the wave characteristics in different height intervals. If hodograph method are used for analysis, many intervals do not meet the characteristics of monochromatic waves (Figure 10 already shows that gravity waves are polychromatic waves). Therefore, we hope that the you could understand that we use Stokes parameters to extract the parameters of gravity waves. Moreover, to avoid the limitations of a single detection, we also utilize ERA5 data to analyze the wave characteristics over a longer period and a wider area, which is used to verify our results.

At the end, Authors are grateful to the anonymous reviewer for providing valuable comments to improve the manuscript up to this level. We greatly appreciate the time and effort you put into improving the quality of my manuscript, and we have benefited immensely from your selfless comments and suggestions. **Besides, if you have more suggestions or comments about my manuscript or the content of the reply, I will always be pleased to make timely replies and revisions and benefit from communicating with you.** Finally, thank you again from the bottom of my heart.

Response to Reviewer #2:

General comments:

This study obtained middle atmosphere temperature and wind measurements from 20-60 km in northwest China by two meteorological rockets. The detection results are compared with satellite, empirical model and reanalysis data, and the error analysis theory is carried out in combination with the of the drop sounding and atmospheric disturbance characteristics. The observations in the manuscript provide valuable results for understanding the atmospheric environment in the near space. Moreover, the authors, in combination with ERA5 data, have captured typical cases of gravity wave, which is a very interesting result. Although the authors' dataset and observation could be of high scientific value, the study in its present form suffers from several flaws and I recommend publication with suitable revisions.

Response: Thank you for your understanding and recognition of our work. Without your

help and advice, the manuscript would not have been significantly improved. We have carefully reviewed the comments and have revised the manuscript accordingly. Our responses are given in a point-by-point manner below. Changes to the manuscript are shown in the revised manuscript with “track changes”.

Specific comments:

1. The theoretical background introduced in the introduction is not complete enough. Since a considerable part of the manuscript is about the analysis of atmospheric disturbance characteristics, the author needs to emphasize in the introduction the significance of atmospheric fluctuations in detection, or why the rocket detection results should be used to analyze the characteristics of gravity activities?

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the following modifications:

L40 Added “Atmospheric disturbances, as the superposition of waves at different scales (including turbulence, gravity waves, planetary waves, etc.), are one of the main dynamic processes in the near space. As the height increases, the density decreases exponentially. The amplitude of these disturbances, such as gravity waves, gradually increases during the upward propagating process, and the impact of the wave becomes more and more significant (Lindzen, 1981; Alexander et al., 2010)”

L61 Added “Due to the large amplitude of atmospheric waves in this height range, the momentum and energy dissipated by wave fragmentation can cause drastic changes in meteorological elements such as wind field, density and temperature in the surrounding atmosphere. Therefore, analyzing the interaction mechanism between atmospheric wave and background atmosphere has always been one of the important research directions of in-situ observational data.”

2. Effective height interval for analysis is from 20~60 km.

Does the rocket stop receiving data when it actually reaches a height of 20 kilometers (during the descent phase)? Why is only the data over 20 kilometers mentioned here? If the author analyzes the data from 0 to 20 kilometers together, more valuable results will be highlighted. Also, the maximum detection altitude of the rocket exceeds 70 kilometers (Figure 3).

Response: In fact, the point you put forward is completely correct. During the actual rocket launch, the highest point of the trajectory was at an altitude of over 70 kilometers. However, in the early stage of the separation of the rocket and the parachute, if the descent speed is too fast, the sensor cannot detect effective data (the temperature correction processing in the later stage of the high-altitude part also has a prerequisite, that is, the descent speed of the radiosonde is lower than a certain threshold). Therefore, in the rocket we use, the selection of 60 kilometers as the upper limit of the effective detection altitude is determined based on the performance of the instrument itself, taking into account the range of the falling speed. Similarly, as can be seen from Figure 1, the data return transmission requires a ground receiver. As can be seen from Figure 3, as the falling height decreases, the horizontal drift distance becomes increasingly farther. After the altitude dropped to 20 kilometers, the receive stop receiving (taking into account both

time and data quality). The data analysis range in this manuscript is 20 to 60 kilometers, which is also the standard detection height range for this model of product.

3. The specific calculation process of atmospheric parameters shown in Figure 2 doesn't seem to correspond to the previous statement. For instance, shouldn't base pressure measurement be conducted independently? In the picture, it seems to be obtained after temperature correction. Similarly, it is recommended that the calculation formulas for air pressure and density be further clarified in the main text.

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the following modifications:

Figure 2 was redrawn:

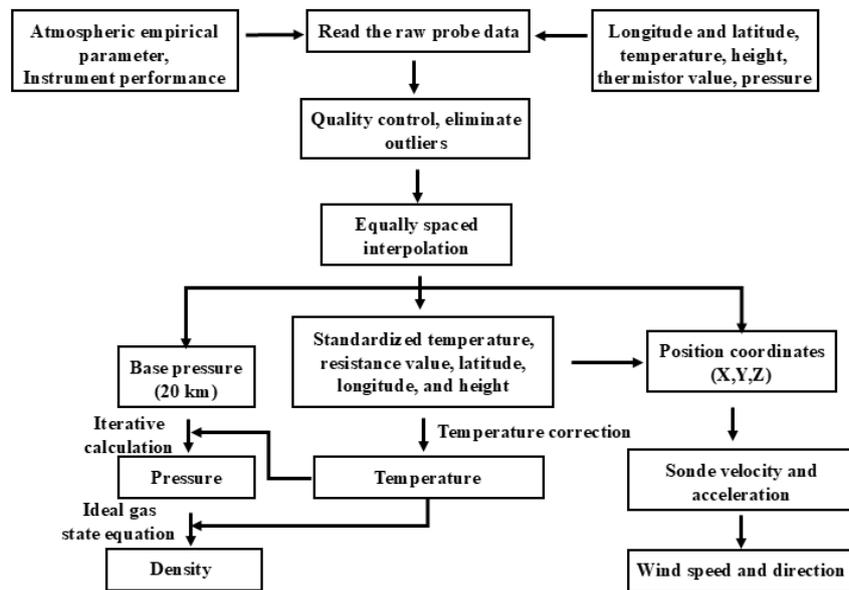


Figure 2. Atmospheric parameters calculation process.

L106 Added “The air pressure at each height layer is calculated from the measured base point air pressure (20 km) using the pressure height formula:

$$P = P_d \exp \frac{-g_0(H - H_d)}{R * T_d}$$

Among them, P represents the air pressure at the calculated height, P_d is the air pressure of the adjacent lower layer, H is the geopotential, H_d is the geopotential of the adjacent lower layer, R is the dry air gas constant, and T_d is the temperature of the adjacent lower layer. Given the temperature and air pressure, the atmospheric density can be calculated through the ideal gas state equation.”

4. Errors and deviations in the result comparison.

Since authors evaluate the accuracy of the rocket detection results, a deviation analysis is conducted by comparing with the reference data, and at the same time, the error results are obtained through iterative calculation of the parameters during the detection process. The author should distinguish the differences between the two results in the

text, and what are the respective functions of the given deviation results and error results?

Response: In the manuscript, the deviation result describes the gap between the rocket detection result and the reference value (satellite, reanalysis, etc.). The greater the deviation, the more it deviates from the reference data. The purpose is to demonstrate the degree of consistency (deviation) between the rocket detection results and other data, and it is a comparison between different data. The error result describes the measurement error of the rocket measurement instrument itself (including systematic error and random error), which is a comparison among different heights and sub-items within the rocket detection results.

Based on your suggestions, we have made the following modifications:

L215: Added “Here, we use the deviation result describes the gap between the rocket detection data and the reference value (satellite, reanalysis, etc.). The purpose is to demonstrate the degree of consistency or deviation between the rocket detection results and other data, and it is a comparison between different data.”

L249 Added “Accurate measurement is the prerequisite for conducting further data analysis and application. To further analyze the sources of deviation between the rocket detection results and other data, as well as the reliability of the disturbance analysis, the error level of the rocket instrument is discussed here, which is a comparison among different heights and sub-items within the rocket own detection results.”

5. Temperature correction.

Temperature correction is the key to ensuring the accuracy of temperature measurement. Judging from the results in the figure, the author's temperature correction results are reliable. However, the main text and supplementary materials lack further descriptions of the instrument's performance parameters, which makes it unclear to readers who focus on the measuring instrument itself the extent to which the instrument parameters affect the measurement. Similarly, the author provided the results of each temperature correction sub-term in the supplementary materials, which are very valuable measurement results. It is suggested that the author further explore and analyze the internal information?

Response: Based on your feedback, we have provided supplementary explanations regarding the information of the instrument itself. We have supplemented the detailed description of the sensor and its performance parameters in the manuscript. We have drawn the internal structure of the radiosonde so that readers can have a more intuitive understanding of the instrument information. At the same time, the information of the telemetry requirements is supplemented.

L79: The rocket radiosonde is mainly composed of temperature sensors, pressure sensors, satellite navigation and positioning modules, data acquisition circuits, transmitters, wireless remote control modules, batteries, switches, fixed frames, insulation boxes and fiberglass reinforced plastic shells, etc. The temperature sensor adopts a bead thermistor, purchased from the shelf, model MF51MP-D (Blue Crystal Electronics). The pressure sensor adopts a high-precision digital pressure sensor, purchased from the shelf, model ms5607 (Switzerland). The navigation and positioning module adopts the high-precision positioning module of Beidou, and the antenna uses a four-arm helical antenna, which is a customized product. The main MCU of the data acquisition circuit adopts a 32-bit

processor with ARM core, featuring low power consumption and mixed signal processing capabilities. It has a 14-bit A/D conversion accuracy, which can meet the measurement accuracy requirements of sensors. The digital transmitter is composed of dedicated RF chips and power amplifier modules to form a frequency point digital transmitter. It has the advantages of small size and adjustable frequency. When used in conjunction with ground receiving equipment, it can achieve data transmission within a diagonal distance range of 200 kilometers. The physical appearance and structural layout of the rocket sounding instrument are shown in Figure 1, and the main performance indicators of the rocket sounding instrument are shown in the table A1.

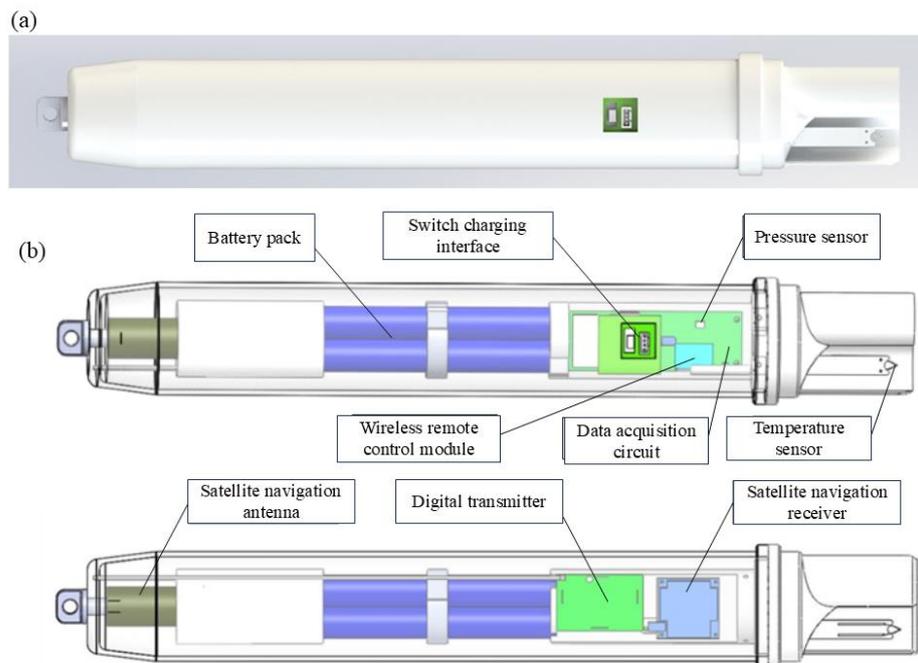


Figure 1. (a) The physical appearance and (b) structural layout of the rocket sounding instrument.

Table A1. Main performance indicators of rocket radiosondes

Indicator name	Performance parameters	
Transmitter frequency	400MHz ~ 406MHz	
Carrier frequency stability	$\pm 20\text{kHz}$	
Emission spectral width	$\leq 50\text{kHz}$ (-50dB)	
Transmitter power	100mW ~ 200mW	
Digital signal transmission mode	GFSK	
Data transmission rate	4800bps	
Data update rate	$\geq 2\text{Hz}$	
Positioning accuracy	Horizontal direction	5m (CEP 90%)
	Vertical direction	5m (CEP 90%)
	Speed	0.2m/s (CEP 90%)

Temperature	Measurement range	-90°C ~ +55°C
	Static calibration accuracy of the sensor	$\leq \pm 0.2^\circ\text{C}$
	Resolution	0.1°C
pressure	Measurement range	1060hPa ~ 5hPa
	Static calibration accuracy of the sensor	$\leq \pm 0.8\text{hPa}$
	Resolution	0.1hPa

As for each temperature correction sub-term in the supplementary materials, we have made the following supplementary discussions:

L233 Added “Among the various correction sub-items for rocket detection temperature, the influence degree of pneumatic heating, current heating, and temperature hysteresis are relatively large, and these influences gradually decrease as the height decreases overall.”

6. Regarding the extraction of gravity waves, the author should provide the original profile of the rocket detection, the fitted background profile, and the disturbance profile, etc., to visually demonstrate whether the extracted waves are reasonable.

Response: In this paper, we need to explore the wave characteristics in different height intervals. If hodograph method is used for analysis, many intervals do not meet the characteristics of monochromatic waves (Figure 10 already shows that gravity waves are polychromatic waves). Therefore, we use Stokes parameters to extract the parameters of gravity waves.

L311: Added “Taking HJ-2 as an example, the extraction process of zonal wind and meridional wind disturbances is demonstrated (Figure A6).”

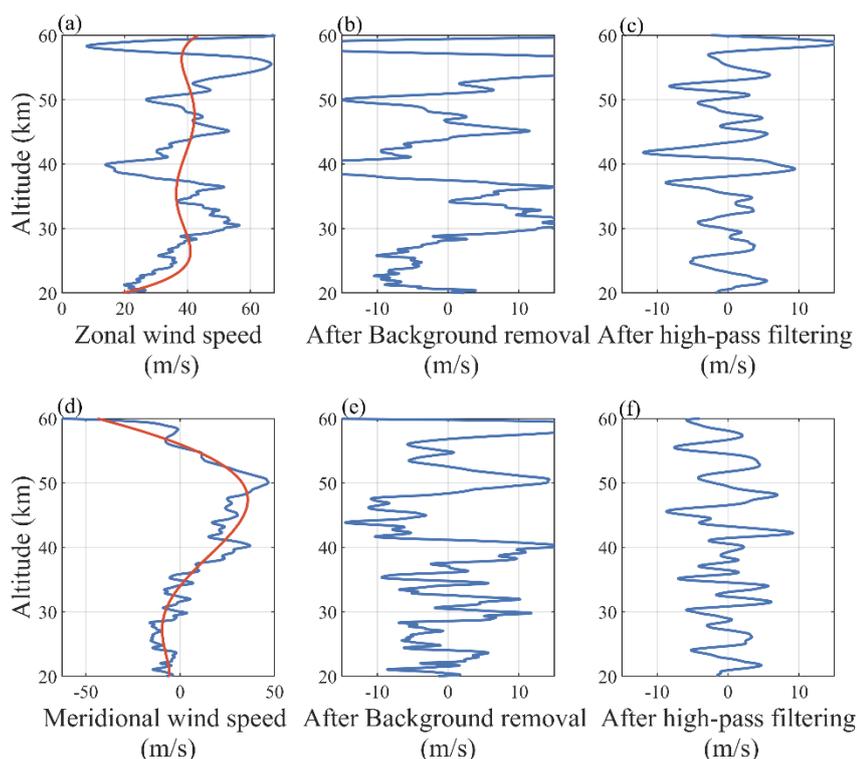


Figure A6. The disturbance extraction process of (up) zonal wind and (down) meridional wind for HJ-2

From the figure, an intuitive phenomenon can be observed: before high-pass filtering, there is a vertical wavelength of 20km (b), and after high-pass filtering, the wavelengths are all within 10km. This also indicates the correctness of data processing.

7. Regarding the slope of the gravity wave spectrum. The extraction of the slope of the gravity wave spectrum largely depends on the fitting interval. Due to the significant fluctuations of the power spectrum throughout the wavenumber range, different fitting intervals may cause obvious slope differences.

Response: Authors strongly agrees with your view that extraction of the slope of the gravity wave spectrum largely depends on the fitting interval, since different fitting intervals may cause obvious slope differences. At the same time, considering the existence of noise, the slopes in spectra demonstrated in the manuscript cannot be interpreted so directly.

So, based on your suggestion, we have removed the description of the FFT spectral results here because their interpretation (especially the slope) may not be entirely accurate, and the Lomb-Scargle spectral results have already achieved the author's discussion purpose: to analyze the dominant vertical wavelengths in the two detections.

8. Based on the parameters obtained by the stokes parameter method, the author points out that the gravity waves of HJ-2 have a consistent propagation process. However, there is a significant change in the horizontal propagation direction (from 215° to -36°). The results in Figure 12 can demonstrate that within the 40-50km range, the propagation characteristics reflected by HJ-1 and HJ-2 through the stokes parameter method are consistent with the wave characteristics of ERA5. However, it cannot be determined whether the wave propagation characteristics at the entire altitude of the same rocket exploration are consistent (whether the wave in 40-50km and the wave in 20-50km are from the same source).

Response: Thank you for pointing out this issue. The author had mentioned in the manuscript the inconsistency between the local and overall wave propagation directions, and believed that this might be related to significant wind speed changes near 40 km. However, the interaction mechanism between gravitational waves and the background field is complex. Changes in the wind field may lead to alterations in the propagation direction, but at the same time, if new wave sources are generated, it will also cause inconsistent propagation directions at different heights. Based on the current data of this manuscript alone, it is impossible to verify whether they come from the same wave source (this does not affect the key point of perturbation analysis: the judgment of wave fragmentation). Therefore, to ensure the rigor of the expression, the author has made the following modifications:

L396 : Deleted “The wave propagation direction of HJ-2 is significantly different in the entire and local ranges, possibly due to significant wind speed changes near 40 km (Figure 5c).”

Minor comments:

1. L24: momentum deposited → momentum deposition

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

2. L91: The captions and the main text should be separated

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

3. L59: The falling spheres can obtain the atmospheric density profile of 30-100 km, and then calculate the wind field, temperature and pressure, the thermistor measurement can obtain the atmospheric temperature from 20 to 60 km, and then calculate the density, pressure, and wind field → The falling spheres can obtain the atmospheric density profile of 30-100 km, and then calculate the wind field, temperature and pressure. The thermistor measurement can obtain the atmospheric temperature from 20 to 60 km, and then calculate the density, pressure, and wind field

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

4. L64: Atmospheric density are measured using GPS data on a rigid falling ball and found that the deviation from → Atmospheric density is measured using GPS data on a rigid falling ball and the measured deviation from

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

5. L70: to obtain near space meteorological detection data from 20 to 60 km → to obtain meteorological detection data from 20 to 60 km

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

6. L91: One space is missing

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

7. L112: form → from

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.

8. L389: are → is

Response: Thank you for pointing out this issue. Based on your suggestions, we have made the corresponding modifications.