The change of rainfall and atmosphere characteristics based on target tracking algorithm and real-time monitoring of college students' physical training

Wang Xianfeng

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Abstract
This paper studies the real-time monitoring of rainfall and atmosphere characteristics and college students’ physical training based on target tracking algorithm. In this paper, we use the target tracking algorithm combined with the GNSS observation stations of BJFS, LHAZ, URUM, CUSV, and PIMO, to calculate the change of rainfall atmosphere characteristics of ULUM station, and then get the PWV above the ULUM station, and compare the PWV obtained by the radiosonde station with the ground-based GNSS inversion results to verify the change of rainfall atmosphere characteristics based on the target tracking algorithm. In order to solve the problem of inaccurate tracking and positioning when the background is cluttered, a target tracking algorithm based on channel reliable local rank transform is proposed. The local rank transform feature combined with lab three-channel image is used to form 16-dimensional feature channel, from which the effective feature channel is selected for fusion to enhance the expression ability of the algorithm for target features. The experimental results show that, compared with the feature channel selected by reliability coefficient, the local rank transform feature channel selected by experience has better tracking effect in specific scene and more accurate position estimation of target. At the same time, with the transformation of China from a sports power to a sports power, sports training is scientific, science and technology help sports, and the guarantee system of sports science integration is gradually improved. The state attaches great importance to the role of science and technology in the training of college athletes, and has purchased a set of Firstbeat sports monitoring system to monitor the athletes’ heart rate in real time. A scientific research group is set up to provide scientific and technological services, record the heart rate of athletes during training and competition, so as to determine the “load characteristics” of athletes, and explore the monitoring of athletes’ training with heart rate as the object, so as to improve the training quality of athletes.

Keywords Target tracking algorithm · Characteristics of rainfall and atmosphere · Physical training · Real-time monitoring

Introduction
Rainfall atmosphere is an important component of the atmosphere, and its concentration in the air directly determines the weather and climate change. It mainly comes from the evaporation of liquid water on the ocean surface, which is the basis of cloud formation and rainfall. The composition of the atmosphere is various, but the rainfall atmosphere only accounts for a very small part of the atmospheric composition, and most of them are distributed in the troposphere, but most of the weather changes are caused by the dynamic changes of the rainfall atmosphere (Jhajharia et al. 2009). Therefore, it is of great significance to fully understand the distribution and change law of rainfall atmosphere, and master the relationship between rainfall atmosphere change and weather change for the prevention of disastrous weather (Kabir and Hossen 2019). Radiosonde technology can obtain high-resolution rainfall structure in the vertical direction (Khalil 2013). Since the 1940s, the sounding station detection technology has been widely used in the detection of atmospheric rainfall content. Because of its high accuracy, the rainfall atmosphere value obtained from the sounding station network is...
usually taken as the true value to study the dynamic change law of rainfall atmosphere. However, radiosonde equipment can only be used once, so the cost of each detection is very high and there are various shortcomings such as low temporal and spatial resolution, which makes it difficult to popularize and apply in a large area in the actual measurement. The main task of target tracking is to predict the position of the target in the subsequent frame according to the position information of the target in the current frame (Li et al. 2014). Target tracking technology has shown excellent performance in the fields of human machine interaction, monitoring, robotics and medical diagnosis. In practical application, there are still many challenges to track the target accurately. Such as illumination change, occlusion, shape transformation and other factors will affect the accuracy of target tracking (Limjirakan and Limsakul 2012). In order to solve the problem that when using the current frame sample of the target to train the tracker, when the tracking target is covered by a large area in the process of tracking the target, the obtained training samples will be polluted, which will lead to the drift of the tracking model, and the tracking algorithm cannot accurately track the target (Mahdi et al. 2017). In this paper, the channel reliability coefficient and empirical selection method are used to evaluate the response graph of each characteristic channel, so as to improve the description ability of the tracking target and the success rate of target tracking (Islam et al. 2019). With the conference of “science and technology help the Olympic Games” held in the State General Administration of sports, China’s competitive sports began to introduce western advanced software and hardware systems on a large scale. Based on the analysis of heart rate variability data, Finland’s Firstbeat sports monitoring system obtains athletes’ training load and recovery (Mojid et al. 2015). Golden State Warriors and Chicago Bulls have been mature in the use of this set of sports monitoring system in the training of athletes. Through scientific, accurate and real monitoring of training load, Firstbeat sports monitoring system is of great significance for athletes’ physiological reserve, technical and tactical training effect and quality. The scientific and reasonable training has a positive auxiliary effect on the improvement of the performance of college athletes (Jahani et al. 2017). This study starts from the training methods and monitoring means to provide theoretical basis and reference for the development of college athletes from the perspective of preparing for the Olympic Games (Pandey et al. 2017).

Materials and methods

Data source

At present, more than 700 radiosonde stations have been put into use in China. The distribution of radiosonde stations in China and its surrounding countries is shown in Fig. 1. In this paper, the data of radiosonde stations in W area is selected as the comparison data of water vapor. W radiosonde station is located at 43.78°N, 87.62°E, The altitude is 919 m and the station number is 51463.

Target tracking algorithm design

KCF tracking algorithm initializes the target center position in the first frame of the target video sequence, and uses the target position information to predict the best position of the next frame (Papaioannou et al. 2011). Finally, the target detector includes training samples and detection results. The KCF method uses ridge return to train the detector. The detector selects the tracking window around the target is suitable for the target tracking x. The training function is constructed as follows:

$$\min_w \sum (f(x_i) - y_i)^2 + \lambda \|w\|^2$$  \hspace{1cm} (1)

In Equation (1), f is the classification function, (x) = Tx; x is the sample; w is the weight coefficient; yi is the sample label; From ridge regression, it is concluded that:

$$w = (X^T X + \lambda I)^{-1} X^T y$$  \hspace{1cm} (2)

In Equation (2), W is the weight coefficient; X is the sample autocorrelation matrix; y is a Gaussian function parameter; I is the identity matrix. In Fourier domain, Equation (2) is written as:

$$w^* = \frac{\hat{X}^* \circ \hat{y}}{\hat{X}^* \circ \hat{X} + \lambda}$$  \hspace{1cm} (3)

In Equation (3), W* is the result of FFT; x is the complex conjugate of x; y is the FFT result of y; \lambda is the regularization parameter; \circ denotes the dot product of elements. The kernel function is introduced into the tracking algorithm, and the weight combination of samples in high-dimensional space is as follows:

$$w = \sum \alpha_i \varphi(x_i)$$  \hspace{1cm} (4)

In Equation (4), \varphi (x) is a mapping function; i is the component of sample xi. The closed form solution of classifier (4) is obtained by ridge regression and kernel function theory:

$$\alpha = (k + \lambda I)^{-1} y$$  \hspace{1cm} (5)

In Equation (5), k is the kernel matrix and I is the identity matrix; y is the element of vector y; The solution of a in dual space is:

$$\tilde{\alpha} = \frac{\tilde{y}}{\tilde{k}^T + \lambda}$$  \hspace{1cm} (6)
In Equation (6), $\alpha$ is the weight coefficient; In KCF tracking algorithm, the Gauss kernel is selected:

$$
\hat{k}_{x\tilde{x}} = \exp\left(-\frac{1}{\sigma^2}\left(\|x\|^2 + \|\tilde{x}\|^2 - 2\mathcal{F}^{-1}\left(k_\sigma x\tilde{x}\right)\right)\right)
$$

In Equation (7), $\mathcal{F}^{-1}$ is the IFFT transform; $\sigma$ is the bandwidth of Gaussian function. In frame $t+1$, set the input image as $x$, and the response of the classifier is shown in Equation (4):

$$
f(z) = w^T z = \sum_{i} \alpha_i k(x_i, z) \tag{8}
$$

In Equation (9), $\hat{K}$ is the training sample; $z$ is the detection area. The response of frame $t+1$ is as follows:

$$
\hat{f}(z) = \mathcal{F}^{-1}(\hat{K}x\tilde{x}) \tag{9}
$$

In Equation (9), $\hat{K}$ is the FFT result of the sample $x$ and the detection region $z$. $\hat{f}(z)$ represents the response output.

**Real-time monitoring method of college students’ physical training**

During the training period, each college student athlete should wear a heart rate band before each training and competition, and then take it off after the end. The whole process of real-time heart rate monitoring, and then collate and summarize the trip data. This research period belongs to the special preparation stage before preparing for the world cup, the main training contents are: physical training class, technical and tactical practice, defensive confrontation, competition.

In this survey, Firstbeat was chosen as the measuring machine. It is composed of heart rate band, receiver and computer-based Firstbeat training monitoring system. The Firstbeat heart rate change system was used to record the heart rate of college athletes in training, and four indexes including heart rate change curve, heart rate list, heart rate distribution map and heart rate field summary were collected and displayed. The heart rate curve directly shows the change of intensity during training and the change of heart rate caused by intermittent rest. The heart rate meter shows the heart rate of college athletes in training every five seconds. The heart rate distribution map shows the proportion of the number of center beats in the whole training process. The summary of the heart rate area is based on the target heart rate, which represents the training percentage that exceeds the target heart rate, is lower than the target heart rate, or is lower than the target heart rate. The device can real-time understand the heart rate of college athletes, understand the
maximum and minimum heart rate of college athletes in a certain period of time, and know which heart rate range the heart rate belongs to at this time, and then clearly see which training stage the heart rate of college athletes is higher and which training stage the heart rate is lower. In addition to heart rate, it also includes Trimp, TE, EPOC and other indicators.

This study classifies the relevant data according to the research purpose, and then uses Excel 2016 and SPSS 19.0 to summarize and analyze, find the data rules and summarize the characteristics, so as to provide data support for the paper. Among them, Excel 2016 uses the functions of summation ($\sum$), average value (AVG), max min, and its table icon generation. In SPSS 19.0, single factor multi-level analysis of variance, multiple comparisons, descriptive results statistics and independent sample t-test are used.

Results

Process analysis of ground-based GNSS retrieval of atmospheric precipitable water

In this paper, gamit10.7 software is used to solve the data to obtain the zenith total delay ZTD. The specific process has been given in the above. The observation files needed for data solution can be downloaded directly from IGS official website or Wuhan University data center. The setting of various calculation parameters is introduced in detail, and the NRMS values of 305–334 days in 2020 in the q-file file of GAMIT baseline calculation results are counted. The statistical results show that the NRMS values calculated from each spatial baseline are below 0.25, and the accuracy of data calculation is good. Due to the layout, only the detailed baseline calculation results on day 305 were published. The XYZ coordinate direction error of each baseline is controlled within 1.5 cm. According to the accuracy index requirements, the accuracy of baseline calculation meets the requirements, and the relative baseline accuracy reaches 10–9 level, which indicates that the accuracy of the solution is consistent with the necessity of water vapor inversion. Fig. 2 shows the total zenith delay obtained by the URUM station.

In this section, we first obtain the meteorological data around the URUM Station Detected by the meteorological instrument, and participate in the process of calculating zenith static delay ZHD using SAAS model. In addition, zenith experience delay zhd is subtracted from zenith total delay ZTD, and zenith wet delay ZWD is calculated (refer to Fig. 3 and Fig. 4). In order to get the precipitable water, the conversion coefficient $\Pi$ needs to be determined first, and the final value of the conversion coefficient is determined by the weighted average temperature Mt.

Therefore, in this paper, the weighted average temperature model of W area obtained by Liu Lilong is used to get MT, and then the Atmospheric Precipitable Water Vapor (PWV) is calculated (as shown in Fig. 5).
In this paper, the 30-day Radiosonde data of W Radiosonde station are obtained from the official website of the University of Wyoming. PWV, the sounding balloon is released at 00:00 and 12:00 every day, a total of 60 sets of data, and the results are compared with the GNSS retrieved precipitable water.

Figure 6 shows the comparison of Radio_pwv and Gns_s_pwv. In the figure, they are very close in value and have the same change rule and trend; Fig. 7 shows the difference of precipitable rainfall calculated by the two methods, and Table 1 shows the detailed statistics of the comparison results of precipitation calculated by the two methods. As shown in Fig. 7 and Table 1, the difference between Gns_s_pwv and Radio_pwv is basically around 0, and the maximum difference of all survey data is within 5 mm. The reason for the inconsistency between the two data results may be that the position of the sounding balloon released is inconsistent with the position of GNSS observation station, and the surrounding environment of the two is different, which will have a certain impact on the calculated water vapor content. It can be concluded that using GNSS technology to retrieve precipitable water has good accuracy, little difference with the real water vapor value, and can well reflect the law of water vapor change. Some precision indexes of the two are counted in Table 1. It can be seen from the table that the correlation coefficient of the two reaches 96.21%, showing a strong correlation, and the average deviation is ~0.10 mm, and the mean square error is 2.58 mm. It can be seen that the inversion accuracy is very high, which more clearly shows the feasibility of ground-based GNSS technology in retrieving Atmospheric Precipitable Water.

Analysis on influencing factors of PWV inversion by GNSS

Tide phenomenon will change the load value of the earth and the seabed, which is called sea tide load effect. The influence of tidal load is also an important factor affecting the positioning accuracy of GNSS, especially in coastal areas. According to the survey results, the position error of GNSS caused by tidal load in coastal areas may reach 4–5 times of that in inland areas. In high precision GNSS measurement, the influence of this degree of error cannot be ignored. In the process of using GNSS technology to retrieve precipitable water, the accuracy of PWV mainly depends on the accuracy in that direction. In order to better understand the impact of ocean tide load effect on the accuracy of precipitable water, this paper selects the data from 305 to 335 days in 2020 of BJFS, URUM and LHAZ stations in inland China to carry out experiments with the following two schemes.

The variation curves of precipitation of each station under the two schemes are shown in Fig. 8, Fig. 9 and Fig. 10. It can be seen from the figure that the precipitation variation trend of
each station obtained by two different schemes is highly consistent, the difference of PWV content obtained by BJFS, LHAZ and URUM stations in inland is less than 0.3 mm under the two schemes, and the precipitation curve under the two schemes is basically coincident.

Therefore, when GNSS reference stations in inland areas are selected to obtain high-precision precipitable water, the precision error of precipitable water caused by sea tide model can be ignored. For the convenience of calculation, the sea tide model cannot be introduced to participate in the calculation.

According to several common convection delay models introduced in Chapter 2, different convection delay models obtain different ZHD through data solutions, and the zenith wet delay ZWD is also different, which directly affects the accuracy of atmospheric precipitation.

Therefore, GNSS observation data of the Bureau of URUM from 305 to 315, 2020 are selected in this section, and the zhd is calculated by saastmoinen model, Hopfield model, and black model formula, respectively. In addition, the author uses MATLAB software to compile and use three kinds of convection delay model to calculate the zhd formula, from ZTD solution to PWV calculation of atmospheric pressure reduction, and participates in the whole process of using GAMIT software. Fig. 11 is a ZHD time sequence diagram obtained by using three convection circle delay models, and Fig. 12 shows ZWD time sequence diagram of wet delay of zenith convective ring.

![Figure 8](image8.png)

**Figure 8** Comparison of PWV values of BJFS station with and without tide model

![Figure 9](image9.png)

**Figure 9** Comparison of PWV values of Lhaz station with and without tide model

Figure 13 is the PWV trend chart of Atmospheric Precipitable Water respectively calculated by the three models.

It can be seen from Fig. 11, Fig. 12, and Fig. 13 that the trend of each parameter calculated by the three models is basically the same. It can be seen from Table 2 that the systematic deviation of zenith dry delay ZHD obtained by using SAAS model and Hopfield model is very low, while the black model and SAAS model are about 3 cm, resulting in sharp deviation. It can be seen from Table 2 that the PWV values calculated by the three models have a strong correlation with the water vapor values of the detection station, but the accuracy of SAAS model is slightly higher than that of the other two models. The average variance is 0.3208 mm and the average deviation is 0.0108 mm. Therefore, SAAS model is more suitable.

**Real-time monitoring analysis of college athletes' sports training**

According to the statistics of Trimp of players in different positions in the whole training period, it can be seen that the training load value of center player is the highest, followed by that of guard, and that of forward player is the lowest. Combined with the calculation formula of Trimp, Trimp value is related to training time, training average heartbeat, basic heartbeat and training maximum heartbeat. The higher the training average heartbeat, the higher the training volume.
and training pulse Trimp. Therefore, generally speaking, the higher the Trimp value of athletes, the greater the training load, but also need to cooperate with their own basic heart rate, the average heart rate is not necessarily. The value of Trimp changes with the number of heart beats. From the above results, there is little difference in the average training load of different positions of forward, center, and guard in each class. In the case of small difference, the Trimp value of center is greater than that of guard and that of forward. There are several possible reasons for this result: first, it has a certain relationship with the training plan for position skills of national college students athletes; second, the physiological characteristics of different players are different. The correlation between the position on the basketball court and the Trimp value is weaker than that between the personal physiological characteristics (such as height and weight) and the Trimp value.

The results show that there is no significant difference in the single factor variance of the Trimp value of the players in different positions, which indicates that there is no significant difference in the statistical significance of the Trimp value of the players in different positions, as shown in Table 3. The multiple comparison of the Trimp values of the players in different positions on the field shows that there is no significant difference in the two-way comparison of the Trimp values of the players in different positions on the field. The above statistics show that there is no significant difference in Trimp among athletes in different positions on the field. However, according to the report with the coach after the training class every day, the coach thinks that athletes in different positions on the field should have significant differences in training load, and the difference degree of Trimp in this respect does not match the coach’s expectation. At the

![Comparison of PWV values with and without tide model at URUM station](image1)

**Fig. 10** Comparison of PWV values with and without tide model at URUM station

![Zenith dry delay of URUM station calculated by three tropospheric delay models](image2)

**Fig. 11** Zenith dry delay of URUM station calculated by three tropospheric delay models

![Zenith wet delay of URUM station calculated by three tropospheric delay models](image3)

**Fig. 12** Zenith wet delay of URUM station calculated by three tropospheric delay models

![PWV of URUM station calculated by three tropospheric delay models](image4)

**Fig. 13** PWV of URUM station calculated by three tropospheric delay models
same time, the coaches said that the disagreement about the expected degree and accuracy of Trimp in the questionnaire came from the comparison of Trimp of athletes in different positions in the daily report. Therefore, Trimp is not suitable to use statistical differences to analyze athletes in different positions on the field. National college student athletes, as the highest level of college student athletes in China, have certain representative and case characteristics. We can analyze the Trimp value of athletes in different positions by observing the average value.

Because the Trimp values of college athletes are different in the same training content, the ranking can reflect the training load intensity of athletes. Through the correlation test of Trimp values ranking in the same training content, we can understand the relationship of Trimp values ranking in different training content, that is, whether the ranking is consistent in each training content. Therefore, it is necessary to test the rank correlation of Trimp values in the same training content. Using Spearman correlation to test the ranking of Trimp value in the same content training of college athletes, we can see that there is a very significant correlation, which shows that from a statistical point of view, the ranking of Trimp value in the same content training of college athletes is relatively consistent. To sum up, in the same training content, the Trimp value of athletes presents a more consistent performance, and the same content has a consistent impact on the Trimp of athletes (Table 4).

College athletes have won 9 warm-up games, and the Trimp value of each game is compared. According to the technical and tactical statistics table after each game, the actual playing time of the players and the accurate up and down points recorded by my on-site monitoring are selected to export the original data of Trimp, and all players on the field are screened for accurate data. For example, on June 1, when we played against Belgian college athletes, the athletes’ playing time was 28 min and 34 s. Combined with the accurate time points of the up and down court recorded by my on-site monitoring during the game, the original Trimp report was generated in the firstbeat analysis software according to the re-screening data of the time period, and the Trimp of the movement was 185. According to the actual playing time and the time points of the upper and lower court, the 12 athletes on the court were screened by rank. If the sum of each athlete’s Trimp value is divided by the number of athletes, the average Trimp value of the game on June 1 is 96.62. This is the calculation of Trimp in each warm-up match (Table 5).

Combined with the mean value of Trimp in downwind competition is 120.11, while the mean value of Trimp in upwind competition is 129.38. It can be seen that the Trimp value of college athletes is high in upwind competition, that is, the actual intensity is large. Analysis of the reasons, in the adverse situation of the game, the psychological state of the players eager to catch up with the score will cause excessive actual intensity load in the use of techniques and tactics (Table 6).

In the downwind game, because the score is ahead, the main task is to suppress the opponent’s attack on the basis of winning more points, so as not to give the opponent more chances to score. In the downwind game, because the score is behind, it is necessary to organize faster and more effective techniques and tactics as soon as possible. In order to narrow the score gap, so as to realize the anti super. In the context of

| Model  | Maximum difference/mm | Minimum difference/mm | Average difference/mm | Mean square error/mm | Correlation coefficient | Number of samples |
|--------|------------------------|-----------------------|-----------------------|---------------------|------------------------|------------------|
| SAAS   | 0.4778                 | −0.4752               | 0.0107                | 0.3209              | 0.99                   | 22               |
| Hopfield | 3.0068               | 0.6612                | 1.9432                | 0.7109              | 0.95                   |                 |
| Black  | 5.6793                 | 1.9934                | 3.8132                | 1.0516              | 0.90                   |                 |

| Position Compared | Mean difference (I-J) | Standard error | Significance | 95% confidence interval |
|-------------------|-----------------------|----------------|--------------|------------------------|
|                   | Lower limit           | Upper limit    |              |
| Forward Guard     | 6.1016668             | 11.3470532     | .856         | −24.545098            | 36.748433         |
| Center forward    | 13.0683334            | 11.3470530     | .505         | −17.578431            | 43.715098         |
| Guard Forward     | −6.1016666            | 11.3470532     | .854         | −36.748431            | 24.545098         |
| Center forward    | 6.9666668             | 13.6850608     | .868         | −29.994724            | 43.28057          |
| Center forward    | −13.068333            | 11.3470530     | .505         | −43.715098            | 17.578433         |
| Guard             | −6.9666668            | 13.6850608     | .868         | −43.928057            | 29.994722         |

Table 3  Statistical table of multiple comparison processing results of Trimp values of players in different positions

Table 2  Comparative analysis of PWV calculated by three models and radiosonde data
the rapid development of modern basketball, the game is becoming more and more fierce, players need to consume a lot of physical strength in the game, the load intensity is very large, but comparatively speaking, in the upwind game, players need to invest more and work harder, which makes the trip value of college students’ players in the upwind game is slightly higher than that in the downwind game.

### Discussion

#### Analysis of motion monitoring system

Monitoring refers to monitoring and control. The purpose of monitoring is to ensure that the monitored object can complete the established tasks or objectives, and regularly or irregulairly, continuously or intermittently monitor and inspect the monitored object (Acharjee et al. 2017). According to the actual situation of the monitoring object, the influence of monitoring results on the completion of tasks or objectives is analyzed in time, and the behavior of the monitored object is controlled or adjusted according to the actual situation. In the process of repeated monitoring activities, the monitoring objects can be successfully completed (Bandyopadhyay et al. 2009). Zhang DAHAO believes that in the process of sports, monitoring should be carried out throughout, and covers all indicators, that is, to make full use of the method of quantitative evaluation and qualitative evaluation to comprehensively and accurately evaluate the state of the object, so as to ensure the actual effect of the operation monitoring. Feng Lianshi regards sports monitoring as the main means of coaches controlling the training process. By using sports monitoring, athletes can always be in the best training state in the training process, and thus the training effect of athletes can be improved. In the monitoring of sports, it usually involves the combination and intersection of different disciplines (Croitoru et al. 2013). The common knowledge of sports medicine, sports biomechanics and biochemistry all lay a theoretical foundation and operating principle for the smooth development of sports monitoring. Through this comprehensive method, the athletes’ sports process is monitored in a three-dimensional way, the problems existing in the process of sports are clearly defined, and the problems can be adjusted in time, so as to ensure the quality of training. Feng Xiaohong believes that the main operation content of sports monitoring is to measure and record the athletes’ physical state, so that the athletes’ response to external stimuli can be accurately quantified, so as to evaluate the effect of training content on athletes, and judge whether the training intensity is arranged within a reasonable range, and then coaches adjust the training in time, and modify the training content when necessary, so as to control the effect of athletes training. The article thinks that the sports monitoring can determine the athletes’ body state; It is helpful to choose reasonable training content and training methods, and can thus adjust the sports load according to the specific situation of athletes, timely feedback can stimulate the enthusiasm of athletes training and help the athletes to mobilize their subjective initiative; Help athletes to train in a reasonable training load range, avoid sports injury caused by insufficient training or overloading training; Can estimate the athletes’ level through sports detection and predict the play of the game (Darshana et al. 2013).

#### The current situation of basketball sports monitoring

In the early development of sports, sports physiology is mainly used to monitor the physiological and biochemical indexes of basketball players. There are many researches on monitoring exercise load and fatigue recovery. In the early stage, Li Yu used blood lactic acid and heart rate to monitor basketball training, improved training density, and greatly improved athletes’ heart rate and blood lactic acid. However, due to too many research areas, it was pointed out that the training load of Chinese basketball is far less than the competitive load. After that, the research on physiological and biochemical monitoring of basketball players increased significantly. Some researchers analyzed the heart rate of women basketball players in a regional high-intensity training class, and found that the heart rate interval of high-intensity accounted for more than half of the whole training time, which made it difficult for

| Training content          | TRIMP value (mean ± standard deviation) |
|---------------------------|------------------------------------------|
| Physical Training         | 111.28 ± 15.40                           |
| Fast break training       | 114.42 ± 15.93                           |
| Defensive training        | 124.85 ± 15.48                           |
| Fig. 8 Layup              | 98.42 ± 15.61                            |
| Intensity shot            | 108.92 ± 15.71                           |
| Help prevent pick-and-roll| 85.42 ± 13.99                            |
| Location technology       | 94.14 ± 15.13                            |

| Sum of squares | df | Mean square | F      | Significance |
|----------------|----|-------------|--------|--------------|
| Between groups | 61154.523 | 7 | 8580.095 | 8.324 | .000 |
| Within group   | 125241.136 | 84 | 1408.385 | -- | -- |
| Total          | 186395.651 | 91 | -- | -- | -- |
each athlete to meet the requirements of centralized training (Dinpashoh et al. 2018). Because of the high intensity and short interval, it can detect the athletes with the highest number of center jumps. Pola table can accurately and timely feedback the training situation of players in the basketball training course. Hua Yang used polar watch to monitor the sports of male basketball players in Jilin sports school. As a result, the highest intensity of special courses is lower than that of daily competitions, but the average intensity is higher than that of competitions (Duan et al. 2019). There are several differences in the intensity of sports load carried by athletes in different positions. Heart rate is an effective evaluation method, which can timely and accurately feedback the training intensity to coaches or athletes. Wang Dun monitored the heart rate of basketball players at a city youth sports school. The results show that the intensity, density, and average load of daily training load are much lower than the intensity and density of competition, and the frequency of training interval is too high and the interval time is too long. This is the direct reason why the load intensity and density of pre competition training courses are less than that in the process of competition. Song Heng applied the physiological and biochemical indexes to monitor the physical training of basketball players on high ground, which can monitor and evaluate the heart rate, blood lactic acid, serum CK, hemoglobin, and creatine protein, while the anaerobic threshold, maximum oxygen intake and anaerobic threshold can monitor and evaluate the adaptive sports training methods. Wang Aili et al. Monitored the blood biochemical indexes of Hubei male basketball players, and believed that hemoglobin, urea nitrogen and creatine enzyme can accurately reflect the aerobic endurance level, competitive intensity, exercise volume and recovery ability of basketball players, and can help coaches to judge the reference standard of sports load in the game (Holden et al. 2018).

Analysis of real-time monitoring results of college athletes’ sports training

In this paper, the training impulse Trimp is used to monitor the training of college athletes in 2020, to explore the load characteristics of college athletes in training and competition, and to provide reference for the training monitoring of Chinese college athletes. The conclusions are as follows.

In daily training, athletes’ sports load will be numerical. Comparing the Trimp values of athletes in different training classes, we can find that the training load of athletes is more consistent when they implement the same training plan (Feng et al. 2017). The training load of various technical training contents is in the following order: defense, fast breakthrough, physical training, integrated shooting, position technology, assistant defense.

The results show that the Trimp values of athletes in each competition are different. However, the Trimp value of the players in the upwind game is higher than that in the downwind game. The training intensity of team teaching match can meet the requirement of sports intensity in actual combat.

Trimp value was consistent with physiological and biochemical indexes, and had certain correlation. Trimp reflects the change of athletes’ load, and physiological and biochemical indexes reflect the athletes’ response to training (Guixia et al. 2014). Compared with the physiological and biochemical index detection, Trimp feedback on training is more convenient and timely. At the same time, Trimp only reflects the internal load of athletes. If we need to comprehensively evaluate the sports load, we need to comprehensively analyze and consider with other calculation methods of sports load.

Suggestions on sports training of college athletes based on monitoring results

As the highest level of Chinese college basketball, college basketball players are a team that determines the international status of Chinese college basketball. Their training is more scientific and reasonable. Using reasonable monitoring means to monitor the training load intensity of athletes will directly affect the training effect. In the training of college athletes, we need to adopt more scientific and comprehensive monitoring means to grasp the athletes’ training load and intensity, so as to achieve the expected training purpose. In this study, Trimp is applied to the training monitoring of college athletes to understand the application effect and explore the training load of college athletes (Fu et al. 2017). However, this study is only
in the primary stage, and the specific analysis is not deep enough. The application of Trimp needs further research.

Conclusion

Based on the target tracking algorithm, this paper studies the real-time monitoring of rainfall atmospheric characteristics and college students’ physical training. Although the content of water vapor in the atmosphere is very low, it plays a vital role in energy transmission and weather dynamic changes. The water vapor inversion technology based on target tracking algorithm is a new technology integrating surveying and meteorology. Compared with the traditional water vapor detection method, it has the advantages of low cost, all-weather, high spatial and temporal resolution. In various weather monitoring systems, the target tracking algorithm provides important water vapor information in meteorology research, and has important significance in PM2.5 concentration monitoring in haze weather. In this paper, combined with the measured data of GNSS stations and meteorological stations of BJFS, LHAZ, URUM, CUSV and PIMO, the accuracy of precipitable water obtained by the inversion technology based on target tracking algorithm are compared and analyzed. Finally, this paper establishes the Trimp standard for each college student athlete. Because the Trimp value changes with the athletes’ basic heart rate, physical and mental conditions, each athlete is different. It cannot explain the level of training load intensity through the comparison between team members, but should formulate the Trimp standard according to each athlete’s own situation. It is used to evaluate the training load and monitor the training effect.

Declarations

Conflict of interest The authors declare that they have no competing interests.

References

Ahmadi SK, Halimia G, Ludwig F, Hellegers P (2017) Declining trends in water requirements of dry season Boro rice in the north-west Bangladesh. Agric Water Manage 180:148–159

Bandypadhyay A, Bhadra A, Raghuvanshi NS, Singh R (2009) Temporal trends in estimates of reference evapotranspiration over India. J Hydrol Eng 14(5):508–515

Croitoru A, Piticar A, Dragota CS, Burada DC (2013) Recent changes in reference evapotranspiration in Romania. Glob Planet Chang 111:127–132

Darshana A, Pandey A, Pandey RP (2013) Analyzing trends in reference evapotranspiration and weather variables in the Tons River Basin in Central India. Stoch Env Res Risk A 27:1407–1421. https://doi.org/10.1007/s00477-012-0677-7

Dinpashoh Y, Asl SJ, Rasouli AA, Foroughi M, Singh VP (2018) Impact of climate change on potential evapotranspiration (case study: west and NW of Iran). Theor Appl Climatol 136:185–201. https://doi.org/10.1007/s00704-018-2462-0

Duan W, Chen Y, Zou S, Nover D (2019) Managing the water-climate-food nexus for sustainable development in Turkmenistan. J Clean Prod 220:212–224

Feng Y, Jia Y, Cui NB, Zhao L, Li C, Gong D (2017) Calibration of Hargreaves model for reference evapotranspiration estimation in Sichuan basin of southwest China. Agric Water Manage 181:1–9

Fu Z, Stoy PC, Luo Y, Chen J, Sun J, Montagnani L, Wohlfahrt G, Rahman AF, Rambal S, Bemmelen T, Yang Z, Shirkey G, Niu S (2017) Climate controls over forest carbon uptake period and amplitude of net ecosystem production in temperate and boreal ecosystems. Agric For Meteorol 239:39–19

Guixia Y, Denghua L, Yalong Q (2014) Changes of pan evaporation and its influence factors in China. J Environ Pollut 13(3):601–606

Holden PB, Edwards N, Ridgwell A, Wilkinson RD, Friedrich K, Lunkeit F, Pielke RA, Pinter JR, Balsamo J, Salas P, Lam A, Knobloch F, Chowpreecha U, Fraulies JE (2018) Climate–carbon cycle uncertainties and the Paris Agreement. Nat Clum Chang 8(7):609–613

Islam ARM, Yuan Y, Yang S, Hu Z, Chau R (2019) Assessing recent impacts of climate change on design water requirement of Boro rice season in Bangladesh. Theor Appl Climatol 138(1-2):97–113. https://doi.org/10.1007/s00704-019-02818-8

Jahani A, Dinpashoh Y, Raisi NA (2017) Evaluation and development of empirical models for estimating daily solar radiation. Renew Sust Energ Rev 73:878–891. https://doi.org/10.1016/j.rser.2017.01.012

Jiaharia D, Shirivastava SK, Sarkar D, Sarkar S (2009) Temporal characteristics of pan evaporation trends under the humid conditions of northeast India. Agric For Meteorol 149:763–777

Kabir MH, Hossen MN (2019) Impacts of flood and its possible solution in Bangladesh. Disaster Adv 12(10):48–57

Khalil AA (2013) Effect of climate change on evapotranspiration in Egypt. Researcher 55:7–12. https://doi.org/10.9780/22307850

Li Z, Chen Y, Yang J, Wang Y (2014) Potential evapotranspiration and its attribution over the past 50 years in the arid region of Northwest China. Hydrol Process 28:1025–1031

Limjirakan S, Limsakul A (2012) Trends in Thailand pan evaporation characteristics of pan evaporation trends under the humid conditions of northeast India. Agric For Meteorol 149:763–777

Mojid MA, Rannu RP, Karim NN (2015) Climate change impacts on design water requirement of Boro rice season in Bangladesh. Int J Climatol 35:4041–4046. https://doi.org/10.1002/joc.4260

Pandey PK, Nyori T, Pandey V (2017) Estimation of reference evapotranspiration using data driven techniques under limited data conditions. Model Earth Syst Environ 3:1449–1461. https://doi.org/10.1007/s40808-017-0367-z

Papiouannou G, Kitsara G, Athanasatos A (2011) Impact of global dimming and brightening on reference evapotranspiration in Greece. J Geophys Res 116:D09107. https://doi.org/10.1029/2010JD015525