SMAP satellite ocean surface salinity observations and music classroom effects in coastal areas: environmental numerical prediction

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Abstract

The ocean surface salinity is an important indicator for monitoring the changes in the chemical composition of the sea surface. It can be used to evaluate and optimize the quality of the seawater and then analyze the process of marine fluid mechanics and predict the ocean. Therefore, it has attracted the attention of relevant government departments and is the focus of research by experts and scholars. Satellite remote sensing technology, as an effective means to obtain a large amount of continuous observation of sea surface salt data, overcomes the time and space limitations of conventional observation methods. SMAP’s ocean surface salinity data shows quality advantages, excellent application value, and considerable research potential due to its own characteristics. However, since the emergence of applied technology, due to slow progress and mainly carried out in foreign countries, research results have been few. This paper analyzes the research situation of SMAP data, with the purpose of providing reference for the application of remote sensing data of SMAP in China; review the progress of the main research of SMAP; and provides support for the development of research in China. So as to summarize the problems existing in the sound environment of university music classrooms, from the perspective of the sound environment in campus planning, the architectural design problems of music classrooms and the problems of music classroom teaching are considered. Then use the sound environment of the music classroom to analyze and summarize the problems, and propose simple and effective improvement measures to the music classroom, construct reasonable proposals, and try to avoid the same problem from happening again, which can not only optimize the service to users but also provide a good sound environment for the normal development of university music classroom teaching.

Keywords
SMAP satellite · Salinity observation · Music classroom · Environmental value

Introduction

Salinity is an important indicator to determine the changes in the main chemical components of the marine water environment, and it is also one of the important variables to explain the basic characteristics of the ocean. As the temperature increases, the salinity will affect the density of seawater, leading to the formation of ocean circulation (Adachi and Tainosho 2004). Sea level salinity not only plays an important role in the research of ocean temperature difference power generation and salt transportation, and climate prediction, but also has a wide range of applications in small-scale research (Al-Dousari et al. 2017). In the past, sea surface salinity observations were carried out using navigation, buoys, platforms, etc., but the sea surface salinity data obtained from this was limited in time and space and could not explain the sea surface salinity in a large space or a relatively large time span (Al-Hemoud et al. 2018; Al-Hemoud et al. 2019a). Satellite remote sensing of sea surface salinity is currently the only method capable of long-term, uninterrupted observation and measurement of sea surface salinity. This observation method can solve the problem that the on-site observation method of sea surface salinity cannot be deployed on a large scale (Al-Hemoud et al. 2019b). The current satellite remote sensing sea surface salinity data mainly comes from SMAP satellites. The SMAP...
A satellite was launched from Vandenberg, California, on January 31, 2015. Now, SMAP has been in operation for more than 5 years (Al-Hemoud et al. 2020). China has also launched a study on SMAP sea surface salinity data. However, compared with SMOS and AQUARAS, the research on sea surface salinity of SMAP is still at a relatively preliminary stage, and there are great possibilities and application prospects (Apeagyei et al. 2011).

**Current research status at home and abroad based on SMAP sea surface salinity data**

As the successor of the AQUARAS satellite, the launch of SMAP has attracted the attention of many researchers at home and abroad. The SMAP satellite has been in operation for more than 5 years. Research on the sea surface salinity data based on SMAP has been carried out in an orderly manner, and its research results have been intensively disclosed in the past 2 years (Bergthorson et al. 2015). This article has conducted a statistical analysis of the research results of SMAP sea level salinity data published in major domestic and foreign newspapers from 2016 to now. SMAP's quality assessment and research on sea-level salinity data are mainly focused on the optimization process, but there are relatively few applied researches on ocean prediction (Boldo et al. 2014).

**The effective role of multimedia music classrooms in music classrooms**

**Effectively enhance students’ interest in music**

Nowadays, information technology is becoming more and more developed. In the field of education, the introduction of multimedia classrooms has won unanimous approval from teachers and students and has been vigorously promoted (Bozkurt et al. 2018; Caravanos et al. 2009). Related equipment has become more advanced and more widely used. The application of multimedia classrooms in music classrooms has produced wonderful musical charm, aroused students’ love for music learning and stimulated students’ desire to explore music knowledge, thus making students’ love for music learning more and more obvious, which played a positive role in mobilizing (Cui et al. 2020).

**Effectively activate the classroom atmosphere**

Affected by its unique characteristics, music courses can not only create good scene patterns for students but also cultivate students’ musical feelings in education. Now, the music course can be said to be one of the students’ favorite courses. Especially the multimedia classroom is used in the music classroom, which brings the enjoyment of both hearing and vision to the students and invigorates the atmosphere of the music classroom. Therefore, even if the teacher plays music or songs to the students before class, the students can quickly integrate into the music and make quick adjustments to their own state (Dehghani et al. 2017).

**Effectively enhance students’ imagination**

In the process of music teaching, students’ appreciation of music can bring imagination to students’ music learning and stimulate students’ creativity (Doabi et al. 2018). Multimedia classrooms are used in music classrooms to provide students with a musical esthetic environment and to students realize the beauty of music. Teachers can use multimedia classrooms to cultivate students’ musical imagination and improve students’ esthetic level, which can provide powerful conditions for students’ esthetic development and cultivate students’ creative thinking. Specifically, with the support of multimedia classroom education methods, in order for students to recognize and appreciate the beauty of music, all resources have been fully developed and music is provided to students in the form of images and videos. So as to provide space for students to imagine and make them realize the beauty of music, and with the improvement of musical imagination, students’ creativity in music is also stimulated (Dong et al. 2017). Finally, improve students’ music literacy and cultivate their innovative spirit.

**Research design**

**SMAP and its sea surface salinity data source**

SMAP satellite ocean salinity products can be obtained from the remote sensing system. There are mainly two types of products, L2C and L3. The stripe data is L2C, while L3 is the daily average data and the monthly average data. The spatial resolution of L3 is 0.25°. It is an L2C product for quality management after removing the quality marks of 5, 6, and 7 salinity data. The salinity data with a wind speed of 20 m/s or more is in NetCDF format (Doronzo et al. 2016).

**Sea surface salinity inversion algorithm**

**Principles of sea surface salinity remote sensing**

The radiative transmission model of the ocean and atmosphere is mainly used to show the relationship between the observed brightness and the inversion parameters and is the basis for the measurement and calculation of ocean parameters by satellite remote sensing (Du et al. 2013). Figure 1 is a schematic diagram of the radiation transport model in the ocean and atmosphere. It can be seen from the figure that the brightness
temperature measured by the cosmic radiometer includes not only direct radiation from the sea surface, reflected atmospheric radiation, and direct sea surface radiation (Duan and Tan 2013).

If the Lady’s rotation effect is not considered, the microwave radiation transmission equation in the upper atmosphere can be expressed as follows:

\[ T_{BU} = \int_0^h T(z)k_a(z)\exp\left[-\tau(z, h)\sec\theta\right]dz \]
\[ T_{BD} = \int_0^h T(z)k_a(z)\exp\left[-\tau(0, h)\sec\theta\right]dz \]

where \( T(z) \) represents the temperature of the atmosphere at height \( z \), \( k_a(z) \) represents the absorption coefficient of the atmosphere at position \( z \), and \( \tau \) represents the optical thickness of the atmosphere, which can be expressed as:

\[ \tau(h_1, h_2) = \int_{h_1}^{h_2} k_a(z)dz \]

Physical inversion algorithm

The physical inversion algorithm for sea level salinity is developed based on the Bayesian theory. Bell’s theory has high physical importance and versatility, and it is the most commonly used method for sea surface salinity inversion (Eqani et al. 2016). Based on the Bayesian theory, the density function can be expressed as:

\[ P(S|F) = \frac{P(F|S)P(S)}{P(F)} \]

In the formula, \( P(S) \) and \( P(F) \) are the atmospheric-ocean pre-probability density functions of the state vector and the observation vector, respectively.

Assuming that both the observation vector and the pre-information satisfy the Gaussian distribution, the numerator term of Expression 5 is proportional to the following formula.

\[ P(F|S) \sim \exp\left\{-\frac{1}{2}\left(F - F_{\text{mean}}\right)^T C^{-1} F_{\text{mean}} \right\} \]
\[ P(S) \sim \exp\left\{-\frac{1}{2}\left(S - S_a\right)^T C^{-1} S - S_a \right\} \]

In fact, the denominator of Equation 4 is the normalization coefficient, which minimizes the cost function as follows:

\[ X^2 = \left(F - F_{\text{mean}}\right)^T C^{-1} F_{\text{mean}} + \left(S - S_a\right)^T C^{-1} S - S_a \]

Calculation of environmental noise evaluation in music classroom

A sound level

The sound level is the weight network through the frequency meter, and the unit is dB(A). The specific gravity of A refers to
the 40-square \( i_{so} \)-density line. This is a great attenuation for sounds less than 500 Hz, and it simulates the dullness of human ears to low-frequency sounds. It is widely used as a single value evaluation of environmental noise (Ferreira-Baptista and De Miguel 2005). There are two main reasons: one is the ideal correlation with people’s subjective emotions, and the other is simple and practical for measurement, recording, and analysis (Ghanavati et al. 2019).

### Equivalent (continuous A weighting) sound level

In real life, there is less continuous and stable noise, and most of the noise is subject to change. The equivalent (continuous A weighting) sound level is a public response evaluation quantity based on average energy. This is continuous fluctuating noise represented by a single value. This value calculated based on the noise energy is equivalent to the fluctuating noise that actually exists on the field during the entire observation period.

Expressed in \( L_{ep} \). When reading at the same time interval, the calculation formula is:

\[
L_{ep} = 10\log\left(\sum_{i=1}^{n} 10^{0.1L_i}\right) - 10\log n
\]

(8)

where \( L_{ep} \) is the equivalent sound level, dB(A); \( L_{Ai} \) is the A sound level measured each time, dB(A); and \( n \) is the total number of times to read the sound level of noise A.

If the change of noise with time conforms to a normal distribution, then:

\[
L_{ep} = L_{50} + d^2 / 60
\]

(9)

\[
d = L_{10} - L_{90}
\]

(10)

The equivalent sound level has been widely used to evaluate urban noise and is also China’s environmental quality assessment standard.

### Statistical percentage sound level

The statistical percentage sound level is used to evaluate the continuous fluctuating noise of \( L_{n} \). Most urban noise, especially road traffic noise, fluctuates randomly. Explain the temporal characteristics of urban noise changes. In order to evaluate the noise exposure related to human interference, probability and statistics are used to analyze the records of noise changes over time to obtain statistical percentage noise levels. \( L_{n} \) indicates that the noise level exceeds \( n \)% of the time during the measurement time. \( L_{10}, L_{50}, \) and \( L_{90} \) are usually used for noise assessment to reflect specific environmental noise conditions.

**Measurement methods of indoor and outdoor acoustic environment in music classrooms in coastal areas**

The measurement method of this experiment is mainly based on the measurement conditions inside and outside the university music classroom, noise place, and time-related domestic regulations.

### Measurement conditions

The measurement is carried out under the weather conditions where there is no rain and snow, and the wind speed is lower than the 5 m/s required by the standard.

### Measuring position

(1) Outdoor measurement near the university music classroom these measurement points are operated outside the music classroom under the noise environment required for the exam. The measurement position should be at least 3.5 m away from the reflector (except the ground), or at a distance of 1~2 m from the outer wall, and at least 1.2 m above the ground.

(2) In order to test the noise impact of the environment in the building, it is necessary to measure the indoor space of the university music classroom building. The measurement location is at least 1 m away from the wall and other reflective surfaces, 1.2~1.5 m from the ground, and 1.5 m from the window.

### Measuring time

(1) Selection of measurement time the measurement time of this experiment is daytime. The specific time period is 7:30 to 18:30. Generally speaking, a short-time sampling method is used for measurement.

(2) Selection of measurement day the measurement day is selected from Monday to Saturday.

(3) In the 20-min measurement, the equivalent A sound level and statistical block sound levels \( L_{10}, L_{50}, \) and \( L_{90} \) at each sampling point.

In order to know more accurately and in detail the acoustic environment around the music classrooms of campus a and B of Engineering University, the construction site of the new music classroom of Mingxiang campus, and the acoustic environment noise of the music classroom, the measurement results of campus a, campus B and the surrounding of the new music class were carried out on site according to the above measurement methods. The music classroom is open from 7:00 to 23:00. According to surveys and observations,
many students will come to study when the door opens at 7:00, and there are also students who close home from 22:00 to 23:00. The flow of people on campus is more intense from 7:30 to 18:30 than after 18:30, and the experiment time is from 7:30 to 18:30. During this period, environmental noise is music lessons. The measurement is mainly composed of two parts: the outdoor environmental noise measurement of the music classroom and the indoor environmental noise measurement of the music classroom (Gope et al. 2017).

**Research results**

**Basic data**

Figure 2 shows the worldwide distribution of SSS, SST, WS, WD, WV, and LWC in August 2020. As can be seen from the figure, the distribution law of SST is obvious. Near the equator, the SST will become higher. From low latitudes to extremes, SST gradually decreases. The SST in the Pacific Ocean is higher than the SST in the Atlantic Ocean and the SST in the Indian Ocean. In contrast, the global distribution of SSS and WS is more complicated (Gope et al. 2018).

Figure 2 shows the global distribution of the radiance of H-polarized light and V-polarized light in August 2020. It can be seen from Fig. 3 that the brightness temperature of V-polarized light radiation in the four bands is higher than that of H-polarized light radiation at an incident angle of 35°.

Figure 4 shows the global distribution of backscattering coefficients for HH polarization and VV polarization in the 1.26 GHz band in August 2020. In the figure, the global distribution of the backscattering coefficients of the HH polarization and the VV polarization in the 1.26 GHz band is basically the same. Near the equator, the backscattering coefficients of the two polarization regions are smaller than the backscattering coefficients of the polar regions.

It can be seen from Fig. 5 that at the incident angles of 0° and 60°, 1.4 GHz is not easily affected by atmospheric radiation, and changes in WV and LWC may cause changes in atmospheric radiation.

It can be seen from Fig. 6 that in the 1.4 GHz band, the transmittance of the non-precipitating atmosphere is close to 1 (close to transparency).

**Result analysis of sea surface salinity physical inversion algorithm**

Considering that MICAP is not currently in orbit, this section uses the Monte Carlo method to verify the MICAP multi-frequency band, multi-indentation angle, and active...
and passive sea surface salinity physical inversion algorithm. In the measurement, the root mean square error is generally used to measure the measurement accuracy (Goudarzi et al. 2017). In this section, the square root error is used to measure the output results of the sea surface salinity physical inversion algorithm for active and passive joints. The obtained parameter is $S_i$, the actual value of the obtained parameter is $S_i^{true}$, and when the number of measurement

**Fig. 3** The global distribution of the radiant brightness temperature of the rough sea surface at 1.4, 6.9, 18.7, and 23.8 GHz

**Fig. 4** In August 2020, the global distribution of the sea surface backscattering coefficient in the 1.26 GHz band

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The square root error of the obtained parameter is as follows:

\[
\text{RMSE} = \sqrt{\frac{1}{n} \sum_{k=1}^{n} \left( S_{i,k} - S_{i,k}^{\text{true}} \right)^2 - B_{S_i}^2}
\]

(11)

Among them, the average deviation \( B_{S_i} \) can be expressed as:

\[
B_{S_i} = \frac{1}{n} \sum_{k=1}^{n} \left( S_{i,k} - S_{i,k}^{\text{true}} \right)
\]

(12)

Satellite single transit inversion results

Based on MICAP frequency, incident angle, main passive joint surface salt physical inversion algorithm, and Monte Carlo sampling.
Carlom simulation method, Fig. 7 shows the SSS root mean square error (SSS RMS), SST root mean square error inversion method MICAP single-pixel point use (SST RMS), and WS root mean square error (WSRMS), as well as the angle of incidence and the intercept change of the curve.

In order to evaluate the influence of MICAP device sensitivity on the inversion accuracy of SSS, SST, and WS, Fig. 8 shows the inversion curves of SSS RMS, SST RMS, and WSRMS, which use various levels of device sensitivity as a function.

Table 1 shows the results of inverted MICAP SSSRMS, SSTRMS, and WSRMS after multi-angle averaging of machine sensitivity at different levels. The conclusion drawn from the table is consistent with Fig. 8. In other words, the increase in the sensitivity of the L-band radiometer has a great influence on the accuracy of the SSS inversion. Improving the sensitivity of the C-band radiometer has a great impact on the inversion accuracy of SST and WS and has the greatest impact on the inversion accuracy of SST. Improving the sensitivity of the K-band radiometer also has a great influence on the inversion accuracy of SST and WS.

In order to evaluate the performance of MICAP when SSS, SST, and WS are obtained on a global scale, Fig. 9 shows the global SSS, SST, WS, and SSSRMS, SSTRMS, and WSRMS calculated in one pass using the proposed algorithm distributed.

Table 1 Multi-angle average of inverted SSSRMS, SSTRMS, and WSRMS under different instrument sensitivity

| Serial number | Instrument noise (K/dB) | SSSRMS, SSTRMS, and WSRMS |
|---------------|------------------------|---------------------------|
| 1             | 0.10, 0.3, 0.3, 0.3, 0.1| 0.60, 1.24, 0.96          |
| 2             | 0.12, 0.3, 0.3, 0.3, 0.1| 0.69, 1.25, 0.96          |
| 3             | 0.13, 0.3, 0.3, 0.3, 0.1| 0.71, 1.25, 0.98          |
| 4             | 0.10, 0.4, 0.3, 0.3, 0.1| 0.60, 1.43, 1.01          |
| 5             | 0.10, 0.3, 0.4, 0.4, 0.1| 0.61, 1.33, 1.04          |
| 6             | 0.10, 0.4, 0.4, 0.4, 0.1| 0.60, 1.51, 1.10          |
| 7             | 0.12, 0.4, 0.4, 0.4, 0.1| 0.68, 1.51, 1.11          |
| 8             | 0.13, 0.4, 0.4, 0.4, 0.1| 0.69, 1.51, 1.13          |
Inversion results of monthly average sea surface salinity

The brightness temperature of the initial version measured by the satellite was affected by the drift of the radiometer. A problem was also found during ground testing. The problem of drift is mainly caused by the long-term instability of the receiver. In order to estimate the impact of drift on the accuracy of SSS inversion, it is assumed that the stability of the receiver is almost equal to the sensitivity of the device. Figure 10 simulates MICAP’s monthly average SSS inversion accuracy (30 days, 200 km × 200 km).

The conclusion is that, from the simulation results, based on MICAP’s current design indicators, the accuracy of MICAP SSS inversion using active and passive sea surface salinity inversion algorithms can meet the expected indicators of China’s marine salinity satellites. In terms of low latitudes and mid-latitudes, if the receiver stability of the radiometer is lower than the sensitivity of the radiometer, the monthly mean square root error of the inversion of MICAP SSS will be further reduced. Therefore, in the mid-latitude and low-latitude ranges, the monthly average SSS inversion accuracy is expected to be less than 0.1 PSU.

Comparative analysis of inversion results of different satellite frequency band configurations

Figure 11 simulates the global distribution of $S_{SSS}$, $S_{SST}$, and $S_{WS}$. The algorithm uses No. 1 and No. 2 components and uses the active and passive joint physical inversion algorithm of sea surface salinity. Comparing Fig. 11a and b, the SSS RMS of No. 2 configuration inversion is basically larger than No. 1 in the global range.

Comparing Fig. 11c and d, it can be seen that the SST RMS of No. 2 structure inversion is basically smaller than No. 1 in the global range.
around 1.3 °C in the mid-latitude and low-latitude ranges. Except near the equator, the SST RMS of No. 2 inversion is basically larger than that of No. 1. Comparing Fig. 11e and f, it can be seen that the inversion composed of [WS]RMS and No. 1 and No. 2 shows an opposite tendency. Latitude/latitude is 2° lower than WS. This is mainly because the SNR of high wind speed is higher than that of low wind speed under the same noise level. Similarly, the influence of noise on WS_RMS will be smaller than that of low wind speed.

Figure 12 uses No. 1 and No. 3 configurations to simulate the global distribution of SSS RMS, SST RMS, and WS RMS obtained by the active and passive joint physical inversion algorithm of sea surface salinity. Comparing Fig. 12c and d, in the low latitudes of the southern hemisphere (within 30° south latitude), the SST RMS reversal of No. 3 and No. 1 is consistent, and the temperature error is about 1.2 °C. However, in the high latitude range, the SST RMS of No. 3 that constitutes the inversion is significantly greater than that of No. 1. From Fig. 12e and f to about 10° north and south of the equator, the reversal of No. 3 also shows a substantial increase in WS_RMS. In the sea area of the world, No. 3 constitutes WS_RMS. The reversal is slightly larger than No. 1, but the error of reversing wind speed is below 1 m/s and basically fluctuates around 0.9 m/s.

As shown in Fig. 13, the SSS RMS, SST RMS, and WS RMS based on No. 2 structure inversion are much larger than those of No. 1 and No. 3. In the range of 40°S–50°S, the SSS RMS of No. 2 is basically the same as No. 1 and No. 3. In the range of 40°S–40°N, the inverted SSS RMS of No. 2 is basically 0.1 °C larger than that of No. 1 and No. 3. Near the equator, the reversal ratios of No. 2 and No. 3 are about 0.78 m/s.

**Measurement results and data analysis of outdoor acoustic environment in music classrooms in coastal areas**

According to the results of the field survey, 17, 8, 6, and 6 noise monitoring locations were selected outside the music classrooms on campuses A and B of the University of Engineering, and around the new music classrooms. The measurement results of the AWA627 noise analyzer will automatically calculate a series of data. Tables 2, 3, and 4 show the
measurement data of outdoor environmental noise around campus A and B music classrooms and new music classrooms.

According to the sound environment quality standard GB3096-2008, the measurement area belongs to the “class 1 sound environment functional area,” and the environmental...
noise limit must be 55 dB during the day. Comparing $L_{eq}$ (dB) with the surrounding noise limit, draw the following conclusions. The test points that meet the specifications of the A campus music classroom are A4, A5, A6, A12, and A13, and the test points that are not satisfied are A1, A2, A3, A7, A8, A9, A11, A14, A15, A16, and A17. Generally speaking, the sound environment of music classrooms cannot fully meet the standard requirements.

Comparing different periods, we can see that from 8:00 to 8:30 and 12:00 to 12:30, the noise value is more than 5 dB higher than the standard limit.

From the outdoor auditory environment of the above three music campuses, some rules can be found: (1) The noise level is relatively large in the stadium, basketball court, campus, and the area that is wider from the main intersection. (2) When in and out of class, the noise value is also very large during the time period.

### Measurement results and data analysis of indoor acoustic environment in music classrooms in coastal areas

After measuring the outdoor sound environment, the sound environment inside the music classroom was measured.

According to the actual situation, choose the main measurement space of the music classroom, including classroom area, practice area, library, office management space, traffic space, etc. The indoor spaces of the music classrooms selected as campus A are mainly "I-shaped" rooms on the south, middle, and northwest sides. To the south of "I-shape", there is the main entrance of the music classroom, as well as many practice spaces and classroom areas. In the middle is the classroom area and the library as the main area.

It can be seen from Table 5 that the noise value of the music classroom is higher than the standard value. The high-level classrooms have lower noise than the lower-level classrooms. The atrium is the traffic space for the music classroom. If this space is used as a classroom area, some problems will occur in the sound environment. The atrium is a transportation hub, and there are many people who enter and exit the music classroom. Therefore, the noise here is very high, exceeding the standard limit of 15 dB as a classroom area. Therefore, in subjective investigations, some students think this space is noisy and cannot study. In the original classroom, the classroom in the test was almost full of people. Not just practicing people, there are also many people walking around.

### Table 2: Data sheet of outdoor acoustic environment measurement of music classroom in a campus

| Serial number | Time  | Measuring point | Normative value (dB) | $L_{eq}$(dB) | $L_{10}$(dB) | $L_{50}$(dB) | $L_{90}$(dB) |
|---------------|-------|-----------------|---------------------|-------------|-------------|-------------|-------------|
| 1             | 7:30  | A1              | 55                  | 62.1        | 64.3        | 60.7        | 55.3        |
| 2             | 8:00  | A2              | 55                  | 61.3        | 63.6        | 60.1        | 55.1        |
| 3             | 8:30  | A3              | 55                  | 55.9        | 58.7        | 54.5        | 49.7        |
| 4             | 9:00  | A4              | 55                  | 52.9        | 56.5        | 51.3        | 46.7        |
| 5             | 9:30  | A5              | 55                  | 53.0        | 56.8        | 51.3        | 46.8        |
| 6             | 10:30 | A6              | 55                  | 47.2        | 48.6        | 46.8        | 43.9        |
| 7             | 11:00 | A7              | 55                  | 57.0        | 57.9        | 56.9        | 55.1        |
| 8             | 14:30 | A8              | 55                  | 57.3        | 58.6        | 57.1        | 55.1        |
| 9             | 15:00 | A9              | 55                  | 58.2        | 59.1        | 58.0        | 55.8        |
| 10            | 15:30 | A10             | 55                  | 58.9        | 59.5        | 58.7        | 56.6        |
| 11            | 16:00 | A11             | 55                  | 58.5        | 59.8        | 58.7        | 56.1        |
| 12            | 16:30 | A12             | 55                  | 55.0        | 57.3        | 55.8        | 53.0        |
| 13            | 17:00 | A13             | 55                  | 48.8        | 50.2        | 48.3        | 47.2        |
| 14            | 17:30 | A14             | 55                  | 59.5        | 60.1        | 58.7        | 53.1        |
| 15            | 18:00 | A15             | 55                  | 68.1        | 69.6        | 66.0        | 58.3        |
| 16            | 18:00 | A16             | 55                  | 62.3        | 66.4        | 61.7        | 57.7        |
| 17            | 12:30 | A17             | 55                  | 65.0        | 68.4        | 65.8        | 54.6        |

### Table 3: Data sheet of outdoor acoustic environment measurement data of music classroom in campus B

| Serial number | Time  | Measuring point | Normative value (dB) | $L_{eq}$(dB) | $L_{10}$(dB) | $L_{50}$(dB) | $L_{90}$(dB) |
|---------------|-------|-----------------|---------------------|-------------|-------------|-------------|-------------|
| 18            | 8:00  | A18             | 55                  | 60.9        | 63.2        | 59.5        | 54.1        |
| 19            | 14:30 | A19             | 55                  | 57.3        | 58.5        | 57.1        | 55.4        |
| 20            | 15:00 | A20             | 55                  | 57.8        | 59.3        | 57.5        | 55.4        |
| 21            | 15:30 | A21             | 55                  | 58.7        | 59.6        | 58.4        | 55.7        |
| 22            | 9:00  | A22             | 55                  | 50.1        | 52.7        | 49.7        | 47.8        |
| 23            | 10:00 | A23             | 55                  | 52.3        | 54.5        | 51.8        | 49.1        |
| 24            | 11:00 | A24             | 55                  | 49.7        | 51.7        | 49.4        | 47.2        |
| 25            | 12:00 | A25             | 55                  | 67.2        | 68.8        | 65.5        | 58.6        |
communicating, talking, and making phone calls. Therefore, the noise value of the classroom space is 20 dB higher than the standard value.

It can be seen from Table 6 that the noise value of the two digital practice rooms of the music classroom meets the specification requirements, while the noise value of the teacher’s reading room and the CD practice room exceeds the limit. The practice room in Table 6 is for independent use and will not be combined with the reading room.

It can be seen from Table 7 that the noise value of the ventilation of the hall on the south and north side of the music classroom and the stairs on the south side exceeds the standard value, while the stairwell on the north side meets the standard requirements.

Discussion and analysis

Significance of noise control of architectural acoustic environment in music classrooms in colleges and universities

By effectively controlling outdoor and indoor environmental noise, it can create a quiet and comfortable learning environment and working environment for users of university music classrooms. The university’s music classroom is where the elite gather. A good music environment makes reading a pleasure, allows users to maintain a good state of study and work, and makes the academic and scientific research environment of the university more active and rich.

Measures for noise control of architectural acoustic environment in music classrooms in colleges and universities

Create a good acoustic environment through effective management of campus and music classrooms

(1) Take measures to control the traffic flow on campus, and implement different management methods for vehicles and private cars used on campus. The use of vehicle horns is prohibited on campus.

(2) In the music classroom, signs such as “mute phone” and “walk gently” can be set to promote the common maintenance of the sound environment of the music classroom.

One of the characteristics of university music classrooms is that students, teachers, and music classroom staff gather a lot of people during their exchanges. If only one exit is opened, the flow of people will increase, which will affect the students studying in the music class. Therefore, if there is a lot of people in class, you can open other exits of the music class to disperse people as soon as possible.

Self-discipline and quality of music listeners

In university music classrooms, the audience of music is basically people with higher education, and those who receive higher education naturally have high quality. Before entering the music class, the phone must be set to vibrate or mute consciously. This should be a habit of action, but a quality that people need to have. For example, in a music class,
students’ books, laptops, water glasses, etc. are placed on the table with gentle movements. If you are ready to sit, you need to pay attention to your movements to avoid friction between the chair feet and the ground and make a very dissonant sound.

Reasonably plan the location of college music classrooms on campus, and arrange the surrounding environment reasonably

Starting from the master plan of the campus, the location of the university’s music classrooms and the surrounding environment must be planned and arranged reasonably. This is to reduce and prevent noise pollution and create a good and healthy environment for university music classrooms.

Sound insulation and sound absorption design of music classroom buildings

The healthy environment of university music classrooms directly affects learning and work efficiency, physical and mental health, and user comfort. Through sound insulation and sound absorption, the noise of university music classrooms can be reduced and a good teaching environment can be created. A good sound environment in a music classroom does not mean “it’s better to be quiet.” This kind of misunderstanding, in the sound environment design process of music classrooms, often leads to excessive use of sound-absorbing materials, sound insulation measures, or extreme silent unilateral emphasis. Quieter cannot make people feel quiet and comfortable, but often cause allergies, depression, and even an incredible sense of fear. If the noise is too low or too high, it will have a bad effect on study and work. Keeping a sound environment of noise value within a reasonable and medium range is the best choice. The university’s music classroom has a large building area and many users. Due to the movement of indoor tables and chairs and their walking contact, friction, and collision with the ground, there will be a collision sound on the floor. The use of single-layer cement mortar, earth, and rock will have a very bad effect on the separation of solid sound. In order to reduce the effect of sound, the following countermeasures can be taken.

Soft and elastic materials such as plastic rubber flooring and carpets help to reduce the impact of the floor. However, laying carpets on a large area indoors is too costly and not conducive to cleaning. It can be placed in the vestibule, and each space will have a large carpet place for the entrance and other people. A plastic cushion is arranged between the floor support layer and the surface layer to reduce the vibration of the structural layer. In order to ensure the improvement of sound insulation performance, it is necessary to provide a corresponding isolation structure to the joint between the floor and the wall. This can block air sound and impact sound and reduce the sound energy radiated downward when the floor vibrates. In addition to the ceiling, there are three other things to pay attention to. First, the ceiling material cannot be used with through holes and seams. Second, there is a gap between the ceiling and the surrounding walls, and noise cannot be directly transmitted through the gap. Third, under the premise of meeting the structural requirements of the building, the connection points between the end pieces and the hanging project should be reduced as much as possible, and the hanging points must be elastically connected instead of fixed.

Climbing plants can be planted on the outer wall of the building, which can absorb sound to adjust the environment. By using light soundproof walls, the internal space can be divided. The light sound insulation wall not only plays an effective sound insulation effect but also promotes the flexible

| Serial number | Time           | Measuring point | Normative value (dB) | $L_{eq}(dB)$ | $L_{10}(dB)$ | $L_{50}(dB)$ | $L_{60}(dB)$ |
|---------------|----------------|----------------|----------------------|--------------|--------------|--------------|--------------|
| 50            | Teacher practice room | 10:00         | C6                   | 40           | 44.0         | 46.1         | 42.6         |
| 63            | Digital Practice Room 1 | 10:00       | D6                   | 50           | 43.9         | 46.0         | 42.5         |
| 64            | Practice room with CD-ROM | 10:30       | D7                   | 40           | 43.4         | 45.7         | 42.3         |
| 65            | Digital Practice Room 2 | 11:00        | D8                   | 50           | 42.4         | 44.6         | 41.5         |

| Serial number | Time  | Measuring point | Normative value (dB) | $L_{eq}(dB)$ | $L_{10}(dB)$ | $L_{50}(dB)$ | $L_{60}(dB)$ |
|---------------|-------|----------------|----------------------|--------------|--------------|--------------|--------------|
| 32            | Foyer (South) | 8:00         | B1                   | 55           | 66.0         | 67.5         | 65.8         |
| 34            | Staircase   | 11:30        | B3                   | 55           | 63.0         | 64.9         | 62.8         |
| 39            | Foyer (North) | 16:00       | B8                   | 55           | 55.7         | 57.9         | 54.4         |
| 40            | Staircase   | 16:30        | B9                   | 55           | 47.9         | 49.1         | 47.7         |
use and transformation of the space. The inner wall decoration can use sound-absorbing materials or sound-absorbing structures at appropriate positions to reduce sound absorption and noise. In traffic places such as halls, atriums, and corridors, appropriate use of sound-absorbing materials should be combined with the decoration of the building. In the case of long and narrow sidewalks without sound-absorbing treatment, the corridor can simply function as a noise transmission device. In order to deal with the gap between the door and the door, the key is to improve the sound insulation performance of the door. There are many methods for the closed-loop processing of the door edge, for example, several elastic materials can be used. Windows have many functions, except for lighting, they still need to meet the needs of sound insulation. The university library has a lot of space and many users, so it needs sufficient lighting and ventilation to meet the normal study and work needs of library users. As a result, the window areas of the music practice room, classroom area, and management office space are widened, which is not suitable for sound insulation. Therefore, the best way to solve this contradiction is to use soundproof ventilation windows. The use of this window not only affects the lighting but also does not affect the indoor ventilation of the music classroom, but also ensures a certain degree of sound insulation.

Because the cost of sound insulation and ventilation is high, in general, other methods are used to solve the problems of sound insulation, sound absorption, and noise reduction. Sound insulation and ventilation windows should be used in situations where a part of the space is close to urban noise sources or noise sources in campuses, which seriously interfere with noise. On the feet of tables and chairs of music classrooms, rubber caps or foam plastics can be installed under the tables to prevent noise when the tables and chairs move. If conditions permit, placing a plastic floor on the indoor floor of the university’s new music class can also effectively solve this problem. It can not only achieve the purpose of sound absorption but also play a role in decorating the music classroom. For music classrooms that are not easy to change in use, this method is economical and convenient.

The above analysis achieves the purpose of reducing noise by building sound insulation method and sound absorption method and creates a quiet and comfortable sound environment. These methods should comprehensively consider the overall situation of campus layout, architectural planning, architectural design and select reasonable sound insulation, sound absorption, and noise reduction measures suitable for each music classroom. Among the above countermeasures, in creating a good music environment in university music classrooms, the most important thing is the planning of campus music classrooms and the architectural design of music classrooms. The sound insulation and sound absorption of the building are constructed on the basis of the architectural design of the music classroom according to specific conditions and further implemented. The management and user quality of campuses and music classrooms are a manifestation of a civilized society and an effort to create a good and healthy environment for university music classrooms from another direction.

**Conclusion**

The architectural sound environment of the university music classroom is composed of outdoor and indoor parts, which is an organic whole. The users of the music classroom use the internal space of the music classroom to meet people’s needs, and the sound environment of the internal space will have the most direct impact. The outdoor audio environment will affect the indoor audio environment thereby affecting users. Therefore, the effective control of outdoor acoustic environment noise is to obtain a good indoor acoustic environment, and having a good indoor acoustic environment is the basic purpose of noise control in the acoustic environment of a music classroom. An excellent outdoor audio environment can provide a quiet atmosphere for the indoor audio environment. On the contrary, if the outdoor sound environment is not good, it will bring great pressure to the indoor sound environment. Some measures are to create a quiet indoor sound environment that can compensate for some interference from the outdoor sound environment. Therefore, the environmental noise control of university music classrooms must start from these two aspects at the same time, and neither of them can be ignored. There are many uncontrollable factors in the outdoor sound environment. Therefore, in an outdoor audio environment, it is more effective, economical, and long-term to choose a suitable geographic location than to take various measures to prevent and reduce noise. Regarding the indoor sound environment, it is necessary to take corresponding countermeasures against the building conditions of the music classroom. The sound environment of the university music classroom always affects users in all spaces, and a good sound environment will bring positive effects to users’ study and work.

**Declarations**

**Conflict of interest** The authors declare no competing interests.

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