Tropical cyclone and business English cross-cultural communication based on temporal big data

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Abstract
Numerical simulation has always been the most important method for predicting tropical cyclone activity and has also been widely used in tropical cyclone climate research in recent years. However, the ability of numerical models to simulate tropical cyclone activities on a climate scale is still uncertain. Therefore, it is necessary to strengthen the modeling of the physical process of the model and strengthen the understanding of the impact of simulated tropical cyclone activities. In this article, time information is used to study the activities of tropical cyclones. Since time information is everywhere, a large amount of time information is now generated. This paper proposes a Spark-based auxiliary catalog system for managing large amounts of time data in a distributed environment. It uses a local index structure to significantly improve the query efficiency of temporal operations. Using this technology to explore tropical cyclones in the sea can improve the accuracy of tropical cyclone activity simulation and further the research on tropical cyclone climatology. In this article, we also apply tense big data to business English cross-cultural communication and use tense big data to manage a large amount of information that exists in business English cross-cultural communication, so that researchers can use relevant information of the problem in cross-cultural communication in the company language, and then study these problems. From the perspective of cross-cultural communication theory, this helps to enhance students' phonological awareness and improve their use of business English. This paper uses a large amount of time data as the research basis and applies it to tropical cyclones at sea and business English to promote the vigorous development of cross-cultural communication.

Keywords Temporal big data · Tropical cyclone in the sea · Business English · Cross-cultural communication

Introduction
For decades, many in-depth studies have been conducted on time data. In the era of isodata, it has received more and more attention due to its wide application. For example, a user may want to view demographic information for a specific time management area. The time operation of querying the historical version of the database is usually called time travel. As another example, in the quality control department, a user may want to know how many orders have been delayed over a period of time to query all historical versions of the database during a period of time, such as the above query is usually called a time combination. Another frequently used time activity is time concatenation. For example, a user may wish to merge two or more records with overlapping time intervals and specify keywords and time periods for the records in the query (Ahr 1973). In this article, we will use temporal big data to provide new ideas for the study of tropical cyclones and business English cross-cultural communication. A tropical cyclone is a complex and changeable weather system. Its special characteristics in dynamic range, water vapor range, and thermal range make it very difficult to study and predict the operation (including path and intensity) of tropical cyclones. Due to the short life cycle of tropical cyclones, irregular trajectories, and a severe lack of ocean observation data, numerical models have been considered the most important means for simulating and predicting the functions of tropical cyclones for many years (Baucon et al. 2019). In this article, the use of large time data to study tropical cyclones in the sea provides researchers with a convenient tool to compare the effects of the interaction of different physical factors in the life history of tropical cyclones.
tropical cyclones on the formation and evolution of tropical cyclones. This article analyzes the cross-cultural content from the perspective of cross-cultural communication and practicality, for example, cultural differences, incoherent context content, relevant practical knowledge, etc. Language expression and pragmatic failure have different forms of expression, such as language in oral communication (Bendella and Ouali Mehadji 2014). In communication, actual errors are divided into two aspects: physical errors and actual errors that have nothing to do with body language. It can be seen that in order to achieve smooth communication, foreign language users must have sufficient and solid basic language knowledge. On the other hand, foreign language users must have practical language skills and abilities. Therefore, this article applies a large amount of knowledge to the study of cross-cultural communication in business English. This technology can help foreign language users understand that they need to choose a language that is consistent with the relevant context and culture of oral communication to achieve successful cross-cultural communication (Bottjer et al. 1988).

Materials and methods

Data source

The best tropical cyclone path data selected in this article comes from the 6-h tropical cyclone data provided by the United States Joint Typhoon Warning Center, including tropical cyclone name, generation time, average coordinates, and maximum wind speed near the center. Since the CWRF data is a daily average, only the tropical cyclones on the coast of East Asia with a maximum wind speed of 17 ms−1 and a duration of more than 2 days are selected as choices. According to statistics for 2020, from 2020 to 1894, there were a total of 433 eligible tropical cyclones. In order to better describe the intensity of tropical cyclones, the study calculated the cumulative cycle energy index and potential decomposition index of tropical cyclones. Among them, the ACE index is obtained by calculating the cumulative sum of the square of the maximum wind speed near the center when the tropical cyclone intensity and higher intensity are reached:

\[
ACE = \sum_{i=1}^{n} T_s \sum_{i=1}^{n} V_{\text{max}}^2
\]

(1)

The calculation of the PDI index is based on the definition of Kerry Emanuel et al., namely:

\[
PDI = \int_0^T V_{\text{max}}^3
\]

(2)

The PDI index refers to the frequency and intensity of tropical cyclones, which can be used to describe the potential destructive power of tropical cyclones. In addition, in the tropical cyclone operation simulation evaluation model, the calculation formulas for the TS score, false alarm rate (FAR), and sub-report rate (PO) of each program are as follows:

\[
TS = NA/(NA + NA + NC)
\]

(3)

\[
FAR = NB/(NA + NB)
\]

(4)

\[
PO = NC/(NA + NC)
\]

(5)

In the formula, NA is the number of correct predictions in the model, and NB is the number of incorrect reports in the model. When the predicted result of the model matches the observed result of JTWC, the occurrence time of tropical cyclone and the position of simulated tropical cyclone and the position of tropical cyclone detected by JTWC do not exceed latitude 10°, and it is estimated to be correct in longitude. If the model forecast does not show the results of the JTWC observations, it is estimated as a zero ratio; if the model cannot predict and there are records in the JTWC observations, it is regarded as a false report.

Partitioning method of temporal big data

We know that when sharing general information (such as streaming information) to balance the load on a distributed system, it is usually necessary to obtain the same partition size. When partitioning time data, we also need to ensure that the overlap of the partitions is minimized. Reducing partition duplication can improve the efficiency of the global catalog, reduce the number of partitions that participate in queries, and improve query efficiency. In order to achieve these goals, we partition the time data by symmetrically and sorting the time slots of the regional partitions. We use the example in Fig. 1 to illustrate the partitioning method. It should be noted that although the hash partition method is widely used in other data types and can implement load balancing functions, it may not be suitable for complex time calculation scenarios. The main reason is that due to the randomness of the hash partition, it cannot guarantee the overlap of the partition spacing. For example, consider the time data shown in Fig. 1, which contains the same time records.

Calculation method of a tropical cyclone in the sea area

In order to better describe the intensity of tropical cyclones, the study calculated the cumulative cycle energy index and potential decomposition index of tropical cyclones. Among them, the ACE index is obtained by calculating the cumulative sum of the square of the maximum wind speed near the center when the tropical cyclone intensity and higher intensity are reached.
Results

The influence of cumulus convective parameterization on the simulation of tropical cyclone activity in the sea area

Figure 2a shows the time series of observed and simulated tropical cyclone formation frequency. The observed curve roughly shows a trend that the number of tropical cyclones first decreases and then increases. Generally, the cumulative convection method of this model tends to simulate the number of tropical cyclones less than the observed value in most years. Figure 2b shows the frequency distribution of the observed and simulated tropical cyclones in different months. The number of tropical cyclones observed gradually decreases from January to August and from September to December.

Figure 3 provides the regional distribution of tropical cyclone frequency based on the simulation of the convective parameterization system for each hump and the JTWC statistics. From the tropical cyclone frequency deviation values between JTWC and each graph in Fig. 3, it can be seen that each peak-cloud convection pattern greatly underestimates the tropical cyclone frequency in most areas, especially in low latitudes. The difference between the frequency of tropical cyclones simulated by the system and the observed values is even greater. In addition, the frequency and regional distribution of tropical cyclones simulated in different figures are quite different. In the South China Sea or the waters north of the Philippines, the frequency difference of tropical cyclones simulated by the KF system is the smallest. The difference between the frequency of tropical cyclones simulated by the BMJ program and the observed values is very different, and in principle, it is impossible to simulate tropical cyclones crossing coastal areas. Compared with other systems except the KF system, the ECP system and the Grell system have smaller differences between the frequency and observations of tropical cyclones that occur in the northern Philippines, and they also have better regional distribution in this process to simulate the occurrence and evolution of tropical cyclones.

Figure 4 considers the distribution of tropical cyclones in latitude and longitude, and the abscissa of Fig. 4a has the stroke width interval of tropical cyclones. For example, 15–20 means that the latitude of the tropical cyclone is greater than or equal to 15°N and less than 20°N. As can be seen from Fig. 4a, all charts can better simulate the occurrence of tropical
cyclones with low and medium widths. More than 50% of tropical cyclones are concentrated in the range of 15 to 25° N. Obviously, the number of tropical cyclones at each latitude is simulated by the formula $K_F$ (red line).

The influence of cloud microphysical parameterization on the simulation of tropical cyclone activity in the sea area

Figure 5a provides a time series curve of the observed and simulated frequency of tropical cyclone formation. This curve roughly shows the trend that the number of tropical cyclones first decreases and then increases. Figure 5b shows the frequency distribution of simulated tropical cyclones observed in different months. The observation frequency of tropical cyclones increases from January to August and then gradually decreases from September to December.

The frequency distribution of simulated tropical cyclones from each group in the system varies with latitude. Figure 6a shows that most of the observed tropical cyclones are located in tropical and subtropical regions (15–30°N), which are similar in frequency to tropical cyclones, especially in tropical regions (15 to 25°N). There are almost no differences in the simulations of different systems: only Morrison and Morrison-a diagrams have relatively more simulated tropical cyclones. Figure 6b shows the spatial frequency distribution of tropical cyclones along their length. Most of the observed tropical cyclones are between 115 and 140°E, and the peak value is between 125 and 130° E. All microphysical cloud images in the CWRF model can further simulate this distribution. There is almost no difference between the different systems. Only the Morrison system and the Morrison diagram simulate the frequency of tropical cyclones at 125–130°E.
By calculating TS points, false alarm rate (FAR), and false report rate (PO), the accuracy of different microphysical cloud parameterization methods used to simulate tropical cyclones can be more intuitively reflected. It can be seen from Table 1 that the TS scores calculated using the cloud microphysics parameterization method have little difference: the TS score of most systems is about 0.4, and the difference between the higher TS score and the GCE test with the lowest Lin value is only about 6 percent. The under-reporting rate and the blank-reporting rate can reflect similar results. However, considering the aerosol effect, compared with the Thompson system plan, the TS score calculated by the Thompson-a system has increased. It can be seen that the CWRF model has almost no difference in the ability of different cloud microphysical

![Fig. 4 Frequency of tropical cyclones a with latitude and b with longitude](image)

![Fig. 6 Frequency of occurrence of tropical cyclones a with latitude and b with longitude](image)

![Fig. 5 a Interannual variation diagram of tropical cyclone generation frequency (unit: number) and b monthly variation diagram of tropical cyclone generation frequency simulated by different cloud microphysical parameterization schemes](image)

| Project name | TS   | FAR  | PO   |
|--------------|------|------|------|
| GCE          | 0.439| 0.083| 0.542|
| Lin          | 0.373| 0.159| 0.598|
| WSM6         | 0.411| 0.113| 0.566|
| Eta          | 0.408| 0.118| 0.568|
| Thompson     | 0.391| 0.088| 0.594|
| Thompson-a   | 0.407| 0.114| 0.57  |
| Morrison     | 0.391| 0.147| 0.557|
| Morrison-a   | 0.401| 0.138| 0.566|
parameterization systems to simulate tropical cyclones. It is useful to consider the influence of aerosols to improve the simulation ability of tropical cyclones.

You can view the calculations based on the frequency and intensity correlation coefficients of each cloud microphysical model and the observation results of simulated tropical cyclones in Table 2. Each cloud microphysical map simulates the time series of the ACE index and PDI index describing the intensity of tropical cyclones. The correlation coefficients are all over 0.6. The simulation of the annual change trend of tropical cyclone frequency shows that there are big differences between different cloud microphysical systems and the difference between the best simulation and the worst simulation is almost 0.2. The correlation coefficient between the frequency of the simulated tropical cyclone and the observed value simulated by Lin’s formula is higher than 0.35. Although the Morrison system simulates multiple tropical cyclones, the annual variation of the simulated tropical cyclone frequency model is the best of all systems. Taking into account the influence of aerosols, the time series of the frequency and intensity of tropical cyclones simulated by the Thompson-a and Morrison-a systems are not significantly improved compared with the Thompson and Morrison systems. All in all, the annual frequency changes of tropical cyclones simulated by different cloud microphysical systems are very different: the simulated frequency time series of Lin’s formula are mainly observations, and the Morrison diagram is the worst trend of cloud changes. Taking into account the influence of aerosols, the intensity of tropical cyclones has not significantly improved the frequency and intensity of the simulation.

The influence of boundary layer parameterization on the simulation of tropical cyclone activity in the sea area

Figure 7a provides the observed and simulated changes in the frequency of tropical cyclone formation over the years. The observation curve roughly shows the trend that the number of tropical cyclones first decreases and then increases. In this model, based on the map of each boundary layer, the number of simulated tropical cyclones is usually lower than the annual observed average, while the number of simulated tropical cyclones is about six. The variation curves of tropical cyclone formation frequency in different years are simulated in different boundary layers, and the differences are obvious. Compared with other boundary layer methods, the Boulac system simulates fewer tropical cyclones in most years, while the CAM3, ACM, and UW systems simulate more tropical cyclones in most years.

Figure 8a takes into account the distribution of tropical cyclones obtained from latitude observations and simulations. The observed tropical cyclones mainly occur in low-latitude tropical and subtropical areas. The number of simulated tropical cyclones is still relatively small. The simulation differences between different boundary layer maps are obvious; just like the regional distribution of tropical cyclone frequencies, the number of tropical cyclones simulated by the Boulac formula is lower than those in other diagrams at most latitudes, while simulated cyclones from tropical cyclones. The number is lower at most latitudes. The same number of cyclones can be obtained from the distribution of the number of tropical cyclones along the length. In Figure 8b, the number of tropical cyclones varies with the meridian and the peak at 1250E-1300E, which is reflected in the observation and

| Project name | Cor(frequency) | Cor(ACE) | Cor(PDI) |
|--------------|----------------|----------|----------|
| GCE          | 0.349          | 0.709    | 0.713    |
| Lin          | 0.357          | 0.69     | 0.689    |
| WSM6         | 0.28           | 0.717    | 0.723    |
| Eta          | 0.268          | 0.68     | 0.678    |
| Thompson     | 0.196          | 0.705    | 0.735    |
| Thompson-a   | 0.217          | 0.715    | 0.726    |
| Morrison     | 0.273          | 0.677    | 0.678    |
| Morrison-a   | 0.418          | 0.638    | 0.642    |

Fig. 7 (a) Interannual variation diagram of tropical cyclone generation frequency (unit: units) and (b) monthly variation diagram of tropical cyclone generation frequency simulated by different boundary layer parameterization schemes

Fig. 8a shows the distribution of tropical cyclones along the length. In Figure 8b, the number of tropical cyclones varies with the meridian and the peak at 1250E-1300E, which is reflected in the observation and
simulation of the model. During this period of time, the number of tropical cyclones simulated by the Boulac program was lower than other programs, and in the eastern part of 1250E, the number of tropical cyclones simulated by the UW program was significantly higher than other programs.

By combining the TS score, false alarm rate (FAR), and sub-report rate (PO) of each boundary layer map, we can see that Table 3 shows that the ability of each boundary layer formula to simulate tropical cyclone activity is different. In most models, the TS score obtained is about 0.4. The relatively good CAM3 simulation system and the MYNN system which simulates the relative deviation have a 9% difference between the TS points. Higher than the CAM3 system with the second highest correlation coefficient. However, the correlation coefficient between the PDI index calculated by the CAM3 program and the ACE index and the observed value is higher than other programs. In the MYNN system, the calculation frequency correlation coefficient and the calculation efficiency correlation coefficient are both large, and the correlation coefficient calculated from the boundary layer map is relatively small. Therefore, it can be seen from the above that using the CAM3 program to simulate tropical cyclone activity is closer to the trend of year-by-year changes in the observed values, perceived frequency and intensity, and concentration accuracy. The MYNN program in tropical cyclone simulation is compared with other boundary layer programs.

**Discussion**

**Analysis of causes of pragmatic failure in business English intercultural communication**

If there is a difference in the cultural background between the two parties, the understanding of the communication process will often be biased, leading to actual errors. Thomas believes

| Project name | TS   | FAR  | PO  |
|--------------|------|------|-----|
| CAM3         | 0.439| 0.083| 0.542|
| YSU          | 0.388| 0.079| 0.598|
| MYNN         | 0.349| 0.122| 0.633|
| Boulac       | 0.363| 0.058| 0.628|
| ACM          | 0.410| 0.110| 0.568|
| UW           | 0.402| 0.120| 0.575|

| Project name | Cor(frequency) | Cor(ACE) | Cor(PDI) |
|--------------|----------------|----------|----------|
| CAM3         | 0.349          | 0.709    | 0.712    |
| YSU          | 0.294          | 0.645    | 0.678    |
| MYNN         | 0.270          | 0.650    | 0.677    |
| Boulac       | 0.326          | 0.686    | 0.693    |
| ACM          | 0.403          | 0.687    | 0.715    |
| UW           | 0.312          | 0.674    | 0.679    |
that if the communicator does not follow grammatical rules in terms of word selection and sentence composition, he may be considered “poor language” at best and lack language ability; but if he does not follow practical principles when arguing, it is “poor performance.” Therefore, the consequences of actual errors are much more serious than grammatical errors (Bromley and Ekdale 1984). Therefore, finding out the cause and avoiding actual errors as much as possible becomes the key to solving the problem. The causes of pragmatic behavior errors are usually complex and are mainly summarized as follows.

The first is the cultural difference in practice. The culture of each nation has been developing, accumulating and transforming in the period of continuous development, and has its own style and tradition (Bromley and Ekdale 1986). Every culture has its own way of thinking, code of conduct, and way of doing things. For people affected by it, this is a natural and normal existence, but for people with another value system, it is difficult to understand and recognize (Bromley 1996). Communication errors caused by cultural differences are mainly social and practical errors (Buatois et al. 2017). When the correspondent’s behavior in the new environment has a different meaning from the correspondent’s default behavior, misunderstandings and communication errors will result (Burchette and Wright 1996).

Second, the mentality is different. Mentality plays a very important role in cross-cultural communication. There is a close relationship between the way of thinking and culture, and cultural significance can be directly reflected through the way of thinking (Callow and McIlroy 2011). Due to differences in cultural backgrounds, people have different ways of thinking, and there are ways of thinking in all fields of culture (Chamberlain and Clark 1973). One of the reasons for failure in cross-cultural communication is different ways of thinking. Under normal circumstances, we will record what we experience or see in more vivid ways, such as symbols, graphics, or metaphors, according to one’s most imaginative way of thinking, and we will communicate and use language to convey far-reaching information (Chamberlain 1977). Far less than what we emphasized.

Third, the main reason for actual failure is that contextual factors are not considered. The cognitive environment helps us understand the language better. He pointed out that cognitive context includes the following elements: language context, morphological structure, and social iconic representation. Language usually occurs in a specific language environment. Context refers to the actual language environment or specific situation composed of a series of subjective and objective languages and environments closely related to communication (Cluff 1980). These factors play an important role in semantic expression, and context provides us with a way to actively participate in and conduct a dialogue. When a word appears in a specific language, its semantics becomes complicated and multifaceted, including the meaning of the word and the special meaning given by its cultural context. Therefore, the meaning of words cannot be understood only from the perspective of vocabulary and grammar, but cultural and contextual factors must be considered.

**Cultivation status of business English pragmatic competence**

Pragmatic competence is the ability of people to accurately express their ideas in a specific environment. Pragmatic competence is also divided into two aspects. One is the ability to use language, the ability to communicate using language rules in a specific context, and the other is the ability to socialize, the ability to follow language rules and use the language correctly. The main reason for cultivating the practical skills of business professionals is to enable them to accurately understand the importance of communication between the two parties under different cultural backgrounds and to express their wishes in different situations and naturally express our thoughts and feelings. Due to the many differences between China and the West, it is necessary to create a special atmosphere to boost practical language skills. The “business + English” model is usually used to teach traditional business English. Although it can improve students’ language expression to a certain extent, their practical skills still have shortcomings. General grammatical errors can lead to cultural conflicts in the communication process between the parties and affect the effectiveness of company communication. Pragmatic errors do not mean errors in general wording and sentence structure, but refer to inappropriate errors in speech and certain expressions that are inappropriate because they are not suitable for the purpose of communication and cannot produce the expected effect. Currently, entrepreneurs need to learn some expressions in cross-cultural communication and improve their practical skills.

**Strategies for cultivating business English pragmatic competence from the perspective of cross-cultural communication theory**

Teachers should improve pragmatic awareness

In order to effectively improve the language ability of students, it is necessary to improve teachers’ practical awareness of the teaching process. Once teachers fully understand the concepts of intercultural communication theory, they will have a good and effective way to improve students’ practical skills. Some currently recognized teachers do not have much practical experience in business and only teach based on some theoretical knowledge, so they cannot effectively improve students’ cross-cultural practical knowledge. Qualified foreign language teachers should not only have the basic qualities
of ordinary teachers but also have a thorough understanding of cross-cultural communication and foreign language theory and should effectively improve their personal qualities to approach students’ learning psychology and narrow the scope of teachers to interact with students.

The introduction of culture and pragmatics should be strengthened in teaching materials

At present, the popularity of large commercial enterprises has gradually increased. Textbooks involve different cultural skills and different aspects. However, if we want to increase students’ cross-cultural communication skills in English practice, we still need to carry out some reforms and enrich the teaching materials. Every language is very attractive, so textbooks should have an in-depth cultural introduction to the language, not just let people learn the language on their own. The introduction of cultural studies and business knowledge into English textbooks is very important and can directly affect students’ practical skills. Therefore, when compiling teaching materials, we must adhere to five basic principles, system principles, communication principles, cognitive principles, cultural principles, and emotional principles, with special emphasis on communication principles and cultural principles.

Adopt scenario simulation teaching and practical teaching mode

Business English courses are different from other courses. Therefore, it is necessary to change the teaching methods through the combination of situational simulation and practical teaching in the classroom to enhance students’ understanding of culture and improve their business English practical skills. In the teaching process, must adopt a student-based education model to enhance the interaction and communication between teachers and students, so they can communicate with the soul and gain eye contact, so that students can fully understand the characteristics of children. It should also simulate business practices to help students complete similar delivery tasks in a simulated environment. Every semester, if the university has conditions, students complete similar delivery tasks in a multicultural environment. This kind of classroom design can not only increase students’ interest in learning but also increase cultural awareness and use practical skills.

Conclusion

In this article, by measuring the execution time and throughput of time operations, the time big data technology is applied to the study of tropical cyclones and the communication of English sports culture in the ocean. This article introduces the real data set and the summary data set, the system compares with the reference system. This paper compares the different cumulus convection maps of the CWRF regional climate model, cloud microphysics, and the ability of the boundary layer to simulate the path, and frequency and intensity of the East Asian tropical cyclone from 1991 to 2020 and calculates the TS value and the airspace fractional tropical cyclone simulation. Null report rate, false report rate, and correlation coefficients can evaluate the influence of different cumulus convection systems, cloud microphysics, and boundary layer parameterization systems in the CWRF model on tropical cyclones and provide the best combination model of parameterization to simulate the east subtropical cyclone. The comparison results consistently show that the system proposed in this paper has faster execution time and higher productivity. In terms of time connection, some use cases exceed the frame of reference by nearly two orders of magnitude. This shows that the system structure and the implemented system can provide low-latency, high-throughput analysis, and query of temporary big data. At the same time, we looked at the index overhead in terms of reconstruction time and storage to provide a more accurate reference. In addition, we studied the effect of segment size on the query performance of temporal data and applied it to the study of cross-cultural communication in business English. This article provides basic information about the practicality of undergraduates, highlights the weaknesses of the students, and pays more attention to the teaching process. Provide information about Western culture and customs, including language habits and customs; at the same time, it is also good for both Chinese and Western cultures. In addition, while students develop correct learning attitudes and take various measures to improve actual failures and improve language and cultural use, they also have a clear understanding of the relationship between language and culture. This article innovatively introduces the sub-directory used for temporal data in Spark, which effectively improves the efficiency and scalability of temporal queries on big data. At the same time, we build the system as a third-party library without modifying Spark’s source code, inherit Spark’s fault tolerance and memory computing advantages, shorten the system construction time and make it friendly to developers. The interface provides an exploration cross-cultural communication between new methods of tropical ocean cyclones and business English.

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Declarations

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