

## **Authors' Response to RC5 by Sun-Kyung Lee (Referee)**

Thank you very much for your careful reading of our manuscript and very helpful comments and suggestions. We apologize for our not so quick response due to the unusual situation in our university affected by the Coronavirus epidemic and its prevention.

In the following authors' response to the reviewers' comments, we will italicize the comments, and add our answers below. In the answers, page and line numbers and figure numbers are based on the previous manuscript uploaded as the discussion paper.

*General comments: This study intends to link climate education with music education through very interesting pedagogical approaches regarding climate. Therefore, it is suitable for the special issue of this journal, Geoscience Communication. However, it also has a couple of issues which need to be discussed and revised to be more meaningful. These are some comments to consider when this article is revised.*

Thank you very much for your interest in our study and your valuable comments. Our response to your specific comments is as follows.

*First of all, climate or seasonal changes are usually very closely related to an individual's emotions, life or culture, but many people do not feel it well or notice the connection of them in everyday life. In this regard, this paper attempted to study various scientific geographic characteristics related to climate in Japan and Europe including Germany, to think about the feelings of climate at specific seasons, and to express them with color or music, to appreciate and discuss them. Through this process, it is thought that the influence of climate on human emotions and life can be well understood. However, it may be necessary to clarify and distinguish whether changes in a specific period noted in this paper are climate phenomena that can be explained as characteristics of a longer period or meteorological phenomena caused by seasonal variations.*

In the activities referred to by this review article, we paid attention to some interesting characteristics of the climatological mean seasonal cycles presented with the 30-year mean values and their "standard variability" for that period, although some figures of mean features including the variability for about 10 years are shown as for Germany and Northern Europe (the climate normals of various meteorological elements provided by the Japan Meteorological Agency are the 30-year means). In addition, in order to illustrate the features of the day-to-day variation in the seasonal cycle, the time series for some specific years were also shown (e.g., Figs. 12 and 17). Thus we will try to add a very short explanation of that in the text when Figs. 12 and 17 appear.

We would like to mention that magnitude of day-to-day variation of a meteorological element is also an important indicator of the "mean seasonal state", although its extreme values are sometimes associated with the climate change. Thus we also used the day-to-day variations as a study material for understanding the detailed but important "standard seasonal features" in various regions and seasons.

*Second, meteorological variations and climate change have a major impact on people's lives. They can make psychological changes of people and it can change the way people act. Therefore, the ability to be sensitive on climate change to detect or link the change in life or society, is essential for a sustainable future. In terms of ESD (education for sustainable development), it is important to understand the complexity of climate itself. However, it is more important to*

address the complexity of climate change issue, which is not clearly visible in this article.

I really agree your opinion. In the education on Climate Change including the Climate Action in ESD, it is very important to understand how the climate has been changing, how kind of regional climate response is likely to occur in the future, and how complex the climate change issue is, and so on. However, the change in the future climate can be detected not only by the deviation from the present one but also by the change in the seasonal cycle pattern, i.e., changes in the seasonal maximum and minimum of the “mean” meteorological elements, their maximum and minimum phases, duration of their maximum and minimum phases, their “mean” day-to-day or year-to-year “variability” in each season, and their combination of these elements. We could tentatively call such changes the “distortion of the seasonal progression”.

Especially in middle and higher latitudes, the seasonal cycle of the climate system is clearly seen but shows rather different features from region to region. Thus, in detecting how the climate has been changing or understanding how it is likely to change in the future, it seems to be an effective way to pay attention to the “distortion of the seasonal progression”. In order to do so, understanding of the complexity of the climate itself including the detailed seasonal cycles differently from region to region would be necessary for that basis. If the students understand such detailed seasonal cycles at least for a few regions more deeply, they would be also able to feel more sensitively that the climate is somewhat different from before, which would help for detecting the climate change also scientifically.

This is another reason why we focus mainly on the detailed seasonal cycle itself in our activity, as well as for providing the students’ opportunity for promoting the ESD literacy.

*The third is the pedagogical aspect for climate learning. Authors use various teaching and learning methods including traditional lectures with explanations, graphs, tables, etc., and more innovative methods with project-based learning including composition, playing with instruments, expressions of feelings, explaining etc. The use of these various pedagogical approaches gives students a variety of approaches to climate topics. Therefore, they can experience various aspects of this topic. Also in this process, not only science and music, but also art, Japanese language, social studies, geography learning are involved. Therefore, Fig. 1 of p 19 will need to be revised.*

Thank you very much for your suggestions. We will revise Fig. 1 as follows.

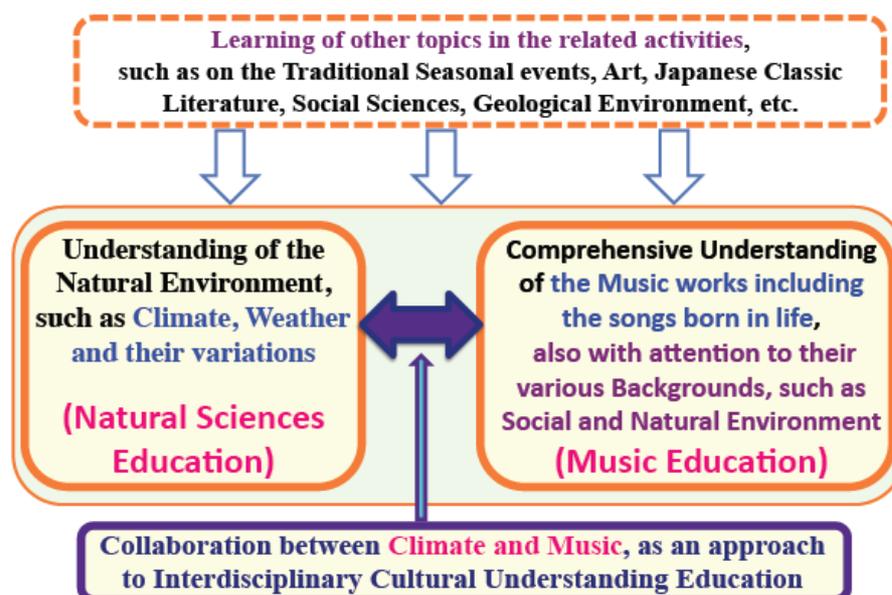


Figure 1: Collaboration between climate and music, toward interdisciplinary cultural understanding

**education.**

*The fourth aspect is related to the lesson study mentioned in the third part. Although this covers lessons, it is difficult to say that it is a lesson study that is generally practiced in Japan or other countries. Authors might want to reconsider the use of the term.*

Thank you very much for your suggestion. In this paper, we will consider to use another term, such as lesson practice and its result, and so on.