

Summary of our activities toward development of the ESD interdisciplinary study plans on climate and cultural understanding education with attention to the seasonal cycle and “seasonal feeling” around Japan and Europe

気候・文化理解教育の学際的ESD学習プラン開発へ向けた取り組み (日本とヨーロッパの季節サイクルや季節感に注目して)

加藤内藏進 (Kuranoshin KATO)*
加藤晴子 (Haruko KATO)**
赤木里香子 (Rikako AKAGI)***

Abstract

We have continued the interdisciplinary integration of the knowledge on climate and music and have developed the crosscutting study plans on the climate and cultural understanding education. A part of these results had been summarized in a Japanese book titled “Climate and music (Cultural understanding and ESD spreading from the “Doors of Song”)” (Kato and Kato 2019), building mainly our papers written in Japanese. This article will re-integrate our above study results, mainly for the climate and songs/traditional seasonal events around Germany, Northern Europe and Japan, with special attention to (A) asymmetric seasonal progression from autumn to next spring around Japan, (B) winter climate around Germany in association with the seasonal feeling on the traditional events “*Fasnacht*” for driving winter away and (C) climate around Northern Europe in association with the seasonal feeling on the summer solstice festival “*Juhannus*” with comparison to the summer climate around Japan.

Keywords: climate and music, interdisciplinary climate and cultural understanding education, seasonal cycle around Japan and Europe, seasonal feeling, ESD, comparative climatology

I. Introduction

Most music pieces have their own cultural background, and the origin and expression of songs are closely related not only to their languages and customs but also to the regional characteristics of natural environment including the climate and its seasonal cycles.

Thus, as illustrated in Fig. 1, scientific study of the climate and seasonal cycle in a regional context would be also useful for understanding the context of music, as well as the other musical backgrounds. Besides, such approach enables the students to sympathize with the feeling of the people and to sing and appreciate the songs as if they have been there since before. In turn, to know how the climate, season and people’s feelings, and so on, are expressed in songs often gives us some interesting viewpoints for the data analyses on climate and seasonal features including their variability.

By the way, climate education is an important basis of the Education for Sustainable Development (ESD) (UNESCO 2006, 2017), relating to the education on environment, disaster prevention, climate variability, and also the cultural understanding education. Furthermore, the climate and weather systems are generally characterized as the non-linear interaction systems with complicated feedback mechanisms, multi-scale structure and variability. This suggests that the education on such climate or weather systems and their variability could also contribute greatly to promoting the “Fundamental ESD Literacy” itself such as thinking of various complex relations, diversity, and so on, among the various ESD targets. This could also lead to promote the students’ ability of understanding of “heterogeneous others”, which is also an important literacy in ESD and Global Citizenship Education (GCED) (UNESCO 2014, 2015). In those activities, selection of the

* 岡山大学学術研究院教育学域（理科） 名誉教授・特命教授，〒700-8530 岡山市北区津島中三丁目1-1
Faculty of Education, Okayama University, Okayama, 700-8530, Japan

** 元 岐阜聖徳学園大学教育学部（音楽）
Faculty of Education, Gifu Shotoku Gakuen University (Former Affiliation)

*** 岡山大学学術研究院教育学域（美術），〒700-8530 岡山市北区津島中三丁目1-1
Faculty of Education, Okayama University, Okayama, 700-8530, Japan

study areas or targets which are not so familiar to the students in their usual lives sometimes gives the considerable advantage for promoting the students' "Fundamental ESD Literacy" including the understanding of "heterogeneous others", by careful examination of the climate data and deeper appreciation of the seasonal feeling expressed in the music works or traditional events.

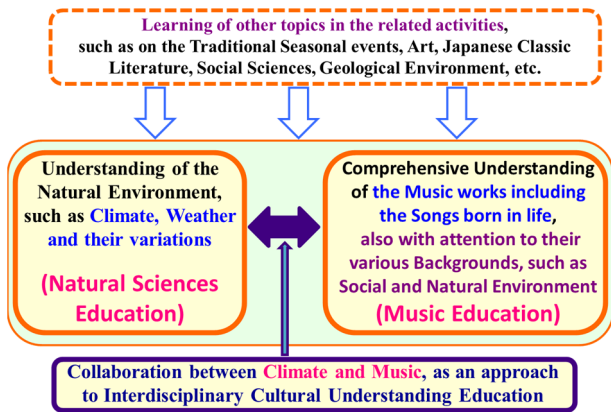


Figure 1 Collaboration between climate and music, toward interdisciplinary cultural understanding education.

As for the climate systems, the seasonality is a common important feature characterizing the climate in the mid-latitude regions. However, many different factors relating to the seasonal cycles result in the great variety of the

seasonal features from region to region within the mid-latitudes.

For example, the significant rainy season called the Baiu in Japan (the Meiyu in China and the Changma in Korea) appears just before the midsummer in East Asia and the heavy rainfall events frequently occur especially from Central China to western Japan in that season, greatly influenced by the global-scale Asian monsoon system (Kato 1989; Ninomiya 1989; Nimomiya and Muraki, 1986; Ninomiya and Mizuno 1987, etc.). Another significant rainy season called the "Aiki-same" (秋雨) (consisting of the two Chinese characters which mean for "autumn" and "rainfall", respectively) appears around Japan Islands, just after the midsummer (Matsumoto 1988). Including these two significant rainy seasons, the annual cycle can be recognized climatologically as the "six seasons" in Japan (Fig. 2), differently from the traditional "four seasons" in mid-latitude regions (Maejima 1967; Arakawa and Taga 1969). These situations result in the considerably larger amount of precipitation around the Japan Islands than in the other midlatitude region such as around Germany (e.g., Kato and Kato 2019).

On the other hand, outbreak of rather cold air from the continent in winter over the warm underlying sea, in association with the East Asian monsoon system results in the extremely heavy snowfall climate in the Japan Sea side of the Japan Islands for its lower latitude (e.g., Nimomiya 1968, 2006, 2007).

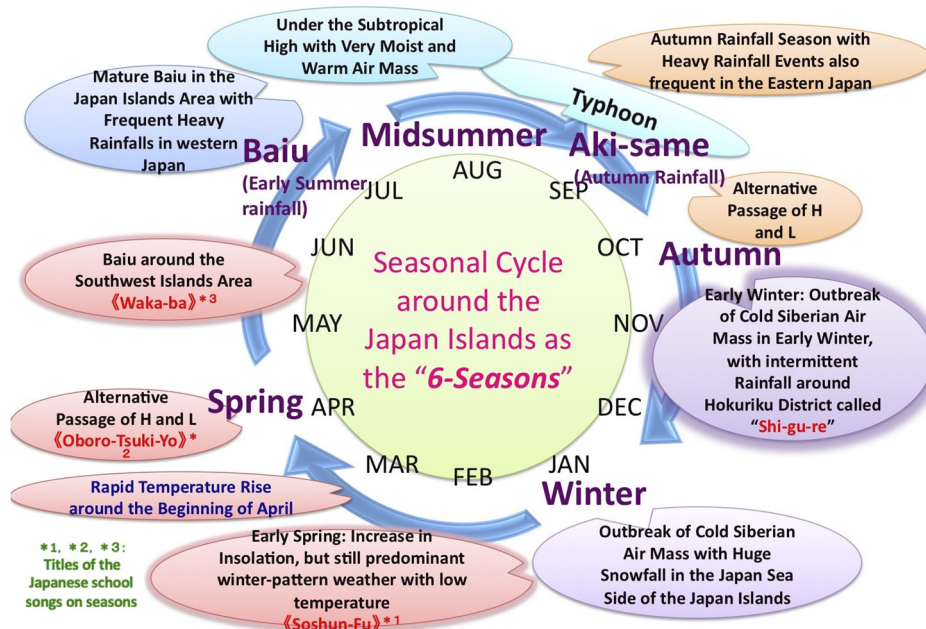


Figure 2 Schematic figure of the seasonal cycle around the Japan Islands, in East Asia.

Furthermore, the global-scale Asian monsoon system can be regarded as consisting of the several subsystems with the considerable phase difference of the seasonal progression among each other, at most by about three months

(Murakami and Matsumoto 1994; Kato et al. 2009, 2011; Kato and Kato 2014a). Since the climate systems in East Asia are greatly controlled by the combined effects of these Asian monsoon subsystems, the short-step transition from

stage to stage with rather different features among each other characterizes the seasonal cycle in East Asia, as also illustrated in Fig. 2.

The Baiu/Meiyu/Cangma in East Asia with the several abrupt seasonal transitions from spring to midsummer is a typical example (Kato 1985, 1987, 1989; Kato and Kodama 1992; Hirasawa et al. 1995; Ninomiya and Muraki 1986). Such seasonal cycle would bring the remarkable change in the “seasonal feeling” from month to month (Kato and Kato 2014a, 2019; Yoshino and Kai 1977). Another notable example is that a rather distinctive season between autumn and midwinter can be identified as “early winter” around the Japan Islands, and that between midwinter and spring as “early spring”. Furthermore, the seasonal progression from autumn to midwinter and that from midwinter to spring show rather asymmetric character (Kato and Kato 2014a, 2019; Kato et al., 2013, 2014, 2015, 2017a), which can be recognized as the “asymmetric seasonal progression” from autumn to next spring around Japan.

On the other hand, we can point out another important factor characterizing the seasonal cycle. For example, amplitude of the day-to-day variation of daily mean surface air temperature is rather larger throughout a year around Germany and Northern Europe, than in Japan. Especially for winter, Kato et al. (2017b) and Hamaki et al. (2018) suggested that intermittent appearance of the extremely cold days in association with the large day-to-day variation seems to result in the “seasonal feeling of very severe winter” around Germany such as relating to the traditional event “*Fasnacht*” for driving winter away (See 3.1) (Moser 1993; Nußbaumer 2010). As for the Northern Europe, the traditional event called “*Juhannus*”, which means the “Summer solstice festival”, is one of the most famous events held in summer. As Kato et al. (2019a and b) mentioned, while the seasonal mean air temperature from late June to July just after the summer solstice gets as high as in summer around Germany, the rather cold days begins to appear already in September, which seems to relate to the “seasonal feeling of the short summer” there (See 3.2).

As such, we will focus our attention to the examples of diverse seasonal cycles as follows, although the many other differences of the regional climate features can be found in the text books by Arakawa and Taga (1969) for Japan, Schüepp and Schirmer (1977) for Germany, and Johannesson (1970) for Scandinavia.

(A) “Asymmetric seasonal progression” from autumn to next spring around Japan.

(B) Winter climate around Germany in association with the “seasonal feeling of severe winter”, also related to the traditional event “*Fasnacht*” for driving winter away.

(C) Seasonal cycle around Northern Europe and the “seasonal feeling of the short summer”, related to the summer solstice festival “*Juhannus*” there.

The interdisciplinary climate-cultural understanding

education on the topic (A) could be a useful approach for promoting the “Fundamental ESD literacy” through the students perceiving the great differences between the two superficially resembling seasons. On the other hand, the topics (B) and (C) by comparing with the climate and seasonal feeling around Japan could give a chance for promoting the students’ “Fundamental ESD literacy” including the understanding of heterogeneous others.



(Kato and Kato 2014a)

(Kato and Kato 2019)

Figure 3 The surface covers of the two books which summarized a part of our interdisciplinary studies written in Japanese, titled “Climate and Music (Seasonal features and songs of spring in Japan and Germany)” (the left figure) (Kato and Kato 2014a) and “Climate and music (Cultural understanding and ESD spreading from the “Doors of Song”)” (Kato and Kato 2019) (the right one), respectively.

Based on these concepts, we have continued the interdisciplinary integration of the knowledge on climate and music, and have developed the crosscutting lesson plans on the climate and cultural understanding education for many years with many co-researchers, mainly focusing on the seasonal cycle and seasonal feeling around Germany, Northern Europe and Japan. A part of these integrated results have been published in the Japanese books titled “Climate and Music (Seasonal features and songs of spring in Japan and Germany)” (Kato and Kato 2014a) and “Climate and Music (Cultural understanding and ESD spreading from the “Doors of Song”)” (Kato and Kato 2019) (Fig. 3). The words “Doors of Song” used for a part of the subtitle of Kato and Kato (2019) were obtained from the famous song “On wings of song” (its German title is “*Auf Flügeln des Gesanges*”) by Jacob Ludwig Felix Mendelssohn Bartholdy (Germany, 1809–1847).

In this review article, we will re-integrate the results of our joint activities on the topics (A) to (C) mentioned above, referring to our previous papers and books (although written in Japanese). It should be also stressed that such activity would contribute not only to promoting the students’ “Fundamental ESD literacy” as the pre-service teacher training but also to their ability to discover the various possibility in their development of such kind of interdisciplinary study materials relating to “climate and music” when they become teachers.

Our previous papers and books have firstly focused on

the various aspects of the climate and seasonal cycle including their variability as an important background of the cultural generation such as music. Paying attention to them, we have examined the seasonal feelings expressed in the music works etc., in order to propose the various possibility for development of the study materials. The interdisciplinary lesson plans were constructed through such consideration.

In analyzing the lesson practice results, it might be also interesting to pay attention to students' perception of the musical emotion, including statistical or psychophysical approach (Juslin 2019; Meyer 1956; Eerola and Vuoskoski 2013; Balkwill and Thompson 1999, etc.). However, we are mainly aware of "what they intended to express based on the interdisciplinary integration of what they have learned throughout the lesson", rather than their workmanship, in evaluating the students' works. Thus, the results on the lesson practices will be introduced mainly by indicating the typical examples of the students' works in this paper, instead of the general results in somewhat statistical and objective way.

II. Interdisciplinary lesson practices with attention to the asymmetric seasonal progression from autumn to the next spring around Japan

2.1 Asymmetric features of the seasonal progression from autumn to the next spring and the relating "seasonal feeling" around Japan

As shown in the upper panel of Fig. 4, the mean air temperature in winter from northeast Siberia to Japan is much lower than the other regions in the same latitude and such cold air mass is called the Siberian Air Mass. At that time, the Siberian High and the Aluetian Low at the surface

level tend to persist during winter and such pressure pattern is called the "winter pressure pattern" in East Asia (Fig. 5).

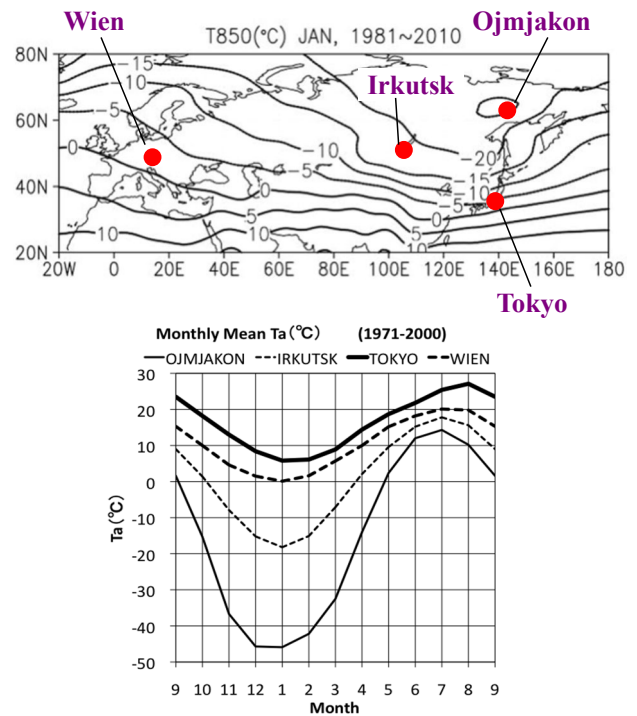


Figure 4 (Upper panel) Monthly mean air temperature at 850hPa level (°C) in January averaged for 1981–2010 (after Kuwana et al. 2016), based on the NCEP/NCAR re-analysis data (Kalnay et al. 1996). (Lower panel) Seasonal variations of the monthly mean surface air temperature at Ojmjakon, Irkutsk, Tokyo and Wien (Vienna). Locations of these stations are also shown in the upper panel.

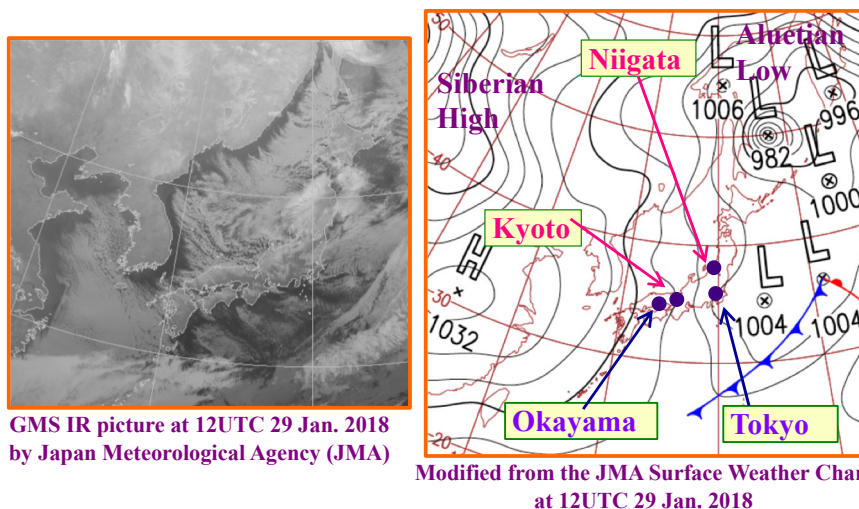


Figure 5 A typical example of the surface weather chart (right) and that of the infrared picture of the Geostationary Meteorological Satellite (GMS) (left) in the "winter pressure pattern" situations around East Asia in midwinter. These figures are cut out from the original figures provided by the Japan Meteorological Agency (JMA). Locations of the surface meteorological stations Niigata (the Japan Sea side), Tokyo (the Pacific side), Kyoto (semi-Japan Sea side climate region (Suzuki 1962)) and Okayama (where the lesson practices by the present authors were made) are also indicated on the weather chart.

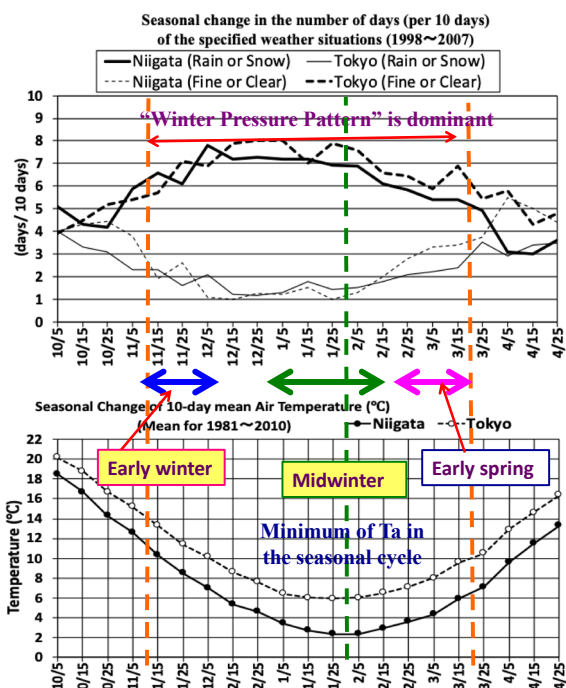


Figure 6 (Upper panel) Seasonal change in the number of days (per 10 days) of the specified weather situations at Niigata and Tokyo (1998~2007). Locations of these stations are referred to Fig. 5. (Lower panel) Time series of 10-day mean air temperature (°C) there (Mean for 1981~2010). These figures are modified after Kato et al. (2013).

Table 1 Number of Japanese classical poems “Waka”s in which the “Shigure” is expressed in the first 8 Waka Collections compiled by Imperial command (“Chokusen Waka-shu”) (modified after Kato et al. (2018)). In detail, see the text.

勅撰和歌集(Name of the book in which the Japanese classical poems (“Waka”s) are collected)	(a) Number of “Waka”s in which the “Shigure” is used for expression	(b) Total number of “Waka”s for the volumes of autumn and winter	(a)*100/(b) (%)
1 古今 (Kokin)	4	174	2.3
2 後撰 (Gosen)	17	290	5.9
3 拾遺 (Shuui)	6	126	4.8
4 後拾遺 (Go-shuui)	6	190	3.2
5 金葉 (Kinyo)	5	165	3.0
6 詞歌 (Shika)	5	79	6.3
7 千載 (Senzai)	21	248	8.5
8 新古今 (Shin-kokin)	35	422	8.3

In that situation, the huge amounts of sensible heat and latent heat are supplied from the underlying sea along the path of the very cold air from the continent, and the convective mixed layer due to the shallow cumuli develops over the sea. These result in the climatologically huge

snowfall in the Japan Sea side of the Japan Islands in winter (e.g., Ninomiya 1968, 2006, 2007).

Besides, it is also interesting that the lowest stage of mean air temperature around Japan (e.g., at Tokyo) lags to that in the northeastern Siberia (e.g., at Oymyakon) by about a month (the lower panel of Fig. 4), with more phase lag of the seasonal progression in the subtropical or tropical western Pacific. Relating to the earlier rapid temperature fall around the northeastern Siberia in the seasonal progression, the appearance frequency of the “winter pressure pattern” begins to increase already in November (early winter) (Fig. 6).

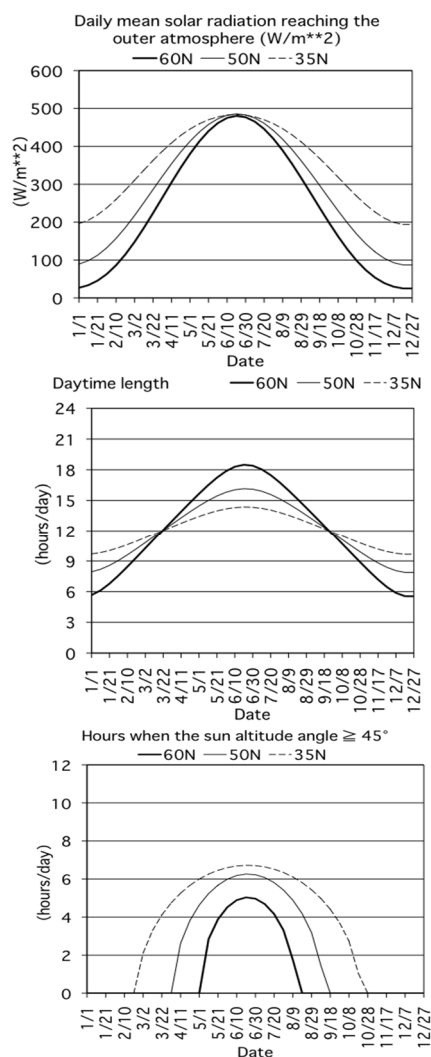


Figure 7 Seasonal variations of daily mean solar radiation reaching the outer atmosphere (Wm^{-2} , upper panel), daytime length (hours/day, middle panel) and the duration time when the sun altitude angle is higher than 45° (hours/day, lower panel) at $35^\circ N$ (broken line, around the southern part of the Japan Islands), $50^\circ N$ (thin solid line, around Germany) and $60^\circ N$ (thick solid line, around the southern part of Finland) (Kato et al. 2019a). The data at $50^\circ N$ and $60^\circ N$ will be referred to in Section 3.

However, the air temperature around the Japan Islands is rather higher than in early March (early spring) when the appearance frequency of the “winter pressure pattern” is nearly the same as in November. In this reason, the precipitation in the plain area of the Japan Sea side in Japan in the “winter pressure pattern” tends to be brought not as snow but mainly as rain.

【Early Winter】

神な月 降りみ降らずみ さだめなき
時雨ぞ冬の はじめなりける
(pronunciation) *Kanna-zuki Furi-mi-Furu-
zu-mi Sadame-Naki/Shigure-zo-Fuyu-no
Hjime-nari-keru*
Poet: unknown(“Gosen”)

(Meteorological situation) The “*Shigure*” precipitation in the early winter monsoon situation is characterized by the intermittent one, i.e., once it begins to rain, it stops soon. Such situation continues for several days.

【Early Spring】

春日野の下萌えわたる草のうへに
つれなく見ゆる春のあわ雪
(pronunciation) *Kasugano-no
Shitamoe-wataru Kusa-no-Ue-ni/
Tsurenaku-Miyuru Haru-no-Awayuki*
by Gon-Chuunagon-Kuninobu
権中納言國信 (“*Shin-Kokin*”)

(Meteorological situation) Although the light snow cover remains in the wide grass field, the new grasses are just growing there in the spring bright sunshine. The contrast among the light green, bright sunshine and the white snow seems to be impressive.

Figure 8 An example of the *Waka* expressing the seasonal feeling in early winter (e.g., “*Shigure*”) and that for early spring (e.g., light snow under the relatively strong sunshine) are shown in the upper and the lower panels, respectively. The former is recorded as 445th work in the 2nd *Waka* Collection “*Gosen*” and the latter as 10th work in the 8th Collection “*Shin-Kokin*” compiled by Imperial command (also see Table 1). Pronunciation and the meteorological situation for each *Waka* are also shown.

The intermittent rainfall due to the shallow cumuli in such situation is called “*Shigure*” (時雨) in Japanese (consisting of the two Chinese characters which mean for “sometimes or intermittent” (“*Shigu*”) and “rainfall” (“*re*”), respectively) and is often used for expressing the “seasonal feeling” in early winter in the Japanese classic literature. Especially we can see the word “*Shigure*” in the Japanese classic poems called “*Waka*” (和歌), a kind of Japanese classical poems consisting of the 31 syllables (Kato et al.

2011, 2012, 2018).

Table 1 indicates number of “*Waka*”s in which the “*Shigure*” is expressed for the first 8 “*Waka*” Collections compiled by Imperial command (“*Chokusen Waka-shu*”) edited from 10th to 13th centuries in Kyoto (modified after Kato et al. (2018)). The location of Kyoto is indicated in Fig. 5. In the first several volumes of each collection, the “*Waka*”s singing the scenery of various seasons are recorded. In Table 1, the ratio to the total number of “*Waka*”s in the volumes of autumn and winter (from early autumn to midwinter) for each collection is also shown. It is noted that the ratio attains up to nearly 5% or more in the 5 “*Waka*”collections (per 8 ones), in spite of so much seasonal scenery sung in “*Waka*”s for each stage of seasonal progression from autumn to midwinter.

On the other hand, the solar radiation is stronger in early spring than in early winter, as indicated by the seasonal variation of daily mean solar radiation reaching the outer atmosphere, daytime length and duration time when the sun altitude angle is higher than 45° (Fig. 7, after Kato et al. (2019a)). It is noted that the asymmetric seasonal progression from autumn to next spring mentioned above is greatly reflected by the large phase lag of the seasonal changes of various meteorological elements among each other.

Such asymmetric seasonal progression from autumn to next spring around Japan would result in rather different “seasonal feeling” between early winter and early spring. For example, while the “*Shigure*” is often used for expression of the “seasonal feeling” in early winter in “*Waka*” as mentioned above, the light snow under the relatively strong sunshine, and so on, is one of the popular scenes for early spring (e.g., Fig. 8). In turn, such difference of the “seasonal feelings” between early winter and early spring expressed in the Japanese classic literature seems to give us an important information for deeper understanding of the climatological seasonal cycle around Japan.

As such, the next subsections will report our interdisciplinary activity mainly for the university students in teacher training course, with focus on the asymmetric seasonal progression from autumn to next spring around the Japan Islands referring to Kato et al. (2013, 2014, 2017b), Kato and Kato (2019), and so on.

2.2 A report of interdisciplinary lesson practice for the university students in teacher training course

2.2.1 Outline of the lesson practice

The lesson practice reported by Kato et al. (2014) was performed as follows on the last day of an interdisciplinary lesson “Human Lives and Environments” at Faculty of Education, Okayama University during 28–30 August 2013.

Instructor: Kato, K. (Meteorology), Akagi, R. (Art) and Kato, H. (Music)

Date and Time: 30 August 2013 (08:40–17:45)

Activities:

(1) Brief summary on the climatological features in that

season and the appreciation of the "seasonal feeling" expressed in the Japanese classic art works

(2) Expression of the seasonal feeling with colored papers (Art)

(3) Expression of the seasonal feeling with small percussion instruments (Music)

(4) Expression with the colored papers on the bases of the activities 2 and 3 (Both).

About 35 students took part in this lesson. About the four fifth of them are not specialized in natural science. This

lesson is open for the all grade student. In this year, the numbers of the second and third grade students in this lesson were 9 and 20, respectively, and there were also several participants of the first and fourth grade, respectively. Prior to this joint activity, Kato, K. had explained to the students the climate around East Asia including the detailed seasonal cycles such as the asymmetric seasonal progression from autumn to the next spring around Japan.



Figure 9 All works by the students in Activity (2) (32 students x 2 seasons = 64 sheets in total) are ordered along the seasonal progression, after Kato et al. (2014).

In Activity (2), the students tried to express the seasonal feelings in early winter and early spring, respectively, by using the 6 colors selected from the 93 colored papers, based on the Johannes Itten’s (1888–1967) exercise for the “four seasons painting” (Itten 1961). This exercise is developed by Itten, when he was teaching in the preliminary course at the Bauhaus in Germany from 1919 to 1922. Originally, this method is to express the differences between the seasons with combination of the various colors created by mixing paints. In this lesson, the colored papers were used in order to make this activity much easier for the students.

At the beginning of this students’ activity, the following announcement was made. 1) Represent your sense of the seasons with 20 squares (4 X 5) of 2 papers (two stages for the early winter and early spring). 2) Select the two stages for the detailed comparison as above. 3) Select 6 colors from a set of 93 colored papers for expression of each season. 4) Think about which color combination is the best. Arrange and paste the selected colored papers on a sheet. 5) Post up your work on the wall of this lecture room at the proper position in the order of seasonal progression from autumn to spring through winter. All works by the students in this activity exhibited in such manner are presented in Fig. 9.

In Activity (3), the students tried to express their own seasonal feeling on early winter and early spring with attention to the difference between the stages just before and after the midwinter, by using the various small percussion instruments (Fig. 10), which are quite popular in

the music education. With use of such instruments, students could take part in the activity easily, i.e., they can easily touch the instruments and can devise various ways to play percussion instruments for the performance of their works.



Figure 10 Examples of the small percussion instruments used in this activity for the university students.

Their composition works were described in the form of the “graphic notation”. Graphic notation, in which visual elements are used to represent music to enable sensory and improvisational expressions, is sometimes used in the modern music instead of using the conventional notation

(see the Endnote (1)). The use of the graphic notation in our activities seems to be convenient to the students expressing their own seasonal feelings freely, regardless of their musical experience or skill.

Each student composed two works expressing early winter and early spring, respectively. Then, students were divided into several groups and each group played a selected set of their works. It took about 30 seconds to play a work. An example of the students' music works in the form of graphic notation comparing the seasonal feeling between early winter and early spring is shown in Fig. 11.

In the Activity (4), the students expressed the seasonal feeling of early winter or early spring also remembering their works in Activities (2) and (3), with less restricted usage of the colored papers than in Activity (2).

2.2.2 Difference of the seasonal feeling between early winter and early spring around Japan expressed in the students' works in Activities (2) and (3)

Analysis results of the students' works in Activities (2) and (3) (mainly for Activity (3)) by Kato et al. (2014) will be briefly introduced here. In Activity (2) (Fig. 9), the cool colors were mainly used with accentuate use of warm colors such as dark red and orange expressing fallen leaves and dead leaves in the works for early winter. It is also noted that the students tended to select the dark colors over light colors even among the cool colors. On the other hand, diverse combination of the rather different colors among the students' works tended to be used for expressing the seasonal feeling of early spring, i.e., not only the contrast between cool and warm colors, but also that on saturation and lightness. The cool colors seem to stand for the cold air and wind, early spring snow, and so on, while the warm colors remind us of the rather strong solar radiation or flowers of plum and cherry. Thus, the students' works as the whole with use of the colored papers seem to succeed to expressing the rather different climate features between early winter and early spring as mentioned in 2.1.

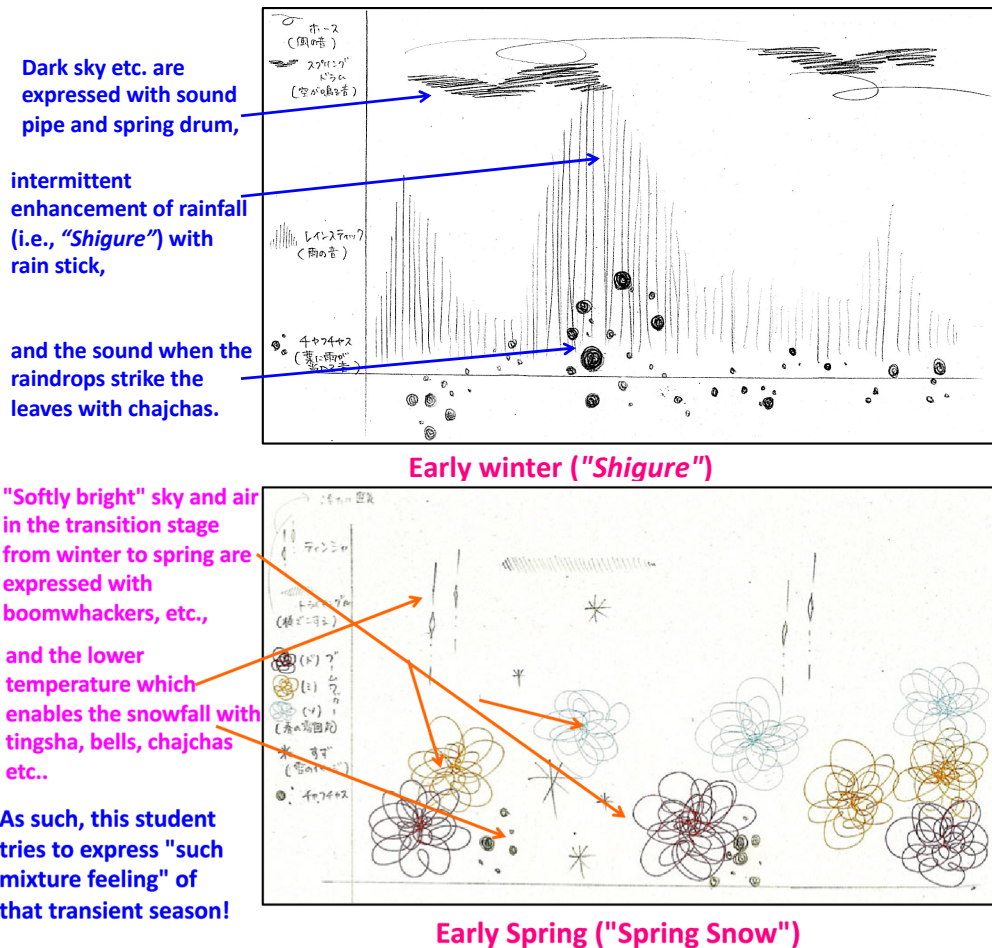


Figure 11 An example of the students' works on the music expression for early winter (upper panel) and early spring (lower panel) in the form of the graphic notation, cut out from Kato et al. (2014). The titles of the upper and the lower panels by the same student are "Shigure" and "Spring Snow", respectively. Some explanation by the present authors is also added outside of the student's works, referring to the student's own explanation on these works. The left and right edges of each figure indicate the beginning and end of the music piece, respectively.

In Activity (3), the students’ works were categorized mainly into two types, i.e., the works with descriptive expression of the meteorological or climatological phenomena characterizing the target seasons, and the ones with abstract expression of the marching season and the related emotion, and so on (Kato et al. 2014). Besides, various kinds of fluctuations such as “*Shigure*” (intermittent rainfall in the “winter pressure pattern”) in early winter, day-to-day alternation of the cold and warm days, and so on, were also presented in their works.

In the work “Early winter” shown in the upper panel of Fig.11, not only the overall impression of this season but also the various instantaneous weather phenomena such as the intermittent enhancement of “*Shigure*” in the sky with the raindrops near the ground striking the leaves of the trees there are also presented descriptively. From such expression we can find the student’s sharp and delicate imagination on the detailed scene of the “*Shigure*” only within the short passage of time. On the other hand, “softly bright” sky and air in the transition stage from winter to spring are expressed by the crescendo effect with boomwhackers, etc. and the lower temperature which enables the snowfall are also presented with bells, chajchas, etc. (lower panel). Furthermore, the student’s works seem to express not only the seasonal feeling derived from the mean seasonal state, but also from a specified situation in the day-to-day phenomena embedded in the seasonal progression.

As illustrated in these examples, the students’ works seem to succeed to present what they intended to express about the asymmetry between early winter and early spring.

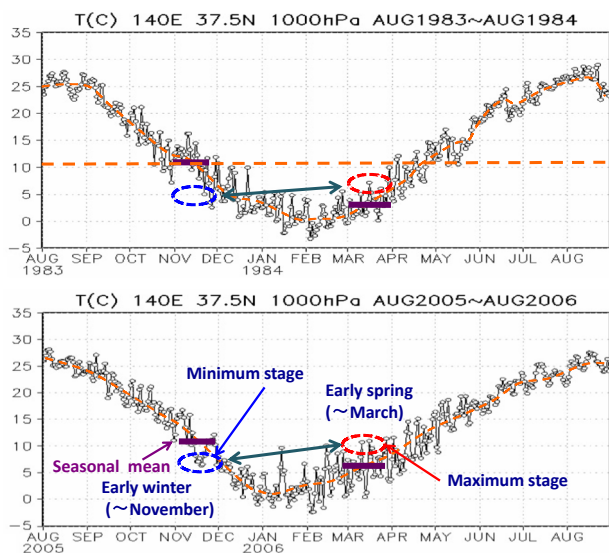


Figure 12 Examples of the day-to-day variation of daily mean air temperature at 1000hPa level (°C) around the eastern part of the Japan Islands (37.5° N/140° E) for the two years of 1983/1984 and 2005/2006 based on the NCEP/NCAR re-analysis data, modified from Kato et al. (2014). Names of the months are shown at the beginning of them. The data at this level were used as the substitute for those at the surface level.

By the way, as illustrated in Fig. 12 (Kato et al. 2014), although the seasonal mean temperature is higher in early winter than in early spring around the Japan Islands, the “maximum value” as the day-to-day variation of daily mean temperature in early spring can exceed the “minimum one” in early winter.

If the people tend to have a stronger impression of the colder days in early winter due to the seasonality toward winter and that of warmer days in early spring, they might feel that it is warmer in early spring than in early winter, not only due to the stronger solar radiation in early spring illustrated in Fig. 7. In general, the people’s feelings are rather diverse even in the similar environment, also due to their emotional factors greatly.

But it should be also kept in mind that we could have many choices what kind of daily meteorological conditions we have stronger impression of, because of their rather great day-to-day variability even within a specified season. Thus, depending upon their personal situations, a part of the natural environment characteristics including their variability could emerge selectively (just we can say the “sensitivity filter”) in the people’s mind to form their diverse seasonal feeling.

The present activity also suggests that not only the seasonal mean meteorological factors but also the characteristic of their day-to-day variability could affect greatly the peoples’ seasonal feeling. Inversely, such “sensitivity filter” on the seasonal feeling seems to give us an interesting viewpoint for deeper scientific understanding of the climate environment, including the seasonal cycles with large day-to-day variability.

Furthermore, our group has made a lesson practice on the similar theme also at a senior high school (although that was only the collaboration between climate and music) (Kato et al. 2017a). In this lesson practice, the following activities were made.

- (1) Imaging of the climate differences between early winter and early spring, based on the seasonal feelings expressed in the Japanese classic poems “*WaKa*”s, after brief introduction of this lesson.
- (2) Trial of arranging the Japanese school songs in the detailed order of seasonal progression from autumn to winter and those from winter to spring by appreciating the seasonal feelings expressed in these songs. The titles of the school songs used in that lesson, and their related information, are listed in Table 2.
- (3) Comparison of the climatological features between early winter and early spring, including the brief data analysis with using several worksheets.
- (4) Trial of the Activity (2) again.

Examples of the scenes of this lesson practice are shown in Fig. 13. Although the details are not shown here, it is interesting that a part of students tended to recognize to be warmer and brighter in early spring than in early winter (Kato et al. 2017a), even after Activity (3). In fact, the

seasonal mean temperature is lower in early spring than in early winter, in spite of the stronger sunshine in a fine day in early spring. This seems to suggest that seasonal feeling

on the warmness could be greatly affected also by the sunshine condition.

Table 2 The titles of the school songs used in this lesson. Each Japanese original title is shown with its pronunciation and English meaning. Its lyricist and composer are also presented. The upper 5 songs are relating to the season from autumn to winter and the lower 5 ones are from winter to spring.

	Japanese original title (its pronunciation)	Meaning in English	Lyricist	Composer
Songs for autumn to winter	紅葉 (<i>Momiji</i>)	Autumn Leaves	高野 辰之 Tatsuyuki Takano	岡野 貞一 Teiichi Okano
	里の秋 (<i>Sato-no-Aki</i>)	Autumn in the Village	斎藤 信夫 Nobuo Saito	海沼 実 Minoru Kainuma
	野菊 (<i>No-giku</i>)	Wild Chrysanthemum	石森 延男 Nobuo Ishimori	下総 皖一 Kanichi Shimofusa
	冬の星座 (<i>Fuyu-no-Seiza</i>)	Winter Constellations*	堀内 敬三 Keizo Horiuchi	ウィリアム・ヘイス William Shakespeare Hays
	たきび (<i>Takibi</i>)	The bonfire	巽 聖歌 Seika Tatsumi	渡辺 茂 Shugeru Watanabe
	早春賦 (<i>Soshun-fu</i>)	Ode to Early Spring Time	吉丸 一昌 Soshimaru Kazumasa	中田 章 Akira Nakada
	どこかで春が (<i>Dokoka-de-Haru-ga</i>)	Spring is Comming Somewhere	百田 宗治 Soji Momota	草川 信 Shin Kusakawa
Songs for winter to spring	春の小川 (<i>Haru-no-Ogawa</i>)	Brook in Spring	高野 辰之 Tatsuyuki Takano	岡野 貞一 Teiichi Okano
	花 (<i>Hana</i>)	Flower**	武島 羽衣 Hagoromo Takeshima	滝 廉太郎 Rentaro Taki
	朧月夜 (<i>Oboro-zukiyo</i>)	Hazy Moon Night	高野 辰之 Tatsuyuki Takano	岡野 貞一 Teiichi Okano

*This is the English translation of the Japanese title. Original title by Hays was "Mollie Darling".

**The flower in the title implies the cherry blossoms along the river side.



Figure 13 Examples of the scenes of the lesson practice at a senior high school, after Kato et al. (2017a). The students are listening to the lecture on the outline of the climate in East Asia (Panel (a)) and the seasonal expression found in the Japanese school songs (Panel (b)), in Activities (1) and (2), respectively. They are trying to arrange the several Japanese school songs which titles are written on the cards in the detailed order of seasonal progression in Activity (2) (Panel (c)). They are finding some features of the asymmetric seasonal progression around the Japan Islands by drawing the graph of the time sequence of 5-day mean air temperature there to compare with the other elements in Activity (3) (Panel (d)).

III. Interdisciplinary lesson practices with attention to the seasonal cycle and the seasonal feeling around Germany and Northern Europe

3.1 Remarks on the seasonal cycle and the seasonal feeling around Germany

Around Germany located near the western edge of the Eurasian Continent, there are many songs and literature in which “the May” or spring is treated as the special season (e.g., Kato and Kato 2011, 2014a). The German art song “*Im wunderschönen Monat Mai*” (“In the especially beautiful month of May”) by Robert Alexander Schumann (1810–1856) is a typical example. However, the feeling of welcoming the special spring season expressed in these works seems more than just waiting for winter to leave. In fact, there is a traditional event called “*Fasnacht*” for driving winter away held around February or March there (Moser 1993; Nußbaumer 2010). The “*Fasnacht*” would be relating to the “seasonal feeling” of “very severe winter” around Germany, as mentioned in the next paragraph. Furthermore, the Japanese researchers on German literature suggested that there are basically two seasons, i.e., “winter” and “summer”, in a year around Germany, with short transition stages called “spring” and “autumn”. The seasonal cycle around Germany could be characterized by the feeling that the winter and the summer battle with each other and the summer wins to drive the winter away (Oshio

1982; Miyashita 1982; Takeda 1980).

It is interesting that not only the seasonal mean surface air temperature around Germany is lower than in the Japan Islands area (~to the south of about 40°N) except for the northern part, but also the day-to-day variation of daily mean temperature there is larger throughout a year, especially in winter (Figs. 14 and 15). Kato et al. (2017b) and Hamaki et al. (2018) suggested that intermittent appearance of the extremely cold days (around -5~-15°C) in winter in association with the large day-to-day variation influenced by the intraseasonal variation of the Icelandic low seems to result in the “seasonal feeling” of “very severe winter” around Germany that they do wish to drive the

winter away.

The area with such extremely cold days accompanied by the large day-to-day variation in winter extends from Germany to the Northern Europe (Fig. 16). Besides, while the seasonal mean air temperature shows the highest from June to August there, its day-to-day variation in summer (mainly relating to the intraseasonal one) is rather larger than in the Japan Islands (Fig. 15). Thus, the summer around Germany seems to be characterized by the persisting “seasonal maximum temperature stage” with the intermittent appearance of rather cooler spell (Fig. 17). And then, the “May” could be regarded as the very season just when the winter has been completely driven away and the “summer” has just begun.

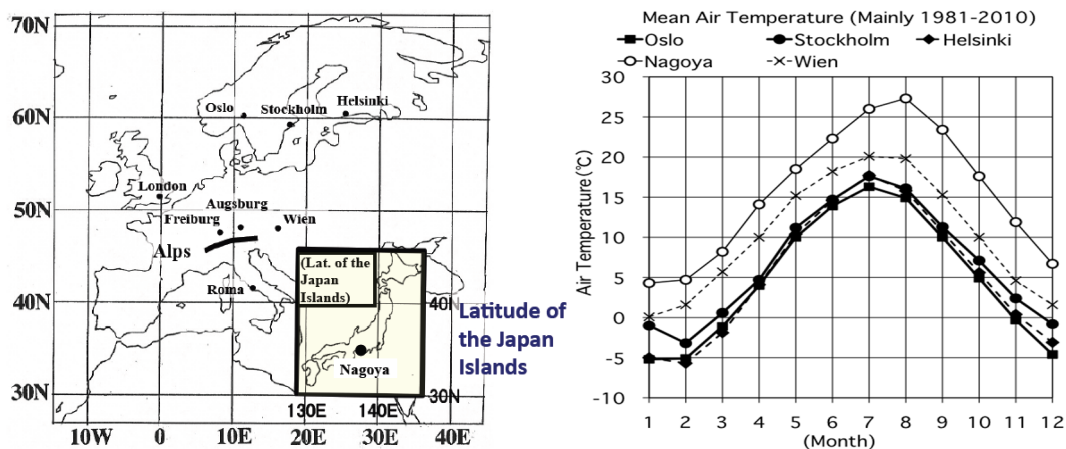


Figure 14 Seasonal variations of monthly mean surface air temperature (°C) at Wien (Austria), Nagoya (Japan, ~ 300km westward from Tokyo in Fig. 4), Oslo (Norway), Stockholm (Sweden) and Helsinki (Finland) averaged for 1981 to 2010, except for 1982 to 1994 at Stockholm are shown in the right panel, after Kato et al. (2019a). Locations of the cities are in the left one.

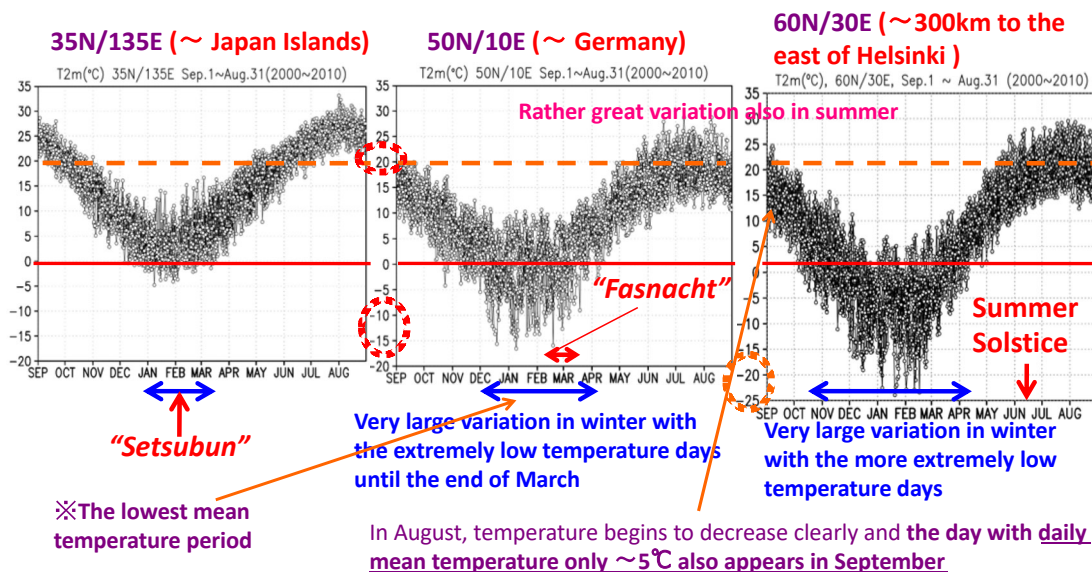


Figure 15 Superpose of the sequences of daily mean surface air temperature (°C) for 11 years (2000/2001~2010/2011) around the central part of the Japan Islands (35°N/135°E) (left panel), central or southern part of Germany (50°N/10°E) (central one) and about 300km to the east of Helsinki (60°N/30°E) (right one), based on the NCEP/NCAR re-analyses data (modified after Kato et al. (2019a)). Names of the months are shown at the beginning of them.

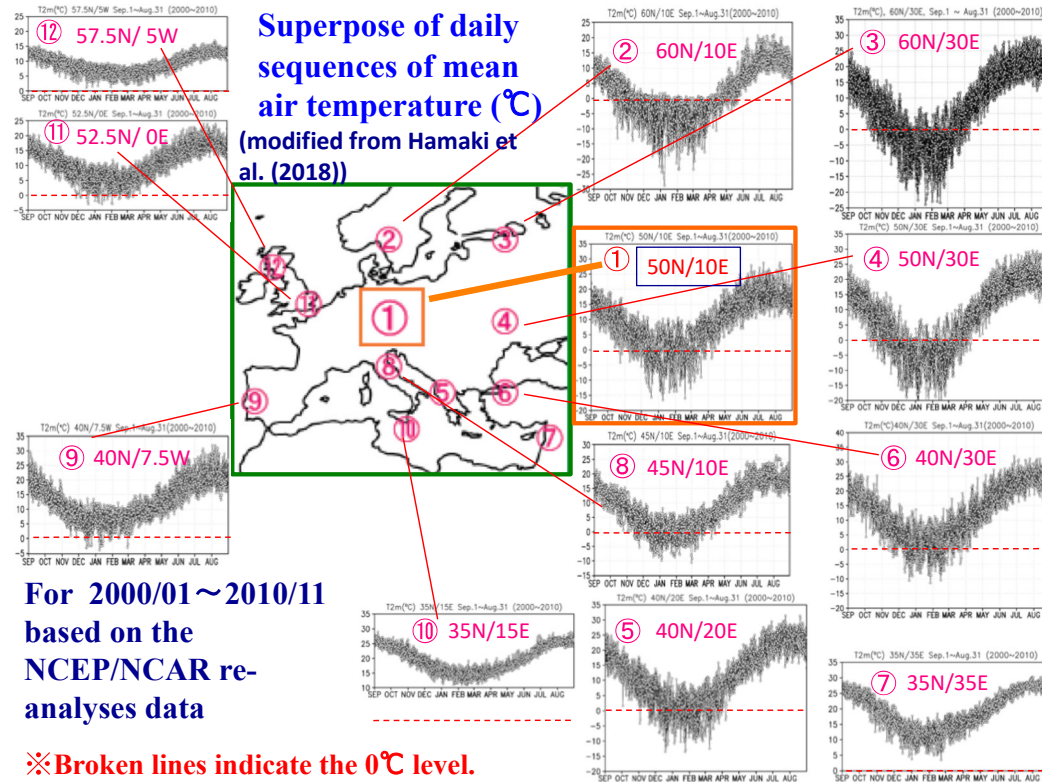


Figure 16 Superpose of the sequences of daily mean air temperature (°C) for 11 years (Sep. 2000~Aug. 2011) similar to those in Fig. 15 at various grid points, based on the NCEP/NCAR re-analyses data (modified after Hamaki et al. (2018)).

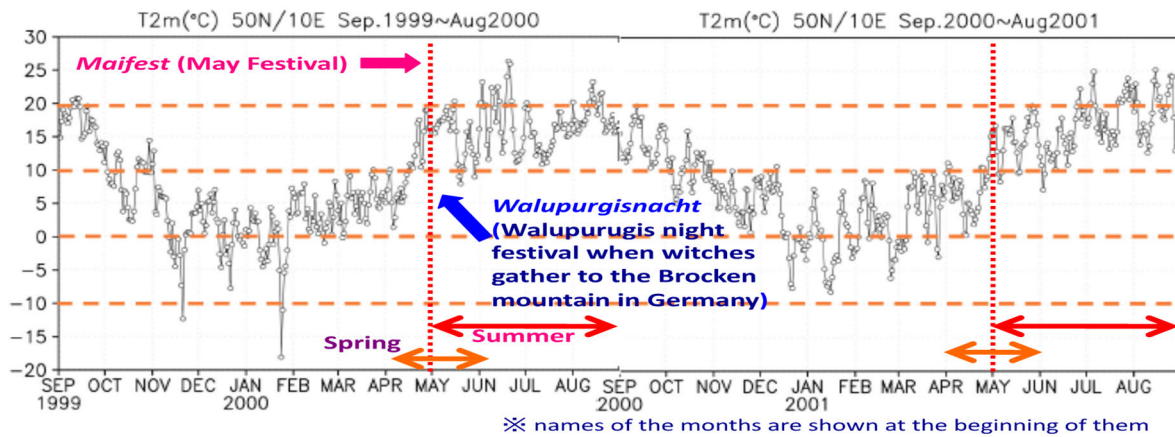


Figure 17 Day-to-day variation of the daily mean surface air temperature (°C) around Germany (50° N/10° E) from Sep. 1999 to August 2001, based on the NCEP/NCAR re-analyses data (modified after Kato and Kato (2019)). Names of the months are shown at the beginning of them

Also in Japan, a traditional ceremony “*Setsubun*” (節分), for calling spring, purging noxious vapors relating to winter such as evil spirits called “*Oni*” (鬼) and welcoming good fortune, is held around the beginning of February (the word “*Setsubun*” literally means “division of seasons”). Some photographs of the scene of the “*Setsubun*” festival took by

one of the present authors are illustrated in Fig. 18. However, differently from “*Fasnacht*” around Germany, the “*Setsubun*” festival is held just when the temperature decrease stops to turn to the rising stage as the seasonal progression (i.e., the seasonally coldest period), while the daily mean solar radiation in a fine day increases considerably from February to March there (Figs. 7 and 15).

Furthermore, although the cold days as in midwinter still tend to appear frequently in February, warm days as in April also appear intermittently after around the “*Setsubun*”.

Munetada Shrine and Okayama Shrine on the “*Setsubun*” day

(Photo by Haruko Kato (one of the authors of this article) on 03 February 2016, in Okayama-city, Japan)

Munetada Shrine (宗忠神社)



Announcement of the “*Setsubun*” Ceremony at the entrance of Munetada Shrine



Bean throwing ceremony called “*Mame-Maki*” (豆まき) in the Munetada Shrine area



People who came to worship at the main hall of Munetada Shrine

Okayama Shrine (岡山神社)



Plum blossoms in the Okayama Shrine area



Main hall in the Okayama Shrine, where the “*Setsubun*” Ceremony is performed

Figure 18 Photographs of the “*Setsubun*” scene at “Munetada Shrine” and “Okayama Shrine” in Okayama-city, Japan, by Haruko Kato, one of the present authors on 3 February 2016 (modified after Kato and Kato (2019)).

3.2 Remarks on the seasonal cycle and the “seasonal feeling” around Northern Europe

In Northern Europe, the traditional event called “*Juhannus*”, which means the “Summer solstice festival”, is held literally around the summer solstice night for celebrating the summer coming. In “*Juhannus*” they put up a white birch as a pole, decorate their house with green leaves and build a bonfire called “*Kokko*”. Furthermore, children have a lot of fun in the forest, with making a cabin called the “*Maja*”, making fairy dolls, and so on.

The seasonal feeling on the summer solstice is also expressed, for example, in a Finnish folk song “The night of the summer solstice”. The text of this song begins with “The long-awaited night of the summer solstice has come.” It is sung that they have done much things for preparing the festival. As such, they are only expecting the very moment as in this song “It is finished to get ready for bonfire, so it is only to wait getting dark”. They are going to sing and dance throughout night together.

As Kato et al. (2019a and b) mentioned, while more extremely cold days than around Germany tend to appear intermittently in winter around Northern Europe accompanied by the large day-to-day variations, the mean air temperature from late June to July just after the summer solstice gets almost as high as in summer around Germany (Figs. 14 and 15). Besides, as indicated in Fig. 7, the daytime length attains more than 18 hours even in the

southern part of “Northern Europe” (60°N) (that is, the very short night), together with the relatively strong sunshine in the daytime. However, the rather cold days begin to appear already in September (Fig. 15), which seems to relate to the seasonal feeling of the shorter summer than that around Germany.

As such, we should note the importance to refer to the climatological magnitude of variability even for understanding the “mean features” of the climate systems and the related “seasonal feeling”, as illustrated in 3.1 and 3.2.

3.3 A report of interdisciplinary lesson practice on the seasonal cycle and the “seasonal feeling” around Germany for the university students in teacher training course

3.3.1 Outline of the lesson practice

The lesson practice reported by Kato et al. (2017b) is briefly summarized in this section. The outline of the class is as follows. This joint activity was performed on the last day of an interdisciplinary lesson “Human Lives and Environments” at Faculty of Education, Okayama University, during 23–26 August 2016.

Instructor: Kato, K. (Meteorology), Akagi, A. (Art) and Kato, H. (Music)

Date and Time: 26 August 2016 (08:40–18:30)

Activities:

(1) Brief summary on the climatological features in winter in Europe, comparing with those in the Japan Islands and appreciation of the “seasonal feeling” expressed in the European painting.

(2) Appreciation of the music works on the European winter and video watching of “Fasnacht”. Then, creation of the music works on their own feeling of “Fasnacht” with small percussion instruments, and playing their music works as in 2.2.1.

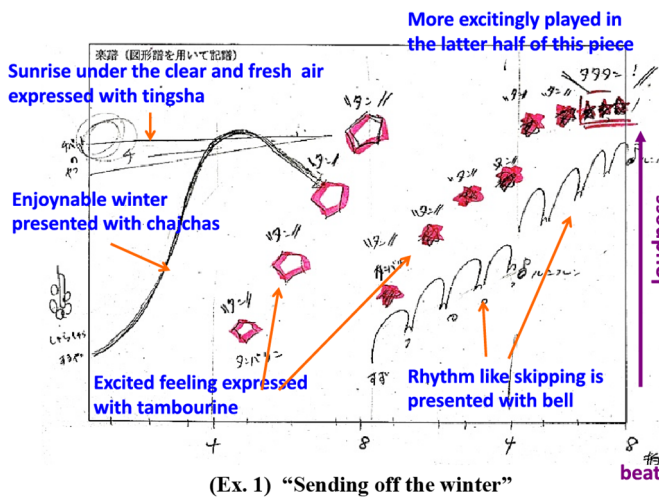
(3) Expression with the colored papers comparing the “seasonal feeling” between midwinter and early spring in the Japan Islands as in 2.2.1, and then, brief explanation of the related climatological features.

About 30 students took part in this class. About the two third of them are not specialized in natural science. This

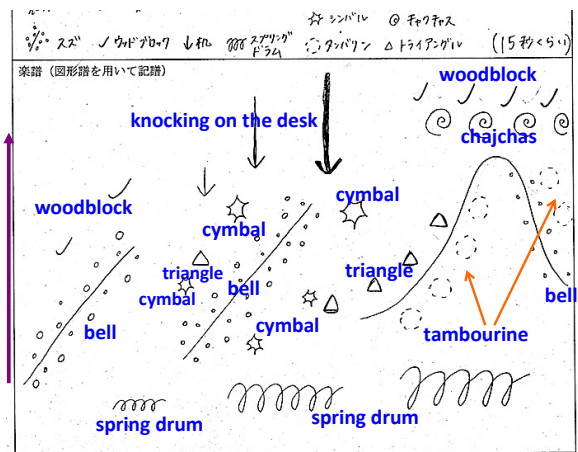
lesson is open for the all grade student. In this year, the numbers of the first and third grade students in this lesson were 16 and 7, respectively, and there were also several participants of the second and fourth grade, respectively. In Activity (2), their music works were described in the form of the “graphic notation”, as in 2.2.1.

3.3.2 Discussion on the students’ composition works in Activity (2)

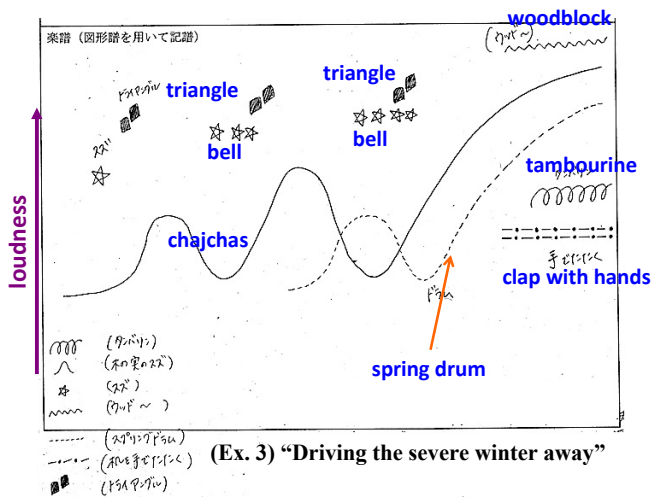
Figure 19 indicates four examples of the students’ composition works (Ex. 1 to Ex.4) on the original “Fasnacht” in Activity (2), after Kato et al. (2017b). The titles and explanations of the works by the students themselves are as follows (translated from Japanese into English by the present authors).



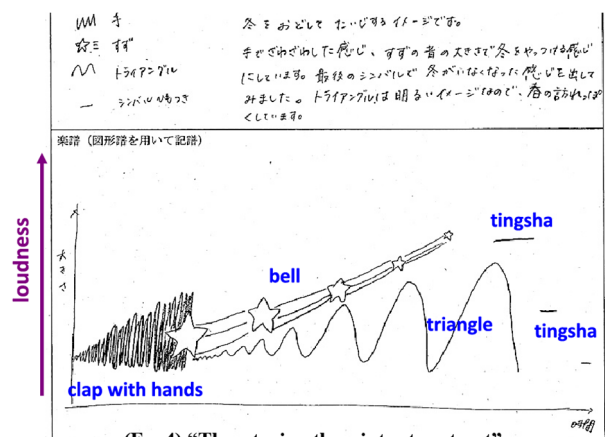
(Ex. 1) “Sending off the winter”



(Ex. 2) “Let’s invite the spring with melting the snow”



(Ex. 3) “Driving the severe winter away”



(Ex. 4) “Threatening the winter to retreat”

Figure 19 Examples of the students’ composition works on their original “Fasnacht”, described in the form of “graphic notation” (modified after Kato et al. 2017b). The left and right edges of each figure indicate the beginning and end of the music piece, respectively. Supplementary explanations are also added in English by the present authors, mainly on the names of the instruments corresponding to the students’ description on the graphic notation.

(Ex. 1) “Sending off the winter”
I like the feeling of “sending off the winter” rather than

“driving it out”. It is colder in winter in my hometown than here, but I feel some beautiful atmosphere. I tried to express

my feeling of “see you again, winter, and thank you!” (not “farewell to it”), with the latter half of this piece more excitingly played.

(Ex. 2) “Let’s invite the spring with melting the snow”

At the first part, I expressed the continuously falling snow in the dark and gloomy winter. I will express the scene that the snow stored in the sky has completely fallen down and the sun welcomes the spring with melting that snow. The final part presents the coming spring lively.

(Ex. 3) “Driving the severe winter away”

The lightly falling snow was expressed with the sound of bell and chajchas at first. As the phrase is repeated again and again, the volume of the bell is enlarged with its short-term fluctuation. Near the final phrase, large spring drum sound, etc. is added, in order to present that the severe winter is just being driven away.

(Ex. 4) “Threatening the winter to retreat”

Feeling of threatening the winter to retreat was expressed. Loud clapping and bell sounds at the beginning stand for defeating the winter. The feeling that the winter has gone out was expressed by the cymbal sound (sound of tingsha) at the end of this piece. The emotion of the spring coming was also presented by the gradually increasing triangle sound toward the end of this piece, due to its bright image.

From these works, we can find out the following. In Ex.1, the student’s unique sense on sending (not driving) the winter seems to be expressed well. In Ex. 2, the darkness of winter and the merry spring atmosphere are illustrated contrastingly. In Ex.3, the gradual seasonal progression of the retreating winter is presented with the combination of changing loudness and tone of the sounds. In Ex. 4, the cymbal (tingsha) is effectively used for the symbol that the winter has retreated out. In these activities, students firstly tried to understand or imagine why the people living there can’t help driving the winter away, based on the climate data. They seem to have an opportunity for realizing the climate in foreign regions and the “seasonal feeling” there, through the composition and performance of the music works in such processes.

3.4 A report of interdisciplinary lesson practice on the seasonal cycle and the “seasonal feeling” around Northern Europe for the university students in teacher training course

3.4.1 Outline of the lesson practice

The lesson practice reported by Kato et al. (2019a) is briefly summarized in this section. The outline of the lesson is as follows. This joint activity was performed on the last day of an interdisciplinary lesson “Human Lives and Environments” at Faculty of Education, Okayama University, 28–31 August 2017.

Instructor: Kato, K. (Meteorology), Akagi, A. (Art) and Kato, H. (Music)

Date and Time: 31 August 2017 (08:40–18:30)

Activities:

(1) Brief summary on the climatological features around winter in Europe comparing with those in Japan, and appreciation of the “seasonal feeling” expressed in Northern European pictures

(2) Watching video material of the traditional seasonal events and life in Northern Europe, appreciation of the traditional songs there, and then, students’ composition and performance of the music works with small percussion instruments on the summer solstice there. Performance was made as in 2.2.1.

(3) Expression with the colored papers on the summer solstice in northern Europe after a brief explanation on the Johannes Itten’s exercise for presenting the four seasons, as in 2.2.1.

Thirteen students took part in this lesson. 2 students are specialized in natural science. This is open for the all grade student. In this year, the numbers of the first and third grade students in this lesson were 4 and 6, respectively, and there were also 3 participants of the other grades, respectively.

In Activity (2), their music works were described in the form of the “graphic notation”, as in 2.2.1. As for the appreciation of the seasonal feeling expressed in the traditional songs there, the following Finnish folk songs were used: “February has come”, “An old frost-man”, “A tune of spring”, “The night of the summer solstice” and “A summer day of Kangasalla”.

3.4.2 Discussion on the students’ composition works in Activity (2)

Characteristics of the students’ music works (13 works in total) were roughly classified into the two types. One is the descriptive expression of figurative scenes imaged by the students (10 works) and the other is the expression of student’s inner or more creative story (not simply the concrete description of the scenes) (3 works in total). In the former type works, various scenes of “*Juhannus*” (Summer solstice festival), such as its liveliness, summer solstice, scene of the nature in summer, children’s activity in summer, were expressed. The works entitled “Dance in *Juhannus*”, “Adventure of summer forest”, and so on, are categorized into this type.

On the other hand, in the latter type works, characteristics of the season, view of life and fantastic story, and so on, were expressed. The works entitled “Long day and very short night”, “Circulation (Seasonal cycle and life cycle)” and “Forest in summer night” correspond to the latter type.

Figure 20 indicates three examples of the students’ composition works (Ex. 1 to Ex.3) on “*Juhannus*” in Activity (2), after Kato et al. (2019a). The titles and explanations of the works by the students themselves are as follows (translated from Japanese into English by the present authors).

(Ex. 1) “Long day and very short night”

After the long and lively day is over, the lonely and dark

night stays only for an instance. I noticed that the daytime in Finland in summer is much longer than in Japan. Liveliness in the daytime is expressed by the sounds of children and animals, while loneliness at night by mokokku (like sound of flogs) and mysterious singing ball.

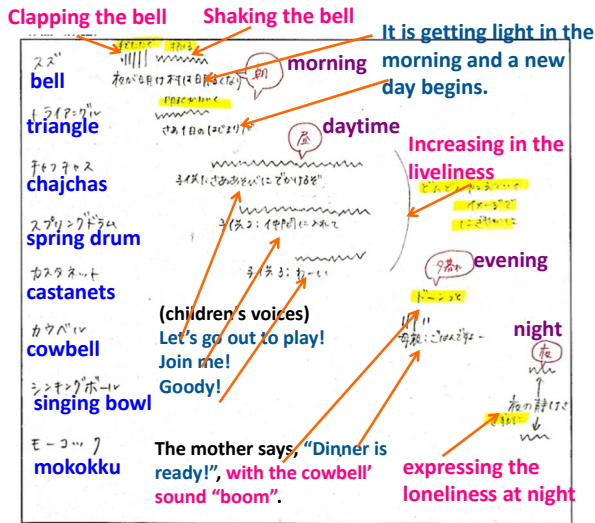
(Ex. 2) "Dance in Juhannus"

Image of a delightful summer solstice day is presented. The evening bonfire is expressed at the beginning of this music with rain stick. Wood block presents the light footsteps of dance and the festival reaching its climax is expressed with chajchas and bell. In the latter-half of the work, the low cowbell's tone represents that the night is

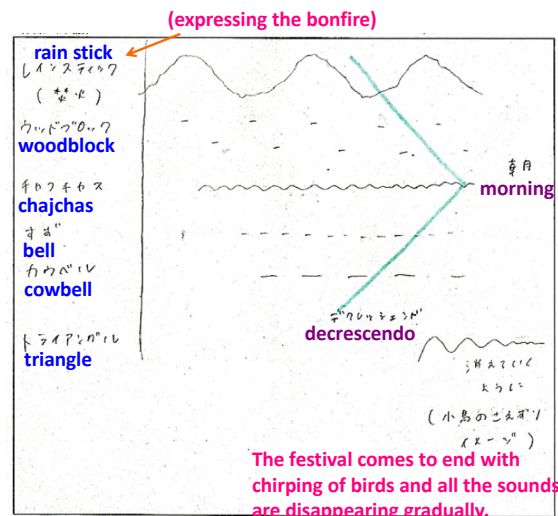
going on. And when morning comes with chirping of birds (which is expressed with triangles), the festival comes to end with the sound of all the instruments disappearing gradually.

(Ex. 3) "Circulation (Seasonal cycle and life cycle)"

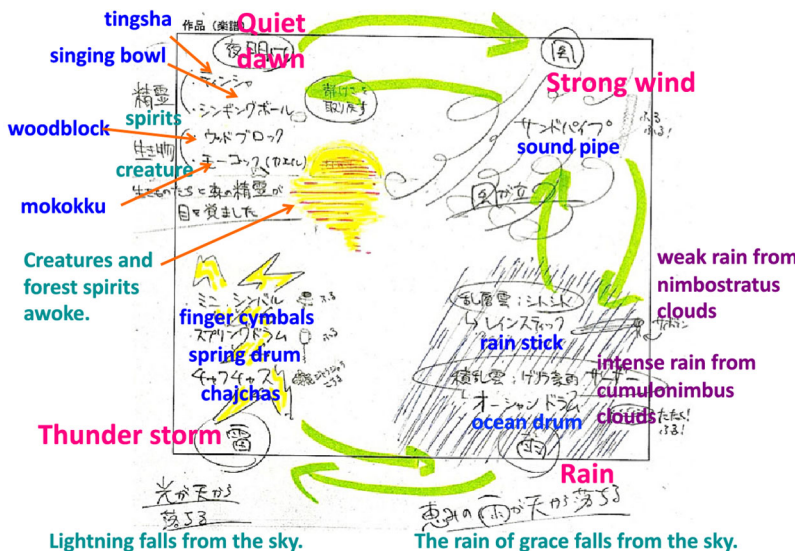
As often said "winter brings the change and gives the emotion of waiting for spring", people in Finland strongly feel the seasonal cycle in their usual life. Furthermore, people engrave their own name of the dead on the trees in forest and return to the nature as a new life cycle. Such transmigration of the soul, i.e., the endless cycle of the death and rebirth and that of all lives in forest is presented.



(Ex. 1) "Long day and very short night"



(Ex. 2) "Dance in Juhannus"



(Ex. 3) "Circulation (Seasonal cycle and life cycle)"



Performance of the Ex.3, by the students including this composer

Figure 20 Examples of the students' composition works on "Juhannus", described in the form of "graphic notation" (modified after Kato et al. 2019a). The left and right edges of the works Ex. 1 and 2 indicate the beginning and end of those music pieces, respectively. As for the Ex. 3, the time progression of that piece is shown in the green arrows. A performance scene of the work Ex.3 is shown in the lower right panel. Supplementary explanations are also added in English by the present authors, mainly on the names of the instruments corresponding to the students' description on the graphic notation.

In this activity, the students seem to have an opportunity for realizing the climate in foreign regions and the “seasonal feeling” there, as mentioned in 3.3. We should also note the importance of knowing the climatological variability even for understanding the seasonal features of the climate and their related “seasonal feeling” there, through the activity on the climate and seasonal feeling for Germany and Northern Europe.

IV. Summary and discussions

In this review article, our interdisciplinary research on climate and cultural understanding education for promoting the fundamental ESD literacy were introduced, including the research on climate and music themselves around Germany, Northern Europe and Japan. In this review article, we focused mainly on the following three topics.

(A) Asymmetric seasonal progression from autumn to the next spring around Japan.

(B) Winter climate around Germany in association with the “seasonal feeling of severe winter”, related to the traditional event “*Fasnacht*” for driving winter away.

(C) Seasonal cycle around Northern Europe and the “seasonal feeling of the short summer”, related to the summer solstice festival “*Juhamnus*” there.

The choice of the study areas or targets including the European regions not so familiar to the Japanese students in their usual lives was aimed to give the advantage for developing the students’ ability of deeper understanding and imagination on what they have not experienced, leading to promote the students’ ability of understanding of “heterogeneous others”. In the analyses of our lesson practice results based on the students’ works, we mainly evaluated how deeply the students considered what they intended to express based on the integration of what they have learned throughout the lesson, rather than how well their works have been completed.

Main climatological features and the results of the interdisciplinary activities on the topics (A) to (C) are as follows.

The topic (A) indicates that while the appearance frequency of the “winter pressure pattern” in early winter and in early spring around Japan is nearly the same, air temperature is rather lower in early spring. But the solar radiation is stronger in early spring. As for the topics (B) and (C), the “seasonal feeling” of the “severe winter” around Germany and Northern Europe seems to be associated with the intermittent appearance of the extremely cold days with the large day-to-day variations, and the seasonal feeling of short summer around Northern Europe would be due to the early seasonal appearance of the rather cold days already in September also with the large day-to-day variability.

The results of the lesson practices on those topics

illustrate that not only the seasonal mean temperature or solar radiation condition but also the large day-to-day variability including the appearance of the extremely low temperature events was strongly reflected in the students’ works, although the statistical evaluation on the students’ understanding would be also needed in the future.

Finally, we will discuss on some viewpoints in understanding the climatological seasonal cycle relating to the seasonal feeling in our interdisciplinary activities.

First of all, the mean seasonal cycle pattern shows great variety. Most simply speaking, the seasonal cycles of the meteorological elements are characterized as sinusoidal waves, respectively. However, in detail, they are sometimes rather distorted from the sinusoidal shapes from region to region, as well as their amplitude and phase. For example, as illustrated in Subsections 3.1 and 3.2, the period of the highest stage of the seasonal mean temperature around Germany is rather longer (from the beginning of June to late August) than in Northern Europe (from late June to late July), although the day-to-day temperature variation is also large in both regions. As for the Japan Islands, the seasonally highest temperature period lasts not so long, i.e., from late July to late August, although such description was omitted in this article. In addition, some meteorological or climatological elements in the same region show sometimes rather large phase lag of their seasonal variations among each other, as mentioned on the topic (A) for the Japan Islands. For example, the seasonal progression of appearance frequency of the “winter pressure pattern”, mean temperature and sunshine conditions show not a small phase difference among each other. Such asymmetric seasonal progression from autumn to next spring would relate greatly to the considerable difference of the “seasonal feeling” between early winter and early spring there.

Another important viewpoint is that we should pay attention also to the regional and seasonal differences of day-to-day variability of the meteorological elements, such as air temperature and so on. For example, the large day-to-day variation of air temperature with extremely low temperature events seems to be an important factor resulting in the “seasonal feeling of the severe winter” in Germany in the topic (B). The seasonal feeling of short summer around Northern Europe in the topic (C) is also due to the large day-to-day fluctuation of air temperature, together with the early seasonal decrease in mean air temperature.

In addition, we would like to add a comment why we take much notice of the climatological seasonal cycles including the day-to-day or interannual variability in our development of the ESD-related lesson plans. Since the climate change together with the change in occurrence of the extreme weather phenomena would have a major impact on people’s lives, one might think that promoting the students’ ability

to be sensitive on climate change is more essential for the Climate Change Education (CCE) in the ESD than understanding the complexity of the climate itself including the seasonal cycles. Naturally, we agree with such opinion. In CCE including the people's ability to change their actions, it is really important to understand how the climate has been changing, what 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, timing of their maximum and minimum phases, duration of the stages with their maximum and minimum phases, their "mean" day-to-day or year-to-year variability in each season, and their combination of these patterns. We could tentatively call such changes the "distortion of the seasonal progression".

Especially in middle and higher latitudes, the seasonal cycles of the climate systems are clearly seen but show 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 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. This could strongly help for promoting their ability to detect or "feel" the changing climate.

As such, the series of our studies on the interdisciplinary climate-cultural understanding education summarized in this review article seem to illustrate the usefulness of taking notice of difference of the seasonal cycle patterns and the magnitude of day-to-day variability relating to the seasonal feeling. However, there are many other types of the seasonal cycles in association with the regional variety of seasonal feelings even within the mid-latitude or higher latitude regions. For example, the German seems to have another special "seasonal feeling" for autumn to early winter. The German poems "*Im Herbst*" (In the autumn) by Rainer Maria Rilke (1885–1926), "*Im Nebel*" (In the fog) by Hermann Karl Hesse (1877–1962), and so on, might be the typical examples. However, the interdisciplinary lesson studies based on further inter-comparison of the seasonal cycles and seasonal feelings including those topics are the interesting remaining problems in the future.

Acknowledgements

The present study was partly supported by JSPS Grants-in-Aid for Scientific Researches (C) (No. 17K04817) and

(B) (No. 17H02700). This review article was once submitted to the Special Issue "Five years of Earth sciences and art at the EGU (2015–2019)" of Geoscience Communication, EGU (European Geosciences Union) and then withdrawn. After that, we have revised that manuscript and re-submitted to this "Okayama University Earth Science Reports" as a new version. The authors would like to express their gratitude to Profs. Sun-Kyung Lee and Emilia Gómez, Dr. Louise Arnal (the signed reviewers), an anonymous reviewer and Prof. Jutta Thielen-del Pozo (Editor in charge of that Special Issue) for their very helpful comments in the rework of this manuscript. They also wish to express their sincere thanks to Profs. Koji Uno, Naoki Sato and Dr. Yuji Kato for their valuable comments in the final revision of this manuscript.

Endnote

(1) Graphic notation (music) — Wikipedia (The free Encyclopedia).

[https://en.wikipedia.org/wiki/Graphic_notation_\(music\)](https://en.wikipedia.org/wiki/Graphic_notation_(music)).

Last accessed on 01 March 2023.

References

- Arakawa, H. and S. Taga, 1969: Climate of Japan, In Arakawa, H. ed. "World Survey of Climatology" 8, Amsterdam: Elsevier, 119–158.
- Balkwill, L.L. and W. F. Thompson, 1999: A cross-cultural investigation of the perception of emotion in music: psychophysical and cultural cues. *Music Perception*, 17, 43–64.
- Eerola, T., and J. K. Vuoskoski, 2013: A review of Music and Emotion studies: approaches, emotion models, and stimuli. *Music Perception: An Interdisciplinary Journal*, 30, 307–340.
- Hamaki, T., K. Kato, K. Otani, H. Kato and K. Matsumoto, 2018: Synoptic climatological analyses on the large day-to-day variation of air temperature around Germany in winter (Relating to the "seasonal feeling" in "Fasnacht", the festival for driving the winter away) (in Japanese with English abstract), *Okayama University Earth Science Reports*, 25, 7–17.
- Hirasawa, N., K. Kato and T. Takeda, 1995: Abrupt change in characteristics of the cloud zone in the subtropical East Asia around the middle of May, *J. Meteor. Soc. Japan*, 73, 221–239.
- Itten, J., 1961: *Kunst der Farbe: Subjektives Erleben und objektives Erkennen als Wege zur Kunst*, Johannes Otto Maier Verlag, Ravensburg.
- Johannessen, T.W.: The climate of Scandinavia, In Wallen, C. C. ed. "World Survey of Climatology" 5, Amsterdam: Elsevier, 23–79, 1970.
- Juslin, P., 2019: *Musical emotions explained*. Oxford University Press.
- Kalnay, E., M. Kanamitsu, R. Kistler, W. Collins, D. Deaven, L. Gandin, M. Iredell, S. Saha, G. White, J. Woollen, Y. Zhu, A. Leetmaa, R. Reynolds, M. Chelliah, W. Ebisuzaki, W. Higgins, J. Janowiak, K. C. Mo, C. Ropelewski, J. Wang, R. Jenne and D. Joseph, 1996: The NCEP/NCAR 40-year reanalysis project. *Bull. Amer. Meteor. Soc.*, 77, 437–471.
- Kato, H and K. Kato, 2011: Seasonal feeling found in German folk songs on "spring" (From the viewpoint of relationship

- between words of the songs and the climatic background there) (in Japanese with English abstract), *The Annals of Gifu Shotoku Gakuen University*, 50, 77–92.
- Kato, H. and K. Kato, 2014a: “Climate and music (Seasonal features and songs of spring in Japan and Germany)” (in Japanese), *Kyodo Shuppan*.
- Kato, H. and K. Kato, 2014b: A trial of interdisciplinary class on the variety of climate environment and music expression in Okayama University —With attention to the difference of rainfall characteristics as an example— (in Japanese with English abstract), *The Annals of Gifu Shotoku Gakuen University*, 53, 55–67.
- Kato, H. and K. Kato, 2016: A trial of interdisciplinary class on the music expression in awareness of its climate background —Comparing the seasonal feelings between the two transient seasons of spring and autumn— (in Japanese with English abstract), *The Annals of Gifu Shotoku Gakuen University*, 55, 1–17.
- Kato, H. and K. Kato, 2019: “Climate and music (Cultural understanding and ESD spreading from the “Doors of song”)” (in Japanese), *Kyodo Shuppan*.
- Kato, K., 1985: On the abrupt change in the structure of the Baiu front over the China continent in late May of 1979, *J. Meteor. Soc. Japan*, 63, 20–36.
- Kato, K., 1987: Airmass transformation over the semiarid region around North China and abrupt change in the structure of the Baiu front in early summer, *J. Meteor. Soc. Japan*, 65, 737–750.
- Kato, K., 1989: Seasonal transition of the lower-level circulation systems around the Baiu front in China in 1979 and its relation to the Northern Summer Monsoon, *J. Meteor. Soc. Japan*, 67, 249–265.
- Kato, K., R. Akagi, H. Kato and Y. Haga, 2014: Interdisciplinary class on the asymmetric seasonal march from autumn to the next spring around Japan in association with the seasonal feeling (Joint activity with art and music expression of the seasonal feeling) (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 36, 9–19.
- Kato, K., R. Akagi, H. Kato, K. Otani, N. Nishimura, T. Mitsuhata, N. Moriduka and S. Sato, 2012: Interdisciplinary class in Okayama University on the climate environment around Japan in association with the variety of seasonal feeling (with attention to the seasonal cycle of rainfall in the warm season) (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 34, 25–35.
- Kato, K., H. Kato and R. Akagi, 2011: Joint activity of meteorology with music and art through a class on the climate system and its relation to the variety of “seasonal feeling” around Japan in the Faculty of Education (in Japanese with English abstract), *Bulletin of Center for Teacher Education and Development, Okayama University*, 1, 9–27.
- Kato, K., H. Kato, R. Akagi and Y. Inada, 2015: Interdisciplinary class on comparative expression of the seasonal feeling by interactive activities of art and music (With attention to the asymmetric seasonal march from autumn to the next spring around Japan) (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 37, 16–26.
- Kato, K., H. Kato, R. Akagi and K. Otani, 2019a: Interdisciplinary collaboration between climate and cultural understanding education for promoting the fundamental ESD literacy (A report of the lesson practice in the university on climate and “seasonal feeling” in the northern Europe) (in Japanese with English abstract), *Bulletin of Center for Teacher Education and Development, Okayama University*, 9, 183–198.
- Kato, K., H. Kato and A. Betchaku, 2009: Toward development of students’ sensitivity to the change in climate environment in East Asia with attention to the variety of “seasonal feeling” in the annual cycle, (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 31, 9–20.
- Kato, K., H. Kato, S. Miyake and T. Mori, 2017a: Interdisciplinary class for high school students on the climate environment around Japan and “seasonal feeling” expressed in the school songs with attention to the asymmetric seasonal march from autumn to the next spring (in Japanese with English abstract), *Okayama University Earth Science Reports*, 24, 5–18, 2017a.
- Kato, K., H. Kato, K. Otani, T. Hamaki and Y. Haga, 2017b: Development of an interdisciplinary class for university students with attention to differences of the climate and “seasonal feeling” in winter (Comparing between those around Germany and the Japan Islands) (in Japanese with English abstract), *Bulletin of Center for Teacher Education and Development, Okayama University*, 7, 157–166.
- Kato, K., H. Kato, K. Otani, and K. Matsumoto, 2019b: Interdisciplinary ESD lesson study for the university students with attention to the difference of climate and seasonal feeling in “summer” among Germany, northern Europe and Japan (in Japanese with English abstract). *Okayama University Earth Science Reports*, 26, 25–36, 2019b.
- Kato, K., H. Kato, S. Sato, Y. Yamada, R. Akagi and K. Otani, 2013: Asymmetric seasonal march from autumn to the next spring around Japan (At the viewpoint of development of interdisciplinary class on the climate environment and the seasonal feeling) (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 35, 23–30.
- Kato, K. and Y. Kodama, 1992: Formation of the quasi-stationary Baiu front to the south of the Japan Islands in early May of 1979. *J. Meteor. Soc. Japan*, 70, 631–647.
- Kato, K., S. S. Nishikawa, and T. Nakakura, 2018: Development of an interdisciplinary study plan on the seasonal transition from autumn to winter around the Japan Islands (Through the lesson study at junior high school with attention to the shallow convective rainfall “Shi-gu-re” in the cold air outbreak situations in early winter) (in Japanese with English abstract), *Okayama University Earth Science Reports*, 25, 19–30.
- Kato, K., S. Sato, H. Kato, R. Akagi, N. Sueishi, T. Mori and I. Irie, 2011: Interdisciplinary class on the climate environment around the Japan Islands in association with the seasonal feeling (with attention to the transition stage from autumn to winter) (in Japanese with English abstract), *Environment Research and Control (Okayama University)*, 33, 20–34.
- Kuwana, Y., K. Kato, Y. Takigawa, Y. Kojima and K. Otani, 2016: A case study on the cyclone activity around Europe from winter to spring of 2000 (in Japanese with English abstract), *Okayama University Earth Science Reports*, 23, 33–42.
- Maejima, I, 1967.: Natural season and weather singularity in Japan, *Geographical Reports Tokyo Metropolitan University*, 2, 77–103.
- Matsumoto, J., 1988: Large-scale features associated with the frontal zone Over East Asia from late summer to autumn, *J. Meteor. Soc. Japan*, 66, 565–579.

- Meyer, L., 1956: *Emotion and the Meaning of Music*. Oxford University Press.
- Miyashita, K., 1982: Forest, mountain and German fairy tales (Nature, legend and poetry), “Basis of German Literature (World of speculation and emotion)” (in Japanese), Ed. by Nishio, K., Ushikaku Publishing Co., Ltd., 90–122.
- Moser, D. R., 1993: Vom Scheibenschlagen in der “alten Fasnacht” vom Fischessen am Aschermittwoch und von anderen Fastenbräuchen, “Bräuche und Feste im christlichen Jahreslauf”, *Edition Kaleidoskop*, 151–164.
- Murakami, T. and J. Matsumoto, 1994: Summer monsoon over the Asian continent and western North Pacific, *J. Meteor. Soc. Japan*, 72, 719–745.
- Ninomiya, K., 1968: Heat and water budget over the Japan Sea and the Japan Islands in winter season —With special emphasis on the relation among the supply from sea surface, the convective transfer and the heavy snowfall—, *J. Meteor. Soc. Japan*, 46, 343–372.
- Ninomiya, K., 1989: Cloud distribution over East Asia during Baiu period in 1979, *J. Meteor. Soc. Japan*, 67, 639–658.
- Ninomiya, K. 2006: Features of the polar air outbreak and the energy balance in the transformed air-mass observed over the Japan Sea, *J. Meteor. Soc. Japan*, 84, 529–542.
- Ninomiya, K. 2007: Synoptic-scale variations in the polar air-mass transformed over the Japan Sea, *J. Meteor. Soc. Japan* 85, 171–186.
- Ninomiya, K., and H. Mizuno, 1987: Variations of Baiu precipitation over Japan in 1951–1980 and large-scale characteristics of wet and dry Baiu. *J. Meteor. Soc. Japan*, 65, 115–127.
- Ninomiya, K and H. Muraki, 1986: Large-scale circulations over East Asia during Baiu period of 1979. *J. Meteor. Soc. Japan*, 59, 409–429.
- Nußbaumer, T., 2010: “Fasnacht in Nordtirol und Südtirol”, Löwenzahn Verlag.
- Oshio, T., 1982: Church and family life in Germany (Daily life in a mature society), “Basis of German Literature (World of speculation and emotion)” (in Japanese), Ed. by Nishio, K., Ushikaku Publishing Co., Ltd., 124–157.
- Schüepp, M. and H. Schirmer, 1977: *Climate of Central Europe*, In Wallen, C. C. ed. “World Survey of Climatology” 6, 3–73, Amsterdam: Elsevier.
- Suzuki, H., 1962: Classification of Japanese climates (in Japanese with English abstract), *Geographical Review of Japan*, 35, 205–211.
- Takeda, A., 1980: “German Folk Songs by Church Calendar” (in Japanese), Toyo Shuppan.
- UNESCO, 2006: “Framework for the UN DESD International Implementation Scheme”, UNESCO.
- UNESCO, 2014: “Global Citizenship Education — Preparing learners for the challenges of the 21st century —”, UNESCO.
- UNESCO, 2015: “Global Citizenship Education — Topics and Learning Objectives —”, UNESCO.
- UNESCO, 2017: “Education for Sustainable Development — Goals Learning Objectives —”, UNESCO.
- Yoshino, M. M. and K. Kai, 1977: The divisions and characteristics of the natural seasons of Japan (in Japanese with English abstract). *Geographical Rev. Japan*, 50, 635–651.