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Meteorological Observations of the French Warship at the End of the Tokugawa Period and Summer Climate Conditions around Hokkaido

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ABSTRACT

Climate variation in recent times has been known around Japan, but it is not clear in the north of Japan. Meteorological observation records in the north of Japan had been left by the French naval physician and it is useful for reconstructing the climate. Climate conditions around Hokkaido are somewhat different from those in Japanese Islands, and it should be careful for reconstruction of climate. In addition, since they were observed through the voyage, other analysis is necessary in each area. The climate conditions in the summer around Hokkaido differ greatly between the case of high pressure prevailing and the case of disturbance prevailing. Further, the contrasting state appear depending on the position of the action center. Climate condition will be reconstructed, by analyzing the observation record of wind and temperature. Such reconstruction is useful to understand the climate at the End of the Tokugawa Period around Hokkaido.

Key words: climate variation, weather observation, 19th century, Hokkaido, *La Sibylle*

1. Introduction

French warship *La Sibylle* came around Japan in the middle of the 19th century, and it sailed to the Kuril Islands and to the western Sakhalin (Demarée, G.R., et al.). When it is sailing, precise weather observation was performed. That is regarded as something oldest at these area as a modern weather observation.

The climate before modern weather observation starting is reconstructed by various methods in Japan, but the observation records are important to reconstruct the climate state of this area. The climate state around here may be changed at that time, but the state of the north of Japan was unclear.

La Sibylle has been sailing and the period of weather observation was short, but many climate elements were observed, then there is a possibility to estimate the surrounding climate state. Particularly, observation records of wind could reconstruct the atmospheric circulation.

As the start, the present climate state will be checked. Synoptic climate state is classified by the air pressure distribution. The typical state of wind and temperature is made clear. And about the observation of *La Sibylle* is clarified.

2. Data and method

2.1 Sailing record of *La sibylle*

La Sibylle sailed on the southern coast of Hokkaido to Urupp Island in August and September, 1855. And it sailed from the Hokkaido west coast to the Mamiya Channel along Primorskii eastern coast, from May to July in 1856,. Weather were observed 5 times in a day (04h, 10h, 13h, 16h and 22h). The location of *La Sibylle* and the direction and force of wind were indicated (Fig. 1).

There is a big fluctuation of wind during sailing, because the date and the location were different. At the southern coast of Hokkaido, strong south winds were observed in 1855. Also near Mamiya Channel, sailing to northward of the Hokkaido west coast in 1856, strong south winds were observed.

2.2 The present weather record

To clarify the climate state around Hokkaido, Meso Scale Model of Japan Meteorological Agency (MSM) is used. The density of surface data are about 5km x 5 km. The area of 41°N - 47.6°N and 137°E - 150°E is subjected. And the period from May to September are chosen, because *La Sibylle* sailed and the sea was gentle for sailing and many observation records could be expected. The days from 2009 to

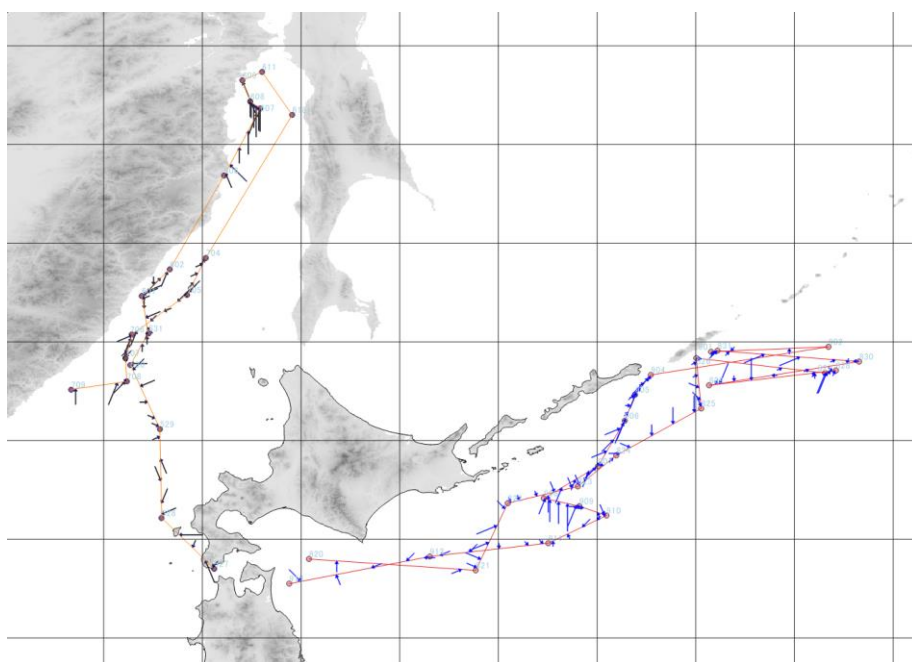


Fig. 1 Cruise route of *La Sibylle* and observed wind

2018 are chosen. Mainly, the sea level air pressure, temperature and wind are subjected for analysis.

2.3 Method

First, the daily air pressure distribution are classified using the cluster analysis. The 96 days are subjected as a sample from 1530 days. The JMP of SAS company is applied in this study (Tab. 1).

Tab. 1 Classification by the cluster analysis (types and date: yyyyymmdd)

1	20090501	20100609	20110531	20110616	20110803	20110904	20110920	20120826	20130529	20130614	20130630
1	20130716	20130902	20130918	20150831	20150916	20160518	20160619	20160721	20160923	20180617	20180921
2	20090704	20090906	20120725	20120911	20130513	20140520	20140605	20140808	20170525	20170728	20170813
3	20090618	20090922	20100524	20100828	20120522	20120927	20160502	20160705			
4	20090517	20100727	20120506	20120709	20130817	20140707	20140824	20150612	20150730	20160822	20170712
5	20090602	20090720	20100508	20100812	20100929	20110702	20140723	20160603	20160907	20170610	20170626
6	20090821	20150714	20180905								
7	20090805	20100913	20110819	20120607	20120623	20120810	20130801	20140909	20140925	20150628	20150815
8	20100625	20100711	20110515	20110718	20140504	20140621	20150511	20150527	20160806	20170509	20170930
									20180601	20180804	20180820

Based on the classification result, discriminant analysis is applied to the whole days and their classification types are clarified.

3. Result

3.1 Classification

The daily sea level air pressure distribution around Hokkaido can be classified into the 8 types. The air pressure distribution corresponds to the wind distribution well. Characteristic air temperature distribution appears in each type (Fig. 2). Those characteristics are as follows:

Type 1: There is a high air pressure on the south side of Kuril Islands, and south wind blows around

Hokkaido. It is warmer in the Sea of Japan than the Sea of Okhotsk. It is hot compared with Type 3.

Type 2: There is low air pressure in the west of Hokkaido and south-east wind blows. There is a high-temperature range in the Sea of Japan side.

Type 3: It is similar to Type 1, but the center of the high air pressure is near Hokkaido more. It is cool in the Sea of Okhotsk, but warm in the Sea of Japan. It is cooler compared with Type 1.

Type 4: The low air pressure stays in the northwest Hokkaido, and south winds blow around Hokkaido. It becomes hot on the Sea of Japan side.

Type 5: There is a low air pressure around Etorofu Island, south of Sea of Okhotsk. Westerly winds prevail. It is cooler by the north wind in the afterward of the low air pressure. .

Type 6: Strong low air pressure stays in the northwest of Hokkaido. Even in the northward, it is remarkable hotness.

Type 7: There is a high air pressure in the Sea of Okhotsk. The leeward of Hokkaido becomes hot.

Type 8: There is high air pressure in the south and westerly winds prevail. It also becomes cool on the leeward of Hokkaido in the Sea of Okhotsk.

3.2 Appearance frequency and change of each type

Monthly appearance frequency of each type is indicated (Fig. 3). Its characteristic is as follow: Type 1: The numbers of appearance are large, especially in May and September. But it becomes smallest in July. Type 2: There are many from June to August. But they are little in May and September. Type 3: They are a lot in May and September like Type 1. But it becomes few from June to August, particularly in July. Type 4: It is many from May to July. But it becomes few in August and September. Type 5: It appears stable, but appearance frequency

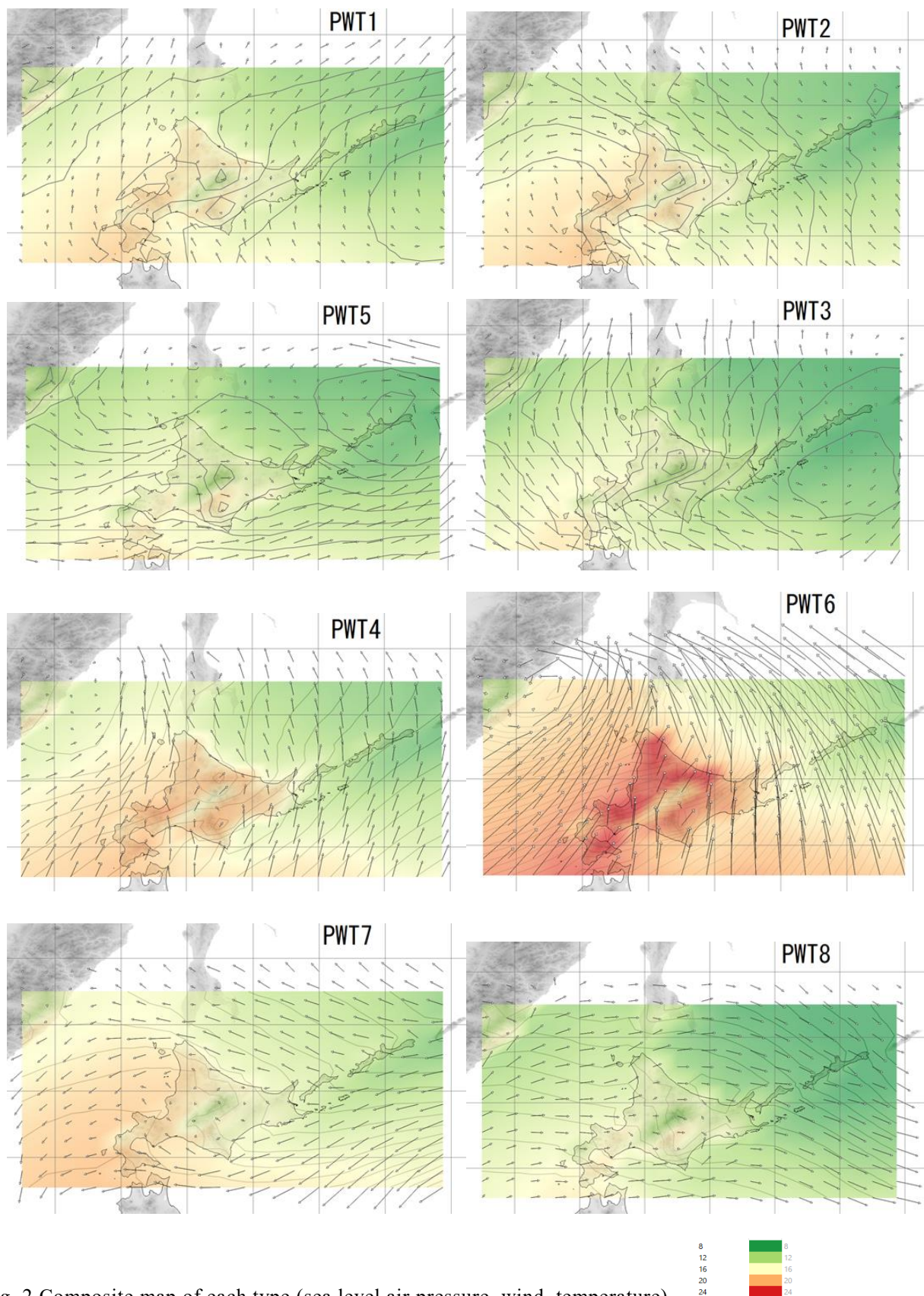


Fig. 2 Composite map of each type (sea level air pressure, wind, temperature)

becomes few in September. Type 6: It appears little in May and disappears after June. Type 7: The

appearance frequency is stable, but particularly lot in August and also in September. Type 8: There are

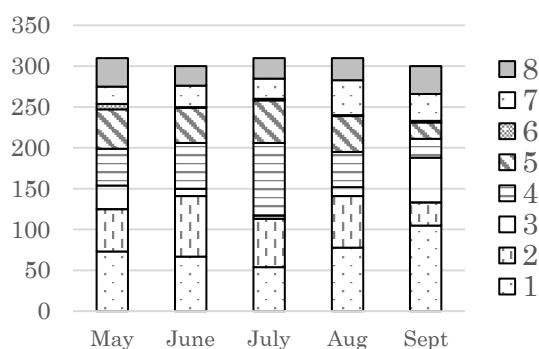


Fig. 3 Monthly appearance frequency of each type

few appearances from June to August, but a lot in May and September.

All over the change in appearance frequency which is according to the year is indicated (Fig. 4). Its characteristic is as follow: Type 1: It's a lot in 2012, but appearance frequency decreases after the year. Type 2: The appearance frequency was stable, but it became a lot particularly in 2017. Type 3: It became similar with Type 1 and highest in 2012. Type 4: It is the largest in 2014. Type 5: The appearance frequency is a lot in 2011. Type 6: There are few appearances, but It appears 4 times in 2009. Type 7: There were a lot in 2009 and 2013, but it was little between then. Type 8: It becomes a lot at the end of the period.

4. Discussion

There are similar types from the location of the action center and prevailing wind direction. The type of low air pressure stays in the Sea of Japan are Type 6, 4 and 2. It is Type 5 that the low air pressure center stays in the Sea of Okhotsk. While, the other types, high air pressure influences. It is in the Sea of Okhotsk by Type 7. It stays in south of Kuril Islands by Type 3 and 1, and in the Pacific Ocean by Type 8.

The type which marks each month from the appearance frequency: Type 6 and 8 of May, Type 2 of June, Type 4 and 5 of July, Type 7 of August, Type 1 and 3 of September.

The type which marks each year from the appearance frequency: Type 6 in 2009, Type 5 in 2011, Type 1 and 3 in 2012, Type 7 in 2013, Type 4 in 2014, Type 2 in 2017 and Type 8 in 2018.

It could be possible to think that the weather in a warm period around Hokkaido is dominated basically by the low air pressure type or the high air pressure type.

5. Conclusion

Weather observation has started from 19th century in Japan. In Hokkaido, except Hakodate in the most south of it, starting of the observation

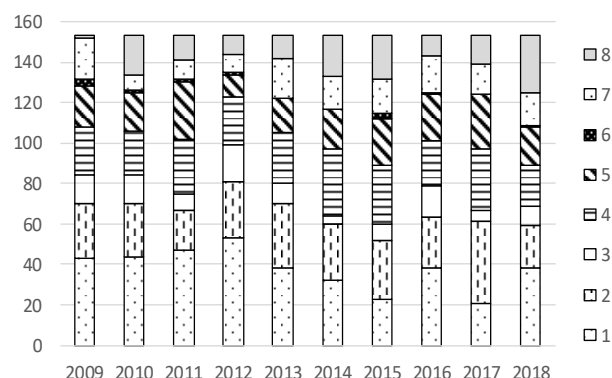


Fig. 4 Yearly appearance frequency of each type

becomes later and the weather stations are limited. Therefore, the observation record of *La Sibylle* is valuable as the actual measurement.

The Pacific anticyclone influences the climate variation in warm period around Japan. Also, it is well-known that Okhotsk high pressure influences in early summer or the rainy season. The weather records of *La Sibylle* can make clarify that around Hokkaido.

Reference

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Summary in Japanese

和文要約

北海道周辺における幕末期のフランス軍艦による気象観測と夏季の気候状態

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1855, 1856年にフランスの *La Sibylle* 号が北海道周辺を周航し、その際に1日5回の気象観測が行われた。この観測記録からの気候復元のため、現在の気候状態との比較を試みる。北海道周辺で多変量解析により明らかにした毎日の気候型では、高・低気圧による影響の差が明瞭である。そのため風観測記録にもとづく復元の可能性が考えられる。

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