Synoptic type analysis of coastal fog occurred at the Korean west sea

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Abstract

In this study, the fog phenomenon occurring at the coast of the Korean west sea was divided into the synoptic type and the cause of fog formation was explained. For this purpose, 81 fog processes from April to August between 2012 and 2014 were classified by the synoptic type and the physical quantities were analyzed in each synoptic type.

Through the analysis, the type of fog can be classified into A cold front type (A cold front approach type and the passage type of a cold front), A deformation field type, A South High North Low type and A Meiyu front type.

Synoptic type was classified by using surface pressure field and analysis of physical quantities was conducted under 850hPa isobaric surface. The data used are RJTD quasi-normal numerical analysis data.

1.0 Introduction

Fog is a common weather phenomenon which reduces the horizontal visibility less than 1 km due to condensation of water vapor in the atmospheric lower layer.[1,5,6]

Sea fog is a fog that occurs in sea, islands, and coastal areas.[3,4,5] Sea fog is a disaster marine weather phenomenon that has great impact on marine activities such as maritime transportation, fishing, Sea oil drilling and h arbor work, and also harms the environment of marine and coastal regions.[3, 4]

The coastal fog in the Korean west sea is the advection cooling fog, that i s, the fog generated when the warm air flows through the cold sea surface. It occurs mainly from April to August when the cold water zone appear clearly. Since fog is formed when a certain physical condition is satisfied in the lower layer of the atmosphere, it is very important in the forecasting practice to identify the synoptic situation which is favorable for fog formation together with the physical quantity analysis.

Through the analysis, it is revealed that the coastal fog on the Korean west sea occurs in five kinds of synoptic types

2.0 Synoptic type of fog and analysis of physical quantities

2.1 A cold front type

There are two types of a cold front approach types and a passage type of a cold front.

2.1.1 A cold front approach type

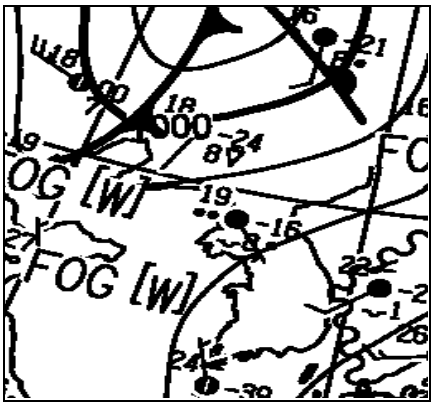

Figure 1. May 25, 2014 15:00 Surface synoptic chart

The fog processes of these types appeared nine times in total, and fog was observed in the coastal districts of South Hwanghae province including Monggungpo, Ongjin, Yonan,Gangryong, Haeju.

2.1.1.1 Synoptic situation analysis (Figure 1)

A typical example is the fog process on May 25, 2014. From 21:00 on the 24th to 21:00 on the 25th, the high pressure of the south of the Korean West Sea and a cold front of the China Northeast Low Pressure slowly approach the Central sea of the Korean West Sea, Warm and moist air continued to flow

Temperature change and advection state on 850hPa isobaric surface showed that temperature increased slightly as warm advection continues to the Korean West Sea.

As a result, a dense fog was formed in various coastal districts of South Hwanghae province including Monggumpo, Ongjin and Gangryong between morning and evening of the 25th.

2.1.1.2 Analysis of physical quantity (Table 1.)

Table 1. May 25, 2014 at 15 PM analysis of physical quantities at the coastal stations of South Hwanghae province

station	Temperature(℃)		Relative humidity(%)			Vertical speed (hPa/h)		Surface wind (m/s)
	Surface	925 hPa	Surface	1000 hPa	925 hPa	1000 hPa	850 hPa	
Monggumpo	9.6	15.5	92	89	25	−0.7	0.2	S4
Ongjin	8.9	15.3	96	95	27	−1.3	1.1	S4
Gangryong	8.8	15.3	96	96	27	−1.5	0.6	S4

When the fog is formed, as shown in the table, the temperature difference between the 925hPa isobaric surface and the surface, is in the range of 6 to 7° C, and the temperature inversion was severe.

Next, it can be seen that the relative humidity of the surface is 92% to 96%, the relative humidity of 1000hPa isobaric surface is 89% to 96%, and the relative humidity of 925hPa isobaric surface is 25% to 27%, and the ascending motion is progressed under 925hPa isobaric surface and the descending motion is progressed in the upper layer of 925hPa isobaric surface, which is a favorable for forming the fog.

Next, a south wind of 4m/s was blown. This indicates an advection process of Warm and moist air.

2.1.2 A passage type of a cold front

The fog processes of these types were a total of 7 times, usually between April and May.

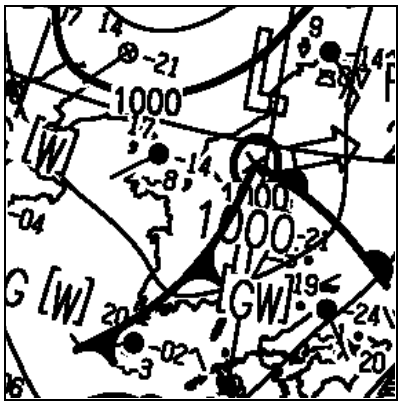

Figure 2. May 26, 2014 at 03:00 Surface synoptic chart

2.1.2.1 Synoptic situation analysis (Figure 2)

As for the synoptic situation, on May 26, 03, a cold front of East Korean Bay low pressure passed through the central part of the Korean west sea, and the high pressure behind a cold front did not follow soon. As a result, After it rained, the atmospheric humidity increased remarkably and fog was formed in most coastal districts in the western coast of Korea.

Temperature change and advection state on 850hPa isobaric surface showed th

at the temperature was lowered slightly as the cold advection progressed.

As a result, on May 26, between the early morning and the morning, the dense fog was formed in most coastal districts of the Korean west sea.

2.1.2.2 Analysis of physical quantities (Table 2)

Table 2 Analysis of physical quantities at the coastal stations of the Korean West Sea on May 26, 2014

station	Temperature (℃)		Relative humidity(%)			Vertical speed (hPa/h)		Surface wind (m/s)
	Surface	925 hPa	Surface	1000 hPa	925 hPa	1000 hPa	850 hPa	
Sonchon	13.6	14.3	96	92	55	−1.7	6.6	W2
West Sea Barrage	13.6	13.9	88	86	56	−2.4	-0.4	W4
Haeju	8.8	15.3	96	96	27	−1.6	2.4	W4

As shown in the table when the fog was formed on the early morning of May 26, there was a weak temperature inversion that the temperature difference between 925hPa isobaric surface and the surface is 0.3 ~ 0.7℃ at Sonchon and West sea gate, there was a strong temperature inversion that is 6.5℃ at Haeju.

Next, as the relative humidity of the surface and 1000hPa isobaric surface was 86% ~ 96%, and the relative humidity of 925hPa isobaric surface was 27 ~ 56%, it was very wet on the atmospheric lower layer and relatively dry on the upper layer.

Analysis of the vertical motion shows the weak ascending air stream generated on 1000hPa isobaric surface and the descending air stream generated on 850hPa isobaric surface.

Next, the west wind of 2 ~ 4 m/s blew, which means relatively cool and humid

advection process. In other words, this fog is an advection cooling fog.

2.2 A deformation field type

The processes of these types were 14 times in total, usually between April and early June.

2.2.1 Synoptic situation analysis (Figure 3)

On the 2nd and 3rd of June, 2013, On the Korean west sea, the deformation field between the western high pressure of and the northern high pressure of the Korean west sea was maintained almost without change for two days. This provided a condition for warm and humid air to flow continuously to the western coast of Korea.

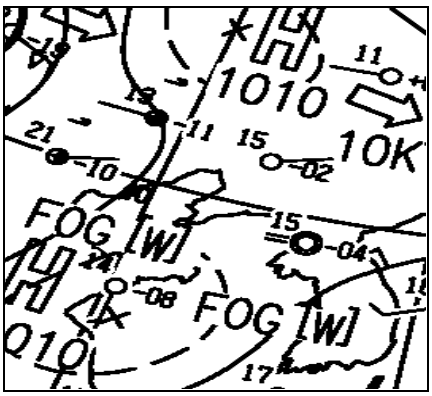

Figure 3. June 2, 2013 at 09:00 surface synoptic chart

Temperature change and advection state on 850hPa isobaric surface showed that temperature increased slightly as warm advection progressed to the Korean West Sea. This provided a very favorable condition for warm and humid air to flow continuously into western coast of Korea.

Therefore, fogs were observed for 2 days in various coastal stations of the western coast of Korea (west sea gate, Onchon, Haeju, Ongjin, Monggumpo).

2.2.2 Analysis of physical quantities(Table 3)

Table 3 Analysis of physical quantities at the coastal stations of South Pyongan province and South Hwanghae province on June 2, 2013

station	Temperature(℃)		Relative humidity(%)			Vertical speed (hPa/h)		Surface wind (m/s)
	Surface	925 hPa	Surface	1000 hPa	925 hPa	1000 hPa	850 hPa	
West Sea Barrage	13.5	15.7	93	91	50	-0.3	1.0	W1
Monggumpo	14.1	15.2	97	97	53	-0.4	1.2	W2
Ongjin	13.9	15.1	97	97	51	-0.2	2.2	W2

As shown in the table when the fog was formed on the early morning of June 2, there was the temperature inversion that the temperature difference between 925hPa isobaric surface and the surface is 1℃ ~ 2℃ at West sea gate, Monggumpo and Ongjin.

Next, as the relative humidity of the surface and 1000hPa isobaric surface was 91% ~ 97%, and the relative humidity of 925hPa isobaric surface was 50 ~ 53%, it was very wet on the atmospheric lower layer and relatively dry on the upper layer.

Analysis of the vertical motion shows the weak ascending air stream generated on 1000hPa isobaric surface and the descending air stream generated on 850hPa isobaric surface.

Next, the weak west wind of 1 ~ 2 m/s was blown, showing the relatively warm advection process.

2.3 A South High North Low type

The processes of these types were 29 times in total, and appeared frequently between May and June.

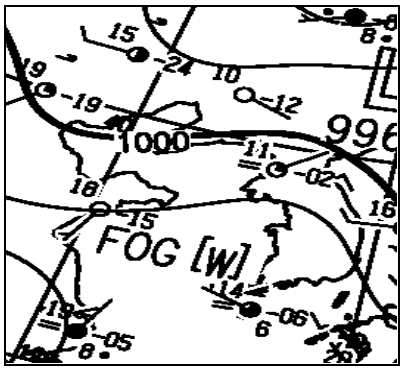

Figure 4. May 21, 2013 21:00 surface synoptic chart

2.3.1 Synoptic situation analysis (Figure 4)

As for the synoptic situation, from May 10 to 13, 2013, the warm and moist air continuously flowed into the western coast of Korea along the border of southern high pressure of the Korean west sea, the fog thickened from the night until the morning, and weakened in the afternoon when the atmosphere was heated, It was foggy for four days.

Temperature change and advection state on 850hPa isobaric surface showed that temperature increased slightly as warm advection progressed to the Korean West Sea.

This provided a favorable condition for warm and moist air to flow continuously into the western coast of Korea.

Therefore, fogs were observed for 4 days in various coastal stations of the western coast of Korea (West sea barrage, Namyang, Onchon, Haeju, Gangryong, Yonan, Ongjin, Monggumpo).

2.3.2 Analysis of physical quantities (Table 4)

Table 4. Analysis of physical quantities at the coastal stations of South hwanghae province on May 10, 2013

station	Temperature(℃)		Relative humidity(%)			Surface wind (m/s)
	Surface	925 hPa	Surface	1000 hPa	925 hPa	
Haeju	11.9	14.4	87	83	40	SW2

Monggumpo	12.2	15.8	85	82	38	SW3
Ongjin	12.2	15.8	85	82	38	SW4

As shown in the table when fog was formed on the early morning of May 10, there was the temperature inversion that the temperature difference between 925hPa isobaric surface and the surface is 3℃ at Haeju, Monggumpo and Ongj in.

Next, as the relative humidity of the surface and 1000hPa isobaric surface was 82% ~ 87%, and the relative humidity of 925hPa isobaric surface was 38 ~ 40%, it was very wet on the atmospheric lower layer and relatively dry on the upper layer. The southern wind of 2～4 ㎧ blew.

During this period, the sea surface temperature of Monggumpo is 9 ~ 10 ℃ and the atmosphere temperature is more than 12 ℃, showing that warm and humid air was flowing into the cold sea surface.

2.4 A Meiyu front type

The processes of these types appeared 22 times in total from the end of June to the beginning of August. The characteristic of this type is that fog is formed with frequent drizzle.

2.4.1 Synoptic situation analysis (Figure 5)

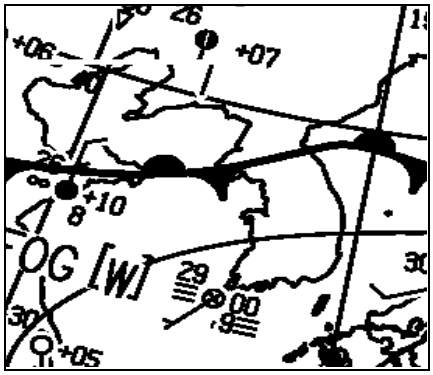

Figure 5. July 12, 2013 9.00 surface synoptic chart

As for the synoptic situation, from July 10 to 14, 2013, and from July 22 to

25, 2013, Meiyu front oscillated slightly at north of N38 ° , it accompanied drizzle, and there was heavy fog for 4-5 days.

Temperature change and advection state on 850hPa isobaric surface showed that warm advection continued to the Korean West Sea.

Therefore, the fogs were observed for 4 ~5days in various coastal stations of western coast of Korea. (West sea barrage, Jungsan, Onchon, Gangryong, Yonan, Ongjin, Monggumpo).

2.4.2 Analysis of physical quantities(Table 5)

Table 5 Analysis of physical quantities at the coastal stations of South Pyongan province and South Hwanghae province on July 12, 2013

station	Temperature(℃)		Relative humidity(%)			Vertical speed (hPa/h)		Surface wind (m/s)
	Surface	925 hPa	Surface	1000 hPa	925 hPa	1000 hPa	850 hPa	
West Sea Barrage	21.8	22.2	98	97	69	-1.3	1.5	SW 2
Haeju	22.6	22.9	96	96	97	-2.2	-1.5	SW 3
Monggumpo	22.4	22.5	96	96	72	-1.2	0.1	SW 3

As shown in the table when the fog was formed on July 12, 2013, there was a weak temperature inversion that the temperature difference between 925hPa isobaric surface and the surface is 0.1~0.4℃ at West Sea Barrage Haeju, and Monggumpo.

Next, as the relative humidity of the surface and 1000hPa isobaric surface was 96% ~ 98%, and the relative humidity of 925hPa isobaric surface was 67 ~ 72%, it was very humid on the atmospheric lower layer and also relatively humid on the upper layer, this is a condition that the fog and the lower layer cloud can overlap.

Next, southwest wind of 2 ~ 3 m/s blew.

During this period, as the water temperature of Monggumpo was about 18 ℃ and the atmosphere temperature was more than 22 ℃, there was a very pronounced temperature inversion on the sea surface.

Analysis of the vertical motion shows the weak ascending motion generated on 1000hPa isobaric surface and the weak descending motion generated on 850hPa isobaric surface, it is a favorable for constant air mixing in the atmospheric boundary layer.

3.0 Conclusion

As mentioned above, the fog formed on the coast of the Korean West Sea is a n advection cooling fog.

When the fog is formed, it can be seen that there is a temperature inversion between the surface and the 1000hPa isobaric surface in all other types exc ept Meiyu front type.

Generally, fog occurs when the relative humidity of the surface and 1000hPa isobaric surface is 83% ~ 98% and the relative humidity of 850hPa isobaric surface is less than 50%. However, during Meiyu period, fog is often overlapped with the lower layer cloud, because the relative humidity of the atmospheric lower layer is 50% ~ 84%, which is relatively high.

Ascending motion is progressed under 925hPa isobaric surface and descending motion is progressed in the upper layer, air mixing in the atmospheric boundary layer is favorable for fog formation

Next, a constant wind of the south wind system is a favorable for fog forma tion.

In addition, it is important to consider the sea surface temperature condit ion and the advection process of relatively warm and humid air.

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