Analysis of Fog Formation Factors at Monggumpo coast of Korean west sea

Pak JongGil[1], Jang DongChol[1], Kim SuSong[2], Ri DuYon[1], Choe YongHo[1], Ja YongRim[1], DokGo HyokChol[1]

[1]State hydrometeorological administration of D.P.R. Korea

[2]**Kim Il Sung** University, Pyongyang, D.P.R. Korea

Abstract

In the paper, the fog formation factors were analyzed at the Monggumpo area of the central coast of Korea. Through the analysis of meteorological factors such as temperature, humidity in atmospheric lower layer, surface wind, and sea water temperature, we revealed the cause of fog formation at Monggumpo water area.

For the analysis, fog observations from 2012 to 2014 (April to August) and RJTD semi-regular analysis data were used.

1 Introduction

Fog is a weather phenomenon where the horizontal visibility of atmospheric visibility is less than 1 km due to the tiny water droplets (or ice crystals) suspended in the atmosphere close to the ground [1，2]. Generally, sea fog is the advection cooling fog, that is the fog formed when the warm/moist air flows through the cold sea surface，and it is formed when air temperature, dew point temperature, and sea surface temperature are similar to each other as the dew point temperature difference of air becomes smaller[3,4,5]. In other words, fog formation in the sea is characterized by Cooling condensation and water vapor transport due to temperature inversion and temperature drop in the atmospheric ground layer.

Therefore, the most important factors in determining the causes of sea fog formation are air temperature, humidity, wind direction and velocity in the atmospheric lower layer and sea surface temperature.

In this study, we analyzed the fog formation factors of Monggumpo water area with a lot of fog by using the fog occurrence observation data and RJTD semi - regular analysis data from 2012 to 2014 (April - August).

2.0 Fog formation factor analysis

2.1 Analysis of fog occurrences according to major fog formation conditions

The number of fog generation according to dew point temperature difference, wind direction, and wind speed was analyzed. According to the analytical data, fog occurred in the range of 0~2℃ of the dew point temperature difference, in the wind direction of the northwest northeast, southeast, and southwest, at wind speeds of 0 ㎧~7 ㎧. Based on this, the grades were divided and analyzed.

As shown in Table 1, when the difference of the dew point is less than 1 ° C, the number of fog occurrences is 51, in this case it is most advantageous for fog formation, for fogging, at least the dew point temperature difference should be less than 2°C.

Table 1. The number of fog occurrences according to major fog formation conditions (surface)

monthly	dew point temperature difference (℃)			wind direction				wind speed (㎧)			
	≤1	1~1.5	1.5~2	NW	NE	SN	SW	0	1~3	4~7	≥7
4	7	1	1		0	7	2	2	5	2	
5	10		3		2	10	1	1	10	2	
6	10	5	3	3	1	9	5	3	8	5	2
7	19	2	5	1	2	18	5	5	9	8	4
8	5	2	1	1	2	4	1	2	5	1	
total	51	10	13	5	7	48	14	13	37	18	6

Next, when the wind direction is southeast wind, the number is 48, in this case it is most advantageous for fog formation, when the wind speed is 1 ㎧~3 ㎧, the number is 37, it can be seen that a certain wind is advantageous for fog formation.

2.2 Analysis of fog occurrences according to humidity condition

The number of fog occurrences was analyzed on the basis of monthly relative humidity data of the surface and 850hPa isobaric surface during the analysis period.

Table 2. The number of fog occurrences according to humidity conditions

monthly	Surface relative humidity (%)			850hPa isobaric surface relative humidity (%)	
	≥90	80~90	≤80	≥50	≤50
4	7	2	0	1	8
5	11	2	0	3	10
6	15	3	0	7	11
7	24	2	0	12	14
8	6	2	0	3	5
total	63	11		26	48

Next, as shown in Table 2, when the relative humidity of the surface is more than 90% , the number of fog occurrences is 63, but on the other hand, when relative humidity of 850 hPa isobaric surface is less than 50%, the number of fog occurrences is 48, it is advantageous for fog formation w-hen it is very wet in the atmospheric boundary layer and dry in the higher layer. If the relative humidity is high at more than 850 hPa isobaric surface, it is likely to become clouds rather than fog.

Therefore, it is important to analyze the relative humidity below the atmospheric bounda-ry layer, but at the same time, the relative humidity should be analyzed above the atmospher-ic boundary layer. so it could be determined precisely whether it is foggy or cloudy.

2.3 Analysis of fog occurrences according to vertical temperature difference and dew point temperature difference

The number of fog occurrences was analyzed on the basis of the difference of air temperature between the surface and 925 hPa isobaric surface, and the dew point temperature difference at 1000 hPa isobaric surface, and 850 hPa isobaric surface.

Table 3. Number of fog occurrences according to vertical temperature difference and dew point temperature difference

Monthly	$T_{925}-T_{surface}$ (℃)			Dew point temperature difference at 1000 hPa isobaric surface (℃)		Dew point temperature difference at 850 hPa isobaric surface (℃)	
	≥1	0~1	≤0	≤3	≥3	≥8	≤8
4	7	1	1	7	2	8	1
5	10	1	2	9	4	9	5
6	10	4	4	13	5	11	7
7	10	6	11	20	6	12	16
8	5	1	2	7	1	5	3
Total	42	13	19	56	18	45	29

As shown in Table 3, when there is a temperature inversion, the number of fog occurrences is 55 of 74, it can be seen that the temperature inversion is an important factor in fog formation. Even if there is no temperature inversion, the number of fog occurrences is 19. At this time, it is necessary to consider whether the water temperature is low or high so that it is possible to accomplish the result in the fog forecast.

Analyzing the dew point temperature difference, the number of fog occurrences is 56 when the difference of the dew point temperature is less than 3°C in the 1000 hPa isobaric surface which can be called the atmospheric ground layer. The smaller the dew point temperature difference is, the better the fog occurrences is. In the 850 hPa isobaric surface, the number of fog occurrences is 45 when the difference of the dew point is over 8℃. The more wet in the atmospheric boundary layer and the more dry in the upper layer, the more advantageous the formation of fog. Therefore, it is necessary not only to analyze the dew point temperature difference at the atmospheric boundary layer but also to analyze the dew point temperature difference at the upper layer. Although not shown in the table, the vertical motion of the air should be well analyzed. Some upward movement in the atmospheric boundary layer and some downward movement in the upper layer are advantageous for fog formation.

2.4 Analysis of Monthly Sea Surface Temperature Distribution in Monggumpo water area and "ㅅ" water area of the North West Sea of Korea

The fact that “cold water zone” exists in Monggumpo water area during the summer is analyzed by comparing the monthly sea surface temperature data of "Monggumpo" water area and "ㅅ"water area of the North West Sea of Korea.

The analysis used observation statistics from 2009 to 2013.

As shown in Table 4, from December 10 to February, surface sea water freezes at the point "ㅅ" and could not be observed. But In the "Monggumpo", there is no phenomenon of surface sea water freezing in the year.

Next, from January to March, the water temperature at the point "ㅅ" is significantly lower than the water temperature at the point "Monggumpo", but the water temperature of "Monggumpo" is significantly lower between April and July. There is little water temperature difference in September.

Table 4. Analysis of Monthly Water Temperature Distribution Range in "Monggumpo" water area and "ㅅ"water area of the North West Sea of Korea (℃)

Monthly	"Monggumpo" (℃)	"ㅅ" (℃)
1	-1.1~1	
2	-1.5~3.8	
3	2.2~5	-1~4
4	4.2~7.7	2~8
5	7.3~15	9~14
6	11.7~16.5	13~22
7	15.3~20.5	20~25
8	20~26	20~24
9	17~23	17~23
10	12~22	11~19
11	8~15	4~13
12	1.5~9	≤6 (from Around December 10, ≤0)

It is very advantageous condition for the formation of fog because the "cold water zone" is clearly located in Monggumpo water area between April and July.

3.0 conclusion

In the above analysis, the most advantageous conditions for fog formation at the Monggumpo coast are as follows: the dew point temperature difference is less than 2℃, the southeasterly wind is 1m/s~3m/s, the relative humidity of the surface is more than 90%, and the relative humidity of 850 hPa isobaric surface is 50% and there is a temperature inversion in the atmospheric lower layer.

As a result, in coastal fog forecasting, it is important to analyze the dew point temperature difference, temperature inversion, and wind conditions on the surface and simultaneously analyze moisture and vertical motion conditions in the atmospheric boundary layer and the upper layer, It is also very important to consider the sea surface temperature condition.

References

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