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남해 및 동해연안에서 해류와 산악영향하의 안개에 대한 수치예보
Numerical Forecasting of Fogs under the Influence of Ocean Currents and Mountains

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I. Introduction

In recent years, it was known that many marine and inland diasters were due to the dense fogs. Fisher and Caplan(1963) described the feasibility of forecasting the formation and dissipation of advection fogs and Mack, et al. (1972) and Mack and Katz(1976) carried out the numerical simulation of coastal fog through the field investigation. Barker(1977) and Fitzgerald(1978) developed a numerical model of the formation of droplet spectra during the early stage of fog formation at sea. Olivier and Stockton(1989) demonstrated the influence of upwelling extent upon fog incident.

The formation of fogs are directly related to variations of sensible and latent heat fluxes near the surface of inland and sea, mainly combined with infrared radiative cooling and heating and water vapor fluxes and momentum transfer over sea surface. Especially momentum fluxes drive the wind driven ocean circulation and produce the changes of vertical temperature and salinity structures of the upper ocean, and also plays an important role in the formation, resulting in the cooling and evaporation of sea water(Steven and Reynolds, 1981).

The first aim of this paper is to investigate the variation of monthly mean frequency of sea fog hours in the coastal seas of the passage of East Korea Warm Current and to reveal the relationships between the monthly frequency of sea fogs and the heat, momentum and moisture fluxes evaluated from monthly averaged surface meteorological and oceanographical variables. The second one is to develop a numerical model which can easilly forecast the formation of fogs in the mountain and coastal regions, and to adopt for forecasting the formation of acid fogs in the near future.

II. Data analysis and numerical method

In analyzing the occurrence of fogs in the coastal regions coastal meteorological and oceanographysical data for 10 years from 1981 through 1990 were used, and for numerical forecasting the formation of fogs in the mountain and coastal sites non-hydrostatic grid-point numerical models were adopted with one way double nesting technique. In the numerical simulation the horizontal resolution of the model with grid intervals of 9km and 20km for the fine-mesh and the coarse-mesh model with double nesting technique, and Vertical resolution with the number of 15 levels in Z^* coordiate on the complex terrain.

In the coarse-mesh and fine-mesh models, leteral boundary data are provided with 12 hourly G-ANL data (global analysis) made by Japan Meteorological Agency and initial fields of winds, potential temperature, specific humidity evalued from G-ANL data for all two models .

III. Result

The occurrence of sea fogs at the four coastal stations in the path of the East Korea Warm Current - Sokcho, kangnung, Ulsan and Chungmuwas was investigated by using ten years - meteorological and oceanographical data. The sensible heat fluxes from April to August at the four coastal stations in the passage of the EKWC had negative values with a minimum in June except for August in Ulsan, which described the heat gain to the sea resulting from heat conduction across the air-sea interface. On the other hand, from October to February had positive values, which mean the heat loss from the sea. Monthly variations of latent heat fluxes showed similary tendencies of monthly variations of sensible heat fluxes and the heats decreased from April to August, but

increased from October to Feburary. That is, the latent heat transfer increased in winter, but decreased in summer. The distributions of monthly averaged momentum fluxes showed small magnitudes from June and to August, but large magnitudes from Dcember to Feburary. The momentum transfer seemed to be coupled with heat fluxes on inducing the cooling of air temperature or sea surface temperature in the study area. The relationship between the air and sea temperatures from the sea surface to the 20m depth of sea water showed good correlation factors of 98 - 70% except Ulsan at 20m depth.

The formaton of coastal fogs in the south-eastern coastal regions of Korea was investigated in April 18 and 19, 1994. High mountains and deep valleies lie with lakes and streams in the west of the inland sides and East Sea of Korea(Japan Sea) in the south-east, which has the characteristics of both marine and mountain climates. At 15 LST(local Stamdard Time) on April 18, relative humidities had generally high magnitudes in the coastal regions and near the East Sea in the north-eastern part of Ulchin, where the main moist advection occurred due to the easterly winds in the East Sea. On the other hand, relative humidities had the low magnitudes less than 70% in the land sides, especially in the low altitudes, that is, plain areas. However, near the top of Chiri mountain(1500m) in the south-west region and Taegreung Mountain(1200m) in the west side of Kangnung city, where the upslope winds prevail the magnitude of relative humidity more than 90% was detected.

Shortly after the sunset, at 18 LST, winds still had eastly in the seas and south-eastly in the land sides, and more than 90% relative humidities were observed with the maximun vale of 100% near Chiri mountain and Taegreung mountain. As the nighttime continues to go on, 21 LST, April 18 and 00, 03, LST, April 19 the upslope fogs and inversion fogs were detected in the west parts of Kangnung, Pusan and near the Chiri mountain. Near 06 LST, which is the sunrise time, winds blow from the north-west and west directions and the downslope winds from the top of mountains were, which can induce the thermal heating near the surface of the plain areas and enhance the evaporation of water contents of air parcels, were observed in the most of coastal and inland regions.