The Research of the Distribution of the Ocean Meteorological Observation Stations Over the Bohai Sea and Yellow Sea

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Abstract: In Bohai Sea and Yellow Sea area, NCEP Global Forecast System (GFS) data (0.5° ×0.5°) and NCEP/NCAR FNL reanalysis data(1° ×1°) have large differences with observation data. Moreover, the authors think that the sparse existing observation station data could not represent the ocean physical character of the zigzag shore line in Bohai Sea and Yellow Sea. For that reason an observation net on ocean and meteorology needs to be established. It is urgent to be resolved how to arrange the ocean meteorological observation station scientifically and reasonably. Therefore, this article discusses the distributions of the ocean meteorological observation stations over the Bohai Sea and Yellow Sea according to error uncertainty analysis of air-sea variables (sea surface temperature, 10m wind, 2m temperature, humidity, sea level pressure, etc.) and observation system simulation experiment (OSSE).
Keywords: Ocean Meteorological Observation, Numerical Simulation, Observation Station Distribution

Ocean is a major supplier of atmospheric heat and the main source of water vapor in the air, so that accuracy of SST has greatly influence on the results of numerical weather forecasting. At present, every 6 hourly NCEP Global Forecast System (GFS) data (0.5° ×0.5°) or NCEP/NCAR FNL reanalysis data(1° ×1°) are used for background field data of the numerical weather forecasting. Remarkably, the SST in these two data is the average value for 7 days, which can't perform daily SST feature in Bohai Sea and Yellow Sea.

Before error analysis of SST data is done, the 64 days data of NCEP/NCAR FNL reanalysis data(1° ×1°) are picked up according to the weather phenomenon of A oil platform in Bohai Sea, which is sunny(total cloud<5) and breeze(<3m/s) between 2011 and 2012. Afterwards, monthly and seasonal average SST errors days are analyzed through comparing NCEP/NCAR FNL reanalysis data(1° ×1°) with NCEP real-time global daily sea surface temperature (RTG_SST) analysis data (0.5° ×0.5°). Compared with FNL, RTG and observation datas, the error value of SST was positively correlated with that of 2m temperature and negatively correlated with that of wind and relative humidity（Fig. 1 & Table 1). So the distribution of SST error is available to represent the distribution of air –sea boundary elements error.

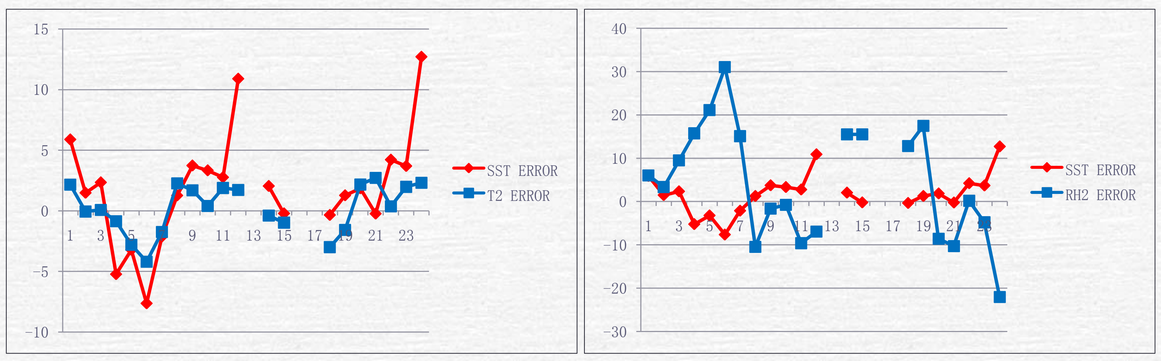

Fig.1 2011-2012 T2 error (left)(Units:℃), relative humidity error (right) (Units:%) and SST error (Units:℃)

Table 1 2011-2012 error related coefficient of air-sea boundary elements

error related coefficient	SST & T2	SST & 10m wind speed	SST & sea level pressure	SST & 2m relative humidity
2011-2012	0.689971	-0.21697	-0.13759	-0.73645
2011-2012 without December	0.871188	-0.51196	0.104541	-0.78427

The results show that the distribution of large error value in spring is similar with that in autumn over the Bohai Sea and Yellow Sea area, and there are several error centers in Bohai bay, Laizhou bay, Liaodong bay, the coastal area of northern Yellow Sea, southern water of Shandong peninsula and eastern water of Jiangsu province (Fig. 2). This phenomenon is attributed to the boundary error between sea and land, coastal current, intertidal zone, etc. In winter and summer, three centers of large error value are located in three bays of Bohai Sea. The error is not obvious along the coast. In winter, there is a special large error which shows obviously seasonal feature in northern of Yellow Sea warm current (30.5° N， 125.5° E). The error increases/decreases with the development/degradation of the Yellow Sea warm current. In consequence, for the setting of ocean meteorological observation stations in the Bohai Sea and Yellow Sea, it should be also considered the seasonal character of ocean current as well as the geographic distribution (Fig. 3).

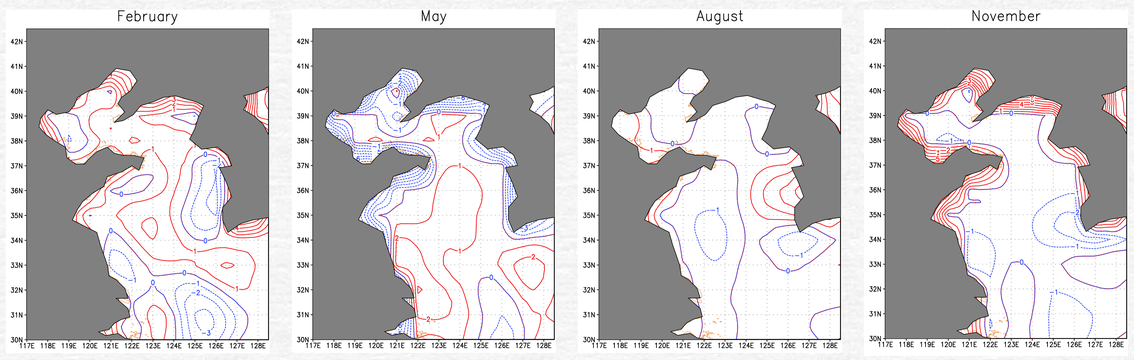

Fig. 2 the distribution of average SST error on representative months (Unites: ℃)

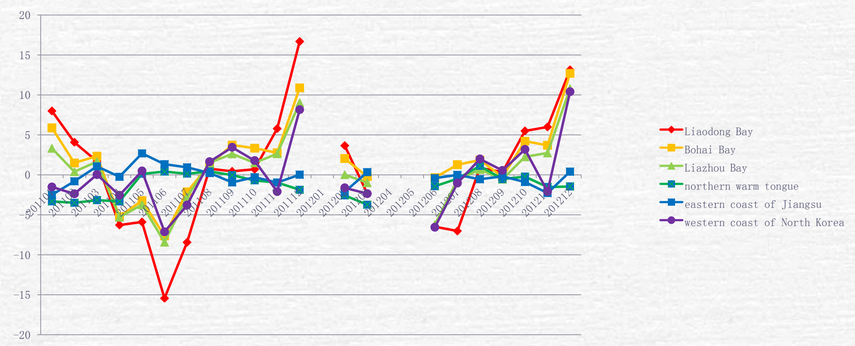

Fig.3 2011-2012 monthly average SST error of selected stations (Unites: ℃)

In order to make OSSE based on the error analysis of SST data, theoretical observation stations are established at the large error location. The background field of numerical weather forecasting system is produced by FNL(1° ×1°) reanalysis data, and SST data of virtual station is extracted from RTG_SST (0.5° ×0.5°). Meteorological variables of virtual stations are produced from real ocean meteorological observation data and RTG_SST data following next steps. Firstly, the error analysis of air-sea boundary layer meteorological variables (10m wind, 2m temperature, humidity and sea level pressure) between FNL data and observation data shows that the SST error influenced the error of air-sea boundary layer variables directly. Secondly, the relationships between SST and air-sea boundary layer meteorological variables in Bohai Sea and Yellow Sea are researched through the methods of correlation analysis and regression model. Thirdly, meteorological data of virtual station can be produced though the combination of Kriging interpolation and SST seasonal circulation situation. Finally, the virtual observation data of seven theoretical stations are composed of SST and meteorological data. Two distribution patterns of theoretical stations are designed. One is located in large error value area, and the other is located in little error area. Two different distribution observation data are respectively assimilated into the background field of the numerical weather forecasting model through observation system simulation experiment (OSSE). Optimal observation station distribution is selected from numerical simulation results. It revealed that station distribution in large error area has great influence on numerical simulation.

In conclusion, observation system simulation experiment (OSSE) provided the theoretical foundation for establishing ocean meteorological observation station network. For achieving more accurate station position, the next work is a combination of SST error analysis and adaptive observation. The sparse data interpolation algorithm based on information diffusion should also be used in the extraction of virtual station.