Activities and operation of the weather forecasting section of the Institute of Meteorology and Hydrology

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1. Introduction

The activities and research studies related to weather forecast have been carried out for about fifty years in Mongolia. Now, Weather forecasting section (WFS) of Institute of Meteorology and Hydrology (IMH) is responsible not only for weather forecast for Mongolia, but also for research studies associated to weather forecast. WFS issues many kinds of weather forecast such as short-, medium-, and long-range weather forecasts, warnings and advisories. Whenever severe weather expected, the warnings and advisories, with detailed information, are issued and distributed to news media and relevant government organizations such as Civil Defense Agency.

Another duty of WFS is to do research study on weather and climate prediction, numerical weather prediction, and climate change and its effects.

From 1997, WFS have emphasized on improvement of weather forecasting technology. As a result of it, the manual operation is rapidly reduced in meteorological data processing.

2. Observational data and its processing

The meteorological Observational Network in NMC consists of various fields of observation such as surface, upper-air, radar and satellite. There are 313 meteorological observational stations, 7 upper-air observation stations and one radar observation. NMC receives and analyzes real time data from polar orbiting satellite, NOAA series. The Doppler radar locates near the airport in Ulaanbaatar. This radar information is valuable not only for aeronaugation but also for short–range weather forecast. Currently, we are using the radar data in weather forecasting as an image.

In addition, WFS receives and analyzes about 1600 SYNOP data, 300 TEMP data, GRID and GRIB data of ECMWF and KWBC a day, from Novosibirsk and Beijing via GTS and VSAT. The data can be either presented in a graphical form, or be used in statistical model to predict weather elements as an input.

Whole of above mentioned data, except radar data, are sent to Weather forecasting Bureaus, which are located in each province through computer network.

Since 1997, IMH have emphasized on development of fully automated technology for data processing. In the frame of it the following software are developed:

- Software for viewing past and current weather condition of local 180 meteorological stations
- Software for visualizing the regional and local weather maps
- Software for visualizing the forecasting maps on grid data of ECMWF, NCEP and RUN
- Software for visualizing the forecasting maps on grid data of JMA DDB
- Software for drawing aerodiagram on an radiozond data

In figure 1, there is shown some of maps and images, which are used in weather forecasting.

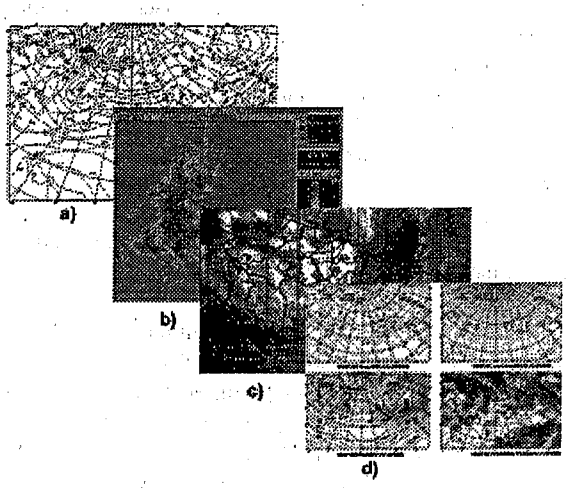

Figure 1. Weather information a) Upper air weather chart, b) radar product, c) cloud image, d) forecast maps.

3. Methods and NWP

There are some statistical methods for forecasting of precipitation amount, maximum and minimum temperature and wind speed for from half-day up to 5 days for 53 cities of Mongolia. The method is based on PPM concept. Firstly, Stepwise Discriminant Analysis is used to determine probability of precipitation for selected city, after that if probability of precipitation is greater than probability of non- precipitation, then stepwise regression is used for forecasting of precipitation amount. The method uses 24-120 hours NWP products of H500, P0, which is received via GTS, as a predictor. The method has been used to operational forecasting activities since June 1999.

Some probabilistic and analogue methods are used in long range weather forecast.

Probability–statistics method of seasonal forecasting by using motions of the celestial bodies

In the method have been applied the theory of self-organization of open, dissipative and non-linear systems, methods of objective classification of the meteorological fields, probability-statistics interpretation and optimization of parameters, motion of celestial bodies and their impacts on the solar activity and a Ocean tides.

Local climate model

Local climate model based on forecasting principle that includes method of parceling out ascending and descending node from data time series curve creating partial linear trend and estimating weighted population mean values.

Probability –statistics model for forecasting extreme events- 'Extreme' model

The model is developed by using discriminate analyses method, classifying the field of monthly mean temperature anomaly into 3 categories such as 'extreme warm', 'extreme cold' and 'near average' and field of precipitation anomaly –such as 'extreme heavy precipitation', 'extreme light precipitation' and 'near average'

The Bagrov and Tokarev filters, those could better indicate the field of monthly mean temperature and precipitation amount, are used to classify the fields into 3 categories.

In order to develop the model, simultaneous and lagged (up to 28 month lag) correlation coefficient of temperature and precipitation with the Northern Hemisphere 500hpa height's, The pacific SST fields and SOI are computed for the 50 year period areas showing correlation coefficients greater than 0.45 are chosen for the further analyses. Finally predictors for monthly temperature and precipitation are selected from the good predictors for the construction of the models. The model output shows the expected probability of the three categories for temperature and precipitation.

Analogue method

A method to estimate the future situation by assuming the change of the present state may be similar to that of the past state if the present synoptic situation is similar to specific past weather.

Analogue method is the find past years which are highly correlated to temperature of 1-3 months before the month to be predicted.

IMH performed mesoscale model MM5v3 in 2000, which was developed in the NCAR, USA. This research approach gives an opportunity to use the model in operational weather forecasting practice. The performance runs including 50-km grid resolution, 45x40 grid covering the territory of Mongolia and 24 layers sigma level at the PC platform with Linux system. In our case, important issues address that to solve boundary condition from global model. The model versions for several specific case (physical parameters. cloud schemes, model options) are performed and nesting capability and one, two-way interaction were tested. IMH is planning to implement to use it the short term forecast in real time from 2003. If the radar and satellite data are used in model as an input, the model output will be more accurate.

4. Weather forecast

Weather forecasts are issued after discussions among forecasters.

The forecasts are immediately transmitted to Mongolian Radio Television, concerned agencies by fax and Weather forecasting Bureaus, which are located in each province through computer network.

Weather forecasting Bureaus, which are located in each province, issue the forecasts for their responsible administration areas.

Short-range weather forecast

Short-range consist of daily forecasts. Daily forecasts are routinely issued four times a day, and consist general weather conditions, precipitation, and wind direction/ speed, temperature. 6 hours forecast for capital city is released 2 times a day. 12 hours forecast for capital city and whole country –every morning and 24 hours forecast for capital city and whole country-1times a day.

Medium –range weather forecast

Medium–range weather forecast consist of 5 days forecasts, and weekly forecasts. 5 days forecasts consist general weather conditions precipitation, wind direction / speed, temperature. Weekly forecasts provide information for seven days outlook and daily precipitation, wind direction/ speed, temperature in whole country.

Long-range weather forecast

Long-range weather forecasts are type monthly prediction, annual climate prediction for IMH of Mongolia. Long-range weather forecasts consist monthly weather outlook and seasonal outlooks. Forecast elements can vary according to all or some of following: monthly mean temperature deviation from the normal, precipitation ratio to the normal and wind speed. There are three categories: below normal, near normal, and above normal. The lower and upper limits of the near normal are –10 C and +10 C from normal for temperature and 80%-120% to the normal for precipitation. The monthly weather outlook

is issued at the end of month. The seasonal forecast includes temperature anomaly, precipitation ratio by category mentioned above, for each month during the season. The seasonal forecast is issued two times a year in late March / Warm season/ in late November /cold season/.

In recent years, we are developing some special forecasting services in order to satisfy the demands of users, such as reservoirs, enterprises, traffic, railway companies and outdoor activities.

Table 1. Criteria for Severe weather alert and warnings

Severe weather information and Warning

Occasionally the IMH issues alarming weather information whenever sudden and important changes of the weather condition are detected or severe weather is anticipated. If severe weather if expected, IMH issues alerting weather information - the severe weather is going to be disastrous, - warning information. Severe weather alert and warning include advisories. Criteria for Severe weather alert and warning is shown in table 1.

Type	Alert	Warning
Storm	Maximum wind speed is expected to be more than 16m/c continuously 3 hours	Maximum wind speed is expected to be more than 28m/c
Sand storm	Maximum wind speed is expected to be more than 16m/c continuously 3 hours	
Snow storm	Maximum wind speed is expected to be more than 12m/c and visibility expected to be less than 2000m continuously 3 hours	Maximum wind speed is expected to be more than 12m/c and visibility expected to be less than 2000m continuously 6 hours
Heavy rainfall	12 hour rainfall amount is expected to be more than 30mm	12 hour rainfall amount is expected to be more than 50mm
Severe Rainstorm	Less than 3 hour rainfall amount is expected to be more than 30mm	Less than 1 hour rainfall amount is expected to be more than 30mm
Heavy snowfall	12 hour accumulated snowfall is expected to be more than 5mm	12 hour accumulated snowfall is expected to be more than 10mm
Hail	expected hail's diameter will be up to 10mm	Expected hail's diameter will be more than 10mm
Heat wave	The following condition are expected to last for more than 2 days; • R.H<30% • Gust >8m/c	
Severe coldness	Minimum temperature is expected to drop more than 20°C within 2 days	

5. Dissemination

All forecasts, advisories and warnings are disseminated not only to the general public but also directly to the governmental organizations and companies concerned with railways, electric power, agriculture, recreation, tourism, etc.

Since 1999, Internet is becoming one of the main ways for dissemination weather forecast.

Modern technology of TV weather broadcasting implemented in 1999.

6. Verification

Reliability of the 6 hours up to 5 days weather forecast is gradually increasing (Fig.2). It is understood that if the skill score of long-range weather forecast stably exceeds 70%, the weather forecasts could give the benefit in an economy of the country. But skill score of long-range weather forecast could not stably exceed 70% (Fig.3). It means that we need to improve our methods or to find another information source.

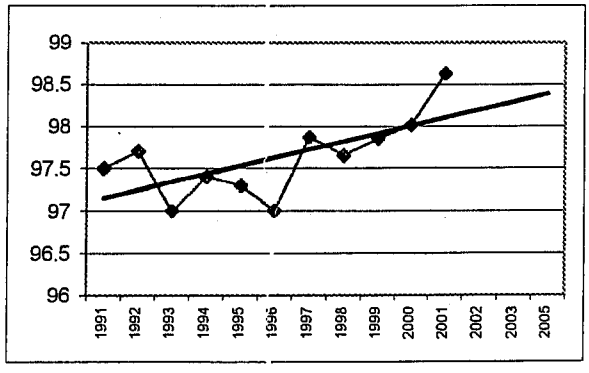

Fig 2. Skill score of 6 hours weather forecast for Ulaanbaatar and it's trend

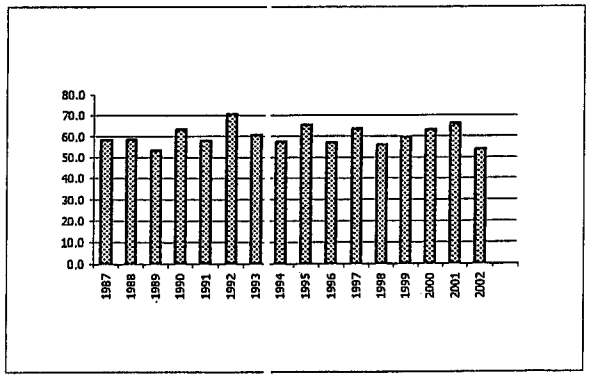

Fig 3. Skill score of monthly weather forecast

7. Research activities

Currently, researchers of WFC are considering on Model Output Dynamic interpretation of NWP products, an objective analysis of atmospheric fronts, data

assimilation and Mesoscale modeling. To input the right initial data in Mesoscale model is very important. Thus, radar and satellite data assimilation is confronted.

8. Conclusion

The radar and satellite data assimilation and long-range weather forecast are becoming high precedence issue.