

# THE USE OF NUMERICAL PRODUCTS FOR MEDIUM-RANGE WEATHER FORECASTING IN HONG KONG

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Summary: This paper reviews some of the current techniques in interpreting numerical products for medium range weather forecasting in Hong Kong, with emphasis on applications reflecting the characteristics of local weather.

## 1. INTRODUCTION

Hong Kong is a metropolitan city with more than 6 million residents. It locates in the sub-tropical region of about 22.4°N at the coast of southern China. Systems from mid-latitudes as well as the tropics can affect the local weather. In particular, northeast monsoons dominate the winter while southwest monsoons prevail mainly in summer. It is rather essential to forecast the activities of the monsoons in order to predict the changes in local weather. Forecasts of temperature in winter and rainfall in spring and summer are of particular importance to the public.

To predict weather in the medium-range, the Hong Kong Observatory relies mostly on outputs from global forecast models. In this paper, some of the current techniques, in relation to interpretation of numerical products, being used in the medium-range weather forecasting in Hong Kong will be reviewed. Possible enhancements of the techniques in future will also be discussed.

## 2. BACKGROUND

The Hong Kong Observatory receives numerical products daily from centres running global models for forecasts up to 144 hours. In the past, products available in the medium-range were gathered via the Global Telecommunication Network (GTS). These products are mainly from the European Centre of Medium-Range Weather Forecast (ECMWF) and the United Kingdom Meteorological Office (UKMO). Since 1996, products from the Global Spectual Model (GSM) of the Japan Meteorological Agency (JMA) have become available. They are retrieved from the Regional Specialized Meteorological Centre - Data Serving System (RSMC DSS) in Japan via ISDN. Products

of selected pressure levels are plotted routinely for reference in the Central Forecasting Office. Other products, including post-processing model outputs, can be accessed by using the GDISPLAY graphic display system, which is developed in-house, available on workstations and X-stations on the network.

Model performance in the vicinity of Hong Kong are monitored objectively and routinely. Error statistics are derived monthly for forecaster's reference.

### 3. NORTHEAST MONSOON

The consideration of synoptic pattern and associated local characteristics are important for onsets of northeast monsoons. *Lam (1976)* stressed the importance of the relationship between eastward moving high latitude troughs at mid-level and the arrival of the northeast monsoons over the coastal region. A trough passing Lake Brikal during Winter is strongly correlated with the onset of northeast monsoons in Southern China, taking a lead time of about 2 days. The 500 hPa products of geopotential heights from ECMWF are rather accurate in predicting the movement of high latitude troughs. Considerable skills can be seen from high anomaly correlation coefficients over our region. Thus, a rule of thumb for the forecast of surges in the medium-range is the monitoring of the trough-ridge pattern in the high latitude, as depicted in the ECMWF forecast.

Due to the blocking of Nanling range to the north of Hong Kong,, Winter surges may come from the east or northeast instead of north and their pressure pattern are classified (*Heywood, 1953*). The associated state of sky and temperature variation can be very different. The synoptic pattern provides hints on the nature of surges. Study has been carried out on the bias of model forecast, aiming at finding the correct synoptic pattern. In the past few years, slight bias on underestimating the pressure over southwestern China were generally observed in ECMWF's forecast, which also varied seasonally. This leads to a more prominent easterly component. During the late winter season, a surface trough can easily be formed to the north of Hong Kong and a replenishment of shallow winter surges may not be reflected in the forecast due to the bias. To tackle this, a filter based on short-term fluctuation is adapted on the products to remove the seasonal symmetric bias. The implementation on the forecast of sea surface pressure using mean-bias removal from the past 14 days is used.

#### 4. TEMPERATURE

To forecast the actual temperature change in Hong Kong, the direct model output of near surface temperature forecast from JMA GSM is used as reference. However, the output resolution is 2.5 degrees, available only for 12Z. Considering the relatively loose grid distribution and topographical influence, the temperature representation may have been smoothed out and has to be interpreted with care. In the past, Kalman filter has been applied in the short-term forecasting by the Observatory's Limited Area Model (OLAM), which provides forecasts up to 3 days ahead. This is basically a 2-parameter Kalman filter applying to the forecasting of near surface temperature. This technique is now being tested with short-term forecasts from JMA GSM and the preliminary results are encouraging. In future, the Kalman filter will be extended to cover JMA GSM temperature forecasts up to 5 days.

#### 5. SYNOPTIC ANALOGUE

The synoptic scale systems generally give a ground picture of the weather over the coastal region. In late winter and early spring, mid-level perturbations originated southeast of the Tibetan Plateau can lead to slight pressure rise to the northwest of Hong Kong, pushing the cold air blocked by the Nanling range southward and affecting the coastal region. This sometimes can lead to significant temperature fall in Hong Kong. The tropics-like atmosphere in summer can be rather unstable and the synoptic pattern does not vary much. However, essential features for severe rainfall, such as the existence of a low level jet together with a mid-level perturbation, can displace slightly geographically and produce very different weather scenarios.

To help locating these variations, a synoptic analogue forecasting system was introduced (*Poon and Ma, 1992*). It basically works as a perfect prog. Assuming that model forecasts are correct, it matches the synoptic weather pattern of different levels and elements with the historical database, which is built upon using ECMWF WCRP Level III data set. The weather in Hong Kong of the matched cases will be listed out as reference. The matching criteria are based on the calculation of the anomaly correlation coefficient and S1 scores. The weights for each matching elements can be assigned differently, to reflect their relative importance in different seasons. The system was set up in late 1992 and applied for short-term forecasts by ECMWF.

In 1997, the method has been extended to cover forecasts up to 120 hours. Forecasts from JMA GSM as well as ECMWF can be used by the system.

The weather of the several best matched cases can also vary significantly. *Lee and Poon* (1997) studied the behavior of the best matched and the sensitivity of the weighting factors. A selectively averaged approach is adopted, aiming at screening out undesirable analogues and identify the group of weather suggested by the remaining. The setting has been tested against 4 forecast elements ( State of sky, Rainfall, Maximum and Minimum Temperature ) and considerable successes have been observed.

## 6. CONCLUSION

The current available medium-range numerical products are of coarse resolution. They cannot be applied directly to predict local weather. Objective interpretation can give a trend in the medium range and helps predicting the general change of the weather. However, it is still rather evident that global models can behave very differently in the medium-range, especially in the sub-tropics. Even at synoptic scale, predictability is an important issue. The behavior of Tropical Cyclones in the vicinity of Hong Kong is not easy to predict in the medium range. Mesoscale systems often dominate in summer and pose another difficult question on forecasting. The hope still lies on the advancement in global models and availability of finer resolution products.

In future, inter-comparison of available global models will be carried out, which will concentrate on their forecast of tropical cyclones and monsoons.

## 7. REFERENCES

Heywood, G.S.P. 1953: Surface pressure - patterns and weather around the year of Hong Kong. Royal Observatory Technical Memoirs No. 6.

Lam, C.Y. 1976: 500 millibar troughs passing over Lake Brikal and the arrival of surges at Hong Kong. Royal Observatory Technical Note (Local) No. 31

Lee, S. M. and H. T. Poon, 1997: Improvement to the Hong Kong Observatory Synoptic Analogue Forecast System. Hong Kong Observatory Technical Note (Local) No. 71.

Poon, H. T. and W. M. Ma, 1992: The Royal Observatory Synoptic Analogue Forecast System. Paper presented in the Seventh Guangdong-Hong Kong-Macau Joint Seminar on Hazardous Weather.