
# Verification of daily minimum and maximum temperatures in Hong Kong


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# Outline

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- **Objectives**
- **Data and Methodology**
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# Introduction

- **Hong Kong Observatory (HKO) uses ECMWF global model forecast as a daily reference forecast for maximum and minimum temperatures for Hong Kong**

- **The model data is available twice daily at 00Z and 12Z and the forecast is up to 10 days ahead**

- **The Direct Model Output (DMO) data are subjected to post-processing automatically at HKO using Kalman Filter (KAL) and regression (REG)**

# Objectives

- **To compare the performance of the three different forecasts: DMO, KAL and REG in predicting min/max temperature in Hong Kong**

- **To find out which forecast is better in predicting min or max temperature**

- **To see whether there is a trend in the skill of the model**

# Data

- **Five years (2004-2008) ECMWF DMO, KAL and REG day 1, forecast data issued at 12Z at a grid point near Hong Kong**
- **Five years (2004-2008) observed daily minimum and maximum temperature data at the Hong Kong Observatory Headquarters**


**Observed data**

**Forecast data**

# Methodology

- **R software was used for scatter plots and compute the following scores:**

**Direction of error**

$$\text{linear bias} = ME = \frac{1}{n}\sum_{i=1}^{n}(y_i - x_i) = \bar{Y} - \bar{X}$$

**Accuracy of error**

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - x_i)^2$$

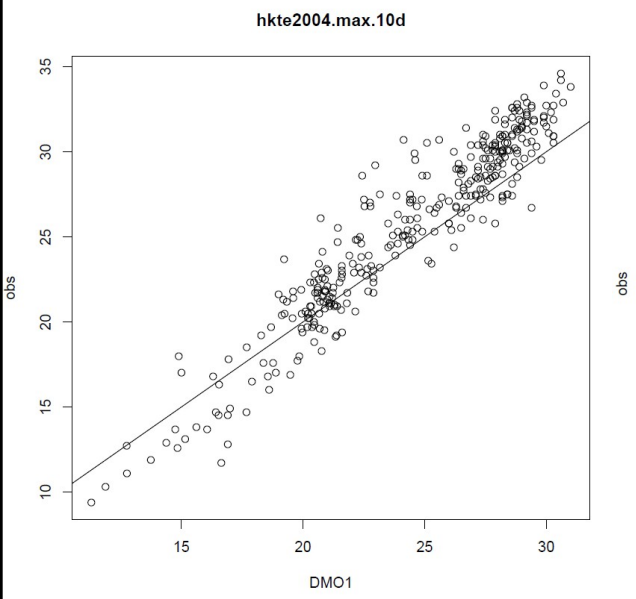
**Skill score**

$$SS_{MSE} = \frac{MSE - MSE_{ref}}{MSE_{perf} - MSE_{ref}} = 1 - \frac{MSE}{MSE_{ref}}$$

# Results

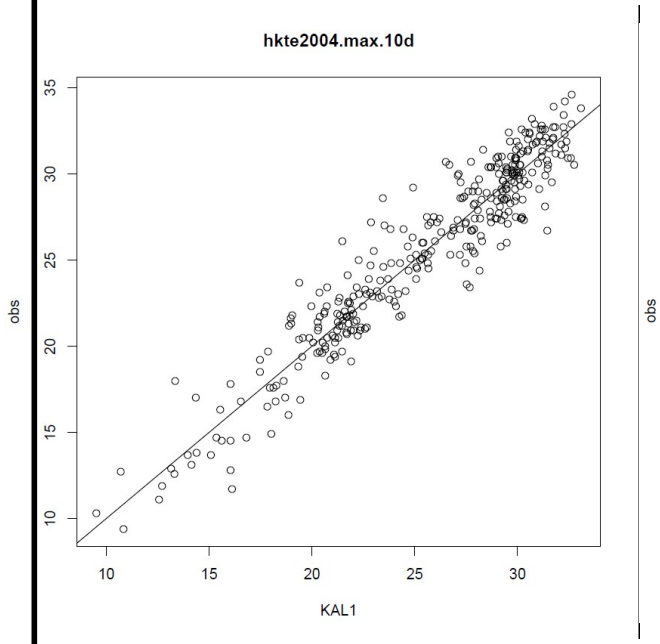
**Maximum temperature 2004**

## DMO1 vs Obs



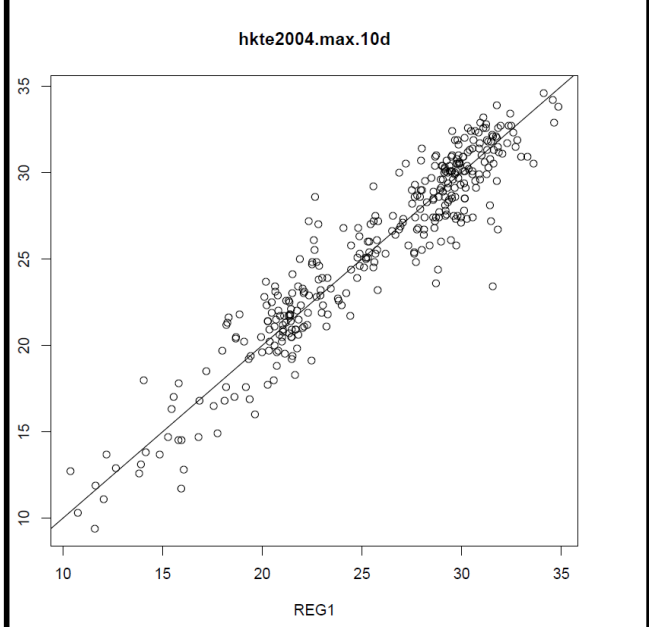

**Bias=-1.2**
**Under-forecast**

## KAL1 vs Obs




**Bias=-0.06**
**Under-forecast**

## REG vs obs

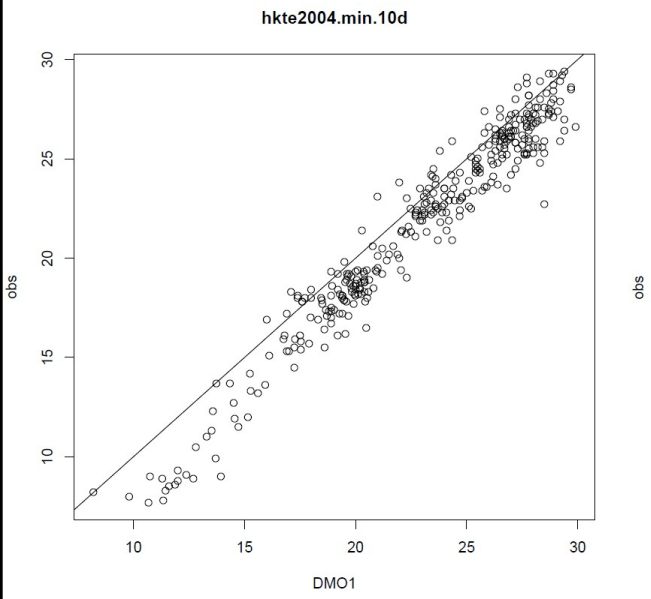



**Bias=0.01**
**Over-forecast**

# Results Continued …

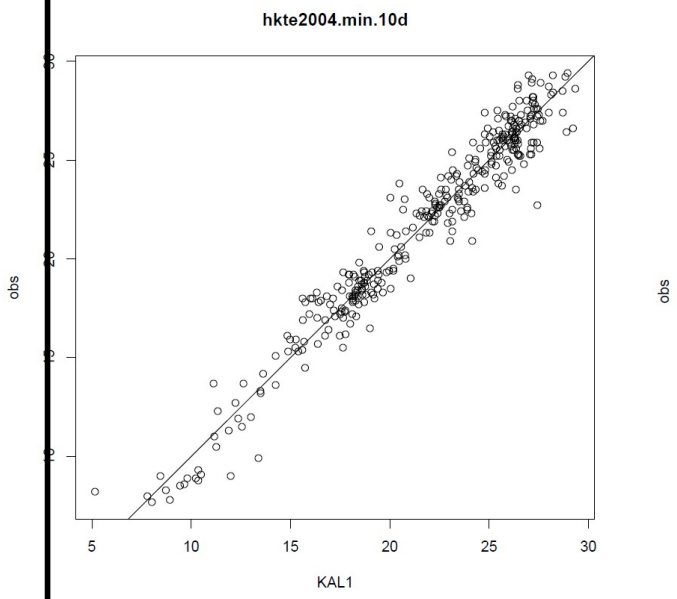
**Minimum temperature 2004**

## DMO1 vs Obs



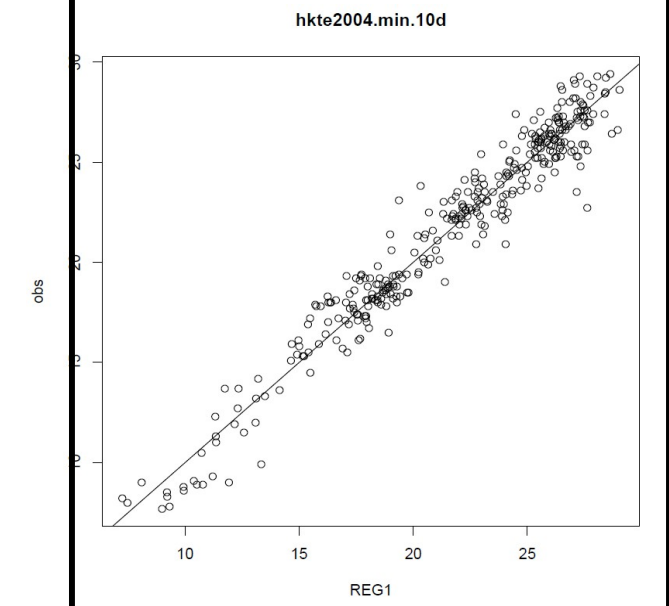

**Bias=1.24**
**Over-forecast**

## KAL1 vs Obs




**Bias=-0.02**
**Under-forecast**

## REG vs obs

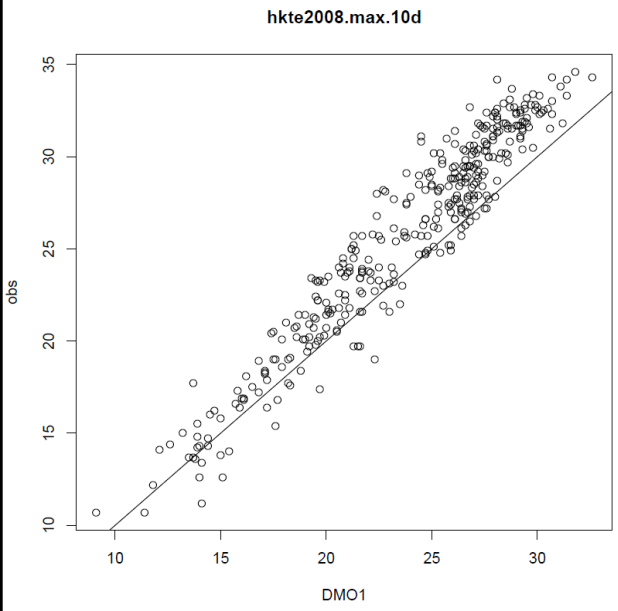



**Bias=-0.05**
**Under-forecast**

# Results Continued …

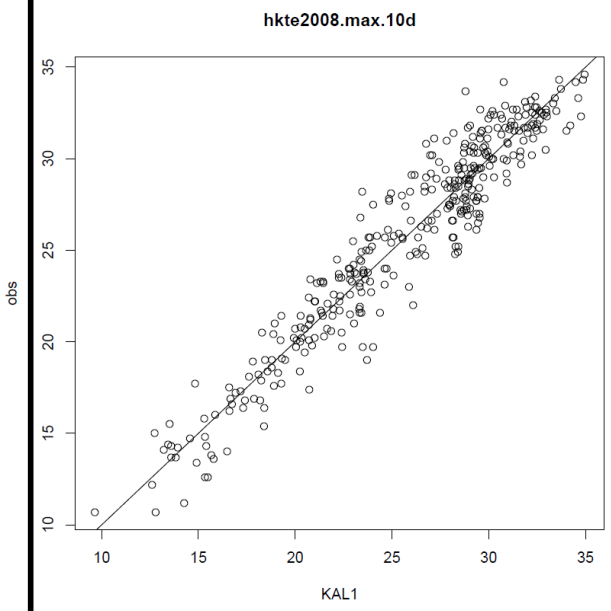
**Maximum temperature 2008**

## DMO1 vs Obs



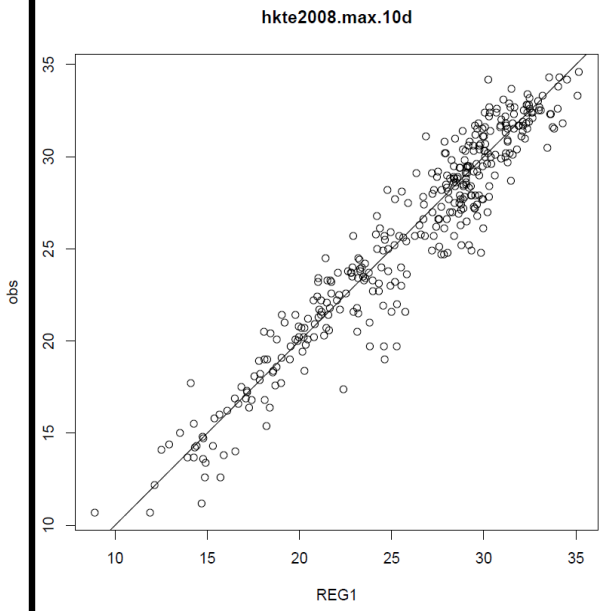

**Bias=-1.98**
**Under-forecast**

## KAL1 vs Obs




**Bias=-0.04**
**Under-forecast**

## REG vs obs

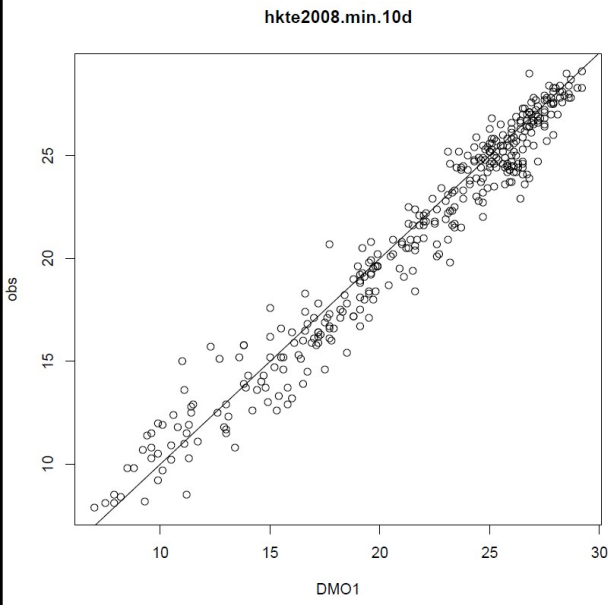



**Bias=0.18**
**Over-forecast**

# Results Continued …

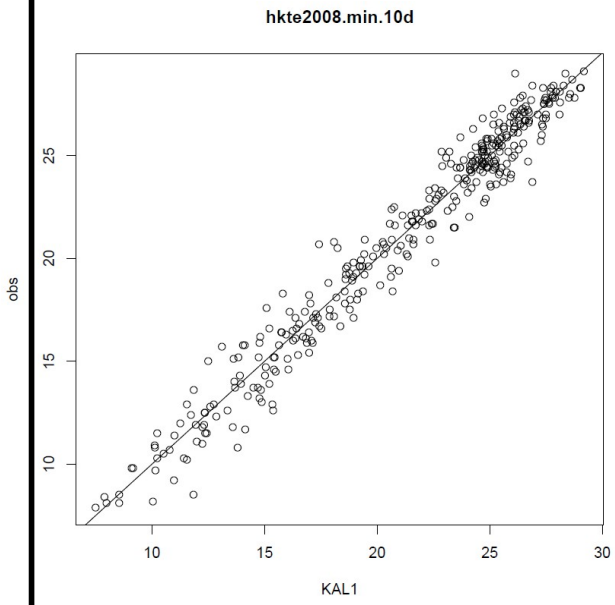
**Minimum temperature 2008**

## DMO1 vs Obs



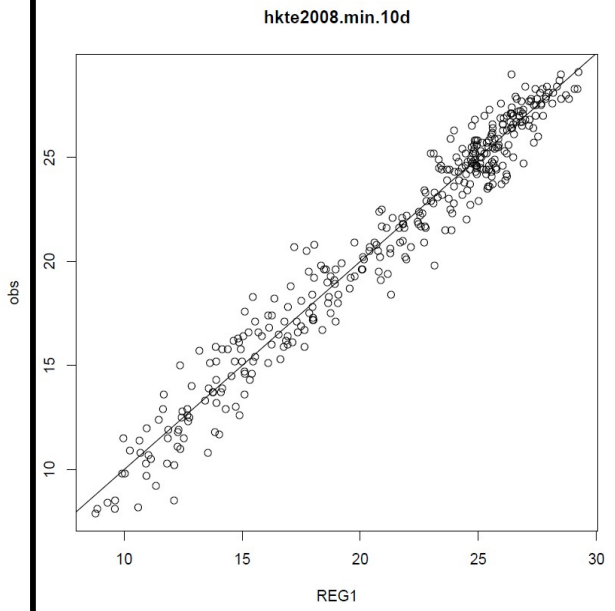

**Bias=0.39**
**Over-forecast**

## KAL1 vs Obs




**Bias=0.02**
**Over-forecast**

## REG vs obs




**Bias=0.09**
**Over-forecast**

# Results Continued …

| 2004_Max | | | |
|---|---|---|---|
| | MSE | MSERef | SS |
| DMO1 | 4,8 | 3,7 | -0,2973 |
| KAL1 | 2.6 | 3,7 | 0.2778 |
| REG1 | 3.0 | 3,7 | 0.1892 |

| 2008_Max | | | |
|---|---|---|---|
| | MSE | MSERef | SS |
| DMO1 | 6,7 | 4,3 | -0,5581 |
| KAL1 | 2,5 | 4,3 | 0,4186 |
| REG1 | 2,6 | 4,3 | 0,3953 |

| 2004_Min | | | |
|---|---|---|---|
| | MSE | MSERef | SS |
| DMO1 | 2.7 | 2,3 | -0,1739 |
| KAL1 | 1,2 | 2,3 | 0,4783 |
| REG1 | 1,3 | 2,3 | 0,4348 |

| 2008_Min | | | |
|---|---|---|---|
| | MSE | MSERef | SS |
| DMO1 | 1.5 | 2,3 | 0.3478 |
| KAL1 | 1.1 | 2,3 | 0.5000 |
| REG1 | 1.2 | 2,3 | 0.4783 |

# Summary

- **Maximum temperatures**
- An increase in MSE for DMO1 from 2004 to 2008, contribuiting to the decrease in skill.
- There was an improvement on MSE for Kalman Filter and Regression from 2004 to 2008, resulted in increase in skill.
- Post processing resulted in improved skills scores as compared to DMO1.

- DMO1 under-forecasts maximum temperatures.
- KAL1 and REG1 correct the scores.

**Minimum temperatures**

- There is an decrease in MSE for DMO1, and improvement in skill scores.
- There was an improvement on MSE for Kalman Filter and Regression from 2004 to 2008, resulted in increase in skill.
- Post processing resulted in improved skills scores even though the model forecast (DMO1) was good.

# Conclusion

- DMO1(model) under-forecast maximum temperature, but over-forecast minimum temperature.
- DMO1 is more skillful when forecasting minimum as compared to maximum temperatures.
- Model post-processing correct forecast scores.
- Kalman filter is a better forecast tool as compared to regression.
- Kalman filter forecasts are easily comparable to observations.
- More studies are required to draw conclusion.

# Thank you