Summary of the 2010 Study on Projections for Extreme Temperatures in Hong Kong in the 21st Century by the Hong Kong Observatory

Background

In 2007, the Hong Kong Observatory (HKO) conducted a study to assess the temperature trend for Hong Kong up to the end of the 21st century. The study utilized monthly temperature figures available at the time, which were simulated by global climate models participating in the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC). The study also estimated the possible change in the frequency of extreme temperature events. Although the projection of extreme temperature trends in the study is scientifically sound and generally in line with the findings depicted in IPCC AR4 and other similar researches, there is a relatively high uncertainty in the projected figures due to the limited resolution of the data used.

2010 extreme temperature projection study

By 2010, more refined AR4 model simulation data, in the form of daily data, has become available to the Observatory. Based on this, HKO re-computed the extreme temperature projections for Hong Kong using the higher temporal resolution model data (i.e. daily instead of monthly) and consequently more sophisticated statistical techniques.

The computations involved commonly accepted IPCC projected global scenarios of economic and social development, which would result in different amount of greenhouse gases being emitted into the atmosphere. A list of the scenarios adopted by IPCC is given in the appendix. Since urbanization is one of the contributors to the rising temperature of cities, this study also takes into account the effects of urbanization in Hong Kong.

Preliminary results of the computation were briefly reported in a press occasion in March 2010. The study has been completed recently and results reported published in a scientific journal.

Results

The 2010 study results suggest that the trends in temperature extremes that have been observed during the 20th century are expected to continue into the 21st century with a significant increase in hot nights and very hot days and a significant decrease in cold days. The updated extreme projection results for Hong Kong in the 21st century are summarized below:

- **More Hot Nights and Very Hot Days**

  The annual number of hot nights (days with a minimum temperature of 28°C or above) and very hot days (days with a maximum temperature of 33°C or above) will increase.

  The annual number of very hot days is expected to increase from the 1980-1999 average of 9 days to **89 days** in 2090-2099. The corresponding lower end and upper end of the projections are **29** and **131 days** respectively.

  The annual number of hot nights is expected to increase from the average of 16 nights in 1980-1999 to **137 nights** in 2090-2099. The corresponding lower end and upper end of the projections are **87** and **175 nights** respectively.

- **Less Cold Days**

  The annual number of cold days (days with a minimum temperature of 12°C or below) will continue to drop.

  The average annual number of cold days is expected to drop from the 1980-1999 average of 17 days to **1 day** in 2090-2099. The corresponding lower end and upper end of the projections are **0** and **5 days** respectively.

- **Climate Projection Uncertainties**

  It is important to note that climate projection is very different from weather or seasonal forecasts. Climate projection involves assumptions in future socio-economic and technological developments and greenhouse gas emission scenarios and aims at describing the plausible change in the future climate from a long-term perspective, rather than depicting the "day-to-day"

or "year-to-year" variations in weather.

Although a majority of the model projections suggests in general consistent trends for the changes in the climate of the 21st century, inter-model differences are still rather large with a divergence in the projections for the future climate. This, to a certain extent, reflects that climate projection is still subject to various uncertainties in the model simulation of the future climate, which depend very much on such factors as future greenhouse gas emission scenarios, the choice of models, model skills, the downscaling methodology, the stability of the statistical downscaling relationships in the future. The technique is expected to continue to improve with time as scientists know more about various climate processes and atmospheric processes that impact on the climate.

A scientific paper discussing the extreme temperature projections in detail is available online at:

T.C. Lee, K.Y. Chan and E.W.L. Ginn, Projections for Extreme Temperatures in Hong Kong in the 21st Century, *Acta Meteorologica Sinica*, **25**(1), 1-20 (2011)
http://www.cmsjournal.net/qxxb_en/ch/reader/view_abstract.aspx?file_no=20110101&flag=1.

Projections for annual number of hot nights, annual number of very hot days and annual number of cold days in Hong Kong

Parameter	Average for 1980-1999 (Observation)	Projections for 2090-2099 based on AR4 daily data		
		low-end	mean	high-end
Annual number of hot nights	16	87	**137**	175
Annual number of very hot days	9	29	**89**	131
Annual number of cold days	17	0	**1**	5

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Appendix

IPCC Greenhouse Gas Emission Scenarios

In order to make a projection of the future climate, it is necessary to develop scenarios regarding the emission of greenhouse gases into the atmosphere. Future greenhouse gas emissions are dependent on many factors such as population growth, socio-economical development, technological advancement, etc. In the IPCC 4th Assessment Report, six emission scenarios for greenhouse gases are employed. The six scenarios in order of descending greenhouse gas emission are: A1FI, A2, A1B, B2, A1T and B1.

Detailed descriptions of these emission scenarios are available at the IPCC website: http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf. The scenarios as portrayed in the website are outlined below:

- The **A1** storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (**A1FI**), non-fossil energy sources (**A1T**), or a balance across all sources (**A1B**) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

- The **A2** storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological changes are more fragmented and slower than in other storylines.

- The **B1** storyline and scenario family describes a convergent world with the same global population that peaks in mid century and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

- The **B2** storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.