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PRECIS를 이용한 우리나라 기후변화 기상자료의 생성

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Generation of Weather Data for Future Climate Change for South Korea using PRECIS

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Abstract

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), climate change is already in progress around the world, and it is necessary to start mitigation and adaptation strategies for buildings in order to minimize adverse impacts. It is likely that the South Korea will experience milder winters and hotter and more extreme summers. Those changes will impact on building performance, particularly with regard to cooling and ventilation, with implications for the quality of the indoor environment, energy consumption and carbon emissions. This study generate weather data for future climate change for use in impacts studies using PRECIS (Providing REgional Climate for Impacts Studies). These scenarios and RCM (Regional Climate Model) are provided high-resolution climate-change predictions for a region generally consistent with the continental-scale climate changes predicted in the GCM (Global Climate Model).

Keywords : 기후변화 시나리오 (Climate Change Scenarios), 지역기후모델 (Regional Climate Model), 불확실성 (Uncertainty), 기상자료 (Weather Data)

1. Introduction

The Working Group III contribution to the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) focuses on new literature on the scientific, technological, environmental, economic and social aspects of mitigation of climate change (IPCC, 2007). According to AR4, climate change is already in progress around the world, and it is necessary to execute mitigation in order to minimize adverse impacts. Global greenhouse gas (GHG) emissions have grown since pre-industrial times, with an increase of 70% between 1970 and 2004.

Table 1 shows the basic characteristics of these scenarios. These data can be used as the

Table 1 The four SRES climate change scenarios

	Economic development	Global population	Technological development	
A1F1	Very rapid growth peak in mid-century declines thereafter	Very rapid growth peak in mid-century declines thereafter	Rapid introduction of new and efficient	High emissions
A2	More fragmented and slower than other scenarios	Continuously increasing	Fragmented and slower	Medium-high emissions
B1	Rapid change toward a service and information	Very rapid growth peak in mid-century declines thereafter	Introduction of clean and resource efficient	Low emissions
B2	Intermediate level	Continuously incr easing	Less rapid and more	Medium-low emissions

basis to assess and help develop sustainable applications for energy-efficient buildings and renewable energy systems in the context of future climate change.

2. Source of Weather Data

The data for this study from the different regions in South Korea cover 40 years (1961.2000). All meteorological and solar radiation data that are used in the study were measured by the Korea Meteorological Administration (KMA). This raises the remarkable likelihood that over the next 100 years we will have a climate on earth that will be warmer than any that the human species has lived through. The rate of this change may be unprecedented in the history of our planet and may be so great that many ecosystems and wildlife species will not be able to adapt.

2.1 Global Climate Model (GCM)

Many emissions estimates have been made, but we use here the preliminary emissions scenarios prepared for the forthcoming SRES for the IPCC. Figure 1 shows the climate grids of HadCM3 data and Tyndall Centre data (TYN SC2.0) for South Korea. GCMs can provide predictions of changes in climate down to scales of a few hundred kilometres or so at best. These predictions may be adequate

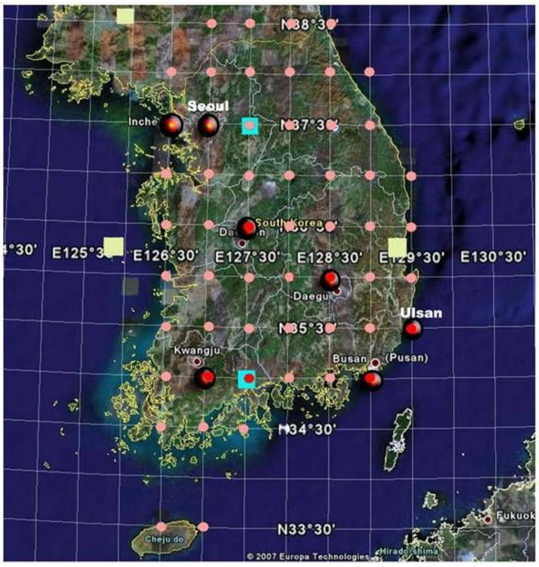

Fig. 1 Climate grids of Hadley model data (HadCM3) and Tyndall Centre data (TYN SC2.0) for South Korea with their longitudes and latitudes

where the terrain is reasonably flat and uniform, and away from coasts. However, in areas where coasts and mountains have a significant effect on weather (and this will be true for most parts of the world), scenarios based on global models will fail to capture the local detail needed for impacts assessments at a national and regional level. The best method for adding this detail to global predictions is to use a regional climate model (RCM).

The annual South Korean mean surface air temperature over the period 1961-90 was 11.5℃ and this had already risen to 12.1℃ during the 1990s. Under four climate models (IPPC, 2001), the rational temperature reaches between 13.3℃ and 17.4℃ by 2100, representing rates of change of between 0.2℃ and 0.6℃ per decade. This compares to a global warming rate of about 0.27℃ per decade since the 1970s. It can be seen from Figure 2 that the warming is much of the South Korea than the global average.

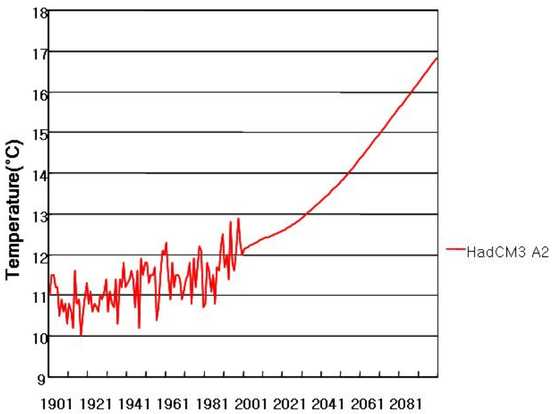

Fig. 2 Observed (1901-2000) and calculated (2001-2100) annual South Korea-mean surface air temperature. The calculated changes are for the A2 scenario with four models.

2.2 Regional Climate Model (RCM)

A regional climate model (RCM) has a high resolution (typically 50 km and 25 km, compared to 300 km in a GCM; see diagram below) and covers a limited area of the globe (typically 5,000 km x 5,000 km; roughly the size of a box around Australia). It is a comprehensive physical model, usually of the atmosphere and land surface, containing representations of the important processes in the climate system. At its boundaries, an RCM is driven by atmospheric winds, temperatures and humidity output from a GCM.

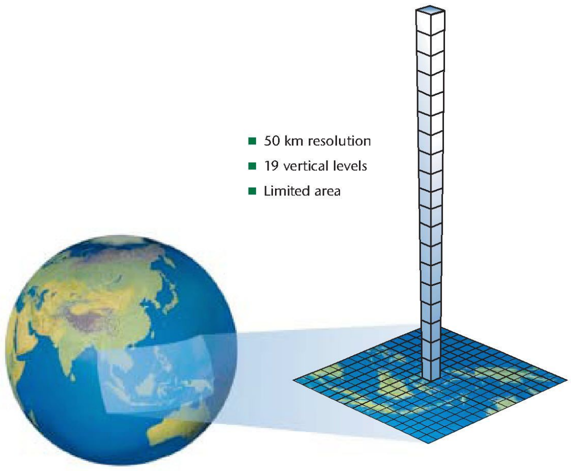

Fig. 3 Schematic diagram of the resolution of the Earth's surface and the atmosphere in the Hadley Centre regional climate model.

The Hadley Centre uses the same formulation of the climate system in RCMs as in GCMs. As a result, the RCM provides high-resolution climate-change predictions for a region generally consistent with the continental-scale climate changes predicted in the GCM. The third-generation Hadley Centre RCM (HadRM3) is based on the latest GCM, HadCM3. It has a horizontal resolution of 50 km with 19 levels in the atmosphere (from the surface to 30 km in the stratosphere) and four levels in the soil.

3. Providing Regional Climates for Impacts Studies (PRECIS)

The Hadley Centre has developed an efficient way of meeting the demand for RCM predictions. It has configured the third-generation Hadley Centre RCM so that it is easy to set up and can be run over any area of the globe on a relatively inexpensive fast PC. This, along with software currently being developed to allow display and processing of the data produced by the RCM, will form PRECIS.

The PRECIS RCM needs to be driven at its

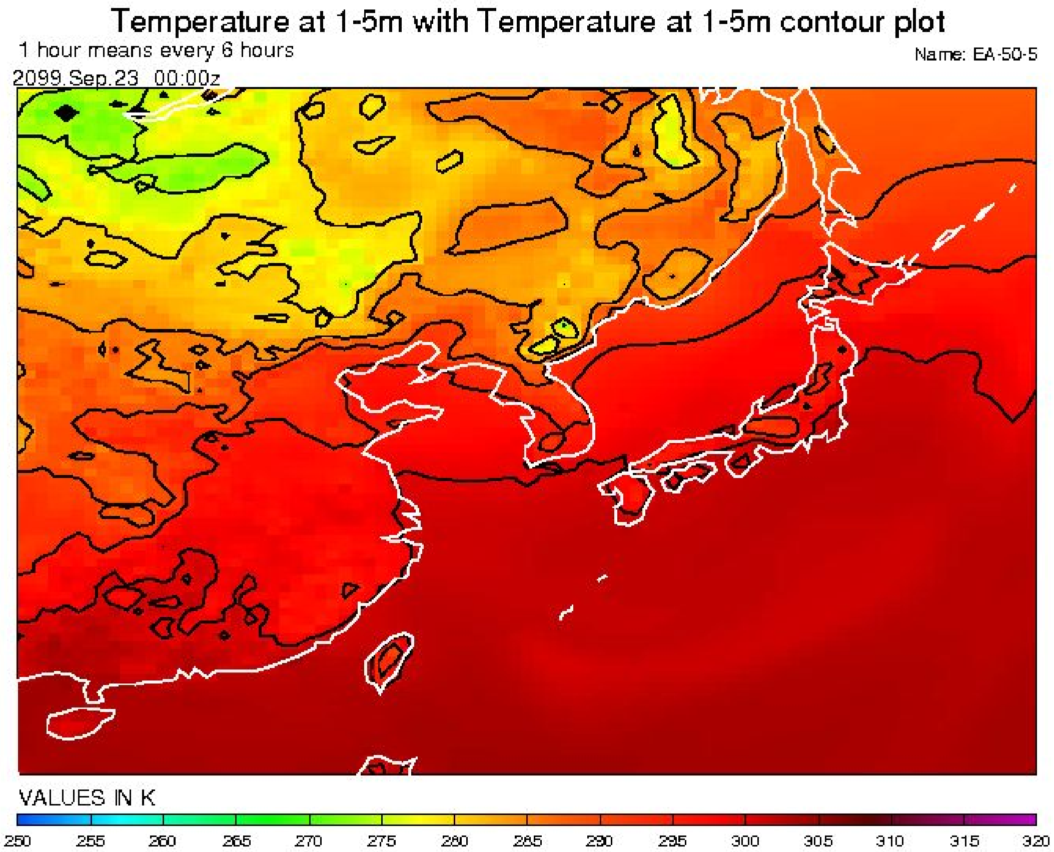

Fig. 3 50km grid box for East Asia for temperature at 1.5m

boundaries by data from a GCM and these will also be supplied, corresponding to a range of emissions scenarios. National climate-change scenarios can then be created locally for use in impact and vulnerability studies using local knowledge and expertise. PRECIS will usually cover regions encompassing several countries that may find it useful to work together. Because an RCM is driven by a GCM field at its boundary, there is a strip about 400 km wide where adjustment between the two models is taking place, and where RCM data are not useable. Hence the minimum working area is 5,000 km by 5,000 km for it to be efficient, which will generally be big enough to cover a number of countries in Fig. 3.

4. Conclusion

The analysis carried out in this study has shown that there is a variation in the climatic elements of South Korea. The annual South Korea-mean surface air temperature over the period 1961-90 was 11.5℃ and this has already risen to 12.1℃ during the 1990s. Under four scenarios and different model runs, the rational temperature reaches between 13.3℃ and 17.4℃ by 2100, representing rates of change of between 0.2° and 0.6℃ per decade. This compares to a global warming rate of about 0.27℃ per decade since the 1970s.

This study generate weather data for future climate change for use in impacts studies using

PRECIS (Providing REgional Climate for Impacts Studies). These scenarios and RCM (Regional Climate Model) are provided high-resolution climate-change predictions for a region generally consistent with the continental-scale climate changes predicted in the GCM (Global Climate Model). It must be remembered that HadCM3 is a generalized circulation model with a large grid-box (200km). The latest regional climate model, HadCM4, should hopefully provide data based on more detailed physical science on a finer grid (25km and 50km) and therefore might be more closely related to current observed data at specific sites.

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References

1. IPCC, Special Report on Emissions Scenarios (SRES): A special report of Working Group III of the IPCC, Cambridge University Press, Cambridge, UK. 2000
2. IPCC, Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.2007
3. Lee, KH., Levermore, G., Generation of typical weather data for future climate change for South Korea, 6th Meeting of the CIB W108 on Climate Change and Built Environment, Terrassa, 2007, pp. 181-191.
4. Lee, KH., Levermore, G., Weather data for future climate building design: analysis for trends, Architectural Science Review, 2010, pp. 181-191.
5. Wilson, S. et al., Installing and using the Hadley Center regional climate modelling system, PRECIS v.1.9.2, UK. Metoffice, 2010.9.