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Assessment of GCM and Scenario Uncertainties under Future Climate Change Conditions

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Abstract: GCM and scenario uncertainties are first investigated for 5 major watersheds (Han River, Paldang dam, Namhan River, Bukhan River and Imjin River watersheds). As a result of this study, it is found that CCSM3-based annual precipitation increases linearly with respect to the 10-year moving average values while CSIRO-based precipitation does not show much of trend. The results from annual DJF mean precipitation show a similar trend with respect to their 10-year moving average values. Both CCSM3- and CSIRO-based annual JJA mean precipitation do not show much of trend toward 21st century. In general, CCSM3-based precipitation values are slightly higher than CSIRO-based values with respect to their annual and annual JJA mean precipitation values, but CSIRO-based annual DJF mean precipitation values are slightly higher than CCSM3-based values. In case of mean air temperature between CCSM3 and CSIRO during 21st century, all of results show a clear trend in warming with the passage of time for 5 watersheds. However the upward trends from CCSM3-based values slow down toward end of 21st century while CSRIO-based values increases almost linearly.

Keywords: GCMs, Scenarios, Climate Variables, Uncertainties

I. Introduction

GCMs (general circulation models or global climate models) outputs are commonly used for climate change study based on the future green house gas (GHG) emissions which have considerably increased over the world. GHG emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change but none of the SRES scenarios represents an estimate of a central tendency for all driving forces or emissions. Those scenarios were basically designed to provide a broad assessment of the response of the global climate system to serve as the basis for devising a set of GHG emissions policies to slow down the rate of growth of GHGs, and to mitigate global warming impacts.

However future evolution is highly uncertain. Furthermore there are fundamental uncertainties from GCM outputs and scenarios. GCM uncertainty, which is due to incomplete knowledge about the underlying geophysical processes of global change, coarse grid resolutions and unresolved processes leads to limitations in the accuracy of the models. Scenario uncertainty results from unpredictability in the forecast of future socioeconomic and human behavior resulting in future GHG emission scenarios. Downscaled outputs of a single GCM with a single climate change scenario represent a single trajectory among a number of realizations derived using various scenarios with GCMs. Such a single trajectory alone cannot represent a future hydrologic scenario and will not be useful in assessing hydrologic impact due to climate change.

II. Evaluation of Uncertainty from GCMs and Scenarios

The GCM and scenario uncertainties are first investigated for 5 major watersheds (Han River, Paldang dam, Namhan River, Bukhan River and Imjin River watersheds). The study area and methodology are same as the study by Jang et al(2015a; 2015b).

It is noted that the figures in this study are shown examples only due to the limited space of the form. However, the full results of this study with the results from Jang et al.(2015a:b) will be submitted in near future.

Figure I shows example comparisons of annual precipitation between CCSM3 and CSIRO during 21st century. CCSM3-based annual precipitation increases linearly with respect to the 10-year moving average values while CSIRO-based precipitation does not show much of trend. In general, CCSM3-based precipitation values are slightly higher than CSIRO-based values with respect to their annual and annual JJA mean precipitation values, but CSIRO-based annual DJF mean precipitation values are slightly higher than CCSM3-based values.

Figure II shows example comparisons of annual mean air temperature between CCSM3 and CSIRO during 21st century. All of results show a clear trend in warming with the passage of time for 5 watersheds. However the upward trends from CCSM3-based values slow down toward end of 21st century while CSRIO-based values increases almost linearly. As shown in Figure I and Figure II, it is clearly found that the results from two GCMs have significant uncertainties.

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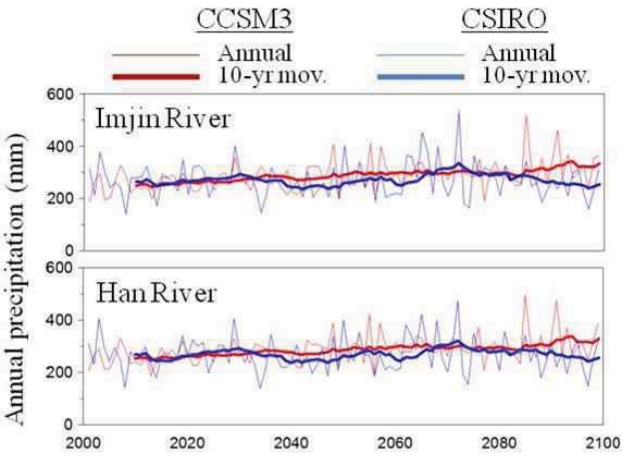

FIGURE I. Example comparisons of annual precipitation between CCSM3 and CSIRO during 21st century.

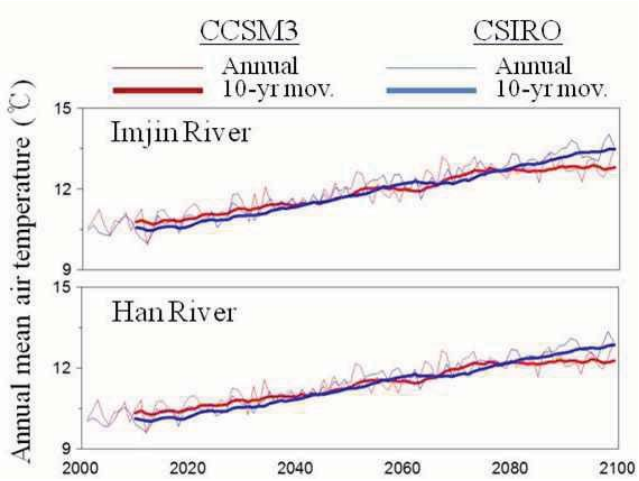

FIGURE II. Example comparisons of annual mean air temperature between CCSM3 and CSIRO during 21st century

Figure III shows example comparisons of annual precipitation by each scenario family (A1B, A2 and B1) during 21st century. It is difficult to distinguish the precipitation trends among scenario families with respect to their annual values, but it can be seen different trends in their 10-year moving average values. A1B and A2 families show the upward trends up to the middle of 21st century, but A2 family shows the downward trends toward end of 21st century with respect to annual precipitation and annual JJA mean precipitation. All scenario families do not show much of trends in annual DJF mean precipitation.

Figure IV shows example comparisons of annual mean air temperature by each scenario family (A1B, A2 and B1) during 21st century. All of results show a clear trend in warming with the passage of time for 5 watersheds. A2 family shows the most warming trends and B1 family shows the mild slope of warming trends compared to other scenario families. As shown in Figure I and Figure II, it is clearly found that the results from each scenario family have significant uncertainties.

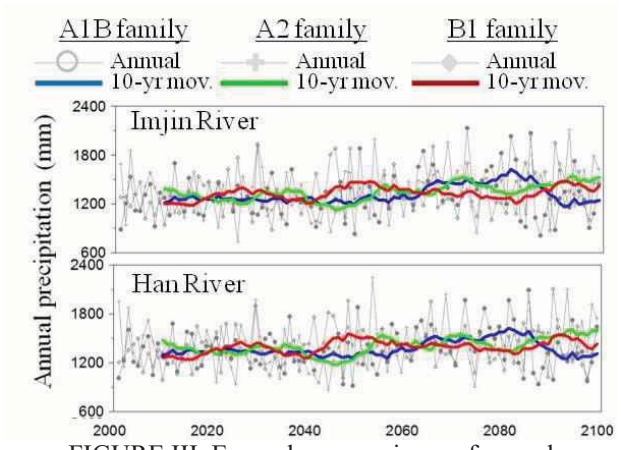

FIGURE III. Example comparisons of annual precipitation by each scenario family during 21st century.

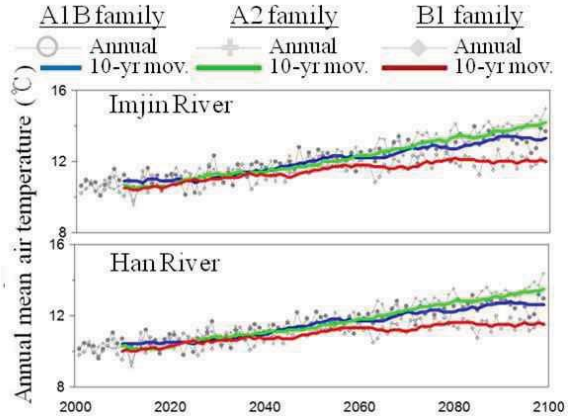

FIGURE IV. Example comparisons of annual mean air temperature by each scenario family during 21st century.

IV. Conclusions

From the study results, it is clear that GCMs and scenarios have significant uncertainties. Hence, it is concluded that a single GCM or a scenario can be representative for the future climate change conditions.

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References

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