CLIMATE MODELING AND SUSTAINABILITY SCIENCE

Akimasa Sumi
Integrated Research System for Sustainability Science (IR3S)/Transdiciplinary Initiative for Global Sustainability (TIGS), The University of Tokyo, Japan

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Summary

Sustainability covers a wide spectrum of issues. One of the important issues is that of the time-horizon, that is, our present behavior being determined by our anticipation of how this behavior will affect future society. Equity between the present and future generations is a critical theme in sustainability.

Anthropogenic climate change is one issue on the time-horizon. Climate modeling is a tool that links the present time and future time, although it is effectively limited to climate change, mainly induced by human activity. The principles are based on physical conservation laws, which are considered to be reliable; however as our knowledge of the Earth's climate is limited and there are many unknown factors and parameters, the reliability of the results given by climate models is limited. Therefore, it is critical to find a way in which information with limited accuracy can be used to solve real problems.

Climate models play another role in sustainability. When we take action towards tackling a real problem, there are many stake-holders with different interests and values. Agreement between these stake-holders has to be made through a democratic process. For this purpose, we need to share facts, and these facts should be the starting point for the discussion. One set of facts is the observational data on phenomena occurring around the Earth both at present and in the past. Information on future climate change, which can be given by climate modeling, is also a fact that we have to share.

Thus, the role of a climate model in sustainability is (1) to form a bridge between the interests of the present generation and the impact these interests have on future generations, and (2) to provide a common base to make agreements in society toward a future sustainable society.

1. Introduction

Recently, the Intergovernmental Panel for Climate Change (IPCC) published the 4-th Assessment Report (AR4) which announced that "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. It is likely that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica) "(IPCC, 2008). These findings have accelerated the movement towards tackling global warming. To do this, it has been proposed that an optimal mix of adaptation and mitigation technologies is desirable. However, global warming is not the only issue we are currently facing. There remain many issues to which our social and financial resources should be allocated, and there are many stakeholders, whose interests often contradict each other. Therefore, it is very important to form a consensus among the various stake-holders in each particular area. In order to achieve this goal, it is critical to share knowledge such as observational data, and scientific and technological findings. In particular, since people have different views, society has to have a common perception about the future, i.e., what will happen in the future.

One of the essential aspects of sustainability is equity between generations, that is, equity between us and our children and grandchildren. In order to consider equity between generations, it is essential to relate present values to future ones. All aspects of a future society cannot be estimated through knowledge obtained at present, but some part of the future environment can be estimated from present day knowledge. One example is the global warming issue. At this time, climate modeling is playing a very important role. The global warming issue is not a problem which has a serious impact on the present generation, but the problem will have a serious impact on future generations. Therefore, we have to consider this issue along the time-axis. In other words, it is impossible to make a reasonable or optimal decision without a reasonable and reliable future projection. I wish to emphasize that reasonable and reliable information about the future climate can be obtained by using climate modeling. Here, it should be noted that climate models have been developed based on scientific knowledge, which has been accumulated by the efforts of scientists. This is the only reasonable way to obtain knowledge about the future. However, as our skill in foreseeing the future is limited, it is critical to pay attention to the limitations of climate modeling.

It is often said that global warming is the first issue where science and policy sit together at the same table. But even so a large gap remains between the two. Scientists can give politicians their scientific understanding of a topic, but those who make policies need information which is relevant. Usually policy makers request more information than science can provide. Then, the question arises as to whether science is unhelpful for making political decisions. The answer is that it is not. In the present world of politics, scientific and technological knowledge is indispensable for making political decisions, because no current issue can be handled without this information. The difficulty is in making politicians understand what the nature of science is. The reason why politicians often cannot believe what science suggests is this. Science is a logical pursuit based on hypotheses, data and assumptions. However, politics has to pay attention to other aspects, such as the aspirations, desires and economic values of its people. It also relates to the value system and mental situation of each individual.

Politics really needs information to make political decisions. Again, it is necessary to provide reliable information for society to make informed decisions.

It is easy to say that the present generation should take action to ensure the welfare of future generations. In reality, the revenue is limited and the financial situation for most people is severe, and many people have doubts about making definite decisions for the future; however, it is certain that many people believe that we should take some action to ensure the future welfare of the Earth. Therefore, in order to achieve a consensus in society for mitigating and adapting for global warming, it is important to discuss how we utilize the information from climate predictions with limited accuracy. In this chapter, various aspects of this topic will be presented and discussed.

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Bibliography

G.H.Brundtland (1987), Our Common Future, Oxford Univ. Press. [WCED report. Comprehensive description about sustainable development.]

E.Kalnay,(2006), MATHEMATICAL MODELS IN METEOROLOGY AND WEATHER FORECASTING, in Mathematical Models. [Eds. Jerzy A. Filar, and Jacek B. Krawczyk], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [http://www.eolss.net] [A comprehensive explanation about a numerical model in meteorology and weather forecasting.]

G.R.North,C.R.Mechoso,(2005), MATHEMATICAL MODELS OF CLIMATE, in Mathematical Models, [Eds. Jerzy A. Filar, and Jacek B. Krawczyk], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [http://www.eolss.net] [A comprehensive review on models for climate, such as AGCM,OGCM, Coupled Atmosphere and Ocean model and application.]

A. Henderson-Sellers, (2004), THE CLIMATE SYSTEM, in Climate Change, Human Systems and Policy, [Ed. Antoaneta Yotova], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [http://www.eolss.net] [General introduction of the climate system from the present Earth Climate, the past climate, human impact and sustainable climate.]

P. Ekins, (2006), THE FUTURE OF SUSTAINABLE DEVELOPMENT, in Dimensions of Sustainable Development, [Eds. Reinmar Seidler, and Kamaljit S. Bawa], in Encyclopedia of Life Support Systems (EOLSS), Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford ,UK, [http://www.eolss.net] [General review about sustainable development]

K.E.Trenberth (1992): *Climate System Modeling*, 788pp, Cambridge University Press, [A textbook on Climate-System Modeling. Dynamics of a climate system and model description are explained.]

J.T.Kiehl and V. Ramanathan (2006): *Frontiers of Climate Modeling*, 366pp, Cambridge University Press, [Present issues in climate modeling is discussed.]

Sumi, A. (2006): On several issues regarding efforts toward a sustainable society, *Sustainable Science*,1,2,DOI 10.1007/s116. 25-0021-6. [Discussion of how to proceed to a sustainable society is presented.]

Biographical Sketch

Akimasa Sumi - was born at Gifu, Japan in 1948. He received BA.D in Physics at 1971, Ms.D in Physics at 1973 and D.Sc in Geophysics at 1985 from the University of Tokyo. He joined the Japan Meteorological Agency(JMA) in 1973 and was appointed to be an associate professor of the University of Tokyo in 1985. Since 1991, he has been a professor in the University of Tokyo.
He started a research career for a numerical weather prediction at JMA. He studied a 4-dimensional analysis and initialization. During 1979-1981, he stayed at the Department of Meteorology at the University of Hawaii. During his stay, he joined in WMONEX (Winter MONsoon Experiment) of WCRP (World Climate Research Programme). Since then, he had been interested in the Asian Monsoon study. When he joined the University of Tokyo, he has started a model development and ENSO (El-Nino and Southern Oscillation) research. He played an important role in promoting an international TOGA (Tropical Ocean and Global Atmosphere) project from 1985 to 1994. At the same time, he engaged in promoting satellite projects such as TRMM, ADEOS and ADEOS-2 in the Japanese space agency. He is now a Technical Counselor at the Japan Aerospace Exploration Agency (JAXA).
In 1991, he had succeeded in establishing the Center for Climate System Research (CCSR) at the University of Tokyo, where a sophisticated climate model has been developed. CCSR are devoted itself to the global warming simulation and submitted results to IPCC AR3, AR4 and AR5. He was a Lead Author of IPCC WG1 AR4.
Recently his interest has shifted from science itself to relationship between science and society. He has joined in AGS (Alliance for Global Sustainability) in 1999 and in establishing a research network of IR3S (Integrated Research System for Sustainability) and TIGS (Transdisciplinary Initiative for Global Sustainability) in 2006.