

HOKKAIDO UNIVERSITY

Title	Drastic Change during Global Warming : How well do we know about global warming?
Author(s)	Ikeda, Moto
Citation	サステナビリティ・ウィーク2008 オープニングシンポジウム「持続可能な低炭素社会を求めて」.平成 20年6月23日.札幌市
Issue Date	2008-06-23
Doc URL	http://hdl.handle.net/2115/34513
Туре	conference presentation
File Information	13-8.pdf



Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Drastic Change during Global Warming How well do we know about global warming?

Moto Ikeda

Graduate School of Environmental Science

Hokkaido University

Agenda

- \doteqdot Global warming is a real and crucial phenomenon.
- (Nobel Peace Prize awarded to IPCC and Al Gore)
- \Leftrightarrow Do we well know about global warming?
- \doteqdot Uncertainty larger than 50% on the warming rate
- Scientific clarification is required on some issues and mechanisms which yield positive feedback in the earth system.
- ☆ Reliable projection on distinct indicators is crucial for scientists to establish credibility.

Global warming in the 21st Century could be 1 to 6

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING



Uncertainty is large due to both scenarios and models.

Warming predicted by models (IPCC)



Temperature projection is important for decision making.

More rain or less rain? (IPCC Report) 2080-2099



Huge Impact on Society

Sea level rise

Tuvalu

Typhoon

Future sea level rise until 2100

Sea level rise will be mainly related to thermal expansion of sea water in the future projection. Only 30 – 50 cm?



Question 5.1, Figure 1. Time-series of global mean sea level in the past and future, relative to zero in 2001. For the period before 1870, we do not have global measurements of sea level. The solid line here is a climate model calculation (Gregory et al., 2006) of sea level change due to natural factors (volcanic and solar variability) and anthropogenic factors; the rather sudden fall early in the 19th century is mainly due to the eruption of Tambora in 1815. The grey shading shows the uncertainty on the estimated long-term rate of sea level change (see Chapter 6, Section 6.4.3). We show a reconstruction of global mean sea-level from tide gauges (Church and White, 2006, Section 5.5.2.1) for 1870-2001, with uncertainties shown by shading, and from satellite altimetry (Cazenave and Nerem, 2004, Section 5.5.2.2) for 1993–2004, both as annual means. For the future we indicate the range of uncertainty due to different choices of emission scenario (see Chapter 10, Section 10.6.5). Beyond 2100 the projections are increasingly dependent on the scenario. Over many centuries or millennia, sea level could rise by several metres (see Chapter 10, Section 10.7.3).



Figure 5.5.7. Thermal expansion curves for 1993–2003, average over 60°S–60°N, based on Levitus et al. (2005a) temperature data (in black; 0–700 m layer), Ishii et al. (2006) (in red; 0–700 m layer) and Willis et al. (2004) (in green; 0–750 m layer). Shaded area and vertical red and green bars represent the 95% errors of the black, red and green curves respectively. The blue curve is the observed global mean sea level by satellite altimetry (yearly-mean, averaged over 65°S–65°N).

The thermal expansion is a major component.



Recent changes of the Greenland ice sheet



Source: Witze (2008)

Mass balance negative: sea-level equivalent to 1.5 to 2.5 cm/100years (Ohmura, 2004) New satellite gravity measurements (2002 - 2005): $6.6 \pm 0.6 \text{ cm}/100 \text{ years}$ (Chen et al., 2006)

Simulation results for Greenland

Surface velocity

differs greatly for the two set-ups!

2100 slow basal slide



2100 fast basal slide



Year-to-year variability, day-to-day variability

We should remember that sea level rises due to also wind-driven general circulation, storm surge and low atmospheric pressure.



Clarify causes and magnitude of sea level rise

- Most scenarios: only 30-50cm rise in the 21st century
- Oceanic thermal expansion near surface is major in the recent 10-year period and the future projection, but minor in last 50 years.
- Mountain glaciers: comparable with the thermal expansion in last 50 years
- In last 50 years, deep ocean warming, and ice sheet melting in Greenland seem to be important.
- Is the future projection correct? Will the sea level rise 100cm, 150cm or more?
- Short-term variability is superimposed on the trend.

Distinct Indicator

Arctic sea ice

Indigenous people

Polar bear

Do you think that global warming is sometimes good for somewhere?

Yes, but it will not continue for long time!

Salmon will not come back to Hokkaido.

Fisheries around Shiretoko



Observed ice cover concentration Ice reduction is significant in last 30 years.

1965-75, Sep

1995-2005, Sep



Observed sea ice melt faster than prediction



AMSR-E Sea Ice Concentration 20050922

2005

Significant year-to-year variability → We should not extrapolate a few-year data for future projection.

AMSR-E Sea Ice Concentration

AMSR-E Sea Ice Concentration

20070815



If this decrease rate continues, the ice cover in this summer will possibly reach the IPCC prediction for 2040-2050.

2nd energetic variability in the atmosphere



If this EOF mode continues to be positive in future, sea ice would be pushed out and low in the Pacific sector.

When will summer Arctic sea ice disappear?

- IPCC Report: the ice cover in summer will disappear near the end of this century.
- The recent ice cover reduction was much faster.
- The ice cover was anomalously small in 2007 summer.
- Significant year-to-year variability
 →disappearance by 2020 might be exaggeration.
- We should be concerned with ice thickness.
- A simple extrapolation is not reliable,
 →but important mechanisms should be explored.
- Consequences have to be looked at in long-term too.

Positive Feedback in Earth System

Terrestrial ecosystem Marine ecosystem & geochemical balance

Expanding desert

Acid ocean

The topics that we focus on Clarify the mechanism of Abrupt Change



The topics that we focus on Clarify the mechanism of Abrupt Change



Global Carbon (Dioxide) Cycle existing amount and annual flux

Atmosphere (750 x 10**9 ton)



Sensitivity for carbon uptake or emission by ocean/terrestrial ecosystem Terrestrial ecosystem will change into source. Ocean responses are so stable. Without climate-ecosystem feedback



Larix Deciduous Forest: simulation study Toda *et al.* (2007)



Hydrologic cycle is also crucial: precipitation decrease \rightarrow productivity decrease

When will terrestrial ecosystem change from sink to source?

- Terrestrial ecosystem will absorb more carbon until mid-21st century.
- The uptake will reduce then, but it is so variable among the future prediction models.
- More careful studies on: responses of boreal forests to warming responses to drought carbon emission from soil such as peat land

Two examples of marine ecosystem response



Marine ecosystem change resulting in carbon emission

- In future prediction models, oceanic uptake is so stable with minor feedback from the climate change.
- Subpolar regions with high primary production will shrink significantly.
- Replacement of dominant plankton species will change the ocean from sink to source.

Scientists should

- try to give more information beyond the non-regret policy,
- pursue to clarify mechanisms of positive feedbacks in the earth system,
- think for 50-100 year future and suggest to take immediate action,
- not be too conservative, but not make a false alarm,
- not try to oversell their own research areas/projects,
- give uncertainty in risk assessment.

G8 Summit Symposium Drastic Change in the Earth System during Global Warming (June 24)

Five hot issues (presenters, moderators)

- 1. Clarify causes and magnitude of sea level rise (J. Church, M. Ikeda)
- 2. Decay of glaciers and Greenland and Antarctic ice sheets (A. Ohmura, R. Greve)
- 3. When will summer Arctic sea ice disappear?(W. Maslowski, M. Ikeda)
- 4. Carbon uptake or emission by terrestrial ecosystem (T. Maximov, A. Itoh, T. Hara)
- 5. Marine ecosystem change resulting in carbon emission (M. Kawamiya, Y. Watanabe)