Implications from climate - carbon cycle modeling on socio-economic scenario development

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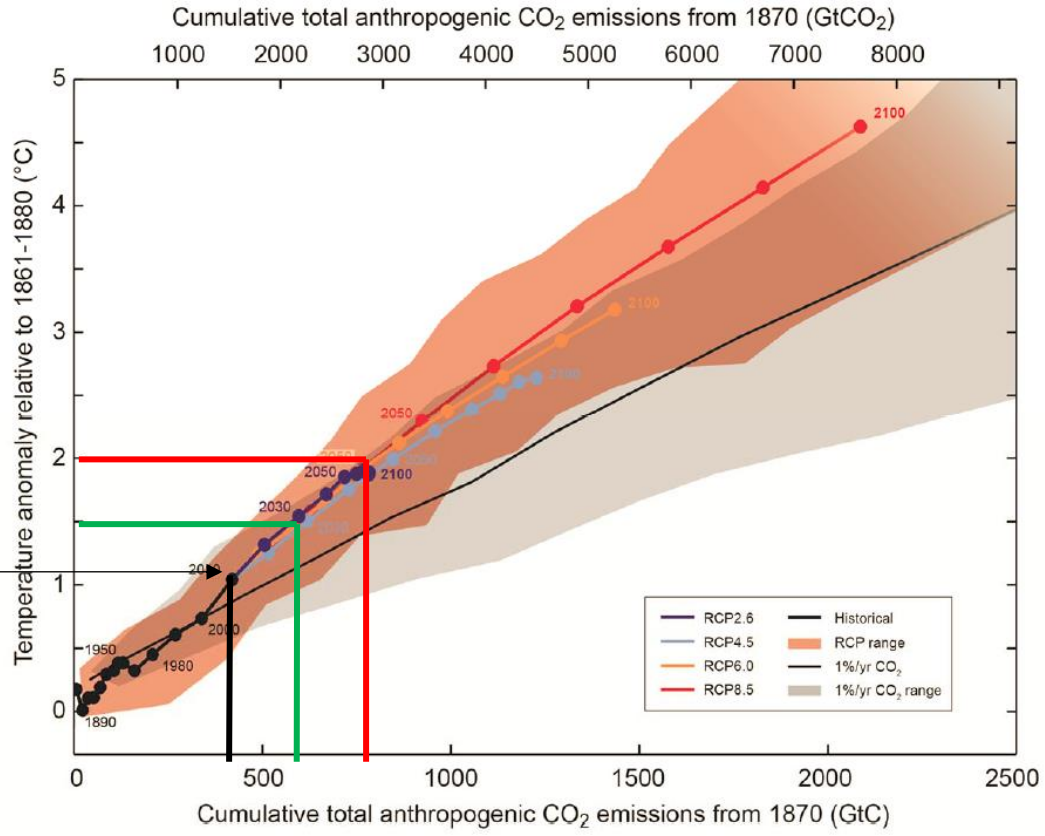
Transient Climate Response to cumulative carbon Emission (TCRE)



2010

IPCC (WG1) AR5

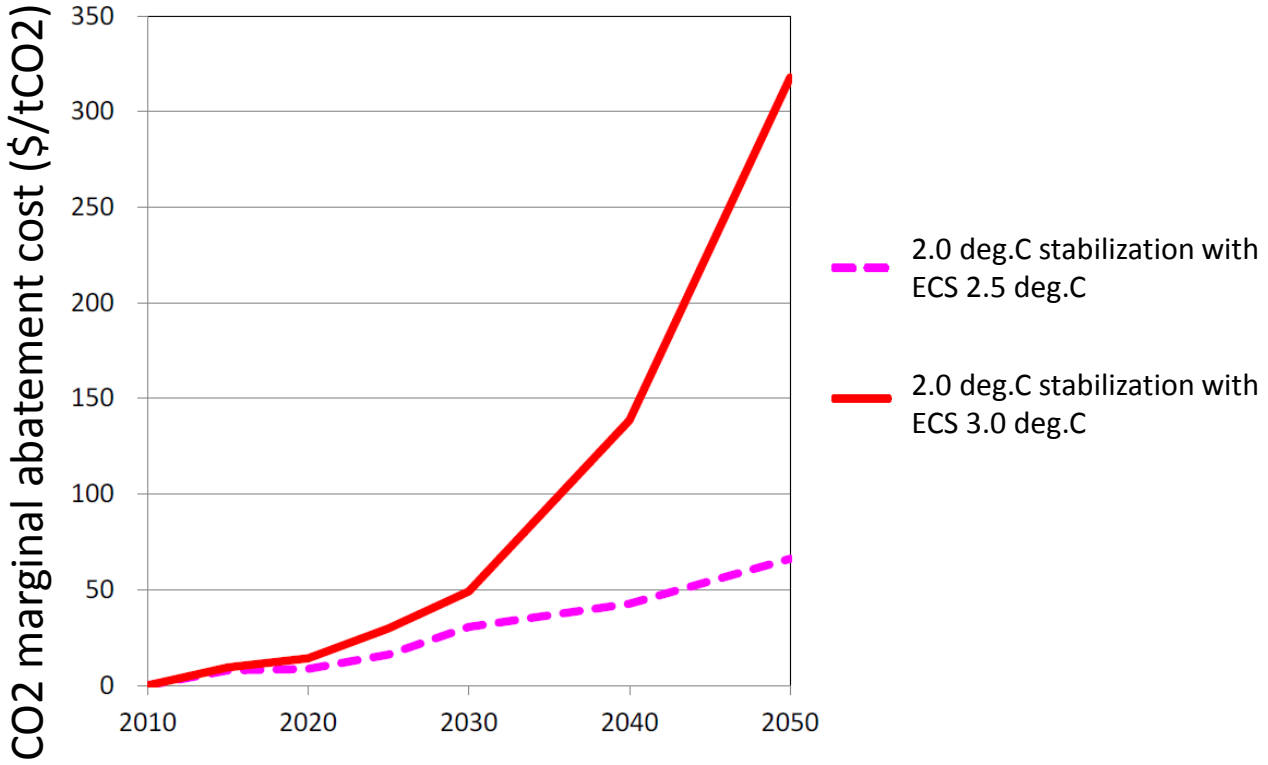
- Transient temperature rise is proportional to cumulative carbon emission up to that time.
- It is an outcome of recent development in climate – carbon cycle modeling
- To attain the 2. deg. target, cumulative carbon emission should be below ~800 PgC
- More than half of that is already emitted.
- Yet, uncertainties are still quite large, which has significant socioeconomic implications.

Implications of uncertainty in TCRE: by analogy with that in equilibrium climate sensitivity (ECS)

＊Equilibrium Climate Sensitivity (ECS): Equilibrium temperature rise under doubled CO_2. Estimated range is 1.5～4.5℃.

→Measure of how warm the earth is prone to be

Estimated cost for climate mitigation is strongly dependent on CS.



Source：Y. Kaya (2015)
http://www.rite.or.jp/news/events/pdf/Kaya_ALPSII_2015.pdf（accessed 2016-5-12）

Carbon cycle also affects mitigation cost estimate

CO_2 emission → CO_2 accumulation→ Warming

Airborne fraction

Transient climate response
=f(ECS, response time of the earth system)

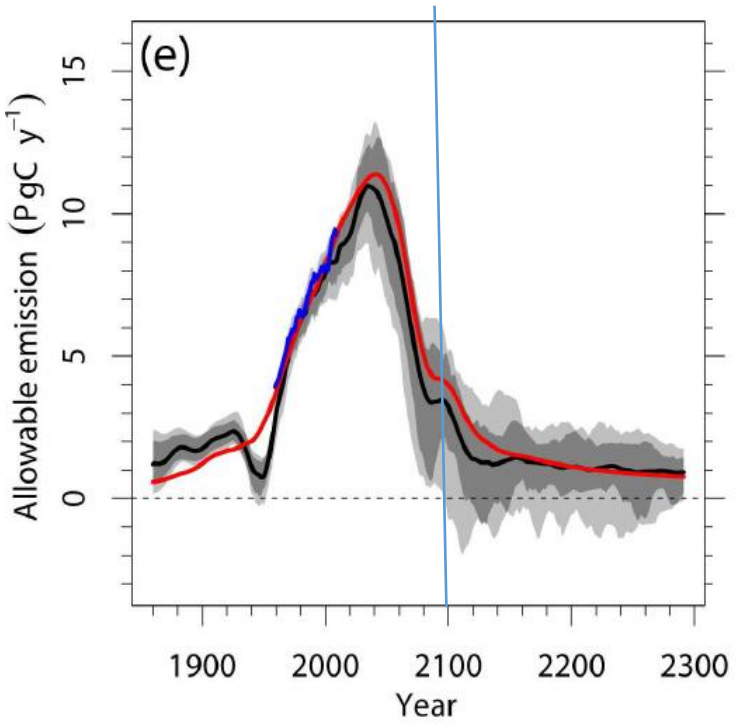
$$\mathrm{TCRE} = \frac{\Delta T}{\Delta C_E} = \frac{\Delta C_A}{\Delta C_E} \times \frac{\Delta T}{\Delta C_A}$$

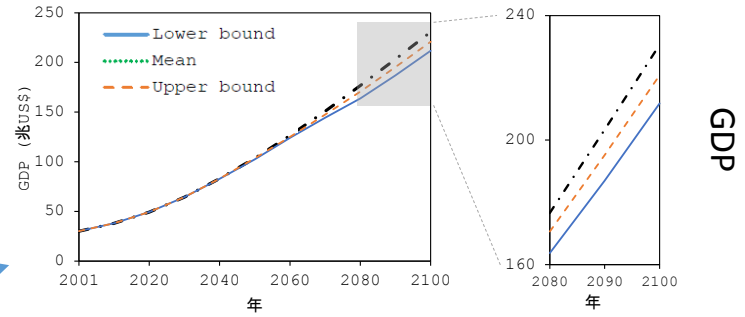
ΔT: Temperature rise
ΔC_E: Cumulative emission
ΔC_A: Atmospheric CO_2

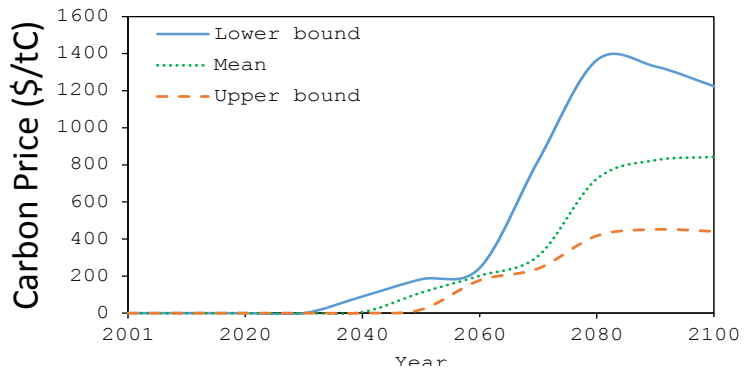
Uncertainty estimate of mitigation cost should consider responses of both carbon cycle and climate to increasing CO_2.

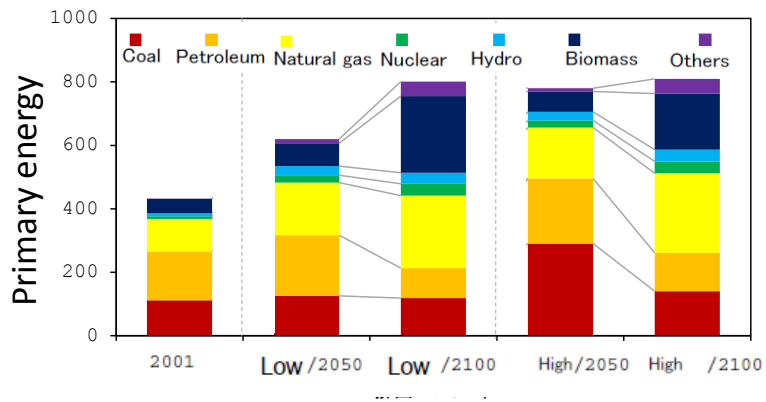
Socioeconomic impact of earth system uncertainty

Uncertainty in emission scenario







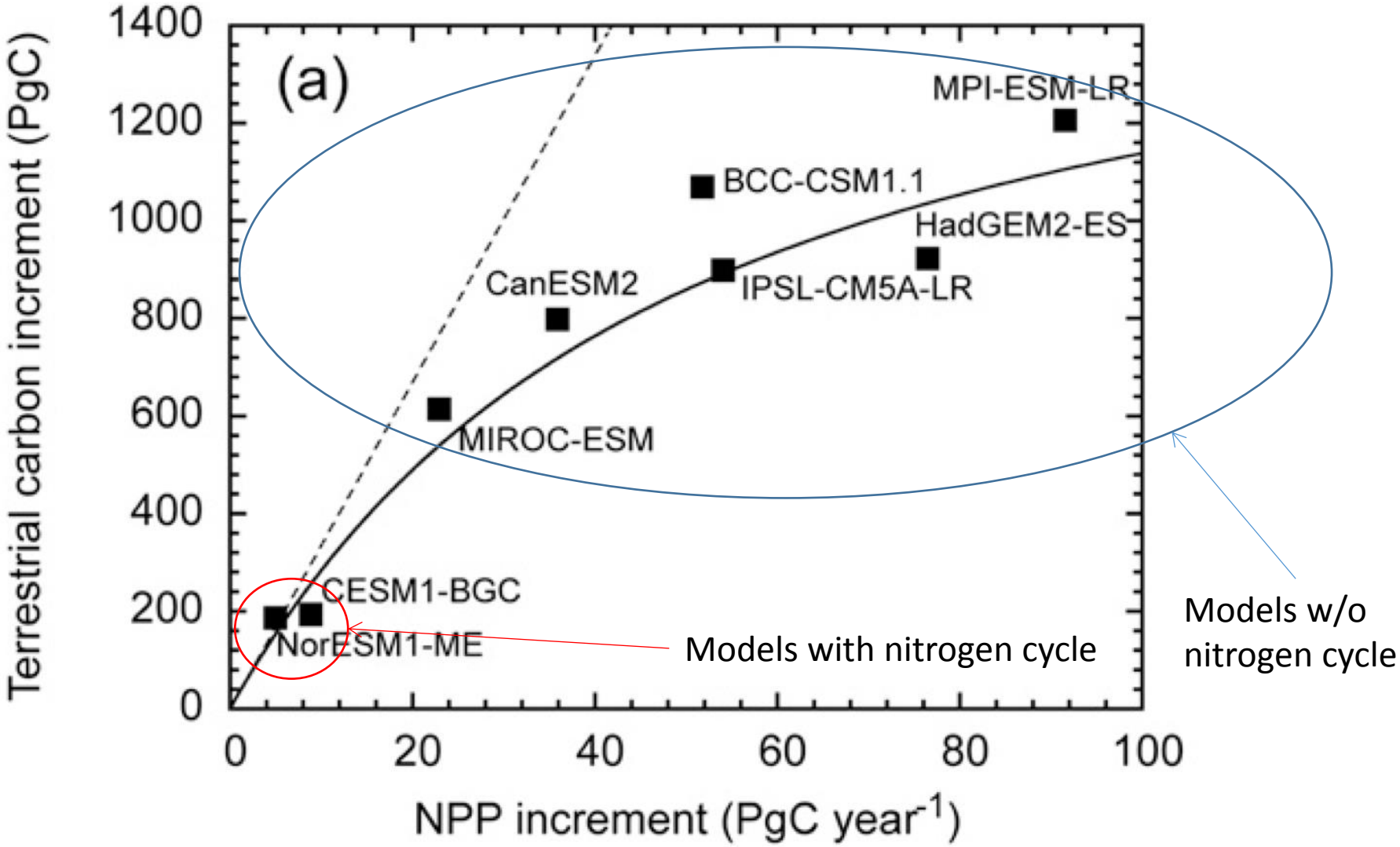


Three-fold difference in carbon price can be seen between the higher and lower bound emission scenario targeting the same concentration scenario.

Matsumoto, K., Tachiiri, K, Kawamiya, M (2015): Impact of climate model uncertainties on socioeconomics: a case study with a medium mitigation scenario, Computers & Operations Research.

Scatter in estimated CO2 uptake by terrestrial ecosystem

Increase of soil carbon storage due to CO2 fertilization effect



Hajima et al.(2014)

SOUSEI Program for Risk Information on Climate Change
気候変動リスク情報創生プログラム

FY 2012-2016

A. Prediction and diagnosis of imminent global climate change (PI: M. Kimoto, U. of Tokyo)

D/A, Event Attribution, Seamless Prediction, ECS, Data Assimilation

B. Climate change projection contributing to stabilization target setting (PI: M. Kawamiya, JAMSTEC)

Climate Scenario, Earth System Model, Tipping Element, Geo-engineering

C. Development of basic technology for risk information on climate change (PI: I. Takayabu, MRI)

Dynamical and Statistical Downscaling, High-res GCM

D. Precise impact assessments on climate change (PI: E. Nakakita, Kyoto U.)

Weather, Water, Coastal Disasters, Water Resource, ecosystem …

E. Promotion office for climate change research and linkage coordination (PI: M. Kawamiya, JAMSTEC)

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Summary

- Transient Climate Response to cumulative carbon Emission (TCRE) is an “earth system version” of transient climate response.
- Uncertainty in TCRE has a huge impact on estimated mitigation cost.
- Introduction of nitrogen cycle strongly affects carbon cycle, and thus TCRE.
- Efforts should be directed toward agreement upon best guess and uncertainty range of TCRE.