Assessment of Global Climate Risk Management Strategies
-Introduction to the interim research report of the ICA-RUS project -

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On behalf of all the ICA-RUS members

ASIA-PACIFIC INTEGRATED MODEL

NIES *JAPAN*

Ongoing research projects on climate change impacts and adaptation at global scale

NIES Climate Change Research Program

- Project 2: Climate change and global risk assessment [2011.4-2016.3]

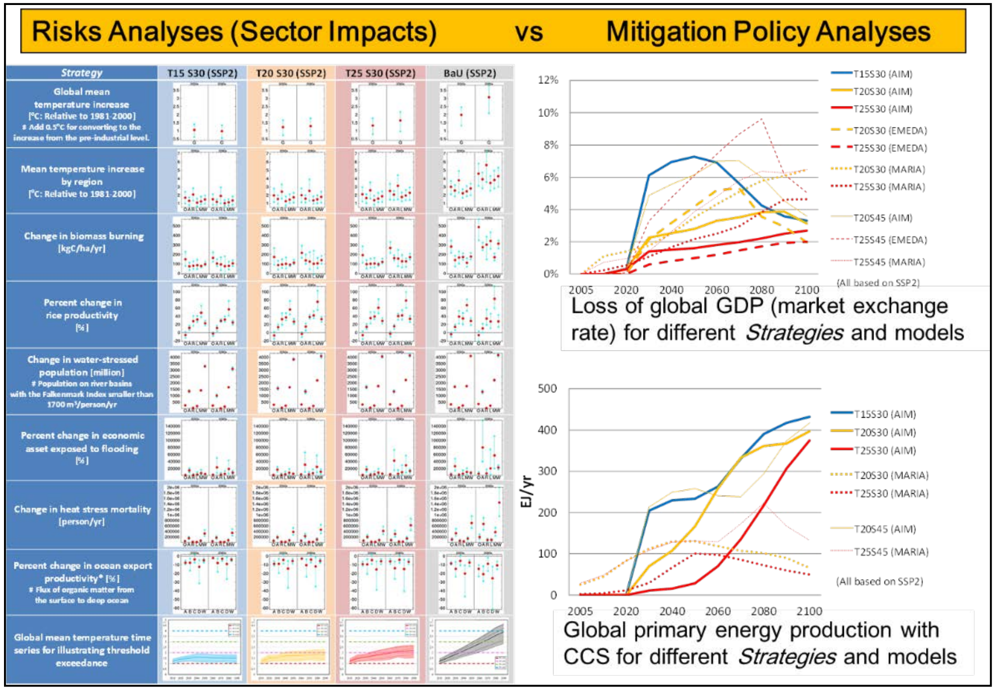
The Environment Research & Technology Development Fund (ERTDF) funded by the MoE

- S-10/ICA-RUS: Integrated research on the development of global climate risk management strategies [2012.6-2017.3]
- S-14/MiLAi: Strategic research on global mitigation and local adaptation to climate change [2015.6-2020.3]

ICA-RUS (FY2012-16)

Integrated Climate Assessment – Risks, Uncertainties and Society

- Objective
  - To propose strategies of global climate risk management
- ICA-RUS REPORT 2015
  - Alternatives Left to Humanity Faced with Global Climate Risks (Ver.1)
  - http://www.nies.go.jp/ica-rus/en/



3rd annual report based on the first version of risk management strategies (English version) has been published in this month.

Background and aim of the ICA-RUS project

Background

UNFCCC COP16, Cancun Accord :

'2 degree' temperature target agreed? ('1.5 degree' also mentioned)

However, …

- *Gap between '2 degree' and bottom up targets from each country*
- *Decision of targets involves value judgment (not purely scientific)*
- *Scientific uncertainty between temperature and emission targets*
- *Linkages between climate policy and water/food security etc.*

➡ *From a long-term perspective, reconstruction of rational strategies to live with uncertain climate risks is needed (Global Climate Risk Management Strategy)*

Aim

- Critical climate risks
- Linkages with water/food etc.
- Risk management options
- Risk perception/values

} Scientific information

⬇

Risk Management Strategies

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Support decision making on national/international climate policies

Steps for developing risk management *strategies* in ICA-RUS

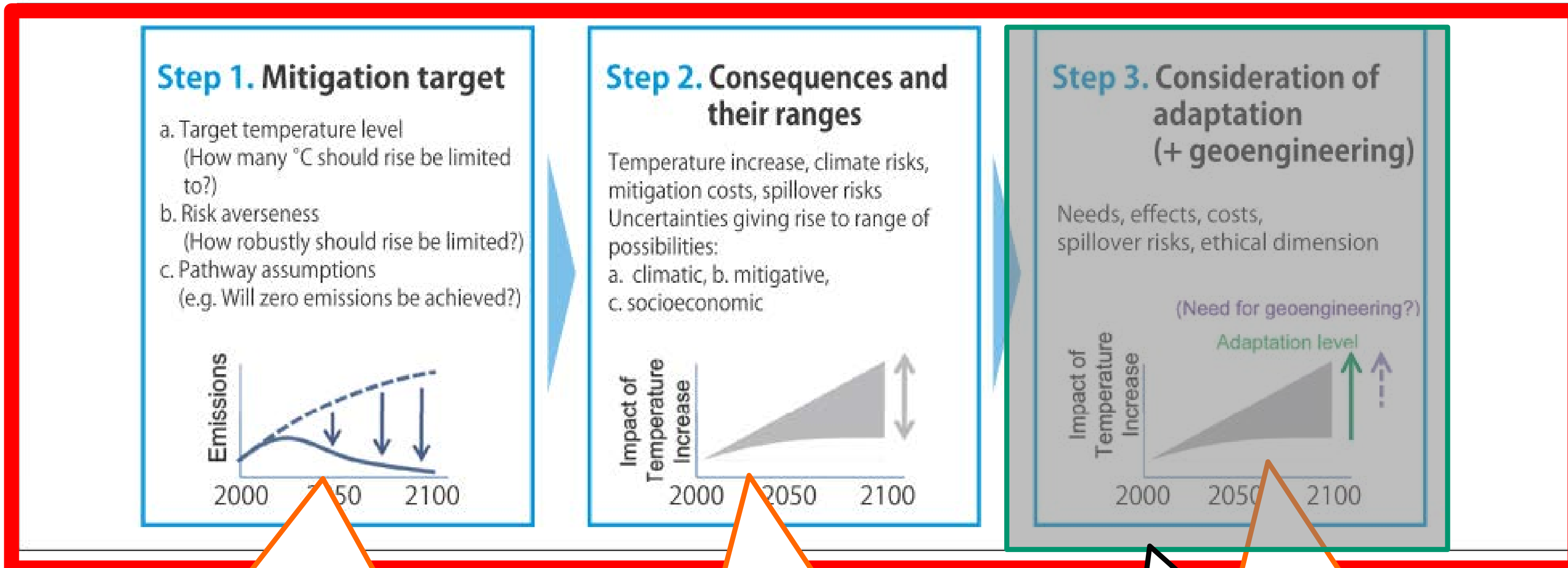


Figure I-1 "Str CA-RUS

Each risk r
choice of r

The mitigation target is defined by target temperature level and risk averseness that is substituted by the assumed climate sensitivity.

Mitigation cost and c
are estimated under t
mitigation target.

geoengineering are considered.

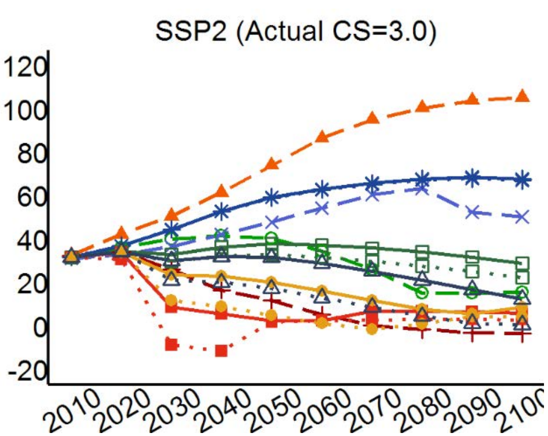
Note: We have not yet conducted Step3 in ICA-RUS Report 2015 analyses.

Finally, the deliverables from those three steps constitute a risk management *strategy*.

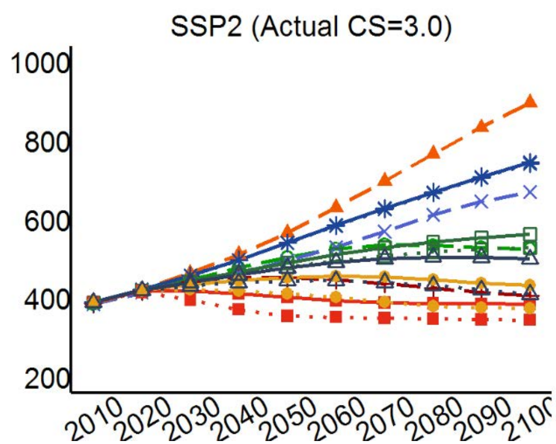
Six risk management *strategies* examined in the report

Strategy	Targeted Temperature Level (relative to preindustrial) [°C]	Assumed Climate Sensitivity to estimate emission pathways [°C]	Probability of meeting the target
T15S30	1.5	3.0	~50 %
T20S30	2.0	3.0	~50 %
T25S30	2.5	3.0	~50 %
T15S45	1.5	4.5	~80 %
T20S45	2.0	4.5	~80 %
T25S45	2.5	4.5	~80 %

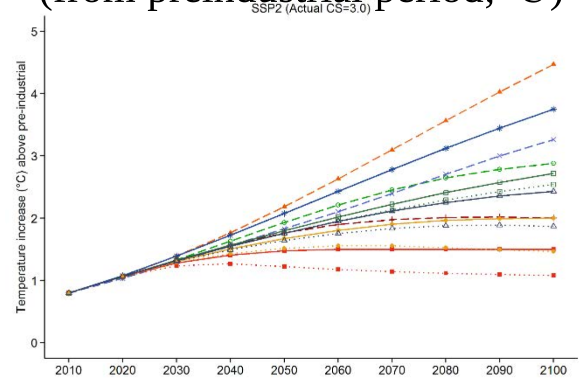
CO2 emission from industry

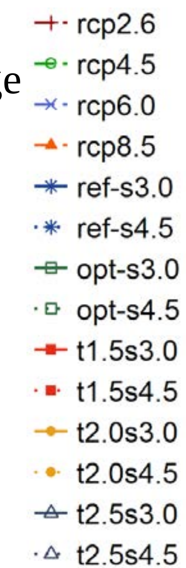


CO2 concentration (ppm)



Global mean temperature change (from preindustrial period; ℃)



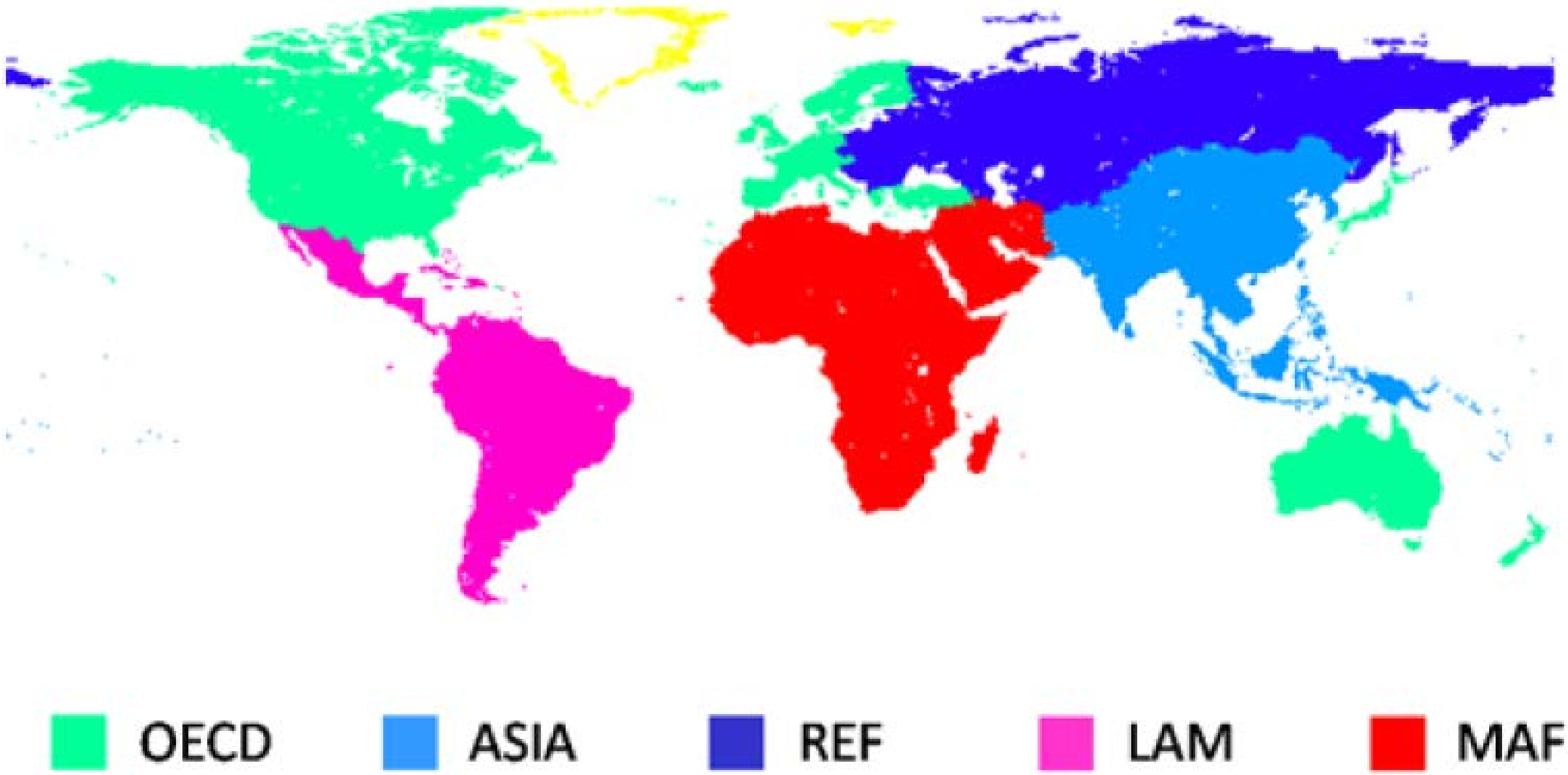


We have assessed risk-management implications of setting 1.5℃, 2.0℃ or 2.5℃ target at about 50% probability.

Impact variables projected for the interim report

Sector	Organization	Impact variables	Resolution
Agriculture	NIAES	Yield (Rice, Spring wheat, Maize, Soybean)	1.125
Water resource	NIES	River discharge Surface runoff Population with water stress	0.5
Terrestrial ecosystem	NIES	NPP/NEP Carbon in biomass Carbon in soil Soil erosion Vegetation fire	0.5
Flood	Tokyo Institute of Technology	Flooded population (100yr-RP) Flooded GDP (100yr-RP)	0.5
Human health	Tsukuba Univ.	Heat stress mortality	0.5
Ocean	Hokkaido Univ.	Anoxic zone Ocean export productivity	1.0

Five regions defined for the analyses



O: OECD90

A: Asia

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L: Latin America

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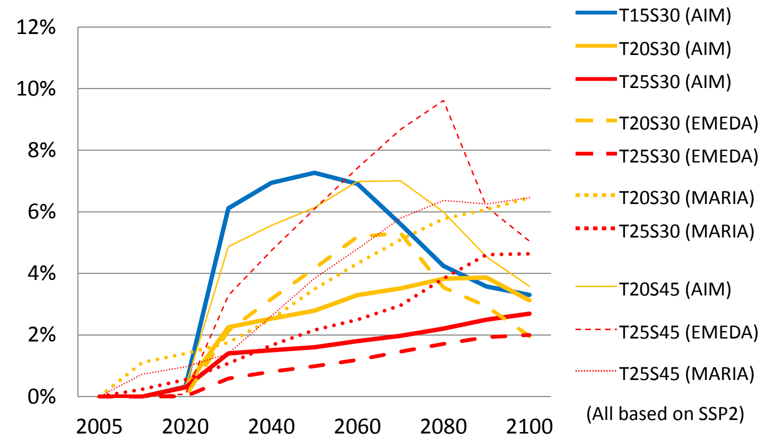
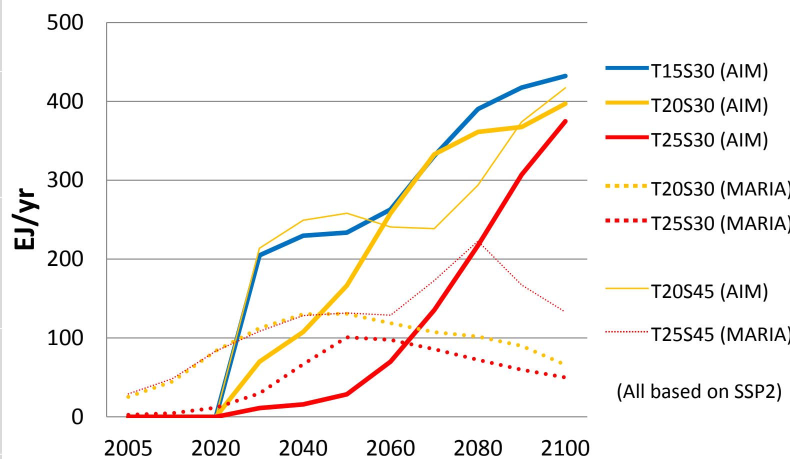
Analyses of risk management strategies

Risks Analyses (Sector Impacts) vs Mitigation Policy Analyses



Loss of global GDP (market exchange rate) for different *Strategies* and models

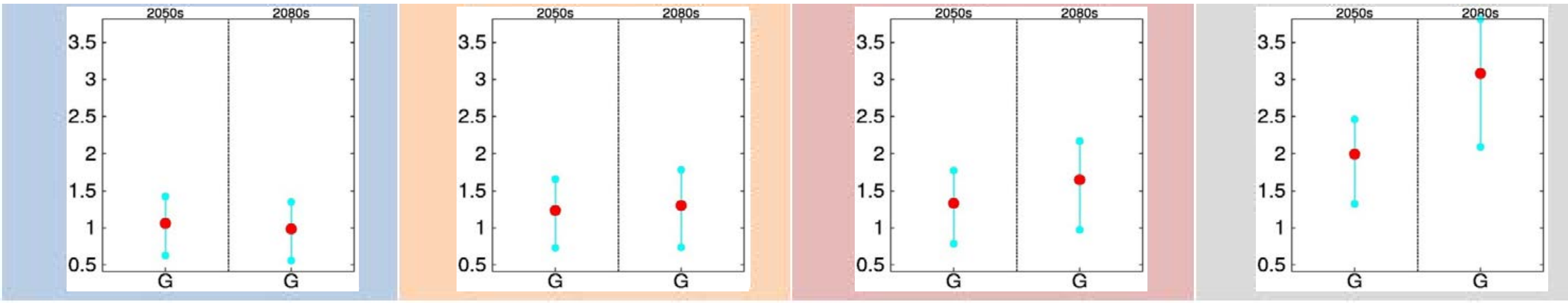


Global primary energy production with CCS for different *Strategies* and models

Results of regional risk analyses (2050s & 2080s)

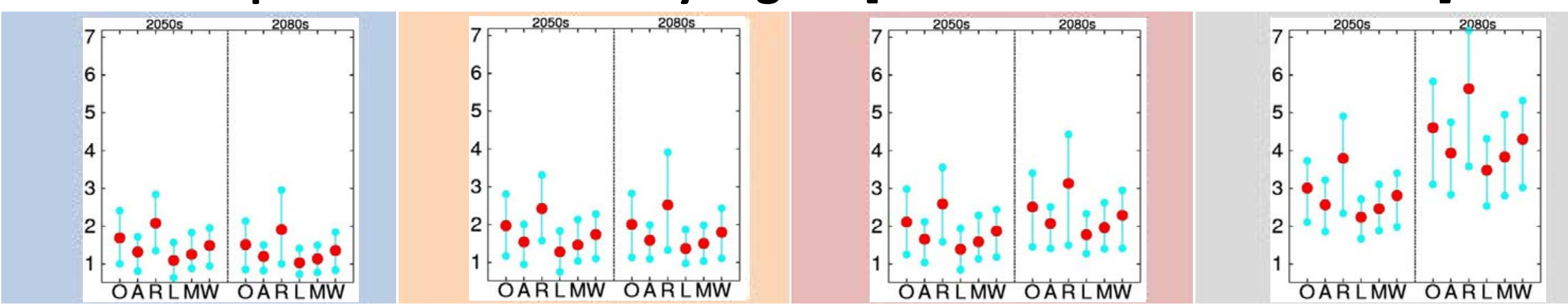
T15 S30 (SSP2)	T20 S30 (SSP2)	T25 S30 (SSP2)	BaU (SSP2)

Global mean temperature increase [℃: Relative to 1981-2000]



Blue vertical lines denote GCM uncertainty. GCM uncertainty range is wider than the difference among the three strategies, T15S30, T20S30 and T25S30. For obtaining change from preindustrial, 0.5℃ needs to be added.

Mean temperature increase by region [℃: Relative to 1981-2000]



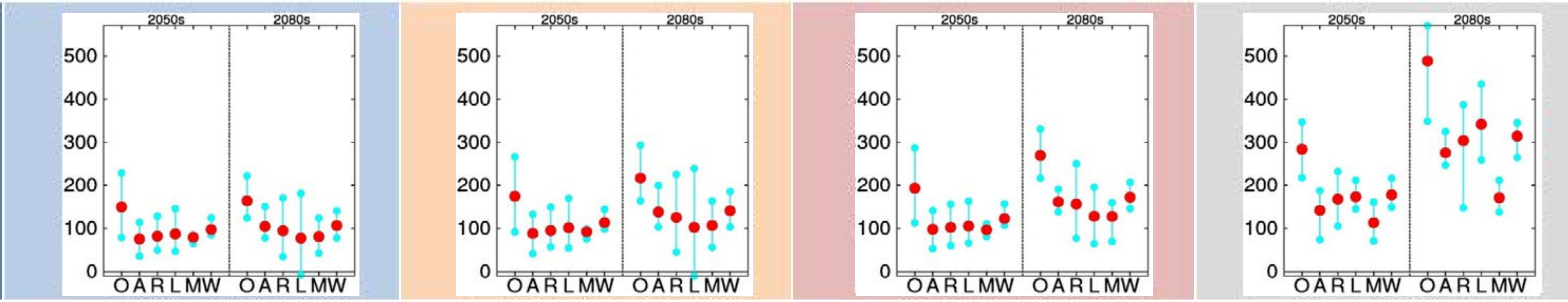
If we look at regional averages, temperature will increase more in R region (FSU and East Europe) than in the other regions. Without any mitigation policy (BaU), 6℃ or larger temperature increase may occur in this century.

O: OECD90 ; **A**: Asia ; **R**: FSU and East Europe ;
L: Latin America ; **M**: Middle East and Africa ; **W**: World

Results of regional risk analyses (2050s & 2080s)

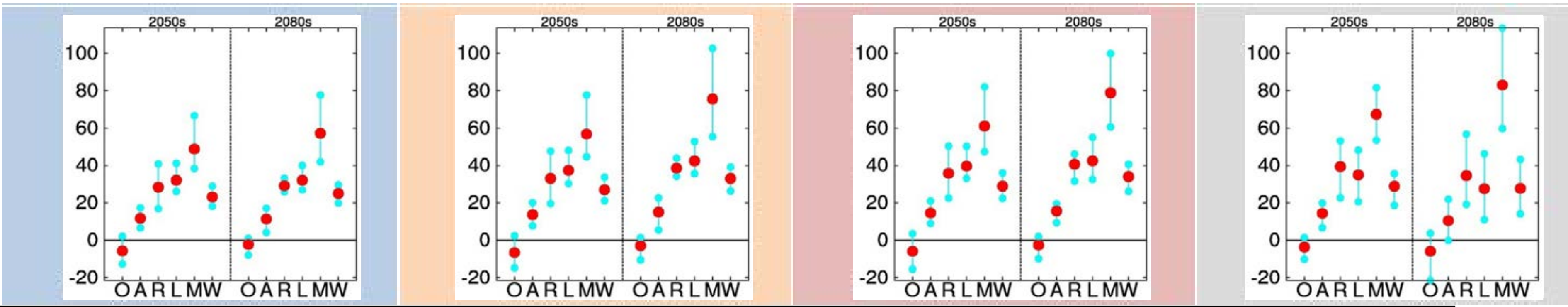
T15 S30 (SSP2)	T20 S30 (SSP2)	T25 S30 (SSP2)	BaU (SSP2)

Change in biomass burning [kgC/ha/yr : Relative to 1981-2000]



With hotter and drier condition, frequency of forest fire increases. Fuel amount also matters. Achieving one of the three *strategies*, change in biomass burning would be reduced by 30-50% from BaU.

Percent change in rice productivity [% : Relative to 1981-2000]



Globally, T20S30 and T25S30 have the highest rates of increase in rice productivity at the end of this century, followed by T15S30 and BaU. A decline is forecasted in OECD, and the differences among *strategies* are small.

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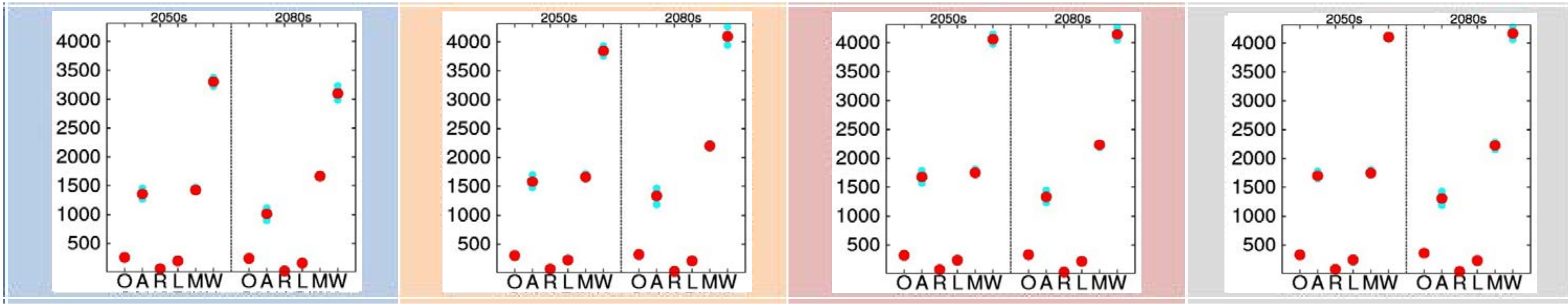
Results of regional risk analyses (2050s & 2080s)

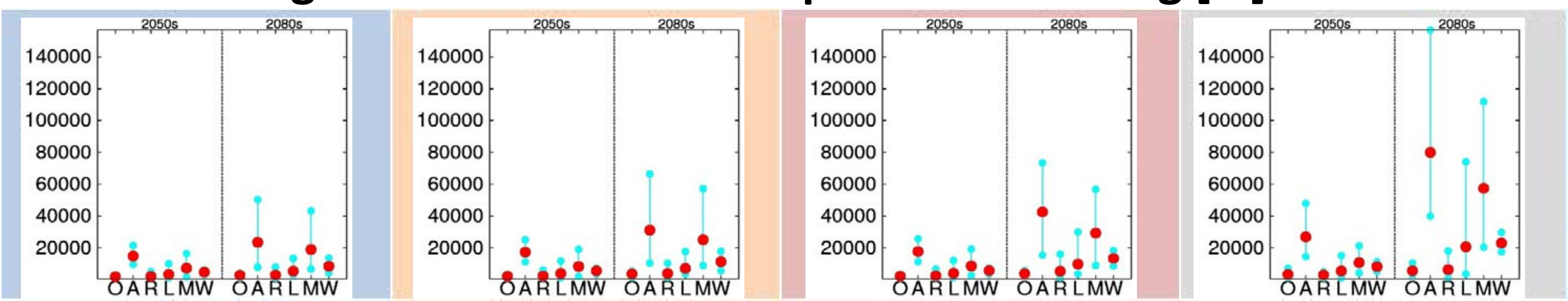
T15 S30 (SSP2)	T20 S30 (SSP2)	T25 S30 (SSP2)	BaU (SSP2)

Change in water-stressed population [million : Relative to 1981-2000]



Sensitivity to change in climate is small. The results are highly dependent on population scenarios and the growth in water-stressed population is higher under scenarios that assume greater population growth.

Percent change in economic asset exposed to flooding [%]



T25S30 has the highest rate of growth in economic asset exposed to flooding of the three *strategies*, and it is projected to produce major growth in economic asset exposed to flooding in Asia, especially in the 2080s.

O: OECD90 ; **A**: Asia ; **R**: FSU and East Europe ;
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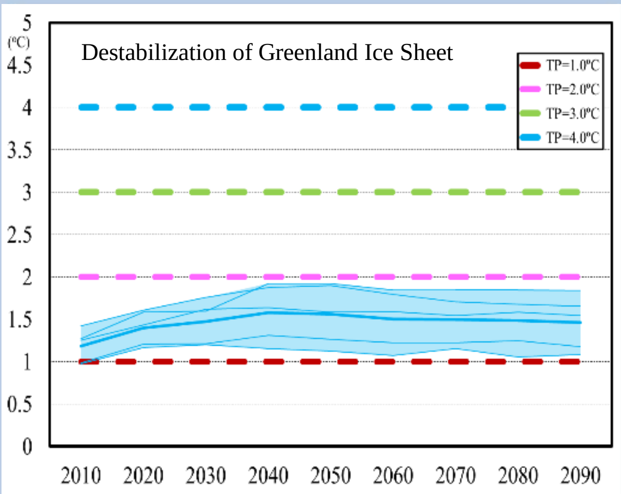
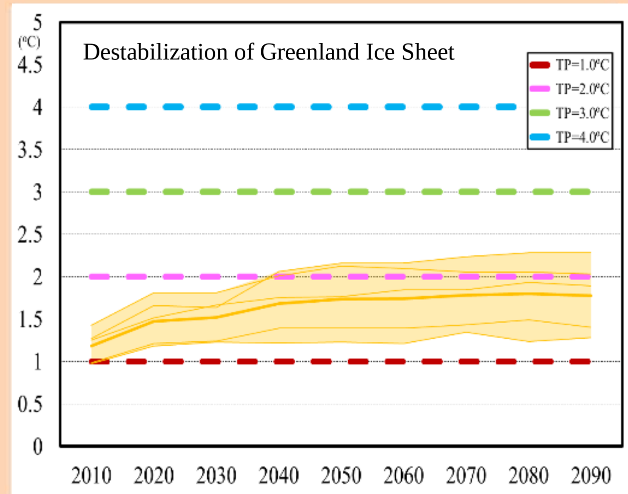
Results of large scale discontinuity risk analyses

Change in global mean temperature (relative to preindustrial) for illustrating exceedance of threshold for Greenland Ice Sheet Destabilization

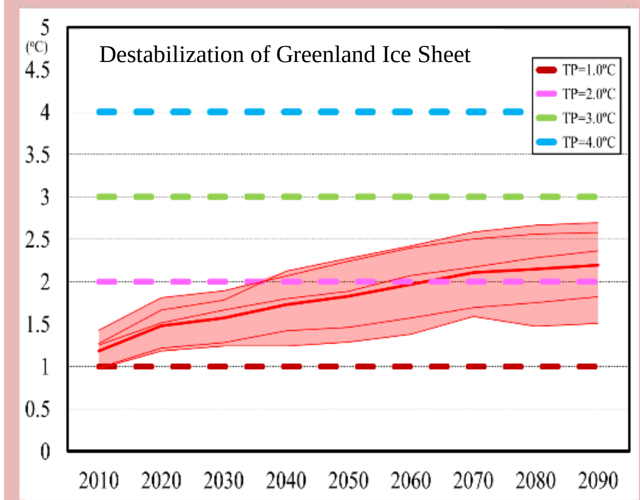


T15 S30 (SSP2)

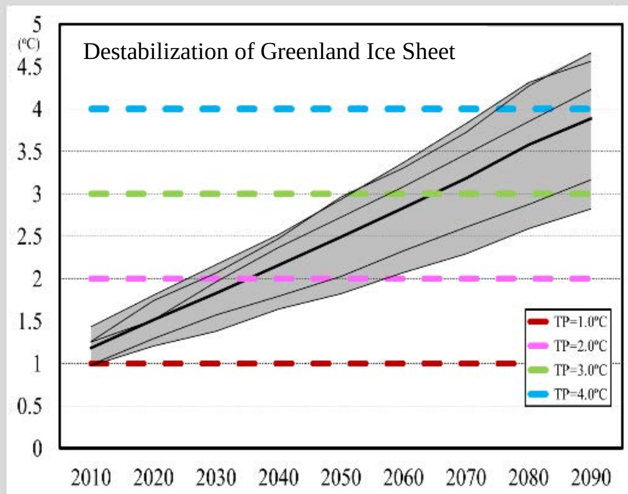


T20 S30 (SSP2)

T25 S30 (SSP2)



BaU (SSP2)

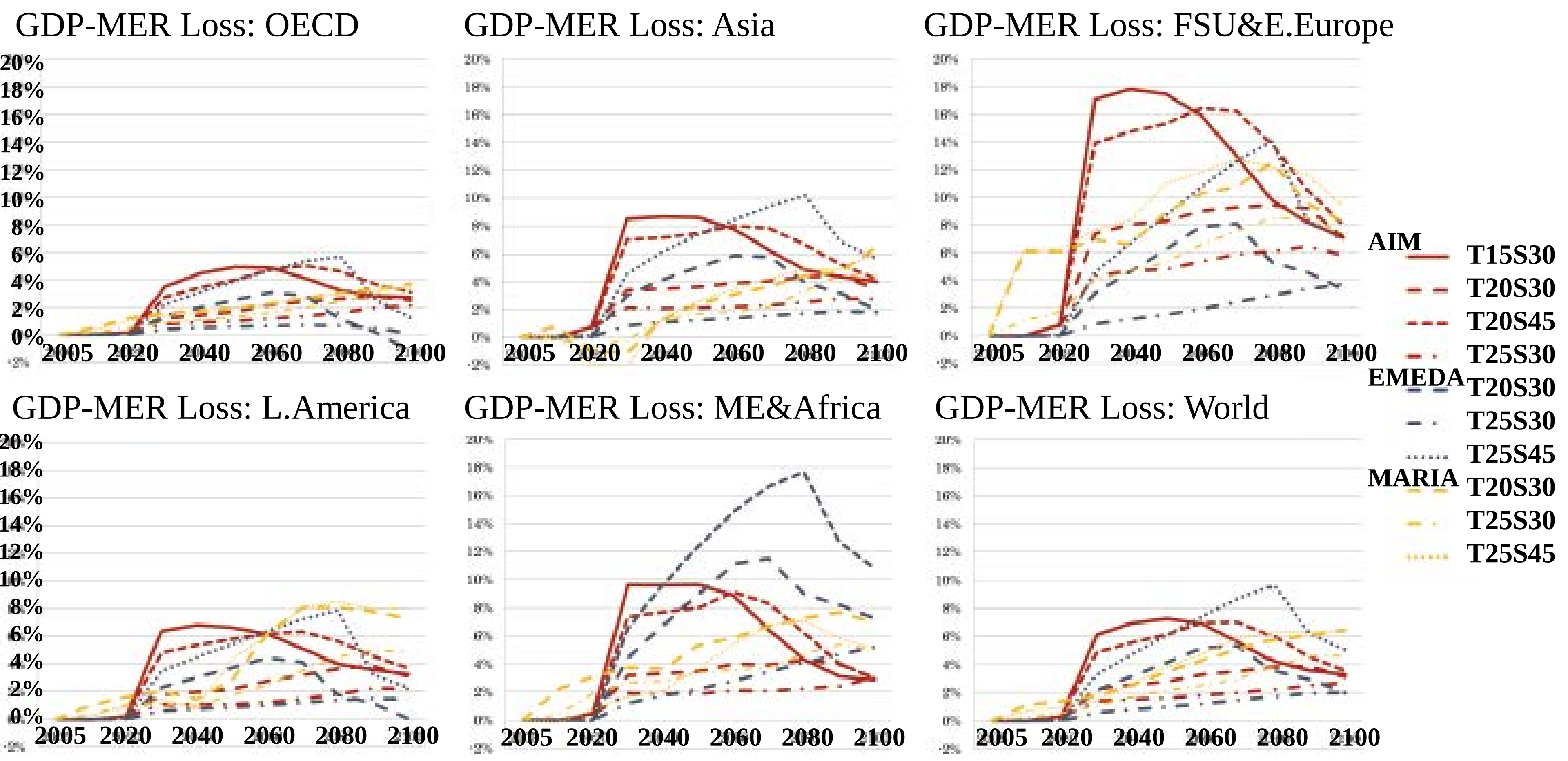


- According to IPCC AR5, the tipping point for destabilization of the Greenland ice sheet can be crossed at a global temperature rise of between 1℃ and 4℃ from pre-industrial levels.
- Thus, if the threshold is just 1℃ (red line), it will be passed unavoidably, irrespective of the strategy to take.
- If, on the other hand, it is 2℃ (pink), the strategic choice will greatly affect the likelihood of the tipping point being passed.

Summary: Risk analyses

- **From the impact perspective, making progress toward a target without fail and dealing with climate uncertainties are more important than the choice of target.**
  - The difference in impacts between any two targets is generally smaller than that between any target and BaU and also than the range of impacts caused by climate uncertainty.
  - Note that a more comprehensive assessment could alter this finding. Especially, probability of crossing certain threshold temperature could be very different for different target.

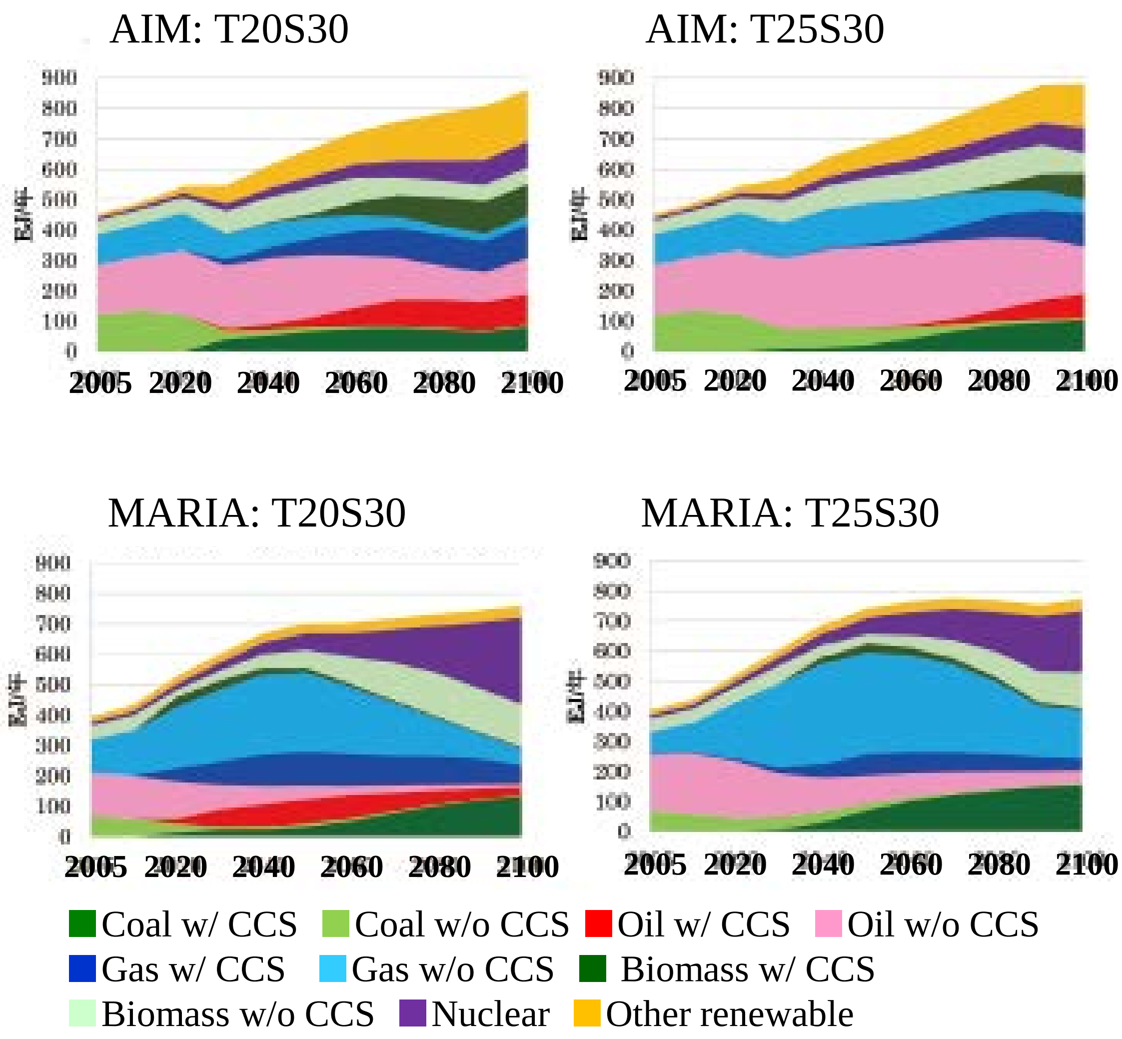
Mitigation Policy Analyses: Regional GDP Loss



- Estimation using multiple integrated assessment models (GRAPE, AIM, MARIA, EMEDA) of the mitigation actions to achieve each *strategy*'s mitigation target revealed marked differences between the strategies.
- Most notably, T15S30 was found to be even more challenging than RCP2.6, the most challenging scenario assessed for IPCC AR5: either it is unachievable except under very optimistic conditions or, depending on the model, no solution is obtainable for it.

Mitigation Policy Analyses: Share of Primary Energy Supply

- The choice of technology options for achieving mitigation targets differs considerably according to model.
  - Large-scale adoption of nuclear power (e.g. MARIA) and large-scale adoption of renewable energy technologies (e.g. AIM) were both demonstrated to be possible methods of achieving the targets.
- On the other hand, fairly large-scale carbon capture and storage (CCS) will be necessary according to all the models.



Summary : Mitigation policy analyses

- **Mitigation costs are very sensitive to the target choice. The most stringent 1.5℃ target could only be feasible under optimistic assumptions**.
  - Large-scale deployment of CCS appears essential while some flexibility is left in the portfolio of mitigation options (e.g., proportions of renewables and nuclear).
  - Bio-energy with CCS (BECCS) would cause a conflict with food production over land under pessimistic assumptions for crop productivity and/or CCS efficiency.
  - Note that models are optimistic for they assume globally optimized economic rationality, while they are, at the same time, pessimistic for they cannot represent unknown innovations that might cause structural changes in energy-economic and social systems.

Comparison between results of risk analysis and mitigation policy analyses

- **Within the scope of this study, impacts are generally less sensitive to a change in target than mitigation costs.**
  - Further work is needed to quantify impacts in monetary terms to complete a cost-benefit analysis.
  - A more comprehensive impact assessment including threshold exceedance could alter this finding.
  - Setting a target is one thing and meeting it is another. Considering the possibility of mitigation failure despite an ambitious target, a decision on a better target is further difficult.

Issues for future research

- Investigation of adaptation efforts and geoengineering possibilities corresponding to the consequences of each strategy
- Expansion of items of impact assessment for each of the strategy and socioeconomic scenarios
- Incorporation into analysis of spillover risks and co-benefits associated with responses
- Study taking into account successive (multi-stage) decision-making (such as a target revision in 2050)
- Consideration of a socially rational decision-making framework that gives due consideration to the characteristics of global climate risks

Key messages

- From the impact perspective, making progress toward a target without fail and dealing with climate uncertainties are more important than the choice of target.
- Mitigation costs are very sensitive to the target choice. The most stringent 1.5℃ target could only be feasible under optimistic assumptions.
- Within the scope of this study, impacts are generally less sensitive to a change in target than mitigation costs.
  - However, a more comprehensive impact assessment including threshold exceedance could alter this finding.

Climate risks anticipated for the alternative futures that are consistent with the INDCs

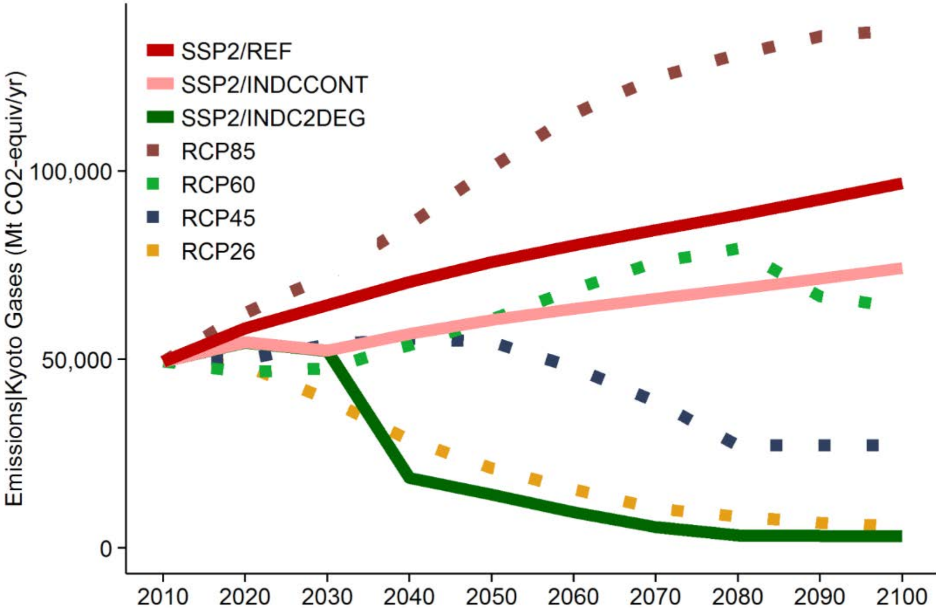
Six risk management *strategies* examined in the report

Strategy	Target Temp. Level (relative to preindustrial)	Assumed climate sensitivity to estimate emission pathways (℃)	Probability of meeting the target
T15S30	1.5	3.0	~50 %
T20S30	2.0	3.0	~50 %
T25S30	2.5	3.0	~50 %
T15S45	1.5	4.5	~80 %
T20S45	2.0	4.5	~80 %
T25S45	2.5	4.5	~80 %

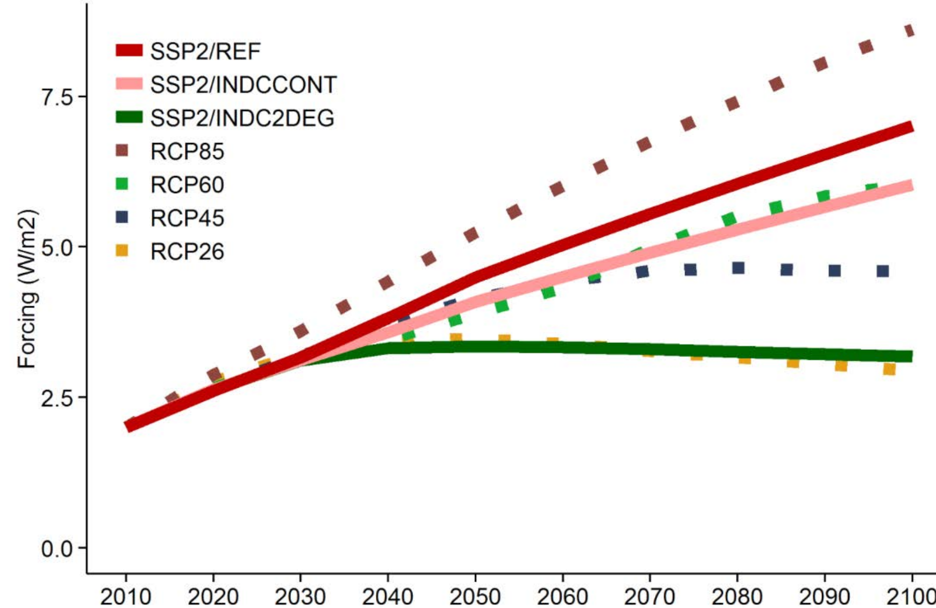
Three additional strategies examined for INDCs evaluation

Strategy	Assumptions
Ref	No climate policy
INDCcont	Copenhagen pledges in 2020, INDCs in 2030, followed by the same carbon price for INDC
INDC2deg	Copenhagen pledges in 2020, INDCs in 2030, and then implementation of mitigation policies to achieve the 2C target

Kyoto-gas emission（$MtCO_2eq/y$）



Total radiative forcing（W/m^2）



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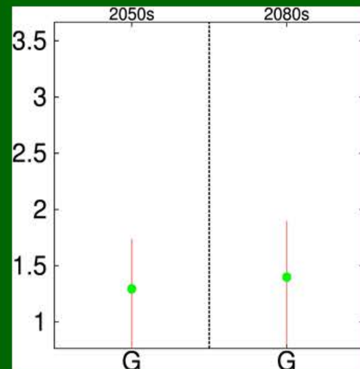
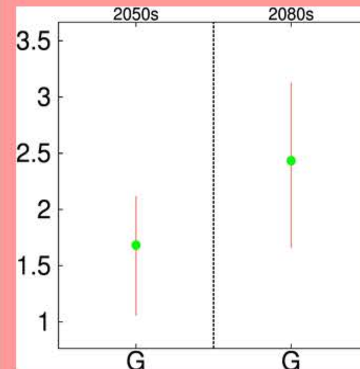
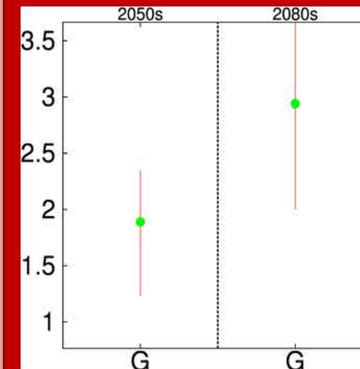
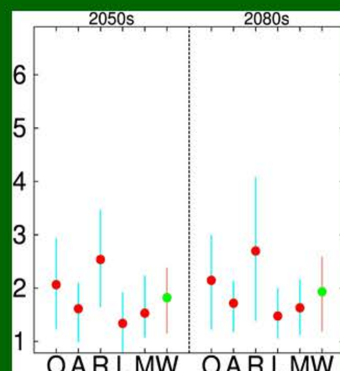
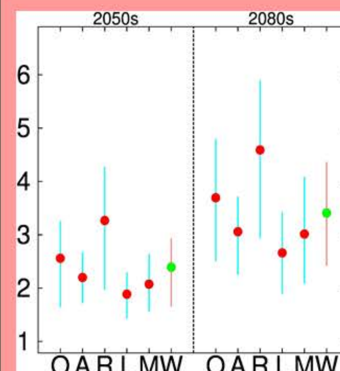
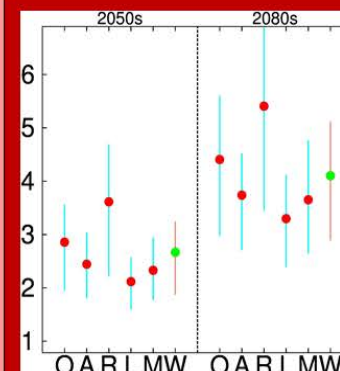
Temperature change for the additional strategies

Strategy	INDC2deg	INDCcont	Ref
Global average temperature change (℃; change from 1981-2000) *0.5℃ added to convert to change from pre-industrial levels			
Terrestrial average temperature change be region (℃; change with 1981-2000)			

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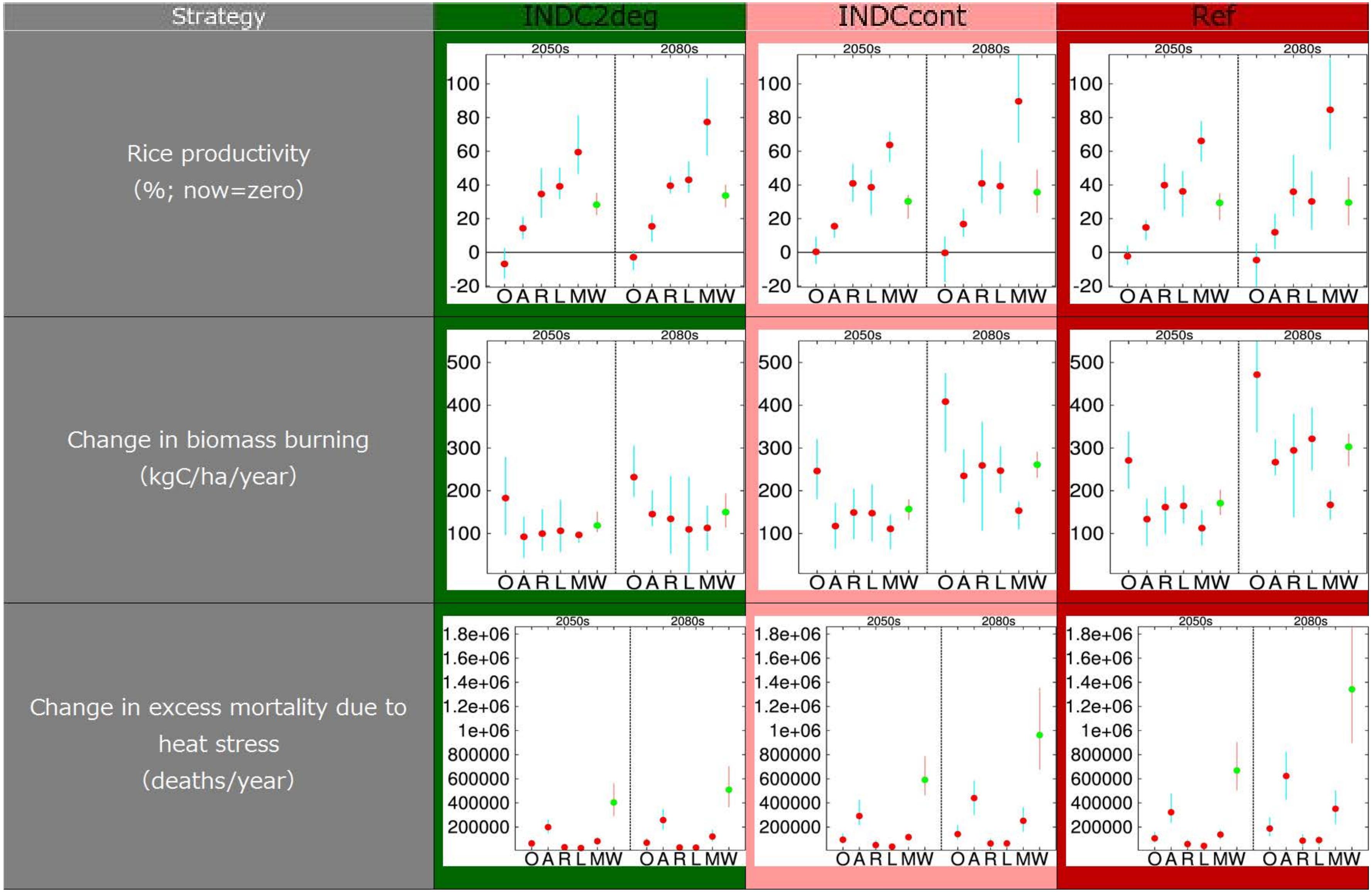
Example of risk indicators for the additional strategies



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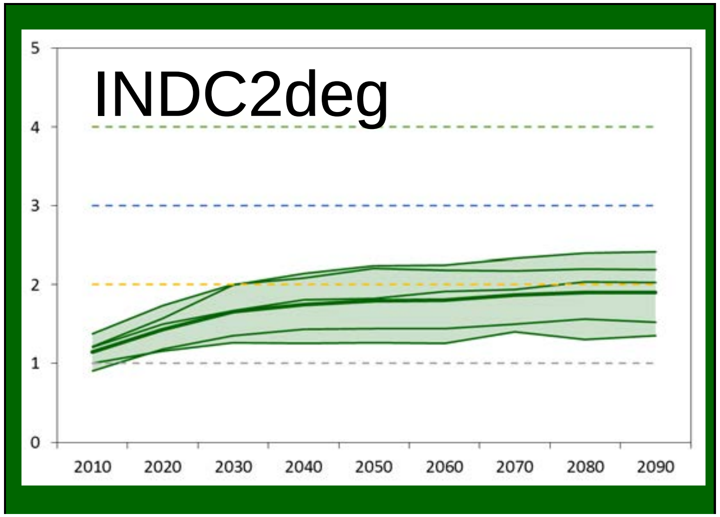
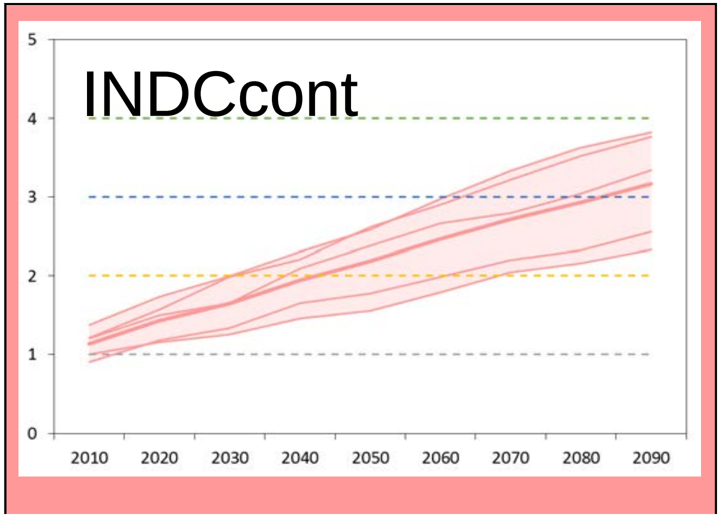
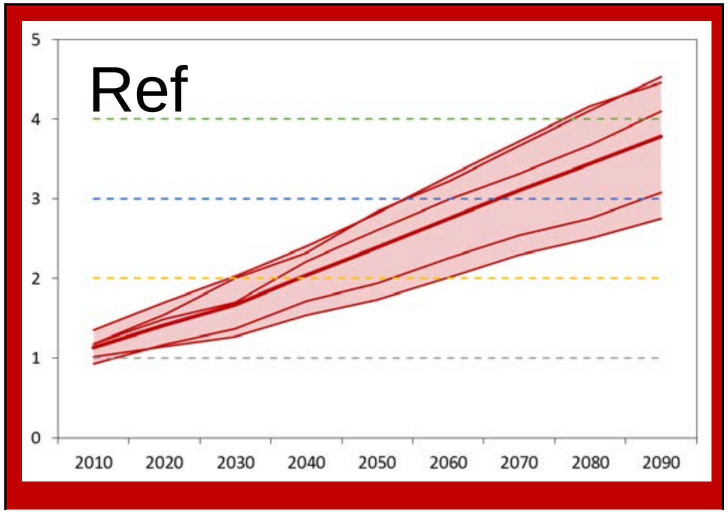
Results of large scale discontinuity risk analyses

Change in global mean temperature (relative to preindustrial) for illustrating exceedance of threshold for Greenland Ice Sheet Destabilization





- According to IPCC AR5, the tipping point for destabilization of the Greenland ice sheet can be crossed at a global temperature rise of between 1℃ and 4℃ from pre-industrial levels.
- Thus, if the threshold is 2℃ (yellow), the threshold is not crossed with about 50% probability under INDC2deg case.
- However, it will be inevitably crossed under INDCcont or Ref case.



Key messages

- For INDCcont case, GMT relative to preindustrial is projected to increase by about 3 ℃ at 2080s（GCM-mean). Through the achievement of INDC2deg, GMT increase at 2080s can be mitigated by 1.5 ℃ from the GMT increase projected for Ref (about 3.5 ℃).
- Similarly, for most of the sector impacts assessed, change in risk is smaller under INDC2deg than under Ref or INDCcont.
- Even if we achieve INDC2deg, climate risks in each sector cannot be zero. Additional risk reduction by adaptation is crucial.
- Consideration of large scale discontinuity risks is important for discussing long-term stabilization target and the mitigation pathways required for achieving the target.

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Thank you for your attention