# Some thoughts on global climate risks and the Paris goals


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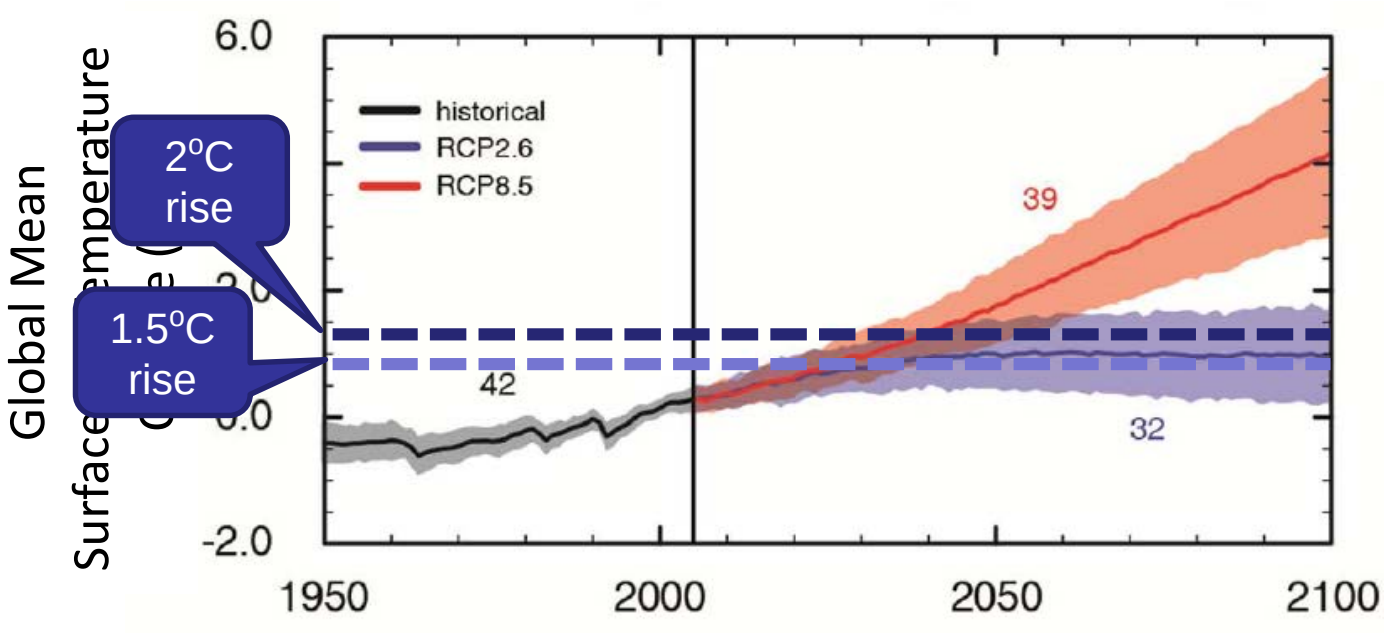
(in Japanese)

# Long-term goal of climate change policy

"… holding the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels"

(Framework Convention on Climate Change COP21 Paris Agreements,2015)



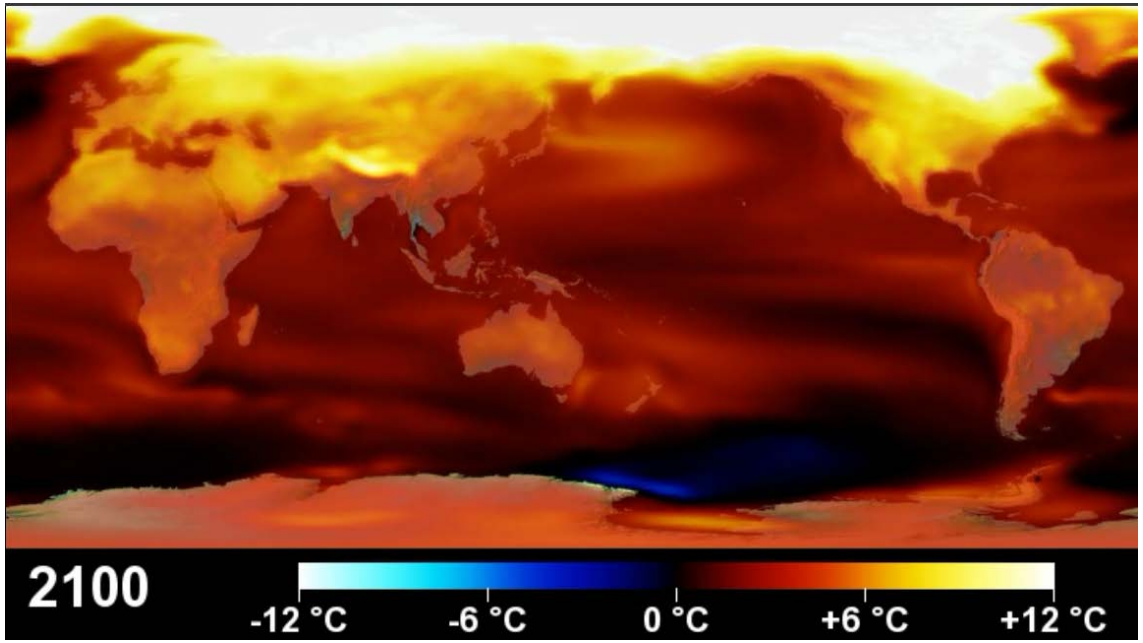

Scenario with no action (RCP8.5)

Scenario that achieves a goal of 'below 2°C' (RCP2.6)

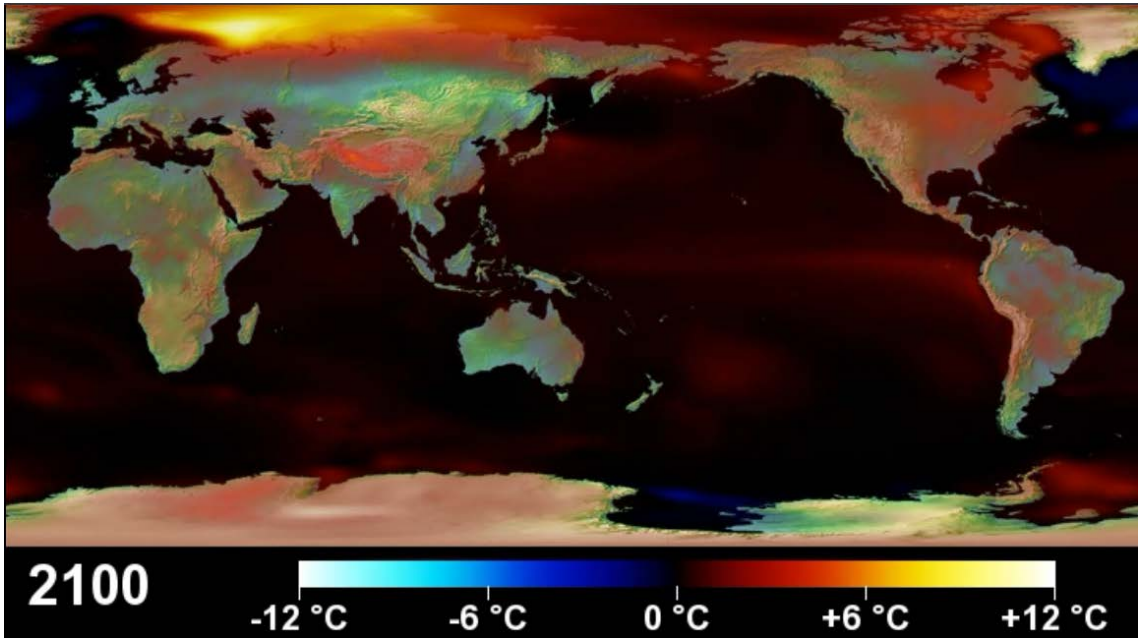
Based on IPCC WG1 AR5

# Simulation of Temperature Change

By MIROC5 Climate Model
(AORI/NIES/JAMSTEC/MEXT)




Scenario with no action
(RCP8.5)

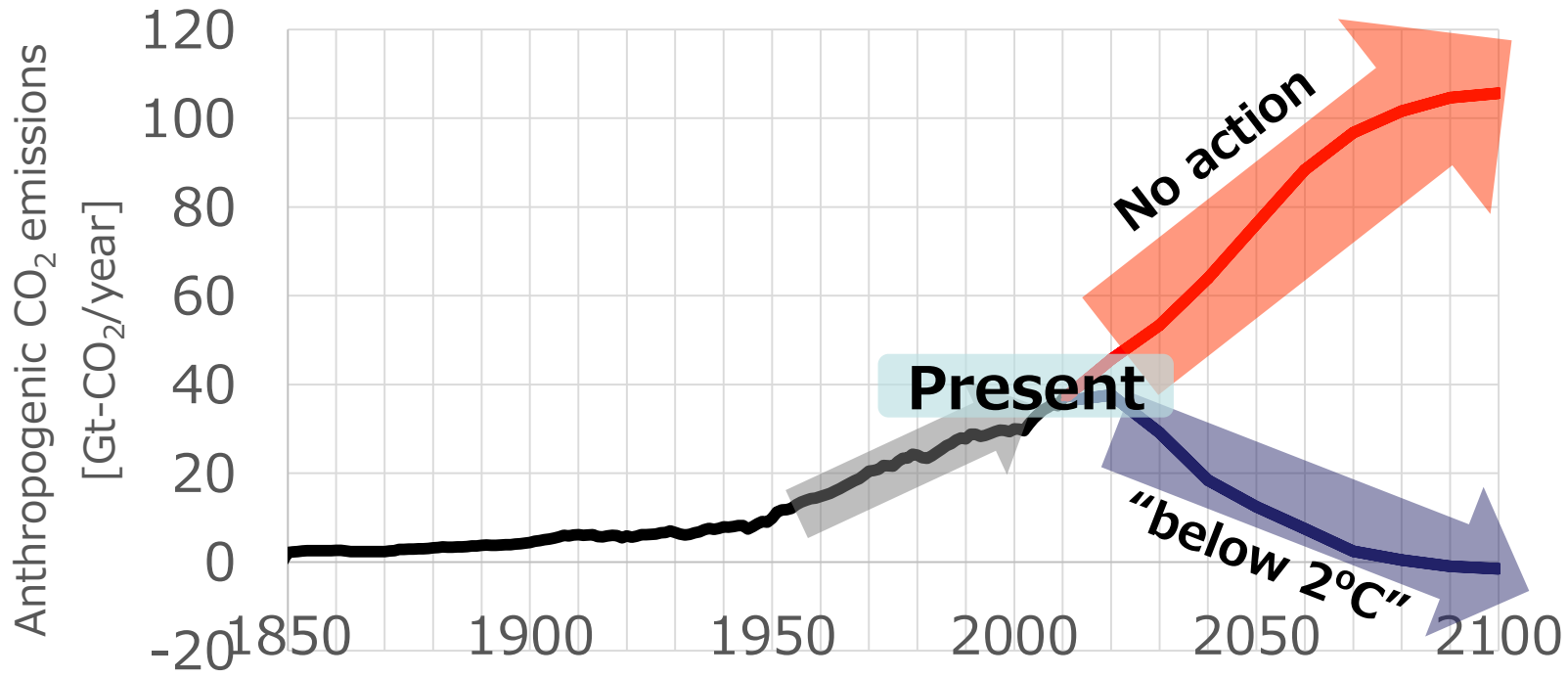



Scenario to achieve
'below 2℃'
(RCP2.6)

# Emission pathway to meet the 2°C goal

"…achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century"

UNFCCC COP21 Paris Agreement (2015)




Compiled by Masahiro Sugiyama and Shinichiro Asayama based on various IPCC material

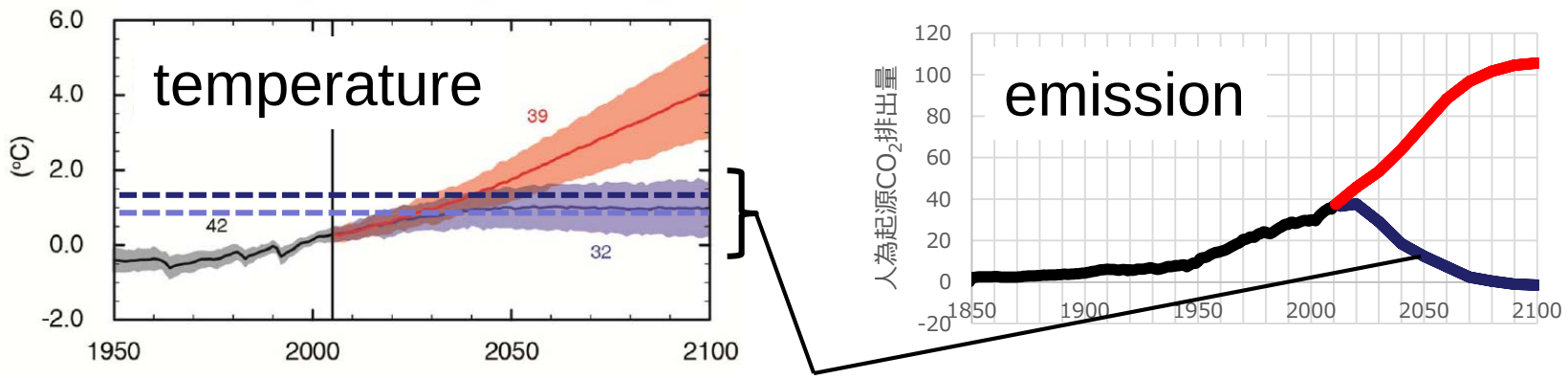
“Temperature goal”: well below 2$^{o}$C, pursue 1.5$^{o}$C

“Emission goal”: net zero GHG emission in 2$^{nd}$ half of 21C

1. Uncertainties in the connection between Temperature and Emission goals
2. Risk treatment strategy in the face of uncertainties
   - Pursuing the emission goal
   - Reducing climate uncertainties
   - Discussing options left in the case that the temperature goal doesn’t appear to be met
3. Toward achieving the emission goal (discourses in Japan)

# Connection between temperature and emission goals (1) Climate uncertainties (RCP2.6 as an example)

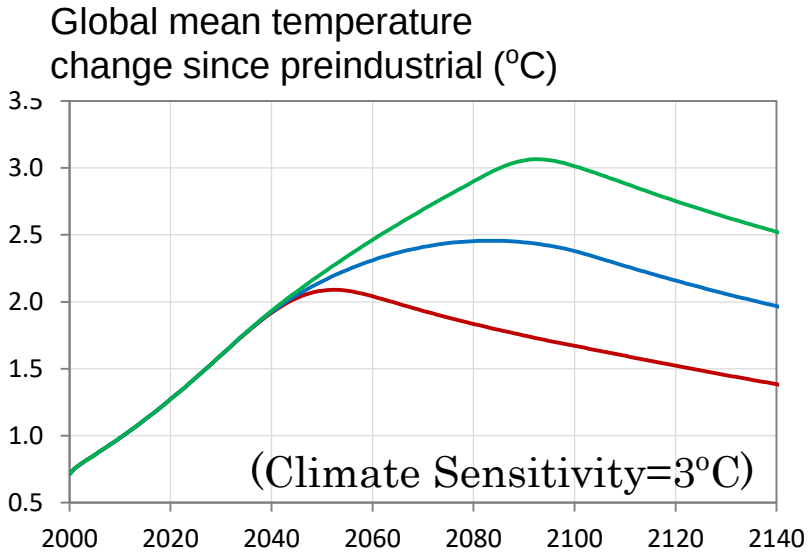
The connection has a range due to uncertainty in “climate sensitivity”

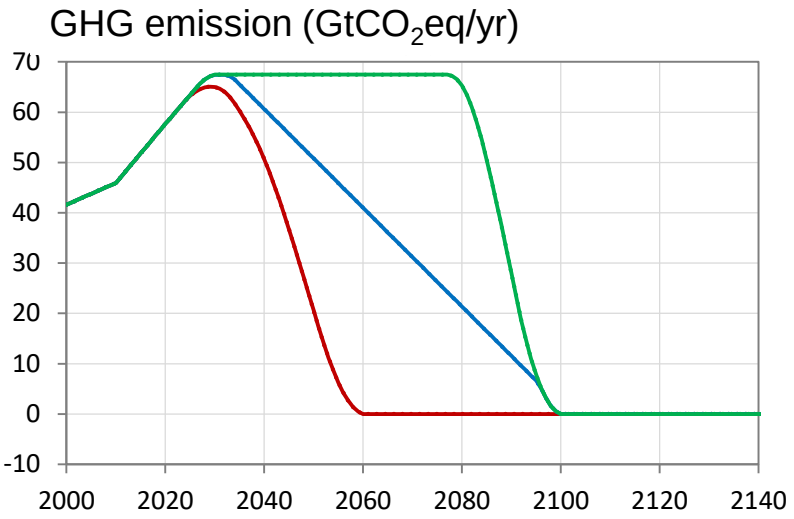



If RCP2.6 (one of pathways to meet emission goal) is realized…,

- Likely below 2°C (~66%)
- More unlikely than likely below 1.5°C

# Connection between temperature and emission goals (2) *When* in the 2nd half of 21C is net zero achieved?

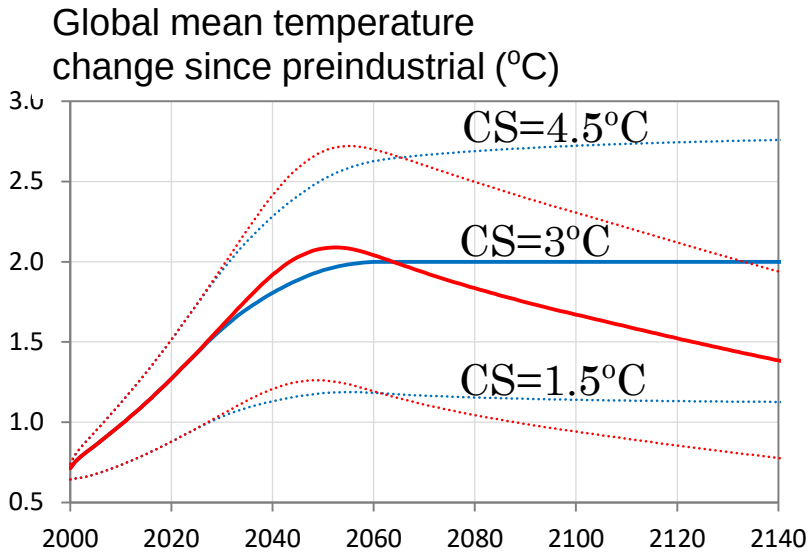


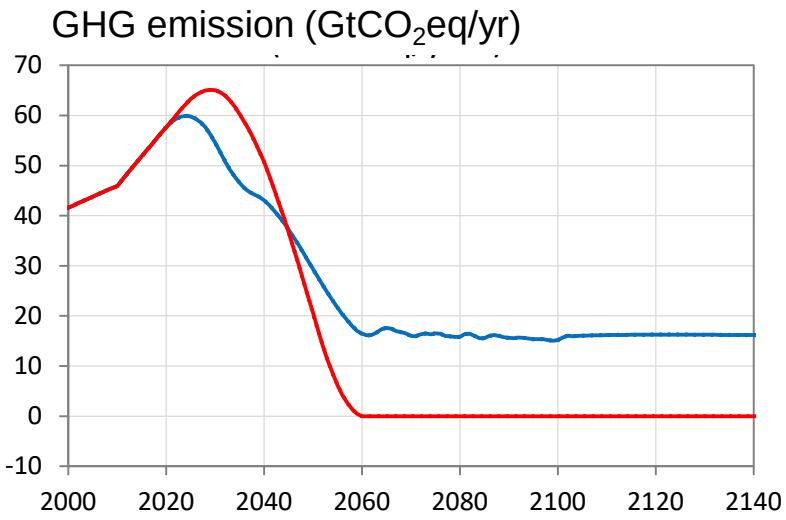




- Peak temperature significantly depends on when the net zero emission is achieved.
- "Emission peaks as soon as possible" is naturally an important condition.

(Tanaka and O'Neill, Nat Clim Change, accepted)

# Connection between temperature and emission goals (3) net zero GHG or $CO_2$ emissions?



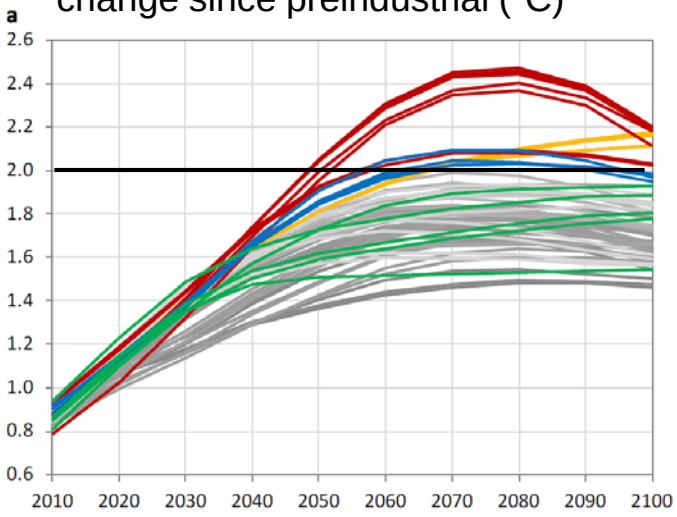




- If temperature doesn't overshoot, GHG emission doesn't have to become net zero.
- Net zero anthropogenic $CO_2$ emission (+minimum essential emission of other GHGs) is more consistent with stabilization (whether the temperature goal is met then depends on climate sensitivity).

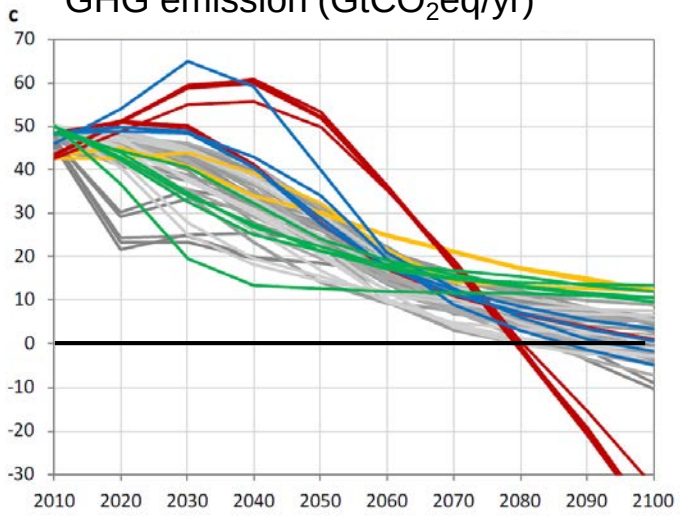
(Tanaka and O'Neill, Nat Clim Change, accepted)

# Connection between temperature and emission goals (3) net zero GHG or $CO_2$ emissions?

Global mean temperature change since preindustrial ($^oC$)




GHG emission ($GtCO_2eq/yr$)




Analysis of IPCC AR5 scenario database

- In the scenarios that meet 2$^o$C goal without temperature decline (green), GHG emission doesn't fall to zero.
- In many of the scenarios with temperature decline (gray), GHG emission falls to zero or negative.

(Tanaka and O'Neill, Nat Clim Change, accepted)

# Connection between temperature and emission goals Summary and discussion

- The connection has a range due to climate uncertainties (temperature goal is a “moving target”).
- If temperature doesn’t overshoot, GHG emission doesn’t have to become net zero ($CO_2$ emission doesn’t have to be negative).
- If the Paris emission goal is modified to be “net zero $CO_2$ emission” (+ minimum essential emissions of other GHGs) in the 2$^{nd}$ half of 21C, its implication for society is clearer (decarbonization and not more than that) and the goal is easier to pursue.
- However, whether the temperature goal is met depends on climate sensitivity and how soon the net zero $CO_2$ emission is met.

# Risk treatment strategy in the face of uncertainties

1. Pursuing the “modified” emission goal

   achieving net zero $CO_2$ as soon as possible

2. Reducing climate uncertainties

   … expected even without improved scientific understanding

3. Discussing options left in the case that the temperature goal doesn’t appear to be met
   a. Accepting/adapting to a warmer world
   b. Boosting mitigation (negative emission)
   c. Climate geoengineering (solar radiation management)

# Reducing climate uncertainties

Prediction of "reducing uncertainties by future observation" with combined ASK method and pseudo-observation approach

Allen, Stott and Kettleborough (ASK) method

(Allen et al., 2000; Stott and Kettleborough 2002)

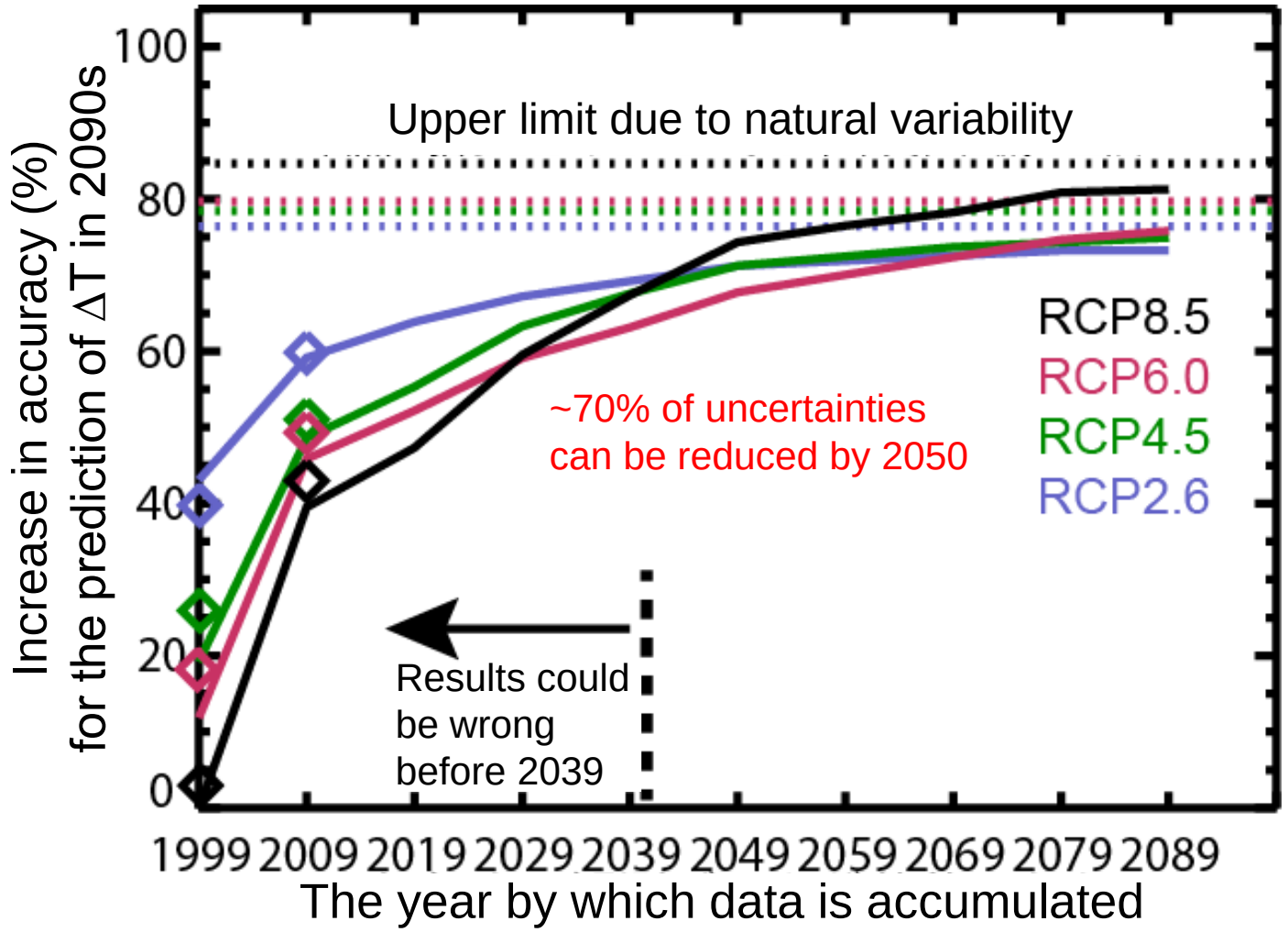
(Eq. 1) Hist Obs = (Model's Hist run – Internal Var)$\beta$ + Internal Var

(Eq. 2) Future $\Delta T$ = ($\Delta T$ in model – Internal Var)$\beta$ + Internal Var

- Adjusting future projections considering that a model will over/underestimate future change at the same rate as the model over/underestimated a historical trend against observation.
- How much uncertainties can be constrained at a certain point in the future can be estimated by regarding one of model projections as a pseudo-observation.

(Shiogama et al. 2016)

# Reduction of uncertainties by accumulated data for future development of climate change




(Shiogama et al. 2016)

As climate uncertainties are getting reduced, a prospect that the temperature goal won't be met could be obtained at a point in time at a certain probability.

(In the case that net zero $CO_2$ emission can't be achieved early enough for actual climate sensitivity)

-> Options left in that case include:

a. Accepting/adapting to a warmer world
b. Boosting mitigation (negative emission)
c. Climate geoengineering (solar radiation management)

or any combination of the above three.

(Emori et al. 2018)

# Risks associated with each option

a. Accepting/adapting to a warmer world
   - Severe climate change impacts and adaptation costs
   - Increasing possibility of crossing any tipping point

b. Boosting mitigation (negative emission)
   - Severe mitigation costs
   - Potential side-effects of mitigation (e.g., conflict over land between massive bio-energy production and food/ecosystem)

c. Climate geoengineering (solar radiation management)
   - Potential side-effects of SRM
   - Governance failure

Shouldn't we start seriously discussing which risks to take?

(Emori et al. 2018)

# Conclusion(1/2)

1. The Paris temperature goal is a “moving target” due to climate uncertainties. We can’t plan and follow an emission path that “surely” leads to its achievement.
2. There are a bunch of studies on scenarios likely (~66%) to achieve the temperature goal. But little has been discussed from a risk management perspective on what if the “remaining 33%” is materialized.
3. The modified emission goal (net zero anthropogenic $CO_2$ emission) has a clear implication for society (decarbonization and not more than that). How about pursuing to achieve this goal as soon as possible and deal with uncertainties separately?

# Conclusion(2/2)

4. Reducing climate uncertainties is one of the keys for obtaining a prospect of achieving the temperature goal or otherwise. Uncertainties will be reduced due to accumulation of data for future development of climate change, even without improved scientific understanding.
5. Any of the options left when we realize that temperature goal won’t be met entails potentially disastrous risks. We should start discussing scientific and social aspects of those risks to prepare to make a judgment of which risks to take.

# What is the key to "solve" the climate problem?


High efficiency (coal) fire

*<- Concerns about lock-in*

Nuclear

*<- Concerns about accidents, waste…*

Innovative technologies

*<- Concerns about realizability*

*Needs more development -> (too expensive and variable)*

Renewables

*<- Could be deployed more (inhibited by conventional system)*

*Efficiency improvement->*

Energy saving

*<- Lifestyle change*

*Concerns about economic -> depression, unemployment, …*

Moving away from Material growth

# What is the key to “solve” the climate problem?