New findings from

CMIP5 Long-term climate change projection

using the Earth Simulator

H. Kondo

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC, Japan)

KAKUSHIN

Climate change projection

using the ***Earth Simulator*** (ES)

- **Long-Term Global Change Projection (~2300)**
- **Near-Term Climate Prediction (20~30 years prediction)**
- **Extreme Event Projection (Typhoons, Hurricanes, Heavy rain, etc.)**
- **Cloud Resolvable Modeling**
- **Parameterization of Marine Microphysics**

Advancing Climate Modeling and Projection

Quantification and reduction of uncertainty

Application of Regional Projections to Natural Disasters

Close Coordination

Impact Assessment Studies (MOE)

Model output

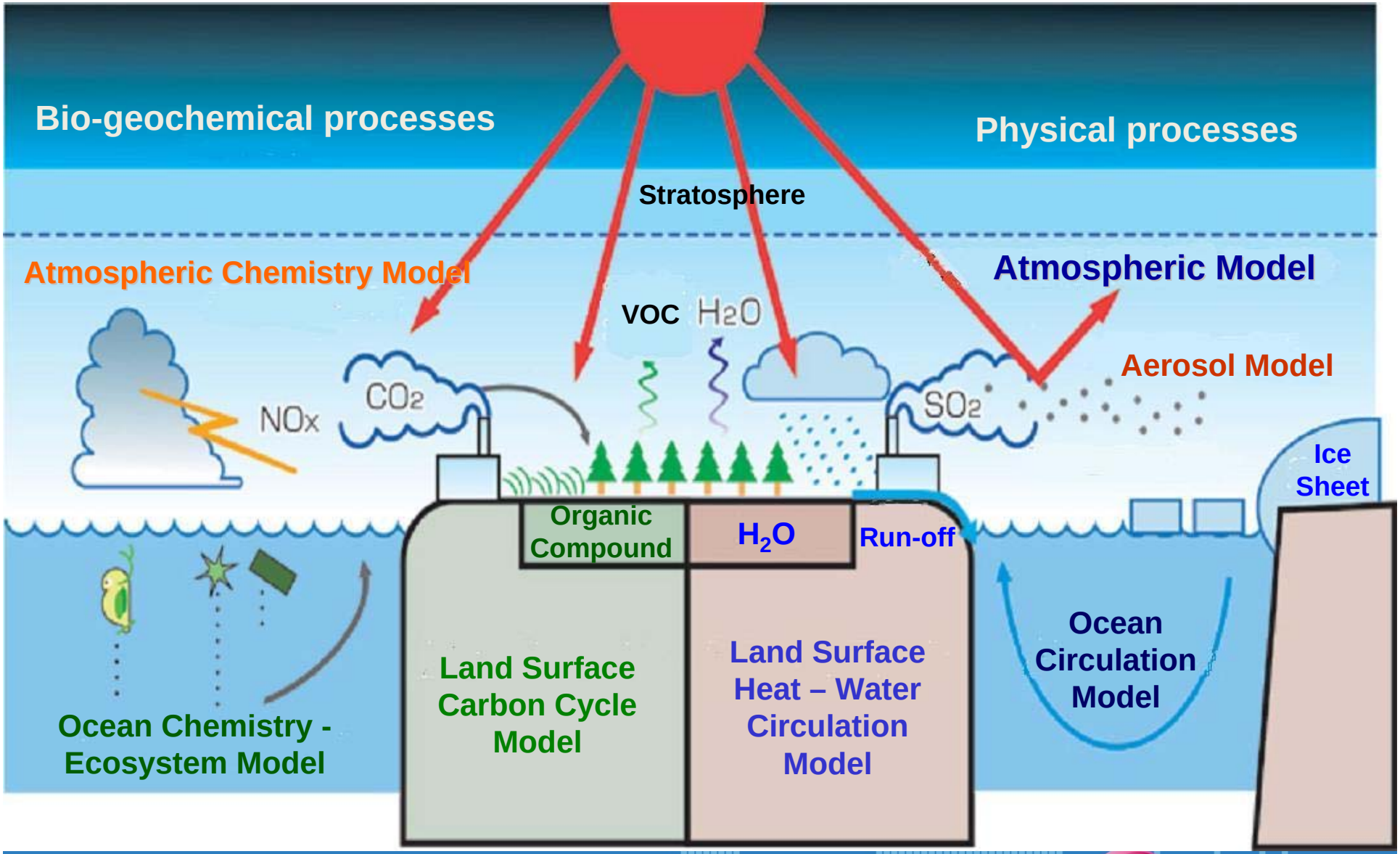
Adaptation Studies

Contribute to IPCC AR5
Scientific Basis for Policymakers

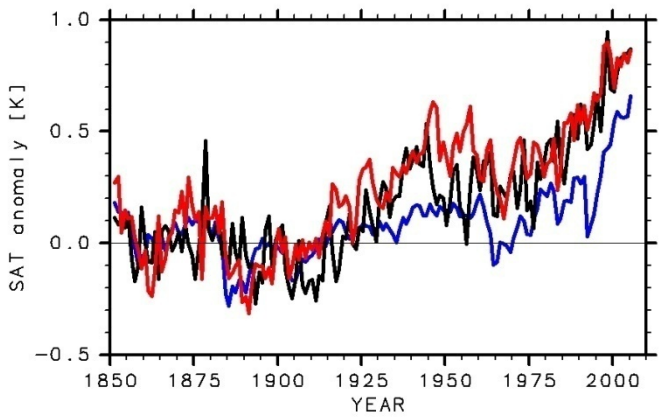
Innovative Program of Climate Change Projection for the 21st Century (= KAKUSHIN)

Innovative Program of Climate Change Projection for the 21st Century

Structure of the Earth System Model (MIROC-ESM)



(JAMSTEC/AORI/NIES/MEXT)

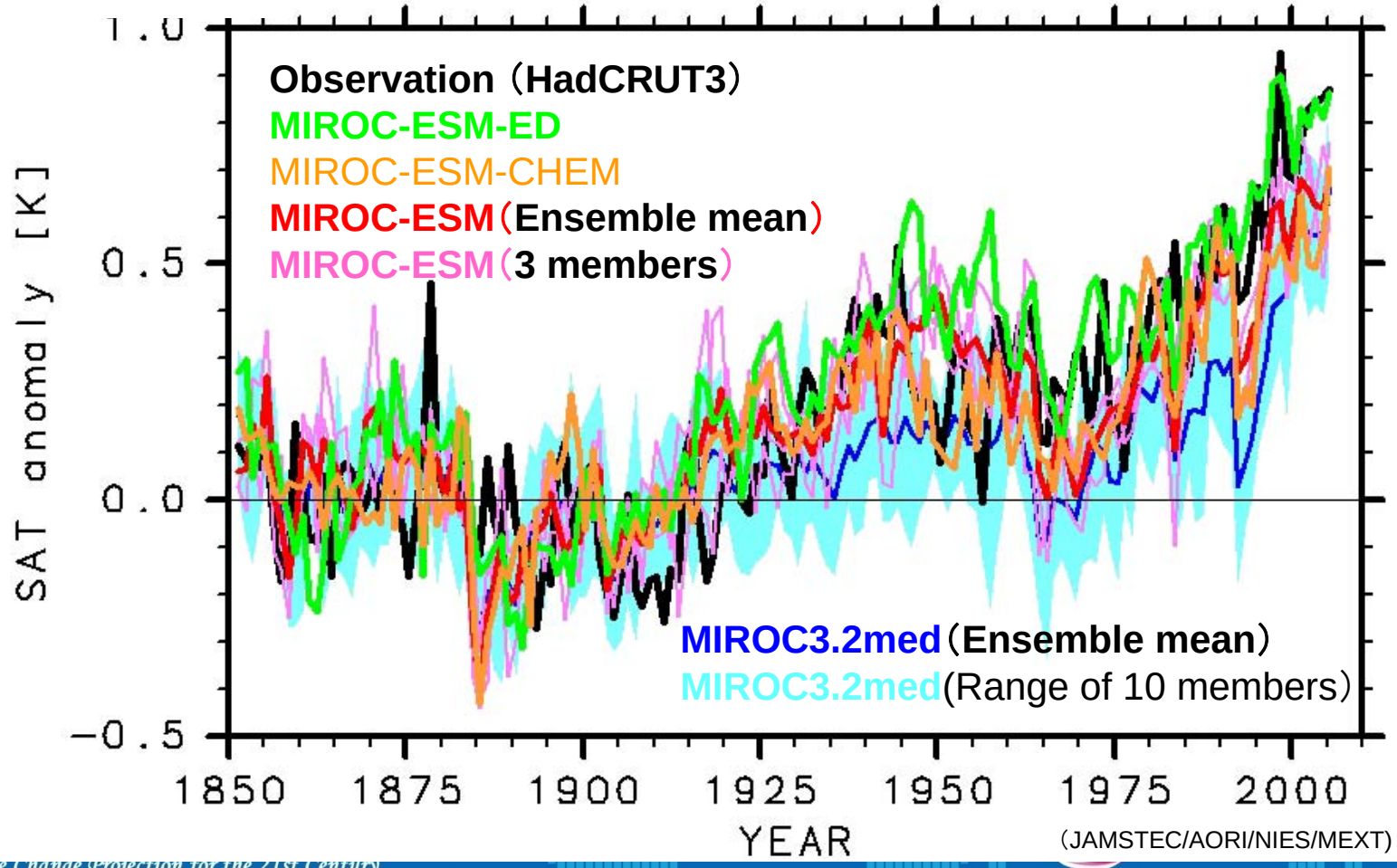


Simulation of the 20th century climate

Global average temperature

(Difference from 1851-1900 averages)

Observation
MIROC-ESM-ED
MIROC3.2med



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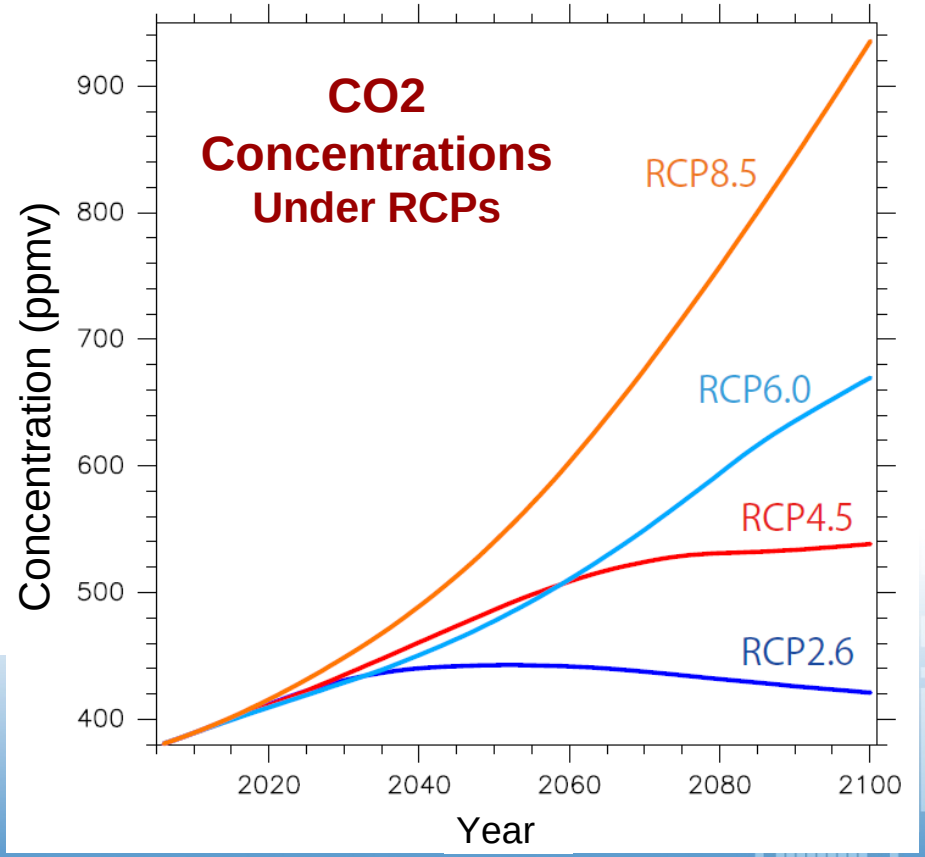
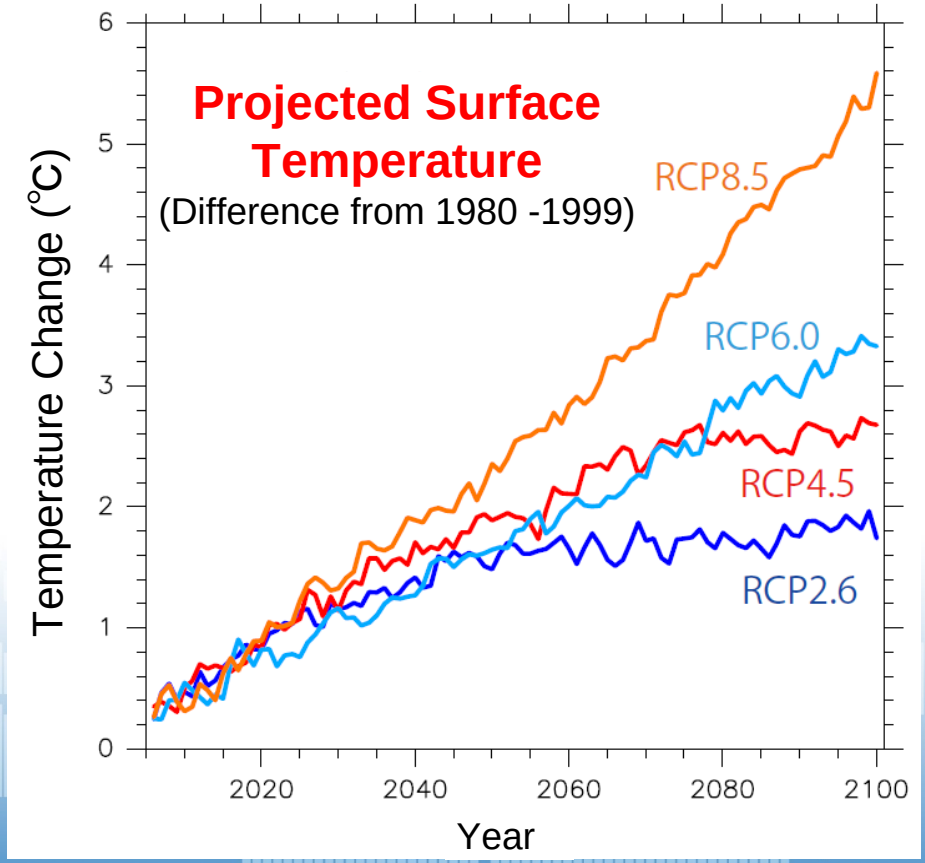
Projected **Surface Temperature Change** under RCP (MIROC-ESM)





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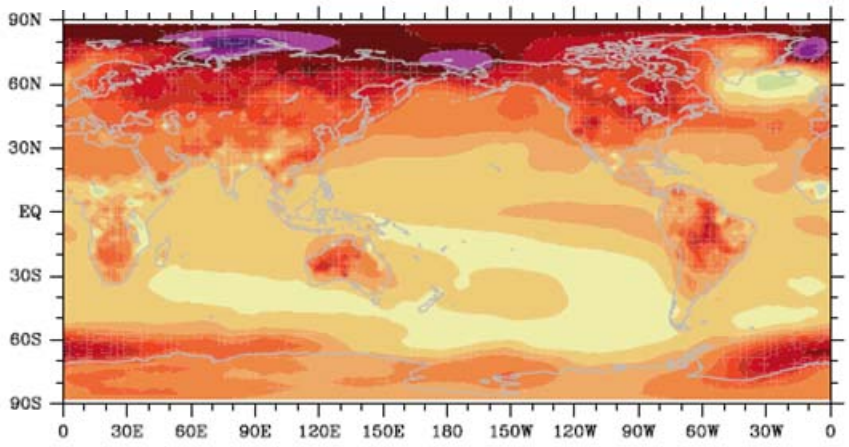
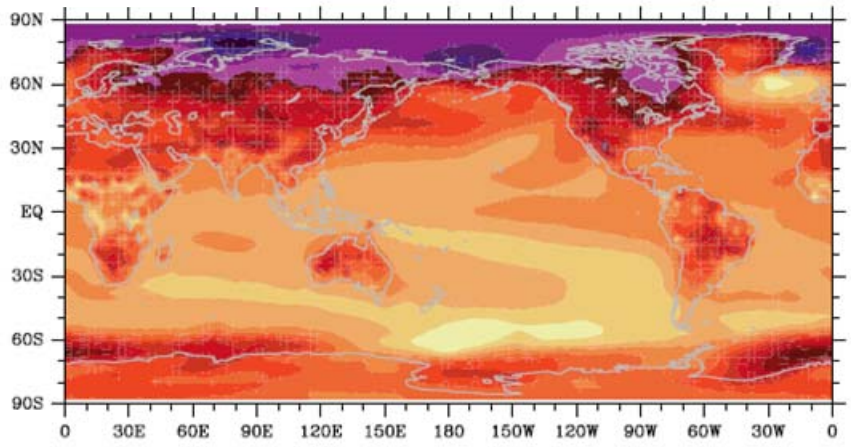
Projected 21st Century Surface Temperature Change

by MIROC-ESM (Difference from 1980-1999)

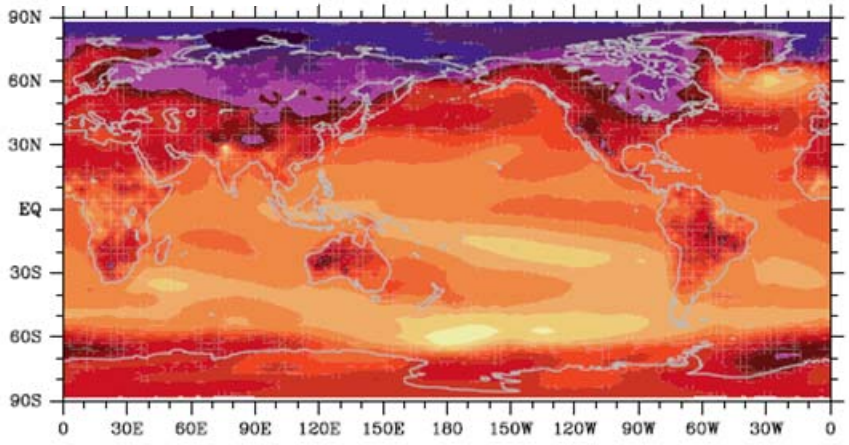
RCP2.6



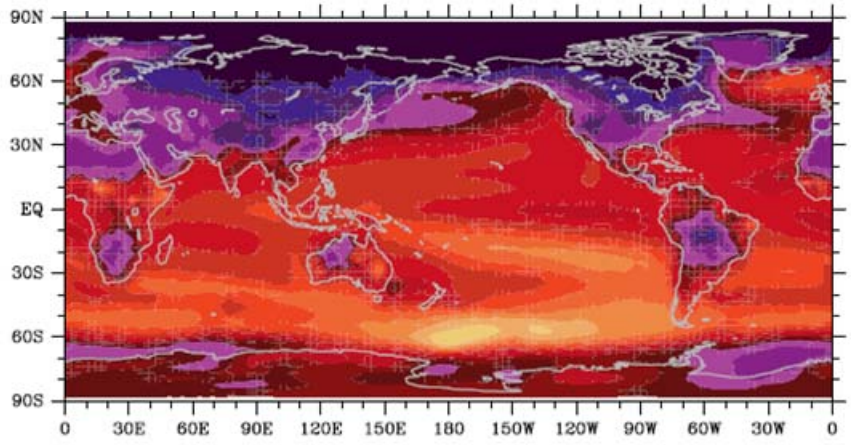
RCP4.5

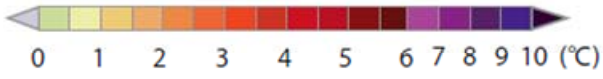


RCP6.0



RCP8.5





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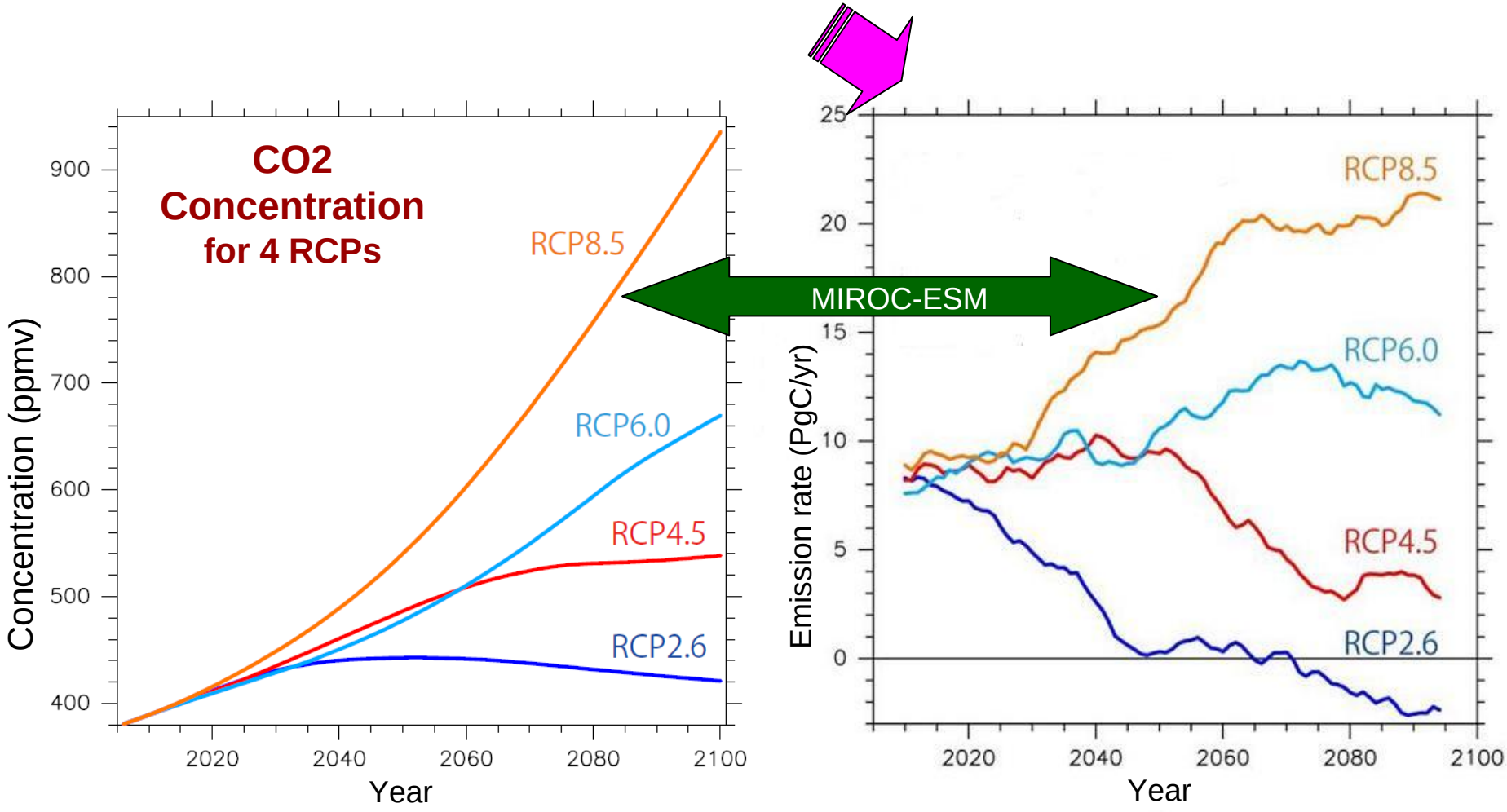
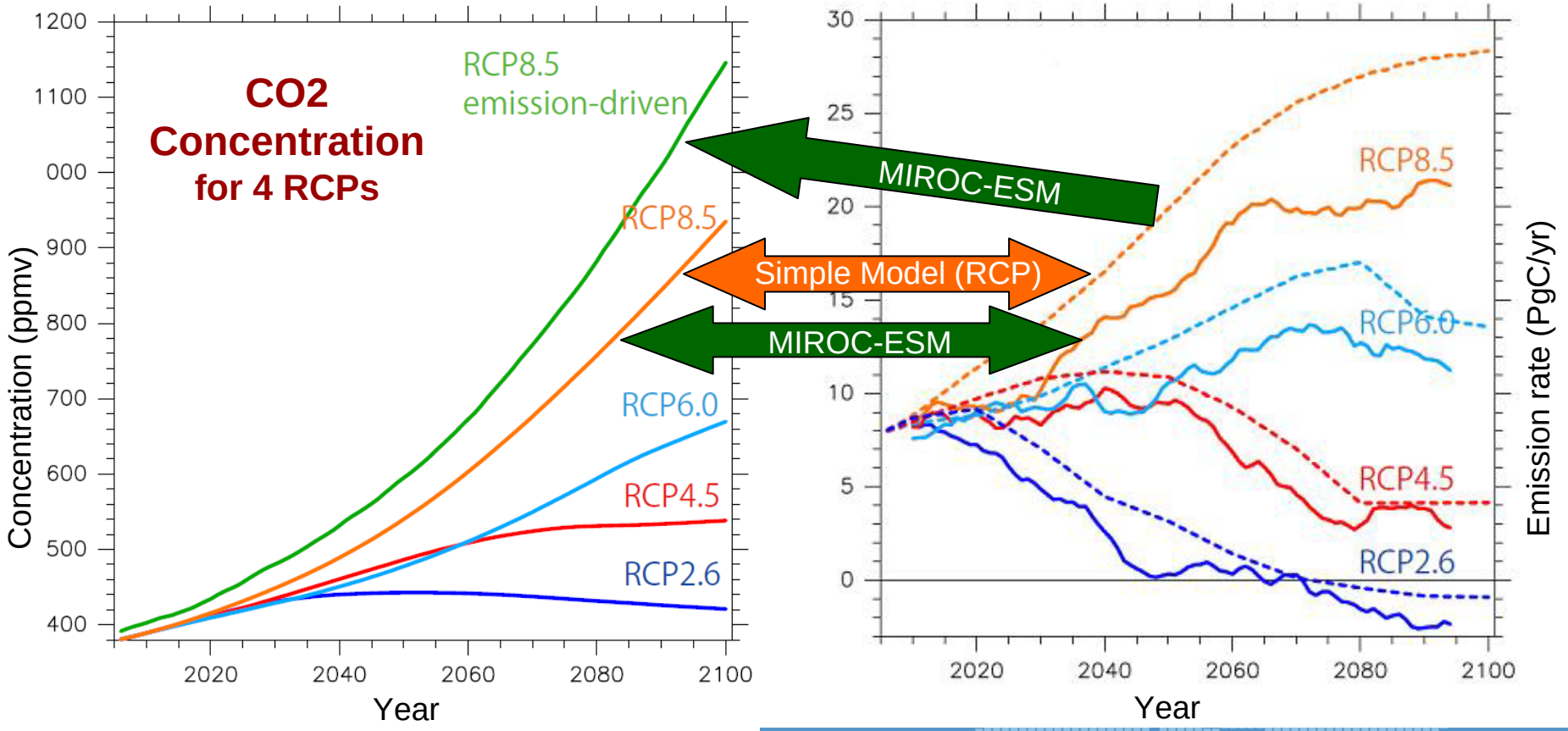
CO_2 Emission rate from fossil fuel *estimated by MIROC-ESM as* necessary to Cause RCP Concentrations



MIROC-ESM shows some different outcomes from the simple carbon cycle model for RCP with implications



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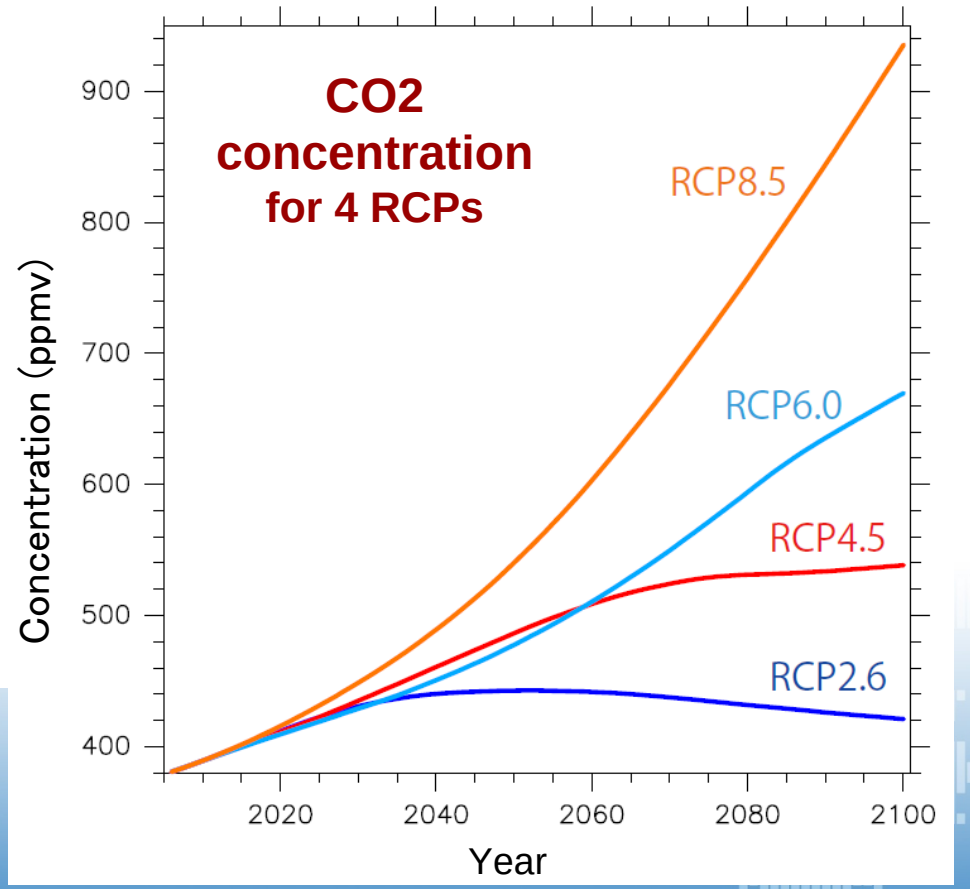
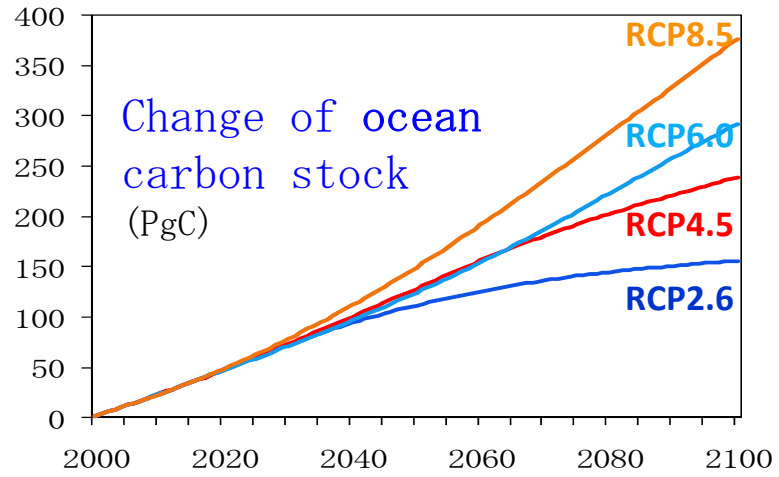
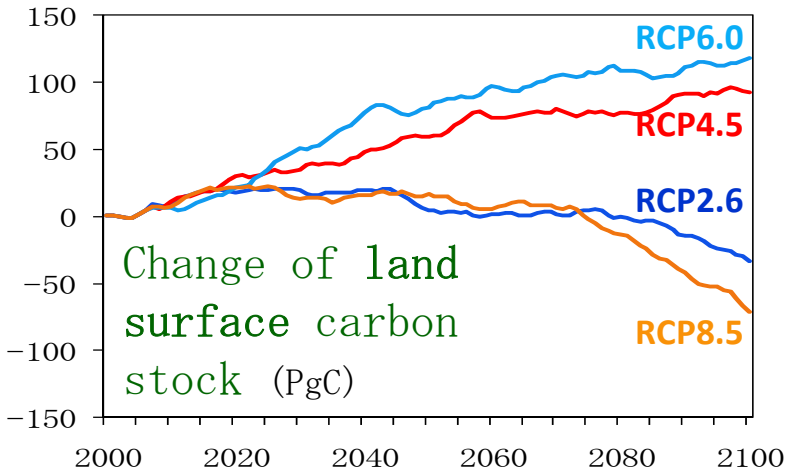
Projected change of carbon stock

in ocean and on land surface







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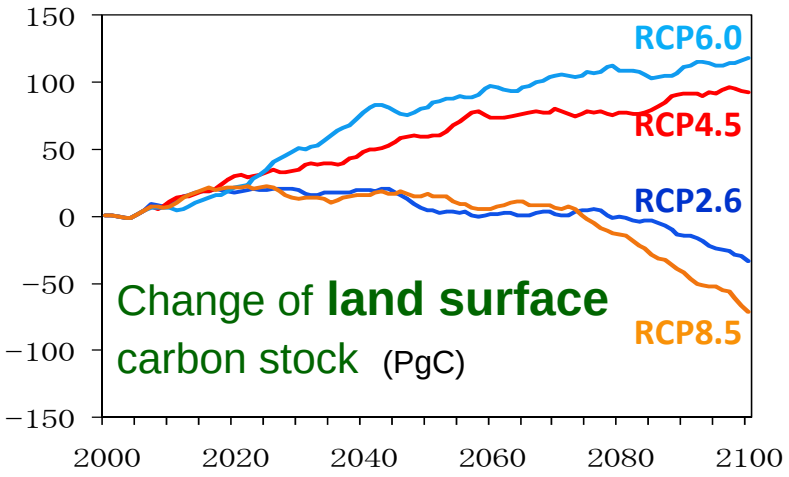
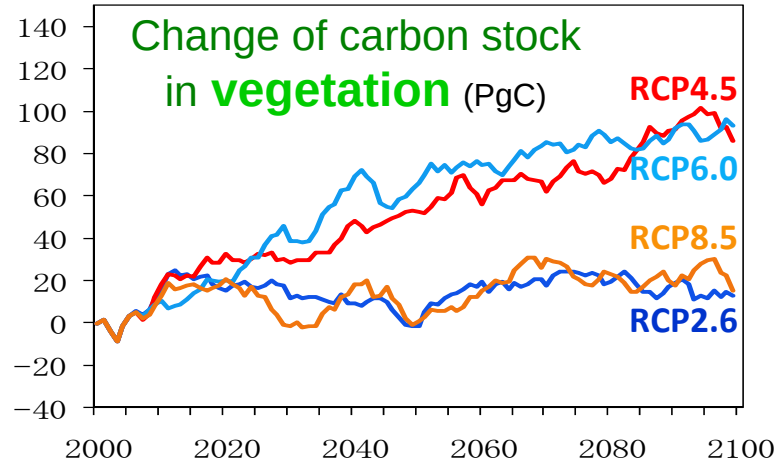
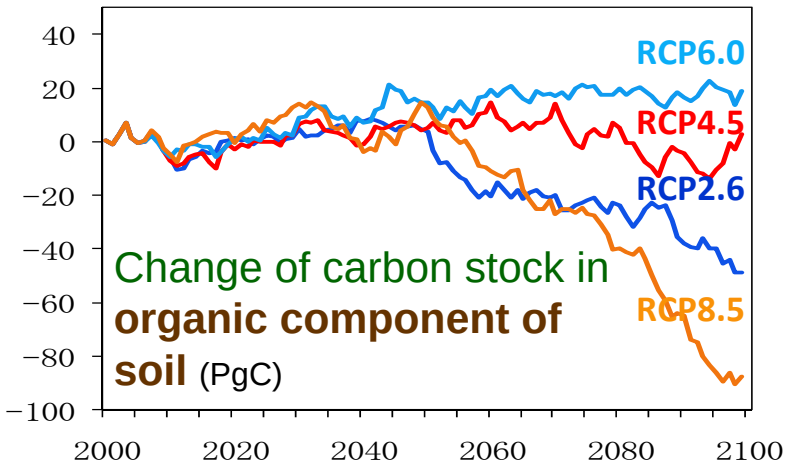
Breakdown of land surface carbon stock







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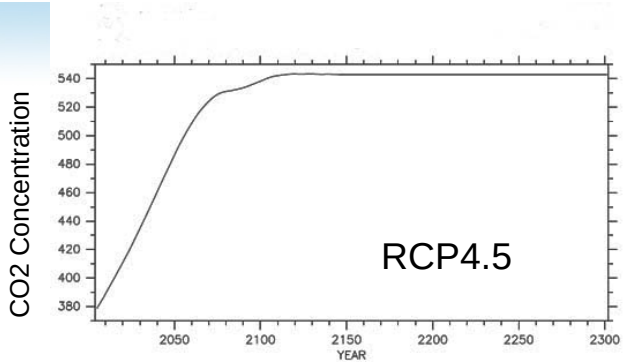
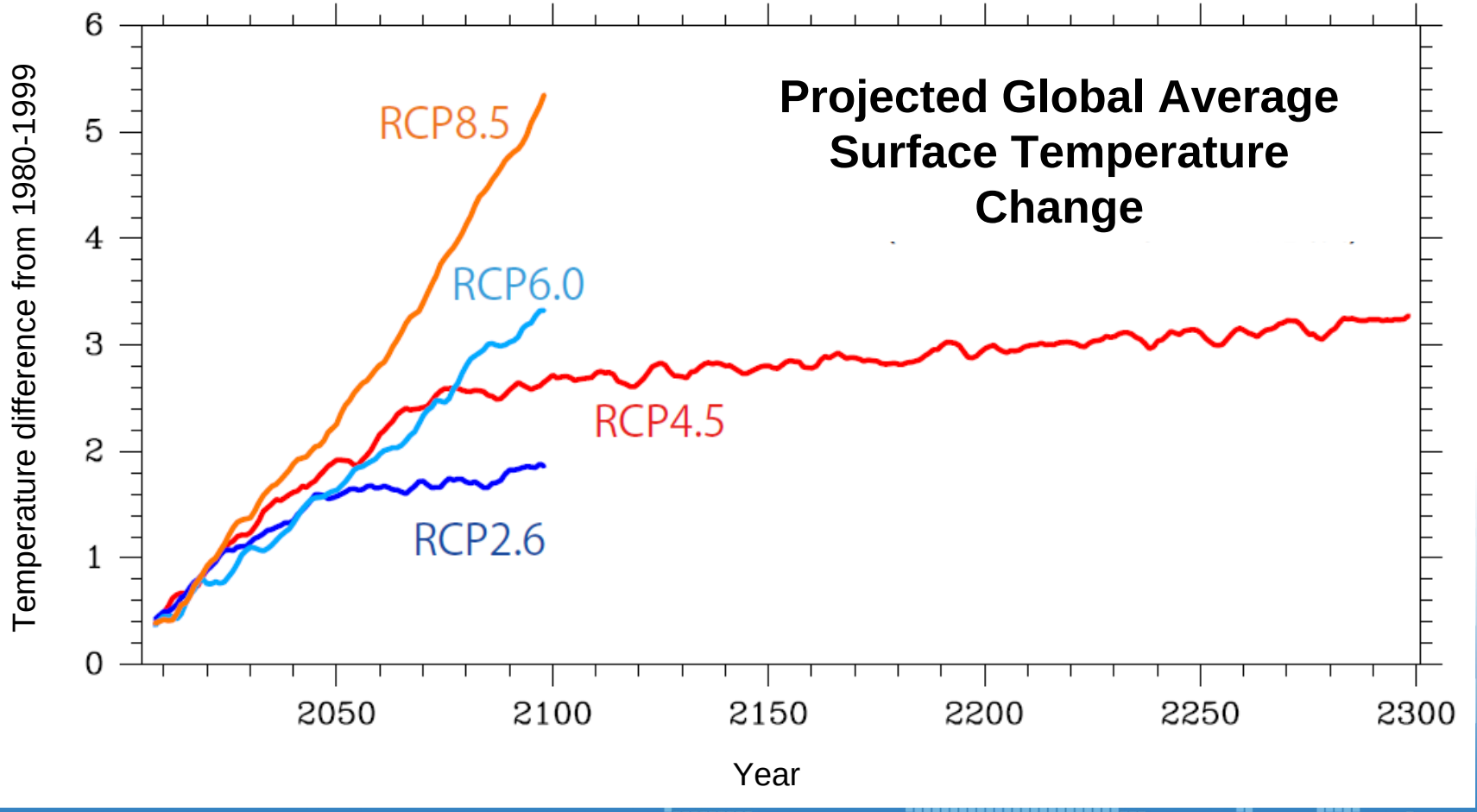
Long-term Projection of

Surface Temperature Change up to 2300

(*under RCP4.5*)





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Projected Vegetation under RCP4.5

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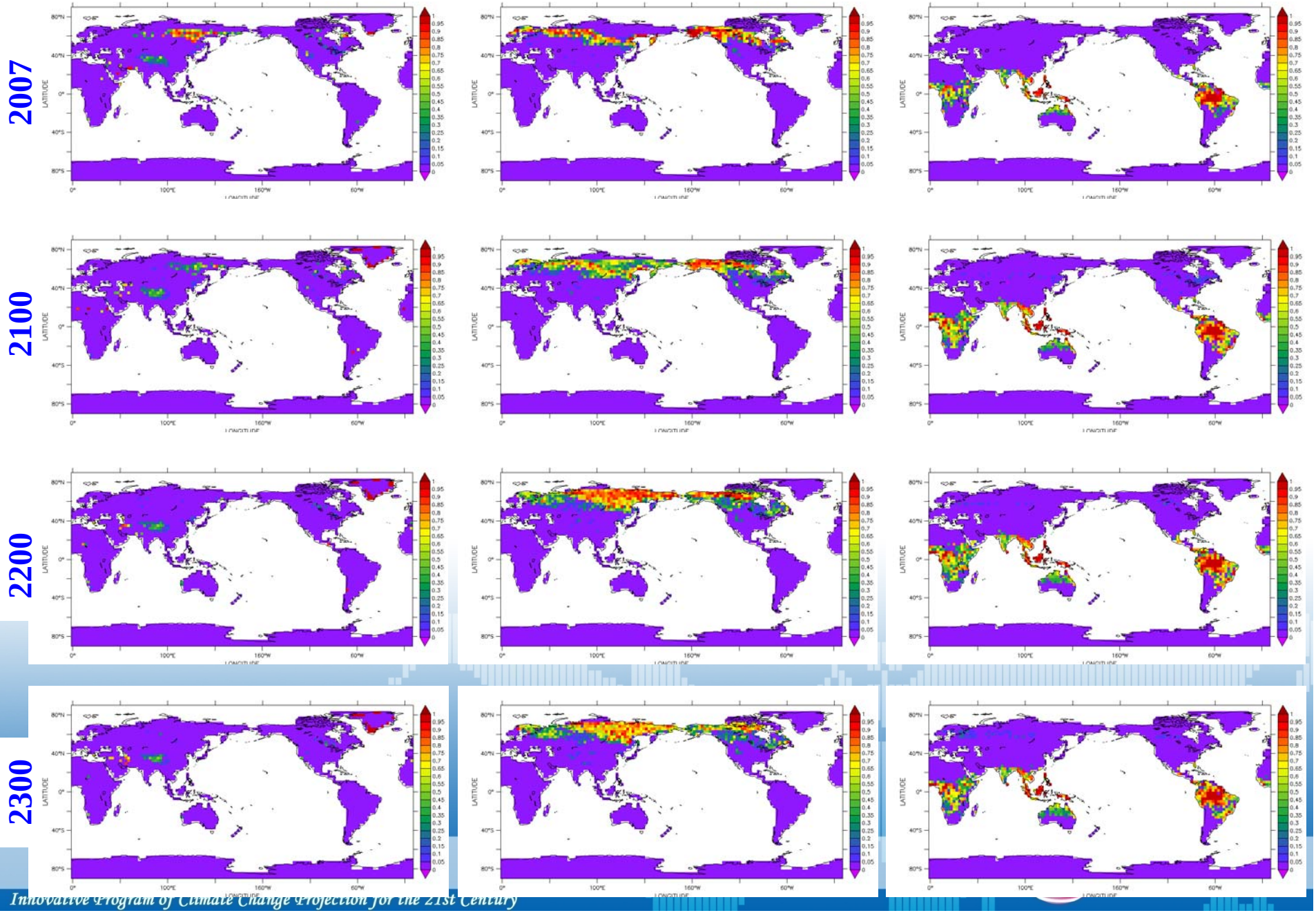

Summary

- In a climate change projection initiative, **KAKUSHIN**, to contribute to the IPCC/AR5, an **Earth System Model (ESM)** has been developed by integrating bio-geochemical process models into a climate model (MIROC).
- The MIROC-ESM includes, in particular, a **dynamic vegetation model (SEIB-DGVM),** where species of vegetation compete each other under a given climate to attain a balanced distribution.
- Major outcomes including new findings from CMIP5 experiments using the Earth Simulator are :
  - Simulation experiments for the 20th century climate show reasonable results.
  - CO_2 Emission rate from fossil fuel *estimated by **MIROC-ESM** as* necessary to cause a RCP concentration scenario is smaller that that estimated in RCP and is almost zero at the middle of the 21st century.
  - CO_2 concentration caused by ***MIROC-ESM*** from a RCP emission rate is, in response, larger than the respective RCP concentration.
  - A 300 year projection under RCP4.5 with stabilized concentration beyond 2100 shows long-term steady rising tendency in global mean surface temperature beyond 2100.
  - Most **boreal-deciduous forests** transform into **boreal-evergreen forests** in 300 years under RCP4.5, while most tropical forests remain the same.
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