Energy Modeling Forum (EMF) 22: Climate Policy Scenarios for Stabilization and In Transition

December 12-14, 2006, Tsukuba

Integrated Assessment PHOENIX - Land-use Modeling and Global Warming Impacts on Agriculture -

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Systems Analysis Group

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RITE

RITE's Study for Climate Change Assessment

- Addressing the Article 2
- Stabilization scenarios

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- Post-Kyoto frameworks
- Assessments of Regional and sectoral frameworks, e.g. APP
- Transition scenarios

Integrated assessment

PHOENIX

- DNE21 Model: -Y2200
  - 10 world regions
- Non-CO_2 GHG Models
- Climate change model (MAGICC+GCM results)
- Global warming impact models
  - Water resources
  - Agriculture (GAEZ base)
  - Human health
  - Biodiversity (Biome base)
  - Sea level rise
- Land use models
  - GLUE Model: bioenergy pot.
  - Forestation pot. estim. model

- DNE21+ Model: -Y2030/2050
  - 77 world regions;
  - detailed bottom-up energy modeling

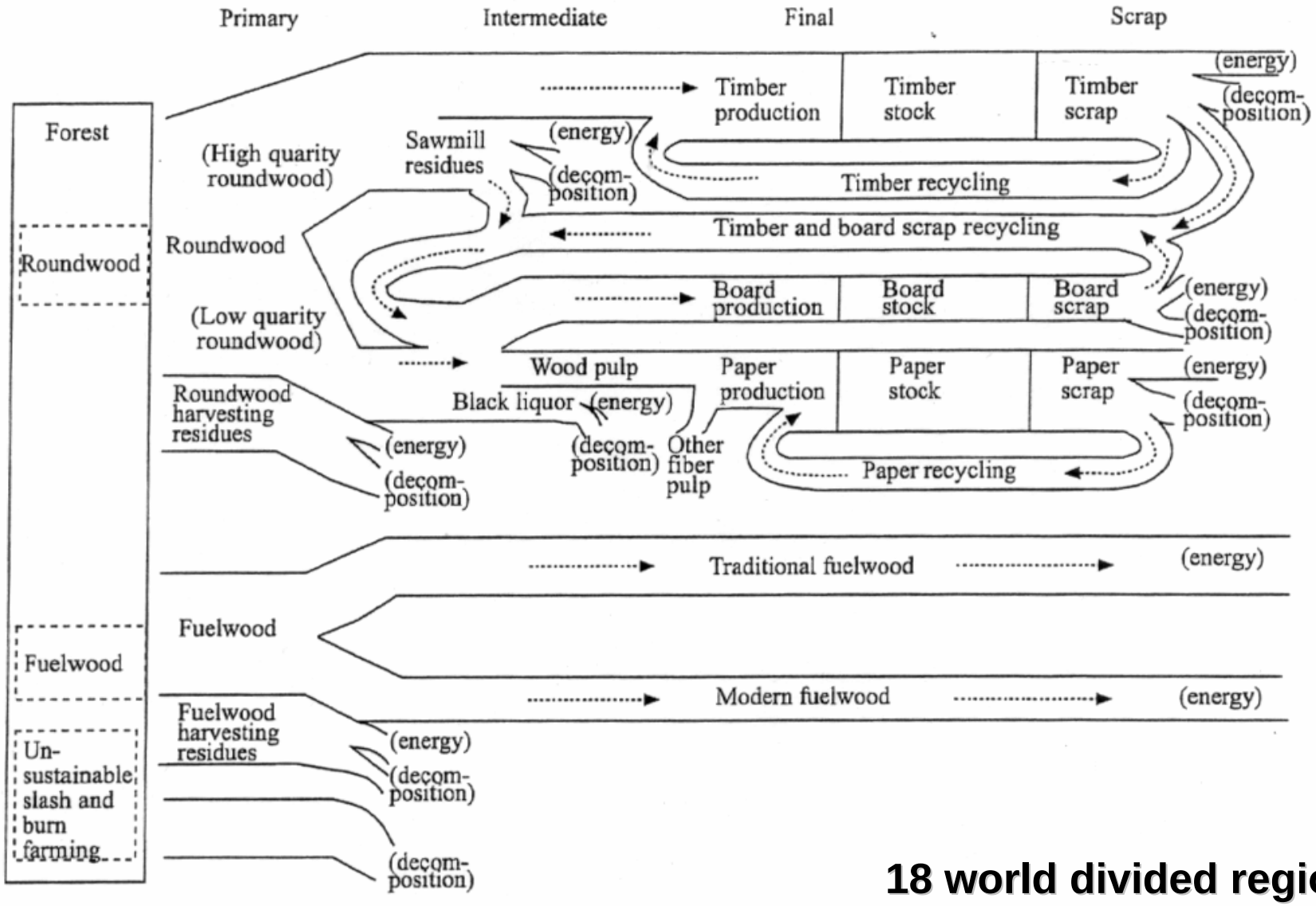
- DEARS Model: -Y2050
  - 18 world regions;
  - 18 non-energy sectors (GTAP base);
  - bottom-up energy modeling

Others

- DNE21-ITC model
  - 4 world regions
- Country model for Japan
  - focusing particularly on CCS

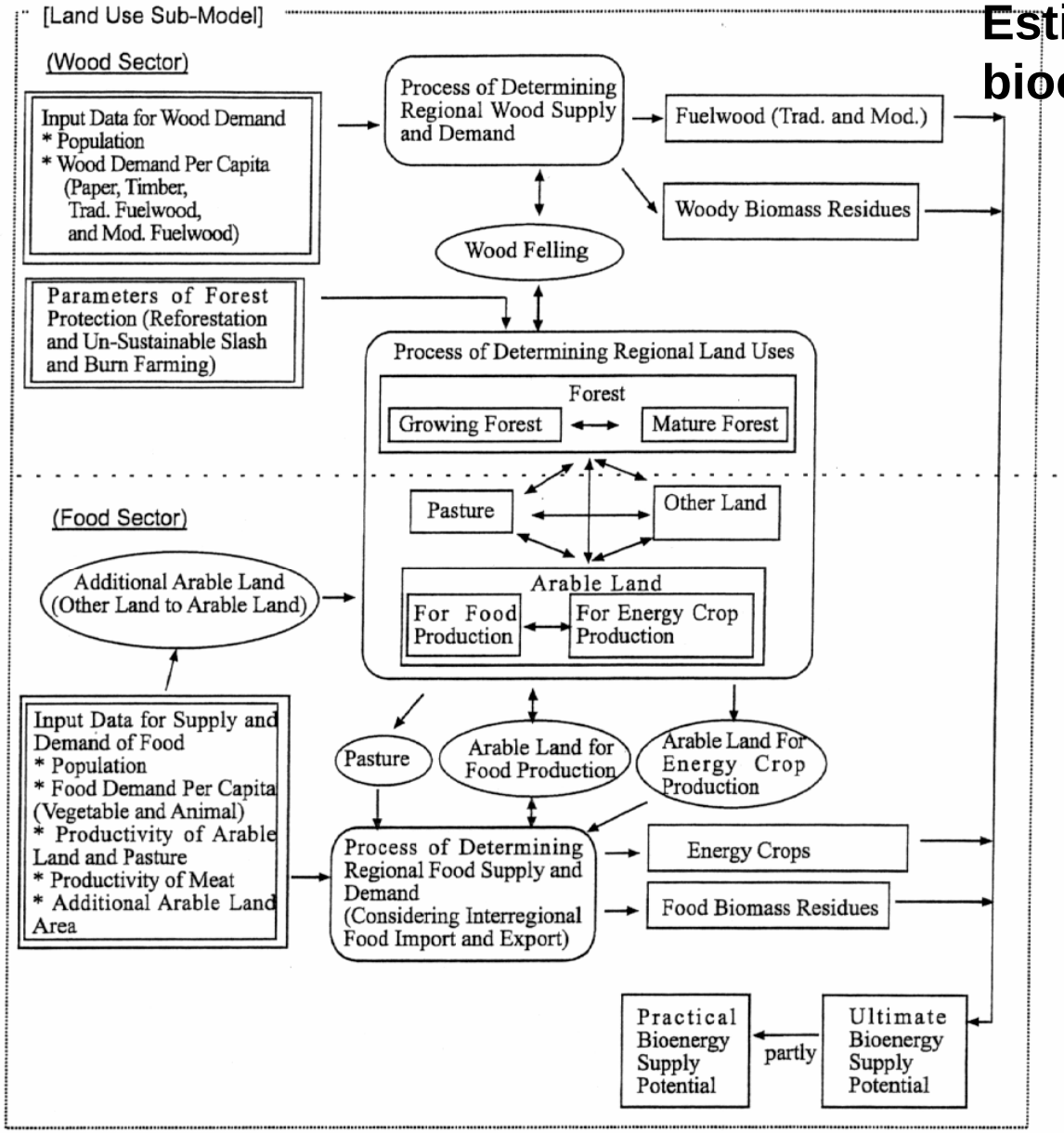
Land-use Model – GLUE (1/2)

Biomass flows considered in GLUE



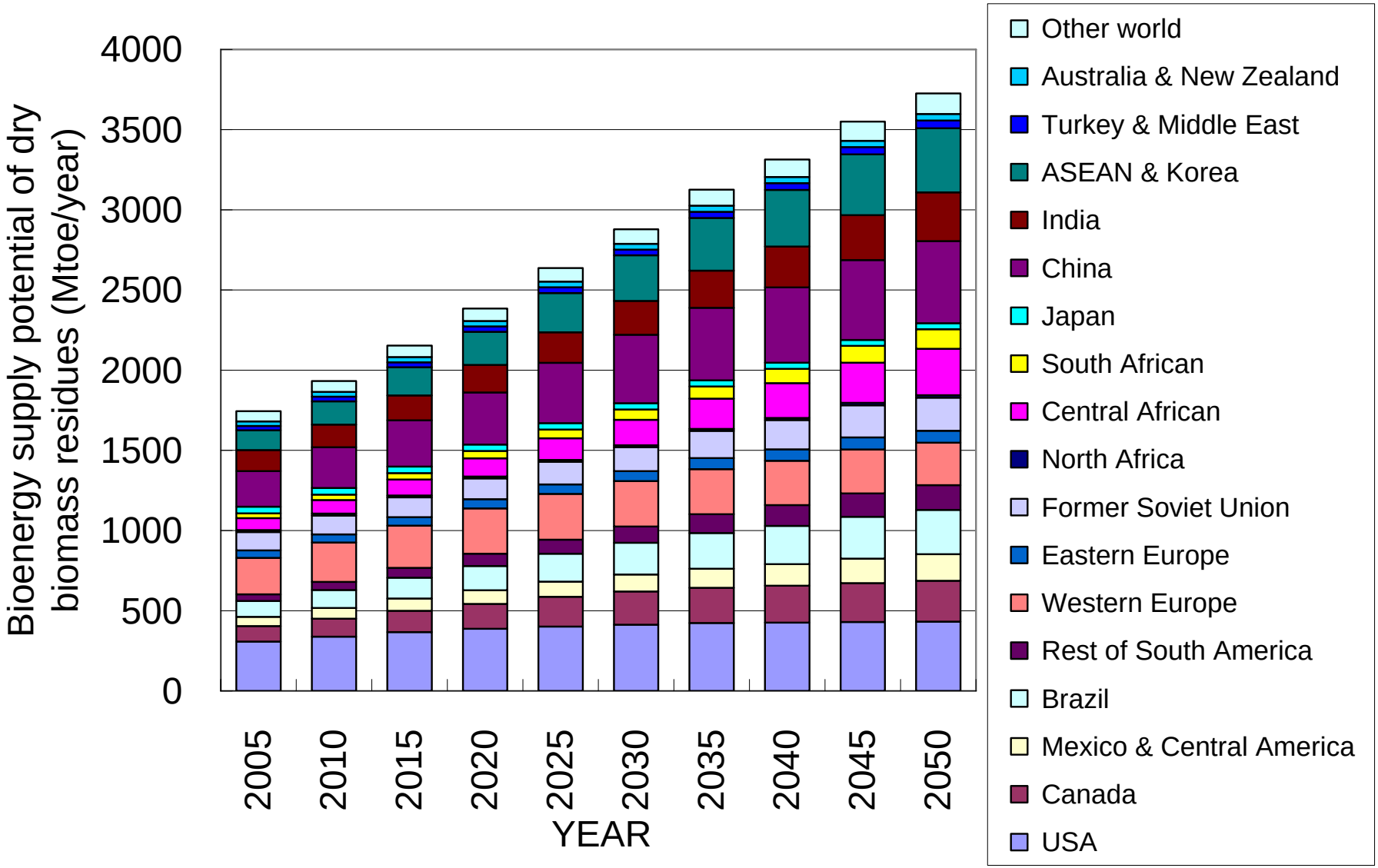
18 world divided regions

Land-use Model – GLUE (2/2)

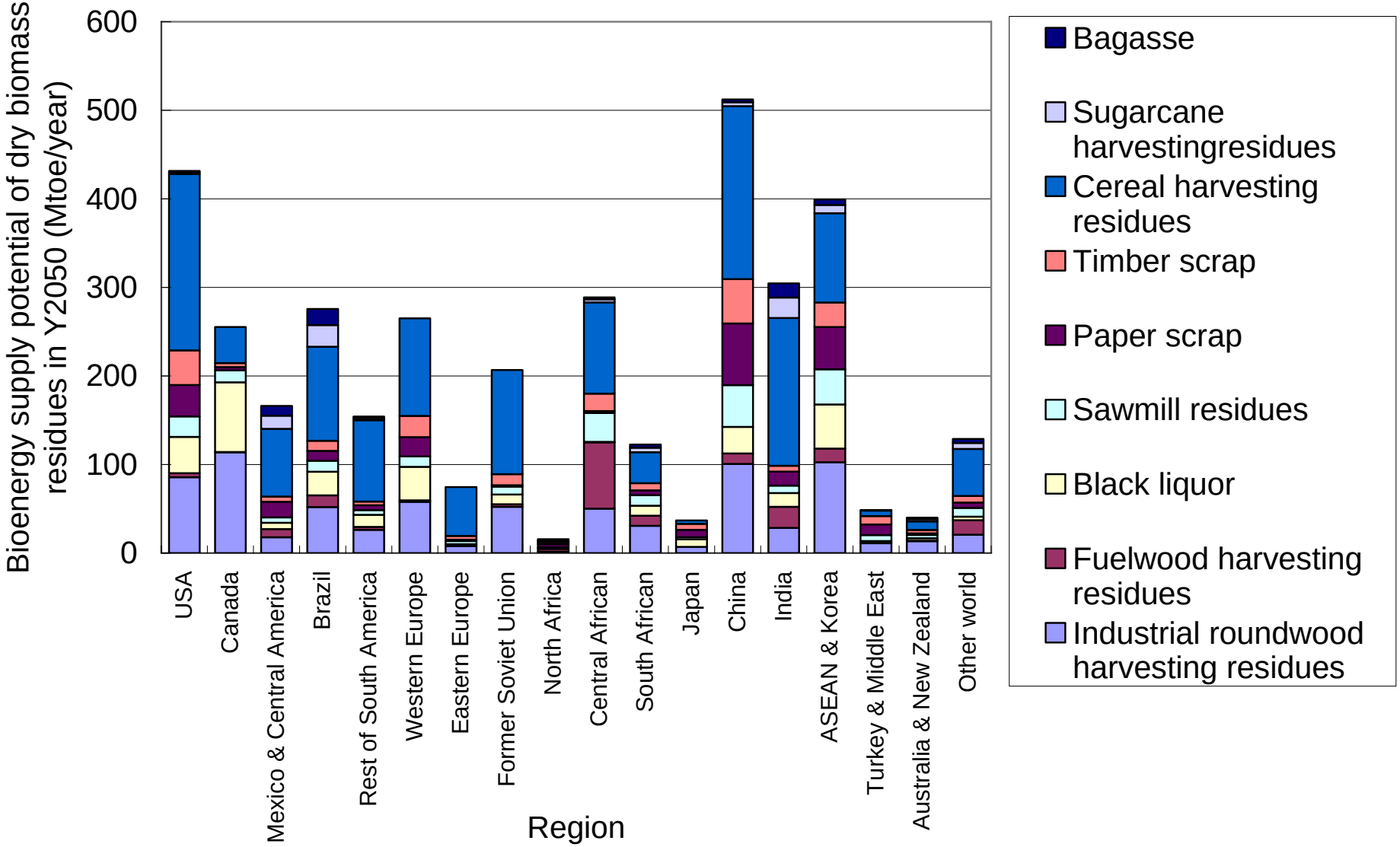


Estimation procedures for bioenergy potentials in GLUE

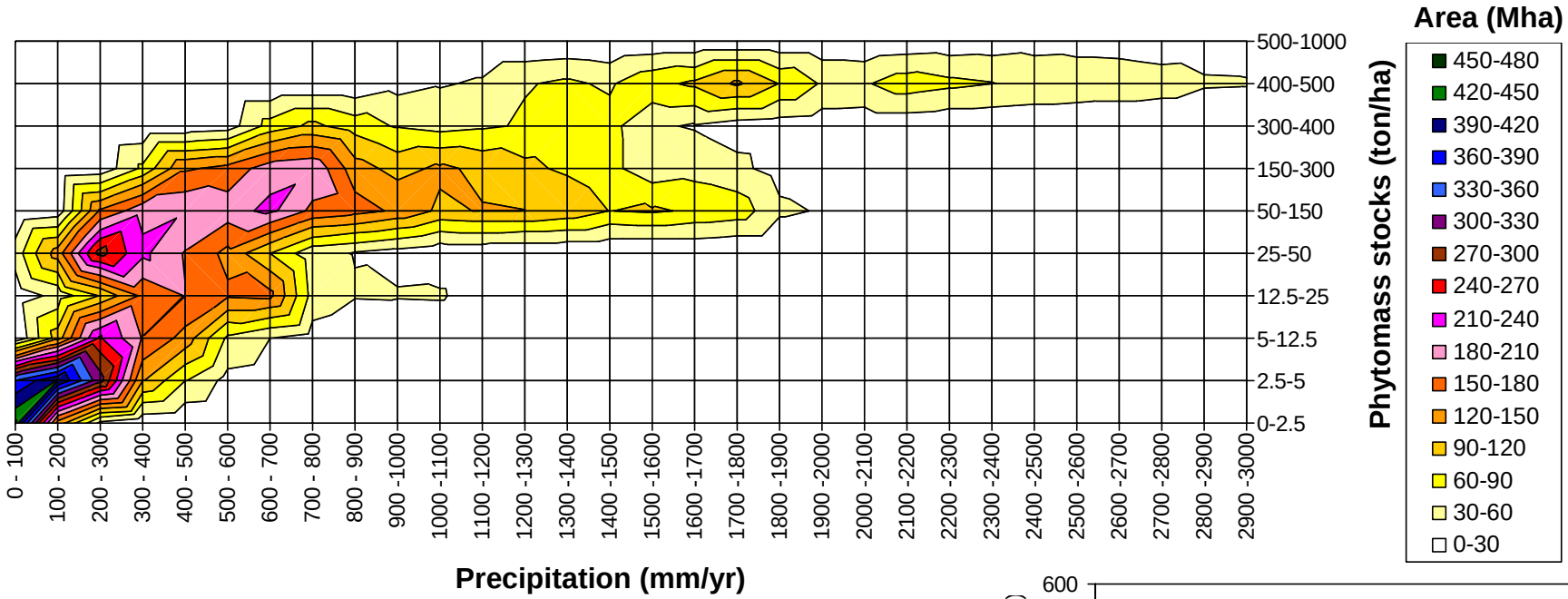
Estimated Bioenergy Supply Potentials by Region



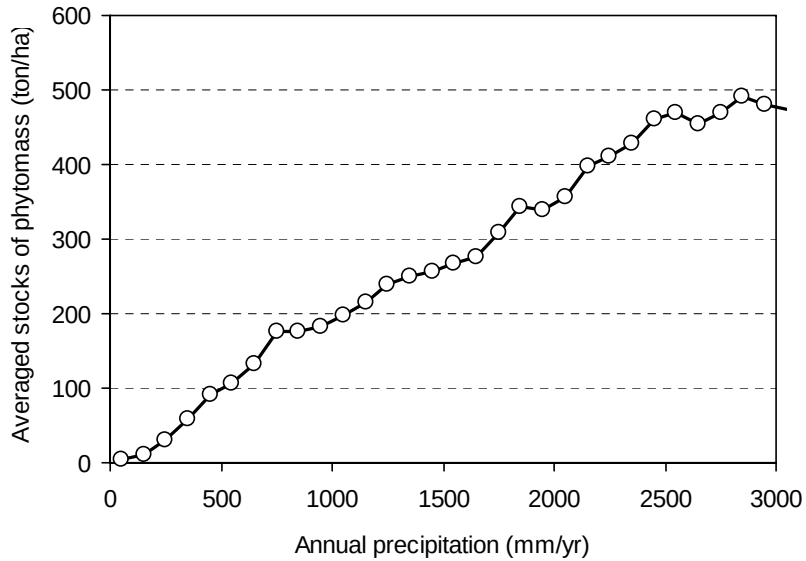
Estimated Potentials of Bioenergy Supply in 2050



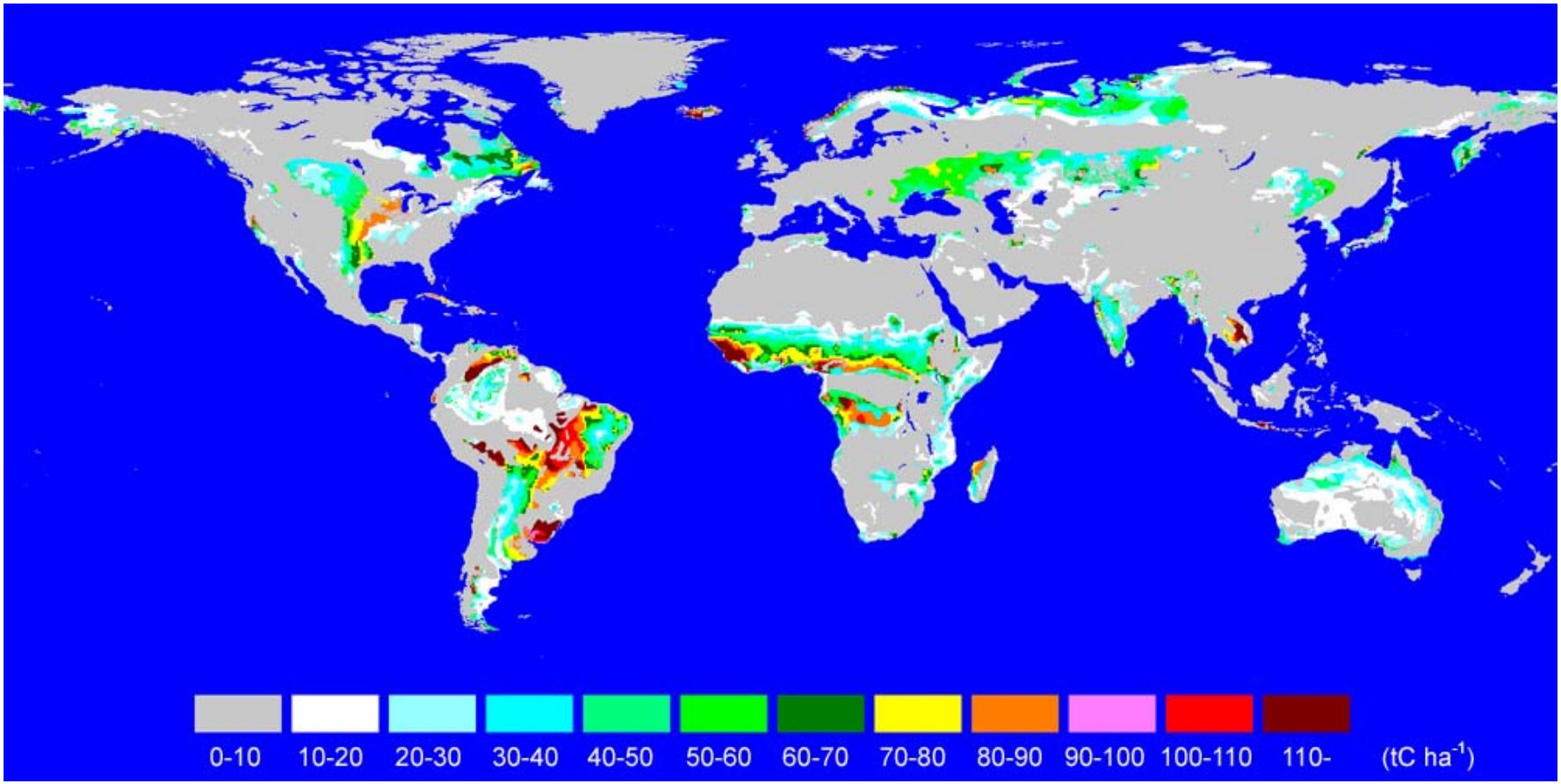
Estimations of Carbon Sequestration Potential by Afforestation/Rehabilitation



- **The area having the stock under the averaged stock for each precipitation level is assumed to achieve the increase in the stock up to the averaged one by afforestation/rehabilitation.**
- **Land use, soil types, slope, temperature conditions are also considered for the estimation.**

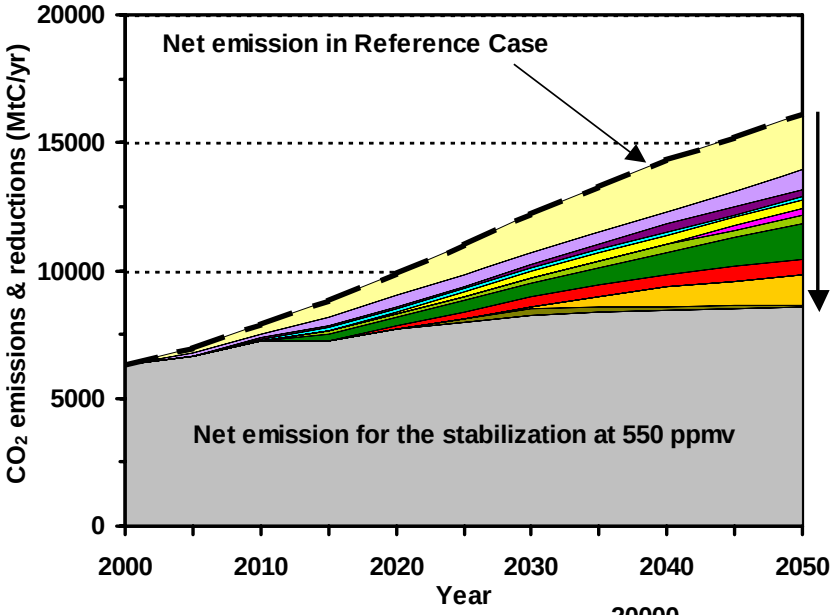


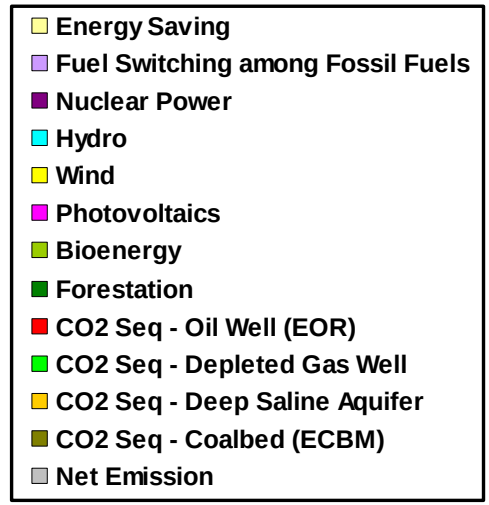
Estimated Carbon Sequestration Potential by Afforestation/Rehabilitation in 1990



The global potentials of carbon sequestration: 170 GtC

Cost-effective Options for Emission Reductions at 550 ppmv by Using DNE21+ Model

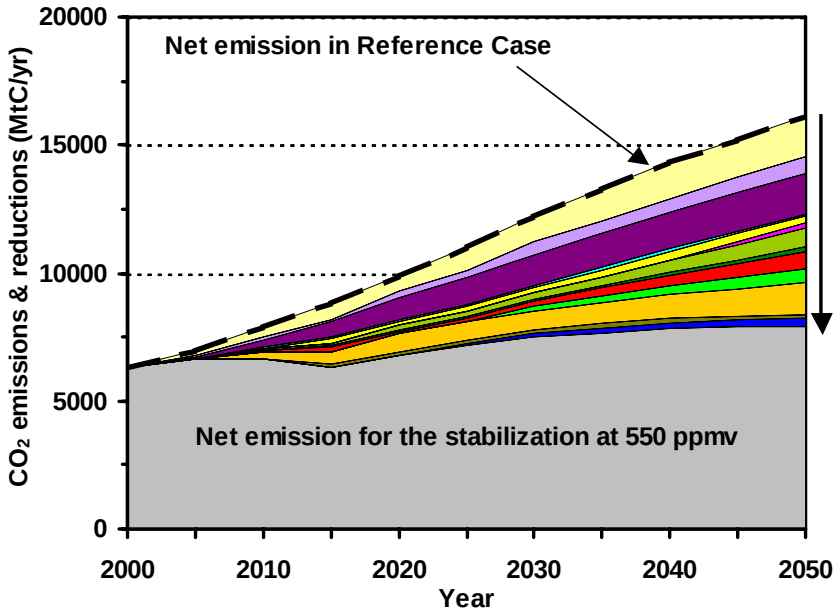


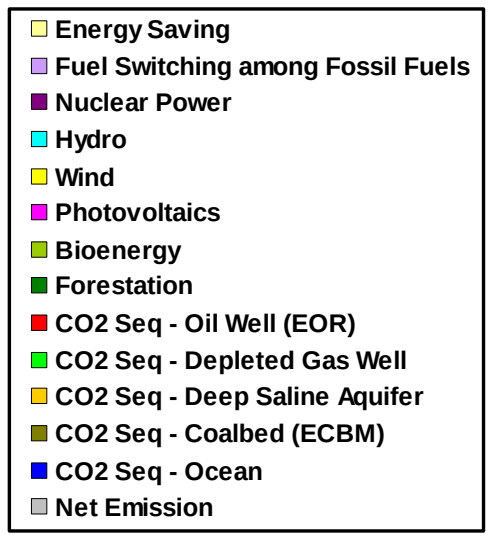


With ET

Without ET

Annex I: 60% reduction in 2050

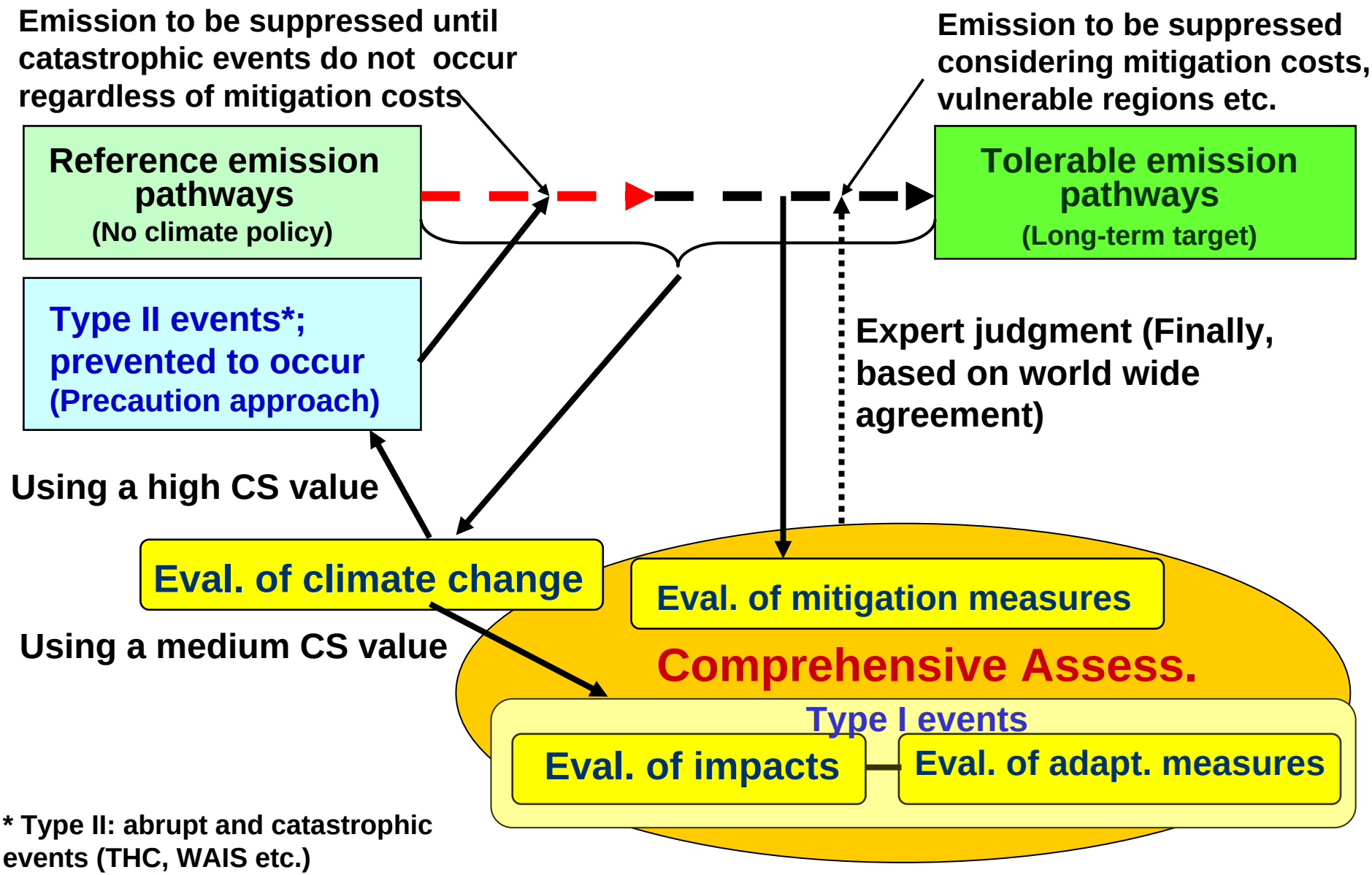




PHOENIX Project

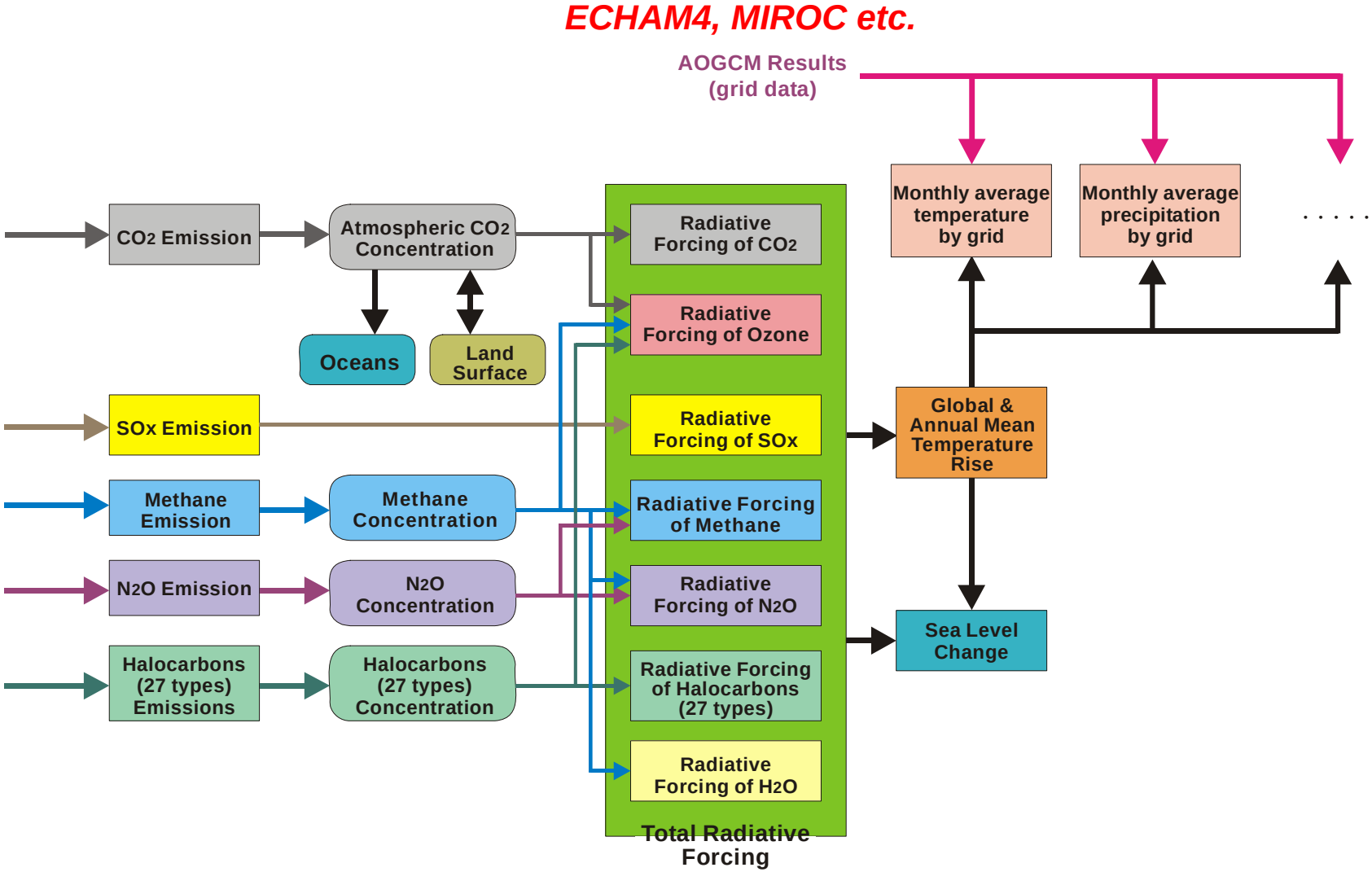
- **PHOENIX: Pathways toward Harmony Of Environment, Natural resources and Industry compleX**
- **Integrated assessment of global warming impacts, adaptations and mitigations**
- **Addressing the ultimate target of Article 2 of UNFCCC**

Assessment Procedure in PHOENIX



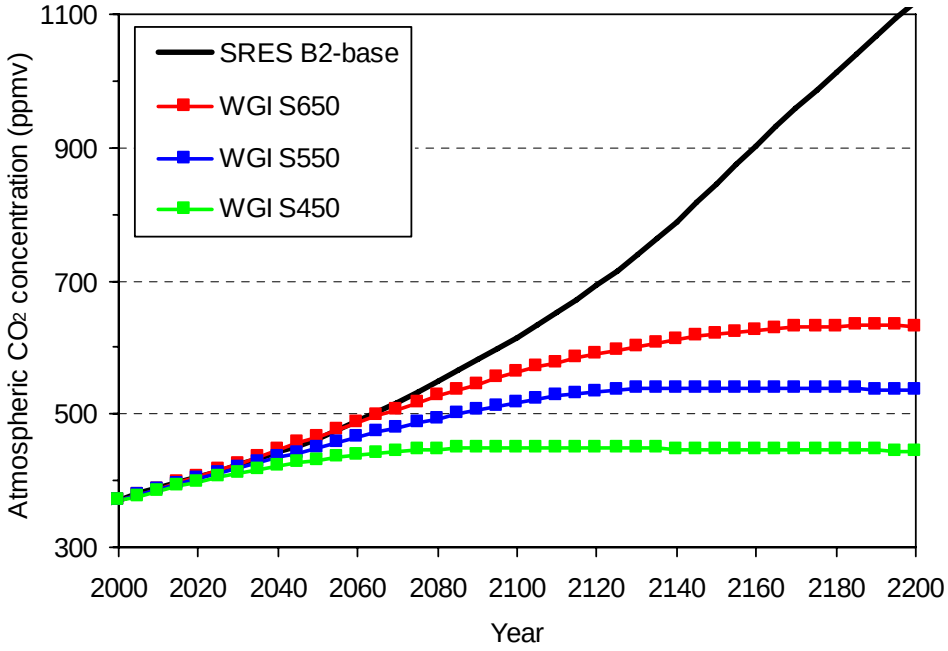
* Type II: abrupt and catastrophic events (THC, WAIS etc.)

The Climate Model
- Integration of SCM and the results of AOGCM -

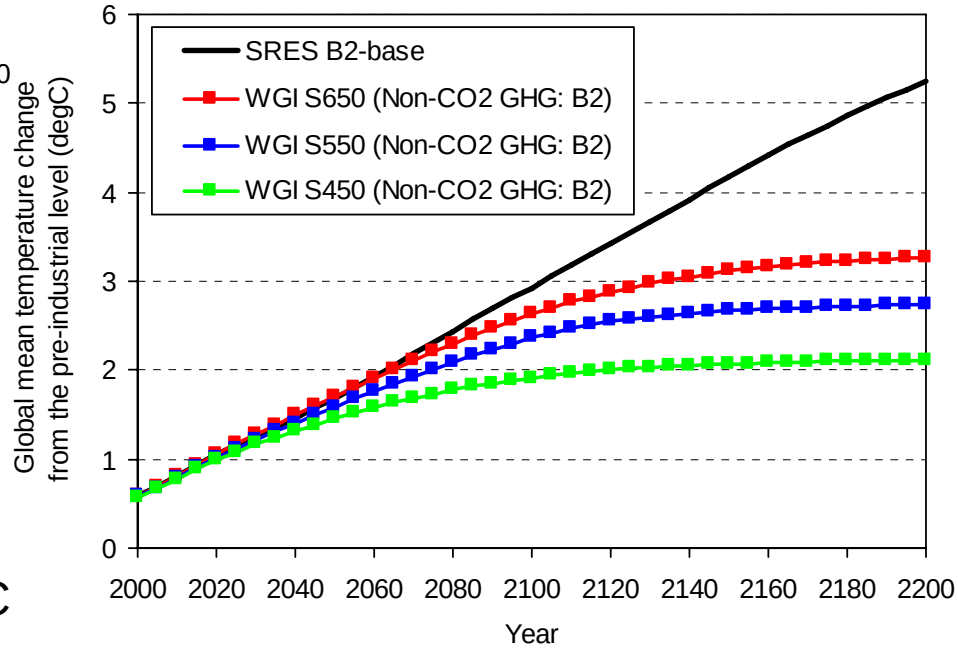


CO_2 Concentration & Temperature Change

Atmospheric CO_2 concentration



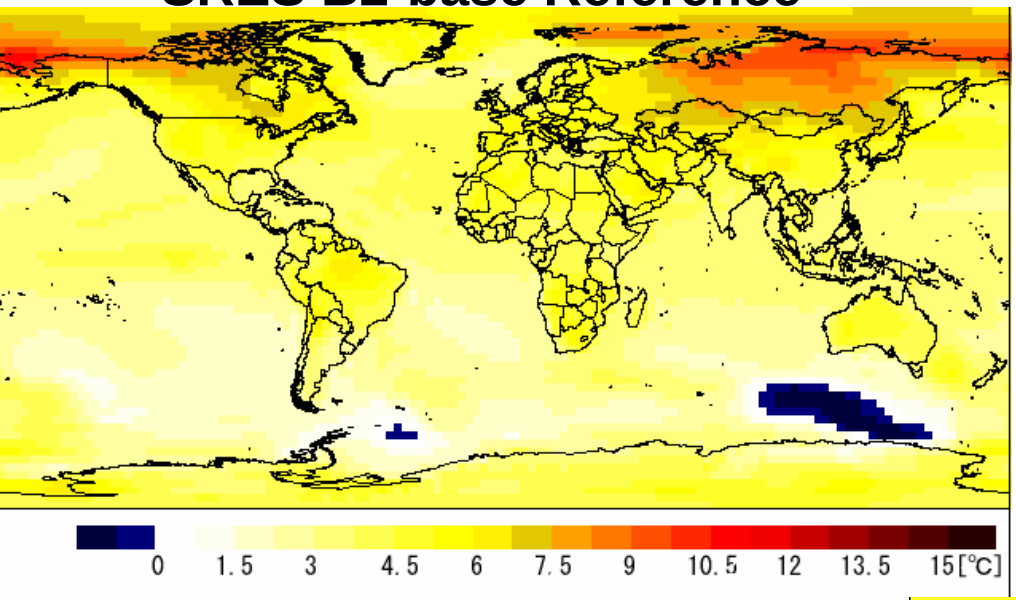
Global mean temperature change



Climate sensitivity: 2.5 ºC

Annual Mean Temperature Change in 2150

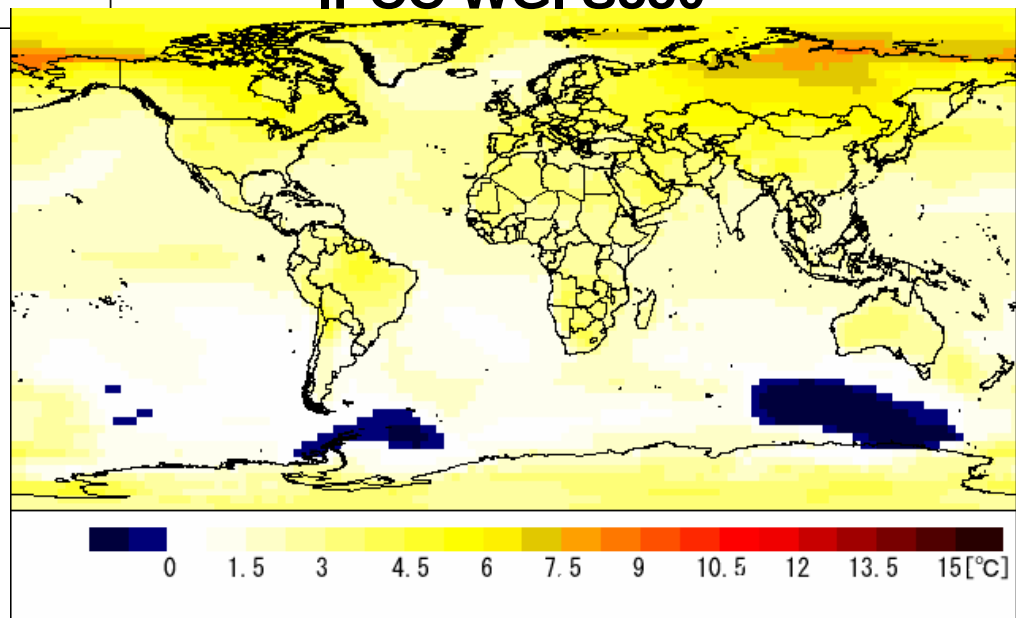
SRES B2-base Reference



GCM results: ECHAM4

Global mean temperature change
+4.2 ºC from pre-industrial levels

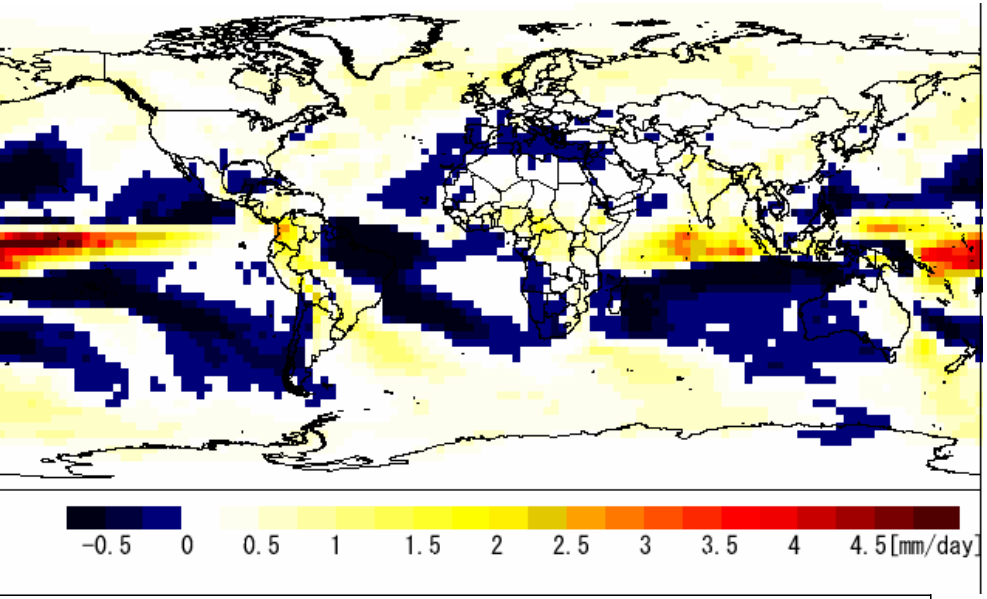
IPCC WGI S550



Global mean temperature change
+2.7 ºC from pre-industrial levels

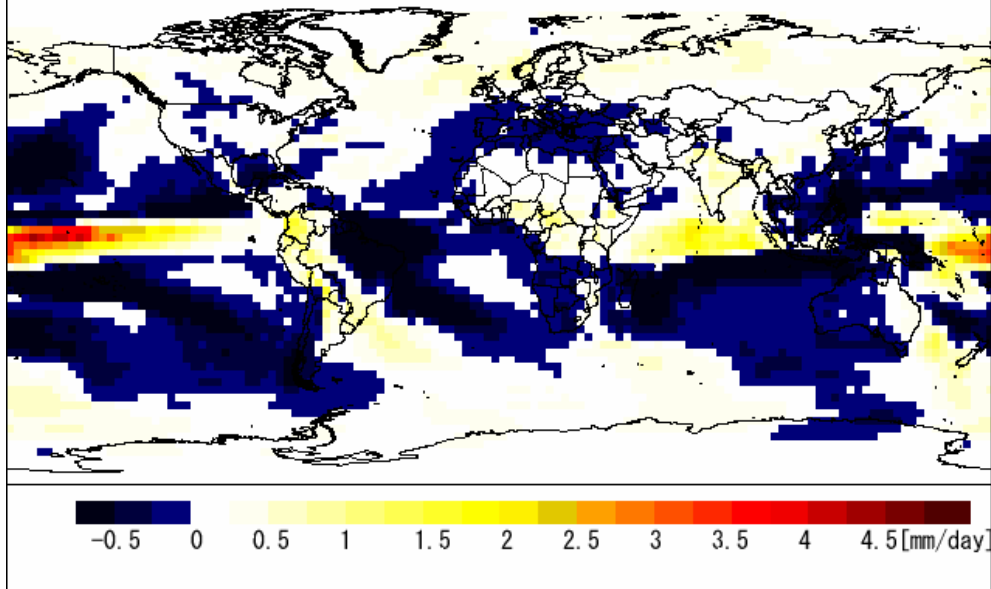
Annual Mean Precipitation Change in 2150

SRES B2-base Reference



GCM results: ECHAM4

IPCC WGI S550

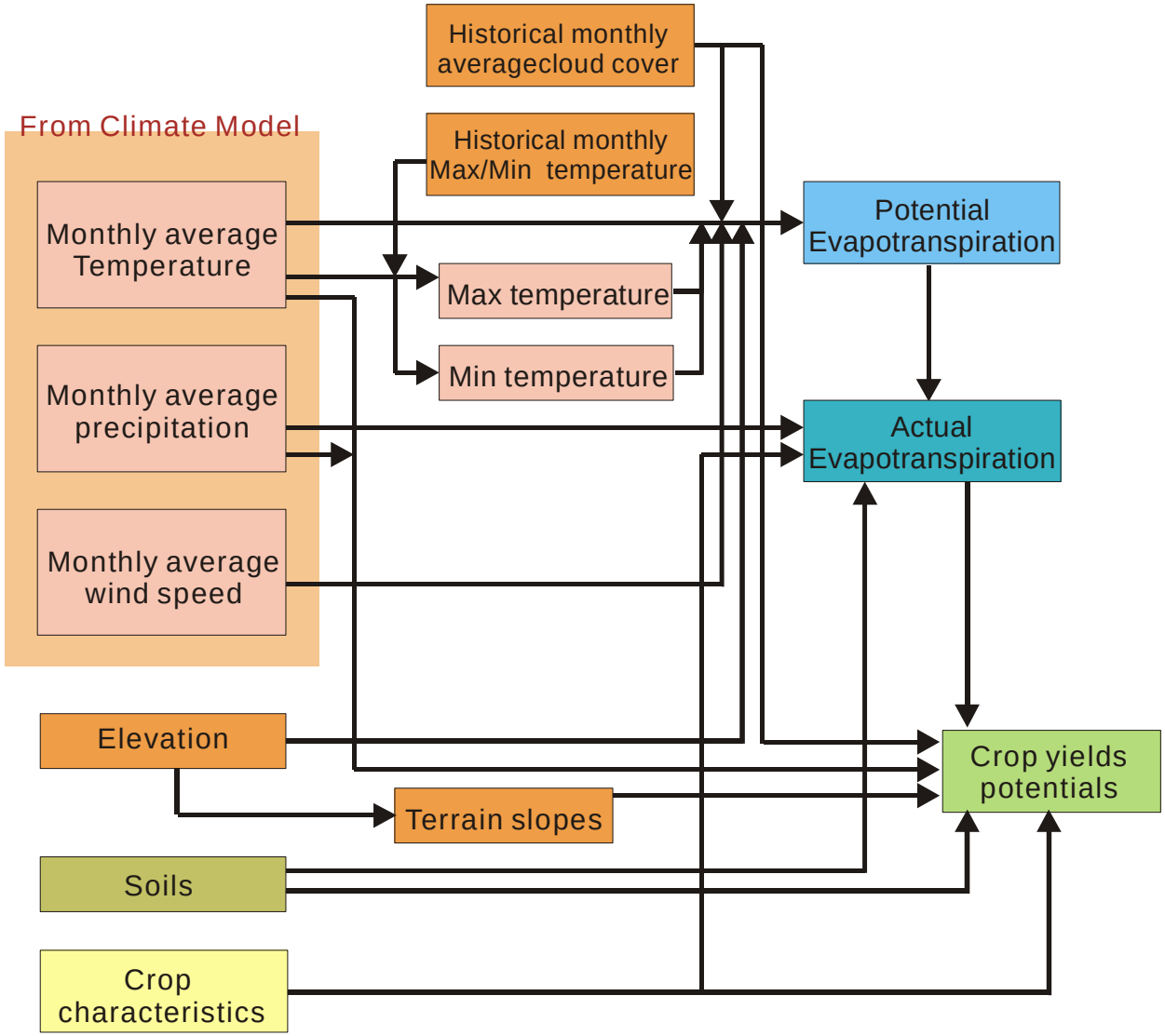


Overview of Crop Potential Model

- The model is based on the GAEZ (Global Agro-ecological Zones) framework developed by IIASA/FAO.
- Crop production potentials are estimated by matching between climate, soil condition etc. and characteristics of crops.
- AEZ has a detailed database of crop characteristics.
- AEZ provides the Leaf area index (LAI) and harvest index depending on the agriculture input levels.

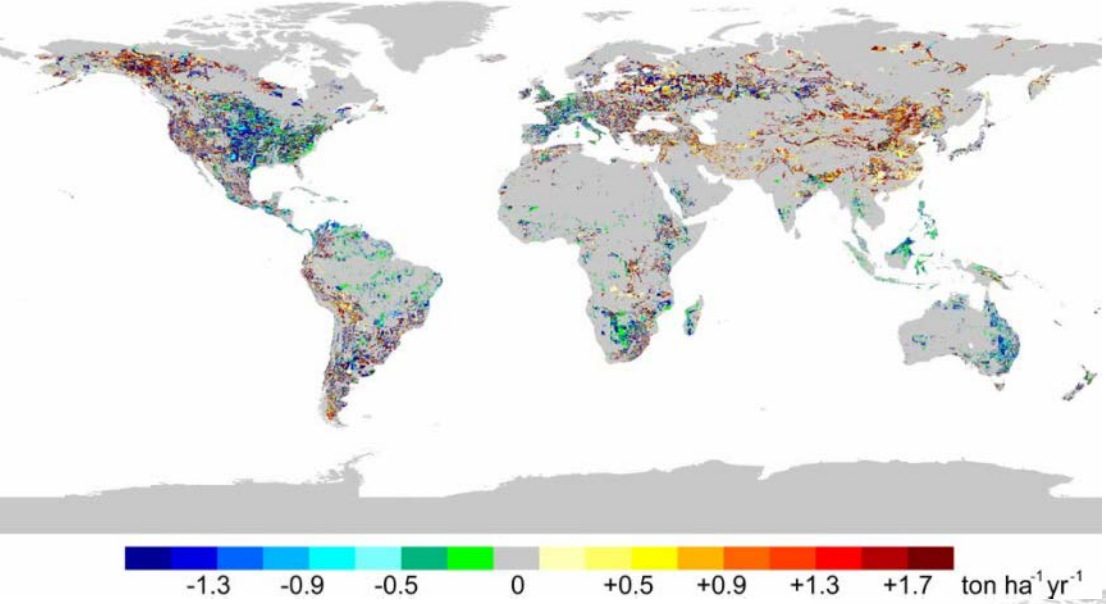
- Consideration of the productivity increase (LAI and harvest index) of agriculture depending on economic levels
- Maximizing the production potentials considering the changes in implantation crops and month, which can evaluate the adaptation effects for global warming

Estimation Procedure of Production Potentials of Crops

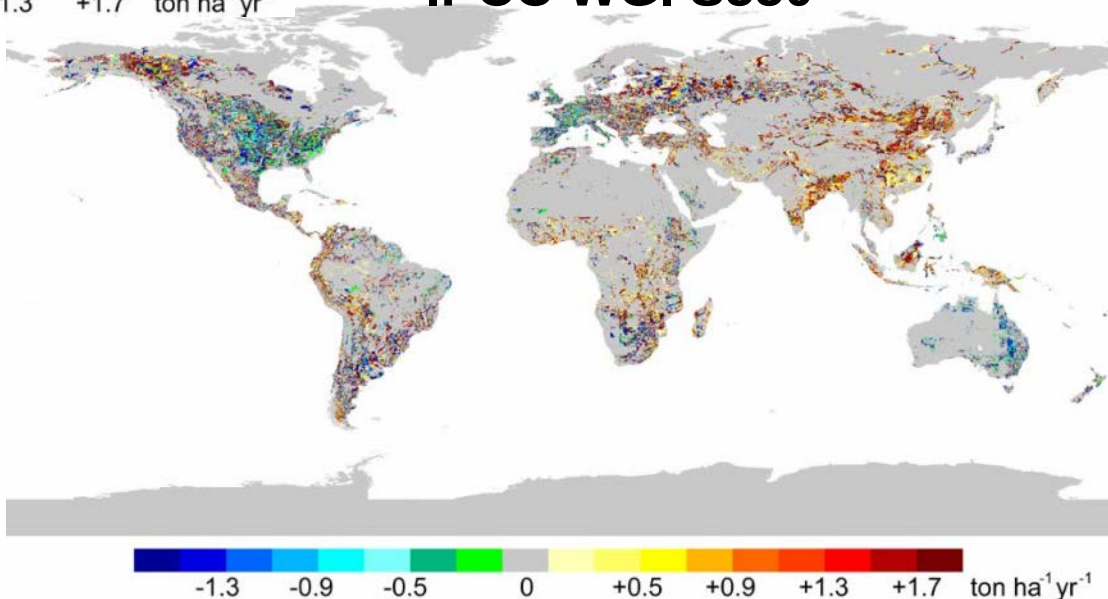


Change in Production Potential of Wheat in 2150

SRES B2-base Reference

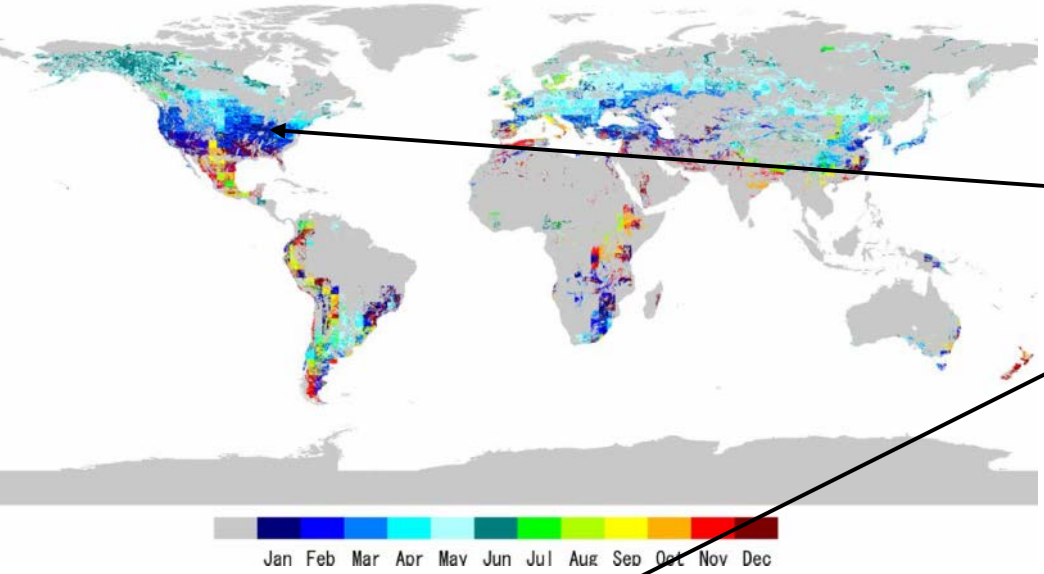


IPCC WGI S550



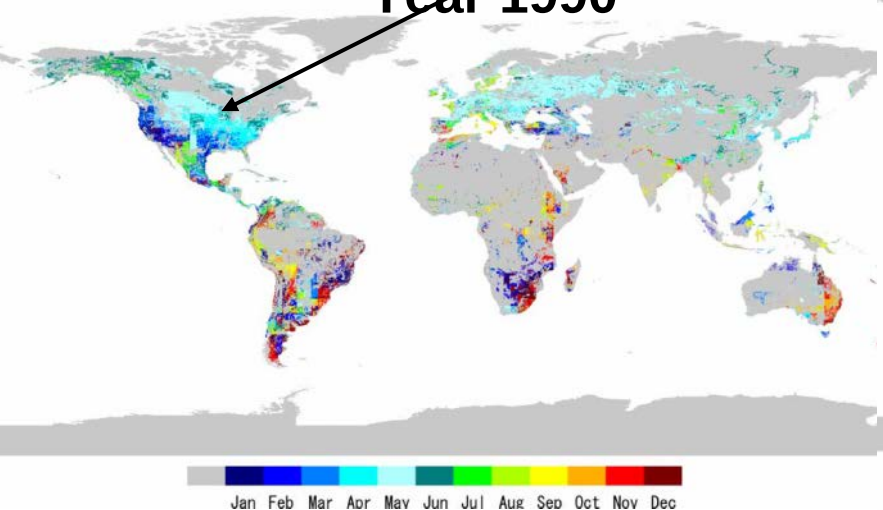
Optimal Implantation Month of Wheat

Year 2150: SRES B2-base Reference

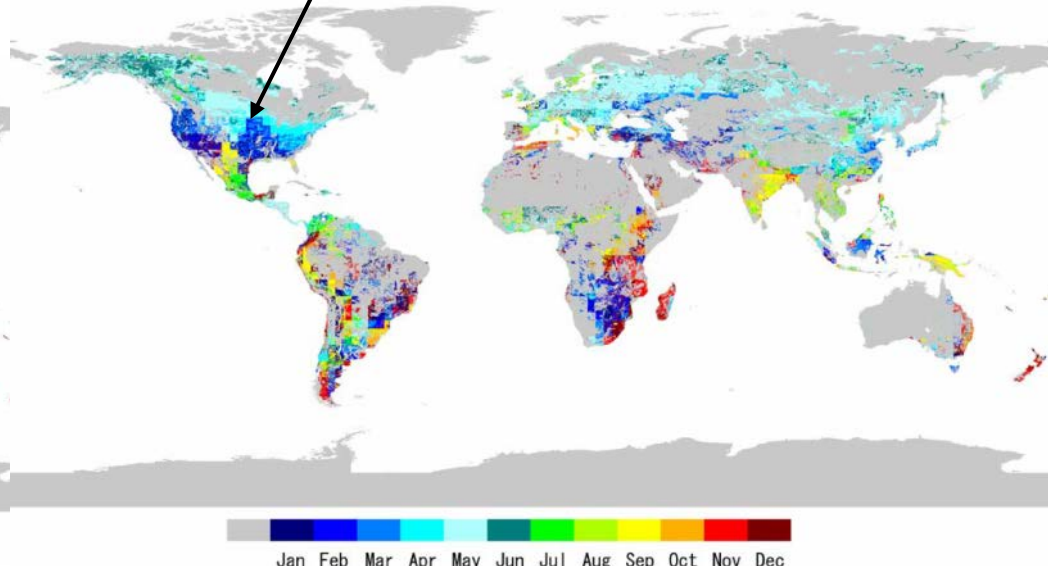


e.g.,
The optimal implantation month shifts from April-May in 1990 to January-February in 2150

Year 1990

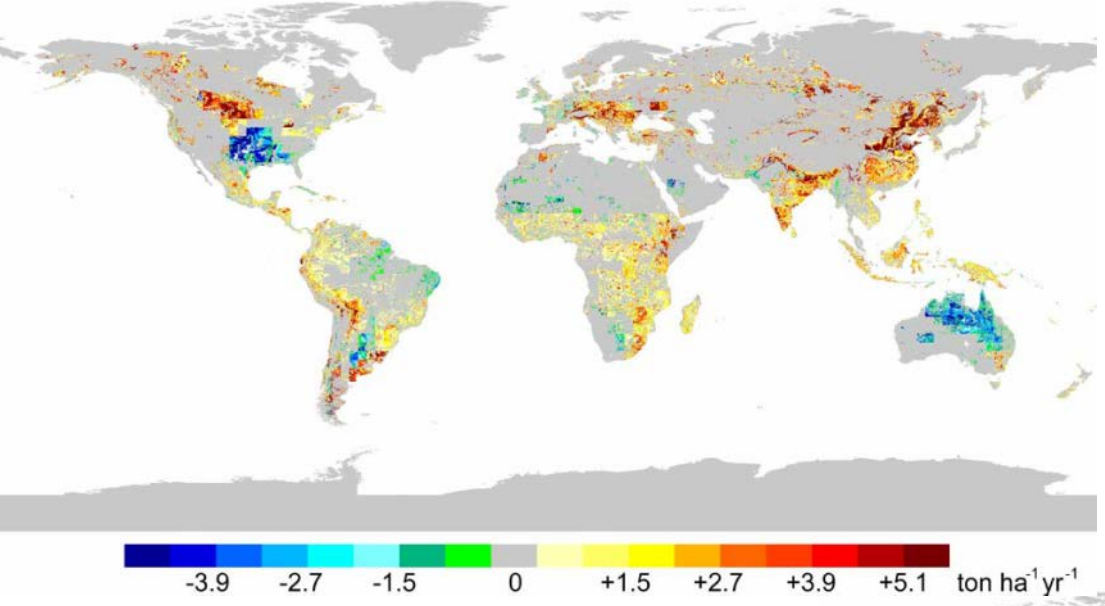


Year 2150: IPCC WGI S550

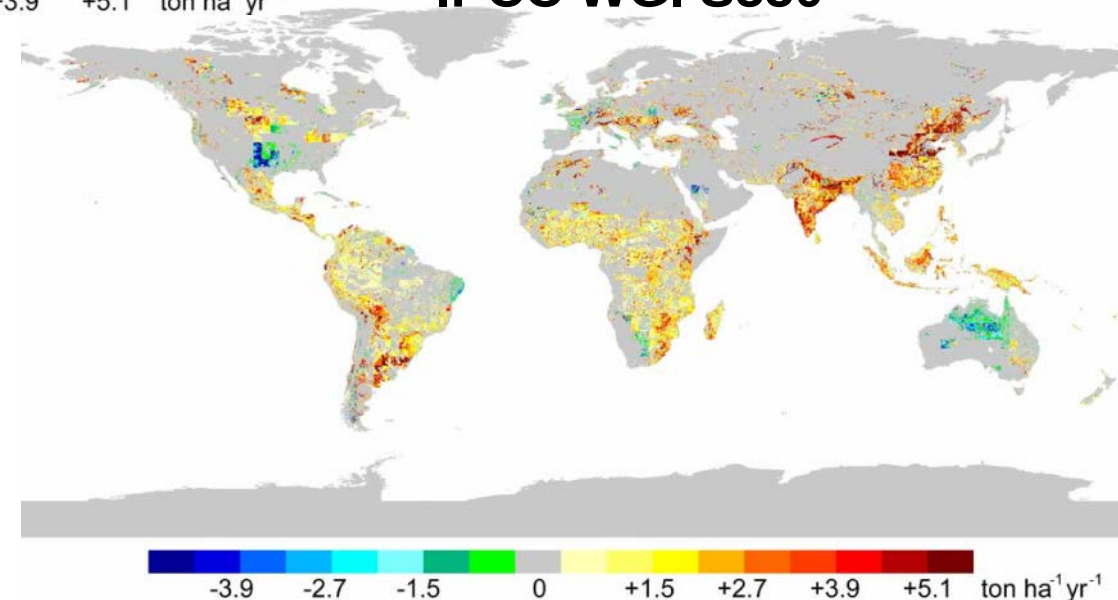


Change in Production Potential of Rice in 2150

SRES B2-base Reference

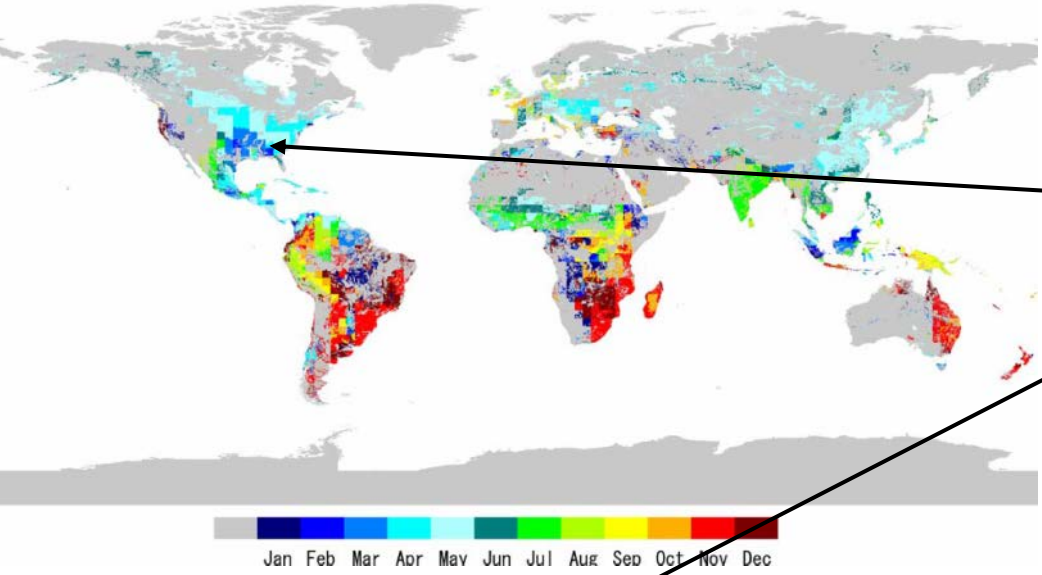


IPCC WGI S550



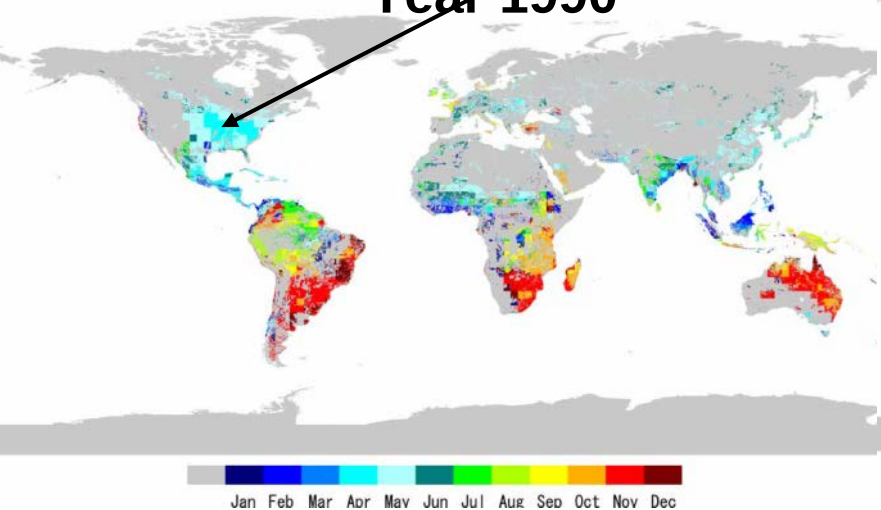
Optimal Implantation Month of Rice

Year 2150: SRES B2-base Reference

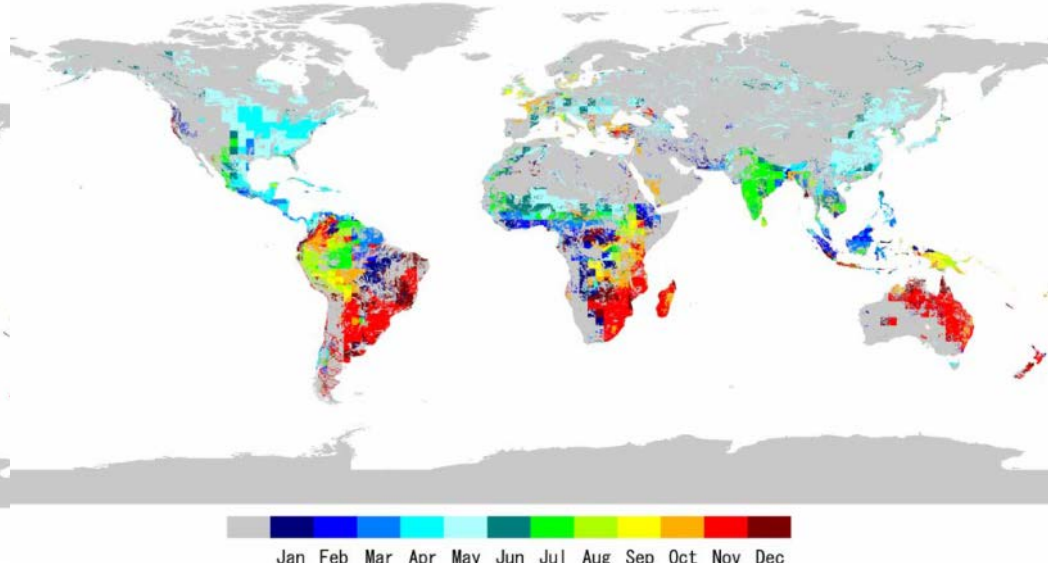


e.g.,
The optimal implantation month shifts from April in 1990 to March in 2150

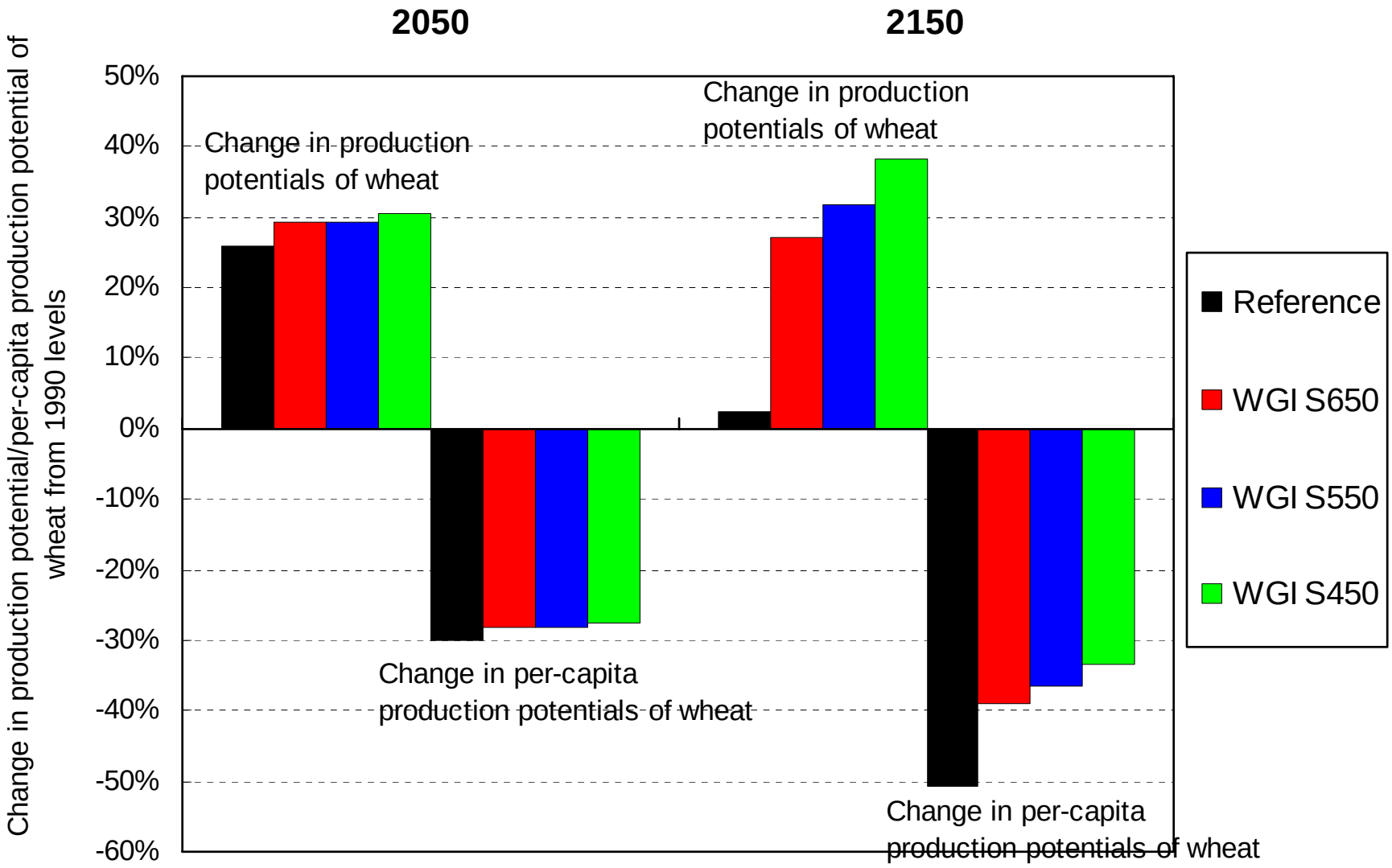
Year 1990



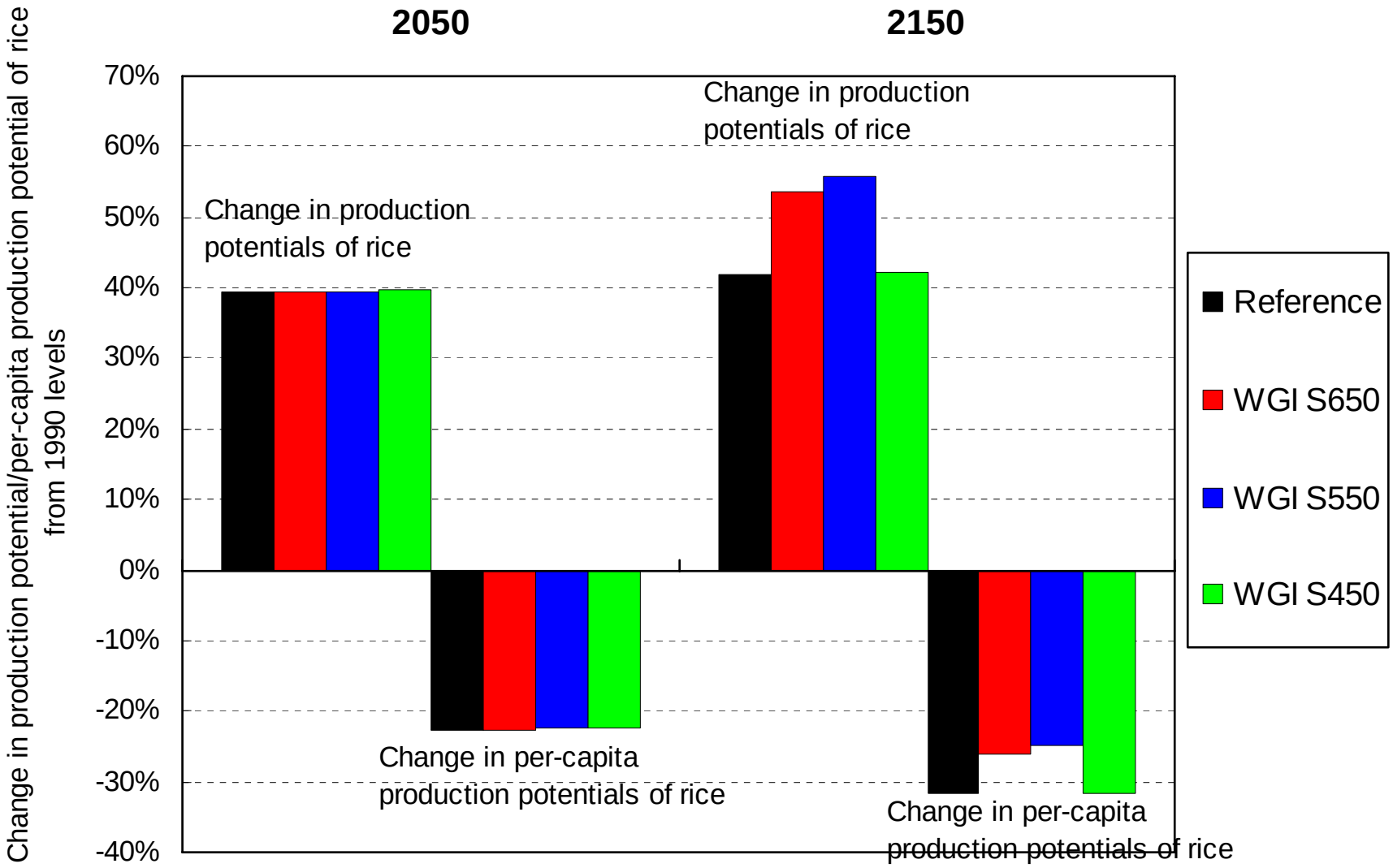
Year 2150: IPCC WGI S550



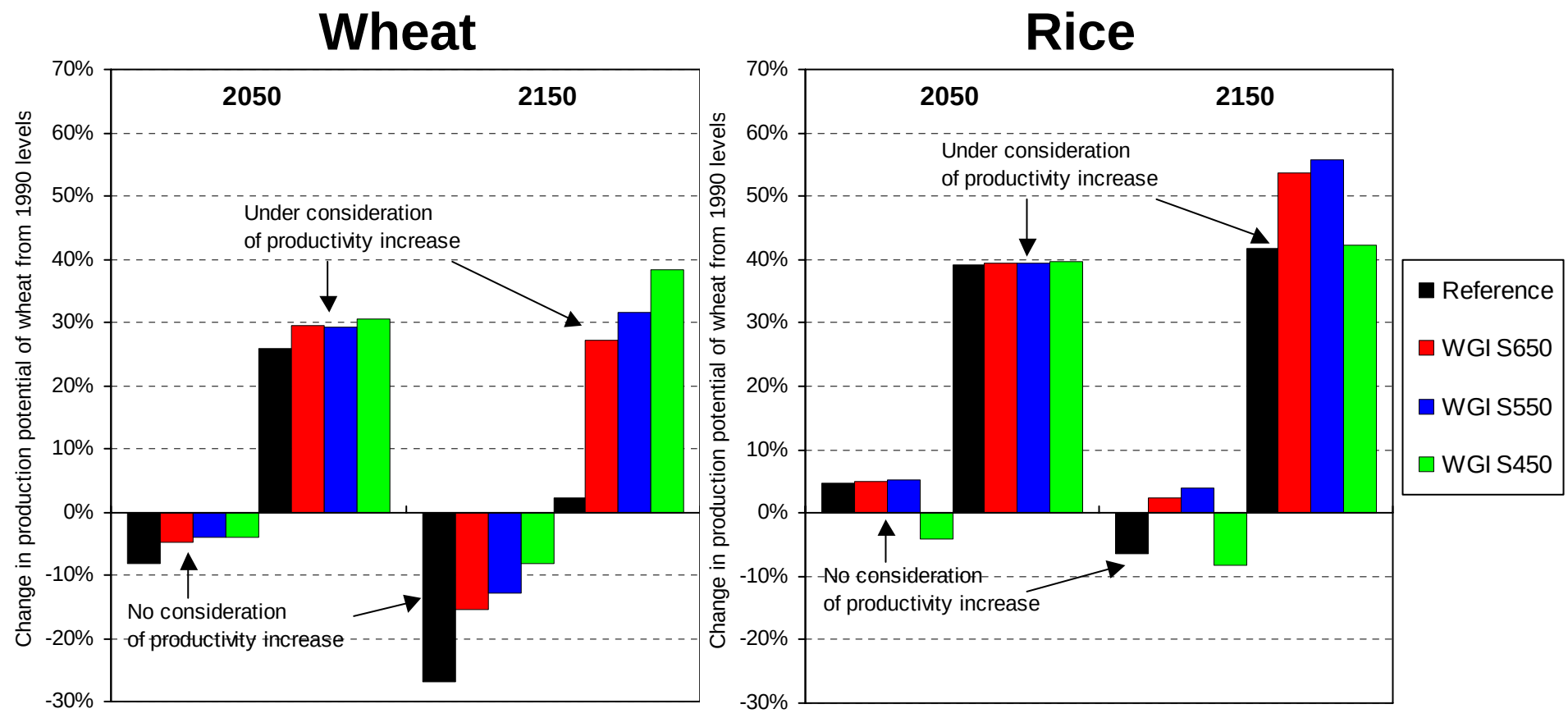
Change in Production Potential of Wheat from 1990



Change in Production Potential of Rice from 1990

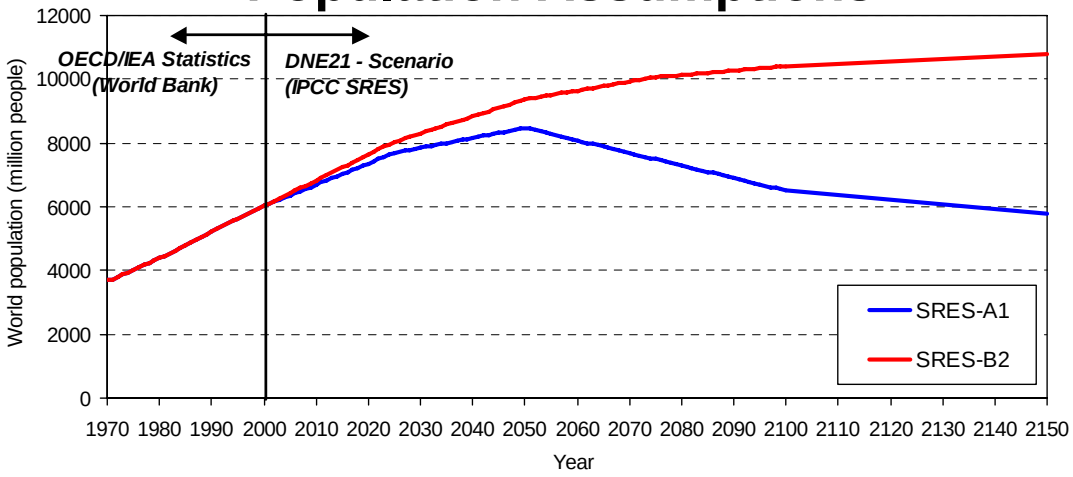


Effects of Increase in Crop Productivity

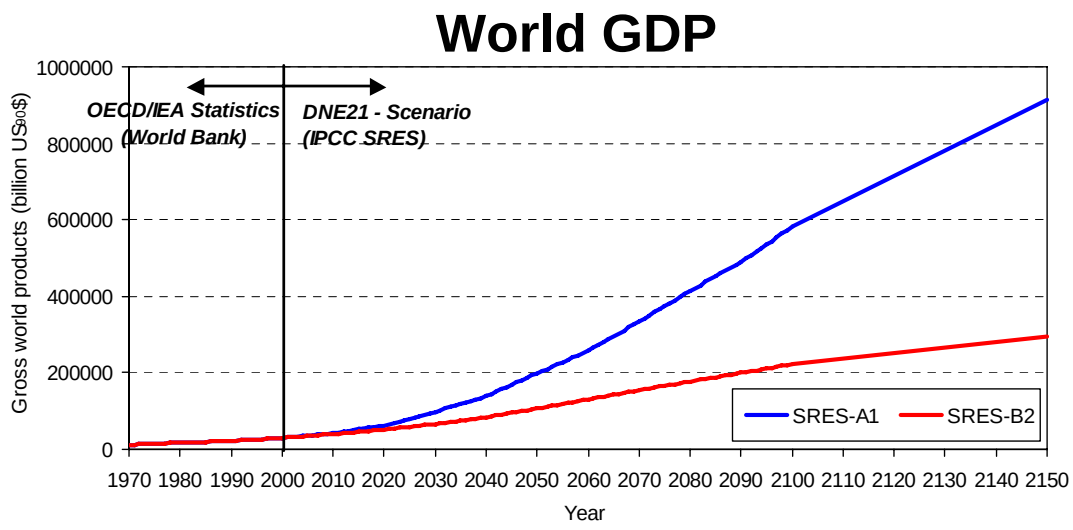


Alternative Socio-Economic Scenarios for Sensitivity Analysis

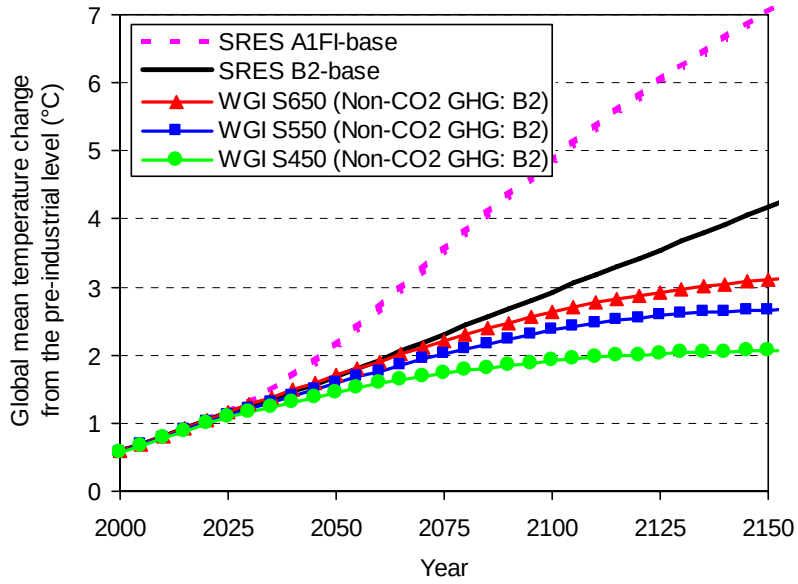
Population Assumptions



World GDP



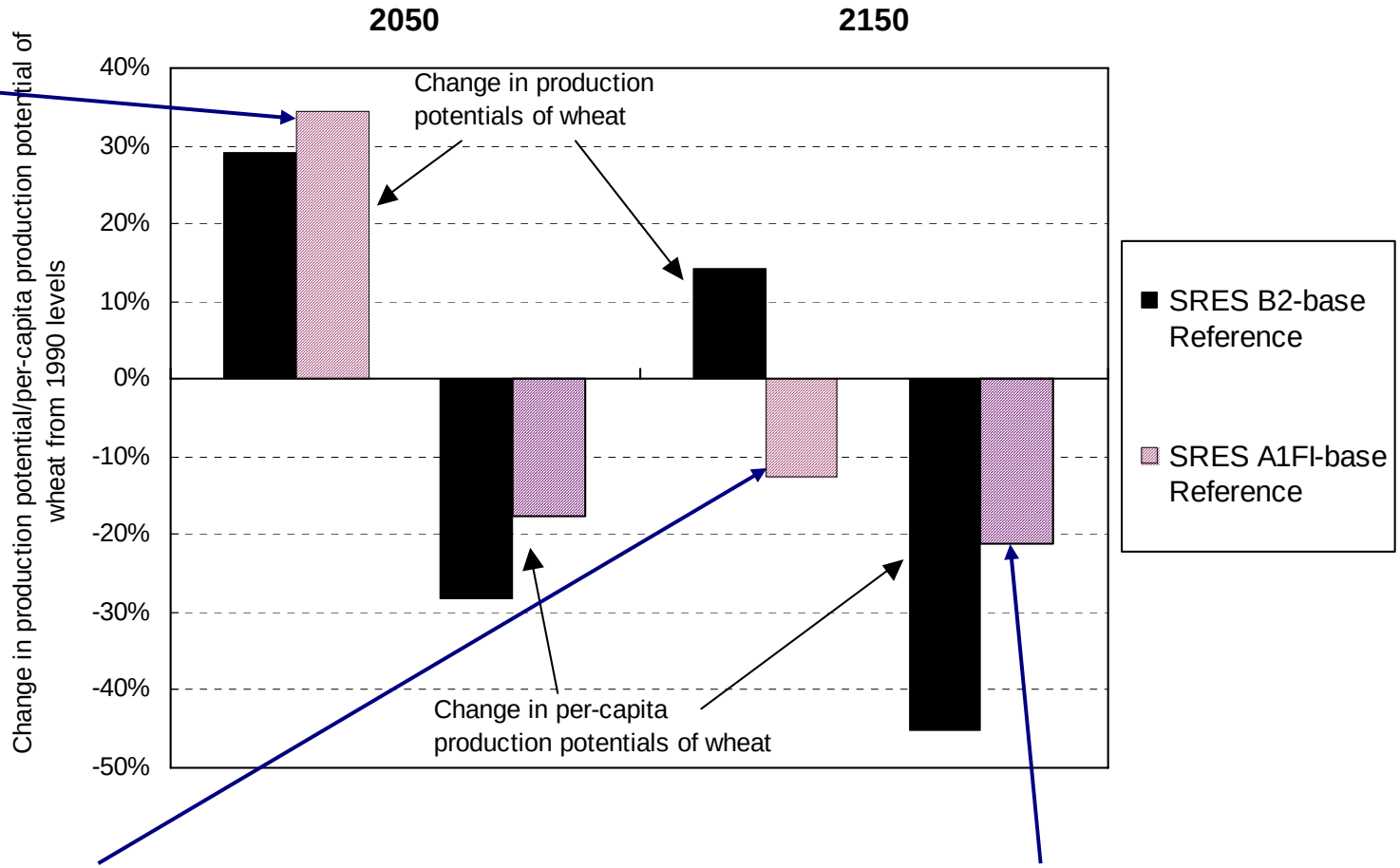
Temperature Change



Sensitivity to Socio-Economic Conditions

- Wheat -

Higher economic growth and improvements of agriculture productivity are assumed in A1FI than in B2, and therefore, the potential production is larger than in B2 instead of larger temperature rise.



However, the potential production in A1FI will be decrease in 2150, due to large temperature rise.

Although large temperature rise is estimated in A1FI, the decrease in the per-capita potential productivity is smaller than in B2, due to a smaller population assumption in A1FI.

Final Remarks

- PHOENIX is conducting consistent assessments for different levels of stabilization scenarios.
- Bioenergy and forestation potentials are evaluated.
- Global warming impacts on potential productions of crops are also evaluated.
- However, Socio-economic conditions would be more influential on crop production potentials than stabilization levels.

- Harder linkages among sea level rise, water resources, agriculture, bioenergy supply potentials, forestation potentials, socio-economic estimates etc. are needed.
- The linkage between DEARS model (using GTAP database) and global warming impacts on agriculture is also an important future work.