The COP21 agreement and relevant scenarios for simulating changes in climate extremes

Claudia Tebaldi, NCAR

Acknowledging the contribution of ScenarioMIP SSC members, and in particular Brian O'Neill and Ben Sanderson (NCAR)

Outline

- The backbones of emission scenarios: Shared Socio-economic Pathways (SSPs)
- The new emission scenarios: the CMIP6-approved ScenarioMIP design, in particular the new “low-warming” scenarios.
- Matching Climate model output and SSPs information to perform impact/exposure/vulnerability analyses

Scenarios dominate climate change analysis

Alternative visions of how future may evolve

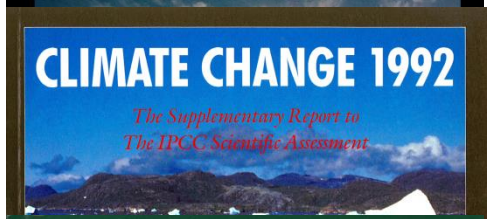
<u>Rationale:</u>

Deep uncertainty

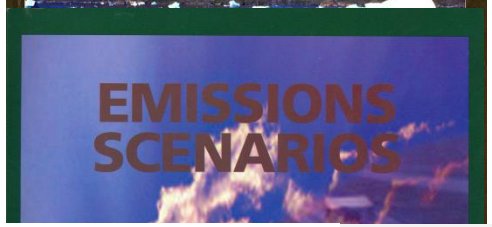
Facilitate integrated research and assessment

1990

1992



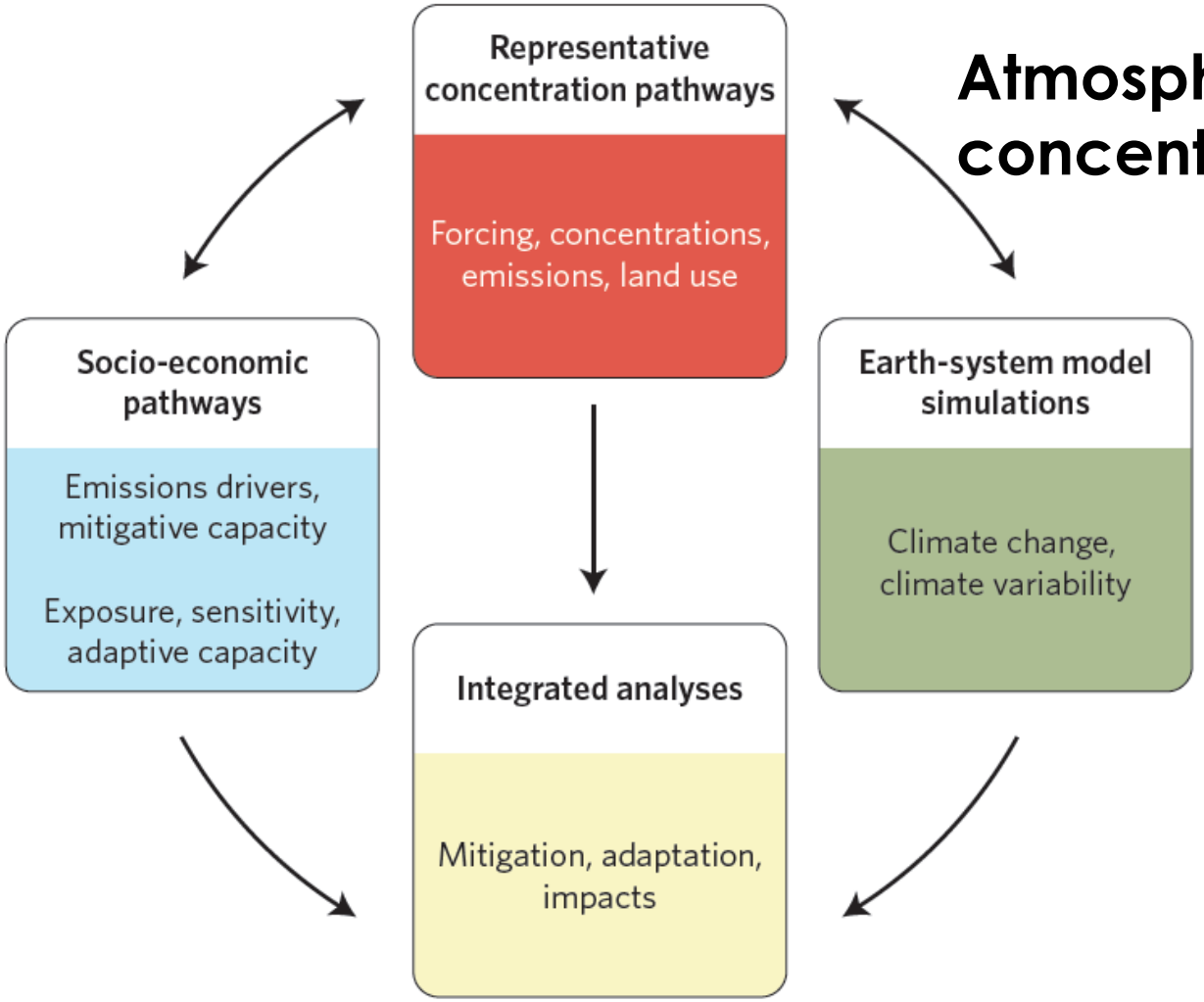
2000



2014
"Shared Socioeconomic Pathways"

The Parallel Process

"Shared Socioeconomic Pathways" (SSPs)



Atmospheric concentrations

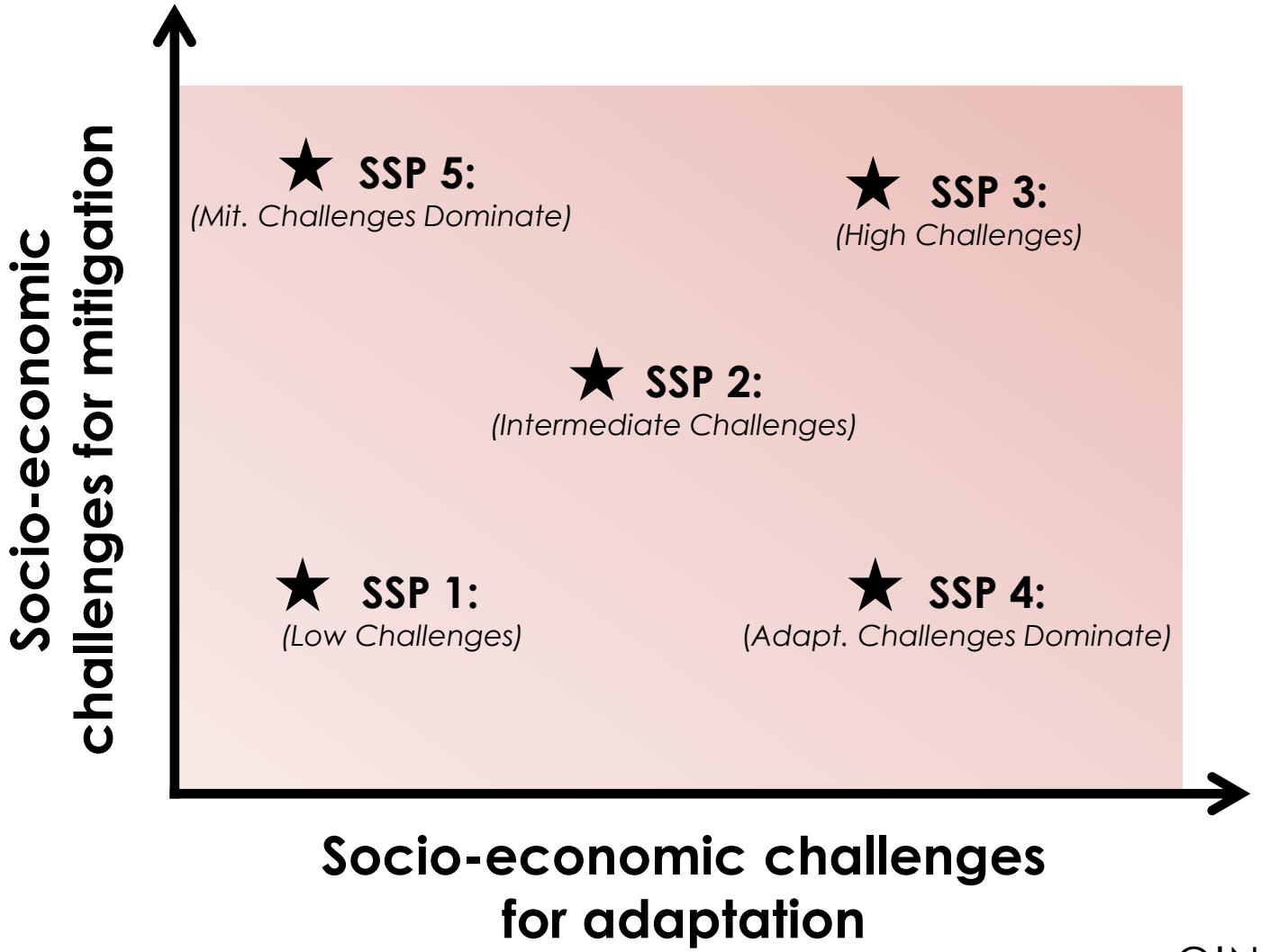
Climate change

O'Neill & Schweizer, 2011; based on Moss et al., 2010.

Shared Socioeconomic Pathway (SSP) Logic

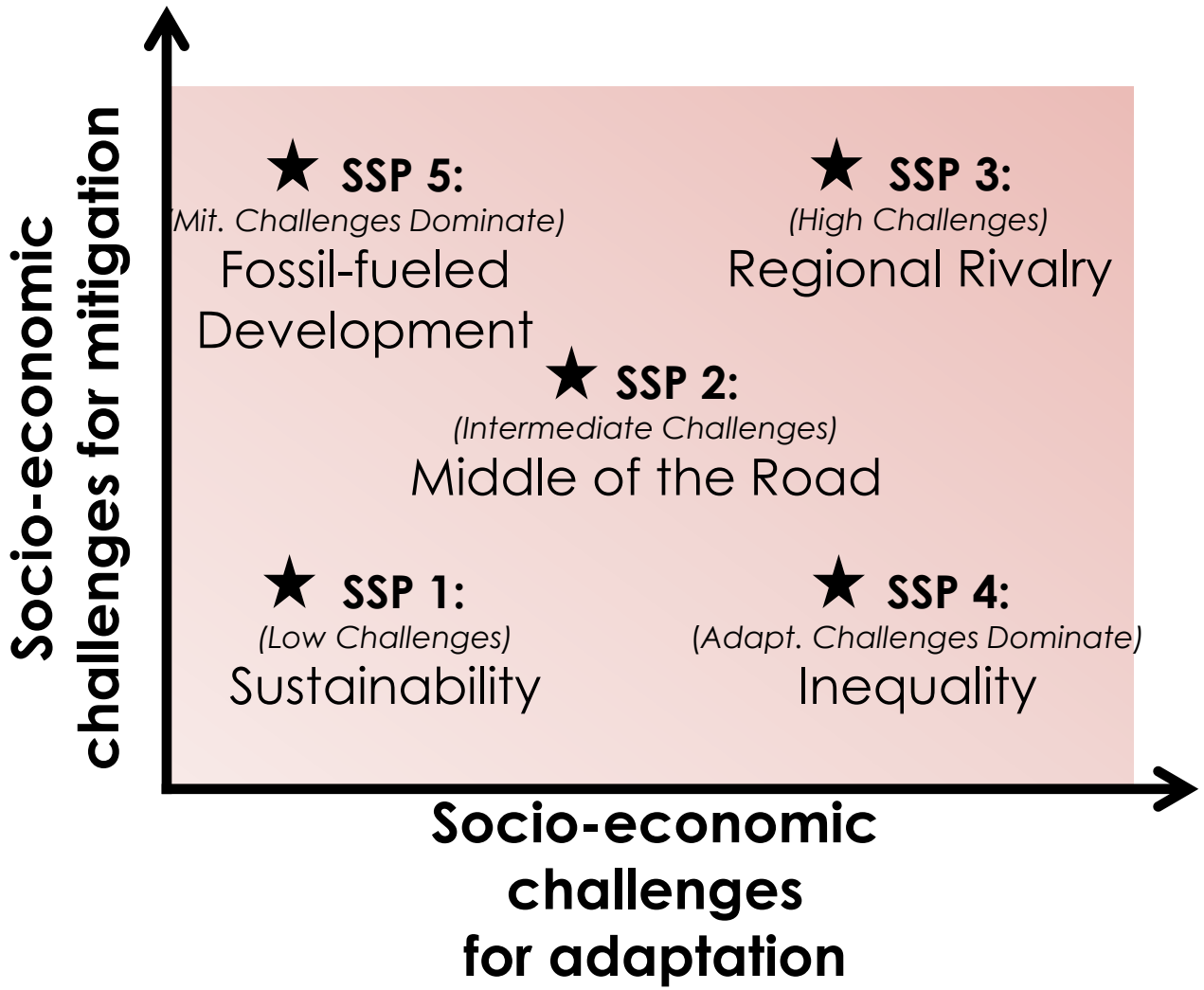
Relevant range of uncertainty spanned:

challenges to adaptation, mitigation



O'Neill et al., 2014.

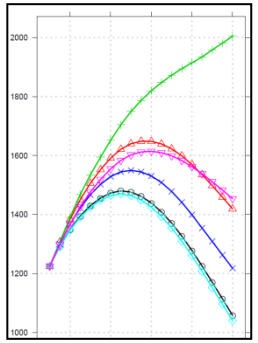
Shared Socioeconomic Pathways (SSPs)



Narrative

Qualitative description of broad patterns of development

Logic relating elements of narrative to each other



Quantitative elements

National:

- Population
- Education
- Urbanization
- GDP

SSP narratives, quantitative elements: **2017 special issue of *Global Environmental Change***.
SSP Database, hosted by IIASA.

From concept to content

What determines challenges to mitigation and adaptation?

What do we know about the outlook for those determinants and their relationships?

SSP Narratives

SSP3: Regional Rivalry

Multi-pole Cold War

Conflict, focus on security

Barriers to trade, migration

Little investment in health, education

Slow technological progress

Weak institutions

Slow income growth

SSP5: Fossil-fueled development

Rise of the global middle class

Rapid technological progress

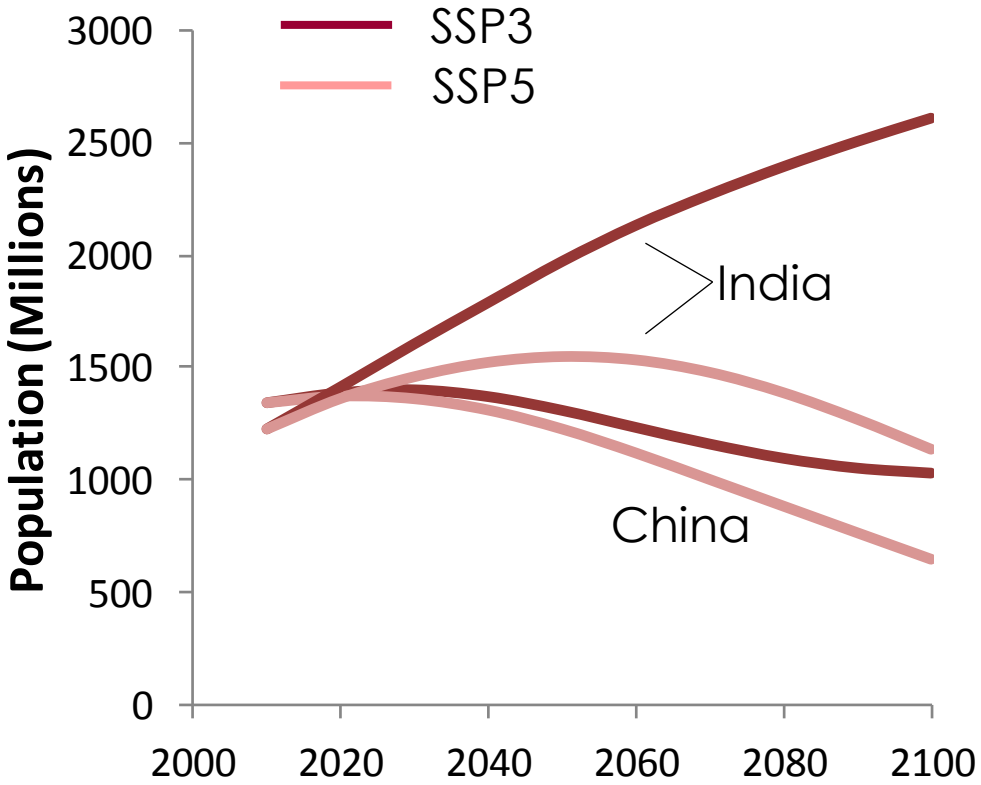
Large investments in human well being (health, education)

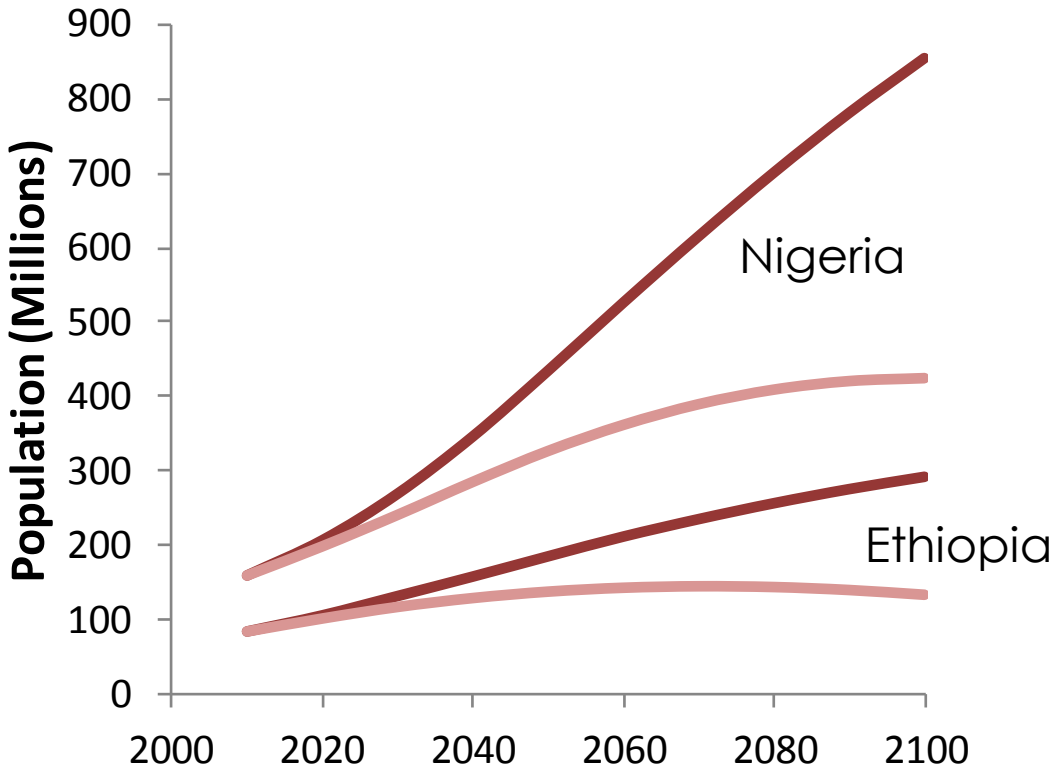
Well functioning institutions

Rapid economic growth

Fossil-centered energy system

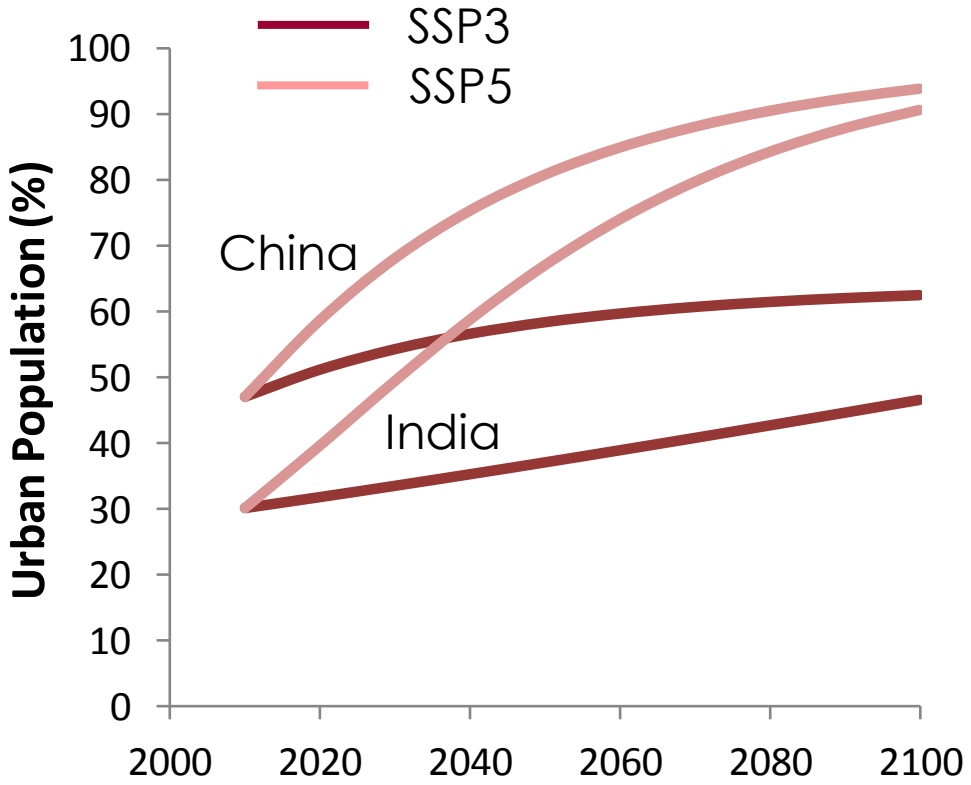
SSP Population: Asia, Africa

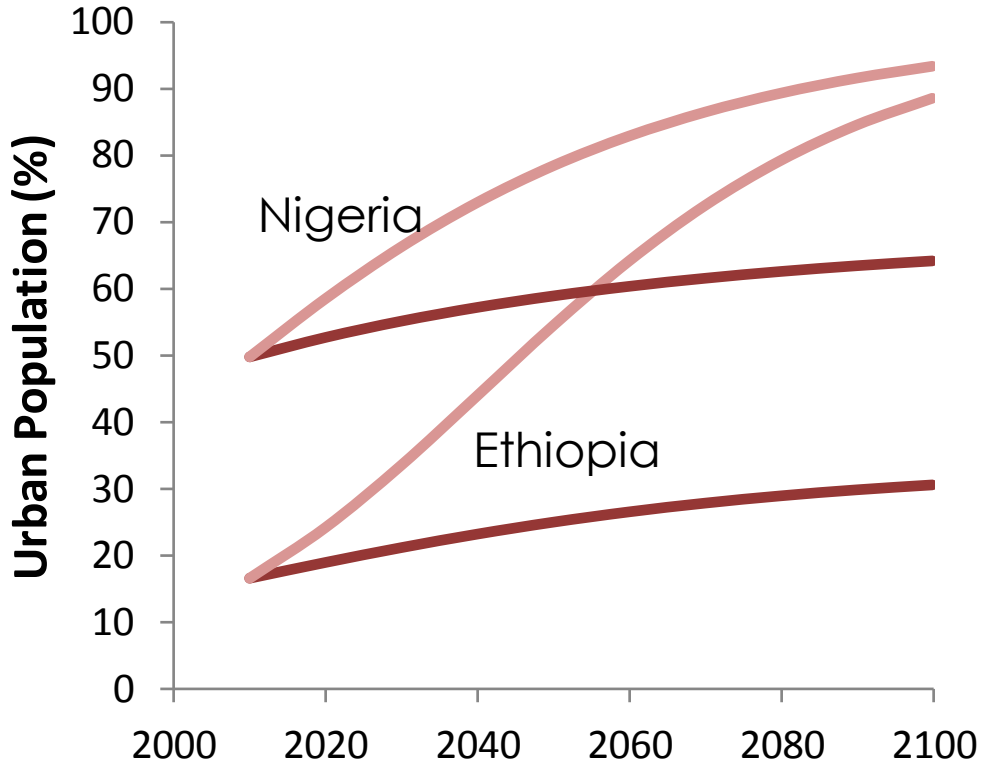




Based on KC and Lutz, 2015.

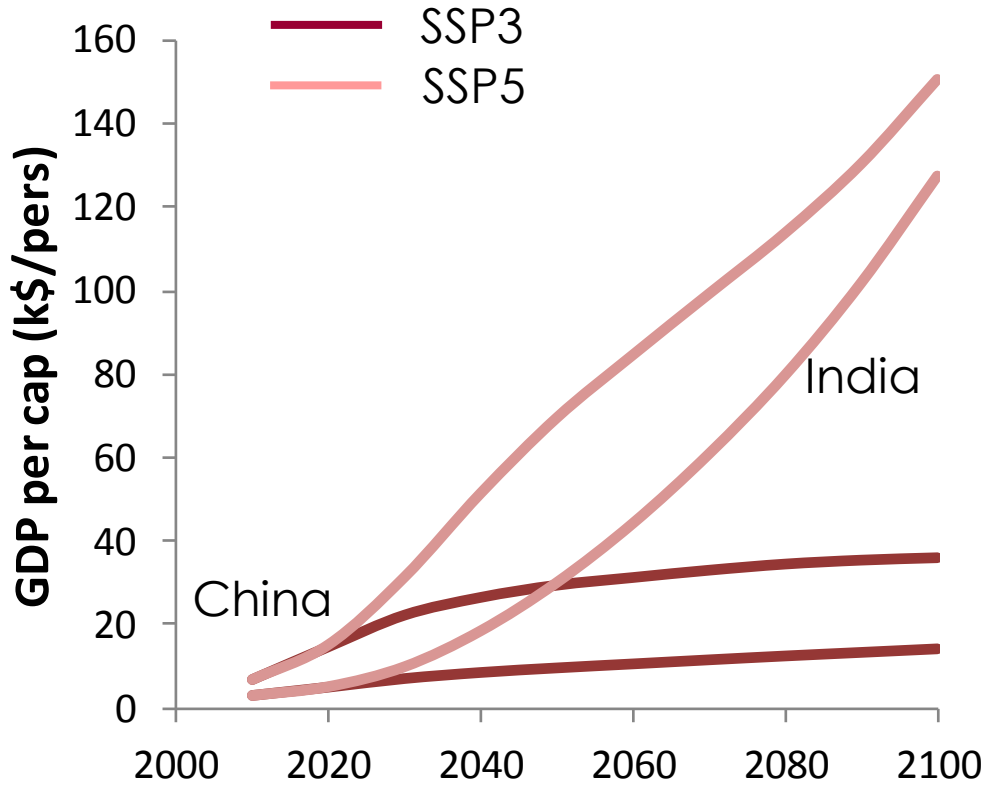
SSP Urbanization: Asia, Africa

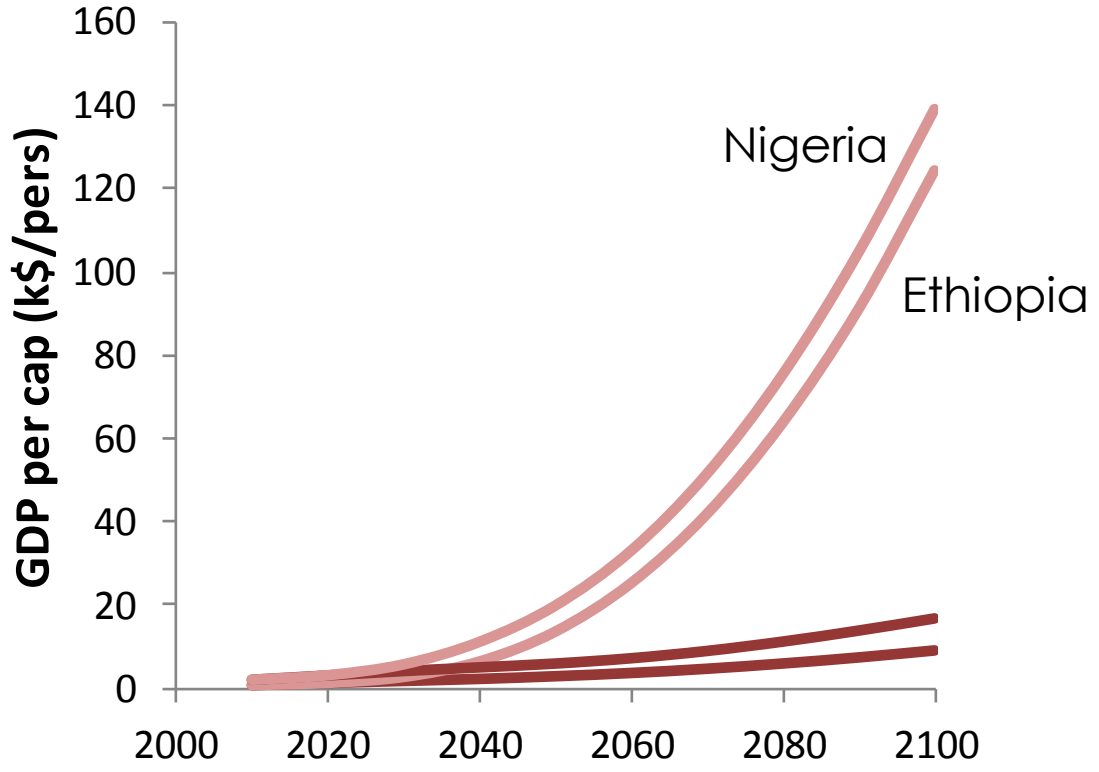




Based on Jiang and O'Neill, 2015.

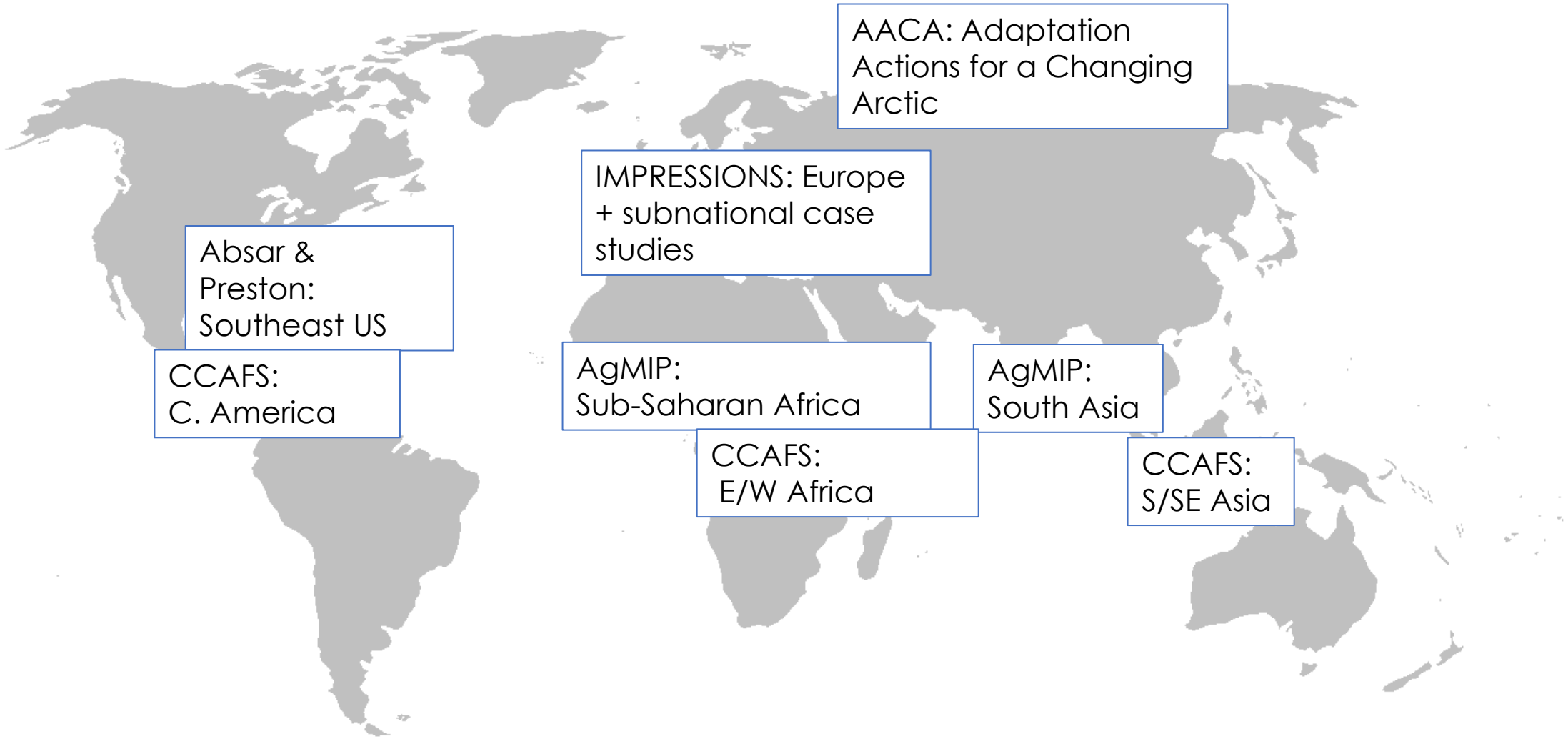
SSP per capita GDP: Asia, Africa



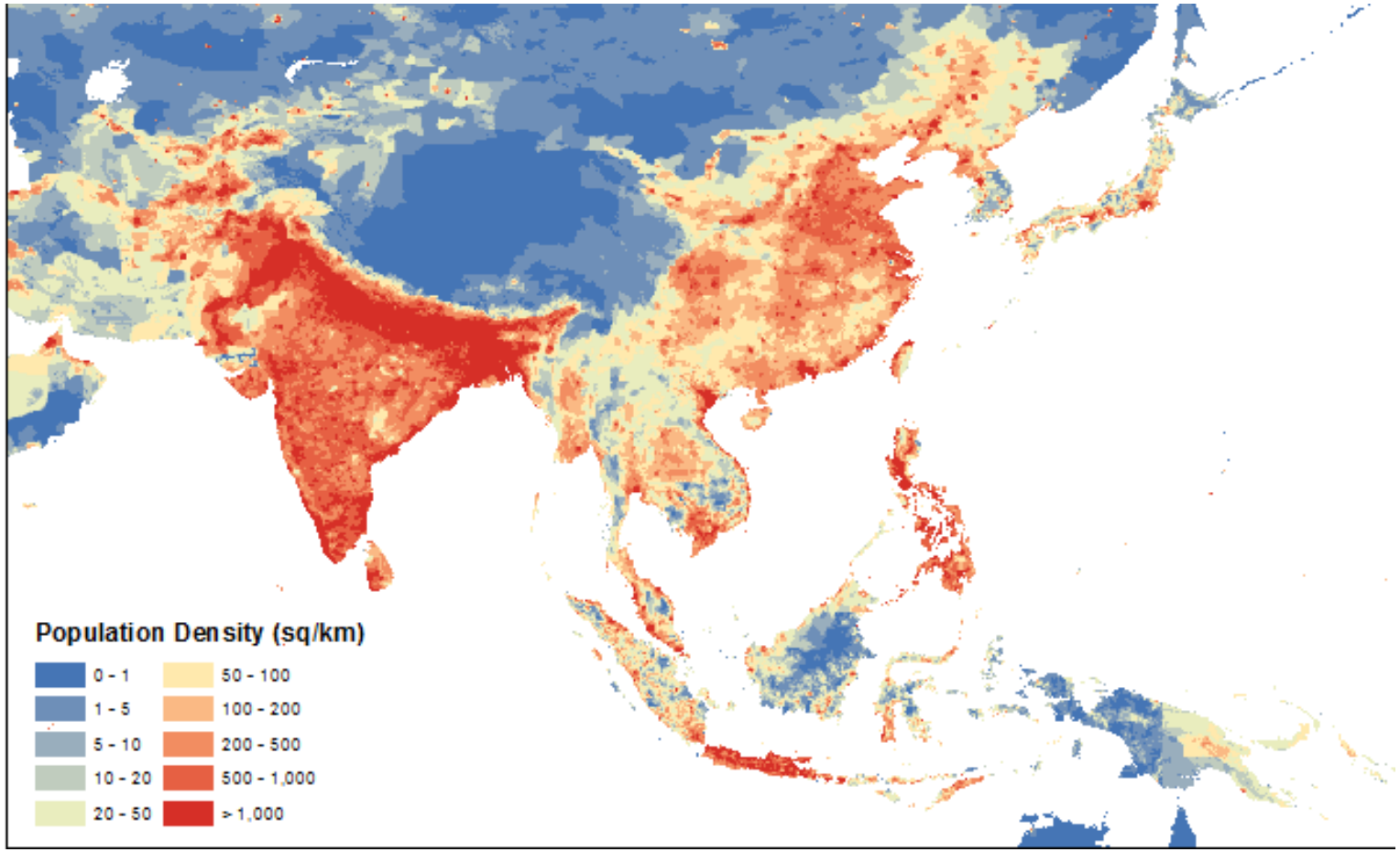


Based on Dellink et al., 2015.

SSP Extensions: Regional



SSP Extensions: Spatial population



Global (Jones & O'Neill, 2016)

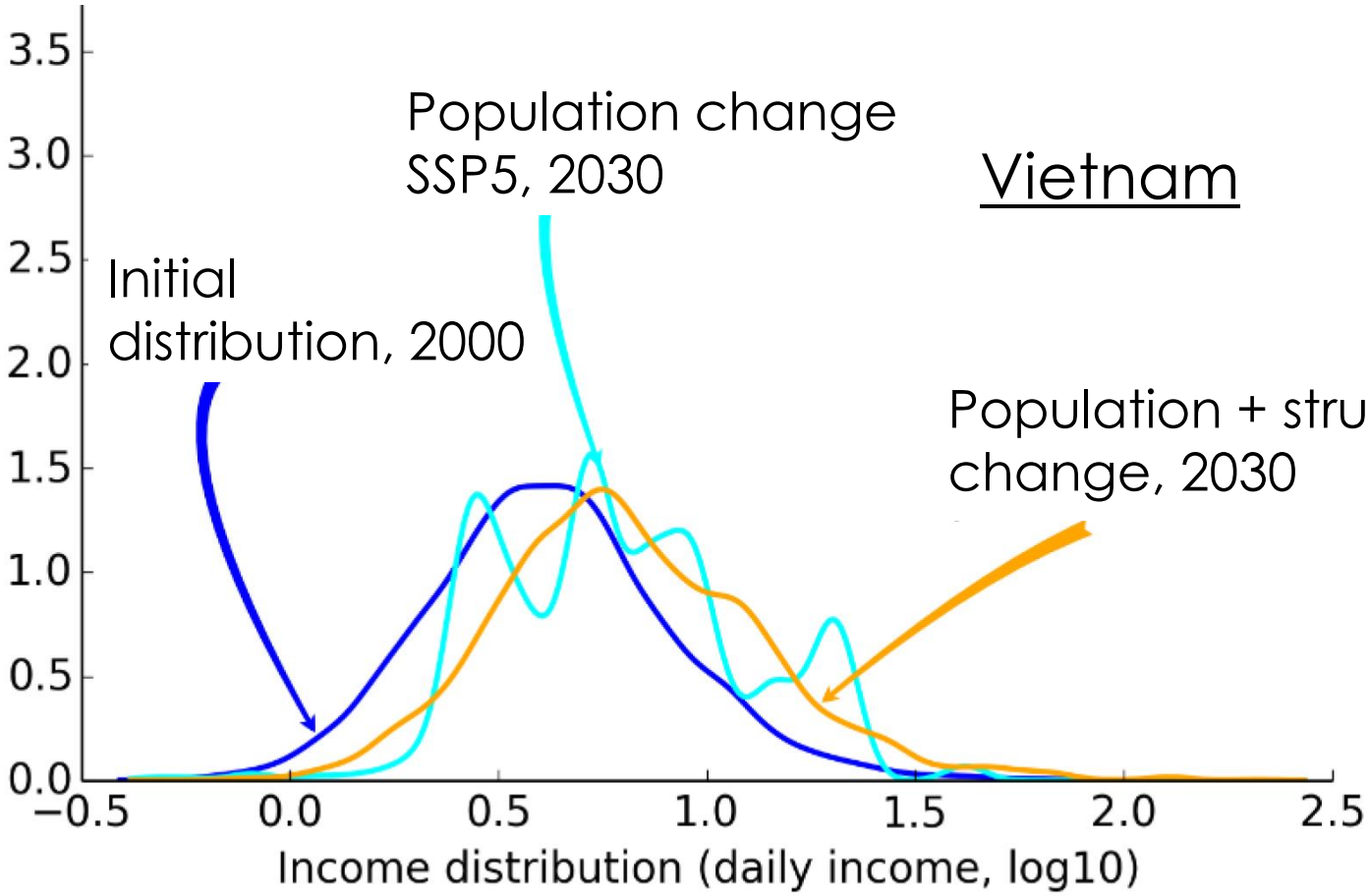
Coastal (Merkens et al., 2016)

Africa (Boke-Olen et al.,2017)

Europe (Terama et al., subm.)

Jones and O'Neill, 2016.

SSP Extensions: Subnational income distribution



2030, 92 countries (Hallegatte & Rozenberg, 2017)

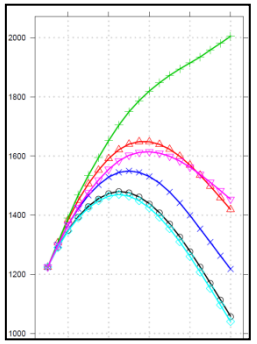
Global (van der Mensbrugghe, 2016)

IIASA

Hallegatte & Rozenberg, 2017

Applications: Baseline emissions scenarios

SSPs



IAMs

AIM

GCAM

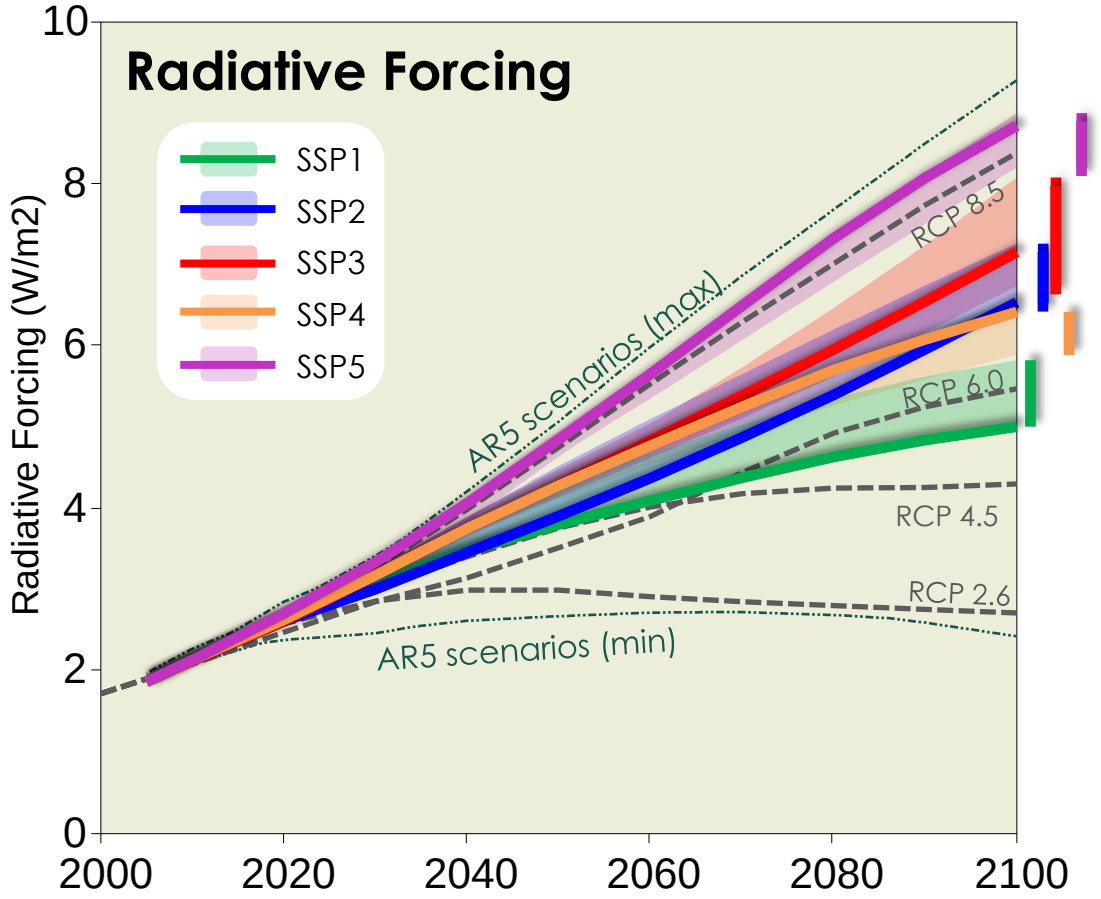
IMAGE

MESSAGE-GLOBIOM

ReMIND-MAGPIE

WITCH

Energy & Land use Emissions



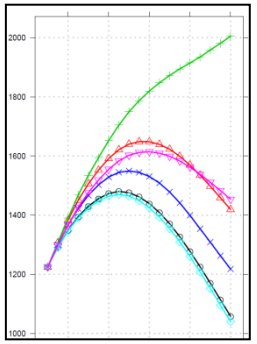
Riahi et al., 2016.

SSP-based IAM scenarios: **2017 special issue of *Global Environmental Change***.

SSP Database, hosted by IIASA.

Applications: Mitigation scenarios

SSPs



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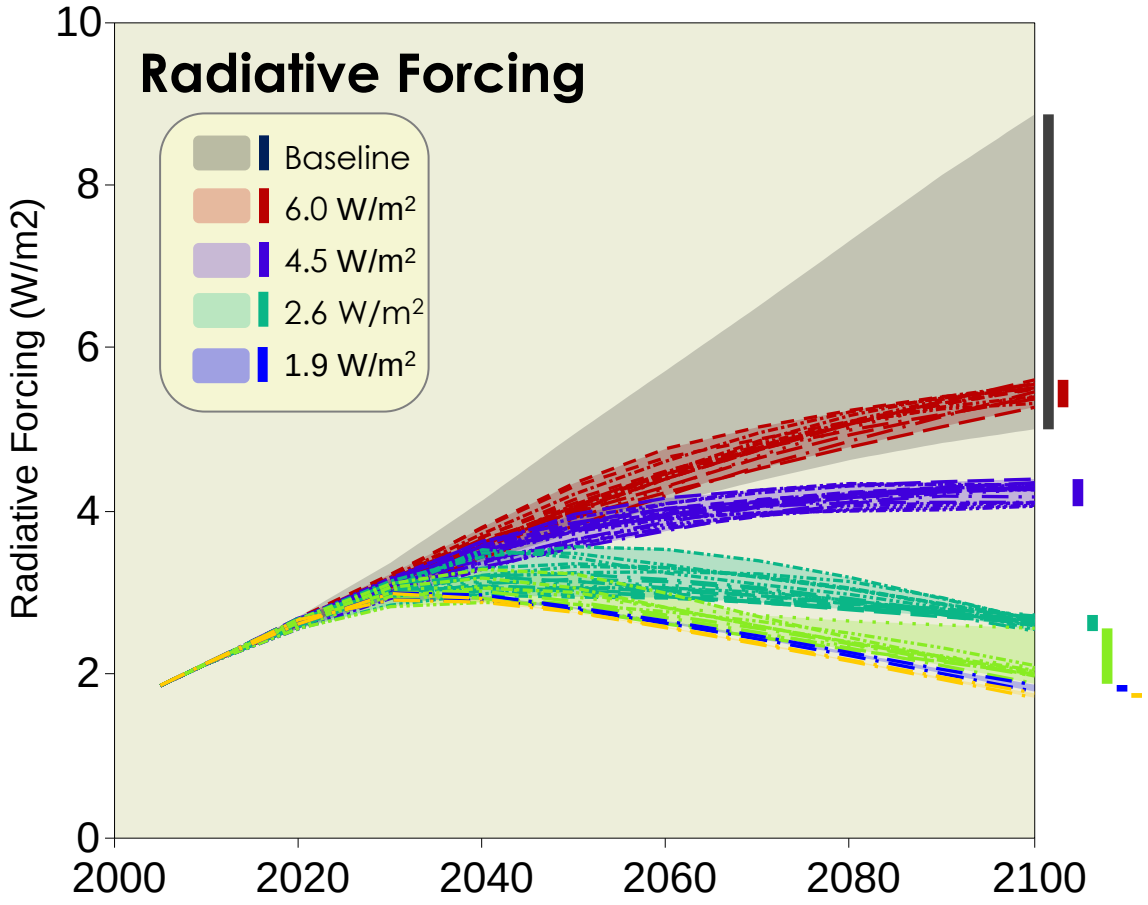
Energy & Land use Emissions



Riahi et al., 2016.

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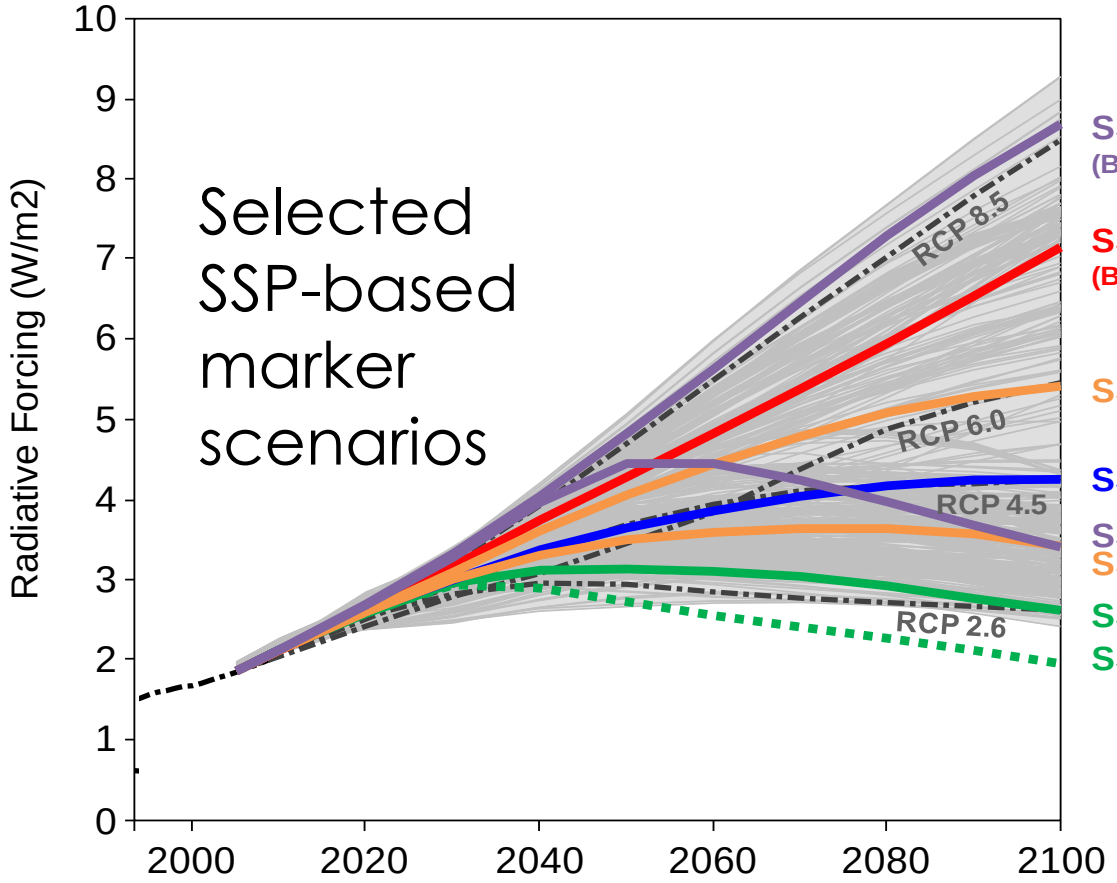
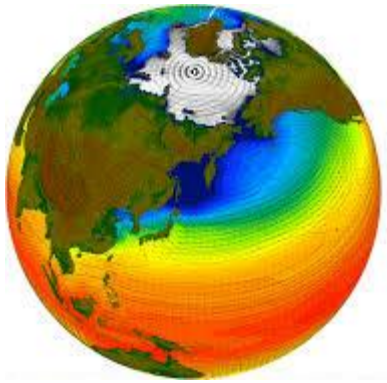
SSP Database, hosted by IIASA.

Applications: Climate projections (CMIP6)



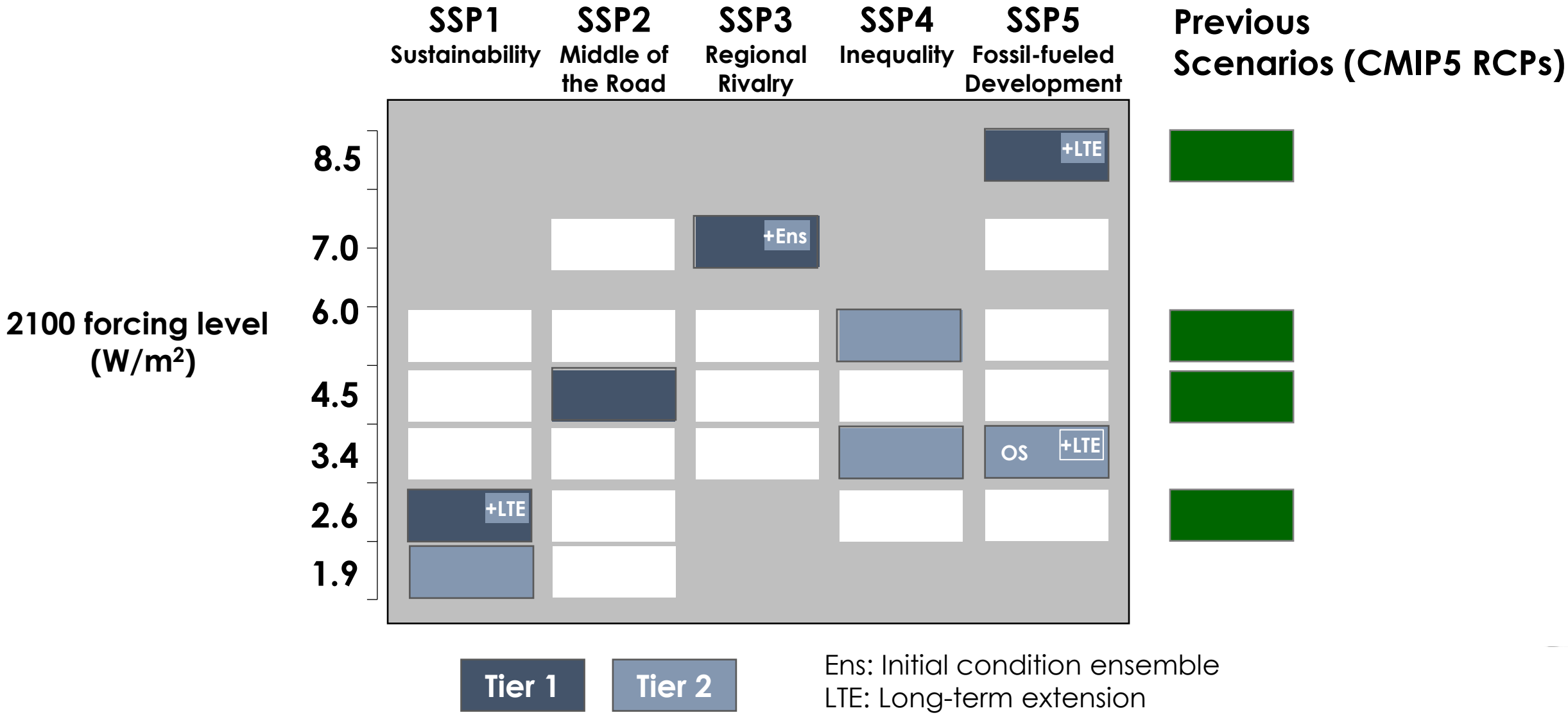
ESMs

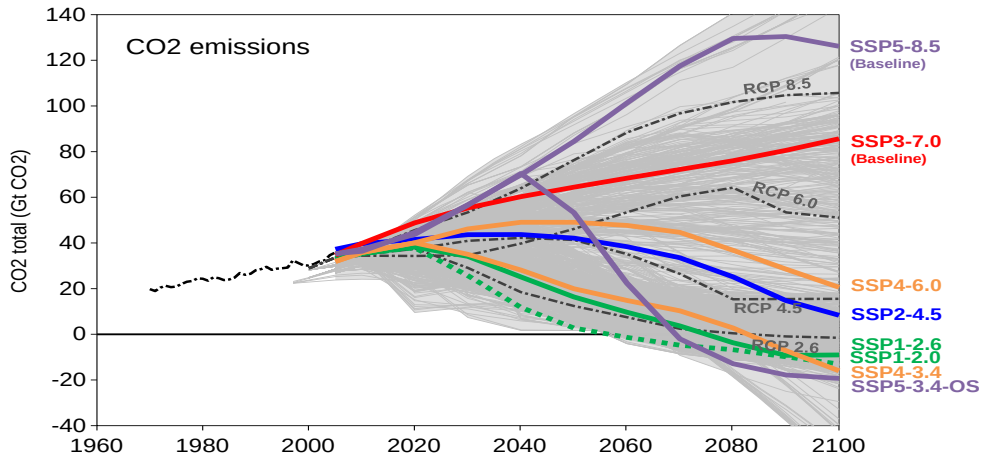


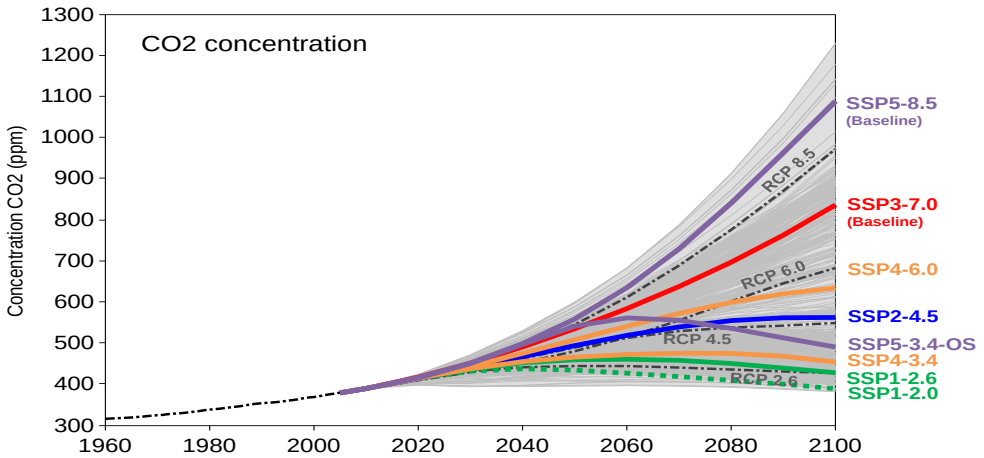
Climate Projections

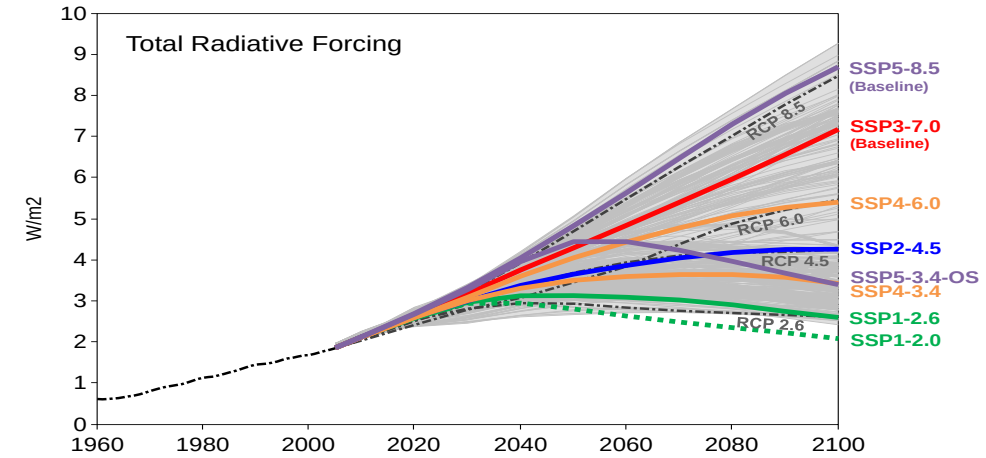
"ScenarioMIP"

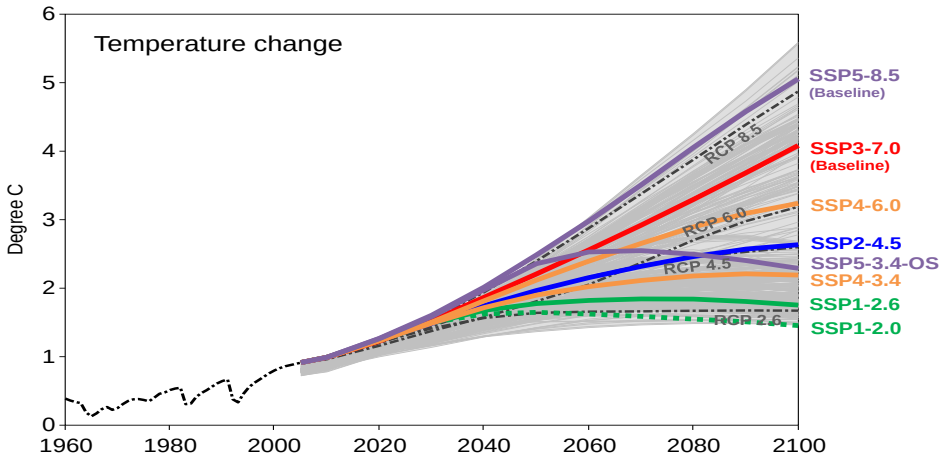
ScenarioMIP Design Summary (O'Neill et al., 2016, GMD)











Courtesy of K.Riahi

ScenarioMIP Design Summary

Tier1

SSP5-8.5
SSP3-7.0
SSP2-4.5
SSP1-2.6

One run per scenario
2016-2100

Tier 2

SSP1-1.9
SSP4-6.0
SSP4-3.7
9 more IC ensemble members for SSP3-7.0
Overshoot
Long-term extensions

While we wait (at least until the end of 2018, maybe longer)

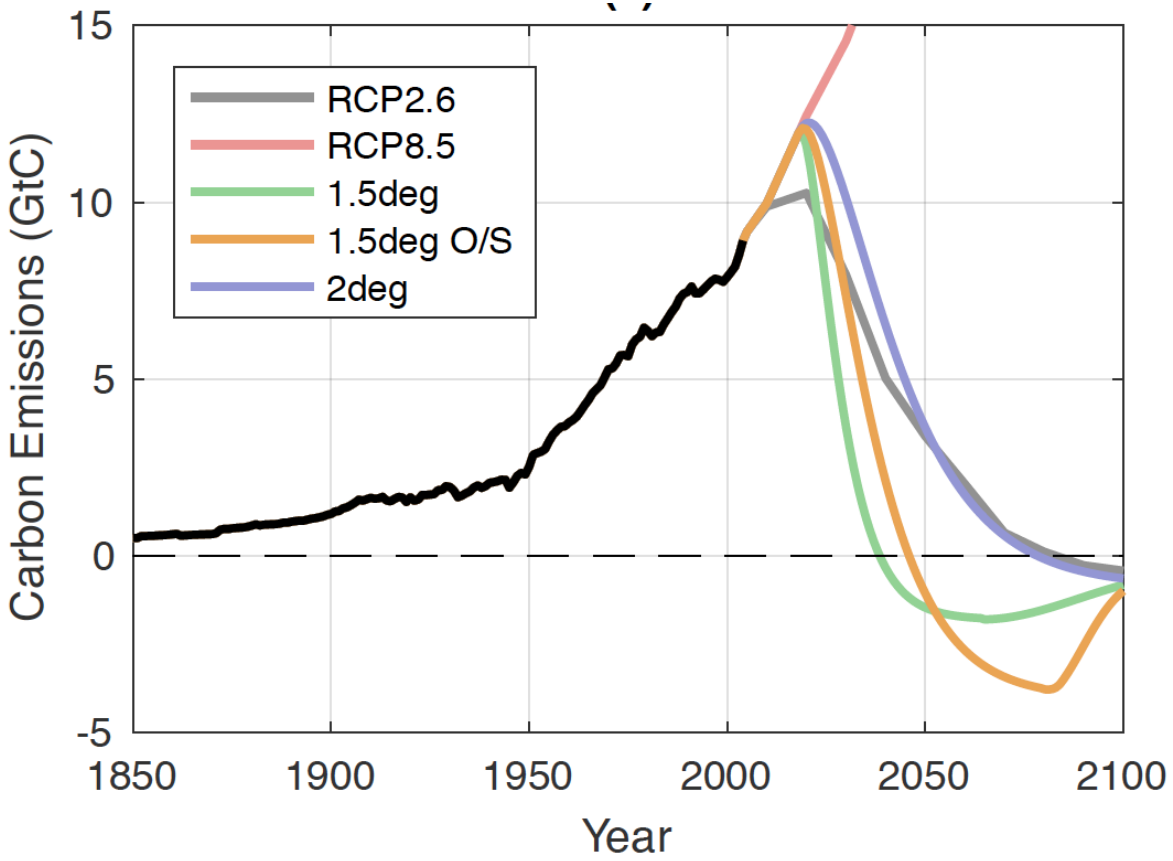
CESM1-CAM5 10-members IC ensembles are available under three low-warming scenarios:

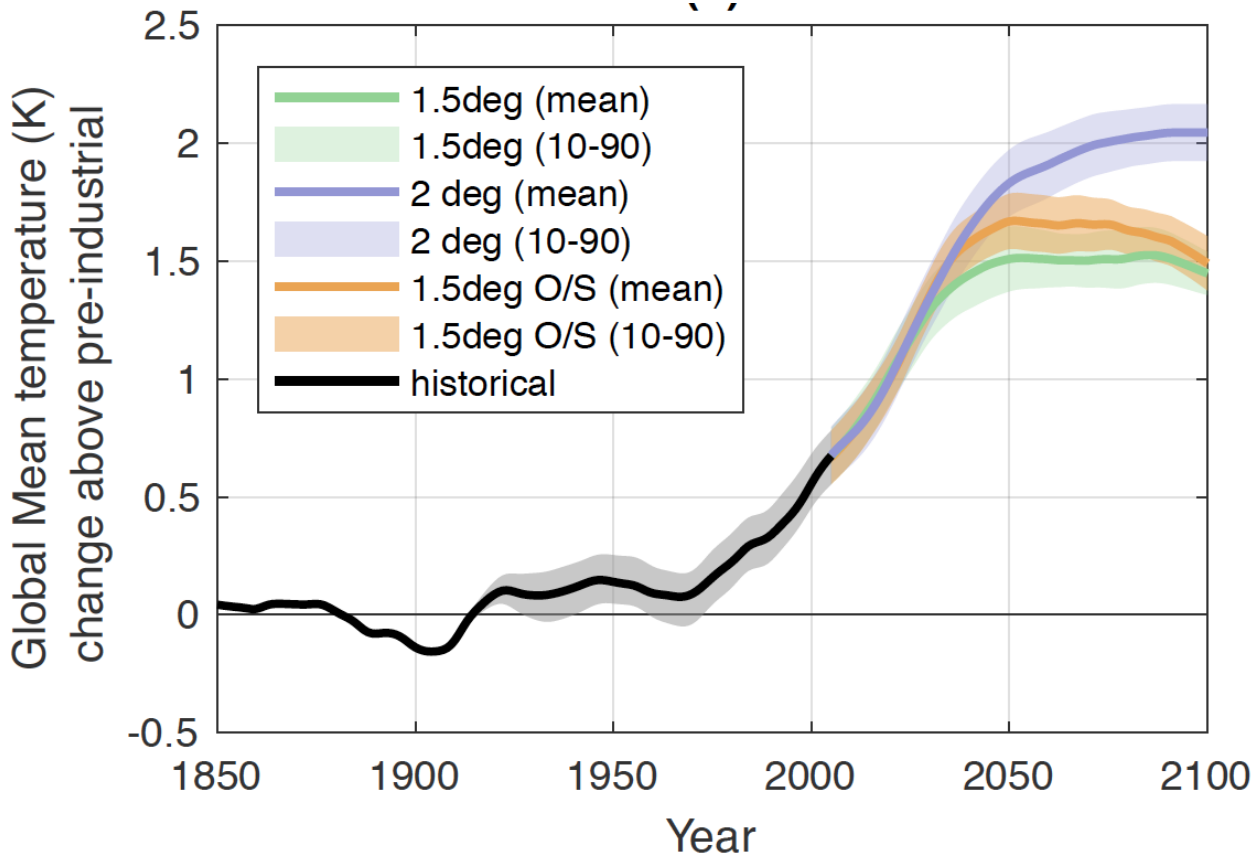
1.5C not exceed
2.0C
1.5C overshoot

Documented here: Community Climate Simulations to assess avoided impacts in 1.5C and 2C futures, Benjamin M. Sanderson et al. ESD, esd-2017-42.

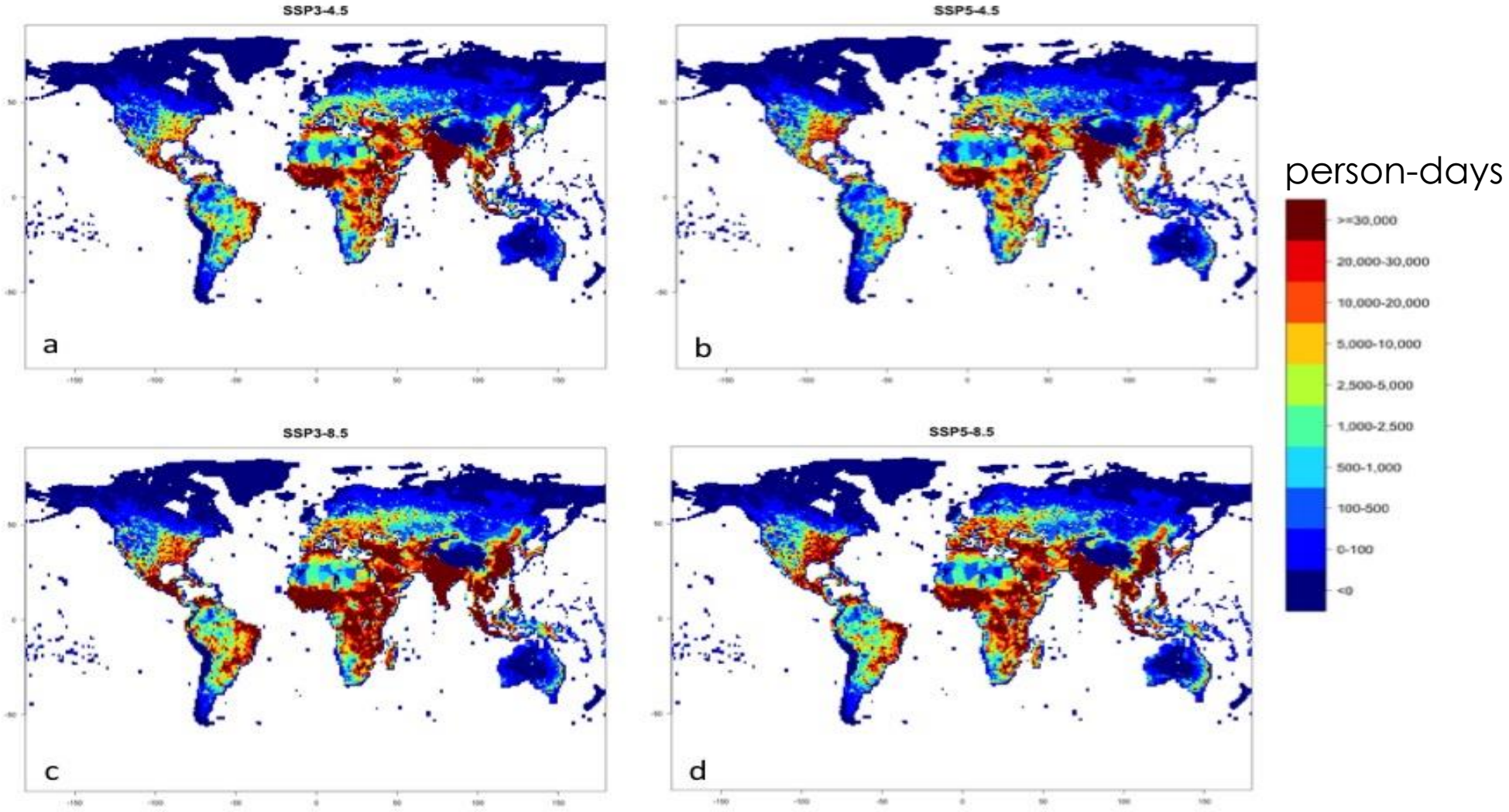
Downloadable from the Earth System Grid website.

While we wait (at least until the end of 2018, maybe longer)





An example of matching climate model output to SSP information: Population exposure to heatwave days (Jones et al., forthcoming)



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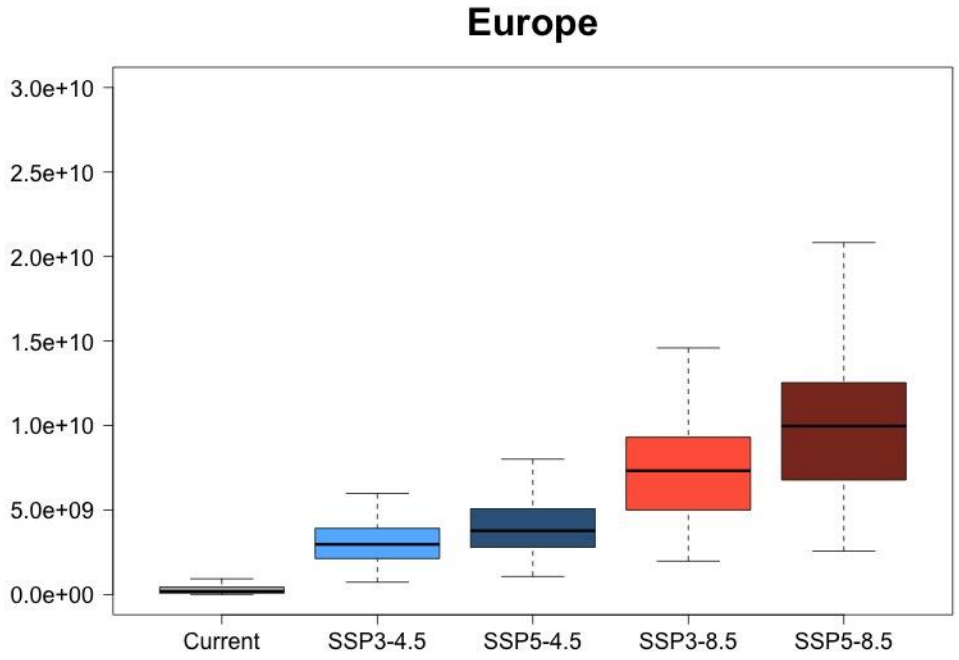

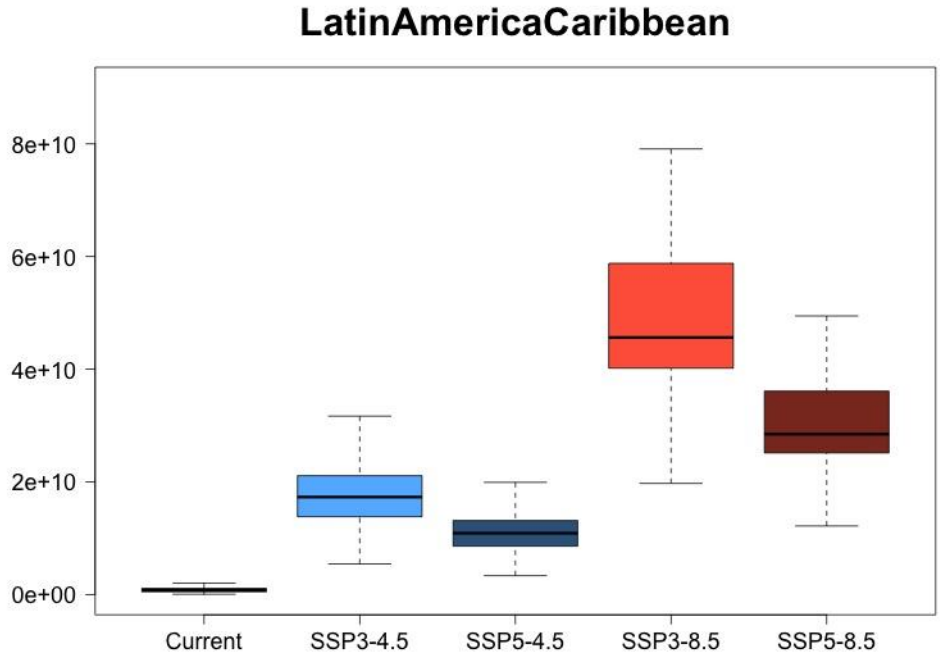

person-days