



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Overshoot Scenarios: Results From and Questions For Integrated Assessment

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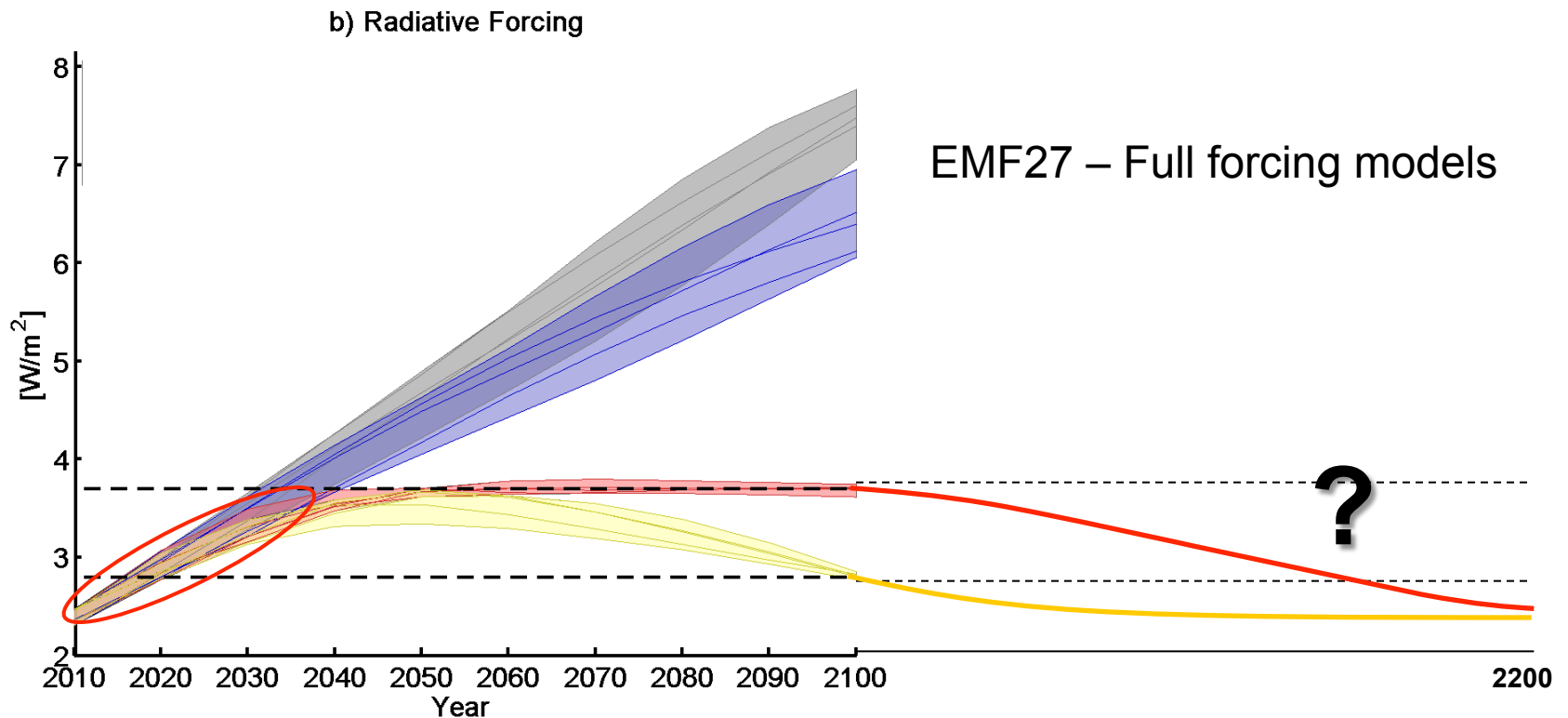
Session #5: Scenarios for Climate Research
and Assessment, Snowmass, 01.08.2013

Overview

- **Definitions of overshoot**
- **Overshoot scenarios – Results from recent IAM studies (ca. 1000 scenarios of ca. 100 different types)**
- **Overshoot scenarios – Questions for IA**
- **Implications for climate projections and impact analysis**

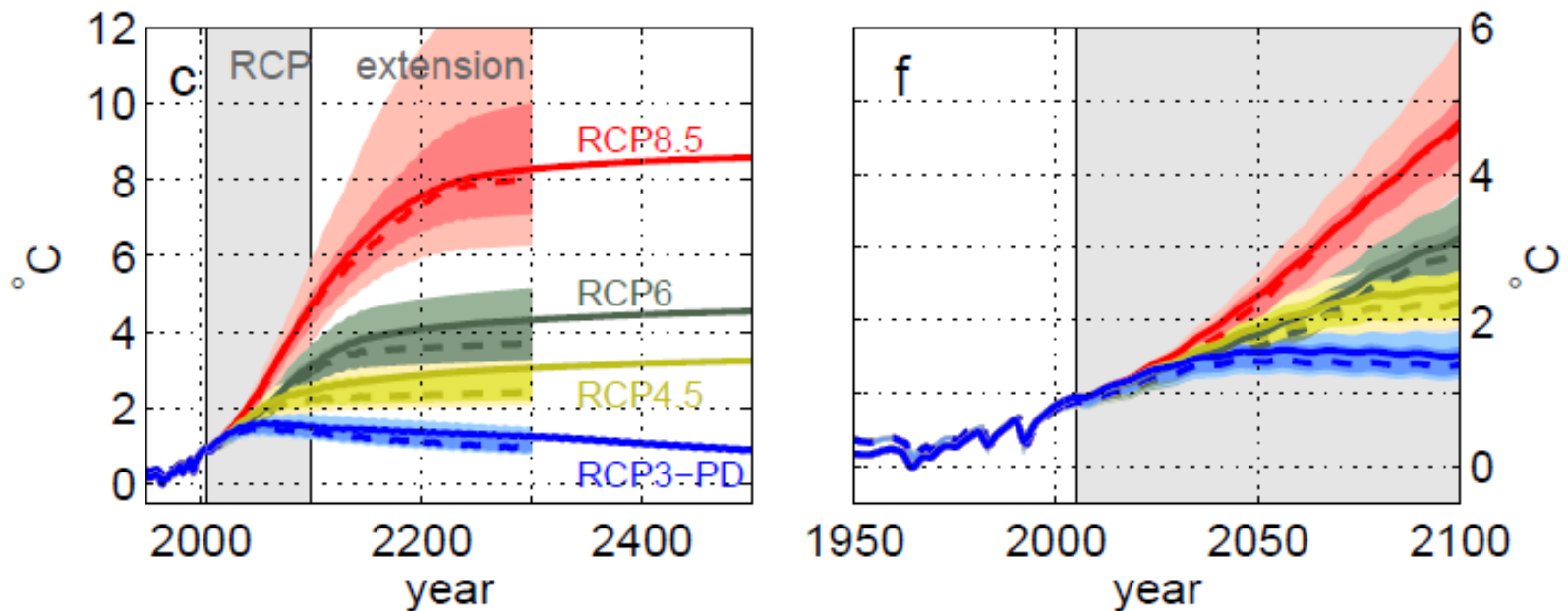
Definitions of overshoot

1. Exceeding a level (e.g. in total radiative forcing) in a target year, usually taken to be the time horizon (e.g. 2100)



Definitions of overshoot

2. Exceeding a target (e.g. the 2C target) temporarily
→ Forcing overshoot does not mean temperature target overshoot



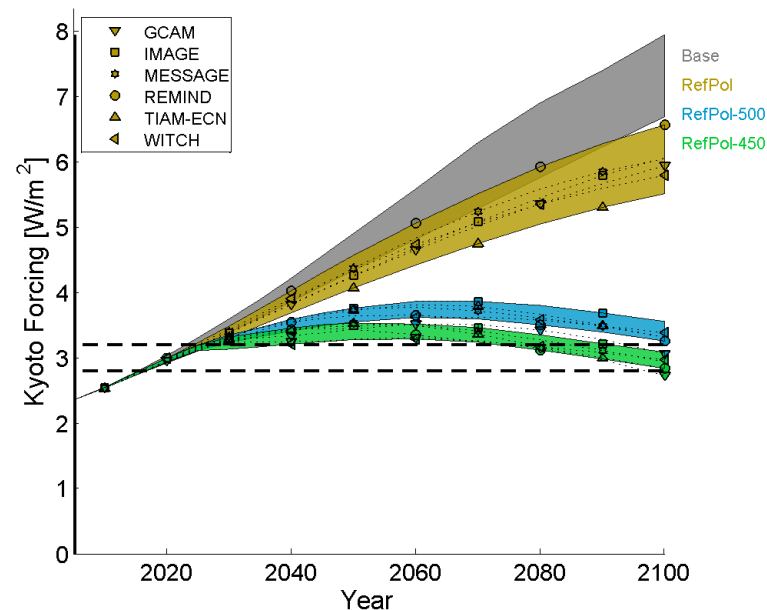
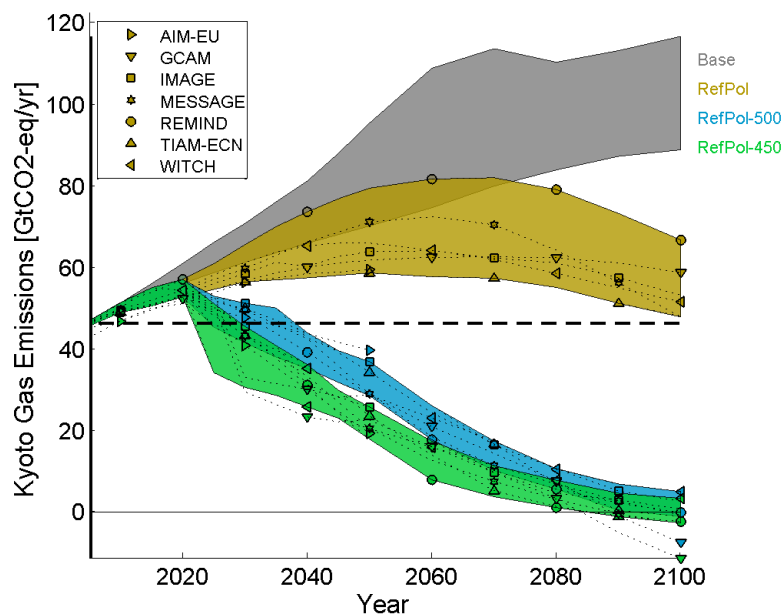
Schewe, Levermann, Meinshausen, 2011. Earth System Dynamics

Overshoot scenarios from IAM studies

Recent IAM comparison studies (EMF27, AMPERE, LIMITS) studied delayed global action and technology availability, including BECCS

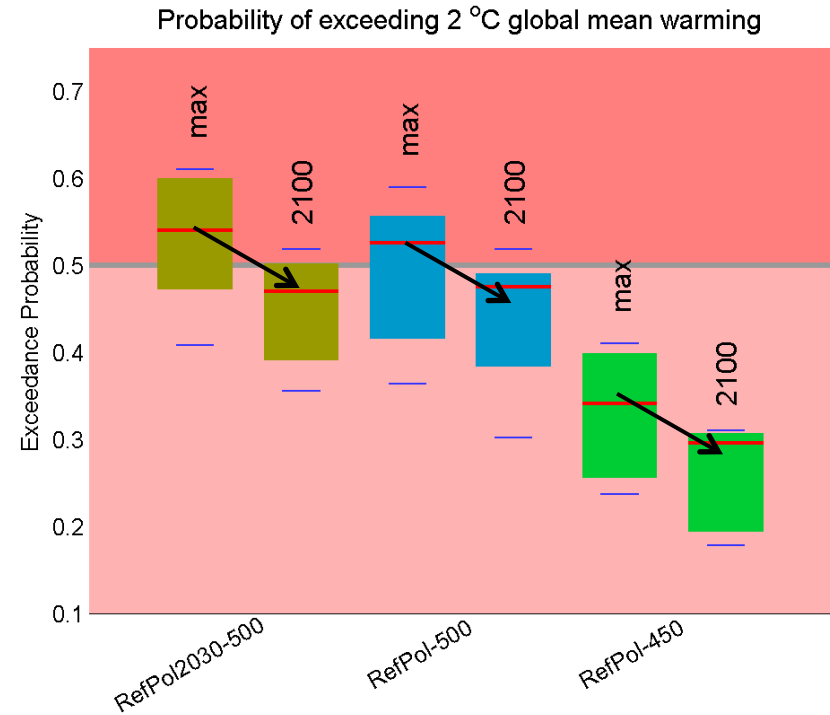
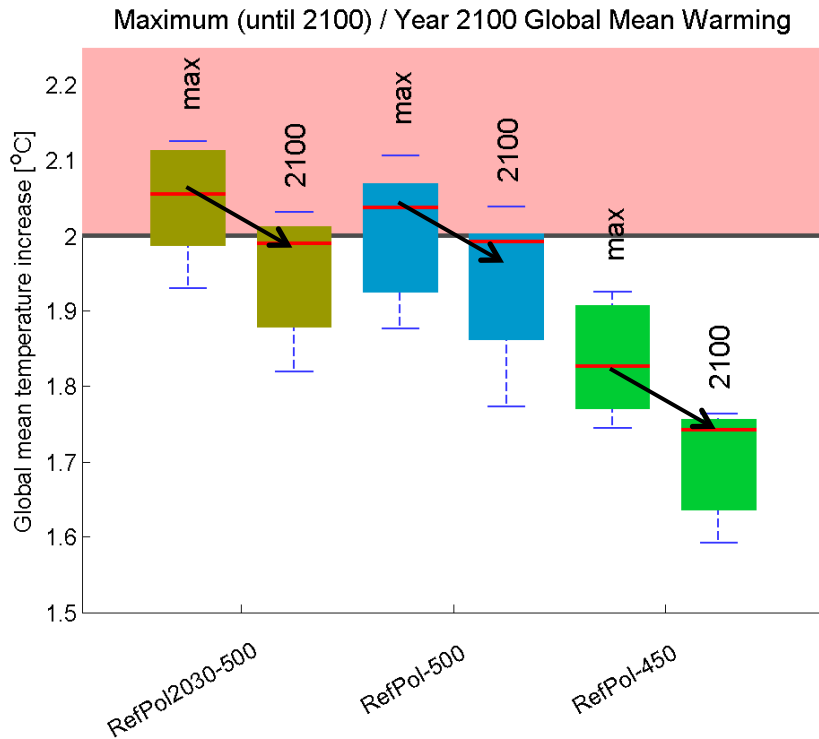
➔ Rich set of overshoot scenarios

Example: LIMITS study on Durban Platform Action Scenarios



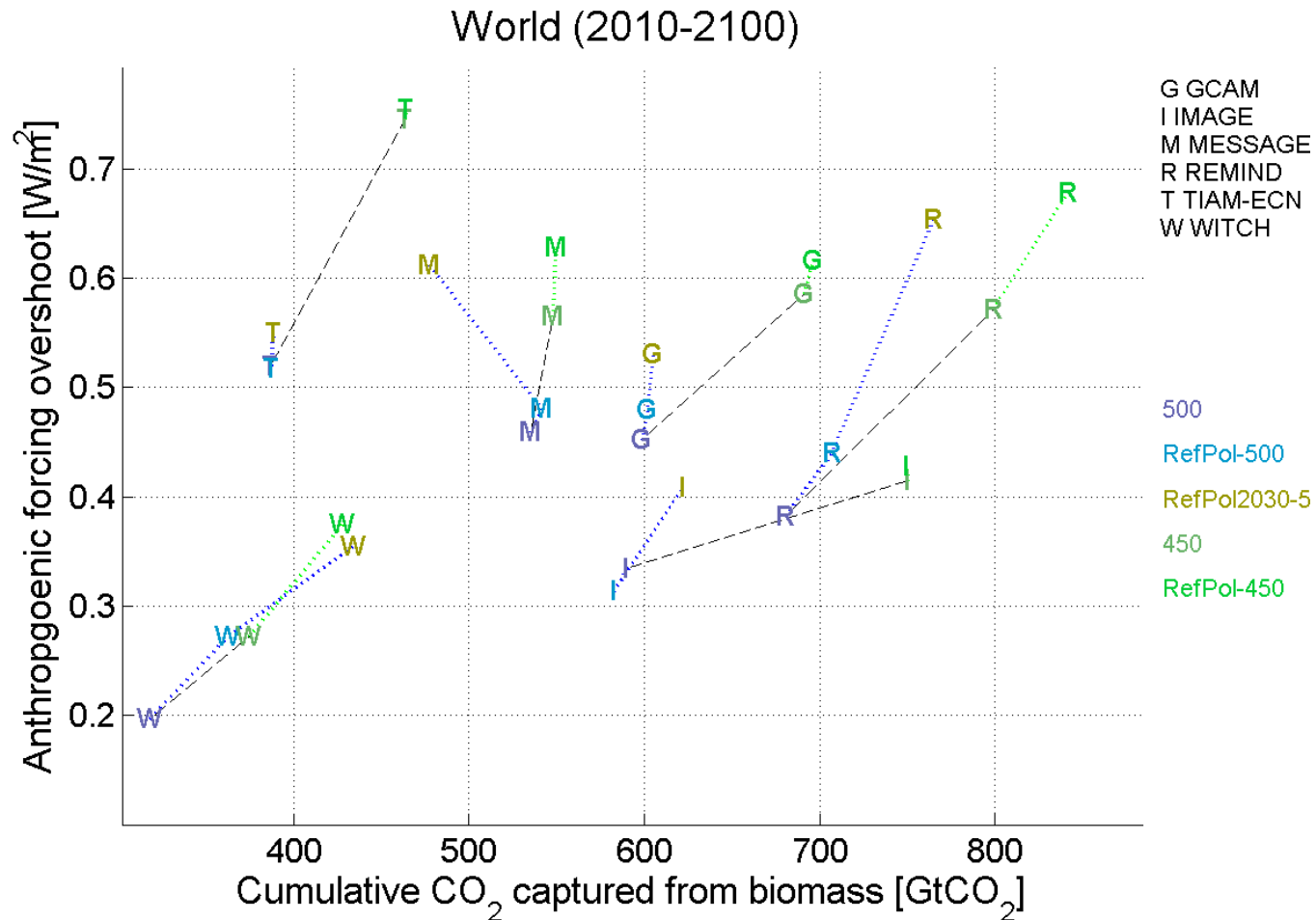
Kriegler, Tavoni et al., Climate Change Economics, submitted

LIMITS overshoot scenarios

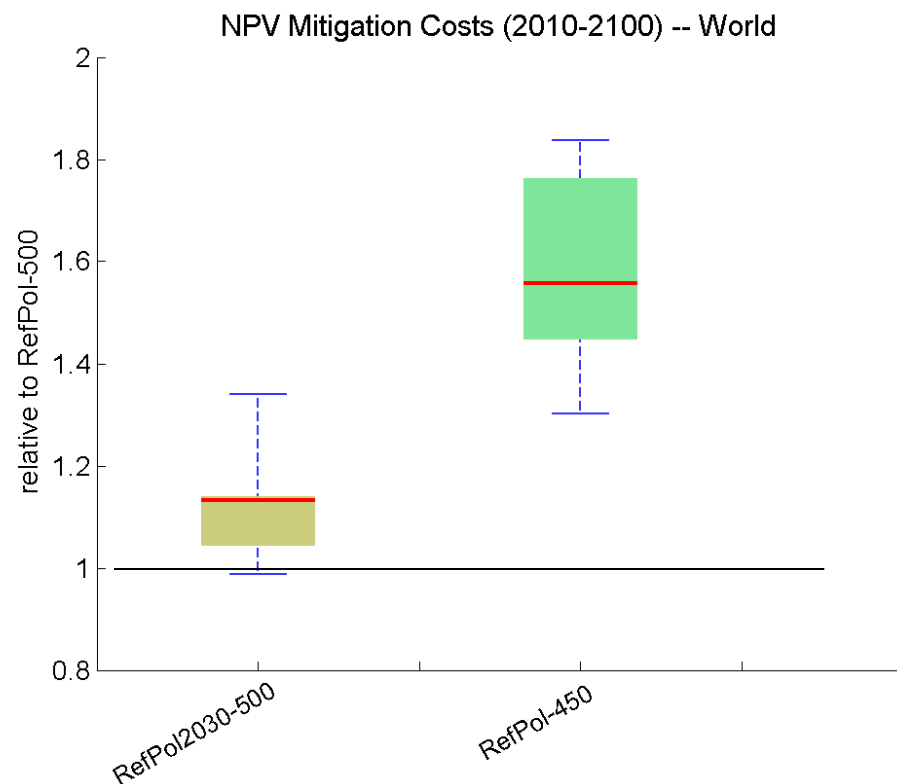


Overshoot: Temperature has downward trend in 2100

Role of negative emissions in LIMITS scenarios



Mitigation costs are sensitive to target level

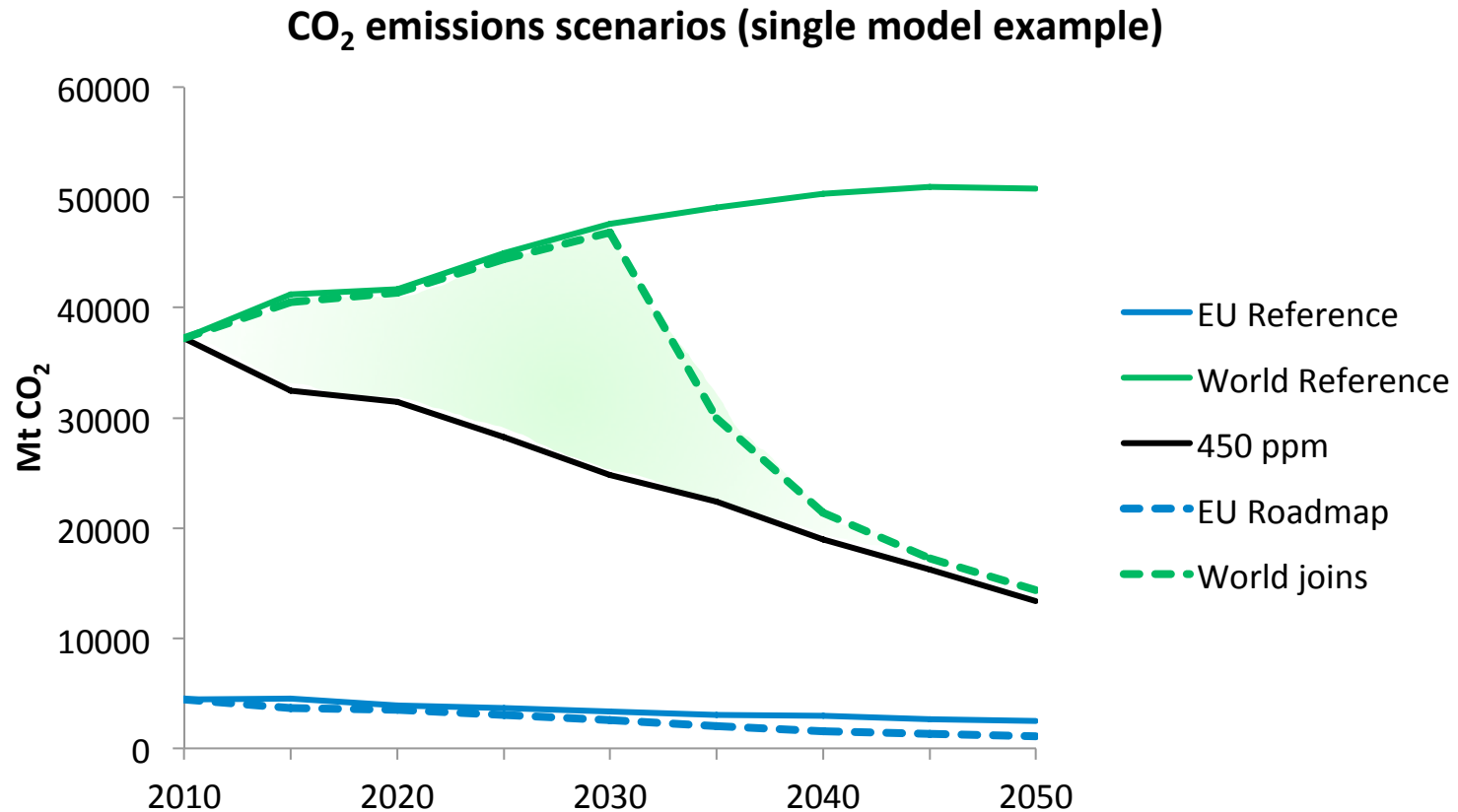


Both targets in the vicinity of 2 degrees ($\Delta T \sim 0.25^\circ\text{C}$)

Mitigation cost increase 30-90% from 450 to 500 ppm

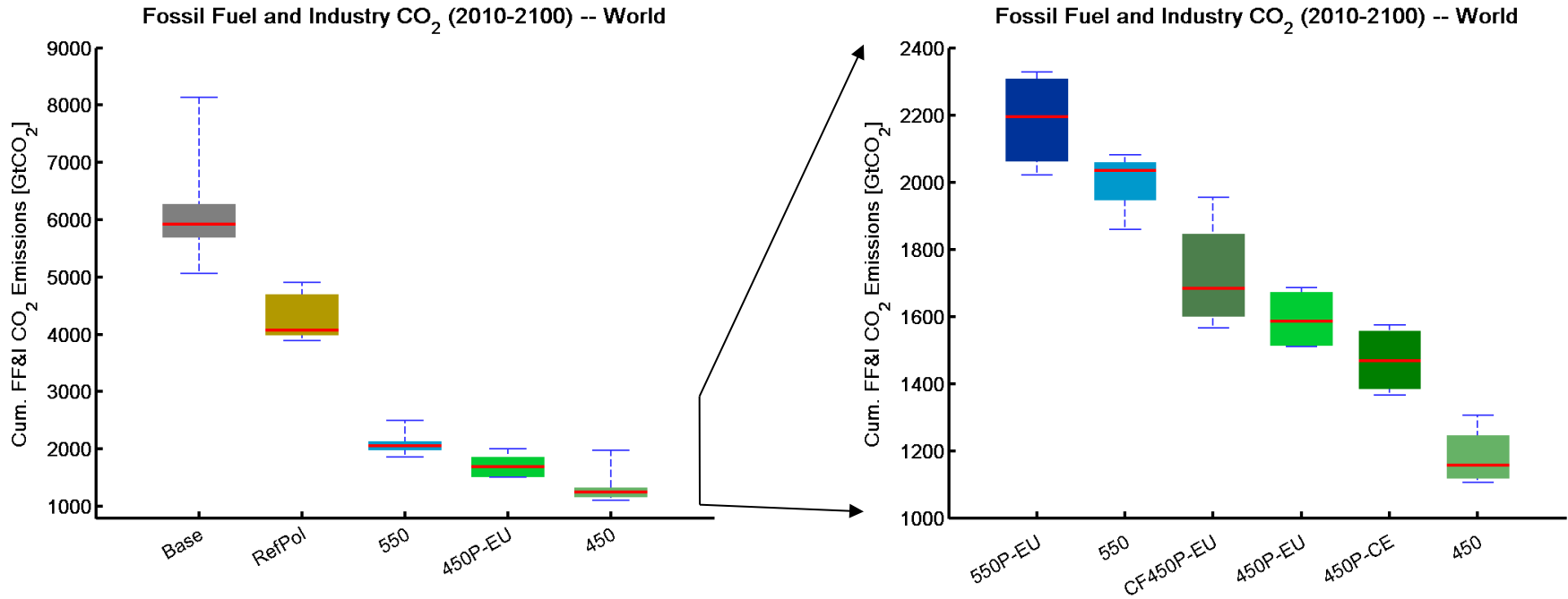
➔ Target levels may be close, but still make a large difference for mitigation

AMPERE (WP3) Study on Staged Accession Scenarios



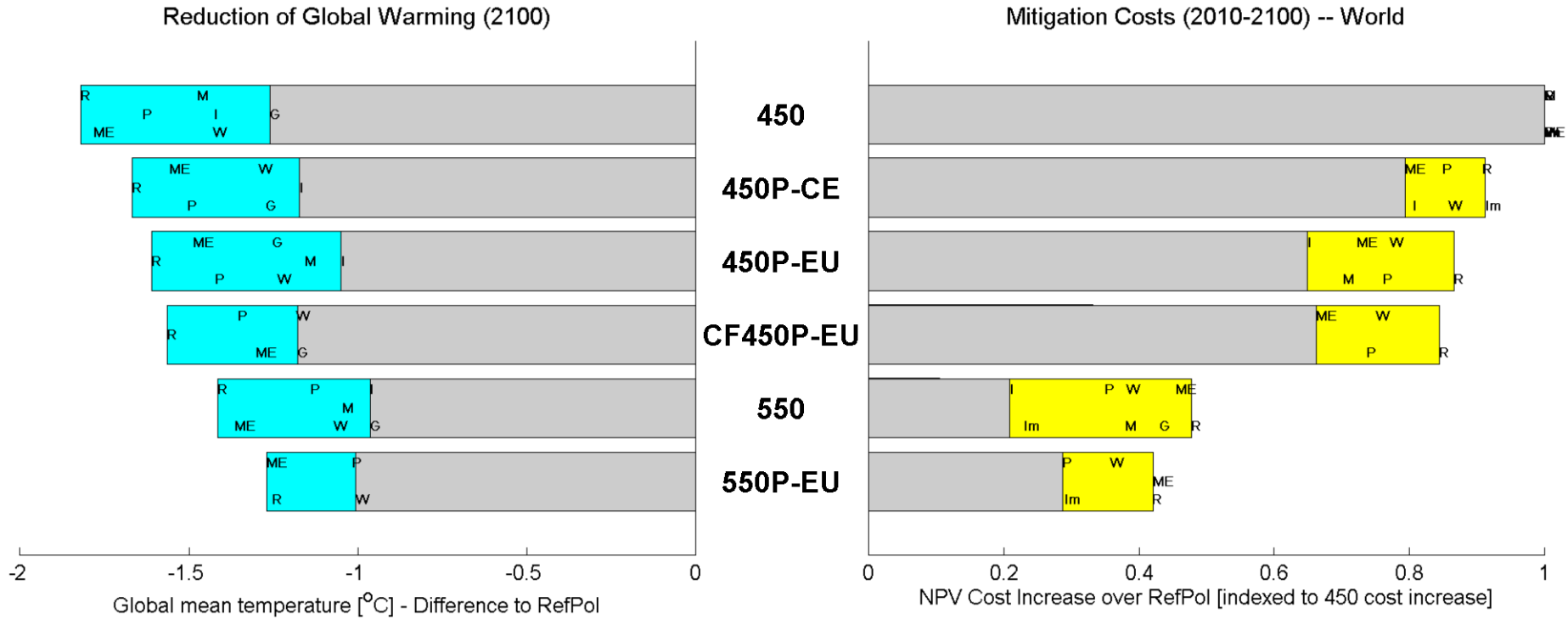
Study design: Excess emissions until 2050 are not compensated in the 2nd half of the century

AMPERE (WP3) Study on Staged Accession Scenarios



Kriegler, Riahi et al., Tech. Forecasting & Social Change, submitted

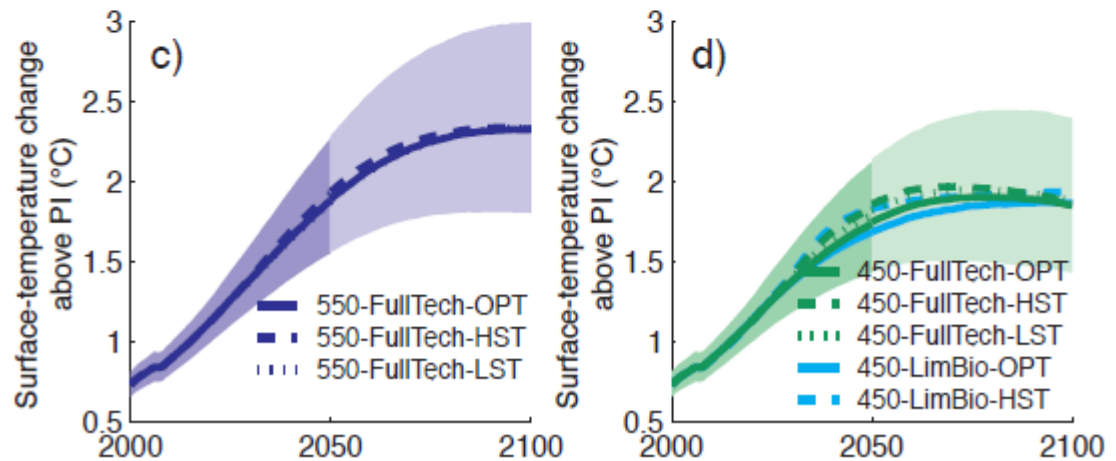
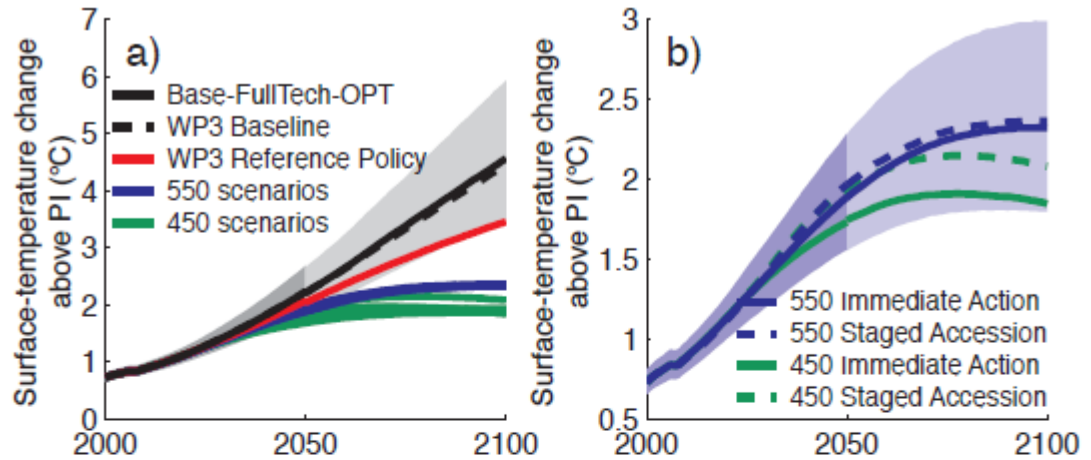
AMPERE (WP3) Study on Staged Accession Scenarios



Kriegler, Riahi et al., Tech. Forecasting & Social Change, submitted

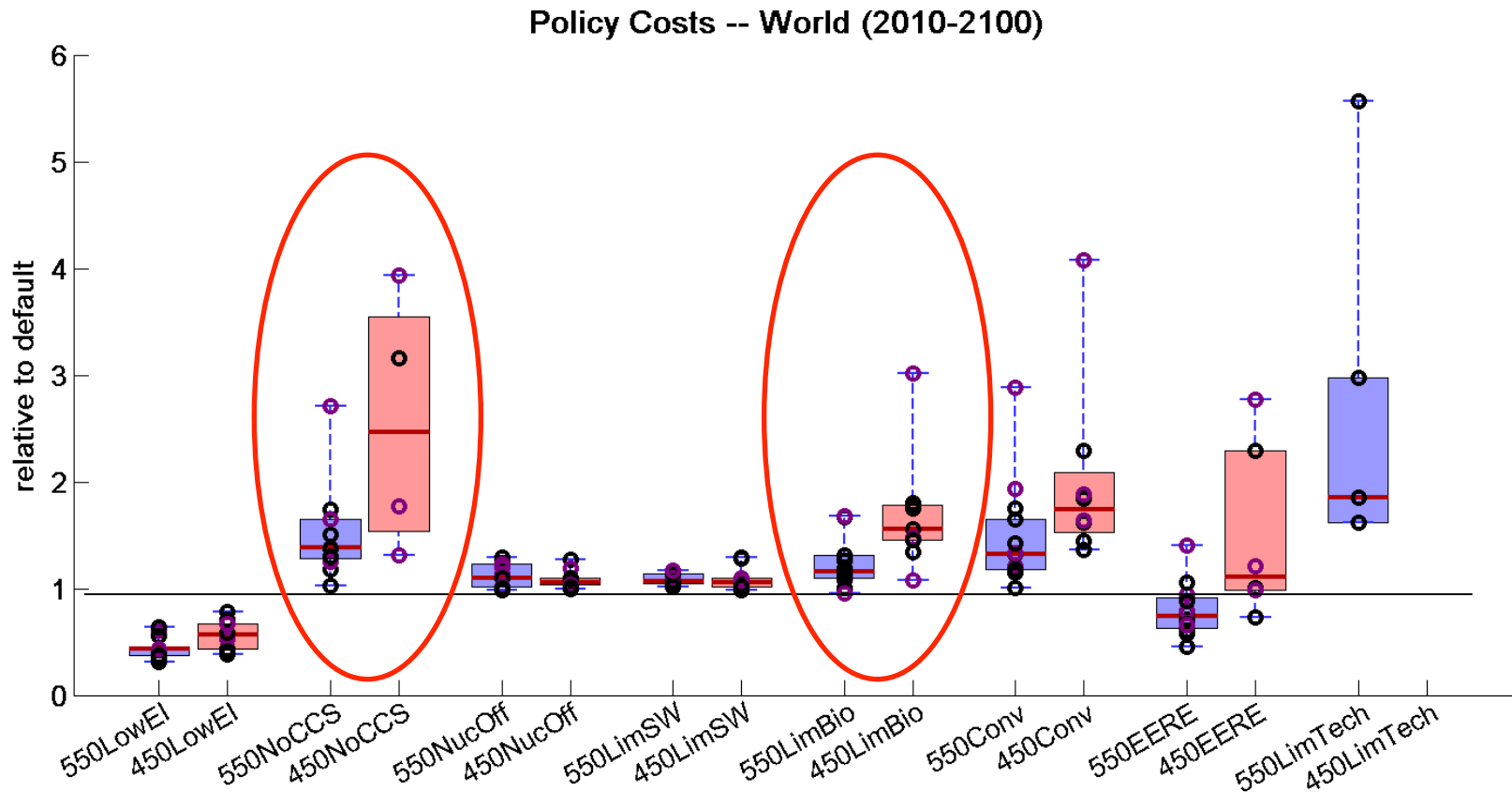
Temperature outcomes of AMPERE scenarios

- Scenarios in the 450 and 550 ppm range are overshoot scenarios
- Declining or stable T in 2100



EMF27 – The role of technology for mitigation

BECCS is very valuable mitigation strategy, particular for 450 ppm



Krey, Luderer et al, Climatic Change, submitted

Kriegler, Weyant et al, Climatic Change, submitted

Questions for IA – Carbon Pricing & Overshoot

How to price negative emissions?

Depends on carbon cycle dynamics:

Is emission and removal of ton CO₂ symmetric, i.e. approx. 0.5 ton added and subtracted, respectively, from atmosphere after ocean / biosphere uptake and outgassing?

➔ If yes, equal carbon price applies. Under which conditions does it hold?

What carbon price path over time? (Blanford, 2013)

- Exponential (Hoteling, assuming CO₂ budget): Favors overshoot
- Quasi-linear (as often emerges from CBA): Dampens overshoot

What are limits to overshoot?

The extent to which overshoot is possible will depend on the achievable rate of emissions drawdown

➔ Can be limited by CCS, bioenergy, cost, carbon cycle constraints

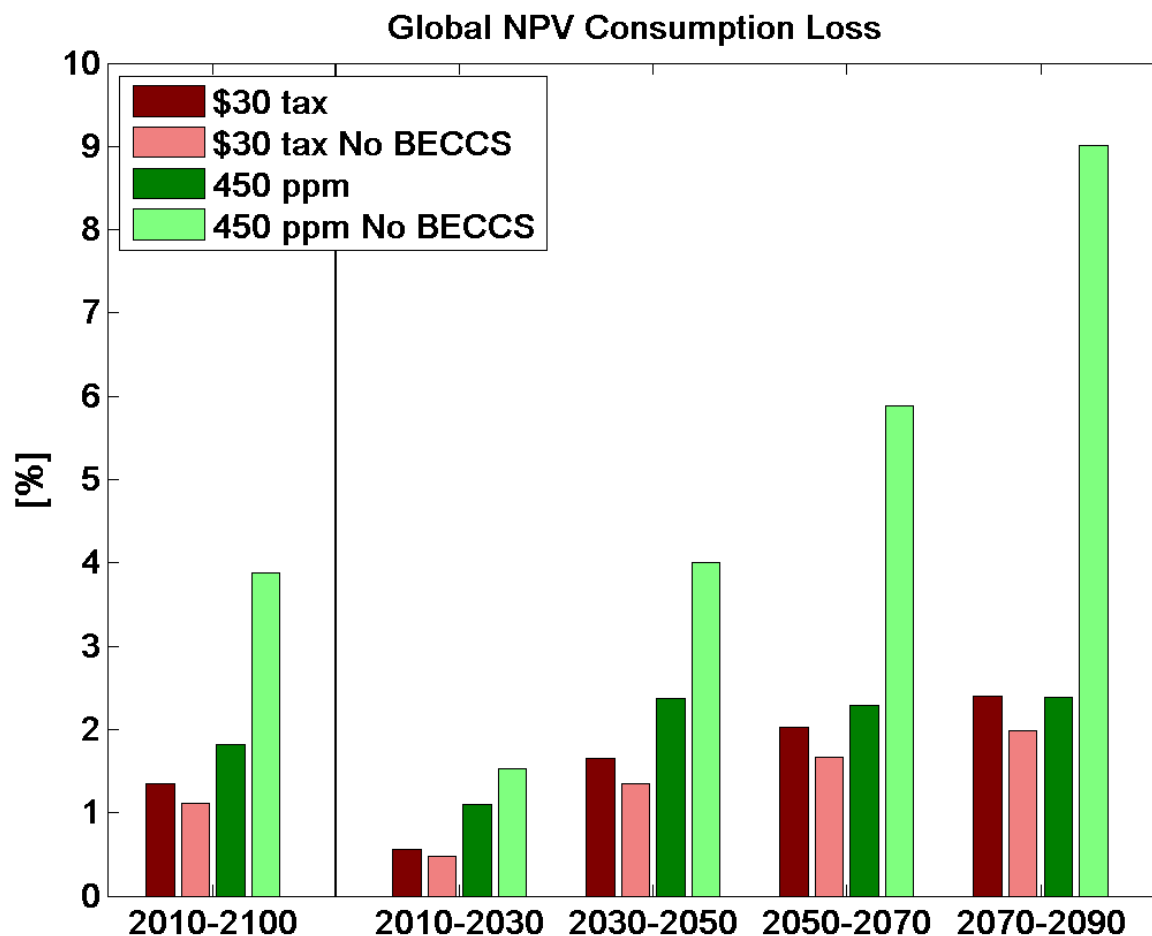
If the extent of overshoot is limited, the extent that the current generation can shift the mitigation burden to future generations is also limited.

Who benefits from negative emissions capability?

Assumption:
BECCS constrained
to max 200 EJ/yr
bioenergy.

→ negative emissions
<15 tCO₂ / yr

→ Future generations
benefit disproportionately
from compensation of
residual long-term
emissions



Kriegler, Edenhofer, Reuster, Luderer, Klein (2013) Is atmospheric carbon dioxide removal a game changer for climate change mitigation? Climatic Change 118.

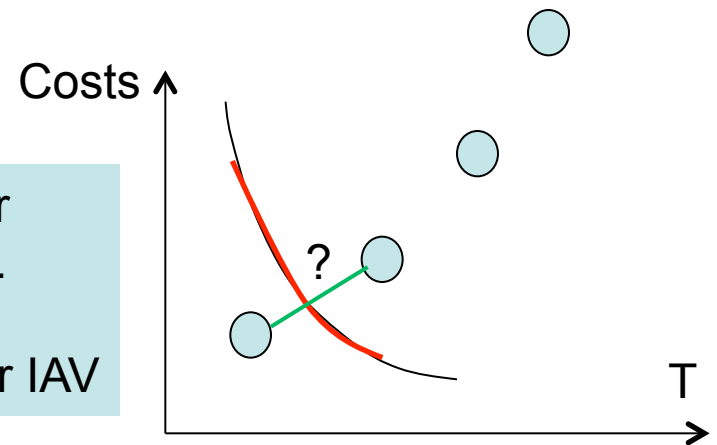
Implications for climate projections

IAM analysis: Large sensitivity of mitigation costs and energy transformation requirements in the range 450 to 550 ppm CO₂e, and to the degree of attainable / admissible overshoot.

But current climate projections do not resolve the space of $< 4 \text{ W/m}^2$ and overshoot, which may be most policy relevant.

More emphasis may be put here, at the expense of high forcing scenarios (6 and 8.5 W/m²)

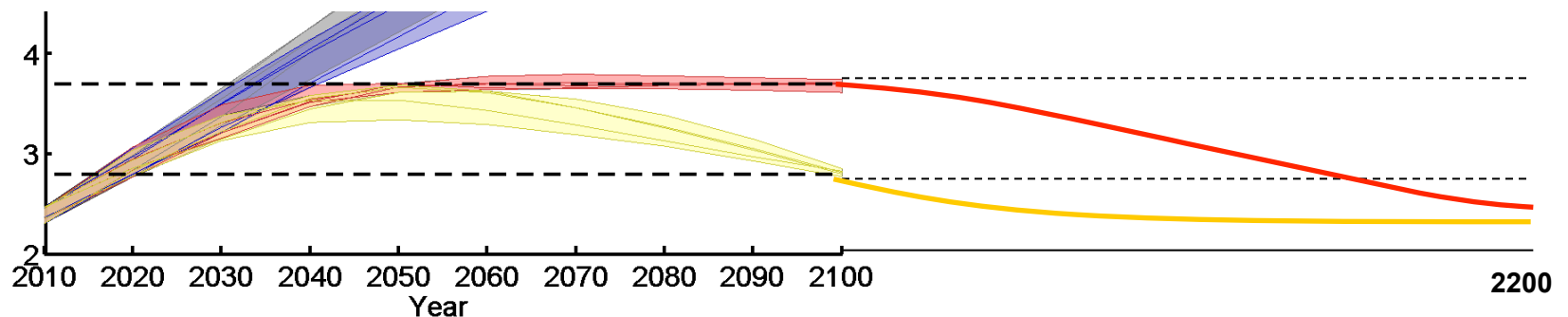
Also: Policy (scenario) space is much larger than ESM / AOGCM can ever hope to cover.
→ Identify (pattern scaling) methods to produce larger set of climate projections for IAV



Implications for impact analysis

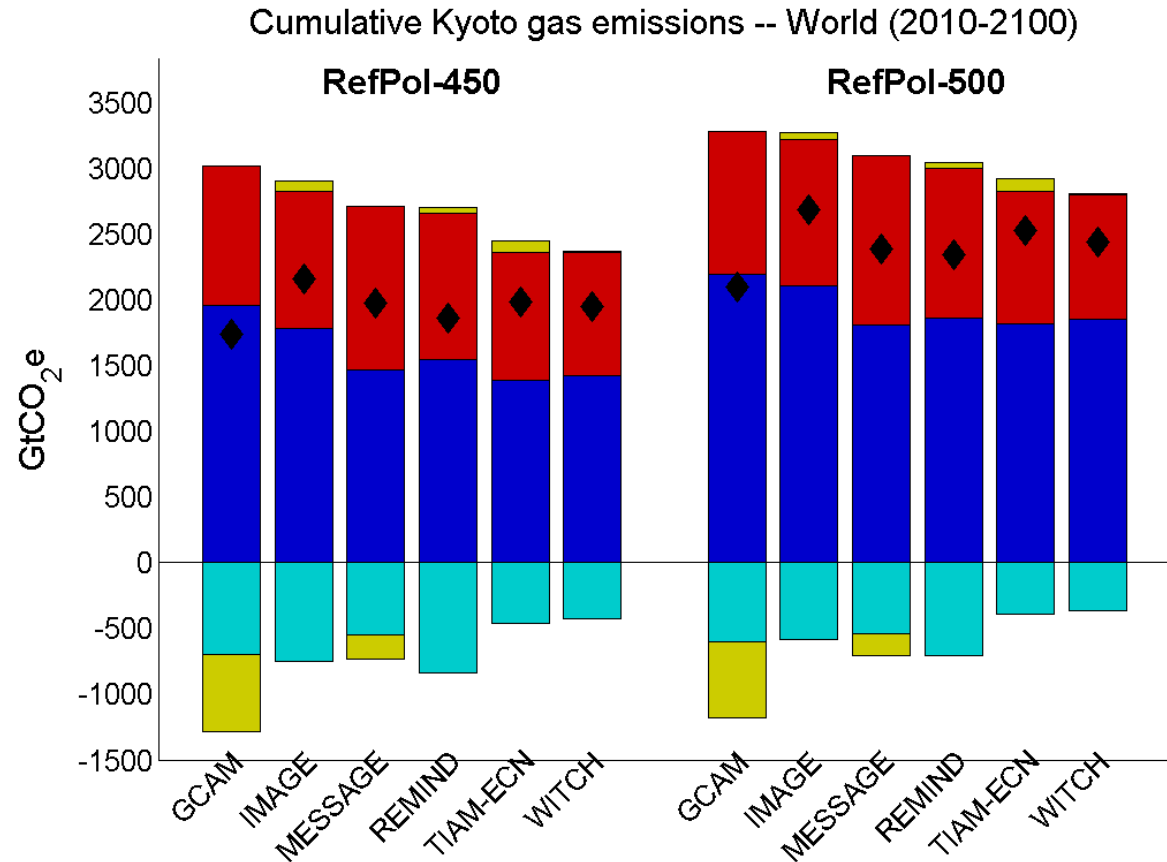
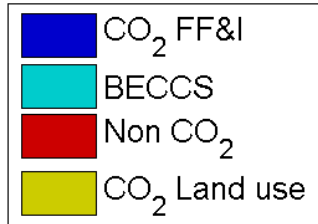
What additional impacts from overshoot (e.g. between yellow and red line).

- ➔ Impacts from higher rates of change
- ➔ Impacts from higher peak warming
- ➔ Which environmental / socio-economic components are vulnerable to overshoot (ecosystems), which are not (ice sheets?)
- ➔ What potential to trigger irreversible / catastrophic events with overshoot?



Discussion

Role of negative emissions in LIMITS scenarios



Why use models?



- How would maps look like without *cartographers*? *Scientists* can play the role of cartographers for the exploration of the solution map.
- And would maps be of any use without *navigators*? *Policy makers* navigate through the maze of possible solutions in the solution map.