

#### The costs and uncertainty of climate mitigation A meta-model

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#### Costs of climate policy: IPCC AR5



WG3: Estimates of the aggregate economic costs of mitigation vary widely, but increase with stringency of mitigation (high confidence). Reaching about 450ppm CO2eq by 2100 would entail global consumption losses 3–11% in 2100



2



# Costs of climate policy: IPCC AR5





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# The costs of achieving climate targets and the sources of uncertainty

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So what are the costs of reaching 2°C and 1.5°C... What is the uncertainty range associated with these numbers? And what determines the uncertainty range?

Most simple model





Emissions (TtCO2)







## Most simple model





#### Most simple model







#### **Monte-Carlo simulation**



#### 6,500 model runs



#### Emissions (Tt CO<sub>2</sub>) Costs: costs(CO<sub>2</sub>)



Emissions (Tt CO<sub>2</sub>)

Temperature:  $T(CO_2)$ 





#### **Monte-Carlo simulation**





Tt CO2

6

5

4

3

2

6

#### **Monte-Carlo simulation**

femp. change (°C)





Emissions (Tt CO2)



Sobol, I. M. On sensitivity estimation for nonlinear mathematical models. *Matem. Mod.* **2**, 112–118 (1990).

Determine impact of uncertainty in each individual parameter on the total variance

Uncertainty:

- > T<sub>2010</sub>
- > TCRE
- $\rightarrow \sigma_{non-CO_2}$
- > costs

#### **Monte-Carlo simulation**





## **Monte-Carlo simulation**

Sobol, I. M. On sensitivity estimation for nonlinear mathematical models. *Matem. Mod.* **2**, 112–118 (1990).



Temperature change (°C)



Socio-economic development

#### **Monte-Carlo simulation**





Low



#### Costs and benefits





Simple

#### The most simple model....

- Nicely transparent and can be easily calibrated to 'iconic' assessment findings
- > Some clear limitations (above all due to meta-model character)
- Code available... but equations and input data can also be taken from the article
- > Model can be easily expanded and updated:
  - Breaking up TCRE in carbon cycle and climate sensitivity uncertainty
  - Adding non-CO2 forcing as separate uncertain term (needs some work on TCRE)
  - Making model temporal and adding economic choices and uncertainty... technology learning, inertia, discount rate
  - schade



#### Some conclusions

- > Do more with statistical interpretations of our data (and be less reluctant)
- > Do more with meta-modelling
- Rapidly increasing costs for low temperature targets, but mostly for some development patterns (SSP5, SSP3) – not for others
- > Uncertainty considerable... but not excessive
- > Uncertainty dominated by costs differences (and underlying the SSPs) → if one wants to reduce uncertainty, might have consequences on where to invest R&D funds