Benefits of climate mitigation in IAMs

The role of the carbon cycle and climate component

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Messages

- Benefits of mitigation (avoided climate damages) strongly depend on climate model of IAMs

- IAMs that find relatively high "optimal" levels of global warming (e.g. FUND) use climate models that lead to low benefits of mitigation

- Climate sensitivity not the most important factor explaining differences in benefits of mitigation: temperature response time is

- The climate components of most IAMs lead to benefits that are in the lower bound of the MAGICC 90% confidence interval
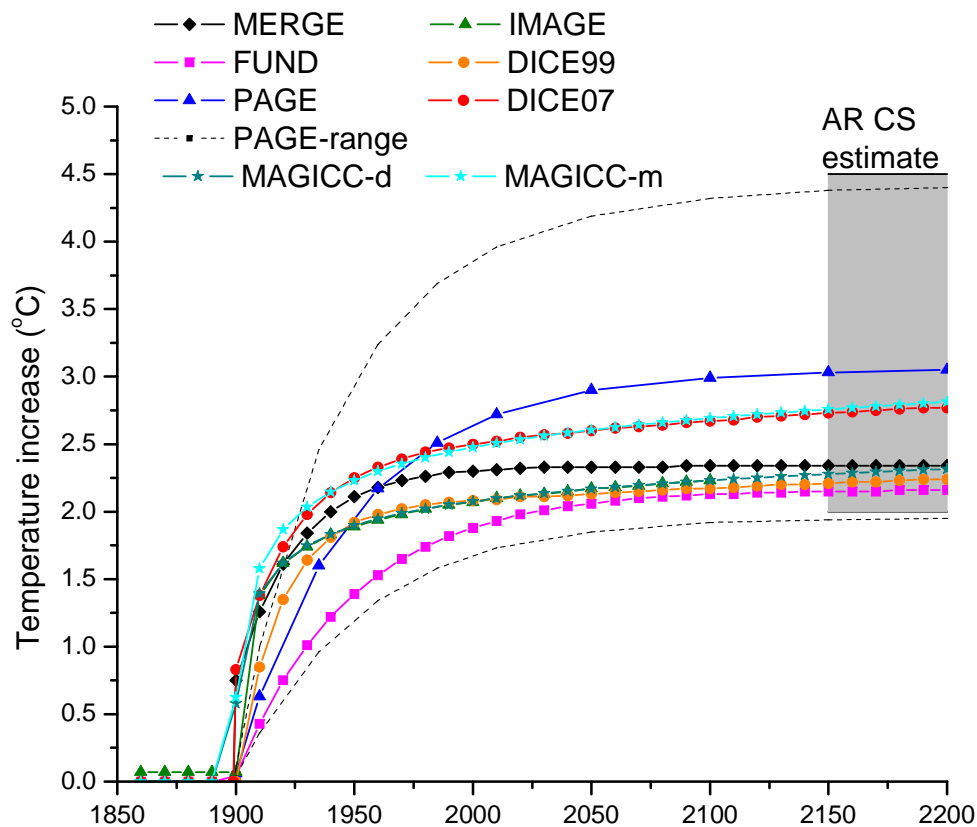
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Background

- IAM models not intended to create new knowledge on climate science, but should use outcomes from complex climate models and their uncertainty

- Van Vuuren et al (2011) & Warren et al (2010) showed that climate response of IAMs is not always within the large uncertainty range of "expert" models

- Is this important? Do differences in climate response affect the benefits of mitigation?

- van Vuuren DP, Lowe J, Stehfest E, Gohar L, Hof AF, Hope C, Warren R, Meinshausen M, Plattner G-K (2010) How well do integrated assessment models simulate climate change? Clim Change 104(2), 255-285
- Warren R, Mastrandrea MD, Hope C, Hof AF (2010) Variation in the climatic response to SRES emissions scenarios in integrated assessment models. Clim Change 102(3), 671-685

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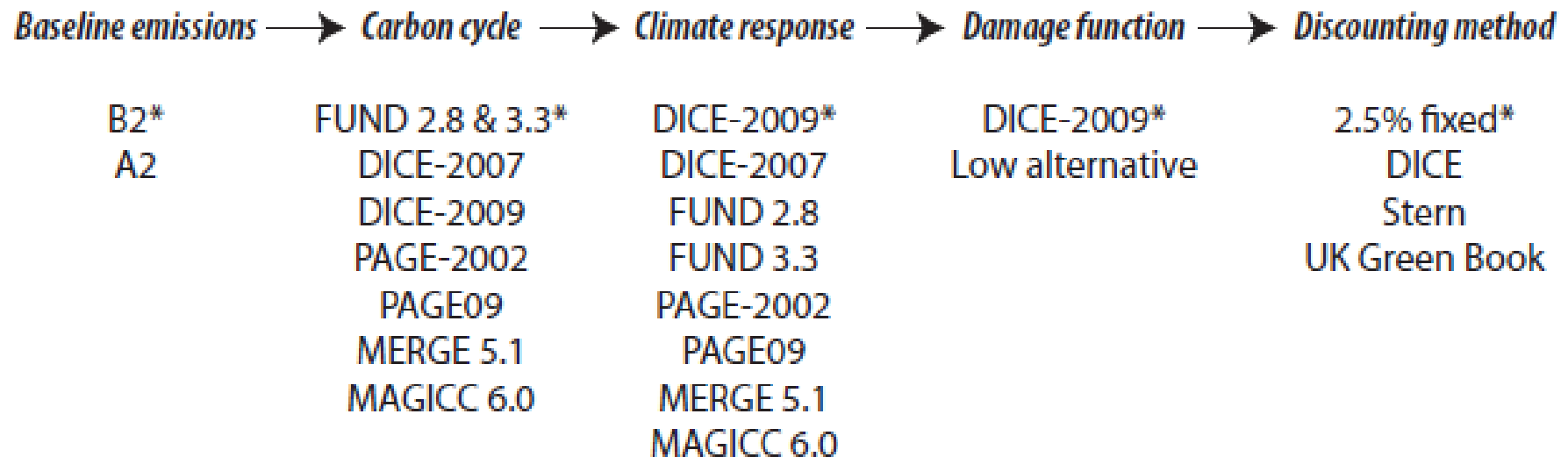# Background: differences in temperature response of pulse experiment

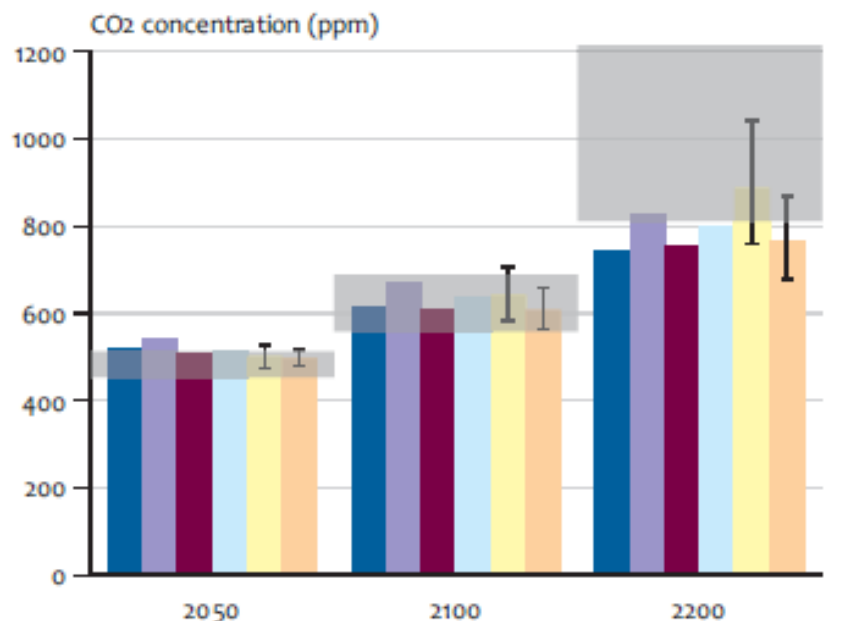temperature effect of doubling of radiative forcing

Van Vuuren et al (2011)

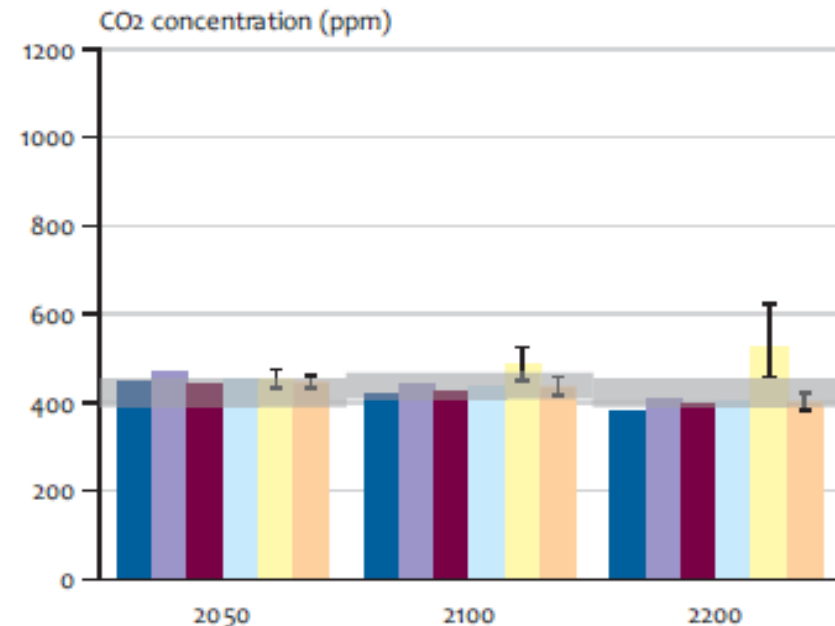# Determining the effect of climate model on benefits of mitigation (only CO2!)

Baseline emissions →	Carbon cycle →	Climate response →	Damage function →	Discounting method
B2*	FUND 2.8 & 3.3*	DICE-2009*	DICE-2009*	2.5% fixed*
A2	DICE-2007	DICE-2007	Low alternative	DICE
	DICE-2009	FUND 2.8		Stern
	PAGE-2002	FUND 3.3		UK Green Book
	PAGE09	PAGE-2002		
	MERGE 5.1	PAGE09		
	MAGICC 6.0	MERGE 5.1		
		MAGICC 6.0		

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Sensitivity of carbon cycle model on concentrations

B2 baseline

CO2 concentration (ppm)

Mitigation scenario

CO2 concentration (ppm)

Carbon cycle model according to:

- DICE-2007
- DICE-2009
- FUND
- MERGE 5.1
- PAGE-2002
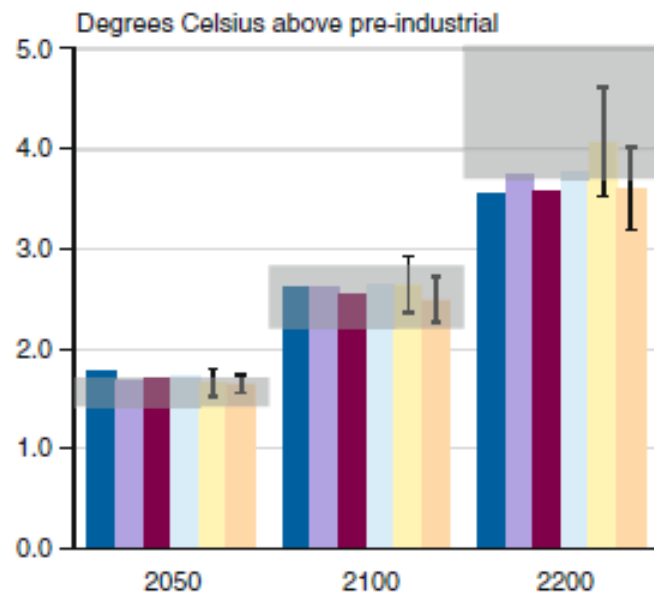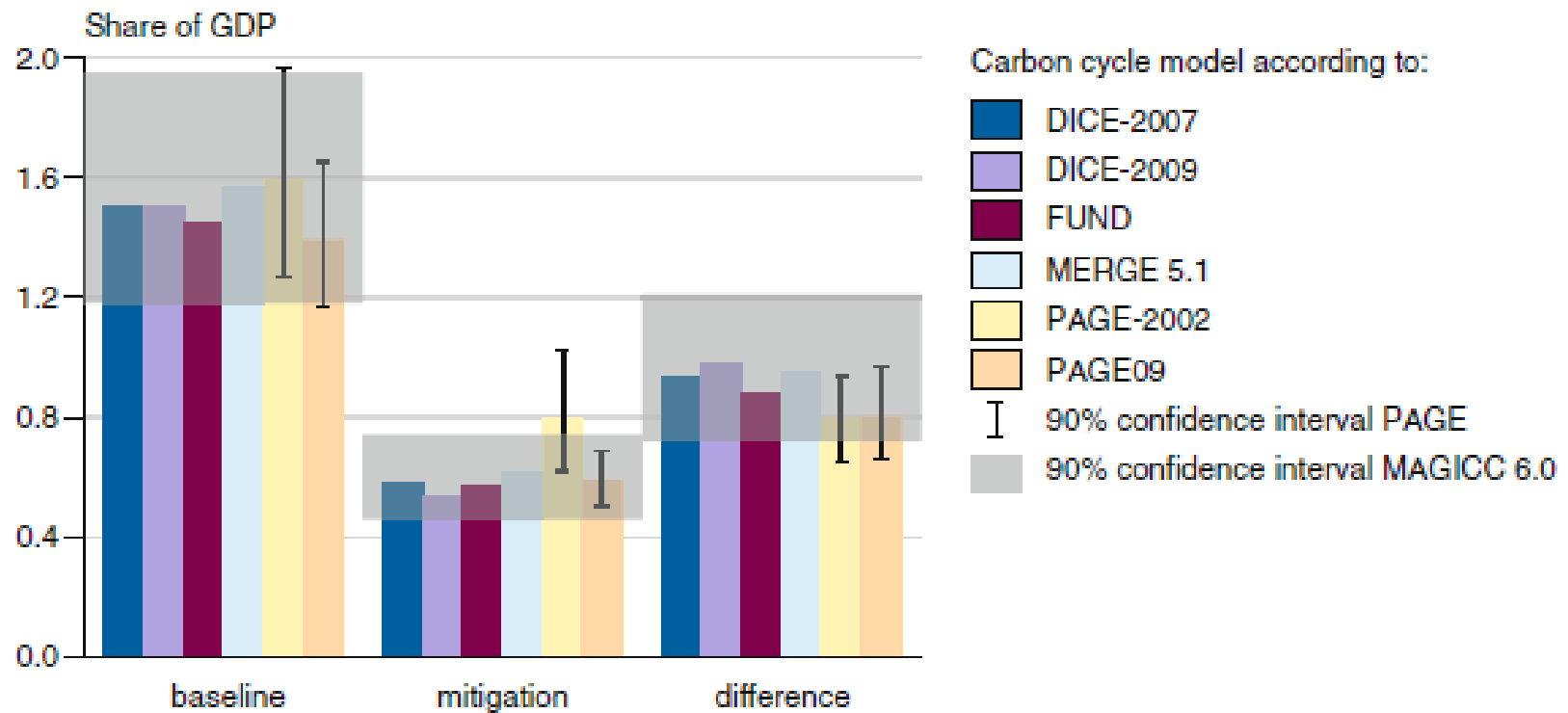- PAGE-2009
- 90% confidence interval PAGE
- 90% confidence interval MAGICC 6.0
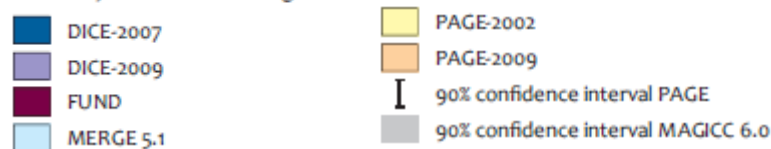
No improvement since Schultz & Kasting (1997)

Sensitivity of carbon cycle model on temperature
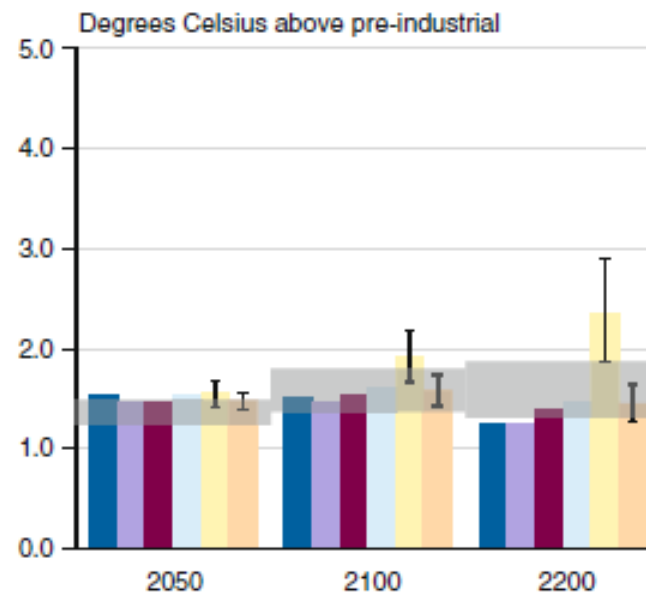
B2 baseline

Degrees Celsius above pre-industrial

Mitigation scenario

Degrees Celsius above pre-industrial

Carbon cycle model according to:

DICE-2007
DICE-2009
FUND
MERGE 5.1
PAGE-2002
PAGE09
90% confidence interval PAGE
90% confidence interval MAGICC 6.0

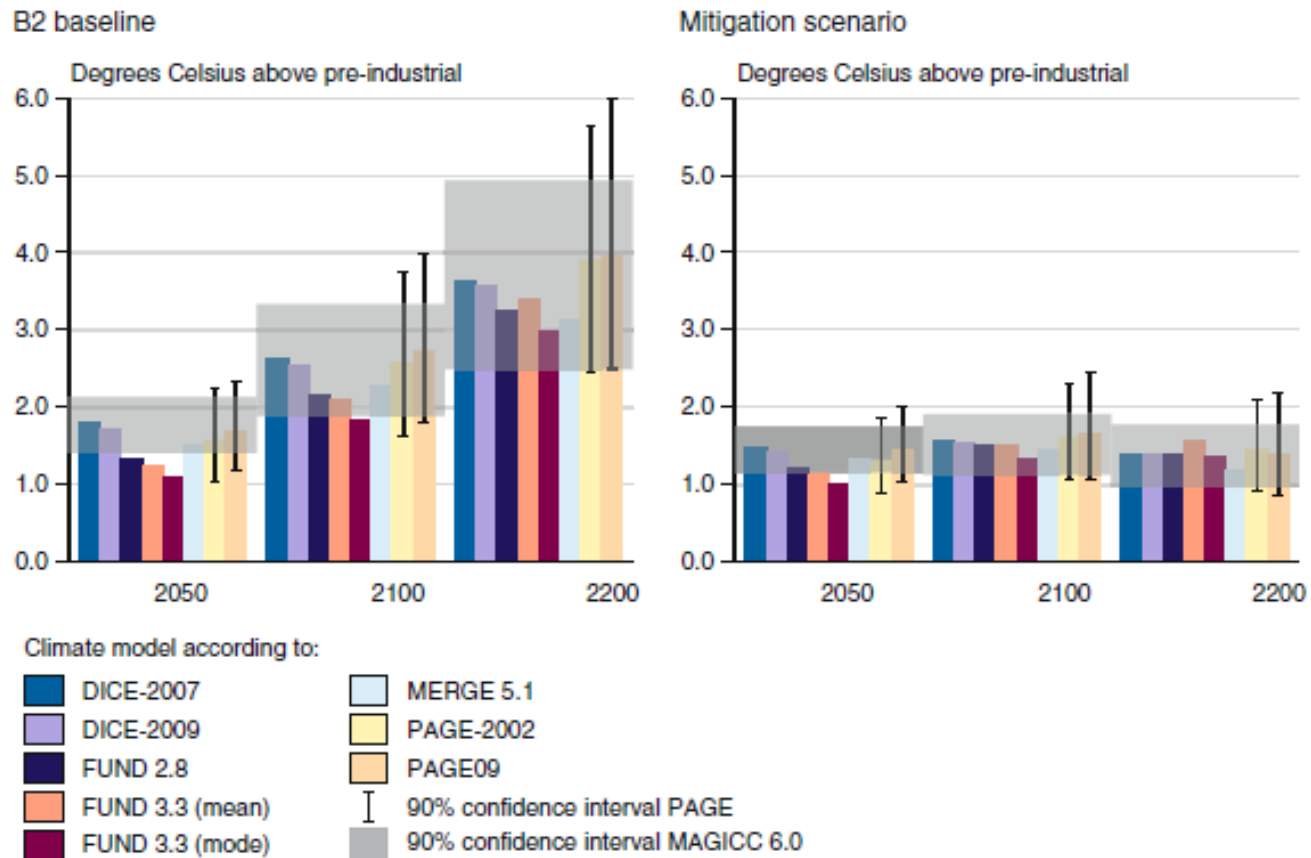Nov 12, 2012 | Andries Hof, Chris Hope, Jason Lowe, Michael Mastrandrea, Malte Meinshausen, Detlef van Vuuren

Sensitivity of carbon cycle model on damage

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Sensitivity of climate model on temperature

B2 baseline

Degrees Celsius above pre-industrial

Mitigation scenario

Degrees Celsius above pre-industrial

Climate model according to:

- DICE-2007
- DICE-2009
- FUND 2.8
- FUND 3.3 (mean)
- FUND 3.3 (mode)
- MERGE 5.1
- PAGE-2002
- PAGE09
- 90% confidence interval PAGE
- 90% confidence interval MAGICC 6.0

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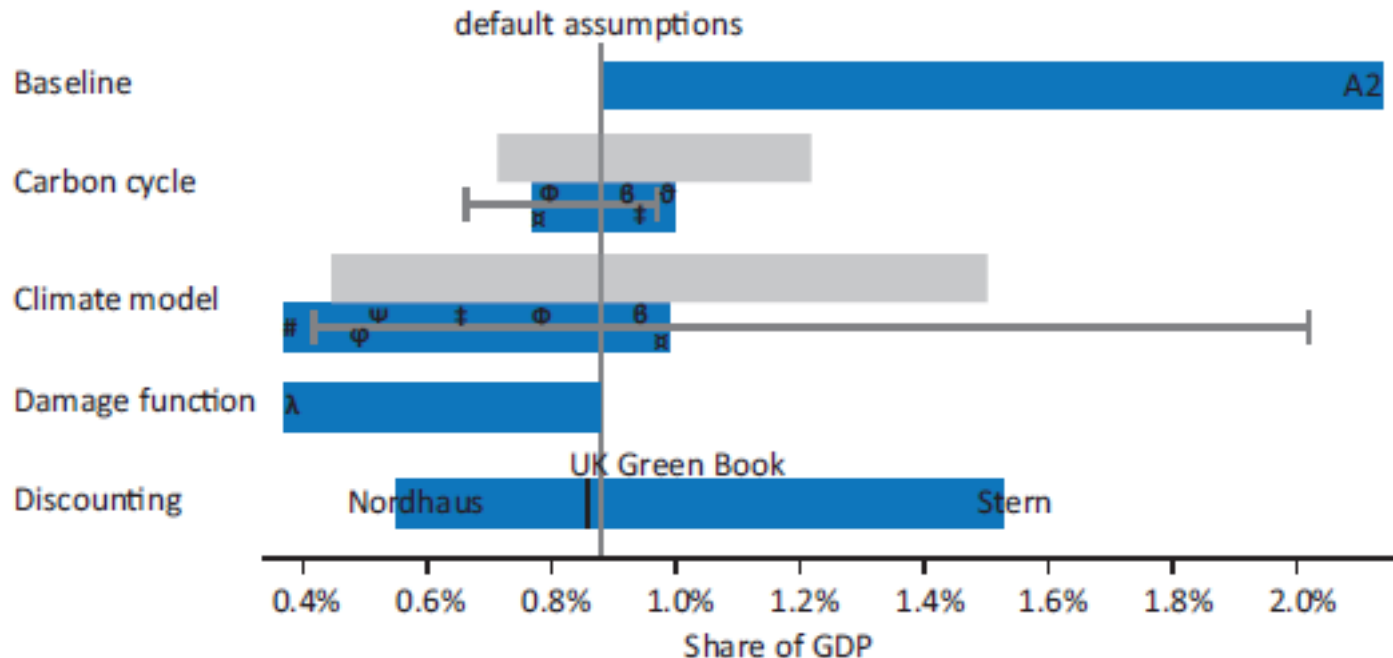
Sensitivity of climate model on damage
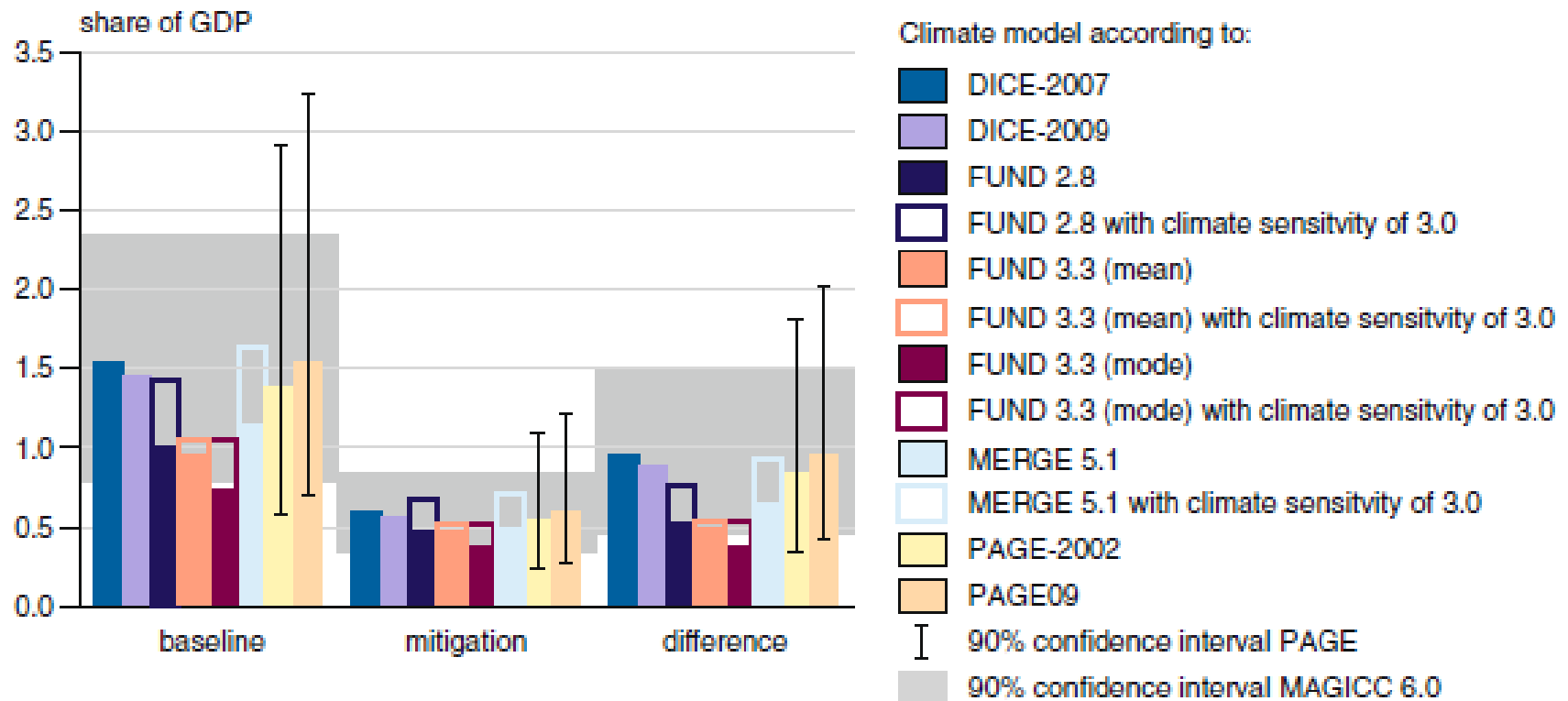
Importance relative to other key assumptions

Legend:
ß = DICE-2007; ϑ = DICE-2009; ‡ = MERGE 5.1; ⲫ = mean PAGE-2002;
¤ = mean PAGE-2009; ѡ = FUND 2.8; φ = mean FUND 3.3; # = mode FUND 3.3;
λ = Alternative damage function; ⊢—⊣ = 90% confidence interval PAGE09;
▭ = 90% confidence interval MAGICC 6.0

Implications for IAM CBA research

- IAMs should capture whole uncertainty range of climate models – since the benefits of mitigation are very sensitive to these models (especially temperature response time)
- Effect of non-CO2 not analysed, but in most IAMs exogenous