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Climate sensitivity and decadal energy budget analyses

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Thanks to Patrick Brown (DUKE)

Forster, P.M. Annual Reviews Earth Planet Sci. 2016,doi:10.1146/annurev-earth-060614-105156

The concept

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$$N = F - \Delta T / \alpha$$

$$\alpha = (F - N) / \Delta T$$

Forster, P.M. Annual Reviews Earth Planet Sci. 2016,doi:10.1146/annurev-earth-060614-105156

Past results

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Study	Year range	Energy imbalance (N)	Model	α (Wm^{-2} K^{-1})	ECS (K)	Notes
Short-timescale (decadal) analyses						
Tsushima et al. 2005	1985–1999	ERBE 60°S–60°N	Equation 1, no forcing	**0.98**	**3.8**	Overestimate of solar sensitivity by factor of 2
Forster & Gregory 2006	1985–1996	ERBE 60°S–60°N	Equation 1	**2.3**	1.6	Effects of regression explored
Lindzen & Choi 2009	1985–1999	Tropical ERBE	Equation 1, no forcing	**4.5**	0.8	Several errors in method identified
Murphy et al. 2009	1985–2005	ERBE and CERES	Equation 1	**1.25**	3.0	Explored seasonal and interannual analyses
Trenberth et al. 2010	1985–1999	60°S–60°N ERBE	Equation 1	**0.8 to 1.6**	2.3 to 4.6	Range depends on case investigated
Chung et al. 2010	1985–1999	60°S–60°N ERBE	Equation 1, no forcing	**0.11**	34	Very big shortwave feedback found
Lindzen & Choi 2011	1985–2008	Tropical ERBE and CERES from 2000	Equation 1, no forcing	**6.9**	0.5	Similar errors as in their earlier work
Tsushima & Manabe 2013	1985–2005	1985–1999, 60°S–60°N ERBE and global CERES from 2000	Equation 1, no forcing	**1.1**	3.4	Used a gain factor approach
Dessler 2013	2000–2010	Reanalyses	Sum of feedbacks	**1.15**	3.2	—
Donohoe et al. 2014	2000–2013	CERES global data	Equation 1	**1.2**	3.1	—
Trenberth et al. 2015	2000–2013	CERES global data	Equation 1, no forcing	**1.13**	3.3	$\alpha = 2.28$ Wm^{-2} K^{-1} if using tropospheric temperatures for regression

Results for CERES

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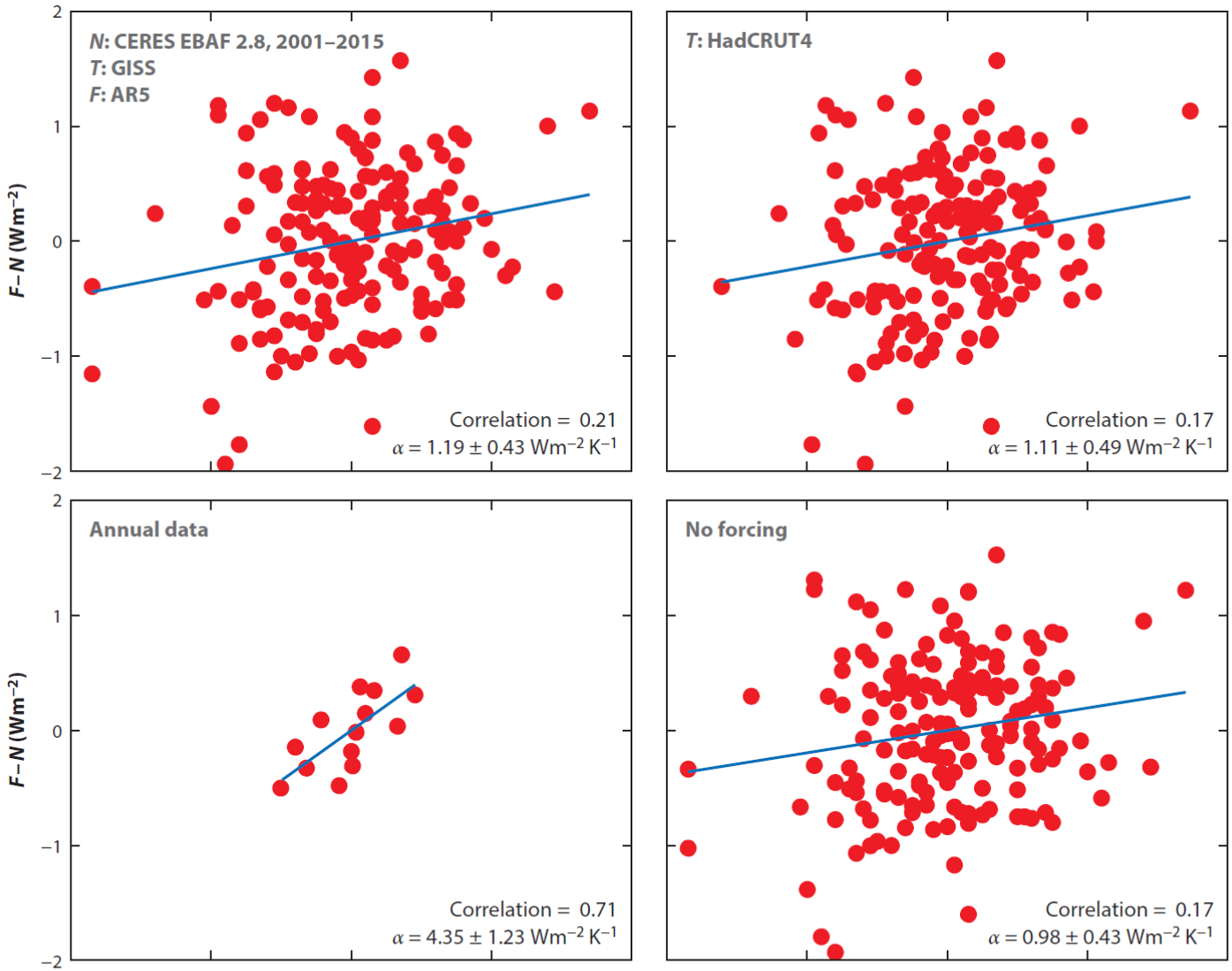

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Results for CERES

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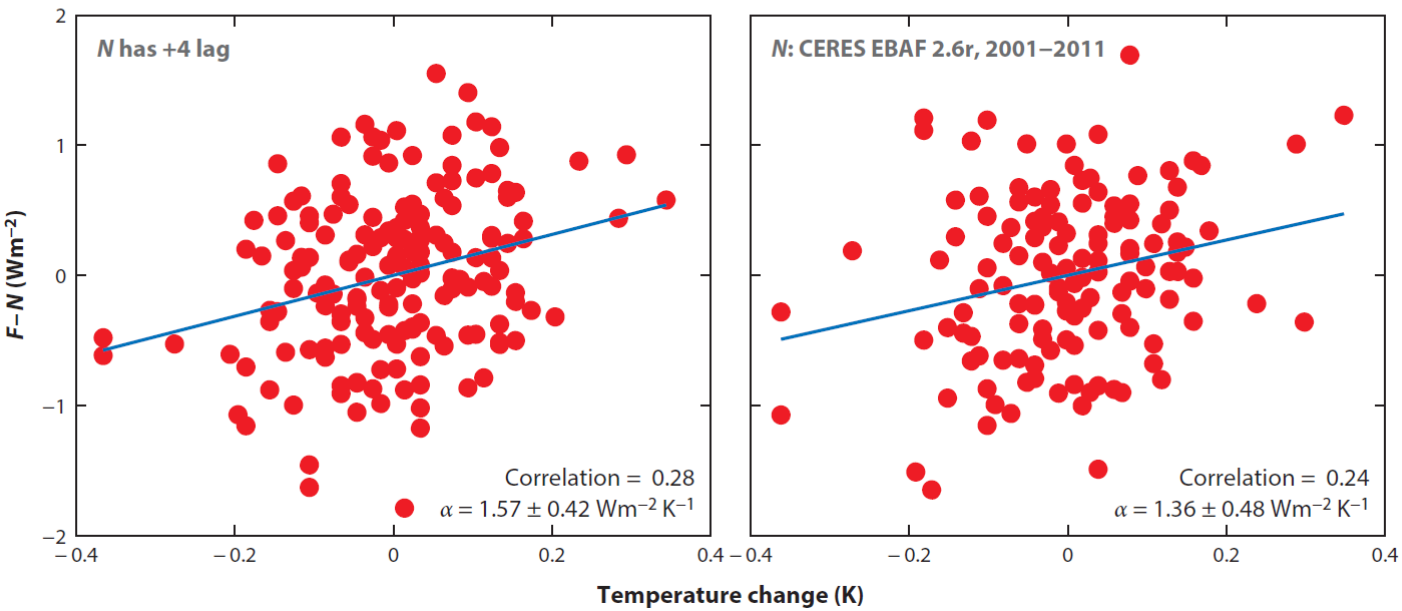

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Component breakdown

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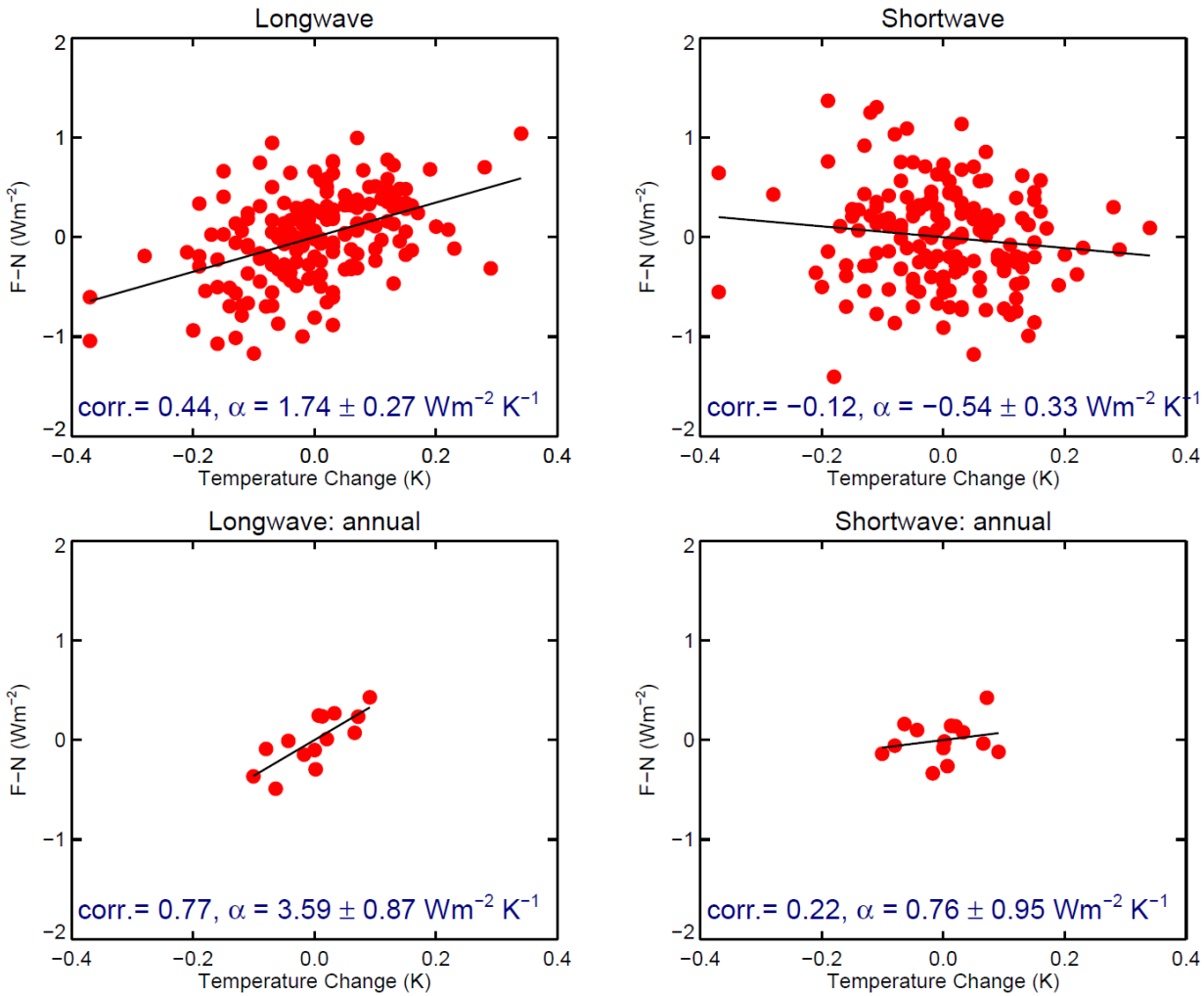

CERES Averaging period

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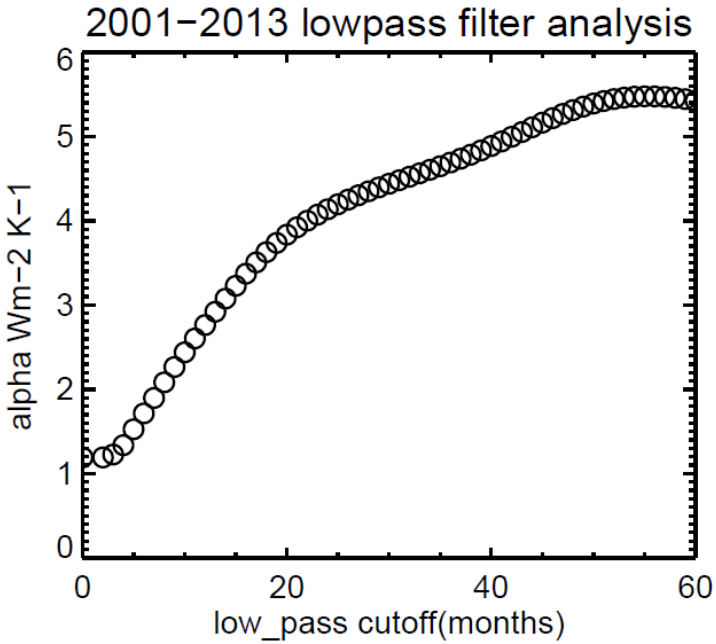
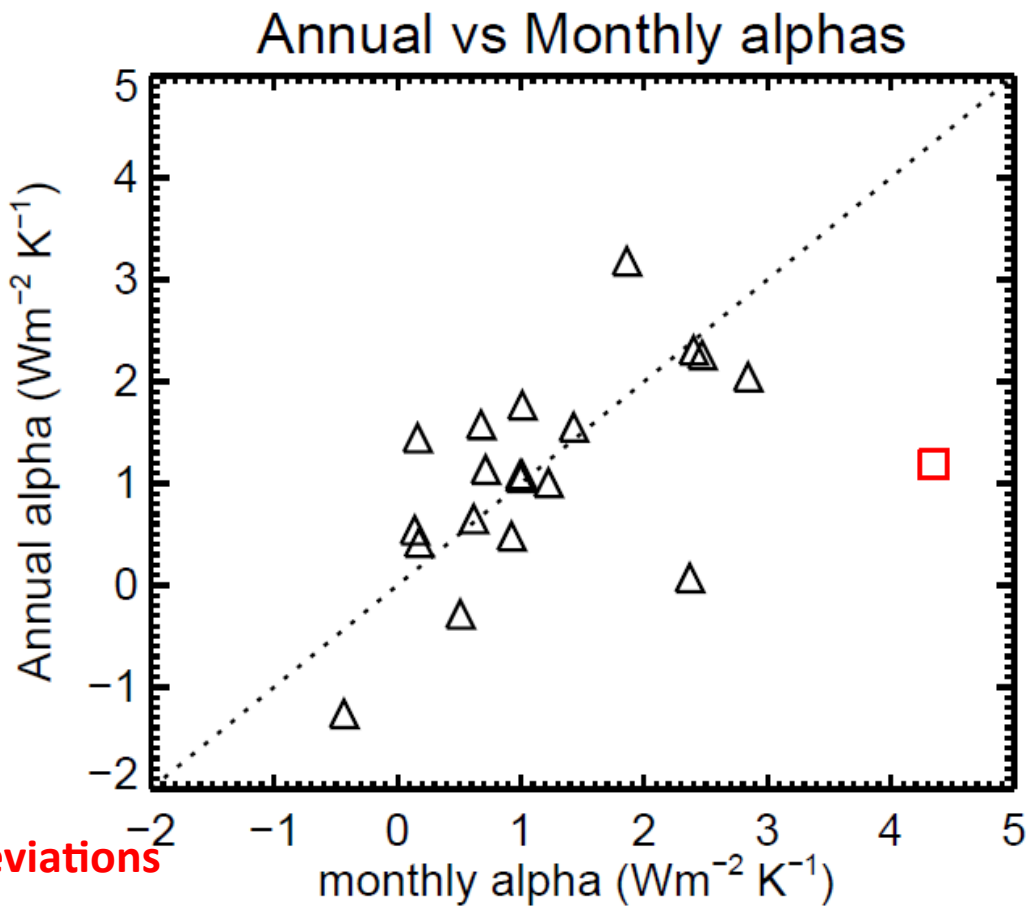
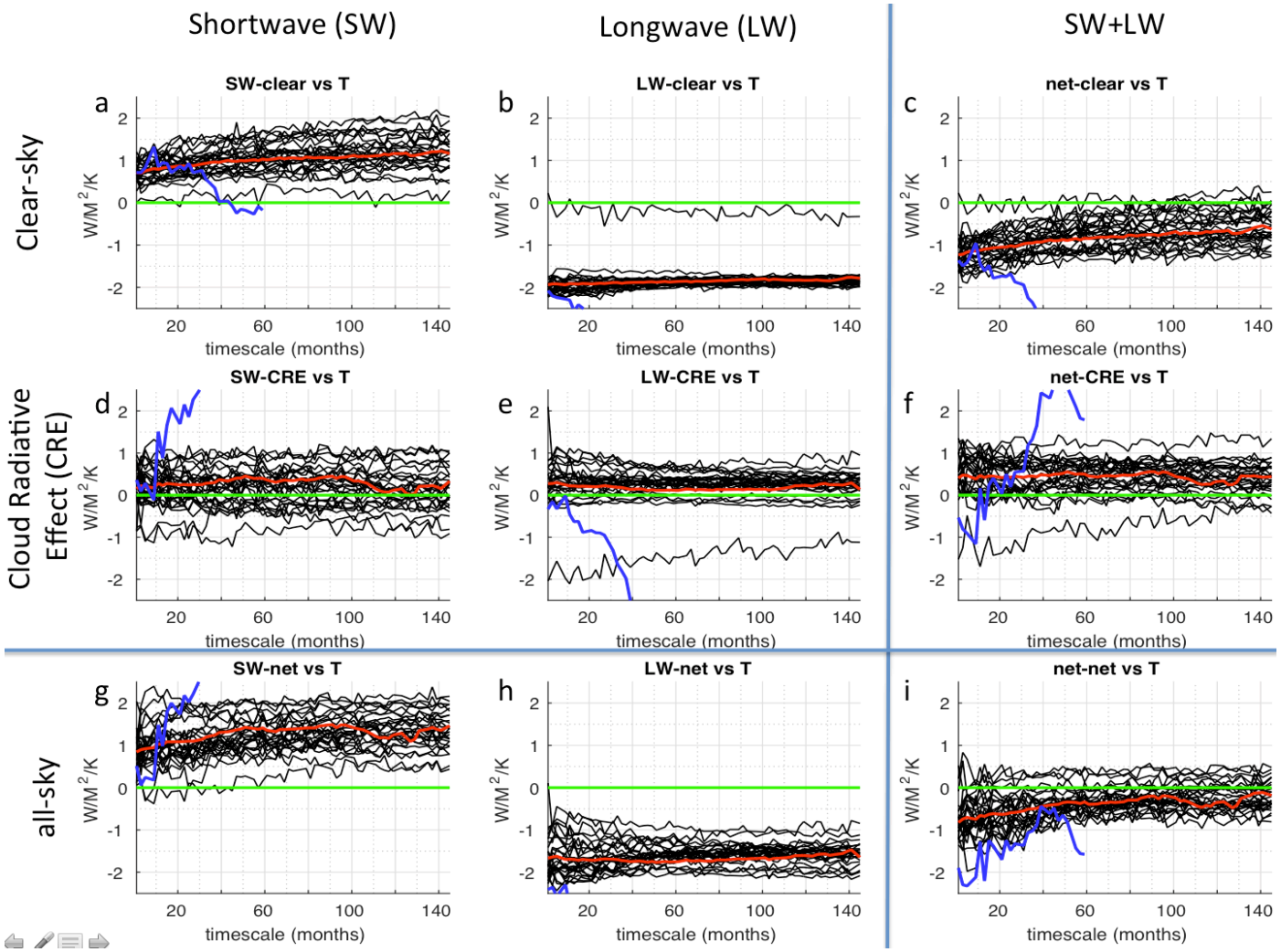




When compared to models over same period difference if over 5 standard deviations larger than model mean difference

Patrick Brown- DUKE



“Perfect” Model Tests

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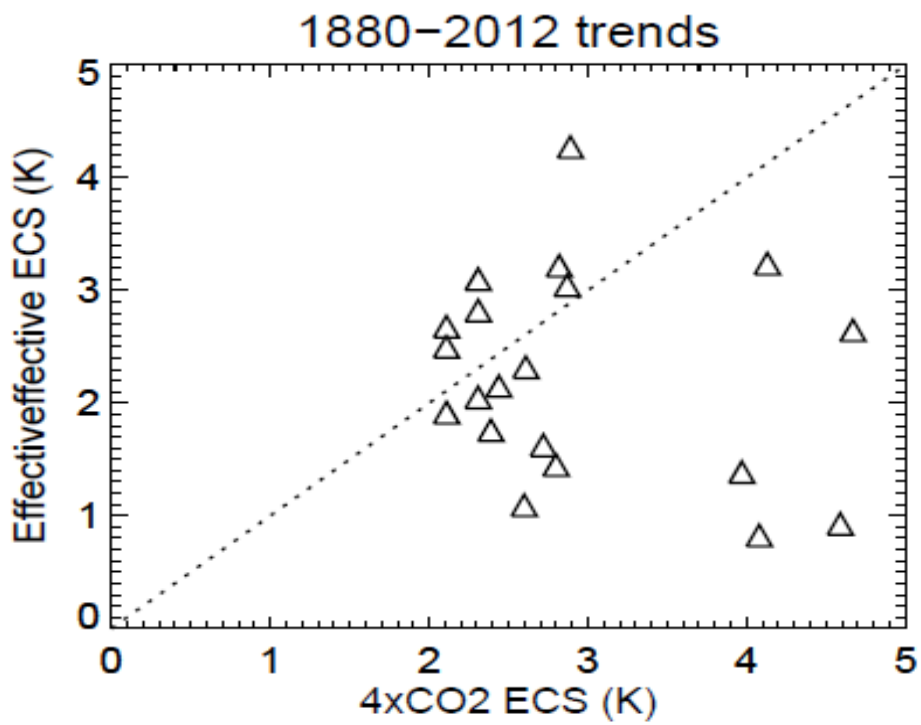

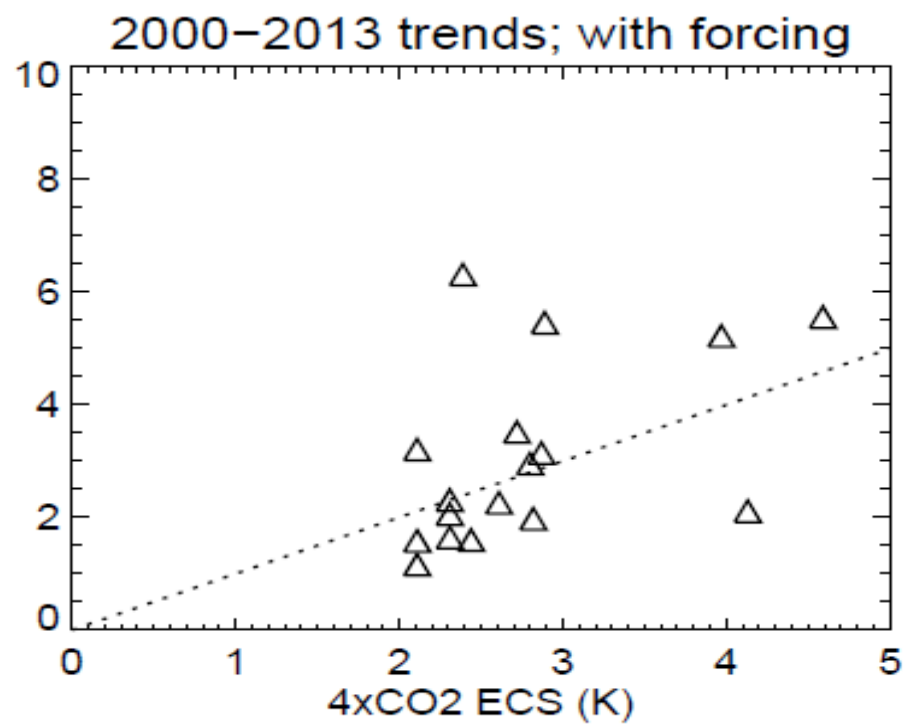

Longer periods with consistent trends help

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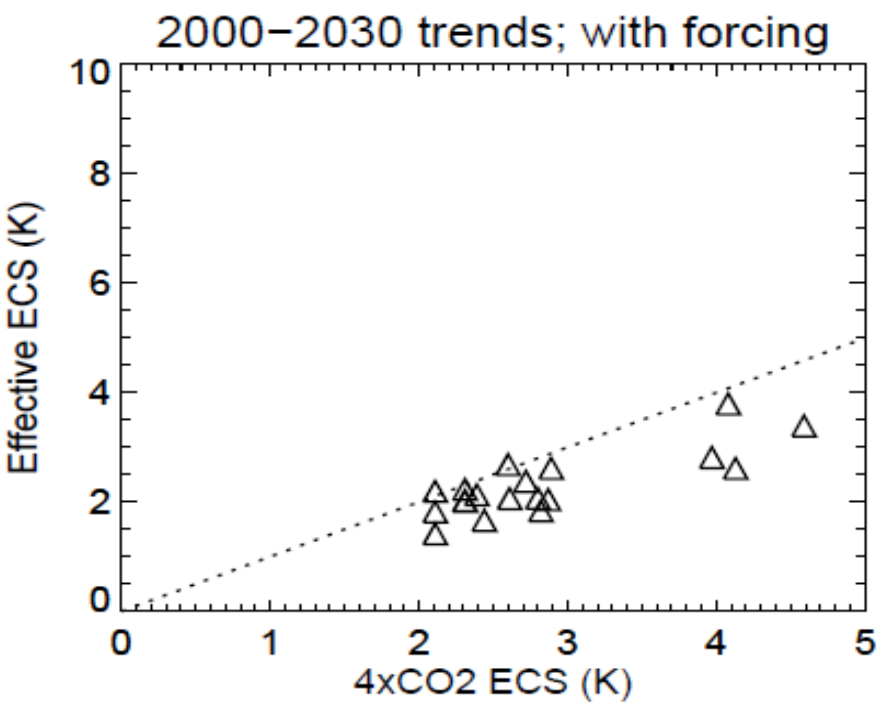

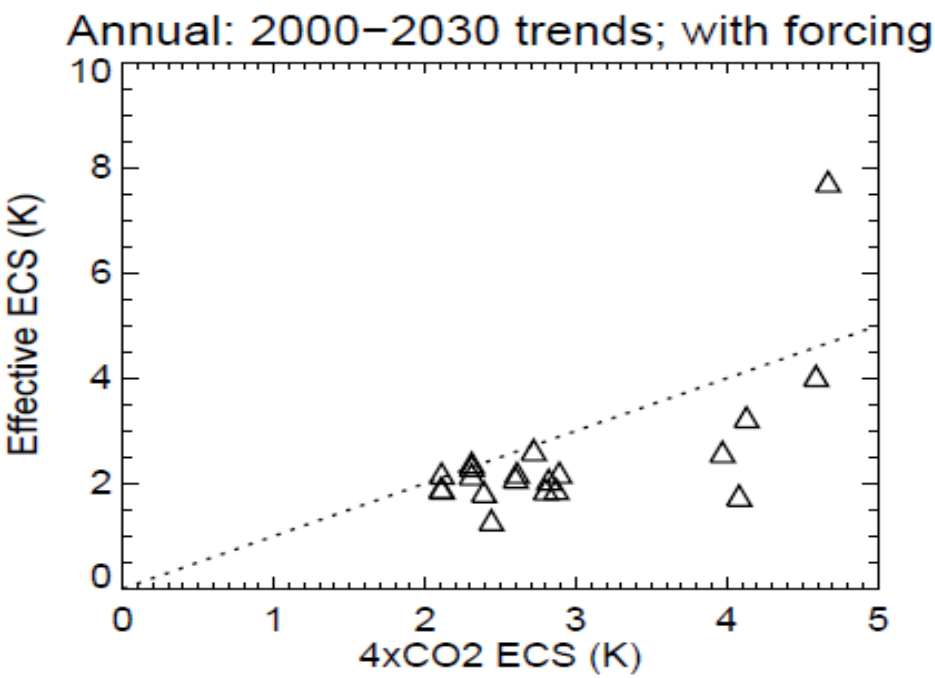

Conclusions

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- There is skill in this method. Effective ECS does relate to actual ECS even on 15 yr periods
- Relation may approximately be 1:1 for current period but also may not!
- Annual CERES result a bit of a mystery (**data processing or physical effect not in models**)
- Need perfect "perfect" model tests → Diagnose ERF in models consistently

rfmip.leeds.ac.uk; Forster et al., JGR just accepted

More info

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http://www.climate.leeds.ac.uk/

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