NCAR's CMIP-5 mirror

/project/cmip5/ETH/cmip5/

http://www.cgd.ucar.edu/ccr/bsander/cmip5

Number of simulations (mon) --- Status: Wed Mar 14 14:30:36 MDT 2012

Experiment: piControl

Ensemble: all

ATM	HadGEM2-ES	HadGEM2-A	HadCM3	bcc-csm1-1	GISS-E2-H	GISS-E2-R	inmcm4	CNRM-CM5	IPSL-CM5A-LR	NorESM1-M	CanCM4	CanESM2	CanAM4	CSIRO-Mk3-6-0	MI
clt	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1
hfls	1/1	0	0	1/1	1/2	1/2	1/1	1/1	1/1	1/1	0	1/1	0	1/1	1
hfss	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/1	0	1/1	0	1/1	1
hus	1/1	0	0	1/1	0	0	1/1	1/1	1/1	1/2	0	1/1	0	0/1	1
pr	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1
prc	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1
prsn	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1
prw	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/1	0	1/1	0	1/1	1,
psl	1/1	0	0	1/1	1/2	2/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1,
rlds	1/1	0	0	1/1	1/2	3/4	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/
rldscs	1/1	0	0	1/1	1/1	1/2	1/1	1/1	1/1	1/1	0	1/1	0	1/1	1/
rlus	1/1	0	0	1/1	1/2	2/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/
rlut	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/
rlutcs	1/1	0	0	1/1	1/1	1/2	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/
rsds	1/1	0	0	1/1	1/2	1/3	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/
rsdscs	1/1	0	0	1/1	1/1	1/2	1/1	1/1	1/1	1/2	0	1/1	0	1/1	1/

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

CAM**cloud**

Perturbed Physics Experiment

Ben Sanderson

Outline

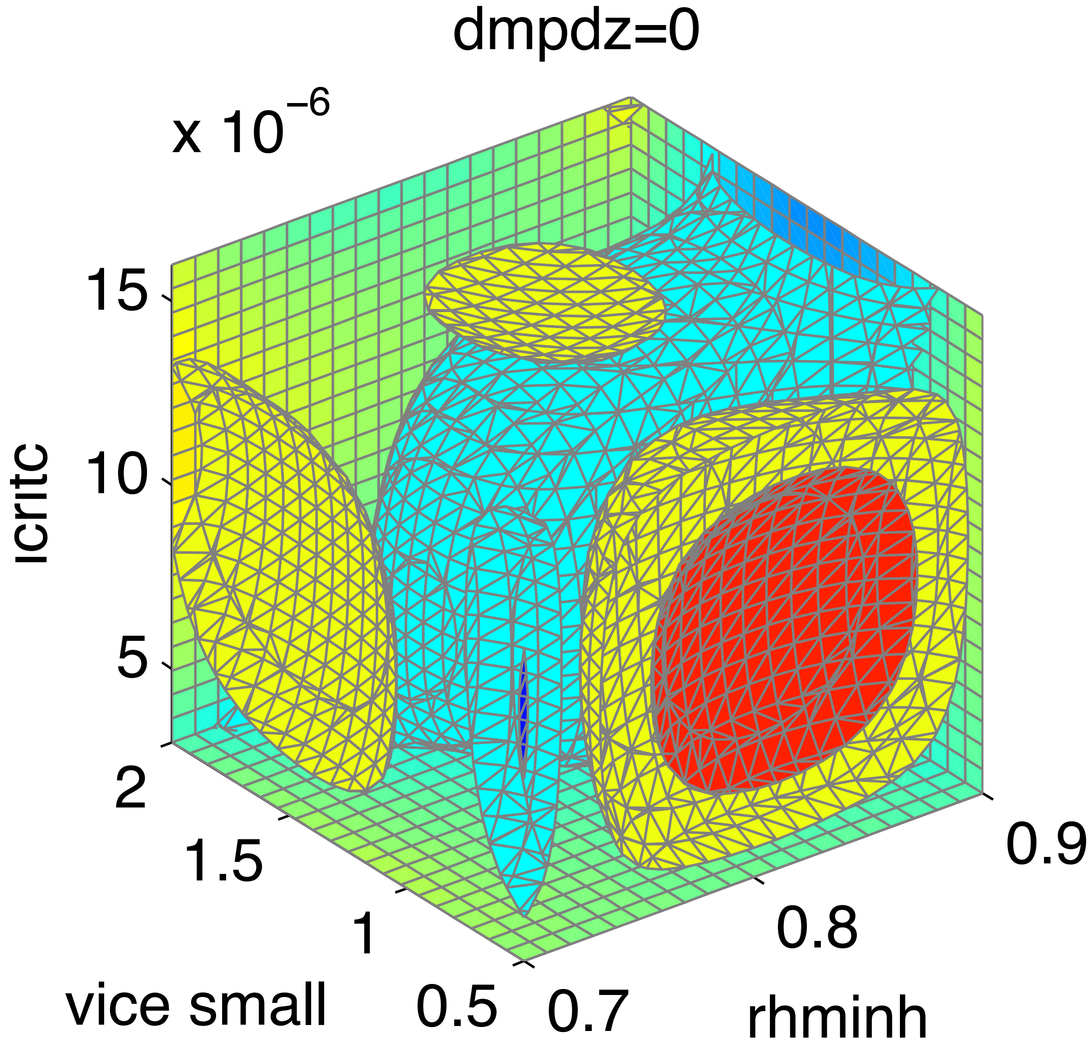
I (the past)

- CAMcube and lessons learned

II (the future)

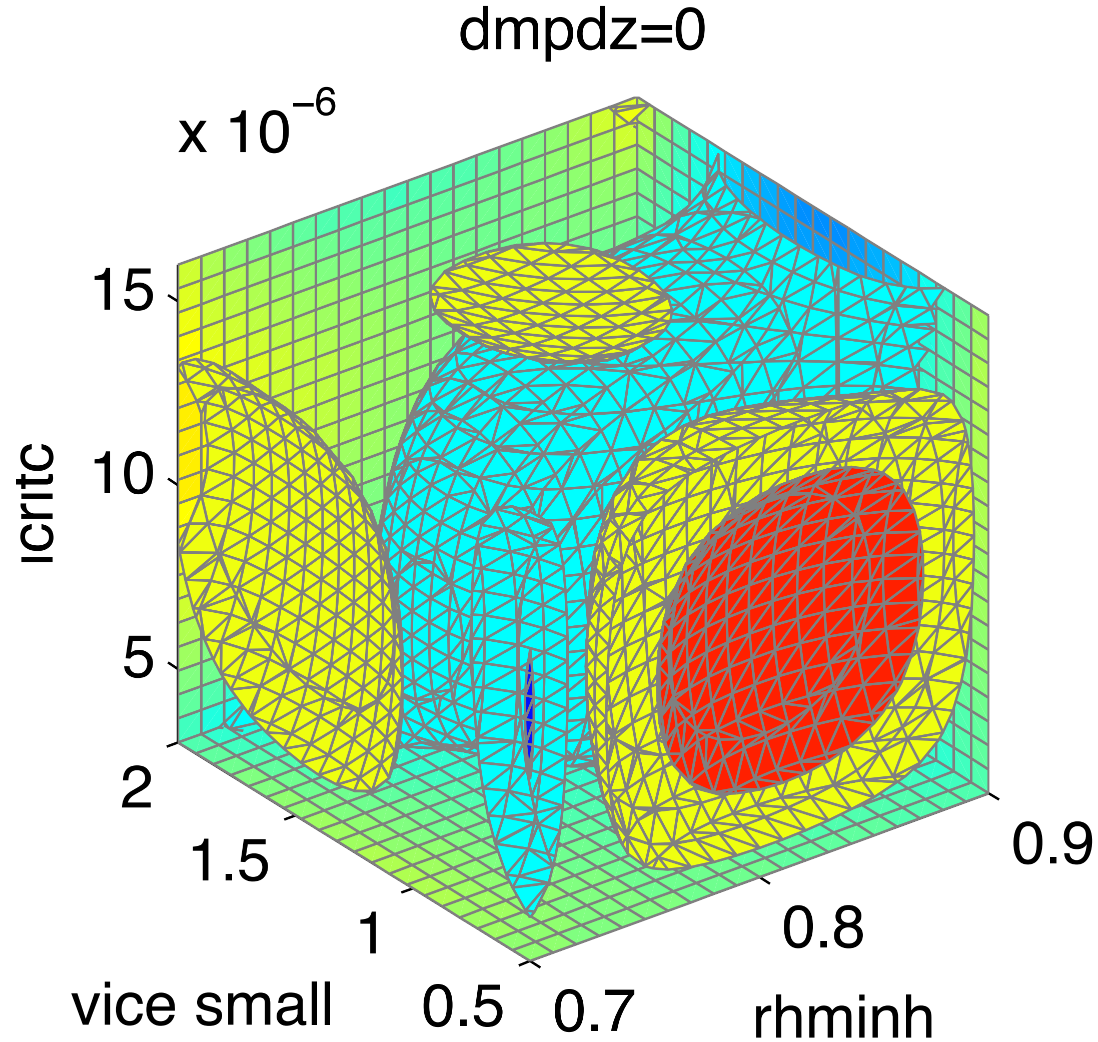
- Semi-empirical surregate models
- COSP-based cloud parameter constraints
- Optimal ensemble generation

CAMcube



Sanderson (2011)

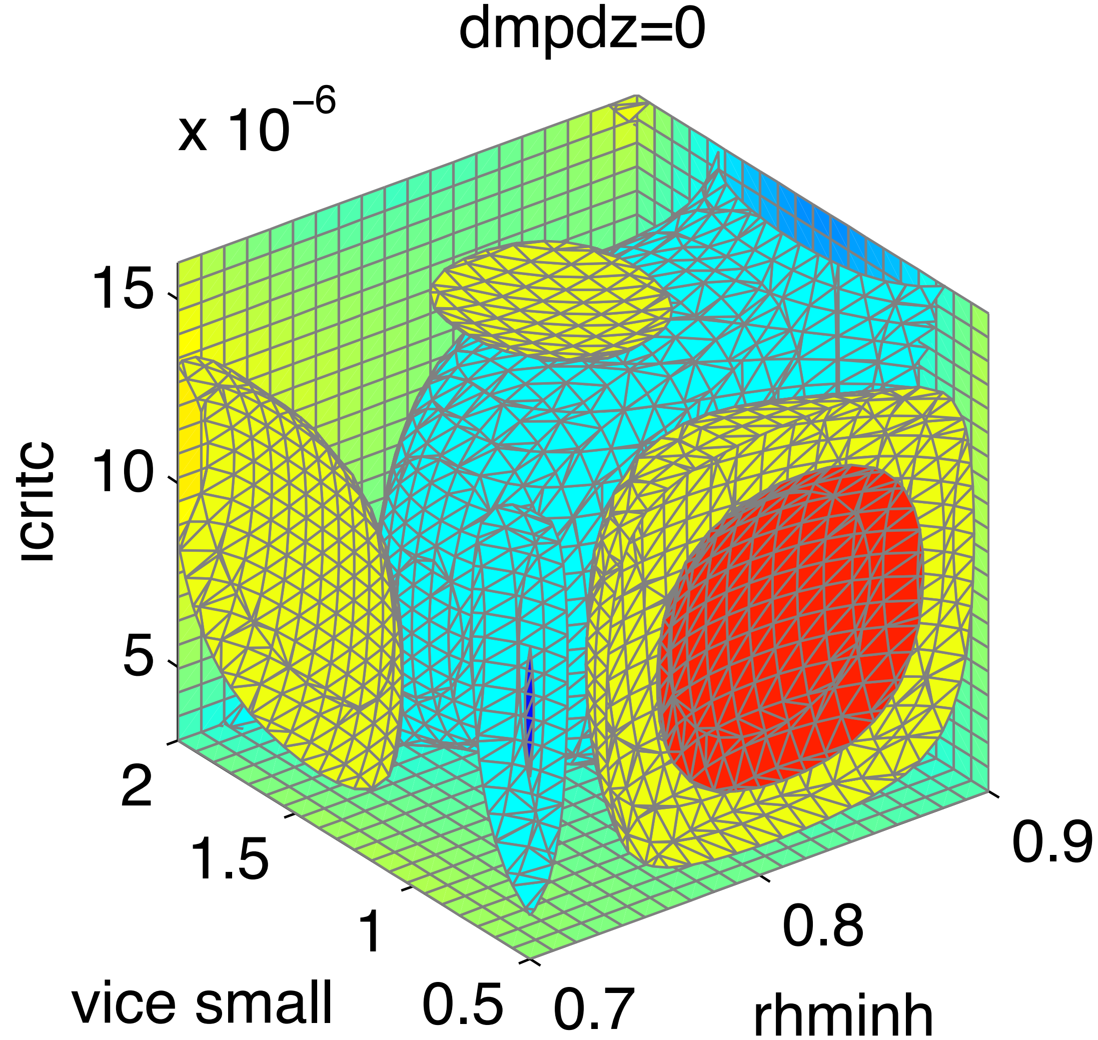
CAMcube



Sanderson (2011)

- 81x3 15yr simulations

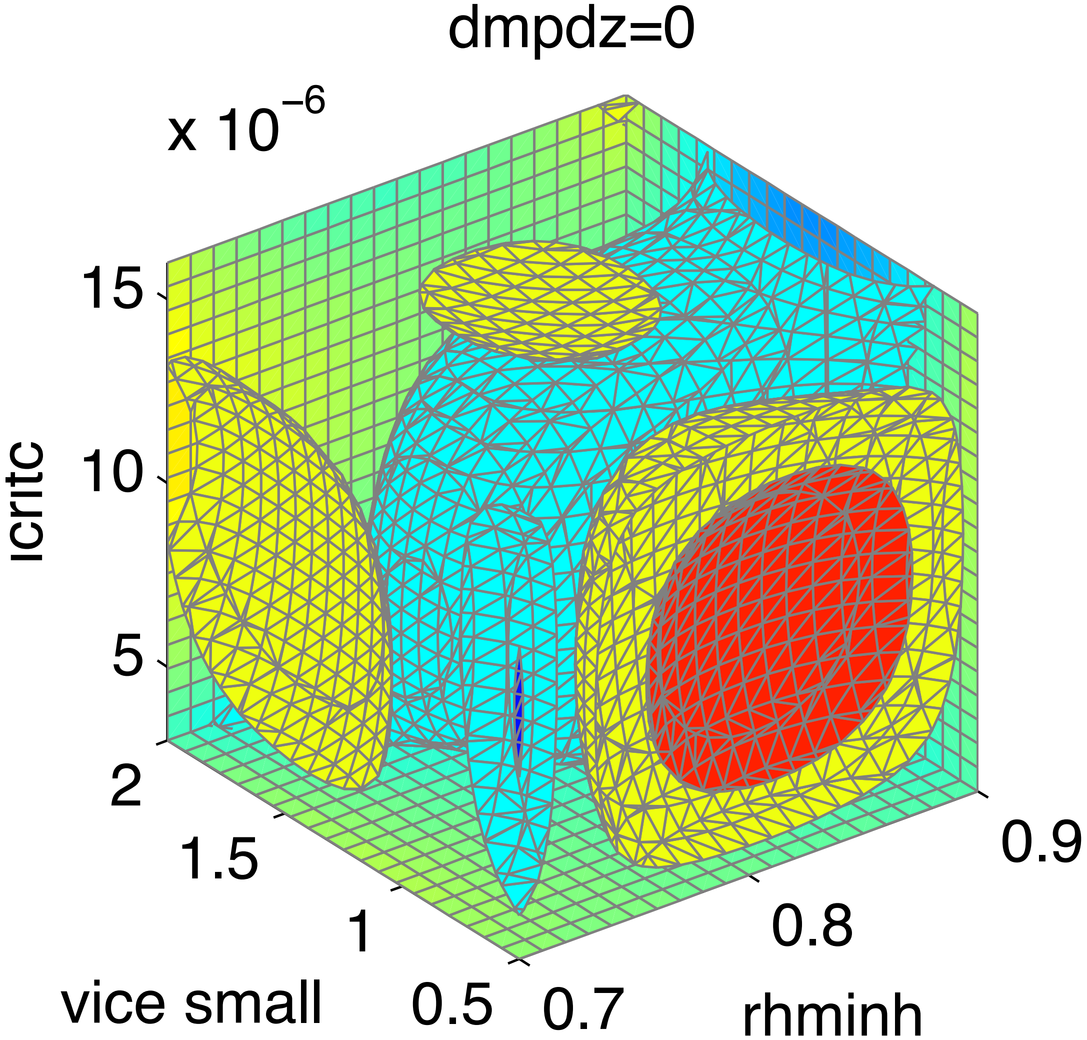
CAMcube



Sanderson (2011)

- 81x3 15yr simulations
- ~2 million hours CPU time

CAMcube



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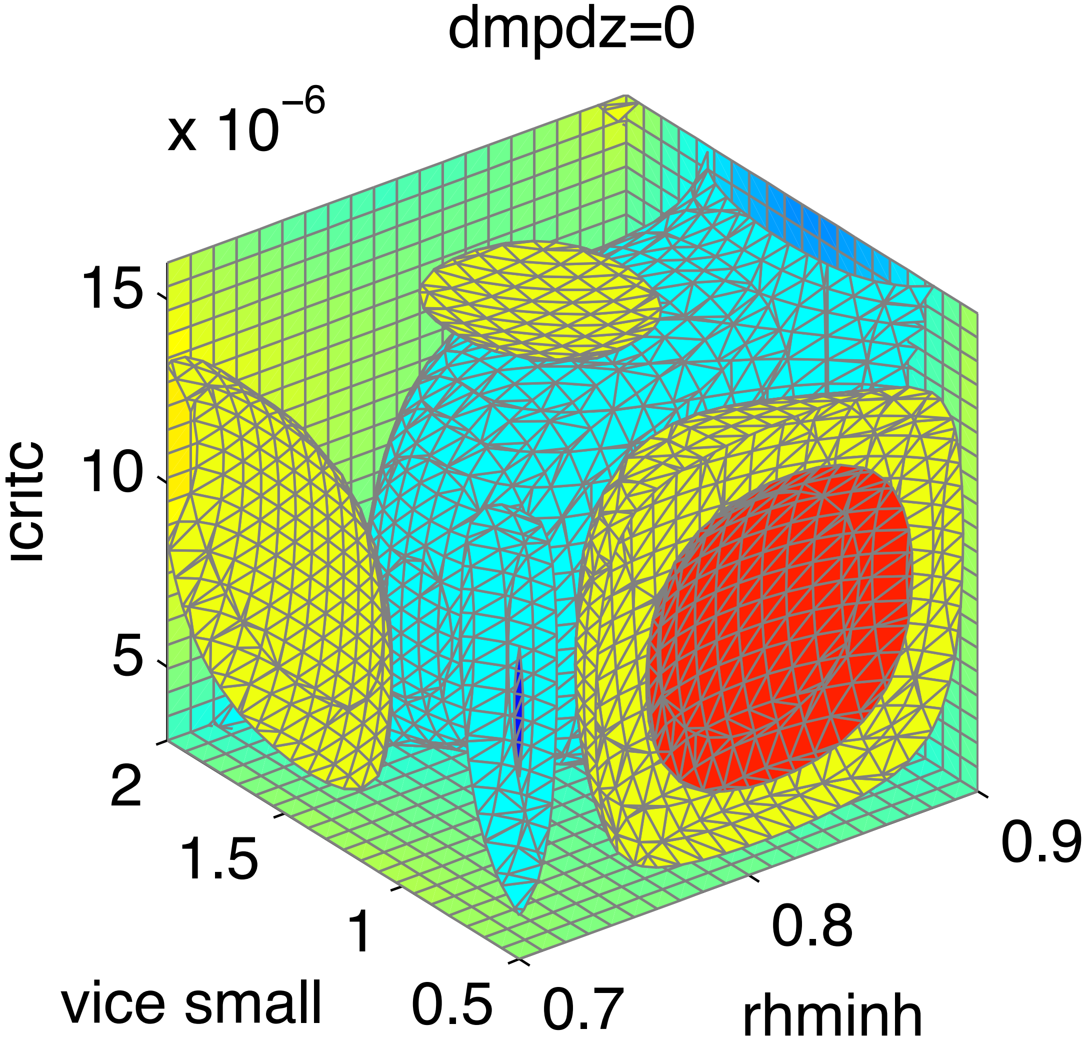
CAMcube



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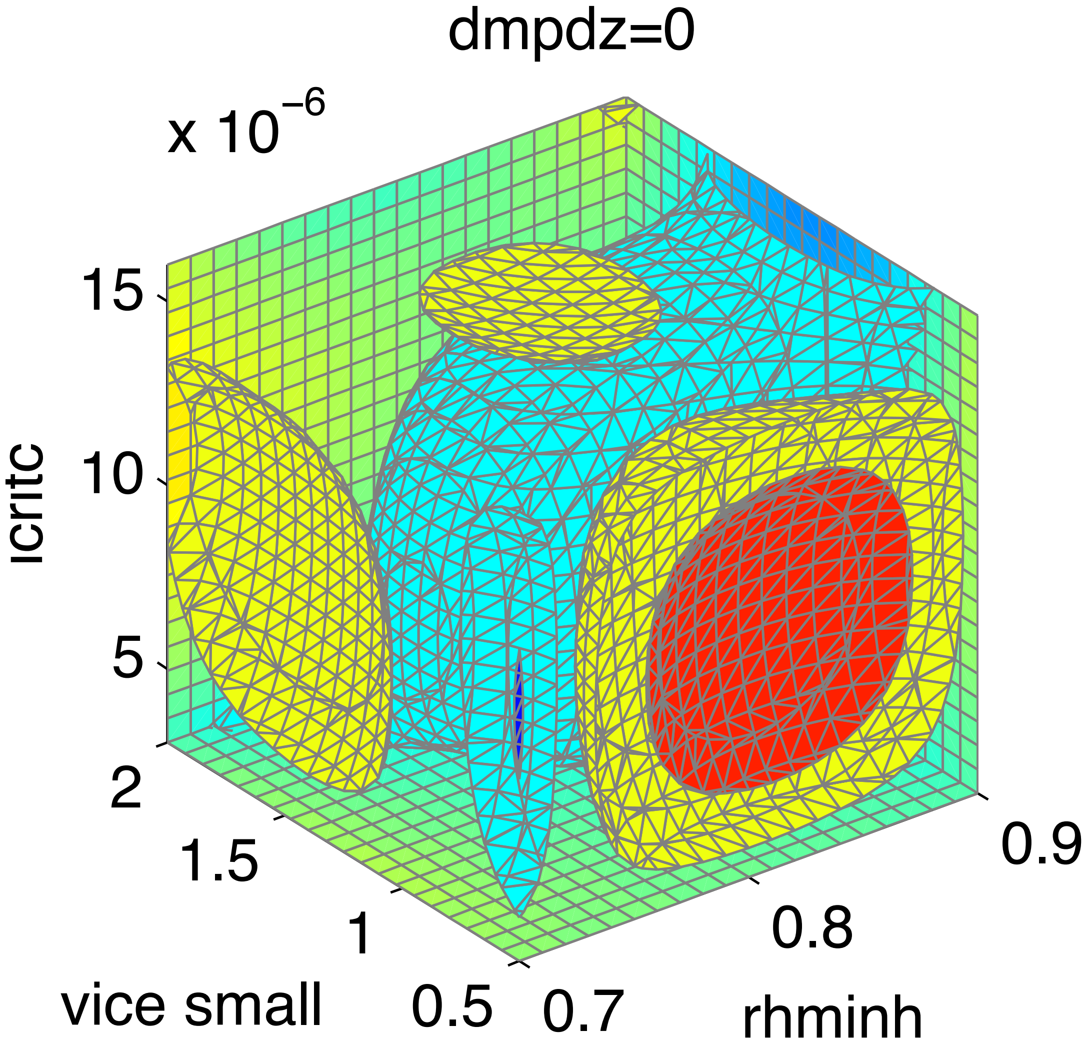

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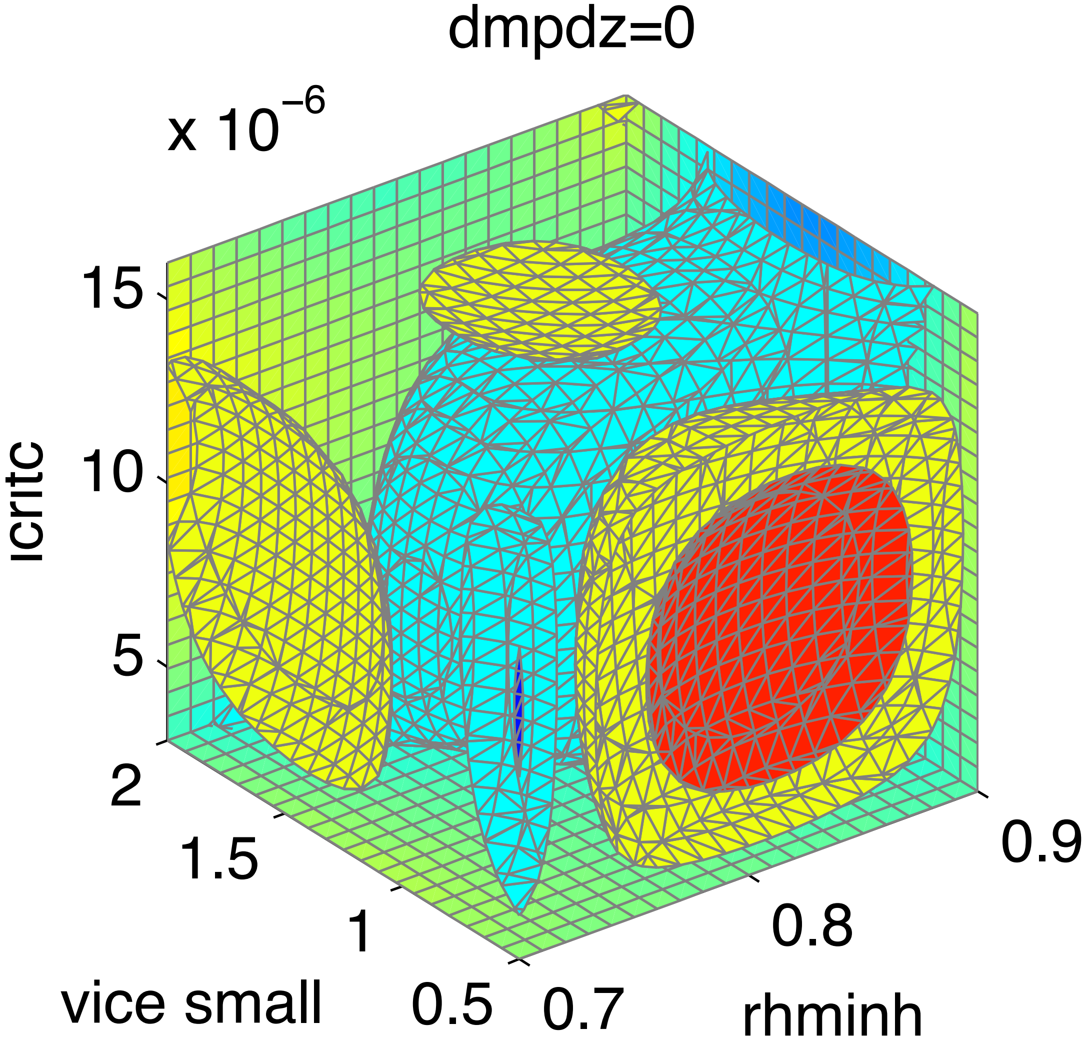

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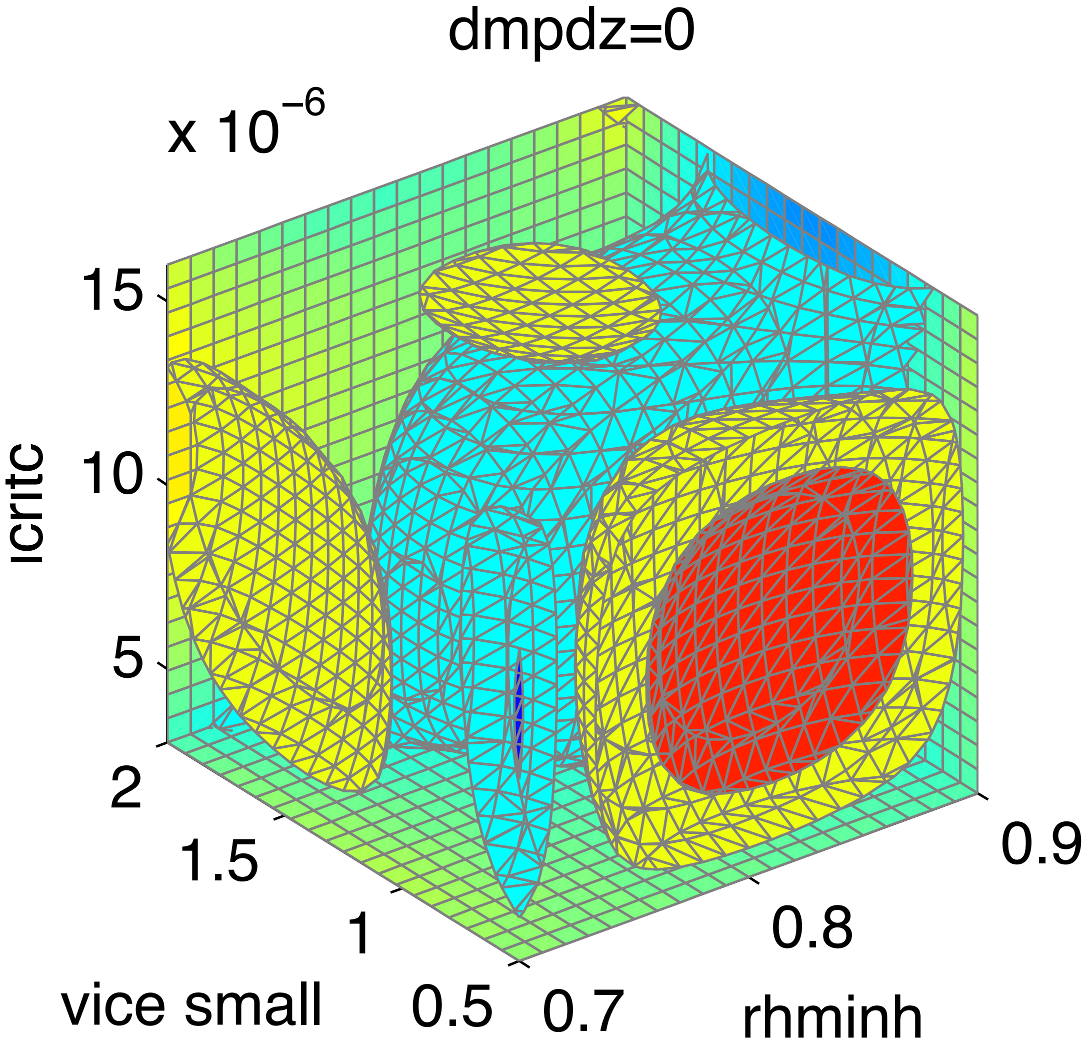
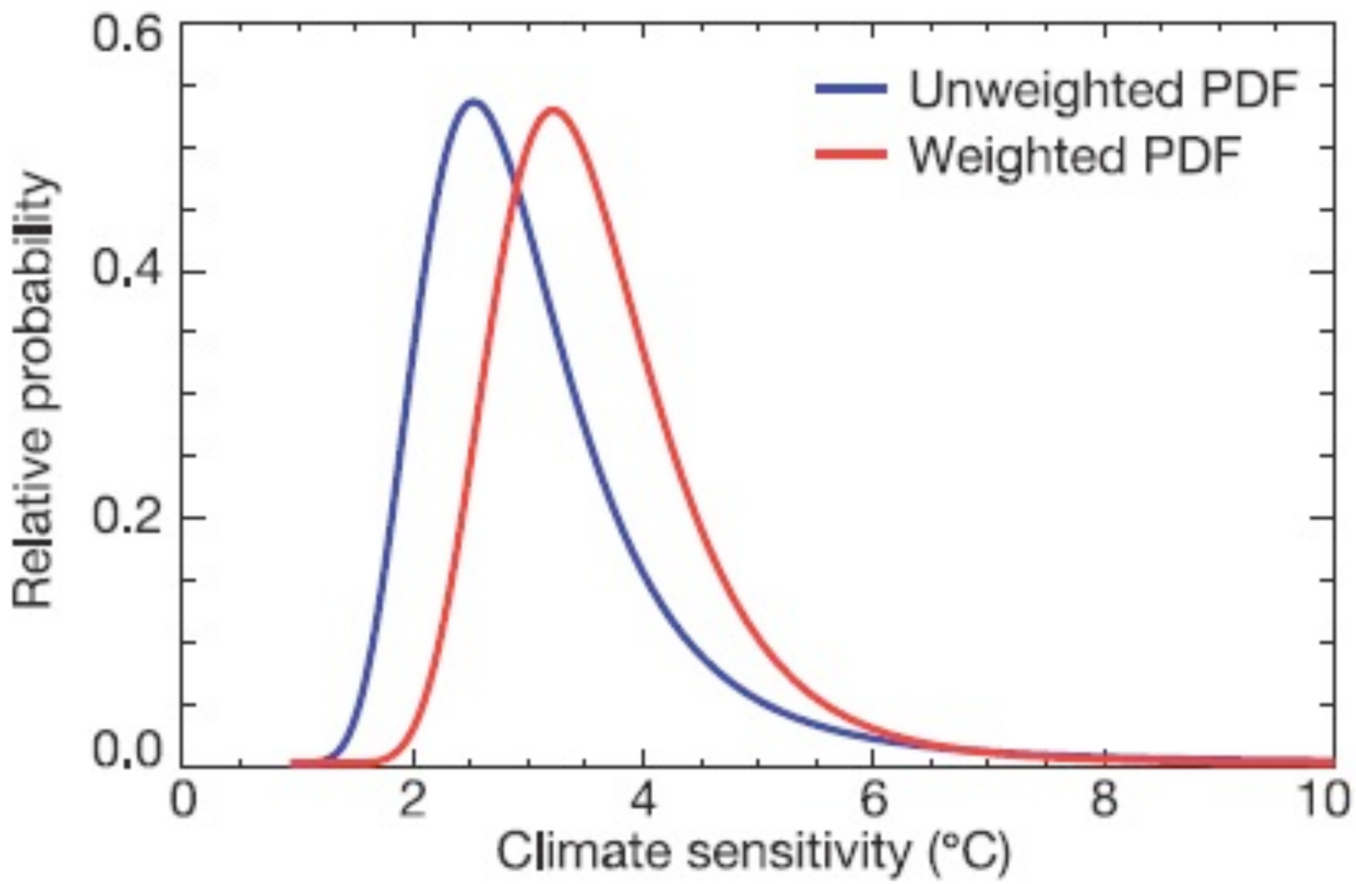


Sanderson (2011)

- 81x3 15yr simulations
- ~2 million hours CPU time
- ~60 MWh (on Jaguar)
- 94 tonnes CO_2 emitted (coal)
- 17 round-the-world flights
- 1/2 million bikes up the Mesa
- $1x10^{-7}$K additional warming above RCP4.5 (S=3.5K)

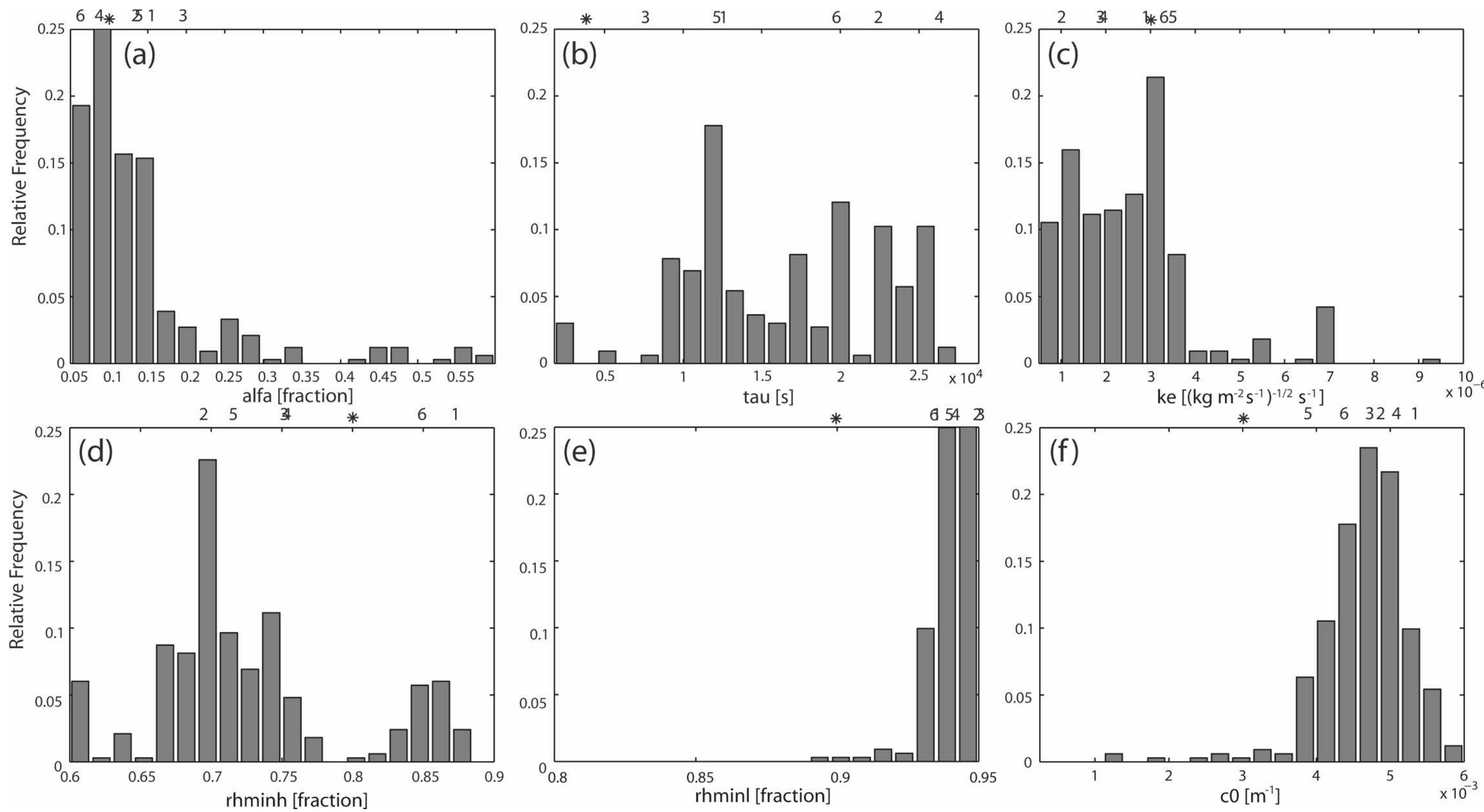
1. Constraint of large scale response variables



Murphy *et al* (2004)

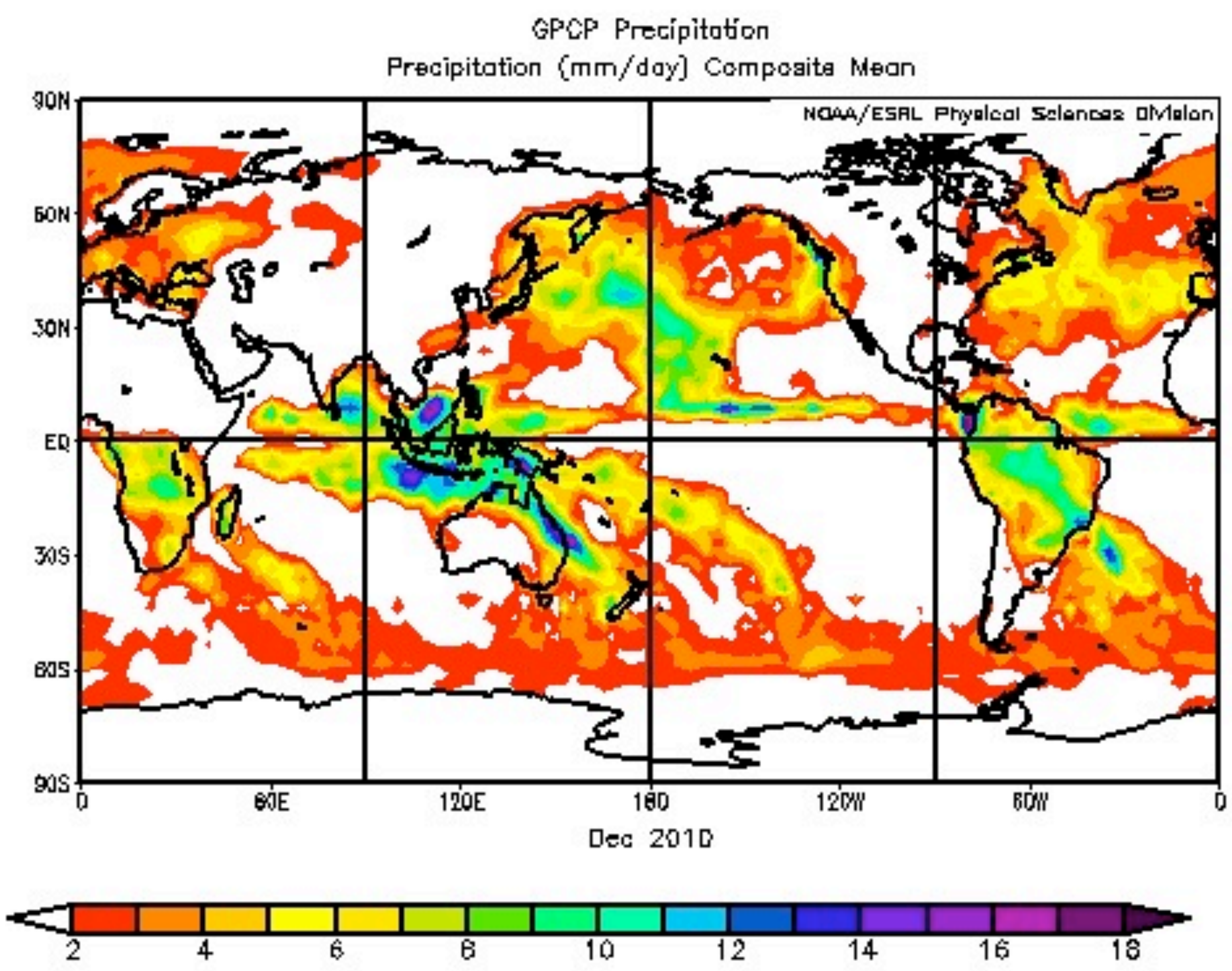
1. Constraint of large scale response variables

2. Optimal Parameter Search

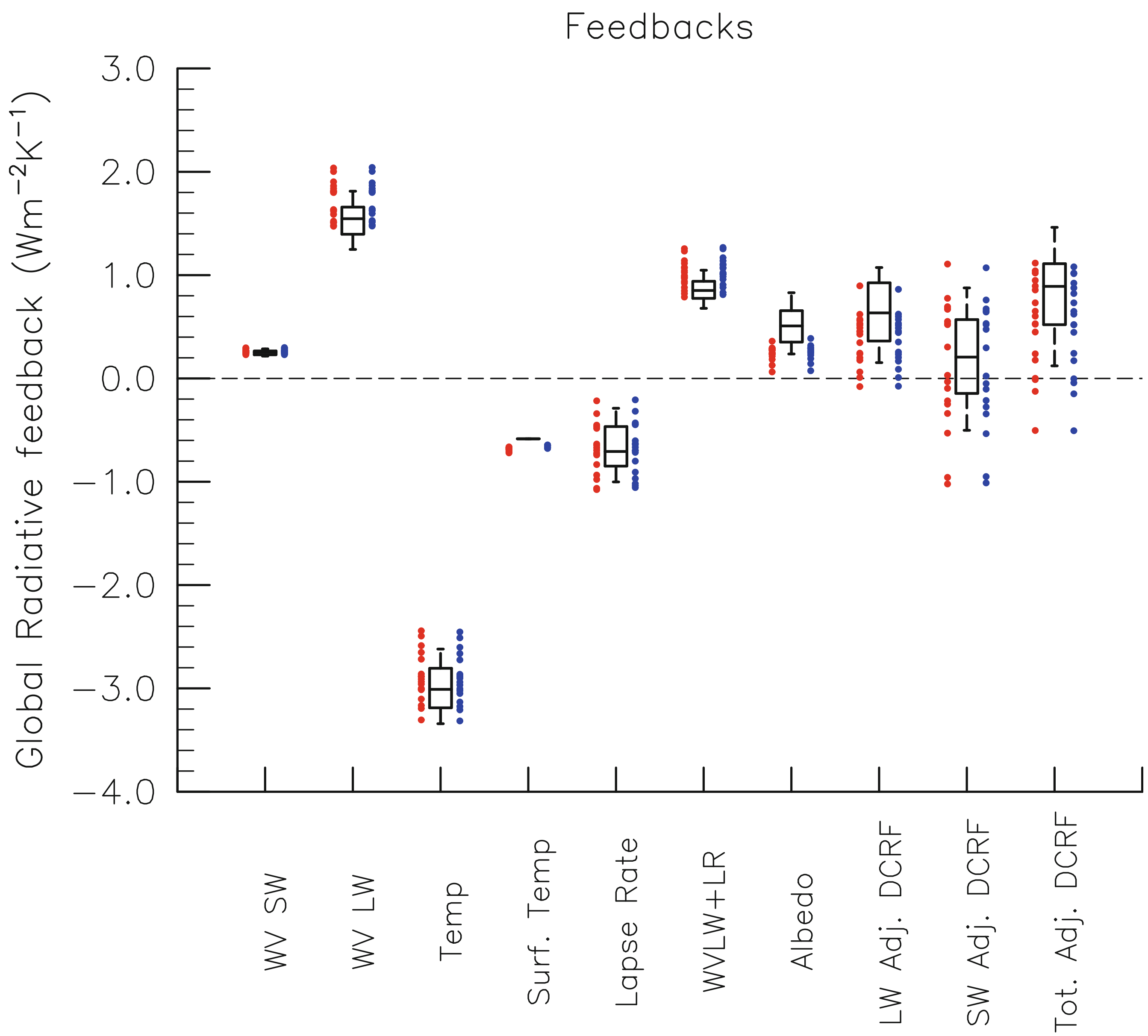


Jackson *et al* (2008)

1. Constraint of large scale response variables
2. Optimal Parameter Search
3. Specific variable optimization



1. Constraint of large scale response variables
2. Optimal Parameter Search
3. Specific variable optimization
3. Process / Feedback analysis



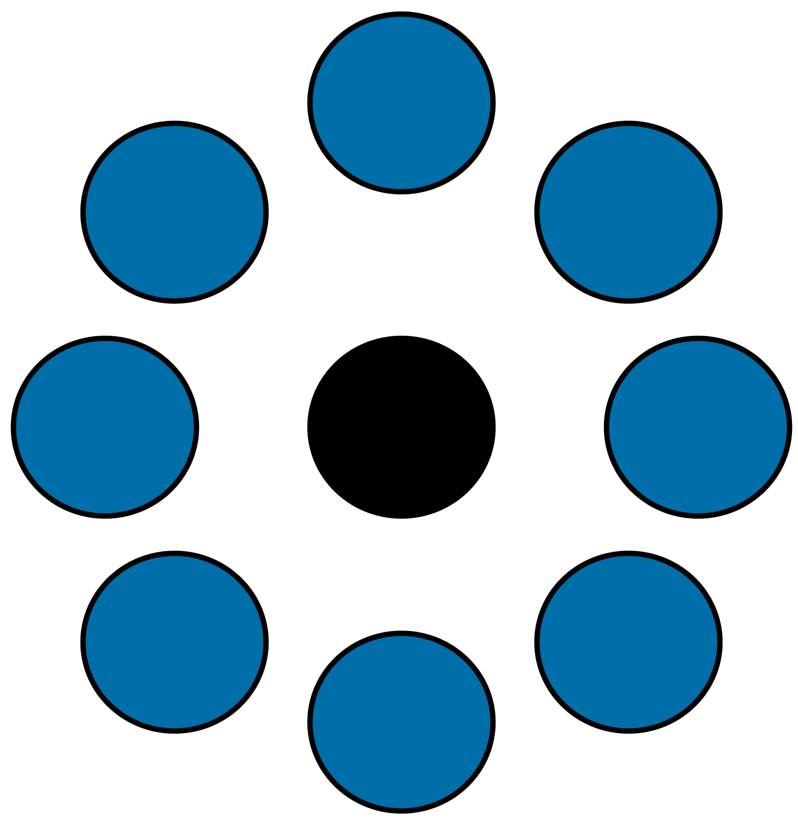
Sanderson *et al* (2010)

CAMcloud

perturbed physics ensemble

Aims:

- Small ensemble of 'plausible' models
- Representing systematic uncertainty in cloud feedbacks



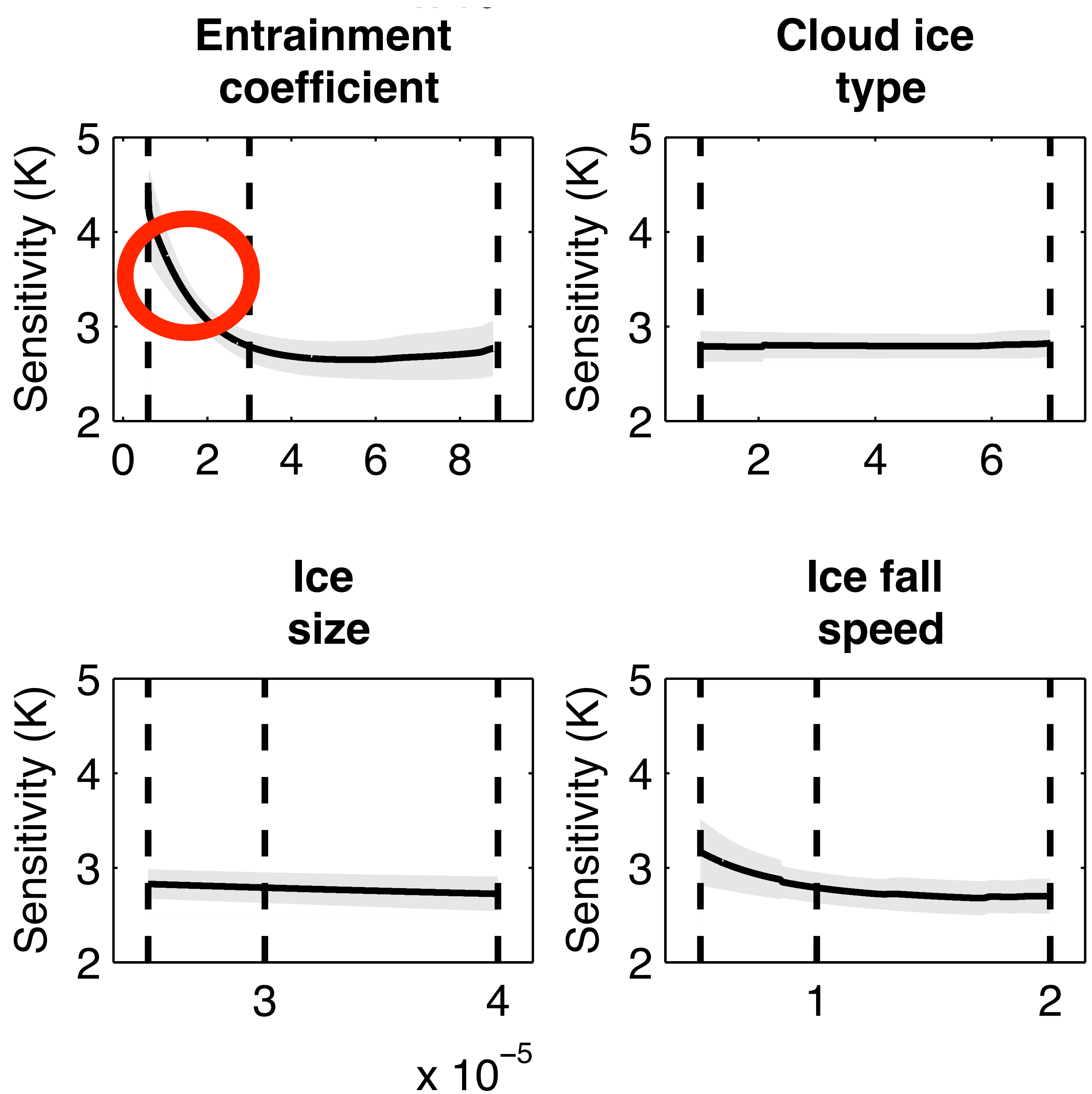
CAMcloud

proposed ensemble

- CAM5 physics
- 6 million hours CPU time
- Perturbations to cloud, microphysics and land surface parameters
- Stage I: Monte-Carlo sampling strategy (AMIP & 4XCO2)
- Stage II: Optimal ensemble (RCP)

Surrogate Models

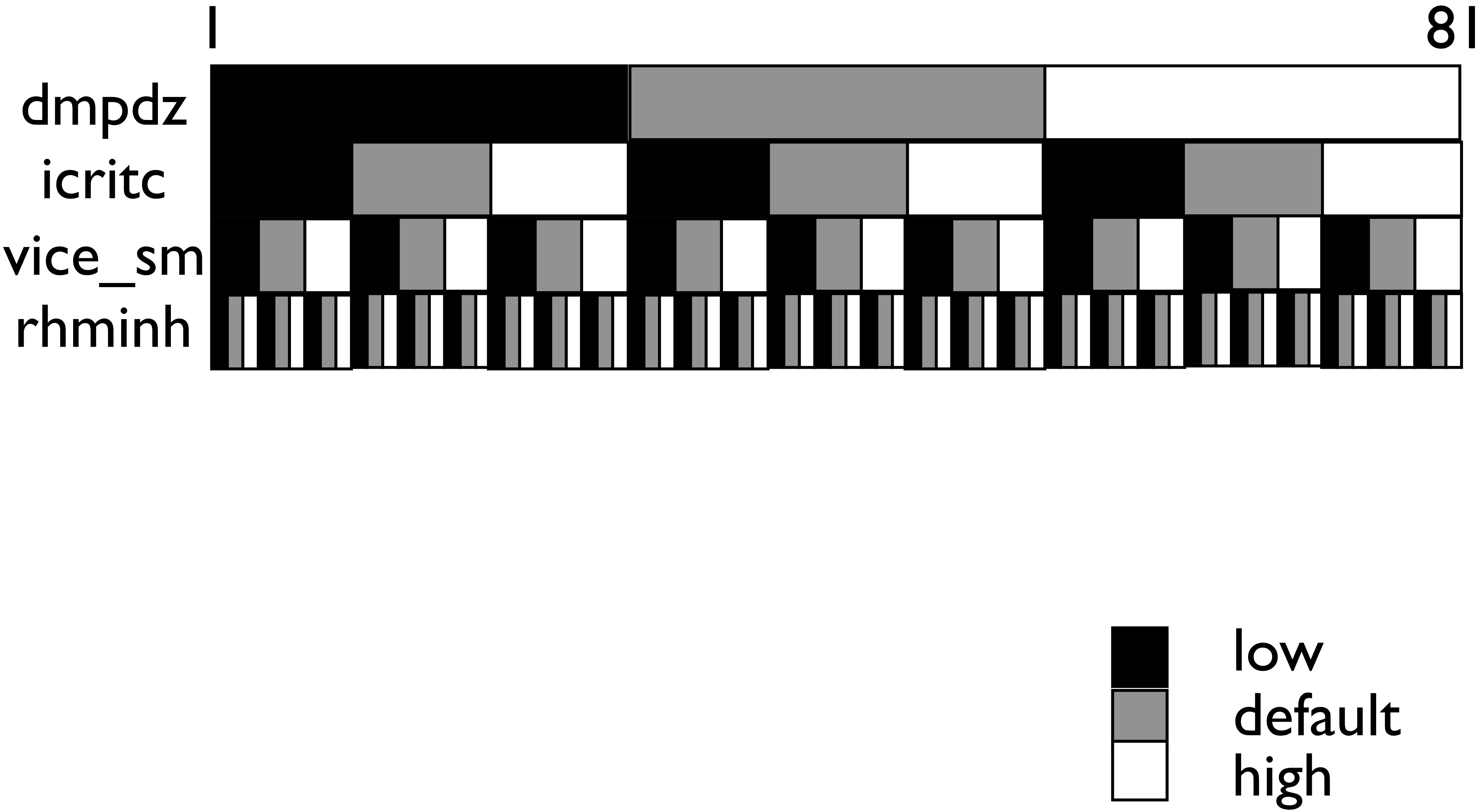
neural network approach



Sanderson *et al* (2008)

Surrogate Models

CAMcube example



The curse of dimensionality

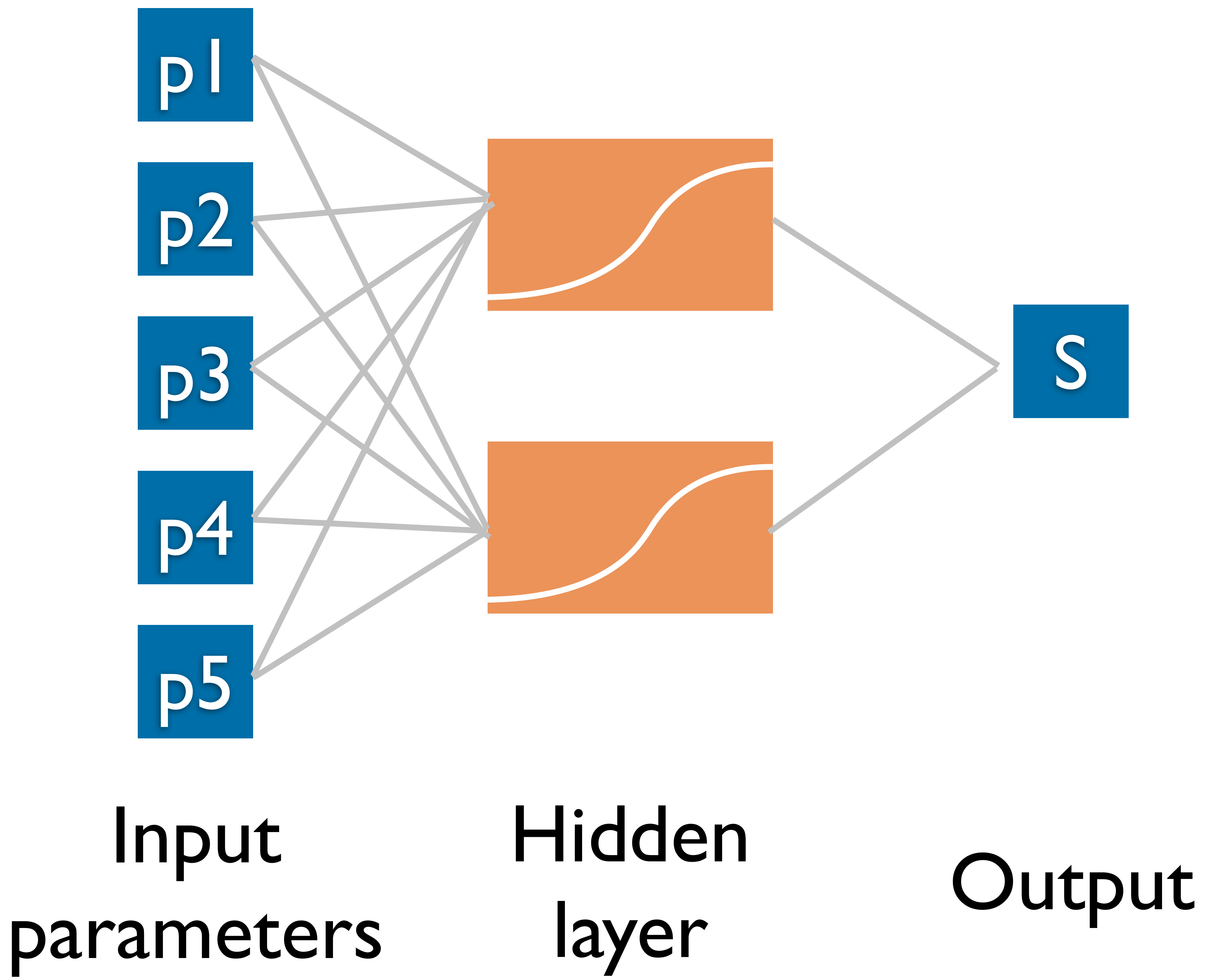
#	Variable Name	Range Low	Range Default	Range High	Description	Namelist Prefix	File Name (.F90)
1	rhminh^	0.65	0.80	0.85	Threshold RH for fraction of high stable clouds	cldfrc_	cloud_fraction
2	rhminl^	0.80	0.91	0.99	Threshold RH for fraction of low stable clouds	cldfrc_	cloud_fraction
3	rliqice	8.4	14.0	19.6	Effective radius of liq. cloud droplets over sea ice	cldopt_	pkg_cldoptics
4	rliqland	4.8	8.0	11.2	Effective radius of liquid cloud droplets over land	cldopt_	pkg_cldoptics
5	rliqocean	8.4	14.0	19.6	Effective radius of liquid cloud droplets over ocean	cldopt_	pkg_cldoptics
6	ice_stokes_fac^	0.25	0.50	1.00	Scaling factor applied to ice fall velocity	cldsed_	pkg_cld_sedimnent
7	capnc	30.0	150.0	155.0	Cloud particle num. density over cold land/ocean	cldwat_	cldwat
8	capnsi	10.0	75.0	100.0	Cloud particle number density over sea ice	cldwat_	cldwat
9	capnw	150.0	400.0	500.0	Cloud particle number density over warm land	cldwat_	cldwat
10	conke^	2.0e-6	5.0e-6	10.0e-6	Evaporation efficiency of stratiform precipitation	cldwat_	cldwat
11	icritc^	2.0e-6	9.5e-6	18.0e-6	Threshold for autoconversion of cold ice	cldwat_	cldwat
12	icritw^	1.0e-4	2.0e-4	10.0e-4	Threshold for autoconversion of warm ice	cldwat_	cldwat
13	r3lcrit	5.0e-6	10.0e-6	14.0e-6	Critical radius at which autocon. becomes efficient	cldwat_	cldwat
14	fac	10.0	100.0	200.0	ustar parameter in PBL height diagnosis	hbdiff_	hb_diff
15	fak	4.25	8.50	17.00	Constant in surface temperature excess	hbdiff_	hb_diff
16	ricr	0.1	0.3	1.0	Critical Richardson number for boundary layer	hbdiff_	hb_diff
17	betamn	0.02	0.10	0.30	Minimum overshoot parameter	hkconv_	hk_conv
18	c0^	0.3e-4	1.0e-4	2.0e-4	*Shallow* convection precipitation efficiency	hkconv_	hk_conv
19	cmftau^	900.0	1800.0	14400.0	Time scale for consumption rate of shallow CAPE	hkconv_	hk_conv
20	sgh_scal_fac	0.8	1.0	1.2	Land roughness scaling factor	physpkg_	physpkg
21	alfa	0.05	0.10	0.60	Initial cloud downdraft mass flux	zmconv_	zm_conv
22	c0_lnd^	1.0e-3	3.5e-3	6.0e-3	*Deep* convection precipitation efficiency over land	zmconv_	zm_conv
23	c0_ocn^	1.0e-3	3.5e-3	6.0e-3	*Deep* convec. precipitation efficiency over ocean	zmconv_	zm_conv
24	capelmt	20.0	70.0	200.0	Threshold value for CAPE for deep convection	zmconv_	zm_conv
25	dmpdz	-2.0e-3	-1.0e-3	-0.2e-3	Parcel fractional mass entrainment rate	zmconv_	zm_conv
26	ke^	0.5e-6	1.0e-6	10.0e-6	Environmental air entrainment rate	zmconv_	zm_conv
27	tau	1800.0	3600.0	28800.0	Time scale for consumption rate of deep CAPE	zmconv_	zm_conv
28	cdn_scal_fac	0.8	1.0	1.2	Ocean roughness scaling factor	(drv_in)	shr_flux_mod
29	z0m_scal_fac	0.8	1.0	1.2	Mois. & heat resistance to vegetation scaling factor	(lnd_in)	Biogeophysics1Mod

27 parameters, 3 values each

$7.62559748 \times 10^{12}$ simulations

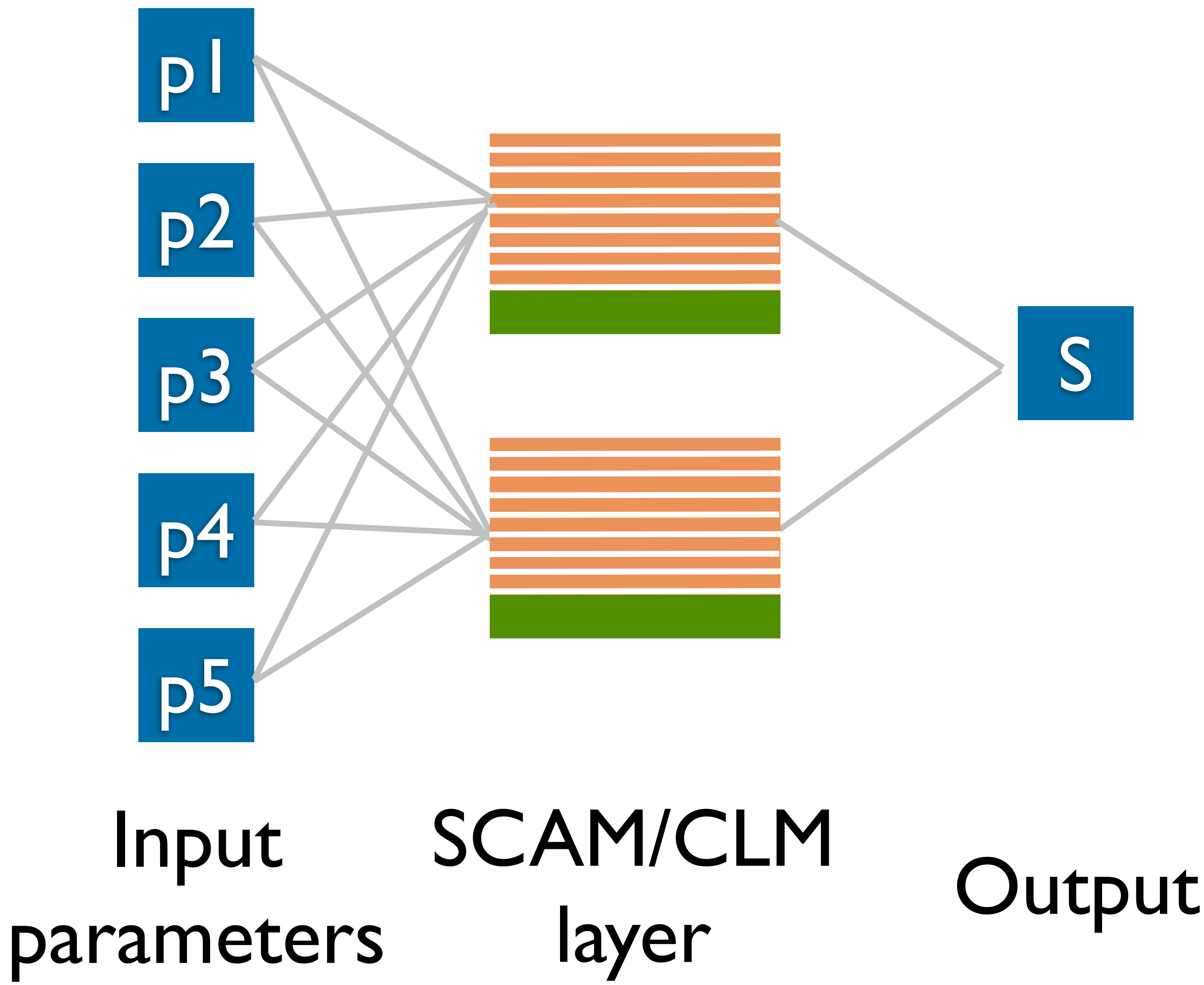
Surrogate Models

neural network approach



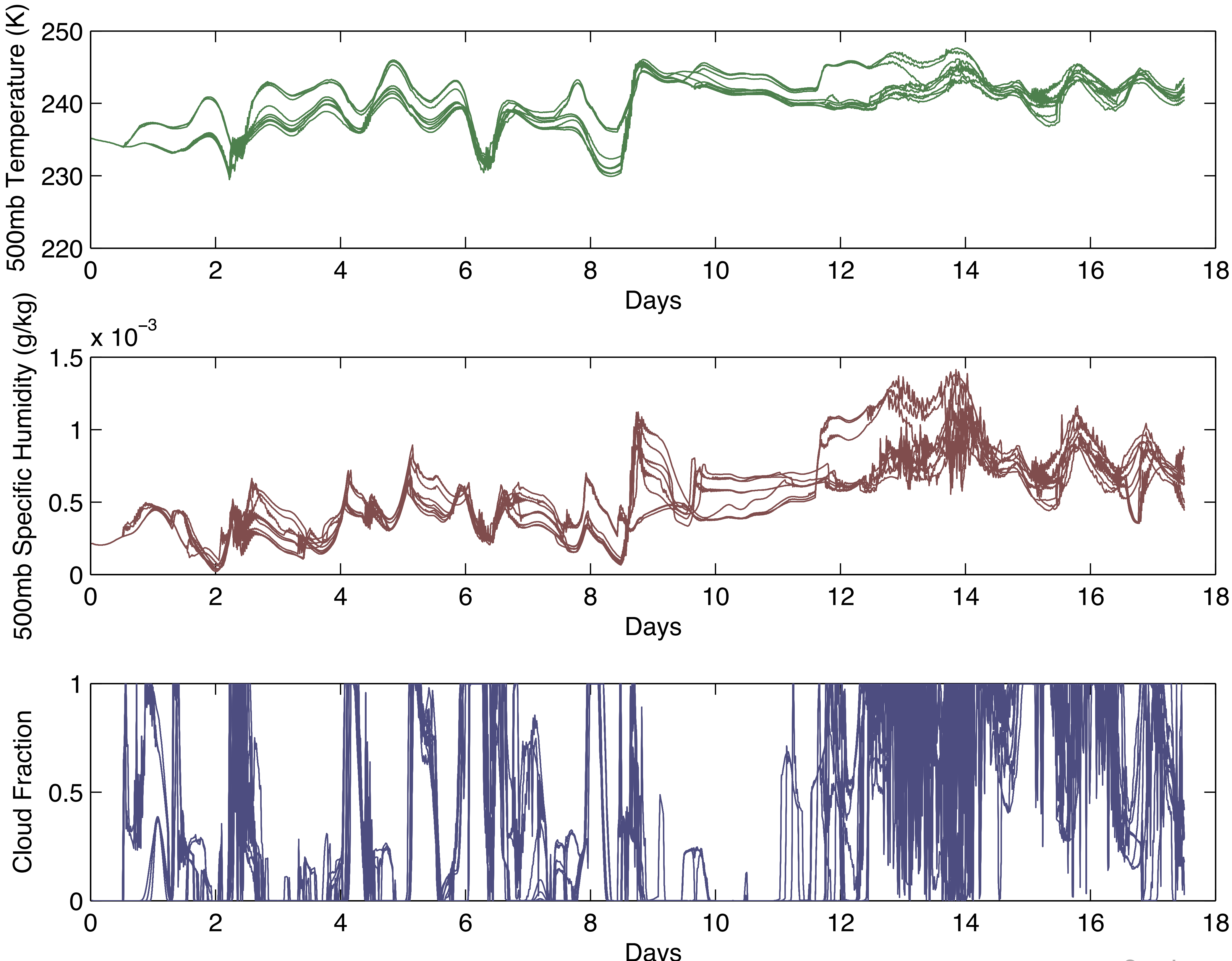
Surrogate Models

semi-empirical approach



SCAMcube

a demonstration



Sanderson *et al* (in prep)

SCAMcube

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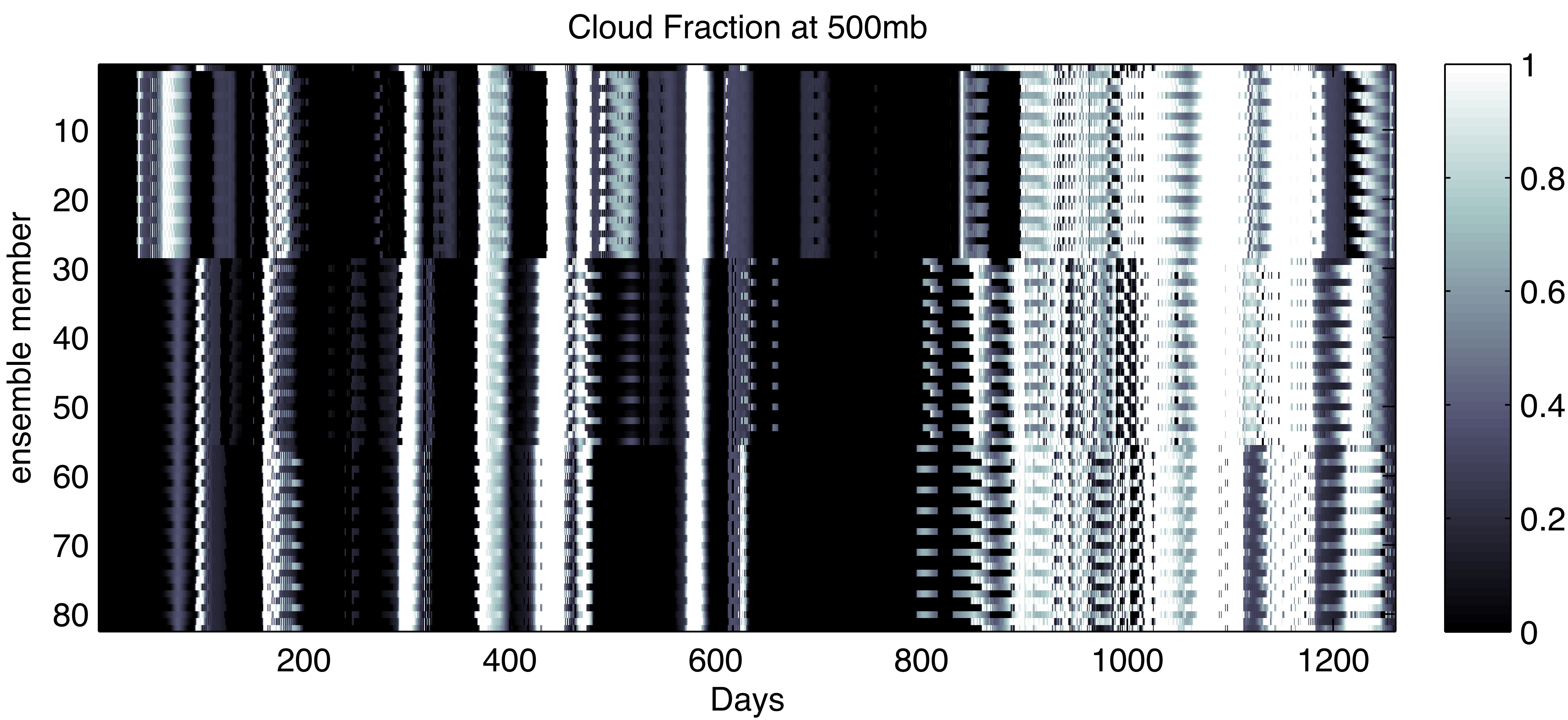

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SCAMcube

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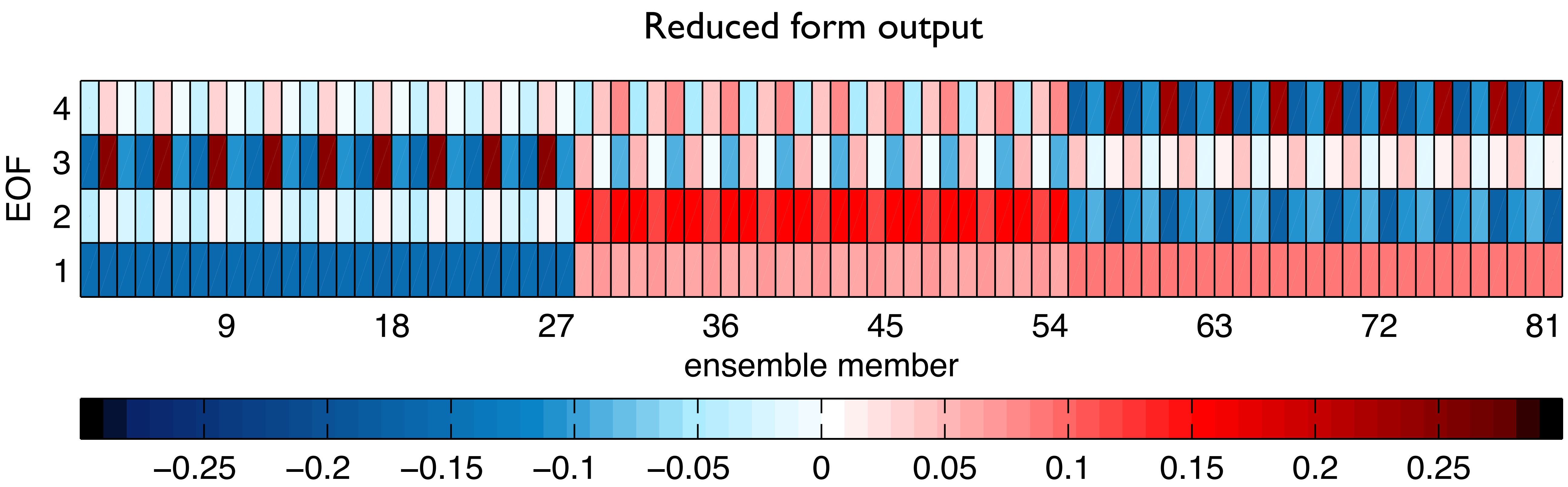
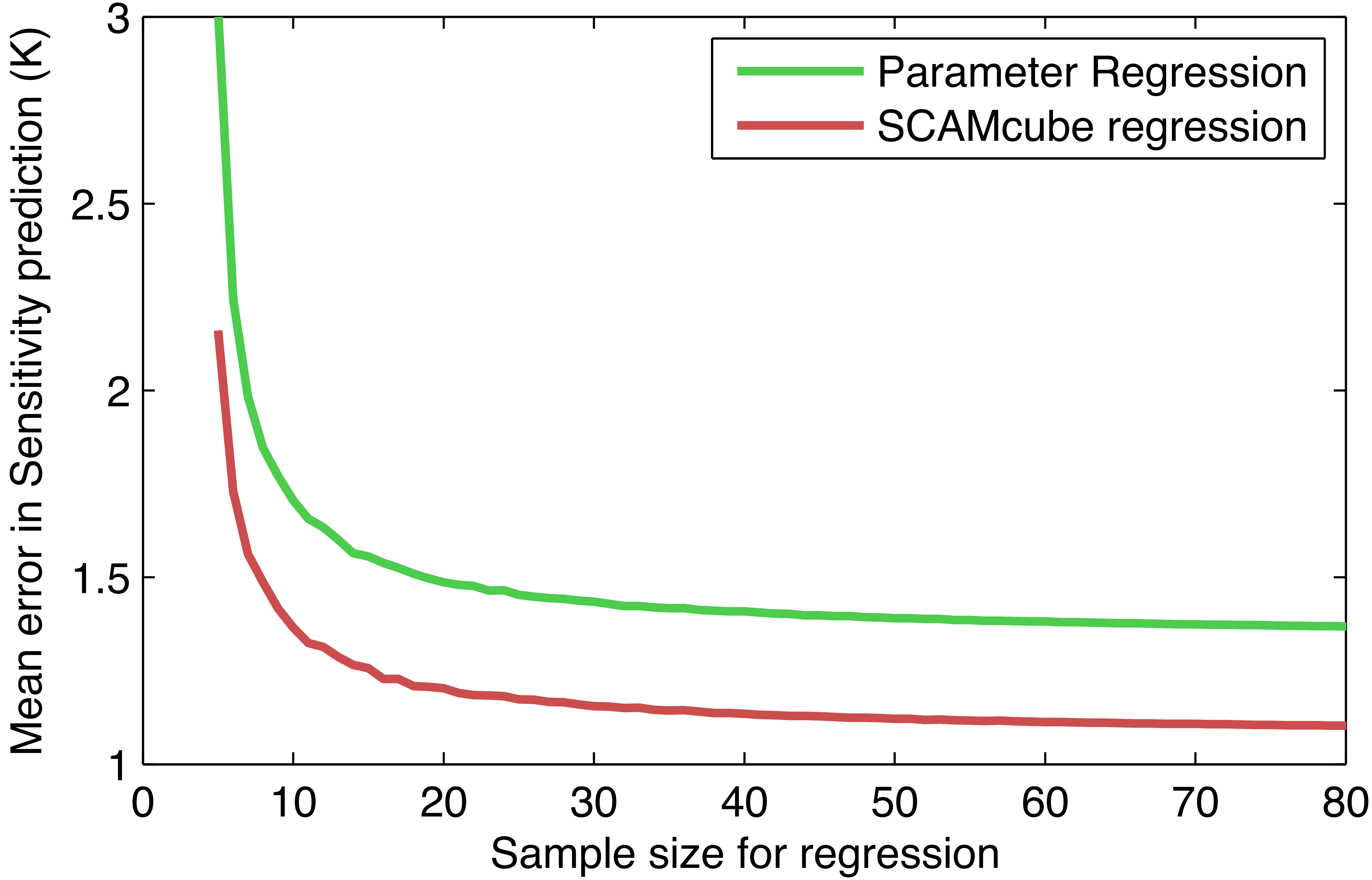
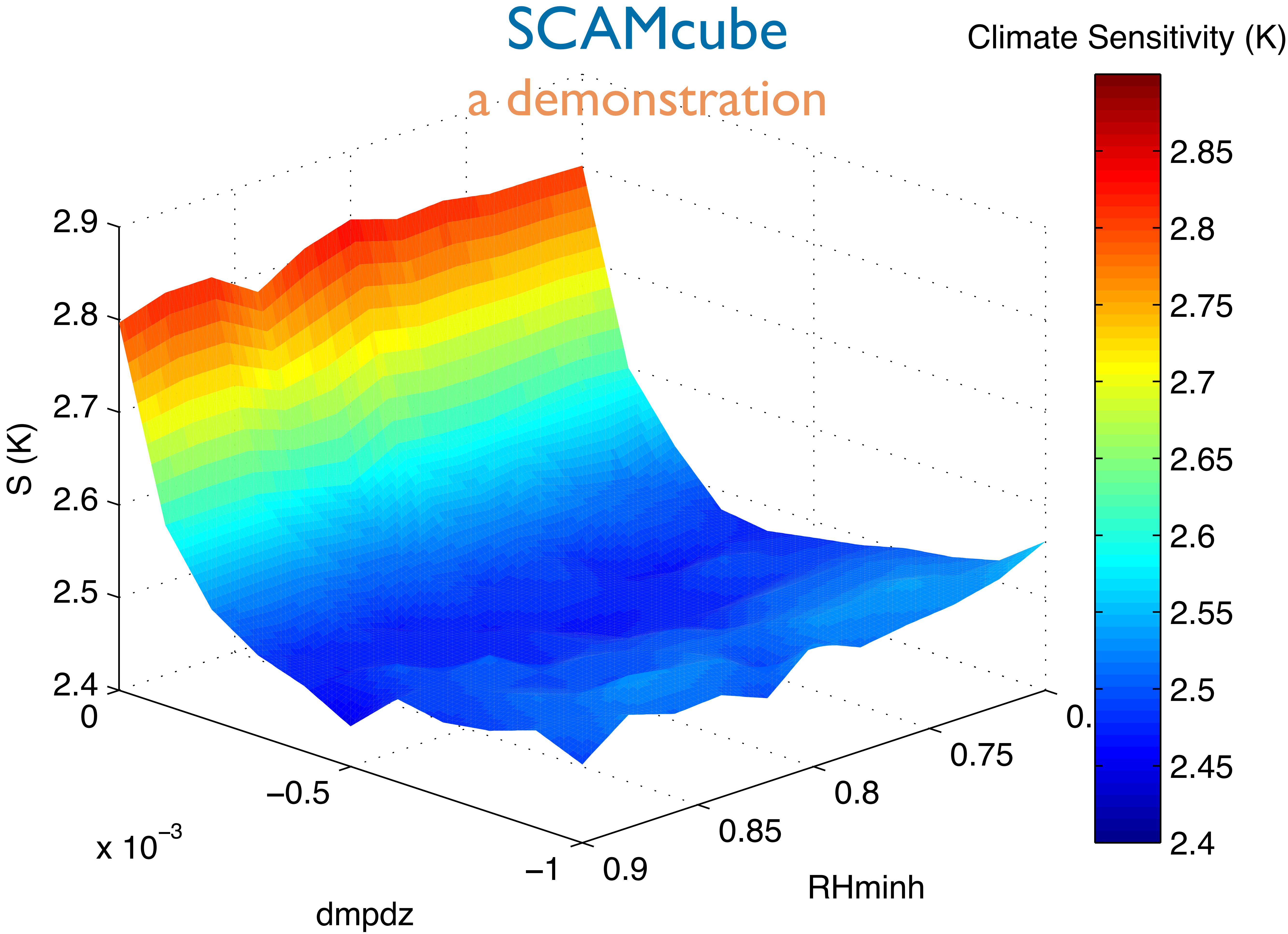


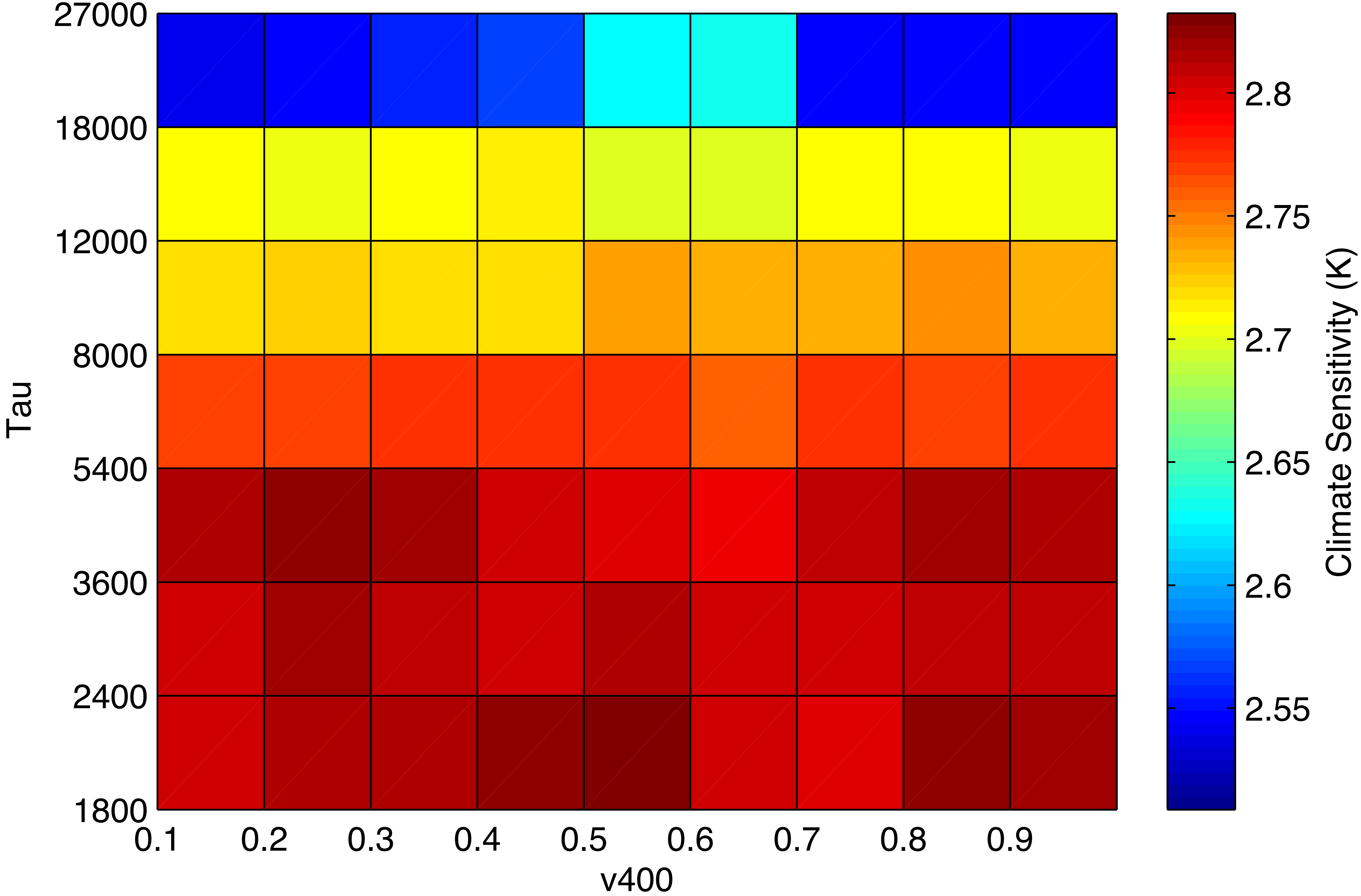
SCAMcube
a demonstration



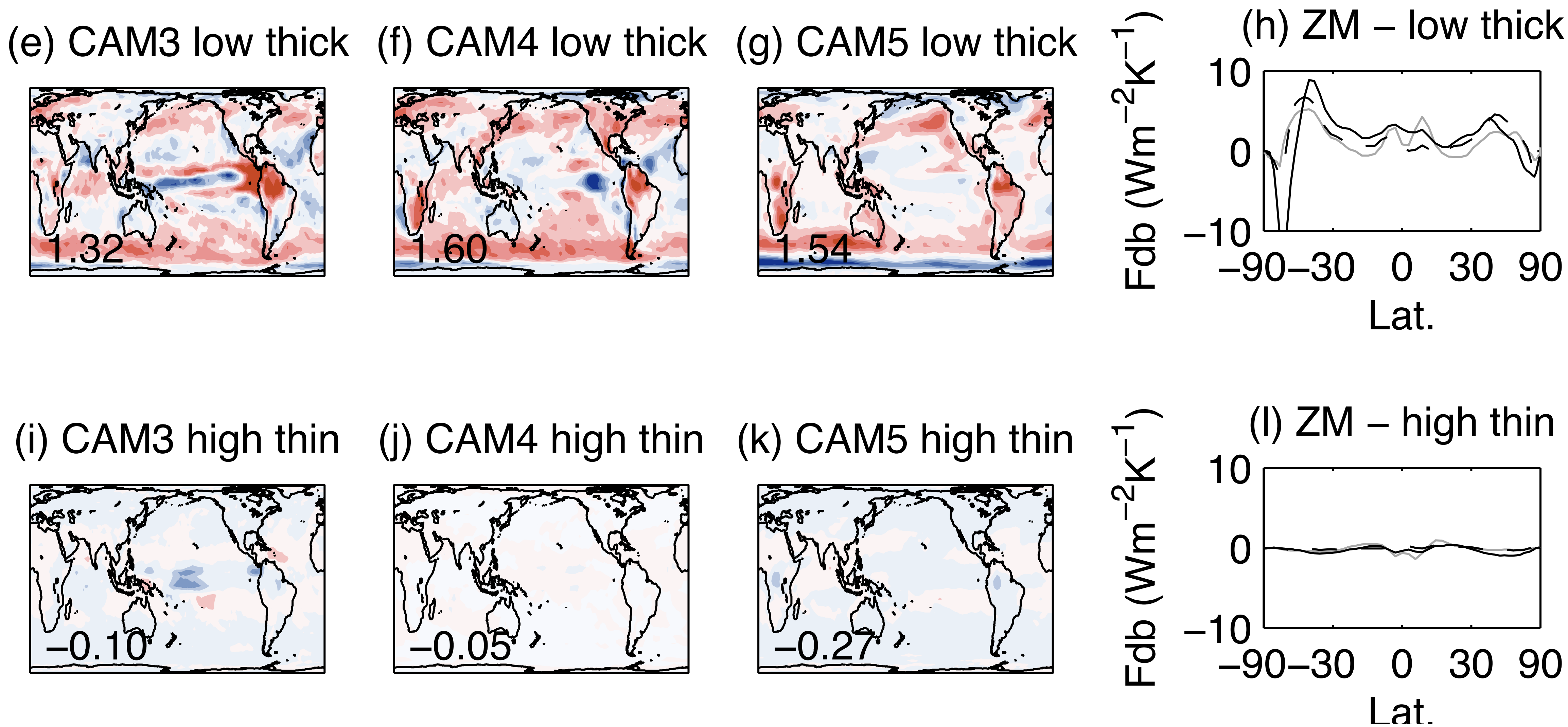

SCAMcube
a demonstration
Climate Sensitivity (K)
2.85
2.8
2.75
2.7
2.65
2.6
2.55
2.5
2.45
2.4
S (K)
2.9
2.8
2.7
2.6
2.5
2.4
0
−0.5
−1
x 10−3
dmpdz
0.9
0.85
0.8
0.75
0.
RHminh

SCAMcube

breaking the curse?



Cloud Feedback calculations



Sanderson and Shell (submitted)

Completed:

- Single variable, single SCAM neuron

CAMcloud:

- Multivariate emulation (focus on COSP output)
- Multiple SCAM neurons in different climatic regimes

Distant Future

- CLM neurons for land model emulation

CAMcloud

proposed ensemble

1 - Initial ensemble, AMIP & 4XAMIP w. COSP output
2 - large Semi-empirical surrogate ensemble
3 - Optimize surrogate for each CFMIP member, determine errors in cloud feedback estimates
4 - Optimize surrogate for observations.
5 - Optimal ensemble (RCP, flux corrected):
   - Skill score
   - Model diversity (clustering)
   - Representative Feedback spread

CAMcloud

proposed ensemble

Timeline

- April/May 2012 - proposal evaluation
- Summer-Fall 2012 - Initial AMIP ensemble
- Fall-??? - Optimal ensemble available