Aerosols as drivers of precipitation change

A PDRMIP multi-model study

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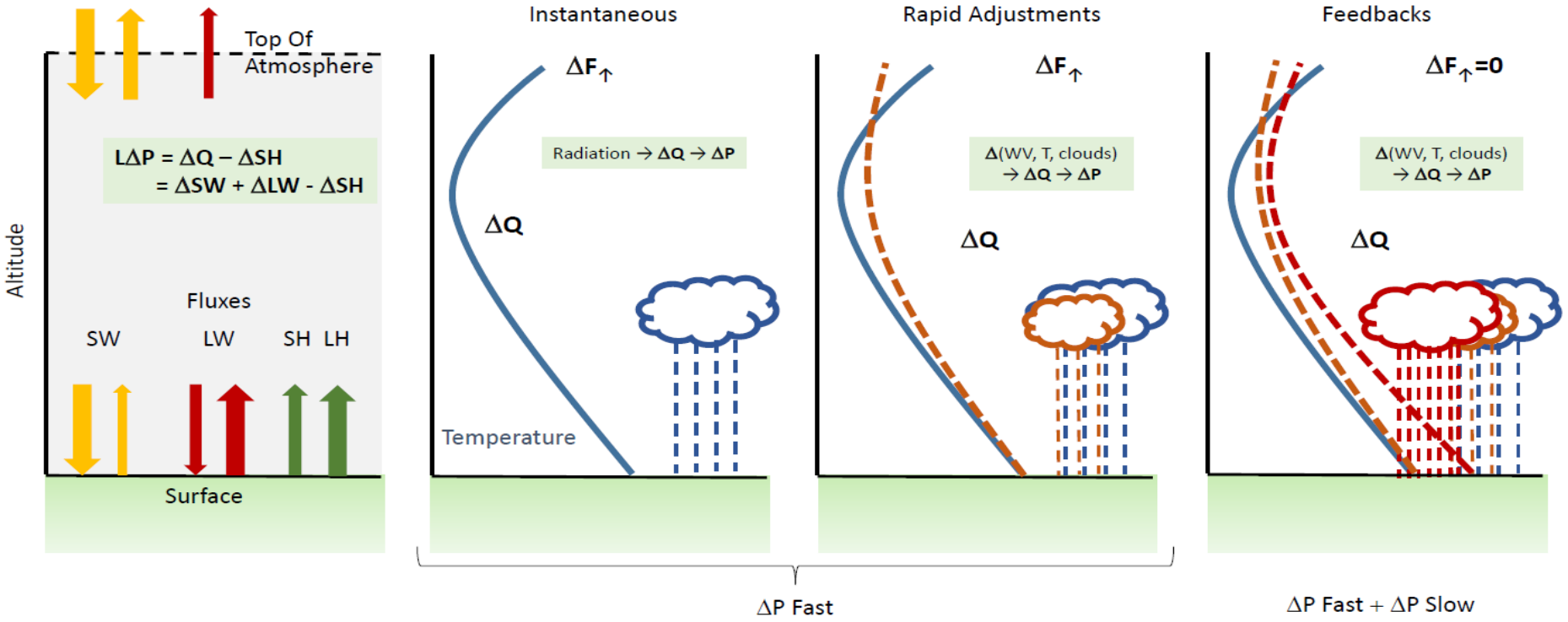
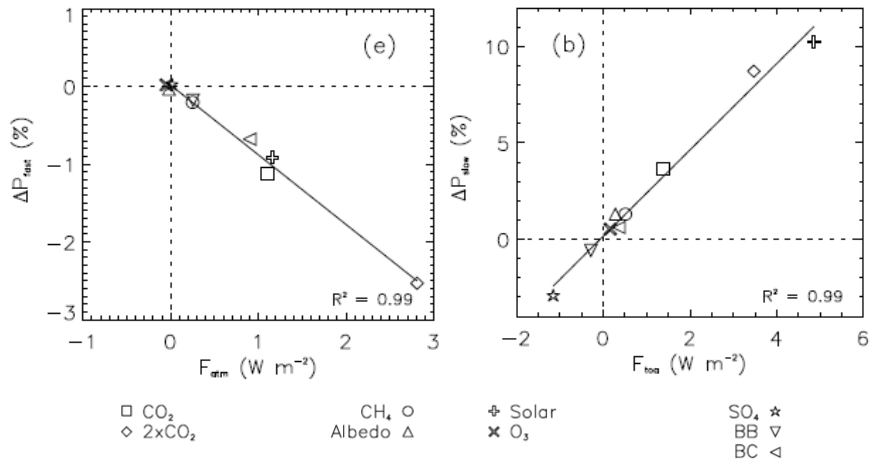


Myhre et al., BAMS, in revision

Broadly, independently of the driver,

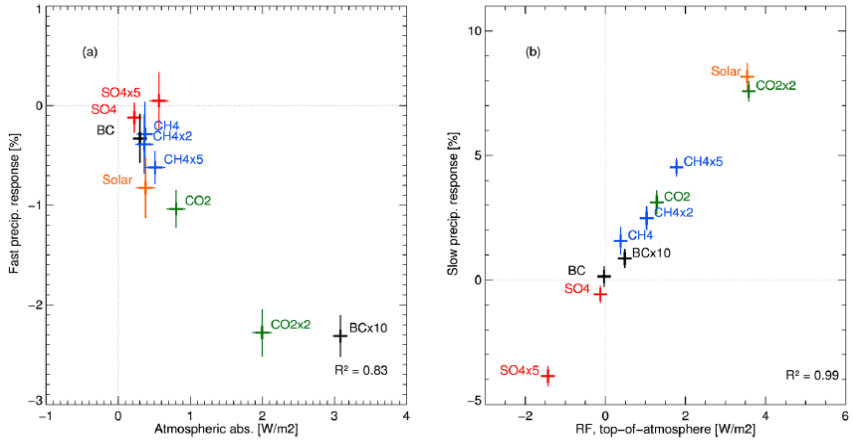
Andrews et al. (2010)



fast precipitation changes (dP_{fast})
scale with the atmospheric absorption

while

Kvalevåg et al. (2013)



slow precipitation changes (dP_{slow})
scale with the surface temperature change

PDRMIP

Precipitation Driver Response Model Intercomparison Project

Experiment Design

PDRMIP core experiments

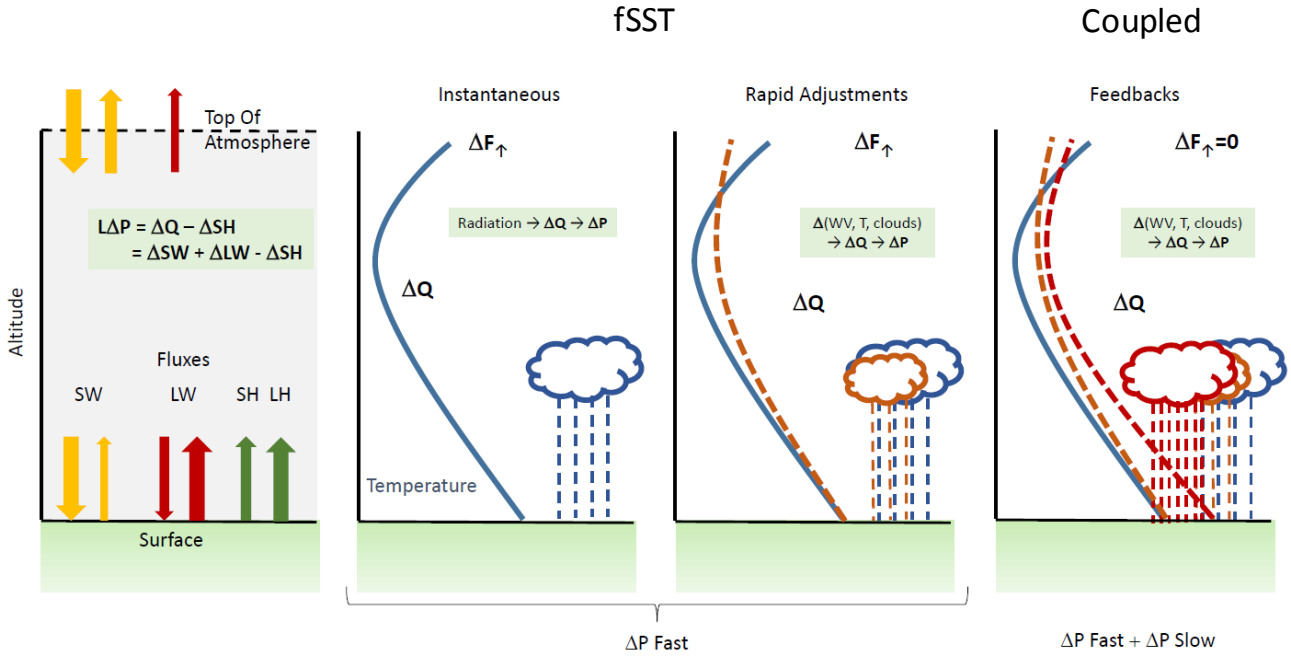
Name	Description	Fixed-SST Nyears	Slab/full ocean Nyears (all output)
Base	Specified present day CO_2, CH_4, solar constant, aerosol concentration	15	100
CO2 x 2	CO_2 from PDC to 2xPDC	15	100
CH4 x 3	CH_4 from PDC to 3xPDC	15	100
Solar	Solar constant increased by 2%	15	100
Sul	Sulphate concentration from PDC to 5xPDC	15	100
BC	BC concentration from PDC to 10xPDC	15	100

PDC – Present day concentration

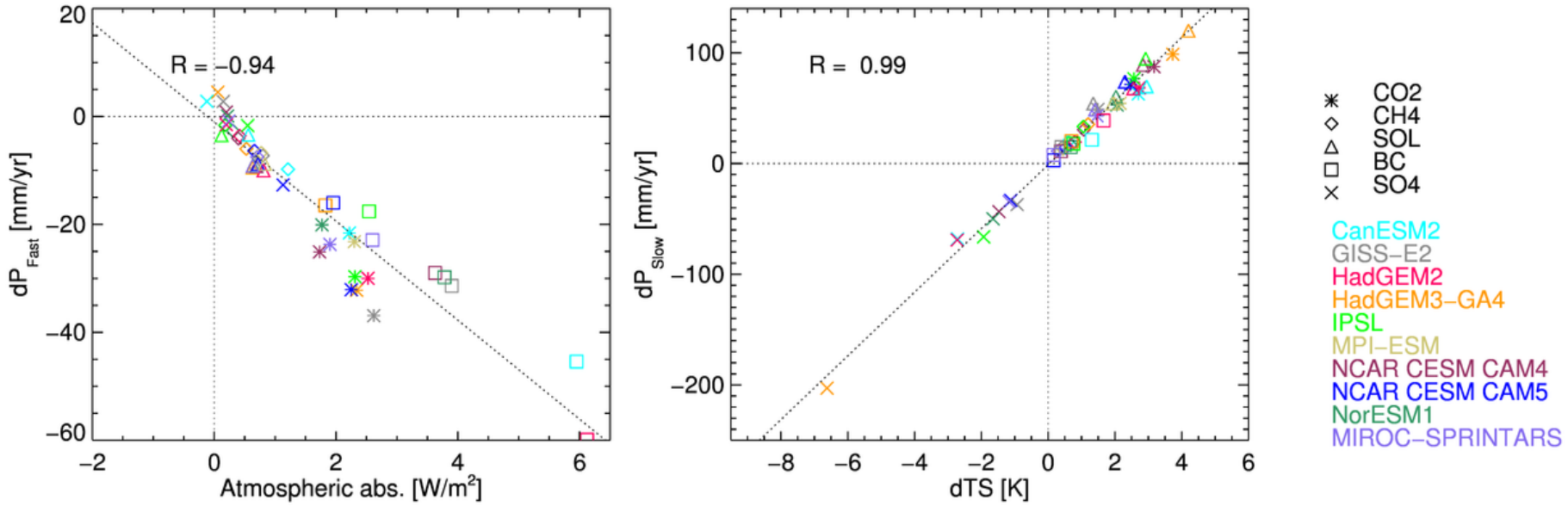
CanESM2
GISS-E2
HadGEM2
HadGEM3-GA4
IPSL
MPI-ESM
NCAR CESM CAM4
NCAR CESM CAM5
NorESM1
MIROC-SPRINTARS

PDRMIP diagnostics

- ERF: Gregory regression (coupled) and fSST
- $dP_{slow} = dP_{total}^{coupled} - dP_{fast}^{fSST}$

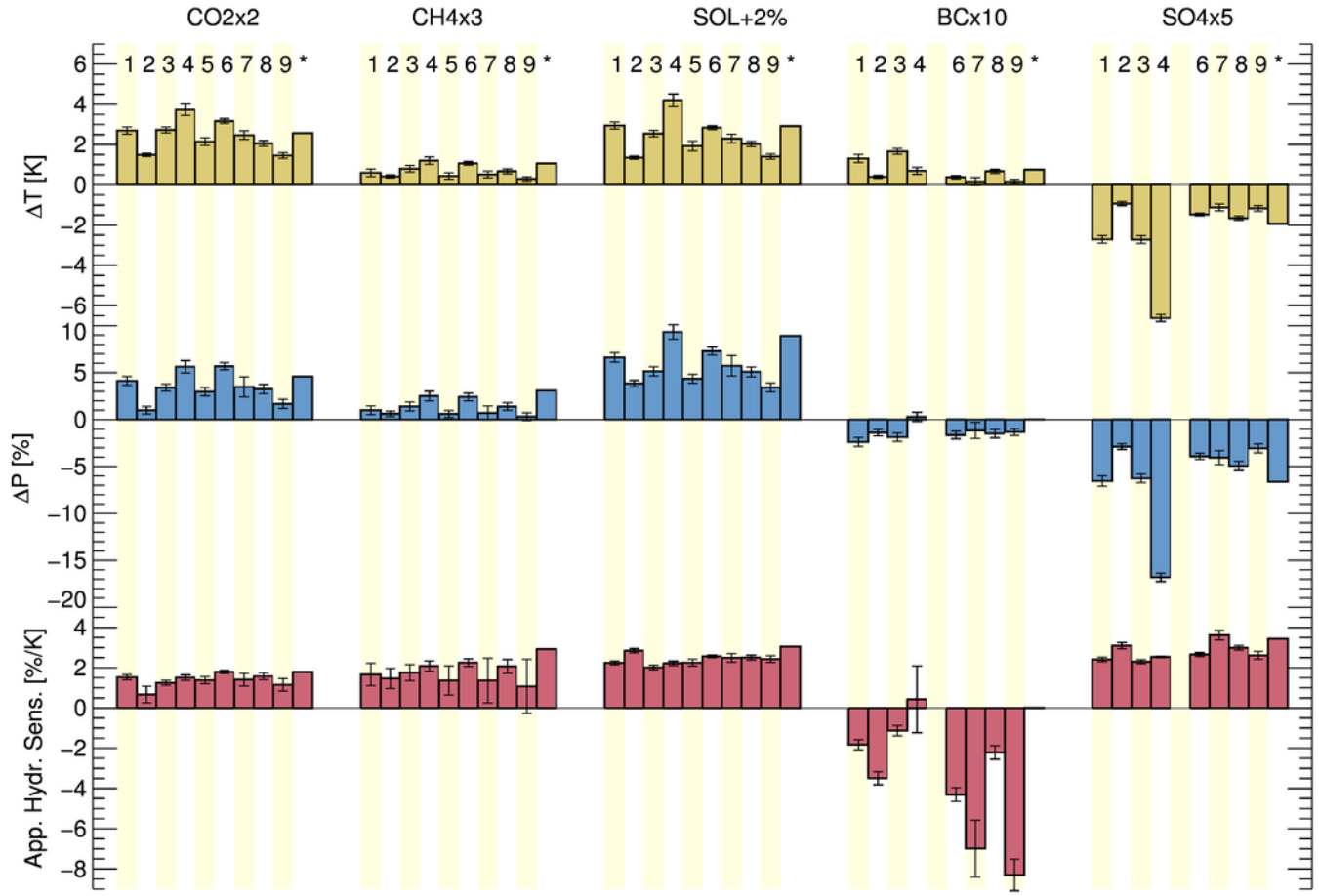


The broad scaling holds for the model ensemble



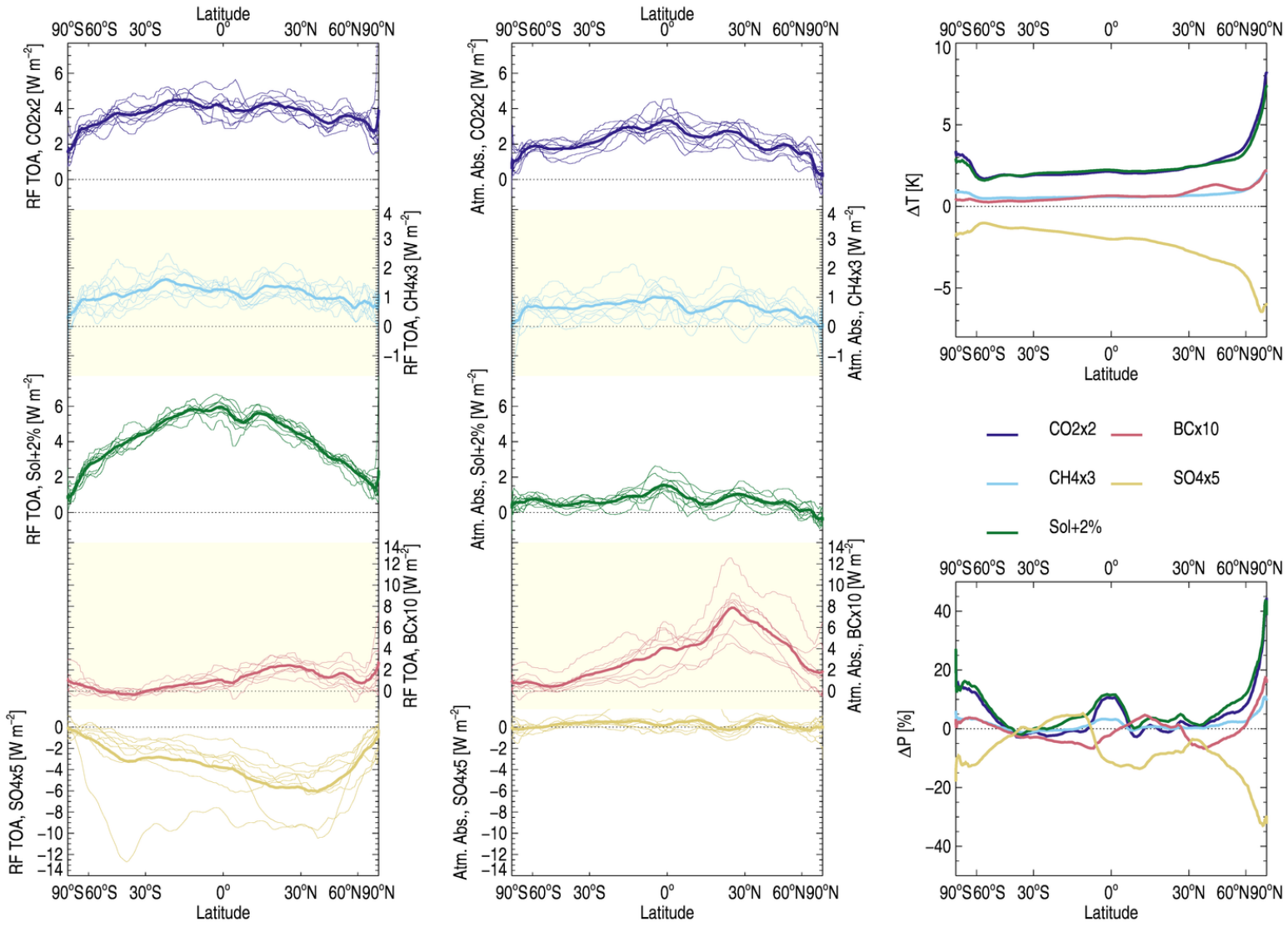
Samset et al., GRL, 2016

Global mean responses: dT, dP and HS



Samset et al., GRL, 2016

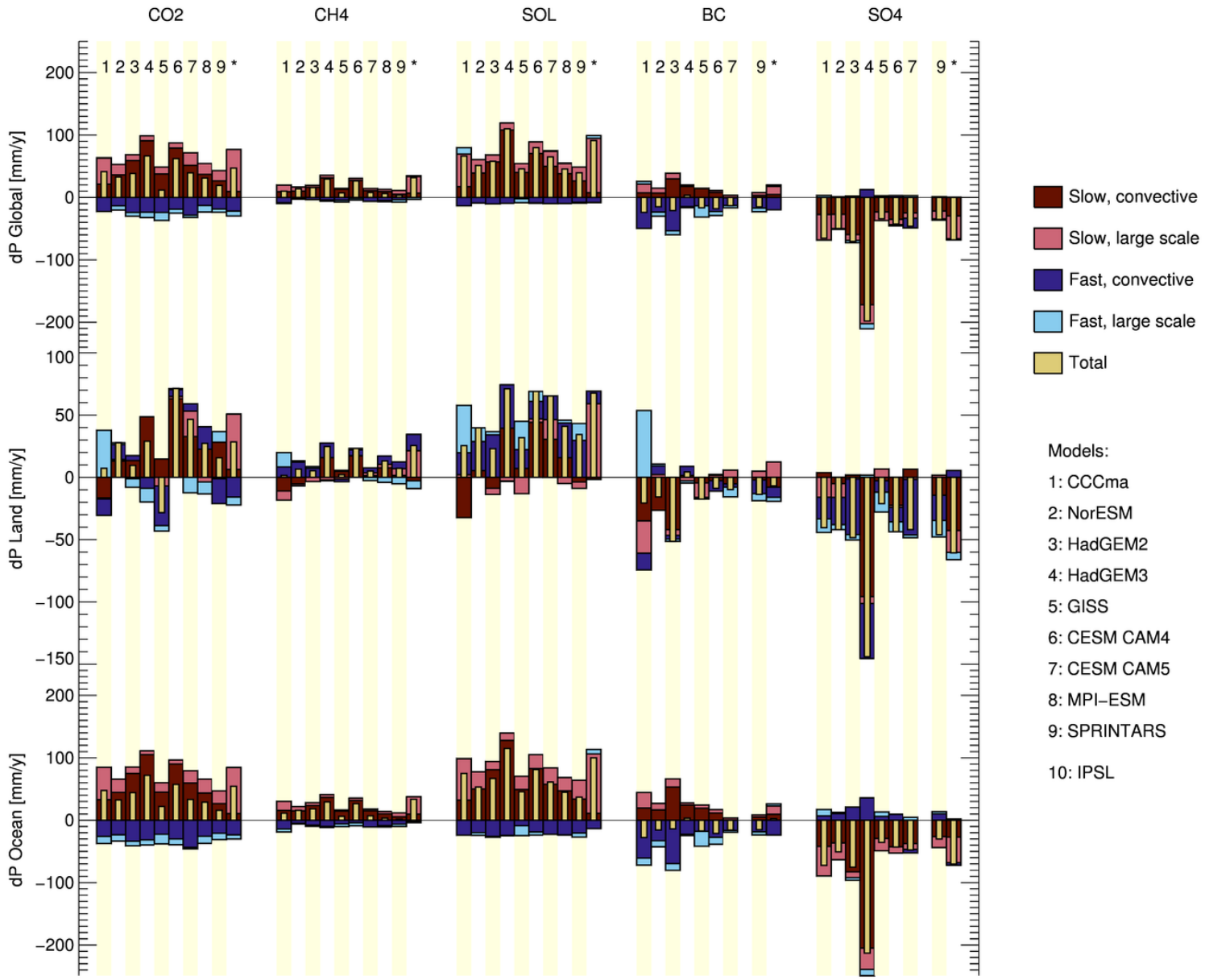
Effective radiative forcing, atmospheric abs., and zonal mean dT and dP responses



Myhre et al., BAMS, in revision

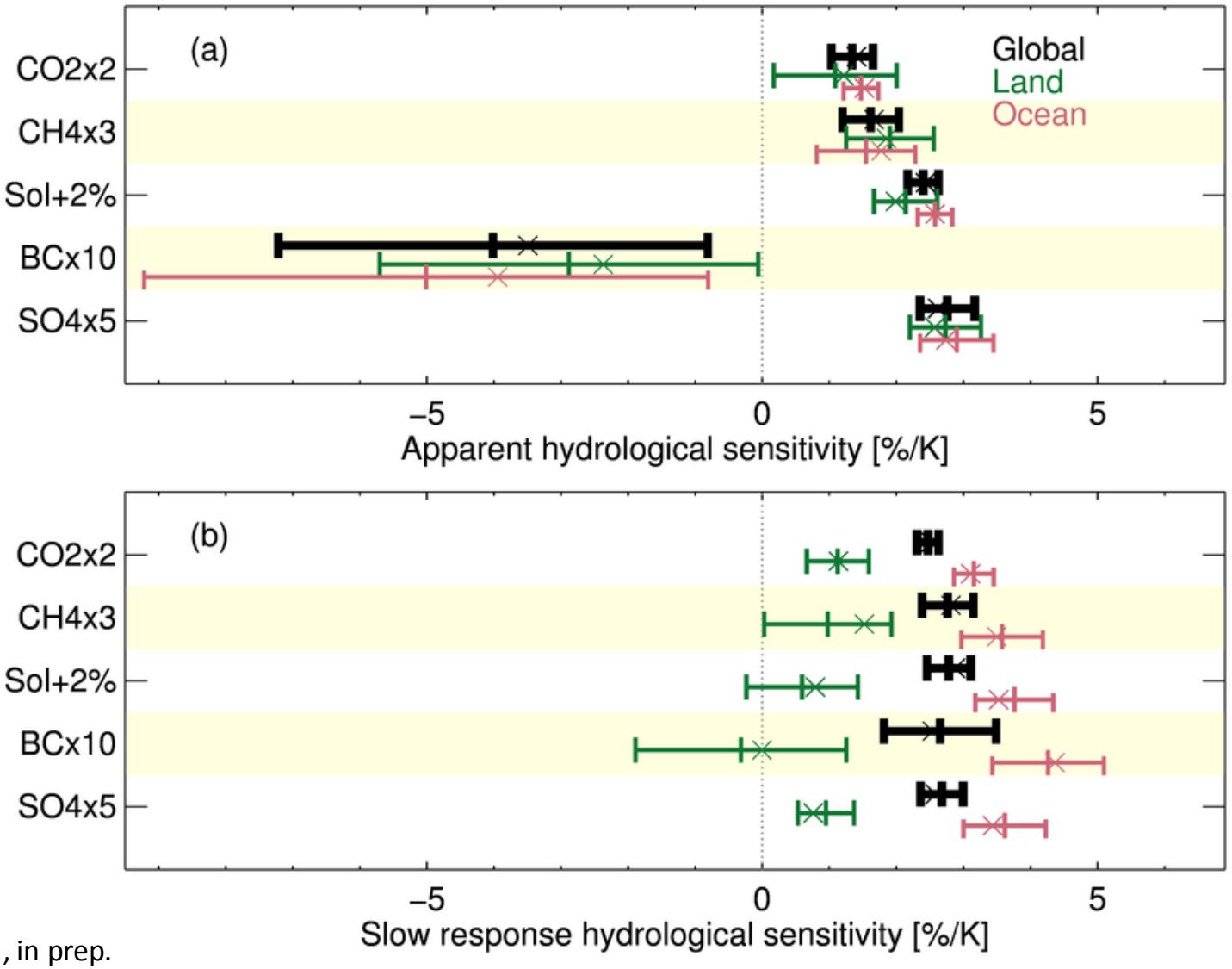
Decomposing the precipitation response into

- Driver
- Fast vs slow
- Land vs ocean
- Convective vs large scale



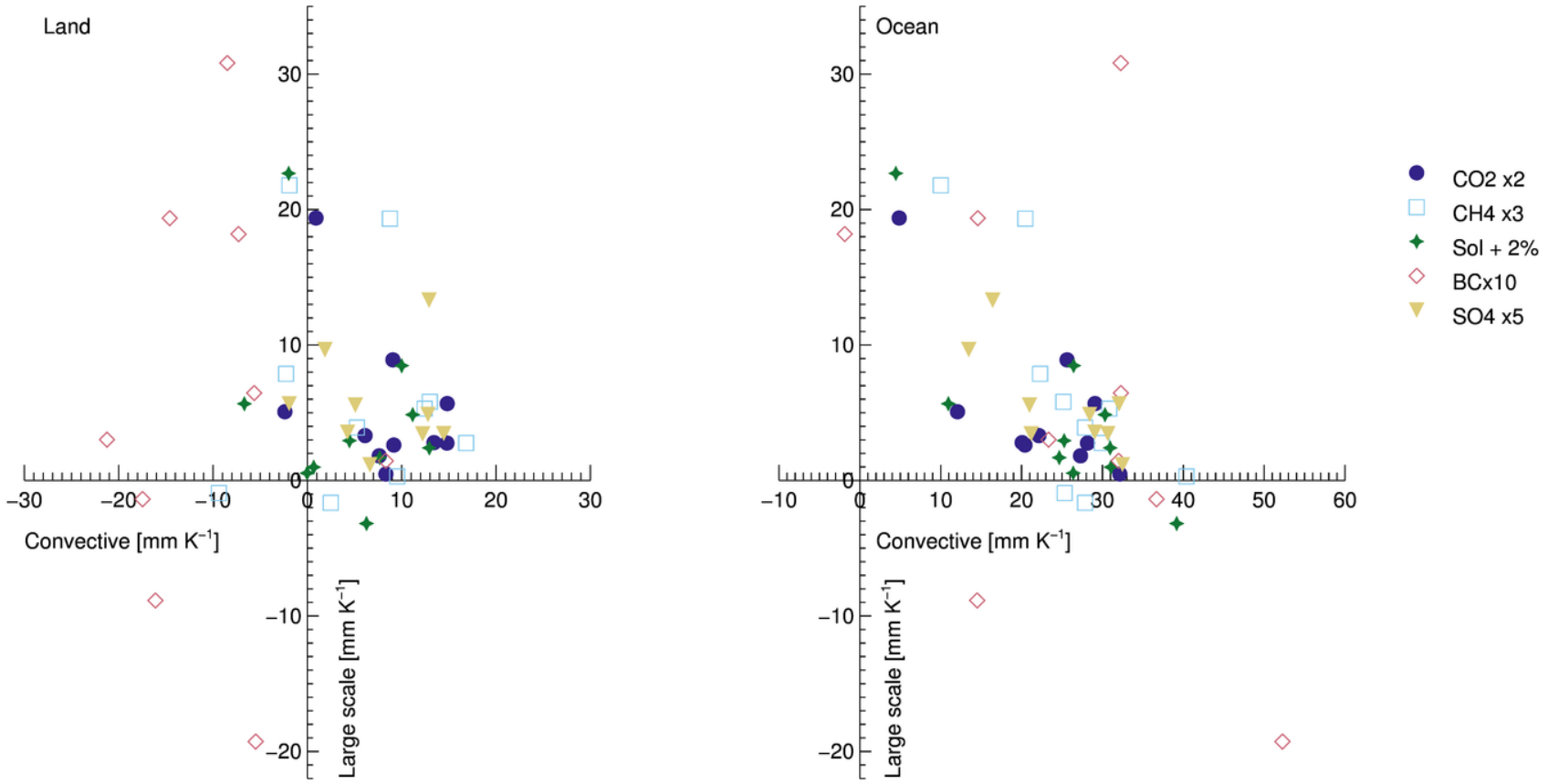
Samset et al., in prep.

Apparent vs slow hydrological sensitivites



Samset et al., in prep.

Slow hydrological response per cloud type



Samset et al., in prep.

Upcoming PDRMIP studies

- Hydrological sensitivities
- Extreme precipitation
- Energy budget view on precipitation change
- Black carbon special study
- Regional aerosol perturbation studies (Asia, Europe)
- …

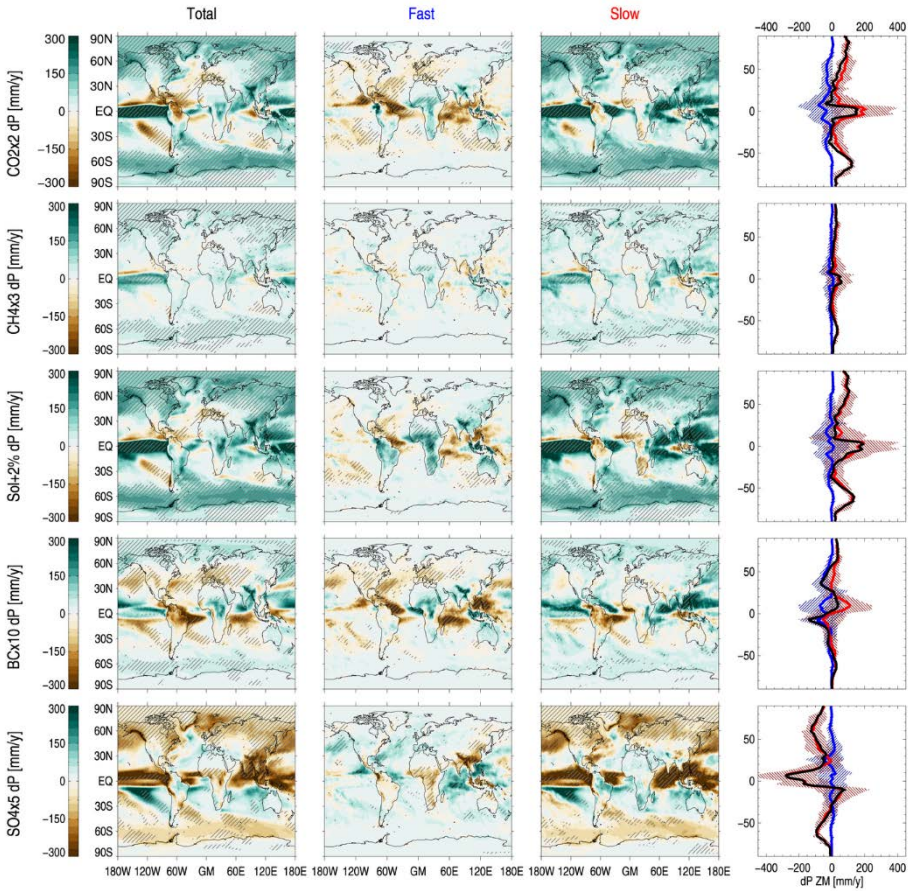
Want access to the simulations? They're freely available through the NORSTORE data storage facility. Procedure: http://www.cicero.uio.no/en/PDRMIP

or email <b.h.samset@cicero.oslo.no>

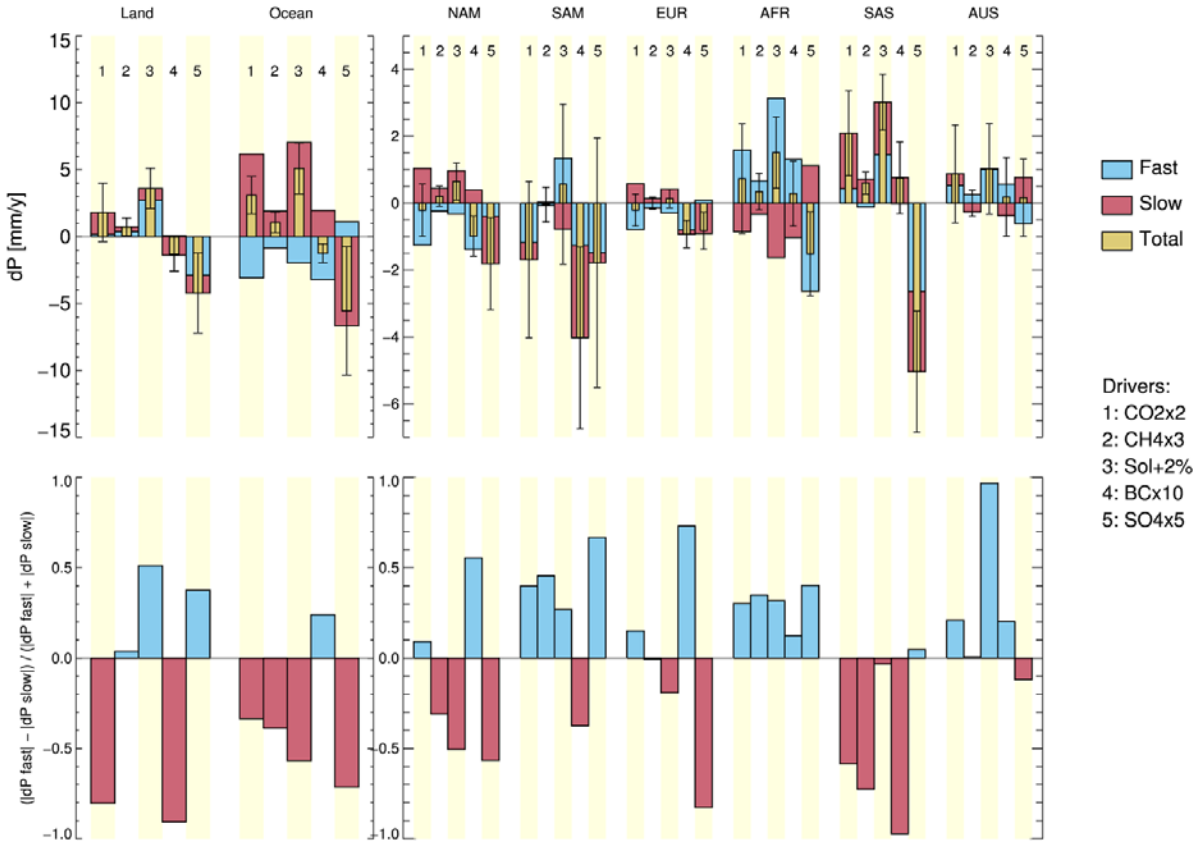
Conclusions

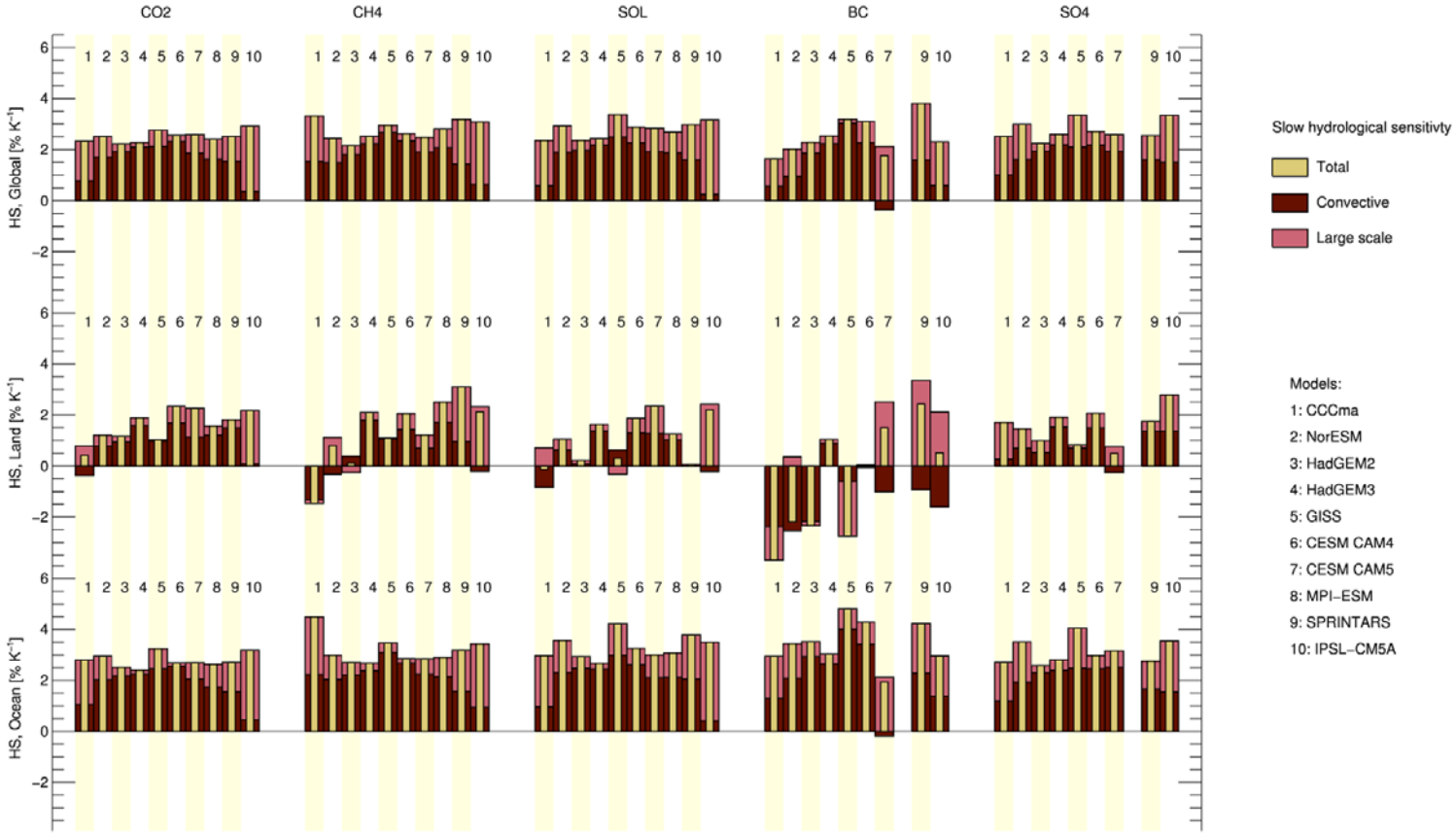
- In PDRMIP, 10 global climate models have performed abrupt perturbations to CO2, CH4, solar insolation, BC and SO4
- Broadly, fast precipitation changes scale with atmospheric absorption, slow changes with surface temperature change
- Many inter-model differences in response strength
- Sulphate behaves much like a negative solar forcing, though with different regional pattern
- BC has completely different behaviour to all other drivers. Fast response/adjustments still dominate, due to low surface temperature response
- Much more to come. And we have really good workshops. Come join the fun!

Backups



Samset et al., GRL, 2016


Land
Ocean
NAM
SAM
EUR
AFR
SAS
AUS
dP [mm/y]
(|dP fast| − |dP slow|) / (|dP fast| + |dP slow|)
Fast
Slow
Total
Drivers:
1: CO2x2
2: CH4x3
3: Sol+2%
4: BCx10
5: SO4x5


CO2
CH4
SOL
BC
SO4
HS, Global [% K⁻¹]
HS, Land [% K⁻¹]
HS, Ocean [% K⁻¹]
Slow hydrological sensitivty
Total
Convective
Large scale
Models:
1: CCCma
2: NorESM
3: HadGEM2
4: HadGEM3
5: GISS
6: CESM CAM4
7: CESM CAM5
8: MPI-ESM
9: SPRINTARS
10: IPSL-CM5A