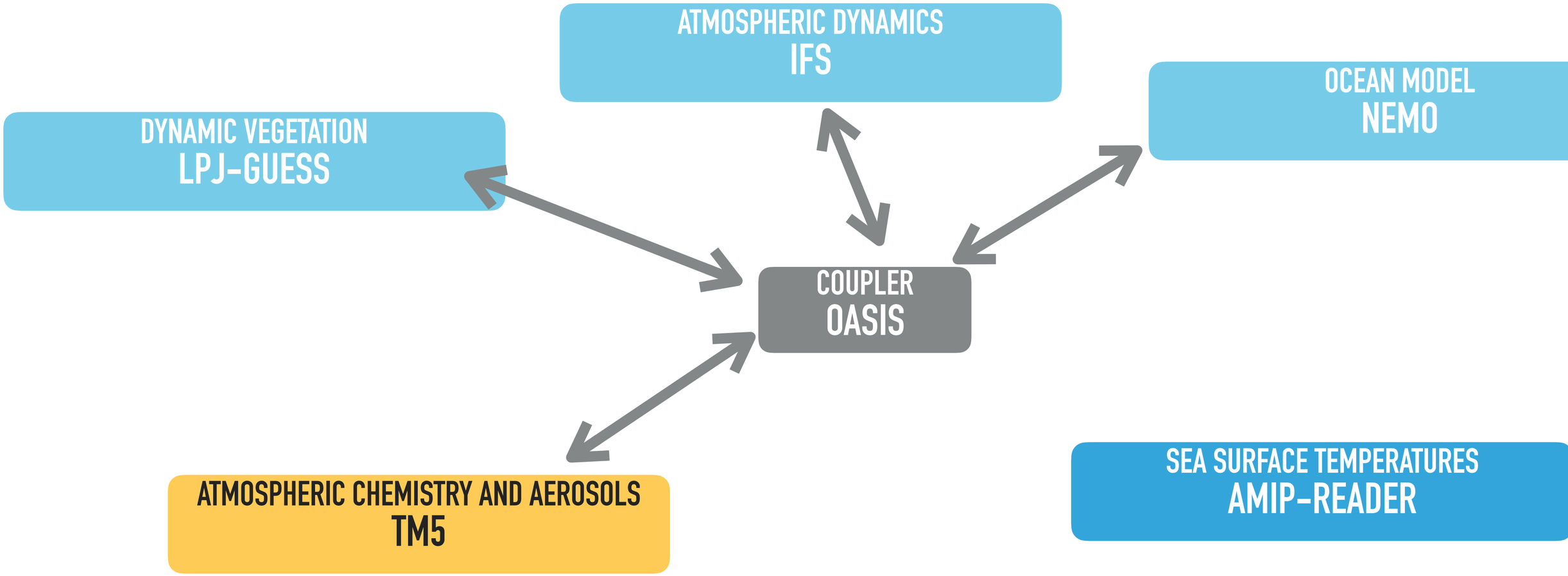
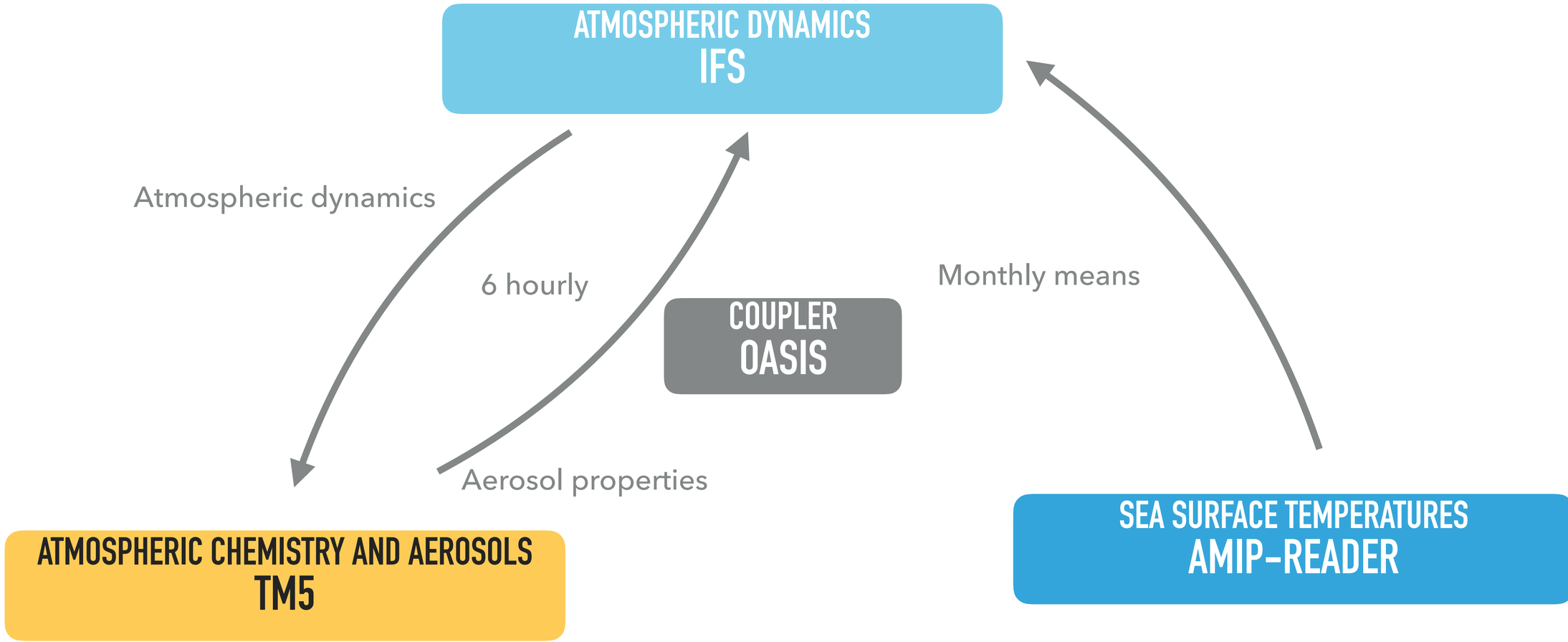
TOMMI BERGMAN, TWAN VAN NOIJE

EFFECTIVE RADIATIVE FORCING OF AEROSOLS IN EC-EARTH

EC-EARTH 3.2 AERCHEM AMIP

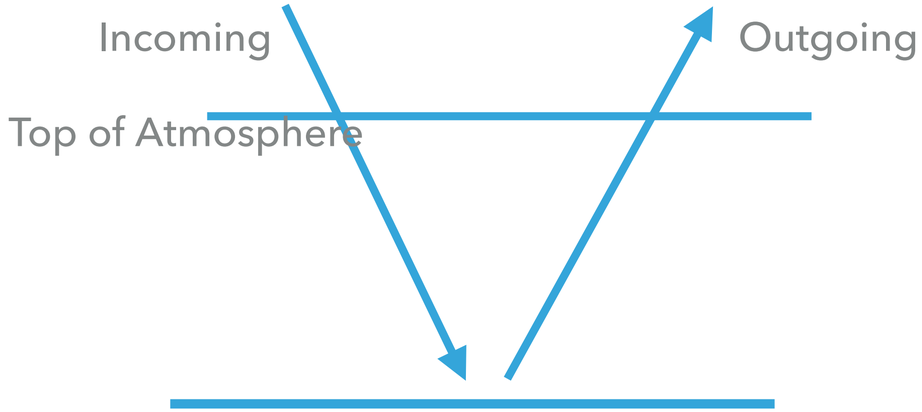


EC-EARTH 3.2 AERCHEM AMIP



BASIC EFFECTIVE RADIATIVE FORCING (ERF)

- Radiation balance at TOA in pre-industrial and present day
- Effective radiative forcing
  - $ERF=F_{pi}-F_{pd}$
- AMIP runs with SSTs for 2000-2014
  - present-day (2000-2014)
  - pre-industrial (1850)



GCM AEROSOL EFFECTIVE RADIATIVE FORCING AT TOA

- ERF from comparison study by Fiedler et al. with parameterised aerosols
  - EC-Earth has higher ERF due to cloud life-time effect
- AerChem version with TM5 of EC-Earth has higher aerosol ERF
- Could impact tuning?
  - could we make it a bit weaker
  - And reduce the AOD bias in Africa and China

	ERF_{TOA} [Wm^{-2}]
ECHAM	-0.50
ECHAM-HAM	-0.52
EC-EARTH	-0.90
EC-EARTH AerChem	-1.48
HadGEM3	-0.40
NorESM	-0.65

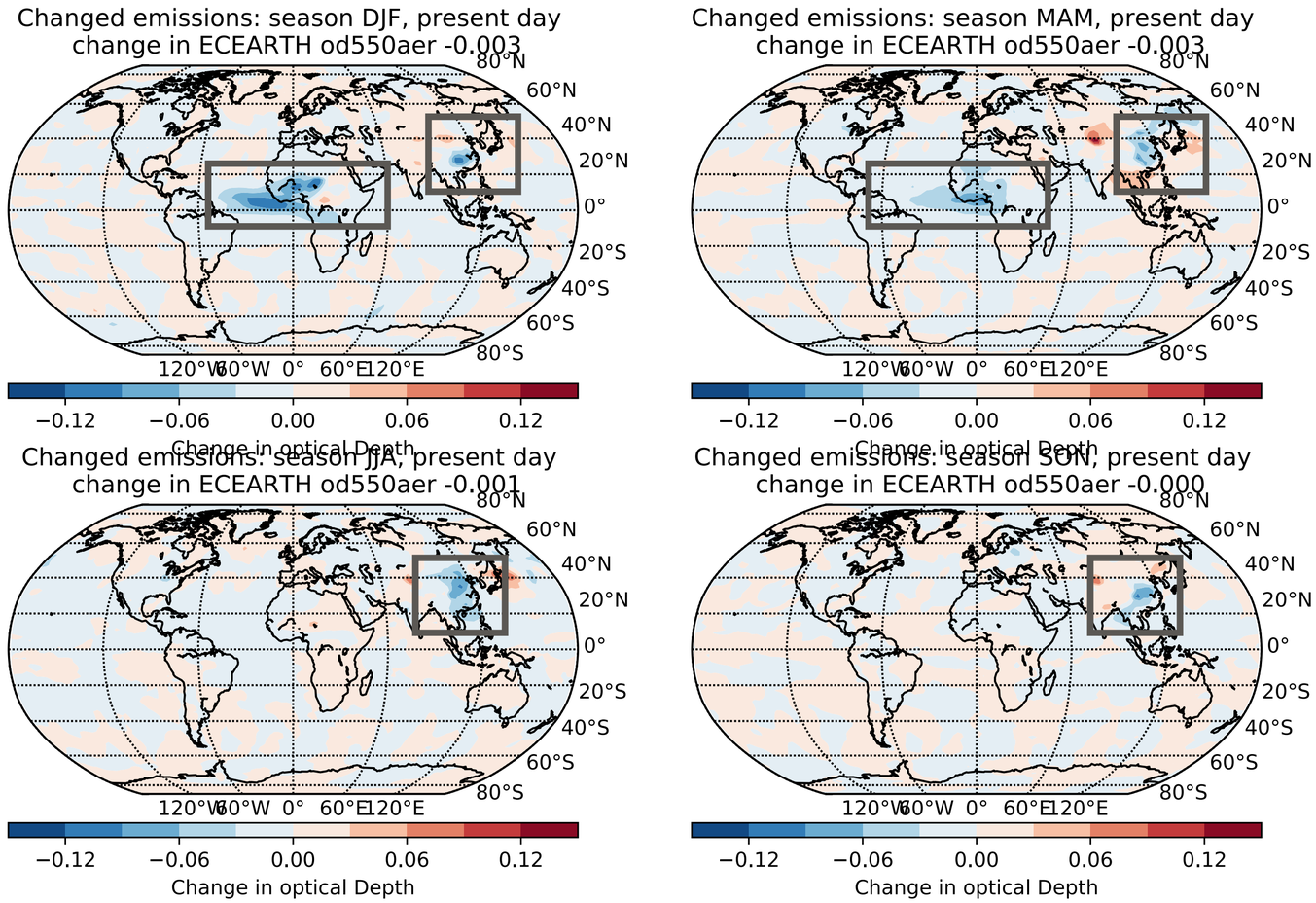
Fiedler et al. (except EC-Earth AerChem)

BIOMASS AND BIOFUEL BURNING ACCUMULATION FRACTION TO 95%

- Fraction of soluble BC from biofuel and biomass burning
  - 0.5 -> 0.95
- Fraction of soluble OC from biomass burning and biofuel use
  - 0.65->0.95

- AMIP runs where pre-industrial
  - emissions and methane concentration in TM5 are at 1850 level
  - IFS radiation scheme uses 2000-2014 O3, CH4
- comparing old and new emissions
  - 1850 (15 years)
  - 2000-2014 (15 years)

Aerosol optical depth



AEROSOL EFFECTIVE RADIATIVE FORCING DECOMPOSITION (GHAN 2013)

- Double call for radiation needed with and without aerosols

NET STD -1.48Wm-2
NET NEW -1.13Wm-2

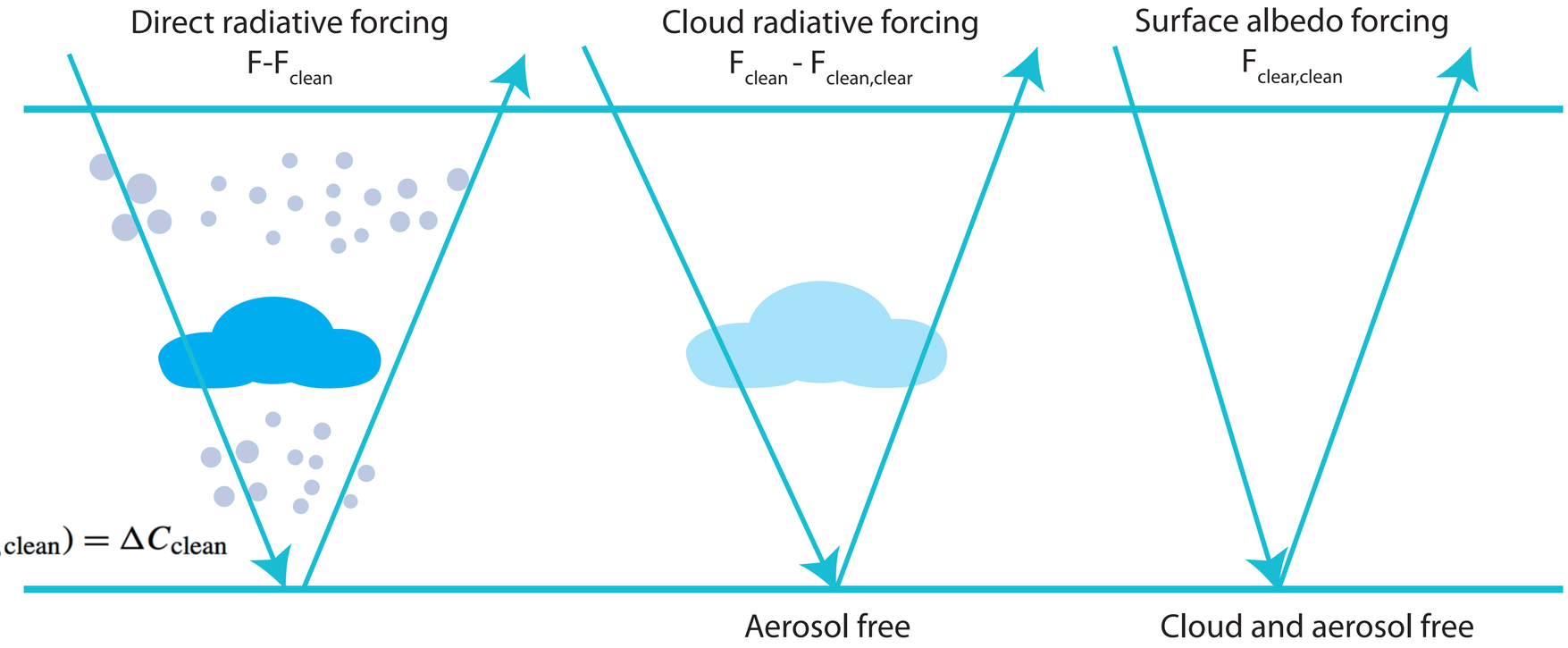
For each forcing the anthropogenic effect is calculated as difference in forcing between present-day and pre-industrial condition

Ghan (2013):

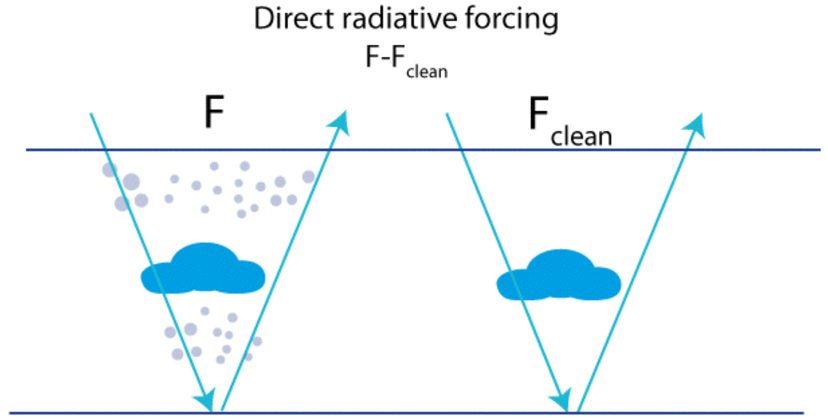
Direct radiative forcing: $\Delta(F - F_{\text{clean}})$

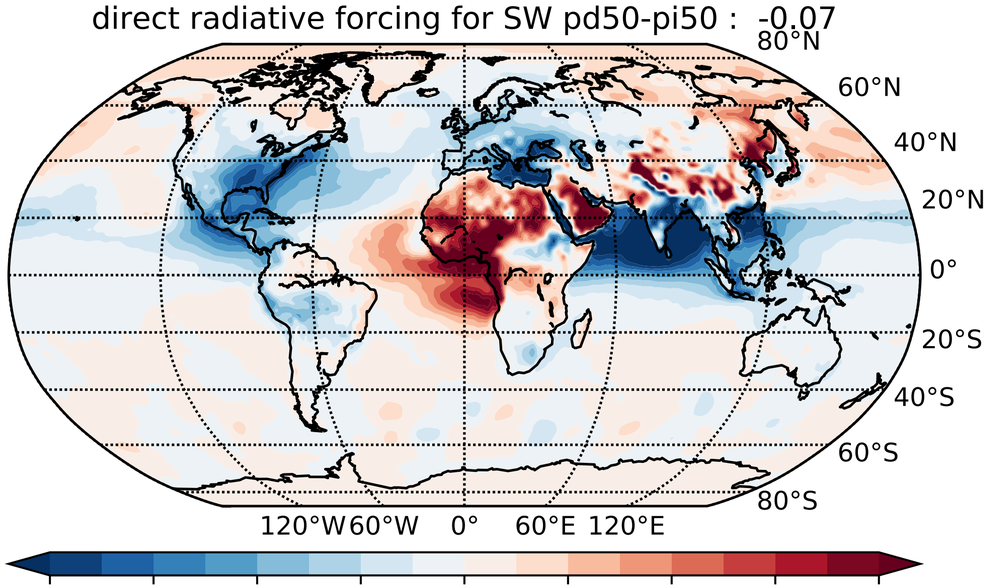
Cloud radiative forcing: $\Delta(F_{\text{clean}} - F_{\text{clear,clean}}) = \Delta C_{\text{clean}}$

Surface albedo forcing: $\Delta F_{\text{clear,clean}}$



ERF SHORT WAVE DIRECT FORCING

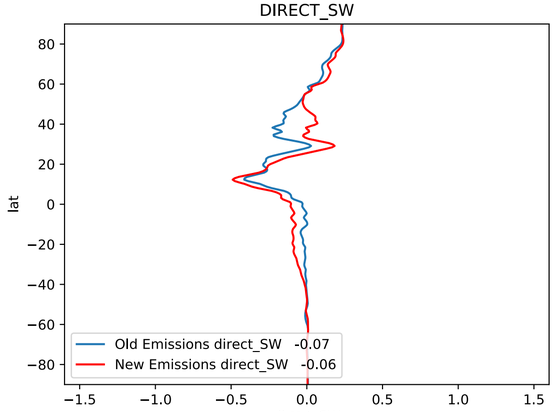


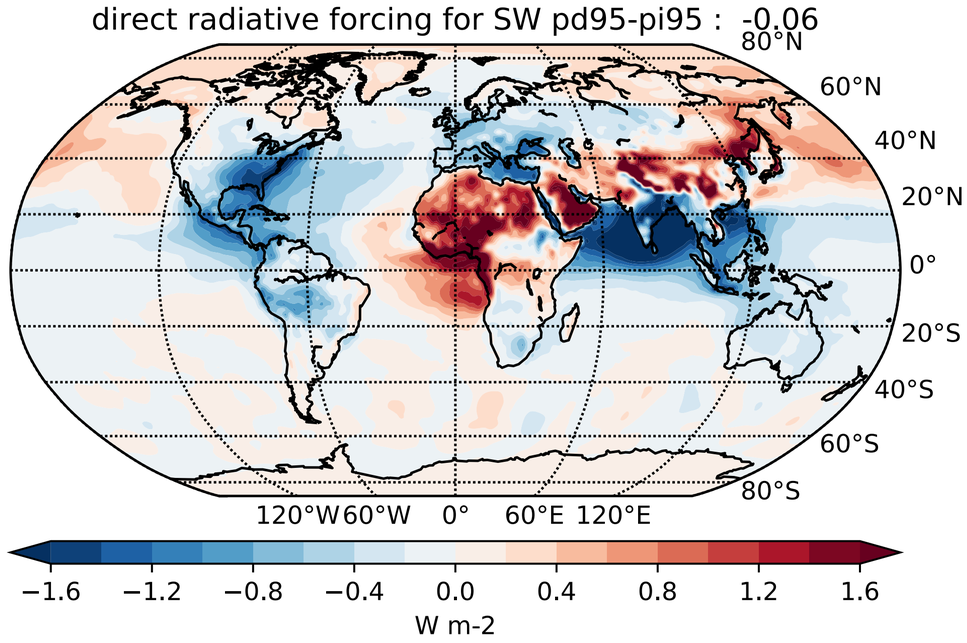


NET STD -1.48Wm-2

NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW				
Cloud LW				
Albedo SW				





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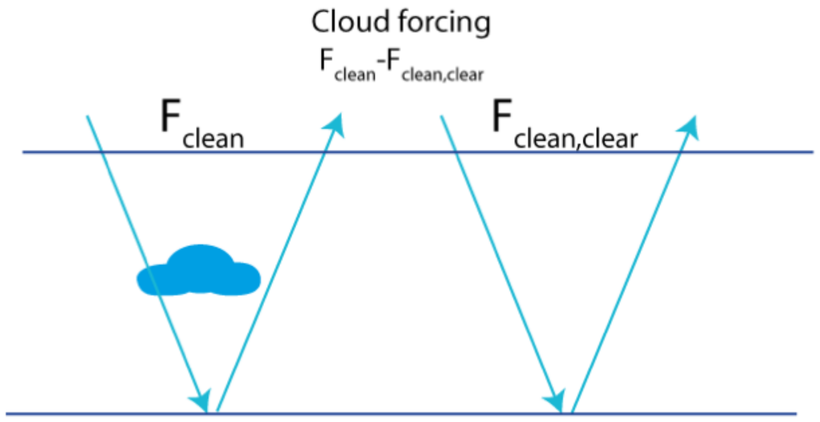
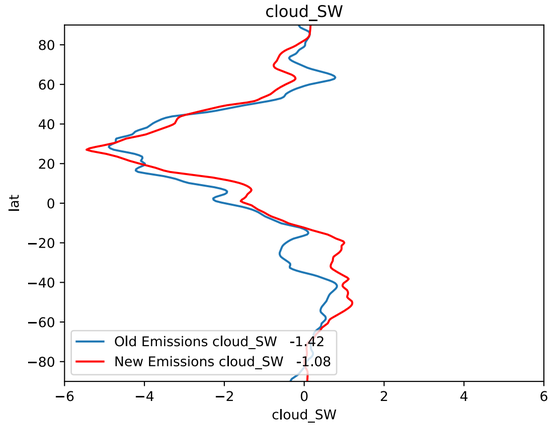
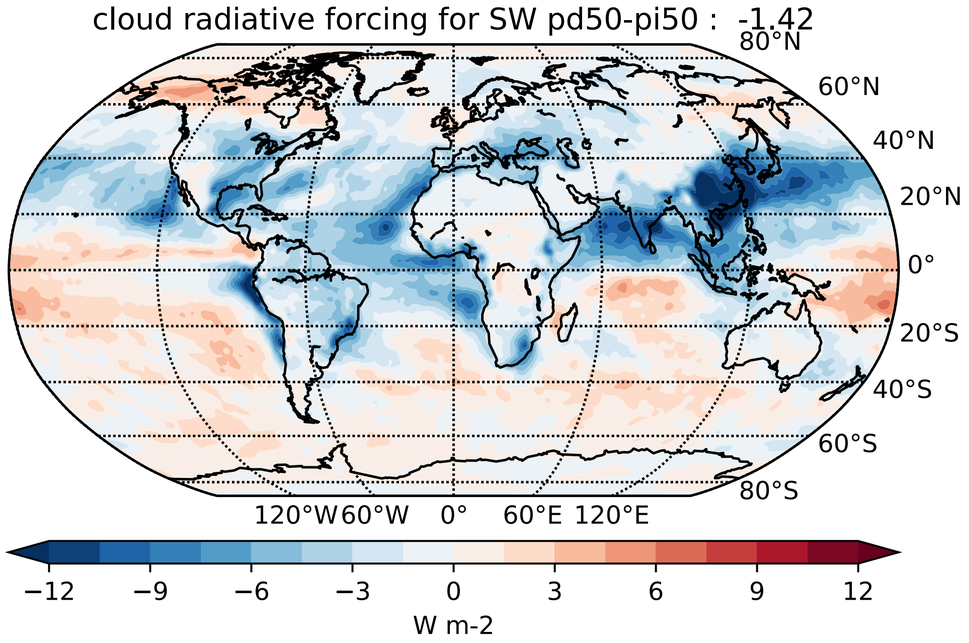
ERF SHORT WAVE CLOUD FORCING

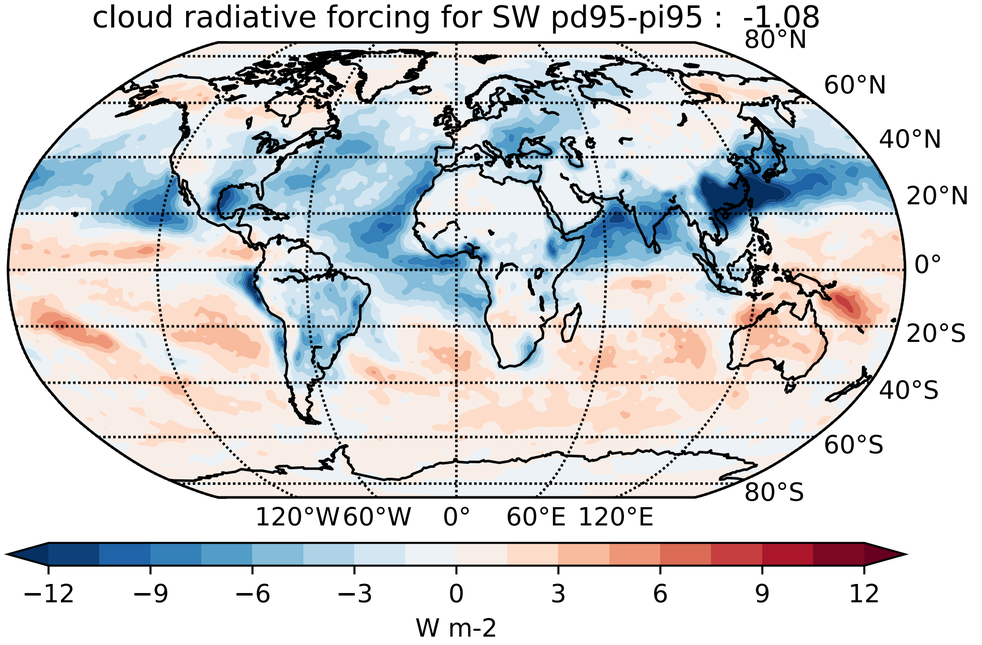


NET STD -1.48Wm-2
NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW	-1.42	-1.08	-2.05	-1.45
Cloud LW				
Albedo SW				







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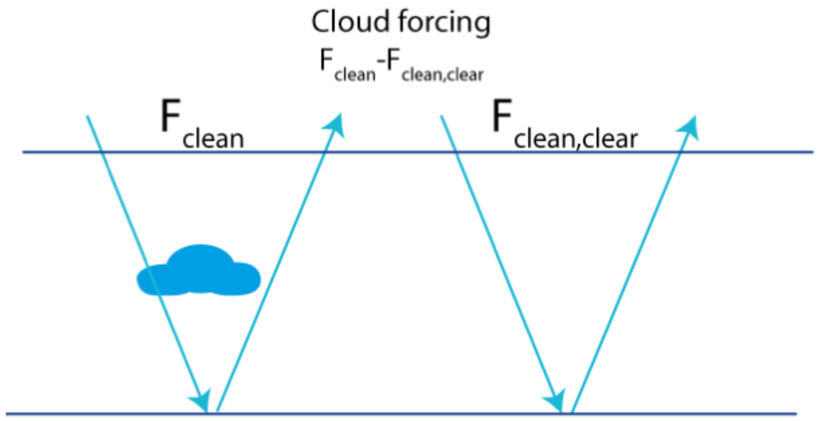
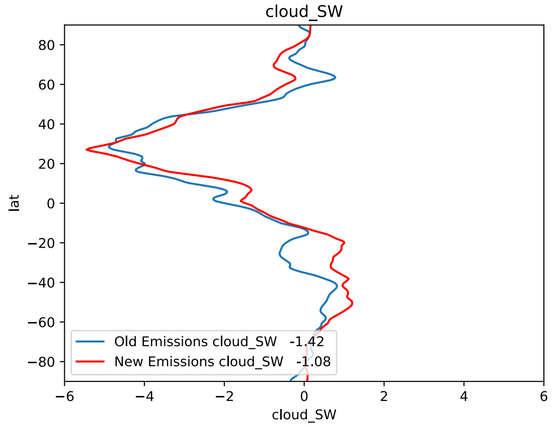
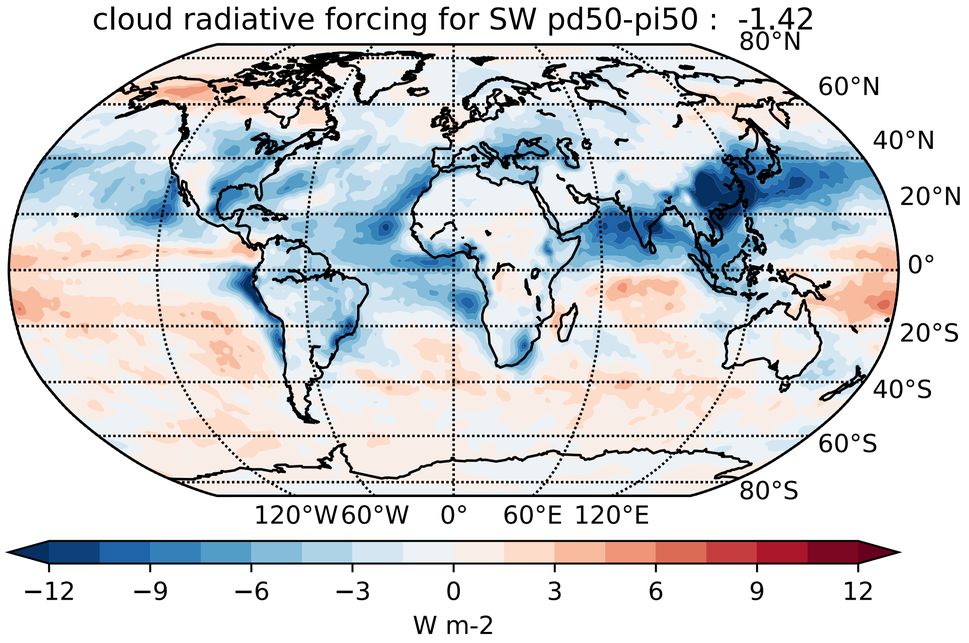
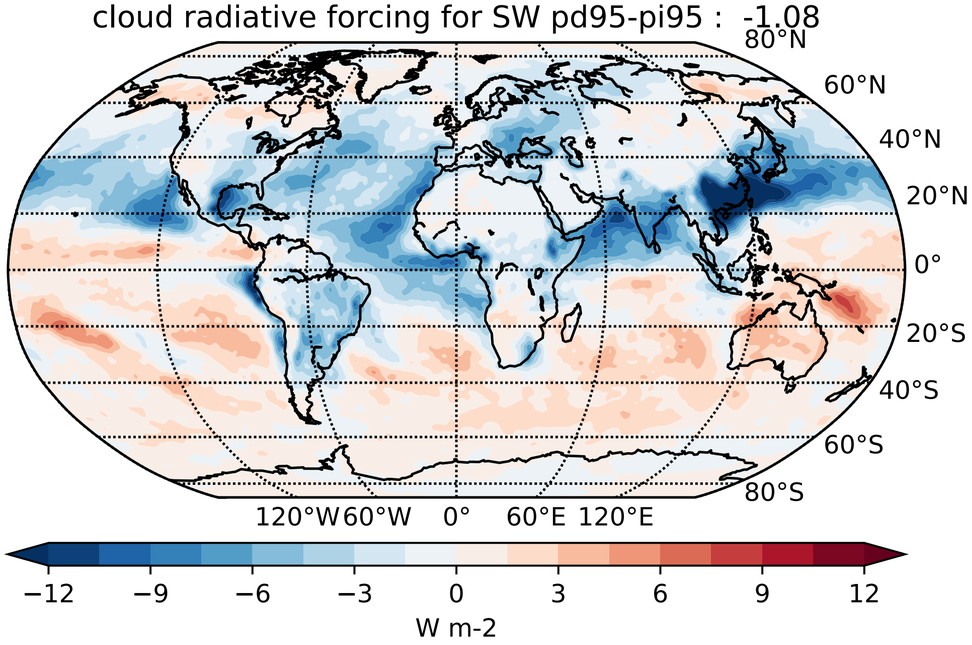


NET STD -1.48Wm-2
NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW	-1.42	-1.08	-2.05	-1.45
Cloud LW				
Albedo SW				







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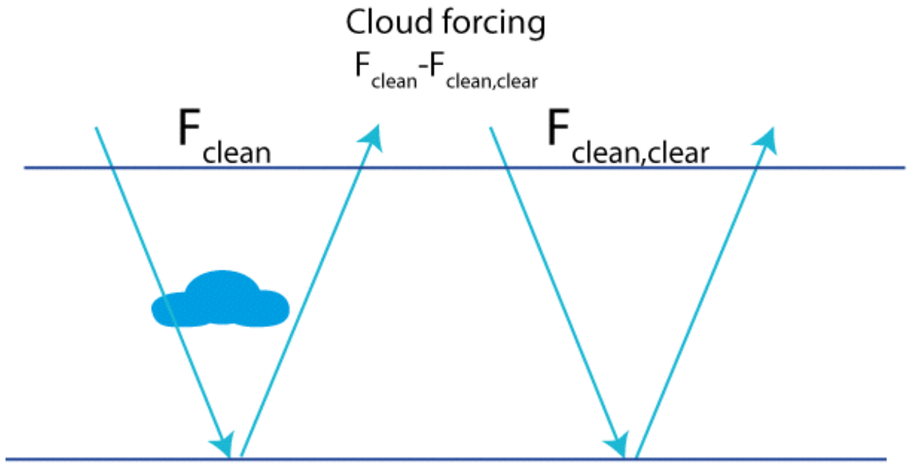
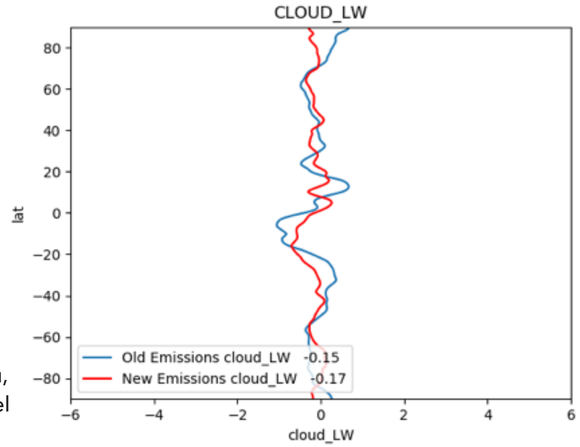
ERF LONG WAVE CLOUD FORCING



NET STD -1.48Wm-2

NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW	-1.42	-1.08	-2.05	-1.45
Cloud LW	-0.15	-0.17	+0.53	+0.16
Albedo				-



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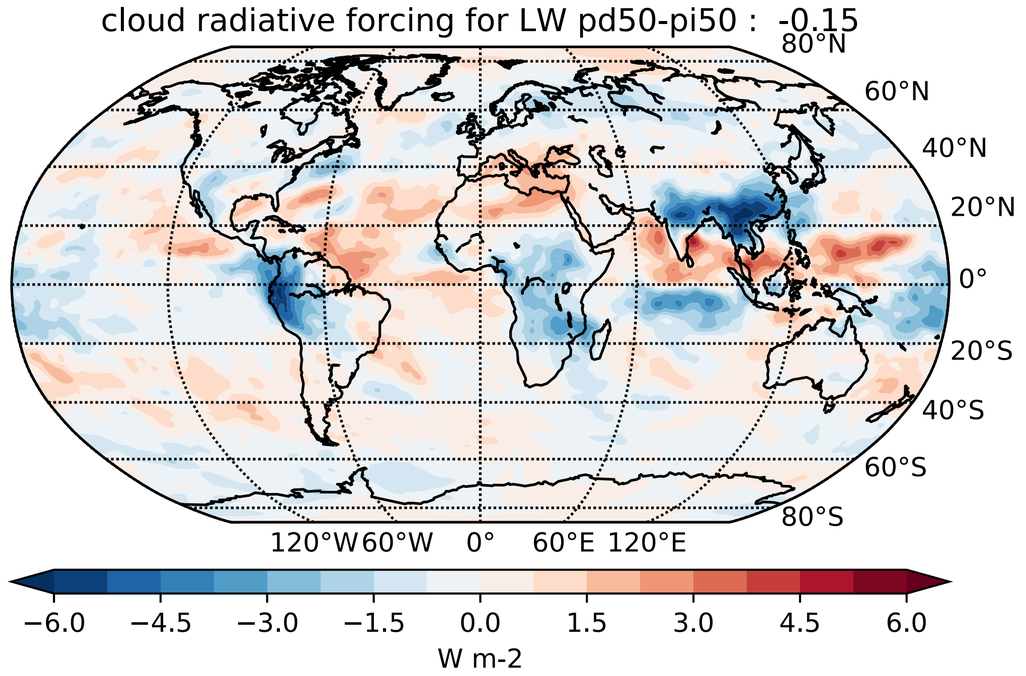
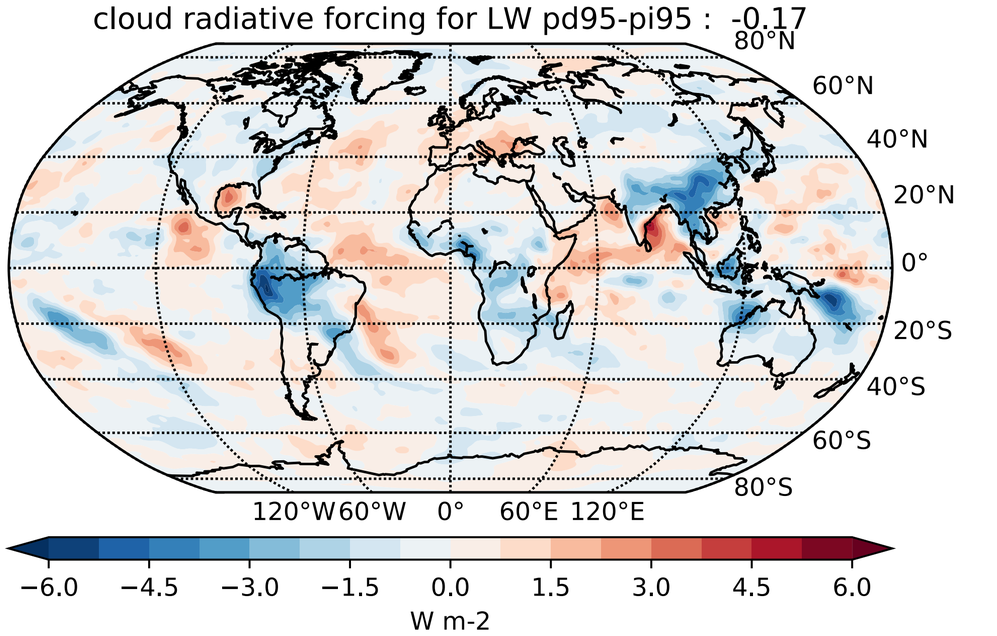
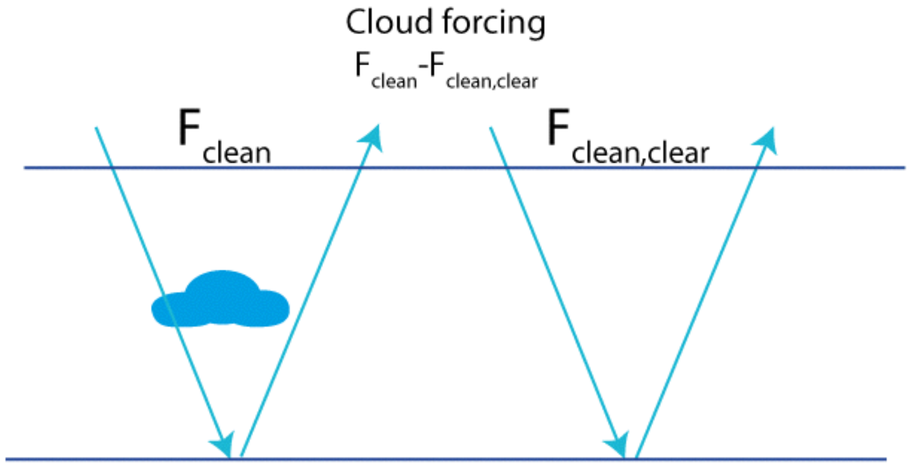




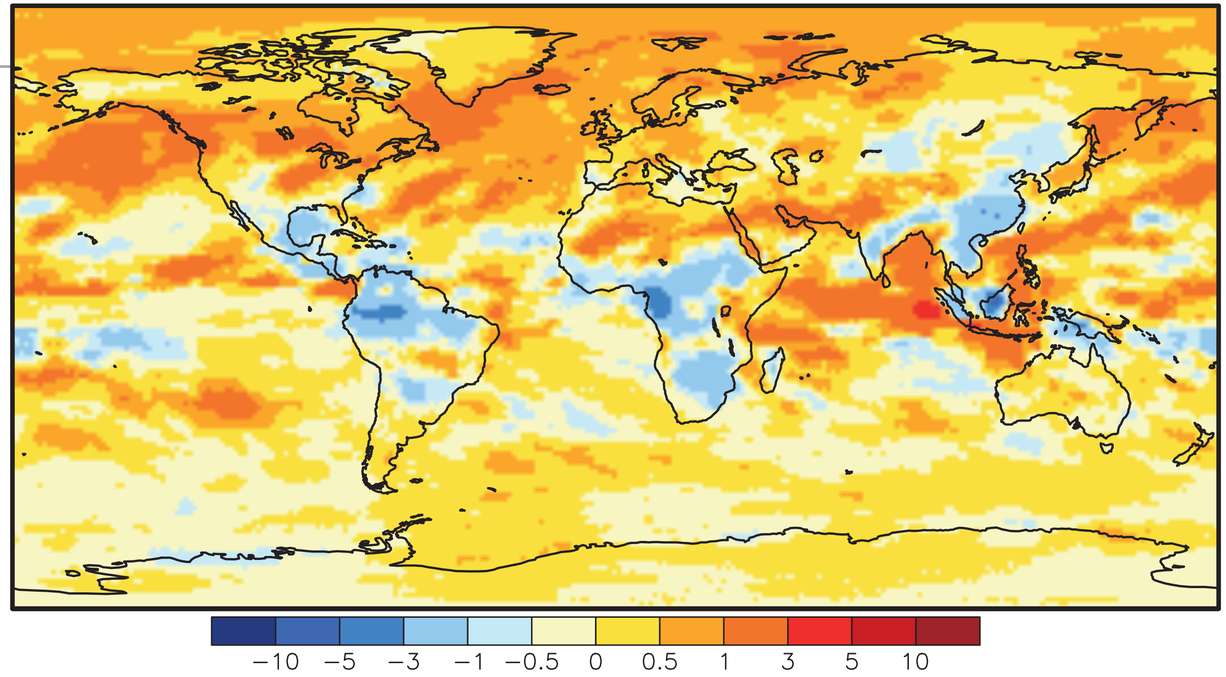
CAM-OSLO

ERF LONG WAVE CLOUD FORCING



LW ERFaci at TOA

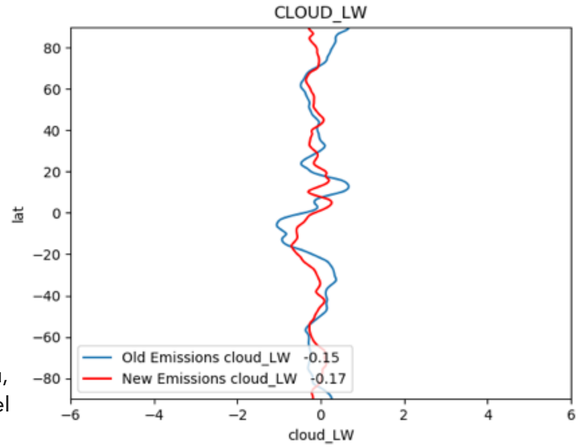
Avg = 0.155 W m^{-2}



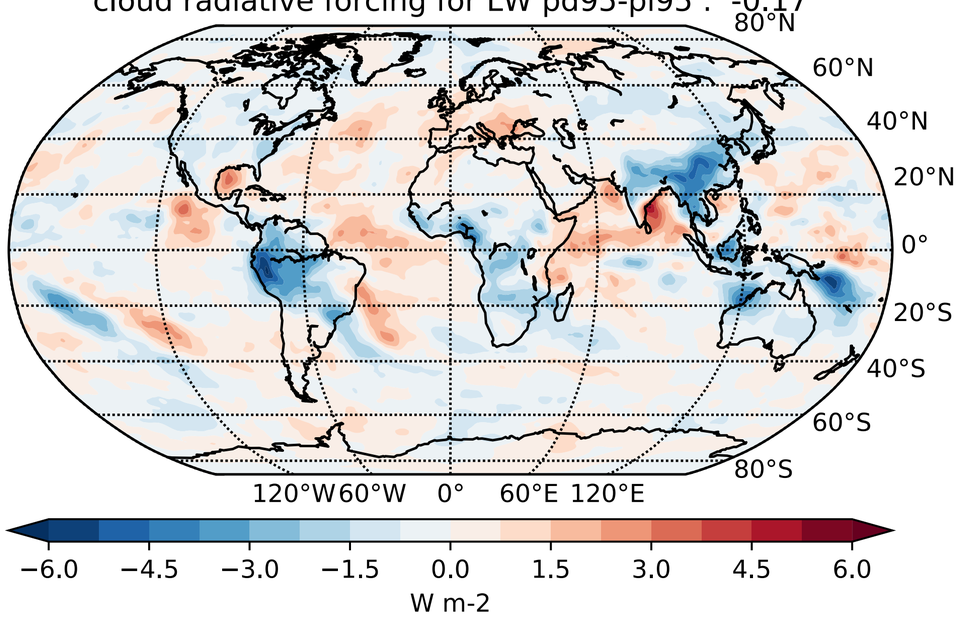
NET STD -1.48Wm-2

NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW	-1.42	-1.08	-2.05	-1.45
Cloud LW	-0.15	-0.17	+0.53	+0.16
Albedo				-



cloud radiative forcing for LW pd95-pi95 : -0.17



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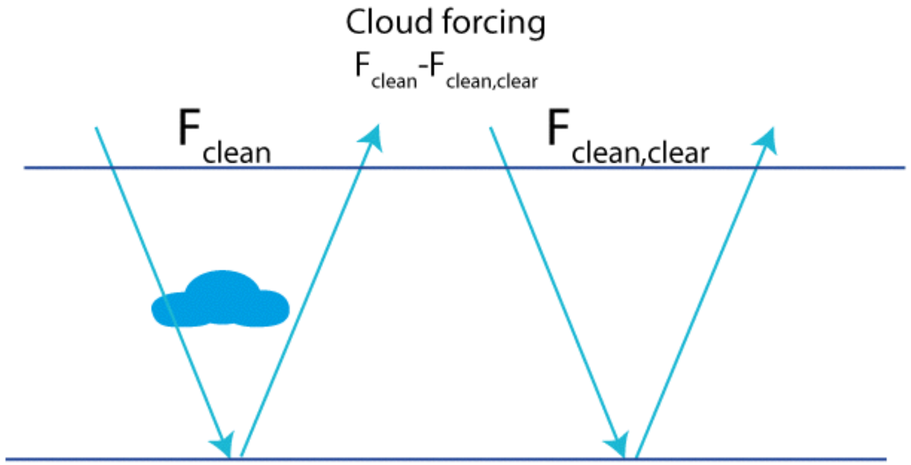
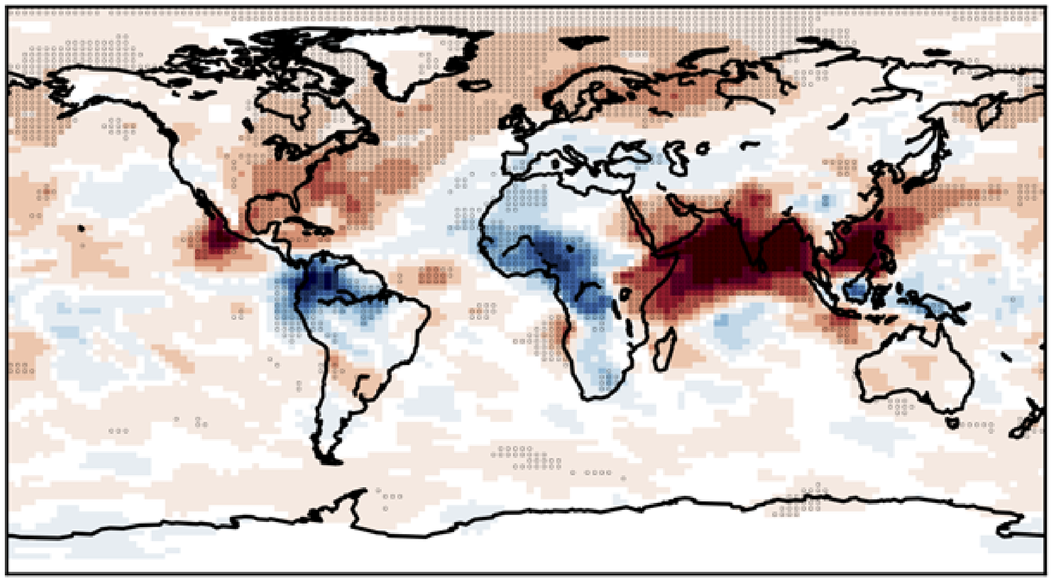
CAM-OSLO

ERF LONG WAVE CLOUD FORCING

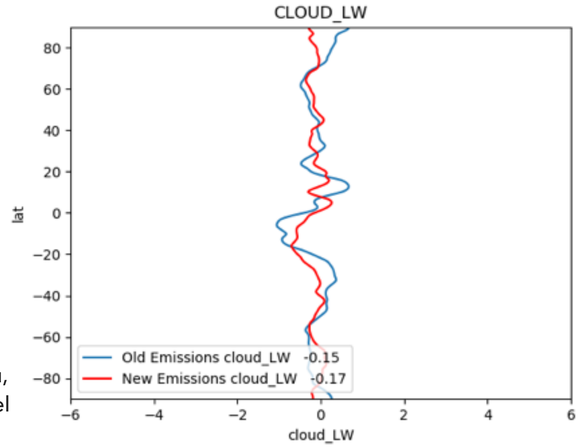


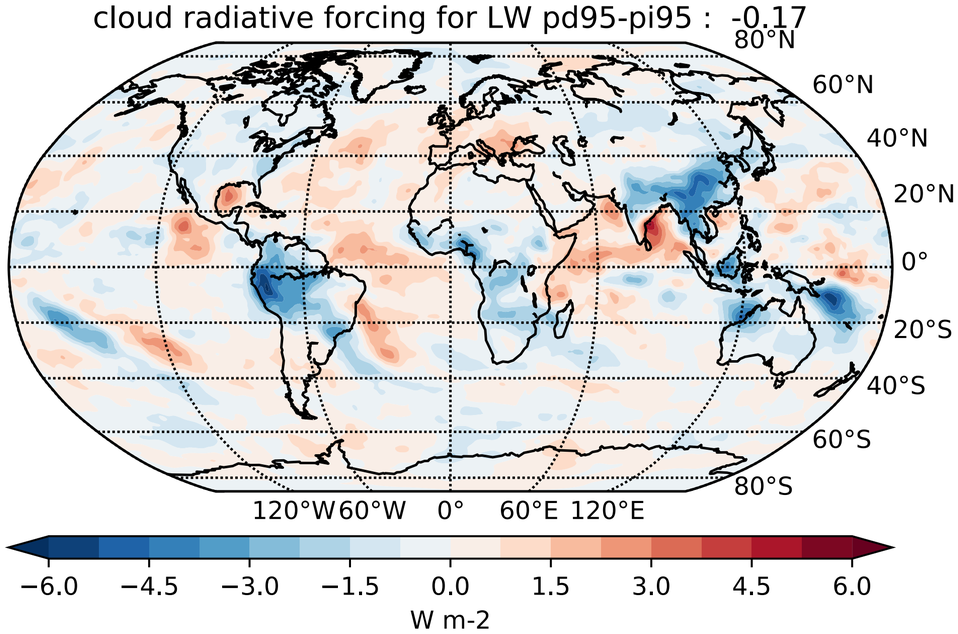


NET STD -1.48Wm-2

NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7	CAM-OSLO
Direct SW	-0.07	-0.06	0.0	-0.09
Cloud SW	-1.42	-1.08	-2.05	-1.45
Cloud LW	-0.15	-0.17	+0.53	+0.16
Albedo				-





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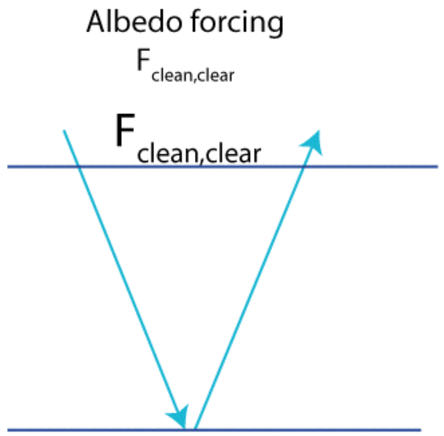
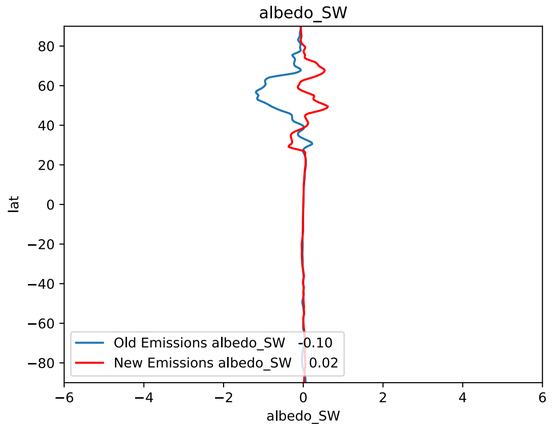
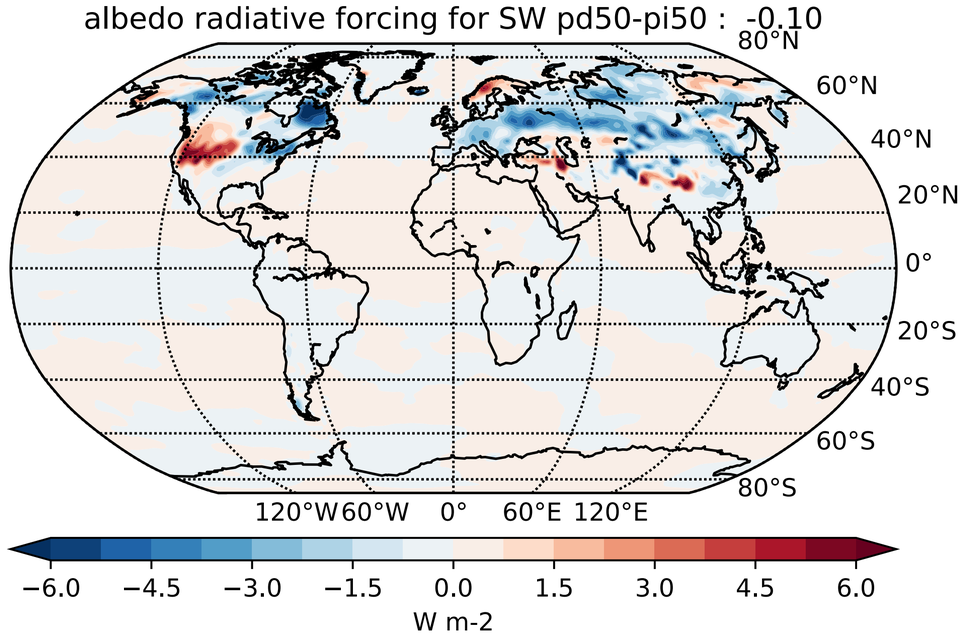
ERF SHORT WAVE ALBEDO FORCING

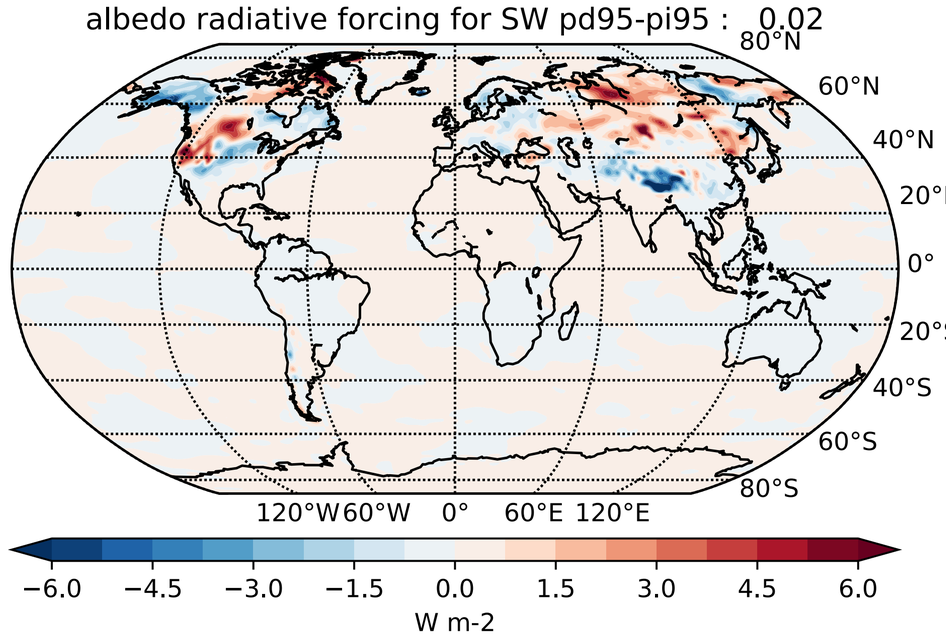


NET STD -1.48Wm-2
NET NEW -1.13Wm-2

	OLD	NEW	CAM-MAM7
Direct SW	-0.07	-0.06	0.0
Cloud SW	-1.42	-1.08	-2.05
Cloud LW	-0.15	-0.17	+0.53
Albedo SW	-0.10	0.02	-0.02







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SUMMARY

- New emissions decrease ERF from -1.48 Wm-2 to -1.13Wm-2
  - closer to simple aerosol version
  - hopefully reduces the need for tuning as the model is so slow
- Main effect comes from change in SW cloud effect
  - from -1.42Wm-2 to -1.08Wm-2
- LW cloud effect (-0.17Wm-2) is totally opposite to other models CAM-MAM7 (+0.53Wm-2) and CAM-OSLO (+0.16Wm-2)
  - Should be looked into