

ERF, LWP, and IWP in NorESM2-LM and NorESM2-MM

June 11, 2020

1 Main points

Based on the atmosphere-only simulations piClim-control, piClim-aer, piClim-oxid and piClim-aeroxid with both NorESM2-LM and NorESM2-MM, we can observe :

Values of **LWP** and **IWP** in reference simulations

1. On the global scale, cloud **LWP** is 3% higher in NorESM2-LM than in NorESM2-MM.
2. On the global scale, cloud **IWP** is 15–20% higher in NorESM2-MM than in NorESM2-LM. Especially in the Arctic, the cloud **IWP** is considerably larger in NorESM2-MM than in NorESM2-LM.

Impacts from anthropogenic aerosols on **ERF**, **LWP** and **IWP**

1. The aerosol **ERF** does not differ more than 10% between NorESM2-LM and NorESM2-MM on a global scale.
2. The geographical distribution of the aerosol **ERF** looks very similar between NorESM2-LM and NorESM2-MM.
3. On a global scale, the impact of anthropogenic aerosol on **LWP** does not differ more than 10% between NorESM2-LM and NorESM2-MM.
4. The geographical distribution of the impact of anthropogenic aerosols on cloud **LWP** looks similar between NorESM2-LM and NorESM2-MM. It is however weaker in NorESM2-MM in the Arctic.
5. On a global scale, the impact of anthropogenic aerosols on **IWP** is not statistically significant in 30-year long simulations.
6. The geographical distribution of the impact of anthropogenic aerosols on cloud **IWP** is very noisy.

2 Global totals

Table 1 : Global mean value of TOA imbalance (**ERF**), cloud liquid water path (**LWP**), and cloud ice water path (**IWP**). Values shown are the mean value in the reference simulation (first column), the uncertainty on this estimated mean value (second column), impact from aerosol emission changes (third column), impact of oxidant changes (fourth column), and impact of emission and oxidant changes together (fifth column).

	piClim-control		piClim-aer	piClim-oxid	piClim-aeroxid
	[mean]	[uncertainty]	[Δ]	[Δ]	[Δ]
ERF [W m^{-2}]					
NorESM2-LM [flux=0]	0.720	0.262	-1.234	0.250	-1.222
NorESM2-LM	0.934	0.210	-1.371	0.233	-1.226
NorESM2-MM	0.493	0.253	-1.260	0.315	-1.115
LWP [g m^{-2}]					
NorESM2-LM [flux=0]	69.465	0.360	3.019	-0.493	3.169
NorESM2-LM	69.146	0.479	3.342	-0.660	3.028
NorESM2-MM	67.520	0.373	3.341	-0.582	2.949
IWP [g m^{-2}]					
NorESM2-LM [flux=0]	12.203	0.0513	0.042	0.013	0.057
NorESM2-LM	12.136	0.0761	0.021	0.002	0.013
NorESM2-MM	14.226	0.0701	0.012	0.065	0.057

3 Geographical distributions

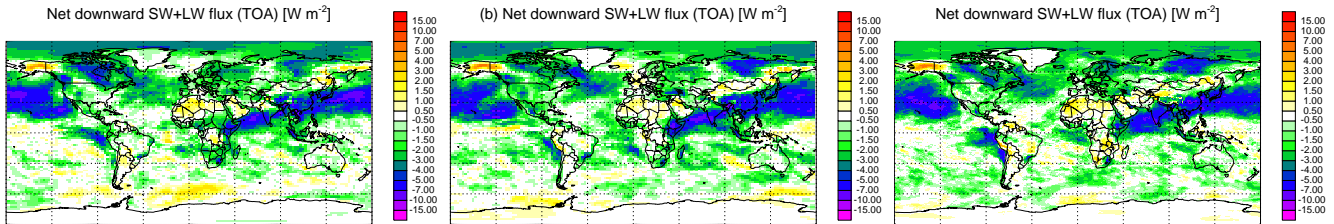
3.1 Effective radiative forcing (ERF)

NorEMS2-LM [flux=0]

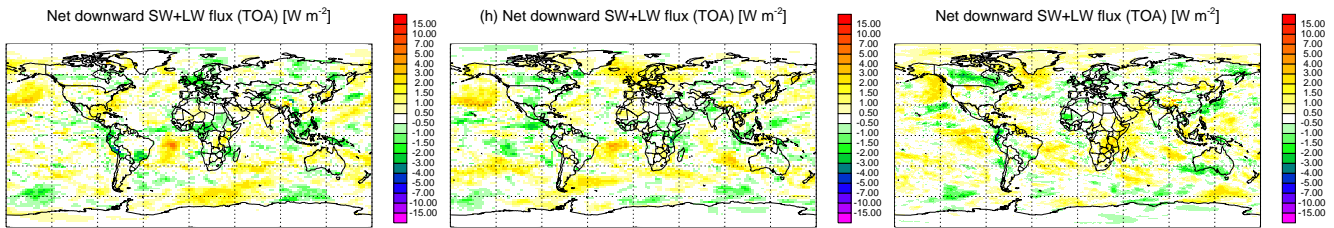
NorESM2-LM

NorESM2-MM

Δ ERF (piClim-aer – piClim-control)



Δ ERF (piClim-oxid – piClim-control)



Δ ERF (piClim-aeroxid – piClim-control)

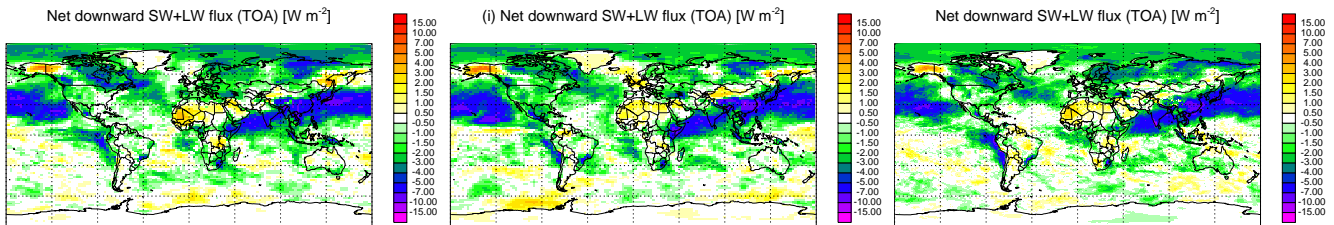


Figure 1: ERF from aerosol emissions (upper panels), oxidant changes (middle panels), and aerosol emissions + oxidant changes (lower panels). The models used are NorESM2-LM with flux=0 (left column), NorESM2-LM (middle column), and NorESM2-MM (right column).

3.2 Cloud liquid water path (LWP)

NorEMS2-LM [flux=0]

NorESM2-LM
LWP (piClim-control)

NorESM2-MM

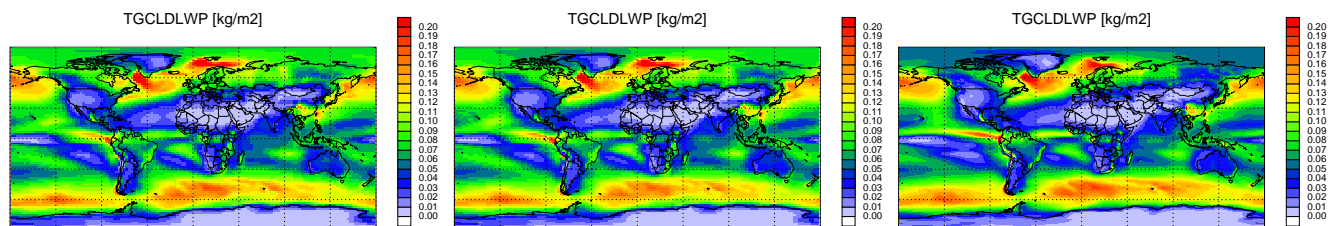
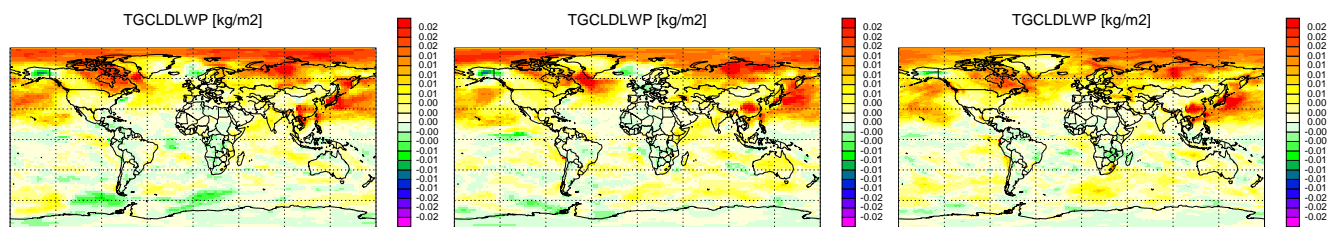


Figure 2: Cloud LWP in the reference simulations. The models used are NorESM2-LM with flux=0 (left column), NorESM2-LM (middle column), and NorESM2-MM (right column).

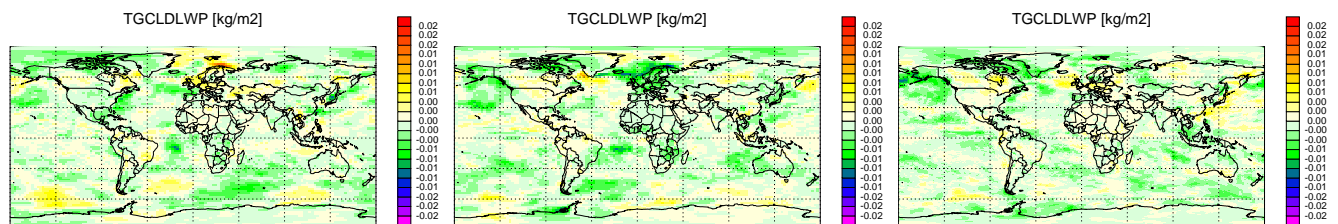
NorEMS2-LM [flux=0]

NorESM2-LM
 Δ LWP (piClim-aer – piClim-control)

NorESM2-MM



Δ LWP (piClim-oxid – piClim-control)



Δ LWP (piClim-aeroxid – piClim-control)

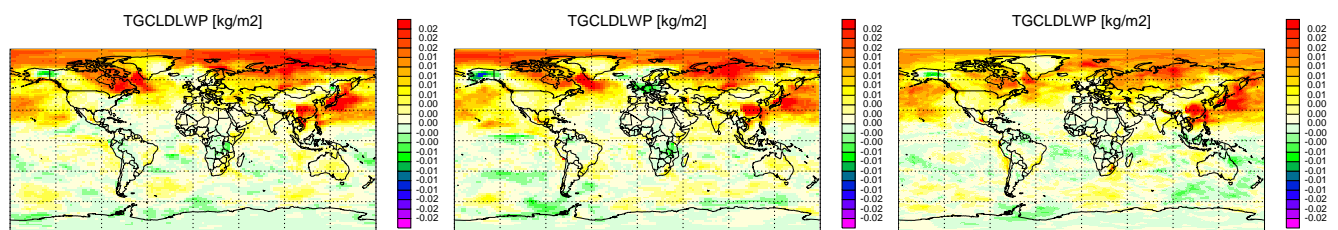


Figure 3: Change in cloud LWP from aerosol emissions (upper panels), oxidant changes (middle panels), and aerosol emissions + oxidant changes (lower panels). The models used are NorESM2-LM with flux=0 (left column), NorESM2-LM (middle column), and NorESM2-MM (right column).

3.3 Cloud ice water path (IWP)

NorEMS2-LM [flux=0]

NorESM2-LM
LWP (piClim-control)

NorESM2-MM

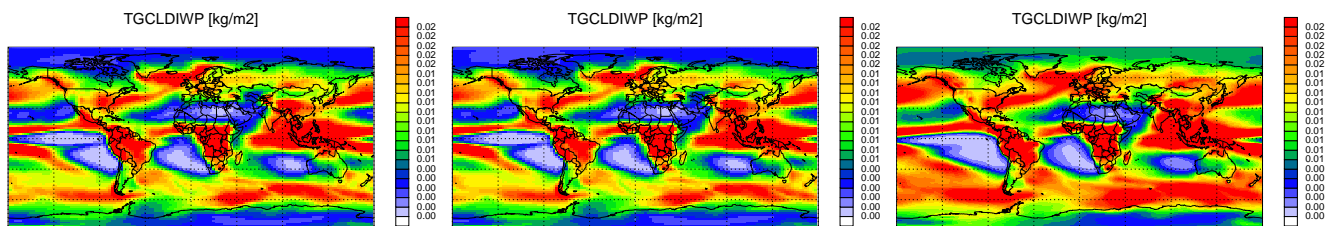
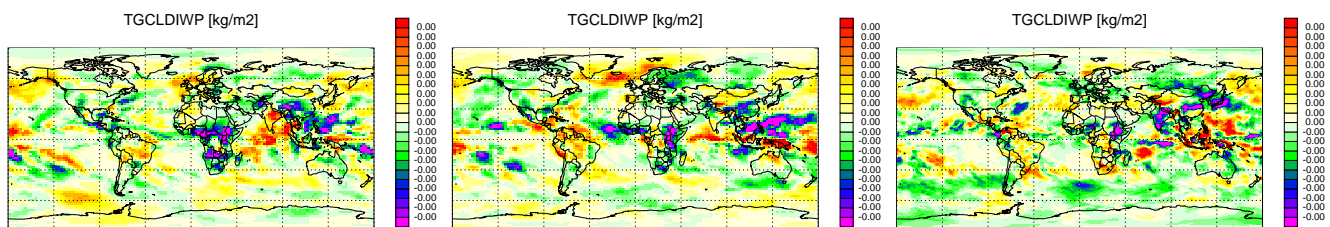


Figure 4: Cloud IWP in the reference simulations. The models used are NorESM2-LM with flux=0 (left column), NorESM2-LM (middle column), and NorESM2-MM (right column).

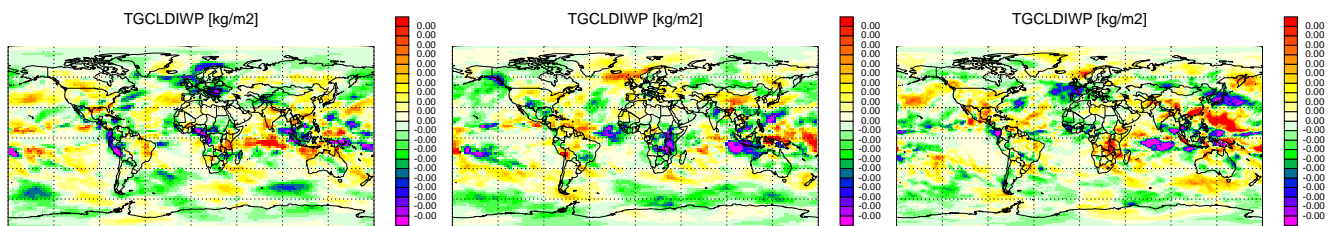
NorEMS2-LM [flux=0]

NorESM2-LM
 Δ IWP (piClim-aer – piClim-control)

NorESM2-MM



Δ IWP (piClim-oxid – piClim-control)



Δ IWP (piClim-aeroxid – piClim-control)

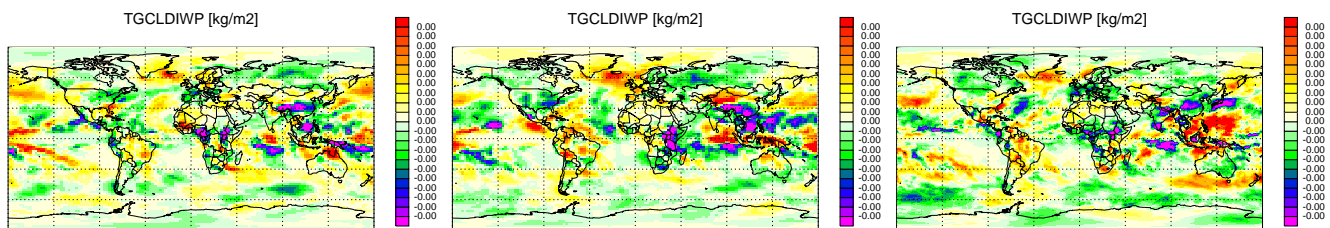


Figure 5: Change in cloud IWP from aerosol emissions (upper panels), oxidant changes (middle panels), and aerosol emissions + oxidant changes (lower panels). The models used are NorESM2-LM with flux=0 (left column), NorESM2-LM (middle column), and NorESM2-MM (right column).