Emission changes in DMS, OM(ni) and sea-salt during spinup of NorESM2 and their impact on the radiative forcing

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1 Radiative efficiency based on atmosphere-only simulations

Based on year 5–30 of the atmosphere-only experiments, one can derive the radiative efficiency of DMS, sea-salt, and OPOM emissions.

Table : TOA imbalance, DMS emissions, sea-salt emission strength, OM emission strength, aerosol optical depth, and column-integrated CDNC in atmosphere-only experiments.

		Reference		1→2xDMS	1→2xsea-salt	1→2xOPOM
		[mean]	[uncertainty]	[Δ]	[Δ]	[Δ]
TOA imbalance	[$\mathrm{W\,m^{-2}}$]	0.933	0.210	-1.422	-2.159	-0.539
DMS emissions	[$\mathrm{Tg\,yr^{-1}}$]	35.29	0.24	**35.42**	0.15	0.02
Sea-salt emissions	[$\mathrm{Tg\,yr^{-1}}$]	3369.6	40.2	-3.4	**3365.1**	-16.4
OM emissions (surface)	[$\mathrm{Tg\,yr^{-1}}$]	55.22	0.21	0.01	-0.04	**12.91**
Optical depth (550 nm)	[-]	0.1343	0.0013	0.0041	0.0820	0.0018
CDNC (integrated)	[$\mathrm{10^9\,m^{-2}}$]	11.16	0.12	1.47	1.35	1.02

2 Overview of the coupled spinup simulations

Table : overview of (some of the) pre-spinup and spinup simulations with NorESM2.

Experiment	Start	End
PRE-SPINUP		
N1850OCBDRDDMS_f19_tn14_noresm-dev-22062018_Original	1	60
N1850OCBDRDDMS_f19_tn14_noresm-dev-22062018_clubb_gamma_coef_.27_micro_mg_dcs_400.D-6	1	60
N1850OCBDRDDMS_f19_tn14_doublesalt	1	195
N1850OCBDRDDMS_f19_tn14_2rosc1dp	1	405
SPINUP		
N1850OCBDRDDMS_f19_tn14_201218	1	90 (135)
N1850OCBDRDDMS_f19_tn14_250119	91	360 (645)
N1850OCBDRDDMS_f19_tn14_Gibr_220319	360	420
N1850OCBDRDDMS_f19_tn14_03042019	421	560 (562)
N1850OCBDRDDMS_f19_tn14_12042019	561	625
N1850OCBDRDDMS_f19_tn14_15042019	626	795 (799)
N1850OCBDRDDMS_f19_tn14_25042019	796	995 (997)
N1850OCBDRDDMS_f19_tn14_08052019	996	1035
N1850OCBDRDDMS_f19_tn14_10052019	1036	1100 (1104)
N1850OCBDRDDMS_f19_tn14_13052019	1101	1515
N1850_f19_tn14_06062019	1516	1565
N1850_f19_tn14_11062019	1566	1600

3 Location of the simulations

TABLE : Overview of location of spinup simulations.

Experiment	Machine	Path
N1850OCBDRDDMS_f19_tn14_201218	Vilje	/home/metno/oyvinds/NorESM2old/noresmdevcases
N1850OCBDRDDMS_f19_tn14_250119	Vilje	/home/metno/oyvinds/NorESM2old/noresmdevcases
N1850OCBDRDDMS_f19_tn14_Gibr_220319	Vilje	/home/metno/oyvinds/NorESM2old/noresmdevcases
N1850OCBDRDDMS_f19_tn14_03042019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_12042019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_15042019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_25042019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_08052019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_10052019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850OCBDRDDMS_f19_tn14_13052019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850_f19_tn14_06062019	Nebula	/home/sm_adagj/noresm/spinupcase
N1850_f19_tn14_11062019	Fram	/cluster/projects/nn2345k/adagj/NorESM/cases

4 Parameter values

TABLE : Overview of parameter values during spinup simulations.

	Period	γ	micro_mg_dcs	cldfrc_iceopt
N1850OCBDRDDMS_f19_tn14_201218	1–90	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_250119	91–360	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_Gibr_220319	360–420	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_03042019	421–560	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_12042019	561–625	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_15042019	626–795	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_25042019	796–995	0.258	0.0005	4
N1850OCBDRDDMS_f19_tn14_08052019	996–1035	0.261	0.0005	4
N1850OCBDRDDMS_f19_tn14_10052019	1036–1100	0.261	0.0005	4
N1850OCBDRDDMS_f19_tn14_13052019	1101–1515	0.264	0.0005	4
N1850_f19_tn14_06062019	1516–1565	0.264	0.0005	4
N1850_f19_tn14_11062019	1566–1600	0.264	0.0005	4

5 Overview of SourceMods

Table :

N1850OCBDRDDMS_f19_tn14_201218					
N1850OCBDRDDMS_f19_tn14_250119		seasalt_model.F90	zm_conv.F90	ice_therm_vertical.F90	
N1850OCBDRDDMS_f19_tn14_Gibr_220319		seasalt_model.F90	zm_conv.F90		
N1850OCBDRDDMS_f19_tn14_03042019		seasalt_model.F90	zm_conv.F90	ice_therm_vertical.F90	RtmRestFile
N1850OCBDRDDMS_f19_tn14_12042019	optinterpol.F90	seasalt_model.F90	zm_conv.F90	ice_therm_vertical.F90	RtmRestFile
N1850OCBDRDDMS_f19_tn14_15042019	optinterpol.F90		zm_conv.F90	ice_therm_vertical.F90	RtmRestFile
N1850OCBDRDDMS_f19_tn14_25042019	optinterpol.F90		zm_conv.F90	ice_therm_vertical.F90	RtmRestFile
N1850OCBDRDDMS_f19_tn14_08052019	optinterpol.F90		zm_conv.F90		
N1850OCBDRDDMS_f19_tn14_10052019	optinterpol.F90		zm_conv.F90		
N1850OCBDRDDMS_f19_tn14_13052019	optinterpol.F90		zm_conv.F90		
N1850_f19_tn14_06062019					
N1850_f19_tn14_11062019					

6 Characteristics of some simulations

6.1 Pre-spinup

I have selected a few simulations which I thought would be relevant.

N1850OCBDRDDMS_f19_tn14_noresm-dev-22062018_Original

- Initial tests with NorESM2 based on CESM2.0

N1850OCBDRDDMS_f19_tn14_noresm-dev-22062018_clubb_gamma_coef_.27_micro_mg_dcs_400.D-6

- Modification of γ and DCS.

N1850OCBDRDDMS_f19_tn14_doublesalt

- Doubling of sea-salt emissions by using pre-factor of two (it implies that also OPOM doubles). The emission strength is still proportional with $U^{3.41}$.

N1850OCBDRDDMS_f19_tn14_2rosc1dp

- Contains convection modifications
- Different wind-dependence for sea-salt and OPOM emissions : the emission strength is proportional with $U^{3.74}$. The emission amounts more than double.

6.2 Spinup

N1850OCBDRDDMS_f19_tn14_201218 [1–90]

- NorESM2 on 2x2 is now using a different ice-option.

N1850OCBDRDDMS_f19_tn14_250119 [91–360]

N1850OCBDRDDMS_f19_tn14_Gibr_220319 [361–420]

- The model characteristics of the Gibraltat straight have been changed.

N1850OCBDRDDMS_f19_tn14_03042019 [421–560]

- Using NorESM2 based on CESM2.1.0 from here onwards.
- Hybrid restart.

N1850OCBDRDDMS_f19_tn14_12042019 [561–625]

- Large change in DMS emission (global total + geographical distribution (?))

N1850OCBDRDDMS_f19_tn14_15042019 [626–795]

- There is a change in sea-salt and OPOM emissions (however, it is not clear where the change comes from).

N1850OCBDRDDMS_f19_tn14_25042019 [796–995]]

- There is a drop in the DMS emissions.

N1850OCBDRDDMS_f19_tn14_08052019 [996–1035]]

N1850OCBDRDDMS_f19_tn14_10052019 [1036–1100]

N1850OCBDRDDMS_f19_tn14_13052019 [1101–1515]

N1850_f19_tn14_06062019 [1516–1565]

N1850_f19_tn14_11062019 [1566–1600]

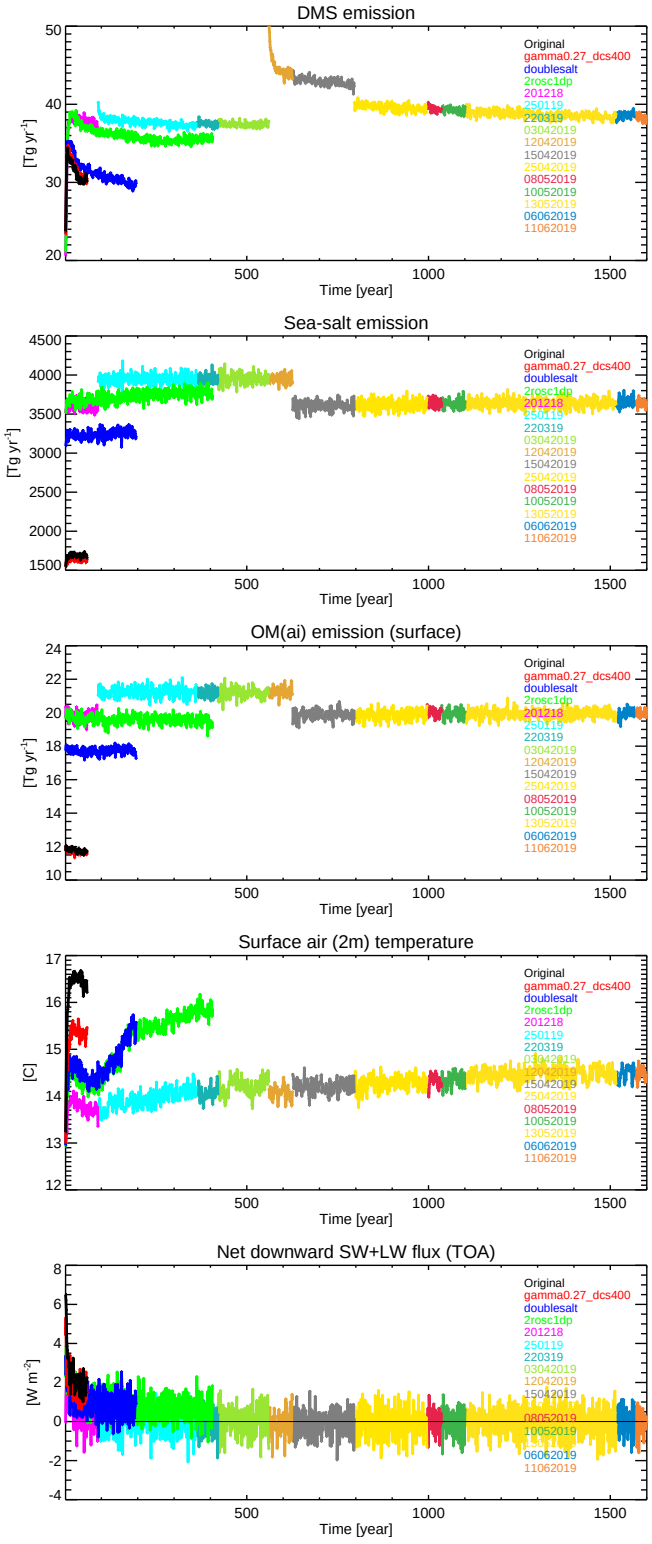

Figure : Global- and annual mean timeseries of DMS emissions, surface OM emissions, sea-salt emissions, near-surface (2 m) air temperature, and TOA imbalance.