Impact of volcanic eruptions on stratospheric ozone in NorESM2 (version1.1)

October 28, 2022

1 Description

We have done senstivity simulations, where we modified how the sulphur emissions from volcanoes are introduced in the model. Firstly, there are simulations without any sulphur emissions from volcanoes. Secondly, there are simulations where we varied the fraction of the emissions that is emitted in the gas-phase (as SO_2) and in the aerosol phase (as SO_4, with a number median radius of 75 nm). Finally, there is a setup where all the volcanic sulphur is emitted as SO_4 with a number median radius of 12 nm.

Simulations have been run on two different resolutions : 0.9°x1.25° and 1.9°x2.5°. All simulations used 32 levels, with a model top around 3 hPa (around 40 km). More experiments are available for the low-resolution setup (1.9°x2.5°), than for the high-resolution setup (0.9°x1.25°).

The simulations have been run for the period 1970–2014. The initial 5 to 10 years of the simulations have to be seen as spin-up, as the initial conditions of many gas-phase species was just 0 values.

The sea surface temperature and sea-ice cover are prescribed, based on observations.

2 Overview simulations

The raw output (1 file per month, containing all variables) of the simulations can be found on nird in the directory :
/projects/NS2345K/noresm/olivie/ozone

Table 1 gives an overview of the setup of the different simulations.

For 4 of the simulations (indicated in bold in Table 1), we have made files which cover the whole time period and contain only one variable (the variables are the ones mentioned in Table 2). These data con be found on nird in the directory :
/projects/NS2345K/noresm/olivie/concatenate

3 Overview variables

Table 2 gives an overview of some of the monthly output variables from NorESM2.

4 Total ozone column

Figure 1 shows the evolution of the monthly-mean ozone column in various regions.

5 Ozone at 50 hPa

Figure 2 shows the evolution of the monthly-mean ozone mixing ratio at 50 hPa in various regions.

Table 1: Overview of available simulations.

SO_2 (gas) (%)	SO_4 75 nm (aer.) (%)	SO_4(na) 12 nm (aer.) (%)	Resolution	Experiment name
–	–	–	0.9°x1.25°	**NFHISTnorpddmsbc_tropstratchem_f09_mg17_20220105_test16**
100	–	–	0.9°x1.25°	NFHISTnorpddmsbc_tropstratchem_f09_mg17_20220105_test12
90	10	–	0.9°x1.25°	**NFHISTnorpddmsbc_tropstratchem_f09_mg17_20220105_test14**
–	100	–	0.9°x1.25°	NFHISTnorpddmsbc_tropstratchem_f09_mg17_20220105_test13
–	–	–	1.9°x2.5°	**NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test13**
100	–	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test02
97.5	2.5	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test05
95	5	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test09
90	10	–	1.9°x2.5°	**NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test08**
80	20	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test10
50	50	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test12
0	100	–	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test03
–	–	100	1.9°x2.5°	NFHISTnorpddmsbc_tropstratchem_f19_mg17_20220105_test11

Table 2: Overview of some of the NorESM2 output variables.

O_3	$\mathrm{mol\,mol^{-1}}$	ozone mixing ratio
cb_O3	$\mathrm{kg[O_3]\,m^{-2}}$	total ozone column
SO_2	$\mathrm{mol\,mol^{-1}}$	sulphur dioxide mixing ratio
mmr_SULFATE	$\mathrm{kg\,kg^{-1}}$	sulphate mixing ratio
cb_SULFATE	$\mathrm{kg\,m^{-2}}$	sulphate column burden
T	K	temperature
PS	Pa	surface pressure
U	$\mathrm{m\,s^{-1}}$	zonal wind
V	$\mathrm{m\,s^{-1}}$	meridional wind

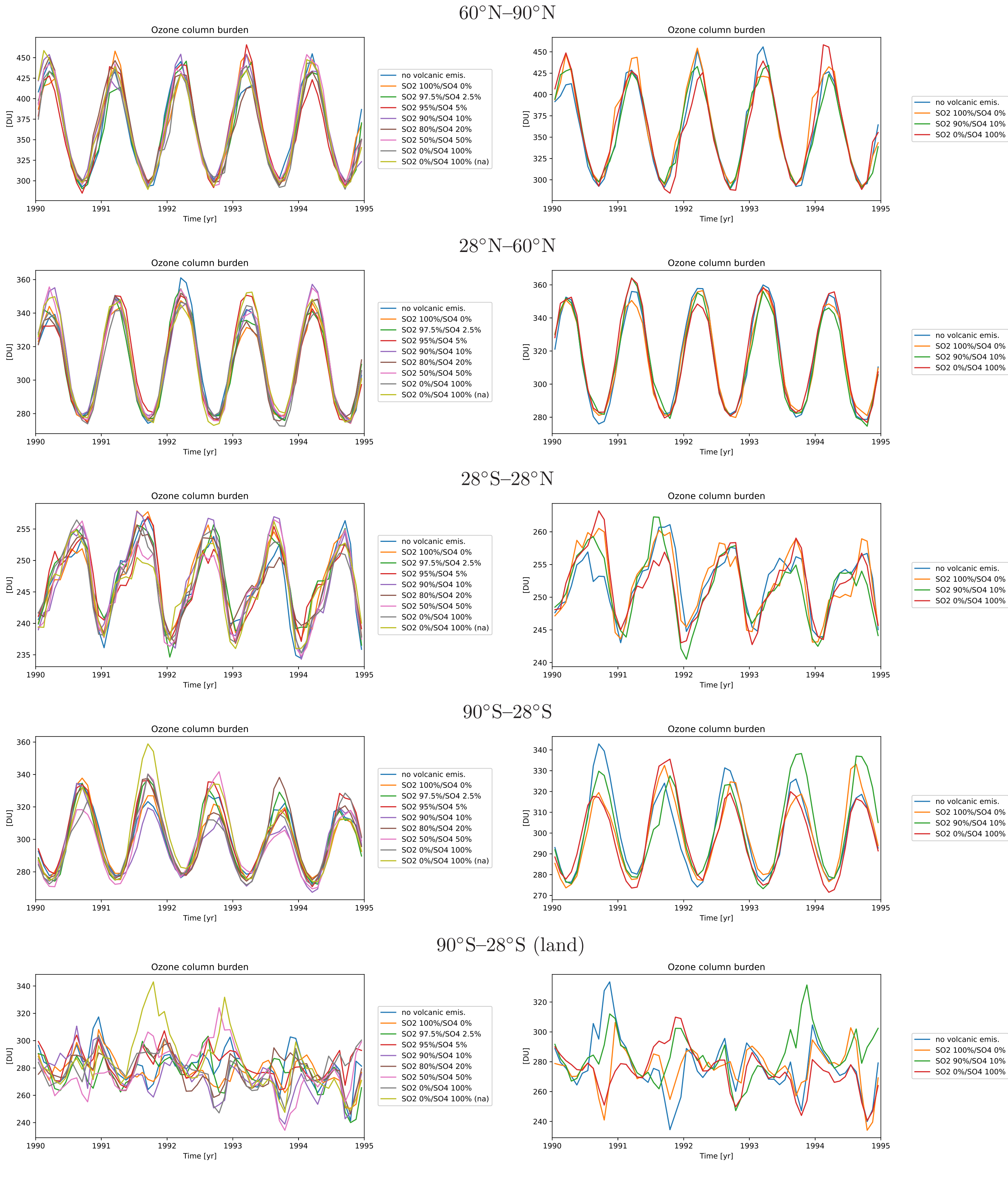
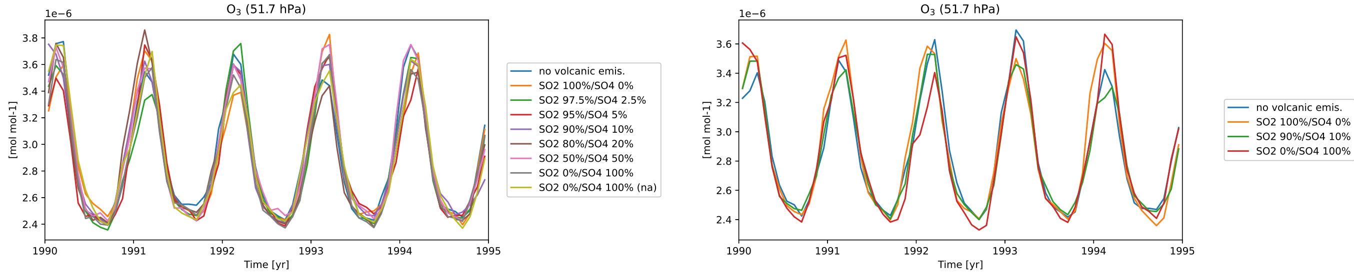
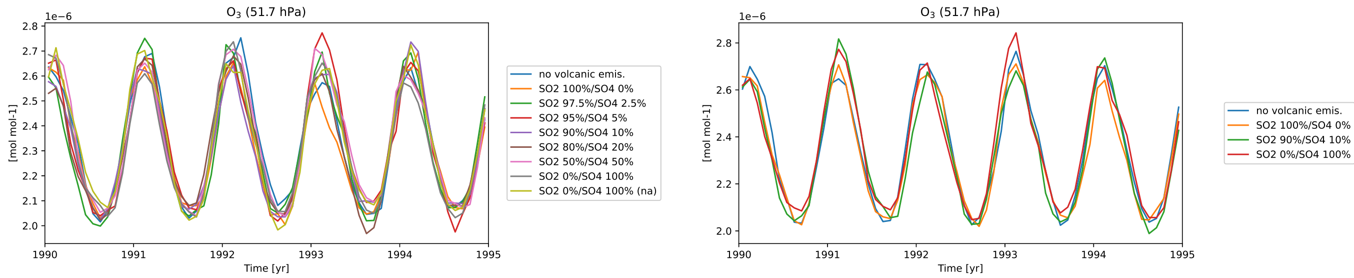


Figure 1: Total ozone column (in DU) averaged over different regions : 60°N–90°N, 28°N–60°N, 28°S–28°N, 90°S–28°S and 90°S–28°S (only over land) using 1.9°x2.5° (left) and 0.9°x1.25° (right) horizontal resolution.

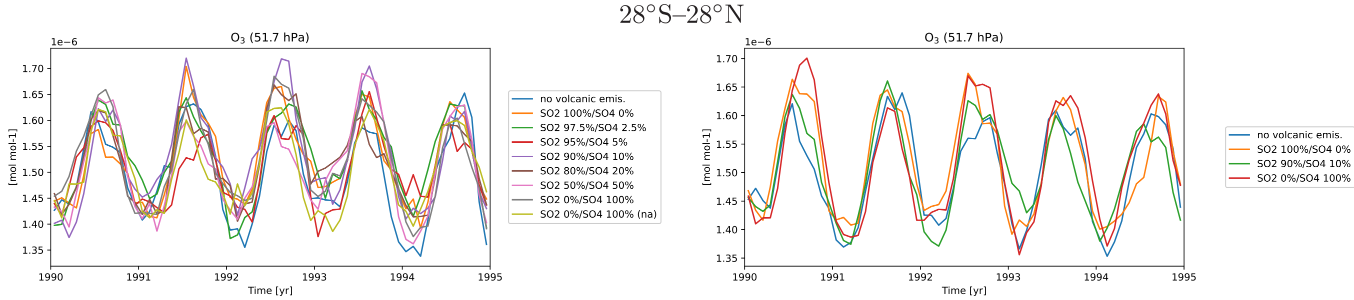
60°N–90°N



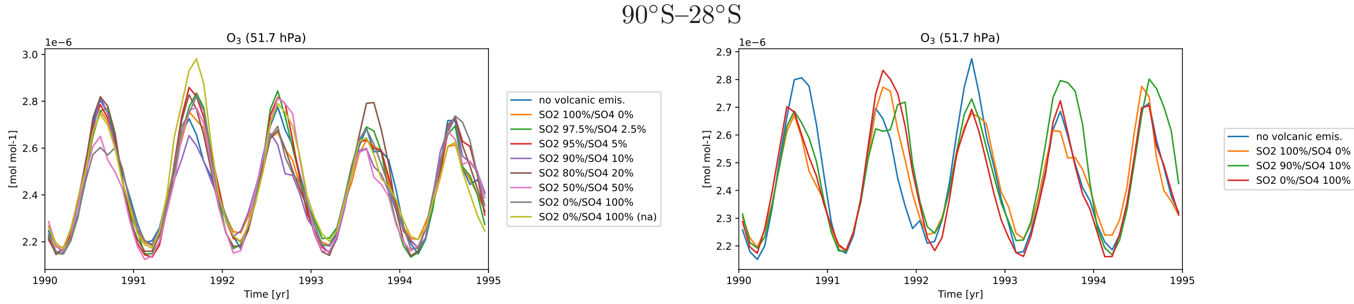
28°N–60°N



28°S–28°N



90°S–28°S



90°S–28°S (land)

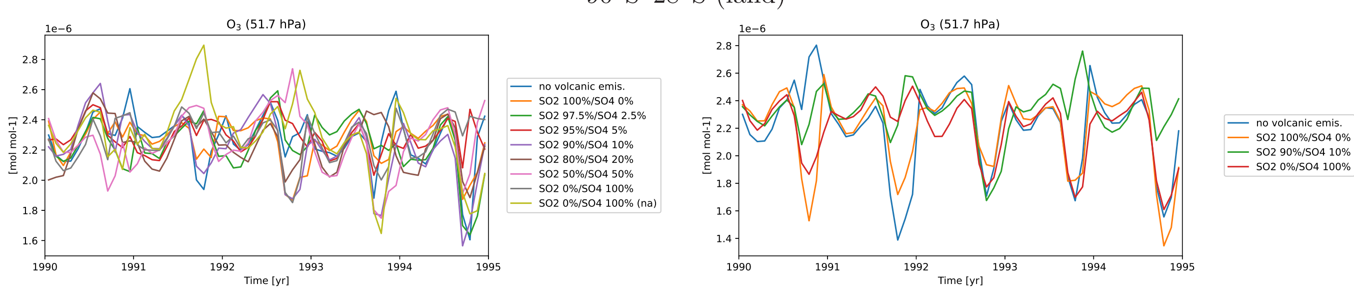


Figure 2: Ozone mixing ratio at 50 hPa averaged over different regions : 60°N–90°N, 28°N–60°N, 28°S–28°N, 90°S–28°S and 90°S–28°S (only over land) using 1.9°x2.5° (left) and 0.9°x1.25° (right) horizontal resolution.