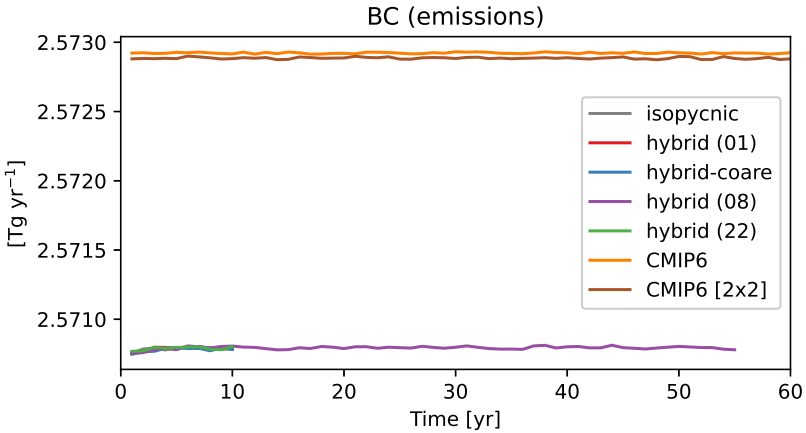
Some aerosol diagnostics in NorESM2.5 simulations

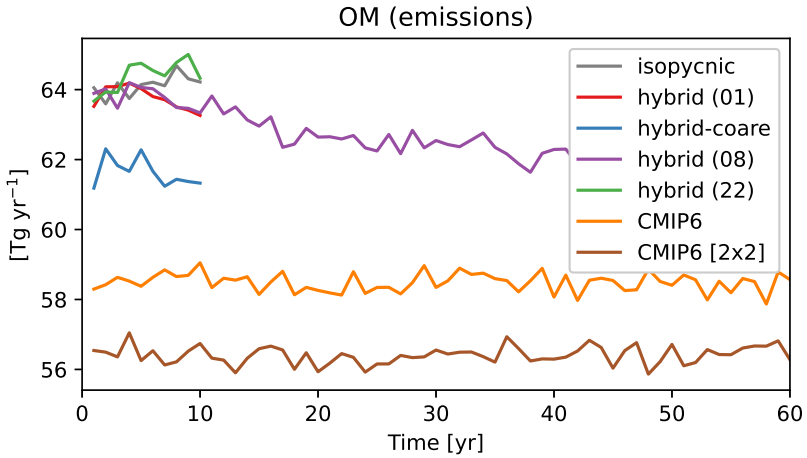
September 1, 2024

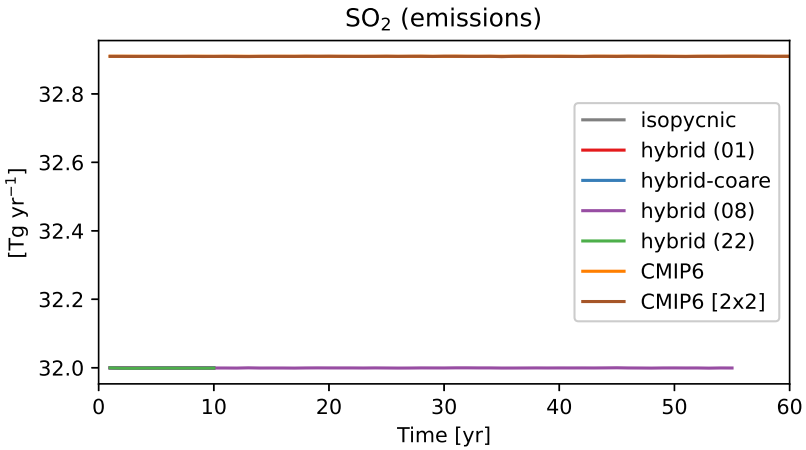
Experiments overview

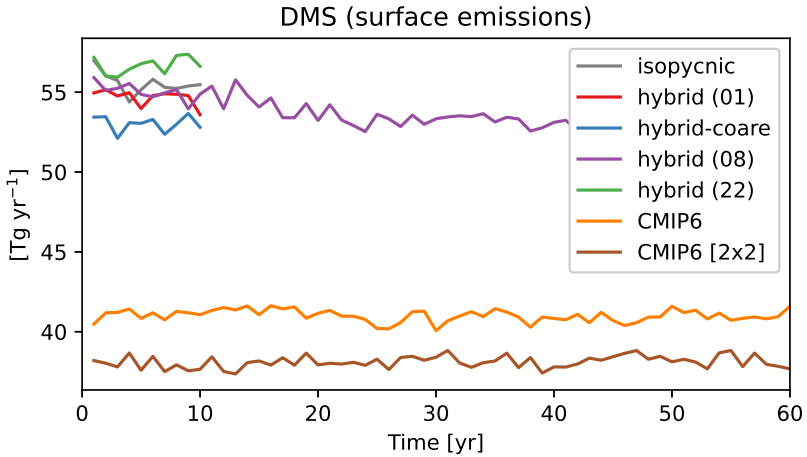
Model	Case name	Length	Resolution
NorESM2.5	n1850.ne30_tn14.**isopycnic**.20240801	1–10	SE/1x1
NorESM2.5	n1850.ne30_tn14.**hybrid**.20240801 **(01)**	1–10	SE/1x1
NorESM2.5	n1850.ne30_tn14.**hybrid_coare**.20240801	1–10	SE/1x1
NorESM2.5	n1850.ne30_tn14.**hybrid**.20240808 **(08)**	1–55	SE/1x1
NorESM2.5	n1850.ne30_tn14.**hybrid**.20240822 **(22)**	1–10	SE/1x1
NorESM2-**MM** (CMIP6)	N1850frc2_f09_tn14_20191001	1200–1299	FV/1x1
NorESM2-**LM** (CMIP6)	N1850_f19_tn14_20190722	1801–1900	FV/2x2

Aerosol emissions (1)



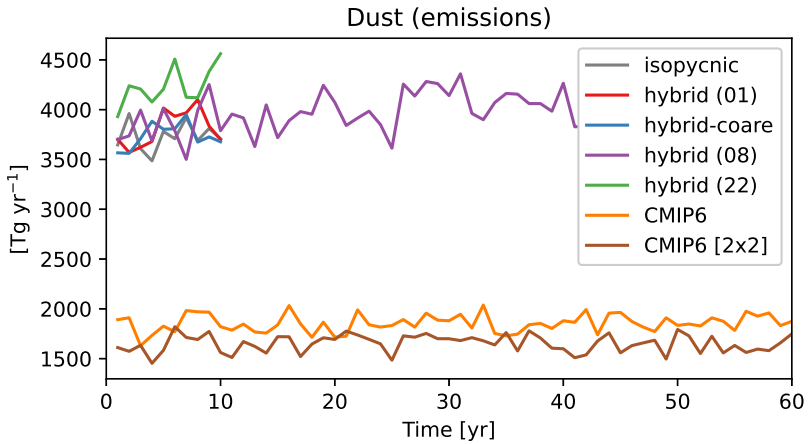


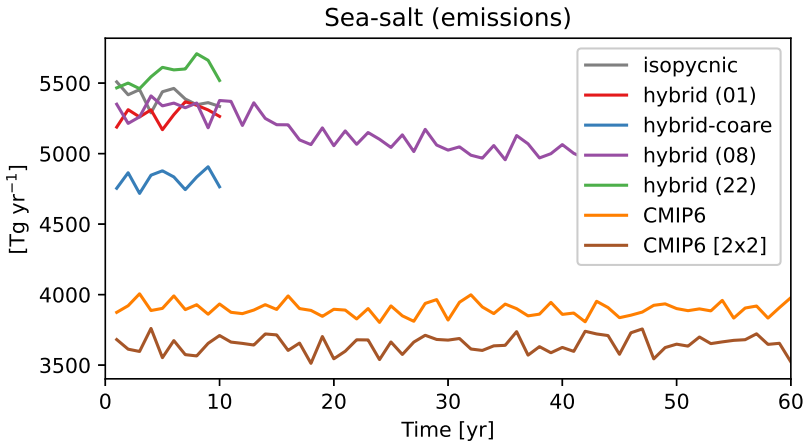


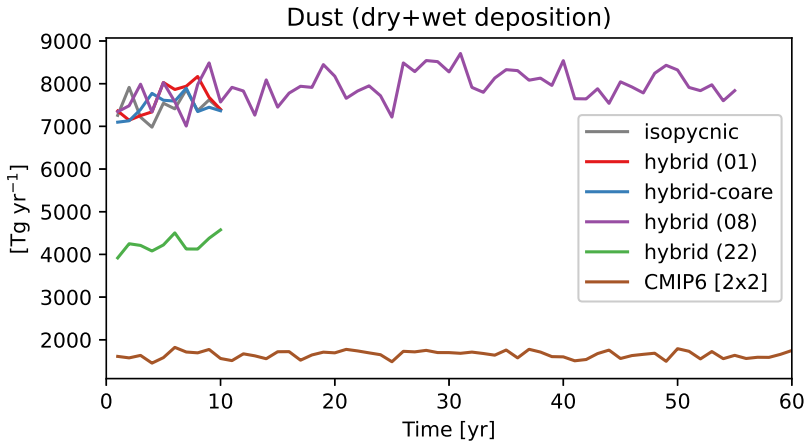


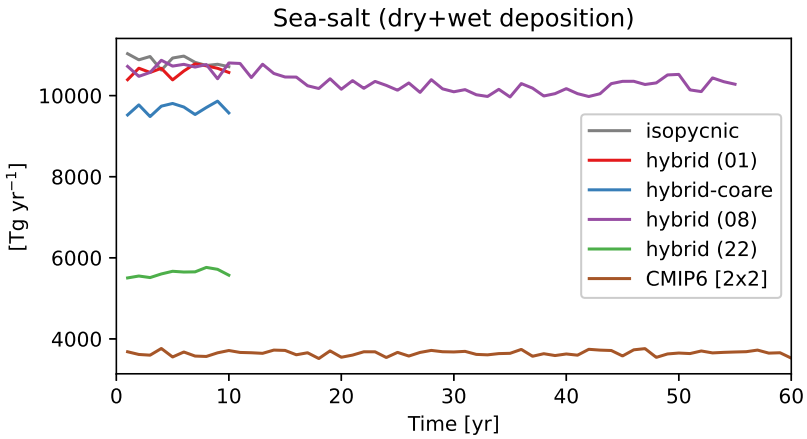
1. BC emissions very similar in NorESM2 and NorESM2.5.
2. OM emissions : stronger in NorESM2.5, probably due to higher ocean emissions (higher wind speeds, see later)
3. SO_2 emissions : differ slightly
4. DMS emissions : stronger in NorESM2.5 by around 35%, probably due to higher wind speeds.

Aerosol emissions (2)



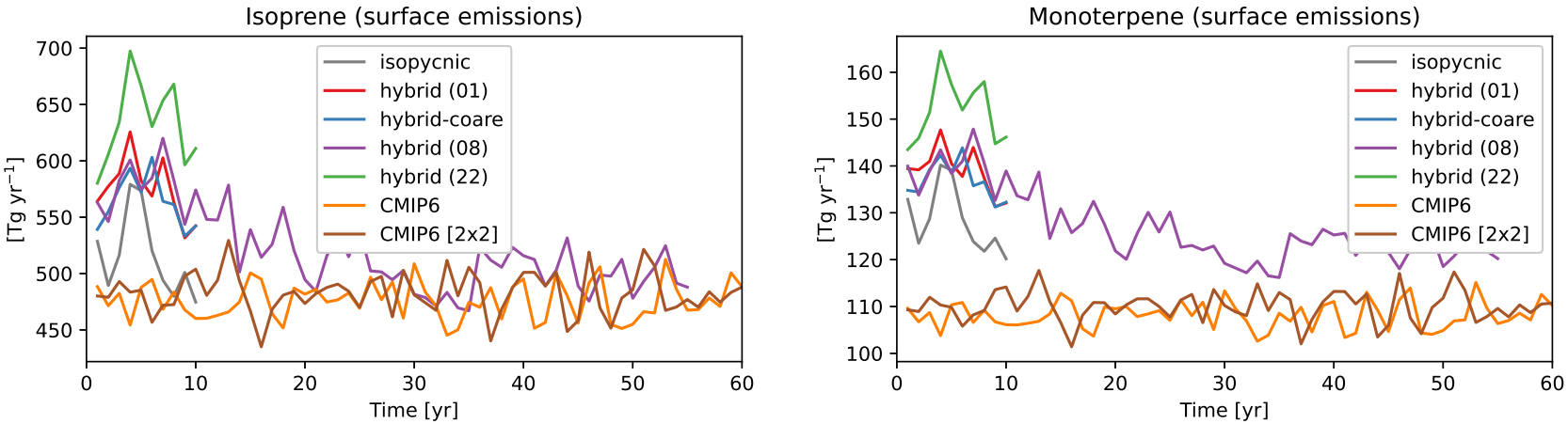






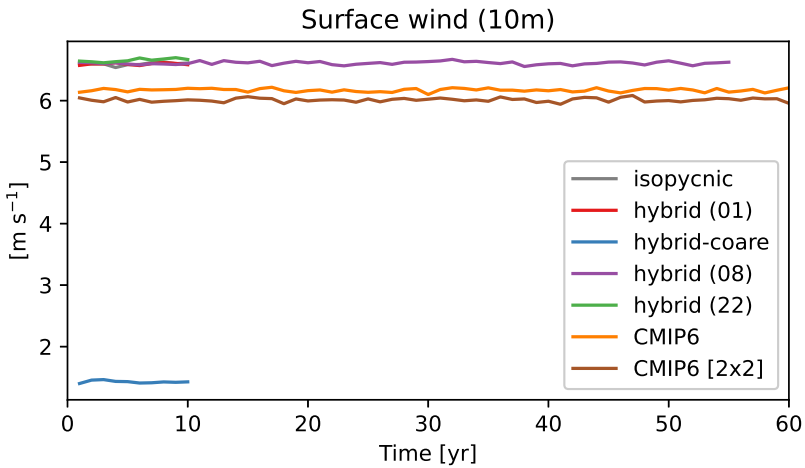
1. In *isopycnic*, *hybrid (01)*, *hybrid-coare* and *hybrid (08)*, the emissions (diagnosed wrongly) differ from the deposition (diagnosed correctly). The actual emission amount ending up in the model is what is seen in the deposition diagnostics.
2. Even in the correct simulation *hybrid (02)*, the dust emission in NorESM2.5 is more than twice as large as in NorESM2. Has the dust emission scheme changed?
3. In the correct simulation *hybrid (08)*, the seasalt emissions are around 35 % higher in NorESM2.5 than in NorESM2, probably due to larger wind speeds.

Aerosol emissions (3)



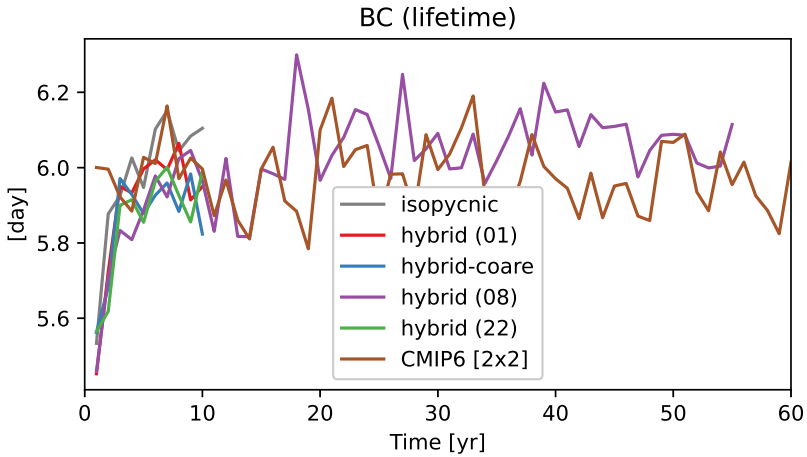
1. In the longer NorESM2.5 simulation *hybrid (08)*, the emissions of isoprene and monoterpenes tends to converge to the NorESM2 values.

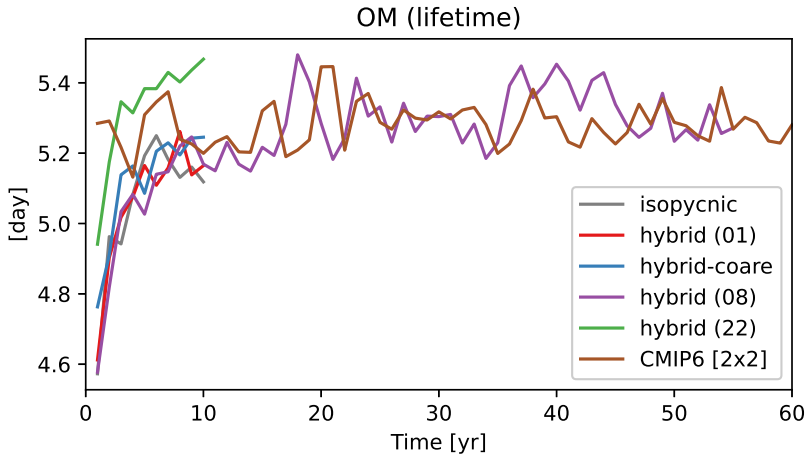
10 m wind speed

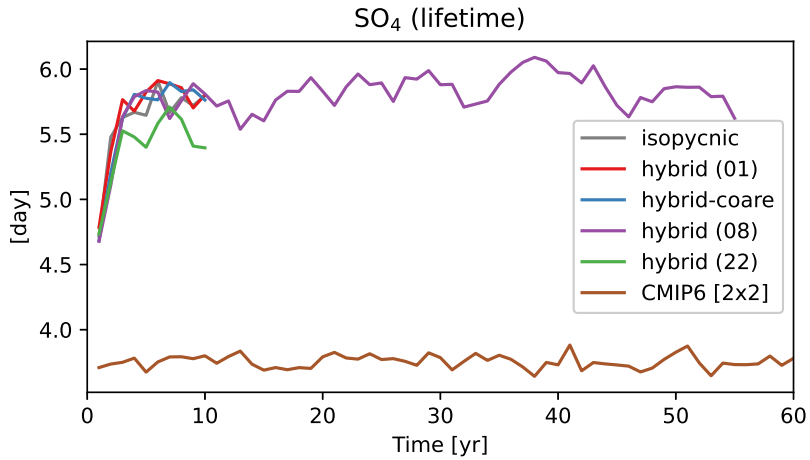


1. Surface winds are around 10 % stronger in NorESM2.5 than in NorESM2. For emissions parameterization depending on the 3rd power of the wind speed, will this lead to emission increases of around 35 %.
2. In the *hybrid-coare* simulation the U10 diagnostic is probably wrong. The model sees probably corrects winds, which most likely are slightly lower than in the other NorESM2.5 simulations as sea-salt, marine OM and DMS emissions are sligtly smaller.

Aerosol lifetime (1)

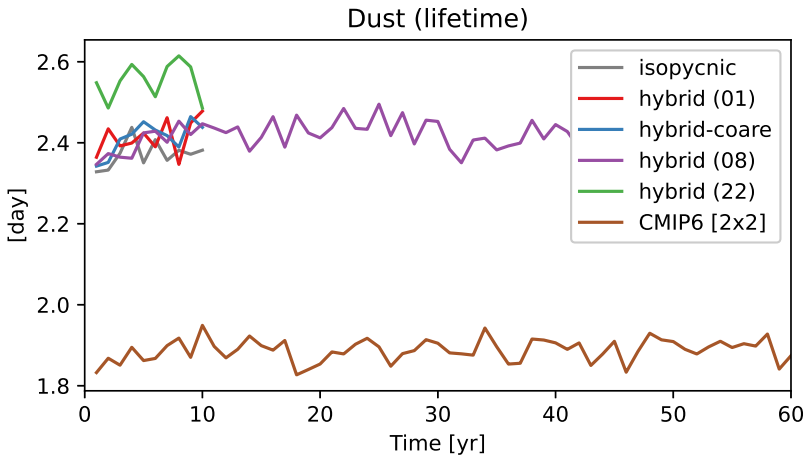


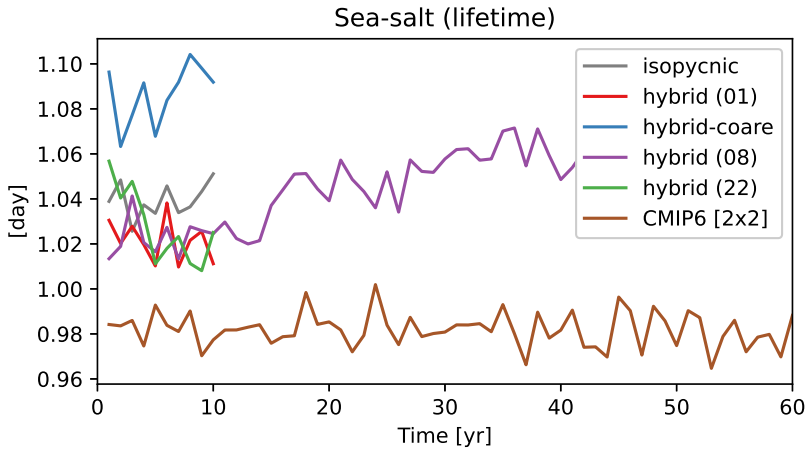




1. Lifetime of BC : similar in NorESM2.5 and NorESM2.
2. Lifetime of OM : similar in NorESM2.5 and NorESM2. Slightly increased in *hybrid (22)*.
3. Lifetime of SO_4 : considerably longer (around 50 %) in NorESM2.5 than in NorESM2. One finds much more sulphate aloft (see later), probably increasing the lifetime.

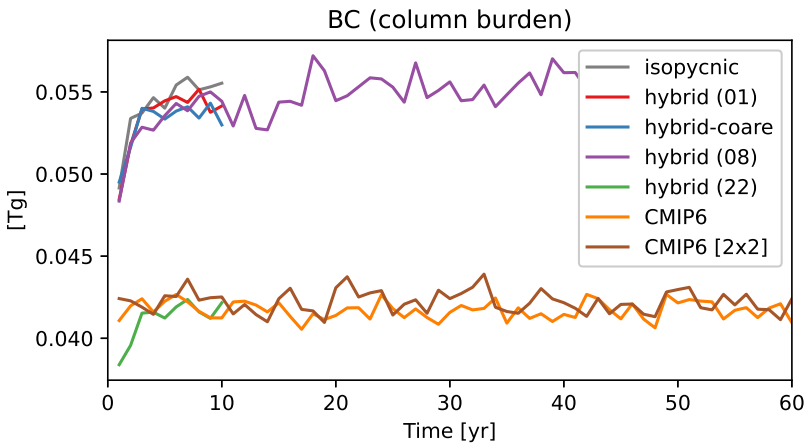
Aerosol lifetime (2)

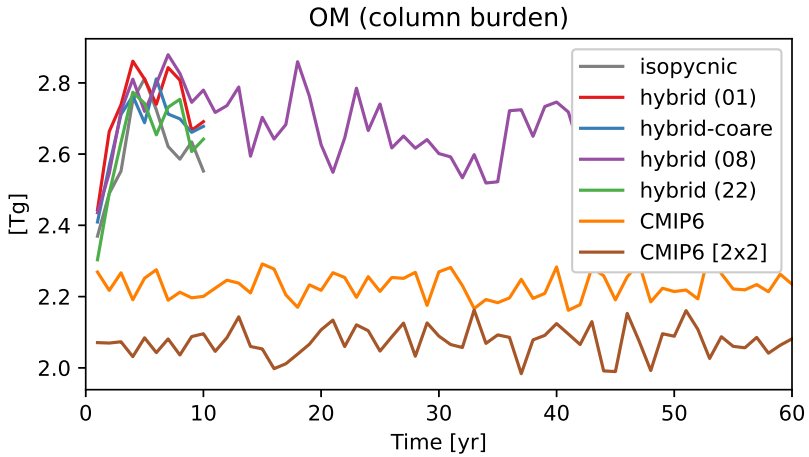


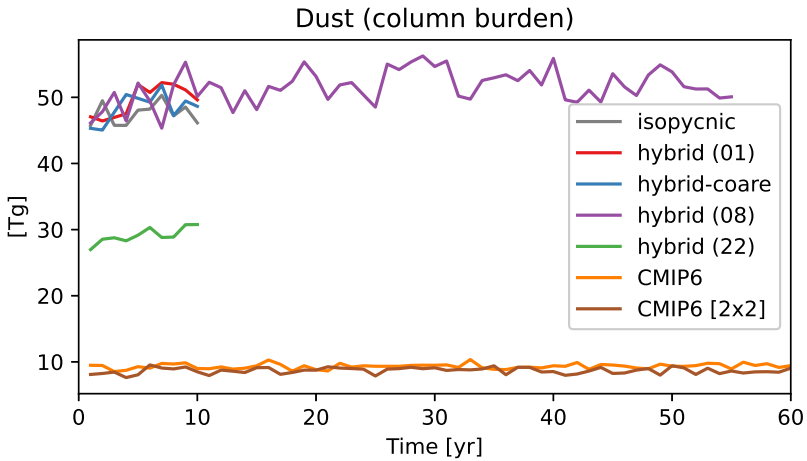


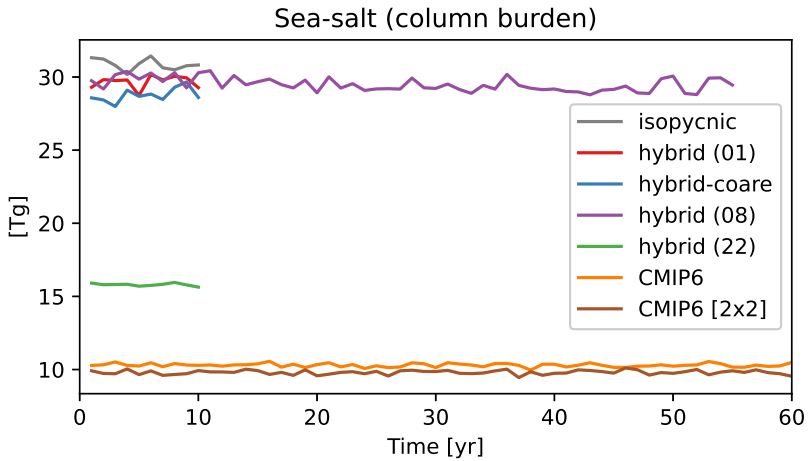
1. Dust lifetime in NorESM2.5 is around 30 % larger than in NorESM2. This can be due to the dry deposition bug correction introduced in NorESM2.1.
2. Sea-salt lifetime increases by 5 % in NorESM2.5 compared to NorESM2.
3. *isopycnic* shows slightly stronger increase in sea-salt lifetime.

Aerosol burden (1)



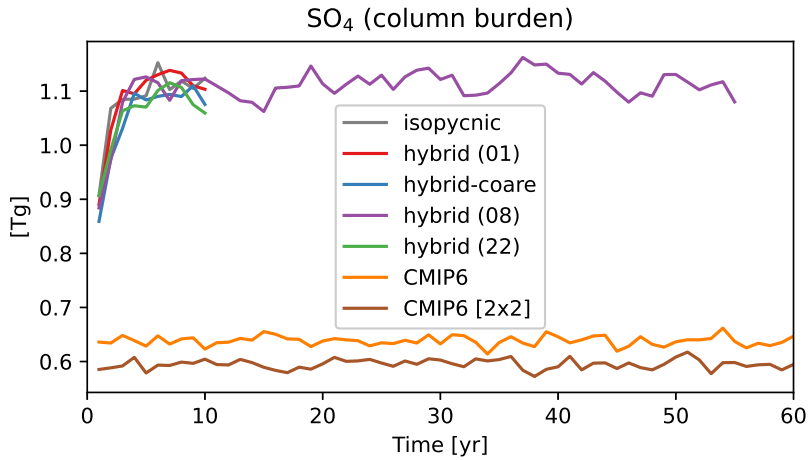






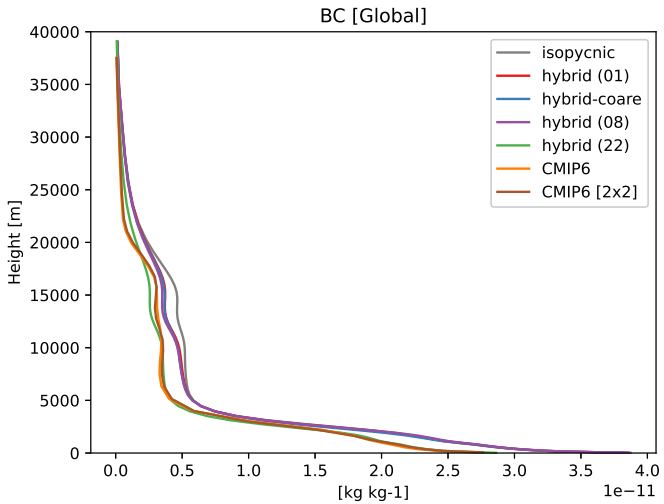
1. BC column burden in *hybrid (22)* is very similar to NorESM2. Other NorESM2.5 simulations (bugged) differed more from NorESM2.
2. OM burden in NorESM2.5 is initially around 25 % higher than in NorESM2. Possibly partially due to initially higher isoprene and monoterpene emissions, partially due to stronger marine OM (due to stronger winds).
3. Dust burden in *hybrid (22)* is around 3 times as large as in NorESM2 (in accordance with emission changing by factor 2.4, and lifetime changing by factor 1.3).
4. Sea-salt burden in *hybrid (22)* is around 60% higher than in NorESM2.

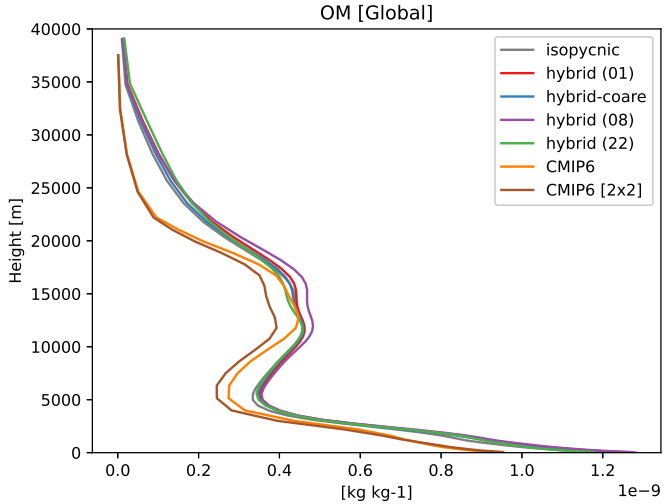
Aerosol burden (2)

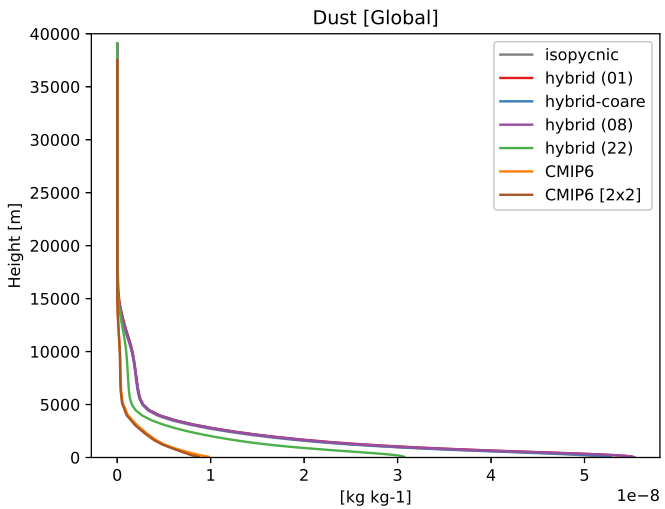


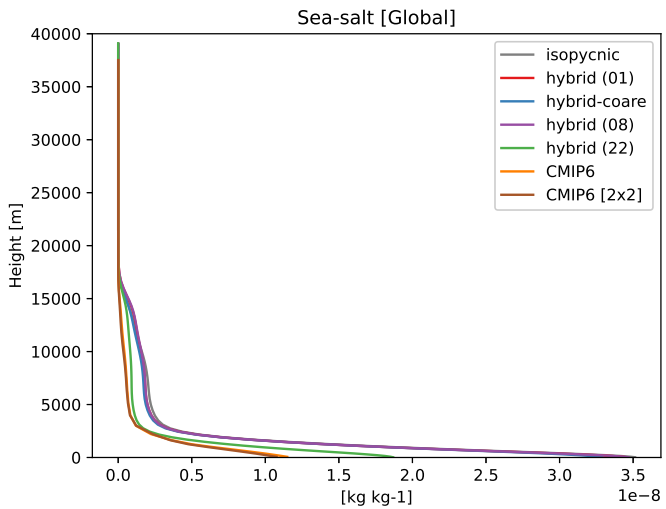
1. Sulfate burden is around 50 % higher in NorESM2.5 than in NorESM2 (in accordance with lifetime change).

Aerosol profiles



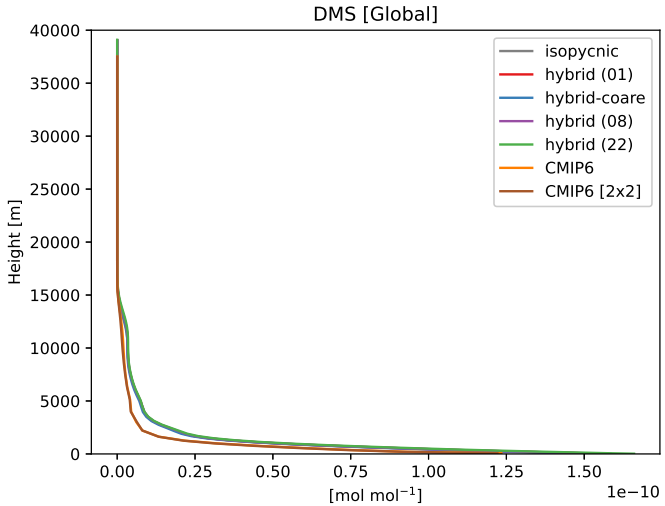


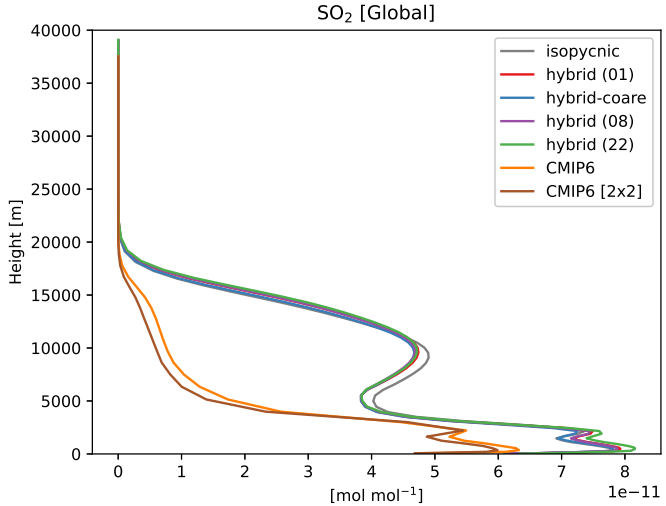


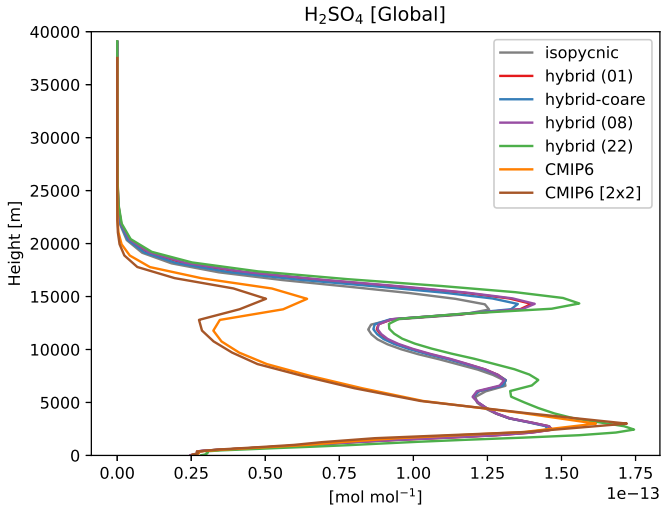


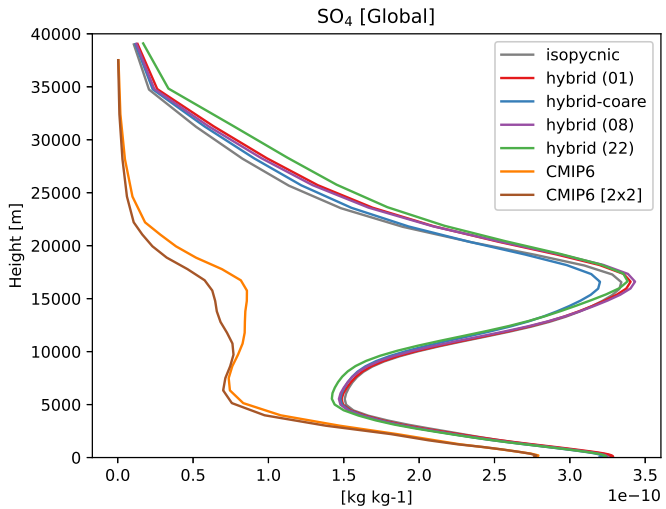
1. In NorESM2.5, BC and OM show considerably higher values than NorESM2 in the stratosphere. For BC, the difference for *hybrid (22)* is less.
2. In NorESM2.5, dust and sea-salt mixing ratios are higher between 5 and 15 km. The difference is less for *hybrid (22)*.

$DMS/SO_2/H_2SO_4/SO_4$ profiles



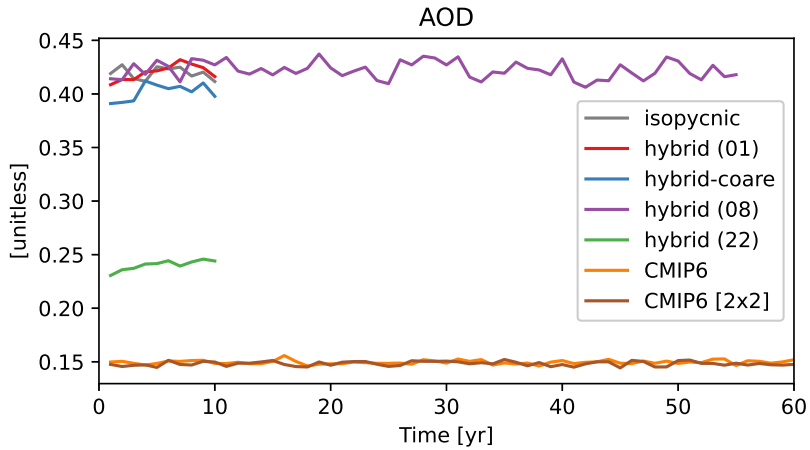






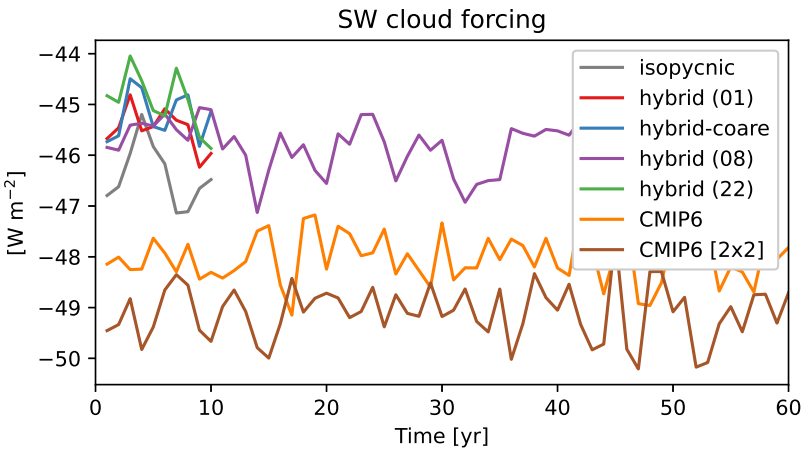
1. Sulfate profile in NorESM2.5 is very different from NorESM2. The upper-troposphere/lower-stratosphere loading might partially come from higher DMS emissions. But there might be other reasons . . .

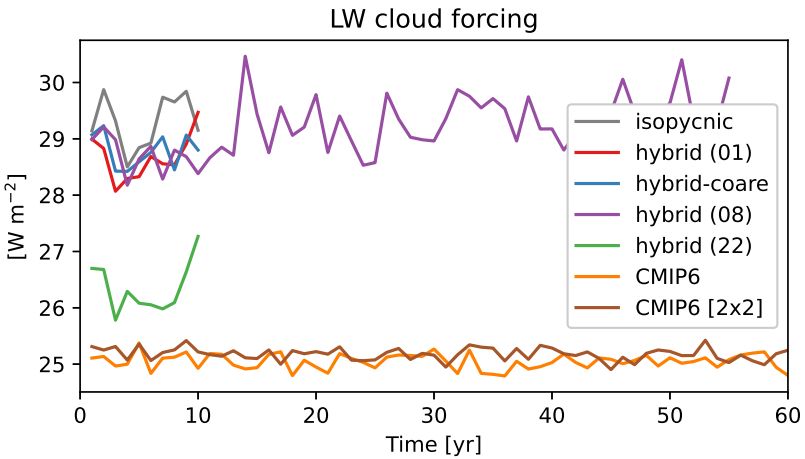
Aerosol optical depth



1. AOD in *hybrid (22)* is 60–70 % larger than in NorESM2.

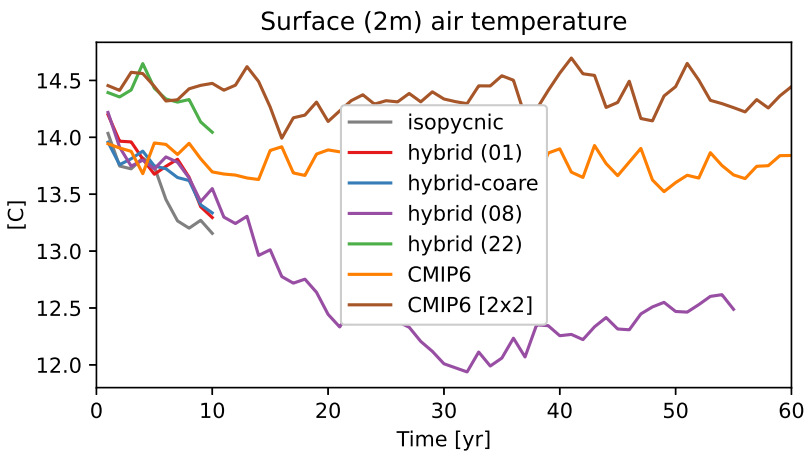
SWCF and LWCF

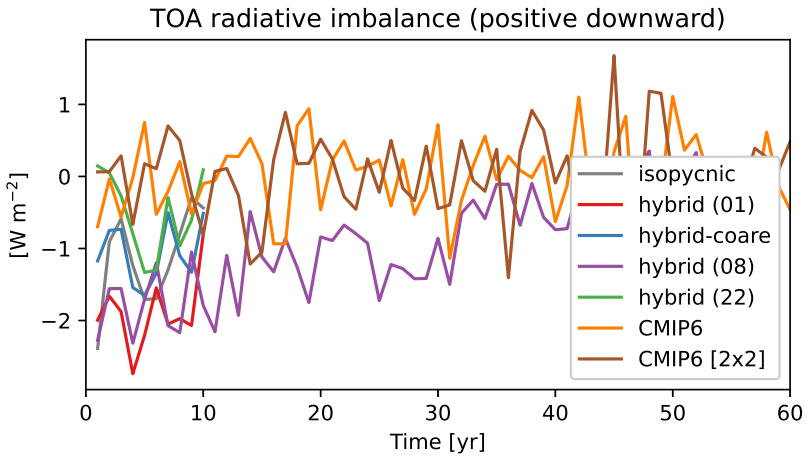




1. SW cloud forcing is around 2–3 W m^{-2} weaker in NorESM2.5 than in NorESM2.
2. *isopycnic* shows slightly stronger SWCF than other NorESM2.5 simulations.
3. LW cloud forcing in *hybrid (22)* is around 1 W m^{-2} stronger than in NorESM2.

Surface (2 m) air temperature and net TOA radiative imbalance





1. Initial NorESM2.5 simulations are considerably colder than NorESM2.
2. *hybrid (22)* is initially as warm as NorESM2-LM.
3. TOA imbalance in *hybrid (22)* is initially around $1\,\mathrm{W\,m^{-2}}$.

Clearsky SW fluxes (TOA and surface)