## 3.      D5.1 Global simulations inventory of Task 5.1

In the first set of simulations, presented D3.1, we examined the sensitivity of the SAOD to the injection height of the smoke plume. The best agreement with observations is found by assuming a maximum injection height at 16 Km. The next step will be to quantify the radiative perturbations in the stratosphere and the global radiative forcing after ANY. Smoke, however, presents rather different properties from the liquid, spherical, less light-absorbing sulfuric acid droplets of volcanic origin that are usually found at stratospheric altitudes. StratoFIRE will explore a detailed characterization of the optical and microphysical properties of stratospheric smoke, which at present remain poorly understood mainly due to the sparsity of the remote sensing /in-situ observations in the LS (Gialitaki et al., 2020). This uncertainty complicates considerably any assessment about the radiative impacts of stratospheric smoke.

**Data access**

The data from the simulations of the ANY event are given in the StratoFIRE website (https://stratofire.space.noa.gr/). Specifically, we have uploaded simulations described in the following table and in D3.1. We carry out sensitivity simulations to examine the sensitivity of the stratospheric aerosol loading to injection height of the smoke (Table 1). The model is running with nudged meteorology from ERA5 till 28 December 2019 and freely thereafter till the end of 2020. We emit 0.9 Tg of smoke composed by 97.5% organic carbon and 25 % Black Carbon. The particles are emitted in the insoluble Aitken mode.

*Table 1 List of the sensitivity simulations with the EMAC model.*

| Simulation | Description |
| --- | --- |
| Free_13Km | Nudging ends 28 Dec 2019. Emission 11-13 Km |
| Free_14Km | As Free but emission between 11-14 Km |
| Free_15Km | As Free but emission between 11-15 Km |
| Free_16Km | As Free but emission between 11-16 Km |

*Table 2 List of variables from the EMAC model simulations upload in the webpage*

The StratoFIRE database includes a subset of the produced variables, owing to storage limitation in the cloud. A description of the dataset is given below and are accessible under the link described in Figure 2.

### *Description of the dataset*

File name: Free_15Km_dtdt_lw_ave_2019-2020_mm.nc

Time Period and resolution: 2019-2022, monthly

Domain: Global, 47 pressure levels but post-processed to flag to the tropopause height. The stratosphere is resolved only.

Variables: dtdt_sw_ave, O3, qm1, t

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The list of the variables and the full names is given below.

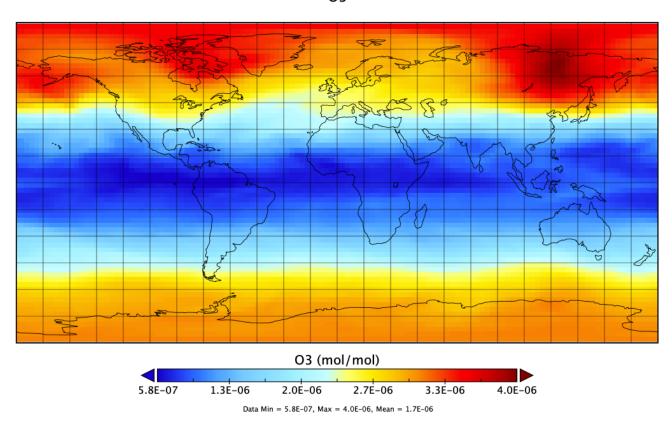| Model variable name | Variable |
| --- | --- |
| dtdt_sw_ave | shortwave heating rate [K/s] |
| O3 | Ozone concentration [mol/mol] |
| qm1 | specific humidity [kg kg-1] |
| t | Temperature [K] |

## O3



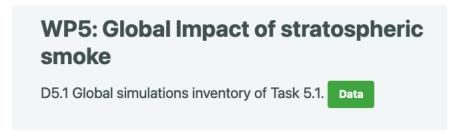Figure 1 Example of stratospheric ozone field at 59 hPa in the Control simulation.



Figure 2 The link for accessing the data.

## 4. Bibliography

Gialitaki, A., Tsekeri, A., Amiridis, V., Ceolato, R., Paulien, L., Kampouri, A., Gkikas, A., Solomos, S., Marinou, E., Haarig, M., Baars, H., Ansmann, A., Lapyonok, T., Lopatin, A., Dubovik, O., Groß, S., Wirth, M., Tsichla, M., Tsikoudi, I., & Balis, D. (2020). Is the near-spherical shape the "new black" for smoke? *Atmospheric Chemistry and Physics*, *20*(22), 14005–14021. https://doi.org/10.5194/acp-20-14005-2020

Sellitto, P., Belhadji, R., Kloss, C., & Legras, B. (2022). Radiative impacts of the Australian bushfires 2019-2020 - Part 1: Large-scale radiative forcing. *Atmospheric Chemistry and Physics*, *22*(14), 9299–9311. https://doi.org/10.5194/acp-22-9299-2022

## 5. Appendix

libRadtran configuration file for 15°-25°S in April 2020 using the AOD from GloSSAC

```
source solar libRadtran-2.0.5/data/solar_flux/kurudz_1.0nm.dat
atmosphere_file libRadtran-2.0.5/data/atmmod/afglms.dat

rte_solver sdisort
pseudospherical
number_of_streams 6
deltam on

sza 30                          # Solar zenith angle
day_of_year 105

mol_abs_param reptran coarse
wavelength 279.0 3001.0
spline 280.0 3000.0 1.0

aerosol_default
aerosol_file tau AERO_TAU/AERO_TAU_2020-04_lat-25-15.dat
aerosol_angstrom 0.72825104 0.6575233
aerosol_modify gg set 0.7
aerosol_modify ssa set 0.95

albedo 0.07
zout surf 15.000 16.000 17.000 18.000 19.000 20.000 21.000 22.000 23.000 24.000 25.000 27.500 30.000 32.500 35.000
37.500 40.000 42.500 45.000 47.500 50.000 toa

heating_rate
output_process integrate
output_user zout heat edir eglo eup edn enet
quiet
```