CONFESS

Consistent representation of temporal variations of boundary forcings in reanalyses and seasonal forecasts

Task 2.1: Tropospheric aerosols

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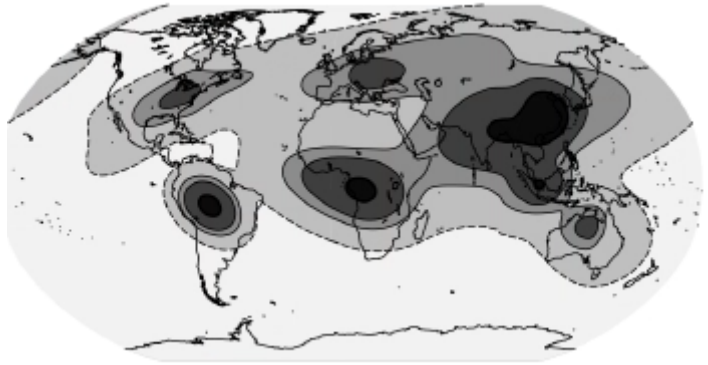
MACv2-SP: original plan, now dropped

- MACv2-SP is a simple plume model of anthropogenic aerosol, used in CMIP6 to explore model sensitivity to aerosol, and also in H2020 PRIMAVERA project.
- Idea was to blend with more detailed present-day IFS climatology to give approximate time-evolution of aerosol compatible with IFS.



BUT two serious issues emerged:

- Need to partition existing IFS climatology between anthropogenic (to be scaled) and an unchanging natural background. For some aerosol types, no way to do this.
- Existing IFS climatology is seriously out of date! Aerosol model has been much improved (including new aerosol types, coupling with full chemistry model, improved emissions etc).

Even without these problems, MACv2SP would give only a very crude approximation of aerosol change.

=> Look for a different approach

Generation of new time-dependent IFS aerosol climatology

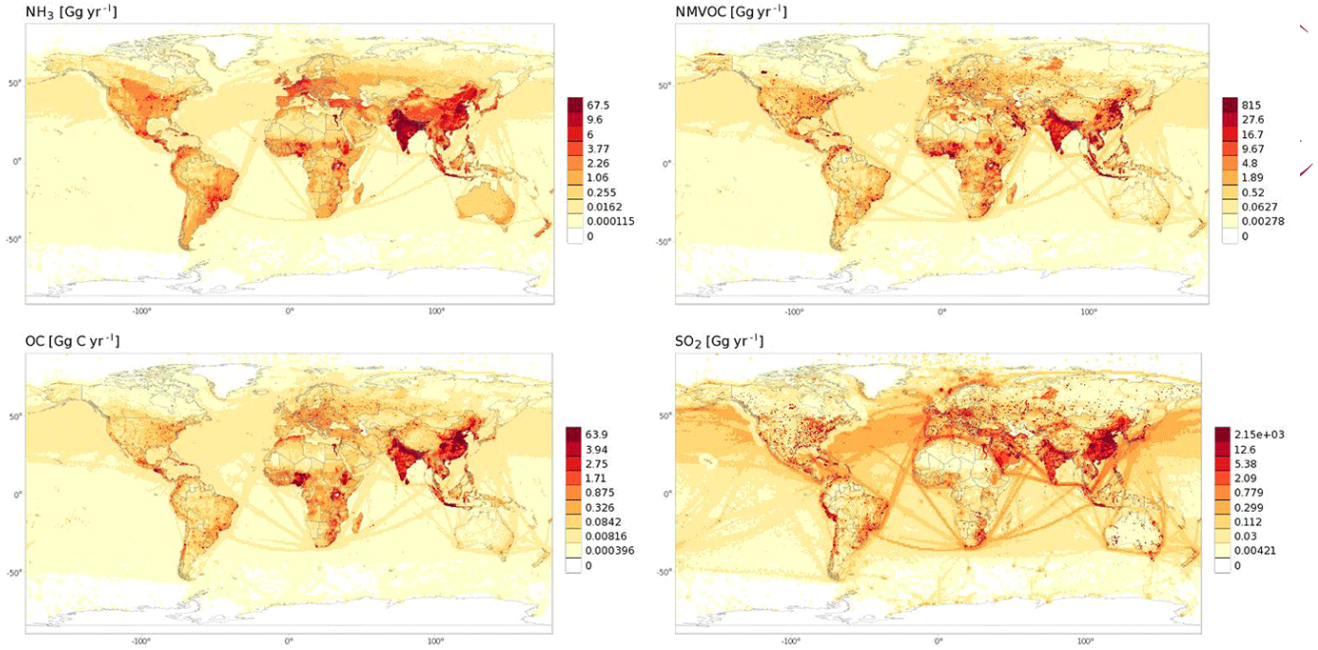
- Primary CMIP6 method of treating tropospheric aerosol is to specify emissions and allow the model to calculate the resulting aerosol distribution.
- Method used to calculate the IFS aerosol climatology was to run the CAMS aerosol model with specified emissions, plus some calibration steps.

$\Rightarrow$ Combine these approaches by running IFS aerosol model over multiple decades to give a time varying aerosol climatology

$\Rightarrow$ Also gives us a new, up-to-date aerosol climatology for use in NWP

Modelling aerosol

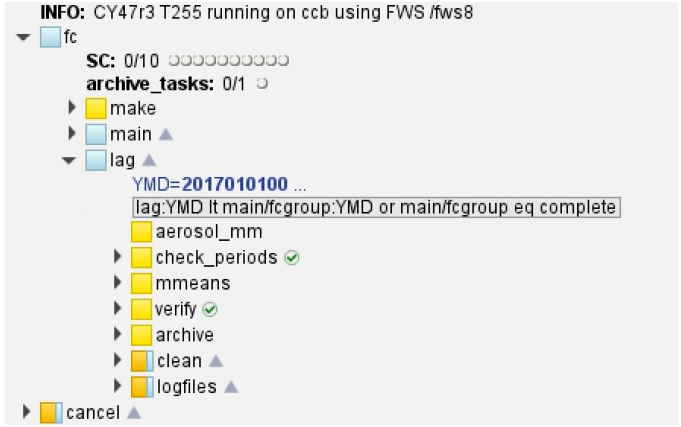
- Aerosol depends on **emissions** and **processes**.
- Detailed emissions data available, e.g. CEDS data for CMIP6 back to 1850 (0.5 degree grid, monthly, multiple species)
- More detailed datasets with sub-daily time resolution available for recent periods.
- New CAMS developments allow more flexible specification of input emissions datasets.
- Latest CAMS aerosol module has 14 species, including secondary aerosols, and is fully integrated with the 56-species chemistry model.
- Latest module also has much improved processes (affecting sources and sinks).



Emissions dataset	Emission species provided
Anthropogenic bulk emissions	CO, CH_4, NH_3, NO_x, SO_2, NMVOC, BC, OC, CO_2
Open burning bulk emissions	CO, CH_4, NH_3, NO_x, SO_2, NMVOC, BC, OC, H_2
Speciated anthropogenic emissions	alcohols, ethane, propane, butanes, pentanes, hexanes_plus_higher_alkanes, ethene, propene, ethyne, other_alkenes_and_alkynes, benzene, toluene, xylene, trimethylbenzenes, other_aromatics, esters
Speciated open burning emissions	$C_{10}H_{16}$, C_2H_2, C_2H_4, C_2H_4O, C_2H_5OH, C_2H_6, C_2H_6S, C_3H_6, C_3H_6O, C_3H_8, C_5H_8, C_6H_6, C_7H_8, C_8H_{10}, CH_2O, CH_3COCHO, CH_3COOH, CH_3OH, HCN, HCOOH, higher-alkanes, higher-alkenes, $HOCH_2CHO$, MEK, toluene-lump

How to create a new aerosol climatology

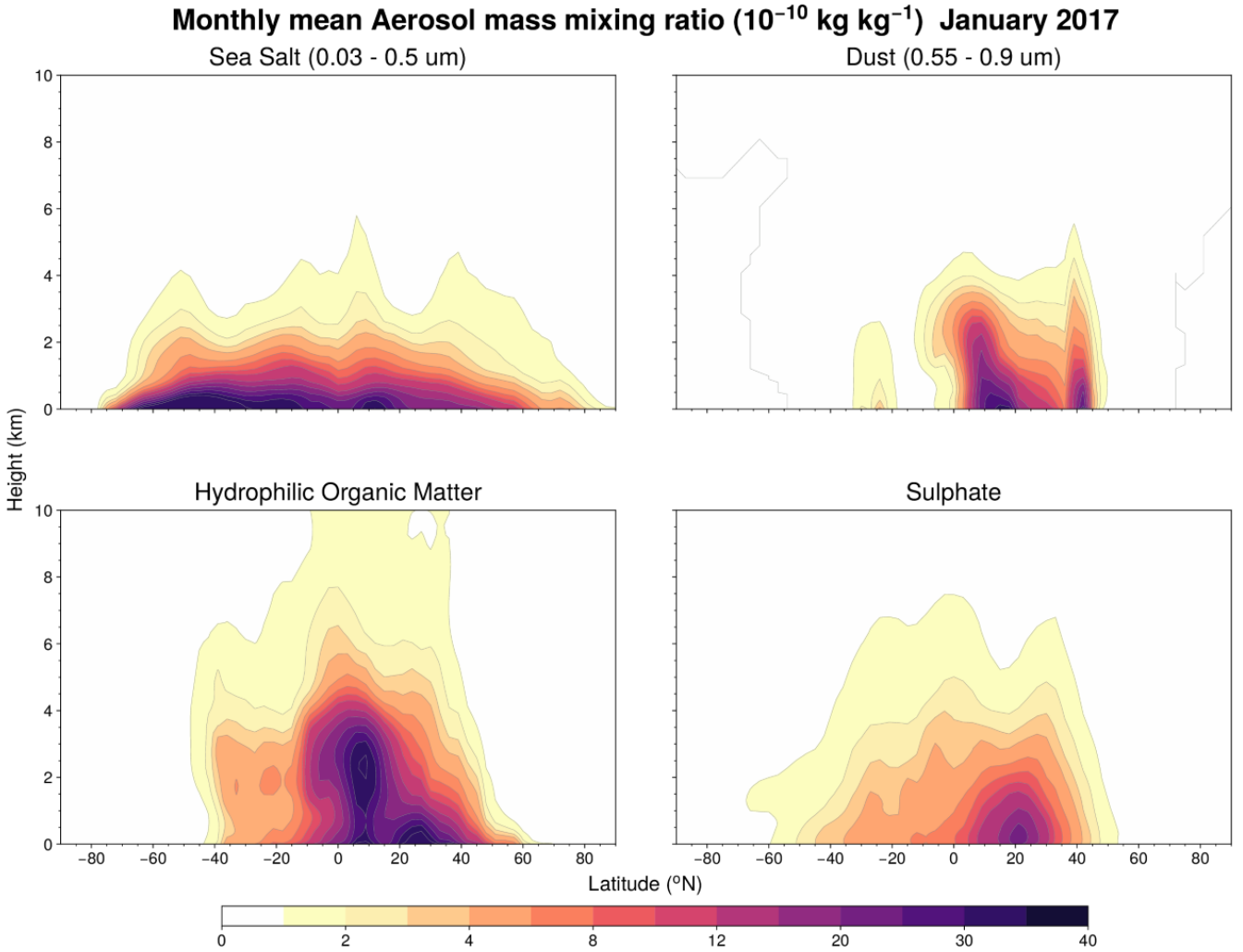
- Run IFS-COMPO suite in pseudo analysis mode with specified emissions (streamlined version of suite)
- Write out full chemistry and aerosol fields (137 levels) every 3 hours, to generate a time-history of aerosol.
- At end of each calendar month, calculate monthly means of the model level data.



<= Task aerosol_mm implemented in suite

- From monthly means, create a climatology for a specified recent period
- Use CAMS analyses of total AOD from corresponding period to work out mean rescaling factor
- Rescale all monthly means by same factor, to give time-varying history

Zonal mean of aerosol mass mixing ratios



Note that aerosol has vertical as well as horizontal structure – need 3-d climatologies

Still to do

- Merge latest version of flexible emission input into streamlined suite (December)
- Run for recent 10-20 year period
- Create 3-d climatologies at chosen resolution
- Choose appropriate calibration scaling (medium-range testing)

=> Defines new fixed aerosol climatology for NWP, for Cy49r1 (March 2022)

=> Time-varying climatology (e.g 10-year running means) defined from longer runs

Questions?

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