Design Document

An enhancement of UKCA emissions with source/sector information

Version-1.0

Background

The UKCA NetCDF emissions processing system currently allows for emission values feeding to a given tracer to be split over any number of files. The critical attribute that governs this functionality is *tracer_name* attribute in the NetCDF emission files. This is translated into the *emitted_tracer* attribute which is present for all the emission fields in the model. Thus, any emission data variables possessing attribute with value *emitted_tracer='X'* are added to the X chemical tracer in the model.

This leads to the following deficiencies in the current system:

1. There is no check in the system that a particular file or field is duplicate[#]
2. There is no check that a specified (fixed/ file based) emission field is being used at the same time as an interactive field for the same source. E.g. isoprene, acetone, monoterpene, methanol, NOx from soil, CH4 (wetlands, other terrestrial sources)

#: Actually, this is a serious deficiency (confirmed by a simple test with same the file added twice to the ukca_em namelist item) and should be fixed immediately, irrespective of the source/ sector enhancement.

The issue at (2) currently has a work around such that certain species like Isoprene and Monoterpene permit only one type of source i.e. either *specified* (file) or *interactive*. Conversely for acetone and methanol, only *specified* values are permitted. Obviously, this leads to the emission values being under-represented due to missing sources like anthropogenic/ biomass for isoprene, monoterpene and biogenic for acetone and methanol.

Hence, there is a need for the emission processing system to be improved such that it can handle multiple sources of emission for a given chemical field, with adequate checks to detect and prevent any duplication.

Design details

1. Emission fields – *offline (file-based)* as well as *online (interactive, or from other parts of model*) will have a new attribute e.g. *source_sector.*
2. Each of the emission species (i.e. tracers that need emissions) for that chemistry scheme will have a new attribute *l_check_sources,* which would be TRUE for species that have a likelihood of duplication.
3. Currently, to avoid adding more complexity to the Run_ukca namelist, the *l_check_sources* value will be hardwired in the code, again based on prior judgement regarding which of the species is likely to have this duplication.
4. For backward compatibility, the *source_sector* attribute will be an optional feature unless the *l_check_sources* is set to TRUE. For the same reason, the latter logical will be set to FALSE for all species by default.
5. If *l_check_sources* is set to TRUE for any species/ tracer then ALL emission fields (offline, online) feeding into that species/ tracer need to have the *source_sector* attribute specified.
6. Only a specified subset of *source_sector* values will be permitted, to avoid multiple or slightly varying descriptions of the same source (see below for proposed values).

7. During the initial stage of emissions processing -e.g. in *ukca_emiss_init*, after all files and fields have been looped through and attributes populated- extra code will be required to:
    - Loop over all the emission species/ tracers and find a tracer that requires source checks (*l_check_sources=TRUE)*
    - Loop over all emission fields and find those that feed into that tracer (*emitted_tracer=X)*
    - Temporarily store the *source_sector* values from these emission fields and check whether any value appears twice
    - If so, flag up an error, highlighting the tracer involved
    - Ideally, loop over all the tracers and perform this check, giving information on all duplicate sources *before aborting the model*

Emission Diagnostics

Once a standard set of source/ sectors is established, it would be possible to diagnose the contribution from each source to a given species, of course via addition of new diagnostics to Stash.

Exceptions/ complications

- Values of oceanic DMS, Chlorophyll-a and even iBVOCs, are actually passed to emissions processing from other parts of the model (Ancil reading/ Ocean model via STASH for former and via a module from JULES for the latter). The DMS/Chl-a fields do not have any indication if they are from Ancil or Ocean, while the presence of iBVOCs is dependent on logicals (both UKCA and JULES side). Some thought will be needed to allocate the *source_sector* attribute in a sensible way for these.
- Only the BC and OC GLOMAP-Mode emissions actually feed directly into aerosol tracers as mass. (Seasalt is also populated directly but does not have any specified source). The rest of the aerosol tracers are populated indirectly, with all the emission fields feeding into these currently labelled as 'online'. Allocation of *source_sector* values to these will also need to be considered carefully.

Proposed values for *source_sector*

Note: ter = Terrestrial, oce = Oceanic

Option – A = Grouped:

ter-anthro (e.g. industrial, transport, biofuel, agri, crop burn-off, etc)

t*er-biogen* (e.g. vegetation, soil, wetlands),

ter-fires (natural fires)

oce-anthro (mostly shipping)

oce-biogen (DMS and Chl-a conc, isoprene?, acetone?, NH3)

Option – B: Partitioned:

ter-indus, ter-transp, ter-biofuel, ter-agri, ter-anthro-biomass

ter-vege, ter-soil-nat, ter-wetland,

ter-fire-nat, ter-fire-anthro

oce-ship, oce-vege,

oce-nat (e.g. CH4 from hydrates)

The ‘Grouped’ nomenclature would be useful when only combined data from different sources is available for emissions. This would not force the users to specify a ‘partitioned’ name even though enough information on source is not available.

On the other hand, use of ‘Grouped’ nomenclature would force the combining of different data to fit the categories even if source-wise details are available.