

Emissions Scenarios : what is needed for ESM simulations and why?

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Why ESM (vs emulator) to address policy relevant questions ?

- To properly assess **the impacts** (and/or potential co benefits from alternative policies) and in particular at the regional scale (with consistent effect due to CO₂ changes, SLCFs changes and land use changes in a consistent manner)

- to properly assess the **carbon removal and sequestration strategies**

So far it relied on proposed human management of natural systems represented upstream of ESMs in an idealized fashion during scenario development (see discussion in Sanderson et al. EGU sphere under discussion),

=> need to be assessed by accounting for the full carbon cycle interactions

A need for scenarios to provide landcover / landuse and management (fertilization, irrigation) documented consistently with emissions from fossil fuel use, projected deployment of carbon dioxide removal technologies, deforestation, food and fiber demands, etc

- To determine the **remaining carbon budget** accounting consistently for non-CO₂ trajectories

- to assess the **benefits (or risks) associated with air pollution** (meaning that evolution of SLCF in scenario need to be consistent with climate mitigation and air quality policies, themselves controlled by the socioeconomical narrative)

Note that Meinhausen et al. GMD (discussion) argues for REP (rep. Emission pathways) to enhance uptake and facilitate exploration of alternative socio-economic and other dimensions by adaptation, equity, finance and other scientific communities outside the geophysical science realm. It makes sense, except if you want to answer some of the questions listed above

Rationale: SLCF and land use changes strongly affect regional climate changes. It's not possible to correctly reproduce past trends in Monsoon, or regional T and precipitation trends without accounting for them.

=> Necessary to provide them if you want your scenarios to be also used to **quantify regional impacts or benefits from your assumptions**

Because **SLCF** are very heterogeneous in space and time and have non-linear chemistry and effects, ESM need high resolution gridded anthropogenic emissions of the precursors (NOx, NMVOCs, NH₃, SO₂, CO, black carbon, organic carbon).

Typically for CMIP6, emissions were provided in 0.5°x0.5° by the CEDS
Need to be consistent with past emissions.

Need to be consistent with urbanization spatial extent

Description of the methodology can be found in Hoesly et al. 2018 and WGI Chapter 6 section 6.2.1 for past emissions and Rao et al., 2017 and Gidden et al., 2019 + WGI Chapter 6 section 6.7.1.1)

For **landuse**, description of the methodology can be found in Hurtt et al. 2011

