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Submitted to Session #52 *"Interacting with integrated assessment models for target-seeking under uncertainty"*

A Scalable Interactive Climate IAModel for Experimenting with Diverse types of Pathways

The new "Scalable World Interactive Model" (SWIM) enables users to explore the relative sensitivity to diverse policy options and scientific uncertainties, adjusting hundreds of parameters with immediate (<1sec) response on dozens of plots. Derived from the former "JCM" developed since 2000, which became inaccessible as web technology evolved, SWIM's code (>25k lines) was recently re-written in Scala3, transpiled for calculation within web browsers, with a re-designed graphical interface. While still being developed and updated with recent data, policy pledges, and evolving science, a proof-of concept is already usable at: https://swim.benmatthews.eu/

Originally JCM specialised in climate stabilisation scenarios, applying iterative inverse algorithms seeking regional emissions pathways to stabilise (or peak) concentrations, radiative forcing, temperature or sea-level. This helped fill a gap while IPCC reported only no-policy scenario projections, applying consistent core science to lower pathways. Rapid and robust response to hundreds of parameter combinations also enabled pioneering probabilistic analyses of national equitable pathways below 2C (2003, 2010) and 1.5C (2016). JCM's analysis "Shifting the burden of uncertainty" influenced discussion framing global climate goals, and designing the parallel RCP - SSP structure during the previous scenarios process.

This reminds how interactive models help scenario development :
* understand cause-effect and sensitivity to options / uncertainties,
* add dynamic dimensions to visualisations
* prototype experiments, prioritising complex model runs
* rapidly incorporate updated data
* interpolate between scenarios, downscale regionally.

Interactive models depend on parametrisation, calibrated to complex model responses using scenario runs. This requires scenarios to decompose driving factor assumptions (e.g. economic-demographic feedbacks). Bundling drivers only in "coherent worldviews" (SSPs) hinders calibration of interactive tools to help stakeholders understand cause-effect and marginal benefits of policy levers. Coherence (although unrealistic across regions and timescales) could be better ensured with probabilistic distributions explicitly specifying intercorrelations.

Meanwhile, with "net-zero" policies, the climate gap shifted from science-policy to ambition - implementation (or expert - citizen ?). We still need interactive tools to let stakeholders learn by experiment, comparing local efforts with transitions elsewhere, which requires comparable regional resolution. Currently SWIM calculates nationally, sub-dividing larger nations is anticipated. SWIM also calculates from 1700 to 2300, yet with annual timesteps and including recent perturbations. So the concept "Scalable" applies over time, space, and complexity, enabling users to zoom in and out, from detail to big-picture.

The flexible structure enables coupling feedbacks e.g. between demography and economics, carbon-cycle and temperature, targets and emissions. The structure would permit completing the loop to connect climate impacts back to demographics, the challenge is finding credible functions.
Anticipating closing this circle, one specific focus for future development is human migration, including as a rational adaptation to climate change, among other driving factors. This aspect will be elaborated in another contribution to this conference (session #31).

Developing interactive models calculating quickly and robustly in response to infinite sets of parameters chosen by remote users is challenging, insufficiently appreciated in systems prioritising static paper output. SWIM demonstrates potential to scale further, evolution depends on your support and collaboration.