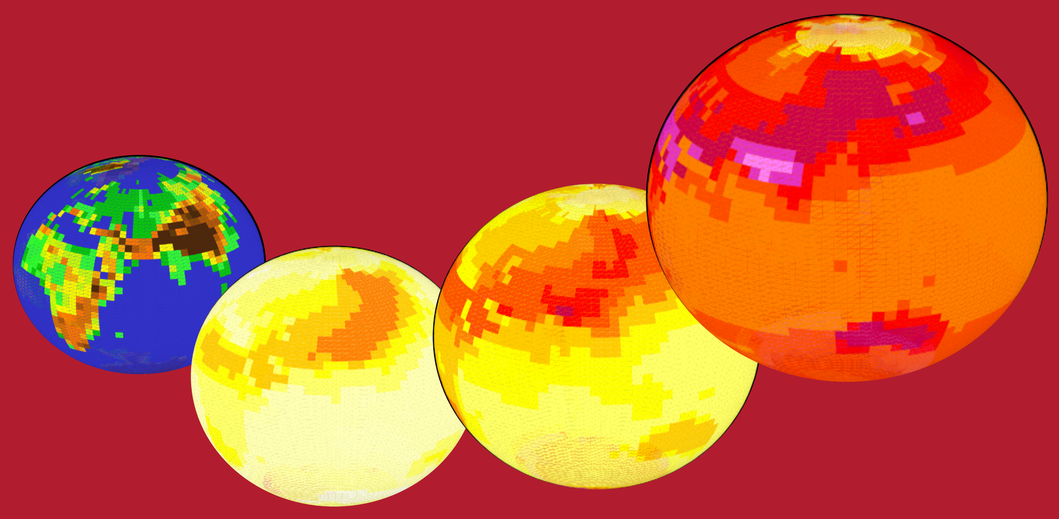
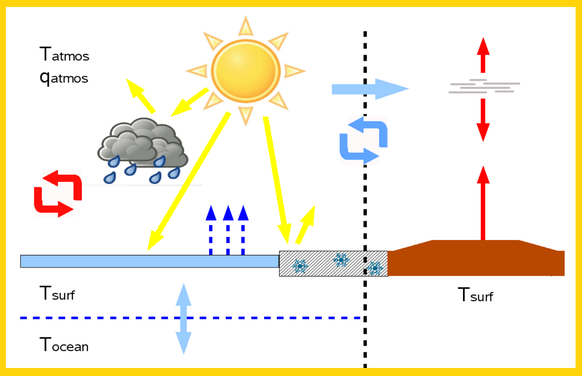
The Monash University Interactive Simple Climate Model



Introduction

The Monash Simple Climate Model (MSCM) is based on a very simple globally resolved energy balance. The model is capable of simulating the main regional characteristics in response to external forcings. It shall give a bridge between the theoretical equations and the fully complex IPCC-type climate models. The model is fast enough to be used in an interactive web application that animates the results and allows to select scenarios, variables and allows to deconstruct the climate system to illustrate how different processes interact to generate the climate response to external forcing.
The MSCM includes several interfaces to deconstruct the mean climate, tutorials and some climate puzzles for exercises.

Model description



Physical processes:

- solar insolation
- thermal radiation including greenhouse effect
- evaporation, precipitation and latent heat flux
- sensible heat flux
- atmospheric transport of heat and moisture
- sea ice and albedo change
- heat exchange with deep ocean

Prognostic Variables:

- atmospheric humidity:
- atmospheric temperature:
- surface temperature:
- deep ocean temperature:

$$\gamma_{surf}\frac{dT_{surf}}{dt} = F_{solar} + F_{thermal} + F_{latent} + F_{sense} + F_{ocean} + F_{correct}$$

$$\frac{dq_{air}}{dt} = \Delta q_{eva} + \Delta q_{precip} + \kappa \cdot \nabla^2 q_{atmos} - \vec{u} \cdot \nabla q_{atmos} + \Delta q_{correct}$$

$$\gamma_{atmos}\frac{dT_{atmos}}{dt} = -F_{sense} + Q_{latent} + \gamma_{atmos}(\kappa \cdot \nabla^2 T_{atmos} - \vec{u} \cdot \nabla T_{atmos})$$

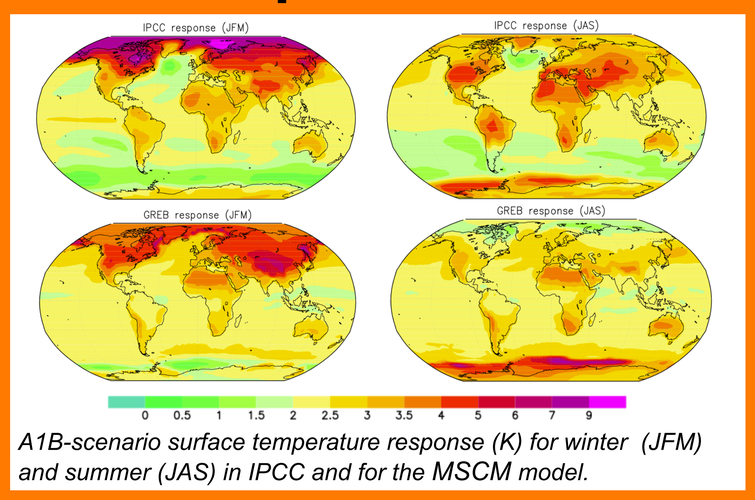
$$\frac{dT_{ocean}}{dt} = \frac{1}{\Delta t}\Delta To_{entrain} + \frac{1}{\gamma_{ocean} - \gamma_{surf}} Fo_{sense} + Fo_{correct}$$

Grid resolution: 3.75ºx3.75º

Benchmark (standard PC) : 2yrs/sec or 100,000yrs/day

Model performance

IPCC vs. MSCM



A1B-scenario surface temperature response (K) for winter (JFM) and summer (JAS) in IPCC and for the MSCM model.

The MSCM Model captures the large-scale features of the ensemble mean IPCC response pattern. A stronger warming over land (land-sea contrast), a polar amplification and a stronger warming on the northern compared to the southern hemisphere are clearly evident. The seasonal differences are also similar in both model responses with a stronger warming in the cold season. The MSCMmodel lies well within the uncertainties of the IPCC models.

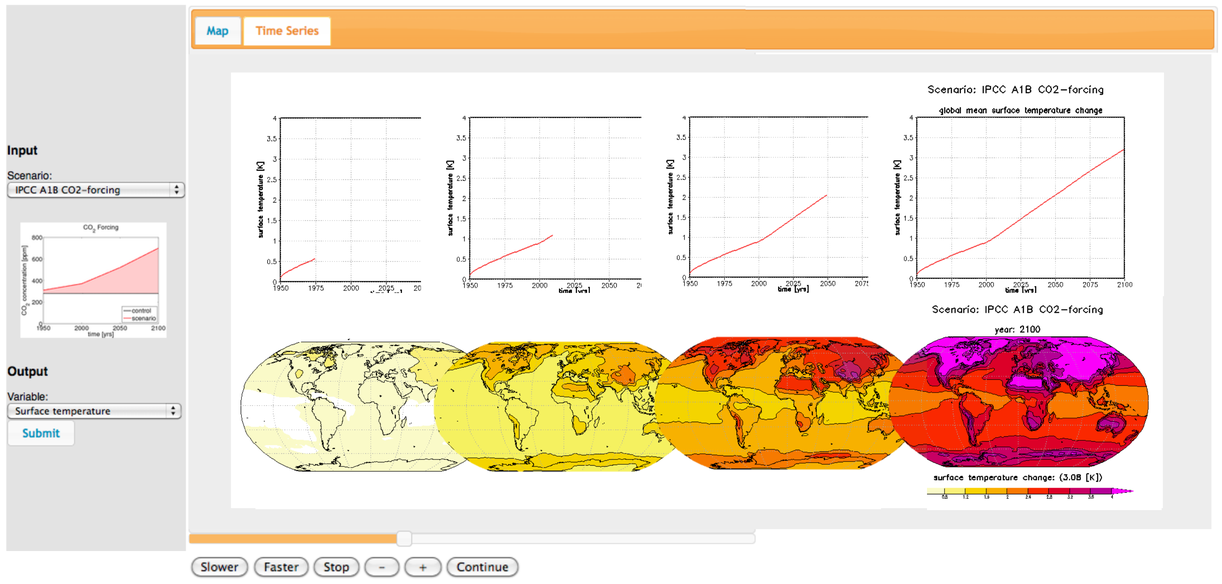
Outlook

✧This interactive web-interface will be further developed. It should be used in the education at universities, high schools and in the general public.

✧***Partners in this project are WANTED!!*** Anyone who thinks that he can contribute to this project by computing, web design, climate modelling or educational skills or by financial support is welcome. Please contact me!

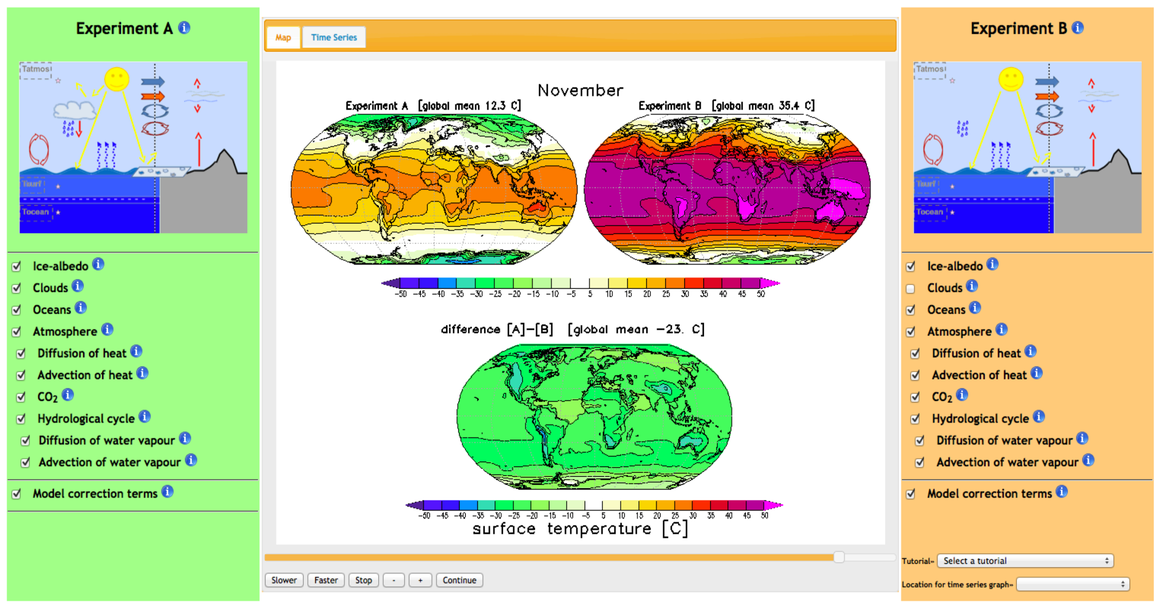
Reference: Dommenget and Floeter, Climate Dynamics, 2011.

Interactive animated scenarios



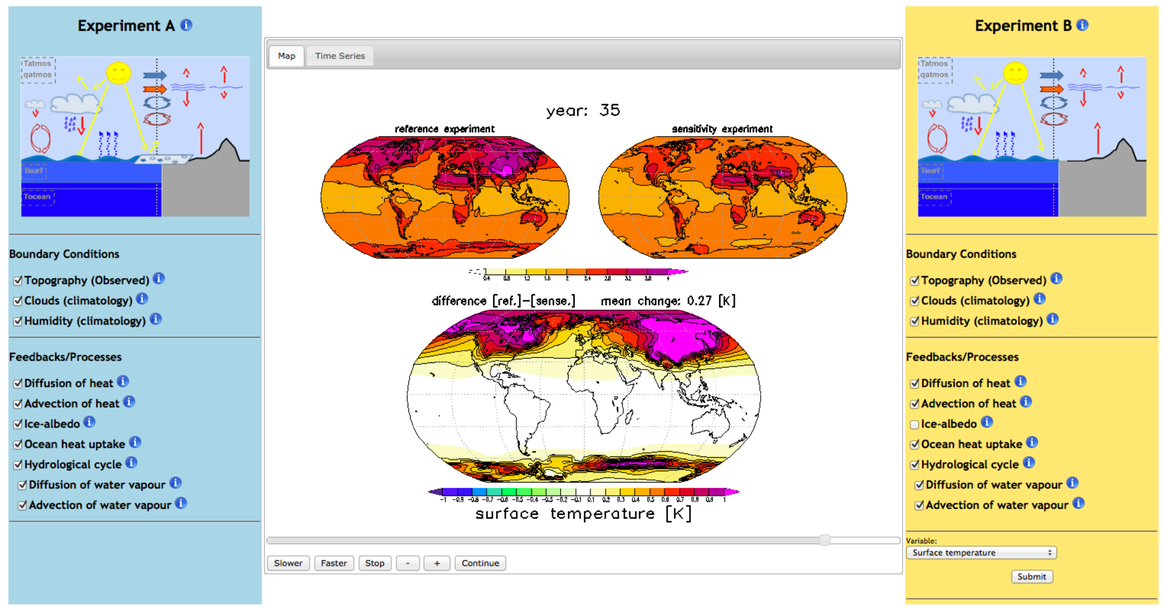
Web interface: You can select a scenario and climate variable and then see the animation of the response evolving in time.

Deconstructing Climate



You can switch off some processes of the model and see how the climate would change. In this example the ocean heat uptake in the sensitivity runs is turned off.

Deconstructing Climate Change



In this example the snow/ice albedo is turned off in the sensitivity run. You can see that the response to 2xCO_2 forcing reduces a lot over Asia and in other regions.

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