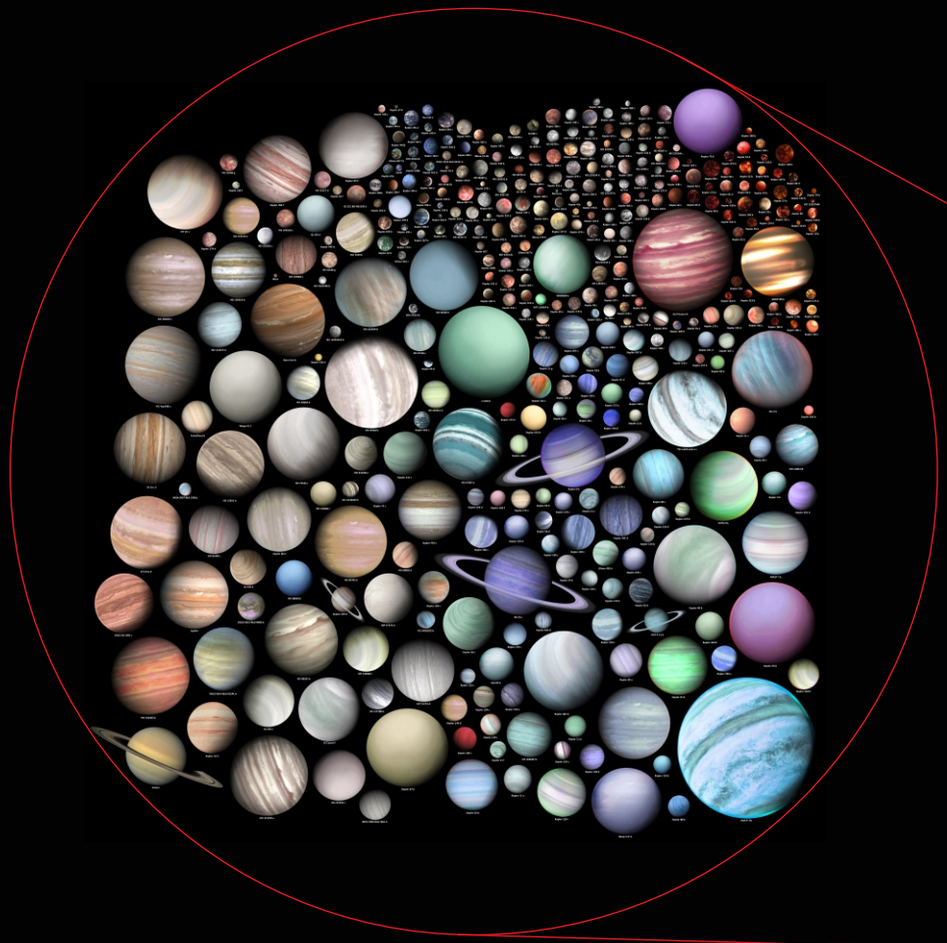
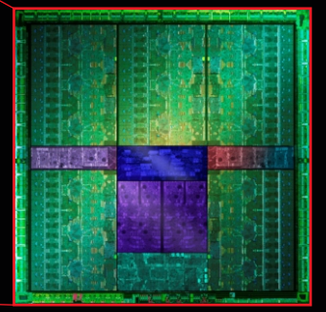
Exoplanet Oceans:

New Opportunities with a ~~New~~ Old Generation of Models

(OR: how to teach old dogs new tricks)

Andy Ridgwell

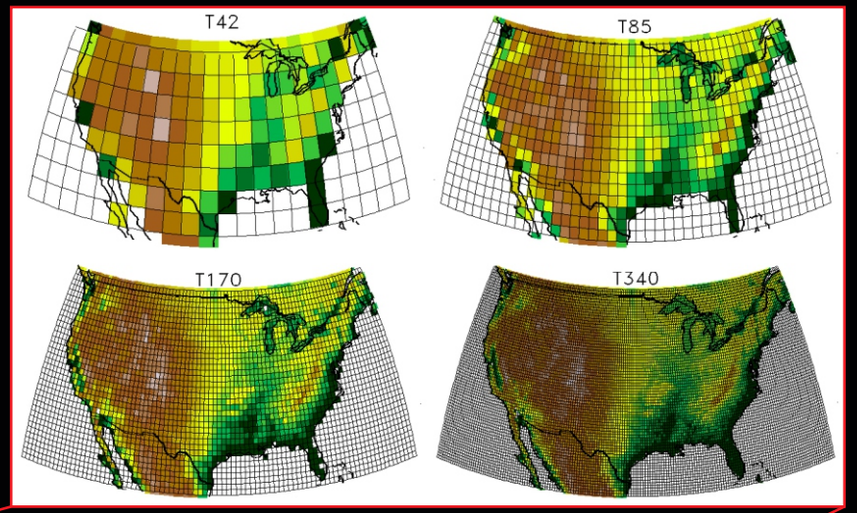




Progress in numerical (ocean/atmosphere) modelling capabilities

Increases in computing power invariably get used to to address the same question (e.g. what is the year 2100 climate?), but at increasing resolution. This is fine ... if you know the details of the question (and boundary conditions).

But, on the earlier Earth, we lack detailed (or almost any) knowledge of e.g. continental area and fragmentation, ocean temperature (or salinity), etc.



0.0000002 Pflops

0.06 Pflops

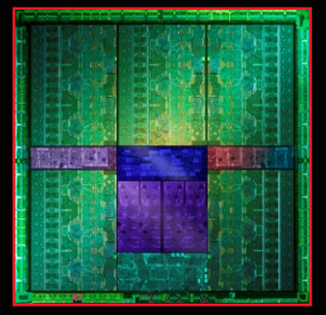
34 Pflops

(1 Pflop == 1.0E15 floating-point operations per second)

3.0 m **4.2 m** **10.2 m**

1960 1970 1980 1990 2000 2010 2020 ...

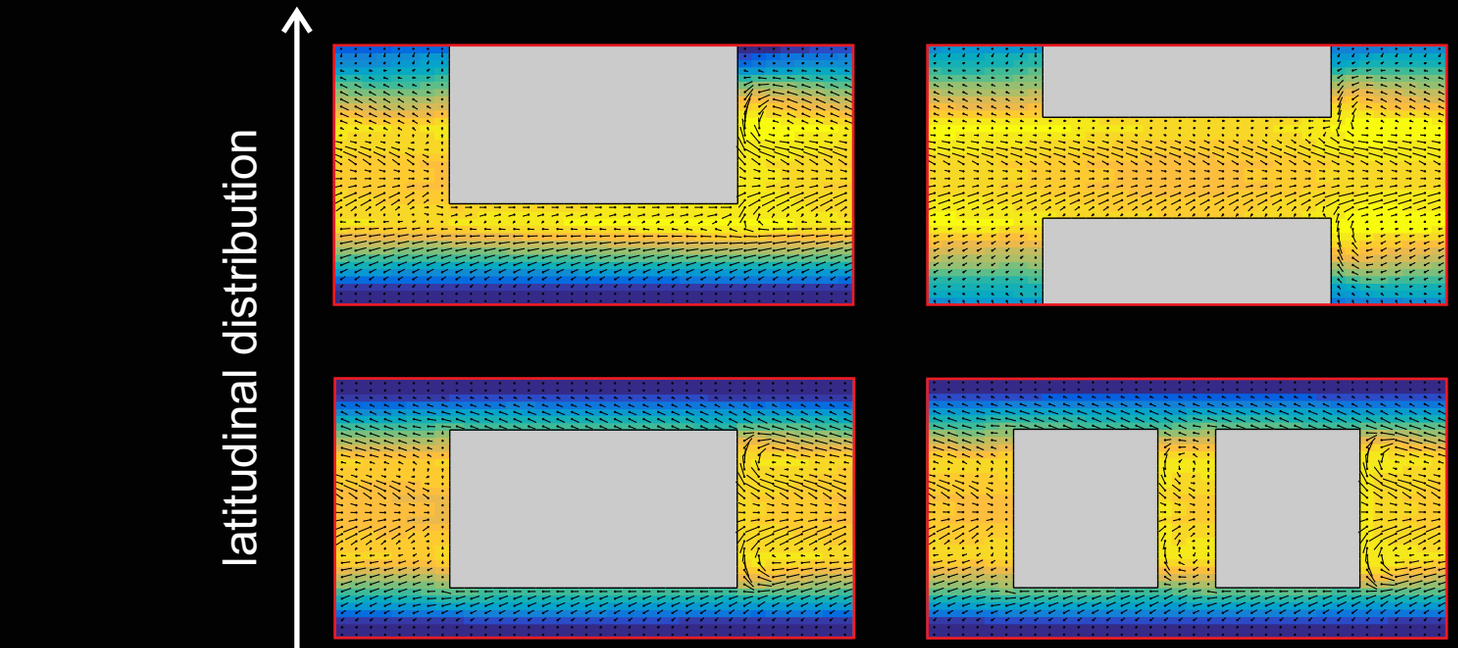
Time (Ma)



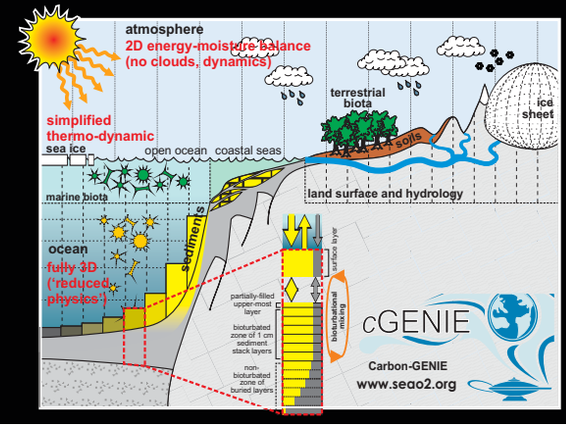
Characterizing Alternative Earths (climates) *in silico*

Large ensembles of (reduced complexity/resolution) models can be automatically generated, varying in a broad range of key parameters (continental area, fragmentation, latitudinal distribution, etc etc.).

Model ensembles can be analysed for relationships between parameters and emergent properties (e.g. of circulation and heat transport).



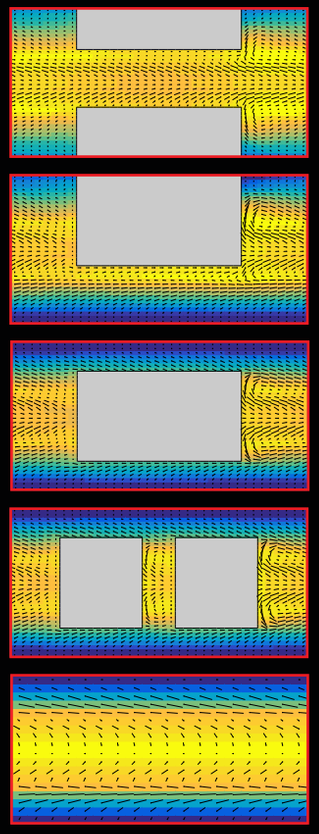
Plots are global lontitude-latitude maps of the ocean surface temperature field (colors) with the surface ocean velocity overlain (black arrows). Simulations made using the ‘GENIE’ Earth System Model.



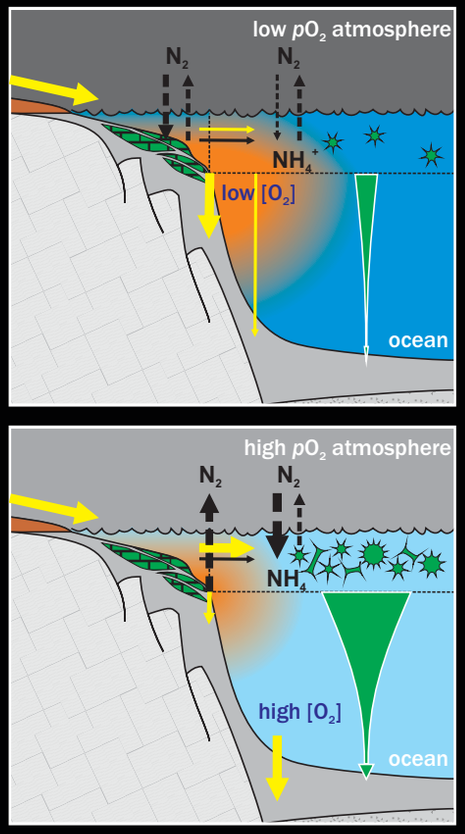
Characterizing Alternative Earths (atmospheric chemistry) *in silico*

Convolute physics ensemble with biogeochemsitry ensemble to create a 'zoo' of potential atmospheric chemistry states.

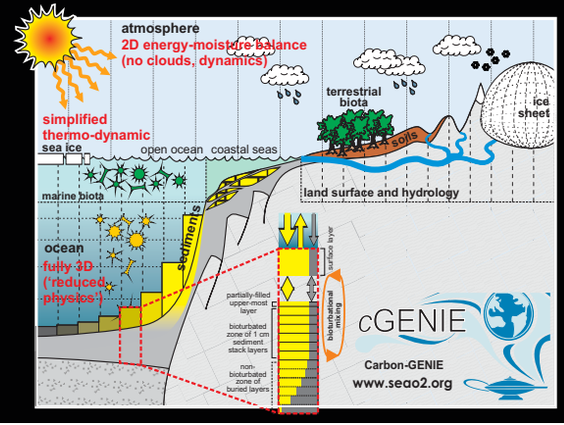
physics ensemble



sub-sets of metabolic pathways & ecosystem structures + varying nutrient and carbon input and output fluxes



Zoo of ocean biogeochemical and atmospheric chemical states



Characterizing Potential Exoplanets *in silico*