

## SYCE 1: Foundations and Perspectives of Climate Engineering

Time: Tuesday 10:30–13:00

Location: HSZ 01

**Invited Talk** SYCE 1.1 Tue 10:30 HSZ 01  
**Oceanic carbon-dioxide removal options: Potential impacts and side effects** — ●ANDREAS OSCHLIES — IFM-GEOMAR, University of Kiel, Germany

Ocean fertilization and alkalinity enhancement by accelerated weathering of limestone or silicate rocks have been suggested as possible options for sequestering atmospheric CO<sub>2</sub>. These methods would have intended and unintended, local and remote impacts on marine ecosystems and biogeochemical cycles. An overview is given on current estimates of the CO<sub>2</sub> sequestration potential of various fertilization and alkalinity-enhancement techniques. Impacts and possible side effects are discussed in a quantitative manner based on results of small-scale field studies and global Earth System model simulations for a business-as-usual CO<sub>2</sub> emission scenario. According to these results, the sequestration potential of the individual oceanic CO<sub>2</sub> removal methods is limited to a small fraction of current anthropogenic emissions. While it is obvious that all methods have undesired side effects, these have to be evaluated against the side effects resulting from an unabated rise in atmospheric CO<sub>2</sub> levels.

**Invited Talk** SYCE 1.2 Tue 11:00 HSZ 01  
**Climate Engineering through injection of aerosol particles into the atmosphere: physical insights into the possibilities and risks** — ●MARK LAWRENCE — Max Planck Institute for Chemistry, Atmospheric Chemistry Department, Mainz, Germany

Climate Engineering (CE) is the intentional manipulation of the Earth's climate in order to counteract the effects of unintended global change due to greenhouse gases and other climate forcing agents, such as reflecting and absorbing aerosol particles. Numerous CE measures have been proposed as cost-effective means to either bypass the slow international actions towards reducing emissions of climate-active gases and particles, or as a solution for potentially impending "climate emergencies" (rapid, irreversible transitions caused by exceeding certain thresholds of climate change). Though often discussed as highly promising possibilities, each proposed CE measure of course harbors large uncertainties and significant potential side effects. The CE measures can mostly be divided into two categories: accelerated removal of carbon dioxide (CO<sub>2</sub>, the primary greenhouse gas) from the atmosphere, and "solar radiation management" (SRM), i.e., increasing the amount of solar radiation reflected back to space. This talk gives an overview of the latter, focusing particularly on the current state of knowledge of proposed SRM measures through injection of aerosol particles, which either directly reflect solar radiation, or enhance the reflectivity of clouds.

**Invited Talk** SYCE 1.3 Tue 11:30 HSZ 01  
**Geoengineering - will it change the climate game?** — ●TIMO GOESCHL — Dept. of Economics, Heidelberg University, Heidelberg, Germany

Emissions reductions aimed at mitigating climate change are - from an economic point of view - an almost perfect example of a global

public good. The scale of the public good is determined by aggregate reduction efforts of all countries. The contribution of individual countries to the aggregate effort, however, can - in the absence of a global institution - only arise out of a bargaining process between individual sovereign states. This is the essence of the 'climate game'. Both theoretical analysis and empirical evidence underscore that the climate game provides problematic incentives for the individual states to jointly generate a satisfactory aggregate reduction effort. Geoengineering has the potential to alter these incentives in a radical way. The reason is that geoengineering efforts differ from emissions reduction efforts in many ways. One important difference in bargaining terms is that the actions of a single player can determine the final outcome. Combined with the very different costs and benefits associated with geoengineering activities, the availability of geoengineering option therefore poses an entirely new set of incentives for countries. This presentation weighs the arguments on the likely impacts on the process and outcome of the climate game of geoengineering options becoming available .

**Invited Talk** SYCE 1.4 Tue 12:00 HSZ 01  
**The gamble with the climate - an experiment** — ●MANFRED MILINSKI — Max-Planck-Institut für Evolutionsbiologie, Thienemann-Str. 2a, 24306 Plön

Will a group of people reach a collective target through individual contributions when everybody suffers individually if the target is missed? This \*collective risk social dilemma\* exists in various social scenarios, the globally most challenging one being the prevention of dangerous climate change. Reaching the collective target requires individual sacrifices, with benefits to all but no guarantee that others will also contribute. It even seems tempting to contribute less and save money to induce others to contribute more, hence the dilemma and the risk of failure. Here, we introduce the collective risk social dilemma and simulate it in a controlled experiment: will a group of people reach a fixed target sum through successive monetary contributions, when they know that they will lose all their remaining money with a certain probability if they fail to do so? We find that under high risk of simulated dangerous climate change half of the groups succeed in reaching the target sum, whereas the others only marginally fail. When the risk of loss is only as high as the necessary average investment or even lower, the groups generally fail to reach the target sum. We conclude that one possible strategy to relieve the collective risk dilemma in high risk situations is to convince people that failure to invest enough is very likely to cause grave financial loss to the individual. Our analysis describes the social window humankind has to prevent dangerous climate change.

**Panel Discussion 12:30 - 13:00**  
**"Perspectives of Climate Engineering"** Andreas Oschlies, Mark Lawrence, Timo Göschl, Manfred Milinski  
**Chair: Thomas Leisner**