Campagne 2020 Contrats Doctoraux Instituts/Initiatives

Proposition de Projet de Recherche Doctoral (PRD)

Appel à projet ITE - Institut de la Transition Environnementale 2020

Intitulé du Projet de Recherche Doctoral : How to govern solar radiation management? Scientific and political assessment of implementation

Directeur de Thèse porteur du projet (titulaire d'une HDR) :

NOM : **MÄÄTTÄNEN** Prénom : **Anni**
Titre : Chargé de Recherche ou
e-mail : anni.maattanen@latmos.ipsl.fr
Adresse professionnelle : LATMOS Jussieu, Tour 45-46, bureau 410, 4 place Jussieu, 75005
(site, adresse, bât., bureau) Paris

Unité de Recherche :
Intitulé : Laboratoire atmosphères et observations spatiales (LATMOS)
Code *(ex. UMR xxxx)* : UMR 8190

Ecole Doctorale de rattachement de l'équipe & d'inscription du doctorant : **ED127-AstronomieAstrophysiqueIdF**

Doctorants actuellement encadrés par le directeur de thèse (préciser le nombre de doctorants, leur année de 1ere inscription et la quotité d'encadrement) : 1, 2019, 50%

Co-encadrant :

NOM : **KLÖCK** Prénom : **Carola**
Titre : Choisissez un élément : ou Assistant professor HDR ☒
e-mail : carola.kloeck@sciencespo.fr

Unité de Recherche :
Intitulé : Centre de recherches internationales (CERI)
Code *(ex. UMR xxxx)* : UMR 7050

Ecole Doctorale de rattachement : **Choisissez un élément :**
Ou si ED non Alliance SU : **ED de Sciences Po**

Doctorants actuellement encadrés par le co-directeur de thèse (préciser le nombre de doctorants, leur année de 1ere inscription et la quotité d'encadrement) : 0

Cotutelle internationale : ☒ Non ☐ Oui, précisez Pays et Université :

Description du projet de recherche doctoral *(en français ou en anglais)*

3 pages maximum – interligne simple – Ce texte sera diffusé en ligne

Détailler le contexte, l'objectif scientifique, la justification de l'approche scientifique ainsi que l'adéquation à l'initiative/l'Institut.

Le cas échéant, préciser le rôle de chaque encadrant ainsi que les compétences scientifiques apportées. Indiquer les publications/productions des encadrants en lien avec le projet.

Préciser le profil d'étudiant(e) recherché.

Context: As greenhouse gas emission reductions are not happening fast enough, increasing attention is being paid to alternative or complementary solutions. Climate scenarios increasingly consider carbon capture and removal methods (IPCC 2018). Solar radiation management (SRM) methods –another class of geoengineering methods– are usually not considered explicitly in mainstream scenarios but they now focus a substantial amount of research. These SRM methods, such as injecting sulphate aerosols into the lower stratosphere, aim at increasing reflection of solar radiation back to space, cooling the Earth. SRM hence does not change atmospheric greenhouse gas concentrations (i.e., the cause of climate change) but can temporarily alleviate some impacts and buy valuable time for mitigation. At the same time SRM also carries a lot of risks, some known (effects on the ozone layer, modification of the regional distribution of temperature and precipitation, termination effect…) and some unknown. These effects are not well understood and contribute to the controversial nature of SRM, which, in addition to the low public awareness, lead to a low public and political support for such measures (e.g. Burns et al. 2016). Climate scientists and negotiators tend to be skeptical towards SRM methods, but support increases among the poorer, more vulnerable countries who have less adaptive capacity and expect more damage from climate change (Dannenberg and Zitzelsberger 2019). More research on SRM is hence called for, and a number of countries have set up dedicated research programs. For these reasons (unilateral) deployment is not beyond the realms of possibility. To date, natural and social sciences approaches to geoengineering have been largely disconnected but there is a strong rationale to combine them (Burns et al. 2016). We do not yet have a comprehensive overview of SRM governance, nor how available scientific information could affect and shape SRM governance. The proposed thesis bridges this gap and combines advanced climate and governance modeling with social science research, in three distinct but inter-related steps.

Step 1: developing governance scenarios

Geoengineering is not yet part of international (climate) governance (Talberg et al. 2018) and the issues it raises are currently largely ignored at the political level. Yet these issues are multiple and complex. SRM might be deployed unilaterally, for example, by a country vulnerable to global warming and willing to cool temperatures locally. However, even for regional SRM, effects are unlikely to remain restricted to national boundaries, and SRM is likely to produce winners and losers. Accordingly, there is broad consensus that even unilateral deployment would require international cooperation and governance, for example to address unintended, possibly larger scale consequences (e.g. Bodansky 2013; Quaas et al. 2016; Larson 2016). In a first step, the thesis seeks to map out, by studying existing mechanisms and literature, potential mechanisms to govern and regulate SRM. This will result in the development of different scenarios of how, and by whom, SRM could be governed in the future. Three likely scenarios will be developed and analysed in detail. First, a global agreement, potentially building on existing frameworks, such as the United Nations Framework Convention on Climate Change, or Convention on Biological Diversity, which include some principles and decisions that are potentially relevant to SRM, and could incorporate SRM more explicitly in their agreements (Talberg et al. 2018). Second, a regional or bilateral new treaty that deals specifically with SRM. This could for example be an agreement between the US and Canada, or between China and neighboring states. Third, it is also possible that countries will not extend existing nor adopt new agreements, and no international SRM governance mechanism will be put in place. For each scenario, key stakeholders and their positions, as well as key mechanisms (e.g. the potential for compensation for negative impacts of SRM deployment) will need to be identified.

Step 2: modeling SRM governance with a climate model coupled to a control model. The scenarios developed in step 1 will directly feed into step 2, modeling SRM governance (collaboration with O. Boucher, IPSL).

We will implement the developed scenarios into a climate model coupled to a control module to simulate in a quantitative manner possible governance systems and assess their resilience level. The scenarios include "human" actors (states or private companies, acting either individually or in coalitions) that may or may not communicate/agree on the actions and have/not have common goals, based on the governance approaches arising from step 1. These scenarios can also include perturbations by natural, unpredictable events (volcanoes) or by unpredictable behavior of the actors. Several tests on the stability of the different SRM control systems will be conducted. More specifically, the control model (a standard PID algorithm) will be coupled to a simplified climate model (for example: FAIR, Smith et al. 2018) augmented with parametrization derived from the climate model of the IPSL (Hourdin et al. 2020). The simplified model calculates the evolution of the average temperature of the planet (or other regional indicators) in response to climatic forcings due to greenhouse gases and SRM. In particular, it will be interesting to consider the evolution of precipitation changes over key regions, which can be done using pre-calculated spatial distributions from the global climate model. The previously described scenarios will allow us to adjust the SRM scenario using the control model: mass of sulfur injected in the stratosphere, frequency of injections... A key question will be to assess the resilience of the control and governance system to natural (i.e. unforced) climate variability. A major challenge will be to reconcile the climate timescales with those of political decision-making, and the spatial scales of SRM effects and state boundaries. Finally, the results of the control model (governance scenarios) will be evaluated based on their capacity to stabilize the climate system and the induced risks (in particular failure).

Step 3: survey experiment

This final step will help understand how scientific expertise and modeling may shape governance responses to SRM. A number of surveys examine attitudes towards SRM and geoengineering more generally (see Burns et al. 2016). These studies find skepticism towards SRM, but attitudes vary becoming more positive among respondents from poorer countries, and countries that are more vulnerable to climate change (Dannenberg and Zitzelsberger 2019). It is likely that scientific results also affect attitudes towards SRM governance. We test such effects through a survey experiment. Respondents are asked about their attitudes towards SRM and the scenarios developed in step 1; are then provided with some results from the modeling carried out in step 2; and are then again asked about their attitudes. Importantly, the information provided to respondents varies among the control and treatment groups. For example, one treatment could be a positive framing of SRM, highlighting positive (side) effects, whereas another treatment would focus on negative (side) effects. This set-up allows us to draw conclusions on how framing of information affects attitudes on SRM governance, and which potential SRM risks and benefits respondents are most concerned about. This would help us better understand how scientific expertise can inform and guide global governance of

SRM. This survey experiment will benefit from the contacts of F. Ravetta (LATMOS) through the European Science Diplomacy Initiative, and a seminar on the topic will be organized at Sciences Po.

Adequation with the Institute: While SRM methods might not appear at a first glance as a sustainable solution to climate change, there are several reasons why this thesis subject is relevant to this call. First SRM methods have been shown to have the potential to cool the planet and alleviate a number of climate impacts including biodiversity losses. Combined with mitigation actions, they can help to "shave the peak" and contribute to maintain the long-term viability of the planet. It is thus important to examine how their side effects and deficiencies can be mitigated by adequate governance. Thus, the question on governance of these actions needs to be studied. Second, SRM methods may be deployed by some actors without or outside a governance system. In such a context, it becomes paramount for other countries to understand how sustainability can be maintained in a situation where the system is partially externally controlled. This PhD thesis aims at coupling atmospheric and political and social sciences to study the governance of SRM.

Roles of the supervisors and their scientific expertise: Anni Määttänen (CR CNRS, LATMOS, Paris) is a specialist of ice clouds and sulfate aerosols in planetary atmospheres. She has supervised 3 PhD theses (1 currently) and 2 post-docs (1 at the moment) on cloud modeling. She is co-lead of an interdisciplinary group at LATMOS on middle-atmospheric particles and the sulfur cycle, focusing also on SRM geo-engineering. She teaches geo-engineering on the course "From climate sciences to climate intervention?" at Sciences Po. Relevant publications: 1) A. Määttänen et al. (2018), New parameterizations for neutral and ion-induced sulfuric acid-water particle formation in nucleation and kinetic regimes, J. Geophys. Res. Atmos., 122. 2) Merikanto, J., J. Duplissy, A. Määttänen, et al. (2016), Effect of ions on sulfuric acid-water binary particle formation I: Theory for kinetic and nucleation-type particle formation and atmospheric implications. J. Geophys. Res. Atmos., 121, 1736-1751. 3) C. Listowski, A. Määttänen, et al. (2014), Modeling the microphysics of CO2 ice clouds within wave-induced cold pockets in the Martian mesosphere, Icarus 237, 239-261.

Carola Klöck (assistant professor of political science, CERI, Sciences Po Paris) works on international climate governance with a specific interest in small island states. Her research examines adaptation finance, climate negotiations as well as local adaptation, using both qualitative and quantitative methods. She has supervised several Master theses and obtained the German Habilitation (equivalent to HDR) from the University of Göttingen in January 2020. Relevant publications include 1) C. Klöck (2020), Multiple Coalition Memberships: Helping or Hindering Small States in Multilateral (Climate) Negotiations? Int. Neg. In press. 2) C. Klöck (2019), Dealing with climate change in the German Wadden Sea: Perceptions, measures, and contestation on Hallig Hooge. Oc & Coast Manag 179: 104864. 3) C. Klöck (2015), Adapting to Climate Change in Small Island Developing States. Clim. Ch. 133 (3): 481–489. doi : 10.1007/s10584-015-1408-0.

Student profile: A Master's degree in atmospheric sciences and/or political sciences is required, and a certain level of knowledge in the other discipline is expected. Fast learning skills will be an asset for mastering the different methods used during this interdisciplinary thesis. Reading literature and writing reports, abstracts and articles will be expected. Good communication and interpersonal skills are necessary.

Merci de nommer votre fichier pdf :
«ACRONYME de l'institut/initiative_2_NOM Porteur Projet_2020 »

à envoyer simultanément par e-mail à l'ED de rattachement et au programme :
cd_instituts_et_initiatives@listes.upmc.fr avant le 30 mars.