Proyectos CLIMAT AmSud – convocatoria 2020

ACE-Amazon - Interaction between large-scale Atmospheric Circulation and dEforestation in the southern Amazon: implications for the local and continental water cycle

Abstract
The Amazon rainforest is the largest continental carbon sink on Earth. It therefore regulates the global carbon cycle and help limiting the rise of atmospheric carbon dioxide, which causes anthropogenic global climate change. Regionally, climate and vegetation are in a dynamic equilibrium, exchanging large amounts of gas, energy and moisture. Particularly, the water recycling in Amazonia plays a key role supplying humidity to neighbouring regions along the Andes mountains and La Plata Basin. Southern Amazonia (south of 8°S) is suffering a significant decrease in rainfall and an increase in dry-season length since the 1970s. Related to these changes in rainfall patterns, more frequent extreme hydrological droughts have been reported over this region. In addition, the high rate of Amazonian land-cover change could affect the climate both locally and on a regional scale. For these reasons, the Amazon rainforest is currently considered as a biophysical system in transition. Indeed, the combined pressure from deforestation, widespread use of fire and climate change can lead to a tipping point for the Amazon rainforest could turn much of it into dry shrubland instead tropical forest. For these reasons, the future of the water cycle in the Amazon and the neighbouring region needs to be addressed by combining diagnostic studies and modelling simulations.
In this context, this project brings together the skills of various South American research teams combining their experiences in South American hydroclimate, atmospheric and hydrological modelling, atmospheric-vegetation interactions and remote sensing. Collaborations among different constellations of members of this team have already contributed with around ten peer- reviewed papers, however, this project will be the opportunity to bring together the common efforts at a regional scale over South America.
The main goal of the project proposed here is to coordinate on-going efforts to analyze impacts on the regional water cycle driven by changes in Amazon vegetation and climate, and to explore the propagation of these impacts to two major regions in South America: the Andes- Altiplano and La Plata Basin. This collaboration will build on active projects each of which involves at least two members of this project: AMANECER-MOPGA, DARI-8, CONCYTEC- Peru (E041-2019-01), and Colciencias Program 70719. The ACE-Amazon project will act as a hub of these efforts in order to provide a French - South American research network.

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ANDESNOW - Quantification of the spatio-temporal variability of the snow cover along the South American Andes

Abstract
All along the Andes, the cryosphere represents an essential component of the hydrological cycle. If glaciers are being studied for several decades, less attention has been paid on the spatio-temporal variability of snow cover at regional scale, mainly because measurements are limited to a few local sites. With the availability of satellite archives and related snow products now covering several decades, it becomes possible to document the spatio-temporal variability of the snow cover area and to be able to detect long-term trends.
Therefore, ANDESNOW aims at strengthening the partnership and collaborations between institutes in Chile, Argentina, France and Peru for studying the spatio-temporal changes in snow cover all along the Andes using satellite remote-sensing. ANDESNOW also proposes a series of training courses for capacity building of students and early career professionals on the use of satellite data in geosciences.

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CF-HEALTHSUD - Exchange and collaboration of experiences and research capacities for the estimation of the carbon footprint in two South American hospitals.

Abstract
Evidence establishes that human activity is linked to global warming and thus climate change. Evidence establishes that it affects and threatens peoples' health. Thereby, it is an urgent challenge to mitigate greenhouse gasses output (GG) and their carbon footprint (CF). Paradoxically, the healthcare sector is a main responsible of the CF, in the United States it produces 8% of the total GG and in the United Kingdom 25% of the public sector's CF. Today there is an increasing need to evaluate sustainability of health systems and technologies regarding their impact on the CF and the analysis of the associated costs, especially in South America. Objective: This project intends to generate collaborative research and experience exchange networks, in which competences for the development of research and estimation of the carbon footprint (CF) could be complimented between the clinic and research centers from France, Peru, Chile and Uruguay. Especially, we pretend to install technical capacities for the study methodology for Life Cycle Assessment (LCA) and CF estimation in Chile and Uruguay centers.

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CliAmWine - High-resolution scenarios for vineyard adaptation to climate change: application to Argentinean and Uruguayan viticulture.

Abstract
Global climate change affects regional climates and has implications for viticulture worldwide. Various studies have addressed the issue of the impact of climate change on viticulture in many wine-growing regions of the world, but few studies are devoted to the observation and simulation of climate and climate change at the vineyard level (local scale). However, variations in vine growth and differences in grape/wine quality are often observed over short distances in a wine-growing region and are linked to local characteristics (slope, soil, seasonal climate, etc.). The high spatial variability of climate caused by local factors is often of the same order or even higher than the temperature increase simulated by the different IPCC scenarios. The winegrowers can adapt to this spatial variability of the climate, notably through their cultivation practices. In the context of climate change, prior knowledge of the spatial variability of climate at fine scales is an asset for defining possibilities for adaptation to the temporal evolution of climate in the medium to longer term. This multidisciplinary and international project aims to produce fine-scale climate change adaptation scenarios by combining simulations of future climate (2031-2050 et 2081-2100) with vine growth models and viticultural practices. These scenarios will be constructed and applied in Argentinean and Uruguayan wine-growing regions where several pilot sites are already being studied by the project teams.
The main questions are: How can spatial variability of local climate be integrated into climate change scenarios? How can we propose methods to the wine industry for adapting to climate change at the vineyard level? To meet these objectives, the XXX project consists of 3 Work packages: (1) Agroclimate measurements at the scale of experimental vineyards; (2) Agroclimate modelling at the scale of vineyards in the context of climate change; (3) Modelling environmental impacts on viticultural ecosystems: adaptation strategies for the wine industry.

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Cyan - Climate dynamics analysis from Data

Abstract
The climate system is a dissipative, nonlinear, complex and heterogeneous system that exhibits natural variability on many scales of motion, in time as well as space, and that is subject to both natural and anthropogenic external forcings. The theory of nonlinear dynamical systems provides a powerful way of considering nonlinear systems of equations that govern geophysical and other flows and phenomena, from biology to society. Low-order models in climate dynamics are highly desirable, since they can provide insight about dynamic interactions between different components of the climate system at a much lower computational cost than those required from high-resolution numerical simulations. These simple models can be used to understand the development of large scale anomalies in atmospheric circulation in the Southern hemisphere and also contribute to understanding their predictability at seasonal scales for concrete applications such as renewable energy productions.
In the recently finished MathAmSud project titled "Mathematical methods for Geophysical flows" (Math-Geo), new interdisciplinary concepts and methods combining topological data analysis and nonlinear dynamics were introduced, developed and tested on analytical examples, with promising results for ulterior application to real data. These strategies include Branched Manifold Analysis through Homologies (BraMAH) as well as Global Modeling techniques (GloMo). Preliminary applications to time series of geopotential heights in the Southern Hemisphere indicate that anomalies in seasonal climate variability can be related to specific dynamical features detectable with topology. The working hypothesis in this framework is that the different processes underlying data (whether numerical or observational) present a structured organization in a low-dimensional approximation of a dynamical reconstruction. The toolkit will be applied to specific datasets including Lagrangian and Eulerian data from floats, satellites, models, and to data collected in campaigns with elephant seals as bio-samplers of oceanographic conditions. The analysis will be conducted with different scopes that include dynamic data classification, model validation and seasonal predictions, model emulation or inter-model comparison. The possibility of improving our current understanding of noise-driven systems with these tools will also be considered. Findings that may support the selection of a subset of ensemble members in global Numerical Weather Prediction (NWP) models that may render higher local forecast skill will be implemented in an electric system simulator used for planning and dispatch of renewable energy.
This proposal gathers specialists with a know-how in the most challenging aspects of the focused research field: mathematical methods for weather and climate (CIMA-Argentina), numerical models and data assimilation (CMM-Chile, CEAZA-Chile), stochastic models for climate dynamics (ENS-France, LEGOS-France), Lagrangian analysis of multisatellite data (LOCEAN France), paleoclimatic modeling (PUC-Chile, IFAECI-France/Argentina), forecasts for renewable energy production (IMFIA-FING, Uruguay), bio-sampling mammals of the ocean environment for the observation of oceanographic conditions (CEBC France, within a program with CNES France and CONAE Argentina), global modelling techniques (CORIA with CESBIO, France) and topology of dynamical reconstructions (IFAECI- France/Argentina).

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EcoDevoKillies - Dancing in the rain: killifish population ecology and developmental dynamics in a seasonal regime undergoing climate change.

Abstract
Biological systems may respond to environmental changes at different levels and time scales by means of processes such as developmental phenotypic plasticity, life history phenology and evolution. Integrative approaches combining embryology and population ecology can aid to better understand and predict the impacts of climate change. Sea- sonal killifishes inhabit ephemeral temporary shallow pools filled by rains and drying according to the local weather and periodicity of rainfalls. Adaptations to these habitats include rapid growth and sexual maturation and drought resistant eggs with developing embryos displaying up to three metabolic arrests (diapauses) during their ontogeny. In- cidence, duration and environmental control of diapauses i.e. developmental plasticity, are crucial for populations to persist over time. Changes in rainfall patterns and temper- ature regimes are expected to affect the dry/wet cycle of these aquatic habitats and the biology of these species. The aim of this project is to produce and combine data from weather, climate, population ecology and developmental plasticity of selected species in natural and controlled conditions to parameterize eco-evolutionary models able to predict the viability of seasonal killifish populations. For this, we will study two regions differentially affected by climate change. 1) a seasonal environment characterized by a long dry period and a short wet one in summer: the western semiarid Chacoan region; and 2) a seasonal environment with a long wet period, a complete drying in summer and a partial or complete drying in winter: the Pampasic region. Climate change is expected to extend the dry period of Chaco and to extend the wet periods in the Pampasic region. Our data and model will provide a better understanding of the impact that climate change will have on seasonal killifish species in these habitats and is expected to allow the design of suitable mitigation and conservation policies.

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GreenAI - Towards an ecologically viable machine learning

Abstract
There is an area that has been neglected by AI researchers and industry: the ecological impact of artificial intelligence itself. Only recently some light has been cast in this direction. On one hand, it has been forecast that by 2030 half of the world's electric energy consumption with be attributed to computing facilities. On the other hand, recent studies show the design and training of a state-of- the-art machine learning models produced the same amount of CO2 as six medium cars during their lifespan. This raises many concerns on how to make an ecologically viable artificial intelligence.
In this direction, it has been hypothesized that cloud and mobile computing, transfer learning, domain adaptation, model reuse, active learning, and evolutionary computing, among others, could contribute to produce an eco-savvy AI. However, this is an area that needs yet to be properly explored both from theoretical and practical points of view.

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HIELO - Interhemispheric view of Holocene alpine glacier variations

Abstract
The current massive shrinking of mountain glaciers is amongst the most evident consequences of our warming Earth. Although today's climate change is driven mainly by anthropogenically-induced greenhouse gas emissions, characterization of the Holocene (last 11,500 years) natural climate variability is of paramount importance when it comes to reliable projections of future environmental change (e.g. water resources). Due to major differences in the distribution of continents, the current rate of warming is higher in the high latitudes of the northern Hemisphere (NH) and over NH landmasses than in the southern Hemisphere (SH), with differing implications regarding the rate and velocity of glacier wasting. One of the big remaining conundra in paleoclimatology concerns the comparative evolution of past climate in both hemispheres during the Holocene, when changing climatic conditions were not controlled by anthropogenic emissions, but by natural forcing mechanisms, for instance the similar impact of volcanism and differing influence of insulation changes across hemispheres.
In the NH, where Holocene glacier variations have been studied for more than a century, research in the field has benefited from the tremendous advent of terrestrial cosmogenic nuclide dating methods (TCND) over the last two decades. The most common radionuclides (10Be in quartz rich rocks, 36Cl in carbonate or other siliceous rocks) are now routinely used to date geomorphological features up to the recent past, where they thus overlap with documentary evidence. The advances of TCND in geomorphology have considerably improved our capabilities of understanding Holocene glacier and climatic evolution, thereby allowing correlation between glacial records and centennial-scale climate events (e.g. ACR/YD, 8.2 ka event, Neoglacial events), which were not possible before. However, local capacity in terrestrial cosmogenic nuclide dating in South America is scarce, hence glacial chronologies are still fragmentary in this part of the world, hampering robust interhemispheric comparisons.
The ambitious aim of the 'HIELO' project is to refine interhemispheric climate-glacier linkages during the Holocene by: (1) developing new TCND-based glacier chronologies for the Andean region, complemented with high temporal resolution dendrochronology, and (2) strengthening of local human resources and public engagement.
Detailed glacial palaeo-records are indeed urgently needed to disentangle, potential underlying climate drivers from glacier dynamics, and ultimately for improving our understanding of future climate-glacier interactions. The impact of climate change on the Andean cryosphere posed a significant challenge to Andean communities. Through effective communication, we seek to empowered local people and motivate them to make a change.

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LCL-RN - Low-Carbon Livestock - Research Network

Abstract
Demand for animal protein is expected to increase by 70% between 2010 and 2050. At the same time, GHG emissions related to agriculture need to be reduced by 66% to limit global warming to 1.5oC. Agricultural emissions represent 25% of anthropogenic GHG emissions. Livestock production contributes 50% of these. A transition of current livestock systems towards low-carbon (C) livestock systems is needed to combat climate change. Nearly 70% of the world's agricultural land is pastureland. In France and South America (SA), pastures are the main production system for ruminants. We propose to establish a Low C Livestock–Research Network (LCL-RN) between France and four SA countries (AR, CO, PE, and UY) with the goal to reduce GHG emissions and increase C storage from pastoral systems by promoting economically feasible best management practices (BMPs). The LCL-RN will consist of an interdisciplinary team of experts in GHG emission measurement, GHG modelling, GHG inventory development, GHG mitigation, C sequestration, rumen microbiology, and in-vitro screening of methane inhibitors. All country leaders of the LCL-RN are in permanent positions this will keep the RN alive and constant efforts will be made to raise funding to keep the network active beyond 2022. The LCL-RN will transfer competency and technology between members through 4 virtual team meetings, 10 closed webinars, and 3 group research stays and to the public through 6 public webinars. Monthly check-ins will be used to remind team members of their commitment to work together and to monitor and ensure the progress of the project. Other activities will include the compilation of databases to identify research gaps and determine BMPs. Findings will be summarized in a policy brief to inform policy makers of the current state of knowledge to allow them to make educated decisions when formulating funding opportunities and policies aimed to accelerate the transition towards low C livestock production systems.

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NetForSur - Assessing Andean forest vulnerability under climate change: a dendroecological, ecophysiological and biogeographic approach

Abstract
A global phenomenon of increased tree mortality and decreased growth attributed to climate change is been observed in all climatic zonation worldwide. It is expected that Andes regions demonstrate an increase in extreme droughts and should be one of the most affected area in South America. Still, their responses to climate change are poorly documented. The NetForSur project seeks to evaluate the vulnerability of mountain forests to climate change, considering emblematic trees species of the region, along a latitudinal gradient in Los Andes cordillera (10°-40°S). To do so, the project will set up an international multidisciplinary research network, complementing dendroecology, wood anatomy, ecophysiology, forest ecology and remote sensing specialists.
Retrospective analysis of the effects of climate change on forests has been almost exclusively done using dendrochronological approaches. Here, we will develop common methodologies to assess forest decline based on a new integrative dendroecological approach not yet existing in the Andes cordillera, giving us the opportunity to be pioneers in South America.
Remote sensors will be used for evaluating decline in sparse forests using drone images, and over whole regions using satellite data.
Adaptive capacities of the species can be evaluated based on physiological traits and their plasticity in response to environment conditions. Hydraulic trait measurements and leaf excess energy dissipation methodologies will allow characterization of the main species at stake in the region.
In addition, using modelling, tree mortality risks under current and future climatic conditions will be evaluated to further identify which regions and species are the most vulnerable to climate change. These results will serve to measure how the impacts of environmental variations have been in a region with high levels of endemism in South America, being useful to stakeholders both in conservation and restoration project.

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OPTATROP - Orographic control on aTmospherical Processes in the TROPical Andes (Madre de Dios River)

Abstract
Understanding and anticipating the evolution of water resources in a context of climate change is at the heart of major societal concerns for the populations of the tropical Andes. The water resources of Andean watersheds in the presence of glaciers are particularly sensitive to global warming as well as to rainfall variability. However, the influence of global climate change on precipitation variability in these regions remains poorly understood, especially in high-altitude areas where quantifying precipitation and its phase, solid or liquid, remains a challenge. Here we focus on one catchment, the Madre de Dios, which is located partly in Peru and partly in Bolivia. The main activities developed through OPTATROP are a strengthening of the collaboration between UMSA (La Paz, Bolivia), UGA (Grenoble, France) and SENAMHI (Lima, Peru) and the creation of two workshops (Climatology 2021 and Hydrology 2022).

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PRELASA - PRecipitation Extremes and Landscape Analysis in South America

Abstract
Understanding global climate change impacts at regional scale remains challenging. This is particularly true for South America, where projections still have large uncertainties. Local forcing due to landscape transformation - in particular, due to deforestation - adds an extra level of complexity, as these changes may result in a significant amplification of the global warming signal at the regional scale.
This project addresses the issue of climate variability and changes and their inter-relationship from the perspective of climate extremes, in particular the potential increase in precipitation extremes, which have a strong potential for socio-economical and ecosystem disruption. We aim at analyzing and contrasting climate and landscape at distinct sites in South America using a common set of climate extreme indices and landscape metrics, in order to deliver a systematic, comparative depiction of climate change and their feedbacks at regional to local scale.

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REPRISE - Reducing climate PRojection uncertainties In South amErica

Abstract
Future climate changes are mainly projected by Earth System Models. Climate scientists do not rely on a single model and several models have been developed in the world. Thanks to the ensemble of multiple models we can calculate future climate trajectories and associated uncertainties. One source of uncertainty comes from models' structure and how the different mechanisms are represented and parameterized. One of the main challenges for climate scientists is to reduce such uncertainties. One possible option is the model development, but this is time consuming and needs large computing and human resources. The second option is to constraint model projections based on present day observations, in order to calculate biases and then correct the modelled data. This approach is known as emergent constraint framework. In the REPRISE collaboration we will analyse current Earth System Model simulations and analyses different output variables related to the carbon cycle, land use and climate, which will be compared to observations-based products. This work will be done through two work packages. The first one will focus on the emergent constraint framework to reduce uncertainties in future projections for specific outputs variables and regions. The second one will look at the model residues and identify their drivers to underlined specific aspect of the Earth system models that must be improved to reduce climate projections uncertainties. These two work packages will be done with a special focus over South America in order to reduce the climate change uncertainties over this region. Two additional work packages dedicated to funding exploration and to results communication/dissemination will also be included to ensure that the current consortium continues after the REPRISE project and to reach local stakeholders.

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WarmFish - Effect of a global warming scenario on the reproduction of fishes of aquaculture interest

Abstract

Global warming is an evidence, and could act by impacting different life history traits of animals. As ectotherm organisms, fish are particularly sensitive to any change in temperature, as it would modify enzyme activity and metabolism of a given individual. Consequently, global warming is expected to impact the reproductive function of fish, which has implication for wild population dynamics, fisheries, and aquaculture. Warmer than-optimal temperatures can affect every scale of reproduction from sex determination to the act of spawning, and these responses are mediated by age in degree/day and are associated with changes in physiology at multiple levels of the brain -pituitary-gonad axis.

In fish, sex determination is characterized by a high plasticity, considering that in spite of genotypic sex many environmental factors can cause shifts from one to another molecular pathway, resulting in organisms with mismatching genotypic and phenotypic sexes (sex-reversal). Interestingly, in most instances, female-to-male sex-reversal has been observed when fish are exposed to relatively warm temperatures. Individuals develop nevertheless functional gonads with normal gametogenesis and respective progenies with full viability, making this as a non-hormonal treatment to manage sex ratios in aquaculture facilities. Although the field of teleost reproduction and temperature is advanced in many respects, we identified areas where research is lacking, especially for larval development, sex determination and sperm quality, when fish would have to face extreme climatic events. On this regard, the goal of the present project is to increase the knowledge exchange through a scientific network working on similar endpoints but on different fish species identified as key for aquaculture in the different countries: Salmon (Chile), European Sea Bass (France), Lisa (Colombia) and Pejerrey (Argentina). The output of our research will hopefully help managing these species that are already facing global warming at different steps of their life-cycle and would thus have concretes implications for aquaculture.

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