RESEARCH TO ADVANCE THE KNOWLEDGE ON CLIMATE CHANGE

FAPESP

FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

RESEARCH TO ADVANCE THE KNOWLEDGE ON CLIMATE CHANGE

JUCA MARTINS/PULSAR IMAGENS

Research on climate change has been developed in São Paulo State for at least the last 30 years. In 2008, the FAPESP Research Program on Global Climate Change (FRPGCC) was established, in order to further advance the understanding of the consequences of global climate and environmental changes in the state. Since 2008, FAPESP has invested more than US$ 30 million on research on this critical issue.

The FRPGCC supports research projects for up to 6 years. One of its major goals is to put together by 2013, a Brazilian Model of the Global Earth System, with a focus on key regional issues such as the Amazon, Cerrado and the South Atlantic regions.

The FRPGCC aims at advancing knowledge on Global Climate Change. The foundation expects that the results of the selected research projects will help in establishing the basis for scientifically based decisions and public policies in this area in Brazil and worldwide.

FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

ALE RUARO/PULSAR IMAGENS

SCIENCE AND CLIMATE POLICY

The Program considers both observational and modeling components, which includes long term environmental measurements and recovery of paleoclimate observations. This is crucial to overcome the lack of long term environmental observations for research, which has proved to be an enormous obstacle to the scientific advancement of global change research in Brazil. This will be achieved in association with other funding mechanisms, both internal and external to the State of São Paulo. Finally, it should be highlighted that the Program also includes a research component on the Earth Science and Climate Policy interface.

The Program will have a substantial technological component for the development of the appropriate technologies for a sustainable future. This strategy do not merely concerns innovative technologies for the mitigation of emissions, but also adaptation in all sectors and economic activities, in the view that climate change has now become inevitable and societies will have to adapt their socio-economical systems.

ERNESTO REGHRAN/PULSAR IMAGENS

RICARDO AZOURY/PULSAR IMAGENS

RICARDO AZOURY/PULSAR IMAGENS

MAIN RESEARCH AREAS

The FRPGCC considers proposals for research which fall within the scope of the Program described, including, in particular, the following areas:

a) Consequences of global climate change to the functioning of ecosystems, with emphasis on biodiversity loss and water, carbon and nitrogen cycles.
b) Changes in the atmospheric radiation balance, including the effects of aerosol particles, clouds, trace gases and land use change.
c) Global climate change and effects on agriculture productivity and food security.
d) Energy production and mitigation of greenhouse gases emissions.
e) Climate change and effects on human health.
f) Human dimensions of global climate changes: impacts, vulnerabilities and social and economic responses, including adaptation strategies.

Research proposals in other areas related to Climate Change may be submitted, provided there is appropriate justification of their connection with the main thematic of the Program and its objectives.

COORDINATING COMMITTEE

The operation of the Program is managed through a Coordinating Committee, with members from the science teams of the projects, appointed by the scientific director of FAPESP. The Committee meets at least monthly, to review and discuss actions as proposed by the projects, identify scientific gaps in the Program, and propose actions to fill such gaps. Current members of the Committee are:

Reynaldo Luiz Victoria, Cena, USP
Humberto Ribeiro da Rocha, IAG, USP
Carlos Afonso Nobre, CCST, Inpe
Paulo Eduardo Artaxo Neto, IF, USP
Newton La Scala Junior, FMVZ, Unesp-Jaboticabal

SÃO PAULO RESEARCH FOUNDATION

RUA PIO XI, 1500, ALTO DA LAPA
CEP: 05468-901 - SÃO PAULO - SP - BRASIL
FONE: 55. 11. 3838-4000

www.fapesp.br

FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

EFFECTS OF EMISSIONS ON CURRENT AND FUTURE RAINFALL

Arnaldo Alves Cardoso
Araraquara Institute of Chemistry, São Paulo State University (Unesp)
FAPESP Process 2008/58073-5 | Term: May 2008 to Jun 2013

Contact: Rua Prof. Francisco Degni, s/n, CEP 14800-900, Araraquara, SP, Brazil | +55-16-3301-9612 | acardoso@iq.unesp.br

Collaborating institutions: Atmospheric Electricity Group, National Institute for Space Research (Inpe); Bauru Institute of Meteorological Research, Unesp; Institute of Chemistry, University of São Paulo (USP); Institute of Geology, State University of Campinas (Unicamp); Ribeirão Preto School of Philosophy, Sciences and Literature, USP.

SCIENCE QUESTIONS AND OBJECTIVES

This project will be the first observation-based investigation of the climate change feedbacks involving precipitation, cloud formation and aerosols in the South American rural subtropics. São Paulo State the main area of study, occupies an area of 248 x 106 km2, with a population of more than 40 million inhabitants, and its GDP (2009) is around US$ 550 billion. The economy is based on agriculture and associated industries. In addition to the world's largest contiguous area of sugar cane cultivation, these regions also produce coffee, oranges and livestock. The region is a natural laboratory for such a study, due to large differences in seasonal weather patterns, with distinct wet and dry periods, and well-defined sources of anthropogenic aerosols, especially agricultural biomass burning.

The project concerns to understand how changes in agricultural practices and land use, amongst other anthropogenic factors, will affect precipitation patterns, due to the influence of changing emissions on the nature of atmospheric aerosols and cloud condensation nuclei. Alteration of the hydrological cycle will have consequences for the availability of water resources, which will affect direct supplies to agricultural, industrial and domestic consumers, as well as hydroelectric power generation capacity. We propose to study the relationships between aerosol physical and chemical properties, cloud droplet size, and the distribution, duration and intensity of precipitation. Field observations will provide the necessary information required to describe the influence of aerosols from different sources on rainfall patterns. We expect to be able to demonstrate whether the impact of anthropogenic activity will in the future

Figure 1. Biomass burning and aerosols

be beneficial or detrimental to agriculture and the wider environment, considering the processes of cloud formation, precipitation, and therefore water supply, under different development scenarios. We propose to Identify relationships between aerosol size distributions, cloud characteristics, precipitation patterns, and atmospheric electrical discharges; analyze the physical and chemical properties of atmospheric aerosols to establish relationships between composition and size distribution; relate aerosol hygroscopic properties to their size, chemical composition, and origin; investigate the influences of major aerosol classes, such as biomass burning aerosols or re-suspended dusts, on precipitation frequency, intensity, and duration; use source apportionment modeling to identify aerosol sources, suggesting how changes in anthropogenic sources will alter the nature of atmospheric aerosols and, consequently, cloud formation and precipitation.

CURRENT RESULTS AND PERSPECTIVES

In the study region, large particles derive almost exclusively from resuspended dusts, which once airborne may be modified by scavenging of reactive gases, producing soluble compounds that increase the hygroscopicity of the particles. Smaller particles are emitted directly during combustion processes, or are formed in secondary reactions involving gaseous precursors during atmospheric transport. Road vehicle emissions are a constant source of both primary aerosols and precursors in the region, while agricultural biomass burning is a very large source of atmospheric pollution, during the dry season and when meteorological conditions are favorable for the activity

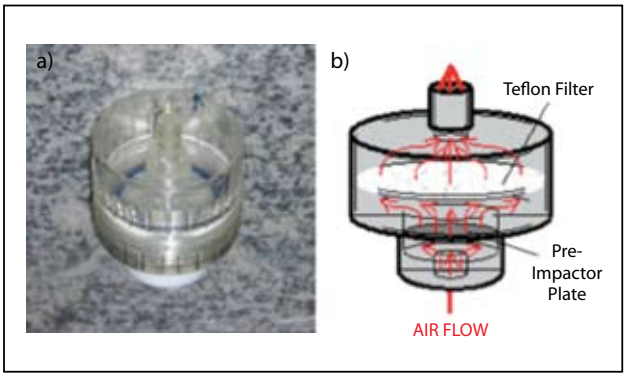

Figure 2. Aerosol sampling

The relationship between the presence of biomass burning aerosols and cloud droplet effective radius (re) was studied. Aerosols emitted during agricultural biomass burning and transported to cloud level during daytime convection caused a reduction in cloud droplet effective radius. An increase in the number concentrations of particles >0.3 μm at night was due to hygroscopic aerosol growth, and confirmed that the particles could act as efficient cloud condensation nuclei. During periods of lower biomass burning activity, it was possible to detect the presence of aerosols that had increased in size due to cloud processing, which also reflected differences in particle chemical composition between periods of low and high biomass burning intensity. The results confirm the viability of using ground based aerosol measurements, together with remotely sensed cloud parameters, in order to identify relationships between anthropogenic aerosols and cloud formation.

RELATED PUBLICATIONS

Allen AG, Machado CMD, Cardoso AA. Measurements and modeling of reactive nitrogen deposition in southeast Brazil. *Environmental Pollution*. 2011. *In press*.

da Silva LC, Allen AG, Cardoso AA. Influence of agricultural biomass burning on cloud droplet size. *Under submission*.

CO-PI'S AND ASSOCIATES

Andrew G. Allen, Institute of Chemistry, Unesp

Raquel F. P. Nogueira, Institute of Chemistry, Unesp

Lilian Rothschild, Institute of Chemistry, USP

Bernardino R. de Figueiredo, Institute of Geology, Unicamp

Jacinta Enzweiler, Institute of Geology, Unicamp

Maria L. A. M. Campos, Ribeirão Preto School of Philosophy, Sciences and Literature, USP

Maria E. Queiroz, Ribeirão Preto School of Philosophy, Sciences and Literature, USP

Gerhard Held, IPMET, Unesp

Ana M. G. Held, IPMET, Unesp

Kleber P. Naccarato, Atmospheric Electricity Group, Inpe

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

GLOBAL CLIMATE CHANGE MODELING: THE BRAZILIAN MODEL OF THE GLOBAL CLIMATE SYSTEM (MBSCG)

Carlos Afonso Nobre
Ministry of Science and Technology (MCT)
FAPESP Process 2009/50528-6 | Term: Apr 2011 to Mar 2015

Contact: Esplanada dos Ministérios, Bloco E, CEP 70067-900, Brasília, DF, Brazil | carlos.nobre@inpe.br

Collaborating Institutions: Brazilian Agricultural Research Corporation (Embrapa); Center for Ocean-Land-Atmosphere Interactions (Cola); Council for Scientific and Industrial Research (CSIR); Federal University of Itajubá (Unifei); Federal University of Lavras (Ufla); Federal University of Rio Grande do Sul (UFRGS); Federal University of Santa Maria (UFSM); Hadley Centre; Indian Institute of Sciences; Indian Institute of Tropical Meteorology; National Institute for Space Research (Inpe); National Institute of Amazonian Research (Inpa); Princeton University; Technical Aeroespace Center (CTA); University of Brasília (UnB); São Paulo State University (Unesp); University of Amsterdam; University of Reading; University of Wageningen; University of São Paulo; Woods Hole Research Center.

SCIENCE QUESTIONS AND OBJECTIVES

Due to the high degree of non-linearity of the Earth system (e.g. moist processes, biogeochemical processes, ocean and atmosphere circulation, cryosphere dynamics and carbon cycles in marine environments), it is only possible to estimate the most probable scenarios of the Earth´s climate through the creation of a model that consistently incorporates the interactions between the relevant hydro-bio-physical-chemical processes of the global climate system. The main goal of this subproject is to bring together the Brazilian scientific community to model the different components of the climate system, such as the atmosphere, the biosphere, the oceans, the cryosphere, the aerosols and the land surface processes, as well as to develop the computational methods necessary for the creation of such a complex model. The creation of the Brazilian Model of the Global Climate System (MBSCG) is an original contribution from Brazil to the international efforts to model and project global climate change, and will enhance the confidence of the scenarios on regional scales, in particular for South America.

Figure1. Schematic Diagram of the Brazilian Model of the Global Climate System and its sub-models. The four sub-models – Atmosphere, Atmospheric chemistry, Ocean and Land – are integrated by a coupler

CURRENT RESULTS AND PERSPECTIVES

One of the most important aspects of the development of the Brazilian Model of the Global Climate System is the multinational cooperation involving leading research institutions from Brazil, the United States, India, South Africa, Argentina, Chile, and Uruguay. Senior researchers and young scientists from these nations participated in at least one of the four workshops organized by the MBSCG project, hosted in Brazil, in 2009. This interest is bringing much needed scientific expertise on topics covering all components of the global climate model under development in Brazil, from forest fire to surface hydrology, effects of river discharge on the ocean, marine biogeochemistry and ice, and advanced topics on atmospheric convection and rainfall. The development of the associated datasets needed for the model runs were discussed. Furthermore, the first scientific paper on the impacts of Amazon deforestation on climate using the coupled ocean-atmosphere global model was published. This coupled model forms the backbone of the MBSCG development, showing the interconnection between rainfall over the Amazon, the general circulation of the atmosphere and the oceans.

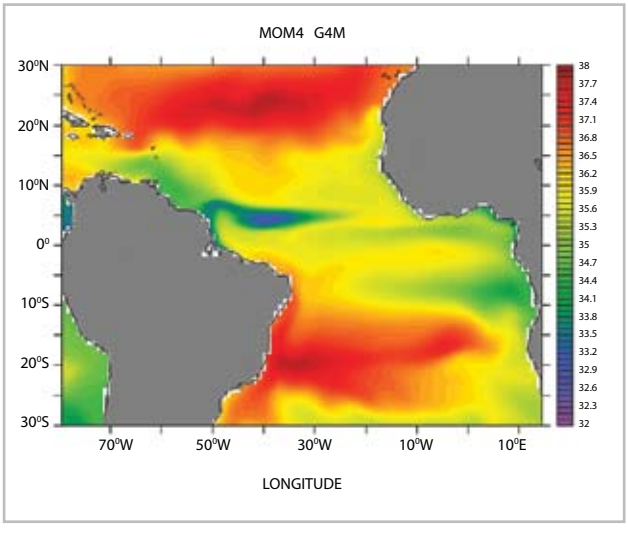

Figure 2: The modeling of river discharges on the global oceans integrates continental hydrology with ocean circulation and biogeochemistry, which in turn impact atmospheric circulation and CO_2 cycles. This figure shows the effect of the Amazon River discharge on equatorial Atlantic sea surface salinity, as simulated by the coupled ocean-atmosphere version of the MBSCG

RELATED PUBLICATIONS

Freitas SR, Longo KM, Silva Dias MAF, Chatfield R, Silva Dias P, Artaxo P, Andreae MO, Grell G, Rodrigues LF, Fazenda A, Panetta J. 2009. The coupled aerosol and tracer transport model to the Brazilian developments on the regional Atmospheric Modeling System (CATT-BRAMS) Part 1: Model description and evaluation. *Atmospheric Chemistry and Physics (Online)*. **9**: 2843-861.

Hoelzemann JJ, Longo KM, Fonseca RM, do Rosário NME, Elbern H, Freitas SR and Pires C. 2009. Regional representativity of Aeronet observation sites during the biomass burning season in South America determined by correlation studies with MODIS Aerosol Optical Depth. *Journal of Geophysical Research*. **114**:D13301.

Nobre P, Malagutti M, Urbano DF, de Almeida RAF, Giarolla E. 2009. Amazon deforestation and climate change in a coupled model simulation. *Journal of Climate*. **22**: 5686-5697.

Senna MCA, Costa MH & Pires GF. 2009. Vegetation-atmosphere-soil nutrient feedbacks in the Amazon for different deforestation scenarios. *Journal of Geophysical Research*. **114**:D04104.

Nobre CA, Brasseur GP, Shapiro MA, Lahsen M, Brunet G, Busalacchi AJ, Hibbard K, Seitzinger S, Noone K and Ometto JP. 2010. Addressing the complexity of the Earth System. *Bulletin of the American Meteorological Society*. **91(1)**: 1377-1388.

CO-PI'S AND ASSOCIATES

Allan Spessa, Antônio Nobre, Bart Kruijt, Benedito Silva, Carlos A. Guimarães Jr., Carlos Raupp, Celso von Randow, Chou Sin Chan, Débora Roberti, Domingo Urbano, Edmo Campos, Eduardo D. Assad, George Philander, Gilvan Sampaio, H. Dolman, Henrique Barbosa, Humberto Rocha, Iracema F. A. Cavalcanti, J. Shukla, Javier Tomasella, Jefferson Simões, João Andrade de Carvalho Jr., João Paulo Delfino, Jorge Bustamante, Judith Hoelzemann, Júlio Chagas, Karla Longo, Lincoln Alves, Luiz Cândido, Luz Adriana Cuartas, Manoel Cardoso, Márcia Yamasoe, Marcos B. Sanches, Marcos Buckeridge, Marcos D. Oyama, Marcos H. Costa, Marta Malagutti, Mercedes Bustamante, Michael Coe, P. N. Vinaychandran, Paulo Kubota, Paulo Nobre, Pavel Kabat, Pedro Monteiro, Regina C. Alvalá, Richard Betts, Rita M. V. Vieira, Roberto de Almeida, Saulo Barros, Saulo Freitas, Silvio Nilo, Suryachandra Rao, Vanessa Canavesi, Walter Collischonn.

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

MINI-FACE EXPERIMENT TO ANALYZE THE EFFECTS OF ELEVATED CO_2 AND WARMING ON PHOTOSYNTHESIS, GENE EXPRESSION, BIOCHEMISTRY, GROWTH, NUTRIENT DYNAMICS AND YIELD OF TROPICAL FORAGE SPECIES

Carlos Alberto Martinez y Huaman
Department of Biology, Ribeirão Preto School of Philosophy, Sciences and Literature, University of São Paulo (USP)
FAPESP Process 2008/58075-8 | Term: May 2011 to Apr 2015

Contact: Av. Bandeirantes, 3900, CEP 14040-901, Ribeirão Preto, SP, Brazil | +55-16-3602-3648 | carlosamh@ffclrp.usp.br

Collaborating institutions: Department of Agriculture, USA; Federal University of São Carlos (UFSCar); State University of North Fluminense (UENF); University of Illinois, USA.

SCIENCE QUESTIONS AND OBJECTIVES

The observed and predicted rise in global atmospheric carbon dioxide concentration (CO_2), together with potential global warming and changes in precipitation, will undoubtedly have a significant economical and ecological impact on world agricultural crop plants, grasslands and forests. However, the response of tropical species to elevated CO_2 and warming has received little attention to date. The major contribution of this research proposal to FAPESP Research Program on Global Climate Change (RPGCC) is regarding the production of new and relevant scientific knowledge with emphasis in adaptation of tropical grazing species to a conservative climate change scenario. This proposal has been specifically designed to address a number of highly focused scientific questions in an interdisciplinary approach, in a national and international collaborative effort among agronomists, biologists, plant physiologists, molecular biologists and zootechnicians, in order to provide milestones and scientific deliverables regarding the responses of two contrasting tropical plants to global climate change. This research proposal aims to determine the effects of elevated CO_2 (600 ppm) and warming (+2°C), induced by infrared heaters, on the physiological, gene expression, biochemical, growth, carbon and nitrogen dynamics and yield responses of two tropical grazing species, *Panicum maximum* (C_4 grass) and *Stylosanthes guianensis* (C_3 legume), grown in consortium on a climate-change impact experiment using a mini-Face (Free air CO_2 enrichment) system. The hypothesis of the proposal is that exposure of plants to high CO_2 impact positively the performance of both functional groups grown in consortium, but the responses of plants will be modified by effect of warning. The major challenge of this project is that it will provide the first study concerning adaptation of grass and leguminous plants growing in consortium to the climate expected 50 years from now and regarding the ability of grazing plants to act as CO_2 sink in Brazilian tropics.

Figure 1. Physiological evaluation of plants through non-invasive and non-destructive methodology

CURRENT RESULTS AND PERSPECTIVES

Plant function is inextricably linked to climate and CO_2. In comparison to plants grown under ambient CO_2, plants growing at elevated CO_2 show higher rates of photosynthesis, decreased water use, lowered tissue concentrations of nitrogen and protein and increased growth and biomass production. However, some species, as the C_4 plants show lower response to elevated CO_2 than do C_3 plants. The stimulation of performance of C_3 plants is one of the most established aspects of rising CO_2, and it has been described in numerous studies. In contrast, the response of plants to future elevated CO_2 interacting with elevated temperature is still uncertain (Ainsworth & Ort, 2010). The major challenge to investigate the effects of elevated CO_2 on plants was the development of the Face (Free air CO_2 enrichment) systems, in which plants are exposed to elevated CO_2 with minimal disturbance of their natural environment like climate and radiation. Across a range of FACE experiments, has been determined that the stimulation of photosynthesis and yield by elevated CO_2 in crop species is much smaller than expected. In Brazil some experiments to determine the effects of elevated CO_2 in plants were carry out using open top chambers in forest species (Martinez et al., 2008) and crops as potato (Olivo et al., 2002) and sugar cane. However, tropical grasslands have been largely neglected despite the fact they cover 50% of the earth's surface, and are in theory as important as forests for the sequestration of carbon. In this study will be monitored the crop performance of the tropical forages Panicum maximum (C_4) and Stylosanthes guianensis (C_3) growing in consortium and exposed to elevated CO_2 and temperature using a miniFACE facility. These studies will offer a mechanistic comparison of the responses of a C_4 grass and C_3 legume to elevated CO_2 and warming.

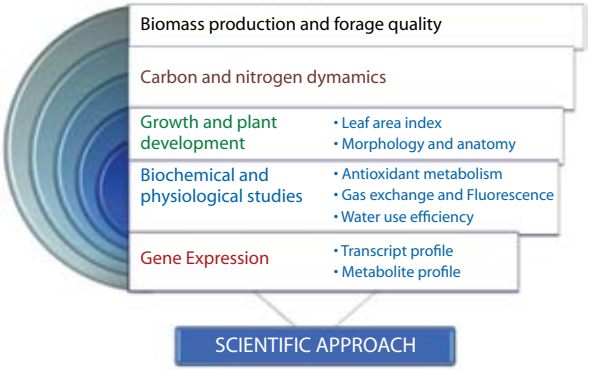

Figure 2. Scientific approach of the project describing the scaling of the impact of elevated CO_2 and temperature on molecular, biochemical and physiological processes that combine to determine the whole plant performance

RELATED PUBLICATIONS

Ainsworth EA, Ort DR. 2010. How do we improve crop production in a warming world? *Plant Physiology.* **154**: 526-530.

Martinez CA, Oliveira EAD, Legracie JR, Approbato AU. 2008. The effects of elevated CO_2 on tropical trees are related to successional status and soil nutritional conditions. In: J.F. Allen; E. Gantt; J.H. Golbeck; B. Osmond. (Org.). *Photosynthesis. Energy from the Sun*. Munich: Springer, **1**: 1383-1386.

Leakey ADB, Ainsworth EA, Bernacchi CJ, Rogers A, Long SP, Ort DR. 2009. Elevated CO_2 effects on plant carbon, nitrogen, and water relations: six important lessons from Face. *Journal of Experimental Botany.* **60**: 2859-2876.

Miglietta F, Hoosbeek MR, Foot J, Gigon F, Hassinen A, Heijmans M, Peressotti A, Saarinen T, van Breemen N, Wallén B. 2001. Spatial and temporal performance of the Mini-Face (free air CO_2 enrichment) system on bog ecosystems in northern and central Europe. *Environmental Monitoring and Assessment.* **66**: 107–127.

Olivo N, Martinez CA, Oliva MA. 2002. The photosynthetic response to elevated CO_2 in high altitude potato species (*Solanum curtilobum*). *Photosynthetica.* **40**: 309-313.

Souza AP, Gaspar M, Silva EA, Ulian EC, Waclawovsky AJ, Nishiyama-Jr MY, Dos Santos RV, Teixeira MM, Souza GM, Buckeridge MS. 2008. Elevated CO_2 increases photosynthesis, biomass and productivity, and modifies gene expression in sugarcane. *Plant Cell and Environment.* **31**: 1116-1127.

CO-PI'S AND ASSOCIATES

Elizabeth Ainsworth, United States Department of Agriculture, Urbana, IL, USA

Miquel Gonzales-Meler, Department Biological Sciences, University of Illinois, Chicago, IL, USA

Milton Groppo Jr., Department of Biology, Ribeirão Preto School of Philosophy, Sciences and Literature (FFCLRP), University of São Paulo, SP, Brazil

Associated Researchers

Carlos H. B. A. Prado, Department of Botany, Federal University of Sao Carlos, SP, Brazil

Hernan Maldonado, CCTA, University of North Fluminense, RJ, Brazil

Collaborator

Franco Miglietta, CNR-IBIMET, Firenze, Italy

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

EFFECTS OF GLOBAL CLIMATE CHANGE ON THE BRAZILIAN FAUNA: A CONSERVATION APPROACH

Carlos Arturo Navas Iannini
Department of Physiology, Institute of Biosciences, University of São Paulo (USP)
FAPESP Process 2008/57687-0 | Term: Aug 2009 to Jul 2013

Contact: Rua do Matão, trav. 14, 321, CEP 05508-090, São Paulo, SP, Brazil | 55+11-3091-7560 | carlos.a.navas@gmail.com

Collaborating Institutions: Department of Zoology, Rio Claro Institute of Biosciences, São Paulo State University (Unesp); Department of Physiology, Institute of Biosciences, University of São Paulo (USP).

SCIENCE QUESTIONS AND OBJECTIVES

A pattern that is global, yet heterogeneous given regional nuances, is an unequivocal change in the climate of Earth. Although this trend is expected to cause pervasive effects on the biota, the nature, span and final consequences of climate change must differ among taxa, even among animal species, because of the vast diversity in physiological traits and ecological associations evident in the fauna. Understanding the nature of differential effects of climate change on animal species is one of the many urgent and interdisciplinary challenges faced by contemporary science, and enhancing this understanding is the main general goal of this project. We propose an integrative ecophysiological and comparative approach that is derived from the conceptual framework supporting the emerging discipline known as conservation physiology. A main tenet of this discipline is that populations exposed to environmental change may crash when most individuals deteriorate, and that populations decline when individuals reach a physiological state that prevents them to maintain proper internal equilibrium through time. It follows that the effects of climate change on animal species cannot be assessed from the type, magnitude or time scale of the perturbation, but from the physiological states caused by it; and that the same pattern may be deleterious for one species and innocuous to another. We ask: 1) How and why physical variables related to climate interact with other types of environmental change and induce noxious physiological states or prevent reproduction? 2) Why this is so for some animal species but not for others? 3) What are the limits and paths of physiological adjustment to climate? 4) How early stages of life cycles are affected by climatic variables? 5) What are the energetic costs and trade-offs imposed on animals by climate shifts? These general questions are tackled using key models carefully selected from the Brazilian fauna.

*Figure 1. Aestivating frog (*Pleurodema diplolistris*) in the semi-arid Brazilian Caatinga*

Figure 2. A dam blocking fish upstream reproductive migration

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Ongoing projects partial results

1. The differential effects of fragmentation in bats relate to body condition and metabolic costs, in turn caused by differences in temperature and food supply. In rodents relate to different behavioral patterns, including personality. In birds, temperature and food supplies, as well as individual differences in reproductive success relate to the position of the nest in relation to the sun and to the temperature.
2. The resident microbiota living in the skin of anurans is affected by fragmentation, possibly via changes in environmental microbiota, in turn affected by local climatic conditions.
3. The catfish Steindachneridion parahybae has a reproductive period from October to March, with several spawning peaks that did not occur when migration was blocked.
4. Amphibians from the high tropical Andes differ in freezing tolerance whereas species from the semi-arid Caatingas differ in strategies for aestivation and water balance. These findings will help assessing distribution shifts and susceptibility to climate change. Lizard species differ in susceptibility to climate, and rain patterns, more than temperature, determine reproductive success.
5. Aluminum can be considered an endocrine disrupting compound for fish, decreasing plasma levels of progestagen and gonadotropins. Considering the influence of climate changes in fish, temperature affects the structure of fatty acids in cell membranes, and this alteration has a strong relationship with the length of exposure.

*Figure 3. Surubim do Paraíba (*Steindachneridion parahybae*), an endangered teleost species*

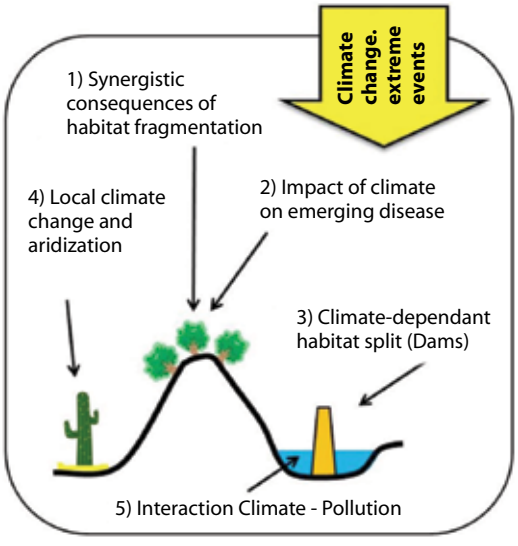

Figure 4. Schematic view of main problems assessed

RELATED PUBLICATIONS

Almeida, CA, Cruz-Neto, AP. Thermogenic capacity of three species of frugivores phyllostomid bats. *J. Thermal Biol.* (*in press, expected publication in 2011*).

Brandt R, Navas C. Life-history evolution on Tropidurinae Lizards: influence of lineage, body size and climate. *Minor modifications requested by PLoS One*.

Caneppele D, Honji RM, Hilsdorf AWS, Moreira RG. 2009. Induced spawning of the Neotropical endangered species *Steindachneridion parahybae* (Siluriformes:Pimelodidae). *Neotr. Ichthyol*. **7**: 759-62.

Correia TG, Narcizo AM, Bianchini A, Moreira RG. 2010. Aluminum as an endocrine disruptor in female Nile tilapia (*Oreochromis niloticus*). *Comp.Biochem.Physiol*. **151C**: 461-66.

Navas CA, Úbeda C, Logares R, Jara FG. 2010. Thermal tolerances in tadpoles of three species of Patagonian anurans. *South Amer.J.Herpetol*. **5**: 89-96.

Titon B, Navas CA, Jim J, Gomes FR. 2010. Water balance and locomotor performance in three species of neotropical toads that differ in geographical distribution. *Comp. Biochem. Physiol*. **156A**: 129-35.

CO-PI'S AND ASSOCIATES

Ariovaldo Pereira da Cruz-Neto, Rio Claro Institute of Biosciences, Unesp

Renata Guimarães Moreira, Institute of Biosciences, USP

Collaborators

José Eduardo Carvalho, Federal University of São Paulo (Unifesp-Diadema)

Vivian Helena Pellizari, Oceanographic Institute, USP

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

THE EVALUATION OF ENERGY EFFICIENCY AND CO_2 EQUIVALENT ABATEMENT POTENTIALS ACCORDING TO DIFFERENT TECHNOLOGY DISSEMINATION POLICIES: GUIDELINES TO PUBLIC POLICY-MAKERS

Gilberto de Martino Jannuzzi
Interdisciplinary Center of Energy Planning (Nipe), State University of Campinas (Unicamp)
FAPESP Process 2008/58076-4 | Term: Feb 2011 to Jan 2013

Contact: Cidade Universitária Zeferino Vaz, s/n, Barão Geraldo, CEP 13083-770, Campinas, SP, Brazil
Caixa Postal 1170 | +55-19-3521-1718 | jannuzzi@fem.unicamp.br

Collaborating institutions: Faculty of Mechanical Engineering, Unicamp; Nipe, Unicamp; International Energy Initiative (IEI)

SCIENCE QUESTIONS AND OBJECTIVES

The wider use of the best current commercial energy efficient technologies, processes and best practices can represent a cost-effective and significant contribution towards global efforts in stabilizing the atmospheric concentration of Greenhouse Gases. A better understanding of existing barriers to scale-up the use of more efficient technologies and addressing suitable policies to guarantee wider dissemination and that the existing energy efficiency potential, is a key element that needs to be brought to the attention of relevant decision-makers. The objectives of the current proposal are two-fold: a) it is intended to evaluate the potential of energy efficiency available in the buildings sector assuming projections over a 30-year time frame according to a select set of different schemes of dissemination policies (control mechanisms, funding mechanisms, support and market mechanisms); b) rank the analyzed dissemination policies according to their relevance and impacts towards climate mitigation efforts using multicriteria analysis. Therefore the objective is not only to provide quantitative estimates of energy savings (and CO_2 reductions) but also show the best ways to achieve these savings. The main target audience of this proposal is the public decision-makers which need a clear understanding of the impacts in climate mitigation efforts of portfolio of options concerning efficiency measures and related dissemination policies.

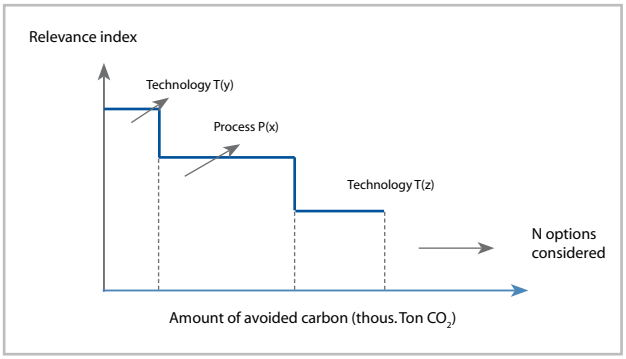

Figure1. Expected results: ranking of policy / technologies that will best contribute towards CO_2 emmission reductions in Brazil

CURRENT RESULTS AND PERSPECTIVES

The presentation of considered energy efficiency options will be ranked accordingly to their implementation relevance and associated with the corresponding impact on the amount of avoided carbon emissions. Such presentation based on transparent information, careful and rigorous analysis should provide a useful guide to decision makers and better understanding on the current knowledge of the contribution of existing options in energy efficiency technologies and processes across the main economic sectors considered. This analysis will be done by all relevant technologies and processes of industrial, buildings and transportation. Each technology/process according to the attributes considered and the MCA objective to combine the evaluation into one index that can be used to rank the lines(technologies/processes).

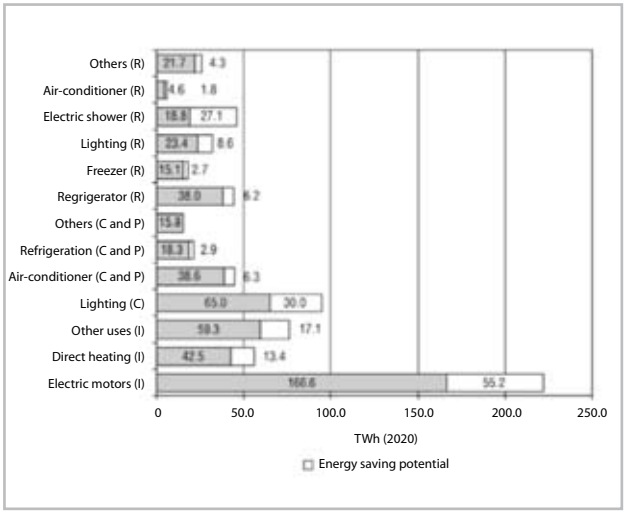

Figure 2. Eletricity savings potential in Brazil by 2020
Source: Jannuzzi et al (2007)

RELATED PUBLICATIONS

Jannuzzi GM, Romeiro A, Melo C, Piacente F, Esteves G, Xavier Jr. H, Gomes RDM. 2007. Agenda Elétrica Sustentável 2020: Estudo de cenários para um setor elétrico brasileiro eficiente, seguro e competitivo. *Série Técnica. Brasília: WWF-Brasil*, 2007. http://assets.wwf.org.br/downloads/wwf_energia_2ed_ebook.pdf.

Volpi G, Jannuzzi G, Gomes RDM. 2006. A sustainable electricity blueprint for Brazil. *Energy for Sustainable Development*. **X**: 14-24.

Pacala S, Socolow R. 2004. Stabilization wedges: solving the climate problem for the next 50 years with current technologies. *Science*. **305**, n. 5686: 968 -972.

CO-PI'S AND ASSOCIATES

Conrado Melo
Sérgio V. Bajay
Paulo F. Barbosa
Paulo Santana

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

CARBON TRACKER AND WATER AVAILABILITY: CONTROLS OF LAND USE AND CLIMATE CHANGES

Humberto Rocha
Department of Atmospheric Science, Institute of Astronomy, Geophysics and Atmospheric Science (IAG), University of São Paulo (USP)
FAPESP Process 2008/58120-3 | Term: Sep 2009 to Sep 2013

Contact: Rua do Matão, 1226, CEP 05508-090, São Paulo, SP, Brazil | +55-11-3091-4713/4705 | humberto@model.iag.usp.br
http://www.dca.iag.usp.br/www/material/humberto/index.php

Collaborating institutions: Agronomy Institute (IAC), Department of Agriculture and Food Supply of the State of São Paulo (SAA); Center for Nuclear Energy in Agriculture (Cena), University of São Paulo (USP); Department of Water and Power (DAEE), SP; Embrapa Environment, Brazilian Agricultural Research Corporation (Embrapa); Institute of Botany (Ibot), Department of Environment of the State of São Paulo (SMA); National Institute for Space Research (Inpe), Ministry of Science and Technology (MCT); National Oceanic and Atmospheric Administration (NOAA), USA; Nuclear and Energy Research Institute (Ipen), Ministry of Science and Technology (MCT); University of Edinburgh, UK; University of Leeds, UK; University of Oxford, UK.

SCIENCE QUESTIONS AND OBJECTIVES

Our research concerns on the investigation of the consequences of either the global climate changes (CG) and the land use changes (LUC) in the functioning of ecosystems, with emphasis on the water and carbon cycles, especially in the sectors of water resources and agriculture, and the balance of carbon in the Amazon basin. We seek to measure and interpret greenhouse gases (GHG) and surface hydrometeorological exchanges at large and regional scale in Brazil, both due to the climate variability and LUC, using consistent field measurements of flux tower sites with measurements of climate, fluxes of CO_2 and evapotranspiration, radiation, soil moisture and river discharge, groundwater, litterfall photosynthesis, and aircraft (*Figures 1 and 2*) and numerical modelling of the land-atmosphere system. We aim to answer (i) if the Amazon basin operates as a sink or source of GHG and (ii) on what extension the LUC alters the water availability and flood events, and how it might combine the CG. By means of a consortium of Brazillian and USA/UK instituions we plan to developing spatio-temporal distributions of carbon fluxes, estimating mean net carbon flux for Amazon basin, using a computational assimilation system – the Carbon Tracker-Amazonia; and calculating the patterns in soil water and river runoff status, flood events and ecosystem productivity in the Amazon basin and across several meso-scale watersheds in the Cerrado and Atlantic Forest biomes for a range of climate scenarios.

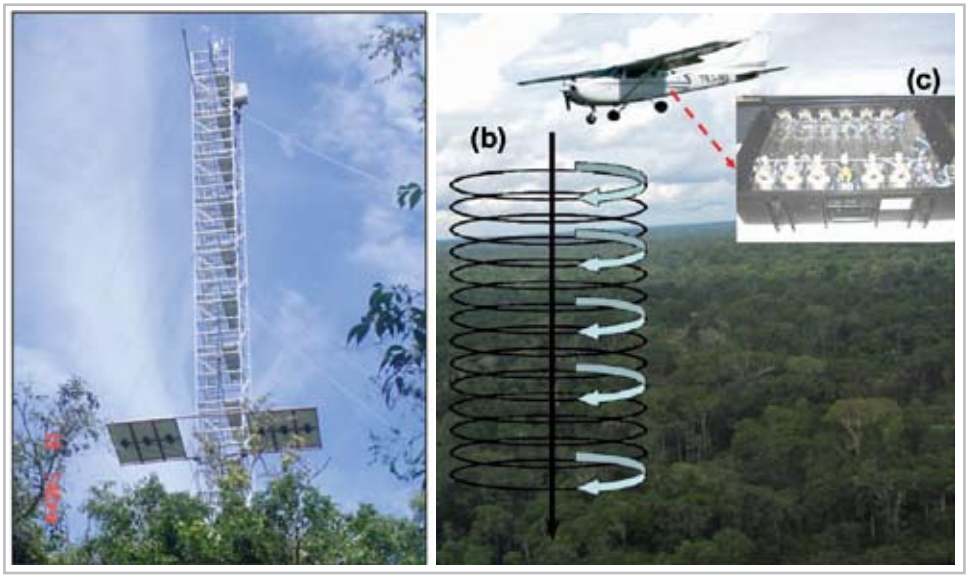

Figure 1. (a) Flux tower over a floodplain area in the ecotonal region of Bananal Island (frontiers of Tocantins-Mato Grosso-Pará); (b) Measurement of atmospheric greenhouse gases with aircraft´s downward sampling using (c) a portable compressor and flask unities

CURRENT RESULTS AND PERSPECTIVES

Vertical profile sampling of atmospheric air from aircraft at Santarem, Manaus and Alta Floresta for subsequent GHG concentration analysis in the laboratory have been performed successfully and preliminarly tested in the Carbon Tracker Amazonia assimilation system, which showed substantial areal contribution over the Amazonia that helped to change the global CO_2 concentration (*Figure 2b*).

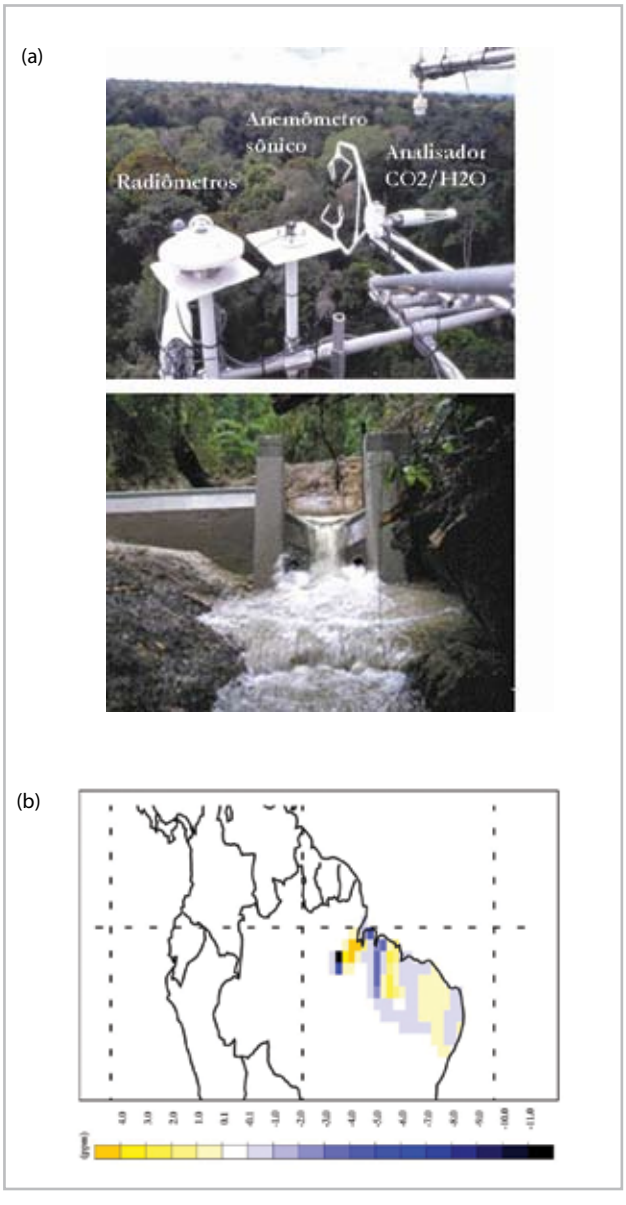

Figure 2. (a) Micrometeorological instrumentation to measure climate, CO_2 flux and evapotranspiration at the top tower, and measurement of basin discharge in the Atlantic Forest; (b) Modelled contribution (in ppm) to the global CO_2 concentration of the surface upwind Santarem, PA

RELATED PUBLICATIONS

Cabral OMR, Rocha HR, Gash JHC, Ligo MAV, Freitas HC, Tatsch JD. The energy and water balance of a eucalyptus plantation in southeast Brazil. *Journal of Hydrology.* **388**: 208-216. 10.1016/jhydrol.2010.04.041, 2010a.

D'Amelio MTS, Gatti LV, Miller JB, Tans P. 2009. Regional N_2O fluxes in Amazonia derived from aircraft vertical profiles. *Atmos. Chem. Phys.* **9**: 8785-8797.

Gatti LV, Miller JB, D'Amelio MTS, Gloor E, Martinewski A, Basso LS, Wofsy S, Tans, P. Vertical profiles of CO_2 above eastern Amazonia suggest a near neutral carbon balance between 2000 and 2009. *Tellus B,* DOI: 10.1111/j.1600-0889.2010.00484.x, 2010 a.

Rocha H, Manzi AO, Cabral OM, Miller SD, Goulden ML, Saleska SR, -Coupe NR, Wofsy SC, Borma LS, Artaxo P, Vourlitis G, Nogueira JS, Cardoso FL, Nobre AD, Kruijt B, Freitas HC, von Randow C, Aguiar RG, Maia JF. 2009. Patterns of water and heat flux across a biome gradient from tropical forest to savanna in Brazil. *J. Geophys. Res.* **114**, G00B12, doi:10.1029/2007JG000640.

Saad SI, Rocha H, da Silva Dias MAF, Rosolem RI. 2010. Can the deforestation breeze change the rainfall in Amazonia? A case study for the BR163 highway region. *Earth Interactions*. **14**: 1-25. DOI:10.1175/2010EI351.1

CO-PI'S AND ASSOCIATES

Luciana Gatti
Alex Krusche
Victoria Ballester
Saulo Freitas
Karla Longo
Osvaldo Cabral
Marcos Aidar
Gré Lobo
Erich Collichio
Orivaldo Brunini
Luiz Martinelli
Laura Borma
John Miller
Emanuel Gloor
John Grace
Y. Malhi
Scot Miller

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

ASSESSMENT OF IMPACTS AND VULNERABILITY TO CLIMATE CHANGE IN BRAZIL AND STRATEGIES FOR ADAPTATION OPTIONS

Jose Antonio Marengo
Earth System Science Center (CCST), National Institute for Space Research (Inpe)
FAPESP Process 2008/58161-1 | Term: Dec 2010 to Nov 2014

Contact: Rodovia Dutra km, 40, CEP 12830-000, Cachoeira Paulista, SP, Brazil | +55-12-3186-8464 | jose.marengo@inpe.br
http://www.ccst.inpe.br

Collaborating institutions: National Institute for Space Research (Inpe); São Paulo State University (Unesp-Rio Claro); State University of Campinas (Unicamp); Technological Institute of Aeronautics/Technical Aeroespace Center (ITA/CTA); University of São Paulo (USP-São Carlos).

SCIENCE QUESTIONS AND OBJECTIVES

Brazil is vulnerable to present-day climate variability and will be profoundly impacted by projected climate changes in the future. Compared to other Latin American countries, Brazil lacks (with few exceptions) of a national and regional strategy for vulnerability assessments and adaptation measures to cope with climate change. Water resources, population, agriculture, health, biodiversity and other key sectors are potentially highly vulnerable to climate variability and change. Social and regional inequalities exacerbate population´s vulnerability to climate change. Therefore, the project aims to establish the base for studies and assessments for impact, adaptation and vulnerability (IAV) in Brazil, using a combination of climate and vulnerability indices based on environmental, geographical-geophysical and social information, in view of identifying areas under risk to climate stress, and to map the vulnerability of population. The project constitutes a step further to the production of future climate scenarios, making use of a new generation of regional climate scenarios which have been generated at Inpe. Specific studies of vulnerability and risk will be done for the Serra do Mar, Paraíba do Sul Valley and São Carlos regions, as well as to the metropolitan regions of São Paulo, Campinas and the Baixada Santista.

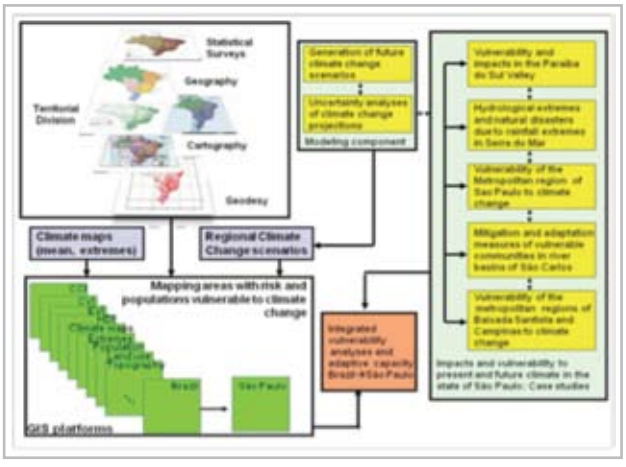

Figure 1. Research strategy of the project: from the generation of high resolution future climate change scenarios to development of detailed analyses in the State of São Paulo

Project activities during 2011-2014:

- The development of future climate change scenarios at regional scales, for various greenhouse gases emission scenarios, together with uncertainty assessments for the XXI Century, using new regional climate models with resolution of 15 km lat long;
- The enhancement of understanding of the impacts of climate and identification of the main regions potentially to be affected by climate change and the vulnerabilities of their populations in Brazil in the following sectors and systems: water resources, social aspects, weather related natural disasters and mega cities;
- The mapping of these vulnerabilities for Brazil using GIS, for the present climate and for some time slices of the present and the future (XXI Century), using vulnerability indices defined based on social, geographical-geophysical and environmental information, as well as indicators of extreme climate events in São Paulo and South America;
- The generation of high-quality scientific information to assist public policy in the areas of adaptation and mitigation, as an effective way to ensure that a broader sustainable development perspective is applied for measuring climate change policy and analysis.

CURRENT RESULTS AND PERSPECTIVES

Changes in the frequency of intense rainfall in the Metropolitan region of São Paulo have been observed since 1930, with more days with rainfall above 50 and 100 mm during the recent decades as compared to 1950-60. This is consequence of the urbanization effect (*Figure 2*).

Work has been undertaken to evaluate extreme events and to catalogue known hazard incidences in both areas and partial results show changes in the frequency of heavy rainfall and hazardous events for cities in the Baixada Santista and Campinas: for instance, from 1958-1967 to 1998-2007 Campinas experienced an impressive increase in the number of impacts triggered by precipitation, from 129 to 3,837 (*Figure 3*). For the municipalities of the Baixada Santista partial evaluations showed that the economic development of the region is based on unsustainable practices: higher number of catastrophic events is associated with higher deforestation rates.

Detailed analysis of hazards in the Paraiba´s Valley derived from newspaper information from 1998 until 2008 suggest that the most frequent event (54%) was flooding, followed by severe storms (25%). Landslides accounted for 11 %, almost the same frequency of flooding and landslides (10%).

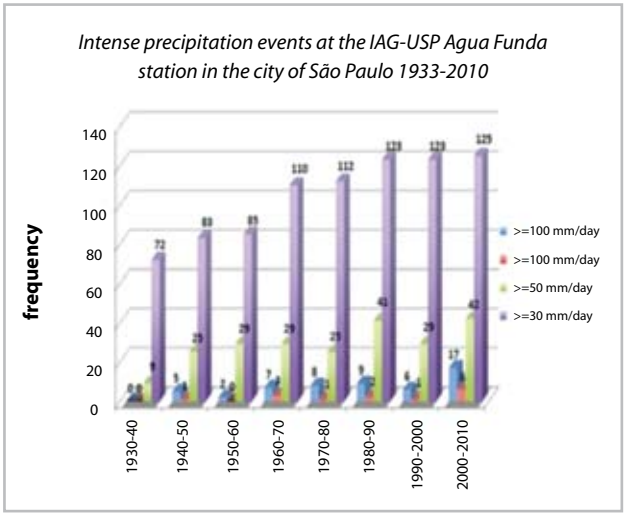

Figure 2. Frequency of intense precipitation events detected at the IAG-USP station of the city of São Paulo, during 1930-2010

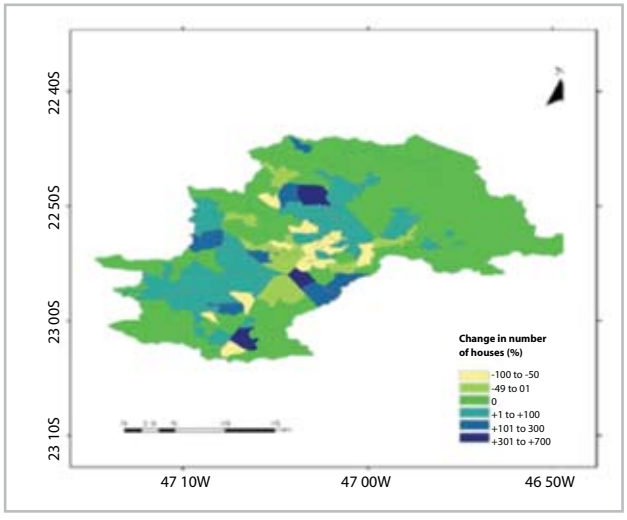

Figure 3. Impacts of intense rain in the city of Campinas, SP during 1958-2007: number of houses flooded for district: 35 districts showed increase while 25 experienced reductions in the number of cases. (Source: Castellano and Nunes 2010)

RELATED PUBLICATIONS

Nobre CA, Young AF, Saldiva P, Marengo JA, Nobre AD, Alves S, da Silva GCM, Lombardo, M 2010. Vulnerabilidade das megacidades brasileiras as mudanças climáticas: região metropolitana de São Paulo. *Sumário Executivo. CCST-Inpe, Unicamp, USP, IPT, Unesp*. São Paulo, 31 pp.

Castellano MS, Nunes LH. 2010. Impactos de chuvas na cidade de Campinas, SP: tendências sócio-espaciais em 50 anos. In: *Simp. Bras. de Climatologia Geográfica*, 9, Fortaleza, CE, 2010. 16p.

Chou SH, Marengo JA, Lyra AA, Sueiro G, Pesquero JF, Alves LM, Kay G, Betts R, Chagas DJ, Gomes JL, Bustamante JF, Tavares P. 2011. Downscaling of South America present climate driven by 4-member HadCM3 runs. *Climate Dynamics.* DOI 10.1007/s00382-011-1002-8, *in press*.

Marengo JA, Tomasella J, Alves LM, Soares WR, Rodriguez DA. 2011. The drought of 2010 in the context of historical droughts in the Amazon region. *Geophysical Research Letters, in press*.

CO-PI'S AND ASSOCIATES

Iracema F. A. Cavalcanti, CCST-CPTEC, Inpe
Regina Alvalá, CCST-CPTEC, Inpe
Gilberto Fisch, IAE, CTA
Magda Lombardo, Unesp-Rio Claro
Eduardo M. Mendiondo, USP-São Carlos
Luci Hidalgo Nunes, Unicamp

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

GENERATION OF ALCOHOL PRODUCTION SCENARIOS AS SUPPORT FOR THE FORMULATION OF PUBLIC POLICIES APPLIED TO THE ADAPTATION OF THE NATIONAL SUGAR AND ALCOHOL INDUSTRY TO THE CLIMATE CHANGES

Jurandir Zullo Junior
Centre for Meteorological and Climate Research Applied to Agriculture (Cepagri), State University of Campinas (Unicamp)
FAPESP Process 2008/58160-5 | Term: Dec 2010 to Nov 2014

Contact: Cid. Universitária Zeferino Vaz, CEP 13083-970, Campinas, SP, Brazil | +55-19-3521-2461 | jurandir@cpa.unicamp.br
http://www.cpa.unicamp.br/sugarcane_fapesp

Collaborating Institutions: CPTEC (National Institute for Space Research, Inpe); CNPTIA, CPAC, CNPMA, SNT (Brazilian Agricultural Research Corporation, Embrapa); Cepagri, Nudecri, IG, Nepo, Nepa, CBMEG, IFGW, FCA, FCM, IE, IFCH (State University of Campinas, Unicamp).

SCIENCE QUESTIONS AND OBJECTIVES

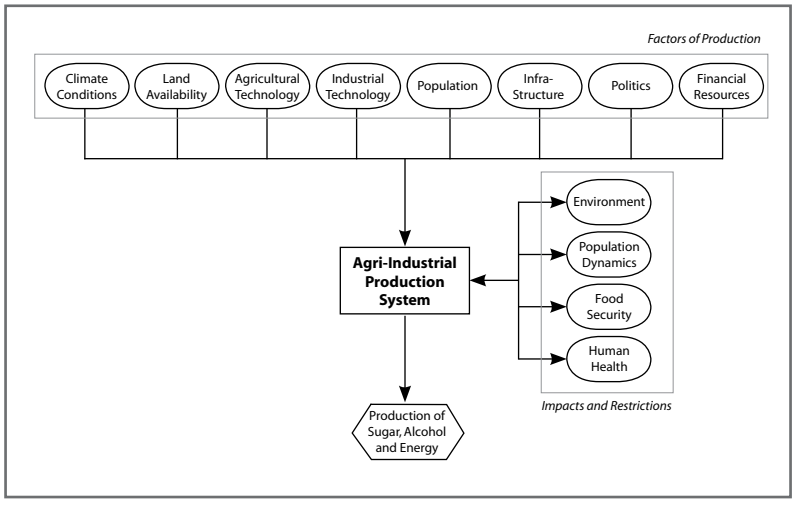

Figure 1. Inputs, factors of production, restrictions and impacts involved in the production of alcohol

The theme of climate changes became part of the everyday life of people and discussions subjects of national and international development policies, as the possibility of climate change is getting bigger in the most drastic way. The main approach recommended at this time is starting to develop methods of adaptation of the human activities to these changes, because the costs and impacts of inaction can be very high. Among the agricultural crops of great importance for the country, the sugar cane has a special feature in the context of climate change due to the potential expansion of the use of alcohol fuel in Brazil and in the world, in the coming years, as a way of mitigating the emissions of greenhouse gases (GHGs). There is, first, a great interest in the expansion of areas for planting sugar cane aimed at meeting the growing demands of alcohol fuel, whereas, on the other hand, several justified restrictions by the potential impacts on the environment, in the food and nutritional security, in the demographic dynamics and in human health and, also, the concerns about the effects of climate change on agriculture. This expansion should be properly planned, also considering, the adaptation to the climate changes, so that Brazil does not miss a great opportunity for business and development, but also, does not have economic, social and environmental damages because of hasty decisions and without the necessary technical and scientific basis. This case shows that the great challenge is to adapt a complex productive system, with several inter-relations, to the climate changes, and as such will be handled in the Project by experts from several knowledge areas, such as, climatology, demographic dynamics, food and nutritional security, scientific communication, public policy, geo-processing, environment, human health and scientific and technological development. The tool to be used in the analysis on the adaptability of the sugar and alcohol sector to the climate change and, in general, the adaptability of the agribusiness as a whole, will be the scenery of the production of ethanol fuel and associated impacts.

CURRENT RESULTS AND PERSPECTIVES

The main expected results with the development of the Project are the scenarios for the production of alcohol obtained from a combination of the determinant factors of this production, for two representative regions in Brazil (one developed and another interested in expanding) in three different periods. These results should enable the obtainment of another relevant result that is the general analysis of the adaptability of an important productive sector of the country to the climate changes. This analysis, in practice, will allow to assess the adaptation capacity of the society to the climate changes due to the complexity of the interrelations of the studied sector with political, economic, social and technical fields.

In addition to those expected results, should also be obtained other important ones throughout the Project, such as:

- Identification of three to five models for forecasting climate changes that are best suitable to Brazil and to impacts and vulnerability evaluations of crops to climate change;
- Identification of the relation between the expansion of plantations of sugar cane and the food and nutritional security;
- Determination of the relation between the expansion of planted areas with sugar cane and the demographic dynamics;
- Deepen communications, for several different public, on the issue of climate change in multiple media;
- Effects of the various technologies available in the adaptation to climate change;
- Effects of the modification of the atmospheric composition due to the use of ethanol fuel on human health;
- Suggestion for public policies to the adaptation of the production of ethanol fuel to the climate change;
- Better knowledge of the relation between the climate and the production of sugar cane;
- Improve of the accuracy, objectivity and anticipation of the harvests of sugar cane forecast methods;
- Methodology that allow to integrate the several different knowledge with the purpose to achieve the overall objective of the Project;
- Training of qualified staff in the area of climate change.
- Evaluations of the climate change impact in the chosen test-areas.

RELATED PUBLICATIONS

Furtado AT, Scandiffio MIG, Cortez LAB. 2011. The Brazilian sugarcane innovation system. *Energy Policy*. **39**: 156-166.

Zullo Junior J, Pinto HS, Assad ED, Marin FR, Pellegrino GQ. 2010. Climate change and sugar cane in the State of São Paulo. In: Luis Augusto Barbosa Cortez. (Org.). *Sugarcane Bioethanol - R&D for Productivity and Sustainability*: *Blucher*. **1**: 195-202.

Belik W, Siliprandi E. 2010. Hábitos alimentares, segurança e soberania alimentar. In: Roberto Vilarta; Gustavo L. Gutierrez; Maria Inês Monteiro. (Org.). *Qualidade de Vida: Evolução dos Conceitos e Práticas no Século XXI*. 1 ed. Campinas: IPES, 2010. **1**: 187-196.

Belik W. 2010. Desenvolvimento territorial e soberania alimentar. In: Niemeyer Almeida Filho e Pedro Ramos. (Org.). *Segurança Alimentar: Produção Agrícola e Desenvolvimento Territorial.* 1 ed. Campinas: Alínea, 2010. **1**: 169-192.

Dias PLS, Ribeiro WC, Sant'anna Neto JL, Zullo Junior J. 2009. Public policy, mitigation and adaptation to climate change in South America. *1. ed. São Paulo: Instituto de Estudos Avançados - IEA/USP*. **1**: 280.

Furtado AT. 2009. Structural changes in the Brazilian energy matrix. *Terrae (Campinas. Impresso)*. **6**: 42-51.

Pinto HS, Assad ED, Evangelista SRM, Zullo Junior J, Ávila AMH de, Otavian AF, Evangelista BA, Marin FR, Pellegrino GQ, Coral G. 2008. Aquecimento global e a nova geografia da produção agrícola no Brasil. *2. ed. Curitiba: Posigraf.* **1**: 82.

Pinto HS, Zullo Junior J, Assad ED. 2008. El calentamiento global y la agricultura brasileña. In: CEPAL. (Org.). La Agricultura - Otra Víctima del Cambio Climático?. *1 ed. Santiago de Chile: Aún Creemos En Los Sueños*. **1**: 63-74.

Zullo Junior J, Pinto HS, Assad ED, Evangelista SRM. 2008. Potential economic impacts of global warming on two Brazilian commodities, according to IPCC prognostics. *Terrae (Campinas)*. **3**: 28.

CO-PI'S AND ASSOCIATES

André Tosi Furtado, Claudia Regina Castellanos Pfeiffer

Associated Researchers

Walter Belik, Tirza Aidar, Vera Regina Toledo Camargo, Peter Alexandre Bleiroth Schulz, Ana Maria Heuminski de Avila, Chou Sin Chan, Anete Pereira de Souza, Rosana Baeninger, Emma Siliprandi, Maria Rita Donalisio Cordeiro, Luciana Alvim Santos Romani, Martha Delphino Bambini, Renata Ribeiro do Valle Gonçalves, Celso Macedo Filho, Cristina Rodrigues Nascimento, Balbino Antônio Evangelista

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

URBAN GROWTH, VULNERABILITY AND ADAPTATION: SOCIAL AND ECOLOGICAL DIMENSIONS OF CLIMATE CHANGE ON THE COAST OF SÃO PAULO

Lúcia da Costa Ferreira
Environmental Research Center; Population Studies Center, State University of Campinas
FAPESP Process 2008/58159-7 | Term: May 2009 to May 2010

Contact: Rua dos Flamboyants, 155, Cidade Universitária Zeferino Vaz, CEP 13083-867, Campinas, SP, Brazil
+55-19-3521-7690 | luciacf@unicamp.br | http://www.nepam.unicamp.br/projetoclima

Collaborating institutions: Embrapa Satellite Monitoring, Brazilian Agricultural Research Corporation (Embrapa); Federal University of São Carlos (UFSCar); Geological Institute of São Paulo (IG), Department of Environment of the State of São Paulo (SMA); Indiana University and Associate Faculty Earth System Governance (IHDP); Institute for Technological Research (EPT).

THE KEY QUESTION AND OBJECTIVES

The key question is how demographic and social dynamics interact with the ecological dynamics of forest cover to produce a region of high environmental vulnerability in a context of global climate change on the coast of São Paulo, Brazil.

This project proposes a polycentric and interdisciplinary approach at various levels with active oversight of local, regional, and national stakeholders to addressing the complex problems of climate change caused by greenhouse gas emissions.

The main specific objectives are identify, describe, map and analyze: 1) In view of social and environmental vulnerability, the dynamic social, political, demographic and environmental in study area, aiming to identify and map their key challenges - both from the standpoint of ecological characterization with a focus on biodiversity, and also on human dimensions of sustainability, such as environmental conflicts in the region, and political-institutional responses to the problem; 2) In view of social and political adaptations, the patterns of : land use and land cover; production and consumption of natural resources; mortality by groups of cause.; experience of municipal governments in harmonizing economic growth, social justice and environmental protection at the local level, seeking to identify them; conflicts (local, regional and global actors and arenas) concerning the irregular settlements on the Serra do Mar State Park; human activities related to urban sprawl and growing infrastructure needs have already affected adjacent forest areas in terms of floristic composition, when compared with similar forest in other areas of the Northern Coast of São Paulo, and whether air pollution and deposition of nitrogen compounds produced by the Gas Processing Plant under construction will enhance plants' growth rate.

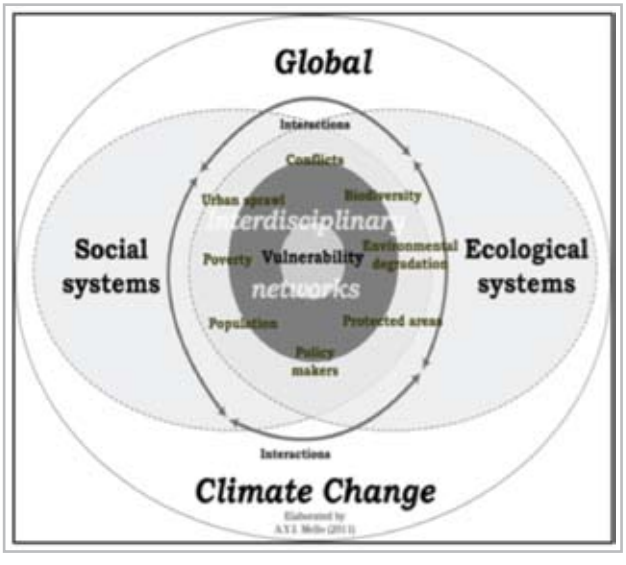

Figure 1. Conceptual framework

CURRENT RESULTS

Consolidation of data from Census 2000 in a georeferenced database. Data on notifiable diseases on the basis of Datasus; Data Transmitted Diseases Water and Food (TDWF) historical records of the epidemiological surveillance.

Role of local governments in areas with effects on climate change. Political-institutional strategies (federal, regional and local). Political-Institutional structure in coastal cities of the State of São Paulo. Environmental legislation in the coastal cities of the State of São Paulo. Estimation of human occupation on the shoreline in urban areas in the north coast of São Paulo.

Survey and identification in the north coast: social actors and institutional decision-making arenas, patterns of interaction and action strategies; main centers of scientific expertise acting in direct and indirect environmental arenas in the region; patterns of land management, legal instruments (State Park, National Park, Master Plans in the city of Ubatuba, integrating factors and disintegration of social groups in decision making; civil associations and executed projects; thick description of the videos of the public hearing portion of the Marine Mussel Project; dynamic process of defining environmental risks and impacts of the Gas Treatment Unit Caraguatatuba.)

Definition of two focus groups to discuss climate change and risks.

Based on census tracts and areas of consideration, we analyzed the distribution of population, people with incomes of up to two minimum wages, water and sewer service and garbage collection to Caraguatatuba and Santos on the coast of São Paulo, also different types risk and vulnerability (landslides, flooding, shoreline distance).

Obtaining data of the physical environment in institutions such as IPT and Civil Defense.

Phytosociological inventory and summer sample of tree ecophysiology parameter in lowland tropical atlantic moist forest in Caraguatatuba.

Definition of indicators and vulnerability maps for coastal areas, identifying the variables that make up the regional scenario of urban sprawl and environmental changes.

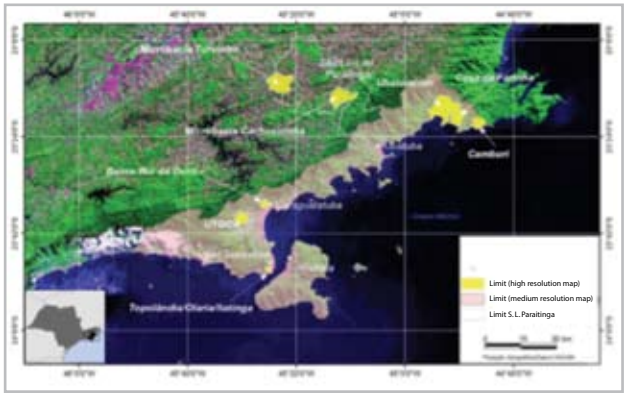

Figure 1. Mapping coverage and use of land

RELATED PUBLICATIONS

Ferreira L, MartinsR, Barbi F, Ferreira L, Mello L, Matenhauer A, Oliveira de Souza F. 2011. Governing climate change in Brazilian Coastal cities: risksand strategies. *Journal of US-China Public Administration*, ISSN 1548-6591, USA. **8(1)**: 51-65.

Martins R, Ferreira LC. 2011. Climate change action at the city level: tales from two global cities in Brazil. *Management of Environmental Quality*. ISSN/ISBN: 14777835.2010.

Martins RD, Ferreira LC. 2010. The research on human dimensions of global environmental change in Latin America: looking back, moving forward. *International Journal of Climate Change Strategies and Management*. **2**: 264-280.

Seixas SRC, Barbosa RV, Renk M, Asmus GF, de Mello AYI. 2010. Global environmental change and health: a preliminary approach about Caraguatatuba county, North Coast of São Paulo. *Teoria & Pesquisa.* **XIX, n. 1**.

CO-PI'S AND ASSOCIATES

Leila da Costa Ferreira, Carlos A. Joly, Roberto L. Carmo, Mateus Batistella, Cristiana Simão Seixas, Sônia da Cal Seixas, Simone Aparecida Vieira, Álvaro de Oliveira D`Antona, Eduardo Marandola Jr., Humberto Prates da Fonseca Alves, Ricardo Ojima, Leonardo Freire de Mello, Marcelo Coutinho Vargas, Thales Haddad de Andrade, Marcos Pereira Marinho Aidar Jorge Y. Tamashiro, Zoraide Amarante, Itapura de Miranda Gabriela Marques Di Giulio, Sunil D. Santha

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

EARLY WARNING SYSTEM FOR EMERGING INFECTIOUS DISEASES IN SOUTHWESTERN AMAZONIA: ADAPTATION TO THE NEGATIVE IMPACTS OF GLOBAL CLIMATE CHANGE ON HUMAN HEALTH

Manuel Cesario
Graduate Programme on Health Promotion, University of Franca (Unifran)
FAPESP Process 2008/58156-8 | Term: Dec 2010 to Nov 2014

Contact: Rua do Jatobá, 909, Parque do Mirante, CEP 14410-325, Franca, SP, Brazil
+55-16-8162-5881 / +55-16-3705-4353 | manuel.cesario@uol.com.br

Collaborating Institutions: Federal University of Bahia (UFBA); Institute of Biomedical Sciences 5 (ICB 5 – Monte Negro, Rondônia), University of São Paulo (USP); São Paulo State University (Unesp), Campus of Jabuticabal

SCIENCE PROBLEMS AND OBJECTIVES

The relationships between some determinants, at regional level, of Global Climate Change and their impacts on Ecosystems Services, especially on the capacity of Amazonian ecosystems to regulate the spreading of vector-borne infectious diseases is the focused problem. In Amazonia, forest burning is used to convert forested areas into pastures or plantations, emitting GHGs. On the other hand, Global Climate Change projections point to a regional decrease in humidity and increase in temperature - climatic conditions that foster forest fires, which in turn will further increase GHGs, closing the perverse circle. Unprecedented regional changes due to the ongoing implementation of hydroelectric dams, hydro-ways and paved roads are expected to have great impacts on the epidemiology of human diseases, over the next years. LUCC and the associated biodiversity-loss favour the disruption of natural cycles that impinge on vectors' abundance, jeopardizing an Ecosystem Service known as Infectious Diseases Regulation (the ability of ecosystems to act as buffer zones between zoo noses and human populations). Increased migration and urbanisation will affect the spread of transmission of vector-borne diseases, by increasing the density of both people and vectors and the transit of people. The most striking changes in the epidemiology of vector-borne diseases already observed in the Andes-Amazon region, so far, are the (re)emerging diseases transmitted by phlebotomine sand flies: Cutaneous Leishmaniasis and Bartonellosis (Carrion Disease). This project aims at developing adaptation strategies and tools to face the negative impacts of Global Climate Change on the health determinants of human communities living in the Southwestern Amazonia tri-national region. Early Warning Systems for Emerging Infectious Diseases will be developed to enable health professionals to anticipate and face the negative impacts of climate change on the spreading of (re)emerging vector-borne infectious diseases. A better understanding of the role played by unsound regional development policies in perpetuating the above-depicted perverse circle will represent a timing response to the urgent need to advance scientifically informed decision-making in respect to socio-economic impacts, vulnerability and responses - concerns of the Global Climate Change Human Dimensions' community.

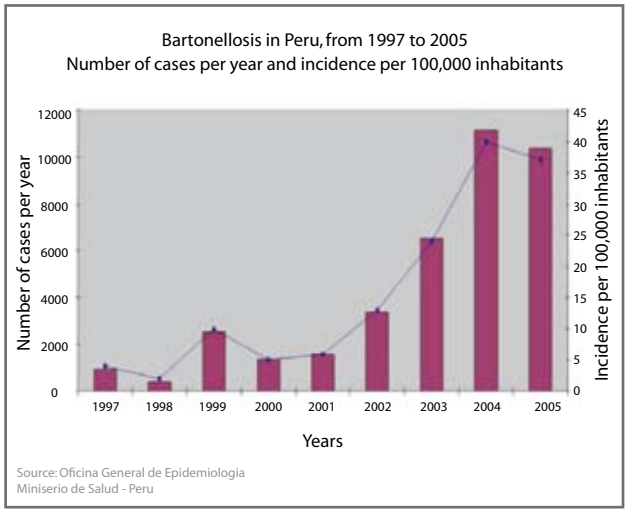

Figure 1. Evolution of Bartonellosis' Incidence in Peru (1997-2005)

CURRENT RESULTS AND PERSPECTIVES

Cutaneous Leishmaniasis is a pan-tropical neglected disease affecting 88 countries, of which 72 are developing ones and 13 are among the least developed. Most of Cutaneous Leishmaniasis (90%) occurs in 7 countries, among them are Brazil and Peru, where environmental changes (such as new settlements, intrusion into primary forest, deforestation, human migration, agricultural development, dams building) increase the exposure to its sand fly vectors and are leading to a clear and disturbing increase in the number of cases. The known reservoirs are both silvatic and domestic: marsupials, rodents, sloths, anteaters, dogs, equines e mules. The interaction parasite-reservoir is a complex system and deserves further investigation efforts to better define the role of reservoirs in the disease cycles. The Pan-American Health Organization estimates five unreported cases for each reported case in the Americas.

Cutaneous Leishmaniasis Detection Coeficient (number of cases per 100,000 inhabitants)	Scales
18	Average in Brazil, in the last 20 years
13 to 40	Average in Peru, from 1985 to 1994
71	Level of very high risk of transmission, according to the Brazilian Ministry of Health
93	Northern Region (average in the last 20 years)
126	Acre State (average 2000-2007)
1,232	Assis Brasil municipality (average 2000-2007)
198 to 1,622	Variation between the six Bolivian municipalities along the tri-national borders (2004)

Table 1. Cutaneous Leishmaniasis Detection Coeficient at different scales

Bartonellosis (Carrión Disease) is caused by *Bartonella bacilliformis*, transmitted by phlebotomine sandflies, and may have three clinical forms: a high lethality acute form know as Oroya Fever; a chronic one known since pre-Incan times as Peruvian Wart; and 9-29% asymptomatic. It was, since pre-Colombian times, a disease confined to high-altitude Andean valleys. In Peru, an alarming spread of the disease during the last decade has been seen, with the number of Departments infected mounting from 4 in 1995 to 14 in 2004 (some at just 150 metres high) and its incidence soaring from 4 to 40 cases per 100,000 inhabitants between 1997 and 2005 (*Figure 1*). In 2004, for the first time, 175 cases were reported in the Department of Madre de Dios, bordering the disease-free Peru-Bolivia-Brazil tri-national borders, where health professionals are not trained to diagnose or to treat the disease. It was suggested that ENSO (El Niño Southern Oscillation) would have influenced the epidemiology of Bartonellosis, and its spreading in Peru is also linked with increased "temporary migration" and "LUCC due to agriculture pressures".

RELATED PUBLICATIONS

Cesario M, Cesario, RR, Andrade-Morraye, M. 2011. Environmental change and health impacts in amazonia. *IHDP Update*. **1**: 26-34.

Mooney H, Larigauderie A, Cesario M, Elmquist T, Hoegh-Guldberg O, Lavorel S, Mace GM, Palmer M, Scholes R, Yahara T. 2009. Biodiversity, climate change, and ecosystem services. *Current Opinion in Environmental Sustainability.* **1**: 46-54.

Cesario M, Andrade-Morraye, M. 2008. Land-use and land-cover changes and the (re) emergence of diseases in Brazil. *Source.* **11**: 61-68.

Aggarwal S, Cesario M, Confalonieri U, Daszak P, Krafft T, McMichael A, Patz J, Sauerborn R. 2007. Global environmental change and human health. *ESSP-GECHH Science Plan and Implementation Strategy.* **1**: 1-88.

Cesario M, Cesario RR. 2005. Infecção bacteriana rumo ao Brasil: endêmica nos Andes, Bartonelose se alastra com abertura de estradas e degradação ambiental. *Scientific American Brasil.* **34**: 10-11.

Cesario M. 1999. What is a healthy ecosystem? *Conservation Biology.* **13**: 5-6.

Cesario M. 1997. Linking biodiversity and health. *Plant Talk.* **8**: 6-6.

Cesario M. 1997. Linking human health and biological diversity. *Conservation Biology.* **11**: 1459-1459.

CO-PI'S AND ASSOCIATES

Luis Marcelo Aranha Camargo, ICB, USP

Maria Emília Bavia, Federal University of Bahia

Antônio Sérgio Ferraudo, Unesp-Jaboticabal

Mônica Andrade-Morraye, Unifran

Associated Researchers

Raquel Rangel Cesario, Unifran

Fernando Dias de Ávila Pires, Fiocruz and Federal University of Santa Catarina

Technicians and Students

Michelle Andrade Furtado, Unifran

Patrícia Pellegrino Colugnati, Unifran

Mateus Ribeiro, Unifran

Natália Gonçalves Amâncio, Unifran

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

NARROWING THE UNCERTAINTIES ON AEROSOL AND CLIMATE CHANGES IN SÃO PAULO STATE – NUANCE-SPS

Maria de Fátima Andrade
Department of Atmospheric Science, Institute of Astronomy, Geophysics and Atmospheric Science (IAG), University of São Paulo (USP)
FAPESP Process 2008/58104-8 | Term: Nov 2011 to Oct 2014

Contact: Rua do Matão 1226, Cidade Universitária, CEP 05508-090, São Paulo, SP, Brazil
+55-11-3091-4706 | mftandra@model.iag.usp.br | http:// www.lapat.iag.usp.br/nuance

Collaborating institutions: Federal Technological University of Paraná (UTFPR); Institute of Chemistry, Institute of Geosciences, Institute of Physics, School of Arts, Sciences and Humanities, School of Medicine, School of Public Health, University of São Paulo (USP); Institute of Botany (Ibot), Department of Environment of the State of São Paulo (SMA); Mackenzie University; National Institute for Space Research (Inpe), Ministry of Science and Technology (MCT); Nuclear and Energy Research Institute (Ipen), Ministry of Science and Technology (MCT).

SCIENCE QUESTIONS AND OBJECTIVES

This project is starting in the first semester of 2011 after a long process of evaluation. The rapid proliferation of megacities (> 10 millions of inhabitants) and their air quality problems are producing unprecedented air pollution health risks and ambient management challenges. Emissions from megacities affect not only local populations but also regional and global scale atmospheric chemistry and climate, as the megacities play an important role in the increase of atmospheric emission of Green House Gases (GHGs) and aerosols. The impact of the megacities is related not only to the air pollutants emission but also to the modification of surface (with increased roughness and drier surface) and consequently the change on the radiative balance and rain formation.

The theme of the project can be summarized as the implementation of a modeling system representing the chemical-physical process in the troposphere and the health impacts at the urban scale. The megacity of São Paulo will be an example of integrated approach regarding evaluating of the impact of the climate change on it air quality. In this project, MASP will be an observatory of the climate, with special attention to the variation of the meteorological characteristics due to the climate change.

The atmospheric aerosols concentrated all the complexity associated to the correct representation of the atmospheric chemistry and dynamical dispersion. The aerosols can be considered as tracers of the atmospheric process, as they are responsible for the radiative and cloud formation.

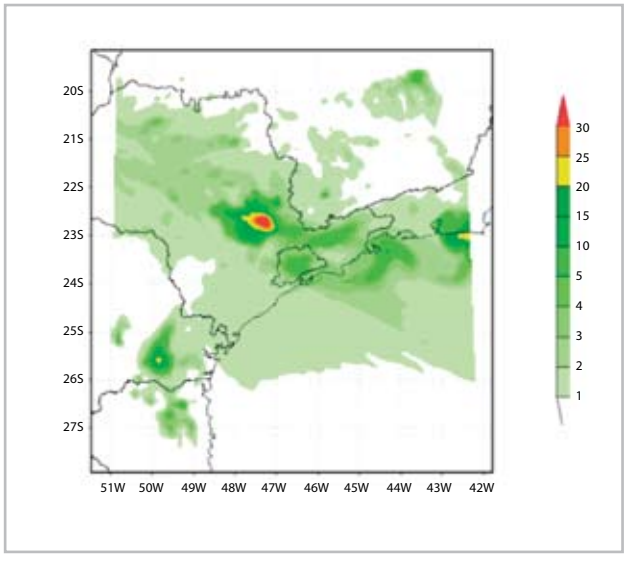

Figure 1. Dispersion of Fine Particles (PM2.5) in São Paulo

CURRENT RESULTS AND PERSPECTIVES

Modeling the impacts of megacities emission involves the knowledge of the sources of these aerosols and gases (both primary and secondary) and their spatial distribution. This includes the processes that lead to the formation of secondary organic and inorganic aerosols and their transport across multiple spatial scales and the chemical and microphysical evolution of primary aerosol species, particularly black carbon which is a strongly radiative absorbing aerosol component. Given the breadth and complexity of the scientific issues involved in global climate, the overall goal of Nuance is the study of the role of primary and secondary aerosol and gases (emissions, production, reactions, radiation interaction, and dispersion and transport process) in the regional scale in Sao Paulo State, South Hemisphere.

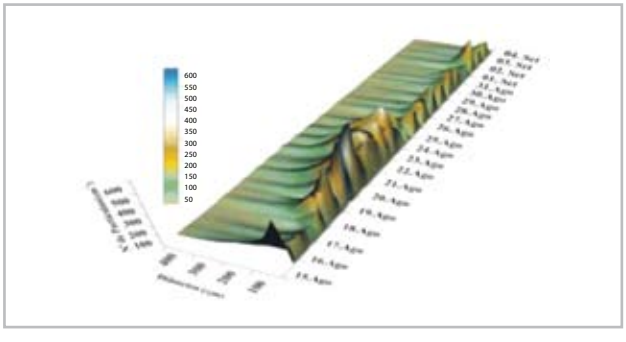

Figure 2. Number distribution of nano particles in São Paulo

Figure 3. Convective system over São Paulo

RELATED PUBLICATIONS

Andrade MF, Fornaro A, Miranda RM, Kerr A, Oyama B, Andre PA, Saldiva P. 2010. Vehicle emissions and PM2.5 mass concentrations in six Brazilian cities. *Air Quality, Atmosphere and Health*. **4**: 108-.

Martins LD, Martins JA, Freitas ED, Mazzoli CR, Gonçalves FLT, Ynoue RY, Hallak R, Albuquerque TTA, Andrade MF. 2009. Potential health impact of ultrafine particles under clean and polluted urban atmospheric conditions: a model-based study. *Air Quality, Atmosphere and Health*. **1**.

Miranda RM, de Andrade MF, Fornaro A, Astolfo R, Andre PA, Saldiva P. 2010. Urban air pollution: a representative survey of PM2.5 mass concentrations in six Brazilian cities. *Air Quality, Atmosphere & Health*. **4**: 100-.

Vasconcellos PC, Souza DZ, Sanchez-Ccoyllo O, Bustillos JOV, Lee H, Santos FC, Nascimento KH, Araújo MP, Saarnio K, Teinila K, Hillamo R. 2010. Determination of anthropogenic and biogenic compounds on atmospheric aerosol collected in urban, biomass burning and forest areas in São Paulo, Brazil. *Science of Total Environment.* **408**: 836-5844.

Landulfo E, Lopes F, Mariano G, Torres A, Nakaema W, Jesus W, Jorge M, Mariani R. 2010. Study of the properties of aerosols and the air quality index using a backscatter lidar system and aeronet sunphotometer in the city of São Paulo, Brazil. *Journal of the Air & Waste Management Association*. **60**: 386-392.

CO-PI'S AND ASSOCIATES

Eduardo Landulfo, Ipen
Paulo Saldiva, FM, USP
Rita Ynoue
Fábio Gonçalves
Márcia A. Yamasoe
Edmilson Freitas
Adalgiza Fornaro, IAG, USP
Pérola Vasconcellos, IQ, USP
Georg Grell, NOAA, USA
James West, University of North Caroline, USA
Risto Hillamo, Finish Meteorological Institution, Finland
Cliff Davidson, University of Pittsburgh, USA
Pierre Herckes, Arizona State University, USA

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

THE IMPACT OF TILLAGE AND HARVEST PRACTICES ON SOIL CO_2 EMISSION OF SUGARCANE PRODUCTION AREAS, SOUTHERN BRAZIL

Newton La Scala Júnior
School of Agricultural and Veterinary Sciences, São Paulo State University (Unesp – Jaboticabal)
FAPESP Process 2008/58187-0 | Term: Jun 2009 to May 2011

Contact: Via de Acesso Prof. Paulo Donato Castellane, s/n, CEP 14884-900, Jaboticabal, SP, Brazil
+55-16-3209-2625 | lascala@fcav.unesp.br | http://www.fcav.unesp.br/lascala

Collaborating Institutions: CNPDIA-Embrapa, Brazilian Agricultural Research Corporation (Embrapa); Federal University of Bahia (UFBA).

SCIENCE QUESTIONS AND OBJECTIVES

Sugarcane crops in Southern Brazil are related to food, biofuel and energy production, being considered as an important alternative when considered the climate change issue. The potential of renewable fuels in contrast to fossil fuels has already been discussed, but few works inferred the right soil management practice in order to promote soil carbon conservation in sugarcane areas. One example is in the so-called "green harvest", which, in contrast to burned, keeps aerial parts of the plant as crop residues on the soil surface, both seen in *Figure 1*, in adjacent plots. As more and more sugarcane areas have been converted to this new management option, the "green harvest", it is necessary to derive the spatial and temporal variability models of the soil CO_2 emission (FCO_2), its relation to soil properties, quantifying how tillage and harvest practices would impact on emissions.

Figure 1. Adjacent sugarcane areas managed under burned and "green harvest" systems

The objective of our project is to determine the impact of tillage and harvest management practices on FCO_2, or soil carbon losses through CO_2 in sugarcane production areas. Our study focuses on FCO_2 as quantitatively as possible, measuring it intensively in time and space close to the period when the soil is bare and FCO_2 is mostly related to the soil carbon decay only. Conceptual theory based on first order decay models have been applied in order to understand the differences and similarities of FCO_2 after tillage systems and its relation to soil properties. Spatial variability models are considered as non isotropic and fractal theory has also been applied to characterize anisotropy of FCO_2 in sugarcane fields. The development of new and non-conventional models is need in order to improve our prediction capacity of FCO_2 in space and time, and consequently on the predictions of soil carbon loss in huge areas.

CURRENT RESULTS AND PERSPECTIVES

In a recent field study, temporal variability of FCO_2 indicates that slash-and-burn (SB) and green (G) managed systems resulted in different total emissions at the end of the 70-day period after harvest, with 692 and 537 g CO_2 m^{-2} for SB and G, respectively. Hence, an additional amount of 42.3 g C-CO_2 m^{-2} was released to the atmosphere in the SB plot when compared to the G plot. The spatial variability analysis presents the higher spatial discontinuity of FCO_2 in the SB location when compared to G, as confirmed by the higher CV values for all studied days. Broader discussions about this experiment can be found in Panosso et al., 2009.

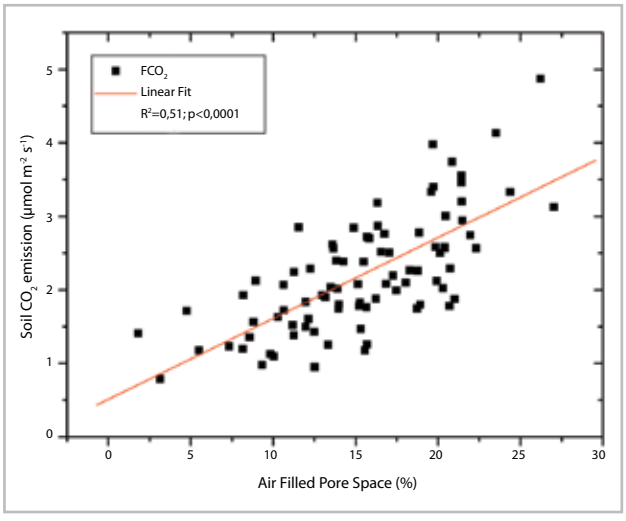

Figure 2. Positive linear regression between FCO_2 and air filled pore space in sugarcane areas

For the better understanding of FCO_2 spatial variability in sugarcane areas, we have conducted regression analysis in which FCO_2 is related to several soil properties. For the G plot, the main property selected which explains 51% of FCO_2 variability is the Air-Filled Pore Space (AFPS, *Figure 2*). The positive relation between FCO_2 and AFPS is probably related to the negative effect of the soil moisture on gas diffusion. A better comprehension of the soil properties effect on FCO_2 in sugarcane areas can be seen in Panosso et al. 2011.

Our main challenge nowadays is to advance into the knowledge on how soil properties, other than AFPS, are related to FCO_2, in order to improve the FCO_2 prediction capacity. We firmly believe that the results of our project could help formulating actions in order to reduce FCO_2, consequently, increasing soil carbon content in sugarcane areas.

RELATED PUBLICATIONS

Figueiredo EB, La Scala, N. 2011. Greenhouse gas balance due to the conversion of sugarcane areas from burned to green harvest in Brazil. *Agric. Ecosys. Environ*. To be published.

Teixeira DB, Panosso AR, Cerri CEP, Pereira GT, La Scala N. 2011. Soil CO_2 emissions estimated by different interpolation techniques. *Plant Soil*. To be published.

Panosso AR, Marques J, Milori, DMBP, Ferraudo AS, Barbieri, DM, Pereira GT, La Scala N. 2011. Soil CO_2 emission and its relation to soil properties in sugarcane areas under Slash-and-burn and green harvest. *Soil Till Res*. **111**: 190-196.

Figueiredo EB, Panosso AR, Romão R, La Scala N. 2010. Greenhouse gas emission associated with sugar production in southern Brazil. *Carbon Bal Manag*. **5**: 1-7.

Panosso AR, Marques J, Pereira GT, La Scala N. 2009. Spatial and temporal variability of soil CO_2 emission in a sugarcane area under green and slash-and-burn managements. *Soil Till Res*. **105**: 275-282.

La Scala N, Lopes A, Spokas K, Archer D, Reicosky DC. 2009. Short-term temporal changes of bare soil CO_2 fluxes after tillage described by first-order decay models. *Eur J Soil Sci*. **60**: 258-264.

CO-PI'S AND ASSOCIATES

José Marques Júnior
Afonso Lopes
Gener Tadeu Pereira
Débora Marcondes Bastos Pereira Milori
José Garcia Vivas Miranda

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

AEROCLIMA – DIRECT AND INDIRECT EFFECTS OF ATMOSPHERIC AEROSOL PARTICLES ON CLIMATE IN AMAZONIA AND PANTANAL

Paulo Eduardo Artaxo Netto
Institute of Physics, University of São Paulo (USP)
FAPESP Process 2008/58100-2 | Term: Jun 2009 to May 2013

Contact: Rua do Matão, Travessa R, 187, CEP 05508-090, São Paulo, SP, Brazil | +55-11-3091-7016 | Artaxo@if.usp.br

Collaborating Institutions: Federal University of São Paulo (Unifesp), Diadema Campus; Federal University of Mato Grosso; Federal University of Rondônia; Oswaldo Cruz Foundation (Fiocruz), RJ; Institute of Physics, USP; Institute of Astronomy Geophysics and Atmospheric Sciences, USP; Max Planck Institute, Germany; National Institute for Research in Amazonia (Inpa); National Institute for Space Research (CPTEC, Inpe and CCST, Inpe); Nasa and Harvard University, USA.

SCIENCE QUESTIONS AND OBJECTIVES

The Aeroclima project is working on unveiling the role of atmospheric aerosol particles in the Amazonian climate, and is part of the LBA Experiment (The Large Scale Atmosphere-Biosphere Experiment in Amazonia). Aerosols are very small particles (1-1000 nanometers) that are the largest uncertainties in global climate change. This project will study the chemistry, physical properties, radiative forcing, capability to become a cloud condensation nucleus among other properties, and will also include the critical aerosol properties in regional and global climate models. Aeroclima will enhance the knowledge on the direct and indirect effects of aerosols on climate for the Amazonia and Pantanal regions. We plan to reduce uncertainties on aerosol direct and indirect radiative forcing trough an approach with detailed aerosol and radiation measurements in several sites, coupled with a modeling component with a regional and global climate models approach. Remote sensing of aerosol and clouds will also help to provide the large scale distribution and characterization. Key aerosol properties such as aerosol size distribution, mass, composition, light scattering and absorption, CCN activity, will be measured for at least one year in three aerosol and trace gas atmospheric monitoring stations. Intensive campaigns will use aerosol mass spectrometers and advanced instrumentation to better characterize aerosol properties. We will also have aerosol vertical profile up to 12 Km, measured with Raman Lidar measurements as well as 7 Nasa/Aeronet sun photometers and radiometers in continuous operation. Airborne measurements using an instrumented aircraft (Inpe Bandeirante) will explore the large scale aerosol properties and distribution over Amazonia and Pantanal. The large scale will be observed with the use of satellite remote sensing using Modis and Calipso sensors. The modeling component will use CATT-Brams and WRF-Chem to study the regional aerosol radiative forcing. Large Eddy Simulations models will be used to study aerosol-cloud interactions. We also plan to incorporate in the Brazilian Global Climate Model under development at Inpe the aerosol parameterization developed in this project. Aeroclima will contribute to the objectives of the FAPESP Research Programme on Global Climate Change (FRPGCC) by expanding the scientific base related to Climate Change, with the observation of key components integrating the Earth System and its interfaces, and specifically in the following highlighted FRPGCC areas: (a) consequences of Global Climate Change over ecosystem functioning, biodiversity, and water, carbon, nitrogen cycles; and (b) atmospheric radiation balance, aerosols, trace gases and land-use change.

Figure 1. Tower of the LBA Experiment in Manaus were the FAPESP Aeroclima project is doing long term trace gas and aerosol measurements

CURRENT RESULTS AND PERSPECTIVES

Two long term aerosol and trace gases measurement sites were installed, close to Manaus and Porto Velho. The site in Manaus is located in a very clean and pristine area, with the lowest possible aerosol and trace gas concentrations in any continental area in the world. The site in Porto Velho is being operated in an area with heavy land use changes, representing areas in Amazonia where anthropogenic contributions are already changing significantly the atmospheric properties. We observed very pronounced changes in the radiation balance and cloud droplet nucleation at these sites. Cloud properties in pristine areas have very different microphysical properties from polluted areas in Amazonia, and this have important impacts in precipitation suppression, surface temperature and the hydrological cycle. The Amazonian vegetation interacts strongly with the atmosphere, with emission of aerosols and trace gases that control cloud droplet formation and evolution. We also observed that the vegetation have important role in maintaining the pristine atmospheric composition in Amazonia, with a strong role in regulating oxidant concentrations in Amazonia. Most of the aerosol particles in clean conditions are actually produced from secondary reaction in the atmosphere, modulated by solar radiation. *Figure 2* shows the distribution of aerosol direct radiative forcing over the whole Amazonia, obtained using remote sensing techniques. A large spatial (as well as temporal) variability can be observed, and the magnitude of the effect (up to -30 watts/m²) have significant effects on ecosystem functioning. This deficit in radiation affects photosynthesis in large areas of Amazonia. It also increase the diffuse radiation flux, increasing carbon uptake by the forest by up to 30% compared with pristine conditions.

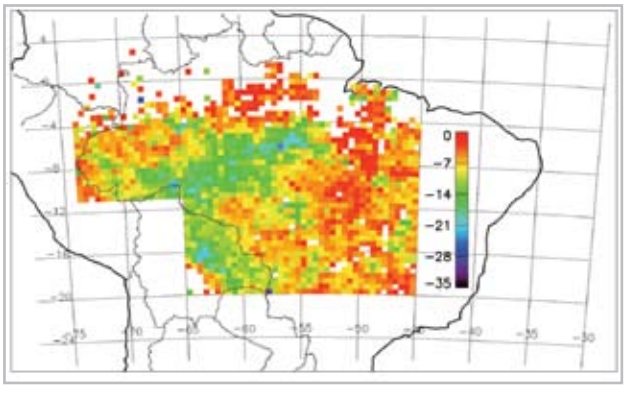

Figure 2. Aerosol radiative forcing at the surface resulting from biomass burning in large areas of Amazonia. A large radiation deficit at the surface of up to -28 watts/m² were observed over large areas in Amazonas, with important effects on the ecosystem functioning

RELATED PUBLICATIONS

Pöschl U, Martin ST, Sinha B, Chen Q, Gunthe SS, Huffman JA, Borrmann S, Farmer DK, Garland RM, Helas G, Jimenez JL, King SM, Manzi A, Mikhailov E, Pauliquevis T, Petters MD, Prenni AJ, Roldin P, Rose D, Schneider J, Su H, Zorn SR, Artaxo P, Andreae MO. 2010. Rainforest aerosols as biogenic nuclei of clouds and precipitation in the Amazon. *Science*. **329**: 1513-1516.

Bowman DMJS, Balch JK, Artaxo P, Bond WJ, Carlson JM, Cochrane MA, Antonio CMD, DeFries RS, Doyle JC, Harrison SP, Johnston FH, Keeley JE, Krawchuk MA, Kull CA, Brad Marston J, Moritz MA, Prentice IC, Roos CI, Scott CA, Swetnam TW, van der Werf GR, Pyne SJ. 2009. Fire in the Earth System. *Science.* **324**: 481-484.

Prenni AJ, Petters MD, Kreidenweis SM, Heald CL, Martin S, Artaxo P, Garland RM, Wollny AG, Poschl U. 2009. Relative roles of biogenic emissions and Saharan dust as ice nuclei in the Amazon basin. *Nature Geoscience.* **2**: 402-405.

Longo K, Freitas S, Andreae MO, Setzer A, Prins E, Artaxo P. 2010. The coupled aerosol and tracer transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS). Part 2: Model sensitivity to the biomass burning inventories. *Atmospheric Chemistry and Physics.* **10**: 7533-7544.

Gilardoni S, Vignati E, Marmer E, Cavalli F, Belis C, Gianelle V, Loureiro A, Artaxo P. 2011. Sources of carbonaceous aerosol in the Amazon basin. *Atmospheric Chemistry and Physics.* **11**: 2.747-2.764.

CO-PI'S AND ASSOCIATES

Maria A. F. da Silva Dias (IAG, USP), Henrique M. J. Barbosa (IF, USP), Alexandre L. Correia (IF, USP), Márcia A. Yamasoe (IAG, USP), Karla M. Longo (Inpe), Saulo Ribeiro de Freitas (Inpe), Plínio Alvalá (Inpe), Enio B. Pereira (Inpe), Fernando R. Martins (Inpe), Luciana V. Rizzo (UFABC-Diadema), Kenia T. Wiedemann (IF, USP), Theotônio M. Pauliquevis (UFABC-Diadema), Sandra Hacon (Fiocruz), Rodrigo Souza (Inpa/CLIAMB/UEA, Manaus), Wanderley R. Bastos (Federal University of Rondonia), Meinrat O. Andreae (Max Planck Institute for Chemistry, Germany), Scot T. Martin and Steven C. Wofsy (Harvard University, USA), José V. Martins and Brent Holben (Nasa Goddard, USA), Markku Kulmala (Helsinki University, Finland), Hans C. Hansson and Radovan Krejci (University of Stockholm, Sweden), William R. Cotton (Colorado State University, USA), George Grell (NOAA, CIRES Boulder, USA).

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

THE ROLE OF RIVERS ON THE REGIONAL CARBON CYCLE

Reynaldo Luiz Victoria
Center for Nuclear Energy in Agriculture (Cena), University of São Paulo (USP)
FAPESP Process 2008/58089-9 | Term: Jun 2009 to May 2013

Contact: Av. Centenario, 303, CEP 13416-000, Piracicaba, SP, Brazil | +55-19-3429-4078 | reyna@cena.usp.br

Collaborating institutions: Embrapa Pantanal, Brazilian Agricultural Research Corporation (Embrapa); Emilio Goeldi Museum, PA; Federal University of Acre (Ufac), AC; Federal University of Amazon (Ufam), AM; Federal University of Rondônia (Unir), RO; Minas Gerais State University (UEMG), MG; Institut de Recherche pour le Développement (IRD), France; Institute of Astronomy, Geophysics and Atmospheric Science (IAG), USP; Institute of Geosciences (IG), USP; Marine Biological Laboratory (MBL), USA; National Institute of Amazonian Research (Inpa), AM; University of British Columbia (UBC), Canada; University of Washington (UW), USA.

SCIENCE QUESTIONS AND OBJECTIVES

We hypothesize that: H1. Hydrology is the main driver of the biogeochemistry of carbon (and other nutrients) in rivers of the Amazon and Pantanal. Hence, different amounts of rain (and runoff) will set new functional levels in these systems; H2. There are common set of drivers controlling carbon (and nutrients) biogeochemistry in tropical rivers of the Amazon and Pantanal. Our current inability to model adequately these systems across all scales results from the lack of intercomparable long-time records, instead of the inadequacy of the models; H3. Rivers are active players in the overall carbon balance of these basins. Climatic changes affecting these systems will also change their role in feedbacks with the atmosphere and the regional carbon cycle. The outcome of this project will be fundamental to the development of the Brazilian climatic model, helping to create a unique design in which not only biosphere but also fluvial feedbacks are considered in the regional carbon cycle. Our main objective is to produce enough scientific information about the functioning of these fluvial systems to be able to develop basin-scale heuristic models linked to regional carbon cycle and allowing to predict their responses to global climate change. The specific goals are:

Goal 1. Obtain detailed information on carbon and associated nutrients distribution and processing along the different spatial and temporal scales necessary to define common sets of drivers in the functioning of rivers under pristine and impacted environmental conditions.

Figure 1. The Beija-Rio Network sampling sites

Goal 2. Reduce the uncertainties in CO_2 evasive fluxes (hence on the role of rivers in the regional C cycle) by increasing the frequency of direct flux measurements with stationary chambers and through specific campaigns using all applicable methods (chambers, gradients, eddy covariance etc.) at end-member conditions (streams vs. large rivers, windy vs. calm conditions, high vs. low pCO_2 rivers, day vs. night fluxes etc.) to define the respective associated errors.

Goal 3. Adjust and validate hydrobiogeochemical models across different space an time scales, in order to test the responses of river systems to changes in their different biogeochemical drivers caused by global climatic changes.

CURRENT RESULTS AND PERSPECTIVES

Our recent results on the controls of the biogeochemistry (and ultimately the fate) of carbon in fluvial systems show that, regardless of any scale or basin characteristic, the distribution of biogenic species show the same seasonal patterns, tightly connected to the hydrograph (*Figure 2*, Richey et al., 2010). A small scale basins, with pronounced dry season, instream processes parallel those in adjacent terrestrial systems (Neu et al., in press). This is extremely important to develop adequate models to describe C cycle in these systems: a common seasonal pattern tied to the hydrograph might simplify significantly the up-scaling. Looking at altered systems as proxies for expected future responses can be an important source of information. Both land cover changes and recent extreme climate events have offered us opportunities to look at some of these responses. For example, our analysis of the 2004 - 2007 data from the Madeira river showed that, although a severe drought that occurred in southern Amazon in 2005 affected total annual discharge both in 2005 and 2006, it was only when a 25% reduction was reached in 2005 that changes in distribution of sediments and dissolved inorganic carbon were significant (*Figure 2*, Leite et al., in press). Therefore, acquiring long-term data as we propose in this project will allow us to establish these types of thresholds essentials to modeling.

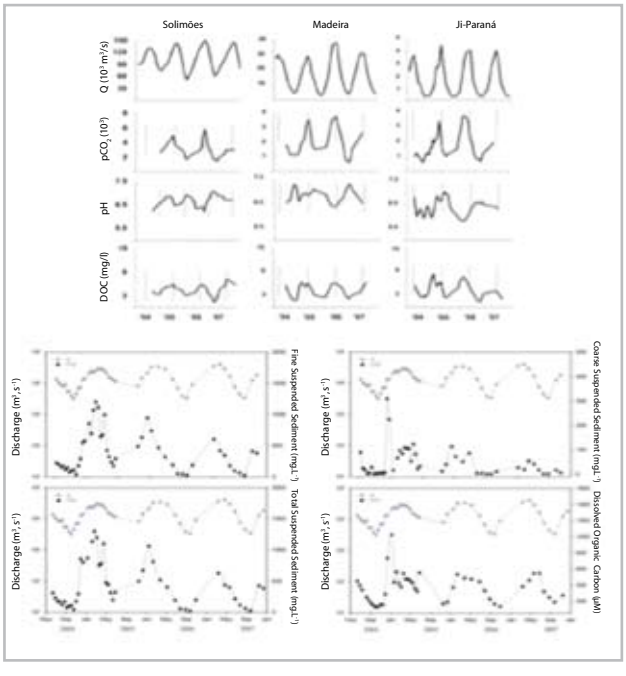

Figure 2. 2004 - 2007 discharge (Q) and chemistry (DOC, PH, susp. sed. and pCO_2) at the Solimões, Madeira and Ji-Paraná rivers

RELATED PUBLICATIONS

Germer S, Neill C, Vetter T, Chaves J, Krusche AV, Elsenbeer H. 2009. Implications of long-term land-use change for the hydrology and solute budgets of small catchments in Amazonia. *Journal of Hydrology.* **364**: 349-363.

Germer S, Neill C, Krusche AV, Elsenbeer H. 2010. Influence of land-use change on near-surface hydrological processes: Undisturbed forest to pasture. *Journal of Hydrology.* **380**: 473-480.

Silveira JM, Barlow J, Krusche AV, Orwin KH, Balch JK. 2009. Effects of experimental fires on litter decomposition in a seasonally dry Amazonian forest. *Journal of Tropical Ecololgy.* **25**: 657-663.

Richey JE, Krusche AV, Johnson M, Cunha HB, Ballester MV. 2009. The role of rivers in the regional carbon balance. *Amazonia and Climate Change.* In: Keller M, Bustamante M, Gash J, Dias P (eds.) *LBA Synthesis Volume - Amazonia and Global Change*. AGU Press.

Krusche AV, Ballester MVR, Leite NK. 2011. Hydrology and biogeochemistry of lowland tropical forests. In: Carlyle-Moses DE, Tanaka T. (Eds.). Forest hydrology and biogeochemistry: synthesis of past research and future directions. *Ecological Studies Series*, n. 216, Springer-Verlag, Heidelberg, Germany: In press.

Leite NK, Krusche AV, Ballester MVR, Victoria RL, Richey JE, & Gomes BM. In press. Intra and interannual variability in the Madeira river water chemistry and sediment load.

CO-PI'S AND ASSOCIATES

Maria Victoria Ramos Ballester, Cena/USP

Alex Vladimir Krusche, Cena/USP

Associated Researchers

Hillandia Brandão, Inpa, AM

Maria Emilia da Cruz Sales, MPEG, PA

Ivan Bergier Tavares de Lima, Embrapa Pantanal

Cleber Ibraim Salimon, Federal University of Acre

Alan Cavalcanti da Cunha, Federal University of Amapá

Jeffrey Edward Richey, University of Washington (EUA)

Christopher Neill, Marine Biology Laboratory (EUA)

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

MODELS AND ACTORS IN THE TRANSITION TOWARDS A LOW CARBON ECONOMY

Ricardo Abramovay
School of Economics, Administration and Accounting (FEA) and Institute of International Relations (IRI), University of São Paulo (USP)
FAPESP Process 2008/58107-7 | Term: Jun 2009 to May 2013

Contact: Av. Professor Luciano Gualberto, 908, CEP 05508-900, São Paulo, SP, Brazil
+55-11-3091-5880 | abramov@usp.br | http://www.nesa.org.br

Collaborating Institutions: Cambridge University, UK; Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Cirad), France; Massachusetts Institute of Technology (MIT), USA; University of Illinois at Urbana-Champaign, USA. This project is part of INCT (Brazilian National Institute of Science and Technology) Climate Change activities and Rede Clima (climate network).

PROJECT SYNTHESIS EMPHASISING ON ITS OBJECTIVES AND MAIN GOALS

Among the world's main CO_2 emitter countries, Brazil is the one whose energetic matrix is least fossil fuel-intensive. This advantage, nevertheless, does not mean that the transition towards a low carbon economy should be an irrelevant subject, nationally.

In one hand, the studies developed under FAPESP's Project "Economia do Clima" (http://unfccc.int/files/adaptation/application/pdf/brazil_climateeconomy_executive_summary.pdf) suggest a highly risky situation. Reduction of agricultural harvests on biophysical handicapped regions, changes of the Brazilian agricultural geography, the occurrence of droughts in the Amazon region, extreme events in metropolitan regions, and uncertainty about some coast cities' future: the occurrence of such scenarios is, in many cases, dramatically close.

On the other hand, there is significant evidence towards an intense social mobilization not only fighting climate changes' effects, but also in favor of designing and implementing production models much less intensive in materials and energy that the current one.

It is under these two lenses that the project deals with the climate change subject in Brazil. More precisely, it concentrates on:

a) The development and improvement of an integrated methodology to forecast the economic impacts triggered by climate change, mitigation/adaptation policies (controlling and taxing carbon emissions) in Brazil, taking into account the several different spatial scales (macro-regions, states and municipalities). Besides, the project aims to link climate change projections with socioeconomic models, in such a way that this attainment will permit an integrated analysis of these economic impacts;

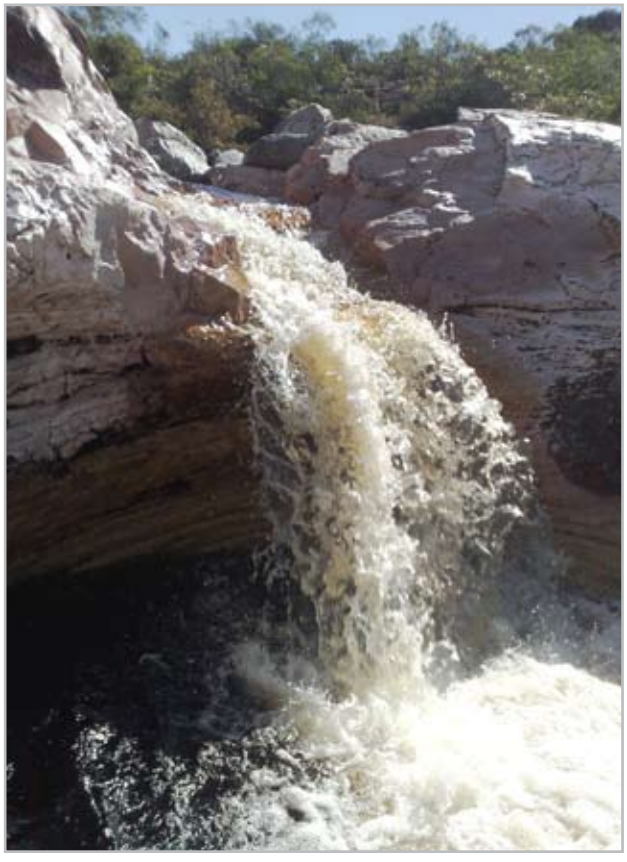

Figure 1. Chapada Diamantina (Bahia): low carbon economy to improve the use of water

b) The transition towards a low carbon economy and society with the following main subjects: Amazon; legislation; socioenvironmental corporate responsability; nuclear energy; measures of development; ecological footprint.

SYNTHESIS OF THE RESULTS AND SCIENTIFIC CONTRIBUTIONS ACHIEVED

The transition towards a low carbon economy cannot be studied without taking into account the role of the social actors involved in the subject. On the one hand, there is a sharp contrast between the promises of economic possibilities of the sustainable use of biodiversity and the restrict horizon of current entrepreneurial action on this subject (Abramovay, 2010). On the other hand, there is a non-negligible number of firms to whom sustainable forest appreciation already assumes a practical and evident dimension (Marcovitch, 2011, concerning the Amazon and Abramovay et al (2010), concerning the round table around commodities). It's important to stress that this social mobilization and the transition process towards a low carbon economy demands the development of new parameters on wealth, growth and well-being (Veiga 2010).

It seems certain that in the future the ongoing global climate changes will have consequences for regions performance. Global warming and rain pattern modifications, as well as other associate aspects, will seriously impact agriculture. These impacts will vary among crops and regions, altering the picture of agricultural competitiveness and, consequently, changing all regional economies considered (Azzoni and Haddad, 2010). Moreover, there may also be important effects over the Brazilian energetic matrix composition, along with their consequences regarding national economic growth (Azzoni et al., 2010).

Furthermore, important simulation and forecast models are being applied by the project. An example is this one: If the costs of global climate changes until 2050 could be anticipated to their present value, and considering an emissions' reduction tax of 1% per year, still the total costs of global warming would range between R$ 719 billion and R$ 3.655 billion (in terms of 2008 Brazilian reais), which corresponds to 25% and 125% of 2008´s national GDP, respectively. Such is the estimation presented by the study "Economia das mudanças climáticas no Brasil"(Economy of Global Changes in Brazil), one of the basic models for the creation of the subproject on modeling which integrates this project under consideration. The mentioned study, which had the collaboration of INCT main climate change researchers, is the first ever attempt to estimate the economic costs of climate change in Brazil, from a broad national economy integrated framework (FAPESP, INCT e Rede Clima).

RELATED PUBLICATIONS

Abramovay R. 2010. Desenvolvimento sustentável: qual a estratégia para o Brasil? *Novos Estudos.* **87**: 86-113.

Abramovay R. 2010. Decarbonizing the growth model of Brazil: addressing both carbon and energy intensity. *The Journal of Environment & Development.* **19(3)**: 358-374.

Abramovay R, Voivodic M, Cardoso F, Conroy M. Social movements and NGOs in the construction of new market mechanisms. *Economic Sociology_the European Electronic Newsletter*. March. Vol 11. N 2:24-30. http://www.abramovay.pro.br/econ_soc_11-2.pdf.

Azzoni CR, Haddad EA, Kanczuk F. 2010. Climate change and energy use in the long-run growth in Brazil. In: *Energy, Bio Fuels and Development: Comparing Brazil and the United States*. Ed. Florence, Kentucky, USA : Routledge Taylor & Francis Group.

Bartolini J et alli. 2010. Alcoa Brazil´s new sustainability model for mining? An independent review, school of international and public affairs (SIPA) from Columbia University, Centro de Estudos das Negociações Internacionais, Instituto de Relações Internacionais da Universidade de São Paulo (IRI-USP), 58 pps. http://www.sipa.columbia.edu/academics/concentrations/epd/documents/Alcoa_FinalReport_10May2010.pdf.

Marcovitch J. 2011. A gestão da Amazônia – ações empresariais, políticas públicas, estudos e propostas. Edusp, São Paulo.

Santos GF, Haddad E, Guilhoto JJM, Hewings G, Imori D. 2010. Spatial interactions between energy and energy-intensive sectors in the Brazilian economy: a field of influence approach. 2010. In: Amann E, Baer W, Coes D (eds). *Energy, Bio Fuels and Development: Comparing Brazil and the United States*. *Routledge Studies in Development Economics*. **352**. ISBN: 978-0-415-56720-6. pp.122-136.

Veiga JE (org). 2010. Energia nuclear: do anátema ao diálogo. São Pualo. SENAC.

Veiga JE. 2010. Sustentabilidade. A legitimação de um novo valor. São Paulo. SENAC.

CO-PI'S AND ASSOCIATES

Jacques Marcovich, EAD, FEA and IRI, USP
José Eli da Veiga, IRI, USP
Carlos Azzoni, EAE, FEA, USP
Joaquim Guilhoto, EAE, FEA, USP
Eduardo Haddad, EAE, FEA, USP
Danilo Igliori, EAE, FEA, USP
João Paulo Cândia Veiga, FFLCH and IRI, USP

FAPESP
FAPESP RESEARCH PROGRAM ON
GLOBAL CLIMATE CHANGE

MONITORING THE MICROBIAL DIVERSITY AND FUNCTIONAL ACTIVITIES IN RESPONSE TO LAND-USE CHANGES AND DEFORESTATION UNDER SOYBEAN AND SUGARCANE CULTIVATIONS

Siu Mui Tsai
Center for Nuclear Energy in Agriculture (Cena), University of São Paulo (USP)
FAPESP Process 2008/58114-3 | Term: Jun 2009 to May 2013

Contact: Av. Centenário, 303, CEP 13416-000, Piracicaba, SP, Brazil | +55-19-3429-4600 Ext. 4640 | tsai@cena.usp.br

Collaborating institutions: Department of Biology, University of Texas at Arlington, USA; Department of Ecological Microbiology, University of Bayreuth, Germany; Max Planck Institute for Terrestrial Microbiology, Germany; Netherland Institute of Ecology; School of Agricultural and Veterinary Sciences, São Paulo State University (Unesp – Jaboticabal); The Center for Microbial Ecology, USA.

SCIENCE QUESTIONS AND OBJECTIVES

One assumption often made is that biodiversity loss is happening more rapidly in the tropics due to agricultural activities. The processes of land conversion and agricultural intensification are one of the most significant causes of biodiversity loss, with consequent negative effects both on the environment and on the sustainability of agricultural production. The consequent reduction in the diversity of the soil community, including cases of species extinction, may cause a catastrophic loss in function, reducing the ability of ecosystems to withstand periods of stress and leading to undesirable environmental effects. Scientists have begun to quantify the causal relationships between (i) the composition, diversity and abundance of soil organisms, (ii) sustained soil fertility and associated crop production, and, (iii) environmental effects including soil erosion, greenhouse gas emissions and soil carbon sequestration. Consequently, actions that directly target the conservation of components of the microbiological diversity will have environmental benefits at ecosystem, landscape and global scales.

Our purpose is to integrate data from soil chemistry and microbiology, molecular biology and bioinformatics in an effort to detect, quantify and correlate the microbial processes involved in the C and N biogeochemical turnover in soybean and sugarcane cultivations, under natural areas (forest) and two agricultural system – conventional and sustainable agriculture (minimum tillage and mulching practices). Using three estimators of diversity (rarefaction, Chao1, ACE), it is proposed a high throughput DNA pyrosequencing and statistical inference to assess bacterial and *Archaea* diversity and quantify the functional genes associated to the microbial turnover in soils under different land use systems and greenhouse gas (GHG) emissions.

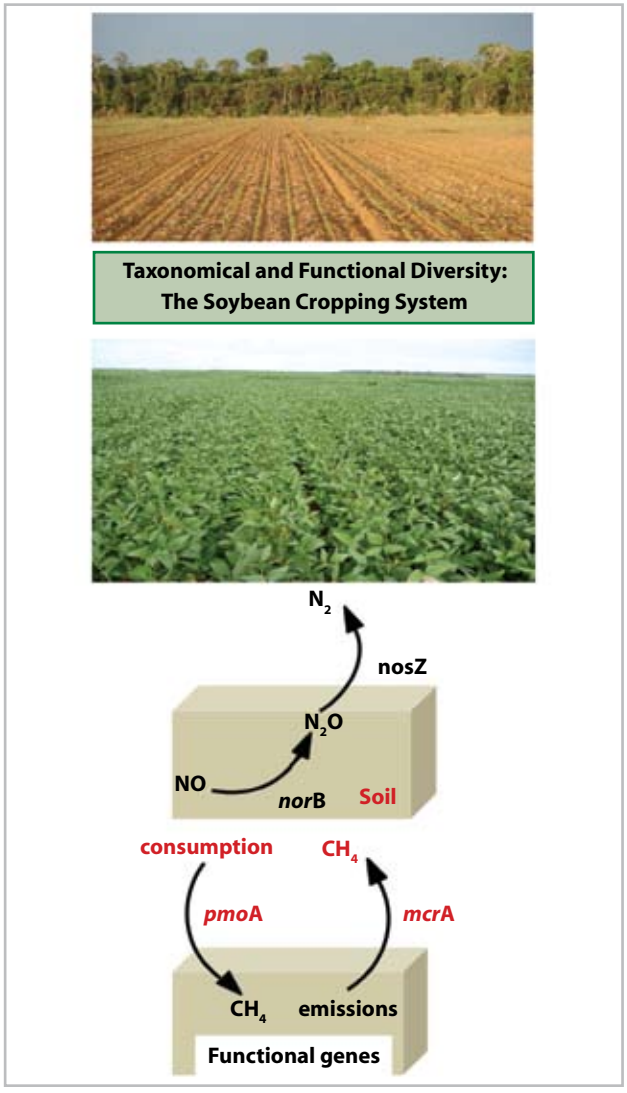

Figure 1. Functional genes of the microbial C and N cycles involved in the greenhouse gas emissions from the cropping systems

CURRENT RESULTS AND PERSPECTIVES

Field and greenhouse (mesocosms) studies using biochemical and molecular tools were developed with the aim of evaluating the impacts of the greenhouse gas emissions/sequestration due to land-use under soybean and sugarcane. We are monitoring 10 different sampling sites under soybean cultivation, the adjacent forests and recent deforestation areas in Mato Grosso and Mato Grosso do Sul and three different sugarcane cultivation system and their adjacent forest areas in São Paulo state.

We found significant differences between the soybean arable fields and adjacent forests regarding to community size of *Acidobacteria* in soil. The highest number of total bacterial 16S rRNA gene copies was detected in the soils taken from longer soybean cultivation past histories. Relative abundances of *Acidobacteria* and *Verrucomicrobia* were lower in soils under recent deforestation history. To validate these results, clone libraries were constructed using two different new specific-primers designed for *Verrucomicrobia* based on sequences previously recovered from tropical soils. Culturability and molecular detection of hitherto-uncultured bacteria from soil were studied from arable field samples collected from different chronosequences of soybean croppings. Bacterial cultivations were undertaken under a similar belowground hypoxic environment of 2% O_2 and 93% N_2 atmosphere with elevated concentration of CO_2 (5%).

Soils from six areas occurring in Southeast Amazonian comprising adjacent forest, deforested field, a 7-year cultivation soybean crop field and pasture of Mato Grosso were collected for profiling the microbial community structures using T-RFLP, a cultivation-independent molecular technique. Redundancy Analysis (RDA) showed differences among the environments, distinguishing the samples according to the land-uses. These analyses also correlated the microbial structures to the soil attributes revealing that those related to soil acidity, as pH, potassium, H+Al, displayed a significant correlation with bacterial and archaeal community structure variance. For bacterial community, the richness of Operational Taxonomic Units (OTUs) did not show significant differences among the sites. On the other hand, the archaeal communities showed sharp decreases in richness from forest to soybean crop and pasture as well.

These data reveal that land-use changes clearly alter the community structure and abundance of bacterial and archaeal domains in soils. Therefore, the molecular determination of temporal and spatial variations in the microbial community structures and functional genes associated to GHG consumption/ emission can be used as additional data when monitored at ground surface or in the rhizosphere of the plant crops.

RELATED PUBLICATIONS

Pazinato JM, Paulo EN, Mendes LW, Vazoller RF, Tsai SM. 2010. Molecular characterization of the archaeal community in an Amazonian wetland soil and culture-dependent isolation of methanogenic Archaea. *Diversity.* **2**: 1026-1047. DOI:10.3390/d2071026. ISSN 1424-2818, 2010.

Navarrete AA, Cannavan FS, Taketani RG, Tsai SM. 2010. A molecular survey of the diversity of microbial communities in different Amazonian agricultural model systems. *Diversity.* **2(5)**: 787-809. DOI:10.3390/d2050787. ISSN 1424-2818.

Taketani GR, Tsai SM. 2010. The influence of different land uses on the structure of archaeal communities in Amazonian anthrosols based on 16S rRNA and amoA Genes. *Microbial Ecology.* **59**: 734-743. DOI 10.1007/s00248-010-9638-1.

Navarrete AA, Pijl AS, van Veen JA, Tsai SM, Kuramae EE. 2011. Real-Time PCR detection of *Acidobacteria* and *Verrucomicrobia* in bulk and soybean rhizosphere soils from Southeastern Brazilian Amazon arable fields. In: *FEMS Microbiology Ecology - Ecology of Soil Microorganisms*. Prague-Czech Republic, April 2011.

Mendes LW, Navarrete AA, Borges CD, Tsai SM. Bacterial and archaeal community structure of soils from southeast Amazonian. In: *FEMS Microbiology Ecology - Ecology of Soil Microorganisms*. Prague-Czech Republic, April 2011.

Pedrinho E, Moreira W, Macedo H, Souza J, Val-Moraes S, Mendes LW, Lemos, E. Bacterial diversity from soils of sugarcane crop and native forest in Sao Paulo State – Brazil. In: *FEMS Microbiology Ecology - Ecology of Soil Microorganisms*. Prague-Czech Republic, April 2011.

Navarrete AA, Arnaldo M, Dias NMS, Borges CD, Gomes JE, Tsai SM. 2011. Culturability and molecular detection of hitherto-uncultured bacteria from soil. In: *HOLOS Environment – Supplement: V Symp. on Applied Microbiology*. Unesp-Rio Claro, SP, Brazil, May 2011.

CO-PI'S AND ASSOCIATES

Eliana G. Lemos, FCAV, Unesp

Associated Researchers
Carlos C. Cerri, Cena, USP
Brigitte J. Feigl, Cena, USP
Carlos E. P. Cerri, Esalq, USP
Danielle G.G. Caldas, Cena, USP
Daniel Saito, FOP, Unicamp
Jackson Marcondes, FCAV, Unesp
Newton La Scala Jr., FCAV, Unesp