Summer School Summary

THE INTERNATIONAL SUMMER SCHOOL ON LAND COVER CHANGE AND HYDROCLIMATE OF THE LA PLATA BASIN

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What: About 45 students from seven countries in South America participated in an intensive course on the role of ecosystems and land cover changes on the La Plata Basin regional hydroclimate

When: 2-13 November 2009

Where: Itaipú Technological Park, Foz do Iguaçu, Paraná State, Brazil

INTRODUCTION AND MOTIVATION FOR THE SUMMER SCHOOL

The La Plata Basin in southern South America has been subject to land cover and land use changes (LCLUCs) since colonial times (Ameghino 1884) and with an accelerated rate in the last decades and over extensive areas. The work of Ameghino even suggested that there were relations between those land use changes and the frequency of droughts and floods in the region. Despite this early knowledge, not much is known of the potential impacts of LCLUC on the hydroclimate of the La Plata basin. Besides, over the last century much of the La Plata Basin has had a reported increase in precipitation and heavy rains (Barros et al. 2000), and these changes -along with an increase in population growth- have resulted in more adverse effects from flooding. To draw attention to these issues, during two weeks in November 2009 the *International Summer School on Land Cover Change and Hydroclimate of the La Plata Basin* was organized at the grounds of the Itaipú Hydropower Plant in Brazil.

The school was the result of the combination of interests between the La Plata Basin Regional Hydroclimate Project (LPB; see http://www.eol.ucar.edu/projects/lpb/), the Inter-American Institute for Global Change Research (IAI), and the International Hydroinformatics Center (IHC) in Itaipú. LPB is an umbrella project endorsed by the Global Energy and Water Cycle

Experiment (GEWEX) and the Climate Prediction and Variability (CLIVAR), both of the World Climate Research Programme (WCRP). LPB has made a priority to train young scientists and promote interdisciplinary collaborations in areas related to Climate, Hydrology, Ecology and Agriculture. The IAI, with a similar agenda, was a natural partner to develop this Summer School, which in turn benefited from Itaipu's interest in relating with the scientific community of neighboring countries.

The choice of location (Itaipú Technological Park) was made so that participants could relate research usually done at academic institutions to applications and operations at one of the largest hydropower plants in the world. The school was attended by 45 advanced graduate students and young scientists with different backgrounds from seven countries, including less-technically advanced ones in the region. Travel expenses of most students were covered by the Summer School, so that the student's selection (there were around 100 candidates) was primarily based on their scholarly merits.

ORGANIZATION AND CONTENTS OF THE SCHOOL

The Summer School was organized within the activities of the Cooperative Research Network "The impact of Land Cover and Land use changes on the Hydroclimate of the La Plata Basin (CRN-2094)" funded by the IAI to investigate the role of land use in the hydroclimate of La Plata Basin. Classes were taught by investigators of the project and invited speakers from diverse institutions. Instructors came from the University of Maryland, the University of Washington, the University of Sao Paulo (Brazil), the University of San Luis (Argentina), the University of Almeria (Spain), and the Federal University of Rio Grande do Sul (Brazil). In addition to the academic instructors, a second group of instructors came from Operational Centers, like the Brazilian Center for Prediction of Weather and Climate Studies (CPTEC), NASA, the United Kingdom Meteorological Office, and the International Hydroinformatics Center at Itaipú.

The school followed an interdisciplinary approach centered in three main themes: (a) Vegetation, Land Cover Changes, Ecosystems and Ecohydrology, (b) Remote Sensing with Applications to Data assimilation and Ecosystems, and (c) Data Assimilation and Mesoscale and Hydrological Modeling. A description of the course contents follows.

The hydroclimate of the La Plata basin. Main drivers of climate in the La Plata basin; precipitation regimes and trends; impacts of extreme events on the basin's hydrology and agriculture; land use practices; monitoring and applications for water resources and water management using Itaipú as an example.

Remote sensing and satellite products. Estimates of precipitation, soil moisture, snow, land cover and vegetation indices using MODIS, Landsat and other satellite sensor products.

Data assimilation systems. Basic concepts of variational data assimilation; Bayes theorem; four-dimensional variational methods implemented at the United Kingdom Meteorological Office; data assimilation of satellite observations for regional numerical weather prediction.

Land data assimilation systems. Introduction to land surface parameterizations; building a Land Surface Modeling (LSM) framework; Land Data Assimilation Systems (LDAS); overview of multi-LSM simulation studies; range in complexity in the representation of land surface processes.

Land-atmosphere interactions and feedbacks. Soil moisture memory processes; mechanisms of land surface-atmosphere interactions (L-A); strength of L-A coupling and its regional dependence; implications for regional climate predictability; L-A feedbacks in South America during the onset of the monsoon.

Ecosystems, land cover/land use changes. Characterization of ecosystems and ecosystem functioning; drivers of ecosystem changes in South America; impacts of LCLUCs on ecosystem functioning and climate; the use of Ecosystem Functional Types to represent the interannual variability of vegetation biophysical properties in regional models.

Vegetation and the water cycle. Components of the water balance: Infiltration, run off, transpiration, drainage, interception and effective precipitation; isotopes in ecohydrology; main controls of the water balance; controls of evapotranspiration, root depth across biomes; tree plantations, shrublands and grasslands; mechanisms of salinization with afforestation; ground water and deforestation; beyond the river: the climatic effects.

Atmospheric modeling. Atmospheric scales; scale separation; regional modeling; initial conditions; mesoscale models; global *versus* mesoscale models; horizontal and vertical resolutions; Hydrostatic *versus* non Hydrostatic models; physical features.

Hydrological modeling and water resources. Runoff generation processes; the role of vegetation and the energy balance; spatially distributed *versus* spatially lumped hydrological models; channel routing and streamflow prediction; macroscale hydrological modeling strategy; the Variable Infiltration Capacity model; model calibration; model evaluation and testing; surface water monitoring; a multi-model hydrological forecast system; forecasting needs for water resources management; overview of streamflow forecasting methods; examples of applications.

Students were presented with current methods to detect and measure vegetation and vegetation changes from space and methodologies to characterize terrestrial ecosystems. The surface water and energy budgets were examined and the possible impacts of land cover and land use changes were discussed. Regional Model and Hydrologic Model approaches including data assimilation of surface and atmospheric observations using satellite information were presented. Classes were complemented with laboratory exercises, two field trips and presentations by the students.

Given the diverse background of the students that came from different fields, the first week was dedicated to laboratory practices including hands-on exercises. A computational laboratory was set up and lab assistants and technical support were provided by Itaipú and CPTEC/INPE.

During the first week, the students were familiarized with computational environments and graphical tools applied in geophysics, such as Linux, GrADS and Matlab. The exercises aimed at developing simple scientific programming skills to work on hydroclimate diagnostics. During the second week, the students run simple case studies using a regional mesoscale model, practiced land and atmospheric data assimilation techniques, and computed simple diagnostics of water and energy budgets estimated from output of a distributed hydrologic model.

FIELD TRIP AND CONSERVATIONISM LESSONS

The international summer school was designed to provide the students with a valuable lesson beyond the classroom-related work. Itaipú is the second largest energy producing hydropower plant in the world opened in 1984 at the border of Brazil and Paraguay. Through two field trips, one to the Itaipú central facilities and the other to visit nontraditional farms, the students were presented with new technologies, conservationist practices and alternative ways of producing energy.

The Itaipú Hydropower Plant has developed a program on renewable energy to promote and demonstrate the technical, environmental, and economical feasibility of renewable energy sources to replace current methods used by the farmers in the region. The environmental friendly programs are being carried out in a region with significant land cover changes due to intensive farming. The field trip emphasized those land use practices that are crucial for sustainable development from natural resources. In addition, Itaipú has created many programs to protect an area of approximately 100,000 hectares between Brazil and Paraguay. The activities include reforesting, conservation of the local biota, rivers and lakes by reintroducing native species including fishes, birds, animals and plants.

The students had the opportunity to visit several experimental farms where different approaches for energy production are being tested. The places visited were representative of many other farms in the region: (a) a large farm with an anaerobic biodigester that converts methane from livestock waste into clean electrical energy to sell it back to the grid; (b) a smaller farm that employs the energy generated by similar means but only for their own operations. The students had the opportunity to follow the whole process from the collection of dejects to details on the power generator functionalities.

The students were given time to make short presentations describing their research interests, which facilitated the exchange of ideas to learn to work in an interdisciplinary environment. The summer school turned out to be a practical channel to incorporate students to the CRN Project, as several expressed their explicit interest in getting involved in this research area. According to their background, students were invited to pursue postdoctoral studies with the research institutes and universities involved in the CRN. By agreement with the academic advisors and the Universities, graduate students were invited to perform research during short term visits at guest institutions. Those students that were selected were granted a scholarship with the support of the CRN.

FINAL REMARKS

The summer school attracted students from diverse backgrounds, like atmospheric sciences, environmental sciences, physics, agriculture, and geography. Despite this wide background, the students found that the course had helped them advance in their scientific development. A survey was distributed and the main results are presented in Fig. 1. The positive responses in the students' evaluations of the course suggest that it could be used as a model for training the next generation of scientists. In addition, the course attracted the attention of regional universities: the University of Buenos Aires gave credits to PhD students that participated in the summer school, and other Universities are in the process of following those steps. The authors of this note are providing support for the necessary administrative process.

In summary, the school gathered students from different disciplines and followed an interdisciplinary approach to study the hydroclimate of the La Plata basin. By economically supporting the students, a major difficulty was removed, and the students with most merits were accepted. The location of the Summer School at the Itaipú Hydropower Plant and the direct access to experience the many activities carried out there proved to be an enticing aspect of the School. Moreover, a channel to involve students in actual research was created. Though this first Summer School did not plan on credit recognition from regional universities, the action taken by the University of Buenos Aires was an unprecedented benefit. Future editions of this Summer School will seek credits of more Universities to further the students' interest.

Acknowledgments

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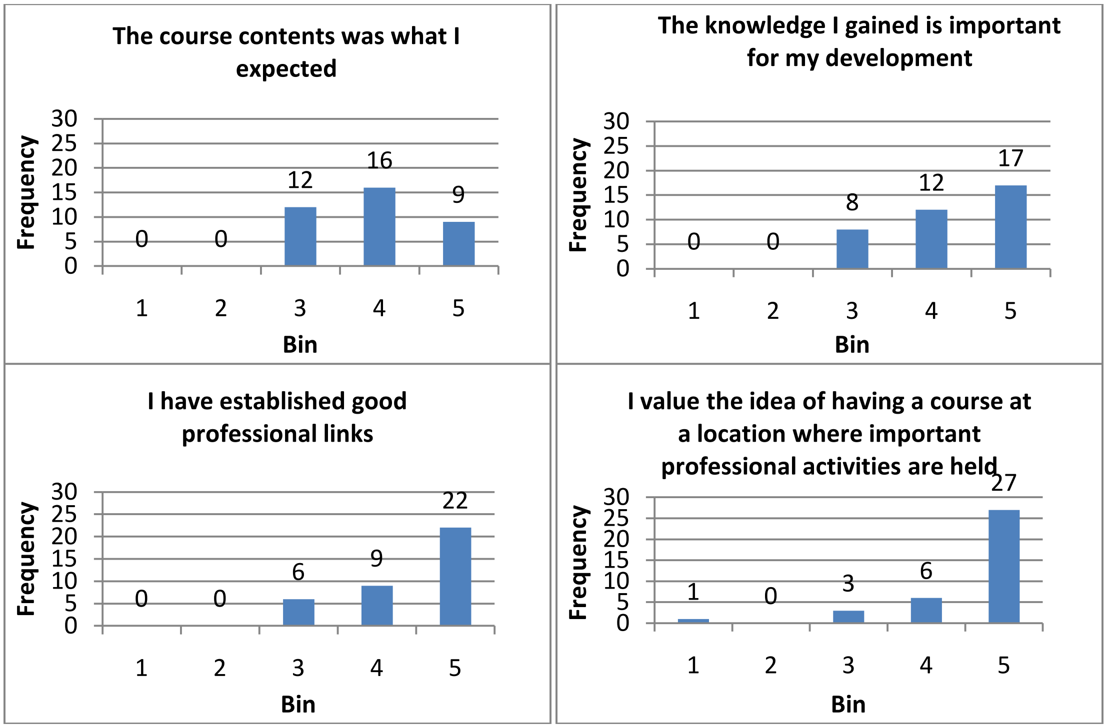

Fig. 1: Students evaluation of the main aspects of the course, where 1 is poor and 5 excellent.

These pictures are offered in the case that one could be included to illustrate the note.