Centro de Ciência do Sistema Terrestre

National Institute for Space Research -INPE-

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Editorial

The United Nations Conference on Climate Change (COP-15) will start in a few days, in Copenhagen. The meeting, that is going to include 192 participating countries united by the UN, will debate the goals of the reduction of Greenhouse Gas (GG) emissions between 2012 and 2020 which will replace the Kyoto Protocol goals. Besides it will negotiate the effective mechanisms to transfer technologies from developed countries to developing ones. This is important because less developed nations do not have enough conditions and resources to carry out adaptation and mitigation actions for climate change (it is estimated that developing countries will need about US$ 160 billions per year to this end).

Another relevant aspect to negotiate in Copenhagen will be the definition of rewards for countries depending on their responsibility of maintaining forests and reduce deforestation rates the so called mechanism “Reducing Emissions from Deforestation and Forest Degradation" (REDD). In this context, the creation of an international funding, fomented by volunteer contributions is planned and intended

Negotiations in Copenhagen will be difficult, once opinions are split into optimist and pessimistic, particularly with respect to the definition of a new climatic agreement. Carlos Nobre, researcher from the National Institute for Spatial Research (INPE, in Portuguese), sees himself as a “moderate optimist” in relation to the COP-15 results. He believes that there will not be definitive and concrete results from Copenhagen, and also that two more COPs will be necessary to more favorable results come up.

Observing the forest from other angles. Crystalline images of the Amazonia. By: Edson Grandisoli. Search: http://www.oeco.com.br/fotografia?start=10

Hope and pessimism will compete until COP-15. Pressure from all social sectors will be fundamental for world leaders reach an agreement that is favorable to the environment, and therefore that guarantees a sustainable and balanced planet for future generations.

Diana Raigoza
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Ready or Not?

A Review of the World Bank Forest Carbon Partnership R-Plans (FCPF)
and the UN-REDD Joint Program Documents
By: Florence Daviet, Crystal Davis, Lauren Goers and Smita Nakhooda. http://www.wri.org/

This paper reviews documentation detailing national REDD initiatives that have emerged from both the FCPF and UN-REDD, in order to assess how these efforts are dealing with fundamental issues of governance in the forest sector that underpin deforestation and degradation problems in pilot countries.

Without addressing these issues it will be difficult, if not impossible, to reduce deforestation and degradation at the national level, and deal with risks of leakage. We recommend improvements to both the FCPF and UN-REDD processes, and the links between them, that will support these objectives.

The World Bank’s Forest Carbon Partnership Facility (FCPF) and the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) are the preeminent multilateral efforts underway to support developing countries to prepare to reduce emissions from deforestation and degradation (REDD). More than US$150 million has been committed to the FCPF, and the government of Norway has donated US$52 million to UN-REDD. Though still in their early phases, these initiatives are already informing international understanding about REDD and readiness, and negotiations within the UN Framework Convention on Climate Change (UNFCCC) about incentives for REDD, including through carbon markets.

In our analysis of the processes and requirements of the FCPF and UNREDD initiatives and of the content of REDD strategy documents that have been produced by participating countries, we find that fundamental issues of forest governance that underpin deforestation and degradation problems are not being adequately considered. Although countries participating in the UN-REDD pilot phase are also participants in the FCPF and representatives of both programs have stated that they will work in close collaboration, it is not yet clear how FCPF Readiness Plans and REDD strategies that emerge from the UN-REDD process will work together to address these gaps.

This working paper therefore provides specific recommendations to strengthen: (i) the quality of pilot country documents with regard to their treatment of forest governance issues, (ii) the design of the FCPF and UNREDD initiatives in order to better support and encourage pilot countries to address governance challenges, and (iii) the linkages between the FCPF and UN-REDD initiatives in order to more systematically address governance and other issues critical to the success of REDD.

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Meteorological Downscaling Methods With Artificial Neural Network Models: South America Project

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The mathematical models used to simulate the present climate and project future climate when forced by greenhouse gases and aerosols are generally referred to as General Circulation Models or Global Climate Models (GCMs). While they have demonstrated significant skill in the continental and hemispherical scales and incorporate a large proportion of the complexity of the global system, they are inherently unable to present local sub-grid scale features and dynamics (Wigley el al., 1990). The project PRID-SAR (IMPROVING DOWNSCALING - SOUTH AMERICA RAINFALL), is main aim of this project is to develop and test a novel type of statistical downscaling technique based on the use of Artificial Networks for South America Continent. The models will be constructed using observed data (South America sector) and then applied to AOCGM output in order to evaluate their ability to produce higher resolution climate change scenarios and improved short-term weather forecast over South America. These projects will asses, as objectively as possible, the potential advantages of using ANN Model to solve three different types of meteorological/climatological downscaling problem. In the two years for project, present five publications in International Journal, Newsletter and workshop in climate change and variability. In this text, the synthesis for two publication in Theor. Appl. Climatol. and the Newsletter for American Geophysical Union (AGU). In the Newsletter for AGU, the paper shows advantages and disadvantages in used Artificial Neural Network (ANN) in downscaling process.

The spatial resolution of GCMs still remains quite coarse: of the order of 300 x 300 km. At that scale, the regional and local details of the climate, which are influenced by spatial heterogeneities in the regional physiography, are lost. Therefore, there is a need to convert the GCM outputs into a reliable data set with higher spatial resolution. This includes outputs with daily rainfall and temperature time series at the scale of the watershed or of a region in which the climate impact is going to be investigated. The methods used to convert GCM outputs into local meteorological variables required for reliable climate modeling are usually referred to as *downscaling* techniques.

There are various downscaling methods available to convert GCM outputs into meteorological variables appropriate for climate impact studies. Spatial downscaling means relating the large-scale atmospheric predictor variables simulated by GCMs to local or station-scale using numerical methods. Among the various downscaling techniques, two major approaches can be identified at the moment, namely, dynamic downscaling and empirical (statistical) downscaling. The dynamic downscaling approach is a method of extracting local-scale information by developing regional climate models (RCMs) with coarse GCM data used as boundary conditions. Empirical downscaling, on the other hand, starts with the premise that the regional climate is the result of interplay of the overall atmospheric and oceanic circulation as well as of regional topography, land-sea distribution and land use (e.g. von Storch et al., 2000). The empirical downscaling methods that are most widely used are the multiple linear regression and stochastic weather generation. However, the interest in nonlinear regression methods, namely artificial neural network (ANN), is increasing nowadays because of their high potential for complex, nonlinear and time-varying input-output mapping. Although the weights of an ANN are similar to nonlinear regression coefficients, the unique structure of the network and the nonlinear transfer function associated with each hidden and output nodes allow ANNs to approximate highly nonlinear relationships.

The simplest form of ANN (i.e. multilayer perceptron) is reported to give similar results compared to multiple regression downscaling methods (Schoof and Pryor, 2001). The ANN approach was found to account for some heavy rainfall events, while they were not identified by the linear regression downscaling technique (Weichert and Burger, 1998).

More recently, Cannon and Whitfeld (2002) found that an ensemble ANN downscaling model was capable of predicting changes in stream flows using only large-scale atmospheric conditions as model input. There are, however, other categories of neural networks that have feedback connections and are thus inherently dynamic in nature. Dynamic neural networks are topologies designed to include time relationships explicitly in the input-output mappings. The application of feedback enables the networks to acquire state representations, which make them more suitable for complex nonlinear system modeling (Gautan and Holz, 2000).

The neural network approach should determine which model contributes most to the output and to the extrapolation of the optimal combination of models to twenty-first century conditions.

1) The importance of an input to a trained variable is actually measured by the magnitude of the weights fanning out from the input. If the weights are small, the input contributes little, if the weights are large, the input contributes more.

2) The neural network parameters, also called weights, are optimized, based on a training dataset. If the distribution of the datasets changes dramatically, the method usually does not project, i.e., the method is considered to have good skills when the input data belong to a distribution similar or close to the distribution of the training dataset.

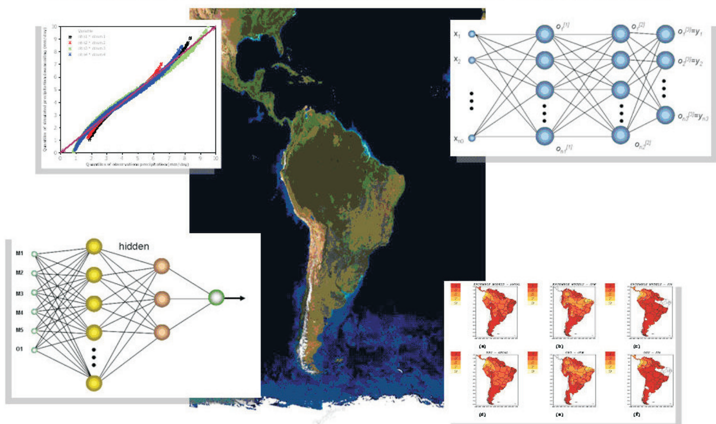
The advantages of the neural network for downscaling are:

a) Much less computationally demanding than physical downscaling using numerical models;
b) Ensembles of high resolution climate scenarios may be produced relatively easily.

and the disadvantages are:

a) Large amounts of observational data may be required to establish statistical relationships for the current climate;
b) Specialist knowledge required to apply the techniques correctly;
c) Relationships only valid within the range of the data used for calibration projections for some variables may lie outside this range;
d) May not be possible to derive significant relationships for some varia;
e) A predictor which may not appear as the most significant when developing the transfer functions under present climate may be critical for determining climate change.

METEOROLOGICAL DOWNSCALING METHODS WITH ARTIFICIAL NEURAL NETWORK MODELS: ADVANTAGES AND DISADVANTAGES



Project from Improving downscaling: South America Rainfall (PRID-SAR)

In the paper publish in the Theor. Appl. Climatol., show the temporal downscaling over Amazon Basin using the ANN method. In this paper, five Atmosphere-Ocean General Circulation Models (AOGCMs) for the twentieth century (20C3M; 1970-1999) and three SRES scenarios (A2, A1B, and B1) were used.

The performance in downscaling of the temporal neural network was compared to that of an autocorrelation statistical downscaling model with emphasis on its ability to reproduce the observed climate variability and tendency for the period 1970-1999. The ANN as well as the autocorrelation model both provided a very good fit to the data. This indicates that an ANN offers a viable alternative for multivariate modeling of precipitation time series.

The results obtained using the ANN model compared with those obtained using an alternative statistical model indicate that the network is a potentially competitive alternative tool for the analyses of multivariate time series.

A major difficulty in using ANN for climate change lies in determining the network's capability to extrapolate. A comparison between ANN and a linear projection based on statistical downscaling allowed us to determine that the ANN penalizes climate change projections.

References for Project

Mendes, D., and Marengo, J. A., Meteorological Downscaling Methods with Artificial Neural Network Models. *Atmospheric Sciences Section of AGU Newsletter*, v3., 3, 2009.

Mendes, D., and Marengo, J. A., Temporal downscaling: a comparison between artificial neural network and autocorrelation techniques over the Amazon Basin in present and future climate change scenarios. *Theor Appl Climatol*, v98, DOI. 10.1007/s00704-009-0193-y, 2009.

References

Cannon, A.J. and P.H. Whitfield (2002), Downscaling recent stream-flow conditions in British Columbia, Canada using ensemble neural networks. J. Hydrol., 259, 136151.

Schoof, J.T. and S.C. Pryor (2001), Downscaling temperature and precipitation: A comparison of regression-based methods and artificial neural networks. Int. J. Climatol., 21, 773790.

Von Storch, H., Cubasch, U., Gonzalez-Rouco, F., Jones, J. M., Voss, R., Widmann, M., and Zorita, E. (2000), Combining paleoclimatic evidence and GCMs by means of data assimilation through upscaling and nudging (DATUN). Proc. 11th Symposium on Global Change Studies, American Meteorological Society, Long Beach, CA.

Weichert, A. and G. Burger (1998), Linear versus nonlinear techniques in downscaling. Clim. Res., 10, 8393.

Wigley, T.M.L., J. Jager, and H.L. Ferguson (1991), in Climate Change: Science, Impacts and Policy, edited by J. Jager and H.L. Ferguson, pp. 231-242, Cambridge Univ. Press, Cambridge, U.K.

Tropical Transplant

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CO_2 fertilization could prevent the Amazon forest from drying up and being replaced by savannah. Increased levels of atmospheric CO_2 are predicted to increase vegetative growth at higher latitudes, but, until now, the impact of fertilization on tropical forests has remained uncertain.

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David Lapola, of the National Institute for Space Research in Brazil, and colleagues examined the impact of climate change on vegetation in tropical South America in the latter half of the twenty-first century with a vegetation model and a range of future climate and CO_2 fertilization scenarios in the article: "Exploring the range of climate biome projections for tropical South America: The role of CO_2 fertilization and seasonality", published in the journal GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 23, GB3003 (2009).

When the fertilization effect of carbon dioxide was included in model simulations, the Amazonian biome remained relatively stable due to increased water-use efficiency and photosynthetic rates. But when fertilization effects were excluded, the Amazonian tropical forest became increasingly dry, and was replaced by savannah.

In both scenarios, when the dry season exceeded an average of four months, less productive biomes, such as savannah, shrubland and semi-desert, predominated.

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