Anji Seth – Research Statement

My research emphasizes regional climate processes with two distinct objectives. The first explores the use of regional climate models to downscale climate predictions and to understand the physical mechanisms associated with regional climate anomalies. The second is to understand the regional outcomes or impacts related to climate anomalies by examining relationships of societies to the climate anomalies they experience. Within the scope of this second objective, we are learning how to monitor evolving regional climate anomalies and their associated impacts and also how to utilize this information to provide context for predictions. These topics are discussed briefly (in roughly chronological order).

Physical influences on regional climate
At the current spatial resolution (~200 km) of general circulation models (GCMs) geographic features such as mountains, coastlines and land-use patterns are not well represented, nor are regional atmospheric features such as low level jets which are have important influences on regional climate anomalies through their role in moisture transport. The increased grid resolution of regional climate models is sought as a potential solution particularly for the purposes of climate prediction. Yet dynamical downscaling methods are expensive, have undergone relatively little testing in the tropics and have yet to be proven as more skillful than simpler statistical downscaling methods. My research examines the potential and the limitations of regional climate models with the perspective that their current utility in developing regions is to build regional scientific research capacity (to study regional climate processes) and also to build the infrastructure (computers, network, data storage) essential for their use.

Land surface processes and heterogeneity
That 200 km GCM grid cells were characterized by a single vegetation or land-use type, lead me to focus on land surface heterogeneity and sub-grid scale processes in climate models for my Ph.D. research. Working with F. Giorgi, R. Dickinson and M. Verstraete, I developed an explicit scheme for representing sub-grid scale land characteristics in climate models (Seth et al., 1994) which has since been implemented in a GCM (Hahmann and Dickinson, 2001) and is being considered for the next version of the Common Land Model (CLM) (R. Dickinson, personal communication). In addition to the mean affects on the grid scale atmosphere, I studied the dynamical influence of surface heterogeneity (Seth and Giorgi, 1996) and showed that mesoscale circulations affect the energy and moisture fluxes through the boundary layer. This work was highlighted in a review paper published in Reviews in Geophysics (Giorgi and Avissar, 1997).

Remote and local forcing of regional climate anomalies
Does “local” soil moisture feedback play a role in a climate anomaly such as the Midwestern floods of 1993 (and 1988 drought) or can “remote” sea surface temperature anomalies explain these events? As a post-doc at NCAR I examined the relative roles of "local" and "remote" forcing on Mid-western U.S. drought and floods (Seth and Giorgi, 1998) and found that local soil moisture enhanced simulated rainfall by as much as 33%. Recently, using the same model in a tropical setting, we found the local forcing (i.e., the Amazon moisture) may have regional influences, which would affect areas both upstream (the north coast) and downstream (southeastern South America) (Seth and Rojas, 2003).
Use of regional climate models for process studies and downscaling
The sensitivity to local forcing (see above) yielded an additional result. We found that the choice of regional model domain and location of lateral boundaries could arbitrarily affect the sensitivity results to soil moisture (Seth and Giorgi, 1998). This result provided evidence to support the skepticism of Working Group on Numerical Experimentation (WGNE) of the World Climate Research Program (WCRP) in this one-way nesting strategy. I have encouraged domain testing as standard procedure in regional climate modeling research and have put this into practice (Seth and Rojas 2003; Rojas and Seth 2003; Landman et al., 2003). The mountain west depends on snow accumulation for water resources, yet low spatial resolution and lack of high elevation observations had prevented climate model studies of this problem. R. Dickinson and R. Bales suggested the use of high elevation SNOTEL data. We proceeded to examine winter-time precipitation and snowpack, using data from SNOTEL sites and regional climate simulations during two anomalous winter seasons. Further, we evaluated the regional climate model’s ability to simulate interannual changes in seasonal hydrology as compared with reconstructed natural flow for the upper Colorado River and aggregate Sierra basins (Seth et al., 1999). This study developed a framework for climate modeling studies of water resources and underscored the need for high elevation data in assessing both precipitation and water resources in mountainous regions. At the IRI I’ve worked with collaborators to test the sensitivity in a tropical setting of regional model simulated seasonal rainfall to reanalyses and GCM boundary forcing and to domain choice (Seth and Rojas, 2003; Rojas and Seth 2003) as well as to periodic model reinitialization (Qian et al., 2003). Currently I’m working with colleagues to examine daily rainfall statistics from a regional climate model and observations for South America (Seth et al., in preparation) and I’m leading a NOAA/PACS funded research effort to compute and analyze long-term integrations of the nested model for South America.

Climate impacts and society
As a developer of IRI’s climate information system, I have been monitoring the evolution of climate anomalies and their associated regional impacts around the globe, with emphasis on monsoon regions. The media is both an important source for such information and a crucial communication link for disseminating climate information between science and society. I have been working on trainings to improve dissemination through the media and research to understand the utility of media as an information source.

Monitoring and diagnosing climate anomalies
I have been the lead developer of the IRI Climate Information Digest, for which there is now a core production team including M. Bell, E. Grover, A. Giannini, B. Lyon, C. Ropelewski, and J. Fang. The Digest is a monthly publication, which provides a global snapshot of recent climate anomalies and their related impacts and looks ahead to the next season’s forecasts. This product raises awareness about current climate events globally and is used as an educational tool in classrooms, graduate courses and training sessions around the world. The Digest has 800 subscribers, of which half are international and one quarter are commercial. Real time knowledge of evolving climate anomalies also lead to highly relevant research questions. A brief analysis of 2002 Indian summer monsoon (Waple and others, 2003) has led me to a more extensive diagnostic
analysis of monsoon variability and its role in large scale circulation of the summer hemisphere. More to come on this in the near future.

*Understanding climate impacts*
Parallel to the development of the Climate Information Digest, a climate related impacts database has been developed to provide a searchable record of events. As many of the impacts reports are taken from media sources, a research project has been devised (in collaboration with D. Fisher in the Department of Sociology, B. Lyon, E. Grover and S. Dani at IRI, and T. Kestin at UCAR) to examine national media coverage of the recent El Niño event (2002-2003) in India, South Africa, Australia and the United States. Analysis of media reports is underway and we expect to publish results in the coming year. A commentary based on observations of climate impacts is in preparation. (Seth and Lyon, 2003)

*Communicating Climate Information*
Comprehensible probabilistic seasonal forecast information is often least available and least accessible to those who need it most. The media is the most prevalent source of such information in many regions. Working with colleagues J. Phillips, T. Kestin and G. Marcus, I provided the climate expertise in creating and implementing a training workshop for television, newspaper and radio journalists from 10 countries in East Africa. A number of these journalists have since organized themselves into an environmental journalism society, and initiated additional training workshops. At the first signs of a developing El Niño in early 2002, with M. Dilley and J. Phillips, L. Goddard, C. Clark and C. Ropelewski, we organized an international workshop with the purpose of having experts from regions share experience in preparedness and communication. 60 experts from Central and South America, the Caribbean, Africa, South and Southeast Asia and the Pacific Island participated and a Workshop Proceedings was published to document the successes in increased awareness and preparedness since the El Niño event of 1997-1998 and the challenges that remain.