NARCCAP 2011

THIRD USERS' MEETING

APRIL 7 - 8, 2011
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
BOULDER COLORADO

NARCCAP

2011 USERS' MEETING

April 7-8, 2011

NCAR

Center Green Laboratory 1

AGENDA

THURSDAY APRIL 7

8:00 a.m.	*Bus departs Golden Buff for Center Green Laboratory 1*
08:20 – 9:00	Pick up registration materials, badges, caps
09:00 – 09:15	Welcome and Overview of NARCCAP – Linda Mearns, NCAR
09:15 – 10:00	Overview of attendees – slides with one sentence introductions (attendee stands at introduction)
10:00 – 10:15	*Break*
10:15 – 12:00	About the RCMs
	Representatives from each RCM group will talk for 18 minutes about the important features of their RCM and what users ought to know about them – sample results if time
	HRM3 – Richard Jones, UK Hadley Centre (presented by Bill Gutowski)
	CRCM – Daniel Caya, Ouranos
	MM5 – Bill Gutowski, Iowa State University
	WRF – Ruby Leung , PNNL
	ECPC/RSM – Ana Nunes, Scripps (presented by Daniel Caya)
	RegCM3 – Mark Snyder, UC Santa Cruz (presented by Ruby Leung)
12:00 – 13:00	*Lunch (Atrium)*
13:00 – 14:00	Panel discussion with Regional Climate Modelers
14:00 – 14:30	Data QC and Archiving: Upcoming Developments – Seth McGinnis, NCAR
14:30 – 15:00	Overview of Phase I Results – Bill Gutowski, Iowa State University
15:00 – 15:30	Special Topics in Evaluation of Phase I – Melissa Bukovsky, NCAR
15:30 – 15:45	*Break*
15:45 – 16:15	Overview of Climate Change Results – Linda Mearns, NCAR
16:15 – 16:45	Quantifying Uncertainty- New Results – Steve Sain, NCAR
16:45 – 17:30	Invited Participant Talks (20 minutes each)
16:45 – 17:05	Use of NARCCAP in the US National Climate Assessment – Ken Kunkel, NOAA (Invited)
17:05 – 17:25	Very Extreme Seasonal Precipitation in the NARCCAP Ensemble – Michael Wehner, LLNL (Invited)
17:30 – 18:00	*Meeting adjourns – transportation to Mesa Lab*
18:00 – 19:00	Poster Session (drinks, hors d'oeuvres) at Mesa Laboratory
19:00 – 20:30	Dinner and poster session (continued)
20:30 – 21:00	*Bus back to Golden Buff and Marriott Residence Inn*

FRIDAY APRIL 8

8:30 a.m.	*Bus from Golden Buff to Center Green Laboratory 1*
9:00 – 12:15	Participant Talks (15 minutes each)
9:00 – 9:20	Downscaling and Adaptation Uncertainty – Joe Barsugli, NOAA, CU (Invited)
9:20 – 9:35	Changes in Wind Energy Resources – Sara Pryor, Indiana University
9:35 – 9:50	Further Dynamical Downscaling Using WRF: High-resolution Simulations of Extreme Precipitation Events in Future NARCCAP Climate Scenarios – Kelly Mahoney, NOAA
9:50 – 10:05	Impacts of Climate Change on Crop Production in the Ogallala Aquifer – George Paul, Kansas State University
10:05 – 10:20	Topic Pods – Introduction – Toni Rosati and Seth McGinnis, NCAR
10:20 – 10:35	*Break*
10:35 – 11:45	Small Group Discussions (Topics TBD, 5 groups)
11:45 – 12:15	Small Group Report Outs
12:15 – 13:15	*Lunch (Atrium)*
13:15 – 14:45	Participant Talks (continued)
13:15 – 13:30	Analysis of NARCCAP Results for the Pacific Northwest – Trevor Murdock, PCIC
13:30 – 13:45	Validation of Different NARCCAP-RCMs in the Southern Part of the Domain – M. J. Montero-Martinez
13:45 – 14:00	Analysis of NARCCAP Multi-RCM Hydro-Climate Scenarios in the Lake Winnipeg Watershed – Jonas Dibike, Environment Canada (presented by Trevor Murdock)
14:00 – 14:15	Bias-adjusting CRCM-CGCM3 Data and its Application in the SWAT Modeling of Lower Missouri River Basin – Lei Qiao, St. Louis University
14:15 – 14:30	Quantification of Uncertainty in High Resolution Temperature Scenarios for North America – Guilong Li, Environment Canada
14:30 – 14:45	Utilizing NARCCAP for Assessing Hydrologic Impacts of Climate change: Methodologies, Tools, and Challenges – Phillip Morefield, US EPA
14:45 – 15:30	Final Wrap-Up
15:30	*Meeting Adjourns*

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P I BIOGRAPHICAL SKETCH

■	Linda Mearns
□	Sebastien Biner
■	Melissa Bukovsky
■	Daniel Caya
■	Philip Duffy
■	William Gutowski
□	Isaac Held
□	Richard Jones
■	Ruby Leung
■	Larry McDaniel
■	Seth McGinnis
□	Don Middleton
■	Ana Nunes
□	John Roads
■	Stephan Sain
■	Lisa Sloan
□	Mark Snyder
■	Eugene Takle
■	Toni Rosati, Student Assistant
■	Joshua Thompson, Student Assistant

■ Attending PIs

http://www.narccap.ucar.edu/

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LINDA O MEARNS

Linda O. Mearns is Director of the Weather and Climate Impacts Assessment Science Program (WCIASP) within the Institute for Mathematics Applied to Geosciences and Senior Scientist at the National Center for Atmospheric Research, Boulder, Colorado. She served as Director of the Institute for the Study of Society and Environment (ISSE) for three years ending in April 2008. She holds a Ph.D. in Geography/Climatology from UCLA. She has performed research and published mainly in the areas of climate change scenario formation, quantifying uncertainties, and climate change impacts on agro-ecosystems. She has particularly worked extensively with regional climate models. She has most recently published papers on the effect of uncertainty in climate change scenarios on agricultural and economic impacts of climate change, and quantifying uncertainty of regional climate change. She has been an author in the IPCC Climate Change 1995, 2001, and 2007 Assessments regarding climate variability, impacts of climate change on agriculture, regional projections of climate change, climate scenarios, and uncertainty in future projections of climate change. For the 2007 Report(s) she was Lead Author for the chapter on Regional Projections of Climate Change in Working Group 1 and for the chapter on New Assessment Methods in Working Group 2. She has also been an author on two Synthesis Products of the US Climate Change Science Program. She leads the multi-agency supported North American Regional Climate Change Assessment Program (NARCCAP), which is providing multiple high-resolution climate change scenarios for the North American impacts community. She is a member of the National Research Council Climate Research Committee (CRC) and Human Dimensions of Global Change (HDGC) Committee, and the NAS Panel on Adaptation as part of the America's Climate Choices Program. She was made a Fellow of the American Meteorological Society in January 2006.

SÉBASTIEN BINER

Sébastien Biner is a climate simulation specialist for the Ouranos Consortium in Montréal, Canada. As such, he contributes to the production, analysis and improvement of the regional climate simulations used by Ouranos users and partners. Scientifically, he is particularly interested in studies related to the internal variability, added value and uncertainties of Regional Climate Models. He is also strongly involved in maintaining and improving the operational infrastructure at Ouranos and in the distribution of climate simulation data. Sébastien is co-supervising graduate students and supervising interns. He has a M.Sc in atmospheric sciences and a B.Sc in physics from the Université du Québec á Montréal. Sébastien is a father of two and a ski and cycling enthusiast.

MELISSA S. BUKOVSKY

Melissa S. Bukovsky is a post-doctoral fellow at the National Center for Atmospheric Research working directly with the NARCCAP project. Her research revolves around regional climate model credibility and diagnostics. She is interested in the determination of model credibility through process-based analysis and the impact of model bias/error and its propagation in simulations from the present-day to the future. Current, specific areas of research include the ability of the NARCCAP models to simulate central U.S. warm-season precipitation, the North American monsoon, observed trends, and the related processes behind these features. She is also working to further downscale select NARCCAP simulations over western North America.

DANIEL CAYA

Daniel Caya holds a degree in Atmospheric Science from UQAM, and began his career as a consultant in meteorology and atmospheric science with a private firm. After earning his PhD in Environmental Science from UQAM, he headed the Canadian Regional Climate Modelling Network from 1997 to 2001. In 2001, Ouranos appointed him to plan, develop and manage the Canadian climate modeling program. Since then he has been directing the Climate Simulation group, in charge of developing and producing regional climate projections for Canadian scientists. Mr. Caya is also an associate professor at the regional climate study and modeling centre (ESCER) at UQÀM, at INRS-ETE and at ISMER (UQAR). He remains very involved in training highly skilled staff to maintain Canadian expertise in regional climate simulation.

PHILIP DUFFY

Dr. Duffy joined Climate Central in 2008 as the Scientific Director of the Palo Alto Office and Senior Research Scientist. Previously he had worked at the Lawrence Livermore National Laboratory, where he was a physicist for 22 years. He is the founder and director of the University of California Institute for Research on Climate Change and its Societal Impacts, and an Adjunct Associate Professor at UC Merced. Dr. Duffy has a A.B. degree from Harvard in Astrophysics, and a Ph.D. from Stanford in Applied Physics. Dr. Duffy is a member of the Nobel-honored Intergovernmental Panel on Climate Change (IPCC). He has published over 50 peer-reviewed papers on many aspects of climate science. His recent work has focused on increasing the spatial resolution of climate projections, to make them more suitable for assessing potential societal impacts of climate change.

WILLIAM GUTOWSKI

William J. Gutowski, Jr. is Professor of Atmospheric Science in the Department of Geological and Atmospheric Sciences at Iowa State University. His research concentrates on the role of atmospheric dynamics in climate, with a focus on the dynamics of the hydrologic cycle and regional climate. Dr. Gutowski's research program entails a variety of modeling and data analysis approaches to capture the necessary spatial and temporal scales of these dynamics and involves working through the Regional Climate Modeling Laboratory at Iowa State University. His work also includes regional modeling of Arctic, African, and East Asian climates, in which he collaborates with scientists from these regions.

Dr. Gutowski currently serves as an Editor for the Journal of Hydrometeorology. He was a Lead Author for two U.S. Climate Change Science Program reports (CCSP 3-1, Climate Models: An Assessment of Strengths and Limitations; CCSP 3-3, Weather and Climate Extremes in a Changing Climate) and a contributing author to the IPCC Third and Fourth Assessment Reports. In addition, he was a member of the U.S. National Academy/Transportation Research Board panel to study the impacts of climate change on transportation. Dr. Gutowski received a Ph.D. degree in meteorology from the Massachusetts Institute of Technology and a Bachelor of Science degree in astronomy and physics from Yale University.

ISAAC HELD

Dr. Isaac Held is a Senior Research Scientist at NOAA's Geophysical Fluid Dynamics Laboratory, where he conducts research on climate dynamics and climate modeling, and is head of the Weather and Atmospheric Dynamics Group. He is also a lecturer with rank of Professor at Princeton University, in its Atmospheric and Oceanic Sciences Program, and is an Associate Faculty member in Princeton's Applied and Computational Mathematics Program and in the Princeton Environmental Institute. Dr. Held is a Fellow of the American Meteorological Society (1991) and the American Geophysical Union (1995), and a member of the National Academy of Sciences (2003). He recently received the AMS Carl Gustav Rossby Gold Medal (2008). He was a lead author of Ch.11 of the WG1 AR4 report on regional projections. He is particularly interested in the connections between planetary scale aspects of climatic responses and regional issues. He has coordinated the contribution of GFDL to NARCCAP, working with Bruce Wyman both to provide time-resolution output from GFDL's AR4 model (CM2.1) for downscaling and to provide data over North America from a time slice simulation with a ~50km version of AM2.1, the atmospheric component of the GFDL model.

RICHARD JONES

Richard Jones is manager of regional predictions at the Meteorological Office Hadley Centre. His main responsibilities are to provide state of the art regional climate modeling systems and to provide and analyze regional climate change scenarios and advice on these as required under contracts for various UK government departments and international bodies. He developed regional climate modeling in the Hadley Centre involving development of a consistent GCM/RCM modeling system; domain-size experiments; climate simulations driven by numerical weather prediction analyses; multi-decade regional climate change experiments; development of GCMs to provide high quality boundary conditions for RCMs; ensemble regional climate change experiments. He is a lead or major contributing author to many publications in regional climate modeling and was a lead author of the IPCC Assessment Reports Three and Four. He led the development of the regional climate modeling system PRECIS, has worked with many European institutes and is currently working with institutes across all continents in the fields of climate prediction and climate scenario development and application. In the NARCCAP project he is responsible for providing boundary conditions from Hadley Centre global climate model projections for downscaling by NARCCAP RCMs, for downscaling the GCMs used in NARCCAP with PRECIS and assisting with interpretation of the model projections.

RUBY LEUNG

Ruby Leung is a Laboratory Fellow at the Pacific Northwest National Laboratory (PNNL) and an Affiliate Scientist at the National Center for Atmospheric Research. She received her MS and Ph.D. in Atmospheric Science from the Texas A&M University in 1988 and 1991. She has performed much of her research using regional climate models since the early 1990s when she developed a regional climate model with special features that account for the subgrid scale effects of topography, lake and vegetation. Her model enables the coupling of climate and hydrologic processes in regions with complex orography. Since then Dr. Leung has led several projects to examine the impacts of climate variability and change and the effects of aerosols on the regional hydrological cycle. In 2001, Dr. Leung organized the Workshop on "Regional Climate Research: Needs and Opportunities" co-sponsored by the National Science Foundation and Department of Energy to examine various approaches to modeling regional climate. In 2005, she organized the Workshop on "Research Needs and Directions of Regional Climate Modeling Using WRF and CCSM". The workshop identified the needs to develop capability for high resolution modeling, regional earth system modeling and up scaling. More recently, she is leading an effort to use a hierarchical evaluation approach to assess global high resolution, global variable resolution, and regional climate models for modeling climate at the regional scale. She is a member of the NRC study committee on "A National Strategy for Advancing Climate Modeling". Dr. Leung is a fellow of the American Association for the Advancement of Science and American Meteorological Society.

LARRY MCDANIEL

Larry McDaniel is a software engineer who has worked on climate, climate change and climate impact on agriculture for the past twenty years here at NCAR. He prepares data sets (observed and model output) for use in agricultural models, heat wave studies as well as other projects. He writes code to analyze and validate model output with observed data sets..

Larry plans to use the NARCCAP data for the above purposes as well as for health and heat waves.

SETH MCGINNIS

Seth McGinnis has worked as an Associate Scientist in ISSE at NCAR since 2003, shortly after he received his Ph.D. in geophysics from CU-Boulder. He has a strong background in computer programming and works on a variety of projects related to making atmospheric science data accessible and usable to end-users of all types. His role in NARCCAP, along with Larry McDaniel, is to quality check (QC) the model data as it is submitted for archiving and publication, checking for errors and ensuring that it meets the formatting and metadata requirements of the project.

DON MIDDLETON

Don E. Middleton leads the Visualization and Enabling Technologies Section in NCAR's Computational and Information Systems Laboratory. He is responsible for developing and managing an emerging technologies program that encompasses data and knowledge management, analysis and visualization, collaborative visual computing environments, Grid computing, digital preservation, and education and outreach activities. Don's professional interests center on the frontiers of managing, preserving, and analyzing large, complex earth system datasets and communication using advanced visual technologies. Don is currently serving in a PI or co-PI capacity on a number of projects, including: the Earth System Grid, the Earth System Curator, the Virtual Solar Terrestrial Observatory, the North American Regional Climate Change Assessment Program, the Cooperative Arctic Data and Information Service, and NCAR's Cyberinfrastructure Strategic Initiative. Don recently completed a term on a National Research Council committee for NEES/NEESGrid and Earthquake Engineering and was a contributing author for the new publication, The Visualization Handbook.

ANA NUNES

Dr. Ana Nunes is a weather/climate modeler at the Experimental Climate Prediction Center (ECPC) at the Scripps Institution of Oceanography. Formerly, she worked with the Modeling Development Division of the Center of Weather Prediction and Climate Studies at the National Institute for Space Research in Brazil, which is considered one of the most prestigious scientific institutions in South America. One of the subjects of her research is improving our understanding of atmospheric dynamics, and dynamical downscaling in particular, via the assimilation of precipitation, as well as the applications of precipitation assimilation to water cycle modeling.

Dr. Nunes is a member of the NARCCAP team, and in charge of the ECPC-Regional Spectral Model (RSM) participation in this program.

JOHN ROADS*

Dr. John Roads is a Senior Scripps Research Meteorologist, Sr. Lecturer and Director of the Experimental Climate Prediction Center (ECPC) at the Scripps Institution of Oceanography, University of California, San Diego. He is also the co-chair of the Global Energy and Water-cycle Experiment (GEWEX) Coordinated Energy and water-cycle Project (CEOP). Dr. Roads was a previous chair of the National Centers For Environmental Research (NCEP) Regional Reanalysis Scientific Advisory Committee, several international Regional Spectral Model workshops, and the National Research Council GEWEX committee. He has also been a Principal Investigator on many NOAA, NASA, USFS; and other US agency grants. He is a Fellow of the AMS and has published more than 140 refereed articles. Dr. Roads is the ECPC principal investigator in charge of contributing the Regional Spectral Model (RSM) simulations to NARCCAP.

*Regrettably, Dr. John Roads died in June, 2008

STEPHAN R. SAIN

Stephan R. Sain is the head of the Geophysical Statistics Project in the Institute for Mathematics Applied to Geosciences at the National Center for Atmospheric Research. He received undergraduate degrees in mathematical sciences and statistics as well as a masters and PhD in statistics from Rice University in Houston, TX. His research focuses on developing statistical methodology for analyzing the complex, multivariate data that are typical in the geosciences. His current work centers around the analysis of regional climate model output, the assessment of the impact of climate change, and the design and analysis of computer experiments. These projects bring together a broad range of statistical areas: spatial and spatial-temporal methods, hierarchical models, statistical computing, and methods for analyzing extremes. As a NARCCAP co-Pi, he is responsible for the development of statistical methodology to assess and quantify uncertainties in the NARCCAP regional climate model ensemble.

LISA SLOAN

Lisa Sloan is a Professor of Earth and Planetary Sciences and the Director of the Climate Change and Impacts Laboratory the University of California Santa Cruz (UCSC). She is also the Vice Provost and Dean of Graduate Studies at UCSC. Sloan received her B.S. from Allegheny College and her Ph.D. from Pennsylvania State University, and did postdoctoral work at the University of Michigan. Sloan joined the faculty at UCSC in 1995. Sloan has been the National Secretary of the American Geophysical Union's Ocean Sciences Section, a scientific Fellow of the David and Lucile Packard Foundation, Editor-in-Chief of the international journal Global and Planetary Change, editor of the international journal Paleoceanography, and has co-chaired the National Center for Atmospheric Research's Paleoclimate Working Group. She has served and continues to serve on and many national scientific advisory boards that deal with past and future climate change as well as scientific computing challenges. Sloan's research is concentrated in two broad areas: (1) understanding the mechanisms of climate changes in the geologic past and (2) studying and modeling future climate change at regional scales and investigating the possible impacts of future climate change on human and natural systems. She has authored or coauthored more than 60 peer-reviewed articles and book chapters, and is a frequent public speaker in California on issues of climate change.

For more information, see http://www.es.ucsc.edu/~lcsloan/

EUGENE S. TAKLE

Eugene S. Takle is professor of Atmospheric Sciences and Agricultural Meteorology at Iowa State University.

Eugene's current climate-related research includes both basic research on climate change and impacts of climate change. Basic research centers on how the features of the earth surface influence turbulent flow and exchange processes that influence surface momentum, energy, and moisture fluxes. Research on climate-change impacts includes assessing the interactive roles of climate and land-manager choices on land-use/land-cover change in agricultural area, development and evaluation of downscaling tools for near-surface flow and impacts of climate change on wind power, evaluating effects of climate changes on Midwest agroecosystems using a climate-crop coupled model, and assessment of variability and trends in Iowa climate data on pavement performance by use of a mechanistic-empirical pavement design model. The land-use/land-cover project uses SWAT (Soil and Water Assessment Tool) to simulate stream flow in large complex watersheds in agricultural areas under current and future scenario climates. Changes in surface wind speed and wind power over the 20th and 21st Centuries are explored through use of statistical downscaling and regional climate models. By coupling crop models with regional climate models we explore the impact of crop selection on carbon uptake and evapotranspiration over the Midwest during the growing season. Roadways in Iowa have been designed under assumptions of average climate conditions that do not reflect actual climate variability or future climate change. Working with civil engineers we are using a standard pavement design model to explore expected changes in various roadway failure modes under actual variability and projected trends in climate over the next 60 years.

Eugene's role in NARCCAP is as part of the ISU team organizing and analyzing the reanalysis-driven runs and contributing to the scenario-driven runs. A central focus is promoting appropriate and effective use of regional climate model information in impacts studies.

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USERS BIOGRAPHICAL SKETCH

Christopher Anderson	Arie Manangan
Daniel Barrie	Martin Montero-Martinez
Joseph Barsugli	Phil Morefield
Marcus Borengasser	Linda Mortsch
Wei Chu	Trevor Murdock
William Forsee	Mohammed Reza Najafi
Yanhong Gao	George Paul
Eric Gilleland	Sara Pryor
Adam Greeley	Budong Qian
Chuck Hakkarinen	Lei Qiao
Dorit Hammerling	Imtiaz Rangwala
Erik Kabela	Darrin Sharp
Sho Kawazoe	Willis Shem
Kenneth Kunkel	Christopher Uejio
Guilong Li	Michael Wehner
Lu Liu	Shuang-Ye Wu
Kelly Mahoney	Feng Zhang

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JOSEPH BARSUGLI

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University of Colorado

I am a research scientist at the Cooperative Institute for Research in Environmental Sciences at the University of Colorado at Boulder. I am also affiliated with the Western Water Assessment, a NOAA-funded "boundary organization" that works with stakeholders Colorado, Utah and Wyoming to improve the use of climate information in water, land, and ecosystem management. After working with NARCCAP output for a couple of years, it has become clear to me that higher resolution simulations are not necessarily easier to interpret for stakeholders. One encouraging trend I am seeing is the increasing willingness on for some stakeholders to accept a "process-based" approach, and the increasing ability of our models to provide that on a regional scale.

Research Interests: Incorporating information from NARCCAP simulations into impacts and management models.

MARCUS BORENGASSER

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Environmental Quality Management/FL Tech

Ph.D., Geology, University of Nevada

M.S., Applied Math, FL Tech

M.S., Computer Science, FL Tech

We are working on a Phase II STTR to develop an analytical method to evaluate and track the impact of climate change on pollutants generated by USA DoD operations. The resulting analytical tool will help decision makers determine the effects of potential climate change on the fate and transport of toxic compounds in the environment.

Research interests: Evaluate the impact of climate change on pollutants generated by USA DoD operations.

WEI CHU

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University of California, Irvine

Biographical sketch: Currently Postdoctoral Scholar at the Center for Hydrometeorology and Remote Sensing (CHRS) in UC Irvine. He received B.S. from Nanjing University in Geology, M.S. from Stanford University in Geological and Environment Sciences, and Ph.D. from University of California at Irvine in Civil Engineering.

Research Interests: Detection of patterns and trends of meteorological fields by mining observational data, which include land-based and remotely sensed. Modeling uncertainties of climate model projection by evaluating model simulations against observations. Development of models and techniques for water planning and management. Study of Pacific Atmospheric Rivers and the connection with extreme flooding on the US west coast using satellite remote sensing data. Scientific computation with emphasis on theory and algorithms for optimization of high-dimensional and complex problems.

YONAS B. DIBIKE

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Environment Canada

Yonas B. Dibike (PhD, PEng) has received his MSc degree in Hydraulic Engineering and his PhD in Hydro informatics from the Technical University of Delft, in the Netherlands. Between 2002 and 2004 he pursued postdoctoral research at McMaster University, in Canada investigating the hydrological impacts of climate change in the Saguenay watershed in Quebec. Between 2005 and 2007, he was NSERC industrial research fellow at Ouranos Consortium on Regional Climatology and Adaptation to Climate Change, in Montreal, Québec. His main research at Ouranos was on development and analysis of climate change scenarios for Québec and Northern Canada using statistical downscaling methods. Since May 2007, he joined Environment Canada as a physical scientist, at the National Water Research Institute's Water & Climate Impact Research Centre located at the University of Victoria, British Colombia. His current areas of research are, among other things, hydro-climate analysis including statistical downscaling of global climate model outputs, impacts of climate variability and change on hydrology and water resources and simulation of lake-ice and lake-water temperature regimes in a changing climate. Yonas is also a Professional Engineer and Adjunct Assistant Professor at the University of Victoria. He has co-authored and published more than 20 papers in international refereed journals and also presented his research works in a number of international conferences.

Research Interests: Hydro-Climate Analysis and Climate Change Impact Studies

BILL FORSEE

bill.forsee@dri.edu

Desert Research Institute

Bill Forsee received his interdisciplinary M. S. from the Rosenstiel School of Marine and Atmospheric Science at the University of Miami, Florida. His M. S. thesis involved the use of a stochastic weather generator and resampling methodology to create daily weather series consistent with El-Niño Southern Oscillation seasonal forecasts of precipitation. He is currently employed as a Technician in the Division of Hydrologic Sciences at the Desert Research Institute in Las Vegas, Nevada. He has worked on projects regarding impacts of climate change upon extreme precipitation events and stormwater infrastructure. He has a wide range of research interests including climate change and variability, ecosystem science, hydrology, geography, and marine science.

Research Interests: Climate change and variability, ecosystem science, hydrology, geography, and marine science.

FRANCIS GACHARI

regcm4@gmail.com

Jomo Kenyatta University of Agriculture and Technology

Francis is currently working on a PhD in Atmospheric Physics at Jomo Kenyatta University of Agriculture and Technology. His work is mainly motivated by the observation that gains so far achieved through research in support of crop and animal production have been severely reduced by the change in climate patterns thereby placing climate science higher up in the order of prerequisites for agricultural production. He has a Masters in Atmospheric Physics from the same university.

Research interests: Inter-comparison between the attributes to the variability of the North American climate and that of the eastern Africa.

YANHONG GAO

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University of Washington

I am a visiting scientist of Dennis P. Lettenmaier group in the department of Civil and Environmental Engineering, University of Washington. I am working on a mega drought project. We use Regional Climate Model (RCM) simulations from the North American Regional Climate Change Assessment Program (NARCCAP) to evaluate implications of climate change for the discharge of the Colorado River in the mid-21st century. We compare historical RCM simulations and simulations from their host global General Circulation Models (GCMs) to 1/8-degree gridded observations of precipitation, surface air temperature and runoff (generated by the Variable Infiltration Capacity (VIC) land surface model forced with gridded observations) for the historical period 1970-1999.

Research Interests: I am interested in the climate change impacts over mountainous region from the Regional Climate models

ERIC GILLELAND

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National Center for Atmospheric Research

I am a Project Scientist in the Joint Numerical Testbed (JNT) of NCAR's Research Applications Laboratory (RAL). My main research interests are spatial forecast verification methods and statistical extreme value analysis. In terms of NARCCAP, my interest is in analyzing severe weather indicators from the climate models. In particular, concurrently high values of CAPE and shear.

Research Interests: Spatial and Extreme Value Statistics

ADAM GREELEY

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Columbia University Center for Climate Systems Research

Adam Greeley is an analyst and programmer at the Columbia University Center for Climate Systems Research. He uses global and regional climate model output to study climate variability and climate change at the regional scale and to create scenarios for impact assessment models for agriculture, infrastructure, health, and water resource applications. He also works with weather generators to study impact model sensitivities to climate changes and daily to interannual variations in precipitation and temperature. Adam is a member of the Climate Scenarios Team for the Agricultural Model Intercomparison and Improvement Project (AgMIP), a transdisciplinary effort to understand climate impacts on agricultural systems and economies around the world. Additionally, he is involved with research on climate variability, climate change and impact assessment as part of the Consortium for Climate Risk in the Urban Northeast (part of the NOAA RISA program) based at Columbia University.

Adam is a graduate of Columbia University's Climate and Society Master's Program and hold a B.S. in atmospheric and oceanic sciences from Stony Brook University.

Research Interests: Decadal climate variability, climate predictability at the interseasonal to interdecadal time scales, and the societal impacts of climate change.

CHUCK HAKKARINEN

chakkarinen@comcast.net

Retired from EPRI

I worked for 29 years as a research manager for the Electric Power Research Institute, prior to retiring in 2003. While at EPRI, I managed all research projects related to the geosciences and modeling of climate change -- global and regional -- including the Project to Intercompare Regional Climate Simulations (PIRCS) -- a predecessor to NARCCAP. I am currently interested in discussing how the regional climate modeling community will adapt to the 20-fold increase in computing power that will become available to the modeling community in 2012.

Research Interests: Further dynamical and statistical downscaling, and in the use of web-based applications to display the spatial and temporal patterns of regional climate model outputs and their comparison to observational data.

DORIT HAMMERLING

doritmh@umich.edu

University of Michigan

I am PhD candidate at the University of Michigan in Environmental Engineering. I hold Master degrees in Engineering and Statistics. My thesis research revolves around a NASA project to derive global atmospheric CO2 concentrations from satellite observations. Before returning to the University to obtain my PhD, I worked in industry on high level control systems.

My research interests are spatial and spatio-temporal statistical methods for geophysical and climate data sets and models.

ERIK D. KABELA

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University of South Carolina

I am a Senior Meteorologist with the Atmospheric Technologies Group within the Savannah River National Laboratory, a Department of Energy national laboratory, for the last four years. I have a bachelor’s degree in Meteorology from Valparaiso University and a master’s degree in Agricultural Meteorology from Iowa State University. I am also currently a PhD candidate in the Department of Geography at the University of South Carolina studying climate change impacts for the Southeast United States.

My current research focuses on the use of downscaled climate model data for assessment of model skill in the observational period as well as future projections of temperature and precipitation change for the Southeast U.S. My primary focus centers on the use of NARCCAP model data to perform model validation and provide assessment of future climate change in the region.

Research Interests: NARCCAP model validation for the Southeast United States during the observational period and projections of future temperature and precipitation change.

SHO KAWAZOE

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Iowa State University

I am currently a 2nd year graduate student in the Department of Geological and Atmospheric Sciences at Iowa State University. I graduated with a Bachelors degree from Iowa State University in Meteorology and Environmental Studies.

My current research incorporates NARCCAP Regional Climate Models, associated Global Climate Models, North American Regional Reanalysis (NARR), and University of Washington gridded observational data to identify environments that are favorable for the development of extreme precipitation events. Part of this project is to assess how well these models collectively reproduce extreme daily precipitation, and part of this project is to provide a baseline understanding of how these events will be ultimately affected by enhanced greenhouse warming. Analysis currently focused on the Upper Mississippi River Basin, with other regions pending. This work is partly an outgrowth of my undergraduate senior thesis, which laid the foundation for the Gutowski et al. (2010) publication on monthly extremes. ---

Research Interests: Study of Extreme Precipitation events in the Upper Mississippi River Basin

KENNETH KUNKEL

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NOAA Cooperative Institute for Climate and Satellites

I am Lead Scientist for Assessments with the NOAA Cooperative Institute for Climate and Satellites and Research Professor with the Department of Marine, Earth and Atmospheric Sciences, North Carolina State University. My research has focused on regional climate variability, extremes, change, and modeling. I have led several projects on the development and quality control of U.S. surface climate data sets used for evaluation of long-term historical trends in extreme climate events, including extreme precipitation, heat and cold waves, and snowfall.

My research interest is focused on regional climate variability, extremes, change, and modeling.

GUILONG LI

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Environment Canada

I am climatologist in Environment Canada. My research interests are climate change impact and adaptation at regional scale and focus on temperature and precipitation changes, extreme values, and their impacts in Canada, such as heat wave, heavy rainfall etc. NARCCAP data provide very high resolution outputs for our study. A current project I'm working on is trying to analyze high resolution temperature and precipitation change and uncertainties in North America. Different statistical methods will be used to construct probabilistic projections of high resolution monthly temperature and precipitation over North America.

Research Interests: My current research interest is to estimate high resolution monthly temperature and precipitation change and uncertainty over North America by using statistical downscaling method.

LU LIU

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University of Oklahoma

• University of Oklahoma, Norman, OK

BS, Environmental Science, May 2010

GPA: 3.59

(Transferred from Beijing Normal University, China)

• University of Oklahoma, Norman, OK

MS, Environmental Science, Water Resources Track, May 2012

Research Interests: Water resources, environmental impacts, climate change, and severe climate events.

KELLY MAHONEY

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UCAR/NOAA/USBR

Kelly Mahoney is currently a postdoctoral research fellow with UCAR's Postdocs Applying Climate Expertise (PACE) program. Kelly's PACE research focuses on warm season extreme precipitation events in the Front Range of the Rocky Mountains, and seeks to better understand how these types of events may change in future climate scenarios. She is using NARCCAP data as initial conditions to high-resolution (1-km) model runs of extreme precipitation events. Results are intended to benefit water managers and related stakeholders by clarifying how maximum precipitation thresholds and other extreme event criteria may evolve in the face of a changing climate in the western U.S.

Kelly graduated in 2009 from North Carolina State University where she earned a B.S., M.S. and PhD in Atmospheric Science. While at N.C. State, she worked on a number of collaborative research projects with the National Weather Service, focusing on topics such as quantitative precipitation forecasting and numerical forecast model representation of severe thunderstorms. Her dissertation work focused on model representation of convective momentum transport, with a larger goal of improving forecasts of organized, warm-season convective systems and the prediction of damaging surface winds.

Research Interests: Kelly is interested in extreme precipitation, high-resolution dynamical downscaling, and applications-oriented approaches to better understanding the potential for changing extremes in future climates.

MARTIN JOSE MONTERO-MARTINEZ

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Mexican Institute of Water Technology

Profession: Climatologist.

Date and Place of Birth: January 30, 1968. Mexico City, Mexico.

Working at IMTA since: February 2000.

Education:

BS in Physics (1989), Autonomous University of Puebla (Mexico)

MS in Geophysics (1993), National Autonomous University of Mexico

PhD in Atmospheric Sciences (1999), University of Arizona (USA)

Postdoc (1999-2000, 1 Yr), University of Dalhousie (Canada)

Detailed Tasks Assigned:

• To perform research in the fields of global and regional climate change, atmospheric numerical modeling, remote sensing applied to fire detection, aerosols (biomass burning), and adaptation measurements to climate change.

Participation in Research Projects:

• Participation in eight projects as PI and collaborating in another eight with other national and international institutions.

Thesis:

• Superadvisor in 5 B.S. theses, 2 M.S. theses and 1 Ph.D. thesis.

Production:

• 5 peer-reviewed papers.

• 4 book chapters

• 9 in-extenso papers on international conferences

• 13 in-extenso papers on national conferences

• 3 research visits to IRI-USA (2008); MRI-Japan (2009) and U. Sydney-Australia (2010).

Researcher for the Mexican Institute of Water Technology since 2000.

Research Interests: GCM validation, statistical and dynamical downscaling, aerosol-climate interactions.

PHIL MOREFIELD

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U.S. EPA Global Change Research Program

I've been a geographer at the National Center for Environmental Assessment for nearly three years. I've worked on a wide range of impact and vulnerability assessments ranging from biofuels to land use and climate change. A major recent focus has been the development of GIS tools that permit the simple and efficient aggregation of climate model output.

Research Interests: Developing tools and workflows to enable the processing and analysis of large archives of climate model output in ArcGIS.

LINDA MORTSCH

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Environment Canada & University of Waterloo

Linda Mortsch is a senior researcher with the Adaptation and Impacts Research Section of Environment Canada and an adjunct in the Faculty of Environment at the University of Waterloo. She has over 20 years experience in undertaking climate vulnerability, impact and adaptation assessments. Linda was the Convening Lead Author for the North America Chapter in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report published in 2007. Her research interests include climate vulnerability, impact and adaptation studies on water resources, wetlands and communities as well as the development of climate change scenarios for these assessments.

Research Interests: The development and use of climate change scenarios for water resources assessments.

TREVOR MURDOCK

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Pacific Climate Impacts Consortium

I am a climate scientist at the Pacific Climate Impacts Consortium in Victoria, BC who works with regional stakeholders. My interests are in providing climate change projections and impacts projections that can be of use for decision-making. My particular interests at the moment are downscaling and indices of extremes, particularly in the Canadian Columbia Basin.

Research Interests: Regional climate change projections, downscaling, adaptation planning, applications, and decision-making.

MOHAMMAD REZA NAJAFI

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Portland State University

I am a PhD candidate working in the Remote Sensing and Water Resources Laboratory at Portland State University. Starting the PhD program in April 2009, I performed researches on the downscaling of large scale General Circulation Models (GCMs), and the uncertainties in hydrologic impact studies due to the climate change. My special interests are in the field of hydrologic climate change impact studies, application of remotely sensed data in environmental prediction, with the main goal of quantifying and reducing the associated uncertainties.

Research Interests: Climate change impact on hydrologic extremes such as floods in the Pacific Northwest.

GEORGE PAUL

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Kansas State University

George Paul is from New Delhi, India. He joined Kansas State University in 2009 fall to pursue his PhD in Remote Sensing Energy Balance Algorithms, at the department of Agronomy. He completed his bachelor's degree in Agricultural Engineering from Allahabad Agricultural University, India in 2002 and Master’s degree in Civil Engineering (Specialization Hydrology) from National Institute of Technology, India in 2004. He received Netherlands Fellowship Program Scholarship to undergone specialized training in Remote Sensing applications in Water Resources at ITC, The Netherlands. Prior to joining K-state he has four years of teaching and research experience at Indian Institute of Technology, New Delhi India. His research focuses on the impacts of climate change and variability on crop production and water resources; testing various crop decision and water management practices as a step towards developing adaptation strategies for coping with climate change. The knowledge generated through his research would help scientists, producers and policy makers to formulate programs to sustain rural communities by improving agricultural productivity and profitability. Another research area, which he cherishes to work, is the Remote sensing based surface energy balance algorithms providing accurate estimates of spatial-temporal Evapotranspiration (ET). Uses of these spatial ET estimates are innumerable including hydrological modeling, irrigation scheduling, drought and flood monitoring and global climate change studies. George is continually publishing and presenting his results to the scientific community.

Research Interests: Impact Assessment, Vulnerability & Adaptation of Climate Change and variability on Water Resources and Agriculture

SARA C. PRYOR

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Indiana University

Sara C. Pryor is Provost Professor of Atmospheric Science at Indiana University, and also holds visiting positions at the University of Aarhus and Risoe National Renewable Energy Laboratory in Denmark. She has published over 90 articles in internationally renowned journals, and is currently Editor of the Journal of Geophysical Research- Atmospheres. Sara's research encompasses both dynamical and empirical downscaling approaches, with the latter focused on probabilistic approaches. She is contributing author to the forthcoming IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, and is currently engaged by the International Atomic Energy Authority for her research on links between climate change, extreme events and critical energy infrastructure. In 2009 a volume she edited on climate variability and change was published entitled; Understanding climate change: Climate variability, predictability and change in the Midwestern USA.

Research Interests: Dynamical and statistical downscaling, primarily with a focus on extreme events.

BUDONG QIAN

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Eastern Cereal and Oilseed research Centre, Research Branch, Agriculture and Agri-Food Canada

Budong Qian is an agro climatologist at Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada. He obtained his doctoral degree in Physics (meteorology) from the University of Lisbon (Portugal) in 2000. Budong is interested in studies on climate variability, climate change and their impacts on agriculture and other aspects of human society. He currently works on developing future climate scenarios as input to crop models for evaluating climate change impacts on annual crop production in Canada. He also uses crop models to assess potential adaptation strategies in crop management to future climate change.

Research Interests: I am interested in applying climate change scenarios simulated by regional climate models to crop models for evaluating climate change impacts and adaptation strategies.

LEI QIAO

leiqiao1981@gmail.com

Saint Louis University

I am a Ph.D. candidate in the Earth and Atmospheric sciences department of Saint Louis University. The hydrological variability due to climate change and land cover/use changes is my main researching activities. Also I am interested in hydrologic model auto-calibration by using multi-source observations such as Remote sensing imagery, GRACE(Gravity Recovery and Climate Experiment), and in-situ measurements.

Research Interests: Climate change induced hydrological variations in the lower Missouri River Basin.

IMTIAZ RANGWALA

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NOAA, UCAR, USBR

Currently a postdoctoral fellow at NOAA ESRL, Boulder. My research interests include understanding climate change at high altitude regions (Colorado Rocky Mountains, Tibetan Plateau) by analyzing observed and modeled climate data. I am also involved in investigating influence of using different techniques for the downscaling of climate projections from GCMs on modeling hydrological impacts and decision making.

Research interests: Understanding climate change in the high mountain region.

DARRIN SHARP

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Oregon State University/Oregon Climate Change Research Institute

Darrin has a BS and MS in Computer Science from the University of Illinois, and an MS in Ecology from Colorado State University. He has experience working in both the high-tech and environmental consulting industries. His interests include the development of information systems used for ecological and environmental research, and the downscaling of global climate model results to the regional level.

Research interests include the development of information systems used for ecological and environmental research.

WILLIS SHEM

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ORAU/ORNL

I received my PhD. (Earth and Atmospheric Sciences) from the Georgia Institute of Technology (Georgia-Tech) in August 2006. My doctoral thesis was entitled ‘Biosphere-Atmosphere Interaction over the Congo Basin and its Influence on the Regional Hydrological Cycle’

My first appointment after graduation was a post-doctoral position at the University of Georgia in Athens (UGA) in the department of Geography (Aug 2006-2008 July). From August 2008 t0 May 2009, I held a temporary faculty position of ‘Lecturer in Meteorology’ at the University of Tennessee in Martin.

I am currently a post-doctoral research associate working for Oak Ridge Associated Universities (ORAU) at the Oak Ridge National Laboratory (ORNL) in Tennessee.

Research Interests: Dynamic downscaling of GCM climate products for region-specific applications e.g. impacts and vulnerability studies.

CHRISTOPHER UEJIO

uejio@ucar.edu

National Center for Atmospheric Research

Chris is a Center for Disease Control and Prevention and National Center for Atmospheric Research postdoctoral researcher. His work builds the evidence base to anticipate how global environmental changes may influence public health. Many important global health problems are sensitive to environmental processes. For example, seven of the top ten global health problems (measured by death, illness, and disability) are related to the environment. Domestically, the recent Environmental Protection Agency endangerment ruling stated that greenhouse gases are a threat to public health and should be regulated. Chris's research portfolio examines a broad range of health outcomes including the safety of drinking water, extreme heat events, mosquito transmitted diseases like dengue and West Nile Virus.

Research Interests: How does weather and climate variability currently influence public health and how may climate change alter these relationships?

MICHAEL WEHNER

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Lawrence Berkeley National Laboratory

My principal research interest is the analysis of extreme weather events in a changing climate. Using generalized extreme value theory; I have compared rare temperature and precipitation events between models and observations and have made projections of long term future changes to this class of extreme event. I have also projected future changes to tropical cyclones and droughts. I aim to help the IPCC AR5 better explain the distinction between “extreme” and rare events. My interest in NARCCAP is to characterize the models' ability to reproduce observed extreme precipitation events.

Research Interests: Projections of changes in extreme and rare precipitation.

SHUANG-YE WU

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University of Dayton

Dr. Wu got her Ph.D in Geography from University of Cambridge. She is now working as an assistant professor in Geology department at University of Dayton, Ohio. Her research interests focus on assessing potential impacts of climate change on hydrological cycles, particularly extreme precipitation events and flooding.

Research Interests: Potential impacts of climate change on extreme precipitation and flooding.

2011 THIRD USERS' MEETING

April 7-8 , 2011

NCAR, Center Green Laboratory 1

ABSTRACTS

ORAL PRESENTATIONS

JOSEPH BARSUGLI

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University of Colorado

Downscaling and Adaptation Uncertainty

We investigate the implications of three different downscaling methods in the context of actual adaptation planning for water resources. The Bureau of Reclamation's Colorado River Basin Water Supply and Demand Study ("Basin Study") is investigating the impacts of climate altered hydrologies on future water supply and demand imbalances in the basin, and will develop and analyze adaptation strategies. The Basin Study is using climate information that has been downscaled using the Bias-Corrected Spatial Disaggregation (BCSD) method. Working with Reclamation researchers, and in parallel to the Basin Study, we investigate the hypothesis that dynamically downscaled projections would make a difference to this impacts and adaptation study. Specifically, we compare results from three different approaches to downscaling climate projections for this region for the mid 21st century based on the A2 emissions scenarios: BCSD, and dynamically downscaled projections from the NARCCAP program.

The climate projections run through the Variable Infiltration Capacity (VIC) hydrology model and the Colorado River Simulation System (CRSS) operations and planning model. Development of decision-relevant metrics of system performance is part of the Basin Study; and will likely play a role in the evaluation of adaptation strategies. Here we present a comparison of these decision-relevant metrics under the two downscaling methods and an analysis of the influence on these metrics of using dynamically downscaled climate projections.

YONAS B. DIBIKE

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Environment Canada

Analysis of NARCCAP Multi-RCM Hydro-Climate Scenarios in the Lake Winnipeg Watershed

This study evaluated hydro-climate data from the North American Regional Climate Change Assessment Program (NARCCAP) over the Lake Winnipeg watershed (LWW) for the baseline (1971-2000) and future (2041-2070) periods. The data are derived from a set of regional climate models (RCMs) driven by global reanalysis (NCEP) and a set of General Circulation Models (GCMs) based on the SRES A2 emissions scenario. Precipitation and temperature outputs from the GCM driven RCMs are compared with the NCEP driven RCMs as well as observed 10 km Gridded Climate Dataset for Canada for the period 1981-2000. The results show that both NCEP and GCM driven RCMs have significant biases in seasonal temperature and precipitation compared to the gridded observed data. Climate change analyses based on future projections indicated that annual precipitation in the region is projected to increase by a combined model average (ensemble mean) of about 6.5%. Seasonal increases are projected for the winter, spring and fall with a decrease in the summer. Maximum and minimum daily temperatures are also projected to increase in the region, with mean annual Tmax increase of 2.6 - 2.9 degrees Celsius and mean annual Tmin increase of 2.4 - 2.8 degrees Celsius. Temperature increases will be most noticeable in the winter and summer. Furthermore, the future projection from CRCM also shows an average decrease in the annual maximum snow pack (SWE) by about 4.5% and the mean snow cover duration (SCD) by about 17 days in most parts of the LWW. There is also an overall increase in total annual runoff projected for most river basins and an overall shift in spring runoff to an earlier period. These projected changes in the hydro-climate regimes of the LWW will have important implications for the nutrient transport regimes of this region, which needs additional investigation using hydrologic and nutrient transport models.

NARCCAP

KENNETH KUNKEL

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NOAA Cooperative Institute for Climate and Satellites

Use of NARCCAP in the US National Climate Assessment

The National Climate Assessment is in the initial stages of preparing a report to be delivered to Congress in 2013. To support regional and sectoral evaluations of impacts, the National Climate Assessment team will be preparing physical climate projections for the nation. We plan to use the NARCCAP simulations as one component of these projections. We also plan to provide information about the fidelity of the control simulations in reproducing the present-day climate. We are very interested in contributions from the NARCCAP users' community. I will discuss specific needs of the assessment.

GUILONG LI

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Environment Canada

In collaboration with Xuebin Zhang[2] and Francis Zwiers[3]

[2] Climate Research Division, Environment Canada, Toronto, Ontario, Canada, [3] Pacific Climate Impacts Consortium, Victoria, BC, Canada

Quantification of Uncertainty in High Resolution Temperature Scenarios for North America

A framework for the construction of probabilistic projections of high resolution monthly temperature over North America using available outputs of opportunity from ensembles of multiple General Circulation Models (GCMs) and multiple Regional Climate Models (RCMs) is proposed. In this approach, we first established a statistical relationship between RCM output and output from the respective driving GCM. This relationship is then applied to downscale outputs from a larger number of GCM simulations. Those statistically downscaled projections were used to estimate empirical quantiles at high resolution. Uncertainty in the projected temperature was partitioned into four sources including differences in GCMs, internal variability simulated by GCMs, differences in RCMs, and statistical downscaling including internal variability at finer spatial scale. We found large spatial variability in projected future temperature changes, with increasingly larger changes towards the north in winter temperature and larger changes in the middle latitudes US in summer temperature. We also found that downscaling to small spatial scale contributes more to the uncertainty in the projected temperature changes than any other sources.

KELLY MAHONEY

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UCAR/NOAA/USBR

Further Dynamical Downscaling Using WRF: High-resolution Simulations of Extreme Precipitation Events in Future NARCCAP Climate Scenarios

Dynamical downscaling of climate model data is an increasingly popular way to link potential changes in the large-scale climate pattern to discernible "weather" at regional and local scales. However, there exists a wide spectrum of possible methodologies that one may use to dynamically downscale climate data. This methodological uncertainty further complicates the fact that the utility of downscaled datasets is often limited by a lack of information regarding skill/uncertainty in the higher-resolution model output.

The problem of downscaling becomes even more acute when dealing with extreme weather phenomena such as flood events, as the ability to resolve fine-scale atmospheric processes becomes critical in forming a realistic picture of future flood risk in complex terrain.

This study uses the Weather Research and Forecasting (WRF) model to evaluate three dynamical downscaling methodologies for extreme precipitation events in the western US. The climate data to be downscaled are provided by NARCCAP's regional climate model simulations. The three approaches are (i) direct downscaling to 1-km grid spacing of the most extreme (i.e., top 1%) precipitation events; (ii) using extreme event composites as initial conditions in the WRF model, and (iii) a "climate perturbation" approach that modifies the initial conditions of a single extreme precipitation event by adding an "average climate change signal" to the thermodynamic fields of the original event.

These three methods are compared for multiple NARCCAP GCM-RCM experiments across central and eastern Colorado, with the ultimate objective of better informing the needs of water resources managers in the western US.

SETH MCGINNIS

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NCAR

Effects of Spatial Interpolation Algorithm Choice on Regional Climate Model Data Analysis

The analysis of regional climate model (RCM) outputs frequently requires spatial interpolation of the data from the model's native grid to another set of locations: a different grid is needed for comparison with other models, a set of station locations for modeling of dependent processes or comparison with raw observations, specific points of interest for impacts studies, and so on. Different interpolation algorithms will produce results with different spatial characteristics, such as smoothness, synoptic patterning, and distribution of extremes.

To explore the importance of these differences in the NARCCAP context, we regrid model output from six different RCMs driven with NCEP boundary conditions using several interpolation methods of varying mathematical sophistication: nearest-neighbor, bilinear, inverse-distance weighting, and thin-plate spline interpolation. For each algorithm, the results are compared with observations, driving data, and source model data to determine what the magnitude of the artifacts due to interpolation is and whether these effects are likely to be significant for inter-model comparison, impacts modeling and analysis, and other uses popular in the NARCCAP community.

PHIL MOREFIELD

morefield.philip@epa.gov

U.S. Environmental Protection Agency

Utilizing NARCCAP for Assessing Hydrologic Impacts of Climate Change: Methodologies, Tools, and Challenges

The U.S. EPA's Global Change Research Program has begun an effort, based on watershed modeling in 20 large U.S. watersheds, aimed at addressing gaps in our knowledge of the potential sensitivity of U.S. stream flow and nutrient and sediment loading to climate change across a broad range of scientifically plausible mid-21st Century climate futures and the methodological challenges associated with integrating existing tools (e.g., climate models, land-use models, watershed models) and datasets to address these scientific questions. The purpose of this paper is to describe the overall structure of this ongoing effort - our methods, sites, models, and scenarios - as well as discuss preliminary results generated to date for a subset of the watersheds. Specifically, we review a representative set of modeling results that encompass the full suite of sensitivity tests we are exploring in this project. These results illustrate a number of key methodological issues, sensitivities, and uncertainties associated with carrying out these types of climate change-hydrologic impacts assessments, including: the sensitivity of simulated changes to the watershed model used, the sensitivity of simulated changes to climate model and downscaling approach used, and the interaction between climate change and other key forcing factors-specifically urbanization and change in atmospheric CO2 concentration. In addition, this suite of results provides an overview of the response to climate change in different geographic regions and the different sensitivities of a variety of flow and water quality endpoints.

TREVOR MURDOCK

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Pacific Climate Impacts Consortium

Analysis of NARCCAP Results for the Pacific Northwest

Regional Climate Model (RCM) projections from the North American Regional Climate Change Assessment Program (NARCCAP) and from Ouranos Consortium have been analyzed over Pacific North America. Preliminary findings include skill of each RCM to reproduce general features of temperature and precipitation climatology over the region under large scale forcing at the boundaries by observations (NCEP2 reanalysis). In comparison to Global Climate Models, RCM results are in much better agreement with historical observations. In particular, the effects of complex topography on precipitation (windward and rain shadow areas) are much improved, as is the ability to capture the effects of elevation on temperature. At the sub-regional scale, however, large differences exist between models. The differences are explored and compared to observations by focusing in on the northern Columbia River Basin. Informed by the results of this comparison, RCM projections of future climate and hydrologic change are shown for the region. Finally, an analysis of extremes was conducted in collaboration with users (Columbia Basin Trust, Engineers Canada, and communities in the Columbia Basin). Projections of extremes inform vulnerability assessments of community infrastructure and adaptation planning.

MARTIN JOSE MONTERO-MARTINEZ

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Mexican Institute of Water Technology

Validation of different NARCCAP-RCMs in the southern part of the domain

NARCCAP is certainly contributing a lot to the investigation of uncertainties in regional scale projections of future climate via dynamical downscaling. It is for sure that the CGCM-RCM nudging process is going to drive more uncertainty than the CGCM simulation alone. However, before studying the CGCM-RCM simulations, this work proposes first to look at the NCEP-RCMs simulations provided by the NARCCAP website. A comparison among the different NCEP-RCMs simulations versus Climatic Research Unit (CRU) data for precipitation and surface temperature on the southern part of the domain is performed here. Different statistical simple products such as bias, correlation, and temporal trends are realized for both variables during the 1981-2000 period. The results seem to support the fact that it could be just as sensitive to choose any of the different RCMs evaluated here than to choose any input data from the CGCMs for the regional projections.

GEORGE PAUL

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Kansas State University

Impacts of Climate Change on Crop Production in the Ogallala Aquifer

Future cropping systems depend on how the future climate unfolds. The objectives of this study were: (a) to analyze climate variability and change resulting from greenhouse gas emissions using high resolution regional climate model (RCM); and (b) to determine its impact on the crop production in the Ogallala aquifer region and analyze adaptation/mitigation strategies. Three RCM's used in this study were Canadian Regional Climate Model (CRCM), Regional Climate Model (RegCM3) and the Hadley Regional Model (HRM3). The A2 climate scenario for historic period (1971-2000) and future (2041-2070) were acquired from North American Regional Climate Change Assessment Program (NARCCAP). Spatial crop modeling was performed in AEGIS/WIN 4.0.2 program available in the DSSAT (Decision Support System for Agrotechnology Transfer) crop simulation model suite. The A2 climate scenario showed variable spatial pattern and magnitude across the Ogallala region with extreme climate conditions during the cropping season. Analyses showed that Ogallala region will experience 4-5 degrees Celsius increase in the maximum temperature for the month of July and August. In addition, rainfall distribution will be highly variable. Simulation results of future climates predicted ~30% decrease in the yield of grain sorghum. However, a substantial increase in wheat production throughout the region with an average increase of ~35% was predicted in future climates. Crop management decision, effects of elevated carbon dioxide and changes in genetics were analyzed as adaptation / mitigation options for improving productivity and decreasing yield losses. Based on our results, agronomists, breeder managers, and water managers can formulate or modify their programs to target the requirements of future climate, water, and food security.

SARA C. PRYOR

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Indiana University

Changes in Wind Energy Resources

The energy sector comprises approximately two-thirds of global total greenhouse gas emissions. For this, and other reasons, it has been the target of efforts focused on climate change mitigation. However, the energy sector is also vulnerable to potential enhancement of the risk posed by regional manifestations of global climate change. I will present analyses of the NARCCAP simulations focused on two key questions; (i) Is there evidence of a change in the wind energy resource that might impact (either negatively or positively) the viability of the wind energy industry? and (ii) Is there evidence for a change in extreme wind speeds that might impact the energy sector?

I will discuss the methods used to address these questions, and the responses that can be derived using the NARCCAP output. Specifically I will show that based on analyses of the NARCCAP model suite, at least for the next 50-years, the wind resource in the regions of greatest wind energy penetration will not move beyond the historical envelope of variability. There is some weak evidence for an increase in extreme wind speeds and gusts, but again, the climate change signal is of comparable magnitude to projection uncertainty and the internal variability. I will conclude by discussing methods to reduce uncertainty and to evaluating pro-active adaptation measures.

LEI QIAO

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Saint Louis University

Bias-adjusting CRCM-CGCM3 data and its application in the SWAT modeling of lower Missouri River Basin

The study applies NARCCAP downscaling climate data to Soil and Water Assessment Tool (SWAT) hydrological model in the lower Missouri River basin. The goal is to reduce the biases between the climate model generated and the observed atmospheric driving forces for improving the confidence in evaluating climate change impacts on the flood-prone region.

MICHAEL WEHNER

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Lawrence Berkeley National Laboratory

Very extreme seasonal precipitation in the NARCCAP ensemble: Model performance and projections

Extreme daily precipitation is analyzed in terms of seasonal twenty-year return values from the ensemble of NARCAPP regional climate models. Significant variation in the models' abilities to reproduce this observed precipitation statistic is found. In addition to substantial biases, the replication of the seasonal cycle of these rare events proves problematic for most of the models, particularly over the southeastern US. The implications for the projection of future changes in seasonal precipitation are discussed.

POSTERS

CHRIS ANDERSON

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Iowa State University

Poster #1 Using NARCCAP data to Quantify Uncertainty in Climate Sensitivity Analysis of Resource Management in Midwest Rivers

NARCCAP data are being used in uncertainty analysis for potential impacts of climate change on management of river systems. Two examples will be given in the poster. The first example shows how NARCCAP data are being connected to probabilistic sturgeon population models through a series of hydrology models. The emphasis of this work is quantifying uncertainty in each step of the linking of models. The second example shows how the spread of watershed-scale data from NARCCAP compares with GCMs, and the types of daily data that are useful in examining potential considerations for Midwest reservoir management, particularly for flood management.

Poster #2 Are non-hydrostatic dynamics necessary in climate simulations of Midwest convective systems?

The debate of what climate model resolution is necessary for impacts analysis is often cast in terms of distance between grid points (i.e., is 50-km grid spacing more useful than 150-km grid spacing). This poster presents an alternative view from an experiment that asks whether non-hydrostatic dynamics, which typically become apparent at grid spacing between 10 and 20 km, are important to warm-season simulation in the Midwest. The experiment compares 12-km simulations with hydrostatic and non-hydrostatic simulations. The results may have implications for a second round of NARCCAP-like projections.

DANIEL BARRIE

daniel.barrie@noaa.gov

NOAA

In economic analyses of wind energy, wind farm projects are assumed to have lifetimes on the order of 20 to 30 years. A particular site may host a wind farm for longer than this period with refurbished or replaced turbines. Over these decadal time scales, the impact of anthropogenic global warming (AGW) on wind patterns could affect the economic viability of the wind resource in a particular location, increasing or decreasing a project's energy yield.

To study the potential impacts of AGW on the wind resource, we have utilized climate model output from the North American Regional Climate Change Assessment Program's regional-scale modeling of projected climate change impacts within the United States. The predicted changes show strong dependence on both the details of the parameterizations in the regional models (e.g. roughness length data sets) as well as strong dependence on the differences in large-scale stationary and transient wave phenomena derived in part from the GCM-forced boundary conditions. We will present findings derived from this data set regarding changes in the domestic wind resource, as well as a discussion of the mechanisms responsible for the observed changes.

MELISSA S. BUKOVSKY AND LINDA O. MEARNS

bukovsky@ucar.edu, lindam@ucar.edu

NCAR/IMAGe

Late 20th Century Temperature Trends in the NARCCAP Regional Model Simulations

In this study we will analyze simulations from the North American Regional Climate Change Assessment Program (NARCCAP) in terms of their ability to reproduce the 2-m temperature trends of the late 20th century over North America. Trends will be compared to the driving reanalysis (the NCEP-DOE global reanalysis II: R2) as well as multiple observation-based datasets for 1980-2004. Likewise, available global climate model (GCM) driven NARCCAP simulations will be examined relative to their drivers and observations from roughly 1970-1999 and compared to their reanalysis driven counterparts. We will also explain some large discrepancies in the regional climate model (RCMs) trends. Current work indicates that some biases in trend are due to model drift. Differences in trends will be discussed in the context of current regional responses to greenhouse warming, implications for bias correction, and uncertainty in future climate projections.

Summertime in the NARCCAP Regional Climate Simulations

This study investigates the performance of the different NARCCAP regional models as driven by the NCEP Reanalysis II for June-August (JJA) from roughly 1980-2000, with a focus on central U.S. precipitation. The North American Regional Reanalysis is used for comparison to present day conditions. Also included is a brief assessment of changes in precipitation between 1971-2000 and 2041-2070 from 3 of the NARCCAP RCMs driven by 3 GCMs: the United Kingdom Hadley Centre Climate Model version 3 (HADCM), the Geophysical Fluid Dynamics Laboratory Climate Model version 2.1 (GFDL), and the Canadian Global Climate Model version 3 (CGCM). All GCMs have been forced with the SRES A2 emissions scenario for the 21st century.

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NCAR/IMAGe/RAL***

NARCCAP Regional Climate Model Simulations of the North American Monsoon

This study focuses on an assessment of the processes related to and the characteristics of the North American Monsoon system from Arizona and New Mexico, southward over Northern Mexico and the Gulf of California in both reanalysis and GCM driven NARCCAP simulations. At a 50-km resolution, better defined topographic, coastline and land cover features should impart better representation of many key aspects of the NAM climate system such as land-sea breezes, convective circulations and land surface heterogeneity. Thus, we will focus on more than just the characteristics of precipitation in the simulations, but also the physical and dynamical processes behind it. We will quantify some of the important characteristics of precipitation (e.g. spatial distribution, frequency, time of onset, and diurnal cycle), but additional processes, such as land surface fluxes, land-sea breezes, convective circulations and moisture flux patterns will be examined in an attempt to define the credibility of the model's projections of future precipitation through more than just their ability to simulate the characteristics of precipitation.

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The spatial distribution of precipitation is very important for water planning over the western United States, where vast man-made infrastructures, such as the Central Valley Project and California Water Project, were built to resolve the mismatch between where precipitation falls and where water is consumed. Recently, Empirical Orthogonal Function (EOF) analysis on the U.S. daily precipitation product of Climate Prediction Center (CPC) revealed that there exist dominant spatial patterns in the precipitation field over the western United States. The spatial patterns are consistent at different spatial resolutions and persistent over decades. The motivation of this study is to evaluate how well dynamical downscaling can capture the spatial patterns of observed precipitation in this region. EOF analysis is applied to precipitation outputs from NARRCAP and the derived spatial patterns are compared with those of observation for the same time period. Moreover, based on model simulations, the spatial patterns of current (1971-2000) and future (2041-2070) with the SRES A2 emissions scenario are compared. The result provides insight into the impact of climate change on the spatial distribution of precipitation, which is helpful to designing adaptation strategies in the western states. This work is our first step towards the development of accurate future precipitation projection for hydrological applications. Based on the skills of simulating the spatial patterns, an ensemble of future precipitation projections from NARRCAP output will be produced.

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Design storm intensities, used in engineering design, are calculated from seven NARCCAP data sets using the Generalized Extreme Value distribution and regional frequency analysis for seven different metropolitan areas in the continental United States. Precipitation intensities for durations from three to 96 hours for a range of frequencies (e.g. 100-year) were calculated from NARCCAP historical simulations and future projections, and NCEP/NCAR North American Regional Reanalysis data. Design storm values from Reanalysis data and NARCCAP historical simulations were compared. Relationships between intensities from Reanalysis and NARCCAP data change substantially depending upon the location and duration; there is some clustering by NARCCAP regional climate model. Comparisons of intensities from historical simulations and future projections for most NARCCAP data sets indicate increases in design storm intensities for many locations and durations. Future work will involve using these values in watershed studies.

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Impact of Atmospheric Tides on Climate models

This study assesses the role of atmospheric tidal waves in observable weather and climate changes with an inclination to extreme hydrology events. The study involves NCEP-Driven RCM Runs and Climate Change Results RCM3+GFDL as practical case studies for the purposes of understanding the processes. Diurnal and semidiurnal tidal oscillations (S1 and S2) on surface pressure will be extracted from the operational analysis product of the European Centre for Medium Range Weather Forecasting (ECMWF) Other data to be used include NCEP/NCAR Reanalysis, Palmer Drought Index, and CMAP precipitation. TRMM satellite rainfall products as well as University of East Anglia's CRU rainfall data will used to investigate the correlation between rainfall and atmospheric tides through empirical orthogonal function analysis. In this study, correlations will be investigated between SOI, IODI, TSAI indices and the temporal variability of surface pressure loading. The influence of enhanced atmospheric tides to extreme hydrology events will be investigated. Climate model simulations as well as predictions from MOHC PRECIS system and those done using the International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4) will be compared focusing on the advantages each model has in representing the regional climatology in terms of spatial and temporal resolution of extremes. NARCCAP simulations are necessary for providing reliable results for hypothetical case scenarios while providing an opportunity for inter-comparison of results.

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We use Regional Climate Model (RCM) simulations from the North American Regional Climate Change Assessment Program (NARCCAP) to evaluate implications of climate change for the discharge of the Colorado River in the mid-21st century. We compare historical RCM simulations and simulations from their host global General Circulation Models (GCMs) to 1/8-degree gridded observations of precipitation, surface air temperature and runoff (generated by the Variable Infiltration Capacity (VIC) land surface model forced with gridded observations) for the historical period 1970-1999. The RCMs capture the primary features of observations better than their host GCMs in part because of their ability to better represent strong upward lift in topographically complex regions. Although the RCMs do not significantly improve the simulation of precipitation, their ability to better represent surface temperature in mountainous regions has important effects on simulations of evapotranspiration, snowpack, and runoff. In the Colorado River basin, the response of cold-season temperatures in headwater streams is key to determining the basin's susceptibility to a warming climate. Due to the cooler temperature and higher snow line in RCMs relative to GCMs, the RCMs project less warming in the spring and thus generate smaller decreases in runoff, both during spring and annually, as compared with GCMs. Changes in surface air temperature, runoff, and snow water equivalent at high elevations all indicate that headwater streams of the Colorado River are less susceptible to a warming climate in climate change simulations that use RCMs than in simulations that use GCMs.

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Space-time statistical model to predict 21st century seasonal temperature averages based on an ensemble of regional climate model runs

We have developed a space-time statistical model to predict 21st century seasonal temperature averages based on an ensemble of regional climate model runs. The space-time model we developed uses observational records to assess discrepancies between the climate model runs for the time period from 1970 to 2010. Those discrepancies are then propagated into the future to obtain blended forecasts. The model features time-varying spatial heterogeneities, which allow for local comparisons of the different runs. The particular model considered is RegCM3, a regional climate model implemented by the Paleoclimate and Climate Research Group of the University of California, Santa Cruz. The different runs are based on three forcings: NCEP, GFDL and CGCM3.

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An inherent challenge of estimating potential climate change impacts on agriculture and water resources involves the incorporation of differing general circulation model output, and the mismatch between such output and the local scale at which impacts occur. This paper investigates dynamically downscaled regional climate model (RCM) output from the North American Regional Climate Change Assessment Program (NARCCAP) in the Southeast United States. Analysis will include assessment of RCM performance in the region during the historical period, with explanations of model bias, as well as quantification of uncertainty in future scenarios that results from differing models and downscaling methods. The focus will be on monthly temperature and precipitation changes across the region.

Two NARCCAP RCMs project warming of 2-4?C for most of the Southeast U.S. by 2041-2070. Preliminary findings of projected change in July precipitation is inconclusive on the estimated magnitude and direction of precipitation change. Discrepancies in precipitation projections across the Southeast is a symptom of choice of cumulus parameterization used to form convective precipitation in the model as well as the models ability to handle tropical weather systems. Historical precipitation for the Southeast U.S. illustrates a wet bias in one RCM and a dry bias in another, further explaining discrepancies in future precipitation projections.

Further analysis will incorporate future projections of additional months and RCMs from NARCCAP. A preliminary analysis of RCM skill in the historical climate will also be presented.

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Regional, Extreme Daily Precipitation in NARCCAP Simulations

We analyze the ability of the NARCCAP ensemble of climate models to simulate extreme daily precipitation and its supporting processes for regions of North America, comparing 18 years of simulations that used observed boundary condition with observations. The analysis includes both RCM and time-slice GCM simulations using approximately half-degree resolution. We also examine extreme precipitation for one of the AOGCMs, the NCAR CCSM that contributed boundary conditions for later NARCCAP RCM simulations. Analysis focuses on an Upper Mississippi River region for winter (DJF) and summer (JJA), building on several previous analyses focused on this region. This is a region where precipitation is depends on storms generated internally by the models.

In both seasons, the high resolution models generally reproduce well the precipitation-vs.-intensity spectrum seen in observations, with a small tendency toward producing overly strong precipitation at high intensity thresholds, such as the 95, 99 and 99.5 percentiles. The CCSM's threshold values are roughly one half the magnitude of those in the models and observations, most likely because of its coarser resolution. Further analysis focuses on precipitation events exceeding the 99.5 percentile occur simultaneously at several points in the region, yielding so-called "widespread events". Collectively, the high-resolution models also tend to produce somewhat more widespread events than the observations. Widespread events in the CCSM occur over areas of similar size, though its magnitude for the 99.5 percentile is substantially lower than for the other models. Further analysis focuses on 500 hPa flow and other fields such as humidity to compare atmospheric states and processes leading to extreme events in the models and observations.

NARCCAP

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In collaboration with Reinder De Jong, Sam Gameda, Hong Wang, Jingyi Yang

Preliminary evaluation on using direct RCM outputs in crop modeling

Future climate scenarios are required as climate input to climate impact models, such as crop models, for assessing the potential impacts of climate change. It is widely accepted that downscaling is required to bridge the gap between large-scale global climate models (GCMs) and impact models. Regional Climate Models (RCMs) are often used to dynamically downscale GCM simulations to climate change information at smaller regional scale. It is also believed that direct RCM outputs could be used to drive climate impact models, especially when the spatial resolution of the RCMs becomes high. In this study, we run DSSAT crop models for common crops (spring wheat, barley, corn, soybean and potato) at seven locations (Agassiz, BC; Beaverlodge, AB; Swift Current, SK; Winnipeg, MB; London, ON; Montreal, QC; Charlottetown, PEI) across Canada. The crop simulations were performed with the same soil and crop management for a selected cultivar at a location, using observed daily climate data and daily RCM outputs at a nearby grid for the baseline period, respectively. The RCMs used in this study are CRCM driven by CGCM3 and HadRM3 driven by HadCM3, being provided by NARCCAP. Results showed that the simulated crop yields could be fairly comparable when direct RCM outputs were used to replace observed climate data, depending on which RCM and the location were used. However, localization of the RCM outputs, for example bias correction or using a stochastic weather generator, may still be required.

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Investigating Projected Warming in the Colorado Rocky Mountains from the regional climate models in NARCCAP

This study investigated projected seasonal changes in the minimum (Tmin) and maximum (Tmax) temperatures in the southern Colorado Rocky Mountains from several regional climate models available from NARCCAP. Sensitivity of surface elevation to the seasonal changes in these two variables was also evaluated. Analysis of the surface energy fluxes, soil moisture, specific humidity, cloud cover and surface reflectivity was performed to diagnose the projected changes in Tmin and Tmax. This analysis also included the assessment of model biases for Tmin and Tmax when forced with NCEP Reanalysis. Important findings included large Tmin increases in winter at lower elevations and large Tmax increases in summer at higher elevations. Possible mechanisms responsible for these changes will be discussed.

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The Oregon Climate Change Research Institute (OCCRI) is examining North American Regional Climate Change Assessment Program (NARCCAP) results as they apply to the Pacific Northwest domain (PNW = OR, WA, ID, AK). Five PNW “sub-domains” have been identified - Coast, Cascades, Desert, Rockies, and Yukon Flats. For each sub-domain, several NARCCAP climate parameters are being extracted, statistically processed, and visualized. For each parameter, the “current” simulation value is being compared to the “future” simulation value. The existence of multiple sub-domains within the larger study area allows for the identification of regional trends, if any, within the larger domain. Multiple NARCCAP Atmosphere-Ocean General Circulation Model (AOGCM)-Regional Climate Model (RCM) pairings are being used in an effort to better represent uncertainties. OCCRI/NARCCAP results for the PNW are also being compared to results from a similar project that used only AOGCM climate model results. The downscaled PNW NARCCAP results will be used by a variety of governmental agencies and non-governmental organizations for climate change impacts planning, simulation, and preparation.

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A validation study of North American Regional Climate Change Assessment Program (NARCCAP) climate simulations is conducted for selected United States Forest Service (USFS) sites in the southeastern USA. Preliminary results focus on qualitative comparisons of seasonal and monthly data from NARCCAP simulations to the regional surface air temperature and precipitation data sets developed at the University of Delaware. Additional analyses extend current validation efforts to more quantitative methods incorporating seasonal and monthly time-series plots of both temperature and precipitation for the selected forest sites. These validation studies are precursors to current research to assess the vulnerability of southeastern forest cover and fire loads to climate change. Anticipated outcomes from this research will be useful for decision support and policy development by national, state, and local stakeholders.

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Potential impacts of climate change on the precipitation pattern in Ohio

This study uses NARCCAP models to assess the potential impacts of climate change on the precipitation pattern in Ohio. It has two main objectives. First, we evaluate the performance of NARCCAP models in terms of whether they capture (a) the spatial variations of precipitation pattern in Ohio; and (b) frequency distribution of daily precipitation data. Second, based on the evaluation, we correct the bias in mean precipitation and frequency distribution of precipitation output from RCMs. After the model biases have been corrected, we then project future changes of mean and extreme precipitation patterns in Ohio. We found that NARCCAP models reproduce spatial variations of Ohio precipitation reasonably well. Ensemble mean of all models performs better than any single model. In terms of frequency distribution of daily precipitation data, all models have biases. They typically overestimate small precipitation events and underestimate extreme precipitation. We used quantile mapping method to correct the bias in frequency distribution. Based on the bias-corrected model output, we find that on average, precipitation in Ohio will increase by 12%. The magnitudes of extreme precipitation are likely to increase more than mean. The increase will be more significant for more extreme events. Northern Ohio is likely to see more increase in both mean and extreme precipitation, which is likely due to increased evaporation from the Great Lakes.

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Comparing Joint Variable Spatial Downscaling Results with NARCCAP Datasets

High resolution climate scenarios produced by the North American Regional Climate Change Assessment Program (NARCCAP) are important resources for comparing and validating statistical downscaling methods. We developed a new statistical technique for downscaling gridded climatic variables-joint variable spatial downscaling (JVSD)-to generate high resolution gridded datasets for regional watershed modeling and assessments. It differs from previous statistical downscaling methods in that multiple climatic variables are downscaled simultaneously and consistently to produce realistic climate projections. We have shown that JVSD is able to reproduce the sub-grid climatic features as well as their temporal/spatial variability in the historical periods. In order to validate the physical realistic of JVSD, we compare the JVSD results with dynamic downscaling datasets from NARCCAP for the future period 2041-2070. The full JVSD (with bias correction) and dynamic downscaling exhibit significant differences for both atmospheric fields. This combined with the favorable JVSD comparison with observed data leads to the conclusion that dynamic downscaling without some form of bias correction may not be suitable for hydrologic assessments. Such a correction could potentially be implemented using the JVSD approach.

NARCCAP: Overview and Sample Results

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INTRODUCTION

The North American Regional Climate Change Assessment Program (NARCCAP) is an international program to produce high resolution climate change scenarios and investigate uncertainties in regional scale projections of future climate by nesting multiple regional climate models (RCMs) within multiple atmosphere-ocean general circulation models (AOGCMs) forced with the A2 SRES scenario and with historical data over a domain covering the conterminous United States and most of Canada and Northern Mexico.

The resulting 60+ terabytes of data are being archived for distributed storage and made available to climate analysis and global change impacts researchers worldwide via the Earth System Grid (ESG). To ensure that the final product is usable by the impacts community, GIS practitioners, climate analysts, modelers, policy-makers, and other end users, data is stored in CF -compliant NetCDF format, making it fully compatible with many popular analysis programs, including ArcGIS, Matlab, IDL, and R. Tools are also available for converting data to plain text.

GOALS

- Exploration of multiple uncertainties in regional model and global climate model regional projections.
- Development of multiple high resolution regional climate scenarios for use in impacts assessments.
- Further evaluation of regional model performance over North America.
- Exploration of some remaining uncertainties in regional climate modeling (e.g., importance of compatibility of physics in nesting and nested models).
- Quantification of uncertainty across all models.
- Creation of greater collaboration between US and Canadian climate modeling groups, as well as with the European modeling community.

NARCCAP AT A GLANCE

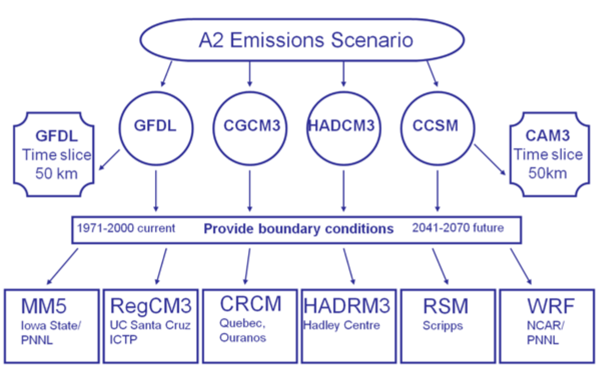
- 4 different AOGCMs driving 6 different RCMs
- 50 km spatial resolution
- 3 hourly temporal resolution
- 52 output variables
- 2 high-resolution AGCM timeslice experiments
- Future emissions scenario: SRES A2

Phase I: RCMs are driven by historical (1979-2004) observed (NCEP2 Reanalysis) data

Phase II: Each RCM is driven by 2 GCMs for current (1971-2000) and future (2041-2070) periods. GCM/RCM pairings are chosen for maximum value in statistical analysis.

Timeslices: Atmospheric components of the GFDL & CCSM global models are run at 50 km resolution using observed SST data (offset in the future scenario) instead of a coupled ocean.

NARCCAP PLAN – Phase II



EXPERIMENTAL DESIGN

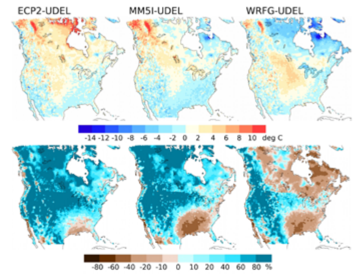
NARCCAP uses a fractional factorial design to manage funding limitations. Each RCM is paired with two GCMs. Timeslice experiments are also performed for two of the GCMs (CCSM & GFDL). Each RCM is paired with one of the two timeslice GCMs. '1^{st}' or '2^{nd}' indicates order of simulation.

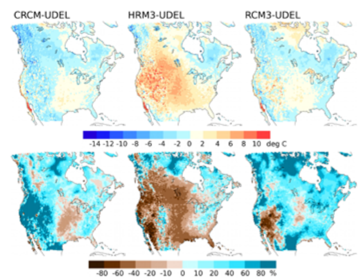
RCM \ GCM	Phase I	Phase II			
	NCEP	GFDL	CGCM3	HADCM3	CCSM
CRCM	DONE		1^{st}		2^{nd}
ECPC	DONE	1^{st}		2^{nd}	
HRM3	DONE	2^{nd}		1^{st}	
MM5I	DONE			2^{nd}	1^{st}
RCM3	DONE	1^{st}	2^{nd}		
WRFP	DONE		2^{nd}		1^{st}

SAMPLE PHASE I RESULTS

At right, winter temperature and precipitation bias relative to the U. Delaware observational dataset is shown for three of the NCEP-driven simulations. ECP2 and MM5I exhibit similar warm biases in central Canada, while the WRFG warm bias is mainly centered in the US and Canadian plains.

The dry bias in the south-central US is due to a secondary maximum in winter precipitation that most of the models have difficulty simulating. CRCM (not shown) and ECP2 perform best in this regard, perhaps because they use spectral nudging, and this precipitation feature is driven by larger-scale dynamic processes.

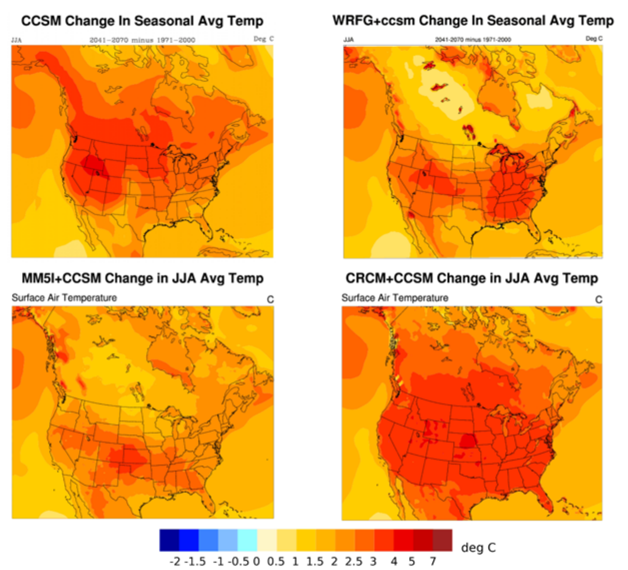




Shown at left is summer temperature and precipitation bias for the three models not shown above. CRCM and RCM3 simulate temperature well, while HRM3 exhibits a warm bias over most of North America. All models have a slight warm bias in the Plains.

Precipitation bias varies, but all models have a dry bias in the Midwest. The secondary maximum here is difficult for models to capture using convective parameterization; RCM3 and CRCM come closest. In the southwest US, there is a strong dry bias in all models except CRCM related to the simulation of the North American Monsoon.

SAMPLE PHASE II RESULTS



Comparison of Change in Summer Temperature: Global vs Regional Model Results

Patterns of temperature change can differ substantially between the global and regional models.

This is the case for the CCSM and the 3 regional models driven by it. Higher temperature changes are found in the CCSM (top left), particularly in the western part of North America, and higher still in the CRCM driven by the CCSM (bottom right) over a large swath of North America.

The WRF (top right) and MM5 (bottom left) driven by the CCSM, on the other hand, project strikingly lower changes in temperature through most of central Canada.