2nd US-Korea Workshop

on Use of High Resolution Model for ISI Prediction of Extreme Events and Its Regional Impacts

International Pacific Research Center
University of Hawaii at Manoa
HONOLULU, HAWAII
October 17-18, 2011

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1st U.S. – Korea Workshop
on Dynamical Seasonal Prediction

21-24 June 2010, APEC Climate Center, Busan, Korea

- The workshop took place from 21-24 June 2010 in the Asia-Pacific Economic Cooperation Climate Center (APCC), Busan, Korea, hosted by the APCC.

- More than 35 climate scientists from 22 institutes/universities of two countries were invited.

- Four major topics of the dynamical seasonal prediction were discussed in depth.

- Website: http://mason.gmu.edu/~kchin/USKOREA

1st U.S. – Korea Workshop on Dynamical Seasonal Prediction

Fall 2010 - Special Biodiversity Issue

International Workshop Promotes Climate Prediction Efforts

Dynamical seasonal prediction, or DSP, is a topic of great interest to scientists around the world. Emilia Jin, an assistant professor in the Department of Atmospheric, Oceanic and Earth Sciences (AOES), has been conducting research on DSP for several years at the Asia-Pacific Economic Cooperation Climate Center (APCC) in Busan, South Korea.

APCC produces real-time operational climate prediction information using a well-validated multi-model ensemble system that collects forecast outputs from fifteen institutions in eight countries.

AOES participants in U.S.-Korea Workshop (left to right): James Kinter, Bohua Huang, Emilia Jin, Jagadish Shukla, Youkyoung Jang, Liwei Jia, and Kristi Arsenault.

This past summer, Jin organized the U.S.-Korea Workshop on Dynamical Seasonal Prediction. Leading scientists from several research institutions and universities in the United States and South Korea met from June 21-24 at APCC to rigorously assess the current status of DSP and develop a visionary strategy to enable and accelerate collaborative activities between the two countries. Five AOES faculty members — Jin, Bohua Huang, James Kinter, Jagadish Shukla, and David Straus — attended the workshop. Doctoral students Kristi Arsenault, Youkyoung Jang, and Liwei Jia also participated in

to affect change.

The interdisciplinary environment at George Mason University encourages collaborative scholarship, new methods of research, and intense curiosity. We have some of the premier environmental researchers and policy experts in the world. Just as the United Nations hopes to draw attention to the world's urgency for biodiversity preservation, our scientists will continue to position us in an international forum for the contribution, exchange, and debate of ideas to preserve all that is unique on our planet.

The workshop, sponsored by the National Science Foundation, the Asia-Pacific Economic Cooperation (APEC), the National Research Foundation of Korea, and the Lotte Scholarship Foundation, was held in parallel with the annual APEC Climate Symposium. Participants developed a realistic roadmap to sustain continuing efforts for mutual benefit; new collaborative activities on Asian monsoon predictability, global system modeling, climate variability and change, high resolution modeling, and extreme weather-climate events; and long-term strategies.

"These international efforts will contribute to the enhancement of understanding prediction of climate modeling for the mutual benefits of the United States and Korea," Jin says.

1st U.S. – Korea Workshop
on Dynamical Seasonal Prediction

4 topics of group discussion:

- **High resolution modeling and extreme weather-climate events**
- **Global system modeling**
- **Asian monsoon predictability and prediction**
- **Climate variability and change**

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High resolution modeling and extreme weather-climate events

1) Common Science Problems

- Modeling and Validation of Extremes
- Address the impacts from increasing resolution, parameterization /resolved physics on tropical storms and the MJO (initially) to long-term extremes (e.g., drought), the impact of SST, and global change.

2) Roadmap for Collaboration

- Dissemination of the High-Res outputs for the community
- Data host
- For common research, the selection of test cases for specific and influential events: 2004 (10 typhoons) vs. 2005/2006 (ATL/hurricane) is one possibility

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George Mason University (GMU), Center for Ocean-Land-Atmospheric studies (COLA) and Korean Atmospheric Scientists in America (KASA) organized this workshop, and National Aeronautics and Space Administration (NASA) and Korea-US Science Cooperation Center (KUSCO) kindly sponsored this workshop.

Organizing Committee

- Dr. Emilia Jin (Chair; George Mason University/KASA)
- Dr. Siegfried Schubert (NASA GSFC GMAO)
- Dr. Bin Wang (Host; University of Hawaii/International Pacific Research Center)
- Dr. James L. Kinter (Center for Ocean-Land-Atmosphere Studies/GMU)
- Dr. Jagadish Shukla (Institute of Global Environment and Society/GMU)
- Dr. Myong-in Lee (UNIST)
- Dr. Young-Chul Kwon (NOAA/KASA)

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Project Athena : Revolutionizing Climate Modeling through Dedicated High-End Computing

Emilia K. Jin and Project Athena Team*

Department of Atmospheric, Oceanic, and Earth Sciences
George Mason University (GMU)
Center for Ocean-Land-Atmosphere Studies (COLA), USA

Next Generation Model Development Center, Korea

Project Athena: Science Goals

The efficacy of using high spatial resolution in global climate models to Improve their fidelity and acuity has been tested.

- *Hypothesis*: **Increasing climate model resolution** to accurately resolve mesoscale phenomena in the atmosphere (and ocean and land surface) can **dramatically improve the fidelity of the models in simulating climate** – mean, variances, covariances, and extreme events.

- *Hypothesis*: **Explicitly resolving important processes,** such as clouds in the atmosphere (and eddies in the ocean and landscape features on the continental surface), *without parameterization*, can **improve the fidelity of the models**, especially in describing the regional structure of weather and climate.

- *Hypothesis*: Simulating the **effect of increasing greenhouse gases on regional aspects of climate, especially extremes**, may, for some regions, **depend critically on the spatial resolution** of the climate model.

Project Athena: Collaborating Groups

COLA/GMU - Center for Ocean-Land-Atmosphere Studies, USA (NSF-funded)

ECMWF - European Center for Medium-range Weather Forecasts, UK

JAMSTEC - Japan Agency for Marine-Earth Science and Technology, Research Institute for Global Change, Japan

University of Tokyo, Japan

NICS - National Institute for Computational Sciences, USA (NSF-funded)

Cray Inc.

Codes

NICAM: Nonhydrostatic Icosahedral Atmospheric Model

IFS: ECMWF Integrated Forecast System

Supercomputers

Athena: Cray XT4 - 4512 quad-core Opteron nodes (18048)

#30 on Top500 list (November 2009) – dedicated Oct'09 – Mar'10

Kraken: Cray XT5 - 8256 dual hex-core Opteron nodes (99072)

#3 on Top500 list (November 2009) replaced Athena – allocation of 5M SUs

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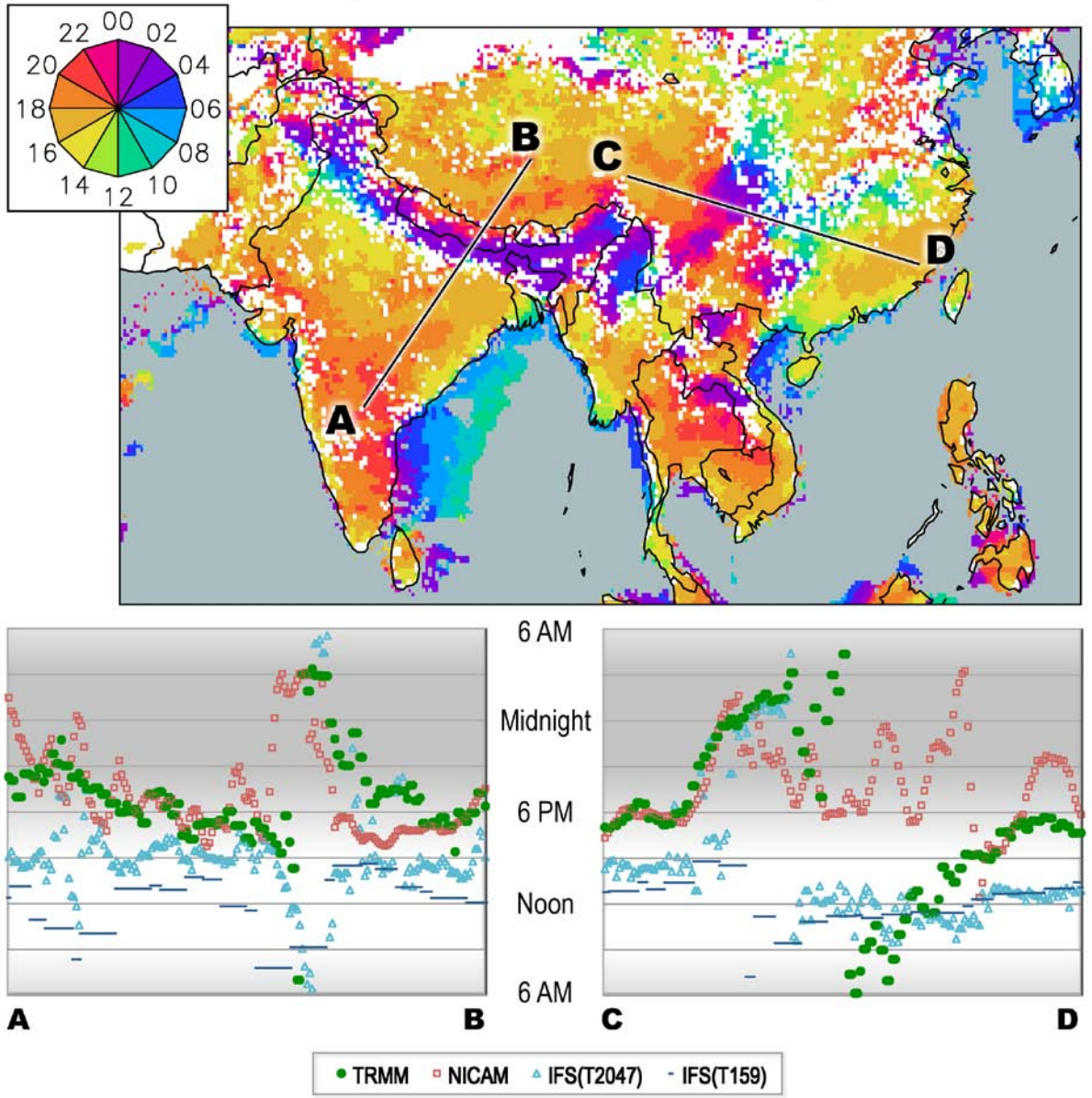
Experimental Design

	Resolution	Grid Size	Time Period	Duration	# of Cases
NICAM	GL10	7 km	21 May – 31 Aug 2001-2009 (except 2003)	103 days	8
ECMWF IFS	T2047	10 km	21 May – 31 Aug 2001-2009	103 days	9
	T1279	15 km	1 Nov – 30 Nov 1960-2007	13 months	48
	T511	39 km			
	T159	125 km			

	Resolution	Grid Size	Time Period	BC
C20C	T1279	15 km	1960-2007	Observed SST and Sea Ice
	T159	125 km		
Time-Slice	T1279	15 km	2070-2117	SST and sea ice increments from AR4 experiments
	T159	125 km		

Diurnal Cycle of Precipitation



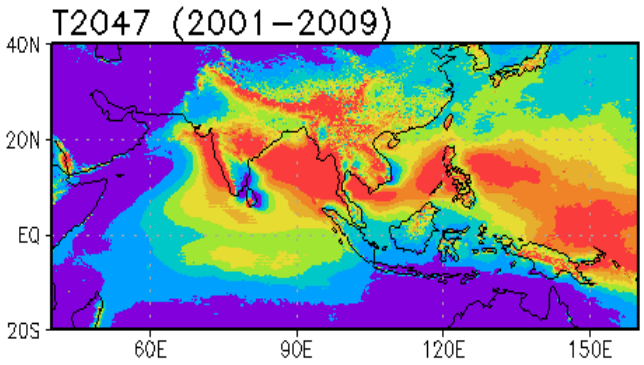
Courtesy of Paul Dirmeyer

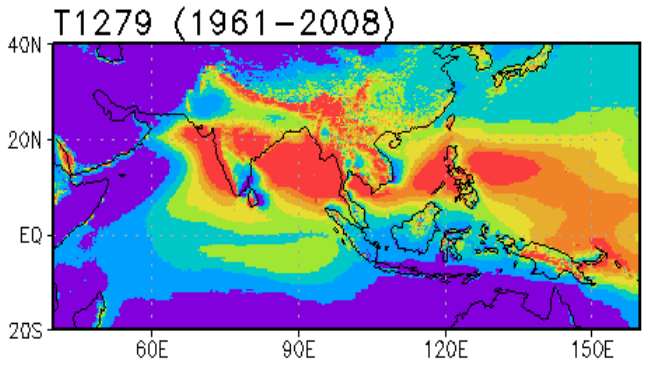
Climatology of JJA Precipitation

Starting from 21 May

Starting from 1 Nov

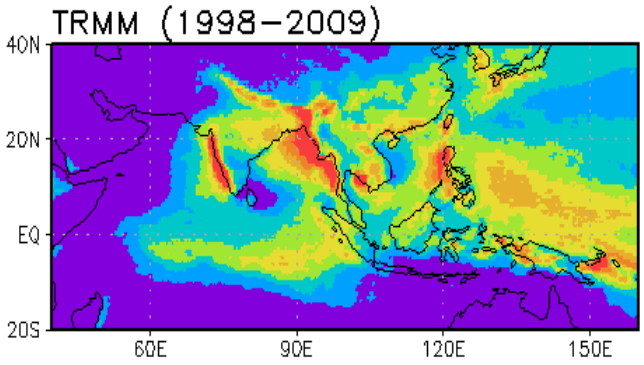
IFS T12047 10 km

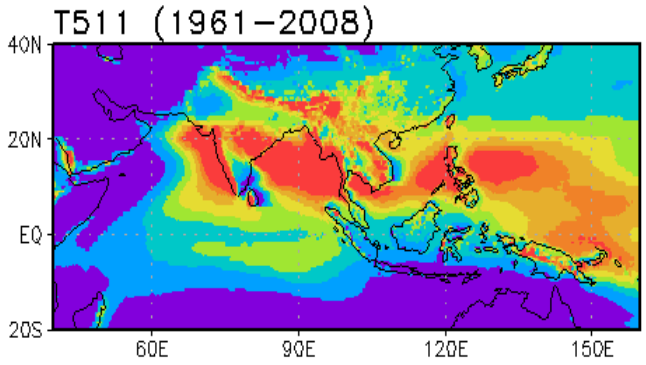




IFS T1279 15 km

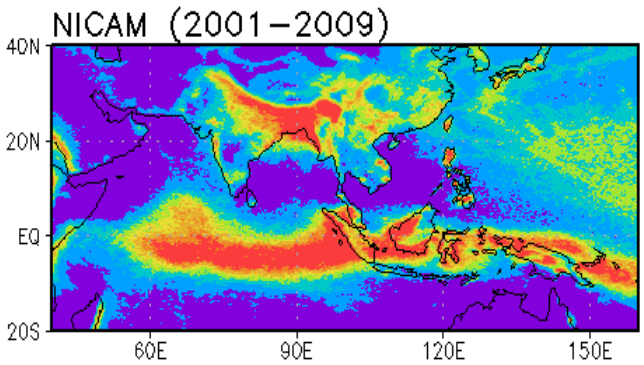
TRMM 25km

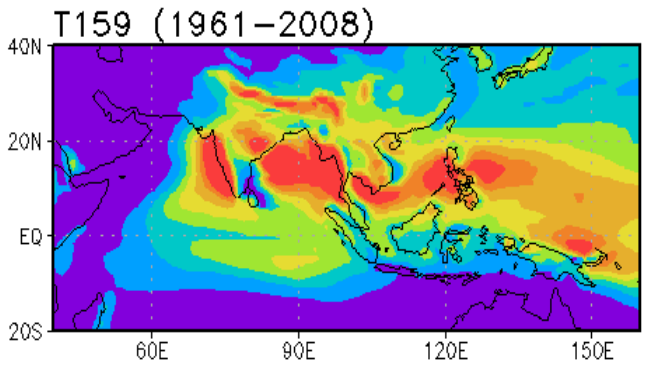




IFS T1511 39km

NICAM 7 km





IFS T1159 125 km

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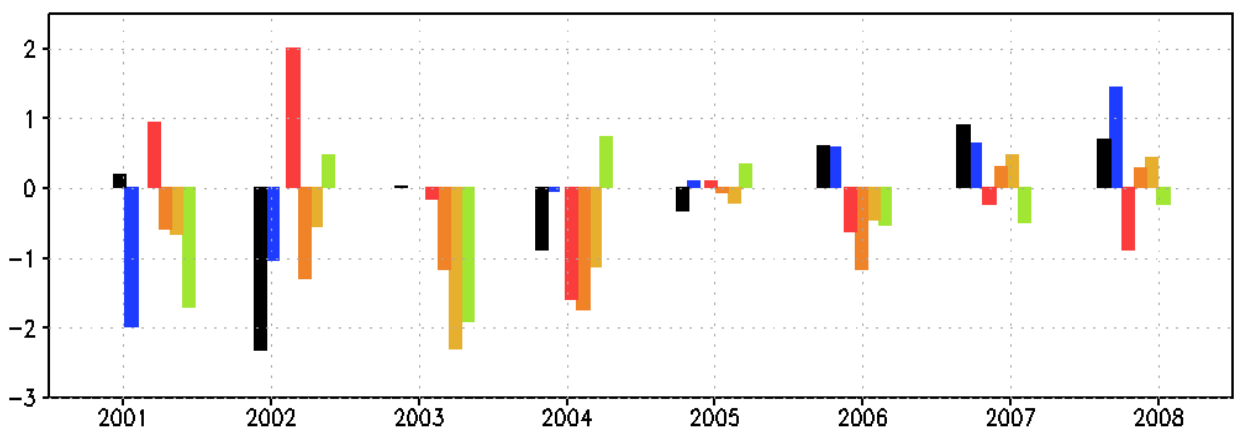
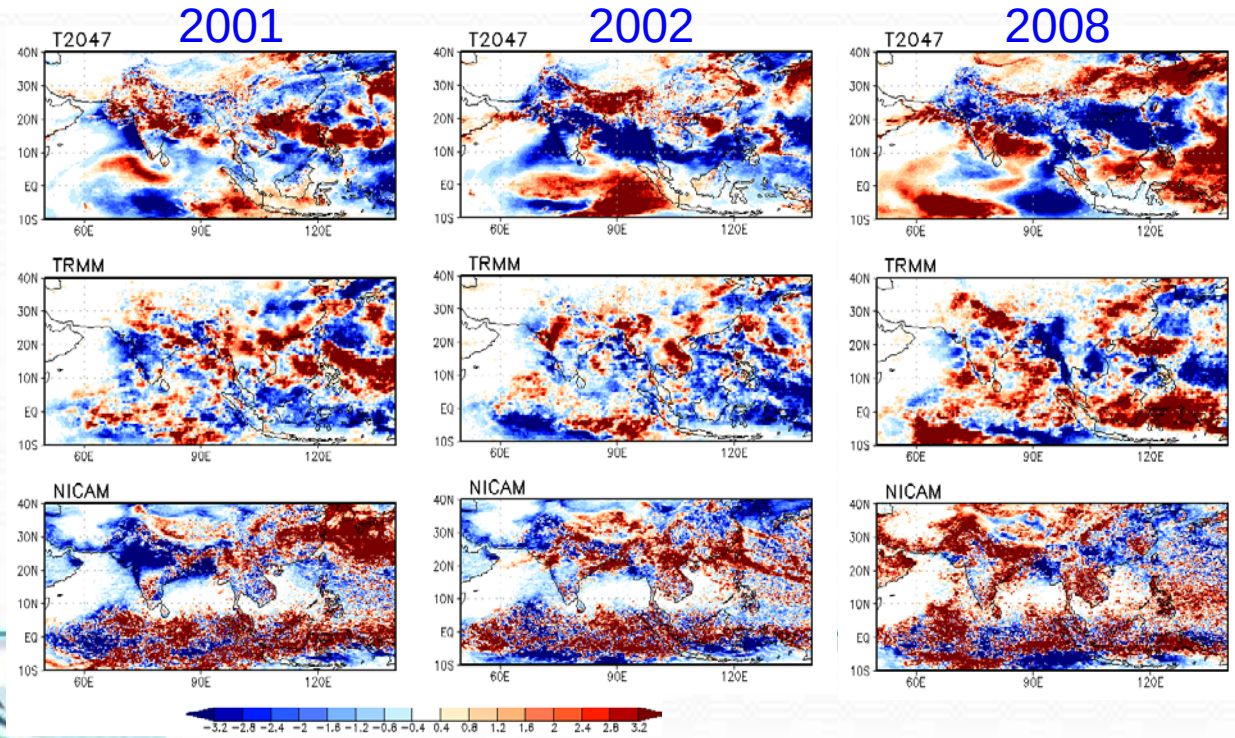
Seasonal Predictability

JJA Indian Monsoon Rainfall Index for 2001-2008



TRMM
NICAM
IFS T2047
IFS T1279
IFS T511
IFS T159



IFS 10 km

TRMM 25 km

NICAM 7 km

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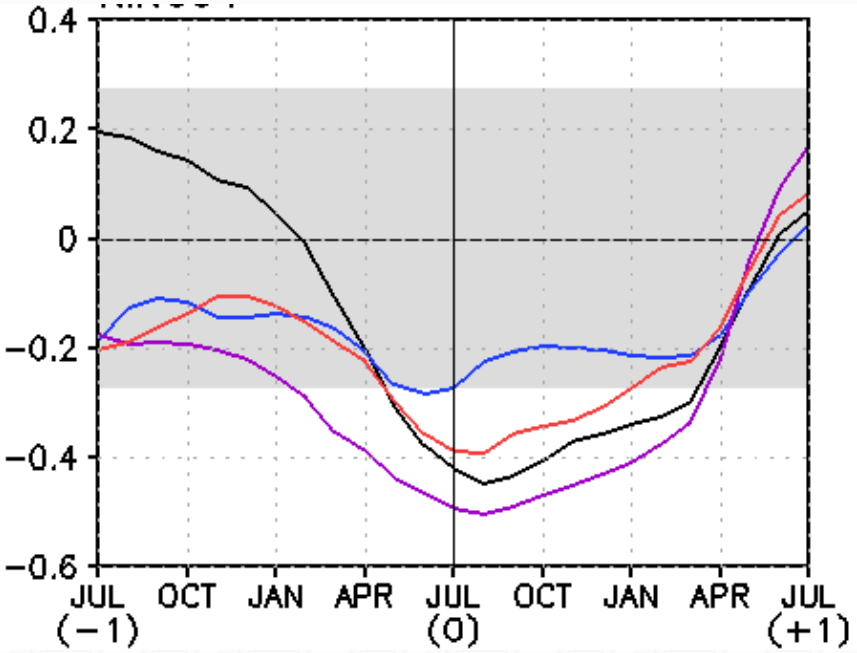
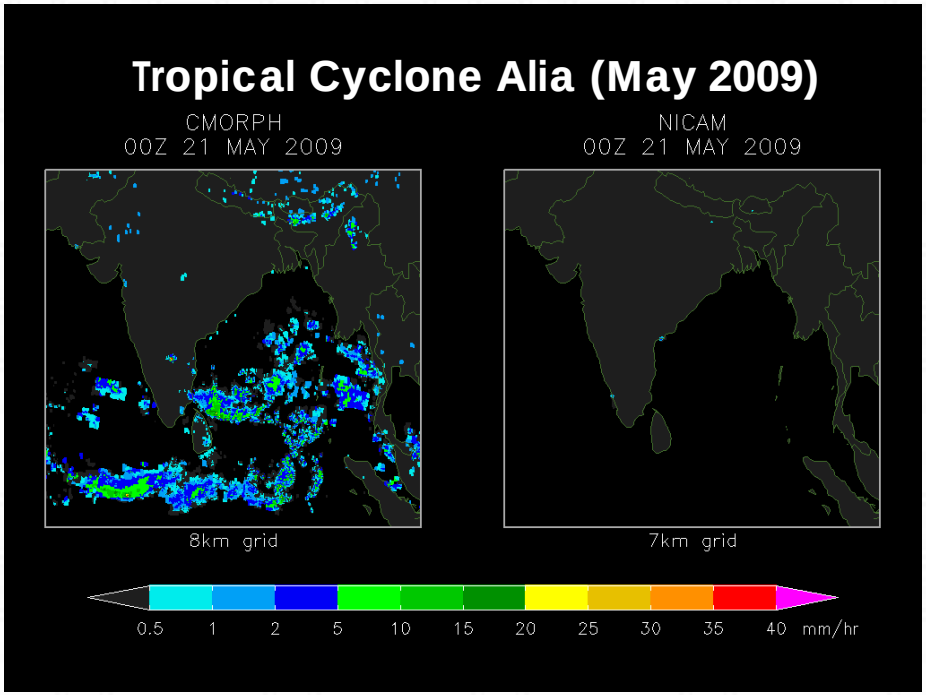
Seasonal Predictability

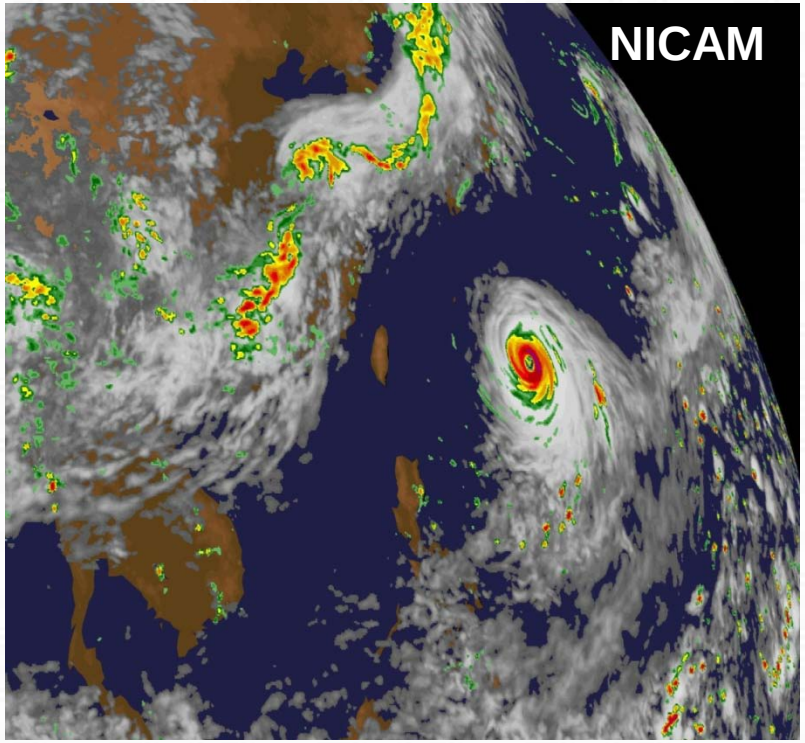
Indian Monsoon Rainfall index



Tropical Cyclone

Impact of Process-resolving





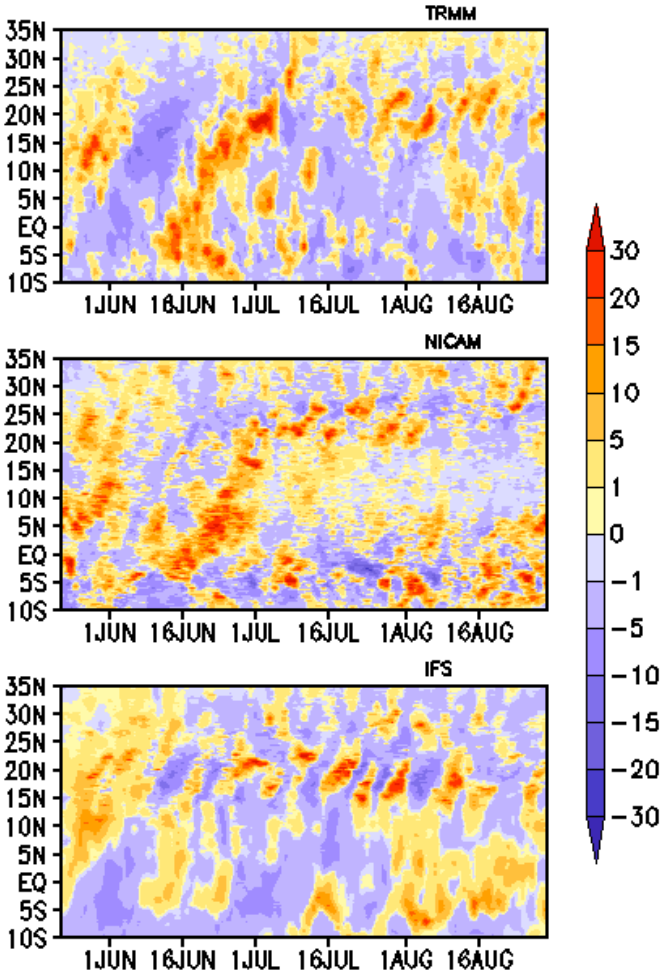
http://wxmaps.org/athena/home/mov/NICAM_p09.mov

Impact of Resolution

Julia Manganello: “The Role of Horizontal Resolution in Simulating Tropical Cyclone Activity with the ECMWF Integrated Forecast System“

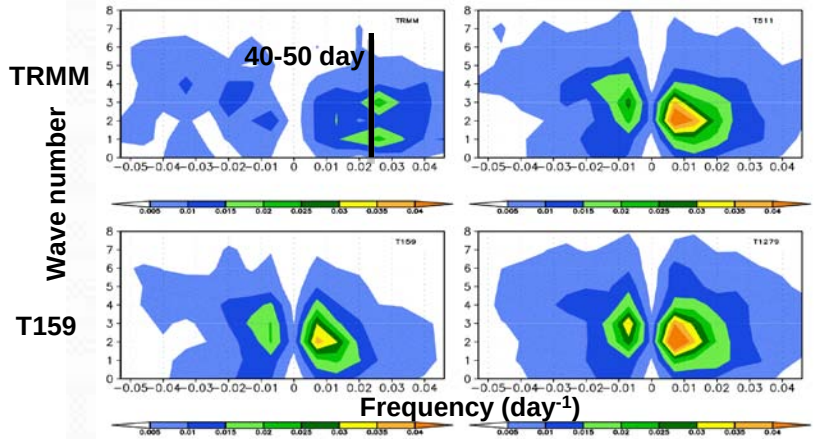
Intarseasonal Predictability

Time-latitude sections of daily precipitation anomalies averaged over 60°E-90°E

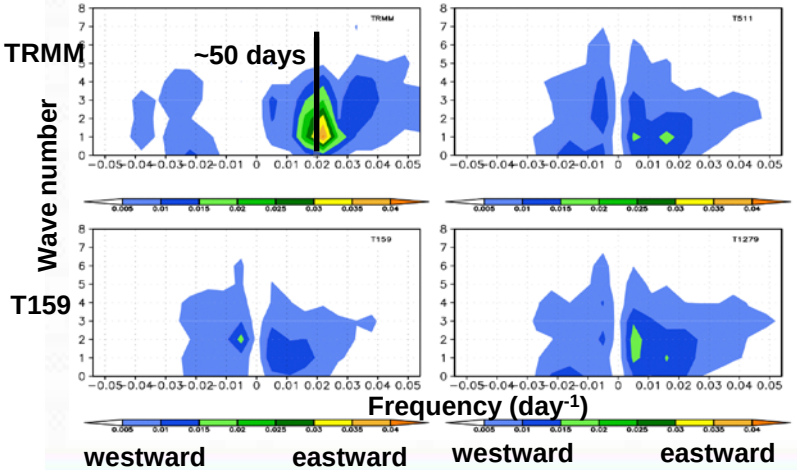


Spectra of 20-100 day filtered precipitation anomalies averaged between 10S-10N along the entire zonal belt

DJFMA

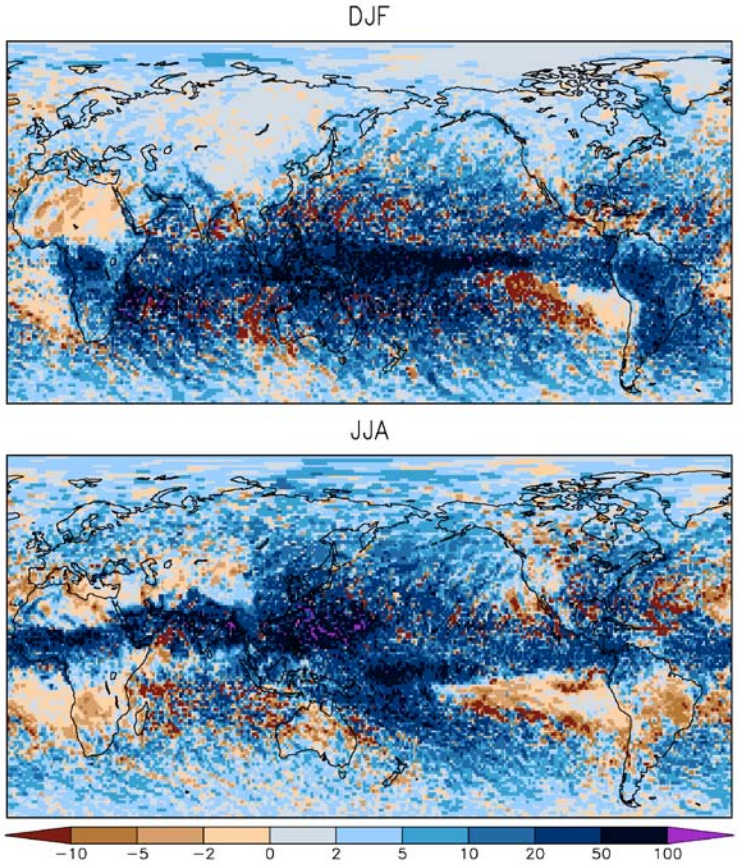


MJJASO



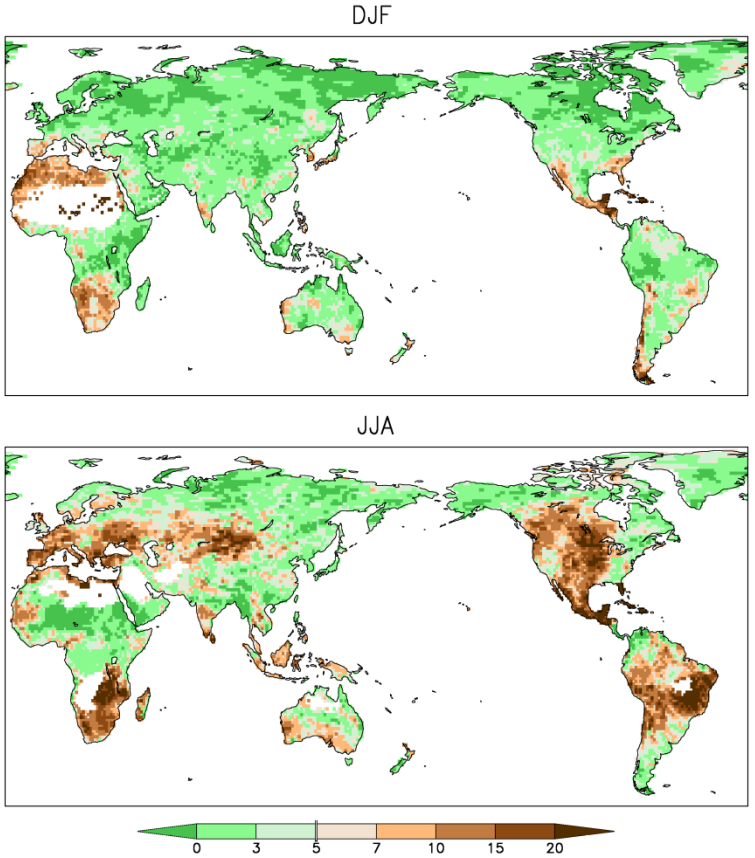
Future Projection of Extreme Events

Flash Flood



Change (21C minus 20C) in the mean precipitation during the five wettest 6-3 hour intervals. Units are mm.

Drought



The number of years, out of 47, when the seasonal precipitation over land from the 21C simulation is less than the fifth lowest total from the 20C simulation

Courtesy of Paul Dirmeyer

Summary (1)

Some improvements due to increased resolution:

- **Euro-Atlantic blocking (**between 125-km and 39-km**)**
- **Synoptic activity in the extratropics**
- **Tropical cyclones**
- **ENSO-monsoon coupling (**between 125-km and 39-km**)**
- **Atlantic air-sea coupling (**between 125-km and 39-km**)**
- **Improvements mostly by increasing resolution from T159 to T511**
- **Some of this skill due to ENSO teleconnections**
- **Important implications for climate change**

Some improvements due to cloud process resolving:

- **Indian monsoon rainfall over continent**
- **Diurnal cycle over continent**

Mostly neutral with some key-errors being unchanged:

- **MJO**
- **Indian Summer Monsoon**

Summary (2)

Dedicated Computing

• Dedicated computational resources can substantially accelerate progress in climate simulation and prediction.

• The overall architecture of HEC center may be quite different considering the number of users projects that gain access to the resources in dedicated mode for substantial contiguous periods of time.

Observations

• Validation of model output at hourly intervals on sub-20-km global grids represents a significant challenge for the current observational network.

• Neither observing system component provides adequate coverage over high or complex topography, where rain rates are frequently high and gradients are sharp.

Data Sharing

• Selected model outputs: http://wxmaps.org/athena/home/index.html

• Enabling free and open access to the model output of the simulations considering the volume of data 0.5PB (1.2×10^{15} bytes) and format

THANK YOU!

ANY QUESTIONS?