INTRASEASONAL TO SEASONAL PREDICTABILITY OF MONSOON OF HIGH-RESOLUTION MODELS IN PROJECT ATHENA

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OVERVIEW: PROJECT ATHENA

The Project Athena collaboration brought together an international team of over 30 people from six institutions on three continents, including climate and weather scientists and modelers, and experts in high-end computing (HEC), to demonstrate the feasibility of using dedicated HEC resources to rapidly accelerate progress in addressing one of the most critical problems facing the global community, namely, global climate change. The scientific basis for undertaking this project was established in the World Modeling Summit, held in May 2008 in Reading, UK, where there was a call for a revolution in seamless weather and climate modeling.

State-of-the-art high-resolution numerical weather prediction models has been ran on multi-year timescales to assess the impact of high resolution on systematic error. Convection-permitting atmospheric models capable of resolving cloud systems in the atmosphere has been used to evaluate the impact of resolving these processes on simulation of seasonal climate.

TWO HIGH RESOLUTION MODELS

Name	Model	Dynamics	Physics	Boundary Condition
NICAM	JAMSTEC Nonhydrostatic Icosahedral Atmospheric Model	Fully compressible non-hydrostatic system	Mass and total energy conservation, Cloud microphysics (Grabowski, 1998)	SST specified & slab ocean
ECMWF IFS	ECMWF Integrated Forecast System	Spectral model	Hydrostatic, Mass flux convection scheme	SST specified

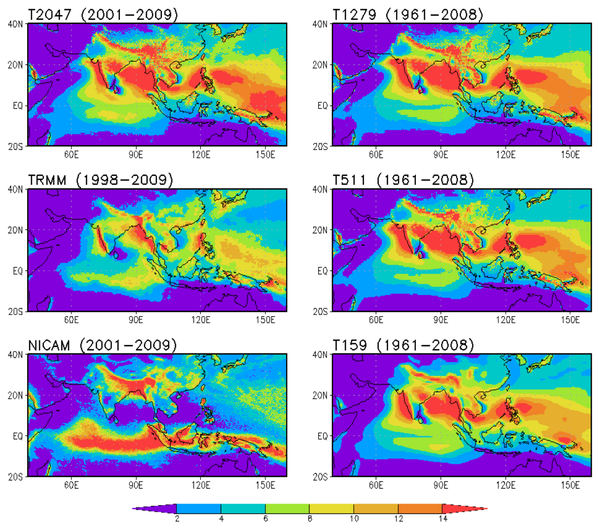
COMPUTATIONAL RESOURCE

ATHENA	Cray XT4	166 TeraFlops 4512 quad-core Opteron nodes (18048)	#30 on Top500 list (November 2009)	Dedicated Oct'09 – Mar'10
KRAKEN	Cray XT5	1.03 PetaFlops 8256 dual hex-core Opteron nodes (99072)	#3 on Top500 list (November 2009)	allocation of 5M SUs

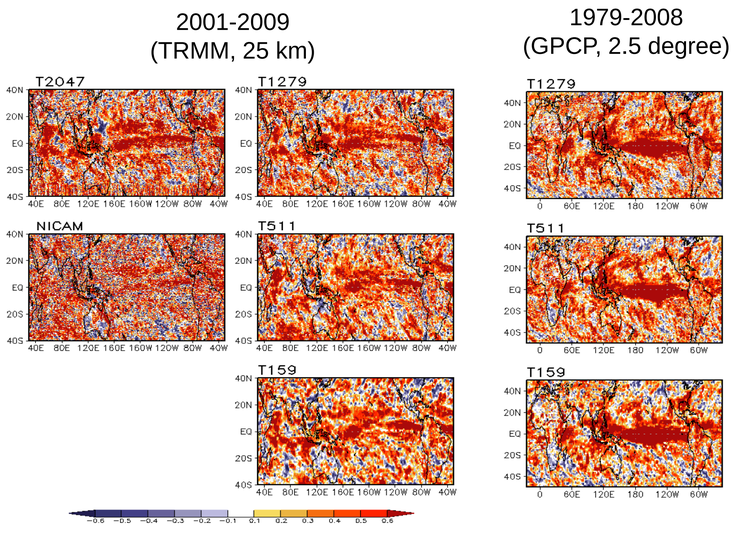
EXPERIMENTAL DESIGN

	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			

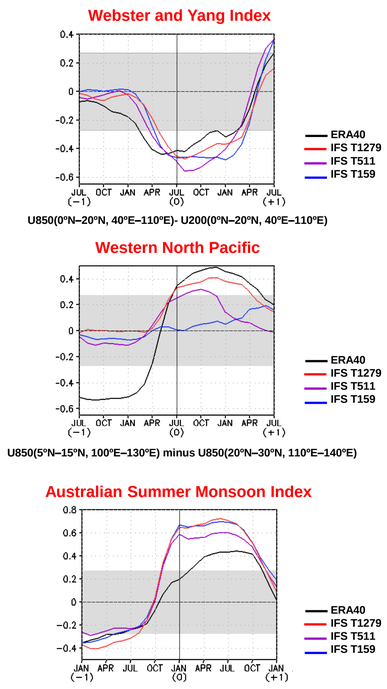
PREDICTABILITY OF SEAONSAL MEAN MONSOON



Climatology of June-July-August precipitation.



Temporal correlation of JJA precipitation anomalies.

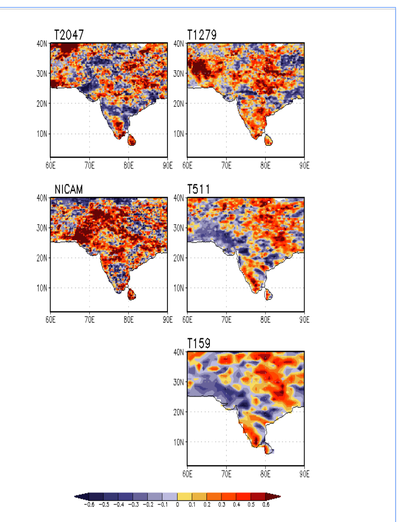


- Lead-lag correlation between observed NINO34 SST and JJA monsoon indices during 1961-2008 in IFS.
- Even though the impact of resolution on the forecast skill is not evident, it shows the gap of predictability of seasonal mean ENSO response between T511 and T159, which is consistent with other results of IFS.

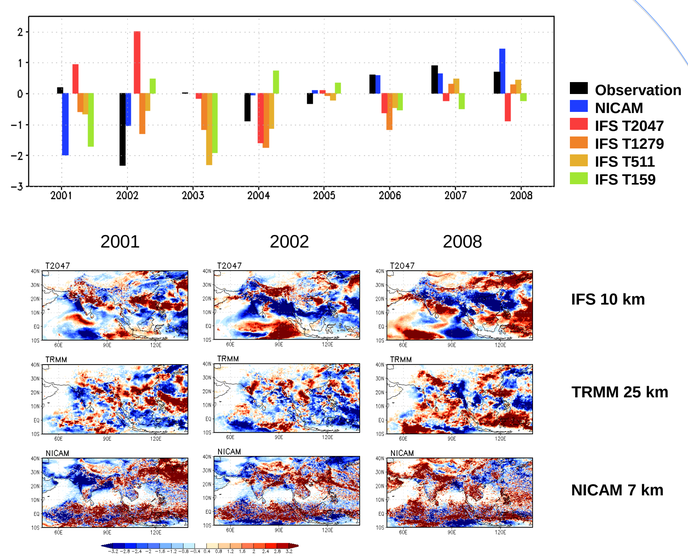
Anomaly Correlation Coeff. (1961-2008)

	WY	WNPMI	ASM
T159	0.37	0.31	0.23
T511	0.38	0.18	0.16
T1279	0.29	0.13	0.32

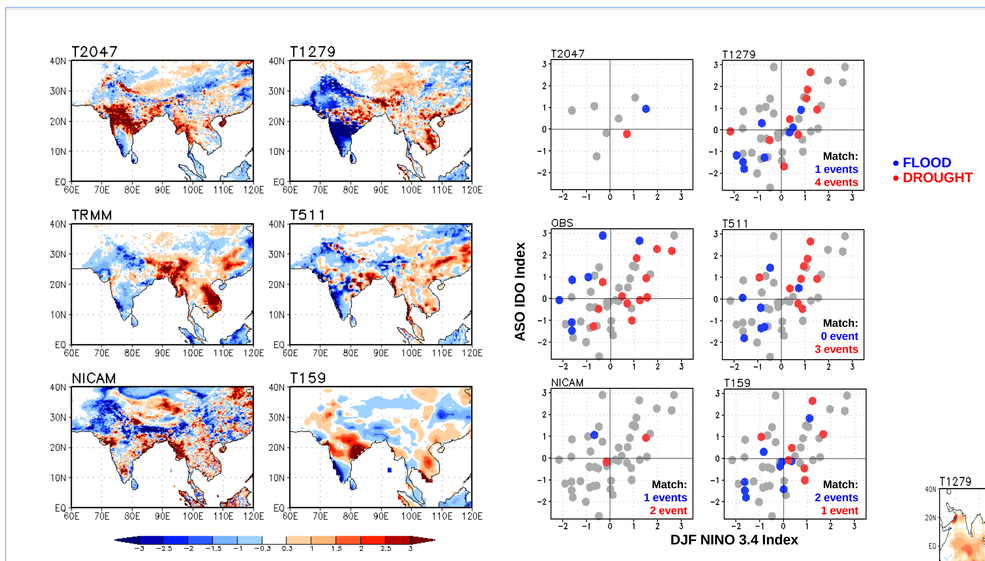
PREDICTABILITY OF INDIAN SUMMER MONSOON RAINFALL



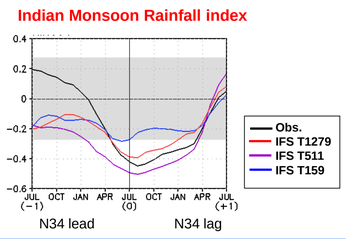
Temporal correlation with TRMM observation of JJA precipitation anomalies.

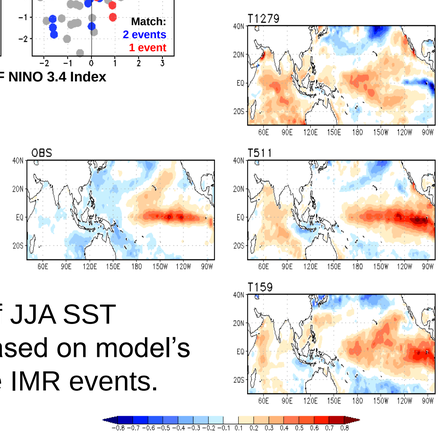


JJA Indian monsoon rainfall index for 2001-2008.

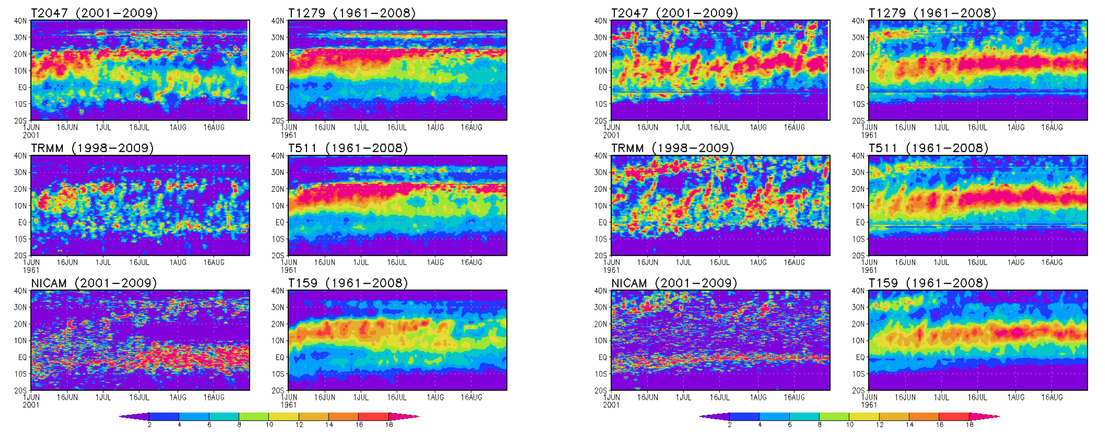


Composite of negative IMR JJA precipitation anomalies (65, 66, 68, 72, 74, 79, 82, 85, 86, 87, 02, 04 cases)





Composite of JJA SST anomalies based on model's own negative IMR events.



Time-latitude cross section of daily climatology of precipitation

SUMMARY

- NICAM (cloud-system-resolving model) outperforms the ECMWF IFS (parameterizing convection model) to simulate the Indian monsoon rainfall.
- The increase of horizontal resolution generally improves the forecast skill of Indian monsoon rainfall. While, the linear relationship is not clear between resolution and monsoon forecast skill in other monsoon regions - the western North Pacific monsoon, Australian monsoon, East Asian monsoon regions, etc.
- Even though there is no evident improvement of mean state and anomalies with respect to the increase of horizontal resolution, the ENSO-monsoon relationship shows moderate improvement in higher resolution more than 125km.
- The monsoon simulated with prescribed SST tends to exaggerate the impact of ENSO.
- The spatial (orographic features) and temporal characteristics of subseasonal variability of monsoon rainfall shows more realistic representation in higher resolution.

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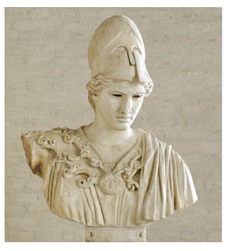

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