TROPICAL INTRASEASONAL VARIABILITY IN HIGH-RESOLUTION CLIMATE SIMULATIONS

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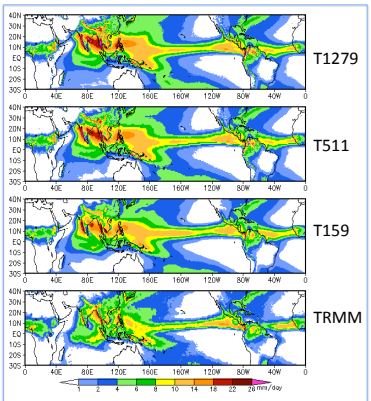
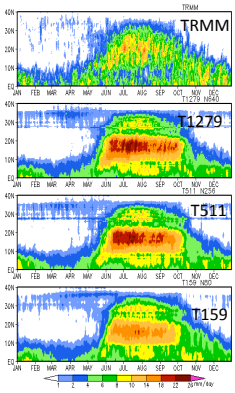
OBJECTIVE

An assessment of the capability of the current high-resolution general circulation models (GCM) in simulating the summer monsoon intraseasonal oscillation (ISO) is presented using the outputs from the European center for Medium-range Weather Forecasts' **Integrated Forecasting System (IFS)**. The IFS is a stand-alone atmospheric GCM with parameterized convection and observed sea surface temperature as boundary forcing. The **impact of mere increase in horizontal resolution on intraseasonal variability** is assessed by examining a series of hindcasts of the IFS of spectral resolutions (approximate latitude-longitude grid resolutions in brackets) **T159 (~1.125°), T511 (~0.351°), T1279 (~0.141°) and T2047 (~0.088°)**. Each case except T2047 consists of **48 13-month long integrations starting from 1st November** of each year for the period 1960-2007. The **T2047 runs (summer hindcasts)** are performed in a similar manner, but for 9 years (2001-2009). They are shorter integrations starting from May 21st of each year and ending in 31st August. All model results are **evaluated against the observations** from the Tropical Rainfall Measuring Mission (**TRMM**).

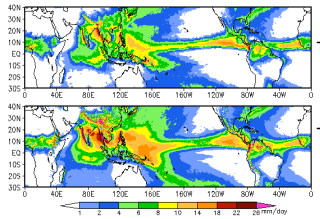
SUMMER MEAN STATE



June-September seasonal climatology of precipitation for 48 years (1961-2008) of IFS hindcasts and 12 years (1998-2009) of TRMM observations.



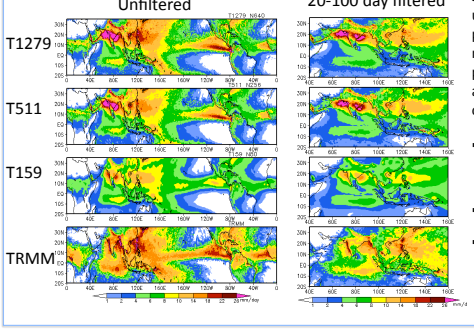
Annual cycle of precipitation: Daily climatology averaged over 70E-90E.



June-August seasonal climatology of precipitation for 9 summer hindcasts of IFS T2047 (2001-2009) and TRMM observations (1998-2009).

- No dramatic improvement in climatology with resolution.
- Increase in rainfall with the horizontal resolution.
- Overestimation of rainfall exists in summer hindcasts of T2047 despite May initialization.
- No noticeable improvement in T1279 compared to T511.
- Increased rainfall over the foothills of Himalaya. This is reflected in the annual cycle also.
- Annual cycle: Heavy rainfall between 20N-10N. No northward progression of monsoon from 10N to 30N.

INTRASEASONAL VARIABILITY

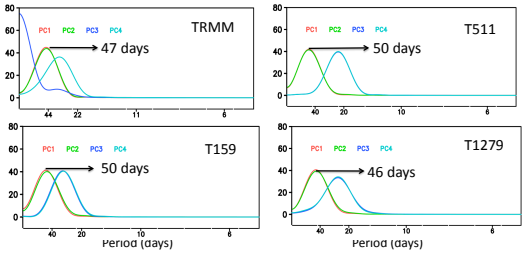


Standard deviation of daily unfiltered and 20-100 day filtered precipitation anomalies during the months June-September for the period 1961-2008 for model runs and 1998-2009 for TRMM observations.

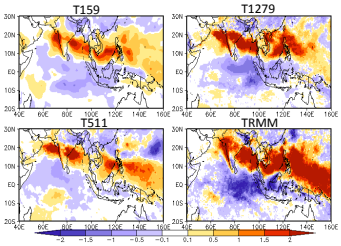
- Improvement is seen over East Pacific, Atlantic, parts of North America (see unfiltered), West Pacific and equatorial Indian Ocean.
- Considerable overestimation over Indian monsoon region.
- Location of maximum variability in Bay of Bengal is shifted from 90E (observations) to 70E (model). Increased resolution does not correct this.

SUMMER INTRASEASONAL MODE

- Northeastward propagating summer monsoon intraseasonal mode is isolated using the multi-channel singular spectrum analysis (MSSA) which is similar to the extended empirical orthogonal function analysis (EEOF)
- MSSA applied over 20-100 day filtered daily precipitation anomalies for the months May through October (1998-2008) in the model. Similar analysis on the same period using TRMM data; but unfiltered anomalies were used in that case.
- Lag window is 85 days.



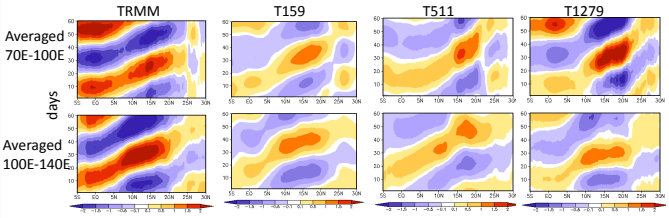
Power spectra of the first four MSSA modes in IFS hindcasts and TRMM observations. First two modes form the summer intraseasonal oscillation in all cases.



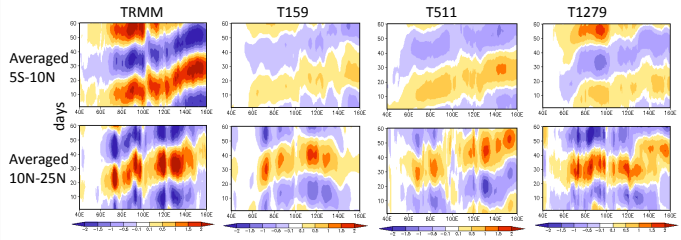
Spatial pattern of the intraseasonal mode

- EEOF maps representing one phase of the oscillation.
- Out of the 85 EEOF maps obtained for a mode, one single map is chosen when the anomalies at the grid point 70E, 20N has maximum amplitude.
- Values are in standard deviation units; do not represent real amplitude.
- T511 and T1279 show better correspondence with observations.

Northward propagation (60 maps of the first EEOF mode averaged over 70E-100E and 100E-140E)



Eastward propagation (60 maps of the first EEOF mode averaged over 5S-10N and 10N-25N)



SUMMARY

- Increase in horizontal produces large amount of rainfall in the IFS model which is unrealistic. There is no noticeable improvement in mean state with increased resolution. Model biases that existed in the lower resolution remained in the higher resolution.
- From a first examination, intraseasonal variability is improved in the higher resolutions. However, over India, the variability is overestimated.
- No clean intraseasonal oscillatory signal was obtained in the unfiltered daily data, as opposed to TRMM observations. MSSA on 20-100 day filtered rainfall anomalies yields the summer ISO in the case of the model runs.
- Spatial structure of the ISO mode in T511 and T1279 are more comparable to observation.
- There is some improvement in northward propagation over India and eastward propagation in the equatorial region in T1279.
- Similar analysis during the winter season did not yield a clear Madden Julian Oscillation (MJO) signal.

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