Dynamical Model Seasonal Prediction of Summer Monsoon Rainfall: Successes and Challenges

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acknowledge

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Open Science Conference 2011
Outline

Review capability to predict seasonal summer monsoon rainfall using dynamical coupled models

focus on **1 month lead** seasonal prediction, as typically issued operationally
e.g. initialized on 1 May for June-Aug season

Hindcasts from variety of coupled model forecast systems

ENSEMBLES (6 models), BoM POAMA, operational models (CFSv1/2, EC Sys3, SINTEX-F)
All systems are ensemble-based (typically 9 members, 30 members for POAMA2)
All but SINTEX-F initialized with observed ocean/atmos states.
All have comparable ocean resolution (~150km x 50km)
Atmospheric resolution varies greatly (POAMA T47/L17 - EC Sys T159/L64)
Hindcasts initialized on 1st each month (except CFS, which is lagged)
Outline


Mean model bias removed, otherwise uncalibrated
Verification with CMAP/GPCC 2.5 deg rainfall and Reynolds OI 2 SST
Results for individual models and Multi Model Ensemble mean (MME)

Summary of results

• Low skill for monsoon rainfall (except Amazon Basin)
• Reflects intrinsically low predictability (except where ENSO-signal is strong)
• Systematic model errors (ENSO-teleconnections) imply full potential has yet to be reached
LT 1 Multimodel Ensemble Mean Seasonal Forecast (ENSEMBLES)
Rainfall correlation using 45-member multi-model ensemble mean 1980-2005

Analyses from http://www.ecmwf.int/research/EU_projects/ENSEMBLES
Monsoon-ENSO relationship

Correlation
Precip vs Nino34 1982-2010 DJF

Gridded rainfall from Liebmann and Allured (2006)

GPCC vs Nino34 1902-2009 JJA
High pass filtered (first difference)

SST vs All-India rainfall

KNMI Climate Explorer
SST vs *Australian* rainfall (north of 25S) 1980-2008

**SON Transition Season**

**DJF Monsoon Season**

correlation

Hendon et al. 2011
LT 1 month JJA 1980-2005 ENSEMBLES

All-Indian Rainfall (correlation)

Compare to Rajeevan (et al 2011)

1960-2005

ENSEMBLES MME 0.45

DEMETER MME 0.28

IMD’s operational forecasts
(1988–2010) 0.29
Regression of ensemble mean rainfall onto standardized Nino34 LT1 forecasts
1980-2005
Despite good skill to predict El Niño, models systematically under-represent the teleconnection to the Indian Ocean.
Forecast N. Austr. Rainfall (correlation)
LT 1 mnth POAMA 1980-2008
Point-wise correlation CMAP rainfall and OI SST 1980-2008

SON

DJF
Lag-1 SST Correlation (obs)

JJA → SON

SON → DJF

Hendon et al. 2011
Correlation N. Austr Rainfall with local SST 1980-2008

Correlation N. Austr Rainfall with Nino34
Conclusions

• **Seasonal forecast skill for summer monsoon rainfall is low**
  Intrinsic limits: weak ENSO signal, local air-sea interaction, low variability, strong intraseasonal variability,……..

• **Numerous model biases suggest upper limit of prediction not reached**
  ENSO (SST pattern) and its teleconnections to land and ocean
  Mean rainfall bias over land and ocean >affects teleconnections
  Mean state bias impacts coupled variability

• **CLIVAR CHFP (an expanded ENSEMBLES)**
  understand monsoon predictability and prediction and highlight model errors
  success will be gauged by feedback to model development

• **Land surface interactions (aerosols)**
  basic understanding of role for monsoon variability/predictability
  fidelity of models
  initialization
extras
Predicting wet season onset: date of accumulation of 50mm after 1\textsuperscript{st} September

Drosdowsky and Wheeler 2012

Mean onset date from observations ranges from early Nov around Darwin/east coast to Dec inland

POAMA2 forecasts initialized on 1 September

Per cent correct for predicting onset date above/below median (50, 60, 70\%)
Correlation $V'$ and $u'$ and mean $V$ (vectors)

NCEP2 1980-2008

SON

DJF
Fig. 10
Correlation Nino3 with All-India Rainfall 1980-2005
LT 1 Forecasts

- Correlation in 21 year sliding window
- Rajeevan et al (2011) correlation based on ENSEMBLES MME

Individual members
Ensemble mean

1970 1994
Rajeevan et al. 2011
LT 1 month JJA 1980-2005 ENSEMBLES

Accuracy score for above/below median rainfall

Average score over all grids over India

58%
50%
42%