Long-range predictions of tropical rainfall with the ECMWF ensemble systems

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Operational forecasts

- ➤ 51-member ensemble from 1st day of the month
- ➤ released on the 8th
- 7-month integration

Experimental ENSO outlook

- 13-month extension from 1st Feb/May/Aug/Nov
- > 15-member ensemble

Re-forecast set

- ➢ 30 years, start dates from 1 Jan 1981 to 1 Dec 2010
- > 15-member ensembles, 7-month integrations
- 13-month extension from 1st Feb/May/Aug/Nov



Bias in S4 re-forecasts: SST (DJF)

Start: 1 Nov. 1981/2010 Verify: Dec-Feb

System 4

Sea Surface temperature

Hindcast period 1981-2010 with start in November average over months 2 to 4





-24 -2 -18 -1.2 -08 -04 04 08 12 18 2 24 6



System 3



SST scores: Nino 3.4 and Eq. Atlantic





Predictability of teleconnections in Sys4: Nino3.4, IOD SST



Bias in S4 re-forecasts: rainfall (JJA)

Start: 1 May 1981/2010 Verify: Jun-Aug

System 4



Hindcast period 1981-2008 with start in May average over months 2 to 4









System 3

Ens-mean ACC in S4 re-forecasts: rainfall (JJA)

Start: 1 May 1981/2010 Verify: Jun-Aug

System 4

Precipitation

Hindcast period 1981-2008 with start in May average over months 2 to 4 Black dots for values significantly different from zero with 95% confidence (1000 samples)





System 3

Predictability of tropical rainfall in Sys4: Sahel (JJA)





Predictability of tropical rainfall in Sys4: East Africa (SON)





Predictability of tropical rainfall in Sys4: South Africa (DJF)





All India Rainfall: S4 fc. for June and July from 1 May I.C.



All India Rainfall: S4 fc. for August & JJA from 1 May I.C.



All India Rainfall: S4 fc. for JJ & JA from 1 May I.C.



ECMWF

- Comparison of model EOF patterns vs. 1st EOF of GPCP 2.1
- Prediction of the interannual variability of PC1 using 1-to-3-dim. model EOF subspaces
- Comparison of actual vs. perfect-model correlation skill for PC1

Region	Acronym	Spatial domain	Seasonal domain	
Central and North America	CNAM	130-55W, 10-55N	Jun-Jul-Aug	
Tropical South America	TSAM	80-35W, 30S-10N	Sep-Oct-Nov	
West Africa	WAF	20W-25E, 0-25N	Jun-Jul-Aug	
Central and Southern Africa	CSAF	10-42E, 35S-5N	Dec-Jan-Feb	
Europe	EUR	15W-45E, 30-75N	Jun-Jul-Aug	
South and SouthEast Asia	SEAS	60-110E, 5-30N	Jun-Jul-Aug	
East Asia	EAS	100-160W, 10-55N	Jun-Jul-Aug	
Maritime Continents	MCON	95-155E, 20S-10N	Dec-Jan-Feb	





GPCP EOF 1

Sys3 EOF 1, 2

Sys4 EOF 1, 2







GPCP EOF 1

Sys3 EOF 1, 2 Sys4 EOF 1, 2







GPCP EOF 1













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Space and time correlations for rainfall EOF1/PC1

	Sys3	Sys4	Sys3	Sys4
Central and North America	88	85	74	74
Tropical South America	26	67	73 (2)	69 <i>(2)</i>
West Africa	33	71	54 <i>(3)</i>	61 (3)
Central and South Africa	69	80	69	70
Europe	84	92	19	17
South and SouthEast Asia	57	5	31 <i>(2)</i>	58
East Asia	81	85	68	52
Maritime Continents	85	87	85	87



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CMWF



- Model biases in System 4 (vs S3): much reduced extra-tropical biases, too strong trade winds and cold SST bias in the equatorial Pacific. ENSO SST variability is over-estimated.
- **SST forecast skill**: similar to S3 in the NINO regions (better in NINO3, slightly worse in NINO4), increased in the tropical and sub-trop. Atlantic.
- **Tropical atmospheric variability:** more realistic patterns of rainfall variability, better simulation of MJO and interannual/decadal variations in tropical cyclone frequency.
- Reliability: the enhanced internal variability and better match between spread and error lead to more reliable seasonal forecasts w.r.t. S3 in both tropical and extra-tropical regions.
- **Regional aspects:** improved predictive skill across Africa and South America; prediction of Indian monsoon rainfall suffers from too strong activity in May/June and reduced connection with ENSO in July/August

