

A Comprehensive Assessment of CFS Seasonal Forecast over the Tropics

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(Presented by Ken Sperber)

Objective

Develop Dynamical Seasonal Rainfall
Prediction System for the
United States Affiliated Pacific Islands

❑ For the USAPI, Operational Seasonal Prediction is based on empirical methods
(He and Barnston 1996)

❑ In a coupled model a successful prediction of ENSO-related SST and precipitation anomalies over the tropical Indo-Pacific basins is expected to have predictive skill for USAPI rainfall and circulation anomalies

Ropelewski and Halpert 1989
Kumar and Hoerling 1996
Su and Neelin 2002
Annamalai et al. 2005
Annamalai et al. 2007

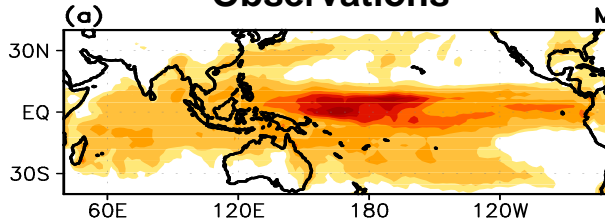
□ Evaluate NCEP Climate Forecast System (CFS) 15 member ensemble

hindcasts for the period 1981-2005. [9-month hindcast for all initial conditions]

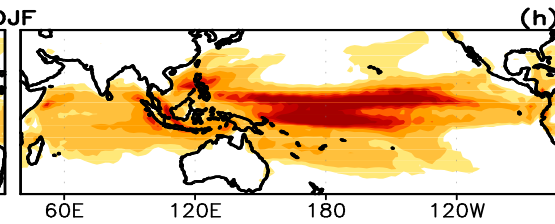
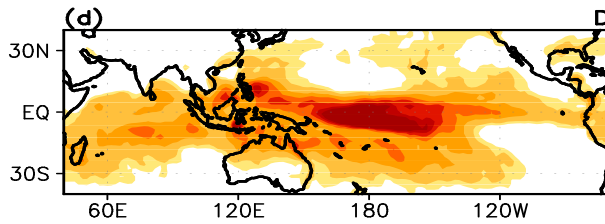
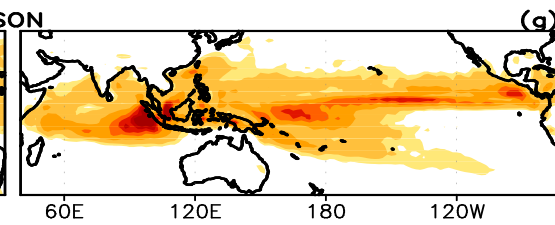
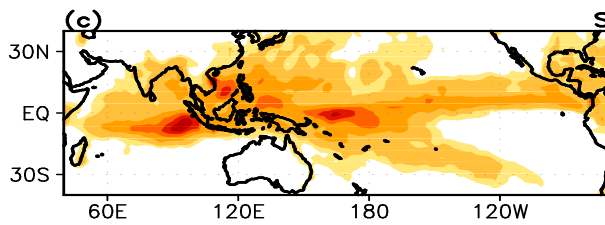
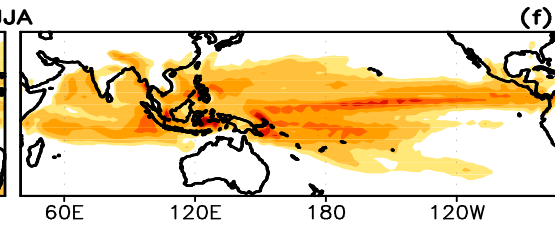
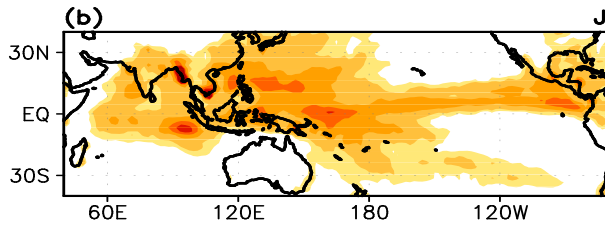
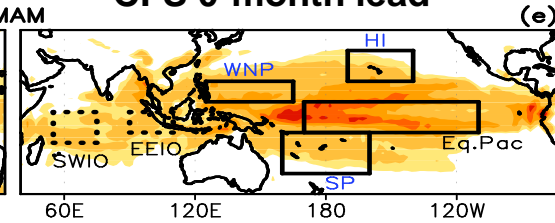
□ Assess the skill from deterministic (**anomaly correlation**), categorical (**Heidke skill score, HSS**) and probabilistic (**rank probability skill score, RPSS**) perspectives.

Precipitation variance for four standard seasons

Observations



CFS 0-month lead



south west Indian Ocean
(15°S-0, 55-75°E; SWIO)

eastern equatorial Indian
Ocean (10°S-0, 90-110°E;
EEIO)

western north Pacific (5-
15°N, 125-155°E; WNP)

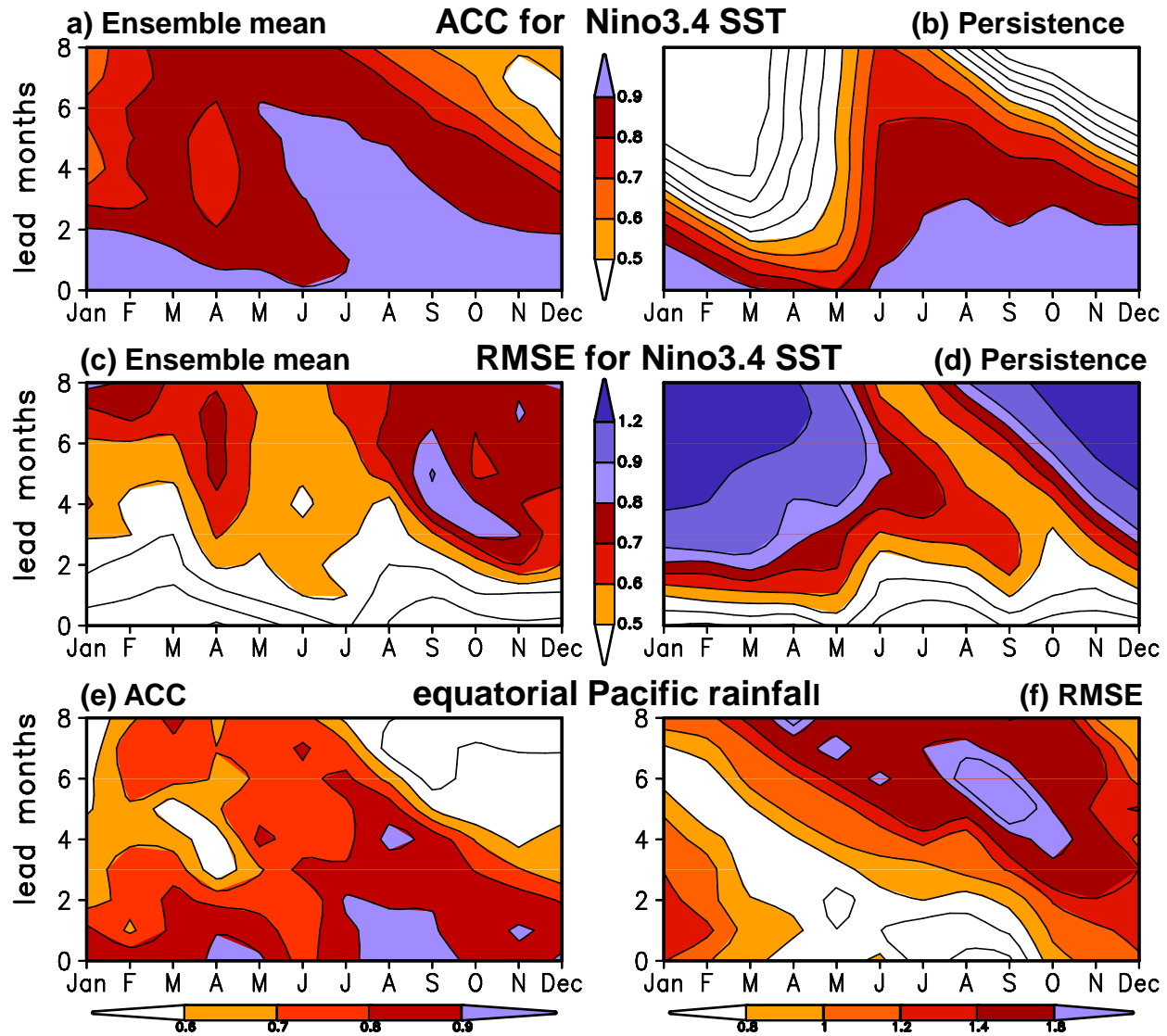
south Pacific (10-30°S,
160-200°E; SP)

Hawaii (15-30°N, 140-
170°W; HI)

equatorial Pacific (10°S-5°N,
170°E-110°W; Eq. Pac)

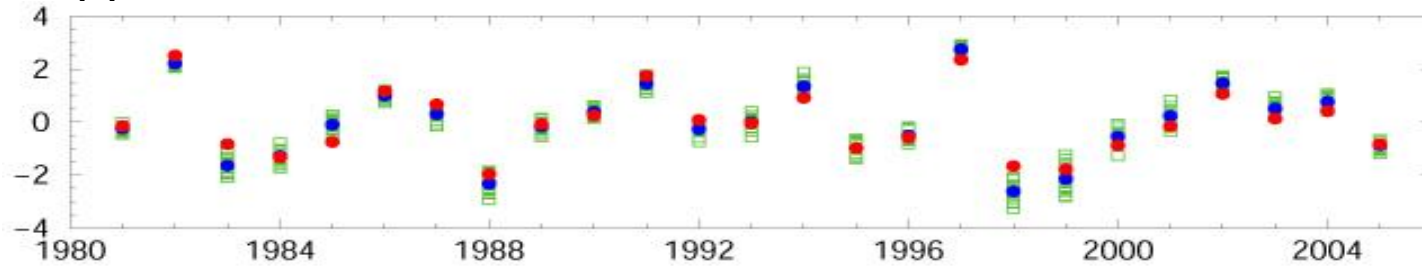
❖ **CFS captures the observed seasonal dependency in regional precipitation variance maxima over the tropics, with some systematic errors.**

ACC and RMSE

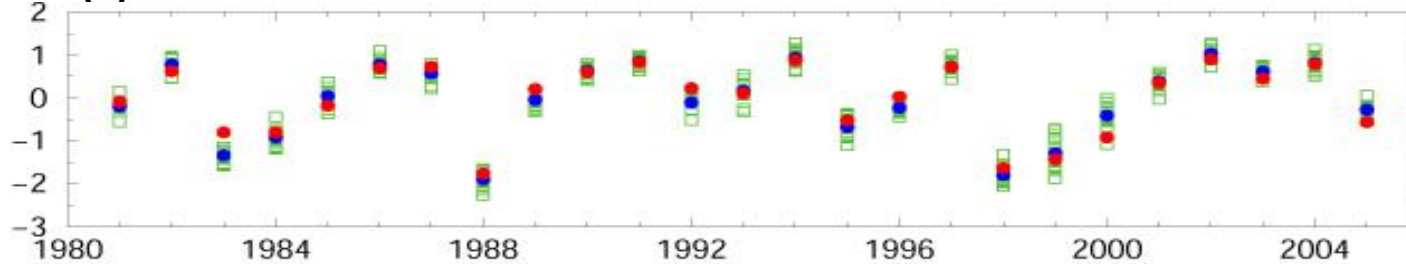


Hindcast of boreal winter (DJF) SST/precipitation at lead 0-month.

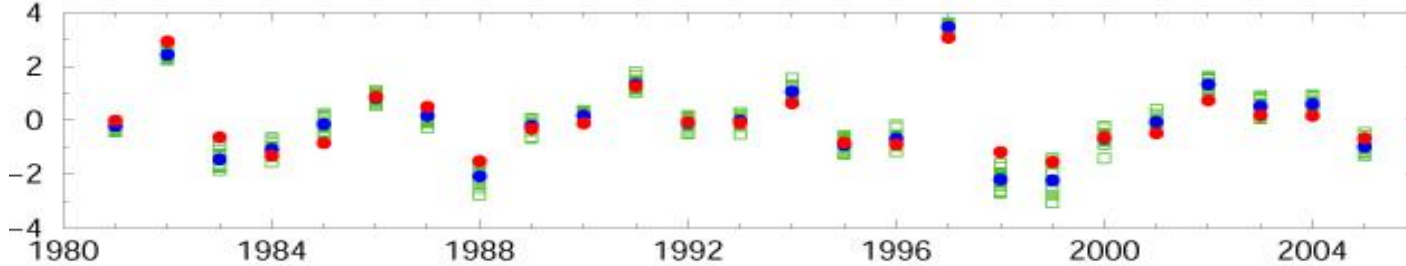
(a) Nino3.4 SST



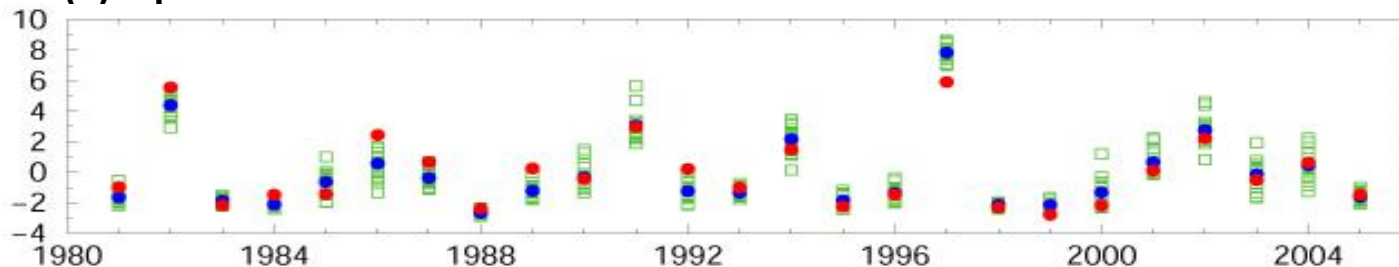
(b) Warm Pool El Niño SST



(c) Cold Tongue El Niño SST

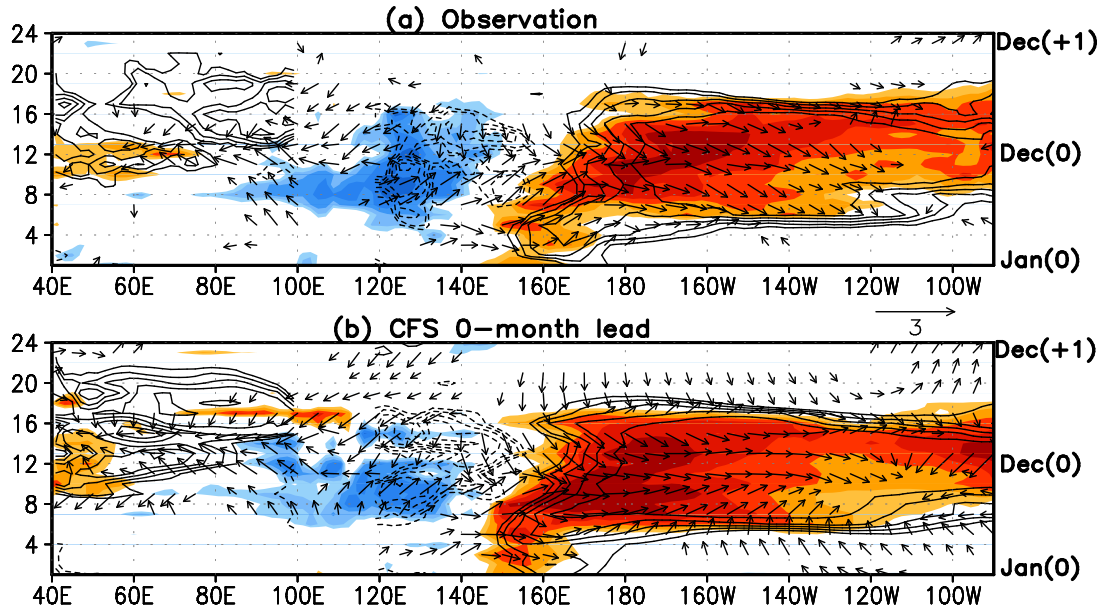


(d) Equatorial Pacific rainfall

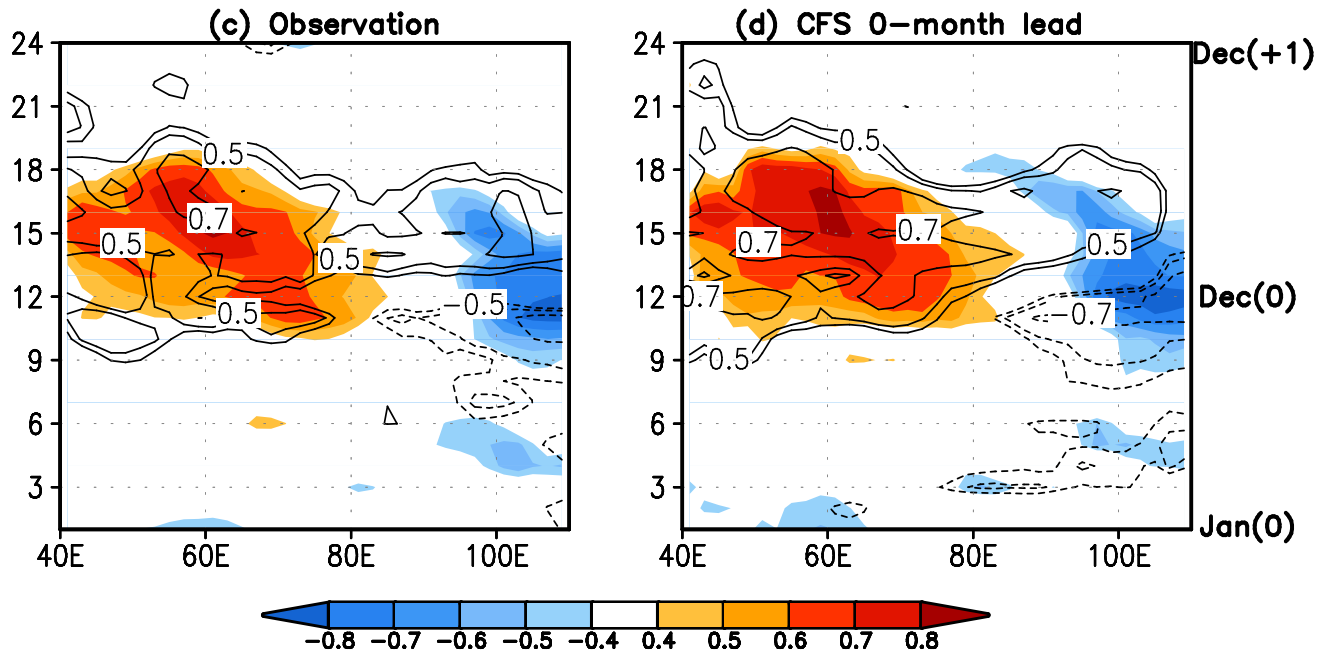


□ Individual member
● Ensemble mean
● Observations

Teleconnection between the tropical Pacific and Indian Oceans

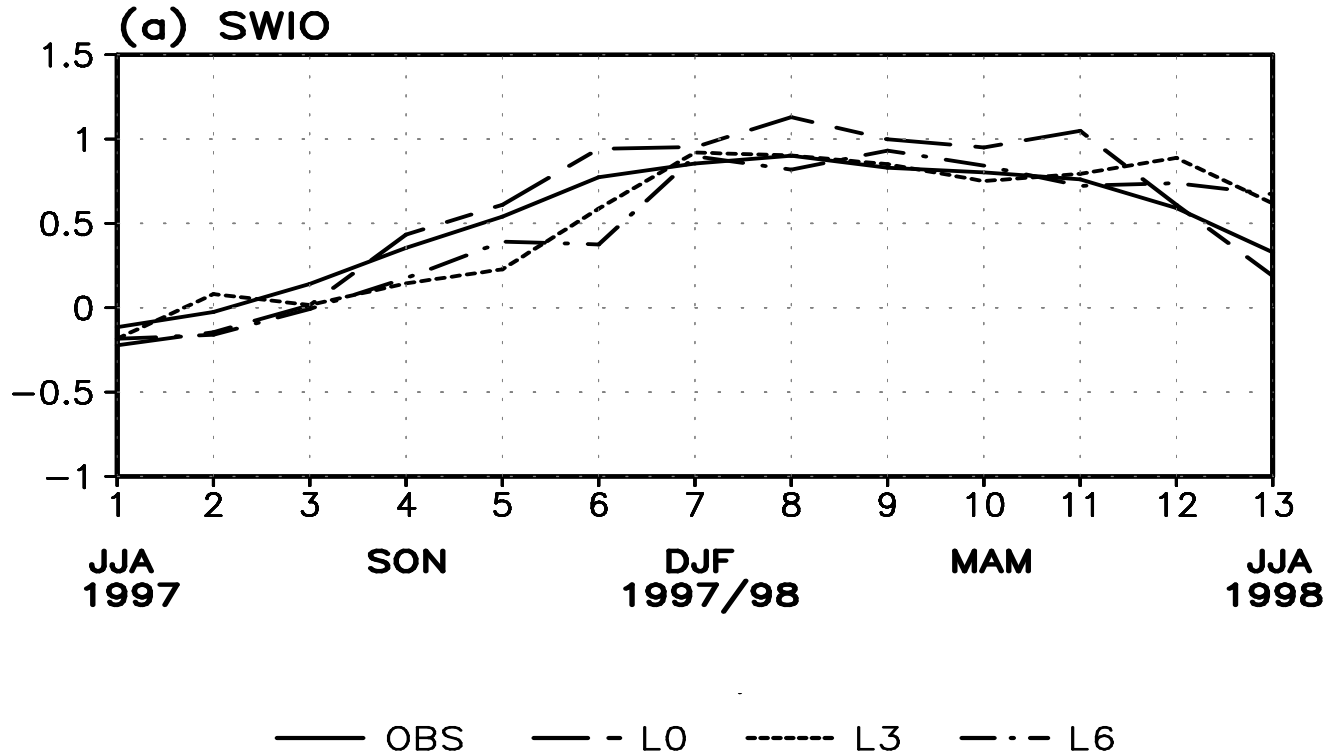


Lagged correlations of SST (contours), rainfall (shaded) and 850 hPa wind averaged in 3°S-3°N with winter (DJF) Nino3.4 SST index

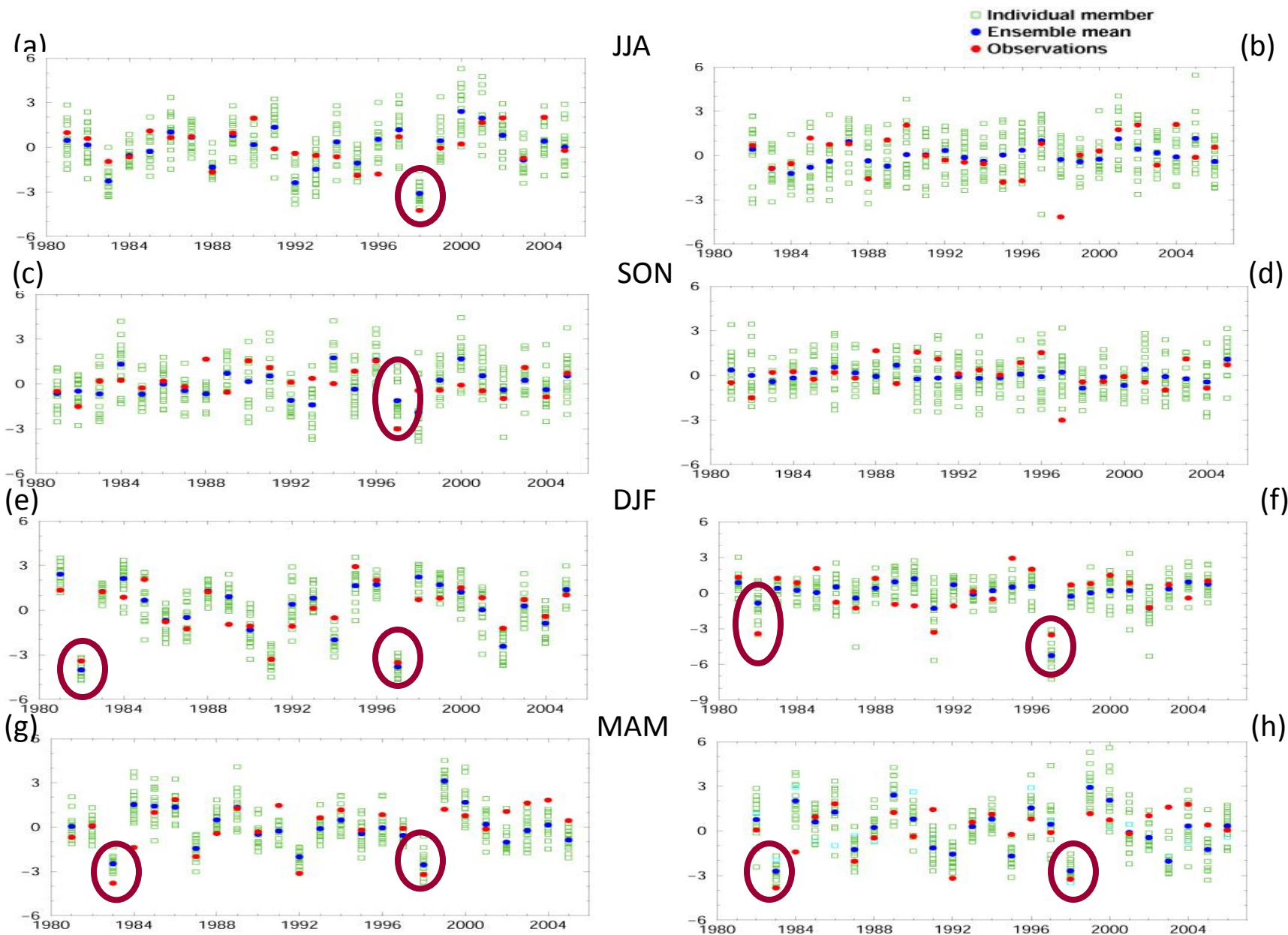


Lagged correlations of SST (contours) and SSH (shaded) averaged in 8°S-12°S with winter (DJF) Nino3.4 SST index

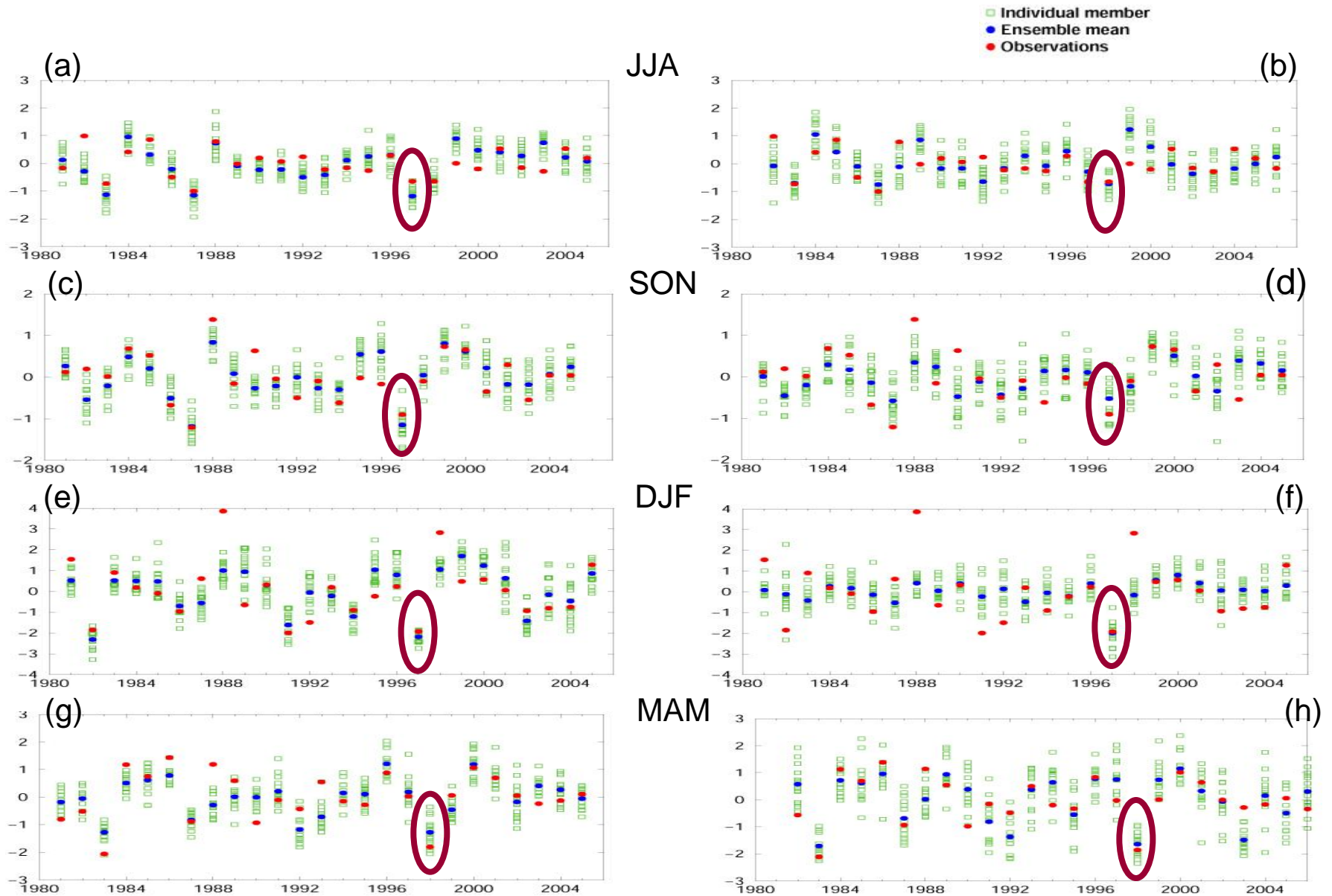
3-month average CFS ensemble mean SST forecast at 0 (dashed), 3 (dotted) and 6 (dashed-dot) month leads over (a) SWIO, and (b) EEIO.



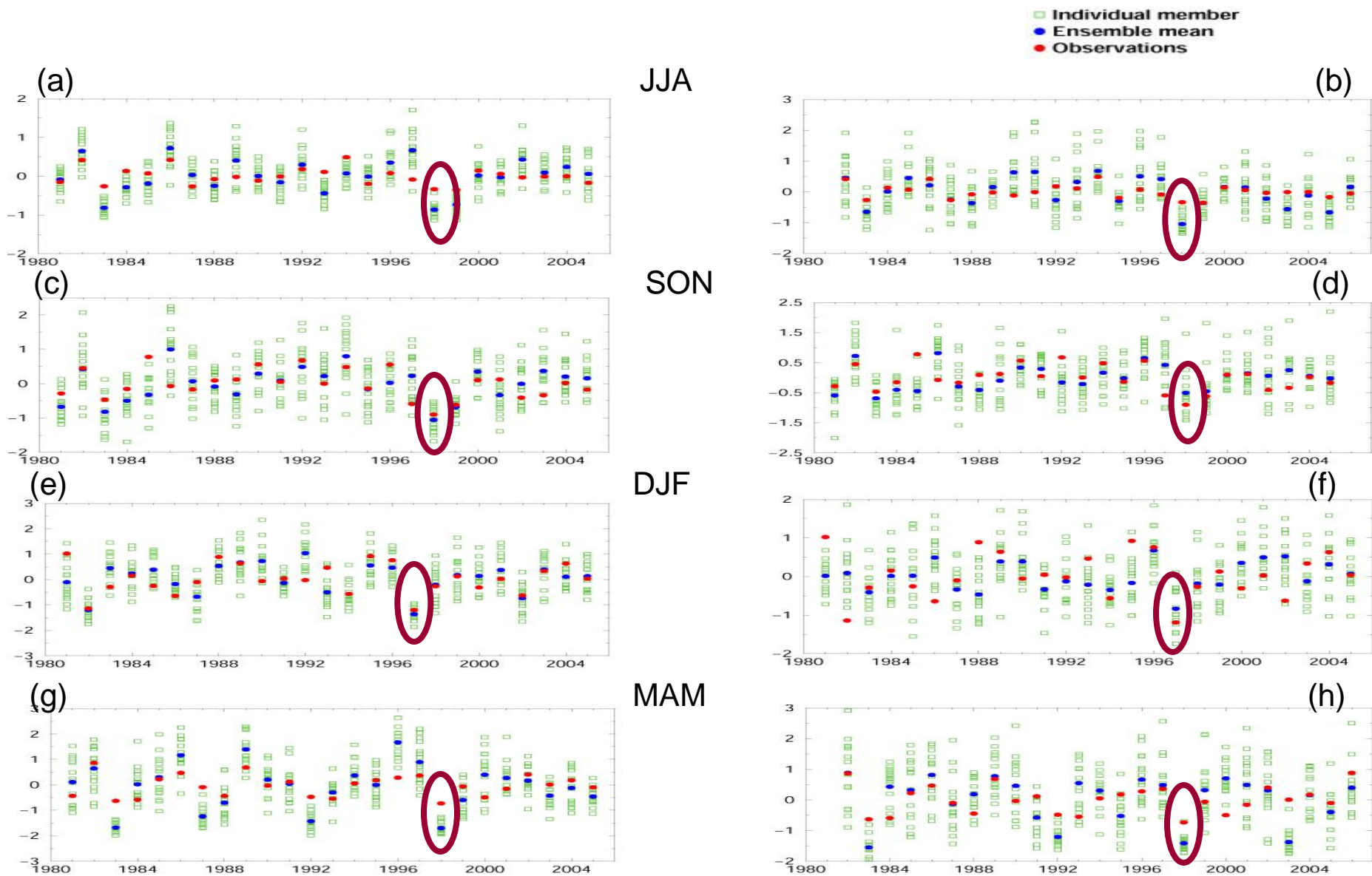
Seasonal rainfall forecast at 0-month (left) and 6-month (right) lead west North Pacific region



Seasonal rainfall forecast at 0-month (left) and 6-month (right) lead over South Pacific region



Seasonal rainfall forecast at 0-month (left) and 6-month (right) lead over Hawaii region

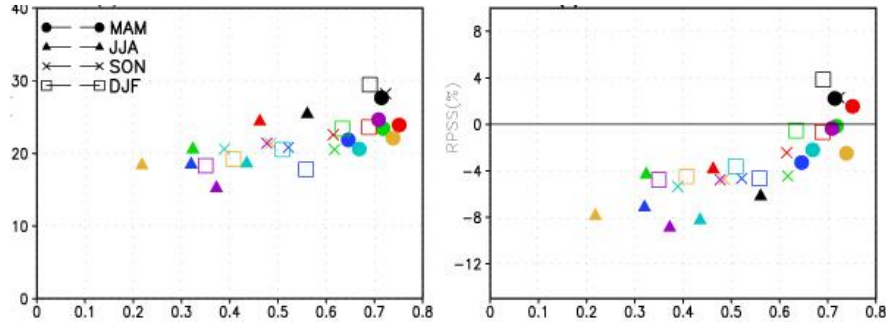


CFS Skill measures (as a function of lead-time) for rainfall over the U.S. Affiliated Pacific Islands (USAPI)

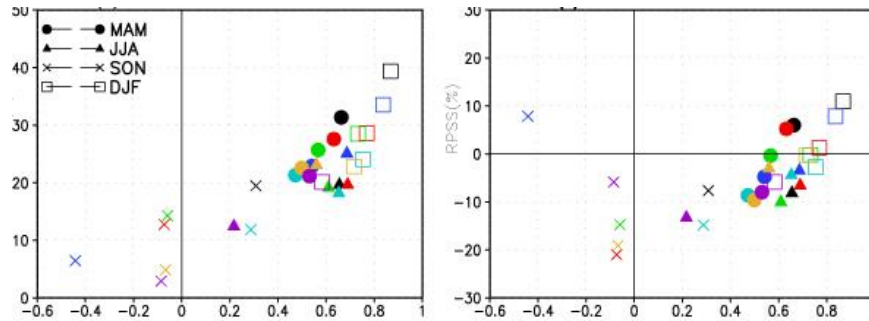
ACC versus HSS

ACC versus RPSS

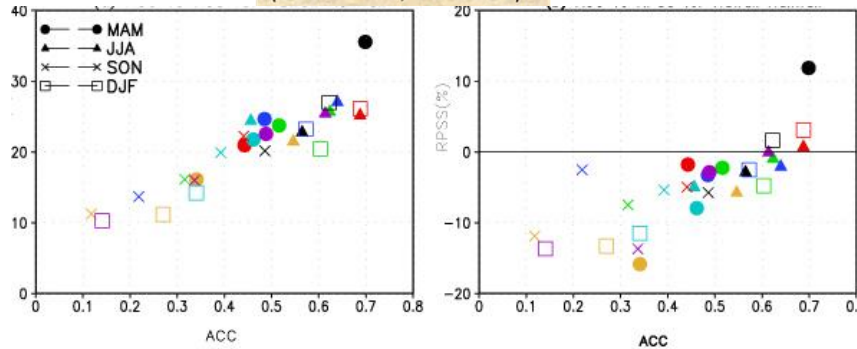
South Pacific Islands
(160-200°E; 10-30°S)



West Pacific Islands
(125-165°E; 5-15°N)



Hawaiian Islands
(190-200°E; 15-30°N)



L0 L1 L2 L3 L4 L5 L6

Summary...

- (i) From 6-month lead onwards, CFS shows high skill in forecasting ENSO-related SST anomalies during the developing and mature phases, including that of different flavors of El Nino
- (ii) The mechanism involved in the teleconnection from the tropical Pacific to Indian Ocean is well-represented in CFS
- (iii) For the USAPI, forecasting the persistence of dryness from El Nino winter into the following spring-summer is skilful at leads longer than 3 months
- (iv) Our results suggest the feasibility that a dynamical system based seasonal prediction of precipitation can be considered

Heidke Skill Score (HSS)

For dichotomous forecasts, the HSS for time-series of length n is defined as

$$HSS = \frac{\left(F_c - \frac{n}{3} \right)}{\left(n - \frac{n}{3} \right)}$$

where F_c is the correct number of forecasts, i.e., the number of cases when the observed category is also the forecast category.

Rank Probability Skill Score (RPSS)

Rank probability skill (RPS) is computed as the sum of the squared differences between the cumulative distributions of the forecasts and observations.

The RPS is defined as

$$RPS = \sum_{m=1}^{m=N} (f_m - o_m)^2$$

where $N = 3$ for tercile forecasts. Here f_m represents the cumulative probabilities of the forecast up to category m , and o_m is the cumulative observed probability up to category m .

- The RPSS which measures the skill with respect to the climatology forecast is defined as

$$RPSS = 1 - \frac{RPS_{fcst}}{RPS_{clim}}$$

where RPS_{fcst} is the RPS for the actual forecast and RPS_{clim} is the RPS of the climatology forecast.