# Experiencia de Predicción subestacional del CPTEC/INPE en Sudamérica

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- Configuración y evaluación del Modelo Atmosférico Global CPTEC/INPE para predicciones subestacionales
- Evaluación comparativa del desempeño del model CPTEC/INPE frente a modelos de proyectos de predicción subestacional a estacional (S2S)
- Ejemplos de productos de predicción subestacional: Nuevo portal web CPTEC/INPE
- Consideraciones finales

Taller virtual de Predicción Subestacional - Base de predicciones históricas

Organizado por SISSA/CRC-SAS con la colaboración del CRC-OSA, 27 de septiembre 2023

# Configuration and assessment of CPTEC/INPE Global Atmospheric Model for sub-seasonal predictions

Guimarães, BS, CAS Coelho, SJ Woolnough, PY Kubota, CF Bastarz, JP Bonatti, SN Figueroa and DC de Souza, 2020: Configuration and hindcast quality assessment of a Brazilian global sub-seasonal prediction system. QJRMS. 146, 728, Part A, 1067-1084

**What is the most adequate model configuration for producing predictions 1 to 4 weeks ahead?**

Model: Brazilian Global Atmospheric model [BAM (Figueroa et al., 2016)] currently used at CPTEC/INPE for numerical weather and seasonal climate predictions

This is the first BAM outcomes for sub-seasonal predictions aiming to determine which model configuration presents the best performance for this time scale: Aligned with WWRP/WCRP S2S project

Special attention is given to characteristics such as vertical resolution, deep convection and boundary layer parameterizations as well as soil moisture initialization

Chosen horizontal resolution: T126 (~100 km)

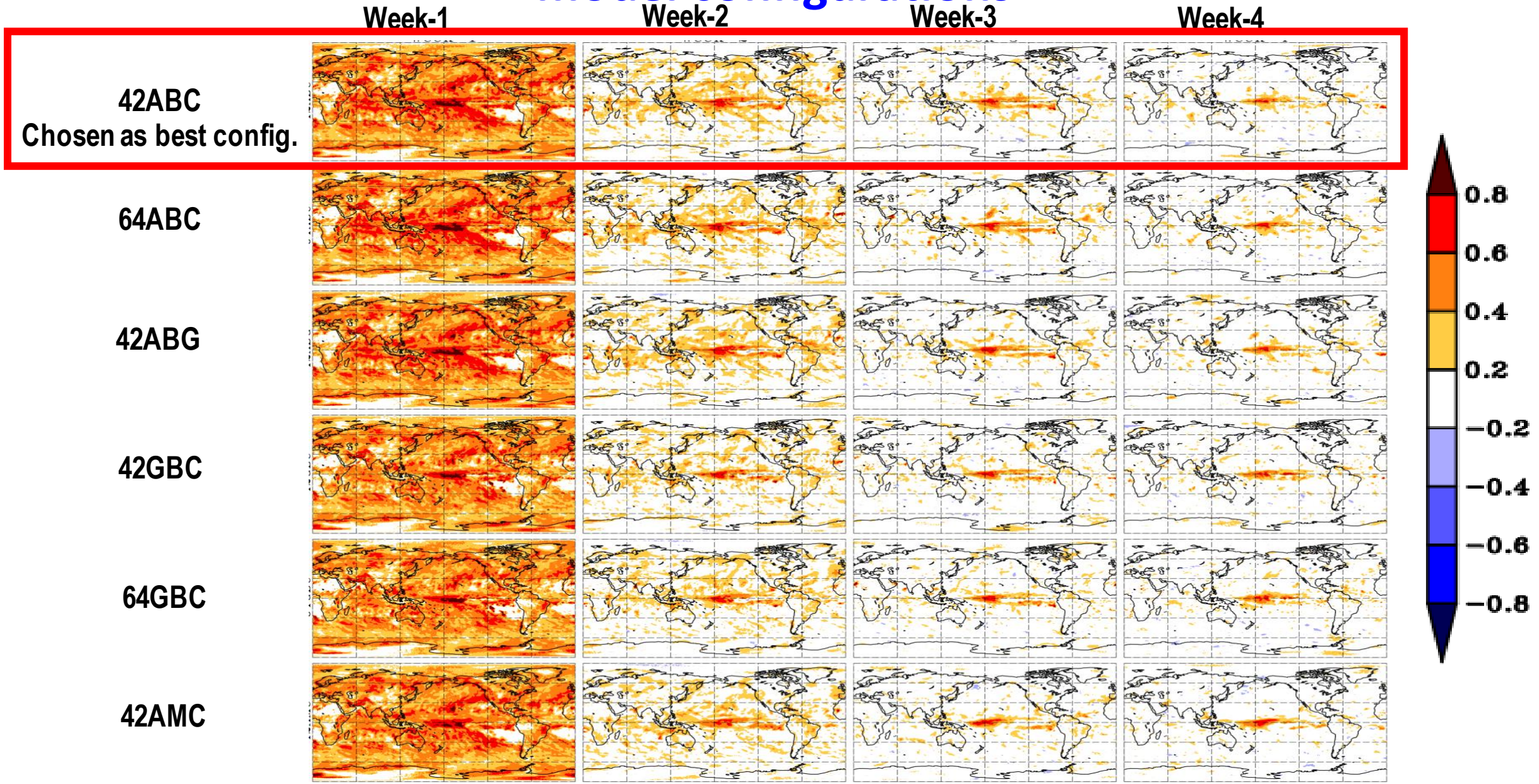
Hindcast ensemble produced twice a month for 12 extended austral summers (Nov-Mar): 1999/2000 to 2010/2011

# BAM-1.2 configuration matrix for sub-seasonal predictions

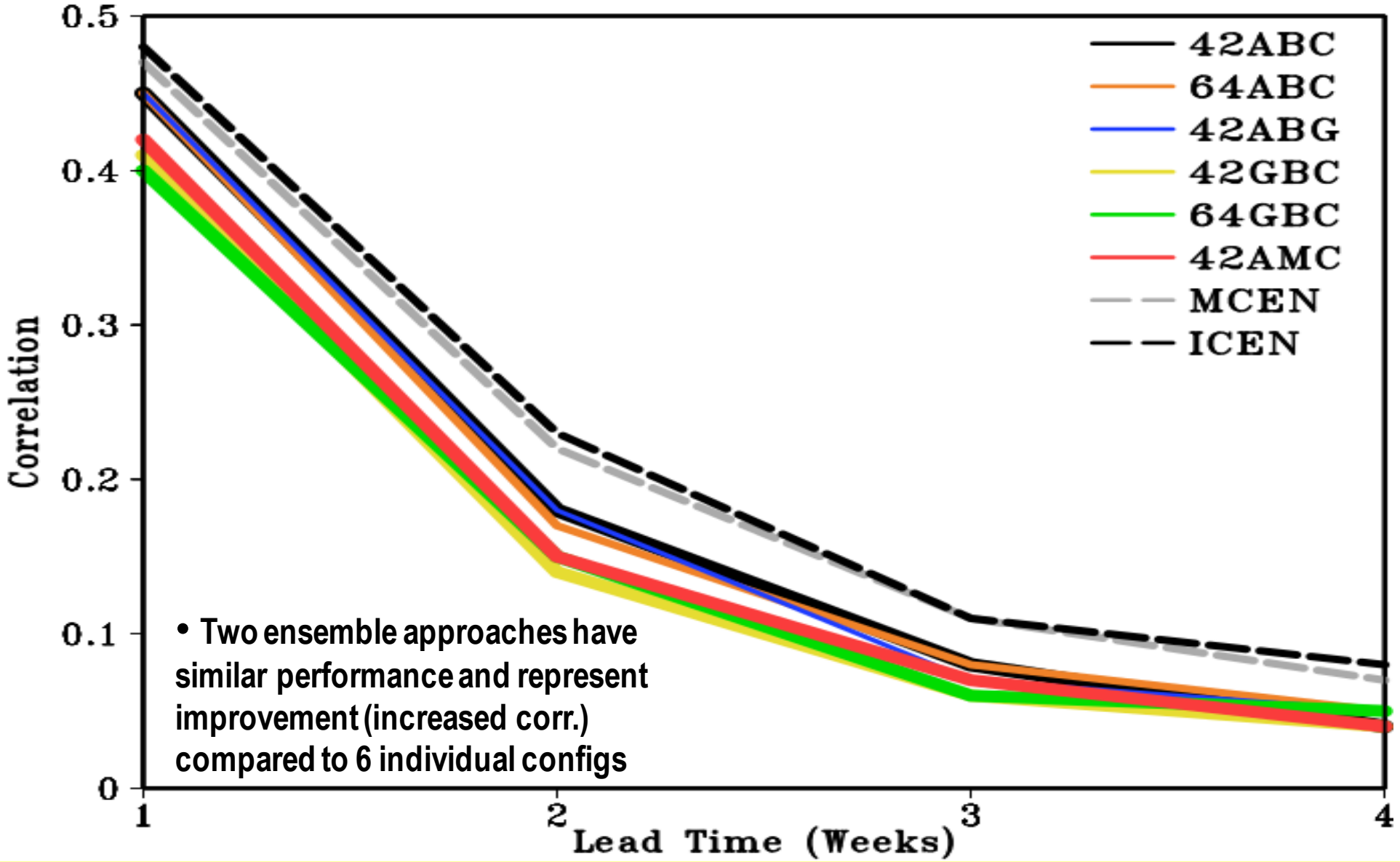
| Configurations | Vertical levels | | Convection parameterization | | Boundary layer parameterization | | Soil moisture | |
|---|---|---|---|---|---|---|---|---|
| | 42 | 64 | Revised Simplified Arakawa-Schubert | Modified Grell-Dévényi | Bretherton-Park (moist scheme) | Modified Mellor-Yamada (dry scheme) | Climatology | GLDAS2 |
| 42ABC | 42 | | A | | B | | C | |
| 64ABC | | 64 | A | | B | | C | |
| 42ABG | 42 | | A | | B | | | G |
| 42GBC | 42 | | | G | B | | C | |
| 64GBC | | 64 | | G | B | | C | |
| 42AMC | 42 | | A | | | M | C | |

# Corr. btw predicted and observed precipitation anomalies for the six model configurations

Guimarães et al. (2020)



# Global mean correlation for precipitation anomalies averaged over 60°N and 60°S




Guimarães, BS, CAS Coelho, SJ Woolnough, PY Kubota, CF Bastarz, JP Bonatti, SN Figueroa and DC de Souza, 2020: Configuration and hindcast quality assessment of a Brazilian global sub-seasonal prediction system. QJRMS. 146, 728, Part A, 1067-1084

# How does CPTEC/INPE model compare with S2S project models?

Guimarães, BS, CAS Coelho, SJ Woolnough, PY Kubota, CF Bastarz, JP Bonatti, SN Figueroa and DC de Souza (2021) An inter-comparison performance assessment of a Brazilian global sub-seasonal prediction model against four sub-seasonal to seasonal (S2S) prediction project models, *Climate Dynamics*. 56, 2359–2375.

This study performed a global assessment of CPTEC/INPE model (BAM-1.2) when producing sub-seasonal predictions, focusing on an inter-comparison with four S2S project models (JMA, ECCC, ECMWF and BoM)

Special attention is devoted to performing a fair comparison between CPTEC/INPE and these four S2S project models in terms of using the same hindcast samples size, the same hindcast period (1999/2000-2010/2011) and the same number of ensemble members

# Main characteristics of investigated models

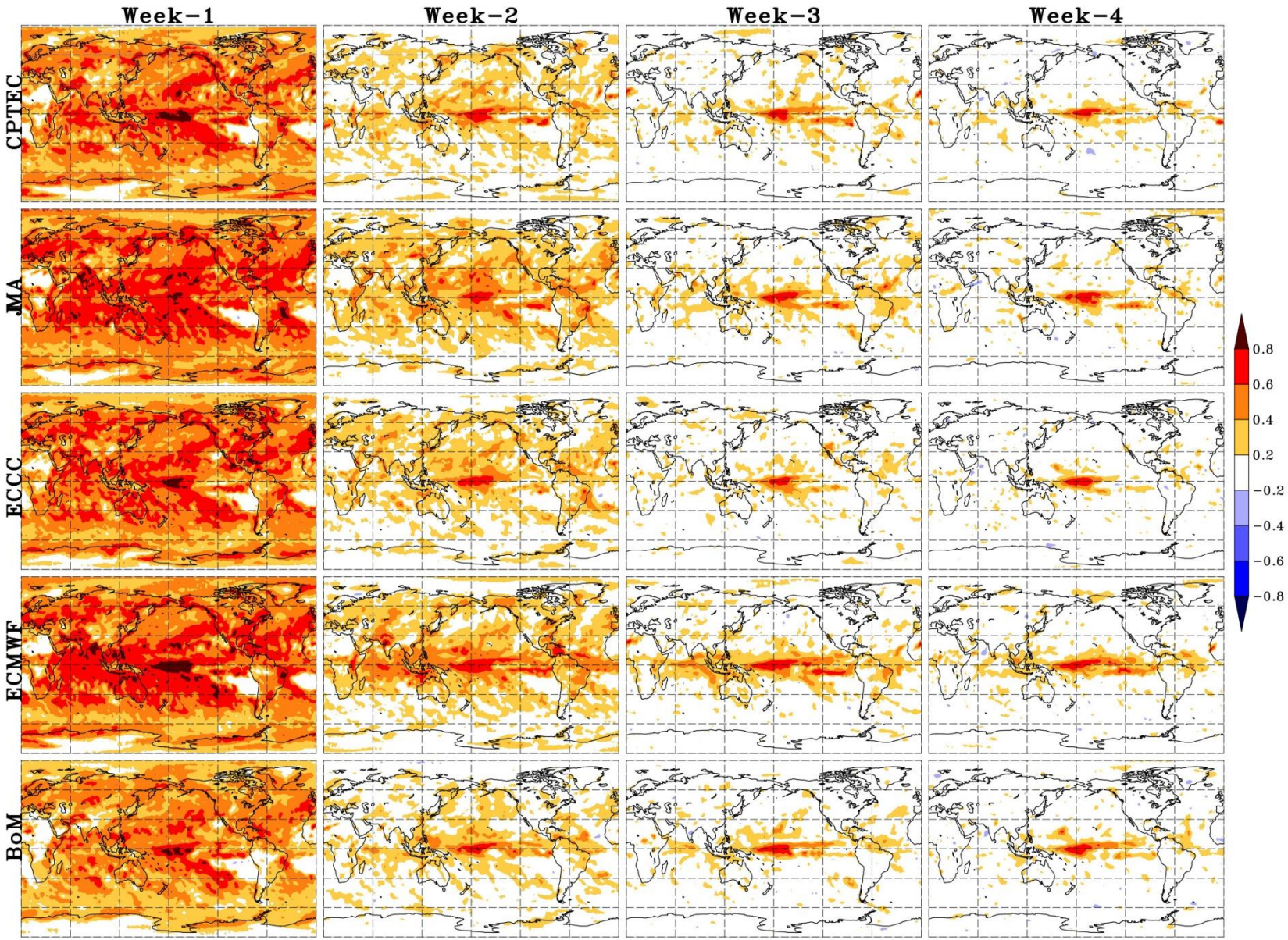
S2S Project models

| | Model version | Resolution | Ensemble Size | Ocean Coupling |
|---|---|---|---|---|
| CPTEC | BAM-1.2 | TQ126 L42 (~100 km) | 11 | NO |
| JMA | GEPS1701 | Tl479 / Tl319 L100 (~40 / 55km) | 5 | NO |
| ECCC | GEPS5 | 0.35°/ L45 (~39 km) | 4 | NO |
| ECMWF | CY43R1 | Tco639 / Tco319 L91 (~16 / 32km) | 11 | YES |
| BoM | POAMA(24a) | T47 L17 (~250 km) | 11 | YES |

**Common ensemble size: 4 members of all models (det. assessment of ens. mean)**
**11 members for CPTEC, ECMWF and BoM (prob. assess.)**

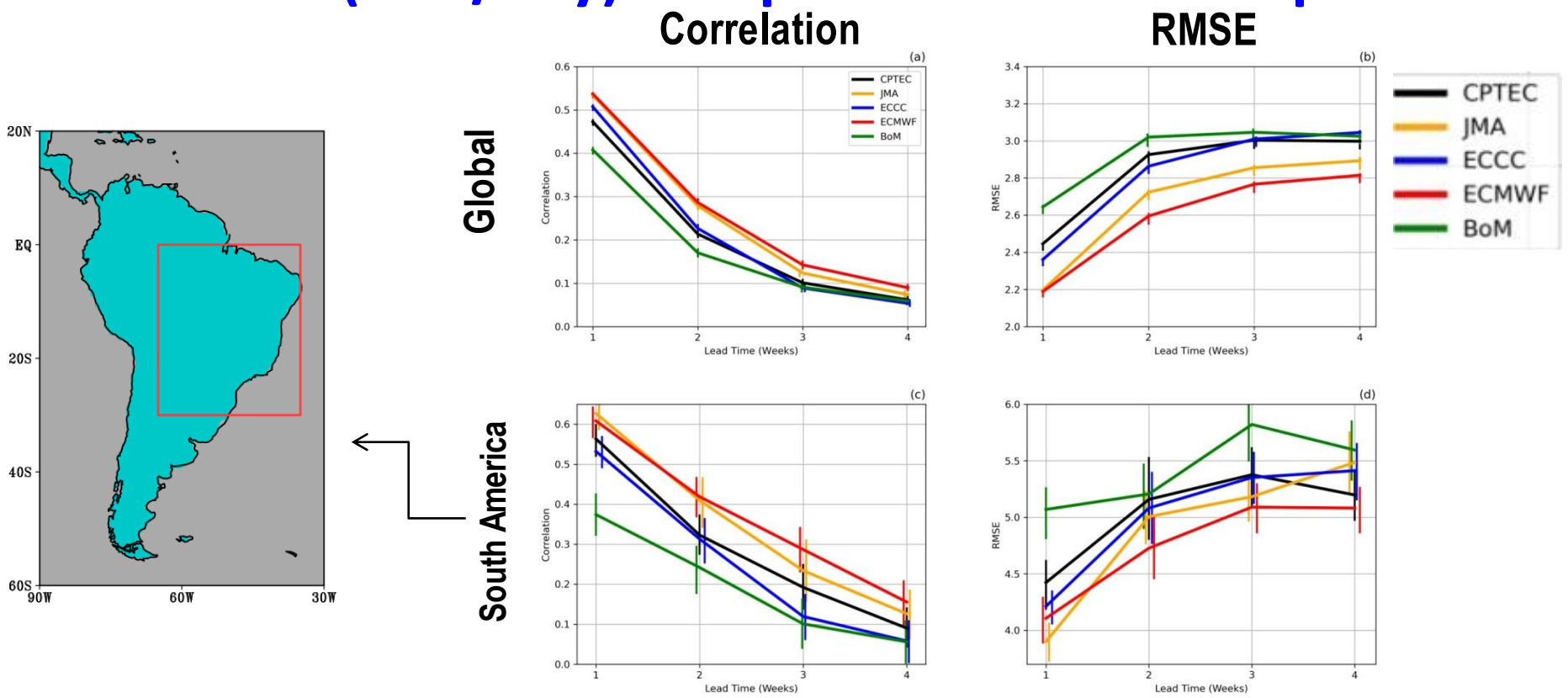
# Corr. btw predicted and observed precipitation anomalies for CPTEC/INPE and S2S models

All models with 4 members



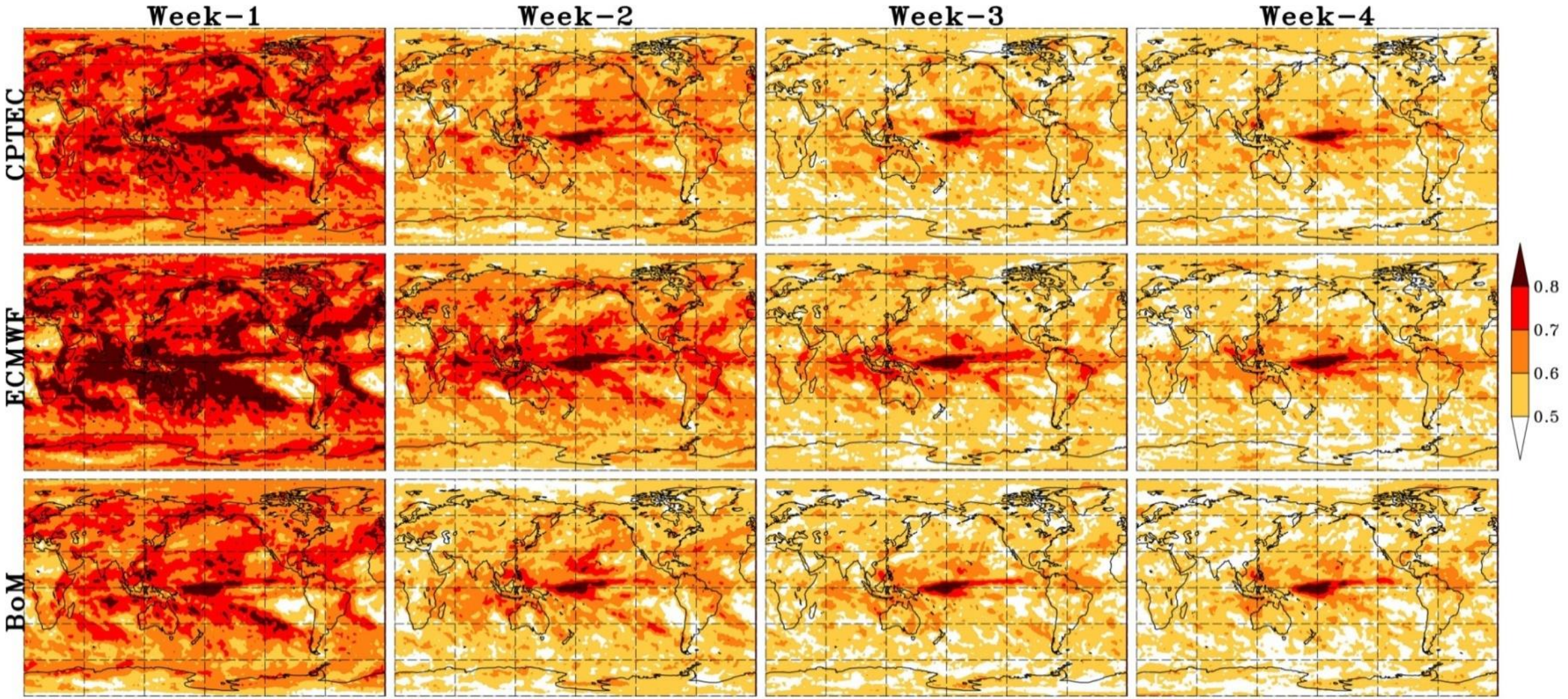

- All models show similar correlation patterns
- Corr. high during first week in most regions and drops rapidly as lead time increases
- High corr. in first two lead times (part. at week-1) assoc. to the pred. prov. by the ICs, high corr. in last two lead times over eq. Pac. assoc. to pred. prov. by ENSO and the MJO
- In general, CPTEC corr. values are larger (smaller) than BoM (ECMWF) and broadly comparable to JMA and ECCC models

# Global (60ºN – 60ºS) and South America (0°–30°S, 55°W–35°W) mean corr. and RMSE (mm/day) btw predicted and obs. prec. anoms.




- All models show a similar drop (rise) in corr. (RMSE) as a function of lead time
- ECMWF (red line) shows the best performance followed by JMA
- CPTEC/INPE (black line) has similar performance to the other models over global and South America region

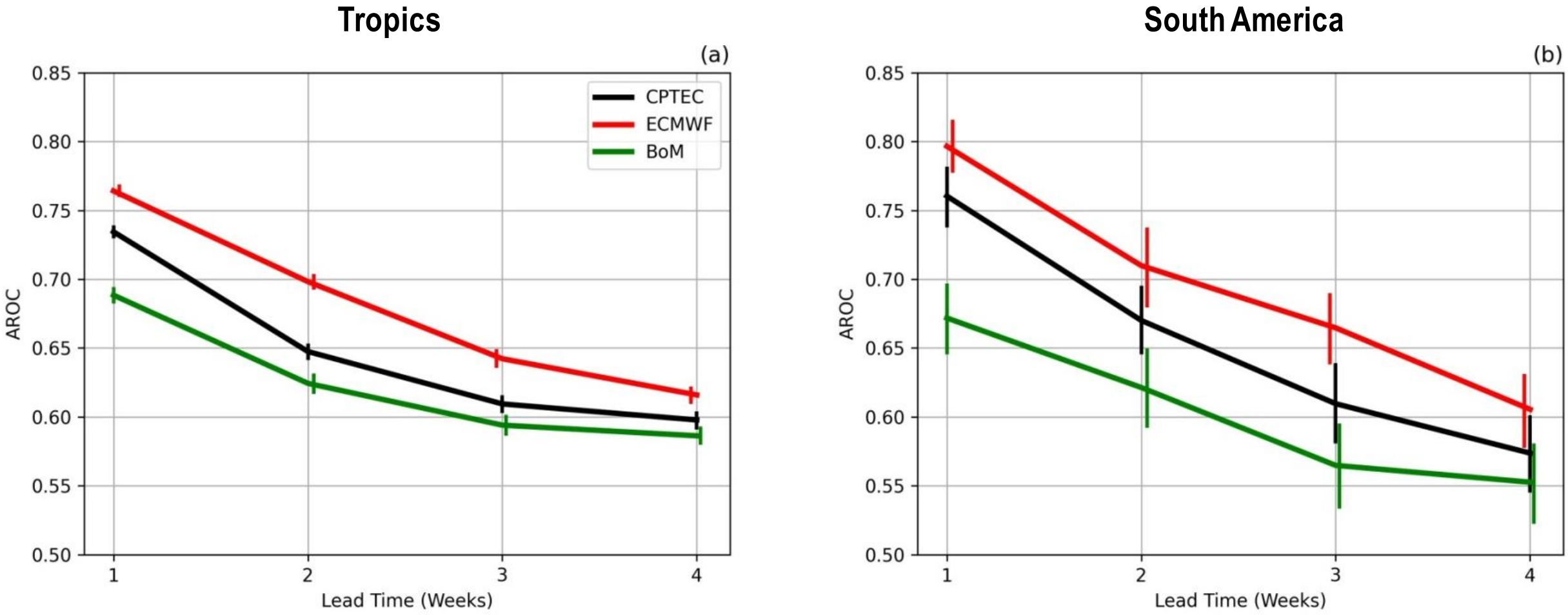
# Area under ROC curve (AROC) for CPTEC and S2S models: event pos. precip. anom.




All models with 11 members

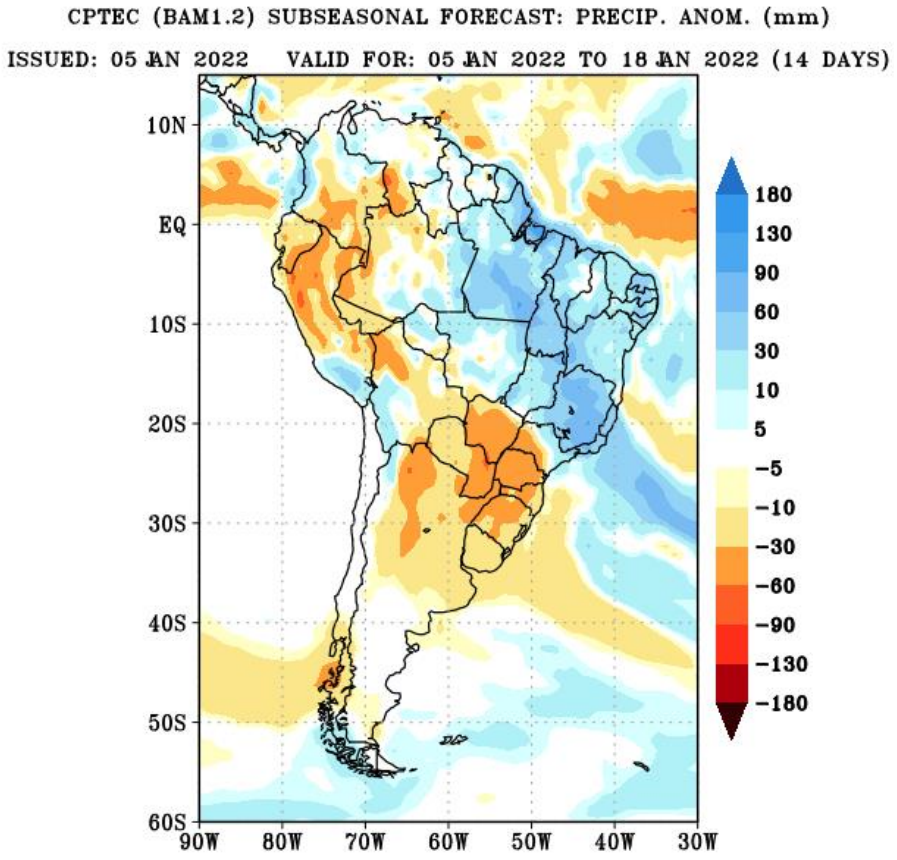
- AROC computed for probabilistic predictions for the event positive precipitation anomaly for assessing discrimination ability
- The three models have comparable AROC spatial patterns

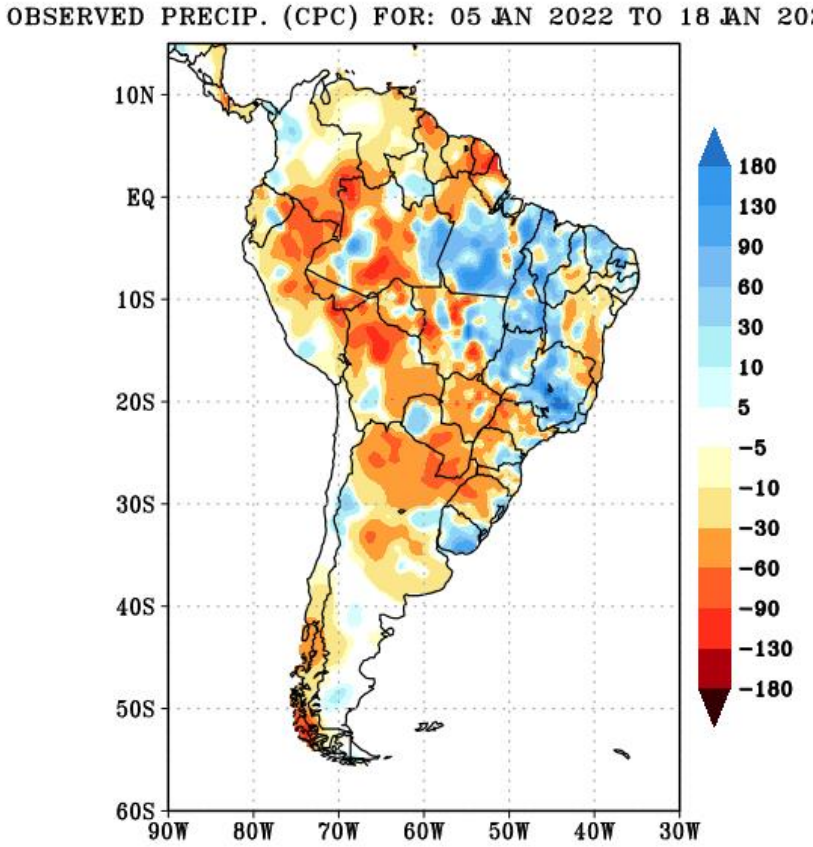
# ROC area for Tropical (30ºN – 30ºS) and South America (0°–30°S, 55°W–35°W) regions: mean values for event positive precipitation anomalies

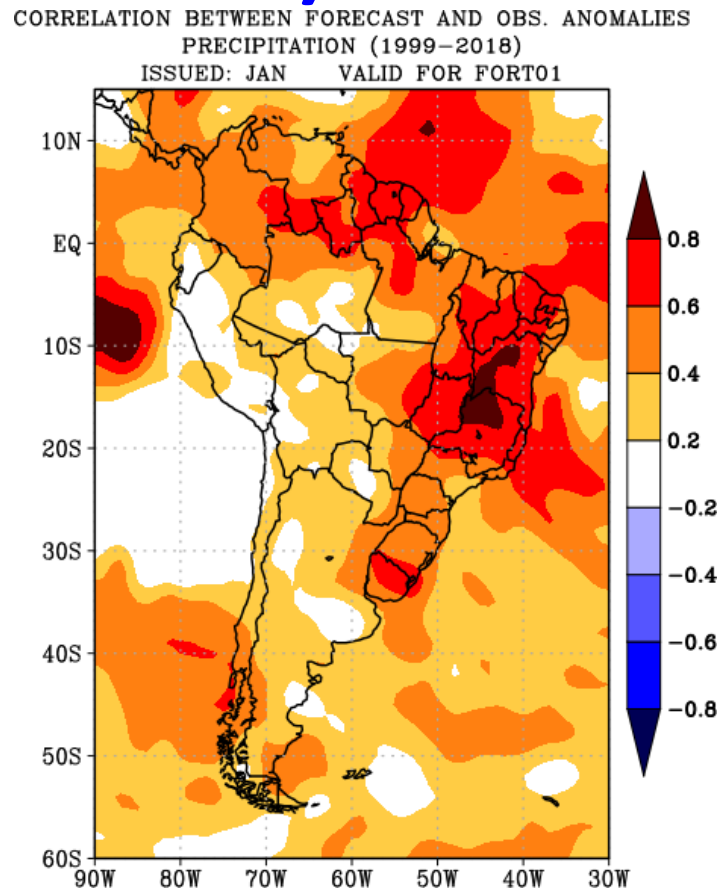



- CPTEC, ECMWF and BoM models show AROC values above 0.5 for all four lead times
- ECMWF ranks as the best model, followed by CPTEC and BoM

# Experimental CPTEC/INPE sub-seasonal precipitation prediction for 14 days accumulation (5-18 Jan 2022)




**Reasonable performance in representing the observed SACZ and precipitation anomalies over northern NE and south Brazil**

# New CPTEC/INPE sub-seasonal prediction web portal

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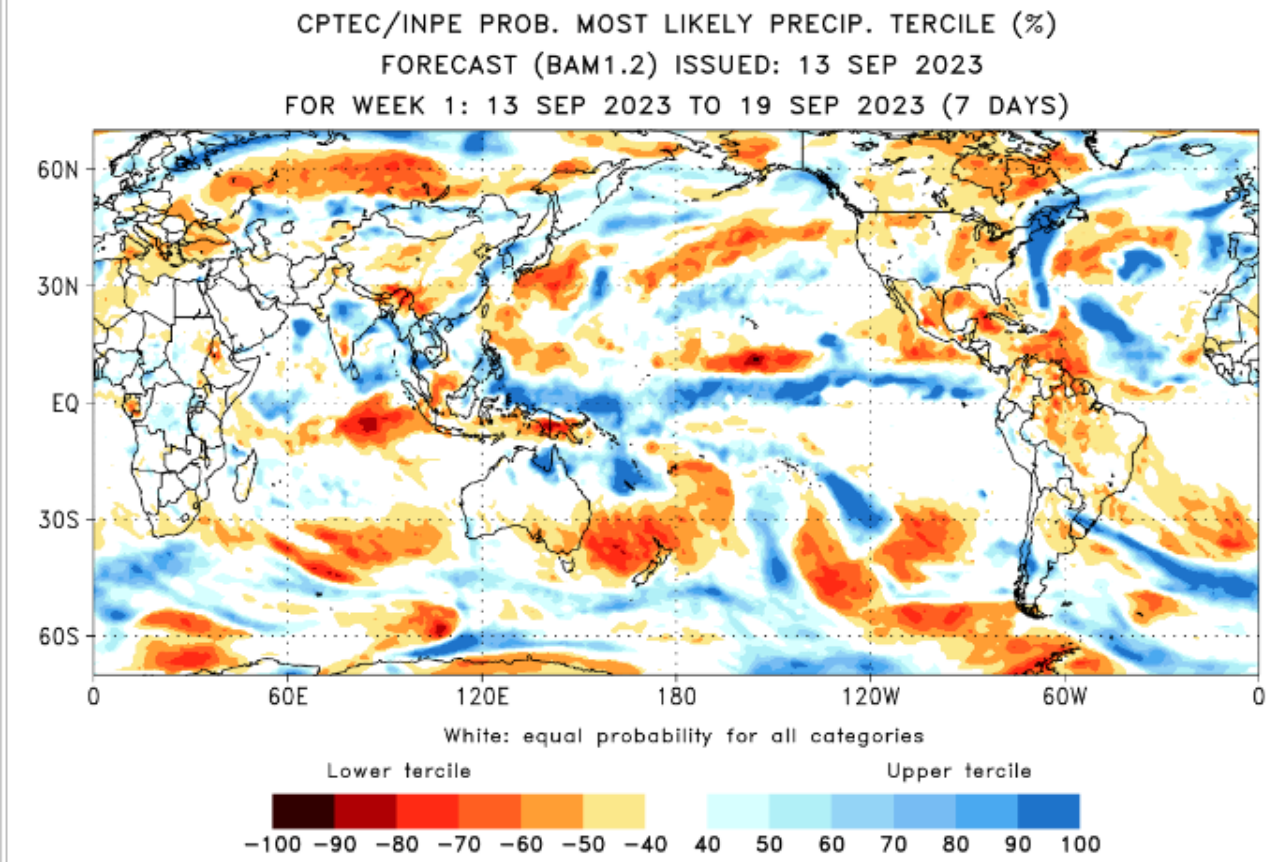
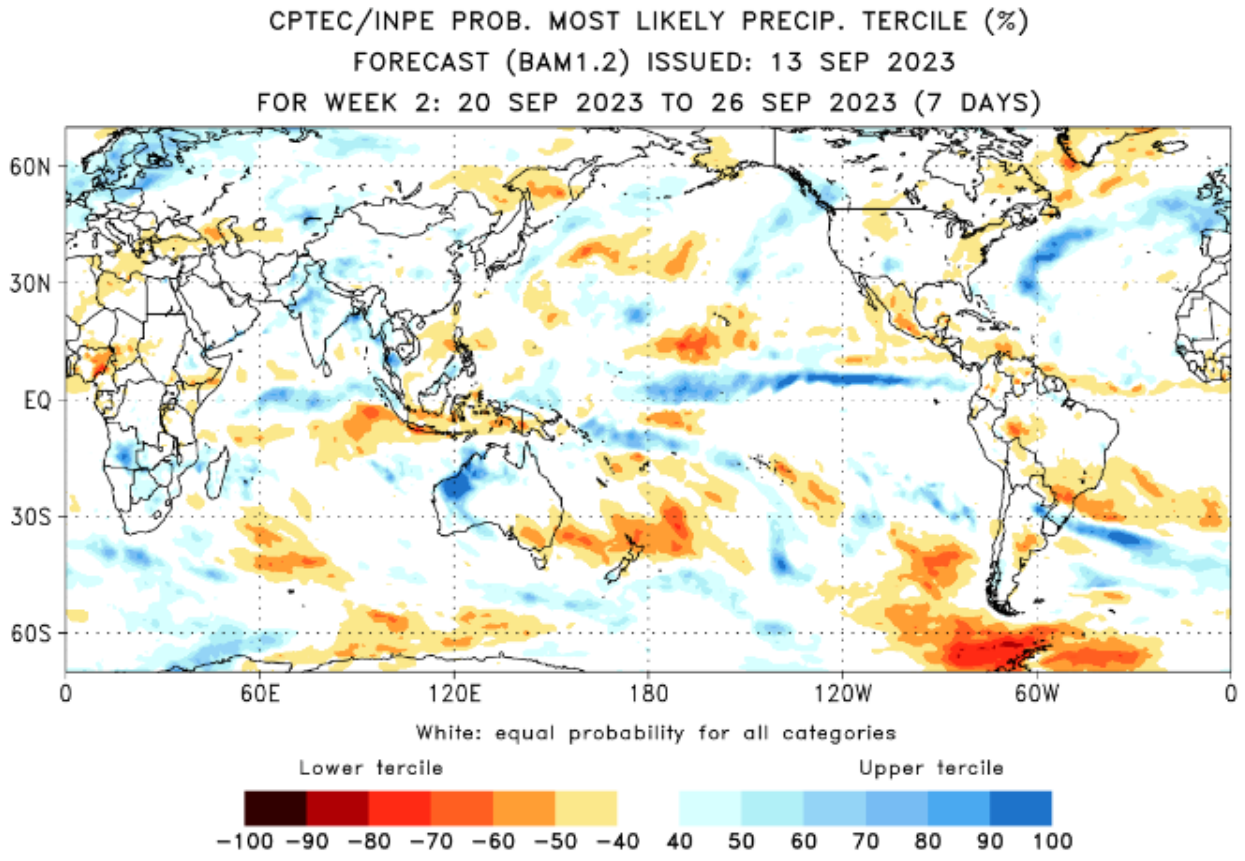
BAM-1.2 - CPTEC/INPE

Regiões: Global | Variável: Precipitação Calibrada | Campos: Probabilidade do Tercil Mais Provável | Produtos: 7 dias | Data Inicialização: 09 2023 13/09/2023




**Forecasts issued Every Wednesday for weeks 1 to 4, fortnights 1 and 2, 21 and 30 days**
**Verification products produced using hindcasts over the 1999-2018 period (20 Years)**

**Calibrated predictions based on linear regression of ensemble mean forecasts on observed precipitation**

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BAM-1.2 - CPTEC/INPE

Regiões: América do Sul

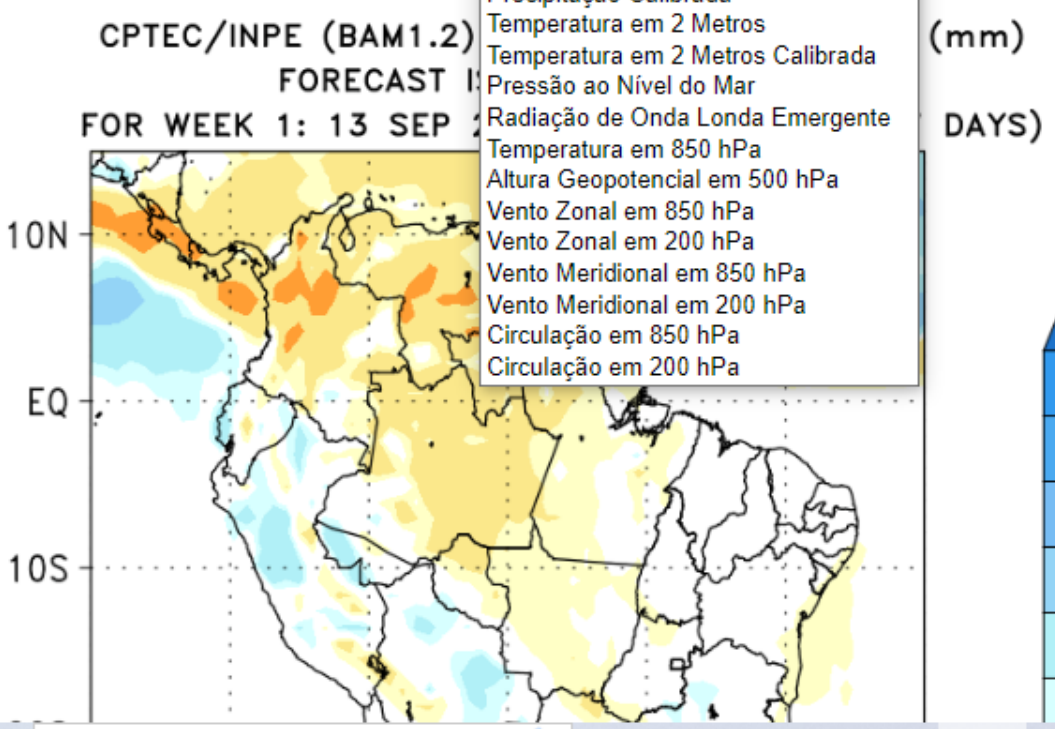
Variáveis: Precipitação

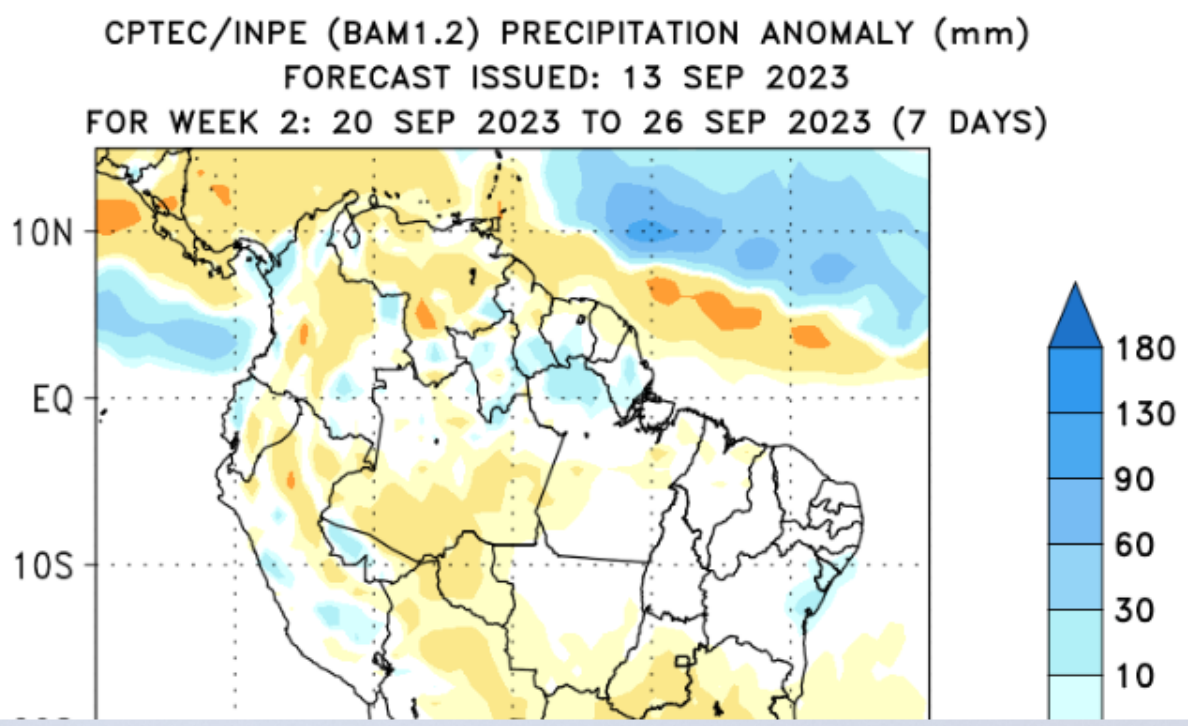
- Precipitação
- Precipitação Calibrada
- Temperatura em 2 Metros
- Temperatura em 2 Metros Calibrada
- Pressão ao Nível do Mar
- Radiação de Onda Londa Emergente
- Temperatura em 850 hPa
- Altura Geopotencial em 500 hPa
- Vento Zonal em 850 hPa
- Vento Zonal em 200 hPa
- Vento Meridional em 850 hPa
- Vento Meridional em 200 hPa
- Circulação em 850 hPa
- Circulação em 200 hPa

Campos: Anomalia

Produtos: 7 dias

Data Inicialização: 09 | 2023 | 13/09/2023

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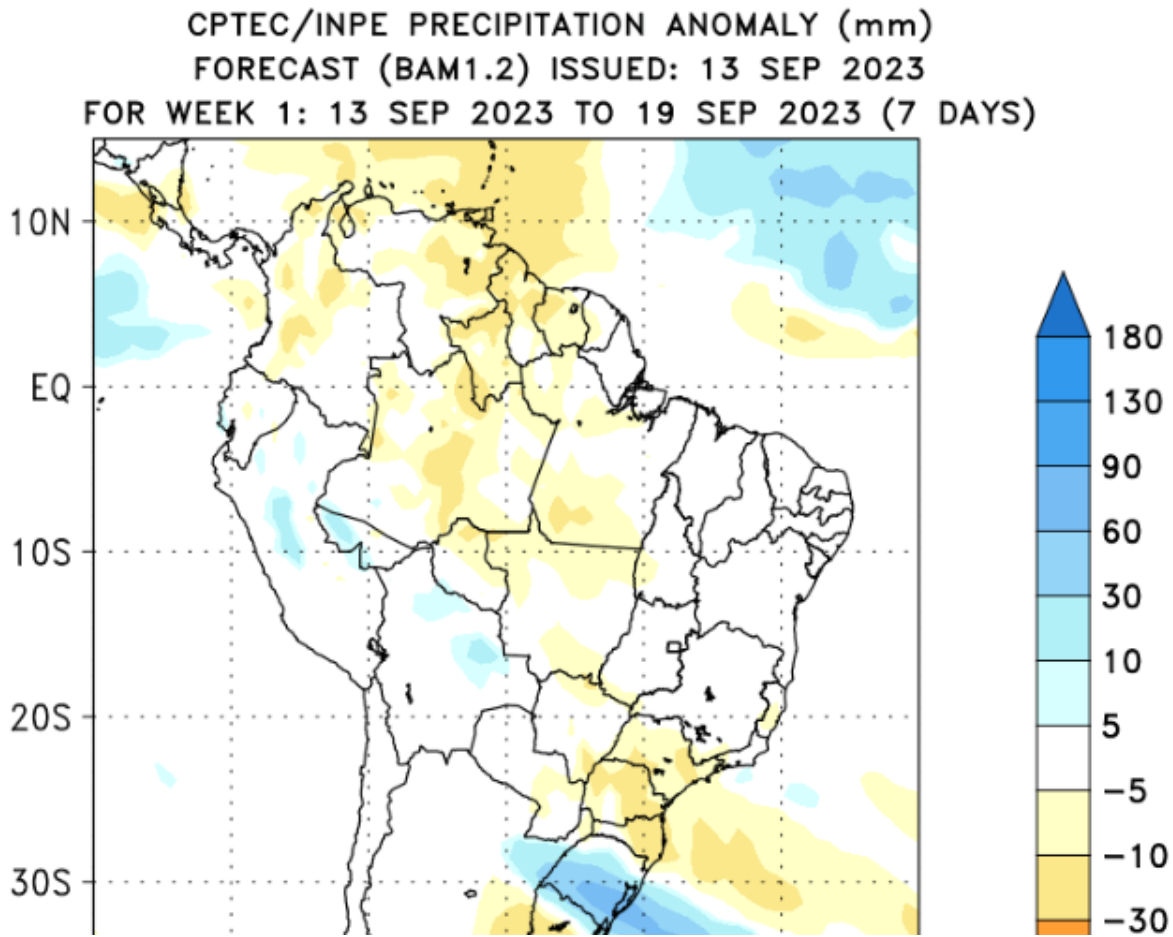
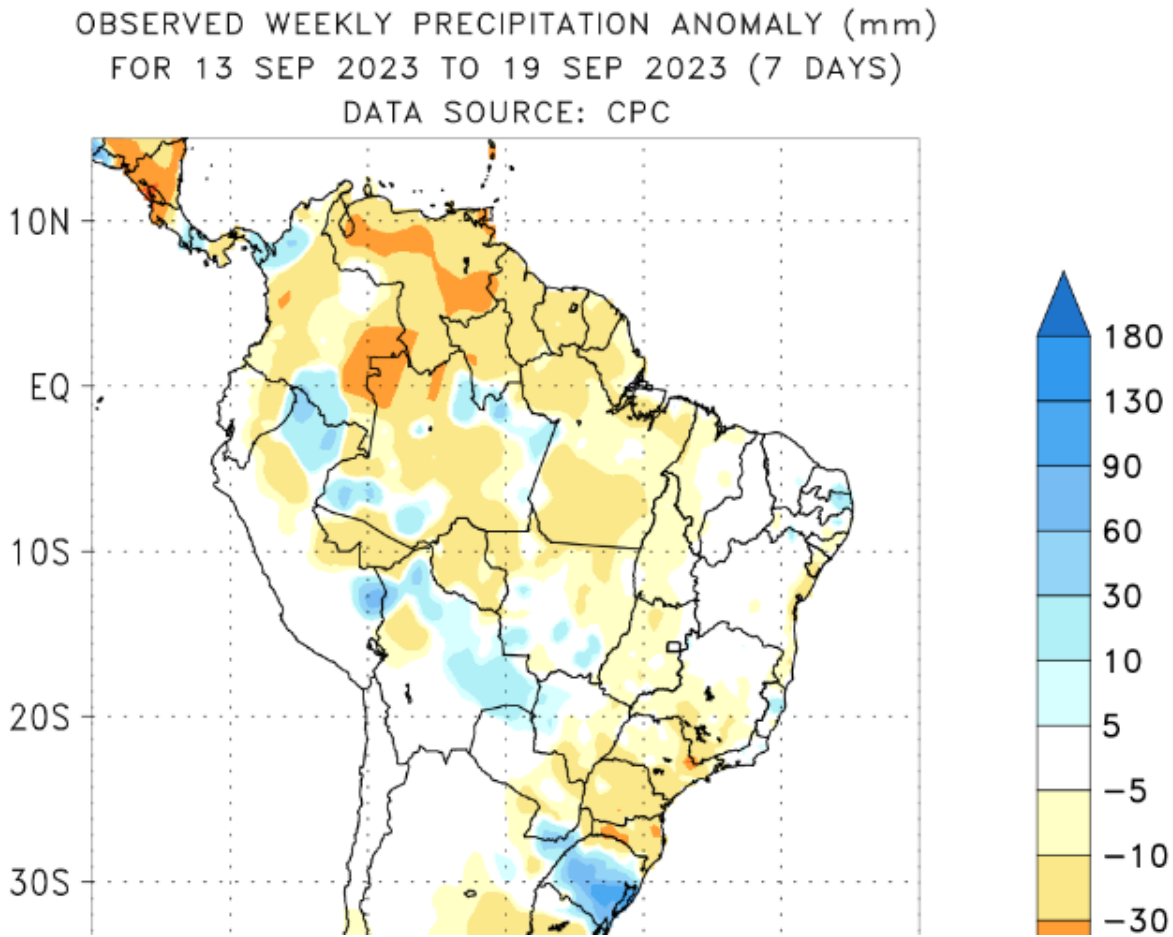
Regiões: América do Sul | Variáveis: Precipitação Calibrada | Campos: Anomalia | Produtos: 7 dias | Data Inicialização: Mês Ano 2023-09-13



# New forecast and verification sub-seasonal prediction products

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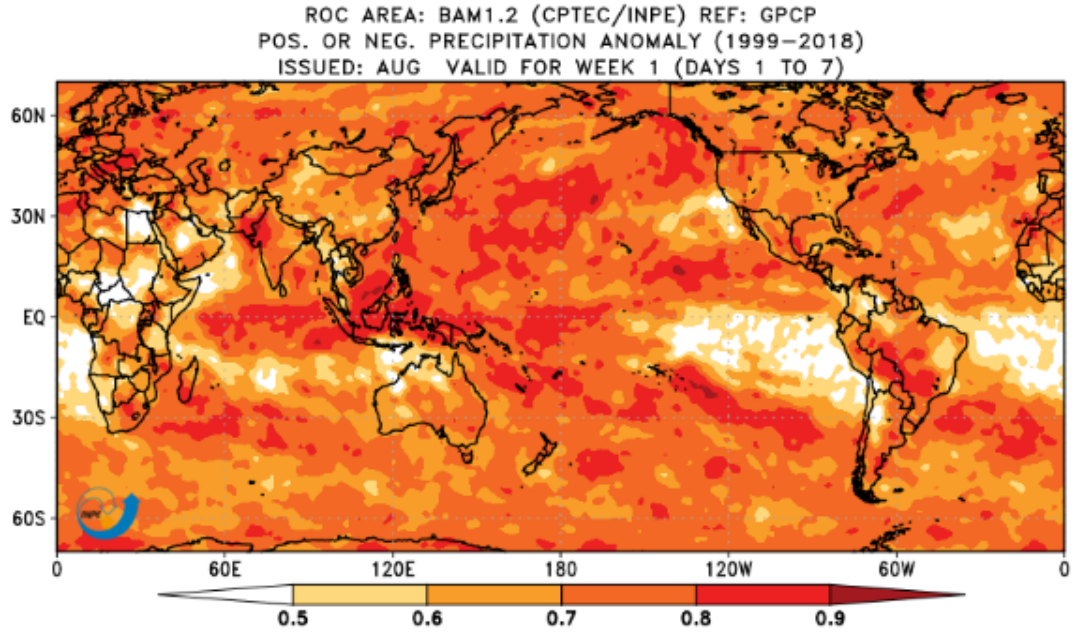
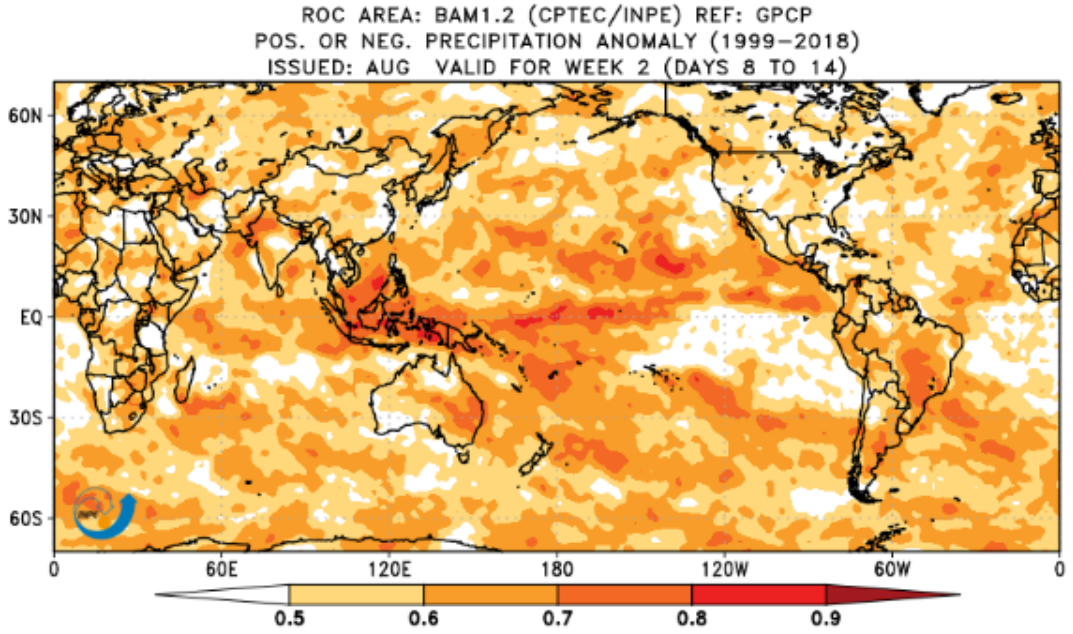
BAM-1.2 - CPTEC/INPE

Regions: Global | Variables: Calibrated Precipitation Anomaly | Verification product: ROC Area (Positive or negative anom | Time range: 7 days | Verifying month: August

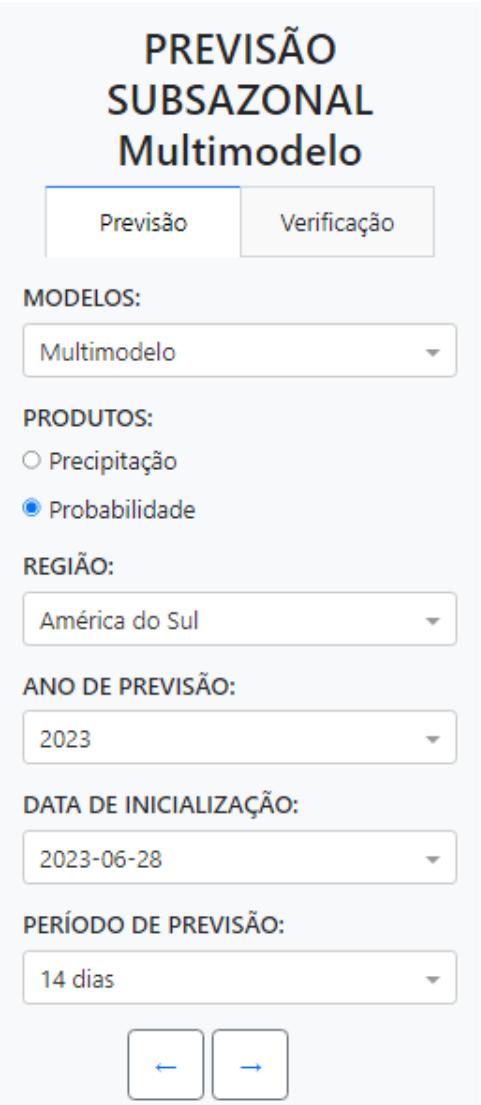


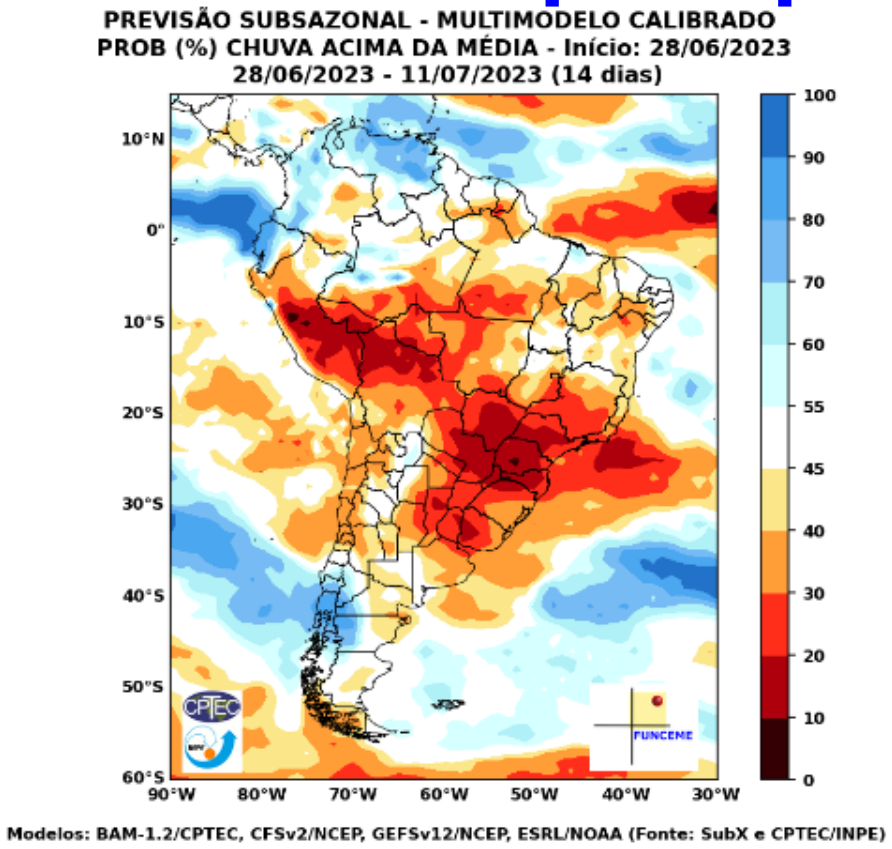




**Forecasts issued Every Wednesday for weeks 1 to 4, fortnights 1 and 2, 21 and 30 days**
**Verification products produced using hindcasts over the 1999-2018 period (20 Years)**

**Calibrated predictions based on linear regression of ensemble mean forecasts on observed precipitation**

# CPTEC/INPE and FUNCEME multi-model ensemble sub-seasonal precipitation predictions




**Models:**
**BAM-1.2 (INPE/CPTEC)**
**CFSv2 (NCEP) [SubX]**
**GEFSv12 (NCEP) [SubX]**
**FIM (ESRL/NOAA) [SubX]**

**Calibrated preditions based on linear regression of the multi-model ensemble mean of the 4 models on GPCP observed precipitation**

**Forecast and verification products for:**
**Weeks 1 to 4**
**Fortnigh 1 and 2**
**30 and 44 days**

**Products for the following regions:**
**Global, South America,**
**Northeast Brazil and Ceará State**

**Calibration and verification performed using 18 years of hindcasts (1999-2016)**

**http://www.funceme.br/dashboard/subsaz_forecast**

# Final remarks

- Configured CPTEC/INPE model and assessed hindcast quality of INPE/CPTEC, JMA, ECCC, ECMWF and BoM models for austral summer sub-seasonal predictions aiming to perform an inter-comparison of CPTEC sub-seasonal predictions (weekly precip. and MJO) with consolidated S2S models.

- The weekly precip. anom. hindcasts assessment revealed that CPTEC/INPE model has performance comparable to the other investigated models for the four examined lead times

- In general, ECMWF showed the best performance for both deterministic and probabilistic predictions

- Results suggest that there is scope to improve CPTEC/INPE prediction system, likely by a combination of including coupling to an interactive ocean, improving resolution and model parameterization schemes, and better methods for ensemble generation

- Experimental sub-seasonal predictions produced with CPTEC/INPE in 2022 showed encouraging results

- CPTEC/INPE developed a web portal and is making available real time sub-seasonal predictions (Global and over various continental regions, including South America)

- CPTEC/INPE and FUNCEME developed a multi-model sub-seasonal prediction system and are making available real time sub-seasonal predictions (Global, over South America, Northeast Brazil and Ceará)

# Thank you for your attention

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