Estimating errors in model variability:

a comparison between seasonal re-forecasts and continuous multi-decadal simulations with the ECMWF coupled model

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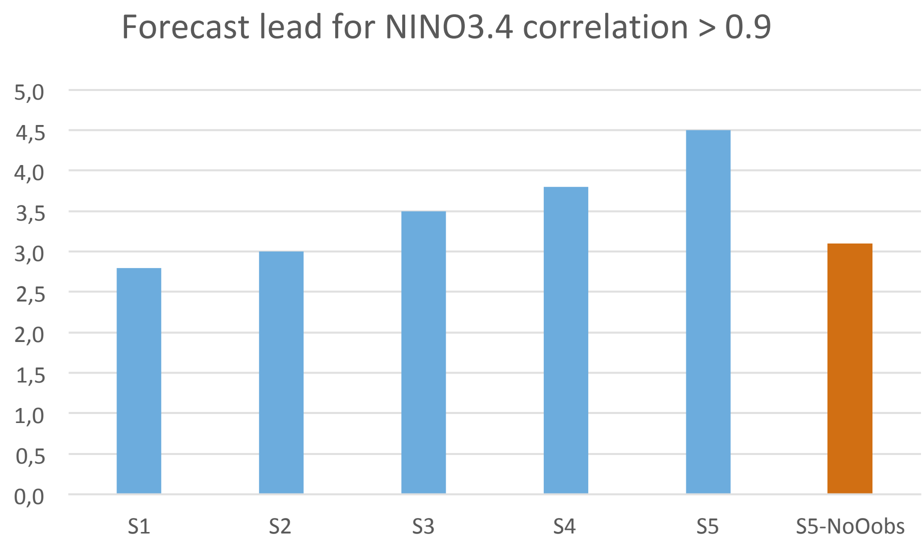
Seasonal forecasts and multi-decadal historical simulations at ECMWF

- **a)** Seasonal fc. System 5 **(Seas5)**
  - IFS cy43r1 Tco 319 (~32 km grid) L91 + NEMO v3.4 ORCA 0.25 deg. Z75+ LIM2 sea-ice
  - 7-month forecasts, 13-month fc. From Feb/May/Aug/Nov
  - Ensemble size: operational fc.: 51 members, re-forecasts: 25 members
  - Re-forecast period: Jan 1981 – Dec 2016 (36 years), IC from ERA-interim + ORA-S5
- **b)** Multi-decadal historical simulations for the EU PRIMAVERA project, following HighResMIP **(ECM-hist)**
  - High res.: IFS cy43r1 Tco 399 (~25 km grid) L91 + NEMO v3.4 ORCA 0.25 deg. Z75 + LIM2 sea-ice
  - Low res.: IFS cy43r1 Tco 199 (~50 km grid) L91 + NEMO v3.4 ORCA 1.0 deg. Z75 + LIM2 sea-ice
  - CMIP6 forcing fields (GHG, aerosol, ozone, …)
  - 1950-2014 started from 50-yr spin-up (1950 forcings)
  - Additional runs: AMIP integrations using HadISST2 data (SST + sea-ice conc.), 1950-forcing control

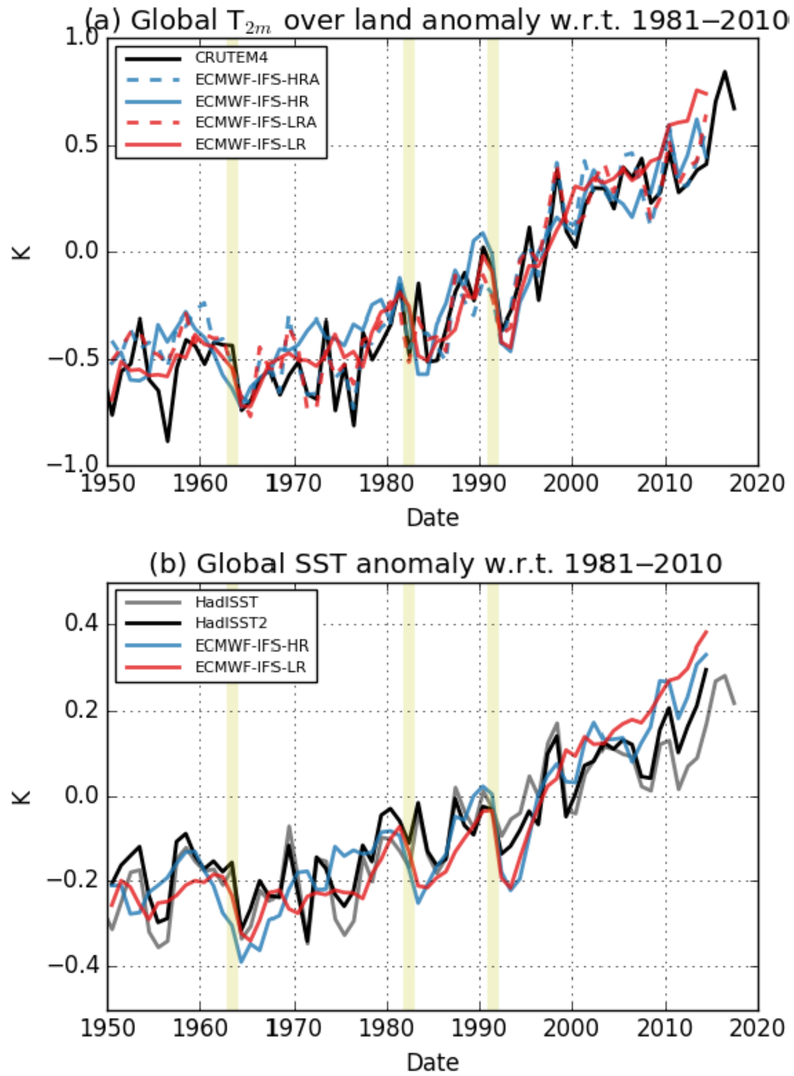
- **Question: what do the systematic errors in (b) tell us about the systematic errors in (a) ?**

Good news: ENSO forecasts, surface temperature trend

Seas5 ENSO predictions



Sfc. T anomaly in PRIMAVERA hist. simulation

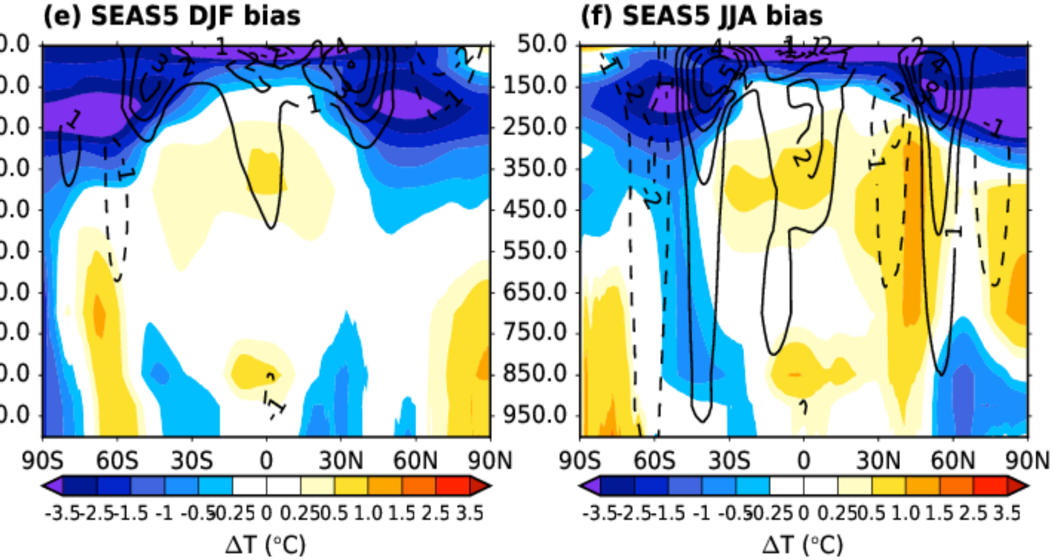


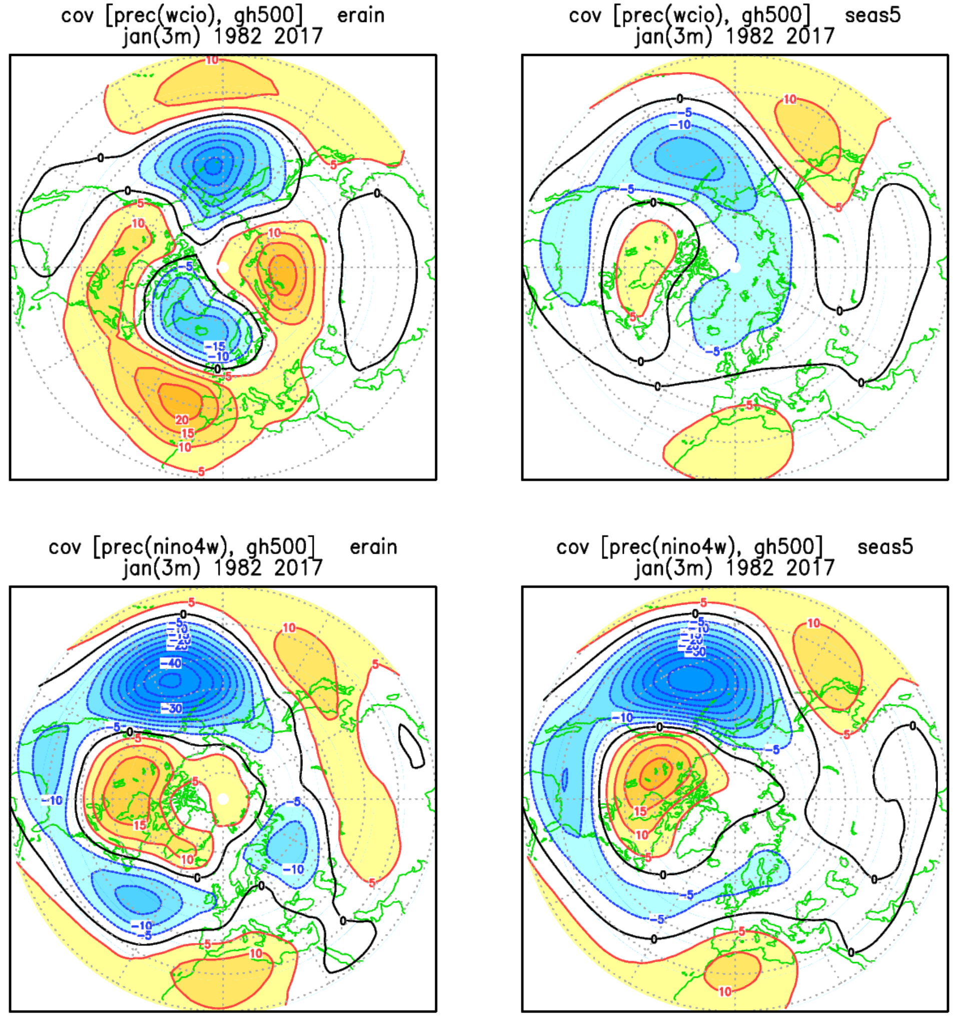
lore info in:

- Stephanie Johnson's presentation on Seas5 this afternoon
- Johnson S. et al.: SEAS5: The new ECMWF seasonal forecast system. *Geosci. Model Dev.* (submitted)
- Roberts C. et al.: Climate model configurations of the ECMWF Integrated Forecast System (ECMWF-IFS cycle 43r1) for HighResMIP. *Geosci. Model Dev.* 2018, doi:10.5194/gmd-11-3681-2018

ECMWF

Seas5: zonal-mean bias, weak teleconnections from Indian Oc. Rainfall in DJF





WC

40E-

10S-

Ninc

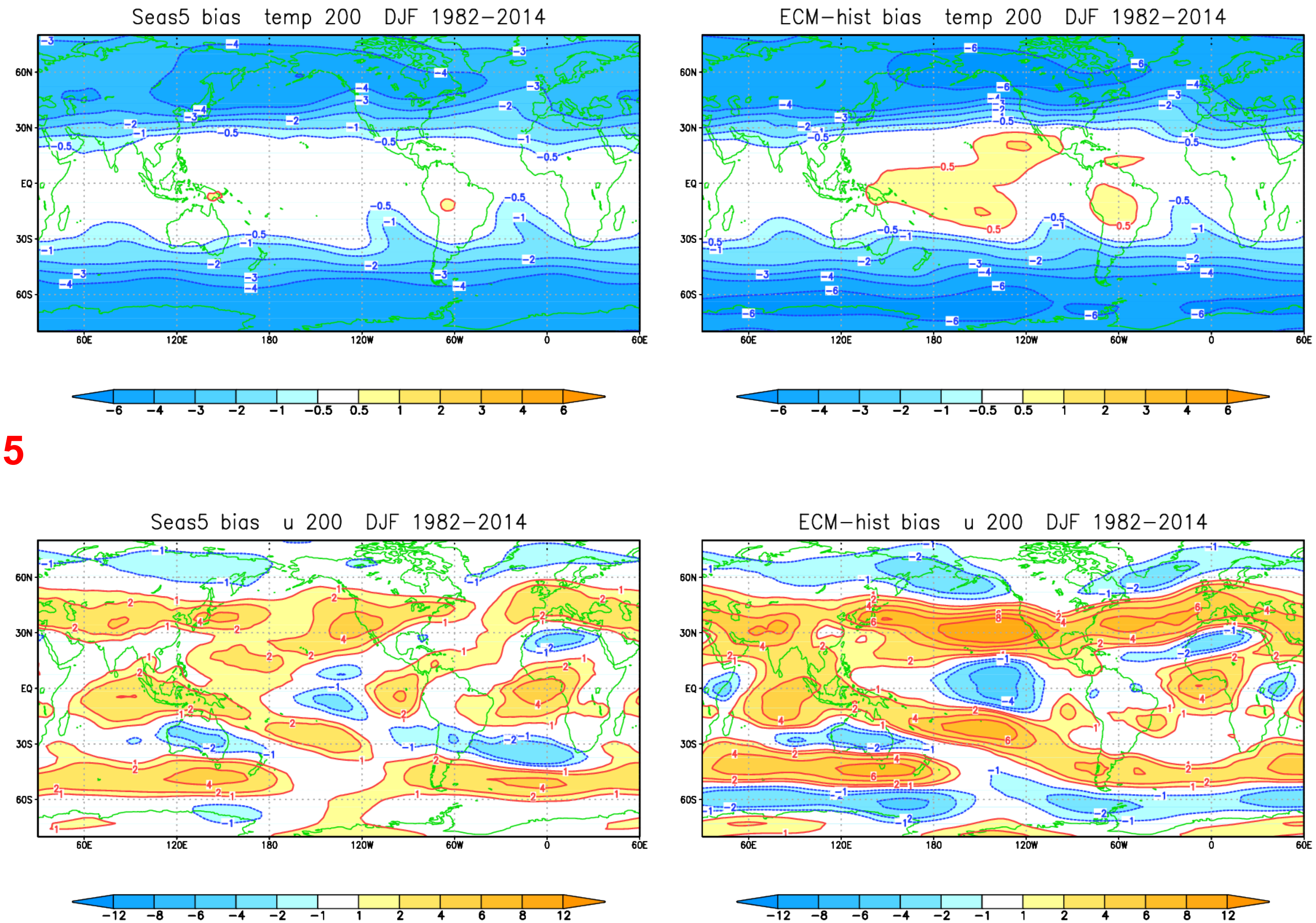
160E-1

10S-

ERA-Int Seas5

ECMWF

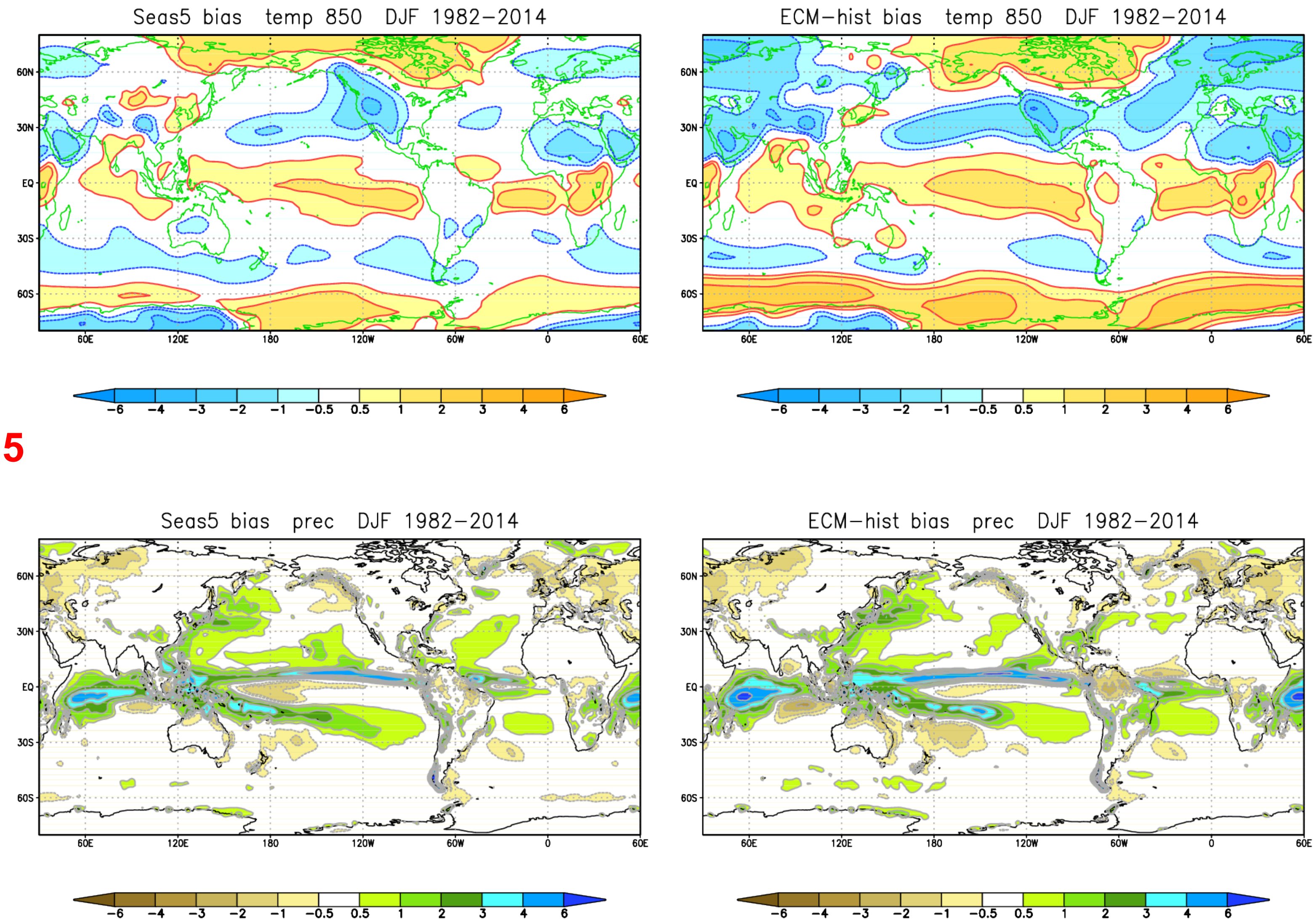
DJF model biases at 200 hPa (T, u)



Seas5

ECM-hist

DJF model biases in T 850-hPa and precipitation

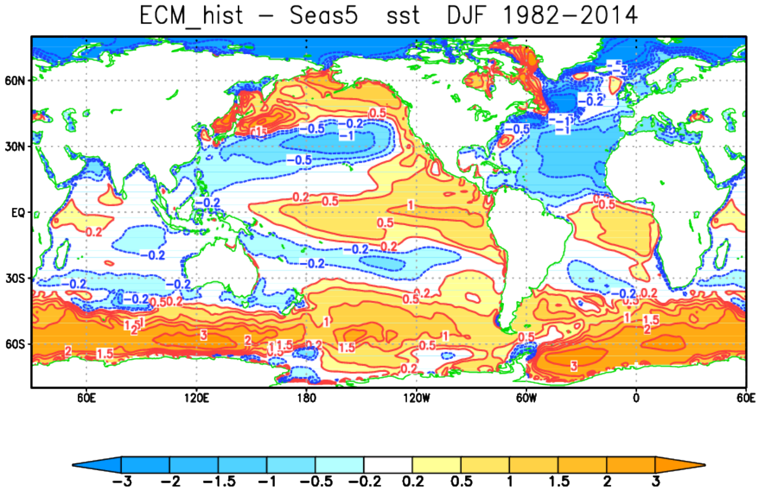


Seas5

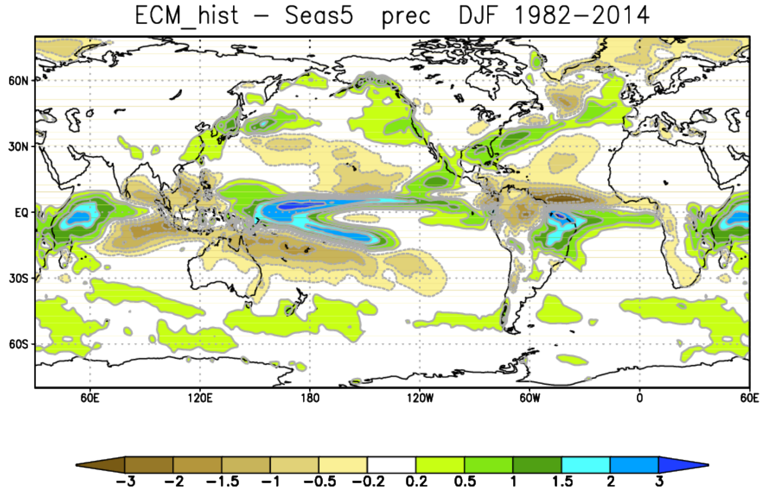
ECM-hist

Differences in DJF model climate: PRIMAVERA historical – Seas5

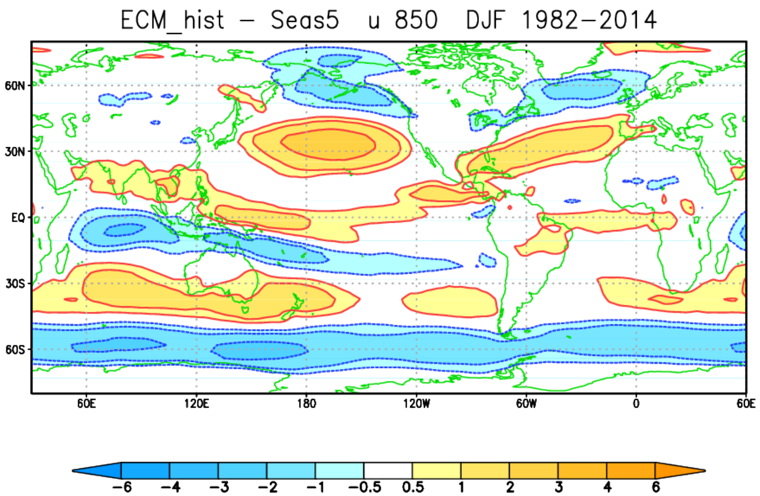
SST



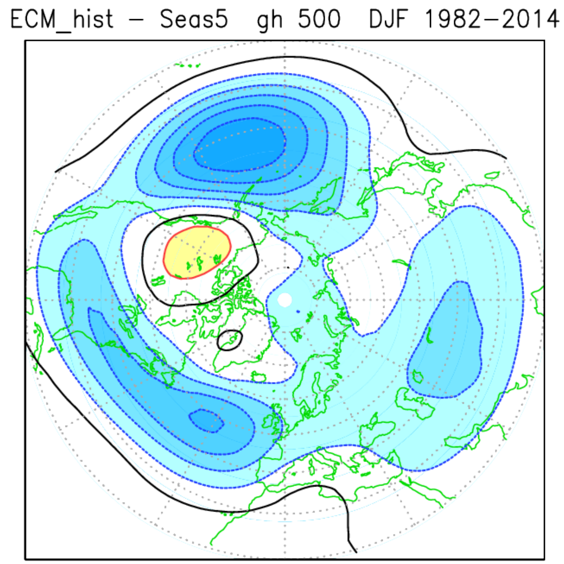
Precip



U 850



Z 500

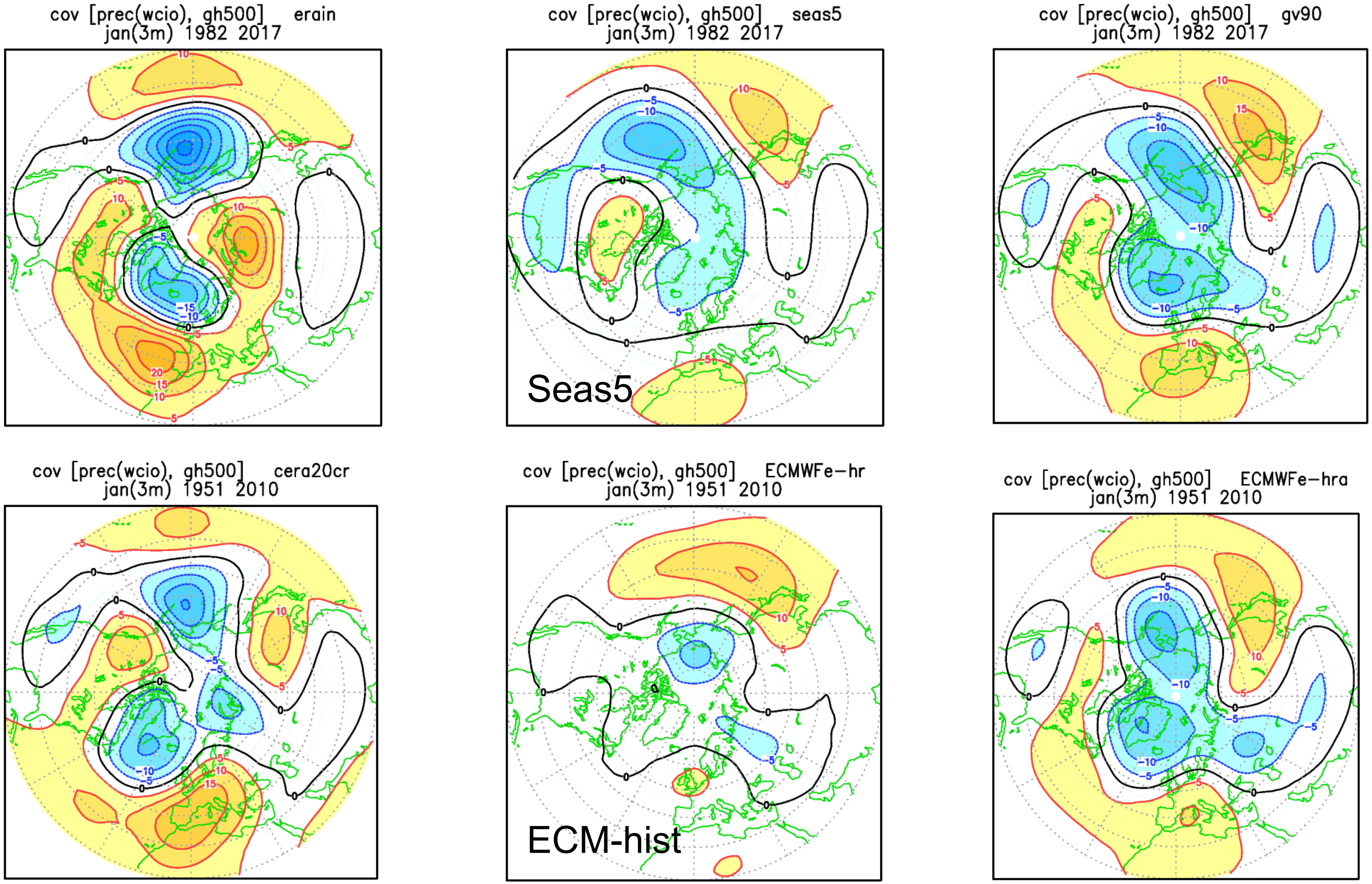


ECMWF

Indian Ocean teleconnections: coupled vs. obs SST experiments

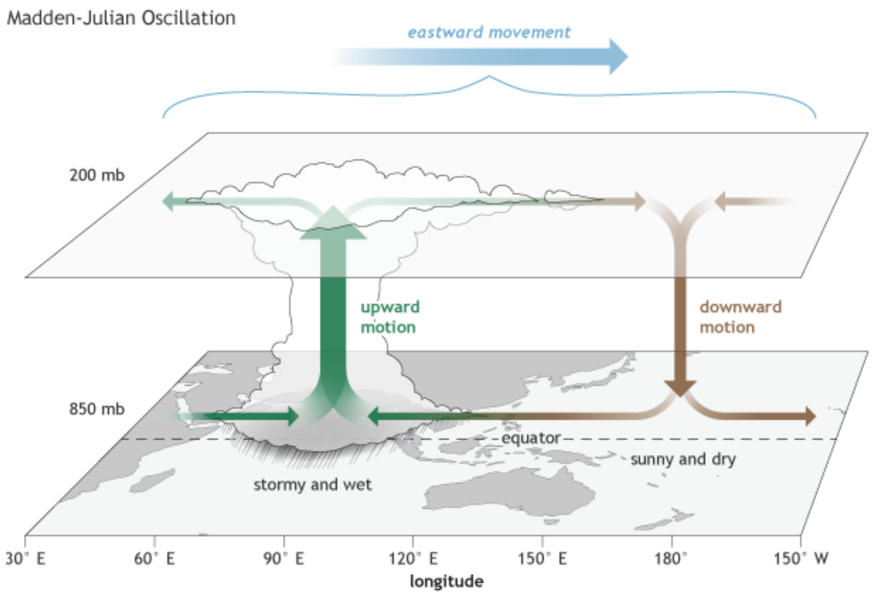
ERA Int

ERA20C



ECMWF

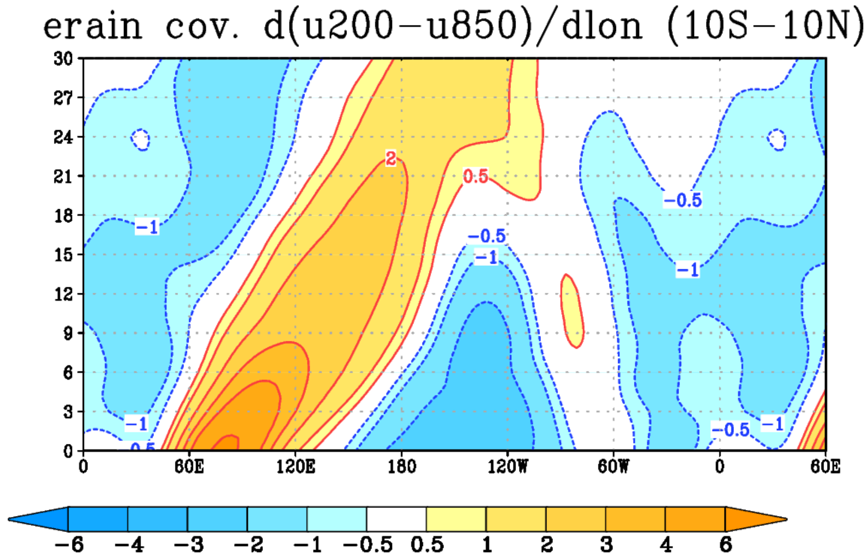
Diagnostics of MJO propagation and teleconnections

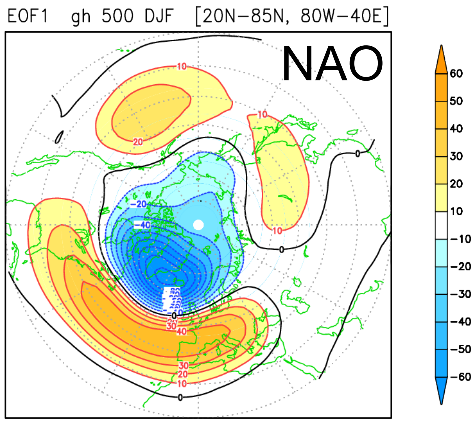


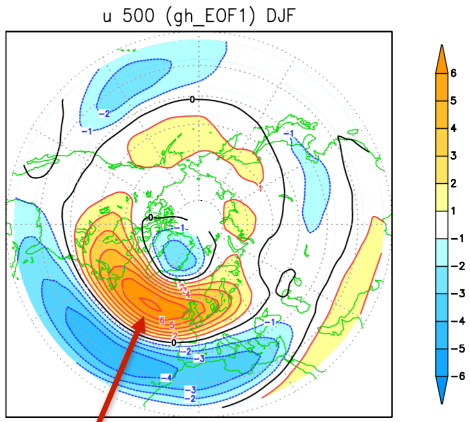
$\partial u_{200}/\partial\lambda$

$- \partial u_{850}/\partial\lambda$

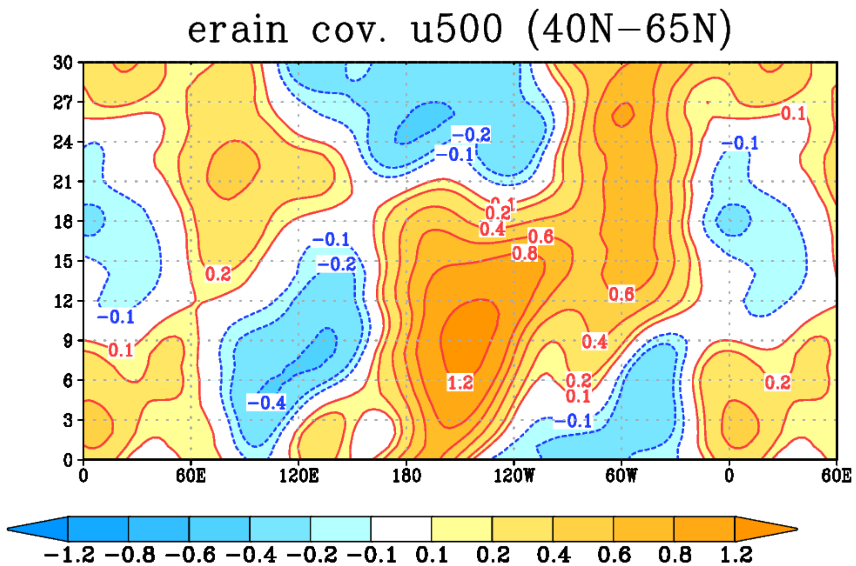
[10S-10N]





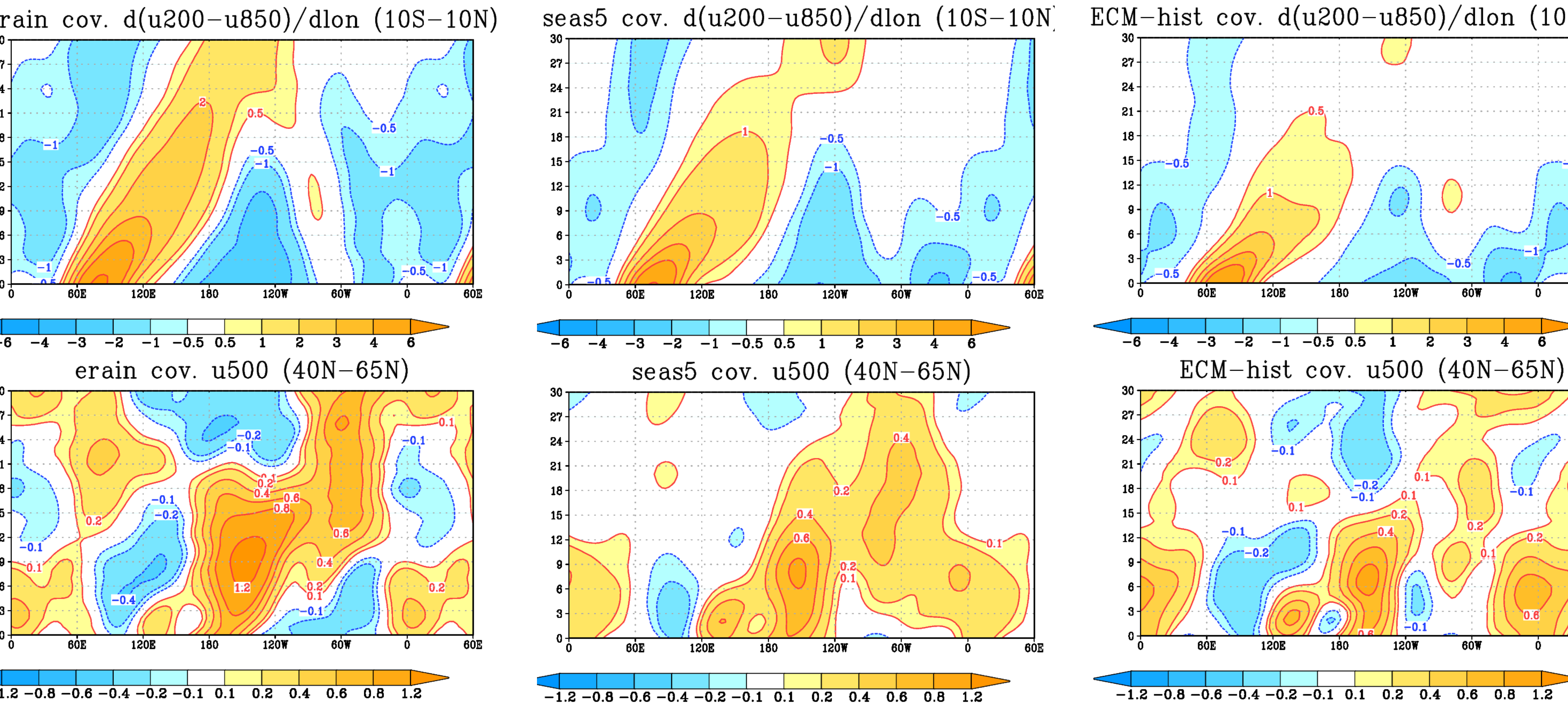


u_{500} [40N-65N]

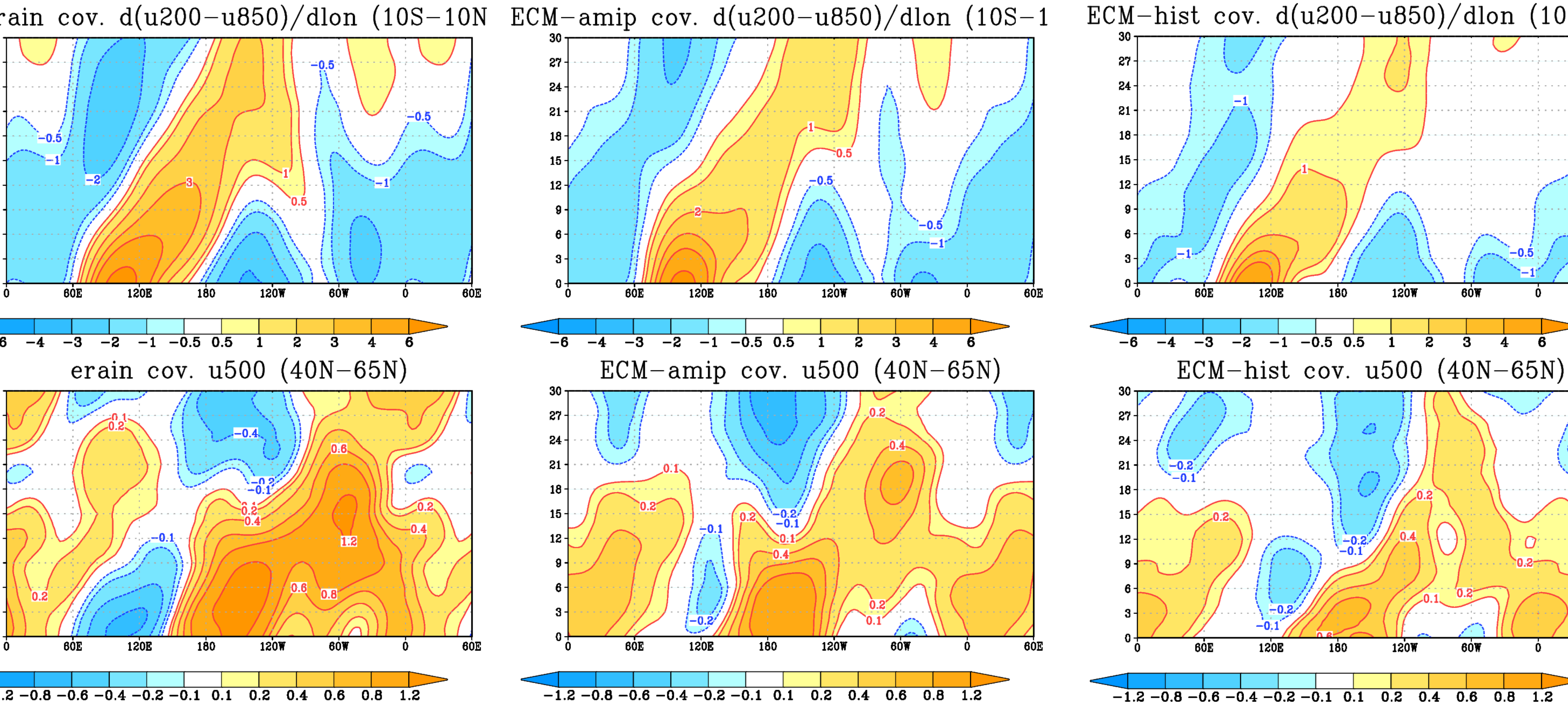


ECMWF

MJO propagation and teleconnections from 75 E



MJO propagation and teleconnections from 105 E



Summary

- Most of the systematic errors in the atmospheric mean state and in the simulation of interannual & intraseasonal variability detected in multi-decadal historical simulations are also present in seasonal re-forecasts made with same version of the ECMWF coupled model.
- Teleconnections associated with seasonal (DJF) rainfall anomalies in the Indian Ocean are poorly represented in both types of simulations, whereas teleconnections from the Nino4 regions are well simulated.
- On both scales, simulations with prescribed, observed SST produce Indian Ocean teleconnections in much better agreement with observations.
- The seasonal-scale teleconnection deficiency is likely to be related to problems in properly representing MJO propagation across the tropical Indian and West Pacific oceans in long integrations of the coupled model.