The Madden-Julian oscillation in ECHAM6

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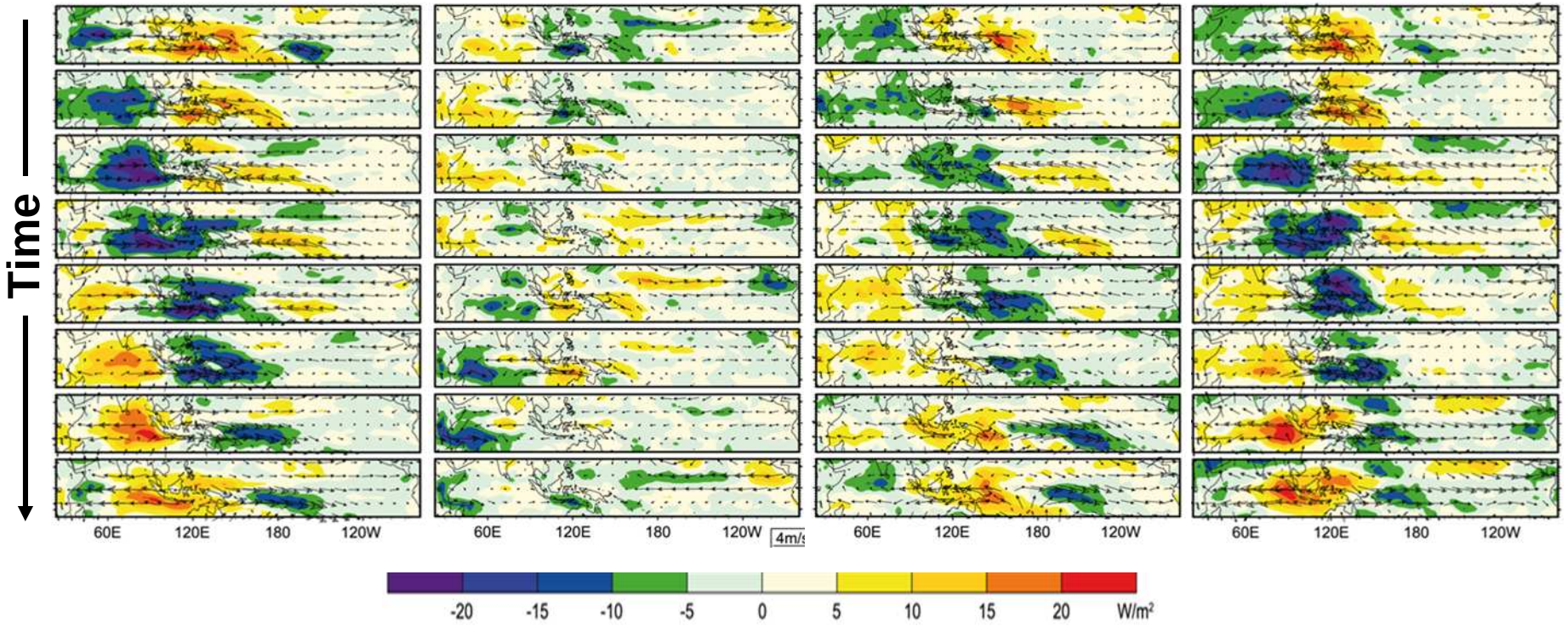
Extremes of MJO-like variability in ECHAM6

ERA40 (1980-1999) **AMIP-TIEDTKE T63L47** **AMIP T63L47** **Coupled T127L95**



OLR: colors 850 hPa winds: arrows

How does MJO-like variability depend on:

- Convection scheme
- Coupling to an ocean model?
- Resolution

How to assess MJO-like variability?

- Quantities that represent MJO-like variability?

→ CLIVAR MJO diagnostics

→ Ensemble of ECHAM6 simulations (coupled, AMIP)

Model

Atmosphere: ECHAM6

Tiedtke scheme with Nordeng modifications

New:

- Shortwave radiation scheme
- Aerosols, albedo
- Better representation upper troposphere/stratosphere

Ocean: MPI-OM

- 40 vertical levels,
- 1.5° or 0.4° horizontal resolution

Experiments

		T127L95 (1°)	T63L95 (1.9°)	T63L47
Reanalysis/AVHRR	4			
Coupled		9	6	10
AMIP		4	1	6
AMIP-TIEDTKE				1

Experiments of one group: Only slight changes

AMIP: SST forced with observed monthly SST

AMIP-TIEDTKE: AMIP without Nordeng‘s modifications

CLIVAR MJO diagnostics

(Waliser et al. 2009)

→ Tropical OLR and zonal winds in 200 and 850 hPa

Quantities:

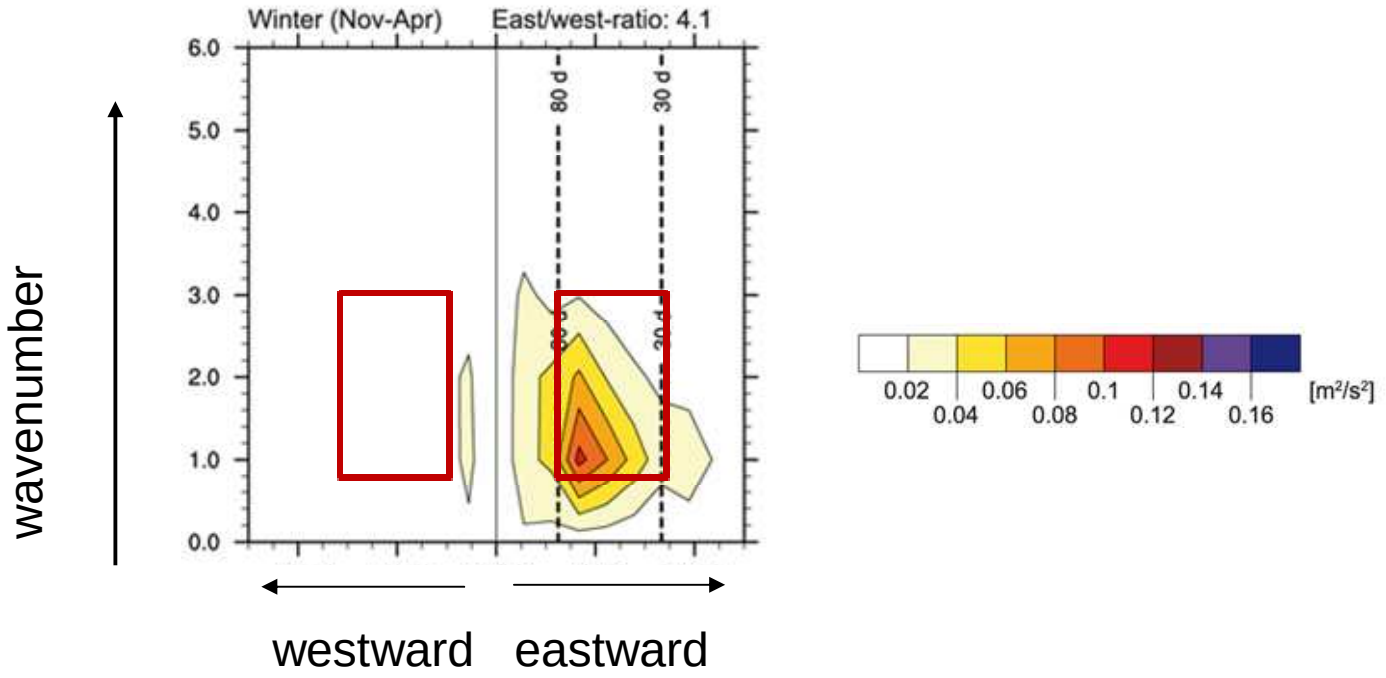
1.) Eastward propagation: Wave-number frequency spectra,Spectral power east/west ratios in MJO-ranges (R)

2.) Convection strength: Fractional explained variances of intraseasonal variability (F) Multivar. EOF

20-year periods

Wave-number frequency spectra

ERA40 Zonal wind (850 hPa)

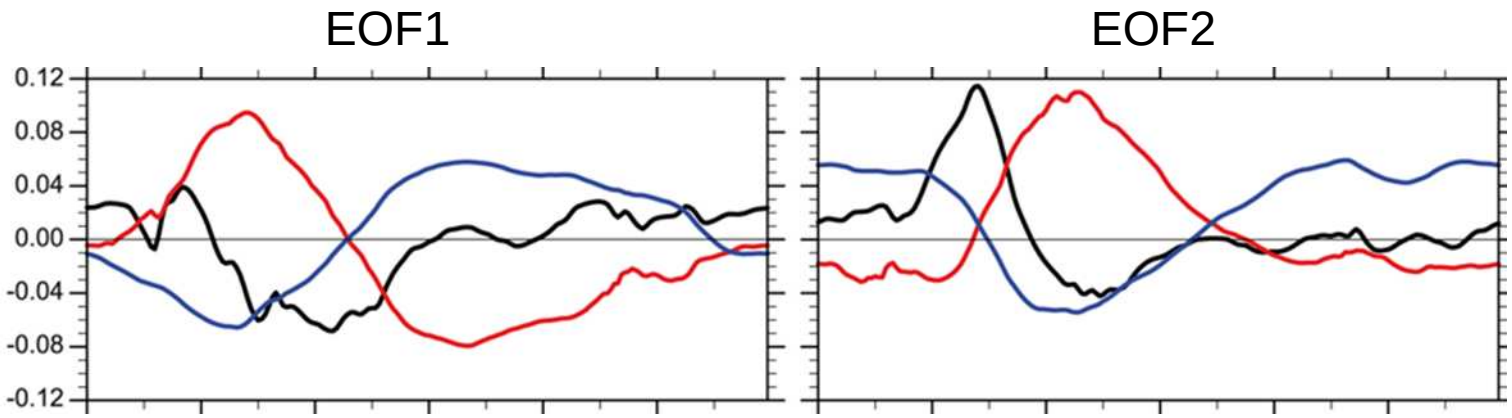


Spectral power east/west ratios in MJO-ranges:

OLR: 2.8, u(850hPa): 4.1; u(200hPa): 3.5

Multivariate EOF – ERA40

(tropical OLR, 200 & 850 hPa zonal winds, 20-100-day filtered)



Fractional explained variances of intraseasonal variability (sum of EOF1 and EOF2)

OLR: 24.2%; u(859hPa): 55.3%; u(200hPa): 41.6%

Spectral power east/west ratios (R)

	R_{OLR}	R_{u850}	R_{u200}	R_{mean}
ERA40	2.8	4.1	3.5	3.5
AMIP-TIEDTKE	0.7	0.6	0.9	0.7
AMIP T63L47	1.2	1.7	2.3	1.7
Coupled T127L95	2.5	3.4	3.1	3.0

→ Generally too low

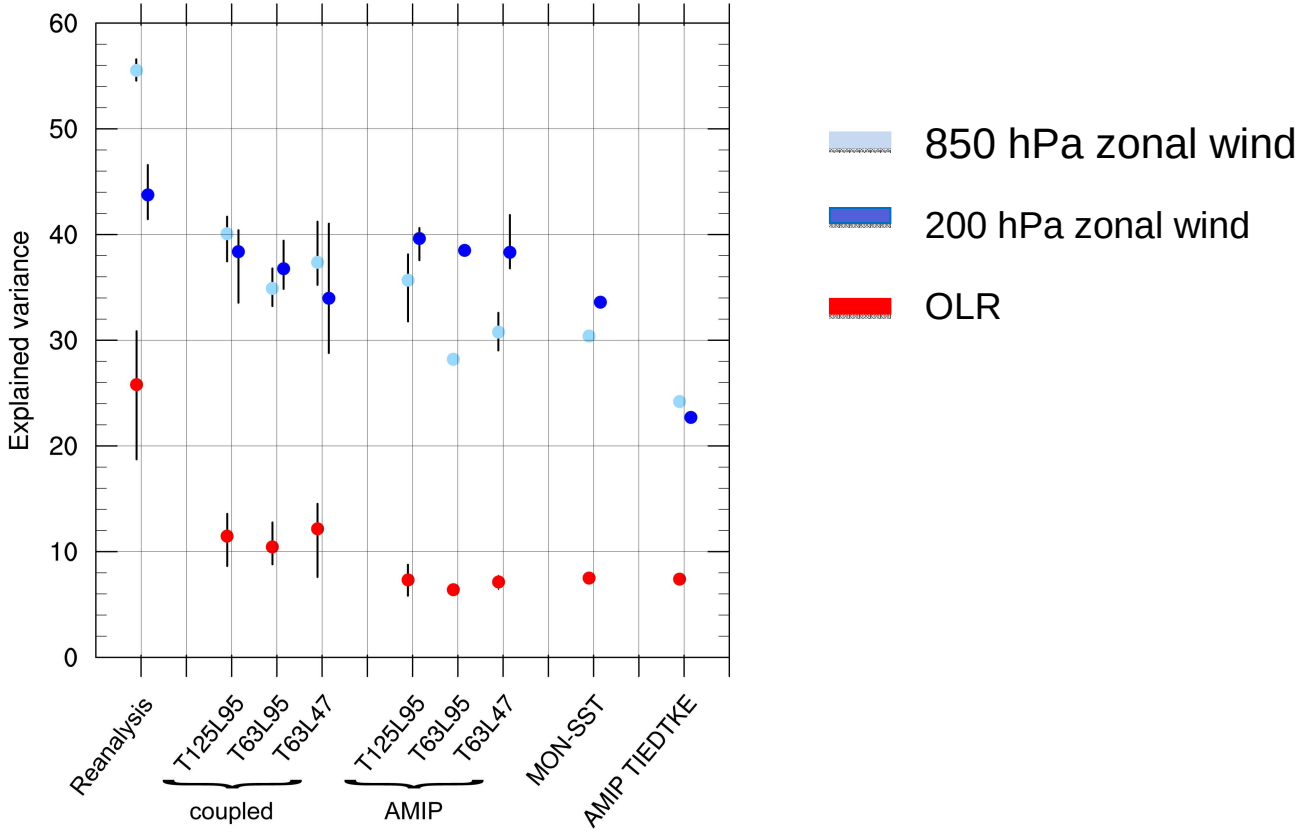
→ R<1 for AMIP TIEDTKE

Fractional explained variances of intraseasonal variability (F)

	F_{OLR}	F_{u850}	F_{u200}	F_{mean}
ERA40	24.2	55.3	41.6	40.4
AMIP-TIEDTKE	7.4	14.2	22.7	18.1
AMIP T63L47	6.6	30.4	38.3	25.1
Coupled T127L95	11.7	41.3	40.1	30.9

Generally too low, especially F_{OLR}

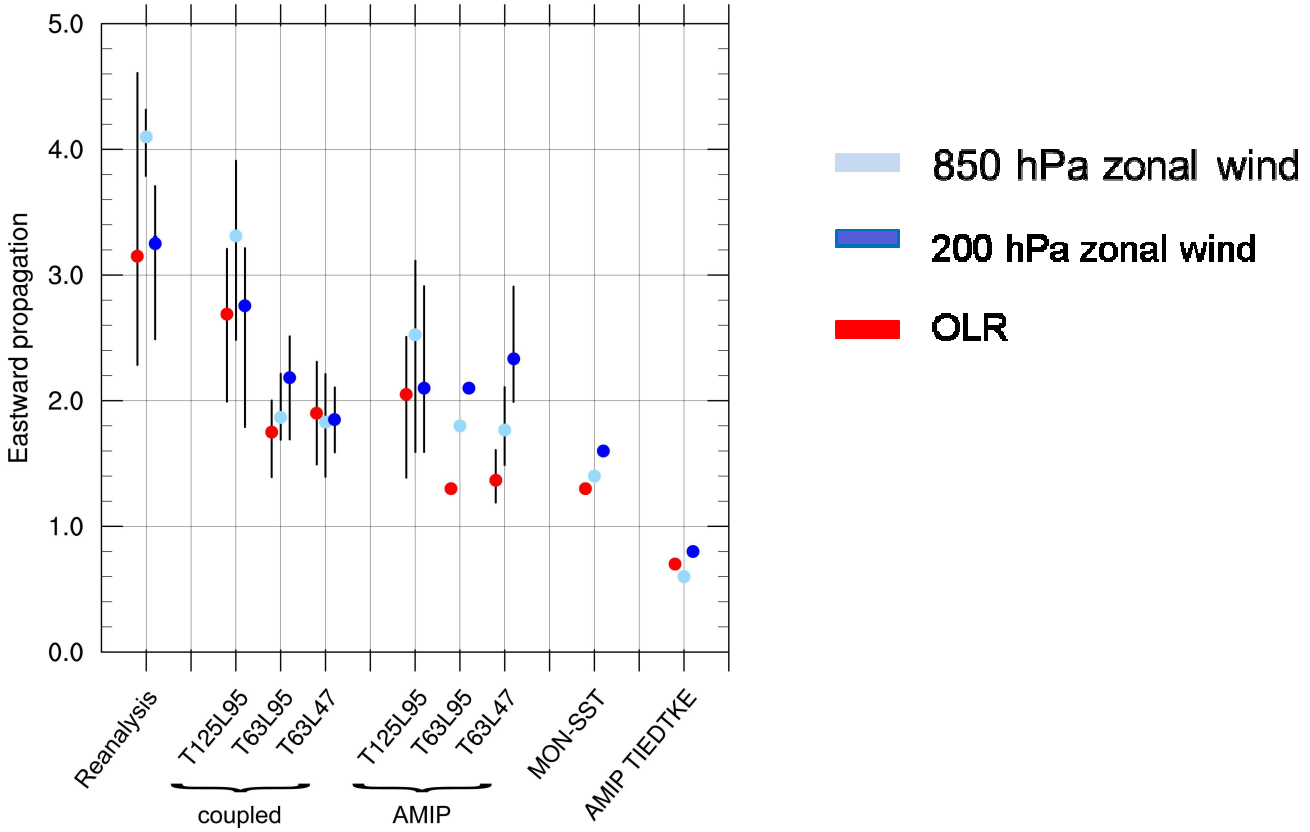
Fractional explained variances (F) (convection stength)



→ F_{OLR} dependent on coupling, hardly on resolution

→ F_{u200}, F_{u850} also dependent on resolution

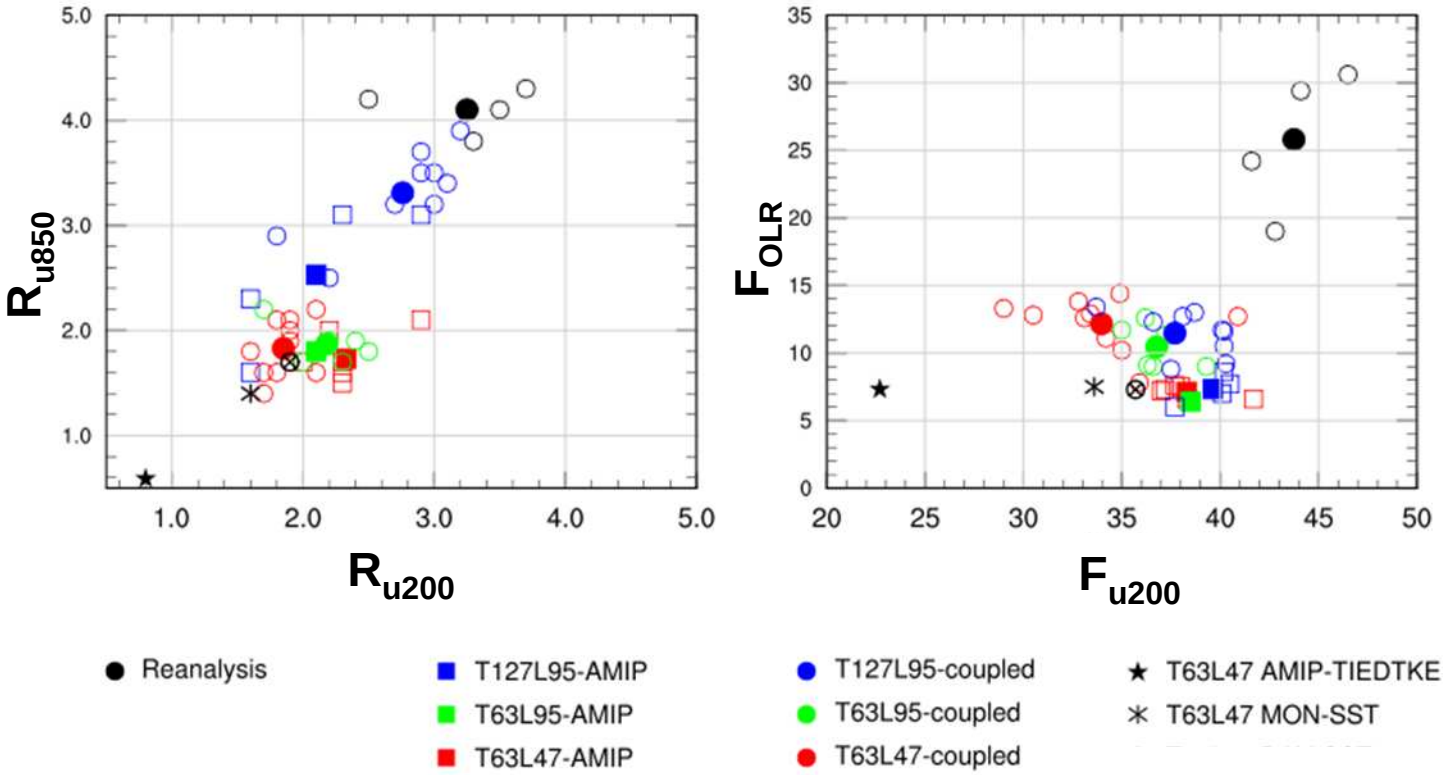
Spectral power east/west ratios (eastward propagation)



→ dependent on resolution

→ more pronounced in coupled simulations

One quantity sufficient to quantify MJO?



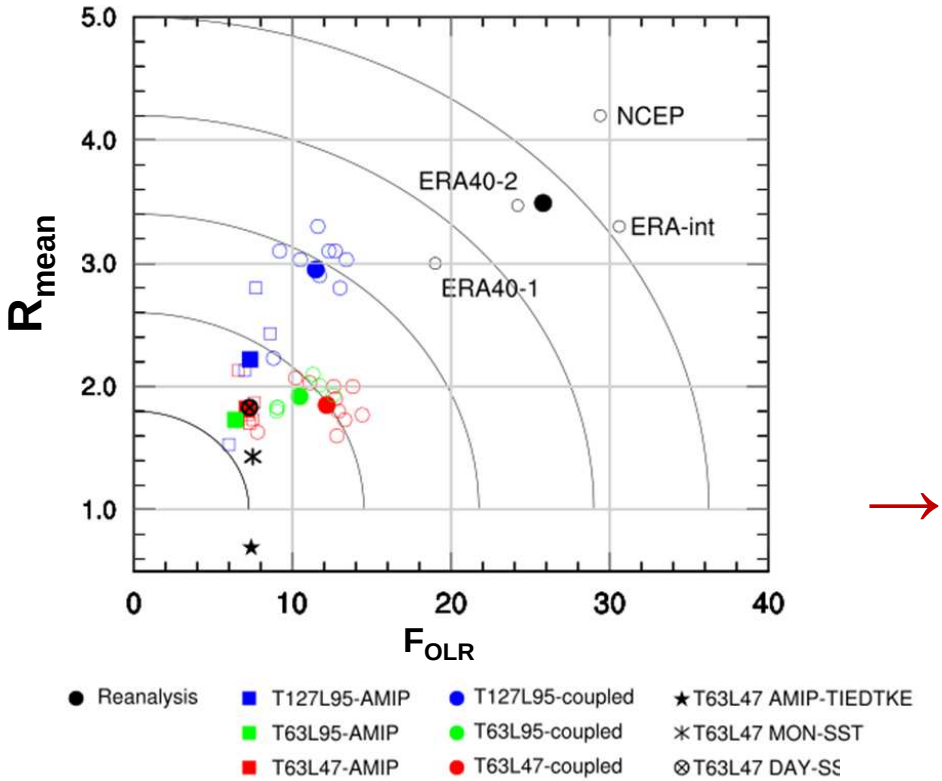
No! Often correlation exists …..

…but not generally: F_{OLR} decoupled

MJO-diagram

Basic MJO characteristics:

- Eastward propagation (mean of R_{OLR}, R_{u200}, R_{u850})
- Convective signature (F_{OLR})



→ R_{mean} and F_{OLR} decoupled

MJO-score

Most important MJO characteristics

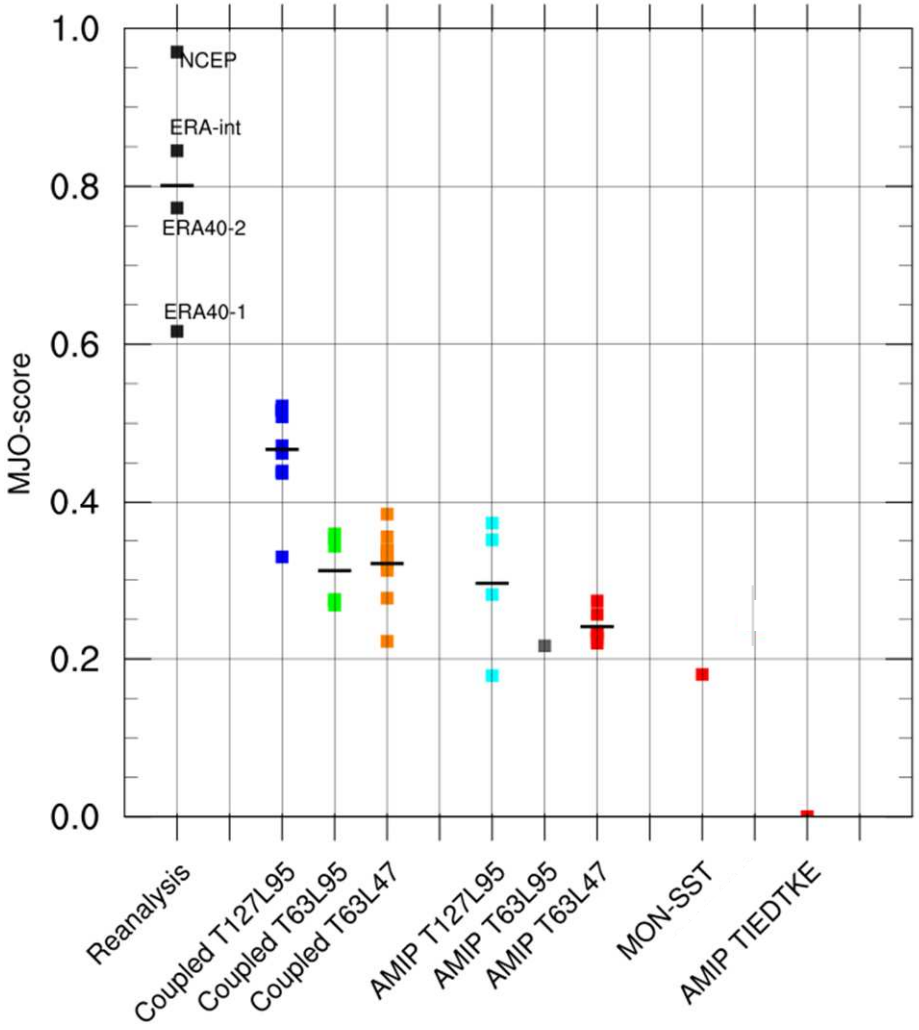
- Eastward propagation R_{mean}(mean of R_{OLR}, R_{u200}, R_{u850})
- Convective signature (F_{OLR})

$$MJO_{sc} = \sqrt{[\max(1, R_{mean}) - 1] \times F_{OLR} / 100}$$

MJO_{sc} = 0, if R_{mean} < 1

decoupled

MJO scores for ECHAM6 experiments



Summary

- ECHAM6 represents MJO-like variability (Tiedtke/Nordeng).
- Spread of MJO-like variability, similar to reanalysis.
- Improving mean state, more sophisticated model (surface coupling, resolution) strengthens MJO-like variability:

  → T127L95 coupled version reveals highest performance.
- BUT: Convective signature too weak and decoupled from other MJO quantities
- New score to assess MJO-like variability

  → model tuning/sensitivity tests

  → MJO sensitivity to climate change.

Crueger, Stevens, Brokopf (2012) subm. J. Climate

Thank you for your attention