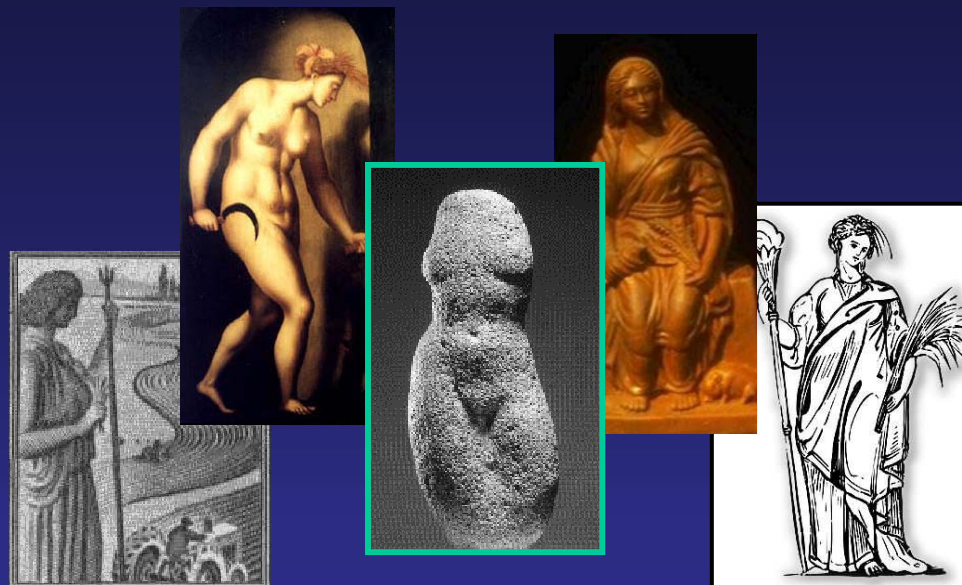
Tropical Intra-Seasonal Oscillations in the DEMETER Multi-Model System



Francisco Doblas-Reyes
Renate Hagedorn
Tim Palmer
European Centre for Medium-Range Weather Forecasts (ECMWF)

Outline

- Introduction to DEMETER
- Multi-model ensemble: a way to sample model uncertainty to increase seasonal skill
- Multi-model ensemble: a tool to diagnose model performance, the ISO case
- Summary

The idea behind DEMETER

- Growing demand for reliable seasonal forecasts
- Two main sources of uncertainty
  - X error in initial conditions
  - X error in model formulation
- Install a multi-model ensemble system
- Evaluate the skill and potential utility

Multi-model ensemble system

- DEMETER system: 7 coupled global circulation models

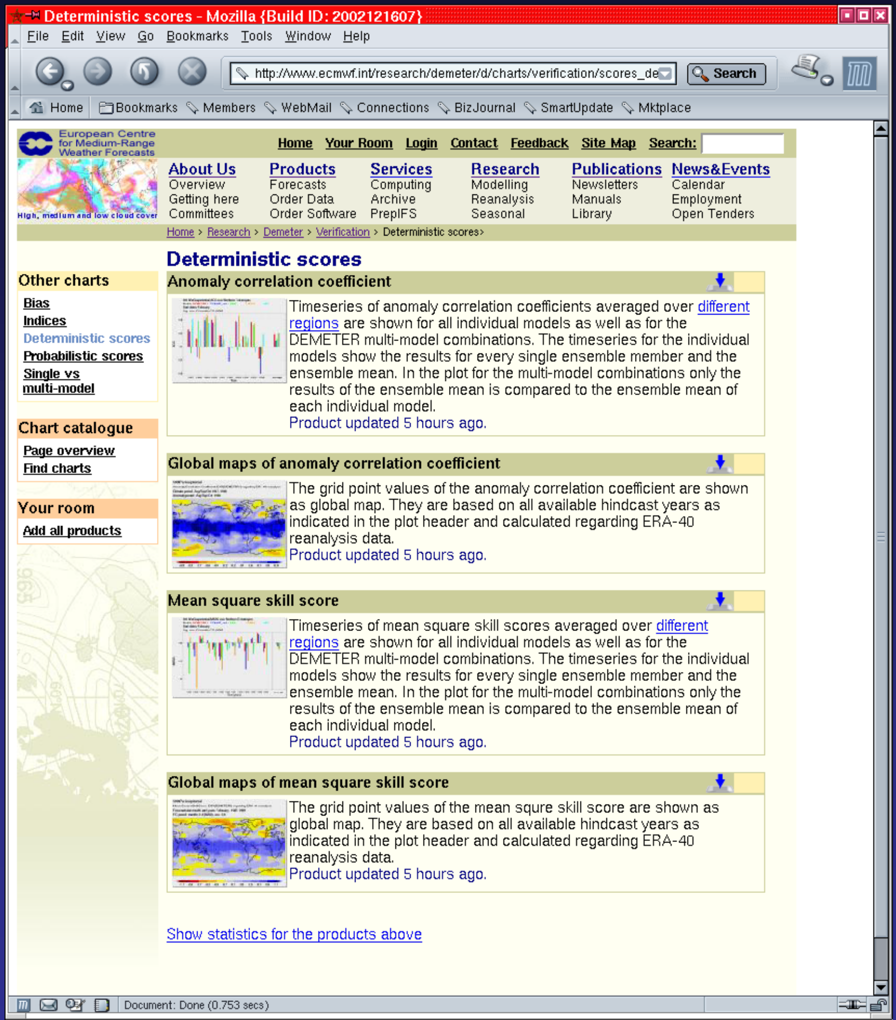
Partner	Atmosphere	Ocean
ECMWF	IFS	HOPE
LODYC	IFS	OPA 8.3
CNRM	ARPEGE	OPA 8.1
CERFACS	ARPEGE	OPA 8.3
INGV	ECHAM-4	OPA 8.2
MPI	ECHAM-5	MPI-OM1
UKMO	HadCM3	HadCM3

4 start dates per year
6 months hindcasts
9 member ensembles
3 ocean analyses, 4 ±SST pert
ERA-40: ocean forcing and atmospheric initial conditions

- Hindcast production for: 1980-2001 (1958-2001)

Verification

- Bias
- Indices
- Deterministic Scores
- Probabilistic Scores
- Single vs. multi-model
- 54-single vs. multi-model
- Ocean diagnostics



http://www.ecmwf.int/research/demeter/verification

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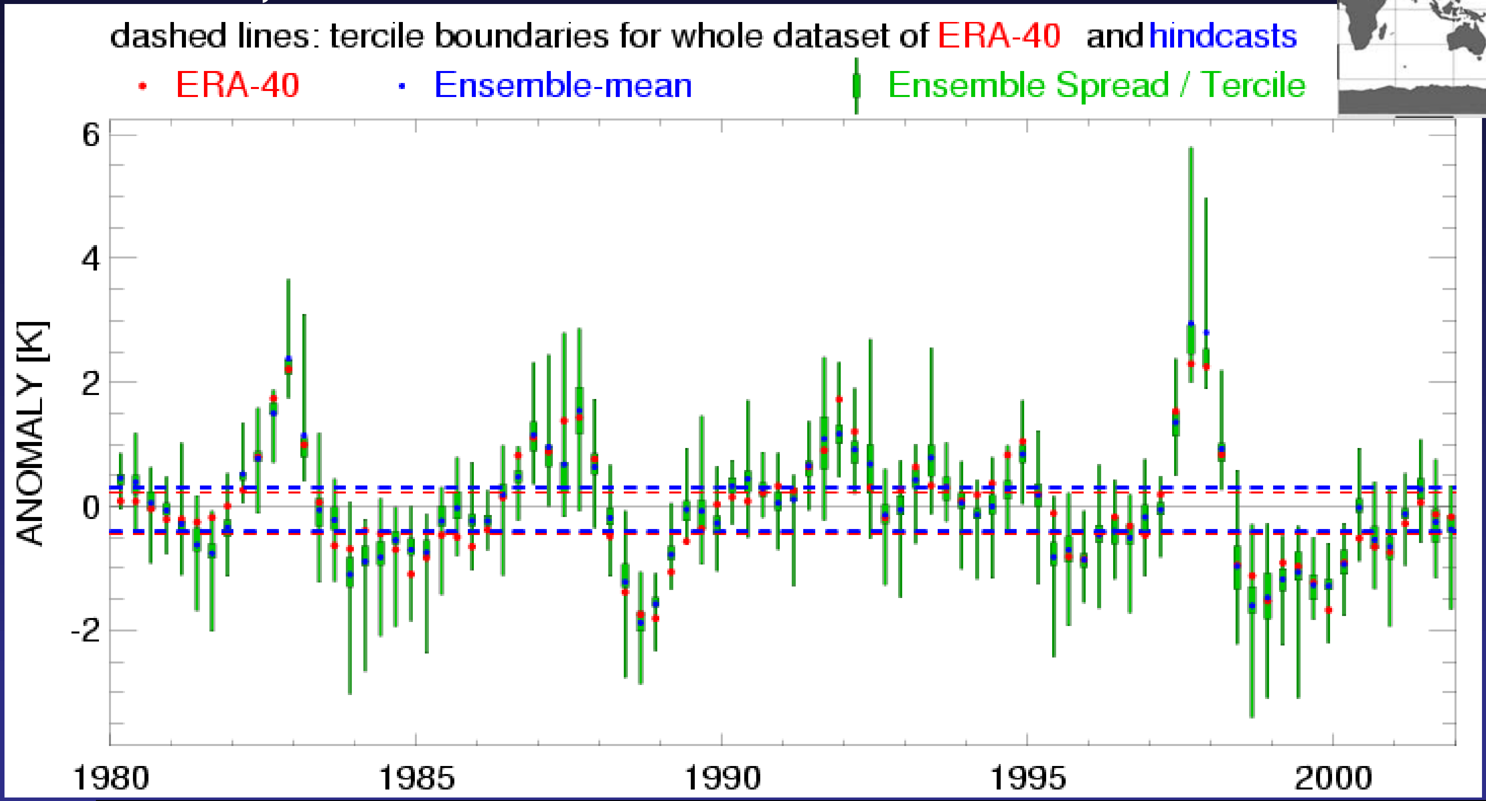
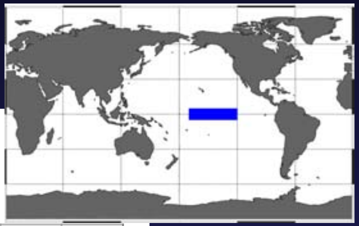
Multi-model forecast skill

Niño-3.4 SST, 2-4 month seasonal hindcasts





	Multi-Model	CERFACS	CNRM	ECMWF	INGV	LODYC	MPI	UKMO
Correlation	0.94	0.93	0.91	0.88	0.91	0.91	0.81	0.89
RPSS	0.58	0.49	0.51	0.45	0.46	0.43	0.24	0.47

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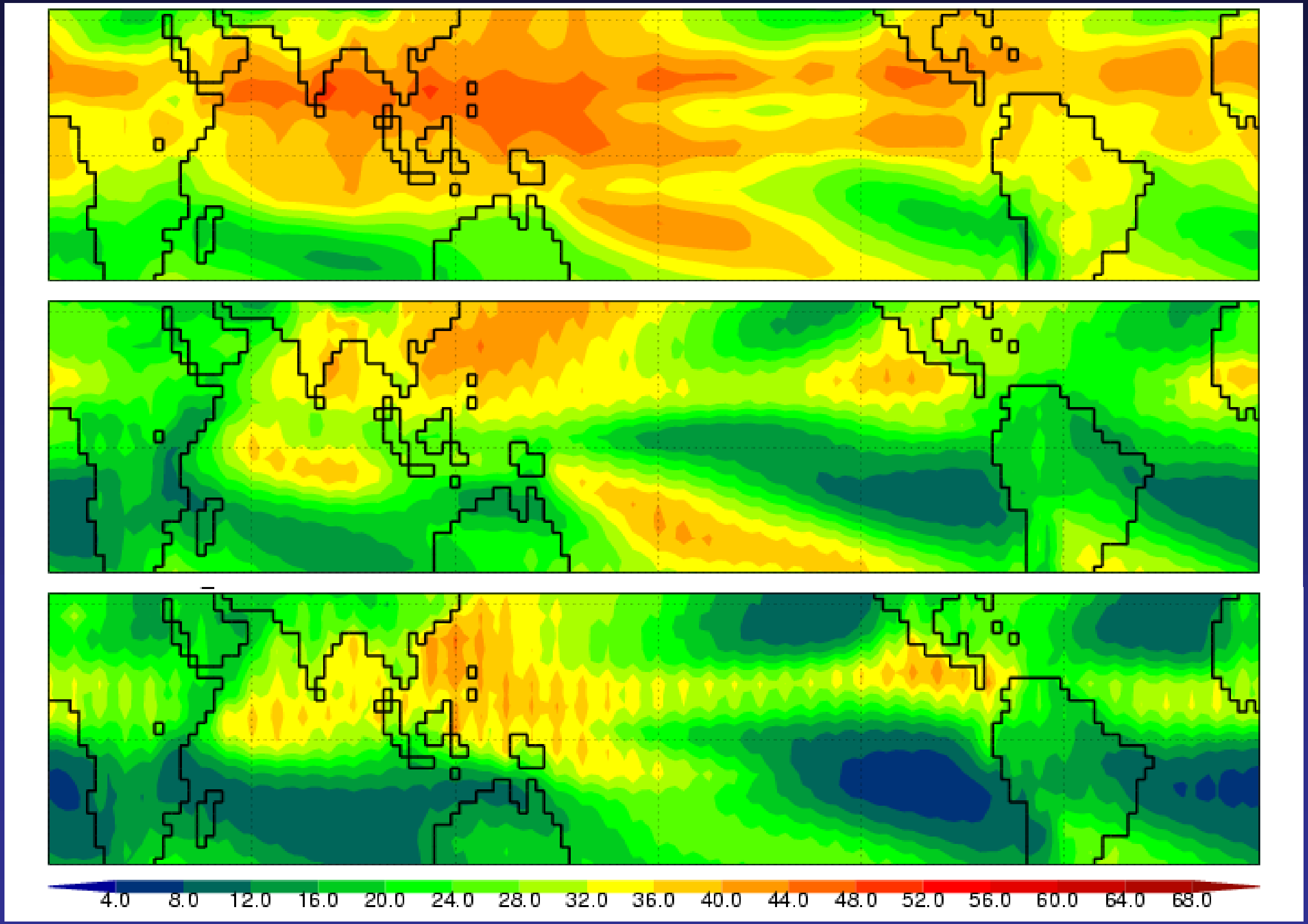
Intraseasonal SD OLR (May to Oct.)

Unfiltered data

Météo-France

Met Office

ECMWF



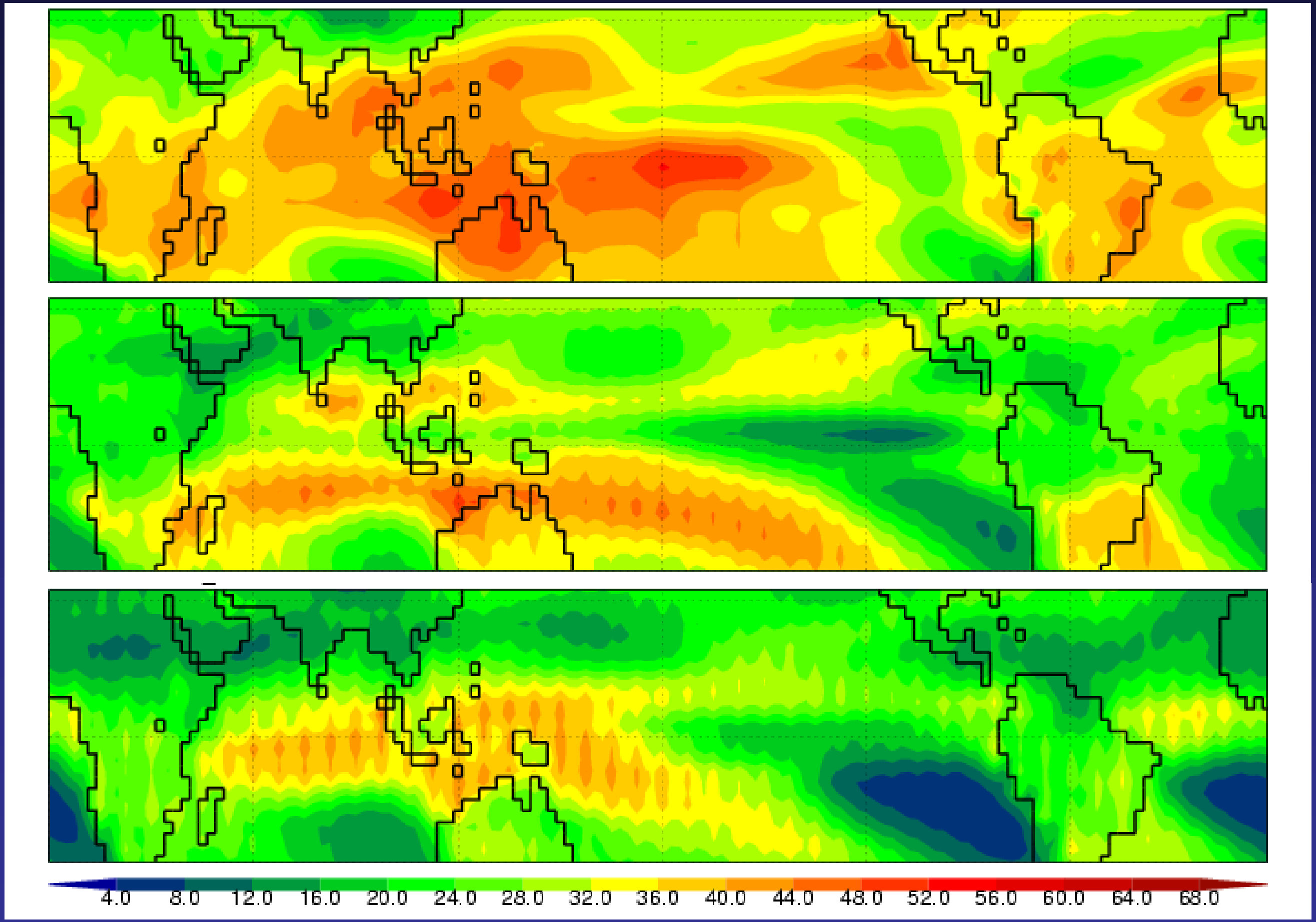
IS SD OLR (Nov. to April)

Unfiltered data

Météo-France

Met Office

ECMWF



IS SD OLR (May to Oct.)

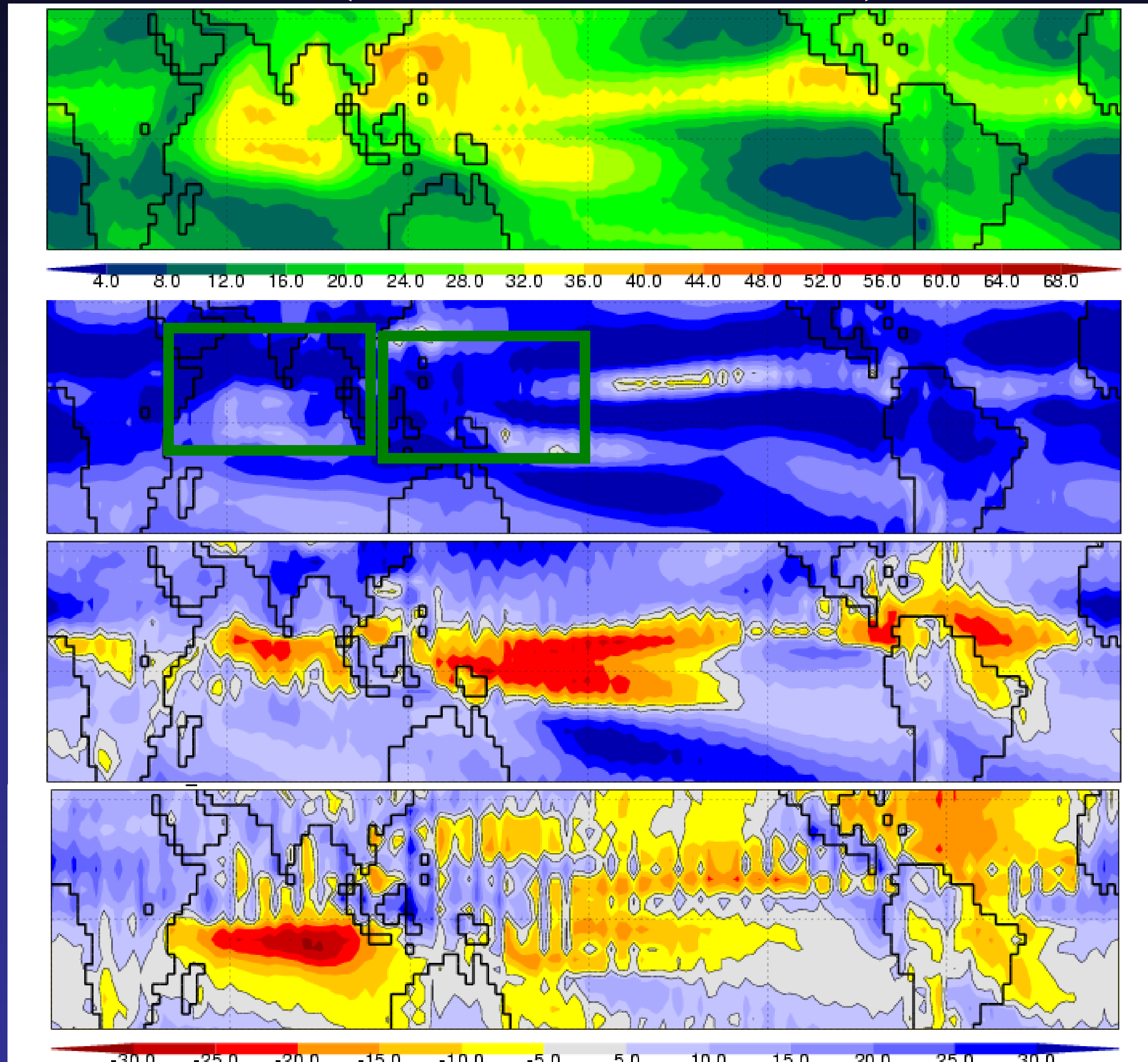
ERA40

Difference wrt ERA40 ↓

Météo-France

Met Office

ECMWF



IS SD U 10m (May to Oct.)

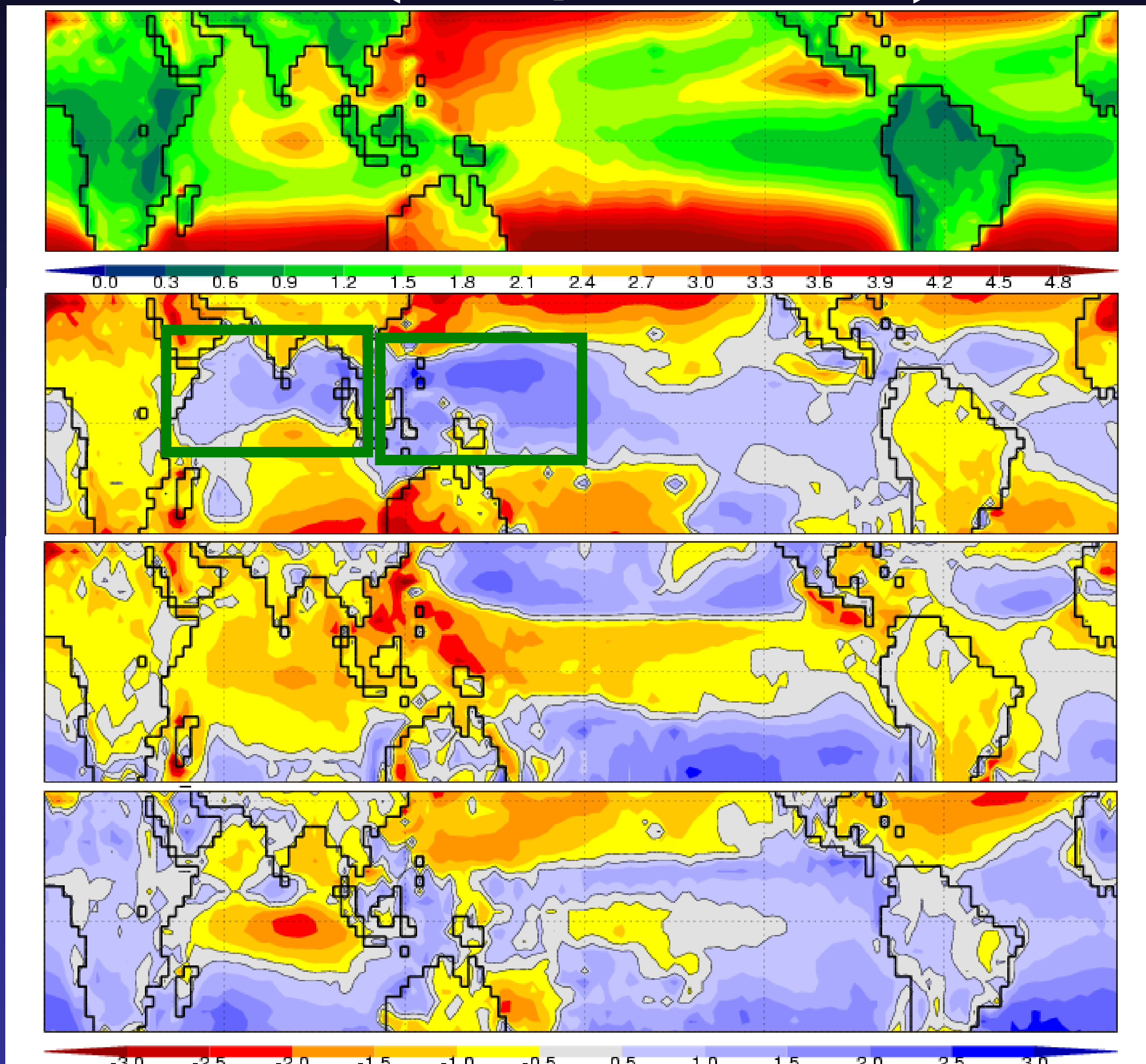
ERA40

Difference wrt ERA40 ↓

Météo-France

Met Office

ECMWF



Coupling (U 10m May to Oct.)

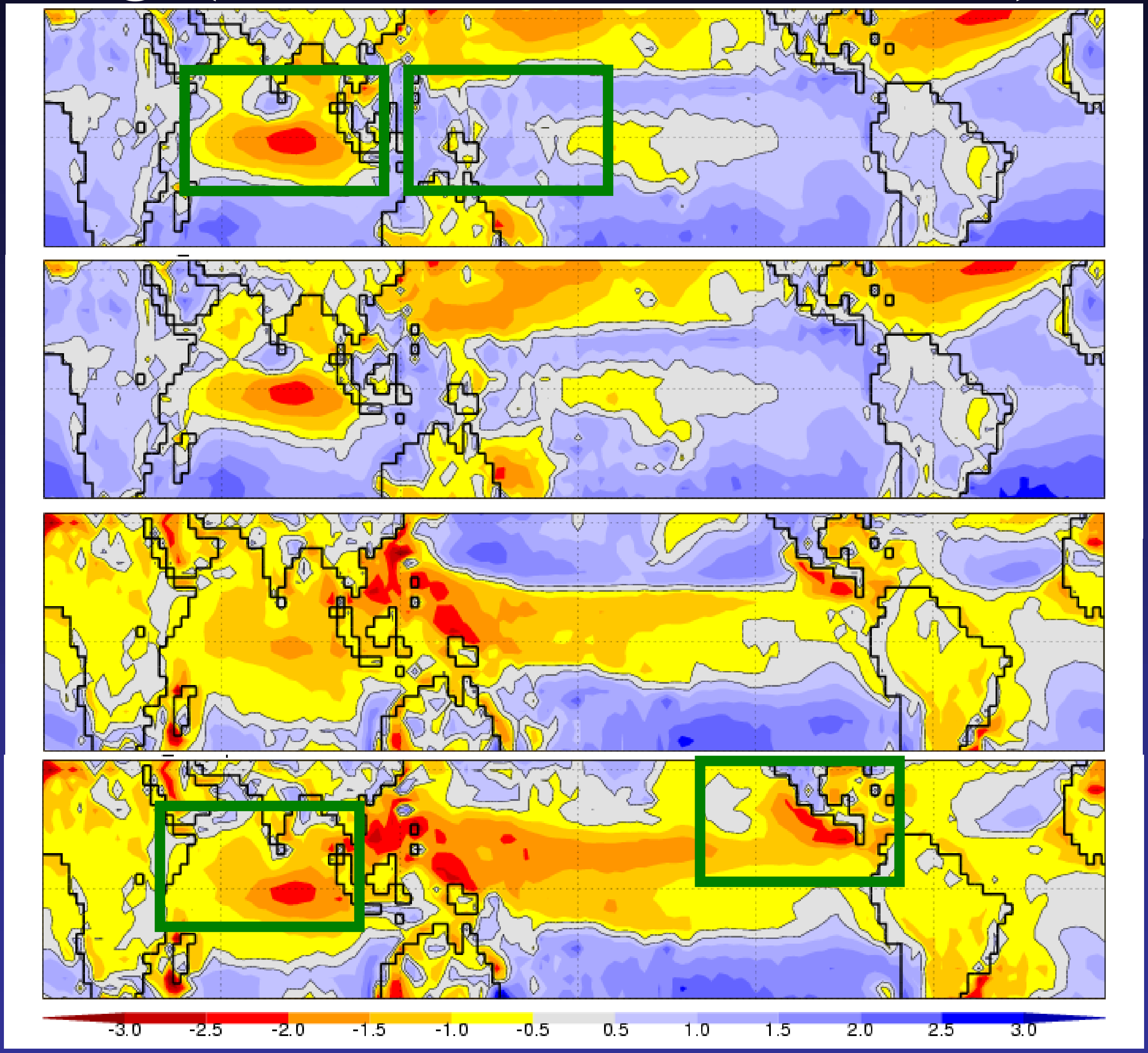
Difference wrt ERA40 ↓

LODYC (IFS+OPA)

ECMWF (IFS+HOPE)

Met Office (coupled)

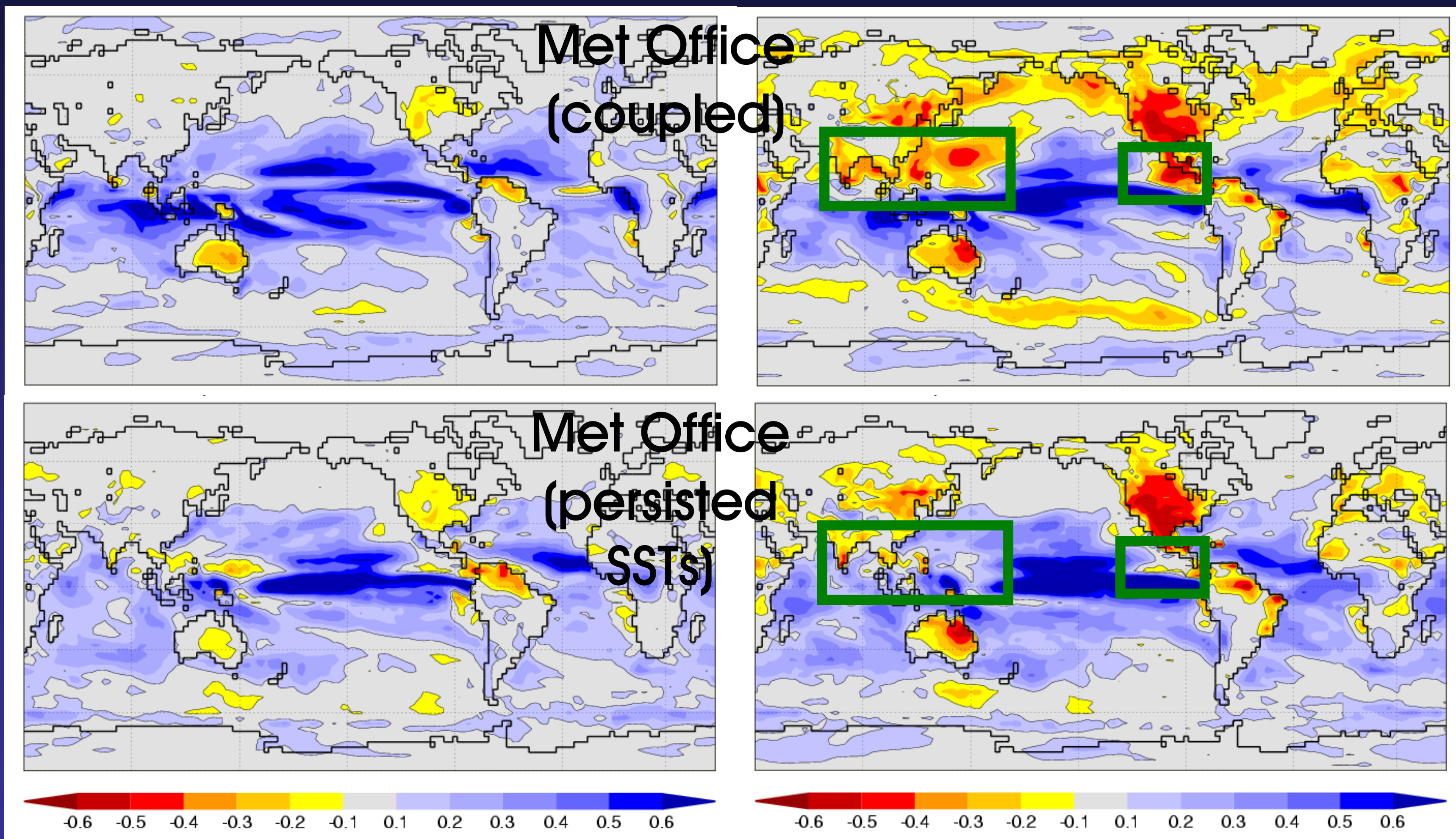
Met Office (persisted SSTs)



SST-precip. feedback (May to Oct.)

SST leading precip by 1 month

Precip leading SST by 1 month

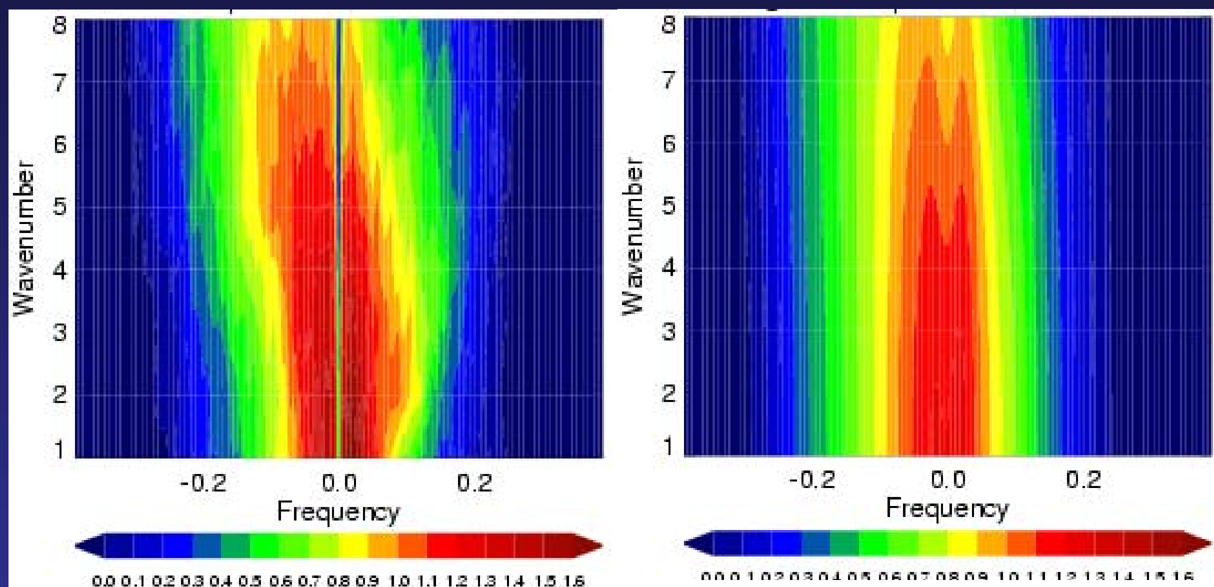


k-ω spectra (May to Oct.)

Two-sided spectrum for OLR (15°N-15°S)

Raw spectrum | Background spectrum

Symmetric component



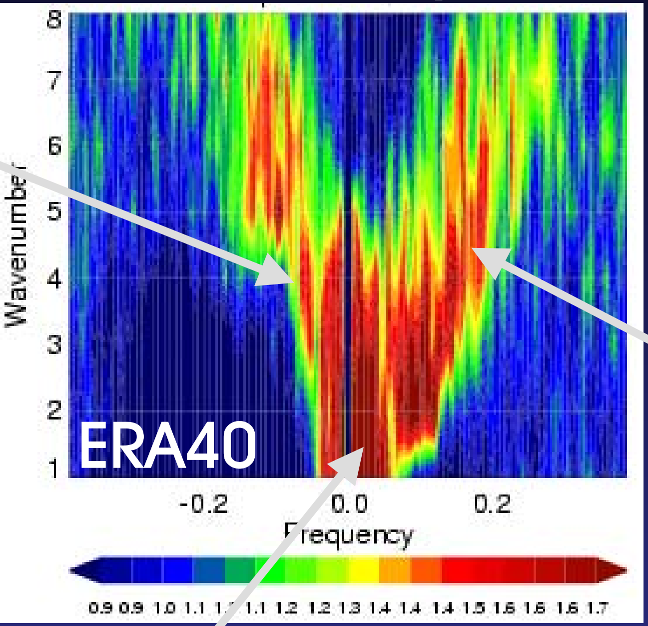
Westward ←

Eastward →

k-ω spectra (May to Oct.)

Two-sided relative spectrum for OLR (15°N-15°S)

Equatorial Rossby waves



Kelvin waves

Symmetric component

MJO

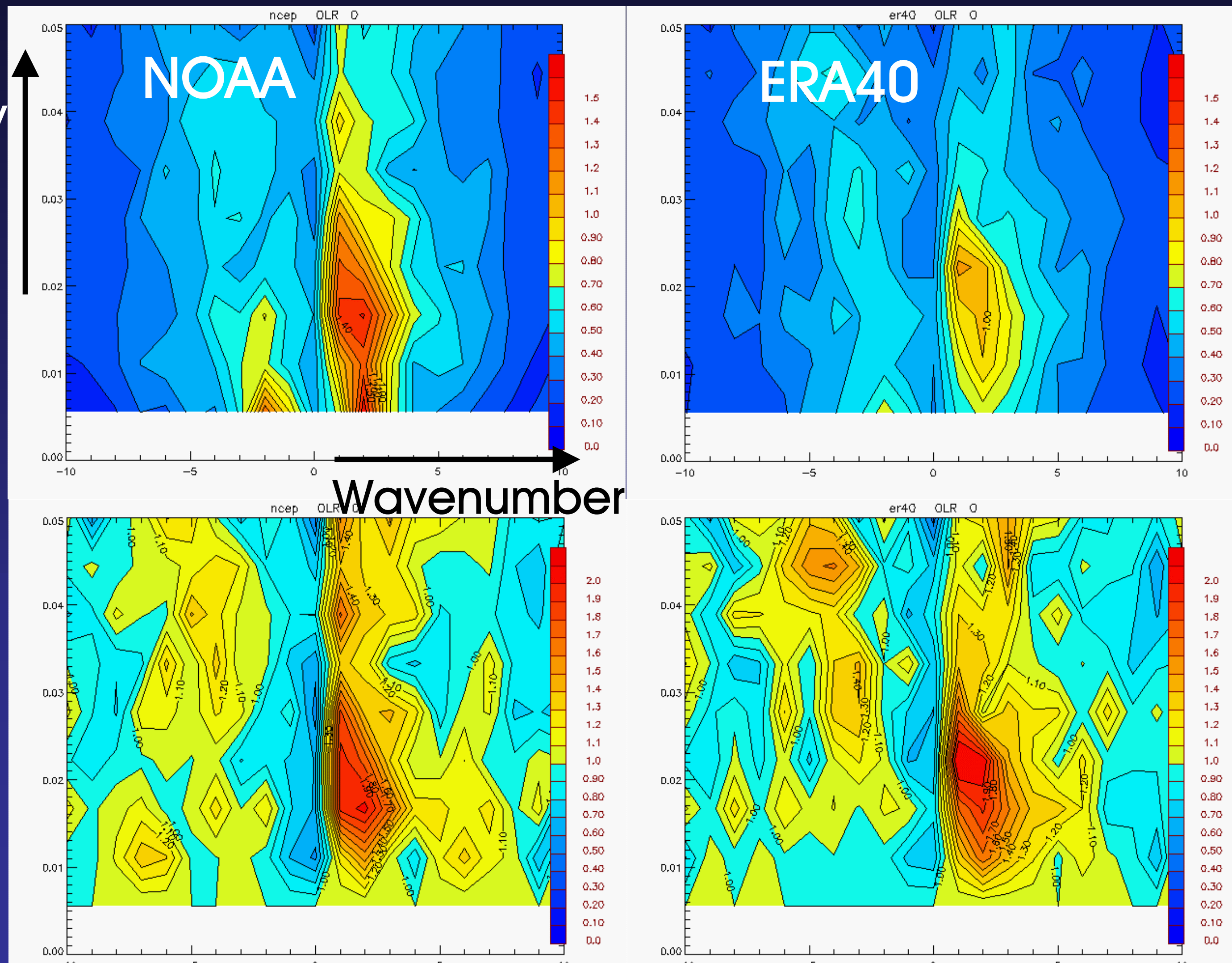
Comparison OLR ERA40-NOAA

Two-sided spectra for OLR (5°N-5°S)

Frequency

Raw spectrum

Relative spectrum

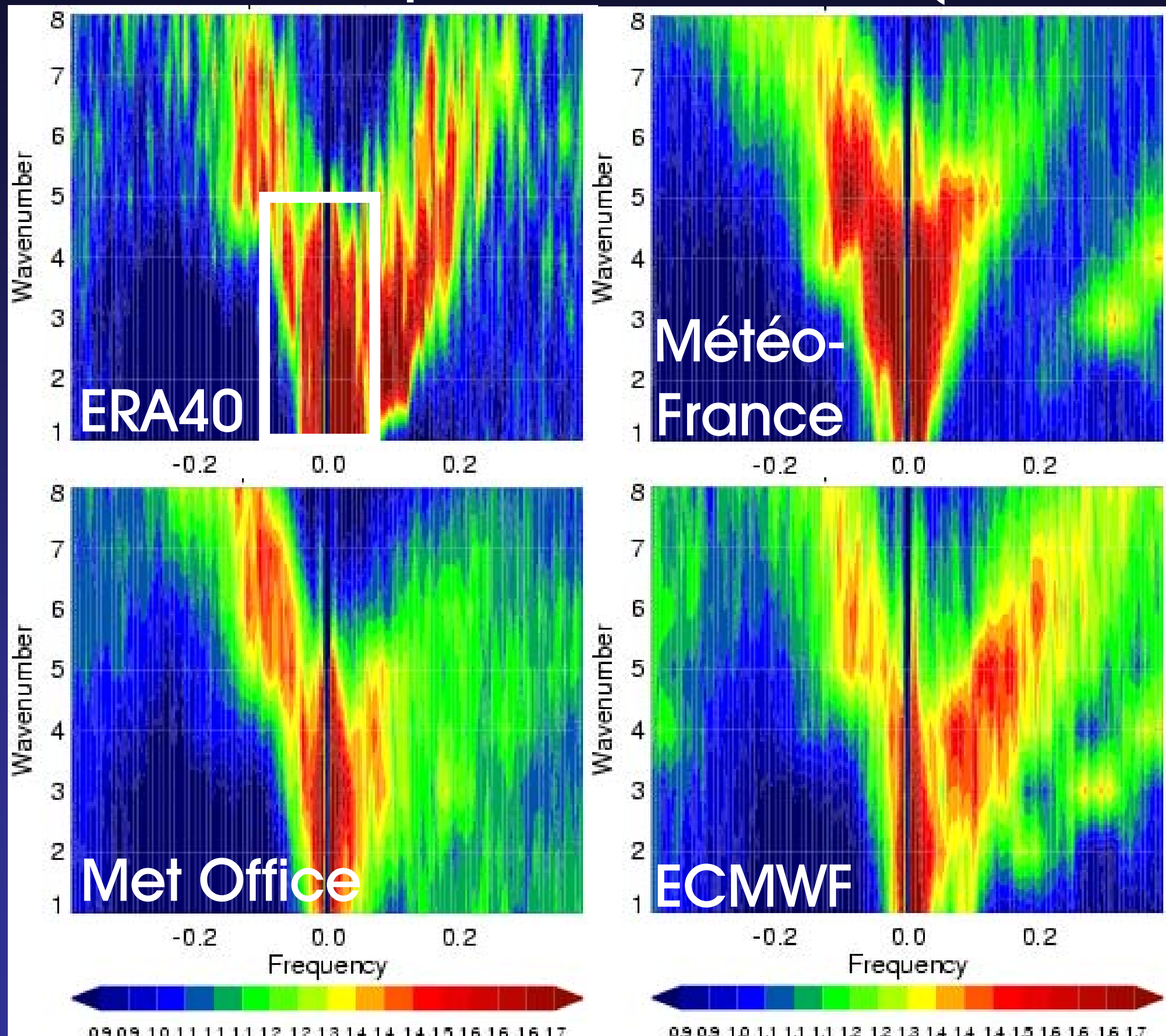


Courtesy from Oscar Alves (BMRC)

k-ω spectra (May to Oct.)

Two-sided relative spectrum for OLR (15°N-15°S)

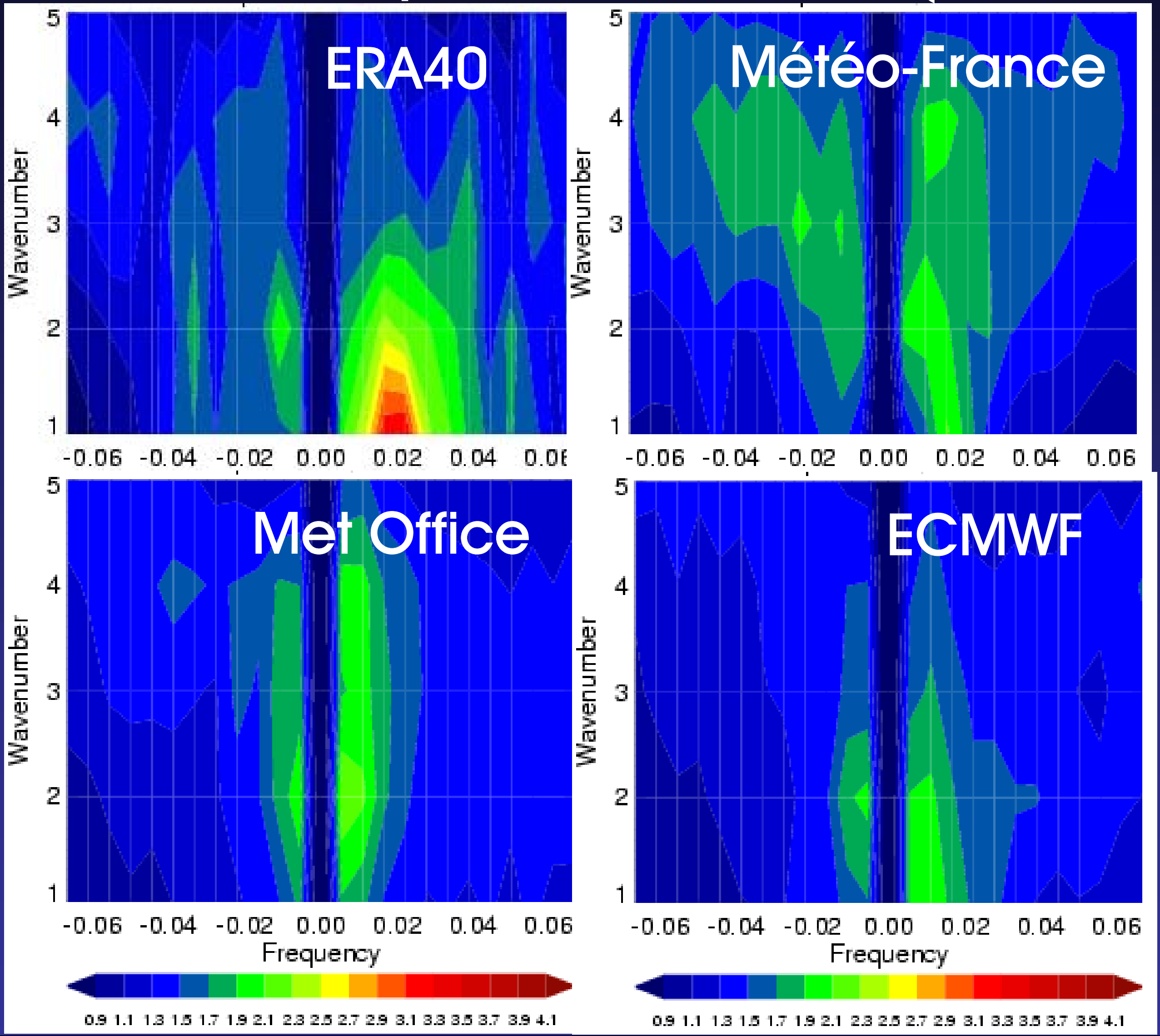
Symmetric component



k-ω spectra (May to Oct.)

Two-sided relative spectrum for OLR (15°N-15°S)

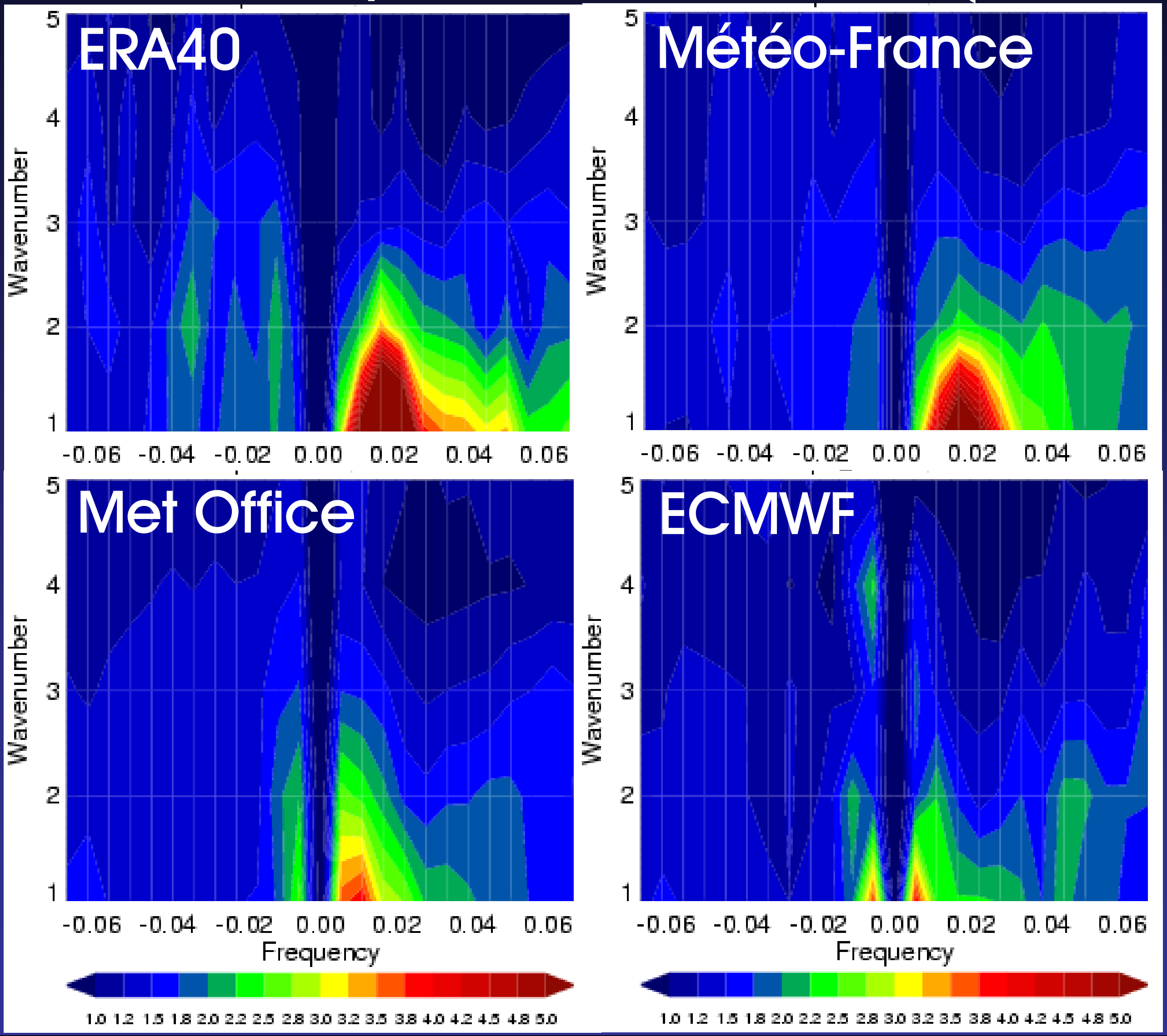
Symmetric component



k-ω spectra (May to Oct.)

Two-sided relative spectrum for U 10m (15°N-15°S)

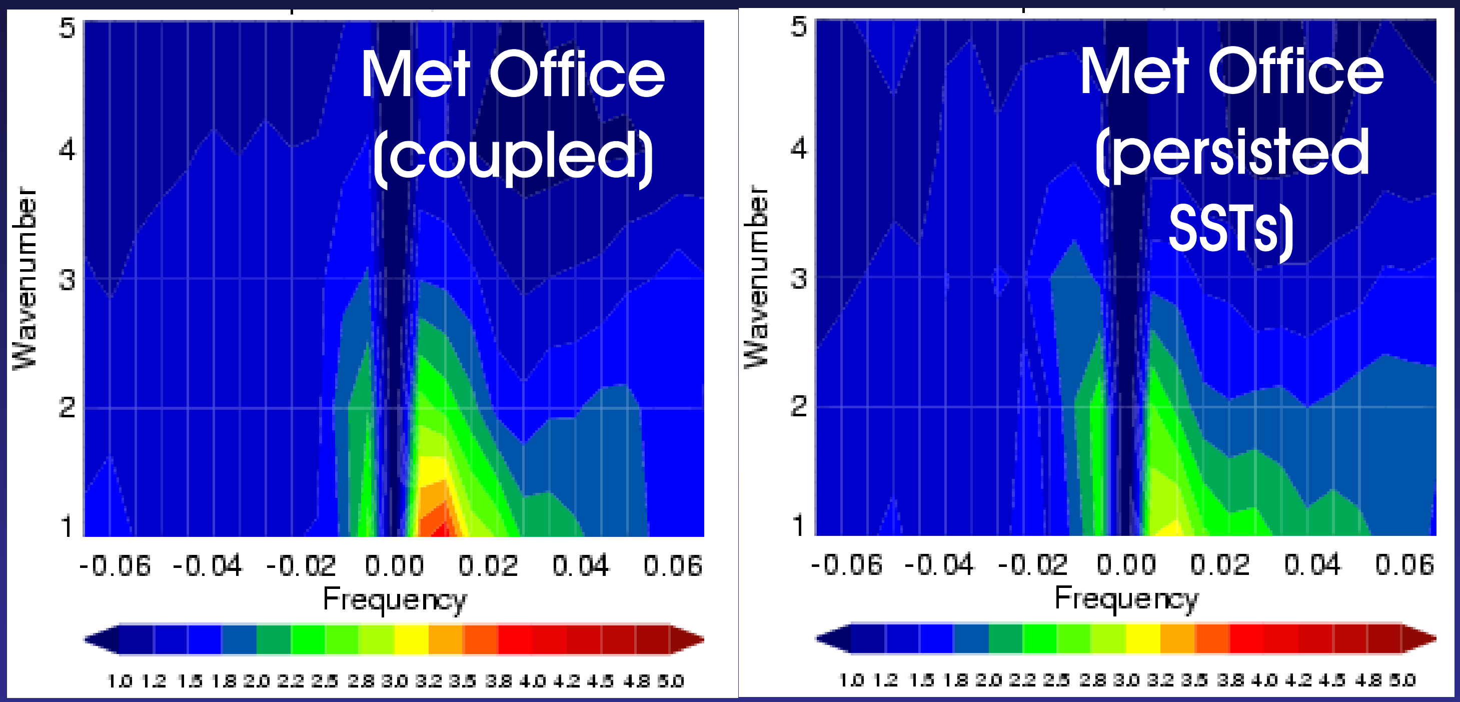
Symmetric component



k-ω spectra (May to Oct.)

Two-sided relative spectrum for U 10m (15°N-15°S)

Symmetric component

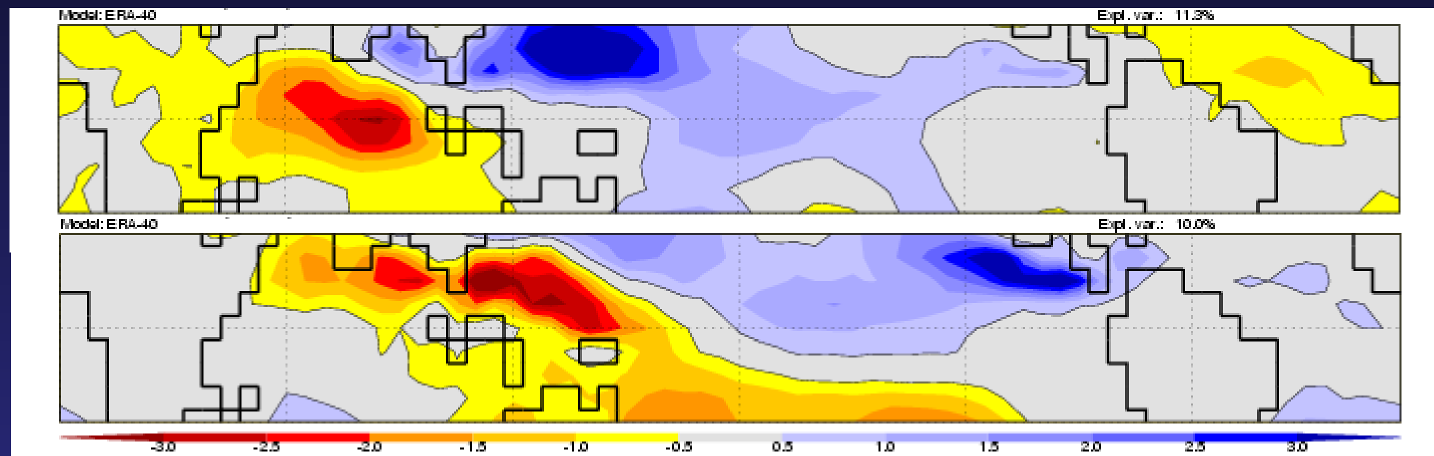


EOFs U 10m (May to Oct.)

20-90 day filtered data (20°N-20°S)

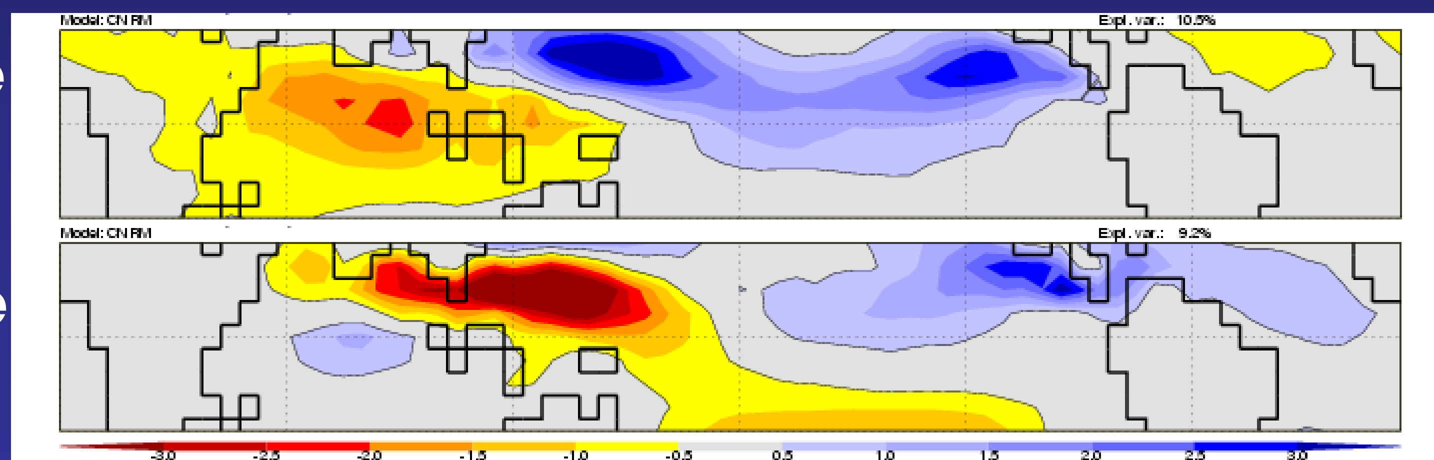
ERA40 EOF1

ERA40 EOF2



Météo-France EOF1

Météo-France EOF2



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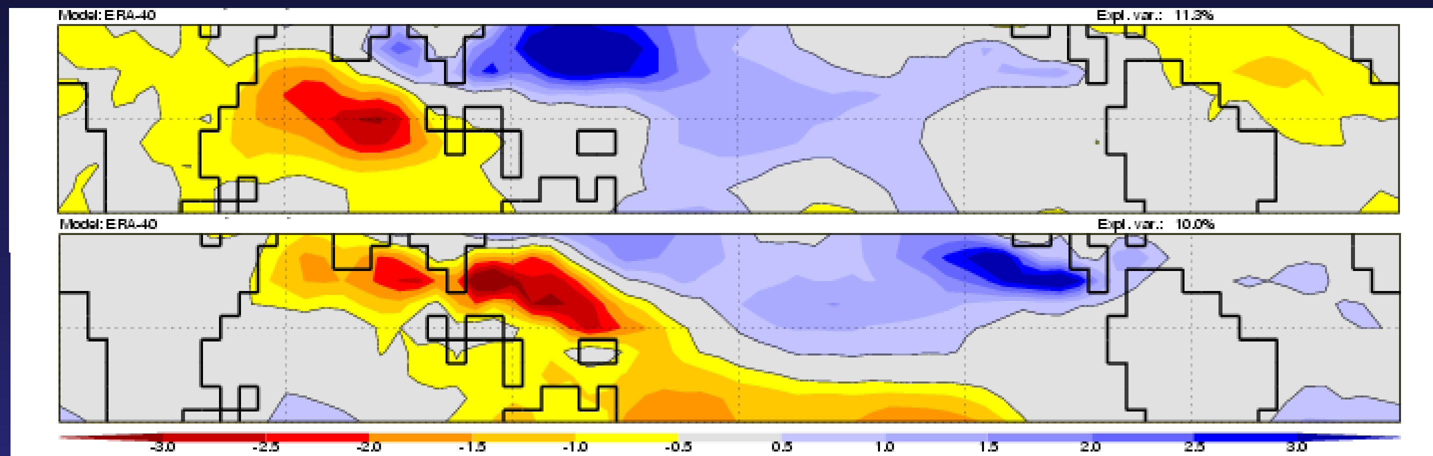
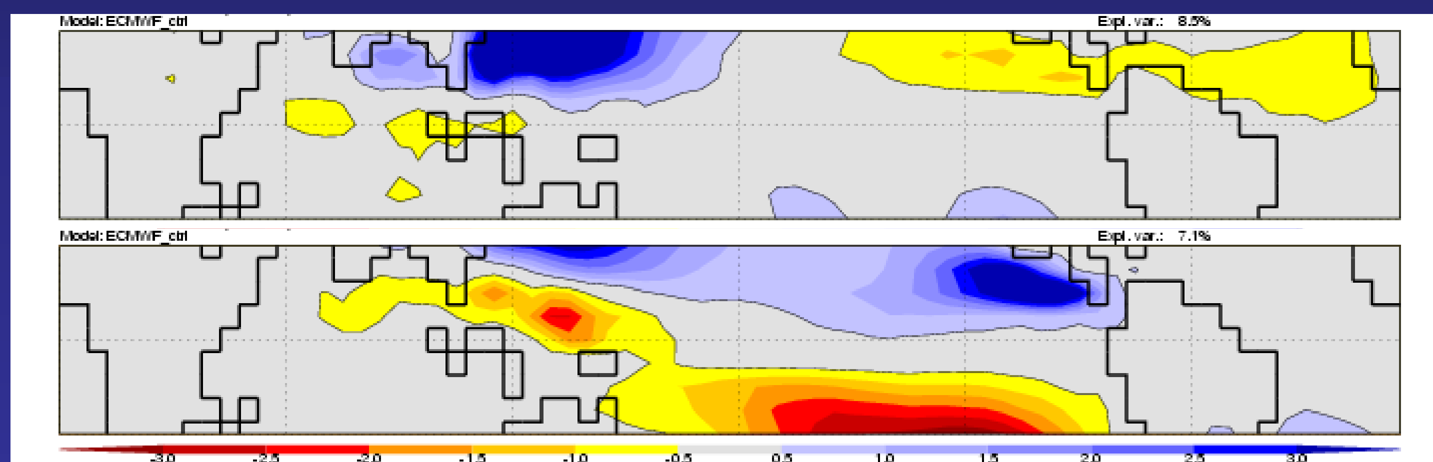
ERA40 EOF1

ERA40 EOF2



ECMWF EOF1

ECMWF EOF2



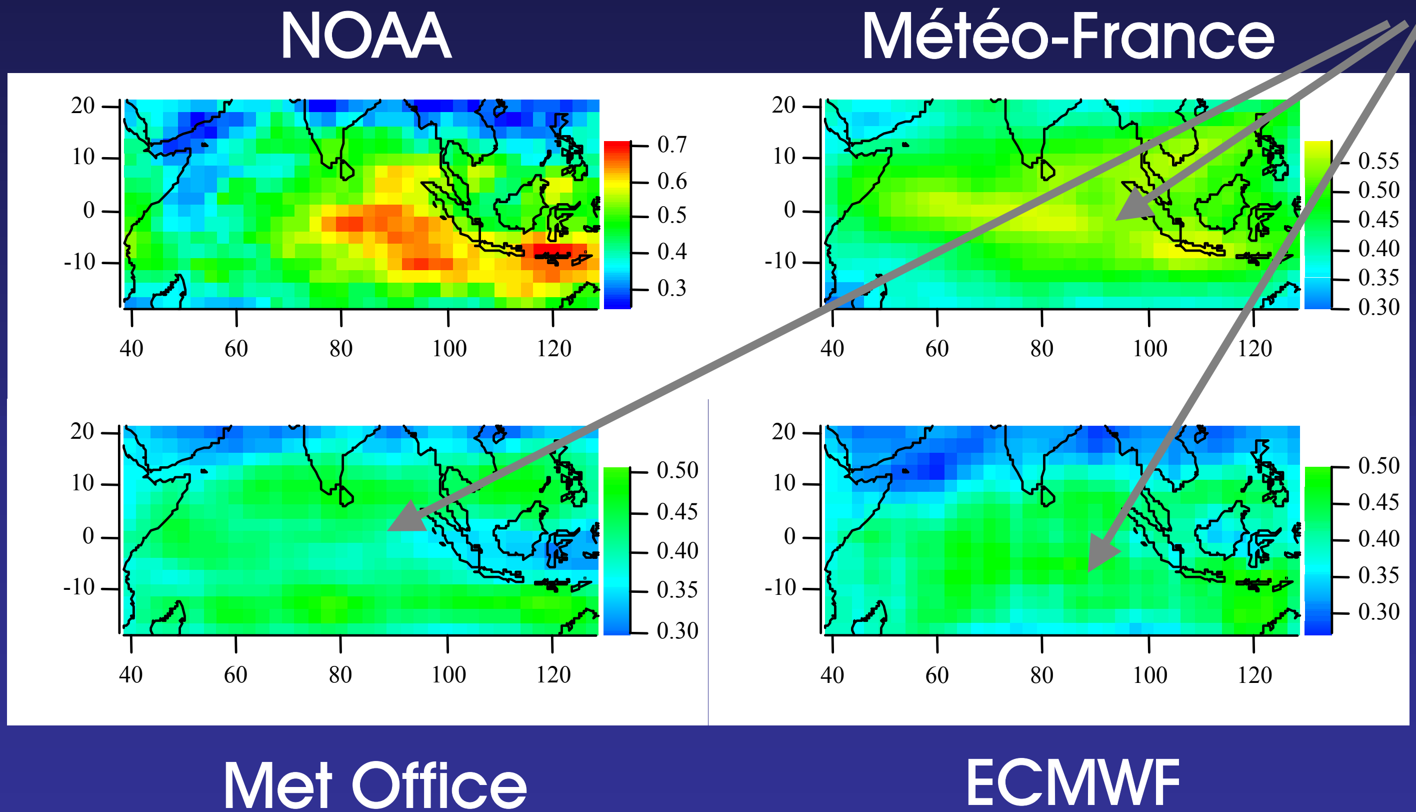
Local mode analysis

- Complex principal component analysis of a 20-90 bandpass filtered field over a region on a 90-day running time window (a new analysis every 5 days)
- Separate analysis for each year and ensemble member
- Provides, for each member and year, an estimate of the IS signal features (date, spatial pattern, activity,…) as part of the most coherent patterns in a spatio-temporal sense
- Collaboration with J. Ph. Duvel (LMD, Paris); preliminary results for OLR during boreal winter

Local mode analysis (Nov. to April)

Percentage of the variance captured by the LM (results without ERA40 influence in the filtering) Average for all members and years

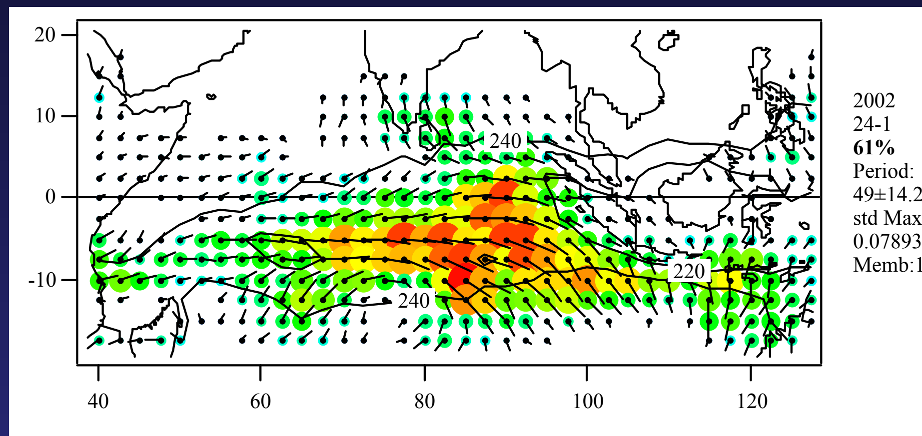
Lack of organization of the modes



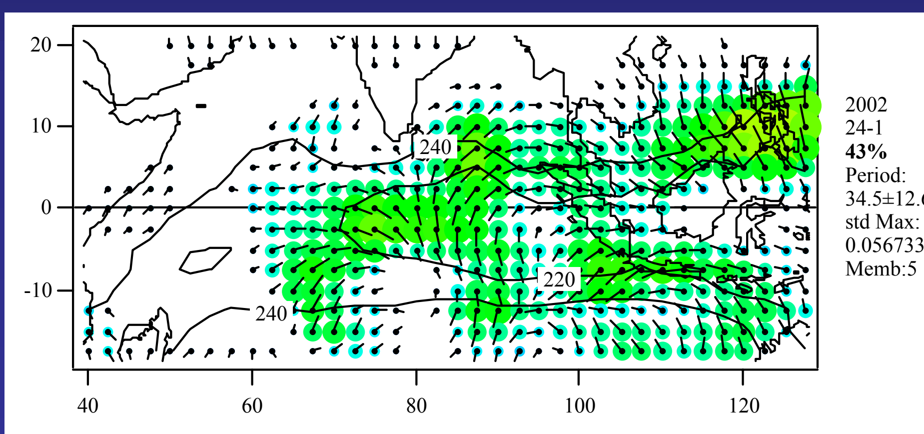
Local mode analysis (Nov. to April)

Example of Météo-France hindcast

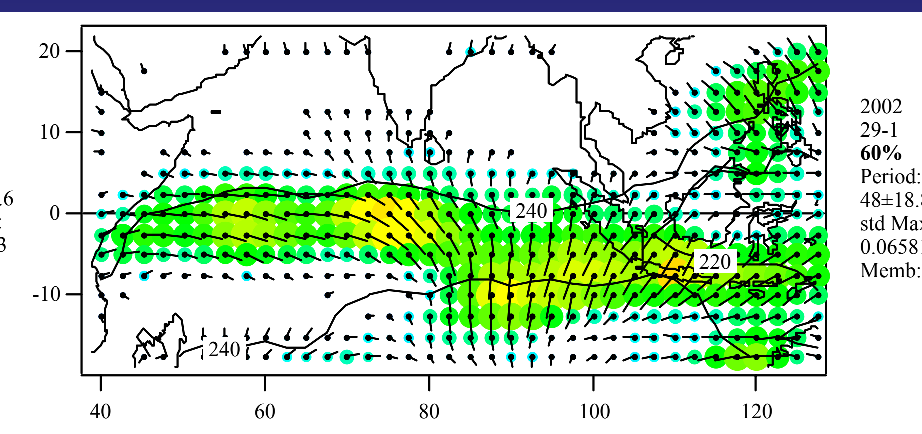
Mode in the NOAA dataset



Mode in ensemble member 5



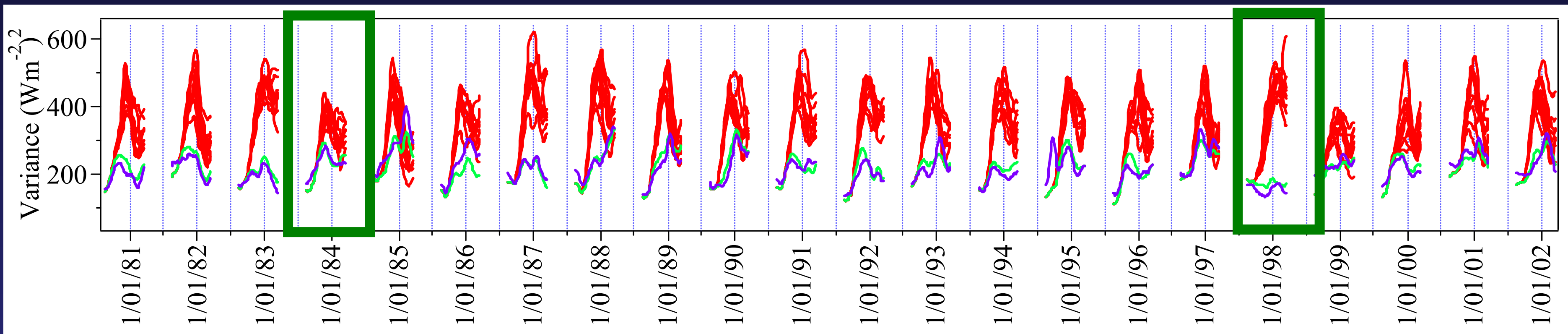
Mode in ensemble member 9



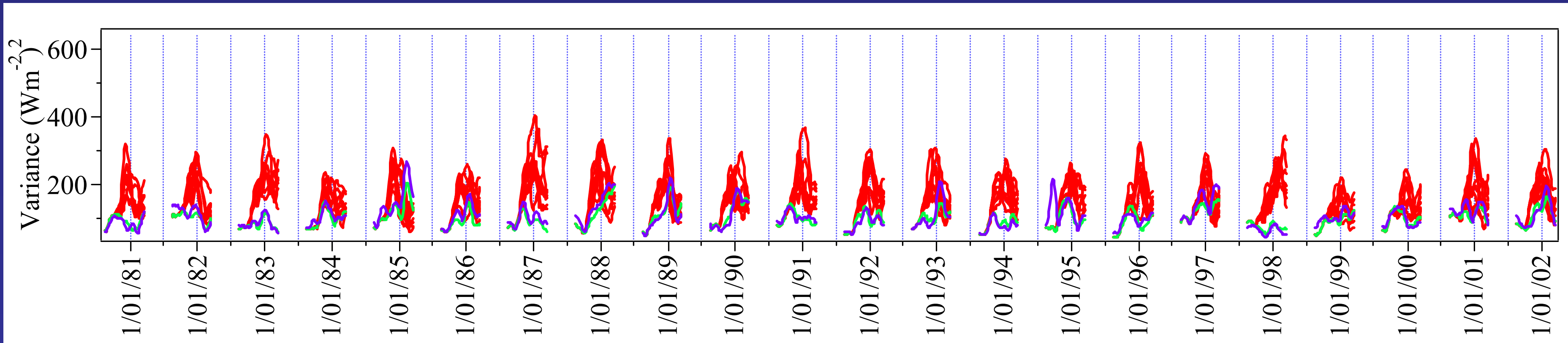
Local mode analysis (Nov. to April)

Results for Météo-France (Indian Basin)

90-day window filtered variance



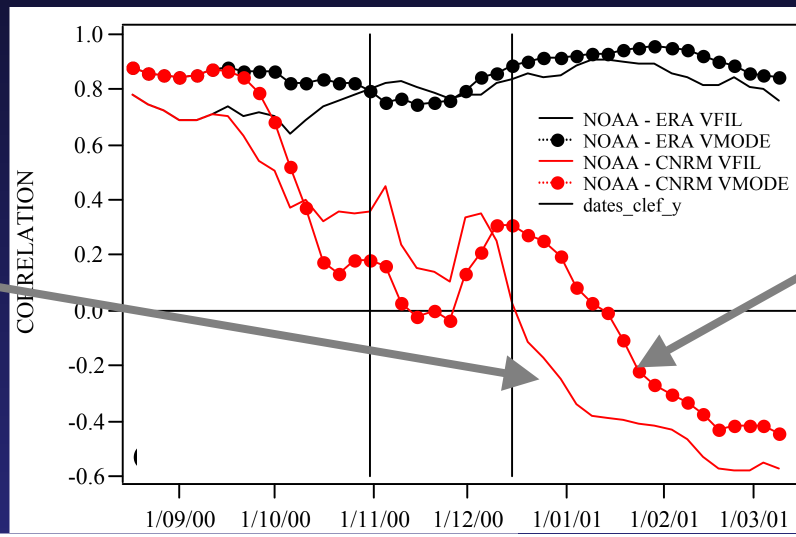
First mode variance



Predictability (Nov. to April)

Correlation of the variance (ensemble mean)

Météo-France

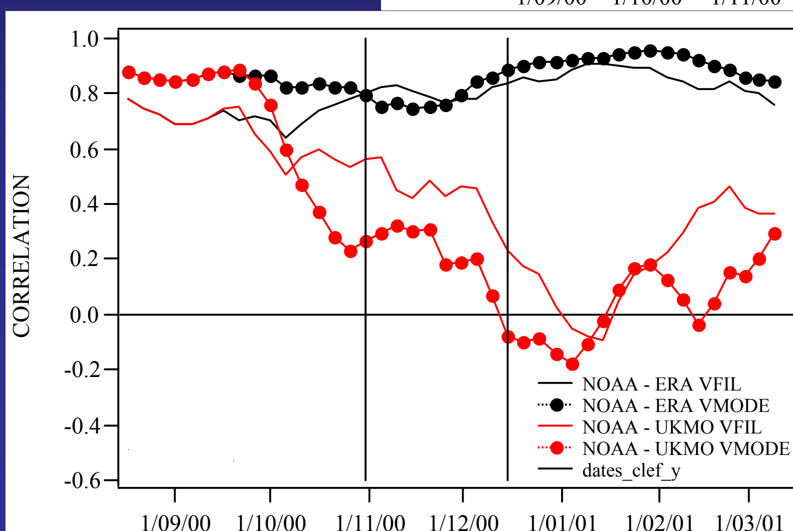


Correlation for the mode activity

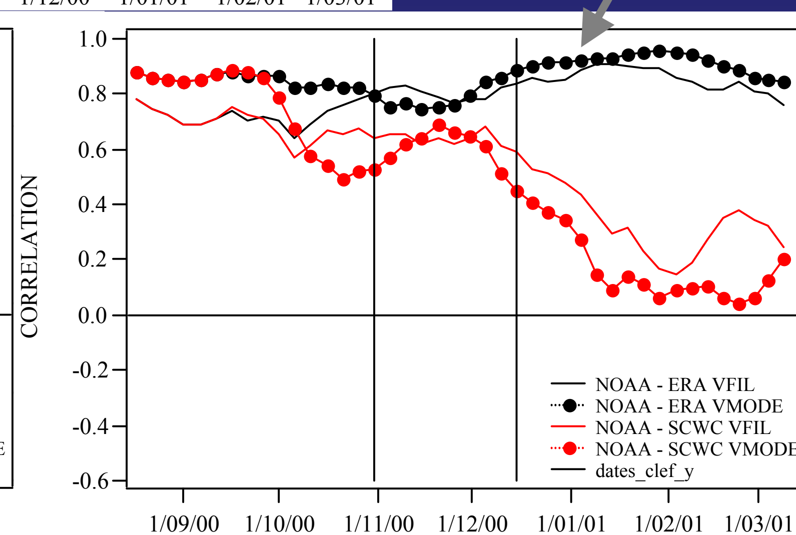
Correlation for the filtered variance

Correlation between ERA40 and NOAA

Met Office



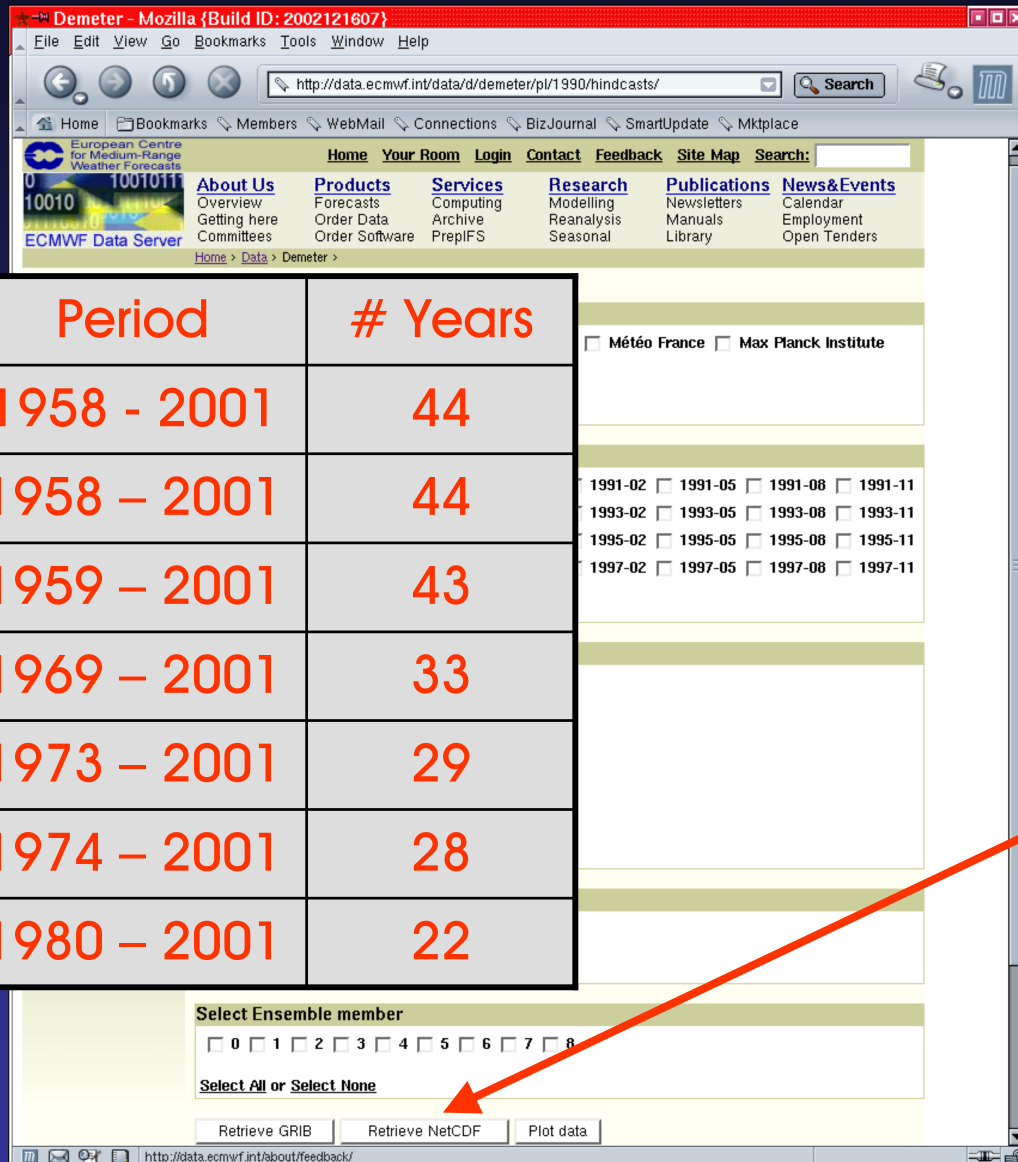
ECMWF



Summary

- Different biases in the intraseasonal variability:
  - ECMWF and MetOffice tend to underestimate
  - Météo-France tends to overestimate
- MJO amplitude and frequency are misrepresented, especially by ECMWF and MetOffice and for OLR
- Beneficial impact of the coupling: increase of variability, representation of feedbacks
- Weak spatial coherence of the large-scale perturbations; link to mean state and variability errors
- No clear signs of long-range predictability of the IS activity (excess of ensemble spread)

http://data.ecmwf.int/data



	Period	# Years
ECMWF	1958 - 2001	44
CNRM	1958 – 2001	44
UKMO	1959 – 2001	43
MPI	1969 – 2001	33
INGV	1973 – 2001	29
LODYC	1974 – 2001	28
CERFACS	1980 – 2001	22

Retrieve NetCDF