CMCC_MED : a 3 components fully coupled climate model

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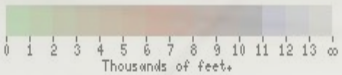
CERFACS - Toulouse, France, May 25-26 2009

Istituto Nazionale di
Geofisica e Vulcanologia



Centro Euro
Mediterraneo per i
Cambiamenti
Climatici

CMCC_MED : a 3 components fully coupled climate model

OUTLINE:

- CMCC_MED AOGCM model overview
- Preliminary results
- Coupling design
- Future development

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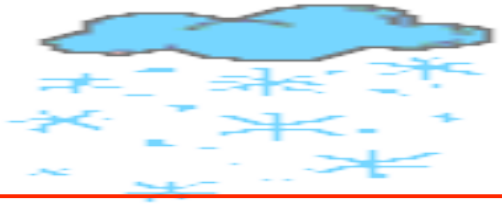
CMCC-MED Model Overview

CMCC_MED components:

1

ATMOSPHERE

ECHAM5 T159L31



COUPLER

OASIS3

(CMCC-SCO parallel version)

2

GLOBAL SEA ICE

LIM

GLOBAL OCEAN

OPA ORCA2 L31

3

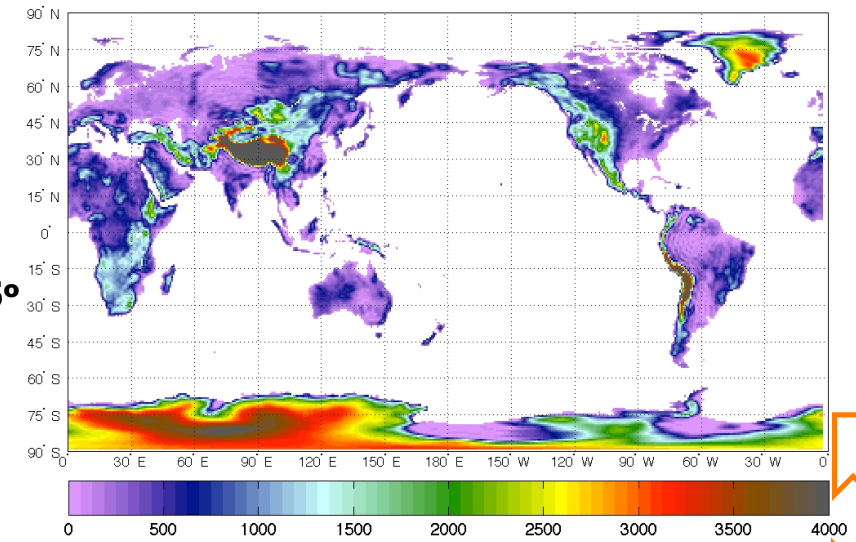
MEDITERRANEAN SEA

NEMO 1/16° L72

CMCC-MED Model Overview

ATM
Glo:0.75º

ECHAM5 T159L31

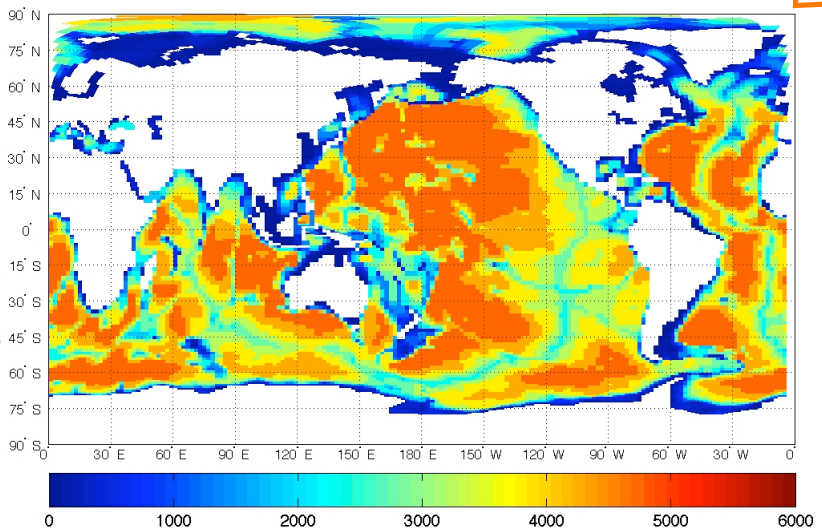


- Ocean-Atmosphere 2h40' coupling freq.
- Global Ocean-Mediterranean Sea two-ways 8h coupling
- Active river runoff
- Aswan Dam (Nile river) after 1968.
- Black Sea-to-Med Sea water fluxes diagn. from ECHAM freshwater budget

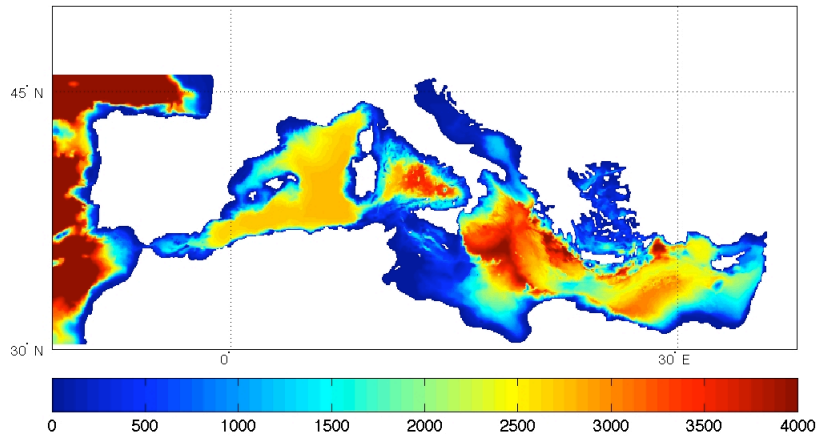
3 coupled components

OCE
Glo:2º
Med:0.06º

OPA Glo ORCA2 L31

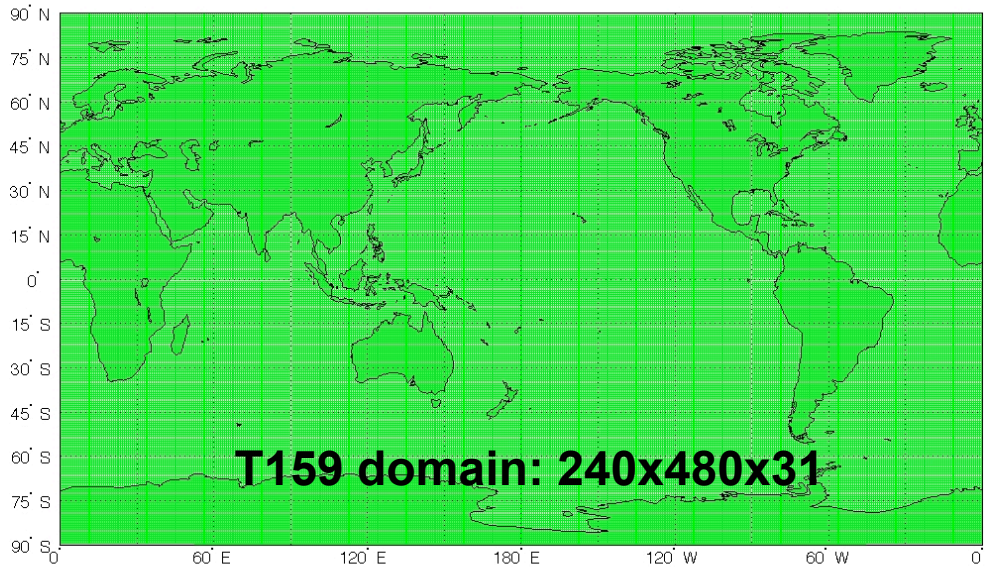


NEMO Med 1/16º L72

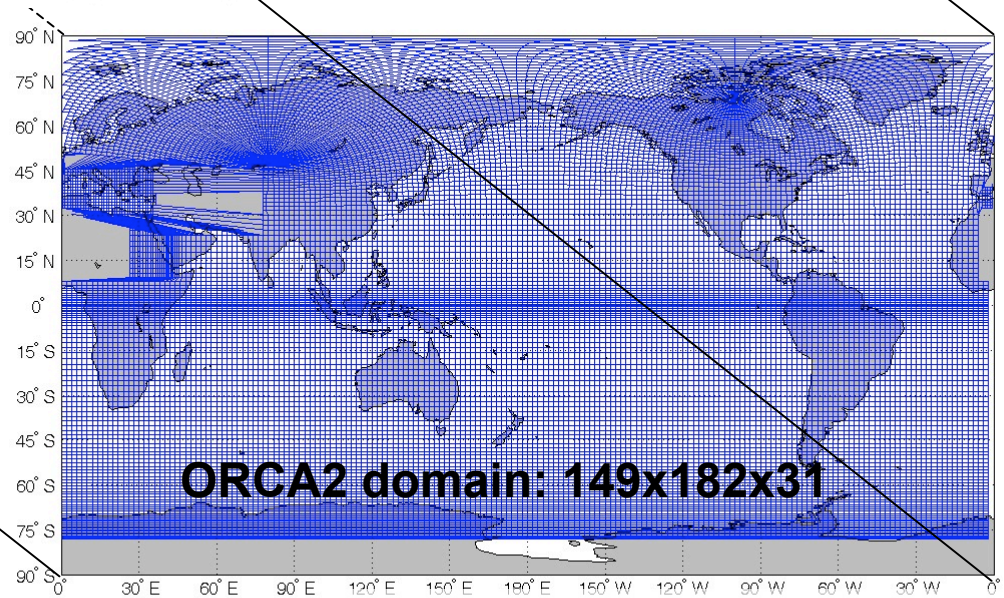


CMCC-MED Model Overview

global atmosphere <--OASIS3--> Global Ocean:



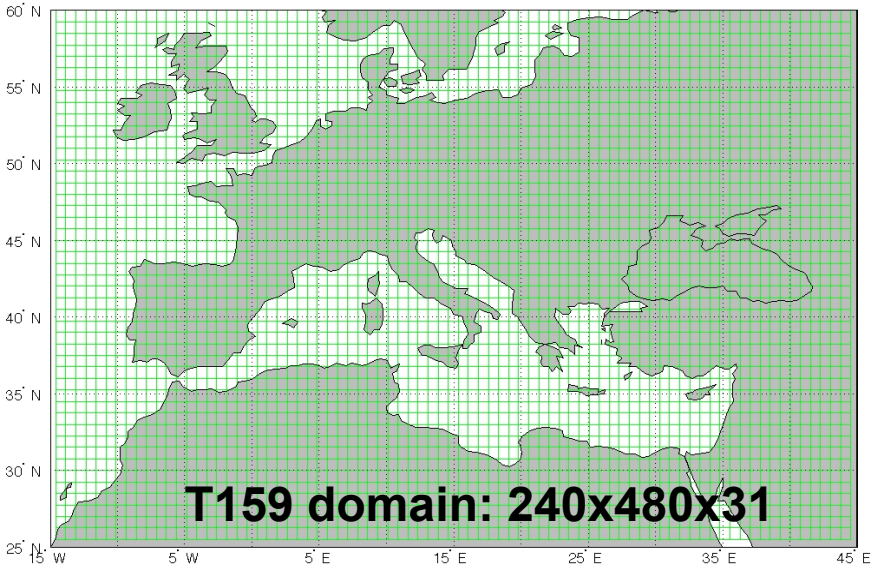
ECHAM -T159 grid



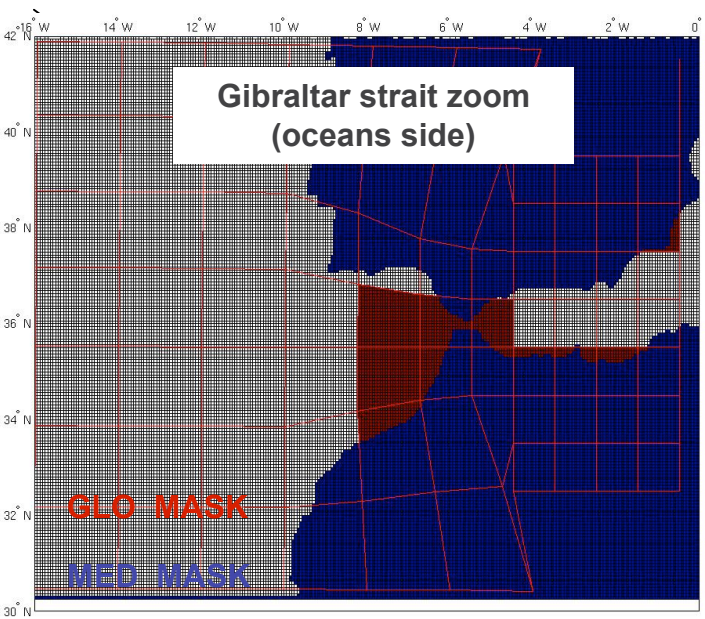
ORCA2 grid

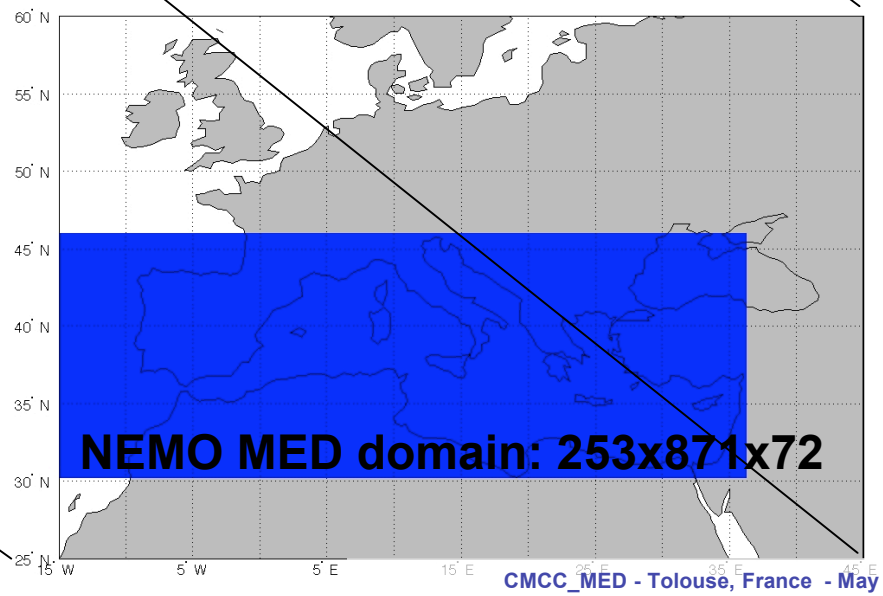
CMCC-MED Model Overview

global atmosphere <--OASIS3--> Mediterranean Sea:



ECHAM -T159 grid





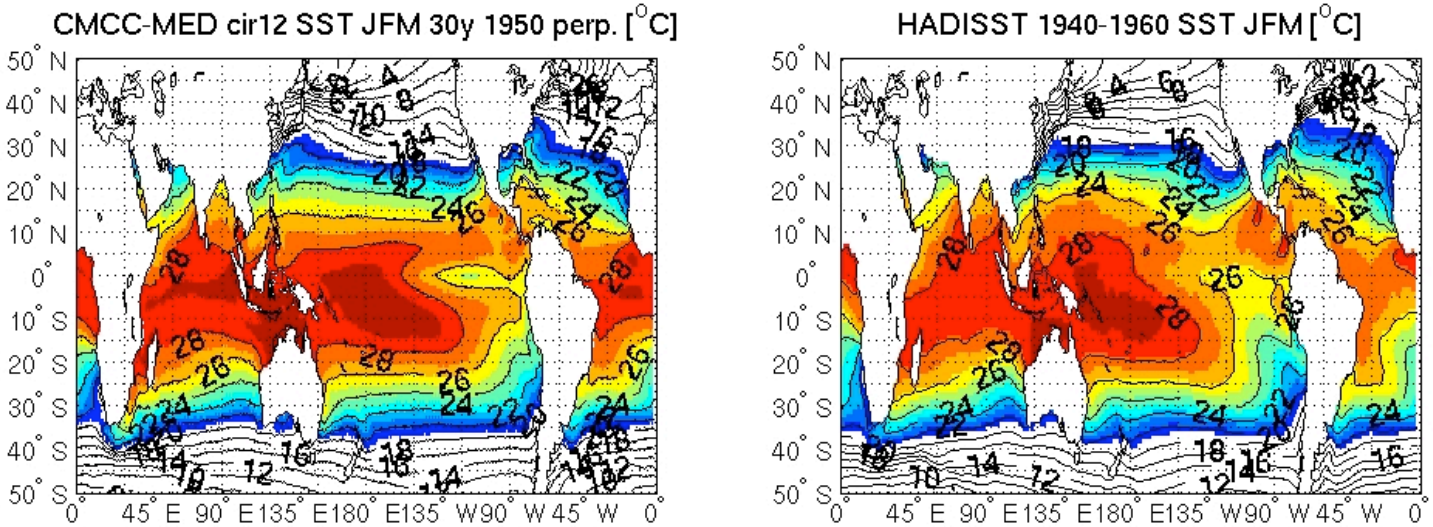
NEMO MED grid

CMCC-MED Preliminary results

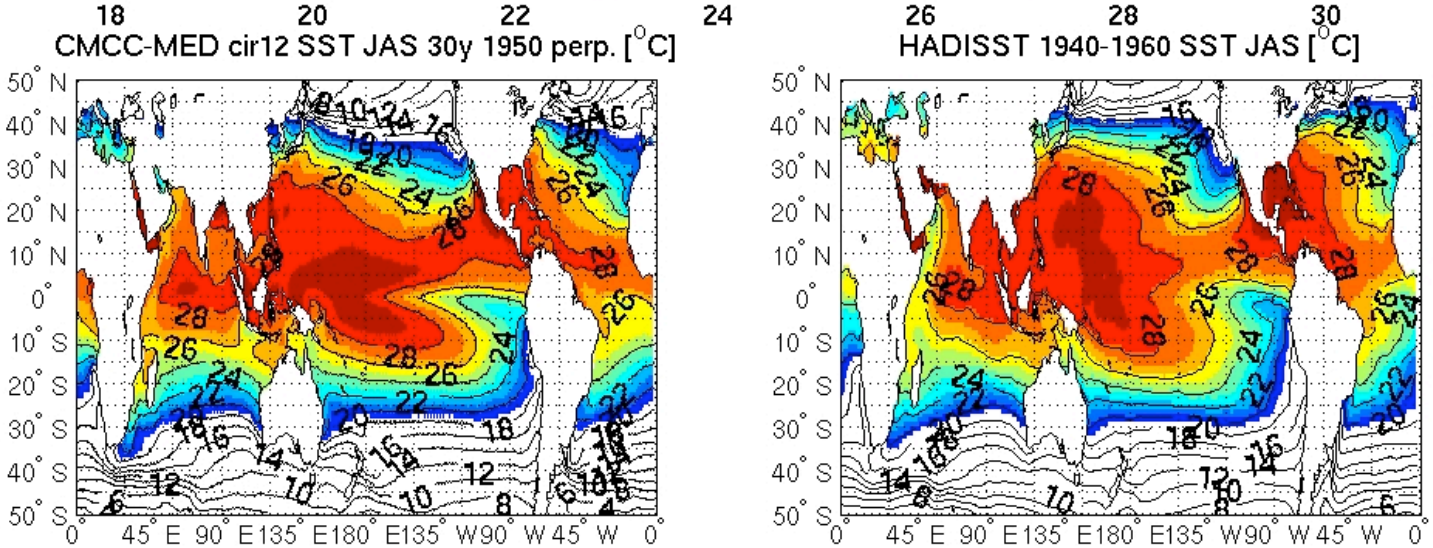
1950 “perpetual rad. forcing” simulation 30y: Sea Surface Temperature [°C]

CMCC_MED | **OBS HADISST**

JFM



JAS

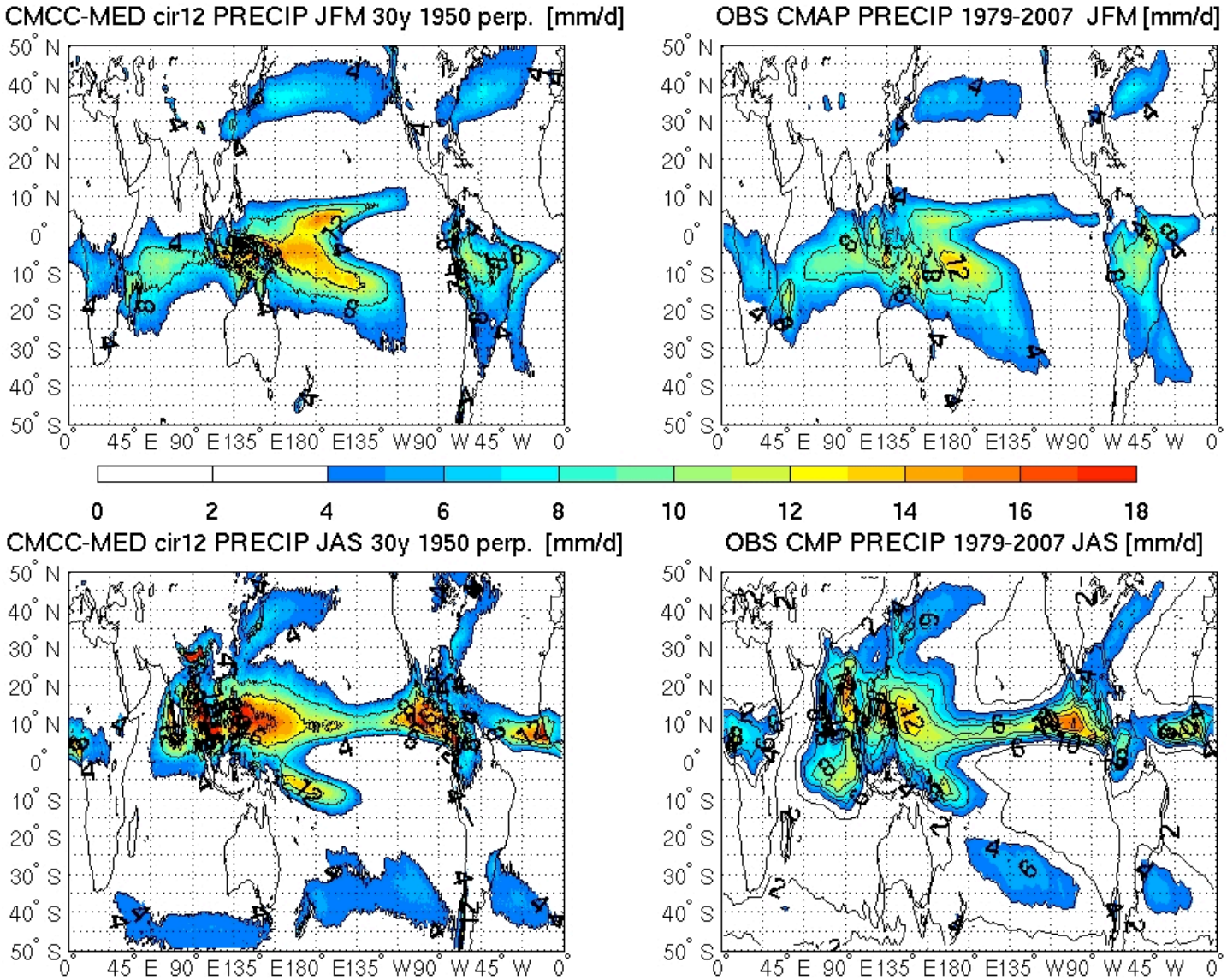


CMCC-MED Preliminary results

1950 “perpetual rad. forcing” simulation 30y: Precipitation [mm/d]

CMCC_MED **OBS CMAP**

JFM

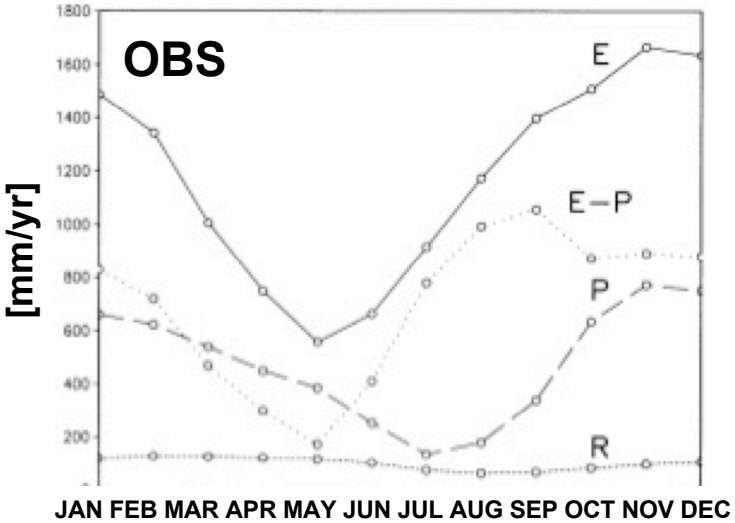


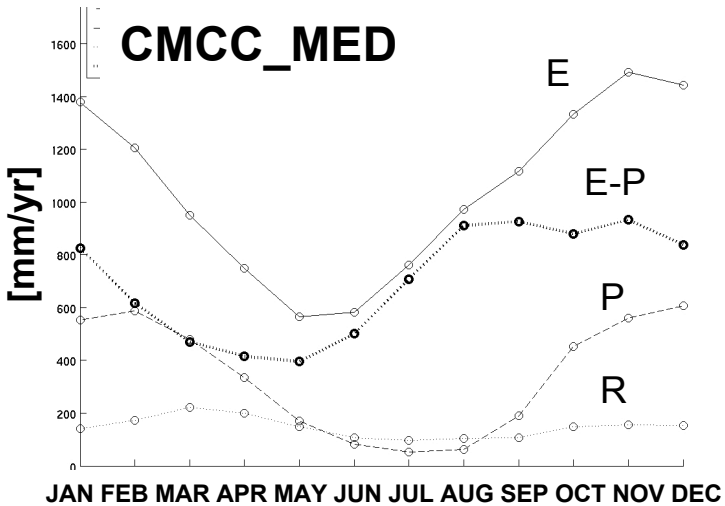
JAS

CMCC-MED Preliminary results

1950 “perpetual rad. forcing” simulation 30y: Mediterranean Hydrological Cycle

Mediterranean Hydrological cycle

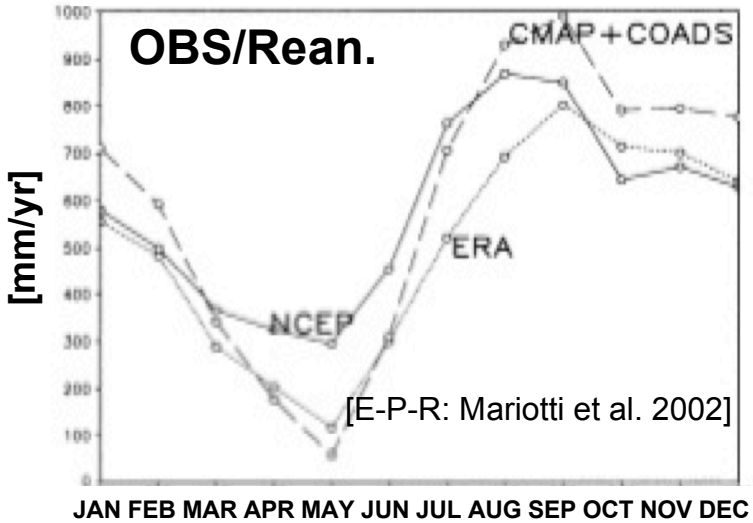


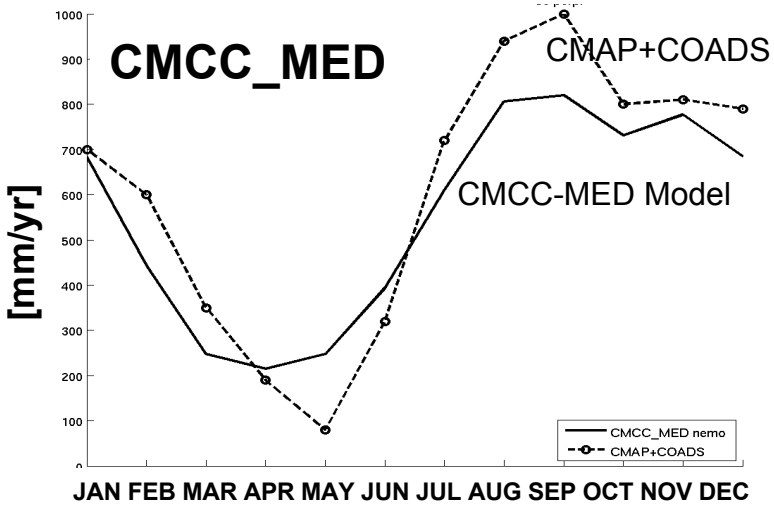


OBS

CMCC_MED

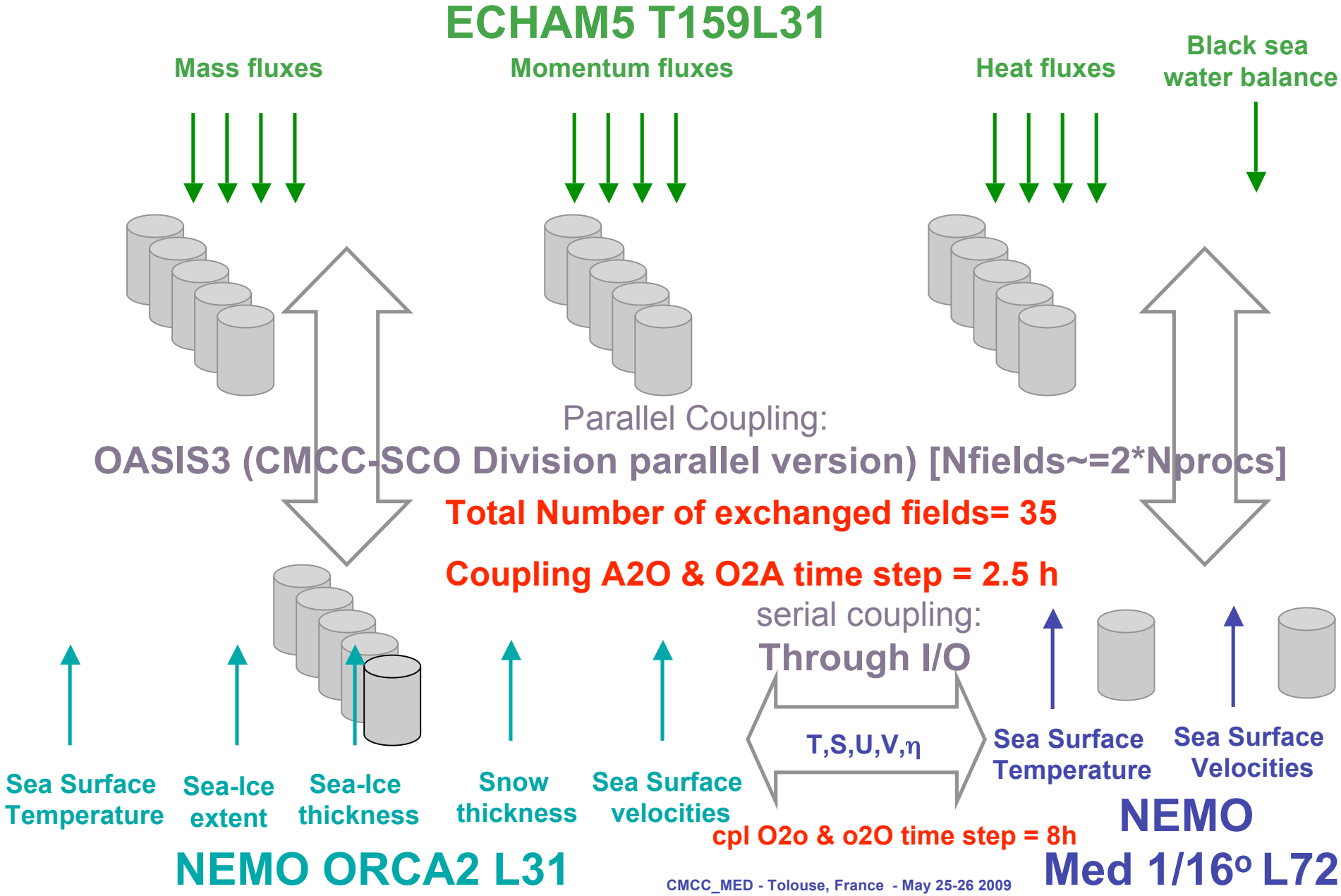
E-P-R Mediterranean Sea





The major features of the mediterranean hydrological cycle are reproduced within the uncertainty range of obs/reanalyses.

CMCC_MED COUPLING DESIGN



CMCC-MED COUPLING DESIGN

Atmosphere - Ocean fields exchanged:

1. TAUXU over open ocean
2. TAUYU over open ocen
3. TAUXV over open ocean
4. TAUYV over open ocean
5. TAUXU over sea-ice
6. TAUYU over sea-ice
7. TAUXV over sea-ice
8. TAUYV over sea-ice
9. Solar Heat Flux over sea-ice
10. Solar Heat Flux on over open ocean
11. Non Solar Heat Flux over sea-ice
12. Non Solar Heat Flux on over open ocean
13. Surface Water Flux
14. Snowfall Flux
15. Continental Water Flux
16. Integral of Total Solar HF over ocean
17. Integral of Total Non Solar HF over ocean

ECHAM5

OPA GLOBAL

1. Sea Surface Temperature
2. Sea Ice Extent
3. Snow Thickness
4. Sea Ice Thickness
5. Surface Northward Sea Water Velocity
6. Surface Eastward Sea Water Velocity

1. TAUXU over open ocean
2. TAUYU over open ocen
3. TAUXV over open ocean
4. TAUYV over open ocean
5. Solar Heat Flux on over open ocean
6. Non Solar Heat Flux on over open ocean
7. Surface Water Flux
8. Continental Water Flux
9. P-E+R balance in black sea

ECHAM5

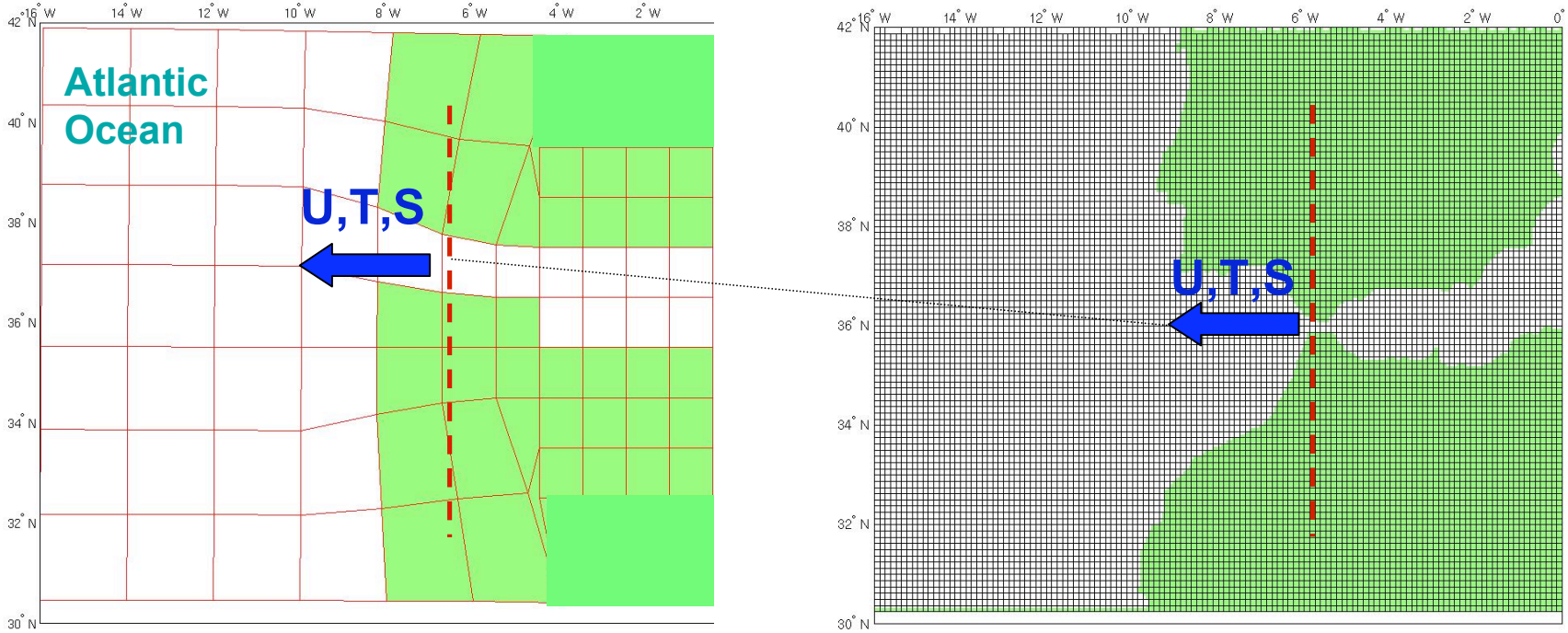
NEMO MEDITERRANEAN

1. Sea Surface Temperature
2. Surface Northward Sea Water Velocity
3. Surface Eastward Sea Water Velocity

CMCC-MED COUPLING DESIGN

Med. Sea to Global Ocean exchange:

OPA GLOBAL **NEMO MED**

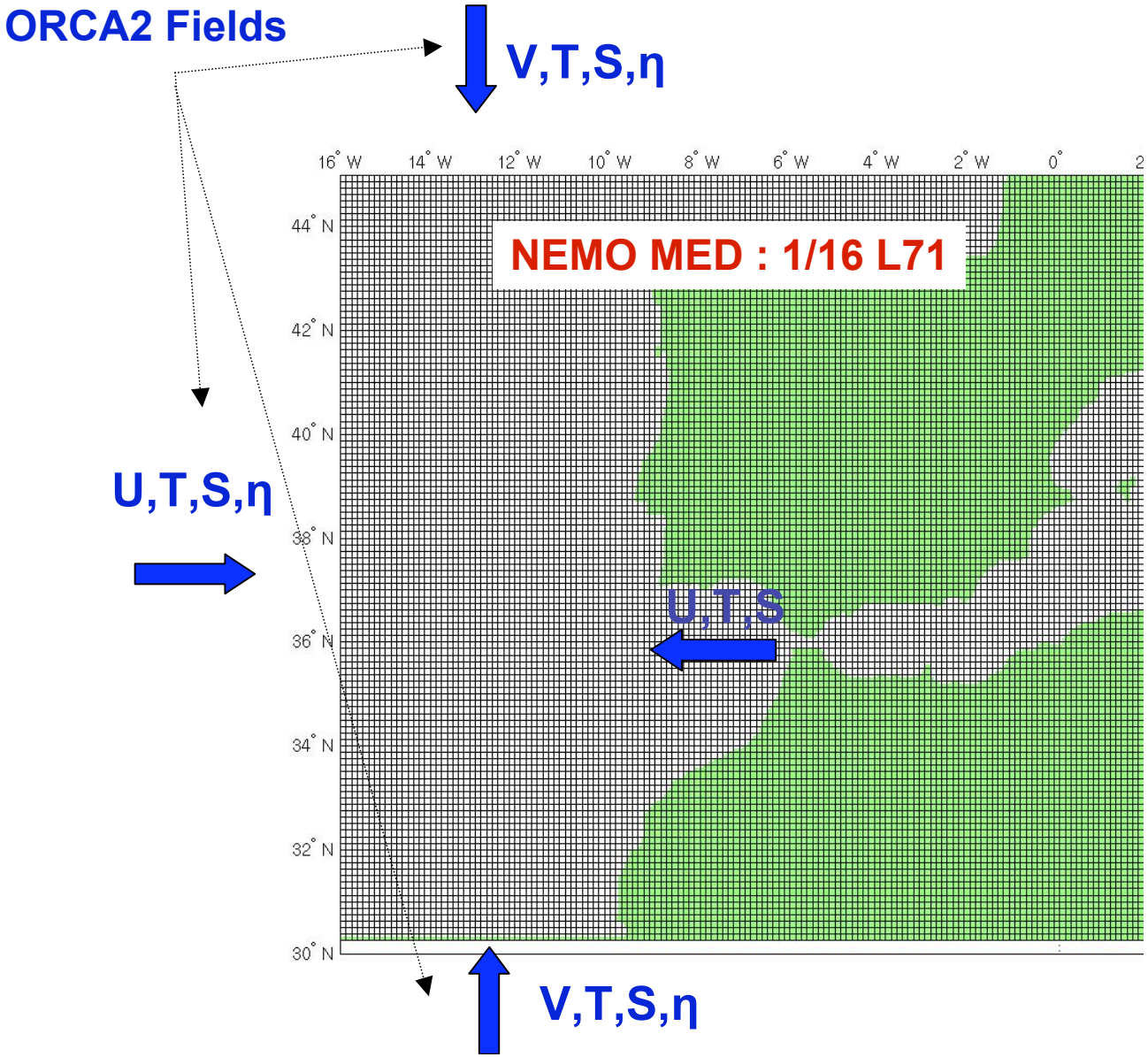


The Med Outflow region in ORCA2 is represented by 1 grid-point only!
→River-like treatment.

Over-write Med Outflow horizontally and vertically interpolated from Hi-res to low-res [frequency of exchange: 8h].

CMCC-MED COUPLING DESIGN

Global Ocean to Med. Sea exchange: The Atlantic Box



Global to Mediterranean exchange occurs through the open boundaries in the Atlantic Box.
Exchanged fields are: horizontal transport (U,V), T,S and surface elevation (η).

==========

ORCA2 fields are:

- time-averaged over the 8h time window
- interpolated horizontally and vertically onto the hi-res MED grid
- checked for transport conservation after the interpolation process

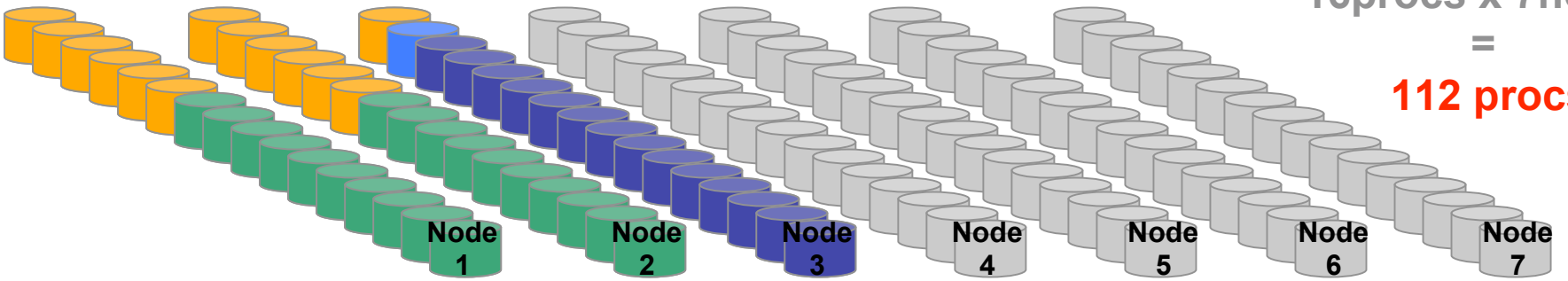
CMCC-MED WORK LOAD

Work load distribution on SX9:

OASIS
13 processes

1 OPA GLO process

SX9 at CMCC:
16procs x 7nodes
=
112 procs



20 ECHAM5 processes

14 NEMO MED processes

Execution time:
50min / simulated month <- OASIS serial v.
40min / simulated month <- *OASIS parallel v.*

Epicoco et al. tomorrow session 2.4

CMCC-MED FUTURE DEVELOPMENT

status of the work:

Done: 1) **Three components coupling (ECHAM5-OPA_GLO-NEMO_MED) through OASIS3 (35 fields exchanged) and through I/O (oce2oce).**

2) **Increased system performances (+20%) thanks to the OASIS3 parallel version developed by CMCC-SCO Division.**

Future?: 1) **oce2oce coupling through OASIS?.**

needs: - Vertical sections exchange.

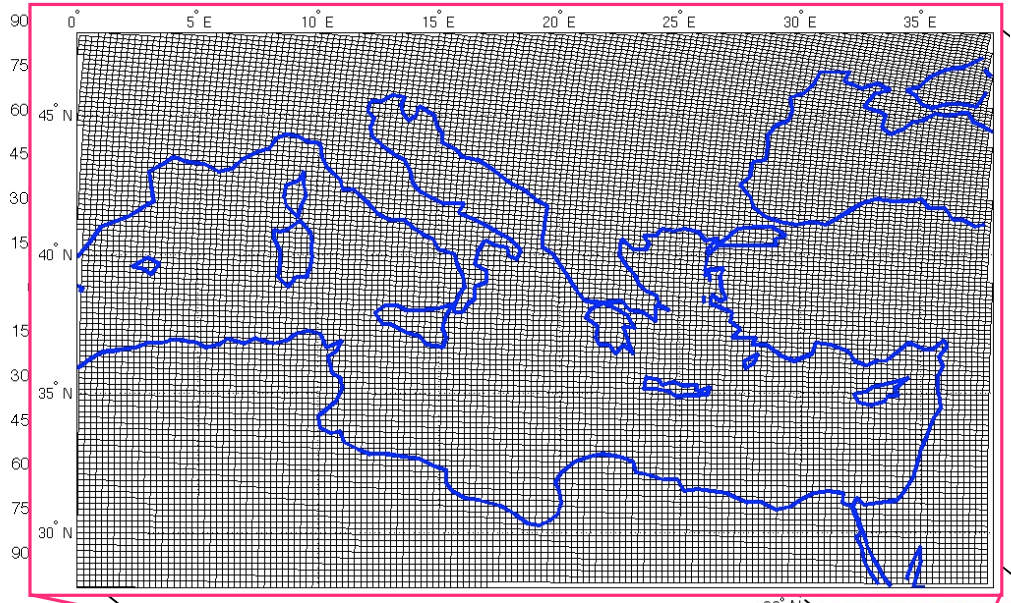
- Flux Conservation through vertical sections.

2) **Single Scalar values exchange.**

3) **resolution increase -> domain decomp. ?**

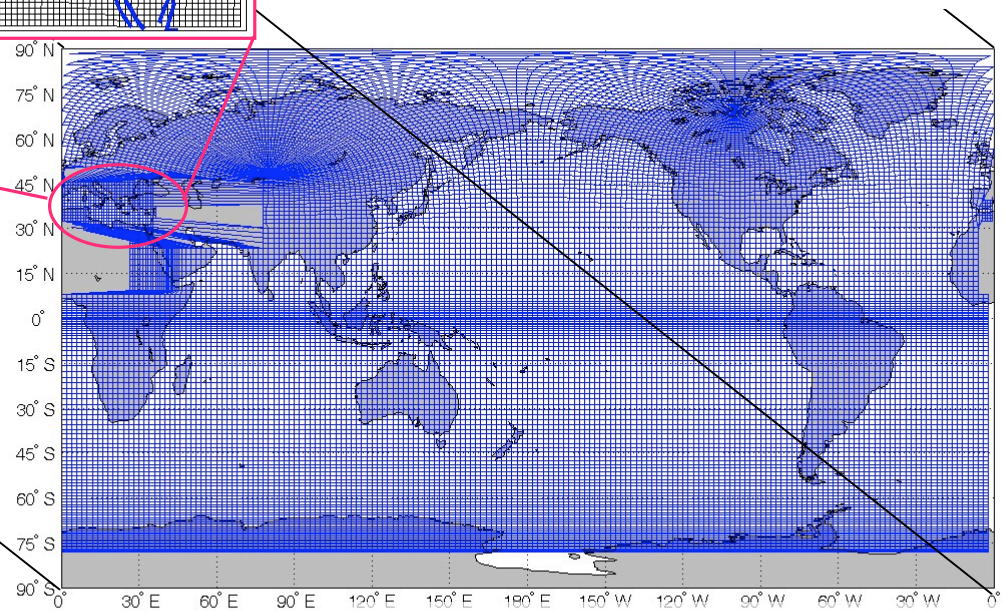
CMCC-MED FUTURE DEVELOPMENT

MODEL DEVELOPMENT : global ocean resolution *increase -> NEMO 1/4º .*



ORCA025 domain: 1021x1442x46

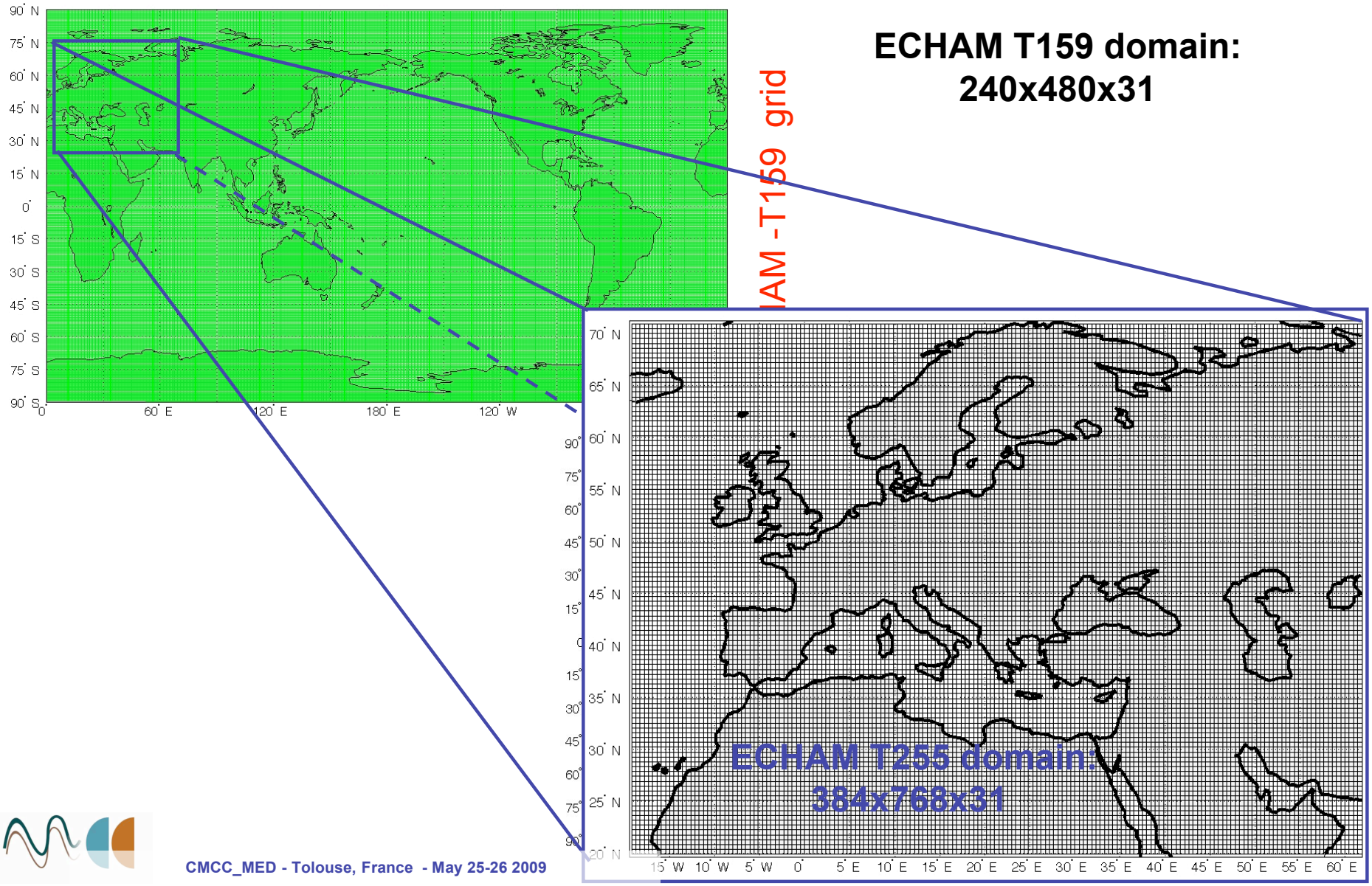
ORCA2 domain: 149x182x31



ORCA2 grid

CMCC-MED FUTURE DEVELOPMENT

MODEL DEVELOPMENT : global *atm. resolution increase ->ECHAM T255 .*



CMCC-MED FUTURE DEVELOPMENT

Space discretization at the intramodel interface:

	Global Atmosphere	Global Ocean	Mediterranean Sea	TOT grid points
INGV-SXG past	160x320 (T106)	149x182 (ORCA2)		78.318 OASIS2.4
CMCC_MED present	240x480 (T159)	149x182 (ORCA2)	253x871 (1/16°)	362.681 OASIS3 paral.
Next CMCC coupled model future	348x768 (T255)	1021x1442 (1/4°)	253x871 (1/16°)	1.959.909 OASIS3/4/5?

CMCC_MED : a 3 components fully coupled climate model

QUESTIONS!

OASIS User Meeting

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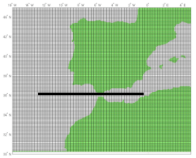
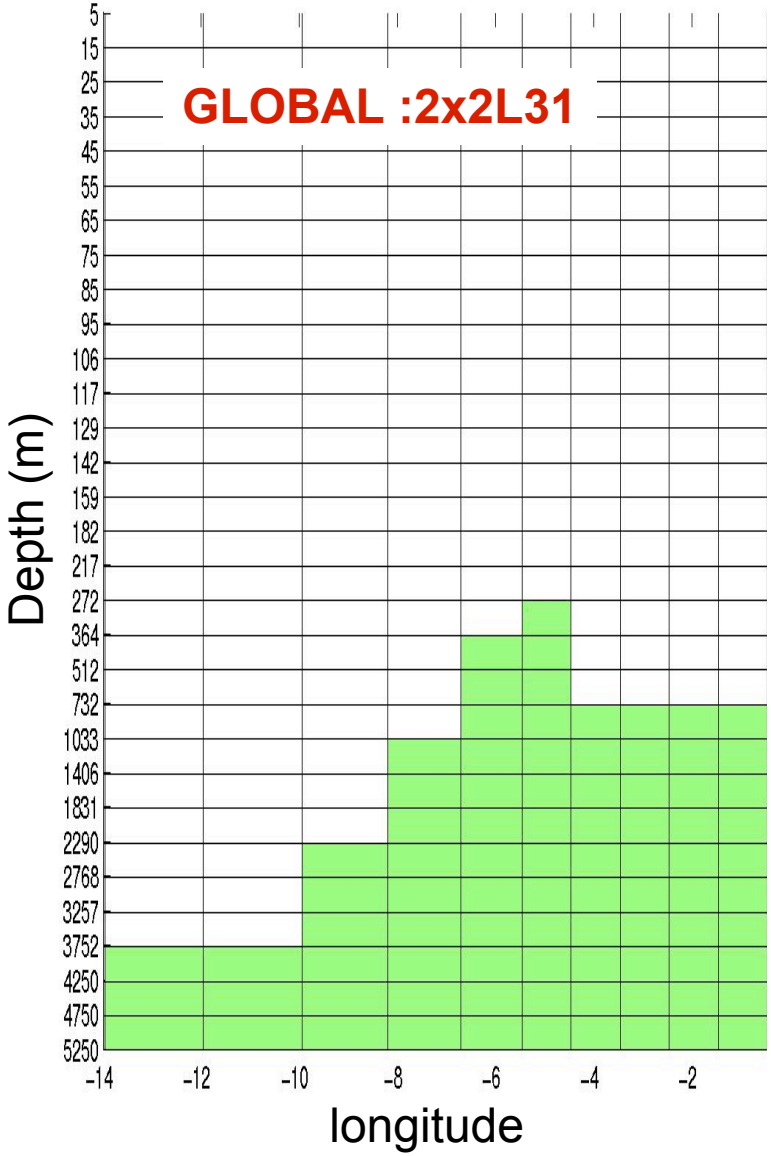
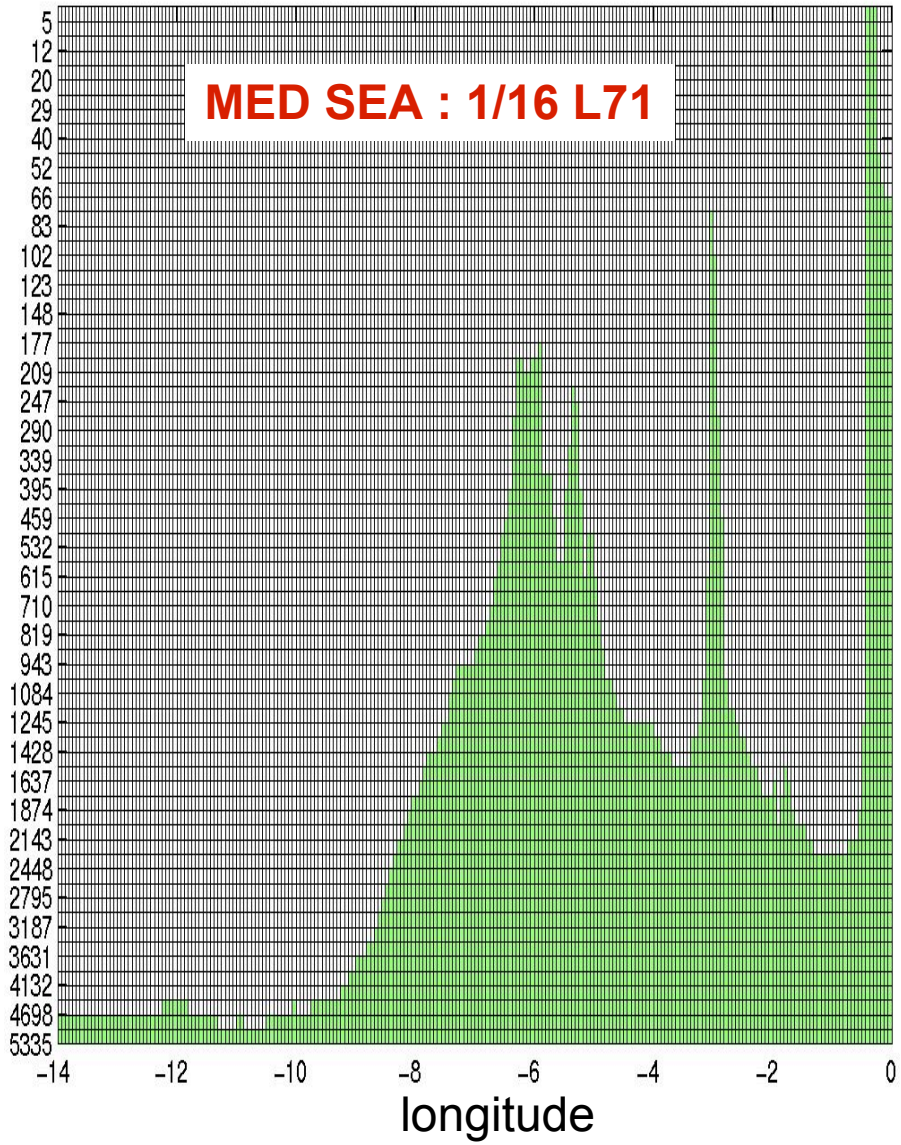
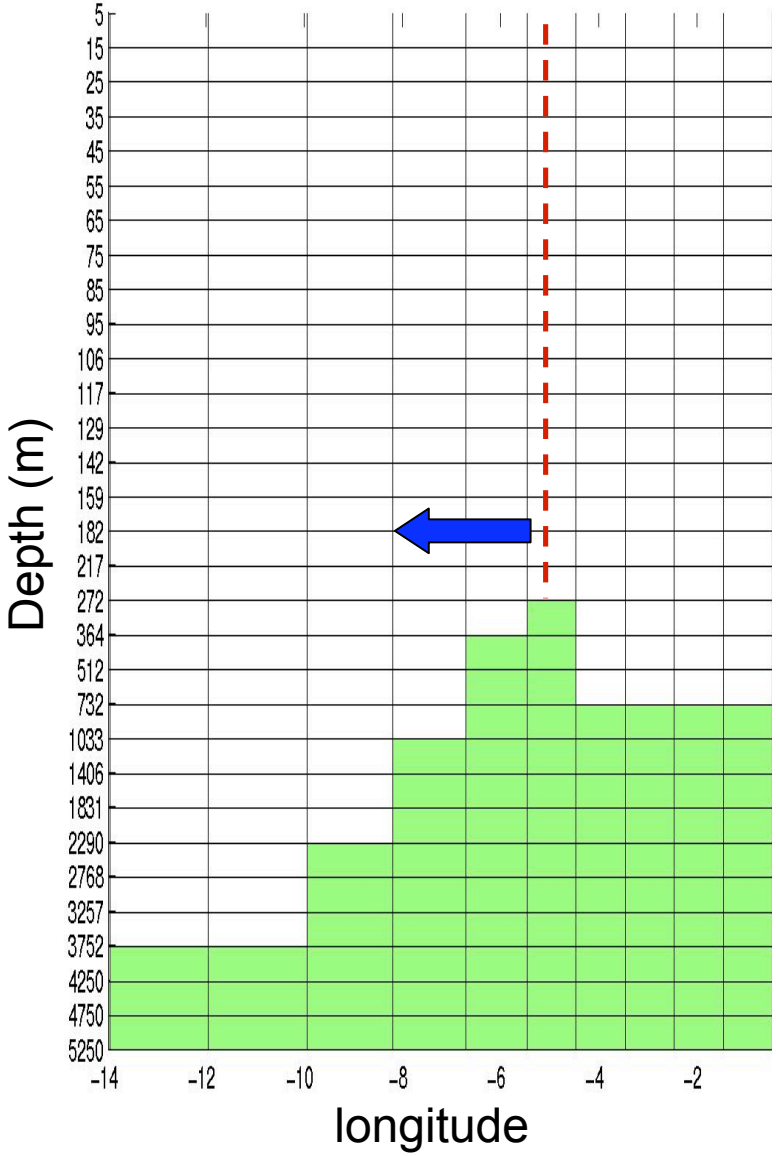
Vertical-Zonal section across Gibraltar Strait







GLOBAL :2x2L31



MED SEA : 1/16 L71