Preliminary - Hydrodynamic Simulations of the European Shelf Sea

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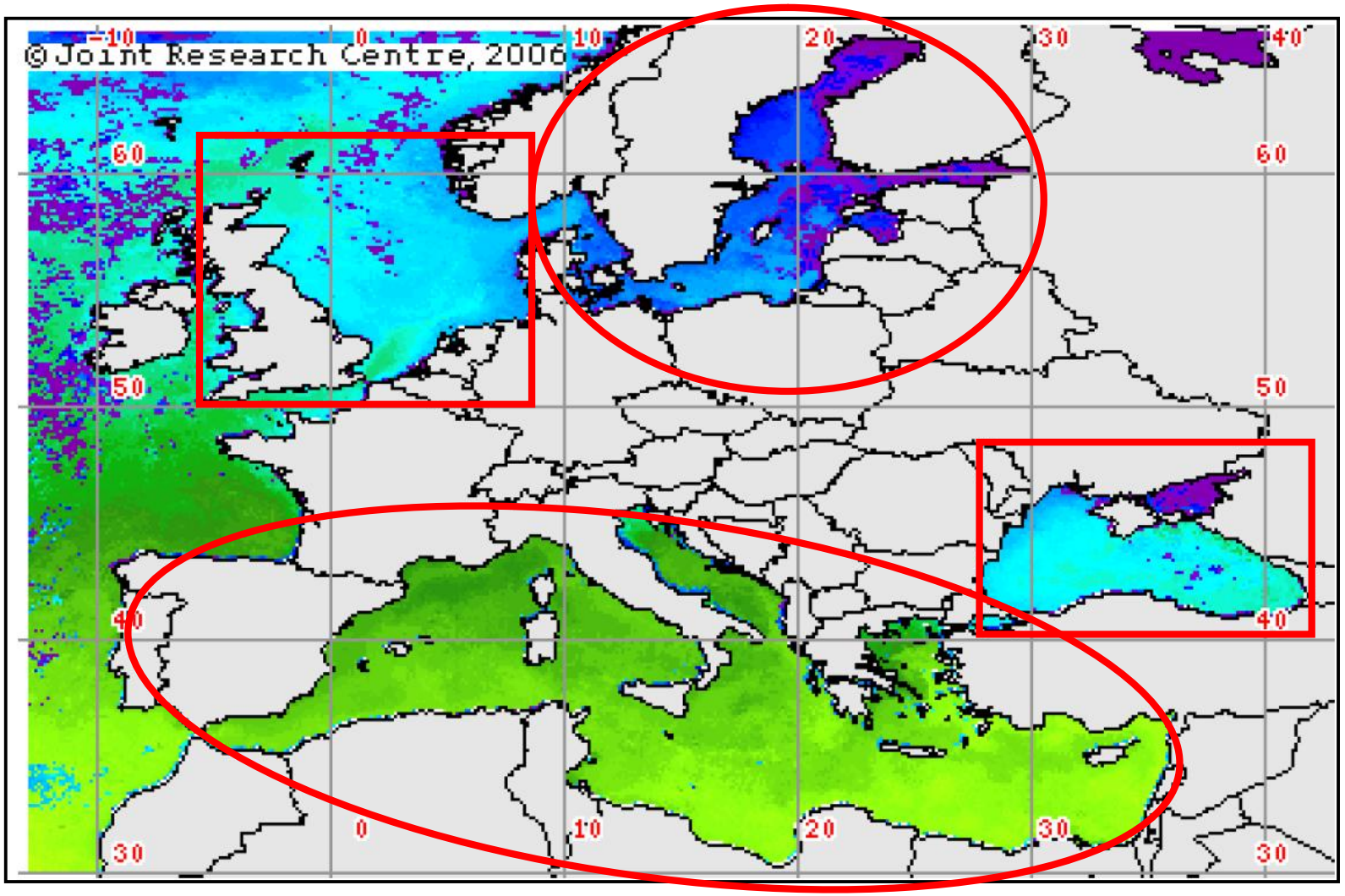
EMIS – regions of interest – missing Shelf



Environmental Marine Information System
http://emis.jrc.ec.europa.eu

Outline

- Why European wide modelling
- Brief introduction to GETM
- Basic features of the setups
- Long term trends of SST
- Compare SST for different Seas
- Results Gulf Lion deep convection
- Conclusions

Motivation

- Try to achieve harmonized European regional Seas simulations
- Using the same model, similar setups and the same forcing
- To build a database for assessing trends and shifts in the marine system
- To support the development of harmonized indicators for European regional Seas

Main software workhorse

3-D GETM model
(General Estuarine Transport Model, initiated at JRC+, .. www.getm.eu, www.gotm.net)

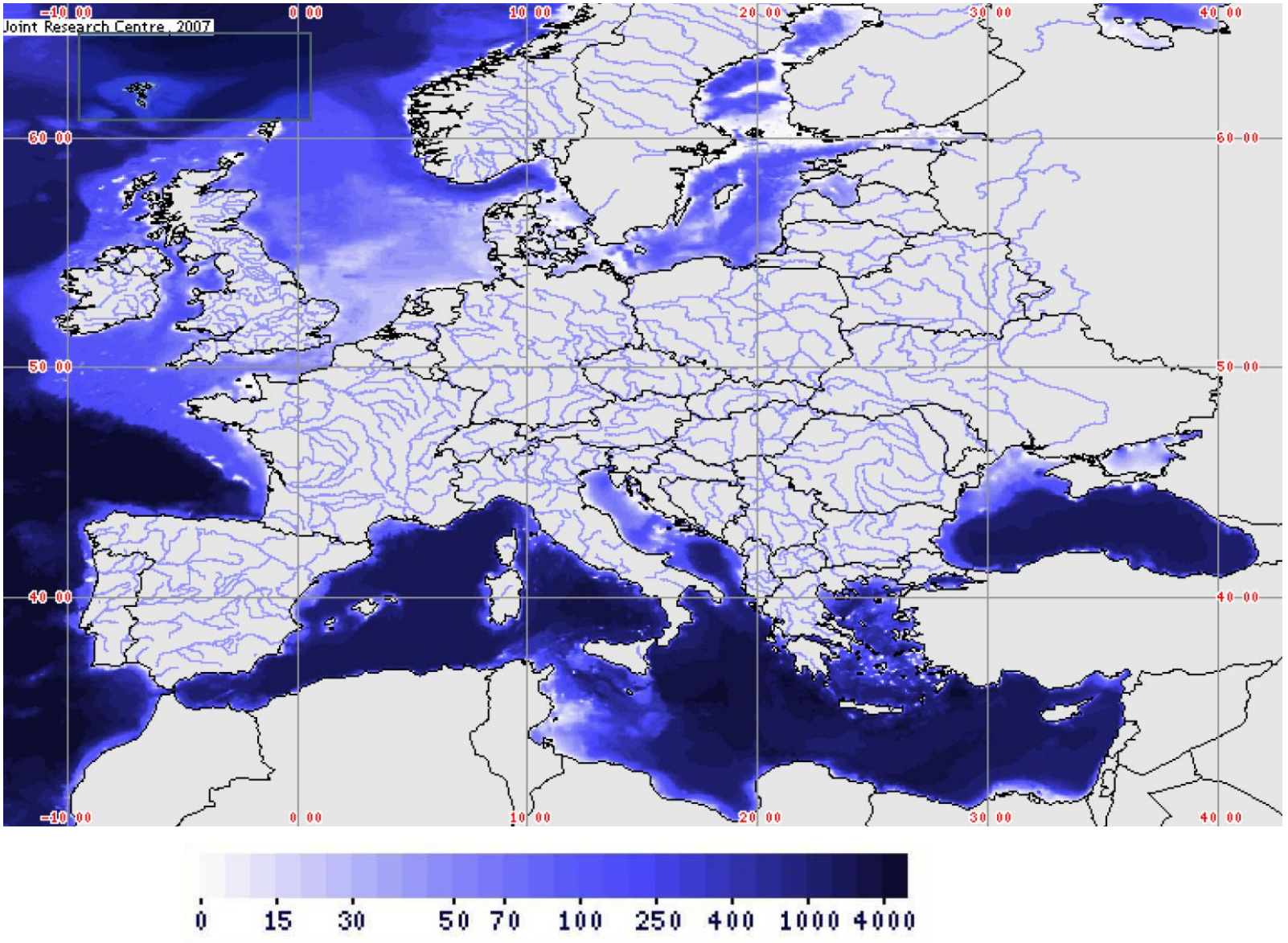
Very important: Open software (allows principally reproducible research)

- *Turbulence model, TVD advection, terrain following coordinates, int. pres. schemes, bio*
- *ECMWF meteorological forcing, ERA40, ERA-INTERIM, analysis data (resolution from 125km to about 12km), time coverage changing*
- *Realistic bathymetry, GEBCO, (0.5x0.5')*
- *River discharge input, GRDC (to be improved!)*
- *Tide simulation, TOPEX/POSEIDON*
- *Validation with available satellite and in-situ observations.*

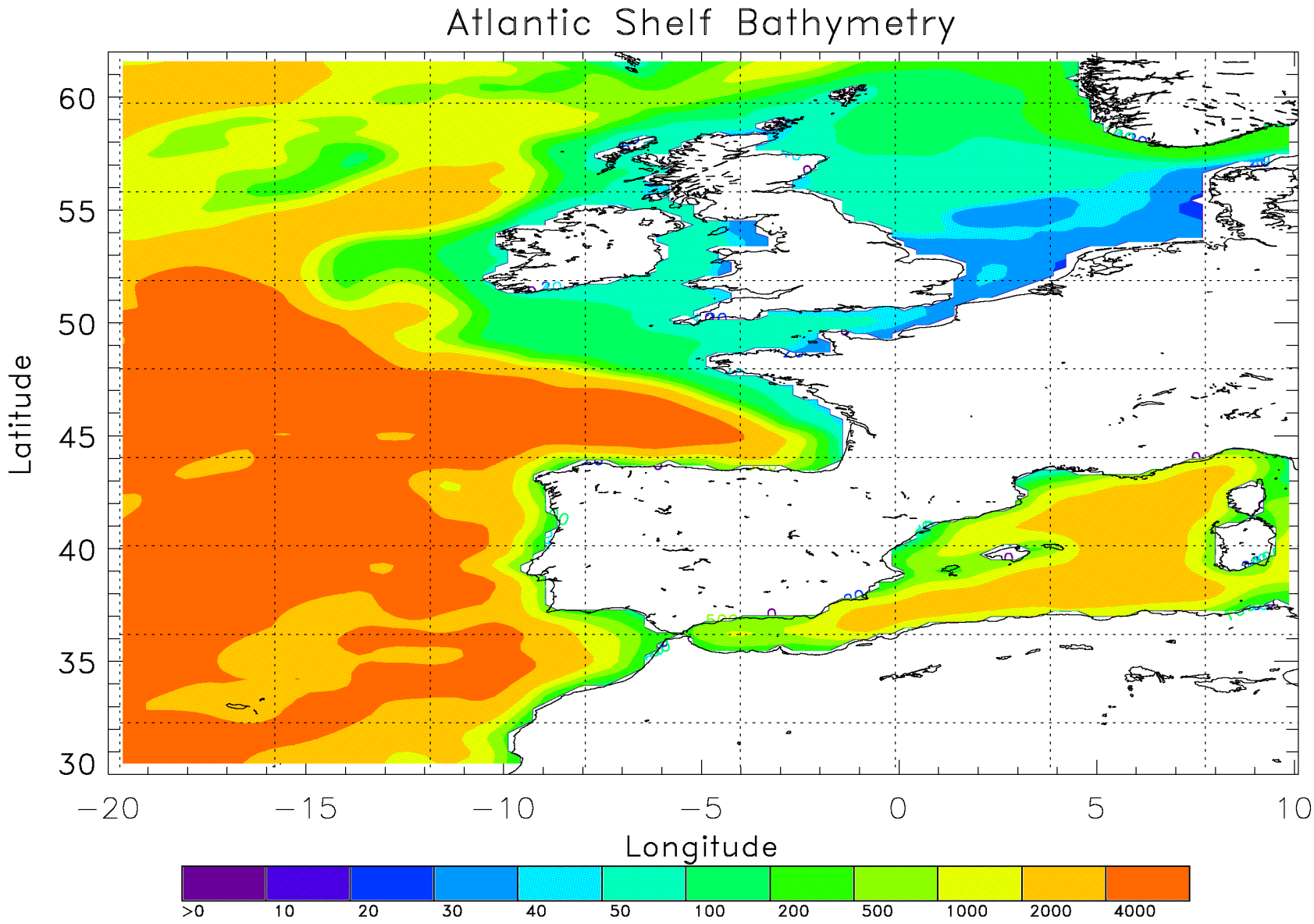
Some setup characteristics

- Rather consistent approach for the simulation of European Seas:
- -Black Sea, 5x5, 2x2, 1x1
- -North Sea, Baltic Sea, 3x3, 3x2, 2x2, 1x1
- -Mediterranean Sea: 15x15,5x5,2x2,1x1
- -Med Sea&Black Sea, 2x2, 1x1
- -Atlantic Shelf: 15x15, 5x5,2x2
  - All European regional Seas under construction
- Multiannual simulations: 1960-2009
- Assessment of trends and shifts
- Indicator development, PSA, OXYRISK

Bathymetry European Seas

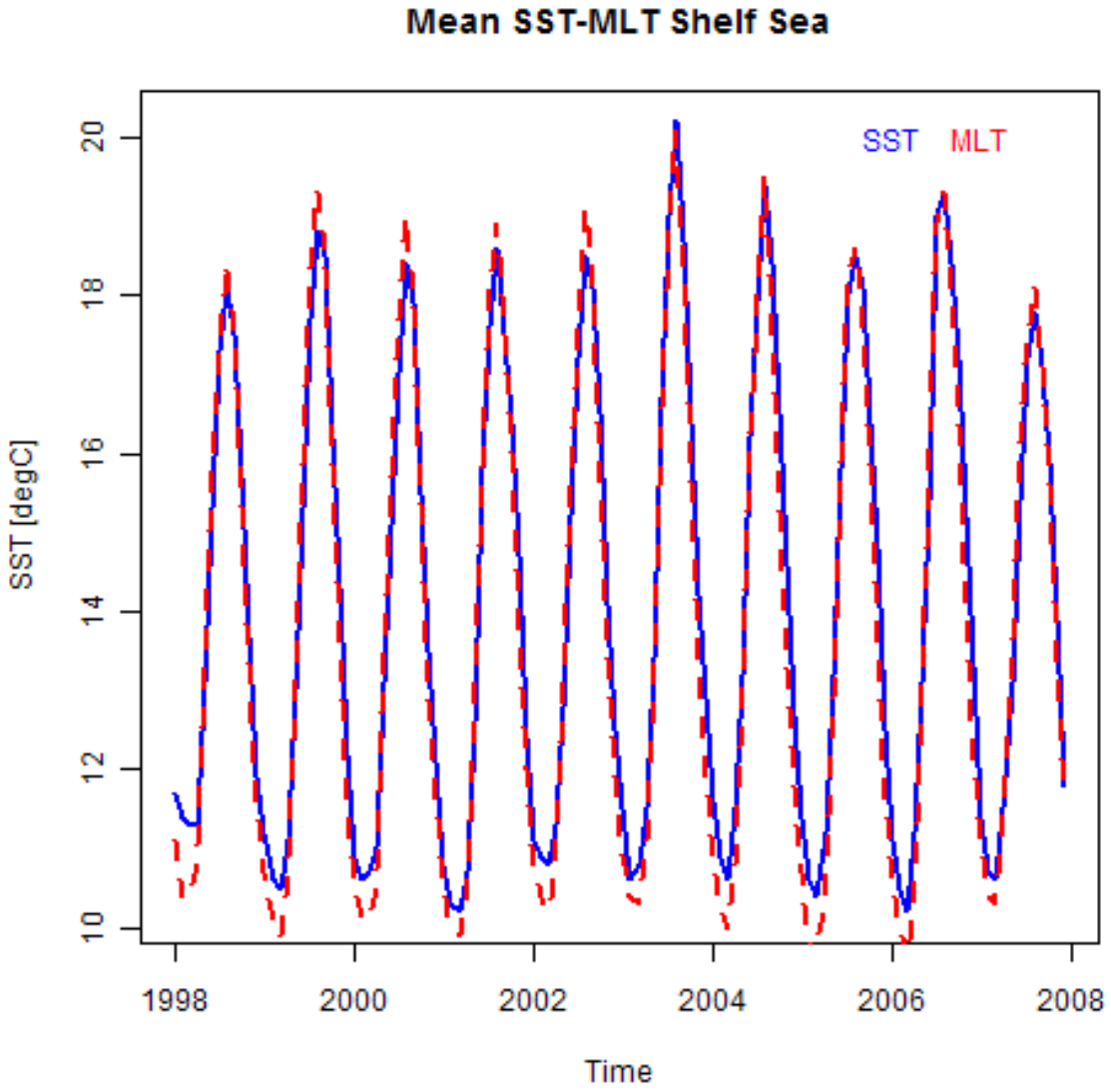


Atlantic Shelf Domain



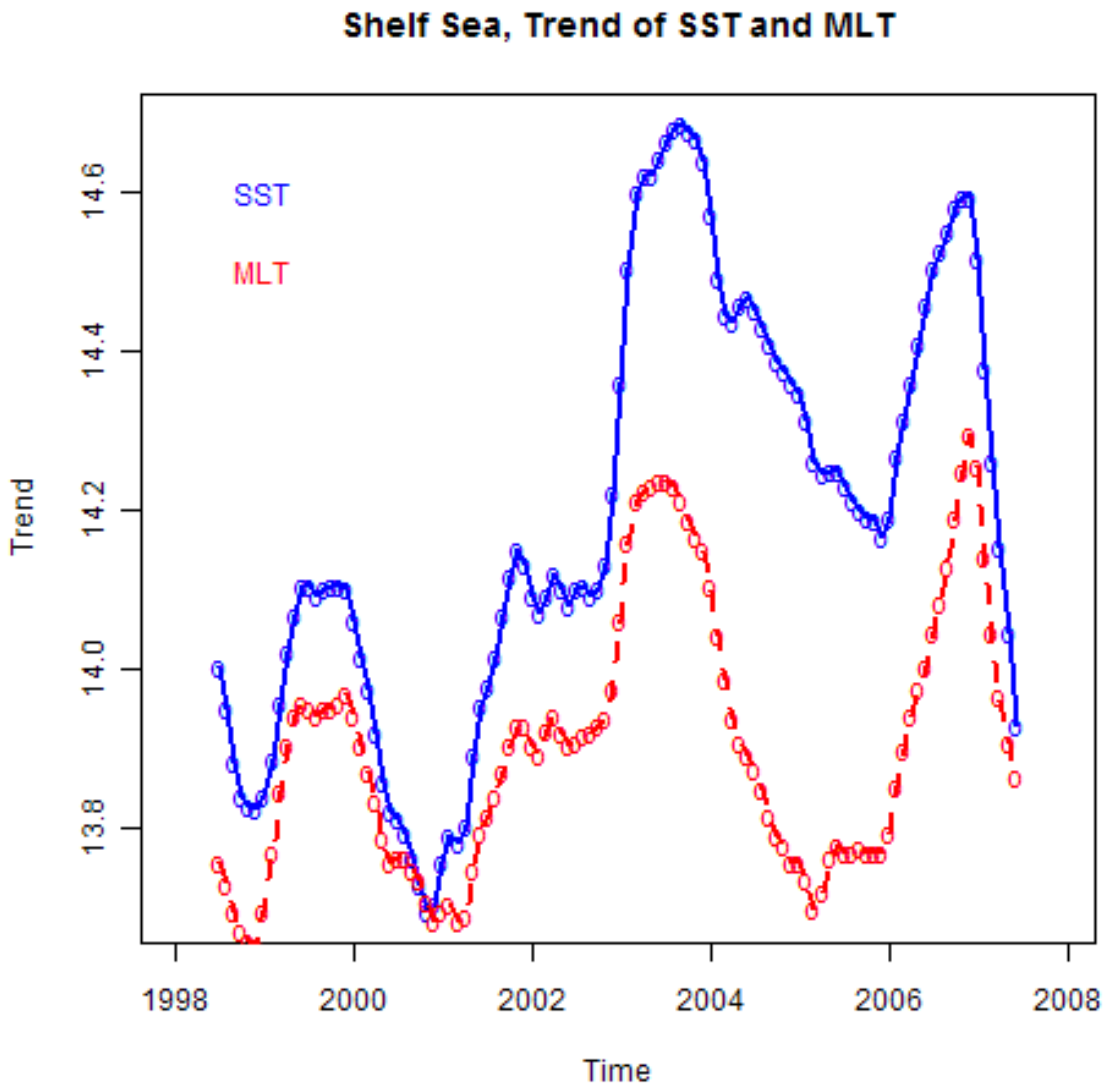
Shelf Compare mean SST - MLT

- Satellite SST AVHRR
- Seasonal cycle rather well reproduced
- Winter minimum about 0.4 degC to cold
- Summer first 5 years 0.3 degC to high



Shelf SST Trend

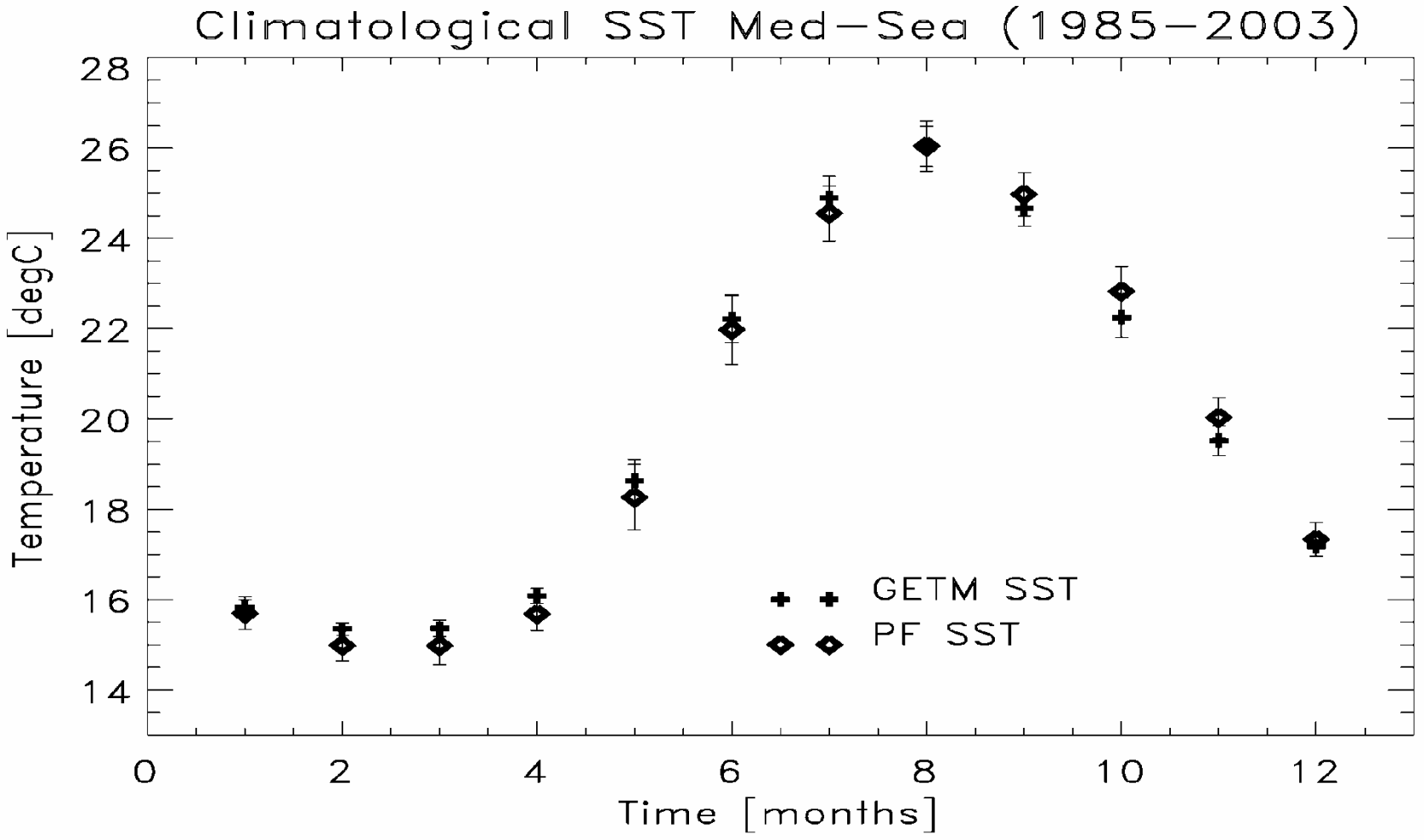
- Low pass filter, removing seasonal signal
- Absolute difference ~0.3K
- Increasing from 2003 (end of ERA40)
- Before ERA-INT, some runs with mixed forcing (visible quality difference!)



Compare different regional Seas

- Problems already with different spatial resolution and temporal coverage of meteo forcing
- But how good is our one flux parametrization fits everything approach?
- Have a look at the different Seas
- First Mediterranean Sea

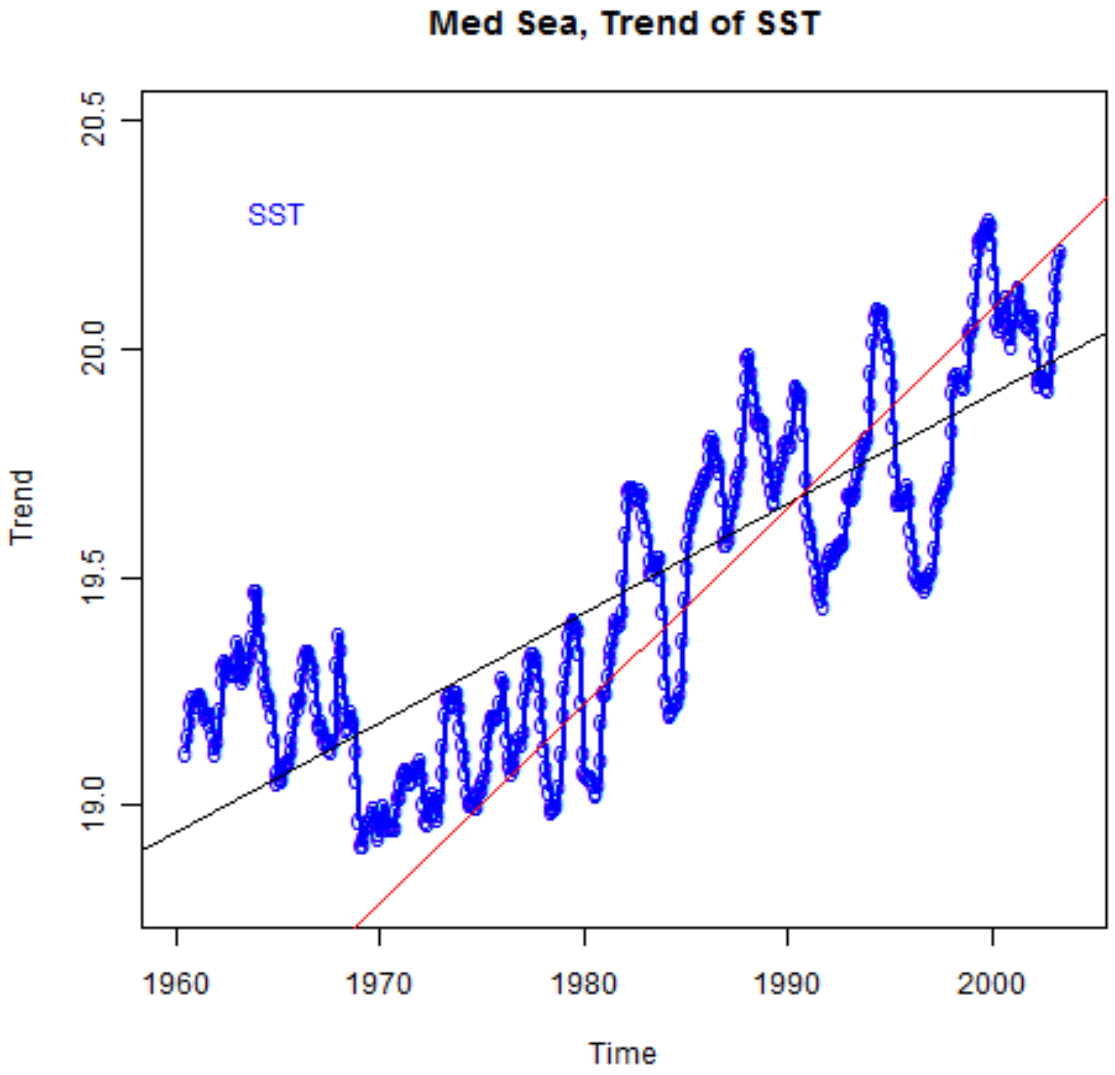
Meteo forcing ERA40 MedSea



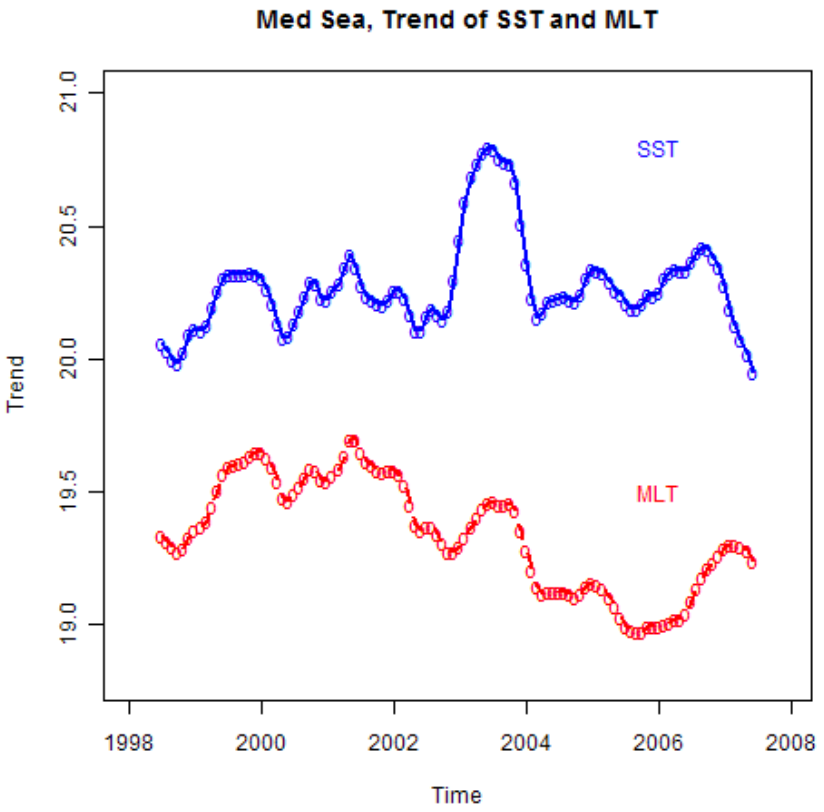
Quite okay, non significant differences of < 0.2 degC

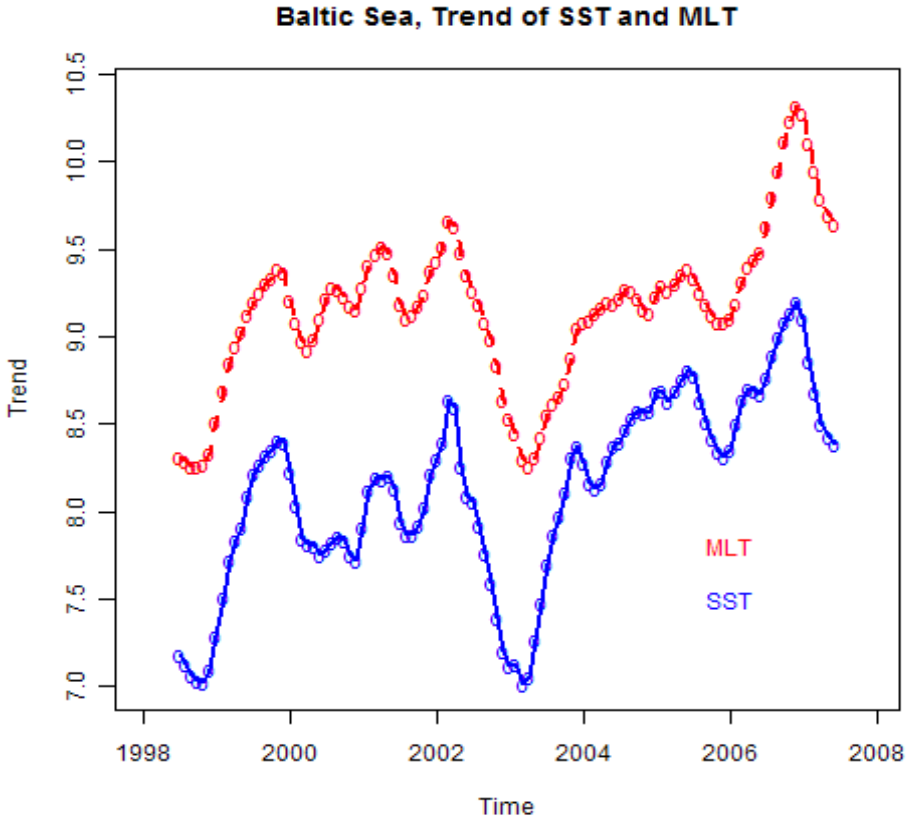
Long term trend Med Sea

- *Model SST*
- *Forcing with ERA40 only*
- *Warming of about 1.05 K*
- *means 0.024 K/year (black line)*
- *1960-1980 no trend*
- *Warming begun only 1980*
- *Then it would be 0.043 K/year (red line)*
- *Trend is actually the same as from satellite (Nykjaer 2008)*



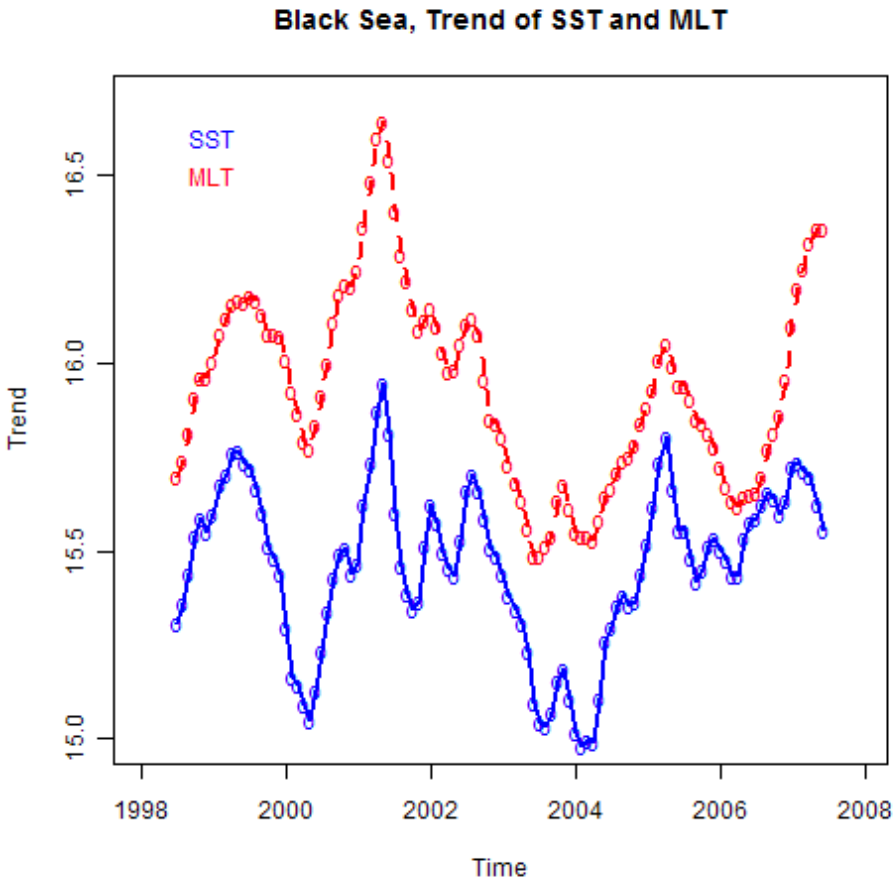
Compare South and North

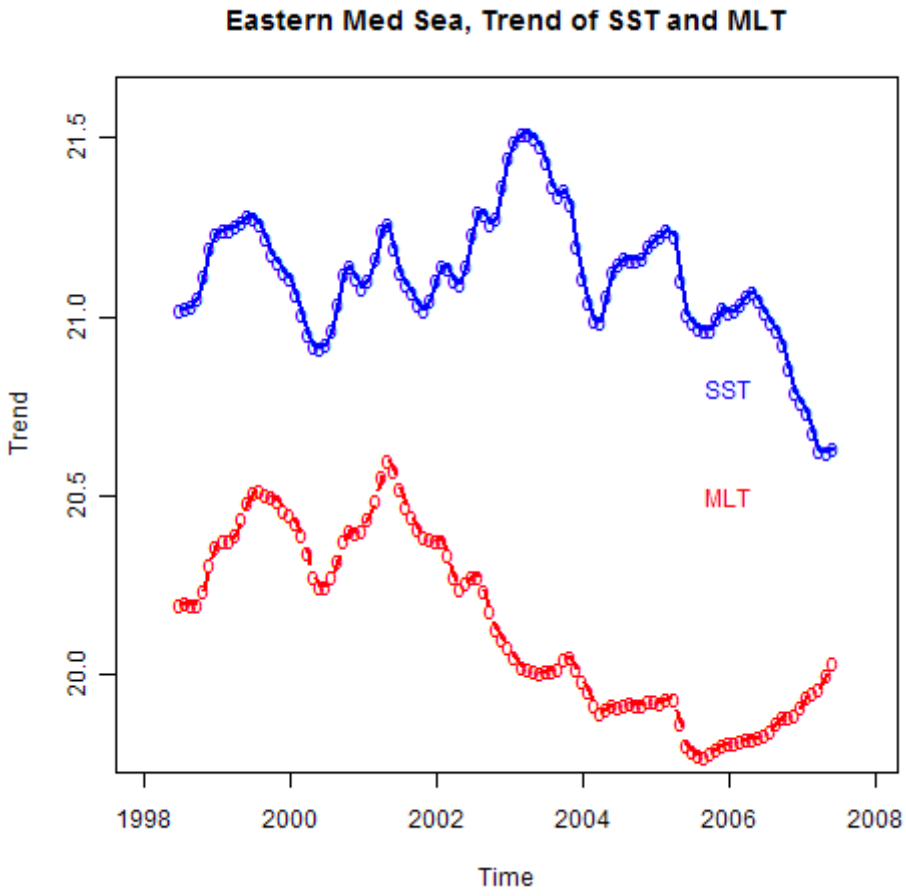




Low pass filtered SST, simulation Medsea to cold, Baltic Sea to warm (const offset), (Medsea forcing quality degradation)

Compare South and North again

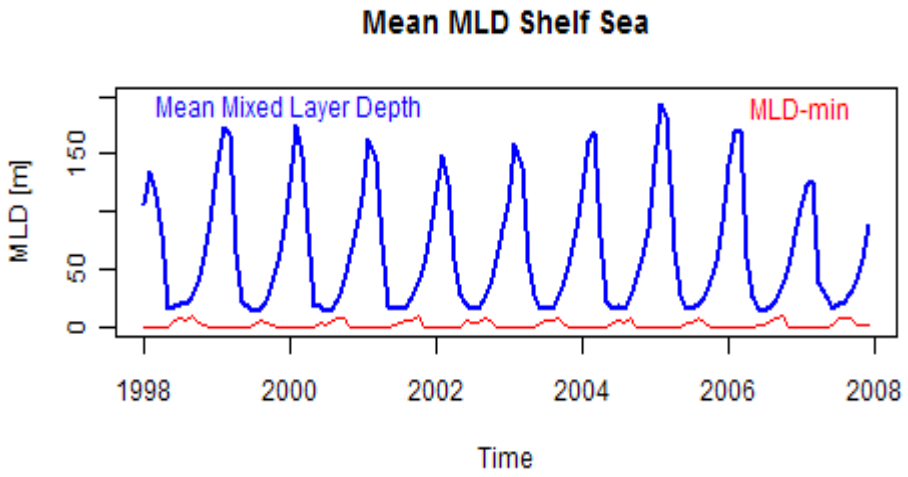


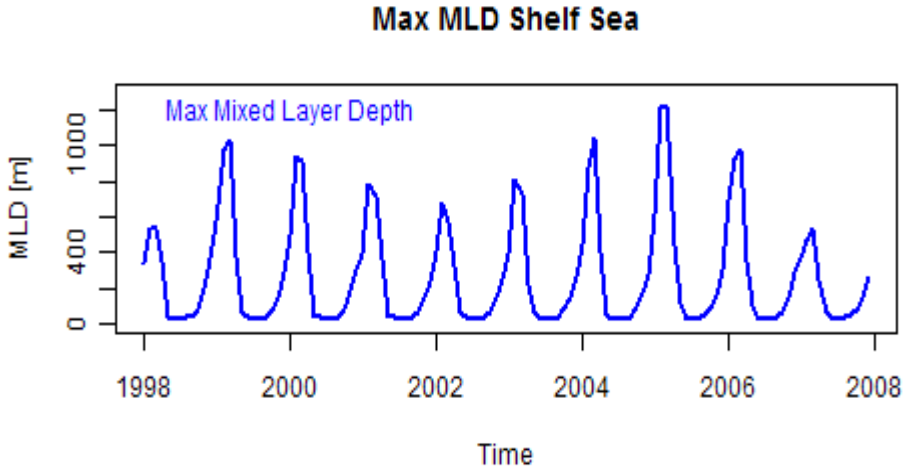


But even only in the South, Black Sea gets to warm,
whereas the Eastern Medsea is clearly to cold
Any good proposals for solving this are welcome!

Mixed Layer Depth

- Mean mixed layer depth (MLD) from Shelf Sea run, interannual variability related to atmospheric forcing
- Important for biology, published on EMIS
- Max monthly mean values above 1000m
- Where?

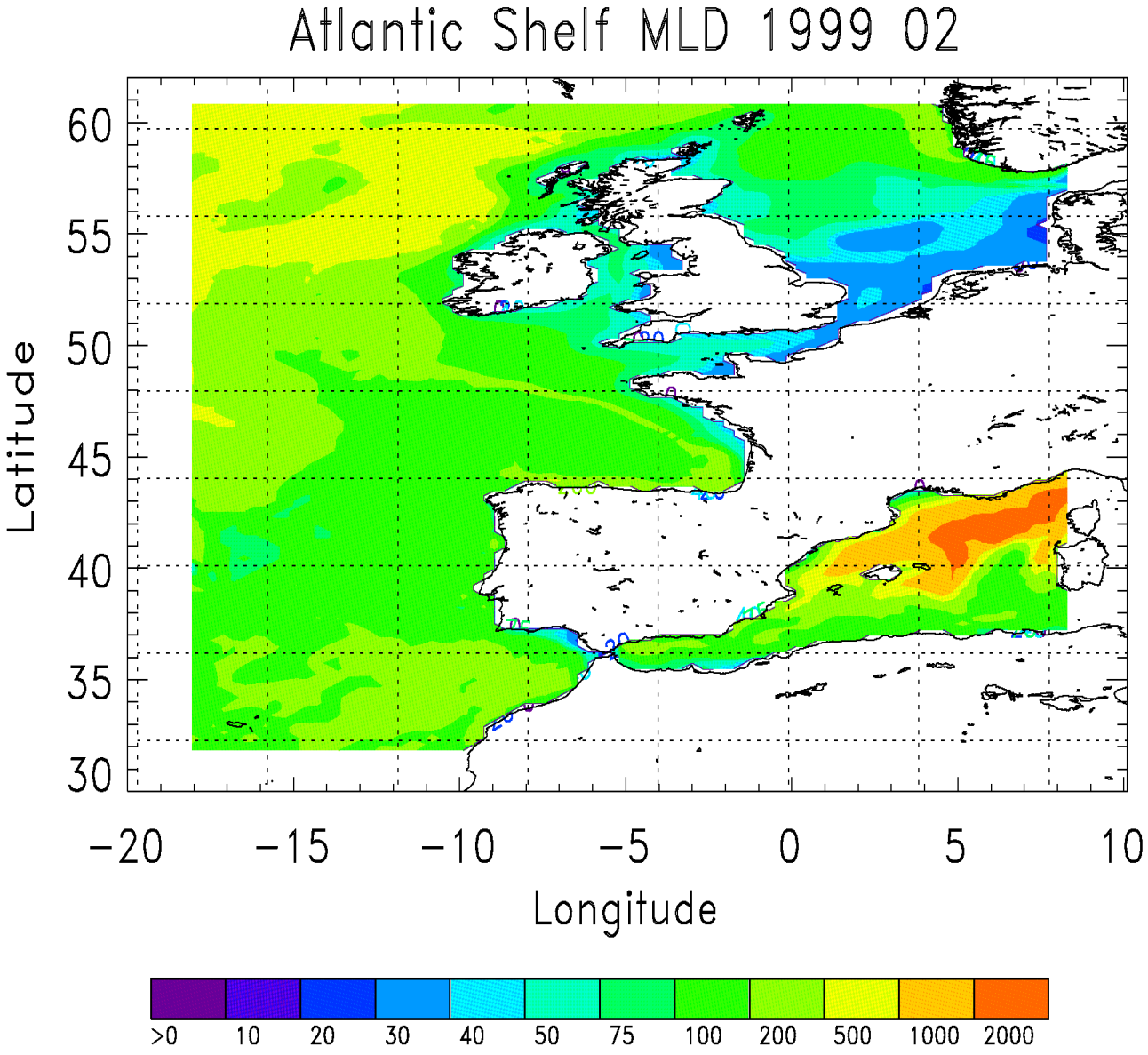




How to simulate deep convection?

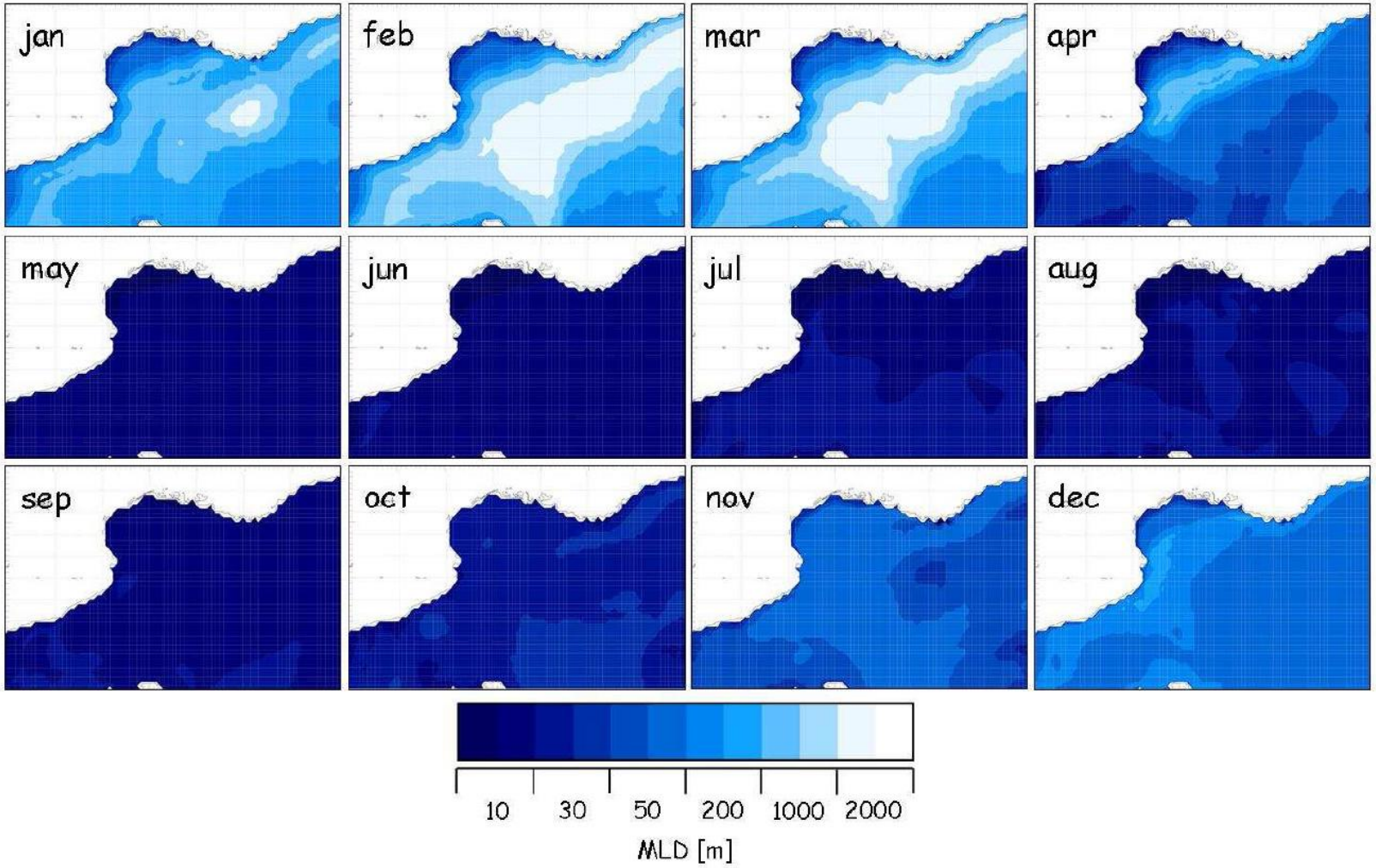
- Deep Convection Gulf of Lions ?
- Herrman and Somot 2008, conclude that with low resolution AF deep convection does not occur, but with HRAF (downscaled ERA40)
- In conclusion, in our runs using ERA40 there should be no deep convection
- Looking on our runs, forced with ERA40 data (e.g. other turbulence model) we get:

MLD and deep convection



Example: Extended region with deep convection during February 1999

Deep convection Gulf of Lions

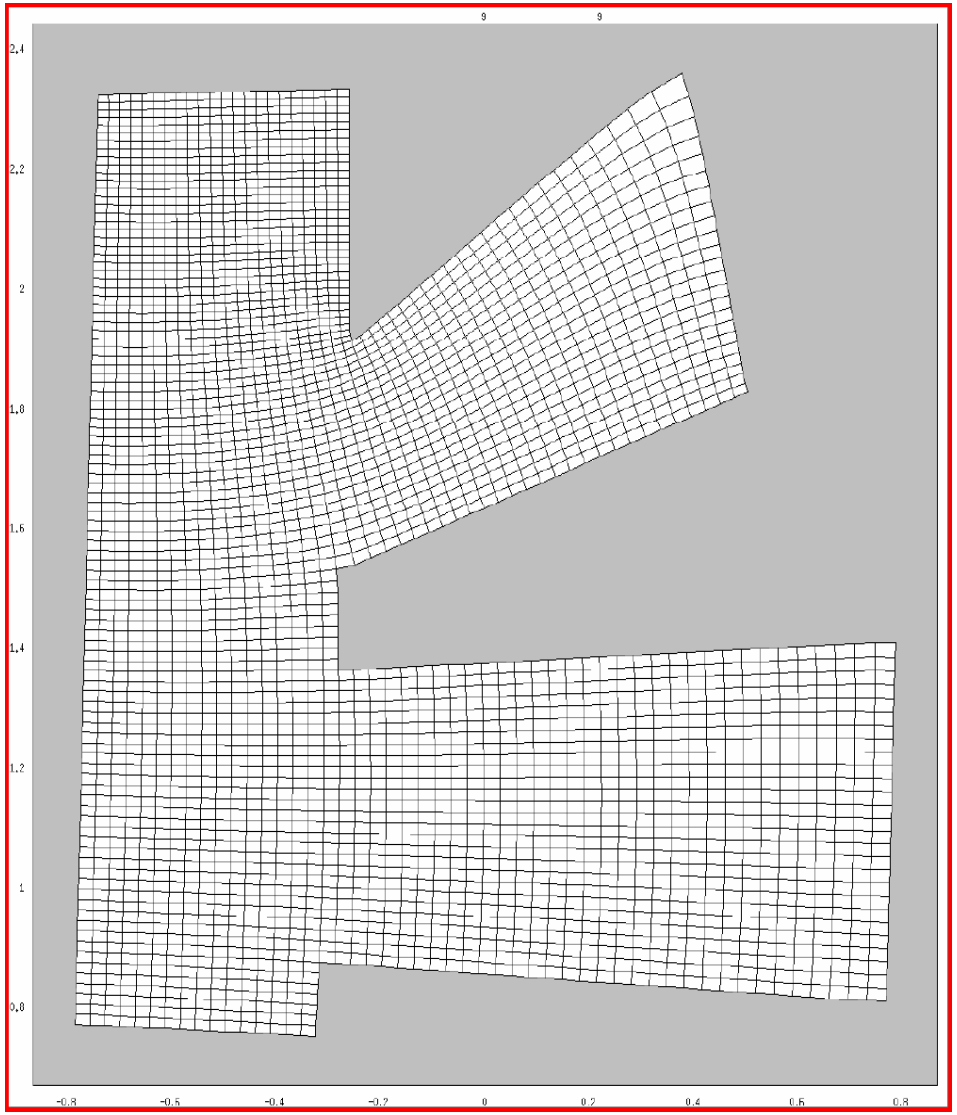


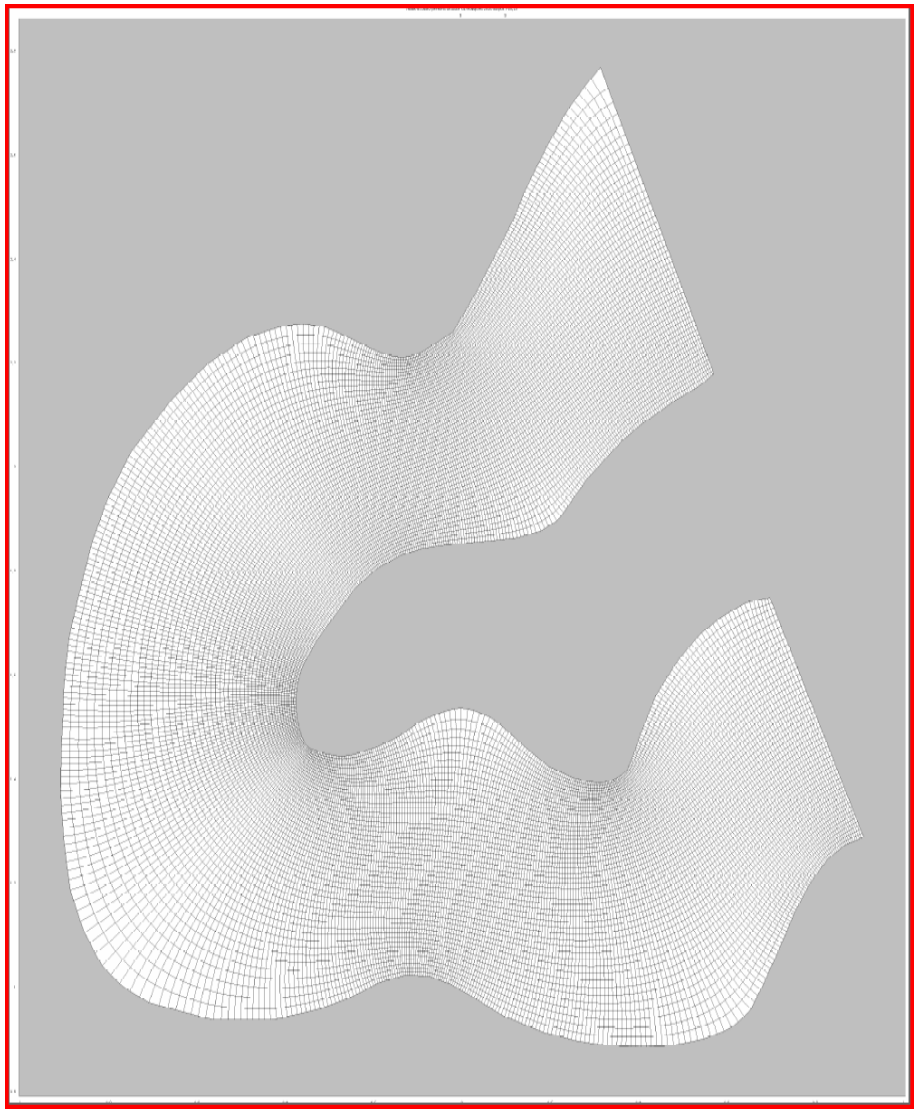
Climatological monthly means, over 10 seasonal cycles (1998 to 2008), of mixed layer depth, *MLD* [m]

How to go ahead?

- All European regional Seas in one domain?
- How to be done without Supercomputer?

Outlook





Final considerations

- Harmonized simulation of European Seas
- Obstacles like harmonized forcing
- Air-sea flux parameterizations only conditionally valid for such large areas
- Not shown, just finished an improved run with changed solar radiation (albedo)
- Not touched, boundary condition problematic
- Not touched, steep bathymetry problem
- Remember “reproducible research”