iFADO
INNOVATION IN THE FRAMEWORK OF THE ATLANTIC DEEP OCEAN

Final Workshop
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Model patching a first step towards upscaling

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EUROPEAN UNION

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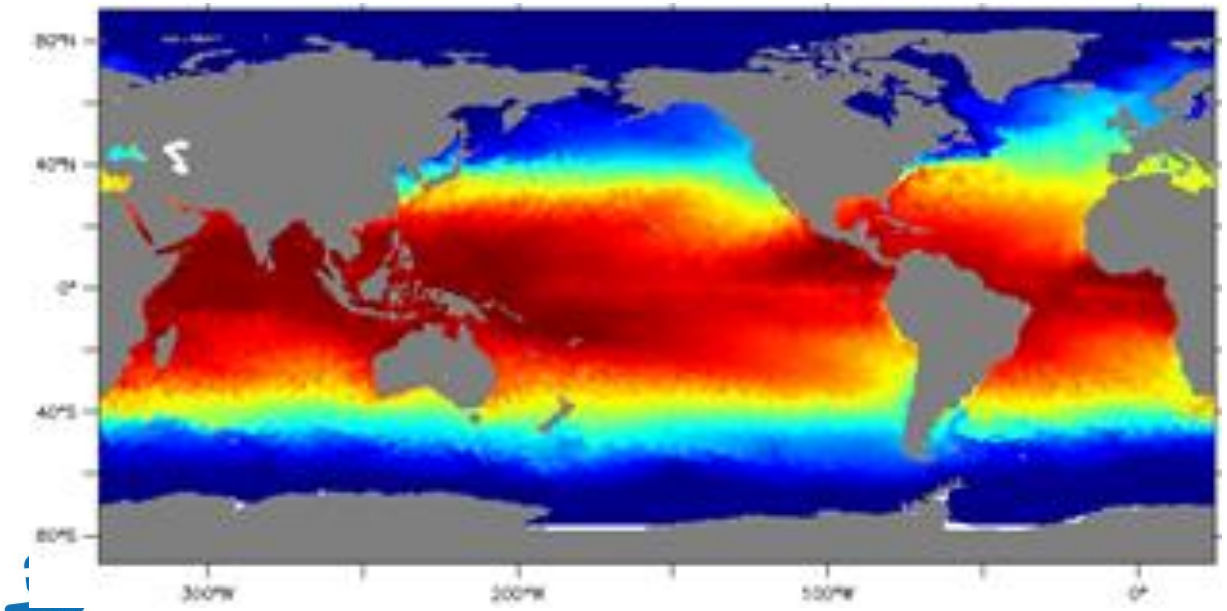
Introduction & Objectives

- Different institutes and centres within regional monitoring and forecasting centres run the models for the various basins.
- The CMEMS products are then used by various oceanographic centres to provide initial and/or boundary conditions to their respective models.
- Nested models usually run at higher resolution and may include more accurate data (bathymetry, river discharge data, etc.).
- Upscaling (Patching) is a common technique for allowing lower-resolution global or basinscale (regional) models to benefit from some of the improvements available in higher-resolution subregional or coastal models (Vandenbulcke and Barth, 2019).
- The upscaling method is used under the assumption that the nested model has better prediction skills than the parent model (i.e., CMEMS)
- Under the iFADO project we made some model patching experiments as first step towards upscaling.

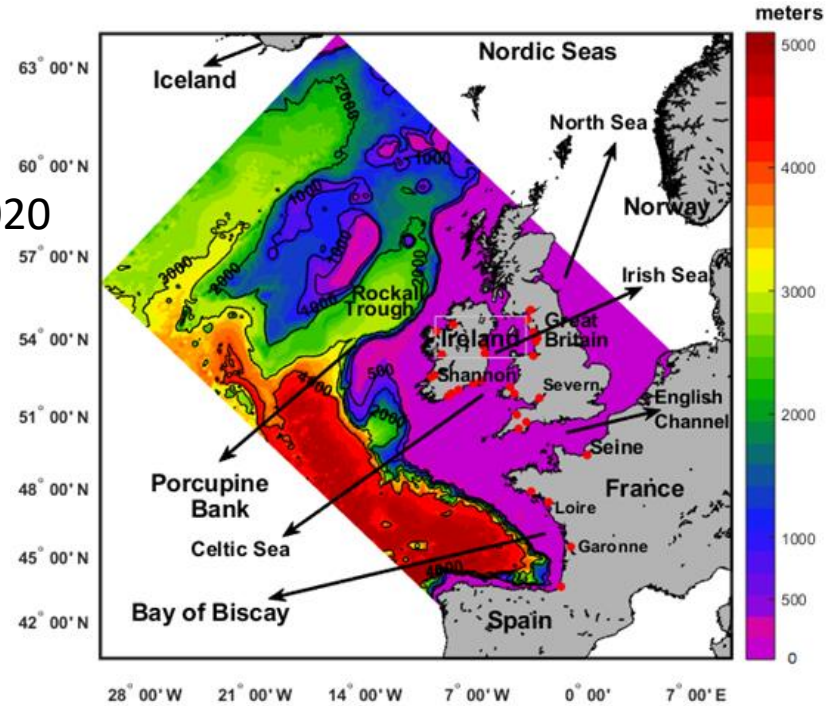
Model patching a first step towards upscaling

A realistic test case is set up with a global model covering the Atlantic Ocean CMEMS GLOBAL_ ANALYSIS_ FORECAST_ PHY _001_024 (Madec et al., 2008), and a nested model covering its north-eastern area NEA_ROMS (Nagy et al., 2020). The horizontal resolution of the NEA ROMS model is 1.1 km, and there are 40 vertical sigma levels in the vertical, with the highest concentration of levels at the surface and bottom. The data from the CMEMS model is freely available on the (CMEMS). The analysis is updated weekly while a 10-day forecast is updated daily.

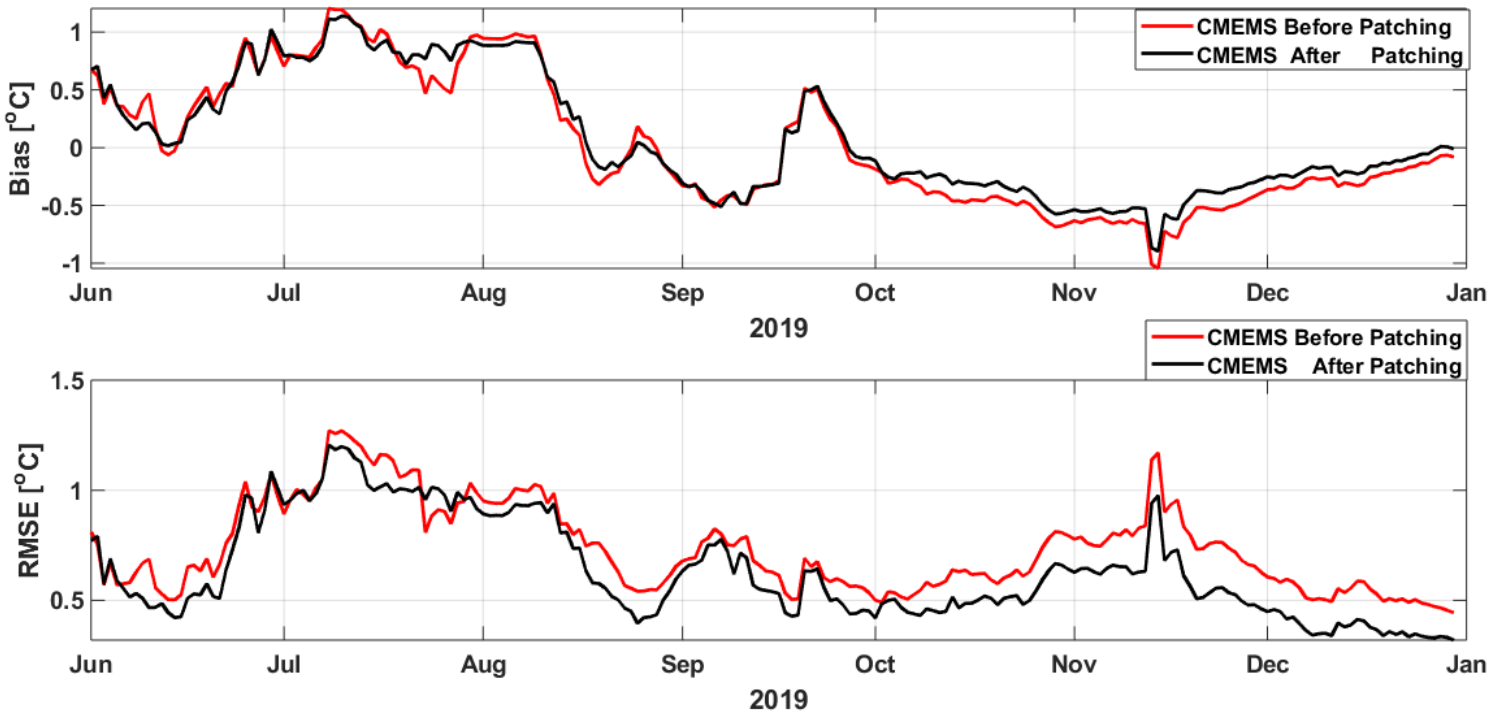
CMEMS-Global



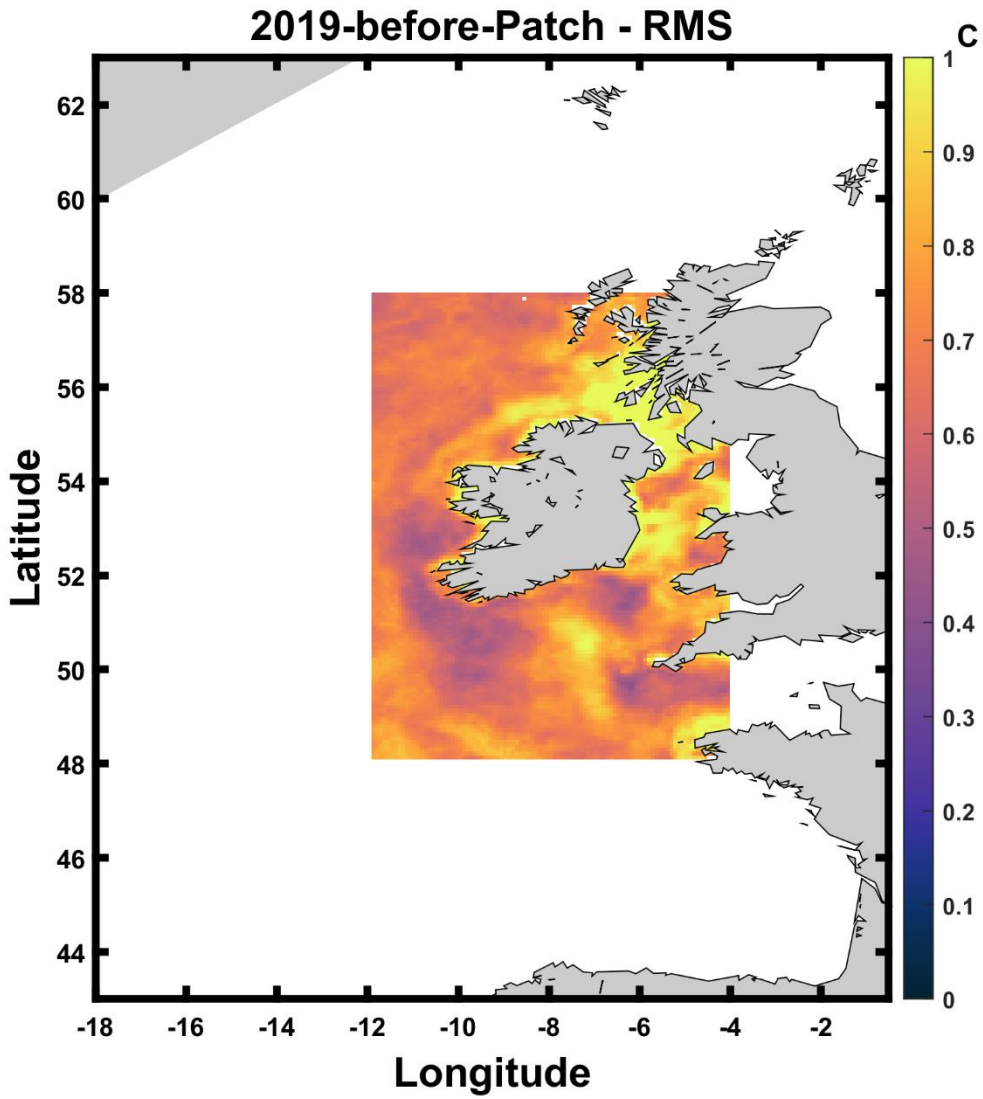
NEA_ROMS
Nagy et al. 2020

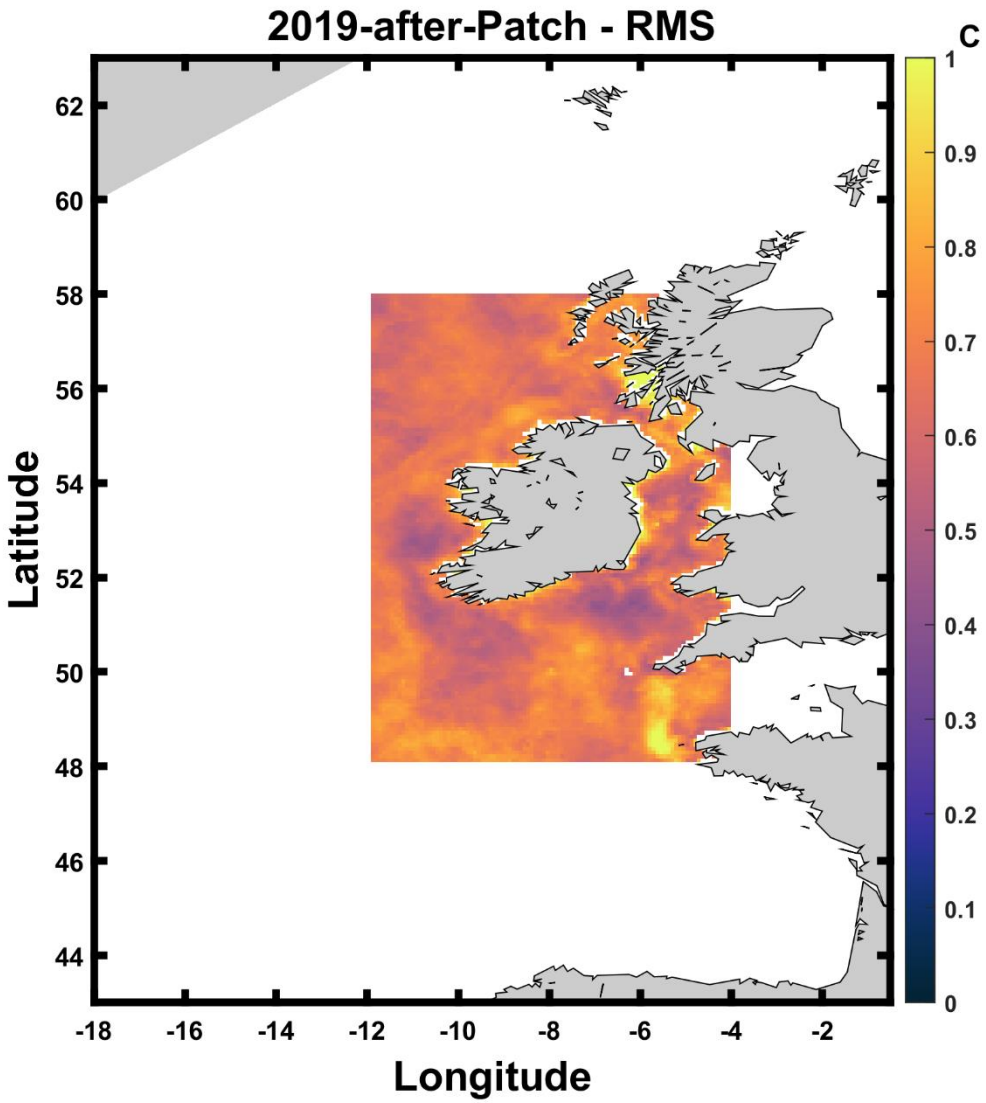


Before and after SST patching 6 months 2019



Validation of SST against ODYSSEA satellite North-Western Europe SST Analysis, daily, 0.02° resolution SST_ATL_SST_L4_NRT_OBSERVATIONS_010_025


2019-before-Patch - RMS
C
Latitude
Longitude
62
60
58
56
54
52
50
48
46
44
-18
-16
-14
-12
-10
-8
-6
-4
-2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0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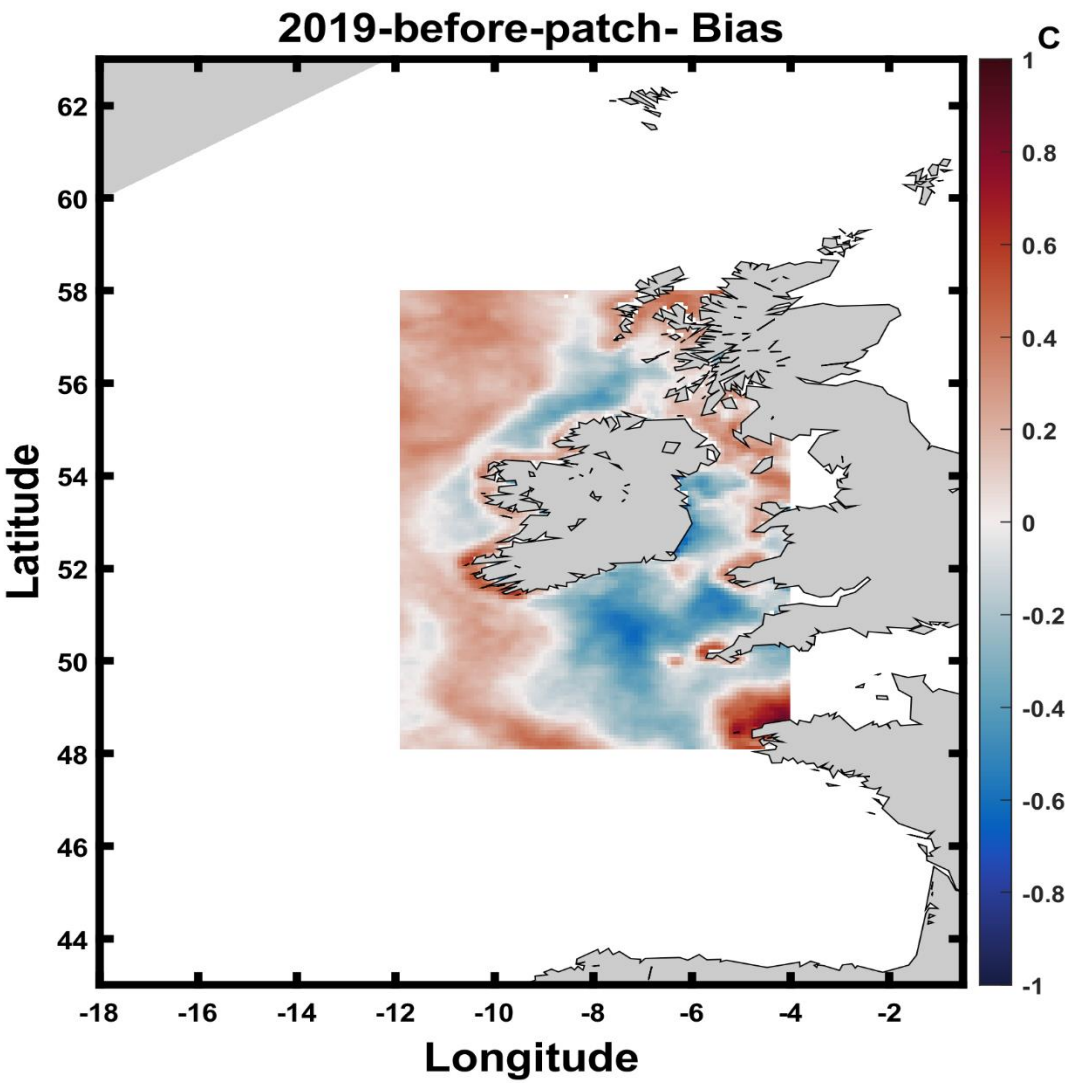
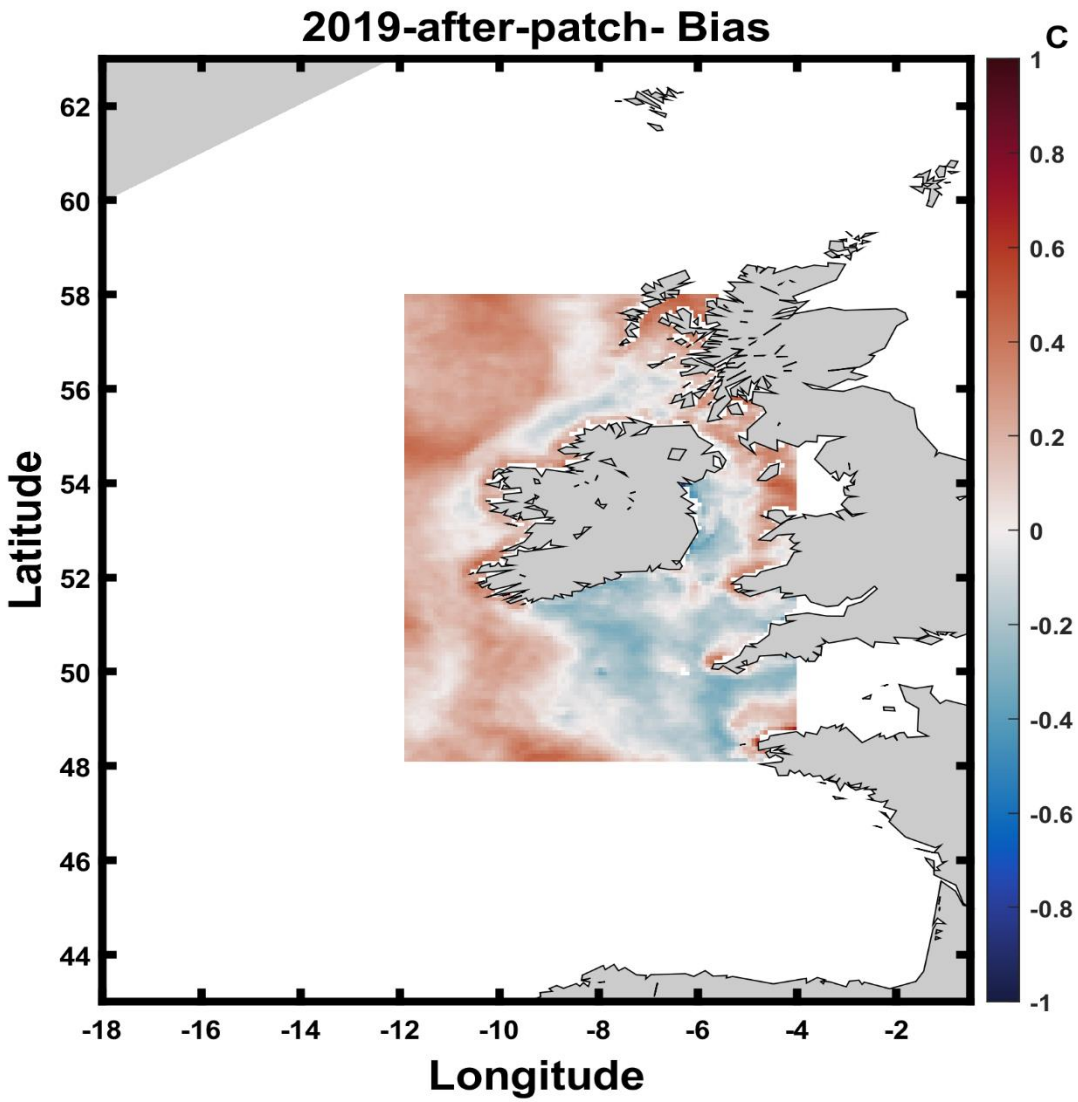

2019-before-patch- Bias
C
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
62
60
58
56
54
52
50
48
46
44
Latitude
-18
-16
-14
-12
-10
-8
-6
-4
-2
Longitude

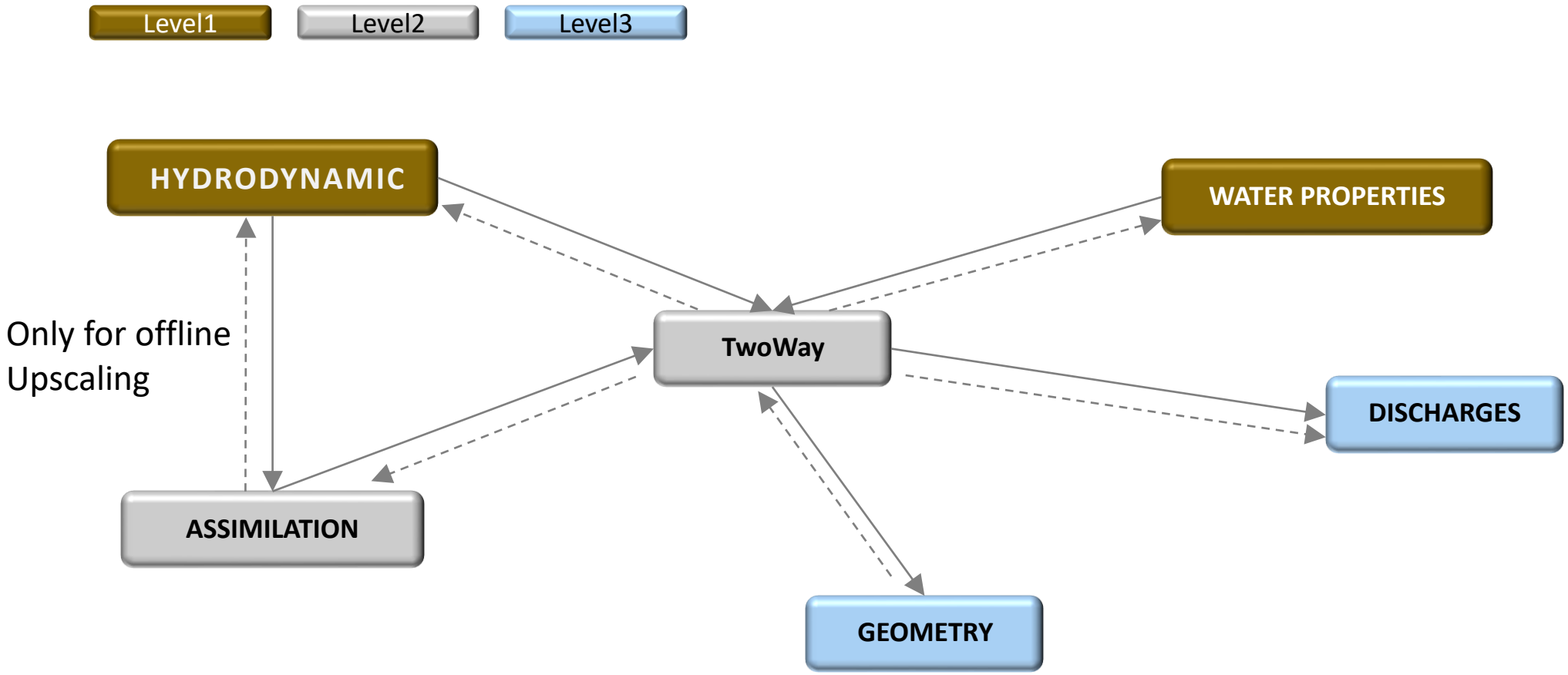

2019-after-patch- Bias
C
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
62
60
58
56
54
52
50
48
46
44
Latitude
-18
-16
-14
-12
-10
-8
-6
-4
-2
Longitude

MOHID Upscaling concept

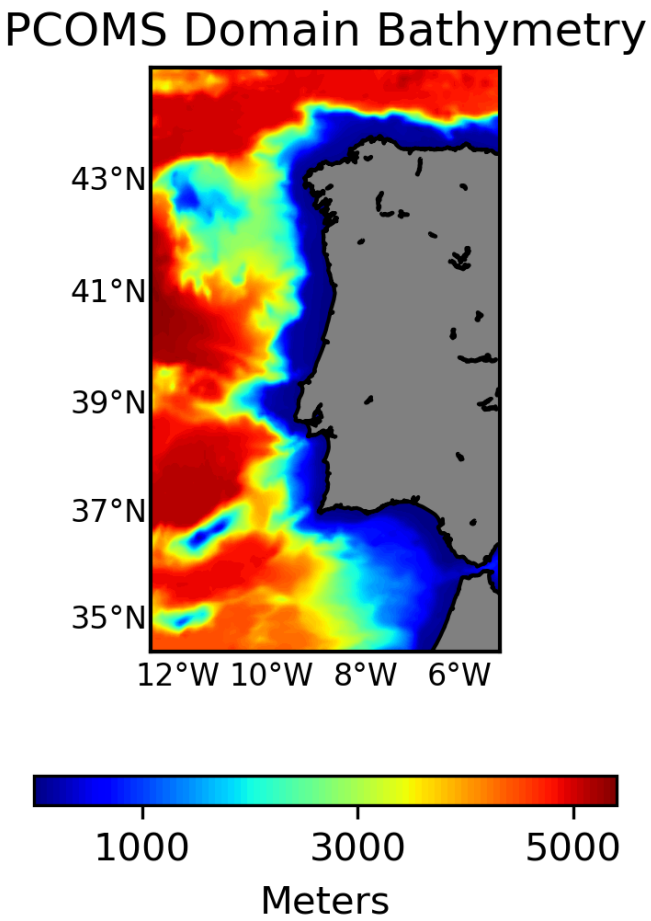
- Nudging based upscaling from a local (child) domain into a regional (parent) domain, applied to the overlapped area with the exception of a number of child domain cells from the open boundary inwards (user specified).
- Applicable to structured grids only (including variable spaced grids);
- Integrated directly in the MOHID model;
- Can be either online or offline, the latter allowing for operational use;
- Focuses on the nudging of horizontal field velocities, temperature, salinity and any other water property defined by the user;
- Volume-weighted average for the averaging of child domain values into parent grid.

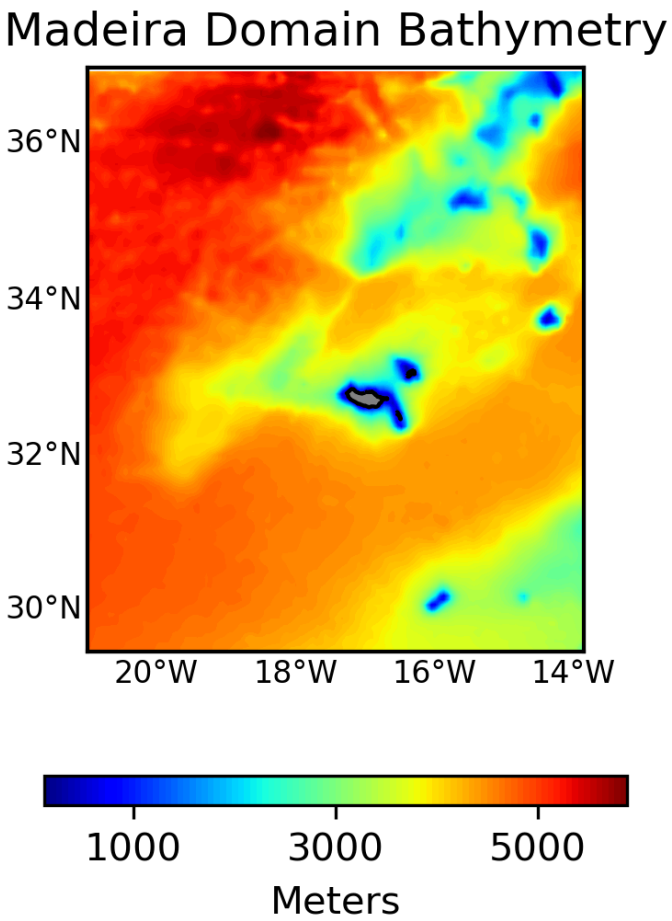
Code overview – integration of offline upscaling

Module TwoWay as an intermediar between the several modules



Western Iberian and Madeira Domains

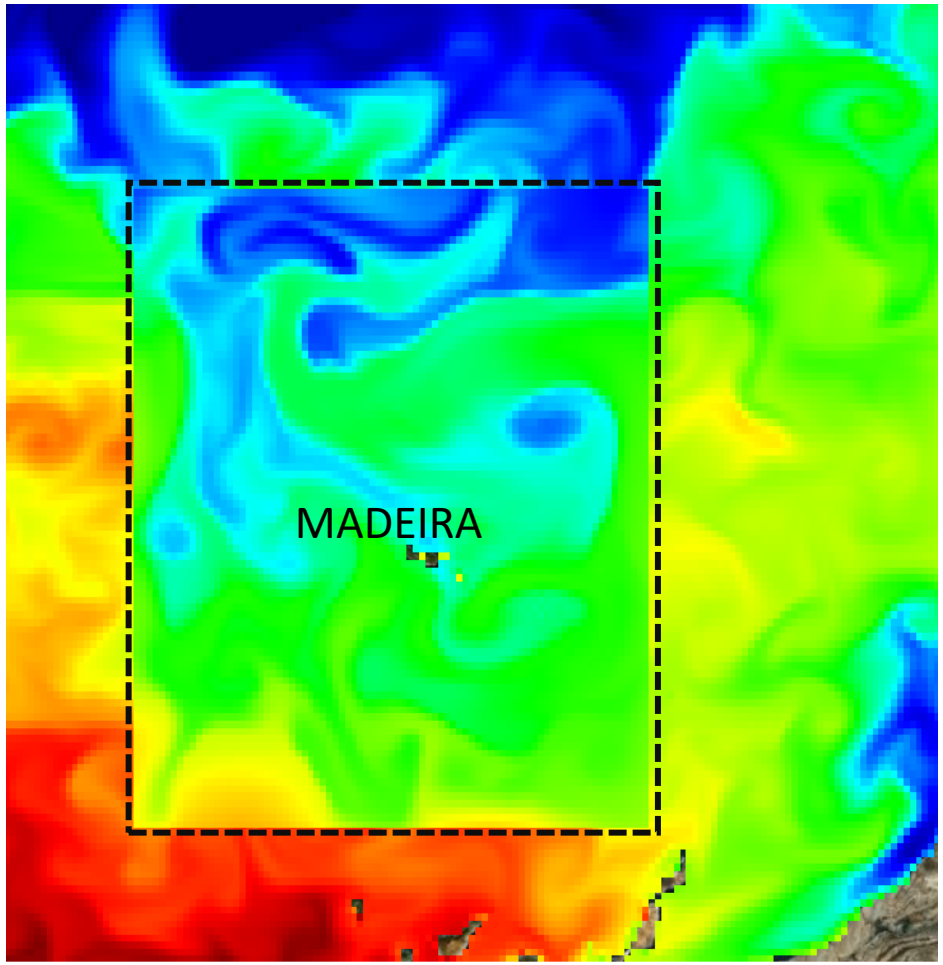




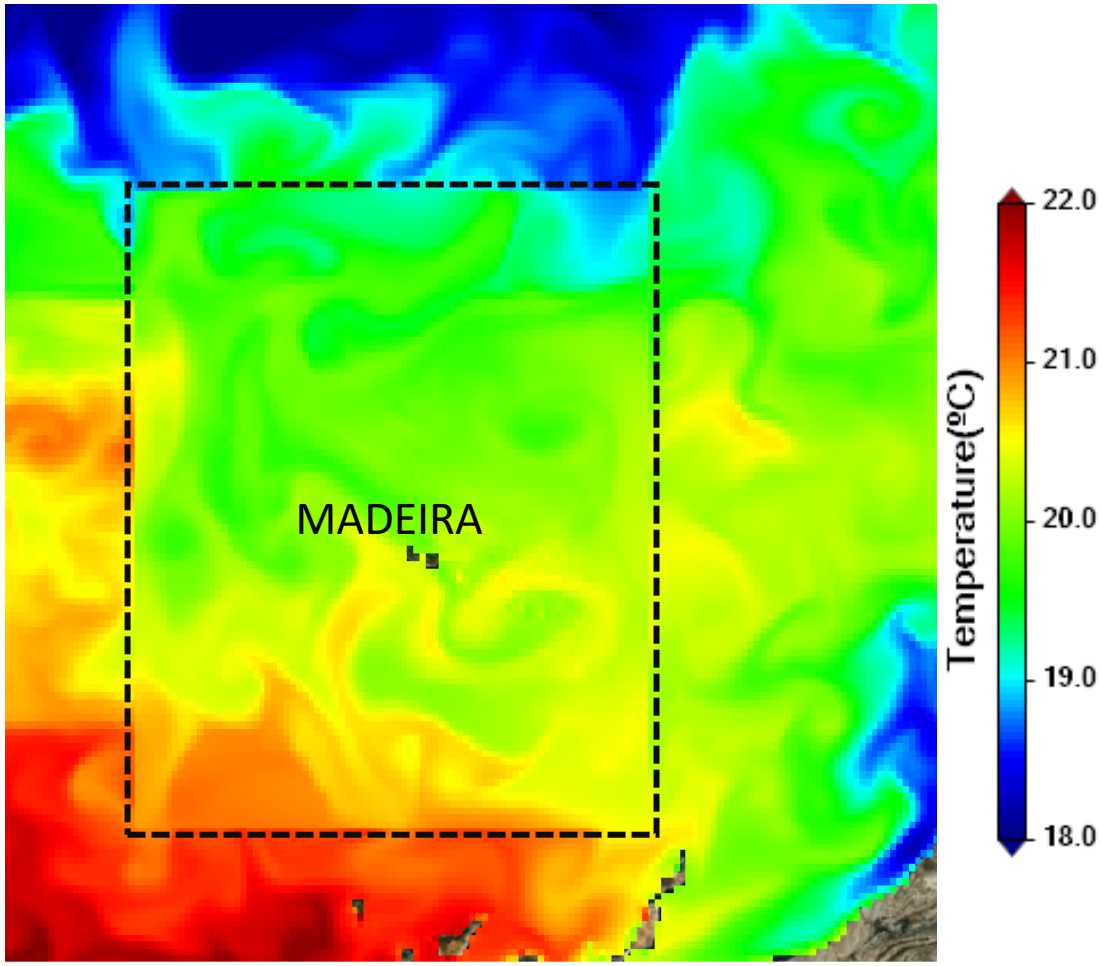
Madeira

1st of Jun 2006

Previous air-ocean heat transfer implementation



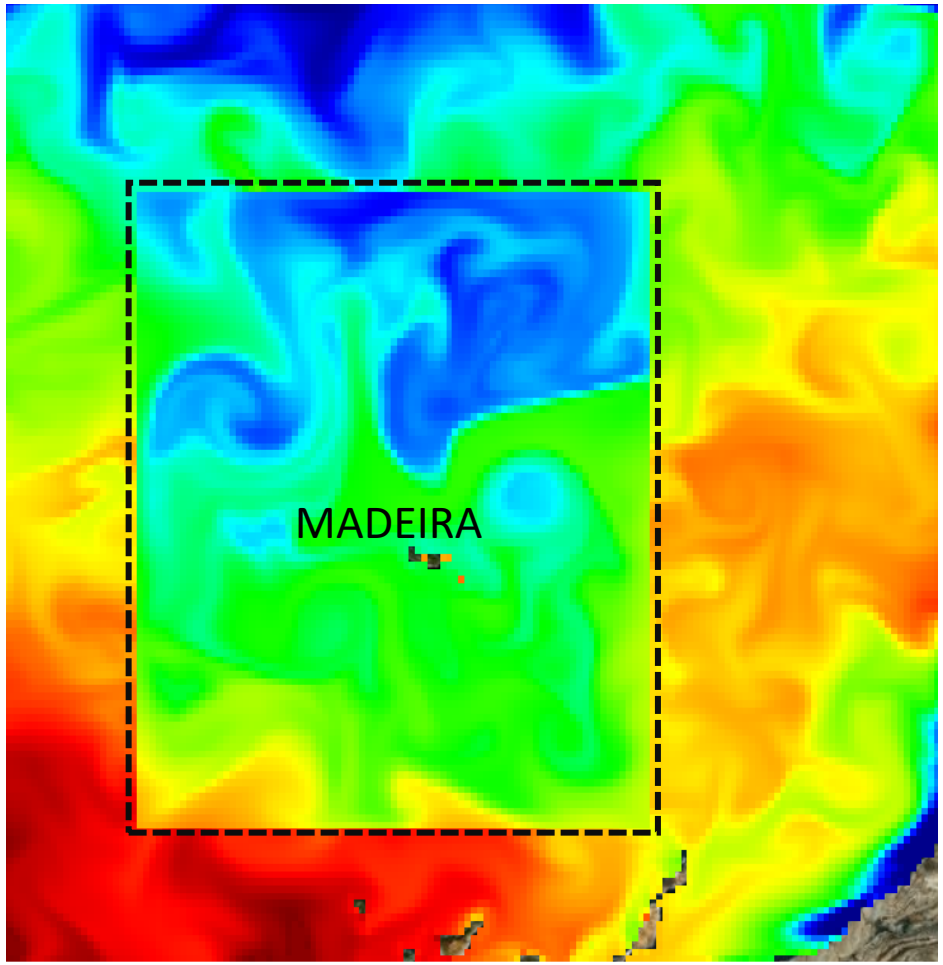
Improved air-ocean heat transfer implementation



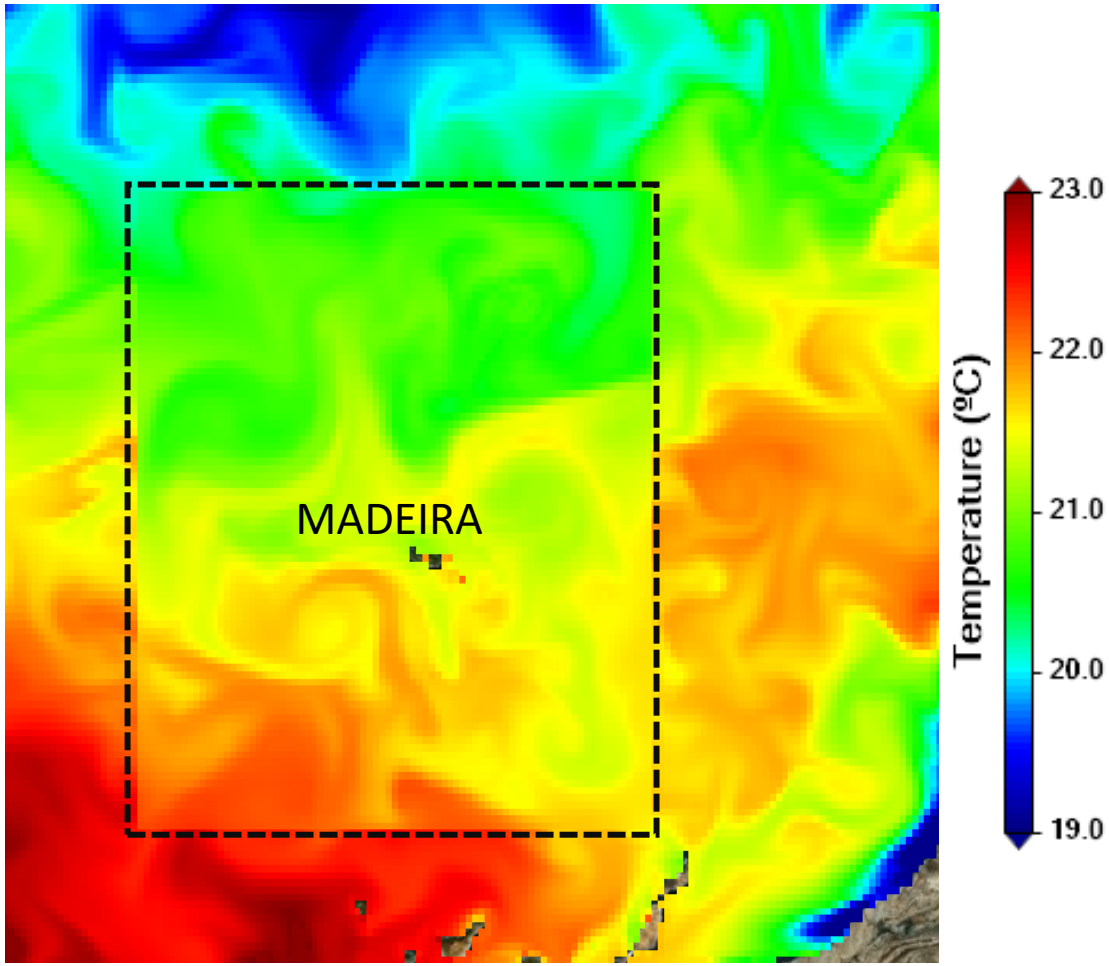
Madeira

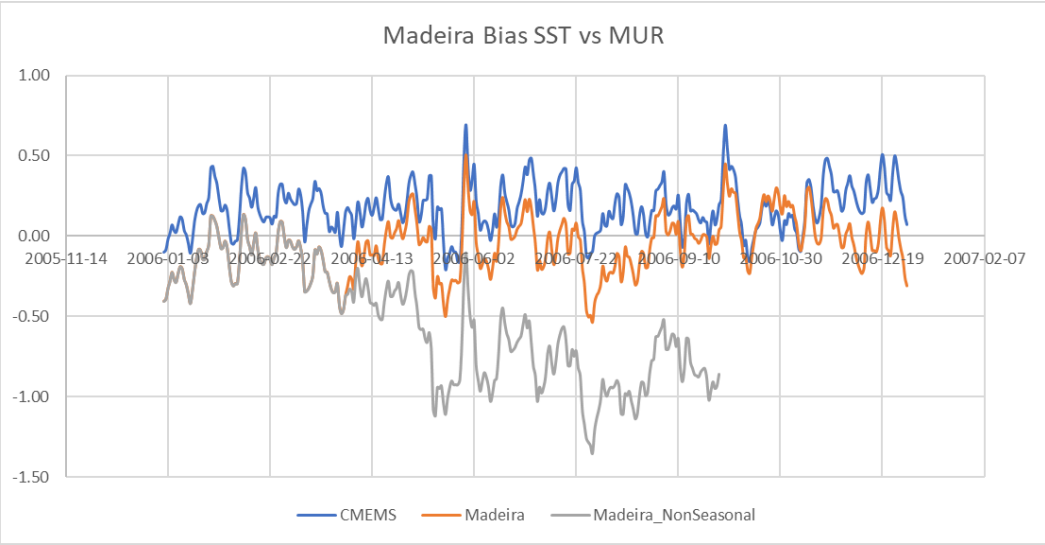
1st of Jul 2006

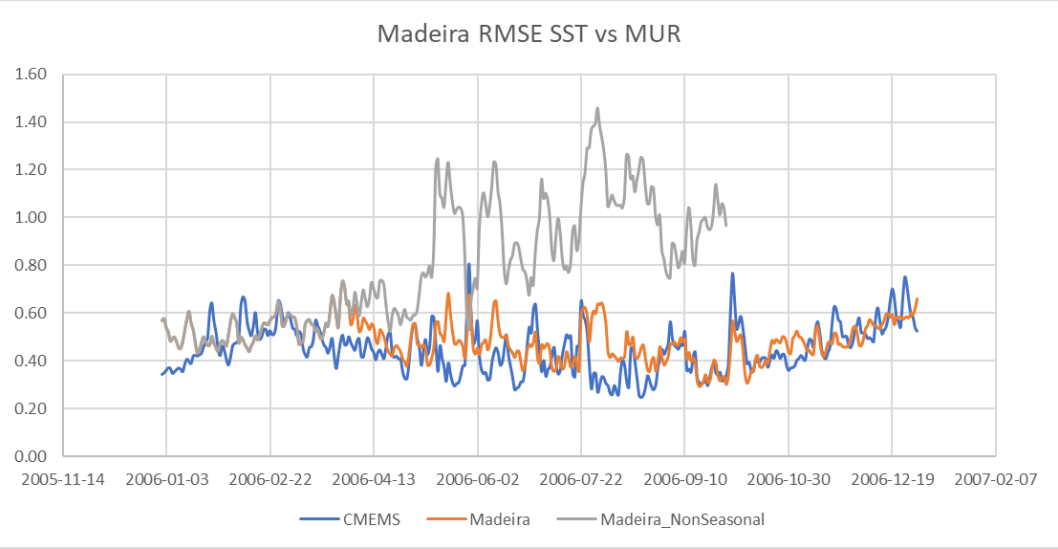
Previous air-ocean heat transfer implementation

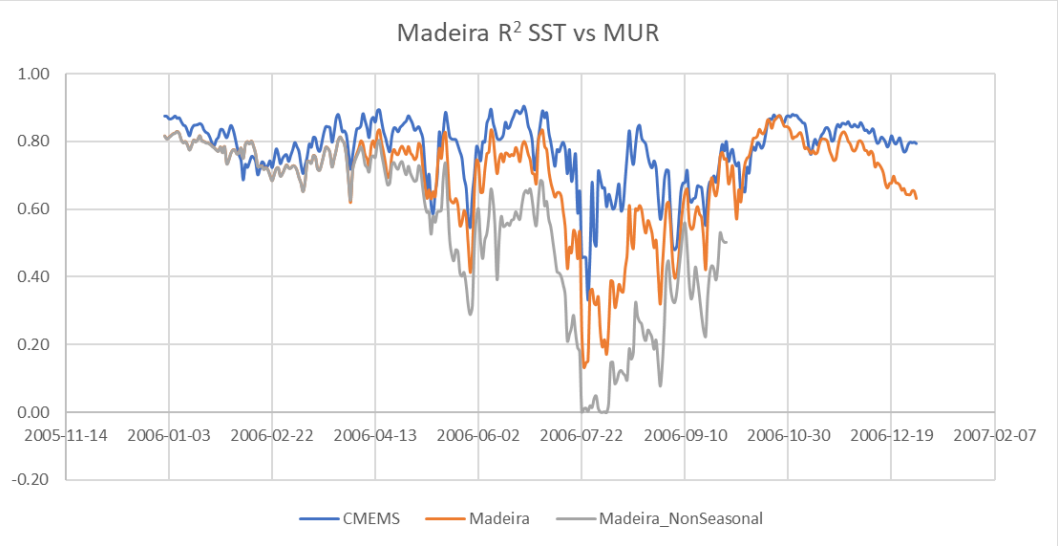


Improved air-ocean heat transfer implementation




Madeira Bias SST vs MUR
1.00
0.50
0.00
-0.50
-1.00
-1.50
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
Madeira
Madeira_NonSeasonal

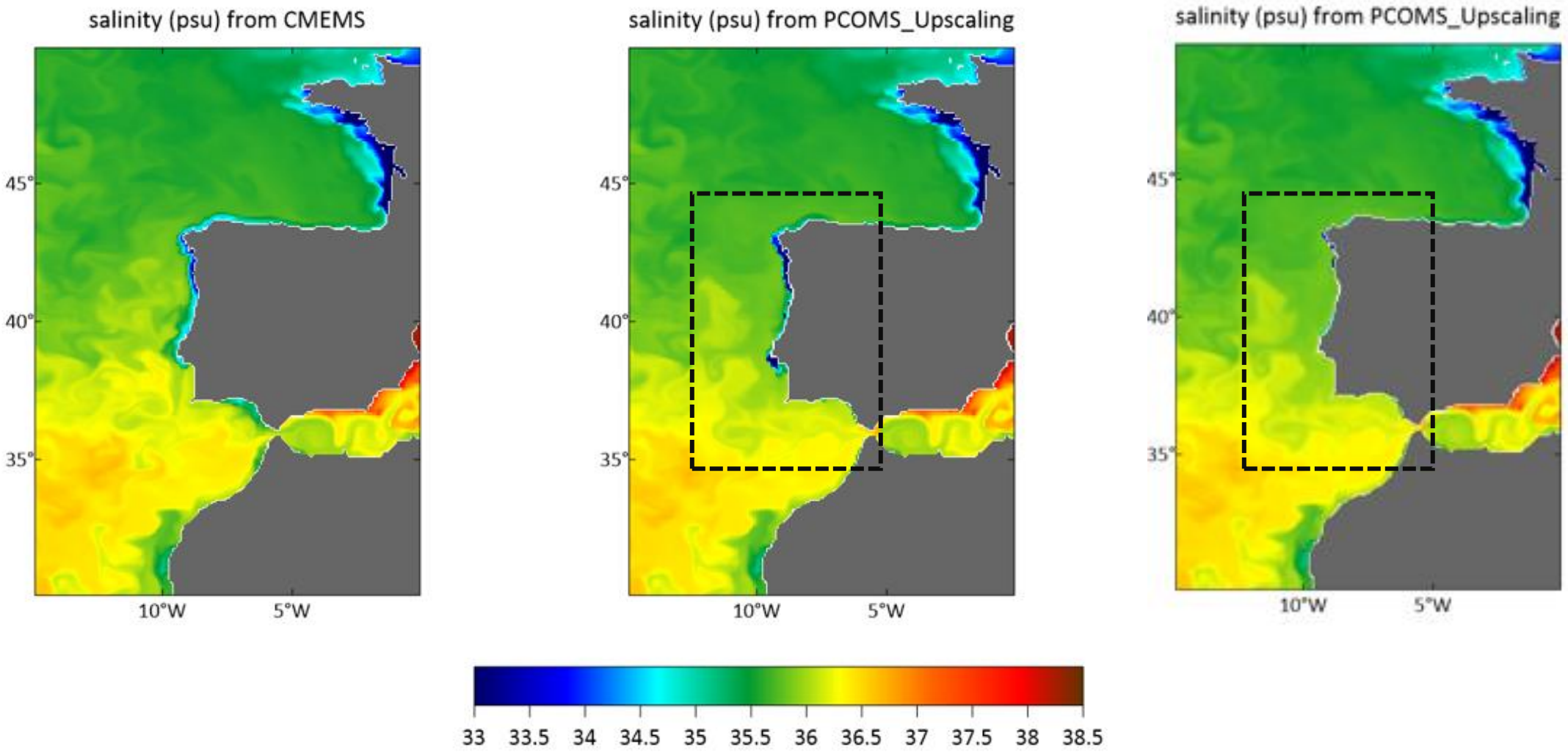

Madeira RMSE SST vs MUR
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
Madeira
Madeira_NonSeasonal

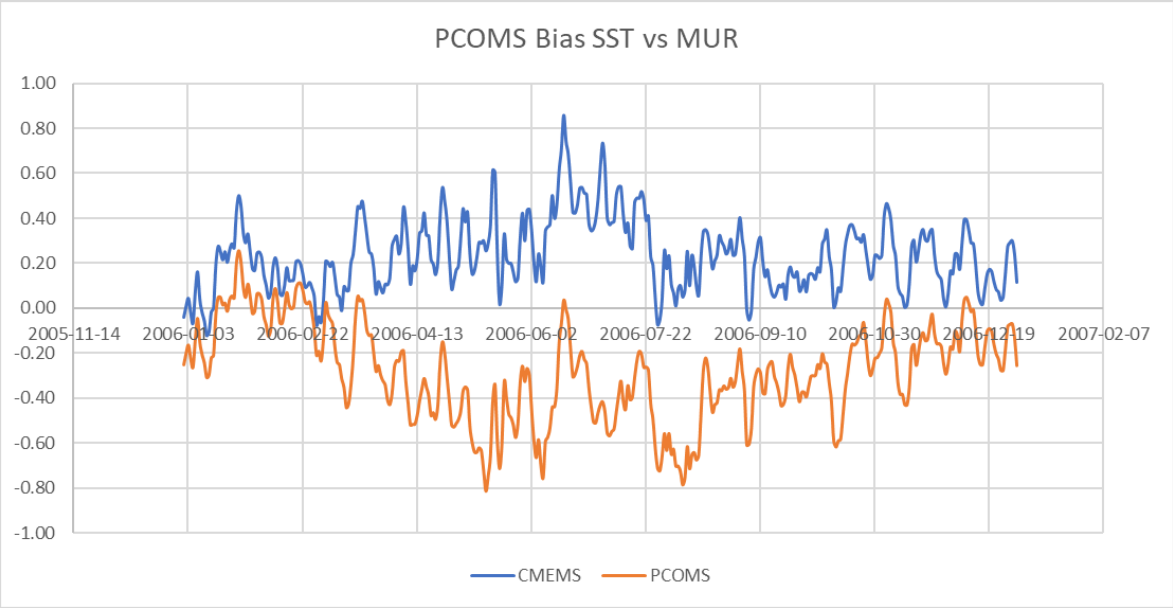

Madeira R2 SST vs MUR
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
Madeira
Madeira_NonSeasonal

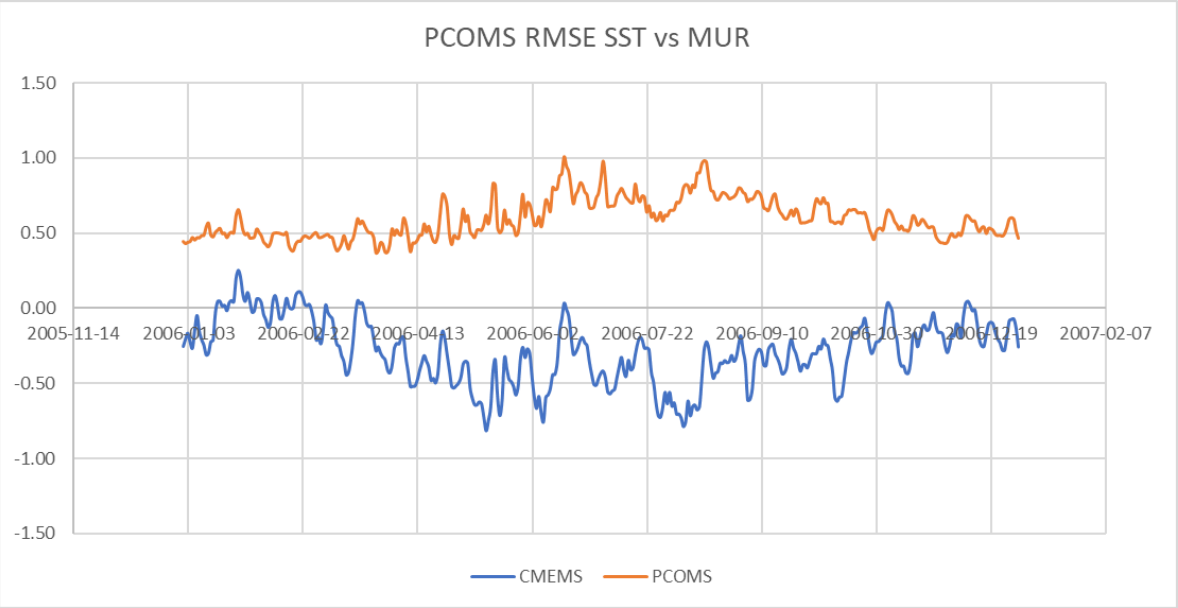
Surface Salinity patching

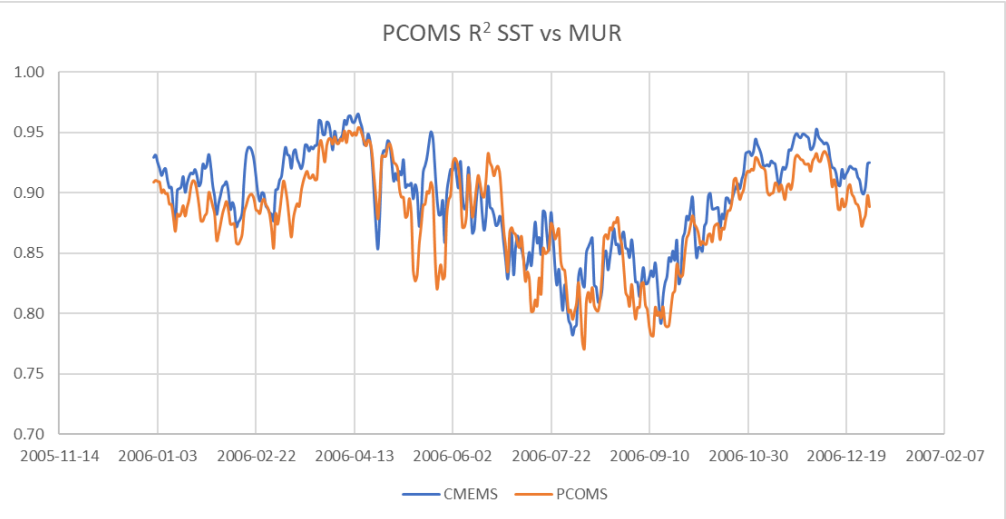
River direct discharge

Estuarine discharge




PCOMS Bias SST vs MUR
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
PCOMS


PCOMS RMSE SST vs MUR
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
PCOMS


PCOMS R2 SST vs MUR
1.00
0.95
0.90
0.85
0.80
0.75
0.70
2005-11-14
2006-01-03
2006-02-22
2006-04-13
2006-06-02
2006-07-22
2006-09-10
2006-10-30
2006-12-19
2007-02-07
CMEMS
PCOMS

iFADO conclusions and relation to deliverables/activities

- In general, the highest RMSE/BIAS values were found for CMEMS model before patching between the CMEMS model and satellite SST. (D.7.3.1)

- When using the upscaling method, it is expected that the feedback from the NEA ROMS, Madeira and PCOMS models will improve the SST field in the parent model after some time (CMEMS). (D.7.3.1)

- When a nested model (NEA ROMS, Madeira, PCOMS) is available, it usually benefits from higher resolution and better representation of some relevant processes.

- However, there is frequently, and especially in the operational oceanography context, no feedback from the nested model (i.e., NEA ROMS, Madeira, PCOMS) to the parent model (CMEMS model).

- The parent model only exchanges data with the nested model by providing initial and/or boundary conditions. As a result, the parent model loses the benefit of having a nested model.

- Thanks iFADO for giving us the opportunity to perform a patching test, which is the first step to use the upscaling method to improve the quality of the parent model from the nested model.