An Error Decomposition Method: Application to Mediterranean SST simulations assessment.

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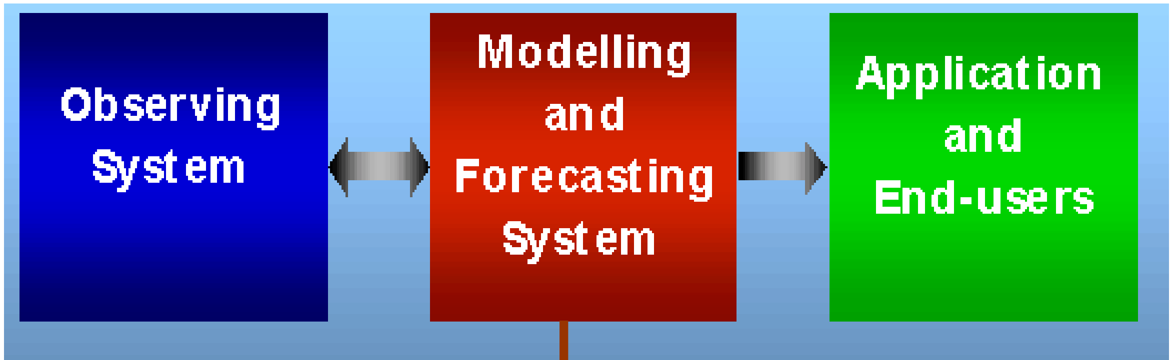
Mediterranean Forecasting System :Toward Environmental Predictions



OGCM

. 3D primitive equation

. Z coordinates

. Horizontal resolution 1/8°.1/8°

. 31 vertical levels

Simulations

. Forecast : 10 days

. Assimilation each week

. Forcing : Rigid lid, Atlantic box,

Heat fluxes from atmospheric fields

Realized in the **INGV** of Bologna : www.bo.ingv.it

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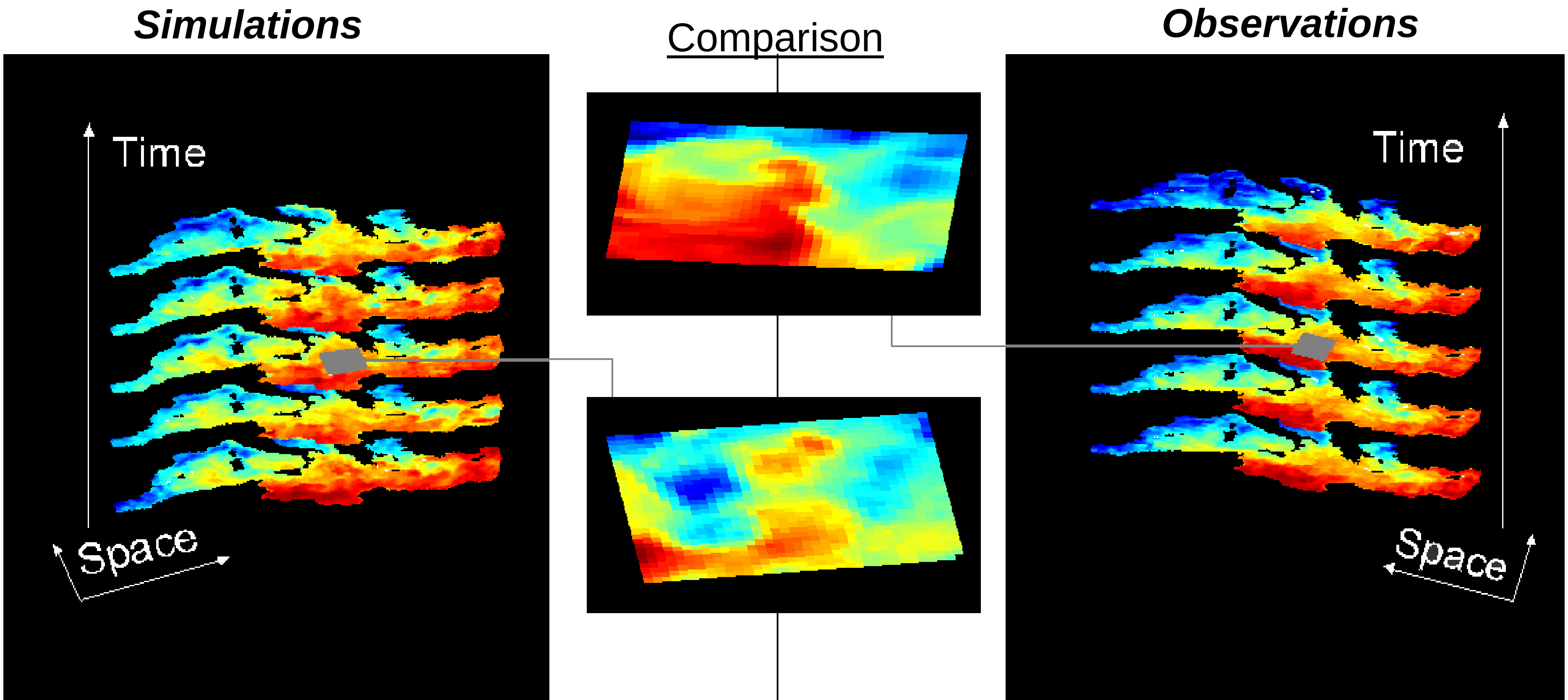
Assessment of the Sea Surface Temperature : The problematic



Snap shot view : no spatial or temporal context

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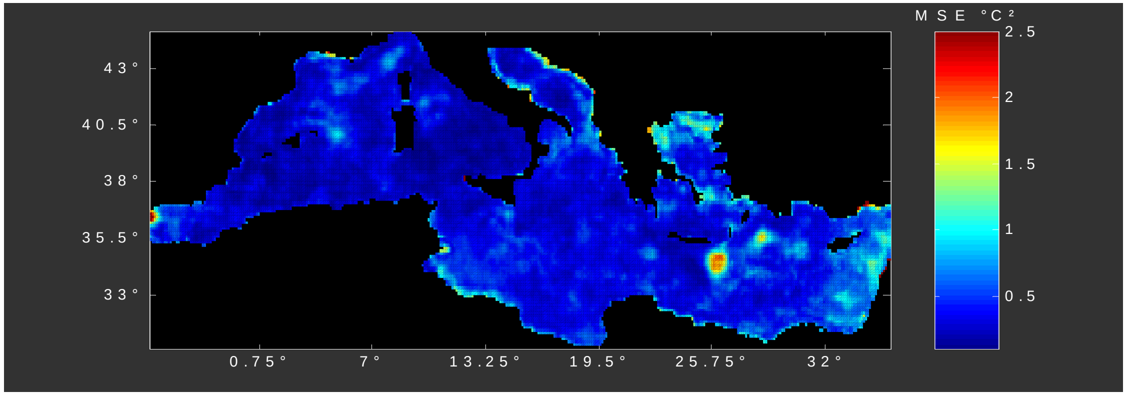
Assessment of the Sea Surface Temperature : The Mean Square Error

$$MSE = \overline{[(S - O)^2]}$$

O : Satellite observations available every week

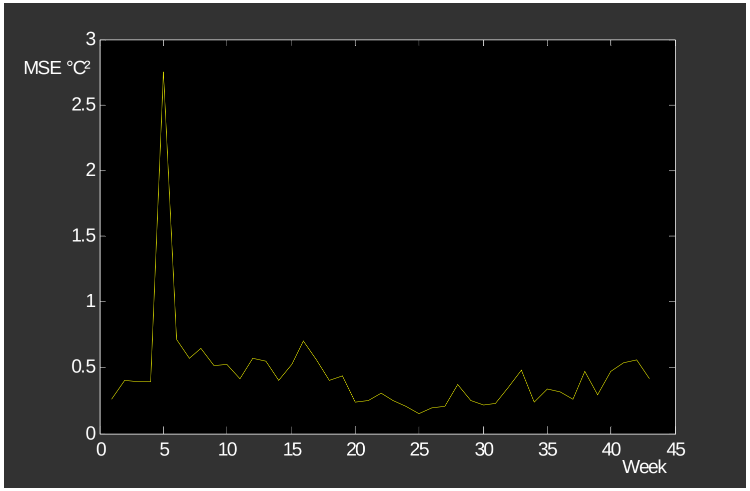


S : Simulations from the OGCM

Hindcasts H_i are provided every days

Hindcasts = Forecast + assimilation

$$S = \left(\sum_{i=D1}^{D7} H_i\right)/7$$



Period: September 1999 – August 2000   Region: the whole Mediterranean Basin

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Error Decomposition Method (EDM) : the principle

Inspired by 'E. E. Ebert and J. L. McBride 2000'.

- $$\mathbf{MSE} = \overline{[(S(i,j,t) - O(i,j,t))^2]}$$

  where S : Simulations ,
  O : Observations
  i , j : grid points
  t : weeks

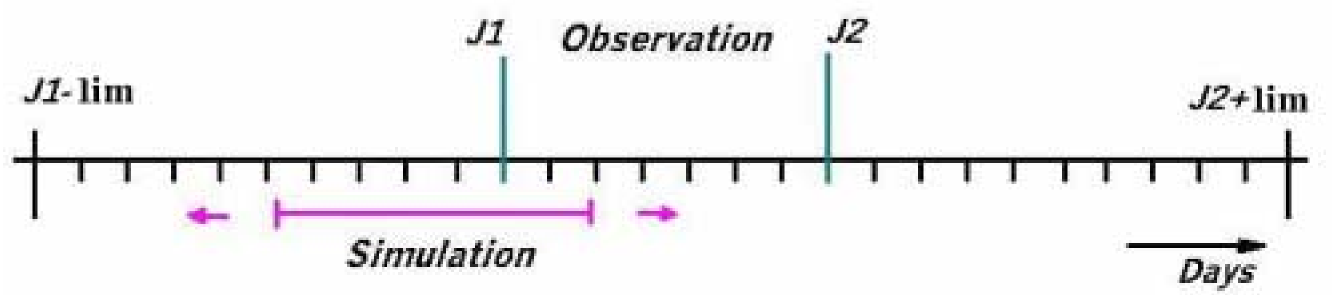
- Parameters optimization
  - **J** the temporal shift,
  - **(d_x, d_y)** the bi-dimensional translation,
  - **T_i** the bias

  minimizing the Mean Square Error

- $$\mathbf{MSE} = \mathbf{MSE}_{\mathbf{Trs\ Time}} + \mathbf{MSE}_{\mathbf{Trs\ Space}} + \mathbf{MSE}_{\mathbf{Intensity}} + \mathbf{MSE}_{\mathbf{pattern}}$$

Error Decomposition Method (EDM) : 1^{st} step

- <u>Evaluation of the time positioning parameter **J** and of it corresponding error</u>



<u>Translation in time</u>: $\mathbf{J}\ \overline{}[J1 - \mathrm{lim}, J1 + \mathrm{lim}]$ as

$$MSE_{M1} = \overline{\{ [S(i,j,\mathbf{t+J}) - O(i,j,t)]^{2} \}} \quad \text{is minimum}$$

$$\mathbf{MSE_{Trs\ time}} = MSE_{O} - MSE_{M1}$$

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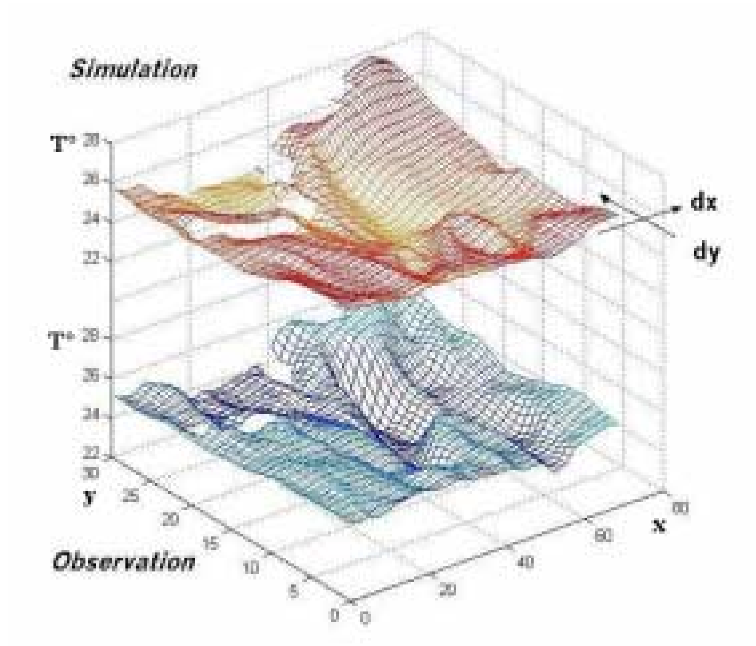
Error Decomposition Method (EDM) : 2nd step

● Evaluation of the space positioning parameters (**dx** , **dy**) and of it corresponding error



Translation in space: $(\mathbf{dx}, \mathbf{dy}) \in [-2, +2]$ as

$$MSE_{M2} = \overline{\{ [S(\mathbf{i+dx}, \mathbf{j+dy}, t) - O(i,j,t)]^2 \}} \quad \text{is minimum}$$

$$\mathbf{MSE_{Trs\ space}} = MSE_{Trs\ time} - MSE_{M2}$$

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- Evaluation of the intensity parameters $\mathbf{T_i}$ and of it corresponding error

Intensity: T_i as

$$MSE_{M3} = \overline{\{ [S(i, j, t) - O(i,j,t) + \mathbf{T_i}]^2 \}} \quad \text{is minimum}$$

$$\mathbf{MSE_{Intensity}} = MSE_{Trs\ space} - MSE_{M3}$$

- Evaluation of the pattern error

Pattern:

$$\mathbf{MSE_{Pattern}} = MSE_O - MSE_{Trs\ time} - MSE_{Trs\ space} - MSE_{Intensity}$$

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- $$\text{MSE}(i,j,t) = \sum_{t}^{\text{T. Domain}} \sum_{i}^{\text{S. Domain}} \sum_{j} \left(S(i,j,\mathbf{t+J}) - O(i,j,t) \right)^2 \; / \; (Ls.Ls.Lt)$$

- $$\text{MSE}(i,j,t) = \sum_{i}^{\text{S. Domain}} \sum_{j} \left(S(\mathbf{i+dx},\mathbf{j+dy},t) - O(i,j,t) \right)^2 \; / \; (Ls.Ls)$$

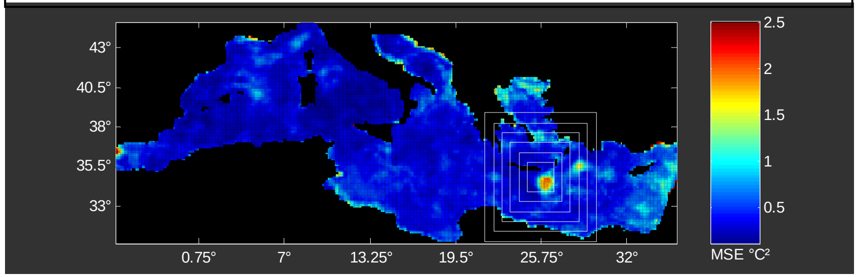
- $$\mathbf{T_i} = \sum_{i}^{\text{S. Domain}} \sum_{j} \left(S(i,j,t) - O(i,j,t) \right) \; / \; (Ls.Ls)$$

where Lt is the length of the time domain (nbr of weeks used)
Ls is the length of the space square domain (nbr of grid pts)

Error Decomposition Method (EDM) : Application 1

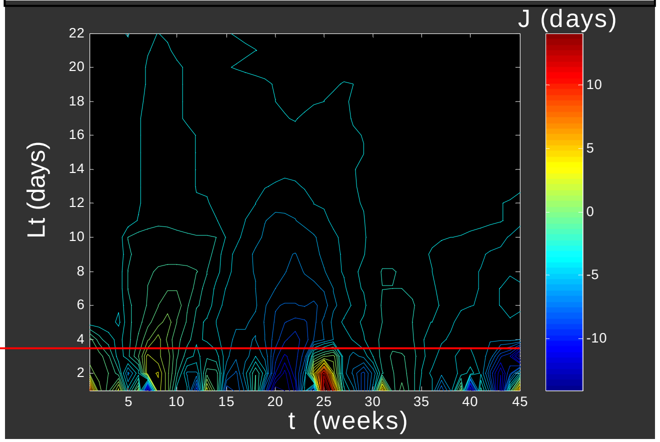
Local analyze (Step by step analysis)

Choice of the region of investigation



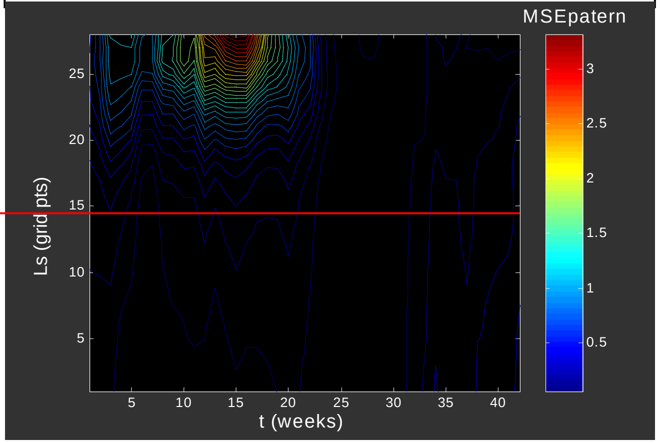
Choice of the temporal length *Lt*

Lt=5 weeks

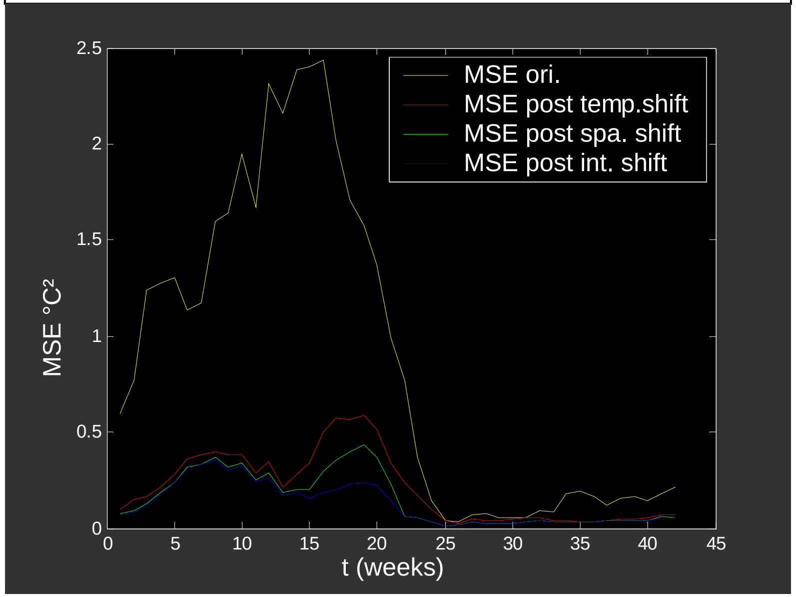


Choice of the spatial length *Ls*

Ls = 14 grid pts



Result



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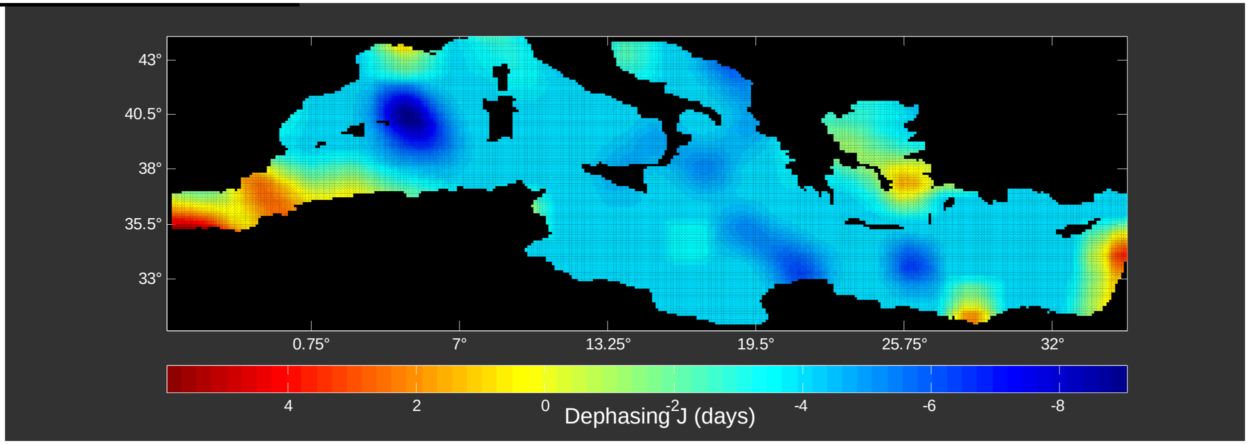
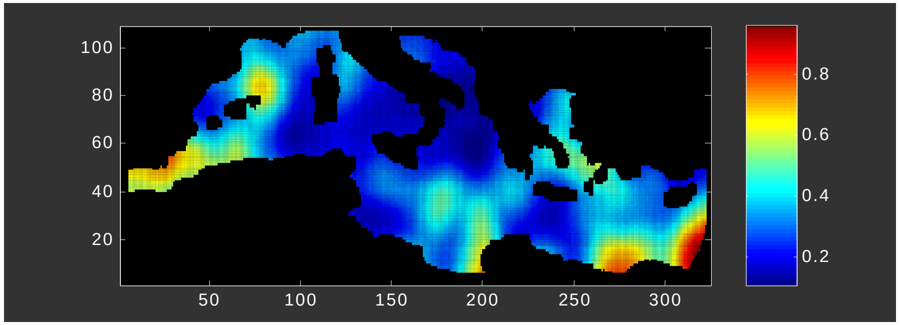
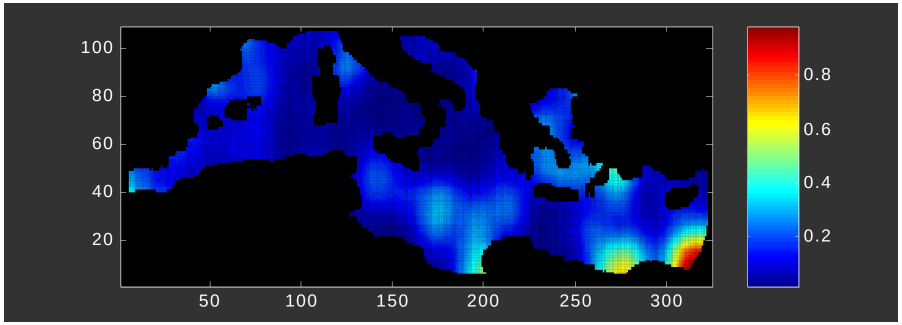
Global analyze (one by one analysis)

1st week of October, spatial length **Ls=14** (1.75°,160 km) , time length **Lt =5** days

Translation in time







MSE original (°C²)

MSE post temporal trans. (°C²)

Gain : 58% MSE resolved

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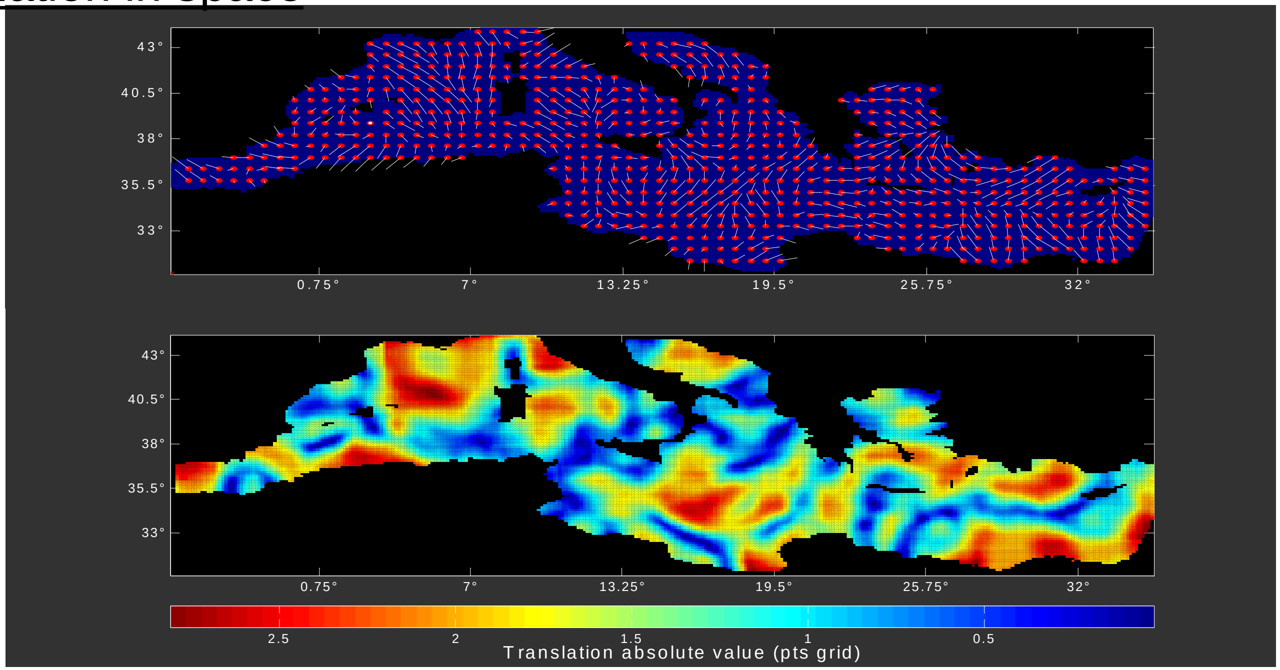
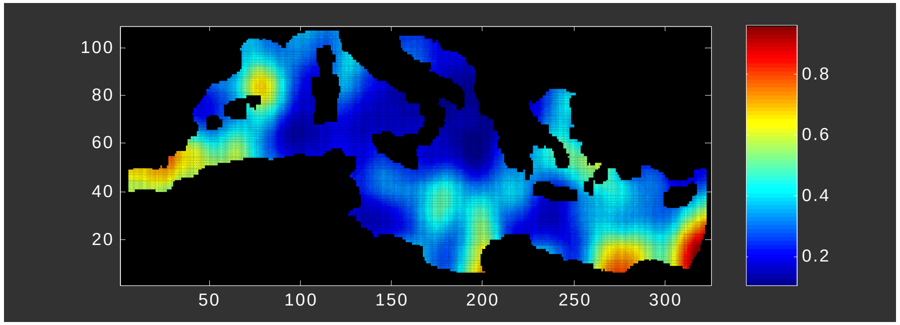
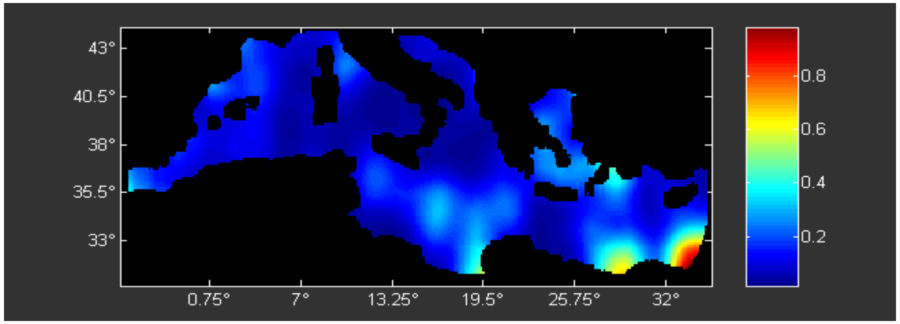
Error Decomposition Method (EDM) : Application 2

Translation in space





MSE original (°C²)



MSE post spatial trans. (°C²)

Gain : 25% MSE resolved

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- ***Analyze of the parameters themselves***

- ***Correlation Type – Source of the errors***

Temporal shift

- Forcing : filtering
- Assimilation : synopticity

Intensity shift

- Forcing : bias
- Missing information

Spatial shift

- Bathymetry : discretization
- Parameterization

Pattern error

- Parameterization : turbulence
- Model discretization

- ***Solution of the double penalty***

Comparison of $MSE_{Pattern}$

E. E. Ebert , and J. L. McBride 2000.

'Verification of precipitation in weather systems: determination of systematic errors'

Bureau of Meteorology Research Centre, Melbourne, Vic., Australia

Thank you for your attention