DIVA Users Workshop 2010

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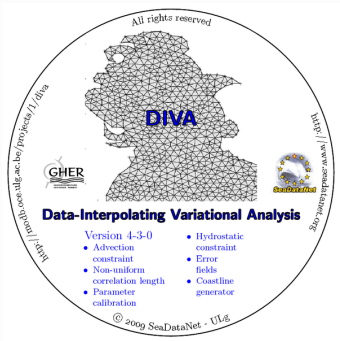
University of Liège

3-7 November, 2010

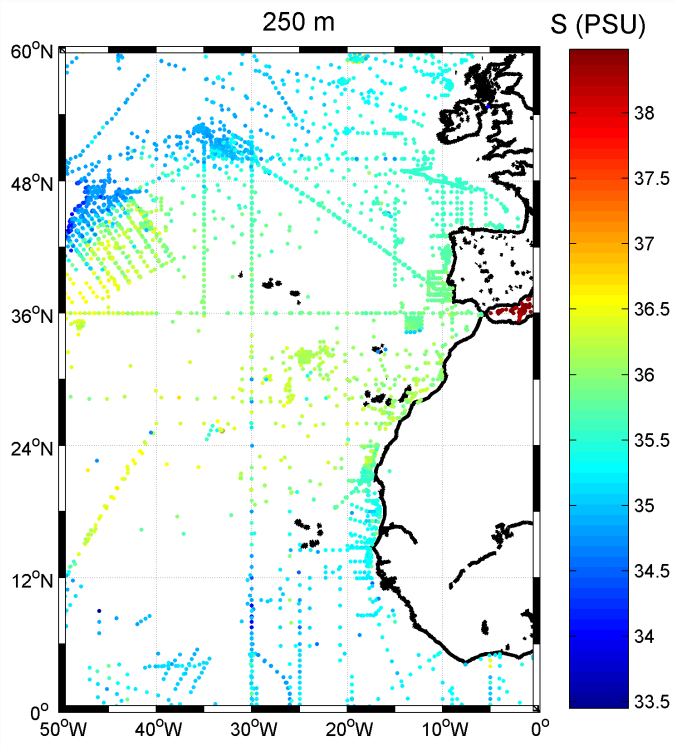
What does DIVA do?

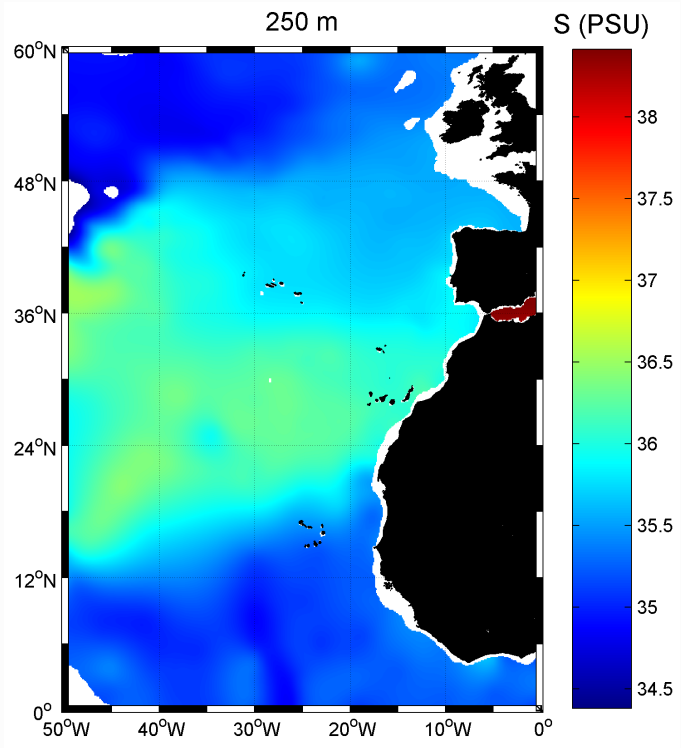


DIVA = **D**ata **I**nterpolatin **V**ariational **A**nalysis

http://modb.oce.ulg.ac.be/projects/1/diva

Objective: gridding in situ data





Why using DIVA?

- approximation (or analysis), not strict interpolation
- limited number of parameters, estimated in an objective way
- efficient solver
- based on free software
- **user-driven** developments

How does it work?

N_d data: d_j at (x_j, y_j)
Field to reconstruct: φ

$$\min J[\varphi] = \sum_{j=1}^{Nd} \underbrace{\mu_j}_{\text{weight}} \underbrace{[d_j - \varphi(\mathbf{r}_j)]^2}_{\text{misfits}} + \underbrace{\|\varphi\|^2}_{\text{field regularity}}$$

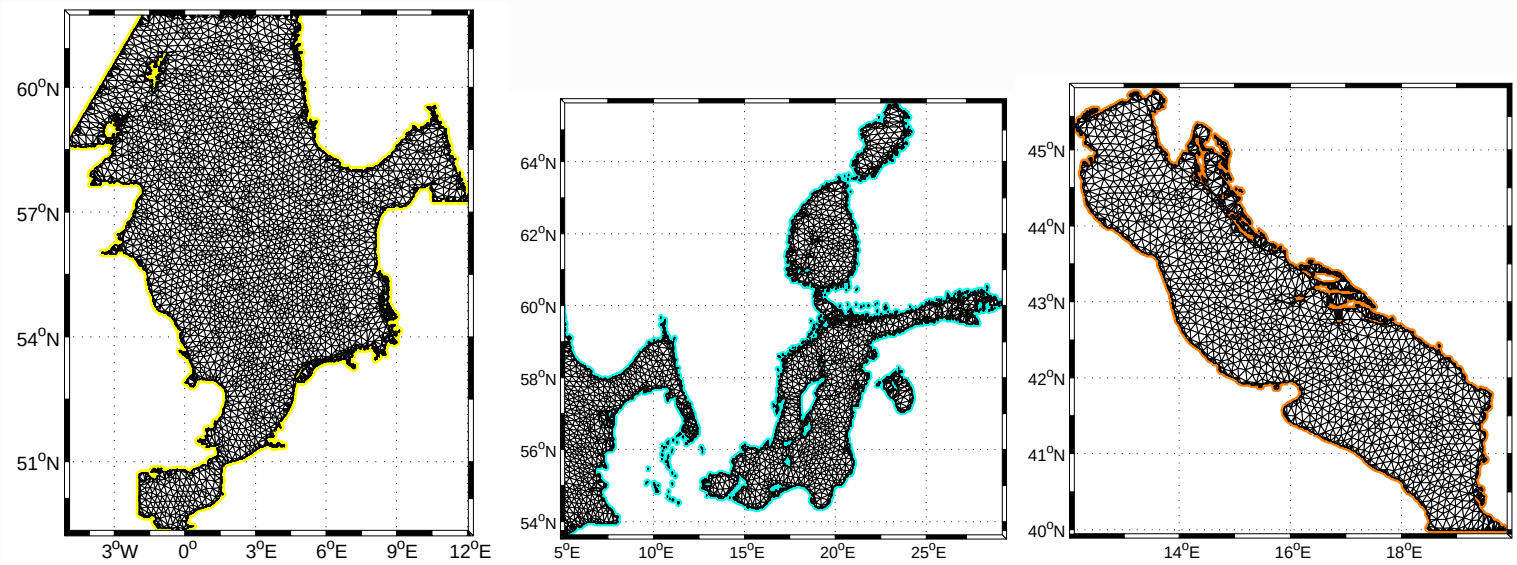
with

$$\|\varphi\|^2 = \int_D (\alpha_2 \underbrace{\boldsymbol{\nabla}\boldsymbol{\nabla}\varphi : \boldsymbol{\nabla}\boldsymbol{\nabla}\varphi}_{\text{variability}} + \alpha_1 \underbrace{\boldsymbol{\nabla}\varphi \cdot \boldsymbol{\nabla}\varphi}_{\text{gradients}} + \alpha_0 \underbrace{\varphi^2}_{\text{field value}}) \, dD,$$

$$\begin{array}{lll} \alpha_0 & : \text{penalizes field values} & \\ \alpha_1 & : \text{penalizes gradients} & \rightarrow \text{data} \rightarrow \\ \mu_j & : \text{penalizes misfits} & \end{array} \begin{array}{ll} L & \text{correlation length} \\ \lambda & \text{signal-to-noise ratio} \end{array}$$

Resolution technique

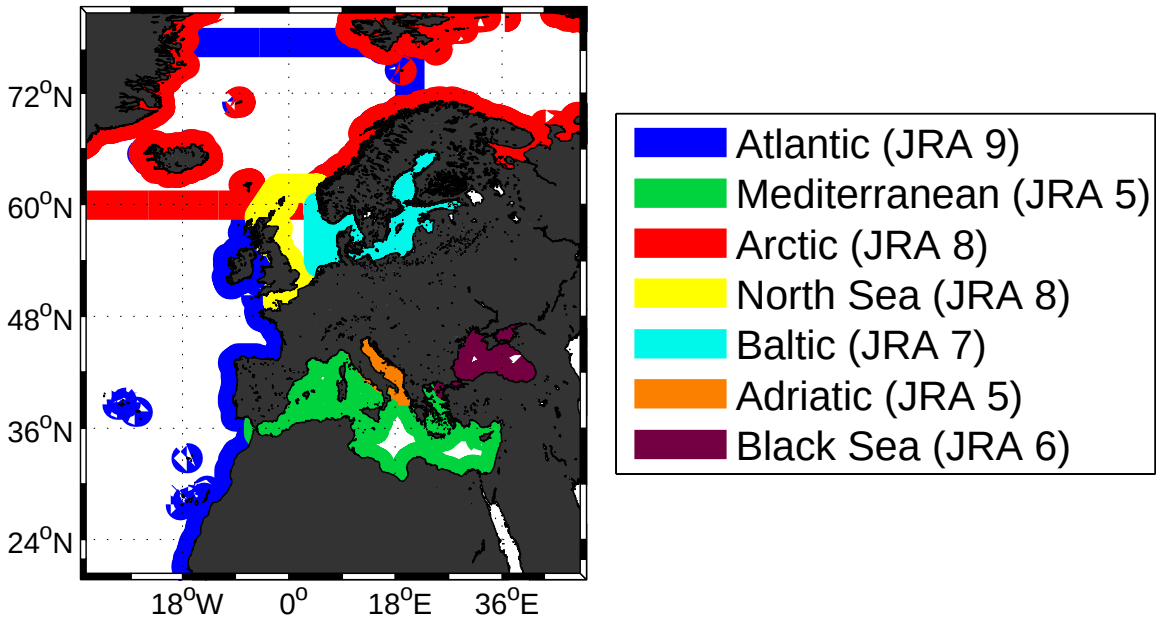
Eqs. (1)-(2) $\rightarrow$ plate bending problem $\rightarrow$ finite-element solver



Advantages:

- boundaries taken into account
- numerical cost (independent on the data number)
- no masking

Who's using DIVA



SeaDataNet regional groups (JRA's)

Emodnet (http://gher-diva.phys.ulg.ac.be/emodnet/):

- Black Sea
- North Sea
- Mediterranean Sea: Adriatic, Balearic, Gulf of Athens and Gulf of Lion

Implementation and developments (1/2)

Code development (1990-1996):

- Variational Inverse Method (VIM) (Brasseur, 1991, JMS, JGR)
- cross-validation (Brankart and Brasseur, 1996, JAOT)
- error computation (Brankart and Brasseur, 1998, JMS; Rixen et al., 2000, OM)

2D-analysis (2006-2007):

- set of bash scripts (`divamesh`, `divacalc`, ...)
- Fortran executables
- parameters optimization tools
- Matlab/Octave scripts for plotting

3D-analysis (2007-2008):

- superposition of 2D layers
- automated treatment and optimization
- stability constraint (Ouberdous et al.)
- advanced error computation (Beckers et al.)

Implementation and developments (2/2)

4D-analysis (2008-2009):

- start from ODV spreadsheet
- dedentring (with J. Carstensen, DMU)
- NetCDF 4-D climatology files

Web tools

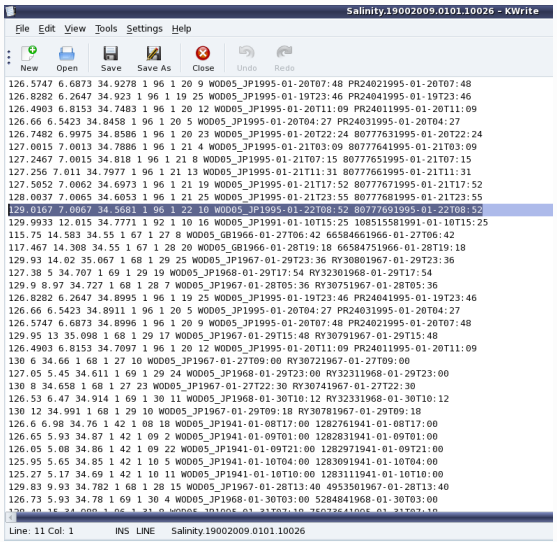
- On-line analysis (Barth et al., 2010, Adv. Geosci.)
  `http://gher-diva.phys.ulg.ac.be/web-vis/diva.html`
- Climatology viewer:
  `http://gher-diva.phys.ulg.ac.be/web-vis/clim.html`

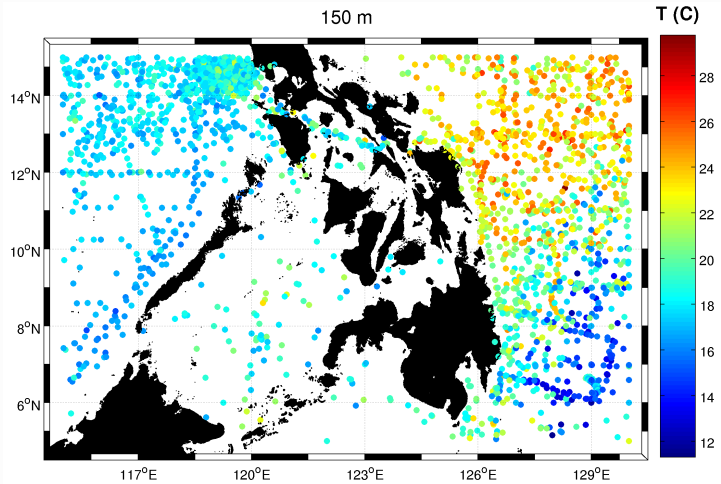
2010 (on-going)

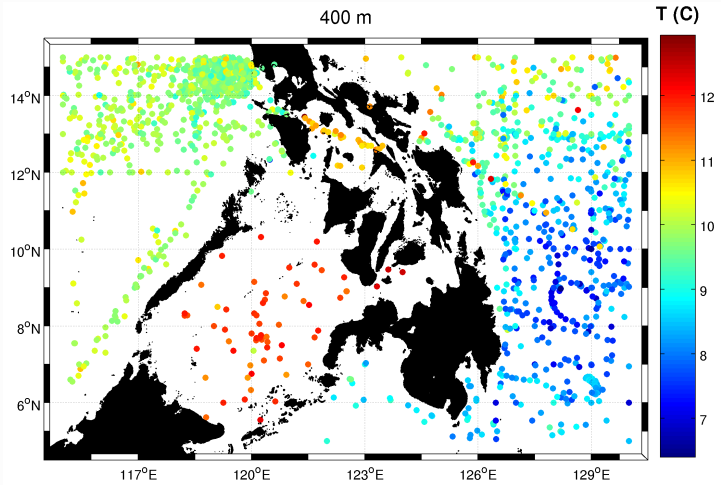
- transition to Fortran95:
  dynamic memory allocation + parallel solver
- multivariate approach
- data transformation tools
- 4-D graphical interface
- *R*–package?
- ...

1. Extraction of data

- Download data from SeaDataNet portal or regional data center
- Format: ODV spreadsheet (`ascii`)
- Select depth/pressure levels
- Select region and time period
- **Extract data**

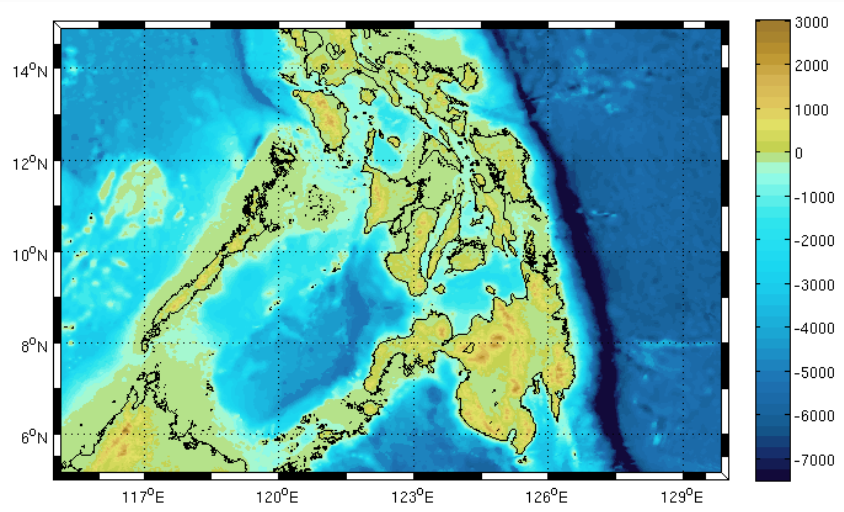


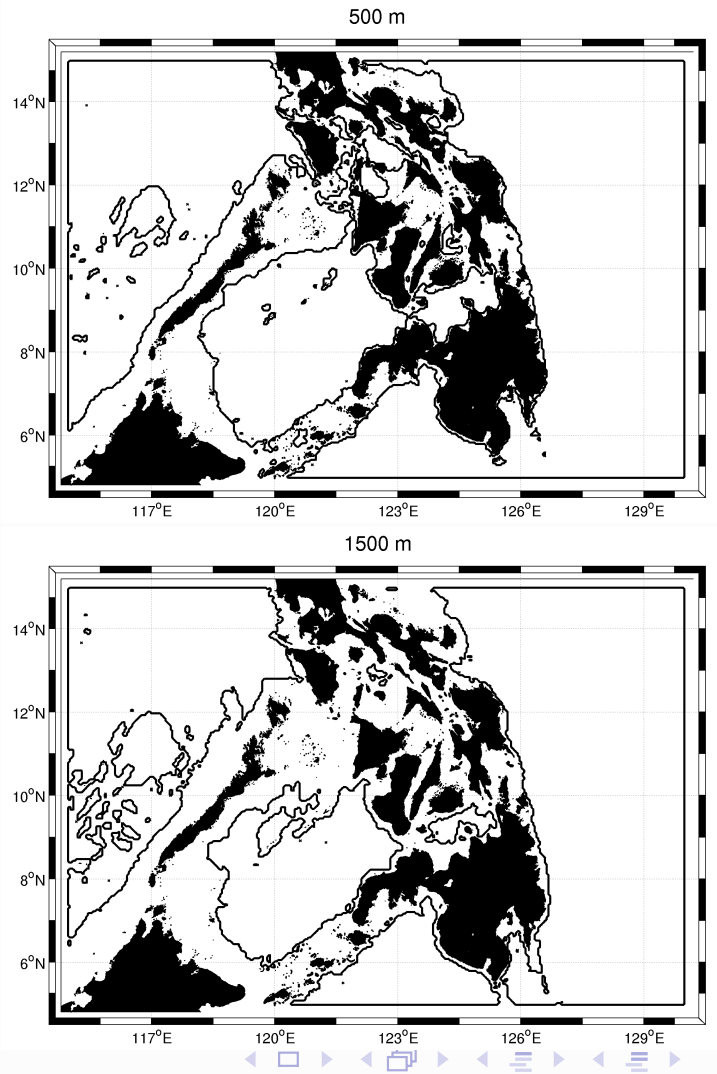




2. Generation of contours from bathymetry

- Download topography from GEBCO database
- Eliminate undesired areas
- Provide list of depth/pressure levels
- **Generate contours**





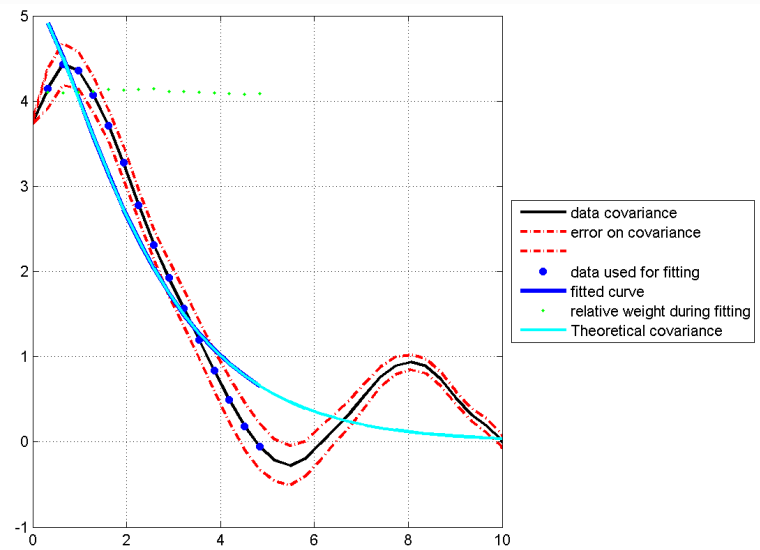
3. Estimation of parameters

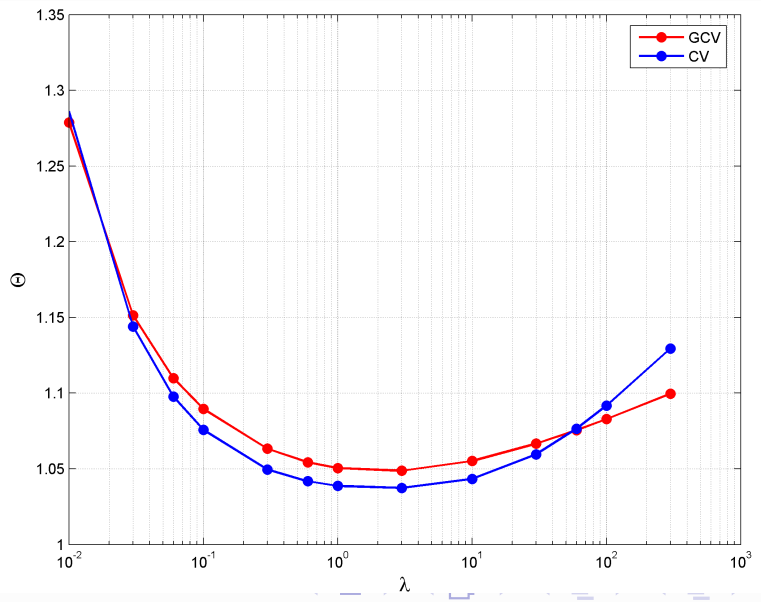
Correlation length L:

- influence of a data on its neighbor
- estimation: fit of data covariance on theoretical function
- requires sufficient amount of data

Signal-to-noise ration λ:

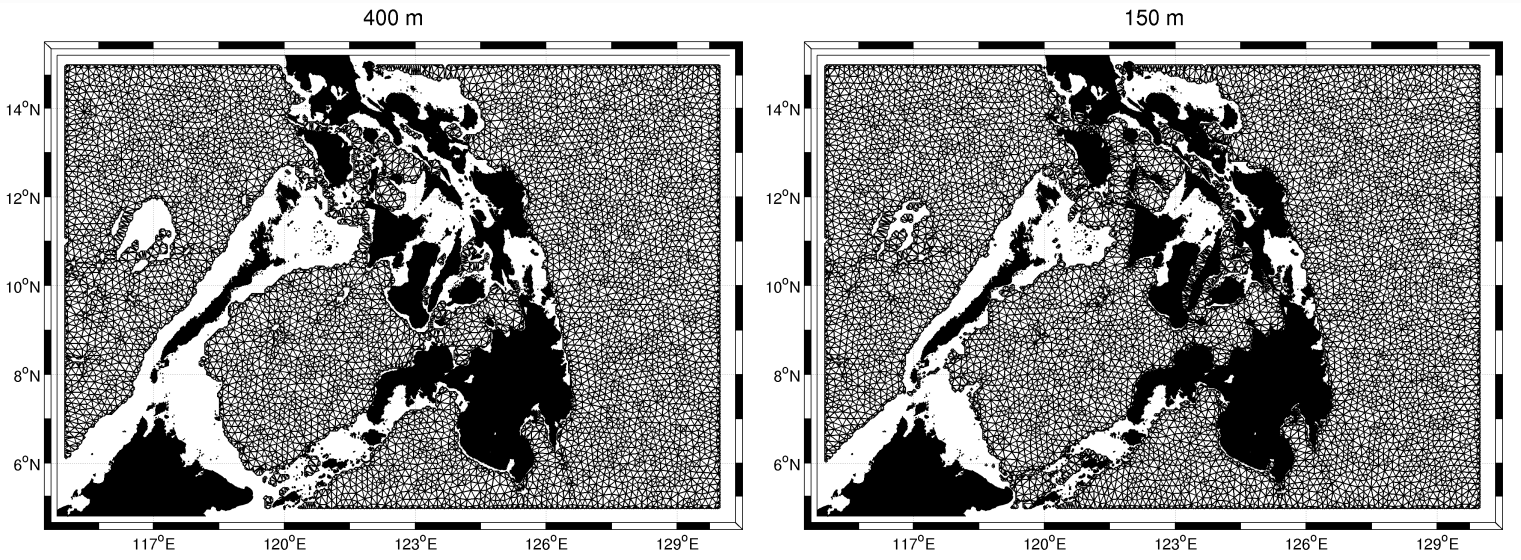
- *confidence* in the data
- instrumentation + representativity + synopticity error
- estimation: generalized cross-validation
- often hard to determinate correctly





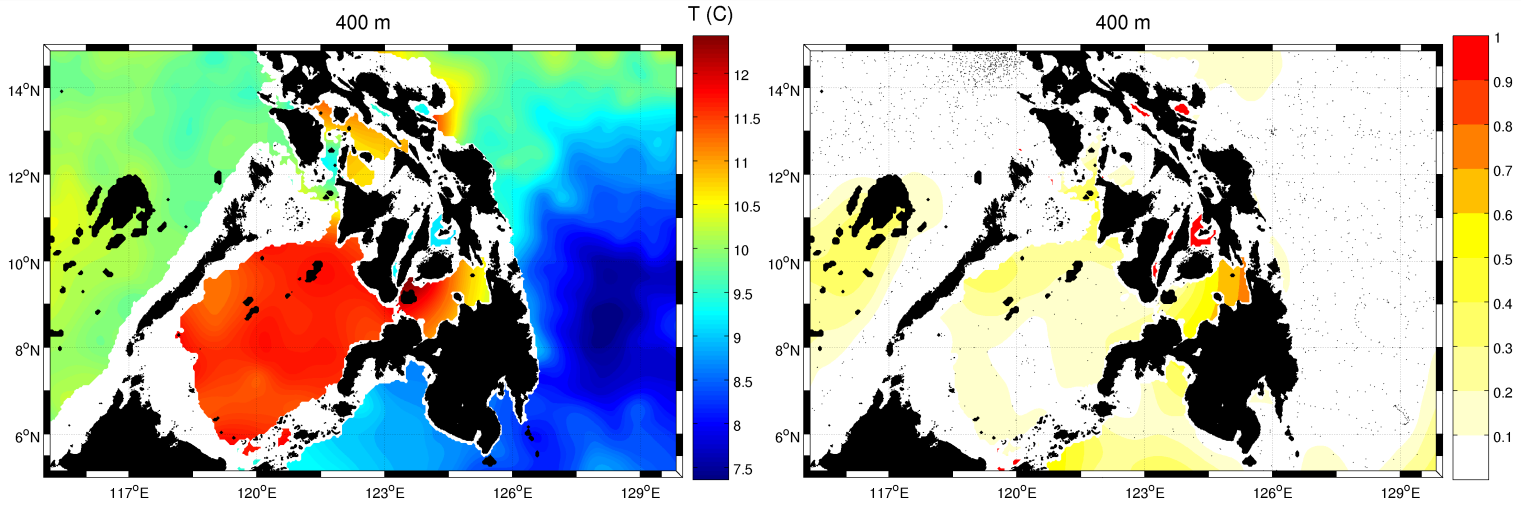
4. Generation of the finite-element mesh

- Mesh size $L_e \longrightarrow$ correlation length
- costly calculations
- L_e related to climatology resolution
- $L_e \neq$ grid resolution!



5. Analysis and error field

- separation of water masses
- large error where no data
- deconnection of fields and error estimates



5. Validation, discussion

- ✓ Overview of the fields: outliers, gradients?
- ✓ Variable range (depth-dependent)
- ✓ Comparison with existing climatologies (WOA09)
- ✓ Coherence of parameters: vertical and temporal variations

- ✓ Hydrostatic stability
- ✓ Check by regional experts
- ✓ Use for numerical model initialization

...

Organization

- Working hours: from 7:00 to 24:00
- Drinking hours: from 7:00 to 24:00
- Eating hours: Bells
- Meals included, drinks to be listed on board
- For diving: contact Alexandre
- For running: contact us

Schedule

Need for **flexibility**

✓ Wednesday 3-11-2010:

- Checking/updating of the installation.
- Distribution of documents and publications.

✓ Thursday 4-11-2010:

- Presentation of DIVA history and last developments
- Preparation of data and parameter files (2 D for beginners, 3 D for experts).
- Production/update of regional climatologies.
- Product assessment/harmonization: discussion.

✓ Friday 5-11-2010:

- Presentation of the data transformation tools.
- Preparation of `xml` files.
- Presentation of the users' results.

✓ Saturday 6-11-2010:

- Discussion on the future developments/improvements.
- Users specific requirements and questions.

Visit

- ✓ Cathédrale Saint-Jean
- ✓ Citadelle
- ✓ Notre-Dame de la Serra

Map


STARESO
Citadelle
Notre-Dame de la Serra
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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42°33'47.97" N 8°42'51.36" E elev 0 ft
Eye alt 16487 ft
Google