Setting up a unified 100m bathymetry model for the French coastal areas

- methodology and innovative outcomes -

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SHOM

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- Input data
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  - Bathymetry modeling
  - Overview of by-products (DTM quality, acquisition year, …)
- Conclusions and Perspectives

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Introduction

- **Context**
  - Importance of bathymetry models for numerous oceanographic projects
  - For each specific project, bathymetry is usually modeled using available data: SHOM bathymetric database (BDBS), port authorities datasets, multi-beam datasets acquired during bathymetry surveys, already existing high-resolution bathymetry models…

  ⇒ Several drawbacks:

    i) Inconsistency between data QC procedures, modeling algorithms and characteristics of bathymetry products,

    ii) Loss of efficiciency and information when the same area need to be modeled again for another project…

- **Objective**

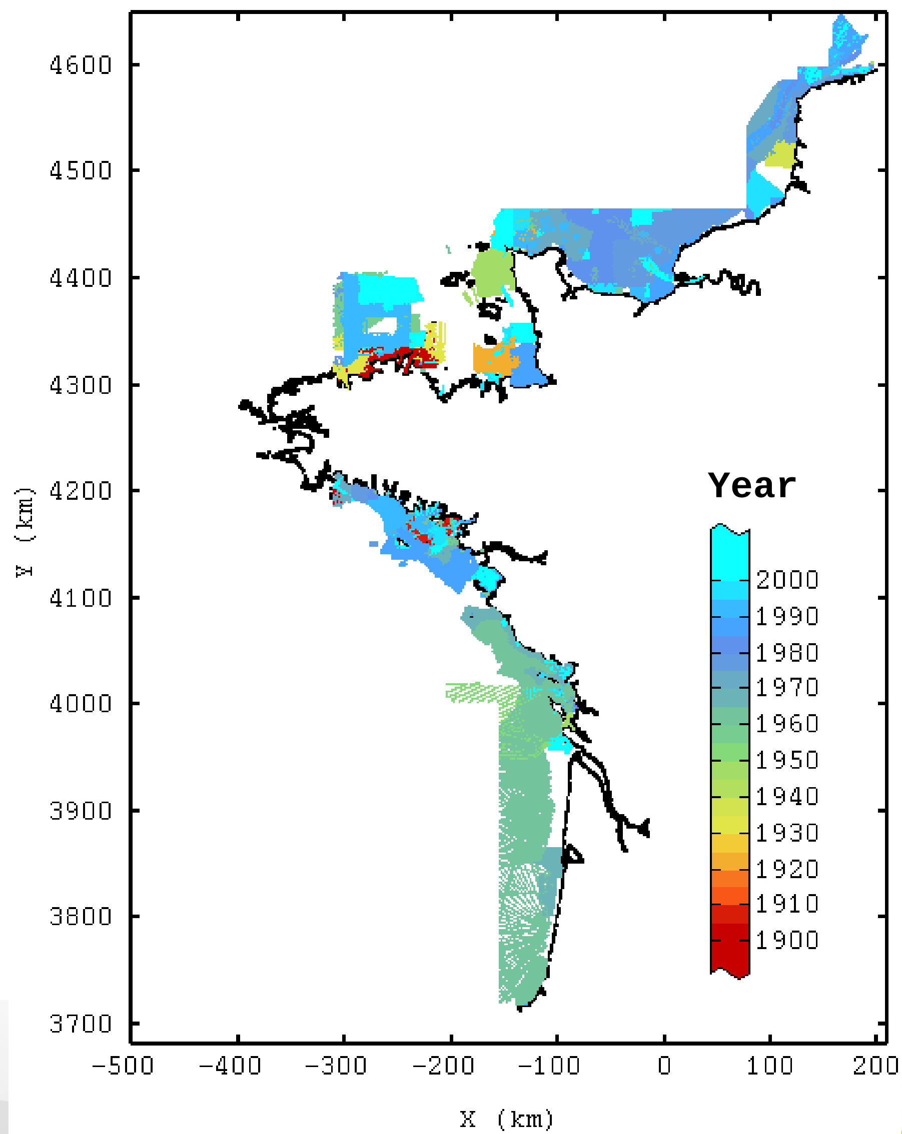
  Set up a unified bathymetry model at 100m which ensures, for the French coastal zones, the consistency of both:

    i) data processing, merge and modeling procedures,

    ii) bathymetry products delivered for a whole region.

Input Data

- **Bathymetric Data**
  - SHOM Soundings (BDBS)



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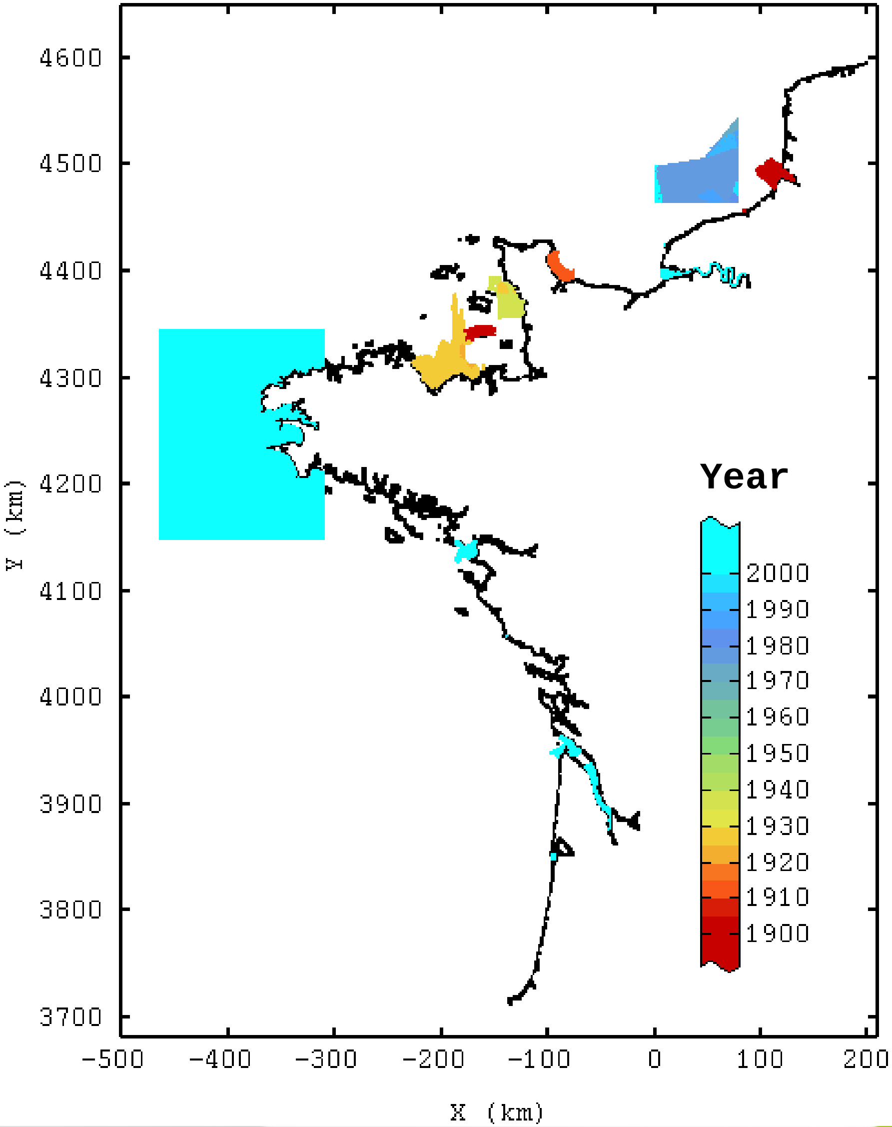
Input Data

- **Bathymetric Data**
  - SHOM Soundings (BDBS)
  - Other sources
    - Bordeaux
    - Various SHOM data
    - Dunkerque
    - SHOM Iroise 100m
    - RouenLeHavre
    - StNazaire



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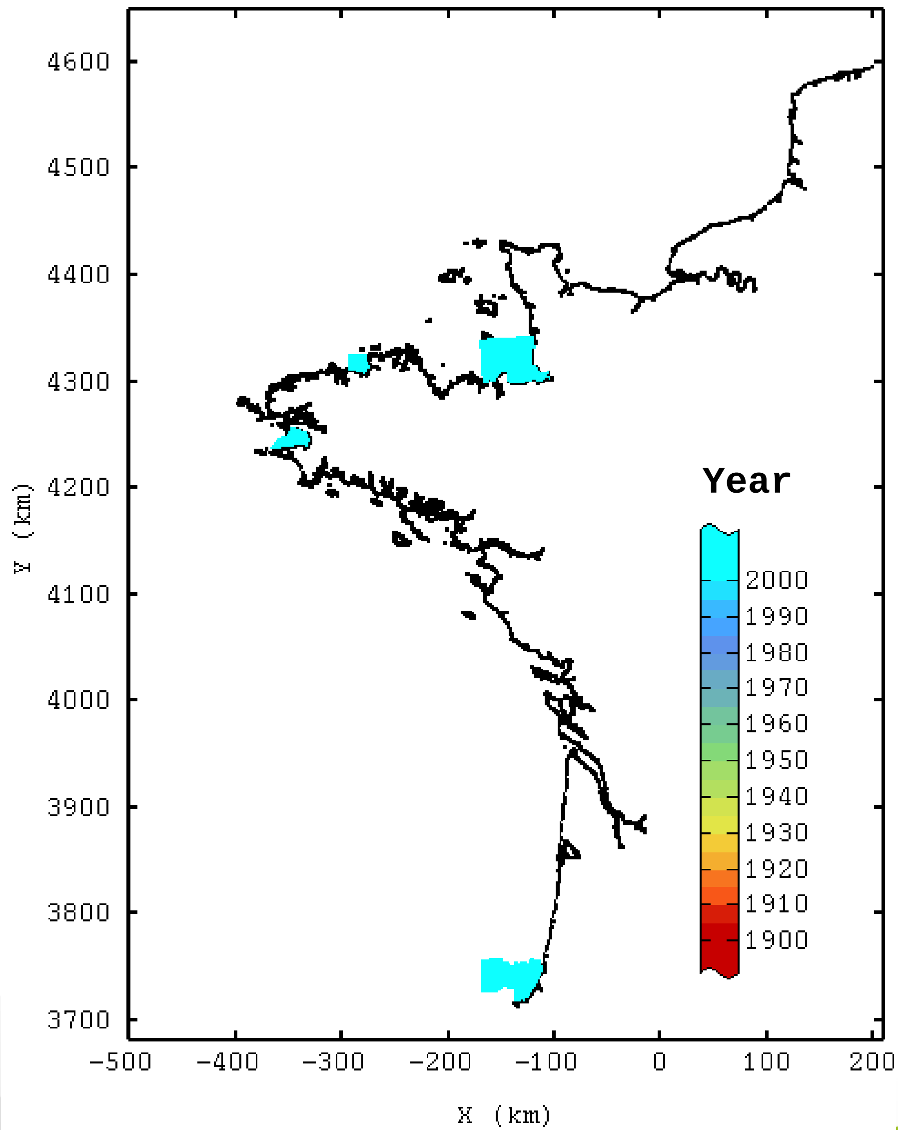
  - Local DTM models
    - Mont St Michel (100m)
    - Lannion bay (5m)
    - Douarnenez bay (10m)
    - Capbreton Canyon (40m)



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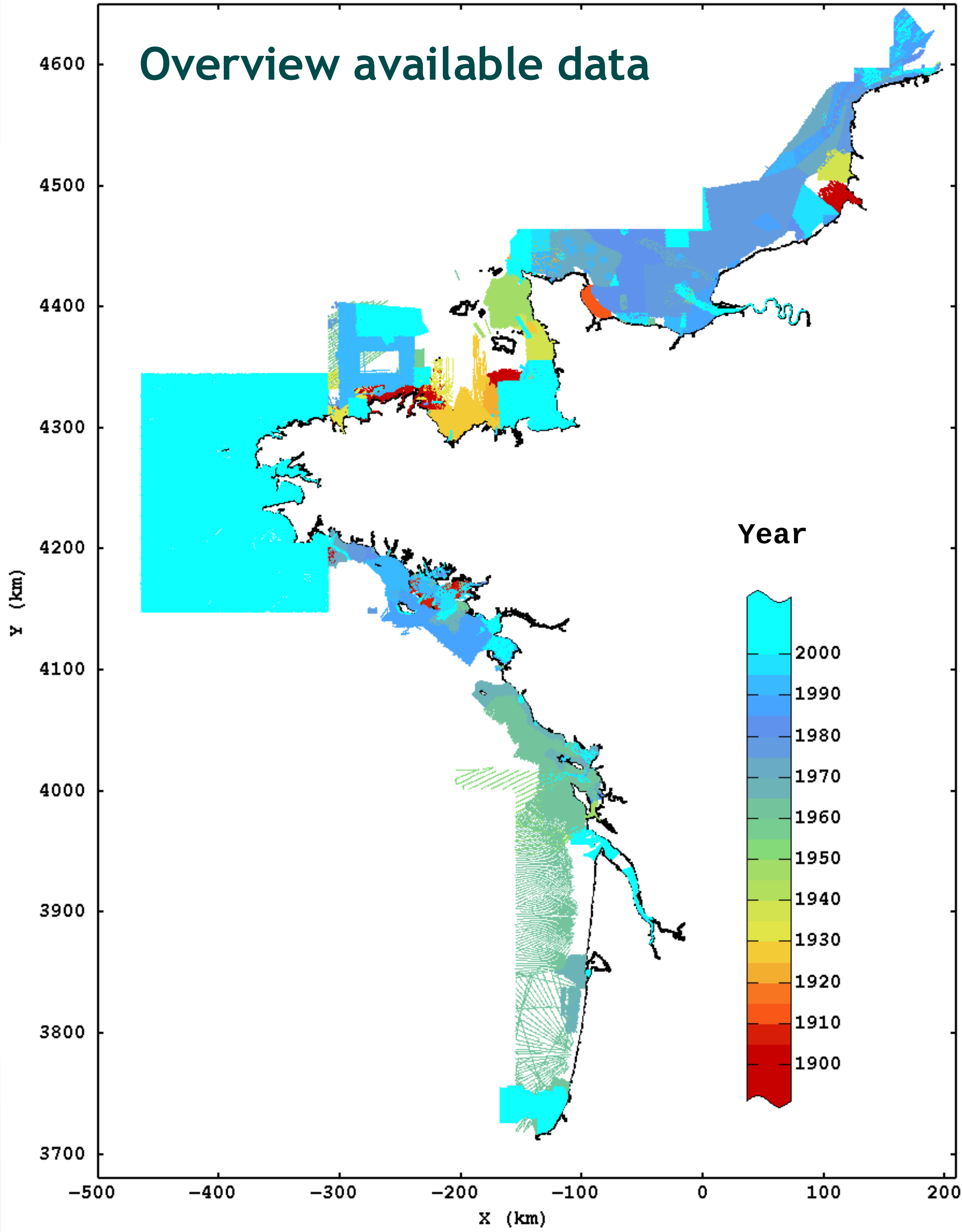
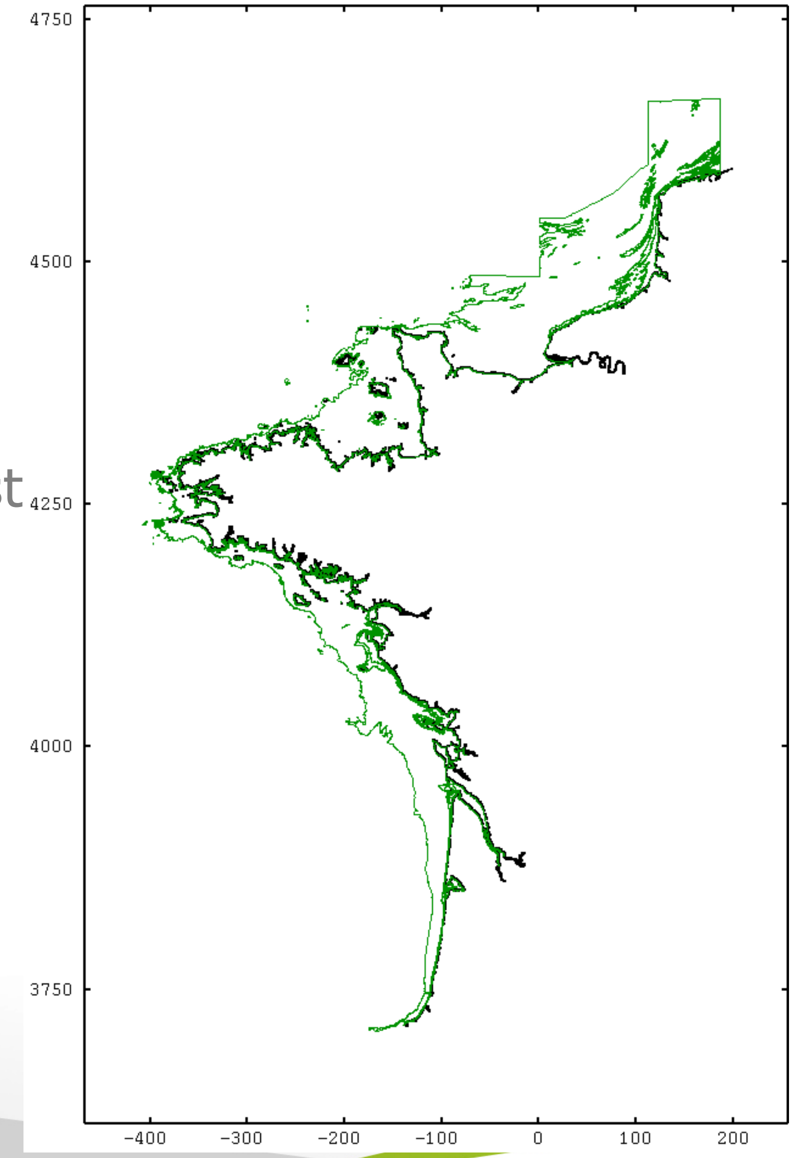


Input Data

- **Auxiliary data : coast line and isobaths**
  - Coast line (black) and isobath 50m (green): frontiers for data interpolation near the coast and towards the open sea
  - Height of the water at the maximum of the highest tide at coast line (SHOM software) potentially used to constrain data interpolation near the coast
  - Isobath zero (ZeroCM - IFREMER/SHOM) used for comparison with the DTM model



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Methodology

- **Pre-processing**
  - Choice of a projection system: Mercator N46
  - Automation of data import (journal files)
  - Acquisition year extraction from the survey number (SHOM) or datafile names (other sources)

- **Data Quality Control**
  - Redundancy and consistency of various bathymetry datasets:
    - Consistency checked in overlapping areas (scatter diagrams, comparison of short range variability…)
    - Application of several priority criteria:
      - spatial area covered by the dataset (the widther the better),
      - acquisition year (the younger the better),
      - data origin (SHOM)
    - Mixing of both manual and automatic procedures
  - Transmission of information about erroneous data to the SHOM
  - Merge of remaining files and tiles

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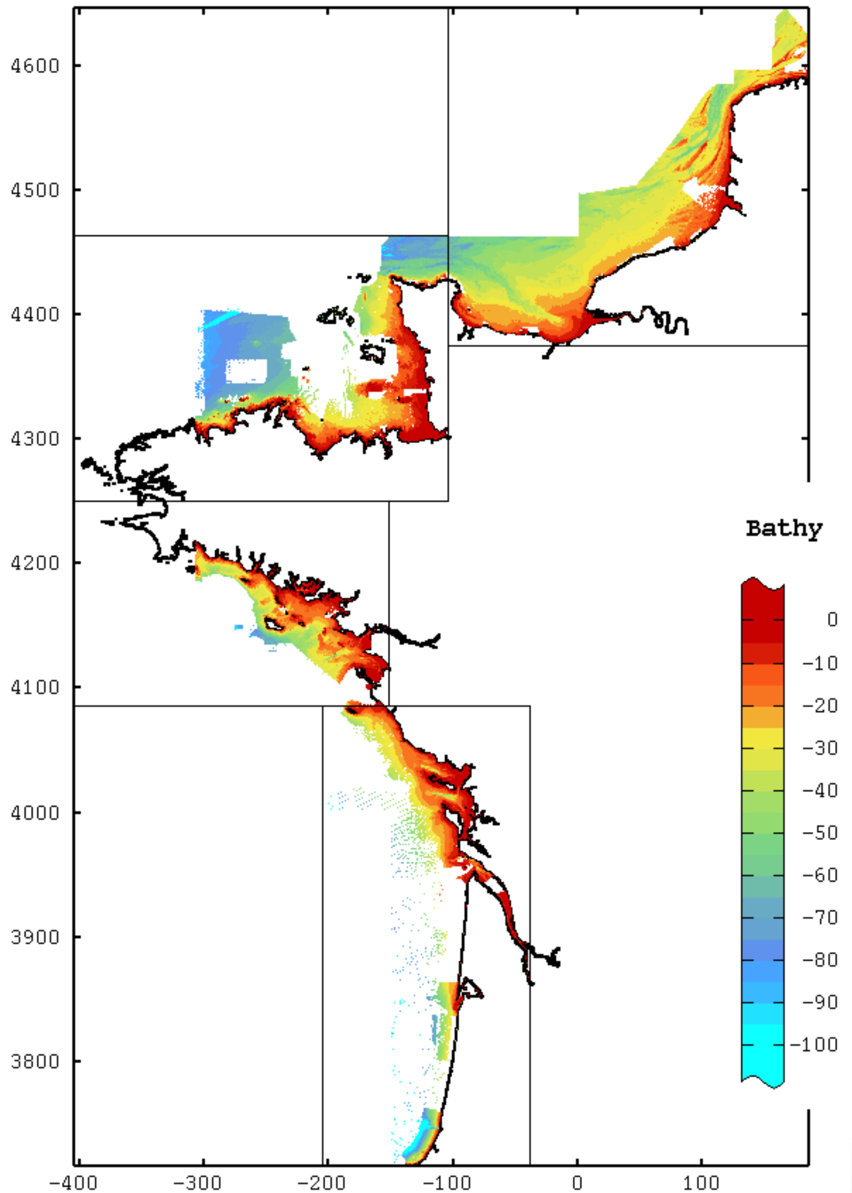
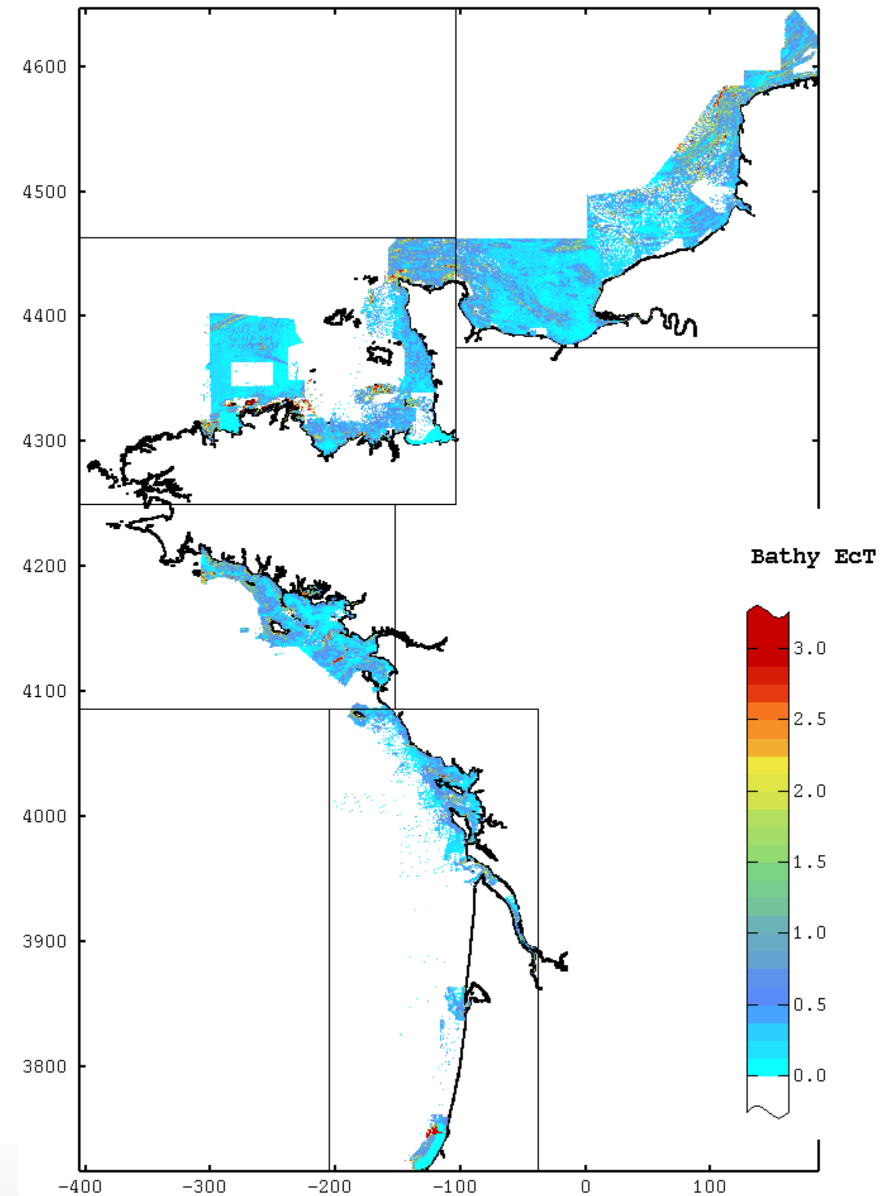
Methodology

- Bathymetry modeling methodology:
  - Geostatistical framework (flexibility, possibility to quantify DTM uncertainty)
  - On two representative tiles, comparison of several modeling techniques:
    - ordinary kriging with default or fitted variogram,
    - FAI-k kriging (fitting of local trends).
- Choice of the most relevant approach based on several criteria:
  - Visual quality control of DTM (empirical)
  - Use of a validation dataset (50% of data) not used for the DTM computation
  - Comparison to multi-beam high resolution models (Lannion)
- Most relevant approach:
  - Kriging with linear model and small nugget component
  - Neighborhood choice:
    - Octants, 2 neighbors per octant (max. number of consecutive empty octants allowed: 3)
    - Neighborhood size: 250m, min. number of neighbors: 4

Bathymetry Model: Results





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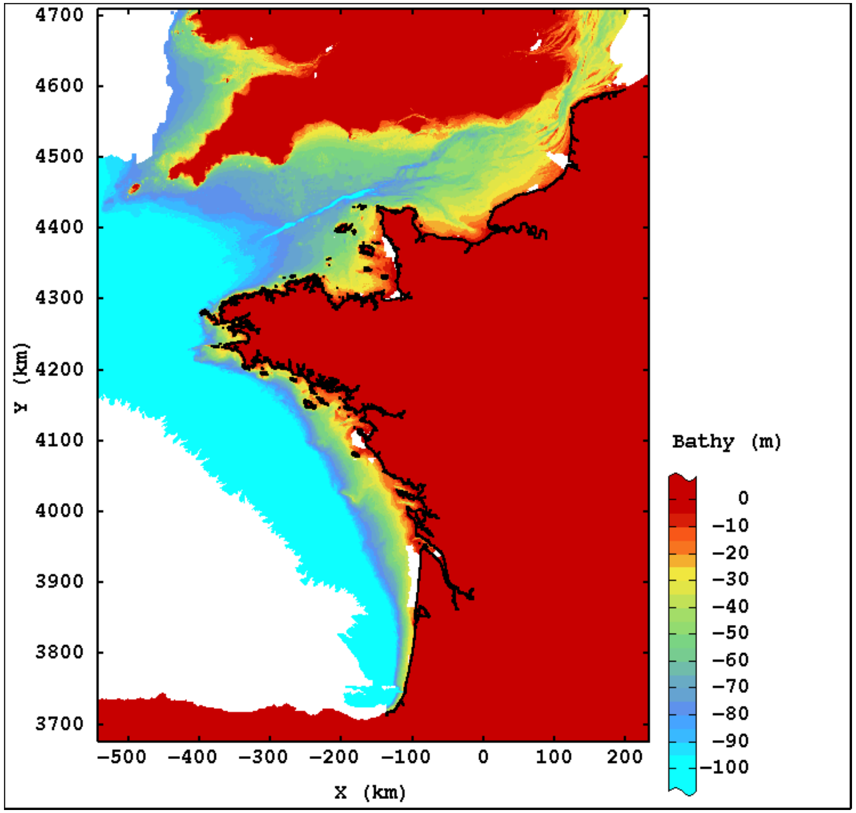
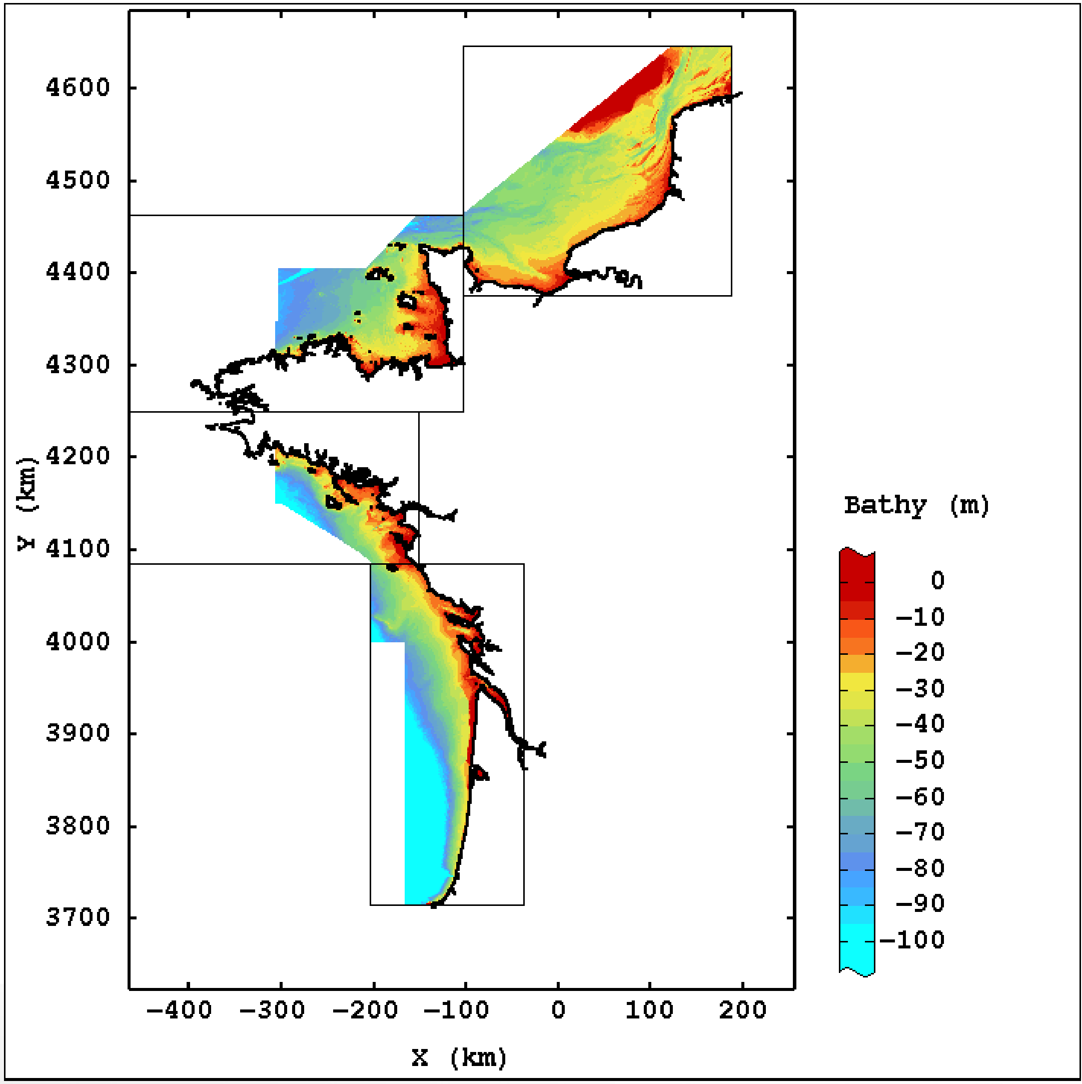
Bathymetry Model: Results

- **Filling towards the open sea: DTM 500m (IFREMER)**





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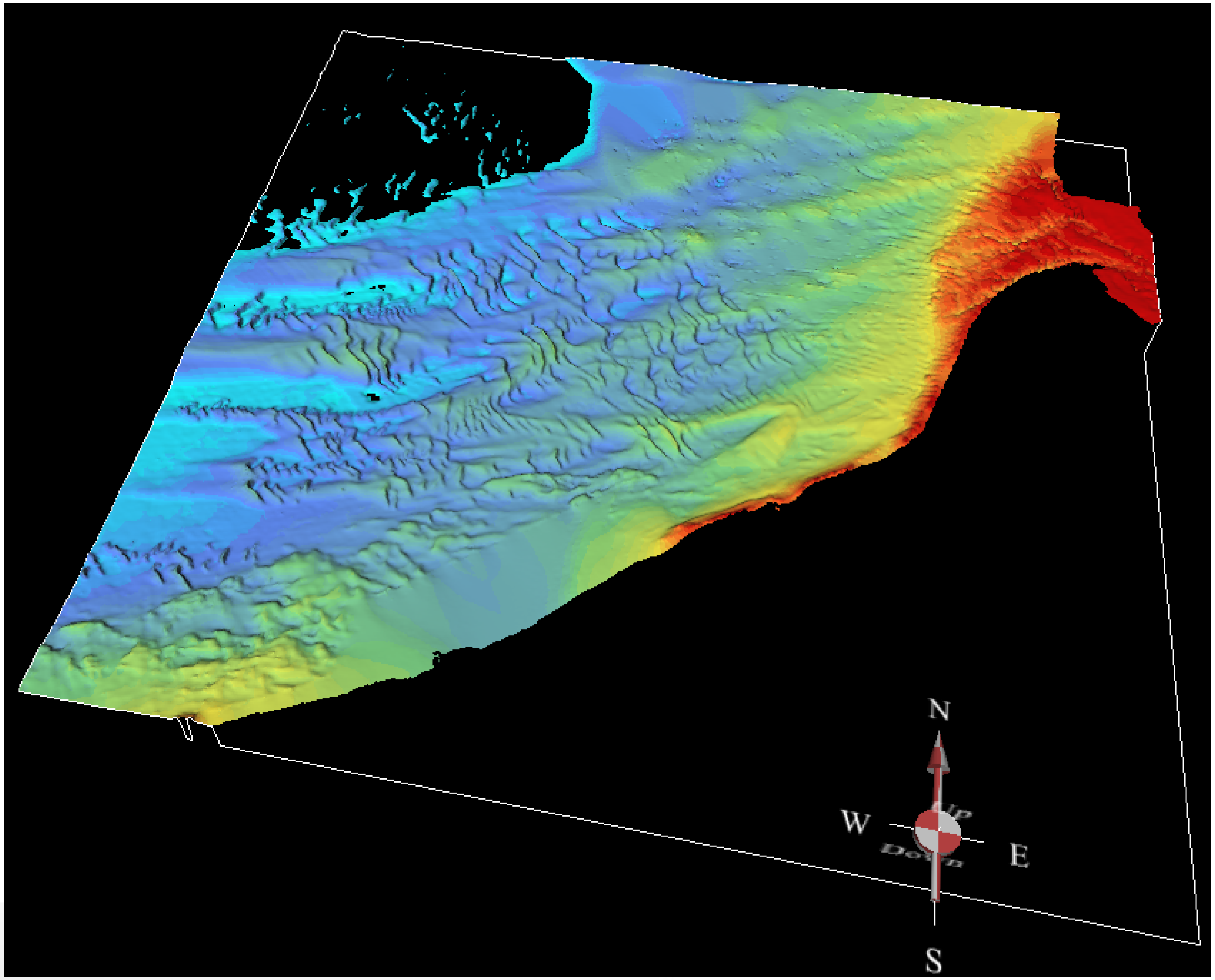
Bathymetry Model: Results

- **English Channel**
  - Undersea dunes
  - Artefacts in the East



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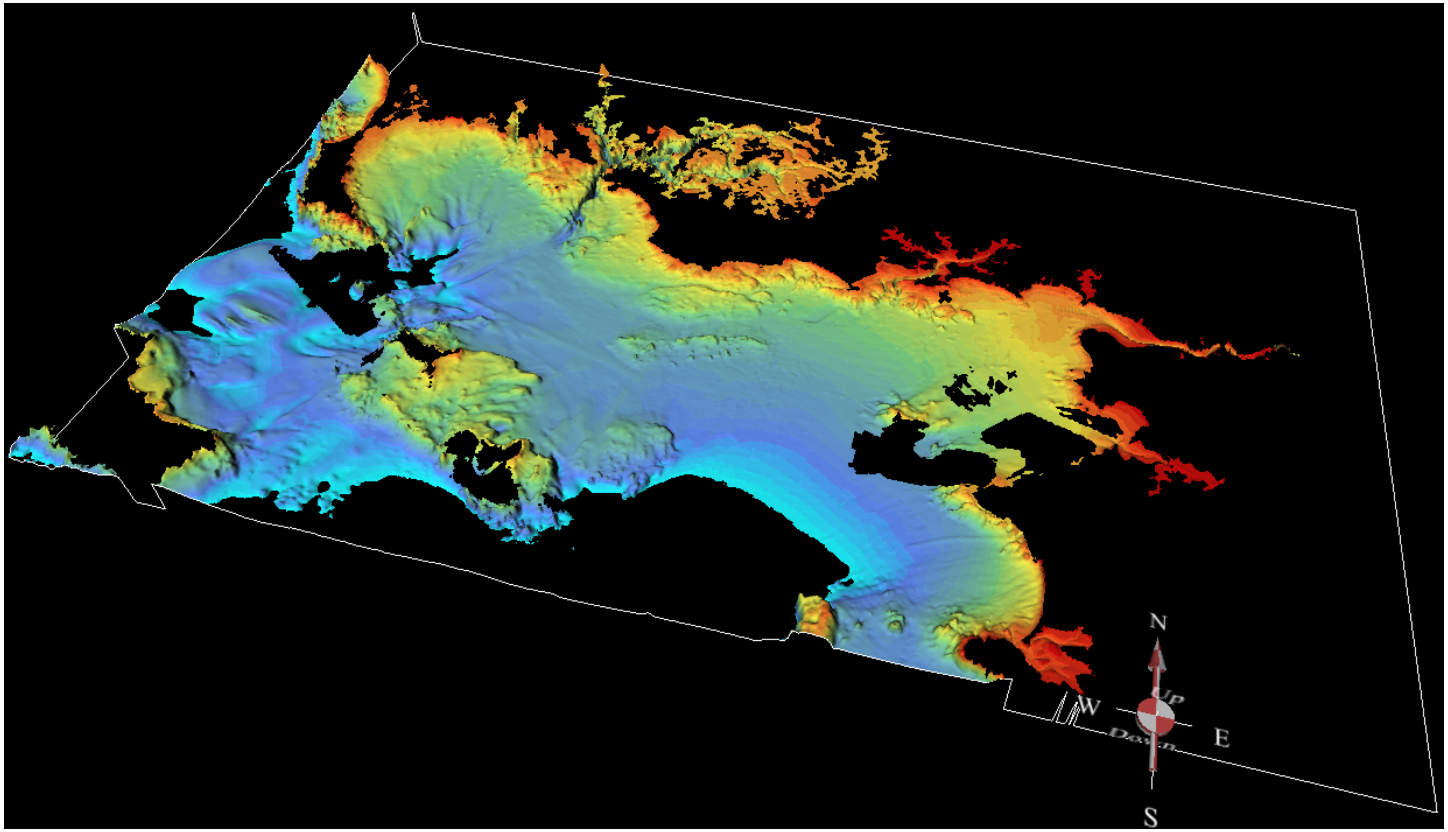
Bathymetry Model: Results

- **Southern Britanny**



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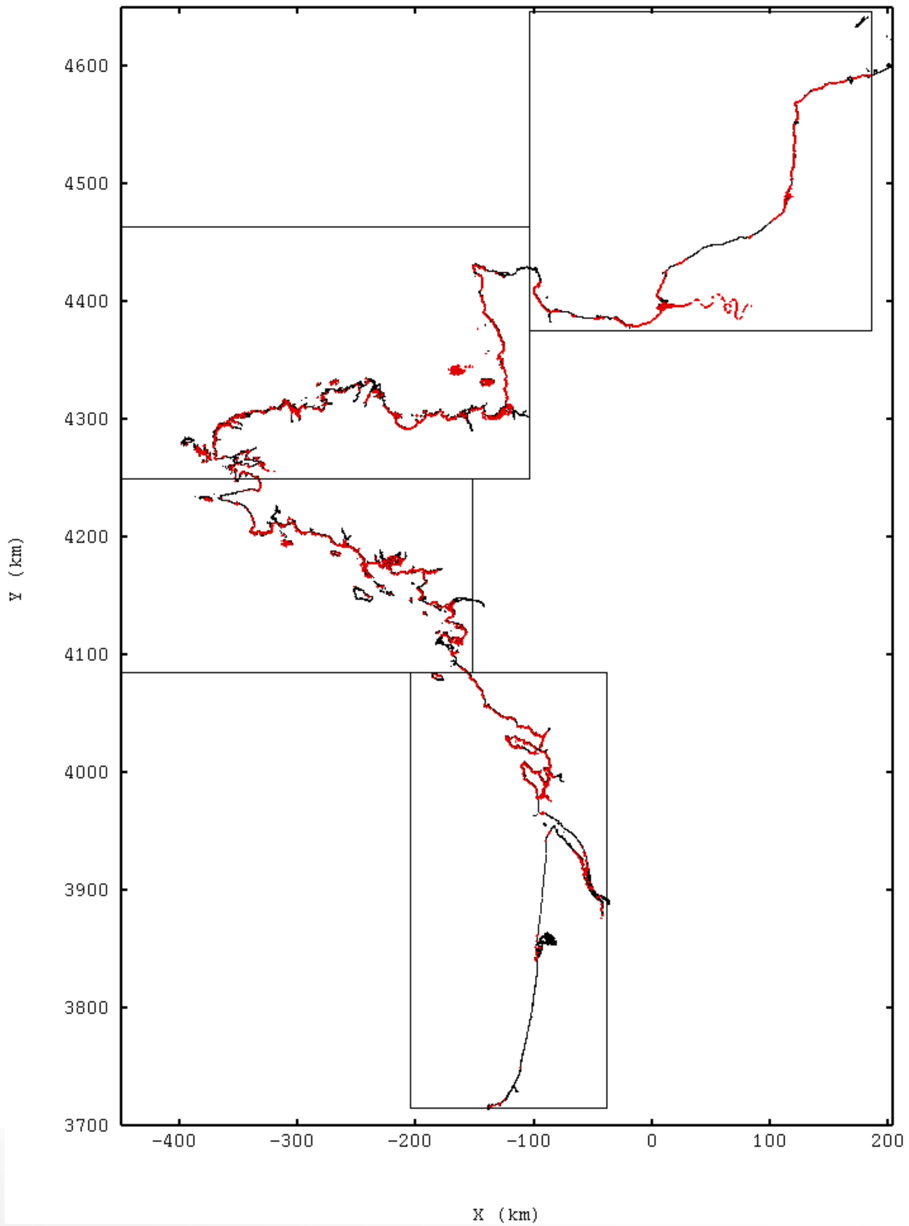
Bathymetry Model: Results

- **Quality control of results**
  - Good consistency of DTM isobath 0m with the reference ZeroCM, except in under-sampled areas



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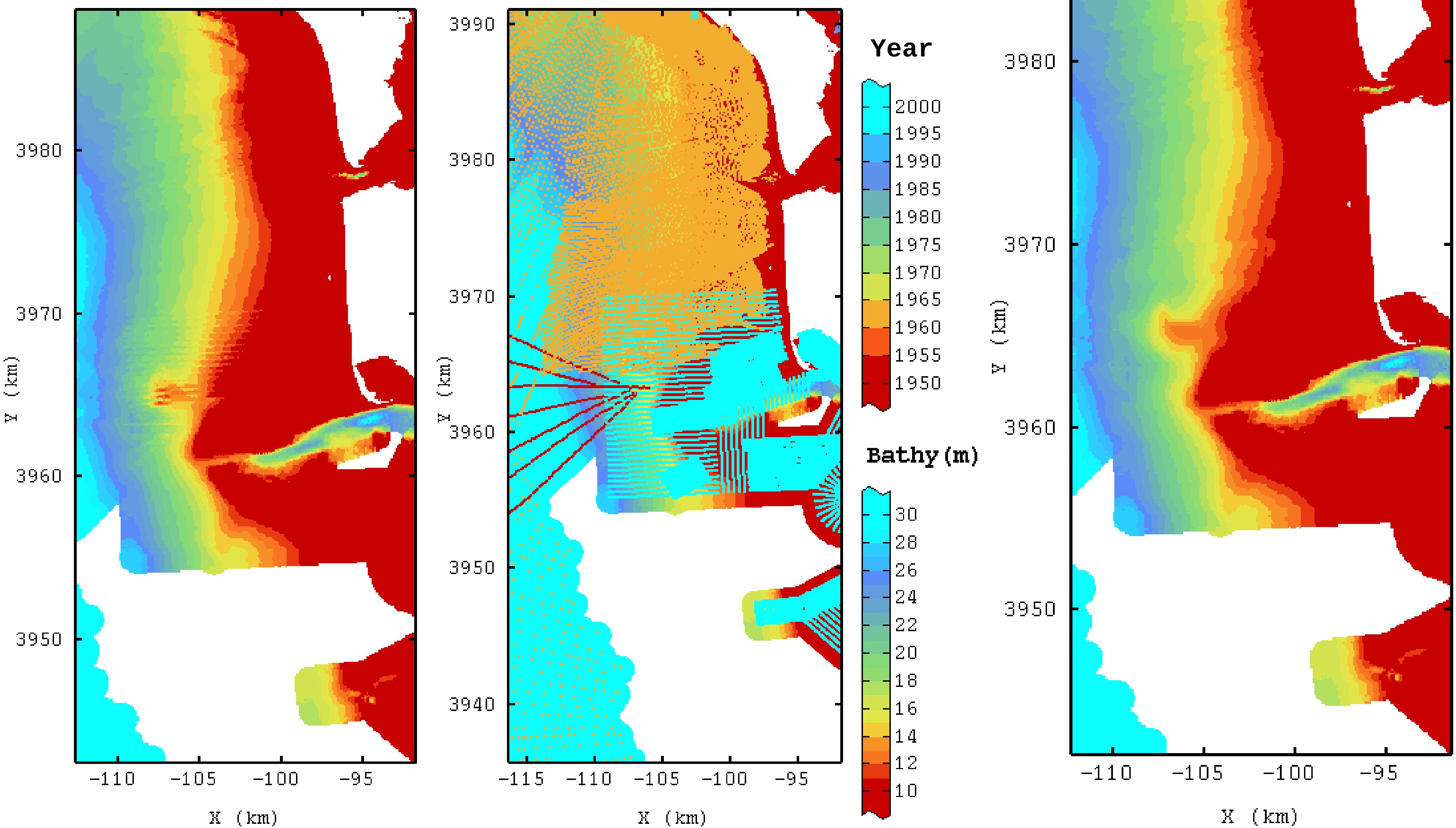
Bathymetry Model: Results

- **Quality control of results: Gironde river's mouth**



Overview of by-products

- **Aim: improve the product qualification**
- **By-products:**
  - DTM uncertainty (quality) $\Leftarrow$
  - Acquisition year $\Leftarrow$
  - Interpolation method
  - Producer / provider organization
  - Survey number
- **Outcome:**
  - These products allow advanced data qualification and are currently transposed to other applications
  - Full automation of the entire procedure

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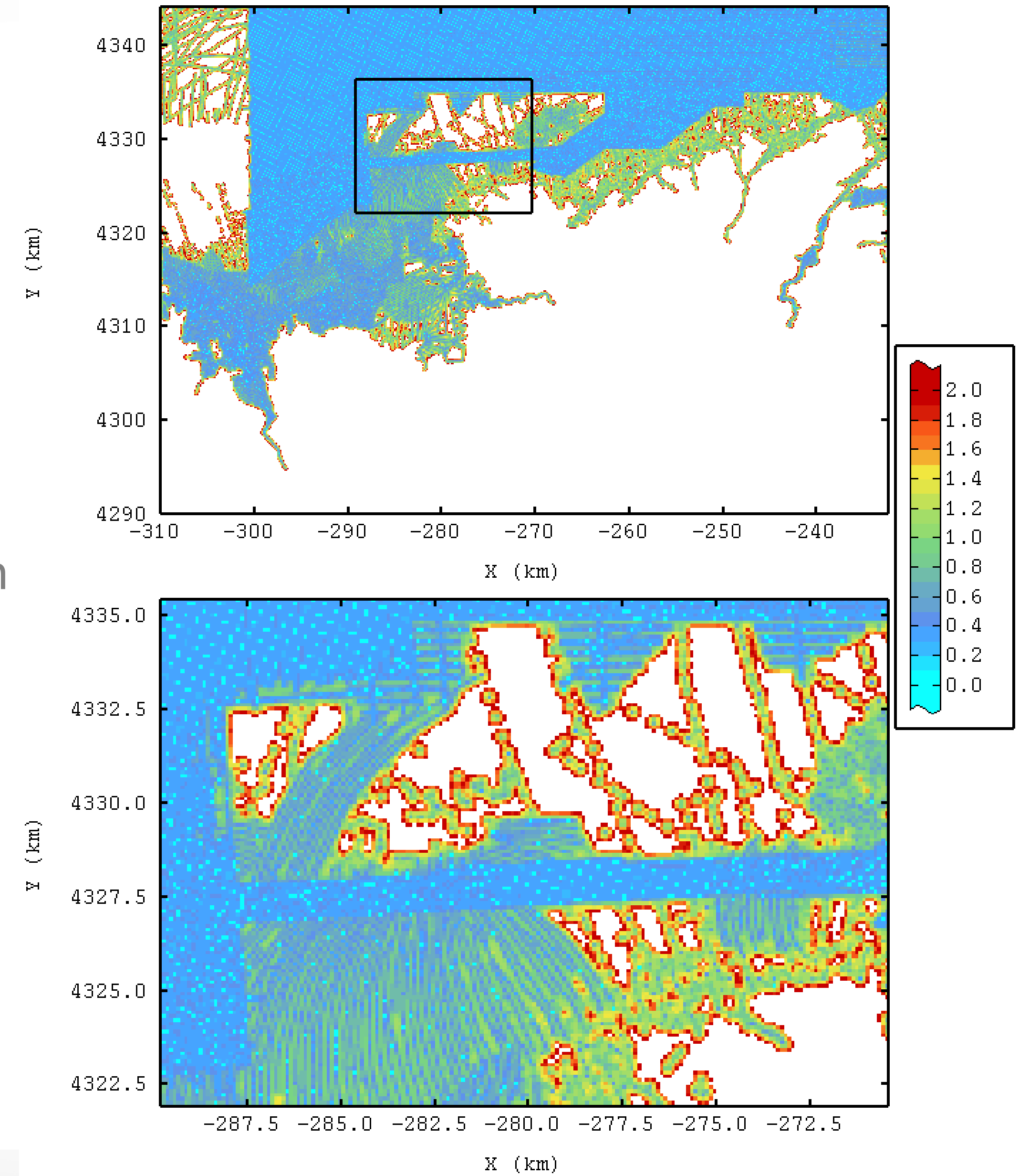
Methodology

- **DTM uncertainty**
  - Kriging standard deviation
  - Unique variogram model (stationary assumption) ⇒ same order of magnitude wherever we are (smooth vs. highly variable areas)
  - Alternative: locally weight the kriging standard deviation according to the local variability of bathymetry



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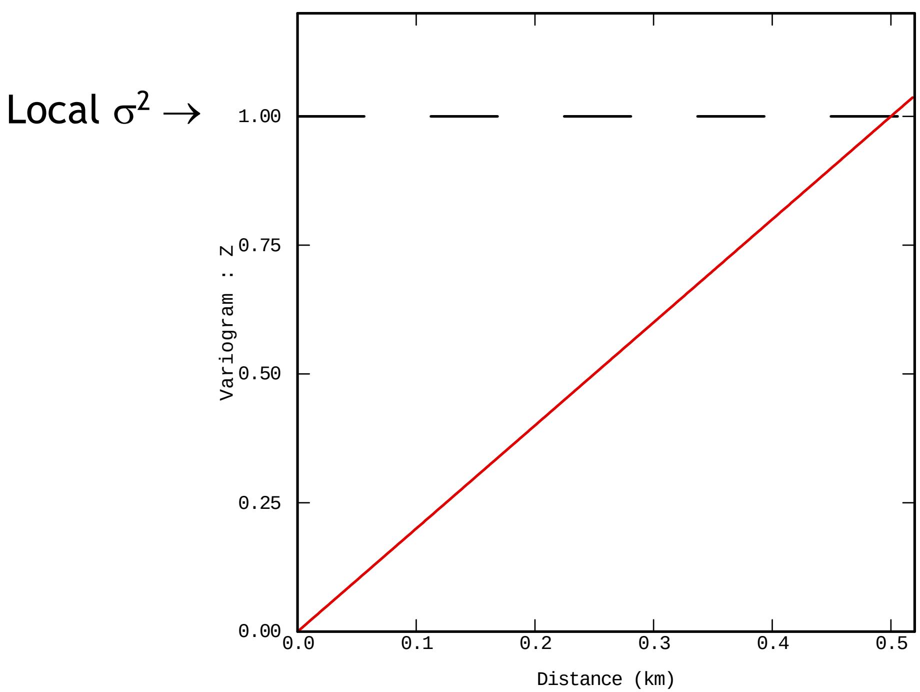
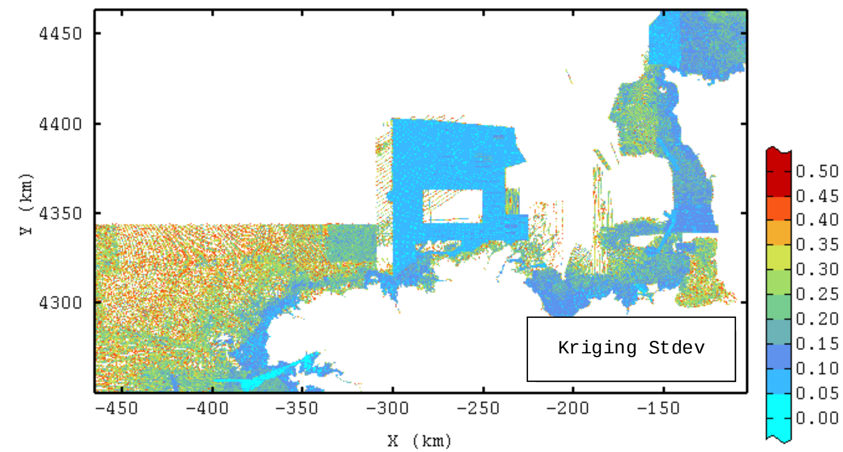
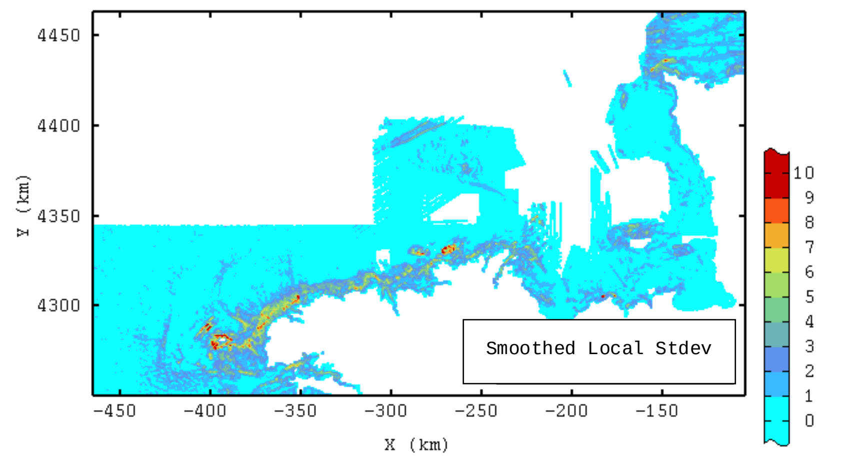
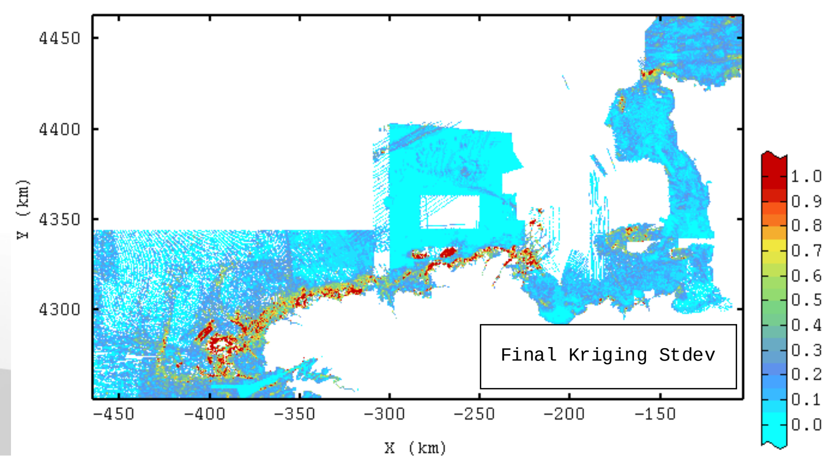
Methodology

- **DTM uncertainty**









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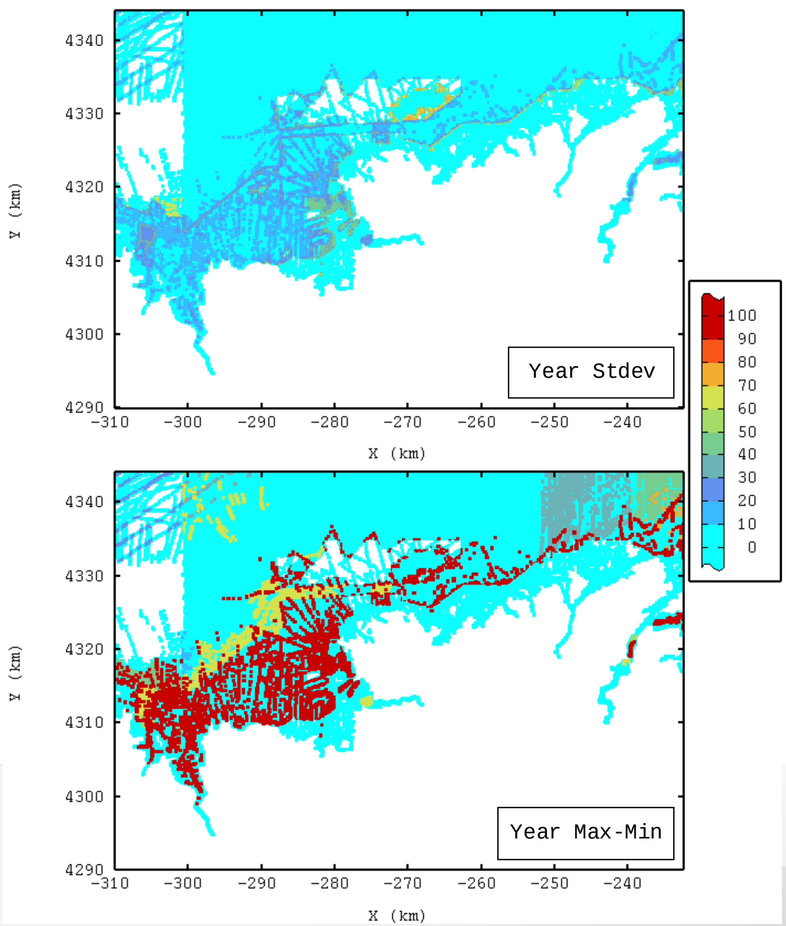
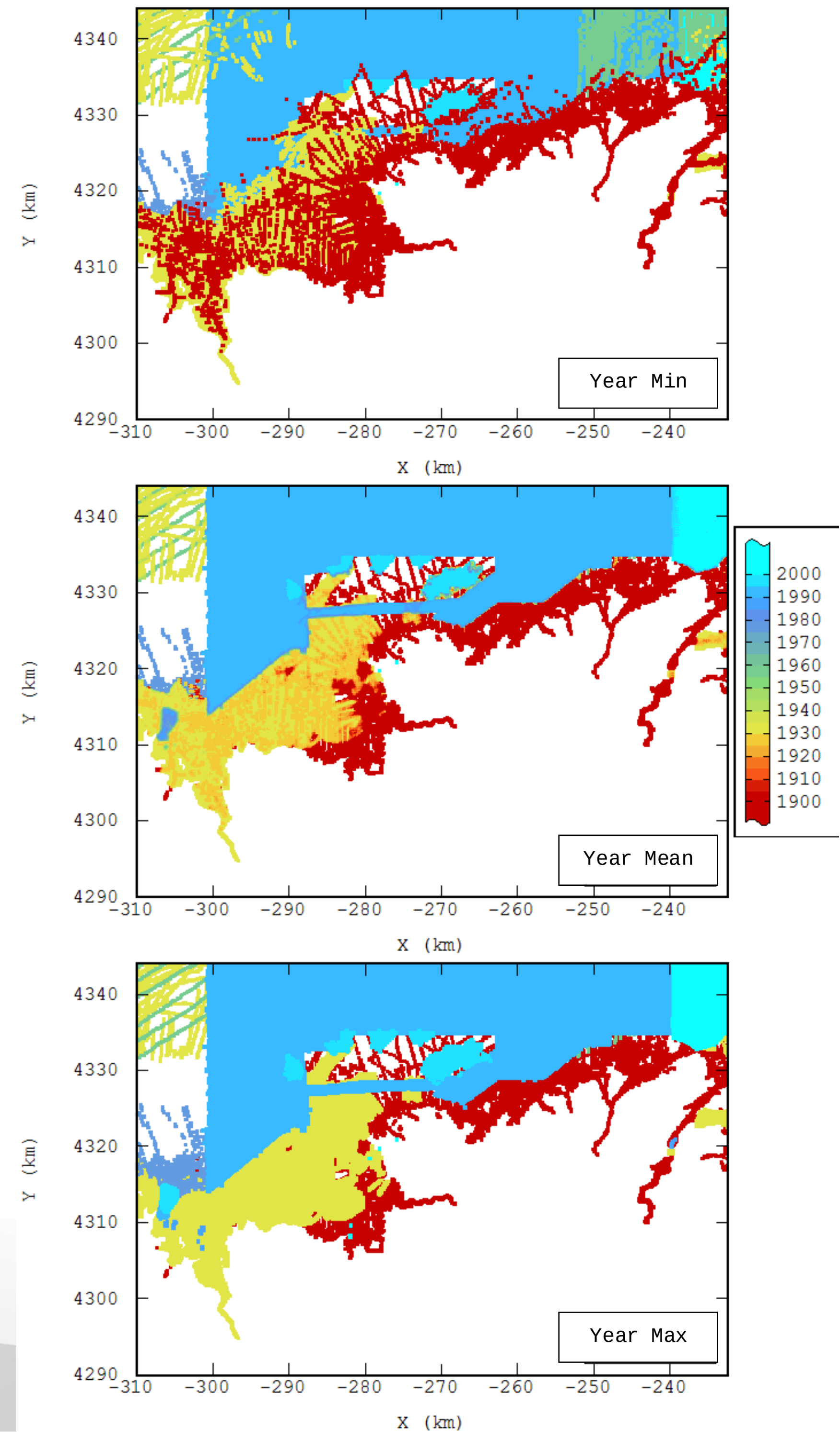
Methodology

- **Acquisition year**
  - Computation of local statistics about the age
  - Acquisition year: average year, standard deviation, minimum, maximum, Difference max-min





Conclusions and Perspectives

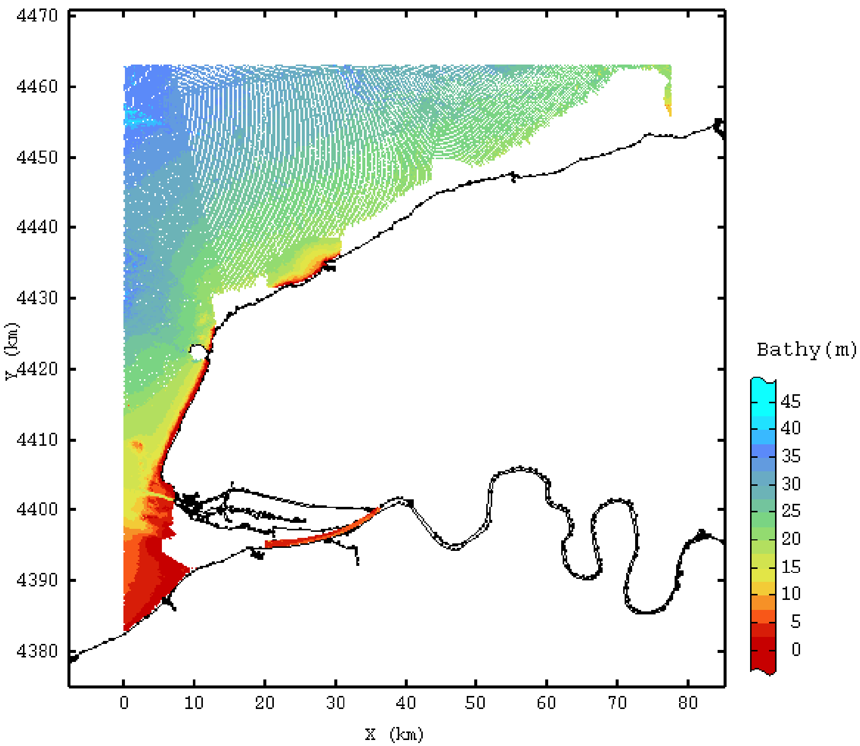
- **Methodological outcomes**
  - Application of classical geostatistical algorithms
  - Fulfilment of objectives in terms of spatial resolution, uncertainty and age description
  - Full automation of the modeling procedure, from data import to DTM export of results
  - Difficulties to identify abnormal profiles on some surveys (ex: MSM)

- **Perspectives**
  - Mediterranean sea and Corsica
  - Regular update of models in order to integrate newly acquired data
  - « Moving-Geostatistics » methodology, jointly developed with the company Estimages, to account for local bathymetry characteristics

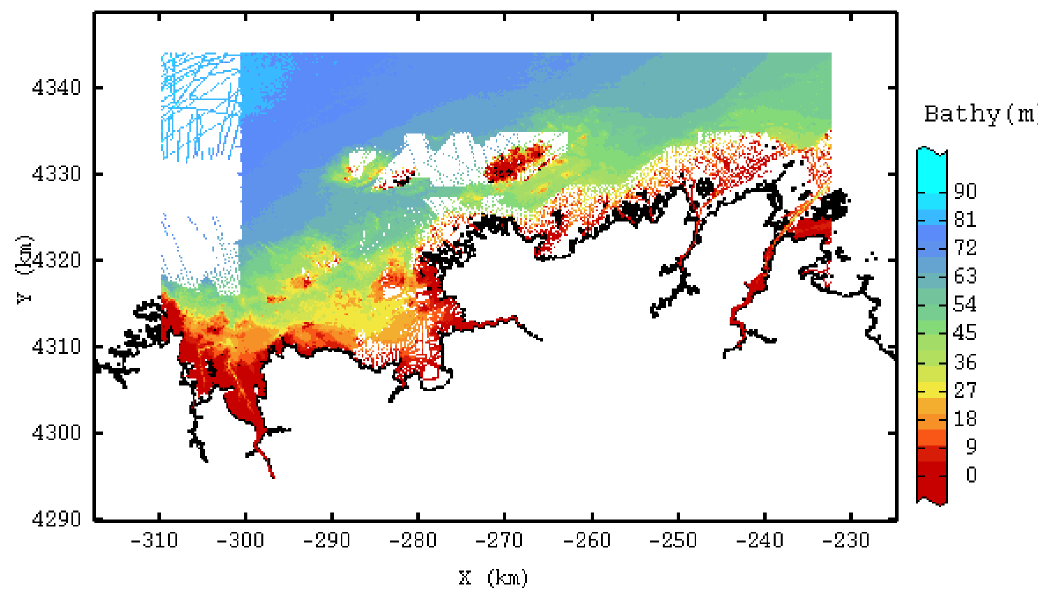
Questions

- **Test tiles for the choice of the interpolation model**

Tile 18090



Tile 14583



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