The Western Mediterranean SST seen through complementary *in situ*, satellite and modelling approaches

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Outline

1. Objectives
   - Combined effort on determinate region
   - representation of seasonal cycle in the region
   - effectiveness of tools in limited area.
   - interactions between approaches
2. Tools
   - circulation model $\rightarrow$ GHER model
   - cloud filling in SST imagery $\rightarrow$ DINEOF
   - *in situ* data analysis $\rightarrow$ Diva
3. Outputs
   - Annual, seasonal and monthly averaged fields, 0.0625-degree resolution
   - SST fields for the year 1998 , $4.5 - 11.5^{\circ} W$ and $40.5 - 45^{\circ} N$

GHER model (1)

General:

Variables: T, S, SSE, u, v, $\texttt{tke}$

Boussinesq approximation, Cartesian coordinates, Arakawa C-grid, mode splitting

k-turbulent kinetic energy closure scheme [Nihoul (1989)]

algebraic equation for ϵ

Atmospheric forcing:

bulk formula [Kondo et al. (1975)]

implementation [Barth et al. (2004)]

Applications:

Western Mediterranean Sea [Beckers (1991)], [Beckers et al. (1997)],

MEDMEX experiment [Beckers et al. (2000)]

GHER model (2)

Nesting [Barth et al. (2002)]:

1. interpolation of fine grid BC's from coarse grid model
2. integration of both grid models for one time step
3. averaging the values of the fine grid model and updating of coarse grid model

Boundary conditions:

Normal velocity: volume conservation + penalisation of abrupt variations

Tangent velocity: bilinear interpolation

Scalars: linearly interpolation normal to the boundary + tangent interpolation

sponge layer: diffusion in the fine model is linearly raised to coarse model diffusion

DINEOF

Ocean satellite data: gappy → gridded field
Objectives:

- identification of dominant spatio-temporal features
- full gridded data at regular time steps
- identification of suspect data

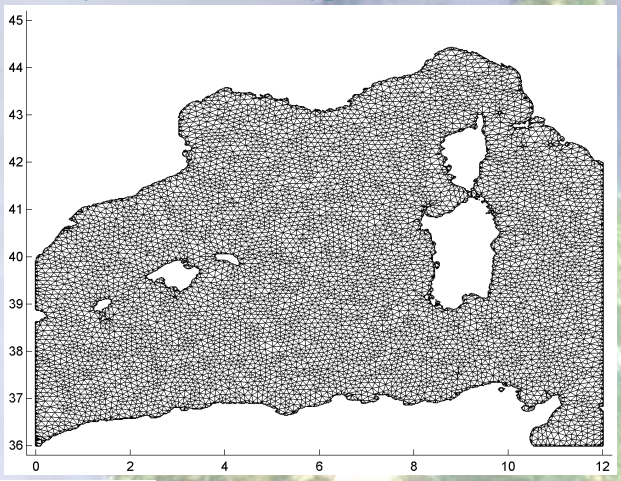
Principle [Alvera-Azcárate et al. (1995, 1996), Beckers et al. (2003, 2006)]:

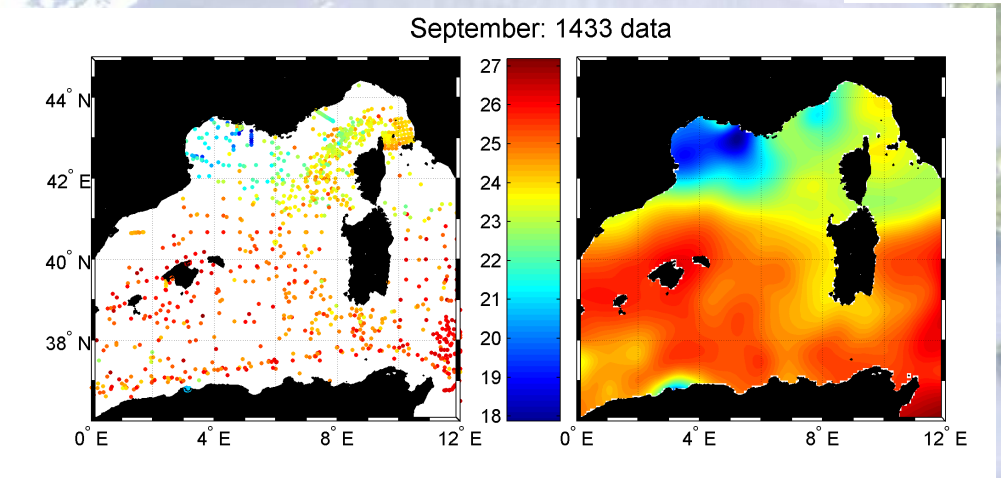
1. Empirical Orthogonal Functions (EOF) decomposition (iterations)
2. General Cross Validation (GCV) → optimal number of EOF
3. Final SVD decomposition

Diva

Data-Interpolating Variational Analysis
[Brasseur et al. (1996), Brankart and Brasseur (1996, 1998)]

- = advanced data-gridding method
- + finite-element resolution
- + coastlines + advection influence
- + error maps
- + many more [Beckers et al. (2008)]





DINEOF

Sources:

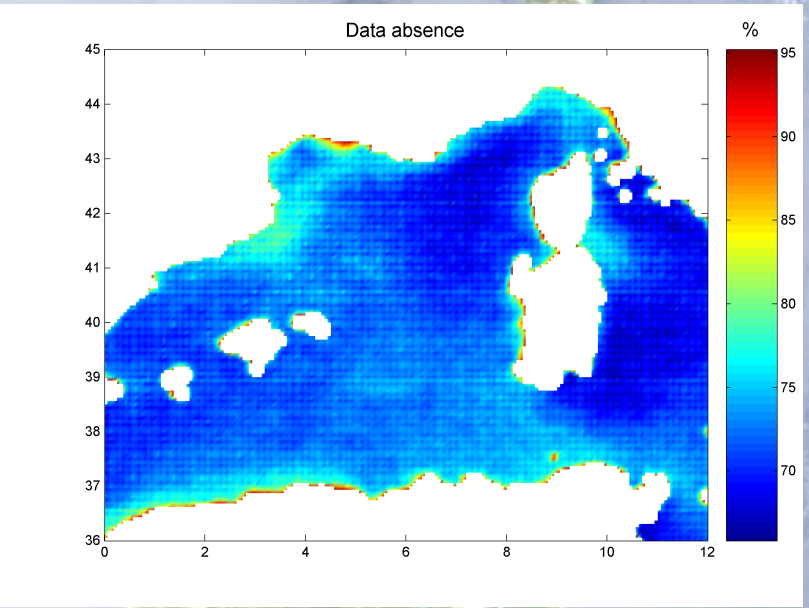
Sensor: AVHRR Pathfinder SST, `http://podaac.jpl.nasa.gov`

Period: 1985-1995

Resolution: remapped daily at $1/16°$ [Marullo et al. (2006)]

Quality: more than 5 % of valid data

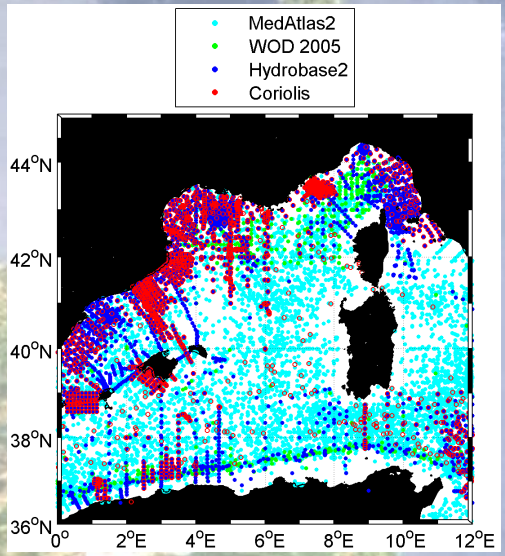
$\longrightarrow$ 3974 images

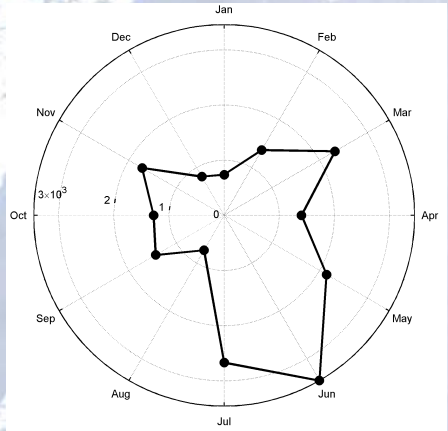


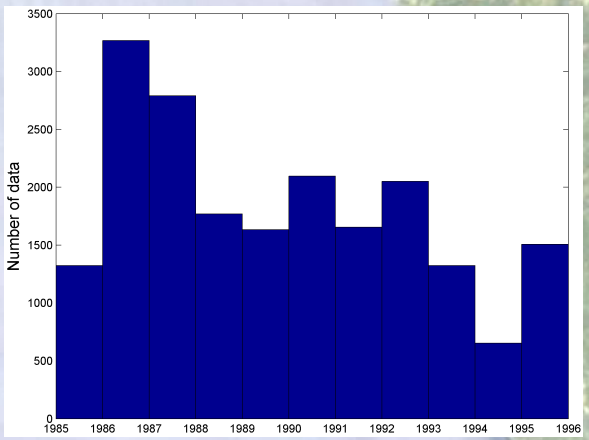
Diva

Data set = aggregation between:
WOD05 + MedAtlas2 + Hydrobase2 + Coriolis

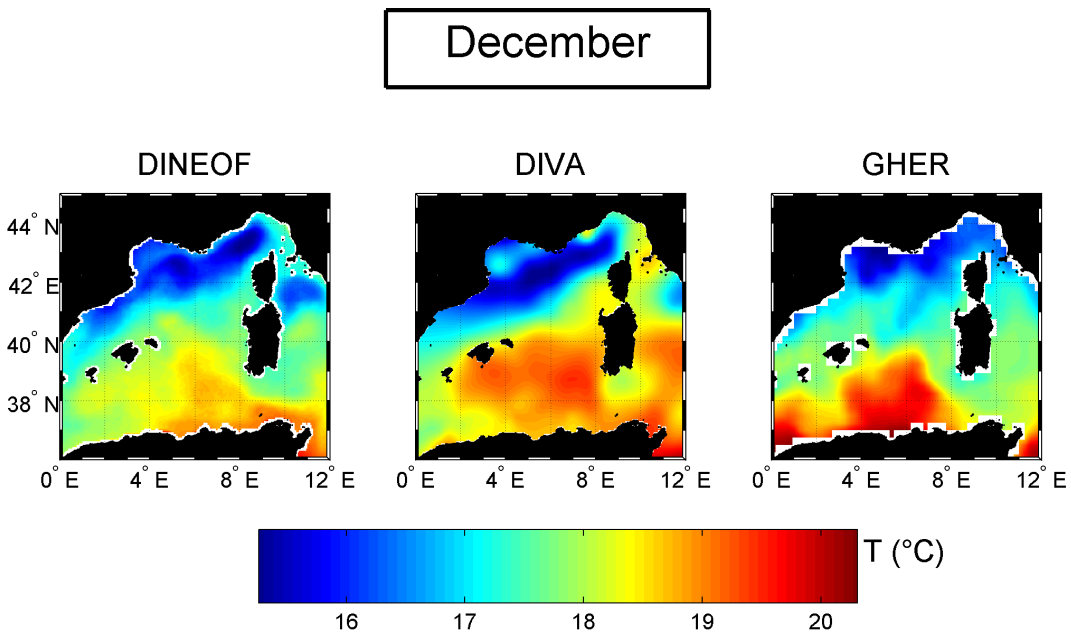
- 24293 unique profiles
- observations with depth $< 5\ m$ (82.6% of the profiles)
- 1986: 3267 measurements, 1994: 653
- $> 40\%$ of data between May and July
- mean: $18.4769^\circ C$, standard deviation: $3.8773^\circ C$
- 99.3% of data have $12 < T < 27^\circ C$





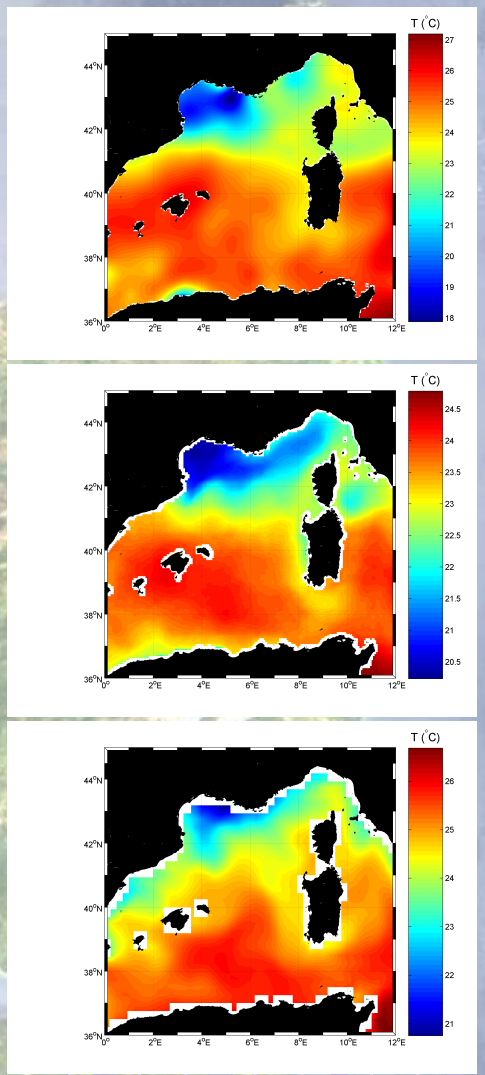


Monthly temperature fields



Origin of the differences

- **Data** analysis:
  + relies on data distribution (time **+** space)
  + needs parameter selection
- **Satellite** images:
  + DINEOF relies on calibration algorithm
  + surface effets
  + inegal repartition of cloud coverage
- Hydrodynamic **model**:
  + forcing accuracy
  + small-scale process parameterisation



Possible improvements

detrending:

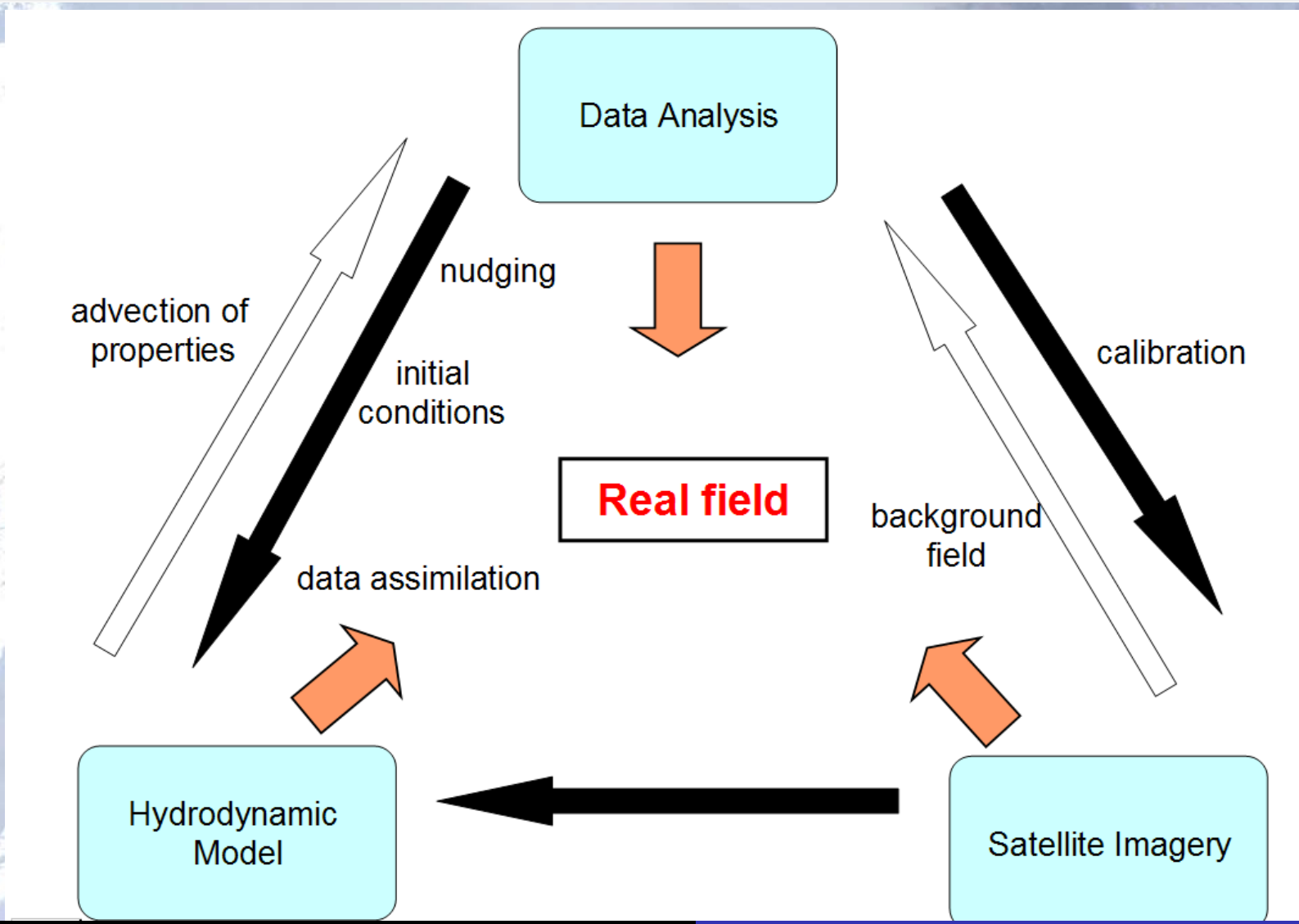
- subdivision of data into several groups
- analysis $\longrightarrow$ computation of a trend for each group:
  trend = misfit with respect to overal analysis
- subtraction of the trend
- iteration until convergence

data assimilation:

- optimal combination of model results and independent data
- Kalman filter, optimal interpolation, nudging, ...

$\longrightarrow$ needs for a strategy combining all the approaches

Interactions between approaches



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Thanks for your attention!