Assimilation of Sea Surface Temperature in the MARS 3D regional modelling system using Ensemble Kalman Filtering

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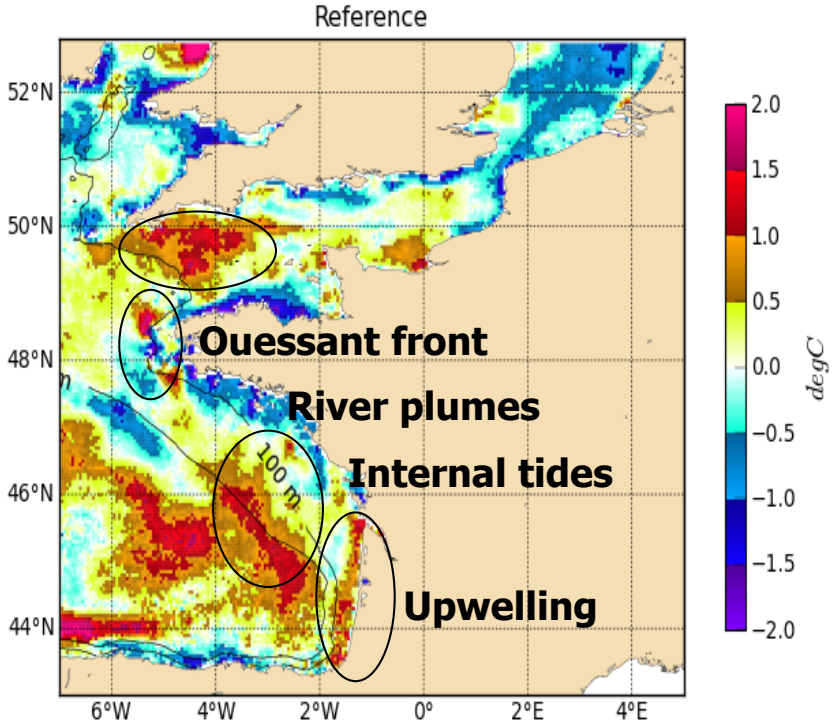
- **PREVIMER** *www.previmer.org*

French Coastal Operational forecasting System

- **MARS-3D (4km res./30 levels)**
- **Model Performance**
  - Satellite Surface temperature (SST) / buoys (stratification)

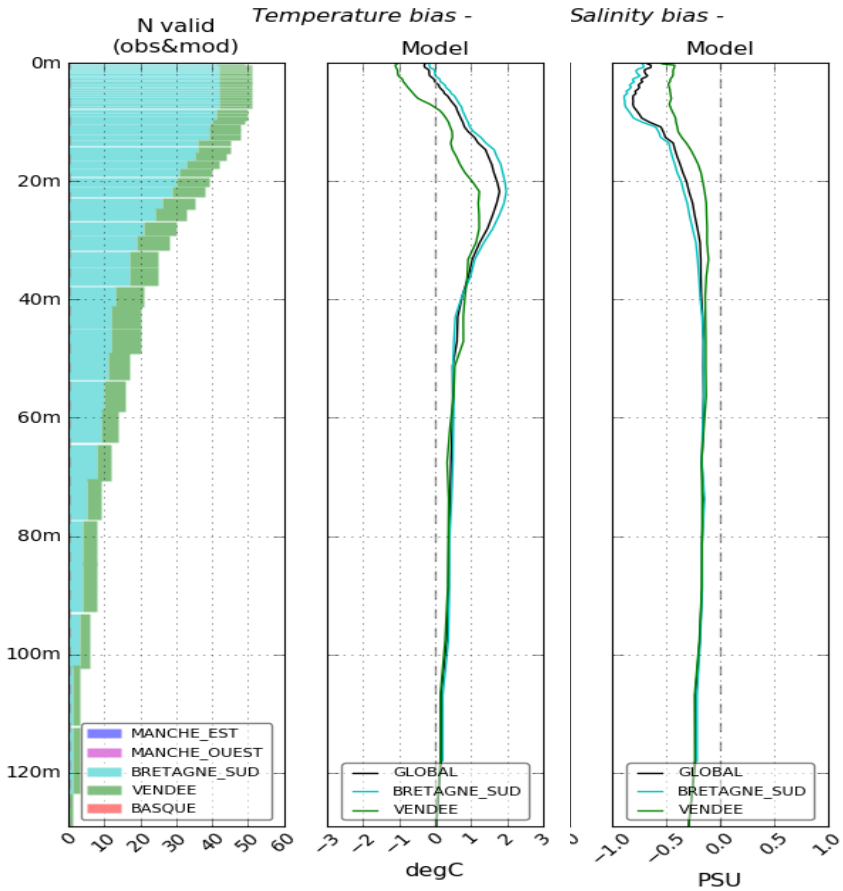


Mean Innovation[°C] – July 2006

- **PREVIMER** *www.previmer.org*

French Coastal Operational forecasting System

- **MARS-3D**
- **Model Performance**
  - Satellite Surface temperature (SST) / buoys (stratification)
    - » Too weak stratification

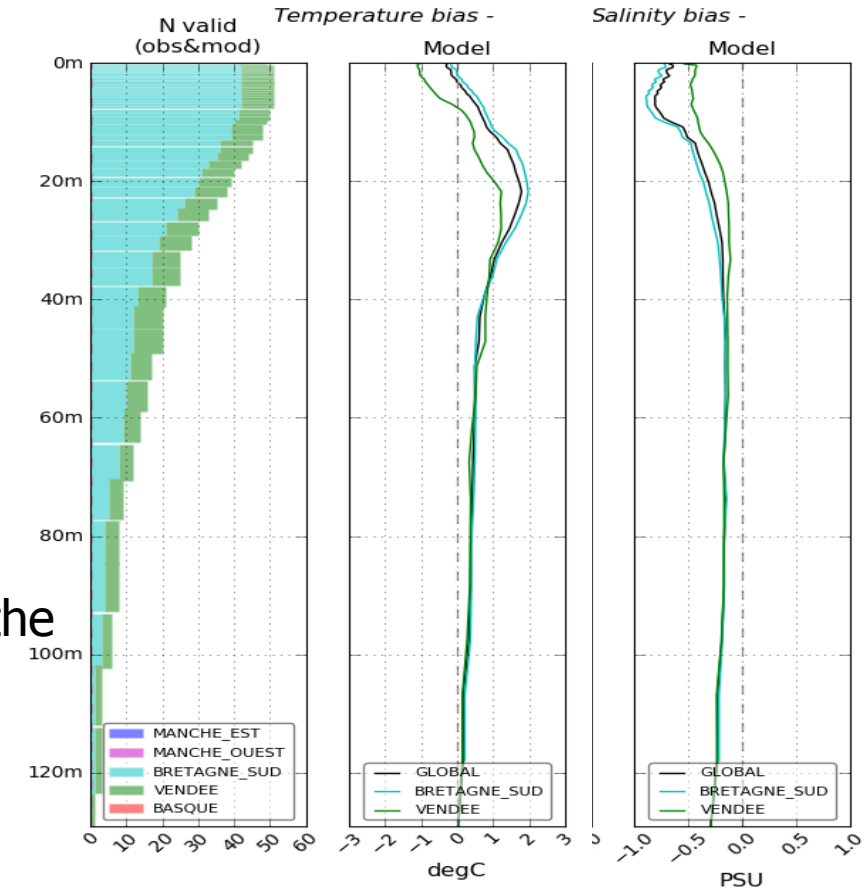


Summer 2003: all profiles in sub-region

- **PREVIMER** *www.previmer.org*

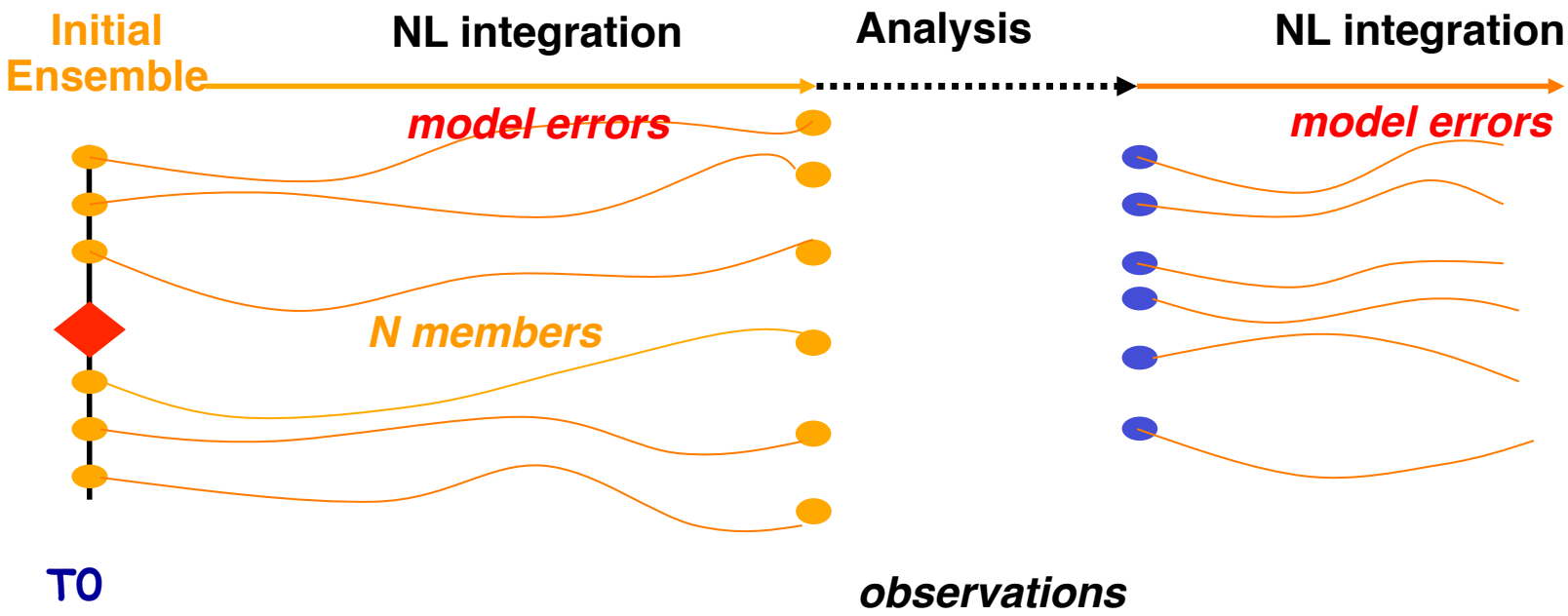
French Coastal Operational forecasting System

- **MARS-3D**
- **Model Performance**
  - Satellite Surface temperature (SST) / buoys (stratification)
- **Data assimilation (R&D)**
  - Improve model SST and stratification predictions over the Channel/Biscay **shelf** using satellite derived surface temperature



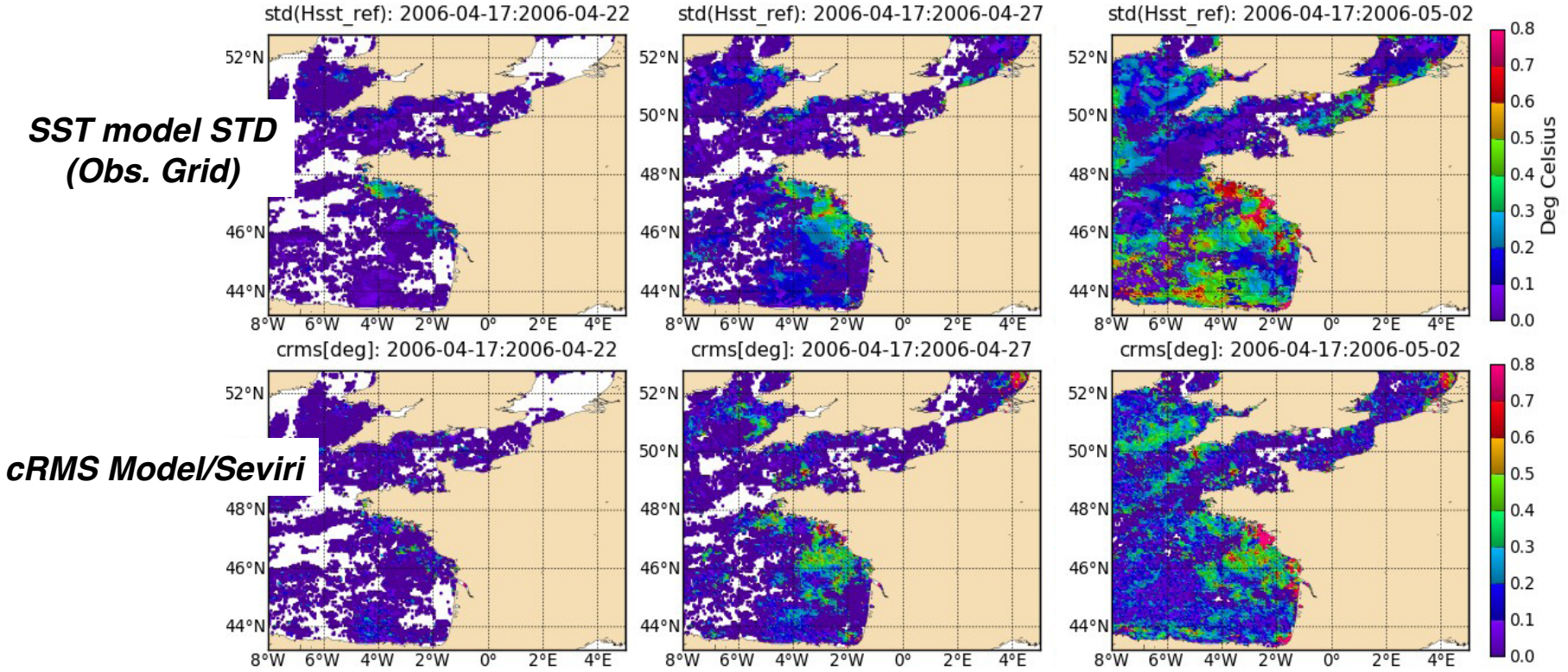
Summer 2003: all profiles in sub-region

- **Ensemble Kalman Filter**
  - **Sequential data assimilation, multivariate approach**
  - **Adapted to non stationary/non linear environment**



- **Ensemble forecast errors**
  - **Sources**
  - **Characterization**
- **Data assimilation experiments**
  - **Framework**
  - **Results**
    - SST
    - Stratification
- **Conclusions**

- **Ensemble forecast assessment: error sources**
  - **Model Forcing**
    - Initial Conditions



Forecast Error Characterization

- **Ensemble forecast assessment: error sources**
  - **Model Forcing**
    - Initial Conditions
    - Meteorological forcing (Wind Stress, thermal fluxes)

      50 members from ECMWF (12h, 0.5°x0.5°)

Forecast Error Characterization

- **Ensemble forecast assessment: error sources**
  - **Model Forcing**
    - Initial Conditions
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      50 members from ECMWF (12h, 0.5°x0.5°)
  - **Internal parameters**
    - General sensitivity study (Friedrich, 2001)
      - Seasonal scale
      - Hydrological interesting areas
      - Ψ +/- 10% Ψ

Forecast Error Characterization

- **Ensemble forecast assessment: error sources**
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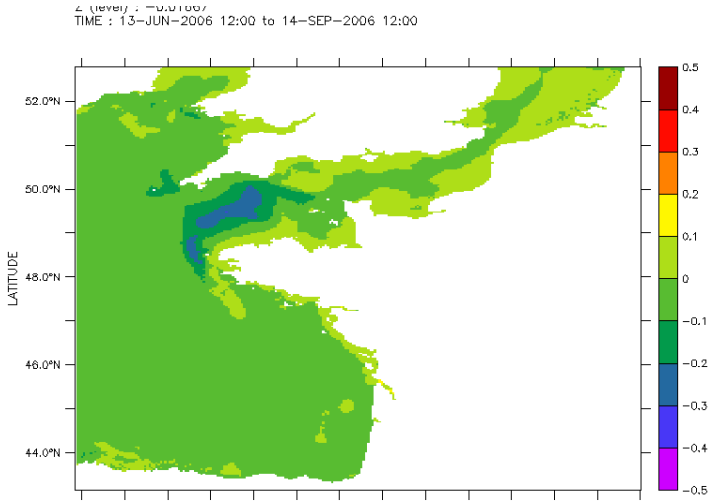
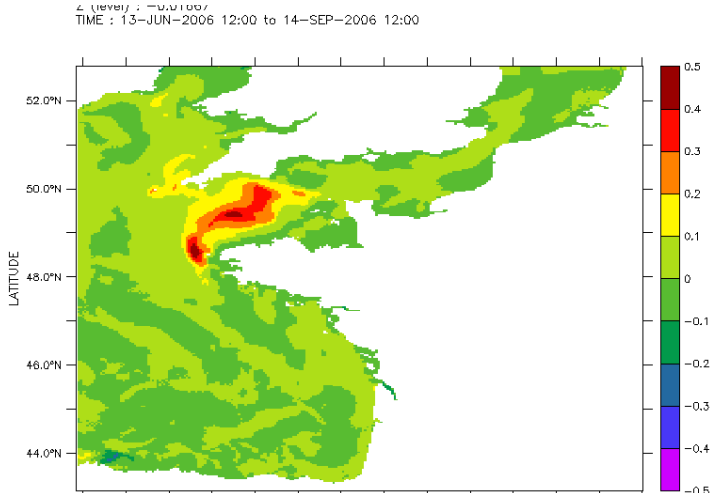


SST Difference de SST due to turbulence parameter increase (ck+10%) (Gaspar)



SST Difference de SST due to bottom friction coefficient increase (z0+10%)

Forecast Error Characterization

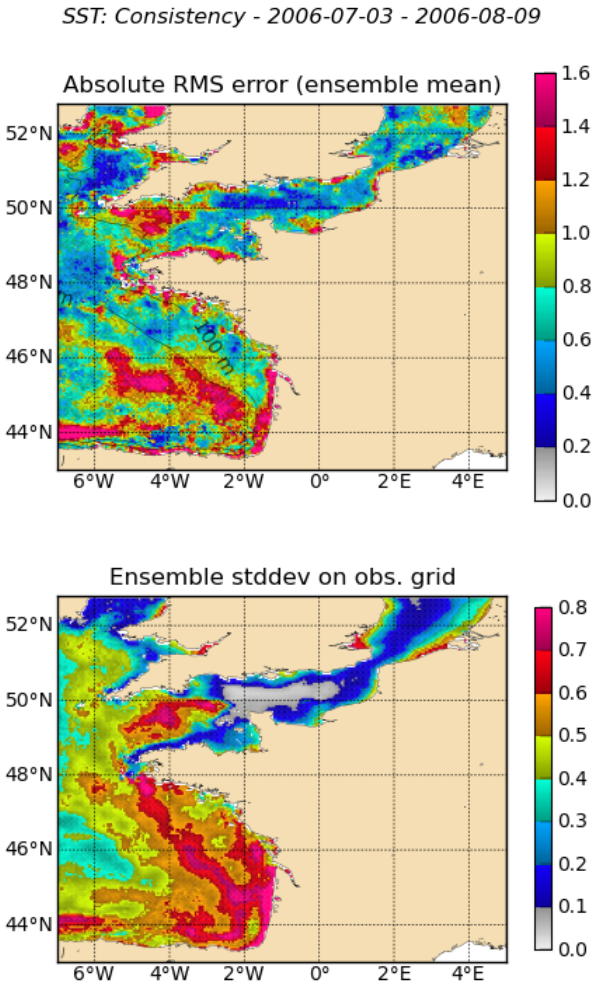
- **Ensemble forecast assessment: error sources**
  - **Model Forcing**
    - Initial Conditions
    - Meteorological forcing (Wind Stress, thermal fluxes)

      50 members from ECMWF (12h, 0.5°x0.5°)
  - **Internal parameters**
    - General sensitivity study (Friedrich, 2001)
      - *Turbulence parameter* (Gaspar et al., 1990)
      - *Light extinction coefficient* (2D, rx=ry=50km)
      - *Bottom friction coefficient* (uniform)
      - *Lateral viscosity coefficient*
    - Non correlated error sources: $\Psi = \Psi 0 + d\Psi$, $d\Psi \sim N(0, \sigma^2)$

- **Ensemble forecast characterization (summer)**
  - **Statistic consistency**

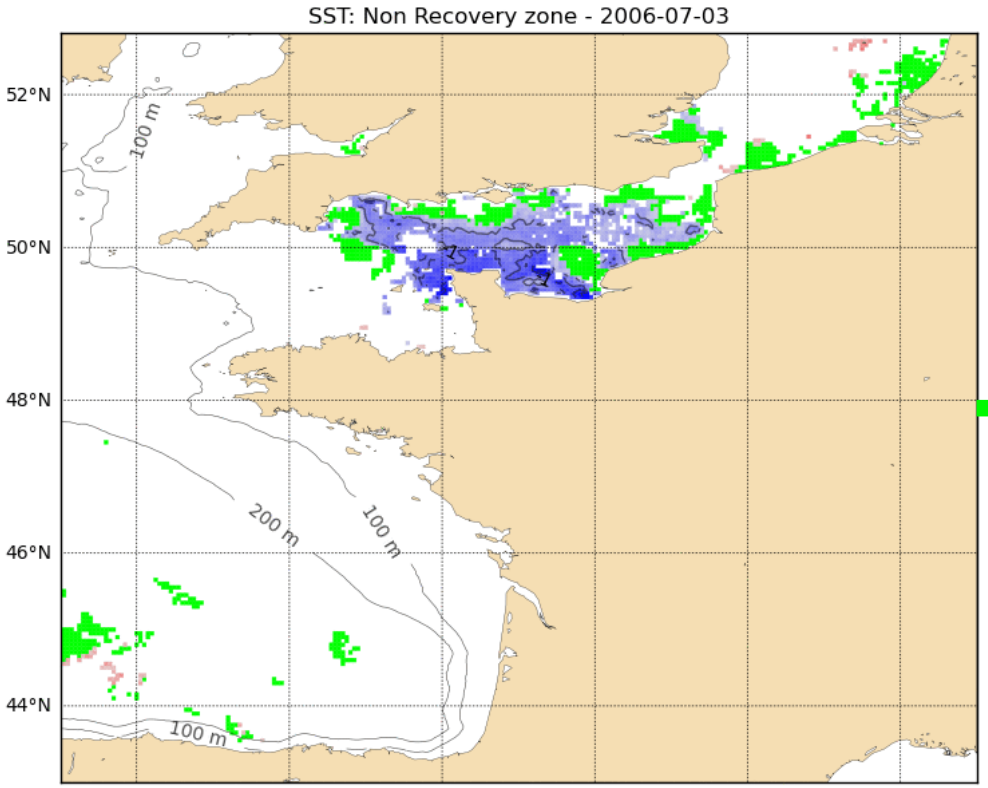
    - Ensemble SST variance generation in max-error areas (Basque, West Manche Channel, shelf break …) → Ensemble adequate to represent forecast model error

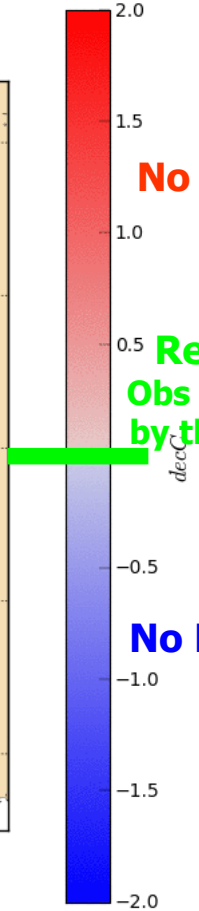
    - Lack of pertinent error sources remain in some areas (North Brittany coastline)

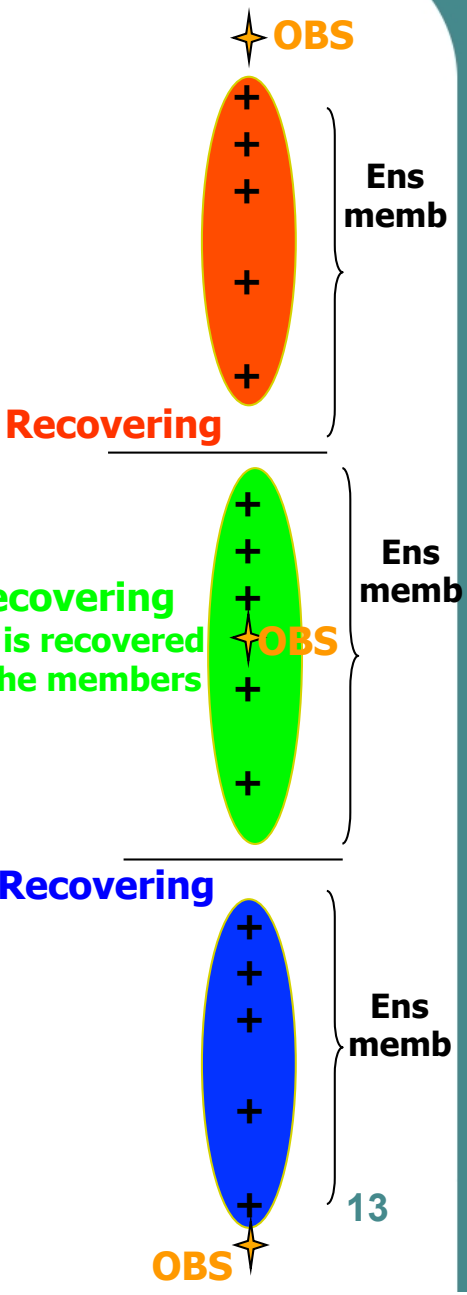


Forecast Error Characterization

- **Ensemble forecast characterization**
  - **Recovering**

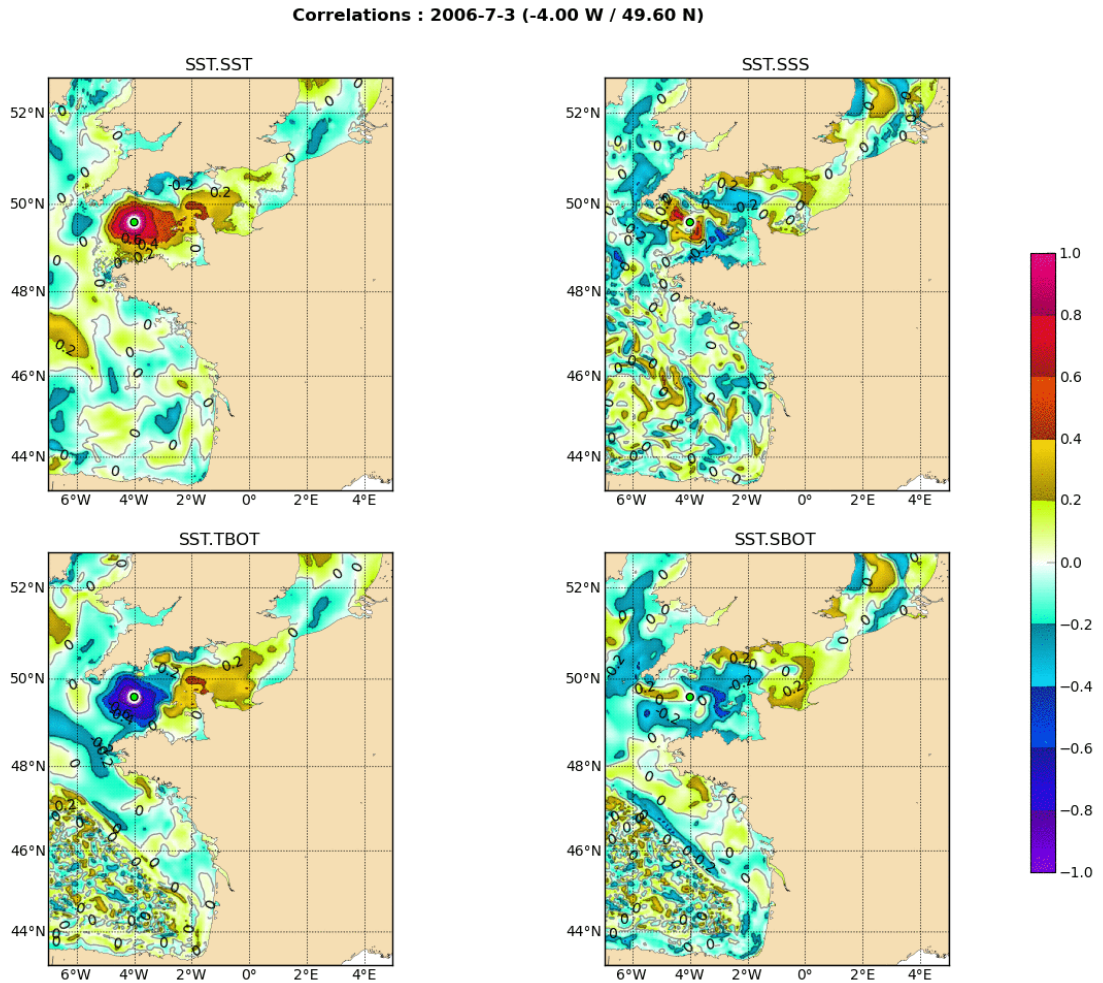






Forecast Error Characterization

- **Ensemble forecast characterization**
  - **Correlations**
    - Non stationary
    - Scales
    - Localization



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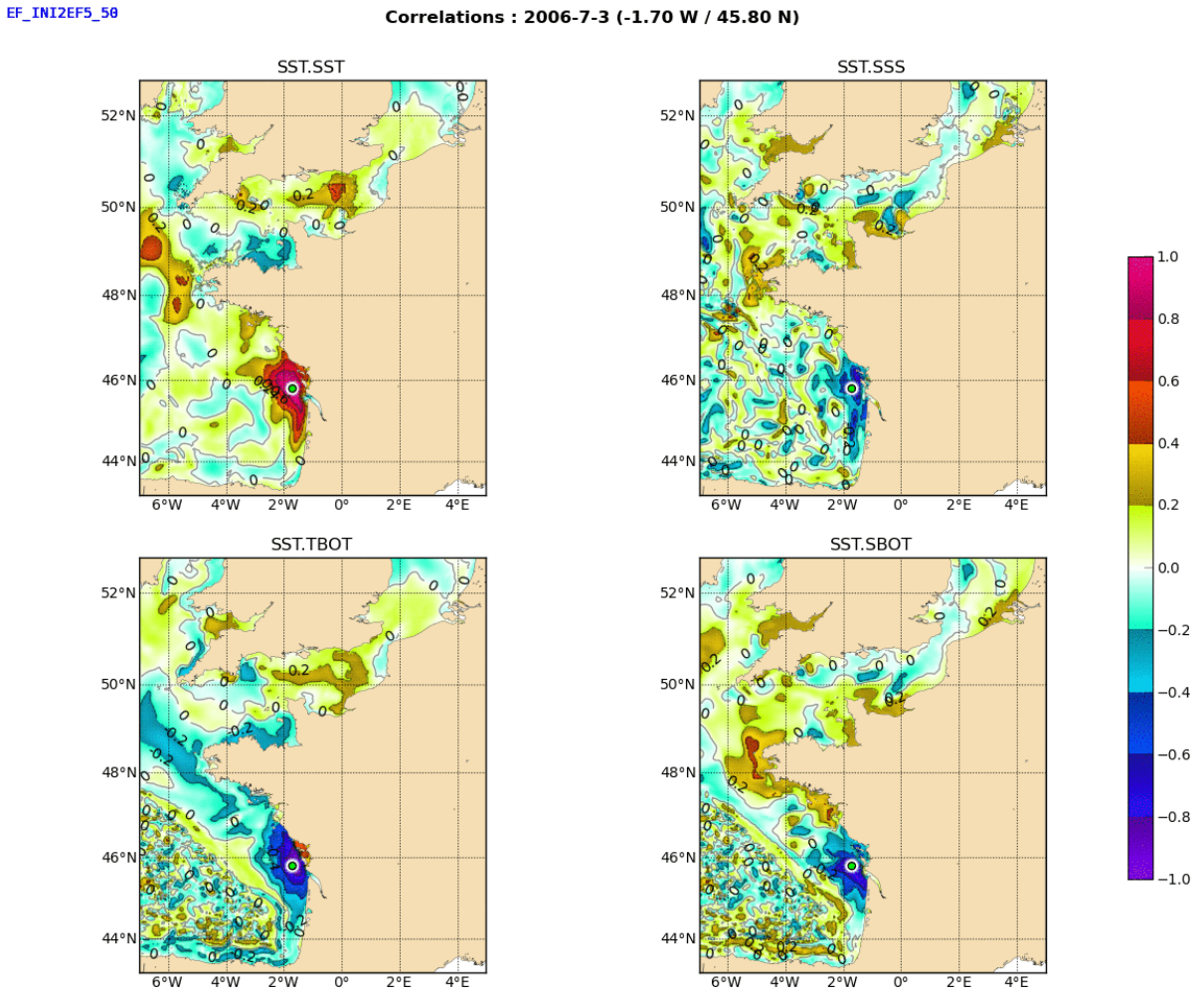
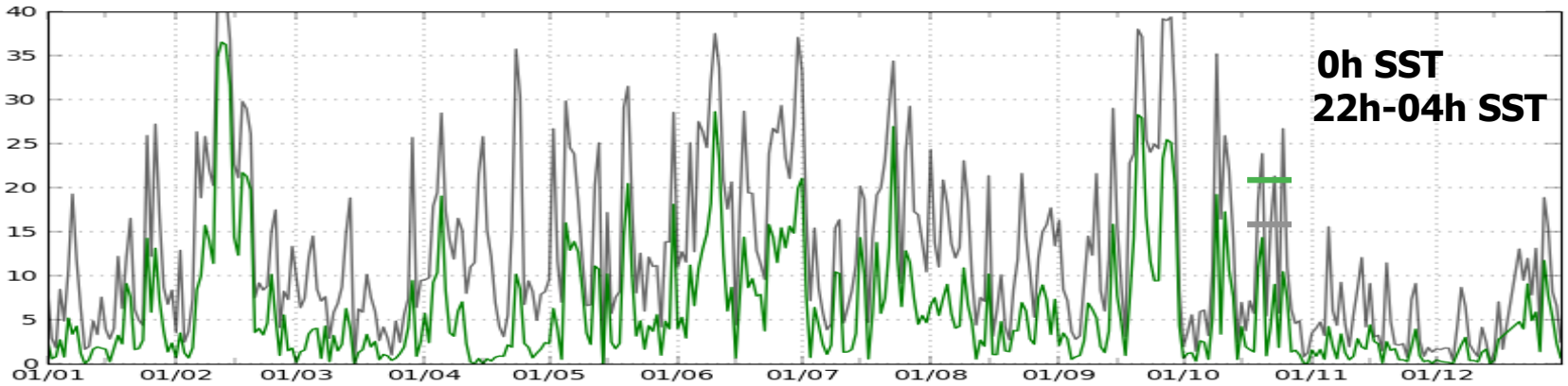


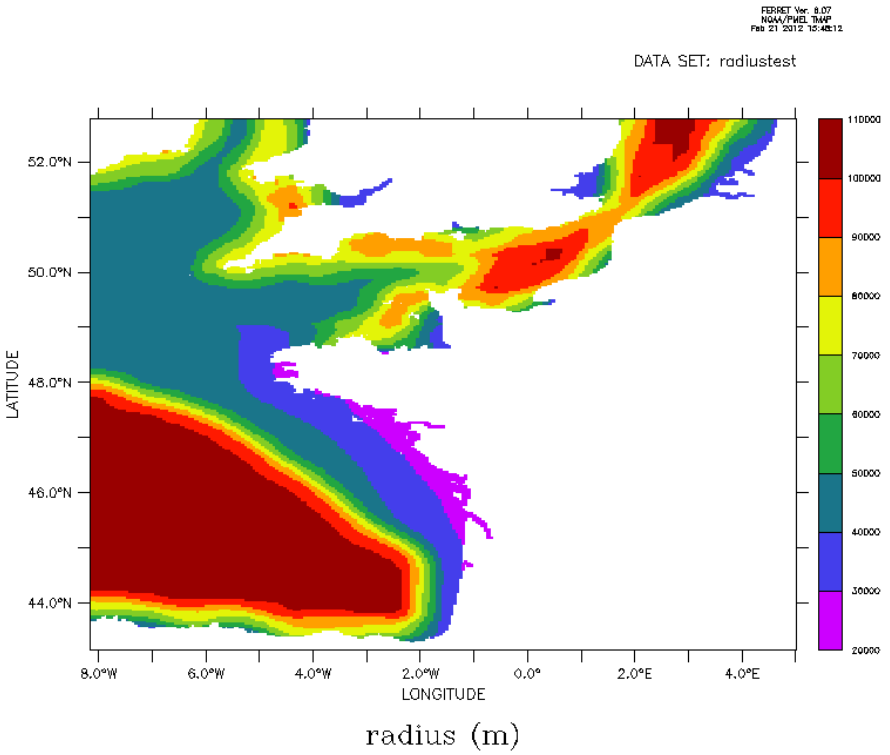
- **Data assimilation framework**
  - **Model errors : 50 members**
  - **Observation errors : SEVIRI SST**
    - Instrumental error: 0.5 °C
    - Observation age error (SST 0h, SST night)



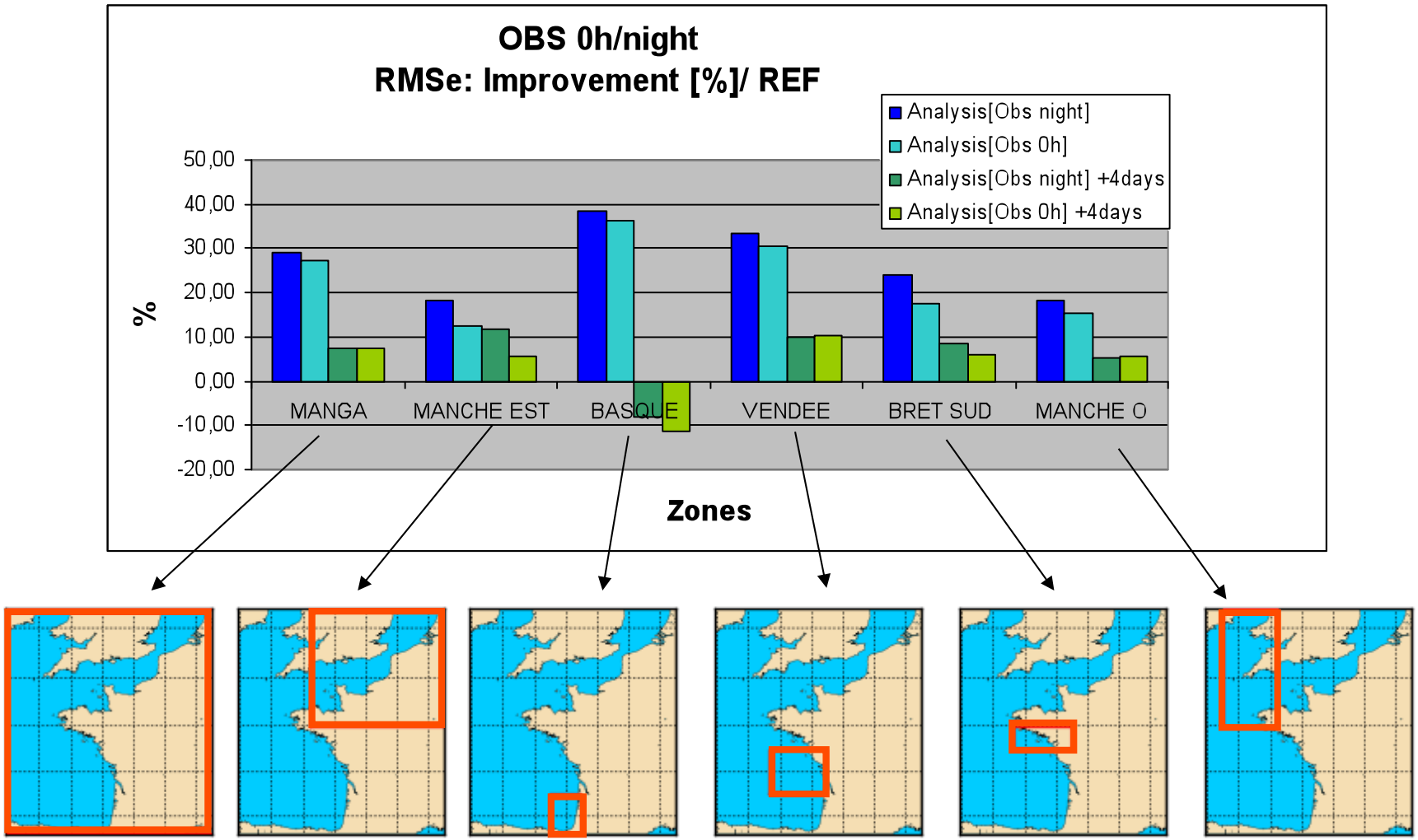
SST Seviri data availability[%] – Year 2008 – MANGA Area

SST Data Assimilation

- **Data assimilation framework**
  - **Model errors : 50 members**
  - **Observation errors : SEVIRI SST**
    - Instrumental error: 0.5 °C
    - Observation age error (SST 0h, SST night)
  - **Localization: 2D**
  - **Cycles: Analysis every 4 days**
  - **Summer 2006: July – Aug 06**



- **Data assimilation Experiment: Results over 6 cycles**

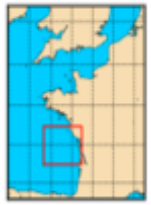


SST Data Assimilation

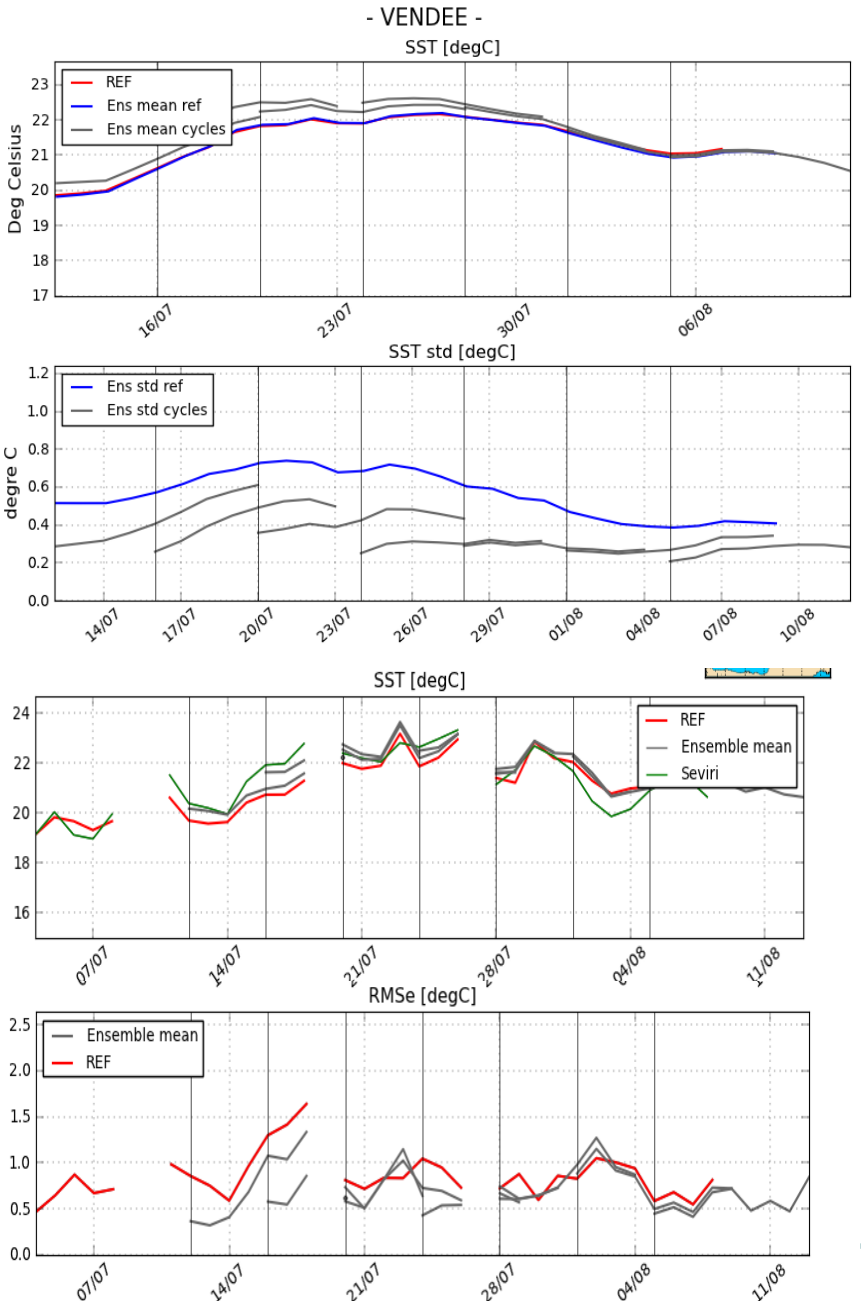
- **Data assimilation Experiment:**

  Results Vendee area

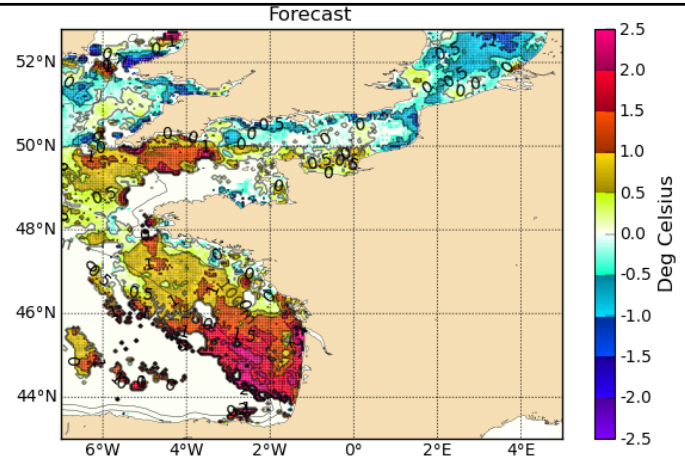
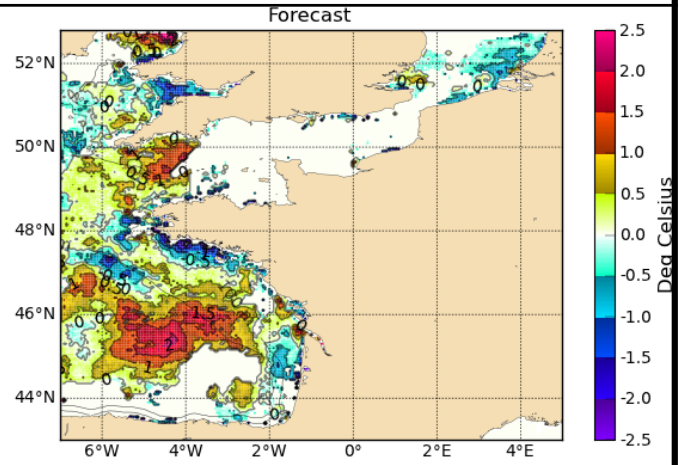
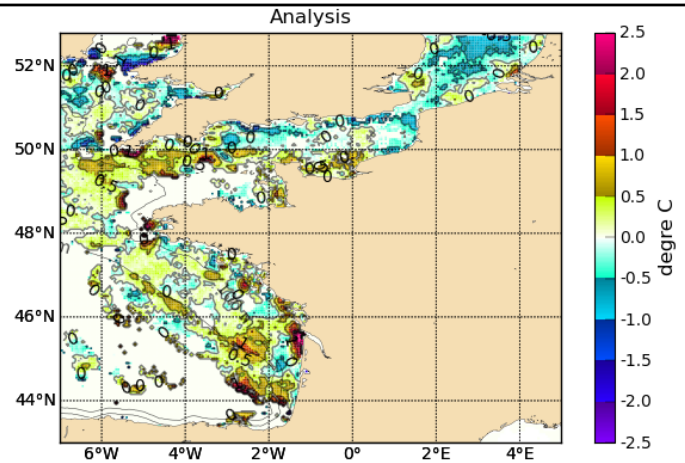
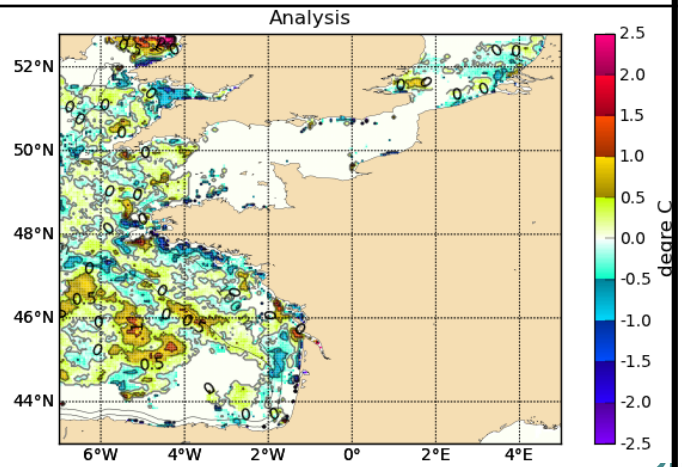
  - **SST ensemble behavior**
    - Ensemble mean / variance



  - **With respect to SST Seviri**
    - RMSe

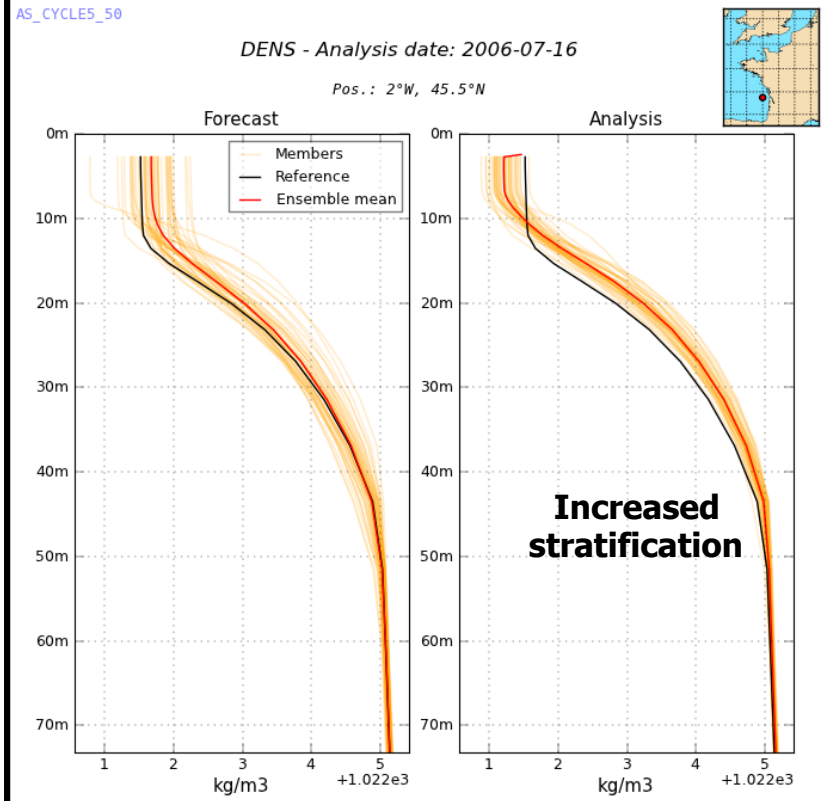
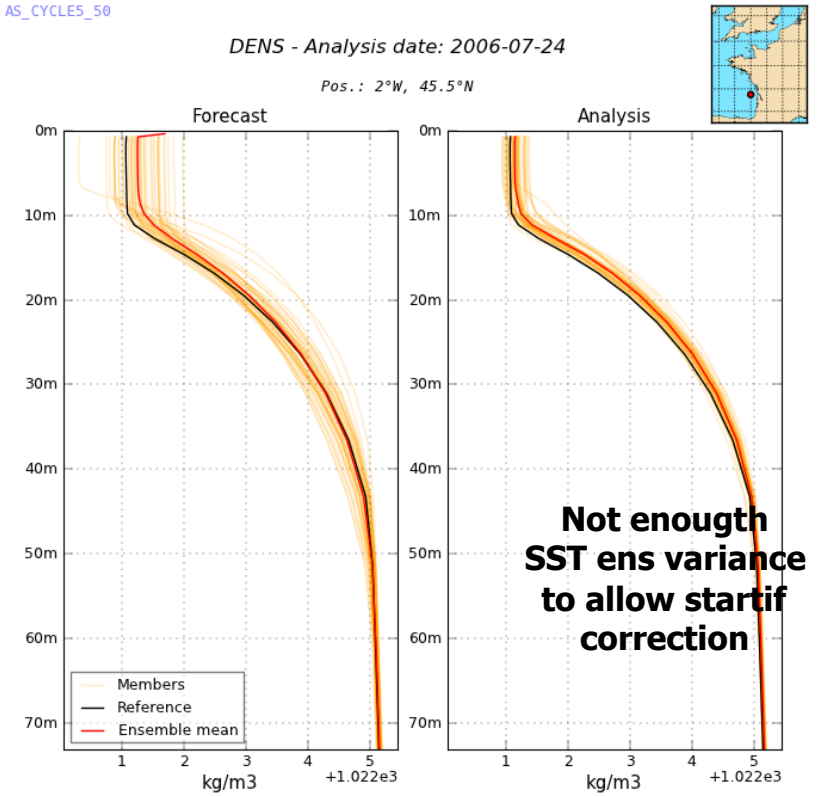


- **Data assimilation Experiment: Results → Innovation [degC]**

	2006/07/16	2006/07/24
forecast		
analysis		

SST Data Assimilation

- **Data assimilation Experiment: Impact on the stratification**

2006/07/16	2006/07/24
	

SST Data Assimilation

- **Data assimilation Experiment: Impact on the stratification**

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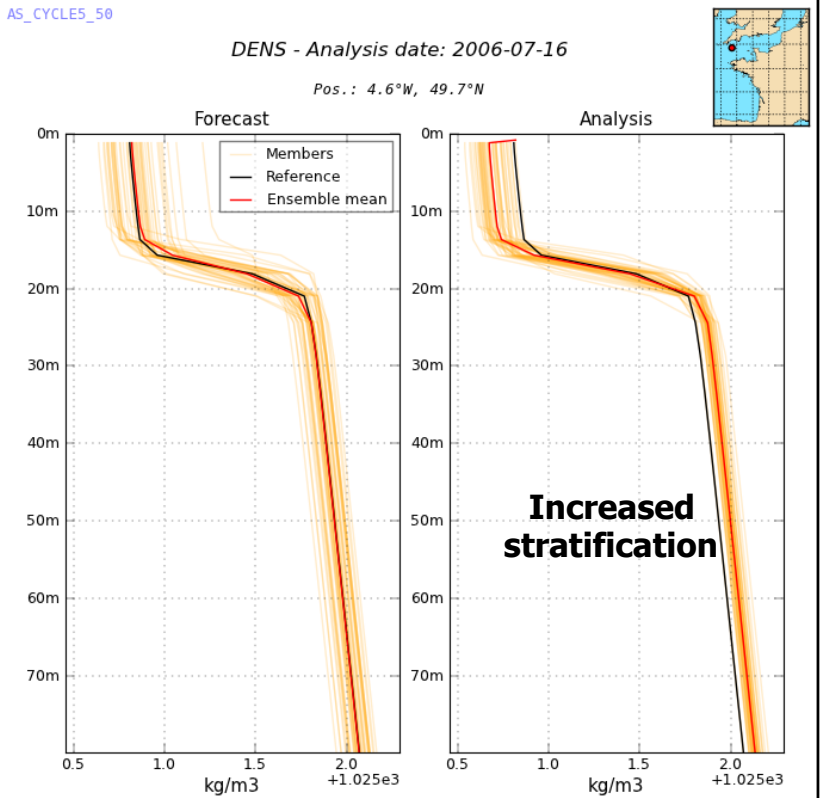
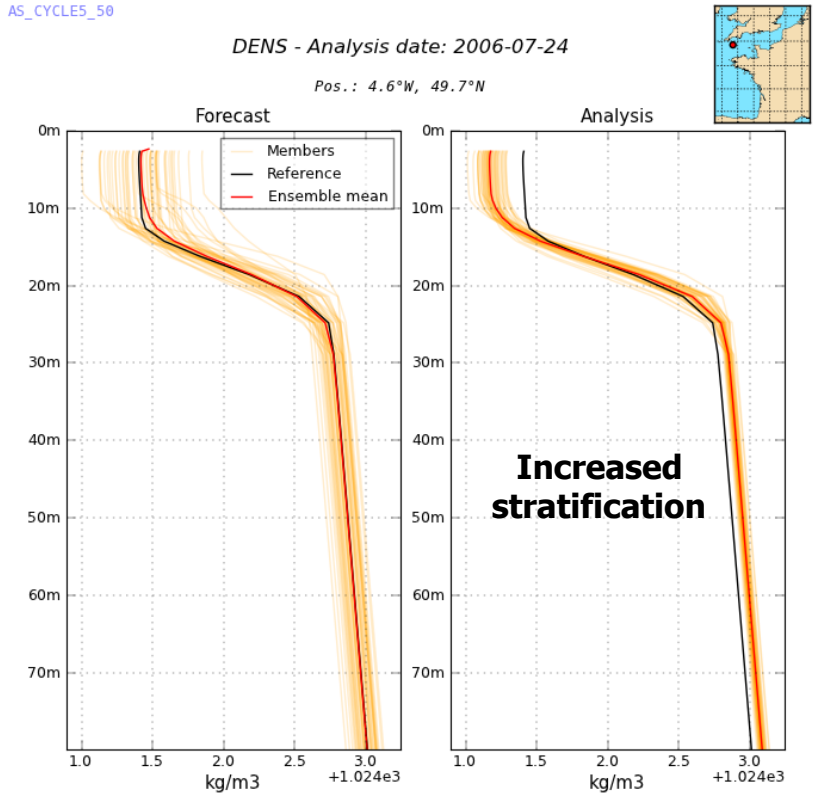
	

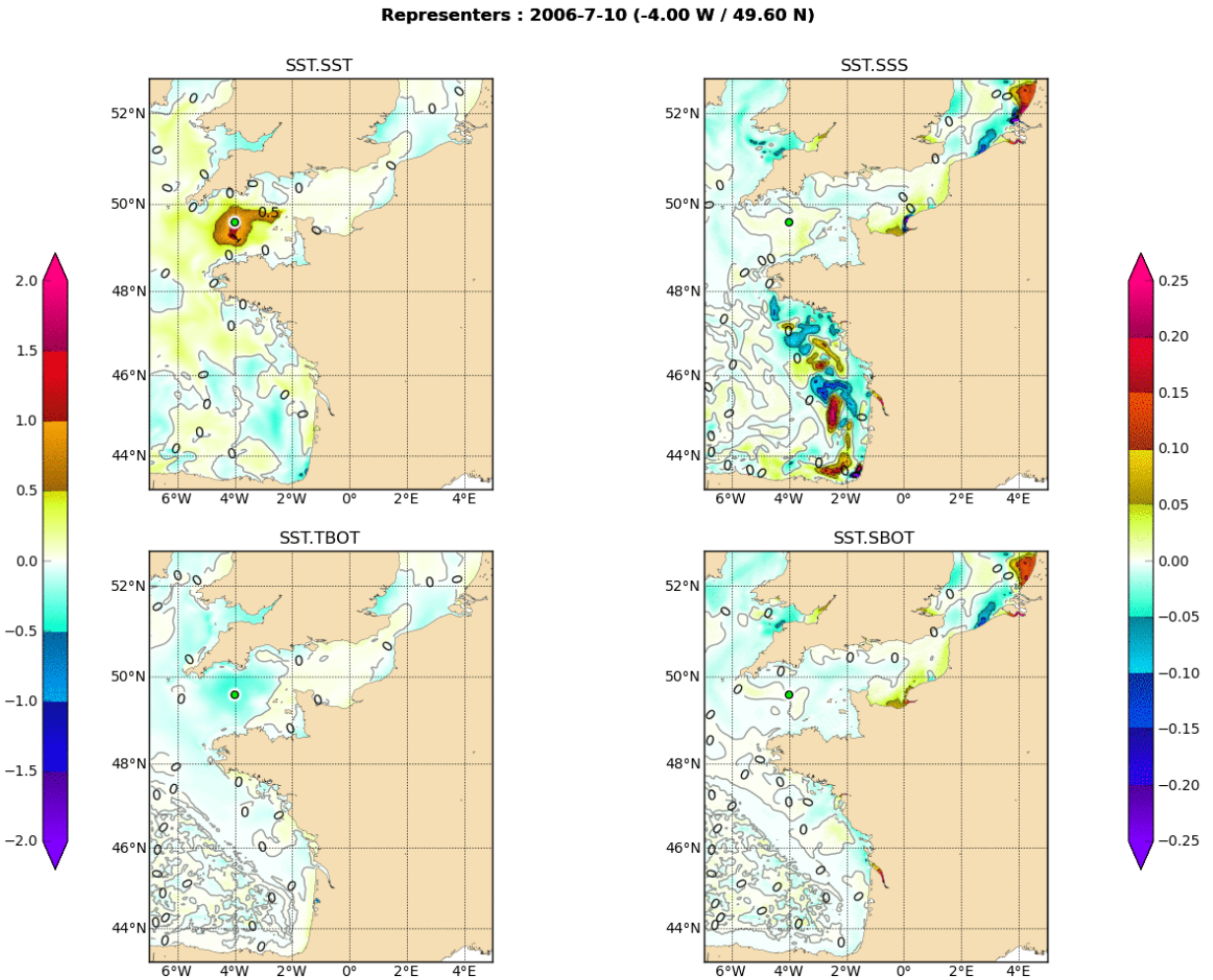
CONCLUSIONS

- **Forecast Ensemble**
  - Able to represent model forecast error (statistic consistency) in summer
  - Still missing some error sources (north Brittany)
- **Ens. characterization leads to EnKF filter tuning**
  - Correlation → 2D-localization,…
- **Observation**
  - Maximizing of their availability using the nocturnal data and associated observation age error
- **Assimilation**
  - Improvement of SST
  - Better ocean stratification
  - Benefit of assimilation remains after 4 days but significantly decreased
- **Perspectives**
  - Algorithms : asynchronous EnKF, IAU
  - Other datasets : in-situ profiles, SST+currents from HF radars (Iroise Sea)

- **Ensemble forecast characterization**
  - **Representers**

Intensification of the thermal stratification

covariance's localization



Forecast Error Characterization

- **Ensemble forecast characterization**
  - **Representers**

Intensification of the thermal stratification

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