The ODYSSEA global sea surface temperature analysis

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Mersea context

SST remote-sensing group

To develop a global analysis and regional fine scale analyses for modellers and downstream services

Collaborative approach :

- several partners : CMS, Ifremer, MetNo, DMI, CNR, NOCS, CLS, UKMet
- field of expertise : sensor intercalibration and merging, specific areas, high latitudes, optimal interpolation,…

=> **Ifremer/ODYSSEA** (**O**cean **D**ata Anal**y**sis **S**ystem for Mer**sea**) chain for global scale analysis

Properties

- *Area : 180W/180E, 80S/80N*
- *Resolution : 0.1 degree*
- *Frequency : daily, centered at 00:00 UTC*
- *Availability : 24 hours delay*
- *Input data : merged SST satellite measurements from both IR and MW sensors*

Input data

Original resol.	Satellite/sensor	product	Provider
1 km	AATSR	EUR-ATS_NR_2P	MEDSPIRATION/IFREMER ftp://ftp.ifremer.fr/ifremer/medspiration/data
2 km	AVHRR	EUR-L2P-NAR17_SST EUR-L2P-NAR18_SST	MEDSPIRATION/IFREMER ftp://ftp.ifremer.fr/ifremer/medspiration/data
2 km	AVHRR	NAVO-L2P-AVHRR17_L NAVO-L2P-AVHRR18_L	GDAC/NASA ftp://podaac.jpl.nasa.gov/pub/GHRSST/data
3 km	GOES/VISSR	OSDPD-L2P-GOES11 OSDPD-L2P-GOES12	NOAA/NESDIS ftp://gp16.ssd.nesdis.noaa.gov/pub/goessst/L2P
9 km	MSG-1/SEVIRI	EUR-L2P-SEVIRI_SST	MEDSPIRATION/IFREMER ftp://ftp.ifremer.fr/ifremer/medspiration/data
10 km	AVHRR	NAVO-L2P-AVHRR17_G NAVO-L2P-AVHRR18_G	GDAC/NASA ftp://podaac.jpl.nasa.gov/pub/GHRSST/data
25 km	AMSRE	USA-RSS-AMSRE-MW-L2-SST	MISST/RSS ftp://ftp.misst.org/amsre/swath/nc
25 km	TMI	REMSS-L2P-TMI	MISST/RSS ftp://ftp.misst.org/amsre/swath/nc

Processing scheme

GHRSST L2P products

⇩ *Observation quality control, correction (sses), filtering*

« re-mapped and filtered products » (0.1 deg. grid)

⇩ *Selection based on proximity to analysis time and best quality*

« composite products » (/day /sensor on 0.1 deg. grid) using data in a time interval ([-3 +3] days around the analysis date).

⇩ *Correction of large scale bias field against AATSR for each sensor*

« **Intercalibrated composite products** »

⇩ *Merging of composite files*

« **multi-sensor composite products** » (/day, 0.1 deg grid, data within [-3 +3] days around the analysis date)

⇩ *Optimal interpolation*

Multi-sensor analysed field

Data selection and correction

- **Data selection**
  - Night time only
  - Quality confidence
  - Satellite zenital angle
  - Aerosols
  - Specific tuning for each product
- **Data correction**
  - Error statistics (SSES)
  - Adjustement of reference sensor (AATSR) to buoys
- **Remapping**
  - Closest neighbour or averaging depending on resolution => superobservations

AATSR SST subskin modelling

- Principle :

Predictors X(i)

L2P informations (SST skin, AOD, Wind speed, proximity confidence, surrounding statistics)

Statistical model →

AATSR SST skin

−

Respond variable Y

SST bias

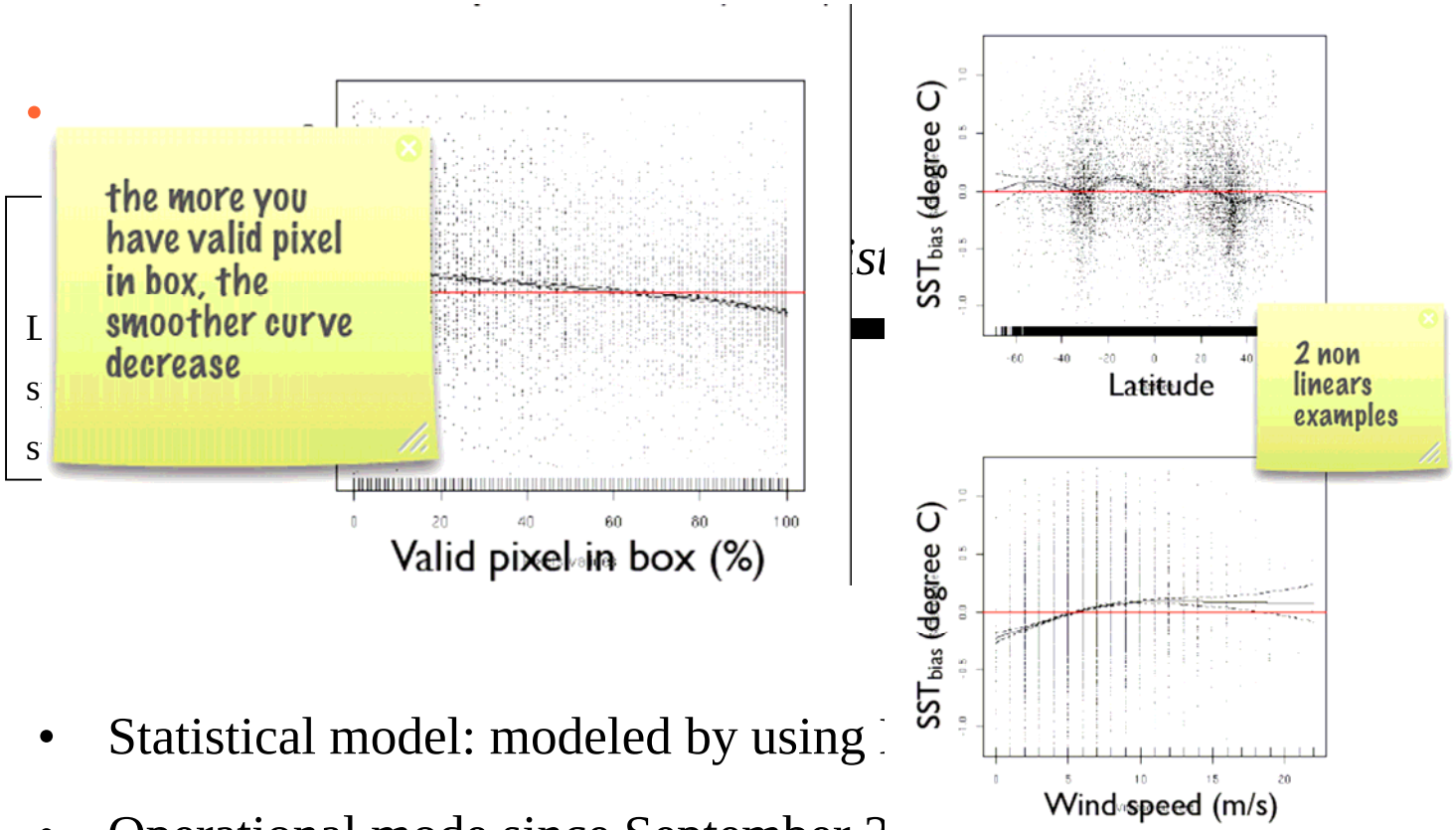
↓

AATSR adjusted SST subskin

- Statistical model: modeled by using Medspiration MDB
- Operational mode since September 2007: linear model ($Y = \alpha^{(0)} + \sum_{i=1}^{p} \alpha^{(i)} X^{(i)}$
  - In test: non linear models:

    regression trees, non parametric models ($Y = \alpha^{(0)} + \sum_{i=1}^{p} f^{(i)}(X^{(i)})$)

AATSR SST subskin modelling



R SST skin

d variable Y

SST bias

SR adjusted

T subskin

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- Operational mode since September 2007: linear model ($+\sum_{i=1}^{p} \alpha^{(i)} X^{(i)}$
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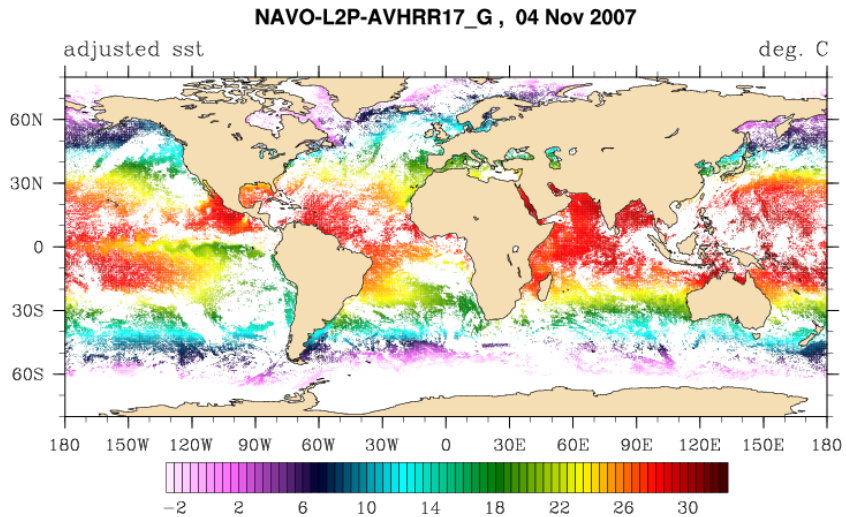
Merging of composite files

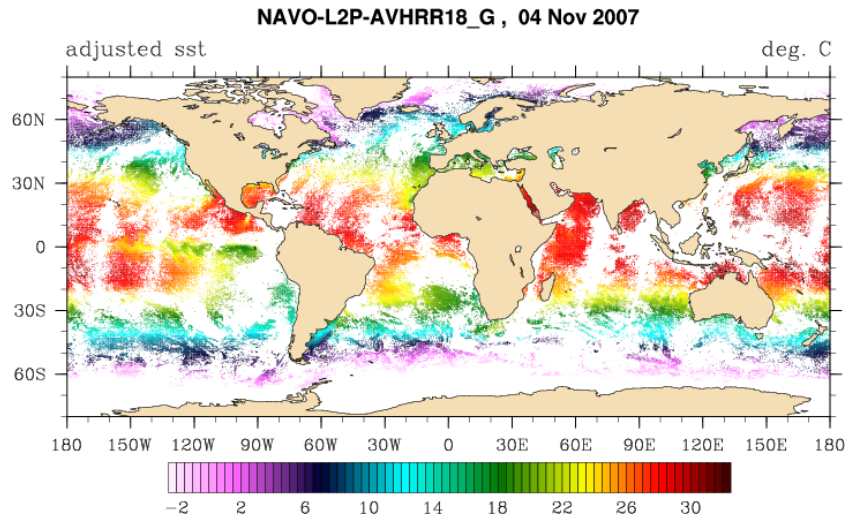
« **multi-sensor composite products** » (/day, 0.1 deg grid, data within [-3 +3] days around the analysis date)

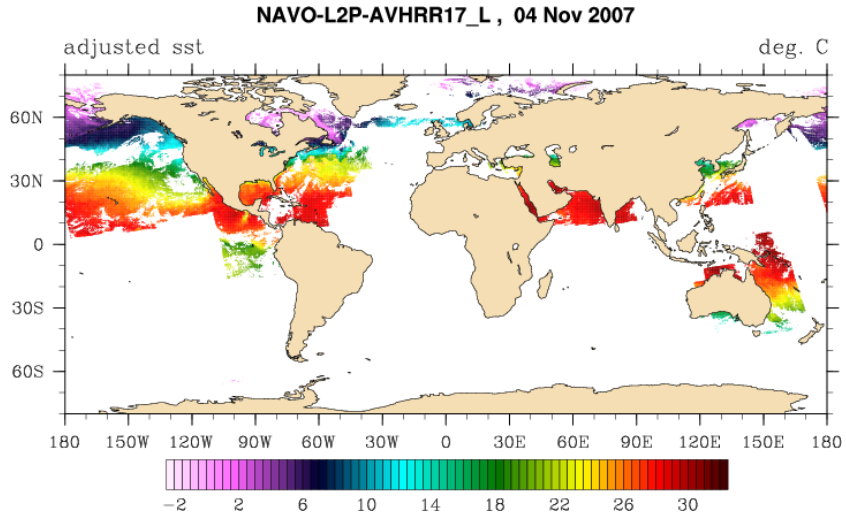
Optimal interpolation

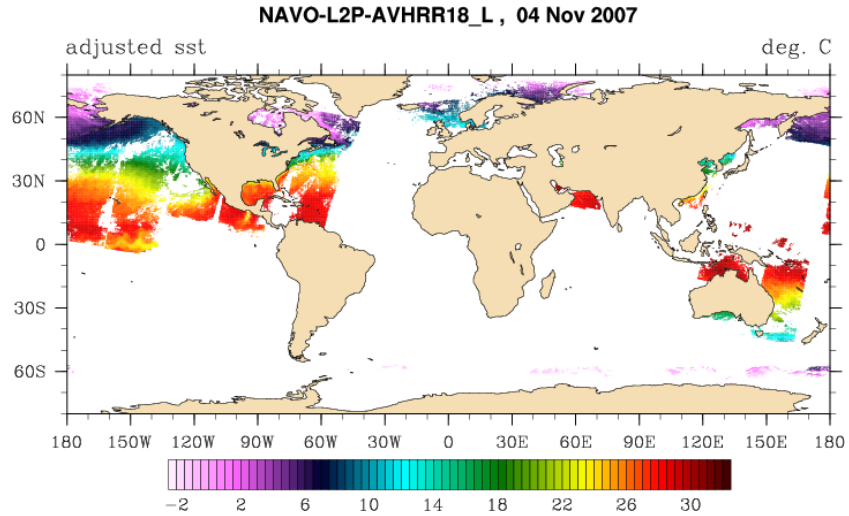
Multi-sensor analysed field

Sampling of composite files (1)

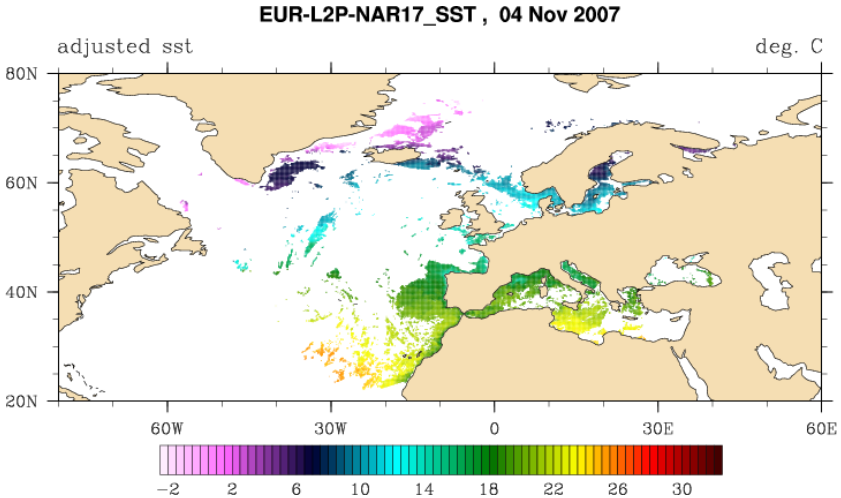


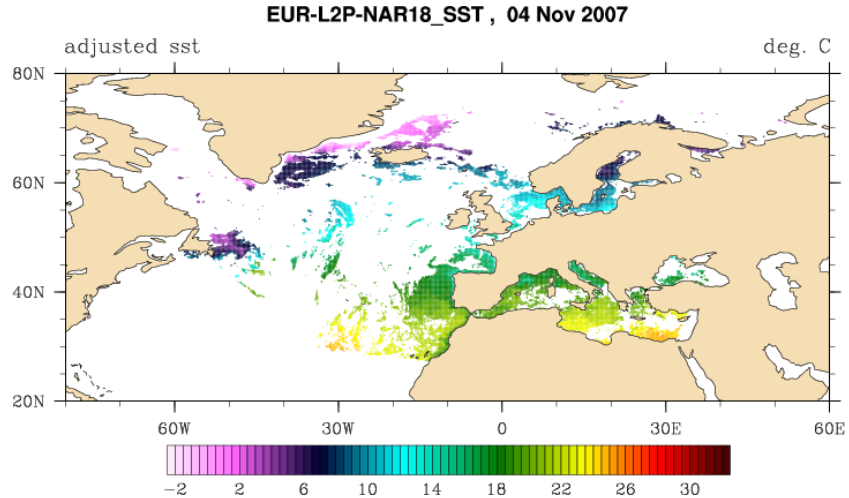


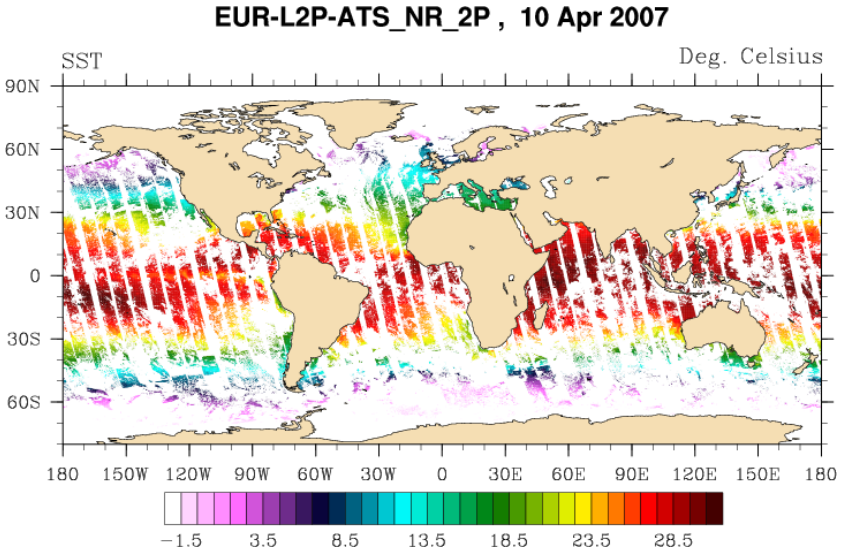


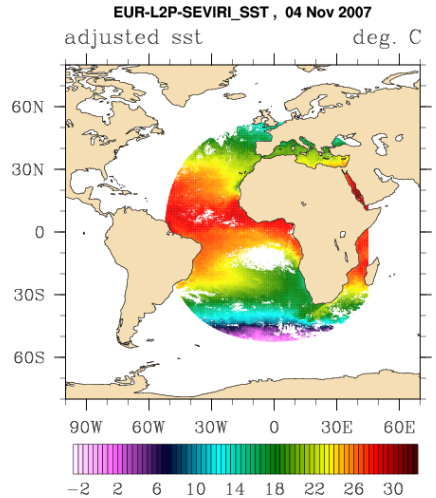


Sampling of composite files (2)

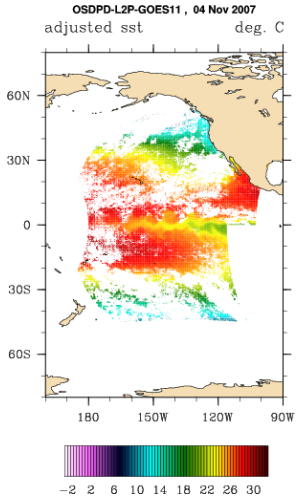


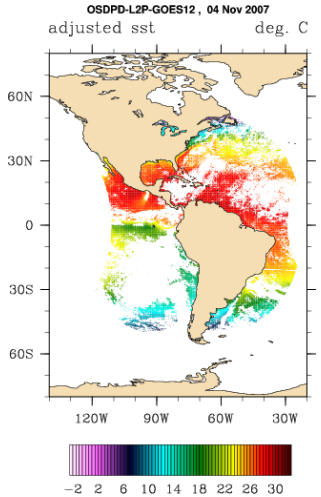


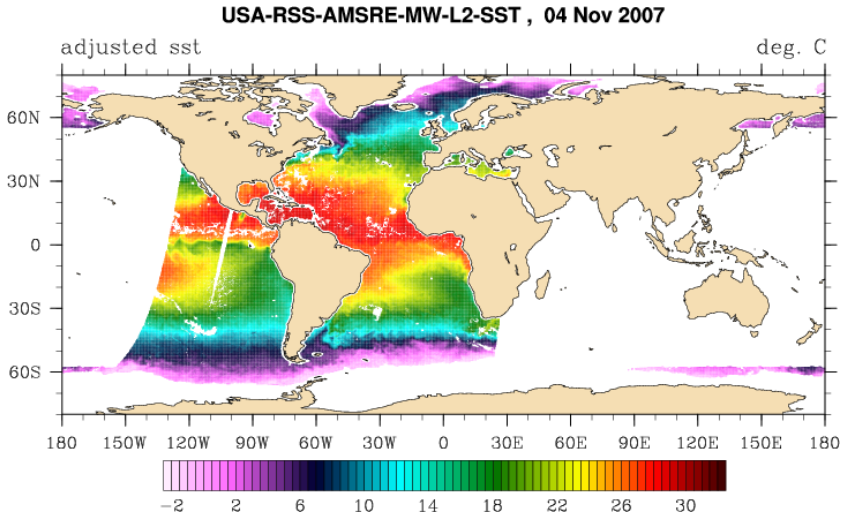


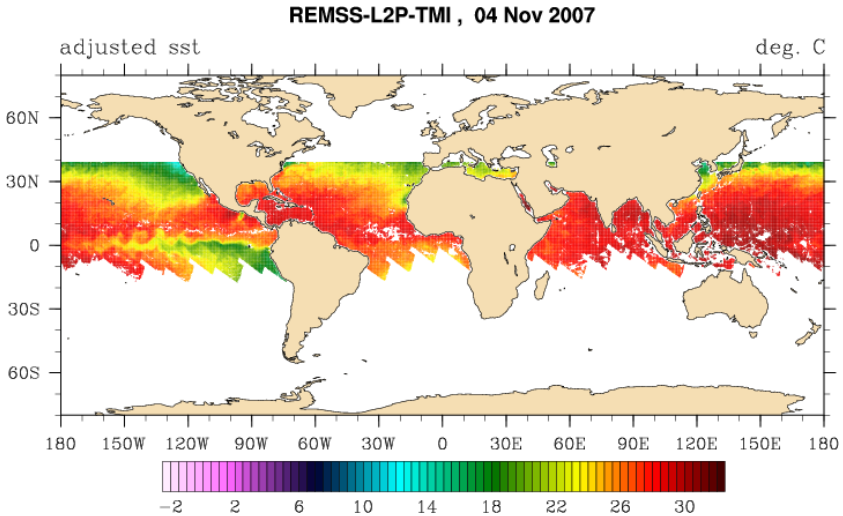


Sampling of composite files (3)









Processing scheme

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Correction of large scale bias field against AATSR for each sensor

« **Intercalibrated composite products** »

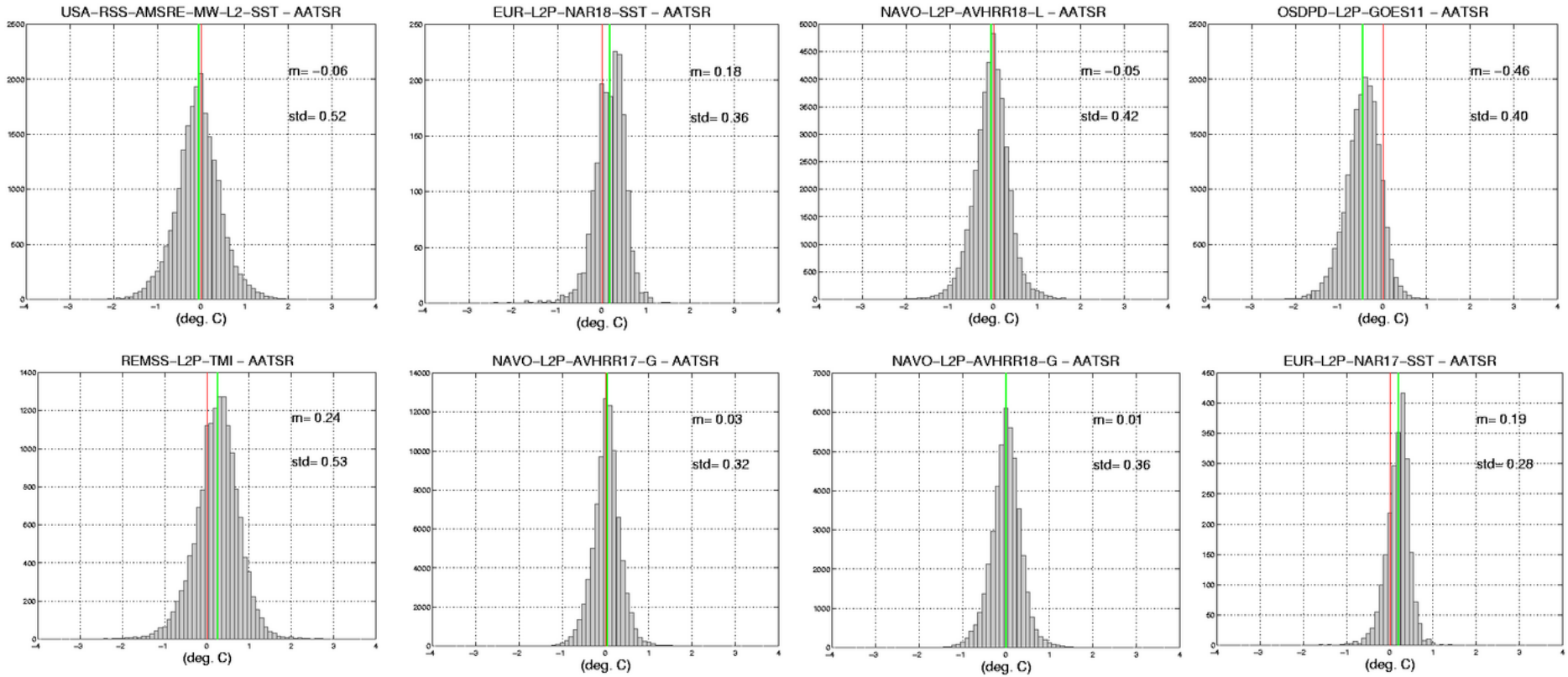
Merging of composite files

« **multi-sensor composite products** » (/day, 0.1 deg grid, data within [-3 +3] days around the analysis date)

Optimal interpolation

Multi-sensor analysed field

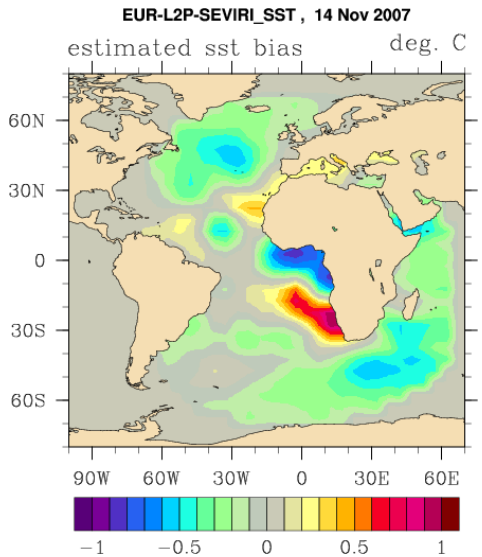
Sensor intercalibration

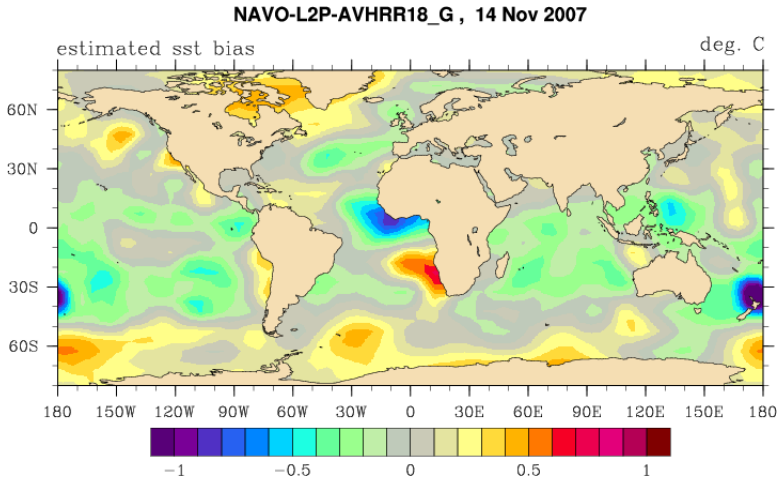


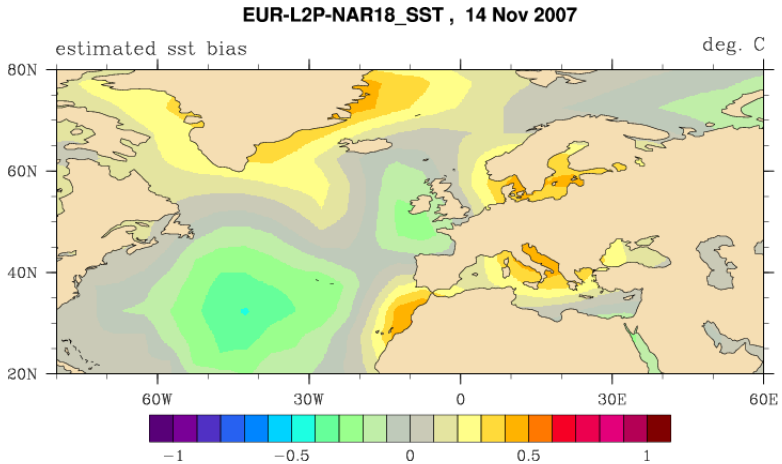
Sensor intercalibration

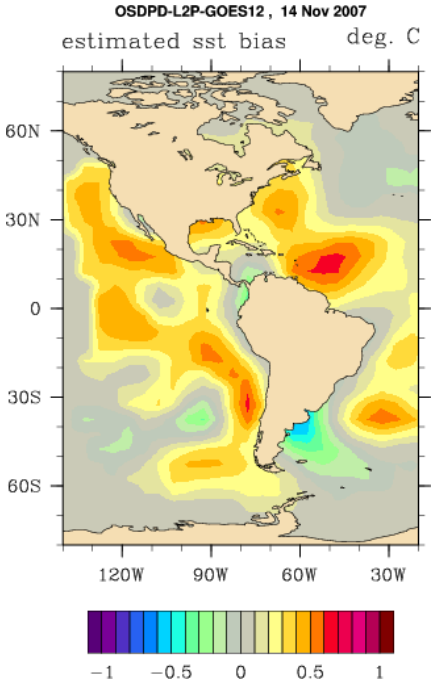
- For each analysis and each sensor, a large scale bias field between the considered sensor and a reference (currently AATSR) is computed.
  - Method: using anomalies between the sensor to be calibrated and the reference over 10 days, large scale biases are estimated by optimal interpolation.
  - Main steps:
    - Computation of reference SST subskin (AATSR)
    - Aggregation of bias information over 10 days
    - Large scale bias estimate (optimal interpolation)
    - Correction of SST (sensor to be calibrated)

Large scale bias correction (sensor intercalibration)









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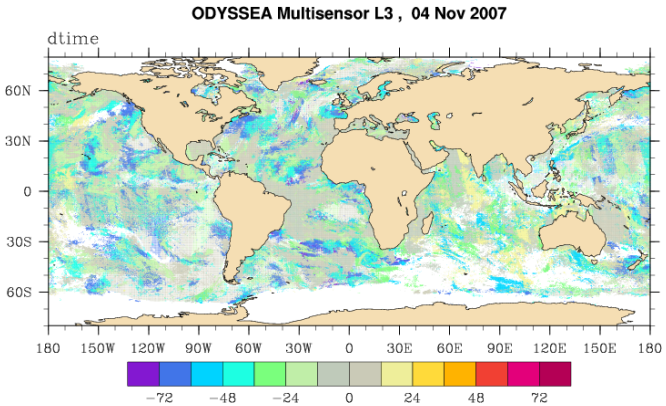
« **multi-sensor composite products** » (/day, 0.1 deg grid, data within [-3 +3] days around the analysis date)

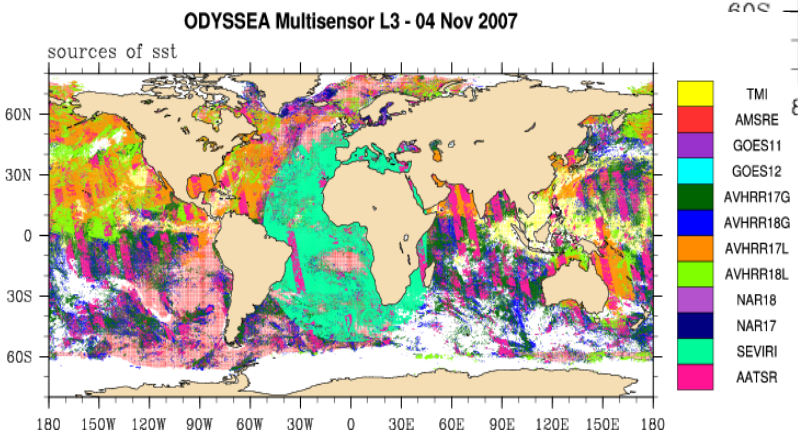
Optimal interpolation

Multi-sensor analysed field

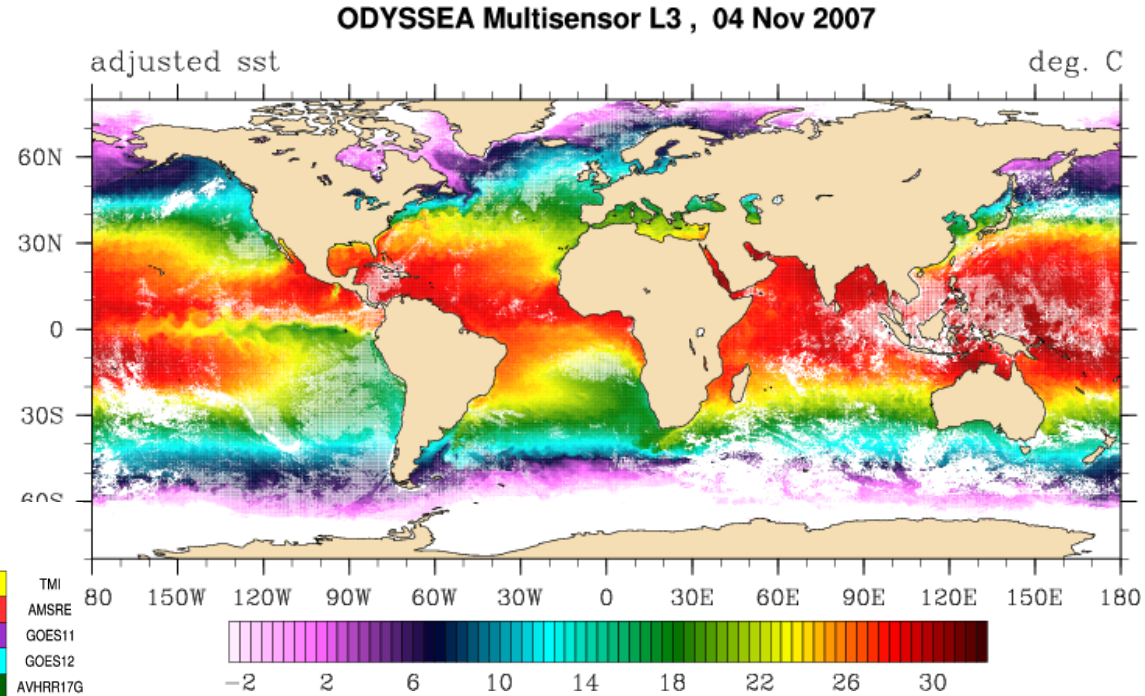
http://www.mersea.eu.org/Satellite/sst_validation.html



Proximity to analysis time



Source of data



This merged intercalibrated multi-sensor product is also distributed on ftp.

Prefered to analysis field by some modellers (Mercator)

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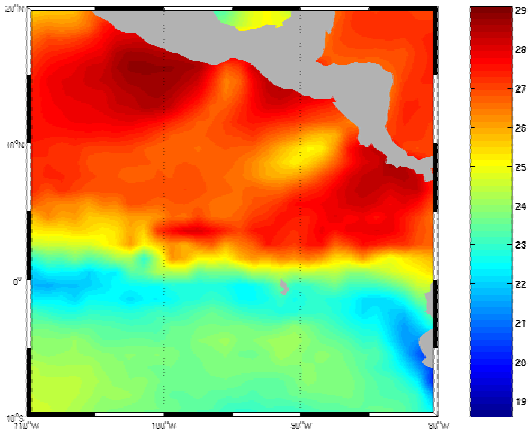
Optimal interpolation

Multi-sensor analysed field

Optimal interpolation

Based on Bretherton [1976]

Background: « daily climatology » (Pathfinder V5 5day climatology filled and averaged on a 1°x1° grid and interpolated in time)

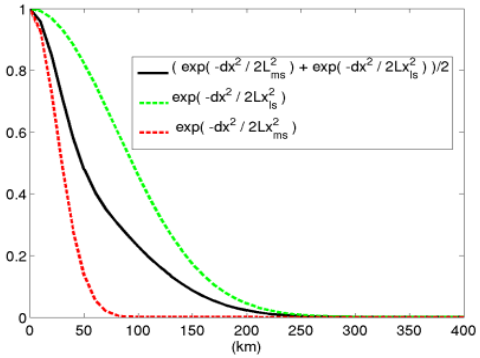


- **Structure function** modeled by the sum of gaussian functions (different scales) with relative weights

$$C(dx, dy, dt) = \sum_{i=1}^{2} \sigma_i^2 \exp -\left(\frac{dx^2}{2L_x^2} + \frac{dy^2}{2L_y^2} + \frac{dt^2}{2L_T^2}\right),$$

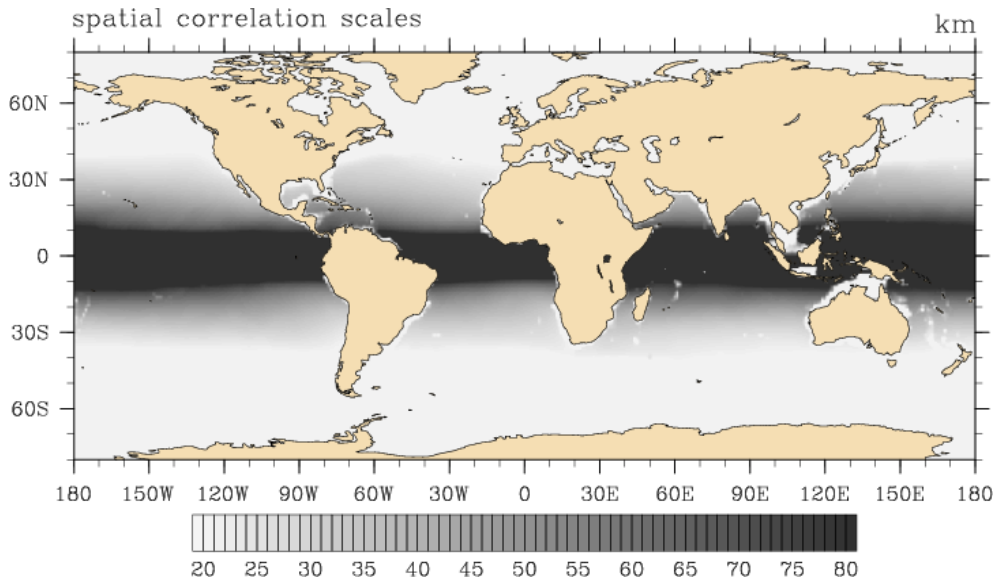
where dx, dy, dt are the space and time separation, L_{ix}, L_{iy}, L_{iT} the corresponding e-folding scales and σ_i^2 the variance.

The first term in the sum corresponds to the large scale field (LS), the second to the meso-scale (MS).



Optimal interpolation

Correlation scales:
in X and Y:~ Rossby radius (bounded by 20 km and by the large scale, here 80 km), isotropic.
In time: Lls=1 day, Lms=2 days

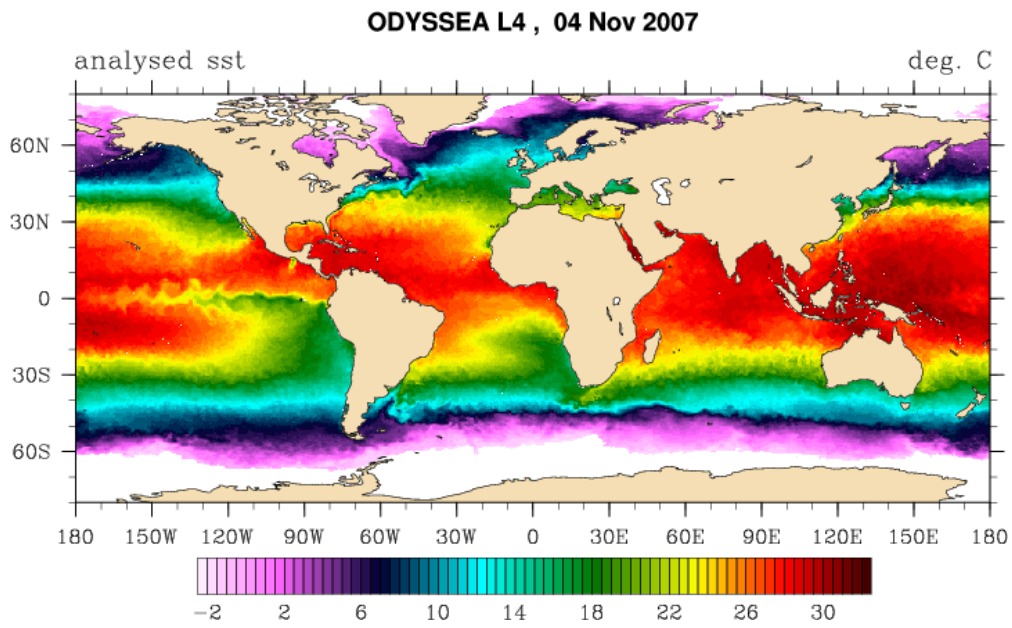


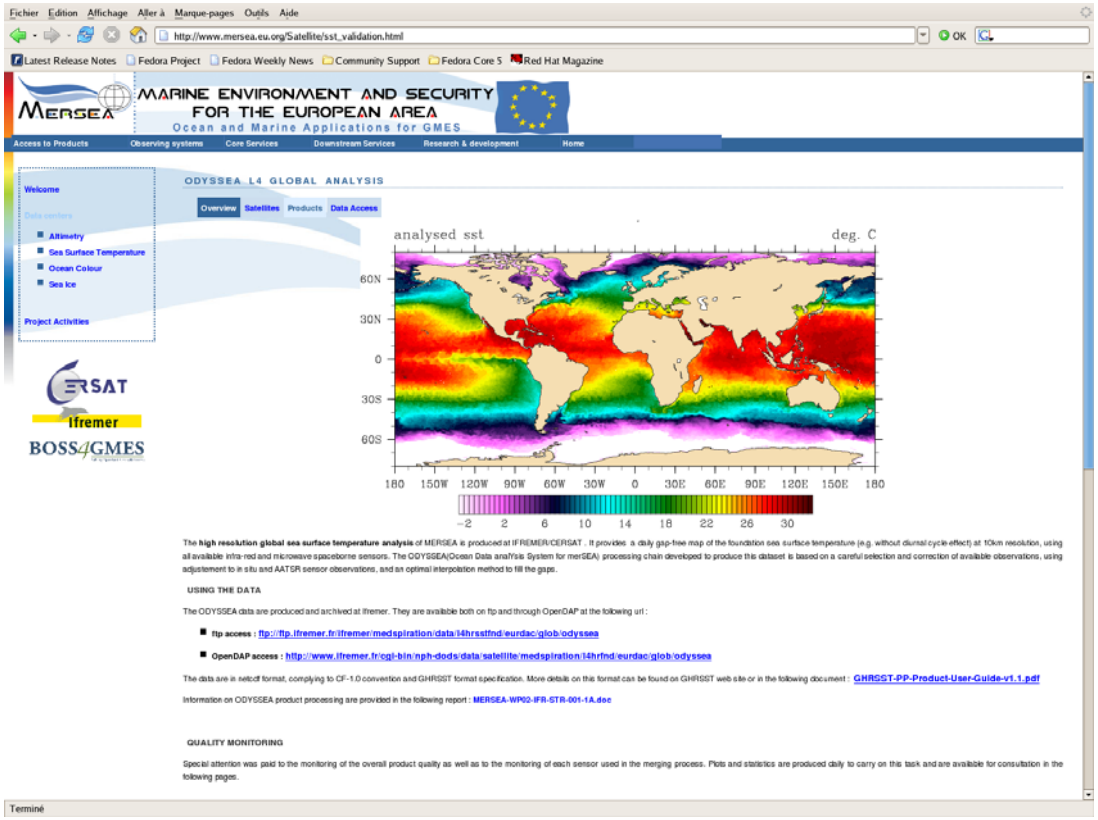
A priori variances set to a constant value: 3°C (to be estimated):

$$\sigma^2 = \sigma^2_{LS} + \sigma^2_{MS} + \sigma^2_{UR} + \sigma^2_{ME}.$$

with σ^2 the full variance of the anomaly relative to the climatology, the sum $\sigma^2_{LS} + \sigma^2_{MS}$ the variance of the signal we wish to represent and the sum $\sigma^2_{UR} + \sigma^2_{ME}$ the variance of the errors. The error is expressed as the sum of two terms: σ^2_{ME} corresponding to the measurement errors and σ^2_{UR} representing small scales unresolved by the analysis and considered as noise, and which are sometimes called representativity errors.

Analysed field





Monitoring tools

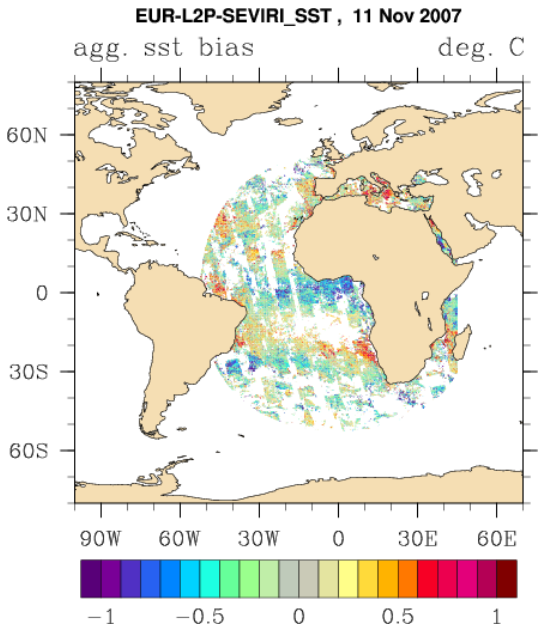
A validation page has been set-up on Mersea web site

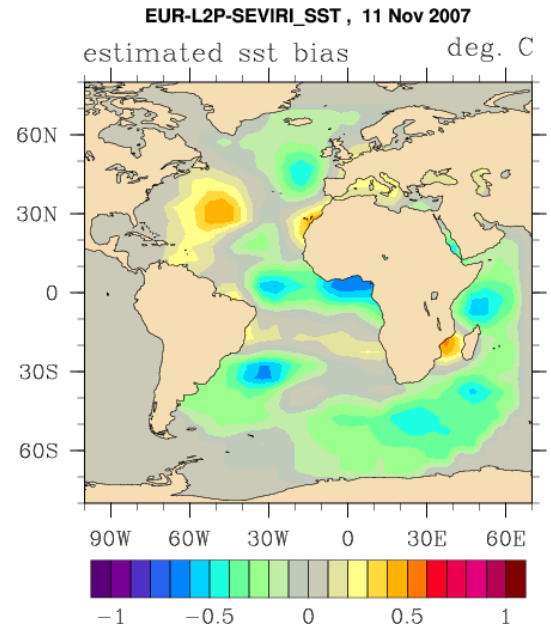
Provides daily monitoring of the data quality of each sensor, long-term statistics, regional zooms, etc…

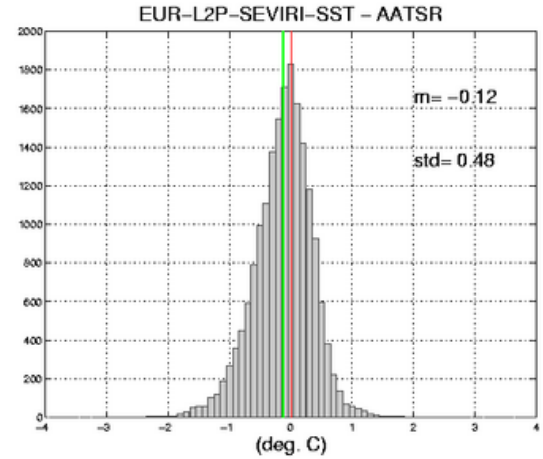
http://www.mersea.eu.org/Satellite/sst_validation.html

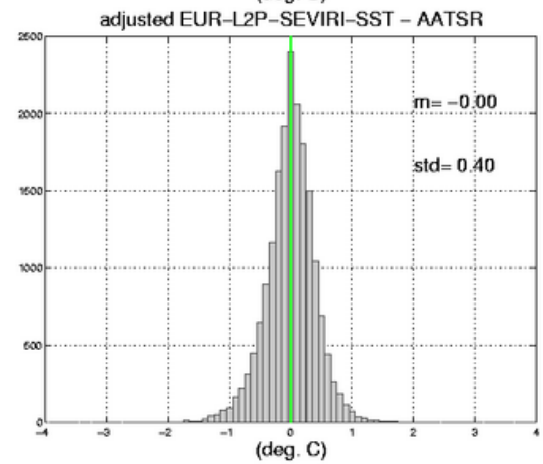
Monitoring tools (some examples)

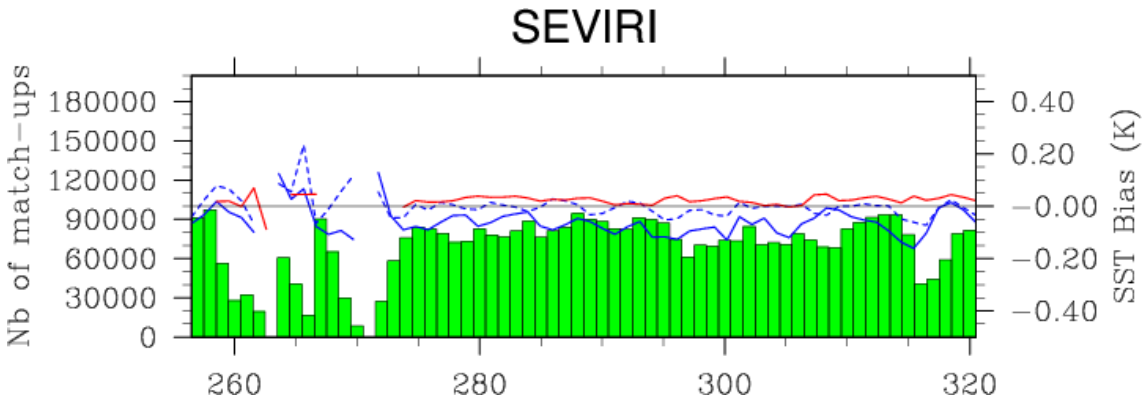
- Sensor intercalibration monitoring









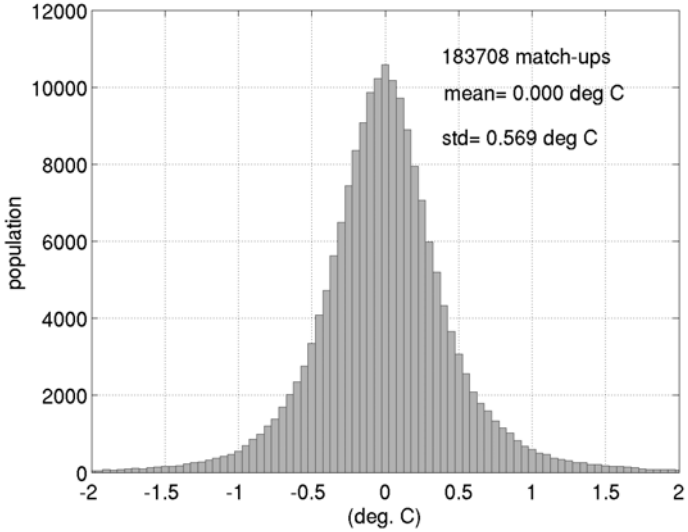


Monitoring tools (some examples)

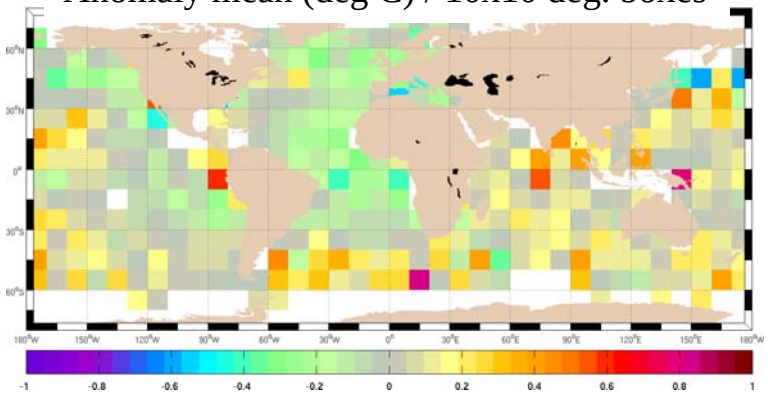
- Monthly comparison between ODYSSEA L4 and in-situ observations (*SST*)

October 2007

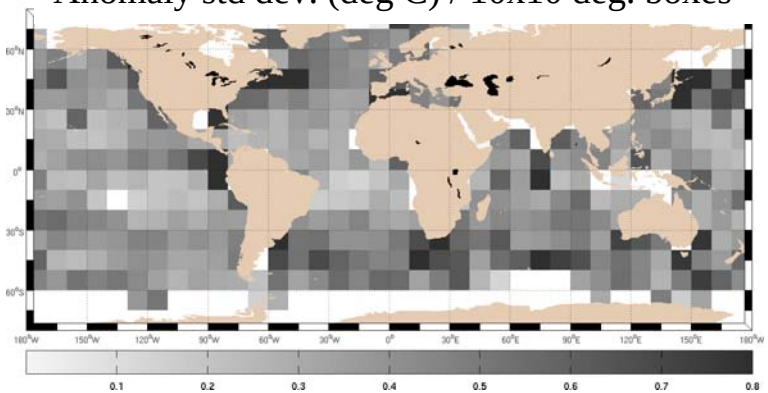
Anomaly distribution



Anomaly mean (deg C) / 10x10 deg. boxes

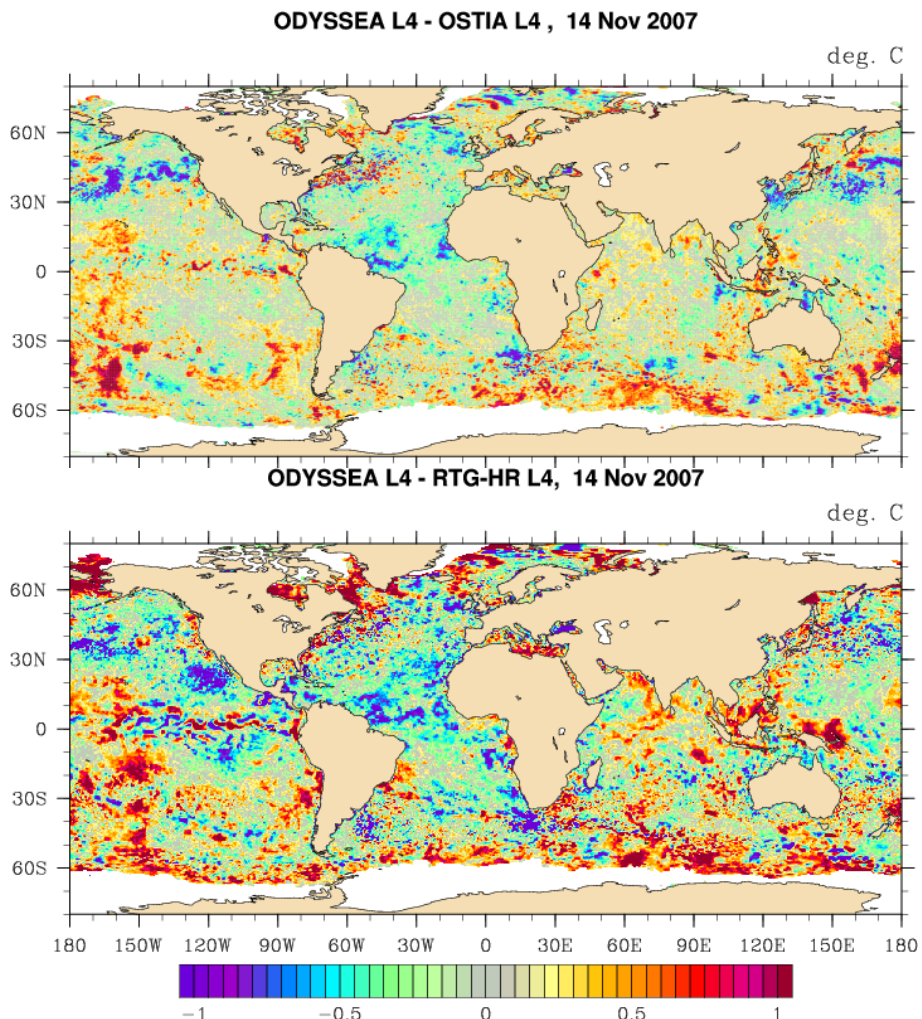


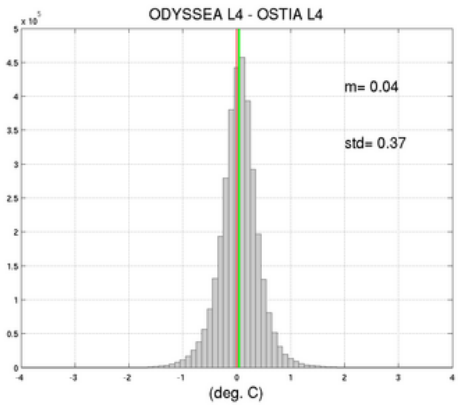
Anomaly std dev. (deg C) / 10x10 deg. boxes

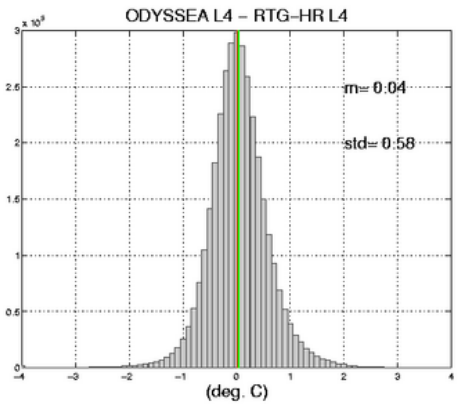


Monitoring tools (some examples)

- Comparisons between ODYSSEA L4 and other L4 products (*SST*)

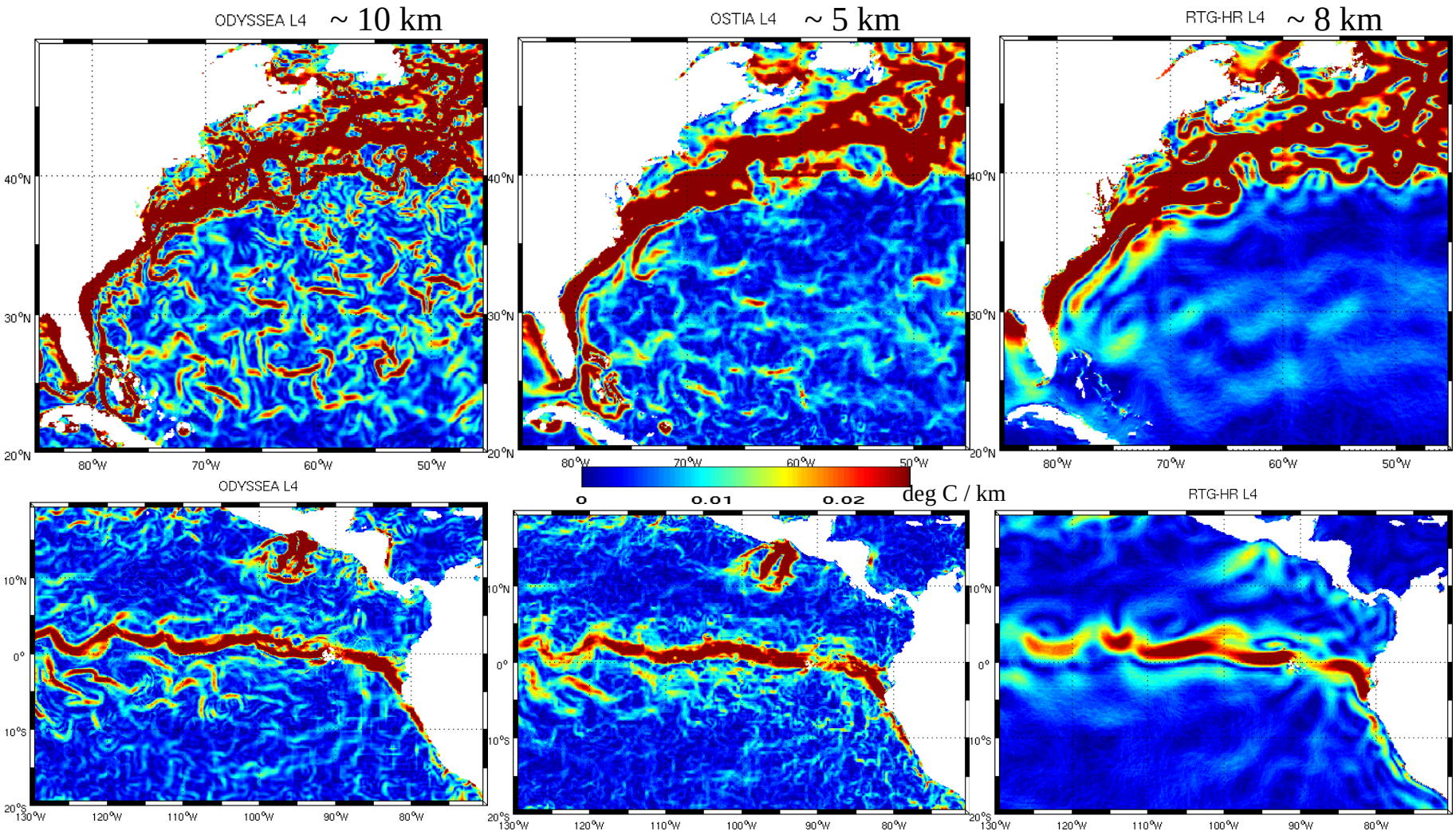




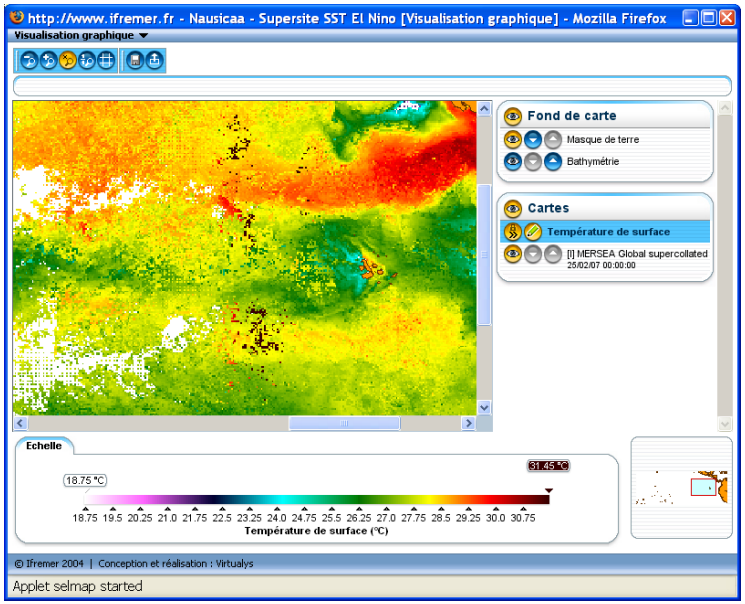


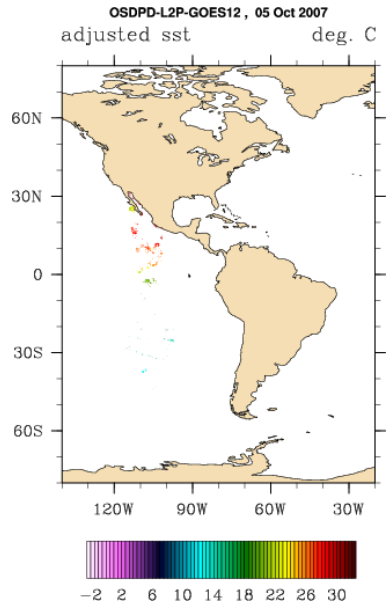
Monitoring tools (some examples)

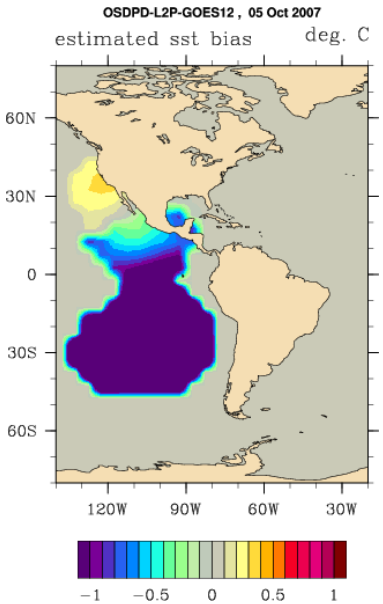
- Comparisons between ODYSSEA L4 and other L4 products (*gradients*)

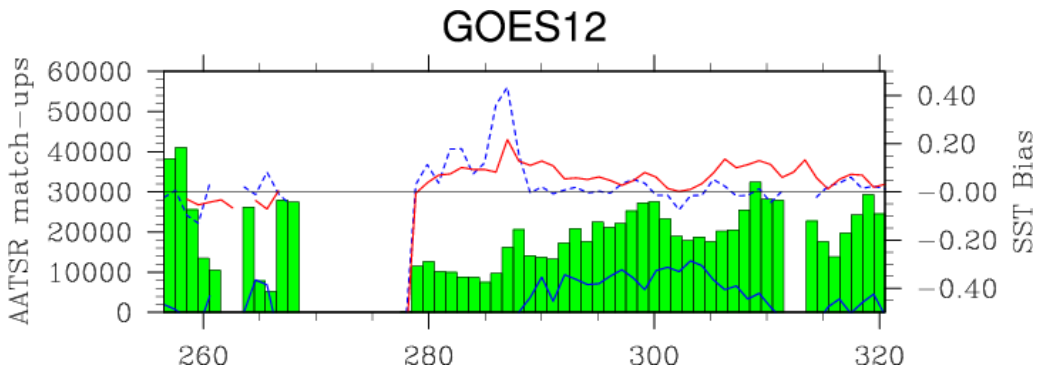


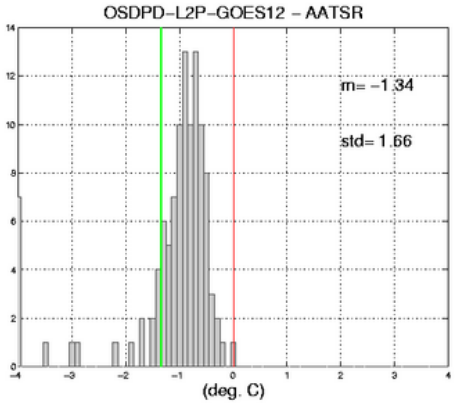
Application of daily monitoring











Conclusion

- ODYSSEA system in operation since October 2007
- Monitoring tools accessible to users, continuous quality control of product
- Both analyses and merged multi-sensor products are useful to users (incl. Modellers)

<u>Future plans</u>

- Reprocessing to be done during over Medspiration/GHRSST era (2008)
- Methodology to be applied to Medspiration L4 products (early 2008)
- Improvement of data preprocessing
- Methodology for an alternative to AATSR
- Correction models to be improved
- New analysis methods to be investigated