# Improved Estimates of Air-Sea Fluxes over the Atlantic and Mediterranean areas

*A. Bentamy; H.L. Ayina; J. F. Piolle; H. Roquet; D. Groizifillon*

## Objectives

➢ ***Carry out necessary R&D activities to merge ECMWF Numerical Weather analysis outputs with high remotely sensed surface parameters to derive near real-time global wind stress and turbulent heat fluxes fields***

➢ ***Set-up and carry-out a demonstration experiment, to produce in near real-time merged global wind stress and turbulent heat fluxes fields (6-12 hourly, 0.25° x 0.25 °)***

- **Collection of satellite, numerical, and in-situ data over the global ocean**
- **Method to estimate surface fluxes from satellite data**
- **Method to merge satellite and ECMWF flux estimates**
- **Validation of retrieved flux fields**

# Near Real Time Data Collection

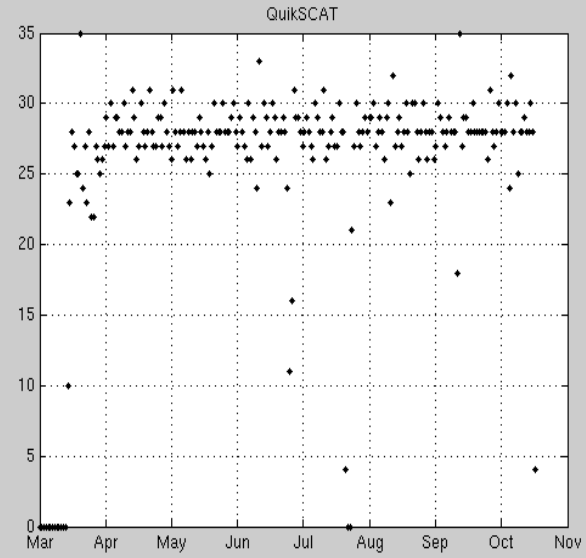
- **Satellite : Scatterometers, Altimeters, and Radiometers onboard QuikScat, Jason, and DMSP**
- **Analysis : ECMWF (Operational analysis)**
- **In-situ : Moored buoys from Meteo-France/UK Met Office, PIRATA, NDBC, TAO**

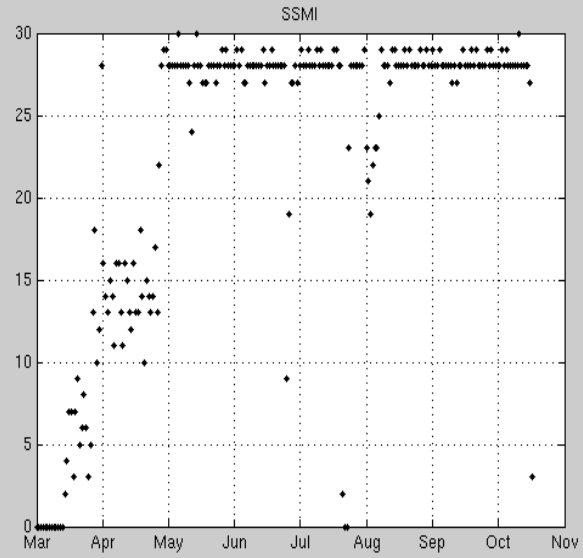
# Near Real Time Data Collection

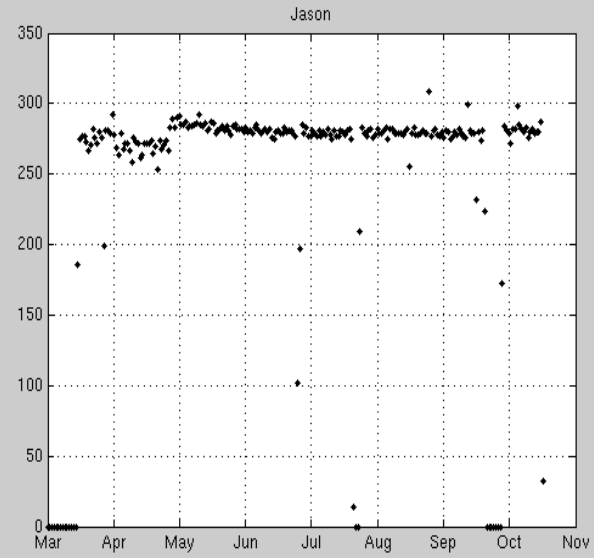
**Data Flow** : Meteo-France → IFREMER (Datacer) → Bagan (Linux ; 4T) → Spool Product/Year/Day

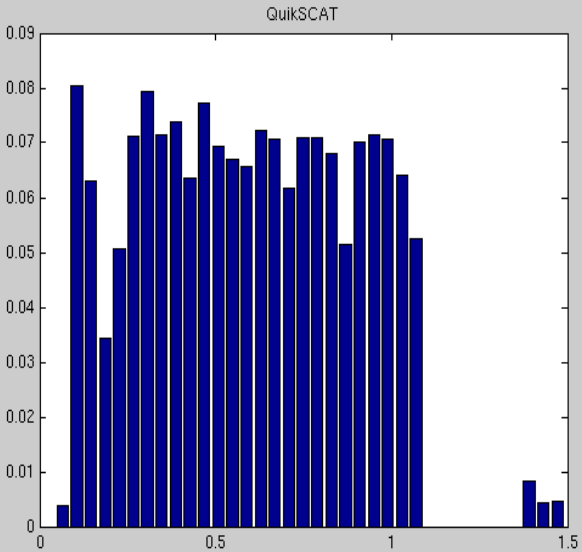
| Data | Center | Availability | Area | Format | Resolution | Volume | Extraction & NETCDF (Test with DLT Data) |
|---|---|---|---|---|---|---|---|
| ECMWF | GODIVA | 15h-24h | Global | GRIB | 0.5°x0.5° | 3.8Mo | 4mn |
| QuikScat | Meteo-France | 2h-36h | Global | BUFR | 0.25° (Swath) | 10*28 Mo | 2mn* |
| SSM/I F13; F14, F15 | Meteo-France | 2h-36h | Global | BUFR | 0.25° (Swath) | 4.5*28*2 Mo | 3*1mn* |
| Jason | Meteo-France | 2h-36h | Global | BUFR | Track | 10*280 Ko | |

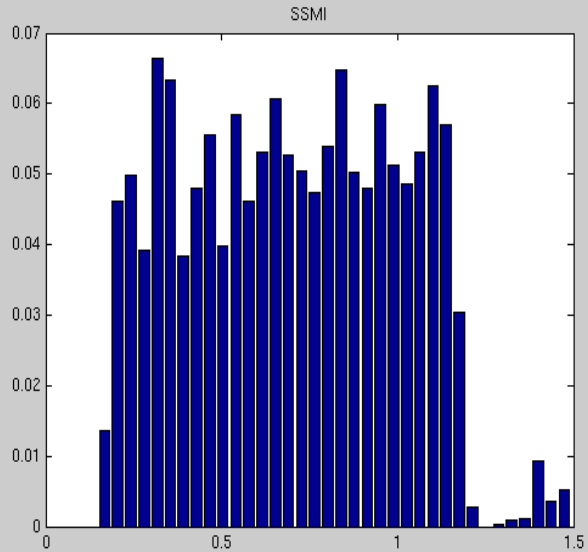
# Near Real Time Data Collection
# (exp. QSCAT50_EGRR_170429 ➔ Oct. 17 06:34)

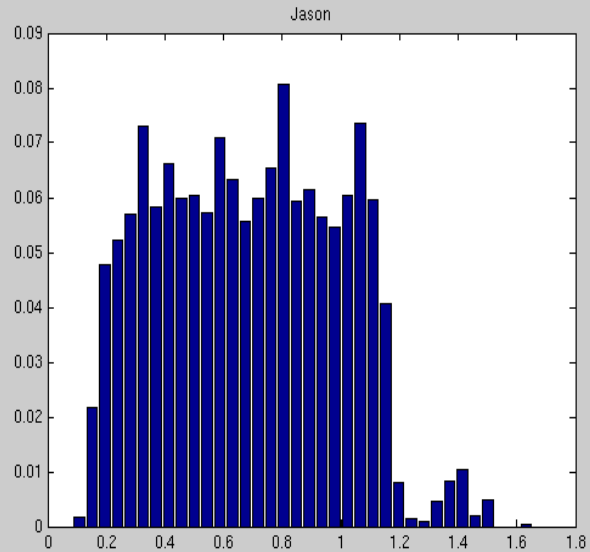


# Quality Control of Near Real Time Data

## Comparisons

- QuikScat off-line (JPL) and NRT products (L2A and L2B)
- SSM/I off-line (MFC) and NRT products (Brightness Temperatures)
- SSM/I off-line (RSS) and NRT wind products (RSS)
- Jason

## Rain Flag

- Portabella *et al* (2002)

# Methods of Remotely Sensed Flux Estimation

- **Merging scatterometer, radiometer, and altimeter data (Bentamy et al, 1999 and 2002)**
- **Methods used to estimate turbulent fluxes (Bentamy et al, 2003)**
- **Analysis of remotely sensed data (Bentamy et 1998, 2002)**

# Enhancement of Surface Fluxes

- **Method : Objective OI**

$$U_a^i = U_b^i + \lambda'(U_o - U_{bo})$$

- **$U_b$ is the background (ECMWF); $U_o$ is the satellite observations (Scatterometers, Altimeters; SSM/I), $U_{bo}$ is the background at observation location, and $\lambda$ are the weights :**

$$\lambda = (\Sigma_o + \Sigma_{bo}) < d_b^i, d_{bo} >$$

$$\Sigma o = < d_o^{'}, d_o >; \Sigma_{bo} = < d_{bo}^{'}, d_{bo}^{'} >$$

$$d_j = U_j - \tilde{U}_j$$

$$-\sum_{i=1}^{n} \lambda_i \Gamma(i,j) + \Gamma(j,0) - \tau_1 - \tau_2 S(j) + \lambda_j \sigma 2 = 0$$

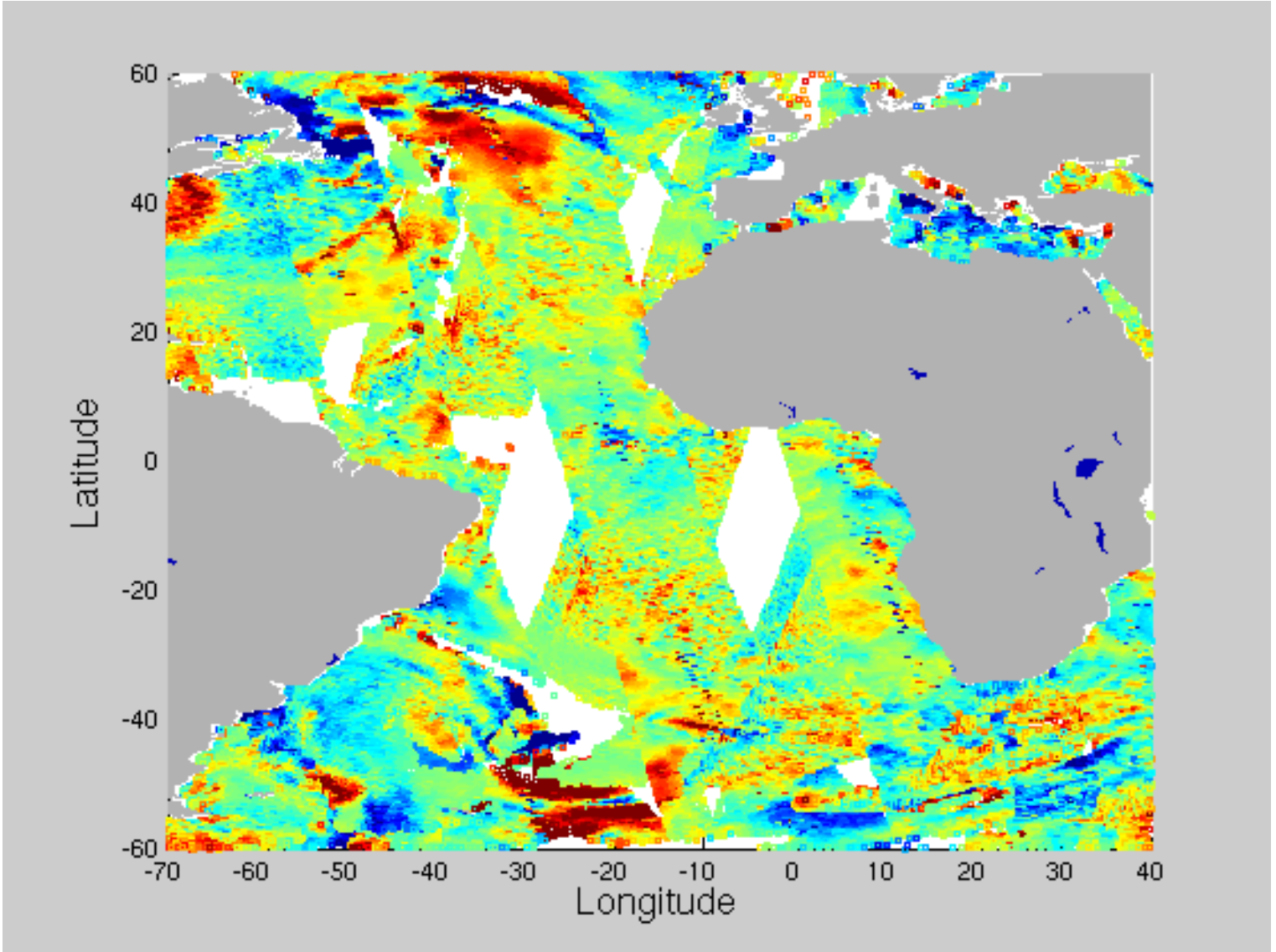
$$\sum_{i=1}^{n} \lambda i = 1$$

$$\sum_{i=1}^{n} \lambda i S(i) = S(0)$$

- **The space and time correlation is parameterized by**

$$\Gamma(\delta h, \delta t) = \varepsilon_p + a(1 - \exp(-\frac{\delta h + c\delta t}{b}))$$

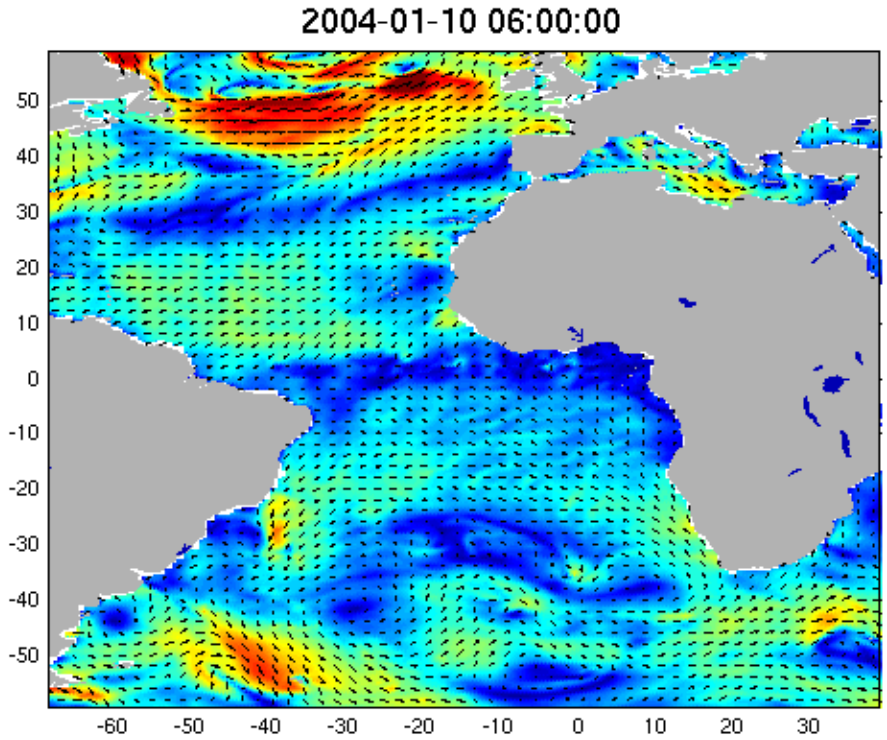
# Example of observations (remotely sensed (QuikScat and SSM/I) – ECMWF wind speed) during the period 1st January 2004 3am – 9am.

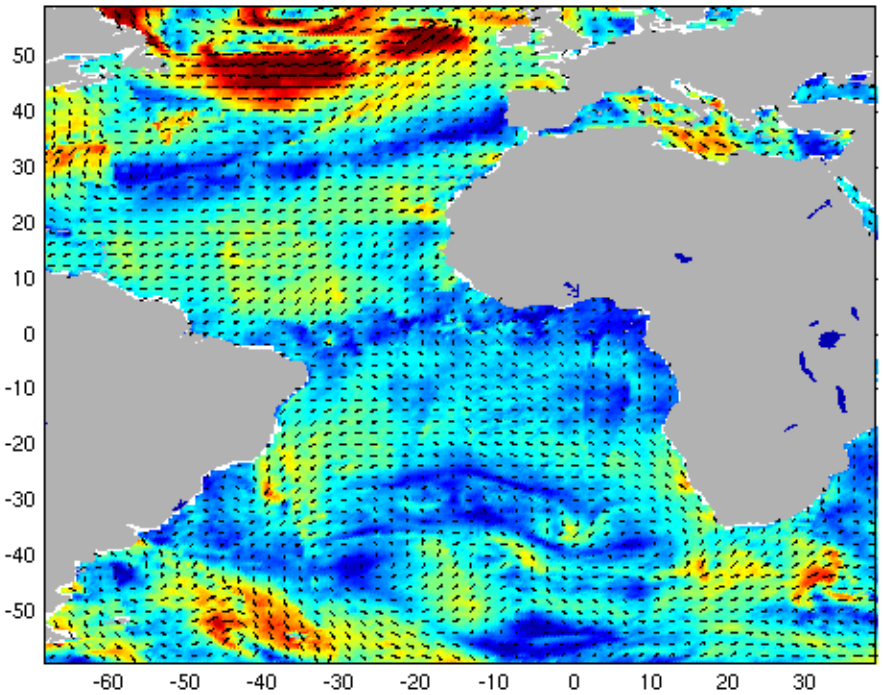


# Example of Blended Wind product from NRT Data

**ECMWF Wind Speed and Direction (0.50°x0.50°)**

**01/01/2004 06h**

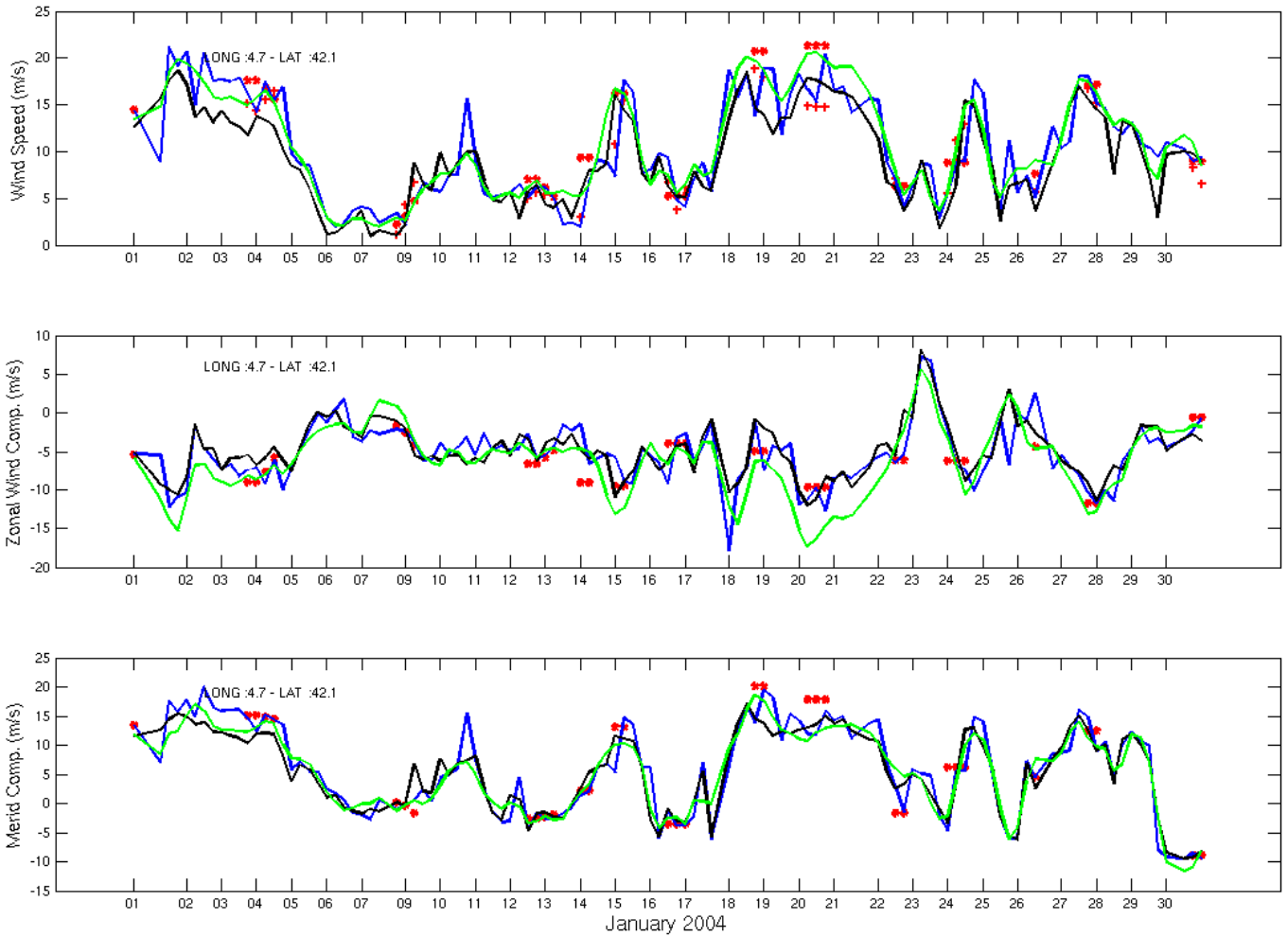



**Blended Wind Speed and Direction (0.25°x0.25°)**

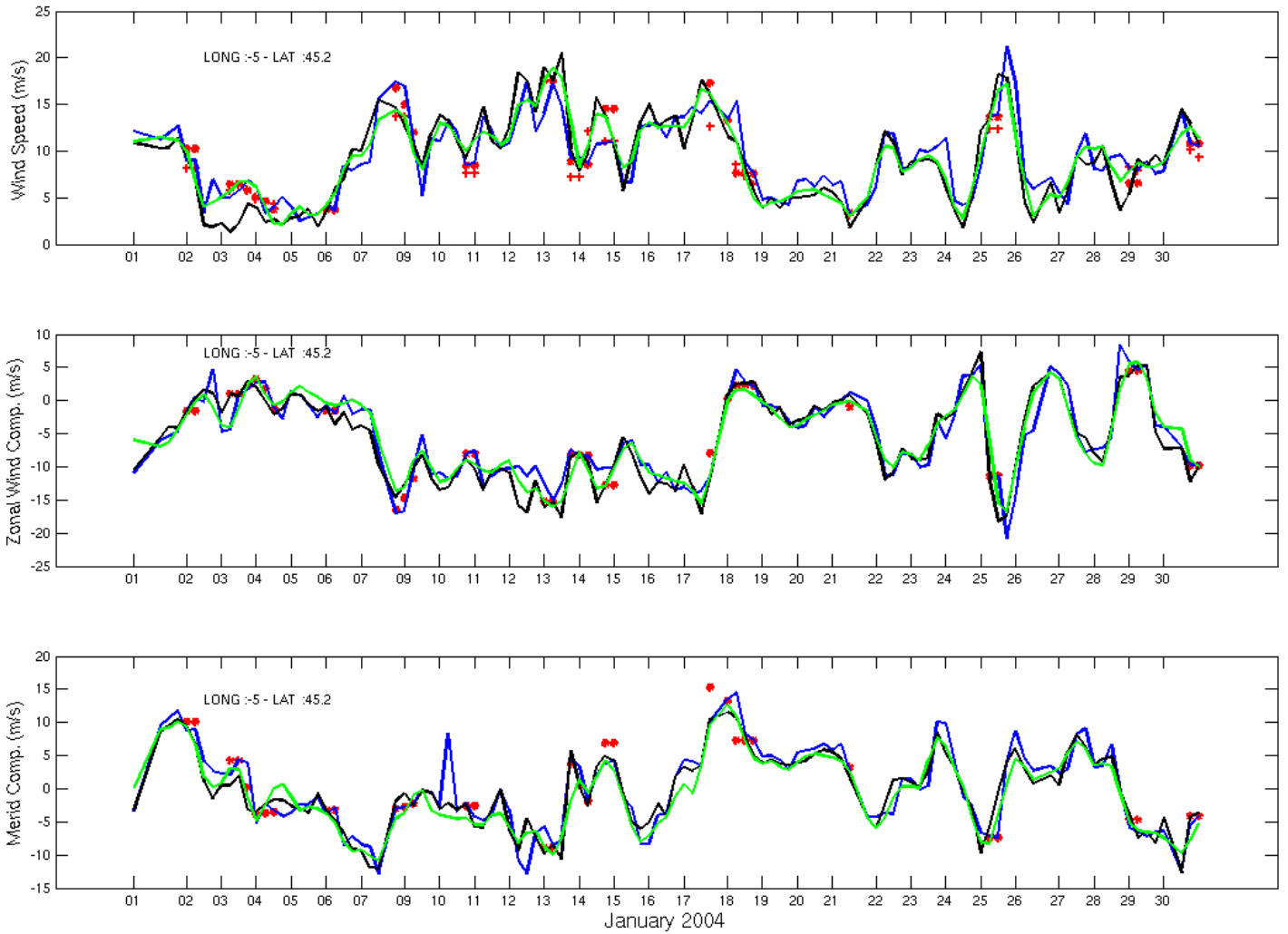
**01/01/2004 06h**

# Example of Validation Results : Time Series at Buoy Location 4.7°E – 42.1°N (Mediterranean Sea).



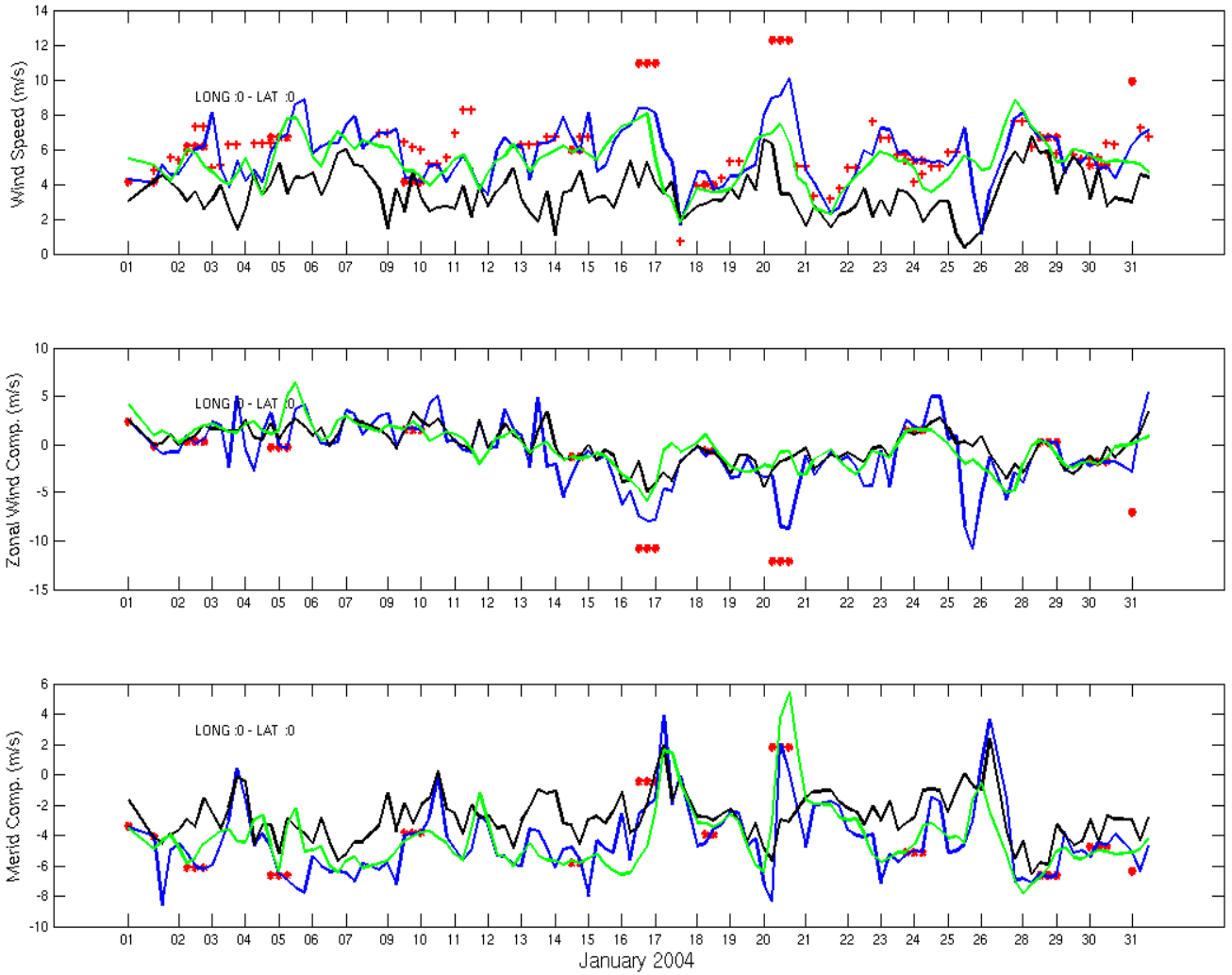

- Buoy
- ECMWF
- Observations
- Blended

# Example of Validation Results : Time Series at Buoy Location 5°W – 45.2°N (North Atlantic)




- Buoy
- ECMWF
- Observations
- Blended

# Example of Validation Results : Time Series at Buoy Location 0°E – 0°N (Tropical Atlantic)




- Buoy
- ECMWF
- Observations
- Blended

# Comparison of Buoy and Blended, ECMWF, and QuikSCAT wind data

| | | Mediterranean | | | | North Atlantic | | | | Tropical Atlantic | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bias | Std | Cor | N | Bias | Std | Cor | N | Bias | Std | Cor | N |
| Wind Speed | Buoy/ Blended | 0.62 | 2.74 | 0.89 | 232 | -0.28 | 2.06 | 0.85 | 692 | -0.25 | 1.51 | 0.79 | 580 |
| | Buoy/ ECMWF | 2.12 | 2.08 | 0.92 | 232 | 0.22 | 1.52 | 0.93 | 692 | 0.92 | 1.07 | 0.89 | 580 |
| | Buoy/ QuikScat | 0.09 | 1.95 | 0.94 | 70 | -0.46 | 2.10 | 0.85 | 250 | -0.32 | 1.32 | 0.85 | 144 |
| Zonal Comp. | Buoy/ Blended | -0.53 | 3.29 | 0.91 | 232 | 0.30 | 2.48 | 0.92 | 692 | -0.09 | 1.79 | 0.89 | 580 |
| | Buoy/ ECMWF | -0.96 | 2.87 | 0.93 | 232 | 0.28 | 1.87 | 0.95 | 692 | 0.12 | 1.14 | 0.94 | 580 |
| | Buoy/ QuikScat | 0.21 | 3.85 | 0.84 | 70 | 0.70 | 2.82 | 0.90 | 250 | 0.25 | 2.34 | 0.87 | 144 |
| Merid. Comp. | Buoy/ Blended | -0.78 | 2.82 | 0.93 | 232 | -0.47 | 2.55 | 0.93 | 692 | 0.09 | 1.91 | 0.89 | 580 |
| | Buoy/ ECMWF | -0.22 | 2.02 | 0.95 | 232 | -0.32 | 2.01 | 0.96 | 692 | 0.04 | 1.70 | 0.91 | 580 |
| | Buoy/ QuikScat | -1.51 | 4.30 | 0.86 | 70 | -0.25 | 2.65 | 0.91 | 250 | 0.03 | 1.32 | 0.94 | 144 |

# Summary / Future

- ***Improvement of retrieved remotely sensed fluxes are expected***
  - *Parametrization*
  - *Resolution (0.5 ° - 0.25 °; 12h – 6h )*
- ***Blended data***
  - *Produce offline and NRT Air-Sea Fluxes*
  - *Accuracy*
  - *New data : WndSat; Metop, ...*
  - *Bias correction : Use in-situ data*
  - *Validation : Forcing experiments (ORCA; MERCATOR; MARS; ROMS)*

# Summary / Future

- **Data access :**
  - GODIVA not operational
    - Server was down for several days
    - Only space regular data are available
  - Use the operational link : ECMWF – M-F
    - The link is unique for all real time data
    - Action under the responsibility of the M-F IT division
    - Special agreement ECMWF – M-F for MERSEA
  - Stability of the system