Analysis of Turbulent Flux Quality

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New Release of Turbulent Fluxes


Wind stress
\[ \tau = (\tau_x, \tau_y) = \rho C_D \bar{U}(u, v) \]

Latent heat flux
\[ Q_{\text{latent}} = -l \rho C_E \bar{U}(q_a - q_s) \]

Sensible heat flux
\[ Q_{\text{sens}} = -\rho C_p C_h \bar{U}(T_a - T_s) \]

Coare3.0 Parameterizations (Fairall et al, 2003)
Consistency Issues: Difference QuikSCAT – ERS-2

Estimation of Turbulent Fluxes: Main Changes

- **Wind (L2b products):**
  - ERS-1 (Ifremer)
  - ERS-2 (Ifremer)
  - QuikSCAT (JPL/PODAAC)
  - ASCAT (SAF OSI / KNMI)

- **Consistency (Bentamy et al, 2012; Grodsky et al, 2012; Bentamy et al, 2013):**
  - ASCAT / QuikSCAT
  - ERS-2 / QuikSCAT
  - ERS-1 / ERS-2

- **Reprocessing:**
  - Correction of QuikSCAT
  - Correction of ASCAT
  - Characterisation of ERS-1 and ERS-2 $\sigma^0$ biases
  - Retrievals of ERS-1 and ERS-2 from Cmod5.n
Long Time Series of Scatterometer Winds Comparisons Versus NDBC Buoys

Wsp Bias (Buoys – Scatterometers)
Long Time Series of Scatterometer Winds Comparisons Versus Tropical Buoys

Wsp Bias (Buoys – Scatterometers)
New Release of Turbulent Fluxes (Bentamy et al, 2013)  
Main Changes

- **Specific Air Humidity**: 
  \[ qa_{10} = f(Tb, SST, Ta) \]
  Tb are from SSM/I F10 – F15

- **Consistency** (Fundamental Climate Data Record (Berg et al, 2012))
  - Tb are from Univ colorado / NOAA/NESDIS

- **Reprocessing**
  - \[ qa_{10} = f_1(Tb_{19V}) + f_2(Tb_{19H}) + f_3(Tb_{22V}) + f_4(Tb_{37V}) + g(SST) + h(\Delta T) \]
  - Calibration based on collocated Tb and \( qa_{10} \) from ICOADS and buoys
New Release of Turbulent Fluxes (Bentamy et al, 2013)

- **Air Temperature:**
  - Corrected Era Interim

- **Sea Surface Temperature**
  - HR SST V2 (Reynolds et al, 2007)

**Objective Method** (Bentamy et al, 2011)

Calculations of Global Daily and Monthly 0.25°x0.25° Flux Analyses.
Assessment of the Turbulent Flux Accuracy

- Spatial and temporal Collocation of Daily Estimates

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Assessment of the Wind Stress Accuracy: TAO, PIRATA, RAMA

Stress Rms (N/m²)

- Ifremer
- Eraint
- Cfsr
- TropFlux

2nd Principal Deviation

Correlation

Mean Departure (%) of 0.07 N/m²
Assessment of the Latent Heat Flux Accuracy: TAO, PIRATA, RAMA
Assessment of the Sensible Heat Flux Accuracy:
TAO, PIRATA, RAMA
Assessment of the Latent Heat Flux Accuracy:
Ocean Sites

LHF RMS Differences (W/m²)

- 32N 145E
- 15N 90E
- 0N 80E
- 8S 67E
- 15N 38W
- 0N 140W
- 0N 170W
- 0N 23W
- 10S 10W
- 0N 165E
- 12N 23W

Legend:
- Ifremer
- Seaflux
- OAFlux
- ErInt
- Cfsr
- NOCS2
- TropFlux
Towards Improved Estimates of Ocean Heat Flux (TIE-OHF)  
ESA ITT

Ocean Heat Flux Recommendations and Priorities

(http://www.wmo.int/pages/prog/sat/meetings/documents/ET-SUP-7_Doc_08-03_WCRP.pdf)
- CLIVAR/ESA scientific consultation workshop on: “Earth Observation Measurement  
Constraints on Ocean Heat Budget”. July 2013
- WOAP, 2012: Report action plan for WCRP activities on surface fluxes, WCRP informal  
CLIVAR GSOP WHOI Workshop report on Ocean Syntheses and Surface Flux Evaluation  
Woods Hole, Massachusetts, 27-30 November 2012
- Oke, PR, O'Kane, TJ 2011, Observing system design and assessment, in A Schiller, GB  
Brassington (eds.), Operational Oceanography in the 21st Century, Springer, Amsterdam,  
pp.123-151
- Pinker R. T., A. Bentamy, K. B. Katsaros, Y. Ma, and C. Li, 2014: Estimates of net heat  
fluxes over the Atlantic Ocean. J. Geophy. Res. VOL. 119, 1–18, doi:10.1002/2013JC009386,  
2014

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Towards Improved Estimates of Ocean Heat Flux

- Institut Français pour la Recherche et l’Exploitaion de la MER (IFREMER)
- Institute of Oceanology, Russian Academy of Sciences (IORAS)
- Institut Méditerranéen d’Océanologie (MIO)
- German Weather Service (DWD)
- Nansen Environmental and Remote Sensing Center (NERSC)
- Plymouth Marine Laboratory (PML)
- Univ. Maryland (UM)
- Univ. Reading (UR)
- Woods Hole Oceanographic Institution (WHOI)

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Requirements for Ocean Heat Flux Improvements

- Improvements of the retrievals (Bulk Variables)
  - Surface Winds
  - Specific Air humidity
  - Air and Surface Temperatures

- Long Time Consistency of Bulk Variables over Global Ocean

- Homogenization of OHF measurements used as ‘Truth’

- OHF parameterizations particularly for high and low wind conditions

- Global Long Time Series of OHF

- Validations and inter-comparisons of available products at Global and Regional Scales

- Make Variable and OHF data accessible
Towards Improved Estimates of Ocean Heat Flux
Expected Results

Reference Data Set Generation

✓ Collecting and archiving EO (especially from ESA sources) and non EO data as well as satellite L3 and L4 and NWP flux products available during common period of at least 10 years.
✓ Assessment of the data quality. It will be determined through comprehensive comparisons with *in situ* flux data
✓ Homogenization of the spatial and temporal resolutions among the selected products.
✓ Determination of product differences at various spatial and temporal scales, and according to atmospheric and oceanic parameters of interest.
✓ Checking for consistency of the ensemble based on the assessment of the heat budget closure for different regions ("cage" approach).

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Summary / To Do

✓ Progress in the consistency of scatterometer retrievals
✓ Paper describing the methods and the validation of retrievals will be submitted
✓ Reprocessing of turbulent fluxes based on the new scatterometer retrievals and FCDR data
✓ Determination of accuracies
  ▪ Global statistics meet the accuracy requirements
  ▪ Further investigations are needed for local assessment

✓ Calculation of Long time series of daily and monthly bulk variables and turbulent fluxes
✓ Uncertainties for each daily and monthly global ocean data file online and available for users
✓ Determination of reference data set for inter-comparison purpose
✓ Product generation, Inter-comparison and uncertainty characterization
✓ Data portal development
Assessment of the Wind Stress Accuracy: OceanSites

RMS Differences (dyn/m²)

OceanSites Buoys

![Graph showing RMS Differences for different locations](image-url)
Assessment of the Sensible Heat Flux Accuracy: OceanSites

RMS Differences (W/m²)

OceanSites Buoys