

# QUALITY CONTROL OF DATA OBSERVATIONS FROM GLIDERS

Genoa 18 -20th September 2018

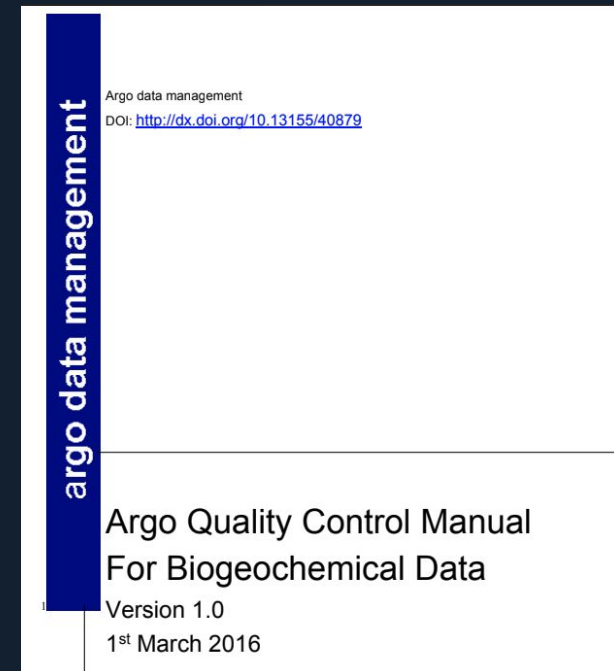
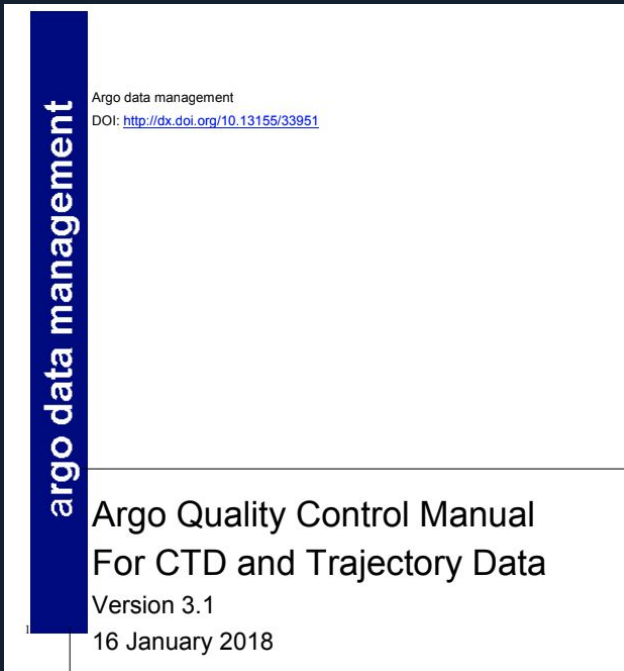
*I. Ruiz, M. Charcos, J. Allen, C. Muñoz, E. Alou, M. Torner*

## Outline

- 1. Global ocean observing system**
- 2. SOCIB QC Glider Toolbox v.1.4**
- 3. SOCIB Delayed mode: Scientific correction**
- 4. Glider community**
- 5. Summary**

# 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**



## 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**

For **gliders** more work is needed:

- International standards?
- Quality control tests and flags?
  - Variables to apply QC?
- Real time / Recovery Time / Delayed mode?

## 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**

For **gliders** more work is needed:

- **International standards?**
- **Quality control tests and flags?**
  - **Variable supply QC?**
- **Real time / Recycled mode / Delayed mode?**



# 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**

For **gliders** more work is needed:

- International standards?
- **Quality control tests and flags?**
  - Variables to apply QC?
- Real time / Recovery Time / Delay

Automated **TESTS** based on ARGO

- Impossible date
- Impossible location
- Position on land
- Impossible speed
- Global/regional range
- Instrument sensor range
- Spike
- Gradient
- Stuck value
- Frozen profile
- Deepest pressure

IODE Flags	
Code	Meaning
0	No QC was performed
1	Good data
2	Probably good data
3	Probably bad data
4	Bad data
8	Interpolated data
9	Missing data

## 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**

For **gliders** more work is needed:

- International standards?
- Quality control tests and flags?
  - **Variables to apply QC?**
- Real time / Recovery Time / Delayed mode?

### Physical variables

Temperature  
Salinity  
Conductivity

....

### Biogeochemical variables

O<sub>2</sub> conc/sat  
Chl *a* - fluorescence  
Turbidity

....

## 1. Global Ocean Observing System

**Quality control** procedure is established for **Argo profilers**

For **gliders** more work is needed:

- International standards?
- Quality control tests and flags?
  - Variables to apply QC?
- **Real time / Recovery Time / Delayed mode?**



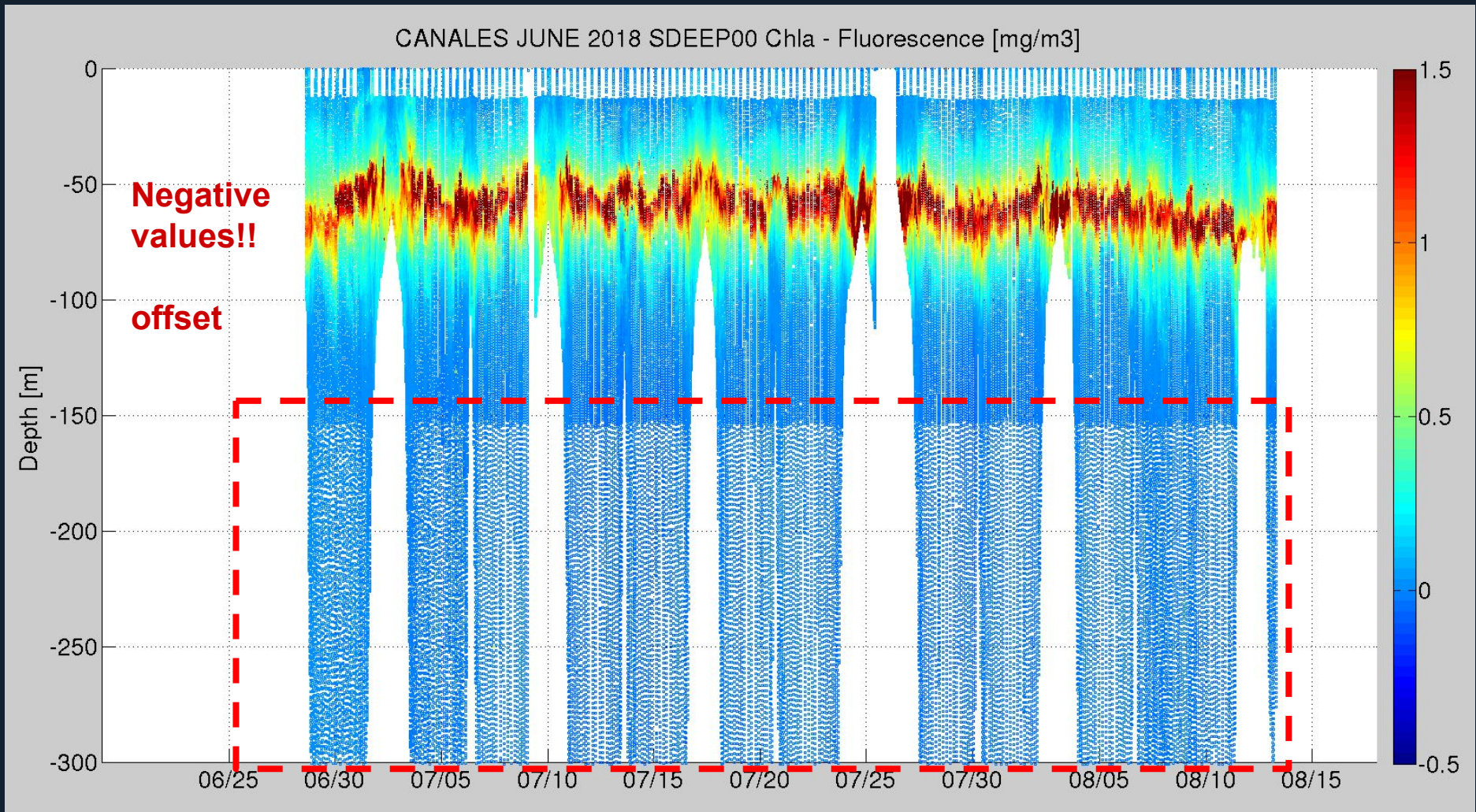
## 2. SOCIB QC Glider Toolbox v.1.4

Real Time and Delayed Time  
(recovery)

	Global range		Regional range		SOCIB regional range	Instrument range		Spike test
Temperature [° C]	-2.5 to 40	DATAMEQ, 2010	10 to 40	ARGO/DATAMEQ - Mediterranean Sea	10 to 30	-5 to 42	Slocum Glider Payload CTD	6 for pressures < 500db 2 for pressures >= 500db
Salinity [PSU]	2 to 41	DATAMEQ, 2010	2 to 40	ARGO/DATAMEQ - Mediterranean Sea	35 to 40	-	-	0.9 for pressures < 500db 0.3 for pressures >= 500 db
Conductivity [S/m]	0 to 8.5	ARGO User manual. V3.2 (2015)	-	-	4 to 6.5	0 to 9	Slocum Glider Payload CTD	-
Density [kg/m3]	-	-	-	-	990 - 1035	-	-	-
Turbidity [NTU]	0 to 50	GROOM / ARGO qc V2.8, 2013	-	-	0 to 10	0 to 25	Wetlabs	-
Chla-Flu [mg/m3]	0 to 50	Argo QC Manual For Biogeochemical Data	-	-	0 to 5	0 to 50	Wetlabs	-
Oxygen conc [umol/l]	-	-	-	-	140 to 350	0 to 500	Aanderaa oxygen optode	-
Oxygen sat [%]	-	-	-	-	50 to 120	0 to 120	Aanderaa oxygen optode	-

## 2. SOCIB QC Glider Toolbox v.1.4

- Problems in the sensors

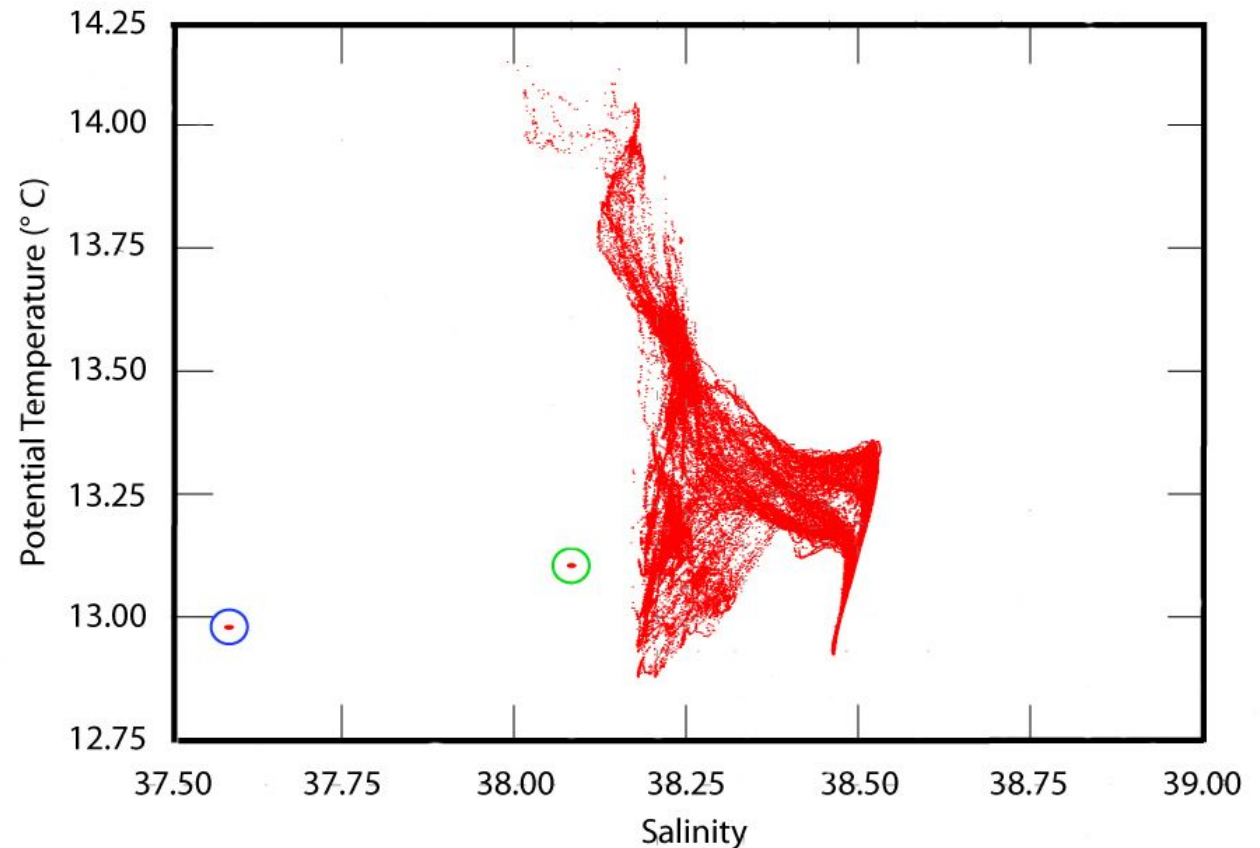


## 2. SOCIB QC Glider Toolbox v.1.4

- Spikes and electronic noise

**Blue circle:** removed by  
an automatic range test

**Green circle:** manual  
removal





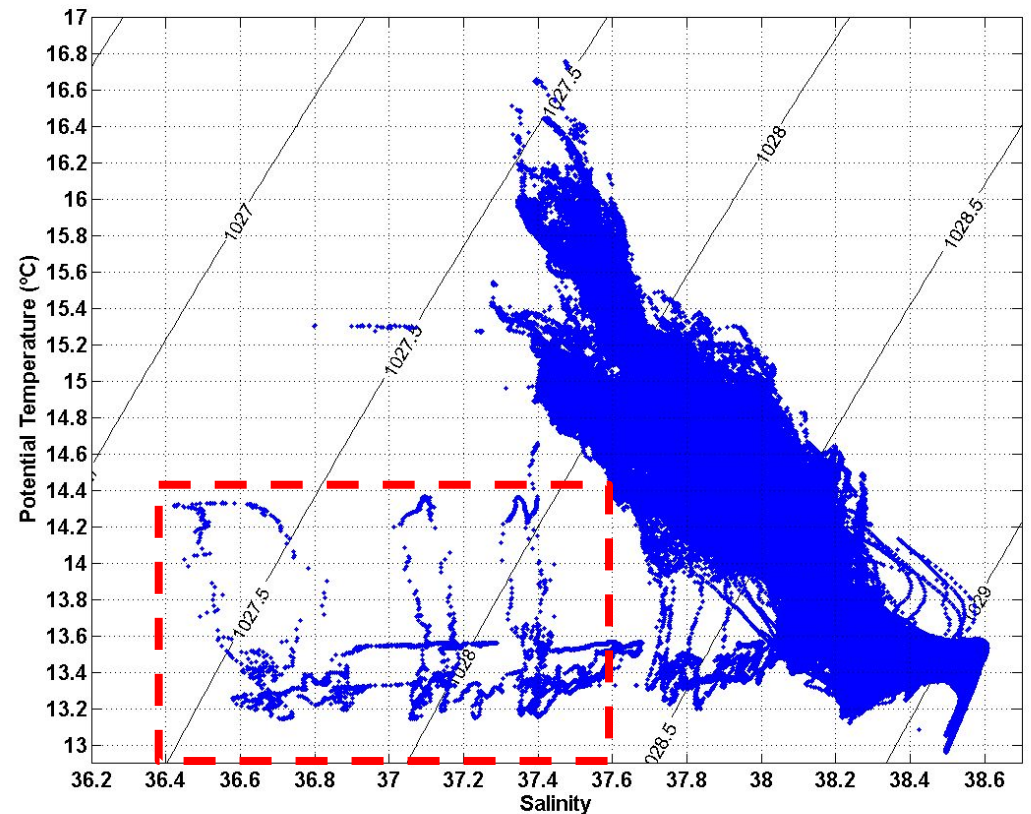
## 2. SOCIB QC Glider Toolbox v.1.4

- Biological fouling



Difficult to identify and correct or discard automatically

Data can be recovered with the application of salinity offsets



### 3. SOCIB Delayed mode: Scientific correction

**OBJECTIVE:** DM correction for conductivity to improve quality of measurements



correcting long-term sensor drifts etc.

**For Argo profilers** (*Owens and Wong, 2009*)

**For Gliders** still has to be **standardized:**

- calibration recorded in the metadata files
- creation of the corresponding corrected variables
- declaration of their associated residual error

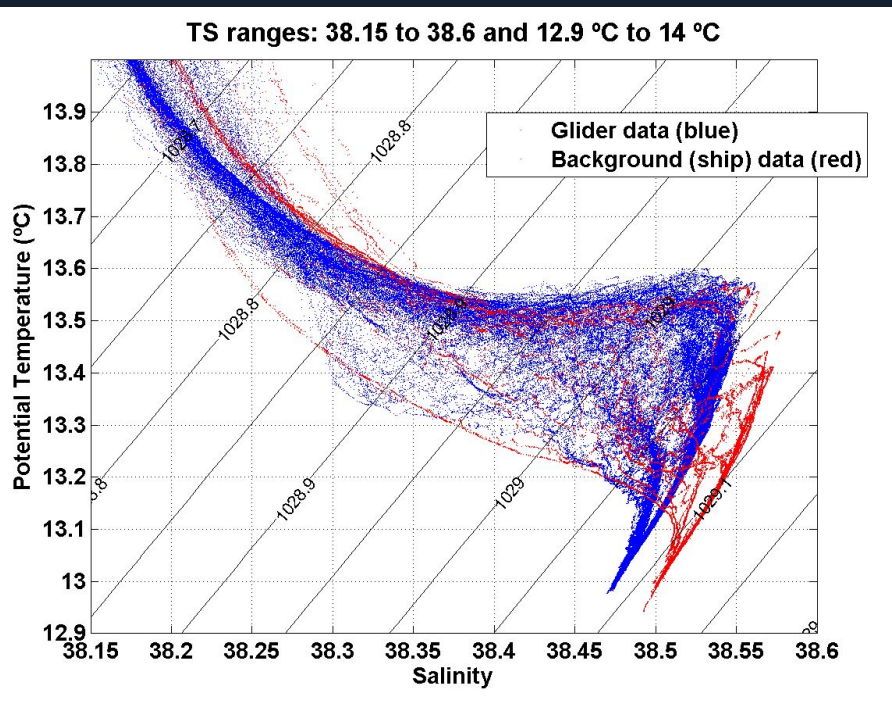
### 3. SOCIB Delayed mode: Scientific correction

For gliders, an **inter-calibration methodology** has been developed by SOCIB:



### 3. SOCIB Delayed mode: Scientific correction

For gliders, an inter-calibration methodology has been developed by SOCIB:

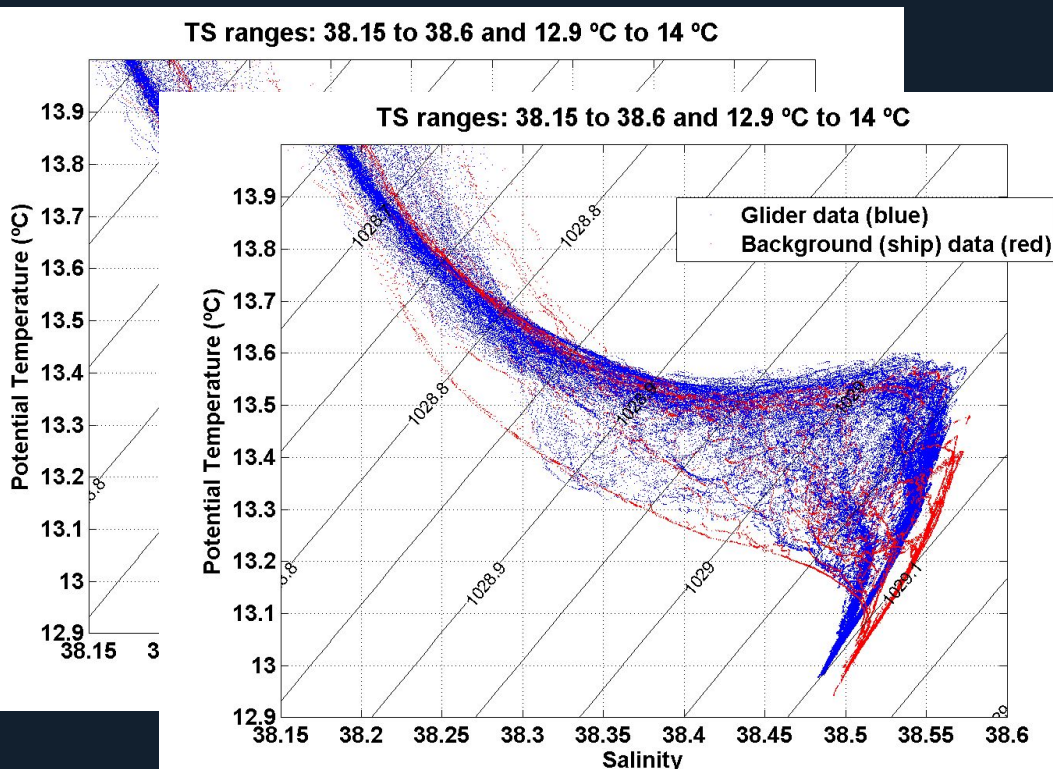


$$Conductivity\_corrected = A * Conductivity\_measured$$

Iterative selection of gradient A field  
correcting glider data to CTD stations

### 3. SOCIB Delayed mode: Scientific correction

For gliders, an inter-calibration methodology has been developed by SOCIB:



$$Conductivity_{corrected} = A * Conductivity_{measured}$$

Iterative selection of gradient A field  
correcting glider data to CTD stations

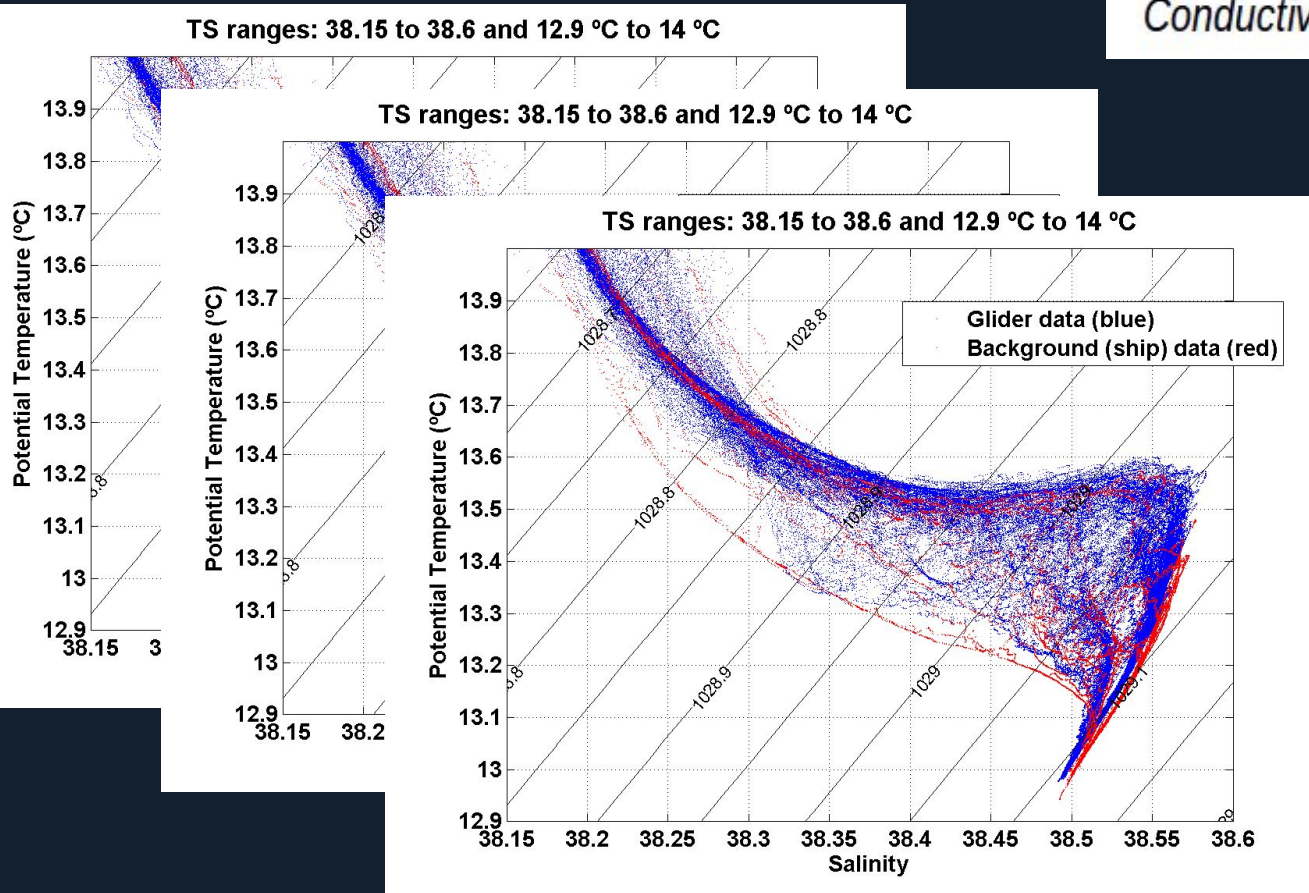


### 3. SOCIB Delayed mode: Scientific correction

For gliders, an inter-calibration methodology has been developed by SOCIB:

$$\text{Conductivity}_{\text{corrected}} = A * \text{Conductivity}_{\text{measured}}$$

Iterative selection of gradient A field  
correcting glider data to CTD stations

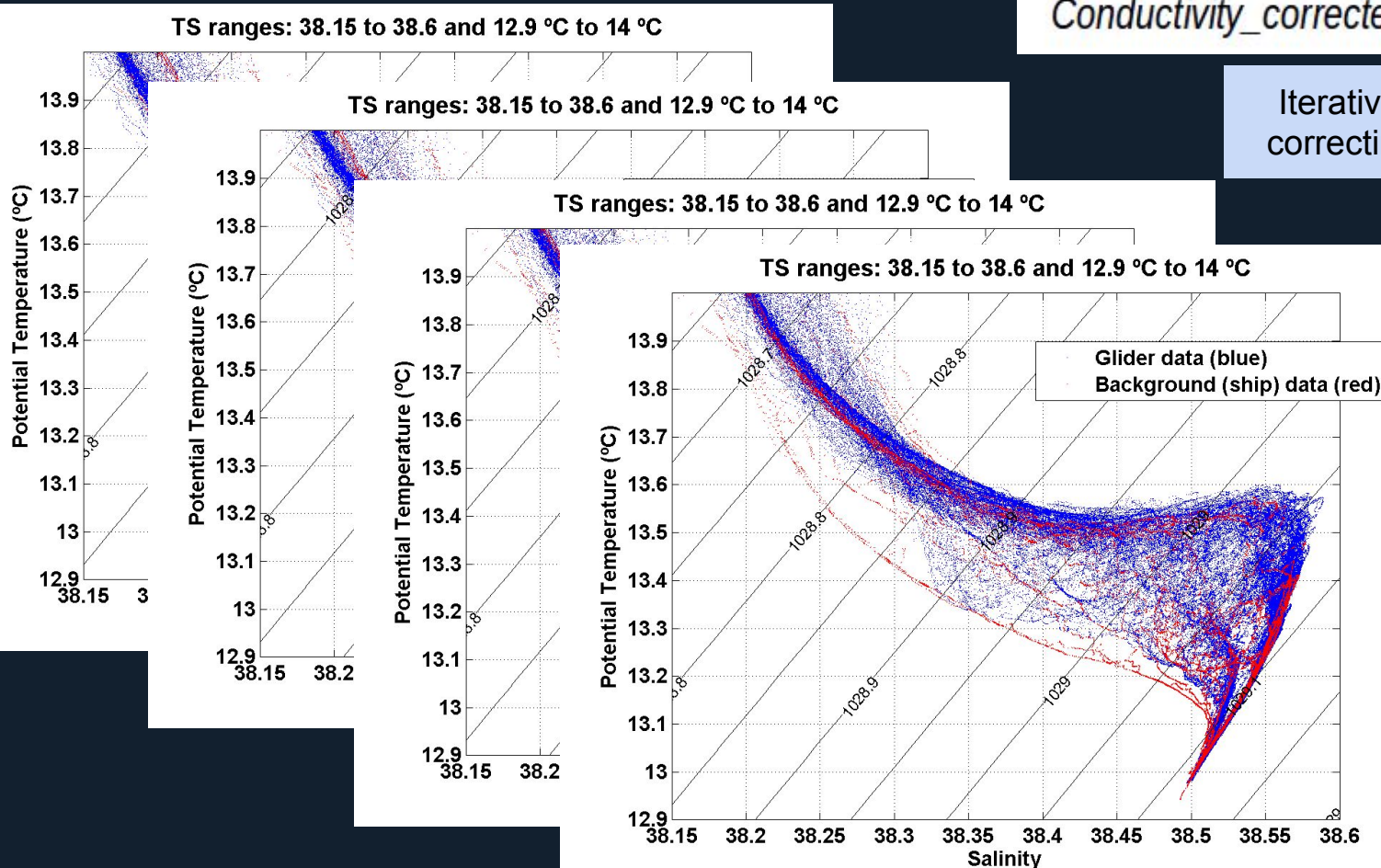


### 3. SOCIB Delayed mode: Scientific correction

For gliders, an inter-calibration methodology has been developed by SOCIB:

$$\text{Conductivity\_corrected} = A * \text{Conductivity\_measured}$$

Iterative selection of gradient A field  
correcting glider data to CTD stations



### 3. SOCIB Delayed mode: Scientific correction

File "dep0015\_ideep00\_ime-sldeep000\_L1\_2015-11-03\_data\_dt\_CORR.nc"

File type: Hierarchical Data Format, version 5

```
netcdf file:/home/cmuno/Desktop/test_nc_files/dep0015_ideep00_ime-sldeep000_L1_2015-11-03_data_dt_CORR.nc {
  dimensions:
    time = UNLIMITED; // (933615 currently)
  variables:
    double TEMP_CORR(time=933615);
      :observation_type = "corrected_measurements";
      :Summary_details = "At this stage, TEMP_CORR is the same as original temperature. This section will be updated if de-spiking is required";
      :_ChunkSizes = 524288; // int

    double SALT_CORR(time=933615);
      :observation_type = "corrected_derived_from_COND_CORR";
      :Summary_details = "Refer to meta.COND_CORR.attributes";
      :_ChunkSizes = 524288; // int

    double COND_CORR(time=933615);
      :observation_type = "corrected_measurements";
      :conductivity_Thermal_CORR_used = "YES";
      :CorrectionCoefficient_A = 1.00021; // double
      :Calibration_Equation = "COND_CORR=A*COND_01";
      :Salinity_error_estimate = 0.01; // double
      :Summary_Method = "whitespace area maximisation of a Theta-S diagram comparison, between glider data and other nearby (in time and space) cruises was employed";
      :Summary_Method_error_estimate = "error estimate is based on the range of salinity values of the comparison cruises at about 13.0C (i.e. at the tail end of the deepest values on the Theta-S diagram)";
      :Summary_Method_Report = "For further details, refer to report...TBC";
      :GLIDER_Report = "http://www.socib.es/?seccion=gliderPage&facility=gliderReports";
      :Background_data_used_for_correction = "Background comparison Cruises used: 1 ) dep0013 03-Nov-2015 2 ) dep0014 23-Feb-2016 3 ) dep0004 02-Dec-2013 4 ) dep0019 26-Nov-2015";
      :THETA-SAL-whitespace_for_correction = "Salinity: 38.05 to 38.6, Temperature: 12.9 to 13.8C";
      :_ChunkSizes = 524288; // int

  // global attributes:
  :name = "http://thredds.socib.es/thredds/dodsC/auv/glider/ideep00_ime-sldeep000/L1/2015/dep0015_ideep00_ime-sldeep000_L1_2015-11-03_data_dt.nc";
  :_CoordSysBuilder = "ucar.nc2.dataset.conv.DefaultConvention";
}
```

- Distribution
- Instrument type info
- correction coefficient
- error estimate
- standard deviation
- summary of the correction reference dataset
- correction procedure



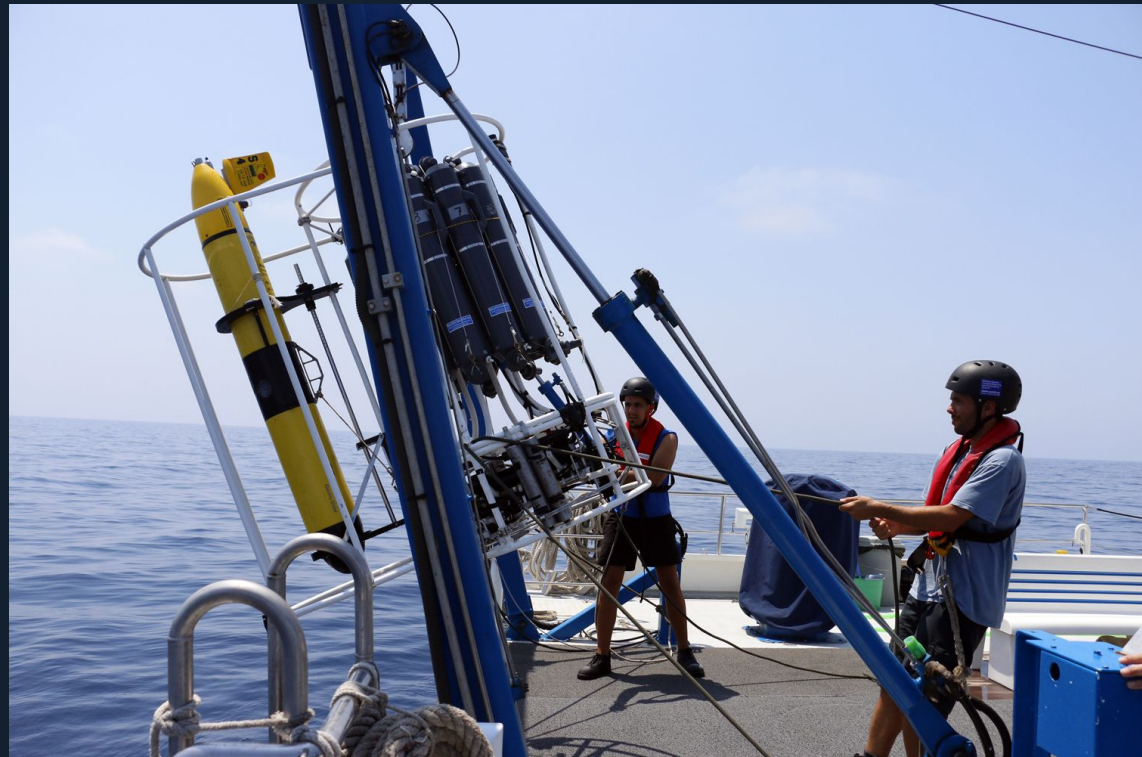
### 3. SOCIB Delayed mode: Scientific correction

Calibrating optical fluorometer and backscatter instruments in-field is notoriously difficult.

Generally these measurements are heavily community composition dependent.

Recently at SOCIB, we have developed the **GARICAST**

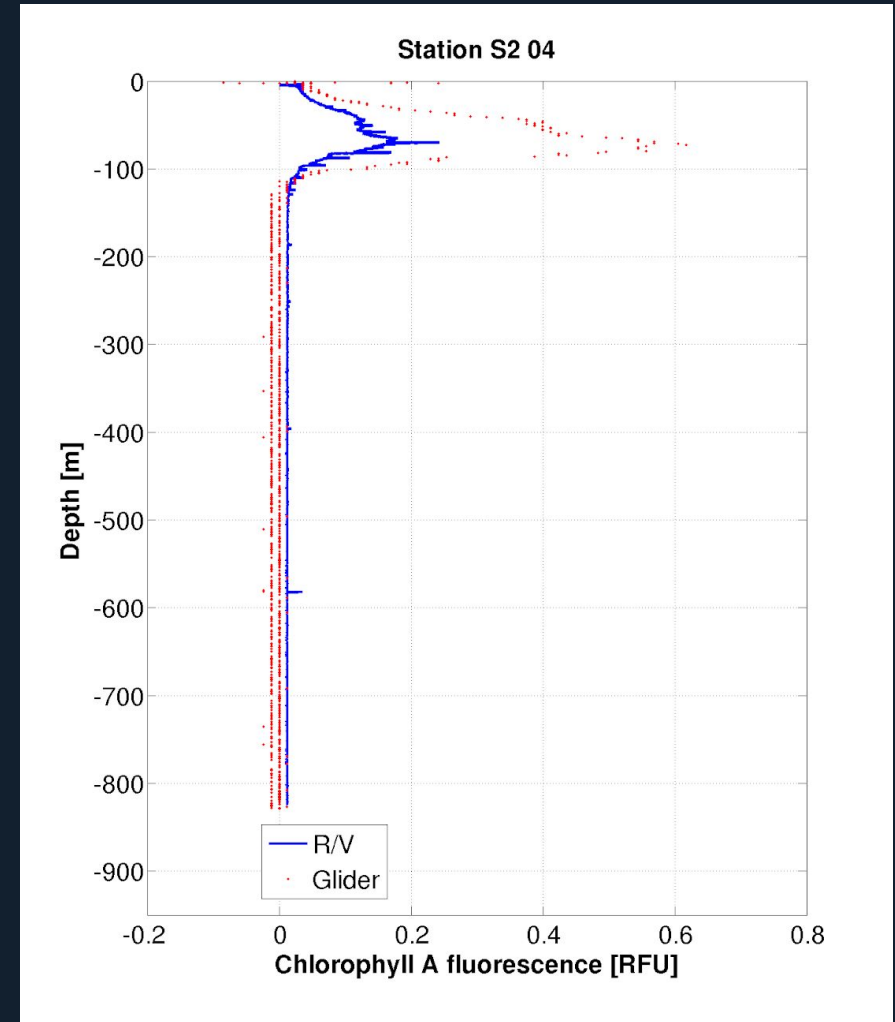
(Glider Against Rosette Intercomparison CAST experiments)



### 3. SOCIB Delayed mode: Scientific correction

**CTD** and a **glider** directly compared in parallel with the CTD instruments and bottle samples

**HPLC/Fluorometry** are then used to intercalibrate both the CTD frame and glider instruments directly



## 4. Glider community

### Sea Glider toolbox University of East Anglia

- Real and delayed time
- Flags improbable engineering values based on calibration files
- Remove outliers and visibly wrong data manually
- Diagnostic plots (T/S diagrams)
- **Finer Quality Control**
- **Not published yet:**
  - automated QC filtering methods and modified Z-scores
  - automated correction of chlorophyll
  - oxygen calibration and drift estimation scripts

#### Used by:

UEA, UIB, CalTech,  
Bergen, VIMS, Shanghai,  
UK National Oceanography  
Centre, British Antarctic  
Survey, U. Southern  
Mississippi, Gotenborg,  
Cape Town

## 4. Glider community


### Seaglider Basestation v2.09

- Spikes
- Remove **wrong data manually** after intercomparison
- **T/S diagram** to detect offset/drift

**Used by:**

SAMS

## 5. Summary

Organization info		Automated QC tests	Variables	Outliers	Reference
Name	SOCIB	Global range	Temperature	-2.5 to 40 °C	DATAMEQ, 2010
Type of glider	Slocum G2		Salinity	2 to 41 PSU	DATAMEQ, 2010
international QC standars	Argo		Conductivity	0 to 8.5 S/m	ARGO User manual. V3.2 (2015)
Flags coding	IODE flags		Turbidity	0 to 50 NTU	GROOM / ARGO qc V2.8, 2013
QC in RT	yes		Chla-Flu	0 to 50 mg/m3	Argo QC Manual For Biogeochemical Data
QC in DT, recovery time	yes	Regional range	Temperature	10 to 40 °C	ARGO/DATAMEQ
QC in DM	yes, inter-calibration methodology		Salinity	2 to 40 PSU	ARGO/DATAMEQ
Toolbox used	Socib glider toolbox v 1.4	Socib historical range	Temperature	10 to 30 °C	
	Glider Salinity correction pack		Salinity	35 to 40 PSU	
Comments:	Netcdf distribution (L0,L1, L2)		Conductivity	4 to 6.5 S/m	
			Density	990 to 1035 kg/m3	
			Turbidity	0 to 10 NTU	
			Chla-Flu	0 to 5 mg/m3	
			O2 concentration	140 to 350 umol/l	
			O2 saturation	50 to 120 %	
<div>Fill in this table for your own organization</div>		Instrument range	Temperature	-5 to 42 ° C	Slocum Glider Payload CTD
			Conductivity	0 to 9 S/m	Slocum Glider Payload CTD
			Turbidity	0 to 25 NTU	Wetlabs
			Chla-Flu	0 to 50 mg/m3	Wetlabs
			O2 concentration	0 to 500 umol/l	Aanderaa oxygen optode
			O2 saturation	0 to 120 %	Aanderaa oxygen optode
<div>Let's collaborate</div> 		Spike test	Temperature	6 for pressures < 500db	ARGO User manual. V3.2 (2015)
				2 for pressures >= 500db	
			Salinity	0.9 for pressures < 500db	ARGO User manual. V3.2 (2015)
0.3 for pressures >= 500 db					



## Acknowledgements:

### Data Center Facility



*J. Fernández*



*M. Charcos*



*I. Ruiz*

### Coastal Research Vessel Facility



*J. Allen*



*E. Alou*



*C. Muñoz*



*A. Cabornero*

### Glider Facility



*M. Torner*



*A. Miralles*



*M. Rubio*

### Facility Support and Technology Development



*B. Casas*



*N. Wirth*



*I. Lizarán*



*P. Balaguer*



*C. Castilla*

Thanks for your time!!

Questions??

Comments??