Paper good practice – Sensors

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A BGC-Argo Guide: Planning, Deployment, Data Handling and Usage

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1. Program conception
- What float platform and which sensors?
- What kind of mission?
  Argo standard or with modifications (for good enough reasons?)
- Who takes care of data flow / in contact with a DAC?
- Who takes care of DMQC?

2. Float handling
- Pre-deployment float testing as a good practice
- Float operations (storage, deployment, mission changes, recovery)

3. Data flow, management, and quality control
- How is BGC-Argo nestled into the Argo data system?
- What data streams and files exist? What's their latency and target user group?
- What's the data flow for quality controlled (QC'ed) data?

4. Data usage
- How and where to find BGC-Argo data?
- How to access the data one is looking for?
- How to interpret the QC state (data mode and QC flags)?

Variable-specific aspects
- What is special about each of the 6 core BGC-Argo variables?

FIGURE 1 | Key points and questions of a "BGC-Argo float life", from conception, float operations, data management and quality control to data usage.

1. Sensor Handling

2. Data Handling

What Sensors?

O_2 Optodes
- AADI 4330, SBE63, ARO FT, RBR?

NO_3 UV-vis Spectrophotometers
- ISUS, deep SUNA, OPUS?

pH ISFET sensors
- deep-sea DuraFET, deep SeaFET

F(Chla) Fluorometers
- ECO, MCOMS

Backscatterometers / Turbitometers
- ECO, MCOMS

Radiometers
- OCR, ?

Float Time

CTDs
- SBE41, RBR

Pre-Deployment Float Preparation

Includes Sensors:

- Sanity Checks on Sensor Data by “Quick Tests”, e.g.,
  - Check Nitrate using clean water. (Reading should be ~Zero.)
  - Check response of F(Chl a) / backscatter to fluorescent / scattering material
  - Check response of radiometer to skylight / shade
  - Check O_2 Optode response to air (not too far from saturation at given T and S=0) and exhale on it (O_2 should go down)

- Sensor Maintenance / Cleaning
  - Optics: Clean windows, put on protective caps
  - O_2 Optode: Do *not* rinse or clean optode with organic solvents, put on protective cap
  - ISFET pH: Keep in salt water, do not rinse with freshwater
  - SBE41 CTD, ISFET pH: Do not let water freeze inside...

Pre-Deployment Float Preparation

Includes Sensors:

- Are sensor data strings correct or corrupted? Possible sensor misconfiguration?
- Always transmit raw data (if possible).

  Processing power of the data system will always be better than of the float/sensor !
- Record all sensor configurations, calibration sheets, serial numbers, etc. *before* throwing the float overboard.
- *Make sure* to record all sensor configurations, calibration sheets, serial numbers, etc. before throwing the float overboard!
- Make a copy of it.

Deployment

! Don’t forget to take off protective caps before throwing the float overboard !

No urgent need for reference samples – but always good for data validation!

- O_2: Float with in air sequence and multipoint calibrated optode
- NO_3: Regression methods (CANYON-B, LINR, ...) work as good in most areas.
- ISFET pH: Strong initial conditioning period of sensor.
- Chl a: HPLC samples of science interest, but calibrations very consistent
- b_{bp}: POC samples of science interest, but calibrations very consistent
- Radiometry: good for science interest, but calibrations very consistent

During Deployment: Mission Requirements and Modifications

BGC-Argo requirement: contribute to the core-Argo mission, i.e.

- profile to 2000 m at least 1-3x per month

O_2 Optodes

- Need surface in-air measurements. (Request it from manufacturer!)
- At least 3x per month

NO_3 and pH

- Ensure deep enough profiles for sensor drift correction on “stable” water mass.

F(Chl a), b_{bp}, Radiometry

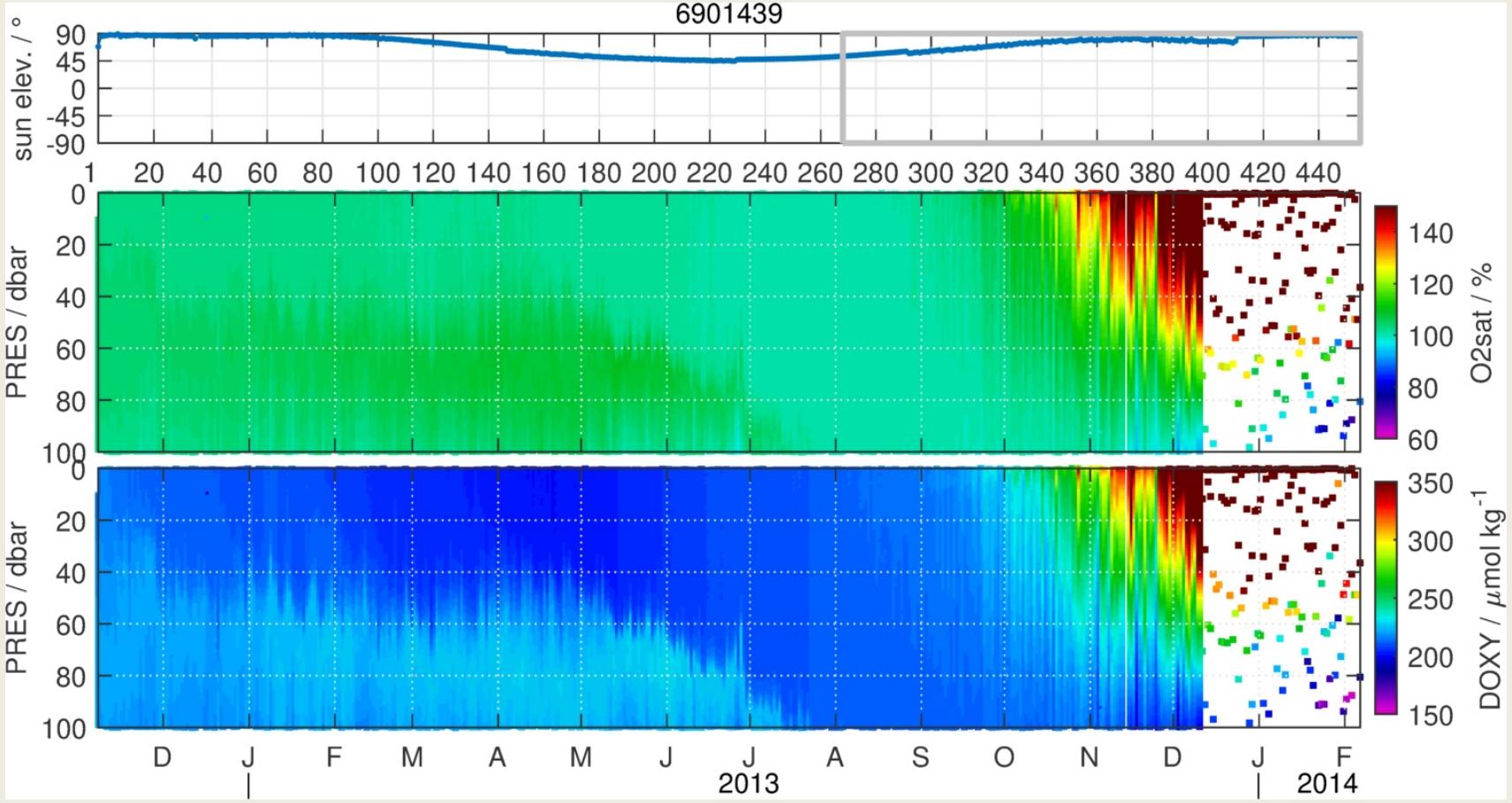
- Perform one deep profile at night once per year when there is the strongest temperature gradient (end of summer).
- High resolution (1 m) F(Chl a), b_{bp} data beneficial for particle dynamics in upper 100’s of meters

During Deployment: Mission Requirements and Modifications

O_2 Optodes, F(DOM), …

- Avoid daily surfacing at noon (in warm surface waters)!

- daily during noon; warm surface

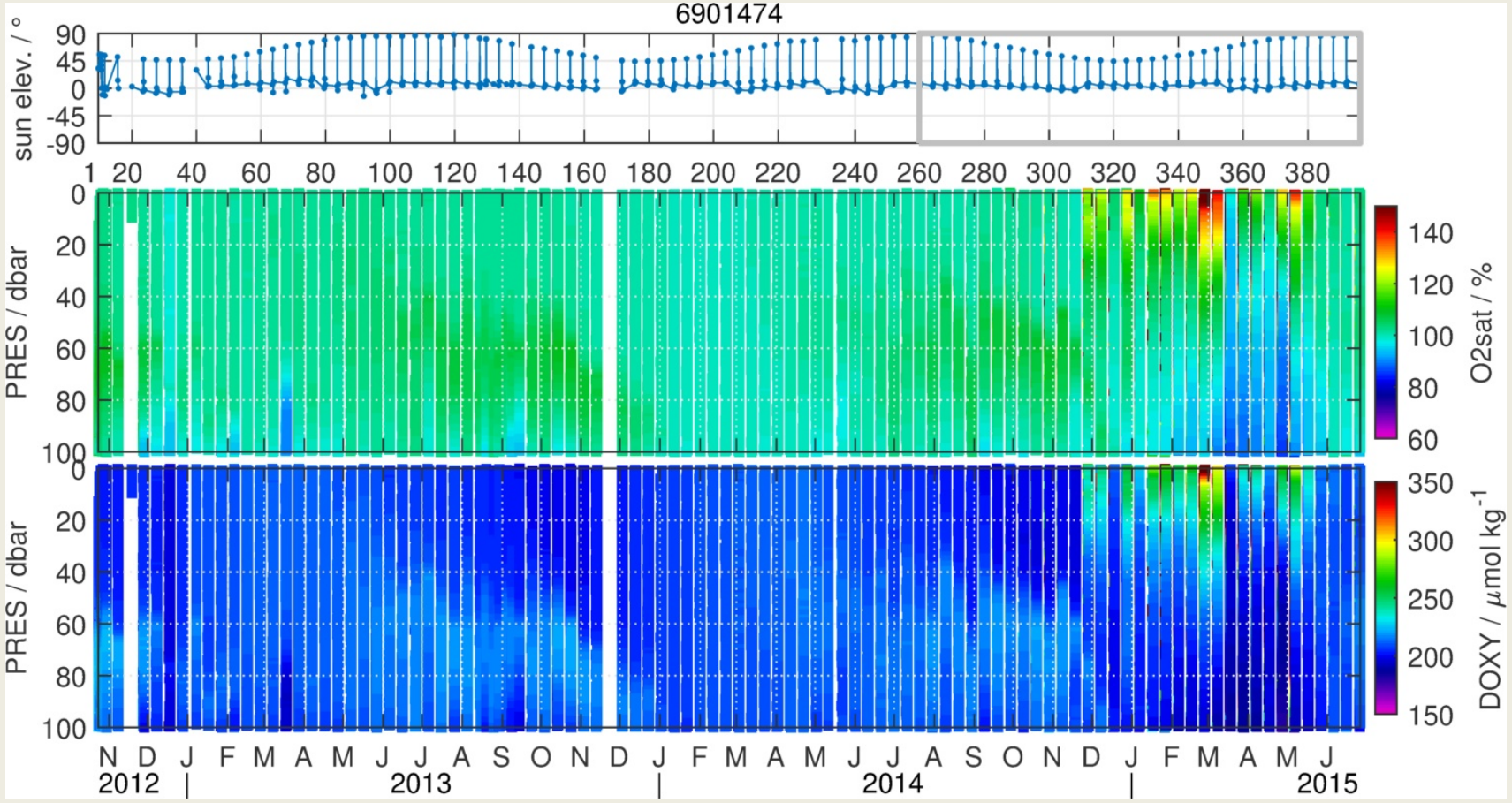


During Deployment: Mission Requirements and Modifications

O_2 Optodes, F(DOM), …

- Avoid daily surfacing at noon (in warm surface waters)!

- daily during noon; warm surface
- 4 rapid cycles at 10 d interval; warm surface

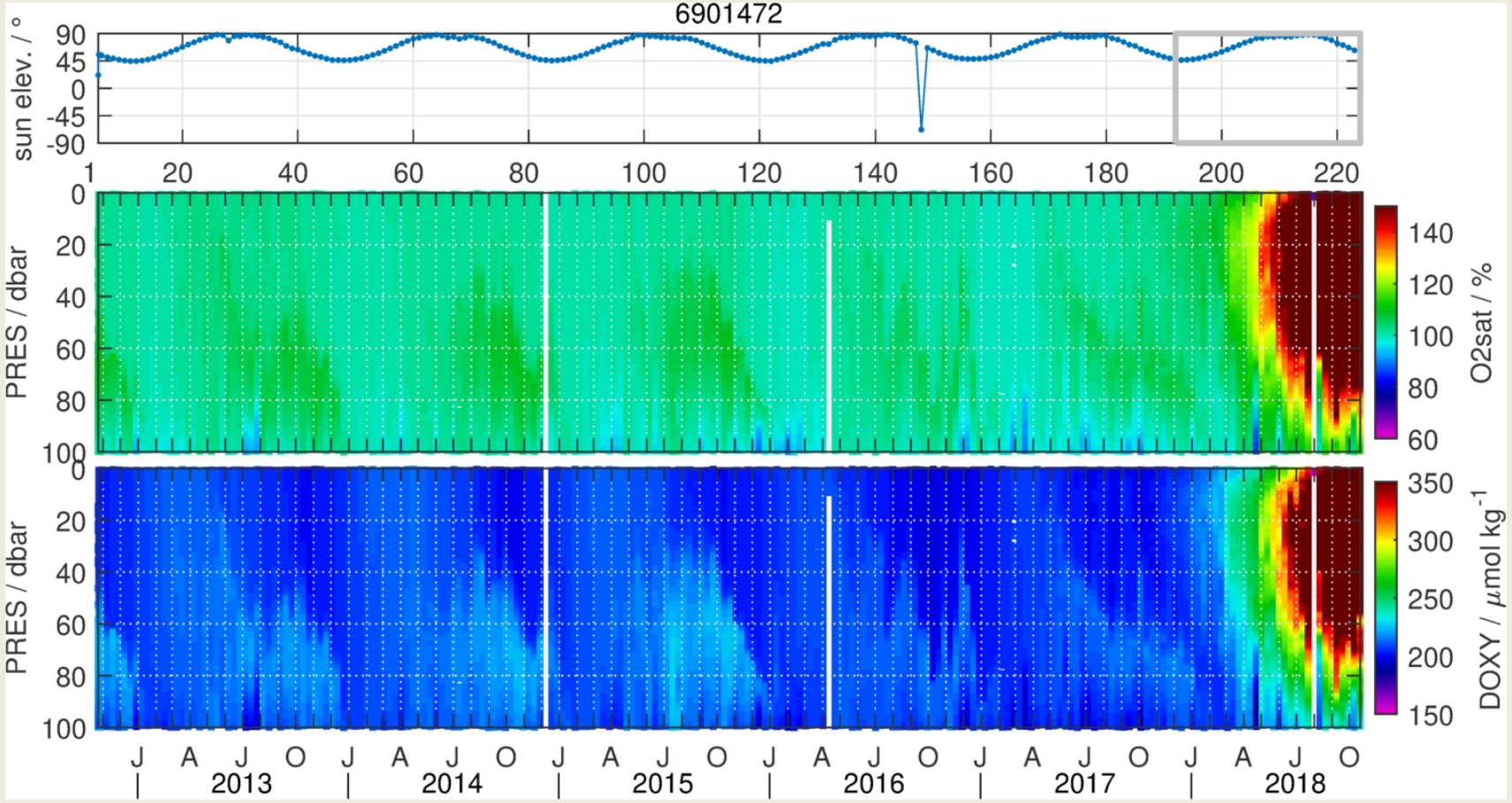


During Deployment: Mission Requirements and Modifications

O_2 Optodes, F(DOM), …

- Avoid daily surfacing at noon (in warm surface waters)!

- daily during noon; warm surface
- 4 rapid cycles at 10 d interval; warm surface
- 10 d during noon; warm surface

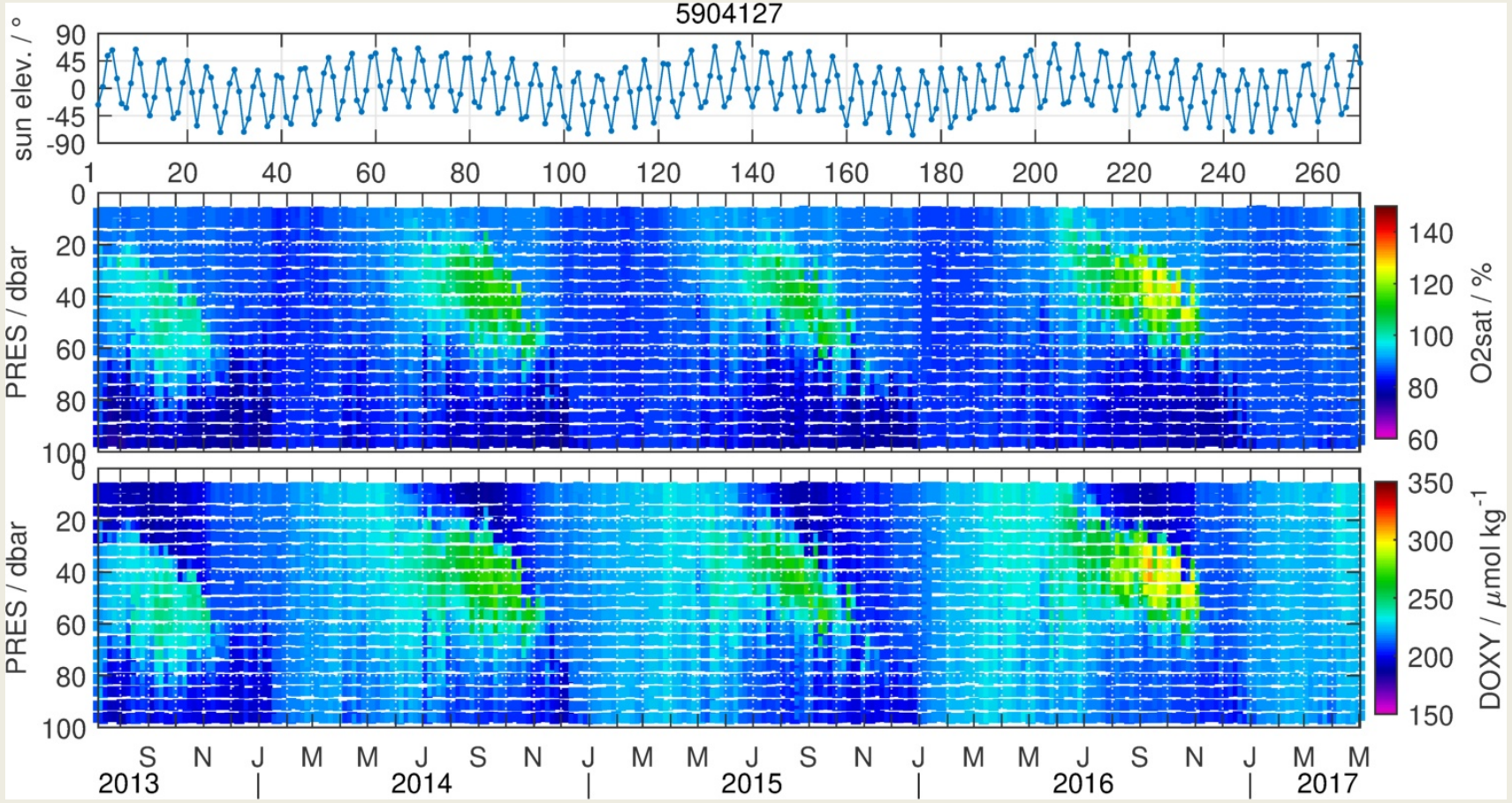


During Deployment: Mission Requirements and Modifications

O_2 Optodes, F(DOM), …

- Avoid daily surfacing at noon (in warm surface waters)!

- daily during noon; warm surface
- 4 rapid cycles at 10 d interval; warm surface
- 10 d during noon; warm surface
- 5 d interval; cold surface



Data Processing and Data Use

TABLE 6 | Overview about BGC-Argo documentation for the 6 core BGC variables.

Parameter	Processing at DAC level	RT and DM quality control
Oxygen	Thierry et al., 2018a (doi: 10.13155/39795)	Thierry et al., 2018b (doi: 10.13155/46542)
Nitrate	Johnson et al., 2018a (doi: 10.13155/46121)	In preparation
pH	Johnson et al., 2018b (doi: 10.13155/57195)	Johnson et al., 2018b (doi: 10.13155/57195)
Chlorophyll a	Schmechtig et al., 2015 (doi: 10.13155/39468)	Schmechtig et al., 2018a (doi: 10.13155/35385)
Particle backscattering	Schmechtig et al., 2018b (doi: 10.13155/39459)	In preparation
Radiometry	Schmechtig et al., 2017 (doi: 10.13155/51541)	In preparation

Header BGC-Argo QC manual: Schmechtig et al., 2016 (doi: 10.13155/40879).

Advanced Processing:

- O_2 time response correction requires time stamps... Required from float firmware!

Data Use:

- Don't even bother to use raw, unadjusted O_2, NO_3, pH data for science. (Ok for diagnostics.)

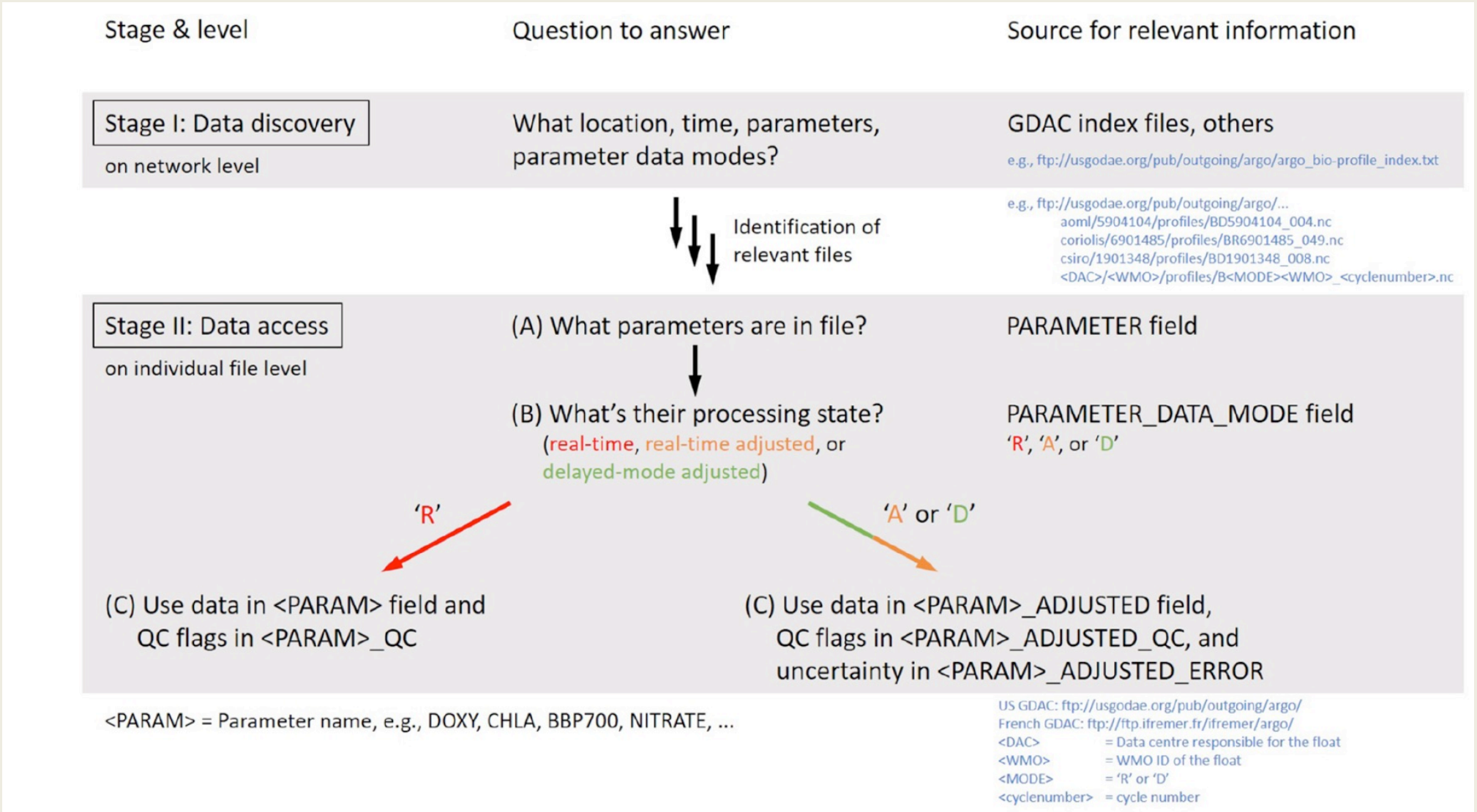


FIGURE 7 | Workflow how to discover **(stage I)** and access BGC-Argo data **(stage II)**.

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Henry Bittig, 29. Jan. 2020