STEP 2016, Physical Oceanography data from moorings M1 and M2

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Moorings M1 and M2 were deployed in Storfjorden (Svalbard) on July 14, 2016 from the French R/V L'Atalante (Chief Sci. EM/FV) and were recovered on September 28 2017 from the French R/V Pourquoi-Pas? (Chief Sci. FV/EM). The two moorings were deployed a few hundred meters apart (Fig 1), at the location occupied by the French OPTIMISM mooring (78°N, 20°E) dedicated to physical oceanography (PO), regularly serviced since 2011 from sailboats.
Mooring M1 includes mostly physical oceanography sensors but also   biogeochemistry sensors (Fig 2). Here only PO data are presented. Two netcdf4 files are provided for M1: one for hydrography (**STEP2016_M1_hydrography.nc**), the other one for currents (**STEP2016_M1_current.nc**). Only one netcdf4 files (**STEP2016_M2_hydrography.nc**) is provided for the shorter M2 mooring as the latter includes only 3 sensors for hydrography.

PO data have been calibrated and validated as part as of a Master's student internship (Abel Pruchon, Ecole Centrale de Nantes), supervised by F Vivier and A Lourenço (LOCEAN). The corresponding cal/val report is available (in French). Conclusions from this report and proposed corrections are applied to the dataset provided here. Pressure sensors indicate that the moorings remained vertical the whole time.
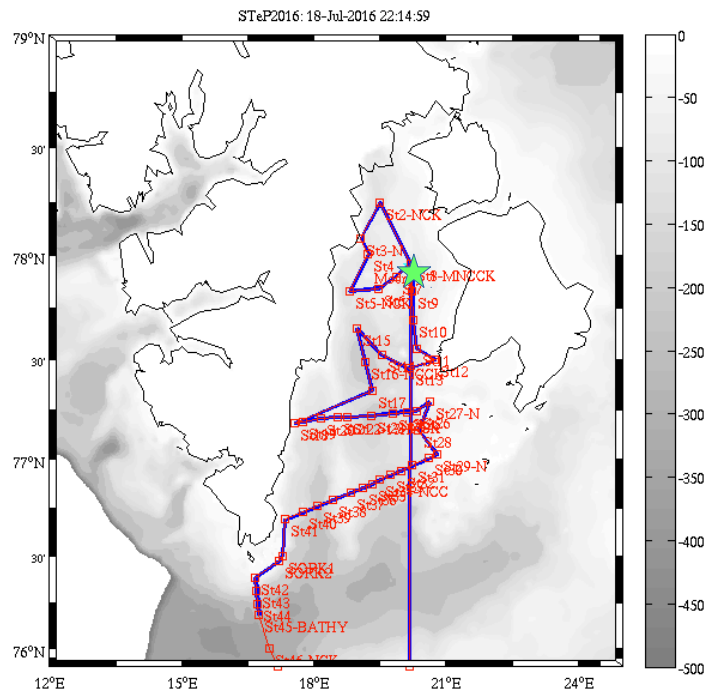

Figure 1: Location of moorings M1 & M2 deployed in Storfjorden (green star) and track from the STEP2016 cruise.

1. Mooring M1

1.a Hydrography

Mooring M1 includes 6 Seabird SBE37 microcat measuring temperature and salinity every 20' and 16 RBR autonomous temperature sensors with a sampling period ranging from 4" to 30" (Figure 1). Note that the actual depth (to which we refer below) is **5m shallower** than indicated on the figure.

The file **STEP2016_M1_hydrography.nc** includes the following fields:

SBE: including SBE_T SBE_S SBE_P. These are native data from SBE37 every 20'. A bias correction of -0.02 was applied to the salinity data from the SBE37 at 75m (the latter was not calibrated) which warrants the stability of the water column during the very weakly stratified winter months. Obviously bogus salinity data from the different sensors were flagged. This manual flagging is not exhaustive, however, and additional editing may be needed.

RBR: including RBR_T and RBR_P. The sampling period for this data set is 30". Time drift for each instrument was corrected (linearly). Only one RBR sensor measures as well pressure (RBR duo @ 70m). Pressure is otherwise deduced from intertwined SBE and from the mooring scheme for offsets. Temperature data every 4" were filtered with a 5 point running mean prior to interpolation. Sensors set to a 30" period (at 25,40, 55 and 75db) were interpolated on the common 30" timeline as is. The temperature record for RBR@75db stops in December 2016.

SBERBR: including SBERBR_T and SBERBR_P. This is an hybrid field with a time resolution of 20' (SBE) but an increased vertical resolution for temperature including RBR data wherever SBE data are not available. RBR data were interpolated as is on the SBE timeline without specific filtering. As above, RBR pressure data are inferred from SBE and from the mooring scheme, except at 70m).

indSBE: denotes the index on the vertical of SBE measurements in the SBERBR field (1,4,7,10,13,16)
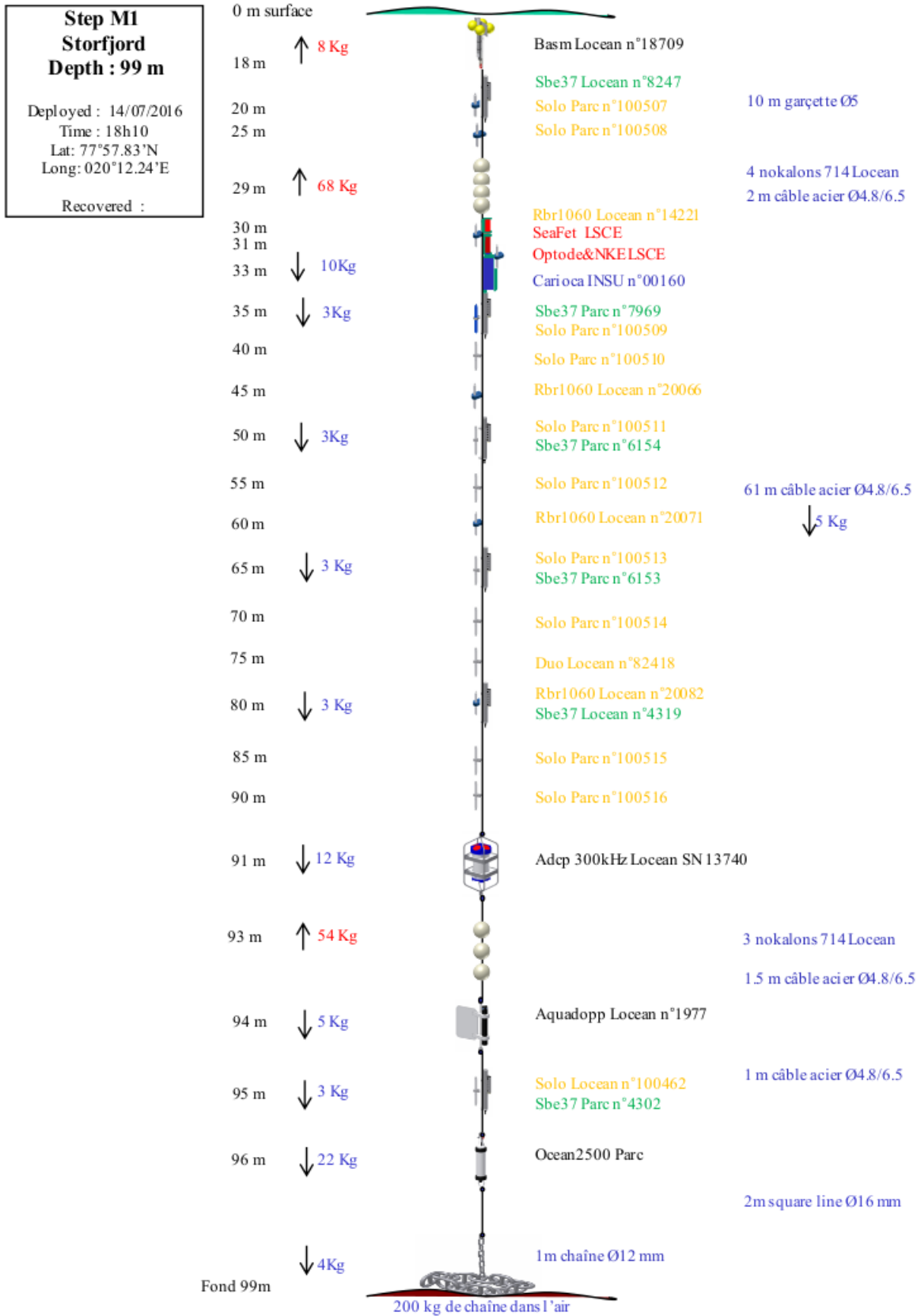
Step M1
Storfjord
Depth : 99 m

Deployed : 14/07/2016
Time : 18h10
Lat: 77°57.83'N
Long: 020°12.24'E

Recovered :

0 m surface

18 m — ↑ 8 Kg — Basm Locean n°18709

20 m — Sbe37 Locean n°8247
Solo Parc n°100507 — 10 m garçette Ø5
25 m — Solo Parc n°100508

29 m — ↑ 68 Kg — 4 nokalons 714 Locean
2 m câble acier Ø4.8/6.5

30 m — Rbr1060 Locean n°14221
31 m — SeaFet LSCE
Optode&NKE LSCE
33 m — ↓ 10Kg — Carioca INSU n°00160

35 m — ↓ 3Kg — Sbe37 Parc n°7969
Solo Parc n°100509

40 m — Solo Parc n°100510

45 m — Rbr1060 Locean n°20066

50 m — ↓ 3Kg — Solo Parc n°100511
Sbe37 Parc n°6154

55 m — Solo Parc n°100512 — 61 m câble acier Ø4.8/6.5

60 m — Rbr1060 Locean n°20071 — ↓ 5 Kg

65 m — ↓ 3 Kg — Solo Parc n°100513
Sbe37 Parc n°6153

70 m — Solo Parc n°100514

75 m — Duo Locean n°82418

80 m — ↓ 3 Kg — Rbr1060 Locean n°20082
Sbe37 Locean n°4319

85 m — Solo Parc n°100515

90 m — Solo Parc n°100516

91 m — ↓ 12 Kg — Adcp 300kHz Locean SN 13740

93 m — ↑ 54 Kg — 3 nokalons 714 Locean
1.5 m câble acier Ø4.8/6.5

94 m — ↓ 5 Kg — Aquadopp Locean n°1977

1 m câble acier Ø4.8/6.5
95 m — ↓ 3 Kg — Solo Locean n°100462
Sbe37 Parc n°4302

96 m — ↓ 22 Kg — Ocean2500 Parc

2m square line Ø16 mm

↓ 4Kg — 1m chaîne Ø12 mm
Fond 99m
200 kg de chaîne dans l'air

*Fig 2: Mooring M1 schematics: **instruments' depth is actually 5m shallower than indicated on the figure.***

1b. Currentmeter data

Mooring M1 includes two devices for current measurements. An upward looking ADCP (RDI WH300 kHz) at 87m (actual depth) and a Nortek Aquadopp single-point current-meter located 3 meters below (Fig 2).

The ADCP sampling is 6000s (1h40m). It performs an average over 18 pings spanning the first 90s of the measurement period, so these are virtually instantaneous measurements. The cell size is 4m. The first 3 bins are out of the water and were therefore dropped. The shallowest bin provided (centered at 5.25db) exhibits much larger (yet correlated) velocities values than that of the bin underneath, and should therefore be considered with some level of caution.

While the ADCP includes a temperature sensor, the water salinity is instead fixed at 35 for sound speed calculation. The corresponding error in velocity is on the order of 3%: no correction for the sound speed was applied. The ADCP temperature sensor appears to have a negative bias of around -0.06 degrees compared with the SBE at 90m: no correction was applied (SBE37 and RBR provide reference temperature measurements).

The Aquadopp (AQD) samples every 20minutes. The pressure sensors does not seem to work correctly. There is an obvious offset and a long term drift of 2db. The short period fluctuations (tides) are however well measured, and well phased with that from the ADCP all along the record, demonstrating that there is no time drift for either instrument, at least at the time resolution of the two instruments. Pressure data from the aquadopp were replaced by that from the SBE37 underneath, applying a -1db offset.

For both devices, no correction was applied for the sound speed velocity (small error), and no correction was applied either for the magnetic declination (11° 44,76' East in December 2016).

The file **STEP2016_M1_current.nc** includes the following fields:

Merged ADCP-AQD dataset with a 6000s time resolution (referred to as "ADCP")
This dataset has 21 levels on the vertical (the upper 20 levels are ADCP cells, and the deepest level is provided by AQD data interpolated on the ADCP timeline (no filtering)).
P: pressure of the different levels
U, V, W: East,North, Upward velocities
errV: Velocity error
corr: beam correlation; 3D fields (one 2D matrix for each of the 4 ADCP beams), set to NaN at AQD depth.
intensity: beam intensity; 3D fields (one 2D matrix for each of the 4 ADCP beams), set to NaN at AQD depth.
ADCP_Heading, ADCP_Pitch, ADCP_Roll, ADCP_Temp (Temperature), ADCP_Pressure (depth of the instrument): 1D time series.

AQD single-point measurements at 90db with a 1200s time resolution (referred to as "AQD").
Paqd: pressure of the different levels
Uaqd, Vaqd, Waqd: East,North, Upward velocities
errVaqd: Velocity error
AQD_Heading, AQD_Pitch, AQD_Roll, AQD_Temp (Temperature), AQD_Cs (sound speed): 1D time series.

2. Mooring M2

On this short mooring located close to M1, dedicated to biogeochemistry and paleo-oceanography, there are only 3 PO sensors: 2 RBRs (one solo at 67db, one duo at 87db) sampling every 4", and one SBE63 at 73db, including salinity and O2 concentration measurements and 2 temperature sensors sampling every hour (see Fig 3).
Note that the actual depth (to which we refer below) is 5m shallower than indicated on the figure.

The file **STEP2016_M2_hydrography.nc** includes the following fields:

SBE: including SBE_T (ITS 90, deg C) SBE_S (PSU) SBE_P (db) SBE_O2(mg/l) and SBE_T2 (oxygen temperature ITS 90, deg C) . These are native data from SBE63 every 60'.   Obviously bogus salinity data were flagged. This manual flagging is not exhaustive, however.
RBR: including RBR_T and RBR_P. The sampling period for this data set is 4". Time drift for each instrument was corrected (linearly). Only one RBR sensor measures as well pressure (RBR duo @ 95m). This RBR stopped functioning properly in July 2017. Temperature after this date has therefore been flagged, while pressure was completed with that from the SBE63, applying an offset of 13.8 db, which ensures almost perfect continuity in the observed tidal oscillations.
Pressure for the other RBR is deduced from the SBE, with a constant offset of -5.5db, according to the mooring scheme. Temperature data every 4" were filtered with a 3 point running mean prior to interpolation on a common 10" timeline.
SBERBR: including SBERBR_T and SBERBR_P. This is an hybrid field with a time resolution of 60' (SBE) but an increased vertical resolution for temperature including data from the 2 RBRs. RBR data were interpolated as is on the SBE timeline without specific filtering. As above, RBR pressure data is inferred from SBE.
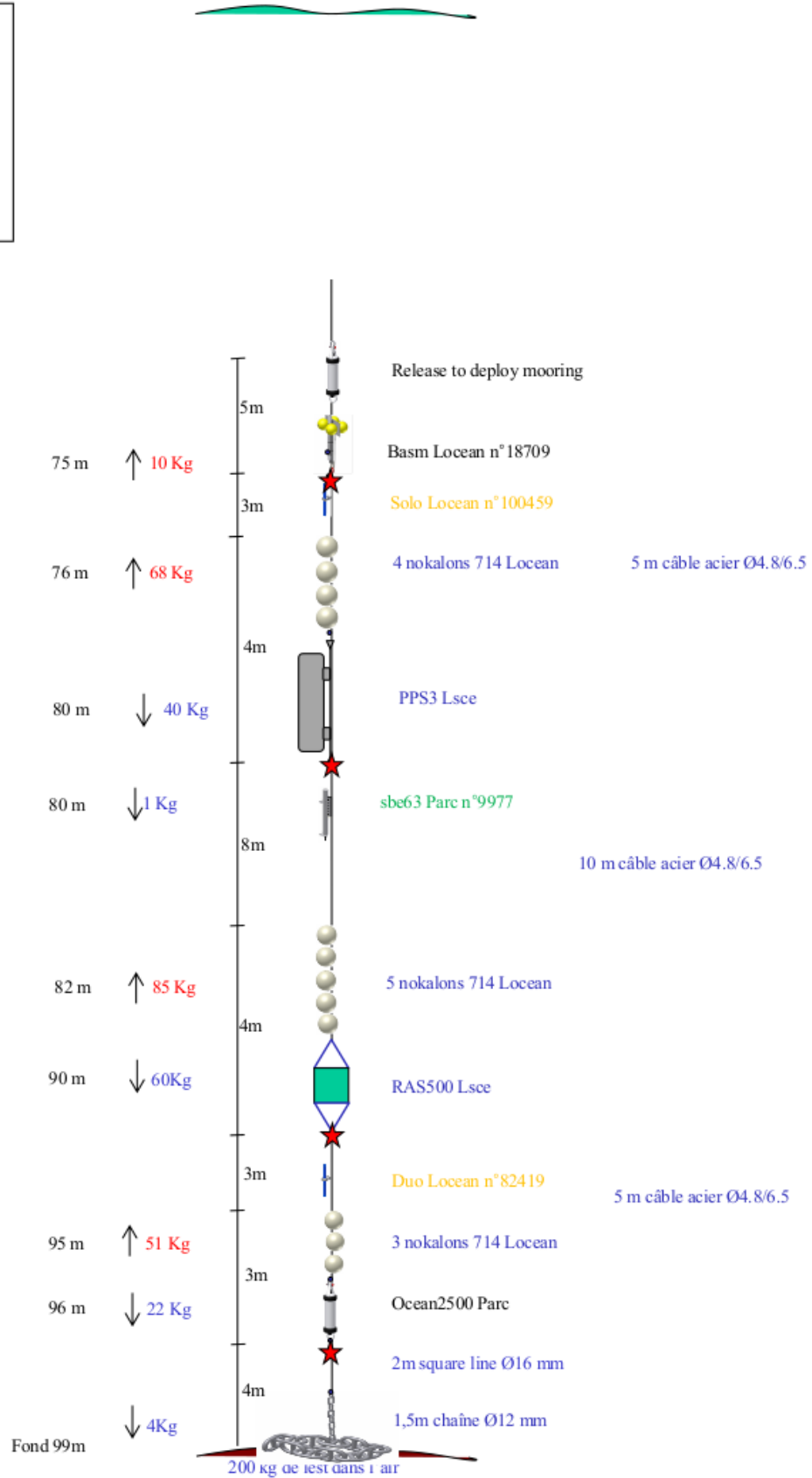**indSBE:** denotes the index on the vertical of SBE measurements in the SBERBR field (2)

*Fig 3: Mooring M2 schematics: **instruments' depth is actually shallower than indicated on the figure (7m for SBE).***