

RUSSIAN-GERMAN COOPERATION

System Laptev Sea



**Frontal Zones & Polynya Systems in the Laptev Sea:
The TRANSDRIFT XIX Expedition, September 2011**

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Expedition Program for Members of the Expedition

- Public version -

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1. INTRODUCTION

1.1. SCIENTIFIC BACKGROUND

Over the past decade it became evident that the Arctic is undergoing significant and sweeping changes such as increased air temperatures and enhanced wind mixing over most of the arctic shelf seas, reduced sea-ice cover and marked changes in amplitude and seasonality of river discharge. Most of these changes are already manifested on shelf environments. The Laptev Sea shelf (Siberian Arctic) and the Laptev Sea polynya were internationally defined as key regions in order to monitor and investigate variability and changes in system parameters in terms of changing boundary conditions as a result of climate change.

The project "Frontal Zones & Polynya Systems in the Laptev Sea" is a multi-disciplinary approach including remote sensing, multi-year sea-floor observatories, ice camps and ship expeditions, and coupled sea-ice-ocean modeling. Russian-German research teams from Saint Petersburg, Moscow, Tiksi, Bremerhaven, and Kiel are studying the flaw polynya in response to oceanic, sea-ice and atmospheric forcings as well as feedbacks of the Laptev Sea flaw polynya to the Arctic System.

1.2. GOALS AND TASKS

The main aim of the expedition TRANSDRIFT XIX is to obtain data on the present state of the marine environment in the Siberian Arctic shelf seas using up-to-date measuring and sampling technique. The major goals of the expedition are the following:

- investigation of oceanographic, hydrochemical, biological, and sedimentological conditions in the inner parts of the seas where frontal zones between riverine and marine waters occur in summer, and polynyas are formed in winter;
- investigation of frontal zones and lateral and vertical flows of heat, salt and particulate matter under different conditions of density stratification and bottom topography;
- investigation of the annual oceanographic records (current velocity, bottom-water temperature and salinity) from multiyear seafloor observatory stations deployed in the Lena polynya area;
- the biological investigations are aimed at 1. monitoring the Laptev Sea shelf ecosystems to gain additional information on the structure and functioning of arctic ecosystems during the ice-free period in relation to various environmental parameters and 2. analyzing food webs and carbon flux in shelf

ecosystems and assessing the role of autotrophic and heterotrophic elements of food webs in the carbon cycle;

- application of the data on the seasonal variability of different parameters characterizing marine ecosystems for climate forecast modeling.

The research tasks correspond to the main research initiatives of the IPY (International Polar Year 2007/08) and the “Laptev Sea System” program. These are:

- oceanographic survey in the Barents, Kara, Laptev, and East Siberian seas during summer and fall;
- hydrophysical investigations within polygons in the Kara and Laptev seas positioned in the local seasonal frontal zones;
- oceanographic measurements at selected stations along transects and hydrophysical polygons;
- water sampling at oceanographic stations for measuring nutrient content, concentration of dissolved oxygen, pH, composition of ions, chlorophyll a concentration, suspended matter and organic carbon content;
- biological sampling (phyto/zooplankton, benthic organisms) at the oceanographic stations;
- marine geological investigations (analysis of downcore records and surface sediment characteristics);
- onboard meteorological survey;
- analysis of the data on thermohaline characteristics of the arctic shelf seas in a specific season;
- analysis of the spatial-temporal distribution of oceanographic parameters over the Arctic seas;
- analysis of the spatial-temporal distribution and seasonal variability of freshwater plumes;
- revealing the seasonal local frontal zones and observation of their variability in space and time;
- characterization of the Atlantic waters entering the St. Anna and Voronin troughs in the Kara Sea and tracing their further subsurface inflow to the Laptev Sea shelf;
- revealing the zone with stagnant waters on the Arctic shelves;
- thermohaline measurements in flaw leads and polynyas;
- estimation of the lateral heat and salt exchange at the freshwater/saltwater interface;
- investigations of the transformation of structural zones and water masses in the shallow regions;

- enlargement of the oceanographic databases of the State Informational World Ocean Service (ESIMO), Russian Hydrometeorological Survey (Rosgidromet), Arctic and Antarctic Research Institute (AARI);
- investigation of the taxonomic composition, total abundance and biomass of phytoplankton and its distribution in the Laptev and Kara seas in relation to diverse abiotic factors and specific conditions of certain years;
- obtaining the data on vertical and lateral distribution of chlorophyll a as the main indicator of primary productivity in the Laptev Sea, its daily and seasonal dynamics;
- investigation of the taxonomic composition, spatial and temporal distribution of zooplankton, seasonal dynamics of its total abundance and biomass, as well as variability of the species composition and relative abundance of certain species depending on hydrological and hydrochemical characteristics;
- obtaining new data on the distribution of benthic species and total abundance, biomass, and structure of benthic assemblages in the shelf zone, especially in the region where the polynya is located in the winter;
- collecting the data on the composition and abundance of ichthyofauna, birds and mammals as the end consumers of food webs.

1.3. EXPEDITION BACKGROUND

The TRANSDRIFT XIX expedition is an integral part of the joined Russian-German project “Laptev Sea System”. It is funded by the German Federal Ministry for Education and Research and the Russian Ministry of Education and Science.

The vessel used for the expedition will be the RV YAKOV SMIRNITZKI (Fig. 1). The RV YAKOV SMIRNITZKI has already been successfully used for the TRANSDRIFT VII, VIII, X and XVI expeditions. In addition to investigating the exchange processes and interaction between atmosphere, hydrosphere and seafloor, seven oceanographic seafloor observatories (“moorings”) are going to be recovered during the TRANSDRIFT XIX expedition. Five of these seafloor observatories were deployed during the TRANSDRIFT XVII expedition in September 2010, two were deployed in 2009, each of them for a period of one or two years to monitor seasonal variability in surface-sediment temperature and in oceanographic parameters within the water column.

Five of these seafloor observatories will be re-deployed throughout the cruise.



Fig. 1: RV "YAKOV SMIRNITSKY", Hydrobase Arkhangelsk, in Tiksi port

2. WORKING PROGRAM - GENERAL

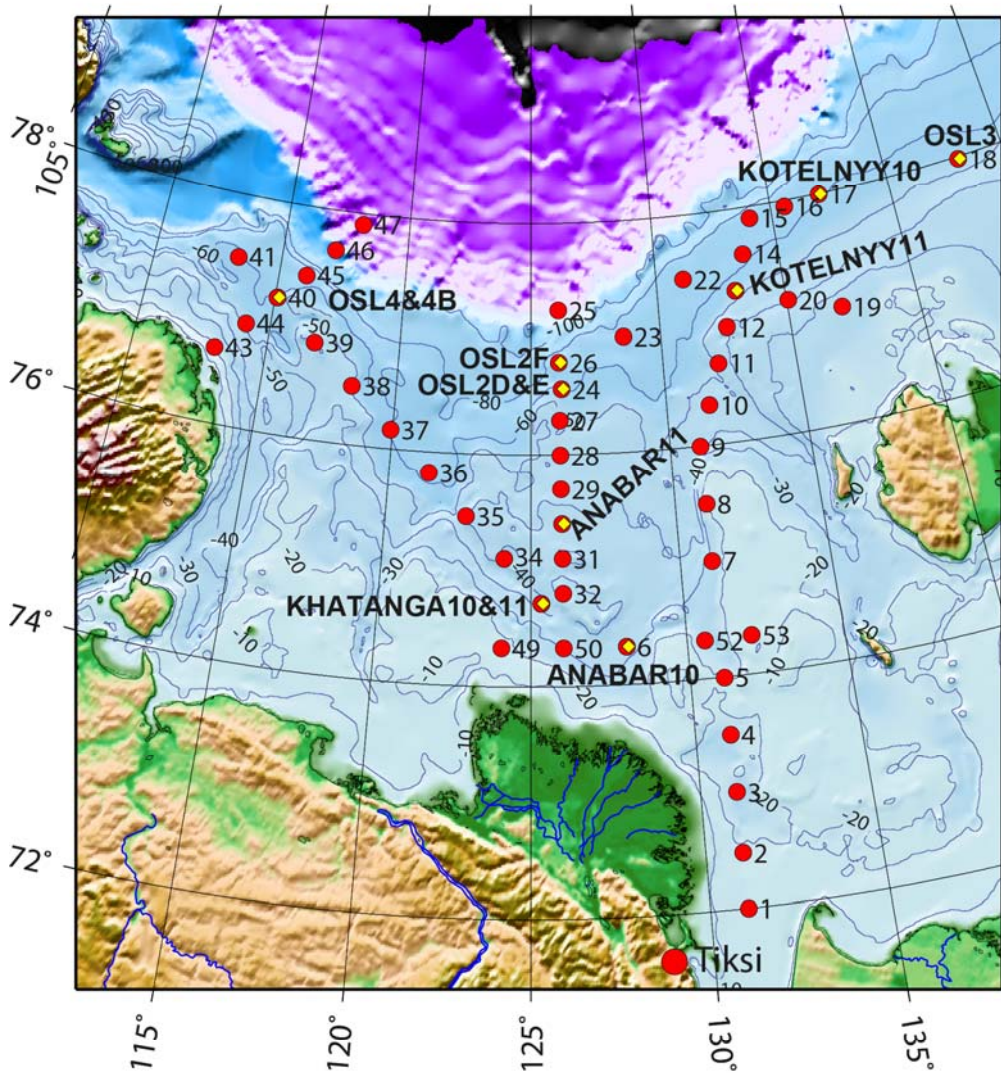
During the TRANDRIFT XVII expedition in 2010 five seafloor observatories (ANABAR10, KHATANGA10, OSL2D, KOTELNYY10 and OSL4 all shown in Fig. 2; the layout of these seafloor observatories can be seen in Fig. 3) were deployed for the period of one year in our working area (Fig. 2) to study the seasonal variability in temperature and salinity distribution within the water column, interacting processes in the transition water column/sediment and in the current system, the transport processes as well as to monitor the ice conditions.

Two seafloor observatories (OSL3 and OSL2E) were deployed in 2009 already, and need to be recovered also.

Two of the seafloor-observatories were deployed in the near shore area north of the Lena Delta to characterize processes in an onshore/offshore environment, to study changes in the hydrodynamic system and its interaction with the seafloor, and to catch polynya events during winter time. All other seafloor-observatories were deployed more on the outer shelf. All of these seafloor observatories will be recovered during the TRANSDRIFT XIX expedition, and five will be re-deployed.

Complementary high resolution (temporal and spatial) measurements of the water column will be carried out near the bottom stations and along linking profiles including temperature, salinity, chlorophyll, oxygen, hydrochemistry, turbidity and total suspended matter concentration measurements in the water column. These measurements will be carried out by using a programmable carousel water sampler (Fig. 4).

Proposed station plan for TRANSDRIFT XIX (August / September 2011)



- ◆ Mooring positions
- Rosette/CTD stations

The station numbering indicates the planned order of performing the stations.

Start of cruise: Tiksi
End of cruise: Tiksi

Mooring recovery:

- ANABAR10
- KOTELNYY10
- OSL3 (dredging, from 2009)
- OSL2D (dredging, from 2009)
- OSL2E
- KHATANGA10
- OSL4

Mooring deployment:

- KOTELNYY11
- OSL2F
- ANABAR11
- KHATANGA11
- OSL4B

Fig. 2: Bathymetric map of the Laptev Sea and main target area for the TRANSDRIFT XIX expedition. Hydrographical stations are marked red, while deployment and recovery of the seafloor observatories are named and marked yellow. Please note that the numbering does not necessarily show the order in which the stations will be performed.

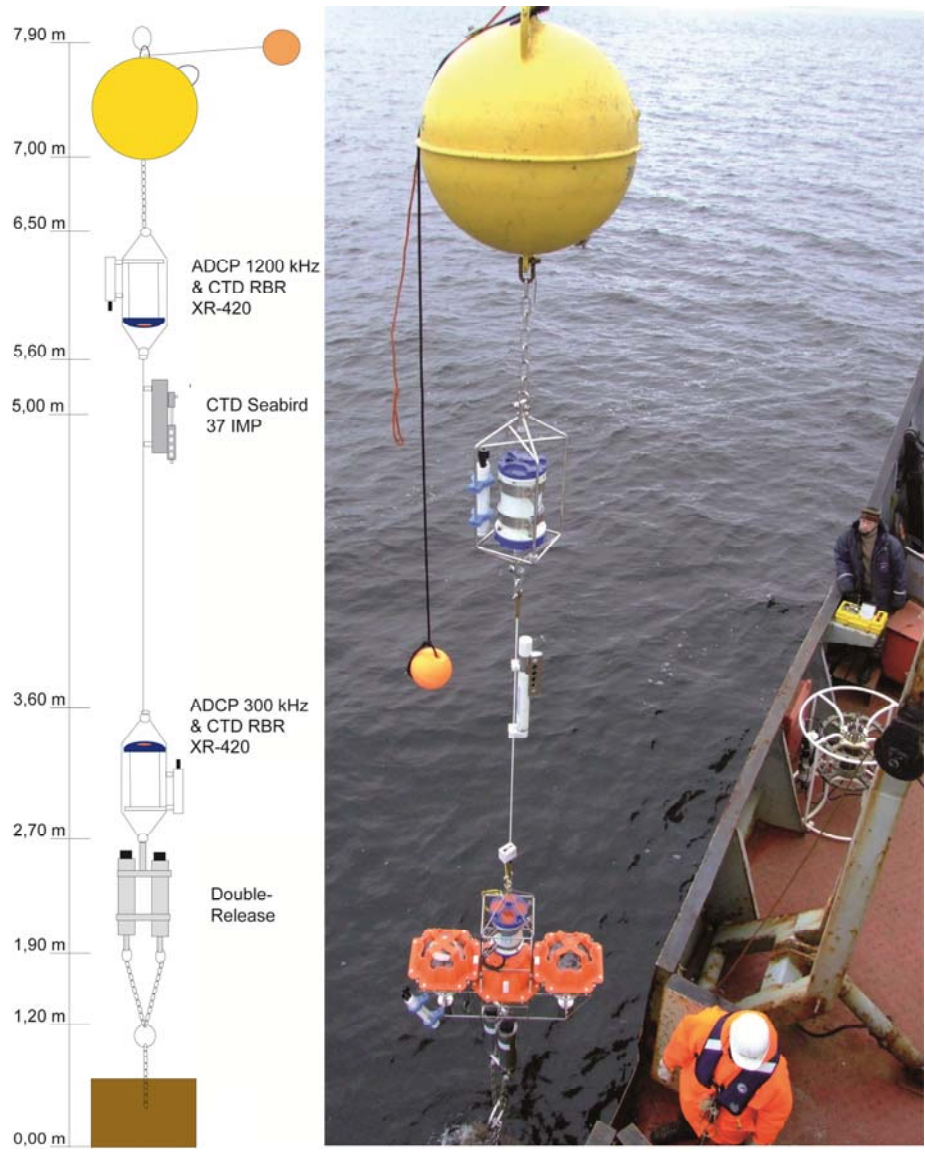


Fig. 3: Seafloor observatory KHATANGA, which was deployed in summer 2010 and will be recovered during the TRANSDRIFT XIX expedition. The design of all the seafloor observatories is either the same or slightly adapted to local conditions.



Fig. 4: Carousel water sampler (“Rosette”) Seabird 32C with attached AFM (Automatic Fire Module) and CTD (Conductivity-Temperature-Depth) Seabird 19+.

2.1. METHODS AND EQUIPMENT - GENERAL

- Seafloor observatories ANABAR, KHATANGA, OSL2D/E/F, OSL3, OSL4 and KOTELNYY, usually equipped with upwards looking Acoustic Doppler Current Profilers (ADCP, Workhorse Sentinel 300 kHz, RDI-Teledyne) and downwards looking ADCP 1200 kHz, 2 Conductivity Temperature Depth meters (CTDs, XR-420, RBR) in combination with turbidity meters (Seapoint), and 1 Conductivity Temperature Depth meter (CTD, SBE37IMP, Seabird Electronics); the detailed layout of all the seafloor-observatories we will recover can be found in Appendix 3.
- Carousel Water Sampler SBE32C (Seabird Electronics) with 12 water sample bottles, equipped with an CTD SBE19+ with conductivity, temperature, depth, oxygen, chlorophyll and turbidity sensors, as well as an AFM (Automatic Fire Module) to close the bottles at pre-programmed depths. In addition another CTD SBE19+ with an attached WETlabs WETstar CDOM sensor and a LICOR PAR-sensor will be used.
- On-board water measurements of oxygen
- photometric analysis of dissolved nutrients at the Otto Schmidt Laboratory in St. Petersburg;
- System for membrane filtration (0.4 μm) to determine suspended matter concentration in water samples.

3. WORKING PROGRAM – OCEANOGRAPHY

Drastic climatic changes have recently been observed in the Arctic environment being evident in the sea-ice cover, thermohaline properties of surface and intermediate waters, air temperatures and atmospheric circulation. The Siberian shelves are the regions where the most pronounced consequences of these changes have been observed since the beginning of the 2000s. The warmer atmosphere and longer ice-free period result in more heat being accumulated in the surface, intermediate and bottom layers during summer. This heat is a plausible source for the decreased ice thickness in following winter. The Laptev Sea is also affected by warmer Atlantic Waters (AW) penetrating the outer and inner shelves through the deep submarine canyons. Although AW are insulated from the atmosphere by the halocline layer these waters demonstrate an extreme increase of temperatures and are suggested to present another potential source affecting sea-ice formation. On the other hand, the sea-ice shrinking and river runoff increase likely shift the Laptev Sea freshwater balance to the fresher state. It means that vertical stratification is getting less penetrable for vertical mixing and heat/salt exchange.

However the particular problems concerning the Laptev Sea interior response to the rapid Arctic changes are insufficiently studied. Thus, the continuation of field activities in the frame of the joint Russian-German project “The Eurasian Shelf Seas in the Arctic's Changing Environment: Frontal Zones and Polynya Systems in the Laptev Sea” provides the possibility to conduct the scientific researches aimed to consider the following objectives:

- To determine the general spatial distribution of temperature and salinity over the Laptev Sea shelf and figuring out the position of frontal zones formed between fresh river water plume and more saline waters of deep Arctic basin;
- To examine the influence of atmospheric forcing to the river discharge distribution;
- Tracing the heat content anomalies over the Laptev Sea shelf and their vertical and horizontal extensions;
- To identify (through both thermohaline and hydrochemical analysis) the most shallow evidence of Atlantic Waters at the inner shelf;
- To determine the key mechanisms specifying the seasonal and climatic variations of water mass properties based on mooring records;
- Reflecting the thermohaline preconditions prior to the new seasonal cycle of ice formation.

In order to answer these questions the oceanographic activities during the TRANSDRIFT XIX expedition aim to collect temperature and salinity data allowing us to figure out the general thermohaline pattern over the Laptev Sea shelf in September 2011. These activities include operation at several snap-shot oceanographic sections with a typical distance between the stations of 15-30 nautical miles (see station plan, Fig. 2). Depending on ice and weather conditions the final location of each station might be displaced up to 10 nautical miles from the initial position. The pumped SEACAT Profiler SBE19plus will be used at these stations to gather CTD data having declared accuracies of $\pm 0.002^{\circ}\text{C}$ and ± 0.001 psu for temperature and conductivity sensors respectively.

3.1. METHODS AND EQUIPMENT - OCEANOGRAPHY

The instruments used for oceanographic work are already described in the “methods and equipment - general” section above. The seafloor observatories that deliver the long-term oceanographic data are also described above in the “working program – general” section, and are described in detail in Appendix 3.

4. WORKING PROGRAM – TRACER OCEANOGRAPHY

Aim of our project is to use stable oxygen ($\delta^{18}\text{O}$) isotopes of the water to study the formation of sea-ice and brine waters on the Siberian shelf areas.

Background: A main feature of the Arctic Ocean is the cold and fresh halocline, which is largely insulating the sea-ice cover from the underlying warm Atlantic layer (Aagaard et al., 1981). The Siberian shelves supply freshwater to the Arctic Ocean halocline and are main production areas for sea-ice. As a result brine waters are produced and exported to the Arctic Ocean halocline as well as to the Arctic Ocean bottom and deep waters. An important question is therefore the feedback of these processes to the ongoing climate change, which may alter the ability of the Arctic Ocean halocline to insulate the atmosphere from the warm Atlantic layer and thereby maintain the perennial sea-ice cover.

This study investigates the impact of brine waters on the hydrography of the Laptev Sea. The shelf regions are free of sea ice during summer when large quantities of river water spread onto the shelves. Melt water is also released during this time while sea-ice and brine waters are formed during winter. Since the Laptev Sea is one of the main production area for arctic sea ice, and large quantities of arctic freshwater are released here by the Lena River, possible changes in the Laptev Sea may potentially also significantly influence the Arctic Ocean hydrography.

Our study is carried out on the basis of the oxygen isotope composition ($\delta^{18}\text{O}$) of the water in conjunction with hydrological data. River water in the Arctic is highly depleted in $\delta^{18}\text{O}$ relative to marine waters and the effect of sea-ice melting or formation on the water column can be separated from these two sources since sea-ice processes strongly influence salinity whereas the $\delta^{18}\text{O}$ signal remains nearly unaltered. On this basis winter brine production can be quantitatively evaluated based on $\delta^{18}\text{O}$ and salinity summer data (e.g. Bauch et al., 2009).

Past observations have shown that the circulation pattern within the shelf can strongly influence the structure of the halocline within the Arctic Ocean. Combined salinity and $\delta^{18}\text{O}$ data from summer 2007 revealed a significant change in brine production in the Laptev Sea relative to summer 1994. While in 1994 maximal influence of sea-ice formation is seen within bottom waters, in 2007 the influence of sea-ice formation is highest within the surface layer and only a moderate influence of sea-ice formation is observed in the bottom layer. The observed changes if persistent or more predominant in the future may result in an altered export of waters from the Laptev Sea to the Arctic Ocean halocline (Bauch et al., 2010).

4.1. METHODS AND EQUIPMENT – STABLE OXYGEN ISOTOPES

We plan to take about 400 water samples for $\delta^{18}\text{O}$ during the TRANSDRIFT XIX expedition in the Laptev Sea. Measurement of $\delta^{18}\text{O}$ will be conducted at the Leibniz Laboratory for Radiometric Dating and Isotope Research at Kiel University.

Tentatively planned are 50 CTD/rosette stations with 5 to 10 depth levels depending on water depth. We plan to take samples at all of the CTD/rosette stations planned during the expedition down to the bottom (in order to capture bottom layers or bottom currents). Sampling depth (about): 0, 5, 10, 15, 20, 25, 30, 40, 50... bottom depth). Sampling of the deepest sample should be as close to the bottom as possible. The sampling depths are only suggestions, if more sampling levels are possible and taken, all levels should be sampled without skipping any of them.

4.2. BACKGROUND INFORMATION ON STABLE OXYGEN ISOTOPES

The most abundant isotope of oxygen is ^{16}O . Further stable oxygen isotopes are ^{17}O and ^{18}O . The natural abundance is $^{16}\text{O} = 99.76\%$, $^{17}\text{O} = 0.04\%$ and $^{18}\text{O} = 0.2\%$.

For analysis the ratio of $^{18}\text{O} / ^{16}\text{O}$ (R) is measured and given as the permille deviation relative to a standard. In the case of ocean water this is the sea water standard SMOW (standard mean ocean water):
 $\delta^{18}\text{O} \text{-sample} = (\text{R sample} / \text{R standard} - 1) \times 1000$

Since ^{18}O is slightly heavier a water molecule with H_2^{18}O will behave slightly different, e.g. it will evaporate less easily and later than its lighter counterpart but it will condense more easily and earlier than H_2^{16}O . Therefore there are isotopically different water masses. Most pronounced is the isotopic composition of river water (fed by evaporation and successive precipitation) with a $\delta^{18}\text{O}$ value for the Lena River of about -20‰ . Atlantic water on the other hand has a $\delta^{18}\text{O}$ value of about 0.4‰ .

Since $\delta^{18}\text{O}$ is measured on the oxygen of the H_2O itself it is not a trace element and its conservation is relatively easy. So no poisoning of the water is necessary. And some gas-exchange on a short time duration (bubbling while sampling) is of no harm. The only important thing to remember is to prevent the samples from evaporating: This is why $\delta^{18}\text{O}$ have to be stored (and sampled) in glass-bottles, because the evaporation through plastic containers is too intense. The same is true for the plastic caps, but since the area is small and the samples will be measured within a year, the error is small enough.

5. WORKING PROGRAM – CHROMOPHORIC DISSOLVED ORGANIC MATTER

Chromophoric dissolved organic matter (CDOM) exists in all natural waters. Its source is the degradation of plant material of both terrestrial and aquatic origin. In coastal waters it is present in large quantities due to runoff from rivers and it is responsible for a major part of the attenuation of photosynthetically available radiation (PAR). CDOM's light adsorption properties can result in both a positive and a negative feedback on aquatic organisms. In surface layers harmful UV light is attenuated, while deeper in the water column light is limited (Stedmon and Markager, 2001). The runoff from the Lena to the Laptev Sea is characterized by high concentrations of CDOM. Based on results of recent studies, we assume that riverine CDOM mixes conservatively with seawater. During the TRANSDRIFT XVII expedition it was shown that the CDOM concentration in the Laptev Sea can be used as a tracer for the spatial distribution, transport, and mixing processes of river water on the Laptev Sea shelf. The determination of the CDOM concentration in water samples will be supplemented by in-situ sensor measurements (WETLabs, CDOM sensor) parallel to all CTD casts. In addition samples for the determination of dissolved organic carbon (DOC) will be taken. The comparison between the CDOM data and the DOC concentration will allow us to draw conclusions about the applicability of CDOM as a proxy for dissolved organic matter in the marine environment.

5.1. METHODS AND EQUIPMENT - CHROMOPHORIC DISSOLVED ORGANIC MATTER

5.1.1. Sampling:

Sampling will be carried out along four transects across the Laptev Sea shelf and a transect running from the Lena Delta to the north-western Laptev Sea. Approximately 100 ml of water from different water depth (2m, 10m, 15m, 20m, 30m, 40m, 50m, 70m, 100m, and 200m) will be taken, filtered on board, and analyzed immediately after the expedition at the Otto Schmidt Laboratory in St. Petersburg. DOC samples will be analyzed at the Alfred-Wegener-Institut in Bremerhaven in cooperation with the department of Ecological Chemistry (Prof. Boris Koch).

5.1.2. Method:

Approximately 300 ml of seawater is filled into a pre-cleaned (with seawater from the same water sampler) bottles. Immediately after sampling the seawater will be vacuum filtered (at approx. 300-500 mbar) through a glasfibre filter with a pore size of 0.7 μm (Whatman GFF). The filter should be pre-washed with ~ 100 ml Milli-Q water and approx. 20 ml of the seawater sample (discard this water!). After

washing the filter, 200 ml of seawater is filtered. 100 ml of the filtrate is used to rinse the storage bottles (50ml, brown glass bottle and 60ml HD-polyethylene bottles). The rest of the filtrate is filled into the storage bottles and stored dark and cold (preferably 4°C to 7°C). The analysis will be carried on a SPECORD 200 spectrophotometer at the OSL in St. Petersburg (CDOM) and at the AWI Bremerhaven (DOC).

For the in-situ determination of the CDOM fluorescence a WET-Labs CDOM sensor will be attached to the Seabird 19+ CTD. To obtain depth profiles of the underwater light (PAR , 400-700 nm wavelength) a Quantum Sensor (LI-192 from LI-COR) will be attached to the carousel water sampler and the Seabird CTD.

6. WORKING PROGRAM – HYDROCHEMISTRY

Hydrochemical investigations are important for environmental monitoring. Dissolved oxygen is essential for respiration of organisms. It accumulates in seawater due to photosynthesis and seawater-atmosphere exchange. It is then utilized for respiration and decomposition of organic matter. Nutrients (silicates, phosphates, nitrites, nitrates) form the mineral basis for primary production. Together with temperature and salinity, hydrochemical parameters give evidence for the distribution of water masses and their temporal and spatial variability.

During the expedition, water sampling for hydrochemical analysis will be carried out on several stations in the Laptev Sea (Fig. 2). Water sampling will be carried out with the SBE 32c rosette equipped with twelve 5 l Niskin bottles, SBE 19plus CTD sensor and AFM module. These instruments are already described in detail in the oceanographic section of this cruise report. Sampling will be carried out on standard levels which are for the Laptev Sea Shelf as follows: 0 (surface, so 0-2 m), 5, 10, 15, 20, 25, 30, 40, 50 m and the level which is as close as possible to the bottom).

7. WORKING PROGRAM – BIOLOGY

Climatic changes are one of the most urgent among modern ecological problems. Climate warming strongly affects the high latitudes of the Northern Hemisphere causing shrinking of the ice cover in the Arctic Ocean (Barber & Massom, 2006), enhancing the influence of Atlantic waters on the arctic regions (Polyakov et al., 2005), and increasing freshwater discharge (Berezovskaya et al., 2005). About 50% of the Arctic Ocean area is occupied by the shallow continental shelf, which plays an important role in the transformation of water masses (Aagaard et al., 1981), biogeochemical processes and carbon cycling in the Arctic (Stein & Macdonald, 2004). The forecasted climate-induced changes in atmospheric processes, temperature-salinity characteristics of water masses, water stratification, sedimentation processes, and ice-free period duration will cause changes in light regime and phytoplankton bloom period, as well as the amount and distribution of nutrients. This will directly affect biochemical processes and their rate, planktic and benthic assemblages and the higher components of food webs, as well as the productivity of the arctic marine ecosystems.

The main goals of the biological investigations during this summer expedition are 1. monitoring the Laptev Sea shelf ecosystems to gain additional information on the structure and functioning of arctic ecosystems during the ice-free period in relation to various environmental parameters and 2. analysis of food webs and carbon flux in shelf ecosystems and assessment of the role of autotrophic and heterotrophic elements of food webs in the carbon cycle. The main research tasks are:

- investigation of the taxonomic composition, total abundance and biomass of phytoplankton and its distribution in the Laptev and Kara seas in relation to diverse abiotic factors and specific conditions of certain years;
- obtaining the data on vertical and lateral distribution of chlorophyll a, which is the main indicator of primary productivity in the Laptev Sea, and its daily and seasonal dynamics;
- investigation of the taxonomic composition, spatial and temporal distribution of zooplankton, seasonal dynamics of its total abundance and biomass, as well as variability of the species composition and relative abundance of certain species depending on hydrological and hydrochemical characteristics;
- obtaining new data on the distribution of benthic species, total abundance, biomass, and structure of benthic assemblages in the shelf zone, especially in the region where the polynya is located in winter;

- collecting the data on the composition and abundance of ichthyofauna, birds and mammals as the highest components of food webs

The samples that will be taken during the TRANSDRIFT XVII cruise will allow us to continue multiyear monitoring of the ecosystem of shelf part of the Laptev Sea. Analysis of the long-term data series allows indicating some trends/oscillations in the species composition and dynamics of the pelagic system and providing the background for the further assessment of ecosystem changes connected with climate variability in the Arctic region.

7.1 METHODS AND EQUIPMENT - BIOLOGY

7.1.1. CHLOROPHYLL “A” SAMPLING:

Water samples of 0.5 liters will be collected with the carousel water sampler at standard water depths and will be poured into plastic bottles. The water samples will be processed on board and will be filtered in the laboratory as follows:

1. The water samples are filtered through Whatman GF/F filters (0.7 microns) with pressure of not more than 0.2 bars.
2. After the water was filtered the filters are put with tweezers in Eppendorf tubes, signed with station and depth, and immediately put in the freezer on board, with temperatures not higher than -20°C.
3. Further processing of the samples will take place at the OSL Laboratory with fluorimeter TD 700 and SPECORD 200, after they were transported in a freezer to St. Petersburg.

7.1.2. Phytoplankton sampling:

Phytoplankton samples will be taken by Epstein net with a diameter of 20 cm and mesh size 20 microns. Depth levels of taken samples are in the water column below the pycnocline. After that samples will be poured into plastic bottles and fixed with 4% neutral formalin. Further processing of samples will be at OSL Laboratory and Moscow State University.

7.1.3. Zooplankton sampling:

Zooplankton samples will be taken by Epstein net with diameter 40 cm and mesh size 100 microns. Depth levels of taken samples are in the water column below the pycnocline and the total water column from bottom to top. After that samples will be poured into plastic bottles and fixed with 4% neutral formalin/or 76% alcohol. Further processing of samples will be at OSL Laboratory.

8. WORKING PROGRAM – SEDIMENTOLOGY

The distribution and dynamics of suspended particulate matter (SPM) influence the primary production in terms of availability of nutrients and the absorption of light. Changes in the SPM concentration and distribution might have serious effects on the sensitive Arctic ecosystem, e.g., increased SPM concentration via sediment resuspension and river discharge might impede primary production by limiting light penetration.

To investigate the vertical and horizontal distribution of SPM as well as their dynamics in comparison to the summers of 2007 to 2010 on the Laptev Sea shelf, the later described measurements in combination with one-year monitoring data on salinity, temperature and suspended matter recorded on the inner Laptev Sea shelf as well as in the outer shelf region will be carried out. SPM concentration in the water column can be derived by direct measurements (water samples) and indirect measuring devices (turbidity meter). The turbidity meter emits light of 880 nm wavelength with a constant output time of 0.1 sec. It detects light scattered by particles within the water column and generates an output voltage proportional to particles in the water column. The output is given in Formazine Turbidity Unit (FTU), a calibration unit based on formazine as a reference suspension. In order to estimate the SPM concentration from the turbidity meter signal water samples defined water depths will be taken and filtered. All turbidity measurements will be correlated with corresponding in situ water samples to obtain accuracy by taking the effects of different mineralogy, varying particle darkness, and salinity of ambient water on the response of the turbidity meter into account.

8.1. METHODS AND EQUIPMENT - SEDIMENTOLOGY

8.1.1. Direct measurements – water samples:

Water samples of 0.5 litres each need to be collected with a Niskin water sampler at defined water depths (surface, 5, 10, 15, 20, 30, ..., bottom water sample) and poured into plastic bottles. Before sampling, please check the turbidity profile and do not sample within gradients. Samples from gradients cannot be used for the conversion from optical backscatter data into suspended matter concentration.

The water samples need to be filtered in the laboratory as follows:

- Filter the water samples through (already) pre-weighed HVLP filters by MILLIPORE (0.45 microns).
- Filters need to be washed very carefully with distilled water. This is very important! Otherwise the salt on the filters will cause artificially high SPM concentrations.

- Put washed filters with tweezers in petri dishes for storing and close the petri dishes. Do not tape the dishes before drying!
- Filters need to be dried within the petri dishes on a warm and dust-free place.
- For transport after drying the petri dishes need to be taped.

8.1.2. Indirect measurements

The turbidity meter is already connected to the CTD and will measure the SPM concentration automatically.

9. LIST OF PARTICIPANTS OF TRANSDRIFT XIX EXPEDITION

#	Name	Nationality	Affiliation
1	Bauch, Dorothea	German	Mainz Academy
2	Brück, Bastian	German	IFM-GEOMAR
3	Gukov, Alexander	Russian	Lena-Delta- Reserve
4	Hölemann, Jens	German	AWI
5	Janout, Markus	German	AWI
6	Klagge, Torben	German	IFM-GEOMAR
7	Kolling, Henriette	German	IFM-GEOMAR
8	Martynov, Fedor	Russian	SPBU
9	Novikhin, Andrey	Russian	AARI
10	Novikhina, Elisabeta	Russian	VNIIO
11	Paul, Stephan	German	University of Trier
12	Ulfers, Arne	German	IFM-GEOMAR

10. LITERATURE

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11. PARTICIPATING INSTITUTES

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IFM-GEOMAR

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LDR

Lena Delta Nature Reserve
28, ul. Fedorova
678400 Tiksi, Russia

Mainz Academy

of Sciences, Humanities and Literature
Geschwister-Scholl-Straße 2
55131 Mainz, Germany

12. WEEKLY EXPEDITION REPORTS

More information, the regularly updated expedition diary as well as some photos can be found on the expedition's website:

<http://www.ifm-geomar.de/index.php?id=TDXIX>

APPENDIX 1: STATION LIST (AS PLANNED)

Station number	Long (dec.-deg.)	Lat (dec.-deg.)	Station work	
1	131.00	72.00	Rosette	
2	131.00	72.48	Rosette	
3	131.00	73.00	Rosette	
4	131.00	73.50	Rosette	
5	131.00	74.00	Rosette	
6	128.00642	74.33104	ANABAR10	recover
7	131.00	75.00	Rosette	
8	131.00	75.50	Rosette	
9	131.00	76.00	Rosette	
10	131.50	76.35	Rosette	
11	132.00	76.70	Rosette	
12	132.50	77.00	Rosette	
13	133.00	77.30	Rosette	
14	133.50	77.60	Rosette	
15	134.00	77.90	Rosette	
16	135.50	77.95	Rosette	
17	137.00	78.00	KOTELNYY10	recover
18	143.00890	77.98758	OSL3	recover
19	137.00	77.00	Rosette	
20	135.00	77.15	Rosette	
21	133.00	77.30	KOTELNYY11	deploy
22	131.00	77.45	Rosette	
23	128.50	77.00	Rosette	
24	126.08493	76.57065	OSL2E	recover and OSL2D recover
25	126.00	77.25	Rosette	
26	126.00	76.80	OSL2F	deploy
27	126.00	76.30	Rosette	
28	126.00	76.00	Rosette	
29	126.00	75.70	Rosette	
30	126.00	75.40	ANABAR11	deploy
31	126.00	75.10	Rosette	
32	126.00	74.80	Rosette	
33	125.28905	74.71441	KHATANGA11	recover
34	124.05	75.1	Rosette	
35	122.71	75.46	Rosette	
36	121.34	75.82	Rosette	
37	119.87	76.17	Rosette	
38	118.28	76.51	Rosette	
39	116.69	76.84	Rosette	
40	115.0	77.1666	OSL4	recover
41	113.20	77.45	Rosette	
42	115.0	77.1666	OSL4B	deploy
43	113.0	76.65	Rosette	
44	114.0	76.90	Rosette	

45	116.0	77.40	Rosette	
46	117.0	77.65	Rosette	
47	118.0	77.90	Rosette	
48	125.28905	74.71441	KHATANGA11	deploy
49	123.99685	74.333316	Rosette	
50	125.994516	74.3327	Rosette	
51	128.00642	74.33104	Rosette	
52	130.50	74.3325	Rosette	
53	132.000116	74.33475	Rosette	

APPENDIX 2: SHIP DRAWINGS / DECK PLANS

МИНИСТЕРСТВО ТРАНСПОРТА РОССИЙСКОЙ ФЕДЕРАЦИИ

MINISTRY OF TRANSPORT OF RUSSIA

ГОСУДАРСТВЕННОЕ ГИДРОГРАФИЧЕСКОЕ ПРЕДПРИЯТИЕ

Адрес: 190031, Санкт-Петербург
Московский пр.12
Телекс: 121345 PTB SU, факс: 3103768
Телефоны: (812) 310-37-68, (812) 310-39-70

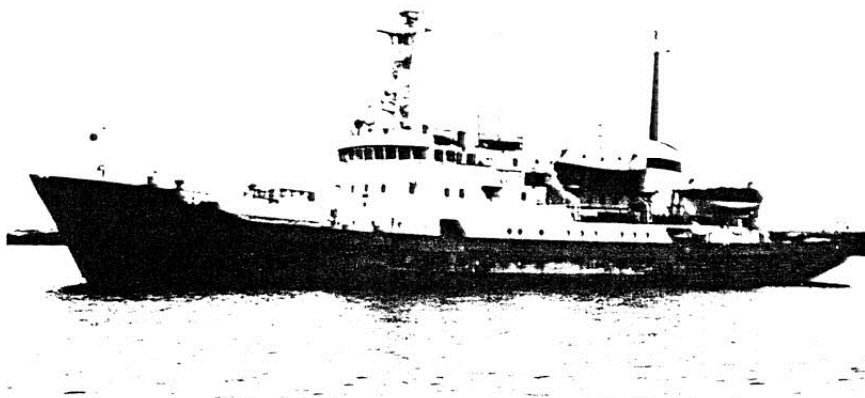


STATE HYDROGRAPHIC DEPARTMENT

Moskovskiy pr., 12
St. Petersburg, 190031, Russia
Telex: 121345 PTB SU, fax: 3103768
Phone: (812) 310-37-68, (812) 310-39-70

HYDROGRAPHIC SURVEY VESSELS

DMITRIY OVTSYN
DMITRIY LAPTEV
EDWARD TOLL
NIKOLAI KOLOMEITSEV
VALERIAN ALBANOV
VLADIMIR SUHOTSKIY
SERGEI KRAVKOV
NIKOLAI JEVGENOV
FEDOR MATISEN
GEORGIY MAKSIMOV
IVAN KIREJEV
PAVEL BASHMAKOV
JAKOV SMIRNITSKIY



OUTLINE SPECIFICATION

MAIN DIMENSIONS

		DMITRY OVTSIN- class	FJODOR MATISEN- class
Length over all	m	67.00	68.74
Length between perpendiculars	m	60.00	60.56
Breadth moulded	m	11.87	12.40
Depth moulded	m	6.00	6.04
Draught at L/2 in salt water	m	4.13	4.16
Tonnage, gross	GRT	1134	1213
Displacement abt.	tonnes	1630	1700
Crew+scientists		20+22	20+28
Speed	knots	14.0	14.0

MACHINERY

The propulsion machinery consists of a six-cylinder four-stroke turbocharged diesel engine, make Deutz RBV6M 358 with an output of 1,470 kW (2,000 bhp) at 5.25 r/s, coupled via a Spiroflex coupling to a four-bladed KaMeWa controllable pitch propeller. Electricity is generated by three 150 kVA diesel generating sets and a 185 kVA shaft alternator. In addition there is a 65 kVA emergency unit. Steam is generated by a 800/350 kg/h at 490 kPa boiler.

Main engine and other machinery remote controlled from a central control room.

PERFORMANCE

The vessel is built of welded steel construction with ice strengthening. This together with the excellent seakeeping ability secures operation in all conditions. In addition to the c.p. propeller there is a bow thruster and a Maierform-type passive antirolling stabilizing tank system.

The vessel is a silent ship and has good manoeuvrability on a speed range starting of around 4 knots. The stores are sufficient for 40 days consumption of 52 crew members. The fuel tank capacities allow for continuous running of the engines for 36 days. Depending on the version there are high standard accommodation for 42/48 crew members making it possible to perform also long sailings.

There are the following research spaces and laboratories:

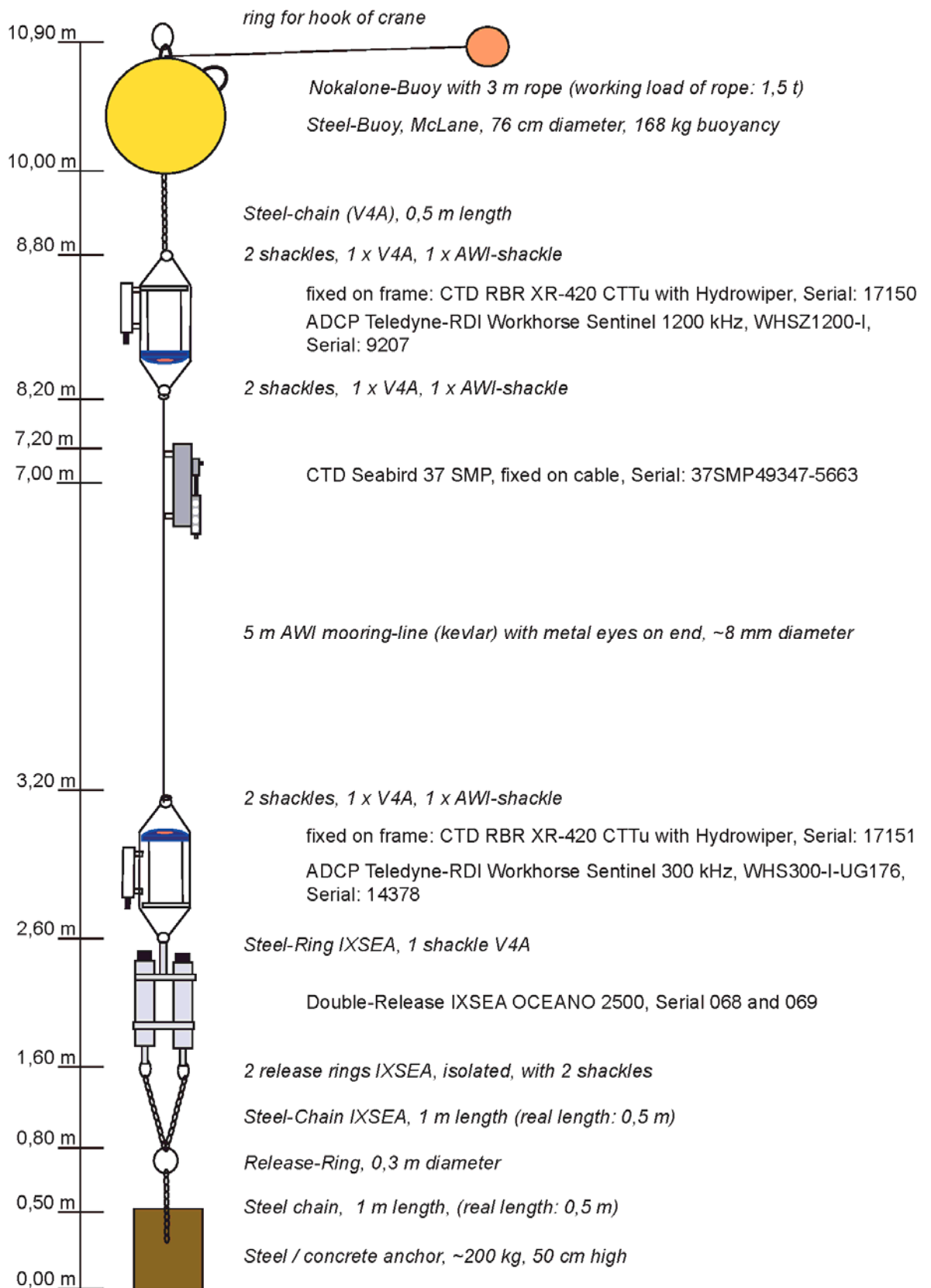
- hydrographic research centre 27 m²
- plotting room 15 m²
- hydrological laboratory 16.5 m²
- rough laboratory 9 m²
- photographic laboratory 4.5 m²

CAPACITIES

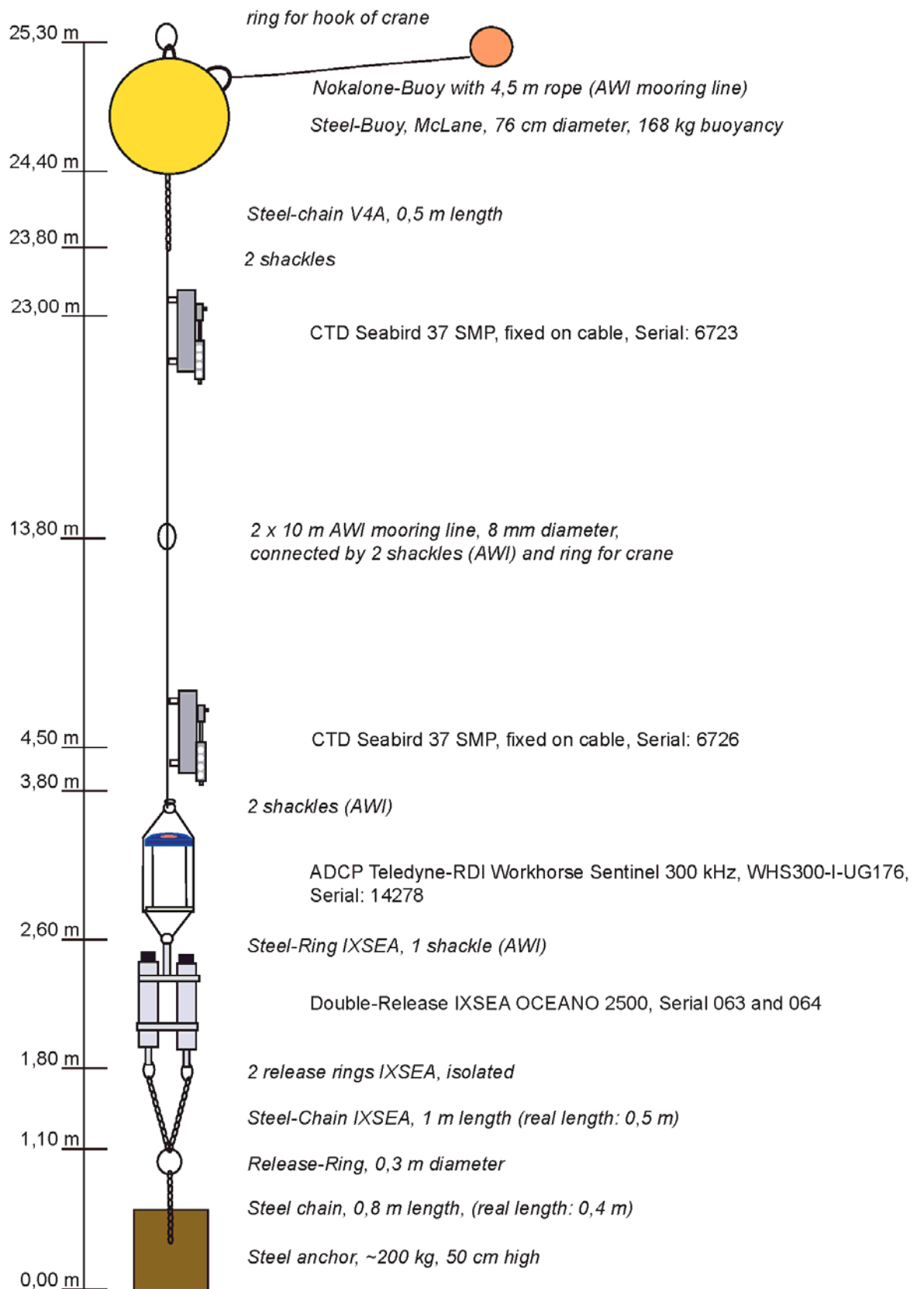
Diesel oil	260 tonnes
Lubricating oil	6 tonnes
Fresh water	160 tonnes
Cargo	abt. 100 tonnes

APPENDIX 3: SEAFLOOR OBSERVATORIES

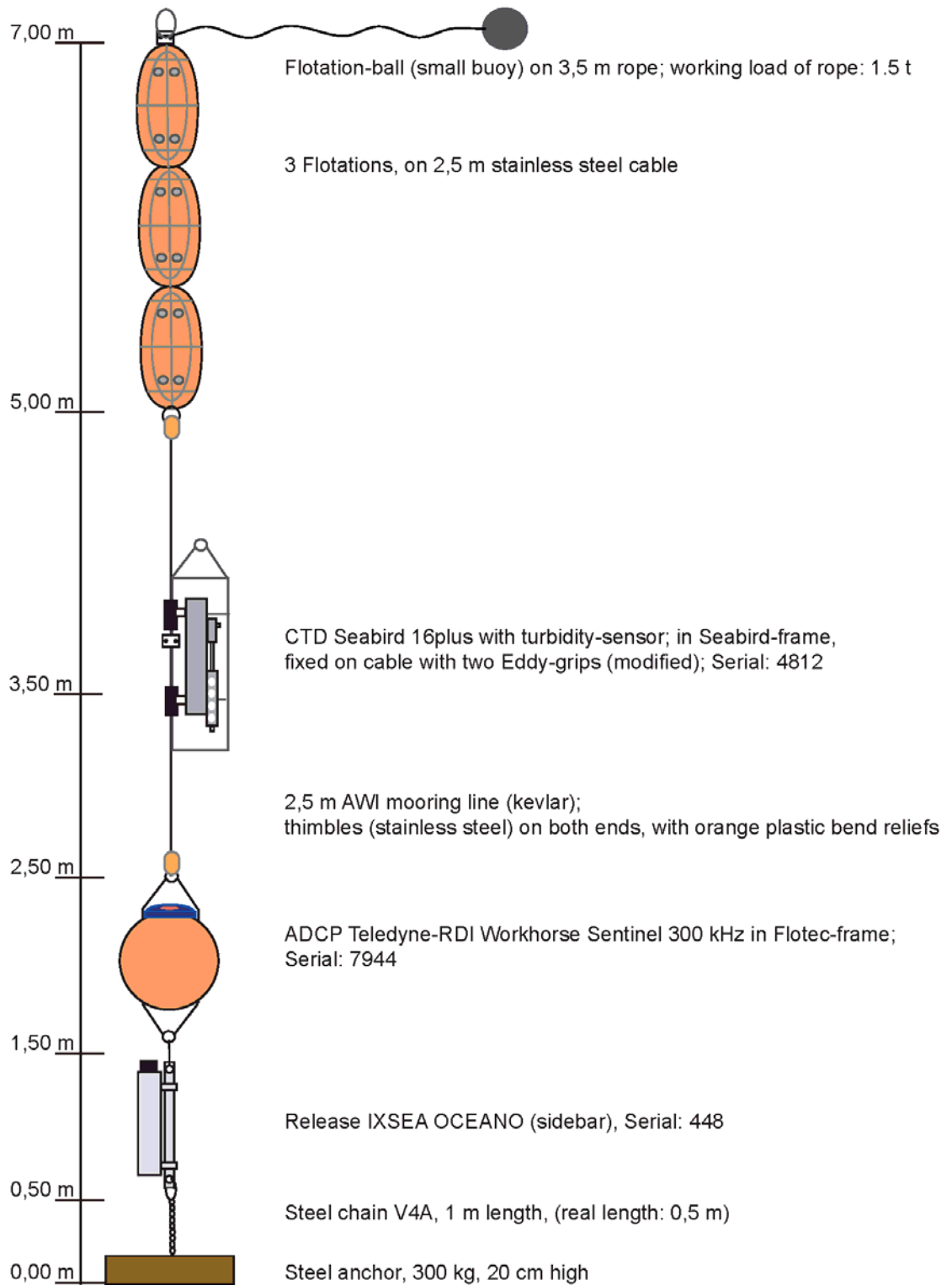
3.1 ANABAR10



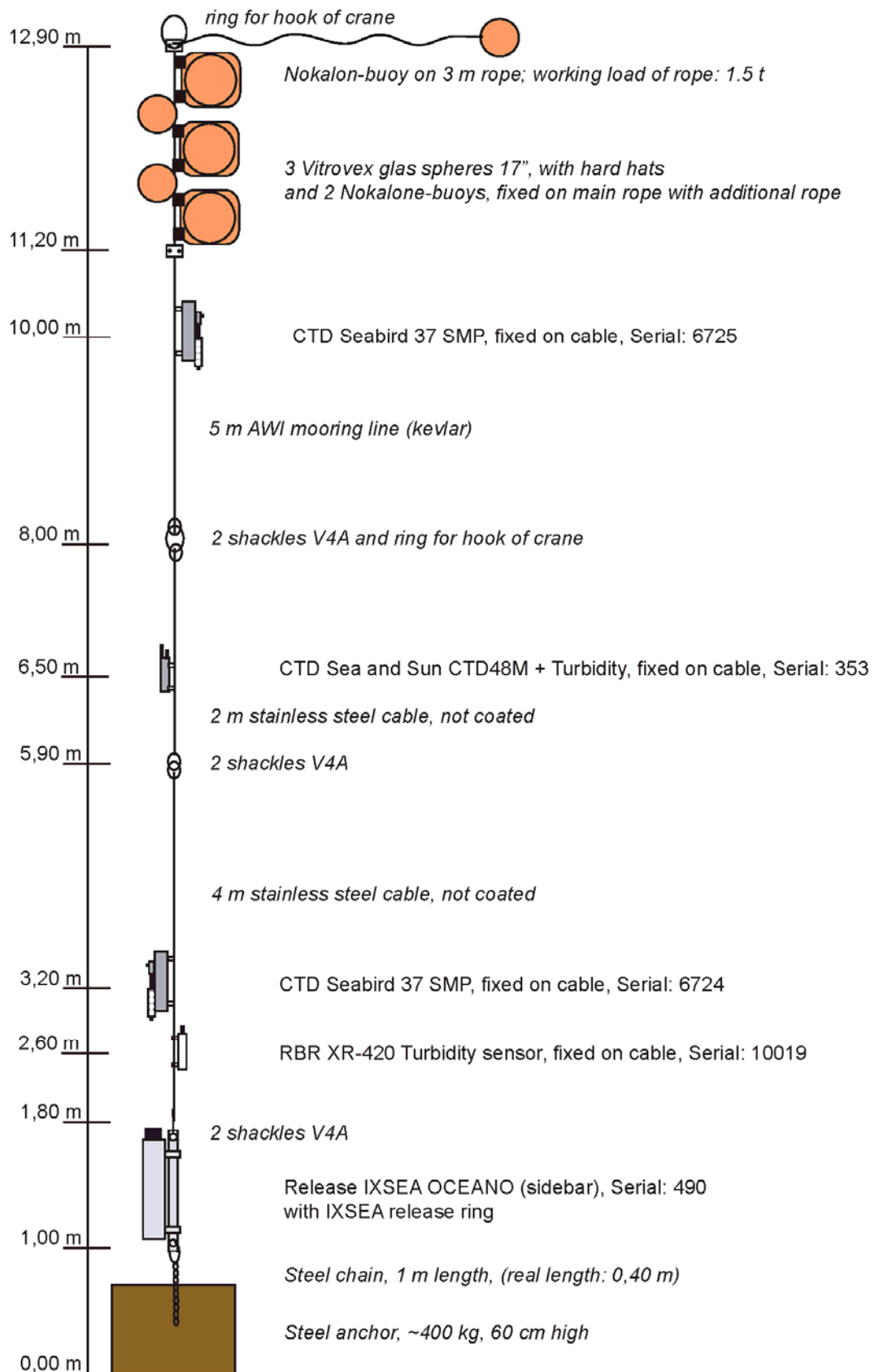
3.2 KOTELNYY10



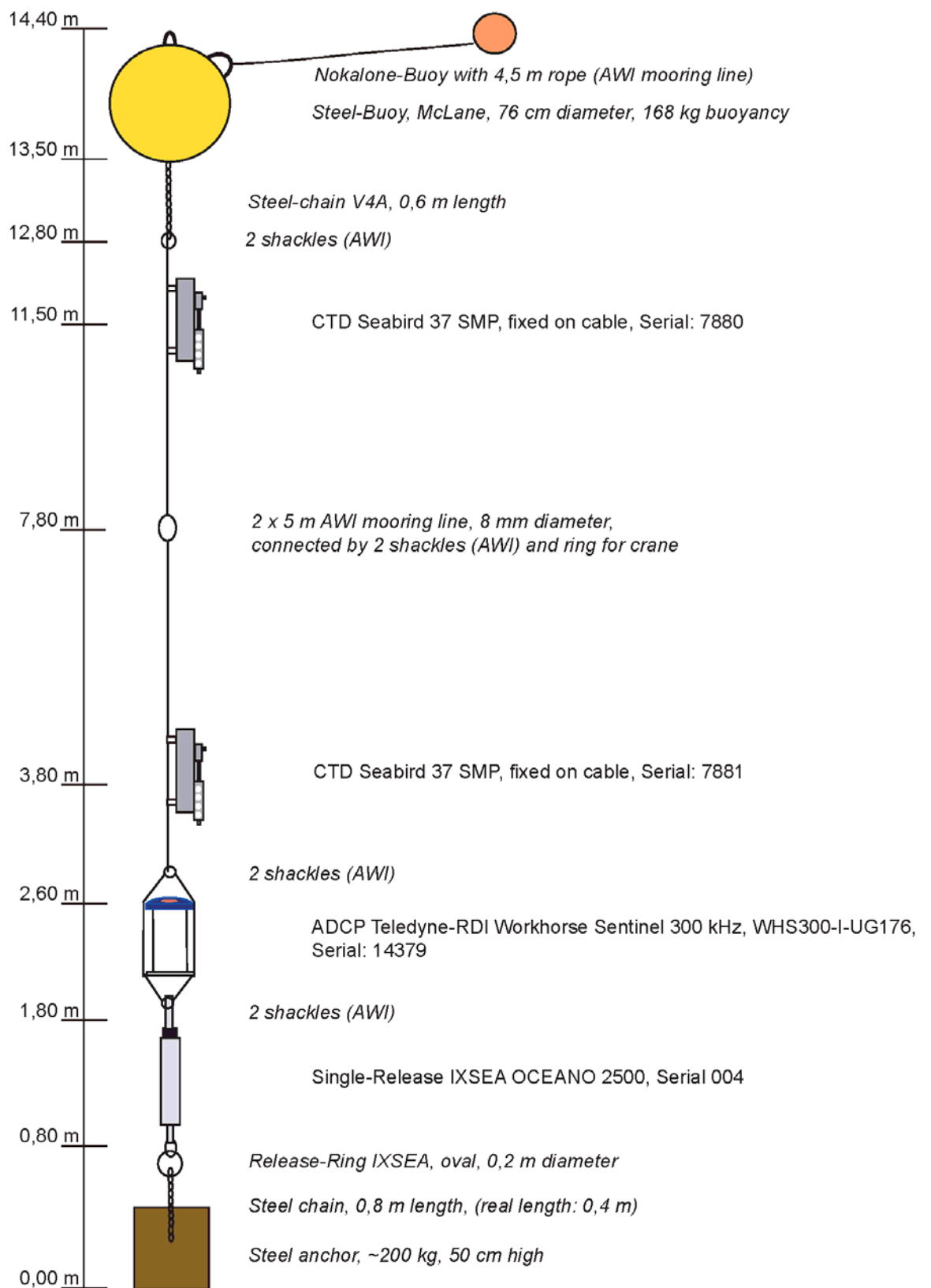
3.3 OSL3



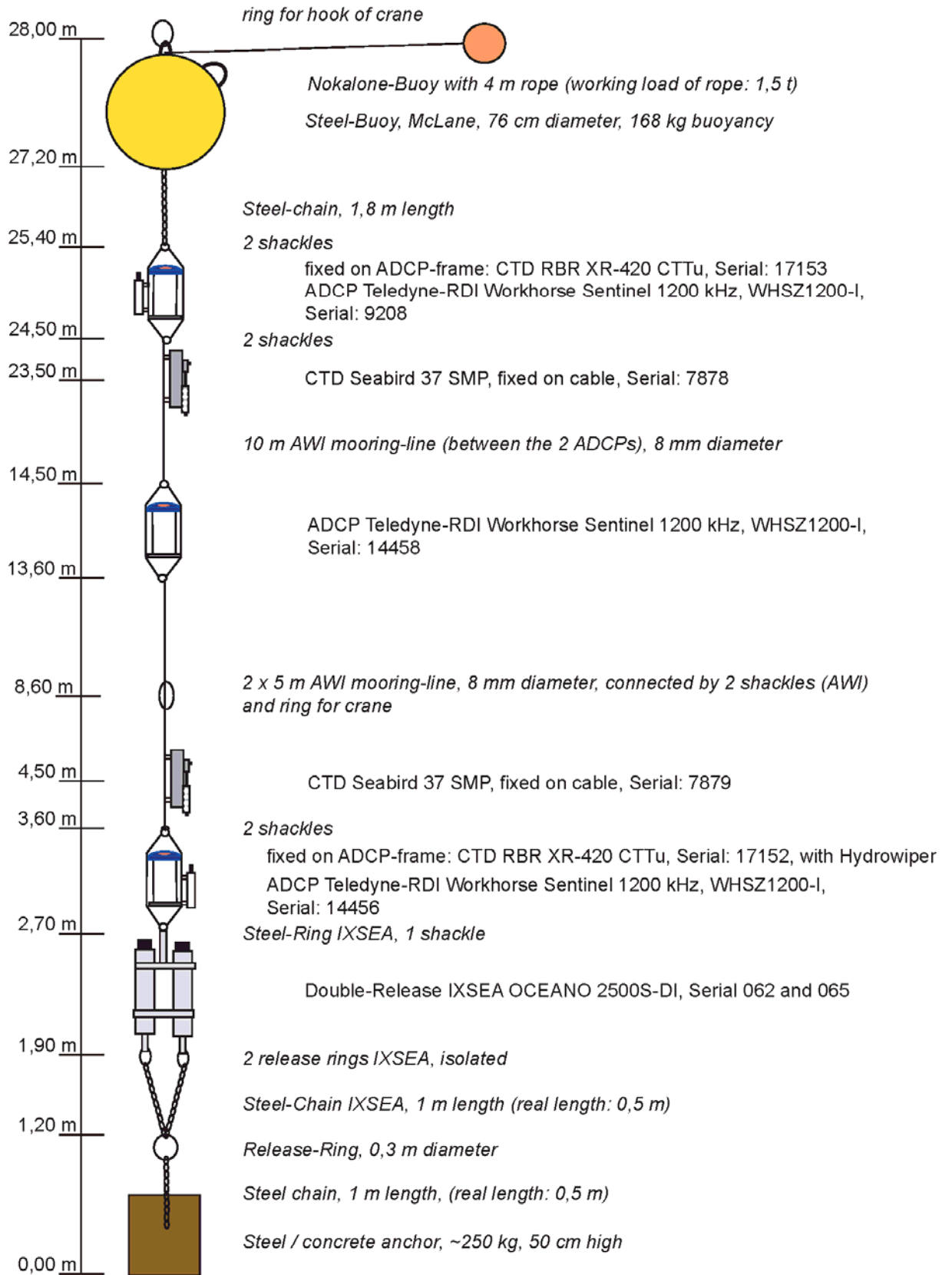
3.4 OSL2D



3.5 OSL2E



3.6 KHATANGA10



3.7 OSL4

