ECORD Evaluation
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ECORD Evaluation Committee (EEC) 2017*

Helmut WEISSERT (Chair)
Maria ASK
Adrian IMMENHAUSER
Eystein JANSEN
Ralf LITTKE
Patrick PINET
Katherine RICHARDSON
Johan ROBERTSSON

The EEC Mandate

The EEC mandate primarily concerns the production of a high-level review focused on three major items:
1. Review of achievements of ECORD within IODP (*has ECORD achieved high quality science and impact?)*
2. Review of the impact of MSPs in particular (*have Mission Specific Platforms completed projects which are complementary to the JR and Chikyu, and how does the science output rank?)*
3. Review of the effectiveness/efficiency of ECORD entities (*are ECORD entities properly designed to face IODP/ECORD challenges?),* especially the performances of the ECORD Managing Agency (managed by the CNRS) and the ECORD Science Operator (managed by the British Geological Survey).

EEC Committee, 2017

Maria Ask, PhD 1998, Professor in Applied Geology, Luleå University of Technology, Sweden. Expertise in Rock mechanics and engineering geology with focus on in-situ stress measurements and laboratory deformation testing of rocks.
Adrian Immenhauser, Professor and Chair for Sediment- and Isotope Geology at Ruhr-University Bochum, Germany. Expertise in carbonate sedimentology and geochemistry, palaeoclimatology, diagenesis and proxy research.
Eystein Jansen, PhD 1984, Professor in Earth Sciences/Paleoclimatology University of Bergen and Bjerknes Centre for Climate Research, Norway; former founding director of the Bjerknes Centre for Climate Research, Bergen, Norway. Expertise in: Cenozoic paleoclimates, stable isotope geochemistry, paleoceanography, Earth system dynamics, Natural climate variability.
Ralf Littke, PhD 1985, Professor in Earth Sciences / RWTH Aachen University Germany; former President of German Geological Union (Geologische Vereinigung). Expertise in: Sedimentary basin dynamics, organic geochemistry and petrology, origin of natural gas and petroleum, thermal maturity of sedimentary rocks, numerical basin modelling.
Patrick Pinet, PhD 1985, CNRS Senior Scientist (Directeur de recherche), deputy-director of IRAP (Institut de Recherche en Astrophysique et Planètologie), Toulouse, France. Expertise in: planetary sciences, impact cratering processes, planetary crusts petrology and mineralogy, geodynamics, space exploration, orbital and in situ remote sensing instrumentation, geodynamics, space exploration, orbital and in situ remote sensing instrumentation.
Katherine Richardson, Professor of Biological Oceanography and Leader of the Sustainability Science Centre at the University of Copenhagen. Expertise in biogeochemical processes in the surface ocean and how these are influenced by climate change. Specifically, how changes in climate and biodiversity in the ocean interact to influence the global carbon cycle.
Johan Robertsson, PhD 1994, Professor of Applied Geophysics / ETH Zürich, Switzerland; Prior to 2012: 15 years research and development experience in oil and gas industry (in last position research director of geophysics in Schlumberger). Expertise in: Physics of wave propagation, exploration geophysics, reflection seismic data processing and imaging,

planetary seismology, numerical modelling, interferometry.
Helmut Weissert, PhD 1979, Professor of Sedimentary Geology, ETH Zürich, Switzerland. Expertise in paleoceanography, paleoclimatology, isotope geochemistry and sedimentology.

Structure

Executive Summary

For 2013-2016, the EEC (ECORD Evaluation Committee) is asked to **(1)** review achievements of ECORD within IODP, **(2)** review the impact of MSPs in particular and, **(3)** review the effectiveness/ efficiency of ECORD entities, particularly the performances of the ECORD Managing Agency (EMA) and the ECORD Science Operator (ESO).
Based on our evaluation, we advise that:

- Expedition members should aim for at first high impact paper 12-18 months after completion of the cruise. It should become common practice to publish highlight results of each MSP expedition in a multi-topic journal such as EOS or a comparable journal, in addition to the current standard of submitting results to the more focused journal Scientific Drilling.
- We encourage the organization of specific sessions at EGU or similar to capitalize on the scientific impact of multi-expedition coordinated scientific drilling programs. It is also important to integrate new scientific results into overarching challenges of the IODP initial science plan from 2013-2023, and to take them as starting point for new research questions and challenges.
- We encourage the MagellanPlus panel to actively encourage workshops in the field of "biosphere frontiers" in order to strengthen this discipline within ECORD and attract younger researchers.
- In order to have a continuous flow of the best scientists in ECORD, member countries should aim for comparable funding pathways and incentives available to early career and established scientists.

In our opinion, the MSPs are a success story as they allow for expeditions to non-traditional and shallow target sites. The financial contribution to MSPs (both in absolute amounts and relative to ECORD contributions to the US and Japanese program) should be strengthened.

- Close cooperation with ICDP (International Continental Scientific Drilling Program) has been established via MagellanPlus workshops and cooperation with the US-based DOSECC is highly appreciated. This cooperation, both on a scientific and technical/operational base, should be further strengthened, also leading towards joint land-sea drilling projects (amphibious projects).
- We recommend keeping the current, extremely effective ESO structure, at least for the next phase 2019-2023.

The ECORD infrastructure is highly decentralized and consists of several separate councils, committees and agencies. It is an infrastructure "owned" by a comparatively large number of countries that all are equally important and actively involved. The ECORD umbrella is widely multinational, implying a rich pool of thematic skills, approaches, and cultures, compared to a one single country. ECORD entities have shown their ability at handling MSP expeditions which introduce significant flexibility in the overall international goals to be achieved by IODP. We are impressed by the multi-national ESO coordination and efficiency.

- Although, it would be tempting to come up with suggestions for streamlining the organization of ECORD, the current operation appears to be highly cost-effective and efficient and should be maintained. We acknowledge the excellent and highly efficient work of both, EMA and ESO, and we firmly support continuation of EMA and ESO to the end of the program. Both, EMA and ESO are of pivotal importance for continuing success of the project.

- ECORD management is a significant strength. The fact that it relies on highly dedicated individuals may be a concern for the stability and continuity in the long run (beyond 2021-2023). Clear long-term commitments and plans should be made at the level of EMA and ESO.
- We recommend to achieve a 2-year rotation scheme for the ESSAC office. ESSAC delegates should not remain longer than 6 years in the ESSAC Committee.
- We recommend that E-OETF (Outreach and Education Task Force) strengthens its contacts to other organizations active in teachers education programs. These organizations may be active on individual country level and ESSAC delegates need to establish contacts to E-OETF. We recommend to develop contacts (MOU) with e.g., IUGS, EGU, or IAS.

In the view of the evaluation committee, the scientific achievements of ECORD within IODP are excellent. The return of science for the investment is outstanding. ECORD scientists are primary proponents on a high number of successful proposals for all three platforms of IODP (JOIDES Resolution (JR), Chikyu, Mission Specific Platforms (MSPs)). It should be targeted to maintain this truly unique and global research structure. ECORD, as part of this structure, should maintain its strengths in being able to finance and perform independent Mission Specific Platform Expeditions.

1. Introduction – 50 years of Ocean Drilling Program

In 2018, the Earth Science community will celebrate 50 years of the highly successful International Ocean Drilling Program. In 1968, the "Deep Sea Drilling Project" was started with the purpose to find additional arguments for or against the seafloor spreading hypothesis. With the confirmation and the establishment of the theory of Plate Tectonics in the early 1970ties, the Deep Sea Drilling Project was in search for new questions related to the world's oceans and their history. Research targets developed within the frame of "Earth System Science" included Paleoceanography, Tectonics and evolution of continental margins and associated oceans, petrology and geochemistry of oceanic lithosphere became new targets of the Ocean Drilling Project. In 2003, the project experienced a major step of extension. Three independent Drilling platforms were introduced, new research themes were added. Geobiology and geomicrobiology of the Deep Biosphere was added to geophysical, geological and geochemical research. The evaluation committee agrees with the global Earth Science community that 50 years of Ocean Drilling Program had a profound impact on the development of Earth Sciences, starting with the establishment of Plate Tectonics and continuing with the rapidly growing fields of Paleoceanography, Paleoclimatology, Marine Geology and Tectonics, Seafloor Geochemistry ,and Petrology and the discovery of the importance of the Deep Biosphere.

The EEC (ECORD Evaluation Committee) is asked to **(1)** review achievements of ECORD within IODP (*has ECORD achieved high quality science and impact?),* **(2)** review the impact of MSPs in particular (*have Mission Specific Platforms completed projects which are complementary to the JR and Chikyu, and how does the science output rank?)* and **(3)** review the effectiveness/ efficiency of ECORD entities (*are ECORD entities properly designed to face IODP/ECORD challenges?),* especially the performances of the ECORD Managing Agency (managed by the CNRS) and the ECORD Science Operator (managed by the British Geological Survey).

As input for this evaluation, the EEC has received the report "ECORD Evaluation Report 2017_low res.pdf" in advance of the meeting. This was followed by meeting at Bremen Core Repository from 6-9 June 2017, with 25 participants in addition to the EEC. Presentations from ECORD and the scientific community documented activities from 2013-2016 within the subjects: (1) ECORD 2013-2016 overview and the future of ECORD in IODP; (2) Managing ECORD; (3) Implementing MISSION SPECIFIC PLATFORM expeditions; (4) Participating in IODP expeditions - MSP, JR and Chikyu; (5) IODP Science (6) Archiving IODP cores and data: Bremen Core Repository; (7) Engaging the community; and (8) Communicating: ECORD outreach activities.

Figure 1. Participants at the EEC meeting at BRC.

2. Review of achievements of ECORD within IODP

The ECORD Science Report documents the strong impact of European Science to IODP. Currently 418 ECORD scientists are proponents of active IODP proposal, this number is higher than the one from the US or Japan. 37-39% of all proposals within IODP come from ECORD scientists every year. From 2014 to 2016 34.8-37.1% of the IODP proposals had ECORD lead proponents. The ECORD science community has contributed more than 7000 serial publications since the beginning of IODP in 1969. Proposals for IODP and proposals from ECORD scientists cover all four of the major themes in the IODP science Plan 2013-2023:

- "Climate and Ocean Change"
- "Biosphere Frontiers":
- "Earth Connections: Deep Processes and Their Impact on Earth's Surface Environment"
- "Earth in Motion"

2.1 Achievements

The scientific achievements of ECORD within IODP are excellent. The return of science for the investment is outstanding. This is exemplified by the following observations of the review panel:

ECORD scientists have a highly visible position within IODP. It is clear that the ECORD science community is a driving intellectual force in the program and is responsible for innovative and daring scientific endeavors. There has been a steadily increasing participation by ECORD scientists and as co-chief scientists on the expeditions during the evaluation period and this number more than reflects the contributions to the program. ECORD scientists are primary proponents on a high number of successful proposals for all three platforms of IODP (JR, Chikyu, and MSPs). The interest in sailing remains high as shown by the fact that there are more than twice the number of applicants from ECORD countries as can sail on expeditions (and this ratio is higher than the US demand). Specifically:

(i) The expeditions executed during the evaluation period on all three platforms have been successful in reaching the drilling targets and coring results that enable the scientific objectives of the expeditions to be met. The expeditions performed between 2013 and 2016 were highly successful inasmuch as they now enable the science community to answer longstanding questions, for example with regard to climate dynamics and interactions in the Earth System.

(ii) A specific strength of ECORD lies in the very adaptable MSPs that allow for drilling in very shallow and non-conventional settings. This also forms a bridge to amphibious operations including collaboration with ICDP (for example Landslide Project off Nice). JR and Chikyu cover significant portions of the world's open oceans but are less suitable for near coastal and platform top settings (Maldives). The MSPs fill these gaps, and also open up for the inclusion of new types of science and extend the impact of ocean drilling within earth and life sciences.

(iii) The professional execution of both the MSP operations and ESO (BGS, BCR and EPC) enables the excellent science performed in the context of ECORD. Moreover, the overall coordination of EMA in the coordination of ECORD with the other partners within IODP must be acknowledged. Despite the decentralized nature of the ECORD consortium, this means that the science community in Europe only sees one integrated program.

(iv) The Review panel sees MagellanPlus as an excellent tool to develop and translate ideas into successful proposals (the success rate of about 50% is remarkable).

(v) We acknowledge the improving gender balance among shipboard scientist and particularly the balance between young and early career and established scientists. We emphasize the strong impact of women scientists in the MagellanPlus program. However, there is a strong impact of male scientists participating on drilling expeditions.

2.2 Challenges and Recommendations

Below, we list a series of thoughts on the level of suggestions. These concern the following topics: (i) Publication strategies; (ii) the role of geomicrobiology in ECORD; (iii) working towards a homogenization of funding strategies for early career and established scientists across ECORD partners.

Publication strategies: We recommend that ECORD improves its documentation of bibliometric data. Specifically, we suggest that not only numbers of papers and Q1 journals *versus* others should be considered but also the number of citations and the output of bibliometric data per partner country and per expeditions should be compiled. Further, ECORD should consider an open access publication strategy in high-level journals (for example EGU open access journals such as "Climates of the Past" or Geobiosciences"). This specifically refers to thematic issues as aims to reach a community outside of the typical IODP/ECORD readership (outreach). Expeditions such as Chicxulub or Atlantis Massif have a significant potential here.

The review panel noted that the publication output of MSP and JR expeditions is heterogeneous when compared across recent activities of ECORD. We acknowledge that this might reflect the publication strategies of different disciplines but this might have other reasons too. We suggest that the scientists involved in a specific expedition should aim for at first high impact paper 12-18 months after completion of the cruise. We suggest that it should become common practice to publish highlight results of each MSP expedition in EOS or a comparable journal. This provides the opportunity to reach science communities outside IODP and to inform them about exciting results of MSP expeditions. We recommend to synthesize the outcome of sister cruises (for example Monsoons, volcanic arcs) across different expeditions. In order to achieve this, we encourage the organization of specific sessions at EGU and/or Goldschmidt in order to develop a strategy to capitalize on the scientific impact of multi-expedition coordinated scientific drilling programs.

Role of geomicrobiology in ECORD: The Biosphere Frontiers topic is crucial to ECORD. In turn, ECORD and IODP are crucial and have enabled shifting the limits of microbiological research. This not only involves microbial biota at 100's of meters' of depth in the sediment or basement rock environment but also sediment-microbe interaction at shallow burial depths. We noted that none of the present MagellanPlus panel members has a background in microbiology and suggest that this should be corrected. We encourage the MagellanPlus panel to more actively encourage workshops in the field of "biosphere frontiers" in order to strengthen this discipline within ECORD. We advise to consider a limited number of focused expeditions with a strong focus on biosphere frontiers topics as opposed to a watered-down subcomponent in this field attached to each cruise. Given the demographic structure of geomicrobiologists in ECORD, a rejuvenation of the ECORD community in this field is desirable.

Homogenization of funding strategies across ECORD partners: In order to have a continuous flow of the best scientists in ECORD, different countries should aim for comparable funding pathways and incentives available to early career and established scientists. We noted that there are significant discrepancies in the support structure for scientists between different ECORD partners, and lack of incentives hamper recruitment of the best talent to the program in some countries.

3. Review of the impact of MSPs in particular

ECORD operates Mission-Specific Platforms (MSPs) chartered on a specific project basis for ocean drilling in conditions that cannot be explored effectively by the *JOIDES Resolution* (JR) or Chikyu, including the high latitudes and shallow-water environments, and rock formations that are difficult to core (e.g. unconsolidated sands, reef carbonates and hard rock).

ECORD originally planned implementation of one MSP expedition per year on average for IODP. This aim has almost been reached. Three MSP expeditions have been conducted from 2013-2016: #347 (Baltic Sea) in 2013, #357 (Atlantis) in 2015, and #364 (Chicxulub) in 2016. Three On-Shore Parties (OSPs), with 31-32 participants have been hosted at the Bremen Core repository. A few scientific and technical achievements of three expeditions are highlighted below:

#347: Documentation of the recently found new branch of life ("Asgard"; microbes different from bacteria and archaea). There were some shallow-water drilling targets. The core recovery was good despite of interbeds with unconsolidated sands.
#357: Successful seafloor drilling with good core recovery of mantle rocks during the Atlantis expedition. First employment of seabed drills, new logging and monitoring tools, tracer tests.
#364: Penetration of over 1300 m depth, with 100% core recovery including the Cretaceous/Paleogene boundary at the Chicxulub crater.

The preparation and post-expedition phases before and after each expedition take several years (Fig. 2). This is the reason, why science outcome of the recent (2013-2016) expeditions cannot be judged by any quantitative measures yet: most publications are still in preparation or in review. Therefore, we need to consider the scientific outcome of earlier expeditions as well. Table 1 shows the number of publications with ECORD first authors, sorted with respect to year and expedition from 2013-2016.

ESO has been involved with seven MSP expeditions at various stages, from scoping to drilling and postcruise science reports and post-moratorium sample requests, of which one (Great Barrier Reef; #325) has been finalized, three have been drilled (see above), and three are still in the preparation phase (two of them approved). Planning for the upcoming Corinth (#381) and Arctic (#377) expeditions scheduled for 2017 and 2018 is advanced.

Four past expeditions, which can be better evaluated, were drilled between 2004 (#302, Arctic) and 2010 (#325, Great Barrier Reef) including Tahiti Sea (2005/6) and New Jersey Shelf (2009). In terms of publications, the Arctic Sea expedition #302 was exceptional, leading to more articles than any other IODP expedition since then (i.e., 109 journal papers, 90 conference papers, 16 monographs and 4 Ph.D. theses since expedition). There is also a very good publication record for the Tahiti expedition #310, whereas the output from New Jersey (#313) and Great Barrier Reef (#325) is up to now average if compared to all IODP expeditions. From this data, it is obvious that MSP expeditions have potential to have very high scientific impact.

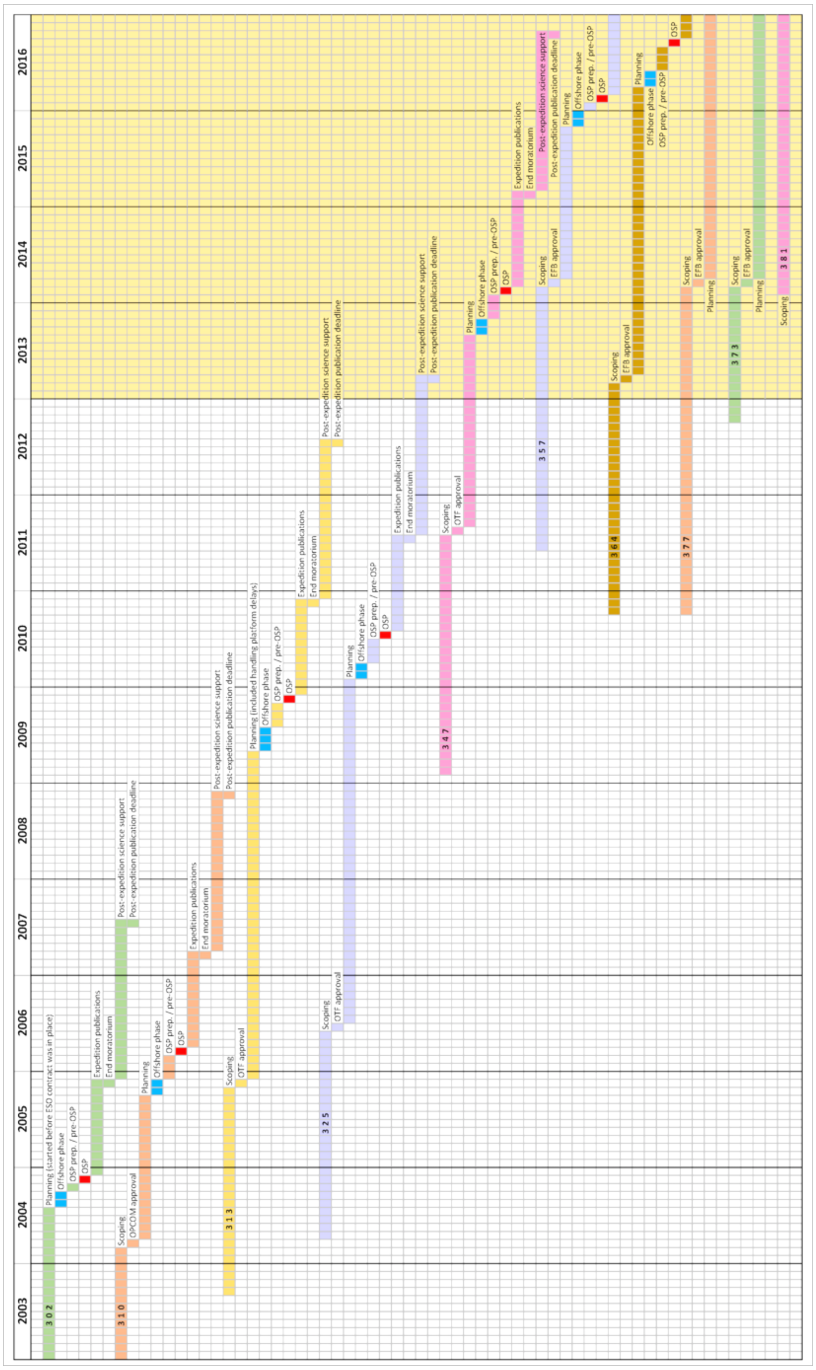

Figure 2. Gantt chart of ESO activities related to MSP expeditions. IODP phase II (2013-2016) is highlighted yellow. Keys: OTF, Operation task Force; EFB, ECORD Facility Board; OSP, On-Shore Party.

Table 1. Number of published journal papers per year and expedition with ECORD scientists first author.

Expedition: Year	***#302***	***#310***	***#313***	***#325***	***#347***	***#357***	***#364***
OP	2004	2005	2009	2010	2013	2015	2016
OSP	2004	2005	2009	2010	2013	2015	2016
2013	3	4	11	2			
2014	5	2	3	3	1		
2015	4	3	0	1			
2016	0	0	1	1	3		1
2013-2016	12	9	15	7	4	0	1
% TOT	11	18	65	44	100		100

Keys: OP, Offshore Phase, OSP, On-Shore Party, % TOT, Percentage of total production of journal papers

ESO is involved in different stages of expeditions including early planning and scoping, operation approval, detailed planning, offshore phase (coring and logging), preparation and execution of onshore science party (curation, support in data collection), management of expedition evaluation and post-expedition science support (Fig. 2). There is an ongoing effort to improve routines and performance. Since 2013, the ESO management group integrates the proponents early in project scoping to ensure that the selected drillship and data acquisition plan fulfil scientific objectives at best possible budget. New logging tools and multisensory core logger (MSCL) were developed to address demands of the #357 Atlantic expedition. The Bremen Core Repository (BCR) is highly active in providing samples for the scientific community, but before and after the moratorium. Either personnel at the BCR collect the sample, or scientists behind the sample request visits BCR and personally collect the samples. In the latter case, there are opportunities to conduct initial sample characterization in house, and to collaborate with other scientists and their laboratories at MARUM. The data management systems are continuously upgraded. For example, Exp. #347 (Baltic Sea) was the first expedition to use IGSNs (International GeoSample Number).

Table 2. Sample requests (all and taken) of MSP expeditions.

Expedition:	***#302***	***#310***	***#313***	***#325***	***#347***	***#357***	***#364***
AOC (m)	339	632	1311	225	1623	57	840
2013-2016							
ASR/SRE	12/9	0/0	6/5	4/0	38/21	41/17	49/26
AST/STE	519/243	0/0	1715/1708	224/4	26834/19700	944/697	11271/5872
2003-2016							
ASR/SRE	66/38	41/16	64/29	33/14	38/21	41/17	49/26
AST/STE	12396/…….	12900/…….	19673/…….	6463/…….	26834/19700	944/697	11271/5872

Keys: AOC, Amount Of Core; ASR, All Sample Requests; SRE, Sample Requests by ECORD scientists; AST, All Samples Taken, STE, Samples taken by ECORD Scientists.; ……., no record

3.1 Achievements

The MSP drilling targets cannot be investigated by the other IODP drilling vessels. As a result, MSPs represent a new scientific frontier of ocean drilling.

Execution of 3 MSP expeditions were successful, both in terms of reaching scientific but also regarding budgetary constraints, safety and environment standards.

ECORD entities (ESO Management, EPC and BCR) have demonstrated their capability of managing MSP expeditions and for supporting the scientific community to achieve the goals. This also includes technical development.

3.2 Challenges and Recommendations

Costs of MSP expeditions are highly variable depending on the sites. Arctic/Antarctic expeditions are very expensive, needing several vessels including icebreakers, but have also a high potential for new scientific discoveries and related media attention. These expeditions might be challenging and risky in terms of logistics and finances, but will be highlights in IODP science. Performing such MSP cruises seems to be more important than having exactly one expedition/year.

Compared to JR and Chikyu expeditions, the price per ECORD berth is slightly higher for MSPs. On the other hand, MSP expeditions are flexible, not causing any permanent costs. In addition, the MSP system provides ECORD members with a stand-alone technology allowing drilling in environments not reachable by JR. Therefore, the financial contribution to MSPs (both in absolute amounts and relative to ECORD contributions to the US and Japanese program) should be strengthened.

We think that it is important to inform the science community on MSP expeditions during and soon after the expeditions in a qualified way. An obligatory EOS letter might be appropriate ways to attract attention.

The way MSPs are planned and operated is in many ways similar to ICDP (International Continental Scientific Drilling Program) projects. Close cooperation with ICDP has already started via the MagellanPlus workshops and cooperation with the US-based DOSECC (Drilling, Observation and Sampling of the Earth's Continental Crust) and is highly appreciated. This cooperation, both on a scientific and technical/operational base, should be further strengthened, also leading to joint land-sea drilling projects (amphibious projects).

ECORD has introduced IKC (In-Kind Contribution). There is a clear need for IKCs for MSP expeditions provided by proponents. In ICDP, proponents are required to generate co-funding. ECORD Council should discuss how this concept might be adapted for MSPs to some extent.

4. Review of the effectiveness/efficiency of ECORD entities (are ECORD entities properly designed to face IODP/ECORD challenges?), especially the performances of the ECORD Managing Agency (managed by the CNRS) and the ECORD Science Operator (managed by the British Geological Survey).

The ECORD Managing Agency (EMA) manages the participation of ECORD's members in IODP, represents the link between ECORD and the other IODP members, provides the central services for funds and oversees the other ECORD entities". EMA *is* administered by INSU-CNRS, Paris, France. The EMA Director is official contact point for ECORD in all relationships with the IODP Structures and partners and he represents ECORD at all important meetings of IODP. EMA is actively involved in development of "Distributed European Drilling Infrastructure" (DEDI). CNRS is the banker of ECORD (free of charge), the funding of the program being ensured by the French Ministry of Research.

ECORD Science OPERATOR (ESO) has been established in 2003 with the introduction of Mission Specific Platforms into the IODP Program. ESO organizes and implements MSP expeditions for ECORD. The three ESO partners contribute experienced staff with scientific, practical, managerial, and extensive ocean drilling research and sailing experience in key areas required to successfully implement MSP expeditions. Key areas include: project management; contracting; drilling and coring; downhole logging; curation; scientific laboratories and equipment; data acquisition, analysis and interpretation; IT and data management; and outreach and education.
Partners:
(i) The British Geological Survey (BGS): offshore operations, coring expertise and operational oversight, procurement services, coordinates permitting and scoping efforts, manages the science party and science outputs, and manages expedition outreach activities.
(ii) MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany. Curation, data basing, and archiving of collected cores, samples. MARUM provides offshore and onshore laboratory facilities.
(iii) The European Petrophysics Consortium (EPC) is managed by Borehole Research at the University of Leicester, UK. In addition to the University of Leicester, the EPC includes the University of Montpellier (Laboratoire de Géophysique et Hydrodynamique en Forage, CNRS) and RWTH Aachen (Institute for Applied Geophysics and Geothermal Energy, E.ON Energy Research Center). EPC provide core physical properties and downhole logging services, and manage sub-contracts and permitting associated with those activities.

4.1 Achievements

The ECORD infrastructure is highly decentralized and consists of several separate councils, committees and agencies. It is an infrastructure "owned" by a comparatively large number of countries and it is important that all feel some degree of ownership to be actively involved.

The current organization of ECORD was put in place to address this need while ensuring as clear areas for responsibility as possible. Although, it would be tempting to come up with suggestions for streamlining the organization, the current operation appears to be highly cost-effective and efficient.

The ECORD umbrella is widely multinational, which means a rich pool of thematic skills, approaches and cultures, compared to a one single country with one dedicated funding agency.

The ECORD science operations (ESO), managed by BGS, successfully organizes mission specific platform expeditions with good or even excellent core recovery in technically extremely challenging oceanic conditions such as very shallow water drilling, Arctic ocean drilling, sea floor drilling.

The ECORD managing agency (EMA) is administered by INSU-CNRS, Paris. It has a proven record of organizing ECORD IODP activities successfully and at reasonable cost. Our assessment is that EMA is a very efficient organization, staffed with only 2 fulltime and 2 part time persons.

ECORD entities have shown their ability at handling MSP expeditions which introduce significant flexibility in the overall international goals to be achieved by IODP. Compared to operating a dedicated drill ship, MSPs can contract optimal platforms that fit specific objectives of an expedition at a good price. It also allows for quick mobilization without much geographical constraints. It also allows for scaling up and down depending on available funds and expeditions. There are clearly a high number of technological achievements that have pushed science boundaries, both in terms of drilling as well as analytical instruments employed at sea and through core processing. ECORD can in that sense is seen as a moderator when setting up a worldwide science program, with useful lessons and spin-offs to be considered for complex undertakings in other fields such as planetary exploration for instance. ECORD may bring in more thematic diversity and flexibility into the IODP and the strategies to be decided and implemented than would a monolithic entity. In this respect, having 'small' contributors at the level of 30K€ should be considered as an asset.

ECORD opens access to alternative drilling technologies (seabed drilling / cartography with multisite drilling, coral reef drilling, Arctic / Antarctic / amphibious drilling in the future) is of high science value.

The Bremen Core Repository (BCR) at MARUM is responsible for curation, data basing, and archiving of collected cores and samples. The BCR is of outstanding quality. Its structure and organization provide superb working conditions for scientists from all over the world using the facility and the cores sampled in the Atlantic and Arctic Oceans and the Mediterranean Sea during the DSDP, ODP and IODP phases of the Drilling Program. The importance of this core repository for generations of scientists to come is unique and samples of even the oldest cores are of high quality and in considerable demand.

As it stands, ECORD appears to be quite a successful truly interdisciplinary program involving early career to established scientists. The ECORD budget appears healthy and optimized. Indeed, the greatest part of the budget goes towards the funding of expeditions. As an example, the MagellanPlus workshop concept appears to be a highly effective mechanism for preparing top quality proposals.

Apart from the financial contributions from membership countries, ECORD has managed to set up an efficient in-kind contributions system. This is another example of the flexibility implemented by ECORD that allows non-member countries to participate to the international efforts and by the same token to leverage from national infrastructures.

EMA seems to be a very efficient organization, staffed with only 4 persons. The director is responsible for the major tasks (IODP Meetings, ECORD Meetings). Does this make the structure, strongly focusing on its director, more vulnerable? If we look at the topics and themes addressed by EMA, we realize that, in addition to coordination duties, the public outreach responsibility seems to be with EMA. However, certain themes, belonging to public outreach are also with ESO and with ESSAC.

4.2 Challenges and recommendations

On the one hand, ECORD management is a significant strength. However, the fact that it relies on a few individuals may be a concern for the stability and continuity in the long run (say beyond 2021-2023). Clear long-term commitments and plans should be made at the level of EMA and ESO. We acknowledge the excellent and highly efficient work of both, EMA and ESO, and we firmly support continuation of EMA and ESO to the end of the program. Both, EMA and ESO are of pivotal importance for continuing success of the project.

In ECORD, the budget for salaries and staff is low. Permanent staff is very few, although this may be at the expense of the cost for part-time employees. It is always a danger that part-time employees actually dedicate their working time as they should when having multiple functions and sources of income. Although we do not have any reasons for thinking that this is not in line with budgets/commitments, it should be recognized as something to keep an eye on. ECORD and EMA activities ask for intense travelling. We recommend that ECORD discuss possibilities of reducing the CO_2 footprint of their operations and the possibility to participate in a CO_2 compensation scheme for air travel. ECORD may take a leading position in this discussion also within IODP.

ECORD delivers highly significant science on a relatively modest budget. The proportional use of the JR by ECORD scientists is significantly greater than what the budget provided by ECORD partners are. However, a big risk for the future is that significant additional funds will be required to continue to operate at this level. Two risks should be considered for the future:

(i) What will happen with the US funding for the JR? If there are cuts in the US science budgets, ECORD member countries could be asked to pick up more of the cost.

(ii) ECORD has undoubtedly benefited from a market situation where the availability of drilling platforms is good and prices low due to the downturn of the oil industry over the last 5 years. A situation where the oil price increases may lead to less available platforms that can mobilize in certain regions of the world and at much higher cost.

The initiation of IKCs has opened up for external funding organizations to ECORD and IODP. A roadmap for alternative sources of funding should be developed. A potential source might be to seek support from industry partners. However, it remains unclear where the fruitful engagements lie. For instance, it is not clear that synergies with oil and gas are particularly great for contributions to ECORD expeditions. Mining industry may be a different story. However, there is a great risk in the public perception if ECORD accepts significant industry funding (for instance becoming associated with industry or geopolitical contexts when drilling in the arctic). The downside appears greater than the potential upside.

The ESSAC Office has been rotating from one ECORD country to another one in a rhythm of 2 years. The transfer from one country to the next country and the related replacement of the ESSAC Chair can result in a loss of expertise and in a significant increase of workload because of the transition of the office from one location to the next one. Despite of these problems we recommend to keep the two-year rotation scheme established by ECORD over the years. This scheme best integrates "small" countries into the ECORD Program. ECORD may even consider, rotating the ESSAC Office preferentially among the "small" countries. It has to be ensured that the knowledge transfer is optimized. This can be achieved by significant temporal overlap of the incoming with the outgoing Chair, for example by appointing the vice Chair from the next upcoming ESSAC Office. In order to maintain a dynamic environment within ESSAC, delegates should not remain longer than 6 years in the ESSAC Committee.

5. ECORD Outreach

Outreach activities are conducted by the ECORD Outreach & Education Task Force (E-OETF), which integrates three ECORD entities - EMA (coordination, publications and web), ESO (MSP expeditions and media) and ESSAC (education) - and ICDP. The E-OETF is coordinated by Patricia Maruéjol (EMA). It promotes outcomes of IODP science to a wide range of audiences and requires development of specific activities and appropriate resources to address scientists including early-career scientists, teachers, general public and media.

ECORD is increasingly active in public outreach activities and in its engagement in IODP teacher programs. This activity belongs to the highlights within the IODP Outreach Program. We recommend that E-OETF strengthens its contacts to other organizations active in teacher's education programs. These organizations may be active on individual country level and ESSAC delegates need to establish contacts between these organizations and E-OETF. We recommend to further develop contacts with IUGS (Int. Union of Geological Sciences) and EGU (European Union of Geosciences). They belong to the most active promoters of Geoscience education for teachers worldwide. Similarly, globally active organizations such IAS (International Association of Sedimentologists) can support ECORD in reaching a global audience.

It will be important to make use of popular science journals (National Geographic, New Scientist, etc.) for the purpose of increasing public awareness of the highly interesting IODP science which is of great societal importance.

Outreach has so far concentrated on students, the general public, and media. It was discussed at the meeting to broaden the scope of outreach to include decision makers, funding organizations, targeted industry, as well as scientists from adjacent fields. It is recognized that this task would need additional staffing. Similar to what has been said above, the support of e.g. IUGS might be beneficial here.

6. Outlook

IODP has developed a very successful three-platform program, which serves the broad interests of the scientific community worldwide. It should be targeted to maintain this truly unique and global research structure. ECORD, as part of this structure, should maintain its strengths in being able to finance and perform independent Mission Specific Platform Expeditions. ECORD may serve as a role model in future ocean research for third party (non-IODP) countries interested in developing expertise in Mission Specific Scientific Drilling Projects. In years of political instability, it is of extreme importance to maintain and develop multinational programs which enrich science and culture at a European and global scale.