Letter of Intent - NFDI4Earth

1 Binding letter of intent as advance notification

This is a binding letter of intent as required as advance notification for a full proposal submission in 2020.

2 Formal details

2.1 Planned name of the consortium

NFDI Consortium Earth System Science / NFDI Konsortium Erdsystemforschung

2.2 Acronym of the planned consortium

NFDI4Earth

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3 Objectives, work programme and research environment

3.1 Research areas of the proposed consortium according to the DFG classification system

NFDI4Earth addresses the research areas: Atmospheric Science, Oceanography and Climate Research (313); Geology and Paleontology (314); Geophysics and Geodesy (315); Geochemistry, Mineralogy and Crystallography (316); Geography (317); Water Research (318), Astrophysics and Astronomy (311), Soil Sciences (207-01).

3.2 Concise summary of the planned consortium's main objectives and task areas

NFDI4Earth (www.nfdi4earth.de) addresses digital needs of researchers in Earth System Sciences (ESS). ESS comprises numerous sub-disciplines with the overarching aim to understand the functioning of all subsystems of the Earth System and quantify their interactions in space and time. ESS responds to today's pressing global change challenges by following a strategy of intensified national, European, international and interdisciplinary collaboration for the creation of global, sustainable solutions. NFDI4Earth is one important building block of this strategy. In a user-driven process NFDI4Earth will provide researchers with FAIR, easy, coherent, efficient, and – whenever possible – open and unrestricted access to all relevant Earth System data, scientific data management tools and data analysis services. The design and implementation of the NFDI4Earth will follow a progressive and iterative process. The NFDI4Earth five years' work plan (2021-26) will be realized in four task areas:

TA 2Participate has the overarching aim to engage with the ESS community as broadly as possible. The TA integrates both students and professionals, addresses service providers as well as scientists through four inter-related activities. This broad approach guarantees that the development of NFDI4Earth is entirely driven by the community's needs and requirements. Measures are designed such that they capture the different velocities of the community's uptake of FAIR principles. *ESS Pilots* are small agile projects proposed and selected by the community through three rounds of open calls and shall manifest the researchers' needs. While pilots are tangible contributions that essentially leverage existing technologies into NFDI4Earth and serve for the requirements engineering in subsequent different task areas, the *Incubator Lab* works as a community-proposed testbed. Open calls for sprint-like projects help to identify most promising new tools and methods and to explore their suitability for ESS RDM and Earth System Data Science. *Education and Training* is the platform to produce open educational resources ready to use and is setting up an institutionalized network of regional NFDI4Earth Education and Training Sites. *Academies* will connect young ESS researchers and their data-driven research to NFDI4Earth in establishing a structured academy program and network.

TA 2Facilitate will offer a first-port-of-call for all participants, community members and interested citizens to start and/or continue their journey to FAIR data use. The TA will provide a *OneStop4All* to act as a first visible contact point. This contact point will provide - in a structured way - fundamental information on elementary FAIR data principles, e.g. how to find and access existing data sets, how to contact existing repositories, how to take first steps in making data FAIRer. Specific user requests will be routed to the *User Support and Data Ingest* as an established virtual user support infrastructure. Here, experts will directly interact with the people asking the questions. A measure *Governmental Data* will provide the wealth of data that exist in governmental data bases and has a strict regulation by national and international laws and standards, thus also providing a different perspective on the FAIR data principles. *Data in Long-Term Storage* provides an additional sustainability perspective that will also be of interest for new comprehensive and long-tail data sets. Thus, making long-term storage more accessible for use (data-in) and re-use (data-out). Providing a best-practise bracket for the exploration of data in all sorts of repositories is the measure *Advancing Tools*. In close collaboration with 2Participate state-of-the-art solutions, mainly based on data cubes, will be explored. This best practice model should be seen as an example, and other data models will be added at a later stage.

TA 2interoperate aims on interoperability and coherence of the large, heterogeneous and strongly segmented range of ESS RDM services offered in Germany. A *Synthesis of a Sustainable NFDI4Earth Architecture* will be developed iteratively and consensus based as the common master plan for the operation of the partners' ecosystems of FAIR ESS data and software repositories, data science collaboration platforms and supporting services for persistent identifiers, registries and vocabularies, metadata repositories. A measure on *Gold Standards for Open and FAIR ESS Digital Objects* builds on existing standards for schemata, encodings, APIs, etc. It will provide a consistent and living knowledge base for ESS RDM standards and a starting point for a self-evaluation of the partners' offerings. *NFDI Commons* acts as the 2-way interface between NFDI4Earth and NFDI and channels the NFDI4Earth contributions into the overall NFDI development. It further ensures the close cooperation with other national stakeholders in the ESS domain. There are several large European and international research infrastructures and advanced data services for ESS data. The measure *International Networking & Embedding* will build and maintain a close collaboration with several of them in order to keep abreast of novel avenues of metadata standards, concepts, information technologies and interfaces. NFDI4Earth will also inspire and contribute to the development of international RDM-related standardisation.

TA 2coordinate covers the overall coordination of the NFDI4Earth consortium, its governance and representation, the internal and external communication, the overall monitoring and quality

assurance of the developments and the establishment of common agreements. The *NFDI4Earth Coordination Office* will administer, support, stimulate and motivate the NFDI4Earth developments and the NFDI4Earth community in the day-to-day running. It acts as the NFDI4Earth point of contact for the NFDI, other NFDI consortia, the DFG, the scientific community, policy and the public. The overall aim is to establish a permanent governance and operational structure for NFDI4Earth representing and integrating the various disciplines of ESS. Designing, establishing and carefully progressing the *NFDI4Earth FAIRness and Openness Commitment* as a commonly agreed and accepted joint vision is key to foster the cultural change in the NFDI4Earth community towards responsible RDM as well as towards open and FAIR sharing of ESS research data and scientific software.

3.3 Brief description of the proposed use of existing infrastructures, tools and services that are essential in order to fulfil the planned consortium's objectives

NFDI4Earth has to deal with a broad variety of data types due to the range of subjects and subdisciplines in ESS. Data stems from a plethora of observations, simulations and analysis in different combinations, forms and formats (numerical, textual, and graphical). Many different open and standardized as well as proprietary data formats and interfaces are used. Relevant standardizations stem for instance from the World Wide Web Consortium (W3C), the Open Geospatial Consortium (OGC), ISO/TC 211 as well as from legal frameworks, e.g. the EU INSPIRE directive. Several approaches exist that address common ontologies. However, it still lacks in providing (semantic) data mapping and transformation paths and data integration remains tedious. Due to the extensive thematic range of NFDI4Earth, a large number of data exploitation methods are required - ranging from numerical and statistical modelling, over machine learning to semi-automated and human interpretation. A common characteristic of ESS data are their spatio-temporal variability and a wide range of space-time reference systems ranging from the smallest to the largest scales.

The NFDI4Earth consortium has been created in a bottom-up process and comprises currently members from universities, research institutions, infrastructure providers, public authorities and different research organizations. A community process to screen the landscape of existing infrastructures, services and collaboration tools supporting ESS resulted in a list of more than 100 platforms and tools. Many of the screened platforms are hosted, co-operated or co-developed by one or several members of the NFDI4Earth consortium. Prominent examples are PANGAEA (AWI), GFZ Data Services (GFZ) and re3data (KIT), Earth System Grid Federation (DKRZ). NFDI4Earth can further capitalize on a series of consolidation efforts, e.g. the DataHub started by the Helmholtz Research Field Earth and Environment In addition, Helmholtz (open) data sci-

ence will become an element of the NFDI4Earth community, supporting researchers outside the Helmholtz realm.

NFDI4Earth includes a number of the German centers for scientific computing and has close linkages and conditional access to HPC and storage resources (e.g. DKRZ, KIT, TUD-ZIH). These services will be further streamlined to offer easy accessible collaborative data science environments for NFDI4Earth.

NFDI4Earth strongly links into international initiatives and networks and will ensure international embedding of NFDI4Earth into for instance ENVRI, ICOS, EPOS, EOSC, ISO, OGC, WDS, RDA, and WMO. NFDI4Earth will connect to international efforts like the climate data store (ECMWF), the European Space Agency (ESA) data cubes, the European Open Science Cloud (EOSC) to develop novel avenues to make scalable data analytics available to a wide user community in the cloud.

3.4 Interfaces to other proposed NFDI consortia: brief description of existing agreements for collaboration and/or plans for future collaboration

In summer 2019, NFDI4Earth started jointly with other NFDI Consortia (DataPLANT. GHGA, KonsortSWD, NFDI4Agri, NFDI4BioDiversity, NFDI4Cat, NFDI4Chem, NFDI4Crime, NFDI4Cuture, NFDI4Health, NFDI4Ing) to develop NFDI Cross-Cutting Topics (see below) and to prepare the collaborative development of the NFDI. In all NFDI4Earth Task Areas common NFDI aspects and NFDI-wide cooperation are addressed. The NFDI4Earth fully shares the idea of the Research Data Commons (RDC) as the NFDI-wide agreed and developed set of basic and common NFDI standards, technological approaches and infrastructure components and will streamline its design and developments according to this concept.

Moreover, NFDI4Earth will particularly act as the NFDI knowledge hub for dealing with Earth related spatio-temporal data. NFDI4Earth agreed jointly with KonsortSWD, NFDIAgri, NFDI4BioDiversity, NFDI4Objects and NFDI4MobilTech on cross-consortium pilots and developments to demonstrate the NFDI benefit for interdisciplinary research. NFDI4Earth plans to run common summer schools on innovative aspects in ESS RDM and in ESS data science in close cooperation with NFDI4BioDiversity.

Additional to the joint work and interfaces addressed as cross cutting topics (see below) NFDI4Earth consortium members do simultaneously participate in other NFDI consortia, thus acting as direct interfaces.

4 Cross-cutting topics

4.1 Cross-cutting topics that are relevant for NFDI4Earth and that need to be designed and developed by several or all NFDI consortia.

The NFDI4Earth co-spokespersons co-drafted and signed the *2019 Berlin Declaration on NFDI Cross Cutting Topics* (https://doi.org/10.5281/zenodo.3457213) and the *2020 Leipzig-Berlin Declaration on NFDI Cross-Cutting Topics* (https://doi.org/10.5281/zenodo.3895209) to define a core set of NFDI topics. Issues that need to be tackled in cross-NFDI activities with the *NFDI Verein* comprise

- NFDI governance model and sustainability, operational, cost-covering and legal models for the coordination bodies/offices of the NFDI and the NFDI consortia
- NFDI wide harmonization and coordination
  - on legal aspects (licensing, intellectual property rights and data protection) and ethical aspects of sharing research data and research software
  - on terminologies (vocabularies and ontologies, reference systems, code lists); common data and metadata standards and encodings (e.g. NFDI core metadata) and unique identifier systems
  - on data and service quality criteria, evaluation and qualification criteria, qualification and/or certification processes for NFDI service offerings and infrastructures, etc.
- International and European embedding of the NFDI consortia, safeguarding NFDI needs and requirements in European/international developments and initiatives (e.g. RDA) on research data infrastructures (e.g. EOSC) and in international standardization bodies (W3C, ISO, etc.)
- Establishing a set of common NFDI shared services that exist in a scientific cloud solution that is supported by and supports German institutions and researchers (e.g. computing and storage services, collaborative working environments, authentication and access mechanisms, registries, long-term archiving etc.)
- Establishing coherent NFDI user-support, linking to existing and emerging research data help desks and support units in the various NFDIs, research institutions and universities
- NFDI capacity building and education with activities towards research data literacy, capacity building on RDM at all levels, establishing professional RDM education and careers
- Stimulating a cultural change of ESS data users and providers towards FAIR and open research data, establishing scientific reputation for research data activities and engagement in scientific software developments, installing common conferences, graduate schools and research projects related to innovative aspects in RDM and data analytics. This is a fundamental building block of the digitalization strategy that our society requires.

4.2 Cross-cutting topics NFDI4Earth contributes to and how

The NFDI4Earth work plan contains several measures to establish common NFDI services. NFDI4Earth consortium members will become members of the NFDI Verein at the earliest possible stage and as a section of the NFDI Verein NFDI4Earth will actively and strongly

- contribute to the NFDI governance model and sustainability models. Several of the NFDI4Earth co-applicants and participants operate research infrastructures of various sizes and with different operation models. Building on the broadness of existing practices and experiences and fully acknowledging the need for linking and consolidating the existing plethora of services and tools the NFDI4Earth members have a vital interest in developing sustainable NFDI operation models.
- support federated user support in NFDI with implementing the virtual user support infrastructure for ESS researchers.
- serve as the NFDI knowledge hub for accessing, using and analyzing Earth related spatio-temporal data – for all different disciplines and application areas that require access to such data and related competencies – and to warrant interoperability to related standards (metadata, encodings, vocabularies, APIs).
- provide networks, engagements and experiences for the NFDI international embedding. NFDI4Earth builds on long standing active participations in various international networks. This applies to ESS related initiatives, such as ENVRI-FAIR, IPCC, WMO, EOSC, and WDS, or the participation in organizations such as OGC to ensure the establishment of international standards or in the implementation of EU Directives, such as INSPIRE, CAFE or WFD. It also includes acting in cross-cutting initiatives such as RDA or the EOSC-Hub.
- participate in the NFDI harmonization efforts. Several NFDI4Earth members can build on widespread and valuable experiences in contributing to international standards and agreements, specifically for metadata standards and spatial data encodings.
- contribute to concepts concerning open scientific software, capitalizing from a well-established culture and skills on community software developments in ESS.
- demonstrate a new quality in interdisciplinary research in common, cross-consortium applications (e.g. with NFDI4Agri, NFDI4BioDiversity, KonsortSWD).
- provide input to education and capacity building modules related to Earth system data management and analysis.
- contribute to the vision, co-design and stepwise implementation of a Common Scientific Cloud building on the commitment of the NFDI4Earth members who operate powerful HPC and storage infrastructures.