

# FAIR4RS: Adoption support

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## Group members

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# Background

In September 2021, the FAIR4RS WG formed subgroups to address milestones for the adoption of the FAIR4RS principles. This document is the output of subgroup 6, focused on adoption support. The subgroup aimed to:

1. Identify and start to work with software projects that are already following FAIR4RS guidelines (or are willing to do so)
2. Identify and start to work with organisations (e.g., national, disciplinary, general) willing to adopt FAIR4RS guidelines
3. Identify and start to work with funders willing to stimulate adoption of FAIR4RS guidelines
4. Facilitate writing up of a variety of types of examples of how FAIR4RS is being adopted (or at least plans for how to do so), to share lessons across the community

## Collection of adoption efforts

The following is a selection of organisations that have started implementing FAIR4RS at different levels of granularity. There are other ongoing adoption efforts that are not included here. We briefly describe the results so far for each organization.

### AGU

**The American Geophysical Union ([AGU](#))** is responding to the FAIR4RS Principles via:

- Outreach/training that leverages the guidance from FAIR4RS, the FORCE11 Software Citation Implementation Working Group, [JATS4R](#), and the [Software Sustainability Institute](#). This includes information on how to improve the underlying metadata and documentation for software as well as how to make it FAIRer, see [Software Citation - 5 Tips | AGU Data Leadership](#) and a recent AGU Fall meeting presentation, <https://doi.org/10.5281/zenodo.5777006>.
- Guidance that stresses the importance of using PIDs (DOIs) for software citation credit and discovery.
- Instructions to authors to preserve their software in a repository (authors often choose Zenodo). Metadata (e.g., versioning, licensing, access conditions) are captured via a repository ([AGU's list of useful discipline repositories](#)), but AGU also asks authors to include this information in the Availability Statement in the Open Research section of their paper along with a link to where the software is being actively developed, often a GitHub repository. See [Data and Software for Authors | AGU](#).
- Guidance that stresses the citation of software, as an in-text reference in the Availability Statement, and in the References section of the paper. The bracketed description in the APA citation style is leveraged to ensure that both humans and machines can recognize

a software citation (e.g., [Software] is used, with all variations pointing to this as well). This also ensures indexing of the citation, especially the DOI, in Crossref.

- Guidance on Jupyter/R Notebooks: [Resources | AGU Data Leadership](#)

One challenge that remains is how AGU manages composites, where a repository uses a single identifier for data, software, and other research objects, or the user does this in a general repository. The specific challenge is around type. Often in composites, the composites are typed as data, which is how search & discovery systems then see them. Ultimately, the searcher has to differentiate what is data, what is software, what is both.

## CoMSES.Net

### **The Network for Computational Modeling in the Social and Ecological Sciences**

([CoMSES.Net](#)), has been working to improve how researchers share, document, and reuse computational models for the study of social-ecological systems since its inception in 2007. Computational models published in the CoMSES Computational Model Library meet most of the current FAIR4RS principles. Gaps remain, primarily in the Interoperable and Reusable principles, but will be addressed after assessing the final FAIR4RS publication. Upcoming work to address issues of interoperability, reusability, and bridging the gap to help researchers improve the FAIRness of their published work will focus on:

1. **Education and outreach:** develop scalable assessment rubrics and modular curriculum for workshops and winter schools / summer institutes / online courses. These may include Carpentries module(s) for building FAIR models from scratch, and converting existing computational models to be more FAIR.
2. **Supporting cyberinfrastructure:** help researchers develop more FAIR codebases from scratch via cookie cutter GitHub repository templates or improve existing codebases via pull request-based augmentation guided by GitHub bots and human curators.
3. **Community development:** CoMSES Net is an international scientific network with over 3,000 members who agree to support ethical practices of open science. The CoMSES.Net science gateway provides diverse platforms for knowledge sharing and disseminating information about FAIR. CoMSES.Net also is a founding member of the [Open Modeling Foundation](#), which will have an even broader mission to recognize FAIR4RS and develop the Interoperable and Reusable dimensions of the FAIR4RS principles for computational models across a diverse set of disciplines.

## Digital Research Alliance of Canada

The [Digital Research Alliance of Canada](#) (the “Alliance”, formerly NDRI) is working on [Inaugural Funding Opportunities](#) that align with principles such as FAIR4RS for research software development and management. The Alliance’s [Research Software Position Paper](#) and [Strategic Plan](#) will include support for the adoption of best practices in research software development and management (including FAIR4RS) throughout the research lifecycle, as well

as support to build and sustain a strong and vibrant research software community. Current initiatives include:

- Promoting the impact and value of research software as a first-class research output to facilitate culture change in the adoption of open science practice
- Supporting the long-term access to, and preservation of research software
- Providing targeted and sustainable funding for both developing new and sustaining existing research software services and platforms

## ESMAValTool

**The Earth System Model Evaluation Tool (ESMValTool)** already follows some of the FAIR4RS principles. The following is a list of components of the software and an indication of how they align with the principles:

- Having a globally unique and persistent identifier, with distinct identifiers for different versions by being indexed in Zenodo: the tool consists of two components, with different identifiers for versions and are indexed in Zenodo: esmvaltool (<https://zenodo.org/record/5658385>) and esmvalcore (<https://zenodo.org/record/5654724>). **This supports Findability.**
- The software is described with rich and searchable metadata by having a citation file (CFF) and being indexed in the Research Software Directory (<https://research-software.nl/software/esmvaltool>), PyPI (<https://pypi.org/project/ESMValTool/>), and Conda-forge (<https://anaconda.org/conda-forge/esmvaltool>). **This supports Findability.**
- Software is retrievable either using PyPI (<https://pypi.org/project/ESMValTool/>), Conda-forge (<https://anaconda.org/conda-forge/esmvaltool>), GitHub source code, Zenodo entries, or docker hub (<https://hub.docker.com/u/esmvalgroup/>). **This supports Accessibility.**
- The software interoperates with other software through exchanging data and/or metadata, and/or through interaction via application programming interfaces (APIs) (I). Software reads, writes and exchanges data in a way that meets climate-relevant community standards like (cf conventions, <https://cfconventions.org/> and CMOR standards, <https://pcmdi.github.io/cmor-site/index.html>). It supports several programming languages like python, R, Julia and ncl and Unix(-like) operating systems. esmvaltool includes qualified references to data, papers and authors of the papers and code. The software provides provenance and citation information regarding the input, processes and output. Provenance information is stored in the W3C PROV XML format (<https://www.w3.org/TR/prov-xml/>) and citation information in Bibtex format. **This supports Interoperability and Reusability.**
- The documentation and tutorial are described with a plurality of accurate and relevant attributes. It has an Apache 2.0 licence <https://github.com/ESMValGroup/ESMValTool/blob/main/LICENSE>. **This supports Reusability.**

## KIT

**Karlsruhe Institute of Technology (KIT)** is currently implementing infrastructure and processes that will facilitate compliance with the FAIR4RS principles for researchers. Project templates including metadata, easy CI pipelines for software publication, etc. This will likely be ready by the end of 2022 but not in time for the RDA VP19. Some aspects of this effort are described by [The openCARP CDE](#).

## NeIC-NICEST

**The Nordic Collaboration on e-Infrastructures for Earth System Modelling (NeIC-NICEST)** is supporting the adoption of the FAIR4RS Principles by the Nordic Earth System Modelling Community. NeIC-NICEST is currently working on guidelines to “package and publish” Earth System Models and related pre/post-processing software following the FAIR4RS principles, and will provide concrete examples with the two main Earth System models in use in the Nordics (NorESM and EC-Earth). Synergies with ESMValTool are to be expected because ESMValTool is part of the “tool-chain” used by Nordic climate scientists.

## Netherlands eScience Center

The [Netherlands eScience Center](#) is adopting the FAIR4RS Principles by using the principles to support the creation of reusable software as part of its calls and projects, contributing to developing the skills necessary to implement them, and promoting the principles on relevant policy agendas at the (inter)national level.

The following are some of the specific actions the eScience Center is taking for adoption of the FAIR4RS Principles:

- Using the FAIR4RS Principles to support the creation of reusable software as part of its calls and projects. All projects funded by the eScience Center are required to have [software management plans](#).
- Contributing to developing the skills necessary to implement the FAIR4RS Principles through skills and knowledge development activities: digital skills training, development of practical guidelines, etc. Their Digital Skills Programme helps develop some of the necessary skills required to develop software that is as reusable as possible.
- Updating the [Five Recommendations for FAIR software](#) website to better align with the FAIR4RS principles. We will also update [howfairis](#), which assesses compliance with these recommendations.
- Promoting the principles on relevant policy agendas at a (inter)national level. For example, the eScience Center is collaborating with the Dutch Research Council (NWO) in the creation of national templates for Software Management Plans. The aim of these templates is to provide guidance for Dutch research organizations and scientific communities, as well as individual researchers, on how to organize research software and ensure its sustainability. The FAIR4RS Principles are being considered as a starting

point in the development of these templates. The guidance provided by the templates will be, wherever possible, closely aligned with the FAIR4RS Principles.

## NIST

**The National Institute of Standards and Technology ([NIST](#)) is addressing FAIR4RS in the following three ways:**

- Creation of a [template repository](#) that explains FAIR4RS requirements that are expected for NIST (National Institute of Standards and Technology) software repositories. It contains metadata files that developers are expected to amend as well as instructions for complying with FAIR4RS requirements. The template repository is created by the [Office of Data and Informatics at NIST](#) and is ongoing work. Future work includes automating FAIR4RS checks on NIST repositories using some of the existing FAIR4RS tools.
- Creation of the [NIST software portal](#), which gathers software metadata and aggregates that data into meaningful views. It promotes FAIR4RS (in particular making software findable) by requiring a metadata file to be present in all NIST repositories with the [code.gov metadata standard](#).
- Planning a Carpentry-style course on software engineering to include a large dose of FAIR4RS.

## NWO

**The Dutch Research Council ([NWO](#))** will include pointers to guidance on adoption of the FAIR4RS principles as part of the guidance provided to projects they fund when research software is one of the outputs of the project. Additionally, NWO is already supporting projects that encourage the adoption of FAIR4RS principles via their Open Science Fund programme.

## UPM

**Universidad Politécnica de Madrid ([UPM](#))** is pushing the adoption of the FAIR principles by developing dashboards for monitoring metrics and visualising scientific production. UPM is collaborating with OpenAire (through the [Connect project](#)) in order to develop a working prototype. The initial focus is on publications, but there is a significant number of software projects in [OpenAire](#) that the project is striving to include. The metrics to be considered in the pilot are still in development by the International Project Office at UPM.

UPM is also coordinating the [InnoCORE EELISA project](#), in collaboration with the University of Bucharest, where a full work package is dedicated to the implementation of Open Science policies and FAIR.

## ZB MED Information Centre for Life Sciences

[ZB MED Information Centre for Life Sciences](#) promotes the FAIR Guiding Principles by providing support, advice, and training to researchers in this regard. ZB MED is now adopting and promoting the FAIR4RS Principles to better support research software. Researchers at ZB MED already follow some practices related to FAIR and openness, including the [recommendations for open source code](#), combined with the [Five Recommendation for FAIR Software tool](#). Currently, ZB MED is adapting and extending these practices to better align them to the FAIR4RS Principles and the adoption guidelines that the same group is working on. Furthermore, ZB MED plans to extend dissemination activities around FAIR to include the FAIR4S Principles so that more researchers understand and adopt them.