



## MOLES Information Model

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The Metadata Objects for Linking Environmental Sciences (MOLES) model has been developed within the Natural Environment Research Council (NERC) DataGrid project [NERC DataGrid] to fill a missing part of the 'metadata spectrum'. It is a framework within which to encode the relationships between the tools used to obtain data, the activities which organised their use, and the datasets produced. MOLES is primarily of use to consumers of data, especially in an interdisciplinary context, to allow them to establish details of provenance, and to compare and contrast such information without recourse to discipline-specific metadata or private communications with the original investigators [Lawrence et al 2009]. MOLES is also of use to the custodians of data, providing an organising paradigm for the data and metadata.

The work described in this paper is a high-level view of the structure and content of a recent major revision of MOLES (v3.3) carried out as part of a NERC DataGrid extension project. The concepts of MOLES v3.3 are rooted in the harmonised ISO model [Harmonised ISO model] - particularly in metadata standards (ISO 19115, ISO 19115-2) and the 'Observations and Measurements' conceptual model (ISO 19156). MOLES exploits existing concepts and relationships, and specialises information in these standards.

A typical sequence of data capturing involves one or more projects under which a number of activities are undertaken, using appropriate tools and methods to produce the datasets. Following this typical sequence, the relevant metadata can be partitioned into the following main sections – helpful in mapping onto the most suitable standards from the ISO 19100 series.

- Project section
- Activity section (including both observation acquisition and numerical computation)
- Observation section (metadata regarding the methods used to obtain the data, the spatial and temporal sampling regime, quality etc.)
- Observation collection section

The key concepts in MOLES v3.3 are:

- a) the result of an observation is defined uniquely from the property (of a feature-of-interest), the sampling-feature (carrying the targeted property values), the procedure used to obtain the result and the time (discrete instant or period) at which the observation takes place.
- b) an 'Acquisition' and a 'Computation' can serve as the basis for describing any observation process chain (procedure). The 'Acquisition' uses an instrument – sensor or human being – to produce the results and is associated with field trips, flights, cruises etc., whereas the 'Computation' class involves specific processing steps. A process chain may consist of any combination of 'Acquisitions' and/or 'Computations' occurring in parallel or in any order during the data capturing sequence.
- c) The results can be organised in collections with significantly more flexibility than if one used the original project alone
- d) the structure of individual observation collections may be domain-specific, in general; however we are investigating the use of CSML (Climate Science Modelling Language) for atmospheric data

The model has been tested as a desk exercise by constructing object models for scenarios from various disciplines.

#### References

NERC DATAGRID: <http://ndg.nerc.ac.uk>

LAWRENCE ET. AL. ,Information in environmental data grids, Phil. Trans. R. Soc. A, March 2009 vol. 367 no. 1890 1003-1014

ISO HARMONISED MODEL: All relevant ISO standards for geographic metadata from the TC211 series (eg. ISO 19xxx), and is harmonised within a formal UML description in the 'HollowWorld' packages available at <https://www.seegrid.csiro.au/twiki/bin/view/AppSchemas/HollowWorld>