HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

SMART MONITORING

DIGITAL EARTH

SMART Monitoring

SMART Monitoring helps to better and faster adjust sensor settings and monitoring strategies in time and space in an iterative feedback.

From sensor to database and data warehouse, Digital Earth develops, establishes, and integrates standardized workflows for near-real-time interactive data analyses, data exploration and collaborative measurement campaign optimization with:

- state-of-the-art IT technology to enhance traditional monitoring,
- automatized data quality control,
- and near real-time data flow and Q/A routines.
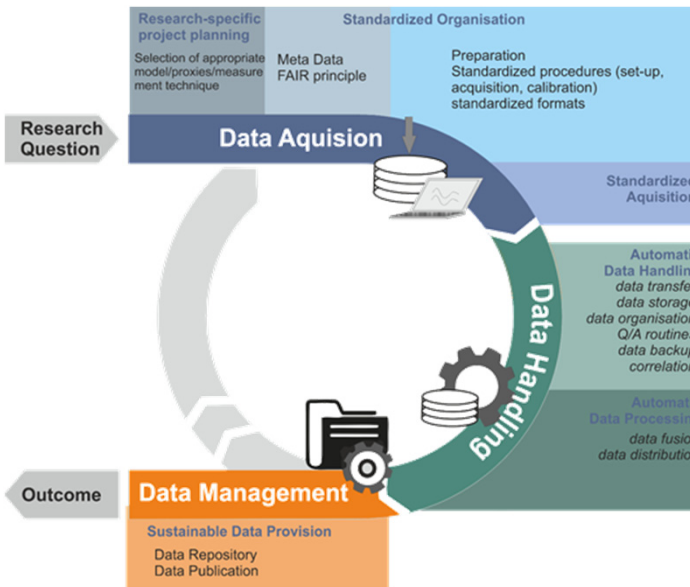
In order to guarantee the sustainable usability of observation data, all monitoring data collected, whether in observatories or during individual measurement campaigns, must be **Specific, Measurable, Accepted, Relevant and Trackable** to meet the **SMART** criteria.

Towards products with high data coverage, quality and visibility

Mathematical and statistical tools or even fully automated machine learning tools in various steps of data flow support scientists to develop workflows and methods for optimizing and designing observation strategies (sensor layouts, sample rates, parameters needed, etc.).
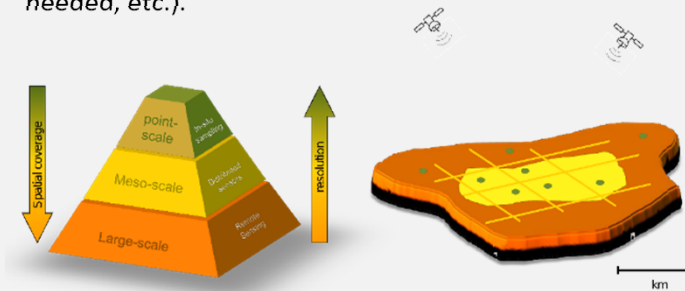
For example, by using the PatReg-Monitoring tool, scientists can define pattern recognition strategies to identify regions of interest within input parameters (data- or model-based) to optimize sparse sampling procedures (or model validation) without compromising the quality of inference.
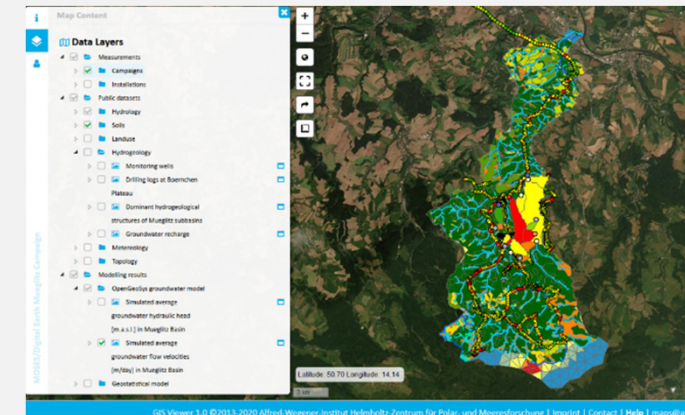

The maps WebGIS-Platform provides visualization and data collection methods of all available data.

Near-real-time data provision

The decision-making process in traditional database environments is often delayed because data cannot be propagated from the source system to the data base in time. These tools use batch processing and operate offline at regular time intervals.

In Digital Earth, we develop Near-Real-Time Extract-Transform-Load tools to promptly transfer data from operational databases into data warehouses.
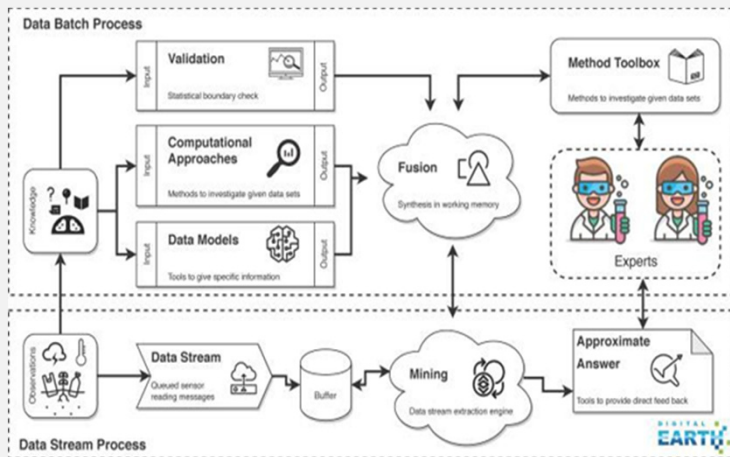
This data-driven monitoring strategy is based on a **data stream architecture** following the measurement paradigm "**P**redictive **O**bject **S**pecific **E**xposure" (POSE). This approach ensures that each measured variable has a definite spatial and temporal reference but can also be assigned to a specific context or prior information. This allows high performance in terms of real-time data provision and enables the usage of artificial intelligence tools on the data stream to feed models and data fusion algorithms.

Cooperation makes the difference

The underlying SMART Concept is the basic requirement to ensure that highly complex data sets can be understood, tracked and reused by third parties over a long term.

To ensure **manageability** and **sustainability**, important standardization concerning formats, procedures and metadata treatment are essential to obtain reliable data for data sharing, data blending and joint data analysis. Within the HGF, Digital Earth works together to coordinate and implement these standards.

Designed, developed, discussed and suggested standardization include e.g.:

- Standardized vocabulary
- Standardized formats e.g. dates, units, positions
- Standardized procedures e.g. reporting, QA/QC, uncertainty analysis, visualization
- Standardized metadata description e.g. regarding sensor intercomparision experiments

Observation of extreme climate impacts in the digital age

"Together we are getting ready to guarantee the common and sustainable use of observation data for the new generation of measurement and monitoring technologies."

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WP1 SMART Monitoring

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