MAELSTROM

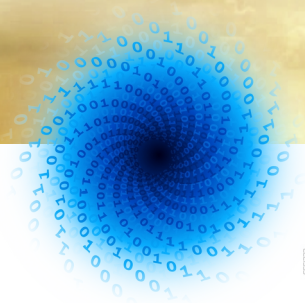
Empowering weather & climate forecast:

ML Apps & Datasets

ML Workflow Tools

Hardware Systems

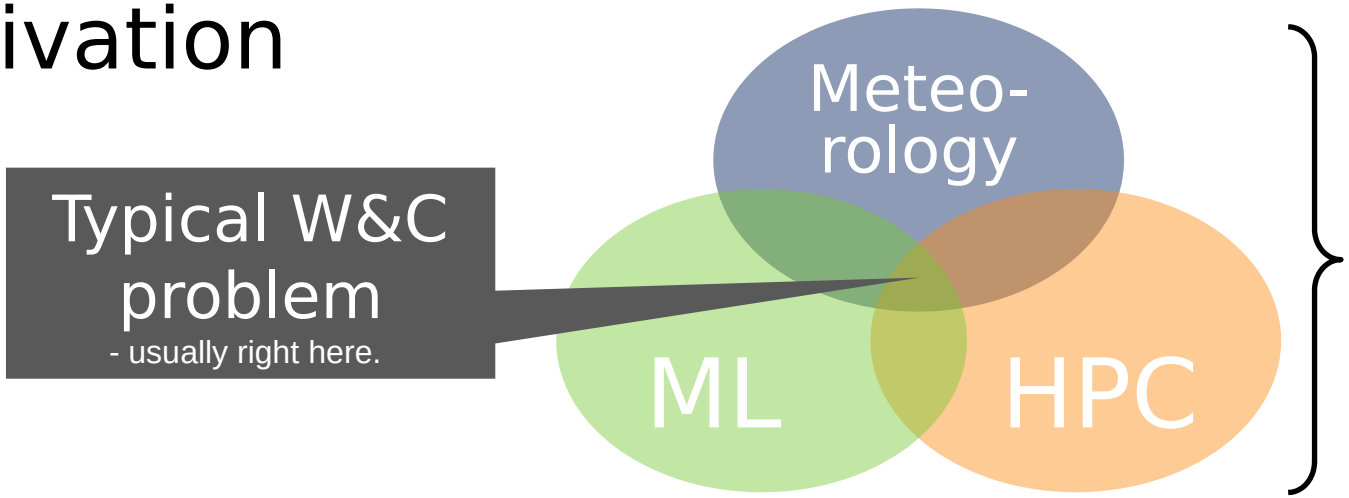
Fabian Emmerich
4Cast



"The MAELSTROM project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 955513. The JU receives support from the European Union's Horizon 2020 research and innovation programme and United Kingdom, Germany, Italy, Luxembourg, Switzerland, Norway".

Co-ordinated by ECMWF

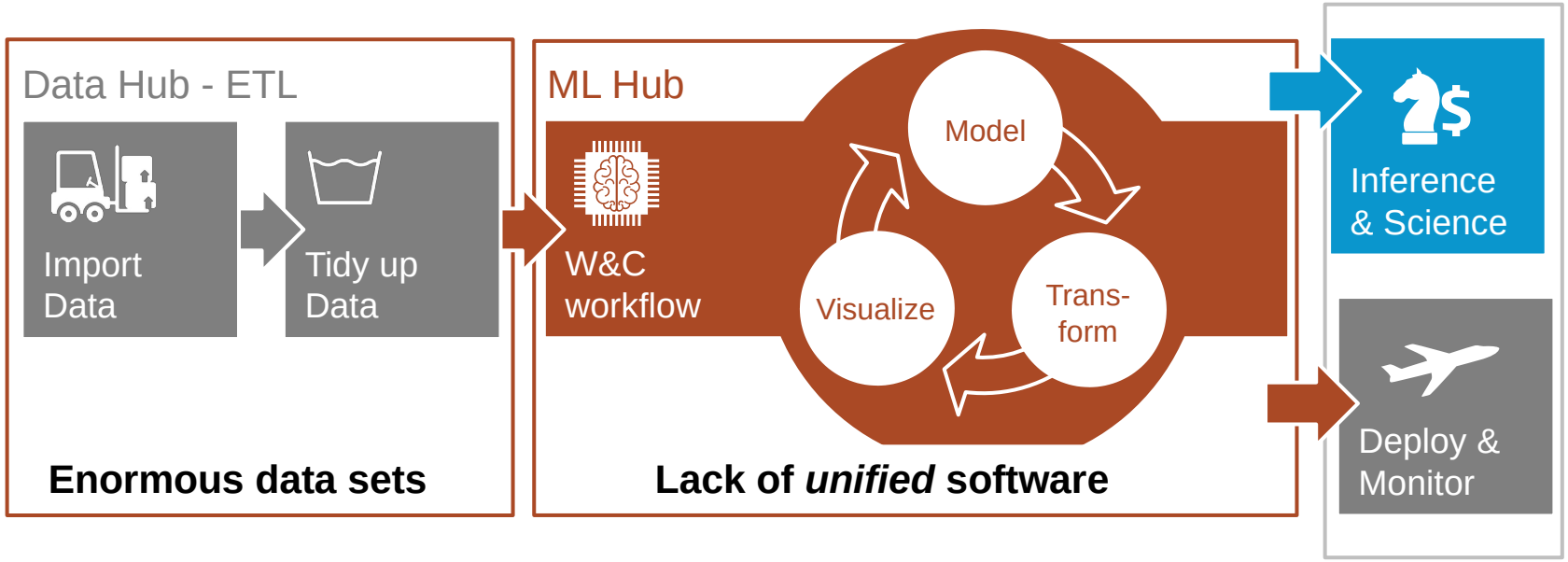
Motivation



Different cultures, approaches & solutions. Unification and extension are needed!

Problem	**Solution**
Complicated workflow	Ease the workflow
Enormous data sets	Pave the way towards exascale data
Lack of *unified* infrastructure	Abstract away infrastructure
Lack of *unified* software	Build software with unified interface

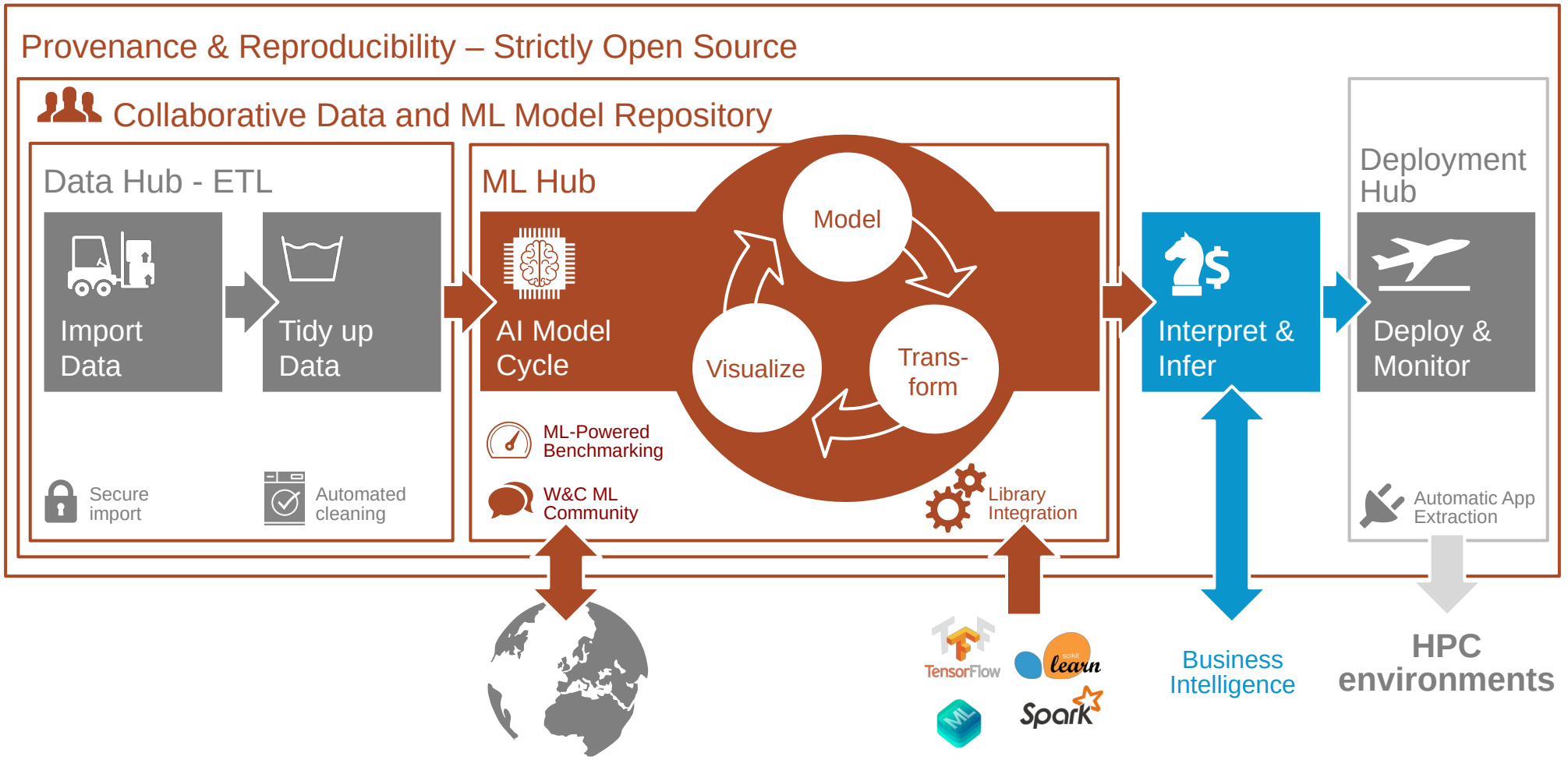
ML workflow today



Unified infrastructure missing today:

Benchmarking	Monitoring	Reproducibility
Collaboration	Framework integration	User interface

Our vision for the workflow



Achievements to date

Survey of typical ML workflow in W&C

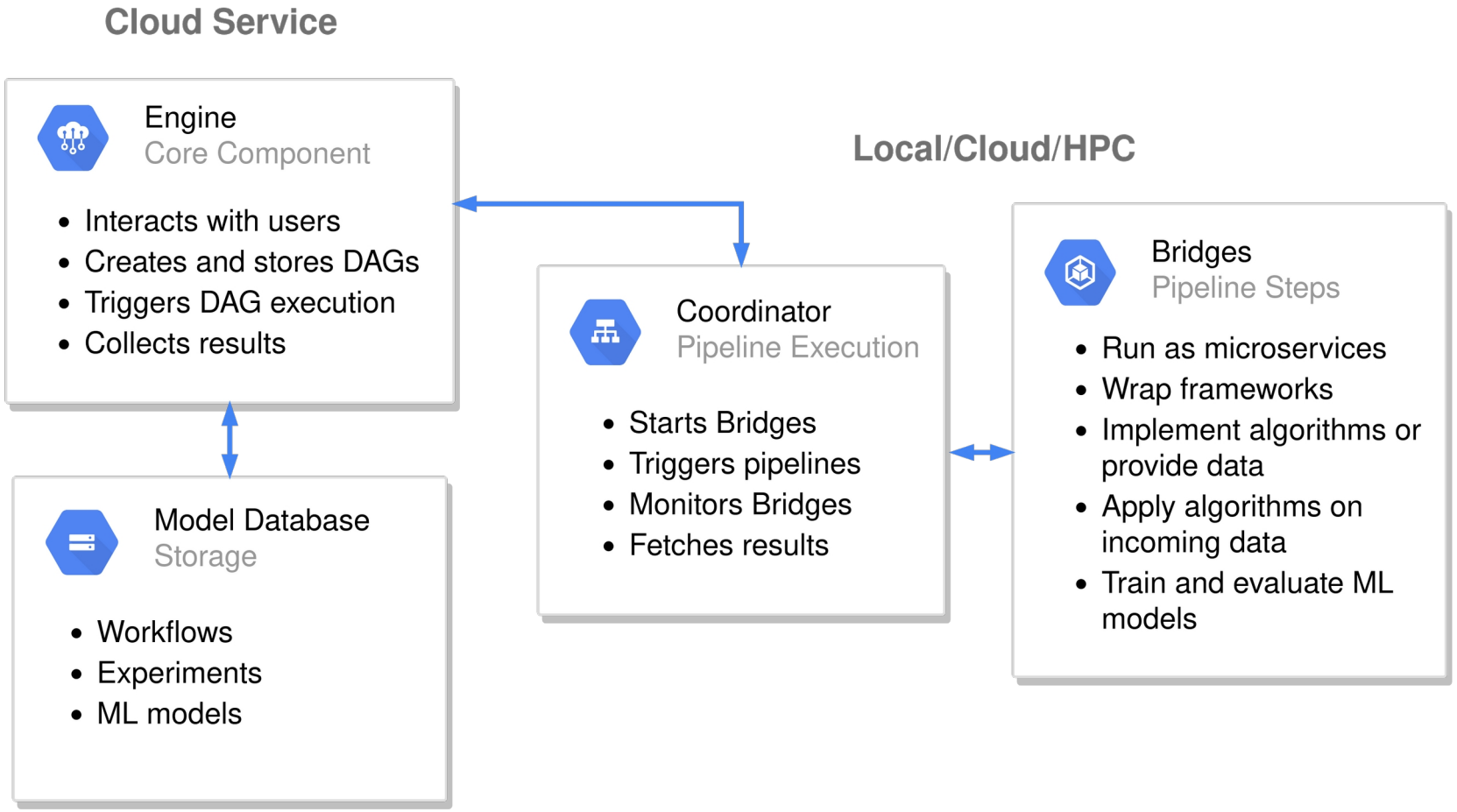
Requirements for workflow tools

MAELSTROM workflow tools v1.0

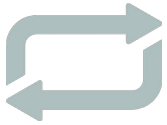
- Based on the Mantik ML tool[1]: open-source software to execute ML workflows on any hardware infrastructure (local machine, cloud computers or HPC architectures)
- Will be used to benchmark different software solutions for MAELSTROM apps
- Store the configurations and results of experiments in the Model Database

[1] www.mantik.ai

Mantik software architecture



Workflow tools key features



Reproducible ML solutions

Share ML solutions across user base

Recommendation of ML solutions to users with specific problems

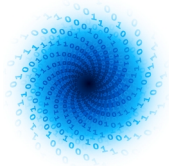
Interface to cloud computing and HPC

Manipulation of execution graphs leading to optimal execution of W&C workflows

Current interfaces

MAELSTROM platform as a ML workflow platform

- Command Line Interface
- Model Database
- HPC interface
- GUI for execution and job status



Code examples

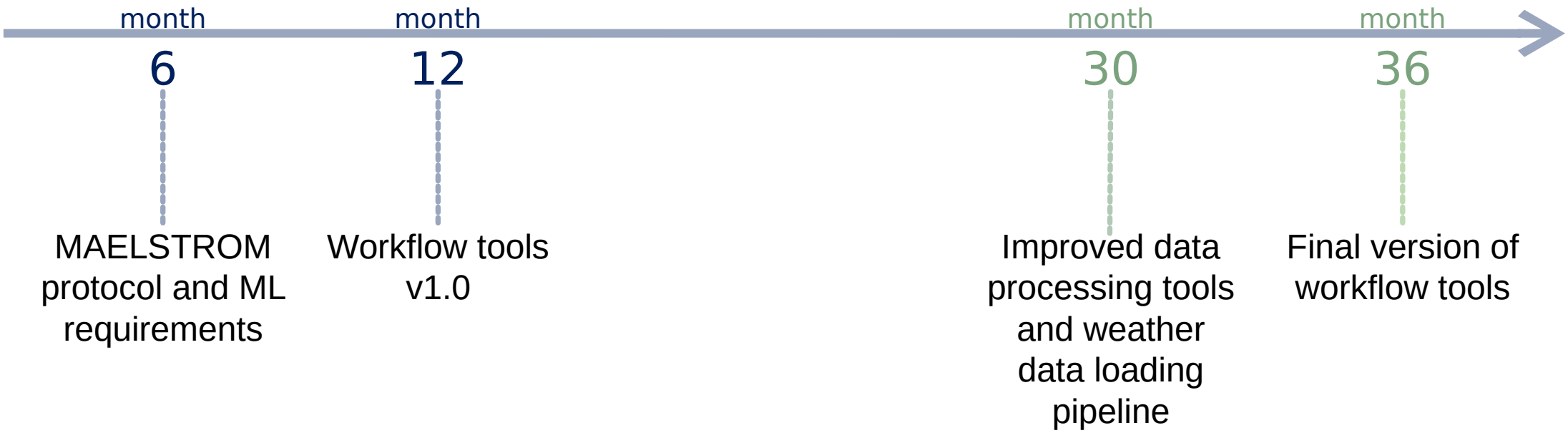
```python
# main.py
import mantik


# Connect to the Mantik Engine.
with mantik.Client("mantik.ai") as client:
    # Add pipeline steps to the Engine's registry.
    dataset = client.add_artifact("dataset/")
    transform = client.add_artifact("transform/")
    model = client.add_artifact("ml-model/")

    with client.enter_session():
        # Train the model.
        pipeline = [transform, model]
        model, stats = client.train(pipeline, data=dataset)

        # Use the model for inference.
        inference = client.apply(model, data=dataset)
```

```python
# dataset/dataset.py

def get(meta: mantik.MetaVariables):
    # Access input parameters.
    variable = meta.get("variable")

    # Create the dataset.
    data = ...

    # Pass the dataset to the next step.
    return mantik.Bundle(data)
```

```python
# transform/algorithm.py

def apply(bundle: mantik.Bundle, meta: mantik.MetaVariables):
    # Access input parameter or data.
    variable = meta.get("variable")
    data = bundle.value

    # Transform the data.
    transformed = ...

    # Pass data to the next pipeline step.
    return mantik.Bundle(transformed)
```

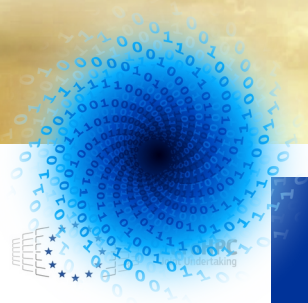
```python
# ml-model/train.py

def train(bundle: mantik.Bundle, meta: mantik.MetaVariables):
    # Train the model on the data (`bundle.value`).
    model = ...

    # Get statistics about the model.
    metrics = ...

    # Return the trained model and any other information.
    return model, mantik.types.Bundle(metrics)


def apply(model, bundle: mantik.Bundle):
    # Apply the model on the input data.
    result = model.predict(bundle.value)

    # Return the result of the inference.
    return mantik.Bundle(result)
```

Vision for the next two years



MAELSTROM

Questions?



"The MAESLTROM project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 955513. The JU receives support from the European Union's Horizon 2020 research and innovation programme and United Kingdom, Germany, Italy, Luxembourg, Switzerland, Norway".

Co-ordinated by ECMWF