Environmental Modelling and Prediction Platform EMP2

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CERN IT

FTI FRONTIER TECHNOLOGIES AND INITIATIVES

EMP2: Summary

Title: EMP2 - Environmental Modelling and Prediction Platform
Dates: March 2023 - Feb 2025

Principal Investigators

- Ilaria Luise (CERN)
- Christian Lessig (ECMWF, Magdeburg University)
- Martin Schultz (JSC)

CERN Team

- Project Leader: Alberto Di Meglio
- Project members: Ilaria Luise (principal investigator), Sofia Vallecorsa (scientific support)

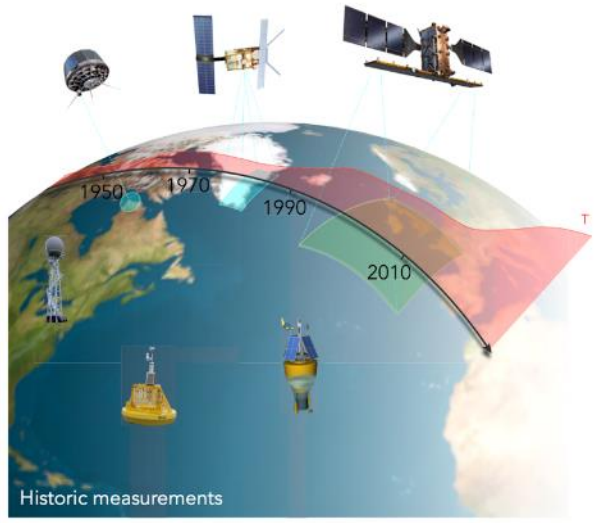
Fundings

- Source: CIPEA programme

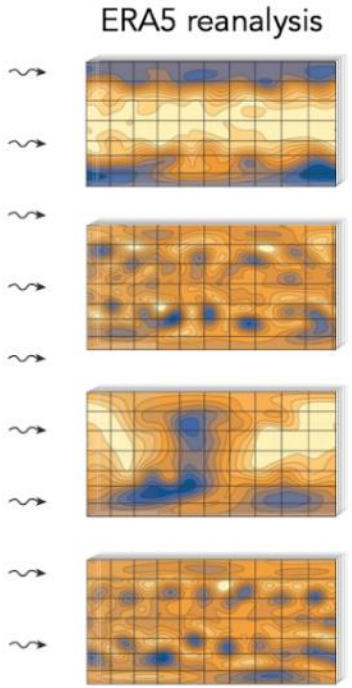
Partners

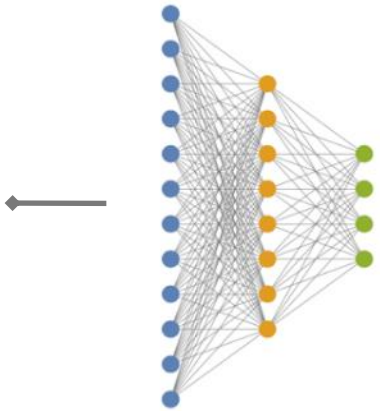
The Project and General Objectives

A machine-learning based global environmental model trained on terabytes of observational data



Observations

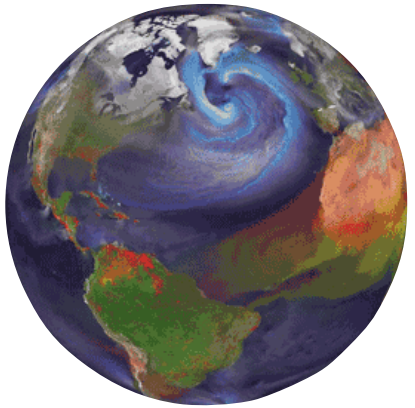




large scale machine learning

Transformers architecture

Spatio-temporal representation of atmospheric dynamics

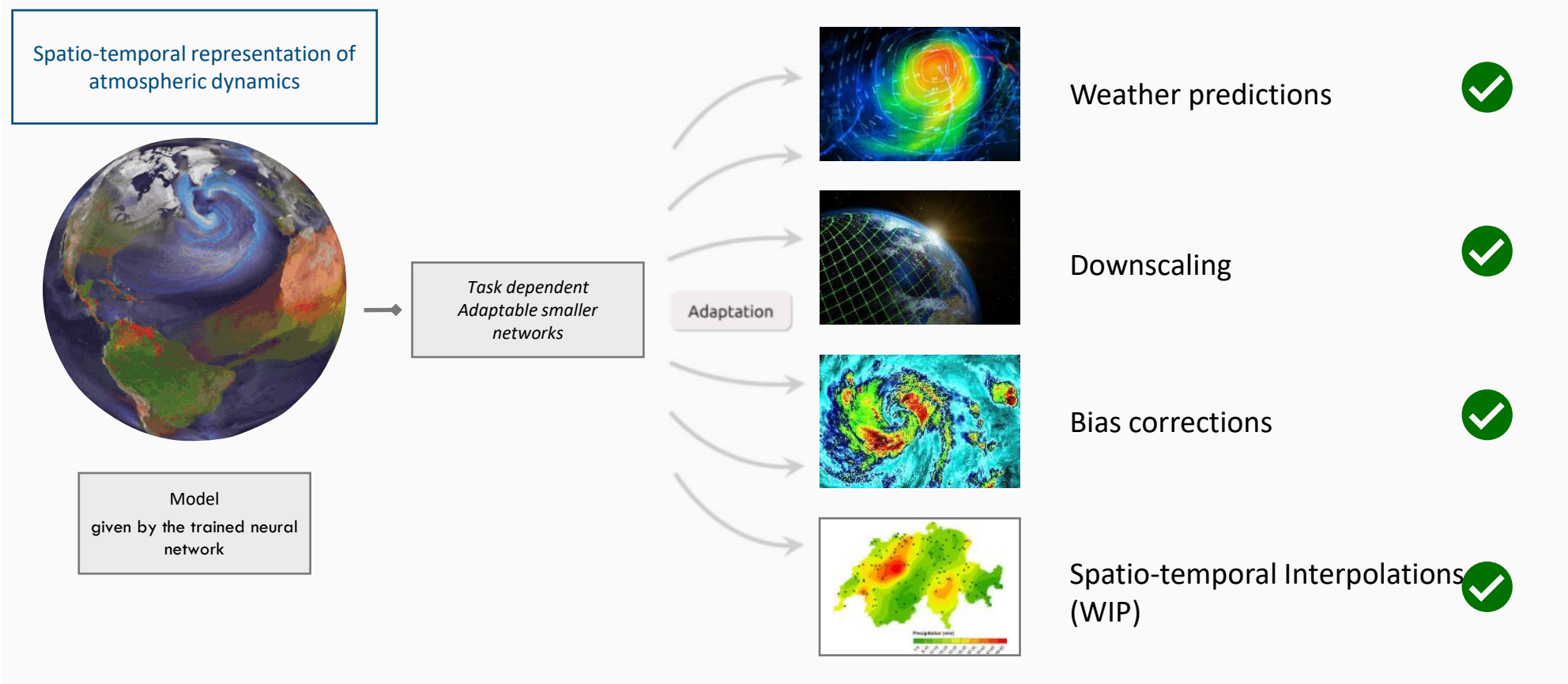


Model given by the trained neural network

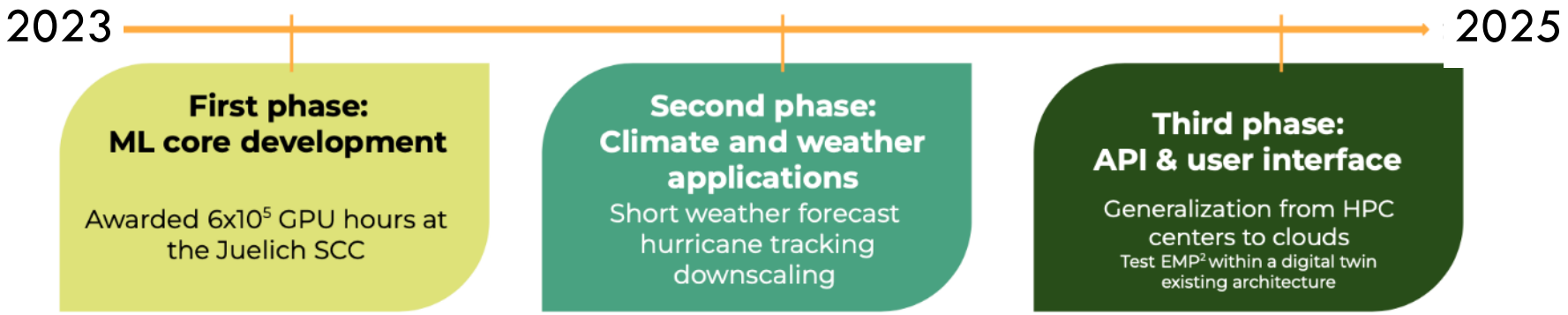
JÜLICH Forschungszentrum

Applications: one model for multiple purposes

Use the learned representation to improve the state-of-the-art of specific weather & climate-related scientific applications



Achievements



- First prototype of ML core model released in August 2023
- Model publicly available on GitHub

- 5 applications tested
- Skillful prediction at the same level of state of the art numerical and Machine-learning models

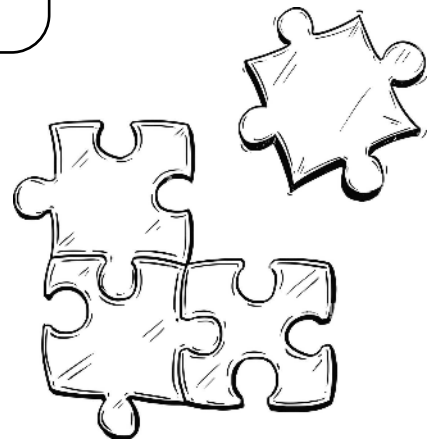
- Implemented a data reader through the interTwin tools

More infos at: www.atmorep.org

Innovation factors & lessons learned

One of the first proof-of-concepts of a global machine-learning based environmental model trained on petabytes of observational data.

First example of large-scale spatio-temporal representation learning (3D space+time) of atmospheric dynamics.



Explore the potential of foundation models in fundamental science.

Apply representation learning to scientific data. Useful e.g. for HL-LHC

Applications:
Faster weather prediction models. Help shaping the next generation of weather prediction models

Innovative probabilistic approach implemented for this kind of models.

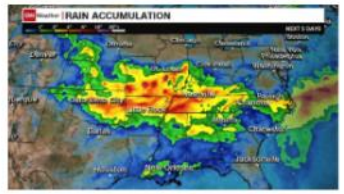
Leads to well calibrated ensemble outputs (no perturbative approach as currently used).

Applications:
First step towards developing data-driven systems that learn directly from observations.

Potential Impact

Integration into current weather forecast models

Potential first user:
EU-funded project MAELSTROM



Licensing to insurances and risk assessment companies

eg. assess floods/droughts/fires risks under climate change

Partnerships in future EU funded projects

prototype of a digital twin encapsulating information from a large dataset ⇒ expertise applicable to other domains

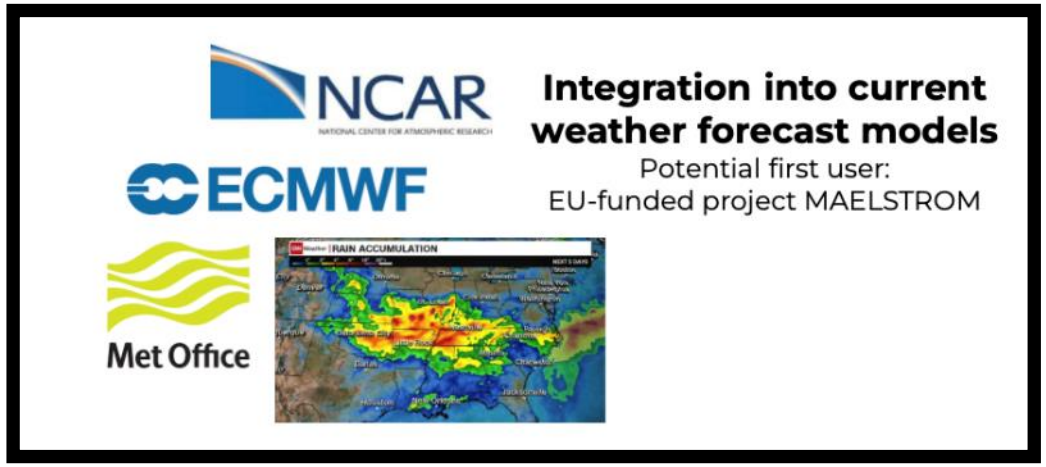
Renewables-based energy companies

e.g. optimize wind or solar farm placement, forecast the productivity of renewable-based power plants

Large high-tech companies

integration of machine learning-based models for weather and climate forecasting into their products

Achieved Impact



Projects that will be using EMP2 as core model:

- RAINA: 2 year project to use the EMP2 core model for extreme event modeling. Funded by the German Minister of Research. Started in 2024.

- HClimRep
  - Partners: JSC (leader), AWI, KIT
  - External partners: ECMWF, CERN
  - HClimRep project proposal:
    - Use AtmoRep as core model for climatological predictions

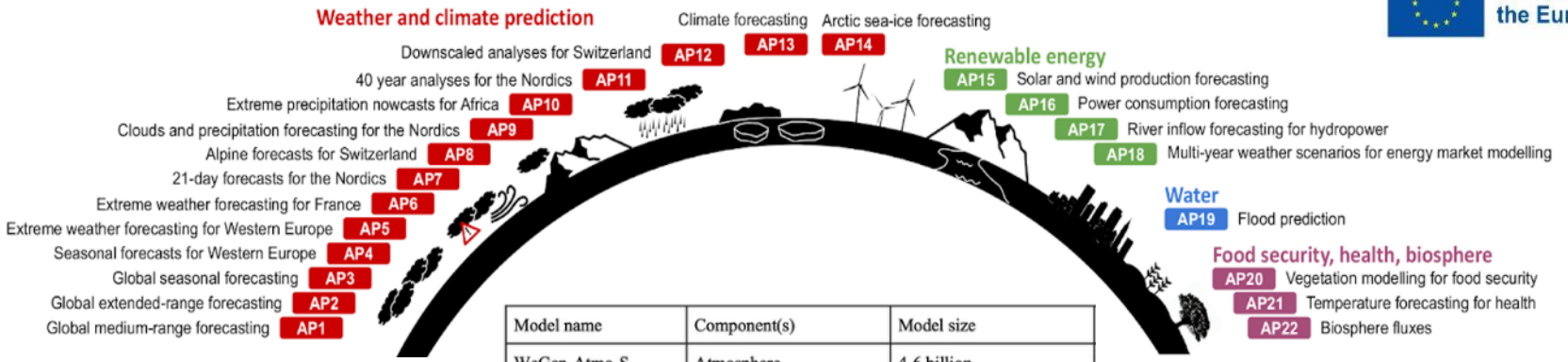
- WarmWorld project: EMP2 will be adapted to the ICON grid (used by the German Weather Service, DWD) and used as core model for AI-based weather predictions.

What's next? The WeatherGenerator

Weather Generator

Funded by the European Union

Coordinated by ECMWF



Model name	Component(s)	Model size
WeGen-Atmo-S	Atmosphere	4-6 billion
WeGen-Atmo-M	Atmosphere	10-20 billion
WeGen-Atmo-L	Atmosphere	50-100 billion
WeGen-Land	Land	100 million
WeatherGenerator	Atmosphere, Land	4-6 billion/50-100 billion

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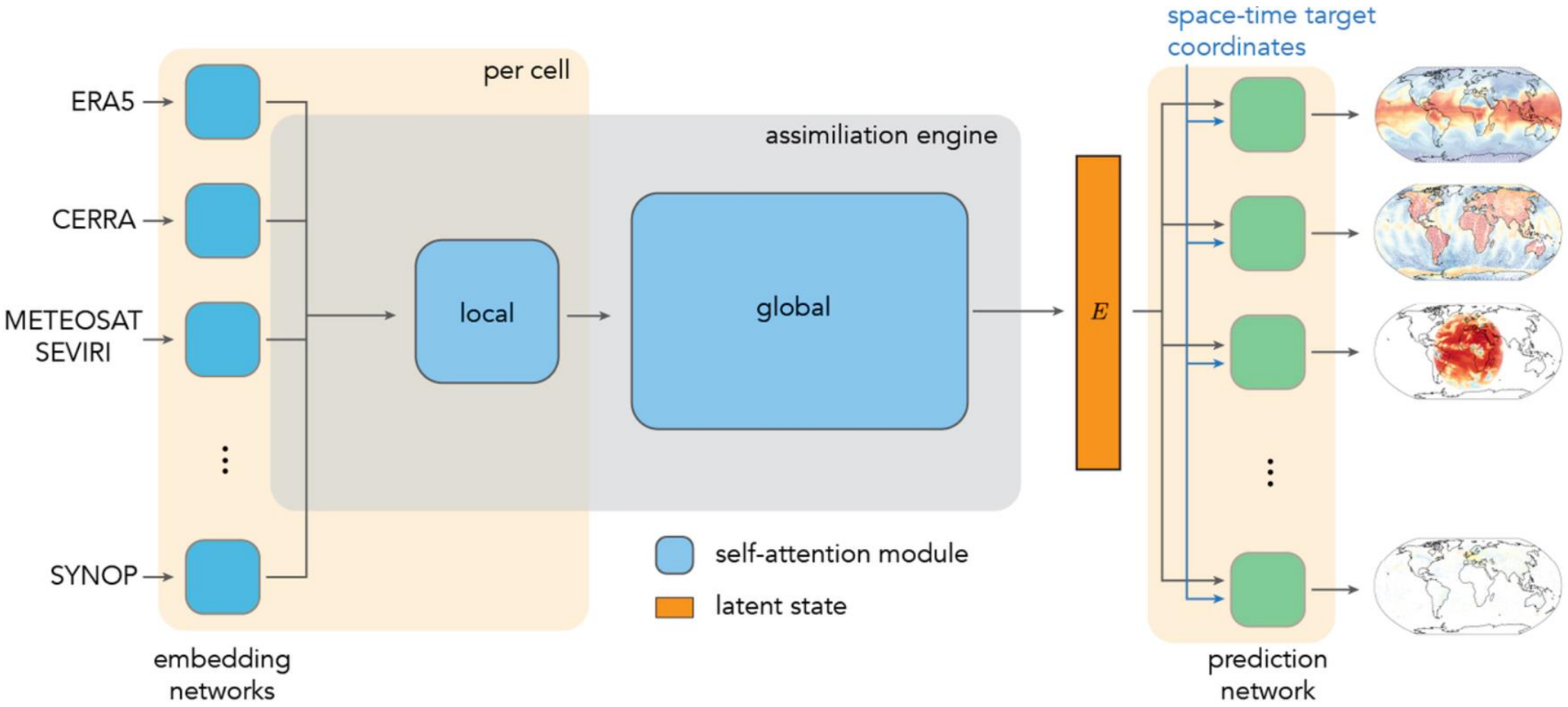
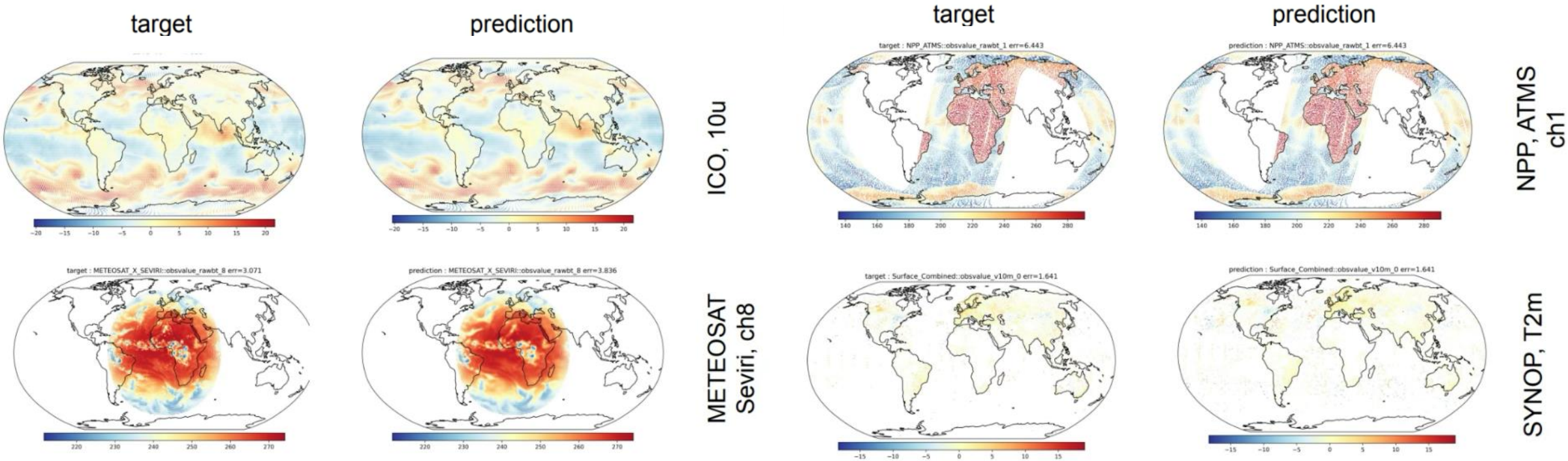
The WeatherGenerator model



Christian Lessig - Technical blog vol. 1 | Weather Generator

Prototype model trained on multiple datasets for extreme weather events and other phenomena



https://github.com/ecmwf/WeatherGenerator

Voir en français

CERN teams up with Luxembourg and the World Food Programme to tackle global hunger

The new partnership aims to leverage state-of-the-art AI technology to speed up progress towards a world with zero hunger

15 OCTOBER, 2024 | By Antonella Del Rosso

Representatives from WFP, LIST and CERN met today in Luxembourg to sign a new strategic partnership that aims to reduce world hunger. (Image:

Related Articles

Strategic AI Partnership: Use cases

LIST, supported by CERN, WFP

1

Damage Assessment and Prediction Platform

- Augmented Building Damage Assessment
- Crop Damage Assessment
- Weather Modeling and Forecasting

WFP, supported by CERN

2

Anomaly Detection for Cash-Based Transfers

Adaptation of the **CERN multi-format anomaly detection algorithms** to the WFP CBT operations to detect anomalies on:

- Registration data
- Photo
- Transactional data

CERN, supported by WFP, LIST

3

Federated Learning Infrastructure for Sensitive Data Processing

- Adaptation of the CERN federated learning platform to **enable the training of AI models** using data from multiple organizations for a broad range of applications

Thanks!

Q/A