

How do we Empower University Research Groups to use FourCastNetv2 for global weather forecasting?

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FourCastNetv2

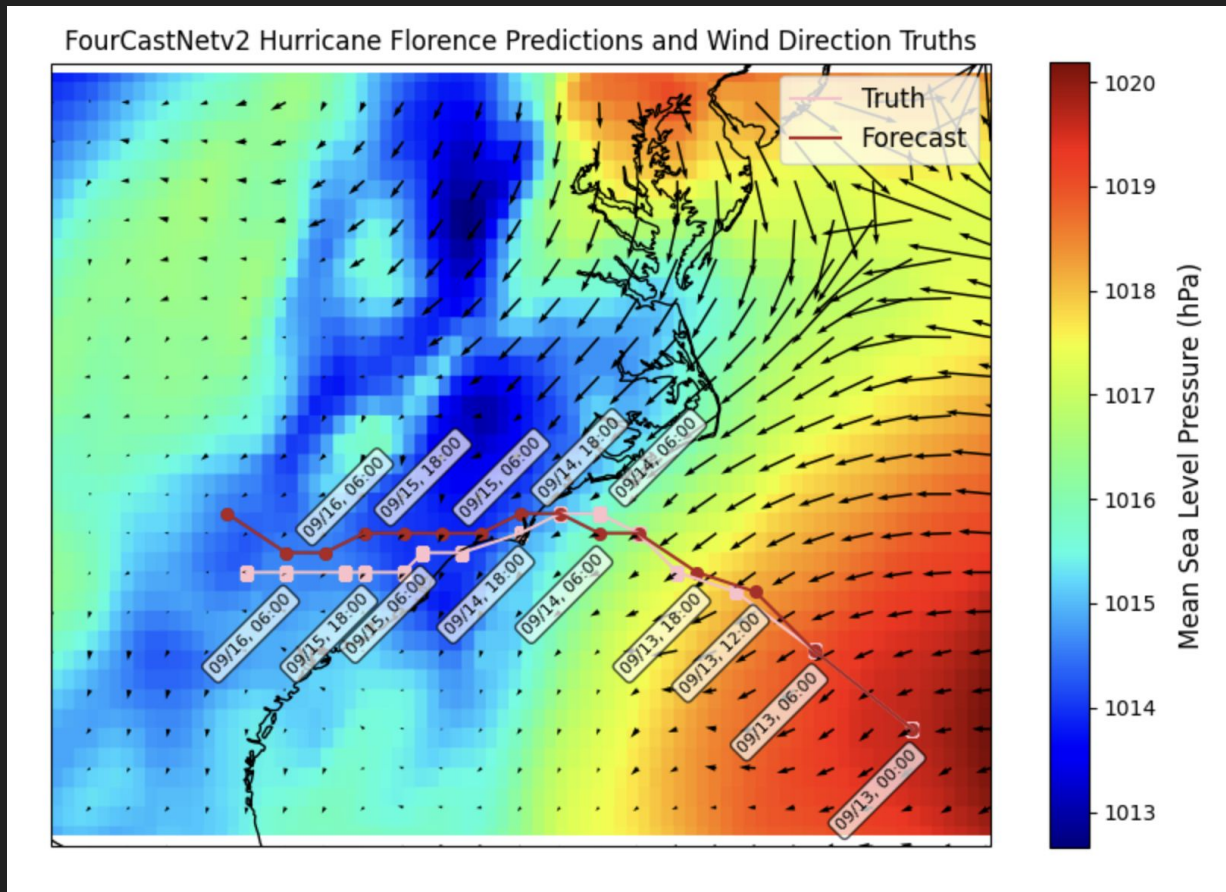


- The original [*FourCastNet*](#) paper introduced a data-driven machine learning model leveraging Adaptive Fourier Neural Operators (AFNO) for weather forecasting.
- In 2023, the Spherical Fourier Neural Operator ([*SFNO*](#)) was introduced, leading to [*FourCastNetv2*](#)—an improved version designed to model stable dynamics on a sphere.
- Both models are highly effective for weather prediction, with *FourCastNetv2* offering enhanced accessibility for universities.
- Our goal is to promote the adoption of *FourCastNetv2* in academic institutions, fostering greater model accessibility, advancing machine learning education, and democratizing weather forecasting techniques.

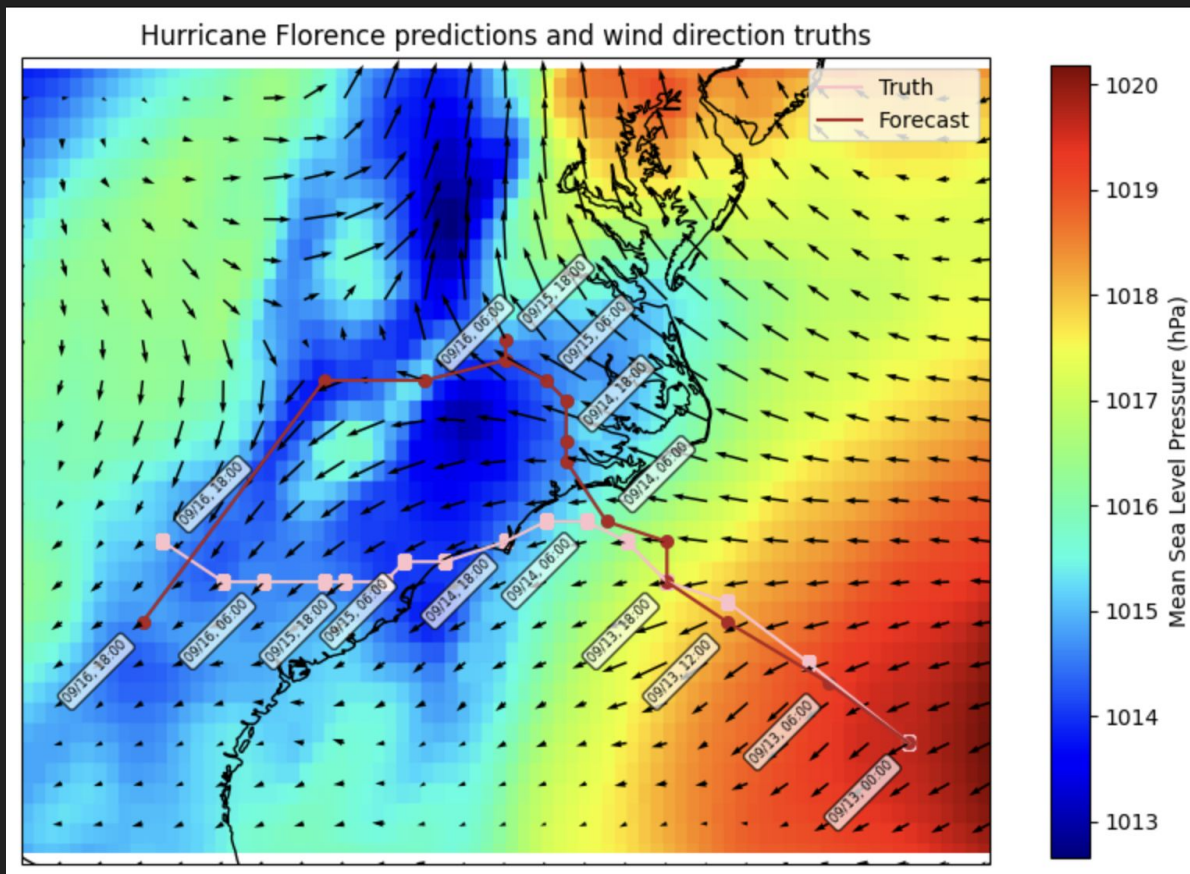
Our Specific Technical Goals for this Session

- Install ECMWF “ai-models” package through PIP
 - ECMWF has produced an experimental API to easily leverage AI weather prediction models. FourCastNetv2 is featured with this API
- Install FourCastNetv2 model to work with “ai-models”
 - Installing ECMWF’s API and FourCastNetv2 are different processes, but tightly coupled
- Perform forecasts with FourCastNetv2
 - forecasting with FourCastNetv2 is as simple as running a command in your machine’s terminal, but requires some setup to enable the workflow
- Interpret and handle FourCastNetv2 results
 - Leveraging FourCastNetv2 requires in depth knowledge of the datastructure used to train FourCastNetv2, as well as the structure of the model’s output. This section will go into depth on how to interpret the model’s predictions with Python
- Showcase several forecasting examples

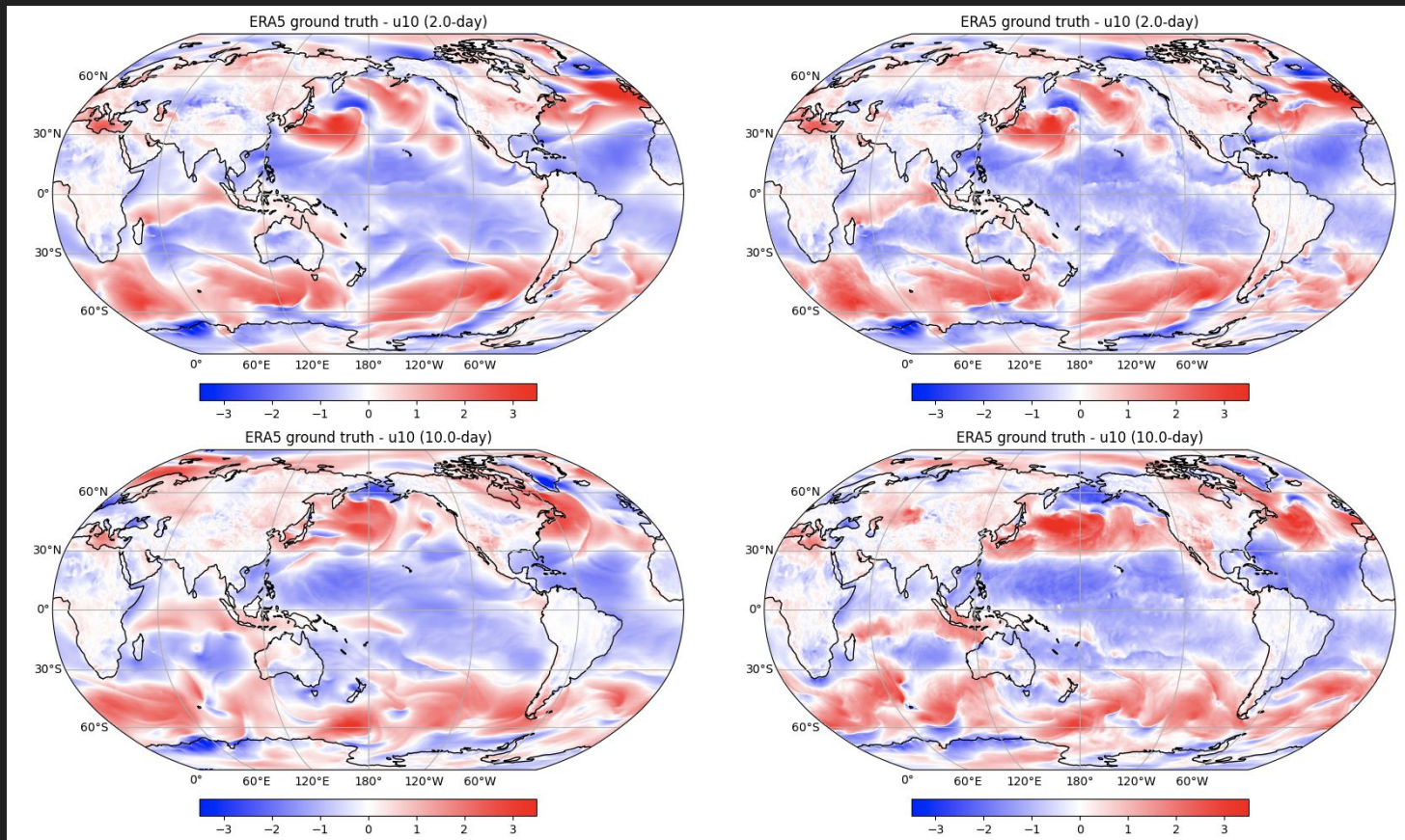
FourCastNetv2 Hurricane Prediction



FourCastNet Hurrican Prediction Contrast



10-day Forecasts

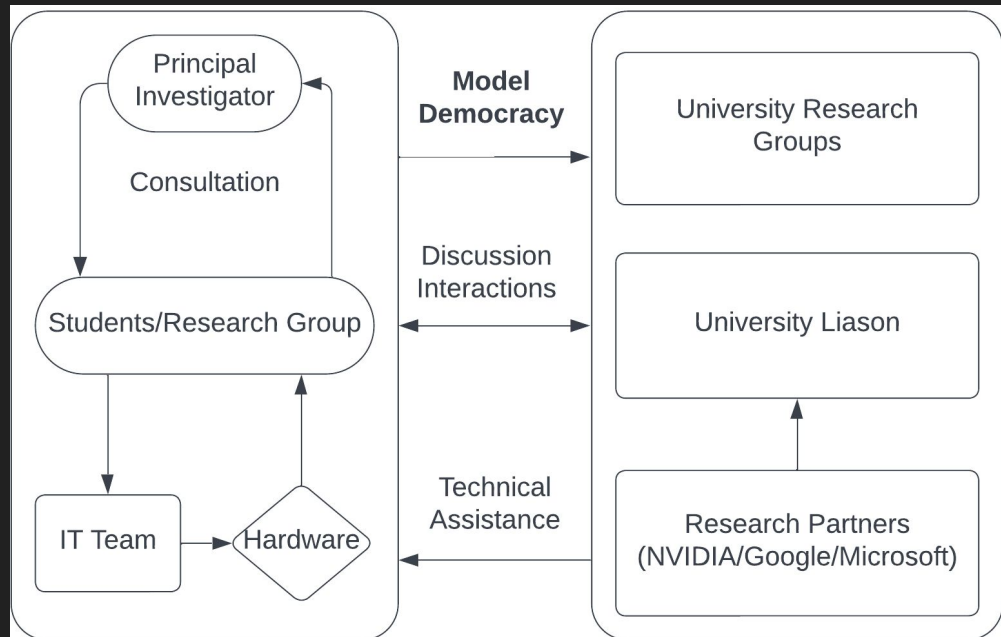


Our experiences/knowledge of interfacing with hardware and TIDE system

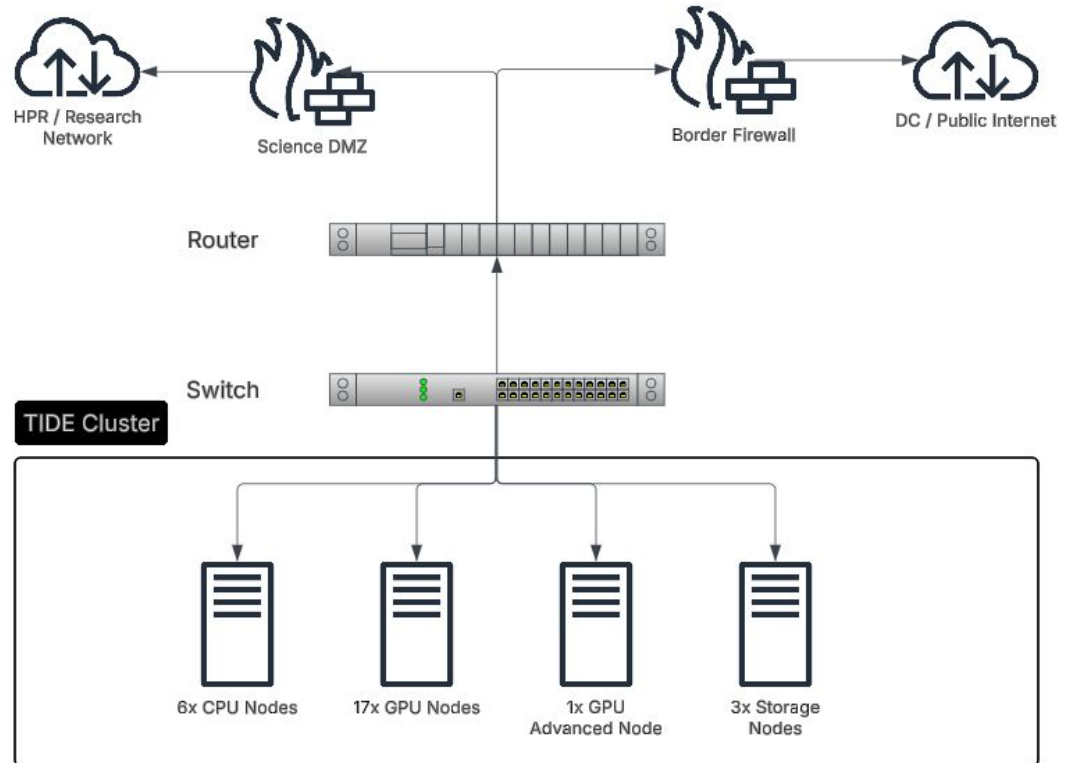
Storage solution required for training data (5TB).

Collaborate closely with IT team to create a product that can function as desired.

University group shares knowledge with others to further model democracy



Setup specifications



Prerequisites

- Python 3.10+
- pip (24.3.1+ works)
- Climate DataStore Account
 - [registration](#)



Install ECMWF's “ai-models” API

- Make a directory to store FourCastNet requirements and results
 - `$ mkdir fourCastNetv2`
 - `$ cd fourCastNetv2`
- Install ECMWF package and FourCastNetv2
 - `$ pip install ai-models`
 - `$ pip install ai-models-fourcastnetv2`
- Try to run
 - `$ ai-models --input cds --date 20230110 --time 0000
fourcastnetv2-small`
- We need:
 - FourCastNetv2's precomputed statistics
 - FourCastNetv2's model weights
 - Climate Data Store API key

FourCastNetv2 requirements

FourCastNetv2 training requires two precomputed files from NVIDIA, with forecasting also needing the model weights.

- `$ curl
https://get.ecmwf.int/repository/test-data/ai-models/fourcastnetv2/small/global_means.n
py --output global_means.npy`
- `$ curl
https://get.ecmwf.int/repository/test-data/ai-models/fourcastnetv2/small/global_stds.np
y --output global_stds.npy`
- `$ curl
https://get.ecmwf.int/repository/test-data/ai-models/fourcastnetv2/small/weights.tar
--output weights.tar`

Climate Data Store credentials

In order to leverage FourCastNetv2 forecasting, we need data to initialize the model. The easiest way to get this data is to tell FourCastNetv2 to pull it from CDS. In order to do that, we need a CDS account, and an API key

- Install the CDS API client
 - `$ pip install "cdsapi>=0.7.4"`
 - `$ touch ~/.cdsapirc`
- Add the following to that file. Your personal access token is available under your profile information in CDS
 - `url: https://cds.climate.copernicus.eu/api`
 - `key: <PERSONAL-ACCESS-TOKEN>`
- Accept the ERA5 Reanalysis licence
 - Accept the license at [this](#) link

Perform Forecasts with FourCastNetv2

Now that we have model weights, and access to data we can use the ai-models API to perform forecasts with FourCastNetv2

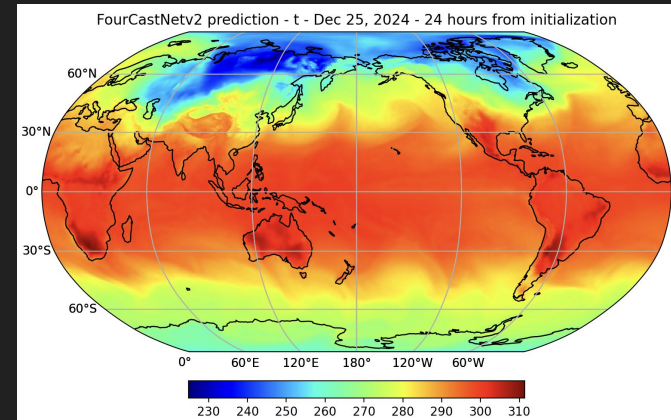
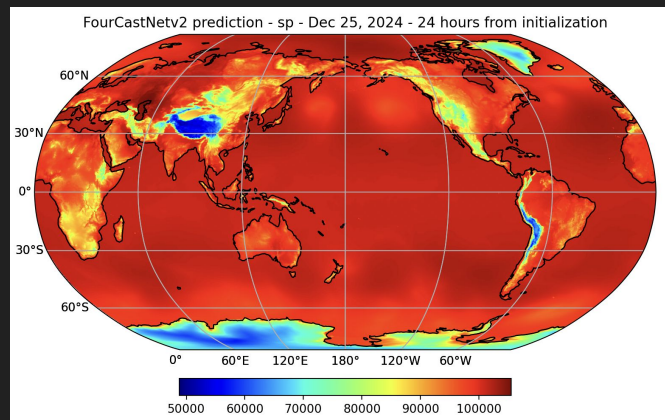
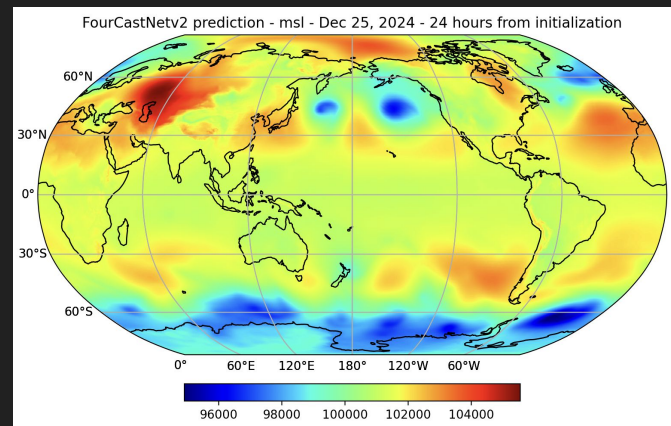
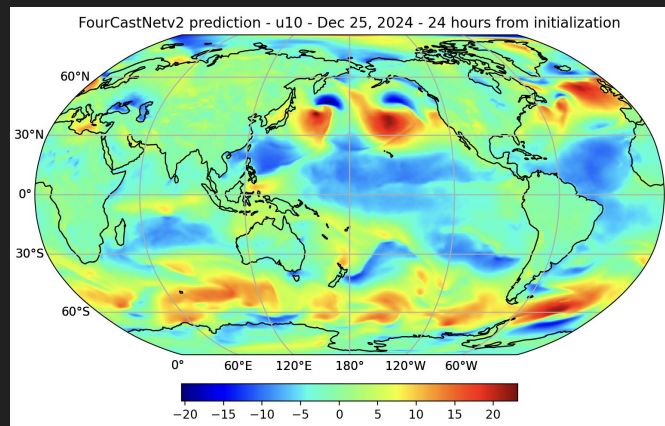
- `$ pip install torch`
- `$ ai-models --input cds --date 20230110 --time 0000 fourcastnetv2-small`
- This will perform a 10 day forecast beginning at 01/10/2023 12:00am UTC.
- The output file will be named “**fourcastnetv2-small.grib**”. The output name can be specified with the `--path` option.

One can perform forecasts for any date where CDS has recorded data. CDS has data from 01/01/1940 to 6 days before the present

Interpreting/handline FourCastNetv2 results

Forecasting with FourCastNetv2 is one thing, but handling the produced .grib file is another endeavor.

- First we must install some python packages
 - `$ pip install numpy`
 - `$ pip install xarray`
 - `$ pip install matplotlib`
 - `$ pip instal cartopy`
- Now we can plot results with [this](#) script



References

1. Iman Khadir, Shane Stevenson, Sam Shen, Henry Li, 2025: **Democracy of AI Numerical Weather Model: An Example of Running the Global Forecasting Using FourCastNet and GPUs.**
2. Jaideep Pathak et. al. 2022: **FourCastNet: A Global Data-driven High-resolution Weather Model using Adaptive Fourier Neural Operators**
3. Boris Bonev et. al. 2023: **Spherical Fourier Neural Operators: Learning Stable Dynamics on the Sphere**
4. Edison Guo et. al. 2024: **FourCastNeXt: Optimizing FourCastNet Training for Limited Compute**
5. Popularizing FourCastNetv2 [Github](#)
6. ai-models FourCastNetv2 [Github](#)
7. ECMWF “[ai-models](#)” API [Github](#)
8. Climate Data Store API [documentation](#)