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OESCHGER CENTRE CLIMATE CHANGE RESEARCH

Deep-S2SWind: A data-driven approach for improving Sub-seasonal wind predictions

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Motivation

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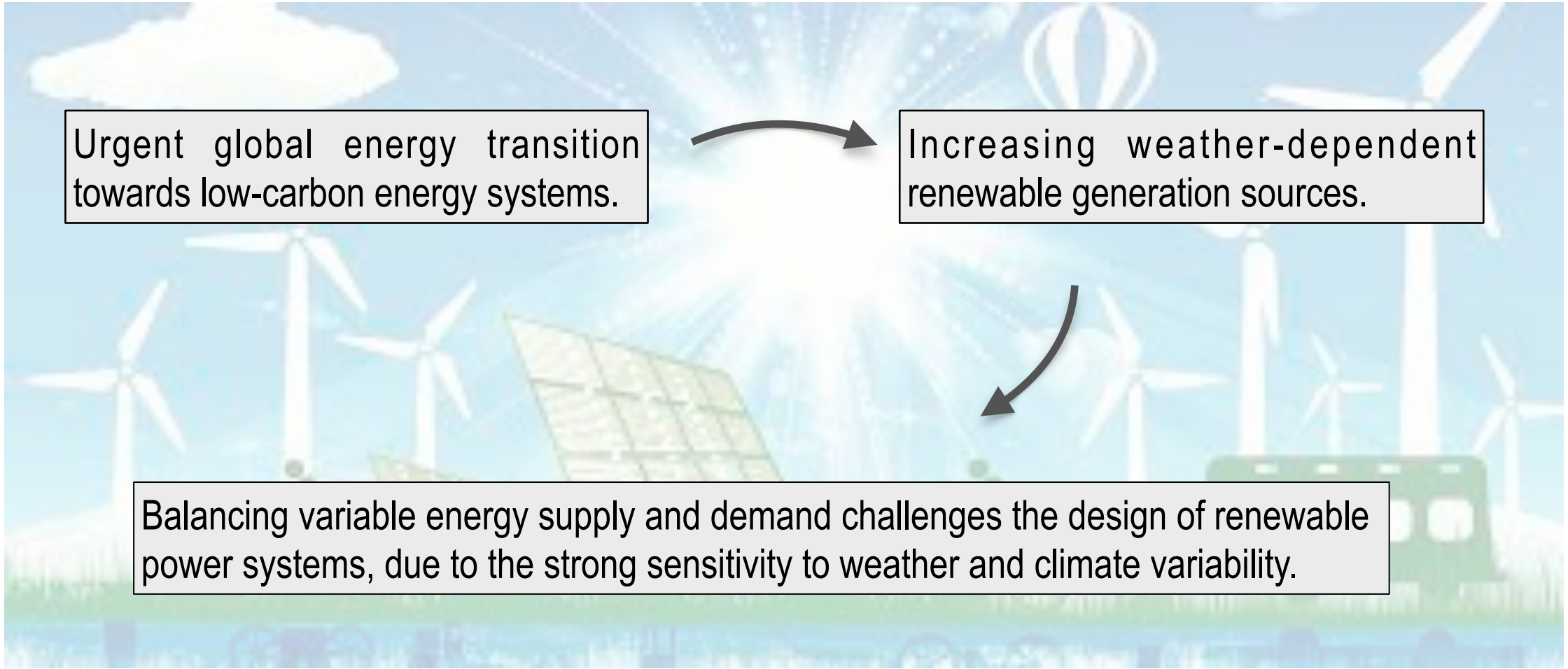

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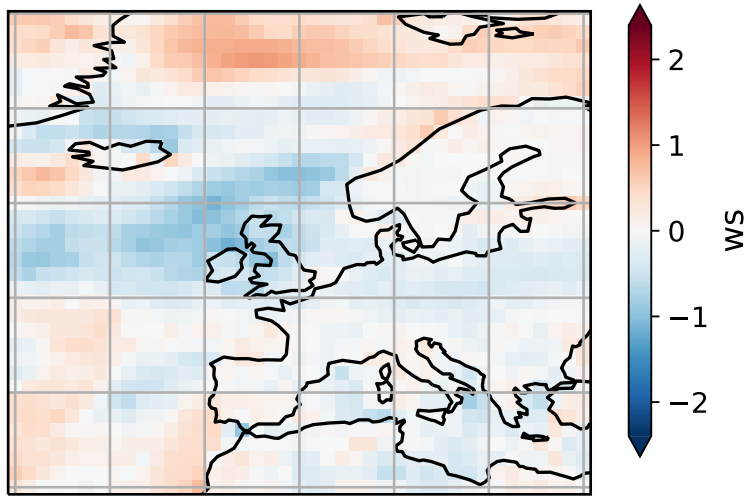
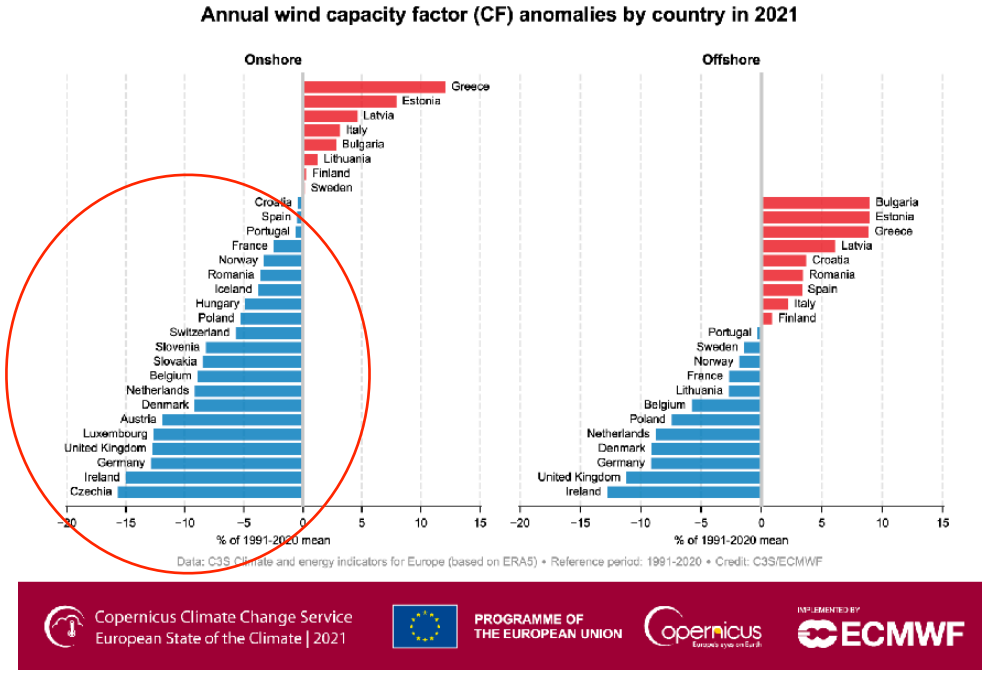
2021 JJA 10m Wind speed anomalies



ERA5 (1979-2020 climatology)



The need for predicting and understanding the spatio-temporal variability of ***wind droughts*** *(prolonged low wind speed conditions)* is a pressing issue for the energy sector.
Wind droughts can occur at *Subseasonal-to-seasonal (S2S)* timescales, thus, providing skilful predictions of wind speed offer an opportunity to the wind energy sector for maintenance tasks and optimally trade power on the markets.

Objective

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- Develop a data-driven ML approach to forecast *wind droughts* episodes at S2S timescales, which have a strong impact on the energy sector.
- Provide further insights to assess the feasibility of data-driven ML for predicting weather extreme events.
- Investigate windows of opportunity that lead to enhanced predictability at S2S by incorporating climate indices (e.g., MJO, ENSO, NAO).

Data and Methods

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ERA 5[1]: 1959-2021
Time resolution: Daily (original hourly)
Spatial resolution: 1º x1º (original 0.25º x 0.25º)

Variables:	**Levels:**
• Geopotential height	200,300,500,850,1000 hPa
• Temperature	200,300,500,850,1000 hPa
• Zonal(U) and Meridional(V) wind components	200,300,500,850,1000 hPa
• Mean sea level pressure	- -
• 2m temperature	- -
• Total column water vapor	- -
• 10m wind speed	- -

Wind drought (WD) definition:

$$WD_{ij} = \begin{cases} 1 & \text{if } 10\ ws_{ij} \leq th_{10} \\ 0 & \text{otherwise} \end{cases}$$

For each *ij* (lon/lat) grid-point

[1]https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-pressure-levels?tab=overview

Methods

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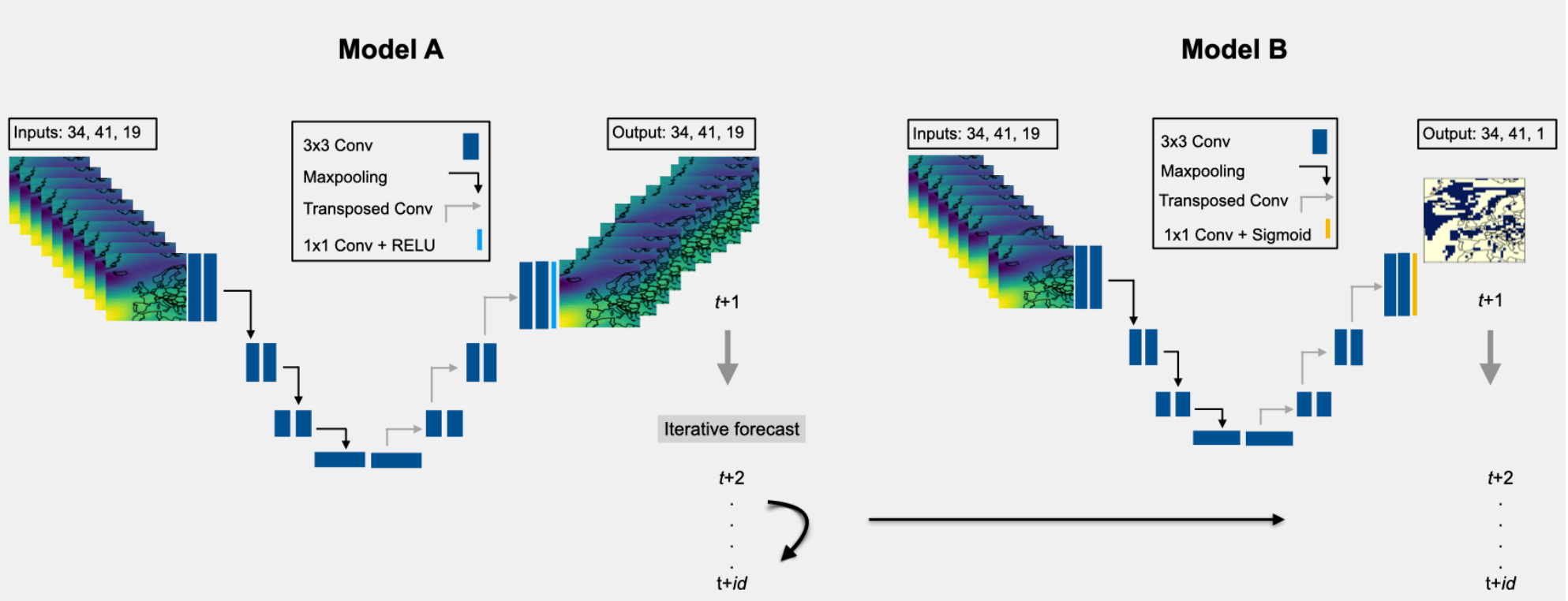

We propose two based models:

- **Model A**: To create iterative predictions up to 42 days (lead times).
- **Model B**: After the training, with outcomes of low wind extremes, **model B** aims at forecasting low wind speed events (i.e., WD) at longer lead times using the iterative predicted fields **model A**.

Preliminary results

Performance of different networks for **Model A**

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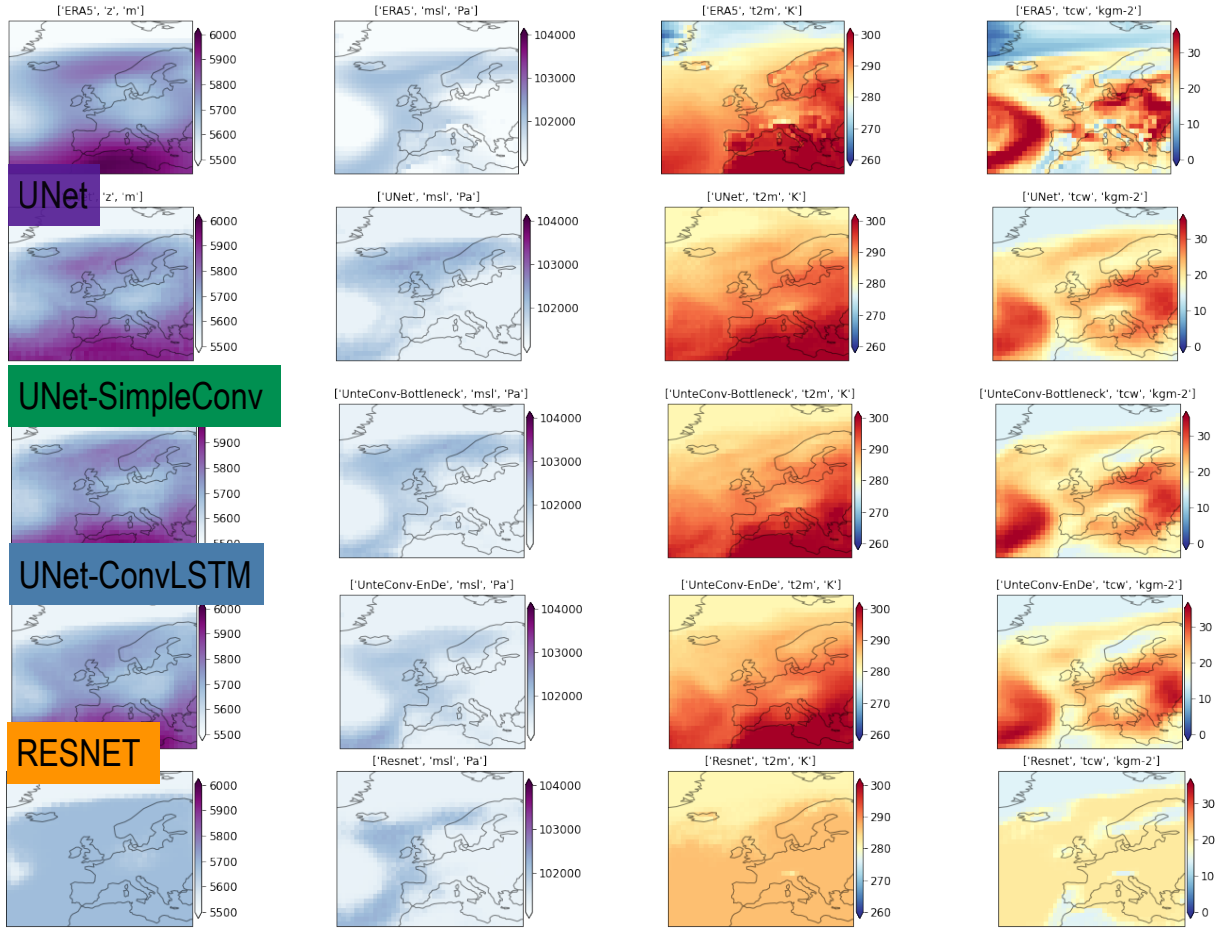
True=ERA5

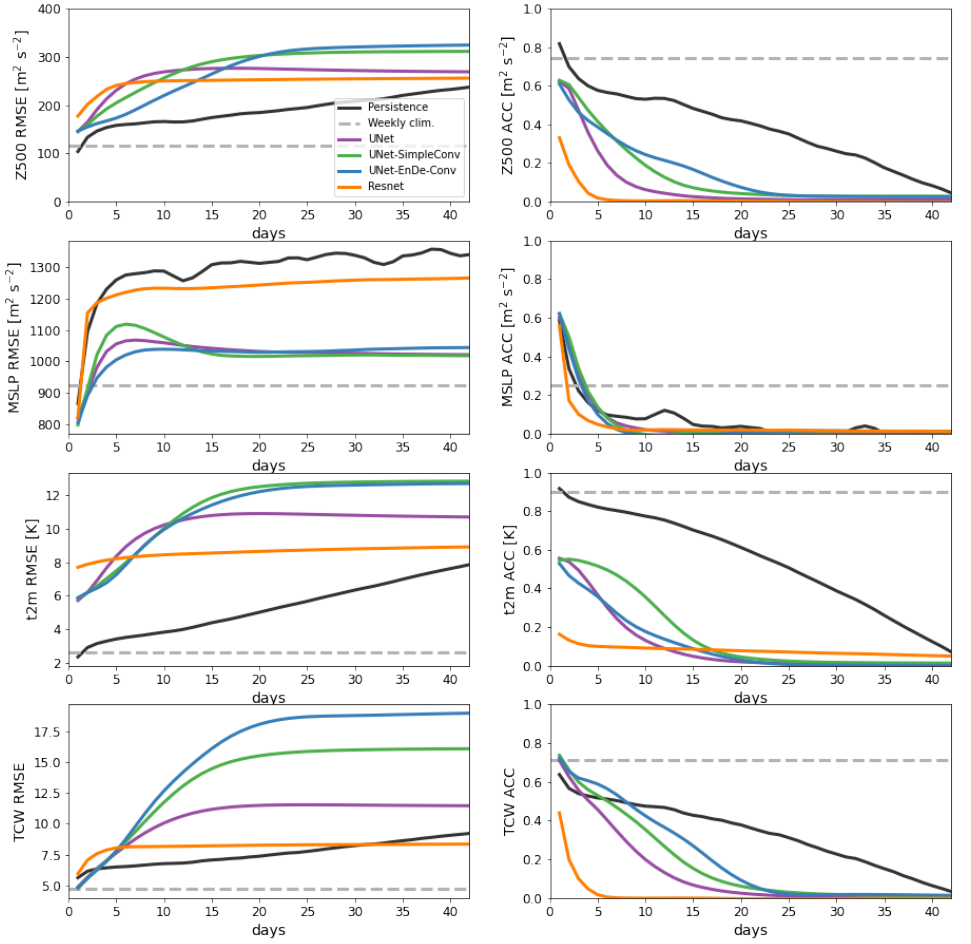
UNet

UNet-SimpleConv

UNet-ConvLSTM

RESNET





Lead times

Ongoing and Future work

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- Model evaluation:

Model A:
Benchmarks: Persistence, climatology, S2S database
Metrics: RSME & ACC (as in WeatherBench, Rasp, 2020)
Ground truth: ERA5

Model B:
Metrics: AUC, precision & recall
Ground truth: ERA5

- Modify **model A** and adapt **model B:** Test other architectures recently emerged in the literature for data-driven approaches (*Pangu-Weather, Bi et al., 2022; Keisler, 2022*).
- Time-aggregation to weekly time-scales to further test the models to S2S timescales.
- Incorporate climate indices (e.g., MJO, ENSO, NAO).

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Thank you!

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Related materials: https://github.com/noeliaof/NeurIPS22_Workshop_ClimateAI