Weather Forecasting for Natural Hazard Prediction

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Introduction

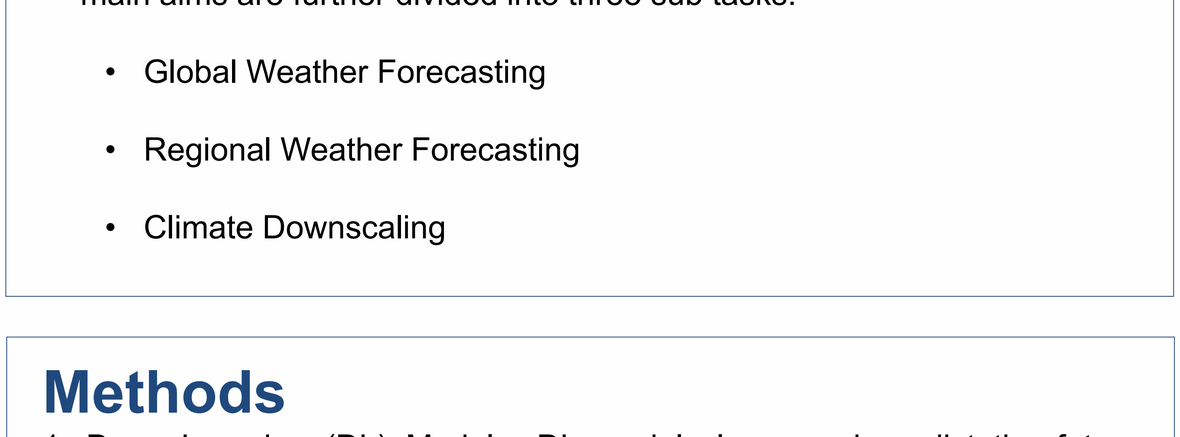
The catastrophic impacts of Climate Change are global. Nevertheless, some regions of the world are now more sensitive to the climate change impacts. For instance, Australia has seen some of the worst bushfires and floods over the past few years. There is a growing need for both improved weather forecasts for disaster mitigation and climate projections for long-term policy making and adaptation efforts. This research is focused on developing efficient weather forecasting system which address the limitations of domain expertise required to operate current operational weather forecasting systems and can be used by people in disaster management to make informed and timely decisions.

Aims

- Prediction of weather variables such as Temperature, Vorticity, Wind Speed, Geopotential etc. using observational and simulated data. The main aims are further divided into three sub tasks:
  - Global Weather Forecasting
  - Regional Weather Forecasting
  - Climate Downscaling

Methods

1. Deep Learning (DL) Models: DL models learn and predict the future weather based on given data as satellite or simulated observations
2. Physics based Modelling: Numerical Weather Prediction (NWP) models rely on the set of initial conditions used as input to physics-based equations to predict the future states.
3. Hybrid Modelling: The methodology involves the use of deep learning to learn data patterns while using physics-based modelling to learn weather behaviour outside of given observations. It is usually integrated using physics-based loss functions, optimizers or change in architecture

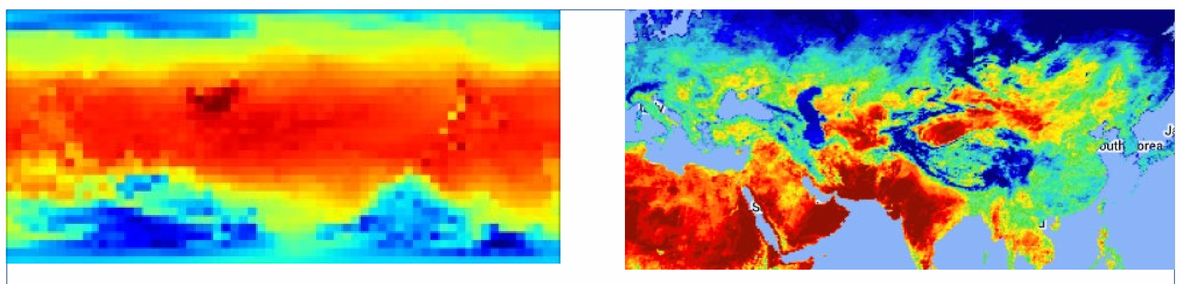


Physics Informed Machine Learning Model for Weather Forecasting [1]

Results

Architecture	6hr-Temperature	168hr-Temperature
ClimaX	095	2.18
FourCastNet	0.72	2.54
PanguWeather	0.59	2.06
GraphCast	0.50	1.88
Integrated Forecast System	0.97	2.24
ResNet	0.76	2.66
UNet	0.77	2.66

RMSE for Temperature at 6hr and 168hr lead times by different architectures



Temperature Spatial Maps of Earth System

References

[1] Schultz, M. G., Betancourt, C., Gong, B., Kleinert, F., Langguth, M., Leufen, L. H., ... & Stadtler, S. (2021). Can deep learning beat numerical weather prediction?. Philosophical Transactions of the Royal Society A, 379(2194), 20200097.

Figure 1: Physics Informed Machine Learning Model for Weather Forecasting

Figure 2: Temperature Spatial Maps of Earth System

Table 1: RMSE for Temp at 6hr, 168hr lead times by different architectures

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