ARTIFICIAL INTELLIGENCE IN WEATHER FORECASTING

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ABSTRACT

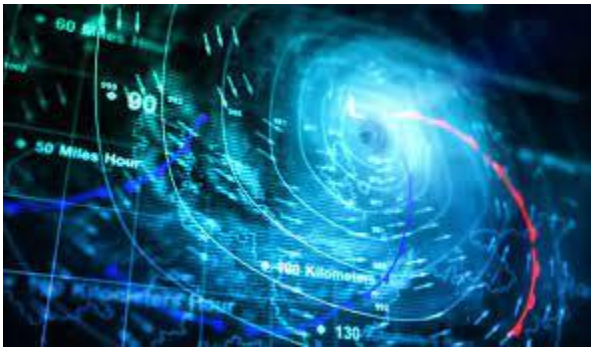
Artificial intelligence on weather forecasting focuses on NWP (Numerical Weather Prediction) model analysis coupled with data-mining using available historical data sets and interpret the equations from weather forecasting systems to provide a single output.

The main idea behind the project is to do a comparative study between numerical models for tropical region. Considering a particular weather model uses a differential equation to input dynamics for a region. Using this, we can similarly input these equations between various models and can reach a consensus for a particular region.

This is just a start-up idea which requires accurate and inline historical data sources from reliable sources to create an accurate forecast system using artificial intelligence.

We will look briefly at each weather model systems which have been accurate for tropical region where our country is situated and we try to establish an interpretation between them to bring out the best possible scenario.

1. INTRODUCTION



Artificial intelligence is making its way into every aspect of the 21st century. As you may know, weather forecasts are very unpredictable. And one field of AI is making significant waves in weather prediction. AI models are trying to improve weather, climate, and disaster predictions.

In the context of climate, these are often called General Circulation Models(GCMs), and the weather prediction NWP models (NWP stands for Numerical Weather Prediction). We discussed forecasting of severe weather based on satellite remote sensor data, and how model

systems predict weather using differential equation.

AI is providing increasingly helpful with this. In the past year, weather forecasting is significantly on improve incline. How AI can enhance meteorology, how it predicts, and how it can be used for future forecasting. In Tamilnadu weather, we focus on three district weather namely KTC stands for(Kanchipuram, Tiruvallur, and Chennai) where weather can change constantly and quite challenging even for global models.

(Index Terms: KTC- Kanchipuram, Tiruvallur, Chennai. NWP-Numerical Weather Prediction ECMWF- European Centre for Medium Weather Forecasts GFS- Global Forecasting System GEM- Global Environment Multiscale model ALADIN- Aire Limitee Adaptation dynamique Development International)

2. European Centre for Medium-Range Weather Forecasts (ECMWF)

The European Centre for Medium- range weather forecasts (ECMWF) is an independent inter-government organization which is both a research institute producing vital and disseminating numerical weather predictions Member States (Europe) as well as globally.

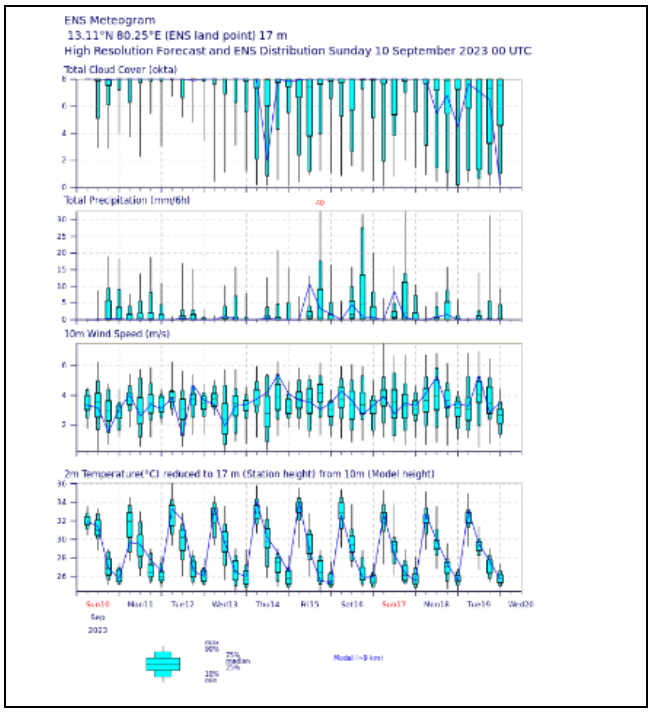
ECMWF has been very successful in predicting weather outside Europe recognizing it as a global- weather model which is been used worldwide and pinning further has a decent success in predicting weather conditions of tropical countries especially India and Sri Lanka.

Not to brag about, but India is one of the countries in the world where weather isn't a cup of coffee unlike other places in the world. You might have noticed accurate weather predictions of rain approaching at this time or so during a cricket match happening in England or Australia and more than 95% time it turns accurate.

Can we replicate that much success here, definitely not as India tending to be a tropical country especially towards its South surrounded by vast mountain hilly ranges and bordered by two- arcs of Indian Ocean- Arabian Sea and Bay

of Bengal which makes it even harder to track formation of cyclones unlike other basins in the world.

What makes ECMWF or shortly ECM is its overall accuracy, you talk about thunderstorms it tops in to maximum accuracy in KTC districts, you talk about temperatures how sunny or pleasant is it going to be: it turns out very much well most of the time, you talk about cyclone tracks none other than ECMWF has been very accurate over past few years in ticking the exact landfall location of that cyclone which makes it a strong weather tool over the others. However, it has its disadvantages which are addressed in upcoming model systems.



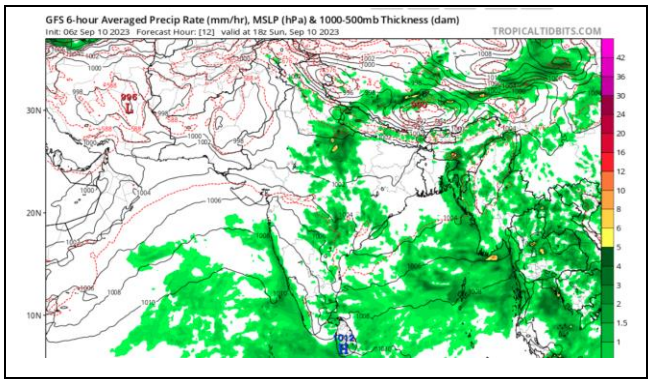
3. Global Forecast Systems (GFS)

The Global Forecast System (GFS) is also called as National Centers for Environmental Prediction (NCEP) weather forecast model that generates data for dozens of atmospheric and land-soil variables, including temperatures, winds, precipitation, soil moisture, and atmospheric ozone concentration. The forecast system couples four separate models (atmosphere, ocean model, land/soil model, and sea ice) that work together to accurately depict weather conditions.

Global Forecast System (GFS) next to ECM is a better weather forecasting model in predicting weather for tropical countries. It is more accurate in short- term weather forecasts for Chennai and KTC region especially thunderstorms.

It also hints about any severe spell days before itself however, the accuracy of these predictions ranges from 50%-70% statistically taken over last 3 years in consideration of KTC region.

Not to forget, the model system is the first one to predict the formation of cyclones in Indian Ocean (IO) basin even ECM and other numerical models struggle to identify the formation of cyclone in the basin.



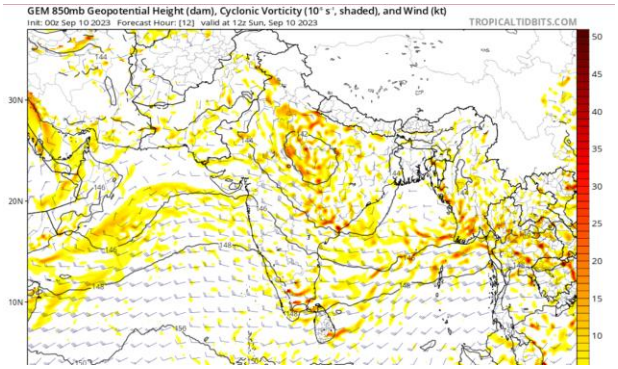
4. GLOBAL ENVIRONMENT MULTISCALE MODEL (GEM)

The Global Environment multiscale model (GEM) is also known as CMC model in Northern parts of America is another integrated weather forecasting model system which uses data assimilated by Meteorological Research Branch (MRB), and the Canadian Meteorological Centre (CMC)

GEM model is widely known in tropical countries as GEM and also CMC is another leading model after the original tropical models- ECM and GFS. Compared to ECM and GFS, GEM provides you grid resolution forecasts for region which makes predictions accurate for other parts of the world.

However, it is not easy to implement the same in tropical countries GEM among meteorologists who predict weather for these regions and local weather bloggers and enthusiasts tend to go for GEM as the third best model after ECMWF and GFS due to its forecast capability.

GEM starts a trend of patterns quite different from other models keeping the effect of another dynamic which others fail to look at. Thereby, produces a new trend of forecast track even though most of the time it may have not turned well or accurate, other two models do bring some changes analyzing the reasons behind GEM run.



5. INTERPRETATIVE ANALYSIS OF NUMERICAL WEATHER MODELS

With the innovation developing faster, human expectation for everyday comforts. We the public need the best forecast possible for our

region, we can't blame the temperate zones, tropical zones for distinguishing weather at a particular region. That's why the comparative interpretation comes in. What if, you input ECMWF, GFS, GEM and not only these ICON (Icosahedral Nonhydrostatic), UKMET (United Kingdom Met Office), JMA (Japan Meteorological Agency) various other models are evolving in predicting tropical weather.

Focusing on the three- ECM, GFS, GEM if we could input the numerical data of all these 3 models let's suppose a cyclone might form in Bay of Bengal next week or so. We can consider GFS data for predicting the formation of cyclone at a particular position in Bay whether it is South- East, South- West, Andaman Sea, North.

Based on GEM data, we can analyze all the possible trends of whether this cyclone will intensify further or will it weaken where it is expected to move initially how it can impact the landfall region.

On the basis of ECM data, we will get a clarity about the landfall location where the cyclone is expected to make landfall. Comprising all these GFS (predicting place of formation), GEM (intensity and possible scenarios), ECM (landfall location) we can interpret all three models and can derive a conclusion or the best possible forecast possible for this cyclone.

This is the main motive of this paper to provide a probabilistic interpretive analysis of accurate weather prediction from numerical weather models for parameters like rainfall, temperature, precipitation, anomalies for KTC region thereby we could get accurate forecast in a regular basis using data- mining and also using ALADDIN (Aire Limitee Adaptation dynamique Development International) models especially the European Centre of Medium Weather forecasts (ECMWF) combined with National Centre for Environmental Predictions.

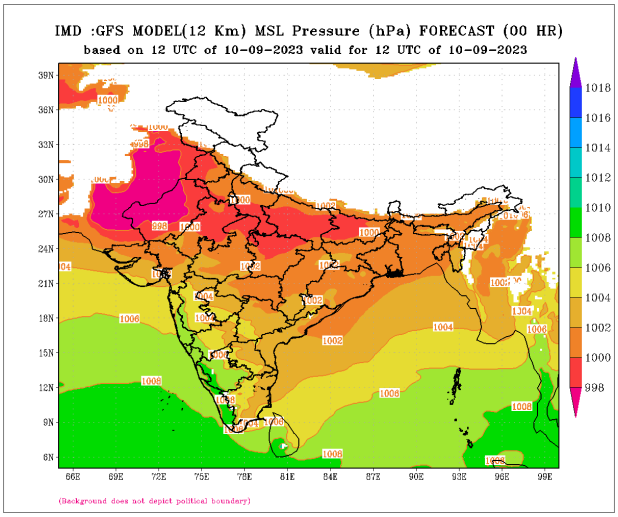
6. RELATED WORK- IMD COLLABS WITH GFS PROVIDING IMD GFS MODEL SYSTEM

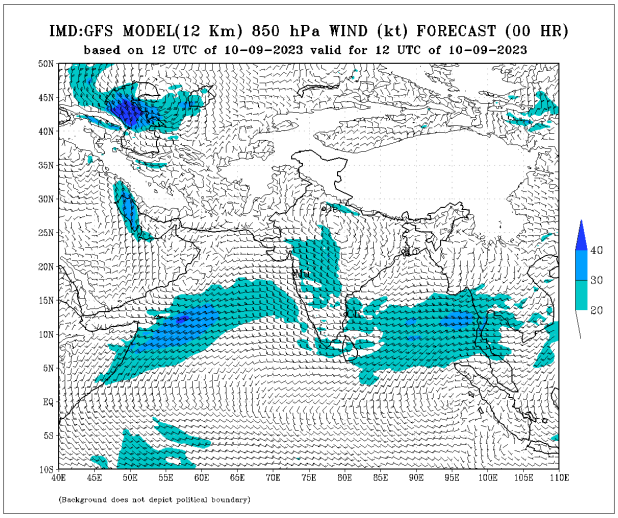
It's unfair to not talk about Indian Meteorological Department (IMD) while discussing about weather predictions in India. IMD has done a phenomenal job in parallel to these weather models past few years in predicting accurately landfall tracks, rainfall intensity in many parts of the country.

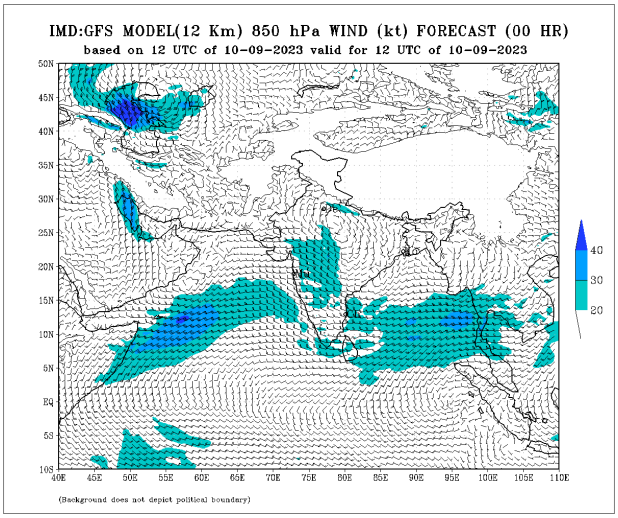
The fact that IMD has also collaborated with GFS to incorporate a new model system named IMD GFS similar to other models like ECM, GFS functions as an interconnected model between IMD and GFS to provide accurate forecasts. To input GFS data along

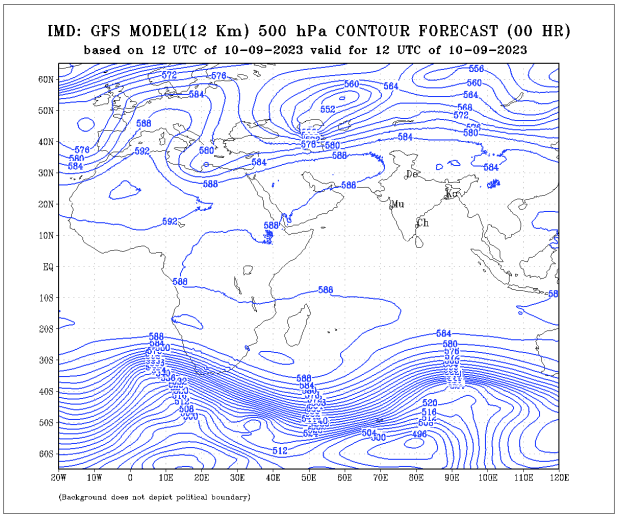
with IMD data sets establishes a powerful base for weather forecasting.

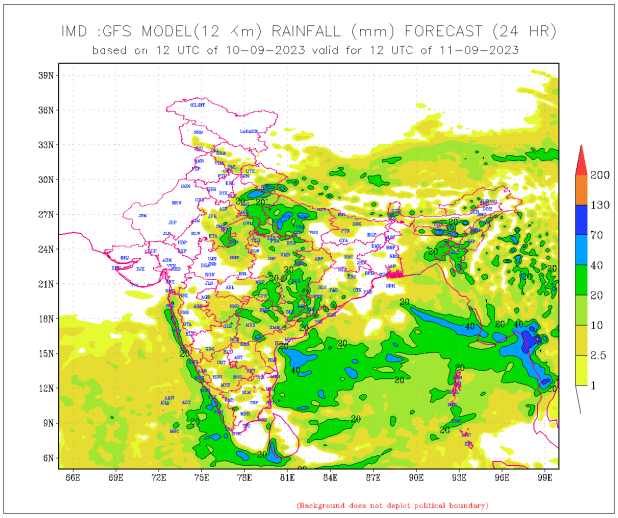
The paper undermines this very aspect of input not only GFS data but also other models sparking innovation and leading to formation of a **SUPER** model system input numerical weather model computations along with data mined from IMD historical data sets dating back from 1875 which will provide us accurate weather forecast as compared to the present forecasts.











7. CONCLUSION

AI in Weather forecasting is quite challenging concerning tropical regions due to unpredictable climate patterns, irregular tracking methods, unavailability of accurate data.

We need accurate data from reliable source for which in tropical region- IMD is one of the best available reliable sources, in future when research scientists require data, they can acquire it through IMD Pune and IMD Chennai which has documented data for over more than 150 years.

Concluding that using numerical weather model inputs along with data mining using artificial intelligence from historical weather data sets of IMD Atlas we can produce a new compatible and accurate weather forecast which will account all the patterns, dynamics into concern through differential equations interpreting all these gives us the best possible output.

8. REFERENCE

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