A Hybrid Prediction (Dynamical/Machine Learning) Approach for Probabilistic Seasonal Outlook for the Famine Early Warning Systems Network

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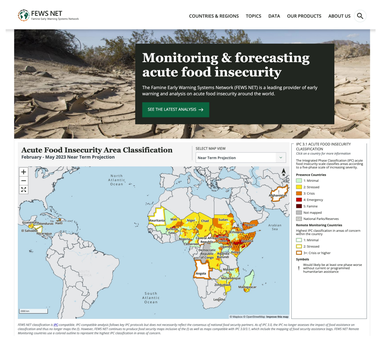
1. Motivations & Goal

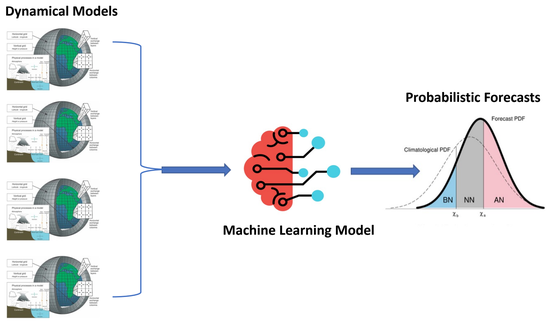
Motivations



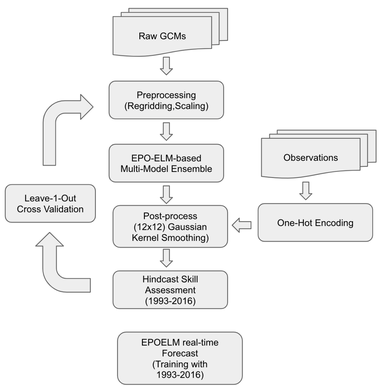
https://fews.net/about-us

- With over three decades of continuous development, the Famine Early Warning Systems Network (FEWS NET) provides early warning and analysis of acute food insecurity based on an evidence basis that includes agro-climatic forecasts.
- To improve agroclimatic forecasts for FEWS NET, we developed an experimental probabilistic multi-model ensemble using a hybrid system based on Dynamical models and Machine learning.

Goal



2. Design of Experiment

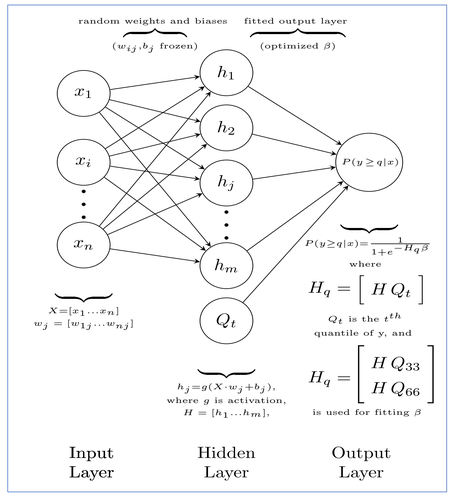


Predictors	**Copernicus Climate Change Service (C3S) GCMs**
Predictand	**Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)**
Targets	**Seasonal and Monthly Average (lead 1,2,3)**
Calibration Methods	**Extended Probabilistic Output Extreme Learning Machine (EPO-ELM)**
Training Period	**1993-2016**
Hyper-parameter tuning	**Stochastic depth-first search algorithm by k-fold cross validation**
Skill Assessments	**Leave-One-Year-Out**

3. Methodology

Extended Probabilistic Output Extreme Learning Machine (EPO-ELM)

- The Extreme Learning Machine (ELM) is a generalized Single-hidden-layer feed-forward neural network with randomly assigns input weights and biases in the hidden layer and calculates the output weights to the output layer using a generalized inverse (Acharya et al, 2014).
- However, since the traditional ELM network only produces a deterministic outcome, we modified version of ELM called Probabilistic Output Extreme Learning Machine (PO-ELM) (Acharya and Hall, 2022).
- As PO-ELM produces only three category forecast, we further modify the PO-ELM and create Extended Probabilistic Output Extreme Learning Machine (EPO-ELM) which produce full probability distribution.
- *XCast*, a high-performance Python data science toolkit for climate forecasting designed by the authors (Hall and Acharya, 2022), is used to implement the PO-ELM.

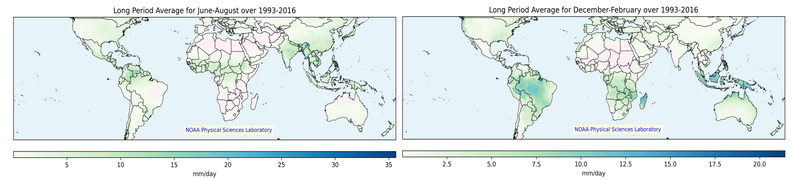


References:

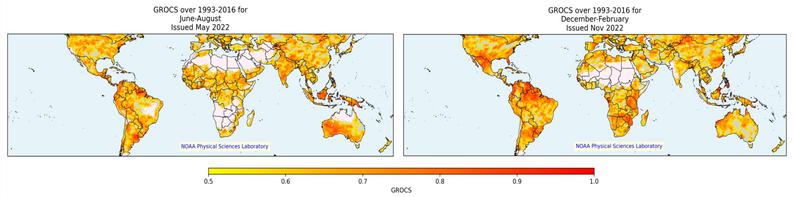
- *Acharya N., Srivastava N.A., Panigrahi B.K. and Mohanty U.C.,2014, "Development of an artificial neural network based multi-model ensemble to estimate the northeast monsoon rainfall over south peninsular India: an application of extreme learning machine", Climate Dynamics, 43(5):1303-1310.*
- *Acharya, N and Hall,K.,2022, "A Machine Learning Approach for Probabilistic Multi-Model Ensemble Predictions of Indian Summer Monsoon Rainfall", MAUSAM, vol. 74, no. 2, pp. 421–428. https://doi.org/10.54302/mausam.v74i2.5997*
- *Hall, K., and Acharya, N.,2022, "XCast: A python climate forecasting toolkit", Frontiers in Climate, 4*

4. Results

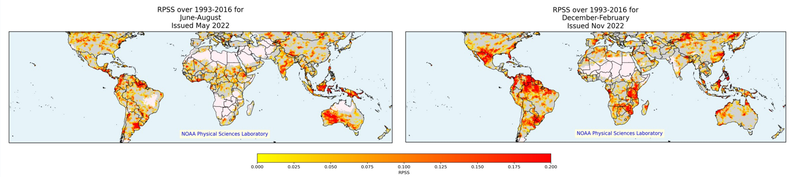
Climatology



Generalized ROC Score



Rank Probability Skill Score



5. Real-time Webpage

- Real-time forecast updated at every 13th of the month for next 3 months and 3 seasons.

https://psl.noaa.gov/forecasts/s2s_fewsnet/

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