DroughtVision - Global Drought Prediction with Computer Vision

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Abstract

The escalating impact of climate change underscores the need for precise and timely forecasts of meteorological phenomena, particularly droughts, due to their extensive effects on agriculture, water resources, and ecosystems. Addressing this, we introduce a deep learning framework that merges Computer Vision with modified Transformer networks, tailored to predict future drought conditions leveraging historical global climate data. Our model inputs are stacked monthly global maps of Sea Surface Temperature, Temperature 2m above ground, and Total Precipitation, each spanning a year, thus creating a 36-channel input to capture seasonal variability. This study extends conventional Vision Transformers (ViT) by adapting them for sequence processing, enabling the model to learn the intricate temporal dynamics and spatial interdependencies inherent in climate data. By employing a sliding window approach, the model assimilates a sequence length of 12 months for each variable, and the target variables are stacks of Standardized Precipitation & Evapotranspiration Index (SPEI). Our modified ViT architecture successfully integrates the temporal sequencing by adjusting convolutional patch embeddings and positional embeddings, rendering the model sensitive to both the chronological progression and spatial distribution of climatic factors. Preliminary evaluations indicate the model’s robust capability in forecasting drought conditions on a global scale. We substantiate these findings with performance metrics that illustrate the model’s efficacy in interpreting and predicting the complex, non-linear, and non-stationary patterns of drought phenomena.
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Input Images
(36 channels)

Generate Patch Images

Output Images (3)

Position and Class Token Embedding

Convolutional Patch Embeddings

Multi-Head Self-Attention

Feed-Forward Network

Transformer Block

Linear Decoder

Residual Connections

Output Images (3)

Equal Sized Pixel Patches

Targets

Standardized Precipitation & Evapotranspiration Index
Stack of N images (for the subsequent N=3 months, adjustable)

• Models undergoing training and evaluation.
• Testing various configurations and hyperparameters.
• Early results show models capturing complex nonlinear and nonstationary relationship between variables.
• Planned feature importance analysis to evaluate variable impact on predictions.

ECMWF
ECMWF Reanalysis v5 (ERA5)

Inputs

Sea Surface Temperature

Temperature 2m above ground

Total Precipitation
Stack of 36 images (3 variables * 12 months)

Sea Surface Temperature

Stack of N images (for the subsequent N=3 months, adjustable)