Parallel and Distributed Deep Learning for Ocean and Wind Current Analysis

Problem Statement:
Accurate prediction of ocean and wind currents is fundamental for many applications, such as climate modeling, maritime navigation, disaster preparedness, and renewable energy optimization. Traditional numerical models, such as those based on computational fluid dynamics, are computationally expensive and struggle with fine-scale resolution and real-time forecasting. Deep learning has become a promising alternative, with large-scale observational data being used to improve prediction accuracy and efficiency. However, training deep learning models on massive oceanographic and meteorological datasets requires parallel and distributed approaches for efficient processing.

Project Scope:
This project aims to implement and evaluate state-of-the-art parallel and distributed deep learning algorithms for ocean and wind current analysis. The primary objectives include:

1. **Data Acquisition & Preprocessing:** Collect large-scale oceanographic datasets from sources such as NOAA and ECMWF, including sea surface temperatures, wind speeds, and current patterns.
2. **Algorithm Selection & Implementation:** Implementing three competing parallel/distributed deep learning models optimized for spatiotemporal forecasting, leveraging frameworks such as PyTorch Distributed Data Parallel and TensorFlow's Multi-GPU Strategy.
3. **Performance Evaluation:** Analyze model performance in terms of prediction accuracy, computational efficiency, and scalability, with a focus on speedup gains from parallelization and distributed training.
4. **Fine-Tuning & Optimization:** Explore hyperparameter tuning, synchronization strategies, and parallelization techniques to optimize performance.