THE TOOL FOR COMPUTATIONAL SIMULATION THE EARTH ENERGY ABSORPTION

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המכללה האקדמית להנדסה בראודה בכרמיאל

Introduction

Our research examines the role of energy accumulation in climate dynamics and extreme weather patterns. Understanding how stored energy influences temperature, pressure, and atmospheric behavior is crucial for improving long term climate predictions.

Problem

Climate changes provide substantial worldwide problems, ranging from severe weather phenomena to disturbances in ecosystems and human civilizations. Long-term prediction of the changes is important unsolved problem

Solution

Our project introduces a new approach by considering accumulated energy as a key factor in climate change. This parameter influences temperature, pressure, and atmospheric behavior. To analyze this, we developed a tool that collects and evaluates climate data, estimating Earth's stored energy. We implemented and compared two independent methods:

1. Solar Radiation and Albedo Analysis
2. Atmospheric Heat Capacity Estimation

Methods

1.Data Collection & Processing:
ERA5 data was obtained in GRIB format, converted to CSV, and analyzed in Google Colab using specialized libraries.

2.Earth Division & Area Calculation:
The Earth was divided into 5-degree latitude increments, with a single representative square calculated per latitude level to simplify energy estimates.

3.Energy Absorption Calculation:
Two methods: Atmospheric Heat Capacity Estimation and Solar Radiation and Albedo Analysis,were compared to ensure consistency in energy absorption results.

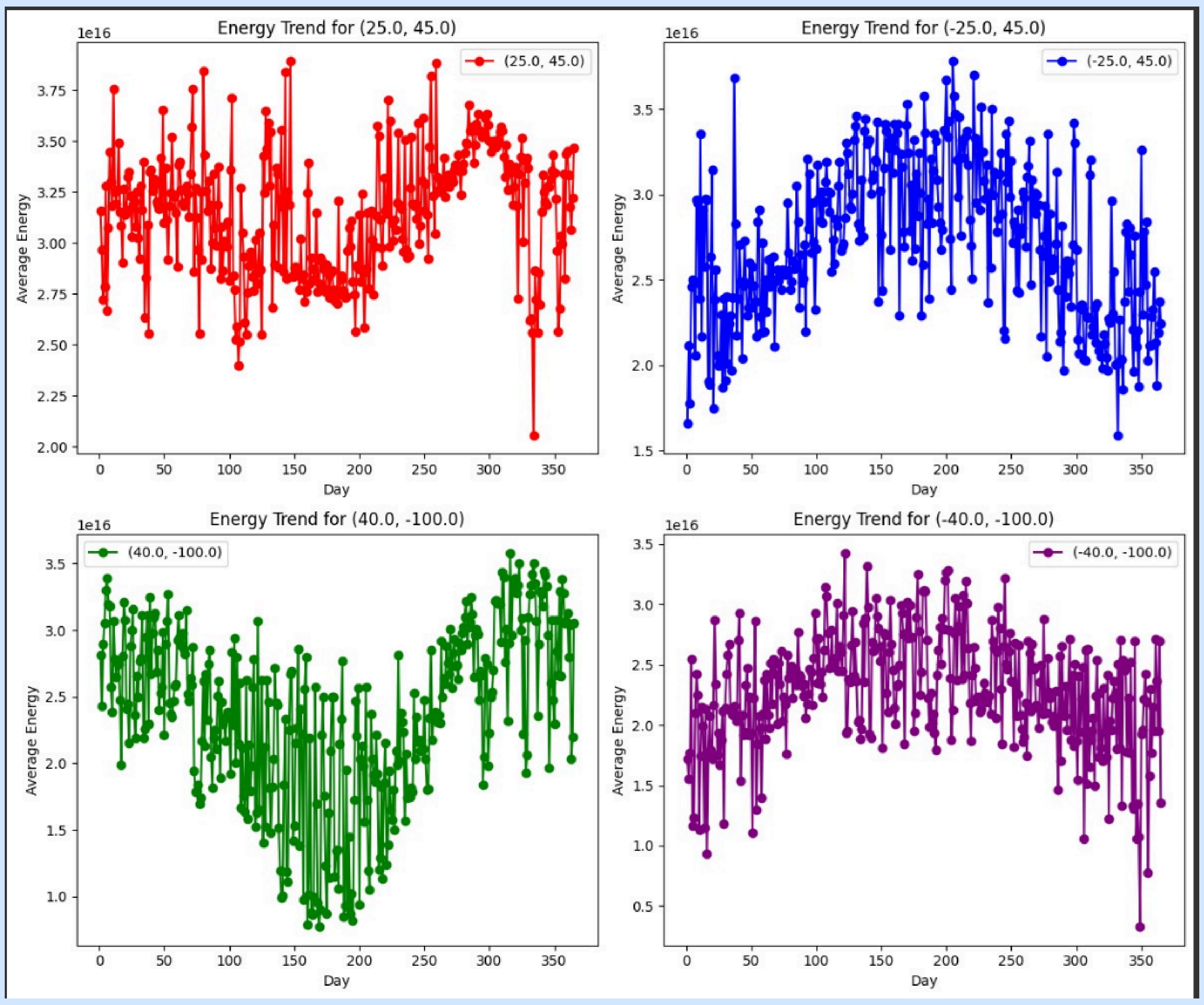
4.Data Processing:
Python and C++ scripts extracted and mapped climate data to grid cells, optimizing calculations.

5.Validation & Results:
The comparison confirmed expected trends but highlighted the need for refinements to improve accuracy.

6.Final Energy Calculation:
Energy values were averaged per latitude level and multiplied by their respective areas, providing a comprehensive estimate of energy accumulation.

Results

Solar Radiation and Albedo Analysis



Formulas

- **Solar Radiation and Albedo Analysis**

$$|STR| - OLR + (TCC - 1) \times \cos\theta \times (1 - \alpha) \times SSRD = E$$

|STR|:Represents the total energy at the surface after balancing emitted and absorbed thermal radiation.
OLR: Represents the heat energy lost to space
TCC: Total Cloud Cover
θ:Angle of incoming solar radiation
α: Reflectivity of the surface(Albedo)
SSRD:Solar radiation reaching the surface

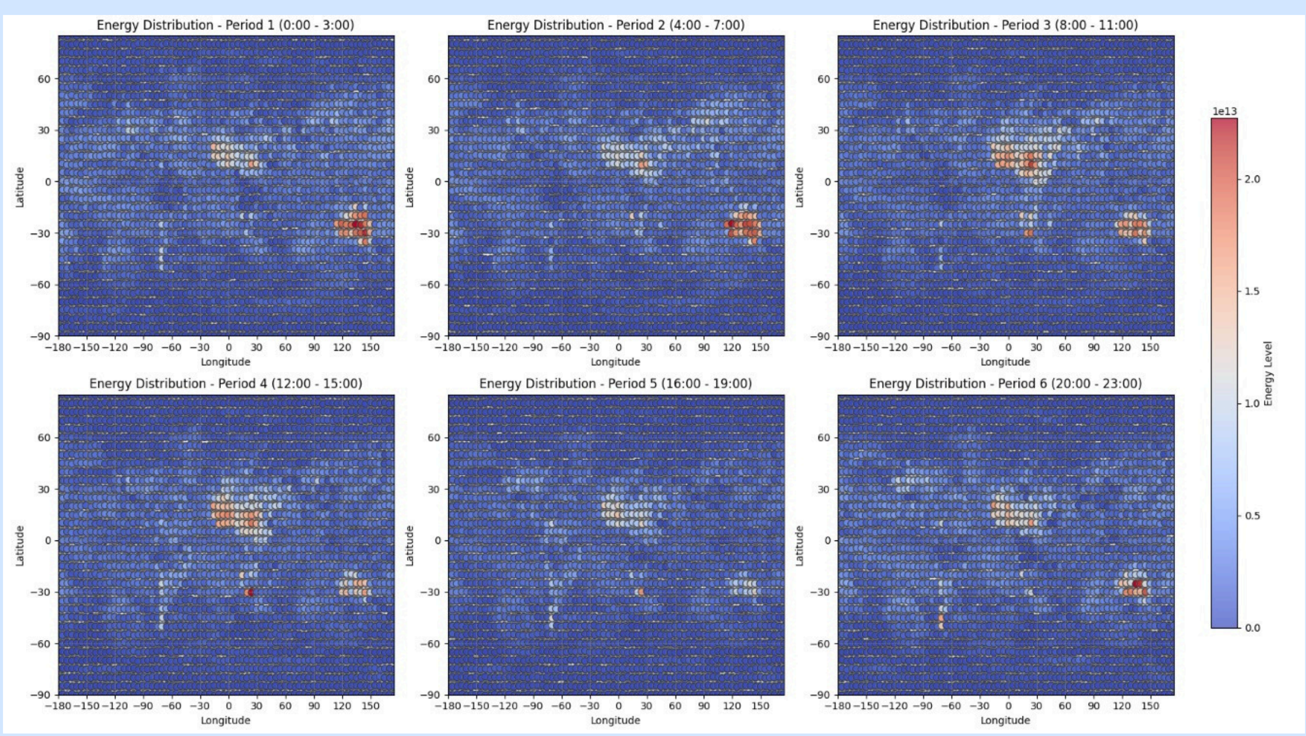
- **Atmospheric Heat Capacity Estimation**

$$E = AREA \times C \times \Delta T$$

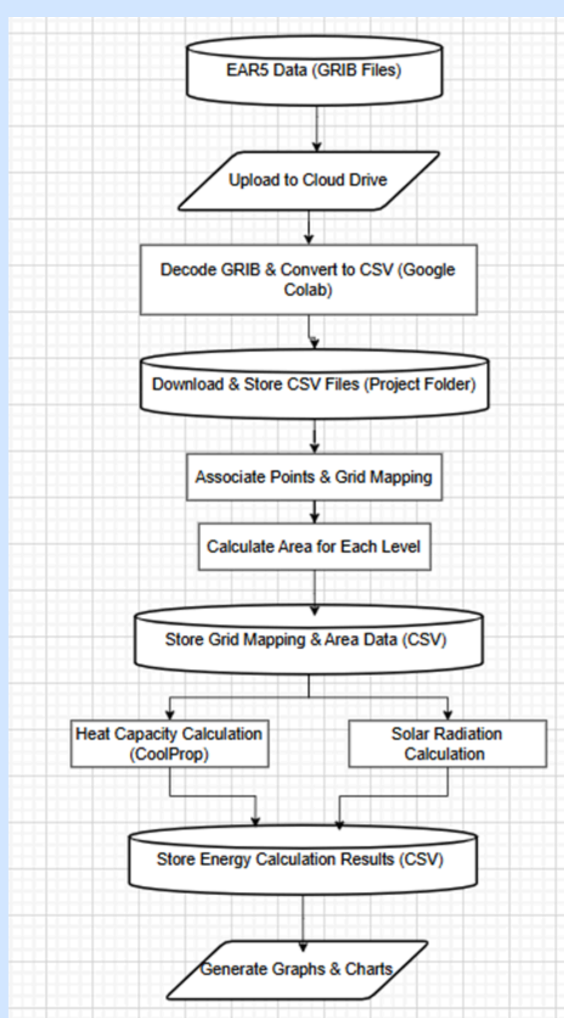
AREA:represent the geographical area of the grid cell where energy absorption is calculated
C: Heat Capacity
ΔT: represent the temperature variation

Results

Atmospheric Heat Capacity Estimation



Work flow digram



CONCLUSIN

Our research developed a computational tool to study Earth's energy absorption using two methods: solar radiation and albedo analysis, and atmospheric heat capacity estimation. By dividing the Earth's surface into a grid and mapping energy distribution, we identified key factors affecting climate, such as humidity, surface properties, and solar angles.

Despite challenges in collecting accurate data and improving formulas, our approach provided useful insights into how energy accumulates in different regions and influences weather patterns. These findings help improve understanding of climate changes and support better weather forecasting and climate adaptation strategies.