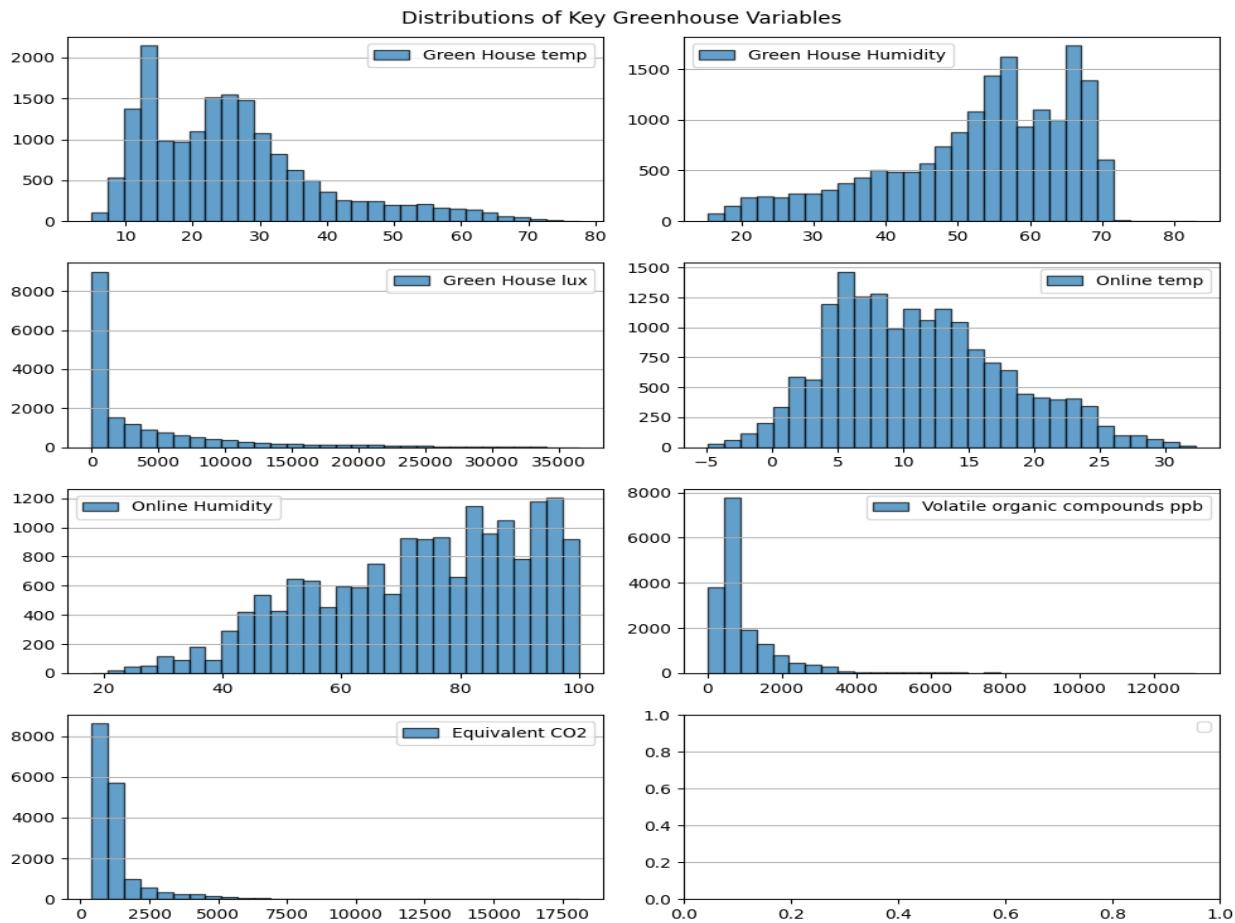


Greenhouse Environmental Time Series Analysis

This report presents a comprehensive exploratory and time series analysis of environmental variables recorded inside a greenhouse. The data consists of 10-minute interval readings for temperature, humidity, and illuminance, spanning March to early July 2021.

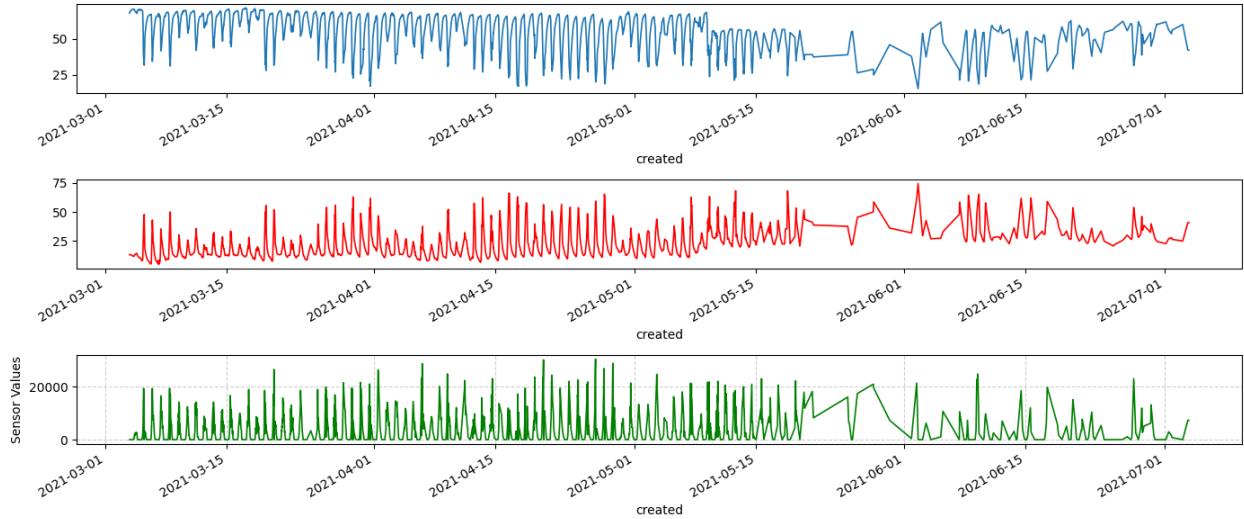


1. Exploratory Data Analysis (EDA) Histogram Distributions



- **Temperature:** Right-skewed, mostly between 12°C and 30°C, with occasional peaks up to ~50°C.
- **Humidity:** Irregular distribution, initially concentrated near 60–75%, with disruptions after mid-May.
- **Illuminance:** Highly right-skewed with dominant values <5000 lux and occasional spikes >20,000 lux.

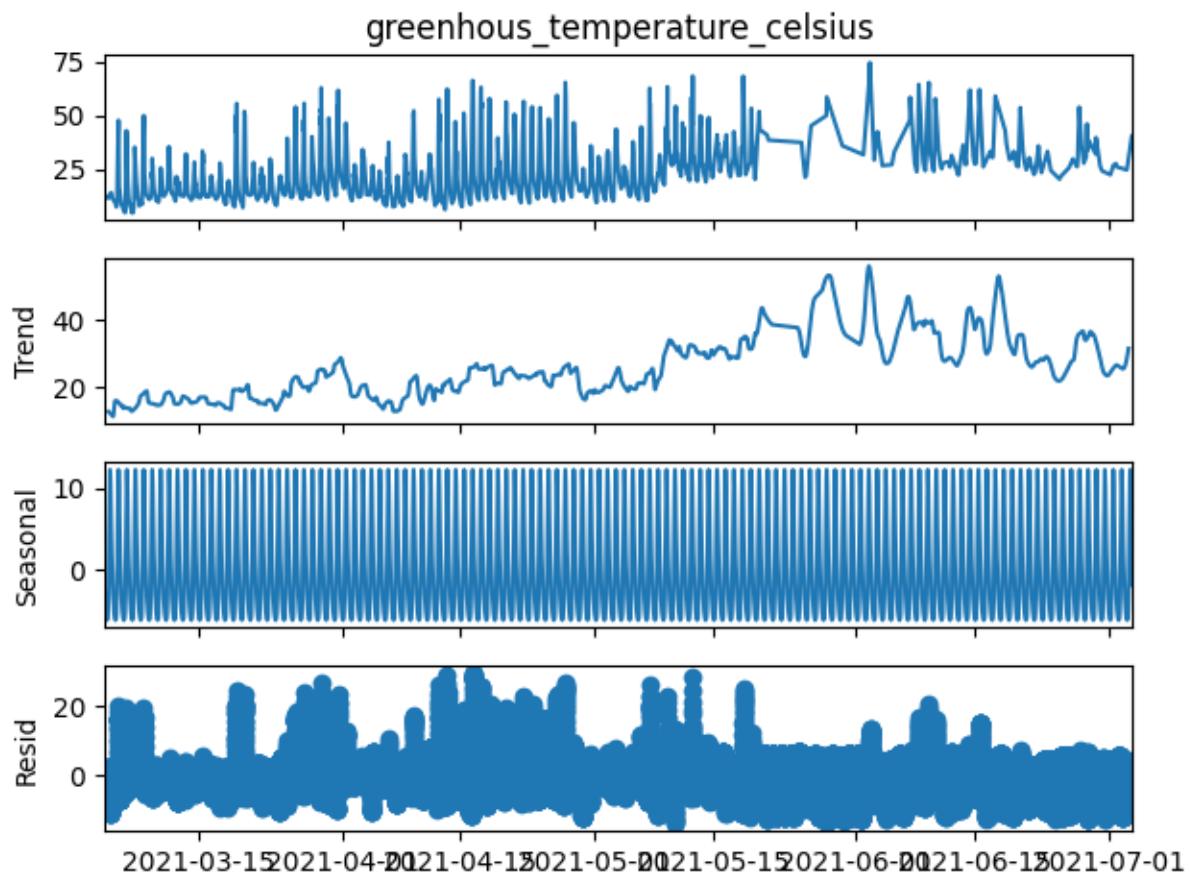
Time Series Overview



- **Daily Cycles:** All three variables exhibit daily patterns.
- **Seasonal Shift:** Notable changes in all variables occur around **May 15**, suggesting a shift in environmental control or seasonal climate.

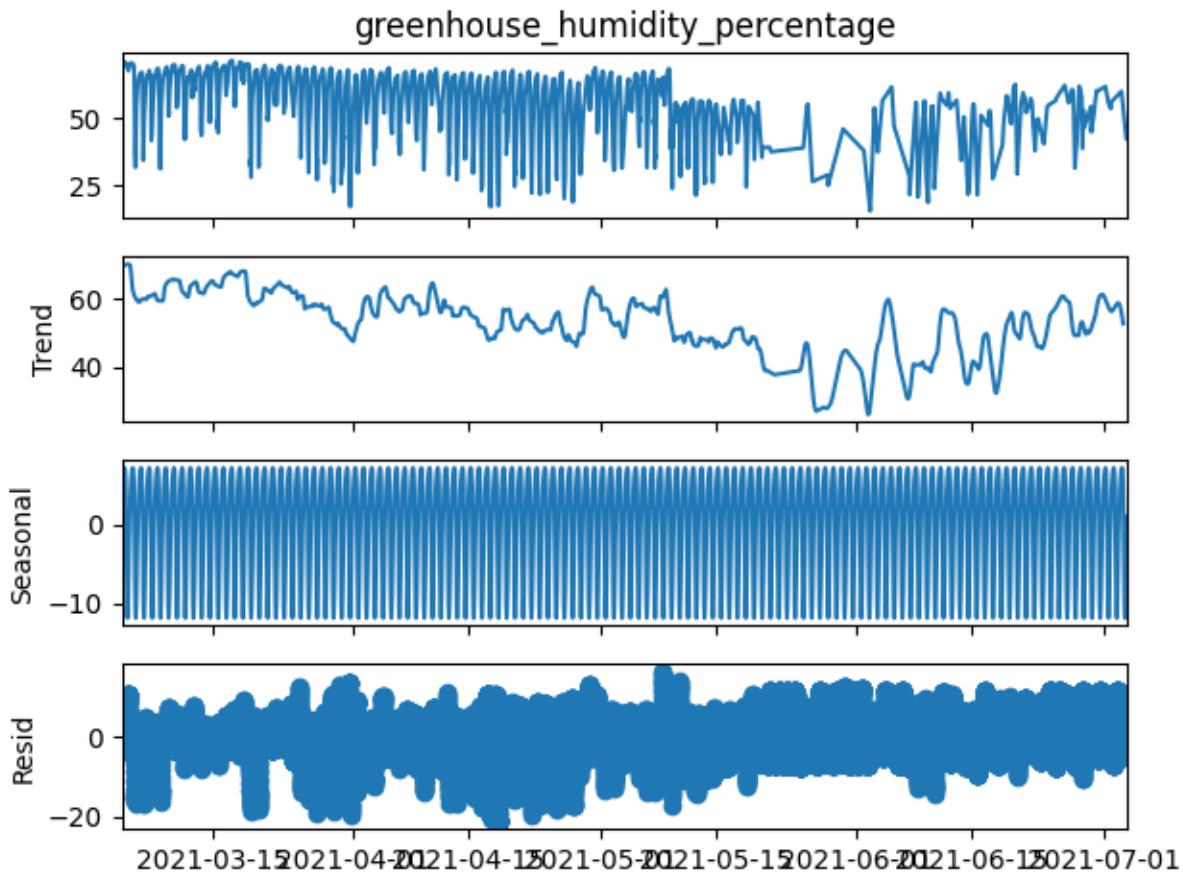
2. 🔎 Seasonal Decomposition

🌡️ Greenhouse Temperature



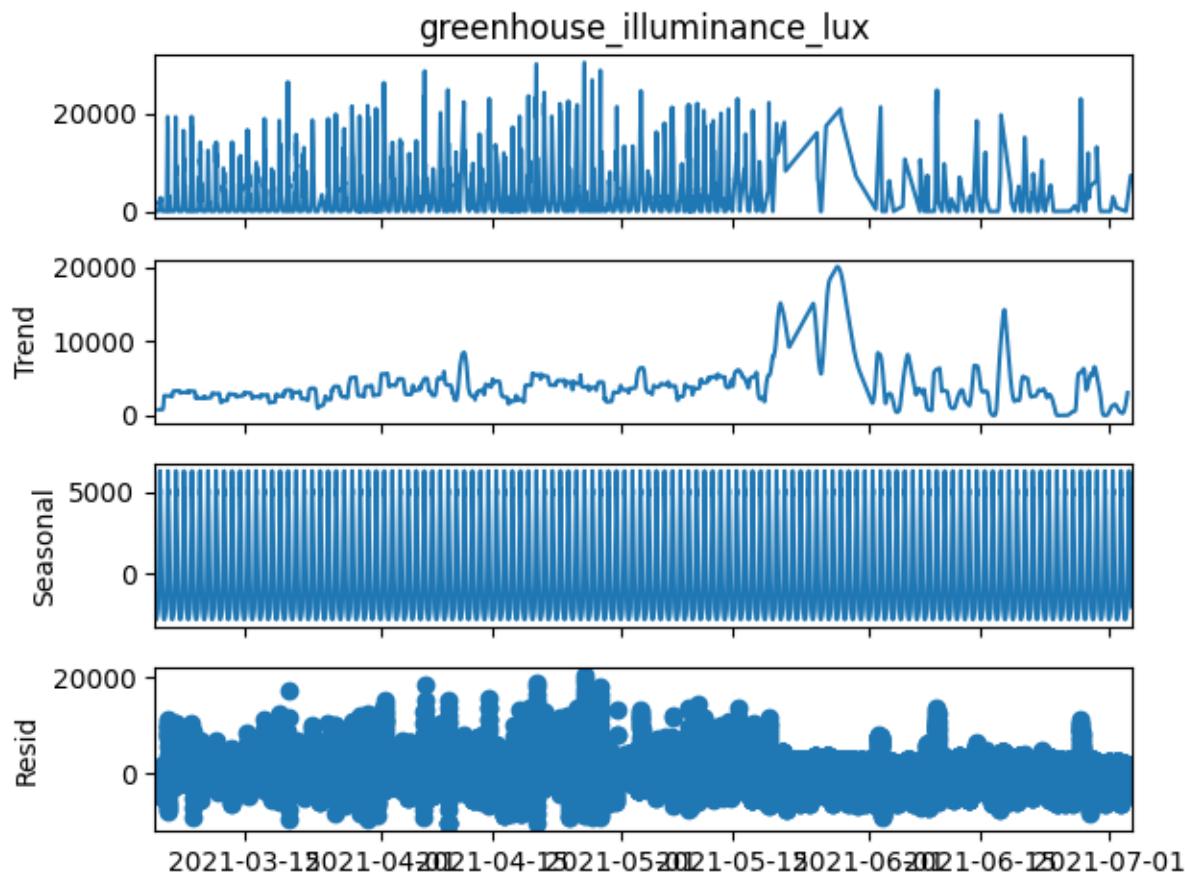
- **Trend:** Rising trend until mid-May, then levels off.
- **Seasonal:** Strong daily temperature cycles.
- **Residual:** Volatility increases after May → possible control changes.

💧 Greenhouse Humidity



- **Trend:** Gradual decline across time.
- **Seasonal:** Clear cycles pre-May, disrupted post-May.
- **Residual:** More noise after mid-May. Suggests intervention events or system changes.

💡 Greenhouse Illuminance



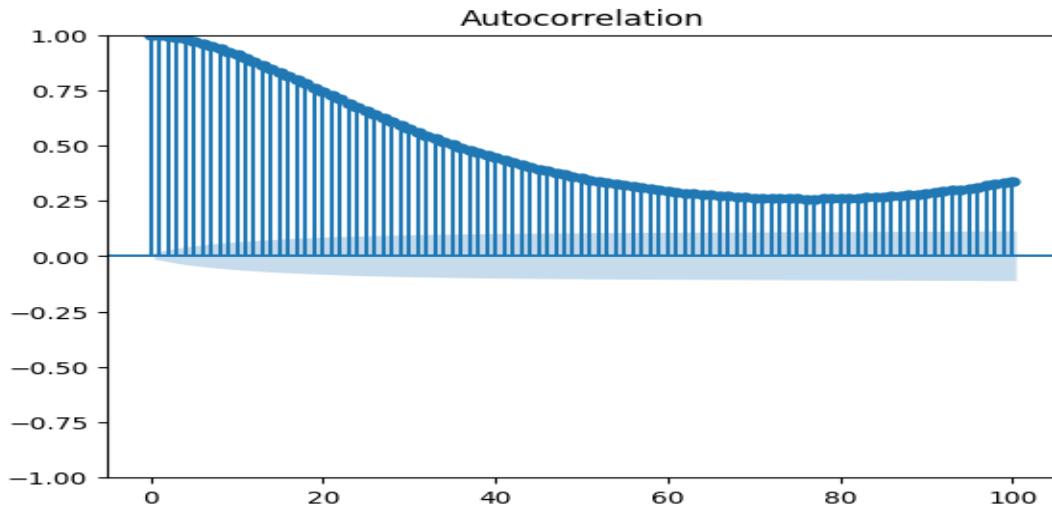
- **Trend:** Brightening trend over months.
- **Seasonal:** Very sharp daily cycles (solar exposure).
- **Residual:** Minimal noise except occasional clouds or shading effects.

3. ⚑ Autocorrelation & PACF Analysis

These plots help uncover temporal dependencies and ideal sequence lengths for modeling.

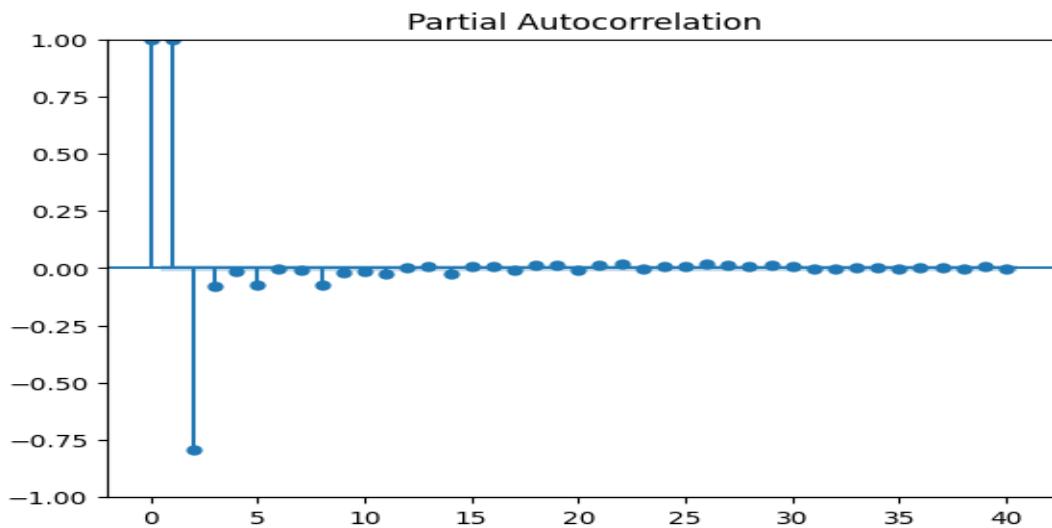
🌡️ Temperature

- ACF:



→ High autocorrelation at short lags, plus a peak at lag $\sim 144 \rightarrow$ daily cycle confirmed.

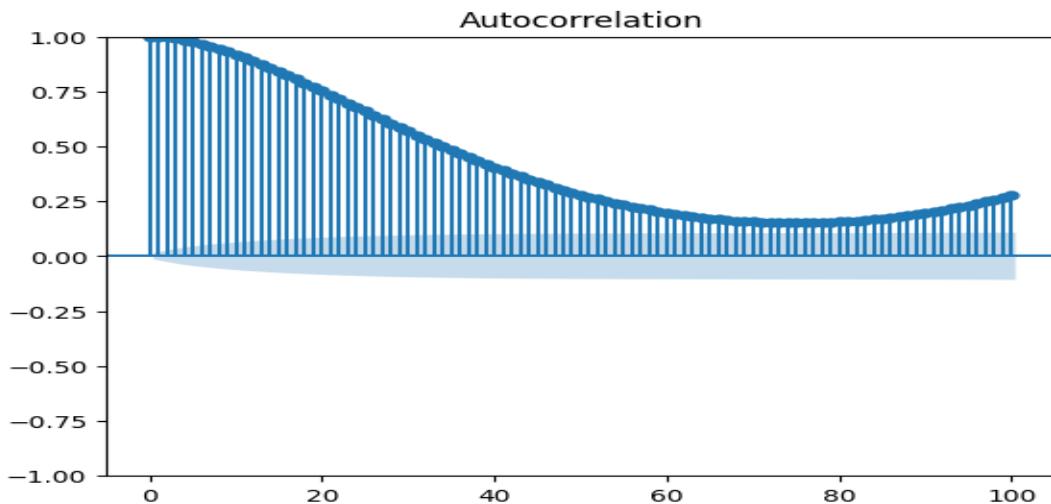
- PACF:



→ Significant lags at 1–3; input window of 3–6 hours suggested for LSTM.

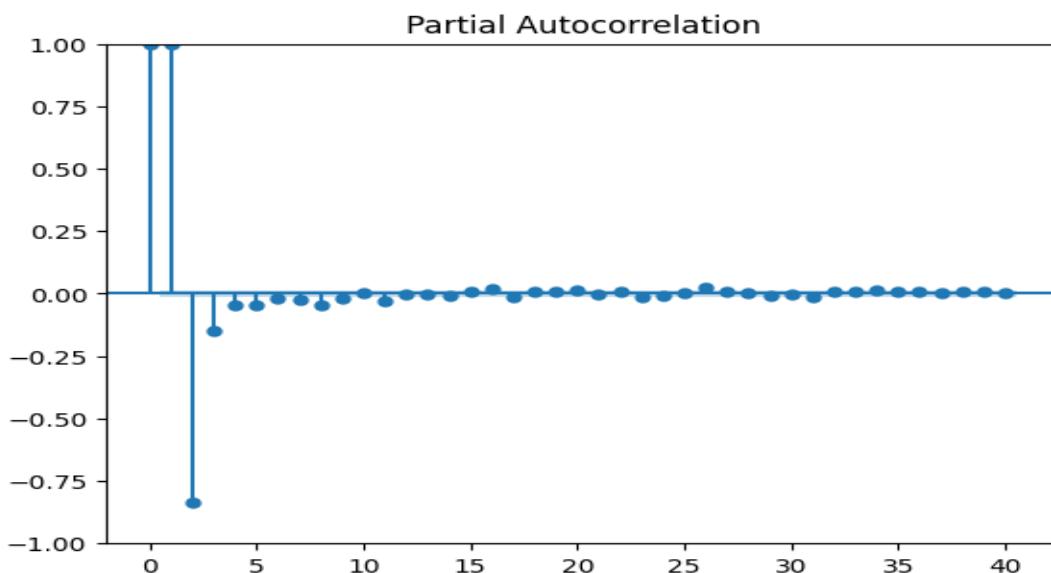
💧 Humidity

- ACF:



→ Strong short-term correlation, less seasonal memory than temperature.

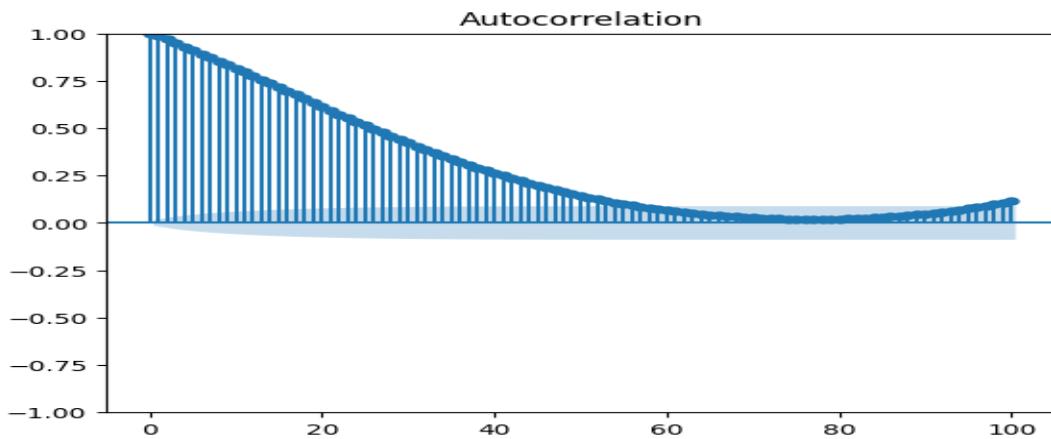
- **PACF:**



→ Lags 1–3 dominate, with a notable negative spike at lag 3 (possible overshoot behavior).

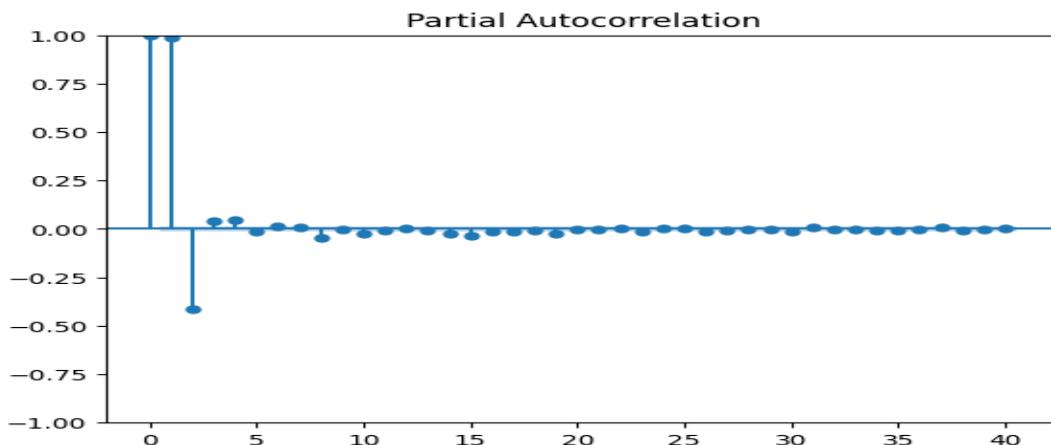
Illuminance

- **ACF:**



→ Very strong periodicity with spikes at lag 144 and multiples (daily solar rhythm).

- **PACF:**



→ Only lags 1–3 contribute direct influence; short memory.



Key Takeaways

- All variables exhibit strong **short-term memory** and **daily cyclic behavior**—ideal for LSTM-based modeling.
- Mid-May marks a **regime shift** across all signals, suggesting possible retraining or adaptive modeling.
- Illuminance is highly predictable and an excellent **exogenous feature** to support temperature and humidity forecasting.
- Based on PACF, recommended LSTM input windows:
 - Temperature: **36–72 steps** (6–12 hours)

- Humidity: **18–36 steps** (3–6 hours)
- Illuminance: **6–12 steps** (1–2 hours)