First-Year Column-Averaged GHG Measurements at Taichung, Taiwan: A New COCCON Station in Subtropical East Asia

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Introduction

Understanding urban greenhouse gas (GHG) dynamics requires separating anthropogenic emissions from regional transport and biogenic fluxes. Deployed in the Taichung Basin, Taiwan, our EM27/SUN spectrometer contributes a vital subtropical dataset to the Collaborative Carbon Column Observing Network (COCCON), filling a critical geographic gap on the western Pacific rim. This location effectively captures the downstream East Asian monsoon outflow and provides essential ground-truth validation for satellite retrievals (e.g., OCO-2, GOSAT) in complex sub-tropical environments. This study resolves the high-frequency diurnal dynamics of XCO_2 and XCH_4, utilizing the diurnal hysteresis effect to successfully decouple urban co-emissions from regional photosynthetic drawdown

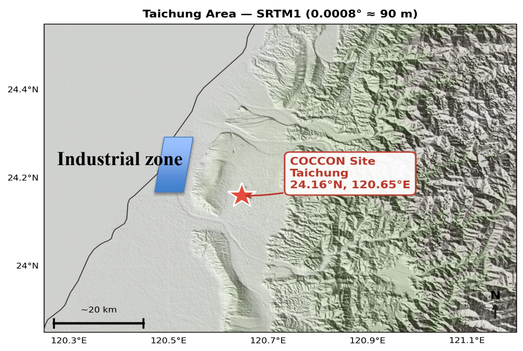
Site & Instrument

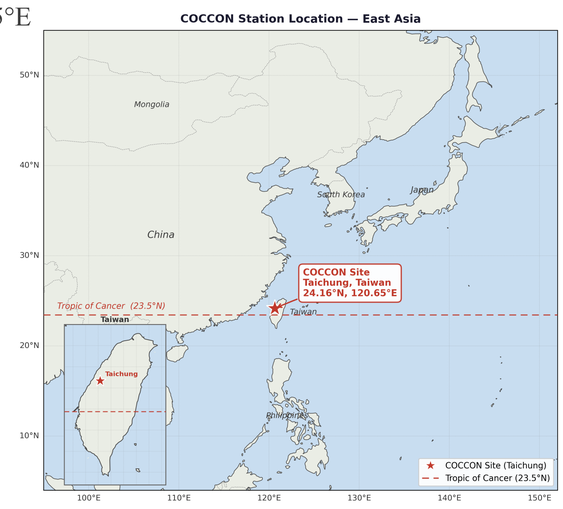
Location: Taichung, Taiwan · 24.16°N, 120.65°E

Instrument: EM27/SUN (SN257),

Retrieval: PROFFAST 2.4

Period: Feb 2025 – Apr 2026 (15 months)



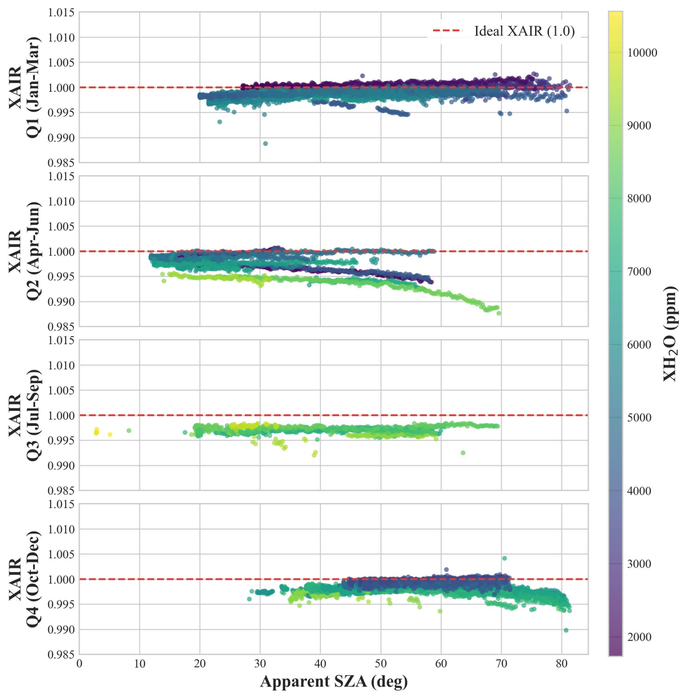


Data Quality — XAIR vs. Apparent SZA

- **Excellent Stability**:

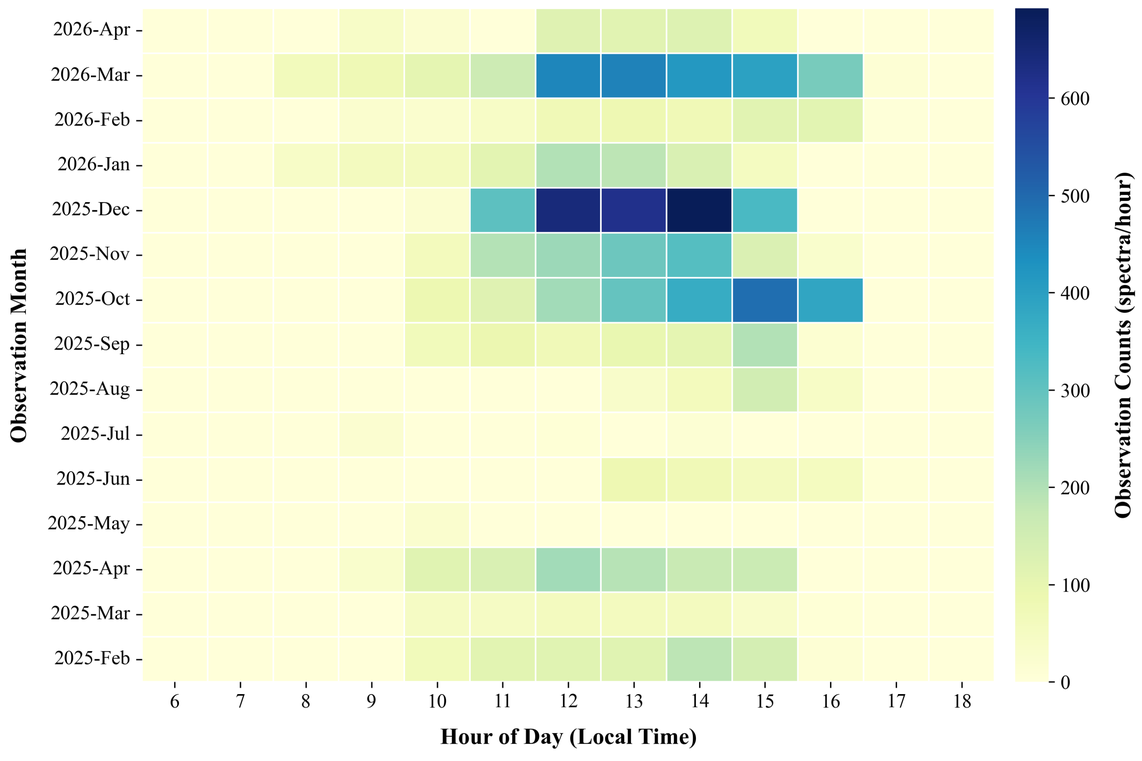
  XAIR consistently clusters around the ideal theoretical value of 1.0 across all seasons, proving the exceptional stability of the SN257 instrument.

- **COCCON-Standard Quality:** The data strictly adheres to international quality thresholds. The minor seasonal variance observed is a negligible artifact driven by Taiwan's sub-tropical humidity.



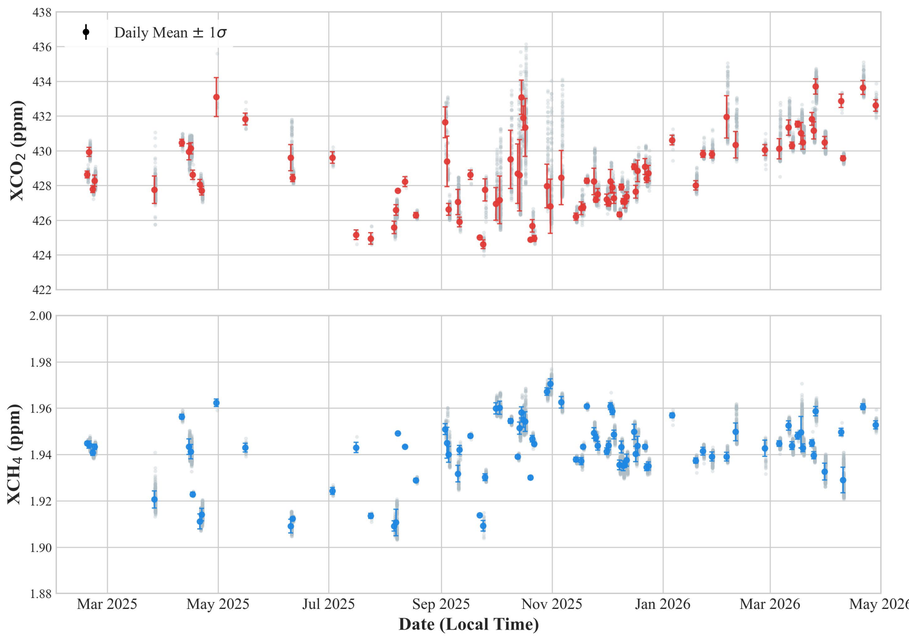
Data Availability

- **Observation Footprint**: The heatmap visualizes the temporal distribution of valid retrievals, demonstrating the continuous operational resilience of the Taichung site over the long-term campaign.
- **Sub-Tropical Island Climate**: Intermittent data gaps faithfully reflect Taiwan's complex maritime climate, which is heavily characterized by persistent cloud cover, monsoonal rains, and summer afternoon thunderstorms.

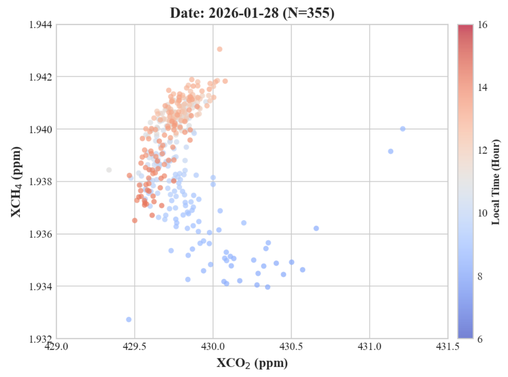


Time Series: XCO_2 & XCH_4

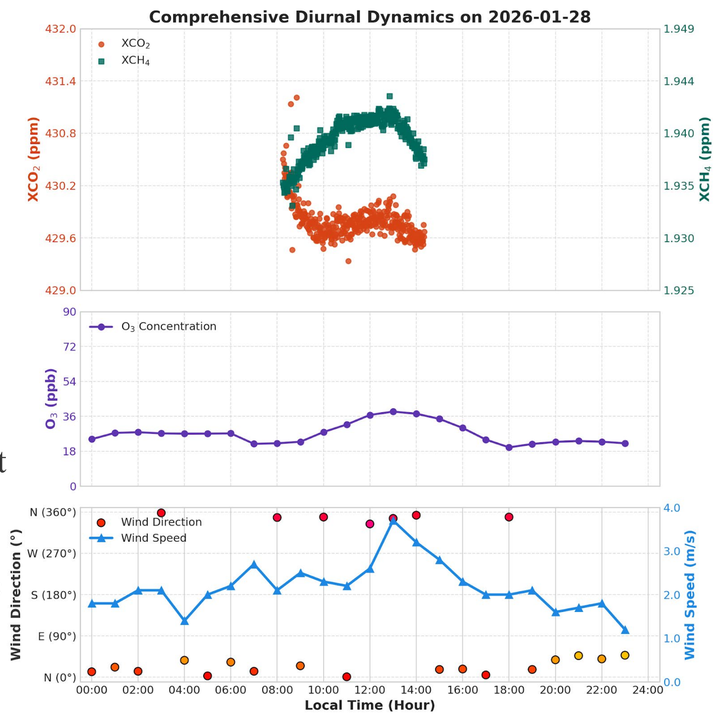
- **Seasonal Cycle**: Clear seasonal oscillations in XCO_2 illustrate the strong biospheric drawdown during summer, contrasting with concentration buildups in winter.
- **Monsoonal & Topographical Effects:** Synchronized high-concentration spikes in both XCO_2 and XCH_4 during winter months (Q4-Q1) highlight the combined impact of East Asian monsoonal outflow and the poor dispersion conditions characteristic of the Taichung Basin.

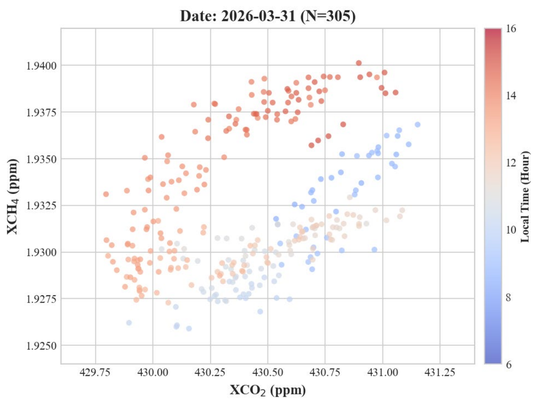


XCO_2 vs. XCH_4 Cases

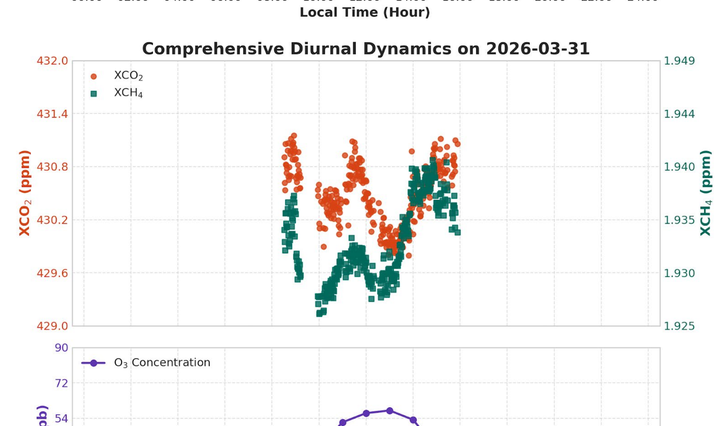


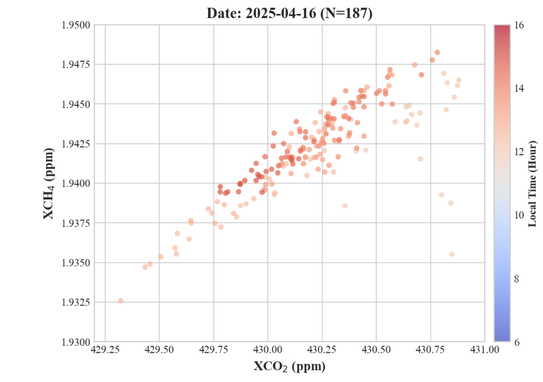
- Contrasting GHG Dynamics: XCO_2 and XCH_4 exhibit distinctly divergent temporal trends under prevailing northerly winds.
- A potential influence from biospheric emissions or localized transport from the northern mountainous regions.



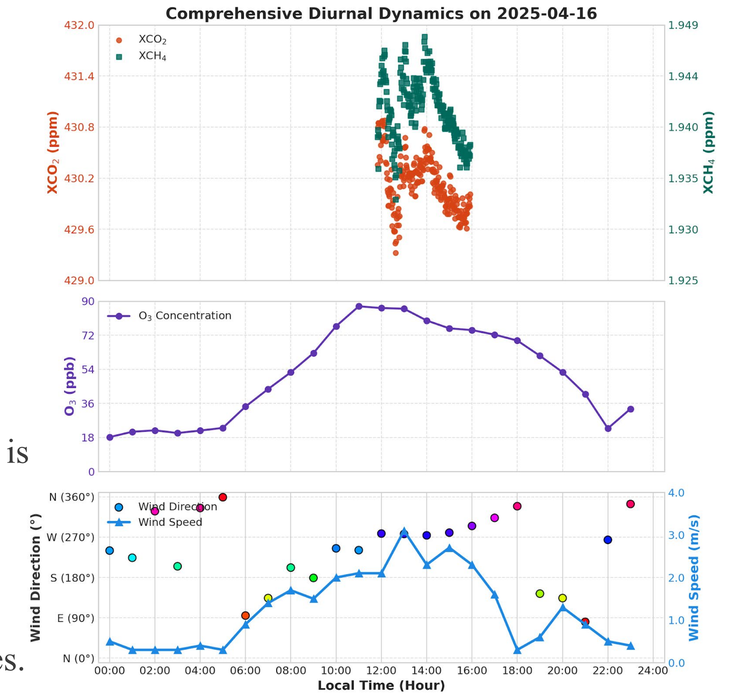


- Distinct XCO_2-XCH_4 emission ratios emerge between morning and afternoon, driven by a wind shift from southwest to northwest.
- Morning patterns reflect local traffic accumulation, while the afternoon shift indicates an influx of industrial pollution carried by the sea breeze.





- A highly synchronized linear relationship between XCO_2 and XCH_4 is maintained under persistent westerly winds.
- The strong co-variation indicate the direct transport of anthropogenic emissions from upwind industrial zones.



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