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Tracker losses: Quantifying the effect of stuck and misaligned trackers using operational data

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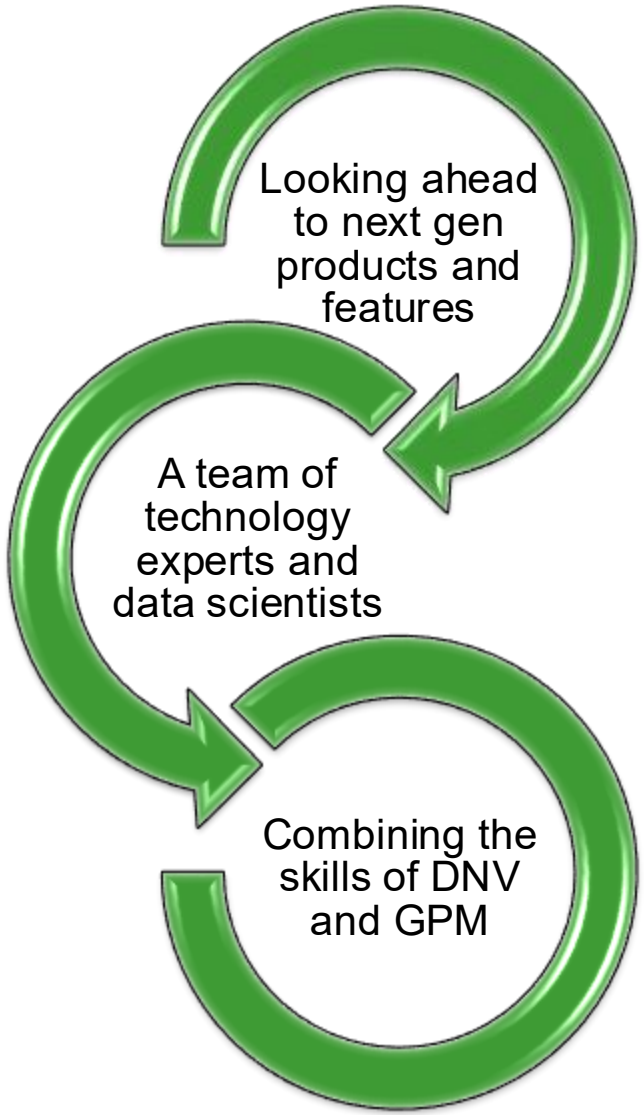
Monitoring, control and optimisation of renewable energy assets.

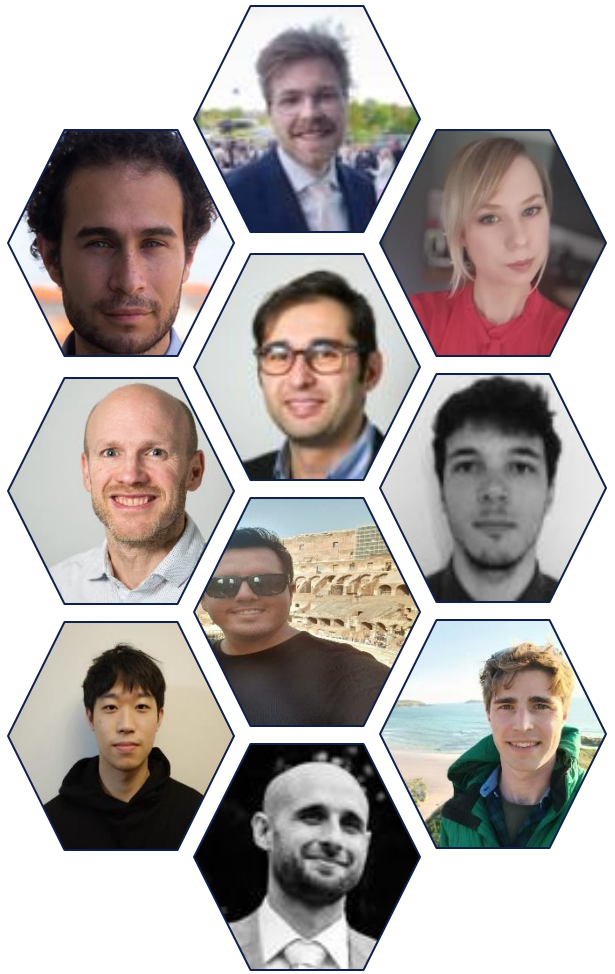
Our footprint today

Total figures	Solar	Wind	Storage
82.2GW	68GW	14.3GW	4GWh
+7.500 Successfully Delivered projects	1.3GW Largest plant	600MW Largest plant	1GWh Managed in Chile LATAM

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The Innovation Team





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The Problem

When trackers fail, so does performance

- Stuck Trackers:
  → Fixed at wrong angles → major energy loss
- Misaligned Trackers:
  → Subtle, harder to detect → long-term underperformance if it's not fixed

Up to 75+% of irradiance loss in clear sky days

- Sensor Misreadings:
  → Pyranometers on faulty trackers skew irradiance data

Impact: Reduced production, misleading monitoring, flawed simulations



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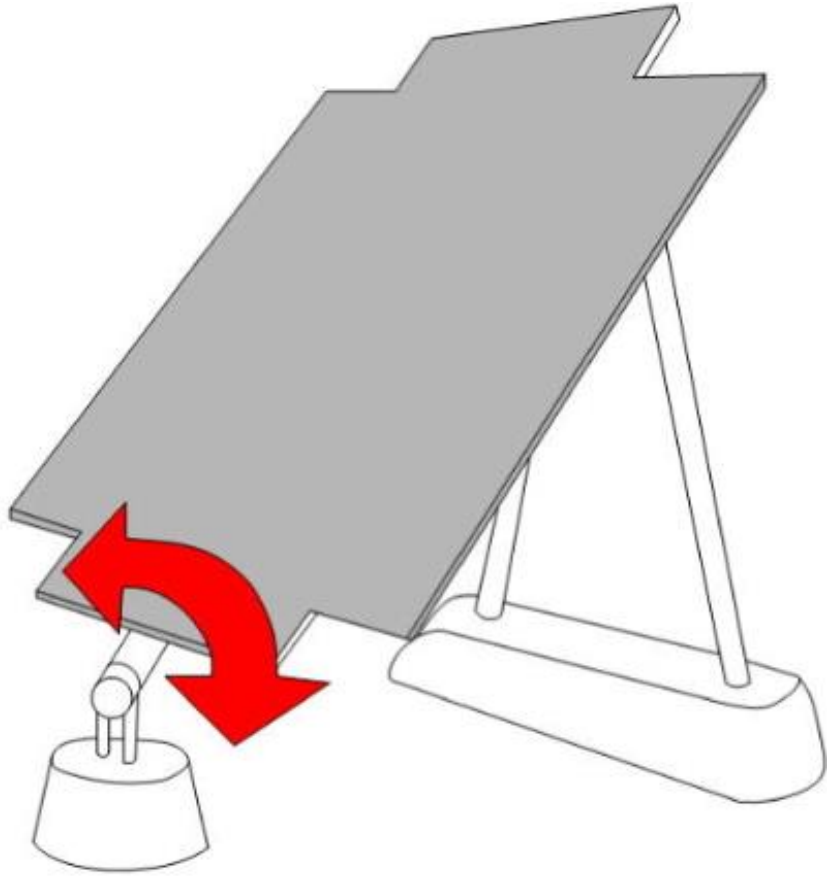
Goal

Isolate and measure energy losses caused by:

- Stuck Trackers
- Misaligned Trackers

Why It Matters:

- Enables accurate loss attribution
- Supports user reporting & optimization
- Complements other loss categories (solar production loss waterfall)



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Methodology



POA irradiance
pyranometer plane

POA irradiance
tracker plane

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Inputs and Outputs

Inputs

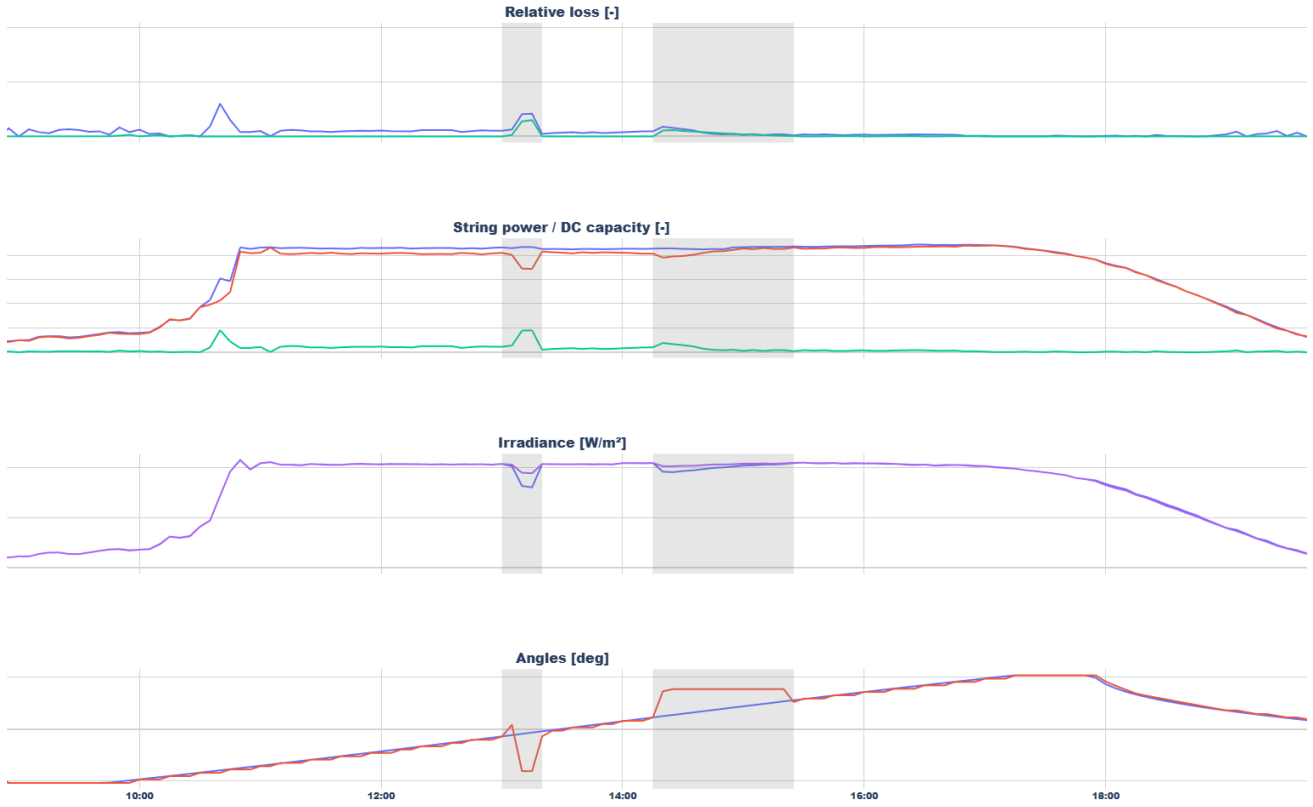
- Timeseries: tracker position, setpoint, POA
- Metadata: coordinates, axis tilt and azimuth, albedo…

Validation

- Timeseries: strings DC power
- Metadata: strings DC capacity
- Tracker to strings mapping

Output

- Power loss %



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Validation

Steps

1. Identify misalignment trackers
2. Identify periods of isolated power loss
3. Simulate tracker POA irradiance
4. Comparison of relative irradiance and power loss

Assumptions

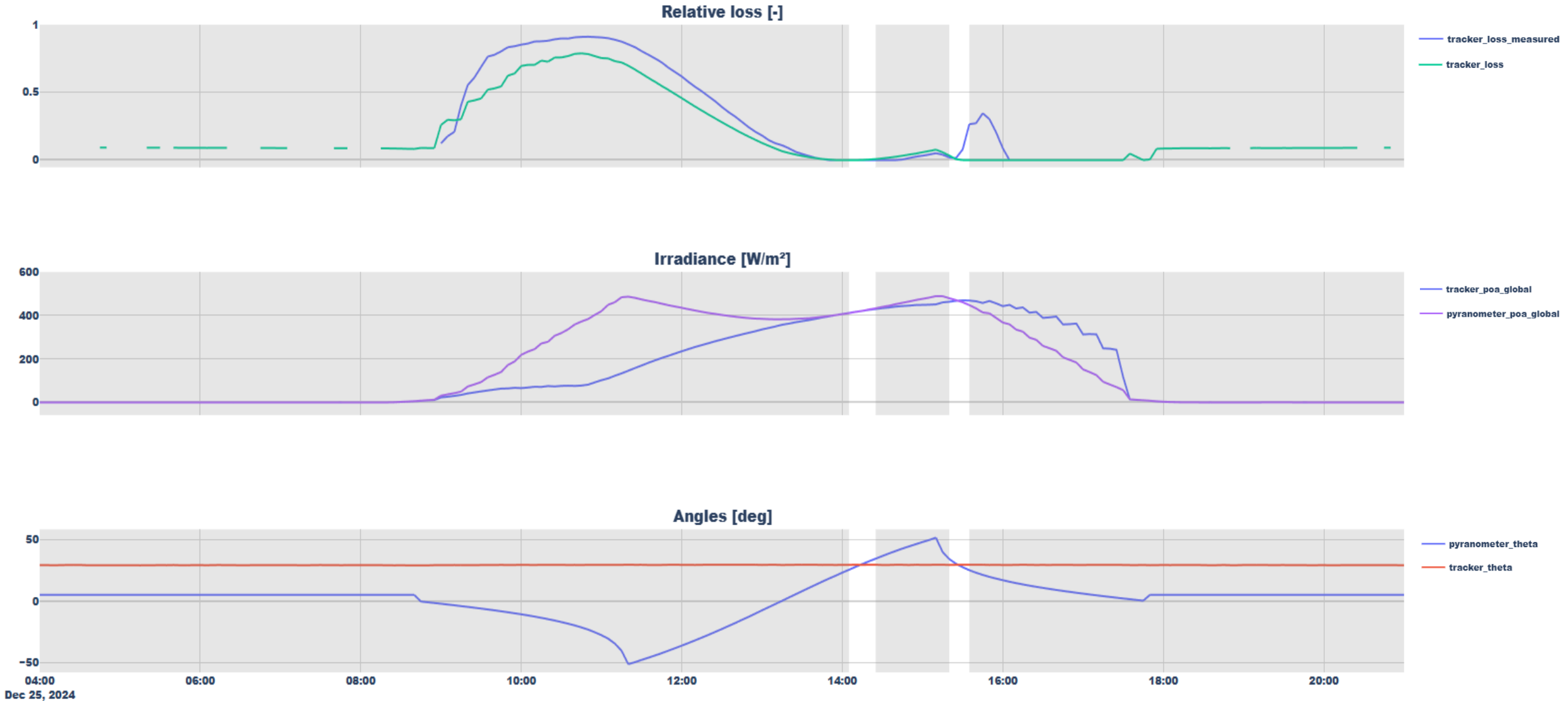
- 2D site: all tracker axes have the same tilt and azimuth
- Correct tracker setpoint position
- Clean POA irradiance



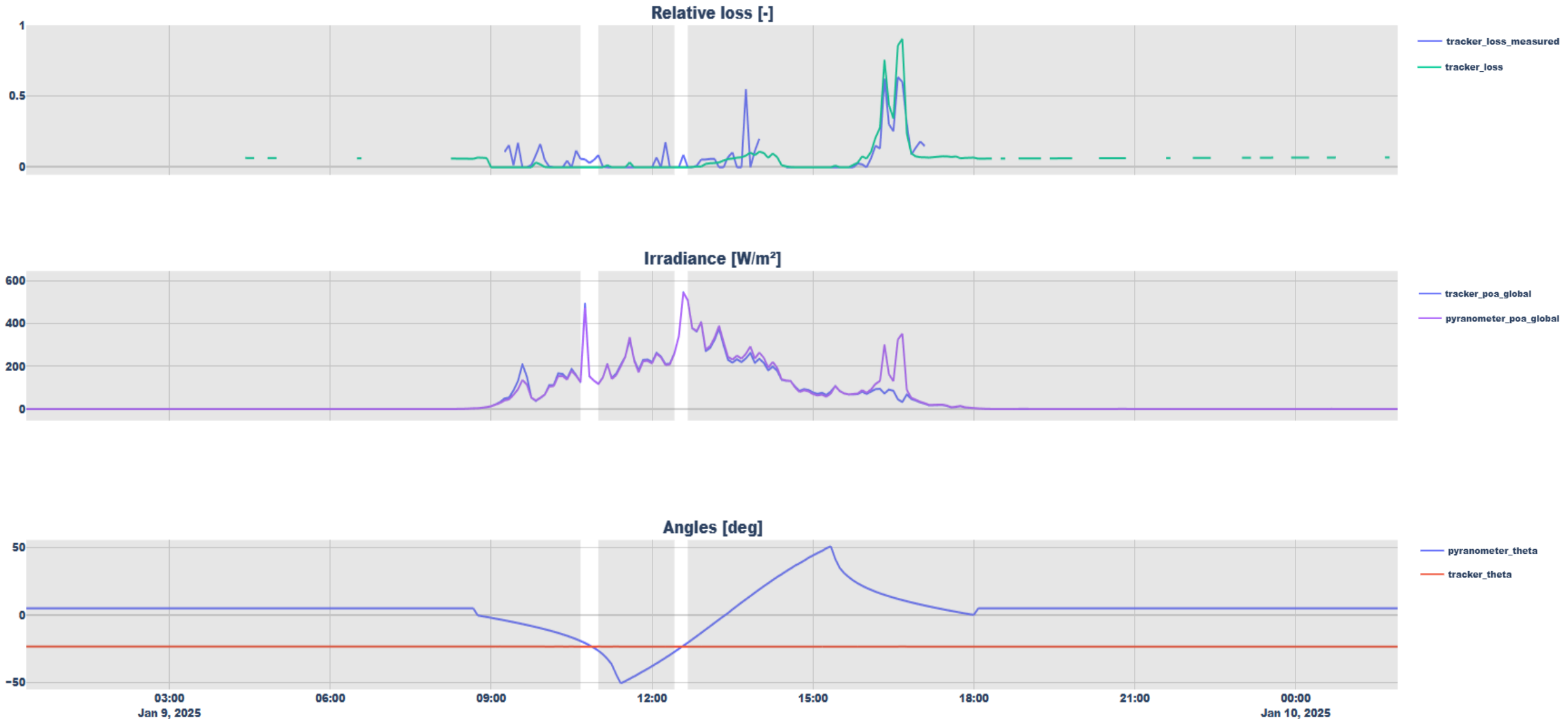
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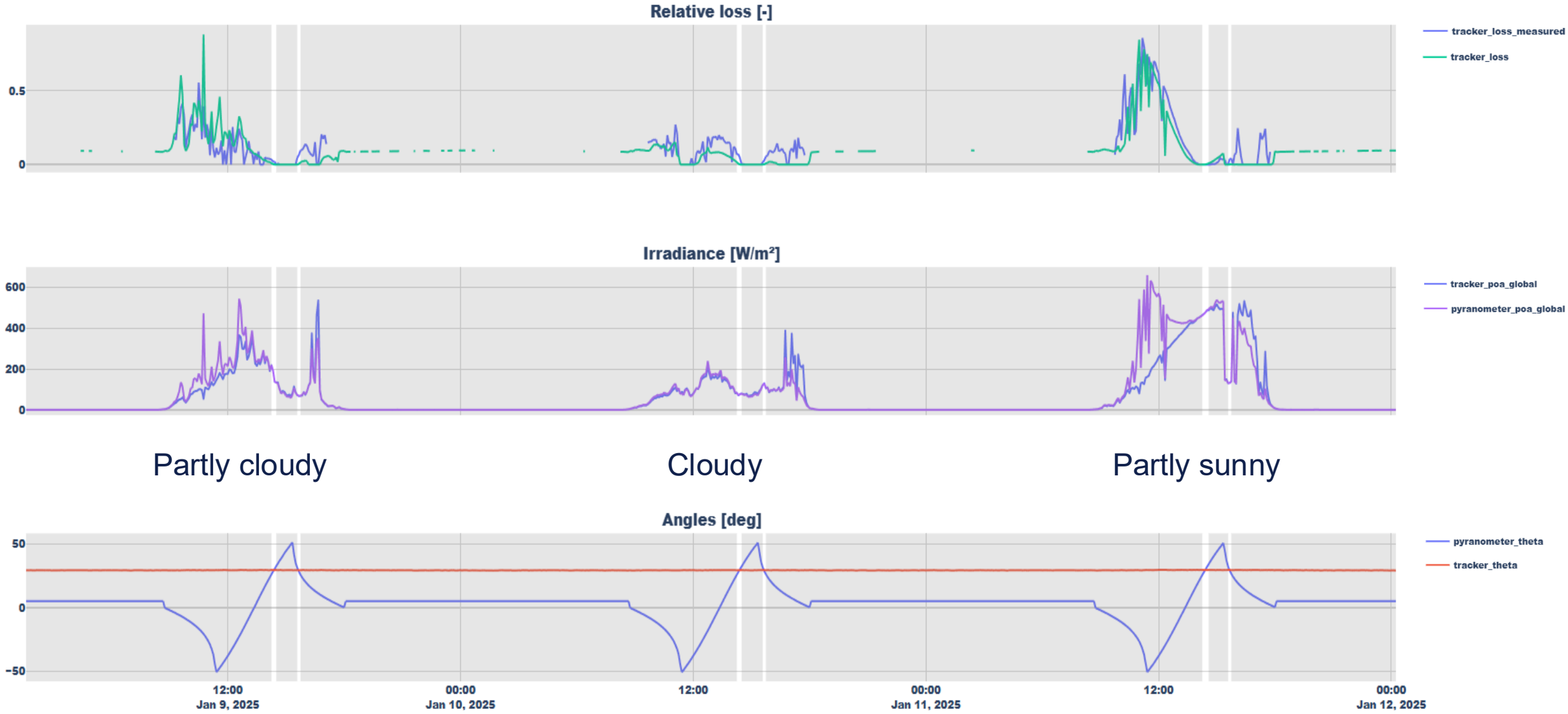
Clear Sky


Relative loss [-]
1
0.5
0
tracker_loss_measured
tracker_loss
Irradiance [W/m²]
600
400
200
0
tracker_poa_global
pyranometer_poa_global
Angles [deg]
50
0
−50
pyranometer_theta
tracker_theta
04:00
Dec 25, 2024
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00

Cloudy


Relative loss [-]
1
0.5
0
tracker_loss_measured
tracker_loss
Irradiance [W/m²]
600
400
200
0
tracker_poa_global
pyranometer_poa_global
Angles [deg]
50
0
−50
pyranometer_theta
tracker_theta
03:00
Jan 9, 2025
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 10, 2025

Different Weather

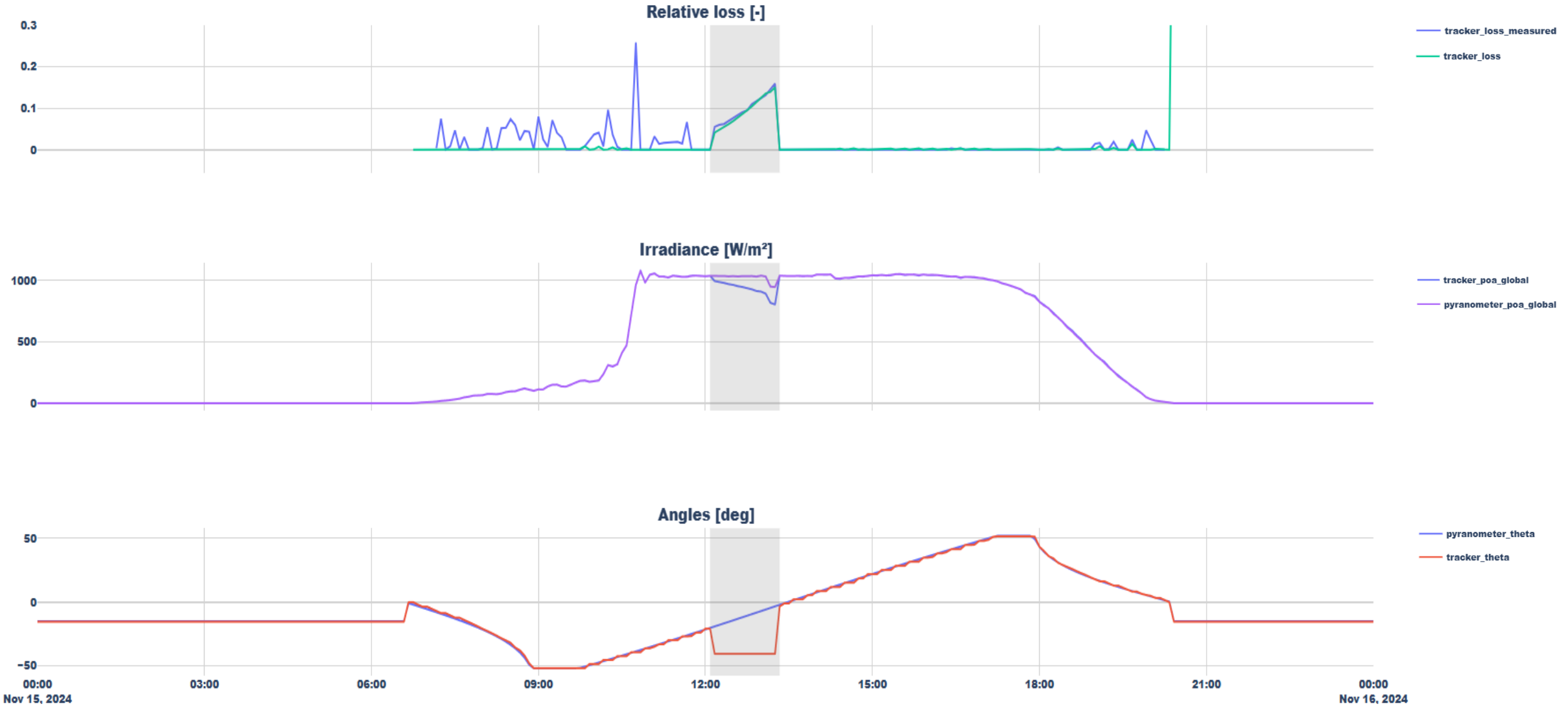


Partly cloudy

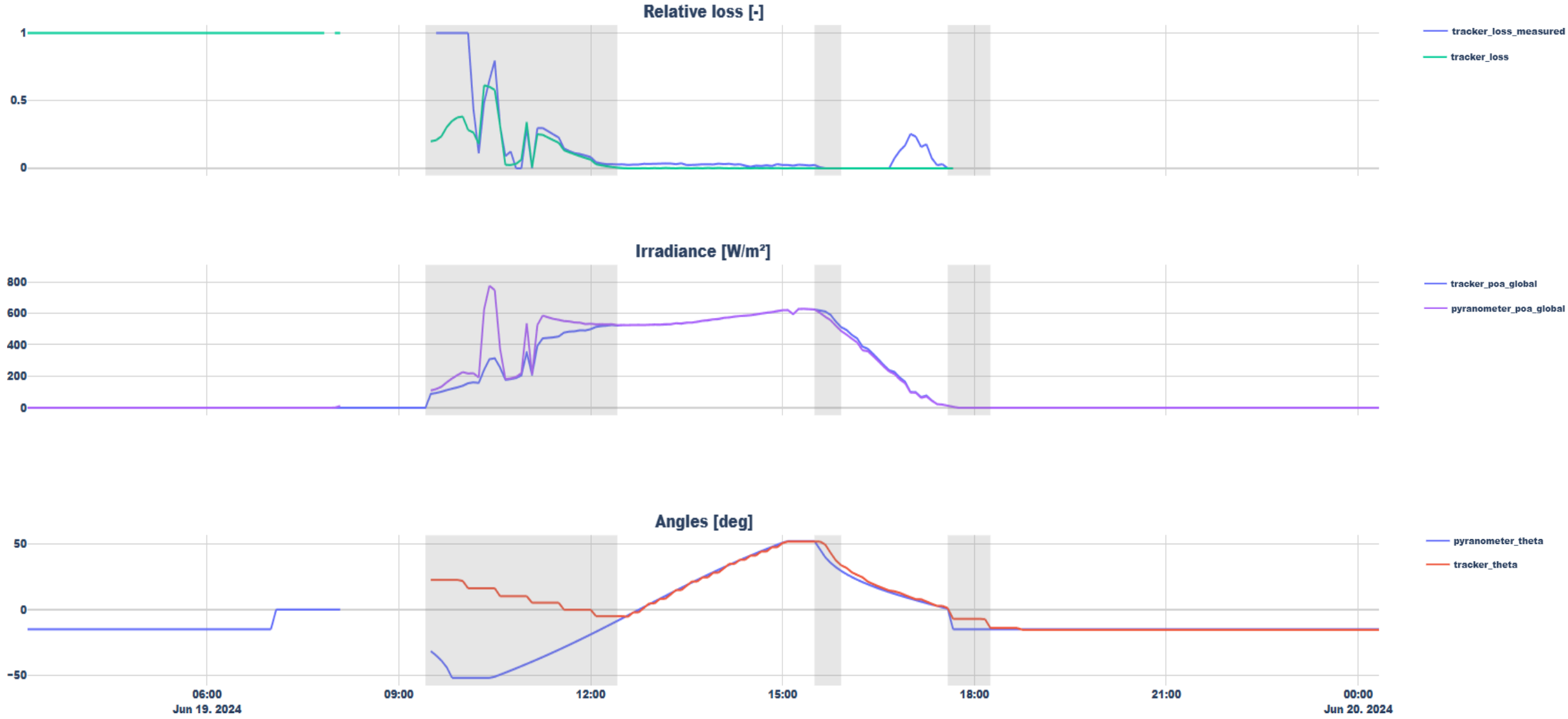
Cloudy

Partly sunny

Short Period of Stuck



Misaligned


Relative loss [-]
1
0.5
0
tracker_loss_measured
tracker_loss
Irradiance [W/m²]
800
600
400
200
0
tracker_poa_global
pyranometer_poa_global
Angles [deg]
50
0
−50
pyranometer_theta
tracker_theta
06:00
Jun 19, 2024
09:00
12:00
15:00
18:00
21:00
00:00
Jun 20, 2024

Conclusions

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Conclusions & Research Outlook

Key Takeaways:

- Algorithm reliably quantifies losses from stuck and misaligned trackers
- It works on different weather conditions with variety of beam/diffuse irradiance ratio
- The accuracy is maintained even if the tracker is failing during short period

Research Directions:

- Develop methods for setpoint validation and correction
- Investigate hybrid loss attribution (shading vs. tracking)
- Extend to non-uniform tracker geometries (e.g., 3D layouts, variable tilt)

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Thanks for listening ☺

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