NEURAL INFORMATION PROCESSING SYSTEMS

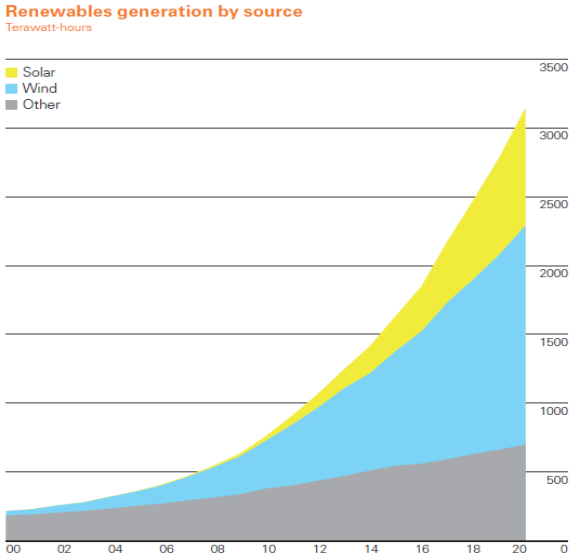
UNIVERSITY OF MARYLAND 18 56

SOLARCUBE

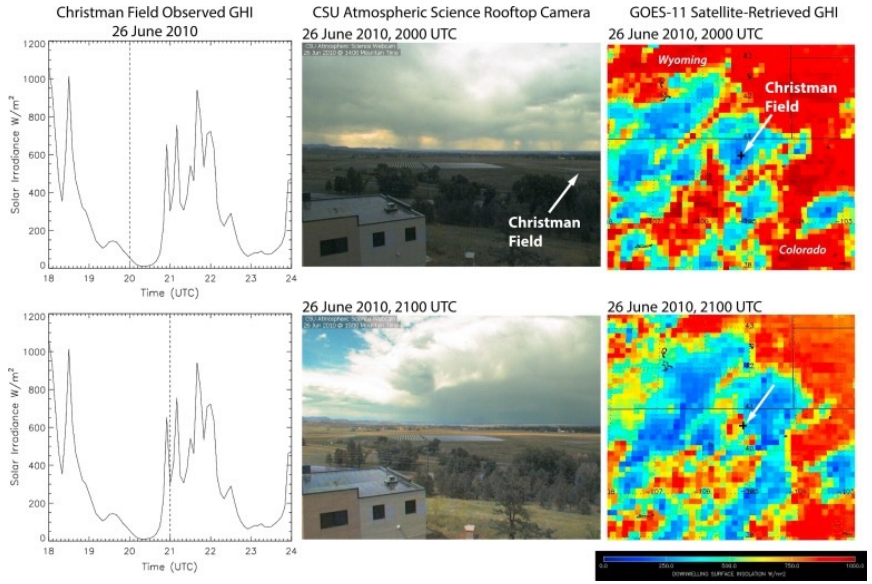
SolarCube: An Integrative Benchmark Dataset Harnessing Satellite and In-situ Observations for Large-scale Solar Energy Forecasting

Ruohan Li, Yinqun Xie, Xiaowei Jia, Dongdong Wang,
Yanhua Li, Yingxue Zhang, Zhihao Wang, Zhili Li

Background



Increasing use of solar energy: Photovoltaic (PV) generation has nearly tripled over the last half decade, increasing from 304.3 GW in 2016 to 760.4 GW in 2020, and is projected to 4,240 GW by 2040 (EIA, 2021).



Highly fluctuated and hard to forecast: a disruption in dense and fragmented cloud cover can lead to a significant surge, up to 700 W/m^2 within a 30-min timeframe (Miller et al., 2018)

SOLARCUBE

Numerical Weather Prediction

Satellite observations

Satellite derived solar radiation data

Area

Ground-measurement

Sky images

Point

30s 1m 15m 3h 6h 24h Several Days

Ultra-short term	Short term	Mid term	Long term
real-time energy dispatch	integrated power systems operation and management	integrated power systems operation and management	power generation, transmission, and distribution scheduling

SOLARCUBE

Numerical Weather Prediction

Satellite observations

Satellite derived solar radiation data

Area

Ground-measurement

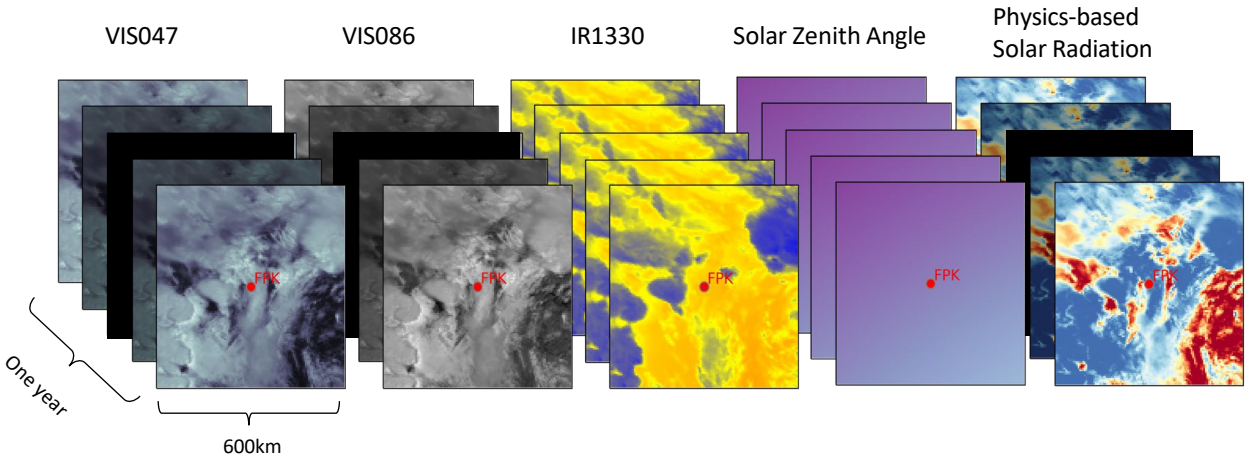
Point

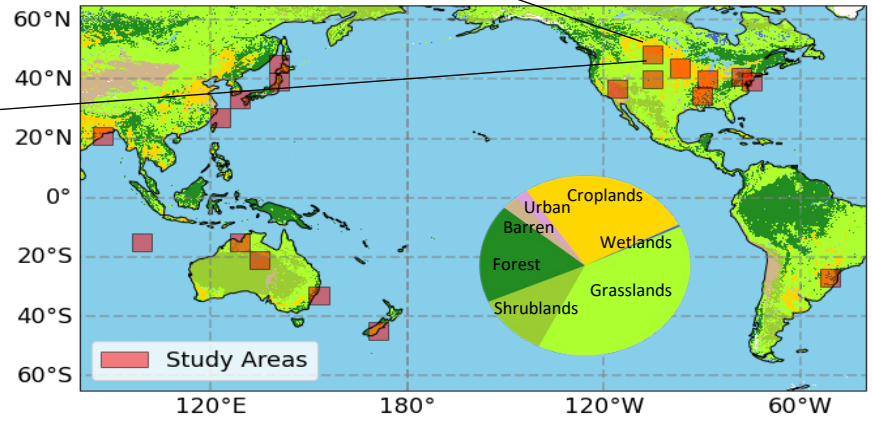
Sky images

30s 1m 15m 3h 6h 24h Several Days

Ultra-short term	Short term	Mid term	Long term
real-time energy dispatch	integrated power systems operation and management	integrated power systems operation and management	power generation, transmission, and distribution scheduling

SolarCube Composition



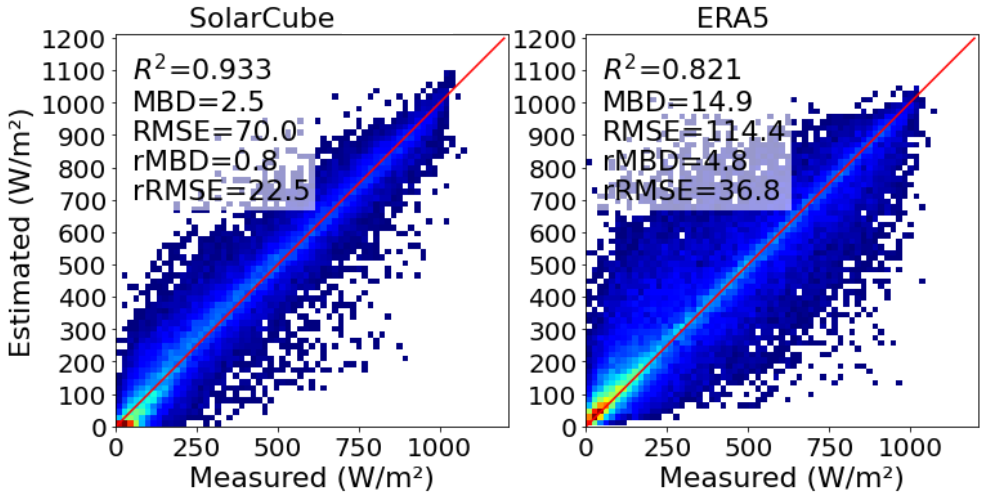


Variable	Source	S. Res.	T. Res.
Area-based variables			
0.47μm visible channel of GOES-16 and Himawari-8 (vis047)	GeoNEX	5km	15min
0.86μm visible channel of GOES-16 and Himawari-8 (vis086)	GeoNEX	5km	15min
13.3μm infrared channel of GOES-16 and Himawari-8 (ir133)	GeoNEX	5km	15min
Solar Zenith Angle (sza)	GeoNEX	5km	15min
Satellited derived Solar Radiation (ssr)	-	5km	15min
Cloud Mask (cm)	NOAA & EUMETSAT NWC SAF	5km	15min
Point-based variables			
Ground-measured solar radiation	SURFRAD, BSRN	point	1min
Land surface types	MODIS	point	static
Elevation	GTOPO30	point	static

Higher accuracy of SolarCube - Physics-derived Solar Radiation data

SOLARCUBE

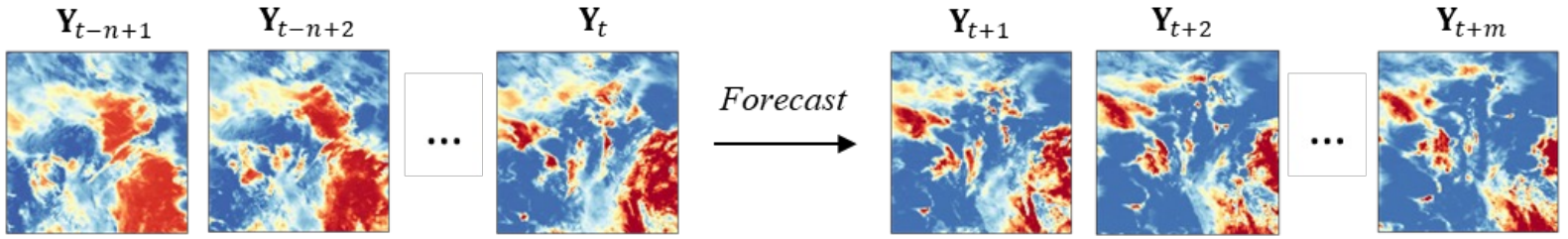
- Used the same algorithm as NASA official products
  - MODIS (MCD18),
  - VIIRS (VNP18),
  - Geostationary Platforms (GeoNEX DSR/PAR)
- First image scale solar radiation data at a 15-minute temporal resolution with high accuracy
- Higher accuracy than ECMWF Reanalysis v5 (ERA5)



Task

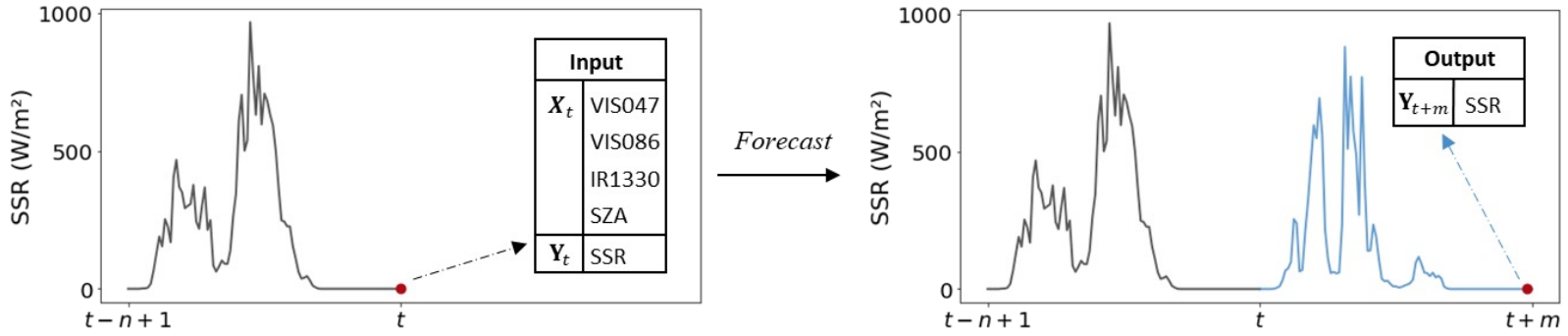
SOLARCUBE

Task 1: Area-based Forecasting



- Short term, time step=12

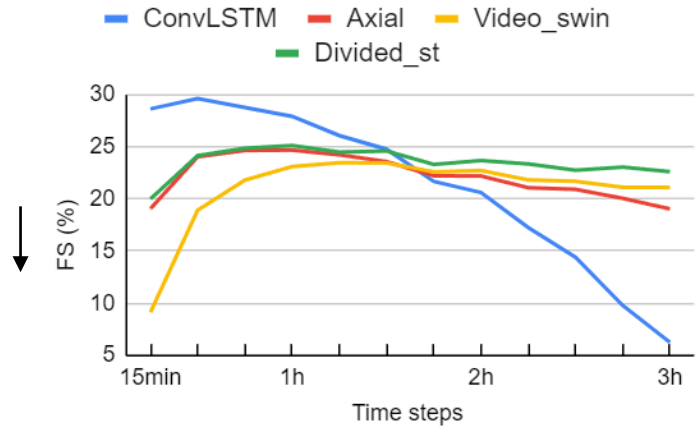
Task 2: Point-based Forecasting



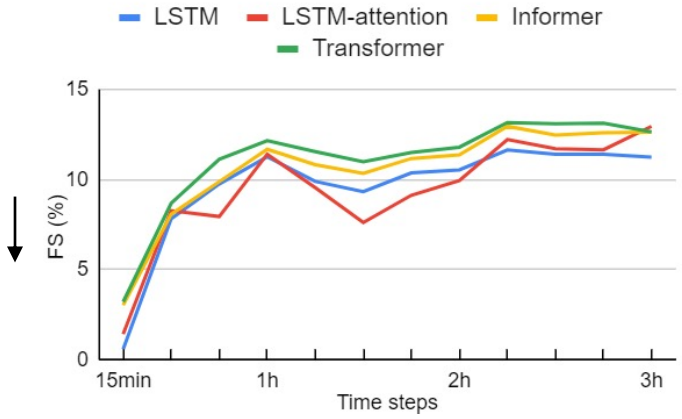
- Short term, time step=12
- Long term, time step=96

Results

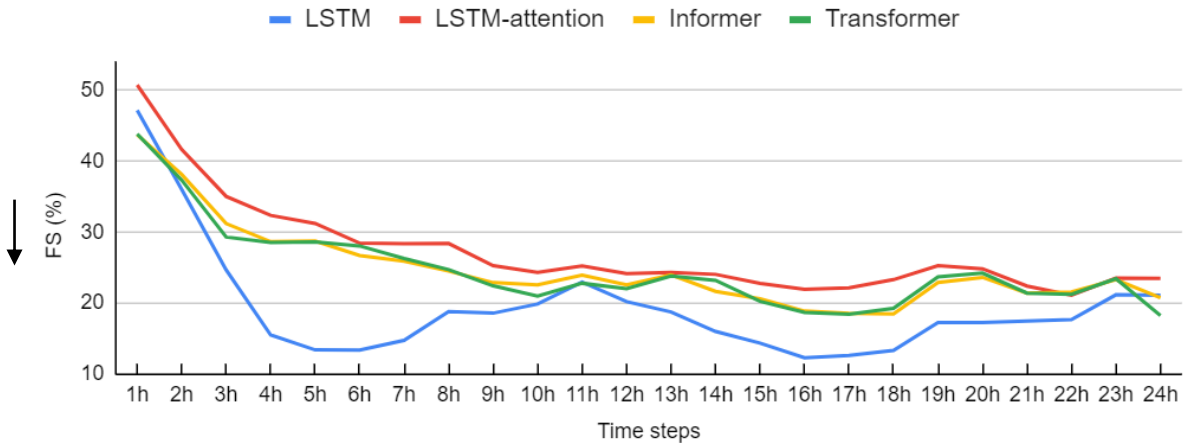
SOLARCUBE



Task1. Area-based short-term forecasting



Task2. Point-based short-term forecasting



Task2. Point-based long-term forecasting

Python package

SOLARCUBE

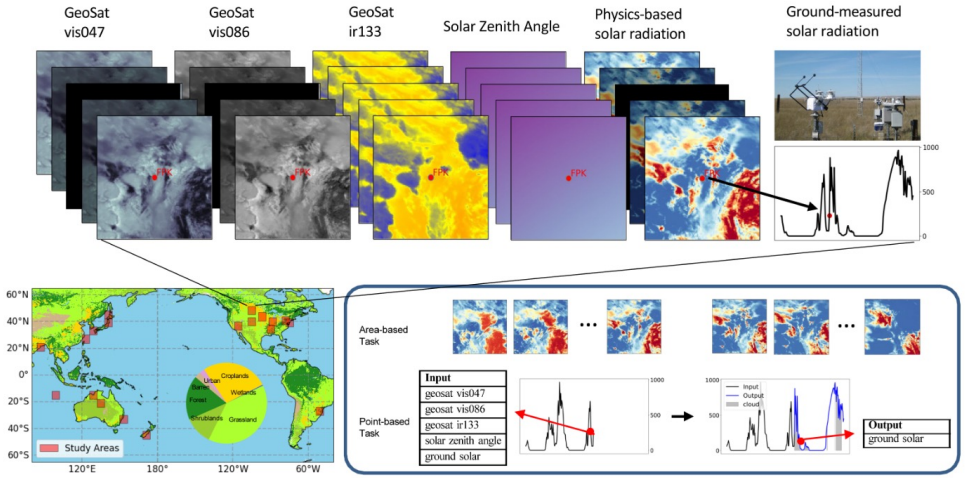
Users can customize

- Input and output variables and types
- Input and output time lengths
- Splitting strategies of training and testing sites

README MIT license

SolarCube

The SolarCube dataset is a collection of temporally and spatially aligned image-based satellite data and point-based insitu data for solar energy forecasting.



This repo contains some code and examples for working with the SolarCube dataset.

- Viewing some samples of SolarCube
- Data Loader of SolarCube
- Data Generator of SolarCube

https://github.com/Ruohan-Li/SolarCube

Why SolarCube?

- First-of-its-kind dataset

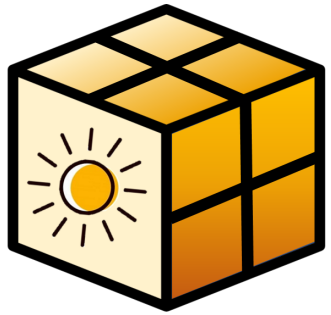
Multi-source, high-resolution, near-global coverage for solar energy forecasting

- Versatile applications

Supports point-based, image-based, and multi-modal forecasting tasks

- User-friendly tools

Includes a Python package for seamless integration and ease of use.



SOLARCUBE

Data: https://doi.org/10.5281/zenodo.11498739
Code: https://github.com/Ruohan-Li/SolarCube