RESOURCE &TECH

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Solar Data Measurements: Quality Control, Visualization, and Gap Filling

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BACKGROUND

In the field of solar data measurements, various errors might arise, such as sensor malfunctions, maintenance downtime, shading, and soiling, which can contribute to potential uncertainties in resource assessment. To address this, a quality control procedure needs to be implemented to exclude invalid data. Once quality control is conducted, invalid data should be removed, and gap-filling techniques need to be implemented to provide clients with complete and accurate data ready for analysis.

OBJECTIVE

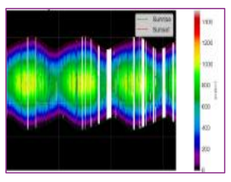
The development and implementation of a quality control procedure for solar irradiance measurements, involving:

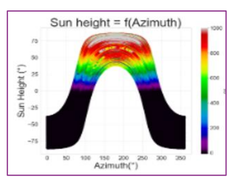
- **Quality control→** A series of automated quality control tests outputting flags for invalid data.
- **Visualization→** A set of auto-generated reports describing data quality and the use of satellite data to re-check data quality.
- **Gap Filling→** Dealing with data gaps, whether due to downtime periods or data flagged as invalid.

METHODS

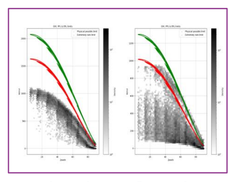
- The solar database is collected through VAISALA's data and scraping through open data sites.
- Sunrise time, sunset time, clear sky values, solar azimuth and solar zenith angles are calculated from the location of the site to be used for quality controlling data.
- Functions are created to generate pdf reports once the quality control procedure is done.

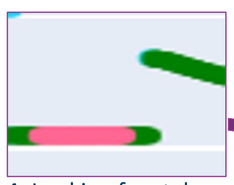
DATA QUALITY CONTROL

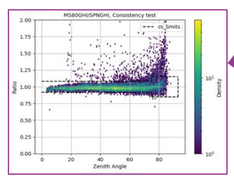

1. Detecting sunrise/sunset



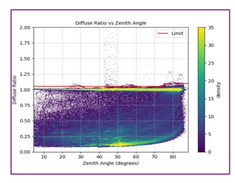
2. Isolating night data


3. Checking for physical possible limits

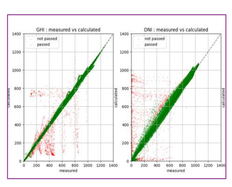

4. Looking for stale periods



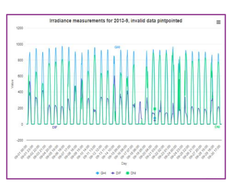
5. Checking for consistency between duplicate measurements



6. Checking for the two-component test limits



7. Checking for BSRN closure limits

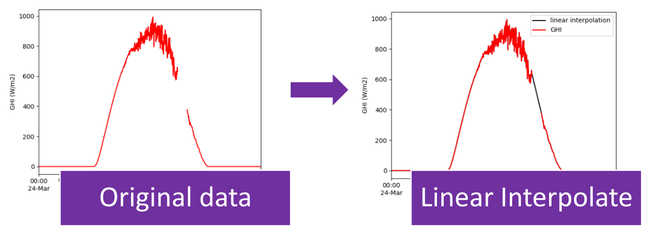


8. Selecting the remaining valid data

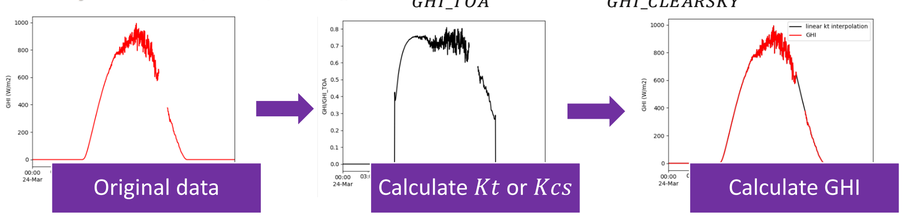
GAP FILLING TECHNIQUES

Four Non-satellite based methods:

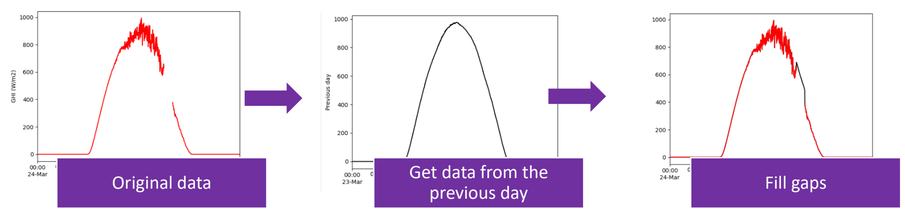
1. Linearly Interpolating GHI



2/3. Linearly Interpolating kt $= \frac{GHI}{GHI\_TOA}$ or Kcs $= \frac{GHI}{GHI\_CLEARSKY}$

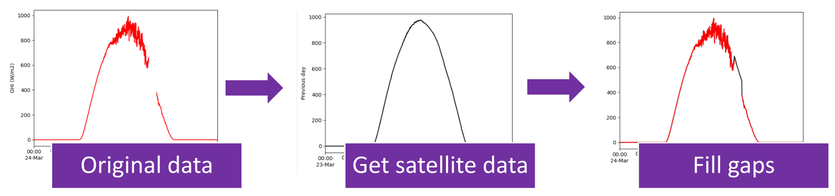


4. Gap filling with next/previous day

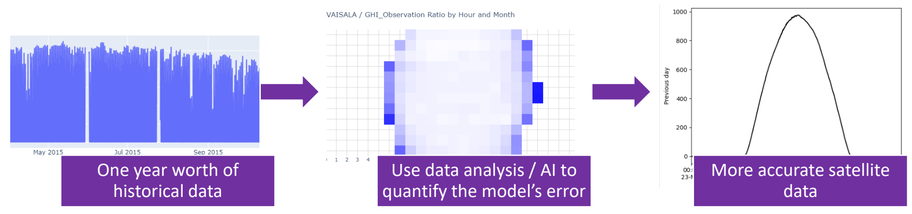


Four satellite based methods:

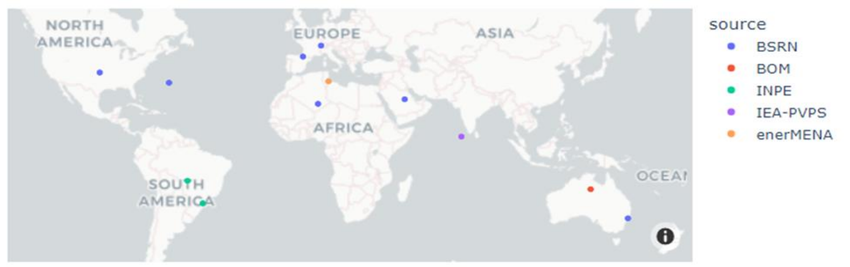
1. Gap filling with raw satellite data



2-4. Gap filling with satellite data enhanced (Three approaches)



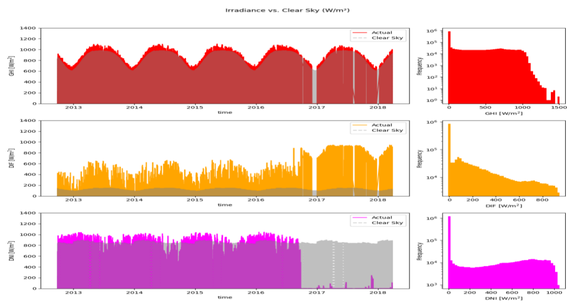
12 Sites selected for the study:

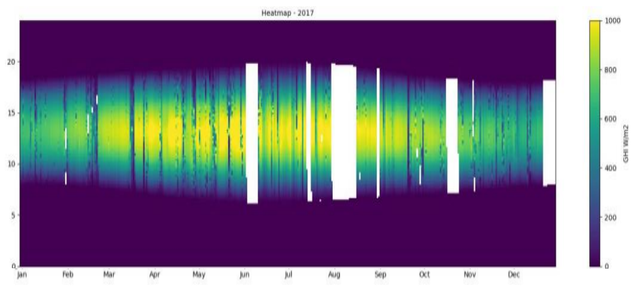


	Gaps smaller than an hour	Gaps bigger than an hour
Most accurate method, for 12 sites average	Interpolating $\frac{GHI}{GHI\_TOA}$ MAE from 0 to 11%	Gap filling Satellite data enhanced MAE 11% MBE 1%

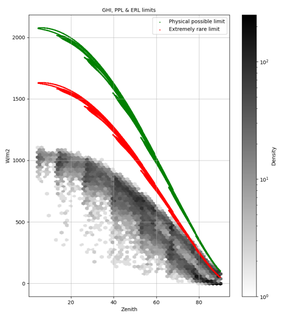
DATA VISUALIZATION

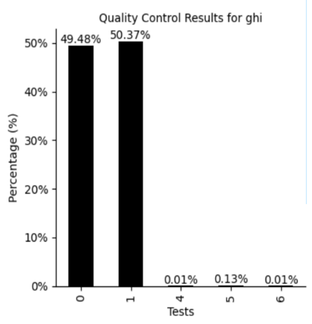
Raw data analysis

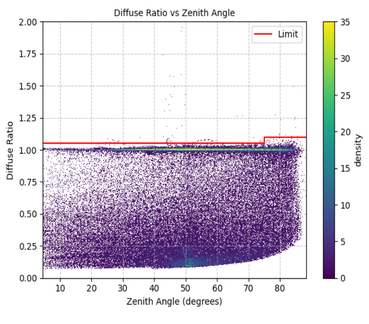


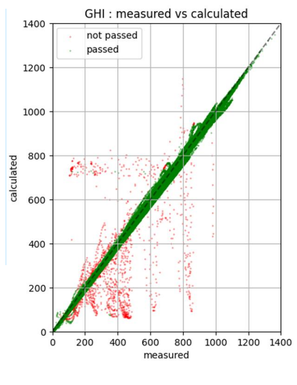


Quality control results analysis

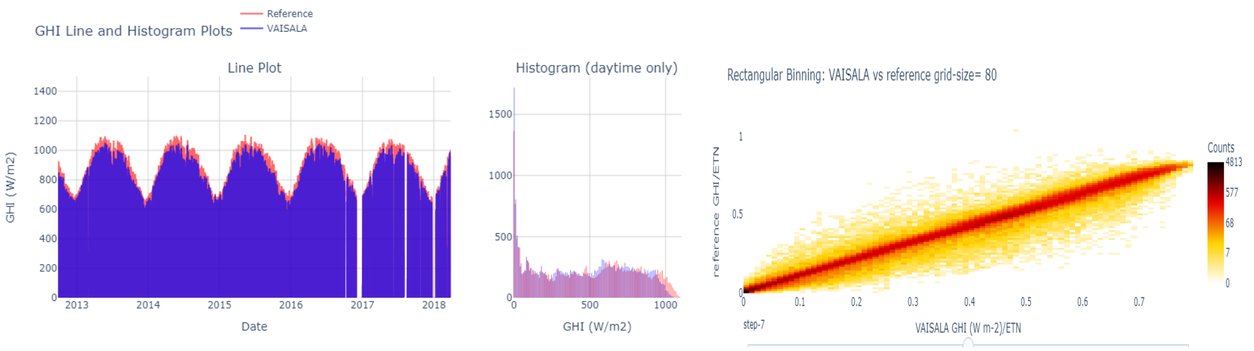








Satellite model comparison



TAKEAWAYS

- Procedure Performed on 2500+ measurements sites.
- Consistency errors detected even for high quality sites, mostly due to the difficulty of accurately measuring DNI.
- Errors in data can still be present after automated quality control but can be detected via the different generated reports.
- The consistency of satellite models can be helpful for shading, soiling and outliers' detection.

CONCLUSION

- The accuracy of gap filling techniques are dependent on the size of the gap and the location of the site.
  - Enhancing satellite models with different AI models produced similar results.
  - Easier to fill gaps on clear sky periods.
  - Difficulty in calculating DNI when based on GHI and DIF
- Usage of quality-controlled data for MOS correction/ satellite models validation.

VAISALA

REFERENCES

1 C. N. Long and E. G. Dutton. BSRN Global Network recommended QC tests
2. A. Bryan, J. Peterson and J. Chard. Gap Filling Ground Measurements of Solar Irradiance. May 2020.
3. R. Jensen, and . Yves-Marie Saint-Drenan. Assessing Solar. May 2020.

CONTACT INFORMATION

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