**Introduction to Satellite-Based Solar Resource Models (SRMs)**

- **TM2**
  - By NREL National Solar Radiation Database (NSRDB)
  - Hourly data from 1980 stations (NSRDB primary measured & 183 secondary modeled), 1961-1990
  - Based on Sando National Laboratory method created in 1985
  - New method that created the 1961-1990 SOLMET/SOLERZ database (TM2), with modifications

- **TM3**
  - By NREL National Solar Radiation Database (NSRDB)
  - Hourly data from 1020 stations (NSRDB primary measured & 183 secondary modeled), 1980-2006
  - Based on Sando National Laboratory method created in 1985
  - New method that created the 1981-2006 SOLERZ/TM3 database (TM3), with modifications

- **Meteonorm**
  - Version 7.1.5-7.1.9
  - Various spatial and temporal resolutions, 1981-1990 and 1999-2010
  - Data source: GSE (GPM), ADO from Solar Consulting Service
  - Siedel’s Gravity 3.0 inverse Distance interpolation amongst nearest stations, coupled with MODIS satellite data or ERA5 reanalysis data that uses Meteosat method

**3TIER 1.0 Dataset**
- 3x1 km spatial, hourly temporal resolution, 1997-2018
- Data source: GSE, MODIS Terra, Dally AOD 450nm
- Modified Keenan CleanSky Radiation Model

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**3TIER 1.2 Dataset**
- 3x1 km spatial, hourly temporal resolution, 1997-2018
- Data source: GSE, MODIS Terra, AOD 550nm
- Modified Keenan CleanSky Radiation Model

**3TIER 2.0 Dataset**
- 3x1 km spatial, hourly temporal resolution, 1997-2018
- Data source: GSE, EOL, Dally AOD 450nm
- REST2 CleanSky Radiation Model

**3TIER 2.1 Dataset**
- 3x1 km spatial, hourly temporal resolution, 1997-2018
- Data source: GSE, EOL, Dally AOD 550nm
- REST2 CleanSky Radiation Model

**SolarGIS**
- Version 2.1.3
- 6x km spatial, 30min temporal resolution, 1988-2018
- Data source: GSE, MODIS, MAC, Meteosat, EOL, FSRI, CFSR, GFS, etc.
- SOLIS CleanSky Radiation Model

**SolarAnywhere**
- Version 2.1, by Clean Power Research
- 10x10 km spatial, hourly temporal resolution, 1990-2018
- Data source: GSE in conjunction with various meteorological sources
- Enhanced Perez SUNY v1.0 CleanSky Radiation Model

**Physical Solar Model (PSM)**
- Version 3.3.2, by NREL National Solar Radiation Database (NSRDB)
- 6x km spatial, 30 min temporal resolution, 1997-2018
- Data source: GSE, MODIS, MIRAS
- FARMSA/AS3 Sky Radiation Model, coupled with REST2 CleanSky Radiation Model
- PAMOSx Cloud Properties

**Characteristics of Selected Sites**

**Site 1: Central California**
- Average GHI across 55km: 1730 kWh/m²
- Annual AOD across 55km: 0.01
- Mean GHI: 2330 kWh/m²
- SolarAnywhere: 2380 kWh/m²
- SolarGIS: 2300 kWh/m²
- 3TIER: 2290 kWh/m²
- Meteonorm: 2300 kWh/m²
- ClearSky: 2300 kWh/m²

**Site 2: Central Mississippi**
- Average GHI across 55km: 1560 kWh/m²
- Annual AOD across 55km: 0.01
- Mean GHI: 2130 kWh/m²
- SolarAnywhere: 2050 kWh/m²
- SolarGIS: 2050 kWh/m²
- 3TIER: 2050 kWh/m²
- Meteonorm: 2100 kWh/m²
- ClearSky: 2100 kWh/m²

**Site 3: Eastern Indiana**
- Average GHI across 55km: 1420 kWh/m²
- Annual AOD across 55km: 0.01
- Mean GHI: 1880 kWh/m²
- SolarAnywhere: 1760 kWh/m²
- SolarGIS: 1760 kWh/m²
- 3TIER: 1760 kWh/m²
- Meteonorm: 1760 kWh/m²
- ClearSky: 1760 kWh/m²

**Monthly GHI & DNI of Selected Sites**

- **Site 1: Central California**
- **Site 2: Central Mississippi**
- **Site 3: Eastern Indiana**

**After-Tax IRR vs DC/AC Ratios – Cont.**

**DNI GHI Impacts on Energy Production**

- DNI is more directly related to energy production than GHI, as reflected by larger R² coefficients for single-axis tracker systems.
- This further indicates that selecting SRMs should pay particular attention to DNI in addition to GHI.

**SRM Impact on Project Economics**

- **NPV ($/Wp)** of Optimized Designs vs DNI

**Key Takeaways / Summary**

- Accurate evaluating solar resource models (SRMs) is of paramount importance to both design optimization and economics.
- Project design in terms of optimal DC/AC ratio is strongly dependent on SRMs; higher irradiance in general enables designing at lower DC/AC ratio, and consequently better economics, e.g., higher IRR and NPV.
- Example site with high variations in DNI across SRMs (at Central Mississippi, 8.47% Coefficient of Variance), a 24.15% increase in DNI results in a 36.56% increase in NPV, which represents roughly $0.09/Wp difference. This means $9 Million difference for a 100MWp project!!
- DNI is more directly related to energy production, esp. for single-axis tracker systems, therefore SRM selection should pay particular attention to DNI, in addition to GHI.
- False SRM selection (as a result of such as merely looking at GHI alone, improperly averaging/balancing SRMs, etc.) could lead to false optimization on higher or lower DC/AC ratios with lower or higher project economics, respectively.