Determination of the Historical Solar Resource for any Latitude – Longitude location in Florida

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Why Is This Important?

- Solar Resource Values are needed to predict long term solar equipment performance and energy delivery.
- Historical Data unavailable for many remote sites and sites where potential microclimates may mediate more generalized predictions.
Methodology

- From the Heliostat-2 Method developed in Europe in the 1990’s.
- Hypothesis: The lightness of each satellite pixel correlates to cloudiness and thus negatively correlates to solar energy reaching the ground.
- Instead of Heliostat-2 photos, utilized 11 years of archived NOAA weather satellite photos from 2000 thru 2010.
Sample NOAA Weather Satellite Photo
- Latitude-Longitude values developed for each pixel.
- Normalized Clearness index (X) calculated for each pixel via:
  \[ X = \frac{\text{max} - t}{\text{max} - \text{min}} \]
  Where \( t \) = gray scale table value from each picture’s pixels.
  \( \text{min} = \min \) (darkest) recorded value
  \( \text{max} = \) value for white
Finding the Correlation

- Laws of atmospheric scattering suggest that the form should be represented by a negative exponential:

\[ \text{Hd} = \text{Hc} \left( a + b e^{X/c} \right) \]

Where:
- \( \text{Hd} \) = measured direct beam
- \( \text{Hc} \) = calculated clear sky ground value
- \( a, b \) and \( c \) are calibration coefficients
- \( X \) is the normalized clearness value, or \( \text{Hd}/\text{Hc} = a + b e^{X/c} \)
Direct Beam Measured vs. Cleanness Index

$r^2 = 0.784233407$ FitStdErr = 0.139924327 Fstat = 334.386674

Rank 28 Eqn 8002 \( y = a + b \exp(-x/c) \) (Exponential)

\( a = -0.038939148 \) \( b = 1.0686478 \)

\( c = 0.31503295 \)
Correlations Used To Create:

- Hourly values for each day of the 11 years were added for daily totals.
- Daily values were averaged to provide monthly values over 11 yrs.
- Monthly values were averaged to provide annual average values.
- All values matrix formatted such that tables could be produced from lat-long inputs to an excel file.
Florida Solar Atlas

- Data Table Values for Monthly Average Data and Annual Average Data Were Converted into Color Tables and Inserted onto the original bitmapped picture file.
- 26 color plates were produced representing Direct Global radiation for each month and annual average and Direct Beam radiation for each month and annual average.
Global Direct - April
Global Direct - June
Global Direct - August
Global Direct - November
Global Direct - December
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