### Solar Resource Mapping in South Africa

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## Outline

- The Sun and Solar Radiation
- Datasets for various technologies
- Tools for Solar Resource Mapping
- Maps for South Africa
- Example of a Potential Assessment



#### THE SUN

- Distance from earth: 150 x 10<sup>6</sup> km
- Diameter: 1.39 x 10<sup>6</sup> km
- Surface temperature: ~5500 °C
- Age: around 4.6 billion years

### Effects of the atmosphere on solar radiation







### **Causes of Variability in Solar Radiation**

- Day/Night
- Seasons
- Weather
- Local Air Pollution
- Distance Earth-Sun (6.6%)
- Solar activity (1%)
  - Sun spots
- Climate Change
  - Global Warming
  - Global dimming
- El Niño







### Radiation data for solar energy technologies

Global irradiation = Direct irradiation + Diffuse irradiation

Category	Schematic	Applications		
Direct normal irradiation DNI		<ul> <li>Concentrating Solar Thermal Power</li> <li>Concentrating PV</li> <li>Tracking PV</li> </ul>		
Global horizontal irradiation GHI		<ul> <li>Horizontal collectors</li> <li>(Agriculture)</li> </ul>		
Latitude tilt irradiation LTI		<ul> <li>Fixed PV</li> <li>Solar water heaters</li> </ul>		

### **Ground Measurements**

Campbell-Stokes recorder



- Most common device
- Simple
- Only records sunshine hours

### Solar radiation sensors

#### **Global radiation**



Pyranometer

- Thermopile
- Accuracy ±3% (daily sums)
- Slow response (>15s)

### Solar radiation sensors

#### **Diffuse radiation**



- Either tracker or shadowring required
- Tracker is expensive
- Use of shadowring necessitates correction function

### Solar radiation sensors

#### **Direct radiation**



Pyrheliometer

- Best accuracy for direct radiation measurements
- Shorter response time (5s)
- Tracker is expensive

### Weather Stations in Different Regions



- with solar radiation measurement
- without solar radiation measurement



### Example for hourly data



### **Ground Measurements**

#### Summary

- Most accurate option
- Expensive
- High maintenance
- Time consuming
- Few stations in South Africa







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#### Method

- Same images as for weather forecast can be used
- Extensive databases are available
- Data over longer time periods are available (20 years)



#### Method



Example



#### Summary

- Fairly accurate Break even of accuracy with ground measurement interpolation: 25-50 km
- Relatively cheap and quick
- Spatial and temporal resolution high enough for site evaluation
- Data over longer time periods are available (20 years)
- Only low resolution datasets have been created for SA

## Solar Maps for SA

#### **Based on Ground Measurements**

- A solar radiation data handbook for Southern Africa (1990)
- South African Renewable Energy Resource Database – Annual Solar Radiation – CSIR, ESKOM, DME (1999)

#### **Based on Satellite Data**

- SWERA Solar resource data for Africa (2006) –
- NASA: Surface meteorology and Solar Energy (2008)
- PVGIS (2007)

#### Based on Satellite Data and Ground Measurements

• Meteonorm 6.1 (2009)









Photovoltaic Solar Electricity Potential in the Mediterranean Basin, Africa, and Southwest Asia

### **Comparison of Data Sets**





# Example Application – Potential Assessment for Concentrating Solar Power in SA

#### **Exclusion Criteria:**



# Example Application – Potential Assessment for Concentrating Solar Power in SA

#### **Exclusion Criteria:**



#### Proximity to Transmission



# Example Application – Potential Assessment for Concentrating Solar Power in SA

Results:		NC	FS	WC	EC
	Total Potential per Province [GWe]	510.3	25.3	10.5	1.6



Detailed map available at www.crses.sun.ac.za

### **Recommendation to Developers**

#### **Small installations**

- Use various datasets
- Track new releases
- Measure solar radiation

#### Large installations

- Use available datasets to detect priority areas
- Order higher resolution data for promising sites
- Measure on most promising sites

### Conclusions

- Several solar resource maps are available for SA
- Accuracy and resolution of publicly available data could be improved
- Satellite derived data present a good option to improve the quality of the available data
- More ground measurements are necessary

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