



**STEPS**

**Solar Energy Symposium  
Nicosia, September 2001**

**Assessment of Solar Energy Resources and Sites  
by Satellite Remote Sensing Technology**

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)  
Institute of Technical Thermodynamics

Dr. Franz Trieb





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**E**xpert System for

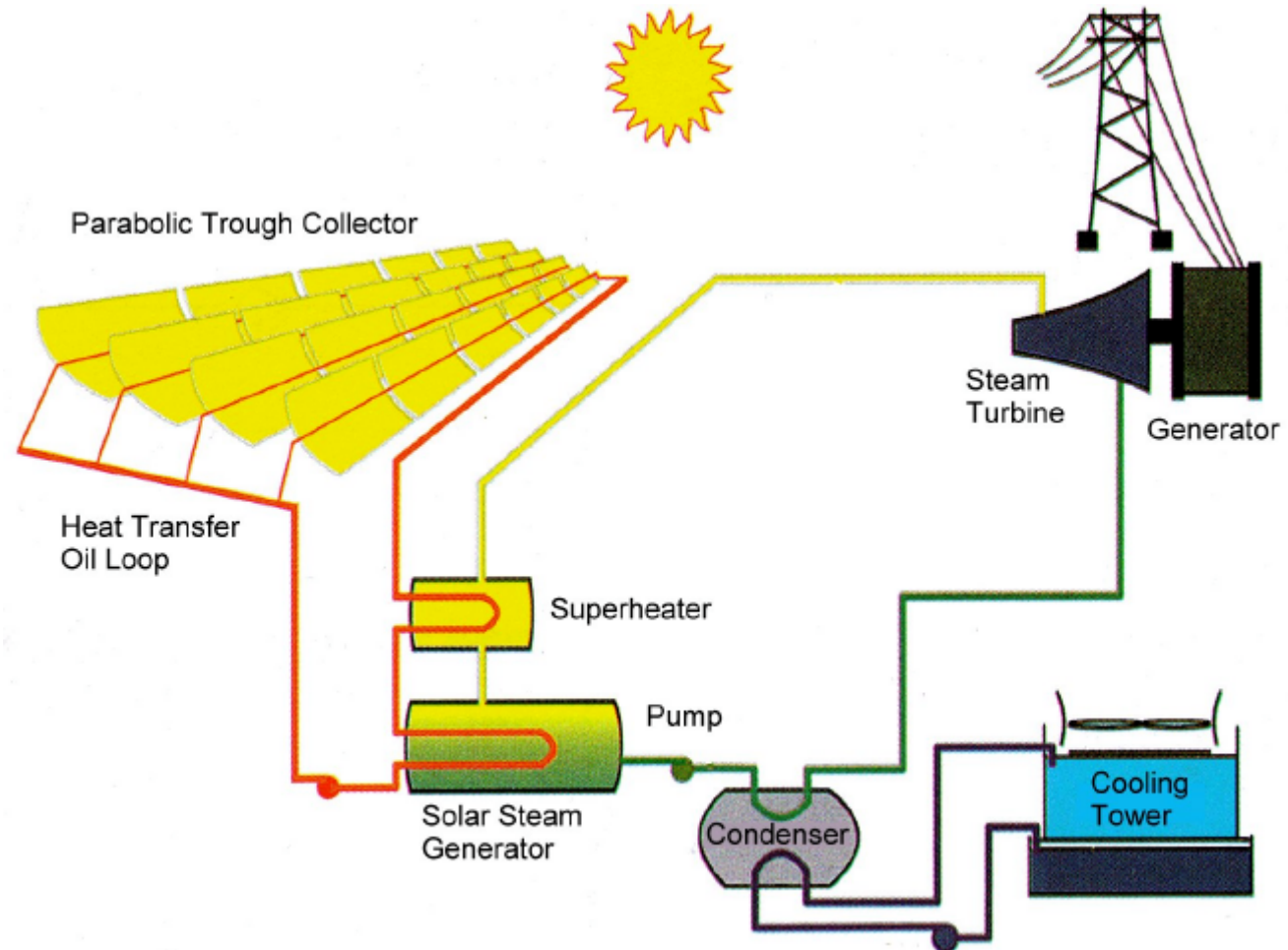
**S**olar **T**hermal **P**ower **S**tations

- Solar Thermal Power Stations
- Solar Radiation Resource Assessment
- Site Qualification
- Site Ranking by Technical and Economic Performance
- Applications



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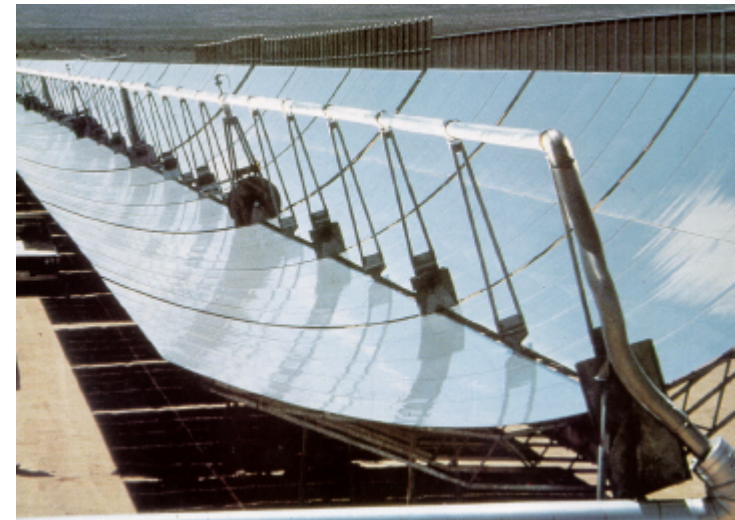
## Solar Thermal Power Stations



Principle of Solar Thermal Electricity Generation

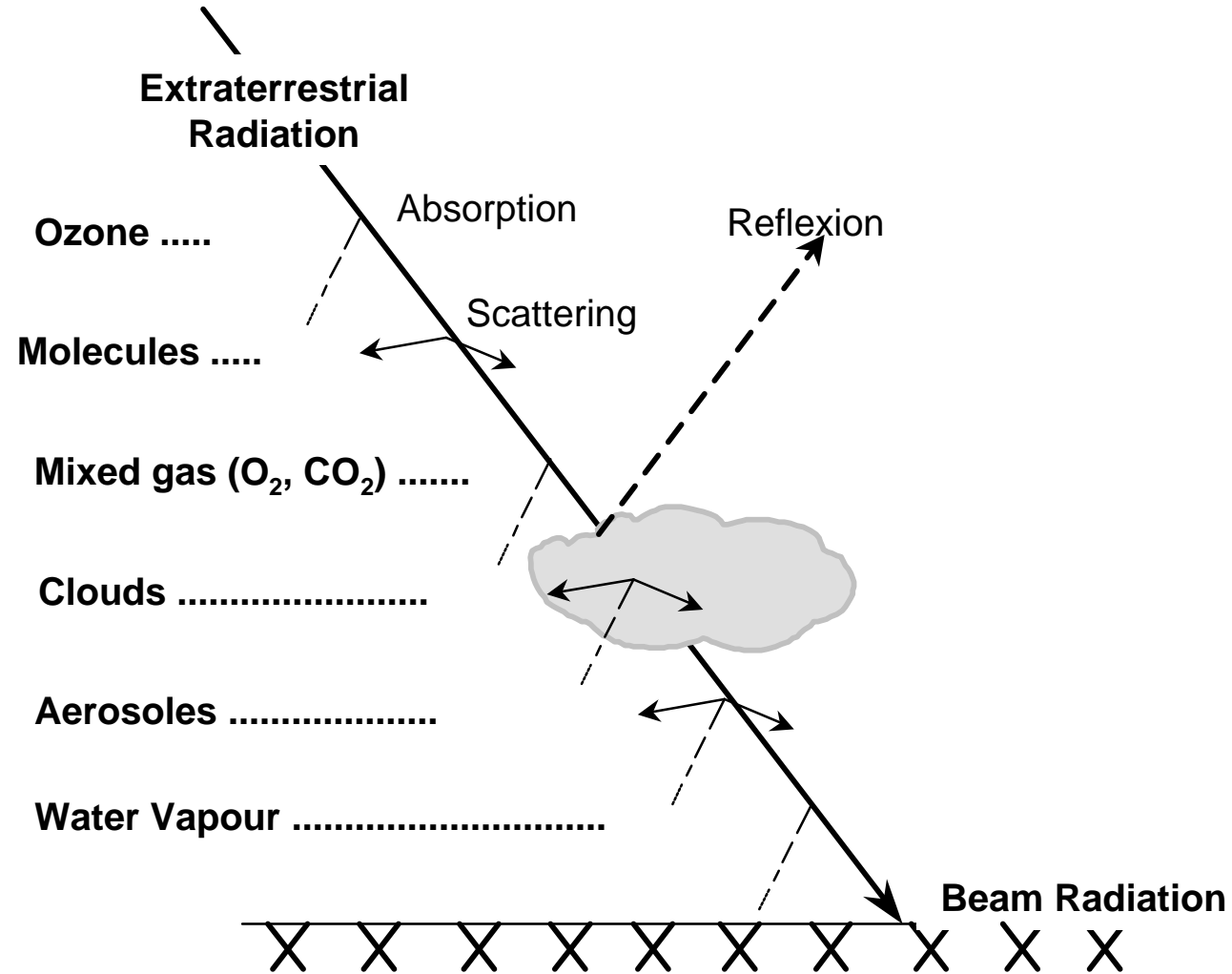


## Solar Thermal Power Stations



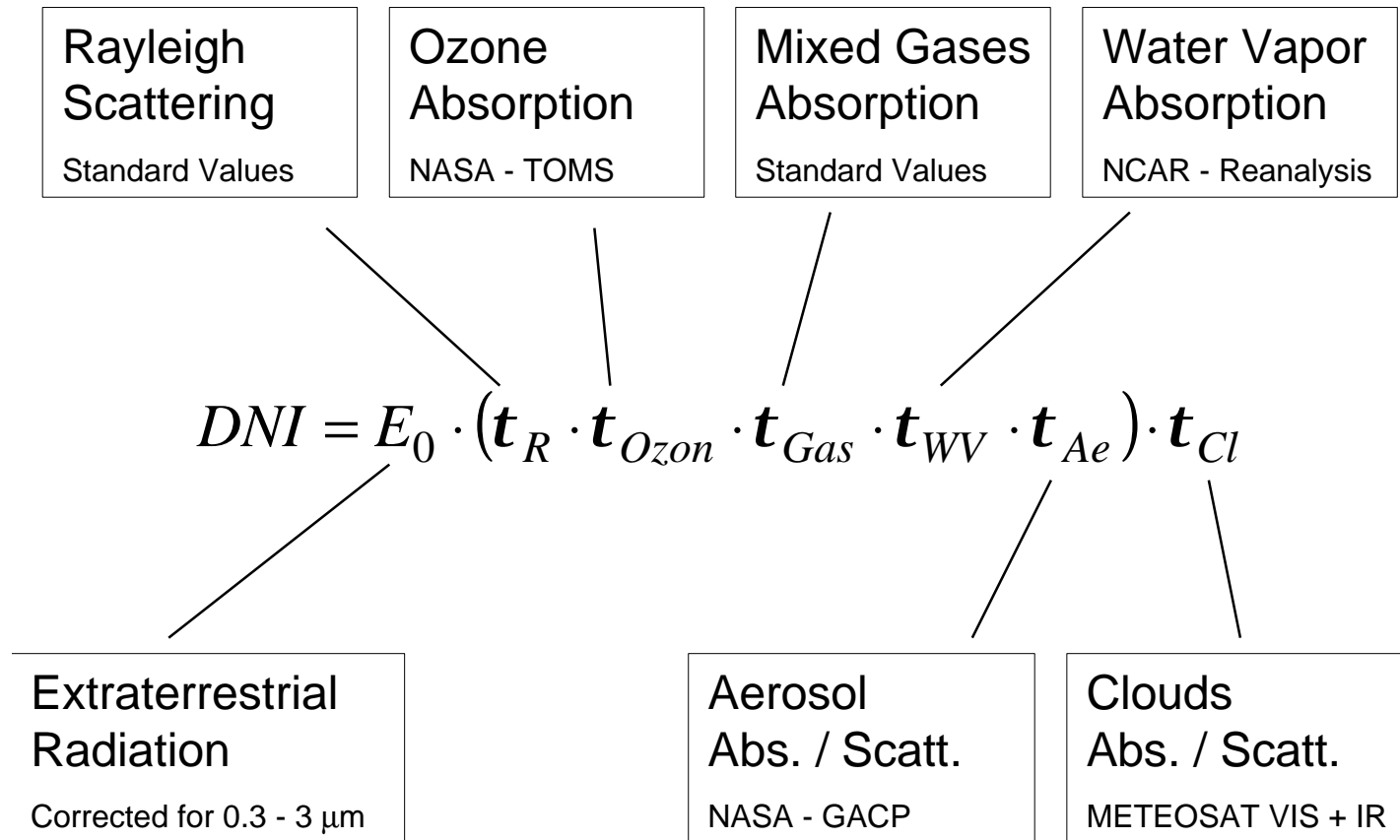
**5 x 30 MWe Solar Electricity Generating System in California**

# Solar Radiation Resource Assessment



Influence of atmospheric parameters

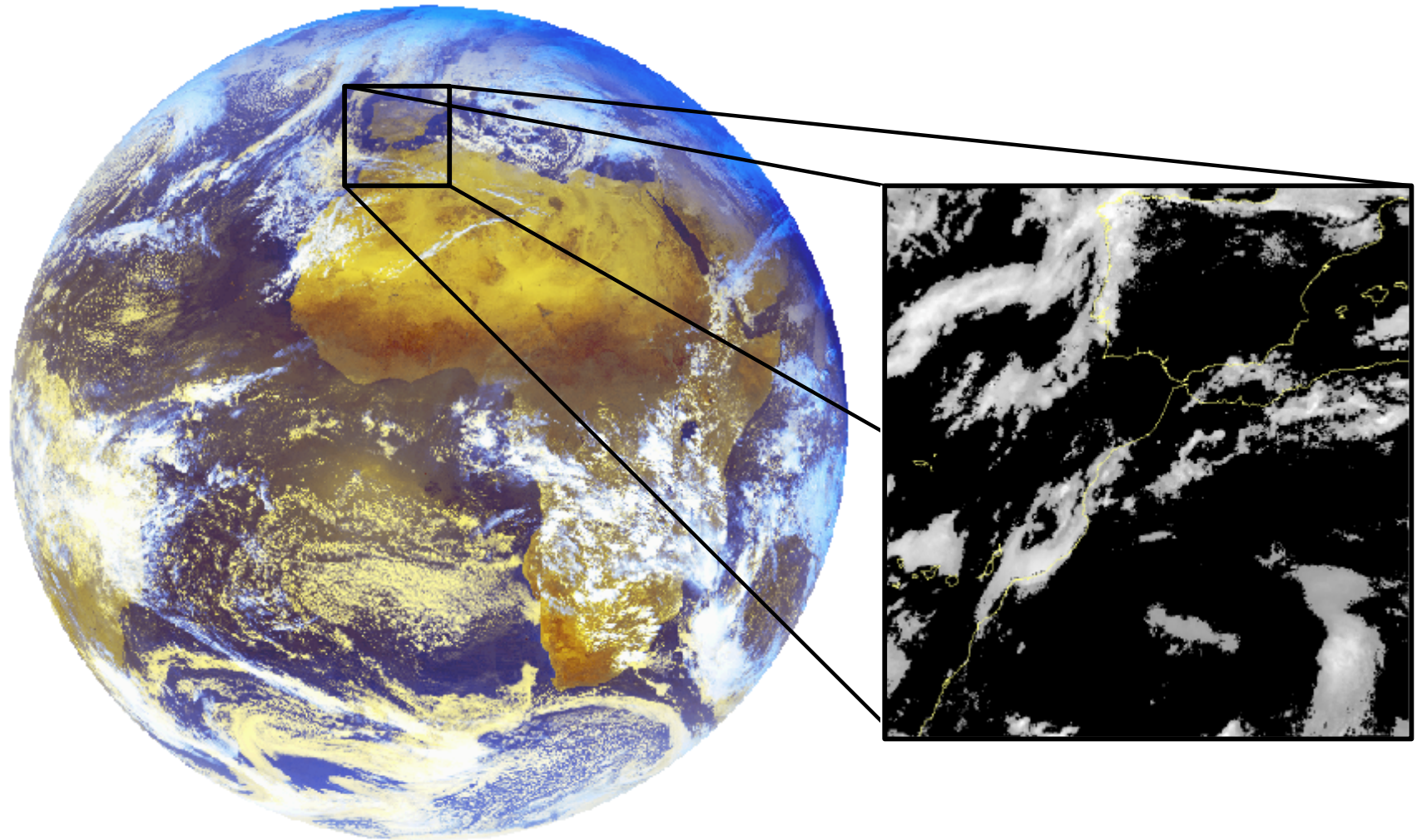
## Solar Radiation Resource Assessment



**Model of the Atmospheric Transmittance to calculate Direct Normal Irradiation on the Ground**

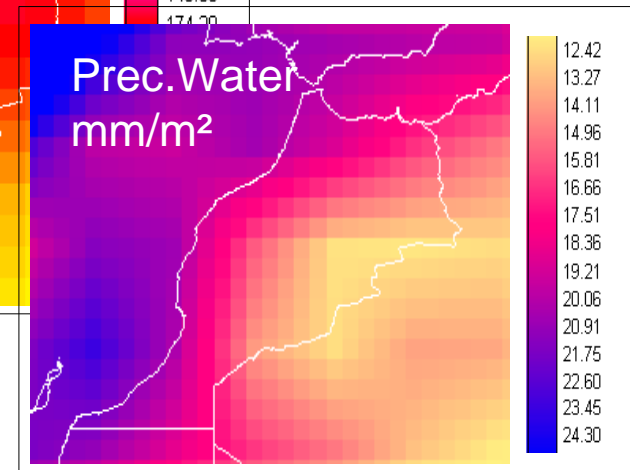
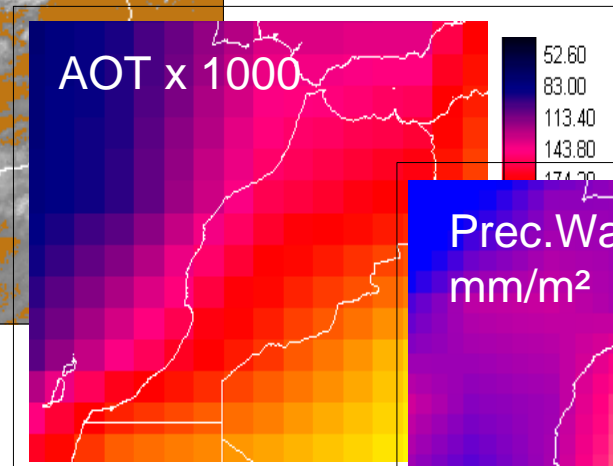
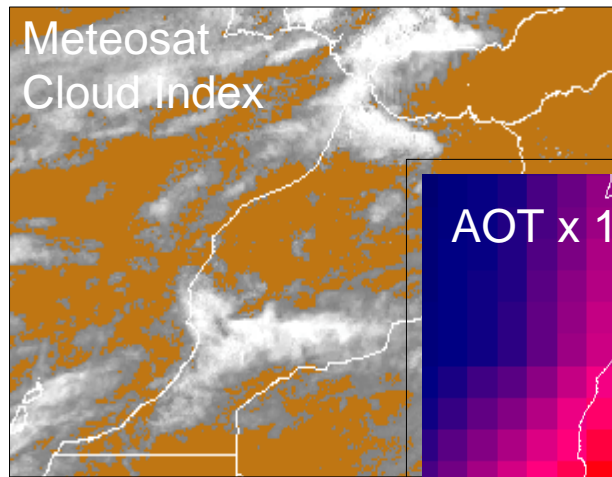
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## Solar Radiation Resource Assessment



**Cloud Index from half-hourly METEOSAT-Images**

## Solar Radiation Resource Assessment

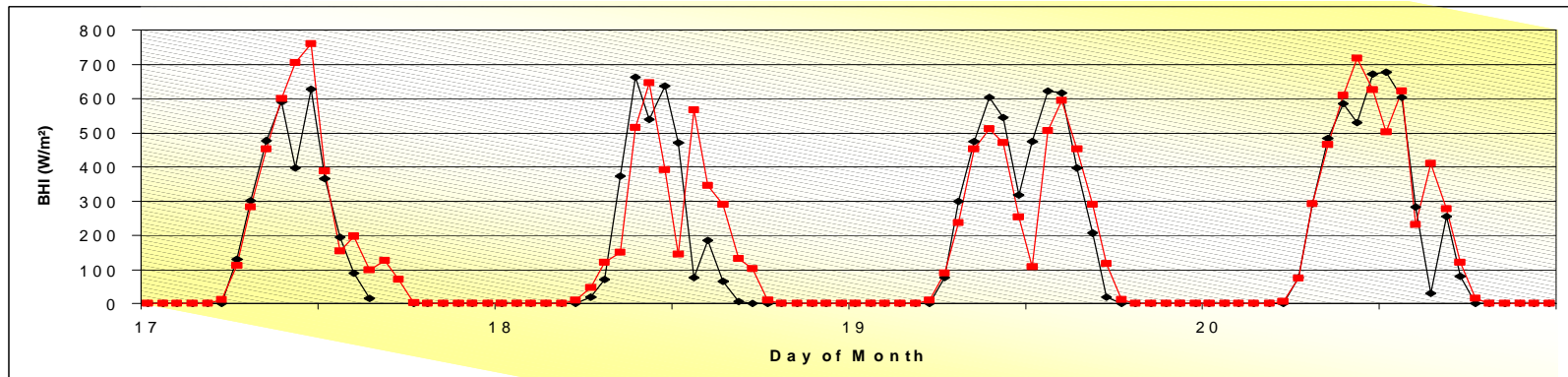
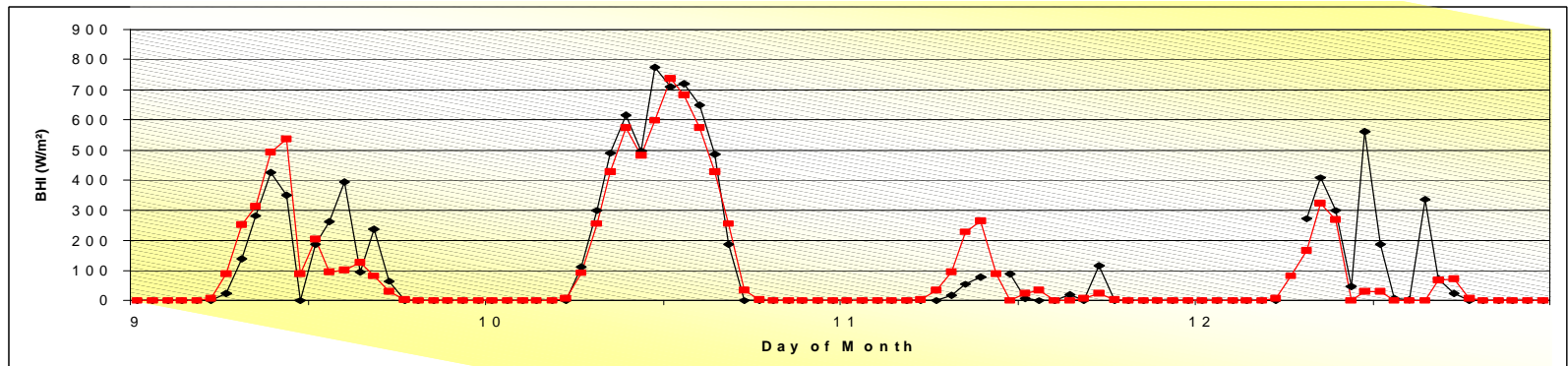


**Mapping and combination of atmospheric parameters obtained from satellite remote sensing**

# Solar Radiation Resource Assessment

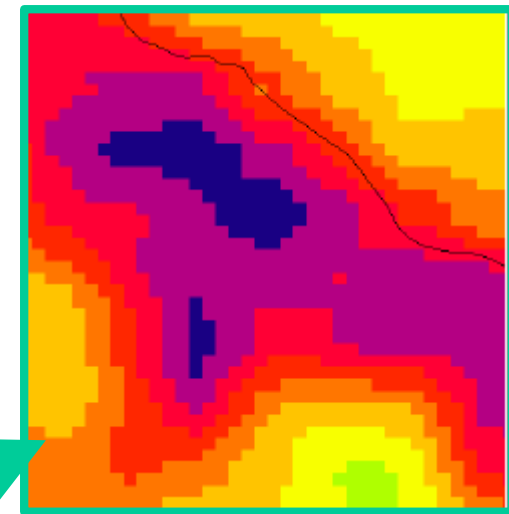
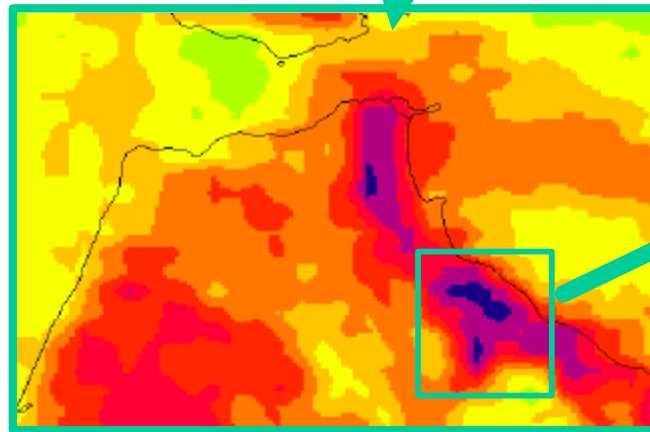
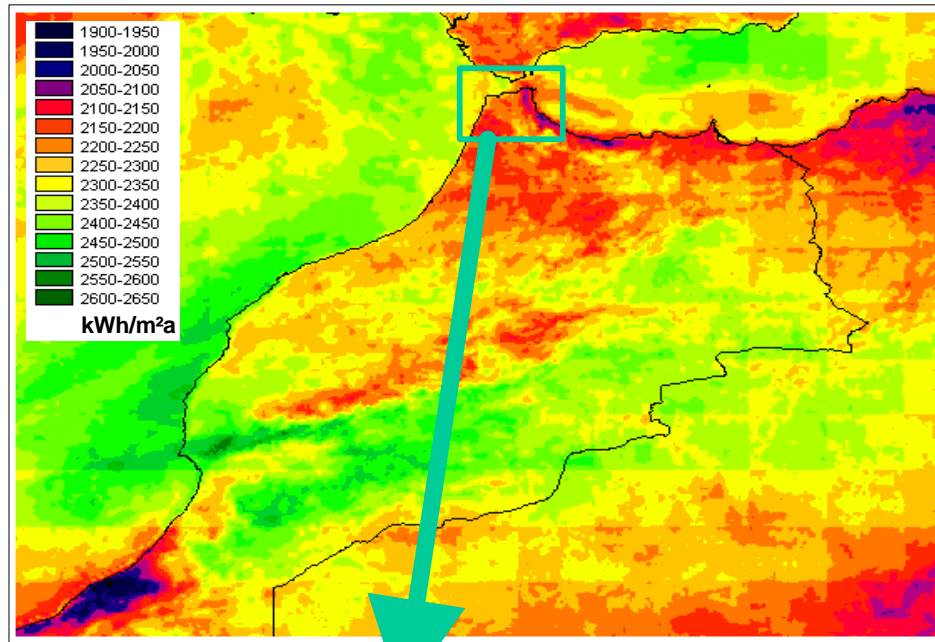
## Beam Horizontal Irradiation Girona, Spain, April 1998

—◆— ground measured  
—■— remote sensing



Relative average deviation of hourly, daily, monthly and yearly sums  
= 35 % (h), 26 % (d), 11 % (m), 4 % (y)

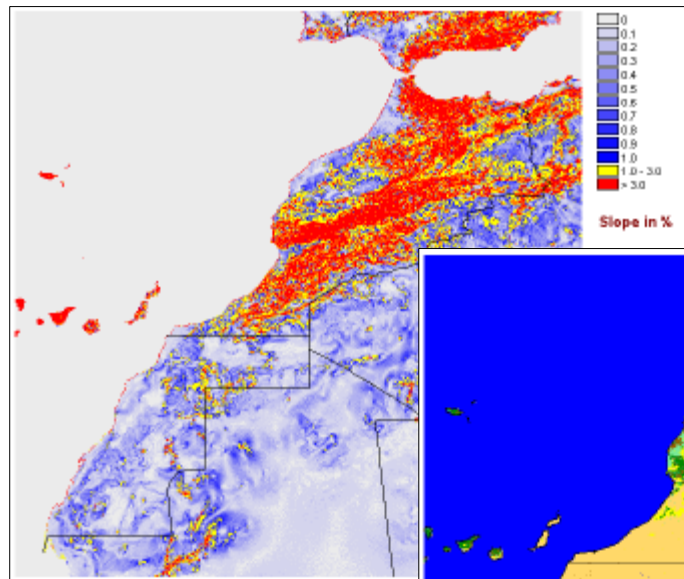
# Solar Radiation Resource Assessment



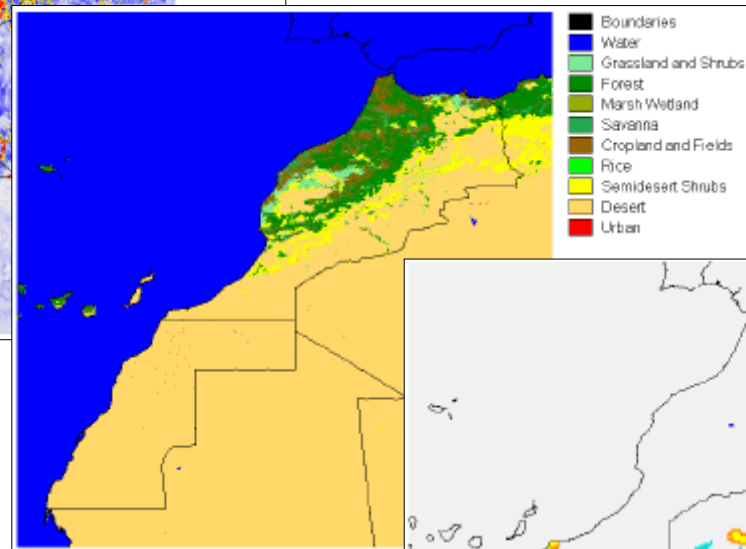
Annual Sum of Direct Normal Irradiation in Morocco (1998)

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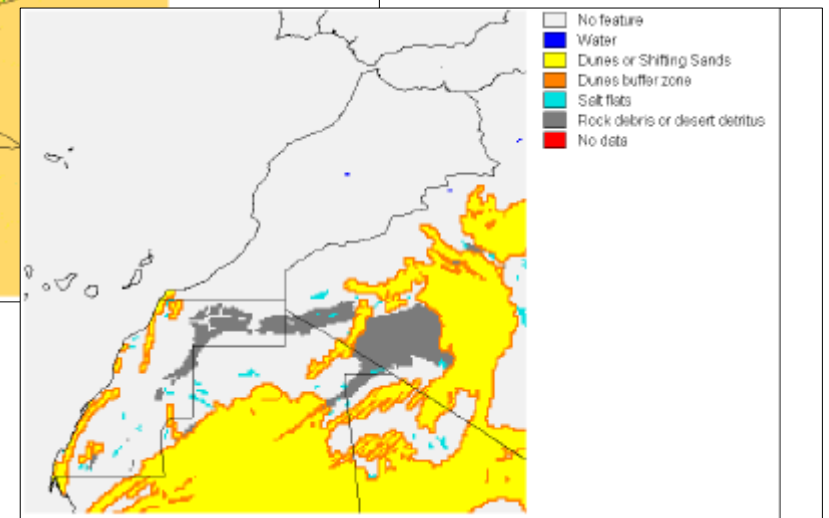
## Site Qualification



Slope



Land Use

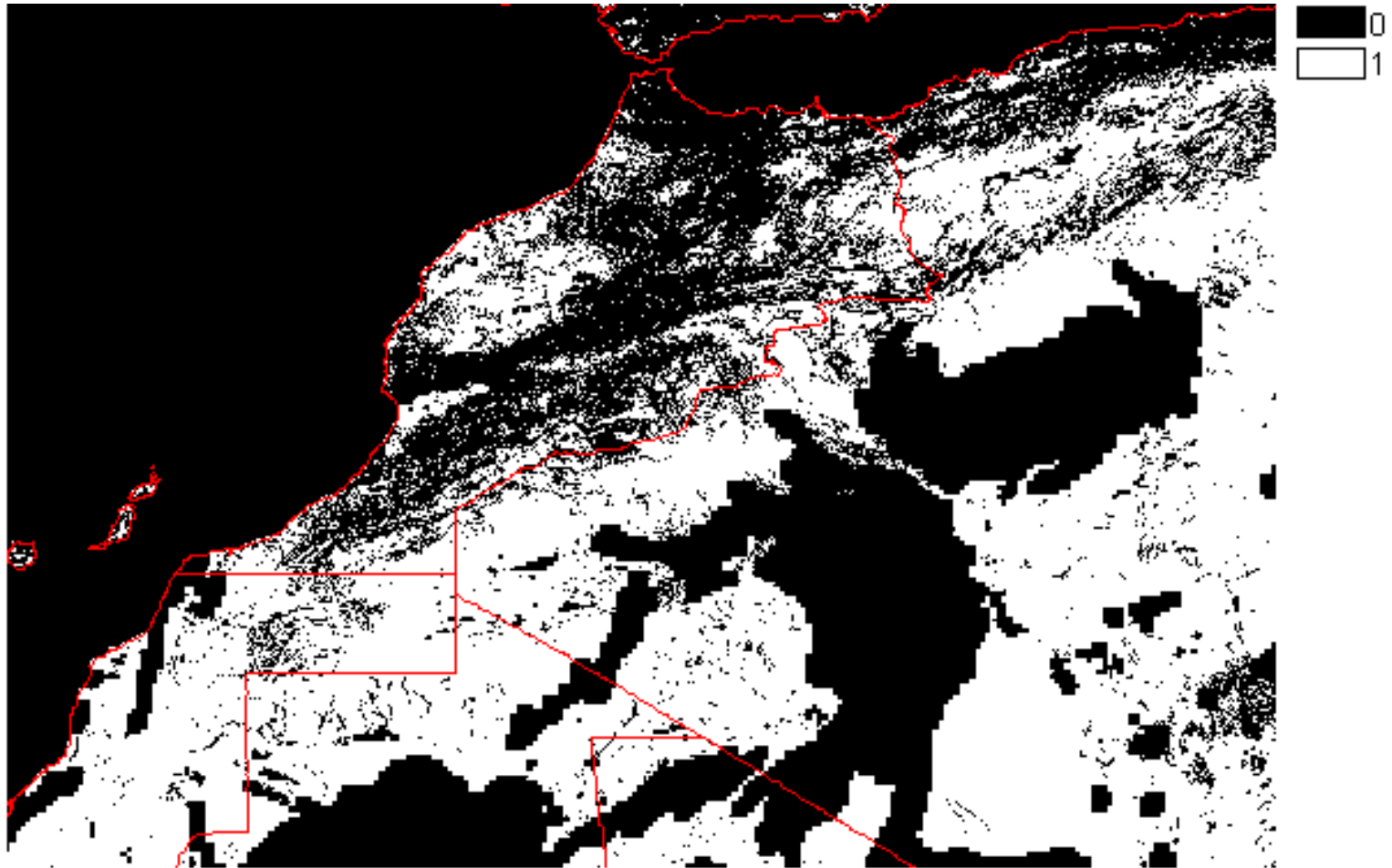


Land Cover, etc.

**Mapping and combination of geographic parameters obtained from remote sensing**

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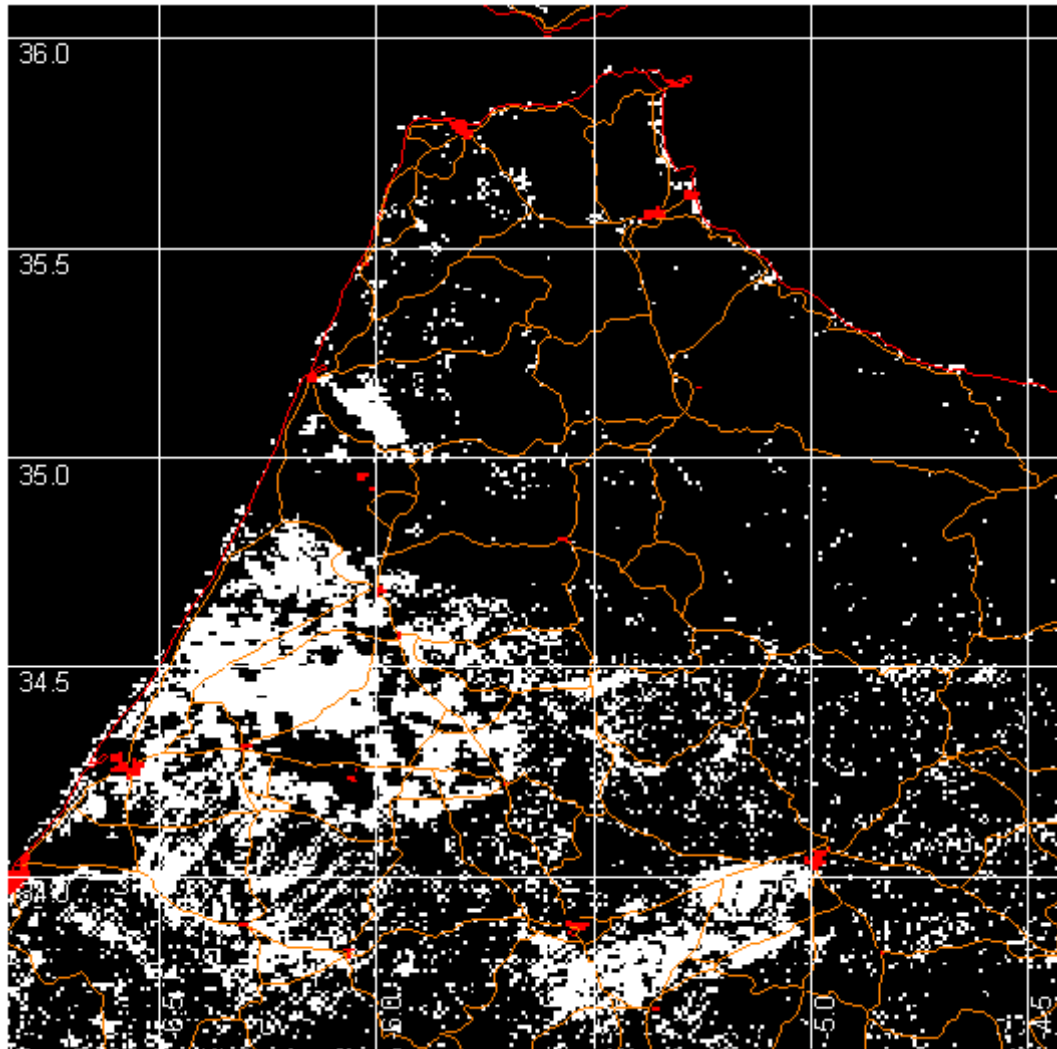
## Site Qualification



**Qualification of Sites for Solar Thermal Power Stations  
in Morocco and West Sahara**

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Site Qualification



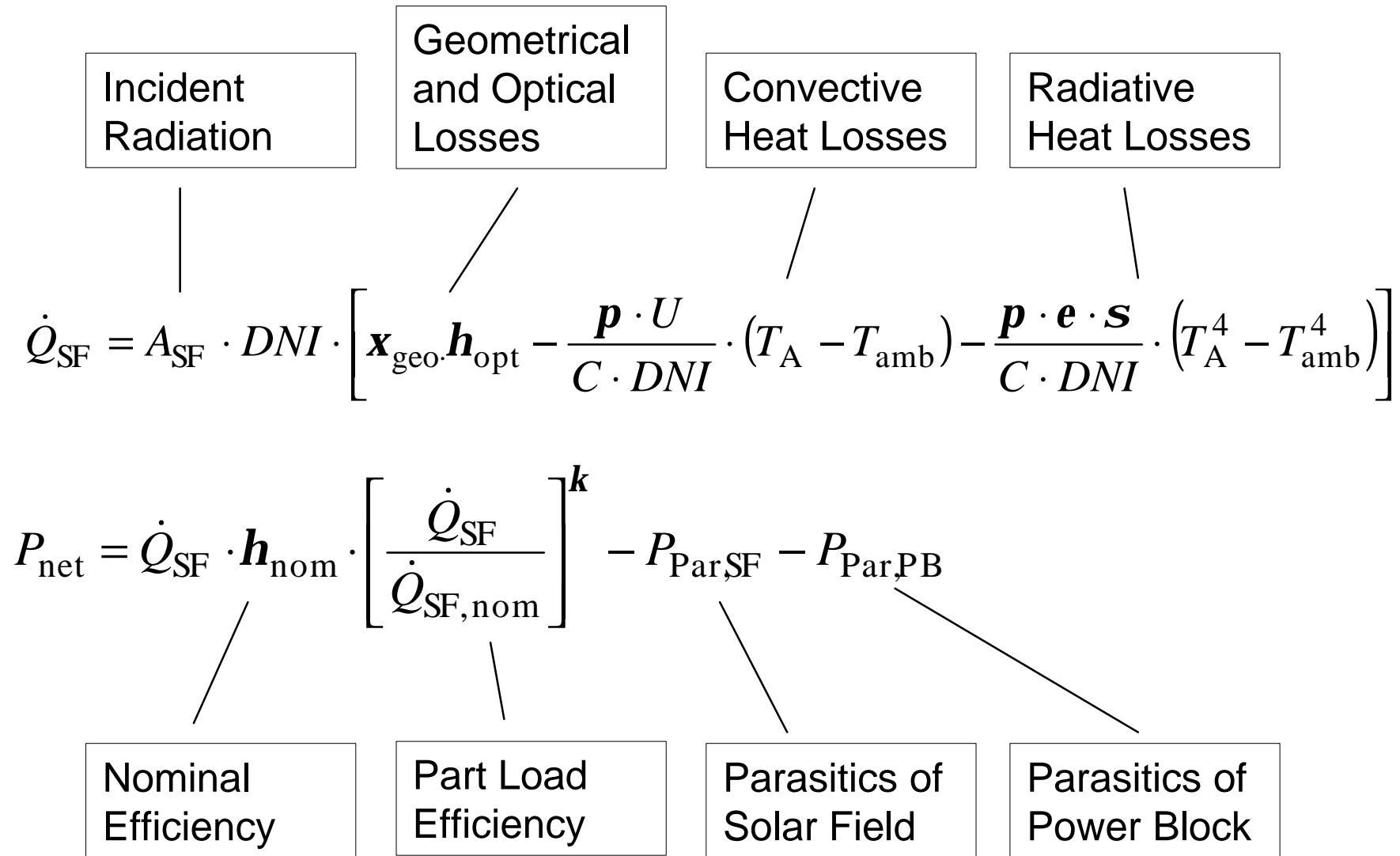
Resolution: 1 km

**Possible Sites for Solar Thermal Power Plants  
in Northern Morocco**



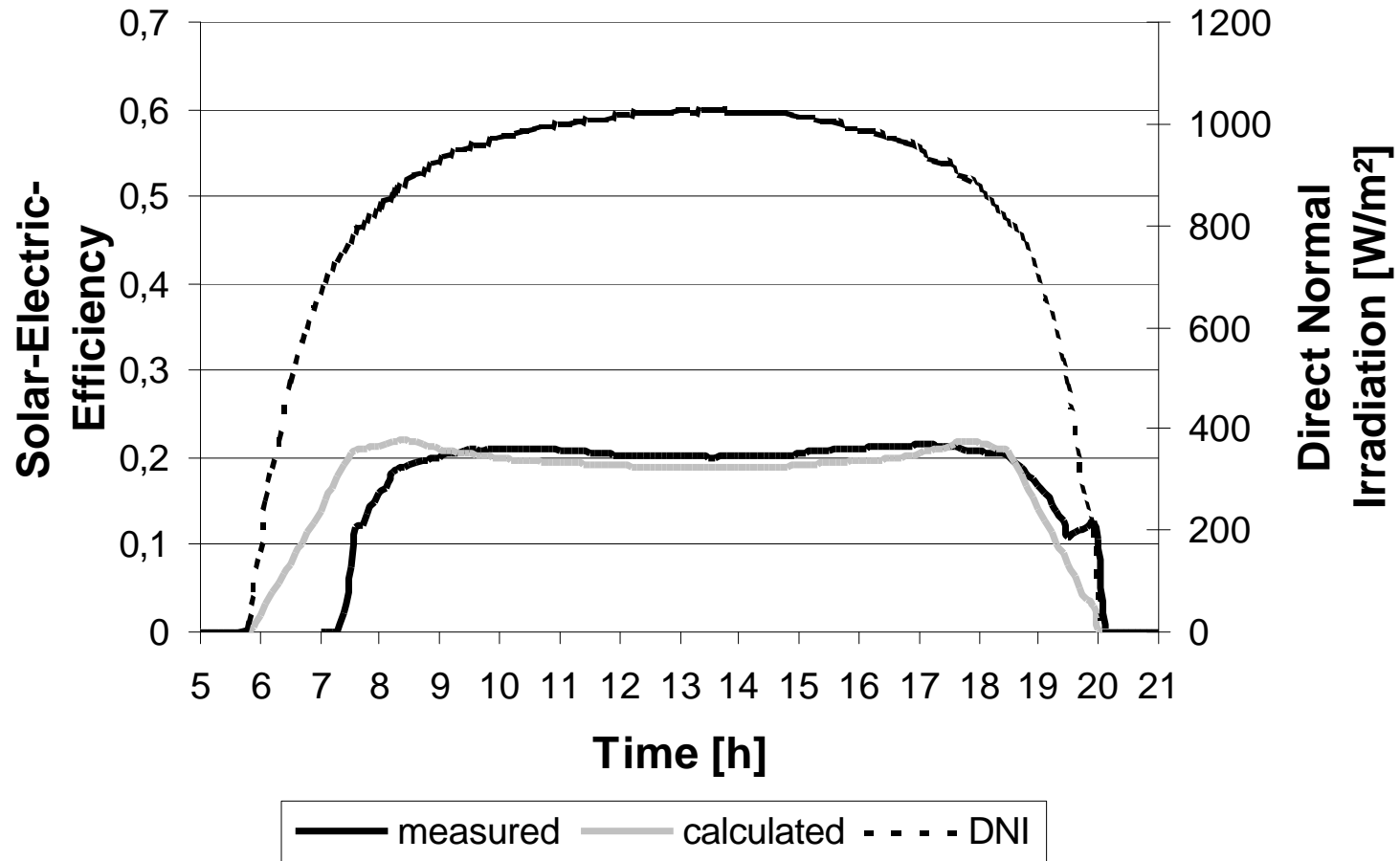
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## Site Ranking

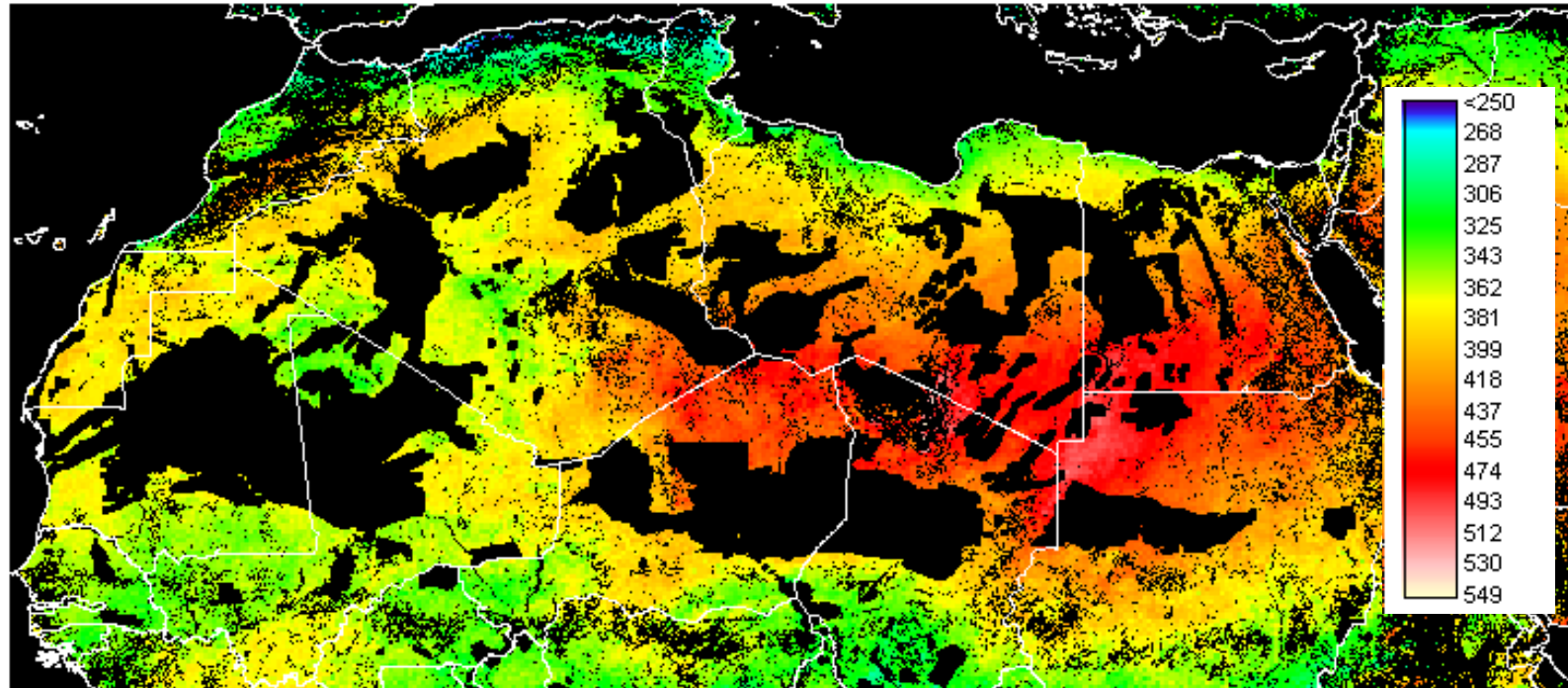


**The Solar Thermal Power Plant Model of STEPS**





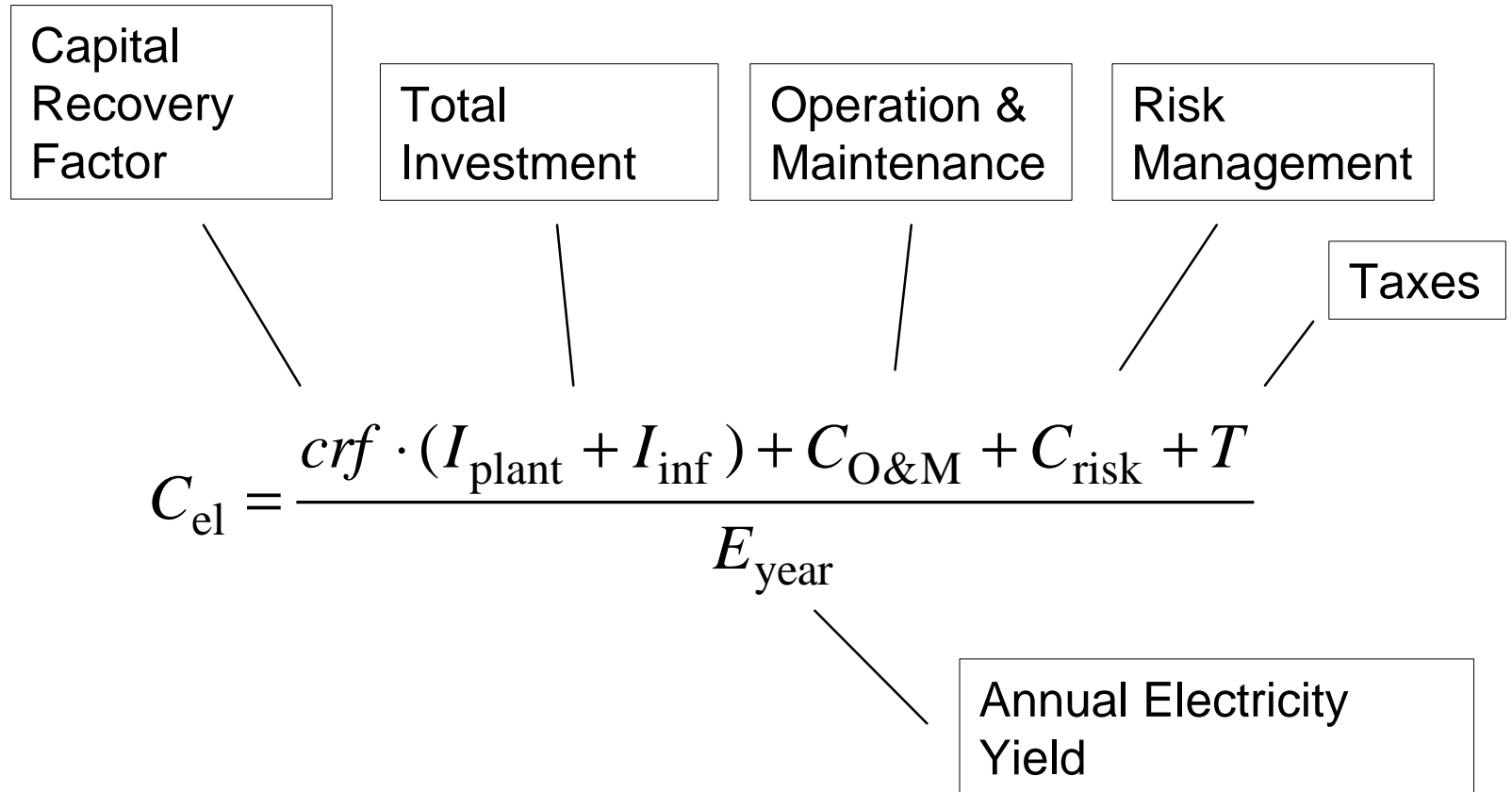
**Simulation of SEGS VI (July 1, 1997)**



**Site Ranking by Technical Performance (Annual Solar Electricity Yield in GWh/y) for 200 MW SEGs in Northern Africa, Optimum Cooling System, Solar Only Operation**

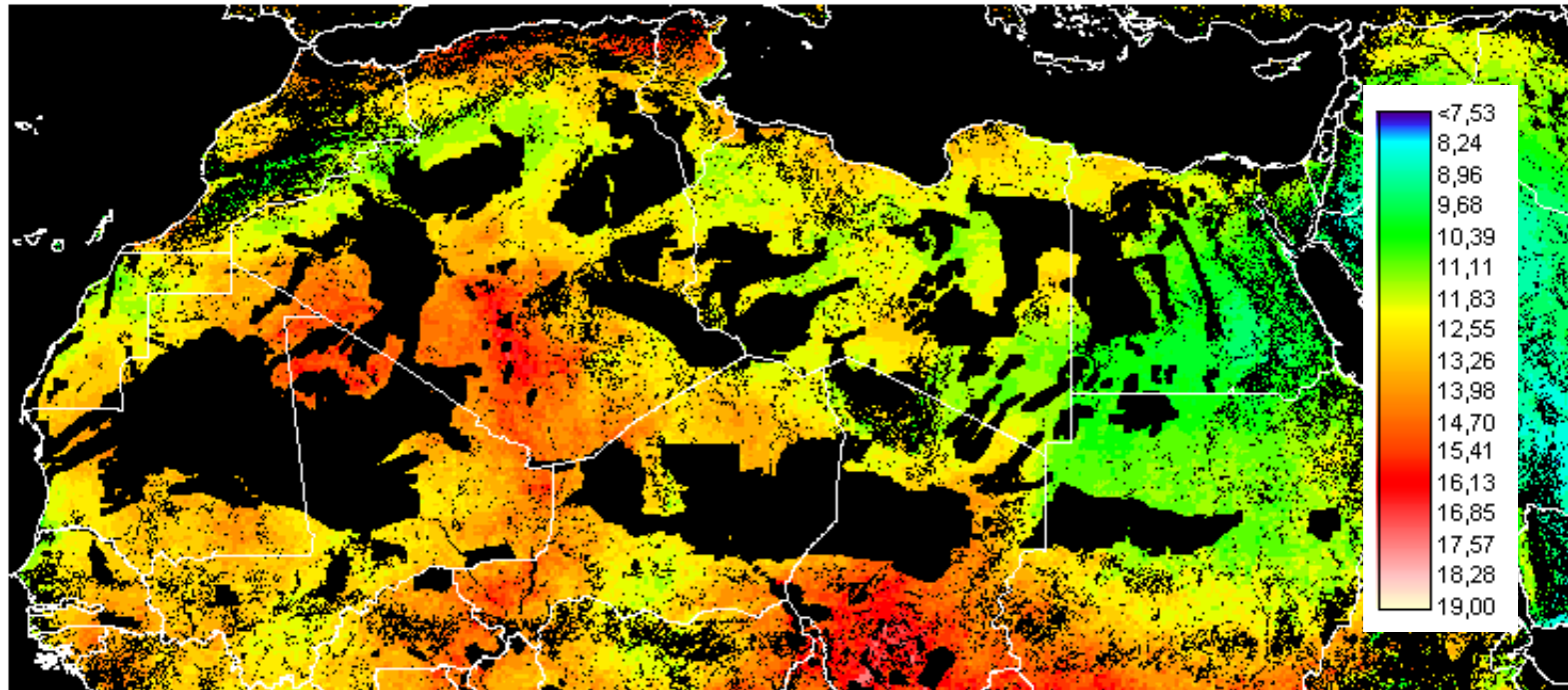
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Site Ranking



**The Solar Electricity Cost Model of STEPS**





**Site Ranking by Economic Performance (Solar Electricity Cost in Euro-c/kWh) for 200 MW SEGS in Northern Africa including Infrastructure Cost (Roads, Pipelines, Grid)**



## Applications

- Feasibility Studies
- Resource Assessment
- Energy Planning
- Technical Assessment: Power, Cooling, Desalination
- Project Development, Engineering
- Geographic Information System



<http://www.dlr.de/steps>