MIT Portugal

PV POTENTIAL

(also) using Geographical Information Systems

Miguel Centeno Brito
Faculdade de Ciências da Universidade de Lisboa

Green Islands Project
Research Integration Workshop
MIT – 25-27 May 2010

MIT Portugal

OUTLOOK

- Terceira Island – radiation data and photovoltaic potential
- Graciosa – radiation data and modeling, a pathway for a solar atlas
- GIS for PV potential assessment

MIT Portugal

Photovoltaic potential in Terceira

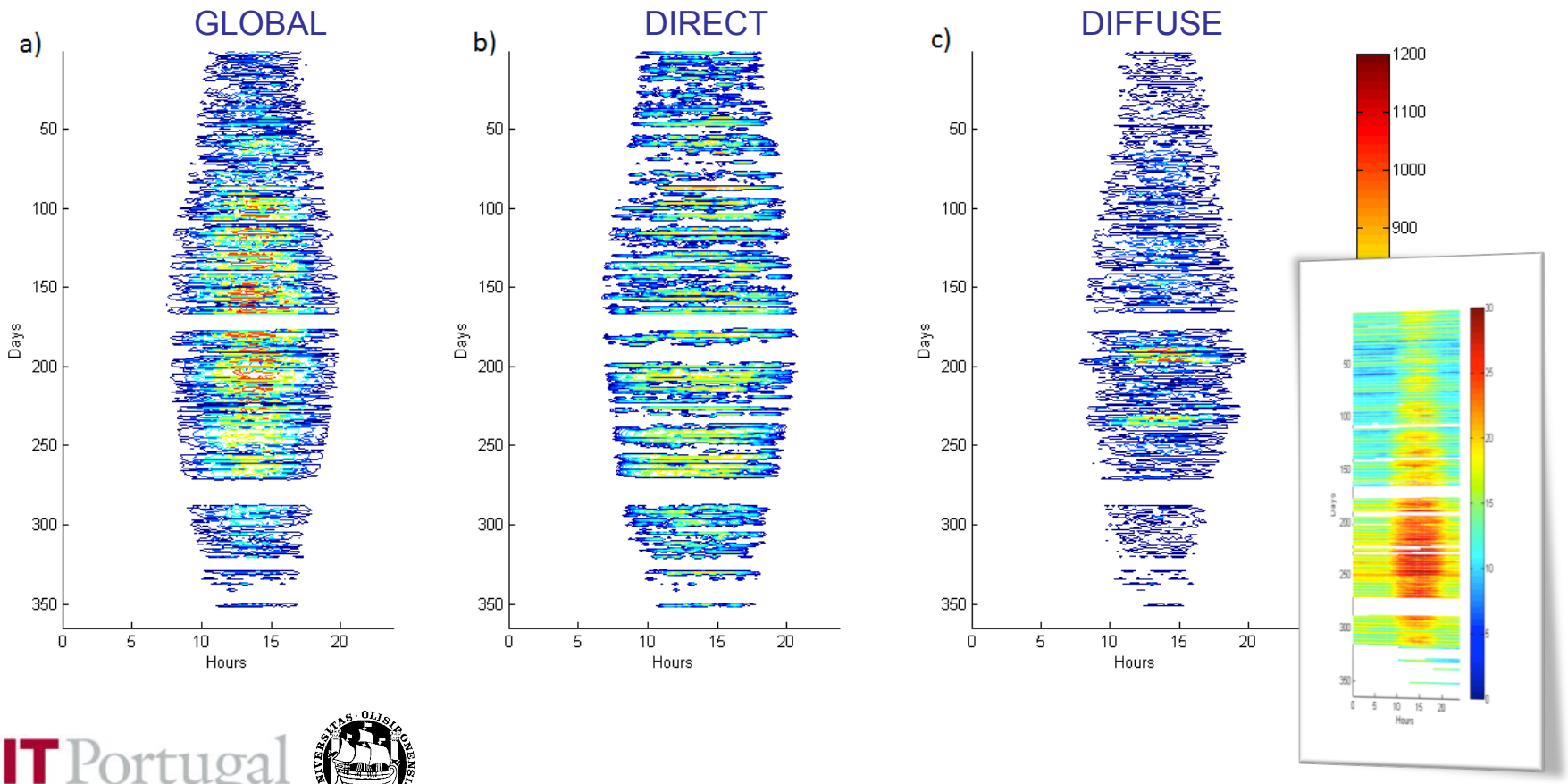
DATA

- Angra Heroísmo, Terceira Island
- 2009 data
- Meteo data: global, direct and diffuse irradiation
- 5 seconds → 15 minutes
- From Paulo Fialho, Azores University, Group of Chemistry and Physics of the Atmosphere

Photovoltaic potential in Terceira

Measured irradiance (W/m^2)

Data: 2009 at Angra do Heroísmo, in Terceira

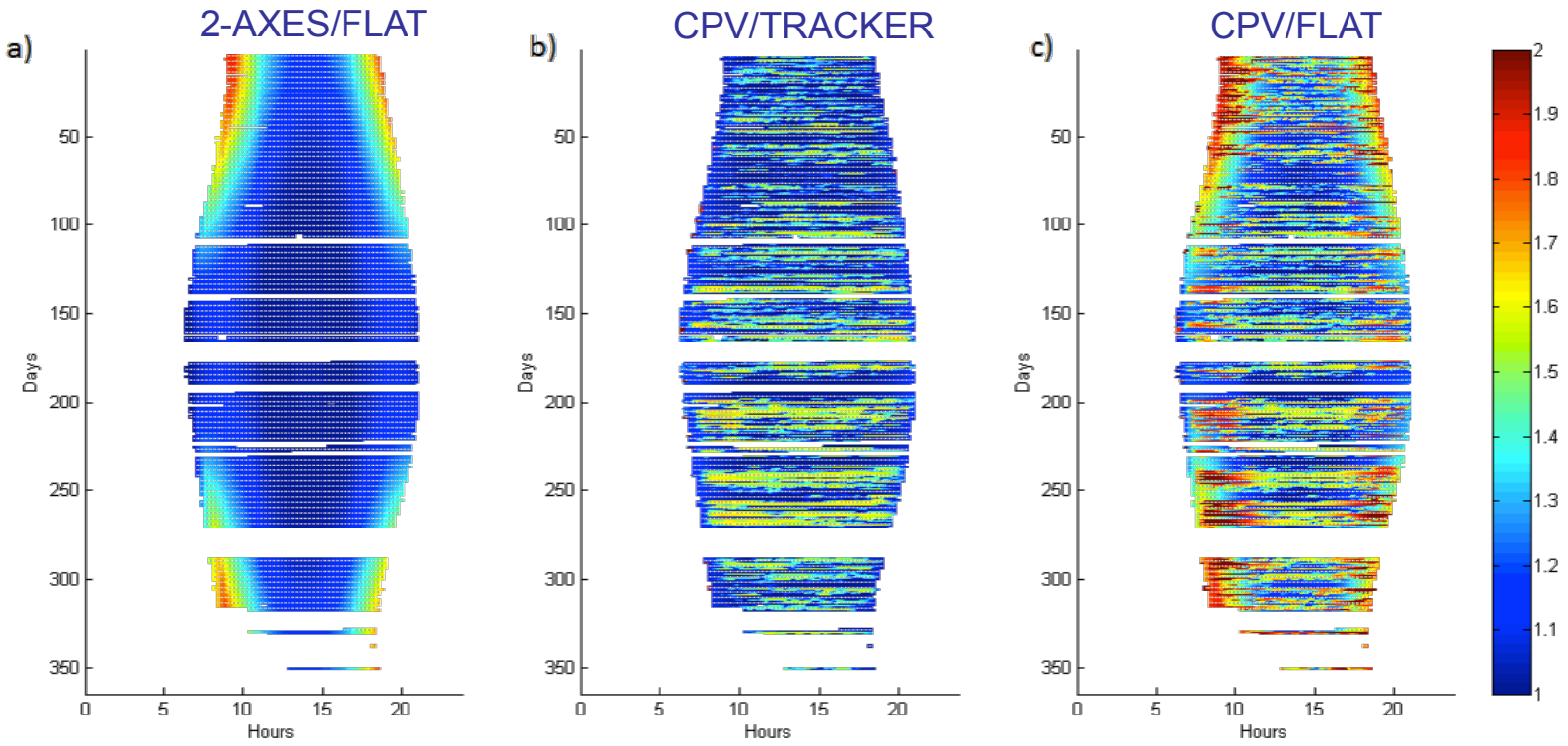


MIT Portugal

Photovoltaic potential in Terceira

Model results: comparing different PV configurations

Data: 2009 at Angra do Heroísmo, in Terceira

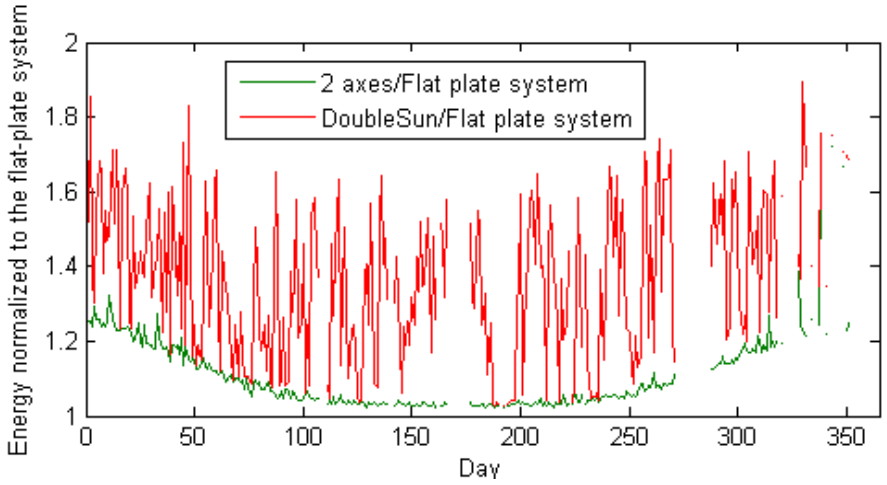


MIT Portugal

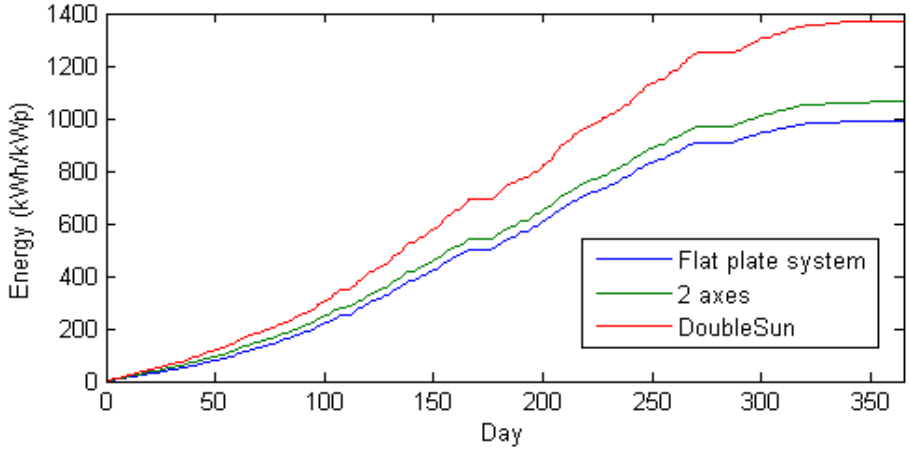
Photovoltaic potential in Terceira

Model results: comparing different PV configurations

Data: 2009 at Angra do Heroísmo, in Terceira



Energy produced by a 2-axes tracking system and CPV normalized to the energy produced by a flat-plate system.



Accumulated energy (kWh/kWp) produced by the flat-plate system, 2-axes tracking system and CPV system.

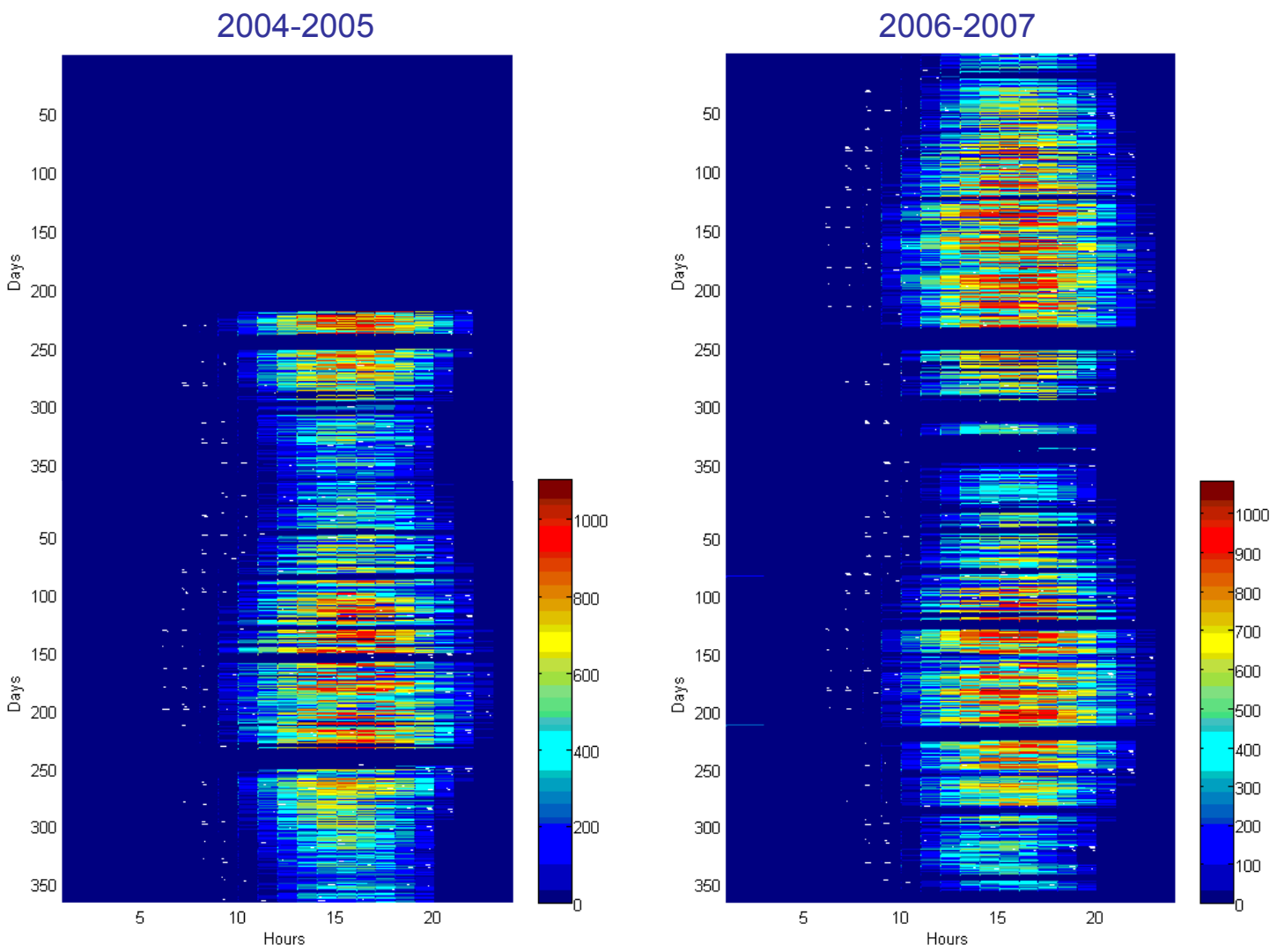
Photovoltaic potential in Terceira

DATA

- PV potential: **1209 kWh/year/m²**, with significant **diffuse radiation** (58%)
- Highest irradiation in the **summer** months when alternative energy sources (e.g. wind power) are less significant
- Solar tracking and/or concentration systems offer a measurable **boost** of generated electricity, particular in the summer months
- However they enhance **short-term variability** thus making it less useful for grid integration, in particular if PV has a relevant slice of the local energy portfolio.

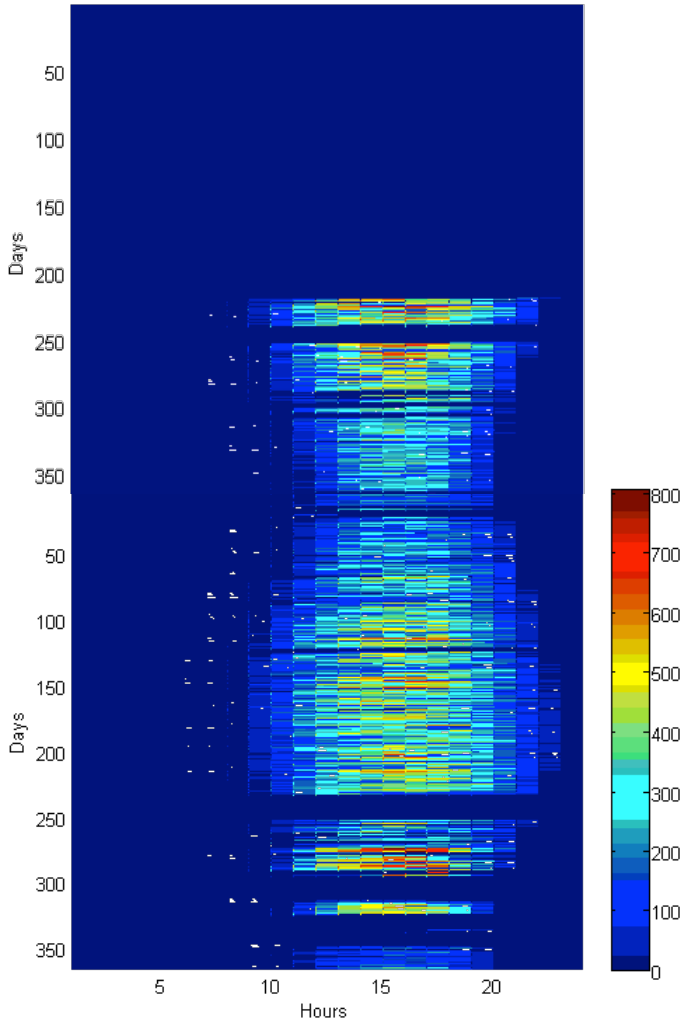
Solar Atlas for the Azores Islands

GLOBAL

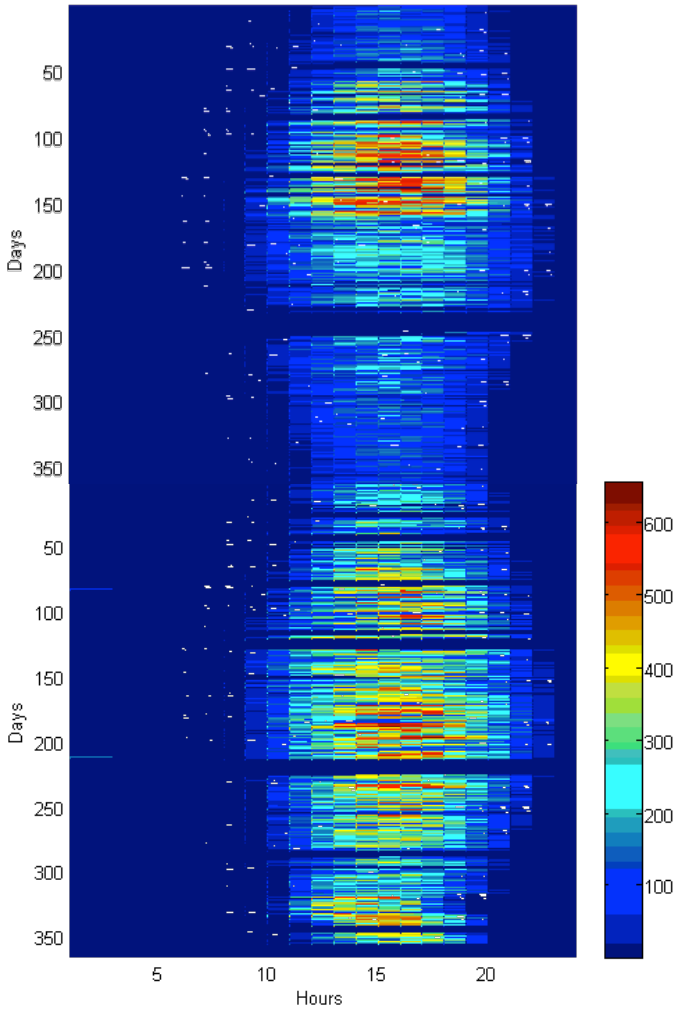


Solar Atlas for the Azores Islands

2004-2005



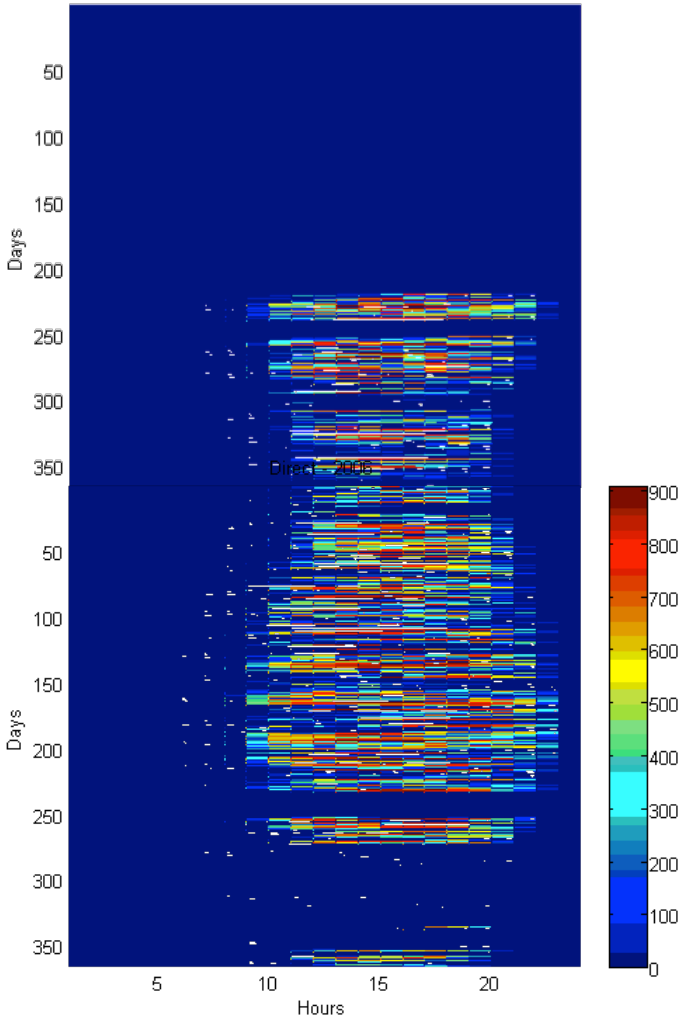
2006-2007



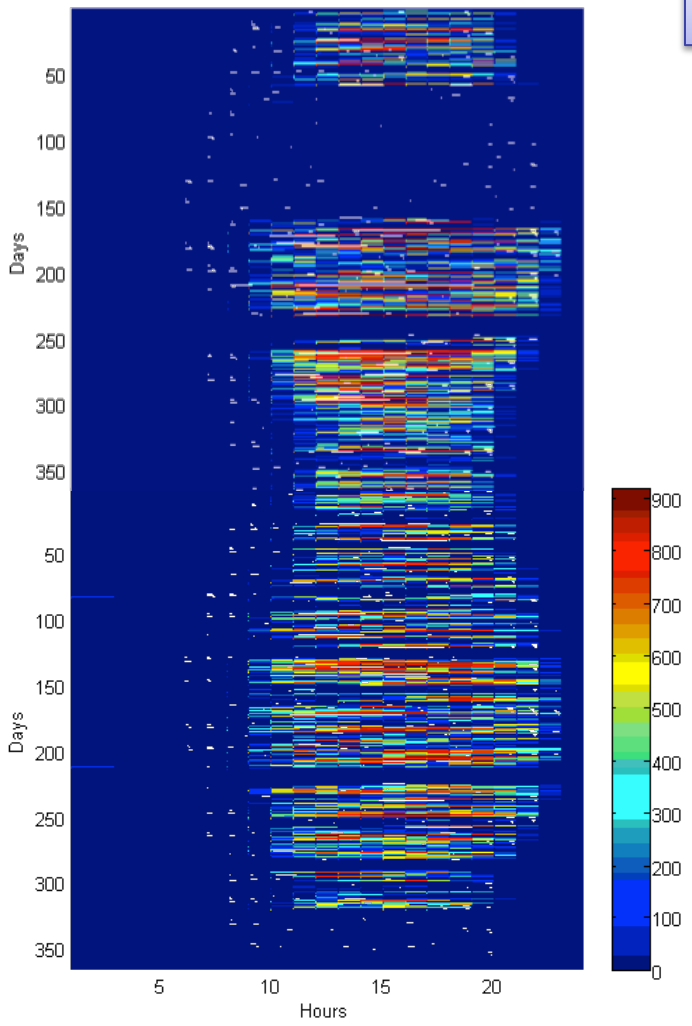
DIRECT

Solar Atlas for the Azores Islands

2004-2005

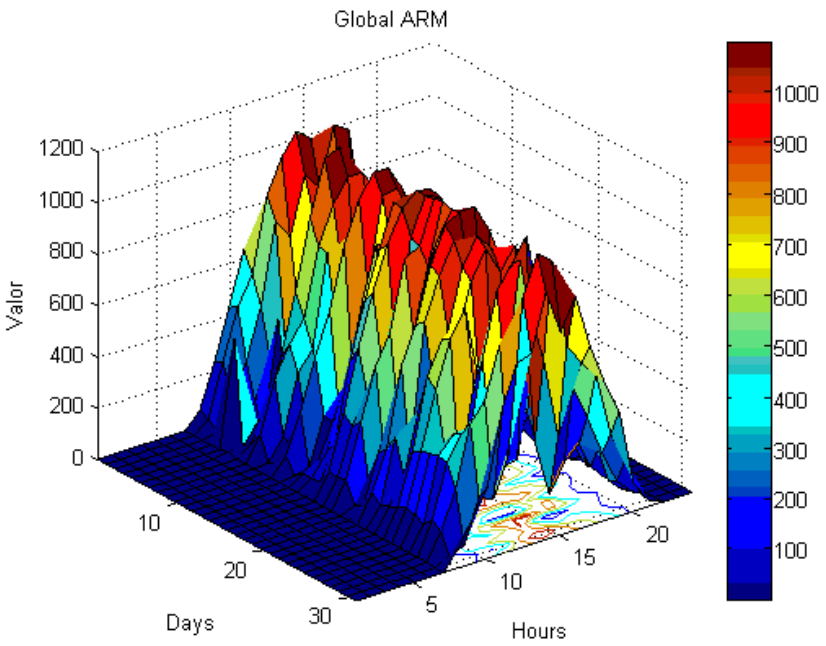


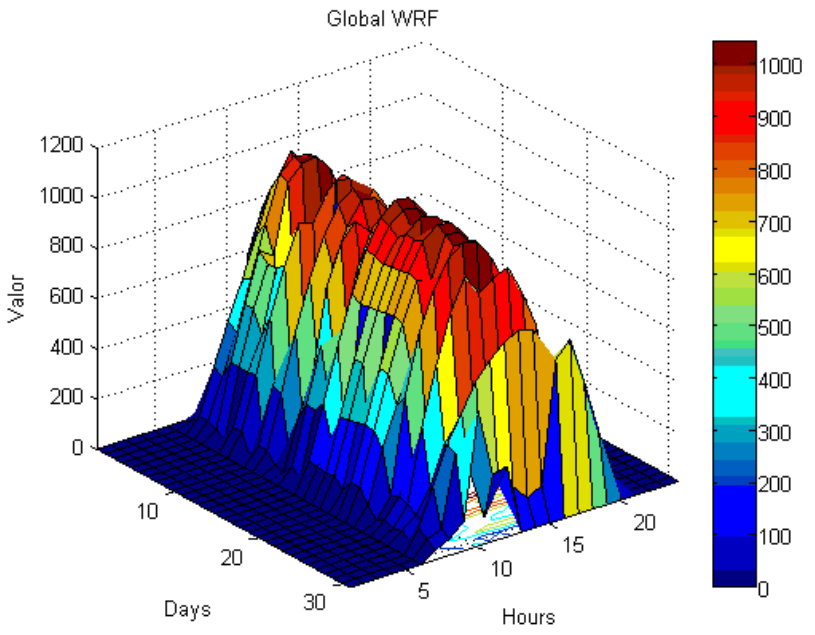
2006-2007



DIFFUSE

Solar Atlas for the Azores Islands





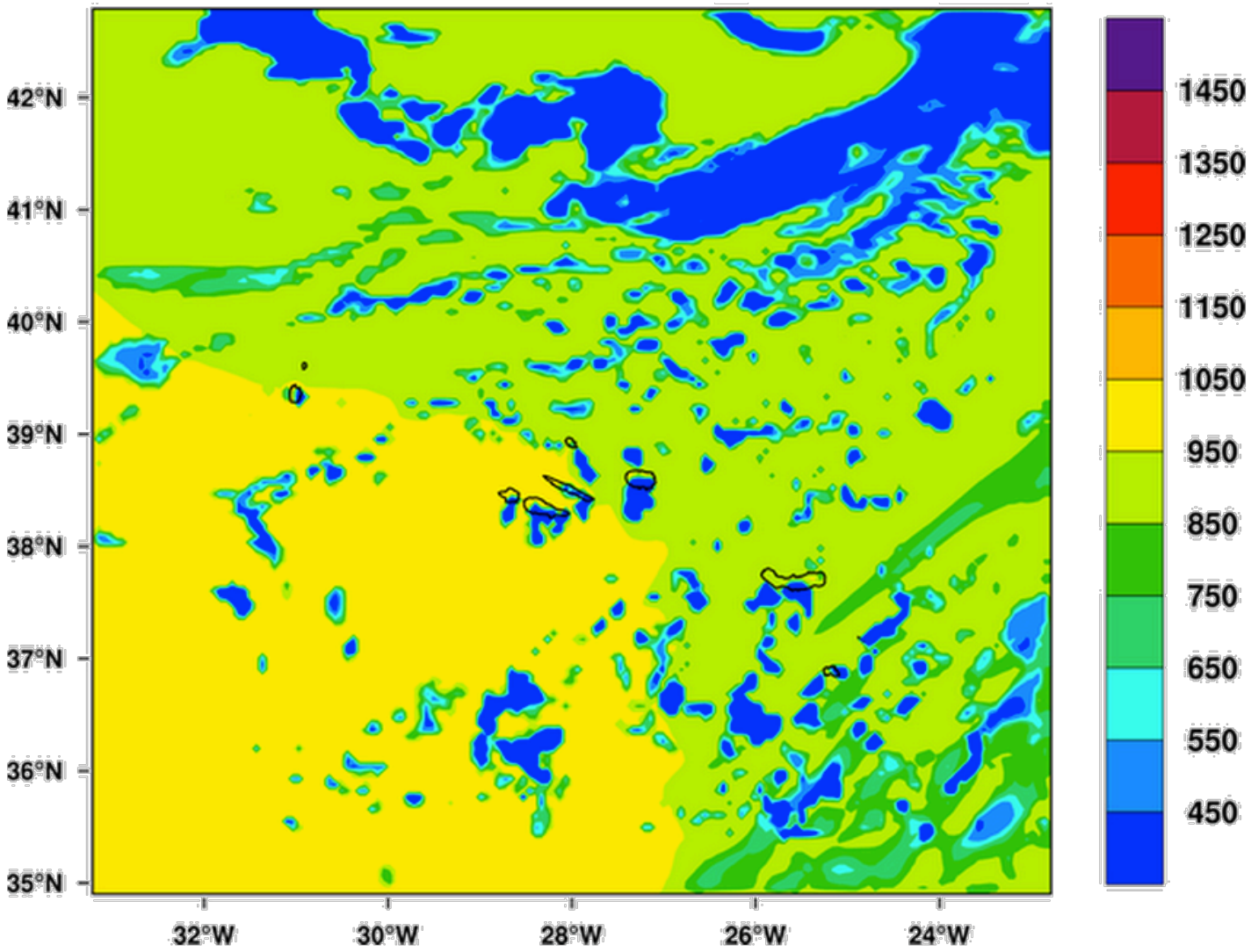
MIT Portugal

ARM - Atmospheric Radiation Measurement, Climate Research Facility

WRF - Weather Research and Forecasting Model

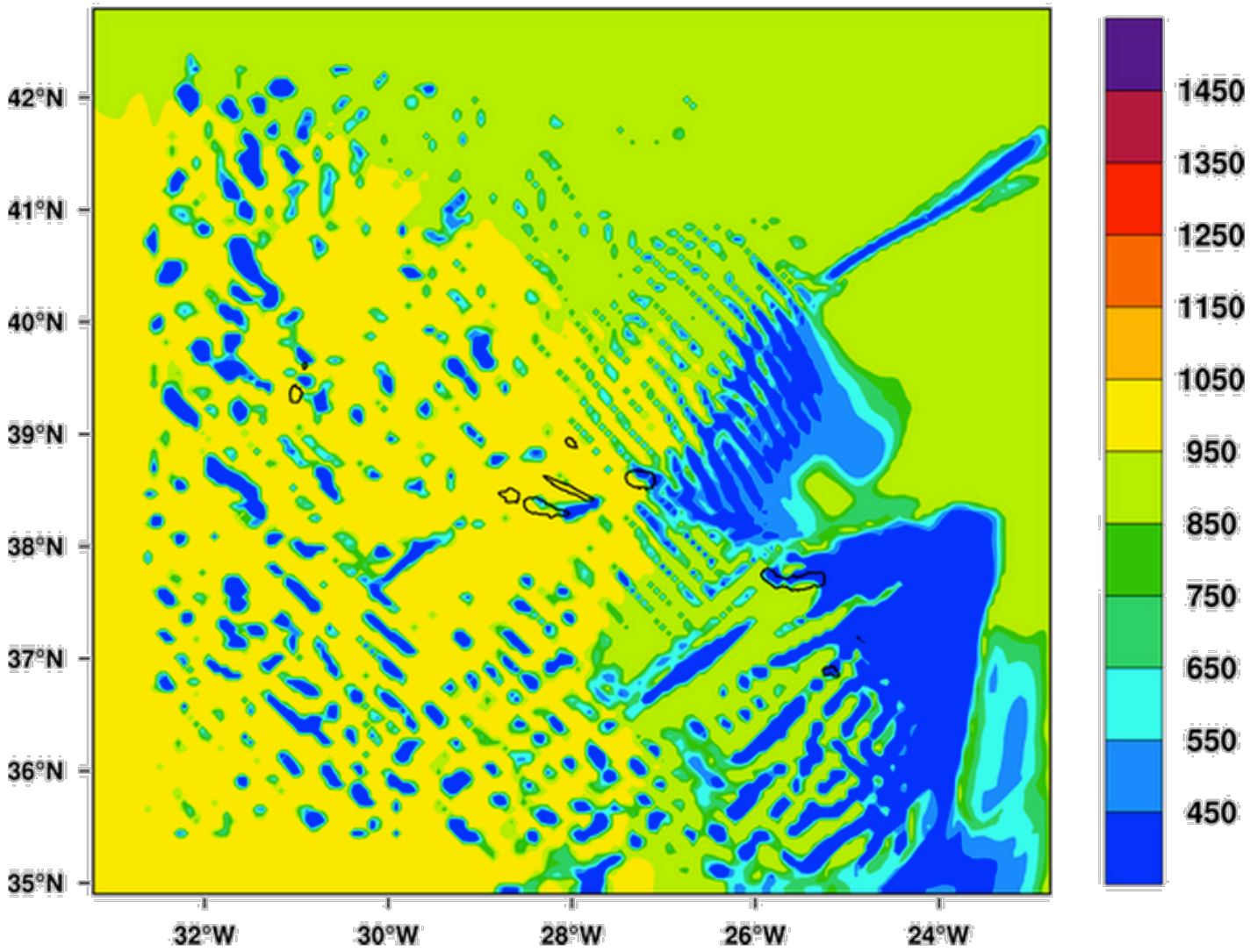
Solar Atlas for the Azores Islands

Azores
6x6 km



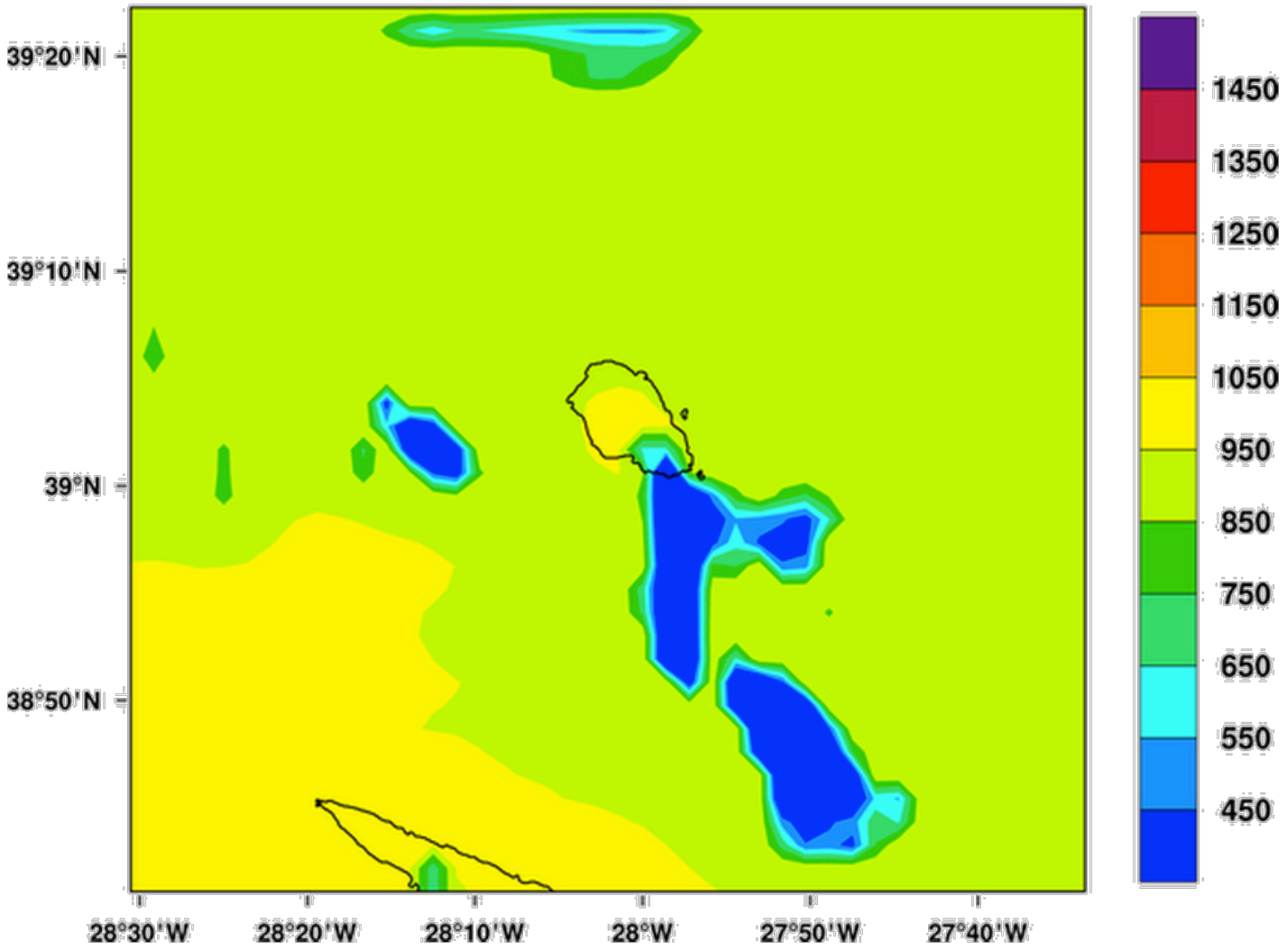
Solar Atlas for the Azores Islands

Azores
6x6 km



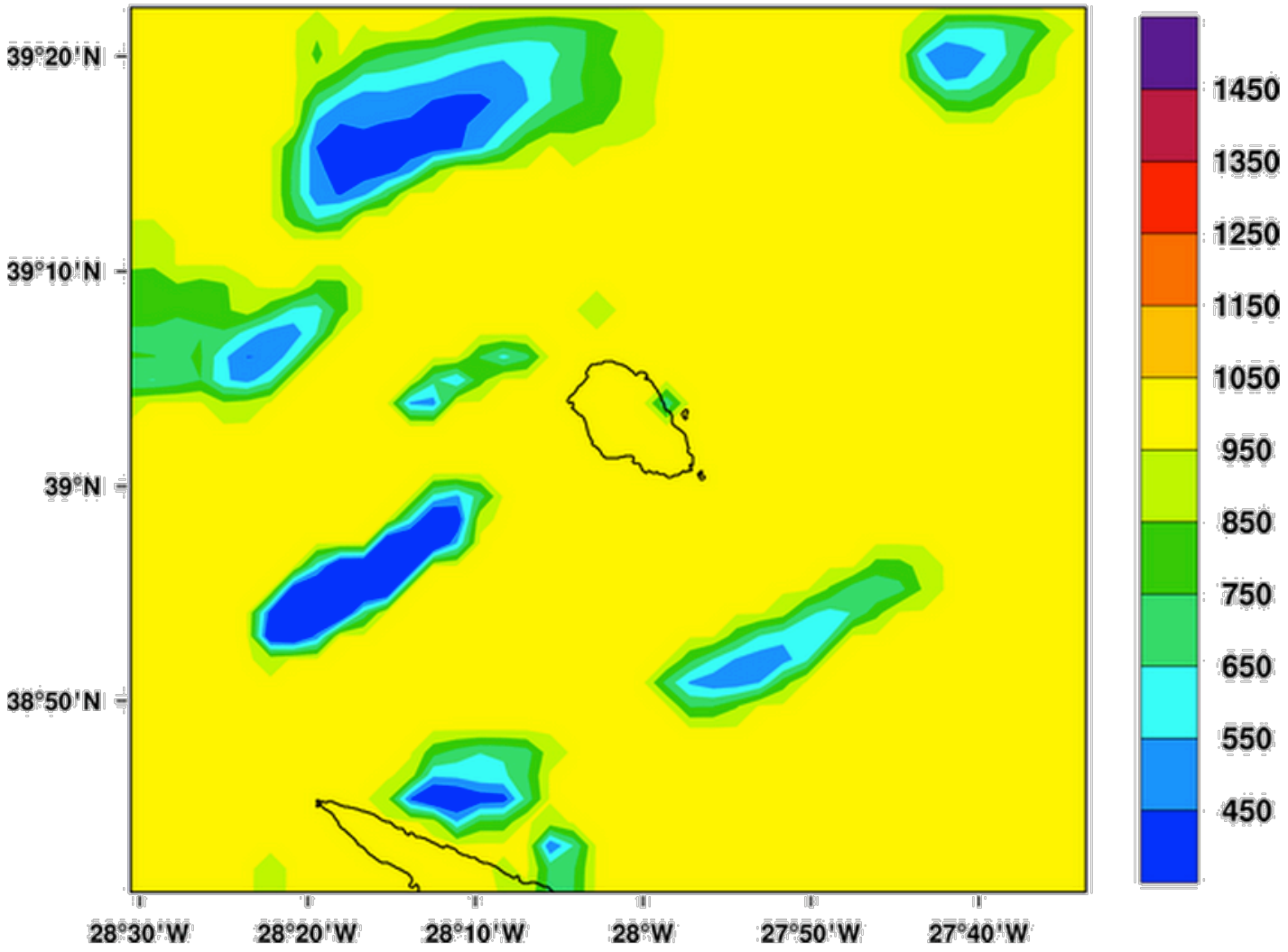
Solar Atlas for the Azores Islands

Graciosa
2x2 km



Solar Atlas for the Azores Islands

Graciosa
2x2 km



Solar Atlas for the Azores Islands

Further work

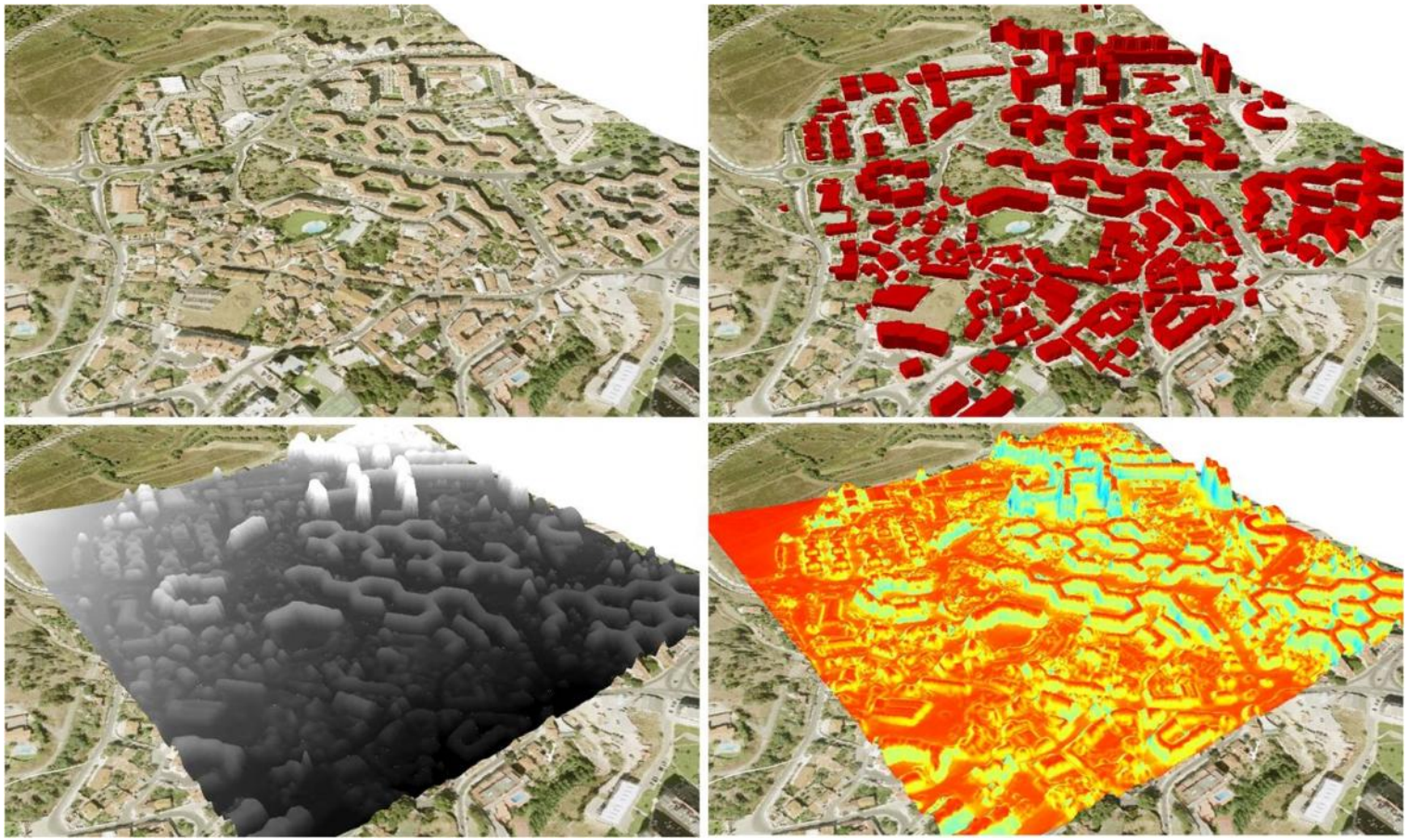
- Long term radiation averages
- Model validation using IM data
- Diffuse radiation calculation

MIT Portugal

GIS for PV potential assessment

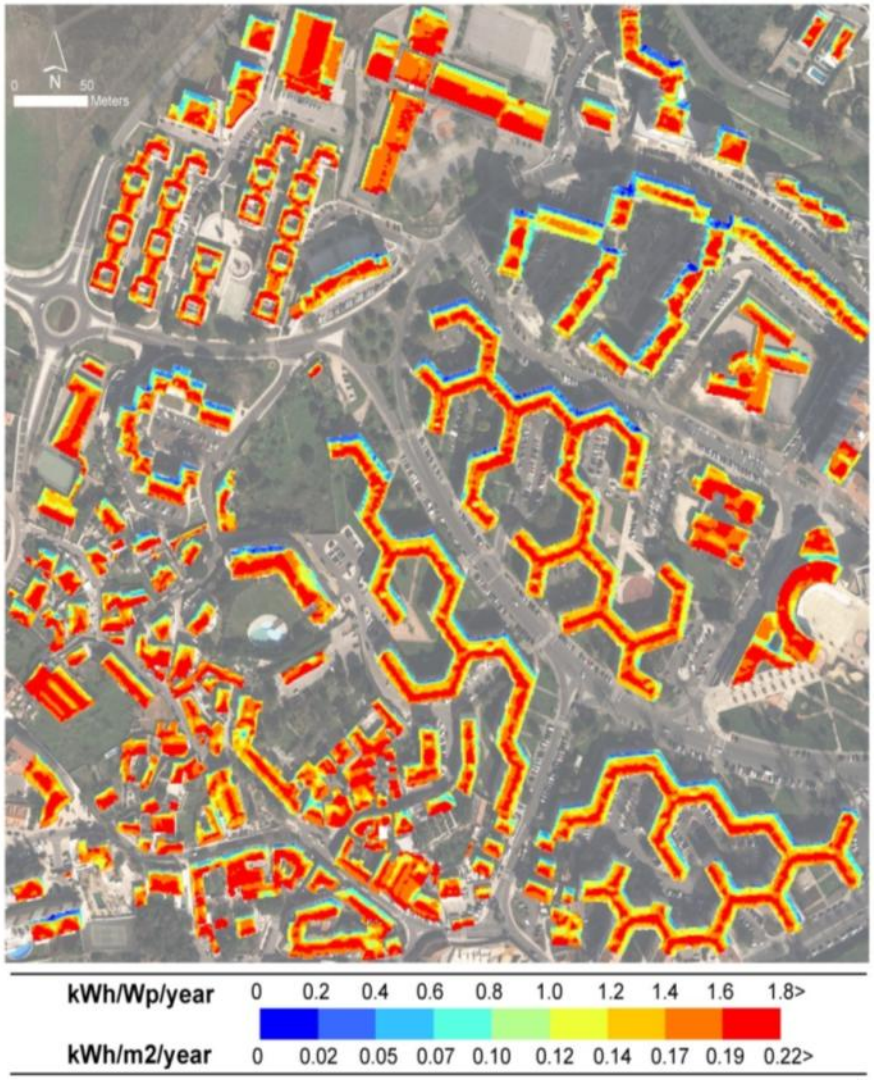
- PV potential using ARCGIS: Lisbon assessment (collaboration with UNL)
- PV potential including facades

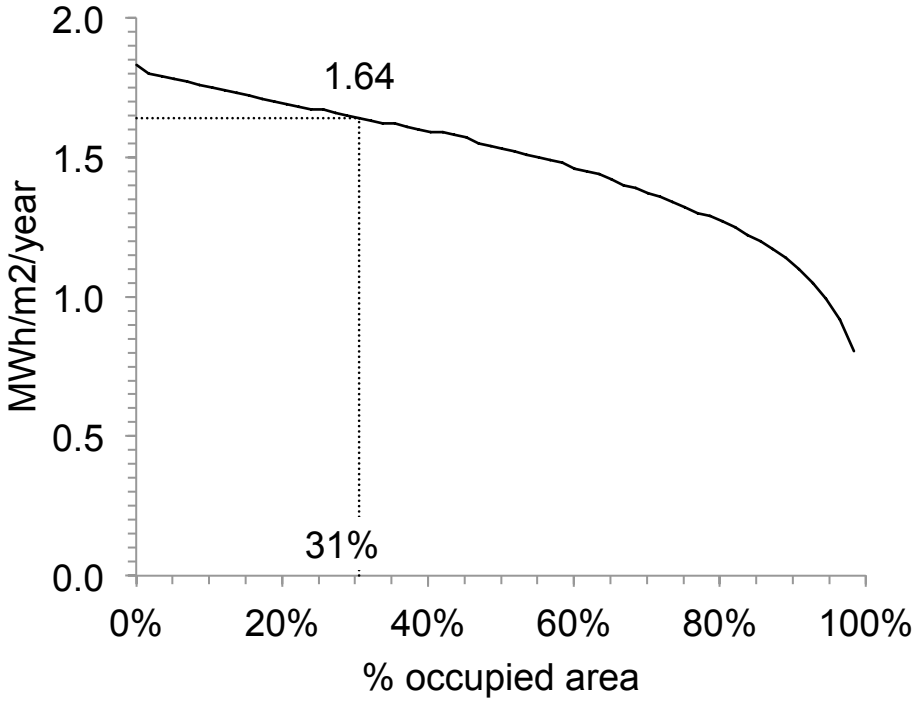
GIS for PV potential assessment



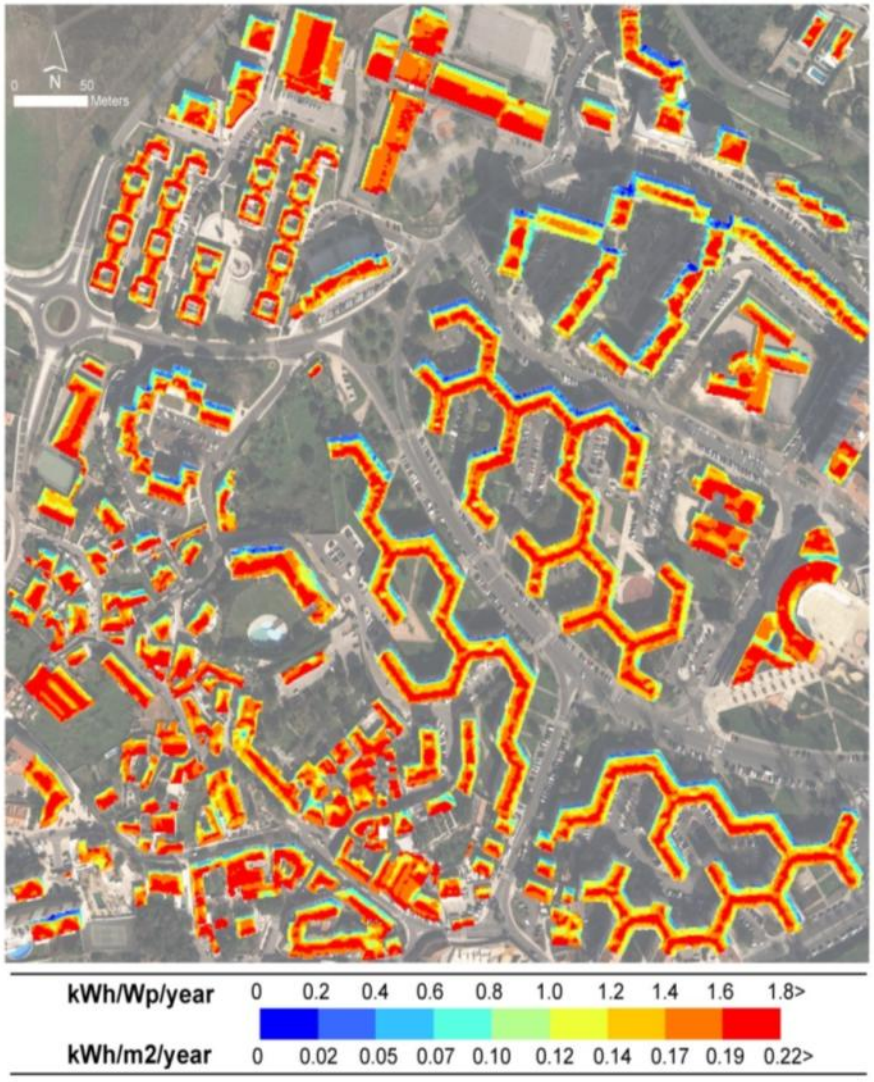
MIT Portugal

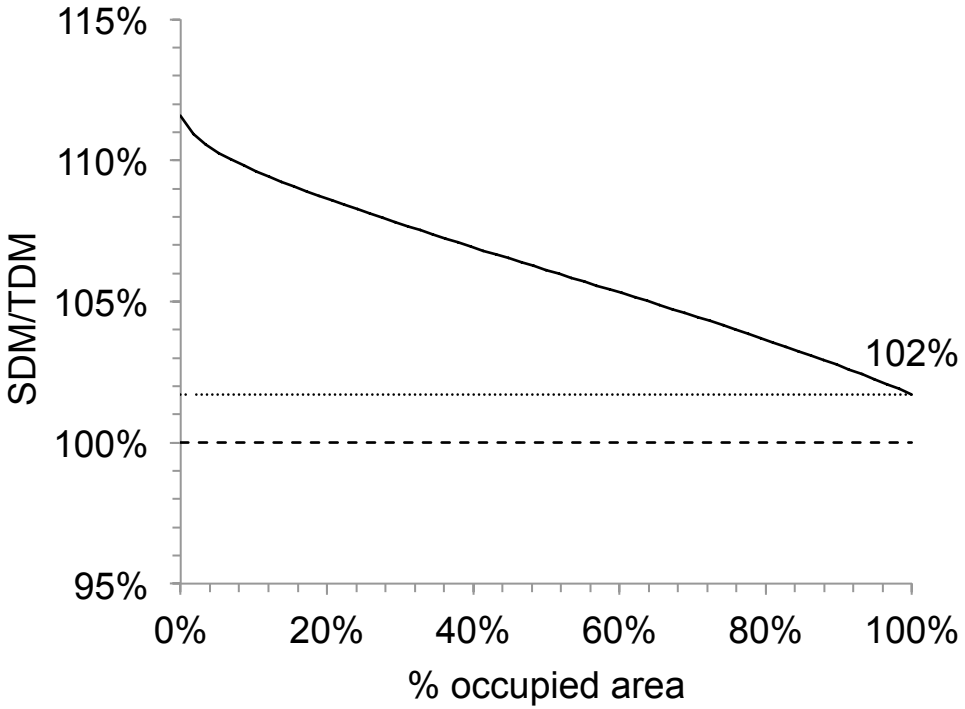
GIS for PV potential assessment





GIS for PV potential assessment





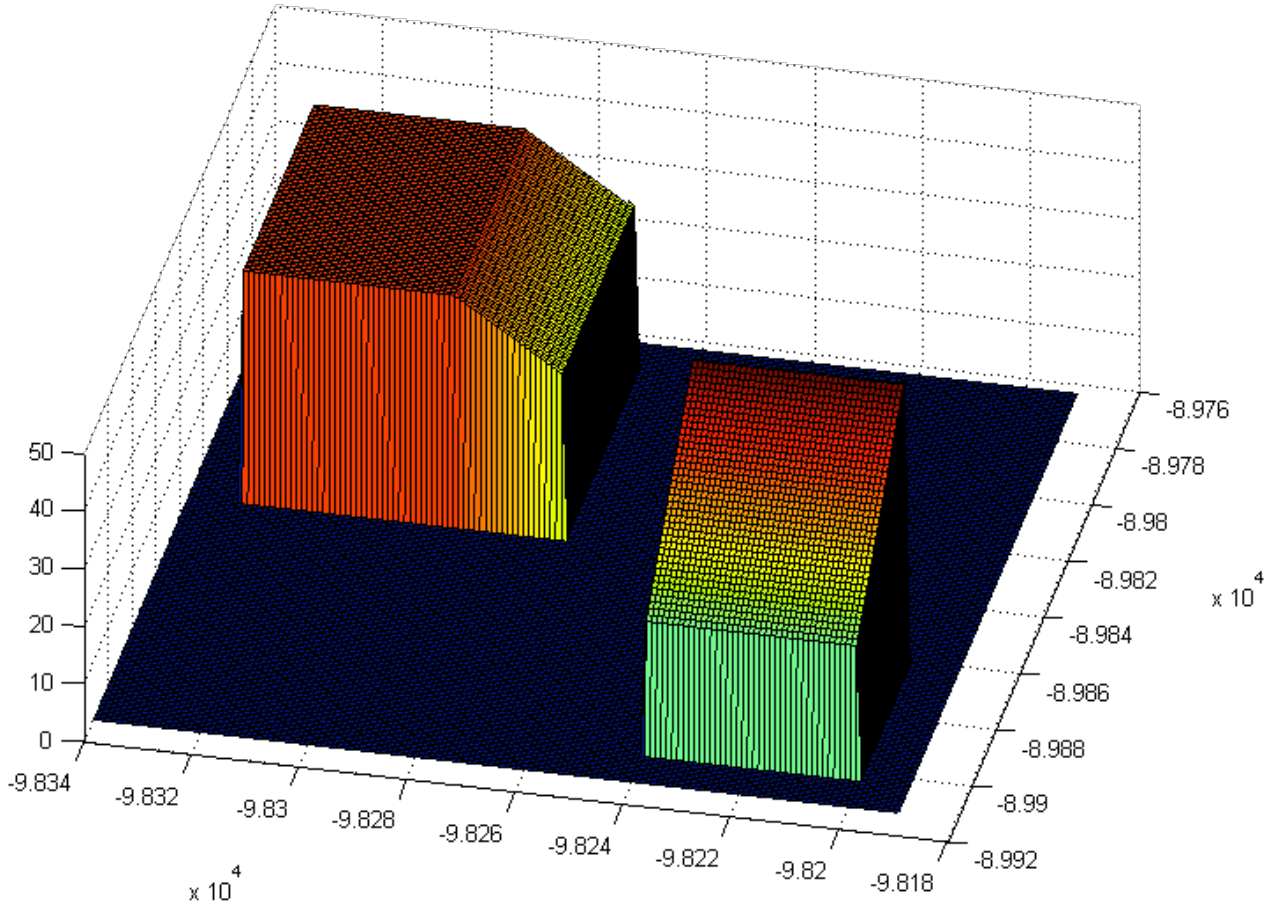
GIS for PV potential assessment

GIS for PV potential assessment: including facades

Analysis of idealized case.

The two buildings under analysis.

Colour code refers to height of each cell. Location is Lisbon.



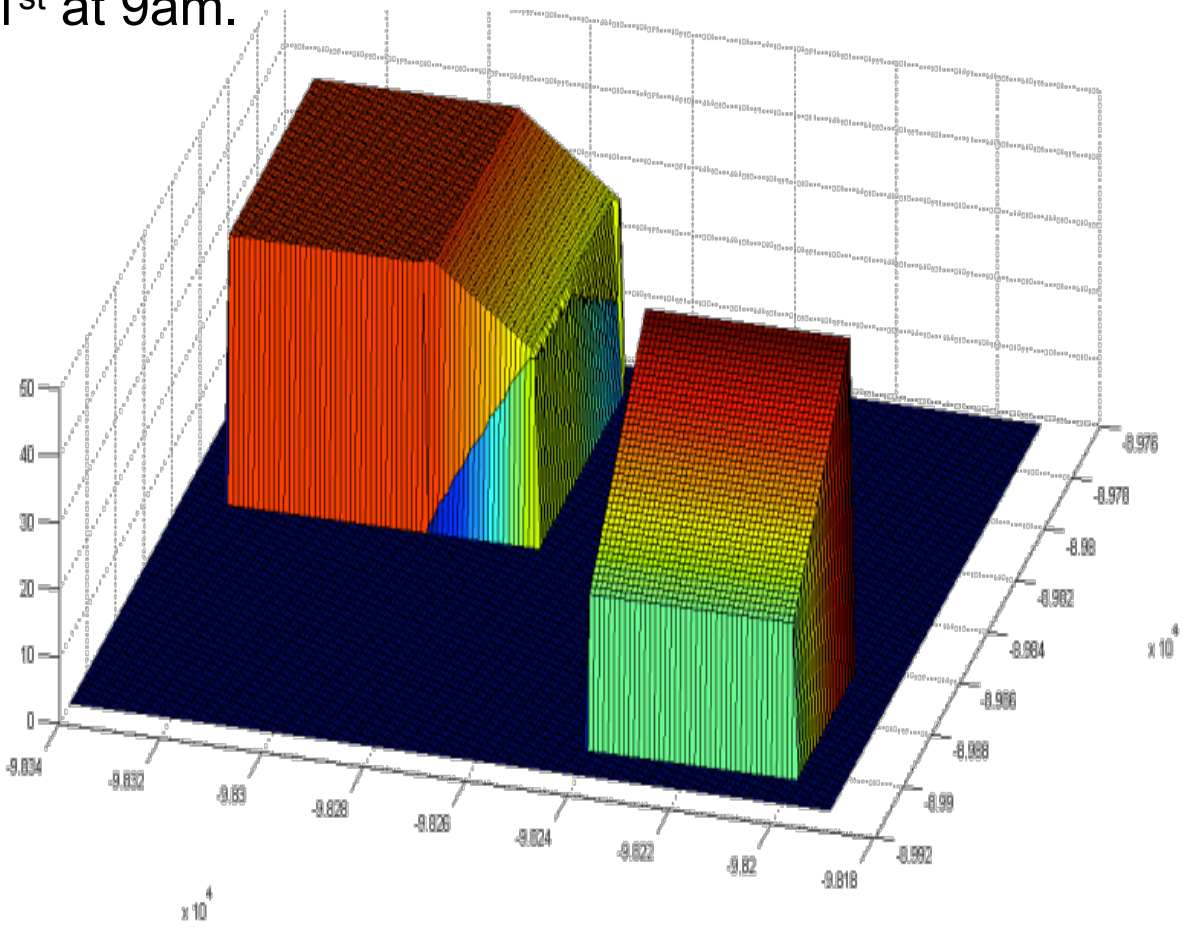
MIT Portugal

GIS for PV potential assessment: including facades

Analysis of idealized case.

Projected shade on the facade.

Model results for January 1st at 9am.



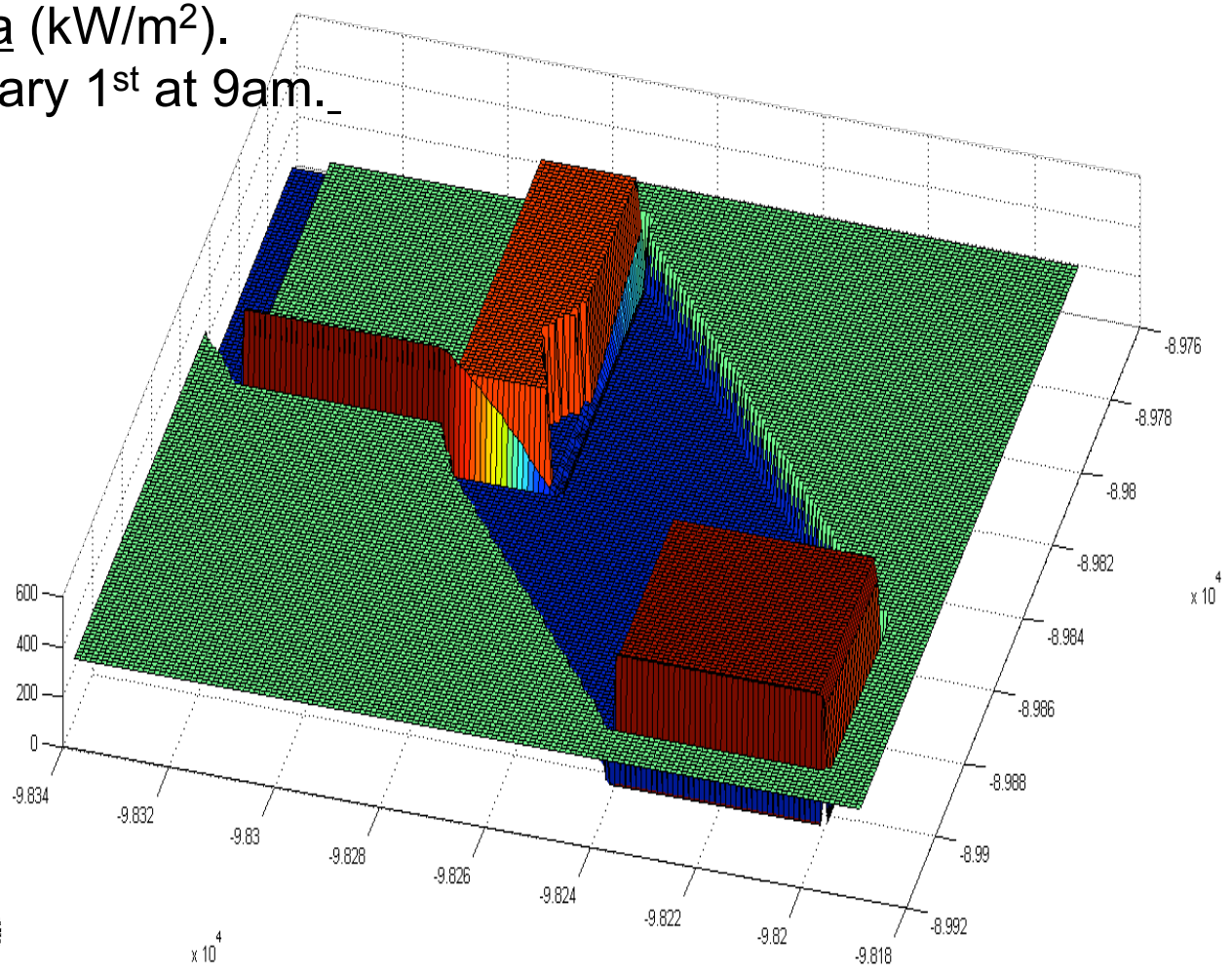
MIT Portugal

GIS for PV potential assessment: including facades

Analysis of idealized case.

Insolation per unit area (kW/m^2).

Model results for January 1st at 9am.



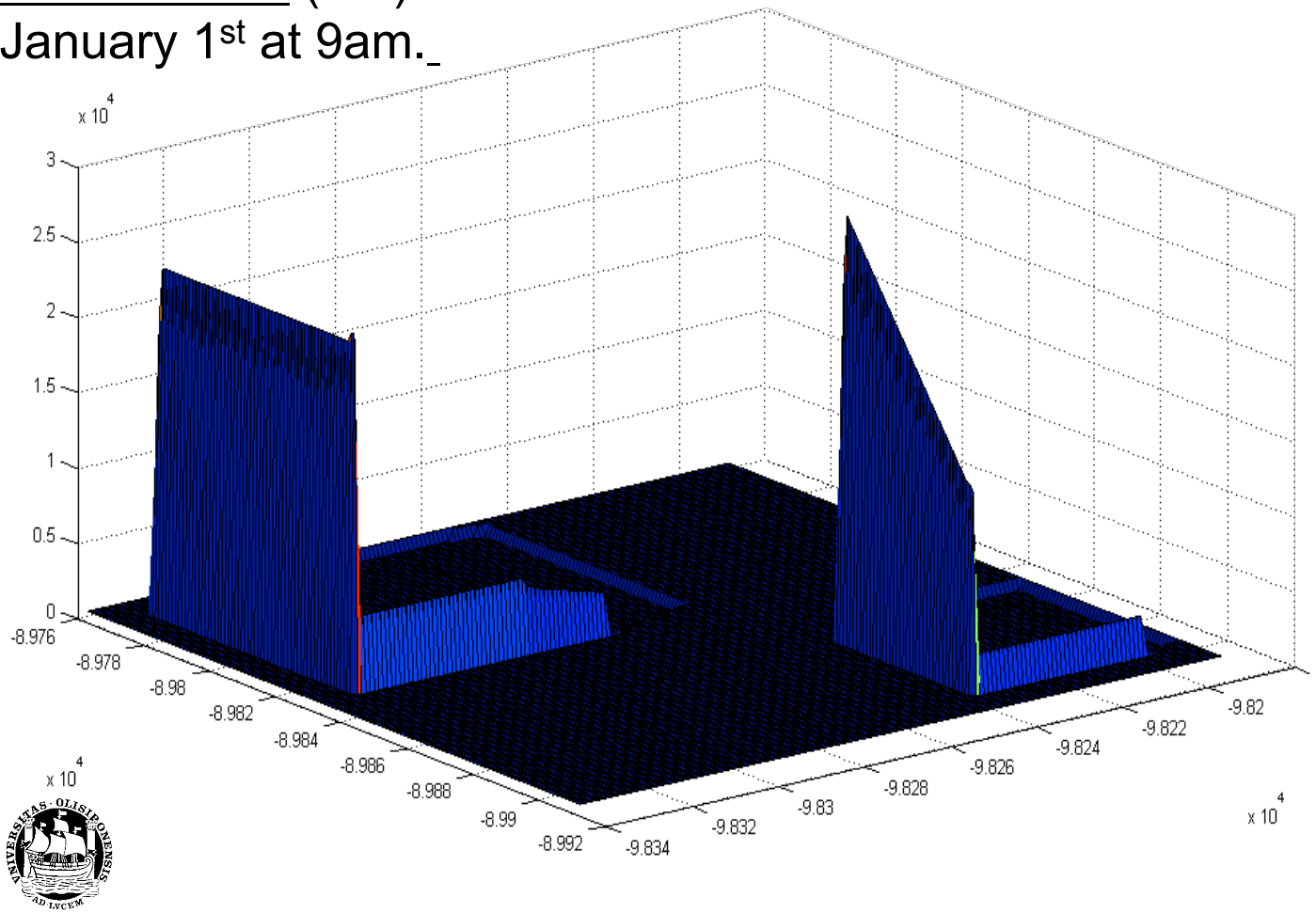
MIT Portugal

GIS for PV potential assessment: including facades

Analysis of idealized case.

Total insolation on the facades (kW).

Model results for January 1st at 9am.

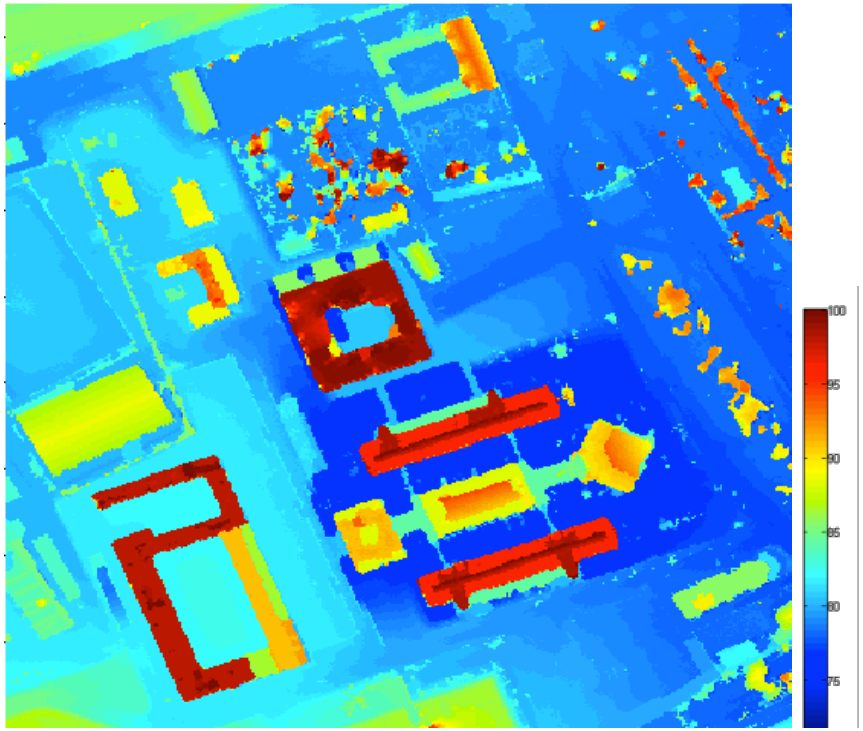


MIT Portugal

GIS for PV potential assessment: including facades

Case study: FCUL campus

Elevation (m).

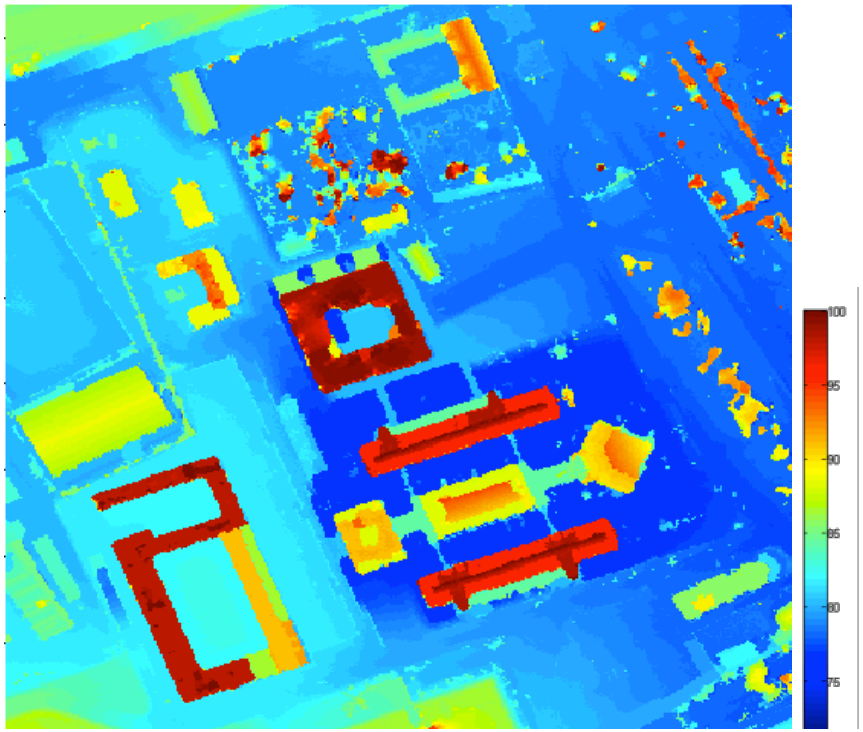


MIT Portugal

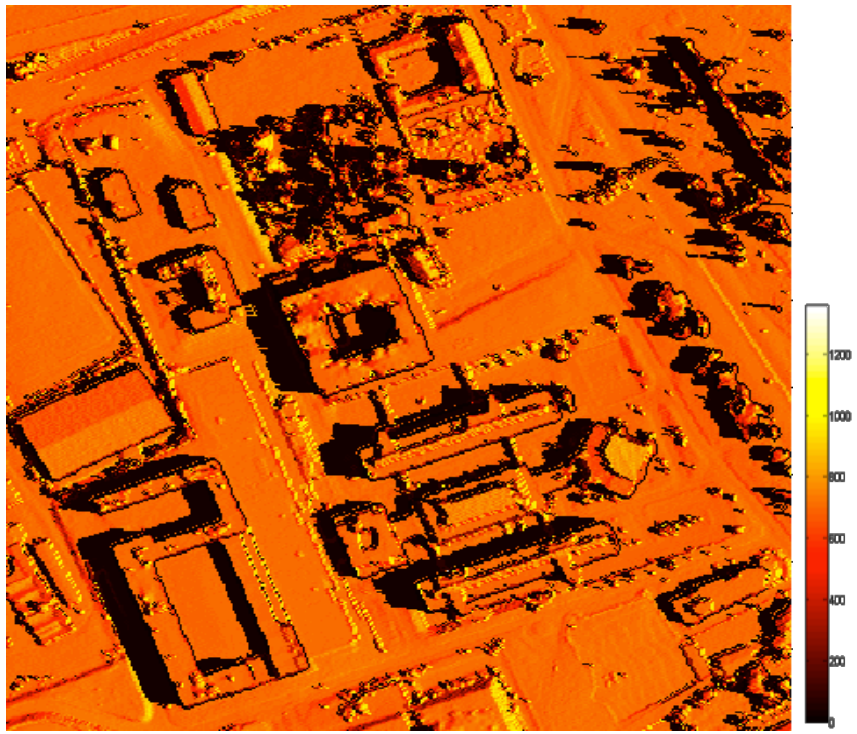
GIS for PV potential assessment: including facades

Case study: FCUL campus

Elevation (m).



Insolation per unit area (kW/m^2).
Model results for June 1st at 9am.



MIT Portugal

GIS for PV potential assessment: including facades

Case study: FCUL campus

Insolation per unit area (kW/m^2).

Model results for June 1st at 9am.

SUMMARY

Solar Energy in the Azores - Green Islands

- Preliminary estimation of PV potential from real meteo data
- Developing Solar Atlas for the archipelago using meteo data + weather modeling
- GIS offers tools for local estimation of solar potential

ACKNOWLEDGEMENTS

PV POTENTIAL & CLIMATE

- Filipa Reis, FCUL (MPP)
- Clarisse Magarreiro, FCUL (MPP)
- Pedro Miranda, FCUL/IDL
- Rita Cardoso, IDL
- Paulo Fialho, Uaç
- Diamantino Henriques, IMAç
- Fernanda Carvalho, IMAç

GIS

- Nuno Gomes, UNL
- Teresa Santos, UNL
- José Tenedório, UNL
- Paula Redweik, FCUL/GEO
- Cristina Catita, FCUL/IDL