
# How can Earth Observations assist the energy sector?

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**World Energy & Meteorology Council & University of East Anglia**
**with input from Copernicus' ECEM team**

European Space Solutions, The Hague (NL), 3 June 2016

# Outline

- It's a crowded space up there
  - Many energy-relevant ESA & NASA missions
  - A variety of (potentially) useful satellite EOs
- How are satellite EOs used for energy?
  - Many applications have been/are being developed
  - Understanding EOs limitations/complementarities
- Looking forward
  - Novel satellite EOs applications for energy
  - What's the uptake of satellite EOs energy applications?

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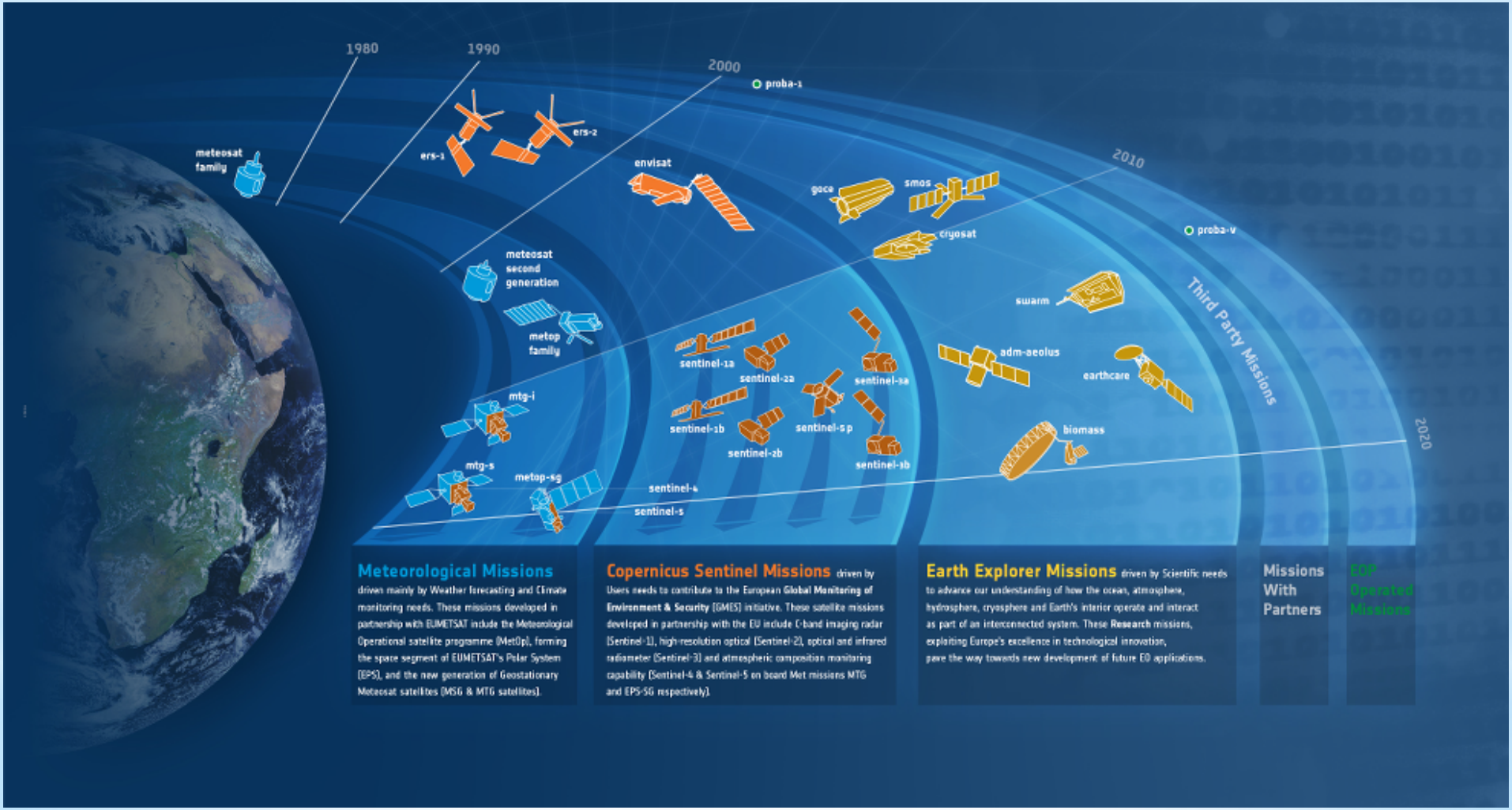
# The ESA EO programme

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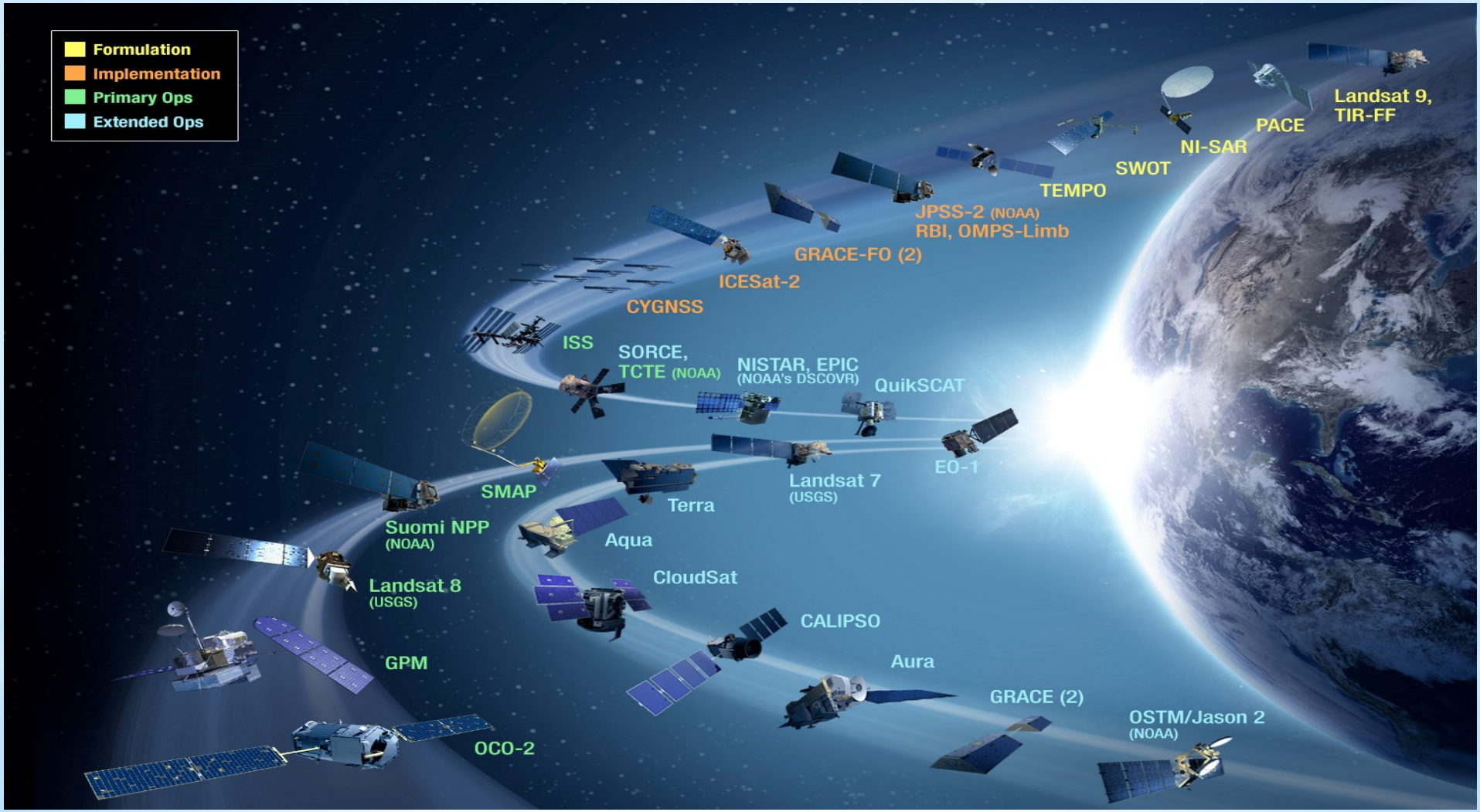
# The NASA EO program



# Satellite EOs & Energy 'pairing'

## Demand
Air temperature
Cloud cover
Water vapour
Albedo
Nighttime lights

## Hydro
Soil moisture
Precipitation
Snow cover
Elevation
River/lake par
Gravimetry

## Solar
Solar irradiance
Cloud cover
Water vapour
Aerosols
Albedo
Air Temperature
Land cover
Elevation

## Biomass
Solar irradiance
Air Temperature
Precipitation
Soil moisture
Land cover
Cloud cover
Albedo
Elevation

## Wind
Elevation
Offshore winds
Wave/currents
Ocean altimetry

## Marine
Offshore winds
Wave/currents
Ocean altimetry

## Thermal
Air Temperature
River/lake par

## Oil & Gas
Offshore winds
Wave/currents
Ocean altimetry

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# Satellite EO Applications for Energy

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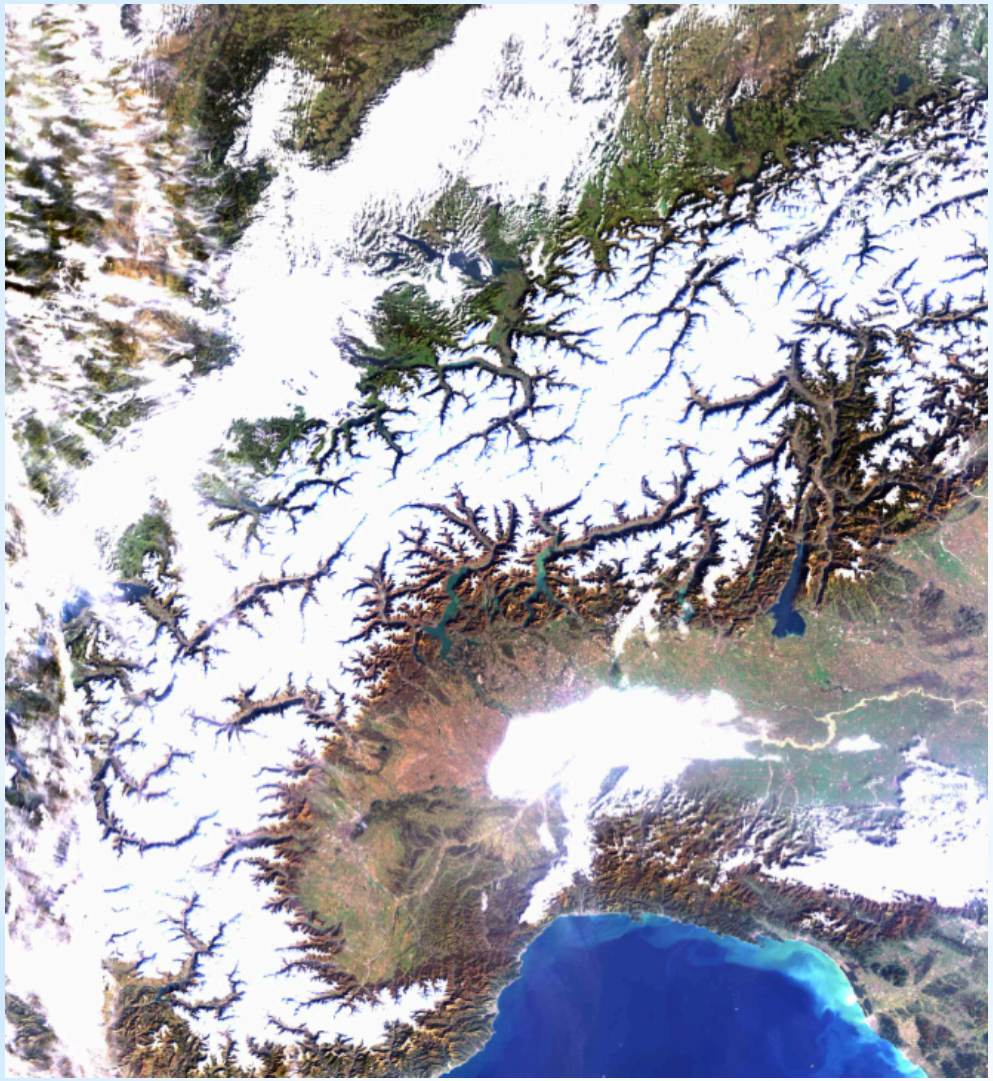
# Snow cover measured from space



From snow extent to snow water equivalent (using snow thickness in situ data), as a proxy for potential hydropower fuel stored in snow

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Mathieu (2015)

# Webservice-Energy


http://www.webservice-energy.org

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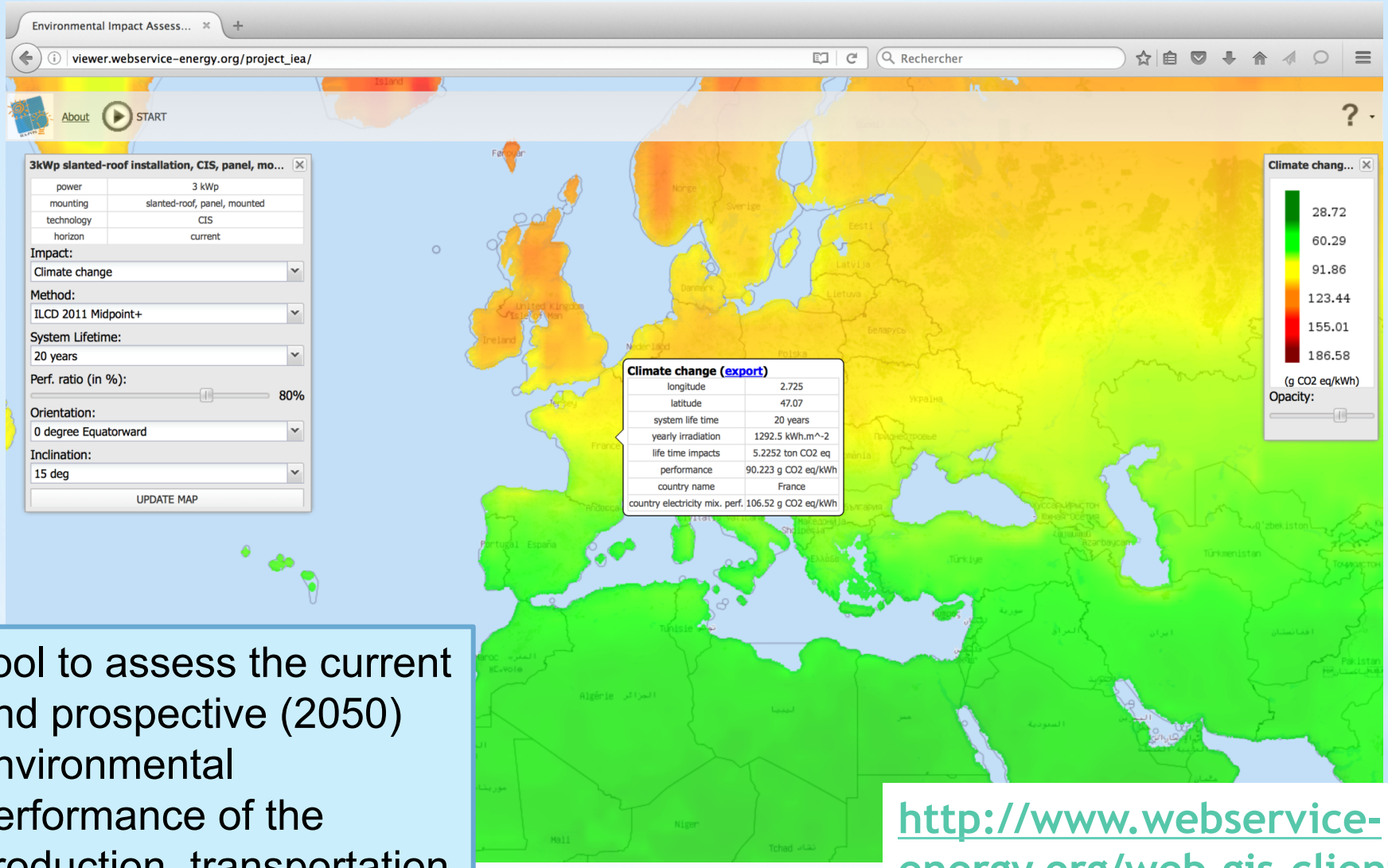
# Environmental performance tool for PV




Tool to assess the current and prospective (2050) environmental performance of the production, transportation and use of PV systems

http://www.webservice-energy.org/web-gis-client

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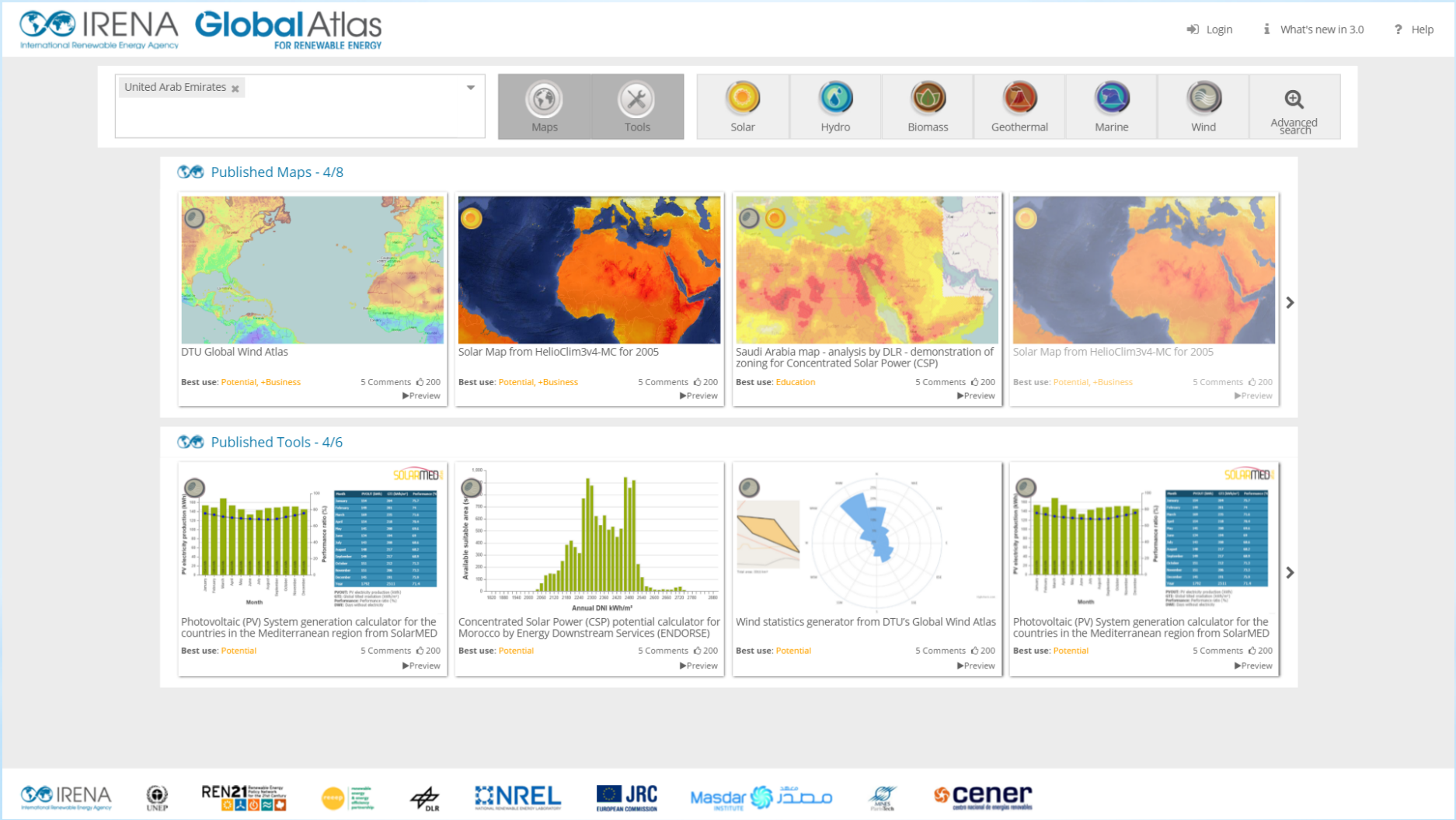
# IRENA Global Atlas

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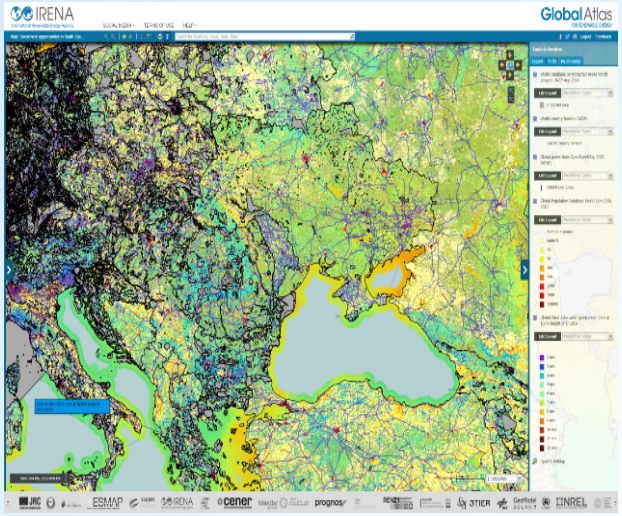
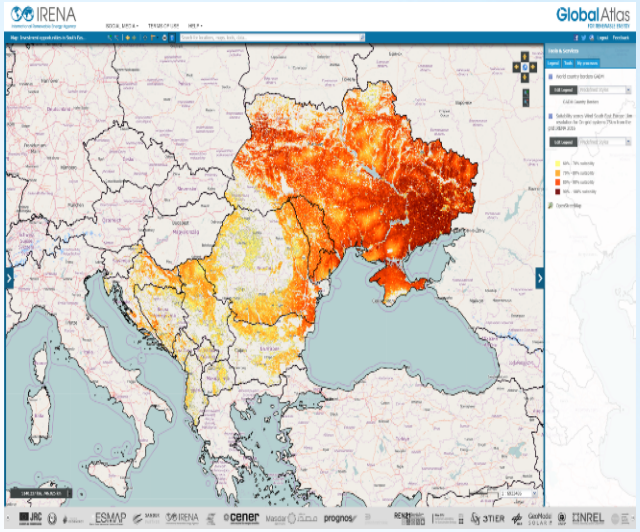
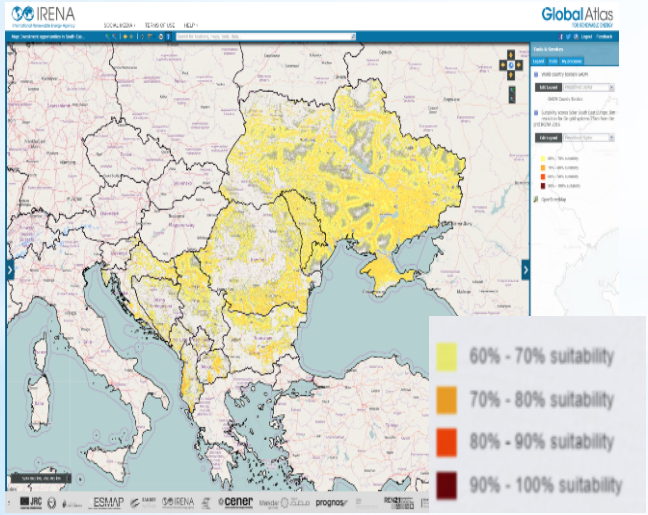
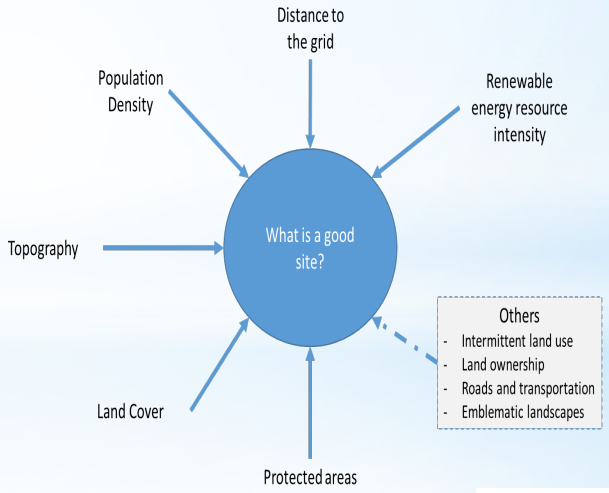
# Combining sources of information

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IRENA
International Renewable Energy Agency

# Limitations satellite-based EO & possible complementarities

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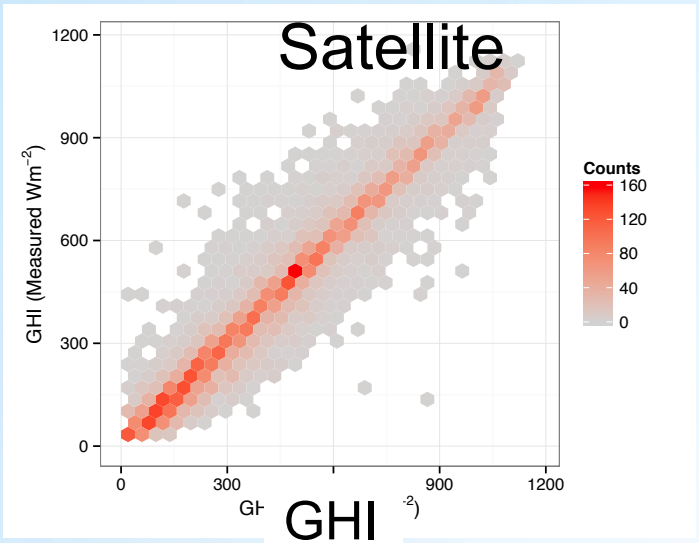
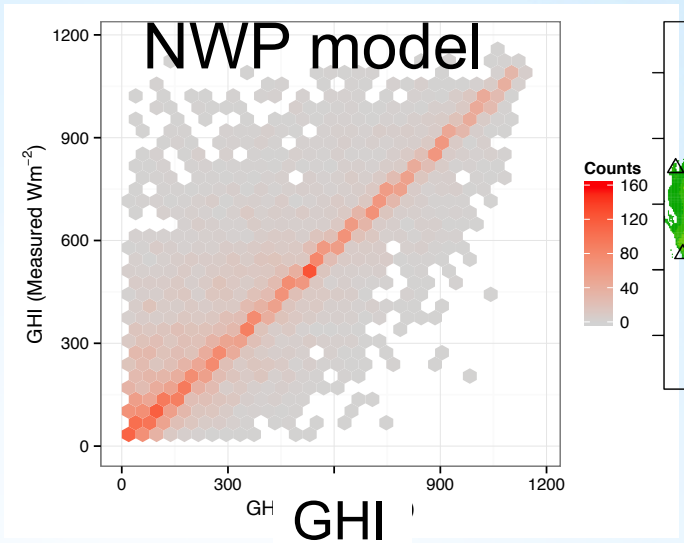
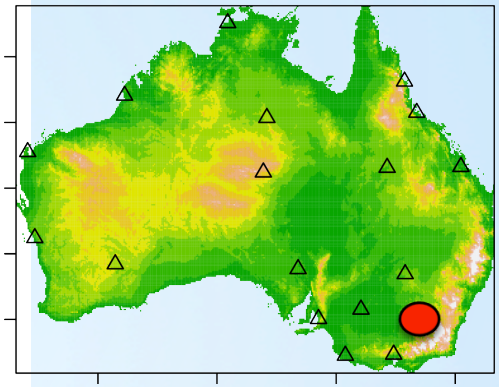
# Solar irradiance assessment



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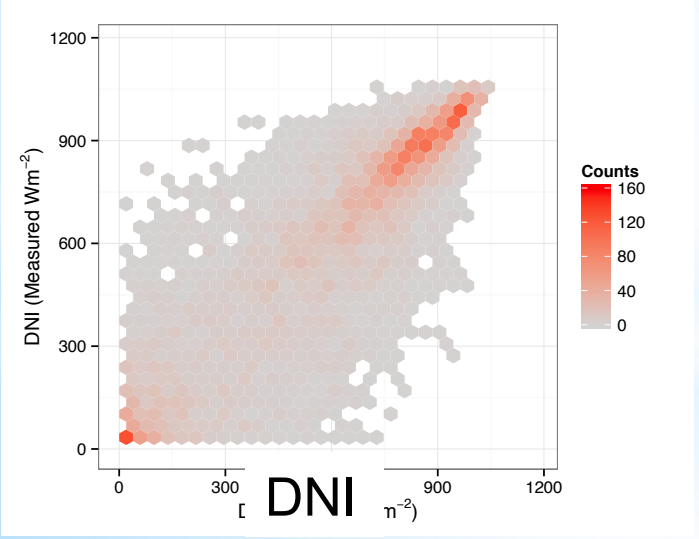


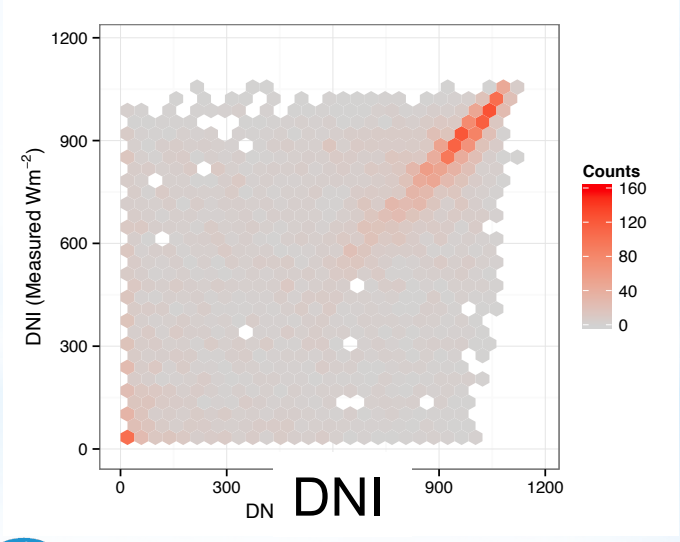


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Davy et al (2016)

# Combining satellite with NWP model

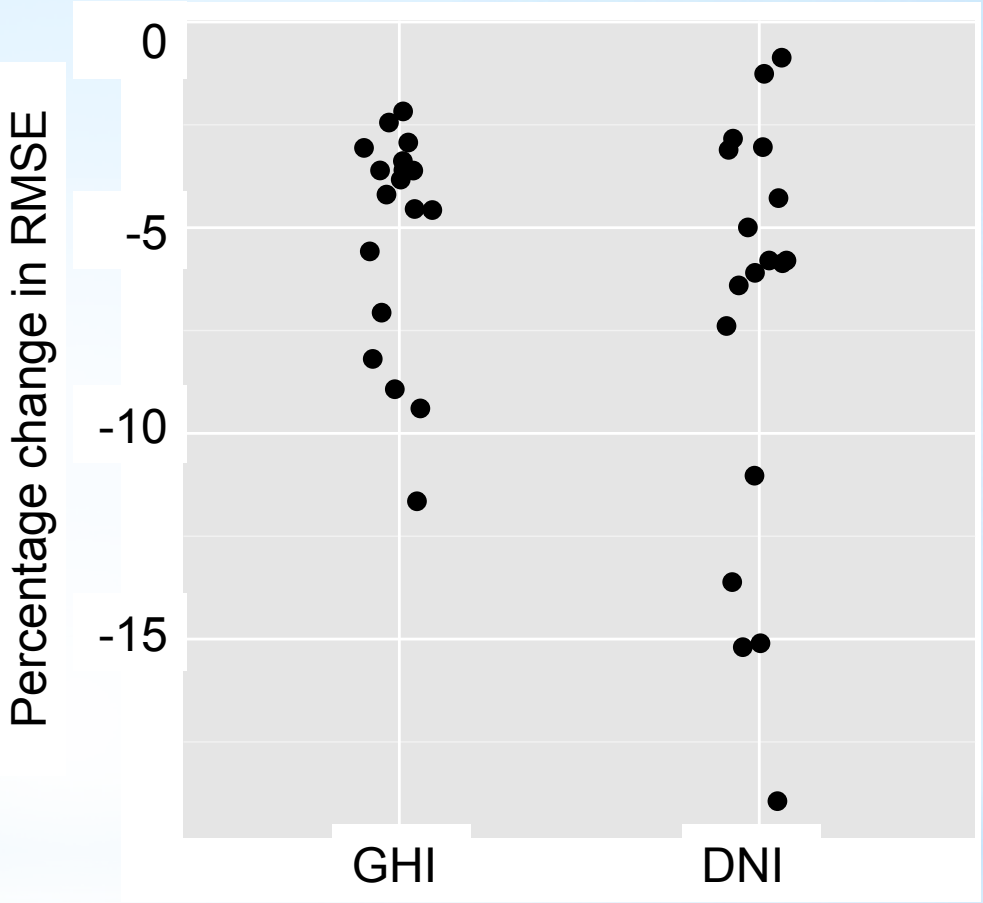
Nonlinear fit to hourly ground station data:

$$k_m \sim f( k_s, k_c, \cos(\theta_z) )$$

Generalised additive model (GAM)

Baseline model, satellite GAM:

$k_m \sim f( k_s, \cos(\theta_z) )$




RMSE change when using NWP model in combination to satellite irradiance, compared to satellite irradiance alone.

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Davy et al (2016)

# Novel EO applications

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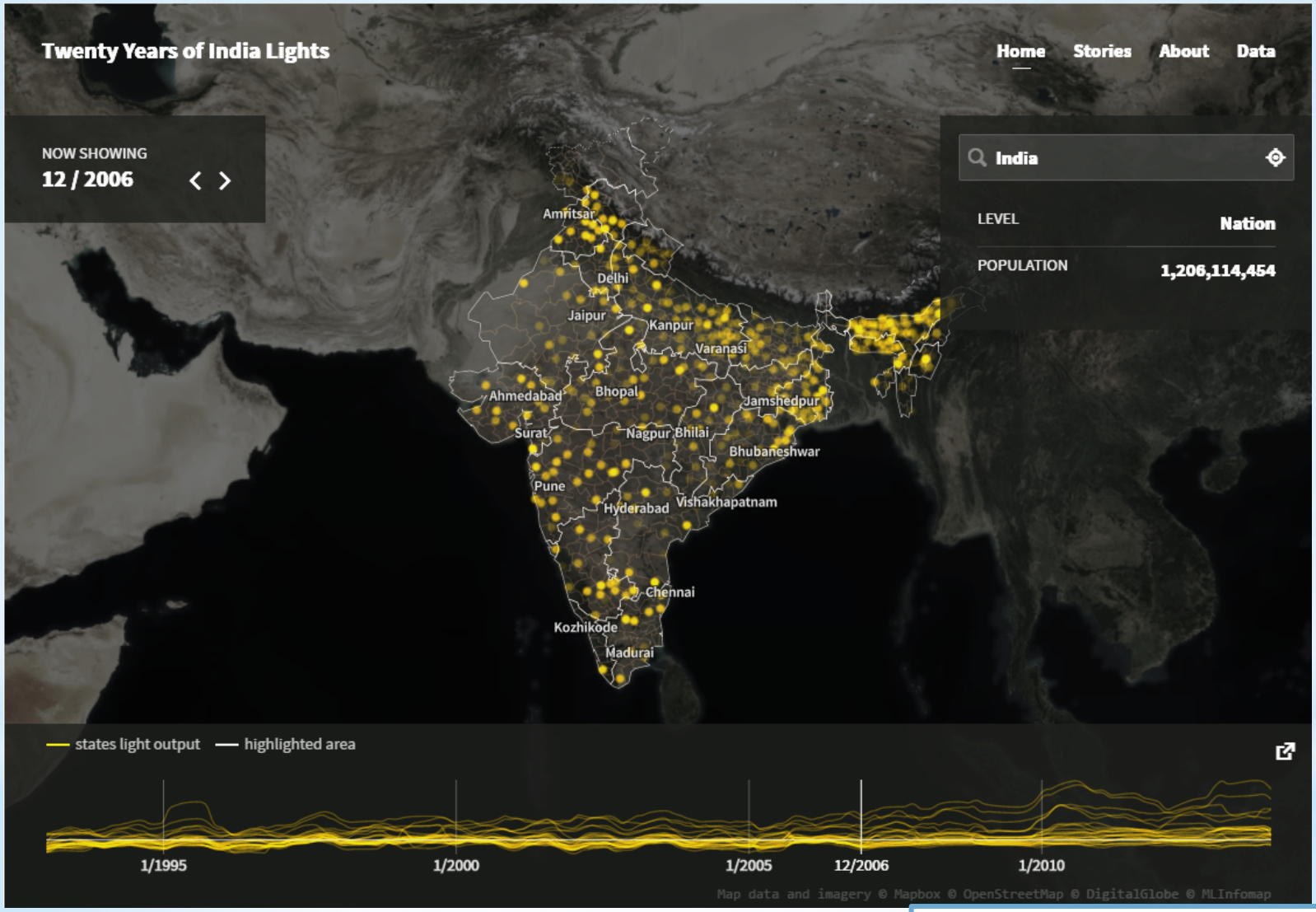
# Eyes in the sky help track rural electrification

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http://blogs.worldbank.org/energy/eyes-sky-help-track-rural-electrification

# MONITORING RURAL ELECTRIFICATION FROM SPACE

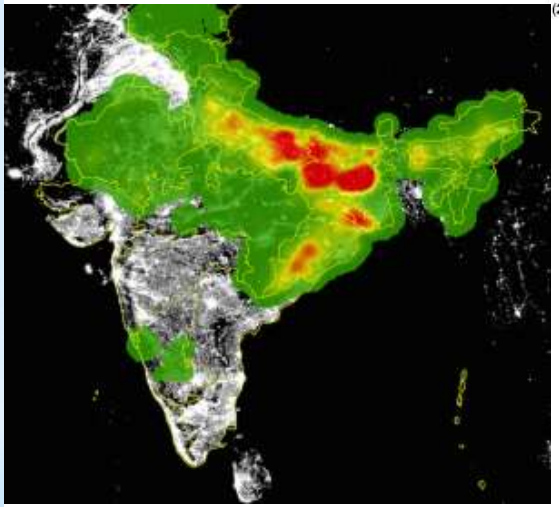
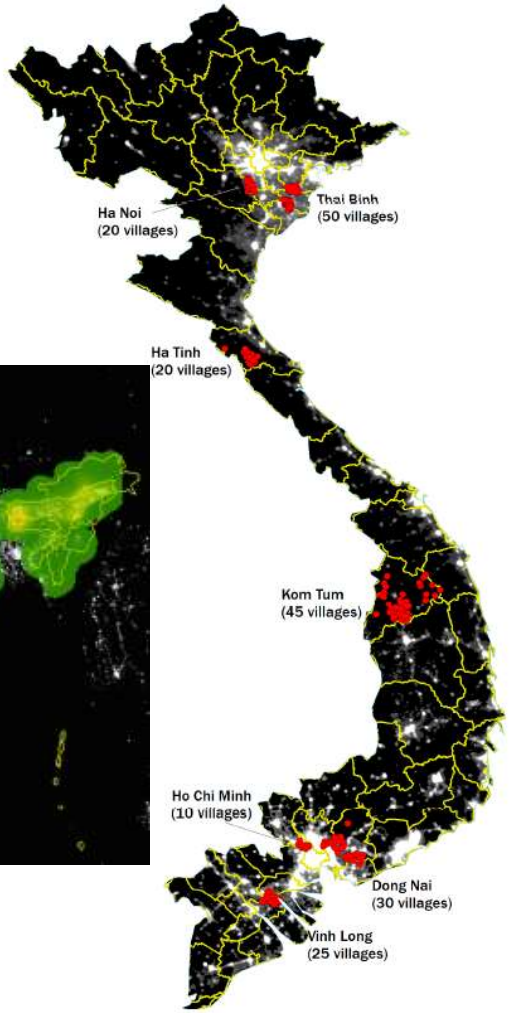


**Figure 3.** Location of surveyed villages.




- **The Tracking Light From the Sky WB Project works in collaboration with National Oceanic and Atmospheric Administration (NOAA), University of Michigan, and Development Seed.**

- **Data-intensive strategy to improve the monitoring of electricity service provision to rural areas in India, following the successful demonstration of the effectiveness of night-time lights satellite imagery for rural electrification monitoring in Africa (Mali, Senegal) and East Asia (Vietnam).**
- **The project collected and analyzed a unique historical archive of nighttime satellite imagery to track the supply of electricity service at the village level spanning nearly 8,000 nights since 1993 in 600,000 villages in India.**



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Courtesy S. Martinez R.

# But what is the uptake of these applications?

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# Some considerations

- Several organisations are developing EO-based applications (ESA, NASA, Copernicus, ARMINES, …)
- … with a varying degrees of co-ordination/ dissemination (IRENA, WBG, GEO, GFCS, …)
- EO data normally used for pre-feasibility assessments – but only a limited number of variables are fully exploited (e.g. irradiance)
  - Private companies develop their own tools … but level of uptake is poorly documented
  - What about a catalogue of EO success stories with guidance on best practice for energy applications?

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Thank you