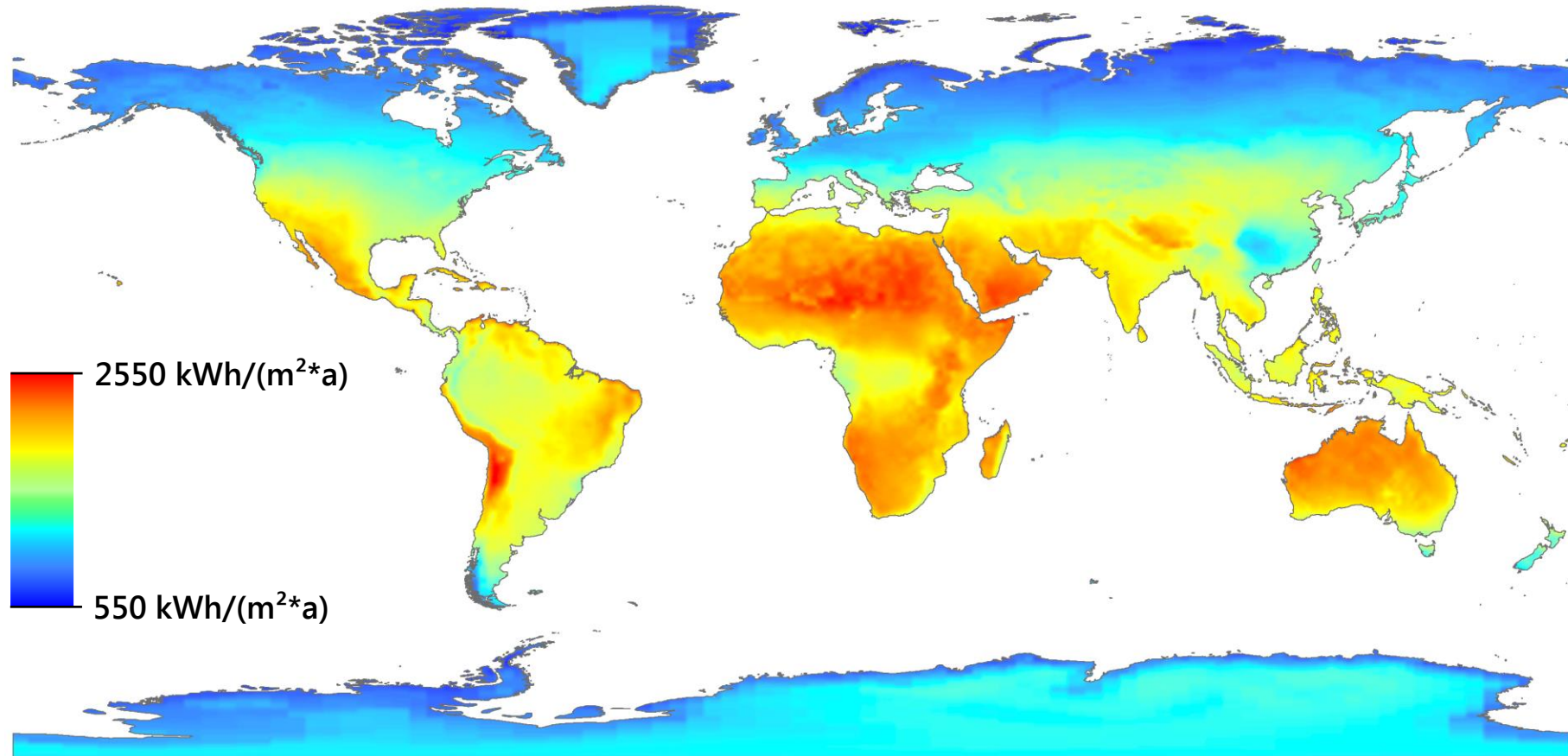




**Global stress classification system for
materials used in solar energy applications**

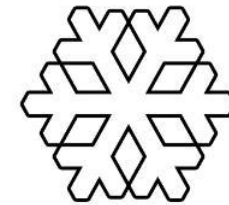
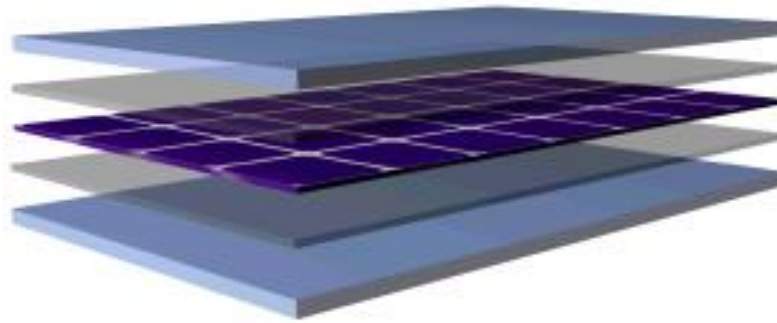
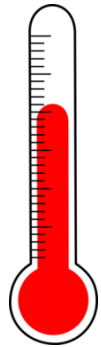
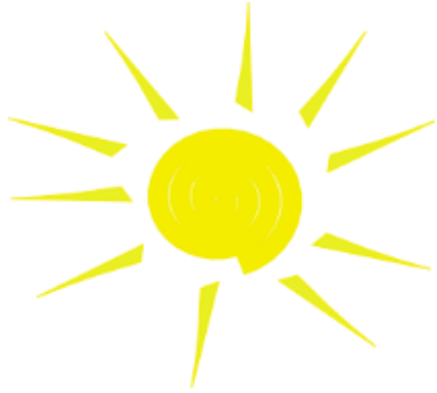
Global solar energy potential



Average global horizontal irradiation

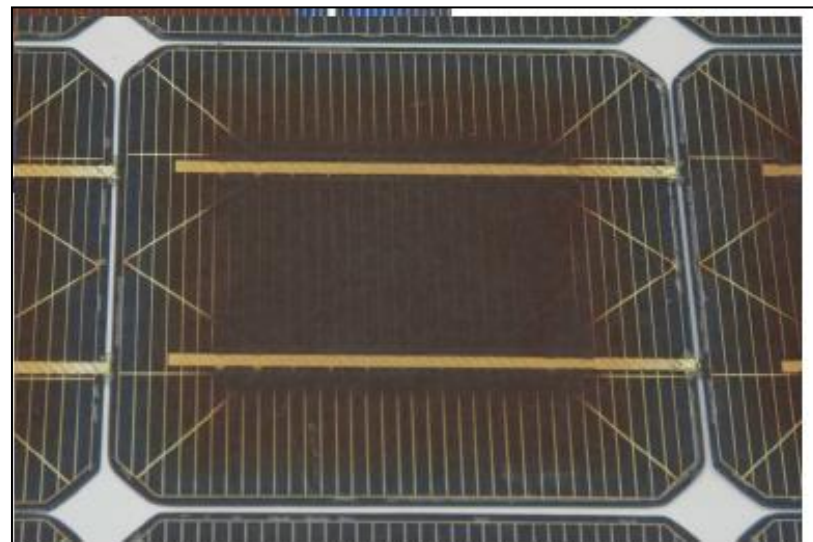
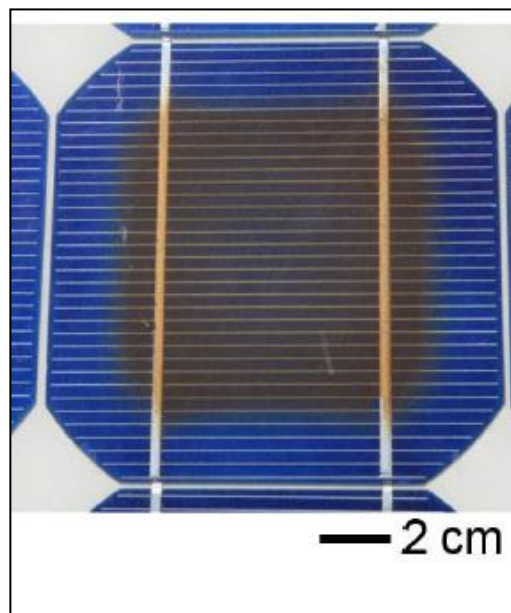


Outdoor exposure



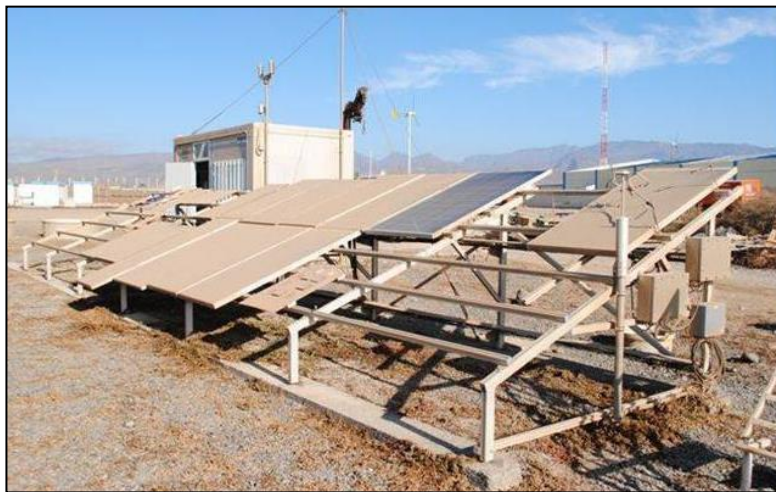
Various environmental stress factors cause different damages on solar energy materials

Damages on PV materials from the field



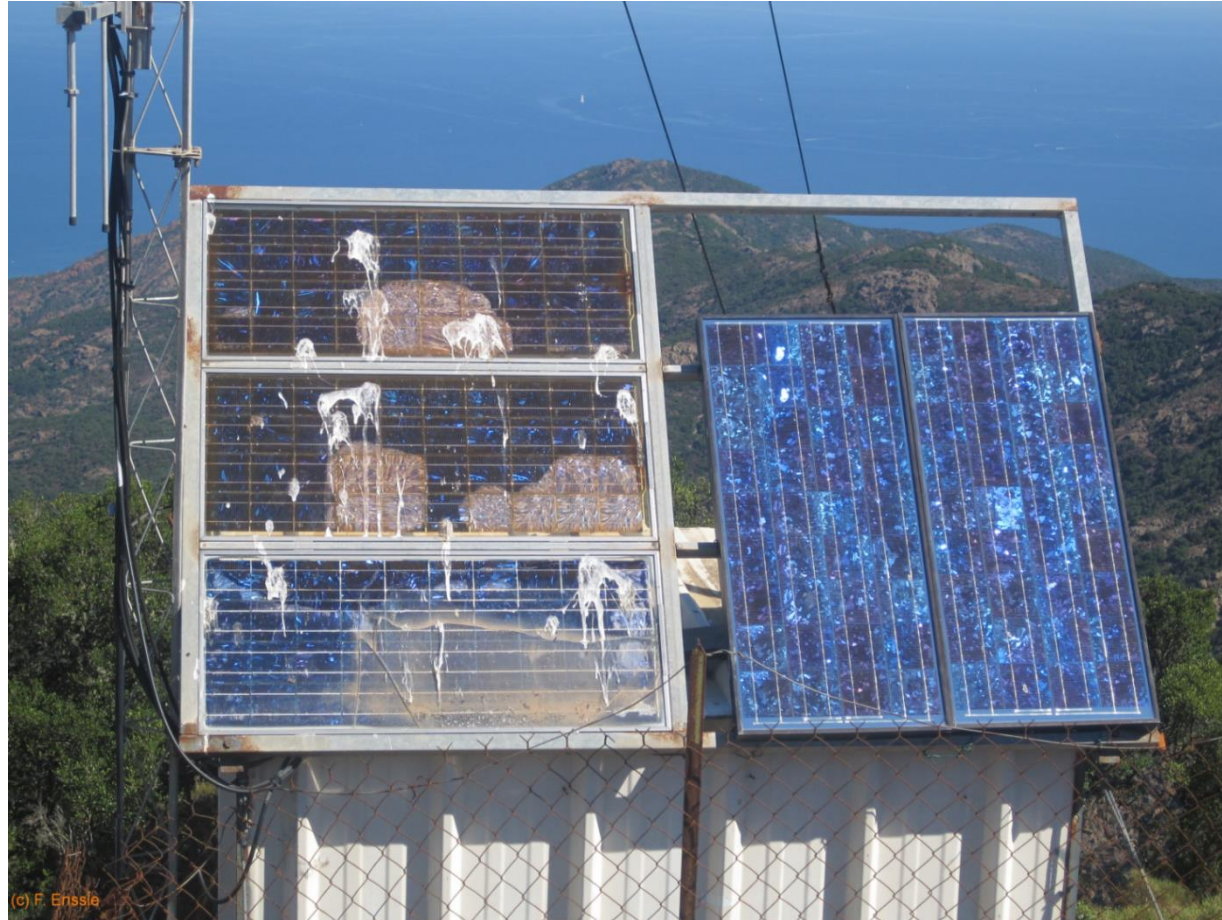
Discoloration of encapsulant

Damages on PV materials from the field



Corrosion of metal constructions

Damages on PV materials from the field



Different effects of extreme degradation

Example of a global classification system

EQUATORIAL

- Af
- Am
- As
- Aw

SNOW

- Dfa
- Dfb
- Dfc
- Dfd
- Dsa
- Dsb
- Dsc
- Dwa
- Dwb
- Dwc
- Dwd

ARID

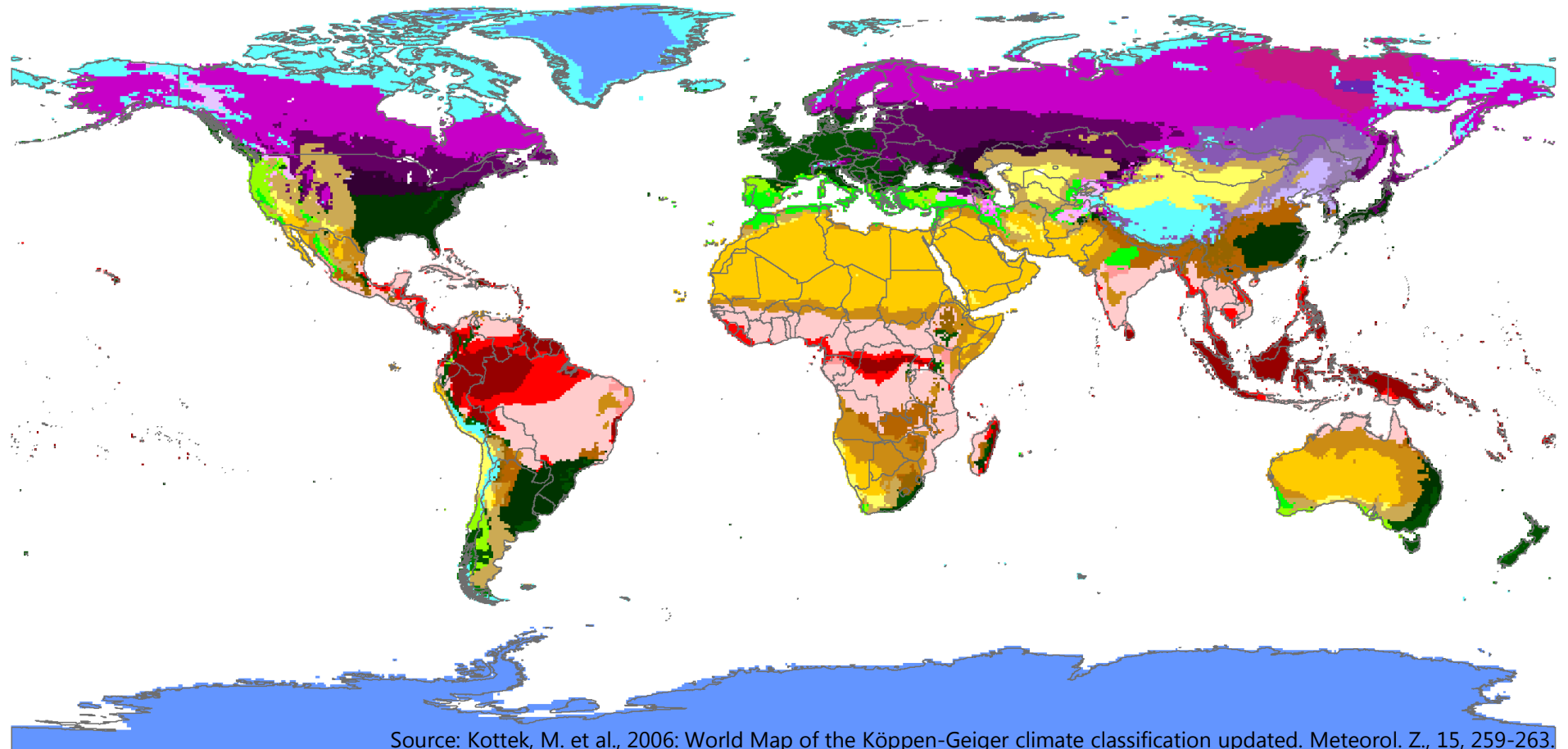
- BWk
- AWh
- BSk
- BSh

WARM TEMPERATE

- Cfa
- Cfb
- Cfc
- Csa
- Csb
- Csc
- Cwa
- Cwb
- Cwc

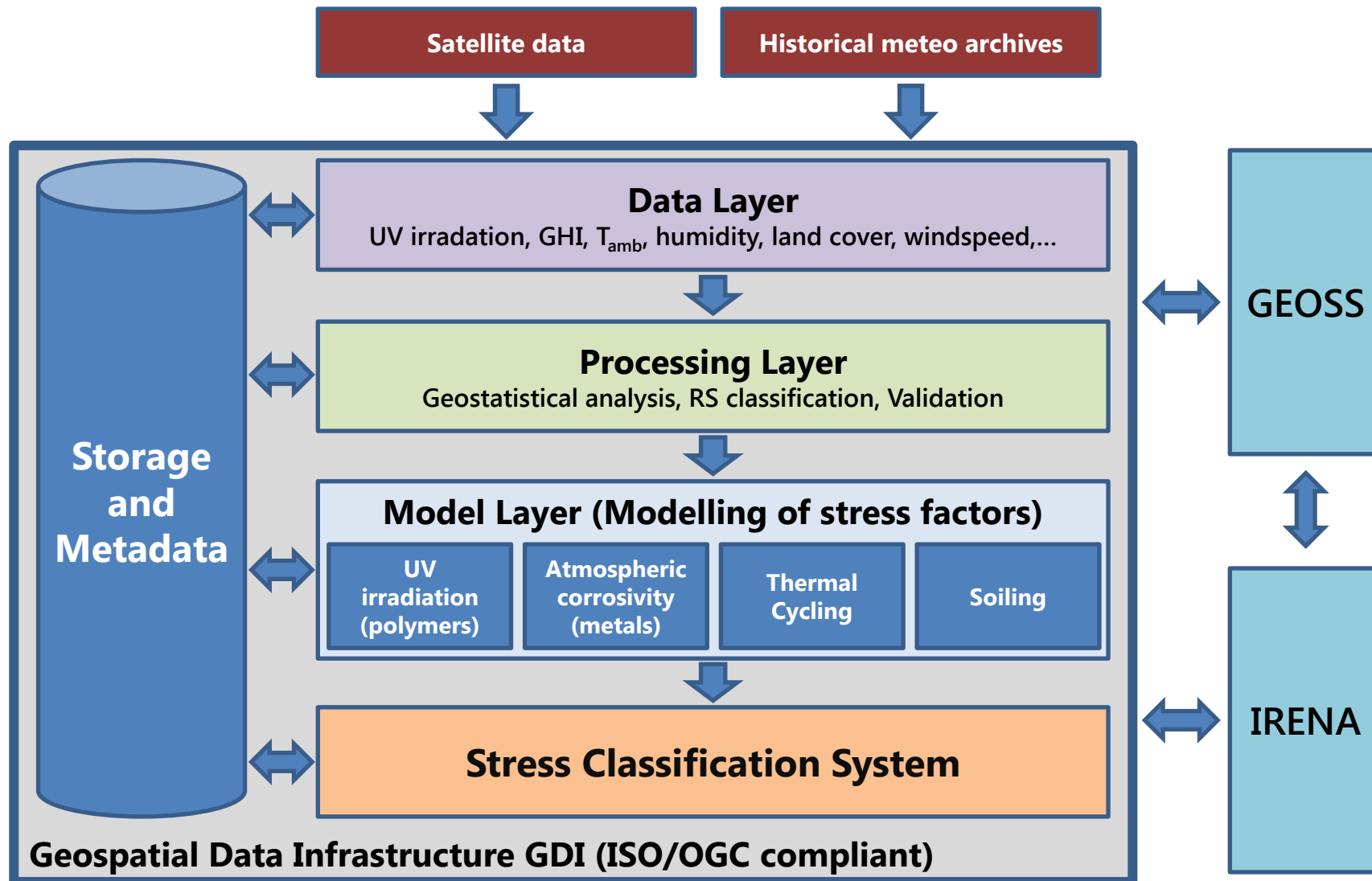
POLAR

- EF
- ET

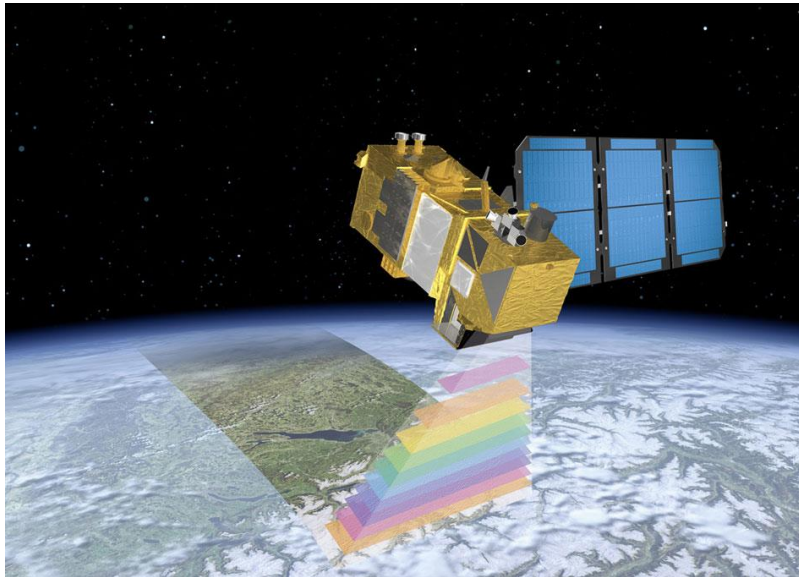


Köppen-Geiger climate classification

Project overview



Data sources

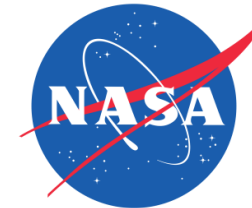


© Airbus Defence and Space



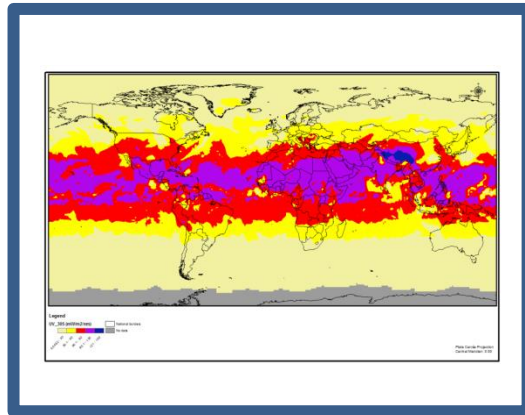
| Name | Version | Data source | Time | Statistics | Area |
|--|---------|--|---------|------------|---|
| SAL - Surface albedo | EDR | Polar orbiting satellites | Monthly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SAL - Surface albedo | EDR | MSG | Monthly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SAL - Surface albedo | EDR | MSG | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SAL - Surface albedo | EDR | Merged MSG and polar orbiting satellites | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SAL - Surface albedo | EDR | Polar orbiting satellites | Monthly | Mean | Arctic |
| SAL - Surface albedo | EDR | Polar orbiting satellites | Weekly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SAL - Surface albedo | EDR | MSG | Weekly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SAL - Surface albedo | EDR | MSG | Weekly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SAL - Surface albedo | EDR | Polar orbiting satellites | Weekly | Mean | Arctic |
| SDL - Surface downward longwave radiation | EDR | Polar orbiting satellites | Monthly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SDL - Surface downward longwave radiation | EDR | MSG | Monthly | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SDL - Surface downward longwave radiation | EDR | MSG | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SDL - Surface downward longwave radiation | EDR | MSG | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SDL - Surface downward longwave radiation | EDR | Merged MSG and polar orbiting satellites | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SID - Surface incoming direct radiation | EDR | MSG | Daily | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SID - Surface incoming direct radiation | EDR | MSG | Monthly | Mean | MSG full disk (includes Europe, Africa, Atlantic Ocean) |
| SIS - Surface incoming shortwave radiation | EDR | Polar orbiting satellites | Daily | Mean | CM SAF baseline area (30N-80N, 60W-60E) |
| SIS - Surface incoming shortwave radiation | EDR | MSG | Daily | Mean | CM SAF baseline area (30N-80N, 60W-60E) |

For example:

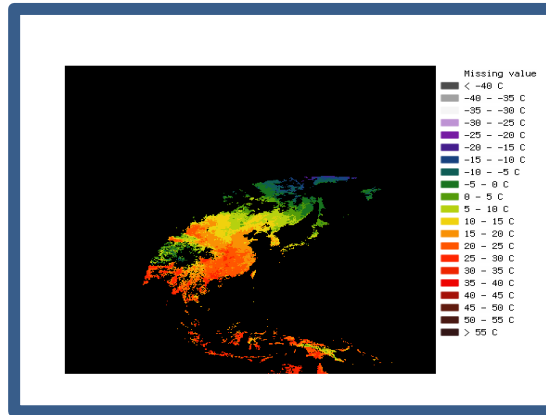


Data processing

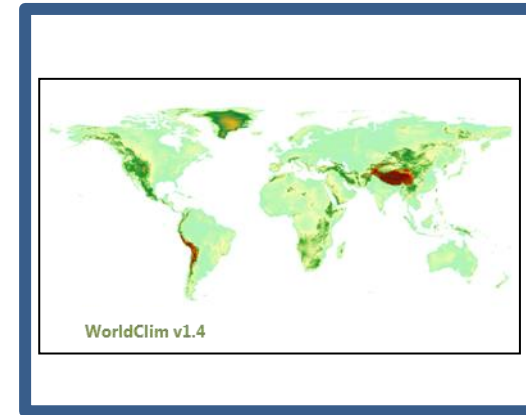
GeoSpatial Layers



UV radiation



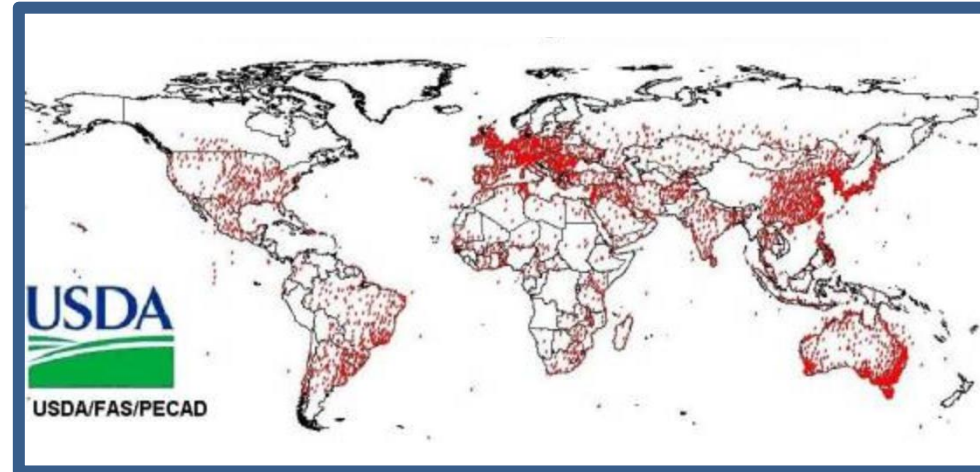
Land surface temp.



Elevation

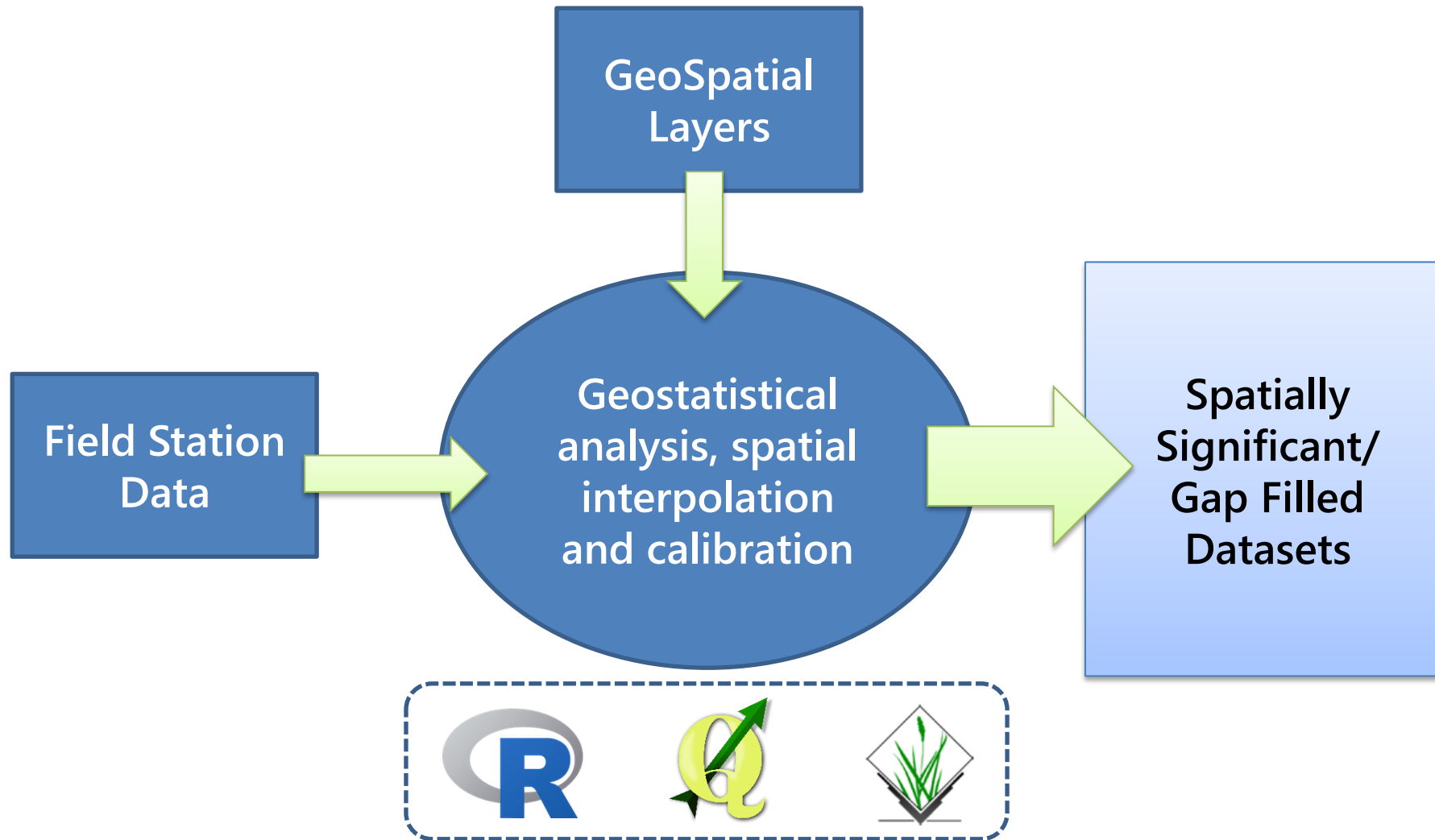
Data processing

Field Station
Data

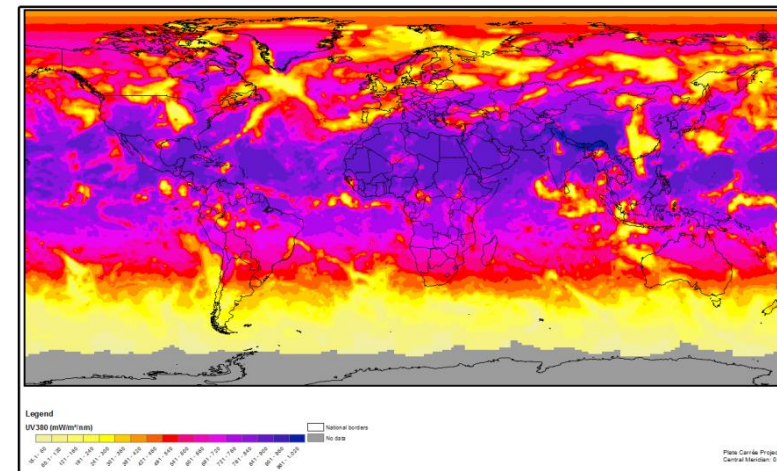
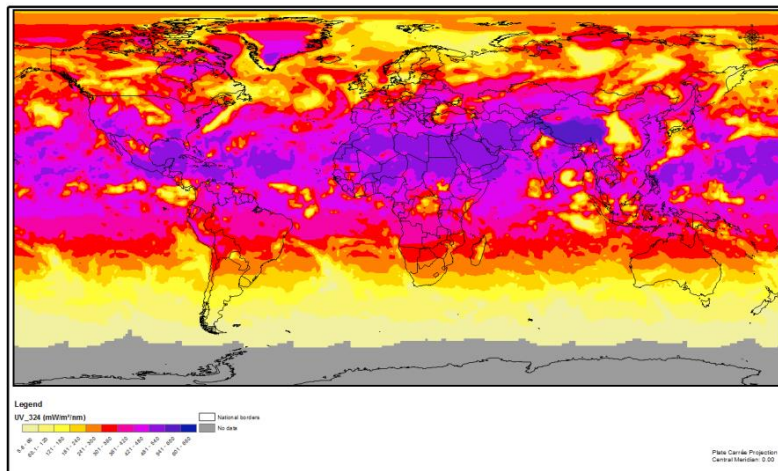
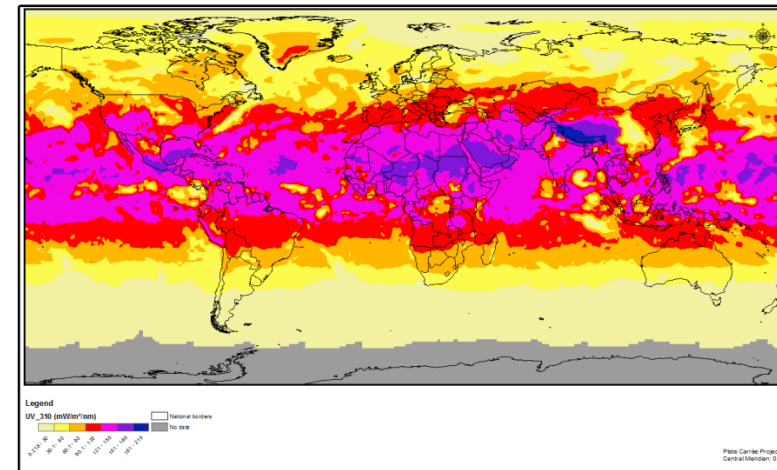
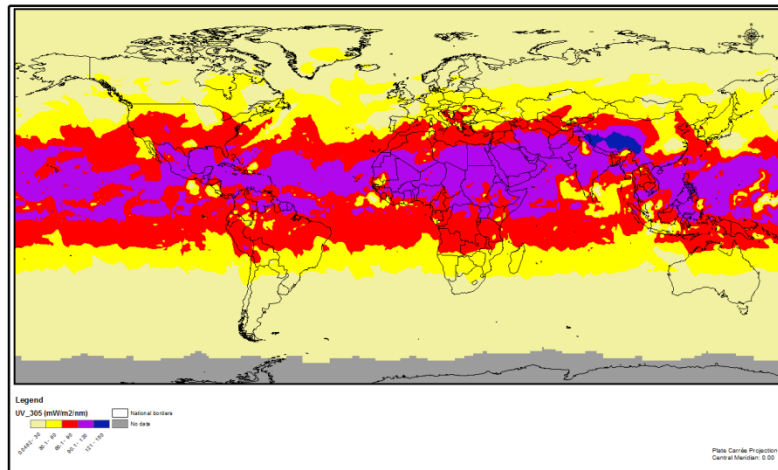


WMO Meteorological Stations

Data processing



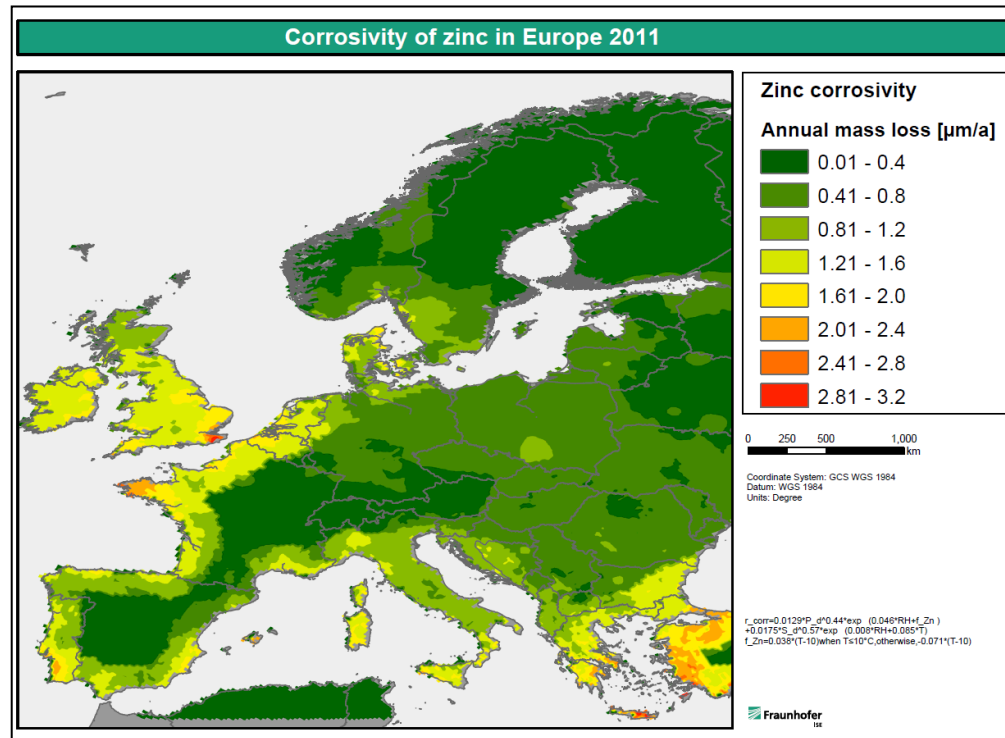
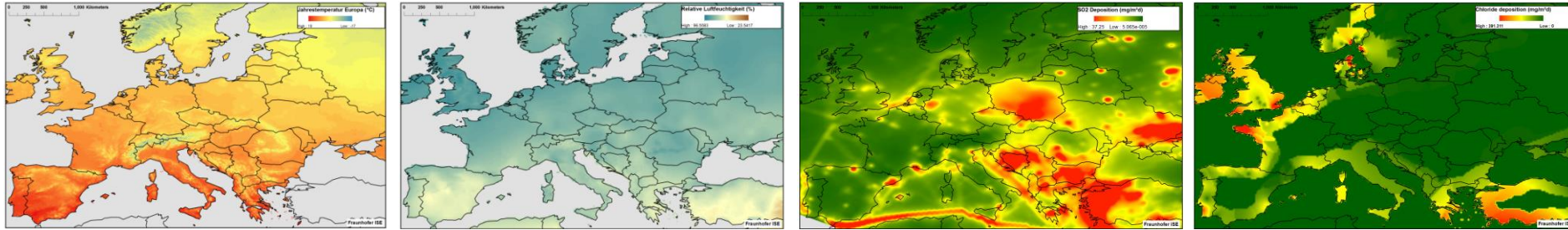
Stress factor modelling: UV irradiation



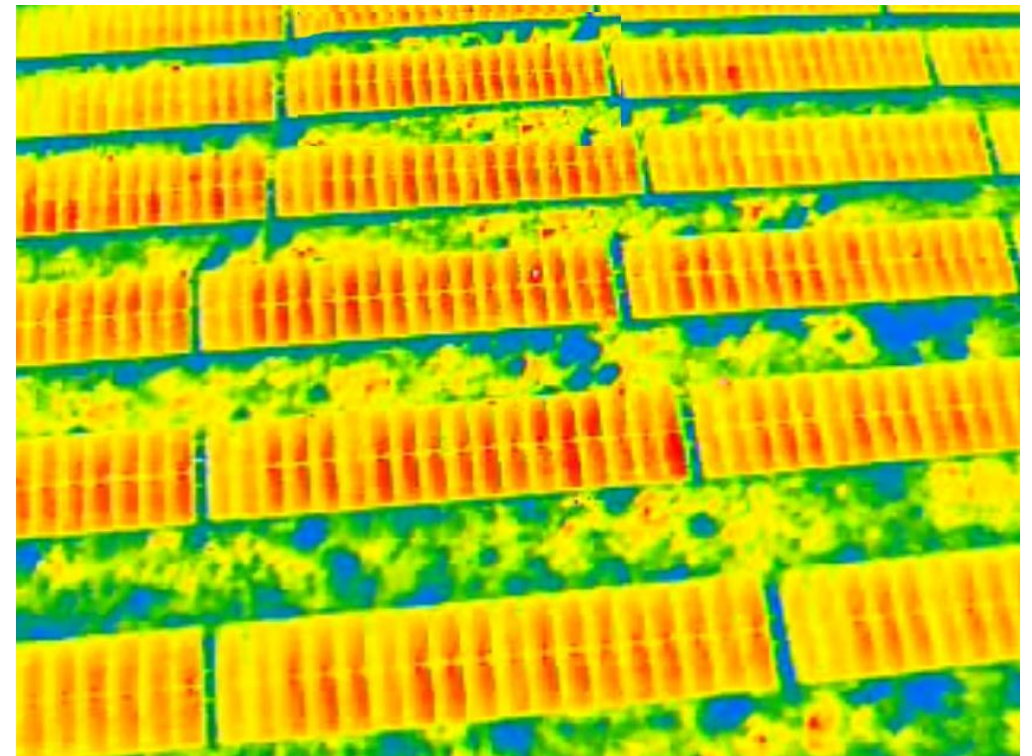
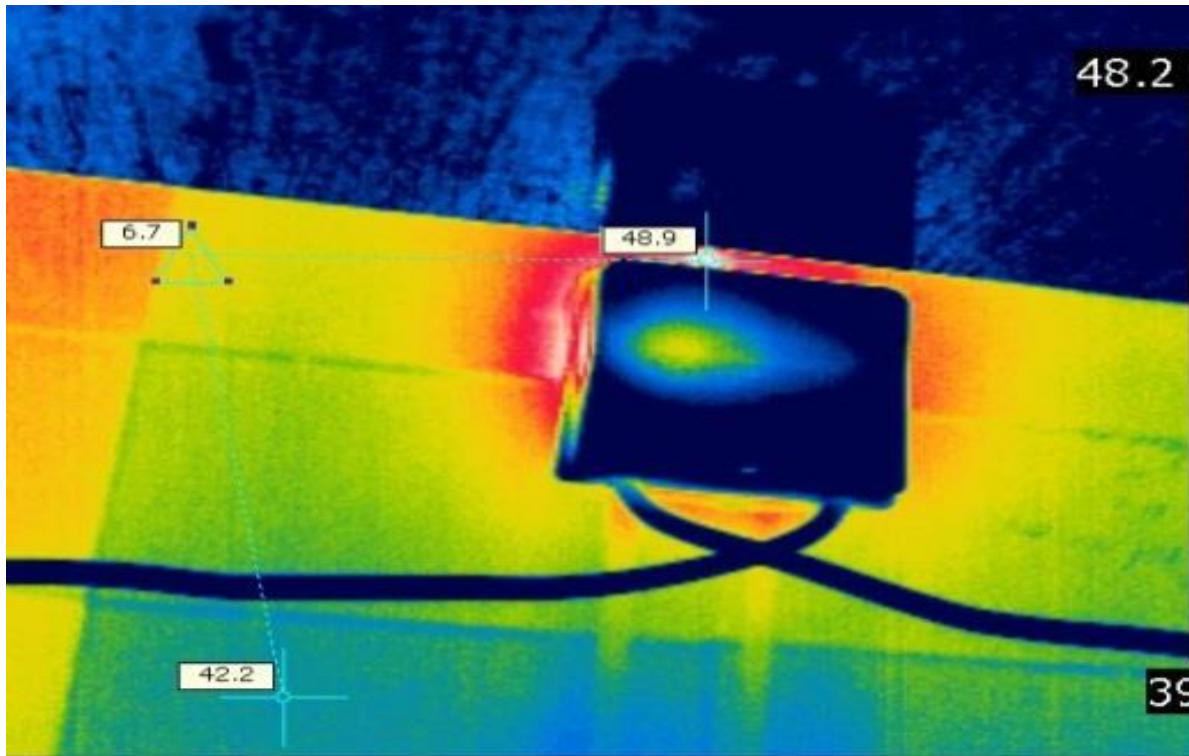
A global map showing distribution of UV irradiance for different wavelenghts on 07/06/2010



Stress factor modelling: Corrosion



Stress factor modelling: Thermal cycling

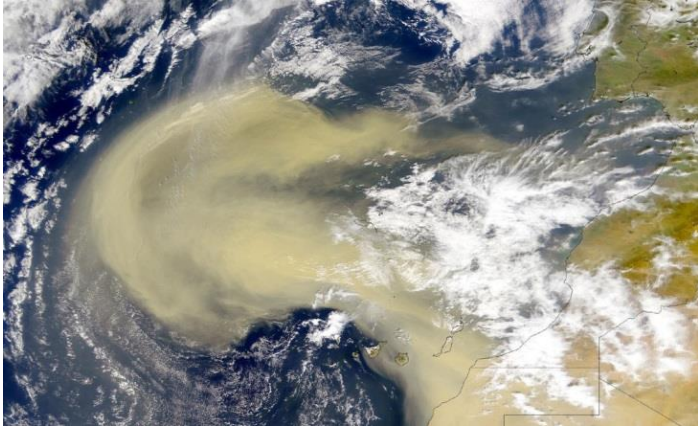


Source: <https://www.aibotix.com/en/inspection-of-photovoltaic-systems.html>

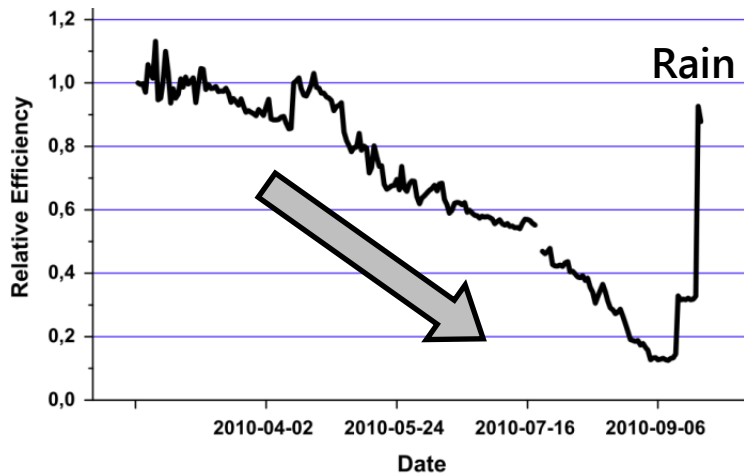
Thermal images of PV systems

Stress factor modelling: Soiling

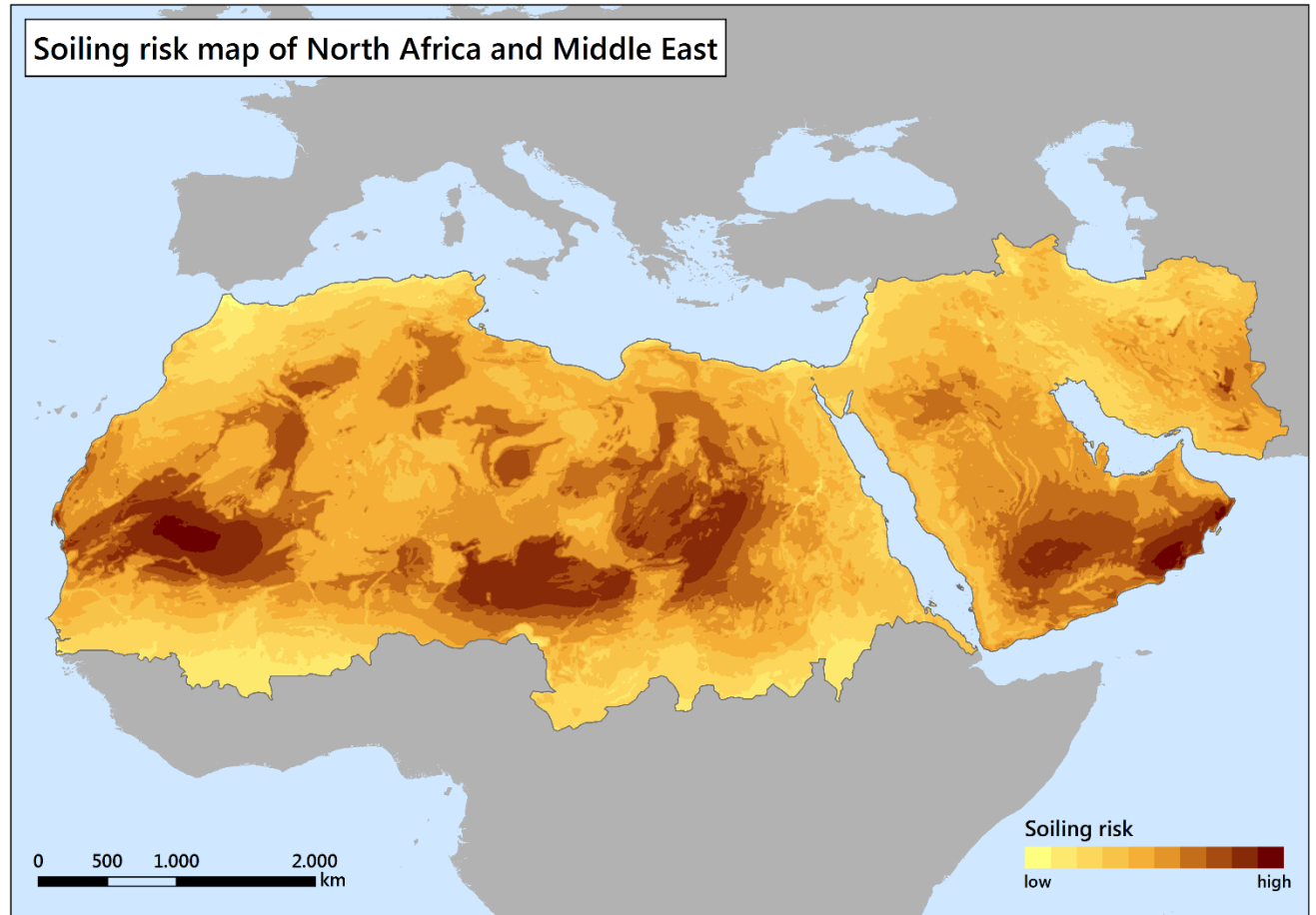
Dust storm over the Atlantic Ocean



Example of extreme soiling on Gran Canaria



Soiling risk map of North Africa and Middle East

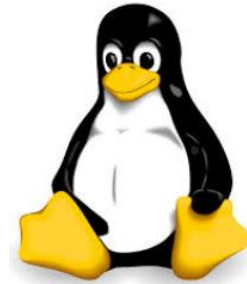


Source: Schill, C. et al., 2015: Impact of soiling on IV-curves and efficiency of PV-modules. Solar Energy, 112, 259-262.

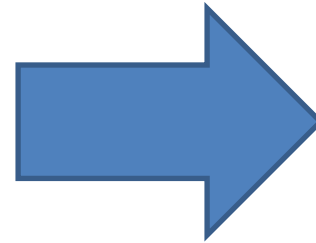
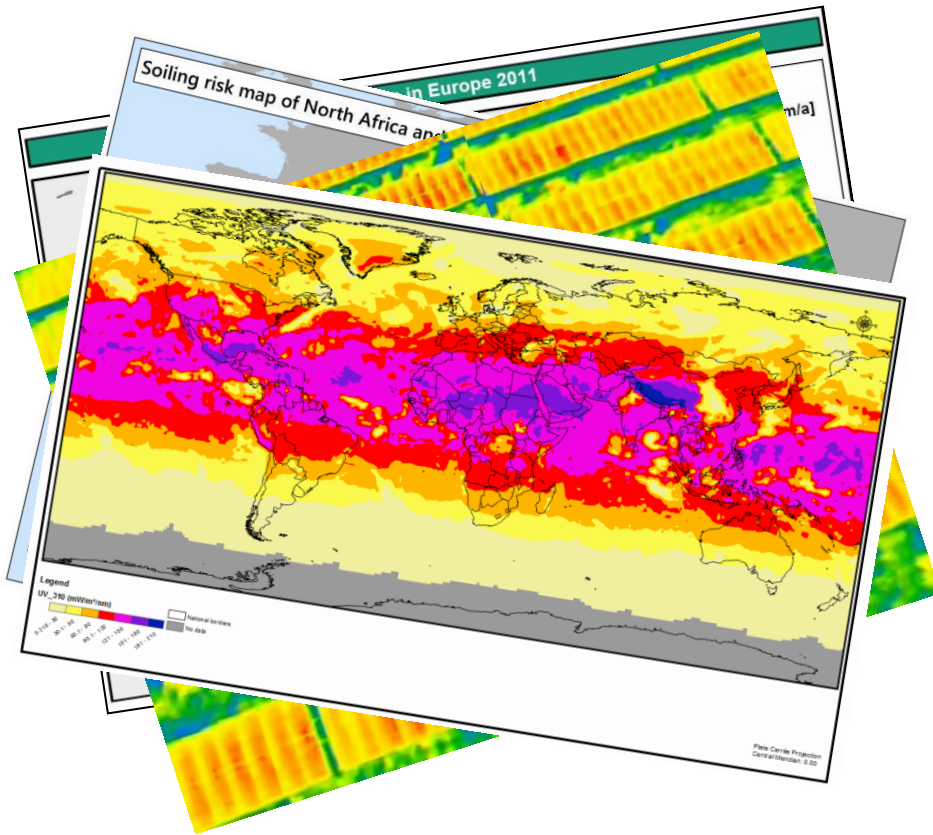


Geospatial data infrastructure

Commitment to Open Source



Objective



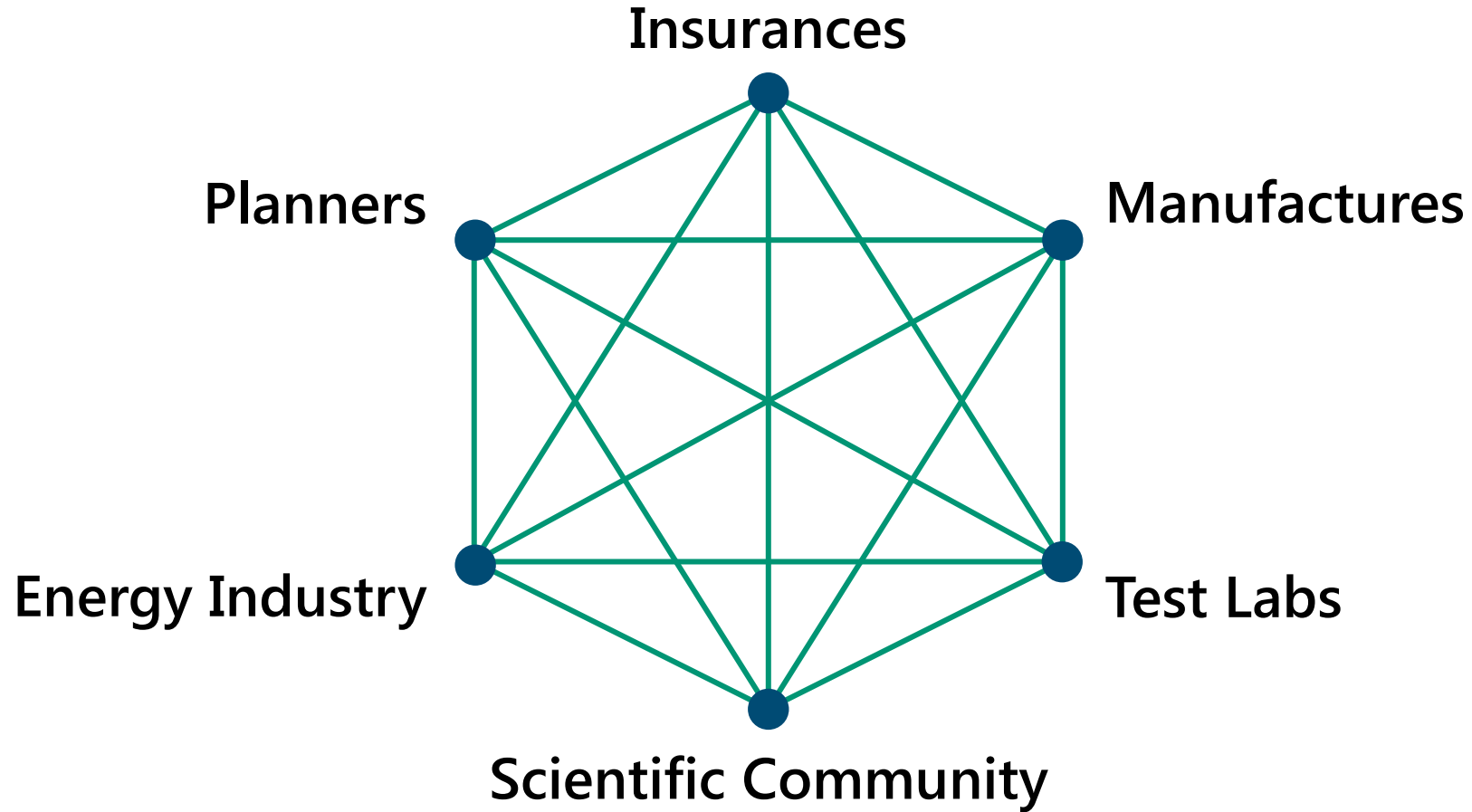
Development of one unified global stress classification system for solar energy applications

- Optimized planning and operation
- Stress zone adapted materials
- Stress zone adapted test procedures
- International standardization

Sustainable use of solar energy



Target audience



Acknowledgment



Funded by:



Baden-Württemberg

MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST



Baden-Württemberg

MINISTERIUM FÜR FINANZEN UND WIRTSCHAFT

