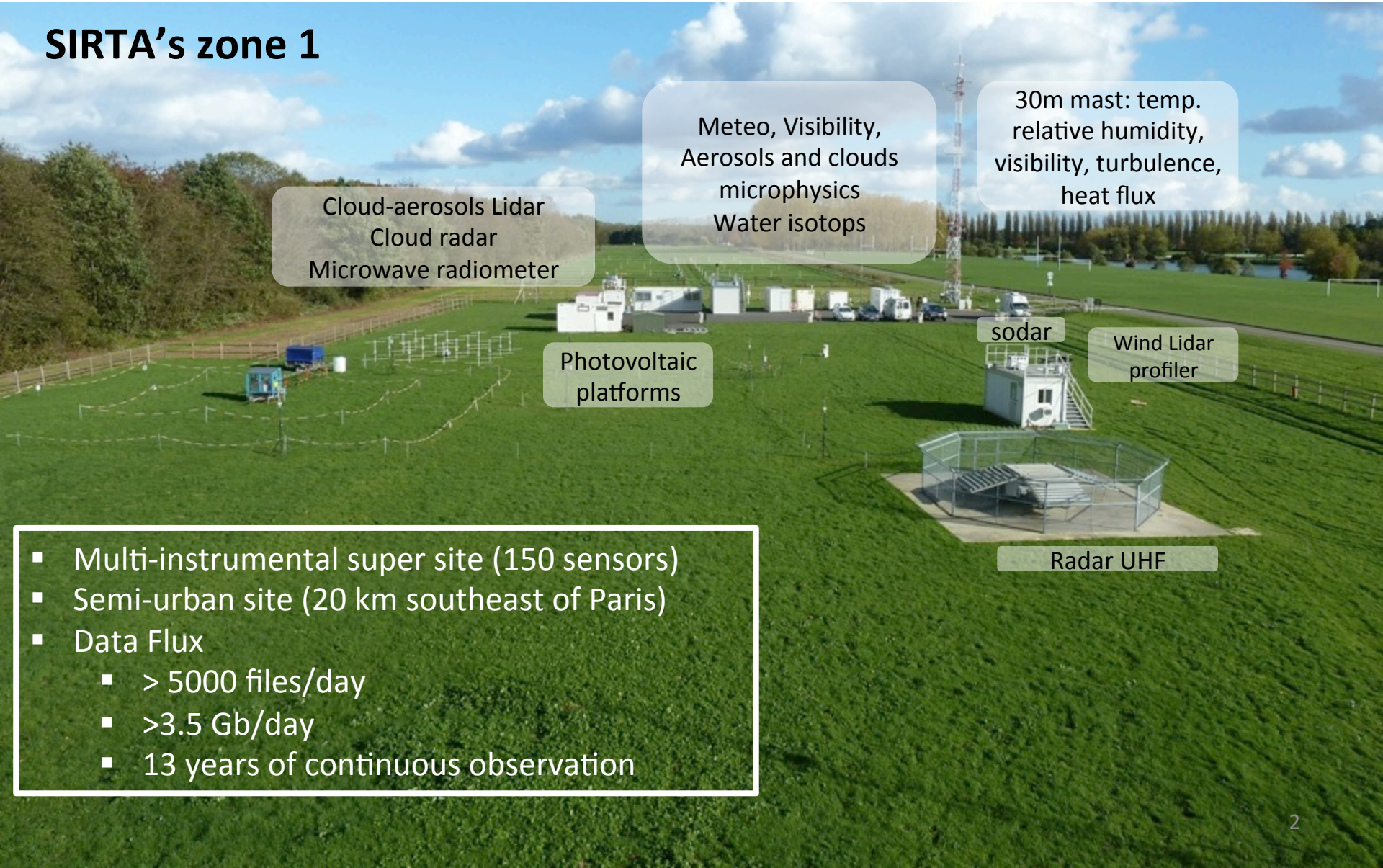
SIRTA-ReOBS: the multi-parameter homogenized and value-added database of the SIRTA observatory in Paris region.

Badosa J. (1), M. Chiriaco(2), S. Bastin(2), JC. Dupont(3), J. Lopez(1), M. Haeffelin(3)

(1) Laboratoire de Météorologie Dynamique, Ecole Polytecnique, Palaiseau, France
(2) LATMOS
(3) Institut Pierre Simon Laplace

SIRTA Atmospheric Observatory in Paris region



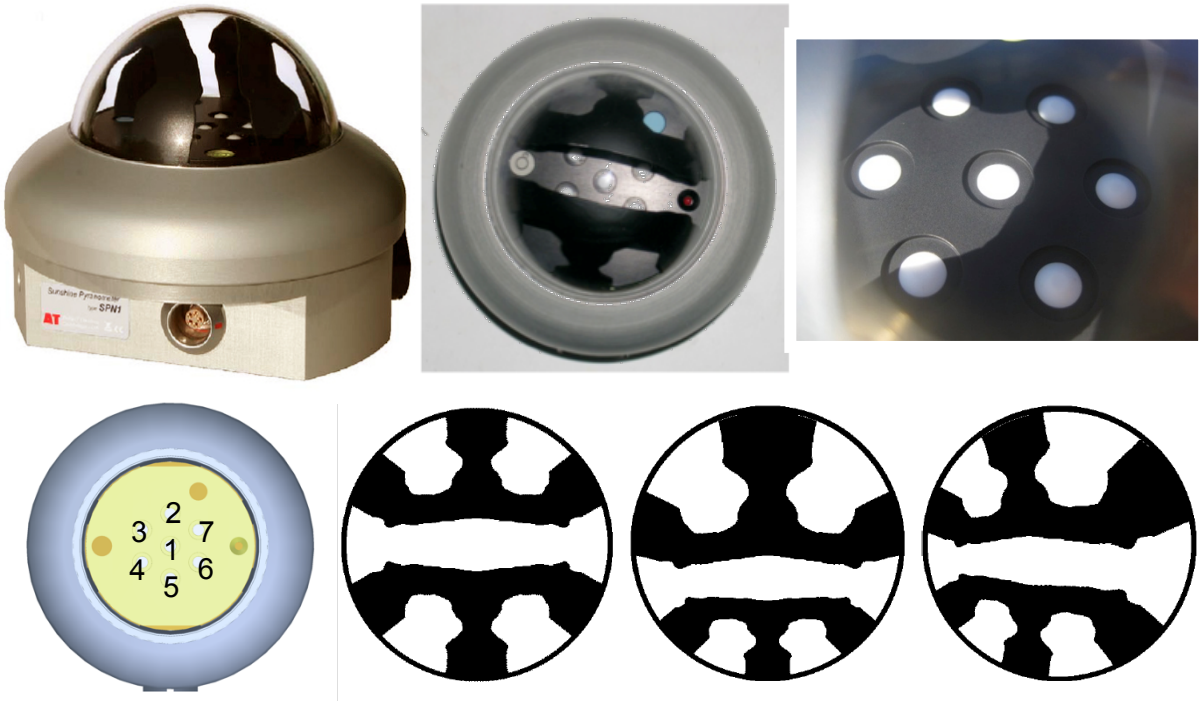
- Multi-instrumental super site (150 sensors)
- Semi-urban site (20 km southeast of Paris)
- Data Flux
  - > 5000 files/day
  - >3.5 Gb/day
  - 13 years of continuous observation

SIRTA Atmospheric Observatory in Paris region

SPN1: An instrument with inherent missing data

responding to a cost-to-performance compromise

Manufacturer: Delta-T (England)
Measurements: 7 thermopiles in an hexagonal symatry and under a mask
Products: Global and diffuse solar (short-wave) irradiance.



Top row: different SPN1 views; photo on the right shows a shadow pattern on the seven sensors for a particular sunny moment.
Bottom row: SPN1 detector numbering; sky seen under shade patterns as seen for sensor 1 (left), sensors 2 and 5 (middle) and sensors 3,4,6,7 (right). Sources: Long et al, 2010 and Delta T, 2007.

More information: Badosa et al, 2014 (AMT)

SIRTA Atmospheric Observatory in Paris region

A joint infrastructure for the atmospheric processes and climate observation and understanding.

SIRTA's main goals:

- **Create scientific knowledge around atmospheric science**
- **Climate monitoring and processes exploring**
- **Field teaching**
- **Dissemination to answer to current society challenges**

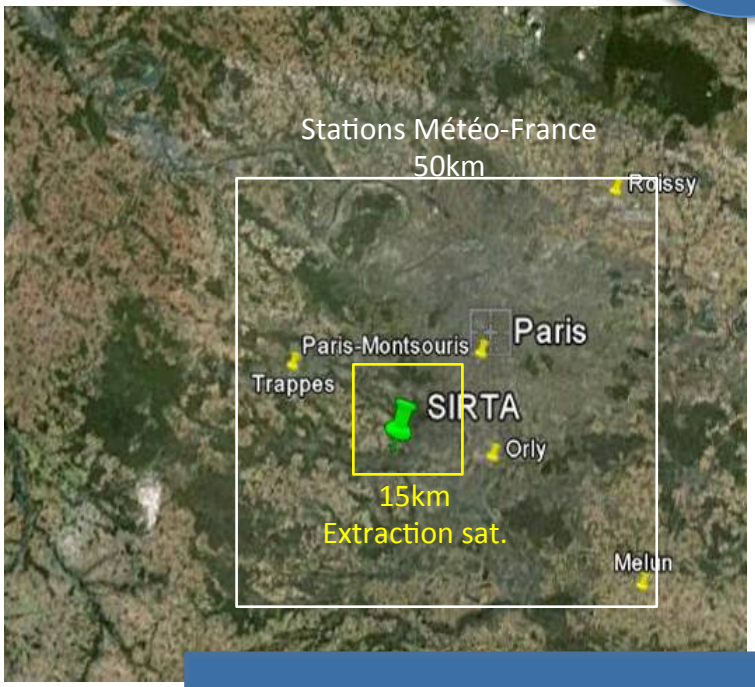
Key facts:

- Founded in 1999
- 6 institutional supervisors: CNRS-INSU, Ecole Polytechnique, CNES, UVSQ, EDF, Météo-France
- 10 research laboratories (IPSL, LMD, LATMOS, CEREA, LSCE, LOA, LPC2A, GeePs, LIMSI, LPICM)
- 1000 "researcher-day" site accesses per year
- 450 "student-day" site accesses per year (from 7 universities)
- 20 publications per year
- 1 Scientific Board with 5 working groups (Regional climate variability, fog and cloud processes, Sources and atmospheric processes, Turbulence and boundary layer dynamics, Renewable energies)

SIRTA-ReOBS: SIRTA + Satellite + spatial uncertainty

SIRTA-*ReOBS* : 12 years of multi-parameter observations at SIRTA

Re = *Re*-calibration
Re-quality-control
Re-averaging
Re-treatment
Re-expertise
…



Satellite obs. extraction

Nearby Météo-France stations

SIRTA Surface, 2m, vertical profiles

- Harmonisation treatment/inversion
- Synchronisations and hourly mean
- Quality control ++
- Standardised nomenclature
- Uncertainty evaluation, representativeness
- Management in instrumentation/algorithm changes
- Documentation/Metadata

SIRTA-ReOBS

✓ Decadal synthesis of around 50 atmospheric parameters

✓ A multi-parameter dataset unique in Europe

SIRTA-ReOBS: Content

- Period: 2003-2014
- Temporal resolution: 1h
- Format: Netcdf
- Number of physical parameters : ~50

- Three variable types:
  - **Standard Meteorological measurements** (2-m Pressure-Temp-RH, U-V at 10m, Precip. + spatial uncertainty).
  - **Advanced atmospheric parameters** (Radiative fluxes, Soil temp. and moisture, heat flux).
  - **Retrieved parameters from observations** (Clear-sky radiative fluxes, aerosol and water vapor optical parameters, Cloud cover, cloud base height (CBH), Mixing layer depth (MLD), Liquid water path (LWP), Meteosat cloud products, Lidar vertical profiles.

- Quality control for each physical parameter:
  - QC Flags: 0 (OK), 1 (extreme values or incomplete hour), 2 (out of physical limits), 3 (missing data).
  - Measurement uncertainty (temporal standard deviation within every hour)

SIRTA-ReOBS: Scientific objectives

Main scientific question:
What's the observed climatic variability in Paris region in a decadal scale?

4 approaches:

- Characterisation of the natural variability
- Understanding the reasons for certain detected anomalies, with distinction of synoptic vs local processes
- Trend detection at the decadal scale and discussion of the anthropogenic contribution
- Study of the impacts/effects of the climatic anomalies on hydrology, agriculture, health, energy and pollution.

SIRTA-ReOBS: Efforts worthwile

These kinds of multi-parameter datasets are essential to answer scientific questions around climate (variability, uncertainty, impacts, trends)

Few supersites existing with a multi-parameter combined dataset
(other examples: sites the US ARM Climate research facility, German multi-instrumented sites used to evaluate the HD(CP)2 climate predictions).

Constructing such a database implies many efforts in:

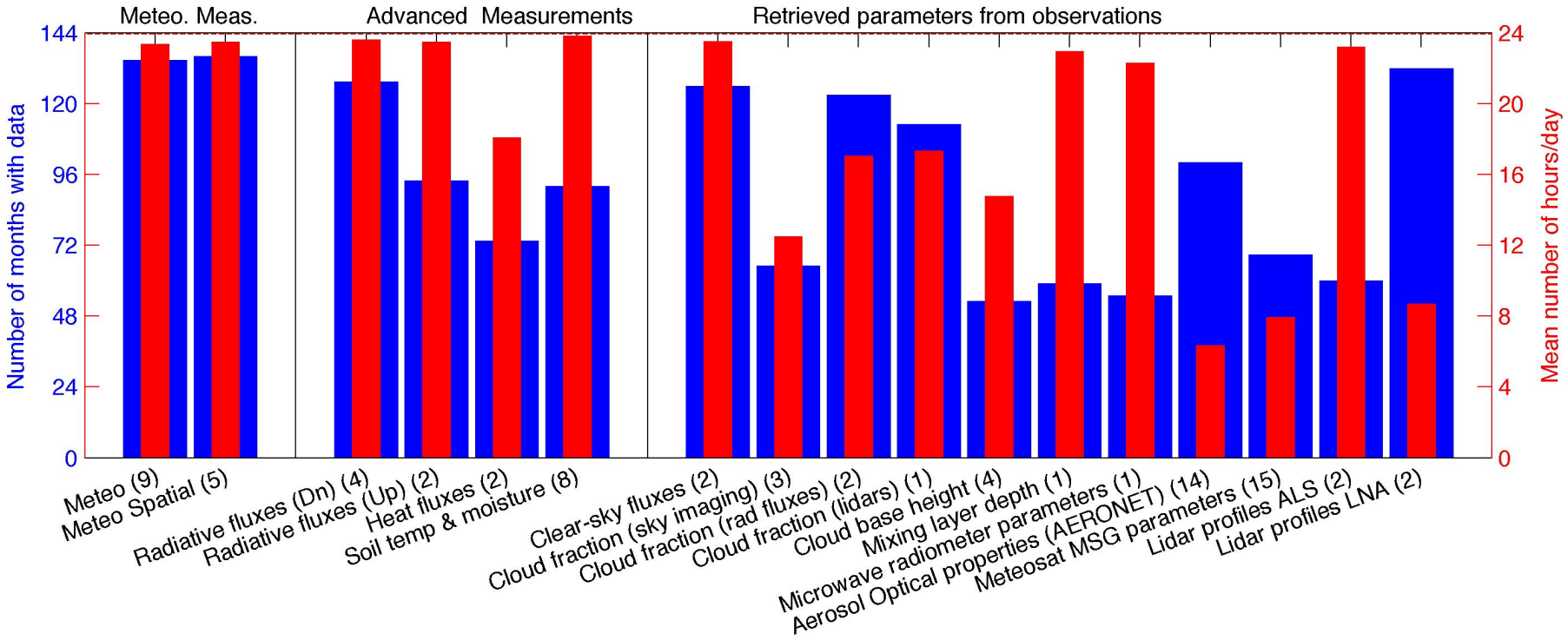
- being able to manage to minimise the effects of instrument changes, calibration changes, in the data.
- dealing with issues such as gaps (missing data).

For this latter, the help from other scientific communities can be valuable.

SIRTA-ReOBS: Data temporal coverage

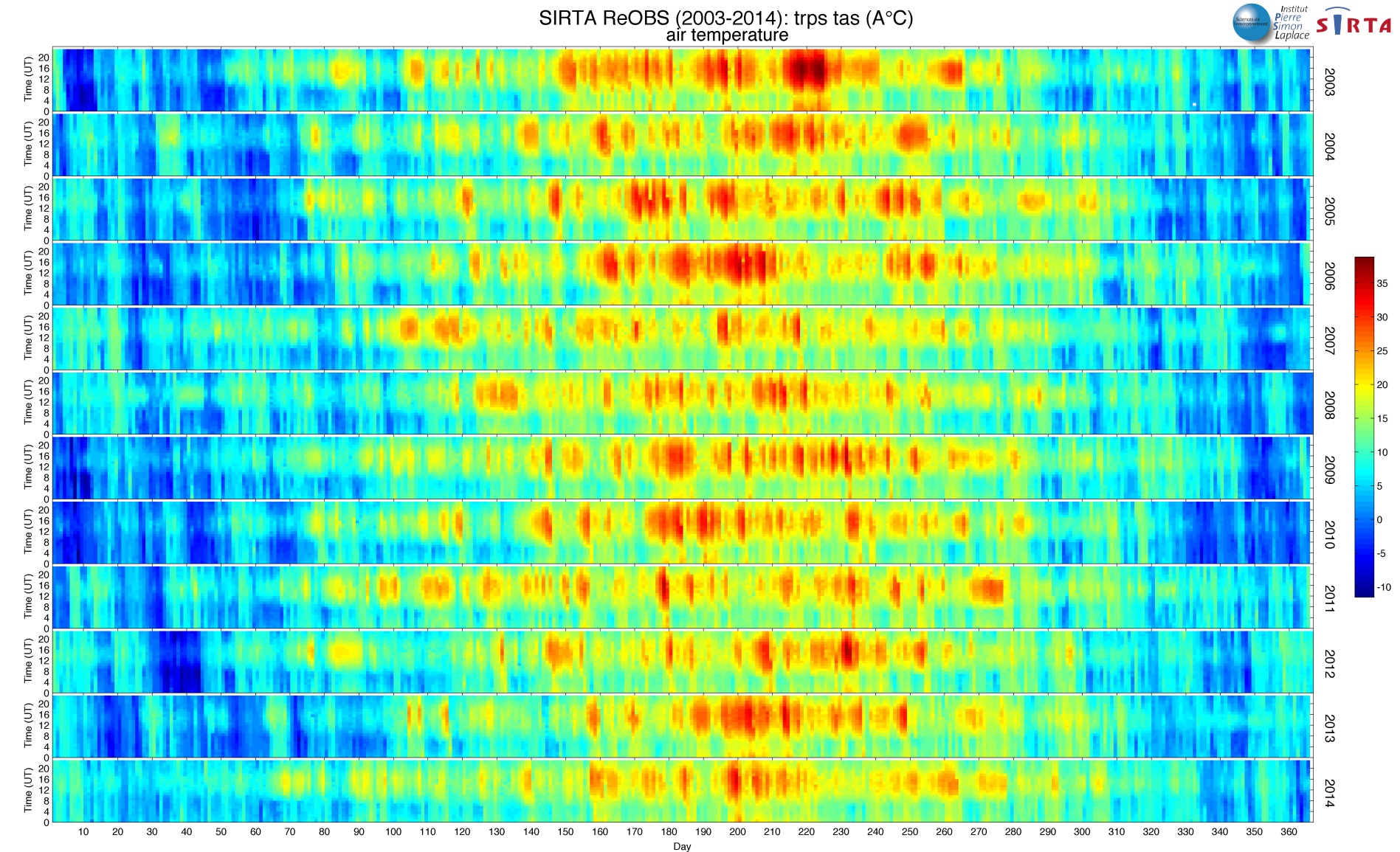
The data temporal coverage is diverse among the parameters in SIRTA-ReOBS.
Different reasons for missing data:

- **Instrument not present**
- **No nighttime measurements:** (e.g. Meteosat reflectance).
- **No Sun:** Some measurements need sunny conditions (e.g. aerosol optical depth)
- **Weekends, holidays:** Manually operated instruments (Lidar)
- **Rainy weather:** The Lidar cannot work under rain.



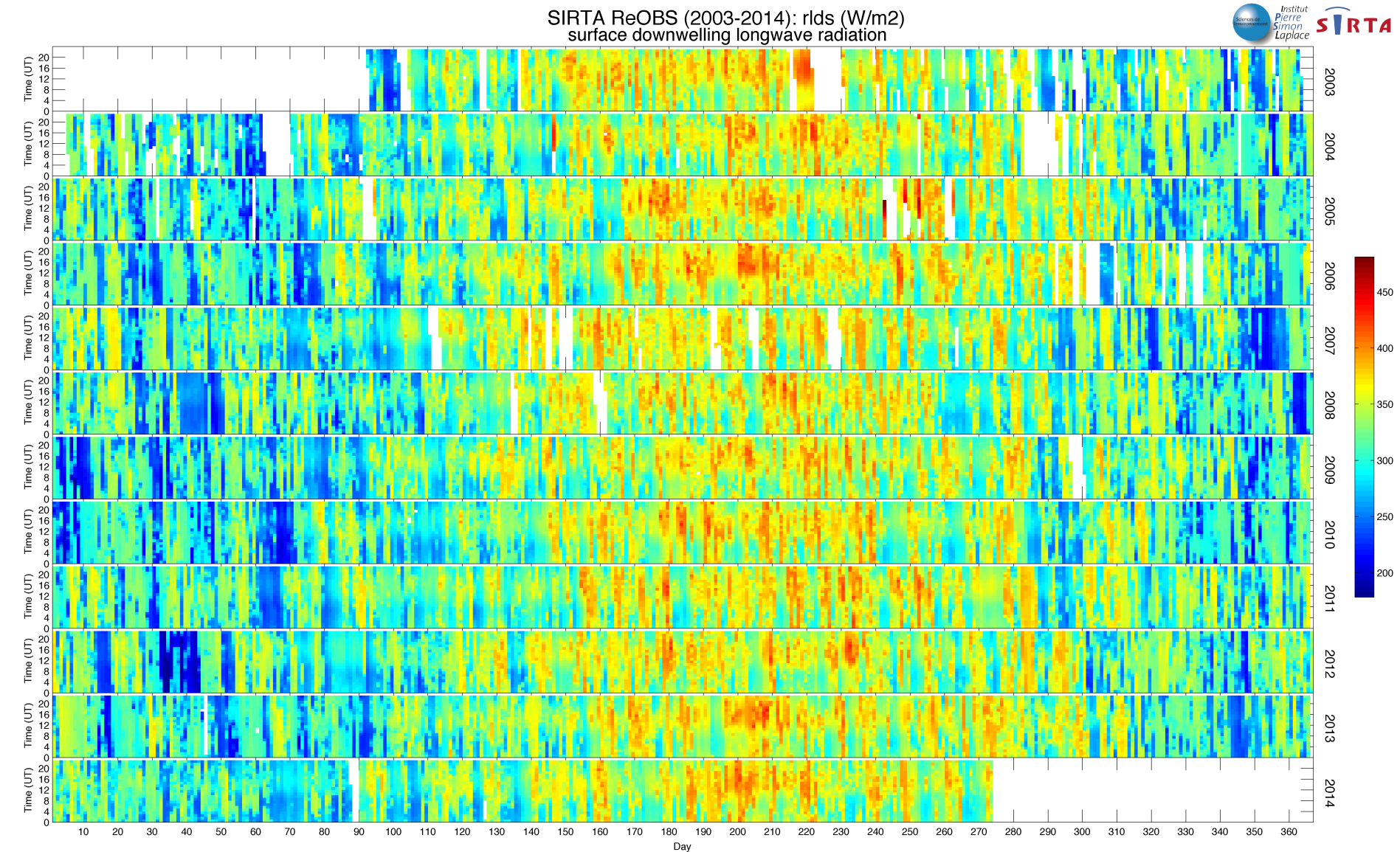
SIRTA-ReOBS: Quicklook figure examples

Air temperature



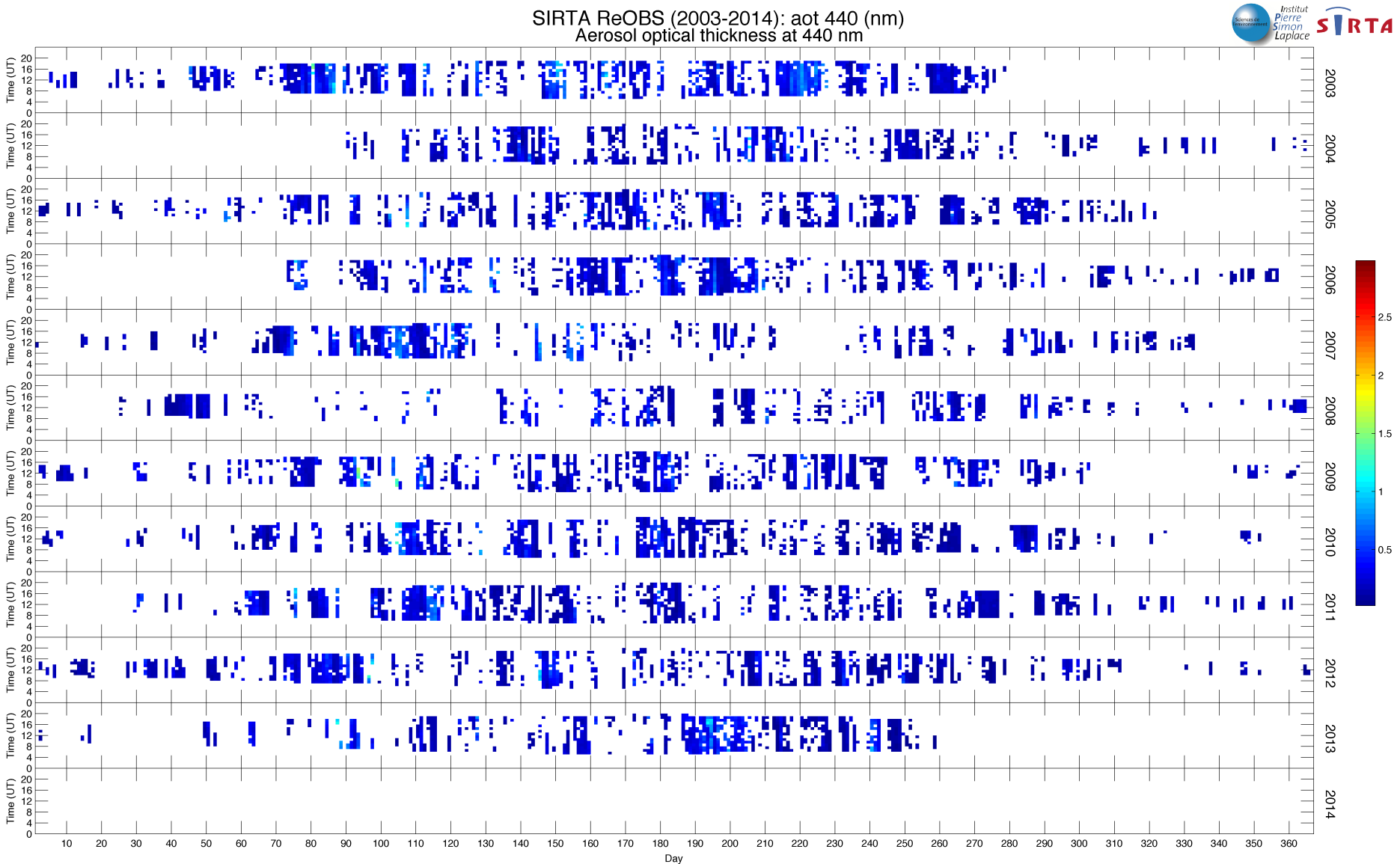
SIRTA-ReOBS: Quicklook figure examples

Surface downwelling longwave radiation



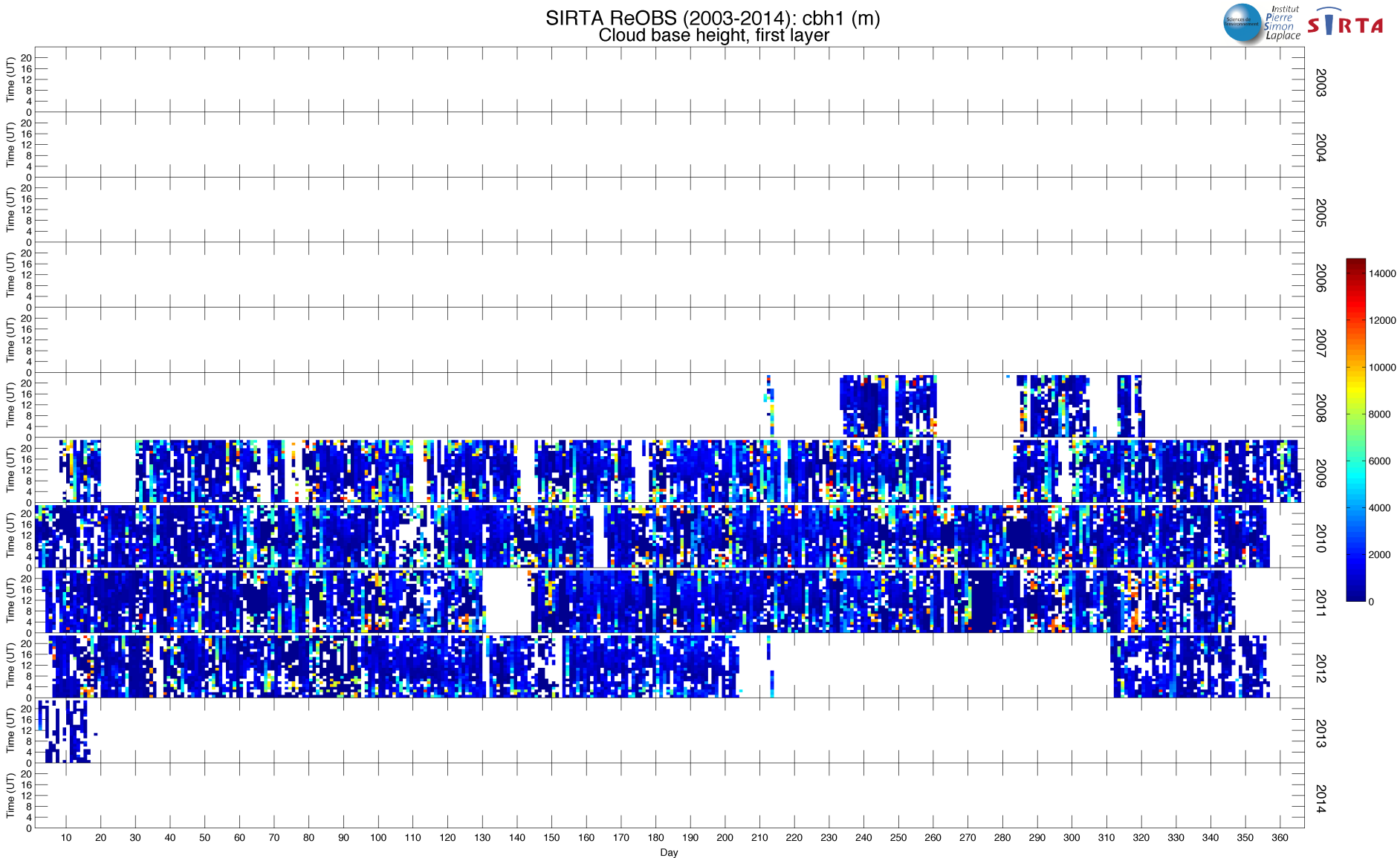
SIRTA-ReOBS: Quicklook figure examples

Aerosol optical depth at 440nm



SIRTA-ReOBS: Quicklook figure examples

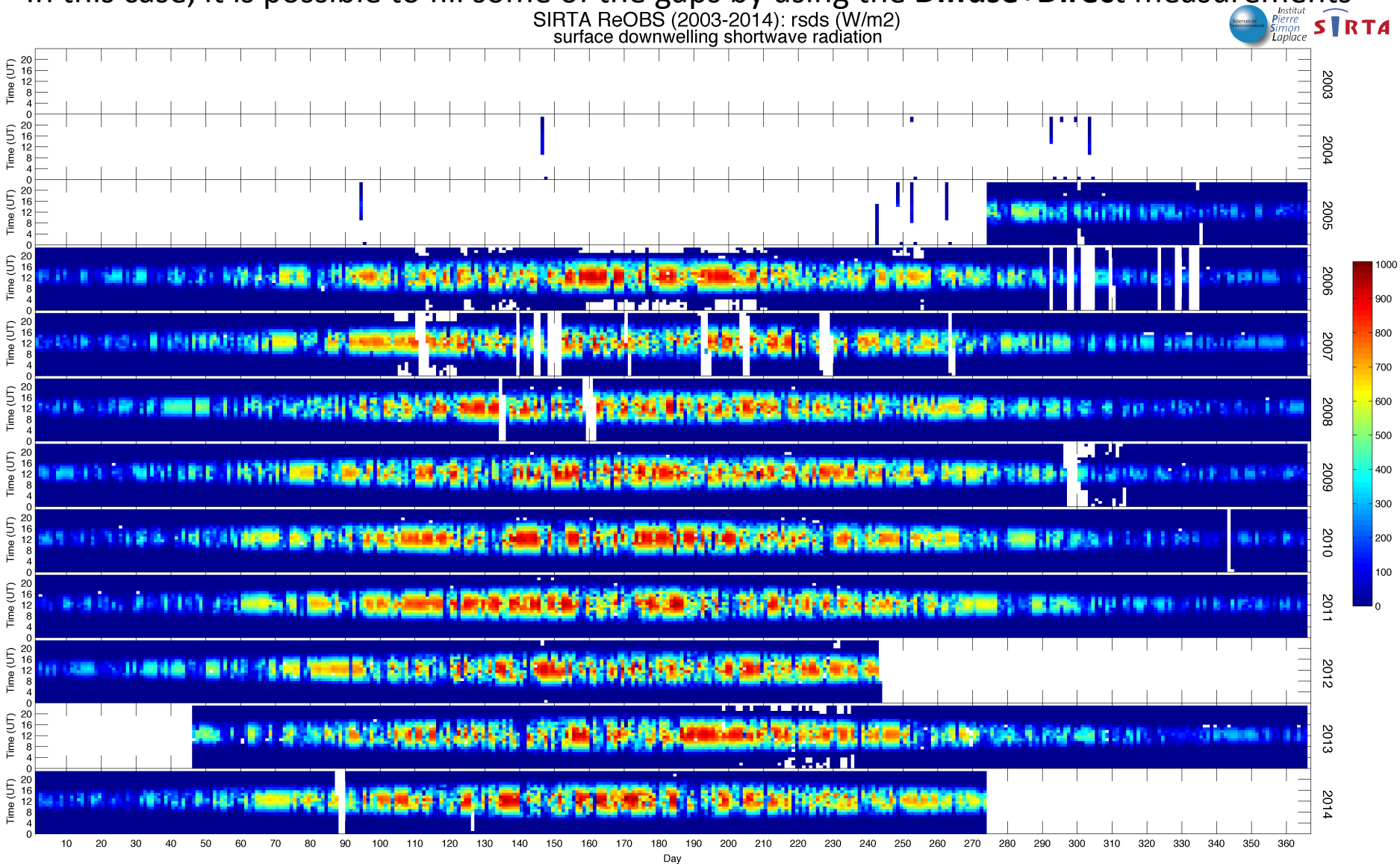
Cloud base height



SIRTA-ReOBS: Quicklook figure examples

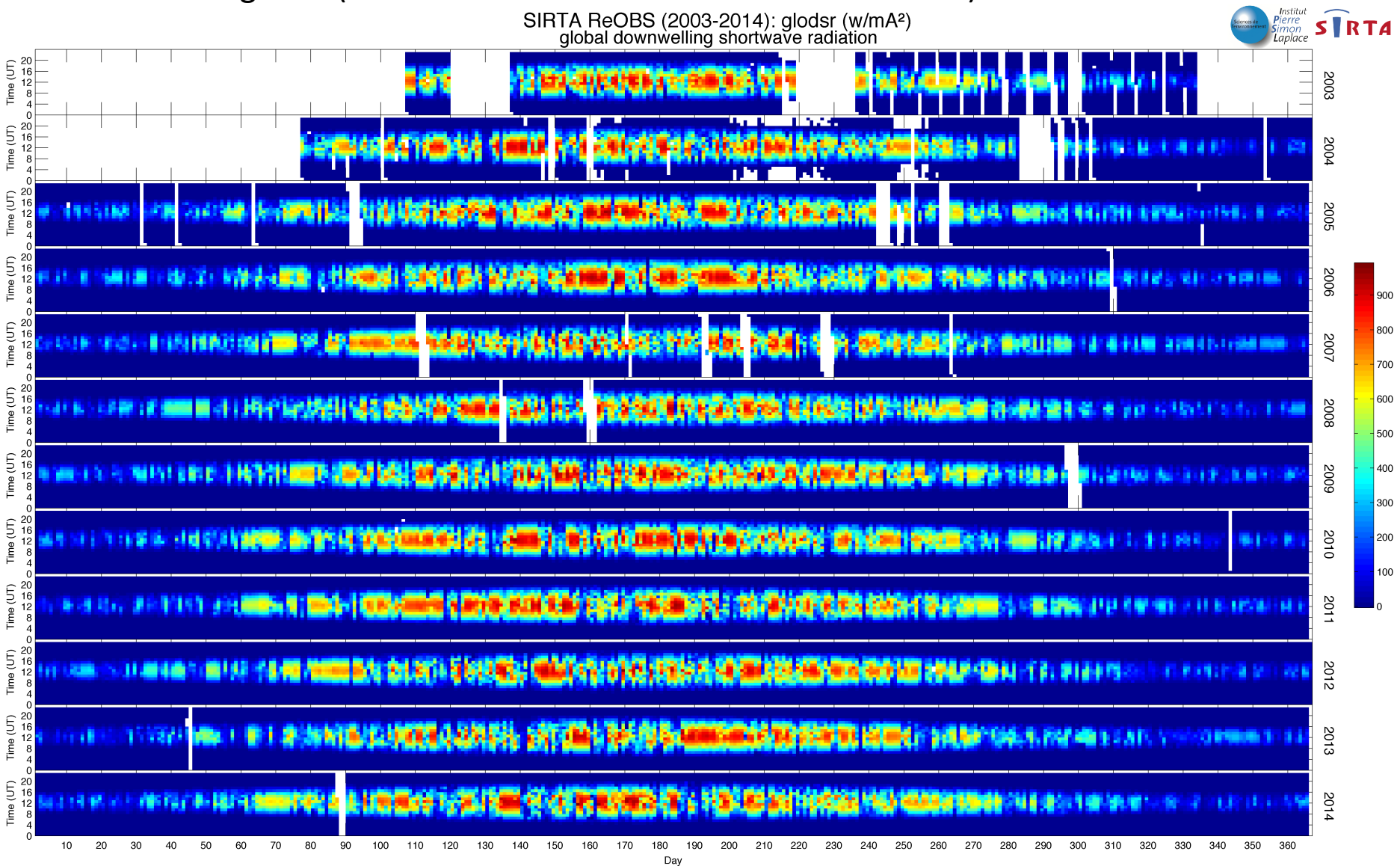
Measured surface downwelling **Global** shortwave (SW) radiation

In this case, it is possible to fill some of the gaps by using the **Diffuse+Direct** measurements



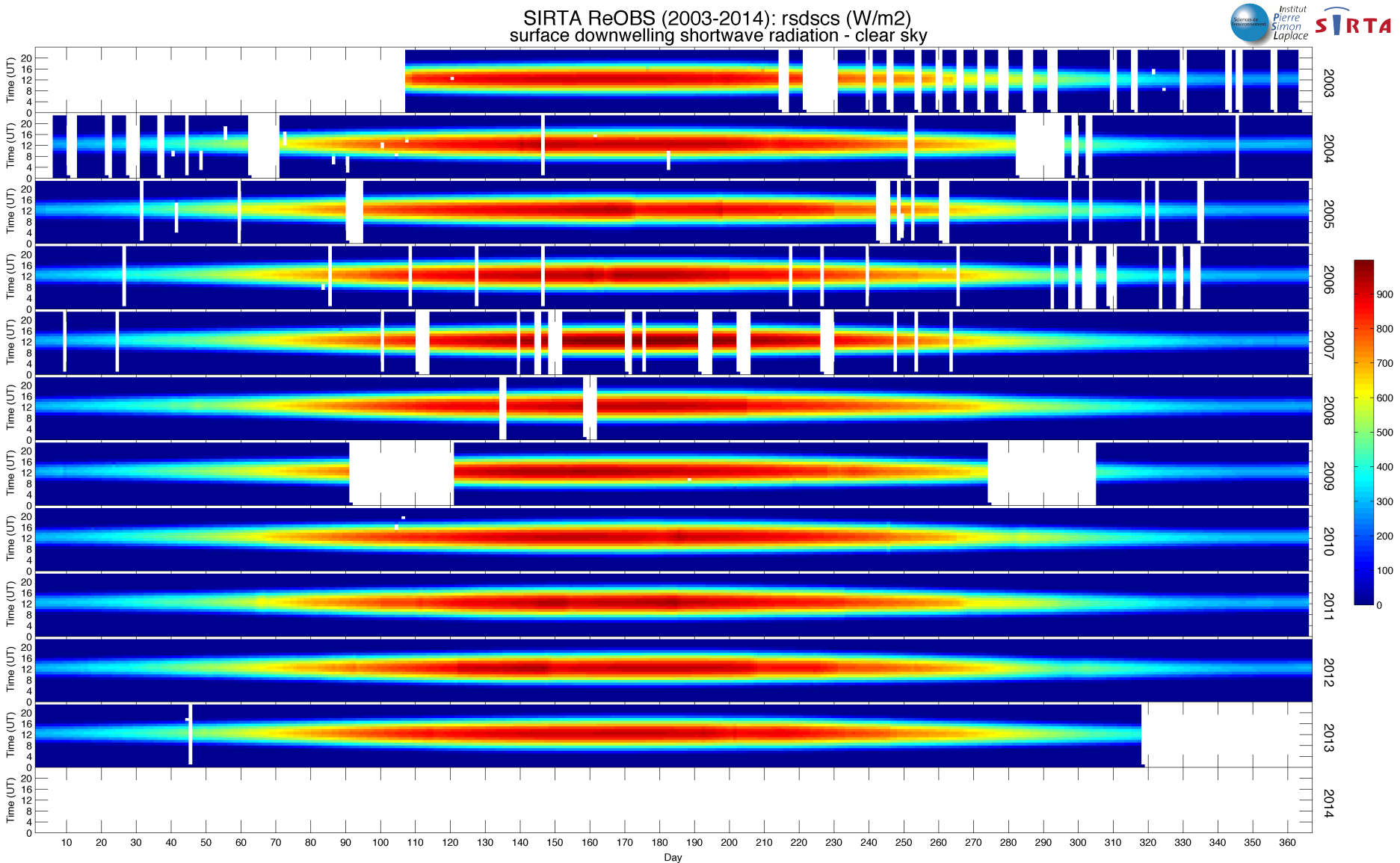
SIRTA-ReOBS: Quicklook figure examples

Best estimate d'irradiance SW global: It combines the measured SW global and the calculated SW global (from the measured SW diffuse + SW direct)



Missing data issues: Uncertainty from the gaps

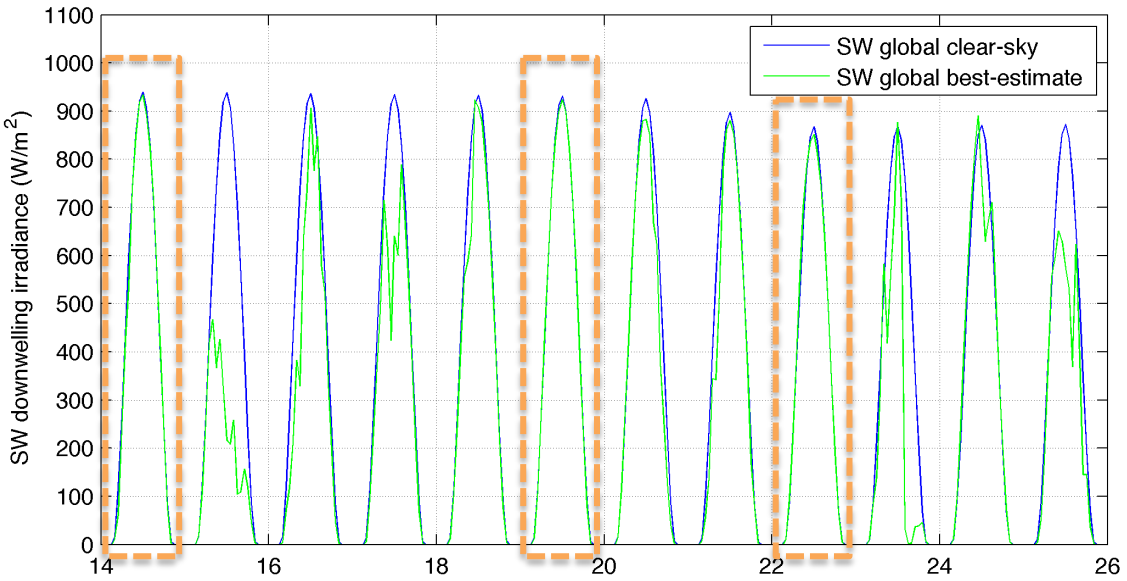
Clear-sky shortwave irradiance

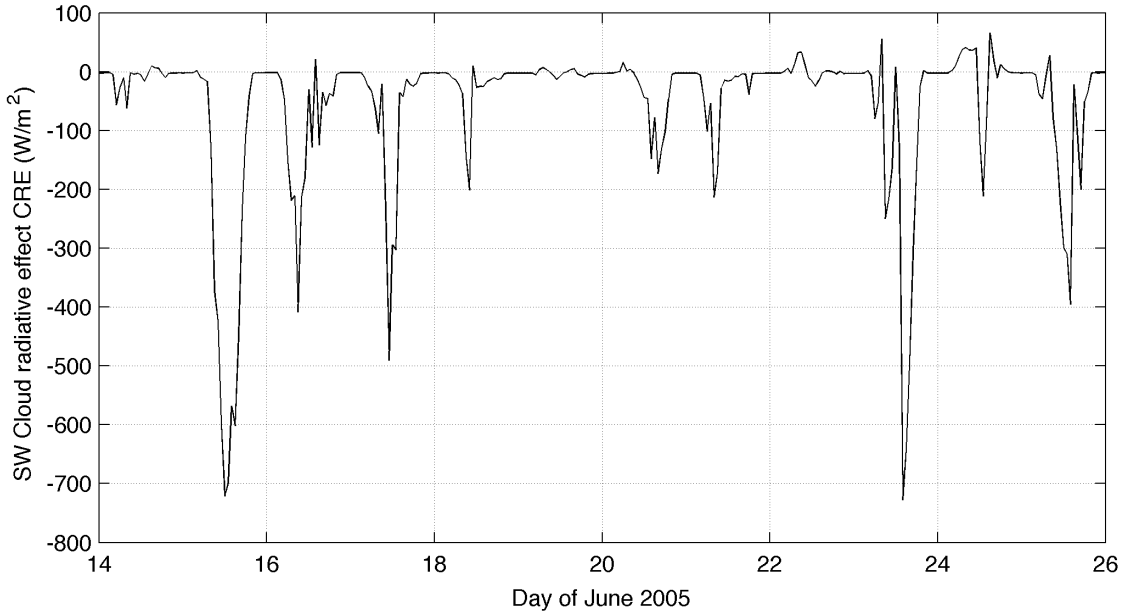


Missing data issues: Uncertainty from filling the gaps

The irradiance for cloudless (clear-sky) conditions is estimated empirically when clear-sky conditions are detected. The gaps in clear-sky irradiance are filled by using the latest available empirical coefficients, leading to uncertainties.

The **CRE (Effects of clouds on solar radiation)** is defined as the difference between the measured and clear-sky-estimated irradiances. The uncertainty in the latter propagates over the CRE.

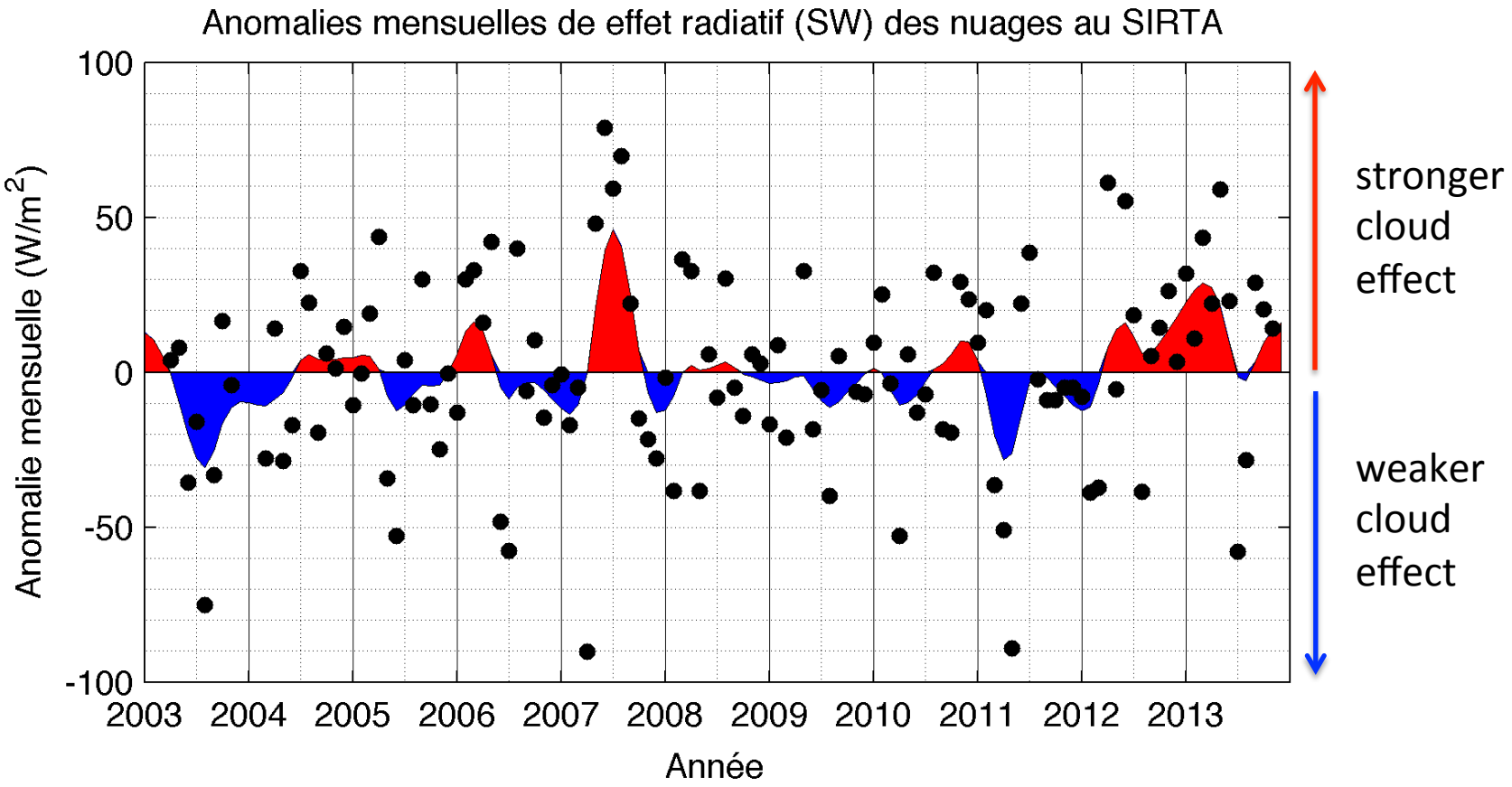




Missing data issues: Uncertainty from the gaps

Monthly anomalies of **cloud effects on solar radiation (CRE)**. Color shading represents a 5-month moving average of the data.

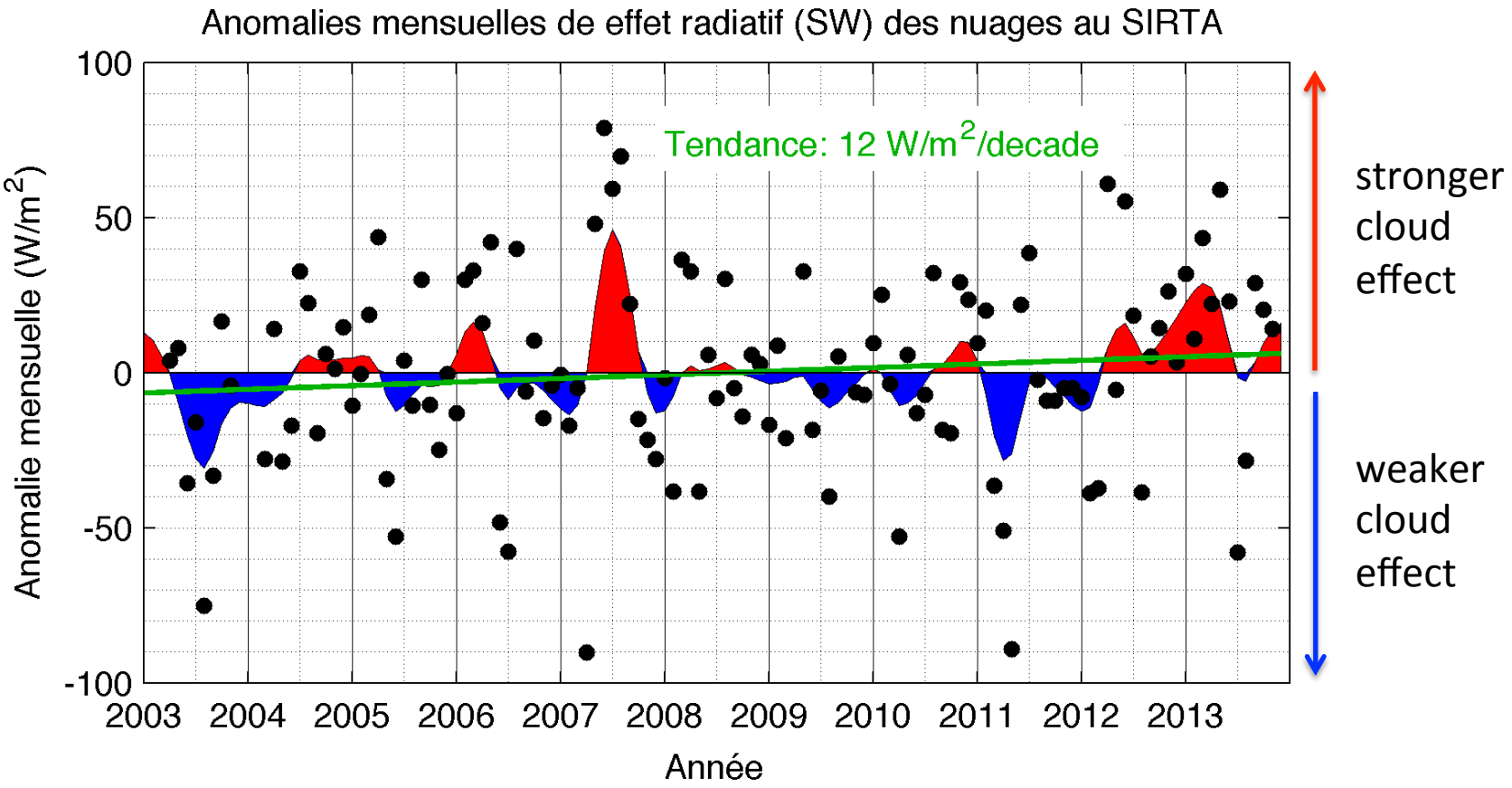
Trend signals are weak, so we need to minimise the impact of missing data on the results.



Missing data issues: Uncertainty from the gaps

Monthly anomalies of **cloud effects on solar radiation (CRE)**. Color shading represents a 5-month moving average of the data.

Trend signals are weak, so we need to minimise the impact of missing data on the results.

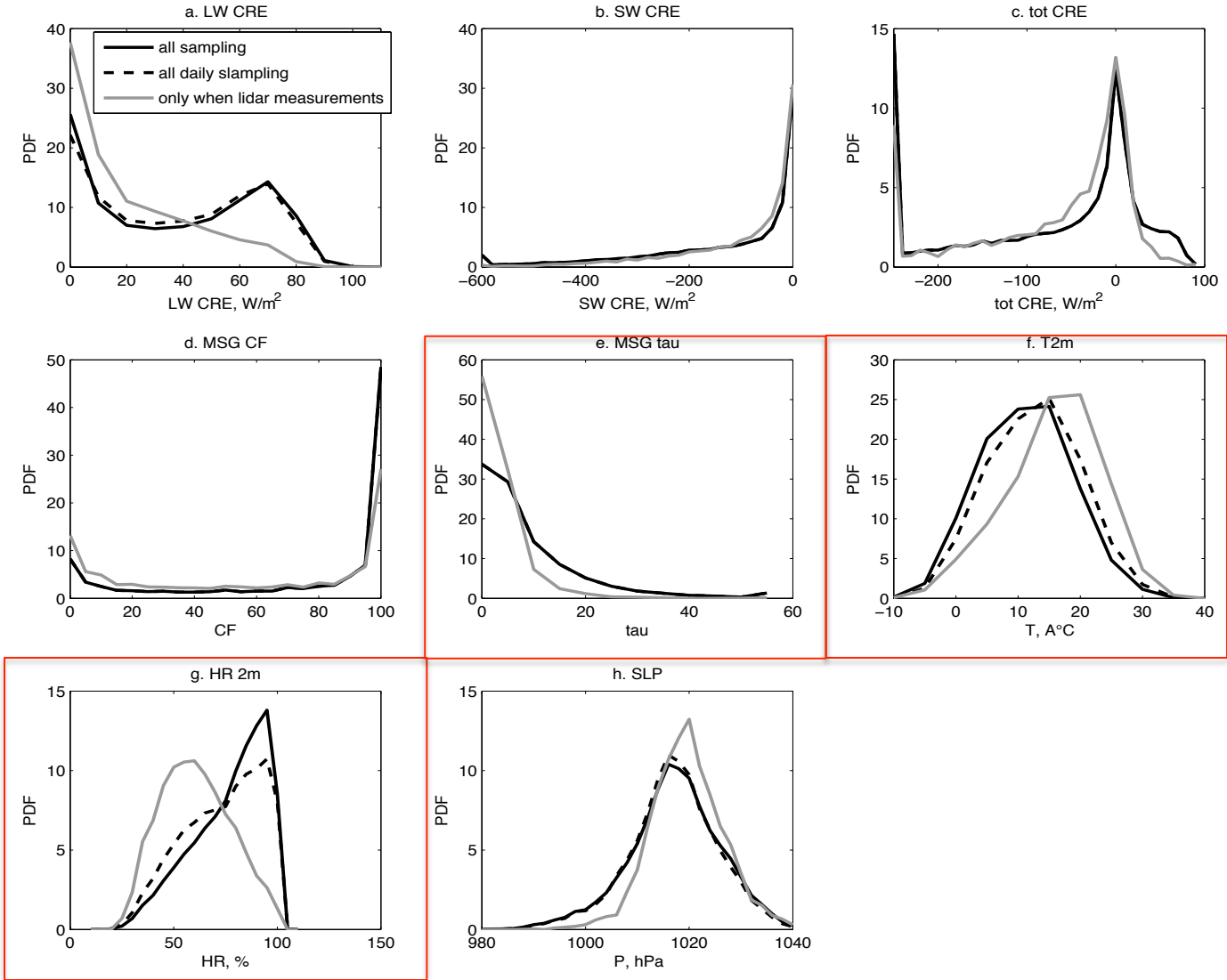


Missing data issues: analyses representativeness

PDF of SIRTA-ReOBS variables fro 2003-2014 according to 3 sampling filters:
(1) All data, (2) daytime only, (3) only when Lidar measures

Lidar measurements are only available when there's no rainy conditions.

As a consequence, lidar measurements representativeness is different from all sampling: **the periods are drier, less cloudy and warmer**.

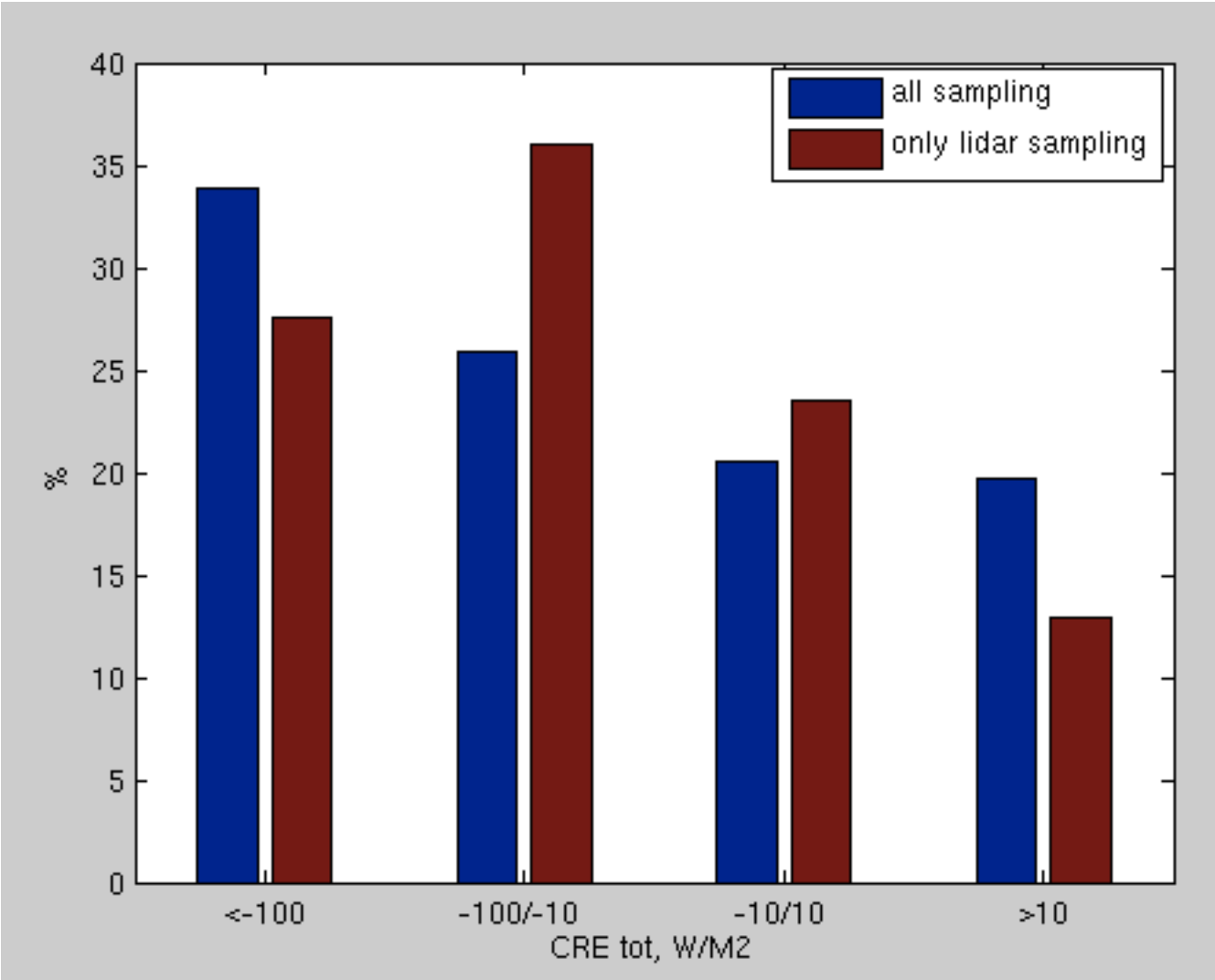


Missing data issues: analyses representativeness

CRE values distribution is sensitive to data sampling (all data vs lidar sampling).
CRE closer to 0 (lower cloud effects) are found with the Lidar sampling, as expected since the rainy and heavy cloudy situations are then missing.

4 classes of CRE_{tot} = CRE_{SW} +CRE_{LW} :

(1) CRE_{tot}<-100W/m^2
(2) -100<CRE_{tot}<-10W/m^2
(3) -10<CRE_{tot}<10W/m^2
(4) CRE_{tot}>10W/m^2



Conclusions and perspectives

- SIRTA-ReOBS database
  - is a unique multi-parameter dataset for climate-related studies.
  - groups about 50 parameters (SIRTA + satellite + spatial) for the period 2003-2014.

- Still progress to be made to deal with missing data (temporal sampling is divers along the parameters):
  - uncertainty due to gaps
    - Additional question: Which is the limit of variability modes analyses (wavelet, Fourier…) with respect to missing data?
  - representativeness when combining parameters with different sampling

- A publication is on the way to present SIRTA-ReOBS (2015).
- SIRTA-ReOBS is currently available for research collaborations
- The user documentation is under construction

Publications using data from SIRTA-ReOBS

Badosa, J., Chiriaco, M., Drouin, M.-A., Lopez, J., Haeffelin, M., Dupont, J.-C., J.-L., SIRTA-reOBS: multi-parameter, long-term, homogenised, and all-in-1-file dataset of atmospheric observations at SIRTA supersite, in prep.

Bastin S., Chiriaco M., Haeffelin, M., Dupont, J. C., Yiou P.: Regional model evaluation using colocated long term ground based observations at SIRTA: when and why does WRF-MEDCORDEX simulation fails? in prep.

Cheruy F, A. Campoy, J.C. Dupont, A. Ducharne, F. Hourdin, M. Haeffelin, M. Chiriaco, A. Idelkadi (2013), Combined influence of atmospheric physics and soil hydrology on the simulated meteorology at the SIRTA atmospheric observatory. Climate Dynamics. Volume 40, pp 2251-2269

Chiriaco, M., Bastin, S., Yiou, P., Haeffelin, M., Dupont, J. C., & Stéfanon, M. (2014). European heatwave in July 2006: Observations and modeling showing how local processes amplify conducive large-scale conditions. Geophysical Research Letters, 41(15), 5644-5652.

Chiriaco, M., Bastin, S., Chepfer, H., Badosa J.: "cloud vertical distribution over 10 years at SIRTA : a weather regime analysis"; in prep.

Campoy, A., Ducharne, A., Cheruy, F., Hourdin, F., Polcher, J., & Dupont, J. C. (2013). Response of land surface fluxes and precipitation to different soil bottom hydrological conditions in a general circulation model. Journal of Geophysical Research: Atmospheres, 118(19), 10-725.

Dione, C., Lothon, M., Bastin, S., Chiriaco, M., Lohou, F., Yiou, P., Barray, J.-L. : "large-scale circulation influence on local processes for 3 different sites in France", in prep

Pal, S., Haeffelin, M. (2015, submitted), Dynamical features and forcing mechanisms governing diurnal and seasonal variability in the boundary layer depths: A five-year long lidar observations over a suburban site near Paris. Submitted to Journal of Geophysical Research (Atmospheres).