Global and local surface albedo : results from the ESA GlobAlbedo, EU-QA4ECV and EU-JRC-GbOV projects

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International Solar Energy Society webinar, 20 November 2018

Albedos from BRDF

Relation of incoming and reflected radiance terminology used to describe reflectance quantities

Incoming/Reflected	Directional	Conical	Hemispherical
Directional	Bidirectional CASE 1	Directional–conical CASE 2	Directional–hemispherical CASE 3
Conical	Conical–directional CASE 4	Biconical CASE 5	Conical–hemispherical CASE 6
Hemispherical	Hemispherical–directional CASE 7	Hemispherical–conical CASE 8	Bihemispherical CASE 9

DHR: "Black-sky"

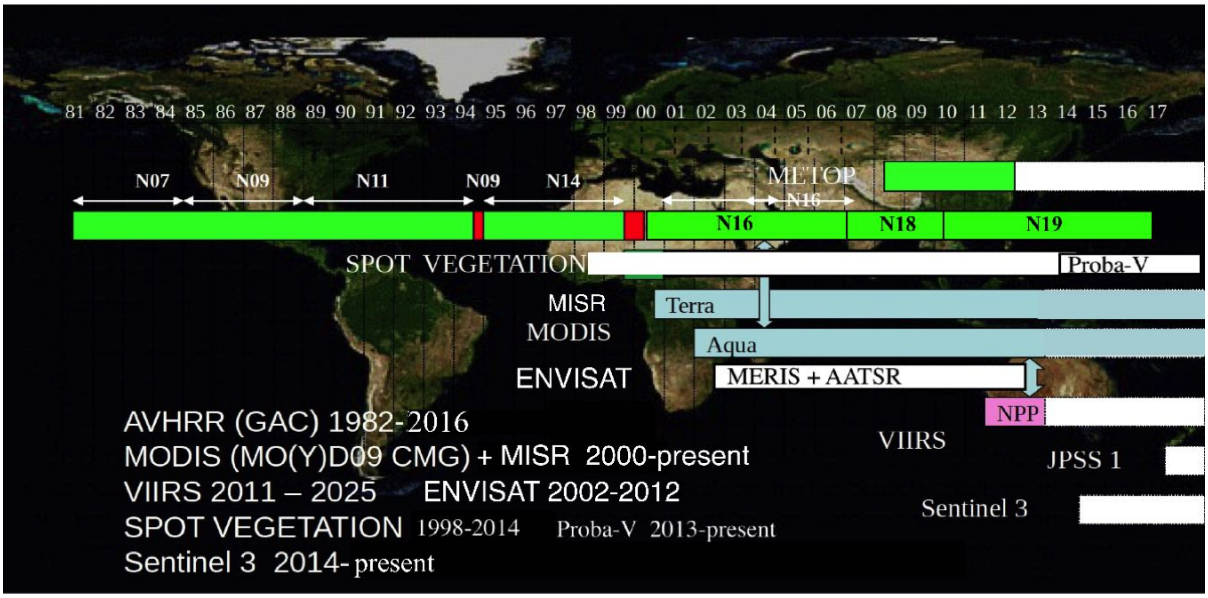
BHR: "White-sky"

The labeling with 'Case' corresponds to the nomenclature of Nicodemus et al. (1977). Grey fields correspond to measurable quantities (Cases 5, 8), the others (Cases 1–4, 6, 7, 9) denote conceptual quantities.

Schaepman-Strub, G. and Schaepman, M. (2006). Reflectance quantities in optical remote sensing—definitions and case studies. Remote Sensing of Environment vol. 103 pp. 27-42.

Albedo Production : Input data streams

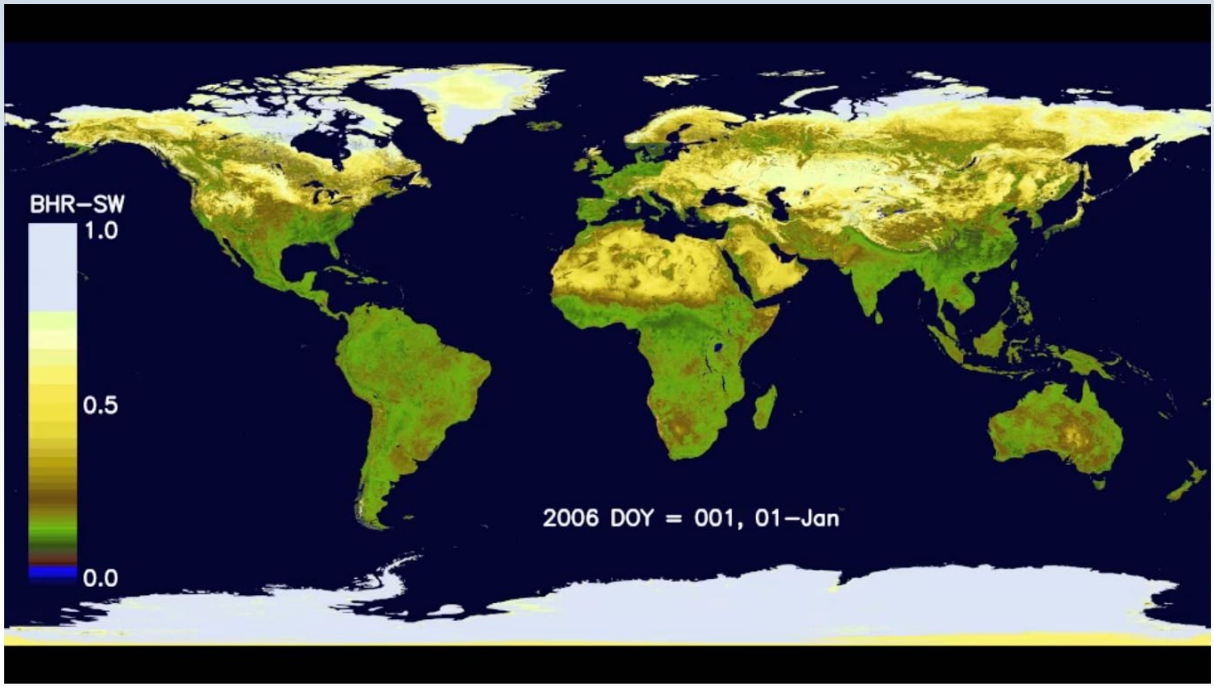
Polar-orbiting satellites for land surface science: 1980s – 1990s data poor, 2000s-data rich



AVHRR 35 year time period LTDR v5.2, Courtesy of E. Vermote (UMD)

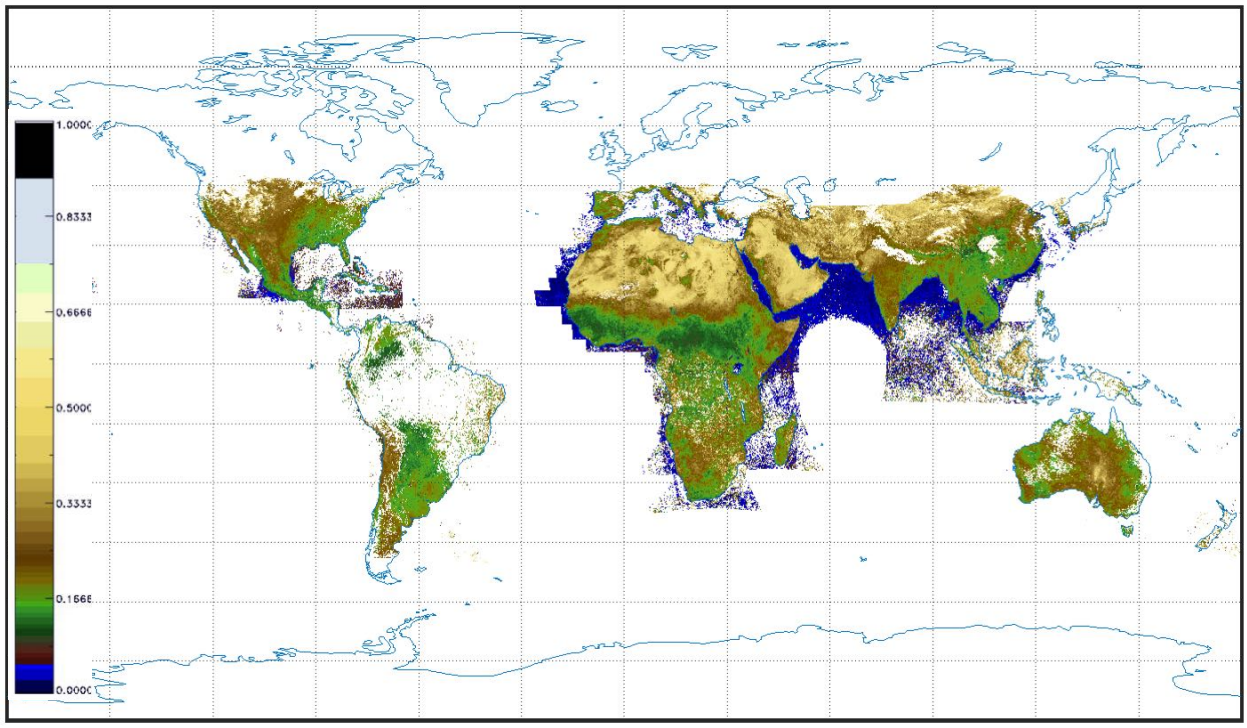
www.GlobAlbedo.org

GlobAlbedo 8-daily 2006 SW BHR (1998-2011) used MODIS, MERIS and VEGETATION



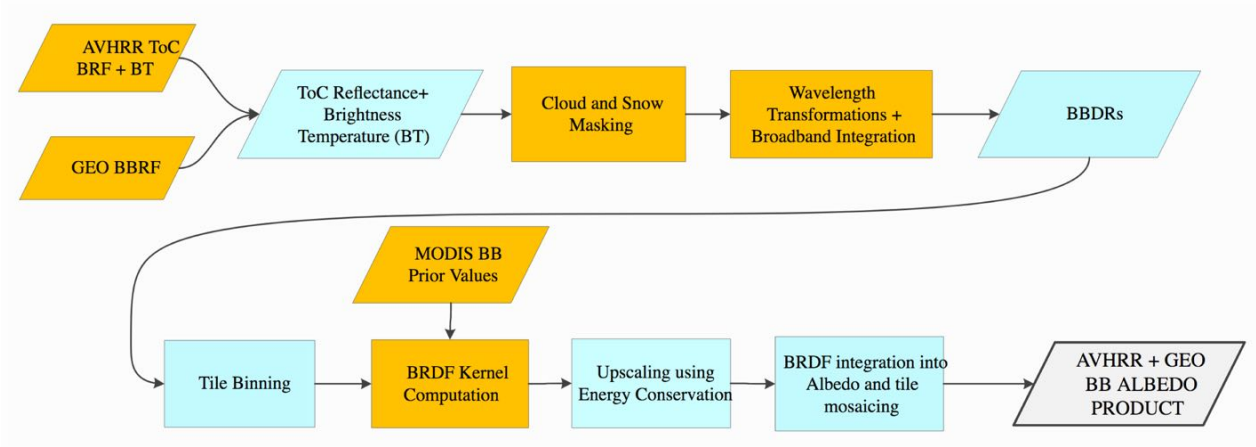
GEO BRF

- **BRF processed from GSA products (Single channel and Broadband)**



Broadband BRF processed from all 5 satellites. Corresponding date : 2000-02-28T

Broadband Daily Albedo (1982-2016)

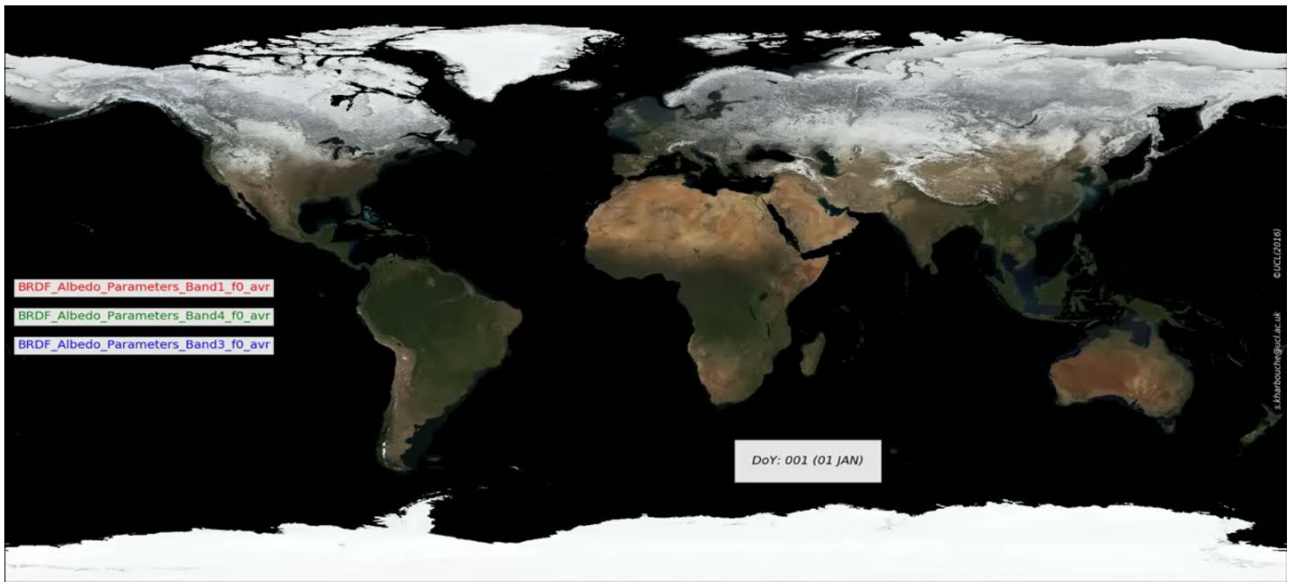


Traceability diagram availability for all products

http://www.qa4ecv.eu/ecv/albedo/avhrrgeo

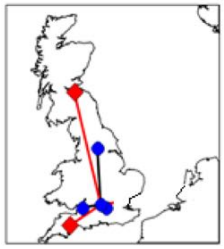
To explore all the individual components

MODIS Collection 6 Daily Climatology



"True" Colour climatology of 26 years of daily MODIS 7 spectral albedos

Albedo: Production at JASMIN@Harwell



JASMIN is a world leading, unique hybrid of:

- 18PB high performance storage (>250GByte/s)
- High-performance computing (>6,000 cores)
- 40PB Archive and Elastic Tape
- Non-blocking Networking (> 3Tbit/sec), and Optical Private Network WAN's
- Coupled with cloud hosting capabilities

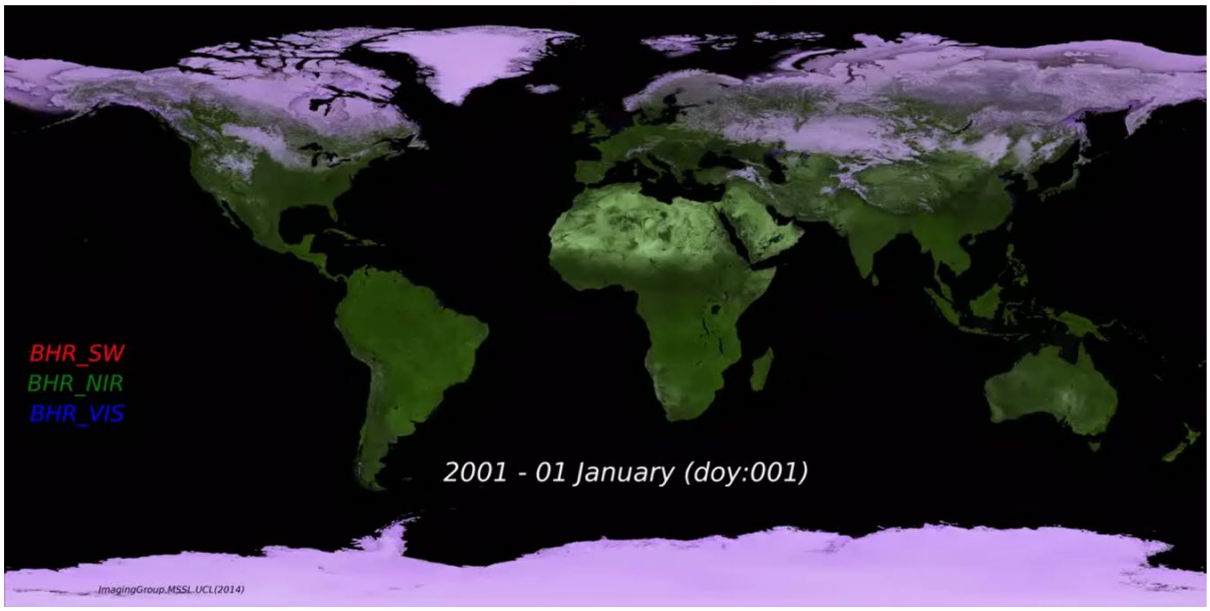
(**Jonathan Churchill**, Jasmin Conference, June 2017)

Dedicated to QA4ECV project:

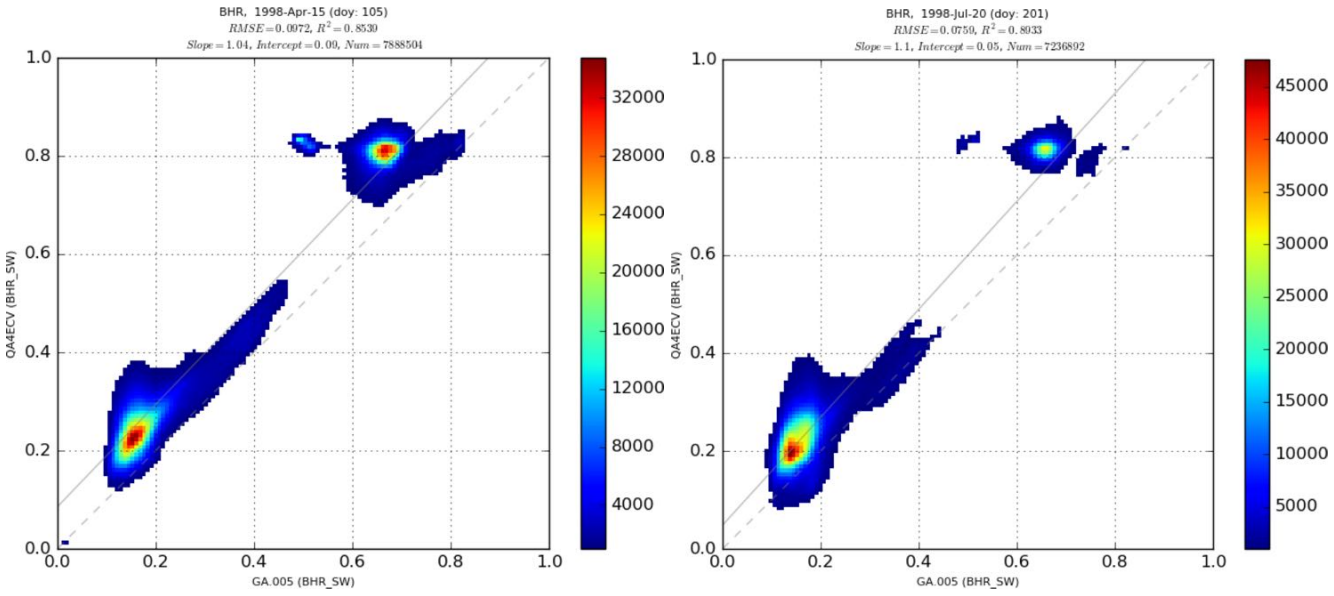
- Memory: +750TB
- Cores: [400, 2000]

- **Broad Band Albedo**
  - 10.5 Tb inputs
  - 2 compute days/yr GLOBAL
- **Spectral Albedo**
  - 11Tb inputs
  - 3 compute days/yr Europe
- **MISR Sea-ice spectral albedo**
  - 30Tb inputs,
  - 0.5 compute days/yr Arctic
- Product sizes:
  - 6 Tb (35 years daily)
  - 0.05Tb (4 years daily)
  - 12 Tb (16 years)

AVHRR+GEO(Tri-spectral BHR)



Inter-comparison on a global scale

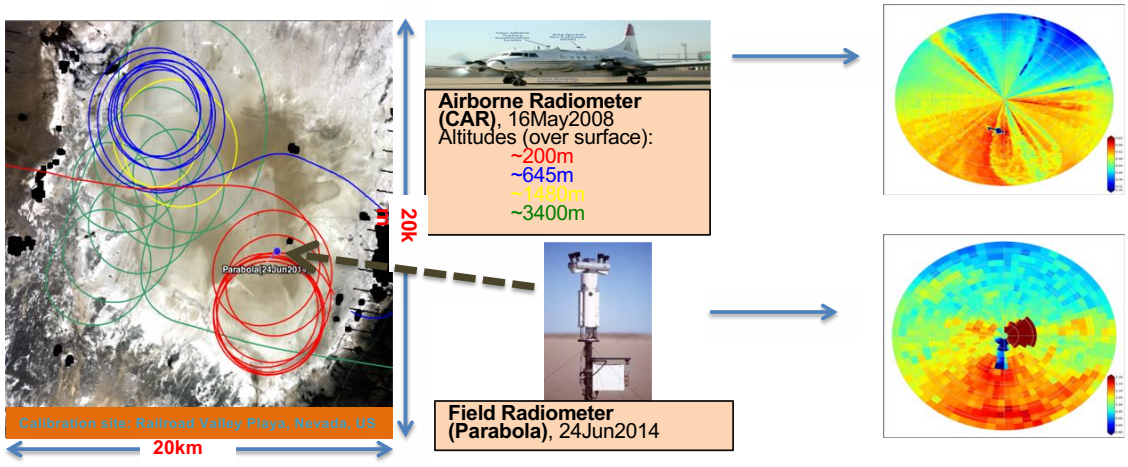


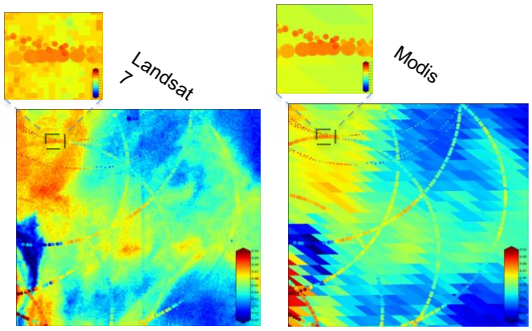
15-Apr-1998

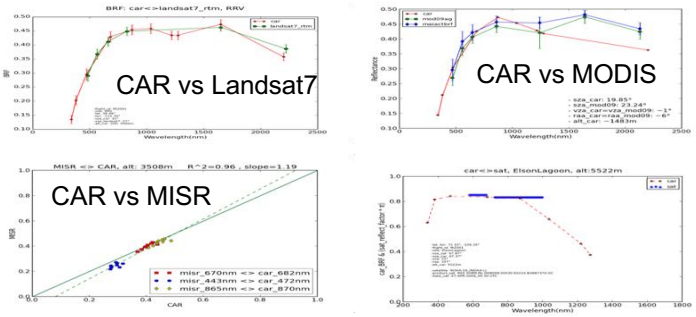
20-Jul-1998

N.B. QA4ECV has better coverage of bright regions cf GlobAlbedo

Understanding the effects of scale from field to aircraft to EO satellite in surface bi-directional reflectance. Kharbouche, Muller et al., Remote Sensing (2017)

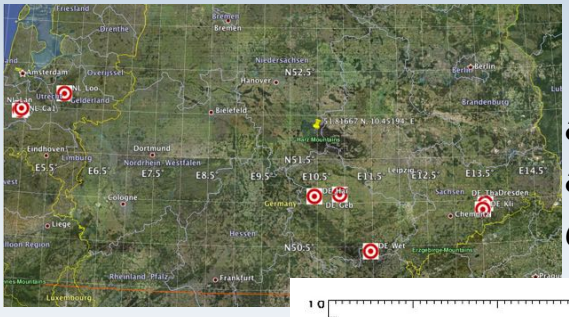




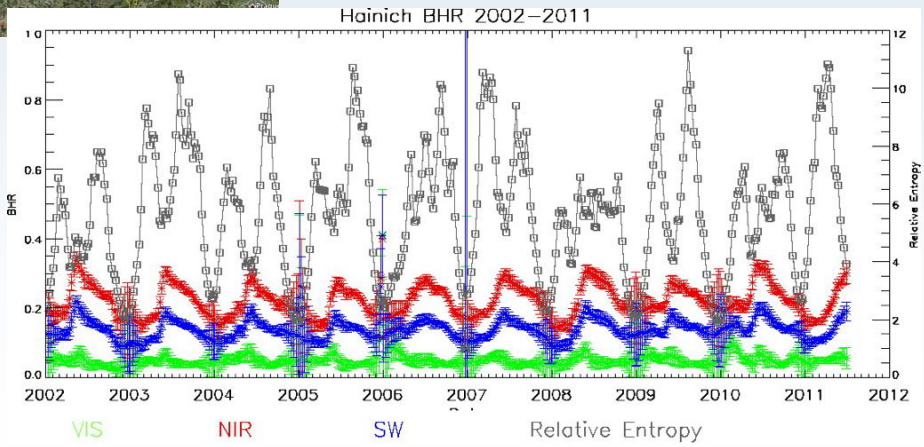


www.GlobAlbedo.org

GlobAlbedo 8-daily BHR for Hainich marked in Google Earth

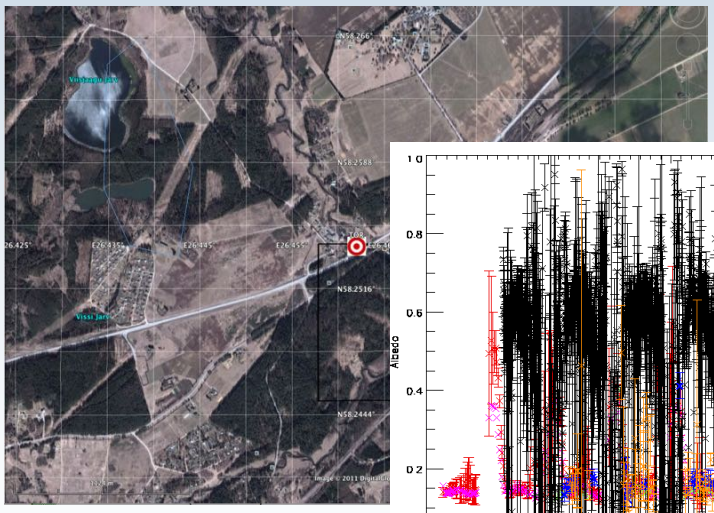


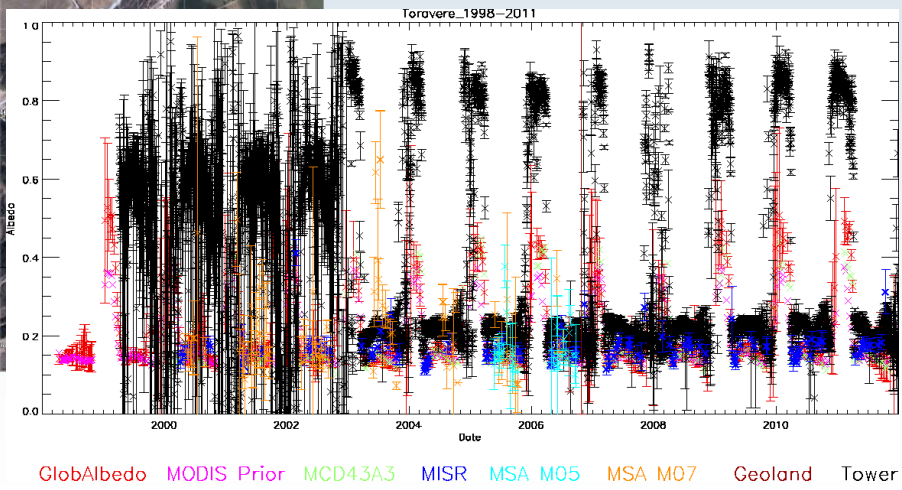
Tower sites across the world employed albedometers to measure shortwave albedo to compare against satellite-derived albedo



CSIRO seminar, Canberra, 1 August 2013

BSRN Toravere: footprint covers multiple land cover types





N.B. Very noisy tower albedometer data, much higher values from tower cf all other EO values

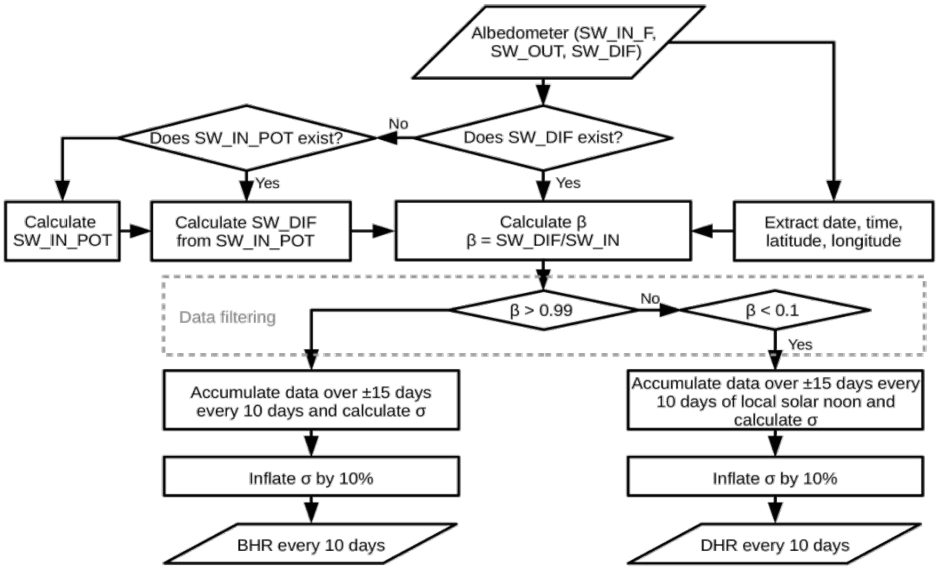
Tower albedometer instrumentation at 70m

Photos of 70m Tumbarumba Flux tower, and configuration of the albedometers (extreme right). Courtesy of Dr William Woodgate, CSIRO Australia

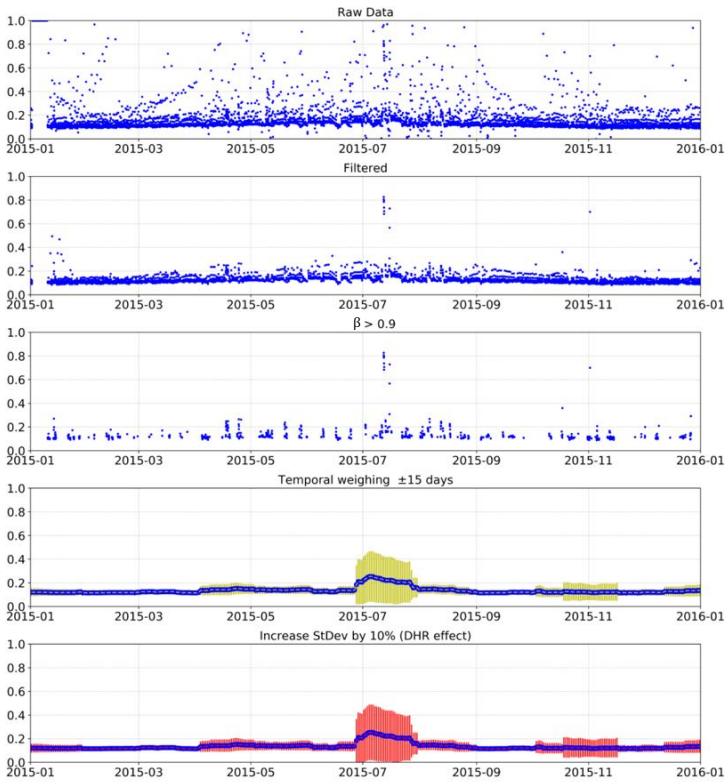
Surface albedo from tower measurements

Typically, in-situ measurements of Blue-Sky (or clear sky) albedo are used to validate surface albedo from satellite observations over homogeneous sites. Here BHR and DHR are used to validate surface albedo in an indirect way.

$$BlueSkyAlbedo = \beta * BHR + (1 - \beta) * DHR$$

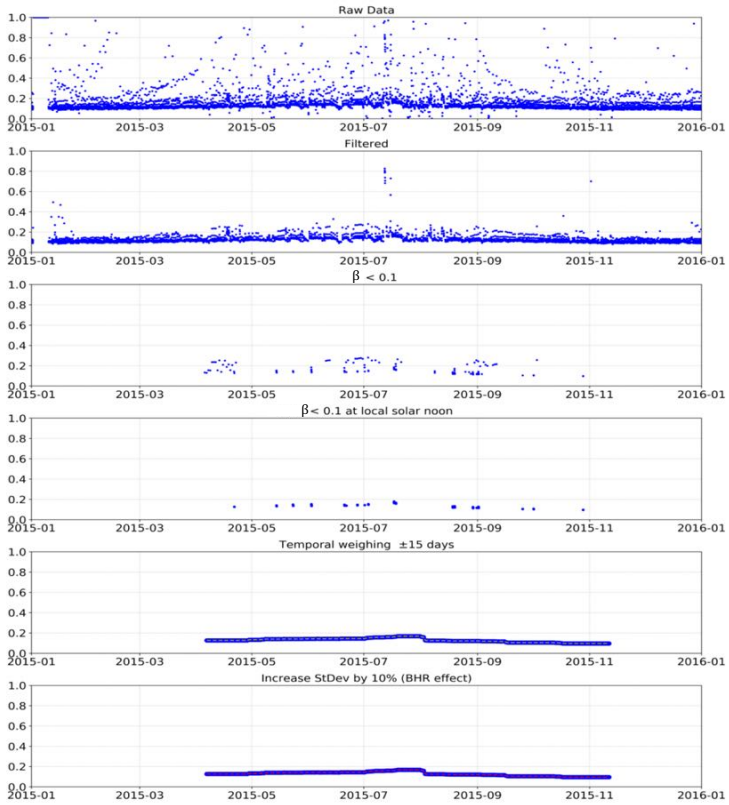


Example of in-situ Tower BHR production



A sample of processed FLUXNET Tumbarumba tower data for in-situ BHR production

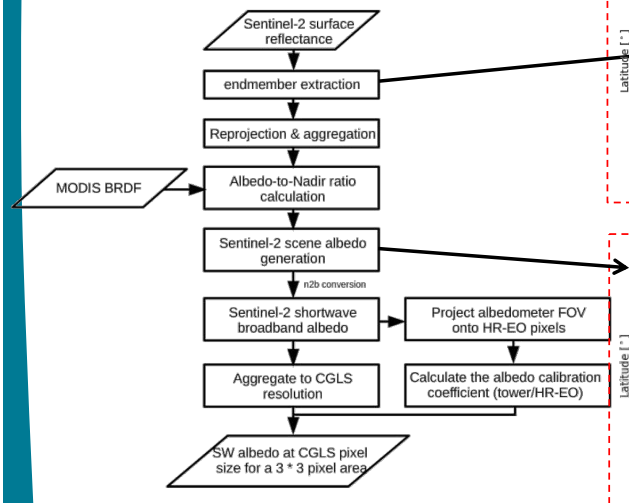
Example of in-situ Tower DHR production

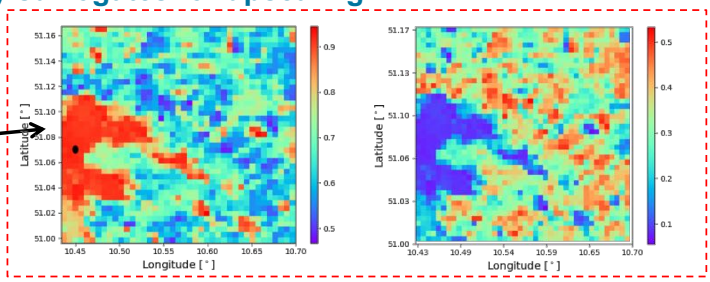


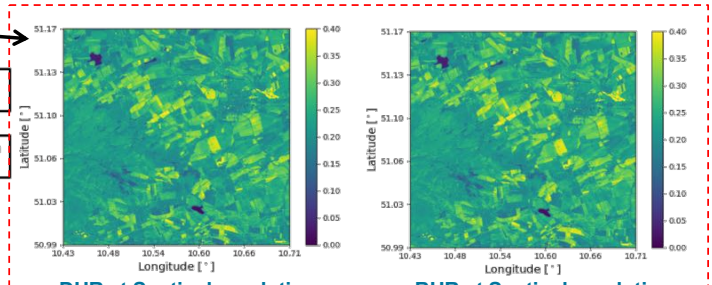
An example of processed FLUXNET Tumbarumba tower data showing the production of in situ DHR.

Upscaling Albedo to Satellite (1km) pixel size over a heterogeneous site

High-resolution DHR and BHR are not directly available from satellite observations. So we need to employ surrogates for upscaling.





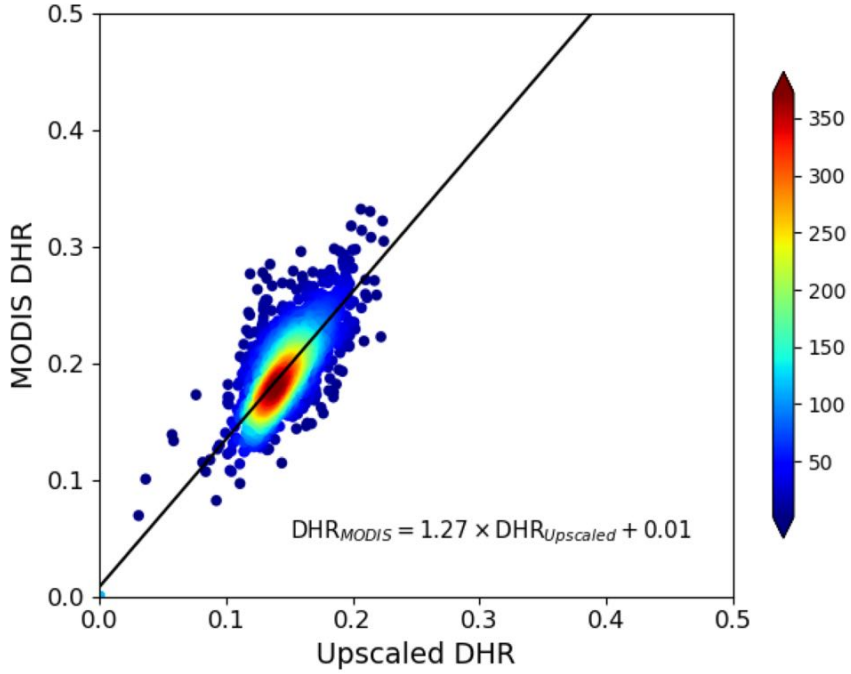


DHR at Sentinel resolution

BHR at Sentinel resolution

Processing chain to calculate high-resolution albedo from HR-EO surface reflectance and MODIS BRDF data.

Validation of upscaled Albedo



Comparison between upscaled DHR and DHR derived from the MODIS BRDF function, at DE-HAI site.

Land Albedo – Summary

- Long time series satellite-derived broadband and spectral albedo products available from fusing US and European polar orbiting and geostationary platform data
- All EO products available through UK CEDA and in future through the EU Climate Data Store with QA defined through EU-EQC
- Operational system (http://gbov.copernicus.acri.fr/) to provide validation data over heterogeneous surfaces using tower platforms with shortwave albedometers
- Moving towards a tower-based hyperspectral BRF system to achieve the same for spectral BRDF/albedo