www.GlobAlbedo.org

Lessons learnt from the ESA DUE GlobAlbedo land surface albedo product validation from European sensors.

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Freie Universität Berlin

Peter North, Andreas Heckel, Swansea University

Olaf Danne, Uwe Krämer, Marco Zülhke, Carsten Brockmann,

Brockmann Consult

Alessandro Cescatti, JRC Ispra;

Simon Pinnock, ESA ESRIN

with contributions from Zhuosen Wang & Crystal Schaaf (U. of Mass., Boston), Gabriela Schaapman-Strub (U of Zurich)

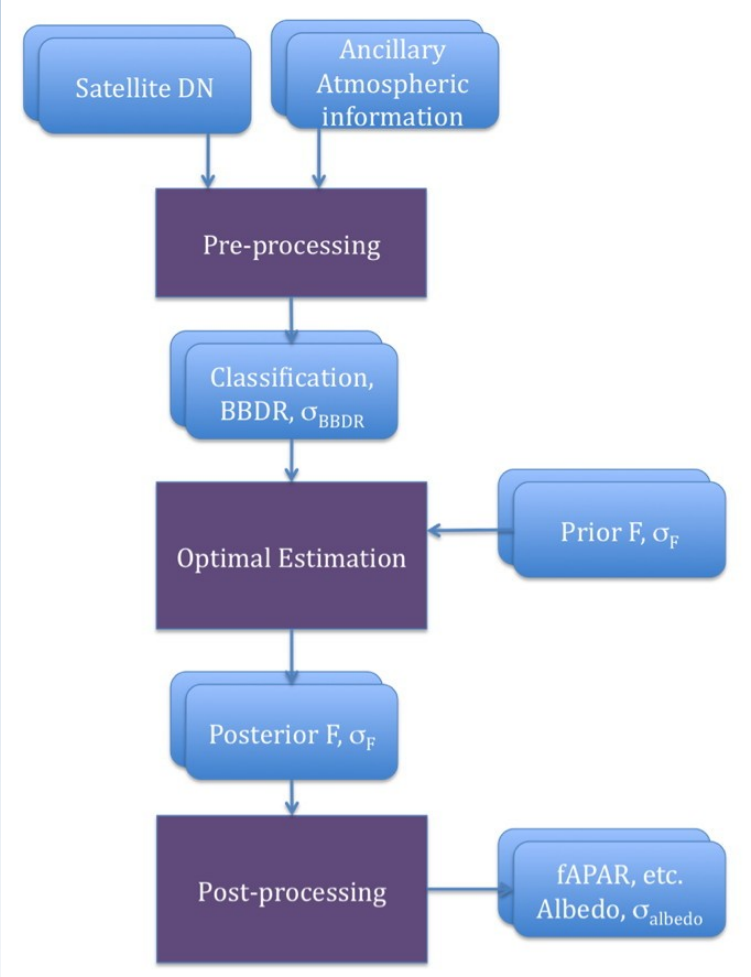
Production of a 14 year record (1998-2011) of 1km Land Surface BroadBand Albedo (BBA) every 8 days as well as 0.05º & 0.5º monthly from European space assets to provide an independent capability to generate this Essential Climate Variable

Overall Aims - GlobAlbedo

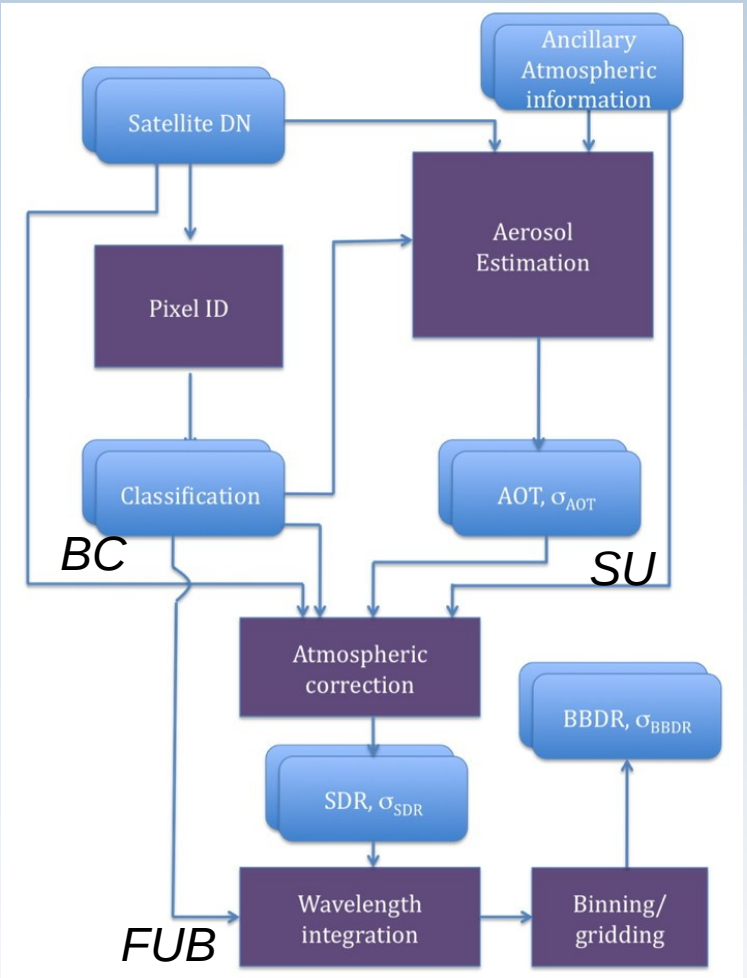
- Input data consists of level 1b (radiometrically calibrated, satellite projection) as well as MODIS C5 BRDF MCD43A1,2 (3/2000-3/2010)
  MERIS (6/2002-4/12)
  VGT (24.3.98-31.1.03) and VGT2 (1.2.03-12/11)
  [ATSR2 6/95-3/00, AATSR 6/02-4/12 unusable due to geocoding]
- An estimated uncertainty (variance-covariance matrix) for each output pixel using an optimal estimation framework
- Validation of final albedo products as well as intermediate products (e.g. cloud masks, aerosol retrievals, narrow-to-broadband)
- GlobAlbedo products freely available via wget/curl, http and

Overall Algorithm & Validation

- MERIS & VGT I/P
- Subset of GlobAlbedo products validated
- Focus on
  Pixel ID
  AOT
  SDR
  N-to-BB
  Albedo
- Internal validation performed by relevant producer
- Albedo validation performed over FLUXNET, BSRN, SURFRAD sites intercomparison with other EO

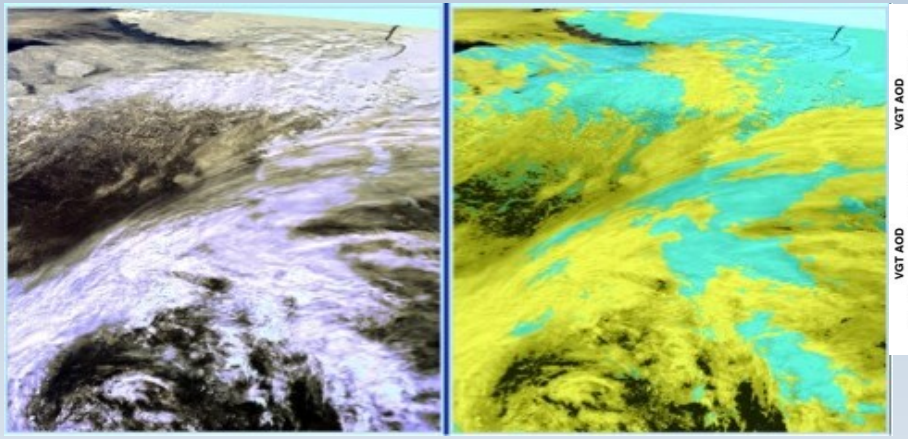


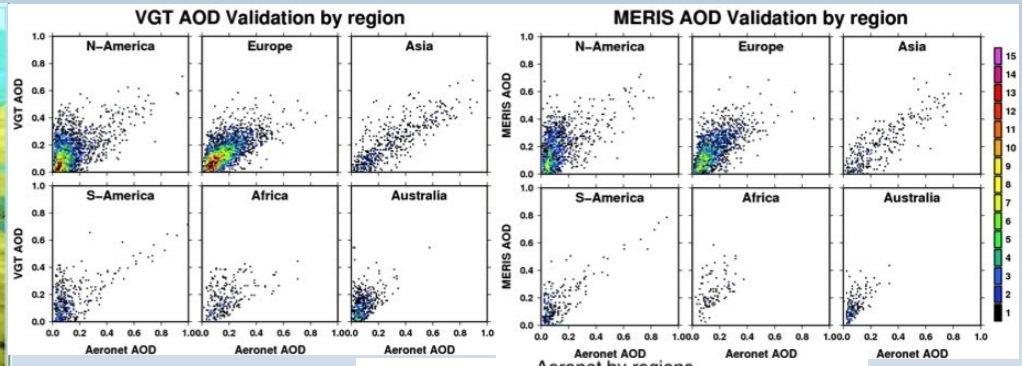
Overall GlobAlbedo processing chain
Muller et al., IGARSS12

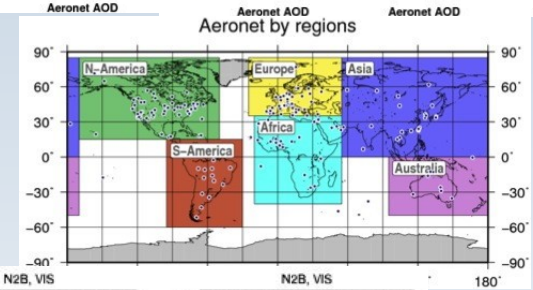


GlobAlbedo product flowchart
Lewis et al., IGARSS12

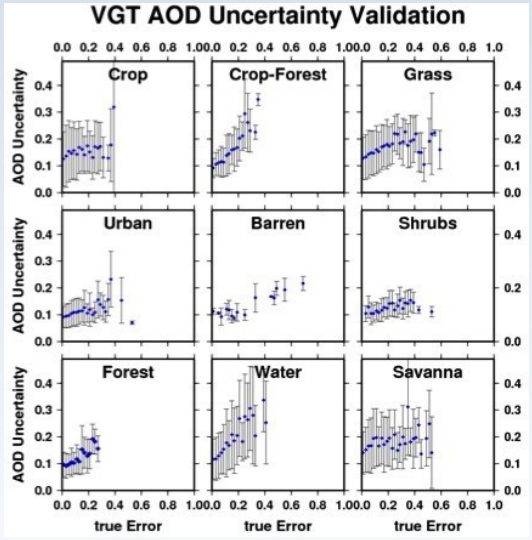
Validation of pre-processing stages from producers

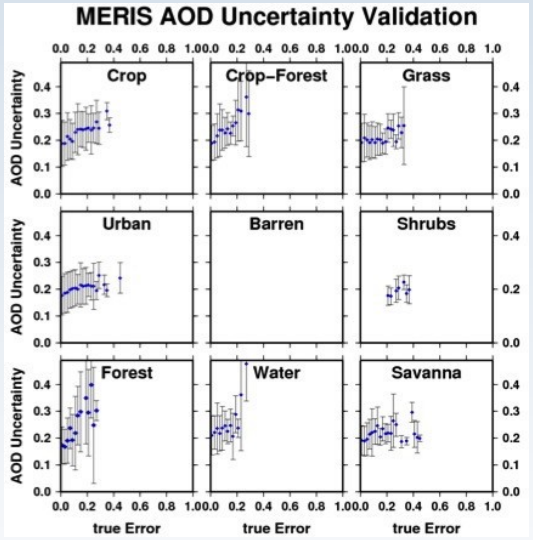


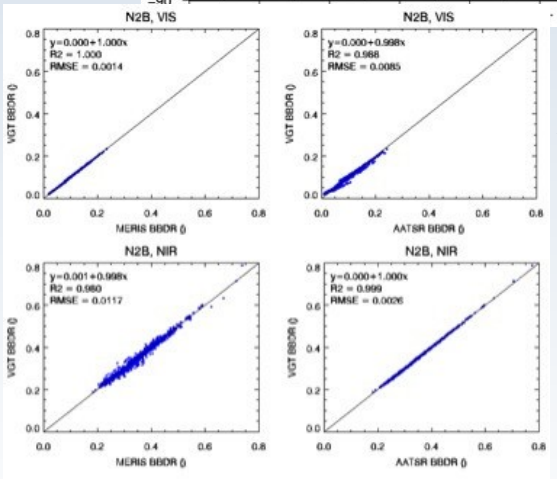




Pixel ID: Cloud, Snow/Ice, Water, Land

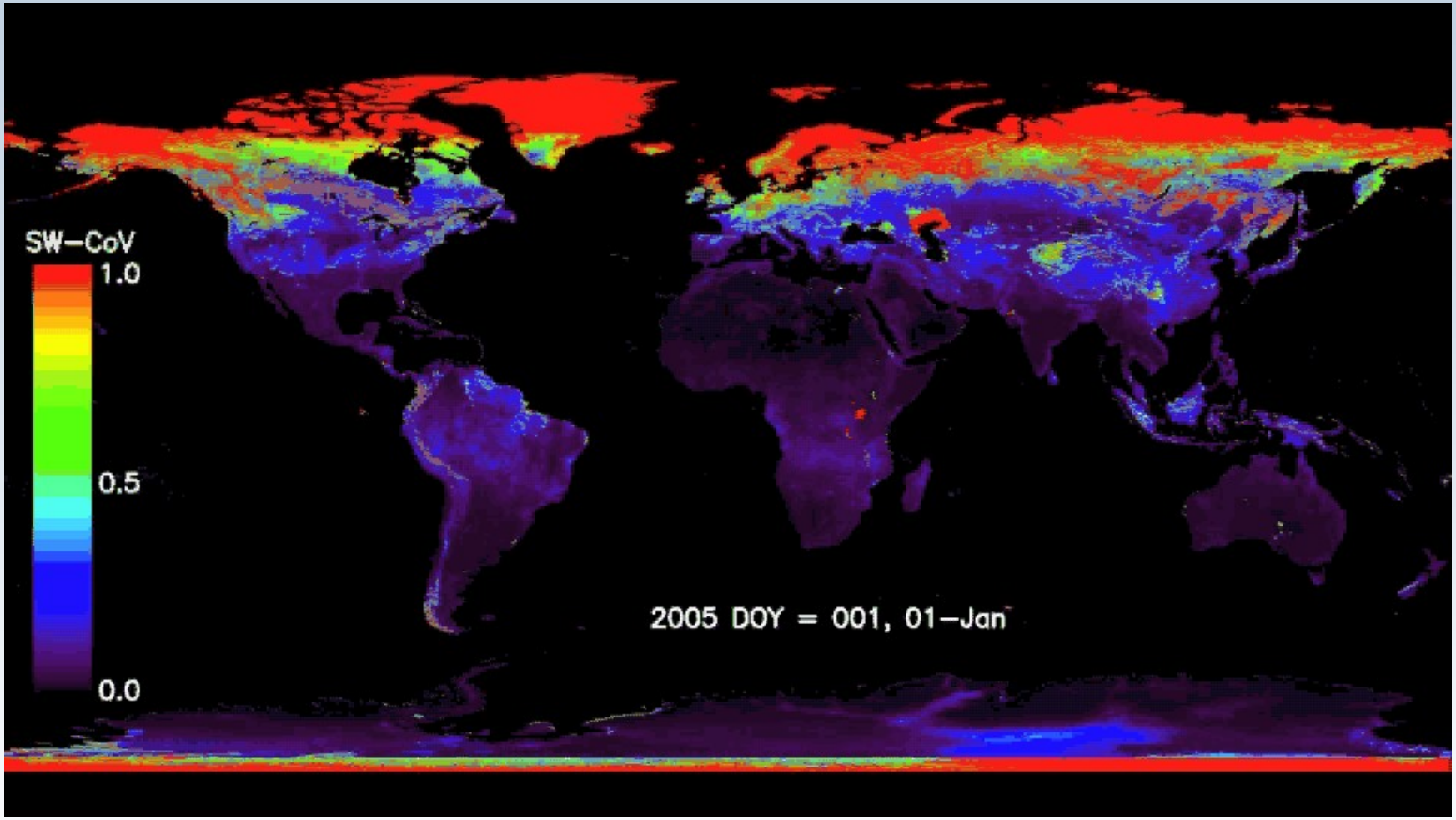




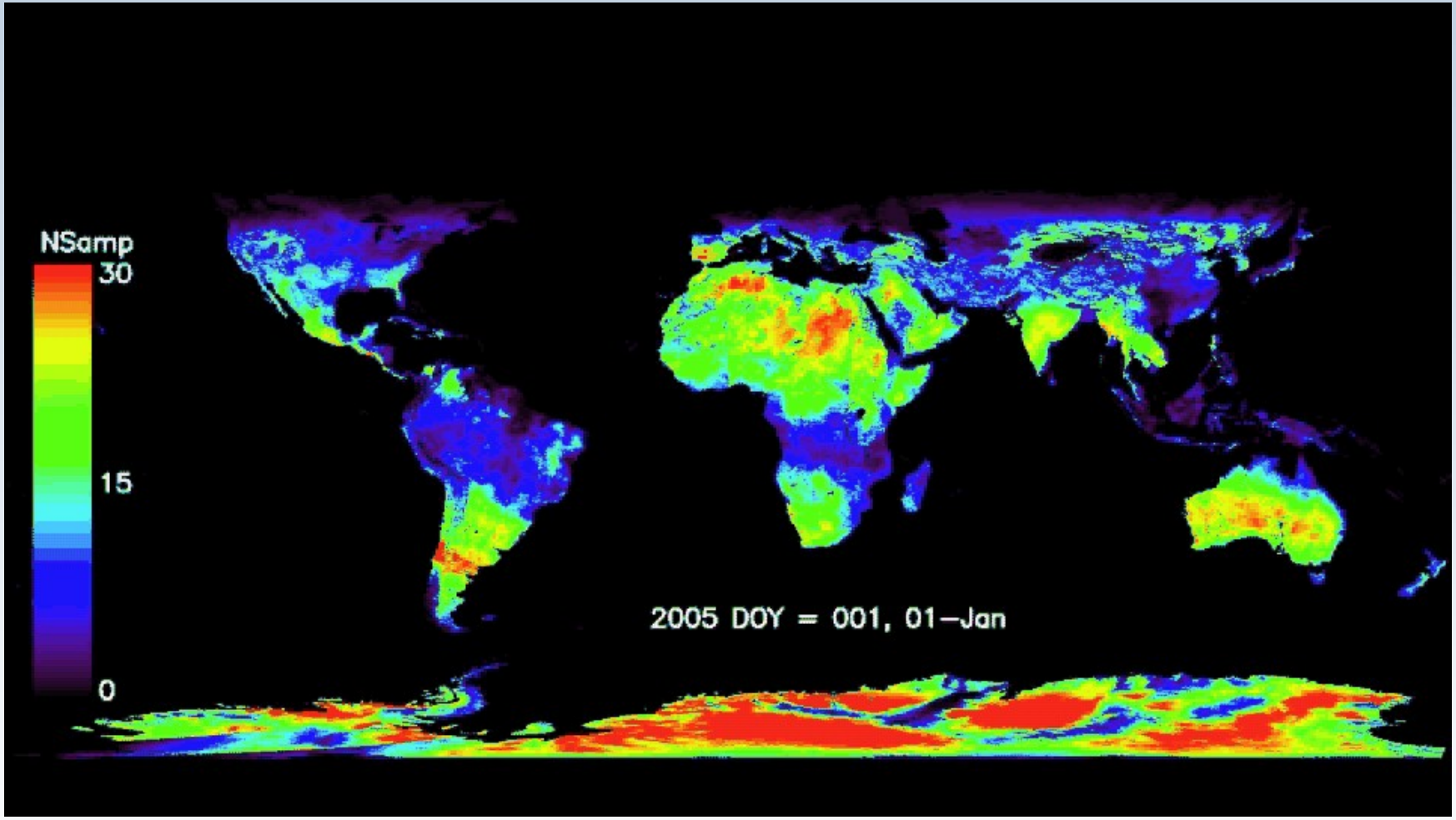


VGT vs MERIS
Not shown:
MODIS vs VGT
MODIS vs MERIS
CHRIS vs VGT
CHRIS vs MERIS

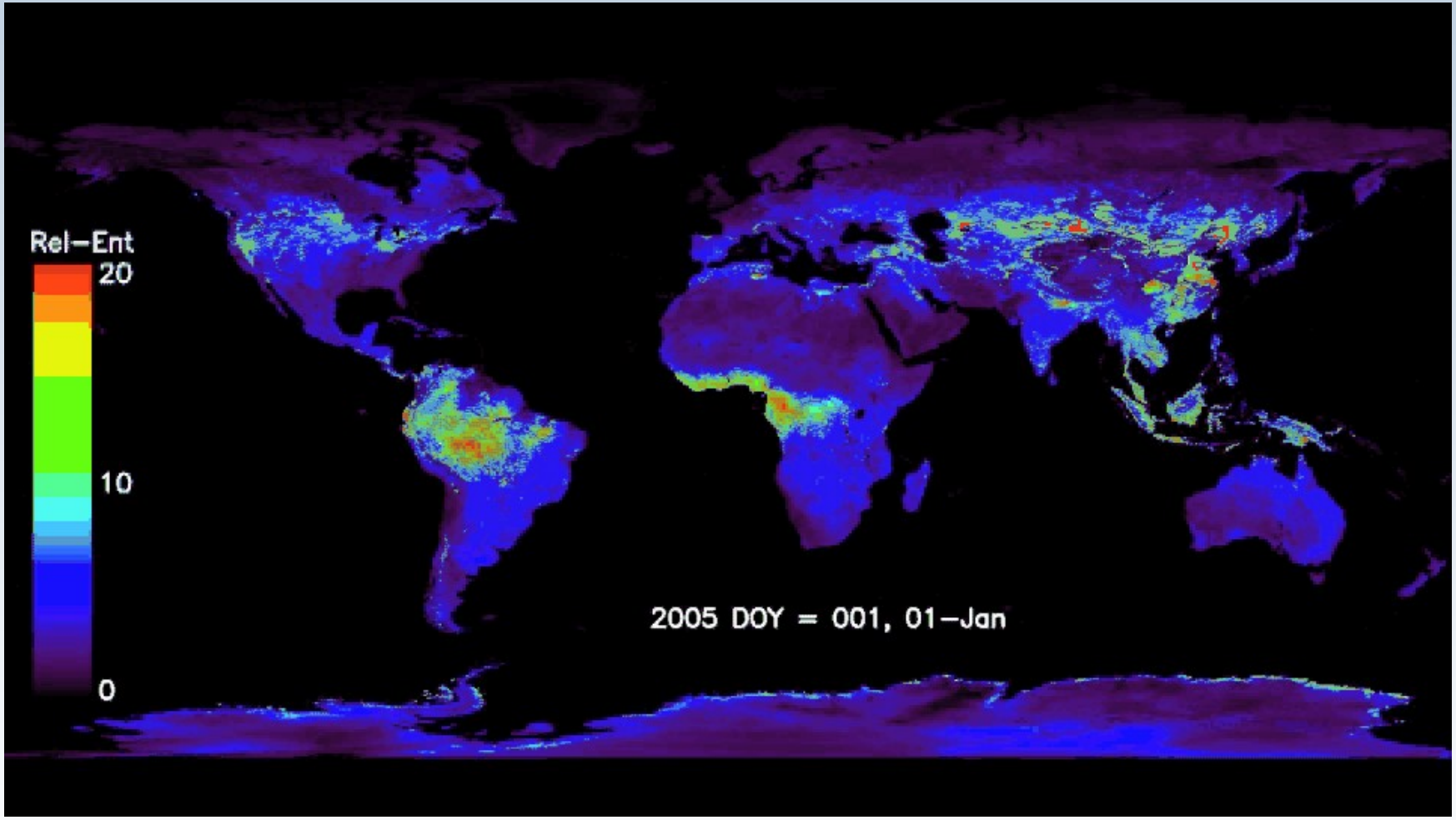
GlobAlbedo 8-daily Coefficient of Variation



GlobAlbedo 8-daily Weighted Number of Samples



GlobAlbedo 8-daily Relative Entropy (≥20 MODIS prior high)

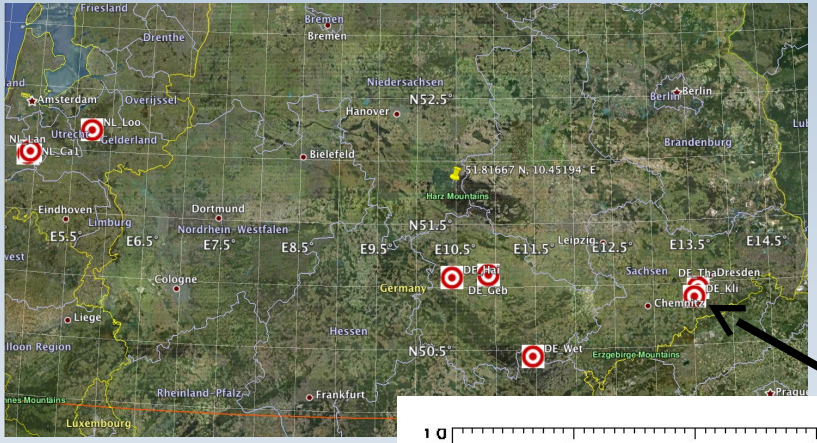


Albedo validation (1998-2011)

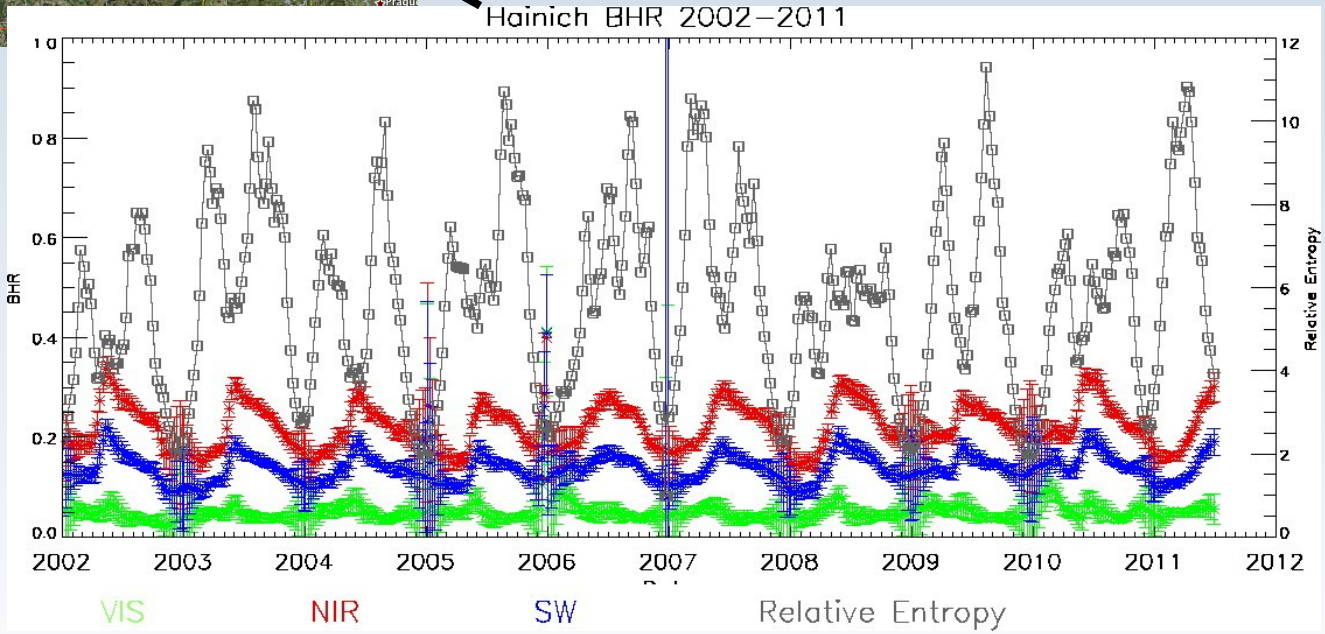
- Focused on 3 aspects
  - Intercomparison of Blue-Sky Albedo with tower albedometer measurements for representative sites which are homogeneous at 1-3km scale (Roman et al., RSE2009), Based mainly on 53 FLUXNET sites (Cescatti et al., RSE2012), SURFRAD and a single non-US BSRN site
  - Assessment of BroadBand Albedo (VIS, NIR, SW) at the global scale on monthly time-steps with MISR and MODIS
  - Assessment of GlobAlbedo with MISR, MODIS, METEOSAT (MSA)
- Tower albedometer data obtained from A. Cescatti from the La Thuile FLUXNET database with assistance from Z. Wang & C. Schaaf of UM Boston
- These data were processed to obtain averages over 11-13h Local Time using VEGETATION-derived AOD, Cloud Fraction and Snow cover
- Focus only on FLUXNET sites which operate the Open or Fair Use policy (Europe, North America, Australia)

N.B. This work uses tower albedometer data acquired by the FLUXNET community and in particular by the following networks: AmeriFlux (U.S. Department of Energy, Biological and Environmental Research, Terrestrial Carbon Program (DE-FG02-04ER63917 and DE-FG02-04ER63911)), AfriFlux, AsiaFlux, CarboAfrica, CarboEuropeIP, CarboItaly, CarboMont, ChinaFlux, Fluxnet-Canada (supported by CFCAS, NSERC, BIOCAP, Environment Canada, and NRCan), GreenGrass, KoFlux, LBA, NECC, OzFlux, TCOS-Siberia, USCCC.

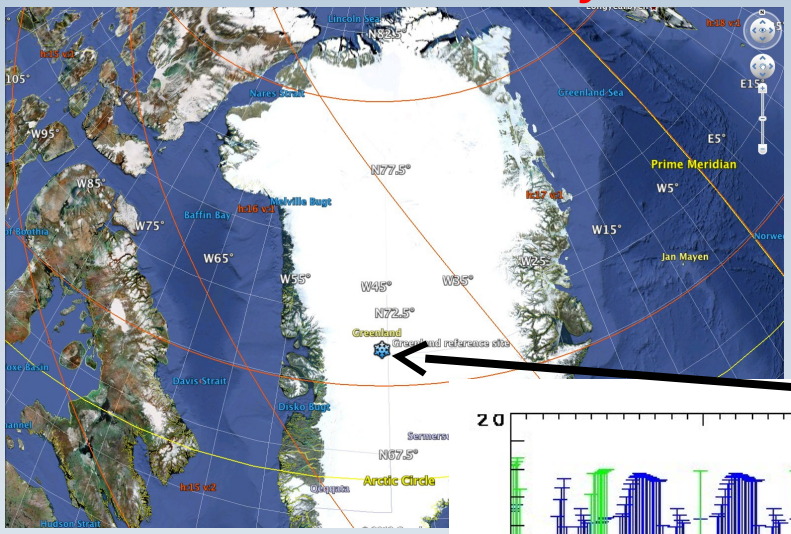
GlobAlbedo 8-daily BHR for Hainich marked in Google Earth



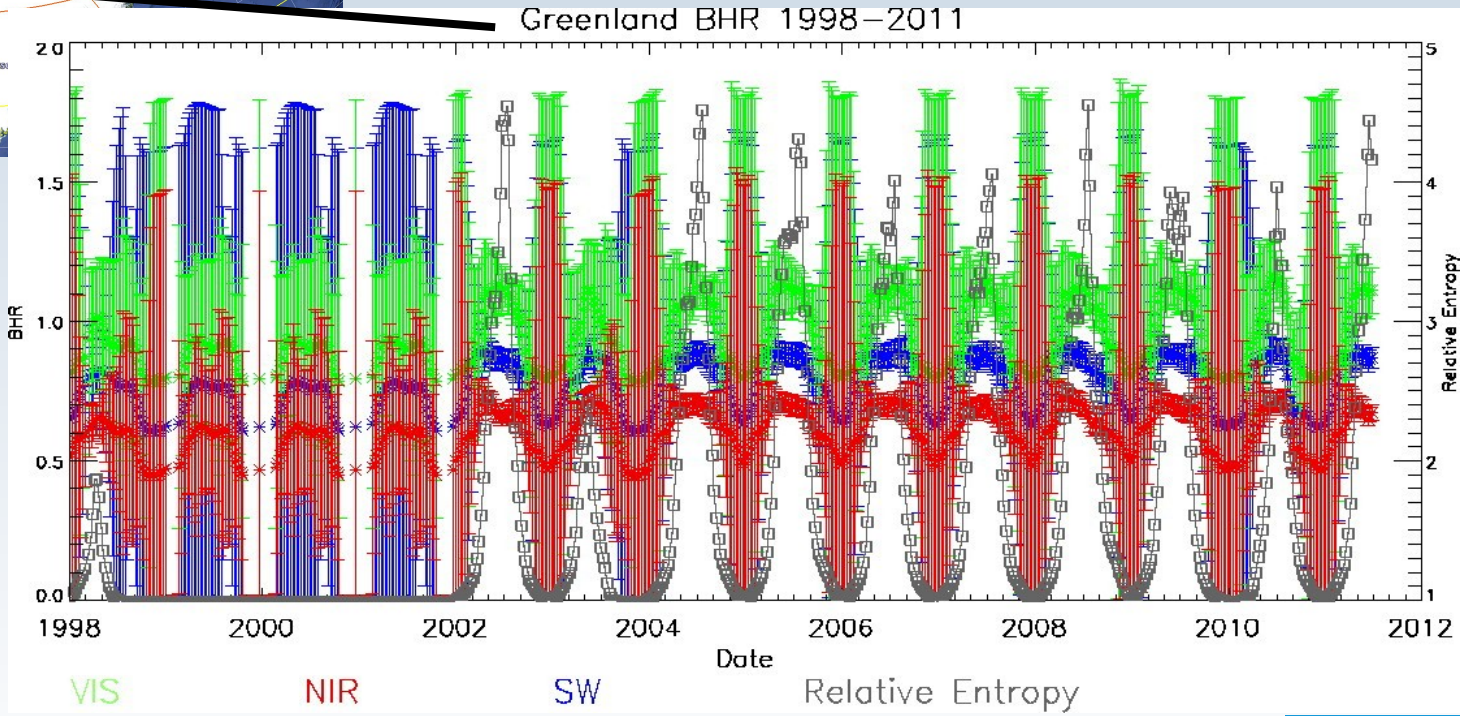
Internal subsetting allows any point or 3 x 3 area to be extracted as CSV and plotted



GlobAlbedo 8-daily BHR for position marked in Google Earth



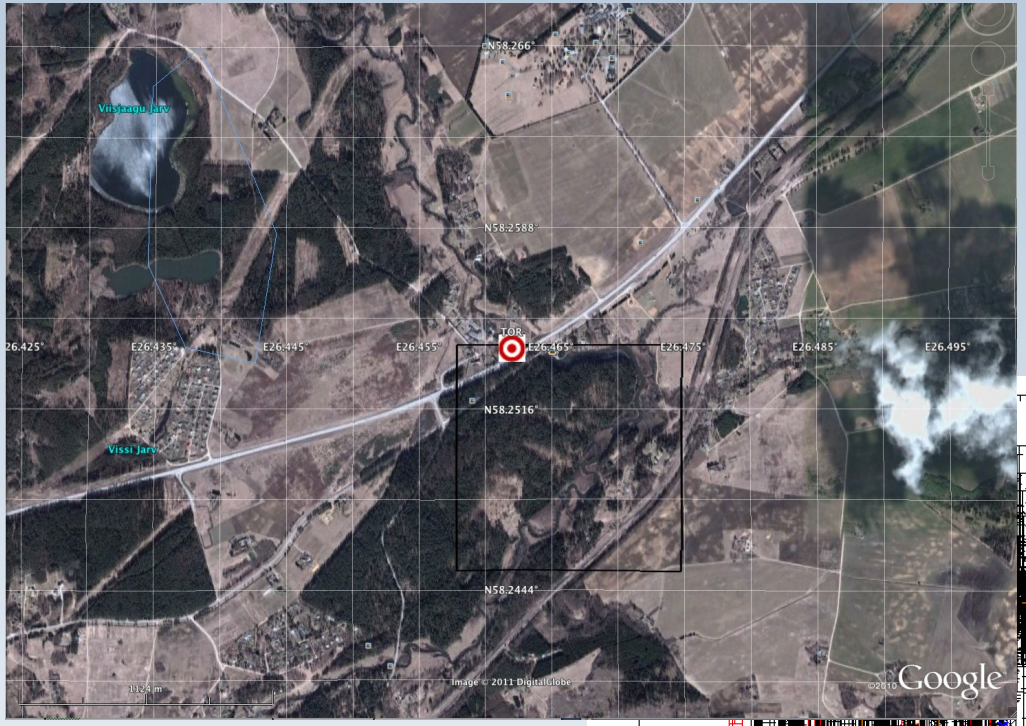
Internal subsetting allows any point or 3 x 3 area to be extracted as CSV and plotted

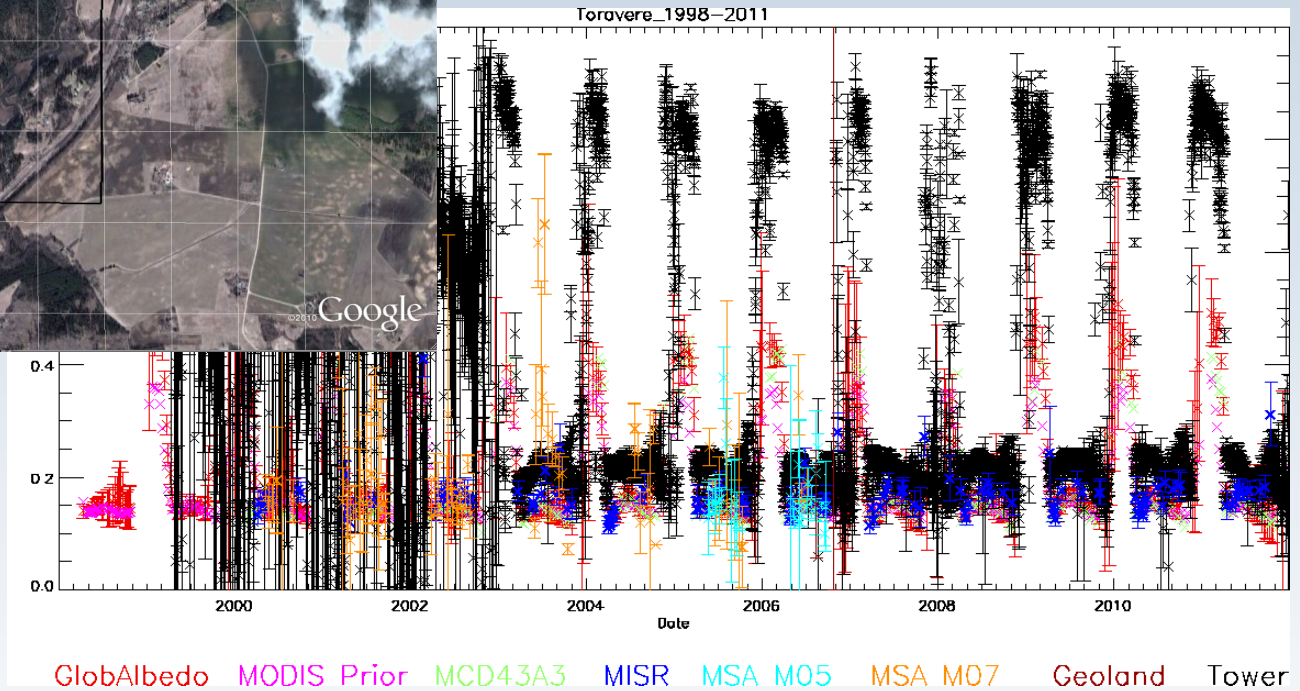


European FLUXNET/BSRN test sites (19 FLUXNET, 1 BSRN)

BSRN Toravere

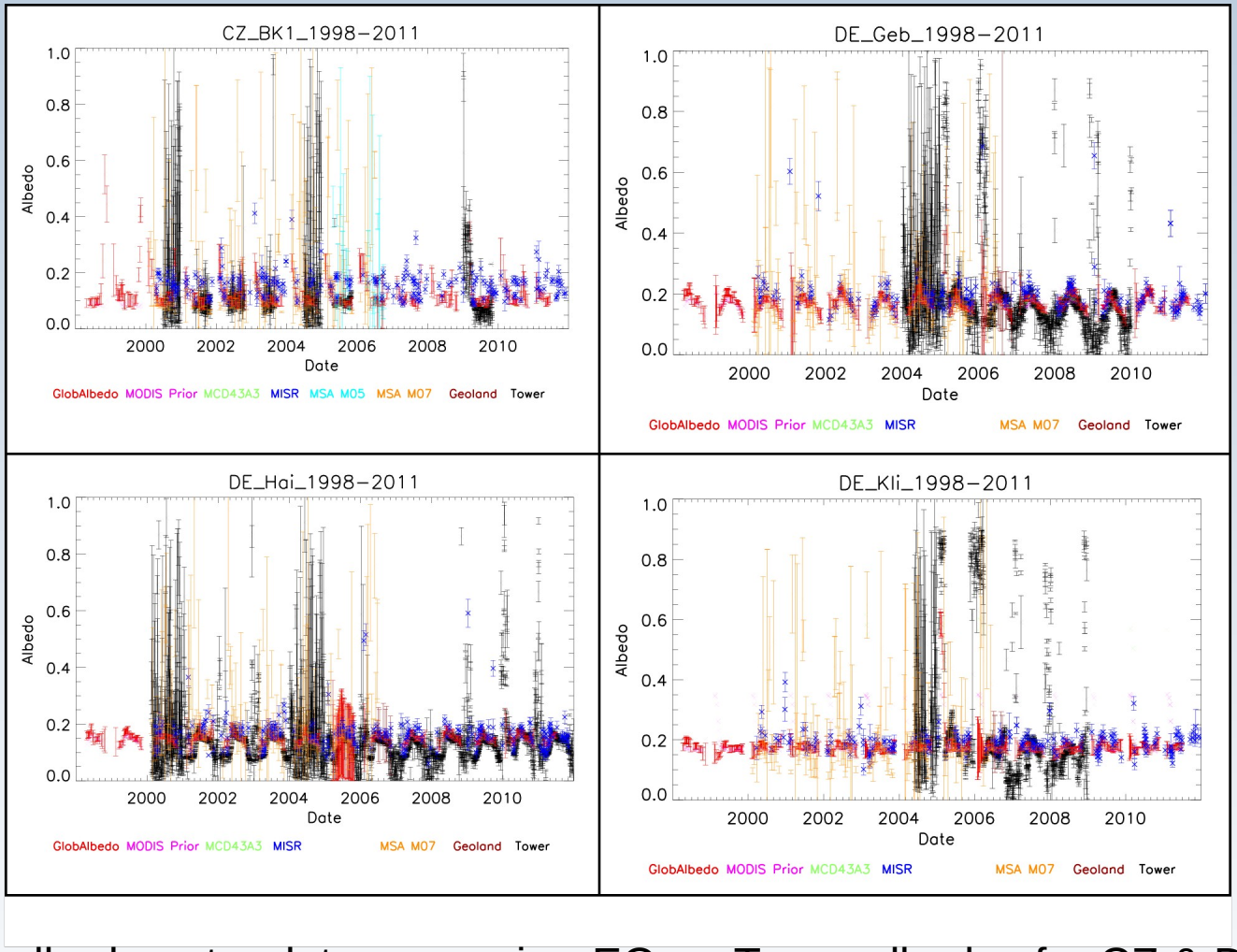
Only “homogeneous” site at 1km





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

Europe – Validation (1998-2011), Exemplars



N.B. Tower albedometer data very noisy. EO >> Tower albedos for CZ & DE_Hainich

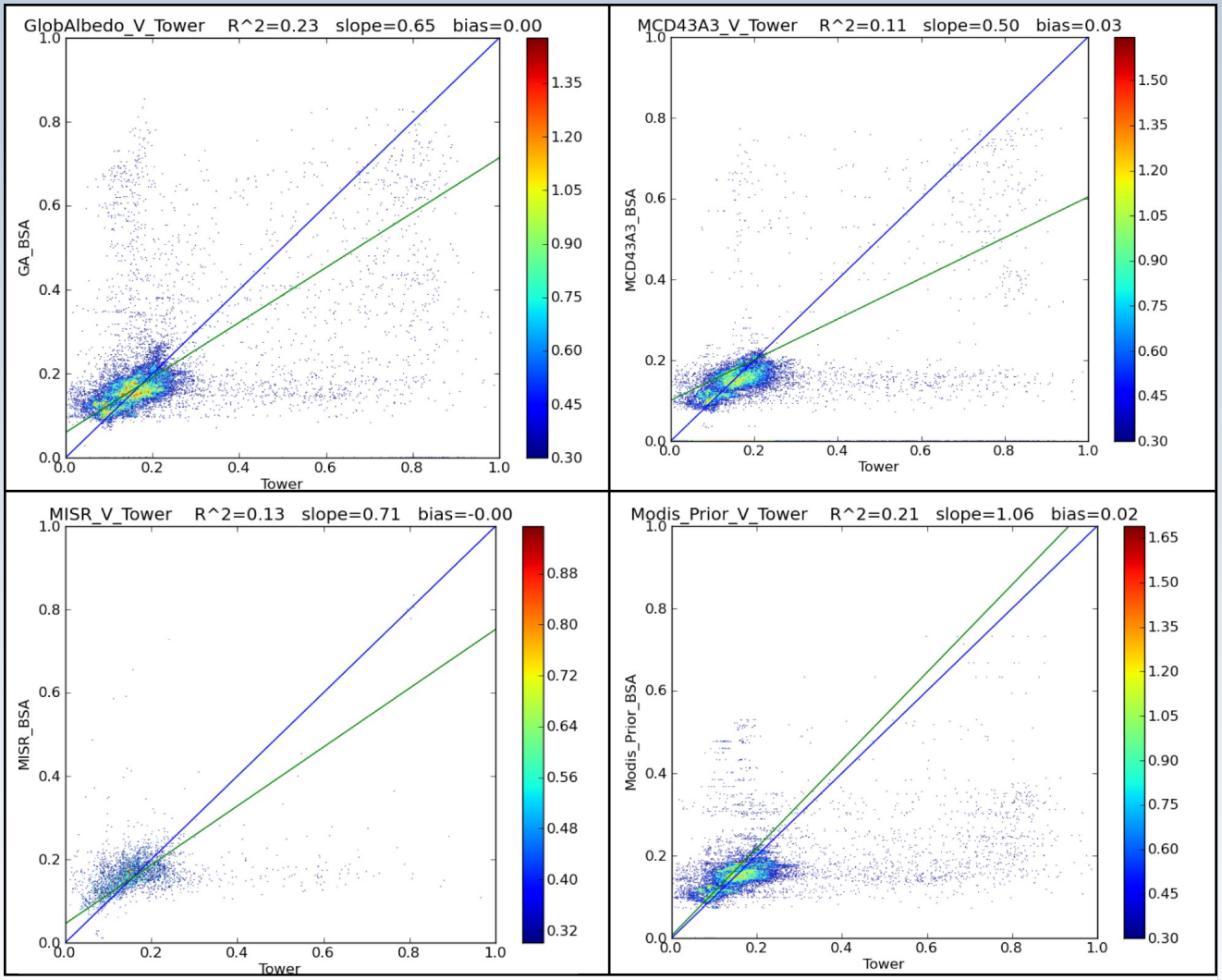
GlobAlbedo, MODIS & MISR vs Tower

GlobAlbedo

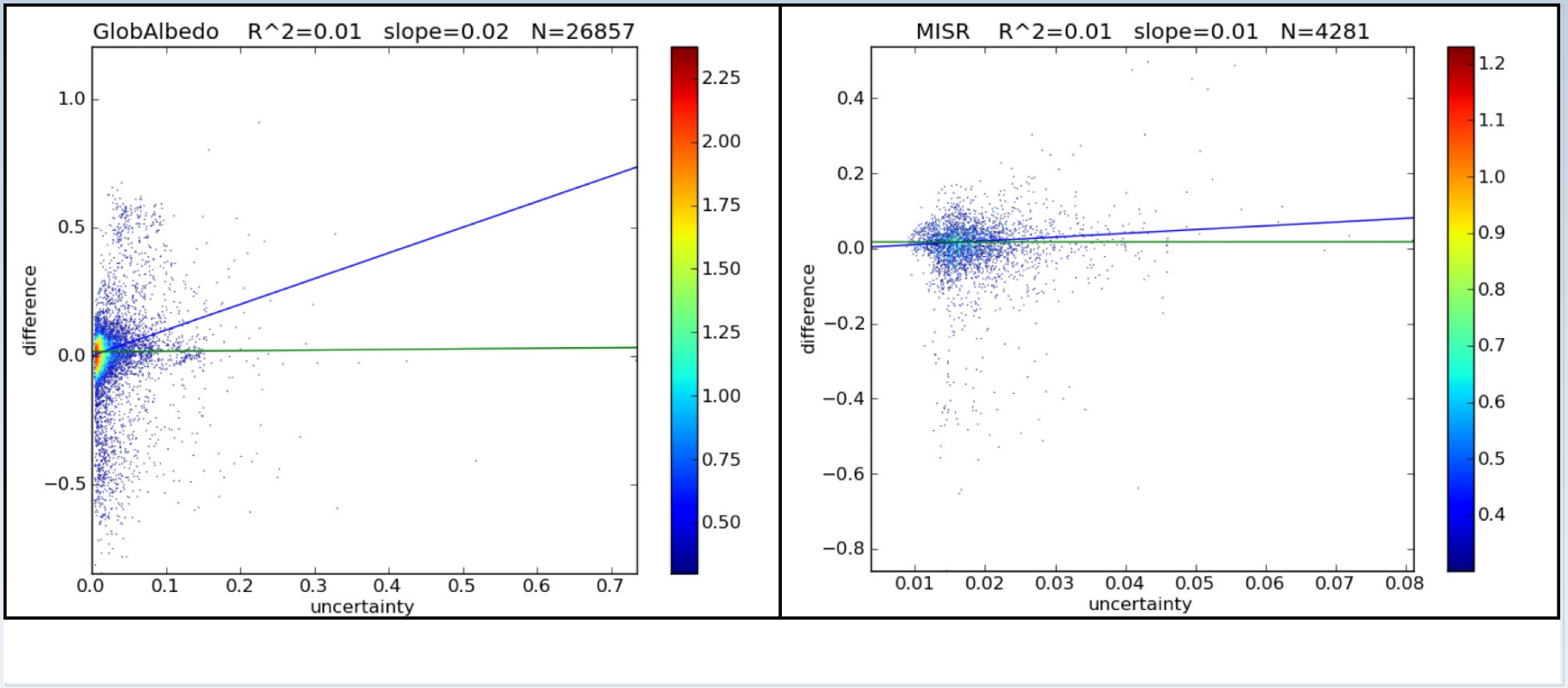
MCD43A3

MISR

MODIS priors



GlobAlbedo & MISR uncertainties vs Differences with Tower

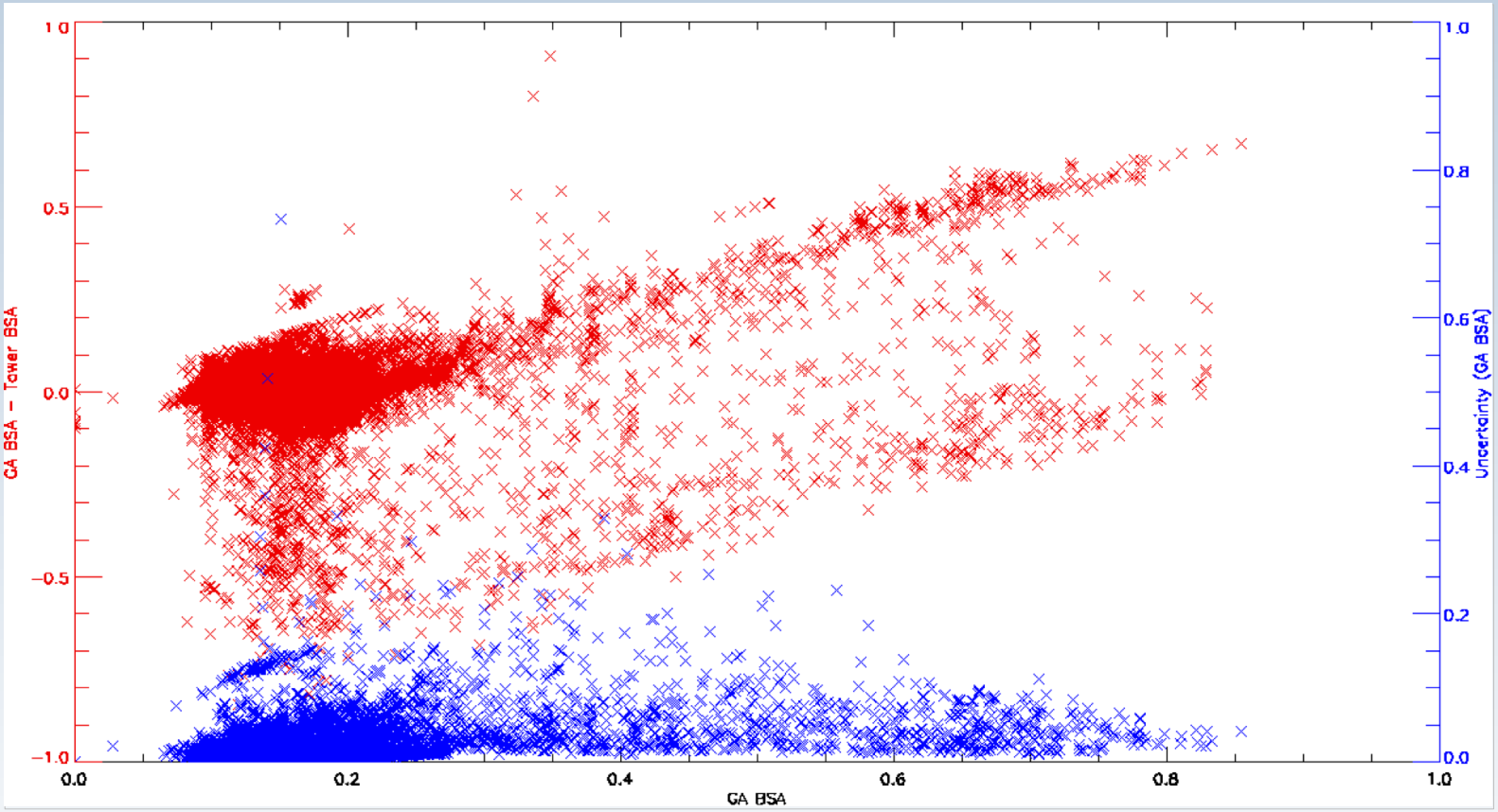


GlobAlbedo

MISR

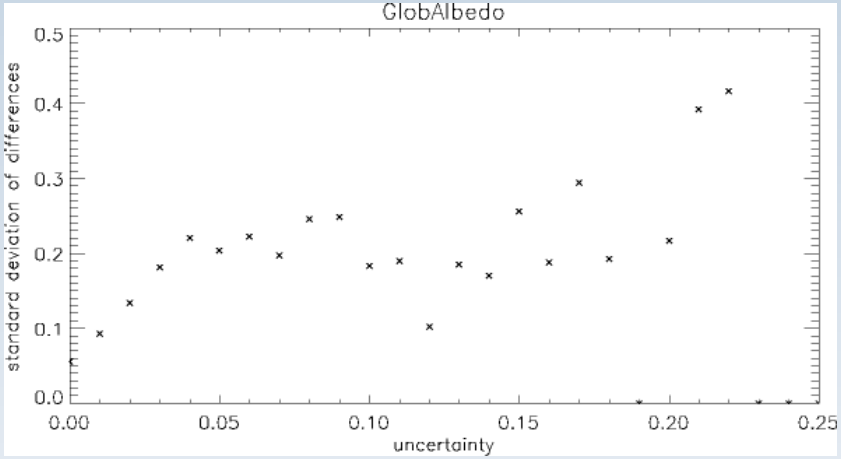
N.B. Majority of differences <0.03

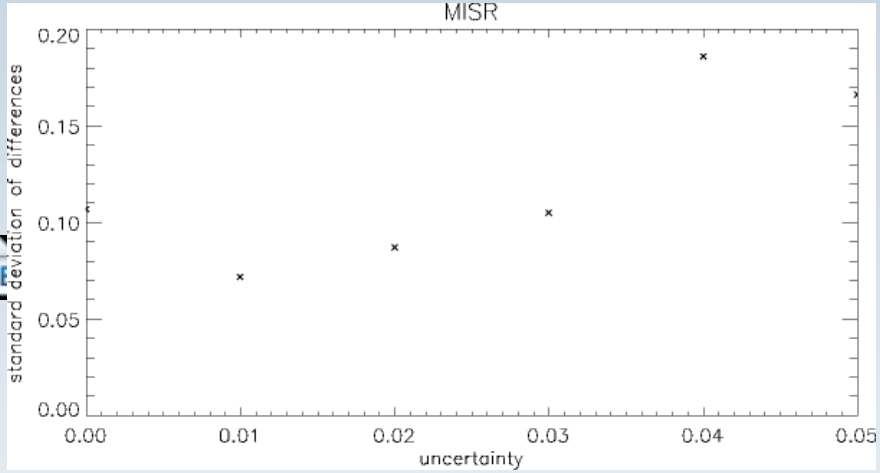
GlobAlbedo Blue Sky Albedo vs Tower difference and BSA value



N.B. Strong correlation of uncertainty with Blue Sky Albedo magnitude

GlobAlbedo & MISR uncertainties vs Standard Deviations with Tower Blue-Sky albedo measurements



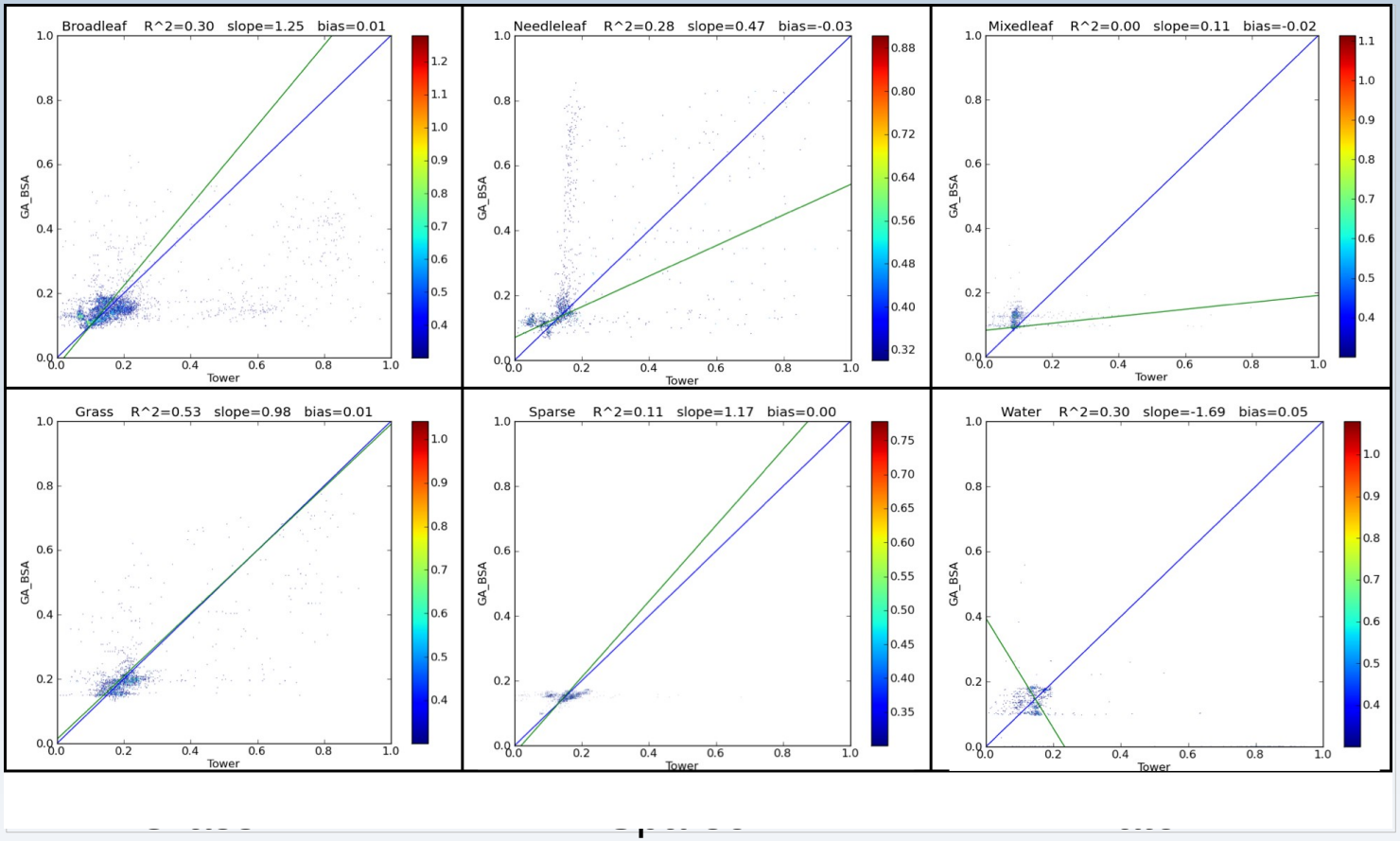


GlobAlbedo

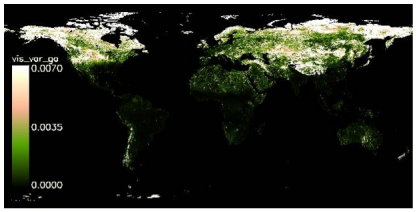
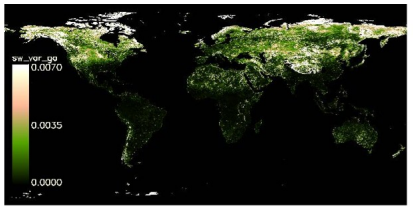
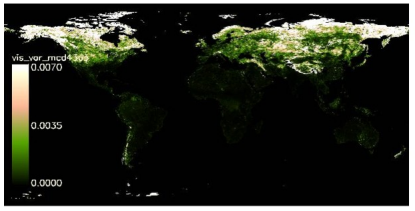
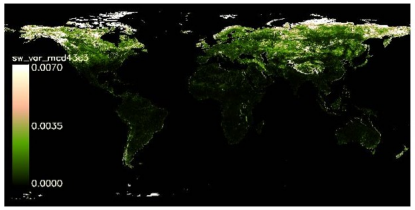
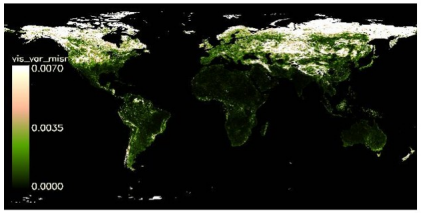
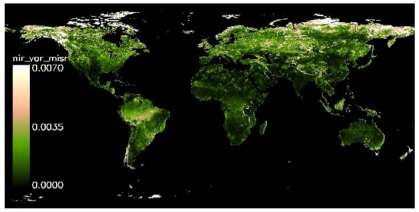
MISR

GlobAlbedo vs Tower in 6 land cover classes

Broadleaf | Needleleaf | Mixed leaf

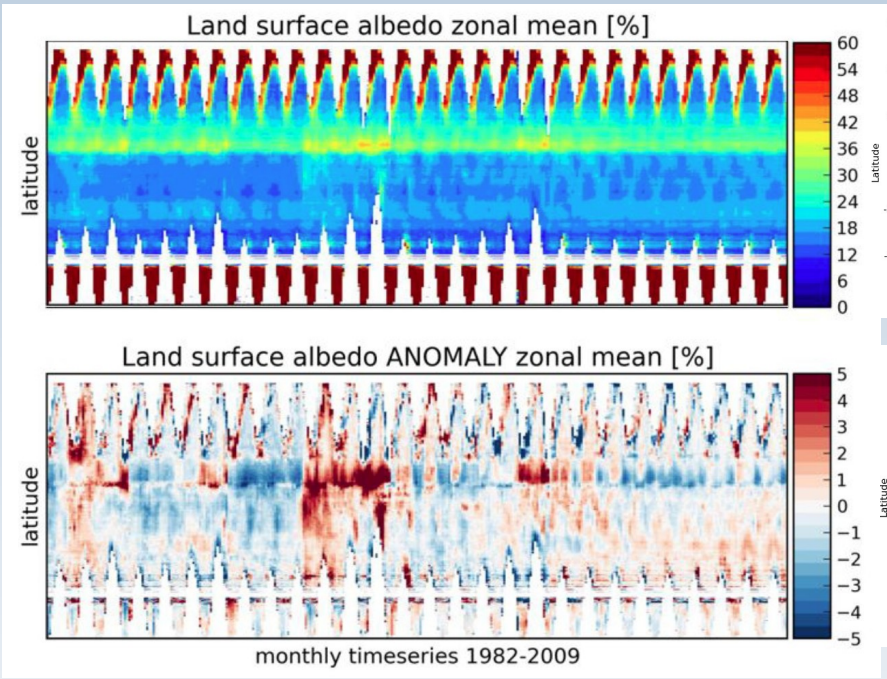


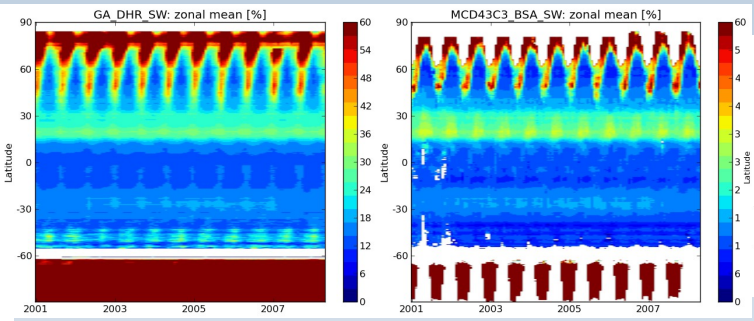
Triple Collocation Variance maps

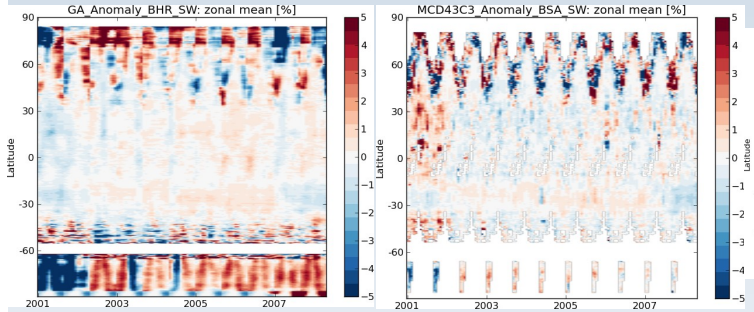
		
GlobAlbedo-VIS	**GlobAlbedo-NIR**	**GlobAlbedo-SW**
		
MODIS-VIS	**MODIS-NIR**	**MODIS-SW**
		
MISR-VIS	**MISR-NIR**	**MISR-SW**

GlobAlbedo variance between MISR and MODIS

Hovmöller Plots of CLARA-SAL vs EO-derived DHR Albedos







CLARA/SAL
Courtesy of Alexander Loew, MPI

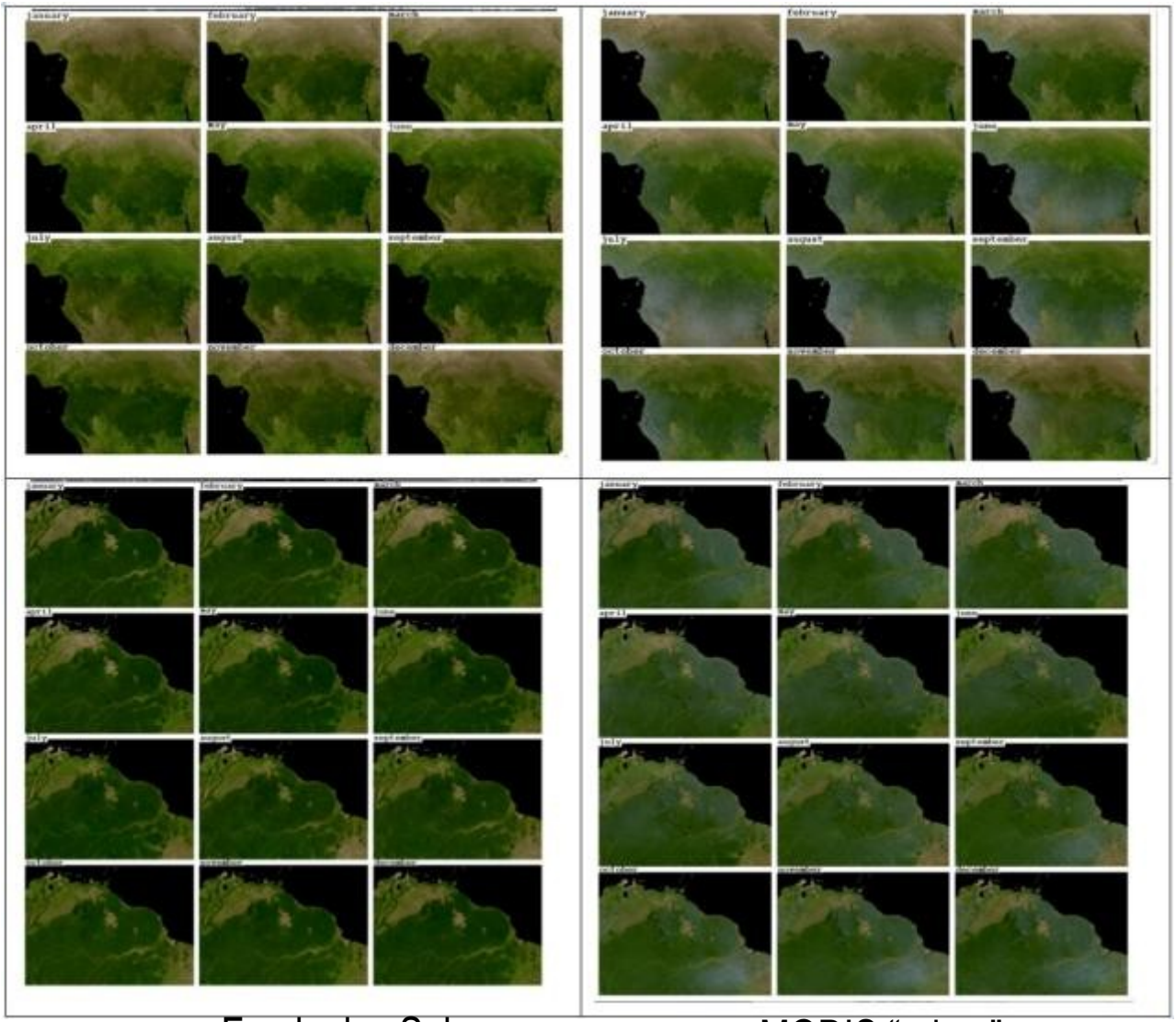
GlobAlbedo

MODIS

MISR

Atmospheric contamination of MCD43 products

- Africa (upper panel) and S. America (lower panel)
- FDS (left) vs GA (right)
- Note the whitish hue due to uncorrected aerosol/cloud contamination issues which are highlighted in the GA product
- FDS uses pixel interpolation/extrapolation to explicitly remove aerosol/cloud in monthly composites"



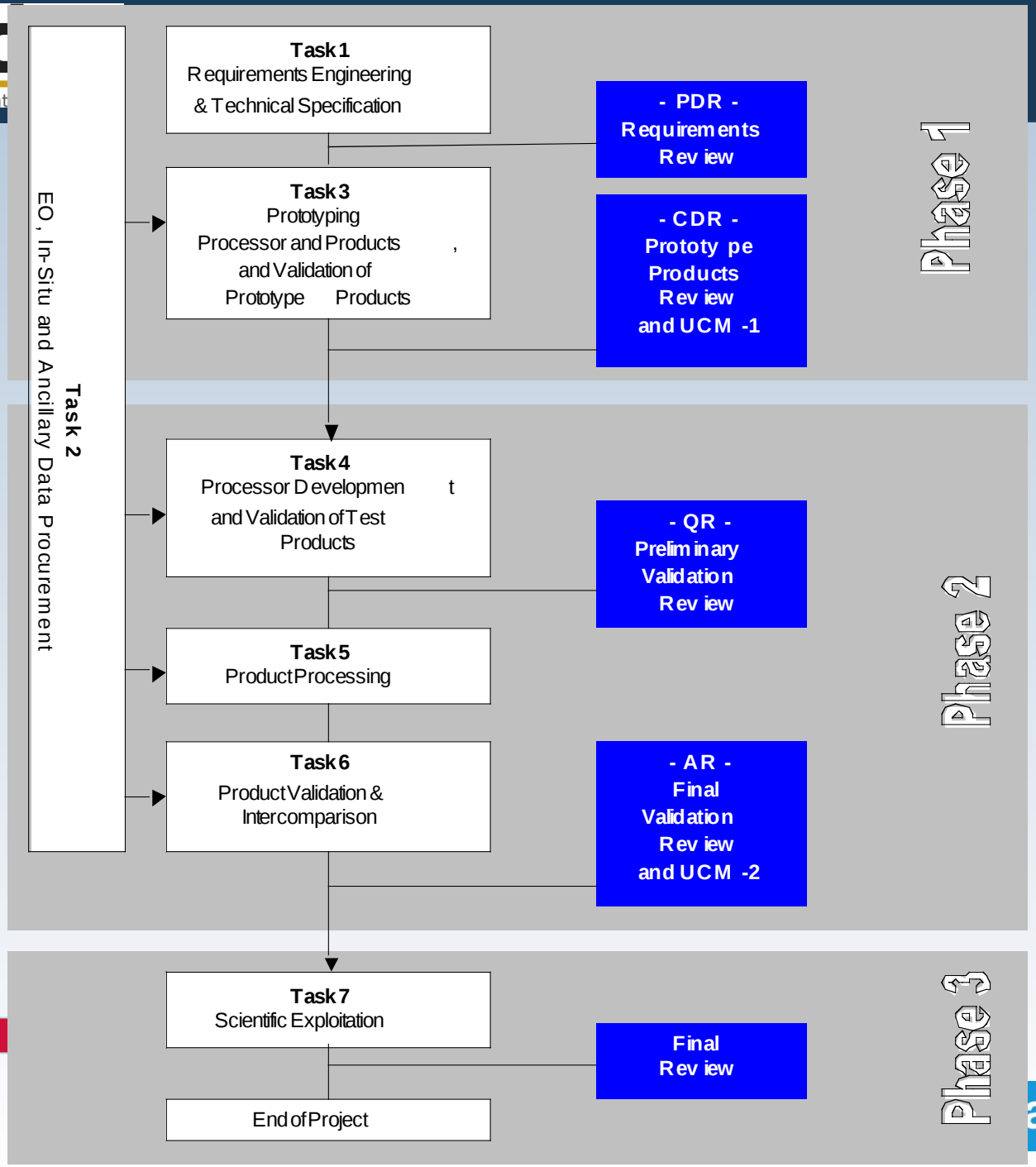
Fonds des Sols | MODIS "priors"

Lessons learnt

- There is no ideal set of "*in situ*" blue-sky (BHR) albedo data. It is inherently very noisy and only covers a small fraction of an EO pixel
- EO-derived results are generally very consistent with each other (with the exception of METEOSAT) but they are often offset from *in situ*
- EO albedo results all lower than tower for snow conditions (N.B. issue appears to be resolved when dealing with daily retrievals such as those from MODIS Collection 6)
- GlobAlbedo uncertainties positively correlated with Blue Sky Albedo magnitudes and with standard deviation of differences
- Triple collocation shows that GlobAlbedo & MODIS have similar behaviour even though relative entropy results indicate that there is little influence outside of persistently cloudy regions of MODIS priors on GA
- All 1km tile-based BRDF and albedo mosaics at 0.05º, all animations of time series freely available on the website!

What next?

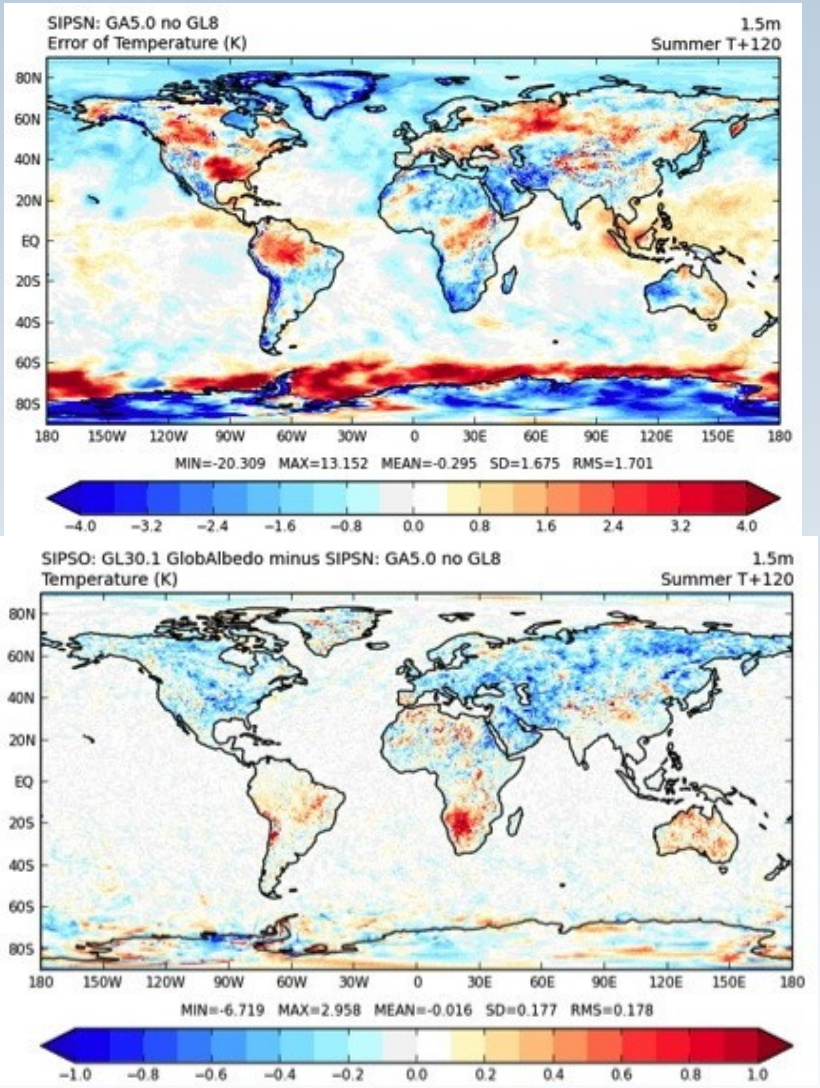
- 1998-2011 complete and available online
- Validation datasets are established from FLUXNET and BSRN for global sites for entire time period
- Inter-comparisons done with MISR, MCD43, METEOSAT, MSG Land-SAF,GEOLAND2
- MPI Hamburg, UK Met Office, ETHZ, CICERO, NCEO, ITI, ECMWF, Météo-France testing impact of uncertainties on NWP forecasts
- Working with scientific partners on evaluation



Who uses our data now and what has it been used for?

- NCEO Reading for data assimilation in coupled atmosphere-land models
- NCEO Leicester for atmospheric chemistry/air pollution
- NCEO Edinburgh for Carbon models
- UK Met Office, MPI Hamburg, University of Zürich, CICERO, ITC, ECMWF, Météo-France, Princeton, ESTELLUS testing impact of uncertainties on Climate and Hydrology forecasts
- ESA press release (7/9/13)

"Tests show that GlobAlbedo data help to give more accurate temperature forecasts over the United States and Asia, especially in summer," said Dr Malcolm Brooks from the Met Office. "We expect to be producing operational forecasts using GlobAlbedo data in the spring of 2014."



Quality Assurance for Essential Climate Variables

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Deputy
Co-ordinator (Land)

Daily albedo (and derived fapar, LAI) for 1982-2015

FP7-SPACE-2013-1
Project No. 607405
1.1.14-31.12.17
SPA.2013.1.1-03: Traceable quality assurance system for multi-decadal ECVs

Mission statement QA4ECV

- QA4ECV will show how trustable assessments of satellite data quality can facilitate users in judging fitness-for-purpose of the ECV Climate Data Record.

- QA4ECV will provide quality assured long-term Climate Data Records of several ECVs relevant for policy and climate change assessments.

ESA CCI Aerosol Cloud CMUG Fire GHG Glaciers Ice Sheets Land Cover Ocean Colour Ozone Sea Ice Sea Level S

CCI

ESA Climate Change Initiative

Wed, 2010-09-01 11:03
Climate change is arguably the greatest challenge facing mankind in the twenty-first century. Its importance has been recognised in re reports from the IPCC and from UNFCCC, and the overwhelming economic consequences are set out in the Stern Report.

GCOS Essential Climate Variables

The 50 GCOS Essential Climate Variables (ECVs) (2010) are required to support the work of the UNFCCC and the IPCC. All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations. Additional variables required for research purposes are not included in this table. It is emphasized that the ordering within the table is simply for convenience and is not an indicator of relative priority.

Domain	GCOS Essential Climate Variables
Atmospheric (over land, sea and ice)	**Surface:**[1] Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget.
	Upper-air:[2] Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance)

Take the survey, be a devil!

http://www.qa4eo.org/survey/

Target Requirements

Variable/ Parameter	Horizontal Resolution	Vertical Resolution	Temporal Resolution	Accuracy	Stability
Black-sky albedo	1km	N/A	Daily to weekly	max(5%; 0.0025)	max(1%; 0.0001)
White-sky albedo	1km	N/A	Daily to weekly	max(5%; 0.0025)	max(1%; 0.0001)

GCOS requirements on Albedo

Target Requirements

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