THE ESA GLOBALBEDO PROJECT FOR MAPPING THE EARTH'S LAND SURFACE ALBEDO FOR 15 YEARS FROM EUROPEAN SENSORS.

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1. GLOBALBEDO PROCESSING AND SAMPLES

A land surface broadband albedo map of the entire Earth's land surface (snow and snow-free) is required for use in Global Climate Model initialisation and verification. A group of 10 users have been selected to work with the GlobAlbedo* Implementation team to define requirements and drive the project towards practical applications of the product. These requirements defined the need to generate a final product on 8-daily at spatial resolutions of 1km in sinusoidal projection using the MODIS 10º x 10º tiling scheme and 0.05º and 0.5º on monthly time-steps.

To generate such a global map by temporal compositing requires both sufficient directional looks and the very precise correction of top-of-atmosphere radiances to "at surface" directional reflectances (SDRs). In addition, such a map requires precise radiometric calibration and inter-calibration of different sensors [1] and the computation of radiative transfer coefficients to derive broadband SDRs from different input narrowband SDRs and given sufficient angular sampling from all the directional looks within a given temporal window, derive a suitable BRDF. This BRDF can be integrated to produce DHR (Direct Hemispherical Reflectance known as "black-sky") and BHR (BiHemispherical Reflectance, known as "white-sky") [2]. The final albedo product has been integrated in three spectral broadband ranges, namely the solar spectrum shortwave (400-3000nm), the visible PAR region (400-700nm) and the near- and shortwave-infrared (700-3000nm). In addition, maps of normalized difference vegetation index (NDVI) and the fraction of absorbed photosynthetically active radiation (fAPAR) will be generated consistent with the albedo product to complement the Globalbedo data set for analysis of vegetation-related processes [3].

To achieve the aim of deriving independent estimates using European only assets, GlobAlbedo set out to create a 15 year time series by employing SPOT4-VEGETATION and SPOT5-VEGETATION2 as well as MERIS. Legacy algorithms for deriving SDRs using an optimal estimation approach are outlined [2] as well as a novel system for gap-filling using ten year mean estimates derived from equivalent BRDFs from MODIS [2]. Each and every output pixel albedo value has an estimated uncertainty associated with it and the corresponding BRDF a full uncertainty matrix for each pixel. Separate BRDFs are computed for snow and snow-free pixels and combined together to yield a gap-free dataset. An example of a sample output product browse in Figure 1 shows the BHR and the coefficient of variation derived from the uncertainty divided by the expectation value (loc.cit.)

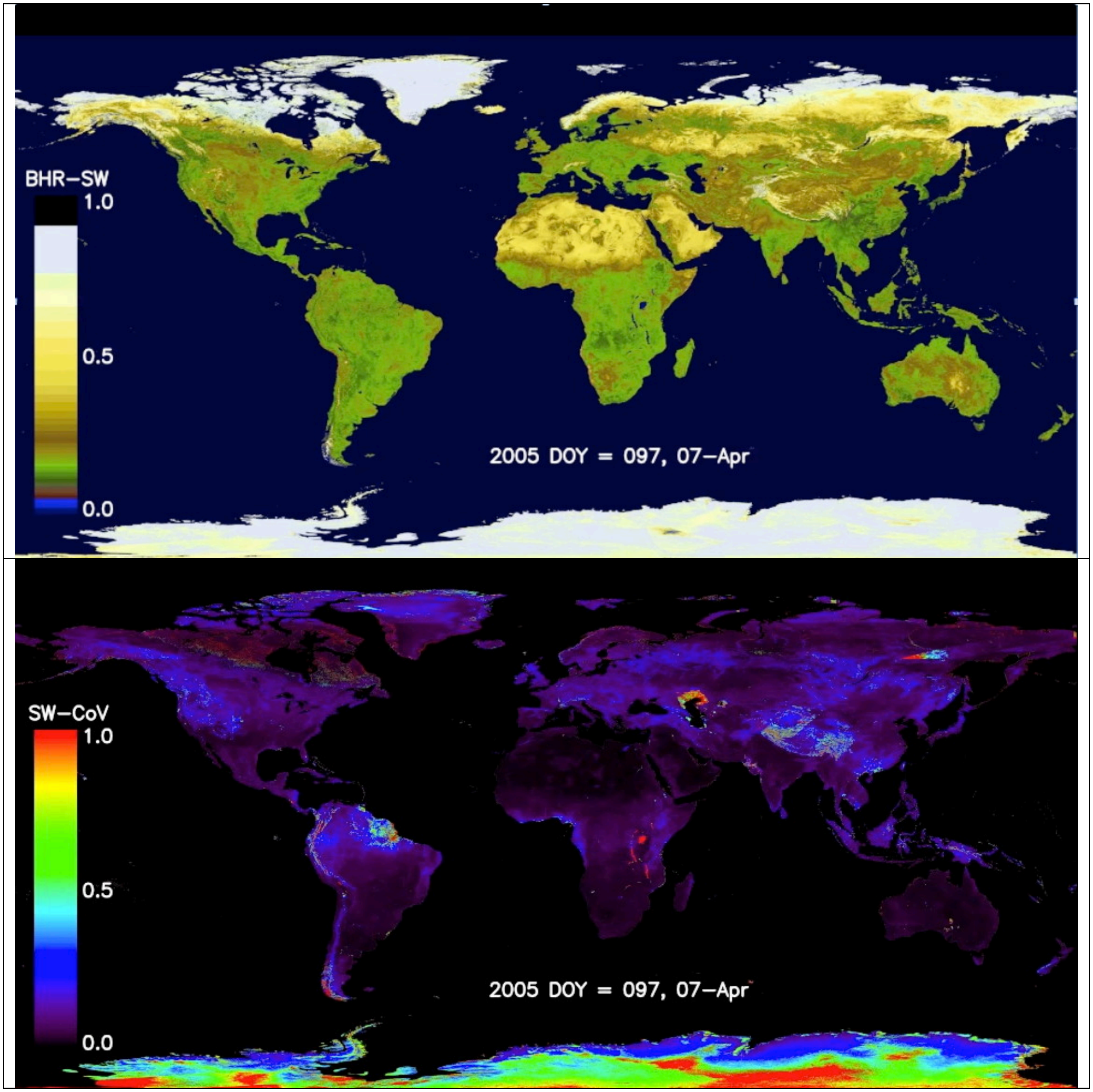

Figure 1. Example of GlobAlbedo Shortwave BHR for DoY 97, 7 April 2005 with the corresponding coefficient of variation showing the impact of the onset of austral summer. See http://www.GlobAlbedo.org/ for further details

Animations of 8-daily and monthly browse products including the full-resolution 1km tiles are available on the website for the products available to date (2005, 2009, 2010 and the first 6 months of 2011). An OGC-compliant server based on OpenLayers also allows display of global data and inter-comparison by flickering from one date with another. Global data at 0.05º and 0.5º, as well as individual tiles at 1km, can be downloaded using wget and scripts can be easily written by the user to harvest the data they require. A novel facility is the ability to extract a single pixel or a group of 3 x 3 or 5 x 5 pixels in CSV format through time for immediate plotting locally.

2. GLOBALBEDO VALIDATION

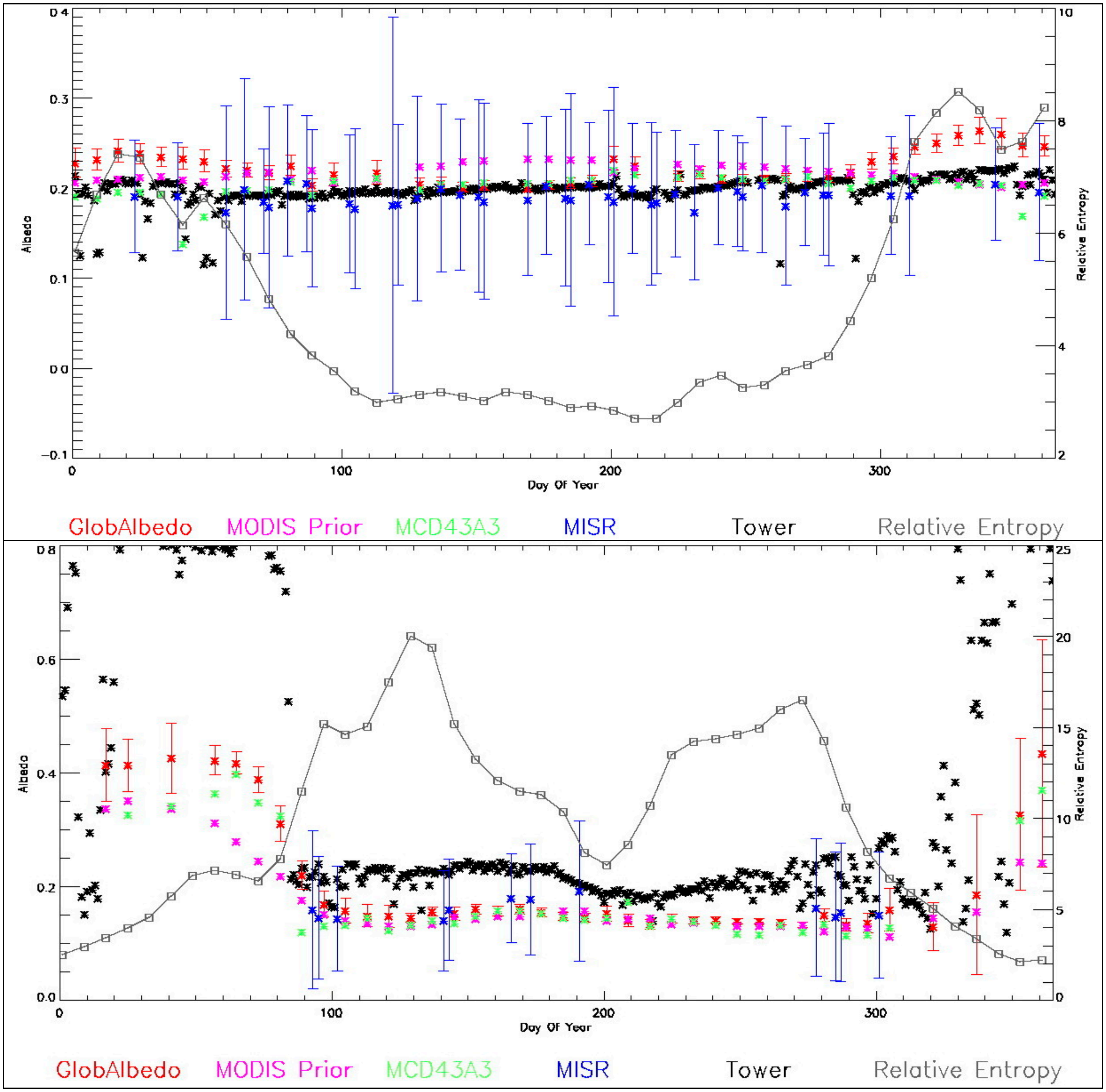

Figure 2. Example taken from [4] of a SURFRAD site (Desert Rock) and a BSRN site (Toravere) of a time series for the whole of 2005 showing Blue-Sky albedo results for tower albedometer, GlobAlbedo, MODIS Prior, MODIS Collection 5 (MCD43A3), and MISR showing uncertainties available for GlobAlbedo and MISR as well as the relative entropy showing the contribution of MODIS priors (for values >>10) for filling in gaps.

Extensive validation has been performed on final GlobAlbedo product for each and every year that correlative data is available. Shown here from [4], in Figure 2 is an example of a time series plot of Blue-Sky albedo from GlobAlbedo, MODIS priors, MODIS Collection 5 and MISR measurements. Uncertainties calculated from within the product [2] are shown for GlobAlbedo and MISR. For a desert bare rock site (upper panel), the GlobAlbedo product shows reasonable agreement with the other EO datasets and with the tower measurements. The differences shown at the year start may be related to spatial variability of the site (loc.cit.). The Toravere site like most BSRN sites is not chosen for its spatial homogeneity but rather it's location close to a suitable laboratory. It has a high degree of spatial variability and almost all BSRN are in this category. In addition, unlike the SURFRAD tower albedometer at 30m with a 100m footprint, Toravere albedometers are at 5m above the surface with a 5m footprint so rendering them unhelpful for the purpose of validating spaceborne-derived land surface albedo. The time series shown for Travere shows a common phenomenon for the more than 80 sites worldwide which have been employed to date, related to the effect of snow in winter. Due to very different fields of view of the local albedometer and the 1km EO-derived equivalent values, snow albedo values from EO are typically 50% of the ones retrieved from local albedometers. In this case, GlobAlbedo appears to be slightly more sensitive to the snow values but this is not necessarily typical.

3. GLOBALBEDO PROSPECTS

The GlobAlbedo data production at UCL-MSSL takes around 3 weeks per output year and produces around 1.5Tb (uncompressed) output. This is running flat-out on a 10-blade (160-core) linux cluster with 48gb of RAM and 1Tb local disk. The processing requires 100Tb of scratch-space to keep all input and output products online. An extensive Product User Manual is available from the website. Currently the production is expect to be completed for the Envisat time period by October 2012 with products being loaded after visual inspection of the browse products and validation using extensive tower-based data and similar EO datasets, including METEOSAT. In the next phase, a variety of different users will assess the impact of the product, and the use of the estimated uncertainties on their particular application.

4. REFERENCES CITED

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