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Analysis of 1989-2004 one km^2 AVHRR data with IDRISI ETM

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The AVHRR MEDOKADS data set developed by Dirk Koslowsky of the Free University of Berlin for the EC EFEDA Projekt [1] can be considered as a 1 km^2 resolution European baseline data set for the beginning of the 21^{st} century. Beside the original spectral channel values and supplemental information it contains deduced albedo, surface temperature and NDVI. To process these derived data with e.g. the Earth Trends Modeler (ETM) of the IDRISI integrated GIS and Image Processing software [2], the decadal data were converted into geographically allocated raster format and arranged as 1989 to 2004/5 time series for the four regions France and Spain, Germany and Italy, the Balkans and the eastern Mediterranean. The ETM requires a continuos data series. Therefore missing decades had to be interpolated. Gaps of less then four decades were filled by numbers ("jokers") far outside the normal range for later correction. Gaps larger than three decades which are present in the data sets of the years 1994 and 2004 are interpolated from decades of adjacent years by means of the "image calculator" module. Windows of any rectangular geographical area from 1 km^2 size on can be extracted by either entering pixel numbers or geographical coordinates. The resulting window data series should be searched for remaining disturbed data caused e.g. by thin clouds or snow which locally had not been removed. Here the "albedo"-values are helpful since they indicate contaminated pixels. These erroneous data could then again be replaced by "jokers" and the window series be run through the "missing data interpolation" algorithm to replace out-of-scale pixels by the harmonic interpolation scheme based upon the HANTS [1] algorithm offered by IDRISI. The data could then be exported into a spreadsheet application for analysis, corrections such as necessary for changing filter specifications in the different instruments [3] and finally for numerical or graphical display.
Examples of 16 years data series for specified continental locations are presented. The "albedo" values, which are in fact directional reflectances, show a strong variability as compared to their small values. Because Koslowsky combined the most reliable pixel values from ten consecutive days, one decadal image may contain pixel values from different satellite overflights and this composition varies from decade to decade. This is partially also reflected in the NDVI data series though its effect is not as grave since the amplitude of these data is larger. The annual course allows conclusions with respect to the ecosystems under inspection and its changes. Inter-annual phase shifts may be correlated with temperatures. Over the years the (normalized) radiative temperature data show a rather regular feature for individual ecosystems. The hot summer 2003 is visible in these surface data, but not excessively.
Various factors affect the measured values such as annual course of the sun, solar zenith angle, measuring geometry, surface bi-directional reflectance distribution function, atmospheric condition (thin clouds, condensation strips, dusk, variable atmospheric water vapour content, volcanic ashes and sulfuric droplets). With the availability of supplemental data, some of these dependencies can in principle be removed or at least be normalized, but a full rectification of the data set is not possible if one deals with these 576 decades per series. The satellite data set should therefore not be regarded as a data set of real physical quantities but as an index providing a measure of the variability of these quantities. Since the pixel values are carefully selected and averaged over a number of different observation geometries it can be assumed that in the long run also the assembly of the uncorrected data represent a fair average of the real situation.

[1] Bolle H-J, Eckardt M., Koslowsky D., Maselli F., Meliá-Miralles J., Menenti M., Olesen F-S, Petkov L., Rasool I., Van de Griend A. (2006) Mediterranean Land-surface Processes Assessed From Space. Springer Verlag, Berlin, Heidelberg, pp 760
[2] Eastman JR (2009) IDRISI Taiga Guide to GIS and Image Processing, Clark Labs, Clark University, Worcester, MA, USA, pp 325 + index
[3] Trishchenko AP, Cihlar J, Li Z (2002) Effects of spectral response function on surface reflectance and NDVI measured with moderate resolution satellite sensors. Remote sensing of Environment 81: 1-18.