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Impact of Orthorectification on Maximum NDVI Composite Data

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Normalized Difference Vegetation Index (NDVI) composite data from the 25 year NOAA AVHRR data record have repeatedly been used to study vegetation dynamics at various spatial scales, including mountain areas. However, topography and accuracy of image geometric registration significantly affect the quality of satellite data, since pixels are displaced depending on surface elevation and viewing geometry. This effect should be corrected for through the process of accurate image navigation and orthorectification in order to meet the geolocation accuracy of 1/3 of the pixel field of view for systematic observations specified by the Global Climate Observing System (GCOS) requirements. Nevertheless, so far, the orthorectification effect was ignored in most AVHRR processing systems and data sets employed for analysis of climate trends.

The present study investigates the impact of orthorectification on the accuracy of NDVI composite data for a mountain region in north-western Canada at various spatial resolutions (1 km, 4 km, 5 km, and 8 km). Data from AVHRR onboard NOAA-11 (1989 and 1990) and NOAA-16 (2001, 2002, and 2003) for the month of August are considered. Data are processed using a processing system called CAPS (Canadian AVHRR Processing System) which optionally offers orthorectification and uses MODIS 250 m precisely georeferenced data as a reference imagery for improving AVHRR image navigation. Validation is performed using MODIS NDVI composite data.

Obtained results demonstrate the significant impact of orthorectification on composite NDVI data in mountainous terrain. Significant differences between corrected and uncorrected data in terms of mean NDVI as well as spatial NDVI variability are observed for areas covering pronounced topography. The NDVI differences may range from +0.3 to -0.4 at local scale, although they are reduced to smaller numbers when aggregated over large areas. Correlation analysis with MODIS NDVI revealed higher linear correlation coefficients for orthorectified images than for uncorrected data.

These effects are also analyzed for commonly used coarse resolution AVHRR Global Area Coverage (GAC) NDVI data from the Polar Pathfinder and GIMMS datasets.

Results suggest that orthorectification should be an integral part of AVHRR preprocessing, since neglecting the terrain displacement effect may lead to important biases and additional noise in AVHRR time series at local scale.