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Synergistic MERIS-AATSR cloud property retrievals using optimal estimation technique

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The ESA Climate Change Initiative (CCI) has been initiated to respond to the need of reliable long-term satellite-based products for climate by generating Essential Climate Variables (ECVs).The main objective of the ESA Cloud CCI is to provide long-term cloud property data sets exploiting the synergy of different earth observation missions. Amongst the cloud ECVs are cloud cover, cloud top height and temperature, liquid and ice water path. Envisaged are two multi-annual global data sets for the GCOS cloud property ECVs including uncertainty estimates. The first set of cloud products will be developed from the so called heritage combined AATSR-AVHRR-MODIS dataset. The second merged cloud products will be developed from a combined AATSR-MERIS data set.

AATSR and MERIS are both passive instruments mounted on the ENVISAT satellite. They have fully overlapping fields of view, with the smaller nadir swath of AATSR centered in the swath of MERIS. In the reduced resolution mode, the spatial resolution of MERIS is similar to the nadir spatial resolution of AATSR (1 km2). They have slightly different observing geometries. MERIS only observes in the visible and near infrared wavelengths, while AATSR also observes at thermal wavelengths.

The main additional information about clouds provided by MERIS are the radiances measured within and close by the Oxygen-A band, at 762 nm and 754 nm, respectively. Oxygen is constant and well-mixed in the atmosphere and therefore can be used to estimate the average photon path length in the atmosphere. In cloudy situations this average photon path length is mainly determined by the cloud top pressure. The cloud top height can therefore be determined from both thermal emission of the cloud using AATSR measurements in the infrared as well as from the average photon path length using MERIS measurements within and near the Oxygen-A band. From previous sensitivity studies it was found that the cloud top pressure derived from MERIS measurements is highly accurate in cases of low single-layered clouds, but less accurate in cases of semitransparent cirrus or multi-layered clouds. In contrast, the cloud top height retrieval from AATSR is more sensitive to high and optically thin clouds, whereas the sensitivity is reduced for low clouds.

To provide error estimates on a pixel basis, the synergistic retrieval of cloud properties, such as cloud top height, cloud optical thickness and effective radius, from the combined MERIS-AATSR data set will be based on optimal estimation theory. Forward models for MERIS and AATSR measurements are developed using the radiative transfer models MOMO and RTTOV, respectively. Furthermore, a study is employed to investigate the use of the different sensitivities of MERIS and AATSR to different cloudy situations (e.g. multi-layer clouds) and how to introduce this information in an optimal estimation algorithm.