based on semi-empiric methods which make use of a 'two-bands adaptive' model (r=0.95) and bio-optical modelling inversion for low chl-a concentrations (r=0.96). Further validation was performed on PC pigments obtained from APEX imagery of 2011 (r=0.93) and of a proxy of PFTs product obtained from 2014 data. In 2011, two cyanobacteria species dominated by PC pigments were relevant in the algal composition. The APEX-derived map of PFTs showed a gradient, consistent with field observations, where diatoms progressively decreased from west to east and contemporarily Chrysophyta and cyanobacteria species dominated by PE increased. Semi-empirical models based on spectral proxies of spectral vegetation indices were used to derive macrophyte canopy parameters maps: i.e. fractional cover (fC) (r=0.94), Leaf Area Index (LAI) (r=0.96), and biomass (r=0.92). These products were analyzed to assess cover, abundance, and spatial variability of macrophyte groups and PFTs, and to investigate the relationships with physico-chemical parameters in the Mantua lakes system.
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12-O Remote sensing of lake carbon dynamics: an evaluation of algorithms for Coloured Dissolved Organic Matter (CDOM).

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There is increasing evidence that lakes play an important role in regional and global biogeochemical cycling, particularly in the storage, transport and transformation of carbon. However, the role of lakes in the global carbon cycle remains poorly constrained and there is much uncertainty about how carbon cycling in lakes is likely to be modified under future climate change. Improvements in our ability to measure and detect changes in carbon storage at large scales are needed if we are to improve our understanding of lake carbon dynamics and its regional and global significance. Remote sensing can provide information on carbon in lakes through, for example, the estimation of absorption by coloured dissolved organic matter (CDOM), a photoactive component and reliable tracer for dissolved organic carbon (DOC).
The recently launched ESA Sentinel-2 MSI and the forthcoming launch of Sentinel-3 OLCI, will provide an improved capability to obtain information on CDOM in lakes at higher spatial and temporal resolutions. However, while many CDOM retrieval algorithms have been proposed, they have not rigorously validated for inland waters and new or modified approaches may be needed to fully capitalise on the potential of the Sentinels and other future satellite missions.
The principal aim of this study is to assess the efficacy of current CDOM algorithms over a wide range of lake optical types. Here we present a first evaluation of CDOM retrieval algorithms incorporating empirical, semi-analytical and analytical approaches, using in situ remote sensing reflectance (R_{rs}) and CDOM absorption (a_{CDOM}) measurements from lakes internationally. The best performing algorithms were then further tested using Envisat MERIS satellite data for selected case study lakes. Finally, this presentation will discuss the implications of this work for remote sensing of dissolved organic carbon in lakes and identify future research priorities.

12-O Reporting the rapid warming of italian lakes derived from homogenized multi-sensor satellite data.

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Recent studies, using a combination of long term in-situ and satellite data indicate that lakes are warming rapidly at the global scale. Lake Surface Water Temperature (LSWT) being sensitive to long term modifications in the thermal structure of lakes is a good indicator of changes in lake characteristics. Further studies are needed to understand variation in

trends, impacts and consequences at the regional scale. However, long term in-situ data recorded with high temporal frequency are often lacking. Remote sensing is considered a promising approach to reconstruct complete time series of LSWT where direct measurements are missing. Temperature of land/water surfaces is one of the direct and accurate measurement using the satellite data acquired in thermal infra-red spectral region. Furthermore, some measurements are even available since the 1980 at the daily temporal resolution and 1 km moderate spatial resolution. In this study, we aim to i) reconstruct a homogenized LSWT database for six large Italian lakes by combining thermal data from multiple satellites, ii) assess the quality of satellite derived LSWT using long term in-situ data collected from these lakes, iii) report the seasonal and annual trends in LSWT using robust statistical tests.
We compiled the LSWT database using daily data spanning 29 years (1986 - 2015) at a spatial resolution of 1 km, time standardised to 12:00 UTC using a new methodology, which combine data from multiple sensors. We used dual thermal channels (10.5 – 11.5 µm and 11.5 – 12.5 µm) and a split window algorithm with sensor specific coefficients to derive LSWT. We calibrated the thermal data acquired by six sensors on-board thirteen satellites and corrected them geometrically before deriving the LSWT. The sensors used for this study were (satellites in bracket) – AVHRR/2 (NOAA-9/11/12/14), AVHRR/3 (NOAA-16/17/18/19), ATSR1 (ERS-1), ATSR2 (ERS-2), AATSR (ENVISAT) and MODIS (AQUA/TERRA). We applied a modified Diurnal Temperature Cycle (DTC) model to correct the LSWT for different acquisition time of the satellites.
Using this new LSWT dataset we are studying the long-term annual and seasonal trends in the peri-alpine lakes - Garda, Iseo, Como, Lugano, Maggiore, and the Lake Trasimeno in Central Italy. We found good agreement between LSWT and in-situ data with an average R^2 and RMSE of 0.90 and 1.5 K, respectively. With regard to seasonal and annual trends, in Lake Garda, surface water mean temperature showed a significant (**P < 0.05) increase with annual rate of 0.013 ºC yr^{-1} and of 0.03 ºC yr^{-1} during summer (Kendall tests and Theil-Sen's slope estimates). The statistical analysis of other lakes are in progress and these results will allow us to evaluate further the accuracy of the LSWT reconstructed using satellite data and assess the regional coherence of the trends detected in lake Garda.

12-O Combination and comparison of airborne and satellite remote sensing data for assessment of lake chlorophyll-a concentrations and water level changes: the case study of Lake Burtnieks, Latvia.

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Regular monitoring of lake chlorophyll-a (chl-a) concentrations and water level fluctuations is necessary for sustainable water resource management and is usually performed by field surveys. *In situ* measurements are accurate, but spatially and temporally limited. Remote sensing techniques can provide data with good spatial and temporal resolution - the possibility to monitor a single lake of interest or several waterbodies simultaneously and analyse historical data from the last 20 – 30 years. Extraction of water quality parameters as well as data on water level changes are among the main remote sensing applications for ecological assessment of water bodies. More complex approaches include also assessment of macrophytes and land cover of the catchment basin.
In this study, we present a combination and comparison of airborne and satellite remote sensing data for ecological assessment of Lake Burtnieks in Latvia. Airborne data were acquired in summer 2014 and consisted of hyperspectral (400-2500 nm spectral range), topographic LiDAR and high resolution (10 cm/pixel) RGB aerophoto data. The acquired data were combined with concurrent field survey information. The combined information was then used to correlate the chl-a field measurements with optical data and water level measurements with water mask obtained from LiDAR and satellite data. Landsat satellite data (26 scenes) from last 30 years were used for monitoring of chl-a concentrations, water level changes and macrophyte cover dynamics. Comparison of high resolution airborne and moderate resolution satellite data products was also performed to test algorithm transfer. Results showed good agreement between chl-a remote sensing data products and in situ observations providing insight into non-uniform spatial distribution of algal bloom. Lake water cover masks obtained from terrain model and water level *in situ* measurements correlated well with water cover masks obtained from satellite spectral data. Remote sensing data products were also evaluated for further use in lake management and ecological scenario modelling.

12-P Methods and tools for assessing impacts of saharan dust deposition in Lake Garda from remote sensing data.

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