Geophysical Research Abstracts
Vol. 13, EGU2011-10459, 2011
EGU General Assembly 2011
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Comparing turbidity patterns of Danube Delta waters with remote sensing techniques: from deltaic lakes to the western Black Sea coastal zone

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The Danube River and its contributors cross nineteen European countries before reaching the West coast of the Black Sea. The fluvial-marine contact zone is quite large because Danube splits up itself into multiple distributaries across a wide deltaic plain. The twelve main mouths derived from the Danube are shared among Romania and Ukraine. Furthermore, the Danube Delta plain possesses about three hundred freshwater lakes. Many of these shallow lakes are connected to channels or canals providing turbid water from the Danube, others depend on inundation events to be supplied by the river water, even though, the majority of them are surrounded by vast areas of compact reedbeds. Danube Delta presents a complex hydrological system which has been greatly changed since the first works for navigation in the nineteen century. This study aims to analyze the turbidity patterns of Danube waters simultaneously on the deltaic lakes and on the Black Sea coastal mixing zone by using optical remote sensing images. Water levels measurements of the Danube river are available since 1932 for the deltaic zone, these data show important inter and intra-annual level variations. Nevertheless, there exists a seasonal comportment characterized by a maximum in April through June and a minimum in September through November. Thus, in the present study we have selected two unlike years with regard to water levels: 2006 with high water levels and huge inundations in the deltaic plain and 2007 without significant inundations and with very low water levels. Multisource high resolution optical sensors (ALOS AVNIR-2, SPOT, LANDSAT and ASTER) were used to analyze the water comportment and the turbidity patterns on the deltaic lakes. Simultaneously the Danube River's plume on the Black Sea coastal zone has been observed by using medium resolution spectrometer images from the MERIS sensor. Daily water level measurements realized near to the entry of the Danube Delta (station of Tulcea) and wind speed/direction data from the GFS model were also used for a better understanding of the turbidity variations along the period analyzed 2006-2007. The results show a dissimilar comportment between waters inside the lakes and on the Black Sea coastal zone. However, turbidity presents great seasonal variability in both cases. River discharge and resuspension due to wind action are important factors to explain lacustrine and coastal turbidity, although local events such as algal blooms and development of submerged and floating vegetation participate considerably in the turbidity behavior of the Danube Delta waters.