



Turbidity variability in lake Banyoles (Girona, Spain): Relationship with anomalous rainfall and atmospheric synoptic flow pattern

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In the last three decades, eleven main fluidization episodes of confined bed-sediments due to underground springs in basin BII of Lake Banyoles (Girona, Spain), have been instrumentally detected. Extensive measurements in the lake have been carried out since 1986, whereas data were only taken intermittently in the 70s and early 80s. Following periods of high precipitation, sediment confined at the bottom of karstic basins migrates from 45 m depth to approximately 25 m depth. As a result of the fluidization event, the turbidity of the lake increases very markedly and the water column maintains the particle volume concentrations of suspended sediment (pVC) as high as 44 $\mu\text{l/l}$, which is about 8-29 times larger than the usual values of pVC. A previous study by some of the authors indicates that the fluidization processes are associated to monthly rainfall 1.5 to 4.5 times larger than the long-term mean (1970-1999). In this study, the relationship between the phenomenon and the occurrence of positive anomalous rainfall in the Catalan pre-Pyrenees is better established using available daily registers of rain-gauges located in the area. Two types of rainfall episodes are found to act as precursors of the fluidizations: (a) moderate to heavy rainfalls occurring in a few days, maybe with torrential character on some days (that is, greater than 100 mm in 24 h), and (b) light to moderate rainfalls, but extending –intermittently– over a long enough period (up to one month) as to force the ground water flow through the bottom of the lake basins. Finally, an investigation of the dominant atmospheric flow patterns during the fluidization episodes is done based on a classification of the daily synoptic states at 12 UTC provided by ERA-40 ECMWF reanalyses. The classification is constructed guided by the analogy to 19 previously derived circulation

patterns that produce significant daily rainfall in Mediterranean Spain. The results indicate an above than average frequency of rain-bearing atmospheric patterns in connection with the fluidization episodes, with a particular incidence of easterly regimes and synoptic situations favourable for torrential rains in north-east Spain.