



GNSS and heat waves: case studies for 2003 and 2007

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Motivation

Heat waves have large adverse social, economic and environmental effects including increased mortality, forest destruction by fire, and effects on water ecosystems and glaciers (Bono, 2004). They cause increased power consumption and cuts, transport restrictions and a decreased agricultural production. The estimated economic losses exceed 13 billion EUR during the August 2003 heat wave in Western Europe and 2 billion EUR during the July 2007 heat wave in Southeast Europe. The aim of this study is to investigate the behavior of water vapour during August 2003 and July 2007 heat waves. Monitoring water vapour during the heat waves is critical, as combination of high temperature and humidity are lethal.

2003 and 2007 heat waves in Europe: GNSS water vapour anomaly

In 2003, the Integrated Water Vapour (IWV) from GNSS station PAYE (Payerne, Switzerland) shows: 1) a large positive anomaly in June (+17%) and 2) a small positive anomaly in August 2003 (+7%) (figure 1a). While the positive IWV anomaly in June 2003 is associated with a large positive temperature anomaly (+5°C, not shown), the same temperature anomaly in August 2003 resulted in much smaller IWV anomaly. This is further discussed in the rainfall anomaly section.

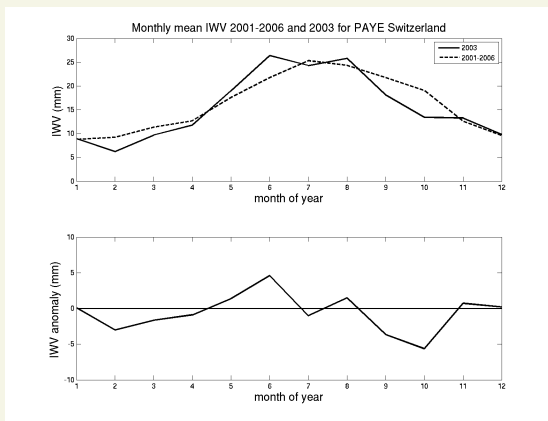


Figure 1a: Monthly mean water vapour, Payerne 2001-06.

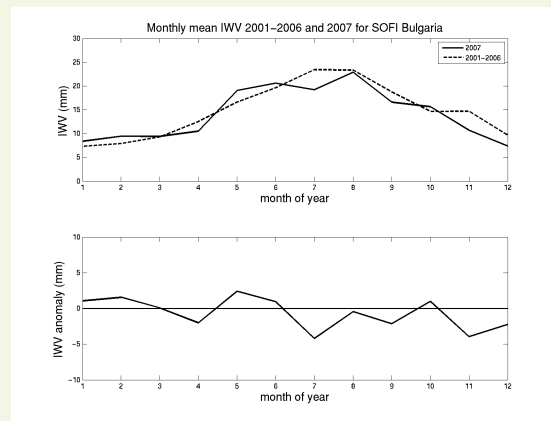


Figure 1b: Monthly mean water vapour, Sofia 2001-06.

In 2007, IWV computed from GNSS station SOFI (Sofia, Bulgaria) shows: 1) a large positive anomaly in May (+15%) and 2) a large negative anomaly in July (-18%) (figure 1b). July 2007 was 3.7°C hotter (not shown) and with 18% less IWV, than the 2001-2006 mean.

2003 and 2007 heat waves in Europe: rainfall anomaly

A consistent rainfall decrease was found in Payerne during the first half of the 2003. In particular, during 2003 spring (MAM), the rainfall decreased by 50% (figure 2a). The lack of rainfall during the 2003 spring and summer resulted in surface drying. Once the soil moisture was depleted, all the heating went into rising temperature, thus explaining the small IWV anomaly in August 2003.

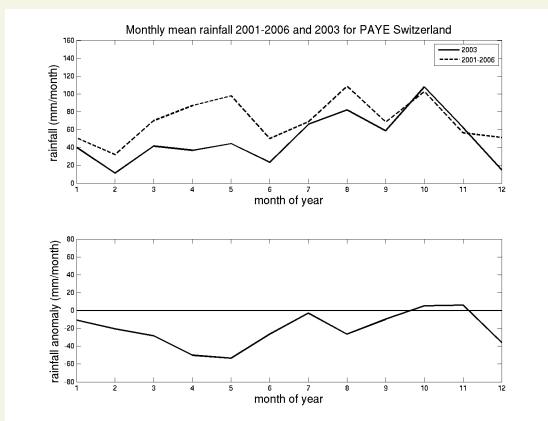


Figure 2a: Monthly mean rainfall, Payerne 2001-06.

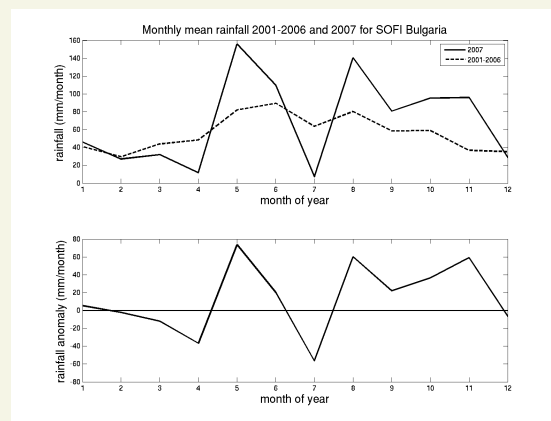


Figure 2b: Monthly mean rainfall, Sofia 2001-06.

The 2007 rainfall in Sofia, Bulgaria was on average 14% higher than the 2001-2006 mean. In 2007 spring (MAM), the rainfall decrease in March and April was followed by a very large positive anomaly in May (+90%). Most likely the rainfall pattern in 2003 and 2007 can explain the difference in the heat wave duration i.e. 2003 being twice as long as 2007.

Acknowledgment & References

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