



The use of acoustic Doppler instruments for high frequency stream data sampling in Denmark

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MOTIVATION

- › Stream and river discharge is an important hydrological parameter
- › Precision/uncertainty of runoff estimates largely depends on frequency of measurements (water stage and discharge)
- › New development in Doppler sensor techniques has enabled high frequency data collection in streams
- › **New instruments and methods require:**
 - experience with measurement procedure
 - test against established methods
 - knowledge of instrument limitations



TWO TYPES OF DOPPLER SENSORS

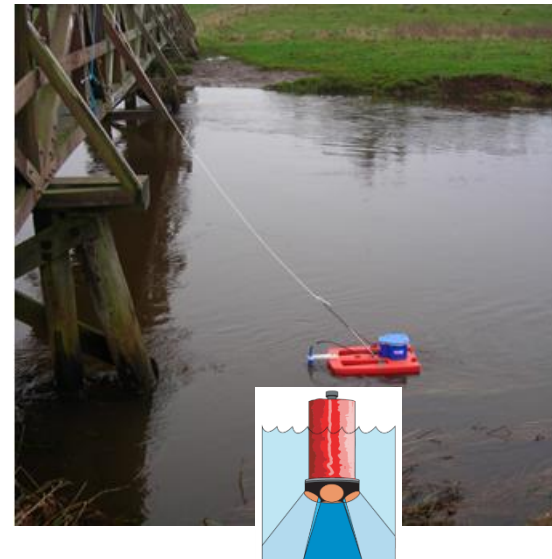
- › Doppler sensors use sound waves to detect particles moving in the water
- › Frequency shift (Doppler effect) occurs → translated to velocity

Acoustic Doppler Current Meter (DCM)



Traditional instrument: propeller

Acoustic Doppler Current Profilers (ADCP)

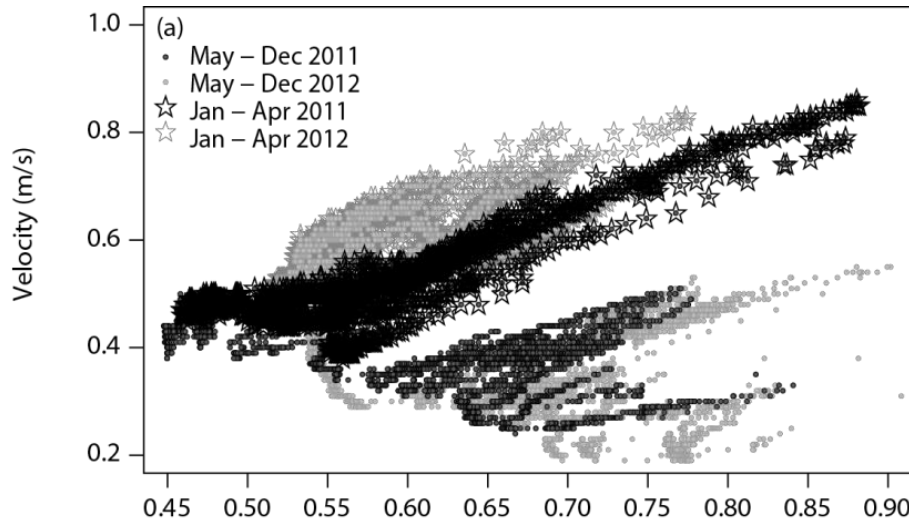


DCM SENSORS, HOW CAN THEY BE USEFUL?

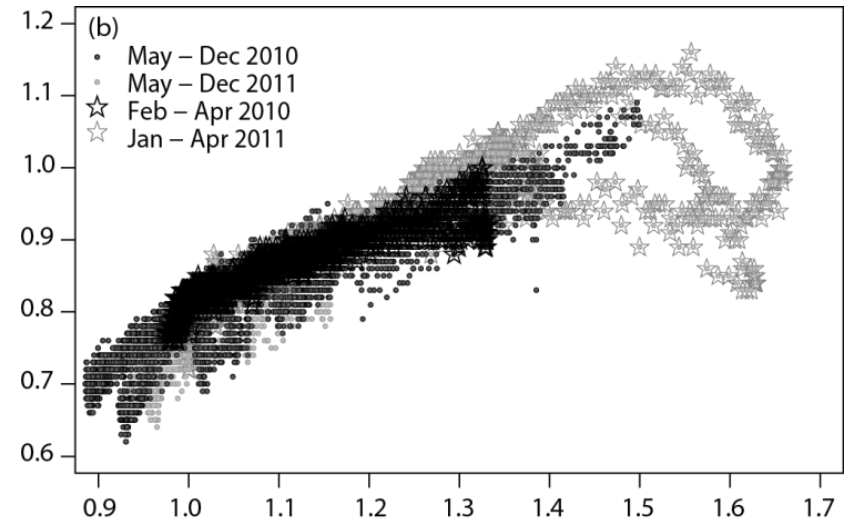
- › Detection of hydraulic shifts
- › The most common method for estimation of stream discharge is the assumption of a unique stage-discharge (**QH**) relation:

$$Q = A(H - H_0)^N \quad (\text{the rating curve})$$

Unstable (small stream)

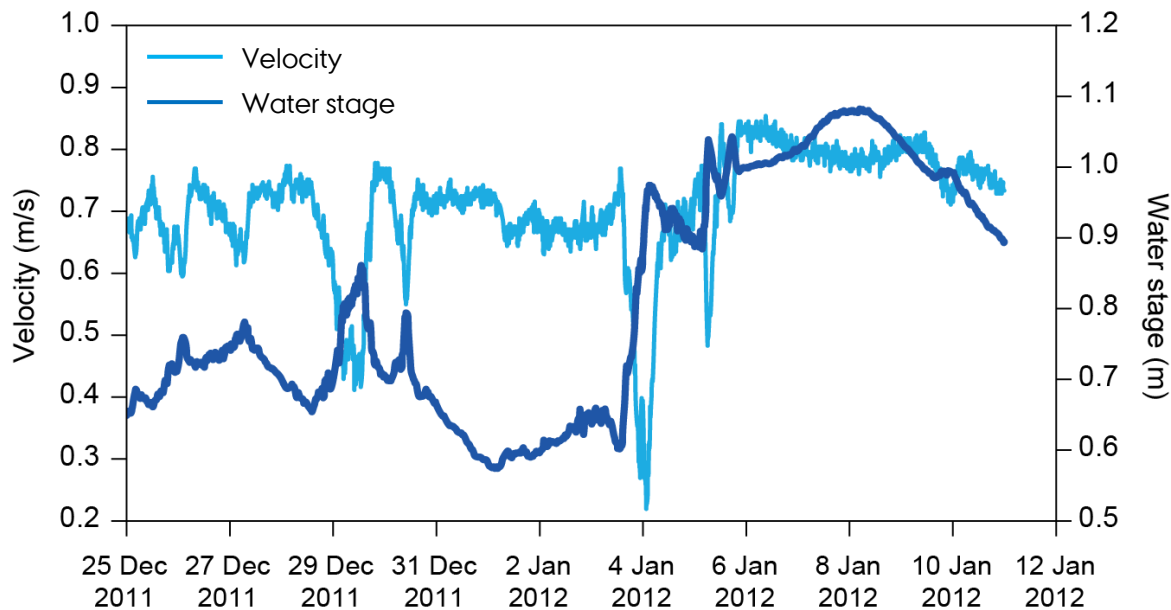


Stable (large stream)



DCM SENSORS, HOW CAN THEY BE USEFUL?

> Detection of tidal effects in Skjern River



ADCP SENSORS – ADVANTAGES AND PERFORMANCE

- › ADCP measurements can be obtained quickly.
- › No general recommendations to towing speed and number of tows.
- › Challenge because measurements can be conducted very fast; faster than natural velocity fluctuations?



ADCP SENSORS - ADVANTAGES AND PERFORMANCE

› Data sampling in one small and one large stream



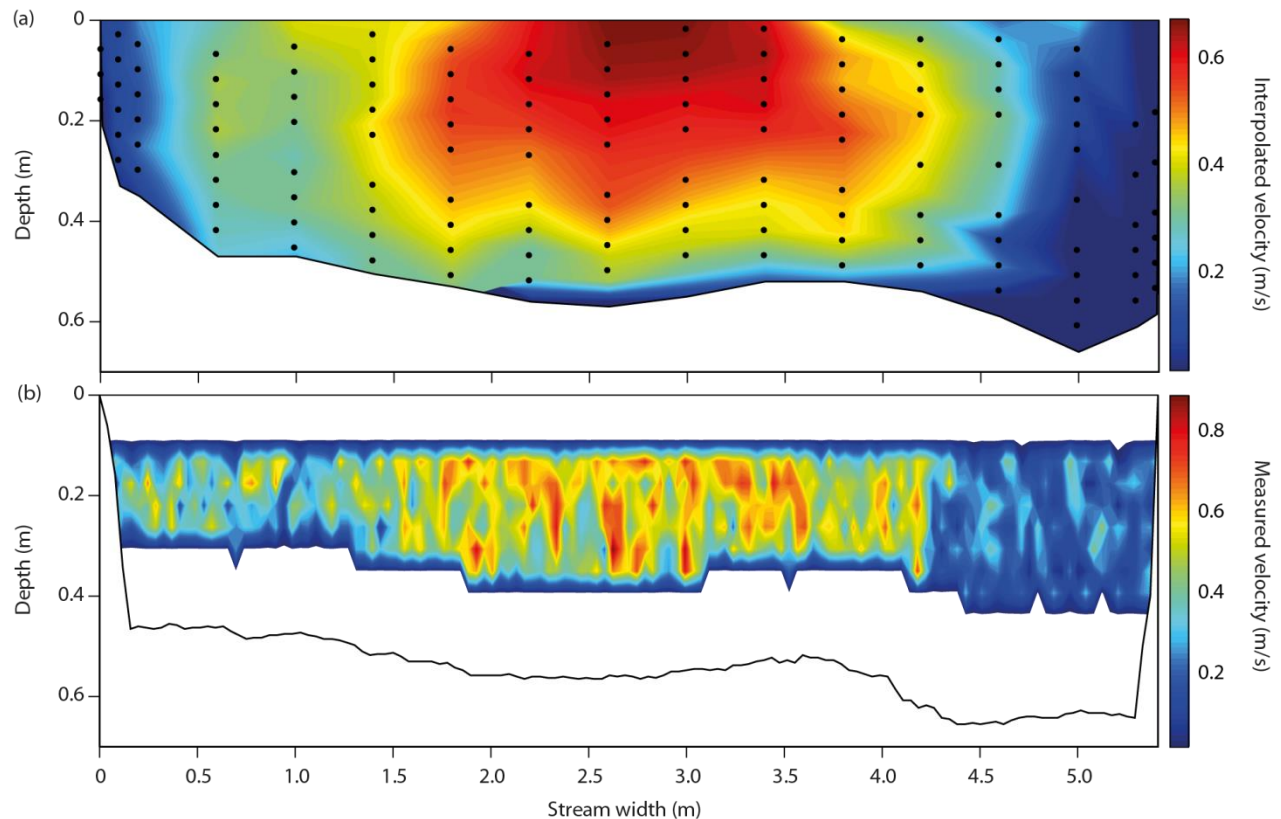
ADCP SENSORS - ADVANTAGES AND PERFORMANCE



ADCP SENSORS - ADVANTAGES AND PERFORMANCE

› Comparison between traditional (propeller) and ADCP method

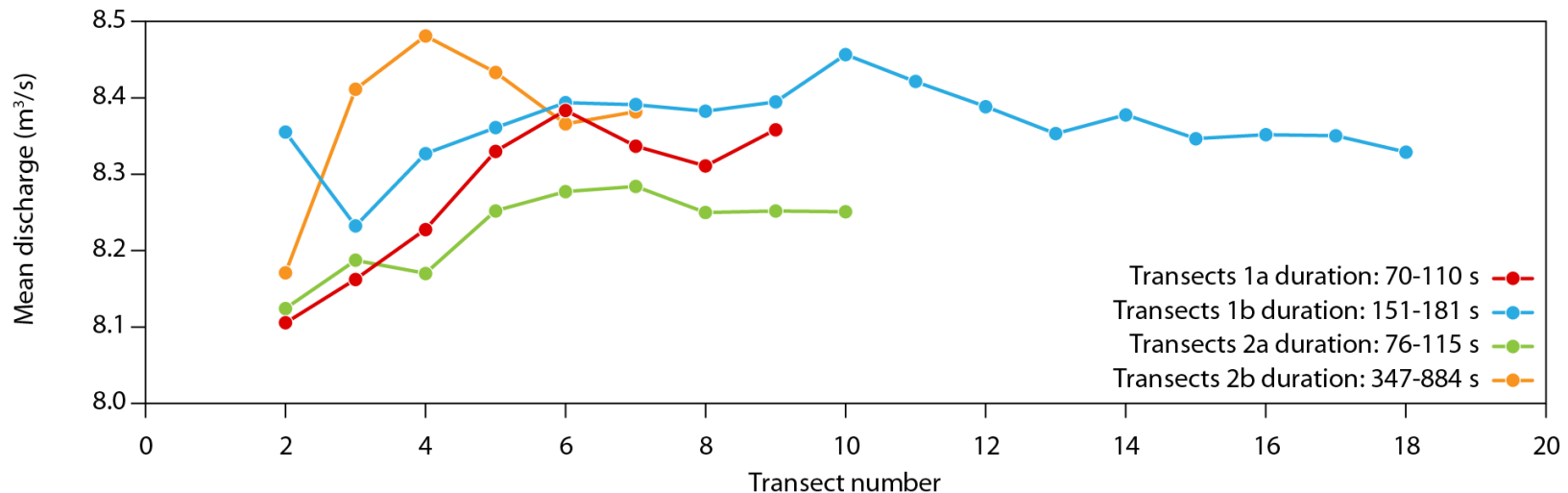
Calculated discharge
 $0.98 \text{ m}^3/\text{s}$



Calculated discharge
 $1.0 \text{ m}^3/\text{s}$

ADCP SENSORS - ADVANTAGES AND PERFORMANCE

> Number of transects and towing speed (large stream ~ 20 m)

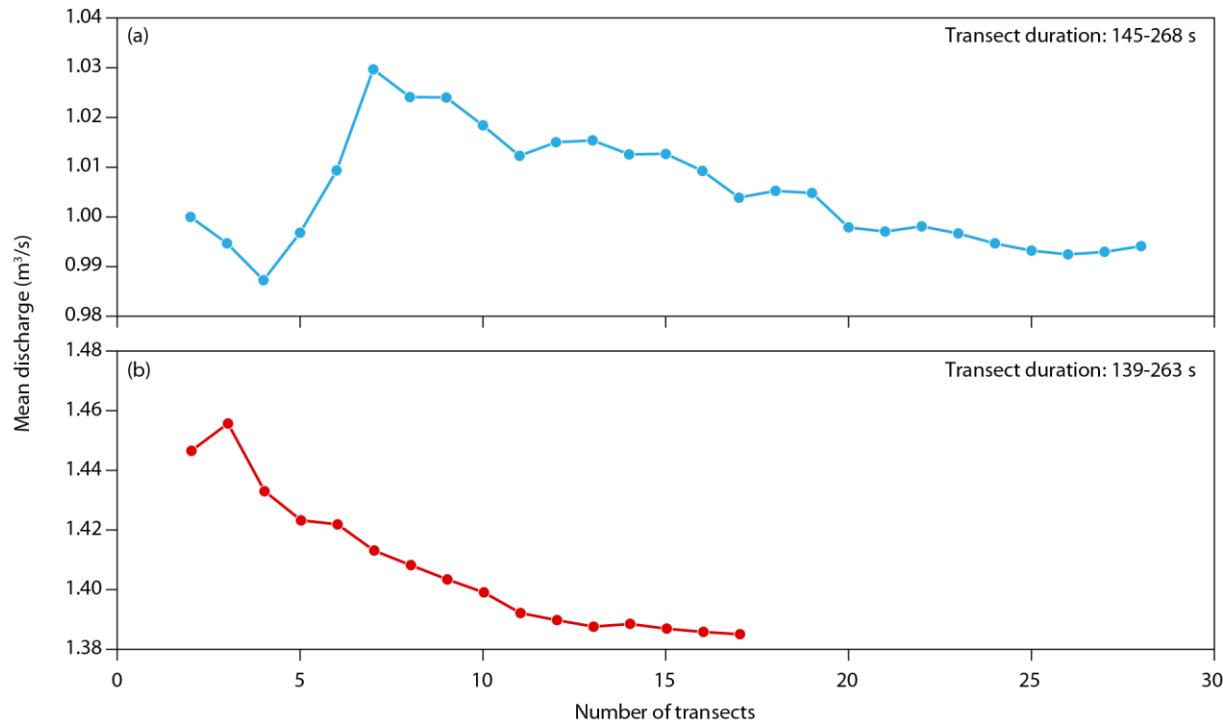


> Mean discharge reached after app. 8-10 towings, number of towings more important than towing speed.



ADCP SENSORS - ADVANTAGES AND PERFORMANCE

› Number of transects and towing speed (small stream ~6 m)

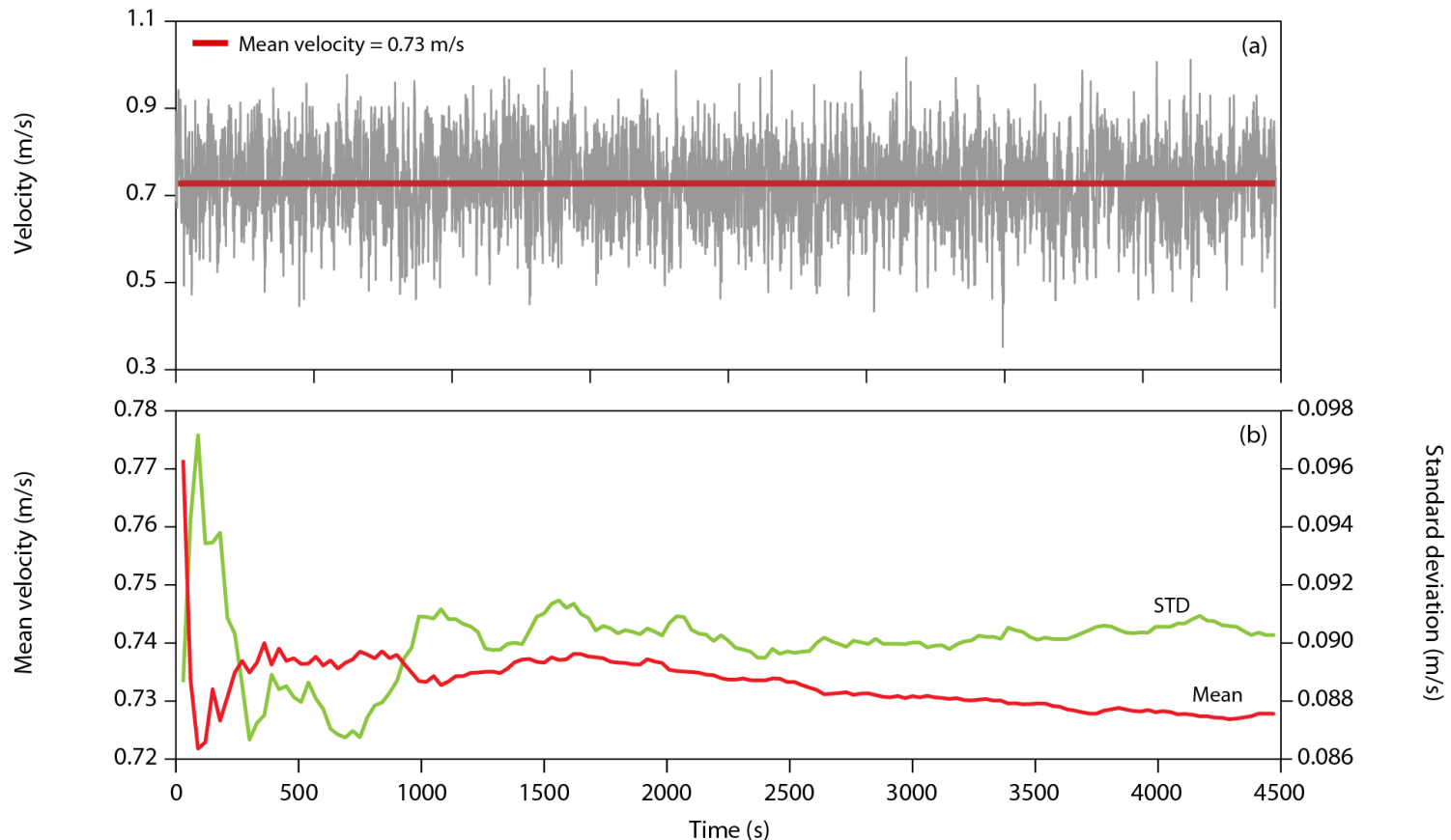


› Mean discharge reached after app. 25 towings during lowflow (a) and after 13-14 towings during high flow (b)



ADCP SENSORS - ADVANTAGES AND PERFORMANCE

› Exposure time (small stream)

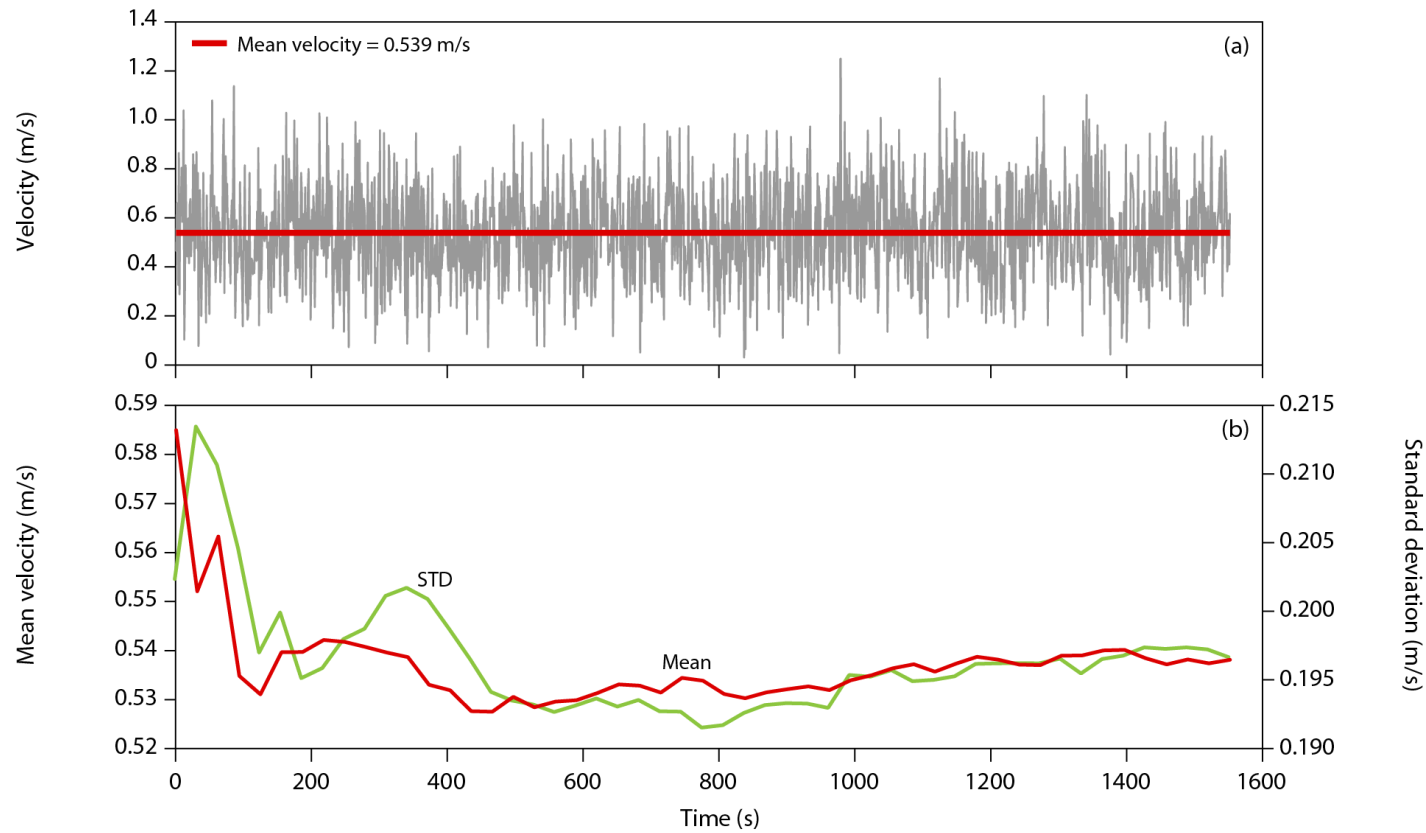


› Mean velocity reached after app. 1 hour



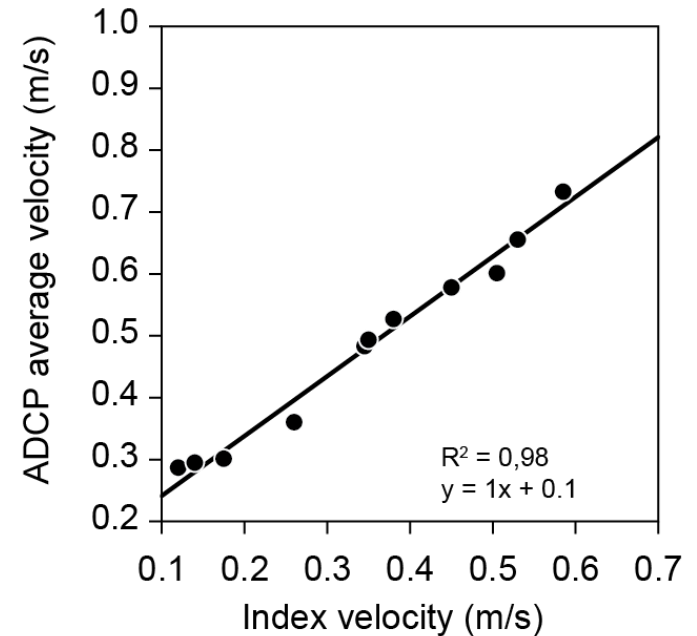
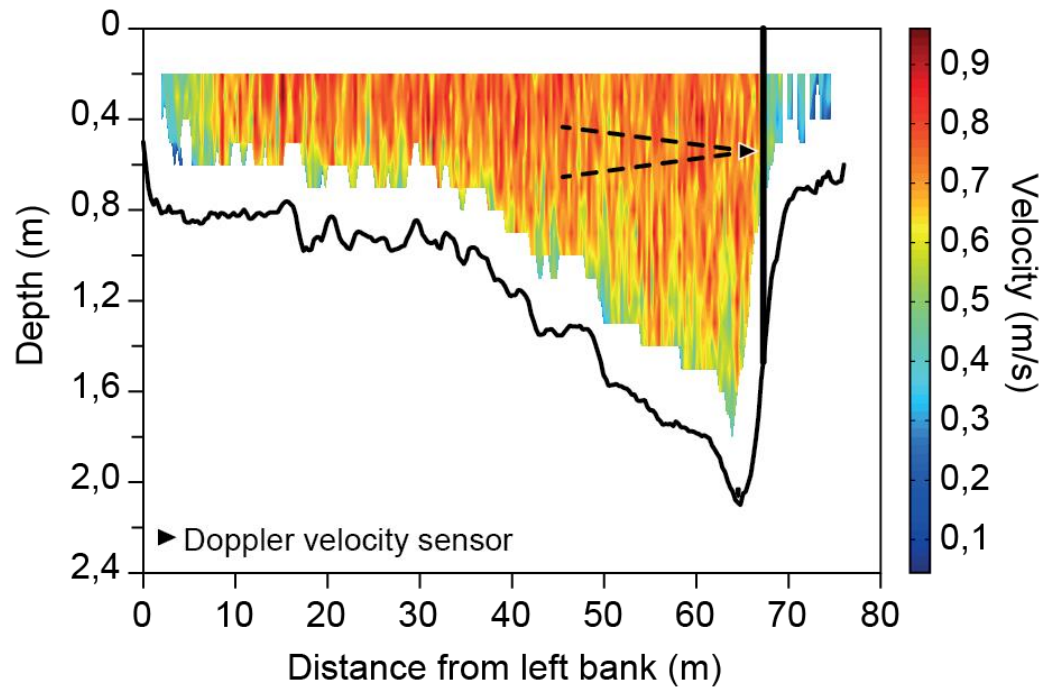
ADCP SENSORS - ADVANTAGES AND PERFORMANCE

› Exposure time (large stream)



› Mean velocity reached after app. 20 minutes

COMPARISON OF DCM AND ADCP SENSORS



CONCLUSIONS

- › Generally DCM and ADCPs are considered useful instruments for advancing streamflow data collection → minimising hydrograph uncertainty
- › Smaller streams and low flow situations require a larger "exposure time" when measured
- › It is found important that these new sensors are used wisely → consider local conditions!





Thank you for your attention!