There are two subjects to be understood and analyzed when using SF-4/5 sap flow sensor:

1. **Understanding of the sensor's output signal and its value and variations.**

This is quite simple and generally described in the appropriate sensor's manual (see attachment). For this particular kind of sensor, only variation of signal has certain meaning. Neither amplitude nor zero offset may be interpreted accurately because they depend on positioning of a sensor, on stem structure, and on a particular leaf transpiration rate. Thus, the only conclusion we can make reliably from the sensor's diurnal record is that the sap flow increases when the signal increases and the sap flow decreases when the signal is reducing. The diurnal curve represents only relative variation of sap flow in a leaf petiole. Please look at the exemplary record of two SF-4 sensors located on different leaves:

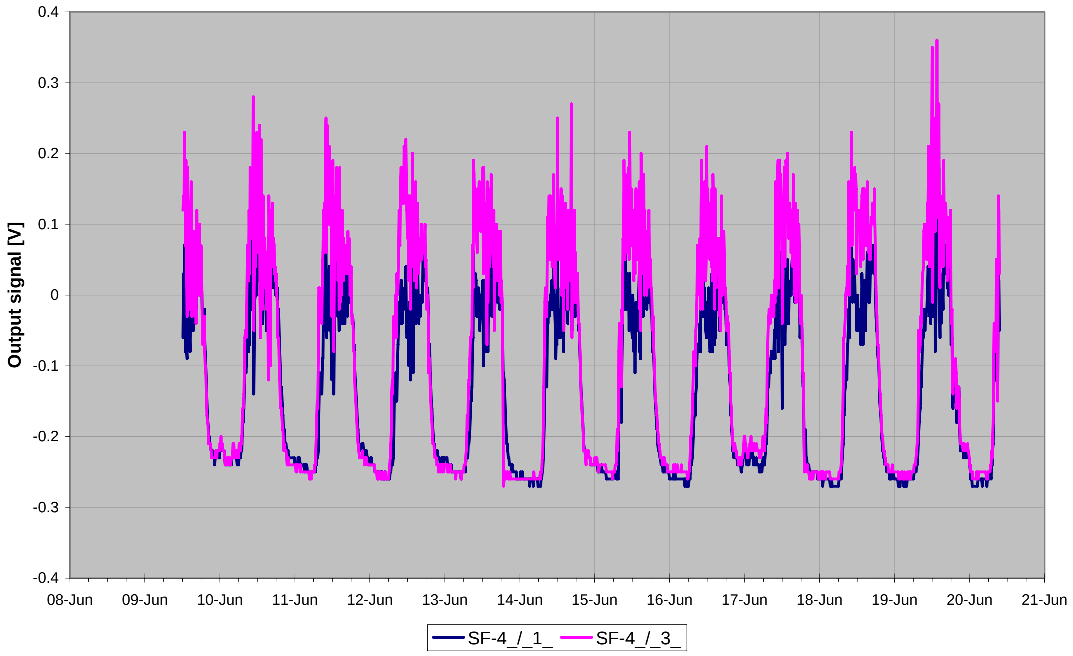


Figure 1

We see that the output signals of both sensors are almost equal at nighttime. The output value is about -0.25 V but this is the zero offset of the signal amplifier and, of course, cannot be interpreted as the negative sap flow rate. At daytime, the signal is rising together with the transpiration rate. The amplitude of signals is a little bit different but this, again, cannot be interpreted as the higher transpiration of the leaf with the sensor SF-4_/_3.

Thus, the sensor's output is relative and proportional to sap flow rate (or transpiration).

2. **Interpretation of diurnal sap flow curve in terms of plant water status.**

When interpreting a sap flow diurnal curve, we look at its shape first. The exemplary record is shown in figure below:

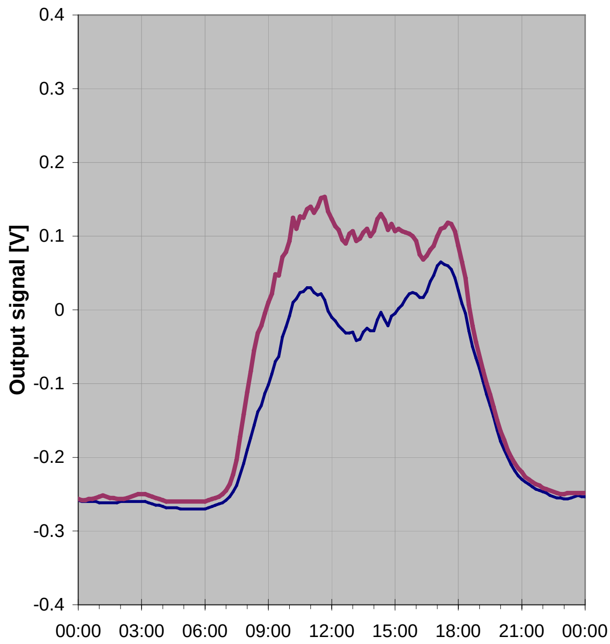


Figure 2. The sensor with dark-red curve is located at the bottom leaf of a tall plant, and the sensor with the blue curve is located at the top leaf.

These records are taken from the same data shown in Figure 1. The records represent sap flow rate of two different leaves: one was located at bottom level of a canopy and the second at one of the top leaves. Apparently, there was certain difference in records' diurnal shape. Transpiration of the bottom leaf increased in the morning and then was slowly degrading as the soil water resources were depleting. Small variations of the signal represent fluctuation of transpiration factors (radiation, VPD). At sunset, transpiration dropped down to minimal value. The top leaf demonstrated certain depression of transpiration between 11:00 and 17:00 that was evidence of stomatal response to water deficit at the top of the tall plant.

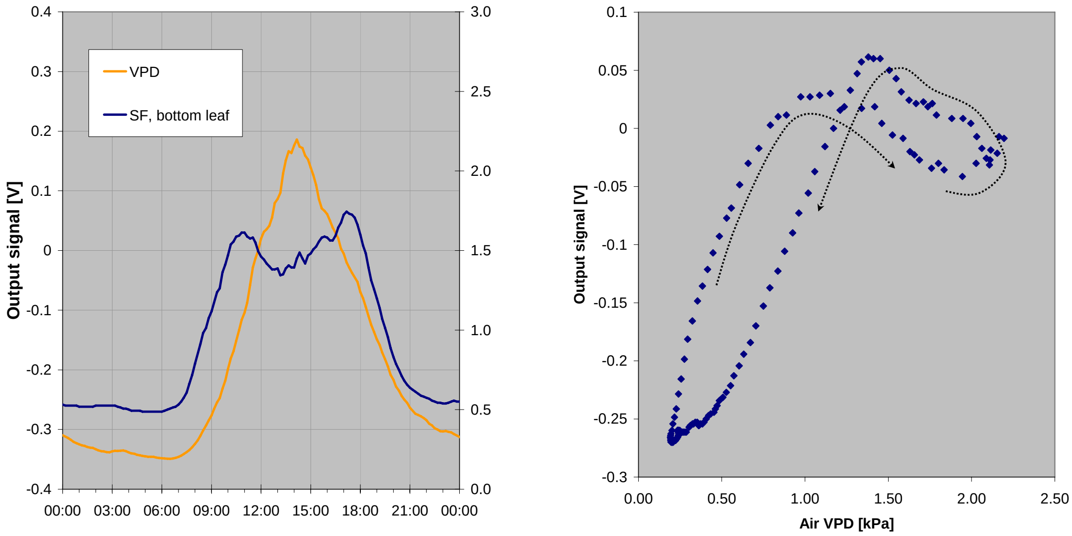
Data on environmental factors, which affect transpiration, are of high importance for correct interpretation of diurnal sap flow curve in terms of plant water state. The vapor pressure deficit (VPD) may be used as an index of evaporation demand of the atmosphere. Every time, when sap flow variation is opposite to the VPD course, it may be interpreted as limitation of transpiration caused by plant, i.e. stomatal limitation. An example is shown Figure 3 below. The plant began to close stomata of that particular leaf at VPD between 1.1 and 1.4 kPA.

It is very useful also to employ other environmental and plant-related data for analysis of plant water status. Soil moisture, solar radiation and stem diameter are among them. In addition to that, it is very important to follow installation instruction for SF-4 and SF-5 sensors to avoid false records and appropriate misinterpretation of plant status. Assuming that you asked me about interpretation of the particular records, I asked you about other relevant information about that particular experiment. Case you need general explanation, I hope that this letter may help you to understand the approach. Do not hesitate to contact me again if you have more questions.

Sincerely,

Yuri Ton

Monday, February 06, 2006



A B

Figure 3. Sap flow and VPD on June 18 (A) and Sap flow against VPD for the same day (B). The dotted arrows indicate the time course of the curve in Fig.3B.