Surface water – groundwater quality relationship: the Fletcher's Creek project

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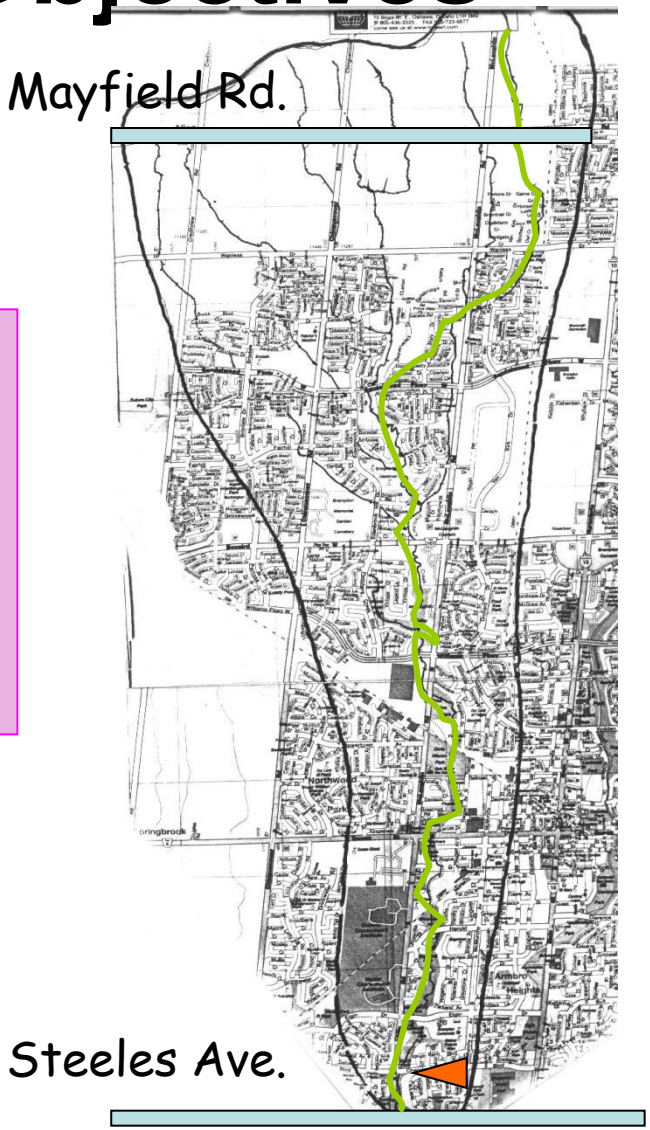
Initial and Current Objectives

The Objective of the project:
to create the database for Separated Flow Approach (SFA) evaluation considering only the drainage function of a watershed

The Findings were:
- **velocity** and **travel time** as the hydrological indicators of water quality conditions, which characterize different transport and solvent capacity in different periods
- **Water and air Temperatures** were considered indirectly through different periods of high correlation between parameters

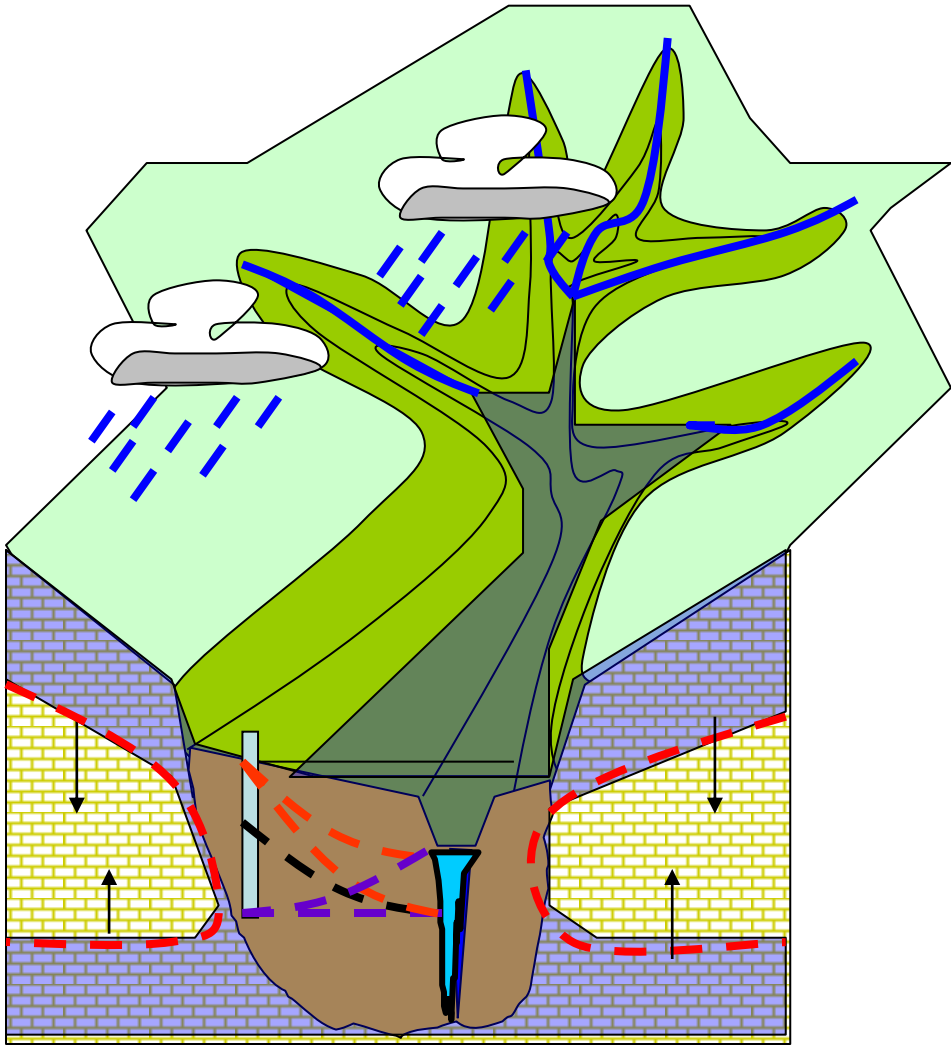
The Separated **Flux** Analysis (SFAN) considering the thermo regulating function of a watershed



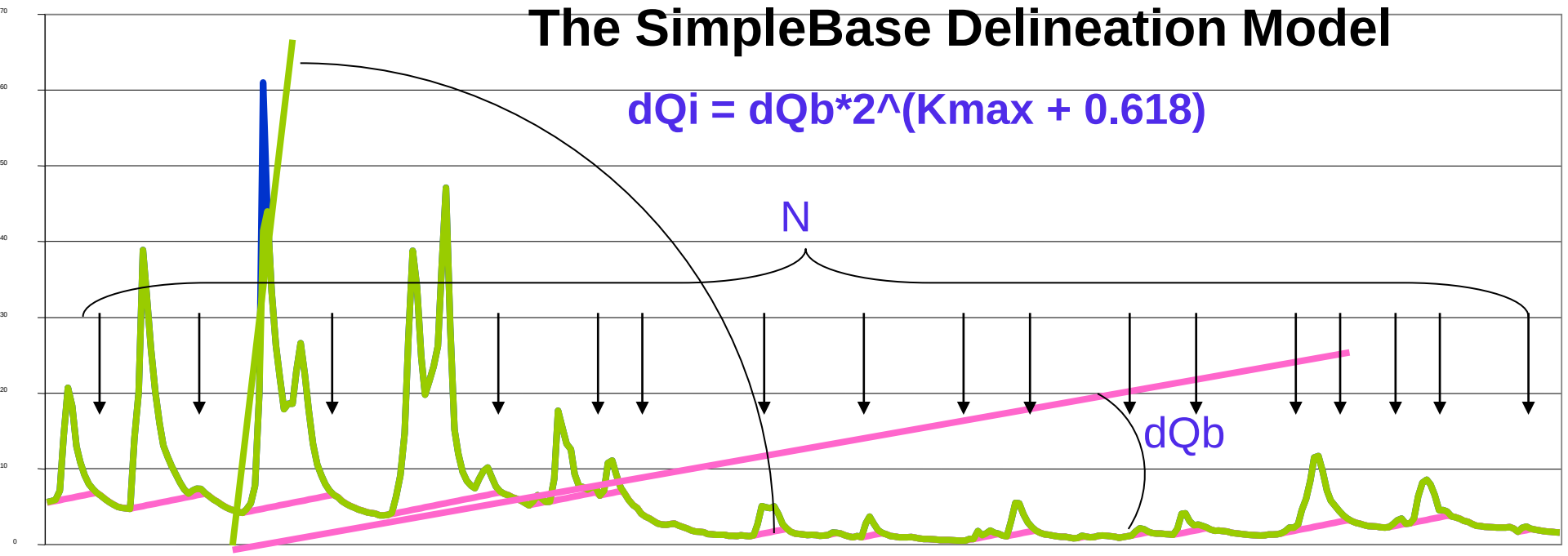
Hypothesis definition

Watershed is a self-organized functional and structurally complex unit of hydrosphere that controls life-sustaining thermo regime within its boundaries.

To protect a source of water we have to know its exact place and role in a functional structure of the watershed

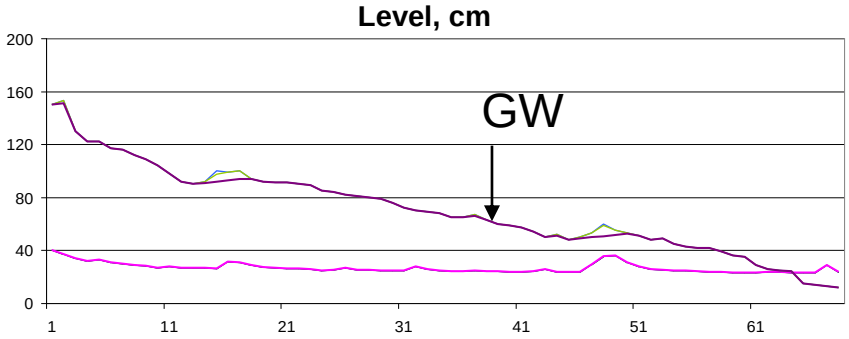


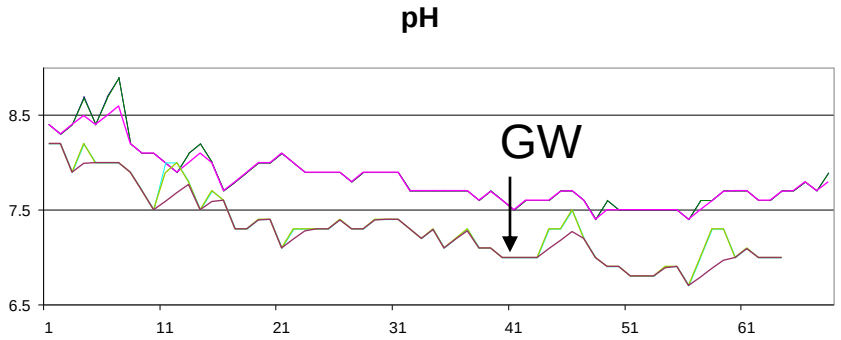
The SFA concept and tool

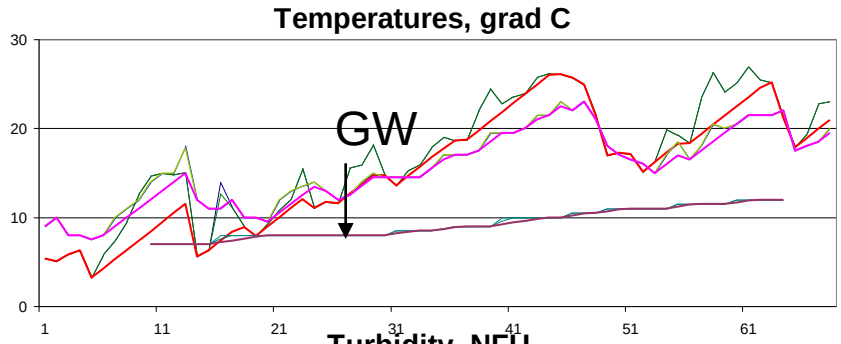


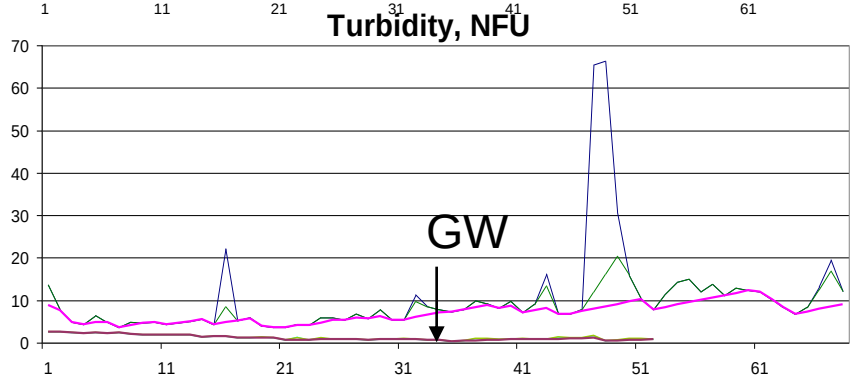
The base component of any parameter, characterized by the highest rate of fluctuation, is the most reactive one. Degree of its relationship with the other parameters indicates the true one.

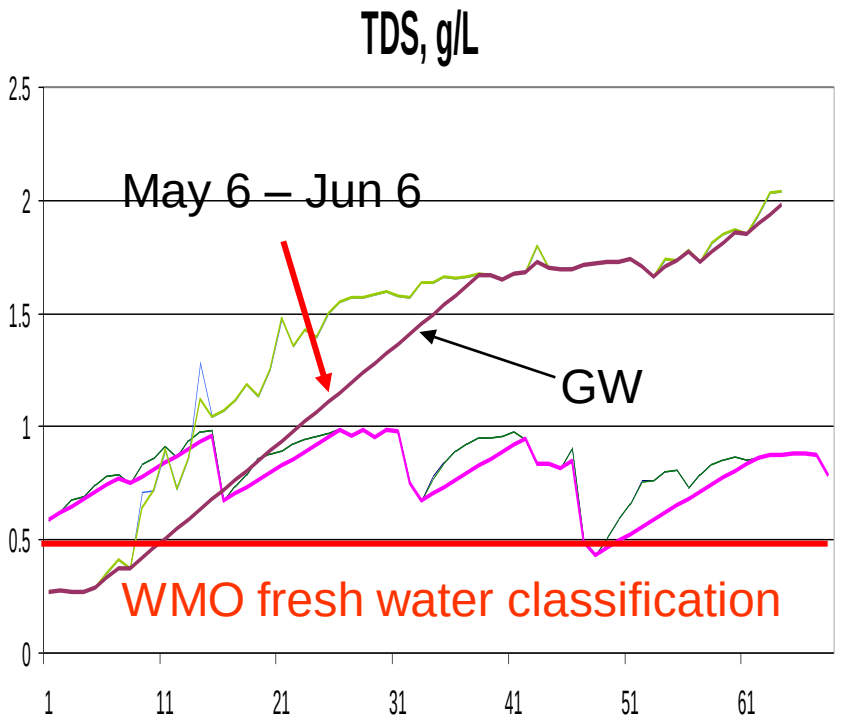
Results of separation by the SimpleBase Delineation Model







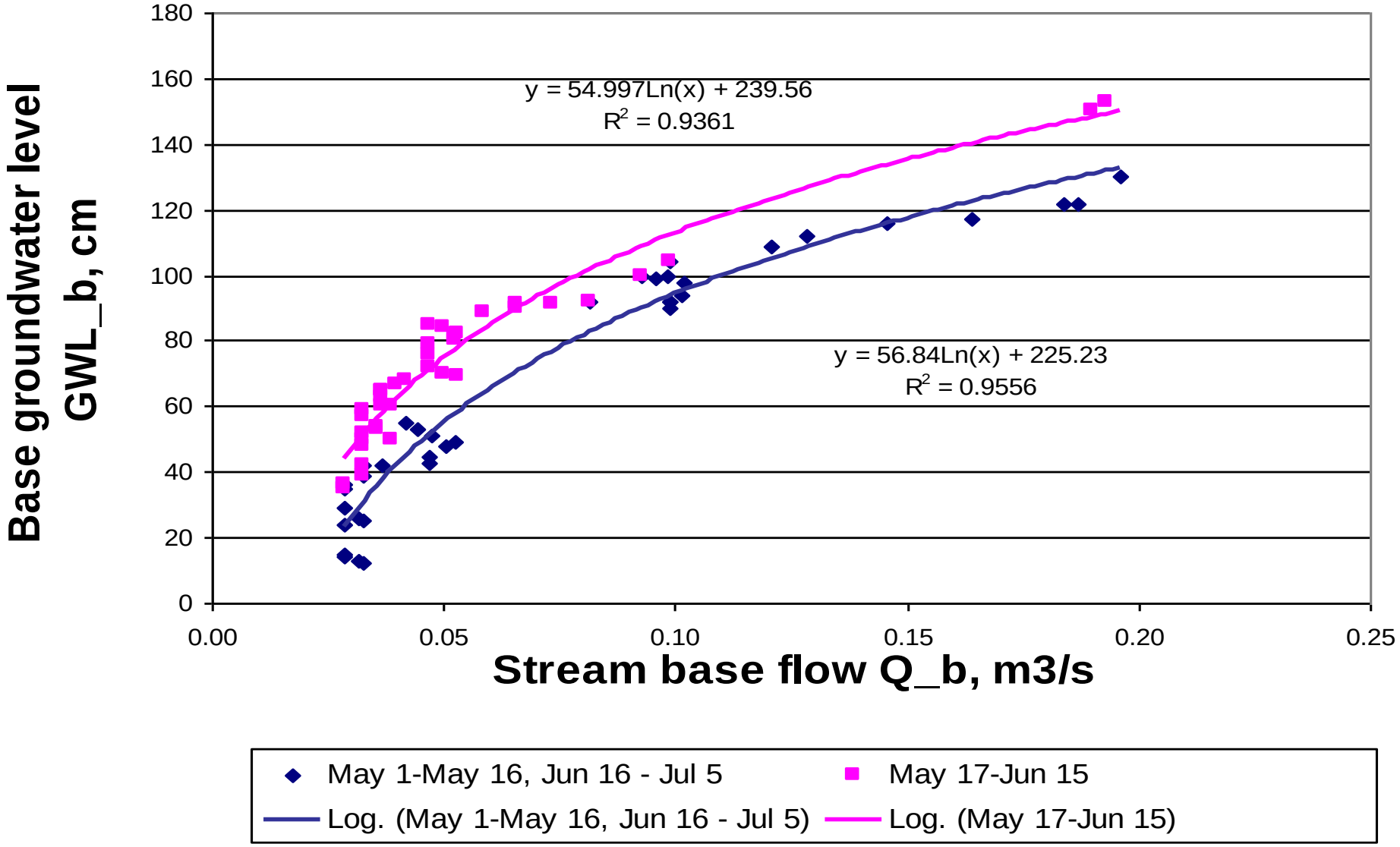




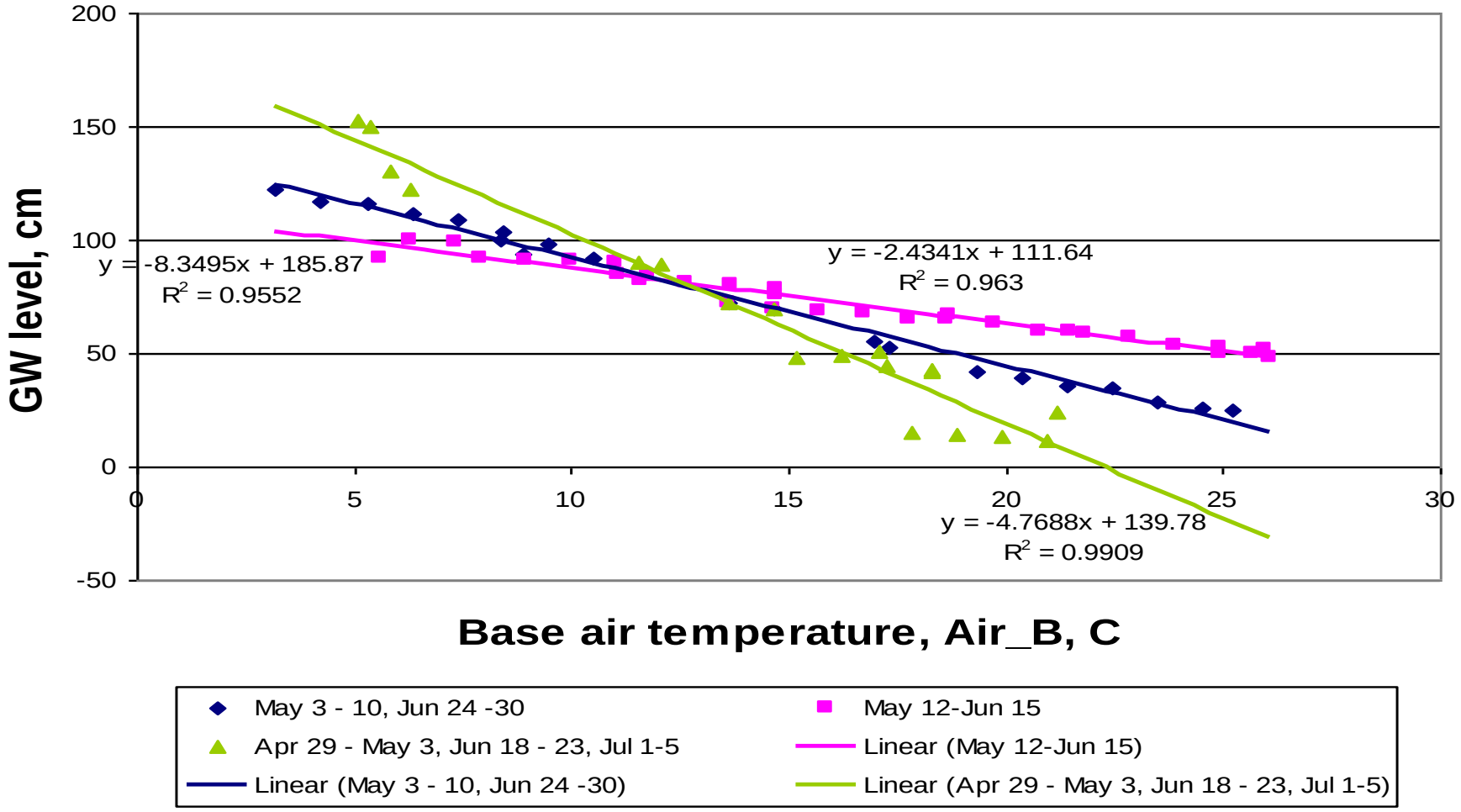
Daily correlation between separated components of surface and ground water parameters

Parameter	GW Level		GW Temperature		GW TDS		GW pH		GW Turbidity	
	Total	Base	Total	Base	Total	Base	Total	Base	Total	Base
Level_T, cm			-0.96	-0.96	-0.93	-0.96	0.85	0.90	0.79	0.84
Level_B, cm			-0.96	-0.97	-0.93	-0.96	0.85	0.90	0.79	0.84
Temp_T, cm					0.82	0.89	-0.76	-0.86	-0.40	-0.55
Temp_B, cm					0.83	0.90	-0.75	-0.85	-0.41	-0.58
TDS_T, mg/L							-0.90	-0.92	-0.92	-0.96
TDS_B, mg/L							-0.88	-0.90	-0.82	-0.87
pH_T									0.87	0.91
pH_B									0.86	0.91
Turb_T										
Turb_B										
Air_T, °C	-0.84	-0.84	0.73	0.73	0.79	0.87	-0.66	-0.73	-0.60	-0.63
Air_B, °C	-0.86	-0.86	0.78	0.78	0.84	0.92	-0.71	-0.77	-0.63	-0.68
pH_T	0.77	0.78	-0.81	-0.78	-0.87	-0.87	0.86	0.89	0.77	0.81
pH_B	0.80	0.82	-0.82	-0.79	-0.88	-0.90	0.88	0.91	0.78	0.82
T_T, °C	-0.84	-0.85	0.74	0.74	0.78	0.86	-0.64	-0.71	-0.54	-0.59
T_B, °C	-0.86	-0.86	0.77	0.77	0.81	0.89	-0.67	-0.72	-0.57	-0.63
TDS_T, mg/L	-0.12	-0.10	-0.40	-0.39	0.20	0.04	-0.03	-0.06	-0.27	-0.23
TDS_B, mg/L	-0.06	-0.04	-0.45	-0.44	0.10	-0.07	0.12	0.10	-0.18	-0.13
Turb_T, NFU	-0.27	-0.30	0.34	0.33	0.26	0.33	-0.28	-0.26	-0.16	-0.21
Turb_B, NFU	-0.70	-0.70	0.87	0.86	0.61	0.76	-0.60	-0.65	-0.39	-0.46
Flow_T, M3/s	0.16	0.12	0.09	0.09	-0.12	-0.06	0.08	0.11	0.10	0.07
Flow_B, M3/s	0.87	0.88	-0.71	-0.71	-0.96	-0.91	0.85	0.88	0.83	0.88
Velocity_T, m/s	0.24	0.21	0.04	0.04	-0.22	-0.15	0.16	0.19	0.19	0.15
Velocity_B, m/sec	0.87	0.87	-0.73	-0.74	-0.93	-0.87	0.83	0.86	0.87	0.90

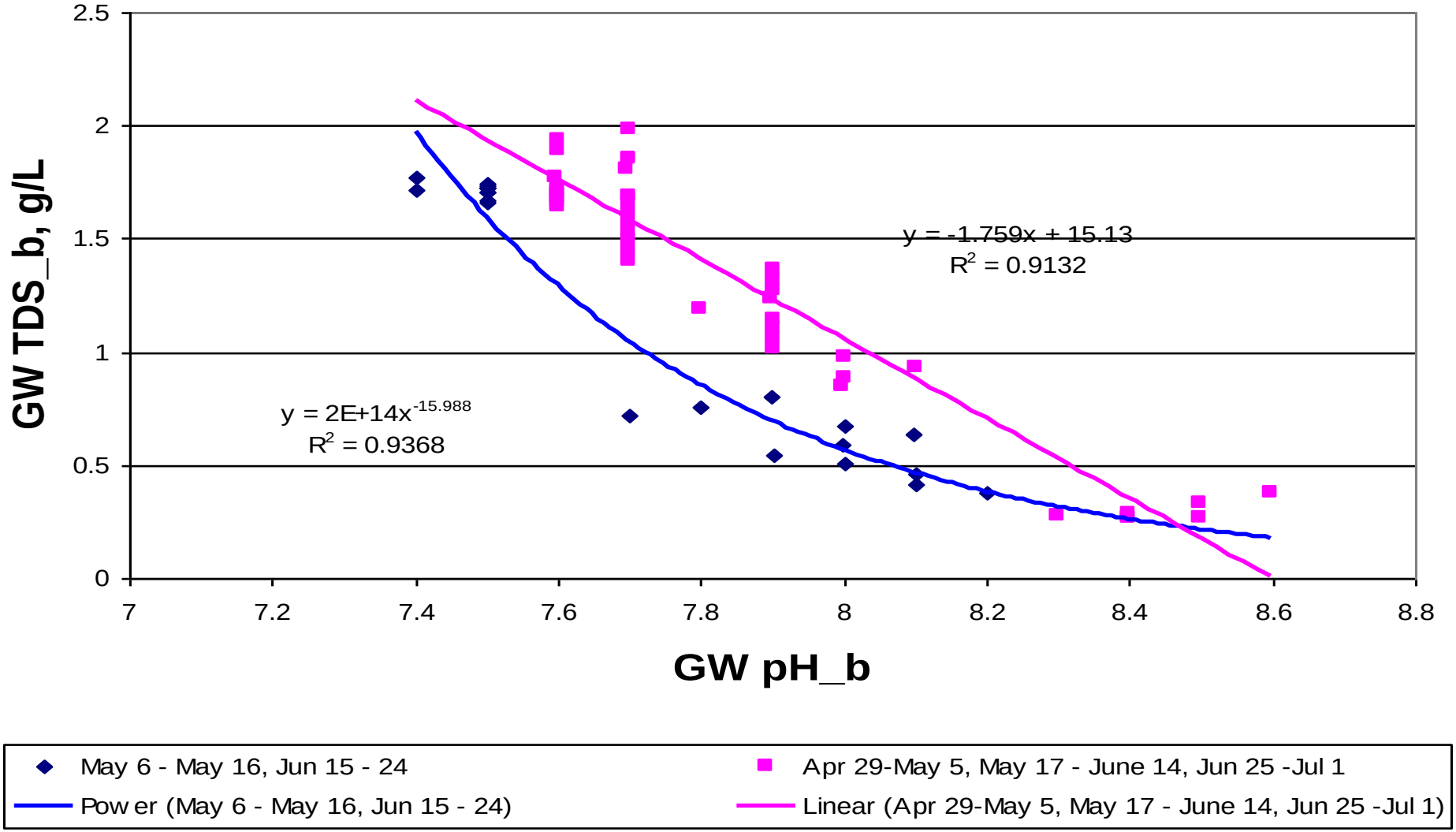
"Base" rating curve (r = 0.88)



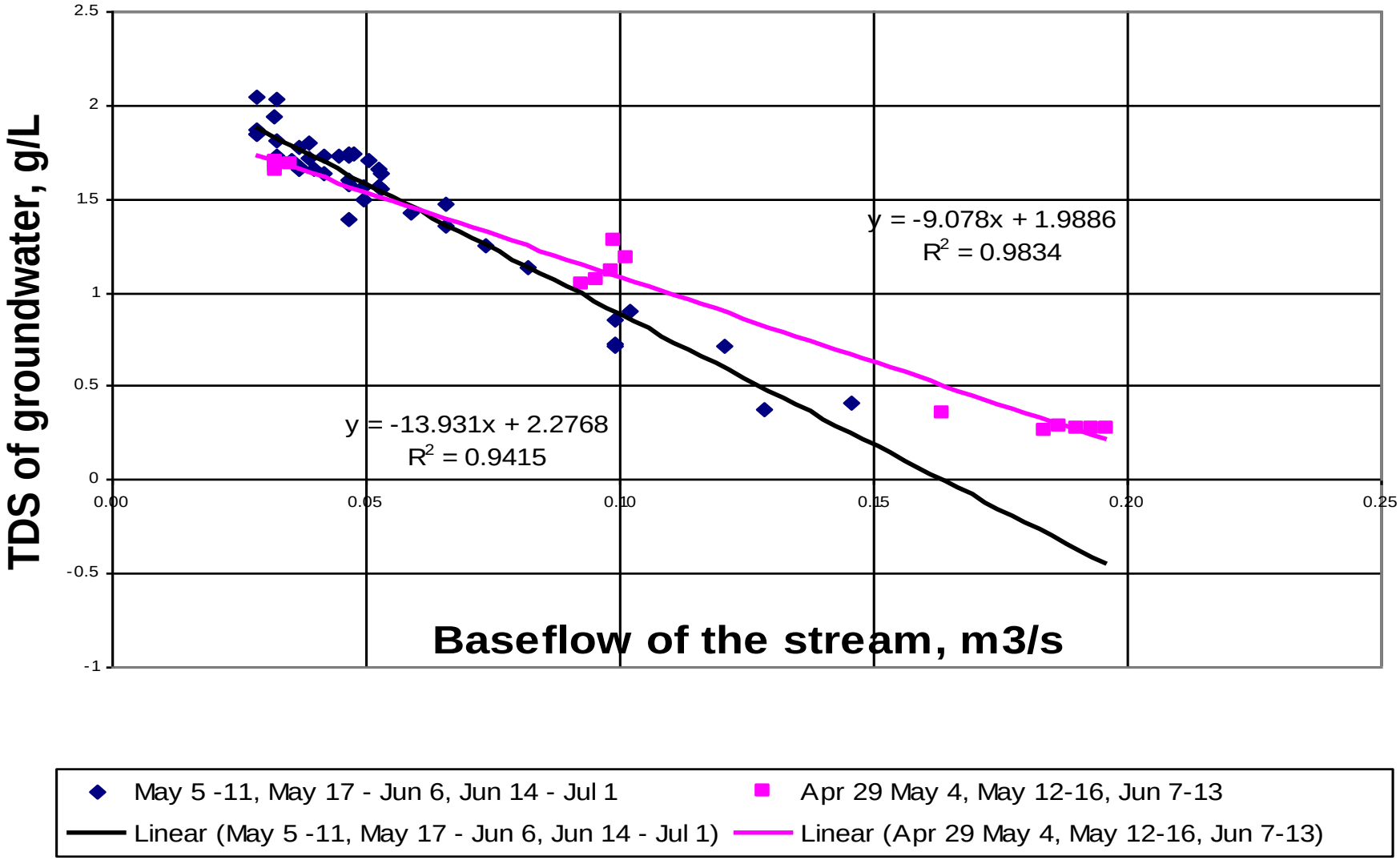
GW level – air temperature (r = -0.86)



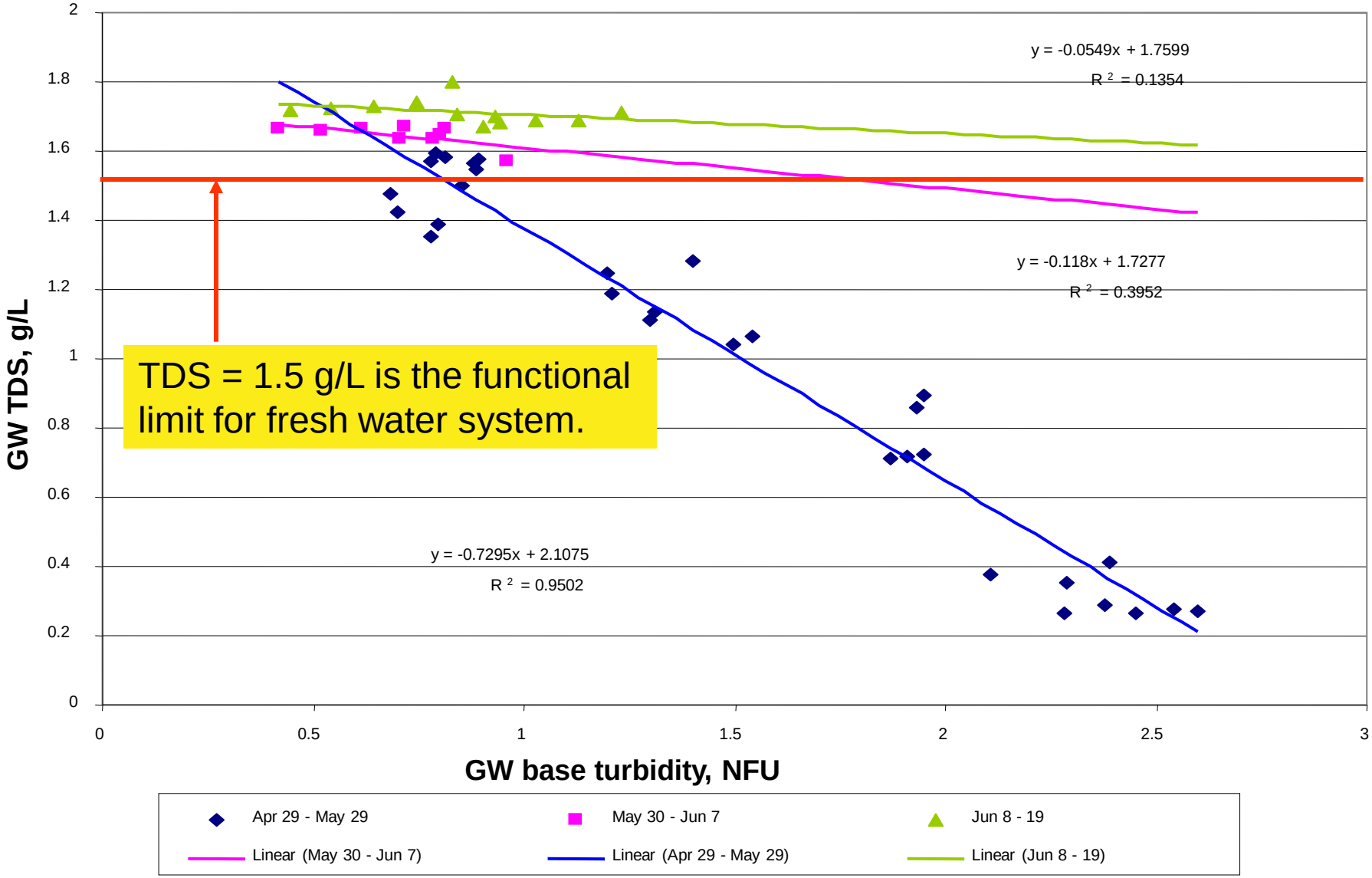
Groundwater TDS vs baseflow pH (r = 0.90)



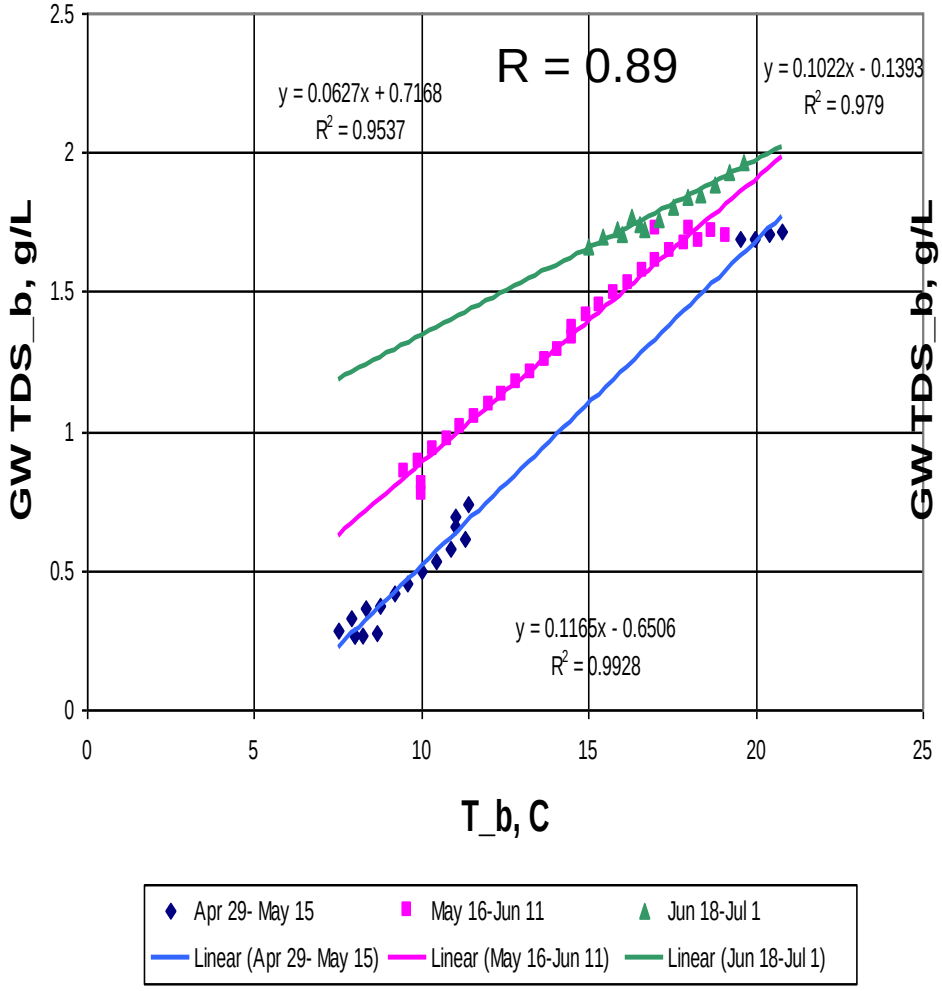
GW TDS vs Baseflow (r = -0.96)

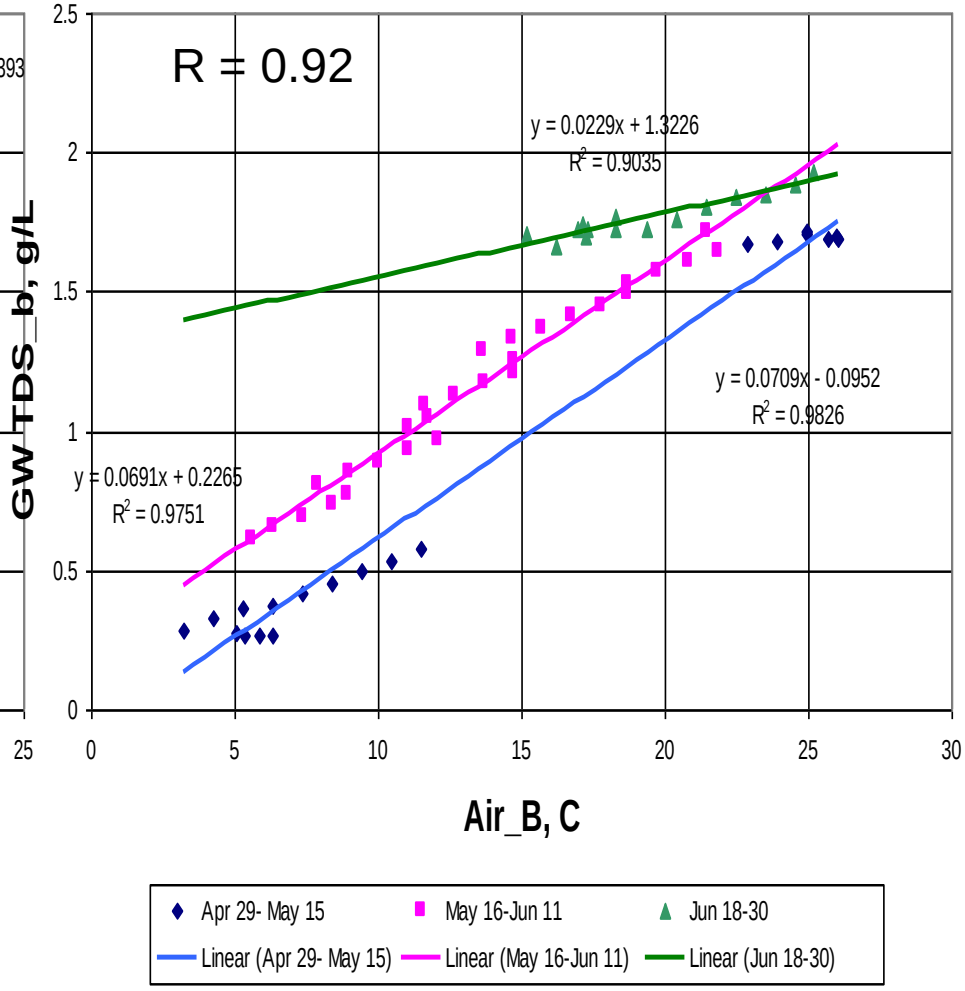


GW TDS vs GW base turbidity (r = -0.96)

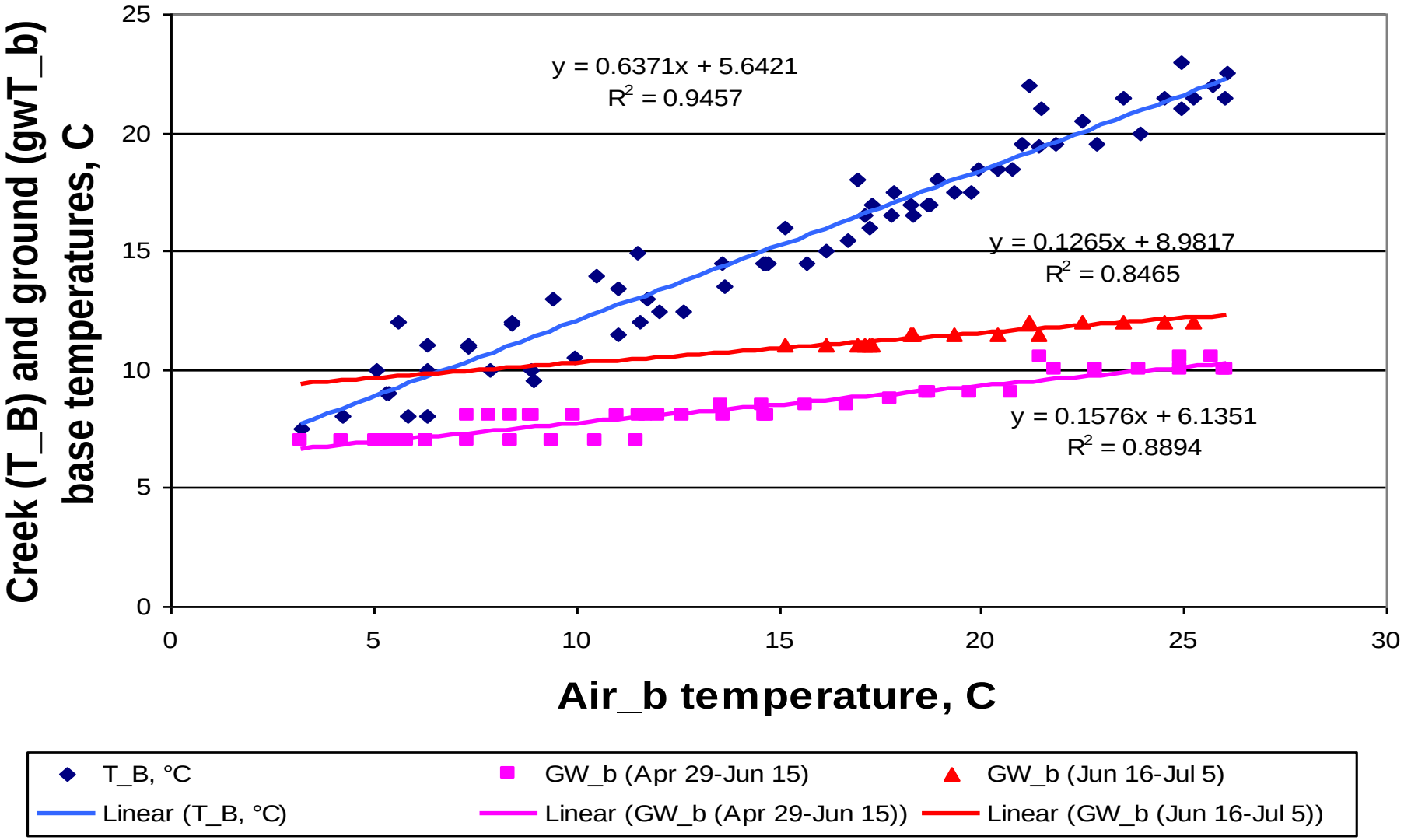


Correlation between groundwater TDS and creek and air temperatures

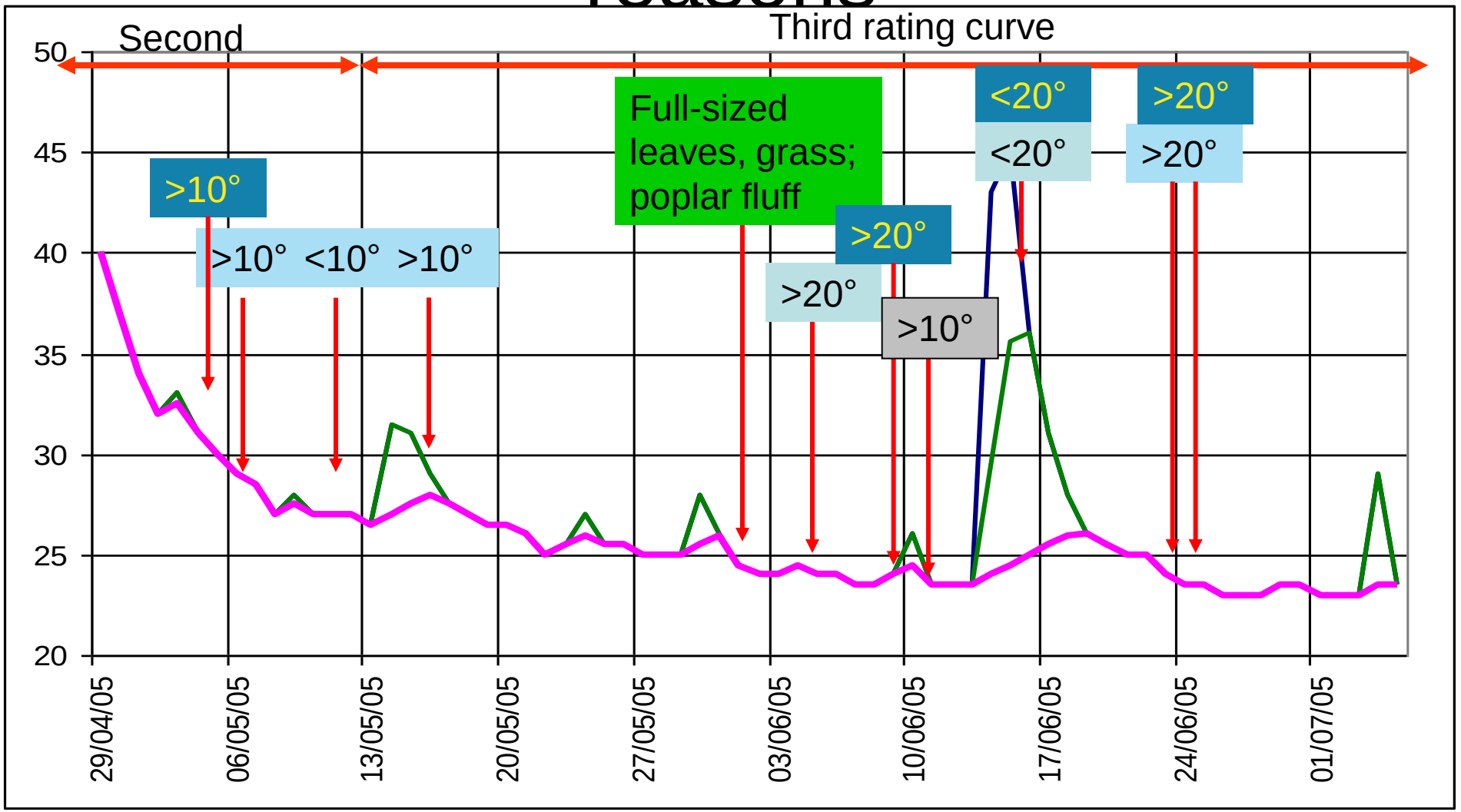




T_b = f(Air_b); gwT_b = f(Air_b)



Different curves periods and their reasons



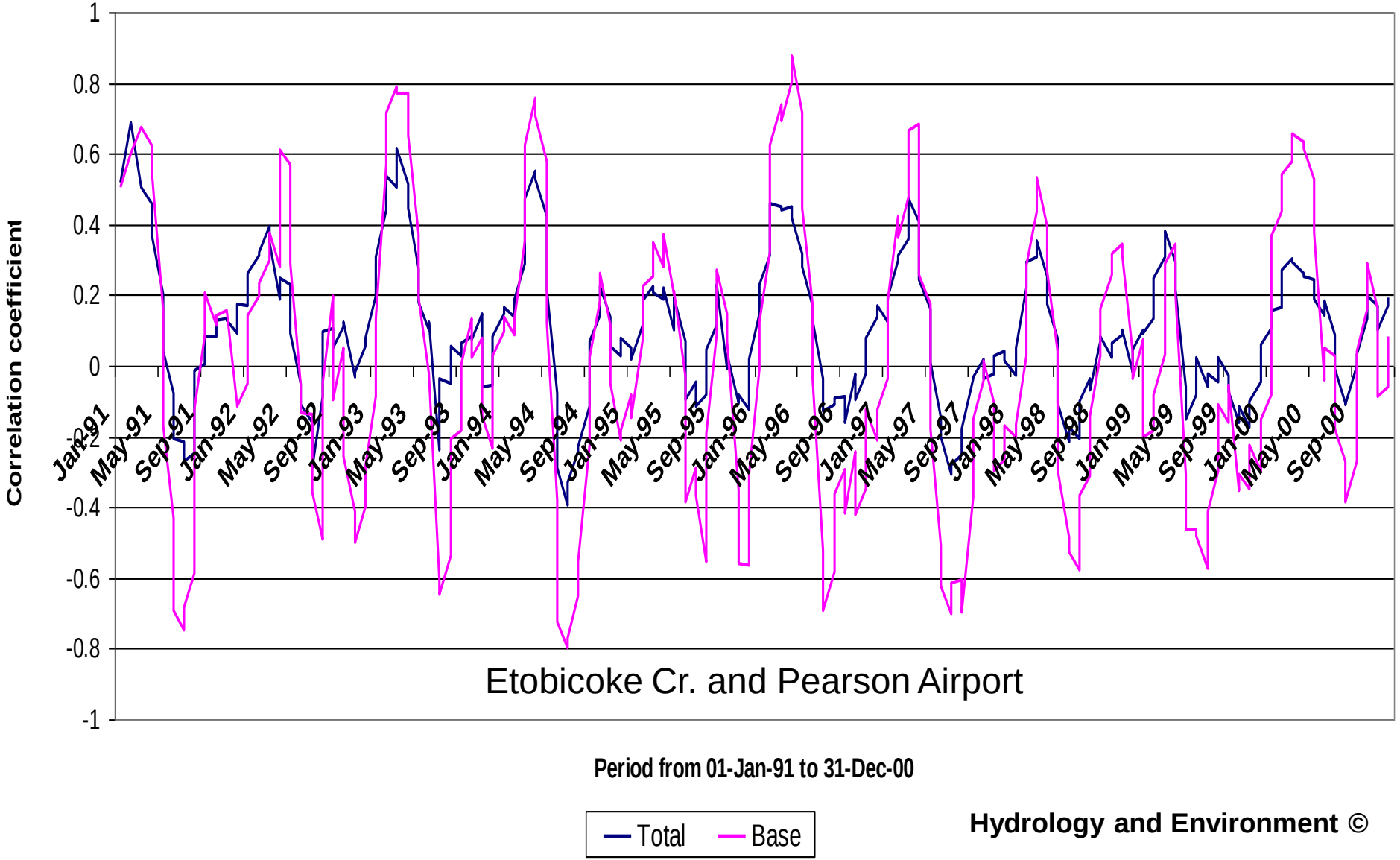
Results of separation for the period of Apr 29 – Jul 05 2005: frequencies N and amplitudes Kmax

Parameter	Ground water			Surface water			Air		
	dQ	N	Kmax	dQ	N	Kmax	dQ	N	Kmax
pH	0.099	13	1	0.099	13	1	n/a	n/a	n/a
Turbidity, NFU/ Humidity, %	0.09	10	2	0.67	16	7	3.4	14	2
Temperature, °C	0.2	8	1	0.99	12	1	1.09	9	2
Level, cm/ Precipitation, mm	0.9	6	2	0.49	10	3	0.02	14	7
TDS, g/L/ AQI	0.043	6	2	0.031	7	1	3.4	14	2
Velocity, m/s/ Wind, m/s	n/a	n/a	n/a	0.004	11	6	3.9	17	1

dQi = dQb*2^(Kmax + 0.618)

The most reactive/sensible parameter for GW is pH; for the stream water it is turbidity; in atmosphere this is wind.

4-month daily periods, bi-weekly sliding correlation between stream flow and air temperature



Conclusions

- The hypothesis of the watershed as the functional unit of hydrosphere to control temperature is true
- The excessively high level of TDS in groundwater accelerates the GW temperature increase during the warm period
- Within the system, the higher rate of base component indicates the higher reactivity of the parameter itself in the examined period
- Interrelated parameters change iteratively, fluctuating in different periods around their temporary stable condition
- The Separated Flux Analysis is the right tool for the environmental assessment and can be used in the water source protection activity to estimate the true relationship between elements of the system, to restore missing parameters using available ones: air temperature and flow.
- The Fletcher's creek daily dataset has to be completed till one year period in order to be an excellent database for any approach evaluation