CSIM in Baltic C

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Tasks

- 7.1 Compilation of river chemistry (first six months)
- 7.2 Model calibration and validation (first year)
- 7.3 Scenario analysis from land cover changes and changes in climate (Ca, inorganic carbon…) (after 2 years)
- 7.4 Scenario analysis on climate change (N, P) (after 2 years)
- Scenario analysis on changes in land cover, land use (N, P) (after 2 years)

Weathering and organic matter

$$4Na_{0.5}Ca_{0.5}Al_{1.5}Si_{2.5}O_8 + 6H_2CO_3 + 11H_2O \rightarrow$$

$$3Al_2Si_2O_5(OH)_4 + 2Na^+ + 2Ca^{2+} + 6HCO_3^- + 4H_4SiO_4$$

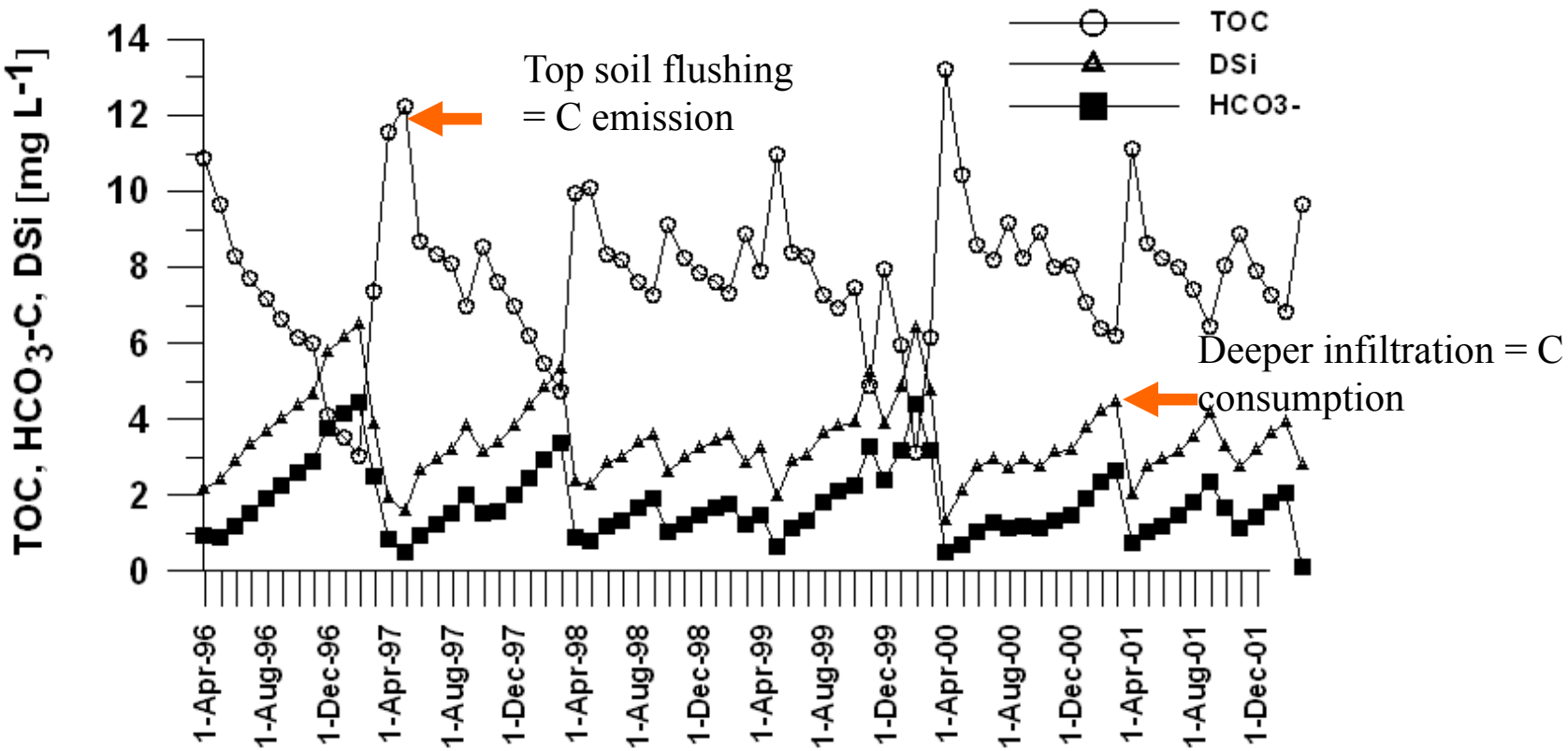
Primary mineral + carbon acid (from soil CO_2) →

Secondary mineral + DSi plus alkalinity

Aquatic conduit a source or a sink for atmospheric C?

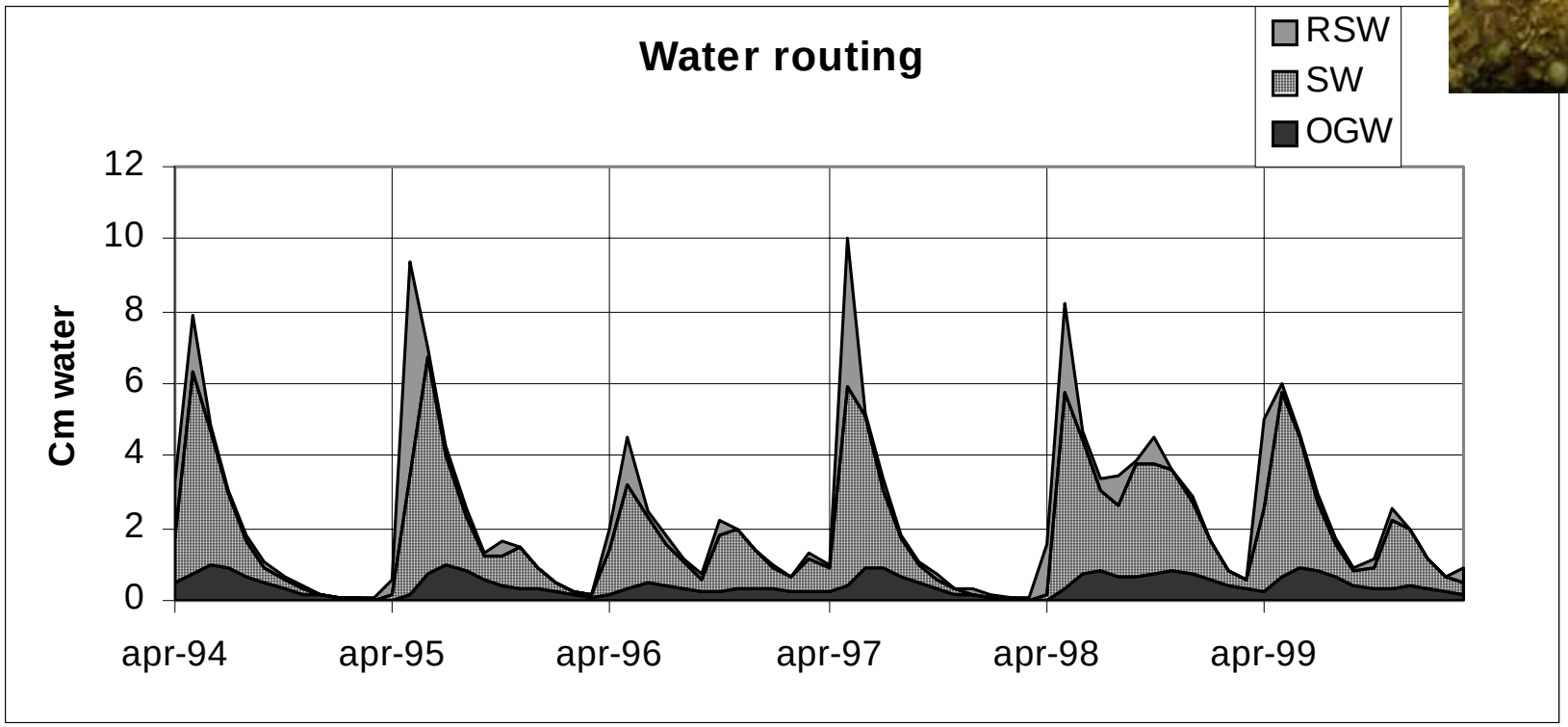
Top soil flushing -> **DOC export** (150 000 tons C via pCO_2)

Infiltration -> **Alkalinity export** (600 000 tons C)



Smedberg et al. 2006, GBC

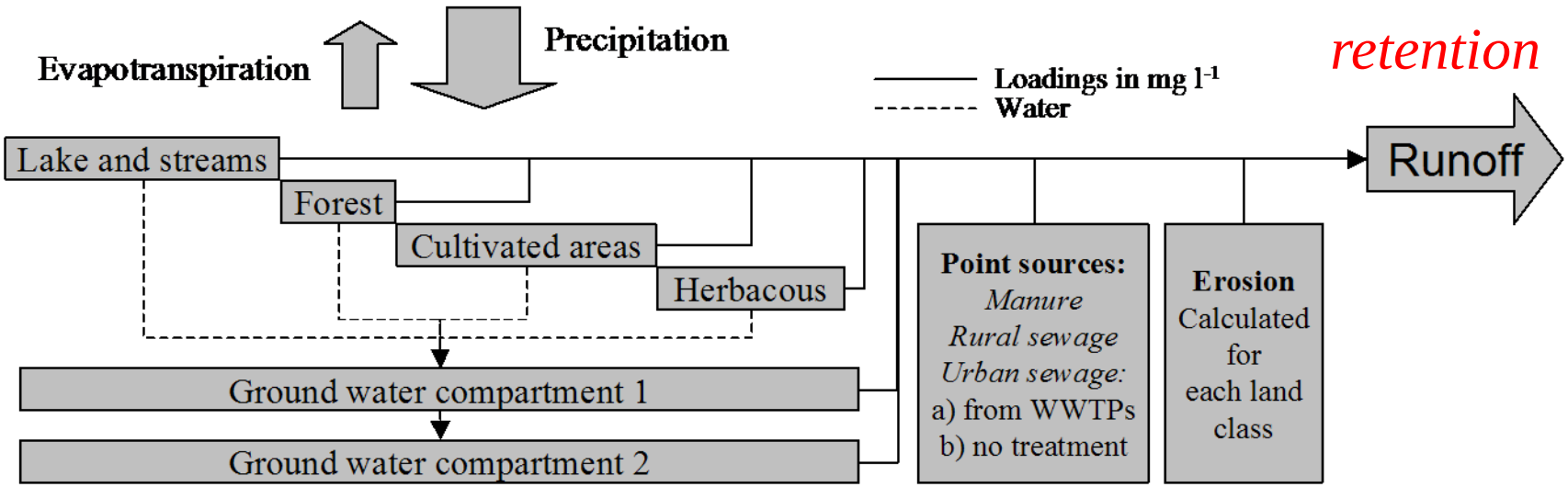
Pronounced spring flow flushing top soils



CSIM

(Catchment Simulation)

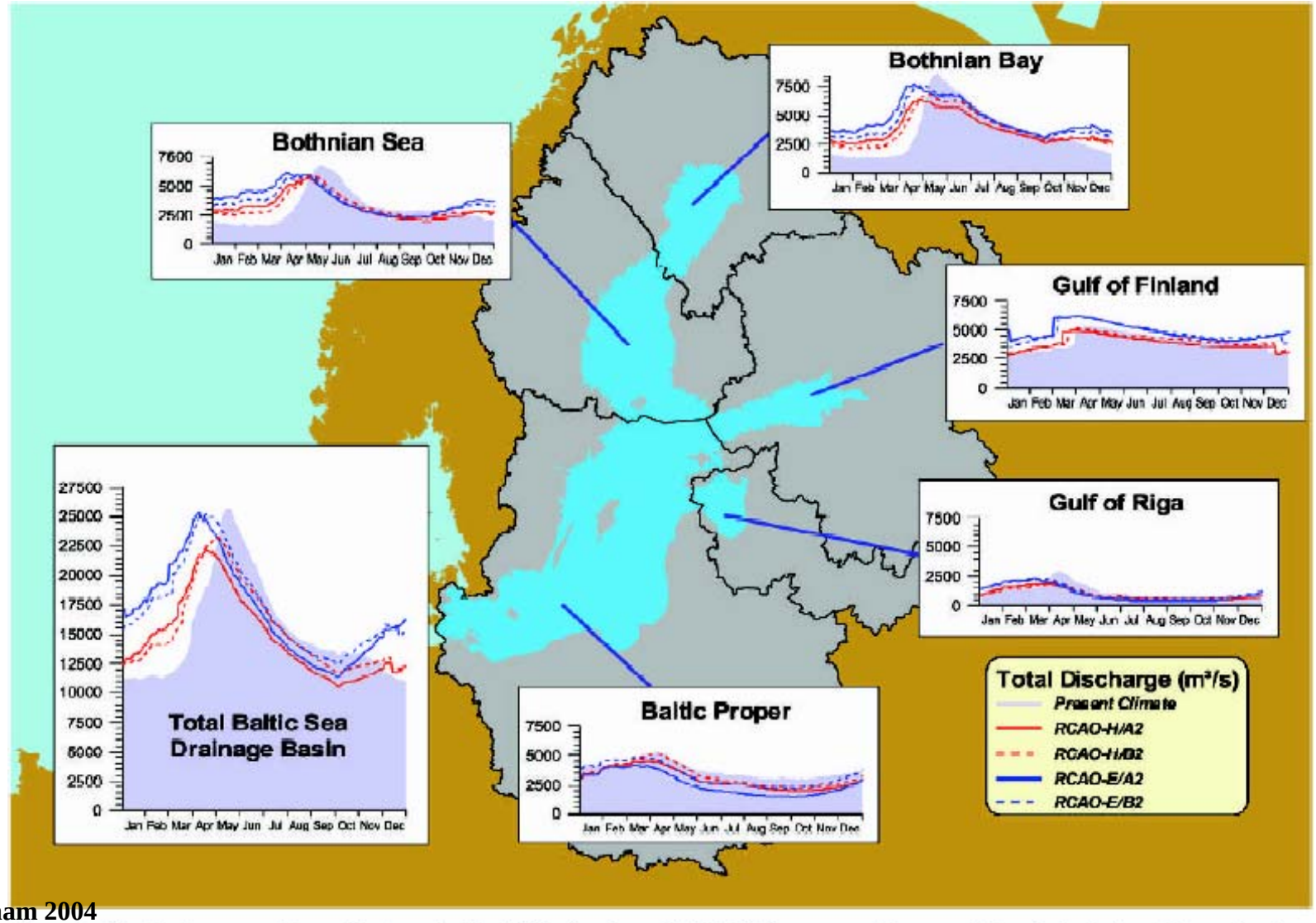
Future: dynamic Riverine retention



Now: fixed type concentrations

Future: Type concentrations =f(land use)

Mörth et al. 2007



Graham 2004

Figure 1. Modeled seasonal river discharge to the Baltic Sea from HBV-Baltic for present-day conditions (shaded) and four climate change scenarios. Shown are daily means over the 23-year modeling period. All plots are drawn to the same X and Y scales.

DIC, DOC, cations and anions

- Subtract cyclic salts to calculate weathering
- Will be modeled by setting
  - DIC=HCO_3- + CO_2(g)
  - SBC= $2Ca^{2+} + 2Mg^{2+} + Na^{+} + K^{+}$
  - SAA= $Cl^{-} + 2SO_4^{2-}$
  - SBC=f(landscape)
  - SAA=f(landscape)
  - DIC=f(landscape)
  - DOC=f(landscape)
- Carbonates very fast weathering
- Silicates, approx. 8% increase in weathering per degree celsius

ANC

- Calculate ANC by taking the ion balance
  - strong basic cations (SBC) – strong acid anions (SAA)

DOC

- Weak triprotic organic acid

$$H^{+} + RCOO^{-} = RCOOH$$

- Typical pK_a values, pK_{a1}=2.5, pK_{a2}=4.0 and pK_{a3}=5.8
- DOC from vegetation model

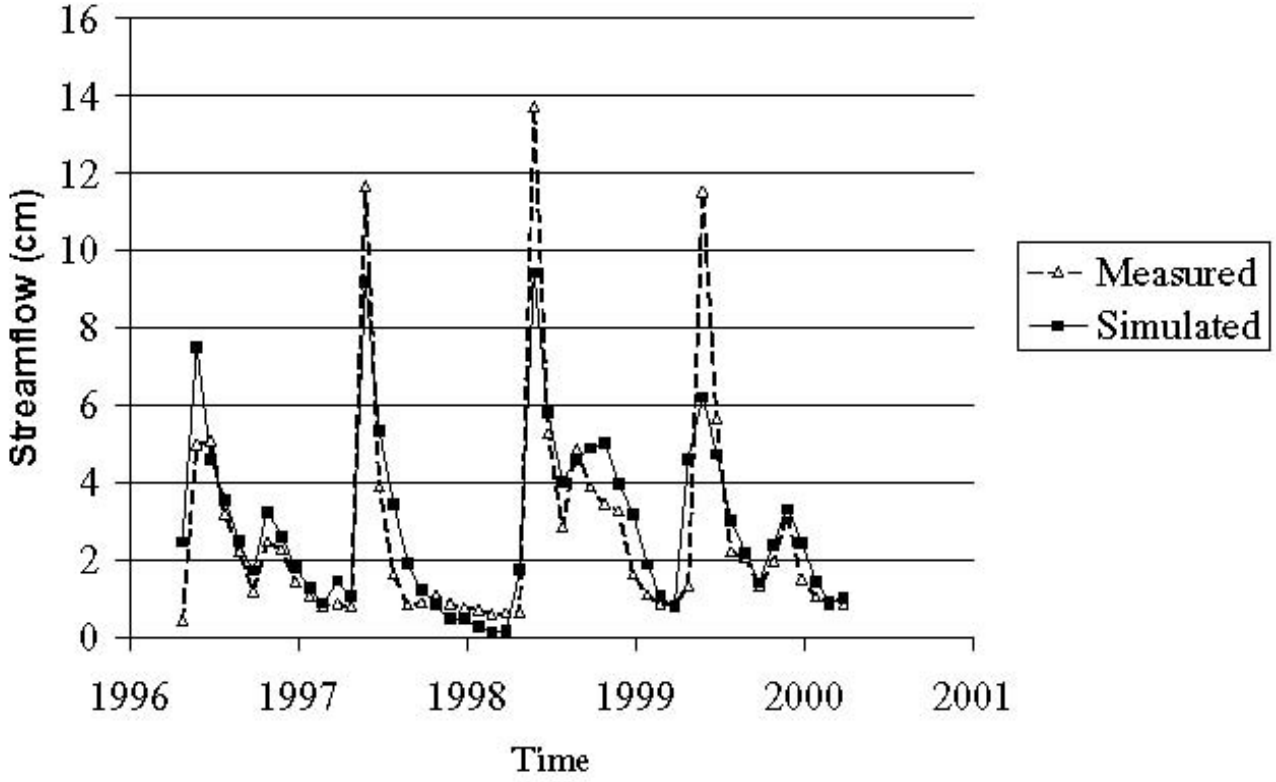
pH and PCO_2

- Alkalinity=SBC – SAA - $RCOO^-$ (from DOC)
  - SBC, SAA and DOC from the model
  - Alkalinity = HCO_3^- - H^+
- DIC, from the model (type concentration)
- pH and PCO_2
  - Alkalinity ≈ HCO_3^-
  - DIC= HCO_3^- + $CO_2(g)$
    - DIC = Alkalinity + K_H x PCO_2 (atm)
    - PCO_2 = (DIC – Alkalinity) / K_H
    - pH = -LOG(K_1 x K_H x PCO_2 / Alkalinity)

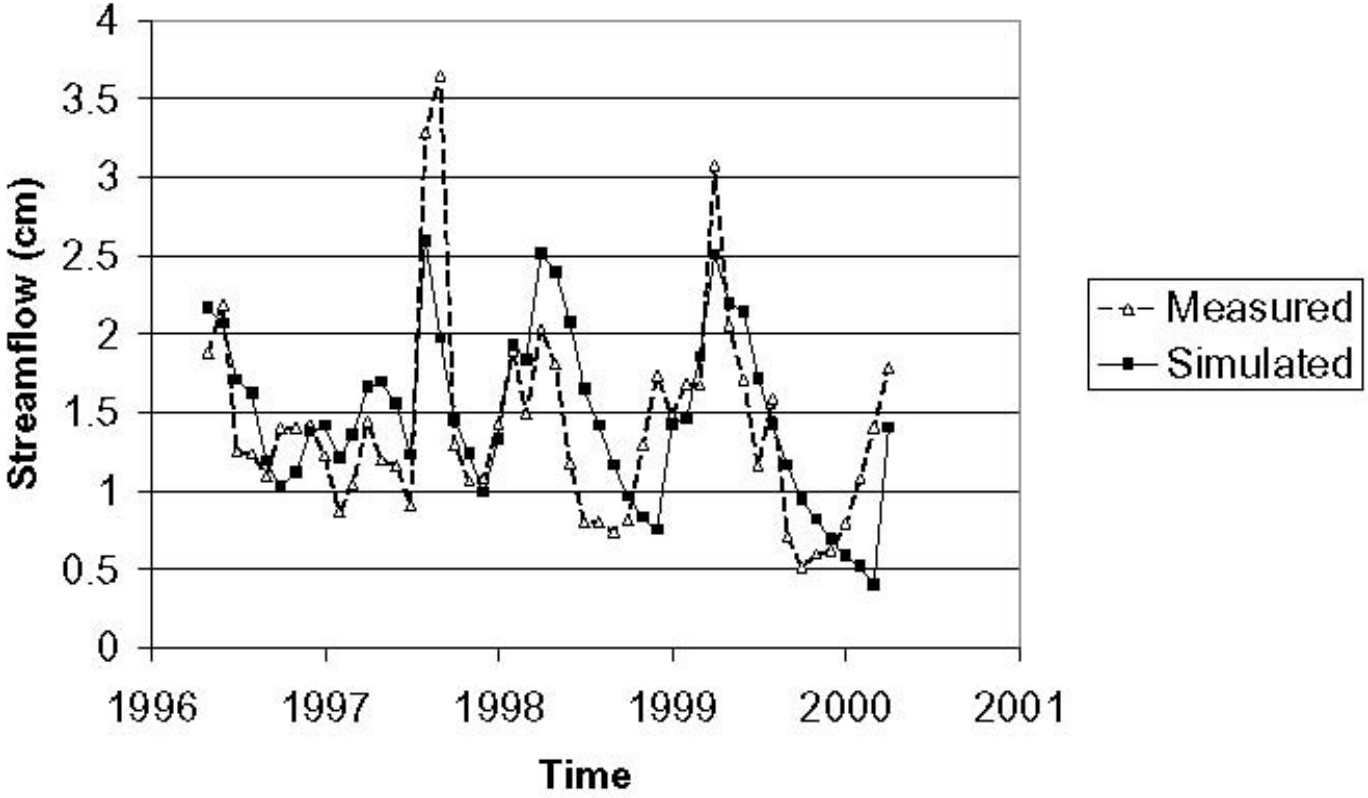
Status of work

- Weather data compiled and ready (MARS)
- Model in modular form
  - Hydrology calibration ongoing
  - Calibration routines (using SDK)
- Weathering
  - Subtract deposition
    - Deposition data compilation ongoing, very tedious (3.9 million rows in the database for the moment)
  - Calculate carbonate contribution (use the Mortatti and Probst approach)
  - 8% increase per degree
- Data for running the model.....

Råne river, Runoff



Oder, runoff


4
3.5
3
2.5
2
1.5
1
0.5
0
Streamflow (cm)
1996
1997
1998
1999
2000
2001
Time
Measured
Simulated

Which data do we need?

- ANC = SBC – SAA
- $RCOO^-$ from DOC
- Water temperature – for weathering and C speciation
- Q

} Present and future

- pH
- Alkalinity

} Present, for model validation

Which data do we have?

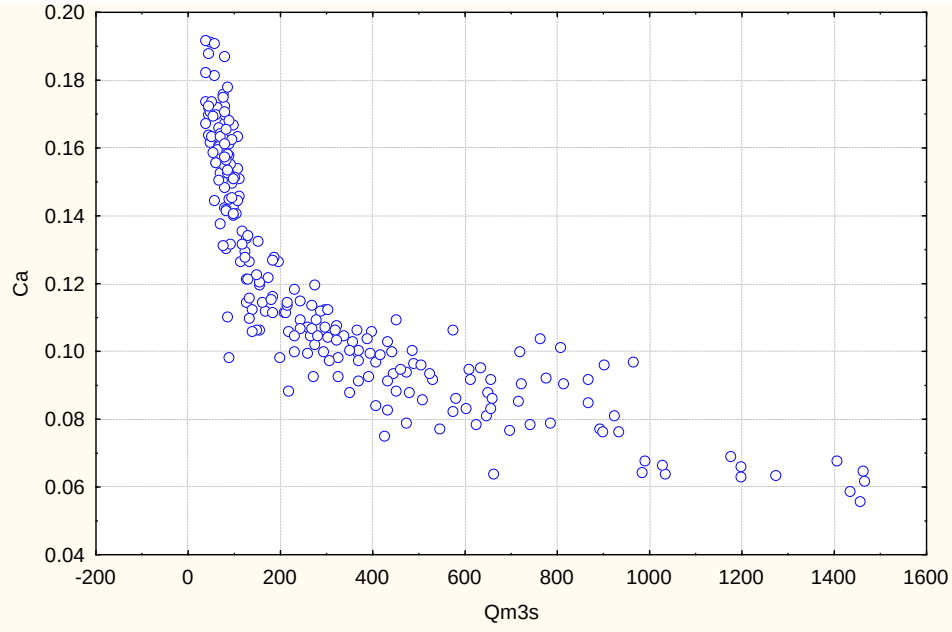
Country	No of rivers	Expected obs. [1]	ANC available obs.		TOC available obs.		pH available obs.		Temp available obs.	
		n	n	(%)	n	(%)	n	(%)	n	(%)
Sweden	36	7776	7490	96	7509	97	7509	97	1983	26
Finland	29	6264	3749	60	3992	64	4554	73	4480	72
Estonia	4	864	**0**	**0**	*138*	*16*	807	93	*0*	*0*
Lithuania	1	216	*67*	*31*	*73*	*34*	158	73	*0*	*0*
Latvia	5	1080	**2**	**0**	**25**	**2**	**25**	**2**	*24*	*2*
Poland[2]	2	432	**86**	**20**	**24**	**6**	*126*	*29*	*125*	*29*
Russia	2	432	**0**	**0**	**0**	**0**	**0**	**0**	*0*	*0*

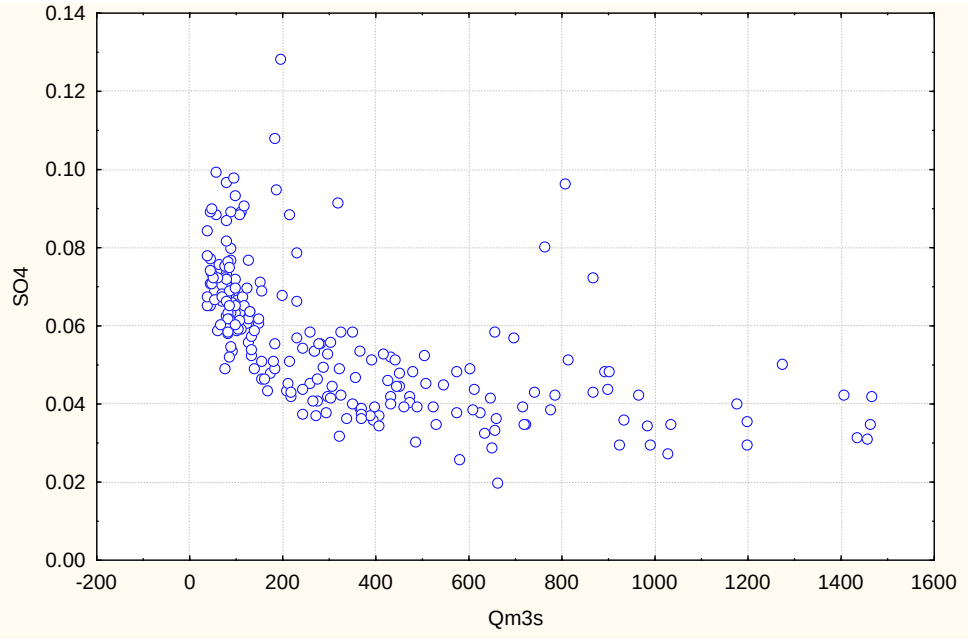
[1] Based on monthly sampling, 1990-2007
[2] One river only (Vistula)

Ca^{2+} and SO_4^{2-}

dependence of discharge.

Kalix Älv

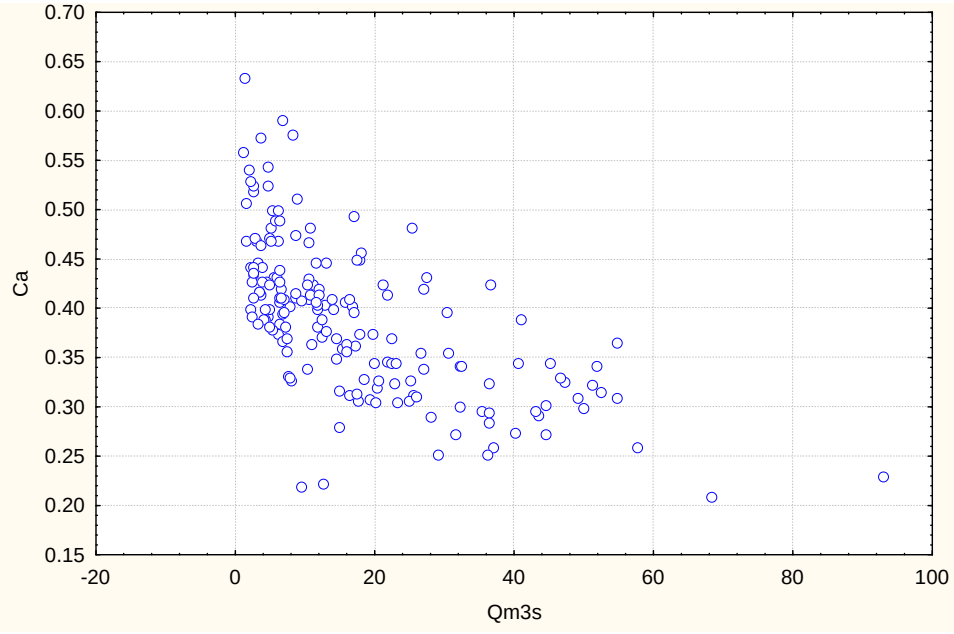


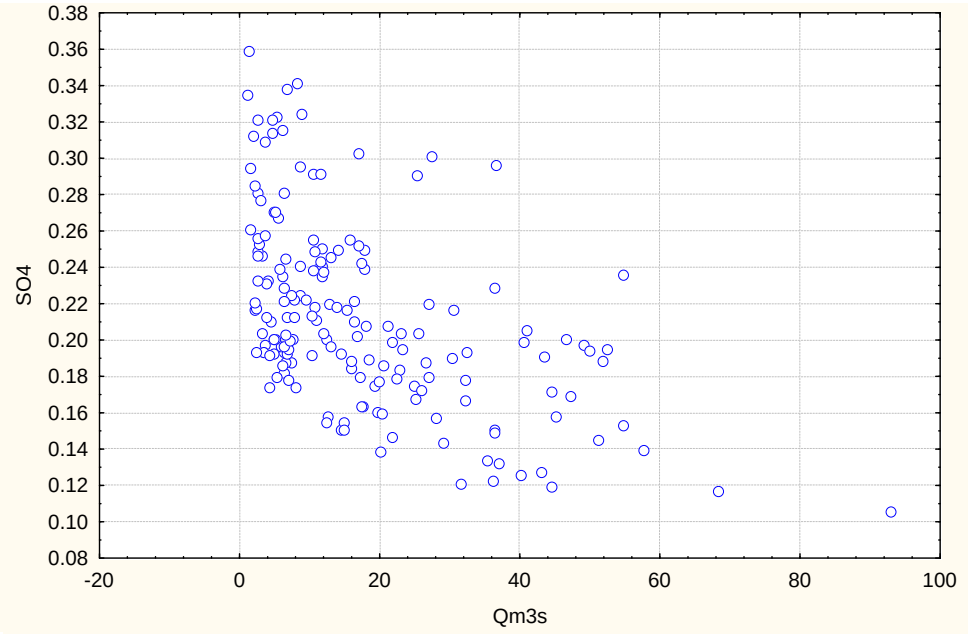


Ca^{2+} and SO_4^{2-}

dependence of discharge.

Vantaa

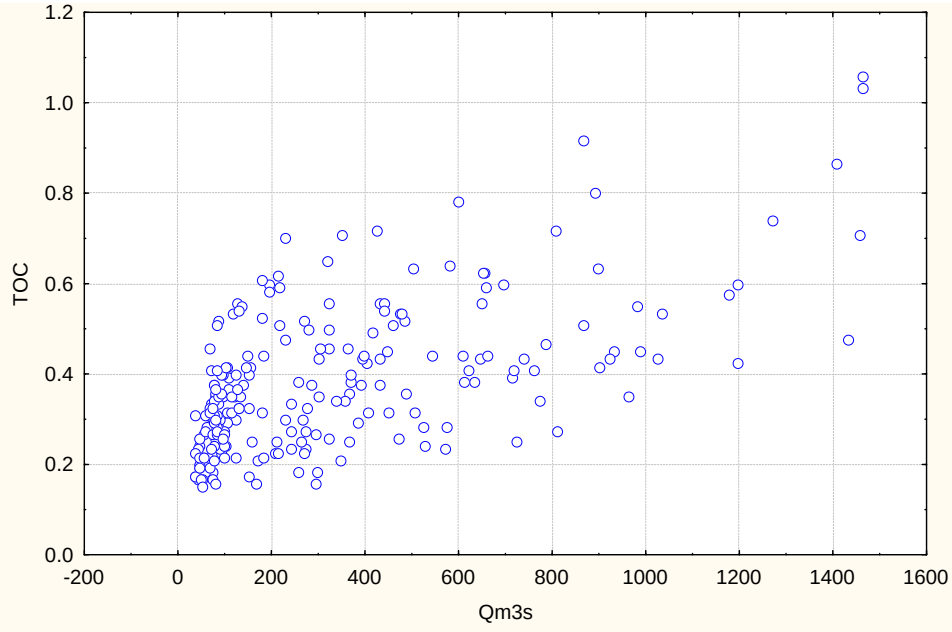




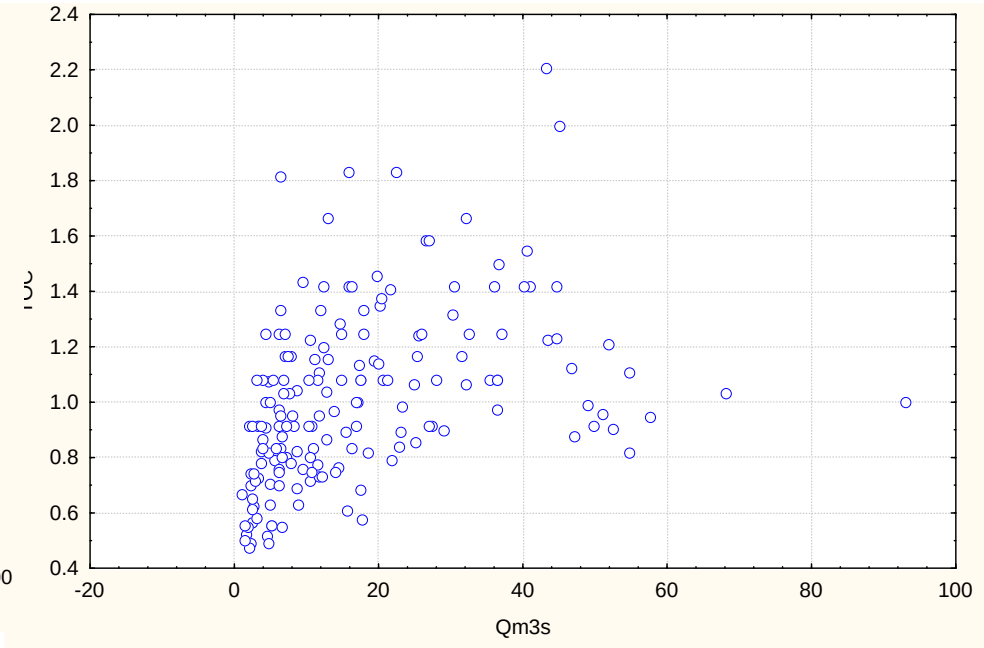
TOC

dependence of discharge.

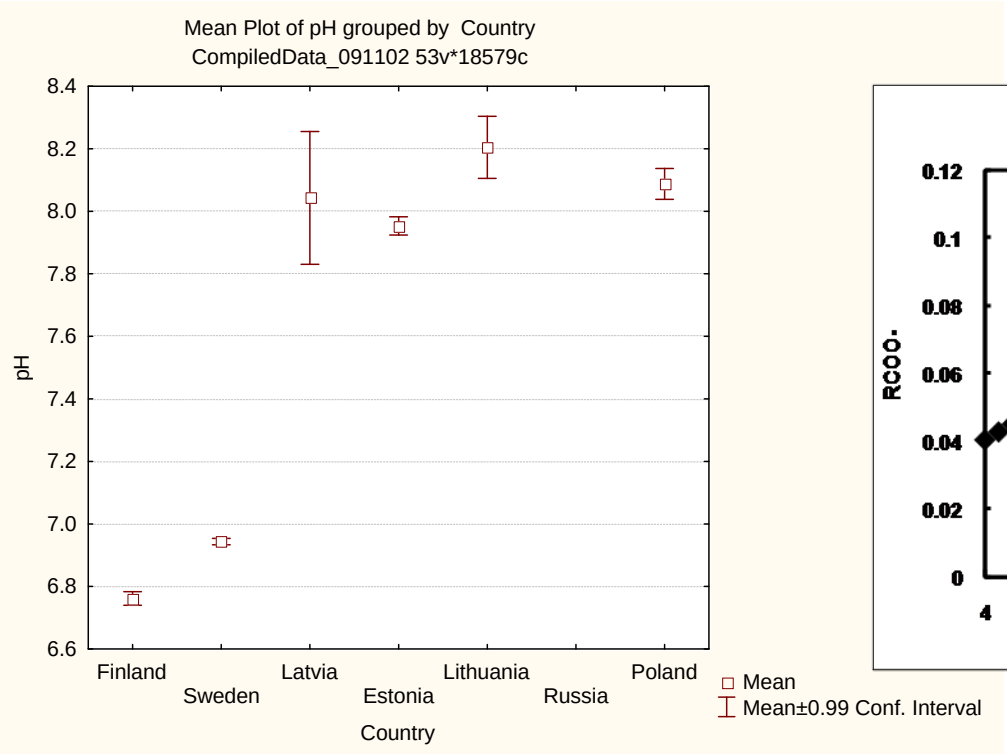
Kalix Älv

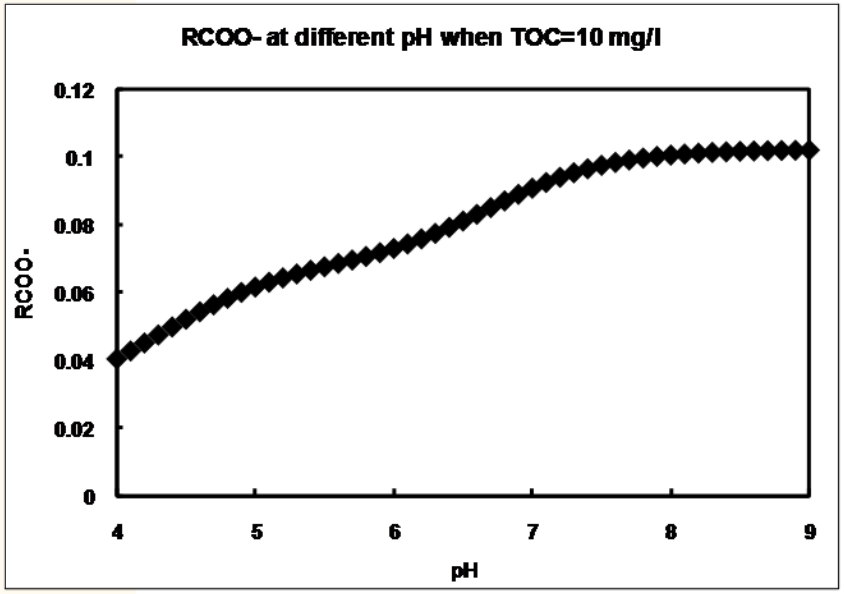


Vantaa



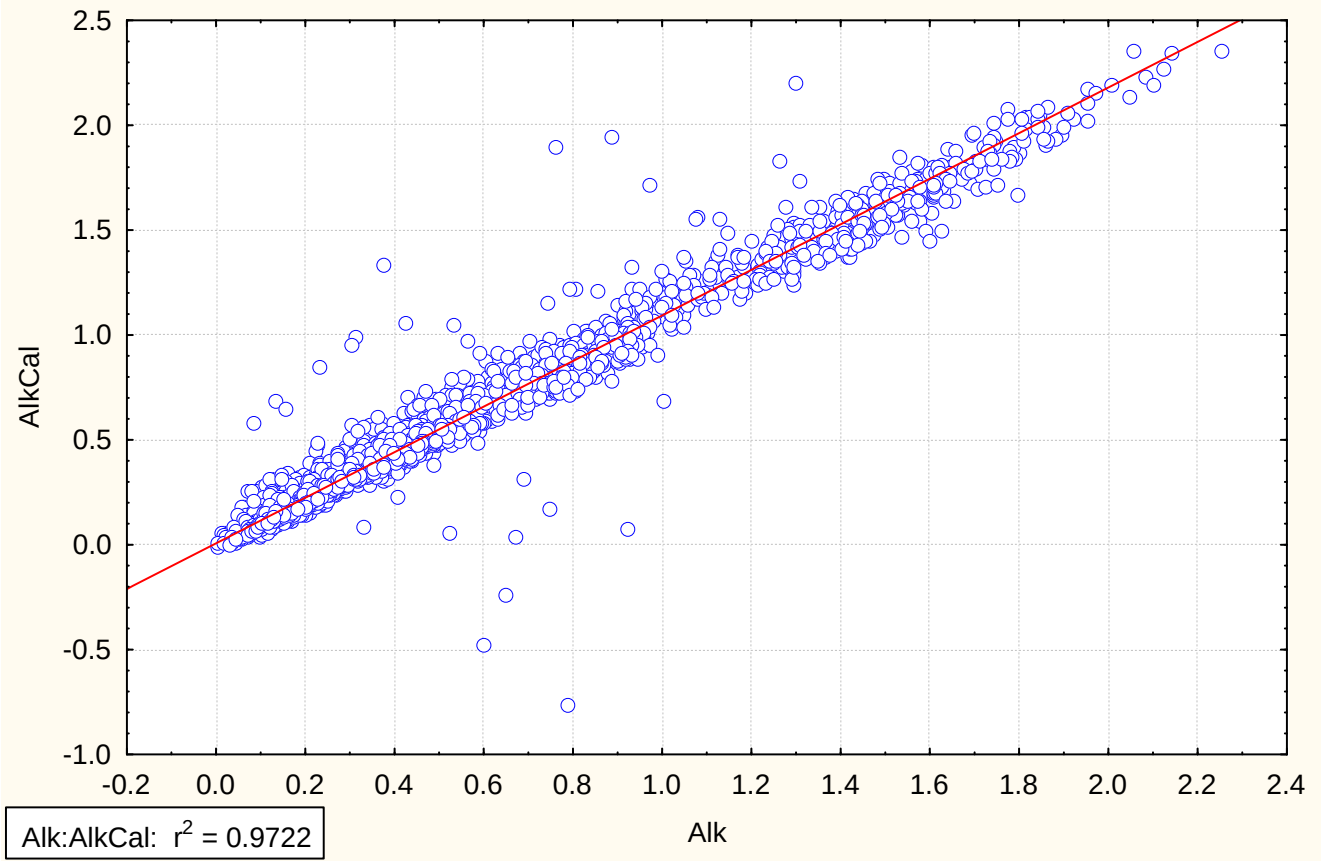
RCOO$^-$ from DOC





Alkalinity calculation

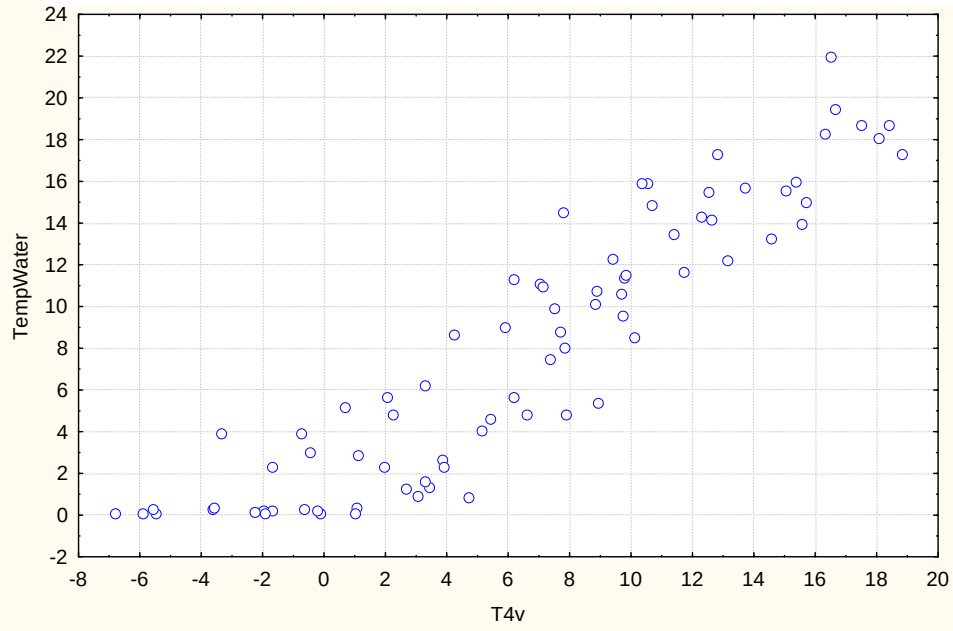
measured versus calculated from ANC and DOC



Temperature estimation

water temp from air temp

Virijoki



Vistula