



Large scale modelling, DIC, DOC, Alk, DIN, TN, DIP, TP

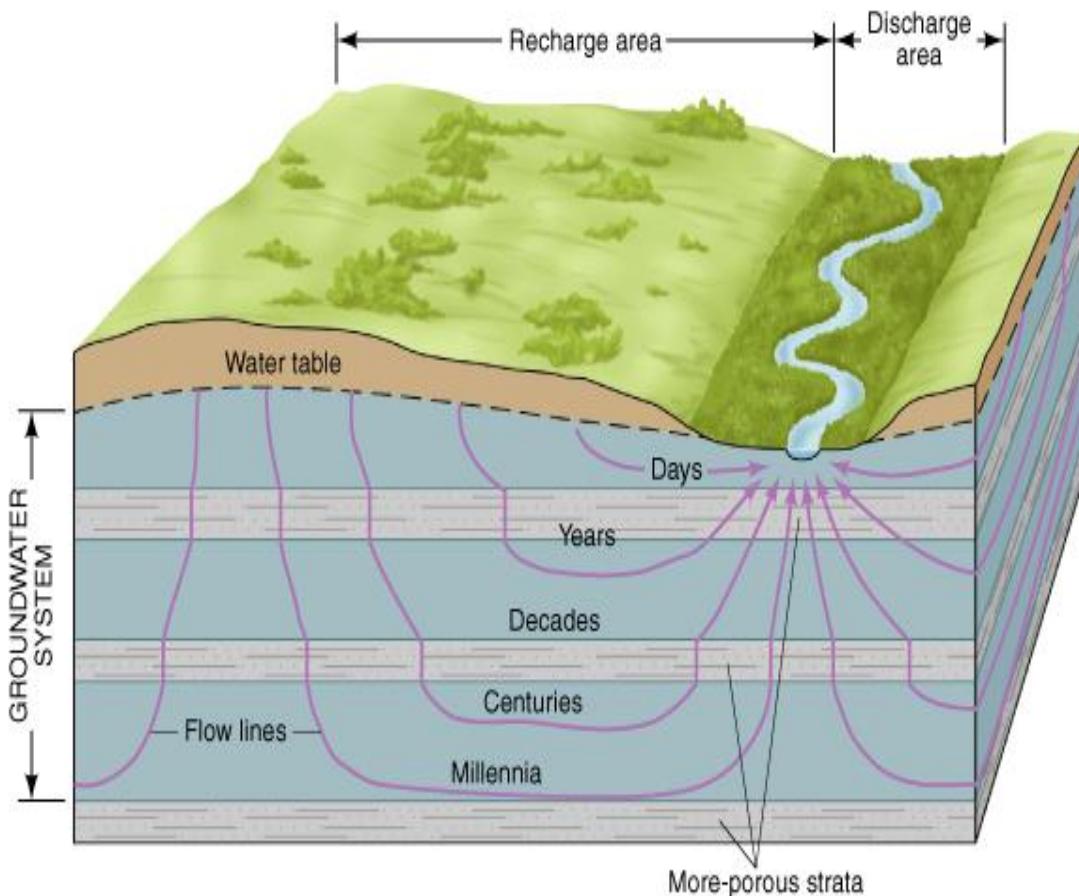
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Humborg, H Eriksson Hägg,
E Smedberg, B Gustafsson

Tasks

- 7.1 Compilation of river chemistry (first six months)
 - Together with Matti Pertillä
 - READY
- 7.2 Model calibration and validation (first year)
 - READY
- 7.3 Scenario analysis from land cover changes and changes in climate (Ca, inorganic carbon...) (Ready)
- 7.4 Scenario analysis on climate change (N, P) (Ready)
- Scenario analysis on changes in land cover, land use (N, P) (Ready)

Model

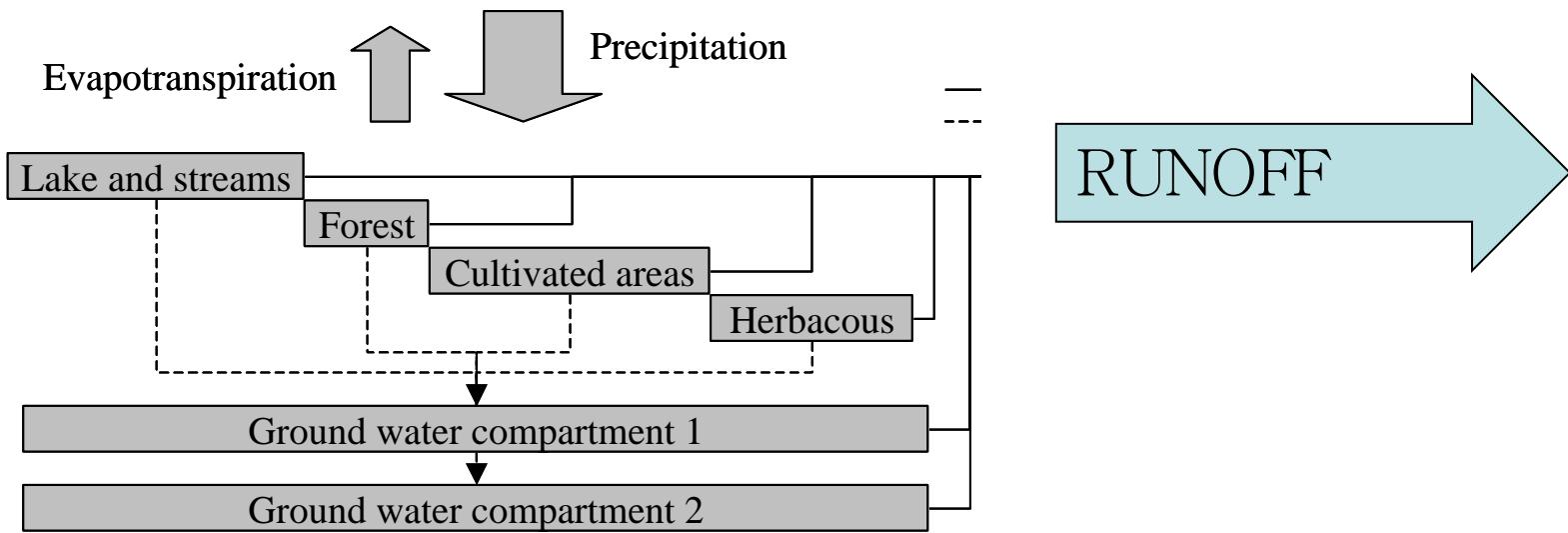
- CSIM, based on GWLF model
- Basic model assumption
 - Water flow path is the most important factor regulating river chemistry



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CSIM

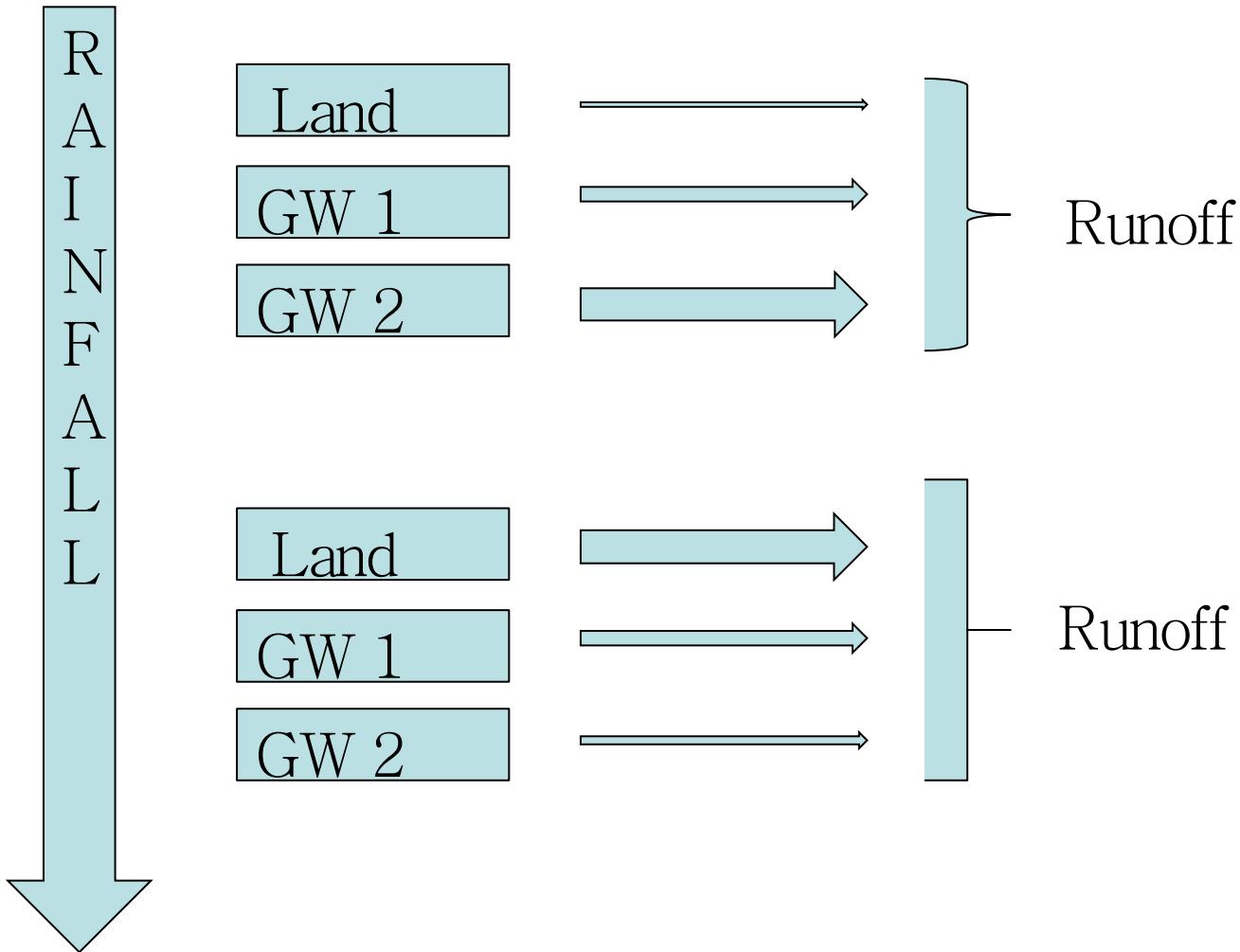
(Catchment Simulation)



Mörth et al. 2007

Calibration

- 1996–2000
- We have for the moment no other complete data set
 - No validation period
 - Many values are guess-estimates
- Calibration set land class concentrations as well as runoff parameters



Assumptions

- DIC calibration data calculated from pH and Alkalinity
 - We have assumed that future DIC values have more or less the same carbon dioxide–bicarbonate fractions
- Alk has been used as a measure of SBC – SAA

How to get dynamics

- DIC and Alkalinity
 - Weathering
 - We have assumed constant deposition
 - Calculation of weathering rates after subtracting deposition for carbonate and silicate rocks for each catchment, mean value for 1996–2000
 - Steady state
 - Biomass uptake

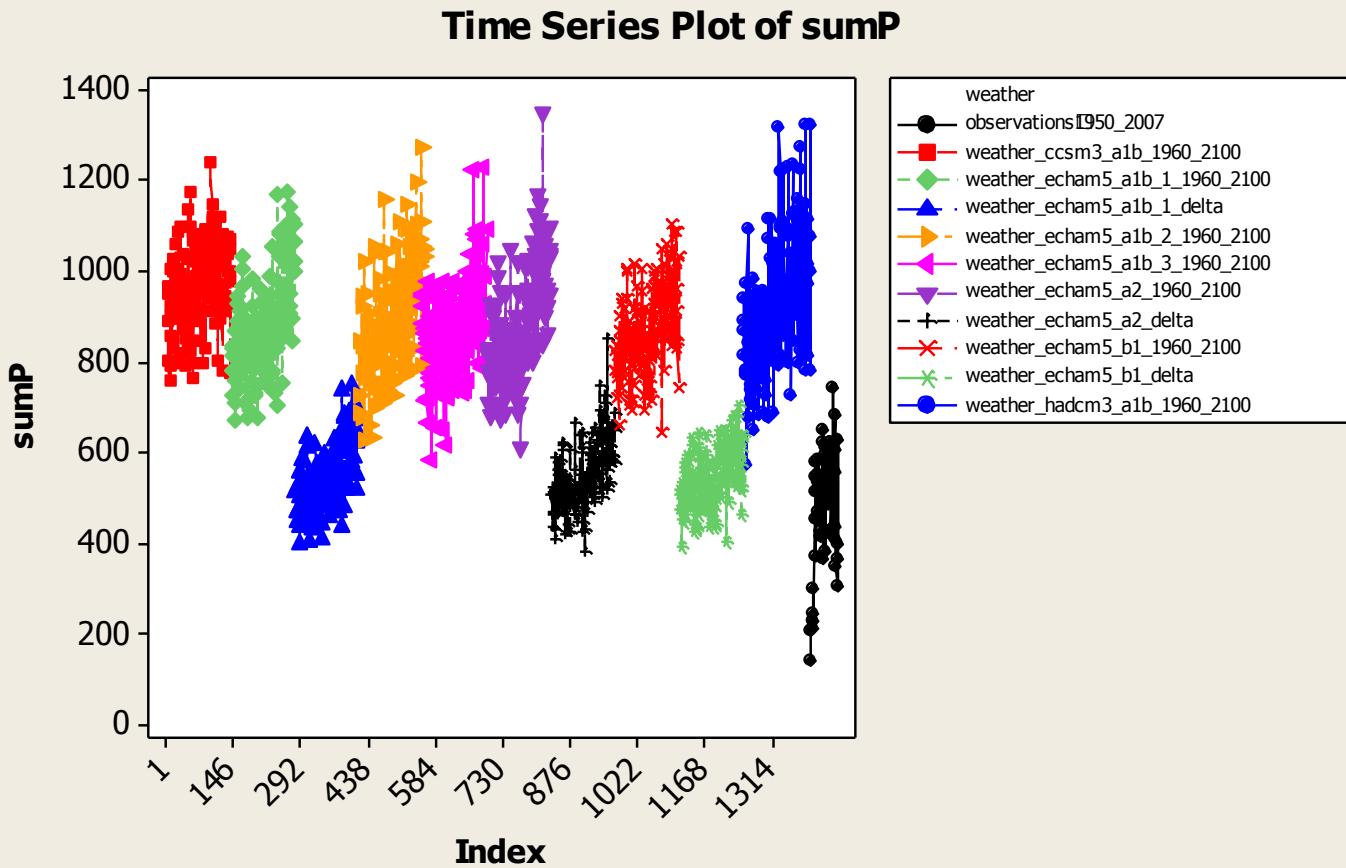
Weathering...

- Used the activation energy to calculate future weathering (Velbel, GEOLOGY, v. 21, p. 1059–1062, December 1993)
 - 77 kJ/mol or 18.4 kcal/mol
 - Corresponds to about 12% increase in weathering per degree celsius
 - Alk (AT) and DIC (CT) increase by a factor 2 for each mol mineral
 - $\text{CaCO}_3(\text{calcite}) + \text{H}_2\text{CO}_3 \rightarrow \text{Ca}^{2+} + 2\text{HCO}_3^-$
 - $2\text{NaAlSi}_3\text{O}_8(\text{Albite}) + 2\text{CO}_2 + 11\text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4(\text{Kaolinite}) + 2\text{HCO}_3^- + 2\text{Na}^+ + 4\text{H}_4\text{SiO}_4(\text{silicic acid})$
- DOC decreases DIC and Alkalinity by, in mmol
 - $\text{DOC} * 100 (\text{uekv charge}/\text{mmol})/1000$

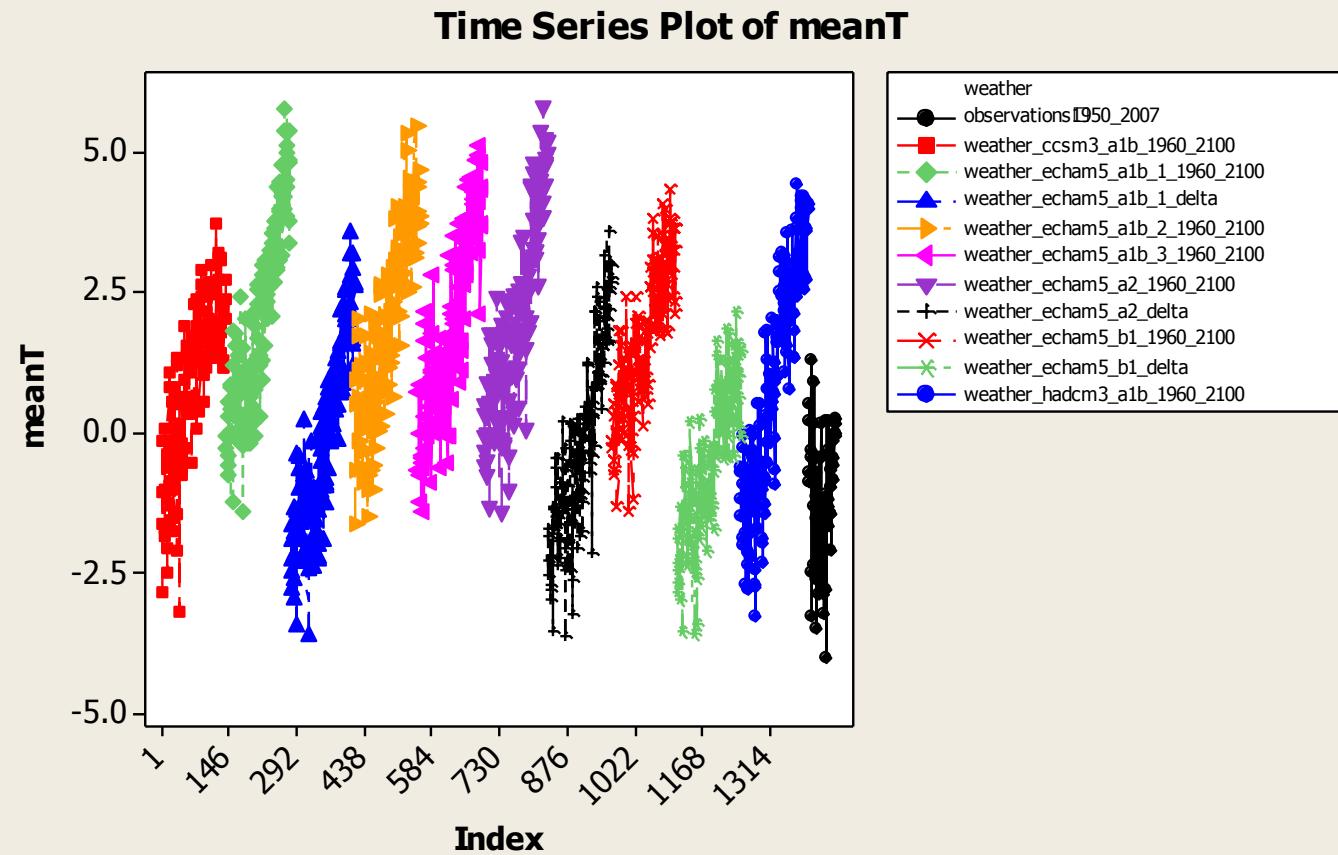
DOC

- We have used the data from Lund and
 - Assumed constant retention of DOC
 - Calculated difference in DOC release from the mean value 1996–2000 (calibration years)
 - This gives a factor
 - Factor is used to increase/decrease the DOC concentration from land classes

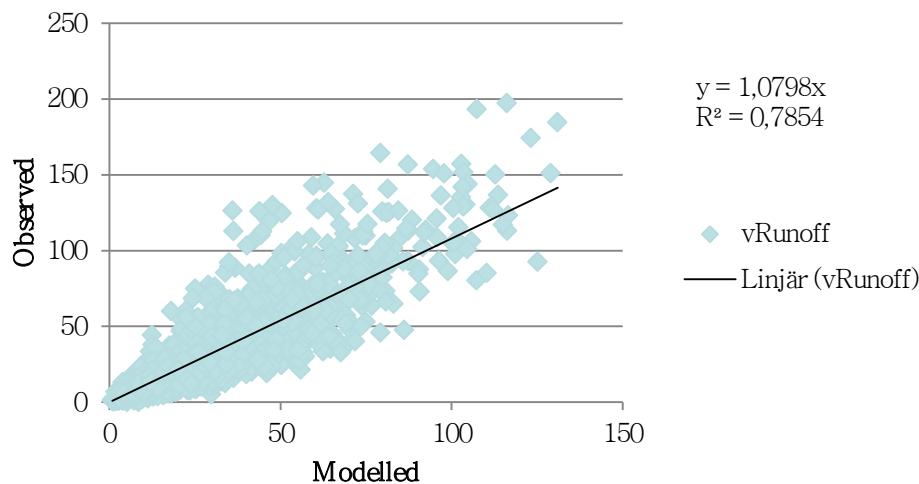
Kalix river Yearly precipitation



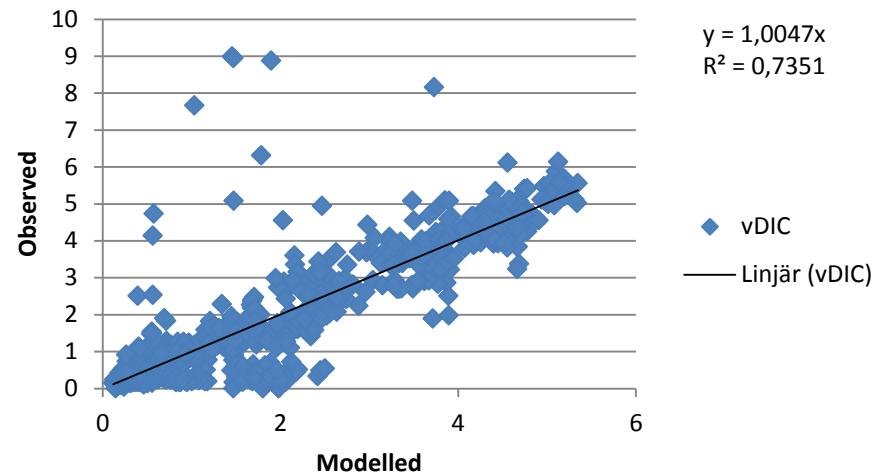
Kalix river
Weather
Mean yearly air
temperature



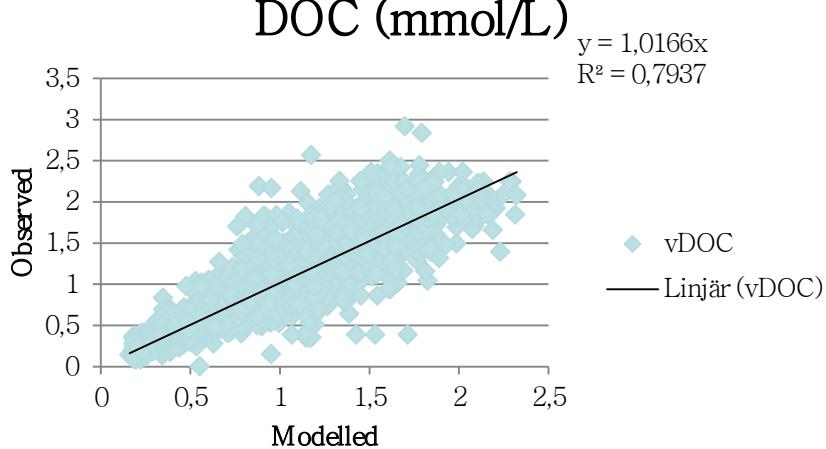
Runoff (mm per month)



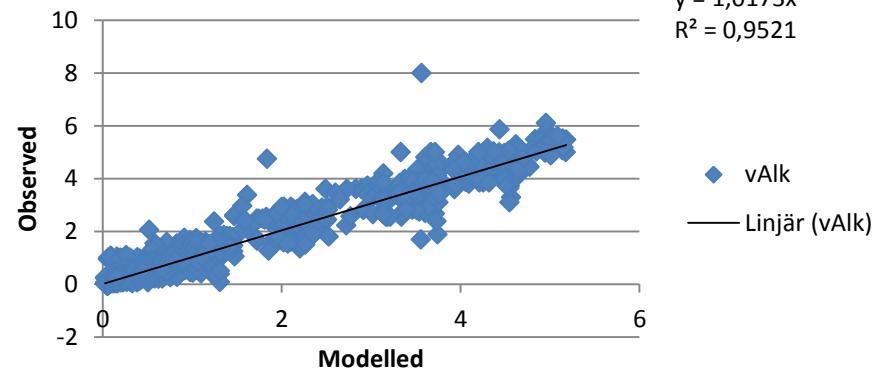
DIC (CT, mmol/L)



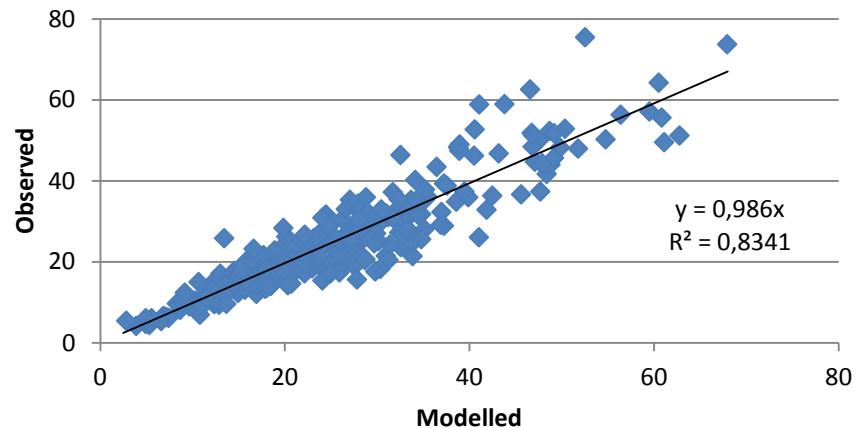
DOC (mmol/L)



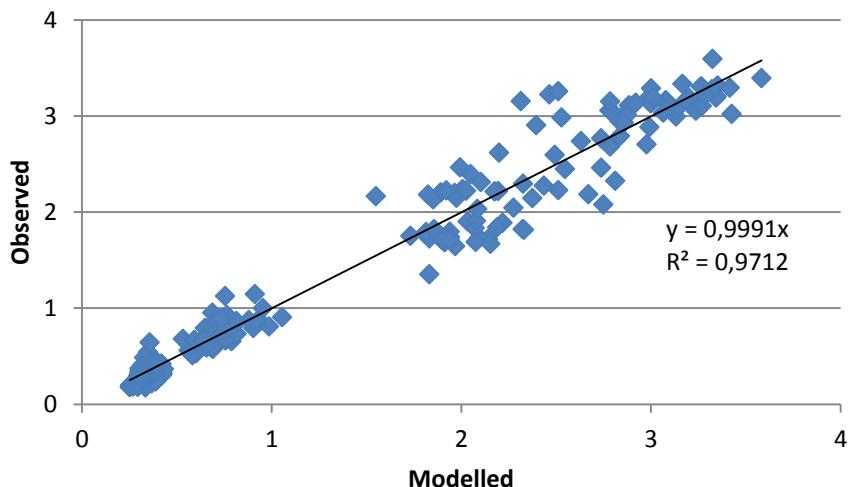
Alk (AT, mmol/L)



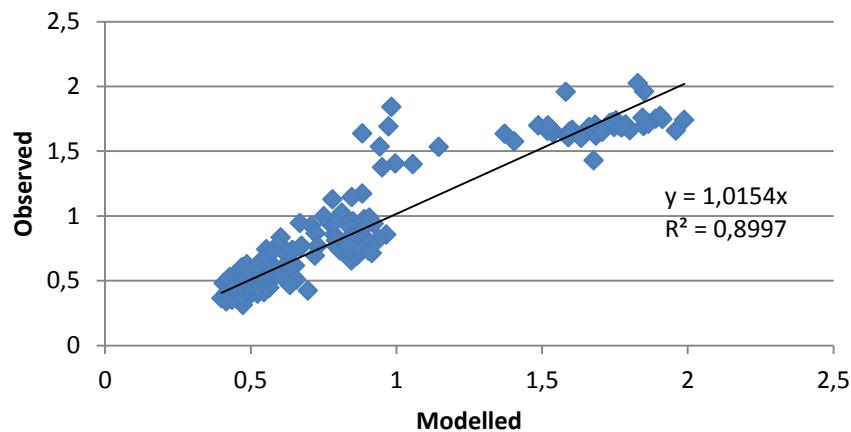
Runoff (mm)



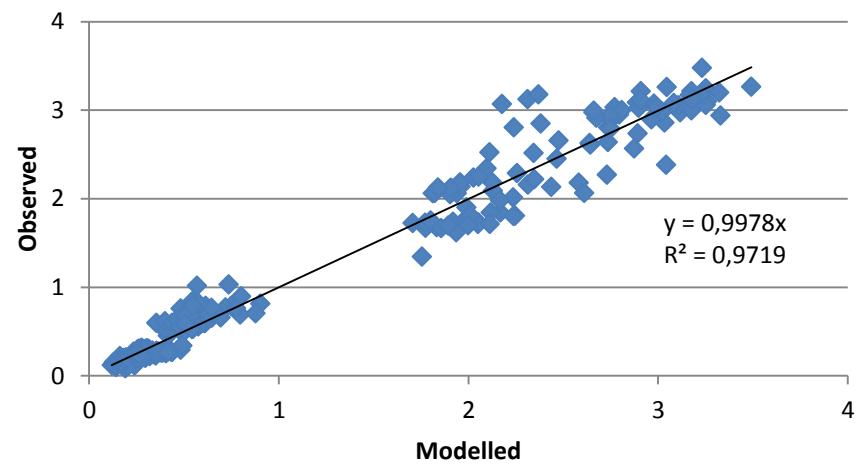
DIC (CT, mmol/L)



DOC (mmol/L)

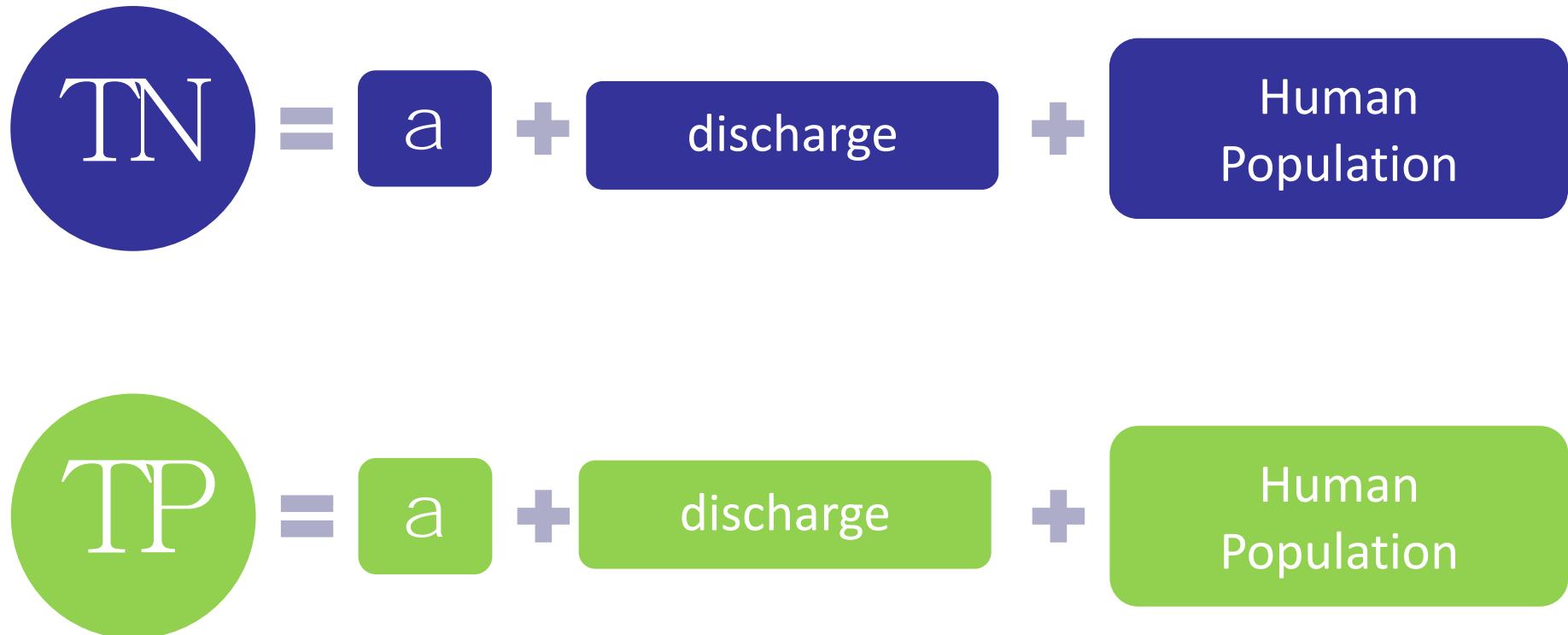


Alk (AT, mmol/L)

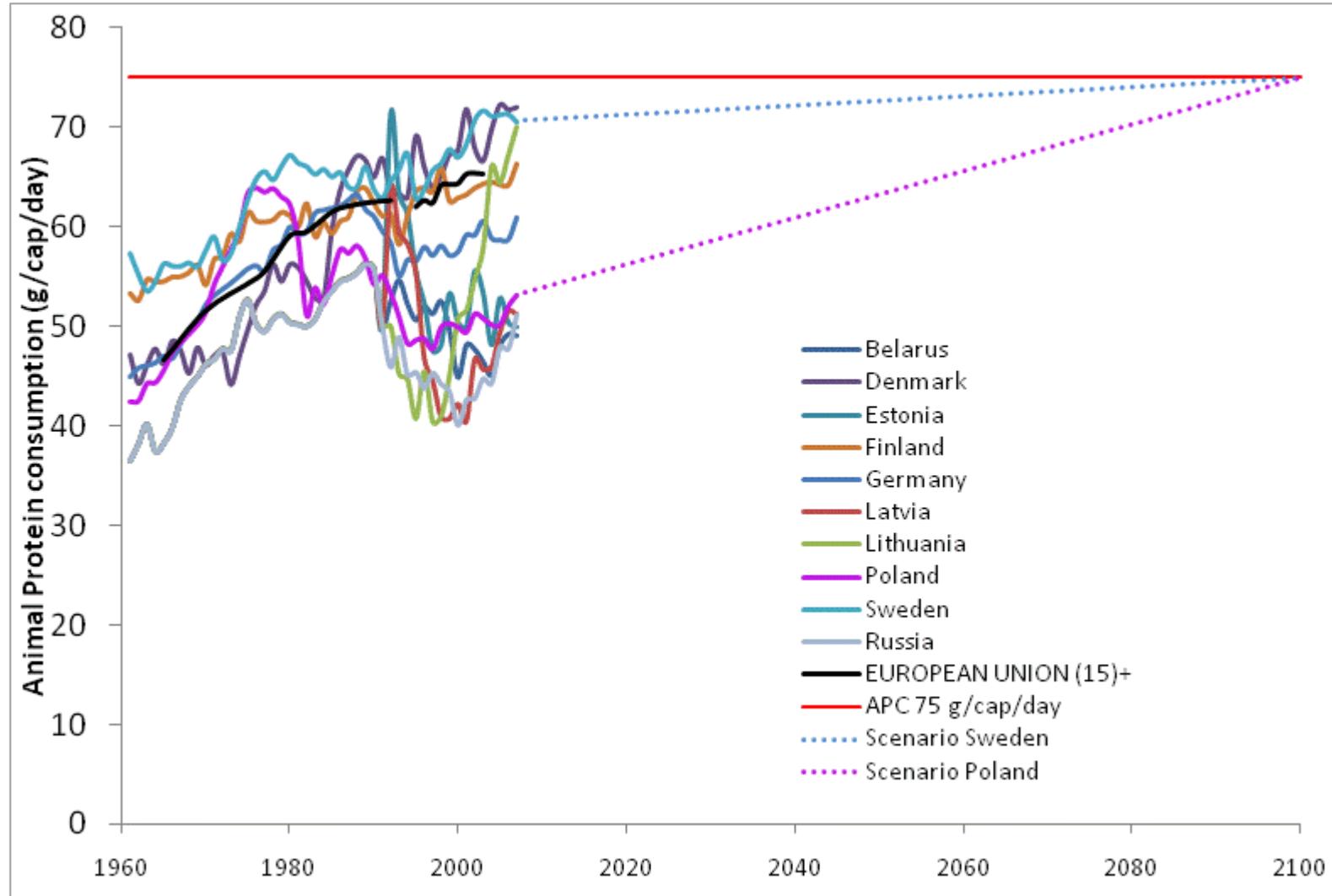


Scenarios, NP Life style Change & Climate change

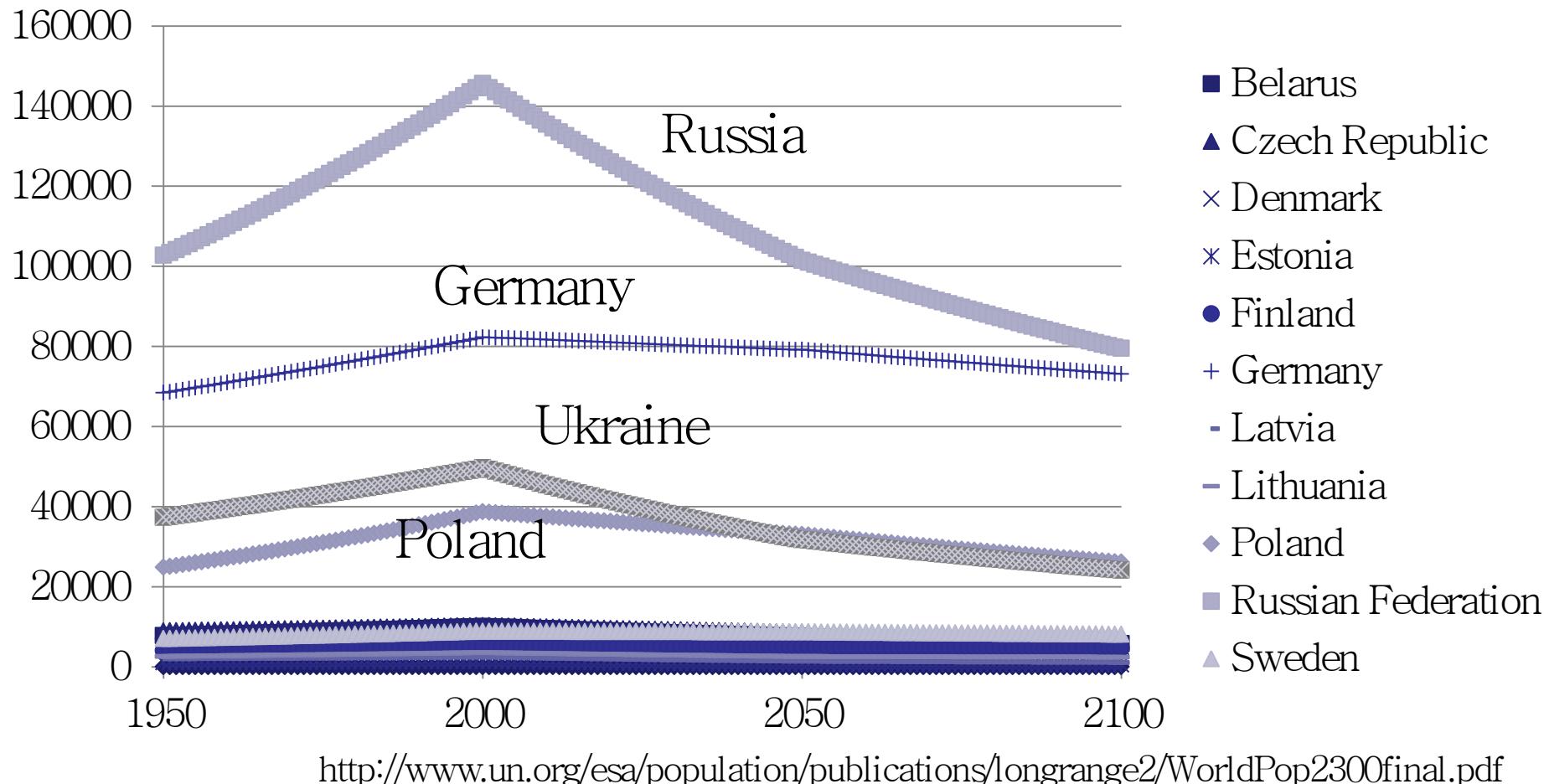
Nitrogen & Phosphorus runoff



Life Style Change - Animal Protein scenario

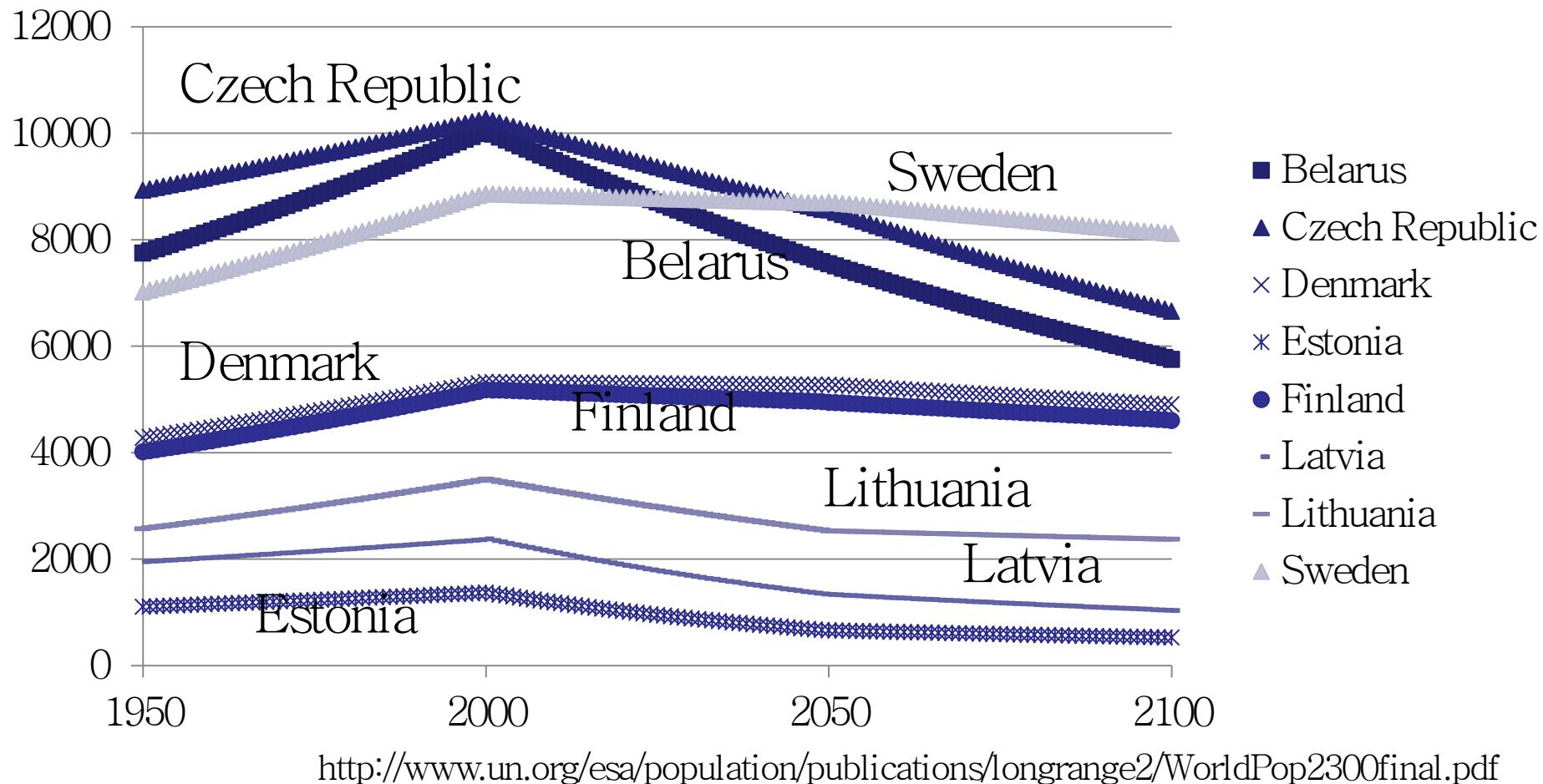


UN Population change scenarios



<http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf>

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”Best practice”

Scenario 12 and 15 - the percentual change rates

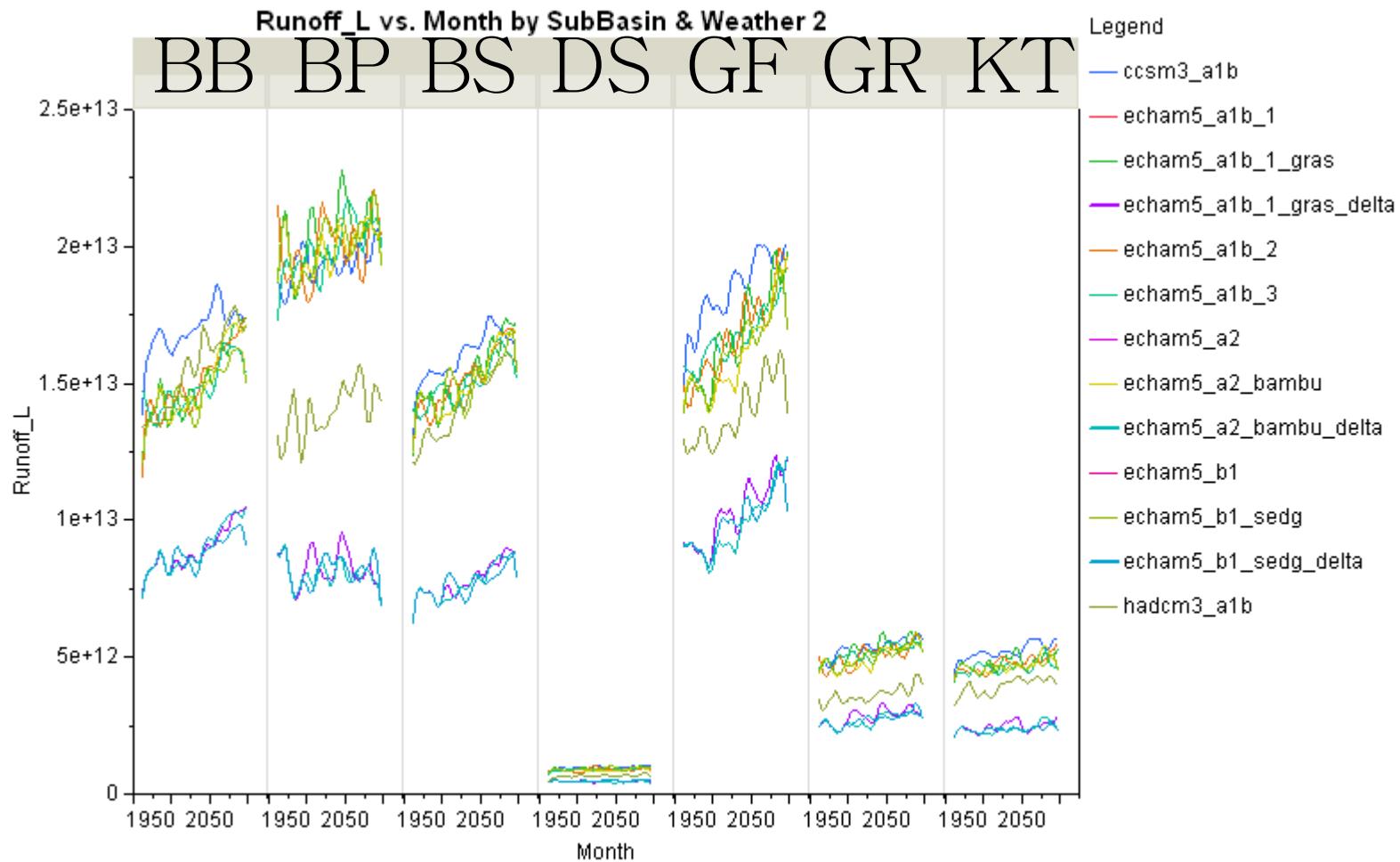
	Reduction on 100 years (%)		annual change (%)	
	N	P	N	P
BB	5	5	0,05	0,05
BS	5	5	0,05	0,05
BP*	26	33	0,3	0,4
GF, GR, DS, KT	9	9	0,1	0,1

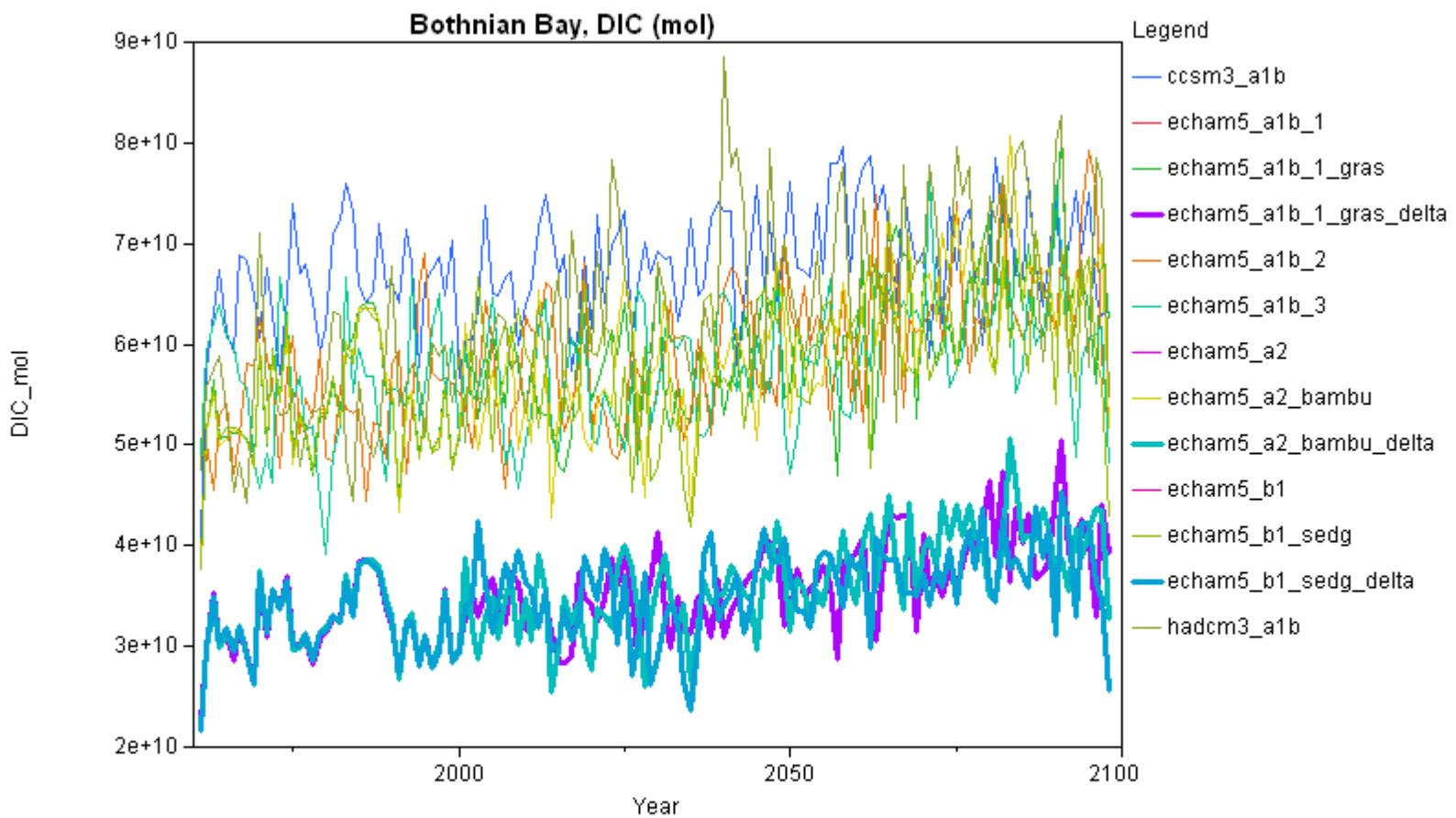
*Based on Voss et al, 2011 (in press), Eustarine, Coastal and Shelf Science. History and scenarios of future development of Baltic Sea eutrophication

Scenarios, NP

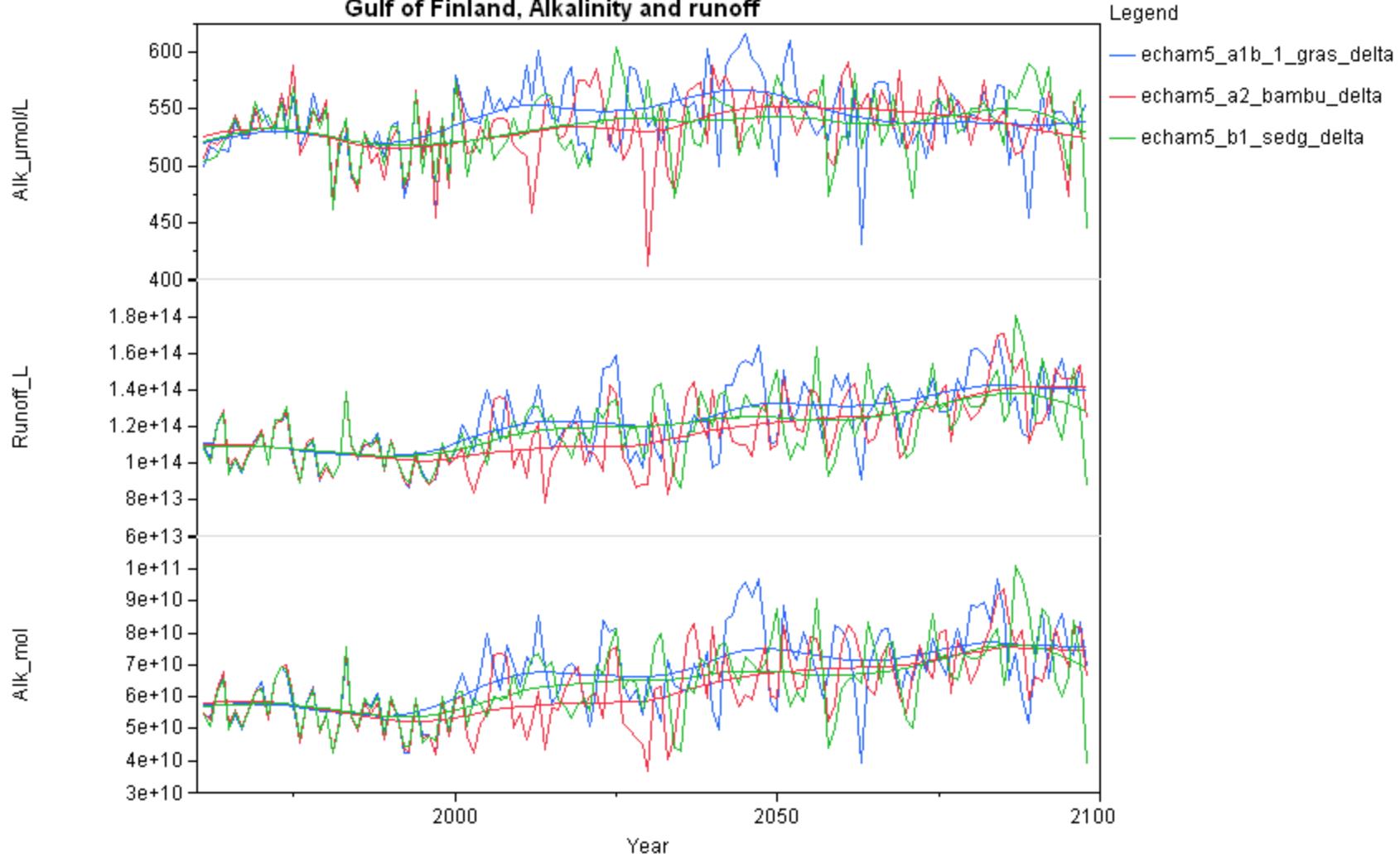
- "Worst Case" (Scenario 10 and 13):
 - Echam A2, Steady state population, APC increase
- "Mean scenario" (11 and 14)
 - Echam A1B, Changing population, APC increase
- "Best case" (12 and 15)
 - Echam B1, Changing population, no APC change, Best practice

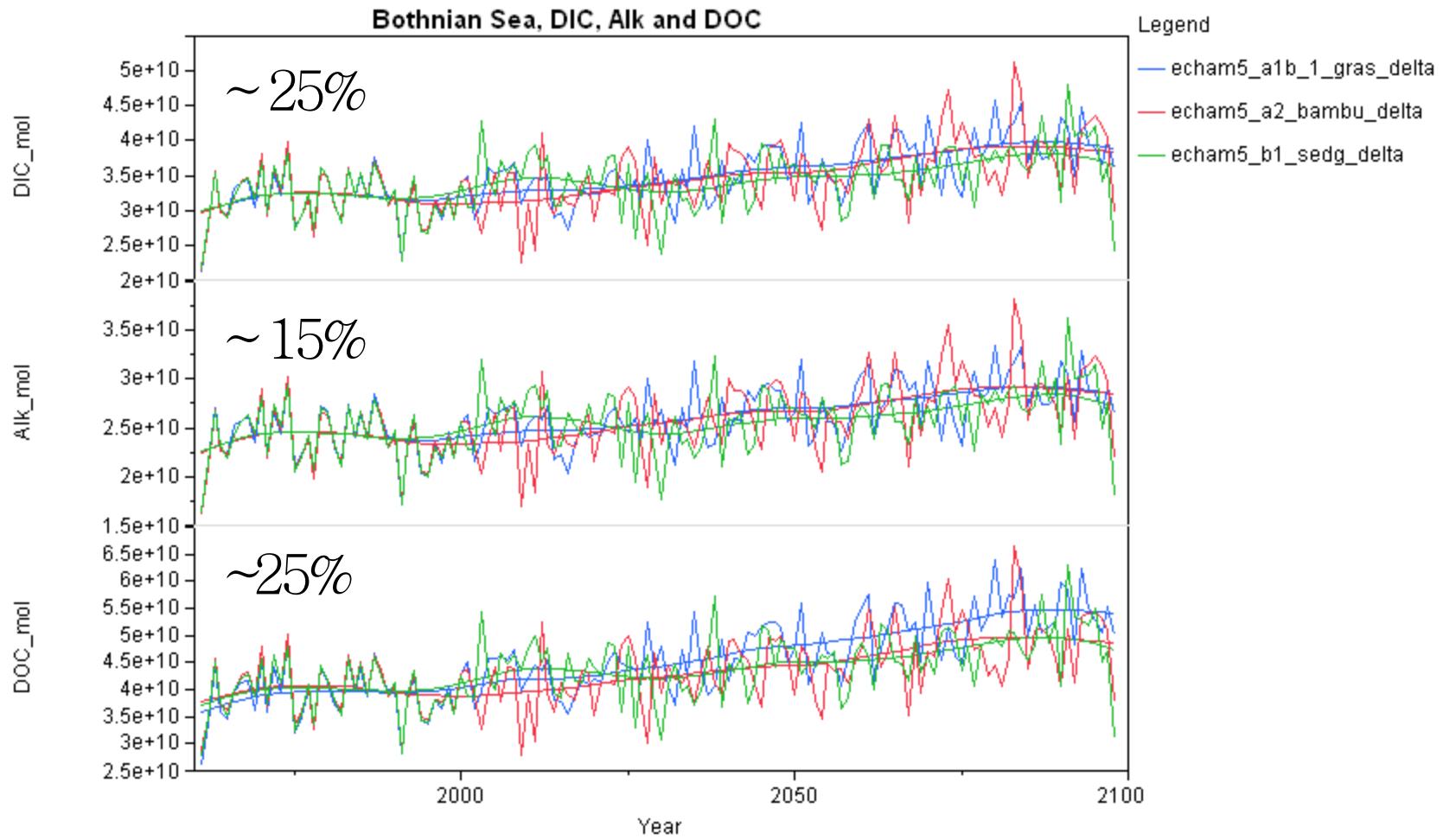
Modelling results

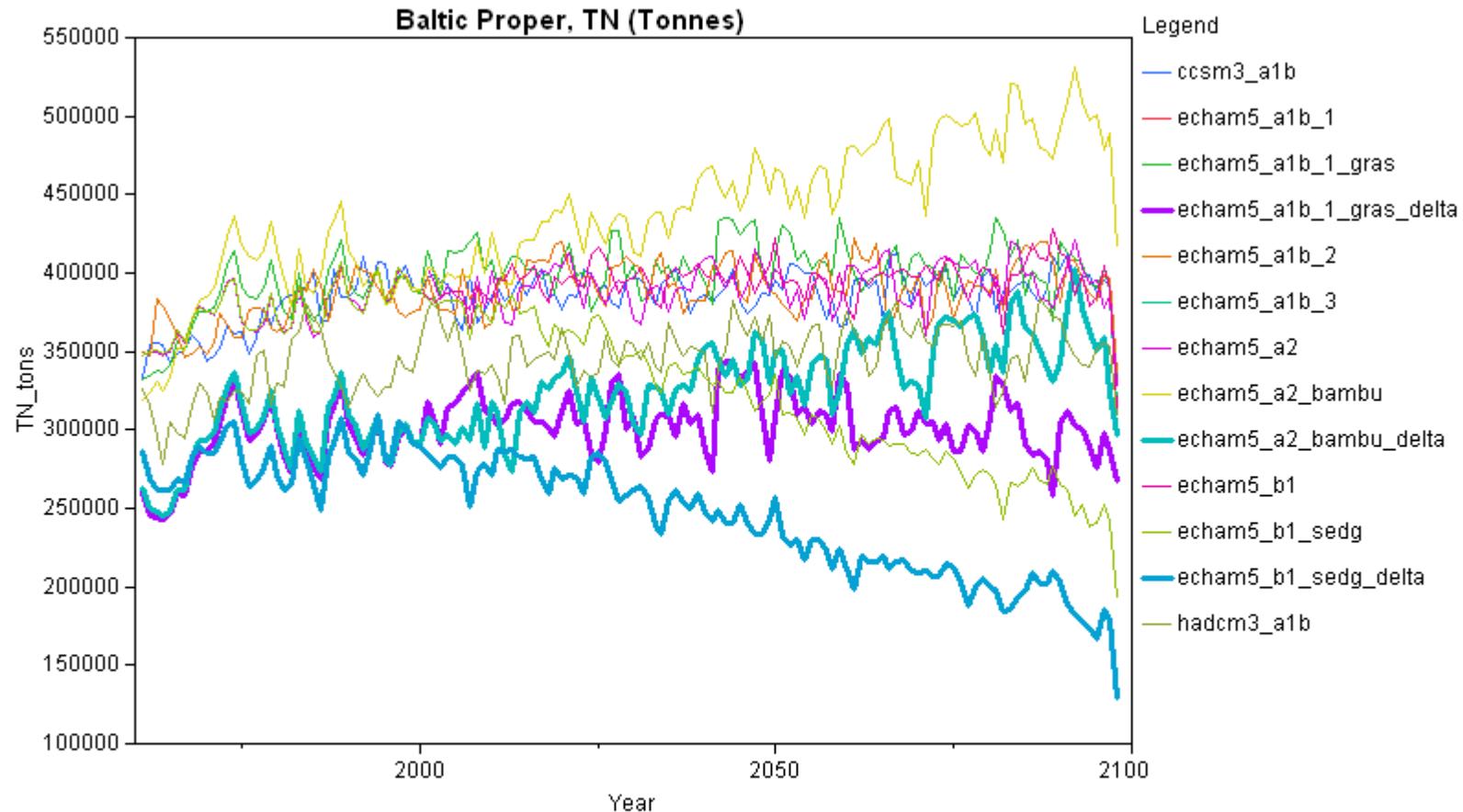




Gulf of Finland, Alkalinity and runoff







Results, summary

- Concentrations of DIC, Alk and DOC generally relatively constant
 - Changes up to 10%
- Flux changes mainly driven by runoff.
- Only scenarios with delta change give reliable results.