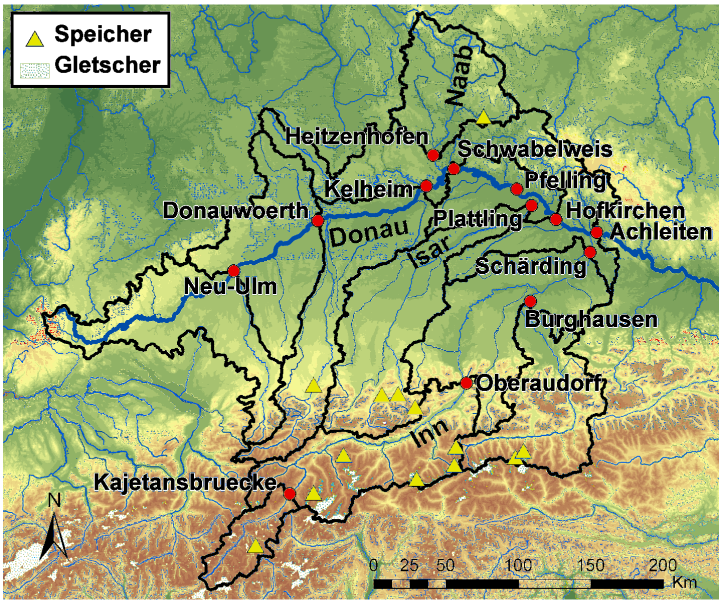
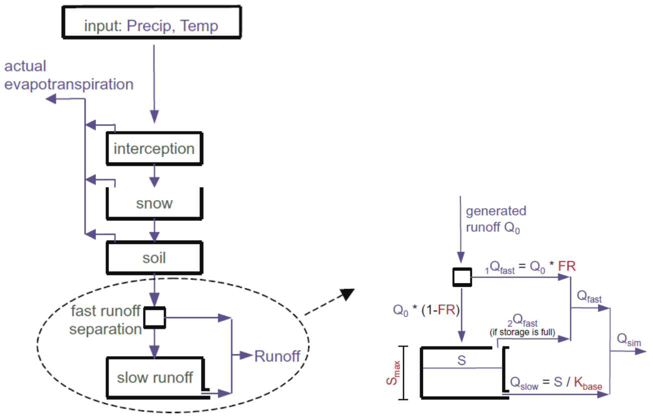
Model: COSERO

Author fact-sheet: Maria Carambia based on B. Klein's documentations

1. General Information	
Model name	COSERO (Continuous semi-distributed runoff model)
Version	Kling et al. (2011)
Author(s) / First publication	Nachtnebel et al. (1993), Kling et al. (2005), Kling (2006)
Contact person (name, email)	Em.O.Univ.Prof. Dipl.-Ing. Dr. Hans-Peter Nachtnebel Harald Kling (Pöyry Energy GmbH, Wien), harald.kling@poyry.com
Institute	Institut für Wasserwirtschaft, Hydrologie und Konstruktiven Wasserbau, Universität für Bodenkultur Vienna
Web site	http://www.wau.boku.ac.at/iwhw.html
General modelling objectives	Calculation and forecasting of flows in rivers, water balance simulation
Domain of applicability	Largely applied in Austria, applied for water balance simulations on the Upper Danube up to the gauge Vienna KLIWAS application domain: 
KLIWAS contact (authority, name, email)	BfG, Imke Lingemann, lingemann@bafg.de
Model adaption in KLIWAS	none
Model coupling in KLIWAS	Input data from model chain "emission scenario - global climate model - regional climate model" Output data not yet used for other models
2. Model description	
Model type	Conceptual model
Temporal discretization	Continuous
Temporal resolution	1d or 1 month
Spatial discretization	Semi-distributed
Spatial resolution	variable

Dimension	-
Short description of model structure detailing main function	Here only the model components of the COSERO model running on a monthly timestep are described. The main components of the model are routines for interception, snow accumulation and melt, a soil moisture accounting procedure, routines for runoff generation. Spatial units of the model are sub basins representing real river catchments. Sub basins of considerable elevation range can also be divided into zones of different elevation. Interception The rainfall is divided into intercepting rainfall (50% of the total rainfall) and throughfall (50% of the total rainfall). The interception water is stored in a bucket with no outlet. The storage is limited to INTMAX. The bucket is emptied by actual interception evaporation. By running the model in a monthly timestep the interception storage may be filled and emptied several times within the timestep. Hence the rainfall is temporarily disaggregated in a number of rain events to take this effect into account. Snow Routine: Precipitation is divided into rainfall (PRAIN) and snowfall (PSNOW) by using air temperature. Above an upper threshold temperature all precipitation is assumed to be rain, below a lower threshold temperature all precipitation is assumed to be snow. In between these two thresholds linear interpolation is used to calculate the fractions. By running the model in a monthly time step an accumulation and melt of snow within the same time step is enabled. Snow melt is simulated with temperature-index approach and additionally by accounting for rain on snow. Temperature variability within the time step (1 month) is taken into account by a disaggregation of mean monthly temperature in temperature classes. The actual evapotranspiration from the snow layer (i.e. snow sublimation) is calculated in the module. Soil Routine: The soil storage is the main storage for extraction of water for actual evapotranspiration. Evapotranspiration is computed as a function of the soil moisture and potential evapotranspiration. Runoff generation is computed as a function of soil moisture with an exponential approach. Runoff Generation Routine: A fraction, which is specified by a parameter, separates a fast runoff component from the generated runoff. The remaining fraction is added to the slow runoff module, which simulates base flow by a means of a linear reservoir with a limited storage. Glacier Module: Glacier melt is modelled via a negative mass balance

	approach. Reservoir Module: Seasonal operation of reservoirs could be considered via seasonal varying storage-outflow functions.
Scheme of model structure	The scheme shows the main model components.  Source: (Kling and Nachtnebel 2009)
Procedure of model parameter estimation	- Calibration for each HRU possible -Automatic calibration routine (Shuffled Complex Evolution automatic search algorithm)
3. Model inputs / Model outputs	
List and characteristics of input variables	Usually mean monthly values of temperature, precipitation and potential evapotranspiration are used as input data for each hydrological response unit.
List and characteristics of output variables	Numerous possible output variables (cf. Kling et al. (2005), Kling (2006) e.g. total computed outflow, actual evaporation Output is available for each simulation time step and for subbasins
4. Examples of model applications	
Catchments, objectives etc.	Seasonal water balance in Hydrological Atlas of Austria (Kling et al. 2007) Raum-zeitliche Wasserbilanz Donau (Kling et al. 2005)
Results of existing comparisons with other models	Schröter, K., Gocht, M., Kahl, B., Rubin, C., Ostrowski, M. (2008): Zuverlässigkeit von Flash-Flood Vorhersagen unter der Berücksichtigung von Unsicherheiten, In: Beiträge zum Tag der Hydrologie 2008 am 27./28. März 2008 an der Leibniz Universität Hannover, Forum für Hydrologie und Wasserbewirtschaftung, Heft 23.08 „Hochwasser, Wassermangel, Gewässerverschmutzung – Problemlösung mit modernen hydrologischen Methoden“
Application in the framework of KLIWAS	Ensemble simulations targeting on the assessment of climate change impacts on the discharges in the Danube River Basin. Evaluation with respect to mean and low flow indicators
5. List of 5 selected references	
Kling H., Fürst J., Nachtnebel H. P. 2005. Spatio-temporal water balance Danube – A	

methodology fort he spatially distributed, seasonal water balance of the Danube basin. Final report, Austrian Academy of Sciences, HÖ 27/2003

Kling H., Nachtnebel H. P., Fürst J. 2005. Mean annual areal precipitation using water balance data. In Hydrological Atlas of Austria, BMLFUW (ed.), 2nd edition, map sheet 2.3, Vienna, ISBN 3-85437-250-7

Kling H. 2006. Spatio-temporal modelling of the water balance of Austria. Dissertation, University of Natural Resources and Applied Life Sciences, Vienna, Austria

Kling H., Nachtnebel H. P. 2009. A method for the regional estimation of runoff separation parameters for hydrological modelling. Journal of Hydrology 364: 1673-174

Kling H., Fuchs, M., Paulin, M. 2012. Runoff conditions in the upper Danube basin under an ensemble of climate change scenarios. Journal of Hydrology 424-425: 264-277

Nachtnebel H. P., Baumung S., Lettl W. 1993. Abflussprognosemodell für das Einzugsgebiet der Enns und Steyr (in German). Report, Institute of Water Management, Hydrology and Hydraulic Engineering, University of Natural Resources and Applied Life Sciences Vienna, Austria