WaSiM – History and Recent developments

Munich, 02/20/2014

Overview

- WaSiM-Basics
- WaSiM-Genaology
- Actual range of Applications
- Future Developments

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WaSiM-Basics

WaSiM = **Wa**ter Balance **Si**mulation **M**odel

Key Features

- Physically based
- Distributed, using a regular grid
- Modular concept
- Portable (Windows, Linux, Mac, HPC)

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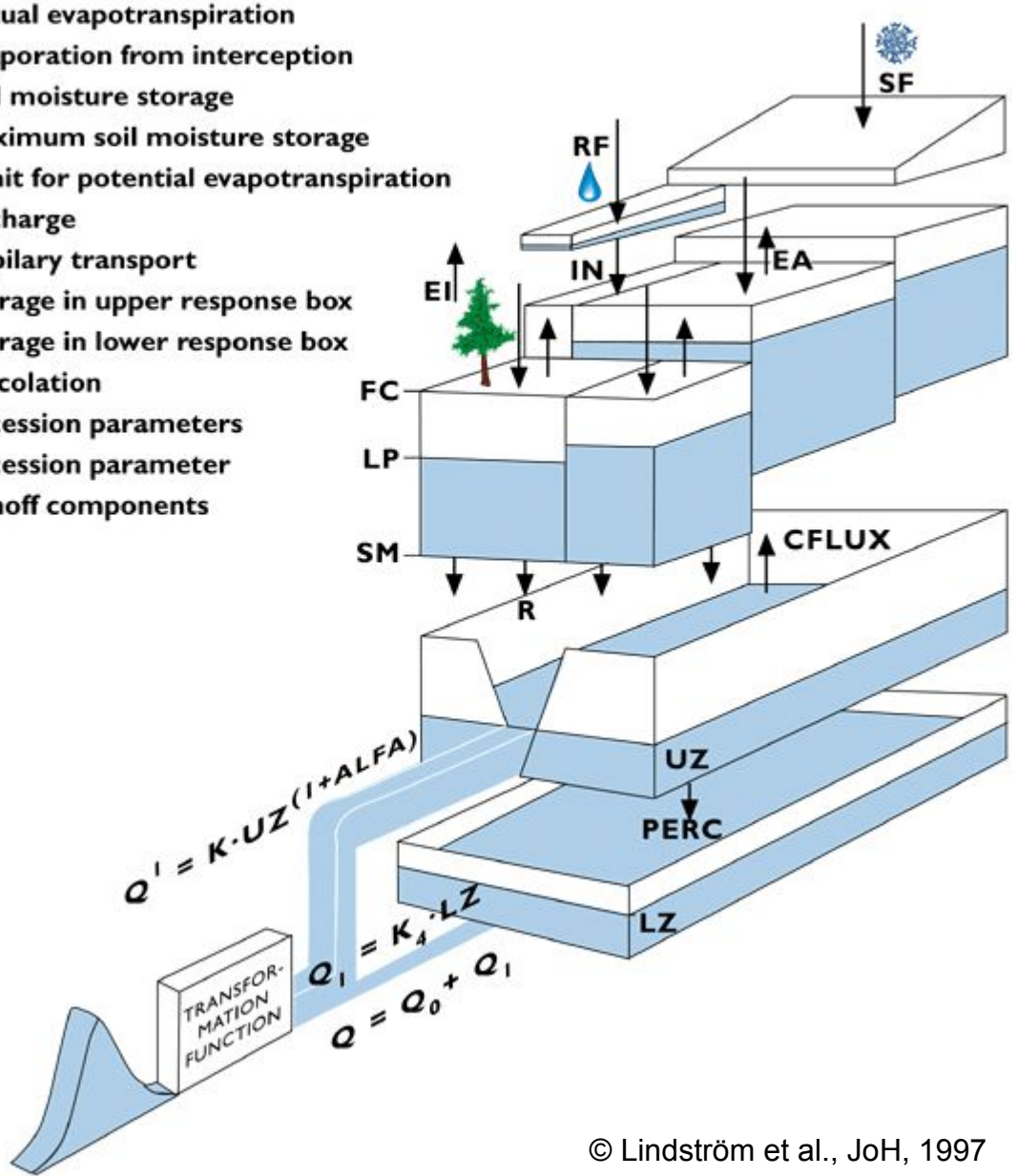
Conceptual model: HBV-96

SF = Snow
RF = Rain
IN = Infiltration
EA = Actual evapotranspiration
EI = Evaporation from interception
SM = Soil moisture storage
FC = Maximum soil moisture storage
LP = Limit for potential evapotranspiration
R = Recharge
CFLUX = Capilary transport
UZ = Storage in upper response box
LZ = Storage in lower response box
PERC = Percolation
K,K4 = Recession parameters
ALFA = Recession parameter
Q0,Q1 = Runoff components

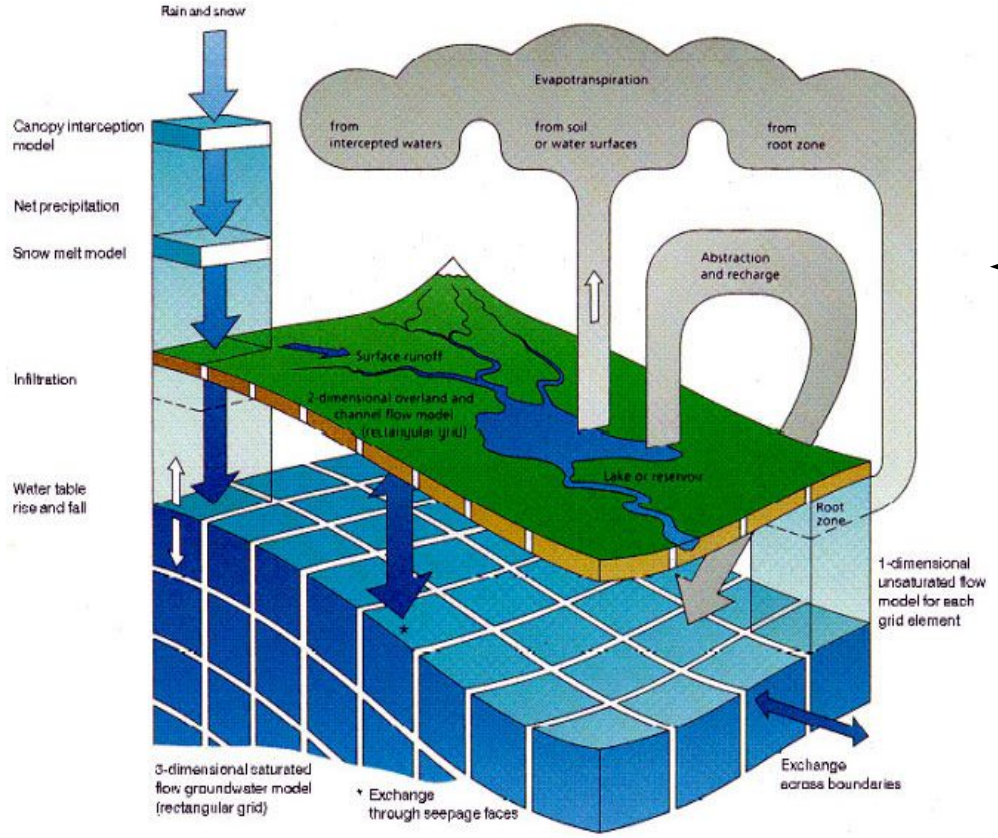


Phys.

Conc.

© Lindström et al., JoH, 1997

Physically based models



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SHE – European Hydrological System — Systeme Hydrologique Europeen

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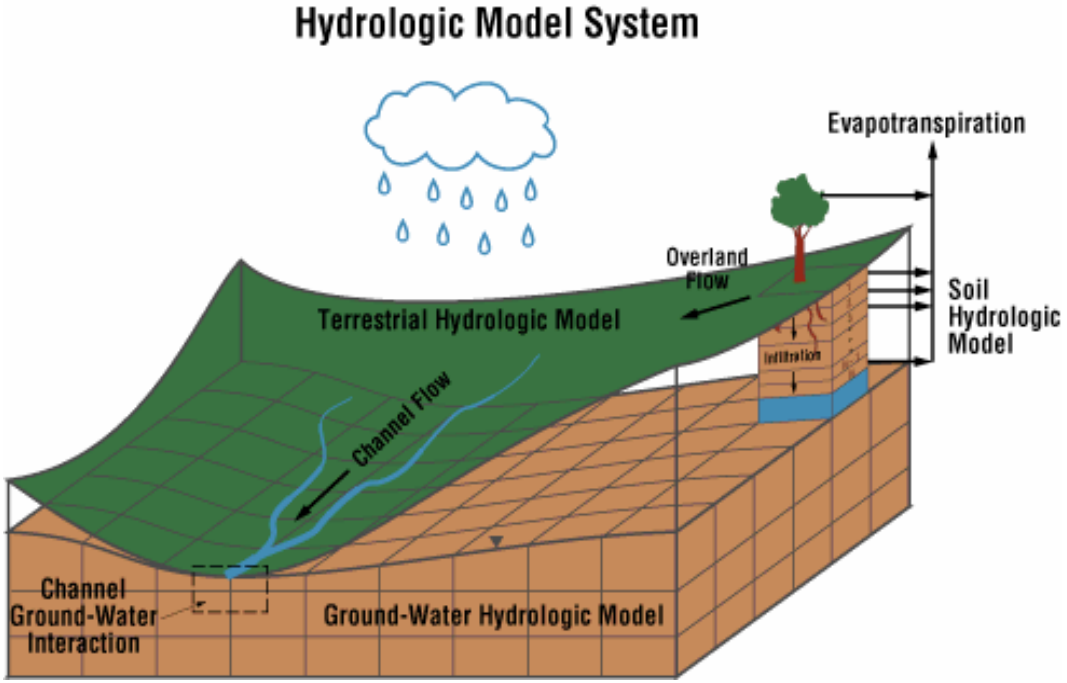

Phys.

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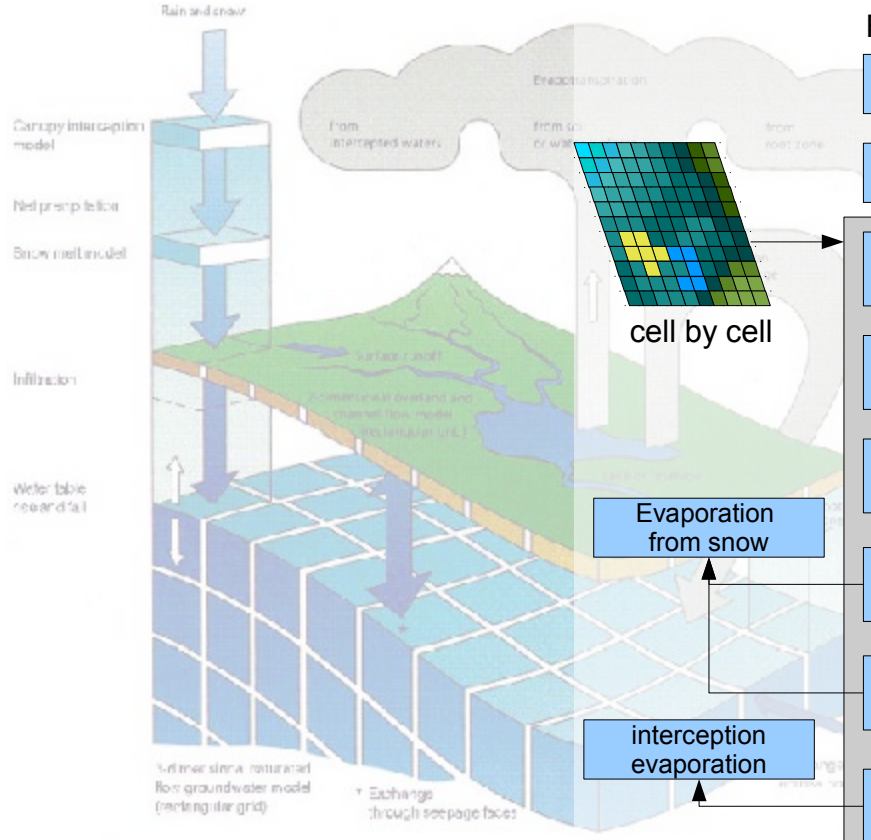
HMS – Hydrologic Model System
Pennsylvania State University

© PSU, 1998

Physically based models



cell by cell

For each time step...

- input (meteorology)
- precipitation correction
- interpolation to grid
- Shading and exposure adjustment for *R* and *T*
- potential evaporation
- snow accumulation and melt
- glacier model (melt and runoff)
- interception
- infiltration/silting-up generation of surface runoff
- unsaturated zone incl. heat transfer
- saturated zone
- discharge routing incl. lakes and reservoirs
- total discharge

Evaporation from snow

interception evaporation

evaporation/ transpiration

surface discharge routing

interflow

baseflow

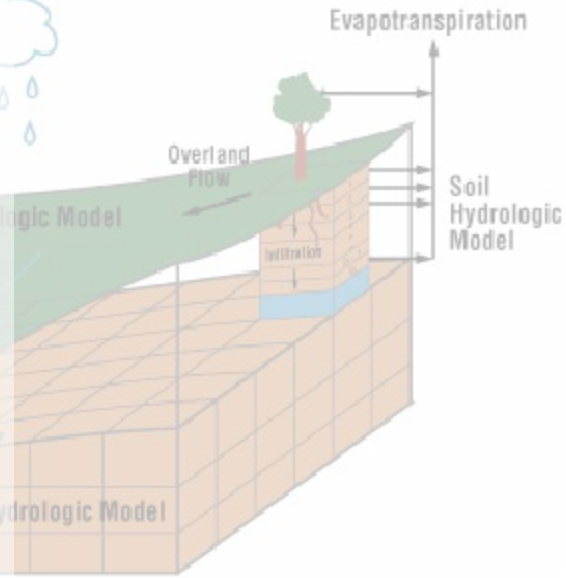
meteo-input:
- temperature
- wind speed
- vapour pressure
- radiation
- precipitation etc.

gridded data:
- DEM
- land use
- subcatchments
- soil types
- river network
- others

configuration:
- control file

Other features:
- Solutes transport modelling
- Temperature modelling (soil only)

WaSiM – Water Balance Simulation Model



Phys.

Conc.

WaSiM-Basics

Distributed and physically based – what does it mean?

- Using a grid with a fix cell size (or variable)
- Resolution: problem adequate elementary area
- Use of effective parameters/algorithms
- Variability comes by superposing many cells

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WaSiM-Basics

What size should the elementary area have?

- Depends on main hydrologic process and scale of the basin
- Lowlands, large basins: ~ 1-2 km
- High mountains: ~ 200...500 m
- Small watersheds: ~ 100 m
- Experimental sites: ~ <1 m … 10 m

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WaSiM-Basics

Modular; problem adequate algorithms, e.g.:

- Topmodel vs. Richards-approach
- Heat transfer
- Tracers, solutes
- Silting up
- Ponding water (dynamically sized lakes)
- Water supply and power generation facilities

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WaSiM-Basics

Portable and independent

- Runs on almost any hardware and operating system → without GUI, only command line
- Compatible input and output formats
- No other software required (except an editor)
- Free to be used for any purpose

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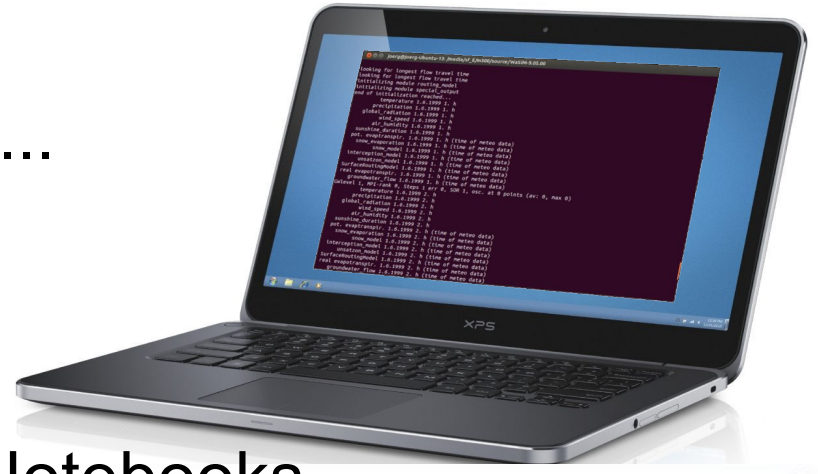
WaSiM runs virtually everywhere...

on Tablets...



...on Notebooks,

Workstations/
PCs, and...

Cray XK6, 1152 cores

… on Supercomputers

SuperMUC, 147456 cores, rank 10 of top 500

WaSiM-Genealogy

Three periods...

- “Ancient” times (1994...1999)
- “Mediaval” times (2000...2005)
- “Modern” times (2005...today)

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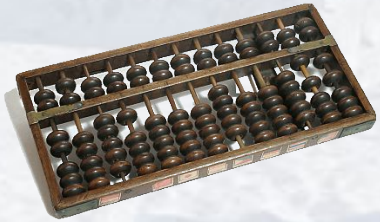
WaSiM-Genealogy

“Ancient” times (1994...1999)

- Basic concepts (most are still valid today)
- 1995-1997: Topmodel version
- 1997-1999: Richards version
  - Tracer,
  - groundwater model



- 16 and 32 bit, Windows and Linux

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WaSiM-Genealogy

“Mediaval” times (1999...2005)

- Only sporadic, minor extensions
  - Snow model
  - Output options
- 32 bit only, Windows and Linux
- Experimental version with GUI

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WaSiM-Genealogy

“Modern” times (2005...)

- Burst of new functionallity
  - Surface routing, silting up
  - Dynamic Glaciers
  - Heat transfer
  - Extended reservoir handling etc.
- 32 and 64 bit, Windows and Linux
- Parallel versions for OpenMP in 2006, MPI in 2014

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Actual Applications

Only some examples...

- Flood forecasting
- Scenario analysis
  - Short term (e.g. flood risk management)
  - Long term (climate change, e.g. recess of glaciers)
- Small scale application for understanding permafrost effects or habitat reactions on changed environments
- Meso and macro scale applications for hydropower, water supply and irrigation optimization
- Other projects for fundamental and applied research

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Future plans

- Snow, glacier and permafrost related issues
  - Snow redistribution (avalanches, wind) (Warscher)
  - Dynamic glacier thickness
  - Heat transfer in snow, groundwater, lakes
  - Ice formation
- Solving the energy balance at the surface
- Support for semi or fully automated calibration
- New, comprehensive graphic tools
- Portable GUI version of WaSiM

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Discussion

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