Hydrologie

Het Hart van Water Resources Management

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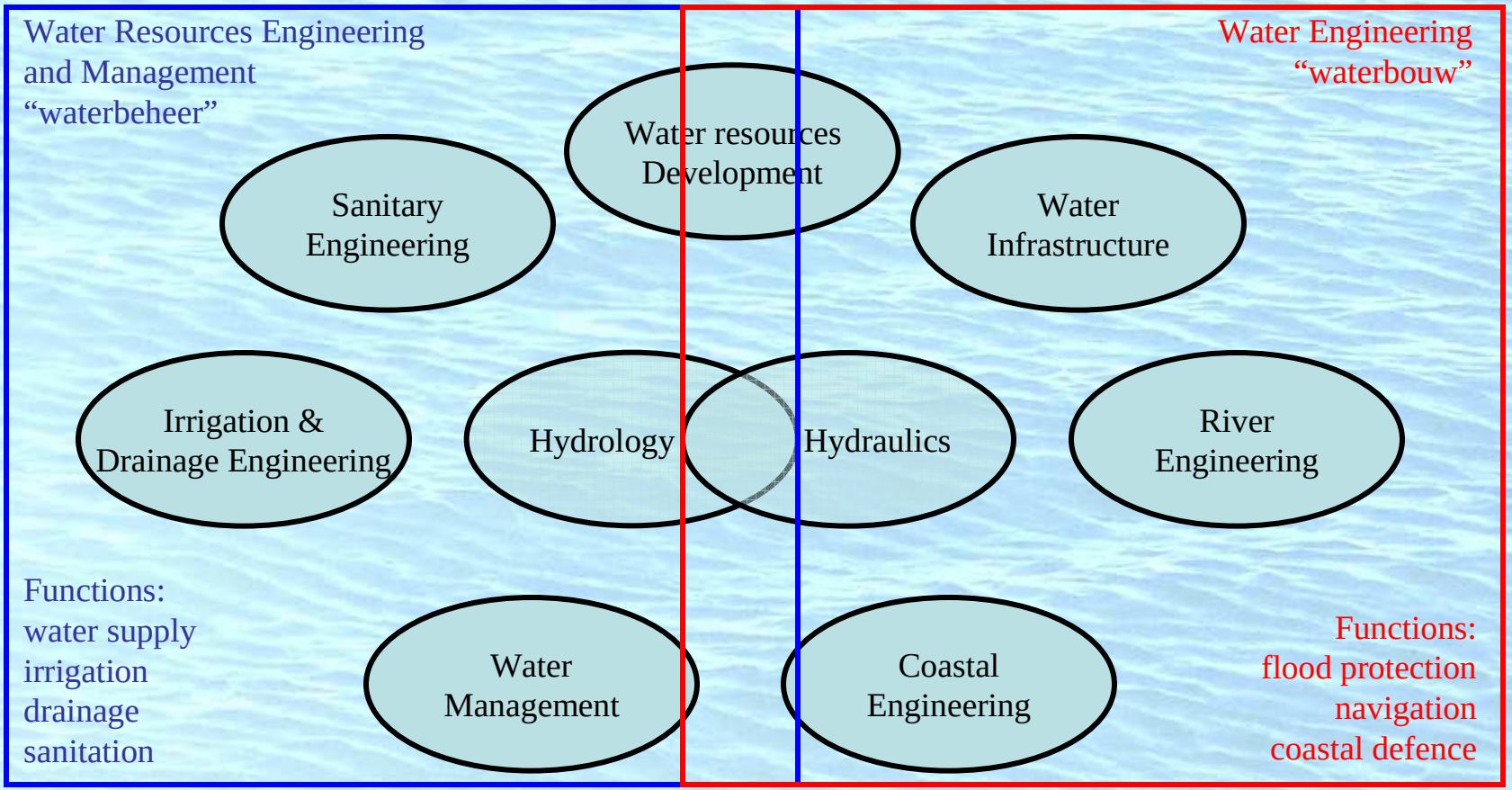
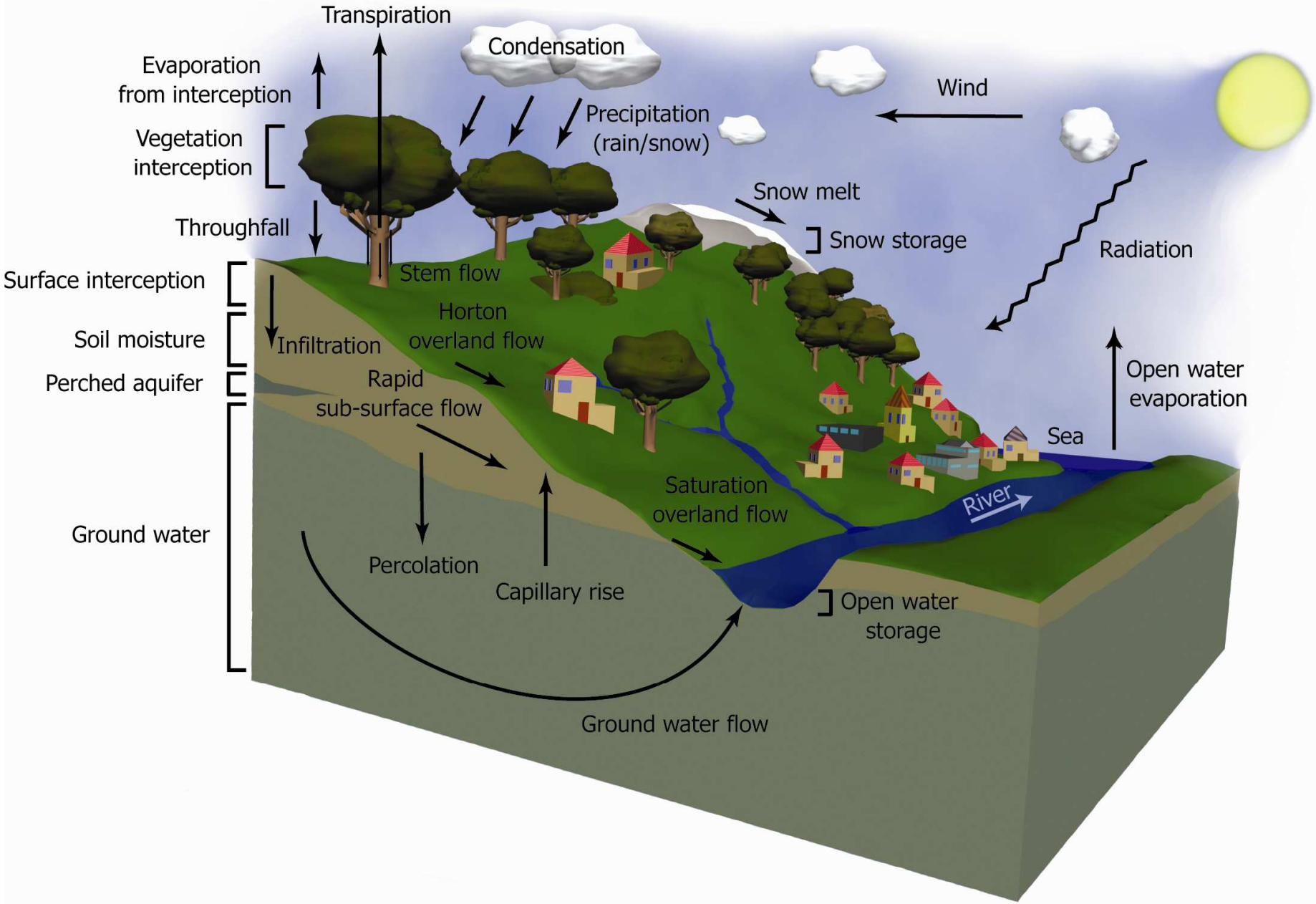
What's in a name?

- Water engineering
- Water resources engineering
- Water management
- Water resources management
- Water resources development
- Hydrology
- Hydrological engineering
- Hydraulic engineering

Water Resources Engineering and Management




Transpiration
Condensation
Evaporation
from interception
Vegetation
interception
Precipitation
(rain/snow)
Wind
Throughfall
Snow melt
Snow storage
Radiation
Surface interception
Stem flow
Soil moisture
Horton
overland flow
Infiltration
Perched aquifer
Rapid
sub-surface flow
Open water
evaporation
Sea
Saturation
overland flow
River
Ground water
Percolation
Capillary rise
Open water
storage
Ground water flow

Hydrological Engineering

- Always in an engineering context
  - for water supply
  - for dimensioning hydraulic structures
  - for drainage & irrigation
  - for water management
  - for river and coastal zone management
  - for water resources development

Hydrological Engineering

- Close links with other sections
  - water resources assessment
  - safe yields
  - rainfall-runoff processes
  - interaction between systems (e.g. watershed-river-coastal; river-polder)
  - design criteria
  - effects of human interferences

Hydrological Engineering

- Focus within an engineering context
  - understanding the processes
  - watershed, river, estuary
  - quantity-quality connection
- Distinction from hydraulics
  - system based (water and matter balances)
  - aggregated scales

Important considerations for Research

- Based on our strengths and track record
  - we have a world reputation in water, both surface and groundwater
- Based on the Dutch main water issues
  - floods (origin, occurrence, frequency)
  - dry feet (land subsidence, rainfall intensity)
  - impacts of human interferences (land-use, climate, environmental quality)

Hydrological Engineering

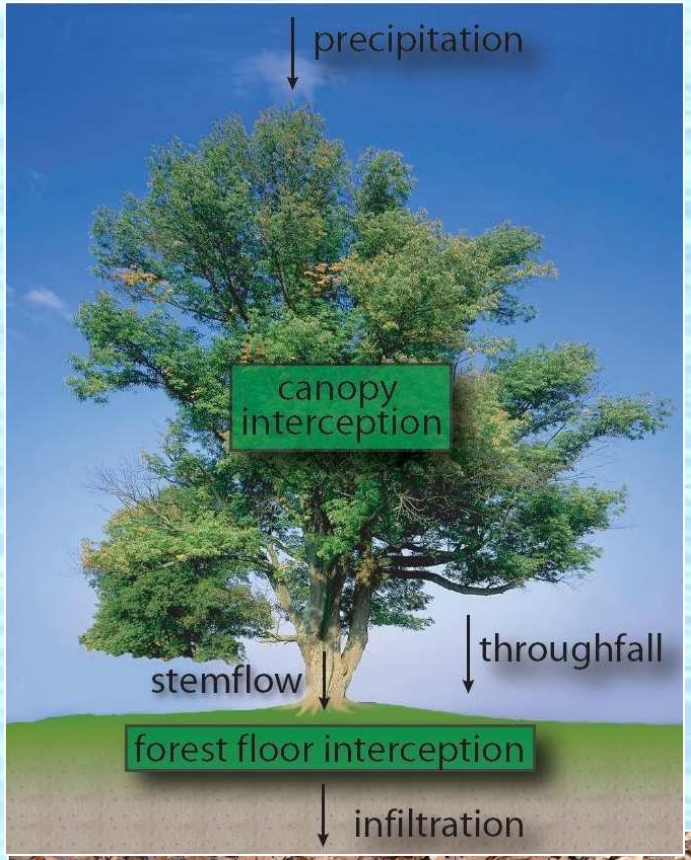
- Research lines surface water
  - Rainfall-Runoff processes (understanding runoff generation, genesis of floods)
  - Hydrology of Deltas (salt intrusion, tides)
- Research lines ground water
  - density driven flow, groundwater exploration
  - time series analysis and modelling

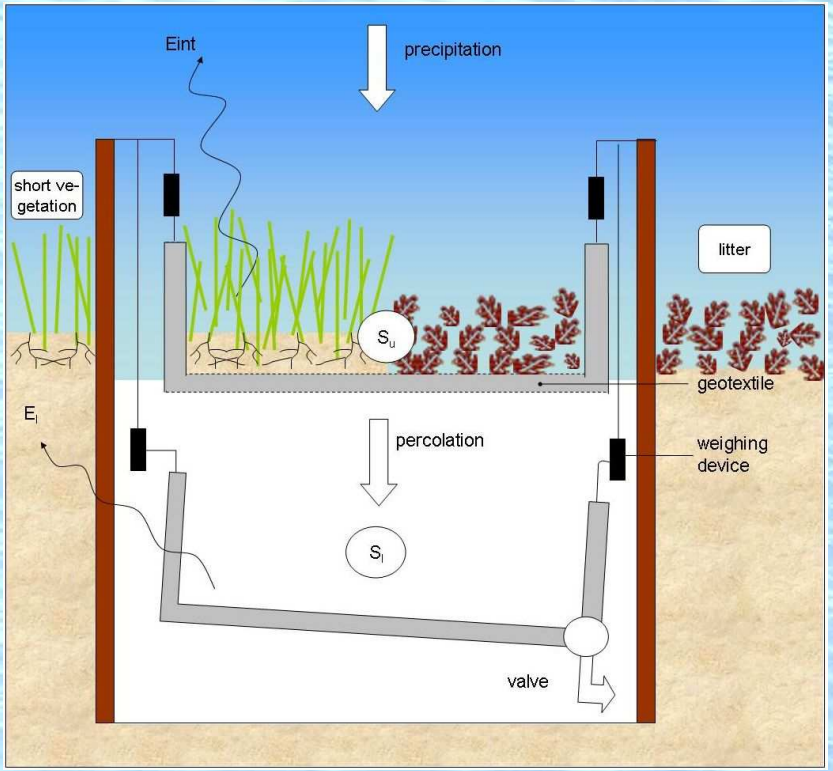
Wat voor dingen doen we ?

- Luxemburg veldonderzoek
  - Interceptiemetingen
  - Temperatuurmetingen
- Nieuwe observatietechnieken
  - GRACE
  - SEBAL
- Modelleren
  - Luxemburg
  - Zambezi

Veldwerk Luxemburg

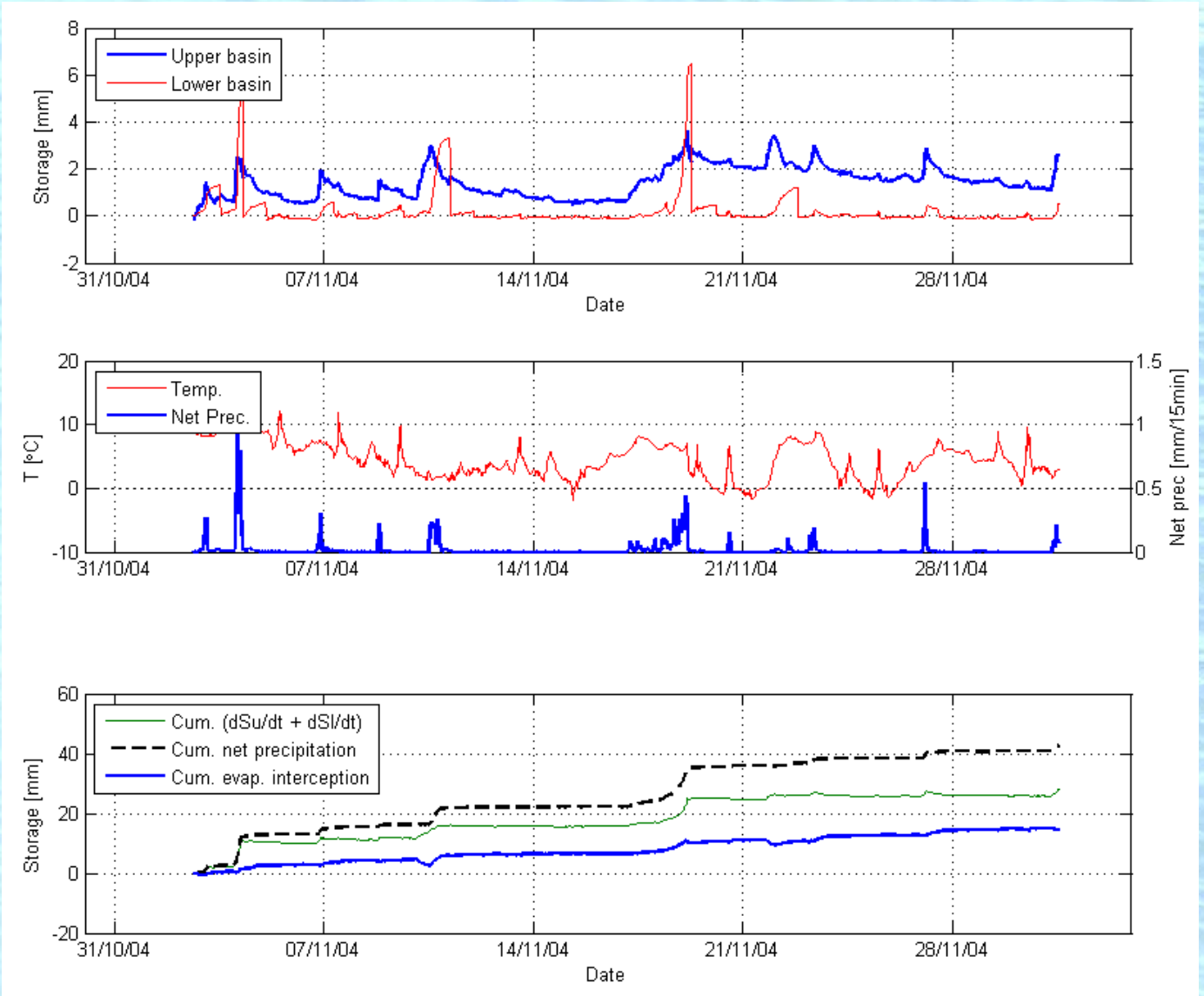
Interceptiemetingen

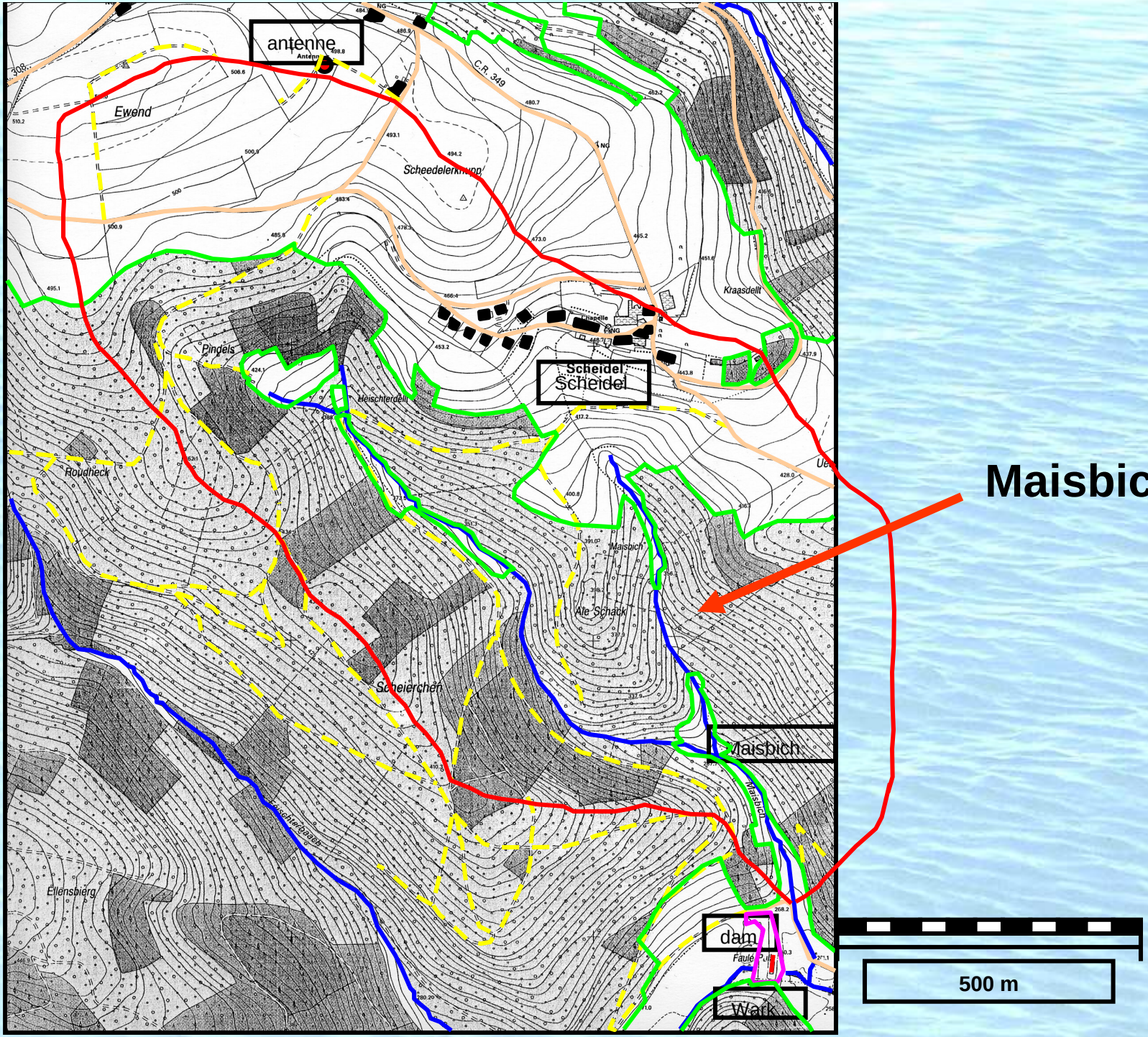




$$E_{\text{int}} = P_{net} - \left(\frac{\mathrm{d}S_{upper}}{\mathrm{d}t} + \frac{\mathrm{d}S_{lower}}{\mathrm{d}t} \right)$$

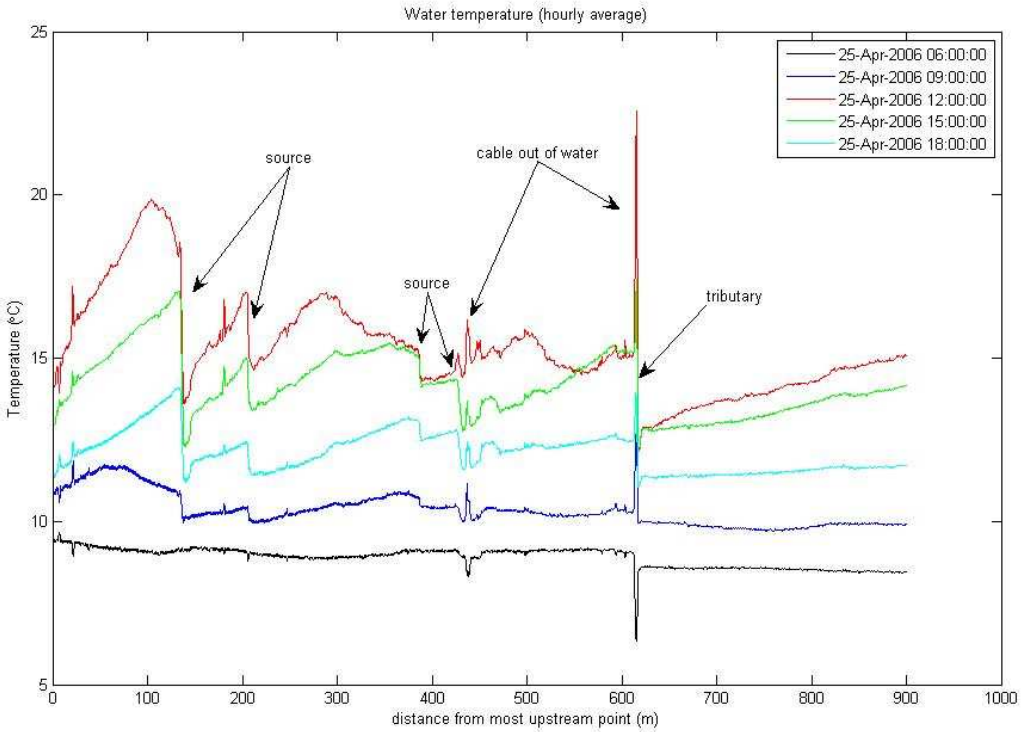
Forest floor interception

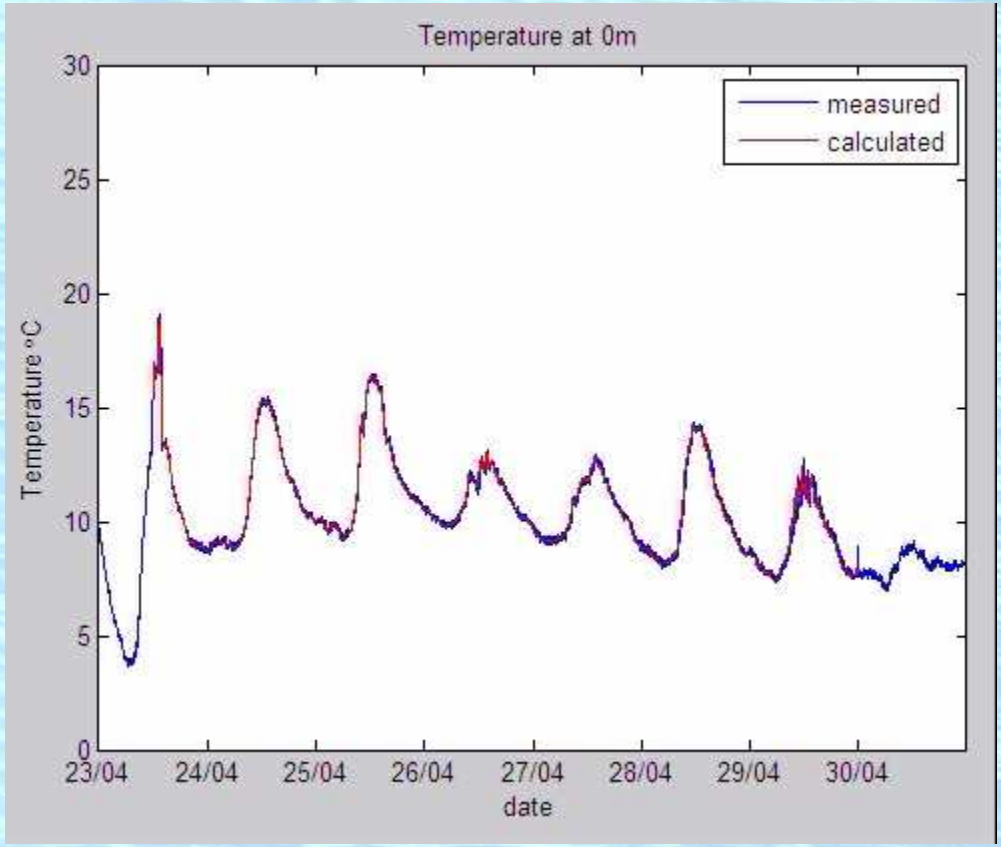



antenne
Ewend
C.R. 349
Scheedelerknupp
Kraasdelli
Pindels
Scheidel
Scheidel
Heischterdelli
Roudheck
Maisbich
Ale Schack
Scheierchen
Maisbich
Maisbich
Ellensbierg
dam
Wark
Maisbich
500 m

Distributed Temperature Sensing

- Glasvezel kabel
- Temperatuur over hele lengte




Temperature at 0m
measured
calculated
Temperature °C
30
25
20
15
10
5
0
23/04
24/04
25/04
26/04
27/04
28/04
29/04
30/04
date

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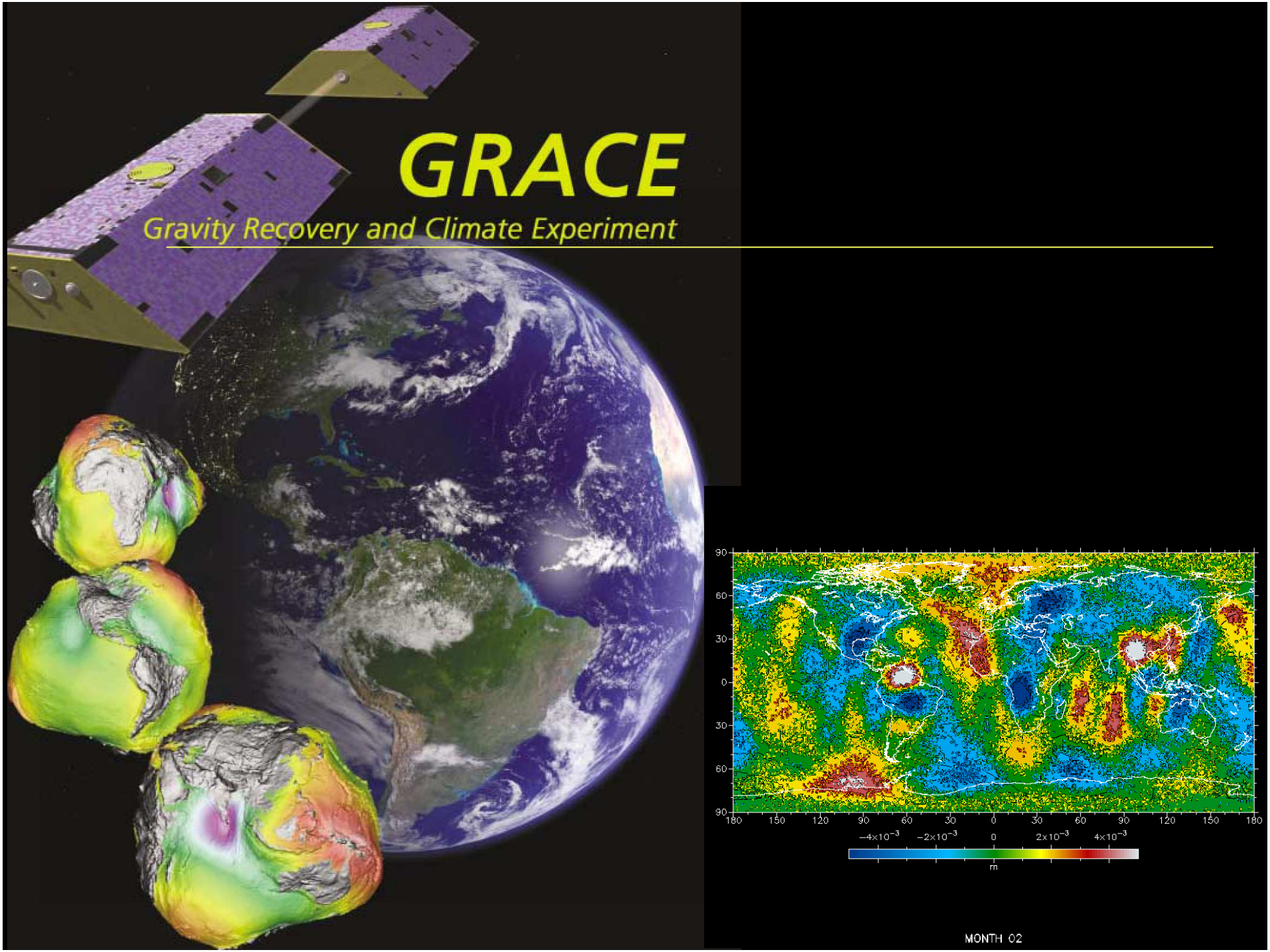
  - GRACE
  - Evaporation sensing
- Modelleren
  - Luxemburg
  - Zambezi

GRACE

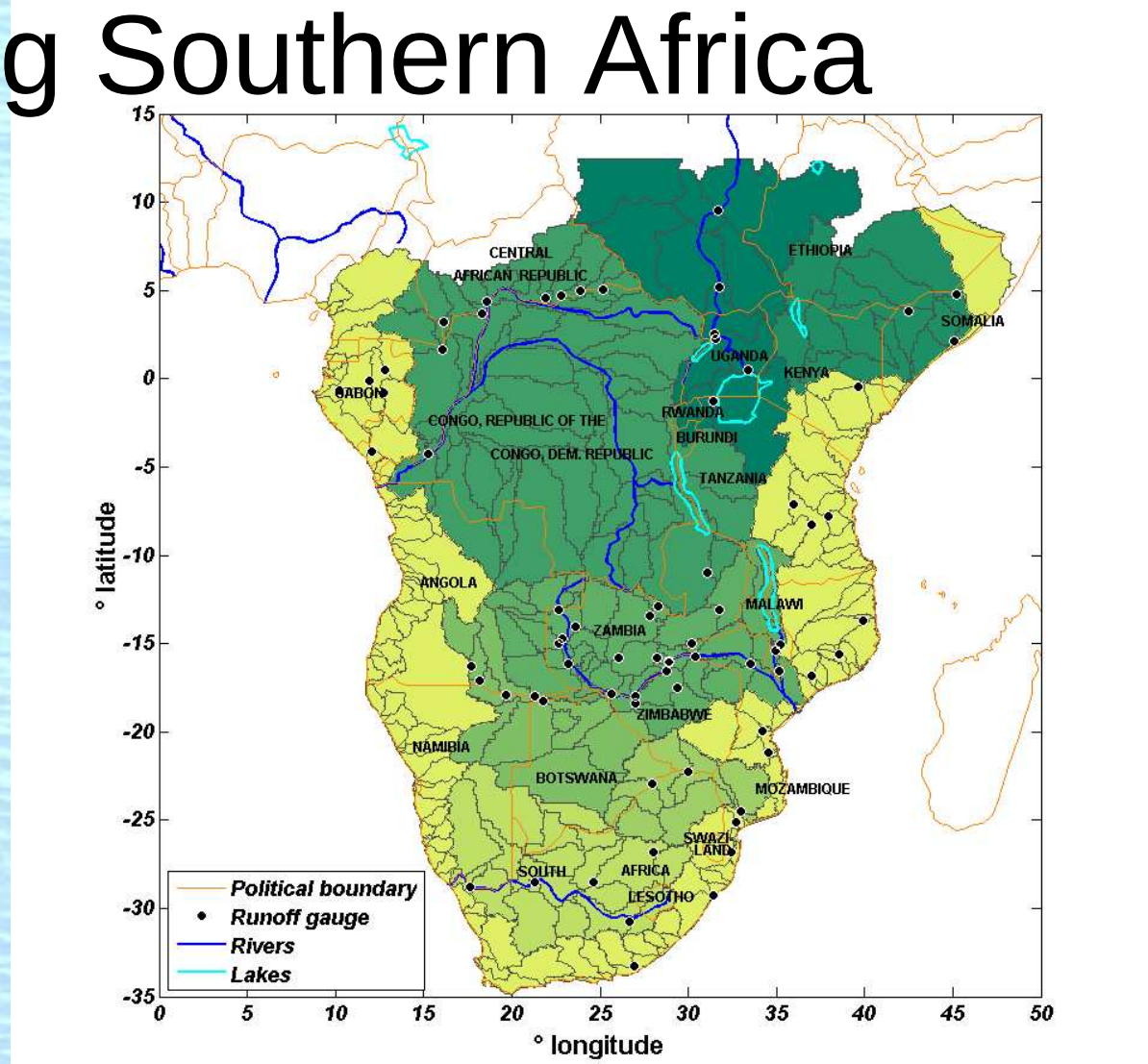
Gravity Recovery and Climate Experiment

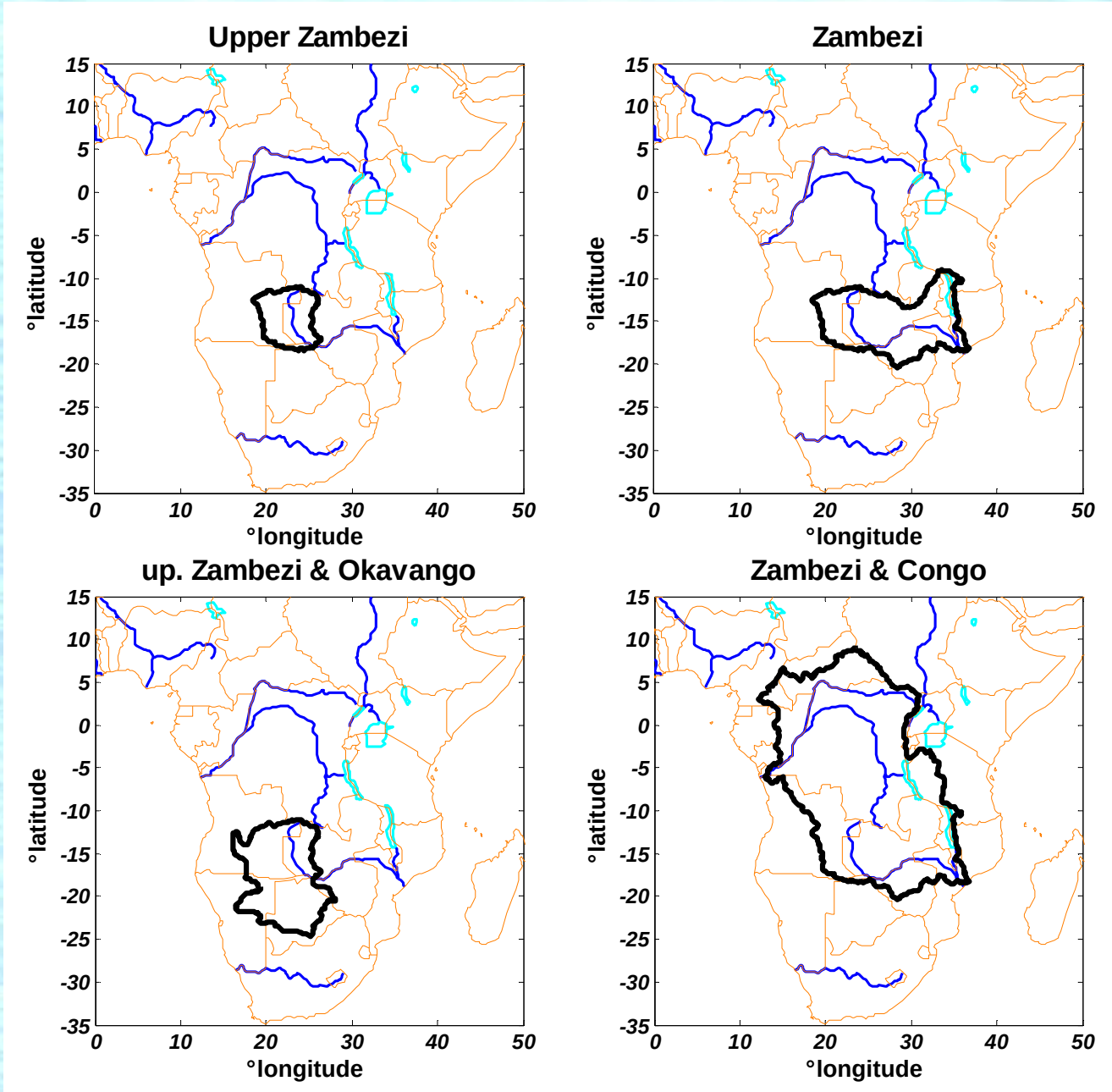


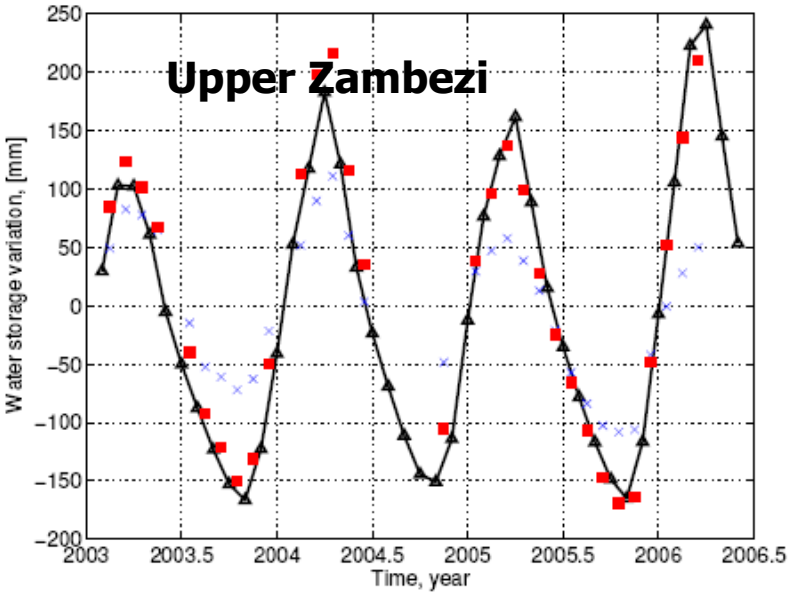
Modelling Southern Africa

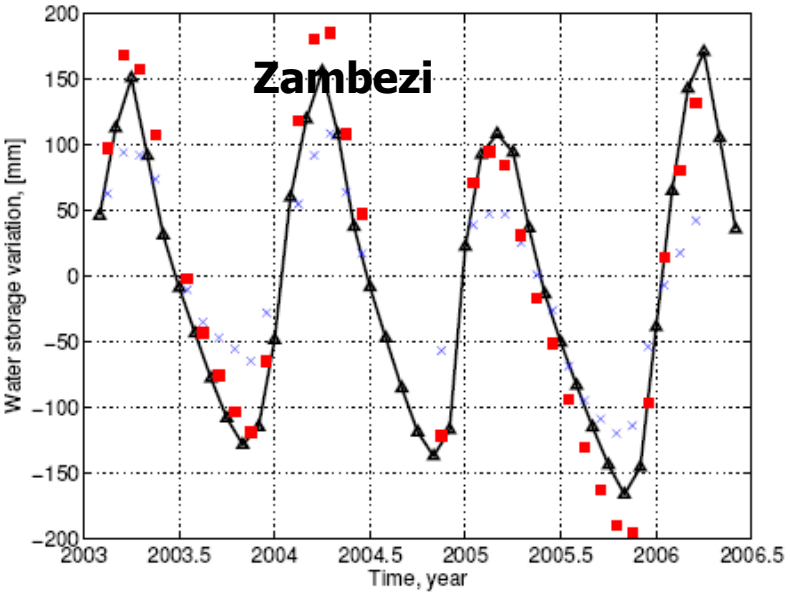
From GRACE

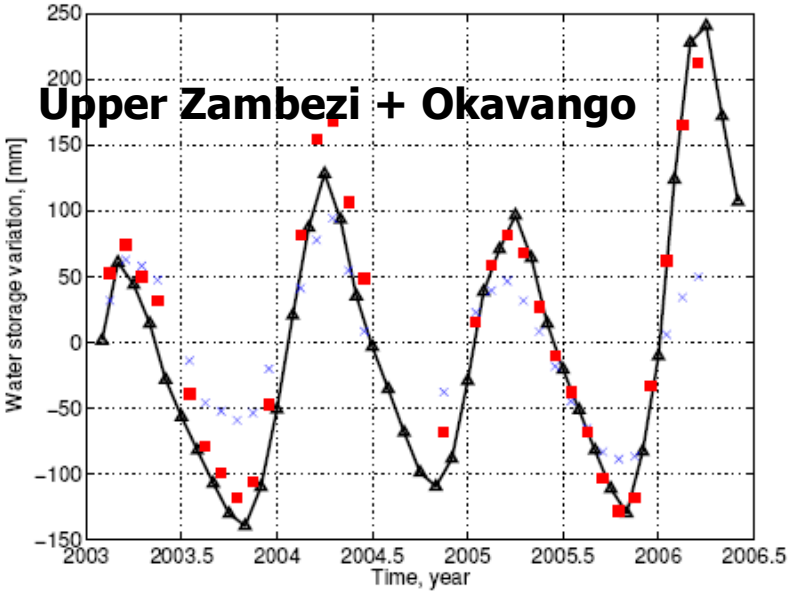
$$\frac{\mathrm{d}S}{\mathrm{d}t} = P - E - Q$$

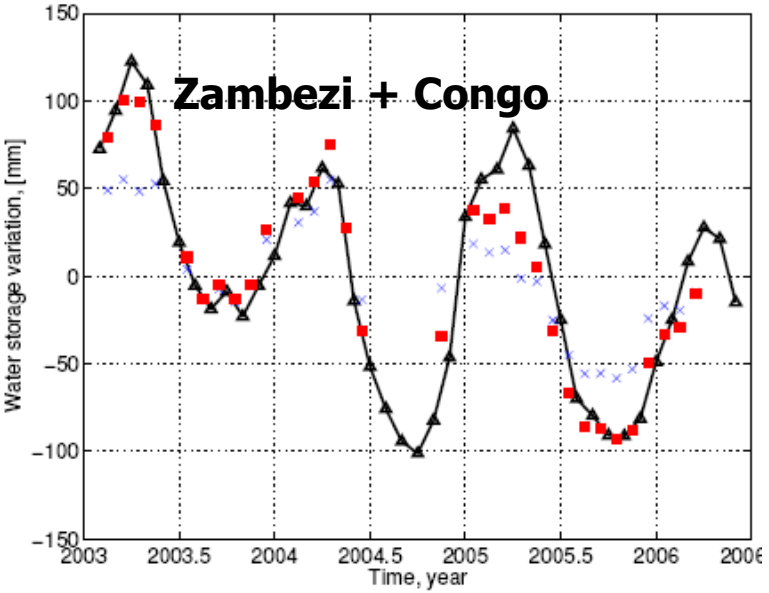



Upper Zambezi
Zambezi
up. Zambezi & Okavango
Zambezi & Congo
°latitude
°longitude
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
0
10
20
30
40
50


Upper Zambezi
Water storage variation, [mm]
Time, year

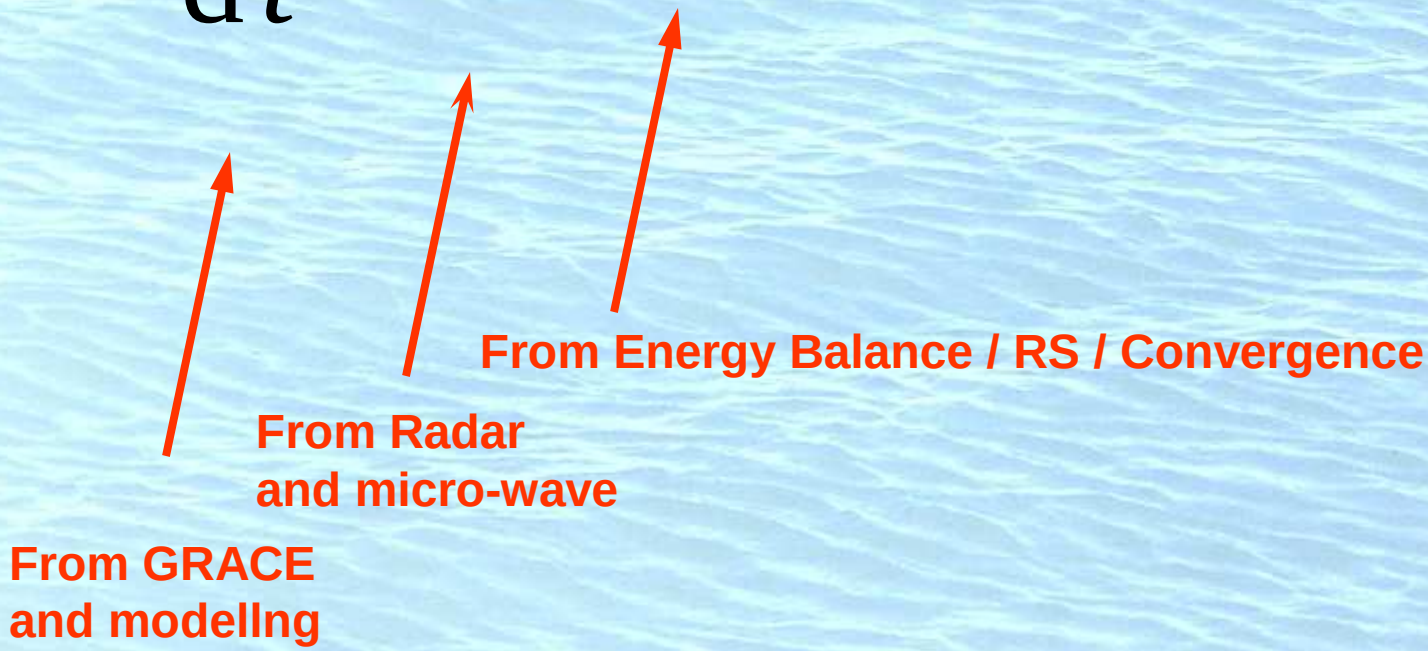

Zambezi
Water storage variation, [mm]
Time, year


Upper Zambezi + Okavango
Water storage variation, [mm]
Time, year


Zambezi + Congo
Water storage variation, [mm]
Time, year

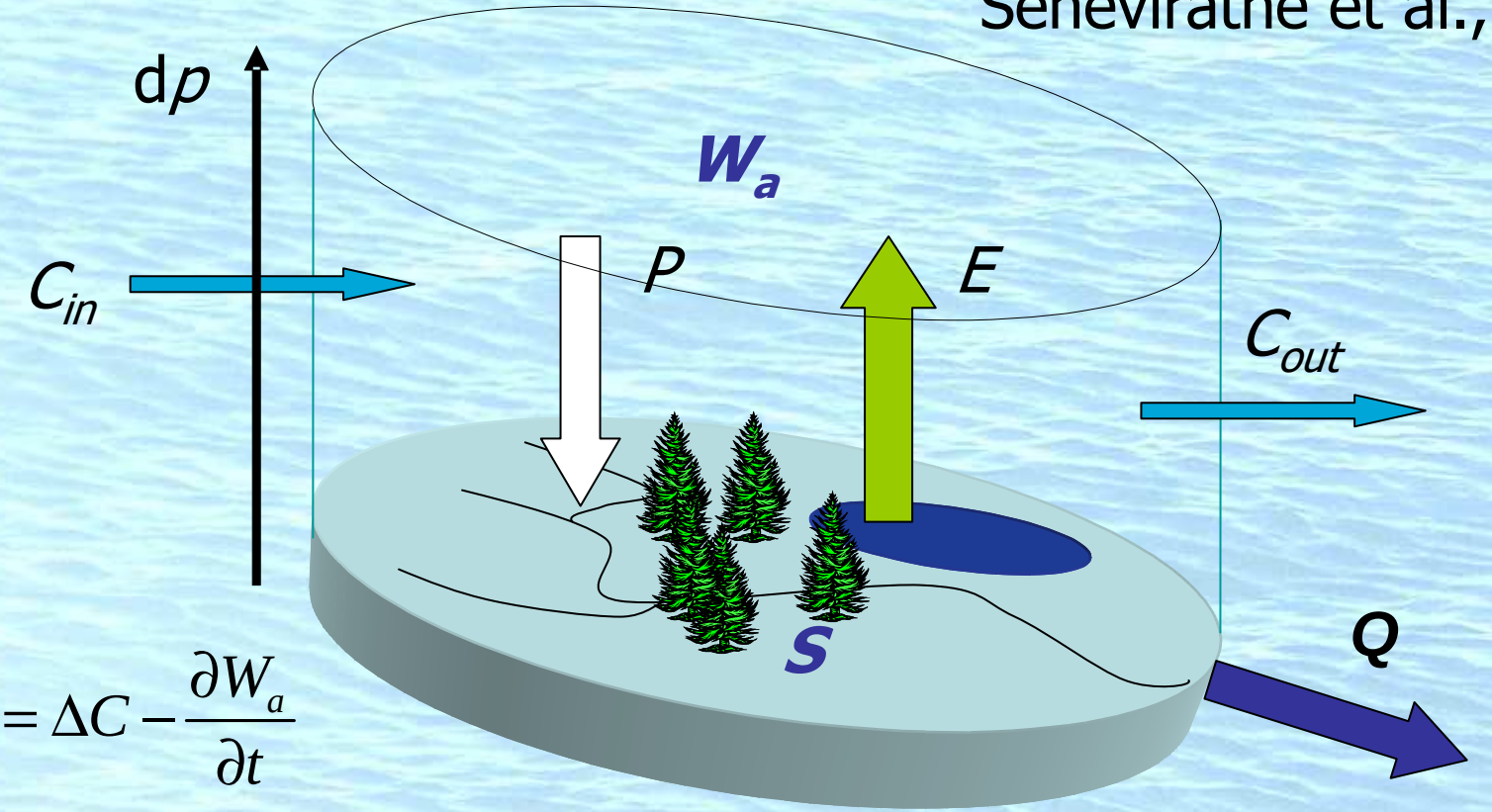
Evaporation sensing

$$\frac{\mathrm{d}S}{\mathrm{d}t} = P - E - Q$$



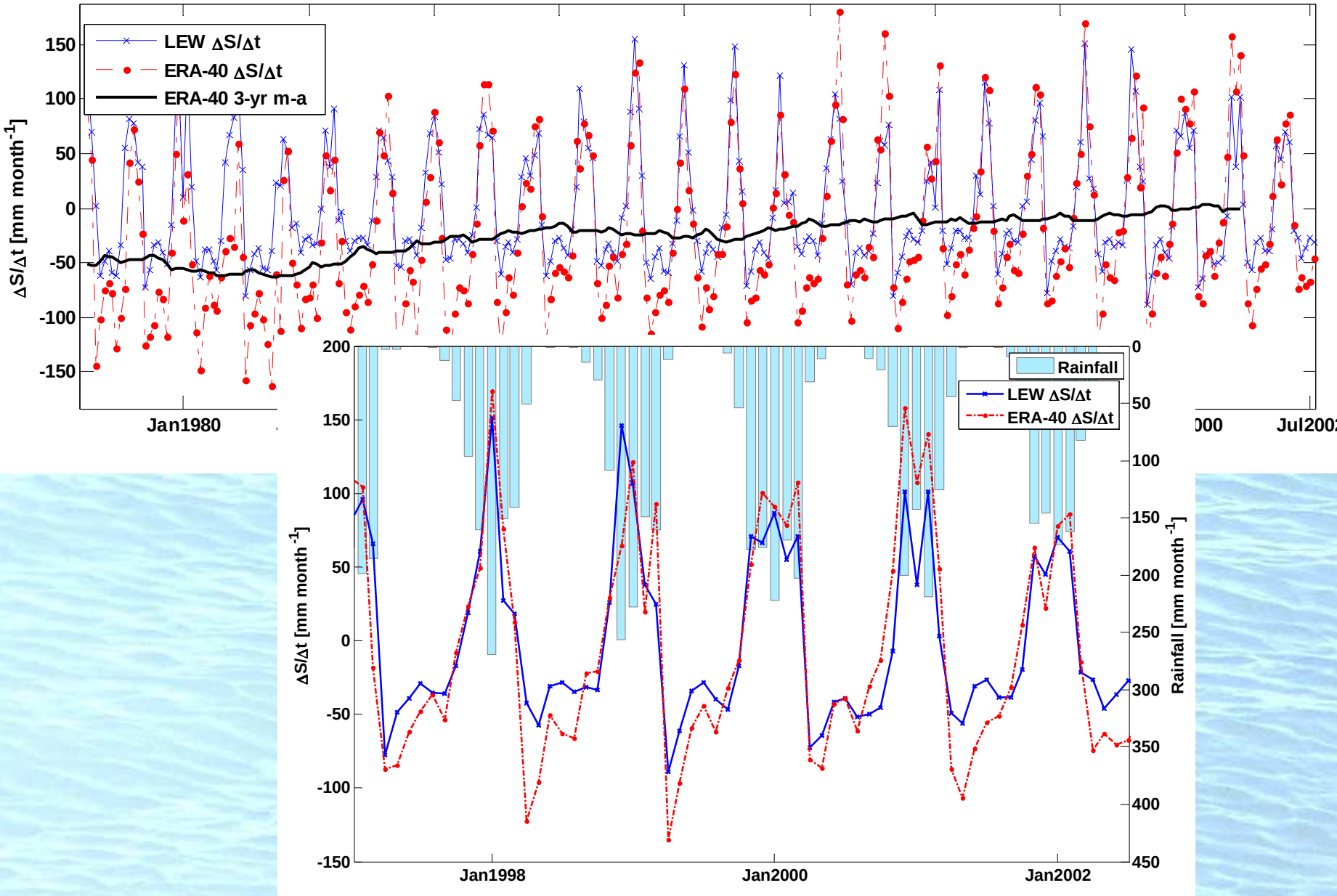
Atmospheric Moisture Convergence

Seneviratne et al., 2004



$$P - E = \Delta C - \frac{\partial W_a}{\partial t}$$

$$P - E = \frac{\partial S}{\partial t} + Q$$


LEW ΔS/Δt
ERA-40 ΔS/Δt
ERA-40 3-yr m-a
ΔS/Δt [mm month-1]
Jan1980
Jul2002
Rainfall
LEW ΔS/Δt
ERA-40 ΔS/Δt
ΔS/Δt [mm month-1]
Rainfall [mm month-1]
Jan1998
Jan2000
Jan2002

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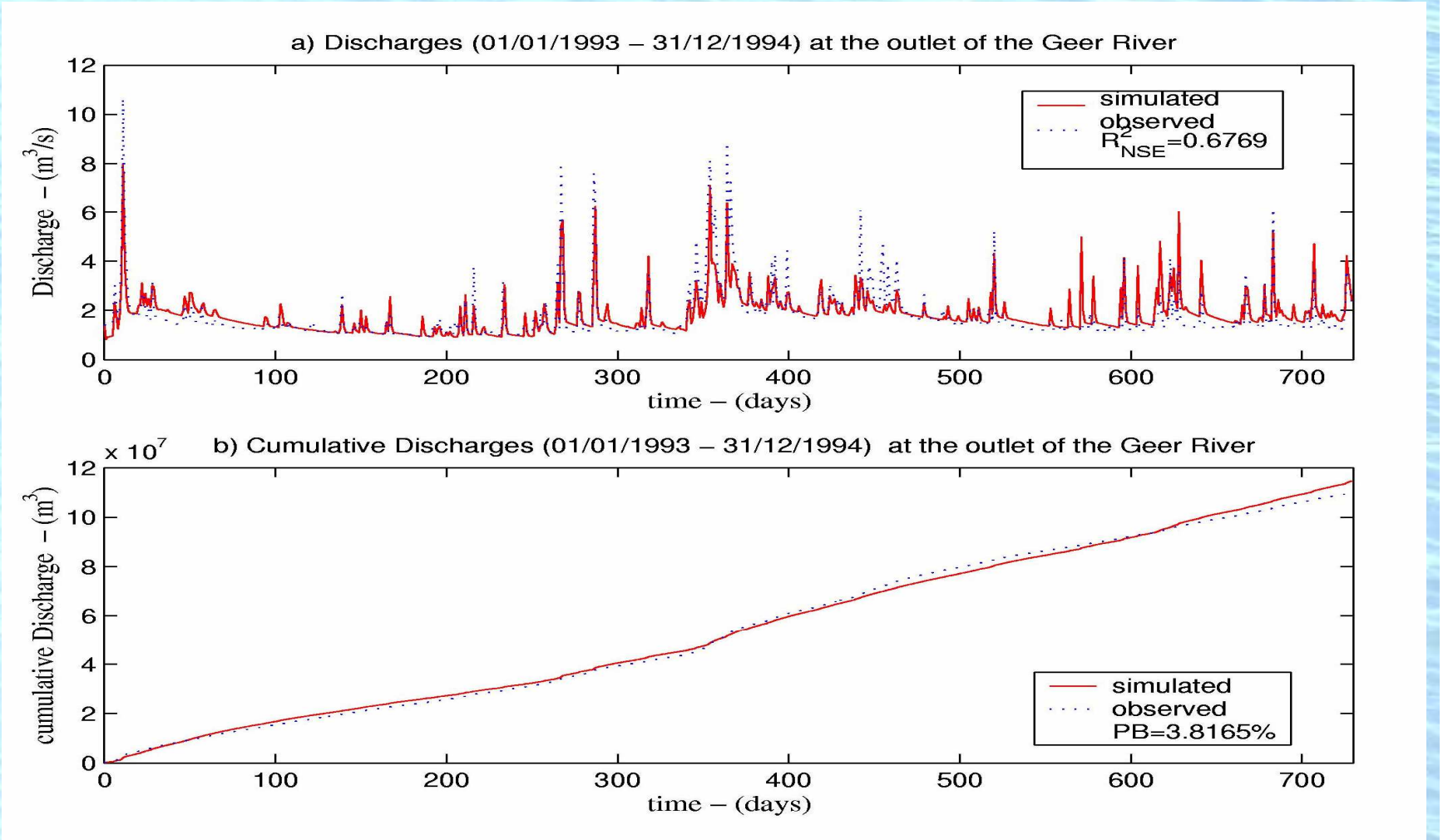
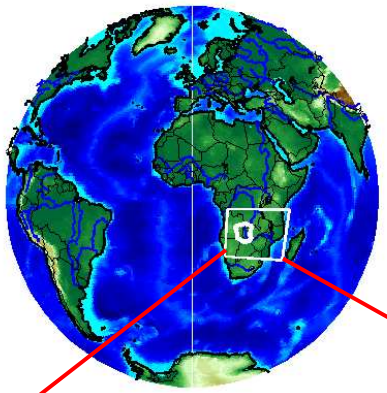
- Modelleren
  - Luxemburg
  - Zambezi

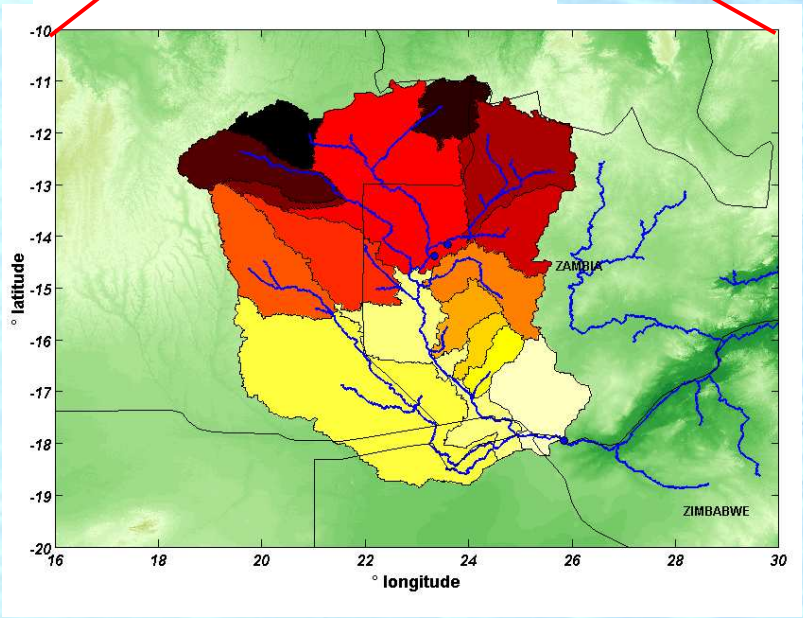
Modellering De Geer

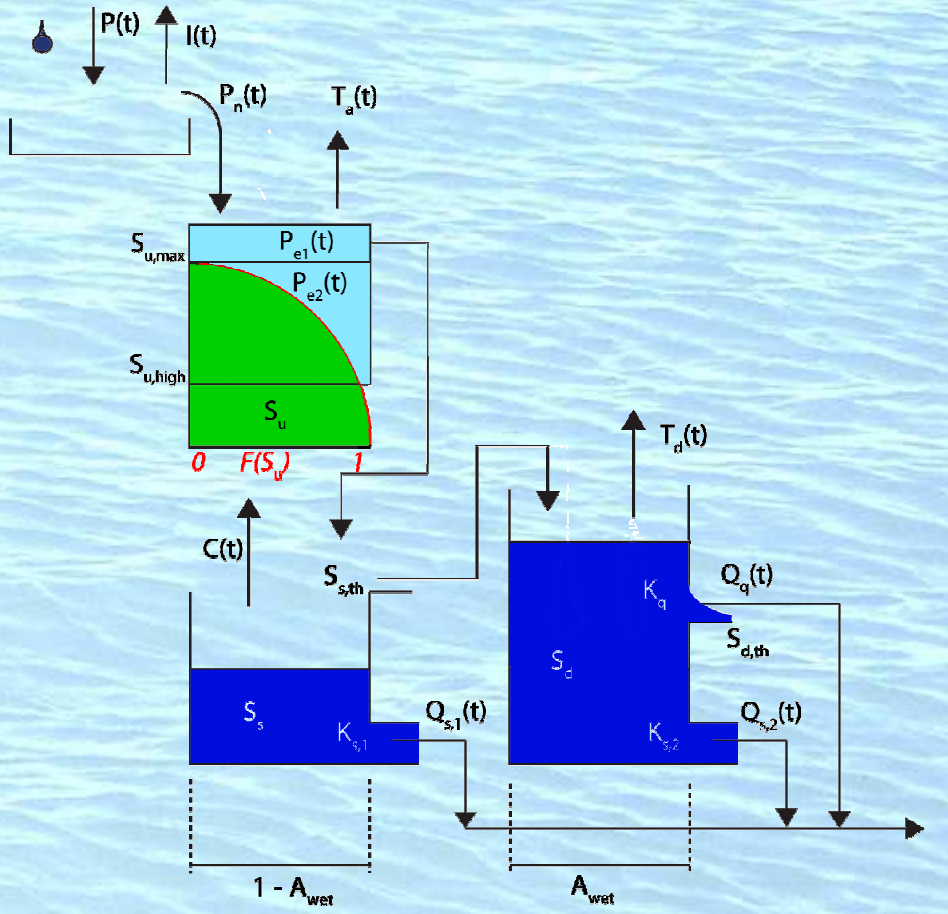



Zambezi

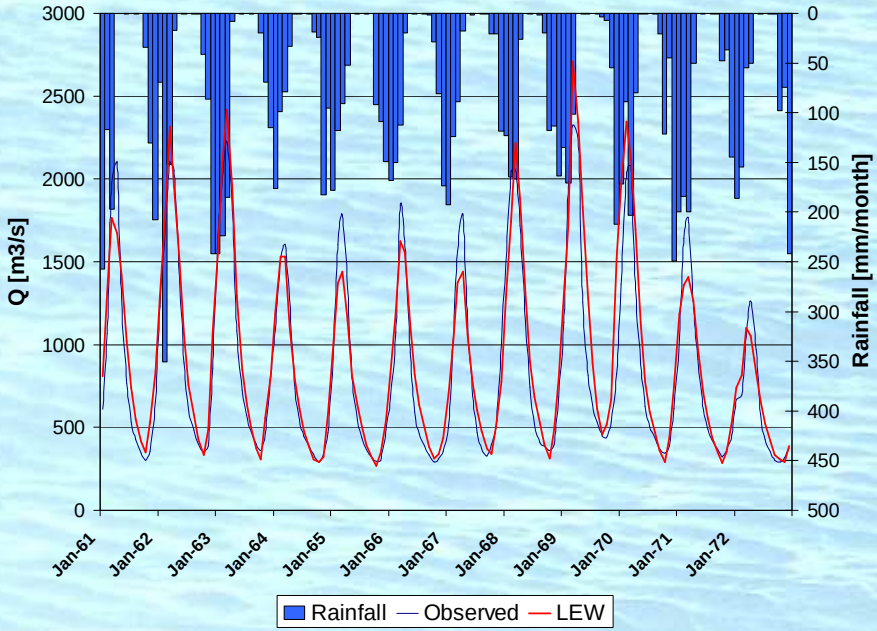
Zambezi Model



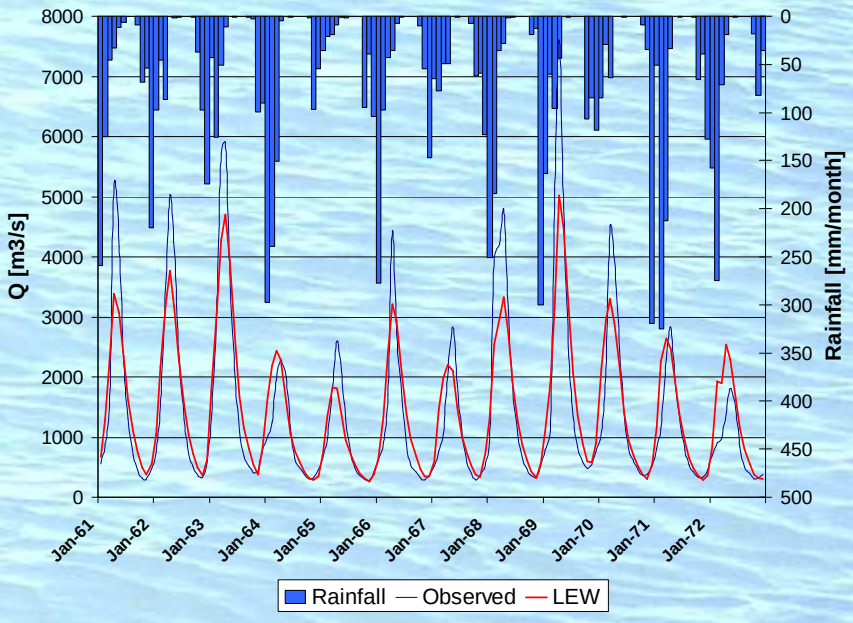




Zambezi Model



Lukulu



Victoria Falls


ISUZU