

Hydrological modelling with JGrass-NewAGE system

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Riccardo Rigon

1. Theoretical

- I. JGrass-NewAGE briefly
- II. Sample component and OMS comp
- III. Application in UBN basin (case study)

2. Practical

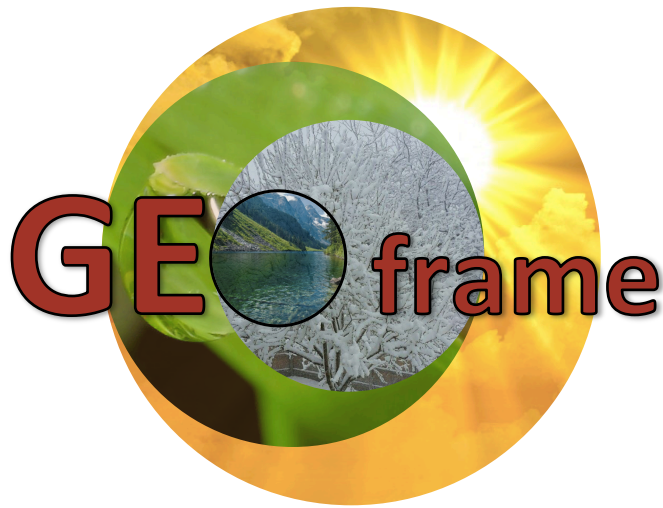
- I. Digital watershed model

Please download oms project from https://drive.google.com/open?id=0B8taAom_i8q_NDhXZ2p3NXh3TzQ

- II. SWR-LWR-ET connection

Please download oms project from https://drive.google.com/open?id=0B8taAom_i8q_WUEzLTNsYINVdHc

JGrass-NewAge system



Geomorphological model setup

GIS-Jgrasstools-Horton Machine

Meteorological interpolation tools

GEOSTATISTICS
Kriging

DETERMINISTICS
IDW,JAMI

Energy balance

SHORTWAVE (SWRB)
Iqbal+Corripio model
Decomposition

LONGWAVE(LWRB)
Brutsaert with
10 parametrizations

Evapotranspiration

Penmam-Monteith

Priestley-Taylor

Fao-Etp-model

Runoff production and Snow Melting

Hymod model

Snowmelt and
SWE model

Non-linear
resevoir model

Travel times and passive solute transport

Backward
travel times pdfs

Forward
travel times pdfs

Passive solute
transport

Channel routing

Cuencas

Automatic calibration

LUCA

Particle swarm

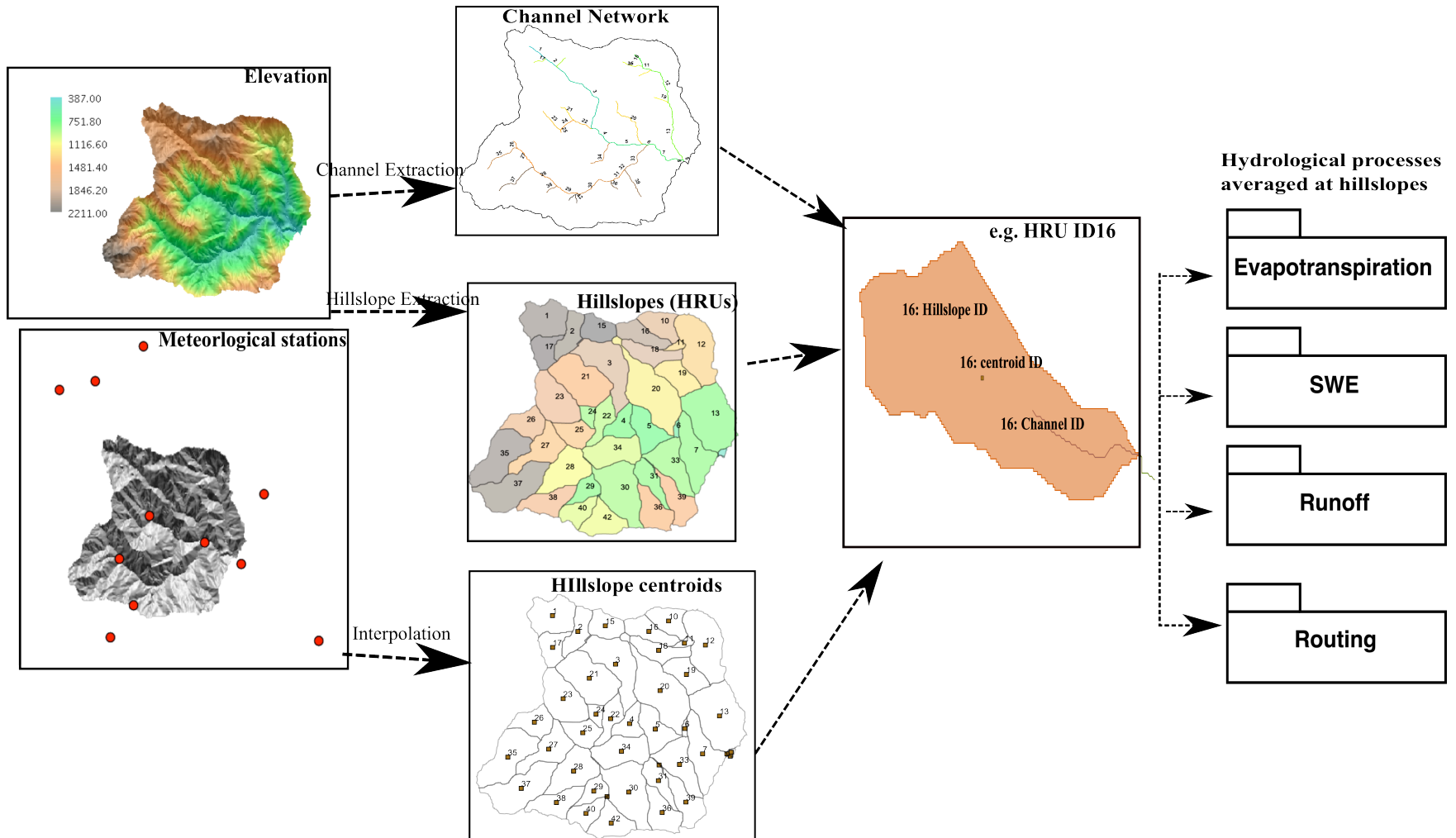
Dream

<http://geoframe.blogspot.com>

Formetta, G., et al. "Hydrological modelling with components: A GIS-based open-source framework." Environmental Modelling & Software 55 (2014)

All info you need: <http://abouthydrology.blogspot.it/search/label/JGrass-NewAGE>

JGrass-NewAge system

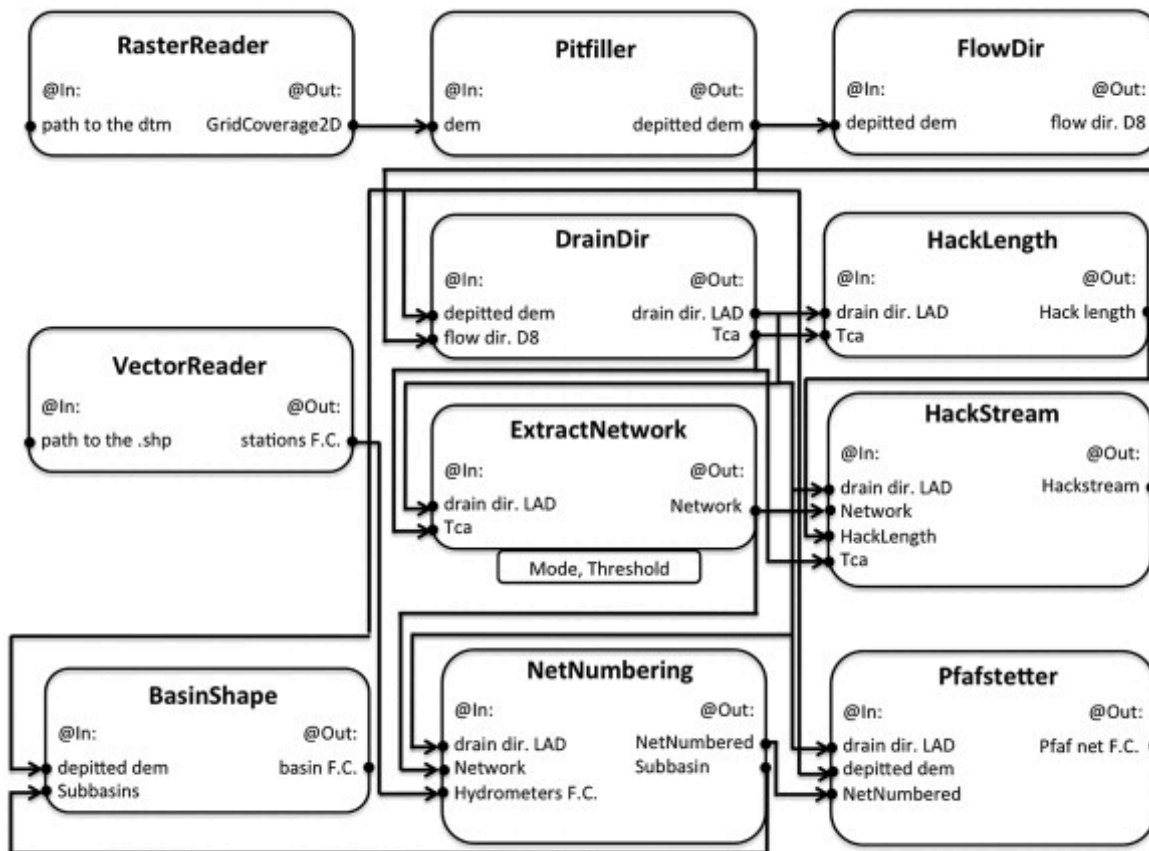


Simplified working framework

JGrass-NewAge system

Workflow.....

uDig-Jgrasstools-Horton Machine



Formetta, G., Antonello, A., Franceschi, S., David, O., and R., R.: The basin delineation and the built of a digital watershed model within the JGrass-NewAGE system, Boletín Geológico y Minero: Special Issue "Advanced GIS terrain analysis for geophysical applications, 2014a.

Wuletawu Abera, Andrea Antonello, Silvia Franceschi, Giuseppe Formetta, Riccardo Rigon. 2014. Section 2.4.1: The uDig Spatial Toolbox for hydro-geomorphic analysis. In: Clarke, L. (Ed.) Geomorphological Techniques (Online Edition). British Society for Geomorphology; London, UK. ISSN: 2047-0371.

JGrass-NewAge system

Components.....

uDig-Jgrasstools-Horton Machine

```
components {
  "rasterReader"           "${GEARS}.io.rasterreader.OmsRasterReader"
  "VectorReader"           "${GEARS}.io.shapefile.OmsShapefileFeatureReader"
  "subbsin_rasterWriter"   "${GEARS}.io.rasterwriter.OmsRasterWriter"
  "pitfiller"              "${HM}.demmanipulation.pitfiller.OmsPitfiller"
  "flowdir"                "${HM}.geomorphology.flow.OmsFlowDirections"
  "DrainDir"               "${HM}.geomorphology.draindir.OmsDrainDir"
  "markoutlets"            "${HM}.demmanipulation.markoutlets.OmsMarkoutlets"
  "extractnetwork"         "${HM}.network.extractnetwork.OmsExtractNetwork"
  "wateroutlet"            "${HM}.demmanipulation.wateroutlet.OmsWateroutlet"
  "pitcutout"              "${GEARS}.modules.r.cutout.OmsCutOut"
  "netnumbering"           "${HM}.network.netnumbering.OmsNetNumbering"
  "networkattributes"       "${HM}.network.networkattributes.OmsNetworkAttributesBuilder"
  "Basinshape"             "${HM}.basin.basinshape.BasinShape"
  "RastCat"                "${GEARS}.modules.v.rastercattofeatureattribute.OmsRasterCatToFeatureAttribute"
  "VectorReshaper"         "${GEARS}.modules.v.vectorreshaper.OmsVectorReshaper"

  "Writer_V_net"           "${GEARS}.io.shapefile.OmsShapefileFeatureWriter"
  "Writer_V_basin"        "${GEARS}.io.shapefile.OmsShapefileFeatureWriter"
```

JGrass-NewAge system

Connection.....

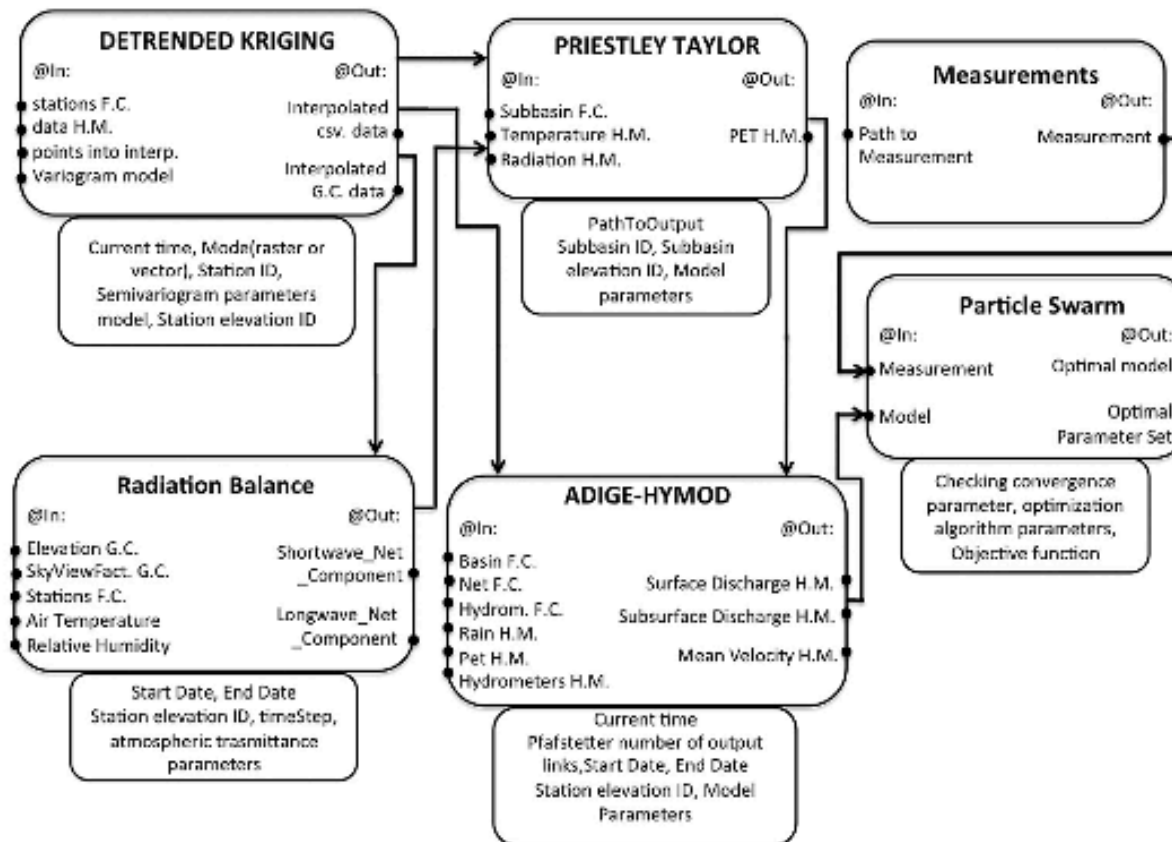
uDig-Jgrasstools-Horton Machine

```
connect {
  "rasterReader.outRaster"      "pitfiller.inElev"
  "pitfiller.outPit"            "flowdir.inPit"
  "pitfiller.outPit"            "DrainDir.inPit"
  "flowdir.outFlow"             "DrainDir.inFlow"
  "DrainDir.outFlow"            "markoutlets.inFlow"
  // extract the network raster map
  "DrainDir.outTca"              "extractnetwork.inTca"
  // "extractnetwork.outNet"      "rasterWriter.inRaster"
  // vectorize the network and various enumeration scheme |
  "pitfiller.outPit"            "networkattributes.inDem"
  "markoutlets.outFlow"         "networkattributes.inFlow"
  "extractnetwork.outNet"       "networkattributes.inNet"
  "DrainDir.outTca"             "networkattributes.inTca"
  // "networkattributes.outNet"   "Writer_V_net.geodata"
  // extract the raster subbasin map
  "DrainDir.outTca"             "netnumbering.inTca"
  "markoutlets.outFlow"         "netnumbering.inFlow"
  "extractnetwork.outNet"       "netnumbering.inNet"
  // "VectorReader.geodata"      "netnumbering.inPoints"
  "netnumbering.outBasins"      "subbsin_rasterWriter.inRaster"
  // "netnumbering.outNetnum"    "rasterWriter.inRaster"
```

JGrass-NewAge system

Workflow.....

Hymod model



Formetta, G., et al. "The JGrass-NewAge system for forecasting and managing the hydrological budgets at the basin scale: models of flow generation and propagation/routing." *Geoscientific Model Development* 4.4 (2011): 943-955

JGrass-NewAge system

Energy balance

SHORTWAVE (SWRB)
Iqbal+Corripio model
Decomposition

LONGWAVE(LWRB)
Brutsaert with
10 parametrizations

Evapotranspiration

Priestley-Taylor

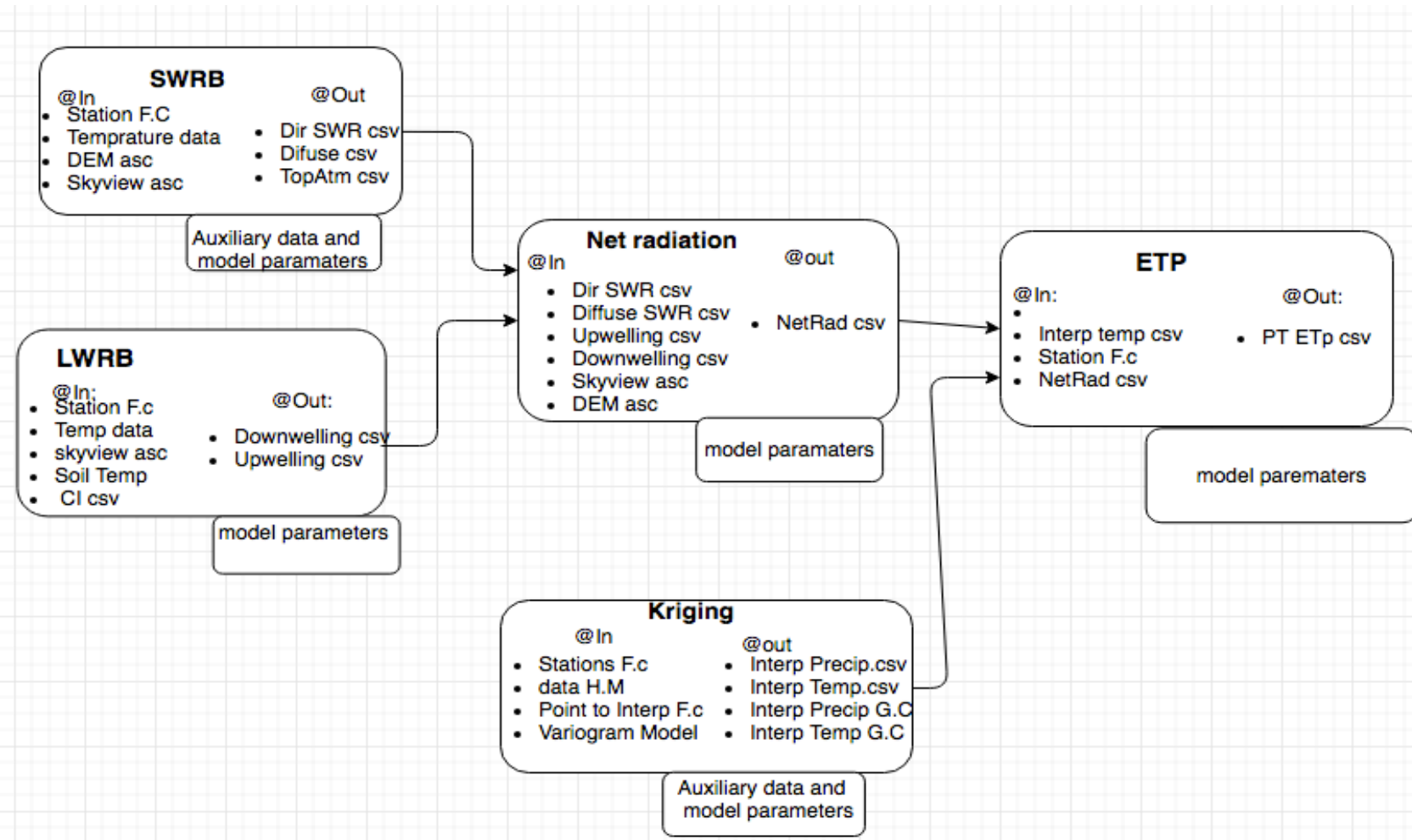
Formetta, G., et al. "Modeling shortwave solar radiation using the JGrass-NewAge system." Geoscientific Model Development 6.4 (2013): 915-928.

Formetta, G., et al.: Site specific parameterizations of longwave radiation, Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-227, in review, 2016

Abera, W., et al, Estimating water budgets components of Upper Blue Nile basin using remote sensing and NewAge-JGrass system, Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-290, in review.

JGrass-NewAge system

Workflow.....



JGrass-NewAge system

Component needed.....

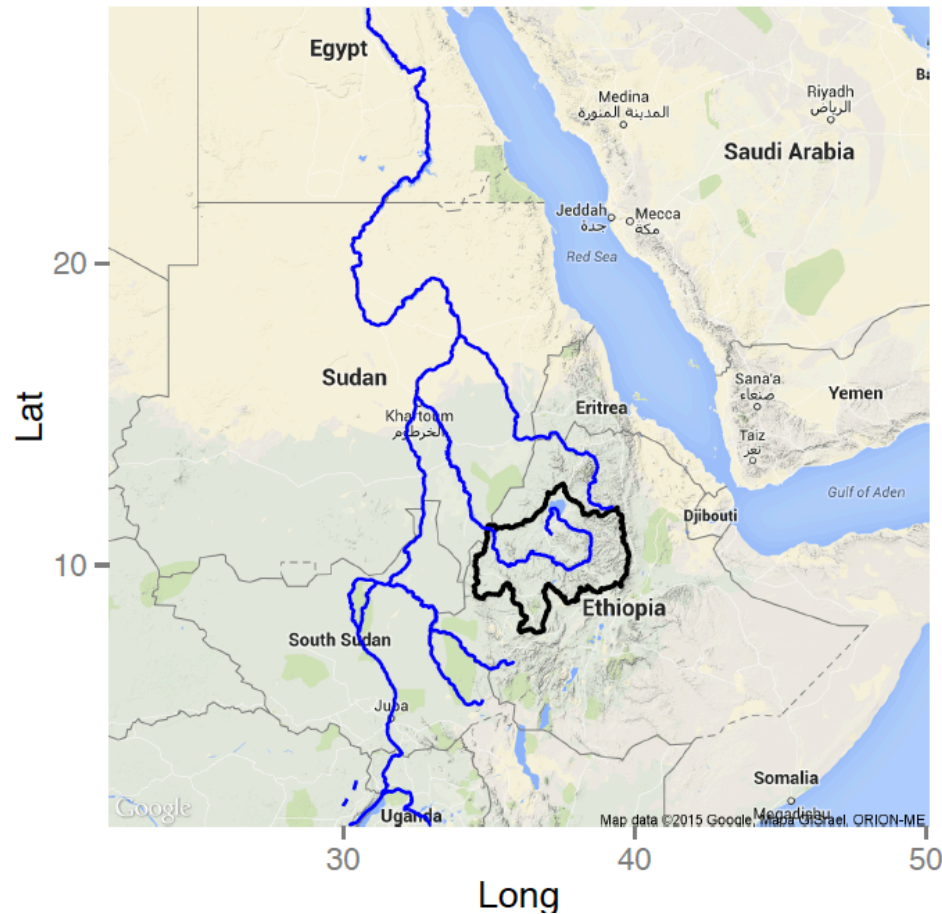
```
components {  
  //reader component  
    "reader_data_temp"      "${GEARS}.timedependent.OmsTimeSeriesIteratorReader"  
    "reader_dem"            "${GEARS}.rasterreader.OmsRasterReader"  
    "reader_sky"            "${GEARS}.rasterreader.OmsRasterReader"  
    "vreader_station"       "${GEARS}.shapefile.OmsShapefileFeatureReader"  
    "reader_data_soilT"     "${GEARS}.timedependent.OmsTimeSeriesIteratorReader"  
    "reader_data_H"         "${GEARS}.timedependent.OmsTimeSeriesIteratorReader"  
    "reader_data_CI"        "${GEARS}.timedependent.OmsTimeSeriesIteratorReader"  
  
  // model component  
    "swrb"                  "swrbPointCase.ShortwaveRadiationBalancePointCase"  
    "l"                     "lwrBPointCase.LwrB"  
    "PTEtp"                 "etp.OmsPriestleyTaylorEtpModel"  
    "net"                   "netRadiation.NetRadiation"  
  
  //writer component  
    "writer_direct"         "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_diffuse"        "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_topATM"         "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_down"           "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_up"             "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_etp"            "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"  
    "writer_net"            "${GEARS}.timedependent.OmsTimeSeriesIteratorWriter"
```

JGrass-NewAge system

Connections.....

```
connect {  
    //connection SWRB  
    "reader_data_temp.outData"           "swrb.inTemperatureValues"  
    "reader_dem.outRaster"               "swrb.inDem"  
    "reader_sky.outRaster"               "swrb.inSkyview"  
    "vreader_station.geodata"            "swrb.inStations"  
    "swrb.outhMdirect"                   "writer_direct.inData"  
    "swrb.outhMdiffuse"                   "writer_diffuse.inData"  
    "swrb.outhMtopatm"                   "writer_topATM.inData"  
    //connection lWRB  
    "reader_data_temp.outData"           "l.inAirTemperatureValues"  
    "reader_data_soilT.outData"          "l.inSoilTemperatureValues"  
    "reader_data_CI.outData"             "l.inClearnessIndexValues"  
    "reader_sky.outRaster"               "l.inSkyview"  
    "vreader_station.geodata"            "l.inStations"  
    "l.outhMlongwaveDownwelling"         "writer_down.inData"  
    "l.outhMlongwaveUpwelling"           "writer_up.inData"  
    // connection of swr and lwr with netradiation  
    "swrb.outhMdirect"                   "net.inShortwaveDirectValues"  
    "swrb.outhMdiffuse"                   "net.inShortwaveDiffuseValues"  
    "l.outhMlongwaveDownwelling"         "net.inDownwellingValues"  
    "l.outhMlongwaveUpwelling"           "net.inUpwellingValues"  
    "net.outhMnetRad"                     "writer_net.inData"  
  
    //connection ETP  
    "reader_data_temp.outData"           "PETep.inTemp"  
    "net.outhMnetRad"                     "PETep.inNetradiation"  
    "PETep.outPETep"                     "writer_etp.inData"  
}
```

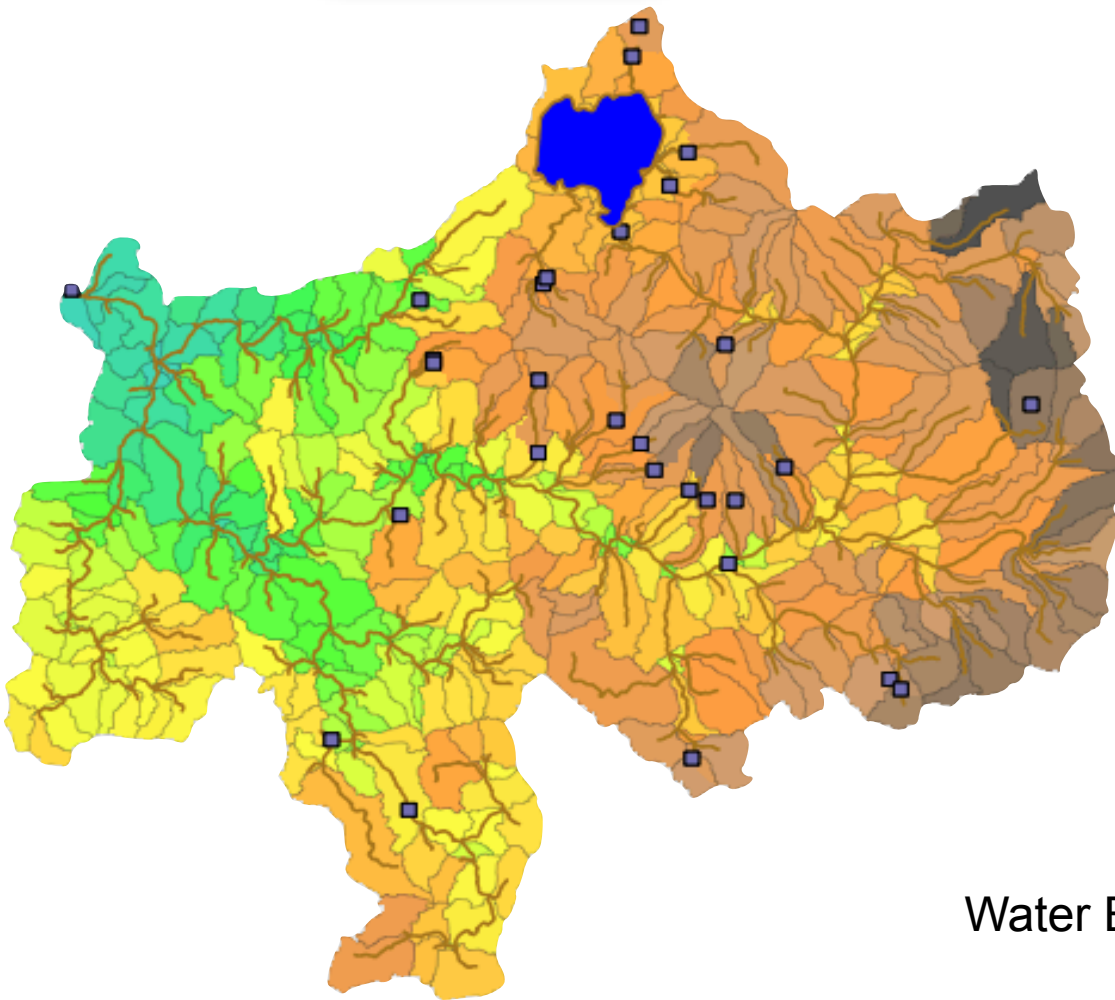

Case Application: Large scale basin



- 176000km²
- Data scarce
- 1994-2009

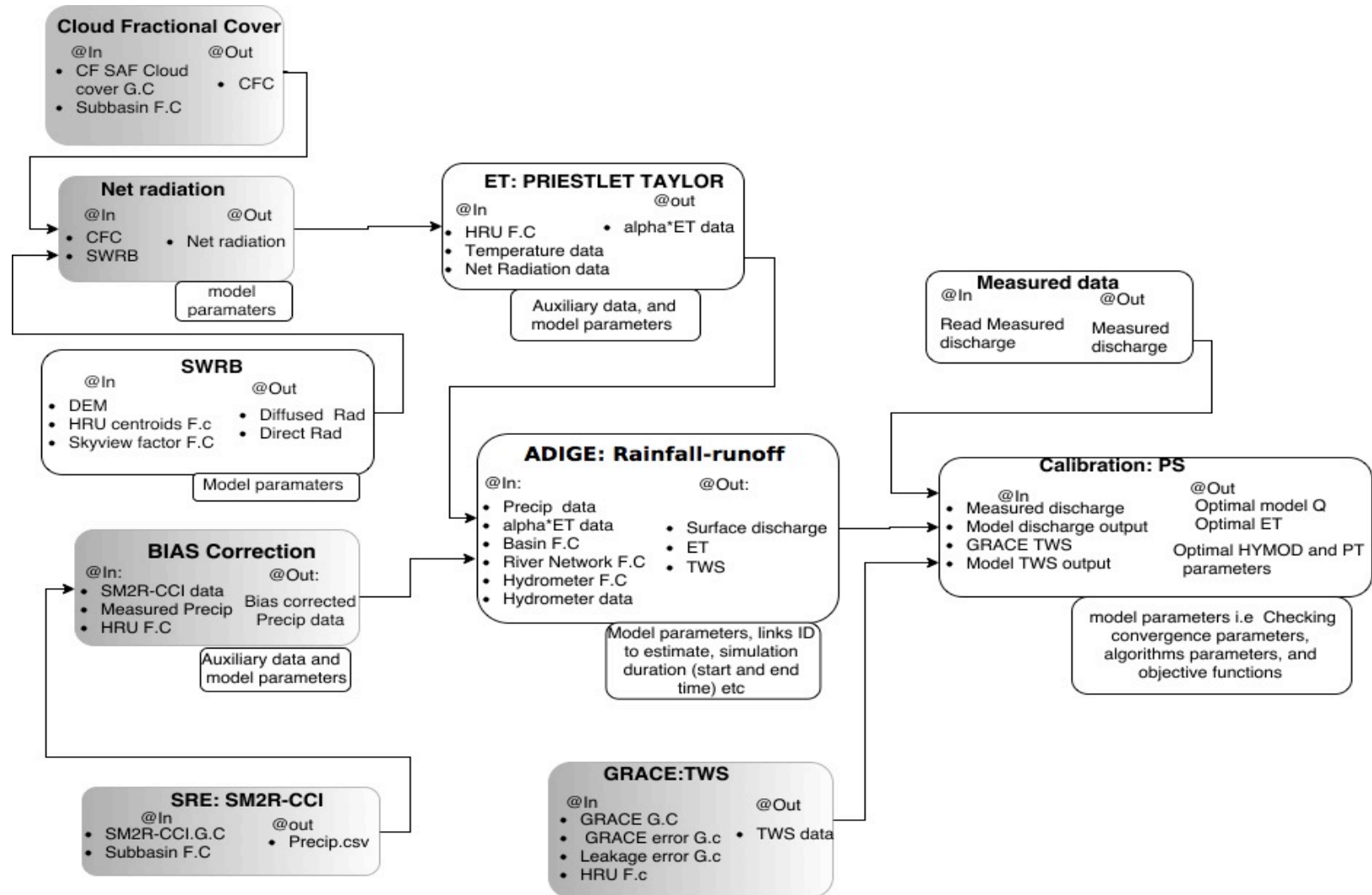
HRU-channel partition

402 HRU



Water Budget at each HRU

Working structure

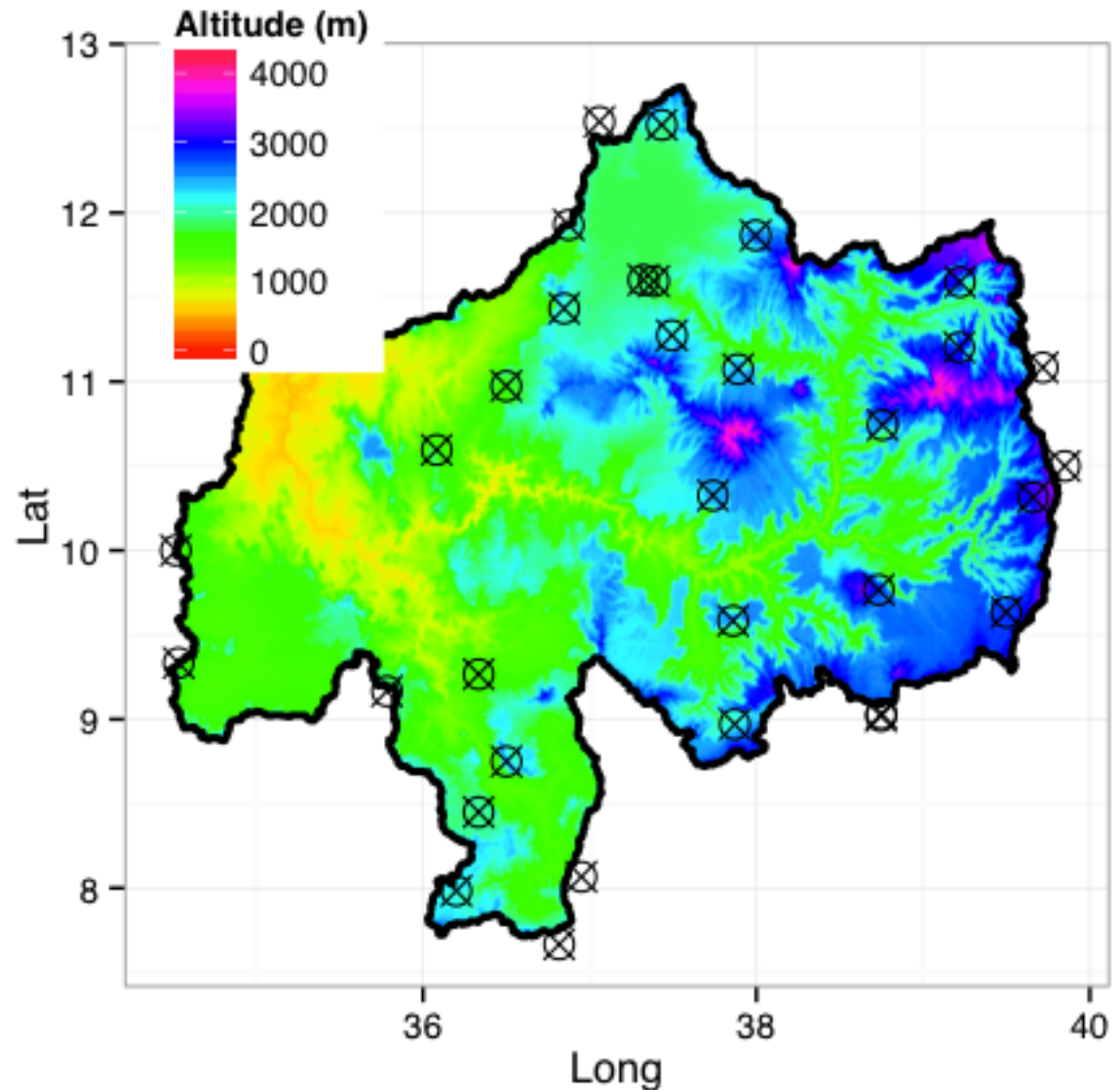


Spatial Precipitation

Gauge stations are very scarce

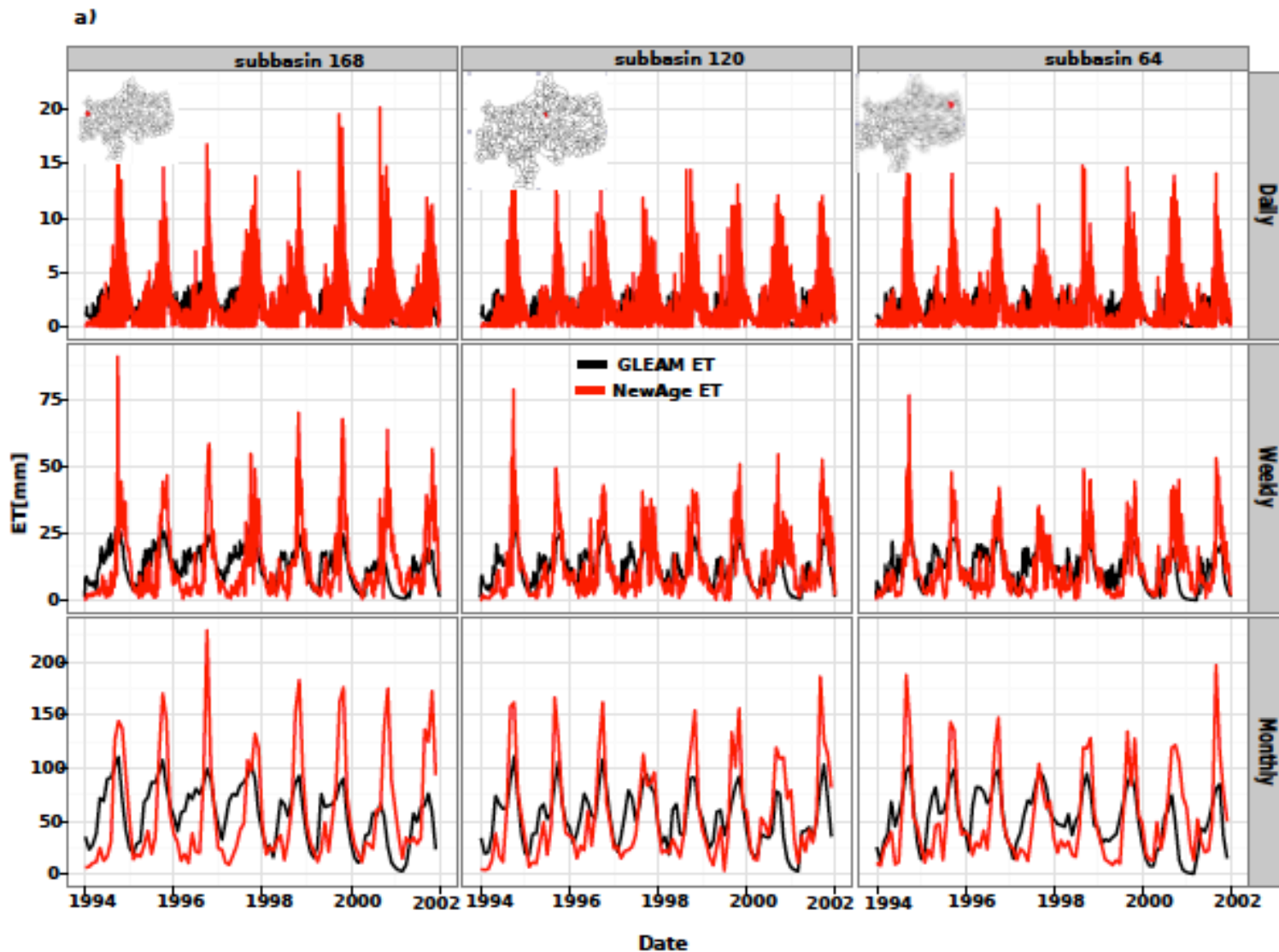
- 1 station/5000km²
- Poor maintenance

SM2R-CCI



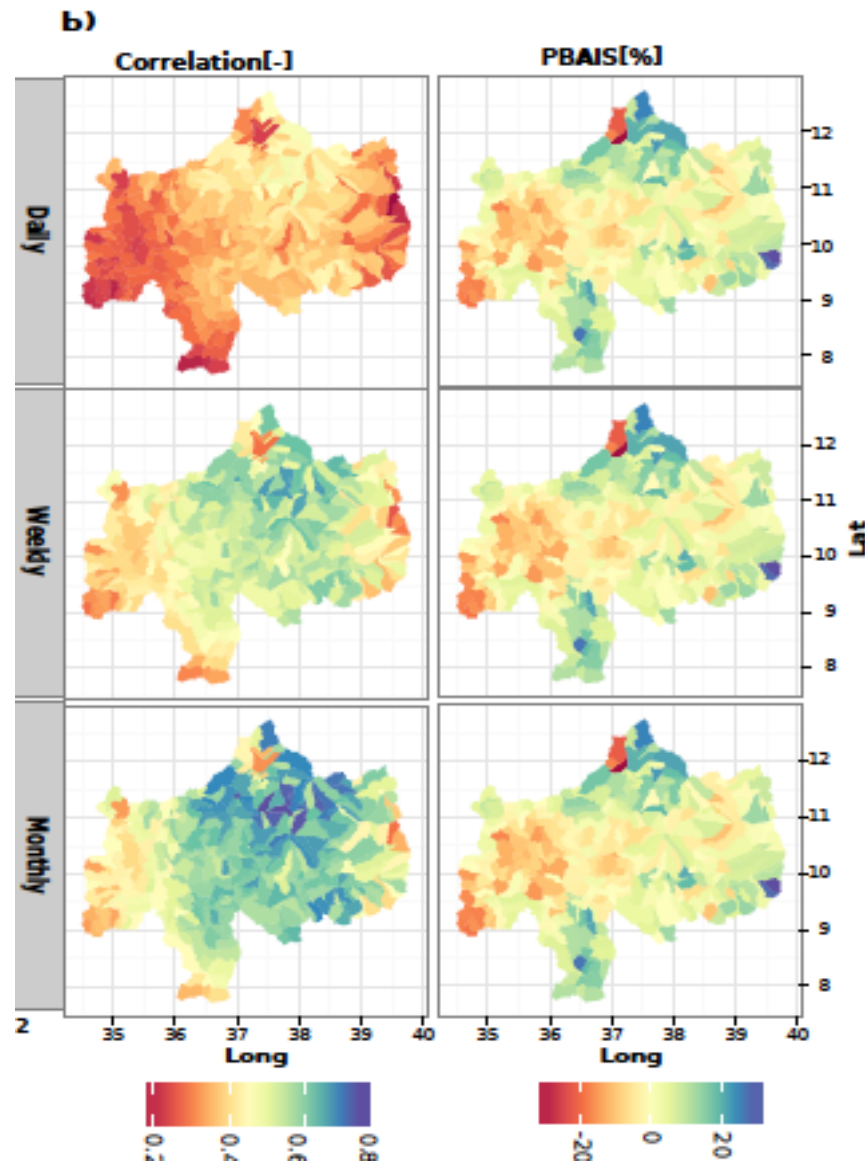
Evapotranspiration

Compare with GLEAM ET

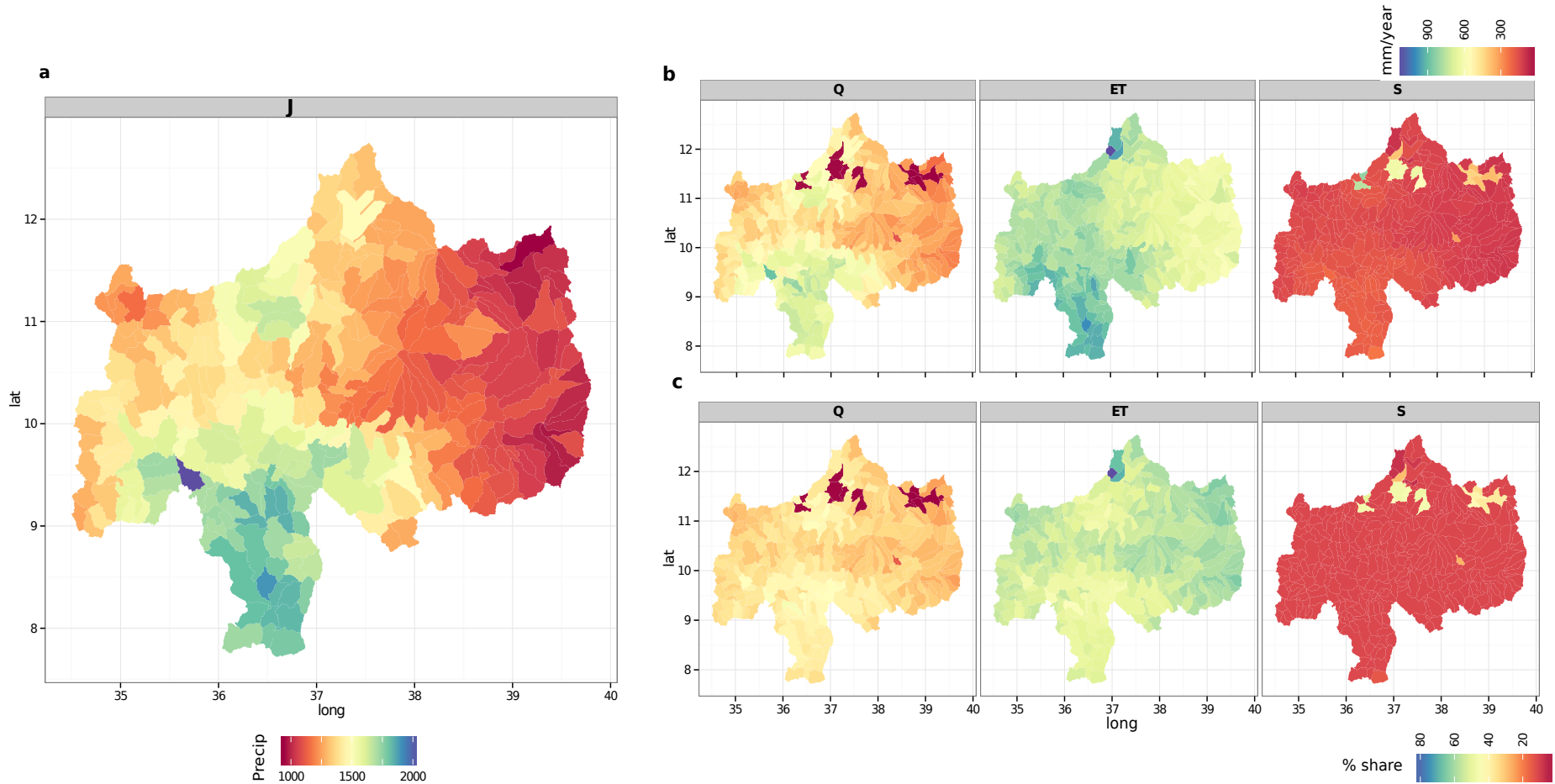


Evapotranspiration

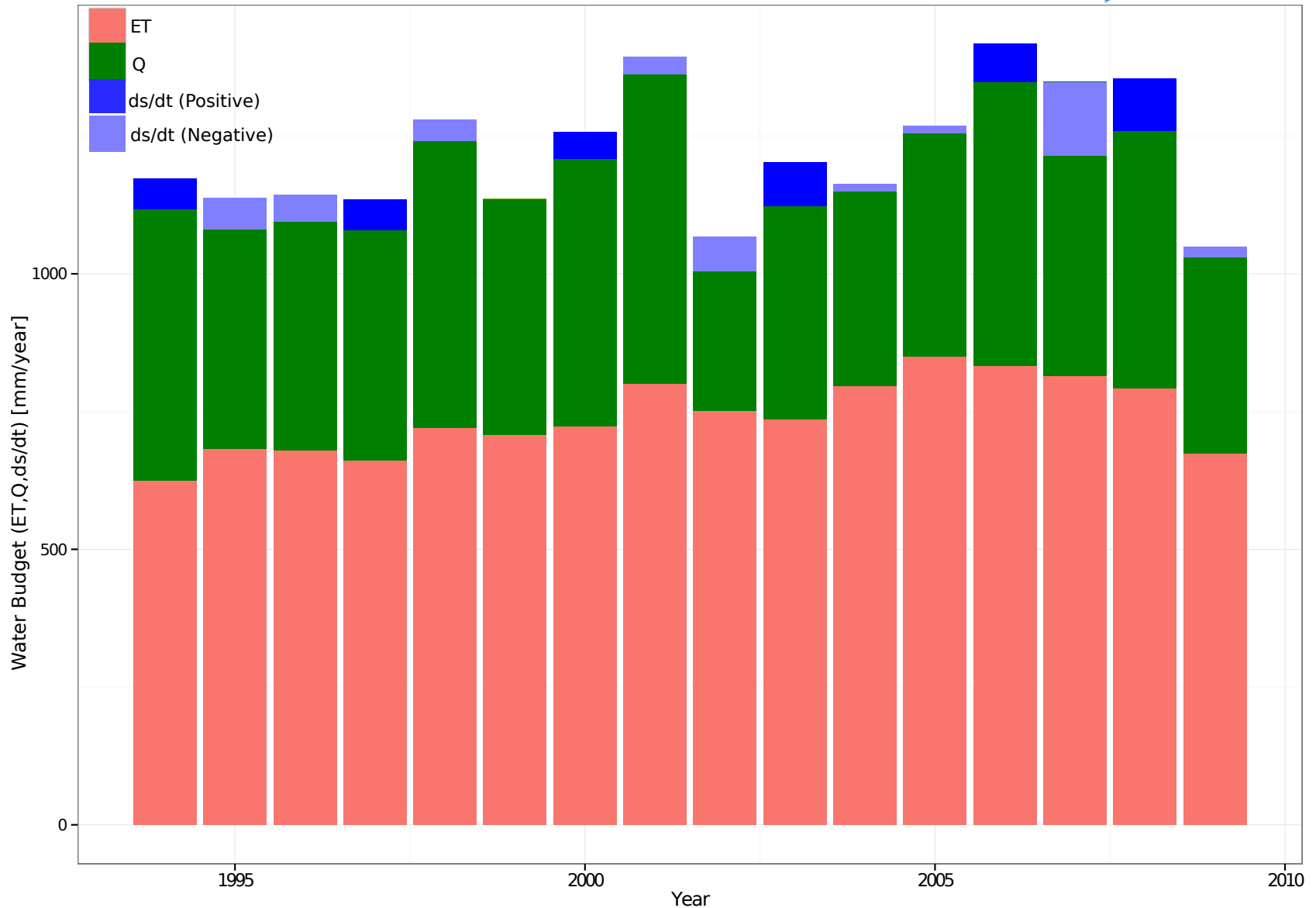
GOF between NewAge
and GLEAM ET



Spatial water budget



Basin average water budget





Thank you for your attention !