



Ongoing and planned drought activities at the JRC:

Towards a European Drought Alert System

Stefan Niemeyer, Ad de Roo, Guido Schmuck

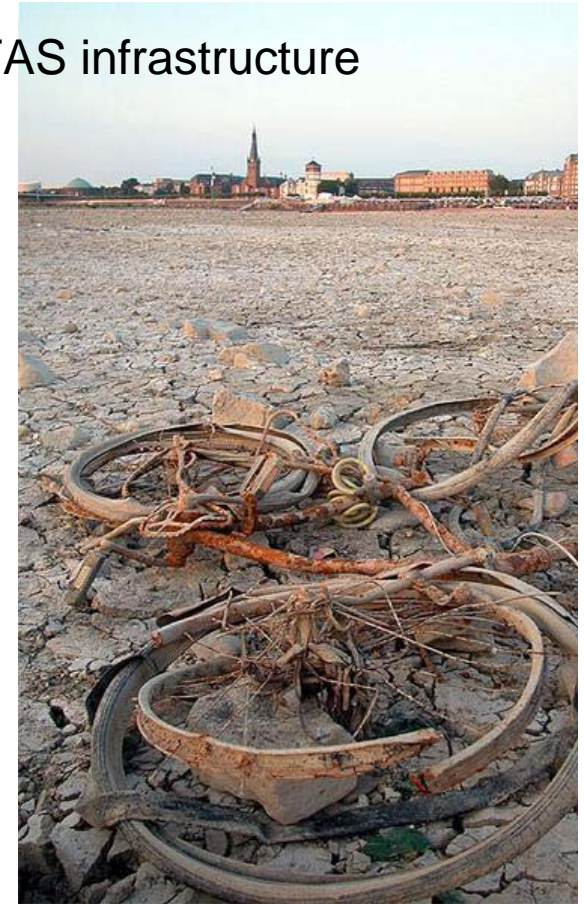


Sicily Joint Workshop on Drought and Water Deficiency:
From Research to Policy Making.
Palermo, 8./9. Oct. 2004



Objectives

- Feasibility of LISFLOOD hydrological model and EFAS infrastructure for drought simulation and forecasting:
 - Low flows
 - Soil water availability
 - Plant water stress
 - Water availability in reservoirs & lakes
 - Groundwater resources
- Vision of a European Drought Alert System (EDAS)
 - analogous to European Flood Alert System
 - using medium-range weather forecasts (3-14 d)
 - using monthly and seasonal forecast products
- Case study Upper Danube catchment area for 2003 drought





LISFLOOD model

a physically based distributed rainfall-runoff model
programmed in a dynamic GIS-language

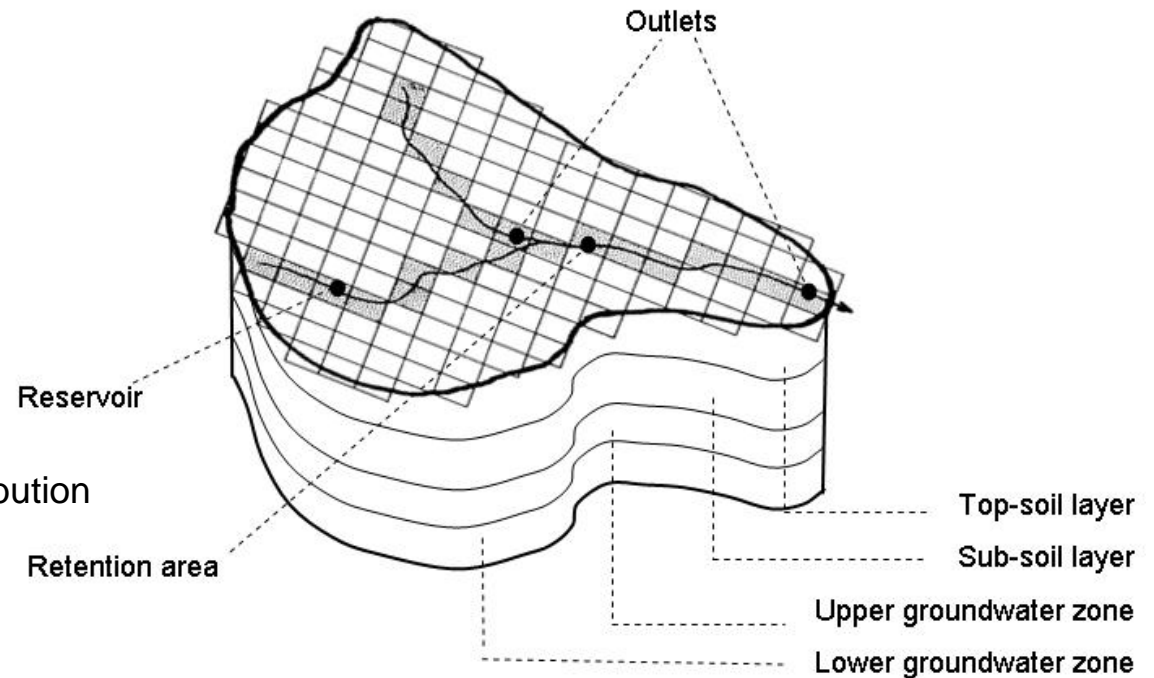
- Division Rainfall/Snow
- Interception
- Evapotranspiration
- Leaf drainage

- Snow melt
- Glacier melt
- Soil freezing
- Infiltration

- Vertical soil moisture redistribution
- Groundwater recharge
- Groundwater flow

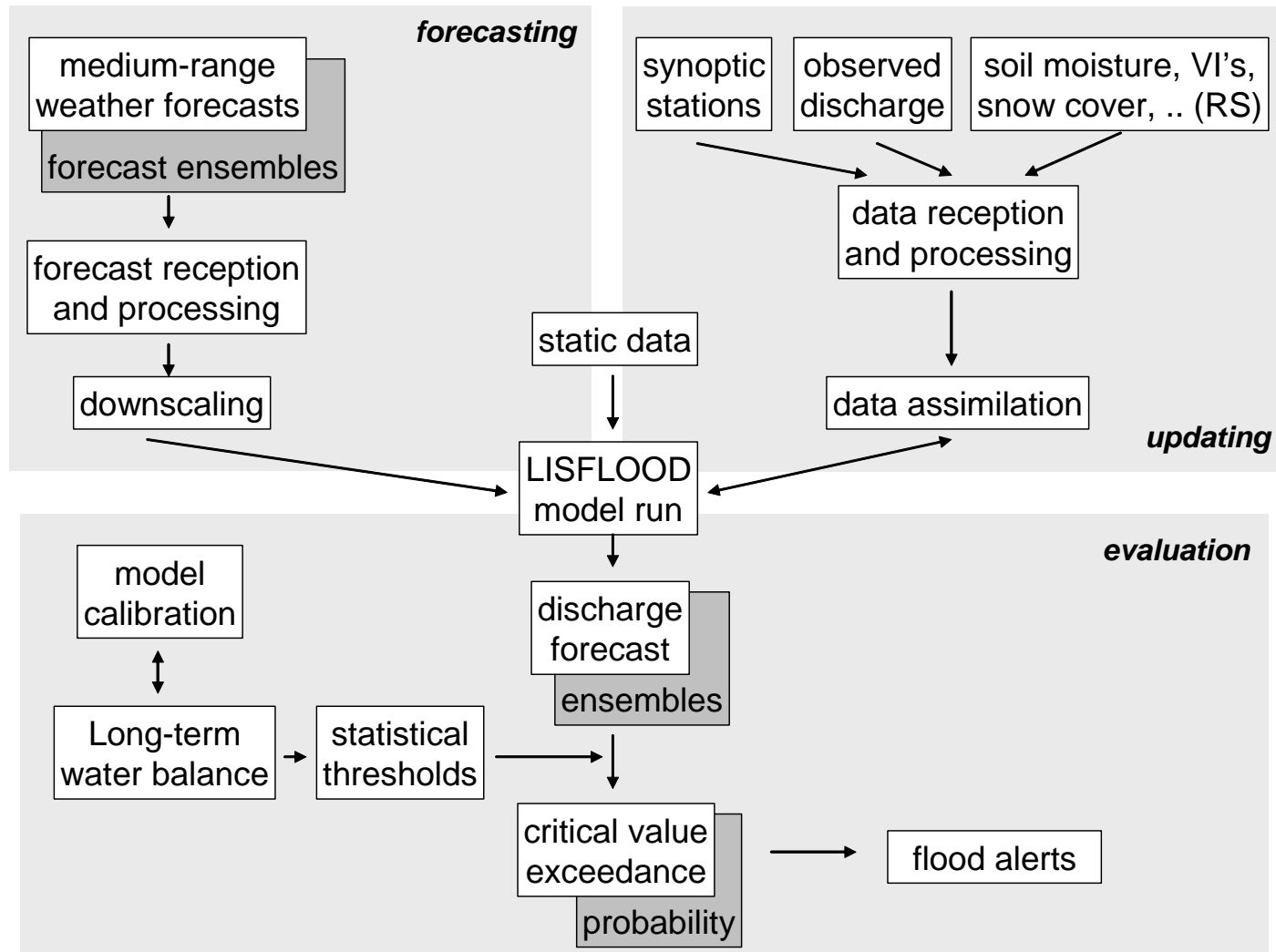
- River channel flow (kinematic and diffusion wave)

- Reservoir operations
- Retention storage / polders
- Lakes
- Dyke breaks (in prep)





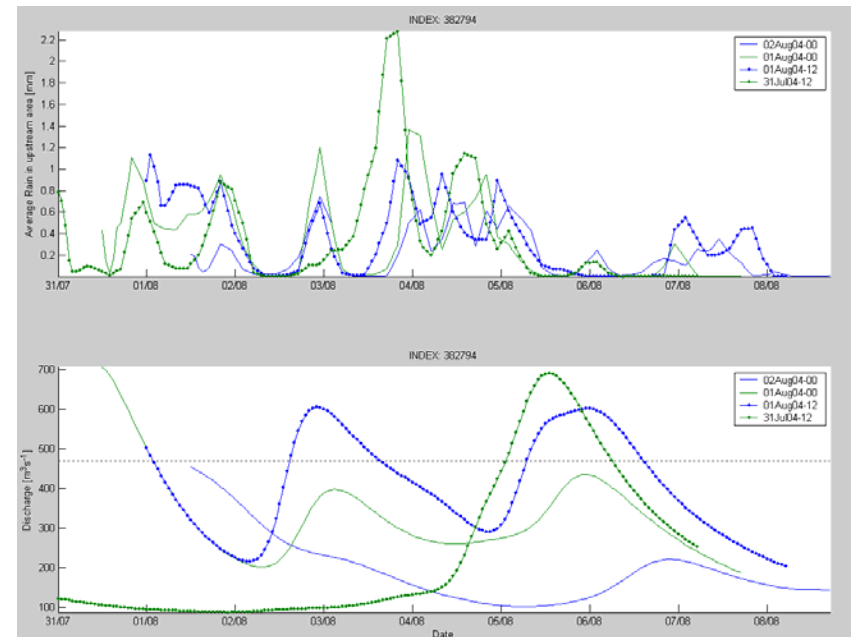
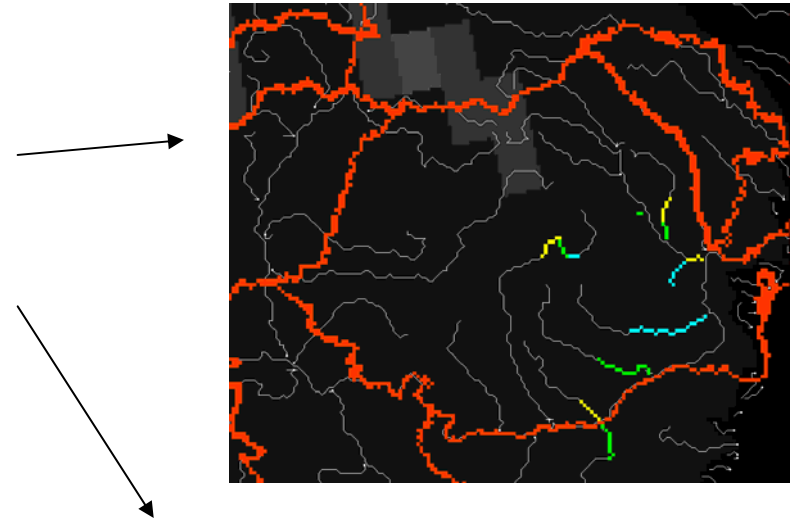
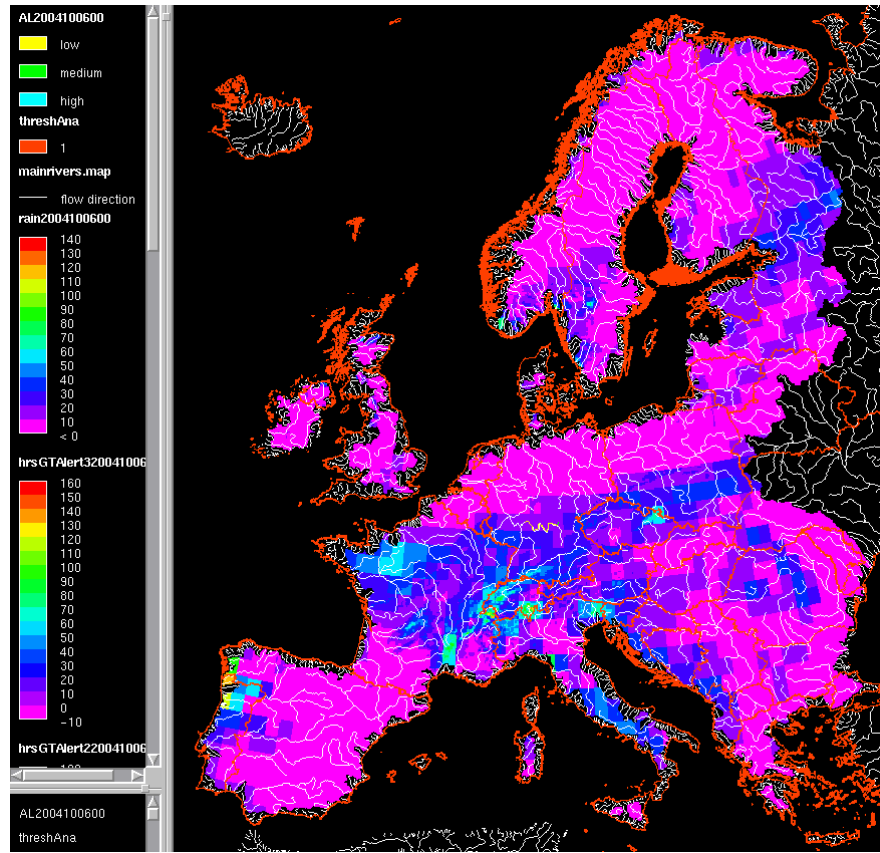
European Flood Alert System





European Flood Alert System

Joint Research Centre





Potential Drought Products

- Hydrographs, indicating low flows
 - Discharges below critical shipping thresholds
 - Discharges below critical drinking water/ water intake thresholds (irrigation, cooling water for industrial plants)
- Soil Moisture Maps
- Soil Water Stress Maps
 - Areas with soil moisture content too low, such that evaporation is reduced: plants under water stress
- Water levels in (hydropower) reservoirs, lakes
- Groundwater levels (?)



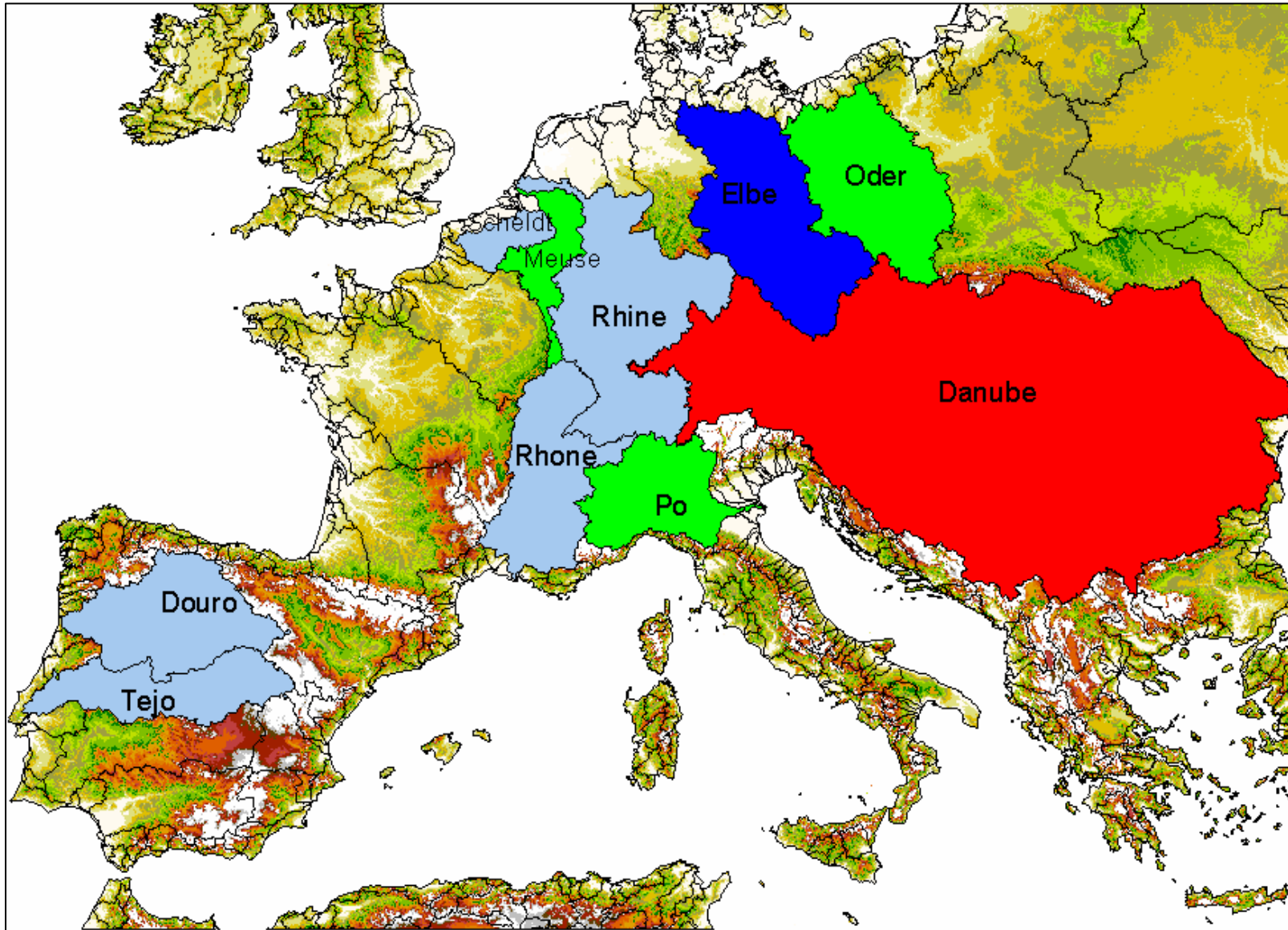
Feasibility Study Droughts

- Examining the existing LISFLOOD hydrological model regarding synergies and limitations for drought simulation and forecasting
- Current LISFLOOD version part of EFAS = European Flood Alert System
- Emphasis on the representation of soil and groundwater components as well as of evapotranspiration processes
 - Both not very important for flood modelling...
 - ...but for droughts!
- Different requirements for meteorological data input
 - For flood forecasting medium-range forecasts up to 10 days are sufficient
 - For drought forecasting monthly or even seasonal forecasts will be necessary
 - + ... similar data formats and processing (ECMWF)
 - ... decreasing accuracy!



Feasibility Study Droughts

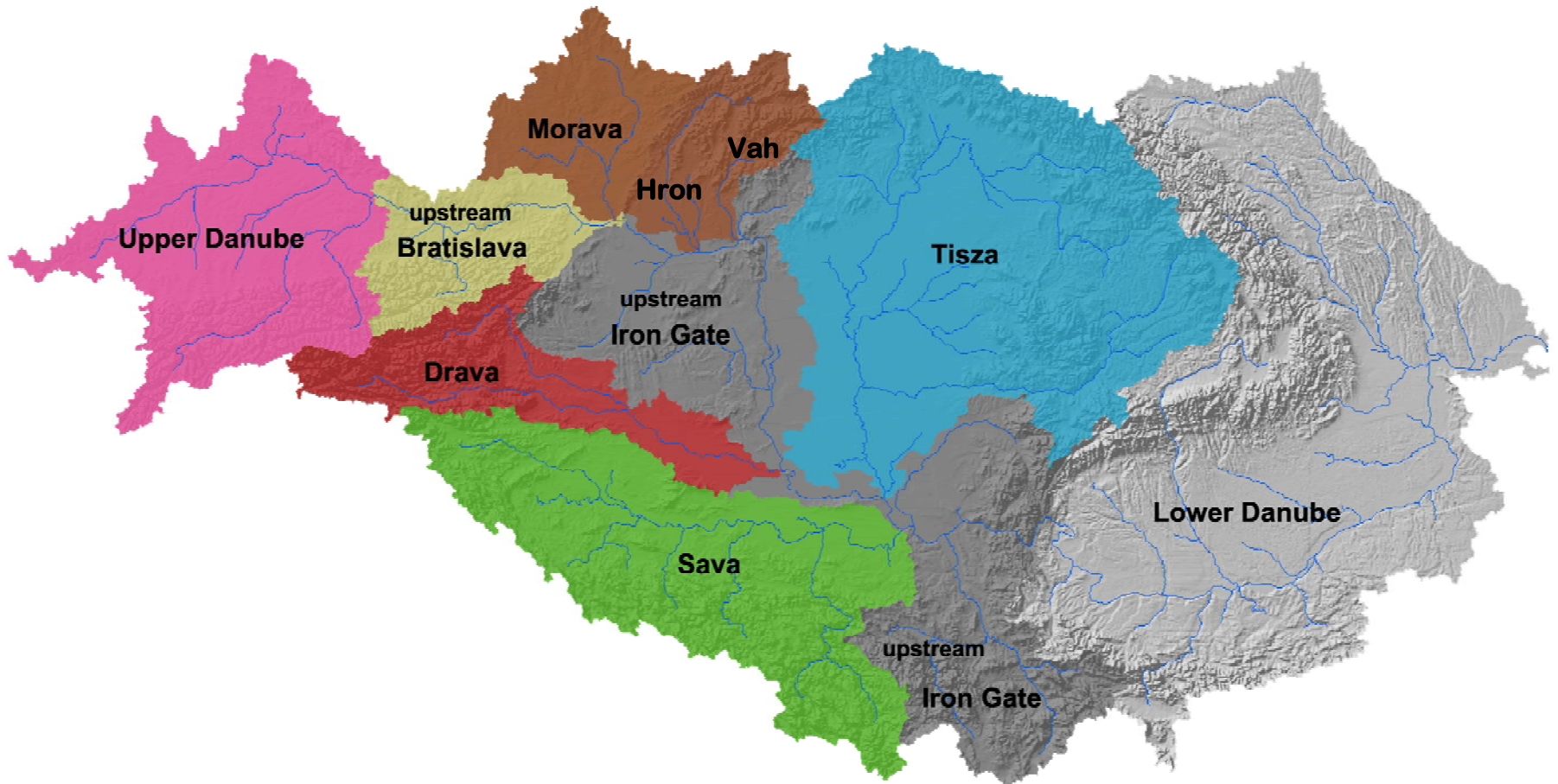
- First preliminary results, concentrating on:
 - Danube catchment area
 - Largest catchment area in Europe
 - 817'000 km²
 - 2'780 km length
 - European drought period of year 2003





Danube Catchment Area

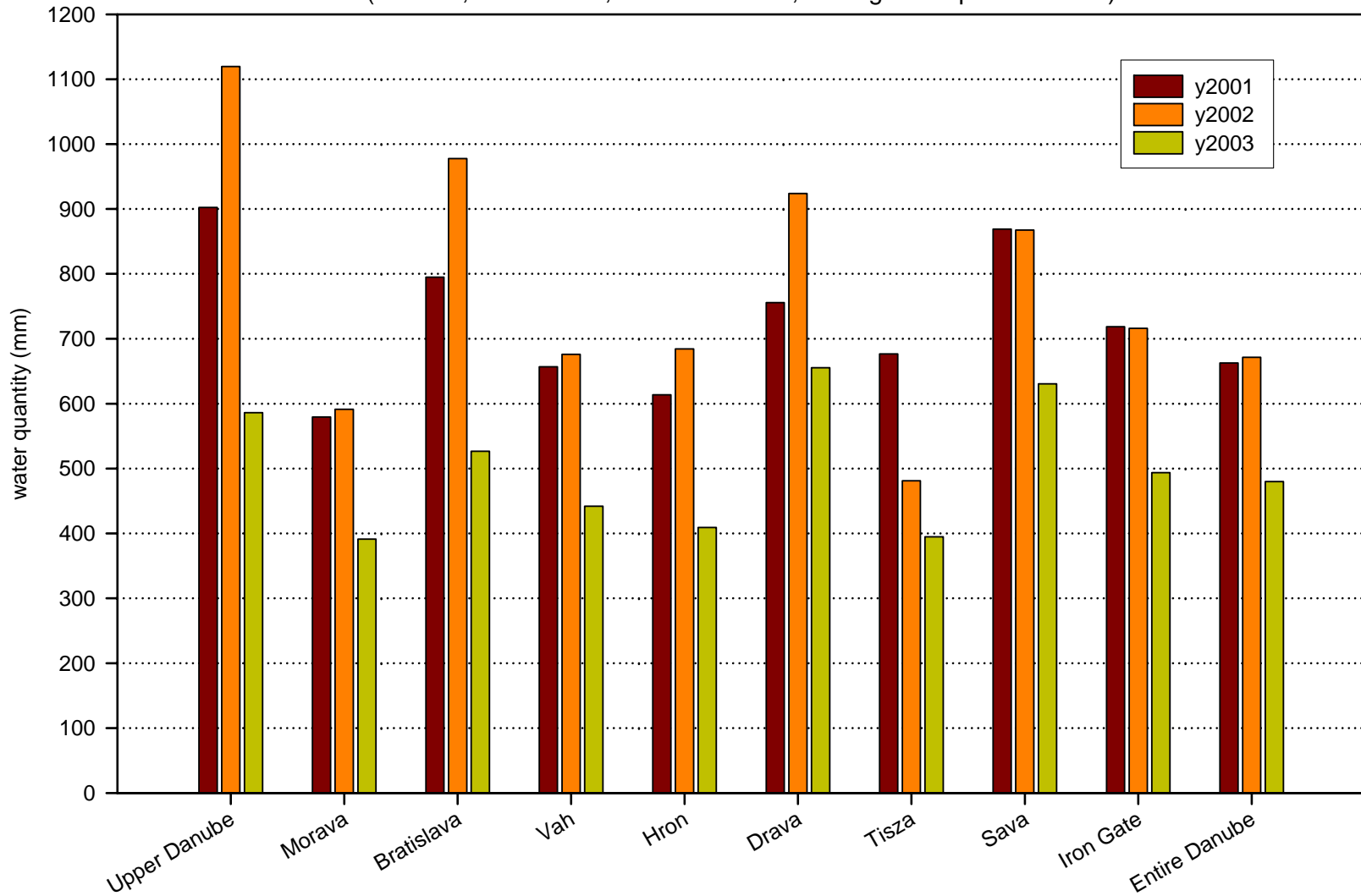
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Danube Catchment Area

Danube catchment area 2001-2003: annual precipitation
(Lisflood, MARS data, init: 01.01.2000, averages of upstream area)

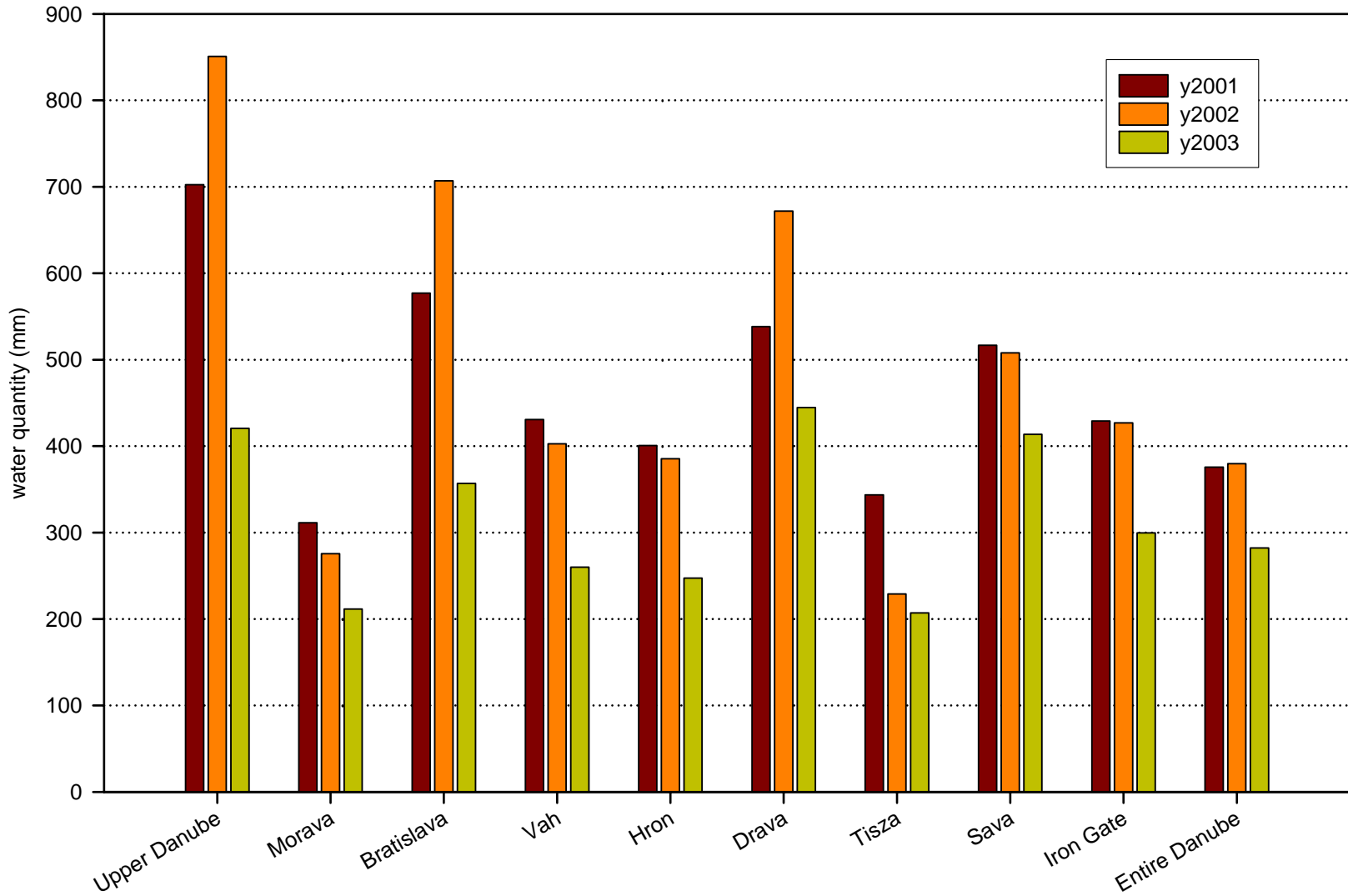




Danube Catchment Area

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Danube catchment area 2001-2003: annual runoff (Lisflood, MARS data, init: 01.01.2000)

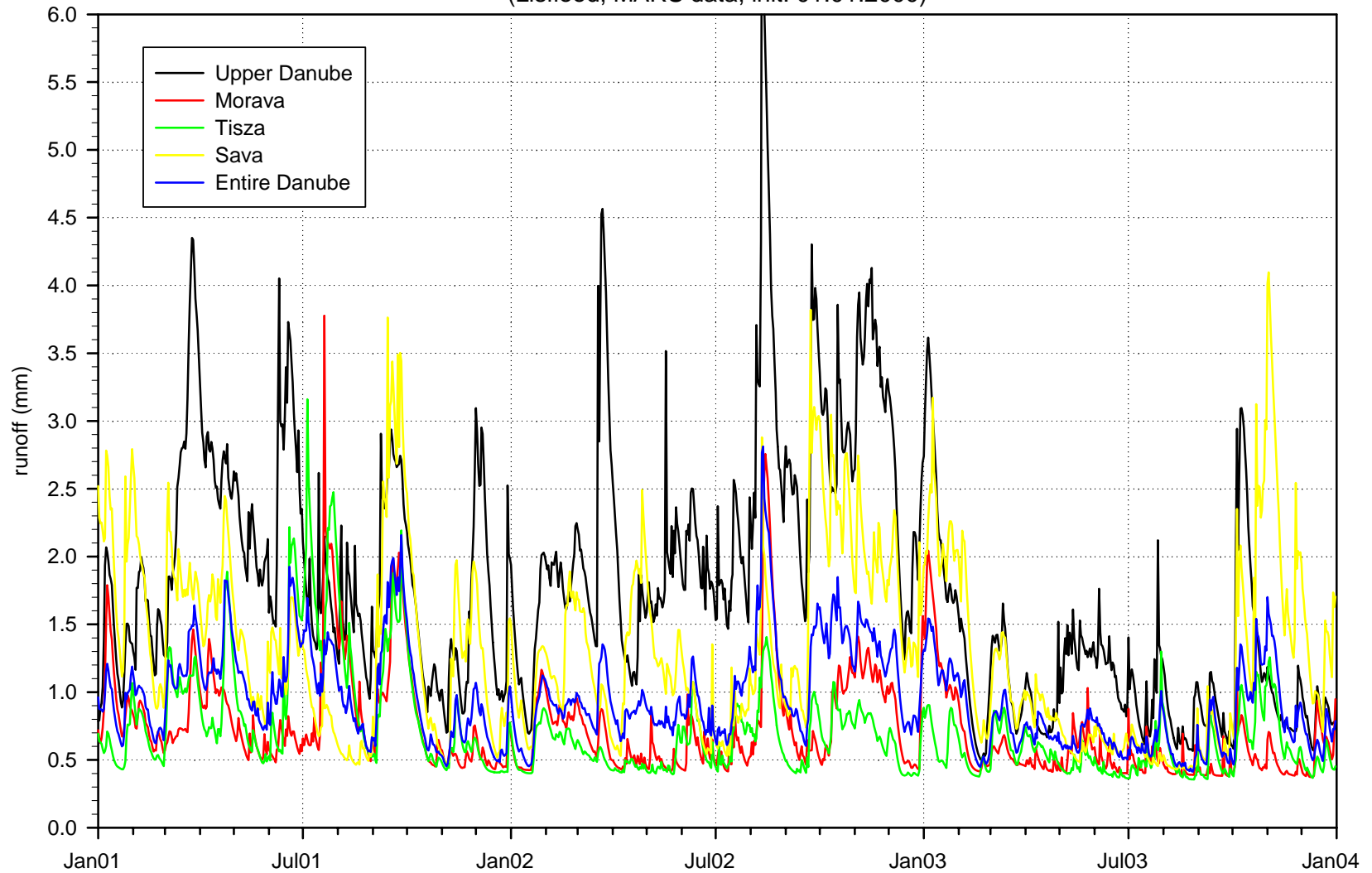




Danube Catchment Area

Danube catchment area: runoff in sub-catchments 2001-2003

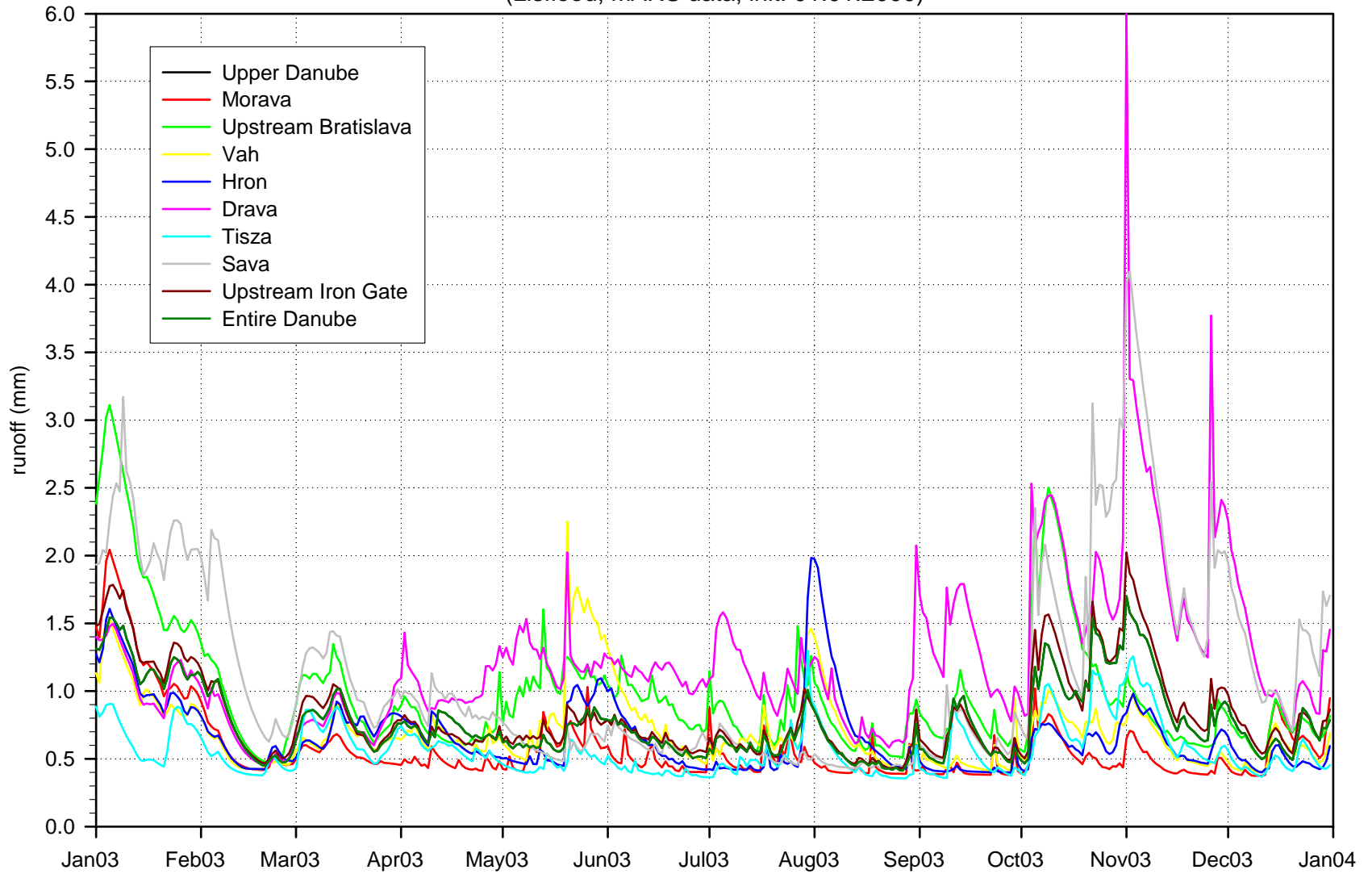
(Lisflood, MARS data, init: 01.01.2000)





Danube Catchment Area

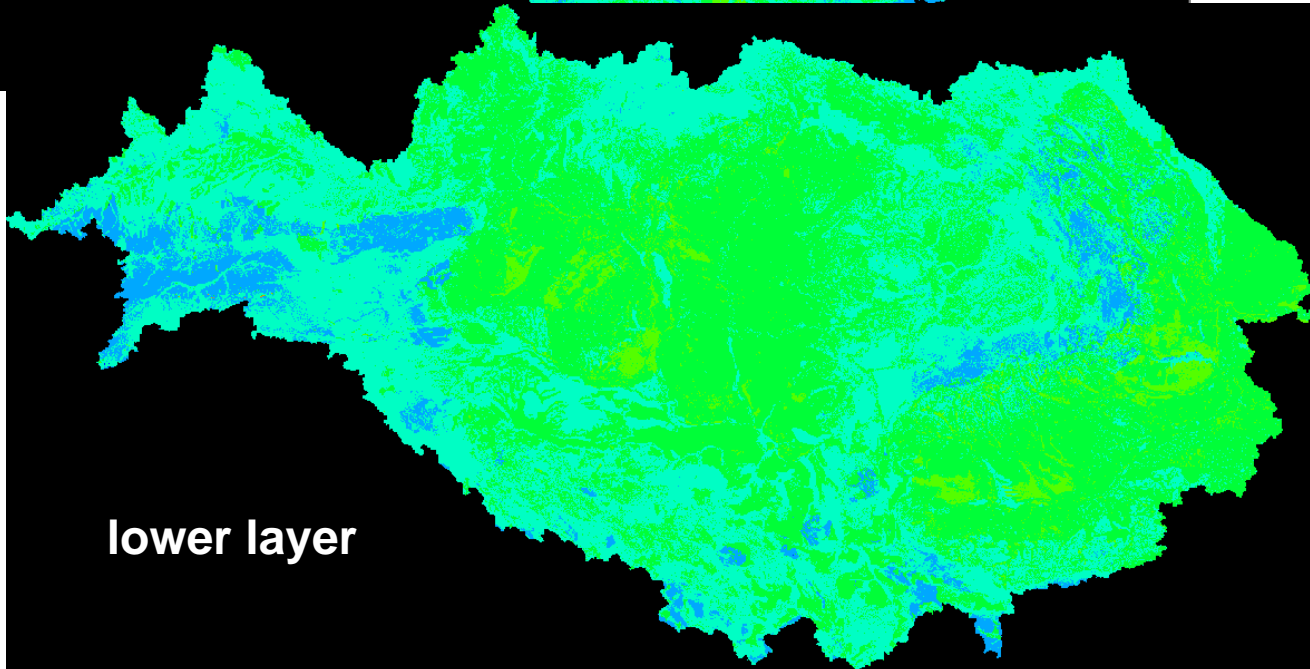
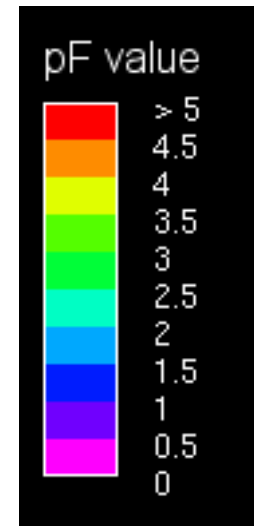
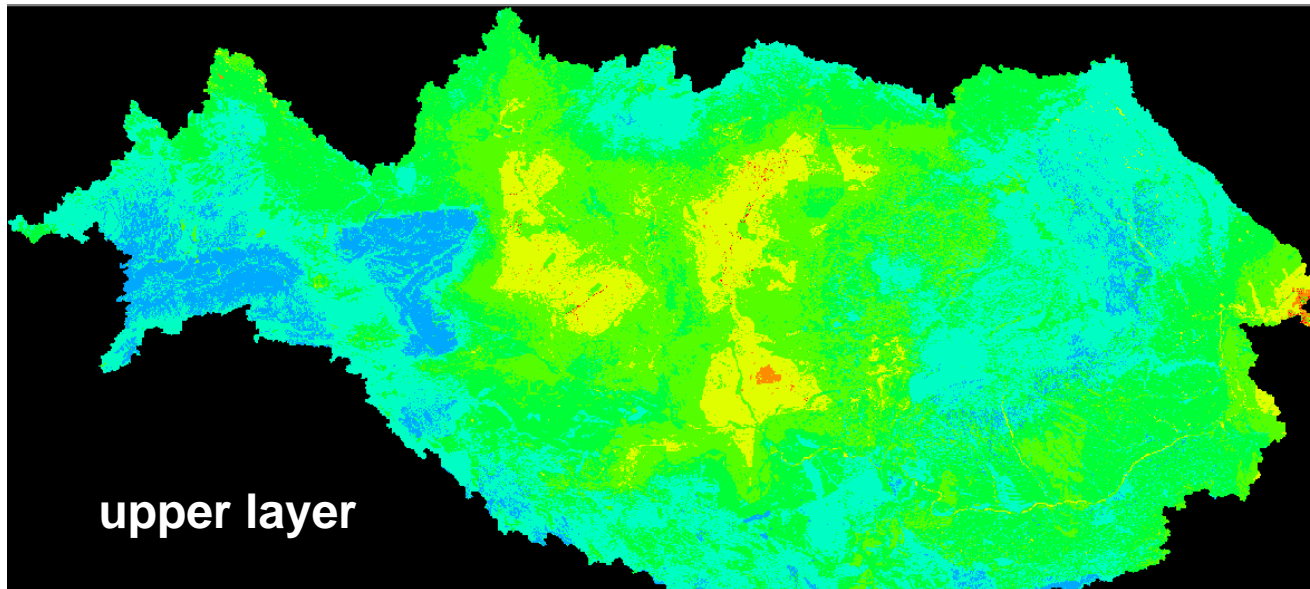
Danube catchment area: runoff in sub-catchments 2003
(Lisflood, MARS data, init: 01.01.2000)





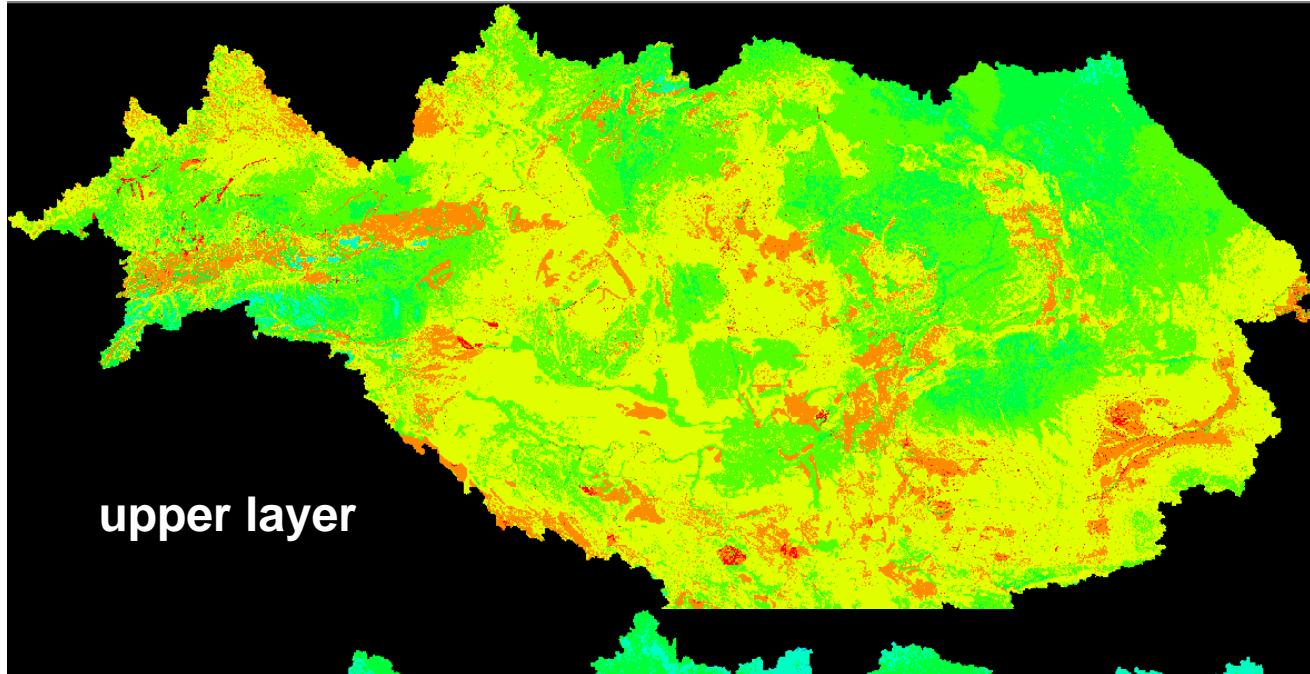
Soil Moisture in Aug. 2002

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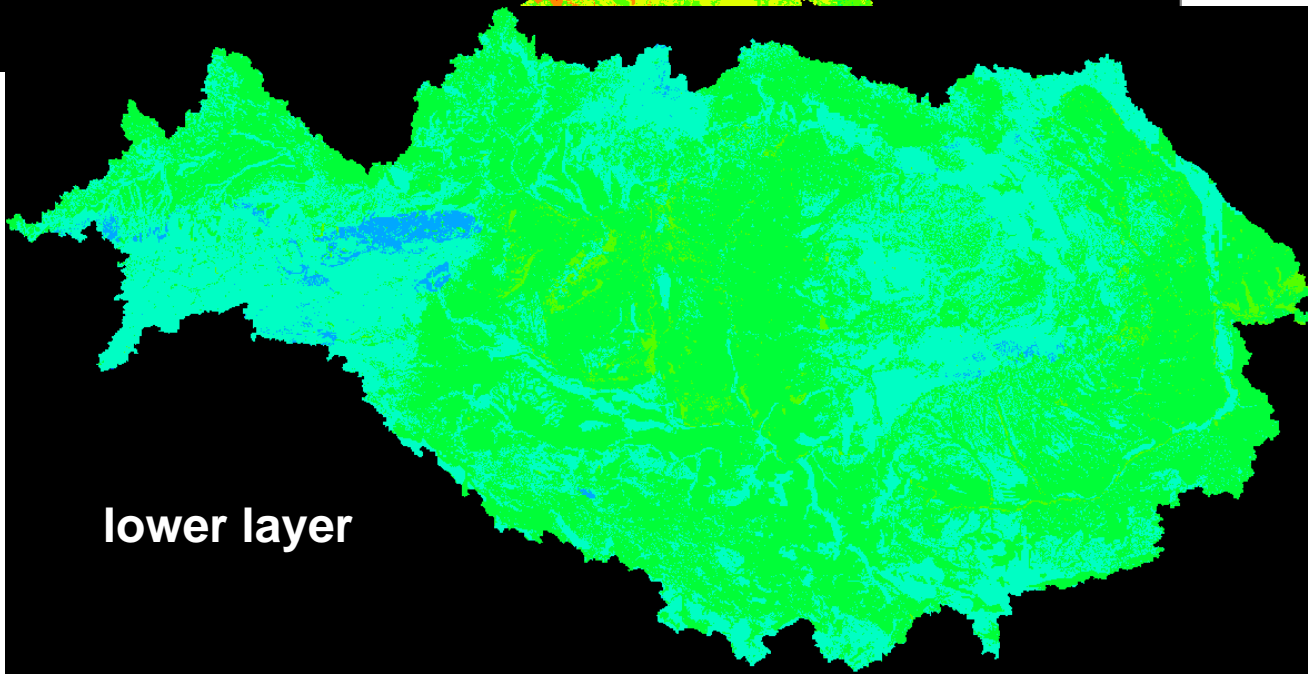
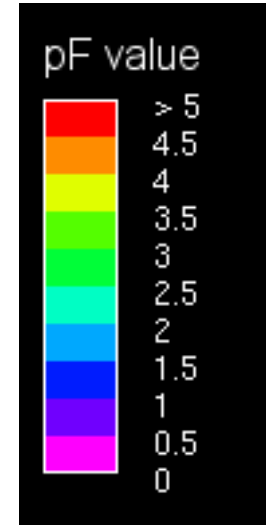




Soil Moisture in Aug. 2003



upper layer

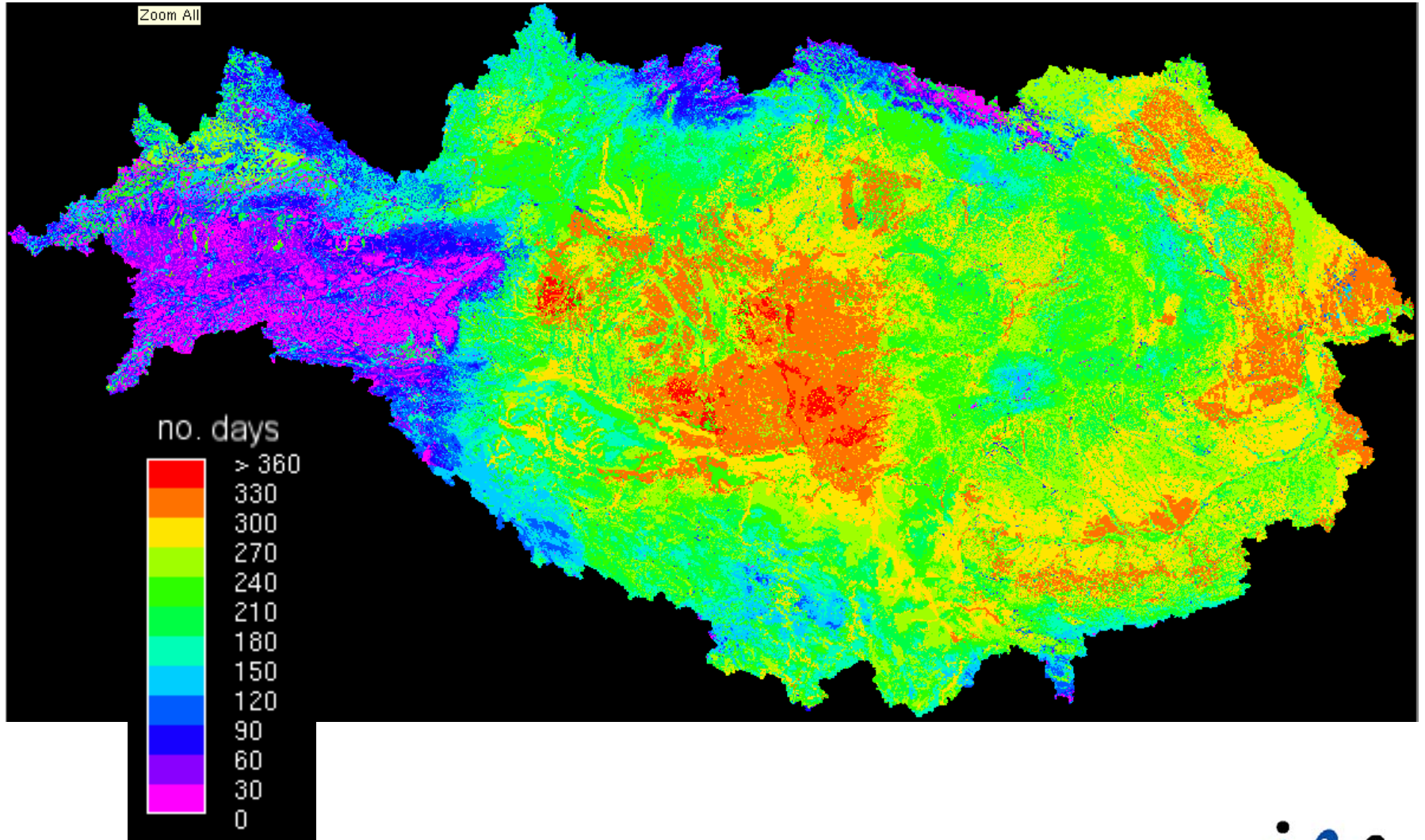


lower layer



Soil Moisture Stress Days in 2000

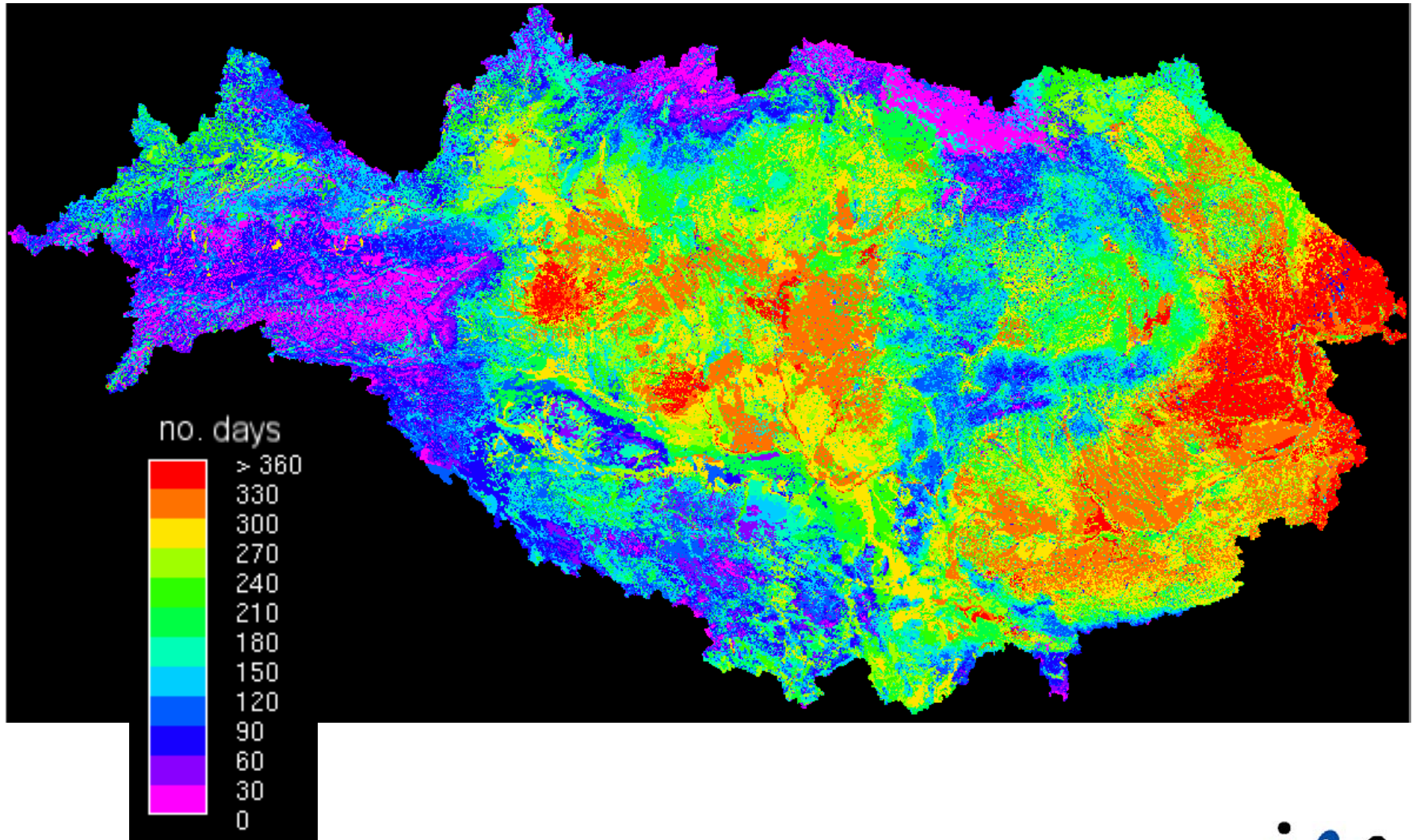
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Soil Moisture Stress Days in 2001

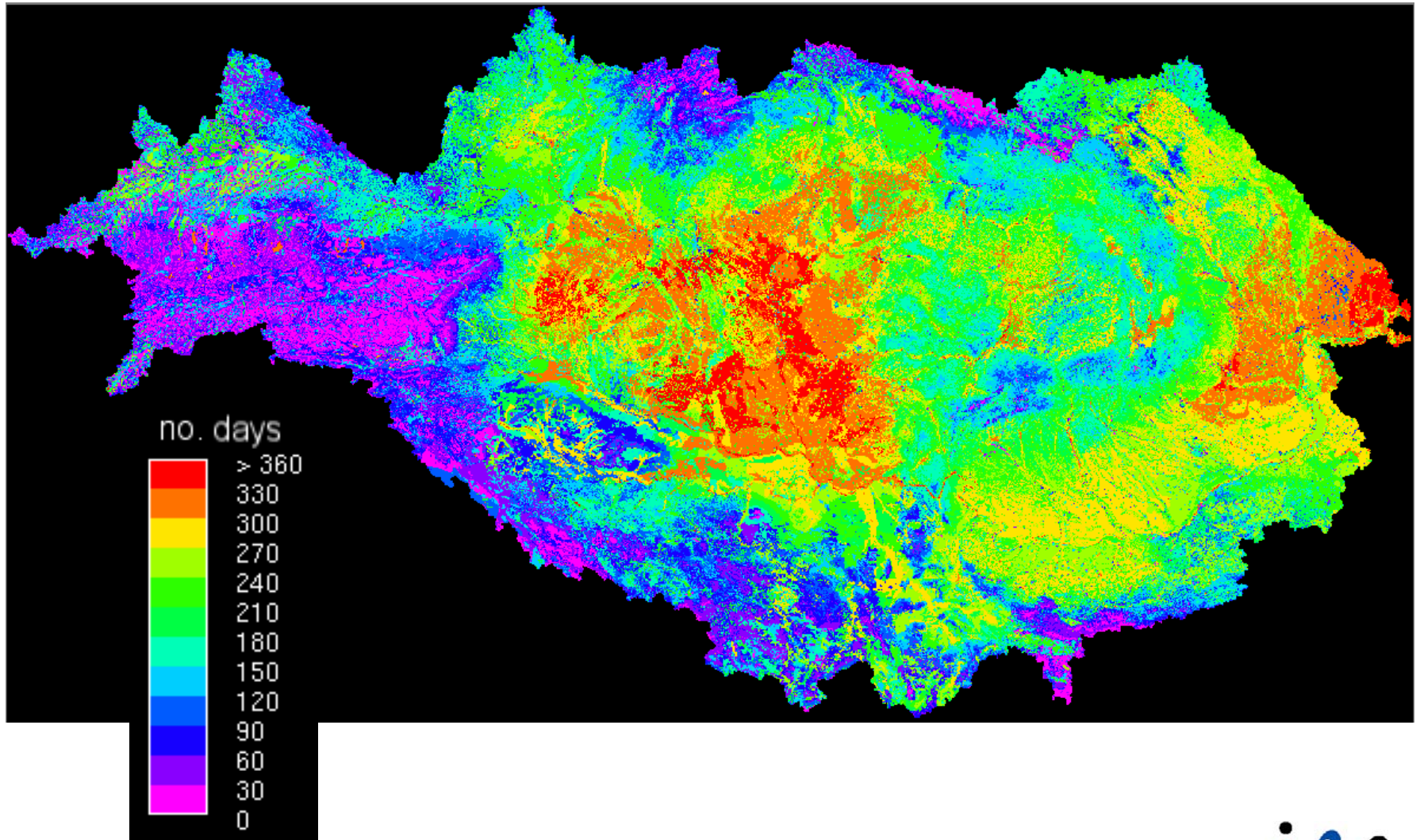
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Soil Moisture Stress Days in 2002

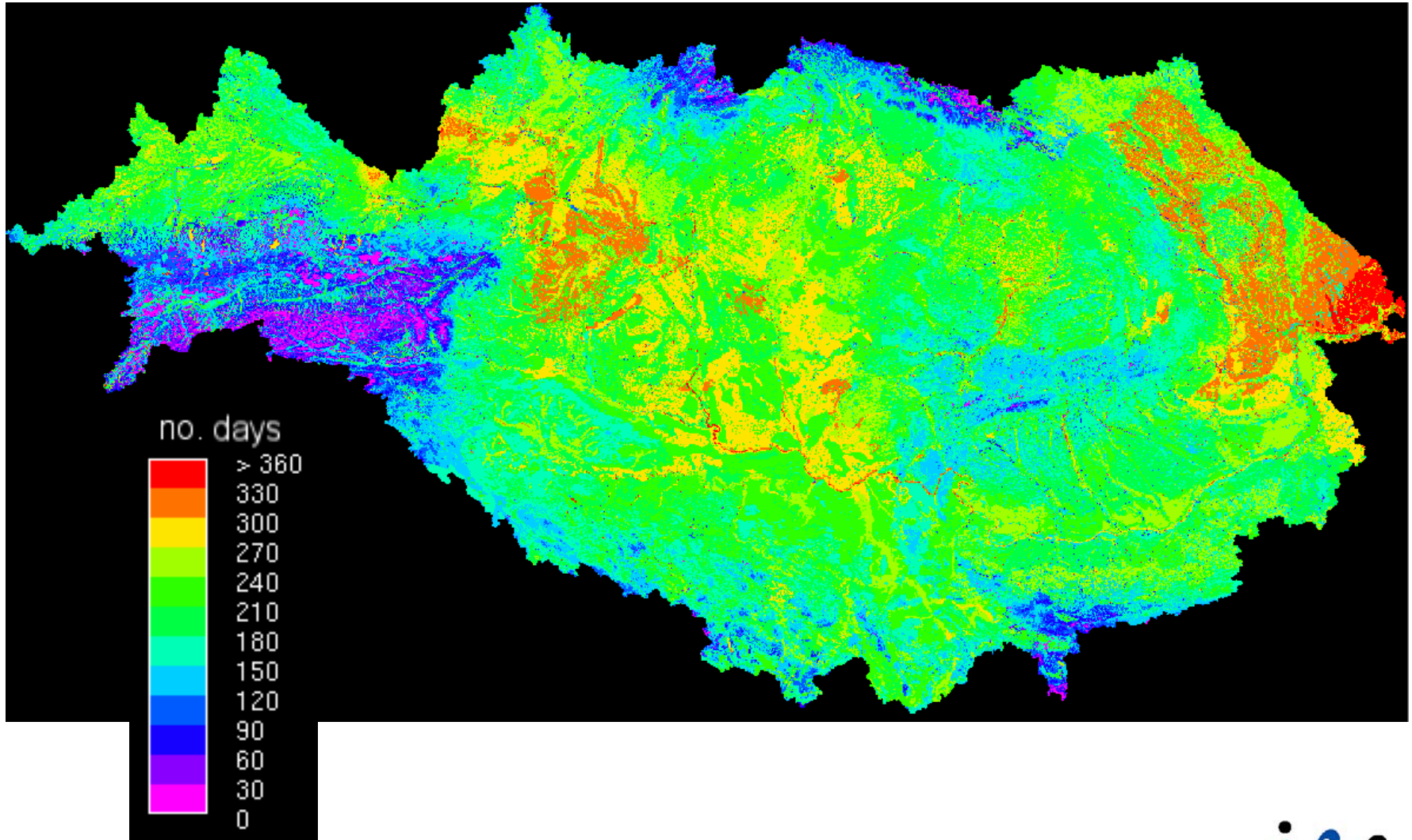
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Soil Moisture Stress Days in 2003

Joint Research Centre





Feasibility Study Droughts

- First preliminary results, concentrating on:
 - Upper Danube catchment
 - Upstream region of Danube river
 - Usually water surplus area
 - 77'000 km²
 - ~ 400 km length
 - drought period in summer 2003

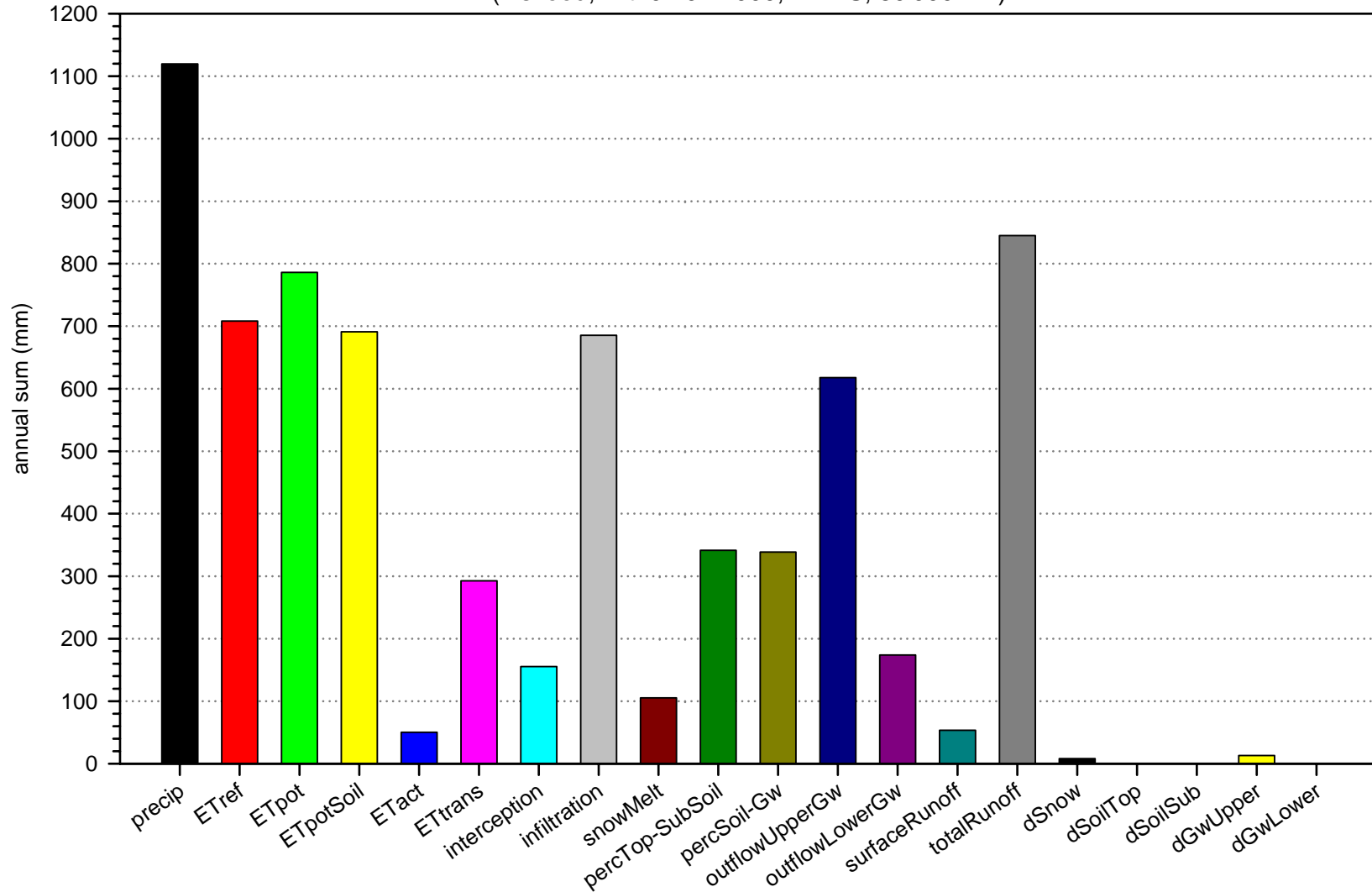


Water Balance Components 2002

water balance terms Upper Danube catchment area, year 2002

(Lisflood, init: 01.01.2000, MARS, 80'000km²)

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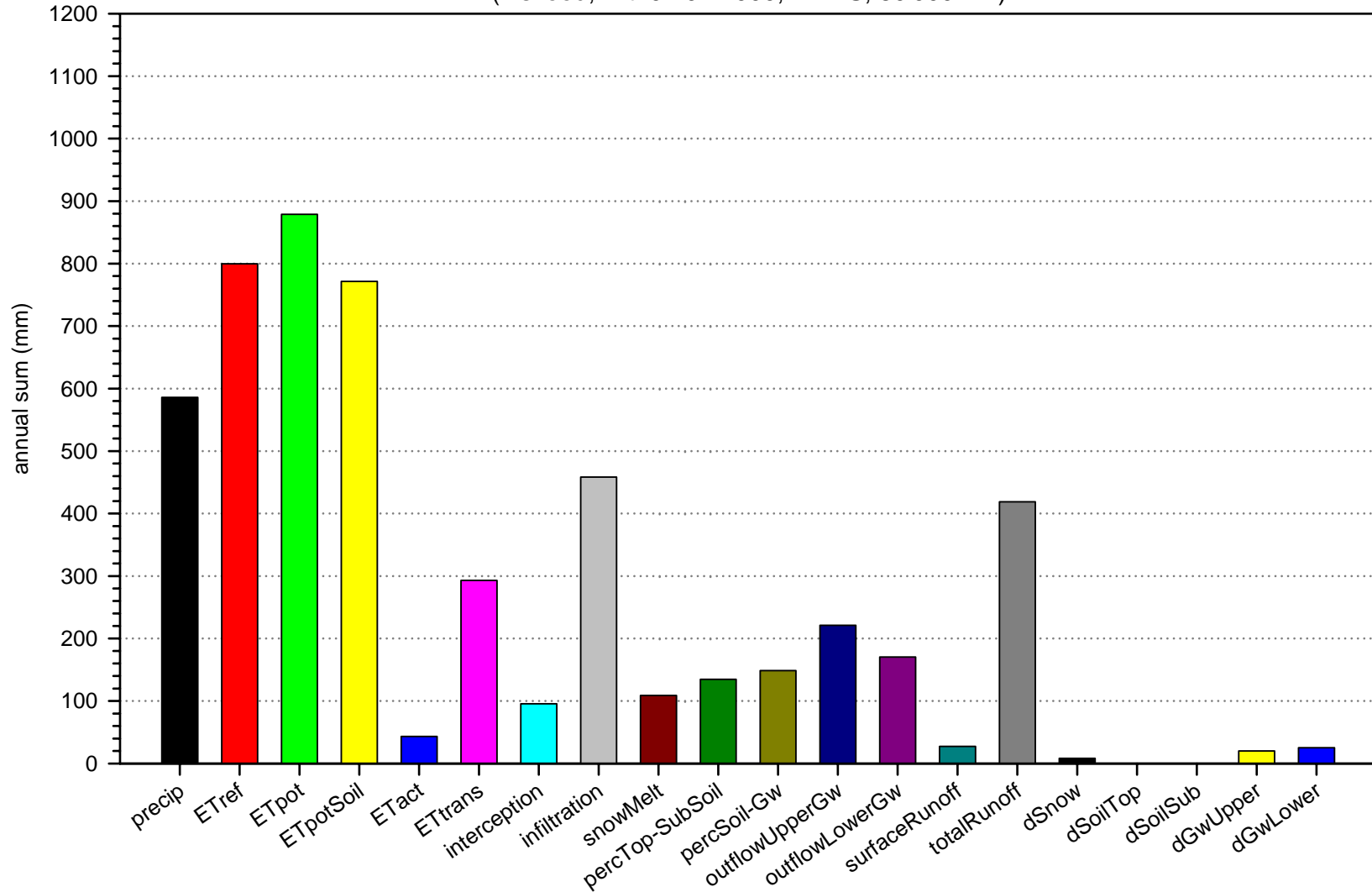


Water Balance Components 2003

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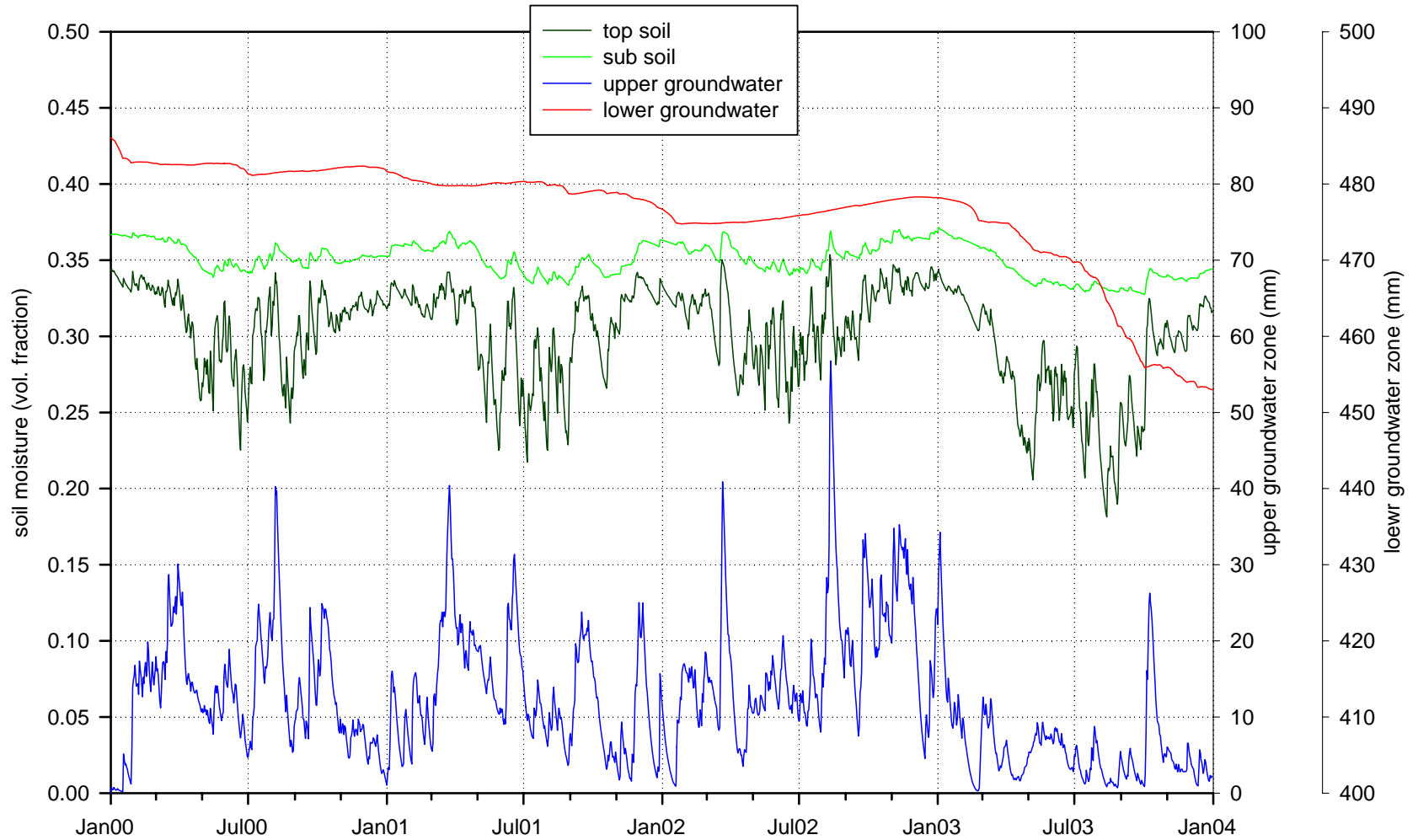
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Soil Water and Groundwater Content

Modelling Upper Danube catchment area 2000-2003
(Lisflood, MARS data, daily, two soil & two gw layers modelled)

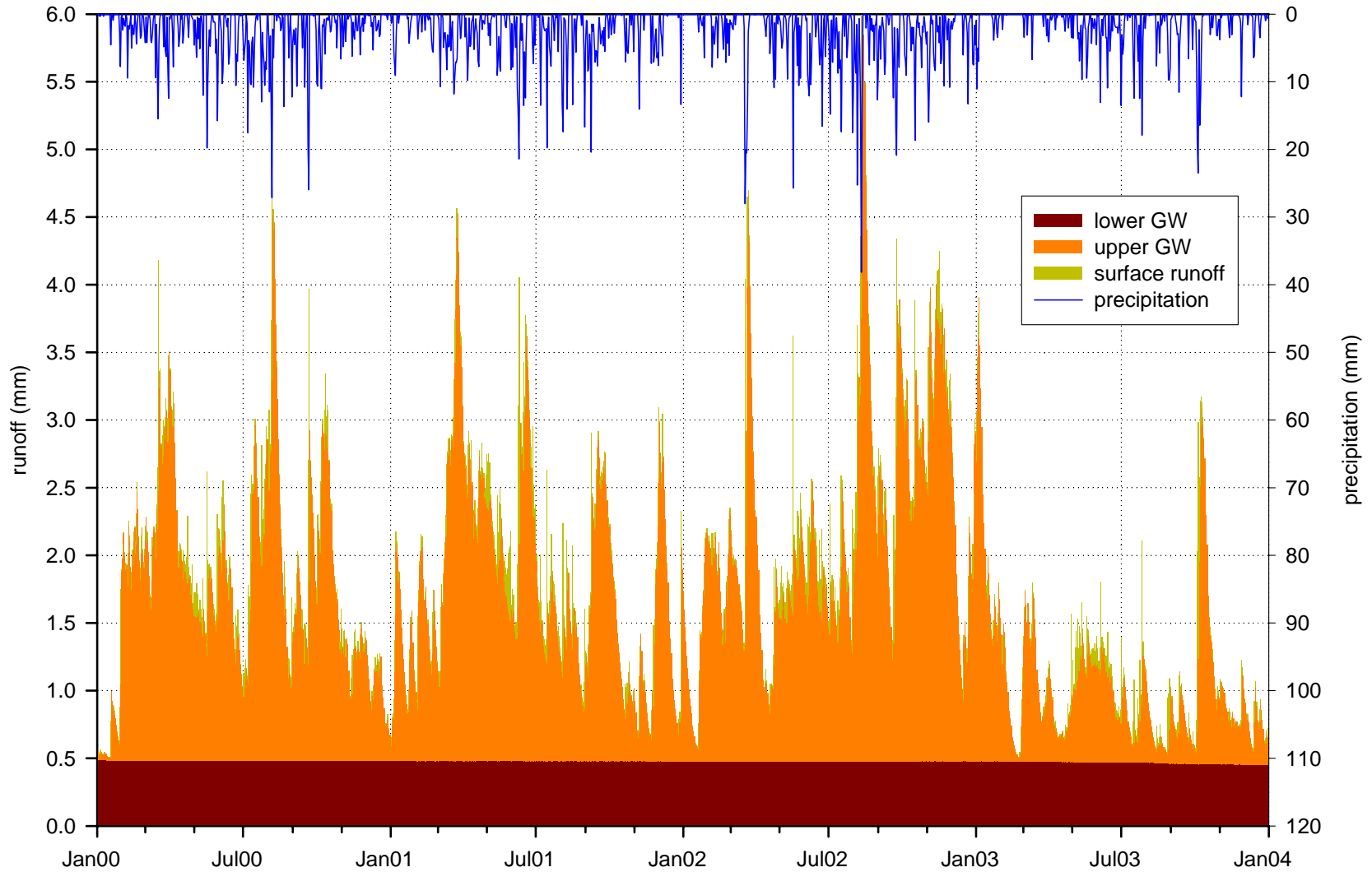


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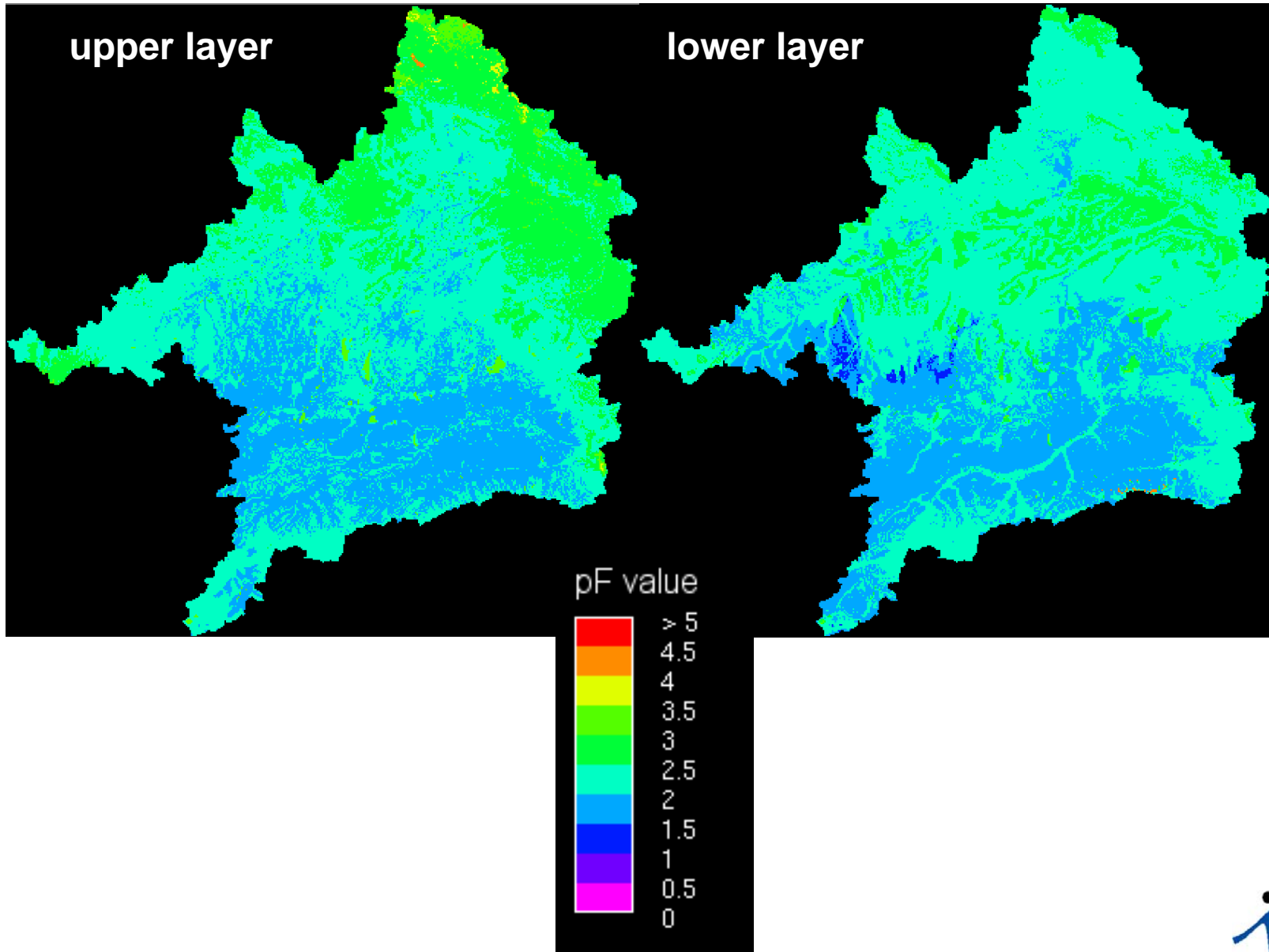
Runoff Components

Modelling Upper Danube catchment area 2000-2003
(Lisflood, MARS data, daily, two soil & two gw layes modelled)



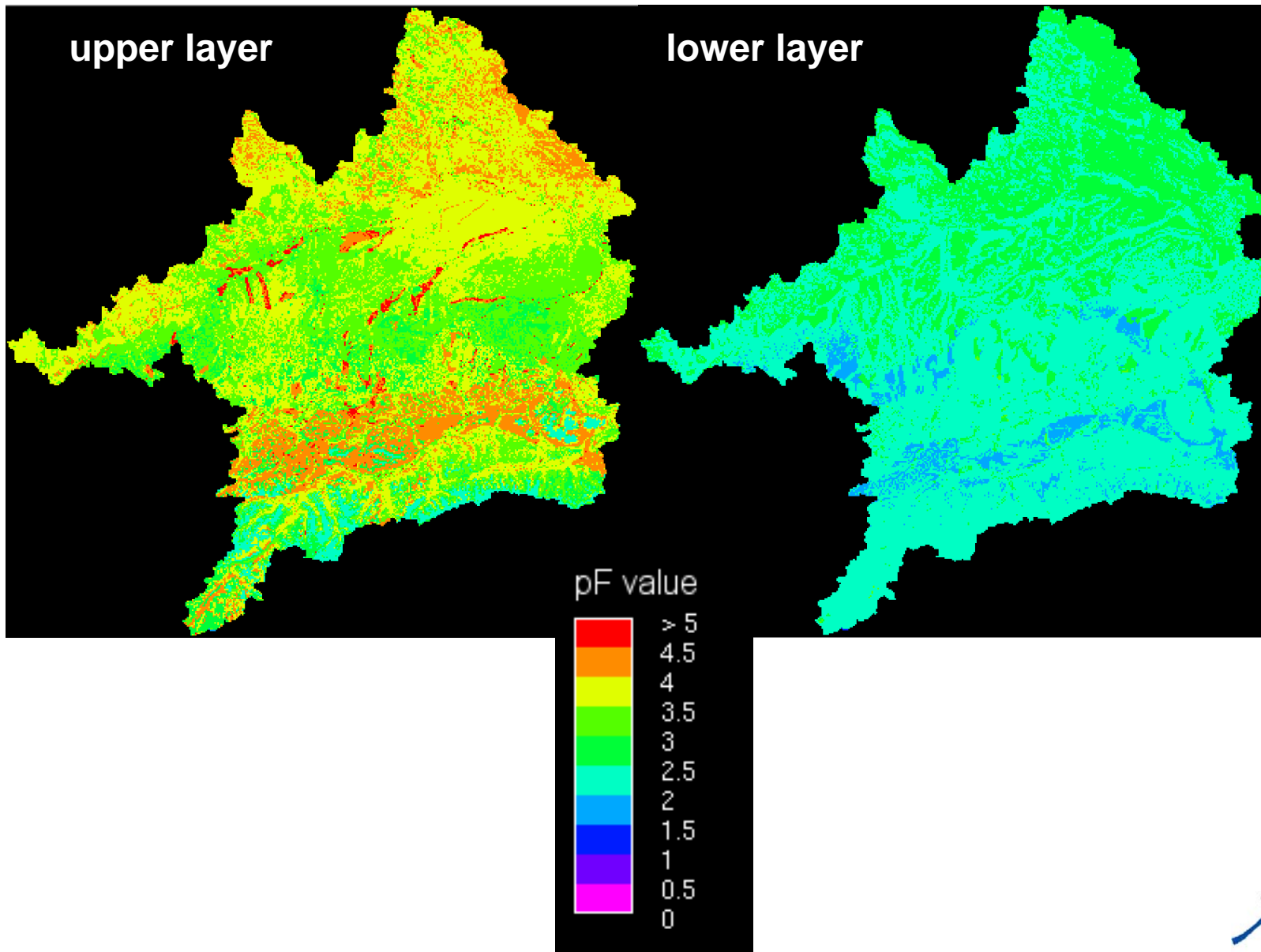


Soil Moisture Aug. 2002





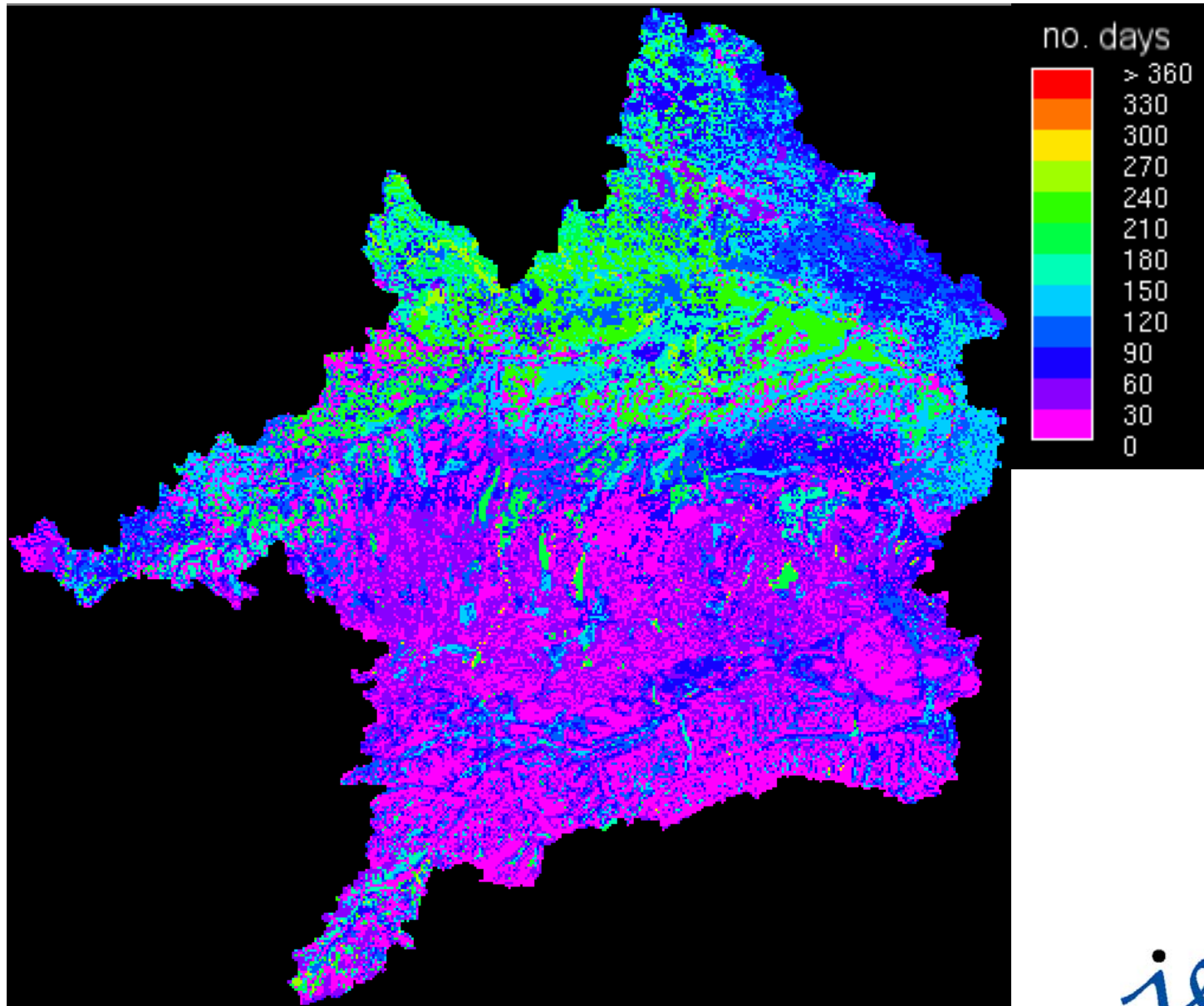
Soil Moisture Aug. 2003





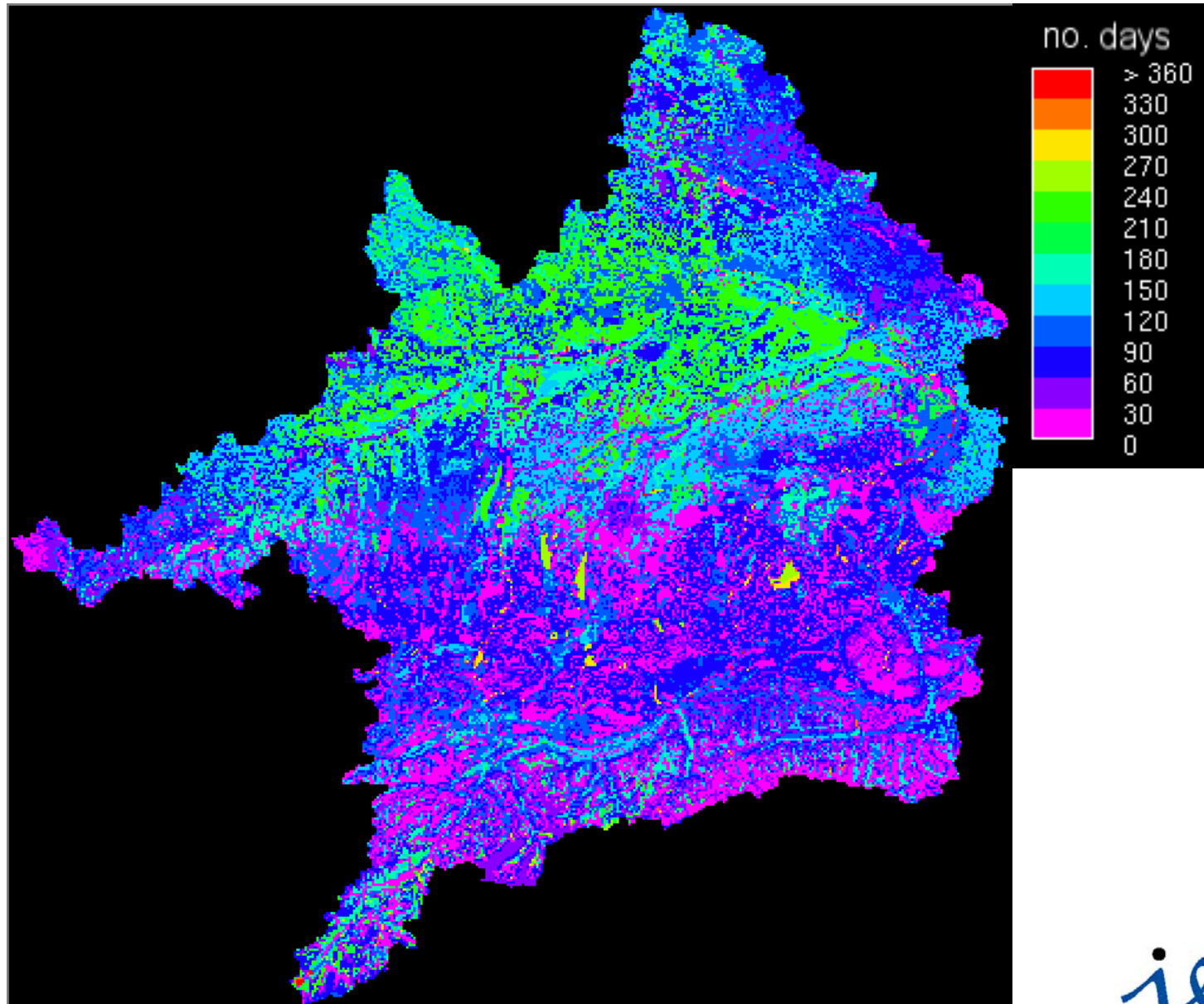
Soil Moisture Stress Days 2000

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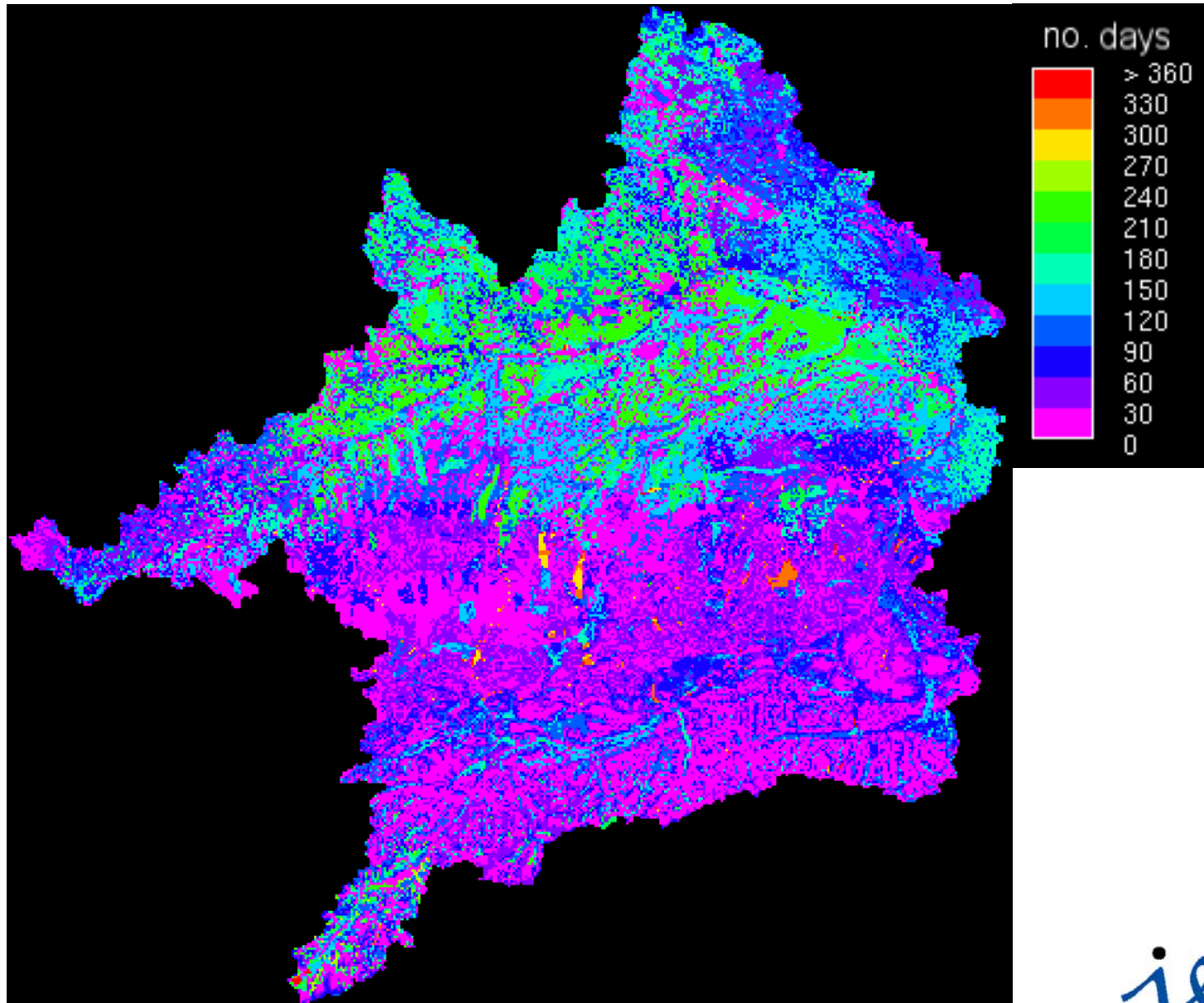


Soil Moisture Stress Days 2001



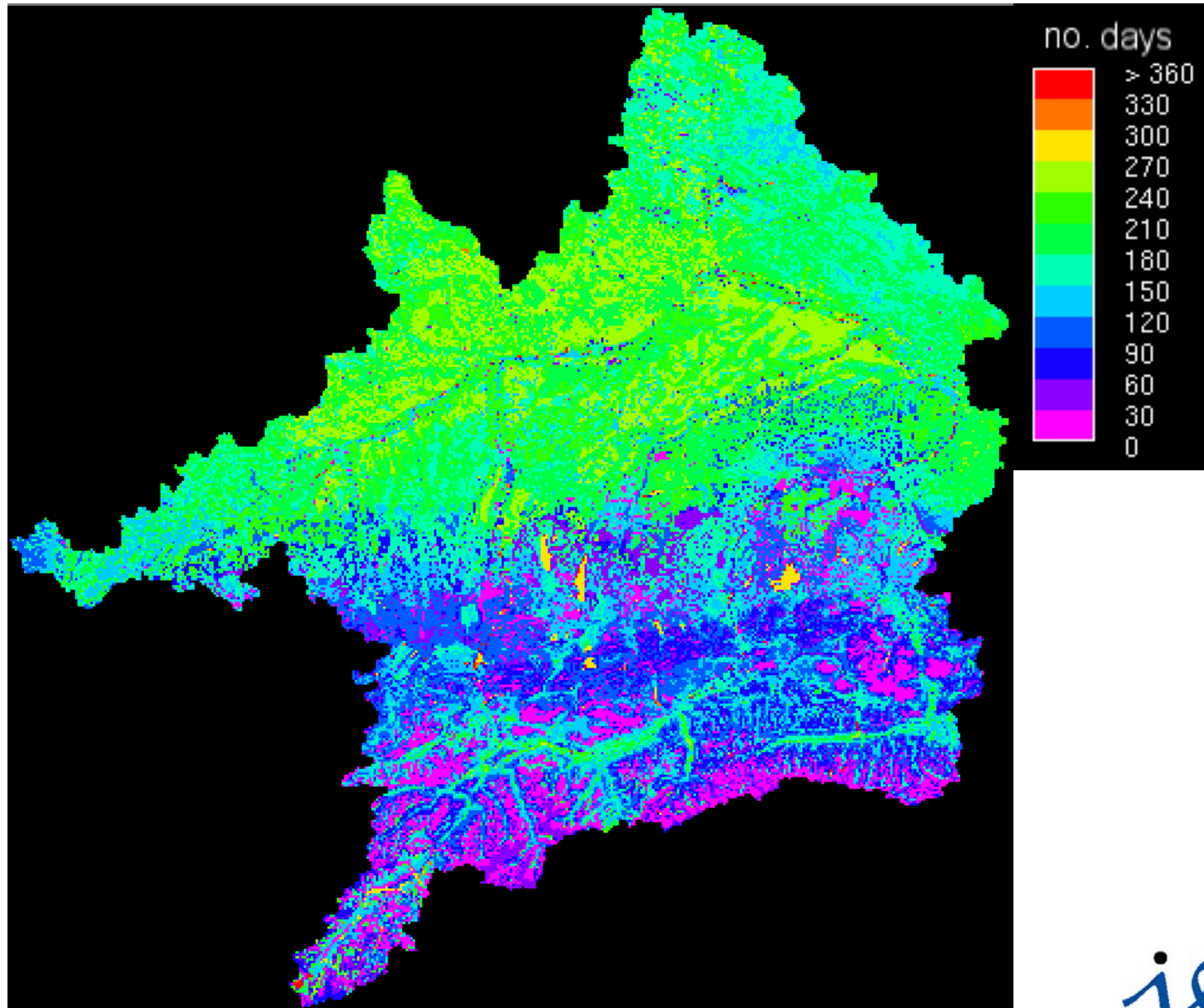


Soil Moisture Stress Days 2002





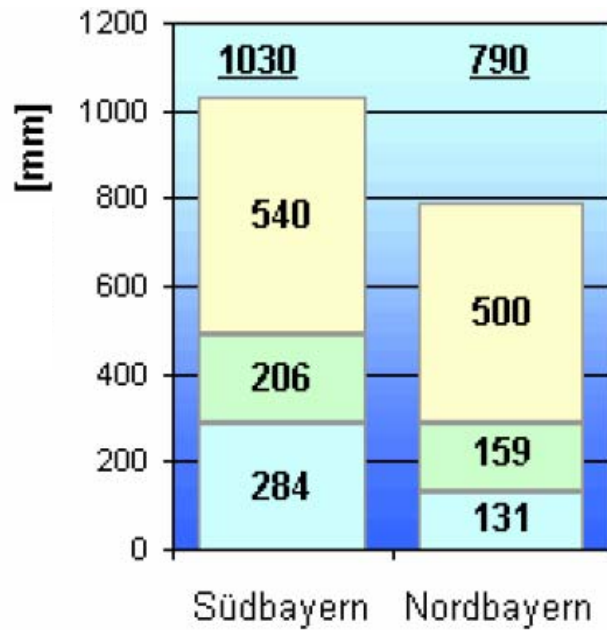
Soil Moisture Stress Days 2003



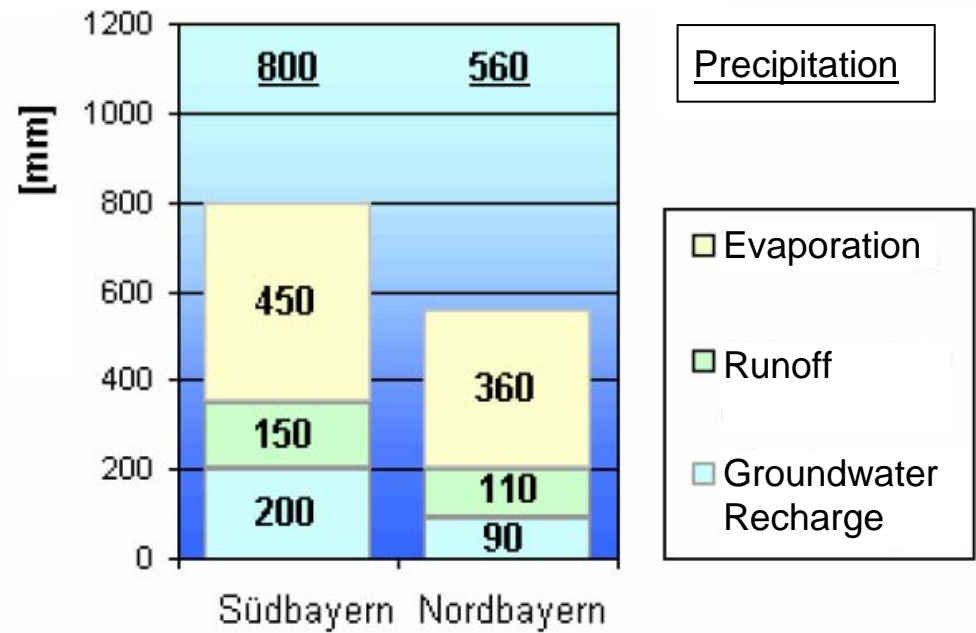


Upper Danube – Validation

Long-term Water Balance Bavaria (1961 – 1990)



Water Balance Bavaria 2003 (ca. 70% of long-term average)



Precipitation

Evaporation

Runoff

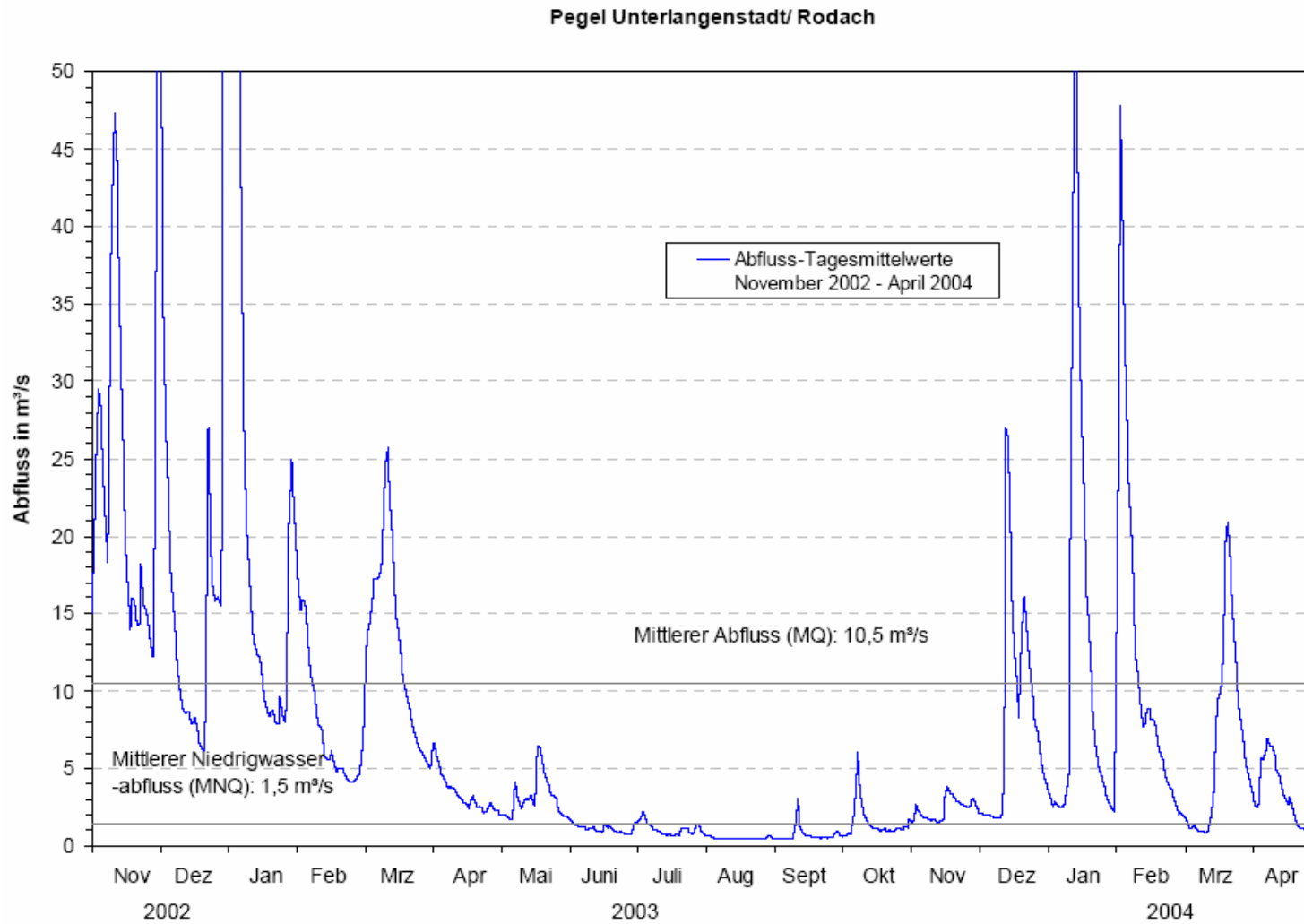
Groundwater Recharge



Bayerisches Landesamt
für Wasserwirtschaft



Validation: Runoff



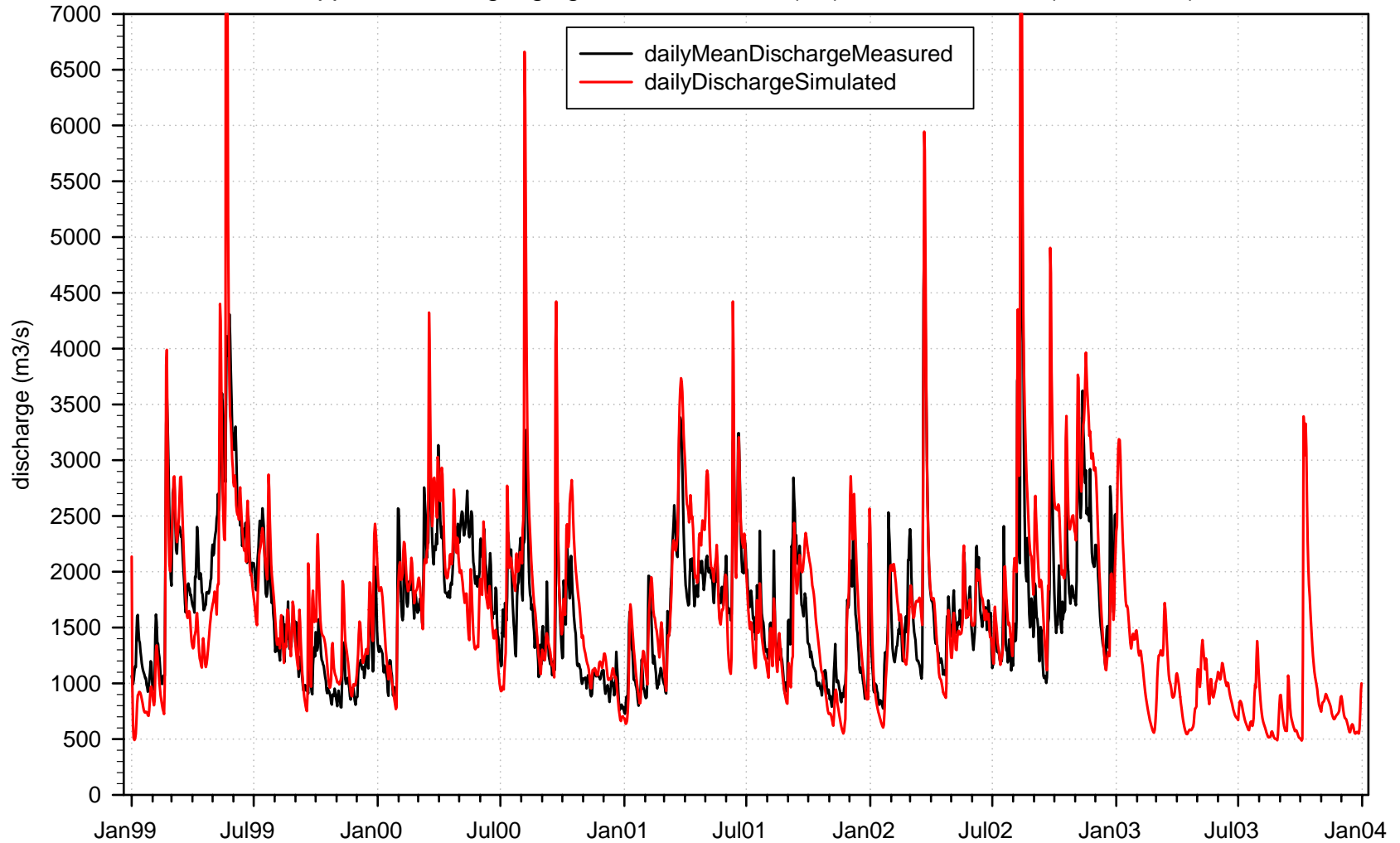
Bayerisches Landesamt
für Wasserwirtschaft



Validation: Runoff

Modelled Discharge 1999-2002

Upper Danube, gauging station Achleiten (AT), catchment area (76653 km²)



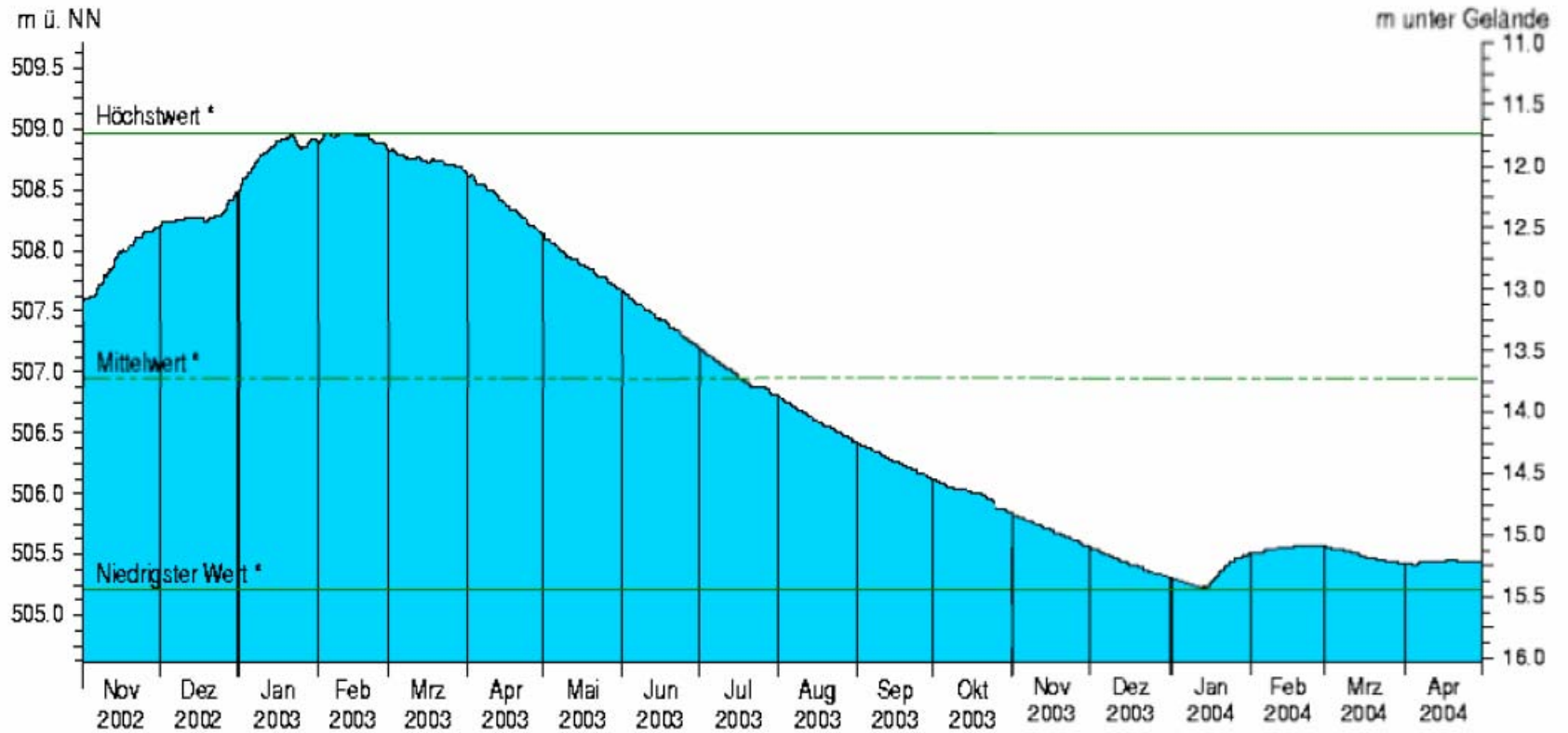


Validation: Groundwater

Messstelle: Forstern Br. 1 alt
Grundwasserleiter: Quartär

Nr: 14108

Geländehöhe: 520,70 m ü. NN



Bayerisches Landesamt
für Wasserwirtschaft



Validation: Groundwater

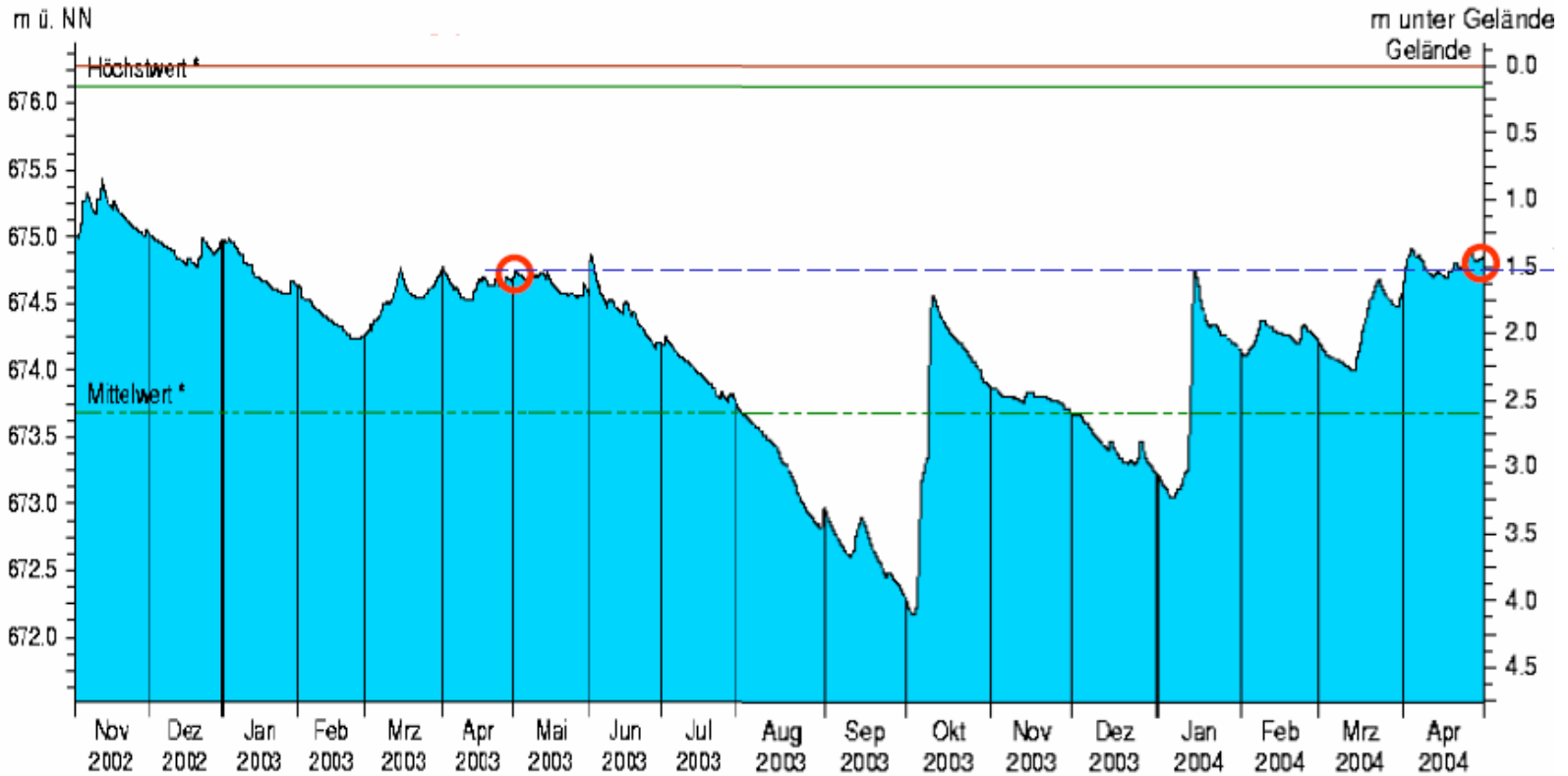
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Messstelle: Garmisch-Burgrain D/1 K

Grundwasserleiter: Quartär

Nr: 25700

Geländehöhe: 676,28 m ü. NN

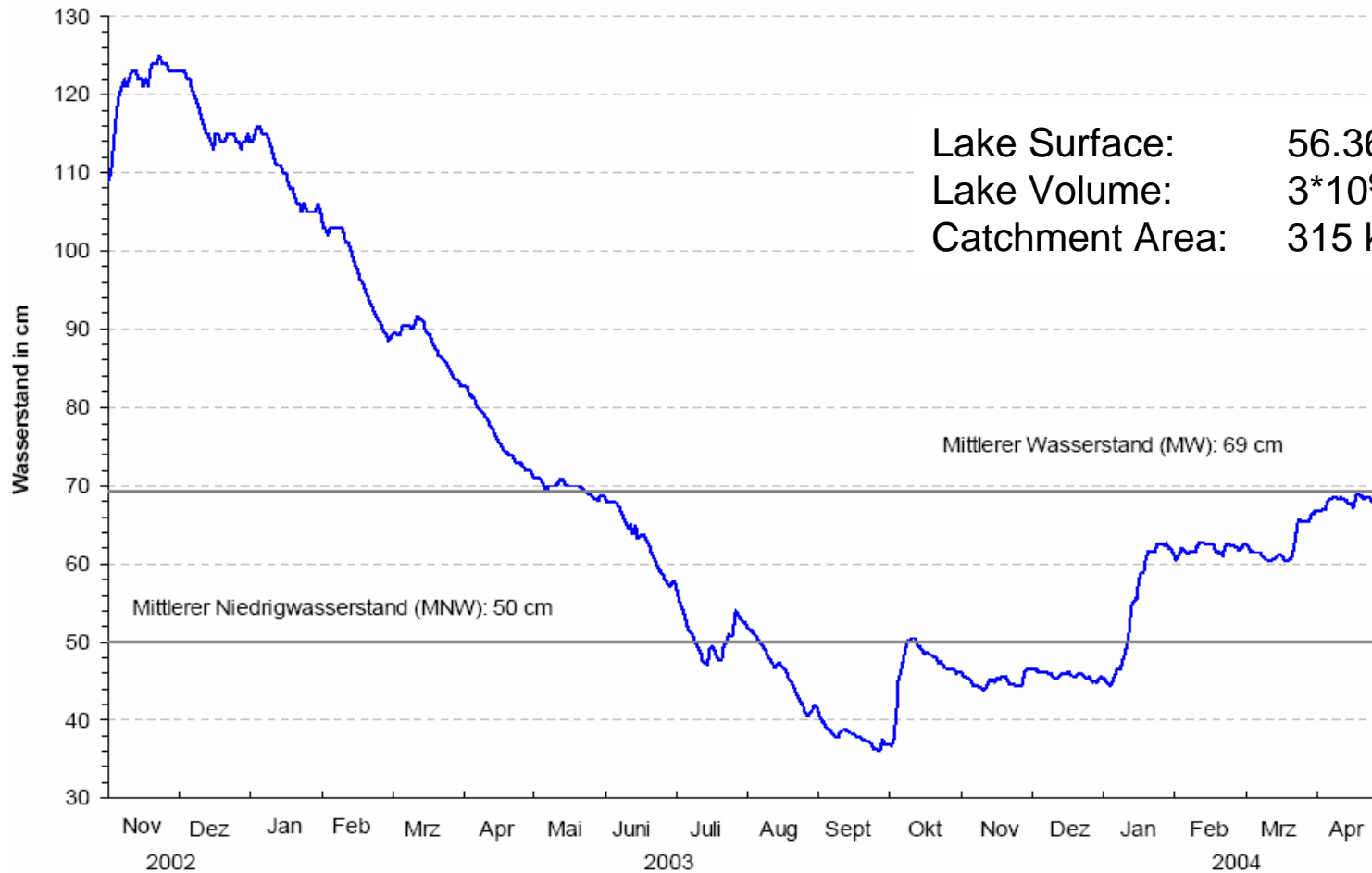


Bayerisches Landesamt
für Wasserwirtschaft



Validation: Lakes

Water Level of Starnberger See, Bavaria



Lake Surface: 56.36 km²
Lake Volume: 3*10⁹ m³
Catchment Area: 315 km²



Bayerisches Landesamt
für Wasserwirtschaft

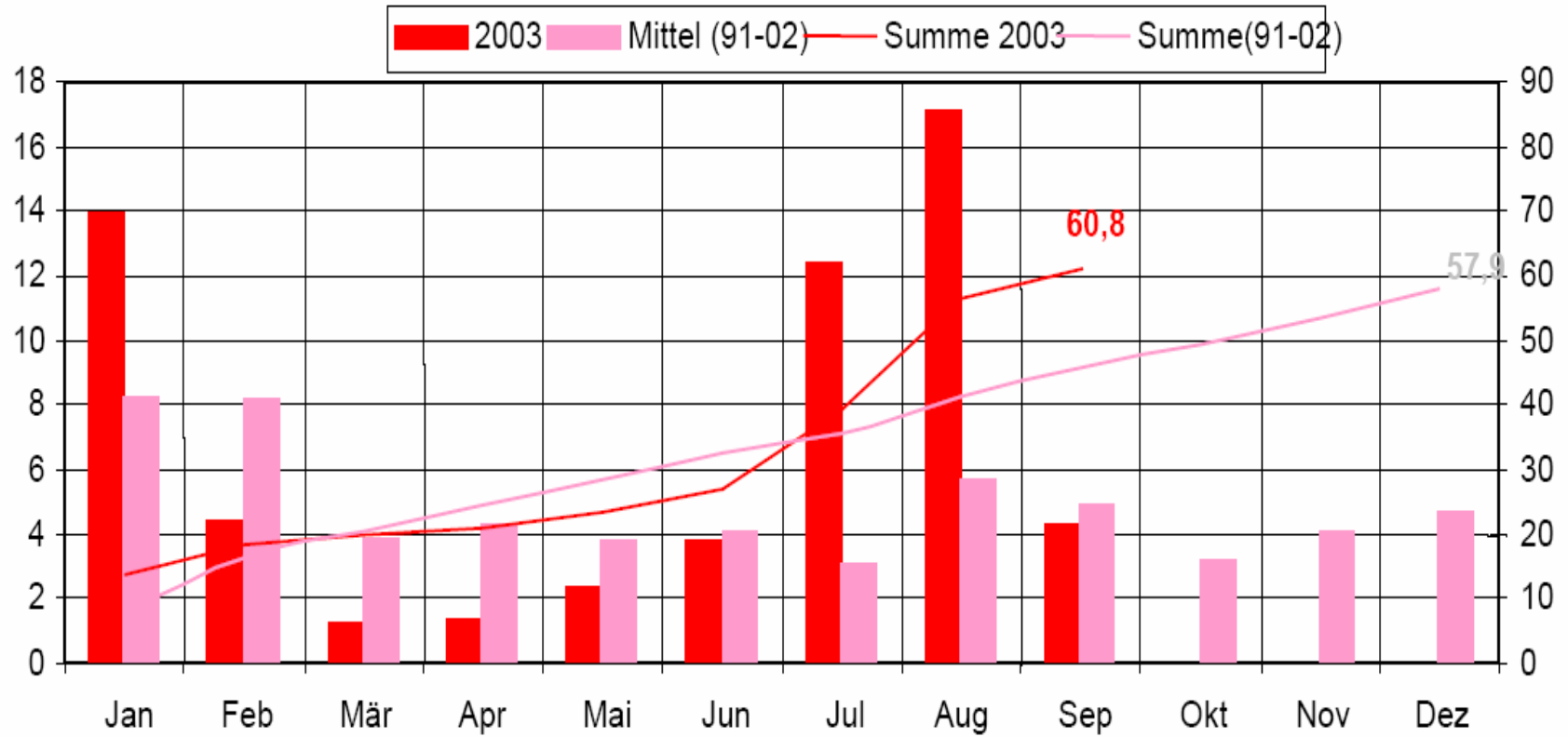


Validation: Reservoirs

Sylvenstein reservoir: Artificial increase of discharge downstream

Mio. m³/Monat

Mio. m³/Jahr



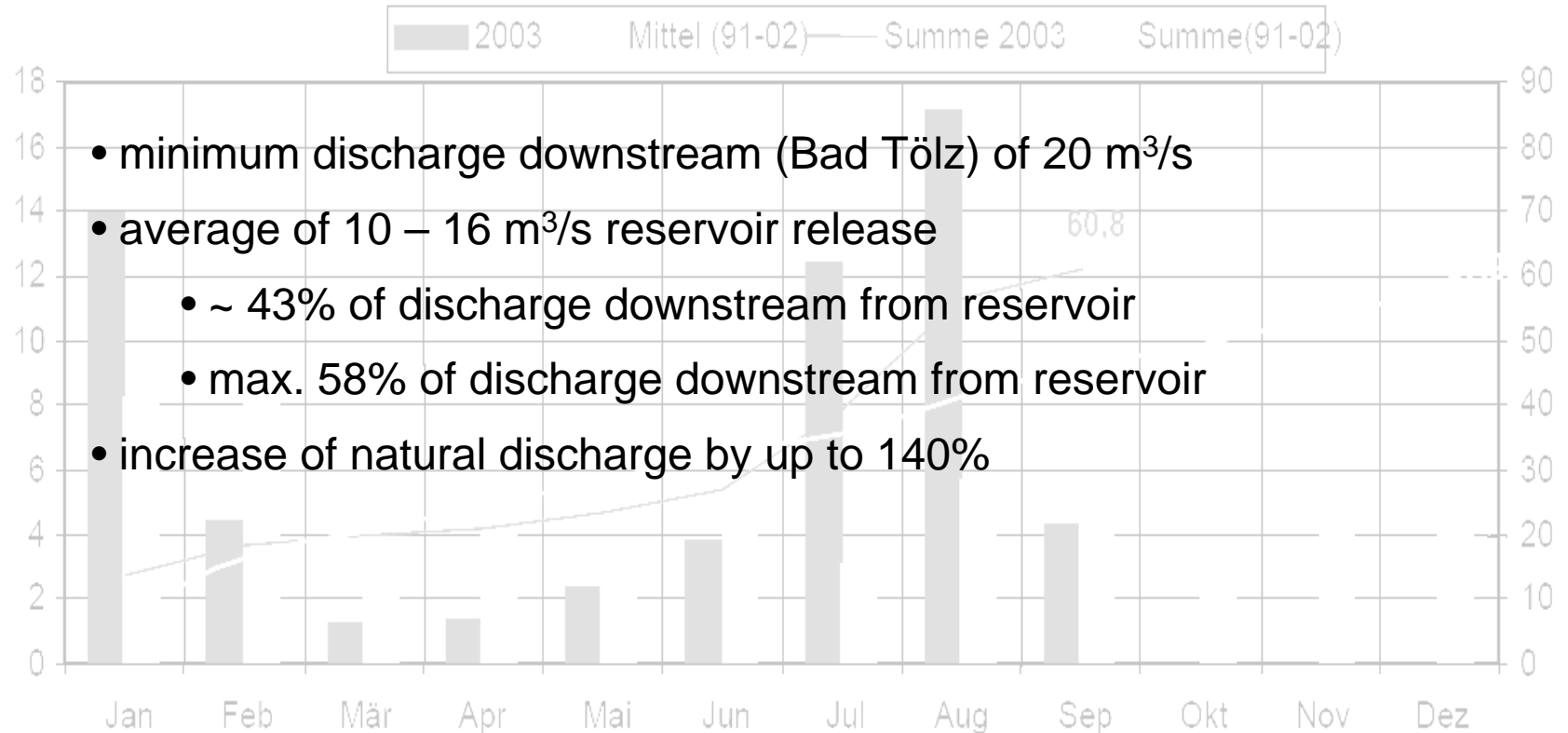


Validation: Reservoirs

Sylvenstein reservoir: Artificial increase of discharge downstream

Mio. m³/Monat

Mio. m³/Jahr



- minimum discharge downstream (Bad Tölz) of 20 m³/s
- average of 10 – 16 m³/s reservoir release
 - ~ 43% of discharge downstream from reservoir
 - max. 58% of discharge downstream from reservoir
- increase of natural discharge by up to 140%





Next Steps

- Examination and validation of model, cont.
 - Vegetation development, consequences for (evapo-) transpiration
 - Groundwater compartments
 - Lakes and reservoirs
- Consideration of additional data
 - Remote Sensing (vegetation, soil moisture)
 - Long-range meteorological forecast data
 - Detailed soil data
 - Groundwater?
- Forecasting droughts
 - Validation by reproduction of past drought situations (e.g. 2003) with forecast data



Acknowledgements

Floods and Other Weather-Related Hazards Team:

| | |
|----------------------|---|
| Model development: | Johan van der Knijf, Ad de Roo |
| EFAS infrastructure: | Giovanni Franchello, Ben Gouweleeuw, Jutta Thielen |
| GIS, Database: | Katalin Bodis, Rado Bonk |
| Danube experts: | Milan Kalas, Janos Szabo, Karl Wachter |
| Elbe experts: | Meike Gierk, Jalal Jounis |



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Contact Details

stefan.niemeyer@jrc.it
ad.de-roo@jrc.it

European Commission
DG Joint Research Centre
Institute for Environment and Sustainability
TP 261, 21020 Ispra (VA), Italy

<http://natural-hazards.jrc.it>



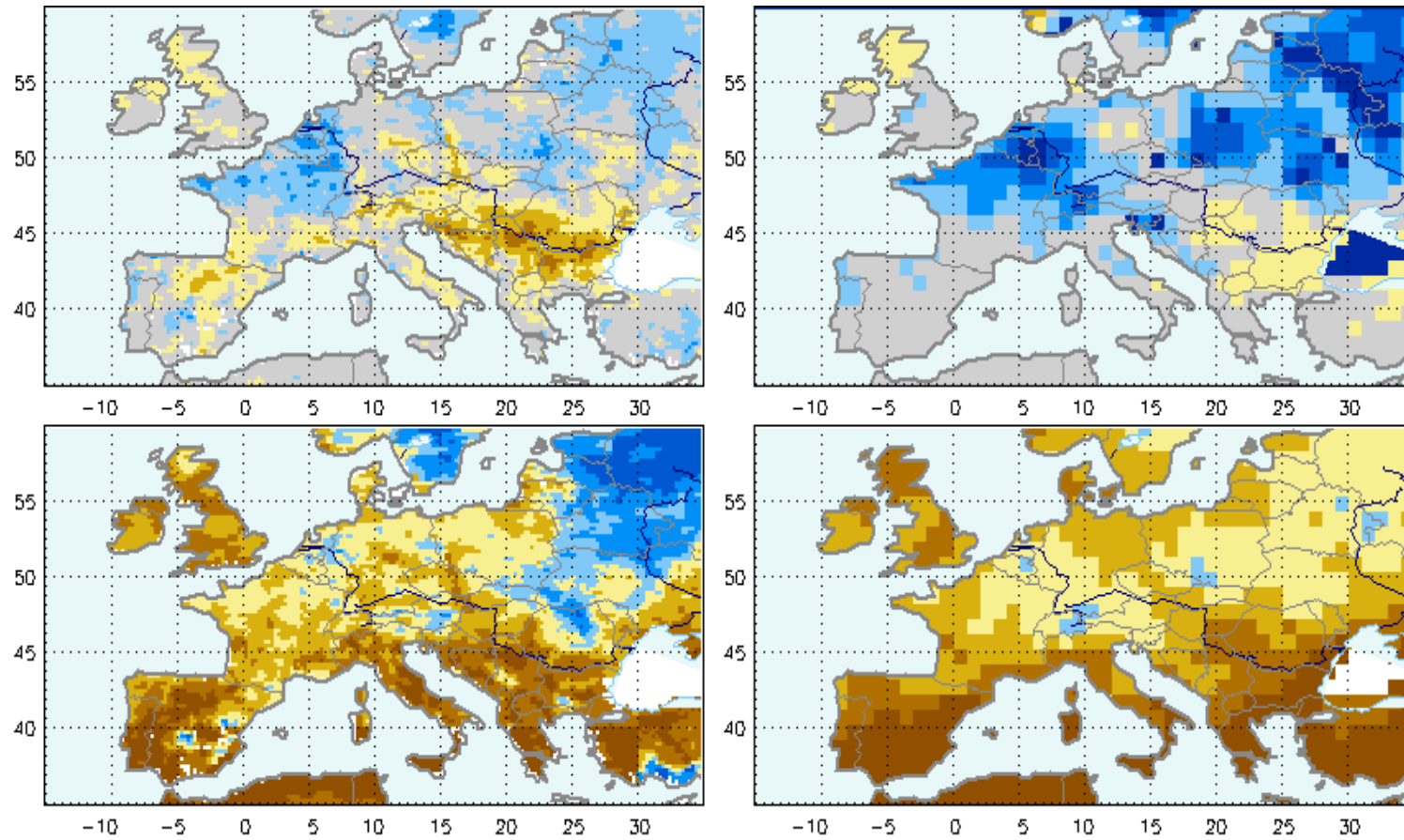


JRC activities on droughts

- Past:
 - Pop-Sicily project (Juergen Vogt)
 - PhD study on “Modelling the surface energy balance on the regional scale with remote sensing and meteorological network data – a case study in Sicily” (Stefan Niemeyer)
 - Catchment Information System (river networks, Roland Hiederer)
- Presently in place:
 - LISFLOOD hydrological model
 - Real-time access to meteo data: Synop stations, European NIMROD radar data, ECMWF and DWD numerical weather forecast products
 - Overview report present knowledge on climate change effects on floods and droughts
 - Forest fire risk forecasting
 - Seasonal crop yield forecast (JRC-MARS), partially based on water balance
 - Core member in IP Flood & Drought (in preparation) with leading European Flood & Drought research institutes
 - Request from European Parliament for alert system for floods and water shortages
 - Inhouse competences: hydrology, meteorology, remote sensing, modelling, GIS, informatics



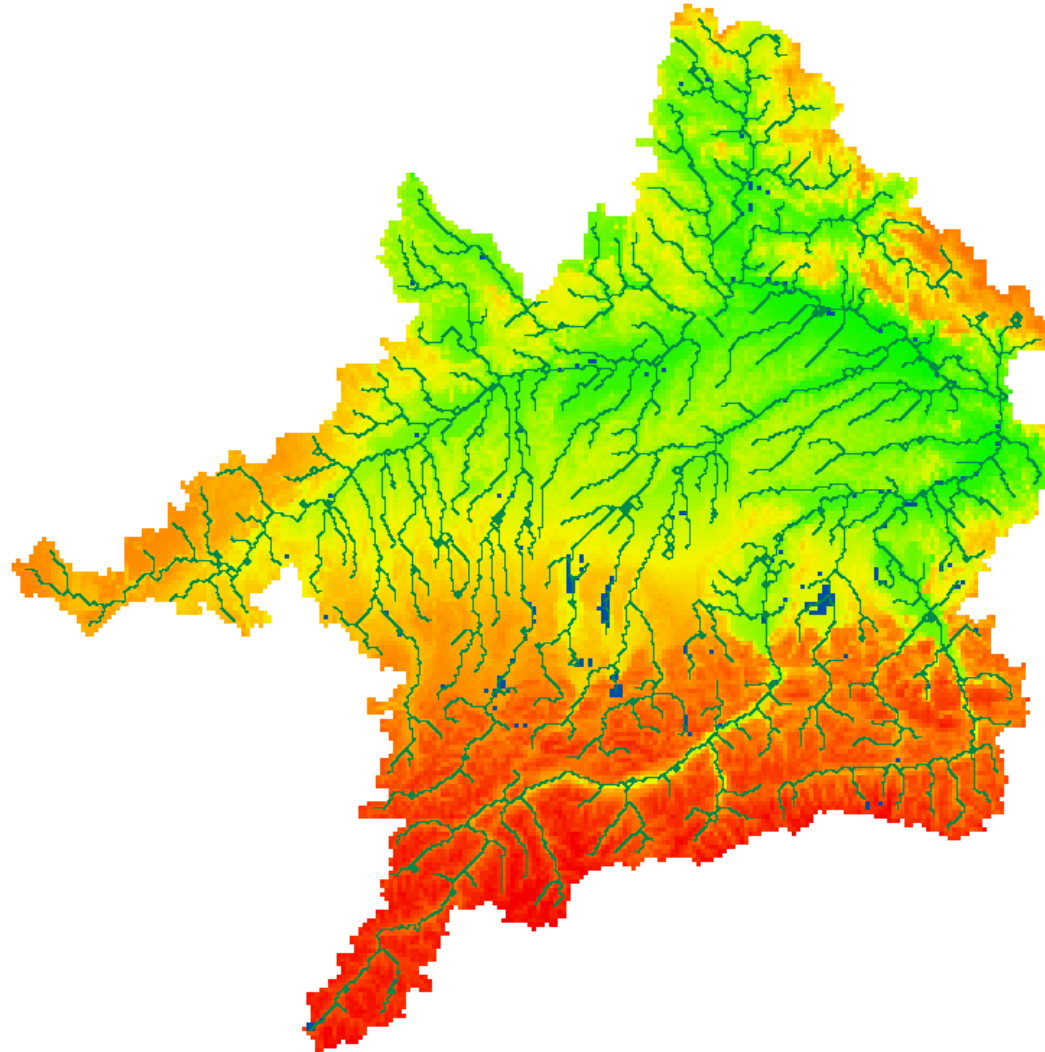
Remote Sensing Products



Soil Water Index from Global Soil Moisture Archive,
<http://www.ipf.tuwien.ac.at/radar/ers-scat/home.htm>
(Wagner et al. 2002)

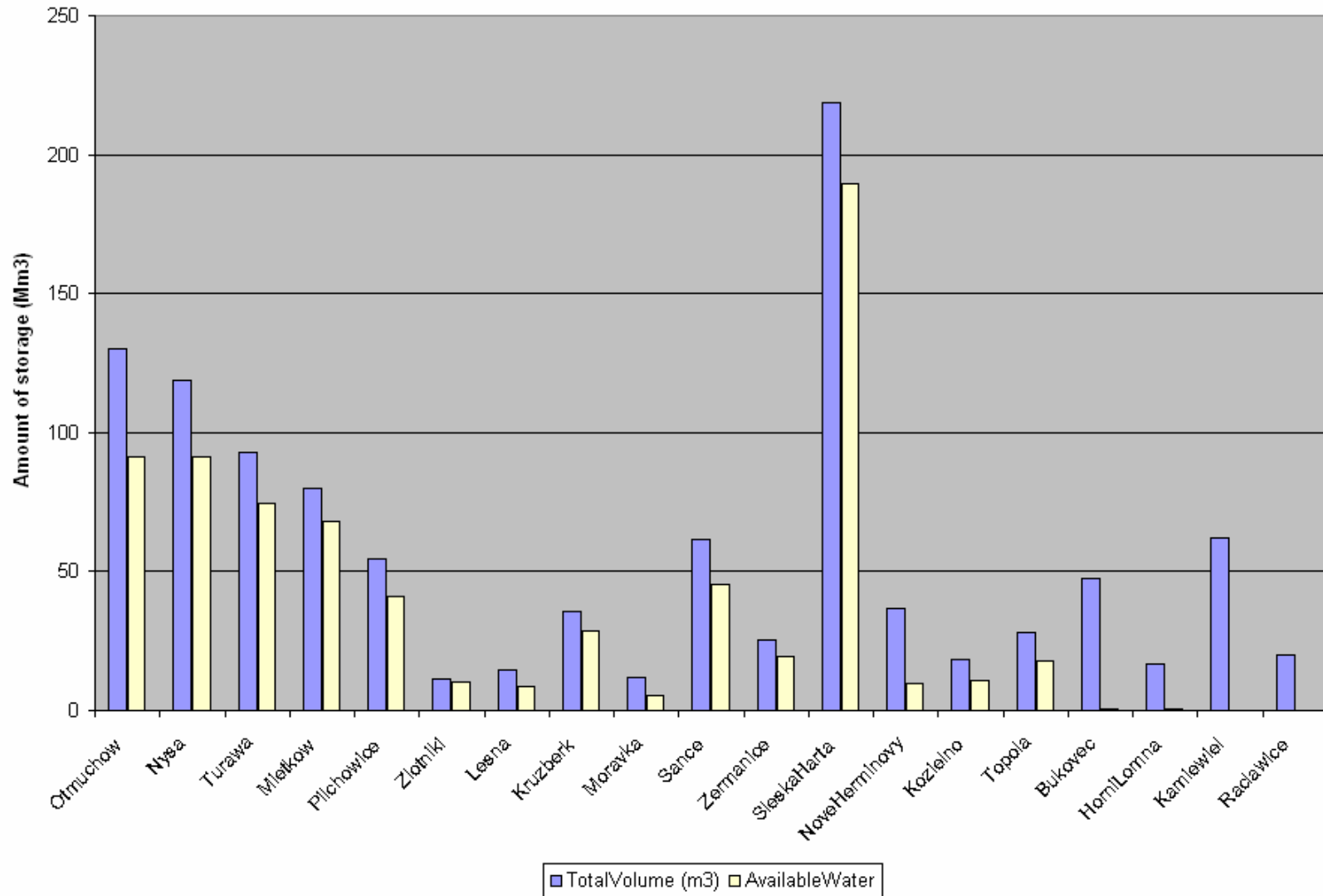


Upper Danube catchment area



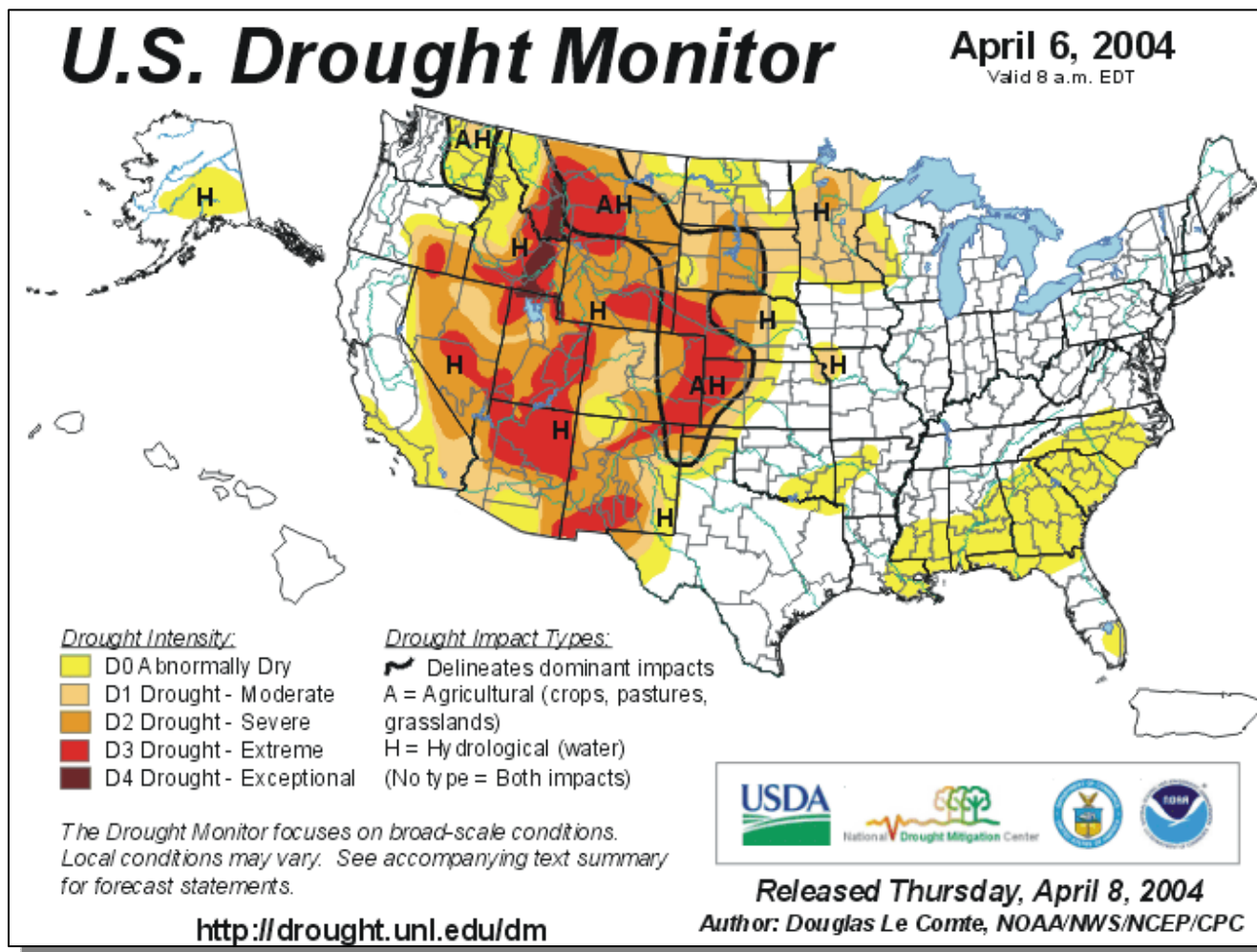


Available Water in Reservoirs





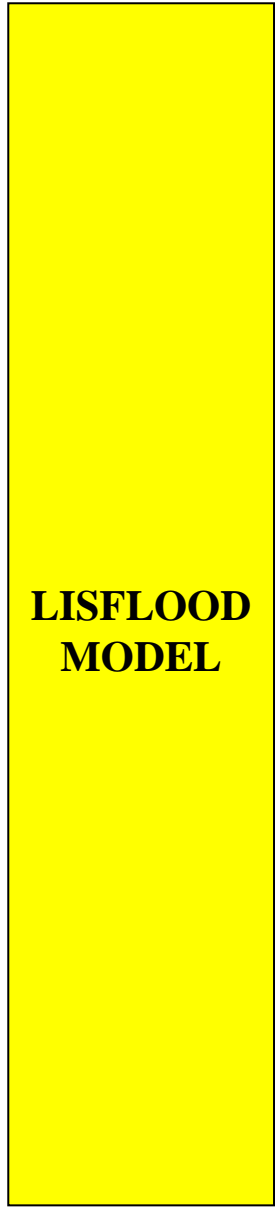
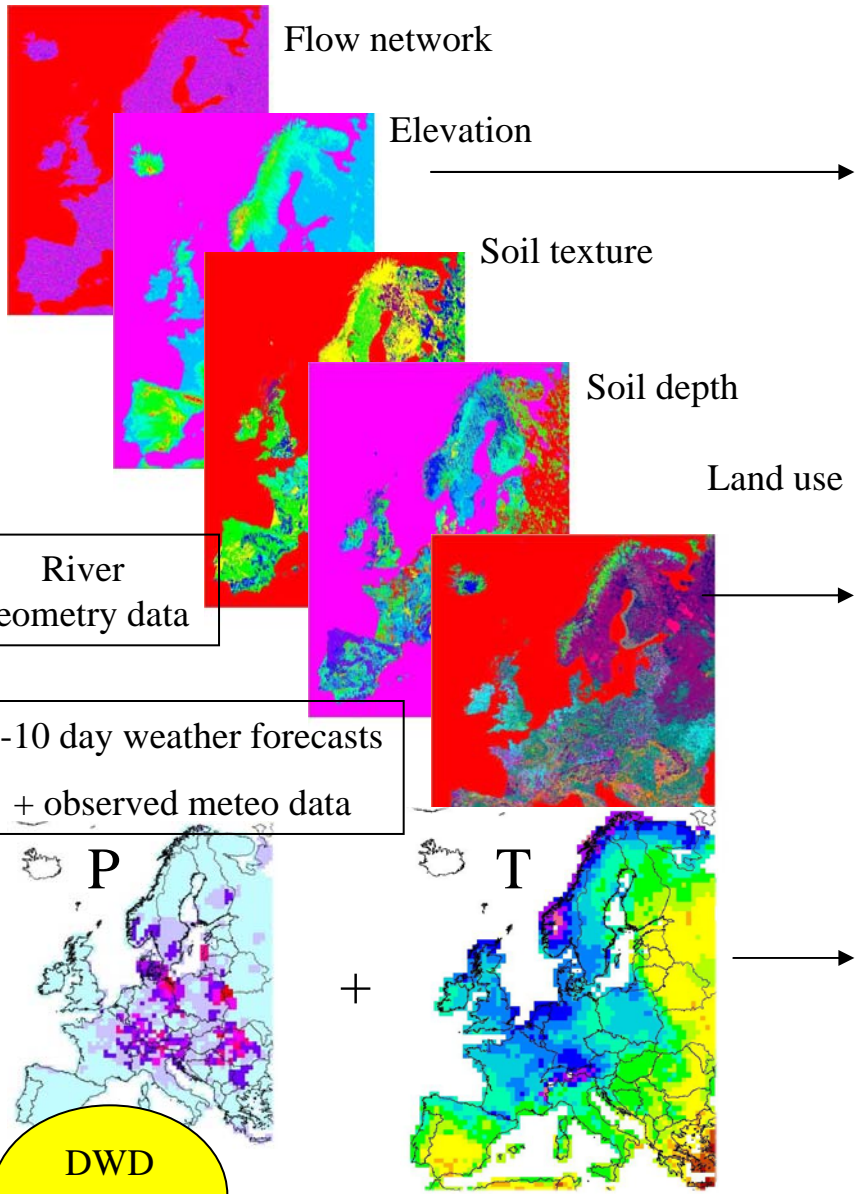
Outlook: European Drought Alert System



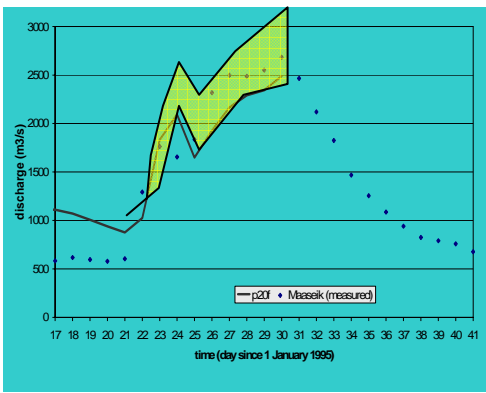


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River Discharge Maps / critical levels



Hydrographs for specific locations, incl uncertainty

EFAS flood alert test message

DWD
ECMWF