Satellite Based Water Monitoring and Flow Forecasting System in the Yellow River Basin

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Contents of the presentation

- Introduction to the EWBMS
- Derivation and examples of data products
- Validation of EWBMS data
- Drought monitoring
- Flow simulation and forecasting
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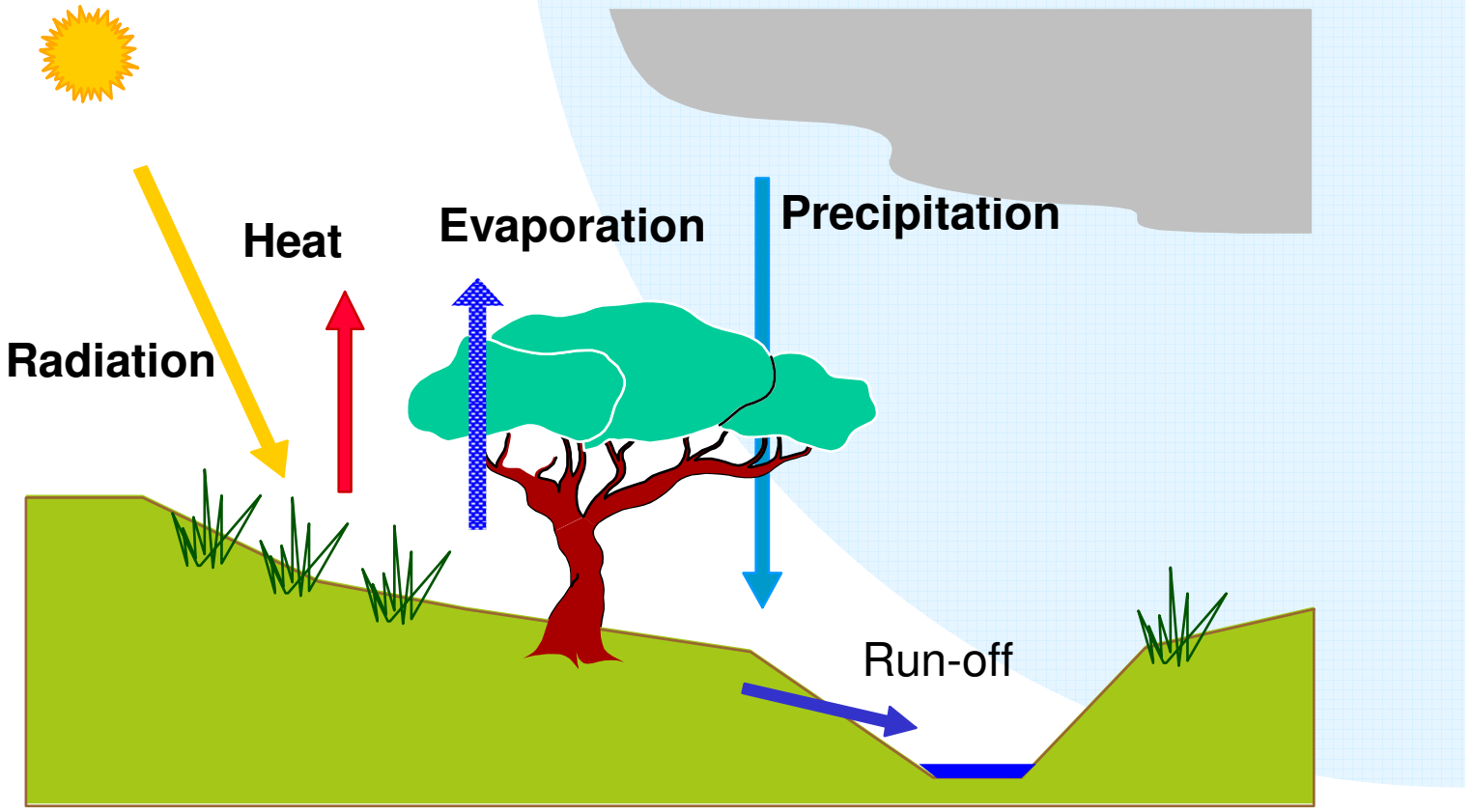
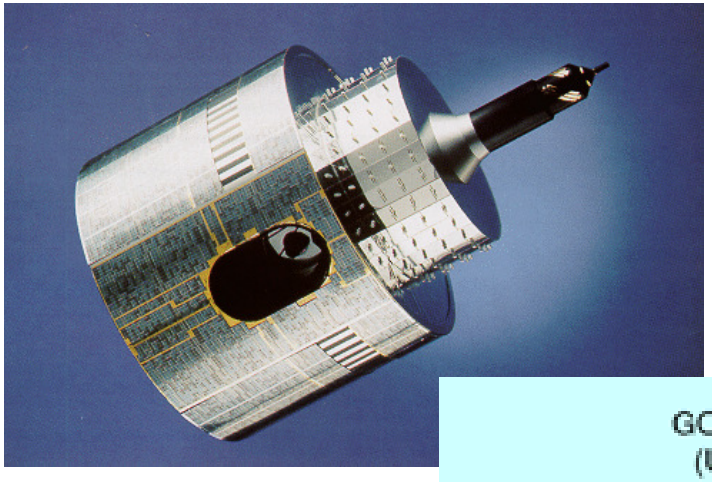
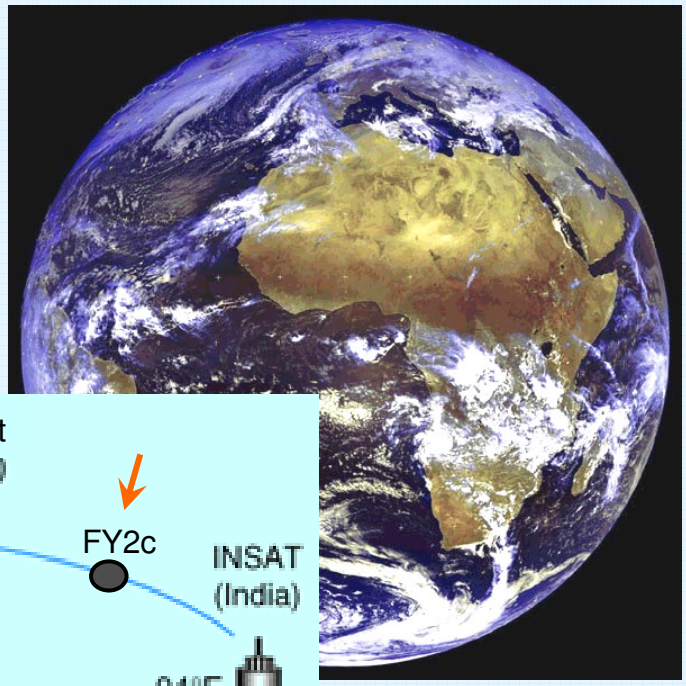
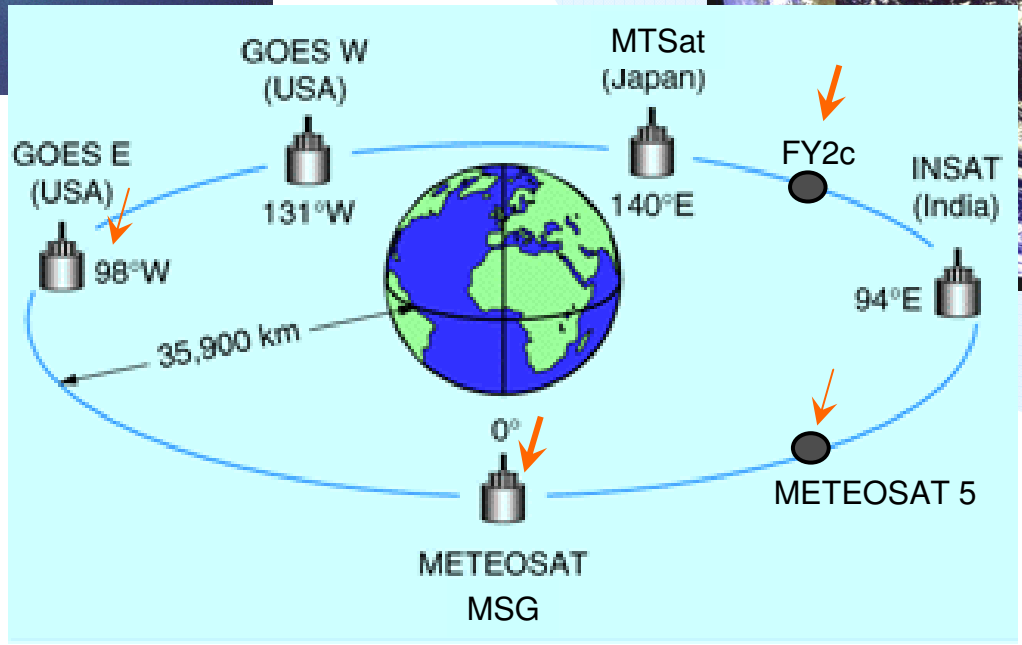
The Energy and Water Balance



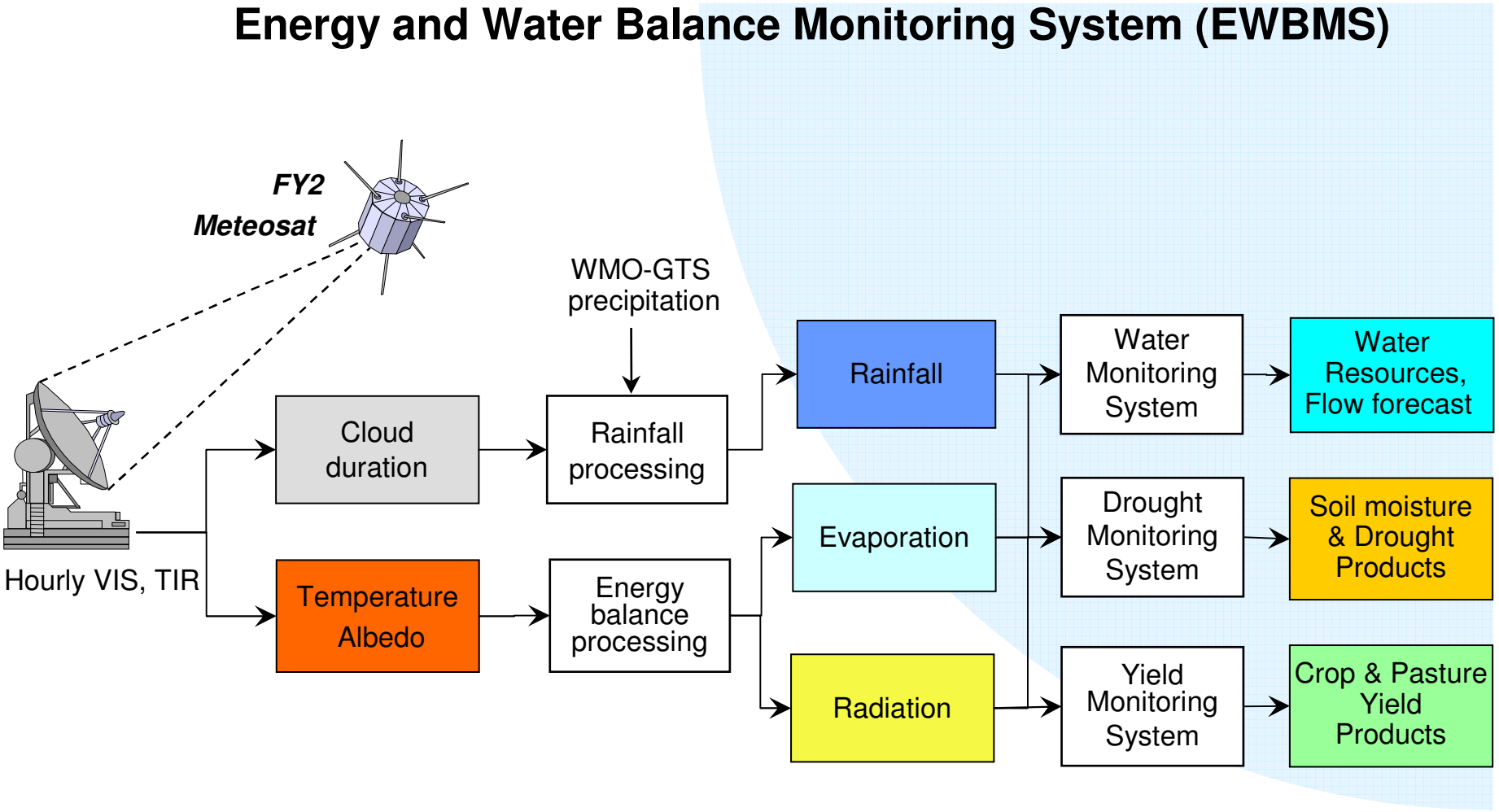
Geostationary Meteorological Satellites





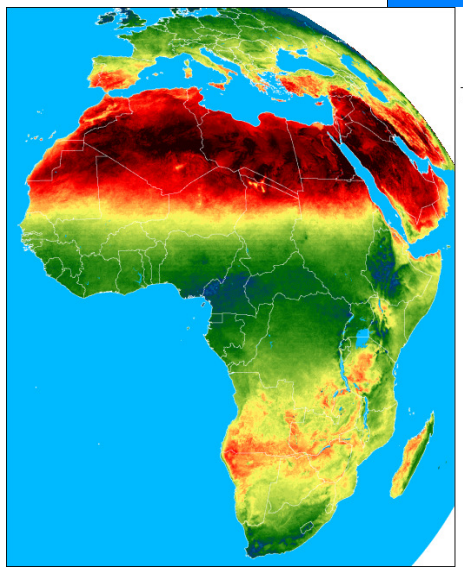


Energy and Water Balance Monitoring System (EWBMS)

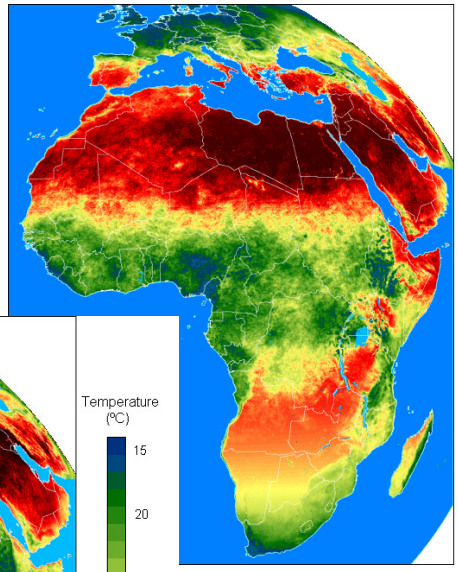


Data products

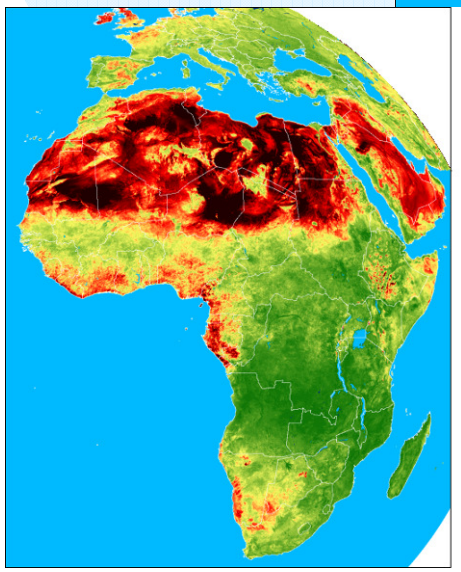
September 2005, 1st dekad



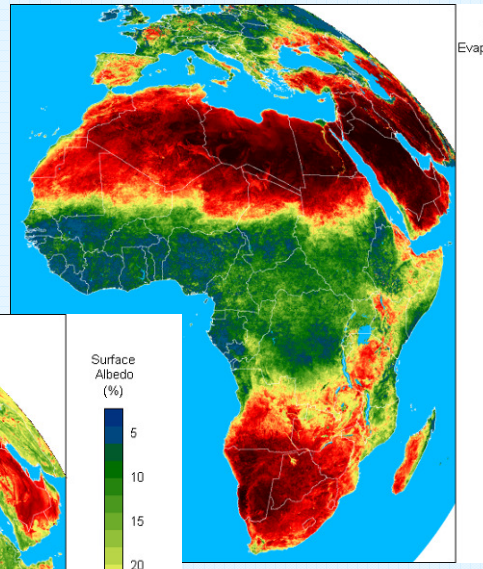
1.5 m Air temperature (°C)



Global radiation (W/m^2)



Surface albedo (%)



Relative evapotranspiration (%)

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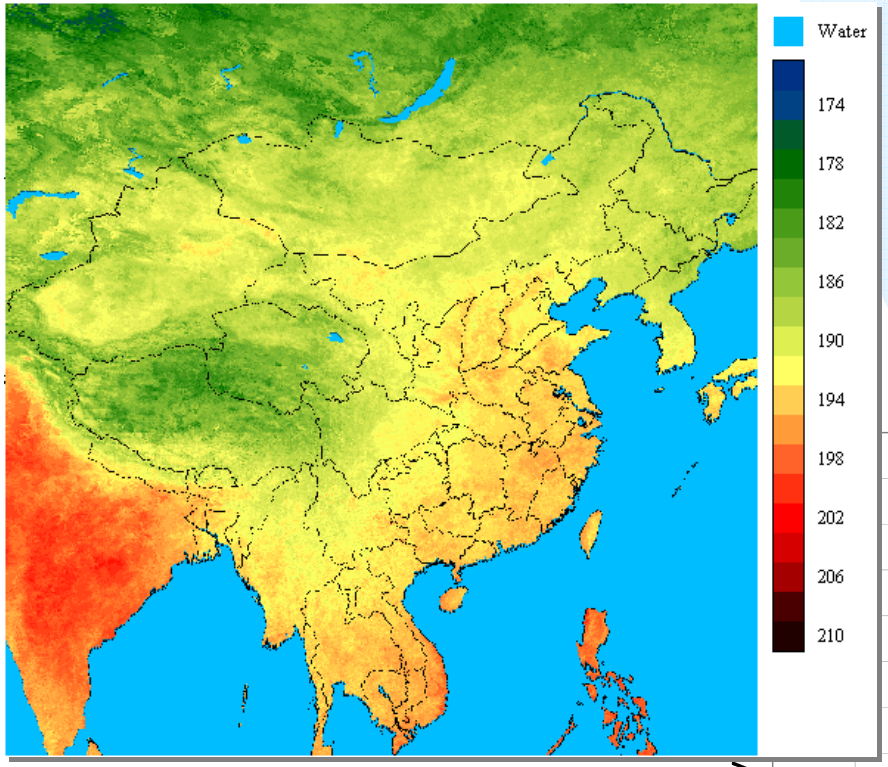
Air temperature mapping

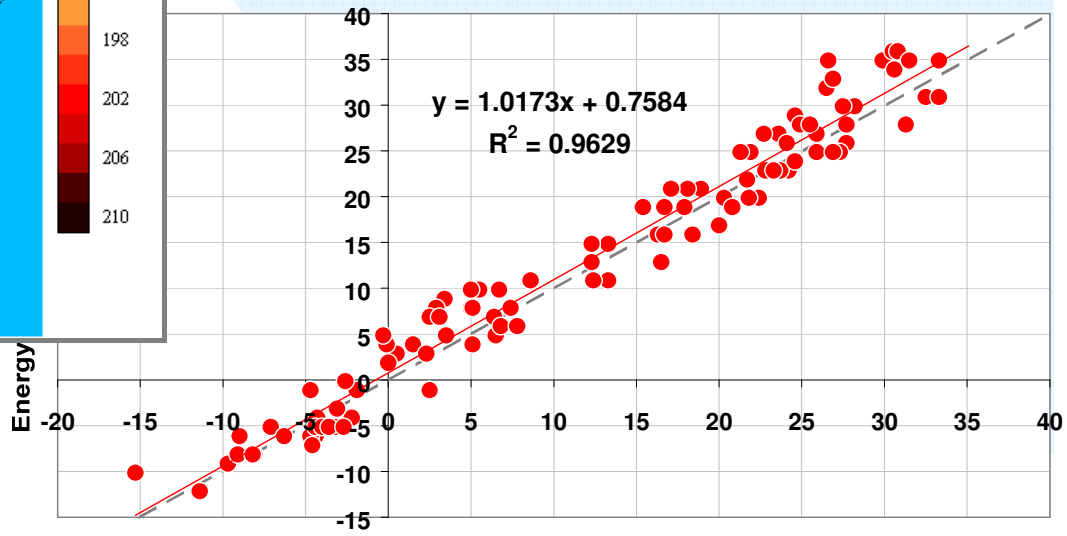
Observation height air temperature map



Boundery layer temperature: based on regression between noon and midnight surface temperatures

1.5 m Temperature: based on mixing surface and boundary layer temperature

China, Bayan Mud (40.75N 104.5E), clear days 2000



GTS ground truth data, daily average 1.5 meter temperature (°C)

Precipitation monitoring

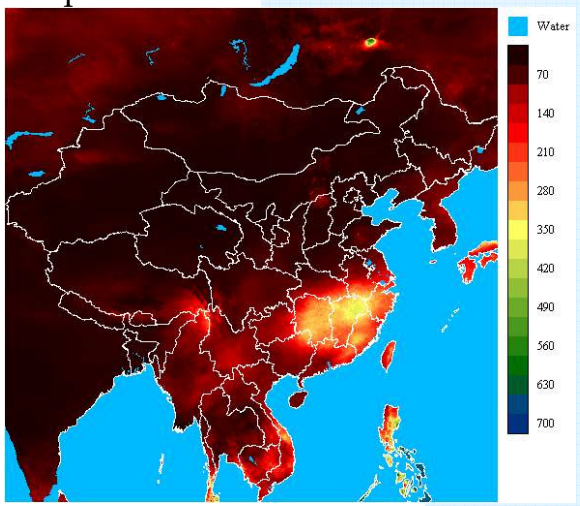
Precipitation processing

- Based on cloud detection, height classification
- Regression between cloud frequencies and GTS rainfall

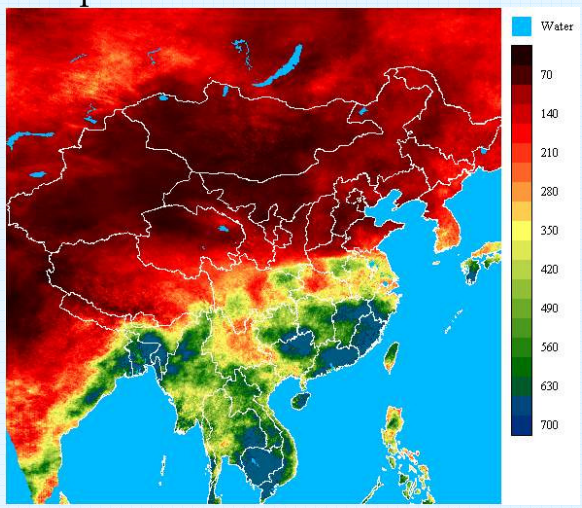
- Rainfall
- Snow storage (if T<0)

Precipitation

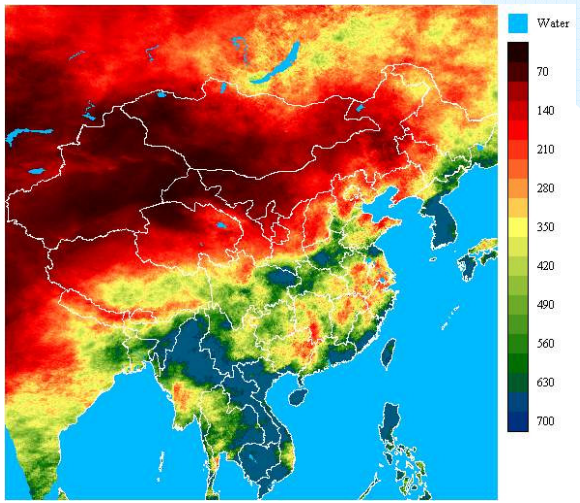
1st quarter 2000



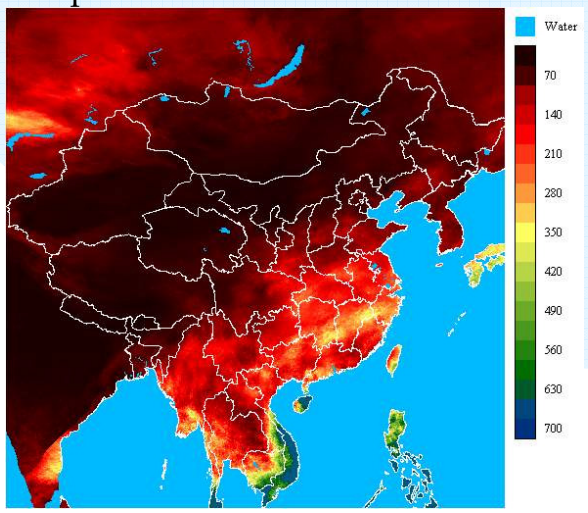
2nd quarter 2000



3rd quarter 2000



4th quarter 2000



Evapotranspiration Monitoring

Energy balance processing

Global and net radiation

Sensible heat flux

Latent energy flux

↓

Actual evaporation

Snowmelt

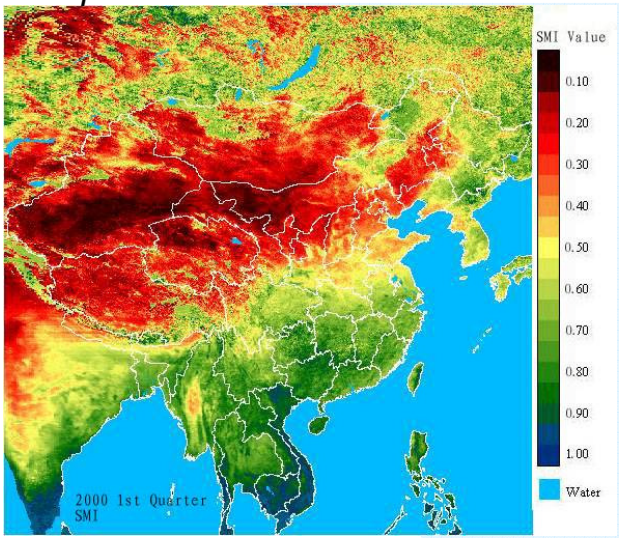
$I_n = (1-A)\, I_{sol} - I_{ter}$

$H = \alpha\, (T_0 - T_a)$

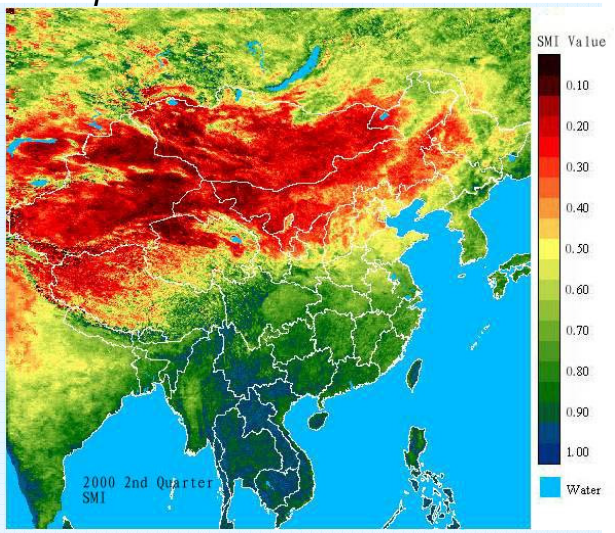
$LE = I_n - H$

Actual evapotranspiration

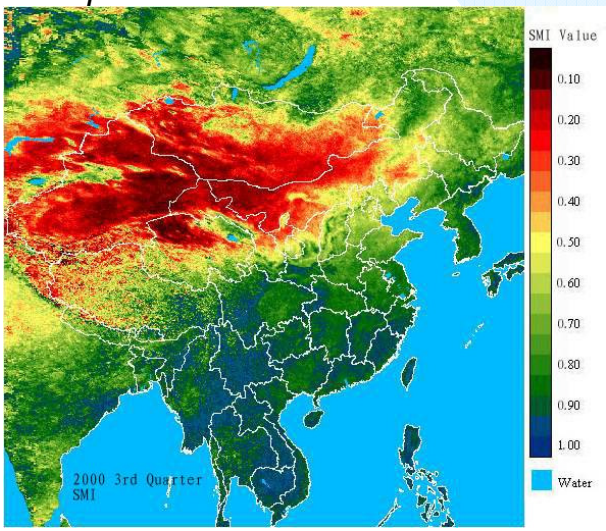
1st quarter 2000



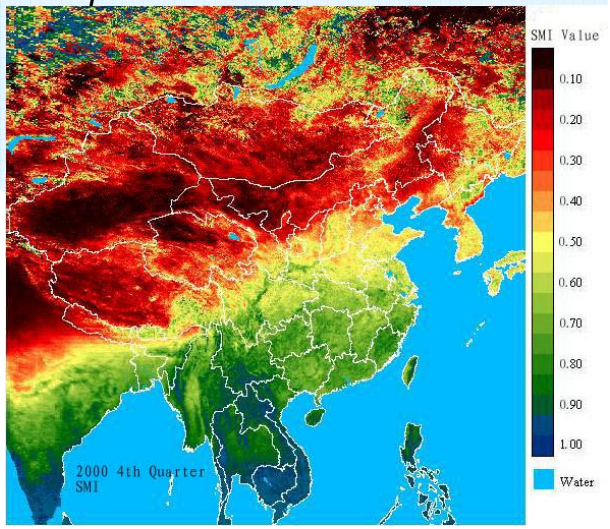
2nd quarter 2000



3rd quarter 2000

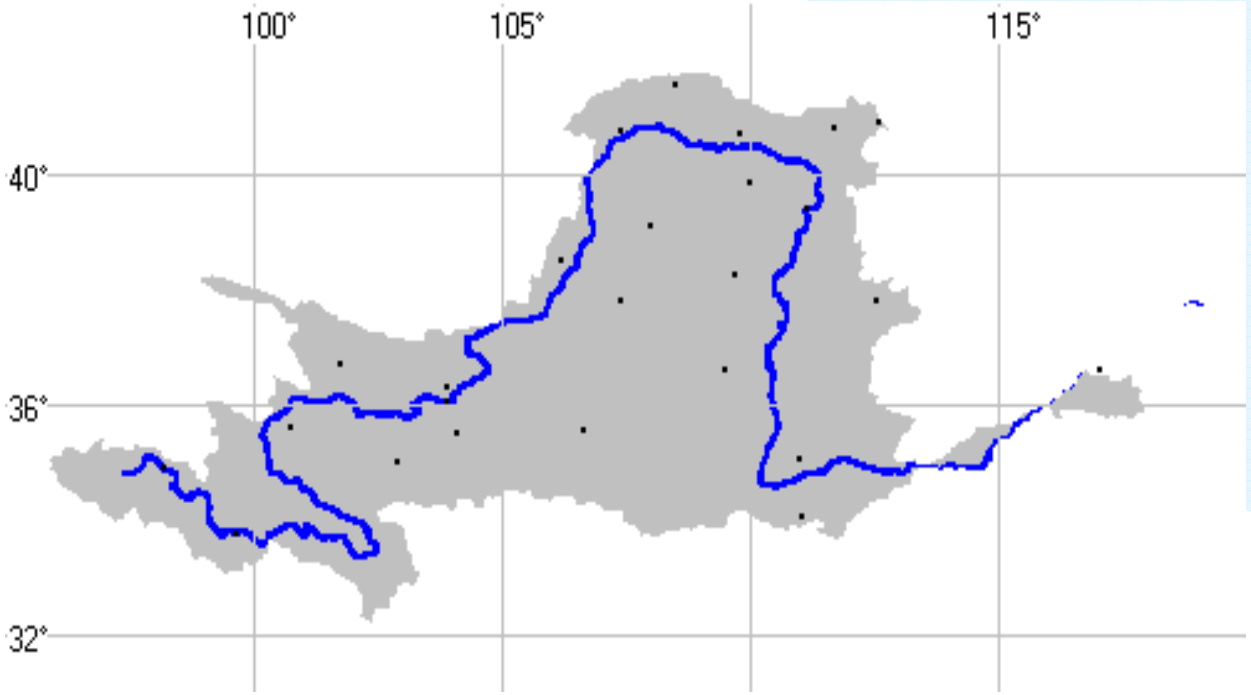


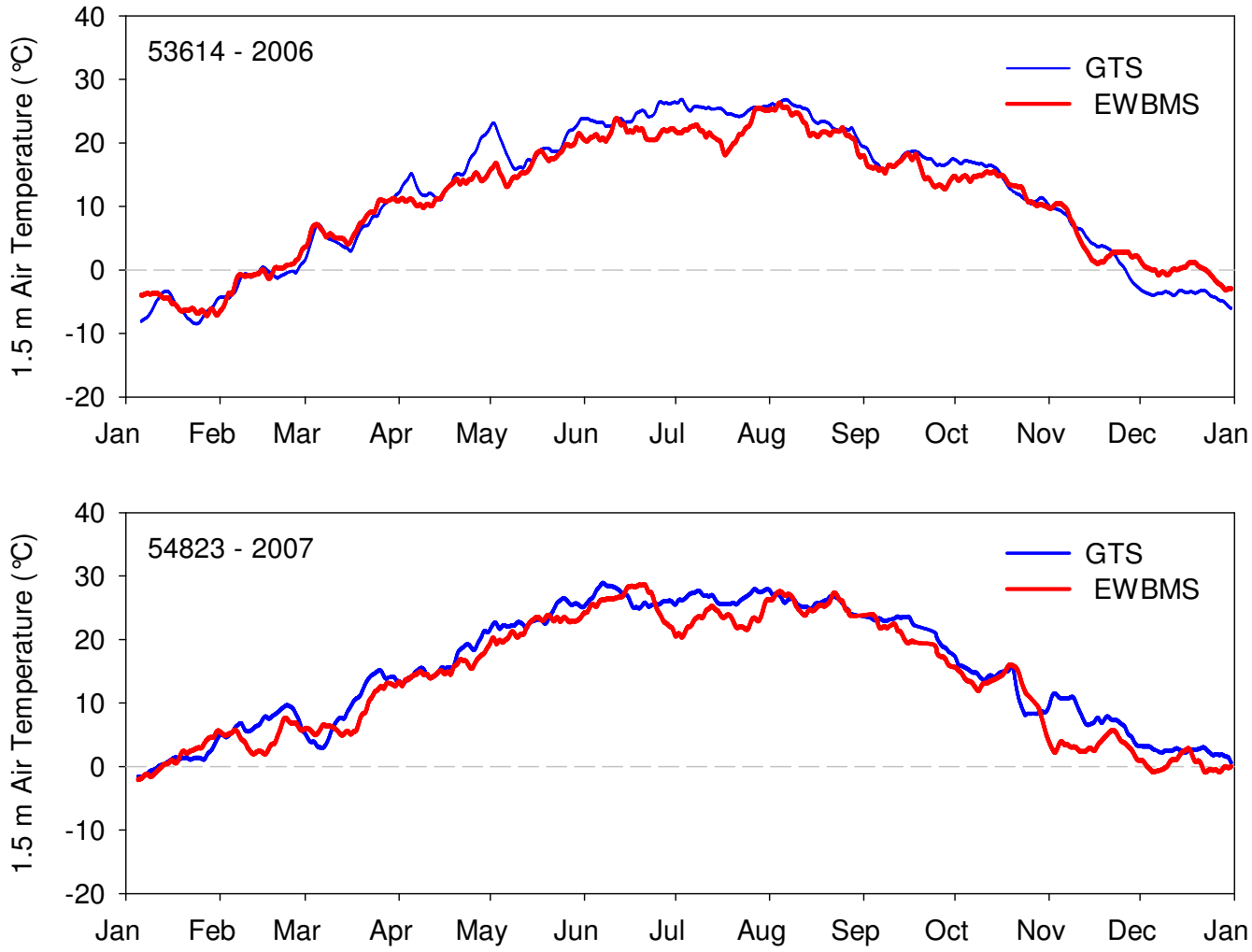
4th quarter 2000



Validation in Yellow River basin

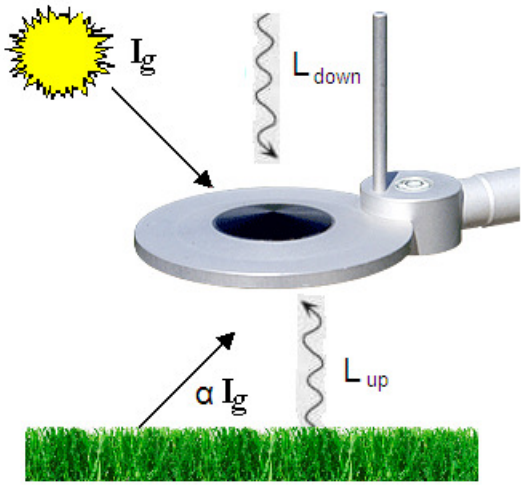
1.5 m air temperature validation



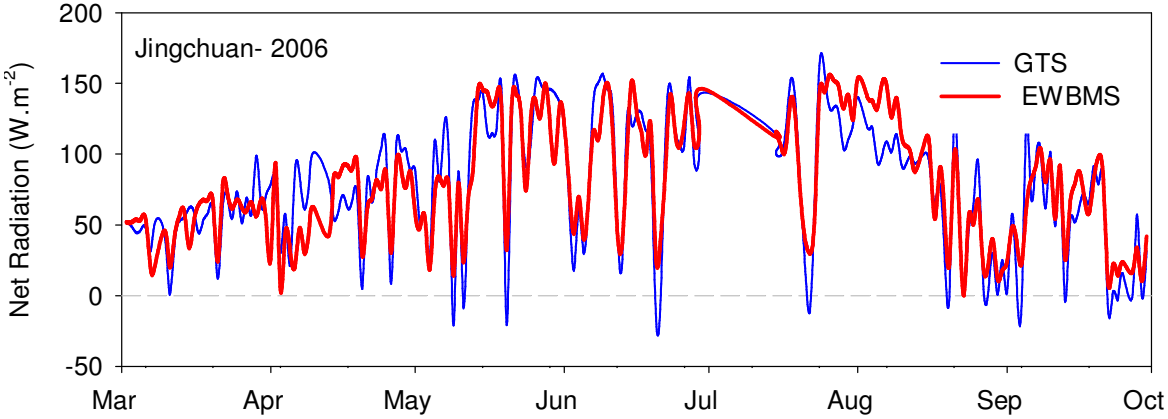

53614 - 2006
GTS
EWBMS
1.5 m Air Temperature (°C)
40
30
20
10
0
-10
-20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
54823 - 2007
GTS
EWBMS
1.5 m Air Temperature (°C)

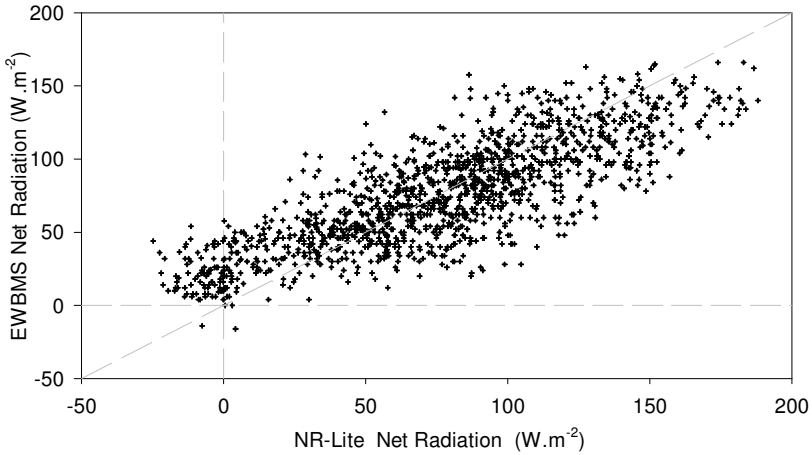
Net radiation validation

Net radiometer

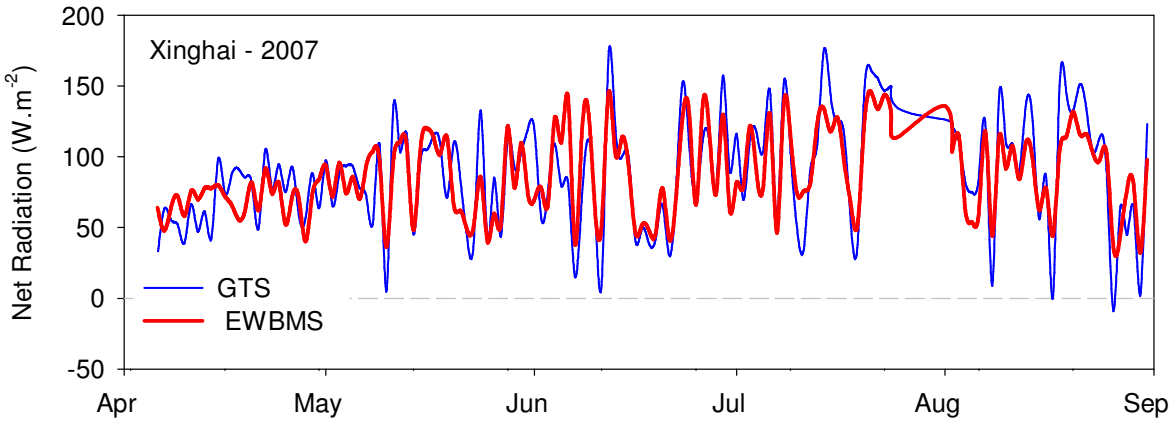


EWBMS and ground measured net radiation





Scattergram 4 NR-Lite stations



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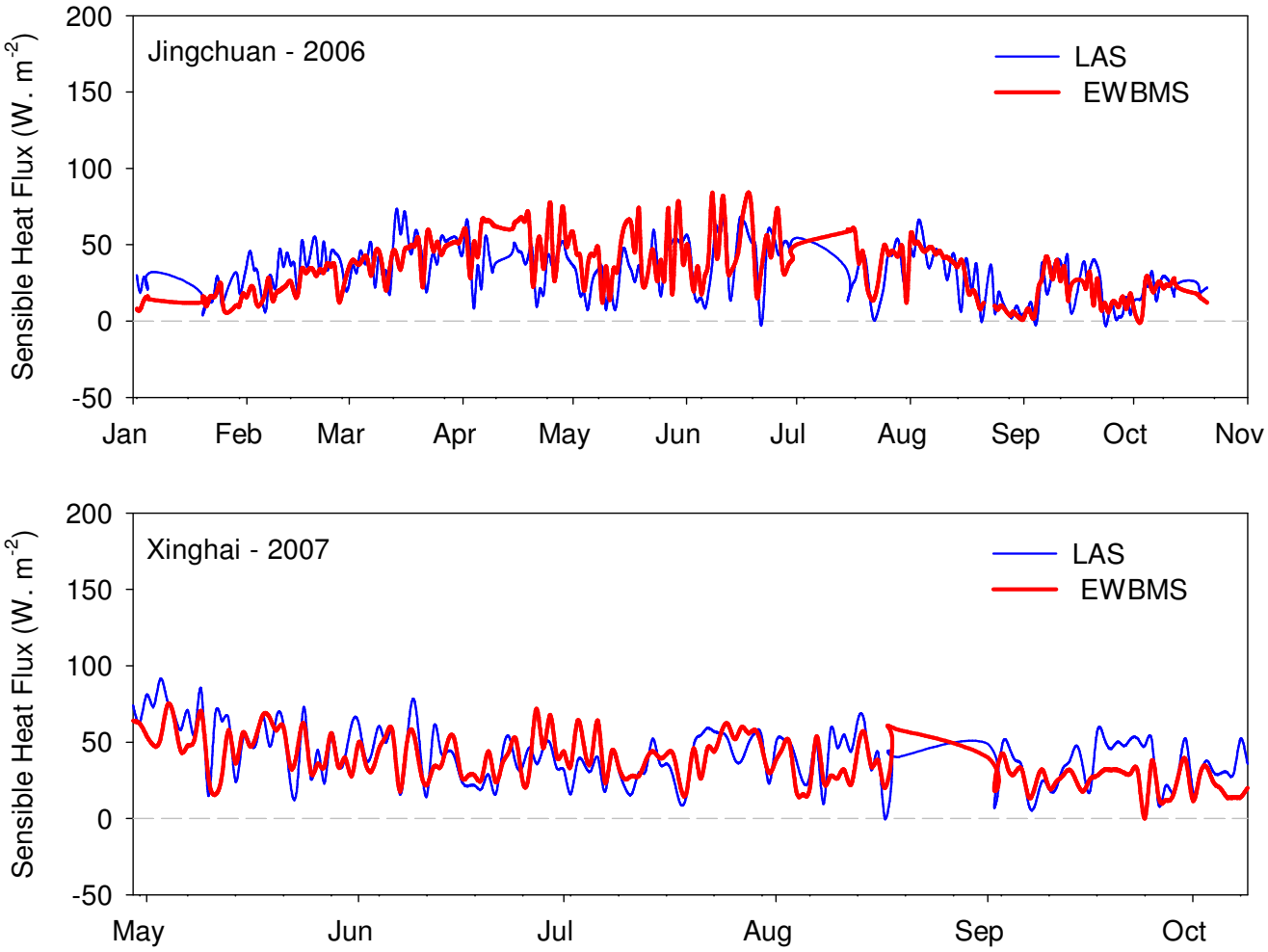
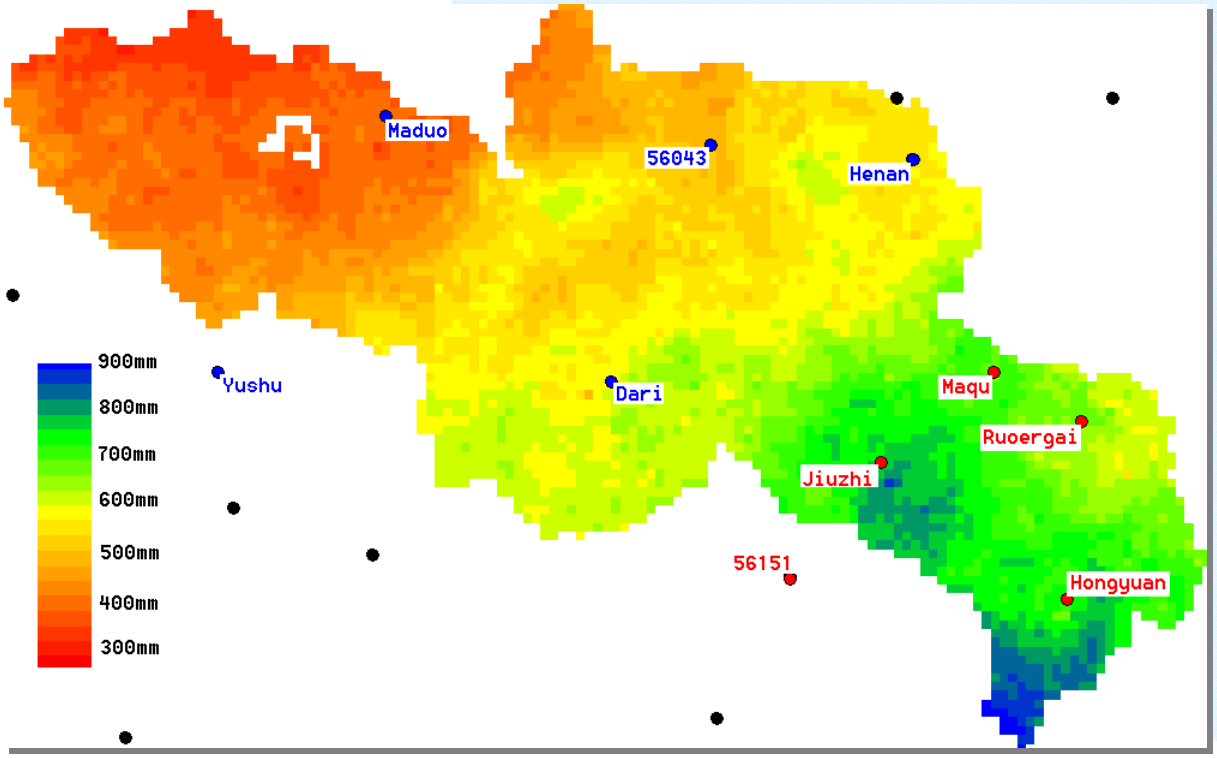
Sensible heat flux validation

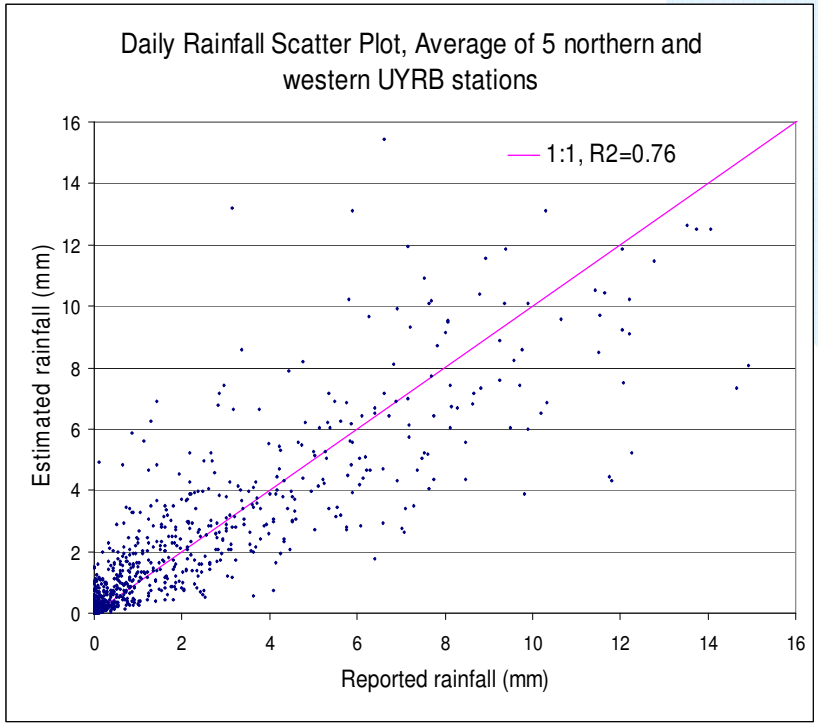
EWBMS and LAS sensible heat flux

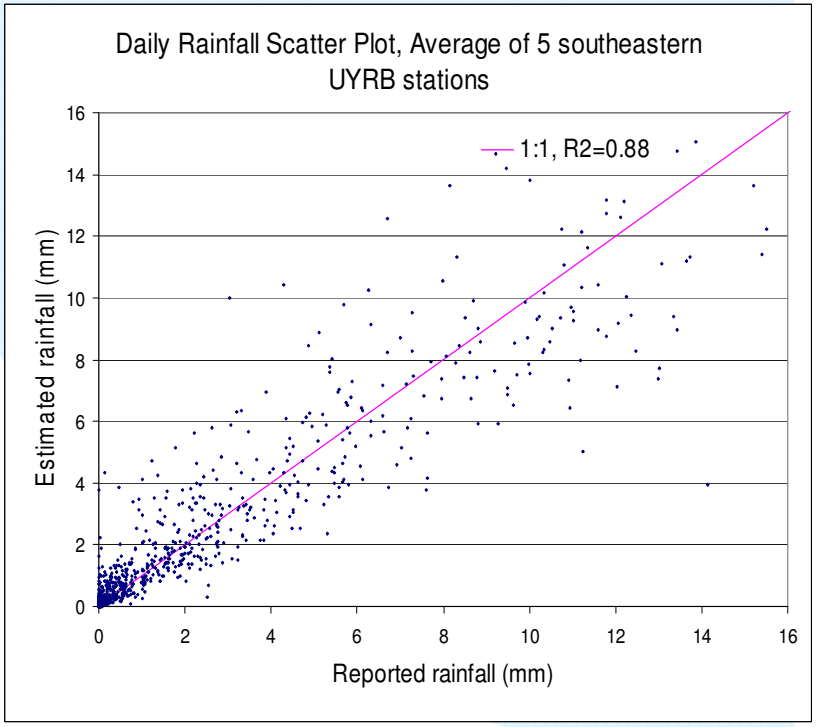


Rainfall and water budget validation

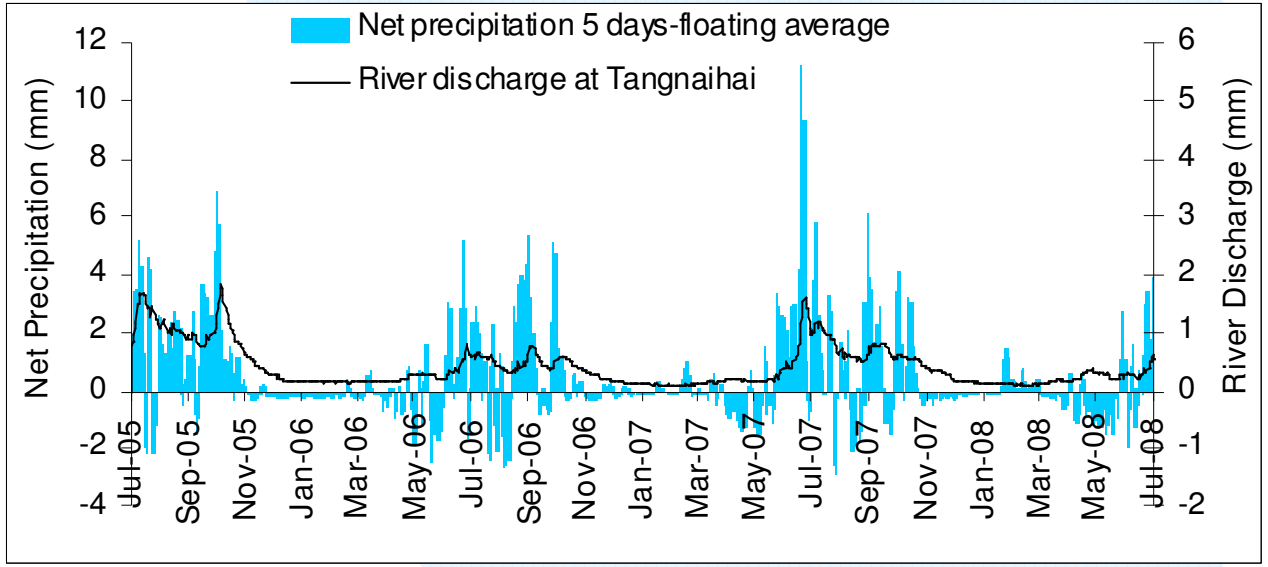


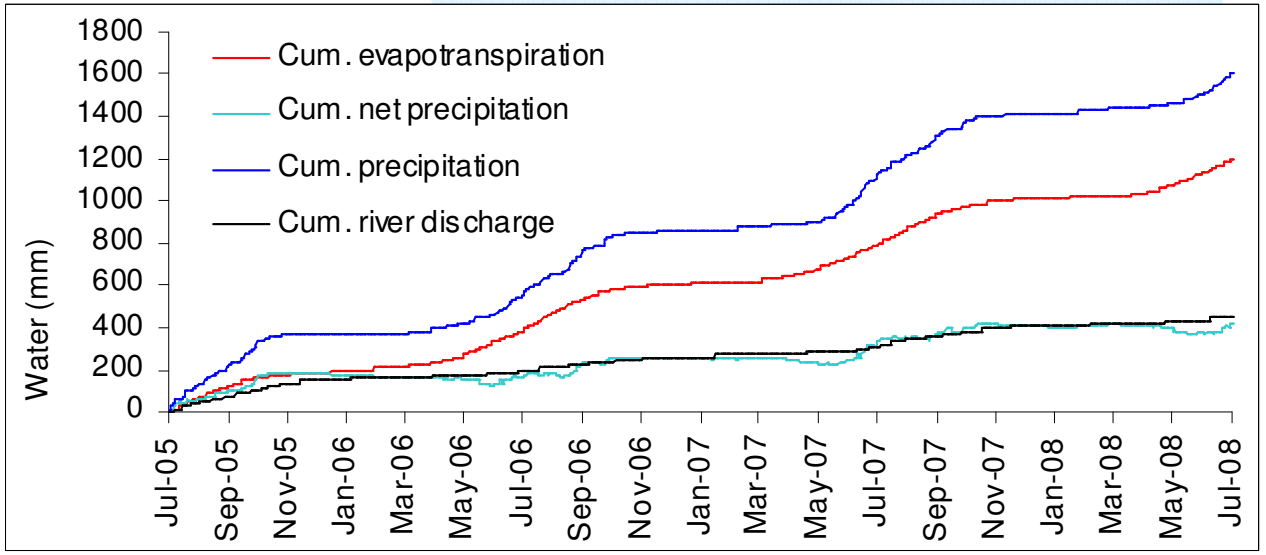
Comparison reported and estimated rainfall





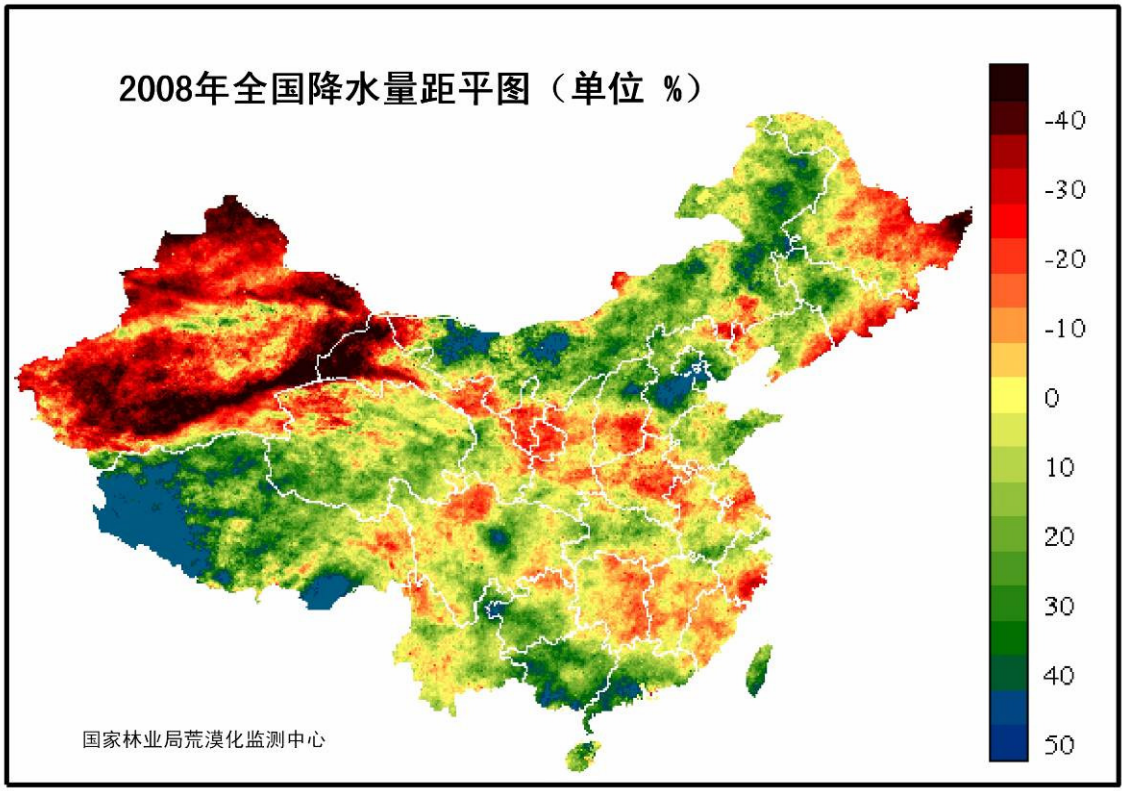
Water budget & discharge





Drought monitoring

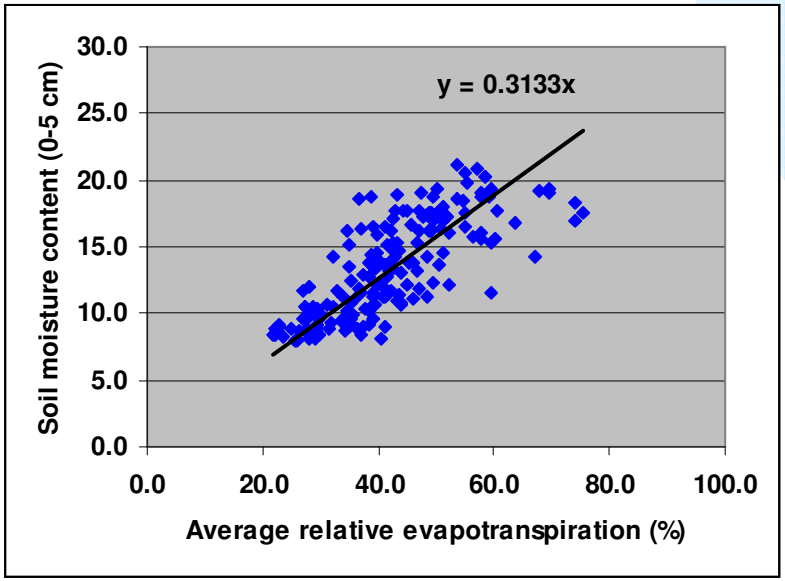
Meteorological drought

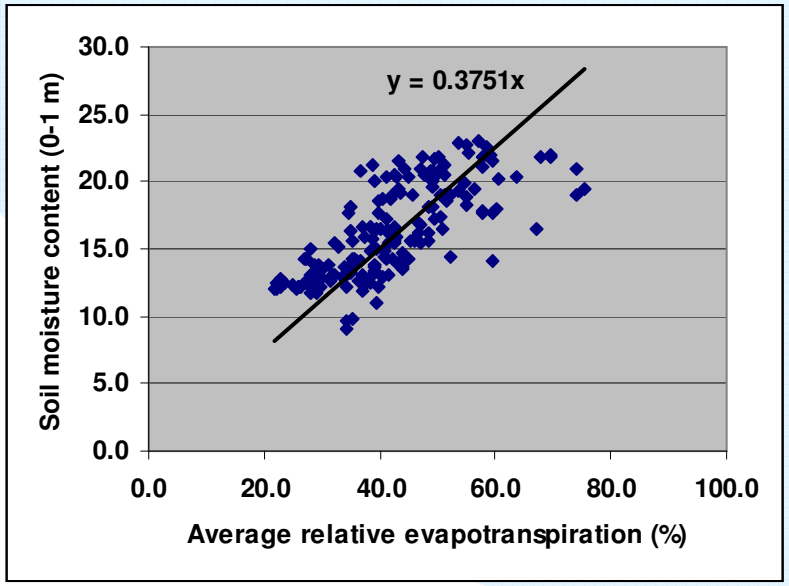


Rainfall deviation from average (SFA-CNDMC)

Agricultural drought (1)

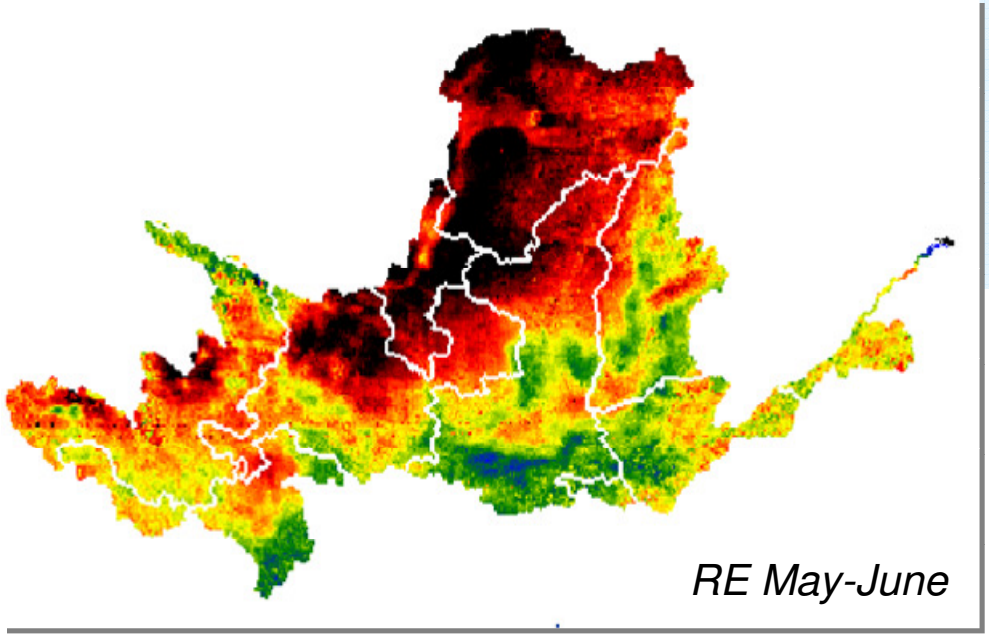
- **2 monthly relative evapotranspiration (EDI)**
- **Proportional to crop growth**
- **Proportional to plant available water (PAW)**



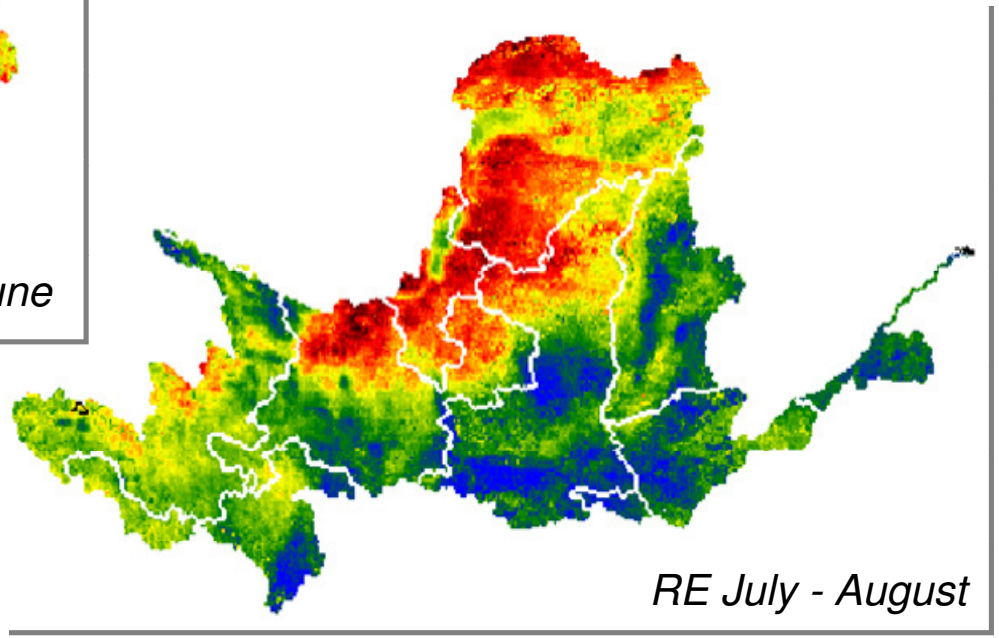


PAW ≈ 0.35 RE

Agricultural drought during 2008



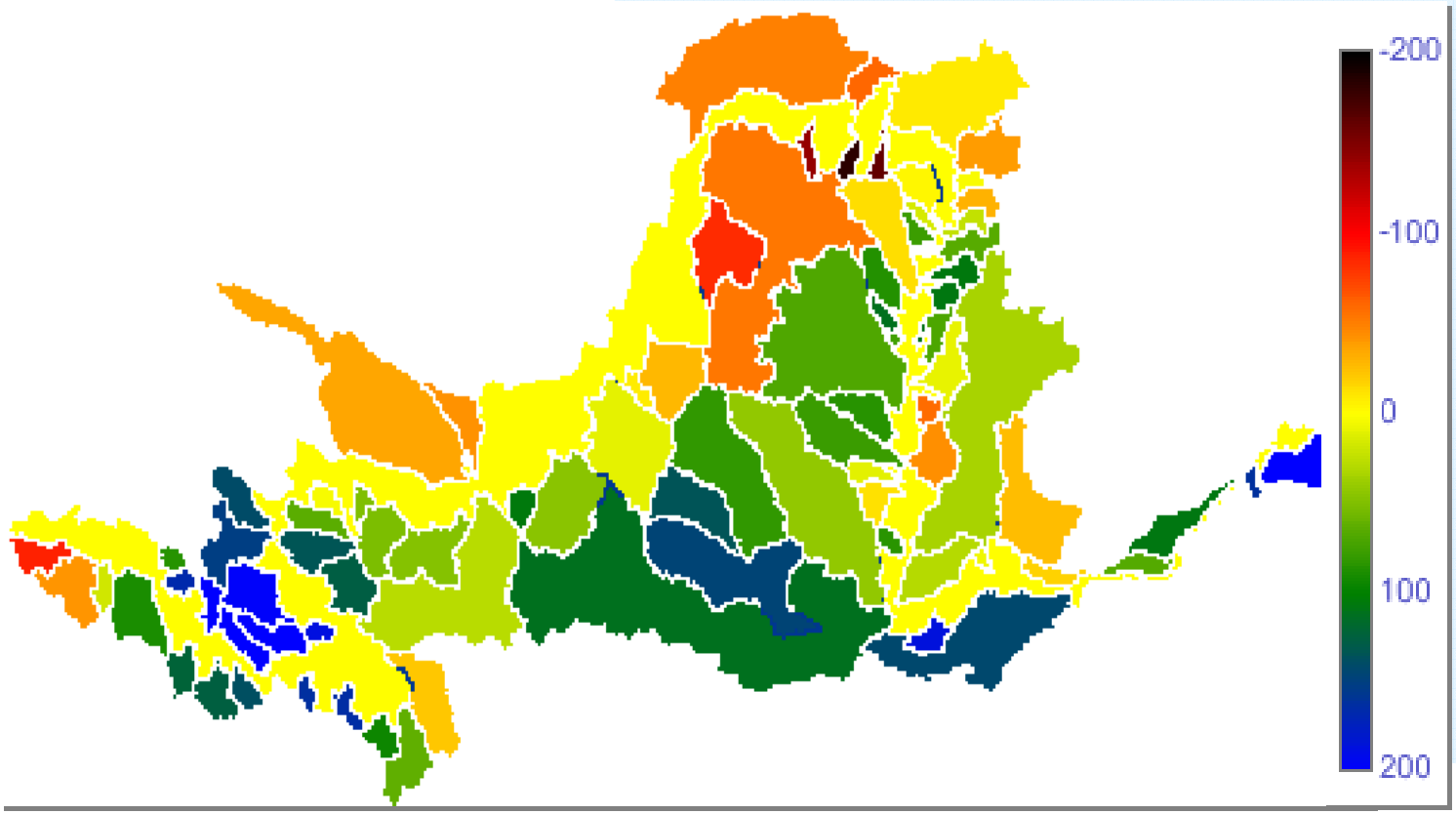
RE May-June



RE July - August

Hydrological drought

CWR = Precipitation – Actual evapotranspiration

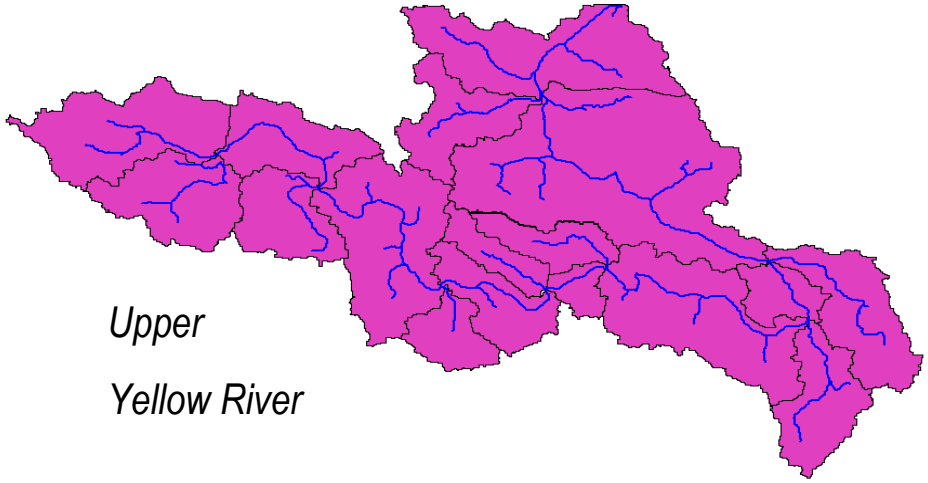


Subcatchment water resources in 2007-2008 hydrologic year

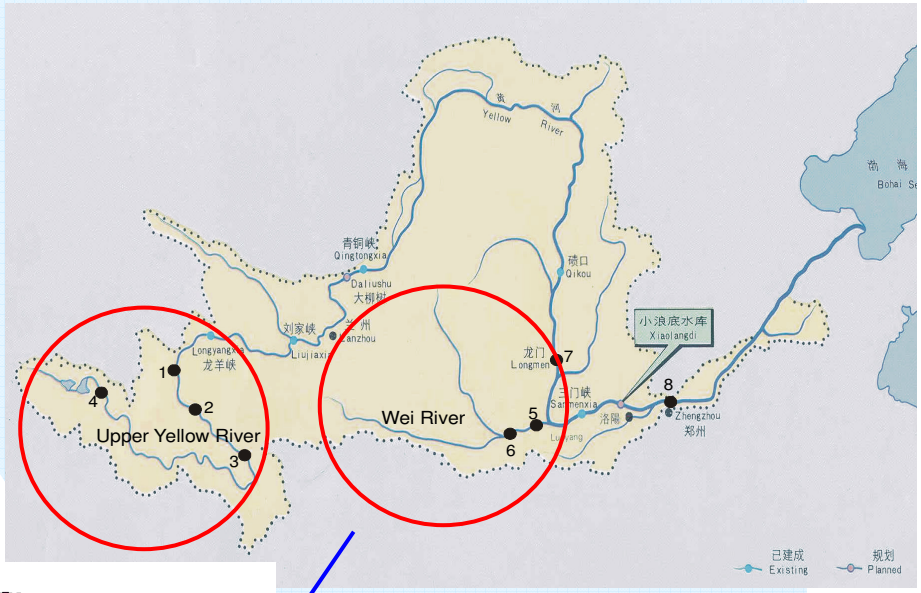
Flow forecasting

UNESCO-IHE

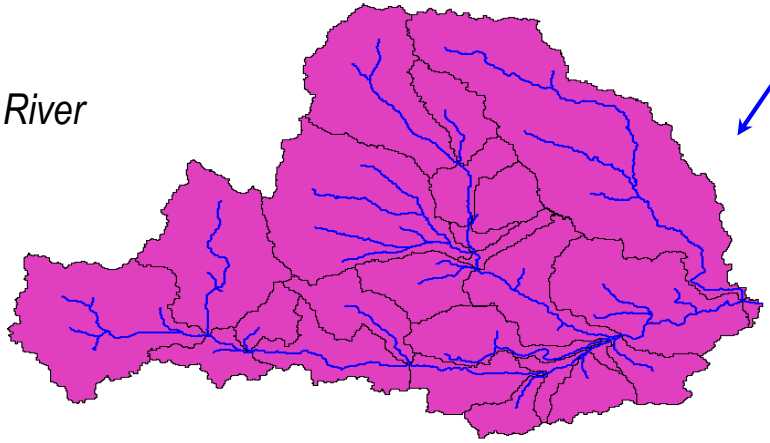
Yellow River sub-catchments



Upper Yellow River



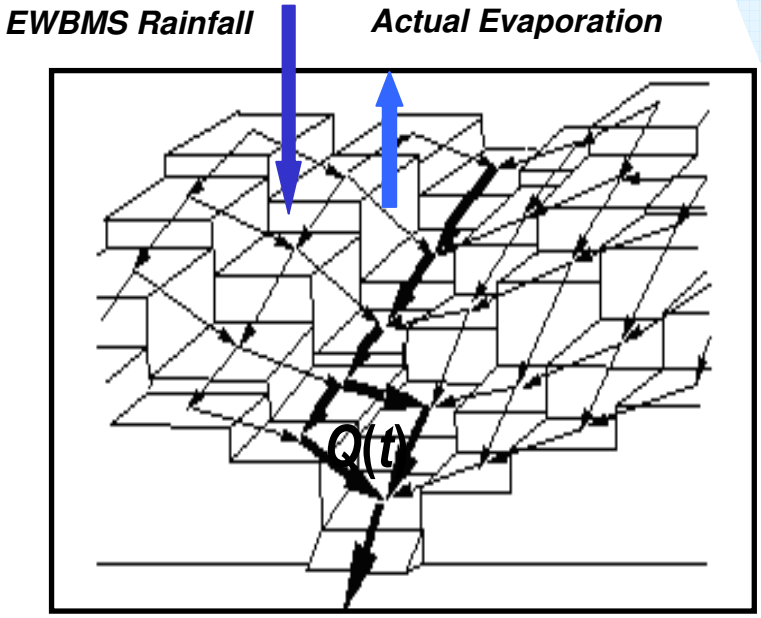
Second largest river basin of China



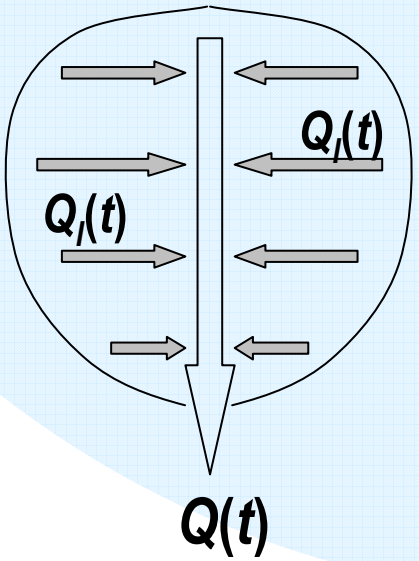
Wei River

Large Scale Hydrological Model (LSHM)

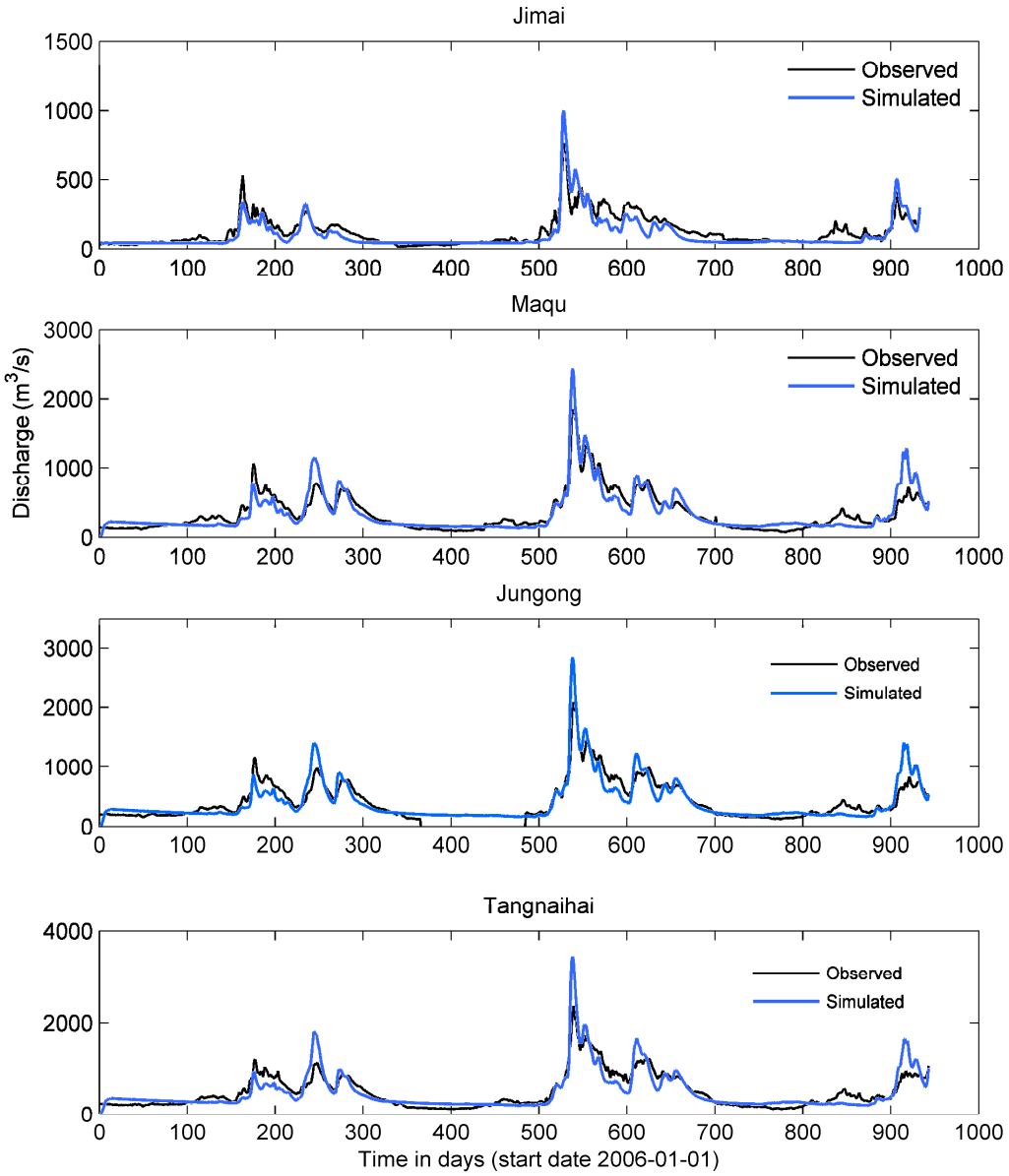
Land component:
2-dimensional diffusion process



River flow component:
Muskingum-Cunge routing



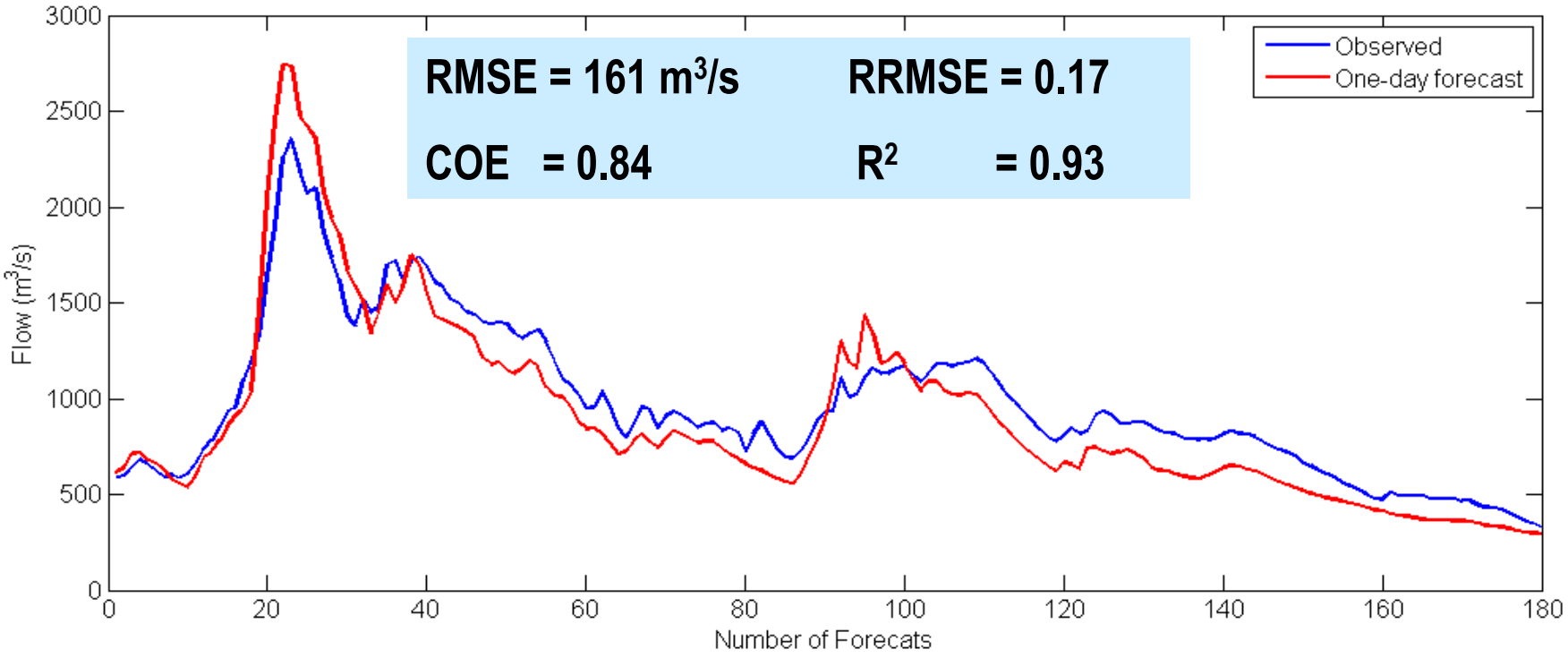
Flow simulation Upper Yellow River



Flow forecast performance UYRB

Criterion	Hydrological station			
	Jimai	Maqu	Jungong	Tangnaihai
R^2	0.8	0.82	0.8	0.8
RMSE (m^3/s)	55.5	128.2	162.3	189.3
RRMSE	0.45	0.38	0.37	0.39
BIAS (m^3/s)	21.9	–2.1	2.6	–3.24
% volume error	17.9	–0.61	0.6	–0.67
Drainage area (km^2)	45,800	86,725	97,825	118,725

One day forecast at Tangnaihai (basin outlet)



Conclusions

- EWBMS is an abundant climate data source
- Wate resources monitoring
- Meteorlogical, agricultural and hydrological drought monitoring

  - Including: Plant available soil water content
- Flow forecasting through LSHM
- Good performance and validation results
- EWBMS and LSHM are fully operational
- Need: High res. Geostationary Hydrological Satellite (HGHS: 0.5 km)

Thank you for your attention

More: www.ears.nl