CEOP Components: Crosscutting Studies

Water and Energy Budget Study (WEBS)

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Chinese Academy of Sciences

Outline

- WEBS objectives
- Recent WEBS Activities
- Connections with other CEOP activities

WEBS Objectives

- Identify suitable data sets for water and energy budget studies;

- Examine deficiencies in the parameterizations for the land-surface, convection, and boundary layer processes;

- Understand and quantify climatology and temporal variability of water and energy budgets for regional hydroclimate “hotspots”

Recent WEBS Activities

- RS-based terrestrial water closure (Princeton)
- RCM inter-comparison (Centro Epson Meteo)
- Improvement of land surface models (ITP/CAS)
- Trend of Tibet energy budget (ITP/CAS)

Science Issue: **Terrestrial Water Budgets from Space**

Land Surface Hydrology Group @ Princeton University

Approach:

Evaluate water budget closure from remote sensing (RS)-only. Quantify uncertainty for each of the independent terms.

Remote Sensing Data:

ET- exploit the suite of sensors on-board NASA Aqua to provide inputs to Penman-Monteith (P-M): AIRS (RH,Tair,Ts), MODIS (LAI, NDVI), and CERES (radiation).

P- NASA TRMM 3b42,3b42RT and/or JAXA GSMaP.

ΔS- GRACE

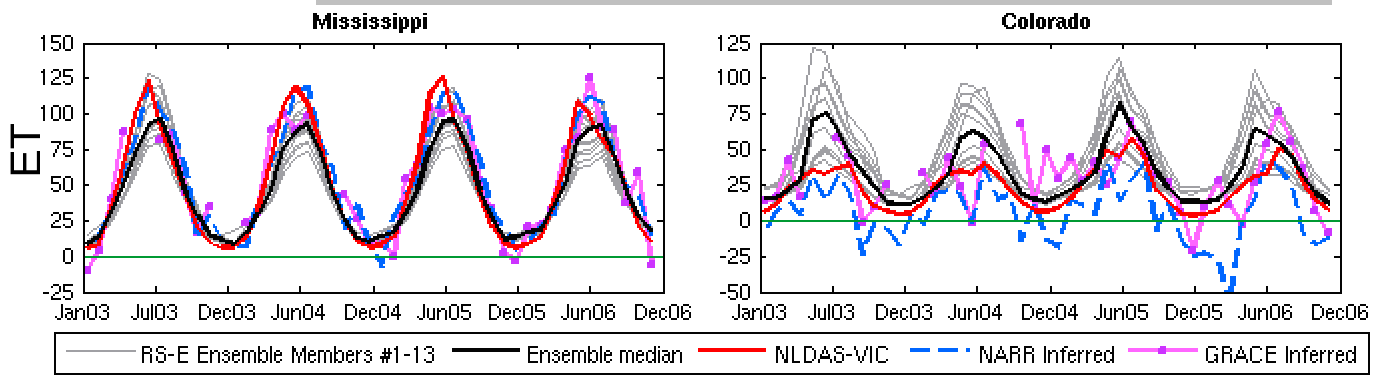
Other Data/Models:

NLDAS-VIC and NARR reanalysis

Evapotranspiration (ET) estimated using a terrestrial water budget:

$$ET = P - Q - \Delta S$$

- ET ← P-M (RS)
- P ← TRMM
- Q ← Runoff Observations USGS (1979-2003)
- ΔS ← GRACE



Publications:

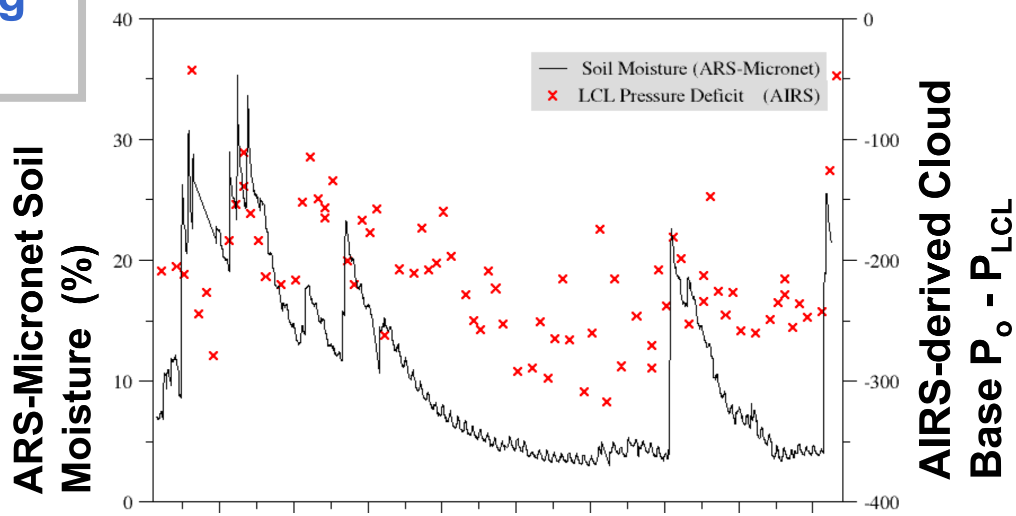
Sheffield, J., C. R. Ferguson, T. J. Troy, E. F. Wood, and M. F. McCabe, 2009: **Closing the terrestrial water budget from satellite remote sensing**, Geophys. Res. Lett., 36, L07403, doi:10.1029/2009GL037338.

Ferguson, C. R., J. Sheffield, E. F. Wood, H. Gao, and D. P. Lettenmaier, 2009: **Quantifying uncertainty in remote sensing based estimates of evapotranspiration due to data inputs over the continental United States**. Int. J. Rem. Sens., in review.

Science Issue:

Evaluating Land-Atmosphere Coupling Through Remote Sensing Observations

Land Surface Hydrology Group @ Princeton University



Approach:

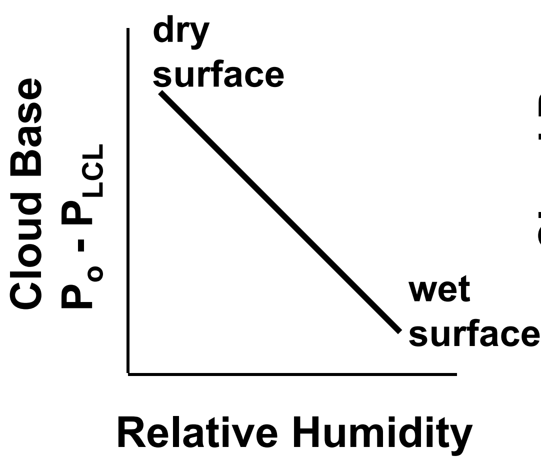
Quantify coupling in terms of observational diagnostics set forth by the work of Betts et al. (2004, 2007) and Findell and Eltahir (2003), using observational products from remote sensing

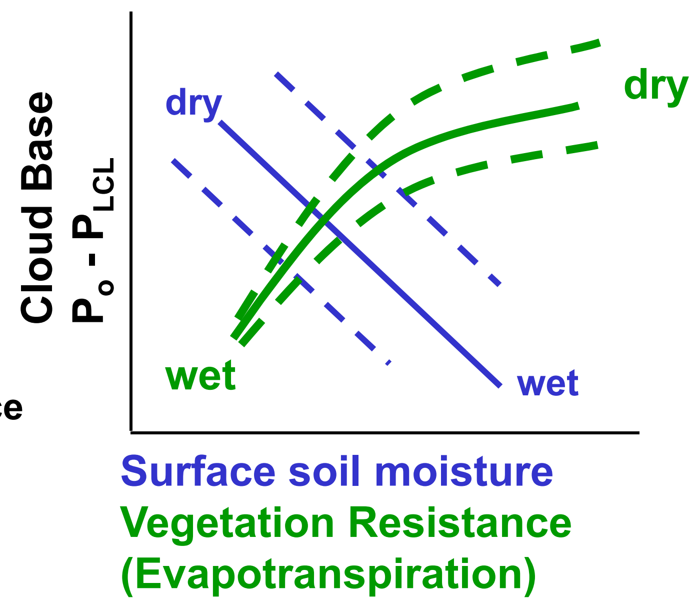
Remote Sensing Data:

NASA Aqua AIRS (RH,Ts), AMSR-E (X-band soil moisture)

Other Data:

Princeton RS-ET, in-situ observations from the Oklahoma Mesonet, West Texas Mesonet and WMO Radiosonde Network





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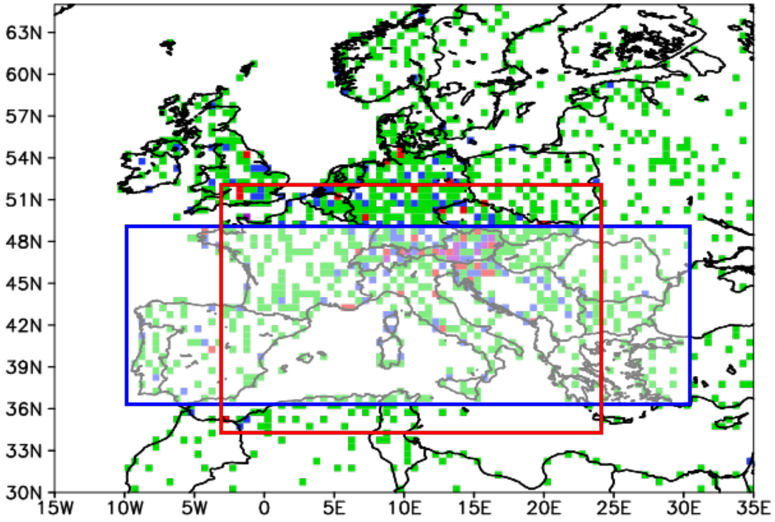
EUROPE: DATA AND ANALYSIS



DOMAINS USED FOR STATISTICS

✓ 36° -49° N; 10° W-30° E → **PRECIPITATION**

✓ *35° -52° N; 3° W-24° E* → ***HGT, TMP,UR,U,V***

MODEL FORECASTS

WRF-NMM v3.0

✓ *32 km horizontal resolution, 38 vertical levels*

✓ *initialization and boundary data: GFS T382L64*

RSM

✓ *50 km horizontal resolution, 28 vertical levels*

✓ *initialization and boundary data: EMC-GCM T126L28*

ECMWF

✓ *25 km horizontal resolution, 91 vertical levels*

✓ *global model T799L91*

OBSERVATIONS

NOAA CPC Daily Rain Gauge Analysis

✓*Global daily precipitation from station data*

✓ *0.5° x0.5° lat/lon, cumulated from 18z to 18z over Europe*

ECMWF ANALYSIS

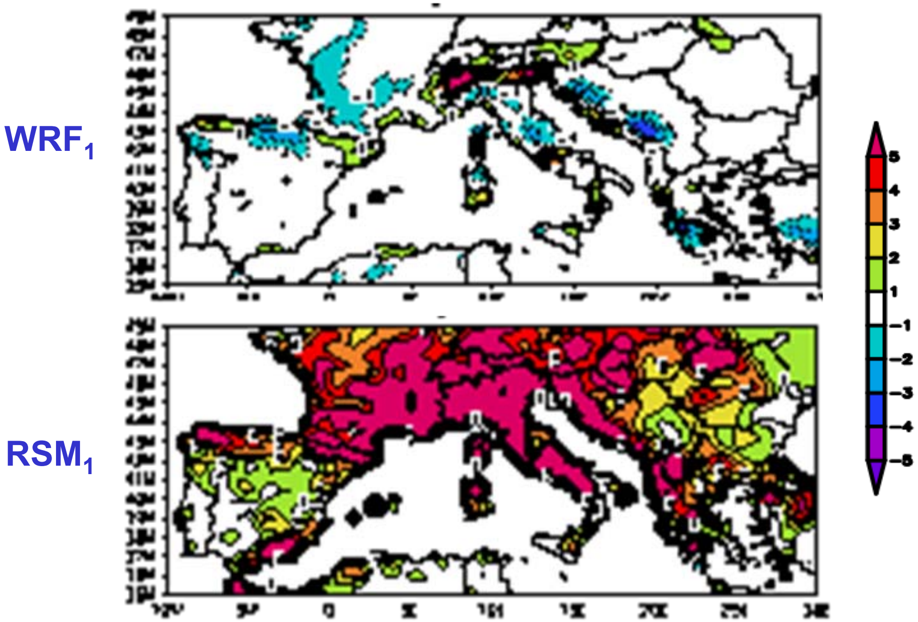
✓ *+00 hrs data, 50 km horizontal resolution, 8 vertical levels*

ALL DATA INTERPOLATED ON 0.5° X0.5° LAT/LON GRID

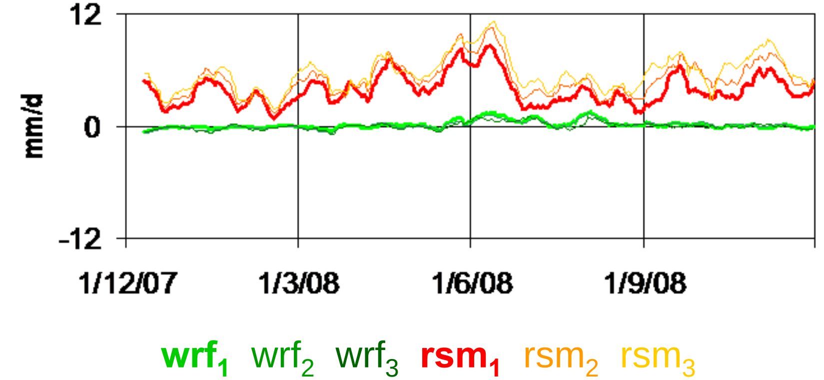
STATISTICS ONLY OVER LAND POINTS

Precipitation: bias and rmse

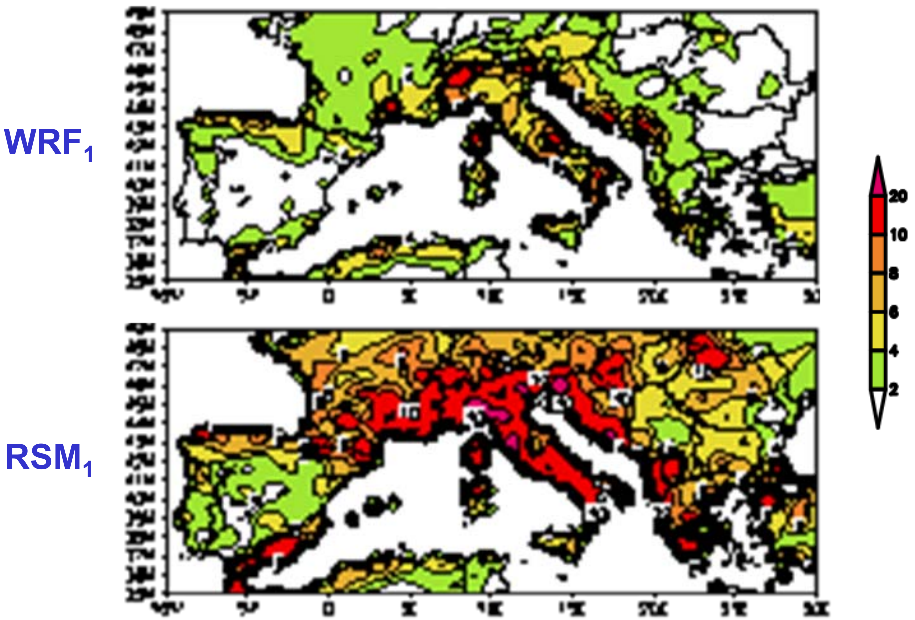
bias



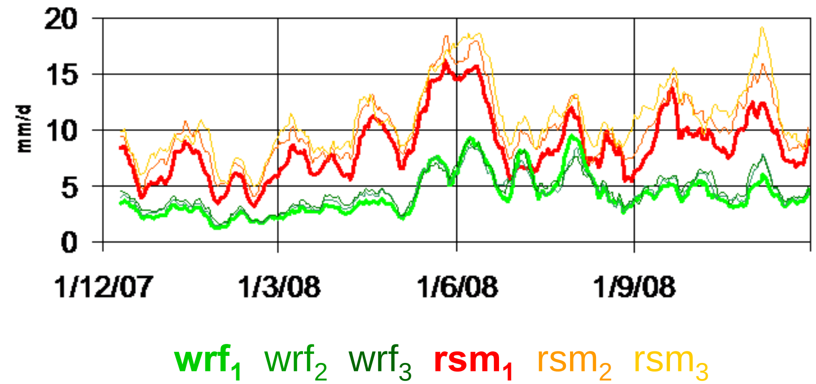
bias – running mean 10 days



rmse



rmse – running mean 10 days



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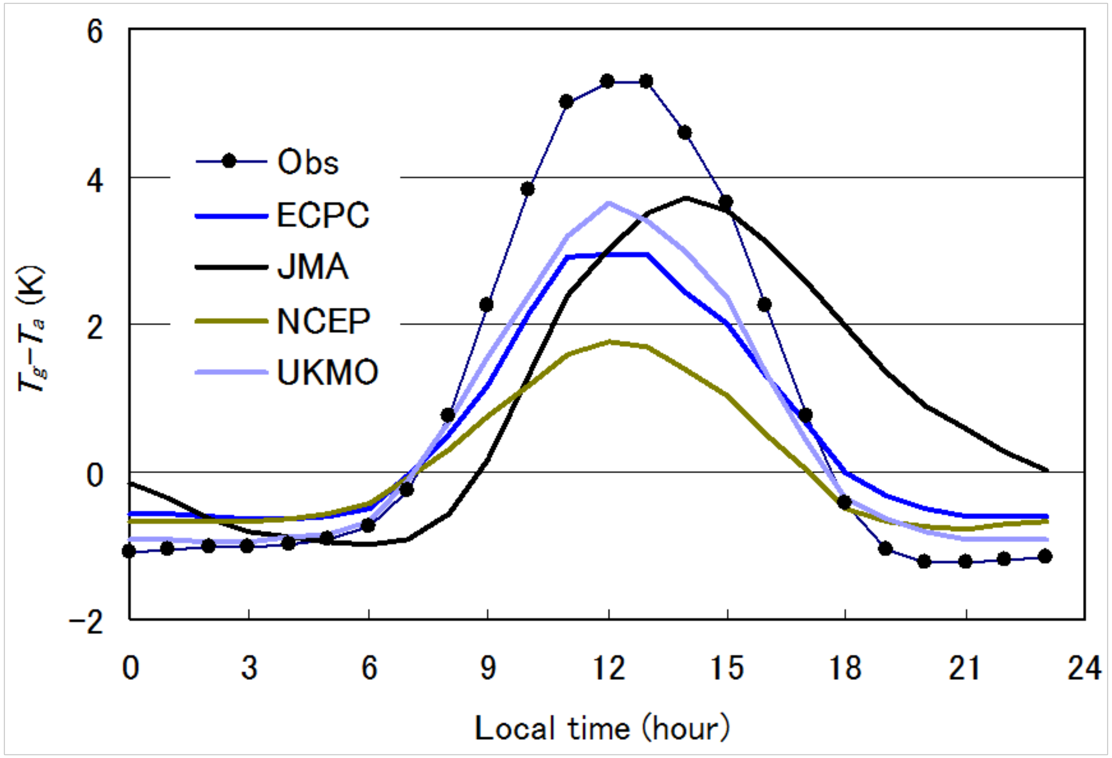
Deficiency in operational models

Composite of 13 sites-365 days



Tg-Ta: Observed > GCM

(Yang et al., JMSJ 2007)

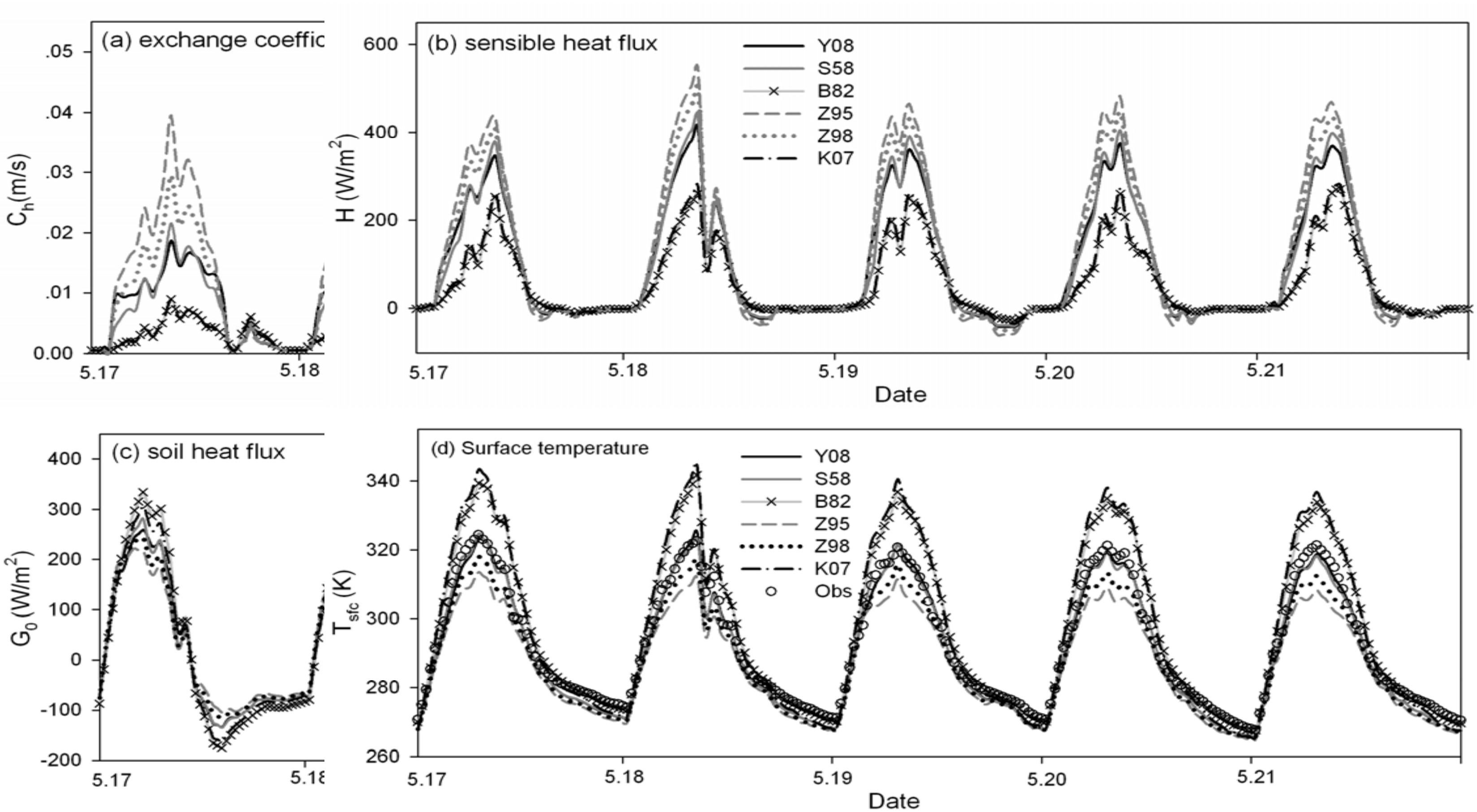
Evaluation of kB^{-1} schemes

Formula	Reference	Abbr.
$kB^{-1} = \ln(\Pr Re_*)$	Sheppard (1958)	S58
$kB^{-1} = k\,\alpha(8\,Re_*)^{0.45}\,\Pr^{0.8}$	Owen & Thomson (1963)	OT63
$kB^{-1} = 2.46 Re_*^{0.25} - 2$	Brutsaert (1982)	B82
$kB^{-1} = 0.1\,Re_*^{0.5}$	Zilitinkevich (1995)	Z95
$kB^{-1} = k\,\alpha\,Re_*^{0.45}$	Zeng et al. (1998)	Z98
$kB^{-1} = 1.29 Re_*^{0.25} - 2$	Kanda et al. (2007)	K07
$z_{0h} = \frac{70\nu}{u_*}\exp(-\beta u_*^{0.5}\lvert T_*\rvert^{0.25})$	Yang et al. (2007b)	Y07[a]

Sensitivity to thermal roughness length (z_{0h}) in Noah

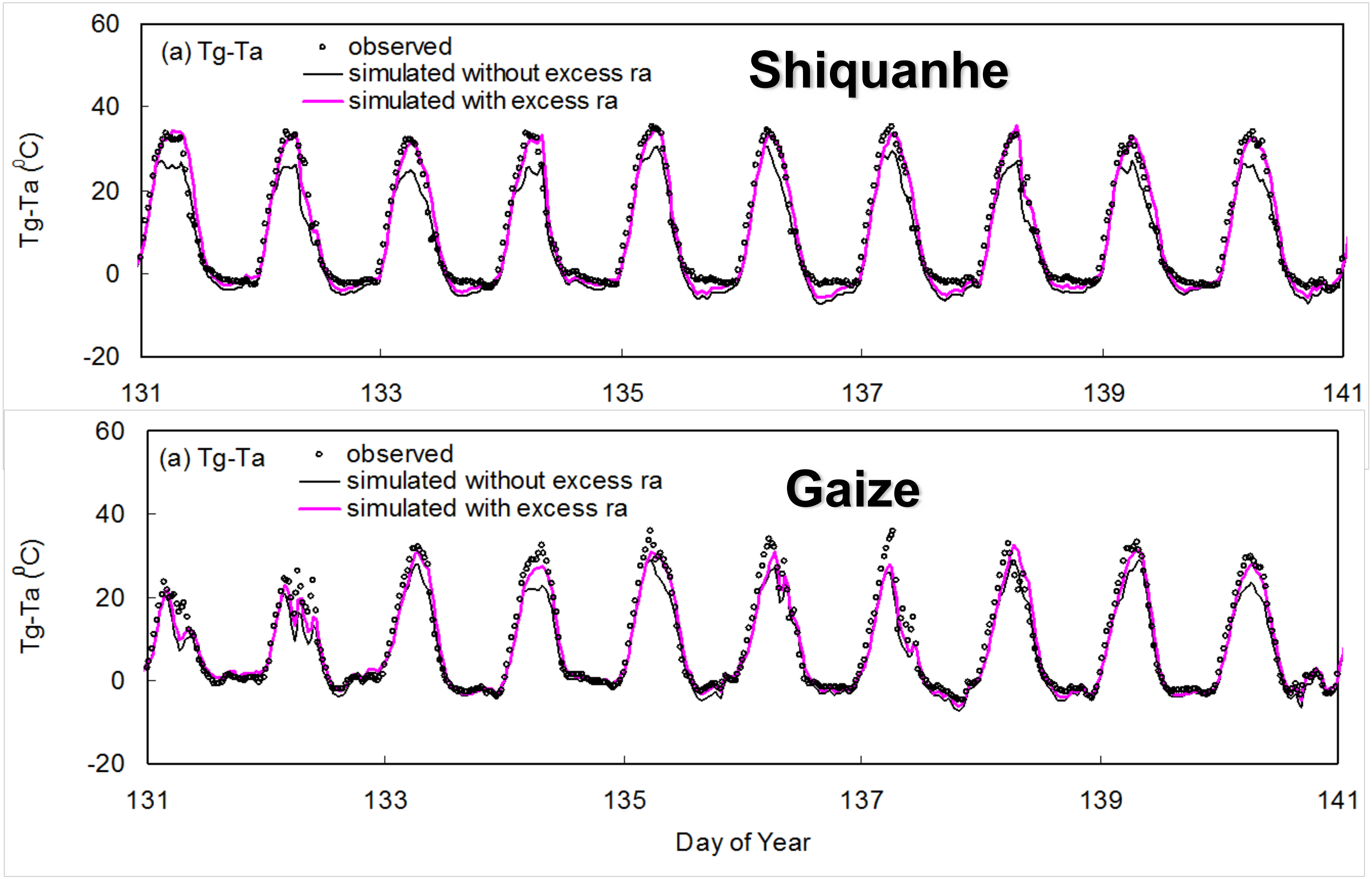
Six *z0h* schemes were implemented in Noah LSM, including

1) S58 (Sheppard 1958) 2) B82 (Brutsaert 1982) 3) Z95 (Zilitinkevich 1995)
4) Z98 (Zeng et al. 1998) 5) K07 (Kanda et al. 2007) 6) Y08 (Yang et al. 2008)



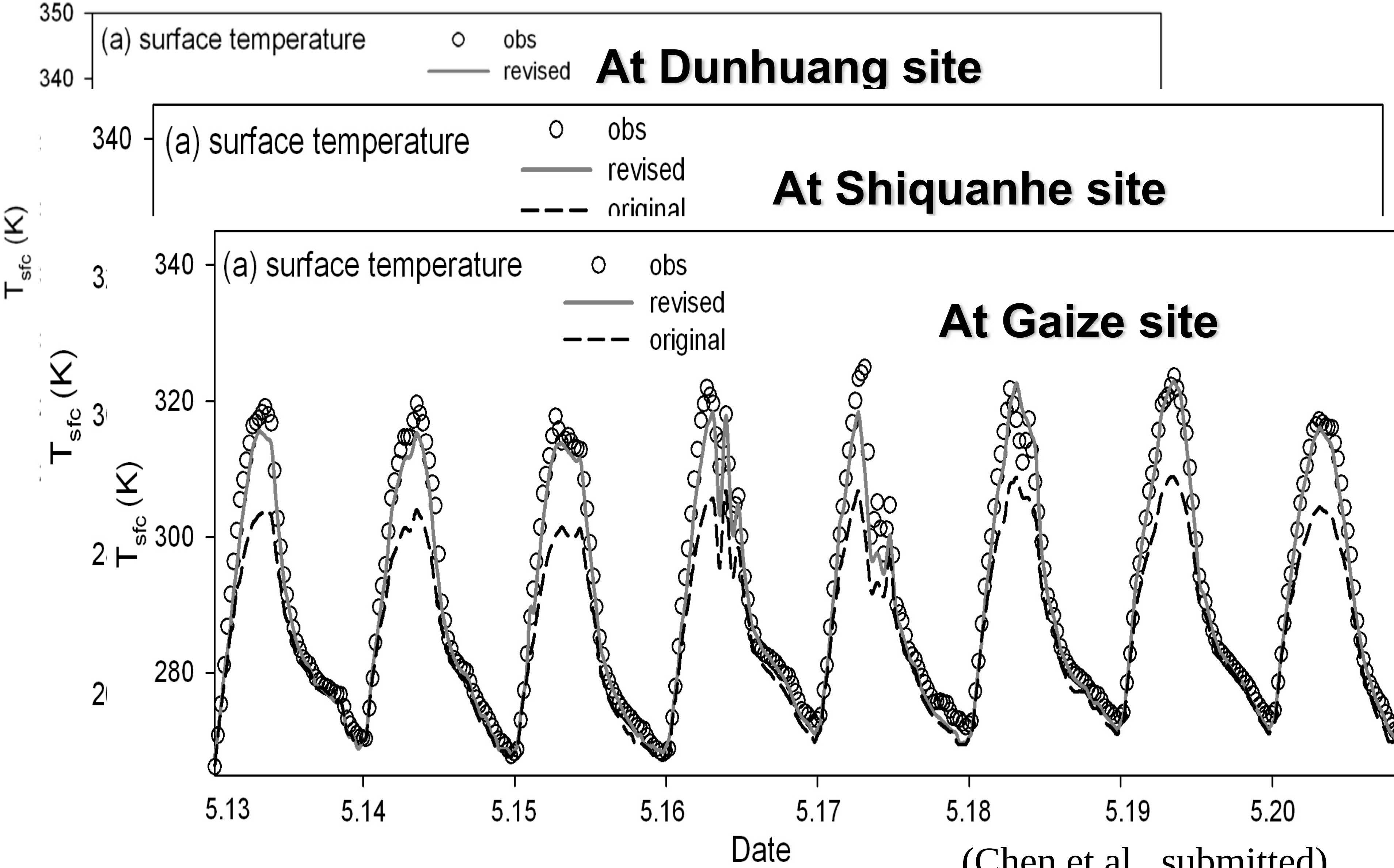
Y08 gives the smaller BIAS, RMSE in Tsfc than other schemes.

Implement Y08 into SiB2



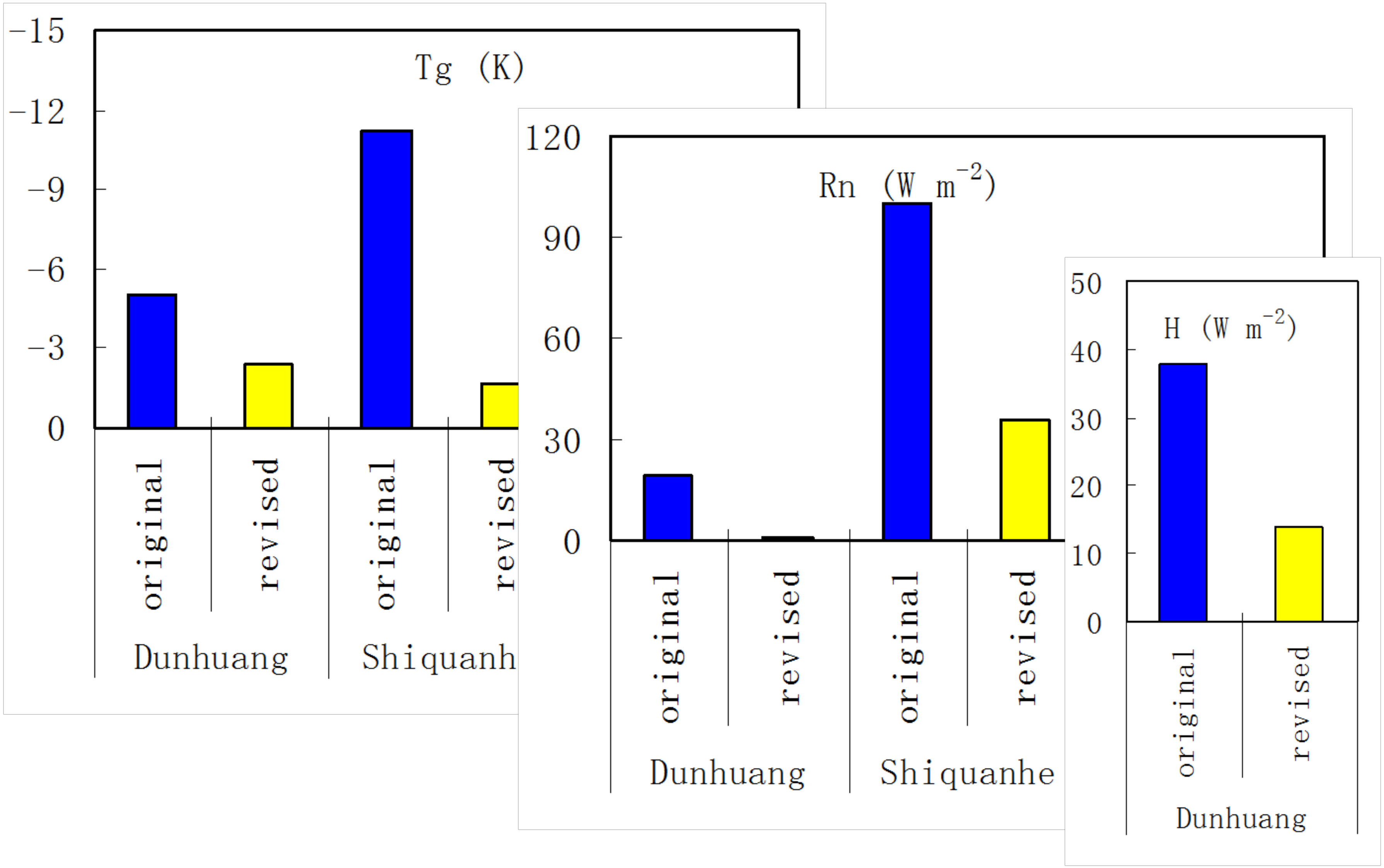
(Yang et al., HESS 2009)

Implement Y08 into Noah

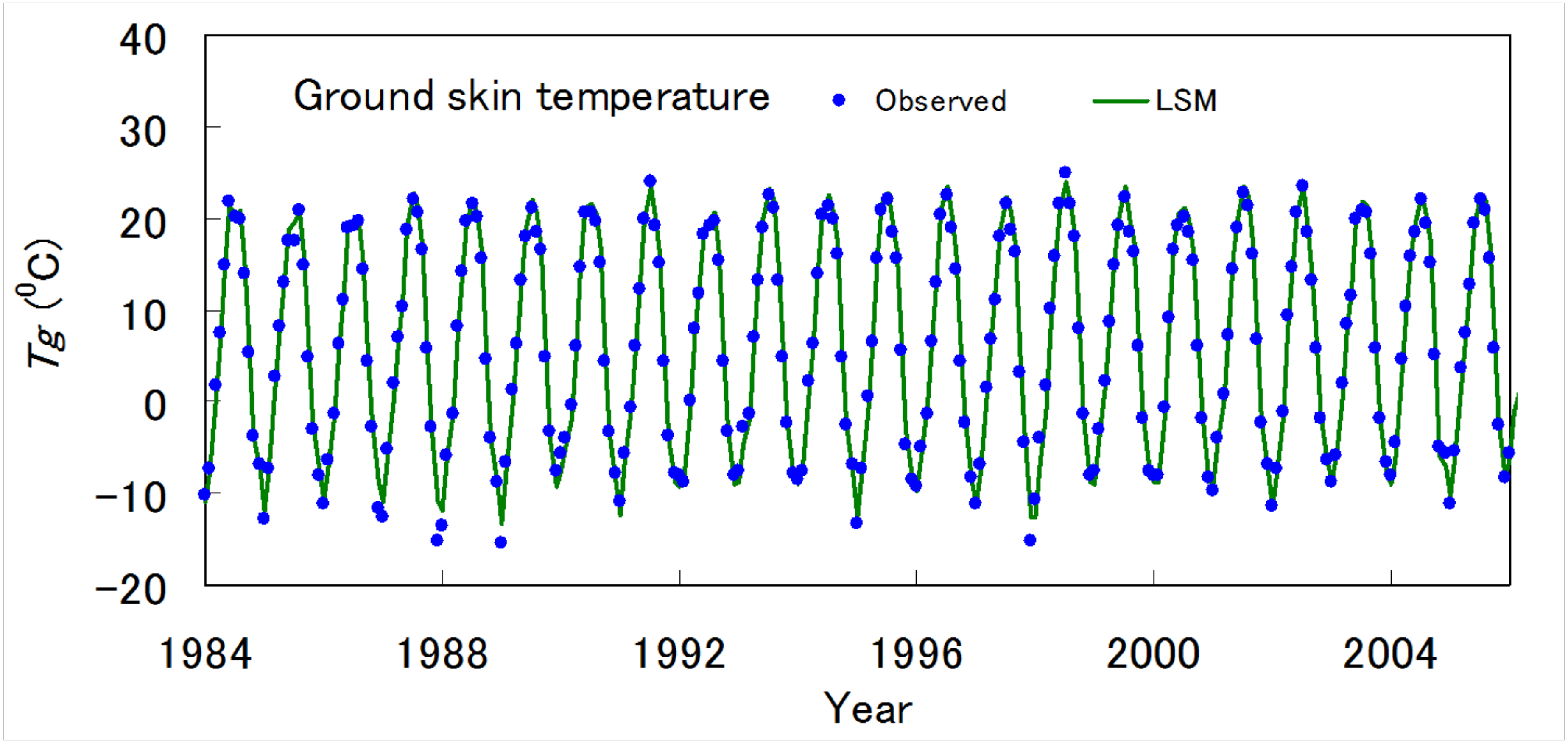


(Chen et al., submitted)

Mean biases at the three sites



Western TP： observe vs simulated



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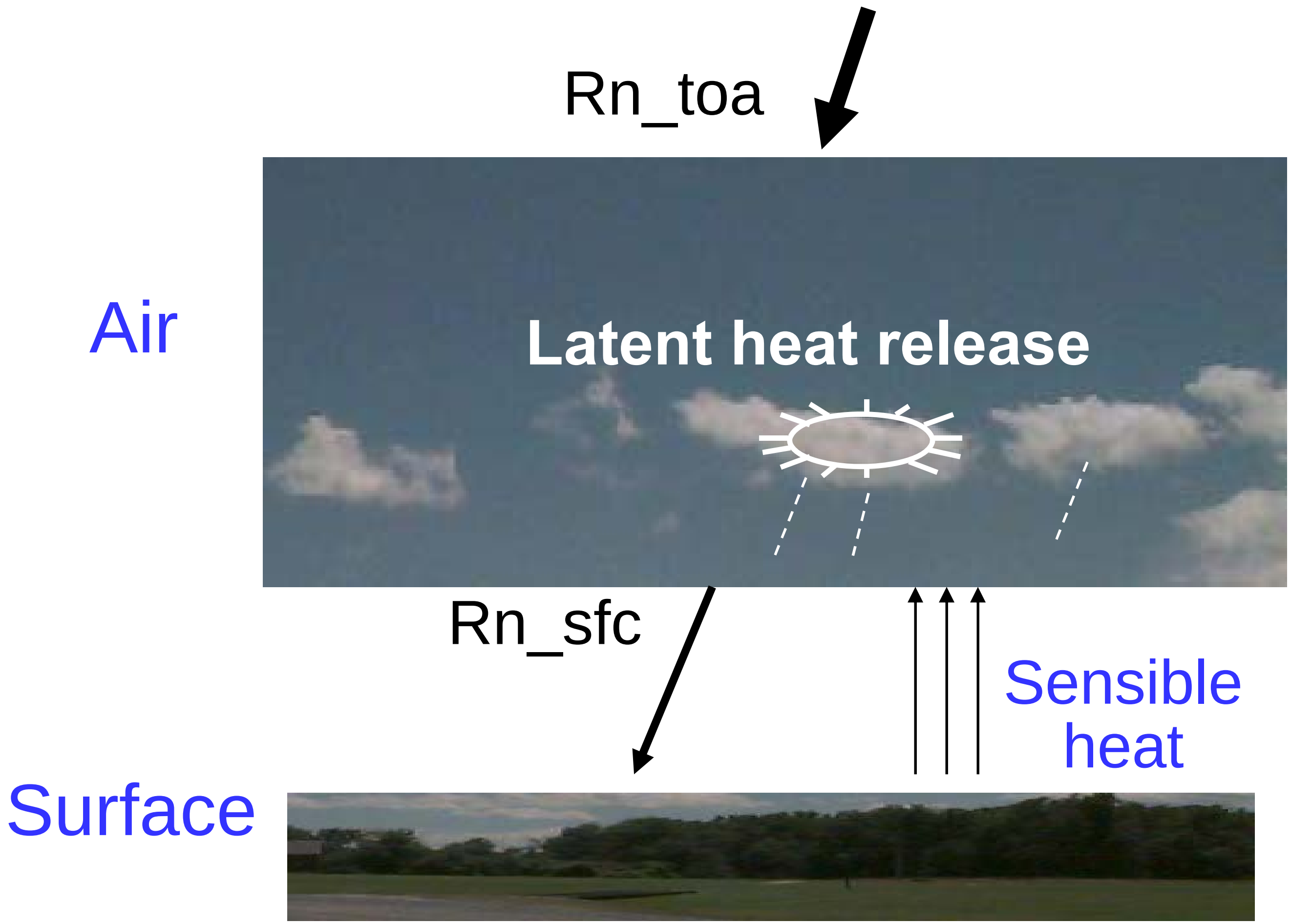
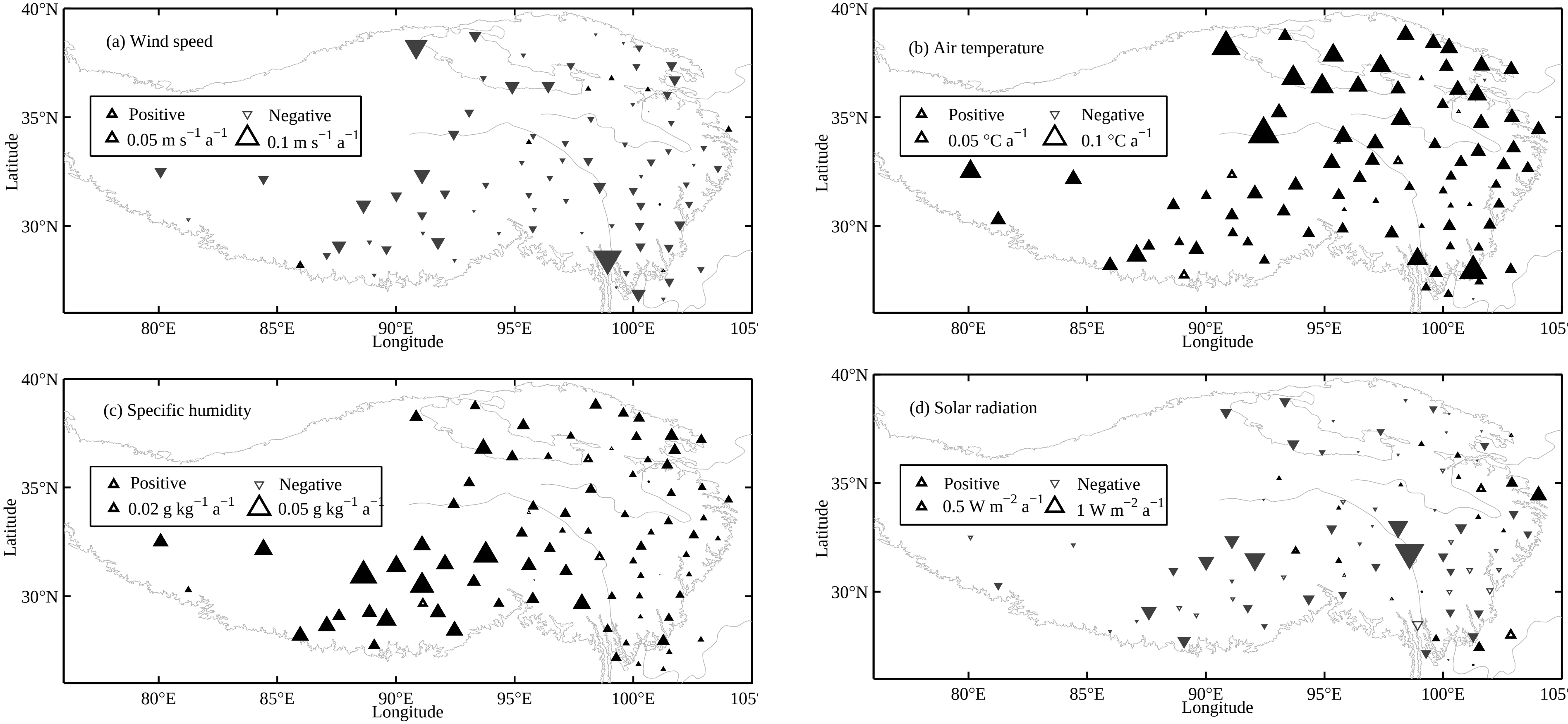
Atmospheric heating



Heat source =H + lP + δR

where δR=Rn_toa – Rn_sfc

Climate change

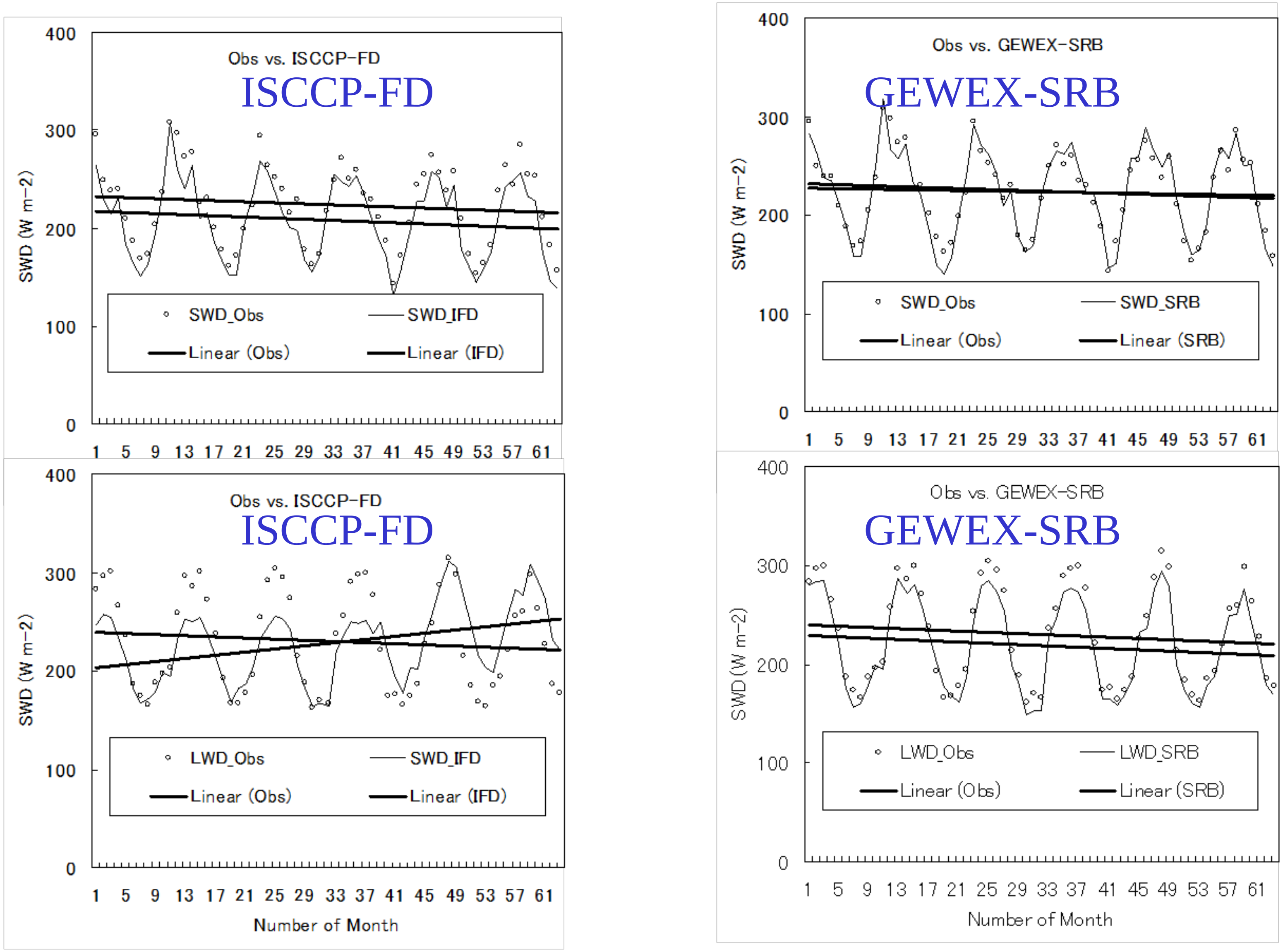


Tibetan Plateau has been experiencing a rapid warming and wetting while wind speed and solar radiation are declining in recent decades.

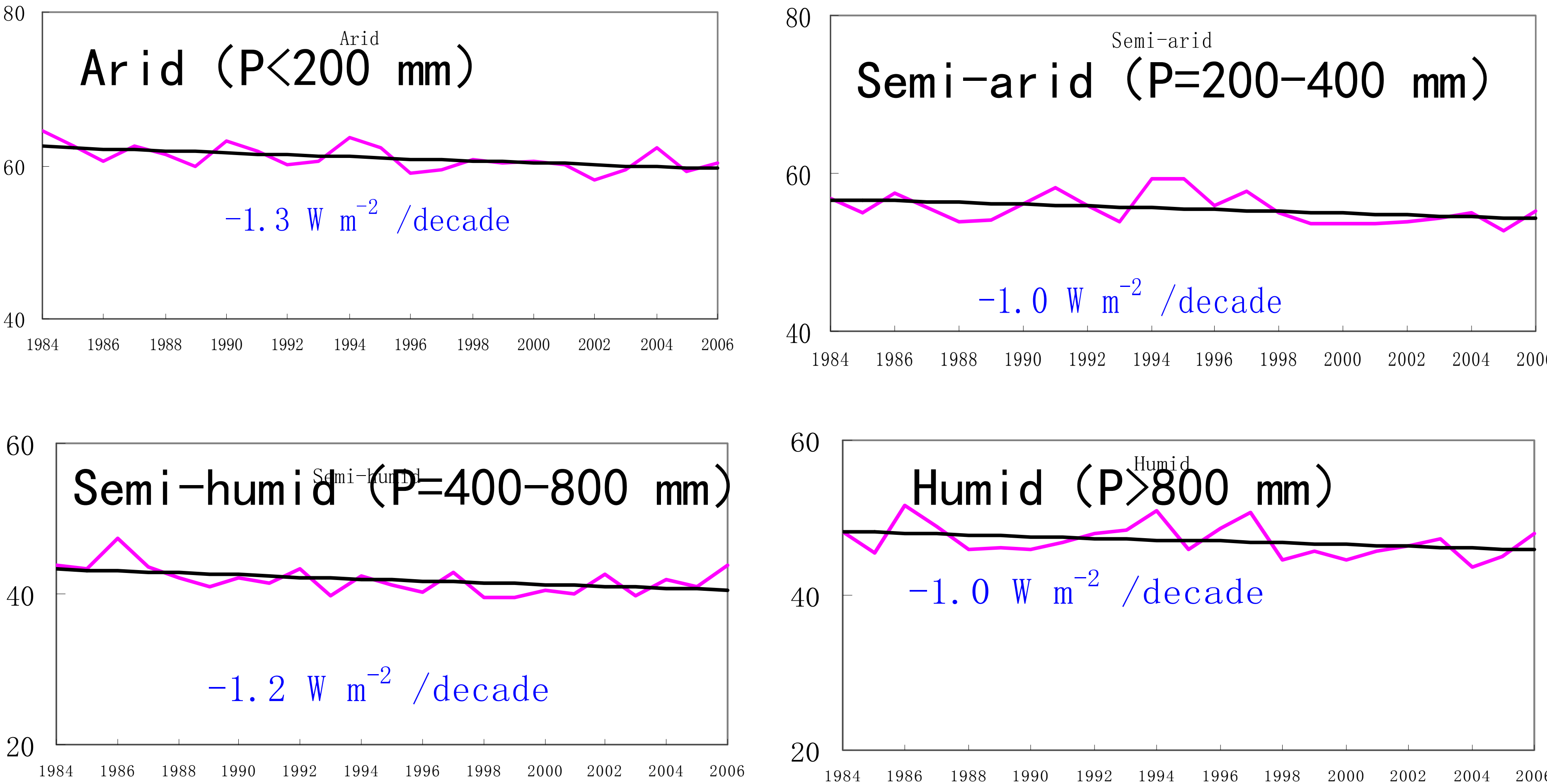
Evaluation ISCCP-FD and GEWEX-SRB at Amdo

SW

LW



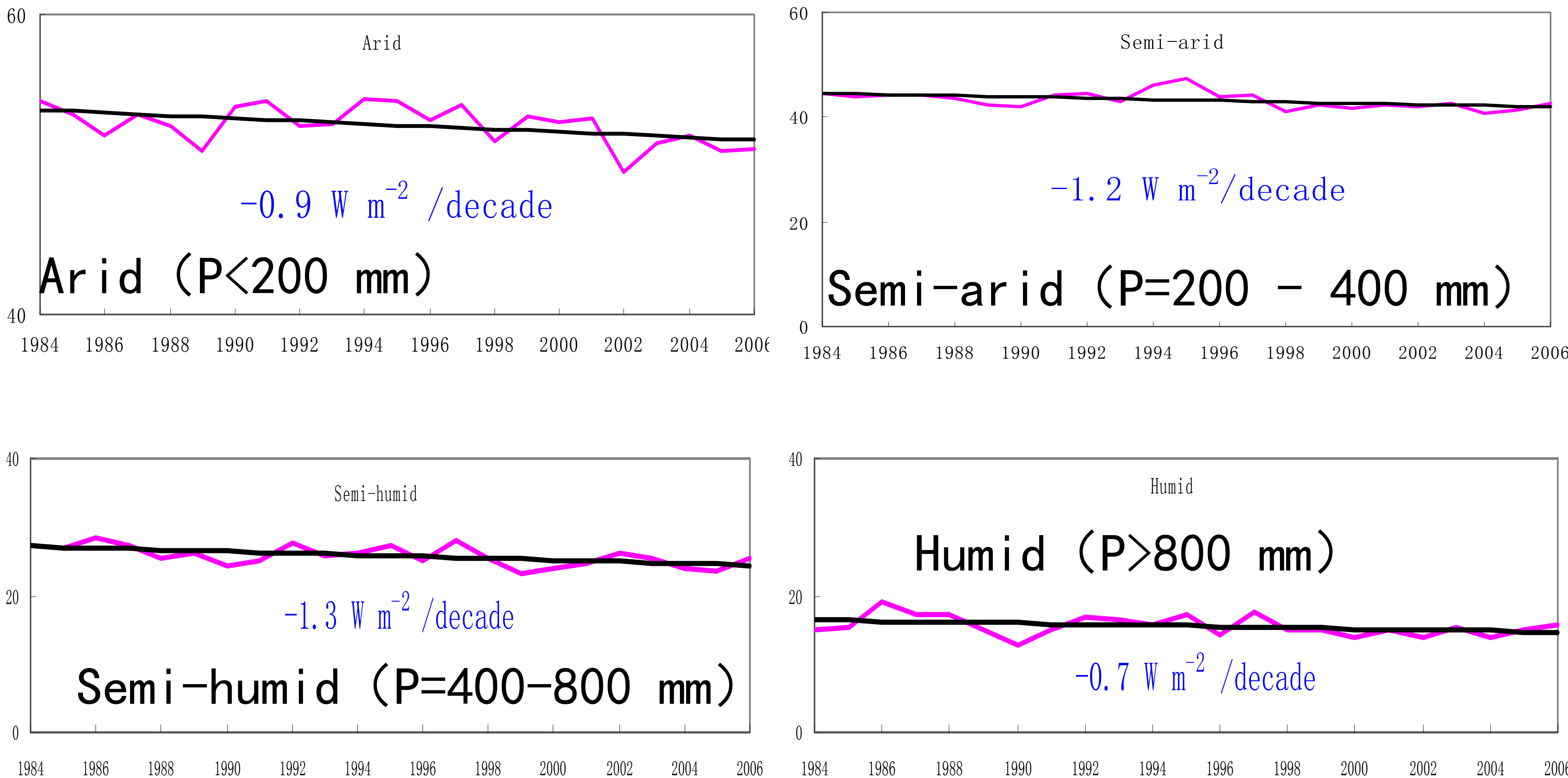
Trend of sensible heat flux from data analysis



Sensible heat flux is weakening ($1Wm^{-2}/10a$),

but the trend is far less than previous one ($3Wm^{-2}/10a$)

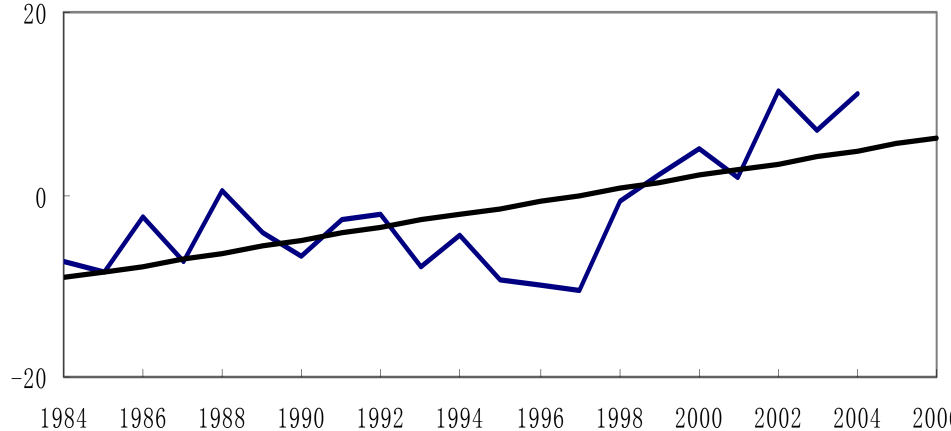
Trend of sensible heat flux from LSM modeling



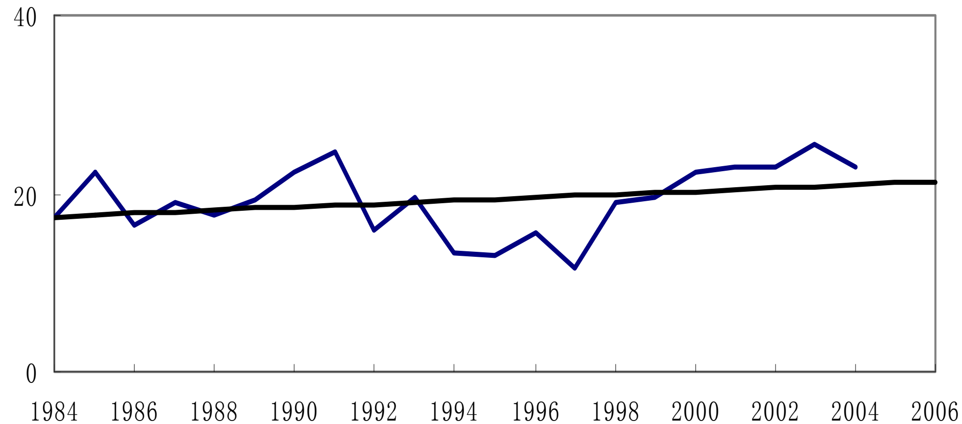
The simulated trend is consistent with the data analysis

Heat=H+LP+δR

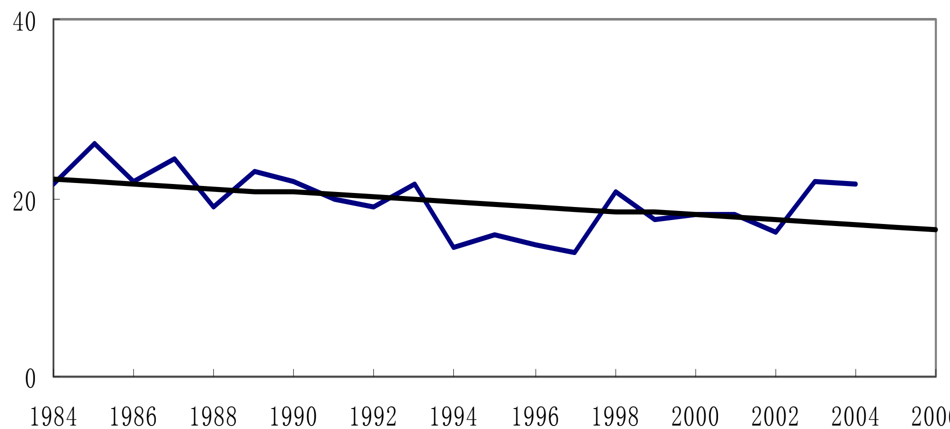
Western (Lon<85E)



Central (Lon=85-95E)



Eastern (Lon>95E)



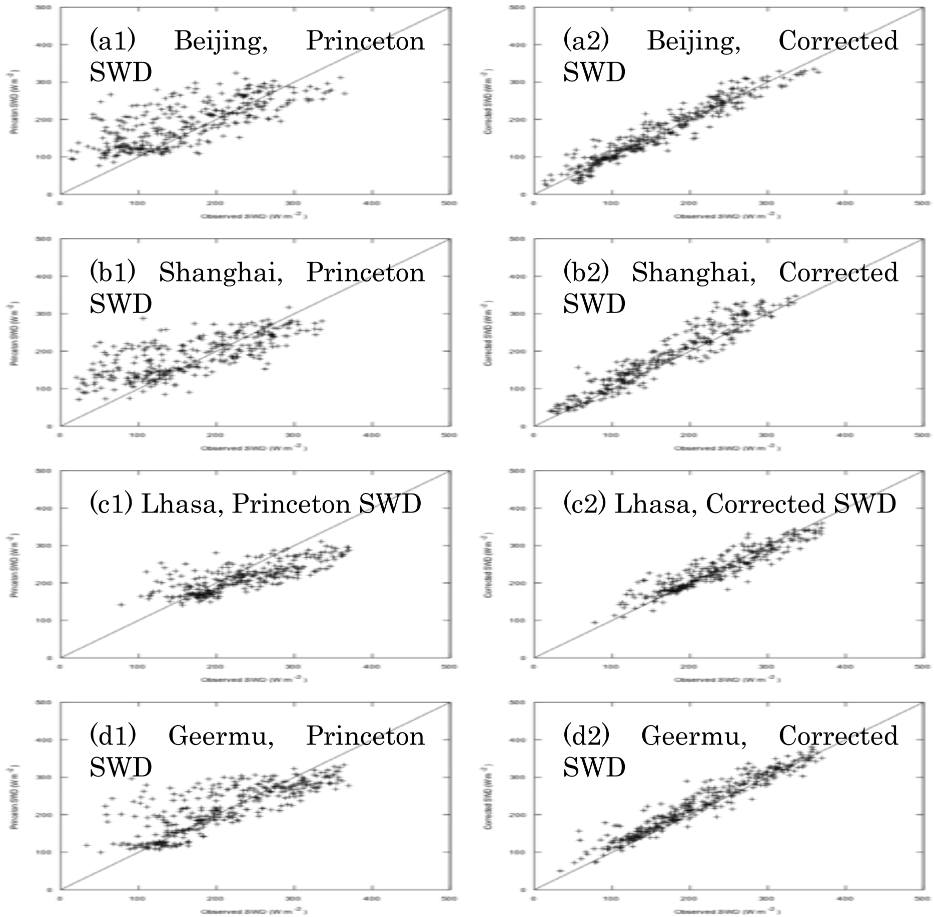
Publications

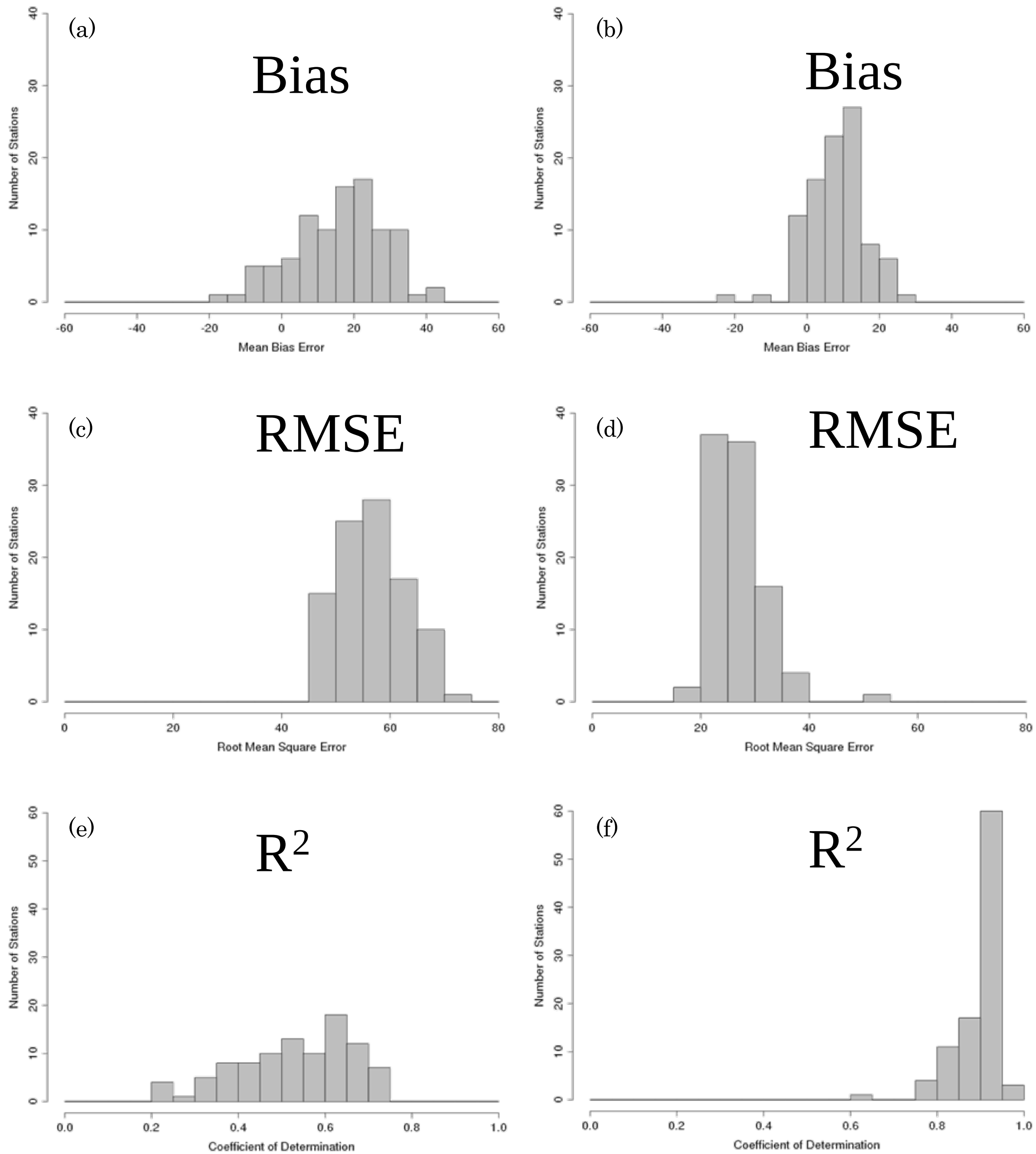
- Ferguson, C. R. and E. F. Wood, 2009: An evaluation of satellite remote-sensing data products for land surface hydrology, Submitted to ***JHM***.
- Sheffield et al., 2009: Closing the terrestrial water budget from satellite remote sensing, ***GRL***, 36, L07403.
- Ferguson et al., 2009: Quantifying uncertainty in remote sensing based estimates of evapotranspiration due to data inputs over the continental United States. ***Int. J. Rem. Sens***., in review.
- Chen et al., 2009: Improving Noah Land Surface Model in Arid Regions with an Appropriate Parameterization of the Thermal Roughness Length. Submitted to ***JHM***
- Qin et al., 2009: Simultaneous estimation of both soil moisture and model parameters using particle filtering method through the assimilation of microwave signal, ***JGR***, 114, D15103.
- Yang et al., 2009: On downward shortwave and longwave radiations over high altitude regions: observation and modeling in the Tibetan Plateau. ***AFM***, in press.
- Yang et al., 2009: Method Development for Estimating Sensible Heat Flux over the Tibetan Plateau from CMA Data. ***JAMC***, in press.
- Yang et al., 2009: Validation of a Dual-Pass Microwave Land Data Assimilation System for Estimating Surface Soil Moisture in Semiarid Regions. ***JHM*** 10, 780-793.
- Yang et al. 2009; Some practical notes on the land surface modeling in the Tibetan Plateau. ***Hydrol. Earth Syst. Sci***., 13, 687–701.

Connections with other CEOP activities

- High-accuracy data for Tibet – modeling and data assimilation
- Energy budget observations on a glacier – cold region and TPE (Third Pole Env.)
- Soil Moisture Array in Tibet (SMART) – modeling and RS
- Mini-PILPS at Asian drylands – CEOP SARS jointly with MARIS (Jun Asanuma)
- Joint workshop – CAS + CEOP HE + CEOP-AEGIS

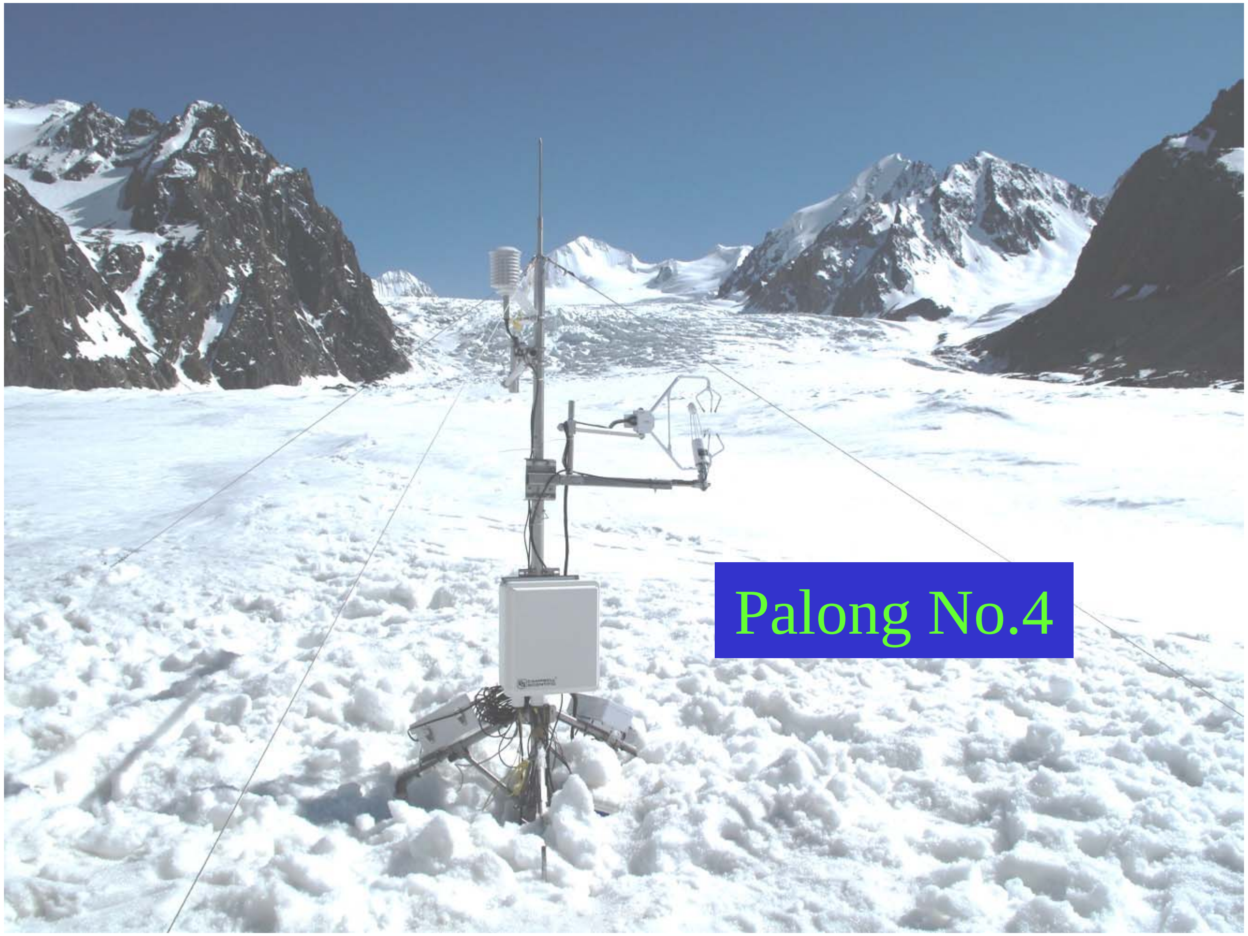
Development a high-accuracy forcing dataset by merging Princeton data and CMA data





(a)
Bias
Number of Stations
Mean Bias Error
(b)
Bias
Number of Stations
Mean Bias Error
(c)
RMSE
Number of Stations
Root Mean Square Error
(d)
RMSE
Number of Stations
Root Mean Square Error
(e)
R2
Number of Stations
Coefficient of Determination
(f)
R2
Number of Stations
Coefficient of Determination

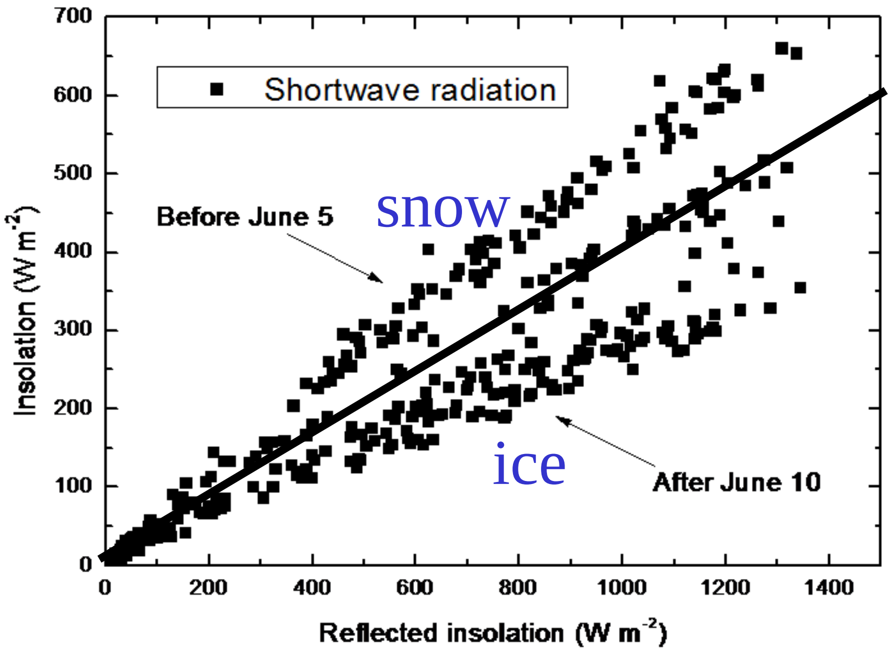
Glacier-melting studies from energy budget



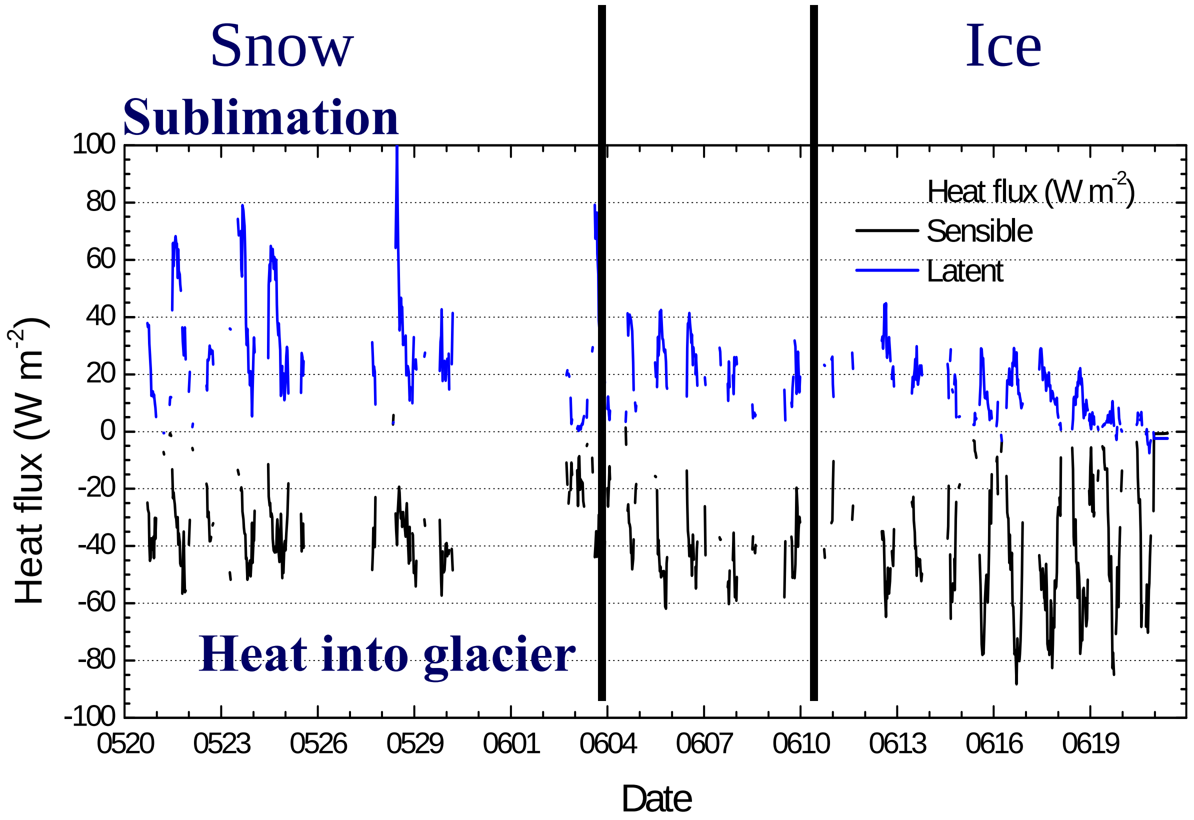
First turbulence station on a glacier in HKT

Albedo of ice surface and snow surface

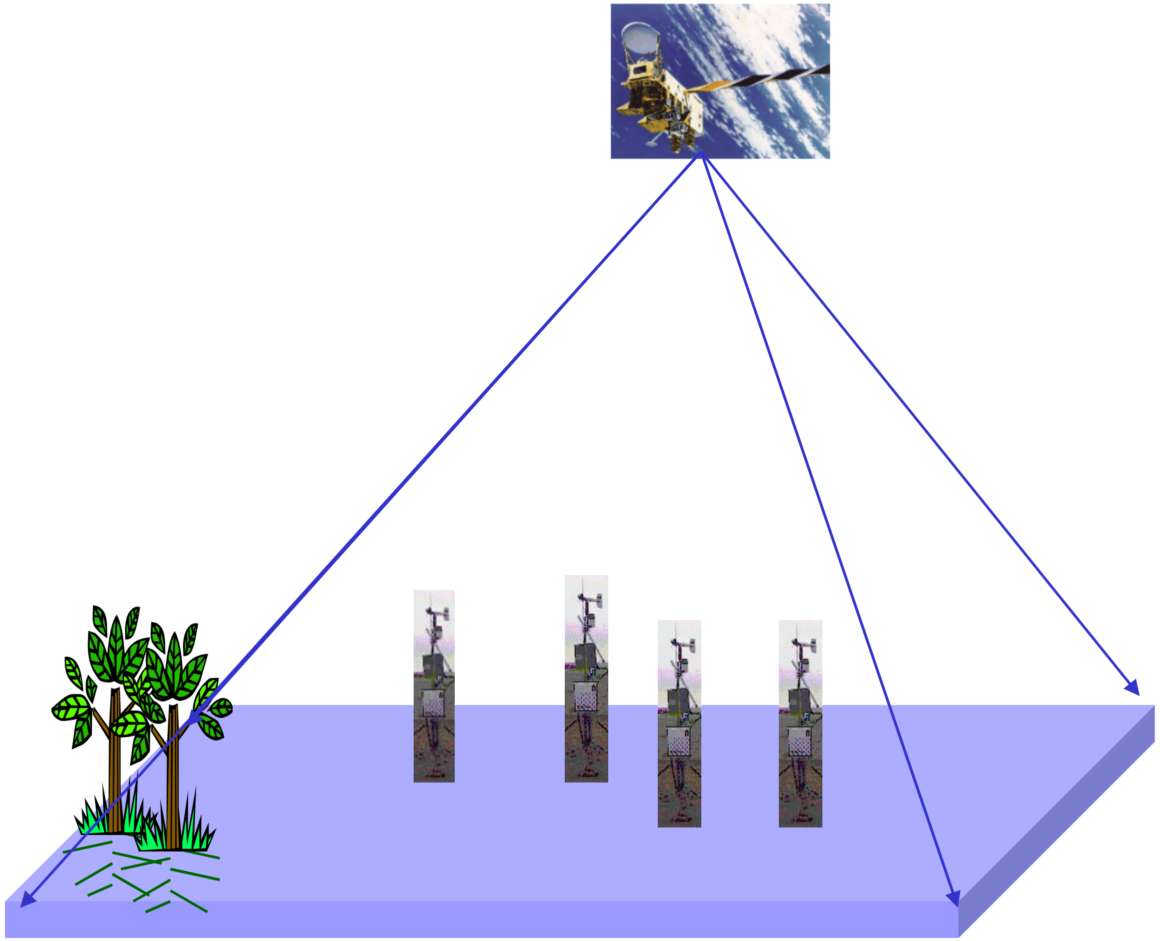
Snow / Ice
surface



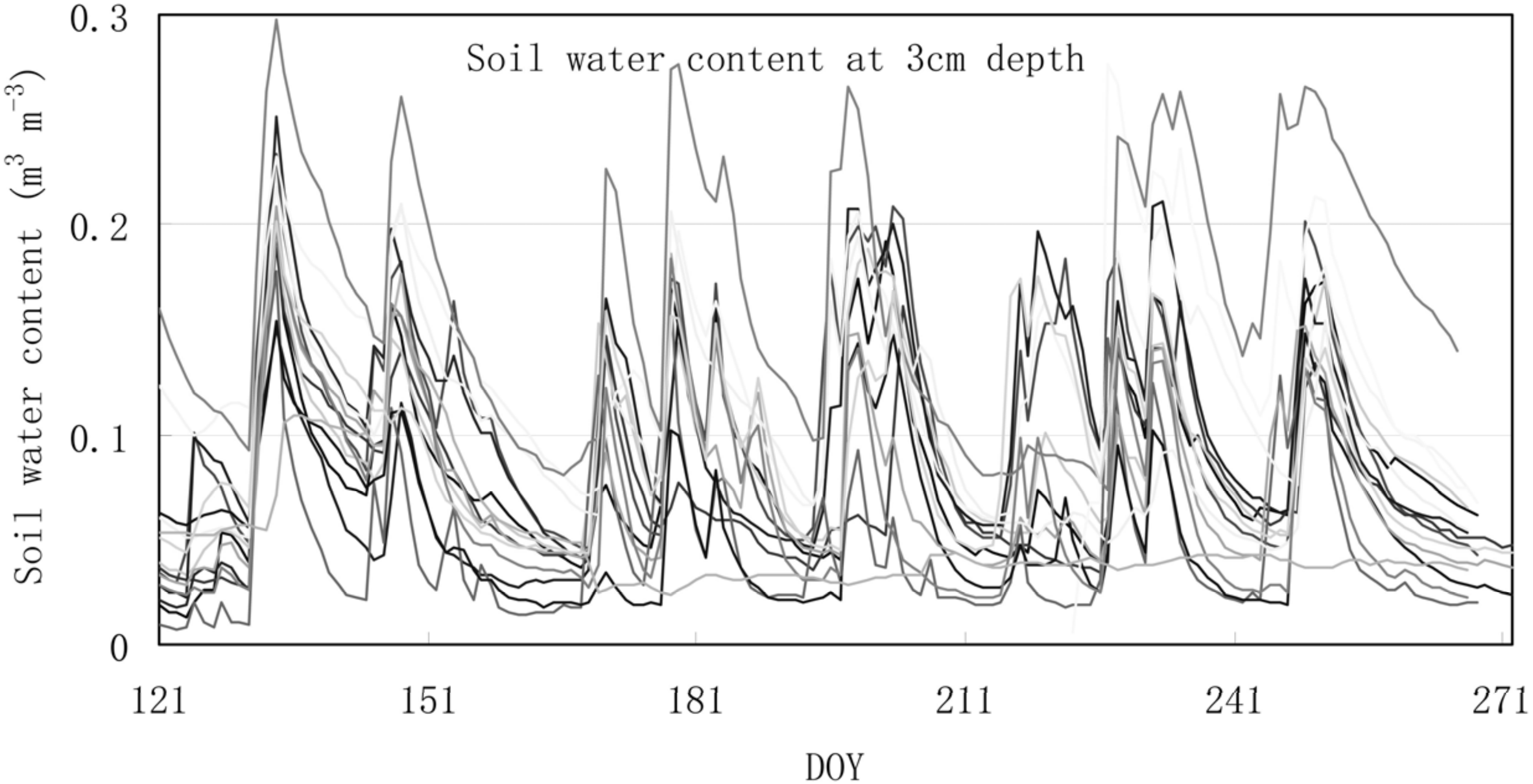
Glacier surface energy budget



Validations of RS soil moisture require dense soil moisture network



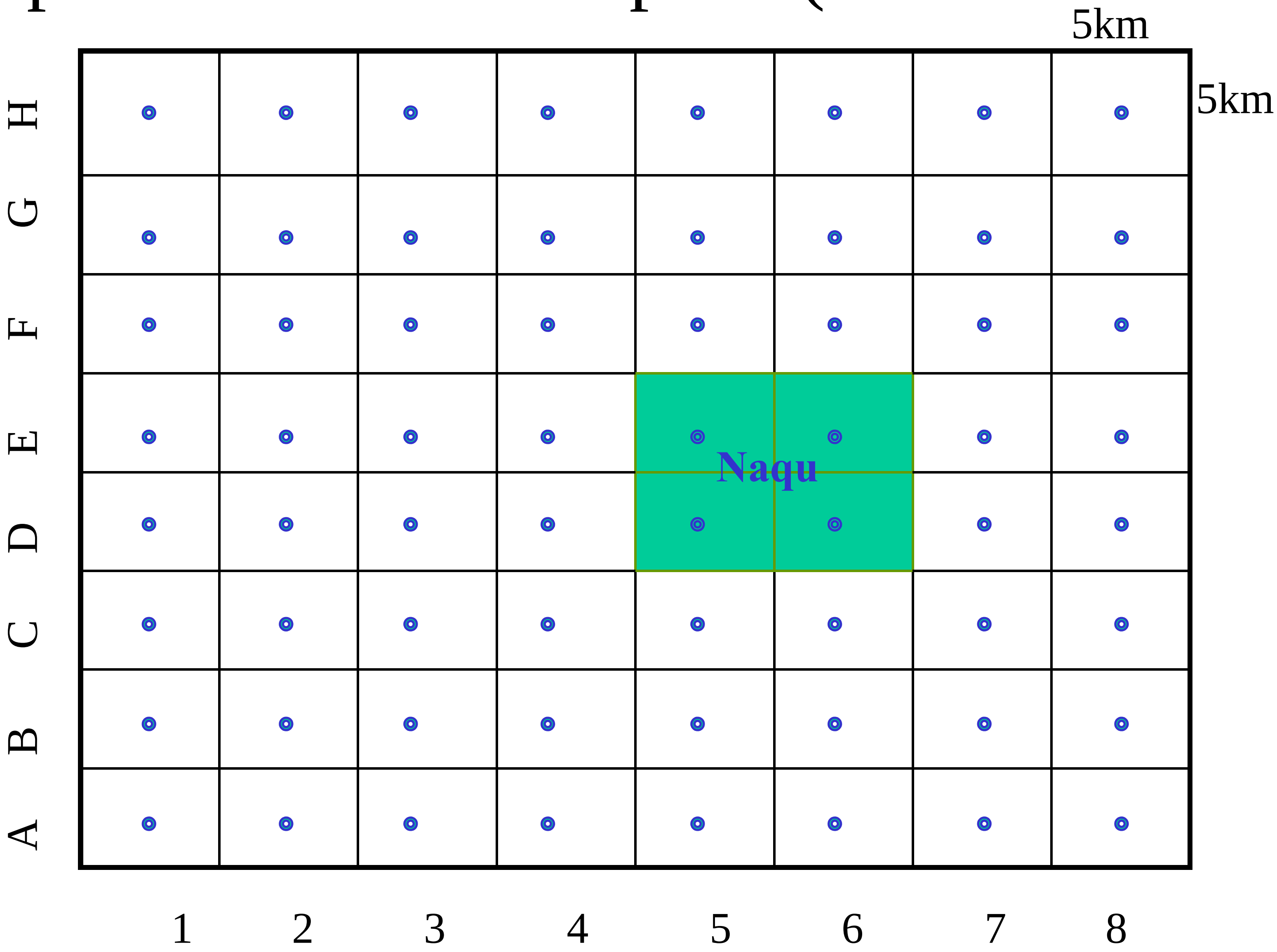
Observed soil moisture at 16 stations in Mongolia

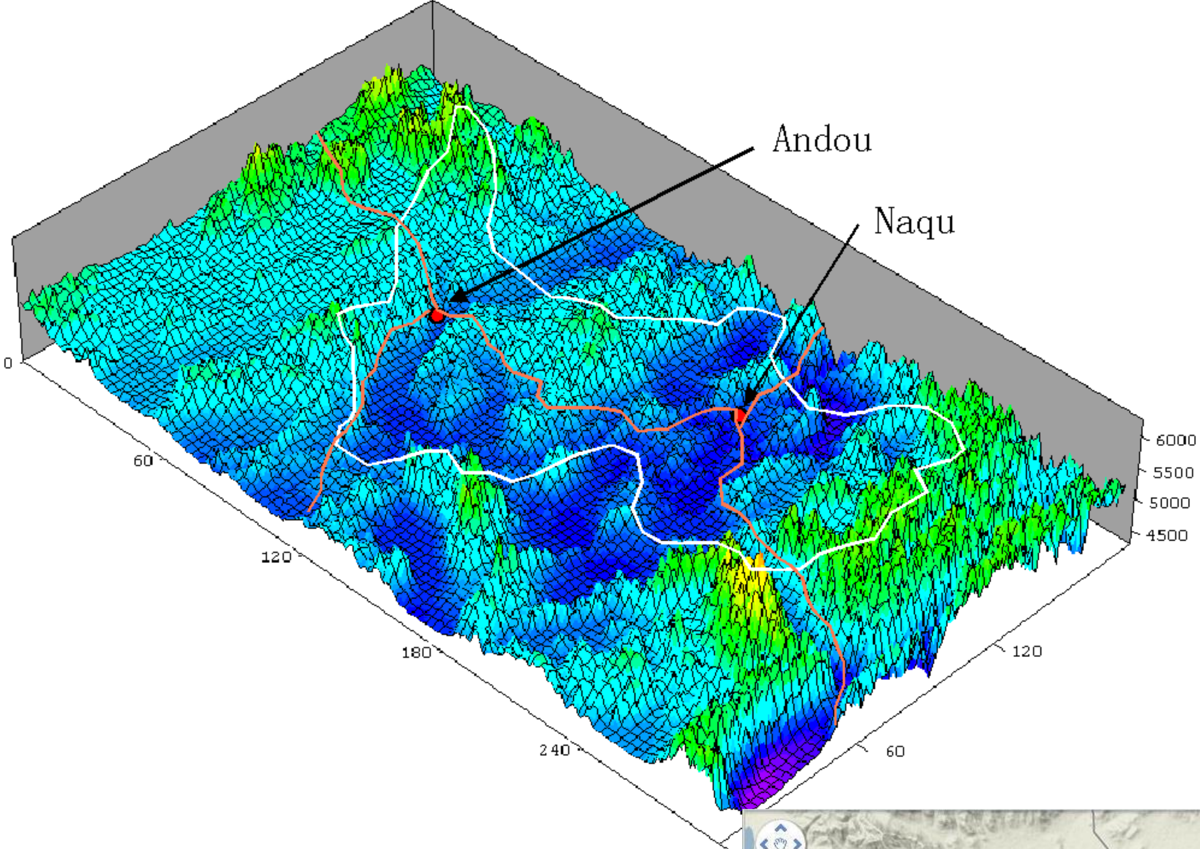


(Yang et al., 2009 JHM)

Soil Moisture Array in Tibet (SMART)

passive sensor footprint (40 km x 40 km)

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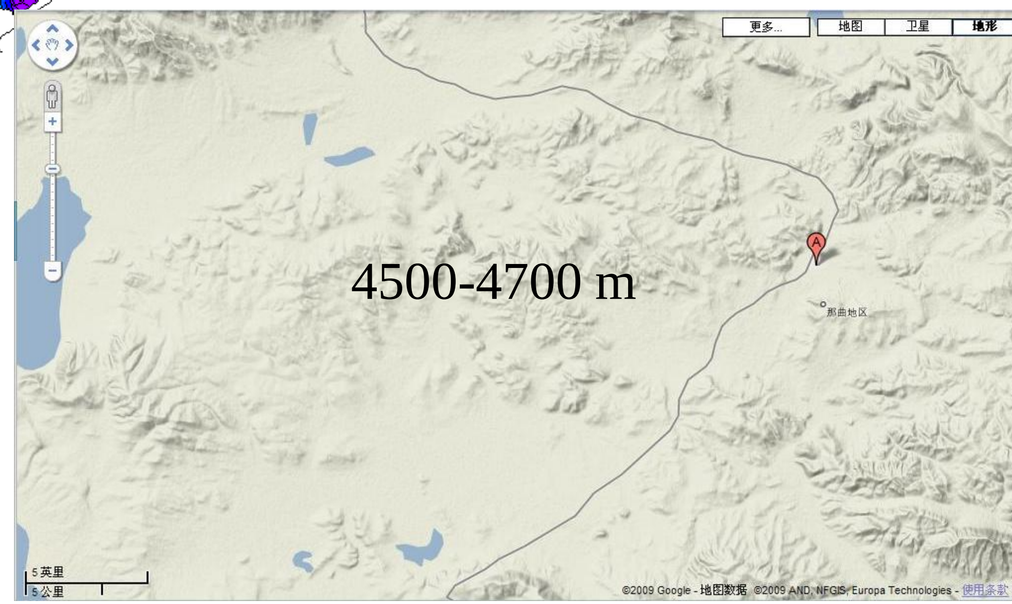
更多...
地图
卫星
地形
4500-4700 m
那曲地区
5 英里
5 公里
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LSM Inter-comparison at Asian drylands

- Key members:
  - Japan: Prof. J. Asanuma;
  - USA: Prof. D. Ojima,;
  - China: Prof. K. Yang,
  - Pakistan: ???? ; Mongolia: ?????

- Timetable
  - 2010: select sites, soil sampling experiments, simple and straightforward comparison between model results, to obtain model uncertainties
  - 2011: Detailed and precise model tests, to reveal key parameterizations in simulating dryland surface processes

2th International Workshop on Energy and Water Cycle over the Tibetan Plateau and High elevations

CAS, CEOP-WEBS, CEOP-HE, CEOP-AEGIS, NSFC (July 19-22, 2010)

http://ceop-cahmda.westgis.ac.cn/

Jointly with The Fourth International Workshop on Catchment Hydrological Modeling and Data Assimilation http://ceop-cahmda.westgis.ac.cn/

CAS-CEOP

19-21 July 2010 Lhasa, China

1

2nd International Workshop on Energy and Water Cycle over the Tibetan Plateau and High-elevations

Click for more deta

CAHMDA-IV

21-23 July 2010 Lhasa, China

2

The Forth International Workshop on Catchment-scale Hydrological Modeling and Data Assimilation

Click for more deta

Instructions:

The two workshops are initiated by

(1) Chinese Academy of Sciences (CAS/CAREERI, ITP, IGSNRR);

(2) Coordinated Energy and water-cycle Observations Project (CEOP);

(3) National Natural Science Foundation of China (NSFC);

Lhasa Branch of Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS)

Science Issue:

Validating Remote Sensing Products for Land Surface Hydrology

Land Surface Hydrology Group @ Princeton University

Approach:

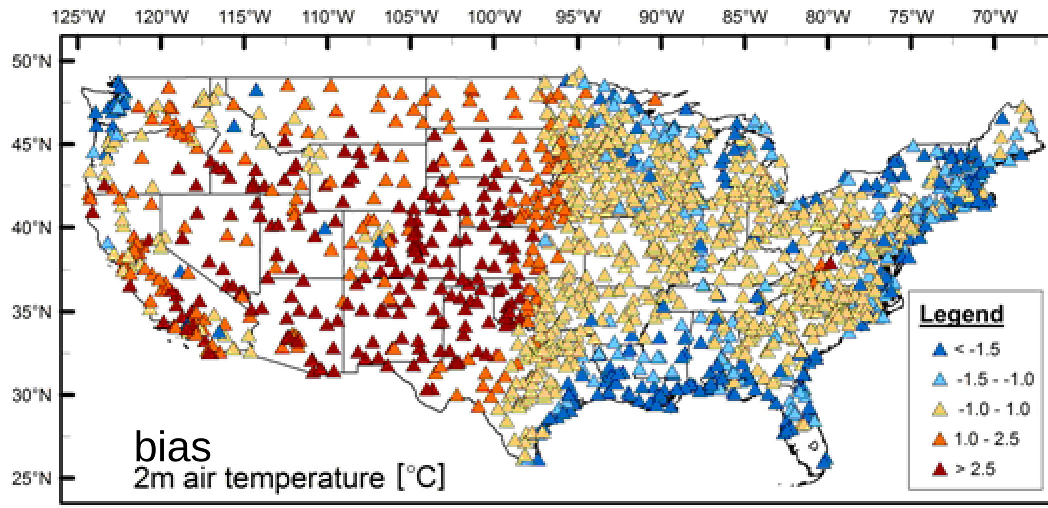
Inter-comparison of RS products with in-situ observations and regional land surface models to quantify errors in global RS-ET and soil moisture (SM) retrievals.

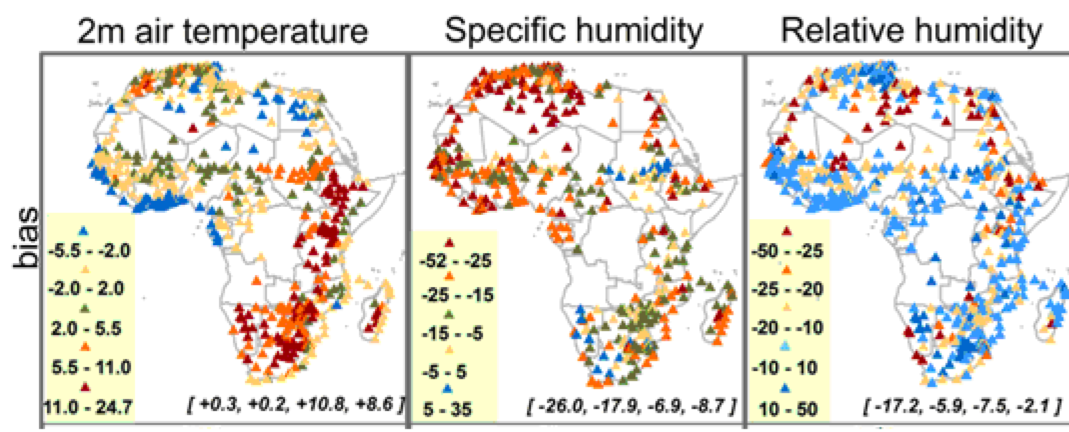
Remote Sensing Data:

AIRS (RH,Tair,Ts), MODIS (LAI, NDVI), and CERES (SW,LW,SWnet, LWnet, albedo, emis), GOES (SW,Ts), AMSR-E (X-band SM)

Other Data/Models:

NARR, VIC, >2,000 NCDC stations





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