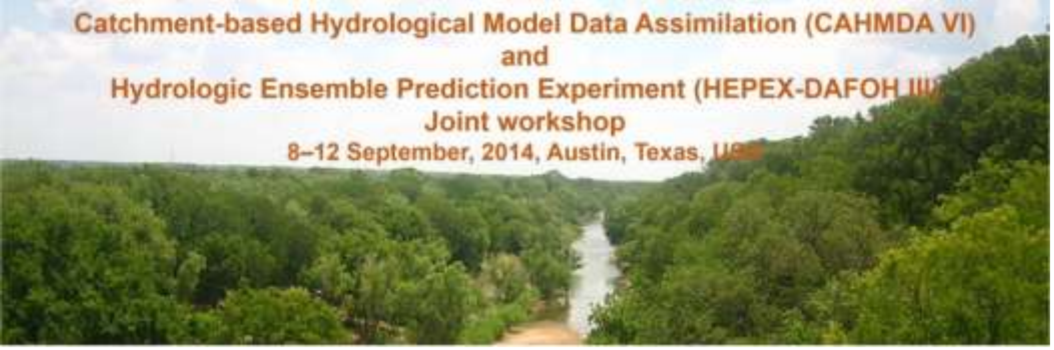

Investigating crop water productivity by using remotely sensed approach for summer maize at Hebei Plain in North China

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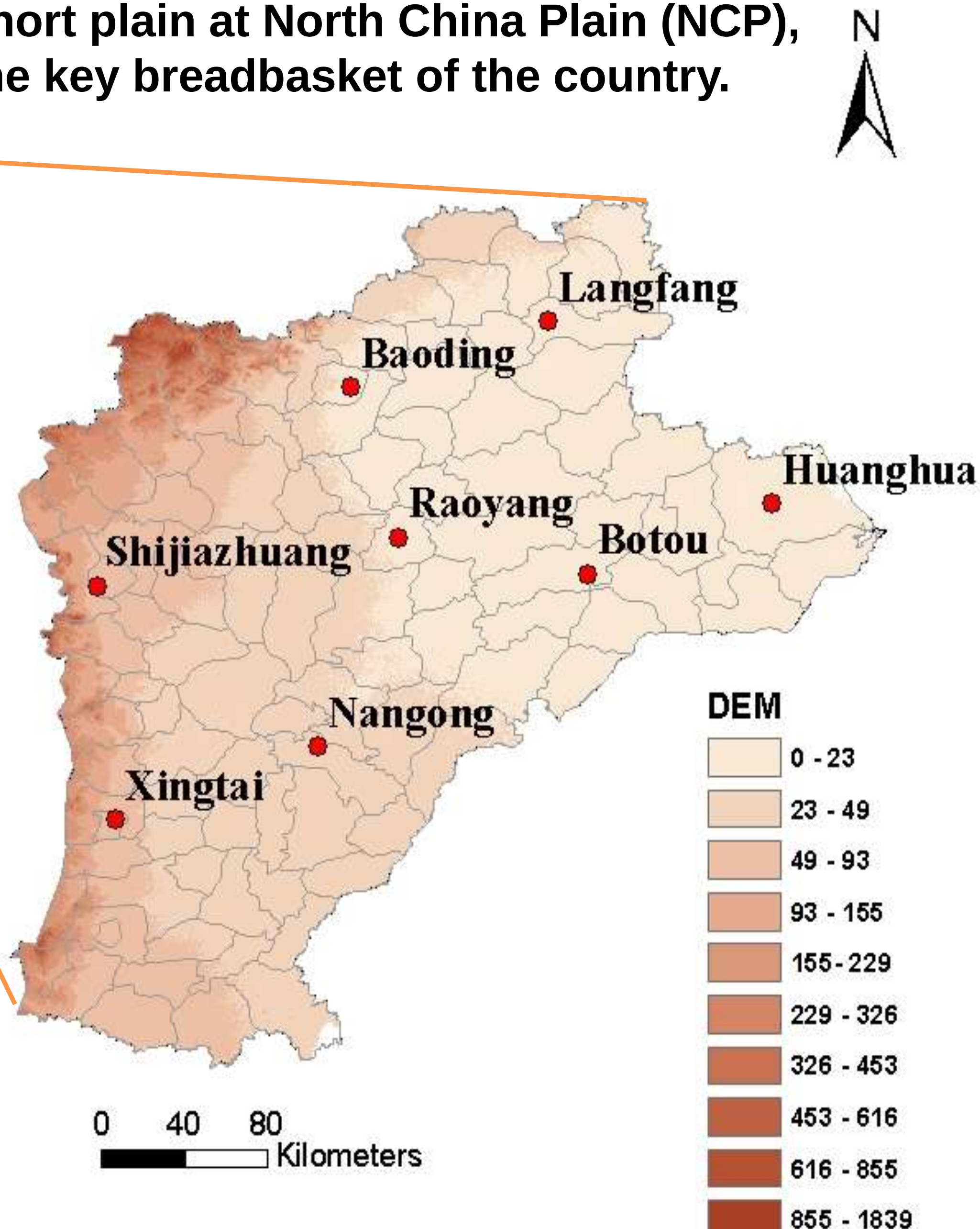
Outline

- Background
- SEBS- coupled-LUE CWP estimation
- Results and discussion
- Concluding remarks

Background

✓**Hebei Plain (HBP) is the most water-short plain at North China Plain (NCP), the key breadbasket of the country.**



✓**Annual precipitation: 550 mm, 90% in June-August.**

✓**Crop: Winter wheat – summer maize (WW-SM)**

✓**Evapotranspiration (ET) :**
WW+SM = 800+ mm/a.
Water deficit = 550-800= -250 mm.

Background

✓Groundwater had been heavily applied to irrigate winter wheat.

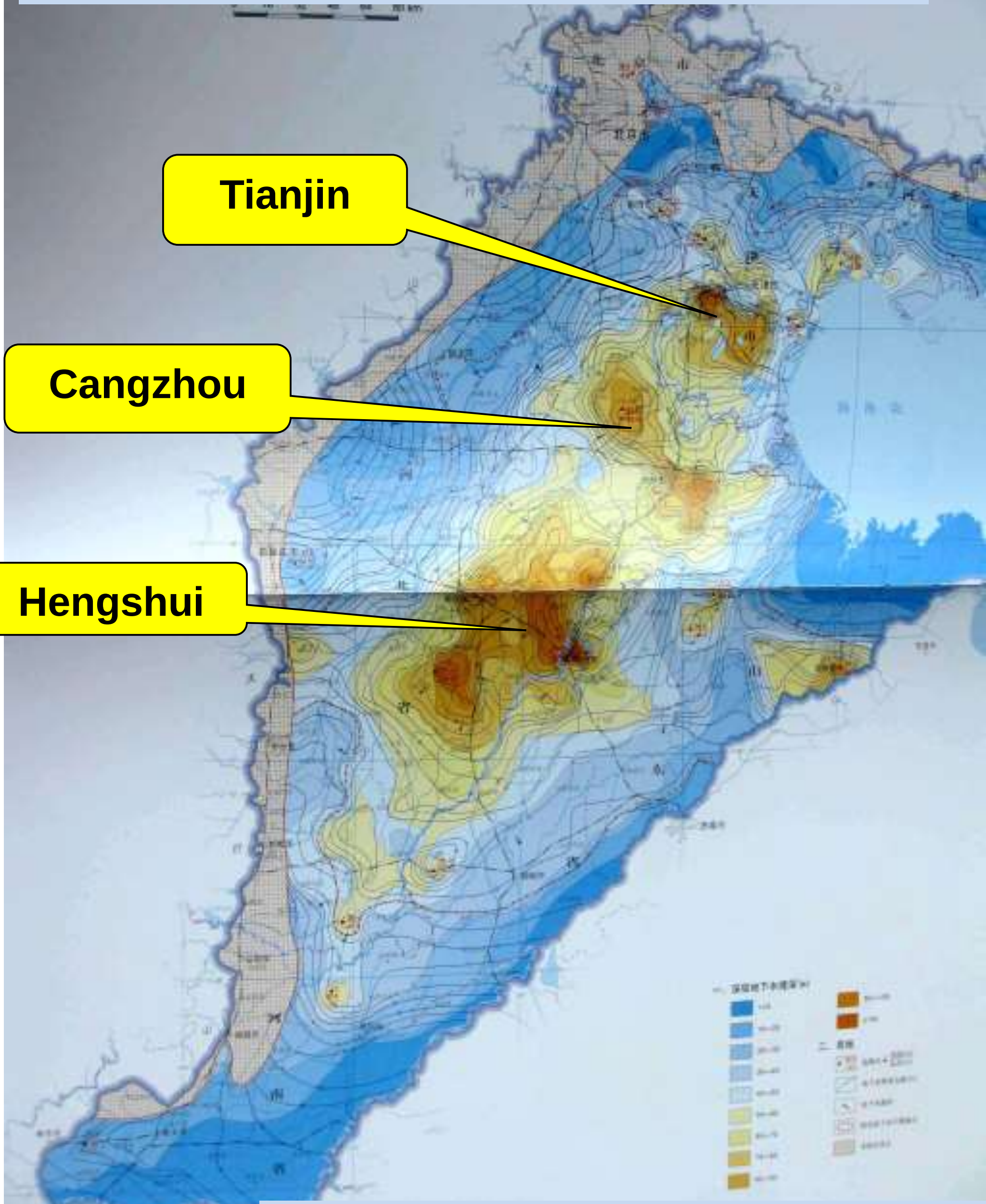
✓Drawdown cones had spread to 70,000+ km^2 at NCP, with three major centers identified.

✓Calling for a shift in cropping system, in which summer maize will be the focus.

✓Regional quantification of Crop Water Productivity (CWP =Yield/ET) is thus necessary.

✓Numerous researches have been done on ET, yield and CWP over HBP or NCP by RS. SEBS-LUE coupled approach were adopted in this study.

Water tables of deep aquifers at North China Plain in June, 2005.



Adapted from Zhang, 2009, China Geological Press.

Background

- **The objectives of current ongoing study are to:**

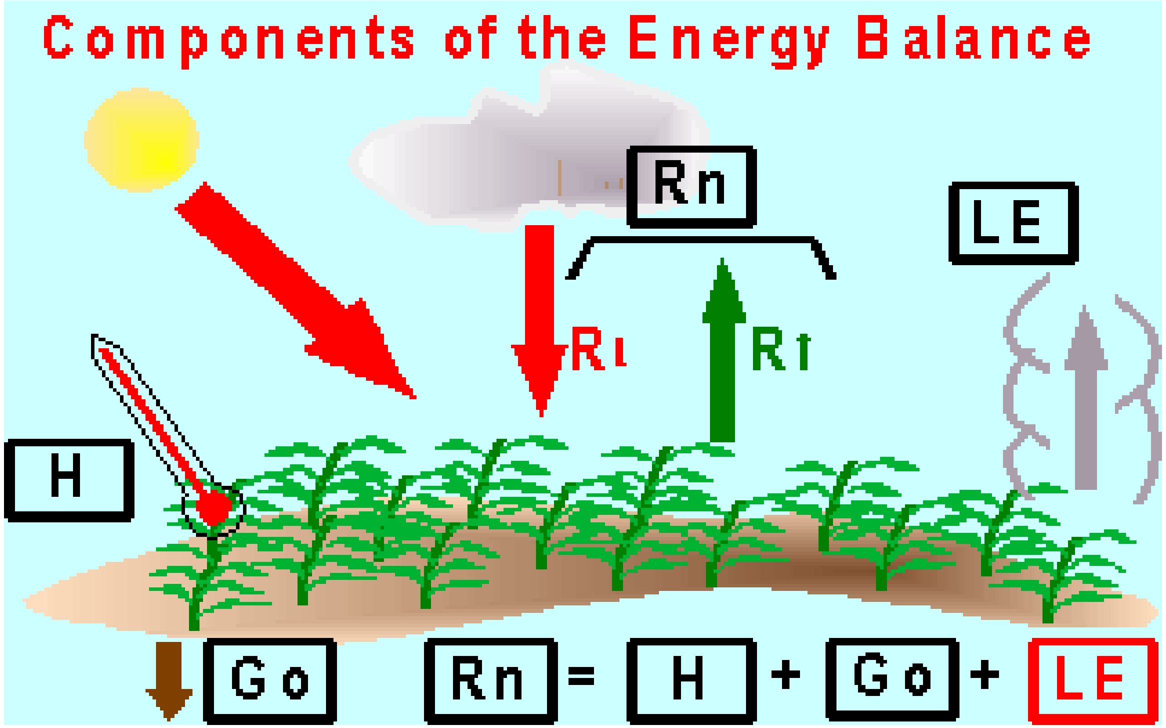
  - ✓ **quantify regional CWP using remotely-sensed approach and calibrate/validate against various measuring, modeling and census data.**

  - ✓ **integrate measuring, modeling and remotely-informed data to develop a hands-on DSS serving for regional water allocation scheme with-in and with-out agricultural sectors, not only for decision makers, but, for farmers.**

SEBS- LUE-coupled CWP

SEBS-based ET

The Surface Energy Balance System (SEBS) model (Su, 2002) was developed to estimate land surface fluxes using remotely sensed data and available meteorological observations.



(ILWIS-SEBS help)

- **The total available energy Rn is used for:**
  - ✓heating up the soil (soil heat flux,G_o).
  - ✓Heating up the surface tranfer to the environment (sensible heat flux,H).
  - ✓transforming water into vapour (latent heat flux, λE).

SEBS- LUE-coupled CWP

LUE-based YIELD

Crop yield is derived from biomass, retrieved by Light Use Efficiency (LUE) model(Field et al.,1995) from the relation of APAR（Monteith,1972) and the rate of transformation of APAR to organic matter, and harvest index.

$$Y = B_{tot} \times H$$

$$B_{tot} = \varepsilon \times \Sigma APAR(t) \times t$$

$$\varepsilon = \varepsilon' \times T_1 \times T_2 \times EF$$

$$APAR = fPAR \times PAR$$

Y： economic yield

B_{tot}： accumulated biomass in period t

ε: the light use efficiency

ε ': maximum conversion factor for above ground biomass when the environmental conditions are optimal

APAR:Absorbed Photosynthetic Active Radiation

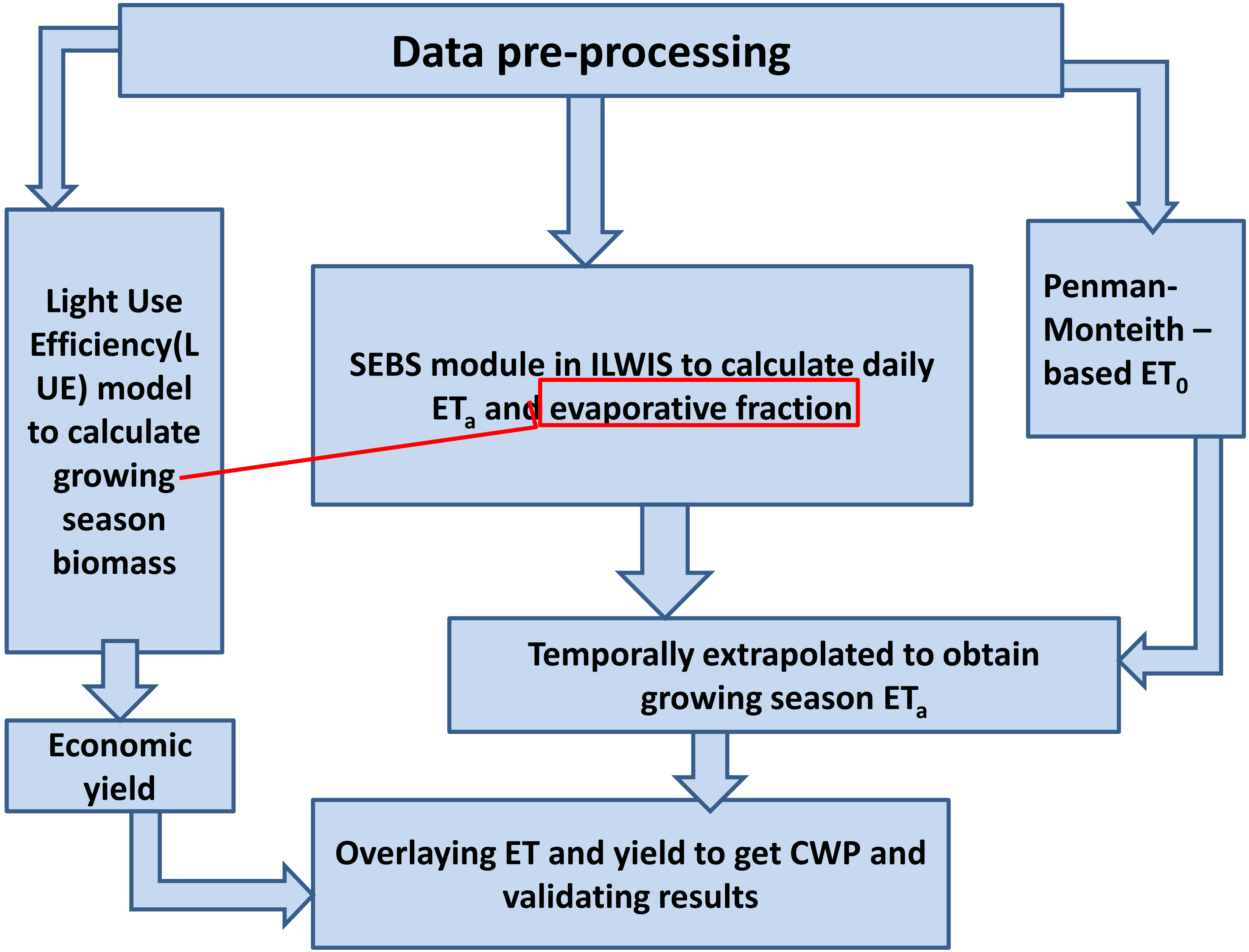
fPAR: APAR/PAR fraction

H： harvest index

T_1,T_2: heat factor

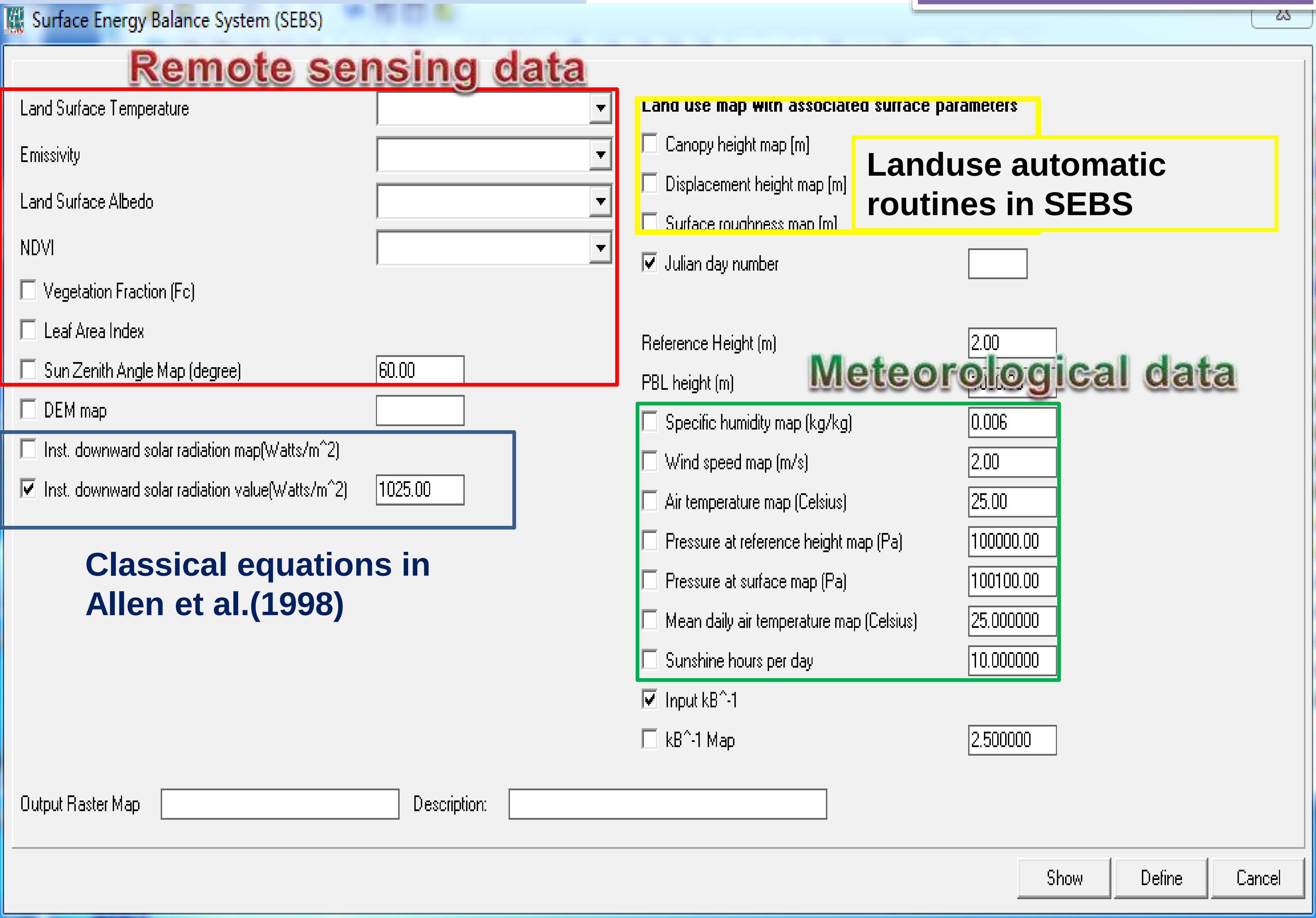
EF: evaporative fraction（SEBS)

SEBS- LUE-coupled CWP



SEBS- LUE-coupled CWP

SEBS in ILWIS



SEBS- LUE-coupled CWP

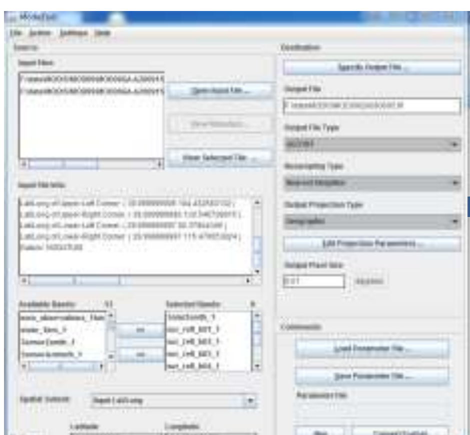
Remote sensing data

ET

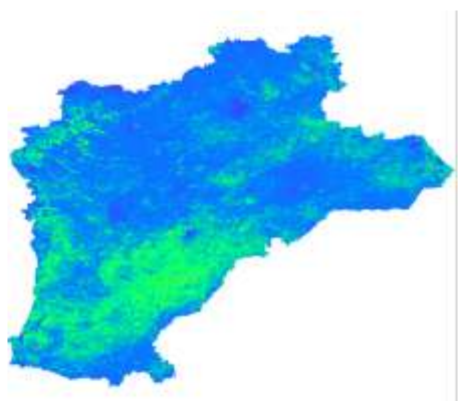
YILED

Product	Content	Spatial Resolution	Temporal Resolution
MOD09GA	Surface Reflectance (Band1-7)	500m/1km	daily
MOD11A1	Land Surface Temperature/Emissivity	1km	daily
MOD15A2	Leaf Area Index/FPAR	1km	eight days

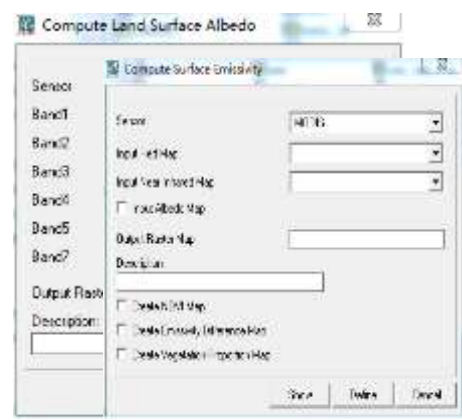
Download :http://modis-land.gsfc.nasa.gov/ (h26v05、h27v05)



MRT(.hdf-.tif)



ArcGIS10.1(HBP)

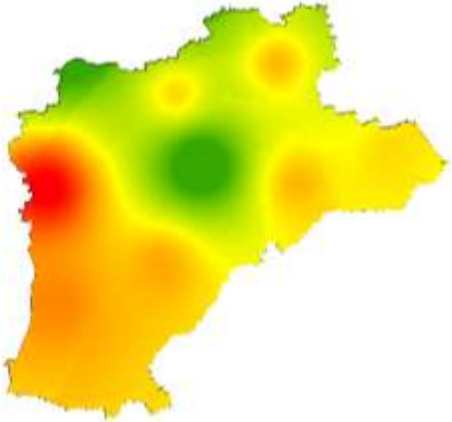


ILWIS(albedo,emissivity)

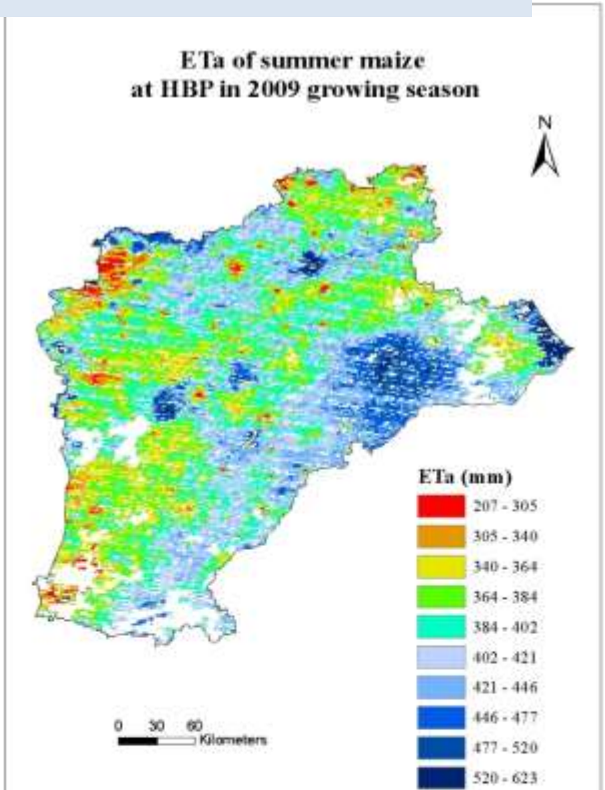
Meteorological data

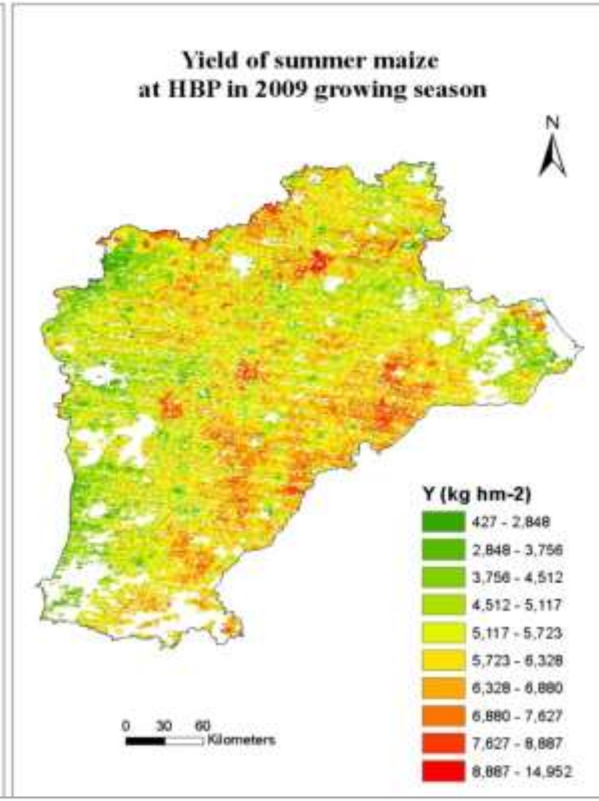
Download :China Meteorological Data Sharing Service System
http://cdc.cma.gov.cn/home.do

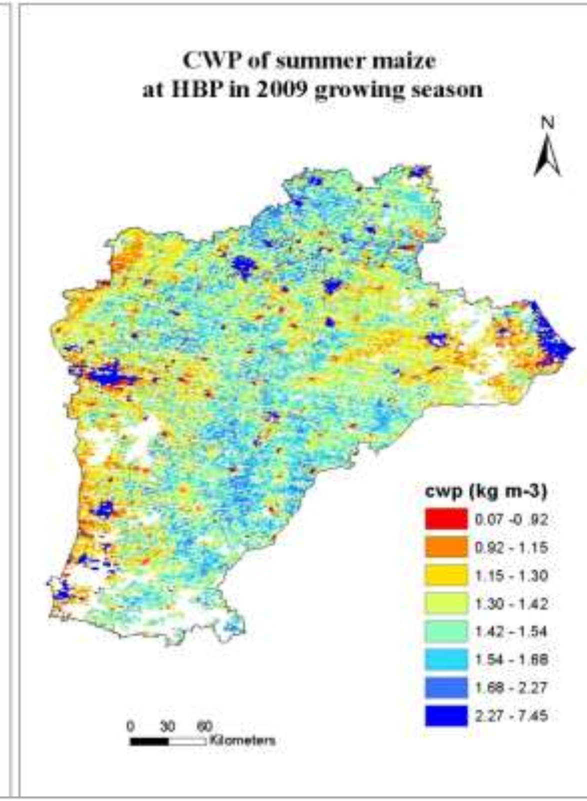
- Air pressure
- Vapour pressure
- Average /Max/Min temperature
- Relative humidity
- Average wind velocity
- Sunshine hour
- Rainfall

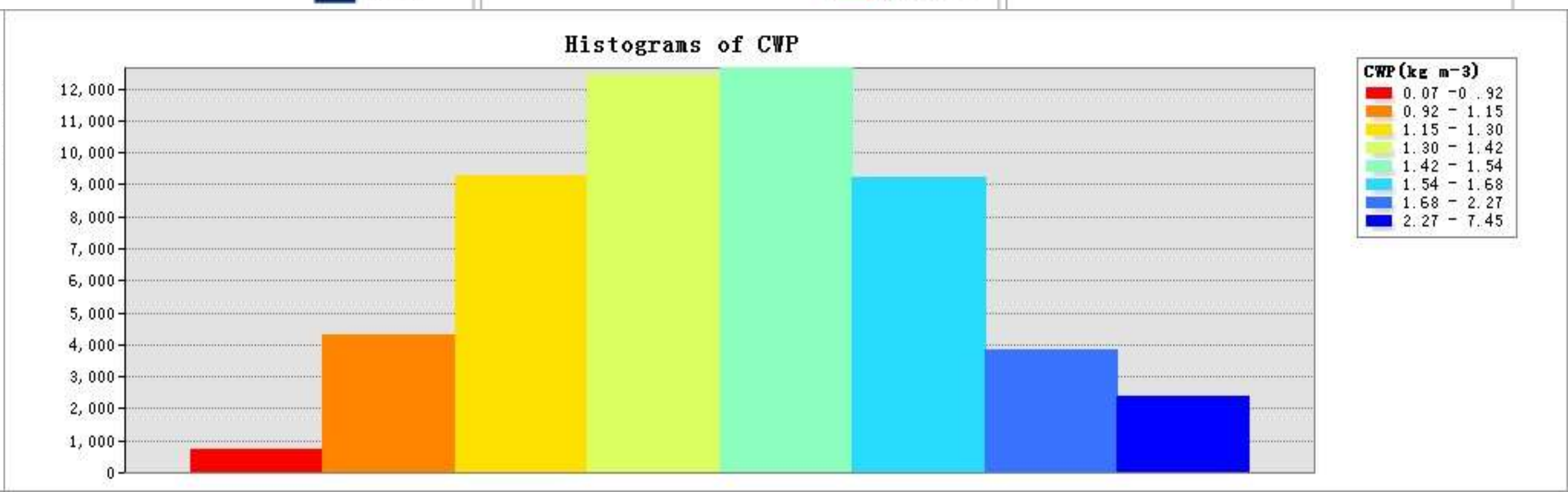


Results and discussion



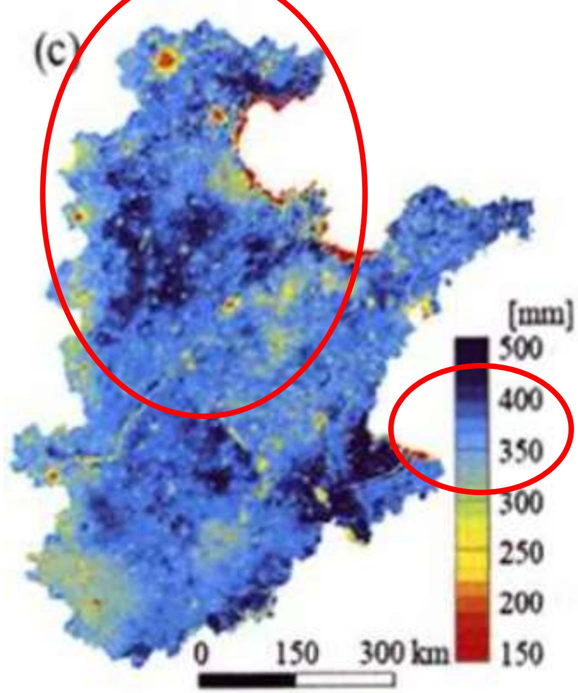




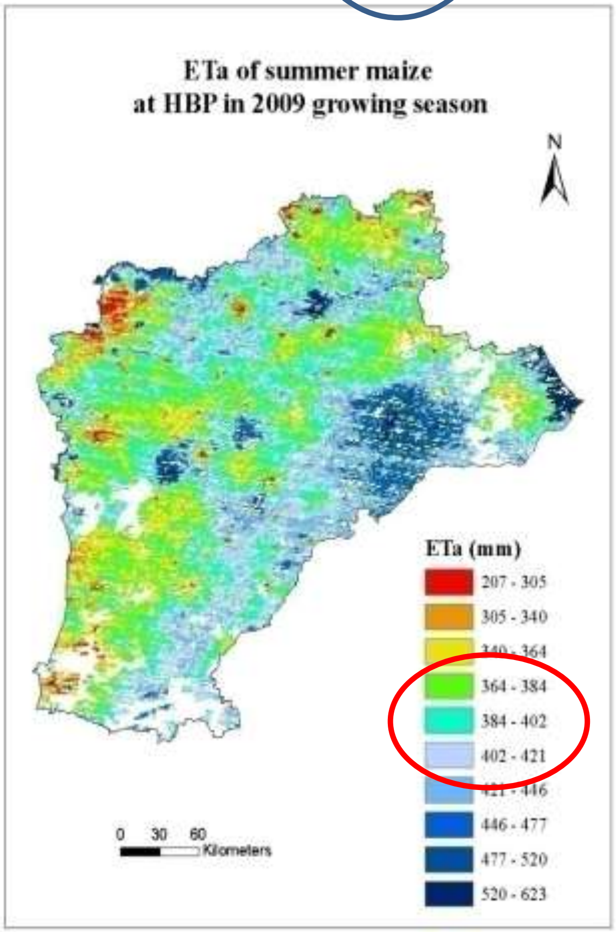


Results and discussion

	MIN	MAX	RANGE	MEAN	STD
ETa (mm)	**207**	**624**	**417**	**396**	**41.45**
Yield (kg hm^{-2})	**427**	**39008**	**38581**	**6448**	**4133**
CWP (kg m^{-3})	**0.07**	**7.45**	**7.37**	**1.63**	**1.05**



Decadal averages of evapotranspiration at North China Plain in summer maize growing period during 2000-2009 (Mo Xingguo et al.,2011)



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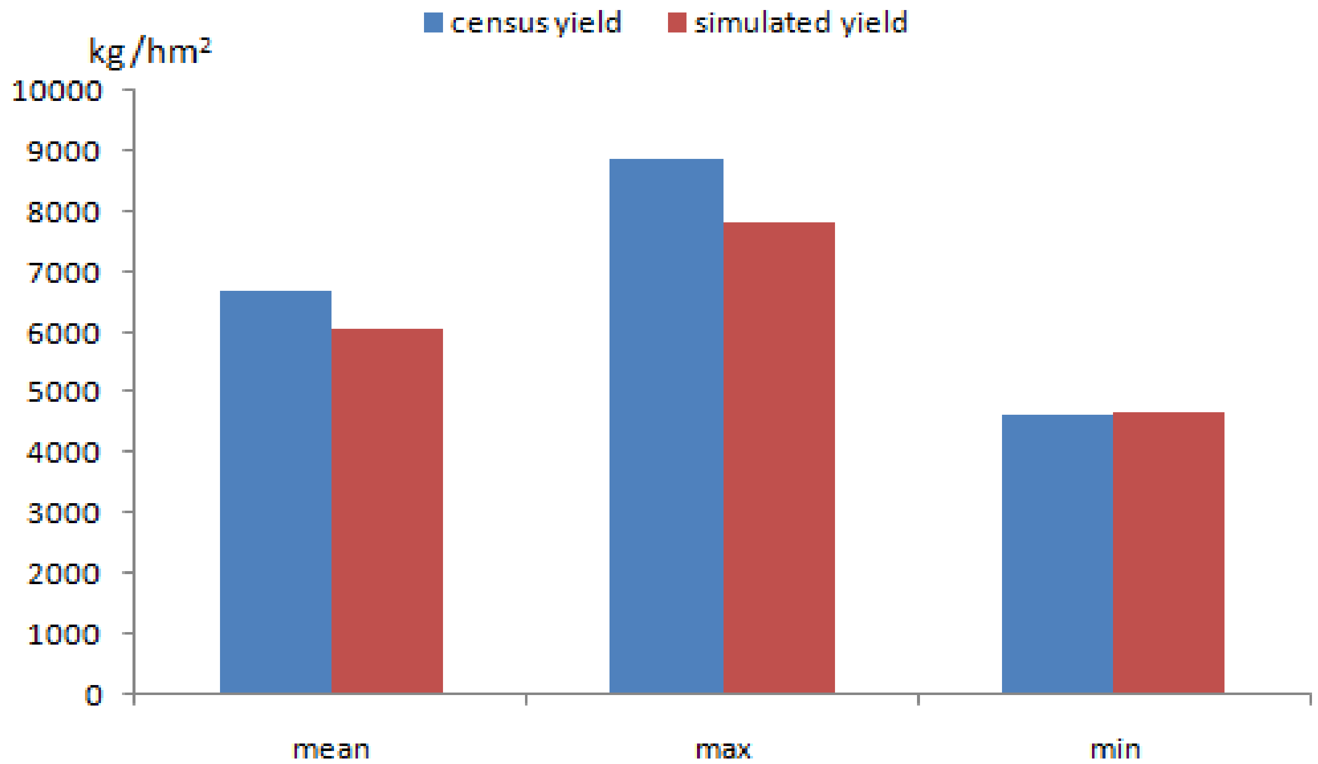
✓**Comparison of LUE-based yield with census data revealed that LUE was capable of capturing regional maize yield in terms of its mean, maximum and minimum values.**



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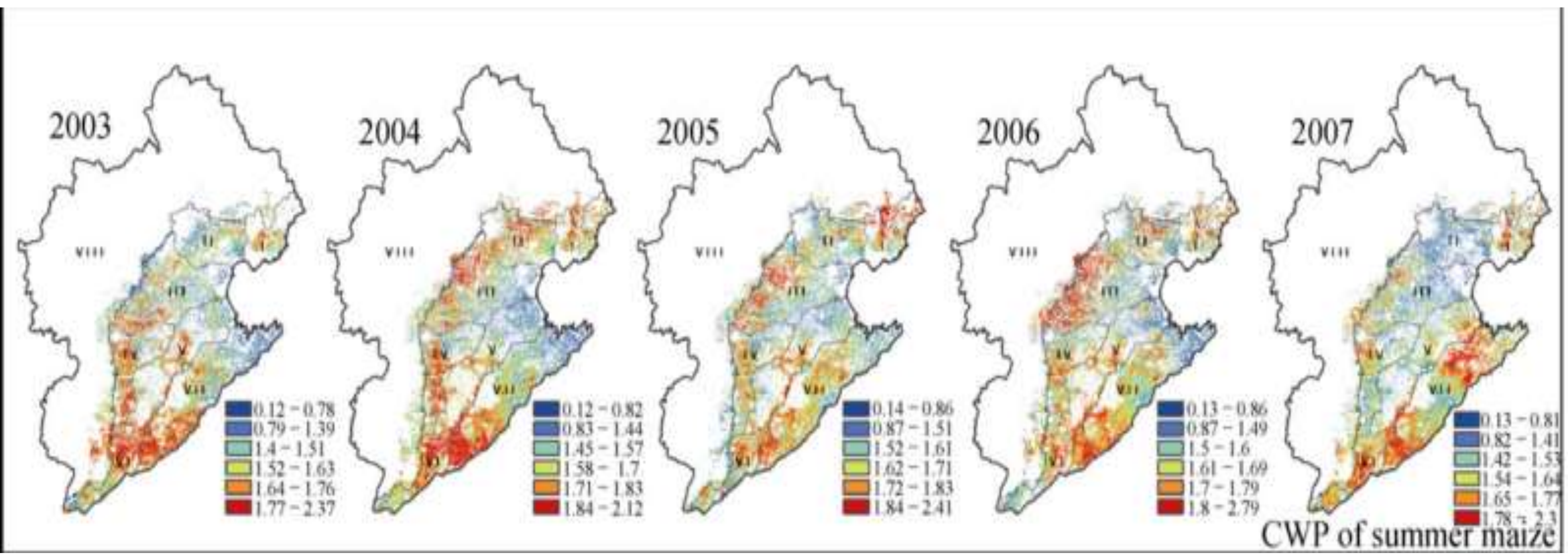

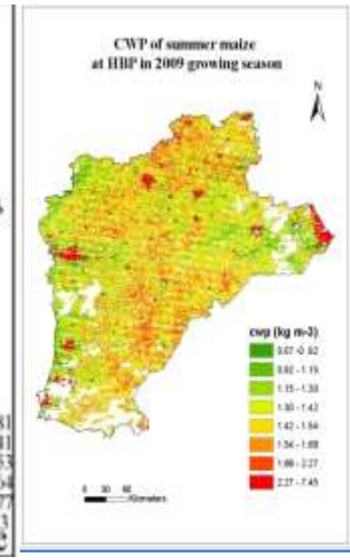

（LI Fapeng et al.，2013)

Concluding remarks

- **The results of maize CWP in 2009 growing season suggested a sensible range, with a mean value of 1.63kg m^{-3}. Further comparison and validation will be done with measuring and modeling results.**

- **The results presented, however, were preliminary, requiring substantial improvement due to the limited data and relatively simplified process.**
  - ✓ **assuming that the study area are all summer maize when calculate the yield. Most of errors and uncertainties may be arising from various land use types other than crops (i.e. residence, construction, road networks etc.) within one pixel measured by 1 km × 1km.**

  - ✓ **But now more detailed crop spatial distribution retrieval through combining MODIS-NDVI and ground-truth crop info is well under way.**

Concluding remarks

- **Interpolation methods should be tuned with specific meteorological variables precipitation, temperature, humidity, pressure etc..**

- **Assimilate multiple-source data to improve on estimating ET, yield and CWP while trading off spatial and temporal resolution. (e.g. Much finer remotely-sensed data shall be used to enhance regional estimation while reducing computation load for such a large area like HBP i.e.70,000+ km^2.**

Concluding remarks

- **Coupling hydro-crop-modeling with measured and remotely-sensed land surface/subsurface process and fluxes (soil moisture obs. like cosmic ray probe, GRACE,…**

- **Downscaling results obtained from global and continental level modeling exercises for reference in regional crop production.**

- **Calling for collaboration in data assimilation approach and efforts in crop water use and DSS.**


Thank
You!