Validation of Land Surface Model (NCAR/CLM3) in Semi-arid Region of China

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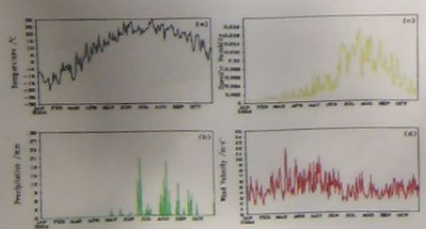
Significance of the Study

- Located in the transitional zone of climate and ecosystem, the semi-arid region is sensitive to climate change. The region is also characterized by the most dramatic aridity trend and frequent land use/cover change.
- Land surface process is an important approach to better understand the mechanism of energy and water cycle over semi-arid area where the land-atmosphere coupling is very strong *(Koster,R.D.et al., Science 305,2004)*.
- The land surface processes in semi-arid region have some unique aspects such as their large spatial diversity and hydrological cycle. Unfortunately, our knowledge in this field is far from enough mainly due to the lack of the long-term intensified observations, which arises big challenges to the proper use of the land surface models.

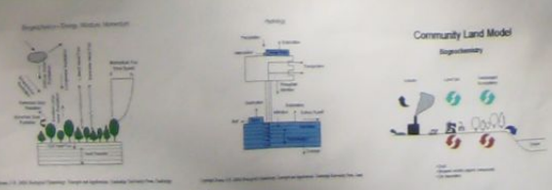
Data and Model

DATA: The long-term enhanced observations at CEOP reference site *(Tongyu, 44.417N, 122.867E)* in semi-arid region of China. The items include surface meteorological elements, near-surface gradient of temp., pressure, humid, and wind; land surface fluxes (sensible/latent heat, CO2, and radiation) as well as soil temperature/wetness profile.

Comparative observations are conducted over two types of land cover (cropland and degraded grassland). Data length is through year 2003 to 2005.

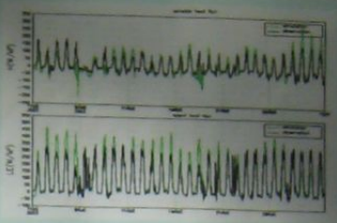


Variations of near-surface temp., precipitation, specific humidity and wind velocity over degraded grassland in year 2004

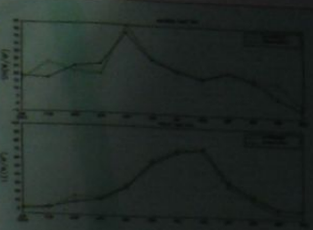


Structure of NCAR Community Land Model (NCAR/CLM3)
(Bonan et al, 2002, 2004; Dickinson et al, 2005)

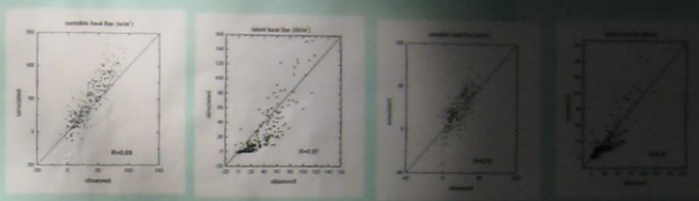
Results of CLM3 simulation against observation



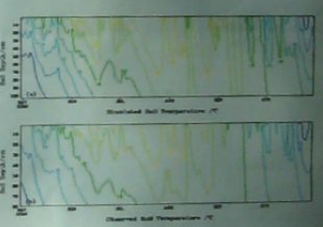
Diurnal cycle of sensible/latent heat fluxes at cropland (corn) in Aug.2003



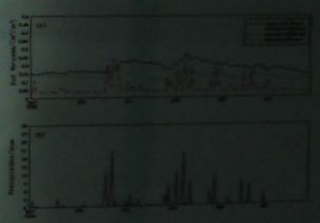
Seasonal cycle of sensible/latent heat fluxes at degraded grassland in 2003



Scatter map of sensible/latent heat fluxes at cropland and degraded grassland in 2004 (all correlation coefficients exceed the confidence level of 99%)



Profile of soil temperature at degraded grassland in 2004 (May-Oct.)



Variation of soil wetness and its relation with precipitation events at degraded grassland in 2004 (May-Oct.)

Year2003 Cropland	Bias (Wm^{-2})	SEE (Wm^{-2})	NSEE	OA (Wm^{-2})	SA (Wm^{-2})	R
LH	-1.7	25	0.5	**35.2**	**33.5**	**0.81**
SH	3.1	20.8	0.64	**24.5**	**27.6**	**0.70**
RN	-1.1	1.22	0.016	**54**	**52.9**	**0.99**
Year2003 Grassland	**Bias (Wm^{-2})**	**SEE (Wm^{-2})**	**NSEE**	**OA (Wm^{-2})**	**SA (Wm^{-2})**	**R**
LH	5.3	22.3	0.5	**32**	**37.2**	**0.86**
SH	1.1	17.7	0.66	**20.6**	**21.7**	**0.64**
RN	-1.2	1.4	0.02	**48.2**	**47**	**0.99**

	Bias (Wm^{-2})	SEE (Wm^{-2})	NSEE	OA (Wm^{-2})	SA (Wm^{-2})	R
LH	-9.5	17.1	0.46	26.5	17.0	0.87
SH	10.5	19.3	0.44	26.8	47.1	0.69
RN	0.97	8.2	0.10	65.6	66.5	0.99
	Bias (Wm^{-2})	SEE (Wm^{-2})	NSEE	OA (Wm^{-2})	SA (Wm^{-2})	R
LH	-6.2	16.2	0.44	26.9	20.6	0.89
SH	5.8	20.7	0.54	33.1	38.9	0.74
RN	-1.4	14.6	0.19	69.4	68.0	0.97

Using Bias, NSEE, SEE, R(corre. Coeff.), OA (Observed Average), SA (Simulated Average) to evaluate the simulation of sensible heat (SH), latent heat flux (LH), and net radiation (RN).

(O_e observed value; M_e simulated value)

$$Bias = \frac{\sum_{e=1}^{n} M_e - O_e}{n}$$

Discussions and Future work

- CLM3 can reasonably reproduce the land surface components and fluxes such as ground temperature, sensible/latent heat fluxes etc. in terms of the diurnal and seasonal variations;
- Differences between model output and the in-situ observation are assumed to be mainly associated with the model parameter setting (e.g., LAI, soil heat/hydraulic conductivity, surface roughness length, etc.) and physical process treatments (e.g., lack of interactive effect of soil thermal/hydraulic processes) as well as the observational errors (observed surface energy balance is about 75%);
- Further studies such as multi-model inter-comparison, parameter optimization, and soil heat/water coupling module are now under way based on this study for the purpose of improving the capability of coupled climate model in the long run.