Key Lessons on Water, Carbon, & Energy Fluxes for the Semiarid Landscapes of Inner Mongolia

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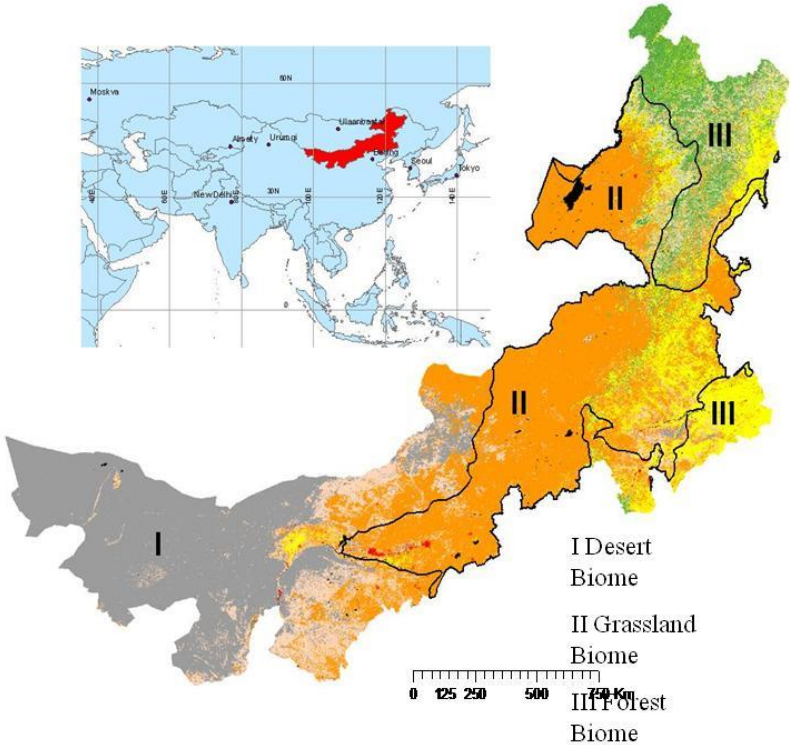


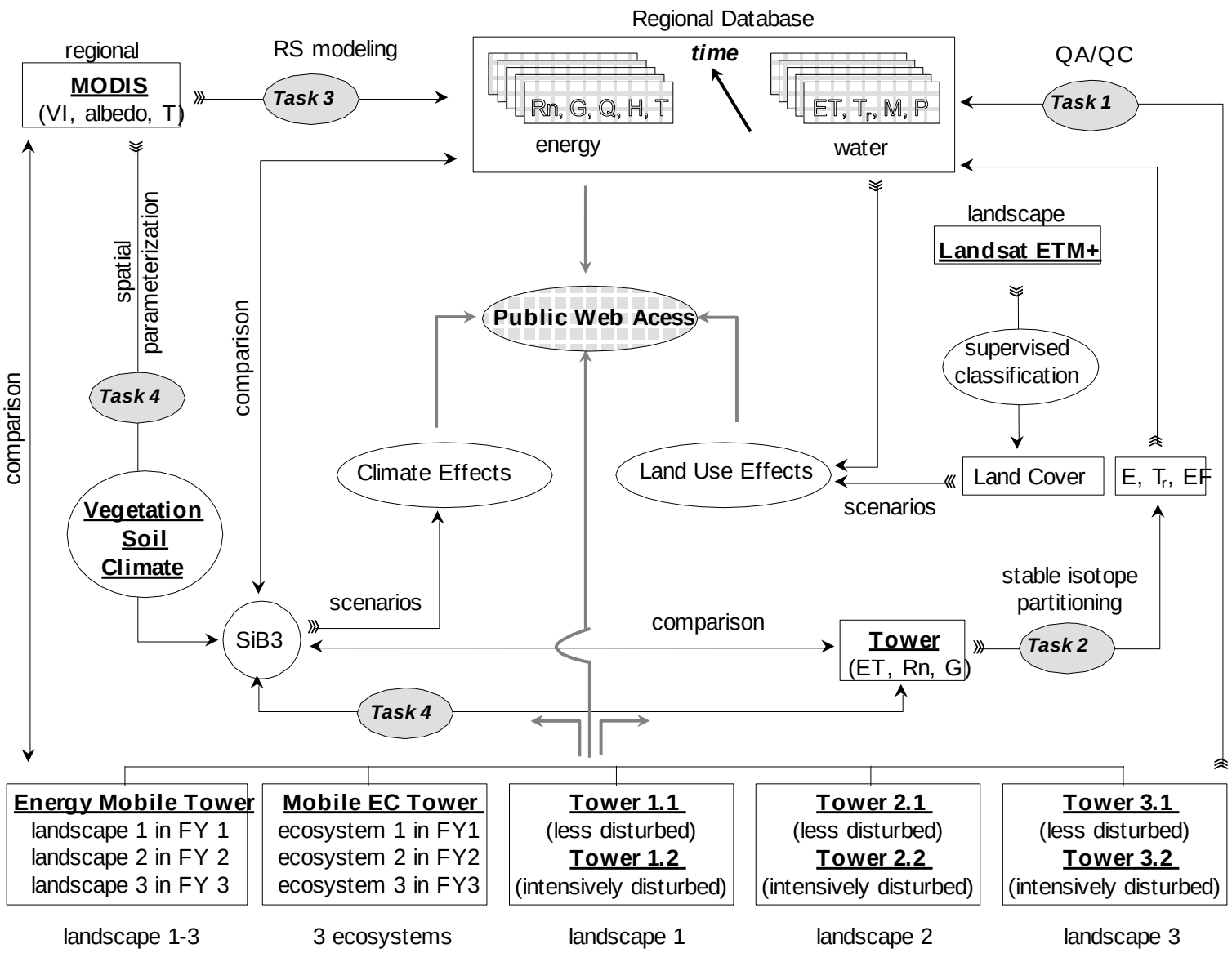
Objectives

- Mechanistically explain the variability of energy (Rn, L, G, Q, H, T) and water (ET, E, EF, Tr, LWSI, Wleaf, M) fluxes along a climatic and land use gradient,

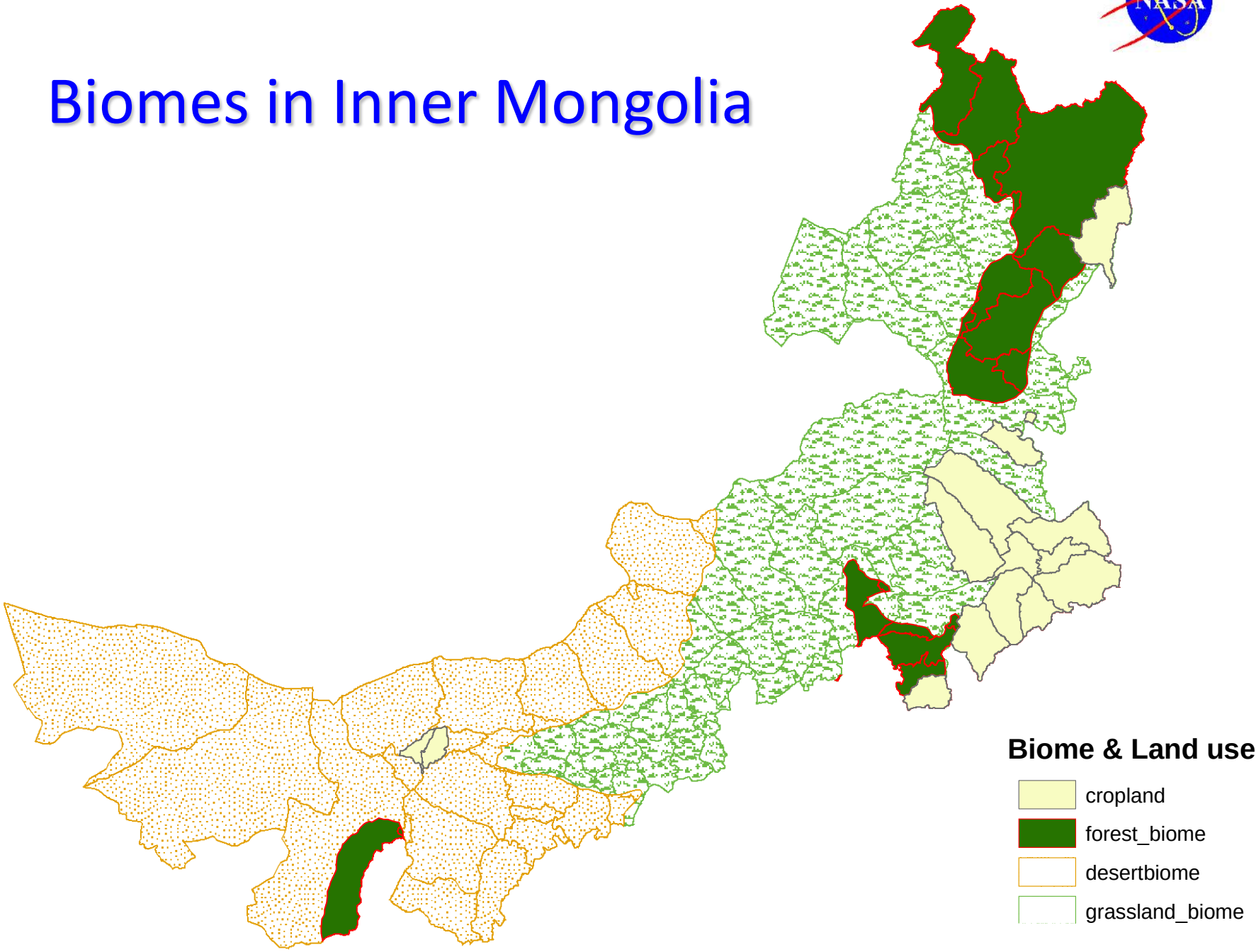
- Develop and validate MODIS-based models for water fluxes,

- Evaluate and improve biophysical models for regional simulations of water and energy fluxes at multiple spatial & temporal scales.

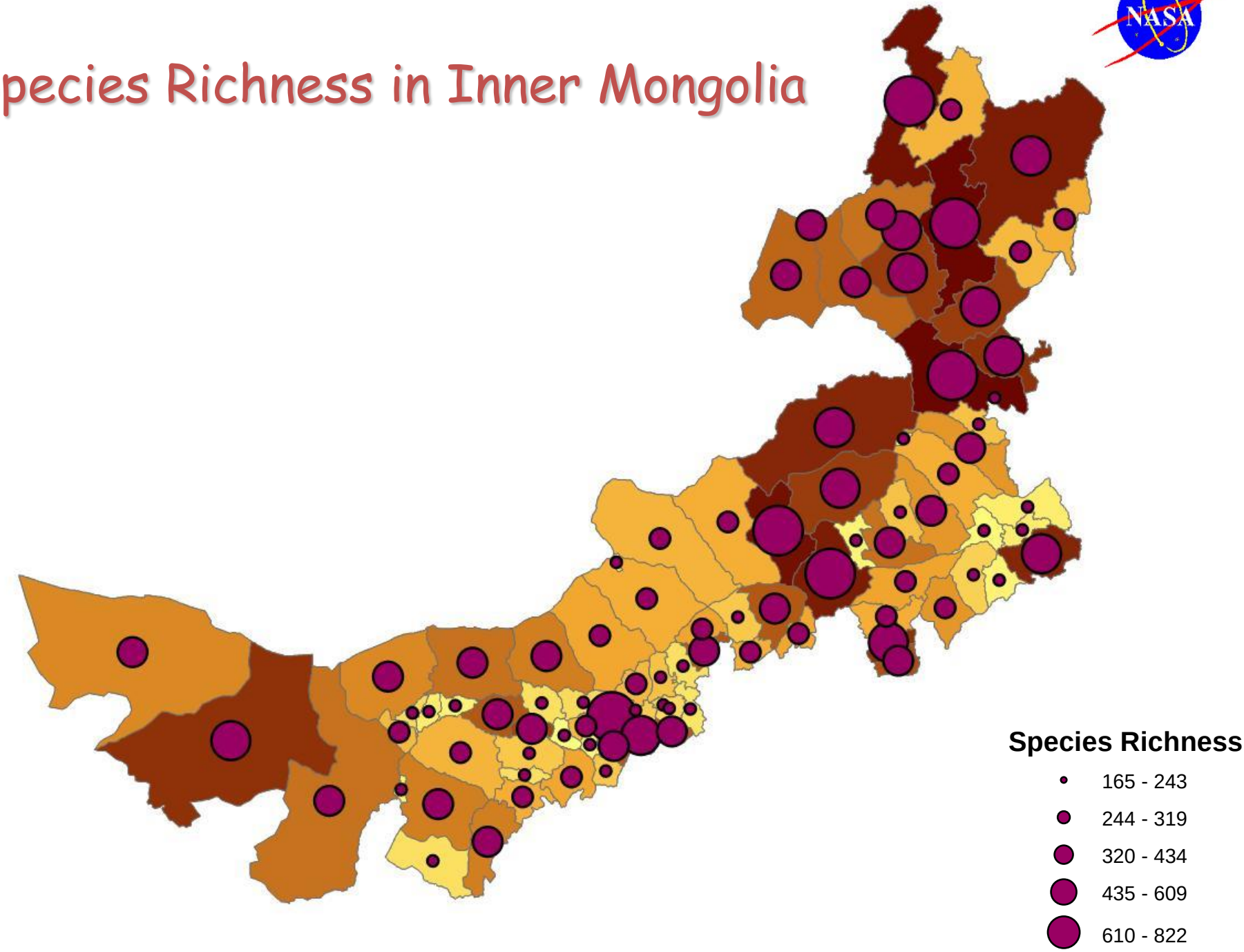
The Conceptual Framework

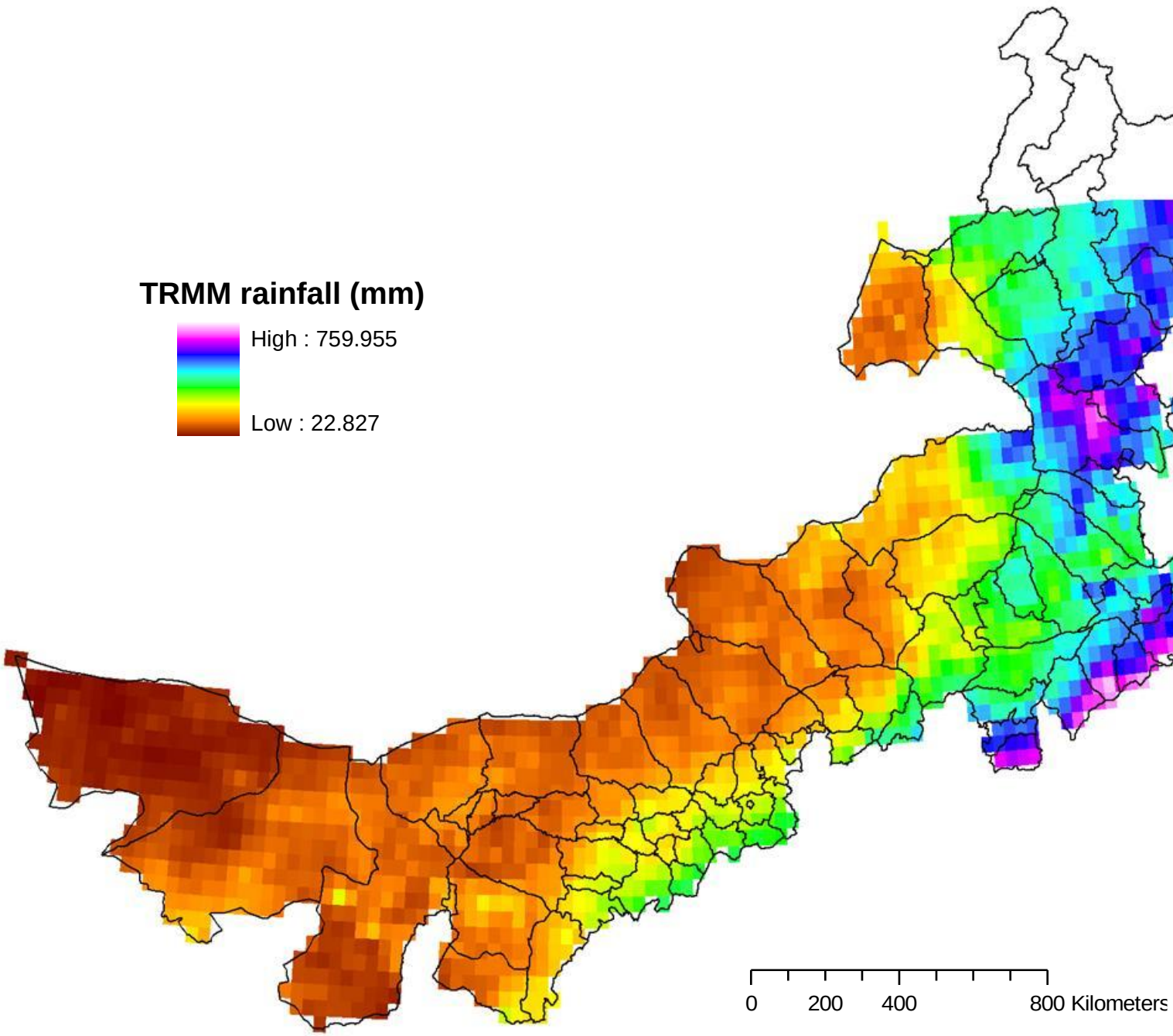


Biomes in Inner Mongolia



Species Richness in Inner Mongolia




TRMM rainfall (mm)
High : 759.955
Low : 22.827
0
200
400
800 Kilometers

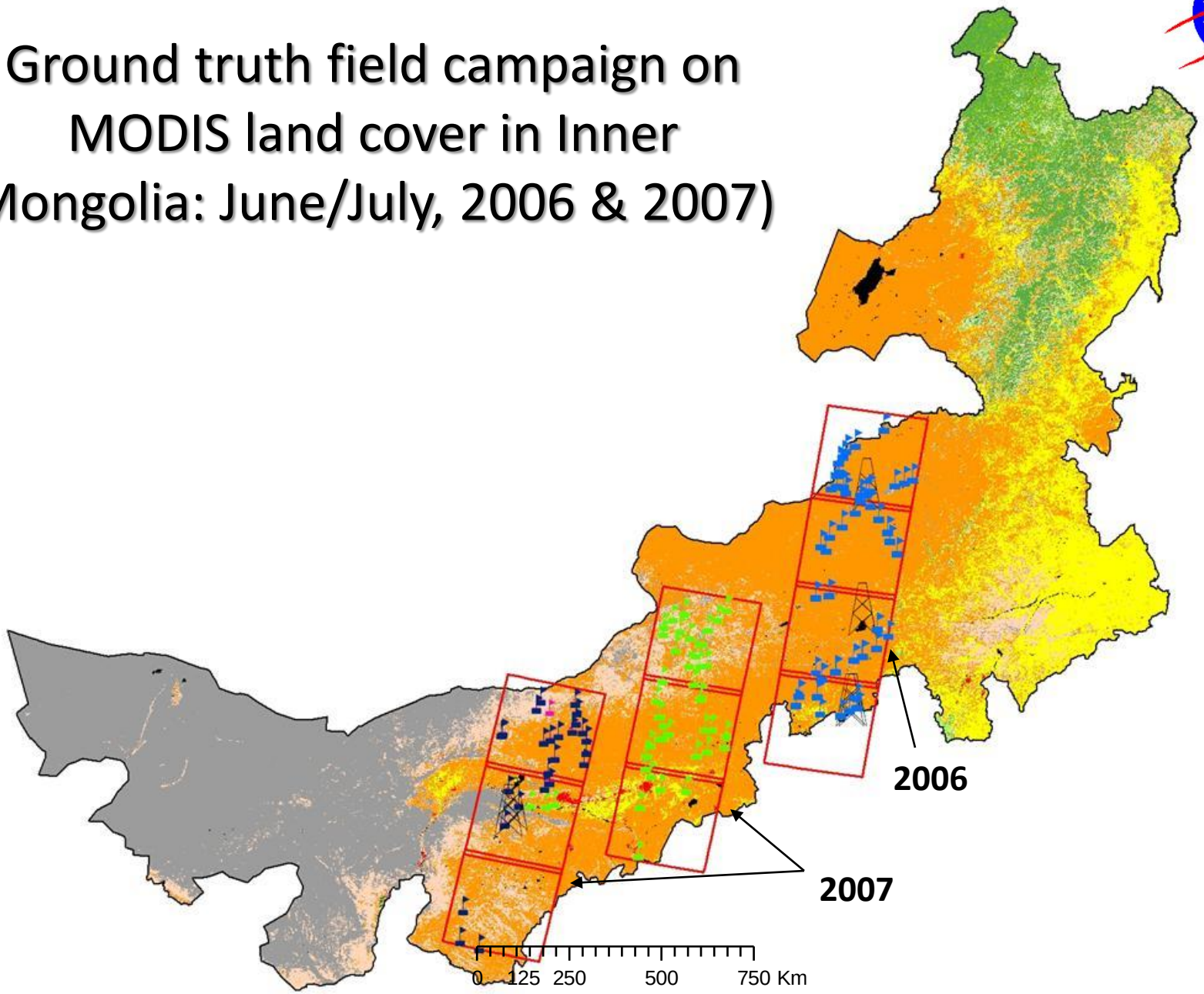
Typical grassland in Dongwu

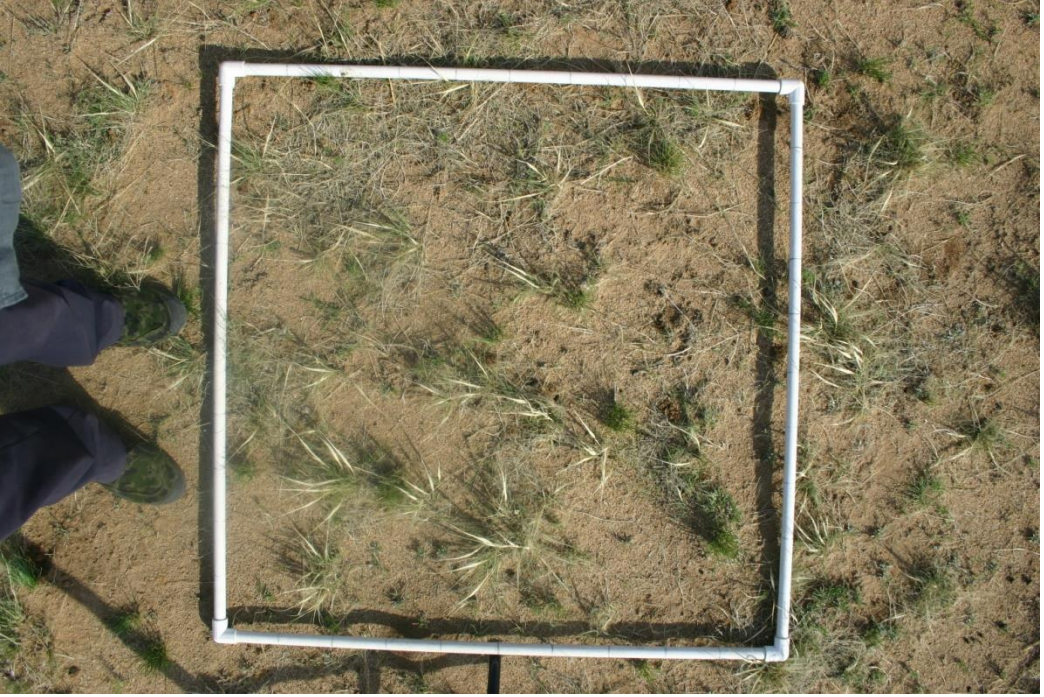
Degraded grassland in Xilinhot

Stipa krylovii grassland in Duolun

Cropland in Duolun

Ground truth field campaign on MODIS land cover in Inner Mongolia: June/July, 2006 & 2007)

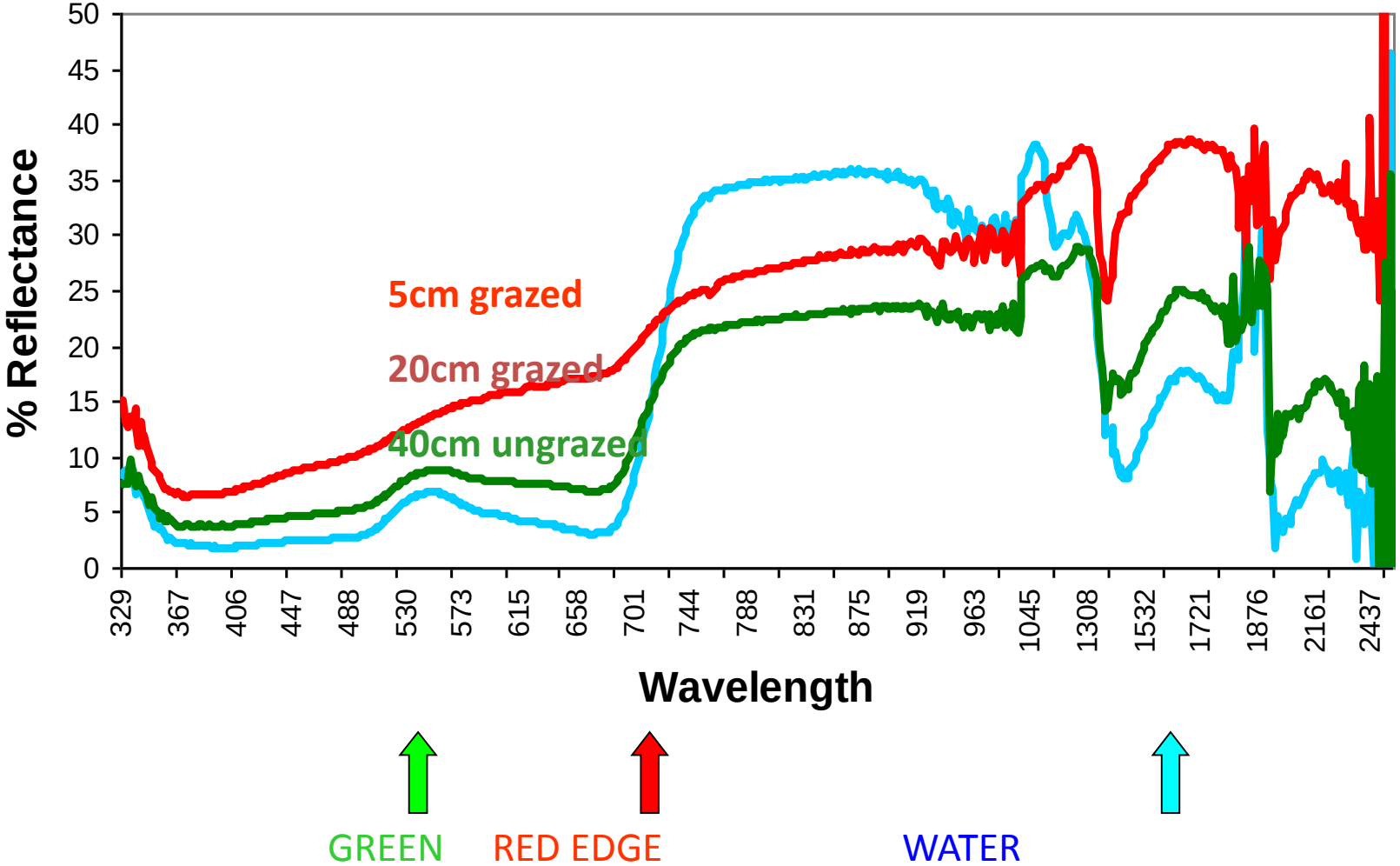




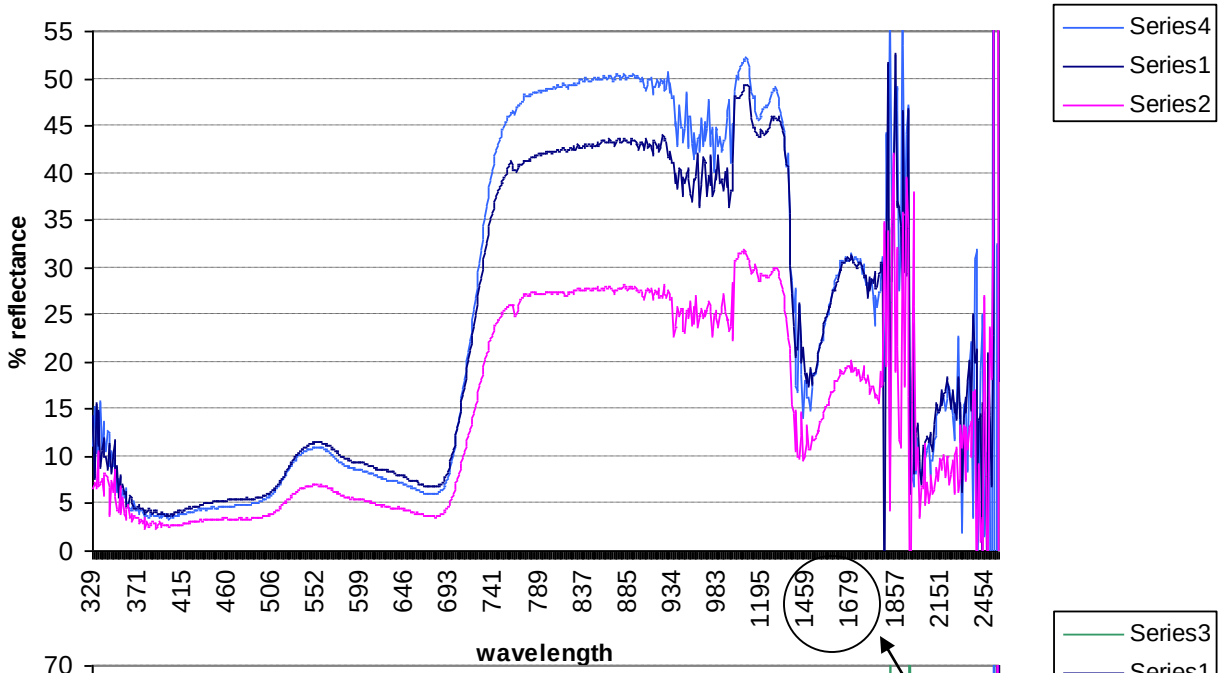
Direct measurements of surface reflectance

Direct measurements of vegetation and soil properties

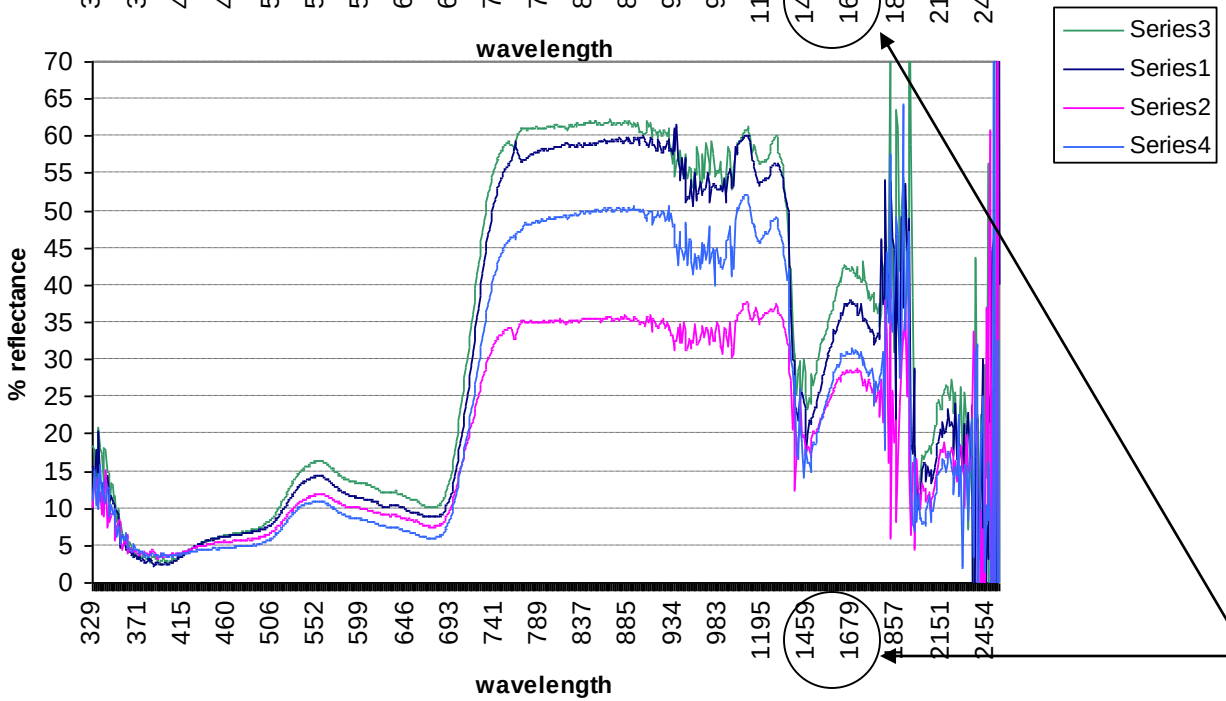
Reflectance (GER 3700) varying by grass height on grazed anc ungrazed prairies in Inner Mongolia



Examples of radiometer spectral signatures



Healthy vegetation



757 spectra from 2006

331 & 748 spectra from 2007

Foliar nitrogen

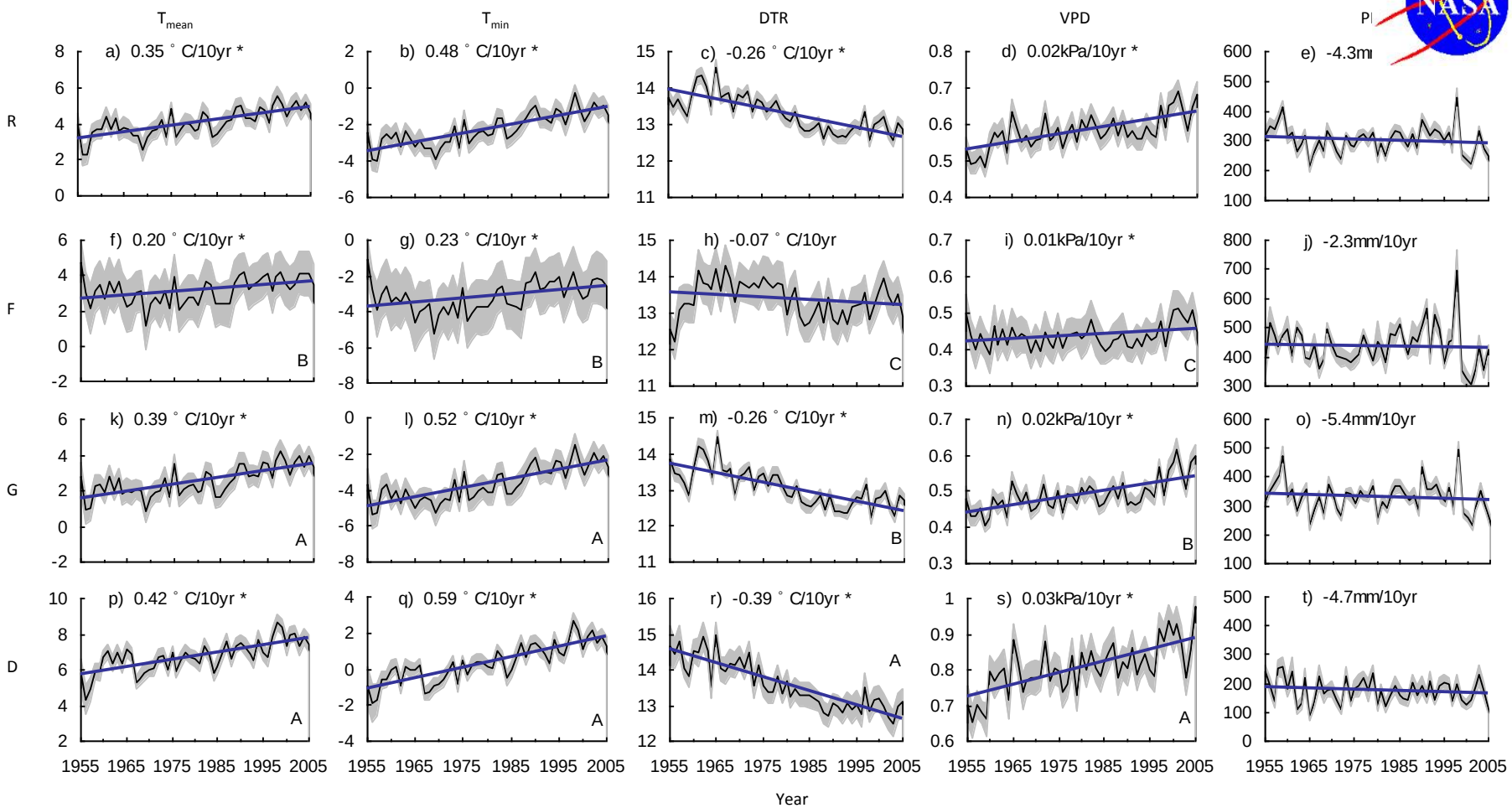
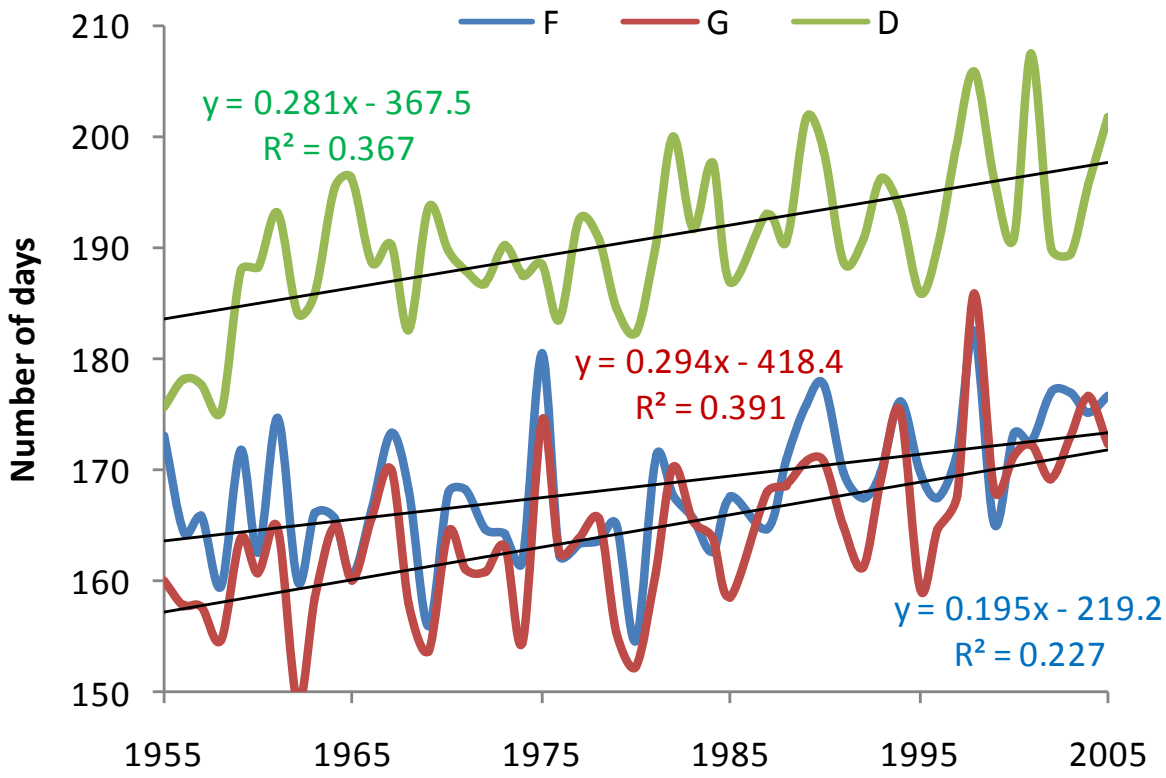
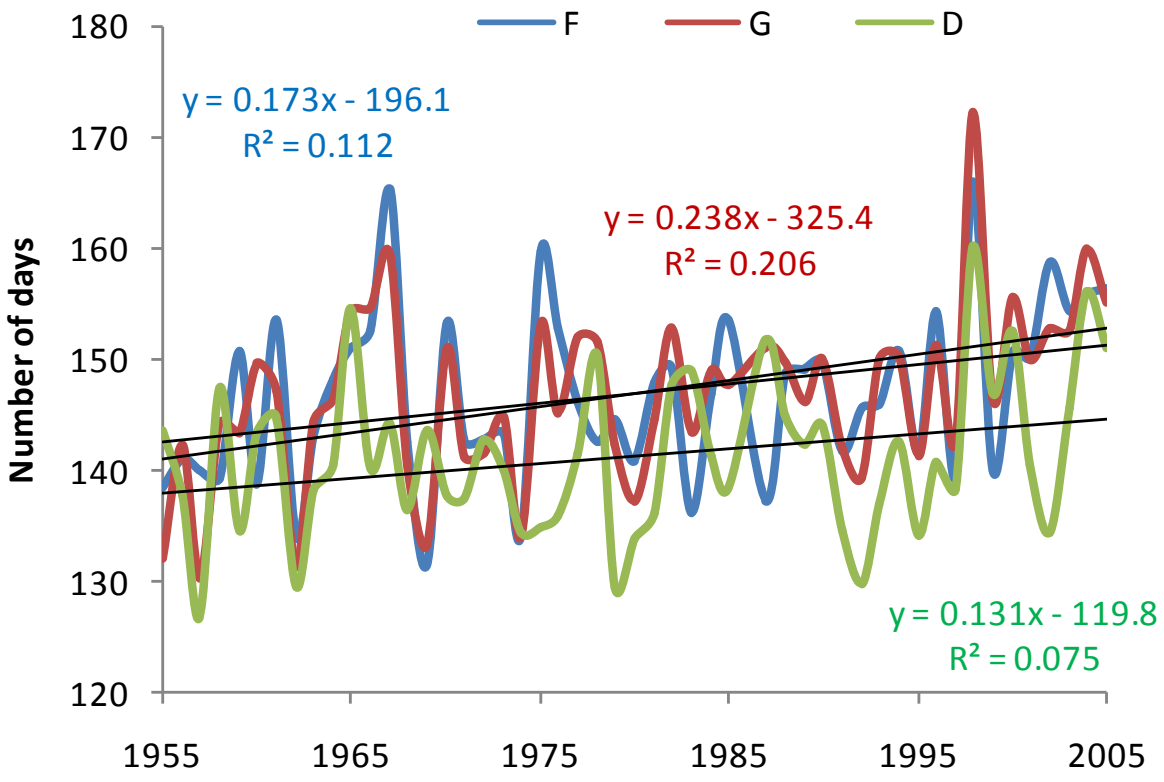


Figure 1. 50-year oscillation of annual mean T_{mean}, T_{min} DTR (˚C), VPD (kPa) and annually accumulated precipitation (mm), averaged for the 51 weather stations (R-region) and those in each biome (F-forest, G-grassland, D-desert), respectively. The shaded area was mean plus/minus standard error. The bold solid line represented the trend. Stars meant slopes were significant at the level of 0.05. Capital letters A, B and C referred to the slope differences among biomes.

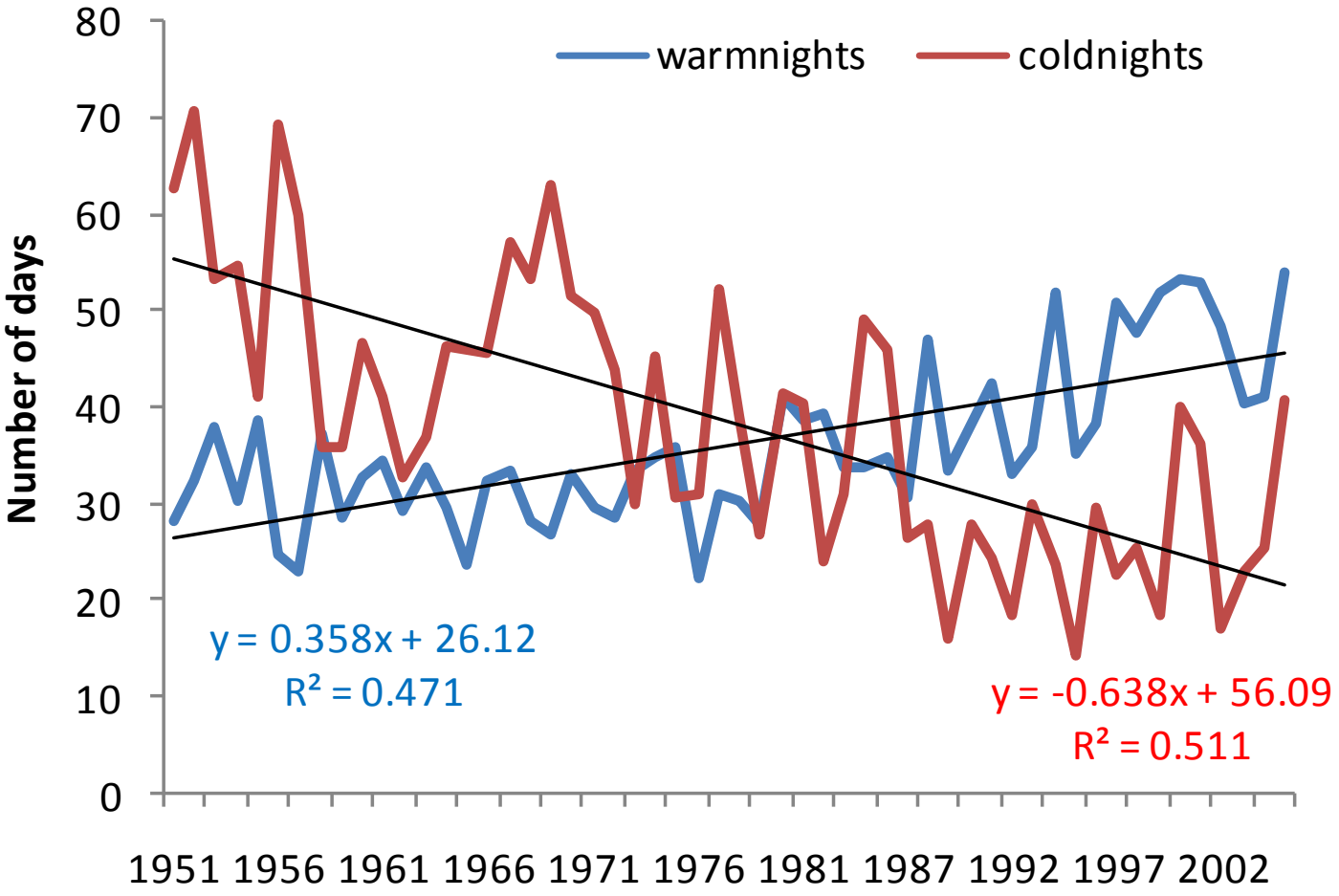
Comparison of trend in growing season length (GSL among three biomes



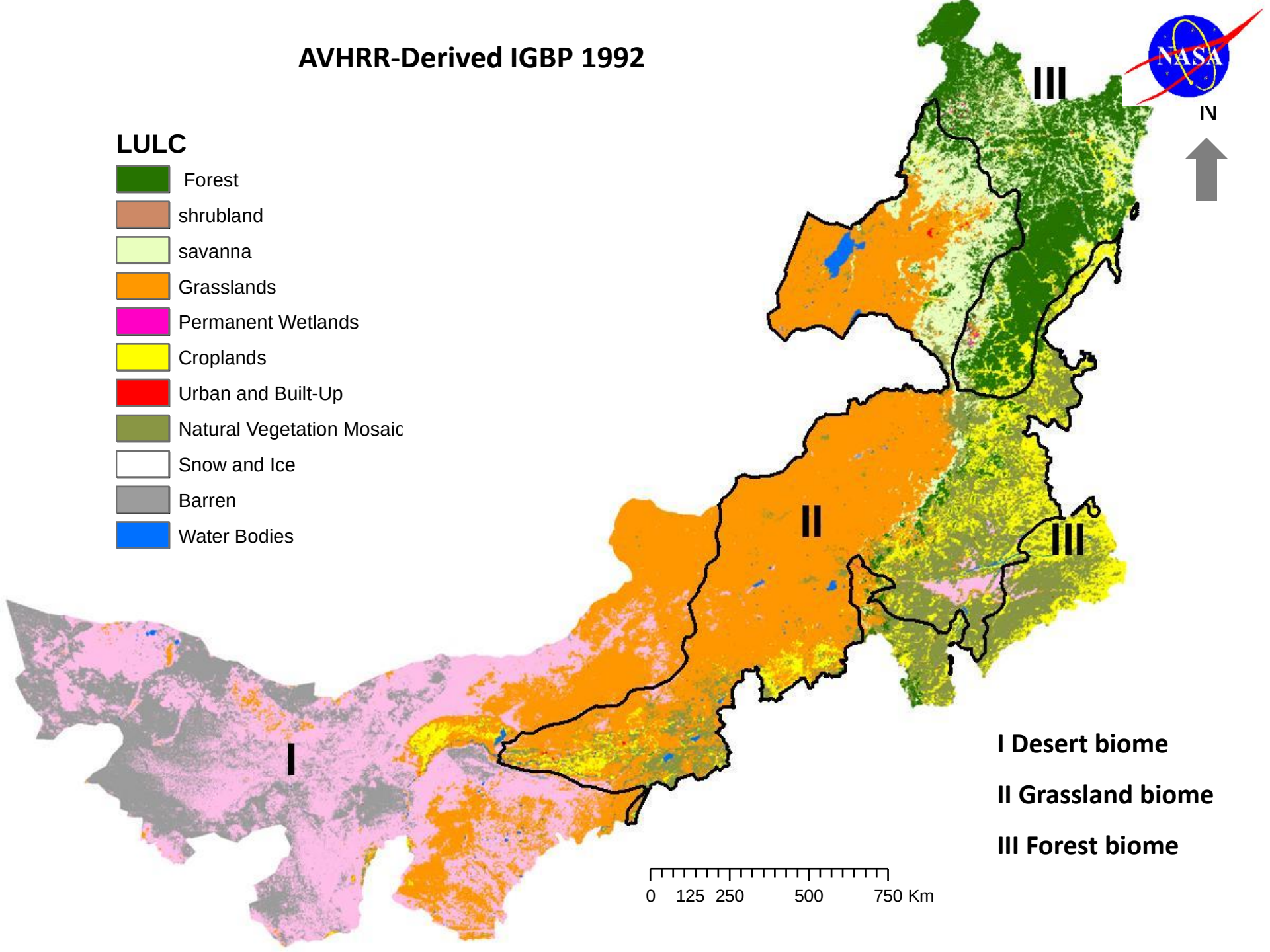
Comparison of trend in heat wave duration index (HWDI) among three biomes

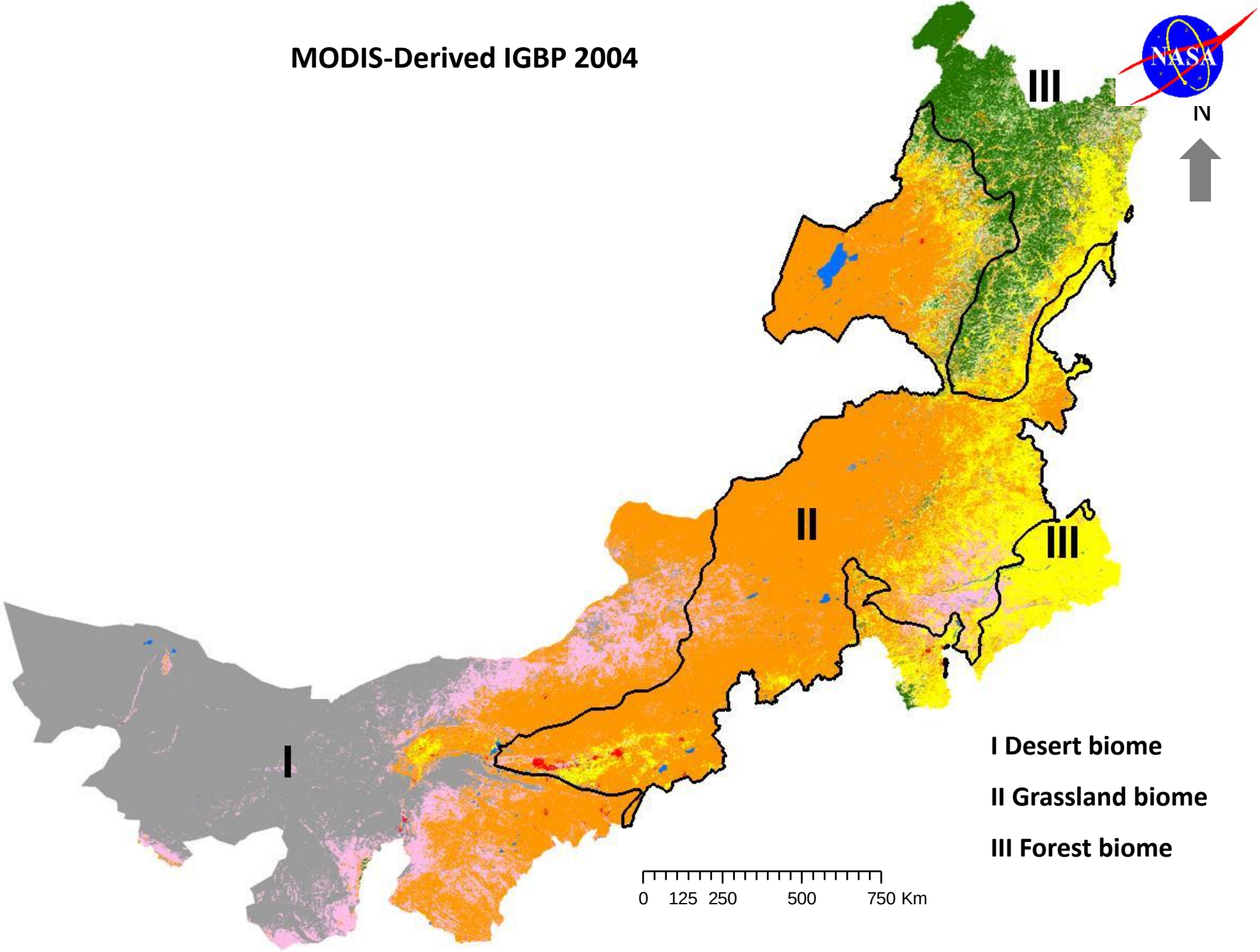


Regional trend of warm nights and cold nights

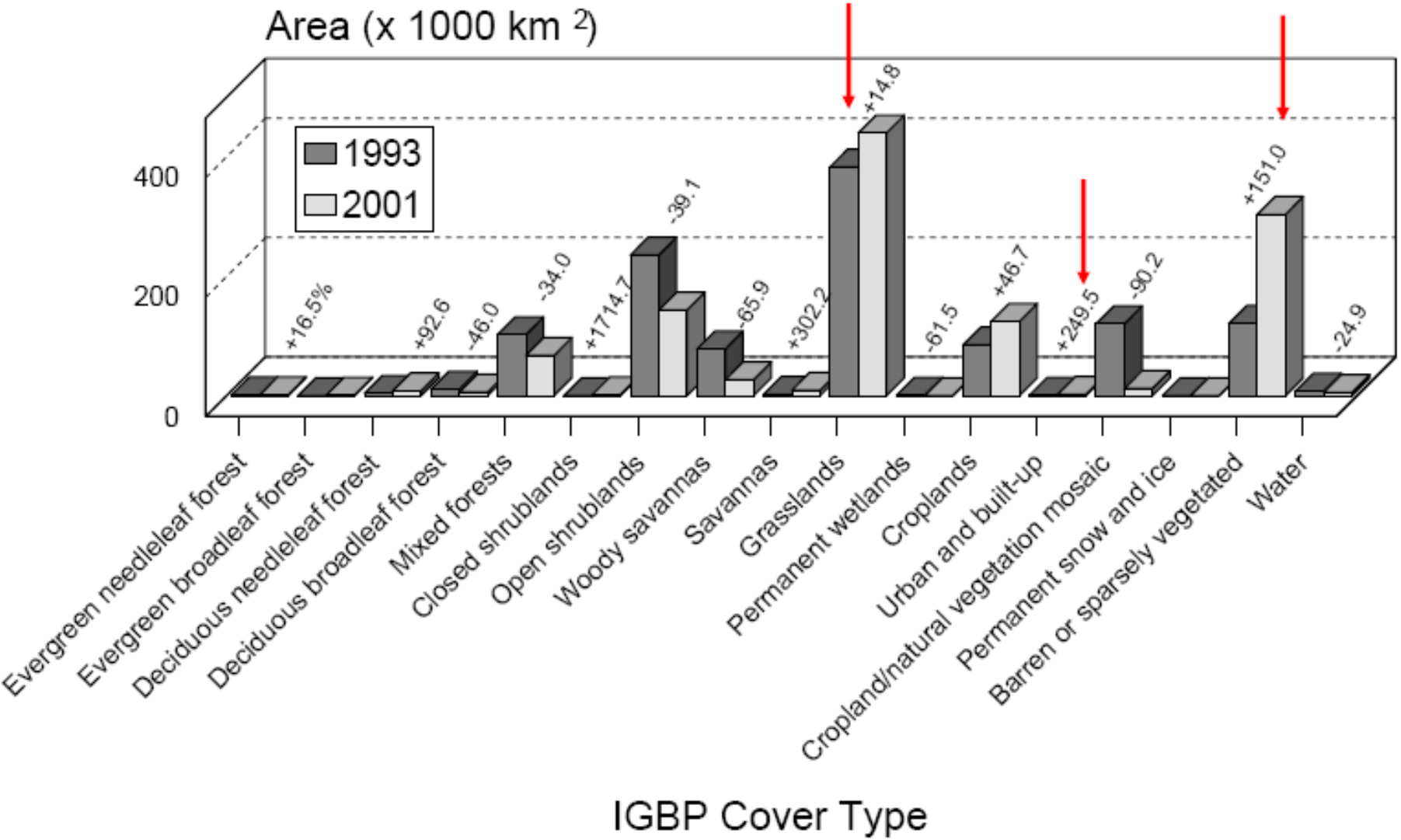


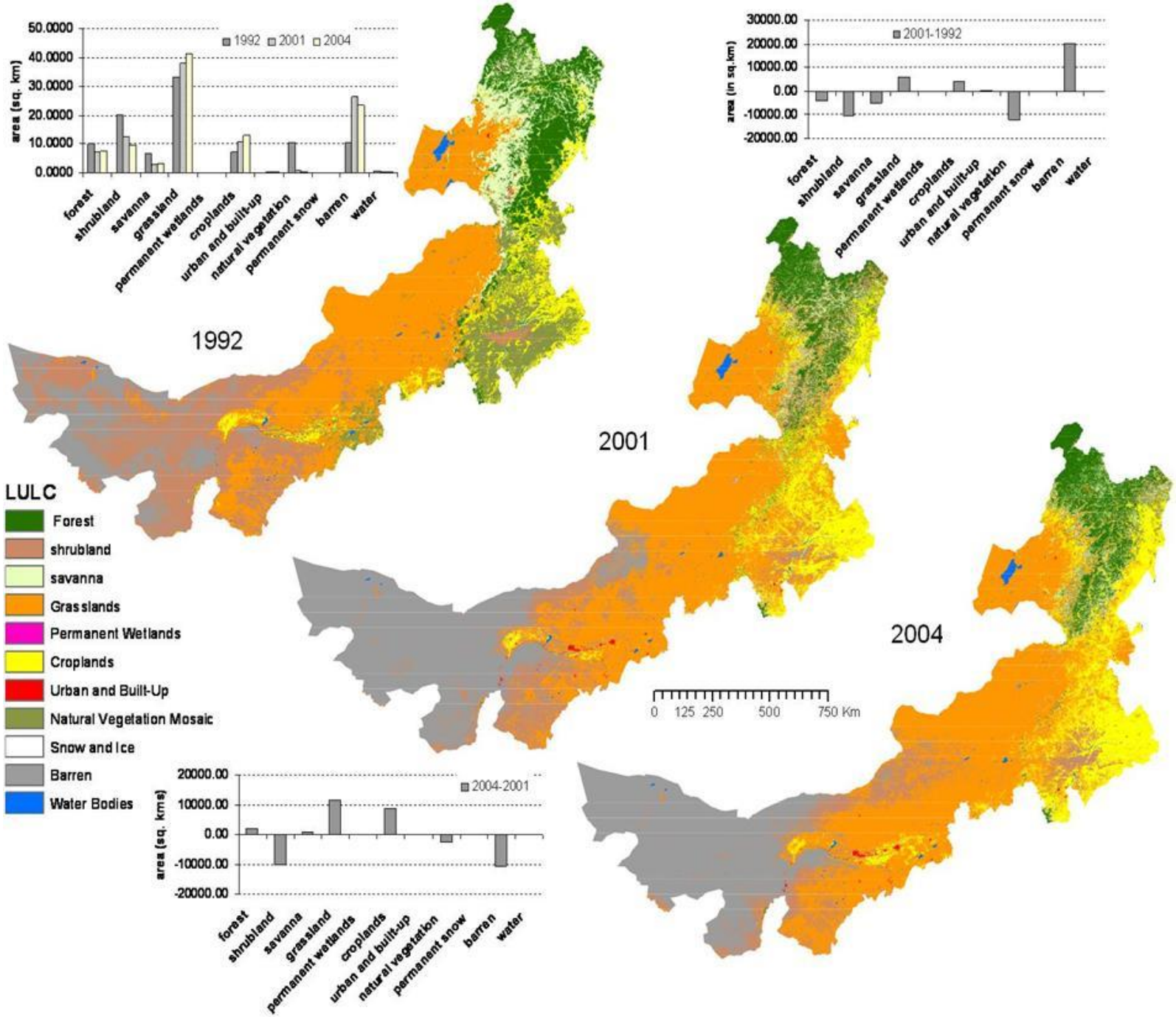
AVHRR-Derived IGBP 1992




MODIS-Derived IGBP 2004
III
N
II
III
I
I Desert biome
II Grassland biome
III Forest biome
0 125 250 500 750 Km

Land cover change between 1993 and 2001 in Inner Mongolia. The numbers are net percent change with negative sign indicating a decrease.

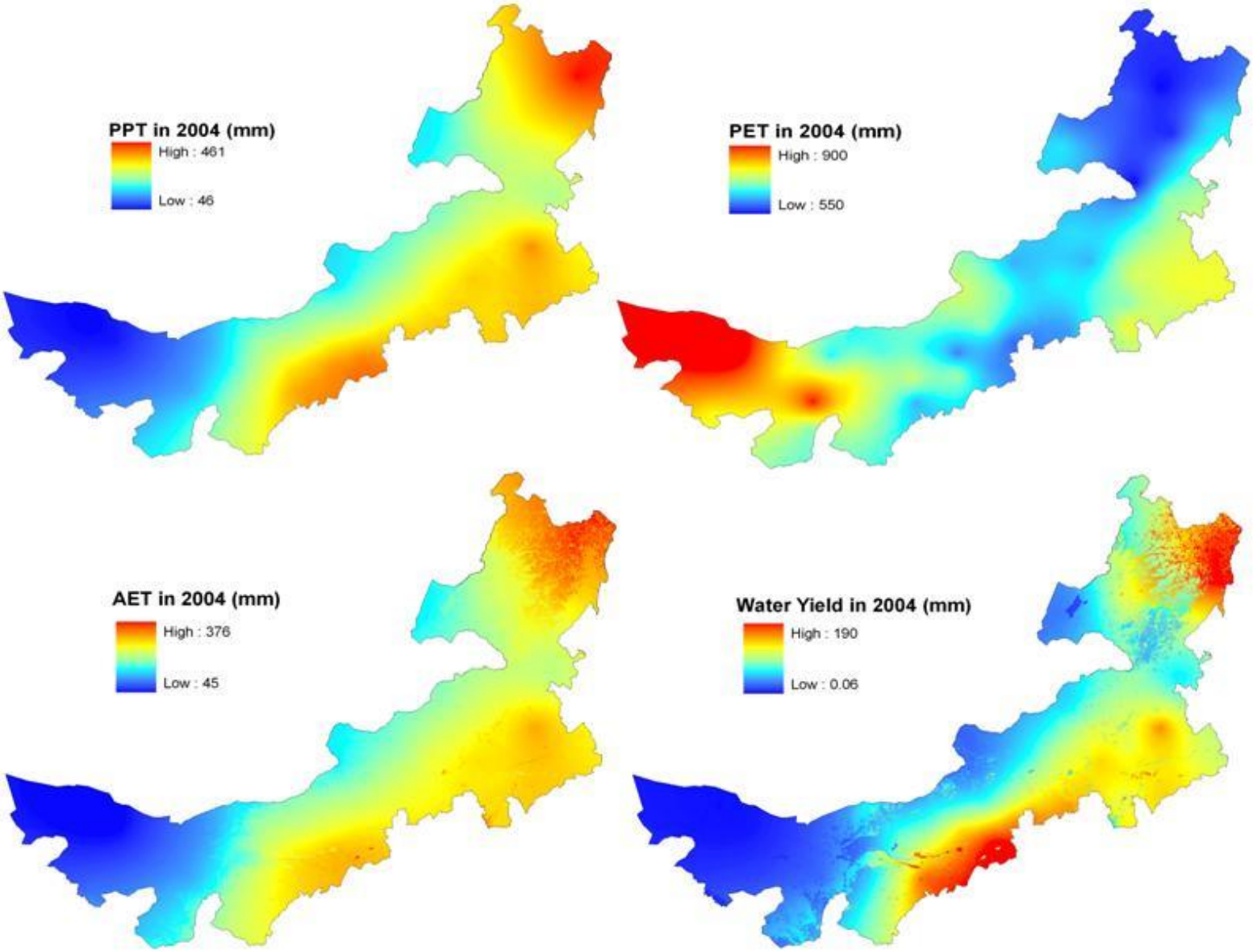



1992
2001
2004
LULC
Forest
shrubland
savanna
Grasslands
Permanent Wetlands
Croplands
Urban and Built-Up
Natural Vegetation Mosaic
Snow and Ice
Barren
Water Bodies
0 125 250 500 750 Km
area (sq. km)
1992 2001 2004
50.0000
40.0000
30.0000
20.0000
10.0000
0.0000
forest
shrubland
savanna
grassland
permanent wetlands
croplands
urban and built-up
natural vegetation
permanent snow
barren
water
area (in sq.km)
2001-1992
30000.00
20000.00
10000.00
0.00
-10000.00
-20000.00
area (sq. kms)
2004-2001
20000.00
10000.00
0.00
-10000.00
-20000.00

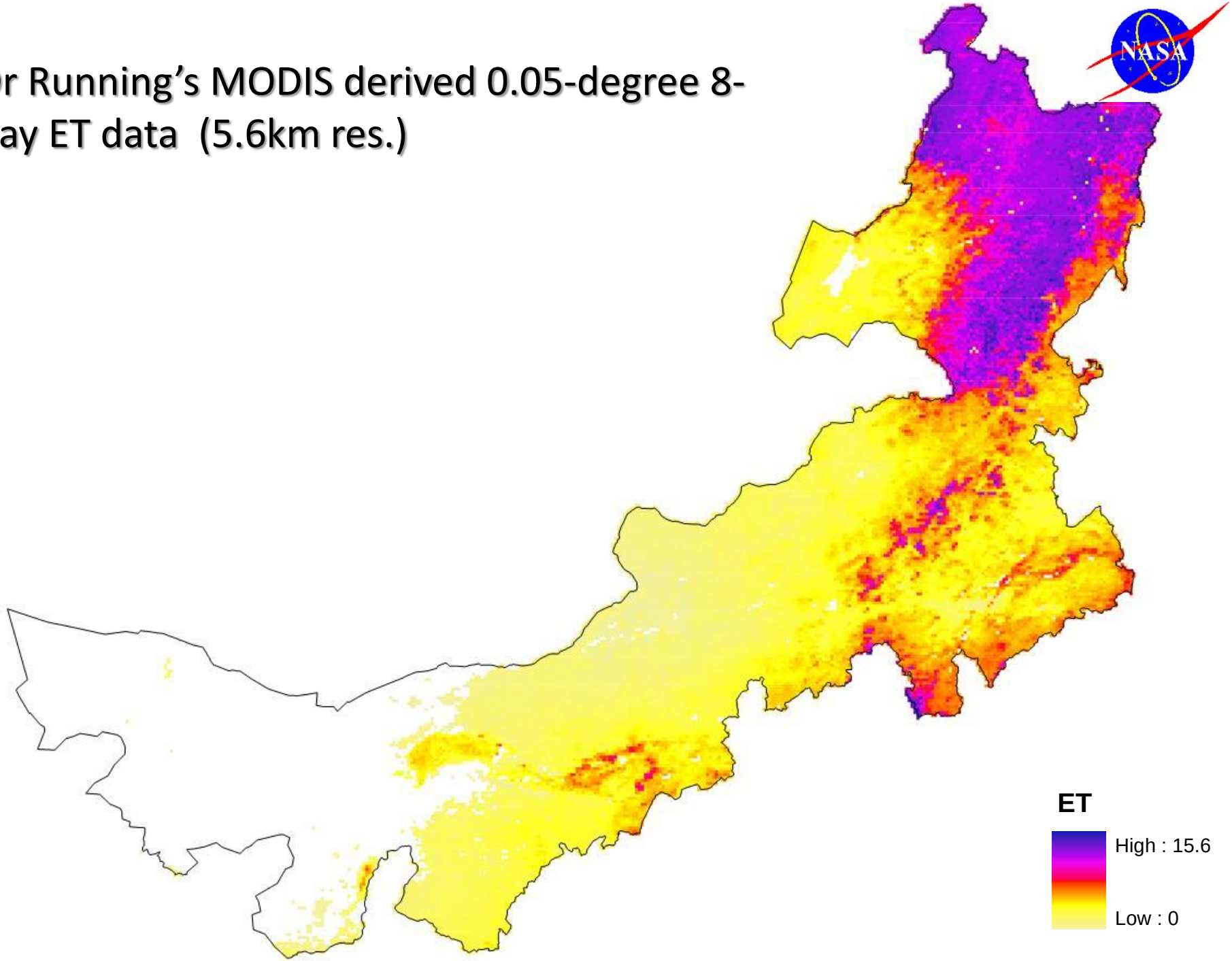
Overall Approaches

- Eddy-covariance flux towers (6 paired-towers since 2005) for time series and validation
- Biophysical models (Monteith, SSEB, VPM) and statistical models) for predictions
- RS modeling (MODIS, TRMM, TM) for spatial coverage

Temporal changes in PPT, PET, water yield and AET (mm) in IM during 1955 to 2005.



Dr Running's MODIS derived 0.05-degree 8-day ET data (5.6km res.)



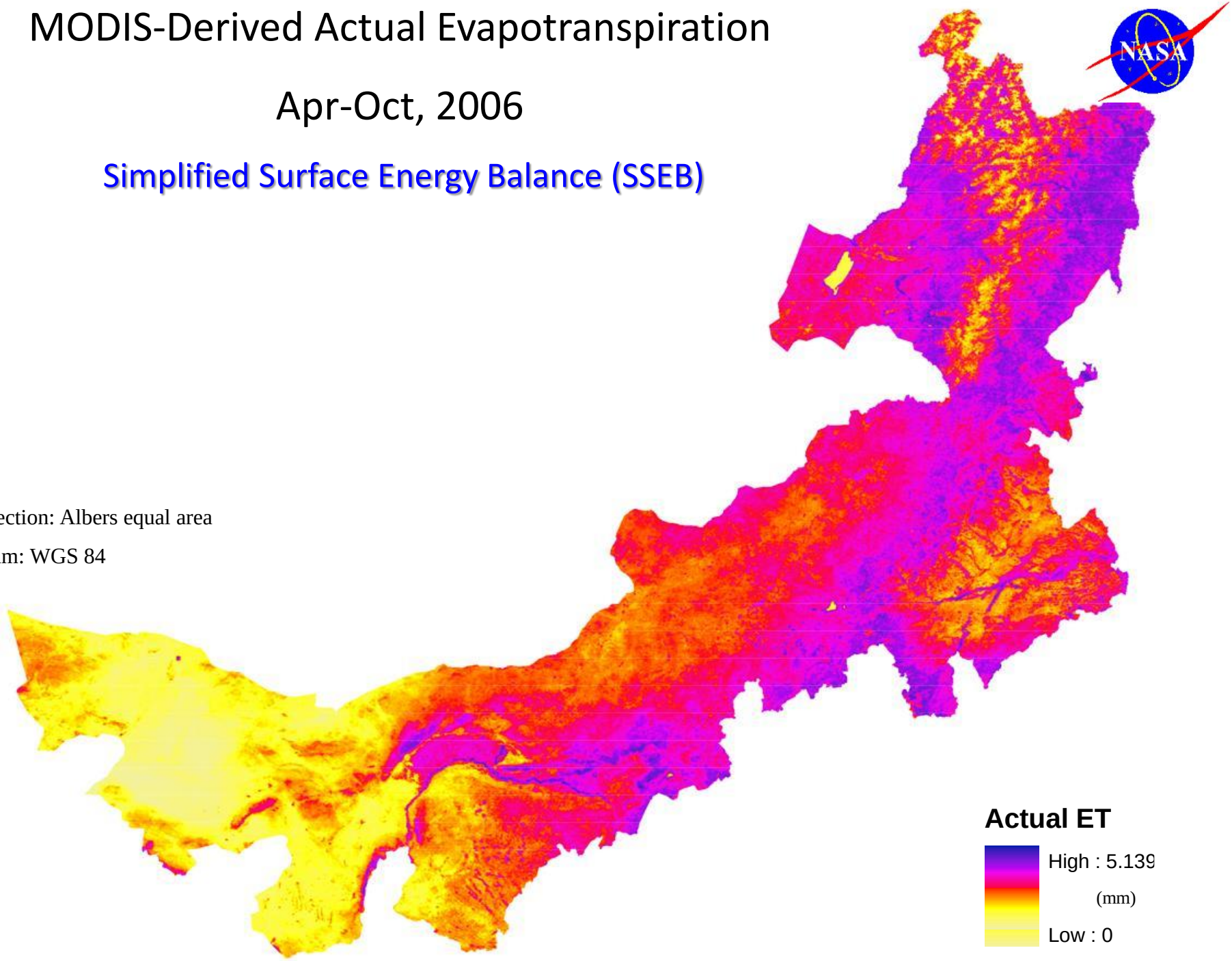
MODIS-Derived Actual Evapotranspiration

Apr-Oct, 2006

Simplified Surface Energy Balance (SSEB)

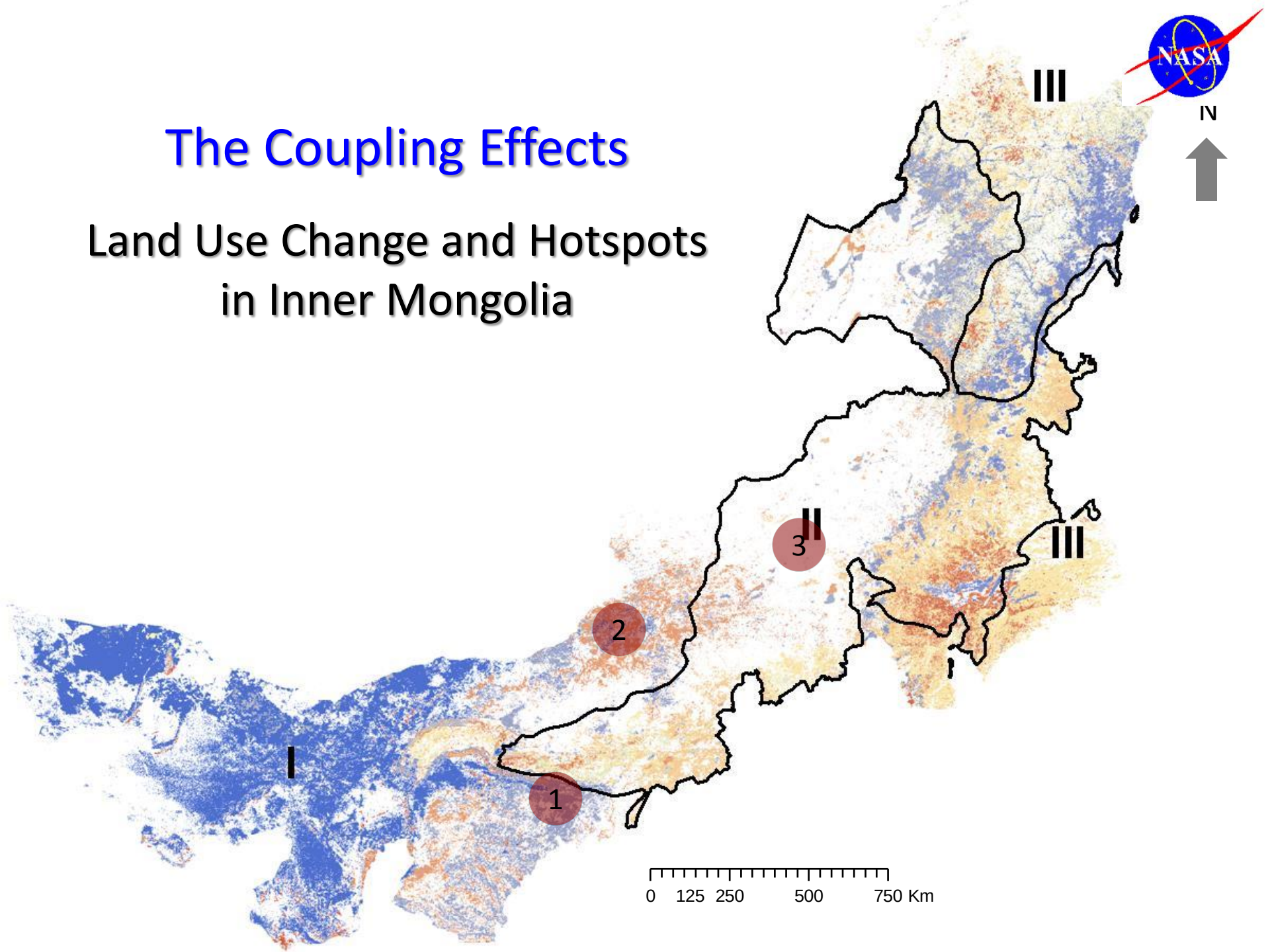
Projection: Albers equal area

Datum: WGS 84



The Coupling Effects

Land Use Change and Hotspots in Inner Mongolia



Repeated ANOVA tests: Coupled Effects of Climate and Landuse on GPP & ET

(1) Gross Primary Production (GPP)

	SSE	%
Type	2.8924	64.3
Year	1.20423	26.8
Year*type	0.40085	8.9
total	4.49748	

2.4

(2) Evapotranspiration (ET)

	SSE	%
Type	11425.4	83.6
Year	1981.1	14.5
Year*type	257.1	1.9
total	13663.6	

5.77