Land-Use/Land-Cover Change In Semi-arid Areas: Jornada Experimental Range Case

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OBJECTIVE:

To examine the effects of the historical vegetation changes that have occurred on the Jornada Experimental Range site on the surface fluxes and near-surface temperature and humidity using a coupled plant and atmospheric model.

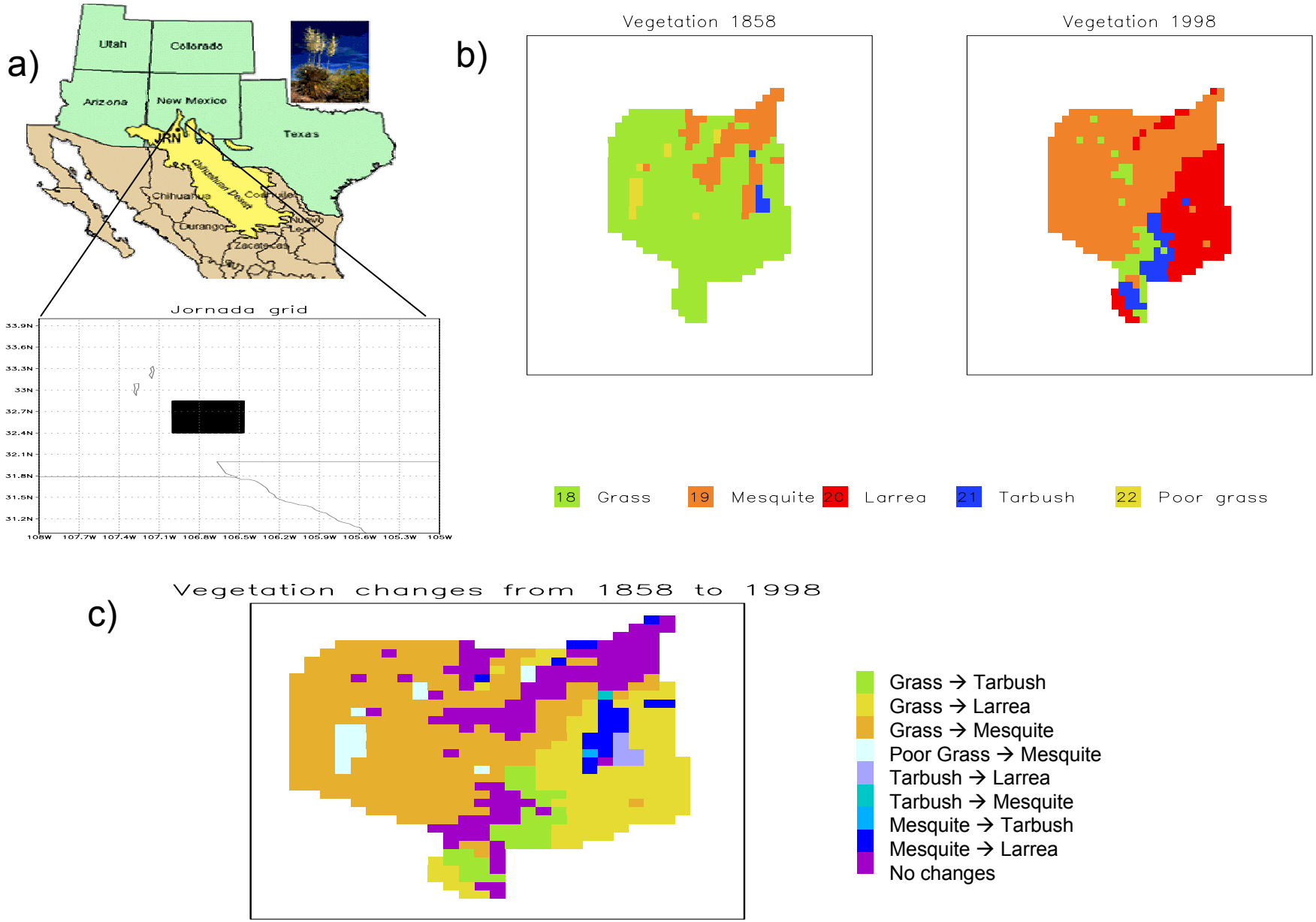
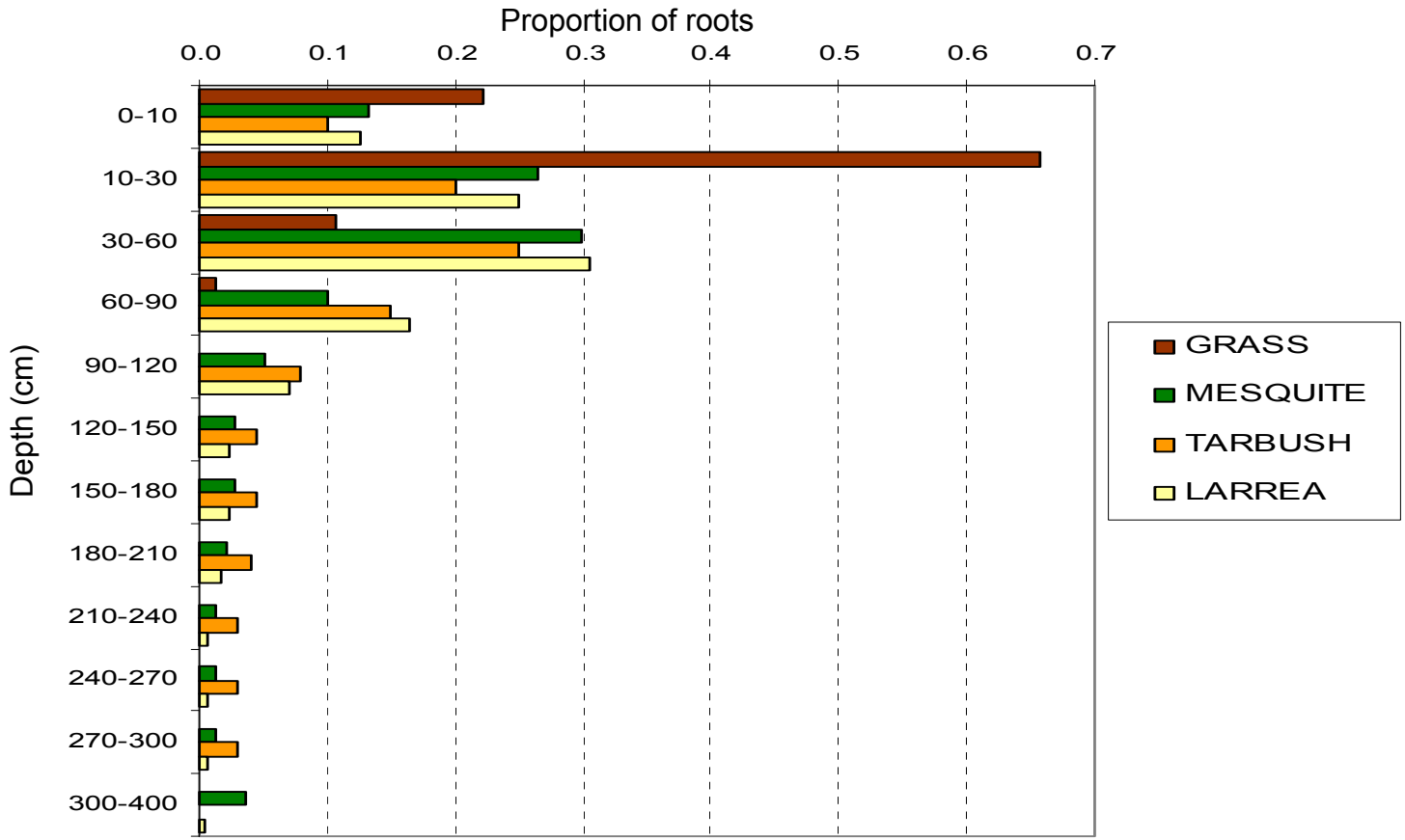


Figure 1. a) Location of the JER and the grid. b) Vegetation maps for 1858 and 1998. c) Vegetation changes from 1848 to 1998.



Root distribution of the different vegetation types considered in the JER domain.

Parameter values for the vegetation types from the JORNEX experiment.

Vegetation types	LAI (m^2 m^{-2})		Vegetation cover (%)		Albedo		Roughness length (m)	Displacement height (m)
	May	Aug	May	Aug	May	Aug		
Grass	0.8	0.8	25.1	**41.8**	0.25	**0.21**	0.018	0.120
Poor grass	0.3	0.3	15.0	**15.0**	0.27	**0.27**	0.018	0.120
Mesquite	1.1	0.9	16.8	**22.5**	0.34	**0.35**	0.060	0.467
Larrea	1.6	0.9	36.5	**37.5**	0.24	**0.28**	0.060	0.760
Tarbush	1.4	0.8	28.7	**32.4**	0.22	**0.24**	0.050	0.433

Experimental Design

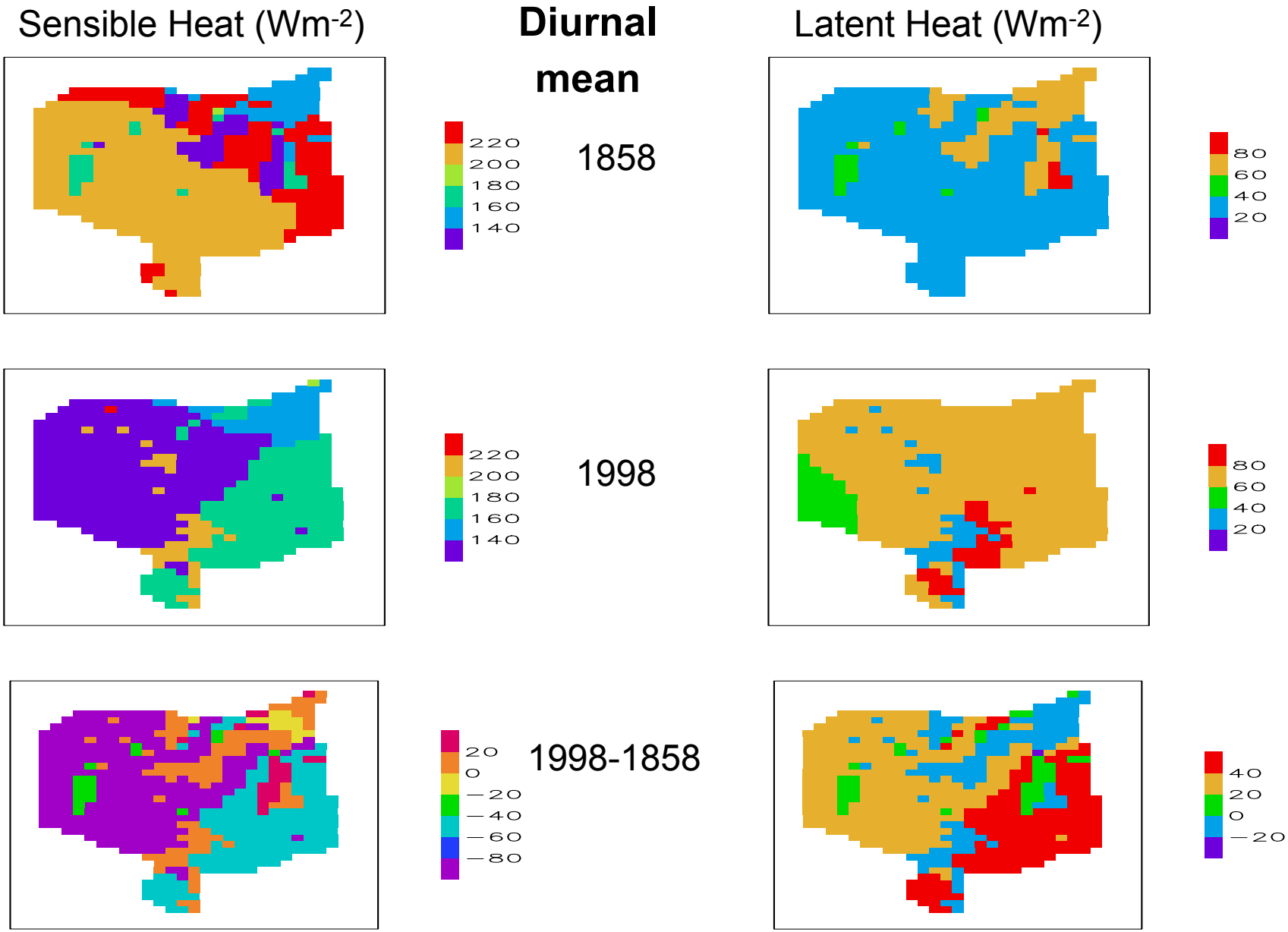
- **Control runs:**

Two experiments, using GEMRAMS, were performed using two land-cover scenarios, 1858 and 1998, with identical initial meteorological conditions (August 25th, May 23rd, 2002)

- **Sensitivity experiments to different initial soil moisture conditions for both land-cover scenarios, 1858 and 1998.**
  - **Dry case:** the whole profile is 20% drier than the control case.
  - **Wet case:** top 90 cm of the soil profile is 20% wetter than the control case, and the rest of the layers are the same than the control case.
  - **Wetter cases:**

    WETT_sfc: top 90 cm of the soil profile is 50% wetter

    WETT_all : all the soil profile is 50% wetter



Diurnal area-averaged of sensible and latent heat fluxes (W m-^{2}) for Aug 25th conditions for 1858 and 1998, and their differences.

Diurnal-area average of sensible (SH) and latent (LH) heat (W $m^{-2)}$ for the control case for August 25th and May 3rd experiments. Bowen ratio (β) was computed based on the diurnal-area averaged values of SH and LH.

	Year	Aug 25th	May 3rd
SH		205	234
LH	1858	33	40
β		**6.2**	**5.9**
SH		153	203
LH	1998	63	65
β		**2.4**	**3.1**

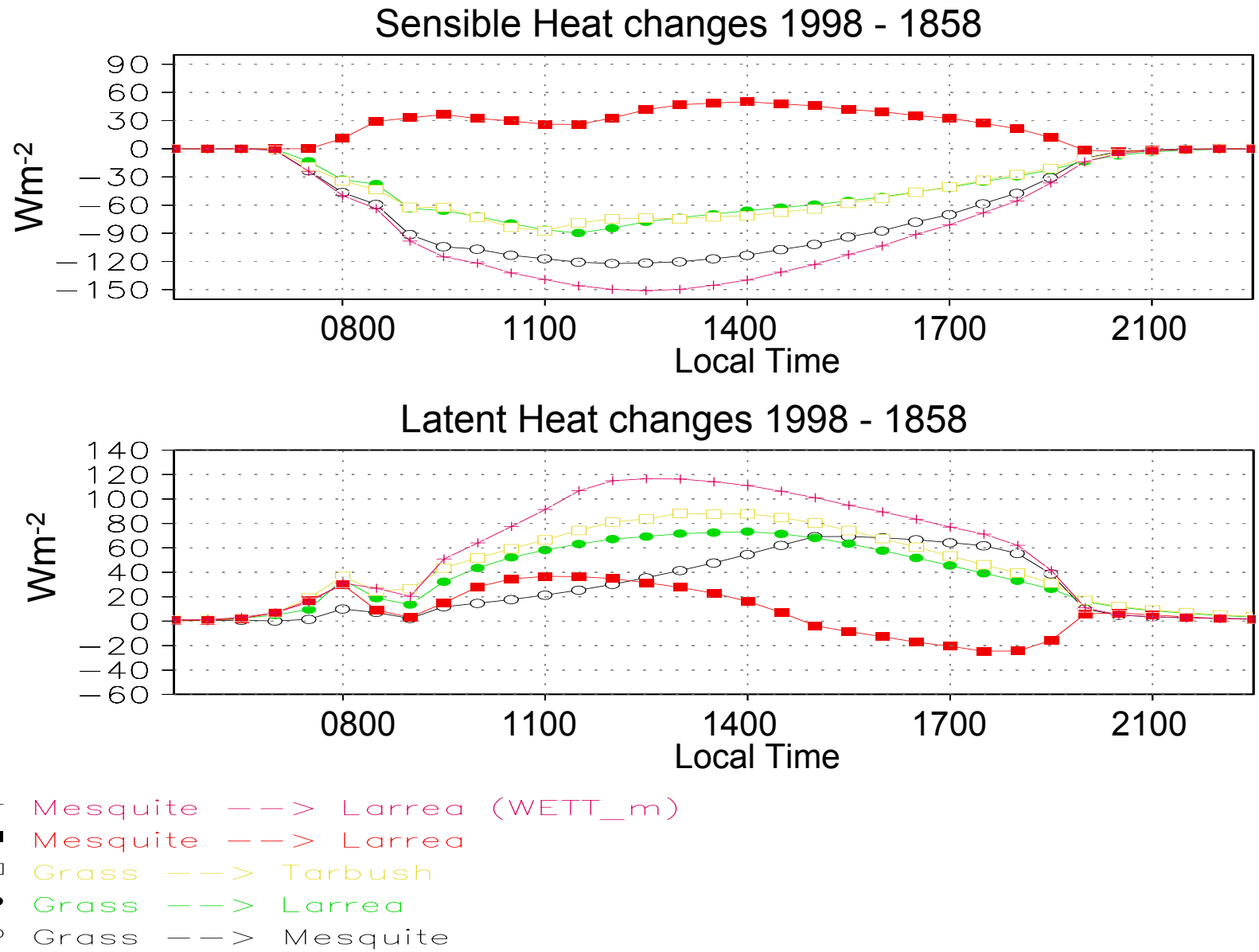
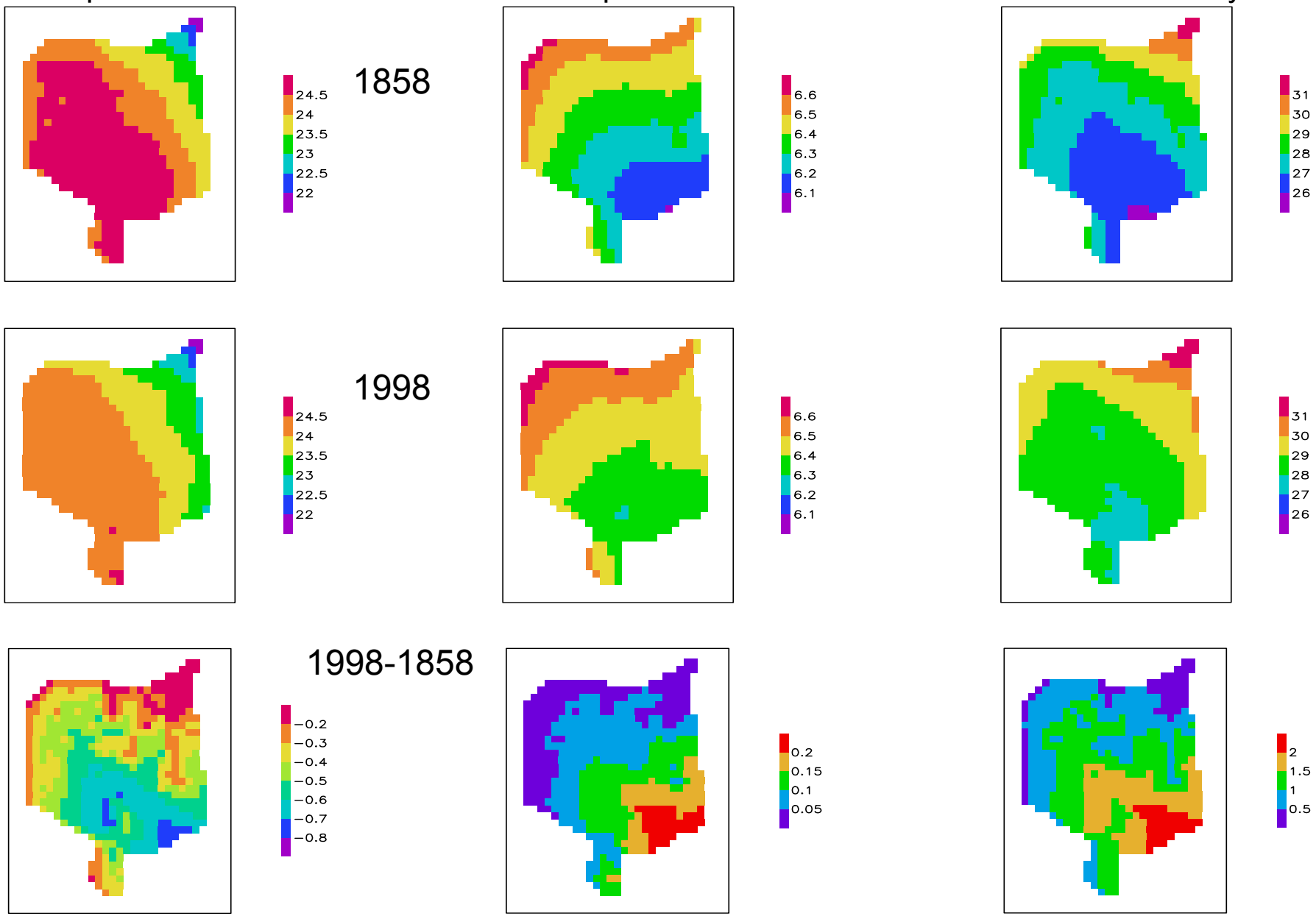
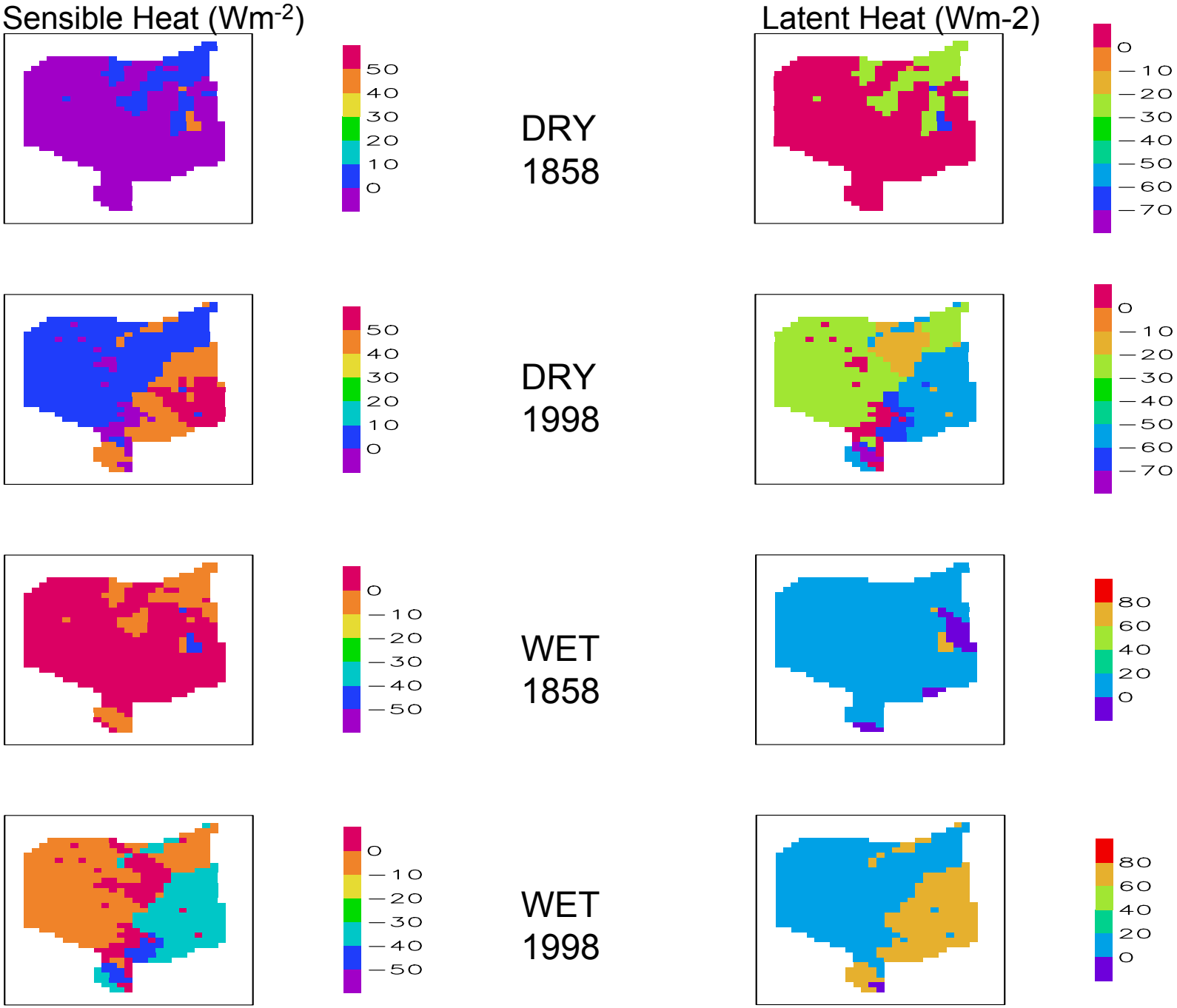


Figure 6. Diurnal evolution of the differences of sensible and latent heat fluxes between the grid cells with the same vegetation changes (see also Figure 1c).

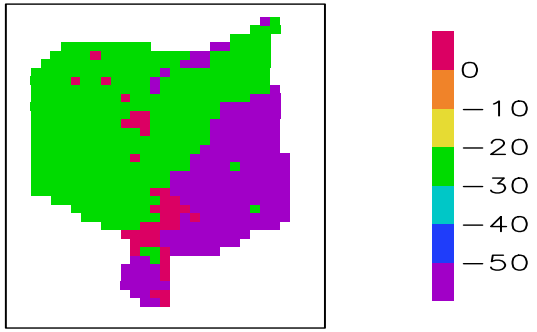


Temperature (°C), water vapor mixing ratio (g kg^{-1}) and relative humidity (%) at 1300 LST for 1858, 1998 and their differences.



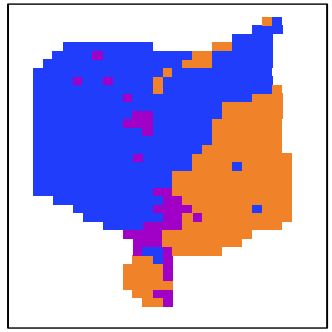
Differences between each sensitivity experiment and the control case.

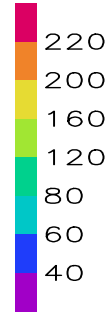
Sensible Heat (Wm^{-2})

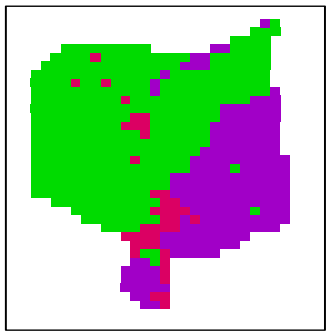


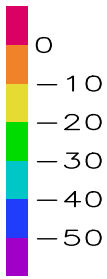
WETTER
50% sfc
1998

Latent Heat (Wm-2)

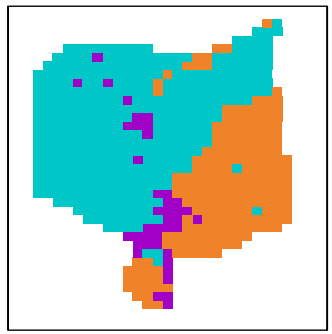


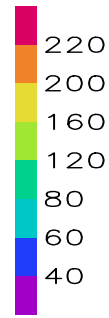






WETTER
all profile
1998





Area average of sensible and latent heat (W $m^{-2)}$ at 1300 LST for the August 25th control case (CTRL) and the soil moisture sensitivity experiments (DRY, WET, WETT_sfc, WETT_all). In parenthesis, the changes with respect to the control case (CTRL).

Year		CTRL	DRY	WET	WETT_sfc	WETT_all
1858	SH	365	365 (0%)	365 (0%)		
1998		289	307 **(6%)**	277 **(-4%)**	238 **(-18%)**	237 (-18%)
1858	LH	46	44 (-4%)	47 (2%)		
1998		87	56 **(-36%)**	113 **(30%)**	191 **(119%)**	202 **(132%)**

Summary

- The **change from an 1858 domain**, mostly covered by **grasses**, to a **1998**, one mostly covered by **shrubs**, led to an overall **decrease of sensible heat and an increase of latent heat**.

- A simulated shift in the energy partition from sensible heat to latent heat resulted in a **cooler** and **moister low atmosphere**.

- **Albedo**, **area coverage** and **root distribution** are the dominant parameters controlling the energy budget in these experiments.

- The different vegetation changes resulted in **spatially heterogeneous** changes in surface fluxes.

- We also performed **sensitivity simulations** to the initial soil moisture conditions. In all the cases, **grasses** were **less sensitive** to soil moisture than the shrubs, and they were more stressed than shrubs for all the simulations.

- **Latent heat fluxes** responded **more** than **sensible heat fluxes** to an increase in soil moisture content.

Future work in Jornada

❑ To extend these one-day long simulations to the whole growing season (i.e March to October) and also to different years.

Future work in SGS

❑ Perform a similar set of experiments for the SGS site, extend these one-day long simulations to the whole growing season (i.e March to October) and also to different years (i.e. drought/non-drought years)

❑ To include CO_2 changes on the experiments.

❑ Vegetation map, "potential"-"actual" (Loveland et al. 1991).

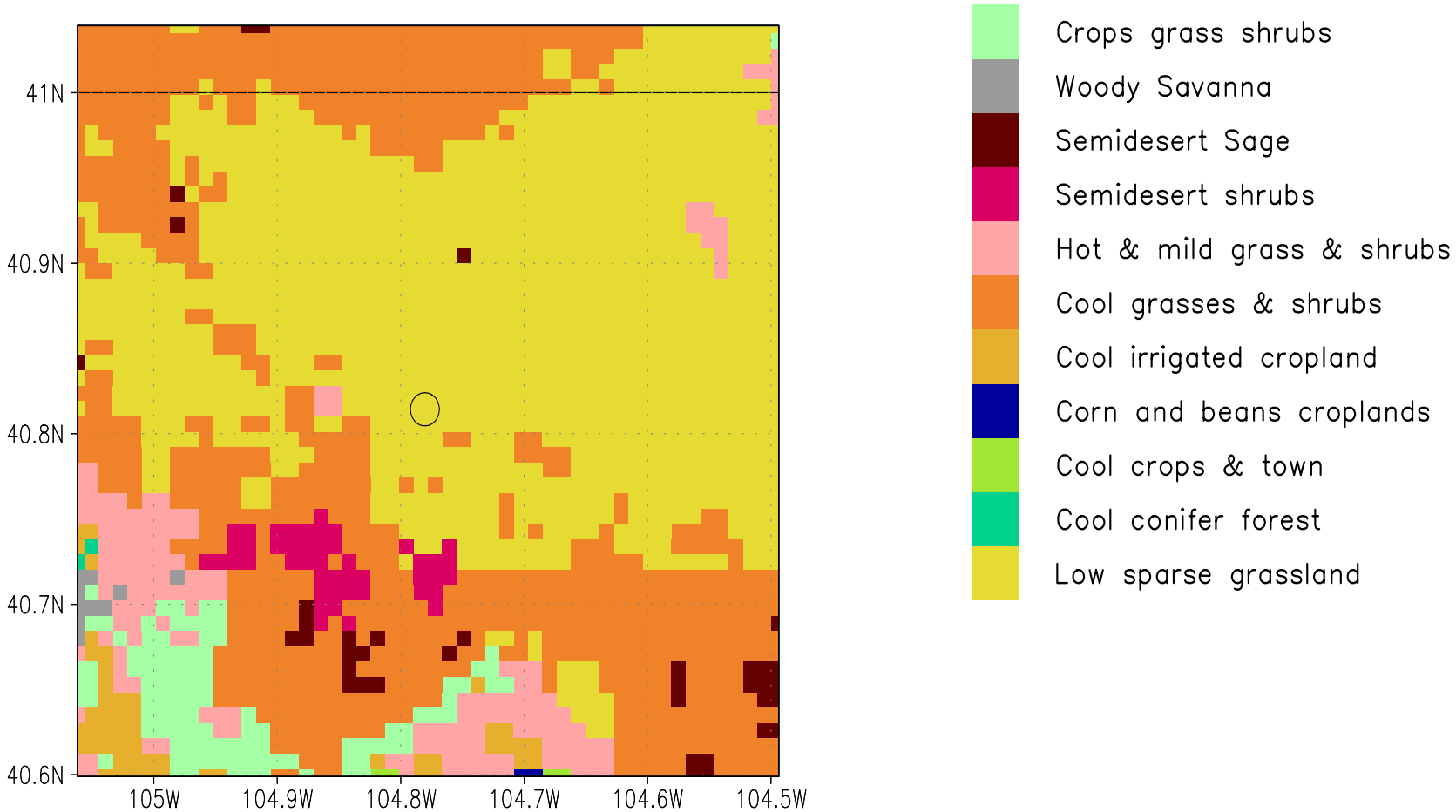
Crops: winter wheat, corn. Need sowing/harvest data; (validation of GEMTM for crops?; it works OK for South America simulations)

Grasses: blue grama, western wheatgrass

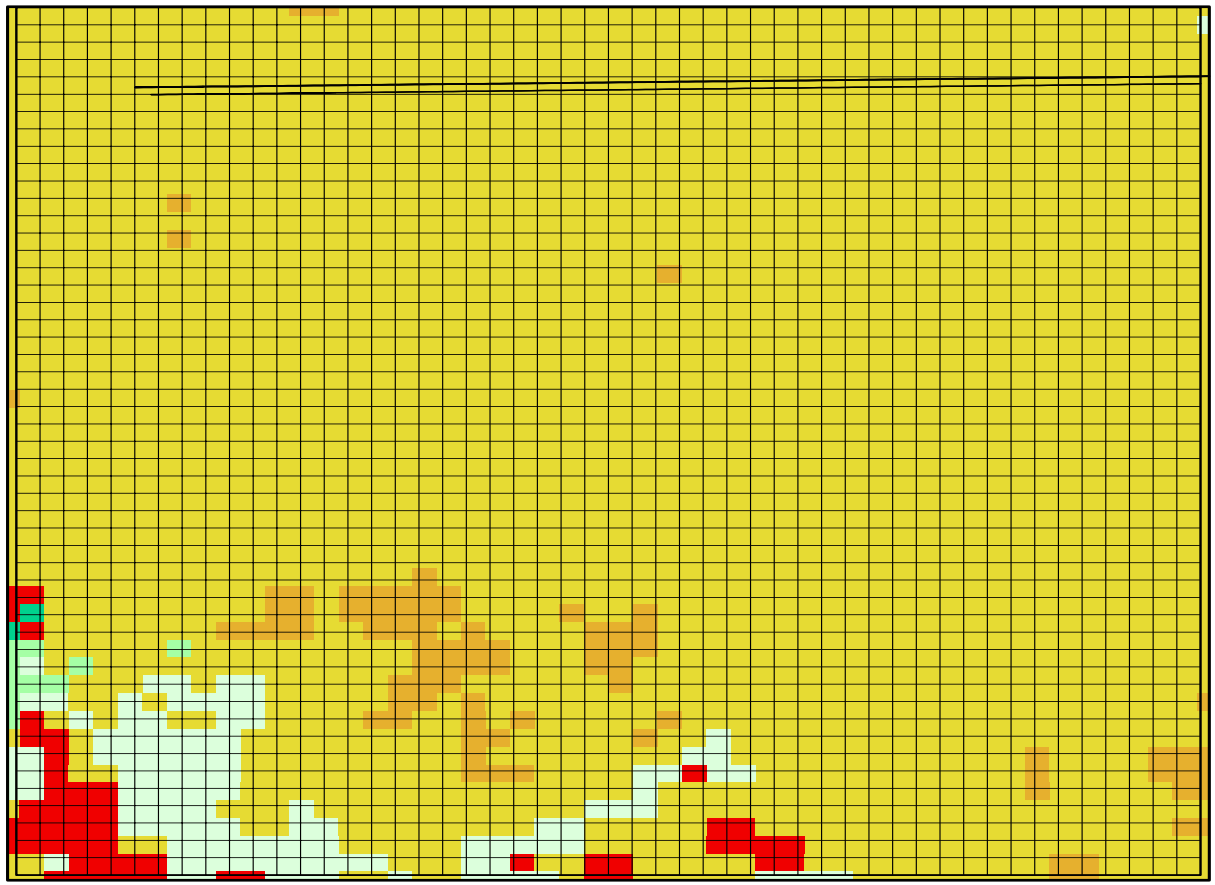
Vegetation parameters: albedo, veg cover, roughness length?

❑ Soil texture map (STATSGO, other). If possible, local representative values of hydraulic parameters (i.e., **saturated soil water content**, **saturated hydraulic conductivity**).

Vegetation types for a 50 x 50 km grid (1 km x 1 km grid space) centered at SGS, from Olson Global Ecosystem (Loveland et al. 1991)



Same map translated to BATS vegetation types (what RAMS uses)



Evergreen need. tree

Short grass

Semidesert

Crop/mixed farm

Irrigated crop

Wooded grassland