

Table S1: Simplified TCP/IP socket protocol between LPJmL and py-coupler used in copan:LPJmL. Upper case words indicate communication tokens: GET_DATA, PUT_DATA, End_DATA, GET_DATA_SIZE, PUT_DATA_SIZE, GET_STATUS, FAIL_DATA, COPAN_OK, COPAN_ERROR. The initialization (init) is the first exchange of coupling information, while in the main phase data is exchanged. The direction refers to the LPJmL point of view.

Phase	Direction	Item	Description
Init	In	version	coupler library version
	In	ncell	number of simulation cells
	In	ninput	number of input streams
	In	noutput	number of output streams
	<i>For each input stream:</i>		
	In	GET_DATA_SIZE	confirmation input info exchange
	In	index	input data index of LPJmL config
	In	type	data type (short, int, float, double)
	Out	nband/ COPAN_ERR	number of bands of input or error
	<i>For each output stream:</i>		
	In	PUT_DATA_SIZE	confirmation output info exchange
	In	index	output data index of LPJmL config
	In	nstep	subannual output time steps
	In	nband	number of bands
	In	type	data type (short, int, float, double)
	Out	COPAN_OK/- COPAN_ERR	copan:LPJmL status
	In	GET_STATUS	confirmation copan:LPJmL status
	Out	COPAN_OK/ COPAN_ERR	copan:LPJmL status
Main	<i>For each input stream:</i>		
	In	GET_DATA	confirmation input data exchange
	In	index	input data index LPJmL config
	In	year	simulation year
	Out	data[ncell, nband]	sequential data in order ncell, nband
	<i>For each output stream:</i>		
	In	PUT_DATA	confirmation output data exchange
	In	index	output data index of LPJmL config
	In	year	simulation year
	In	data[ncell, nband]	sequential data in order ncell, nband
End	Out	COPAN_OK/ COPAN_ERR	copan:LPJmL status
	In	END_DATA or FAIL_DATA	status of simulation success

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1      f"""You are a crop farmer for the 0.5°x0.5° simulation cell
2      centered at {self.position}.
3      You manage the following crop types on your land (with land
4      fractions): {self.crops}.
5      Your aim is to increase your overall harvest as much as
6      possible.
7      However, all you are able to adjust is the amount of nitrogen
8      fertilizer that you apply to your different crops.
9      Use your general knowledge about the location and the crops
10     you are growing.
11     Moreover you know the amount of fertilizer you applied in the
12     past {self.mem_fert} as well as the corresponding crop yields
13     (in gC/m2/year) {self.mem_yield}.
14     Please note that some crops (e.g. rainfed pulses and rainfed
15     soybeans) naturally fix nitrogen and generally require less
16     or no external nitrogen.
17     State the reasoning for your decision explicitly for
18     rainfed rice, rainfed maize, and rainfed tropical cereals for
19     every year.
20
21     Format your response exactly like this:
22     Reasoning: [Max 200 characters]
23     Response: [['crop1','crop2'], [amount1, amount2]]
24
25     Example:
26     Reasoning: Increased temperate cereal N due to low yield
27     response, kept others constant.
28     Response:
29     [['rainfed temperate cereals', 'irrigated biomass tree'],
30     [5, 8]]
31
32     Technical Note:
33     - Use only the format above.
34     - Ensure that crop names and amounts match and that both
35     lists are the same length.
36     - Do not use semicolons ';' in your response.
37     """

```

Figure S1: LLM prompt of the LLM fertilization model as part of land-manager, which is passed to GPT-4o-mini via the openai API (OpenAI, 2024). `self.position` provides latitude and longitude of the cell center while `self.crops` define the grown crops and their land system share. `self.mem_fert` and `self.mem_yield` pass the memorized fertilization rates and crop yields for the corresponding crops of the last ten years.

Bibliography

OpenAI: GPT-4o-mini, URL <https://platform.openai.com/>, 2024.