Impact scenarios of crop production under climate change

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Food security in Kenya

For some crops Kenya depends substantially on imports

wheat 29 % is imported
(of which 30 % come from Russia, 19 % from Argentina, 12 % from Ukraine, 9 % from Canada)

corn 27 % is imported
(of which 45 % come from Mexico, 19 % from South Africa, 11 % from Uganda, 9 % from Zambia)

rice 19 % is imported
(of which 67 % come from Pakistan, 25 % from Thailand)

(numbers are from 2017)

These numbers can fluctuate a bit, depending on the annual production in the various countries. The numbers for corn fluctuate somewhat more than the numbers for rice and wheat.

Climate Impacts

Climate Impacts are consequences of climate change such as

- change in crop production (for better or worse)
- increased mortality due to more frequent heat waves
- death of coral reefs due to ocean acidification

etc.

These are investigated by impact models, i.e. computer programs that simulate the most important biophysical processes and are driven by climate data / socio-economic data

ISIMIP

The Inter-Sectoral Impact Model Intercomparison Project

collects cross-sectorally consistent climate-impacts simulations by providing

- common climate scenarios (daily, gridded data)
- common data sets describing socio-economic conditions (population, GDP, land use etc.)

strives to disseminate data and knowledge widely with low barriers to access.

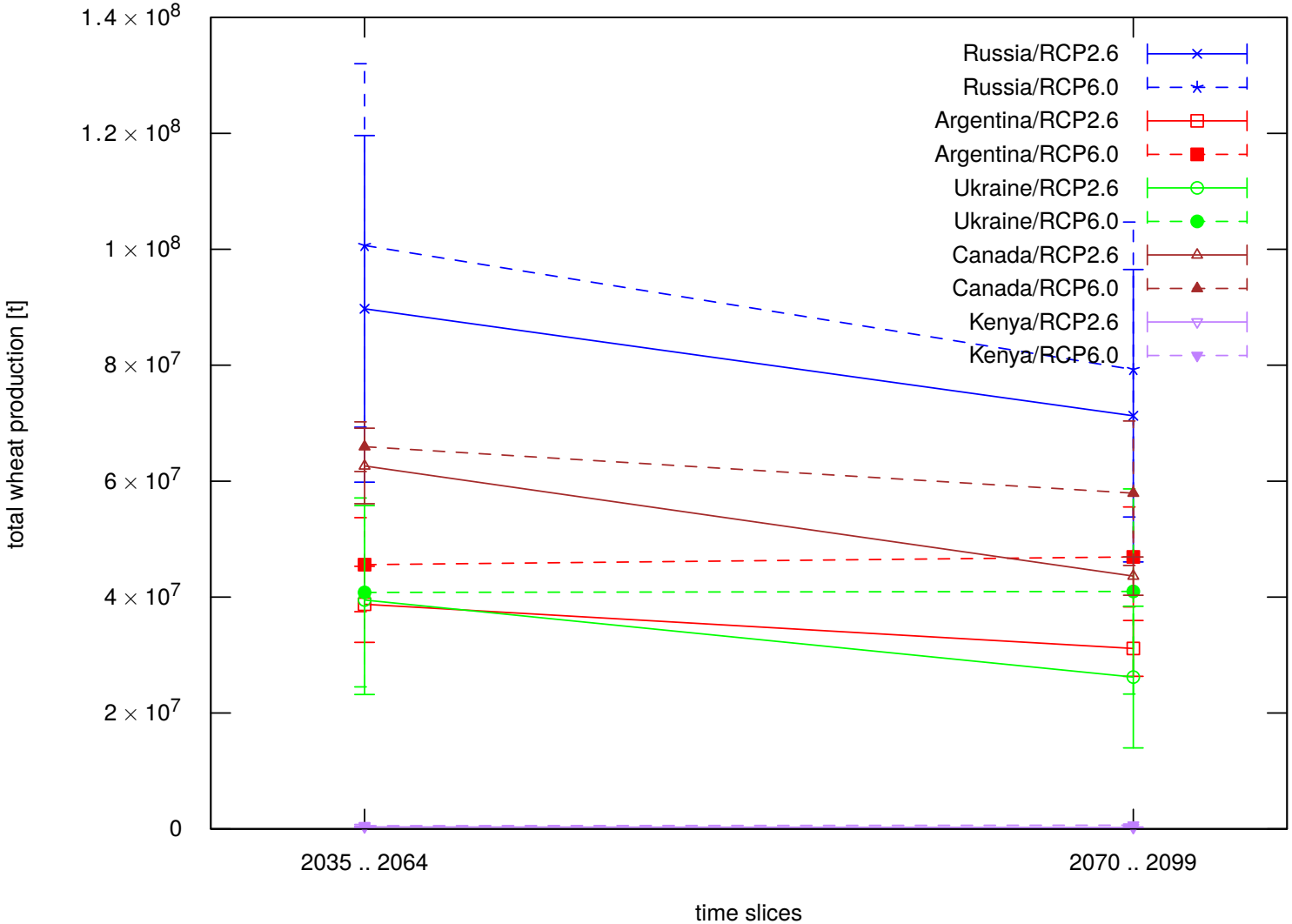
- all results receive a DOI and are eventually publicly available
  `https://esg.pik-potsdam.de`
- (almost) all ISIMIP data products are included: gridded, harmonized impacts simulations, climate data and socio-economic data

Crop models

> *"Agriculture is arguably the sector most affected by climate change, but assessments differ and thus are difficult to compare."*
>
> Rosenzweig et al., (2014)

- models differ substantially in the processes they simulate: CO_2 fertilization, nitrogen stress, …
- crop production depends on 2 major variables: yields (t/ha) and area used for a specific crop; both are very difficult to project
- here we use the land use and crop yield scenarios provided by ISIMIP
- due to the inherent diffculty the results should not be compared to current productions, but we rather should look at trends

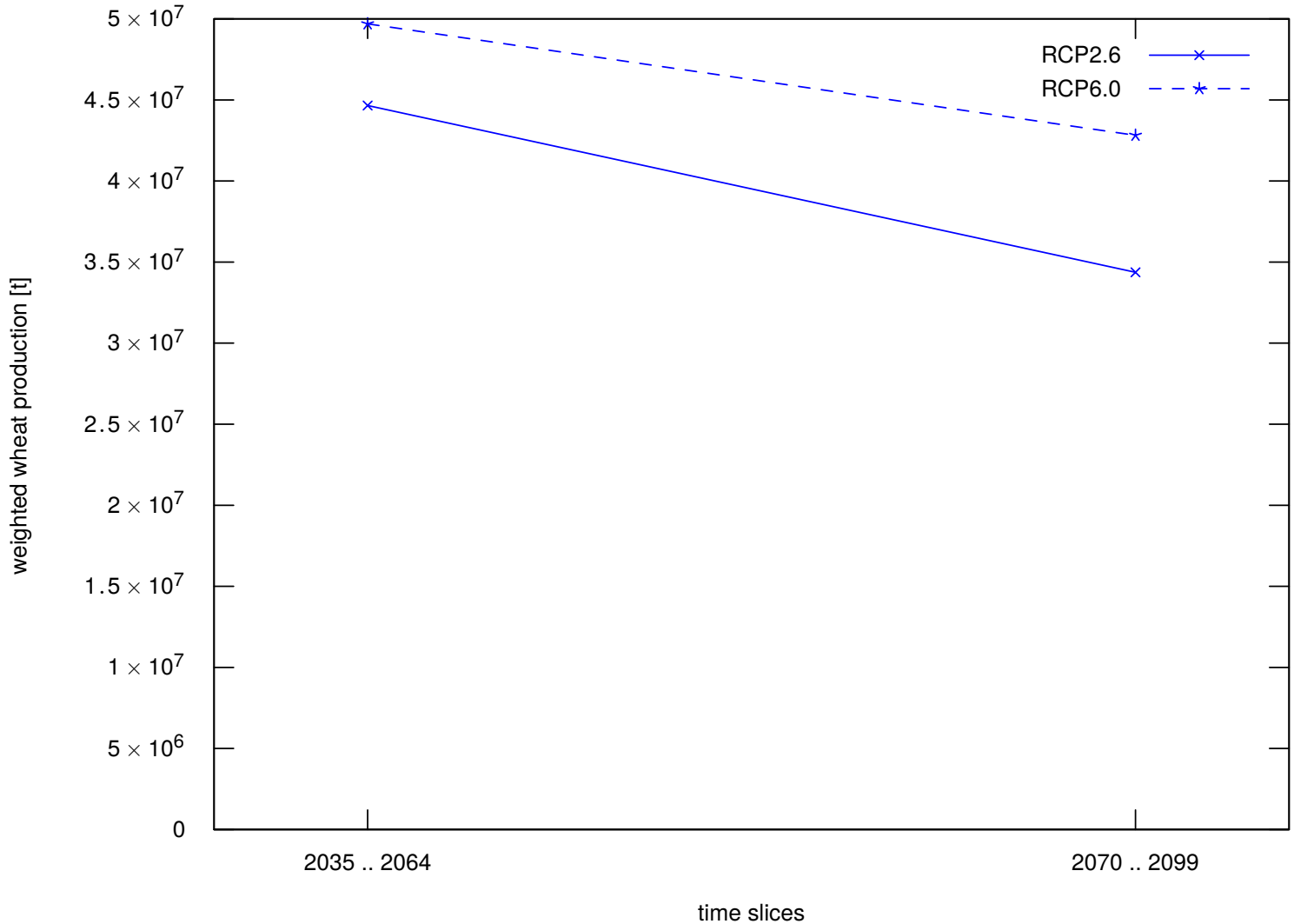
Wheat projection (annual production)



data points: mean of 3 crop models (GEPIC, LPJmL, PEPIC) driven by 4 climate models (GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC5)

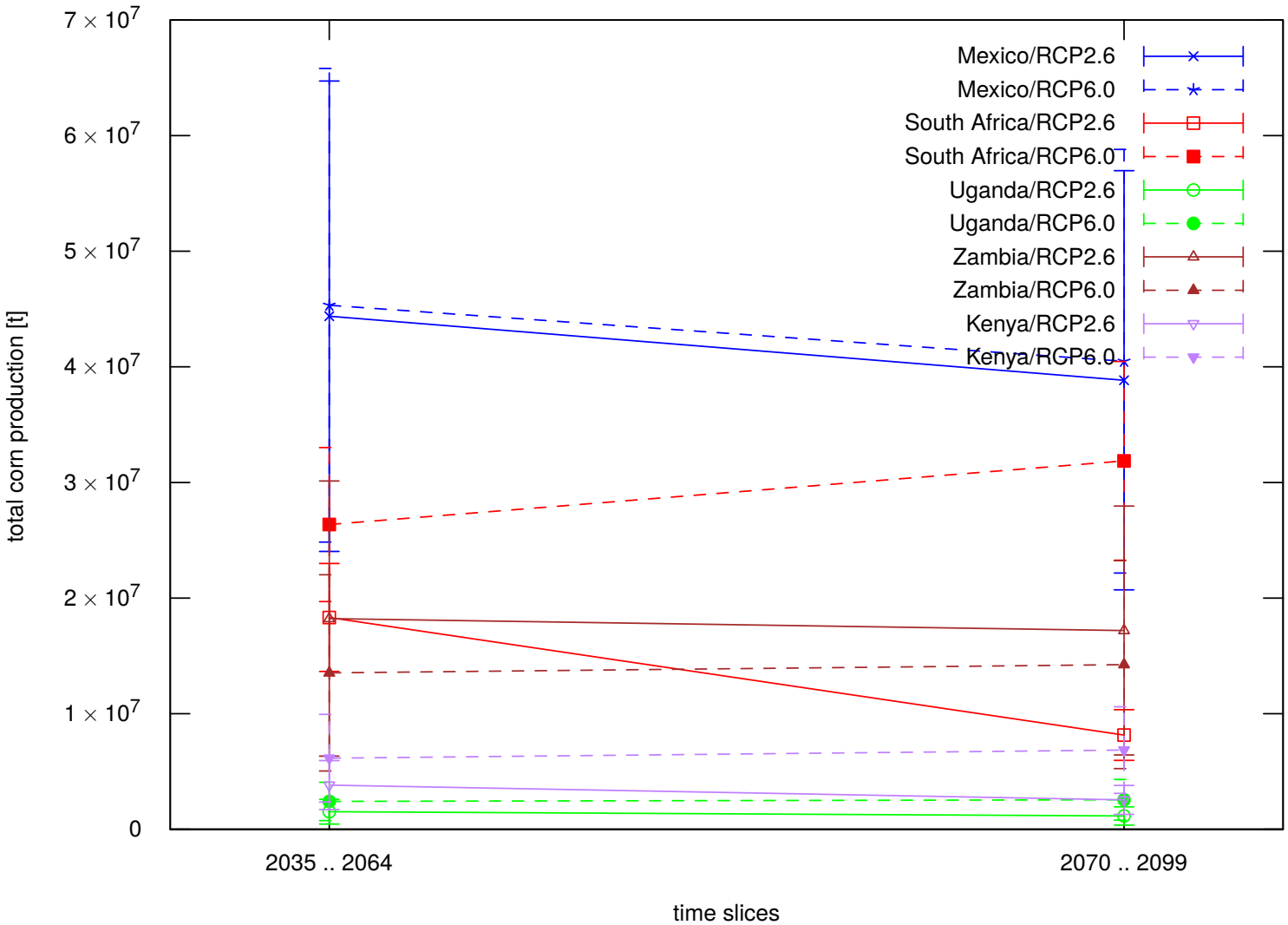
error bars: standard deviation across all climate model / crop model projections

Wheat projection (weighted annual production)



data points: weighted sum of countries' wheat production, weighted by their respective import share

Corn projection (annual production)



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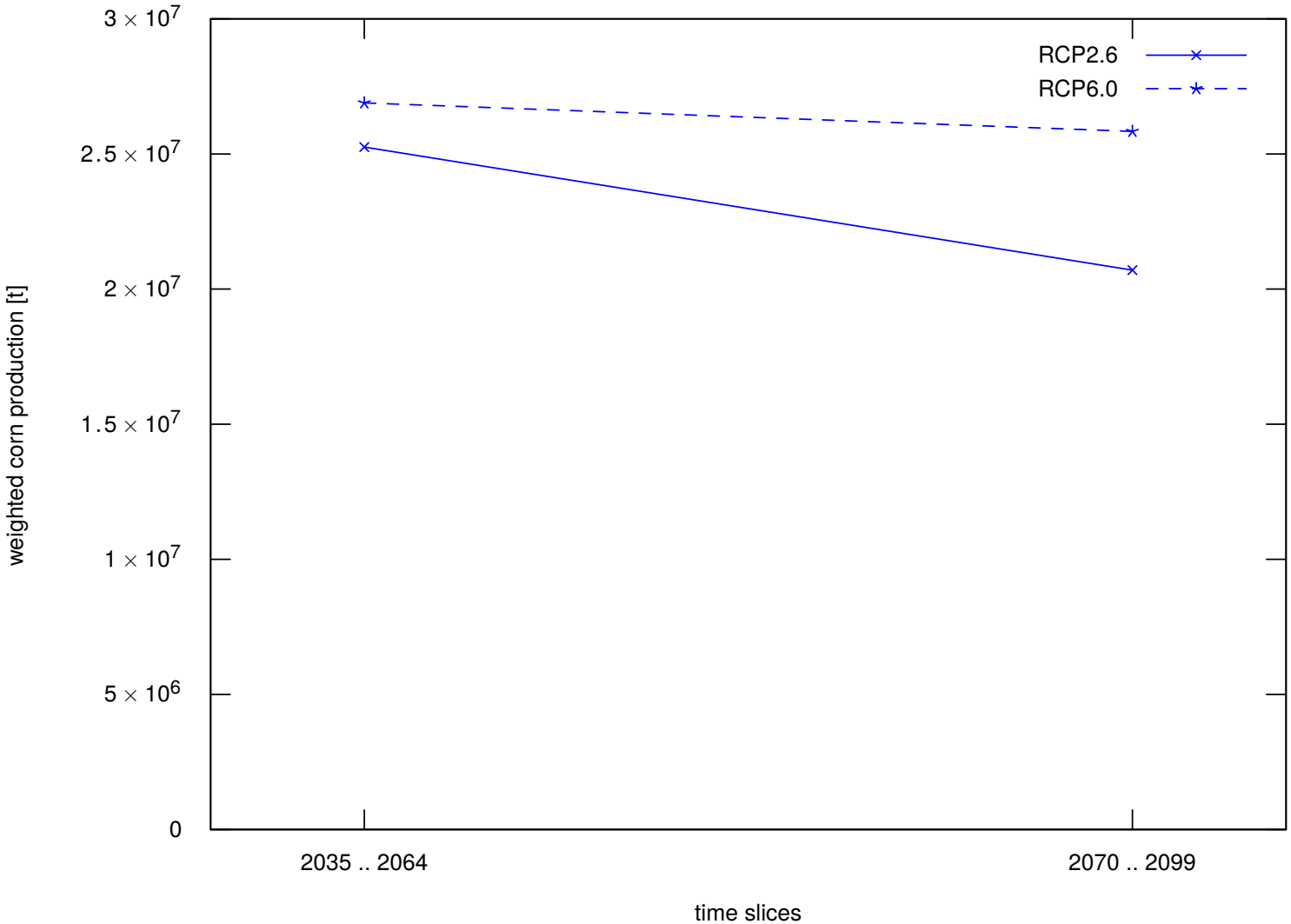
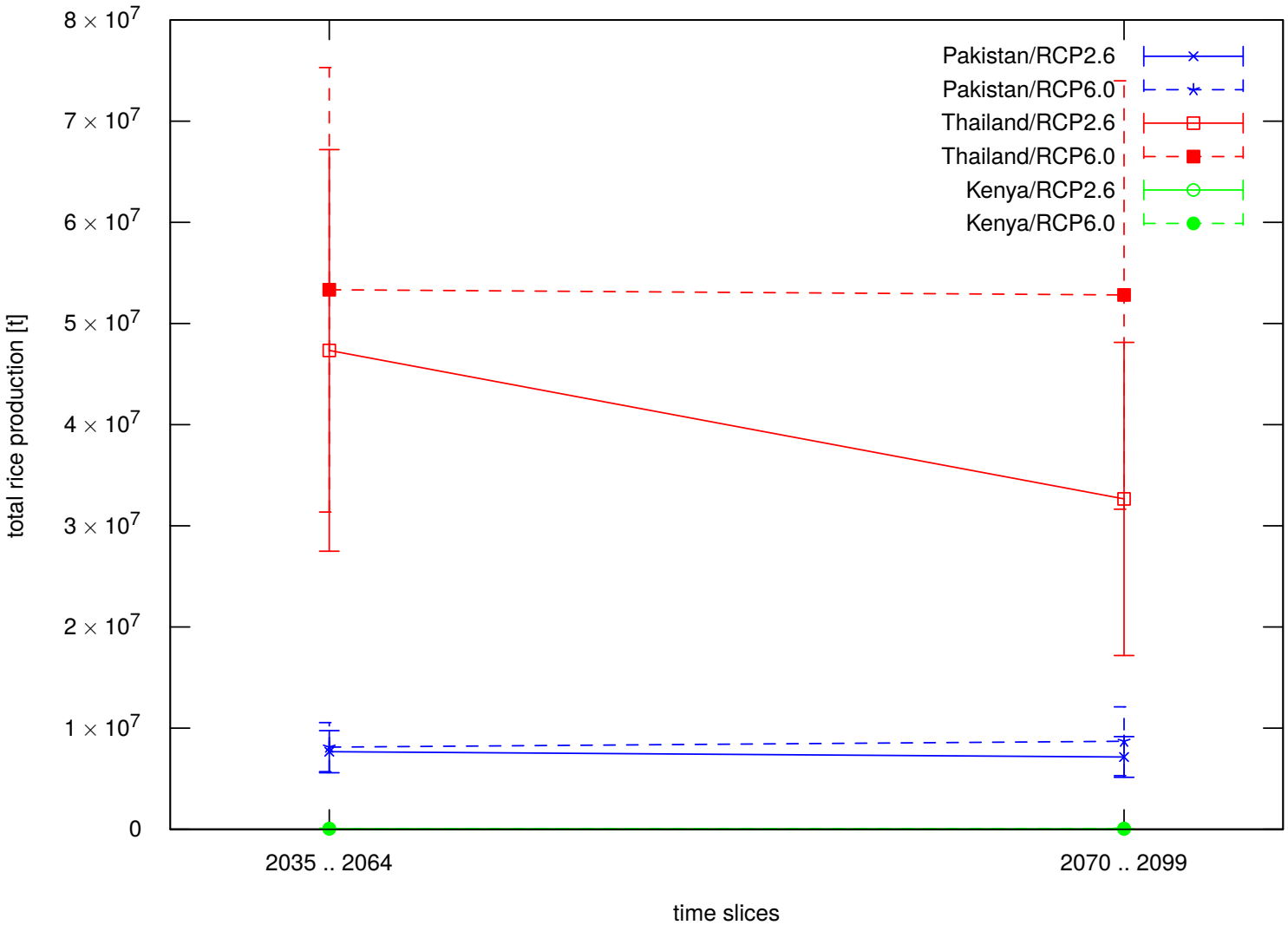


data points: weighted sum of countries' corn production, weighted by their respective import share

Rice projection (annual production)



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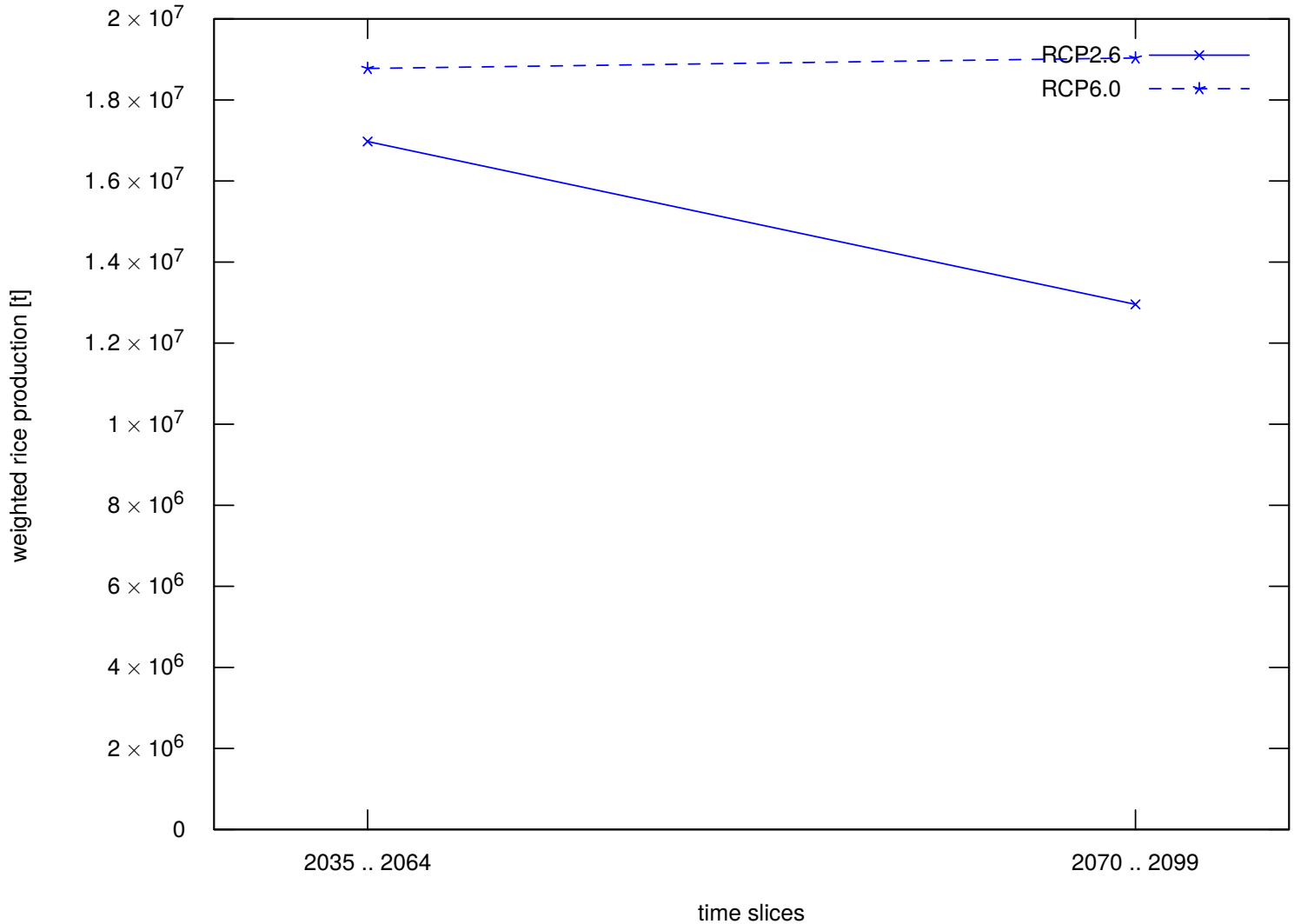


data points: weighted sum of countries' rice production, weighted by their respective import share

The socio-economic dimension (example Pakistan)

Population

current population (2015): 190 Mio
projected population

	min	max
2035 .. 2064	242 Mio	335 Mio
2070 .. 2099	230 Mio	483 Mio

Rice production per capita

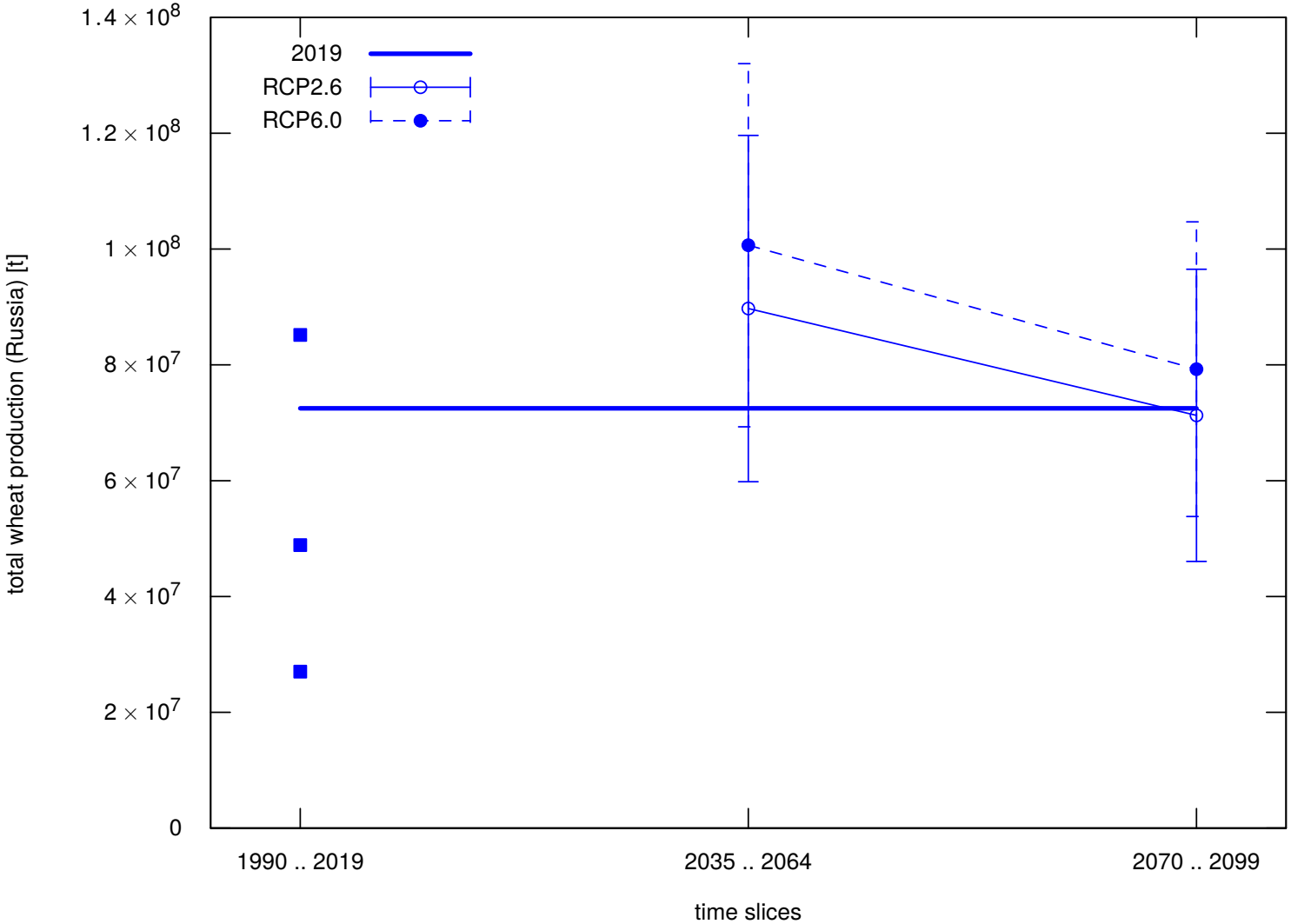
current rice production per capita (2019): 39.4 kg
projected rice production per capita

	RCP 2.6	RCP 6.0
2035 .. 2064	22.9 kg .. 31.7 kg	24.3 kg .. 33.6 kg
2070 .. 2099	14.8 kg .. 31.1 kg	18.0 kg .. 37.8 kg

Summary and conclusions

- in general, production decreases are expected for severe global warming in many parts of the world
- however, models also find increases in production, in particular for mid to high latitude regions at moderate global warming (which is what we looked at here)
- at moderate warming CO_2 fertilization appears to be the dominating effect

Wheat projection Russia (annual production)



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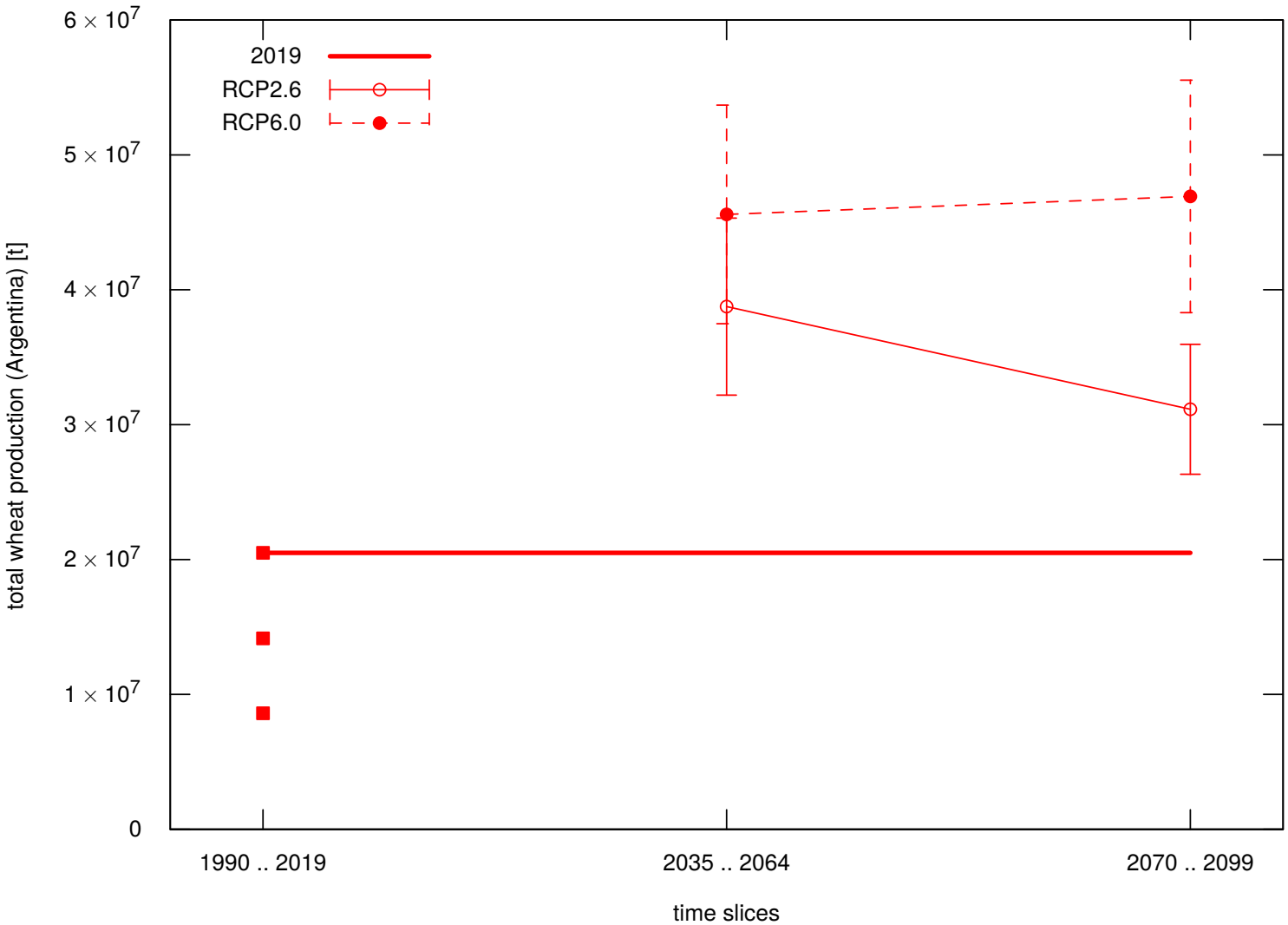
bold line: observed production in 2019

Wheat projection Argentina (annual production)



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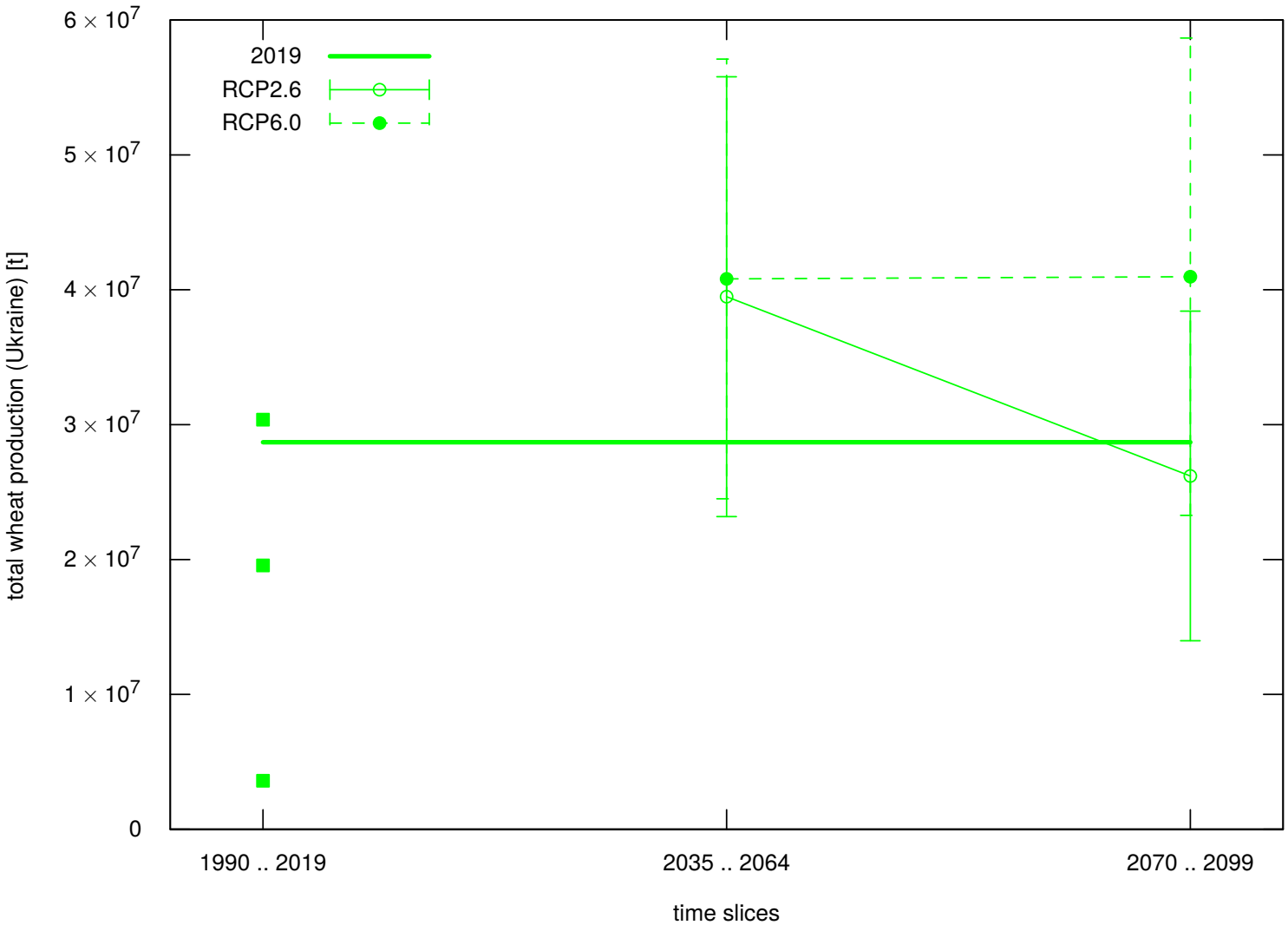
Wheat projection Ukraine (annual production)



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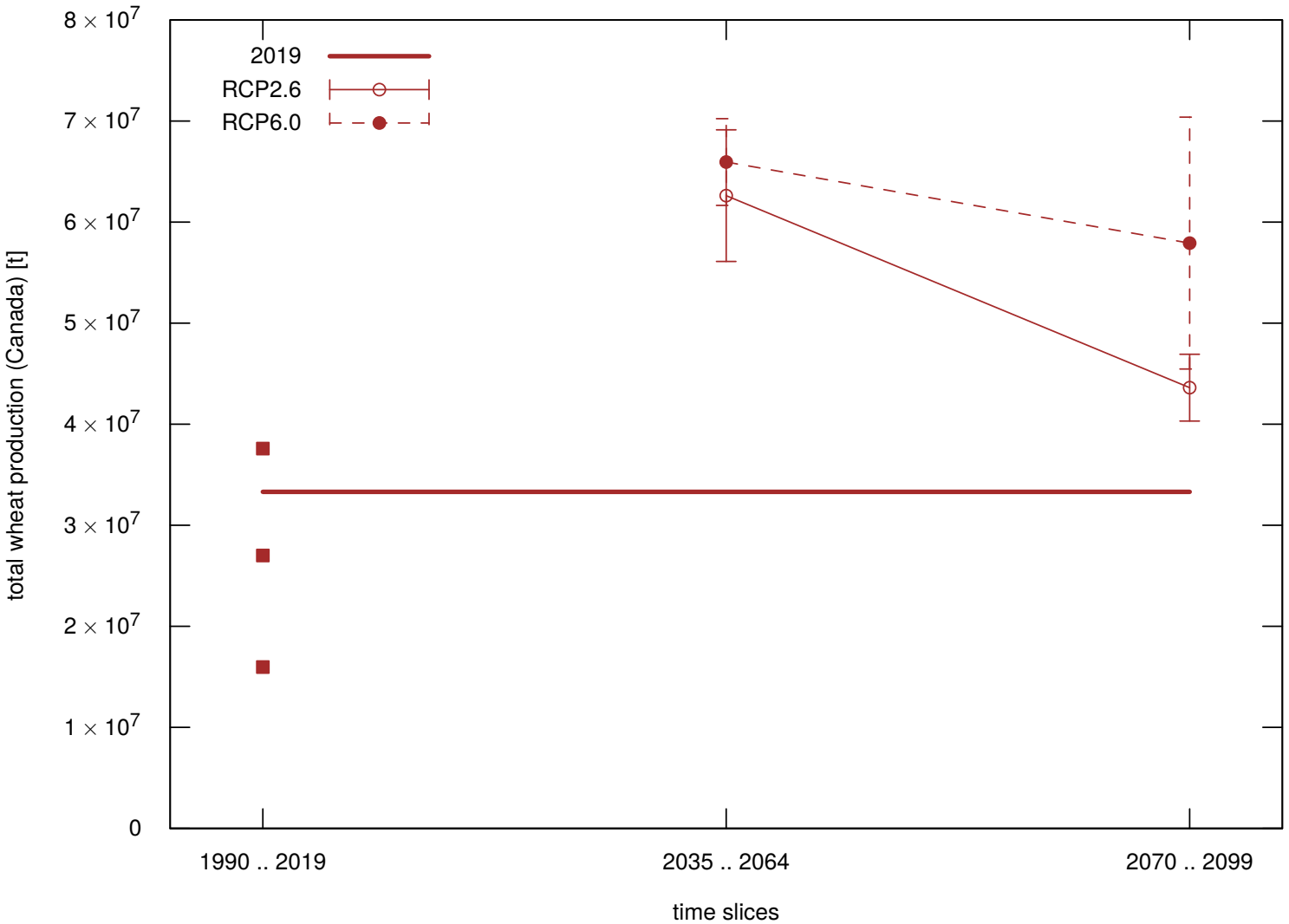
Wheat projection Canada (annual production)



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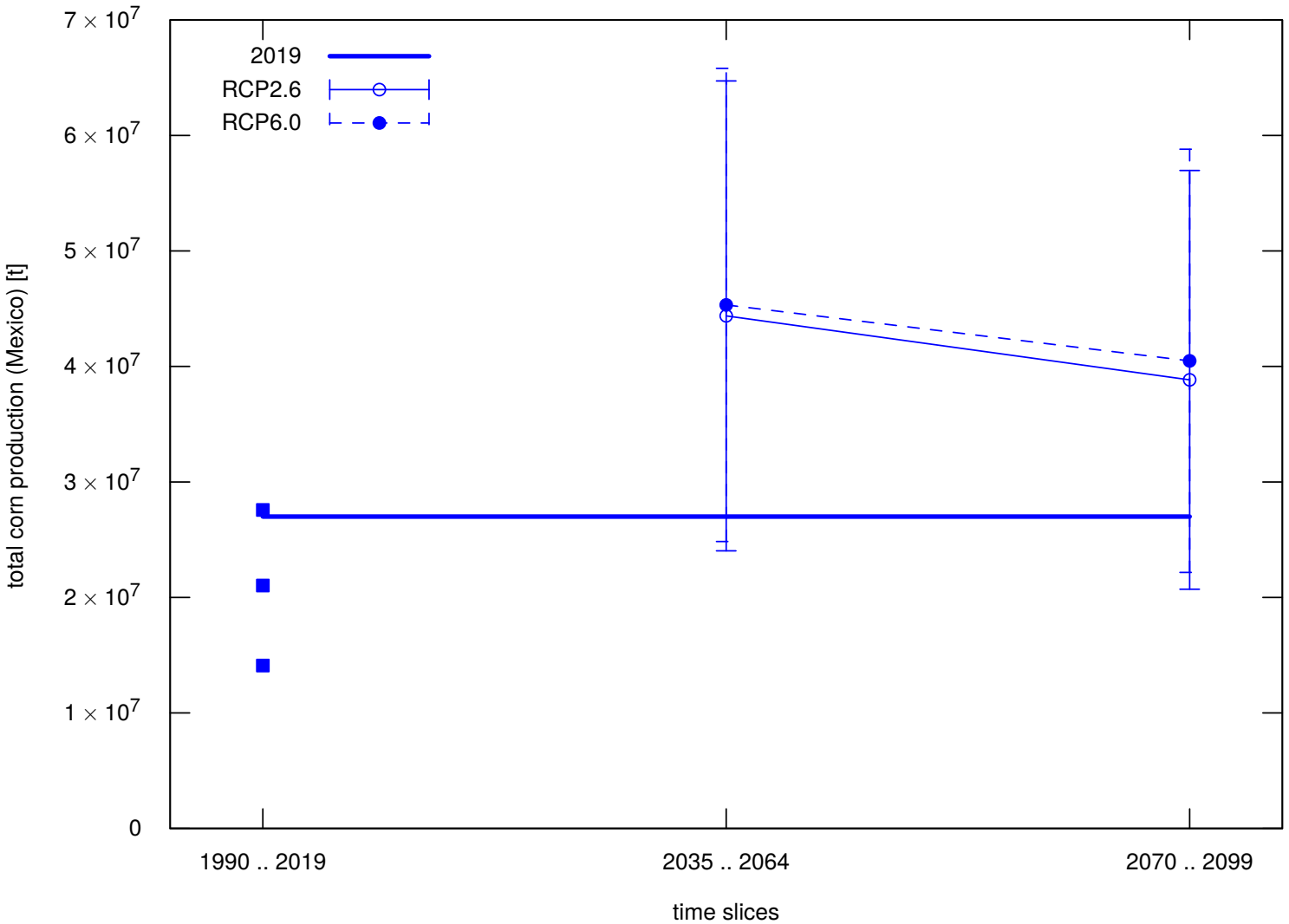
Corn projection Mexico (annual production)



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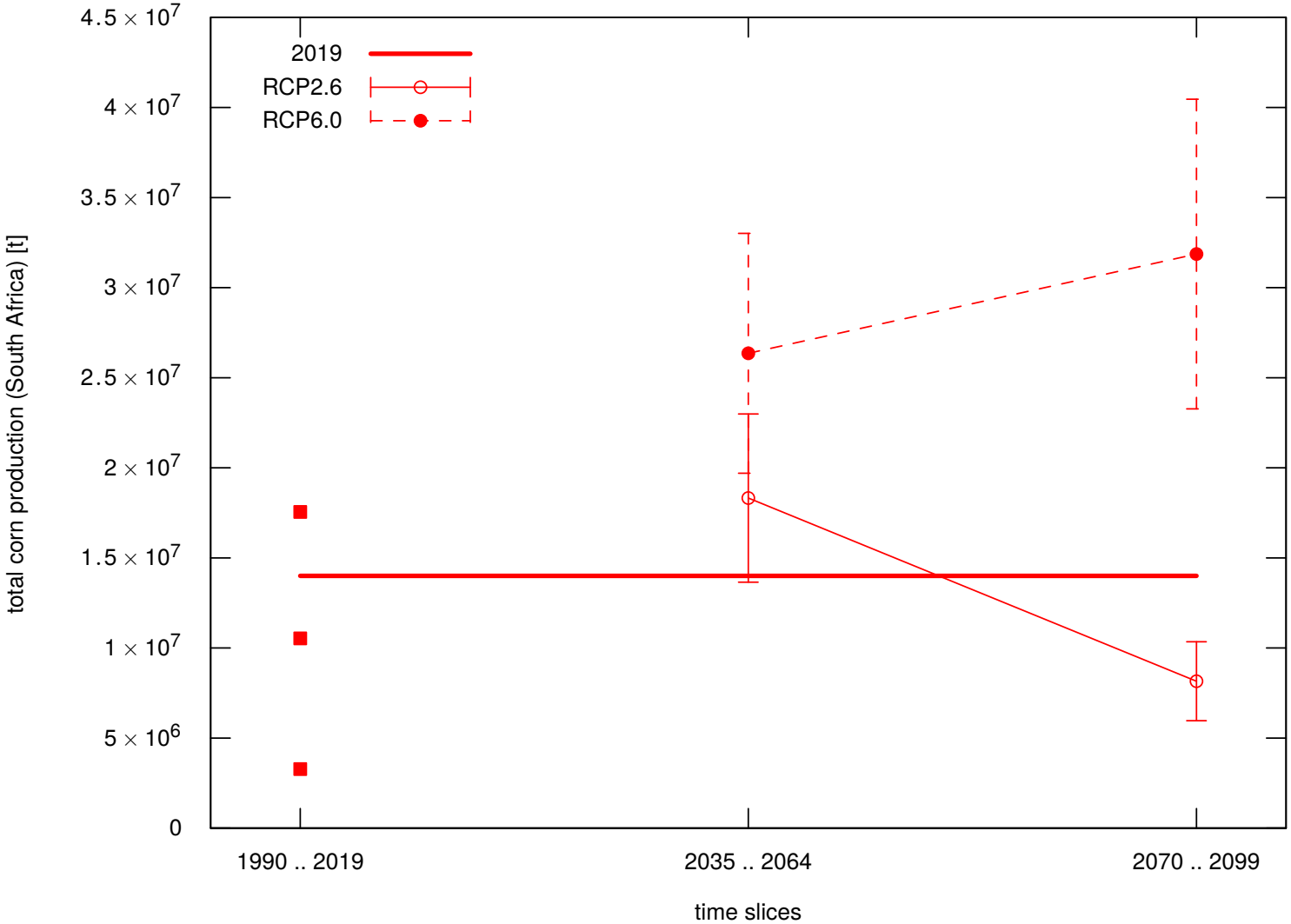
Corn projection South Africa (annual production)



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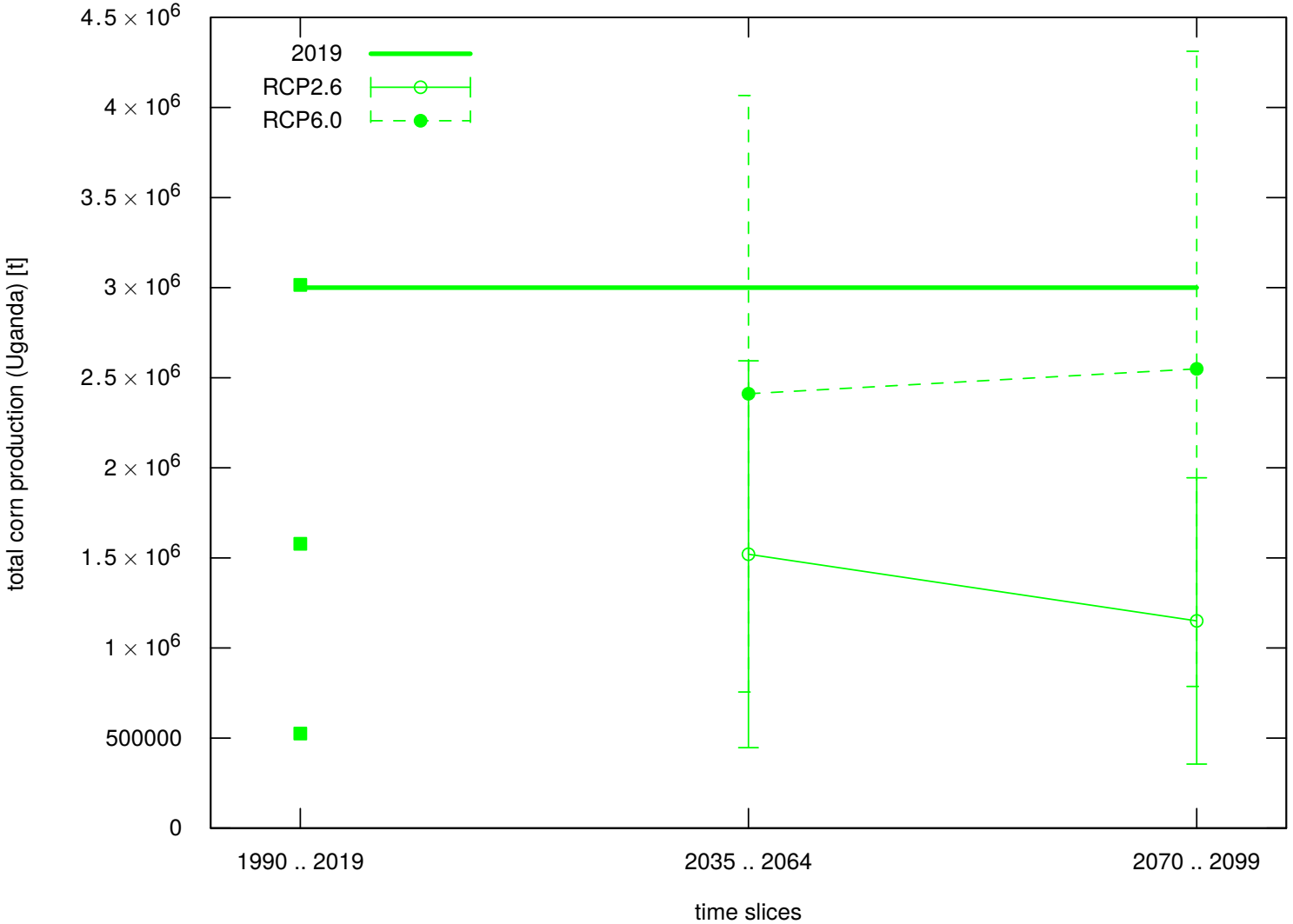
Corn projection Uganda (annual production)



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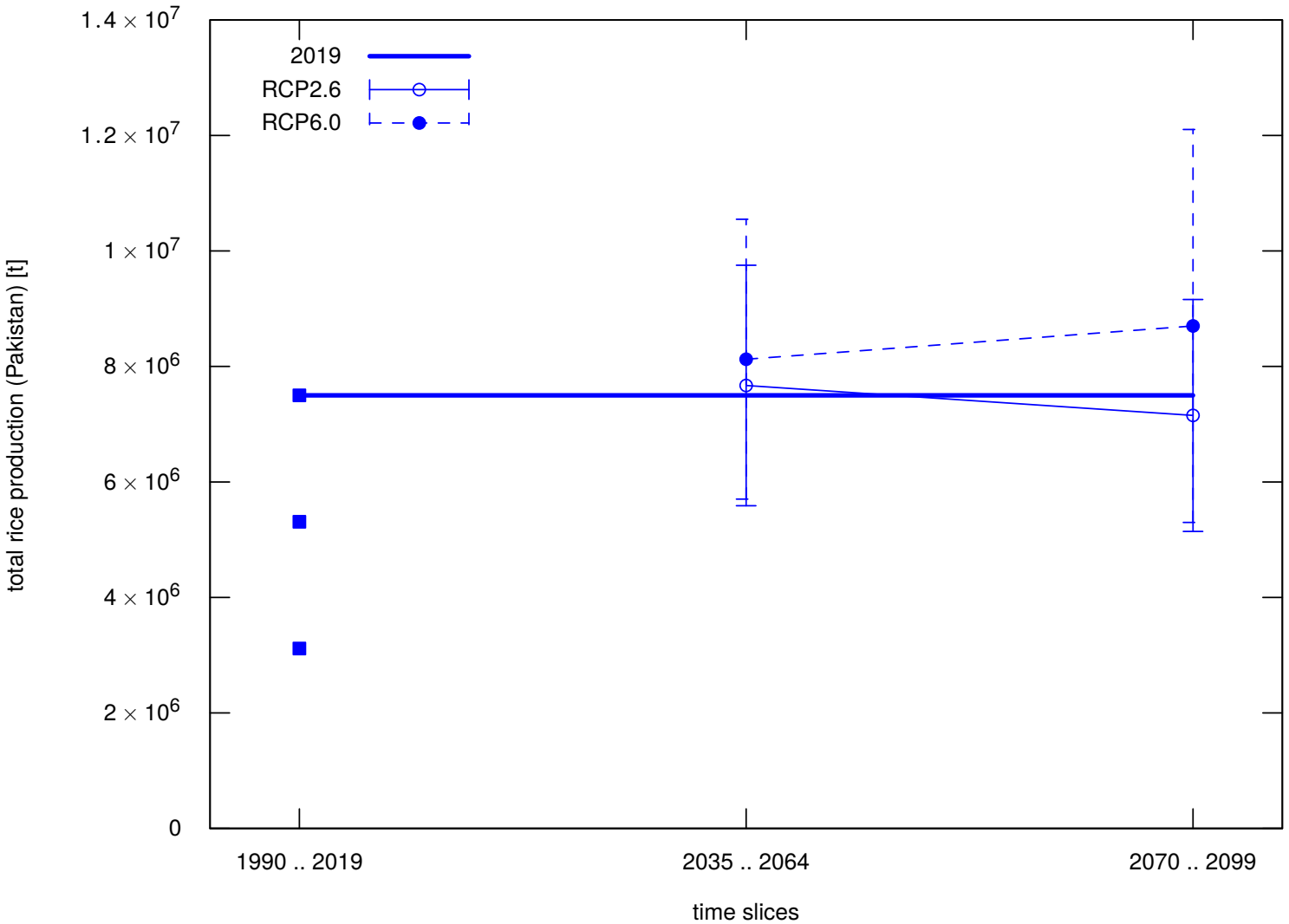
Rice projection Pakistan (annual production)



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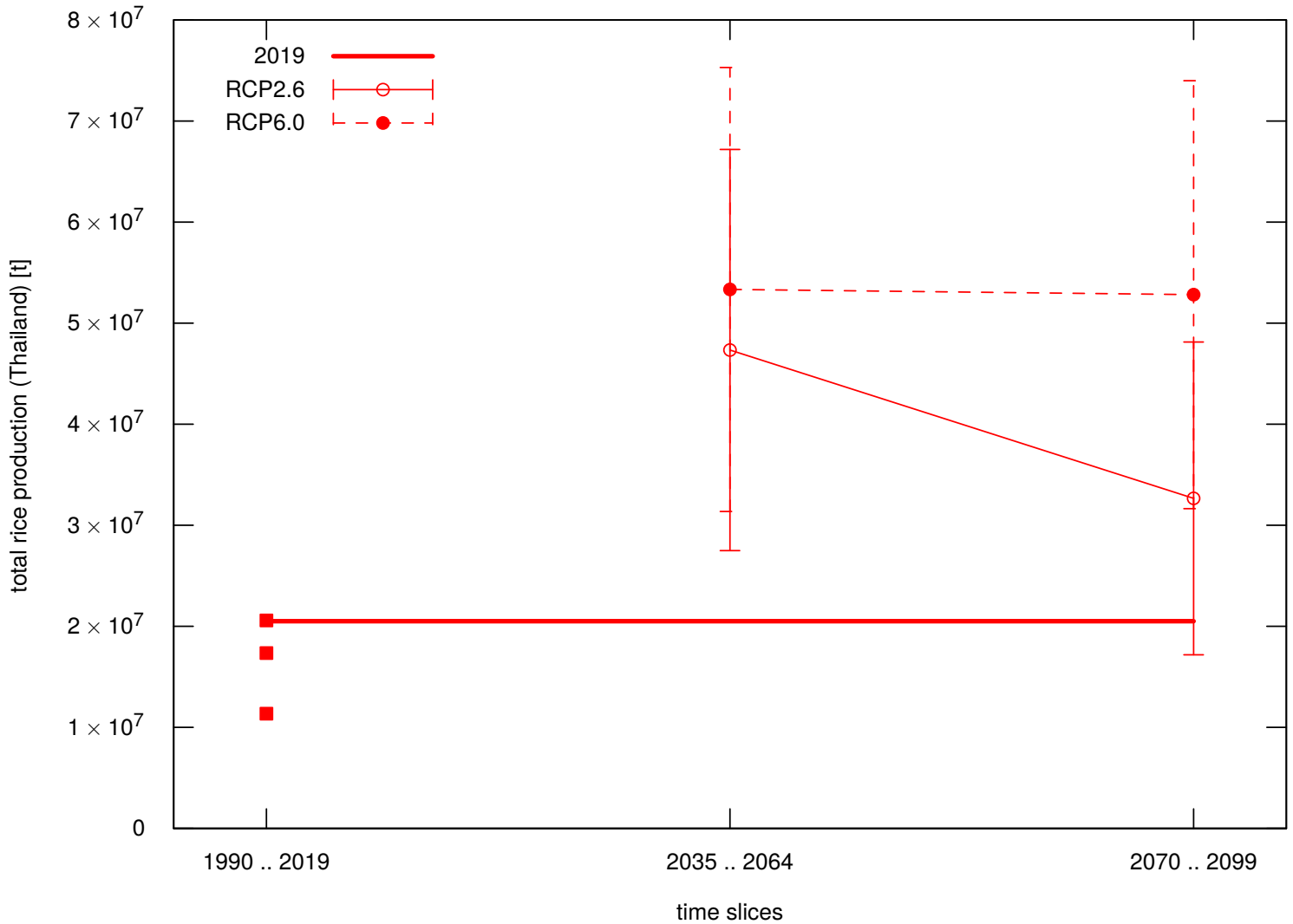
Rice projection Thailand (annual production)



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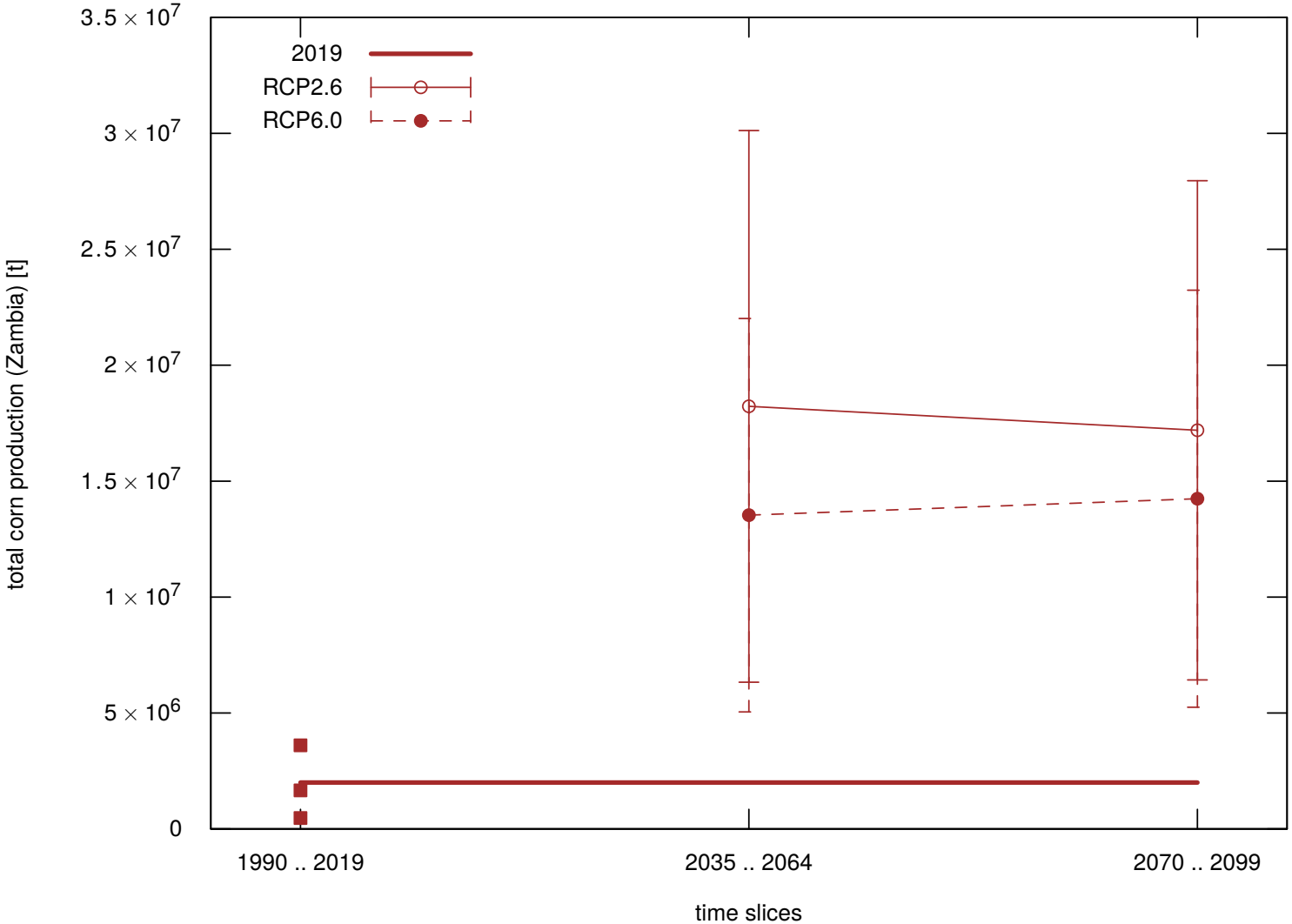
Corn projection Zambia (annual production)



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