Agricultural Institute of Slovenia

Assessing 'CO_2-warming-equivalent' emissions from Slovenian cattle production using GWP*

EAAP - Session 88 - "How the dairy sector copes with EU-Green deal"

Žan Pečnik (presenting author)**, Jože Verbič**
Agricultural Institute of Slovenia

Florence, 4 September 2024

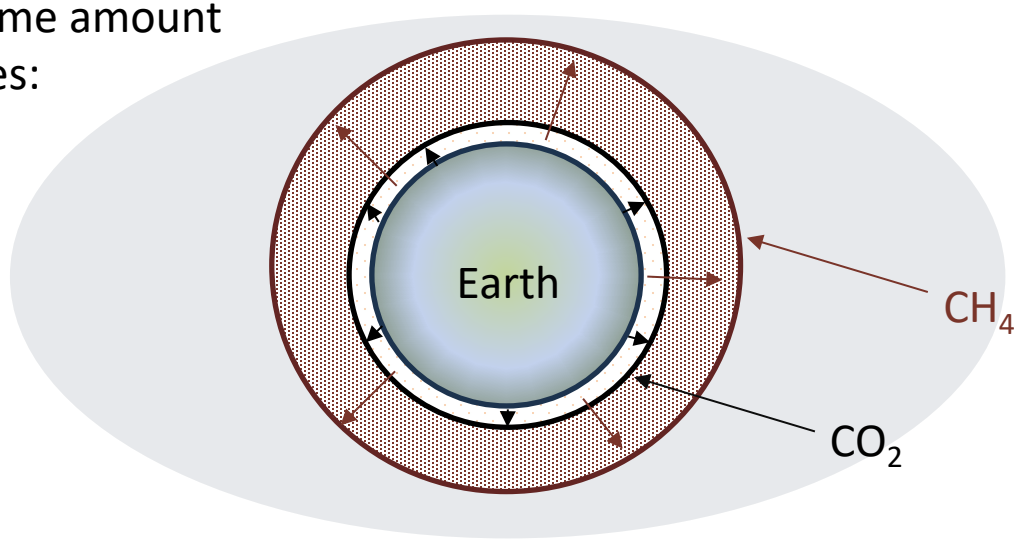
Introduction
Climate pollution

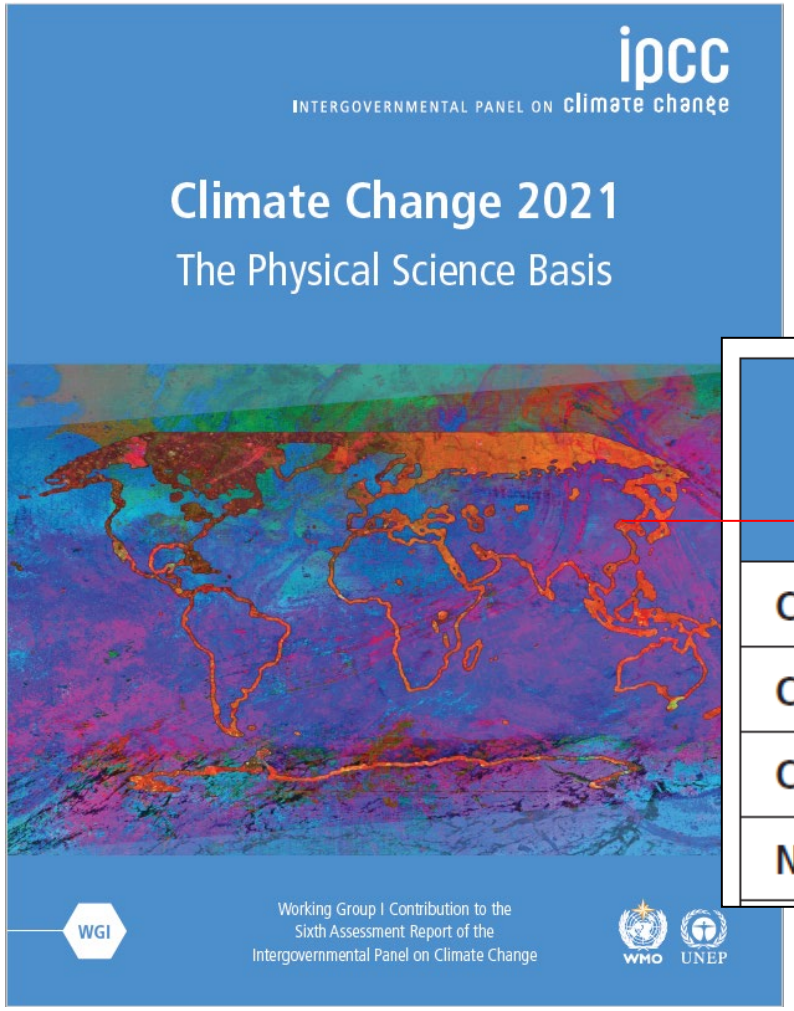
- Livestock farming, especially **cattle farming**, has been criticised for decades as a **climate polluter**
- Emissions of **methane** (CH_4) and **nitrous oxide** (N_2O)

Introduction

GHG emissions: global warming potential

The same amount of gases:



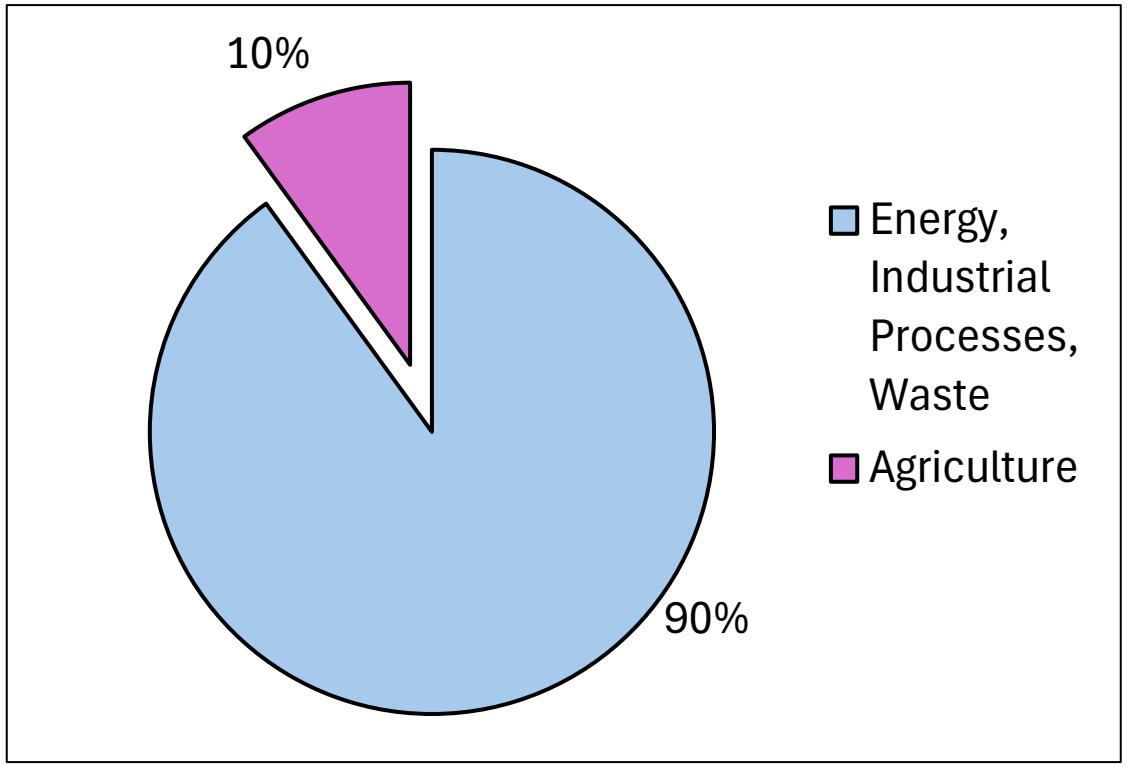


Species	Lifetime (Years)	Radiative Efficiency (W m^{-2} ppb^{-1})	GWP-20	GWP-100	GWP-500
CO_2	Multiple	$1.33 \pm 0.16 \times 10^{-5}$	1.	1.000	1.000
CH_4-fossil	11.8 ± 1.8	$5.7 \pm 1.4 \times 10^{-4}$	82.5 ± 25.8	29.8 ± 11	10.0 ± 3.8
CH_4-non fossil	11.8 ± 1.8	$5.7 \pm 1.4 \times 10^{-4}$	79.7 ± 25.8	27.0 ± 11	7.2 ± 3.8
N_2O	109 ± 10	$2.8 \pm 1.1 \times 10^{-3}$	273 ± 118	273 ± 130	130 ± 64

Table 7.15

Introduction

How we usually report the structure of GHG emissions: CO_2 equivalents

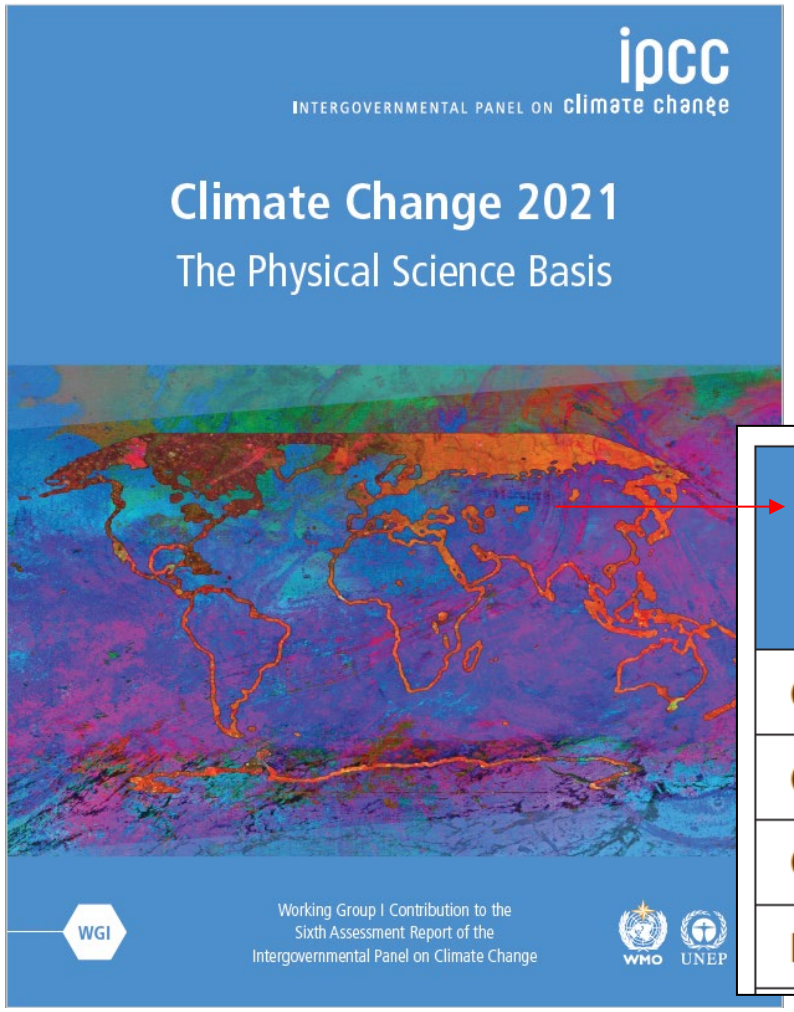


„For 10% of warming is responsible agriculture“.

<u>Inaccurate or unclear conclusions.</u>

Introduction

GHG emissions: lifetime



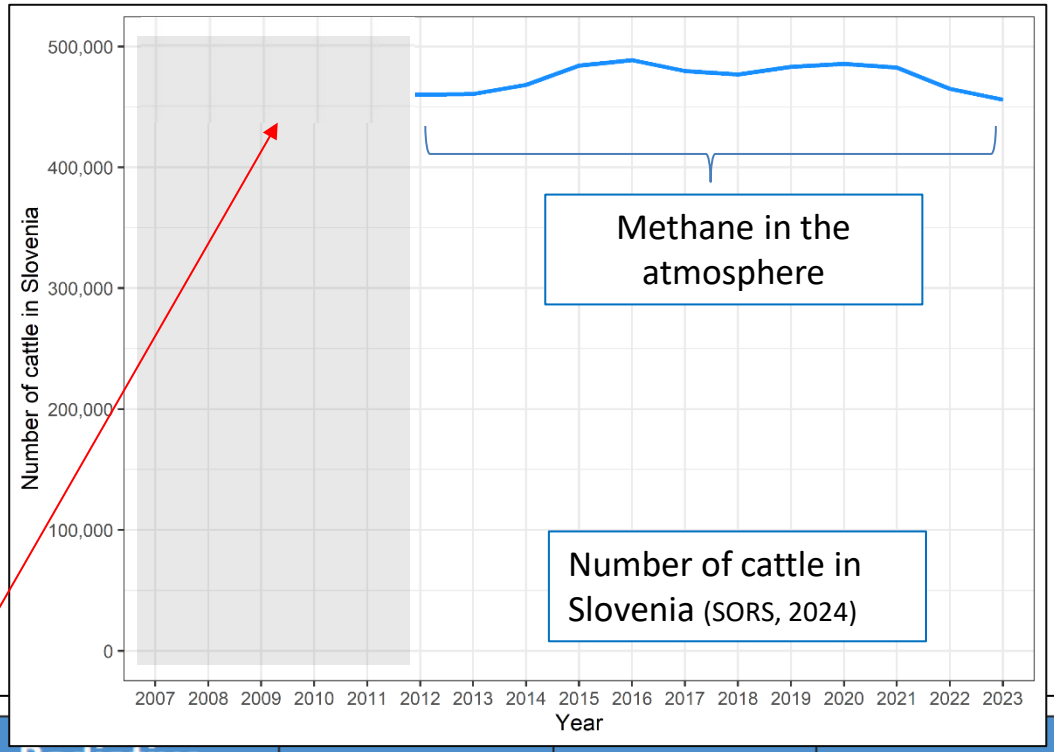


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Table 7.15

Introduction

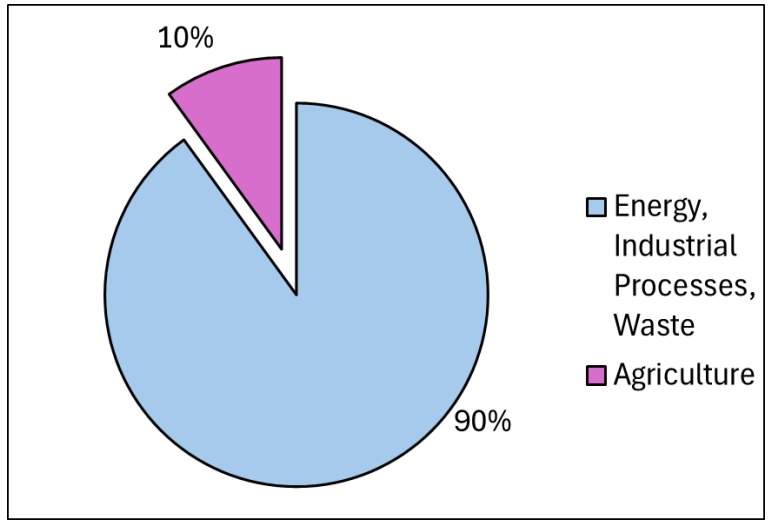
The Paris Agreement

„Article 2

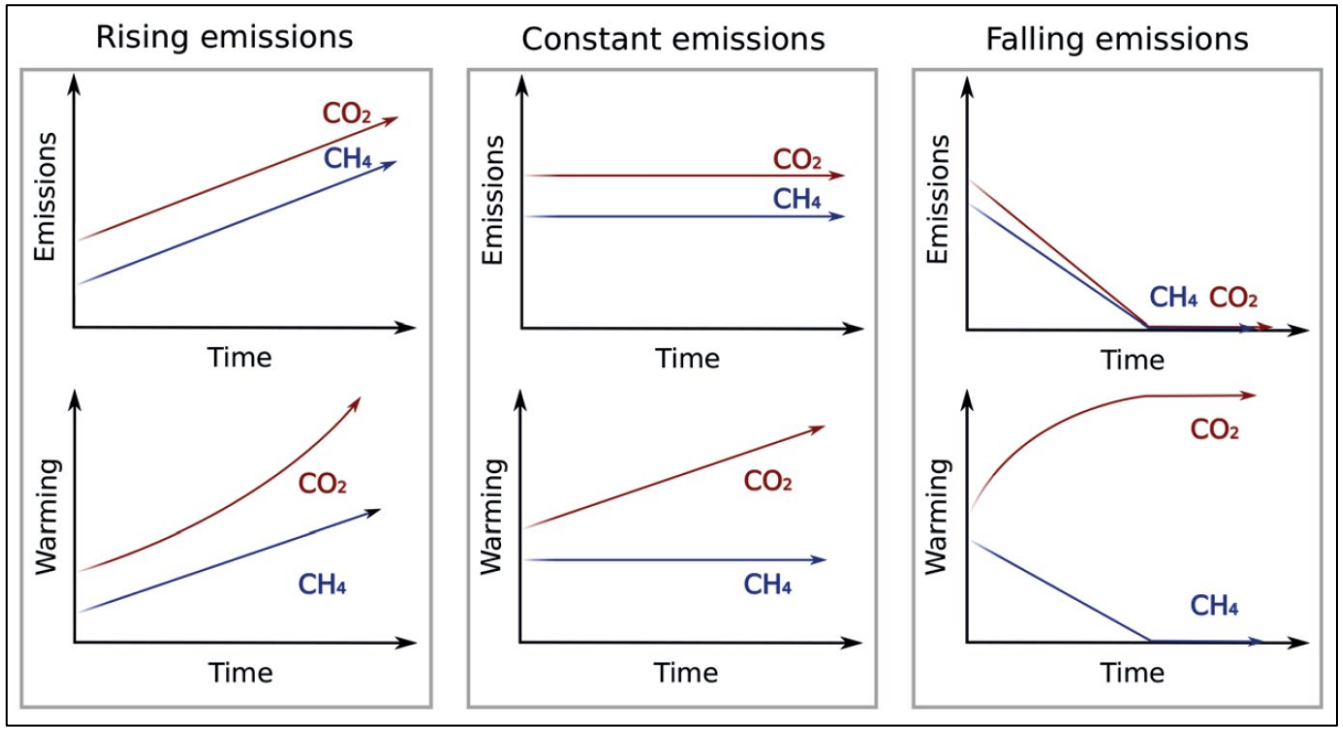
1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;“

≠ CO_2 equivalent emissions



How **temperature** responds differently **to cumulative** and **short-lived climate pollutants**



(Allen et al., 2017)

New use of global warming potentials to compare cumulative and short-lived climate pollutants

Myles R. Allen, Jan S. Fuglestvedt, Keith P. Shine, Andy Reisinger, Raymond T. Pierrehumbert & Piers M. Forster

Nature Climate Change **6**, 773–776 (2016) | Cite this article

npj | Climate and Atmospheric Science www.nature.com/npjclimatsci

ARTICLE OPEN

A solution to the misrepresentations of CO_2-equivalent emissions of short-lived climate pollutants under ambitious mitigation

Myles R. Allen[1,2], Keith P. Shine[3], Jan S. Fuglestvedt[4], Richard J. Millar[1], Michelle Cain[1,5], David J. Frame[6] and Adrian H. Macey[7]

ARTICLE OPEN

Improved calculation of warming-equivalent emissions for short-lived climate pollutants

Michelle Cain[1,2], John Lynch[3], Myles R. Allen[1,3], Jan S. Fuglestvedt[4], David J. Frame[5] and Adrian H Macey[6,7]

MATTERS ARISING OPEN

Check for updates

Further improvement of warming-equivalent emissions calculation

M. A. Smith[1,2], M. Cain[1,3] and M. R. Allen[1,2]

- **CO_2 (=LLCP)** accumulates
  CH_4 (=SLCP) is broken down
- **Declining CH_4 emissions for 3% per decade= net zero warming-equivalent emissions**

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GWP* usage in animal science

some examples

Beginnings of GWP*

2021

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Short communication: climate impact of Australian livestock production assessed using the GWP* climate metric

Bradley Ridoutt [a,b]

2022

Journal of Dairy Research

cambridge.org/dar

Research Article

Cite this article: del Prado A, Manzano P and

The role of the European small ruminant dairy sector in stabilising global temperatures: lessons from GWP* warming-equivalent emission metrics

Agustin del Prado[1], Pablo Manzano[1,2,3] and Guillermo Pardo[1]

J. Dairy Sci. 105:8558–8568

https://doi.org/10.3168/jds.2021-21413

Symposium review: **Defining a pathway to climate neutrality for US dairy cattle production***

S. E. Place,[1] C. J. McCabe,[2] and F. M. Mitloehner[2]†

Liu *et al. CABI Agric Biosci* (2021) 2:22

https://doi.org/10.1186/s43170-021-00041-y

CABI Agriculture and Bioscience

RESEARCH

Open Access

Rethinking methane from animal agriculture

Shule Liu, Joe Proudman and Frank M. Mitloehner*

2023

Contents lists available at ScienceDirect

Animal

The international journal of animal biosciences

Animal board invited review: Opportunities and challenges in using GWP* to report the impact of ruminant livestock on global temperature change

A. del Prado [a,b,*], J. Lynch [c], S. Liu [d], B. Ridoutt [e,f], G. Pardo [a], F Mitloehner [d]

2024

ITALIAN JOURNAL OF ANIMAL SCIENCE

2024, VOL. 23, NO. 1, 1002–1017

https://doi.org/10.1080/1828051X.2024.2373211

Taylor & Francis

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RESEARCH ARTICLE

OPEN ACCESS

Thirty years of global warming potential evolution for the Italian dairy cow sector measured by two different metrics

Marco Berton, Giovanni Bittante, Enrico Sturaro and Luigi Gallo

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Choice of metrics matters—Future scenarios on milk and beef production in Norway using an LCA approach

Stine Samsonstuen [a,b,*], Hanne Møller [b], Borgar Aamaas [c], Marie Trydeman Knudsen [d], Lisbeth Mogensen [d], Hanne Fjerdingby Olsen [a]

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Aim of this study

To calculate and compare the CH_4 emissions from Slovenian cattle production using CO_2-eq under GWP_{100} and CO_2-w.e. under GWP*.

Materials and Methods

CH_4 emission (kT CO_2-eq) calculation:

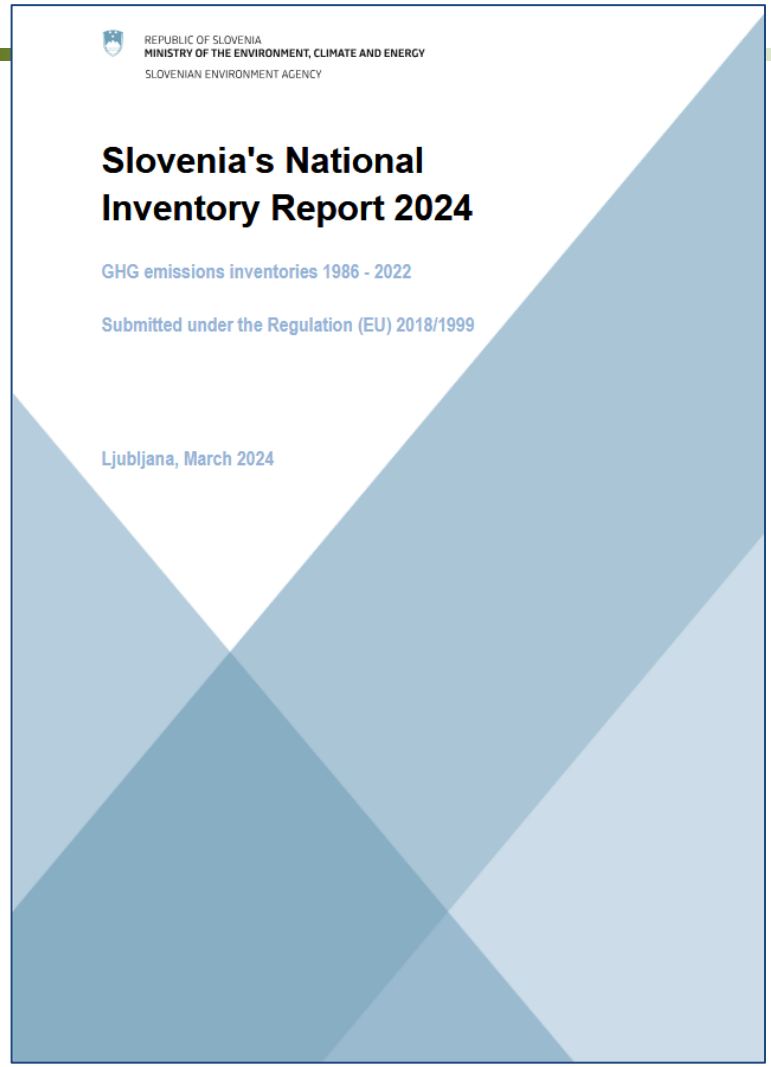


Table 5.1.1: Methods, EFs used and key categories indications for the year 2022 in the Agriculture sector.

	CO_2			CH_4			N_2O		
	Method	**EF**	**Key cat.**	**Method**	**EF**	**Key cat**	**Method**	**EF**	**Key cat**
3.A Enteric Fermentation	NA	NA	NA	T1, T2	CS, D	L, T	NA	NA	NA
3.B Manure Management	NA	NA	NA	T1, T2	CS, D	L,	T1, T2	CS, D	L

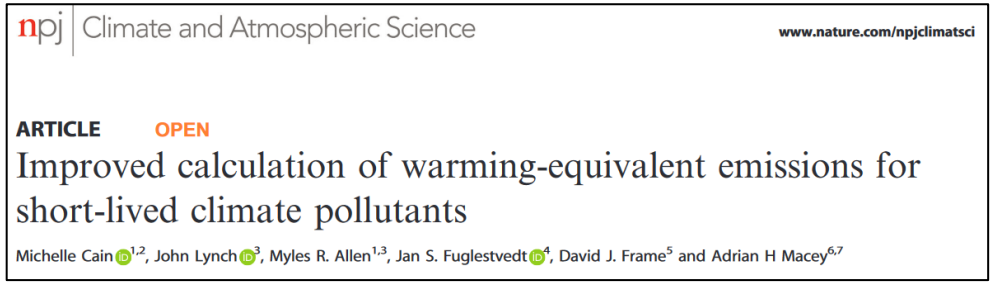
Table 5.2.1: The correspondence between statistical and IPCC categories

IPCC	SORS
Dairy cattle	**Dairy cows over 2 years**
Other cows (suckler-cows)	**Other cows over 2 years**
Non-dairy cattle	**All other cattle**
Non-dairy cattle	**YOUNG CATTLE – under 1 year** calves for slaughter- young bulls calves for slaughter - young heifers calves for fattening - young bulls calves for fattening - young heifers **YOUNG CATTLE – 1 -2 years** breeding heifers in calf other breeding heifers heifers for fattening bulls, oxen **CATTLE – over 2 years** breeding heifers in calf other breeding heifers heifers for fattening bulls for breeding bulls and oxen for fattening

- The **IPCC** and **EMEP/EEA** guidelines, adjusting **Tier 2** to the Slovenian conditions
- CO_2 equivalence from the Fifth Assessment Report (GWP_{100} factors: **28 for CH_4 and 265 for N_2O**)

Materials and Methods

Assesing ‚CO_2-warming-equivalent' emissions



We applied Cain et al. (2019) **GWP* model** on
the total CH_4 **emissions** (kT CO_2 -eq) **between 1985 and 2022:**

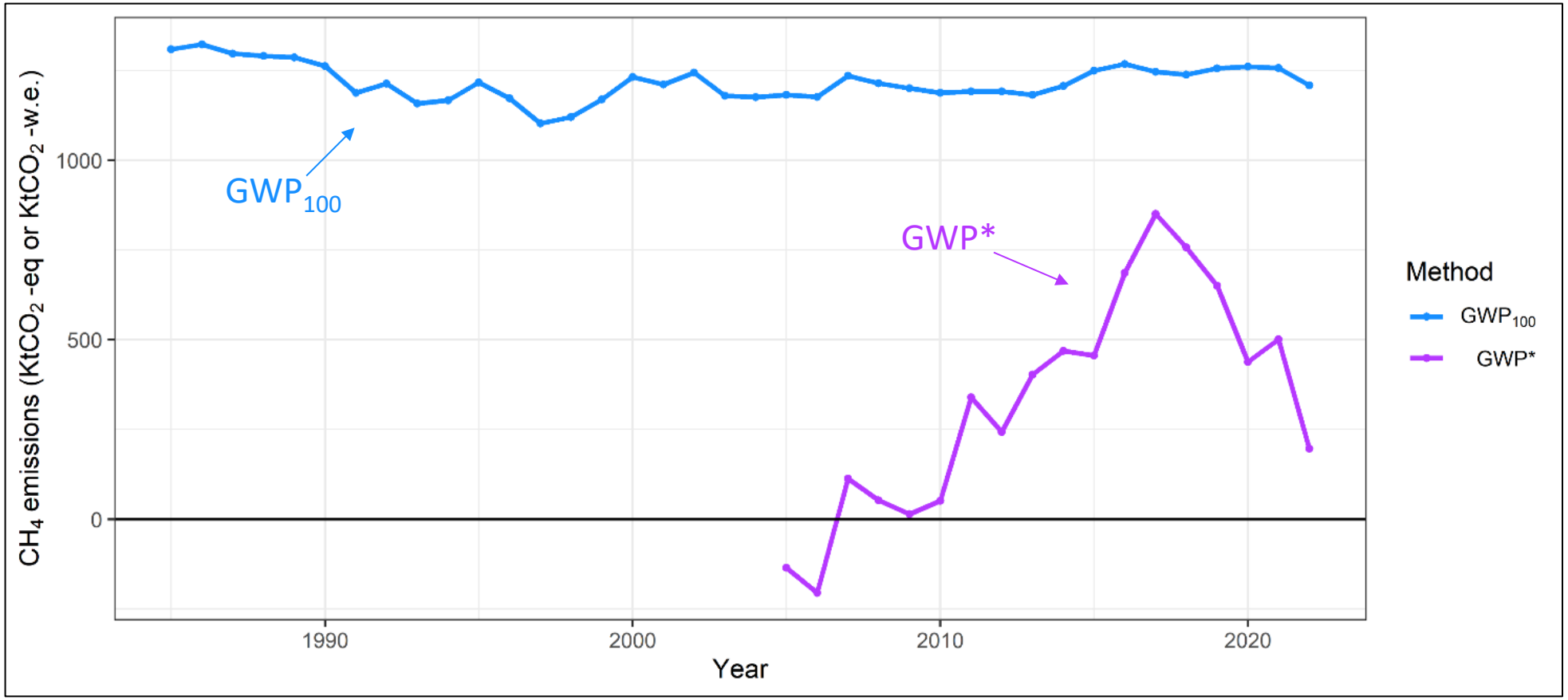
$$E^*_{CO_{2-we}}(t) = 4\ x\ E_{CH_4}(t) - 3.75\ x\ E_{CH_4}(t-20)$$

= CH_4 from **enteric fermentation** and
manure management

Results

Emissions trends (GWP_{100} vs GWP*)

A) Cattle production (total)

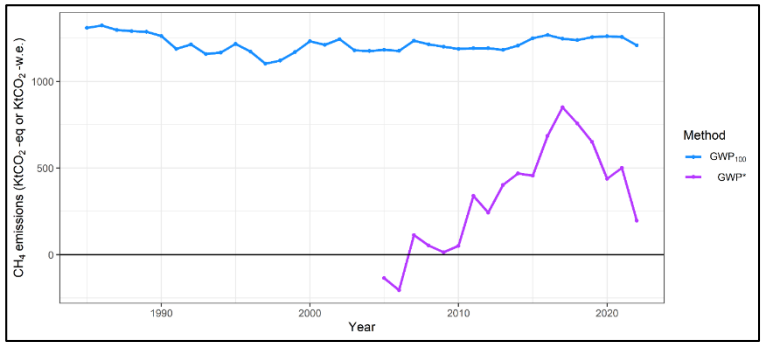


- Average GHG emissions from cattle production (2018-2022) amounted to **1,245 kT CO_2-eq and 509 kT CO_2-w.e.**

Results

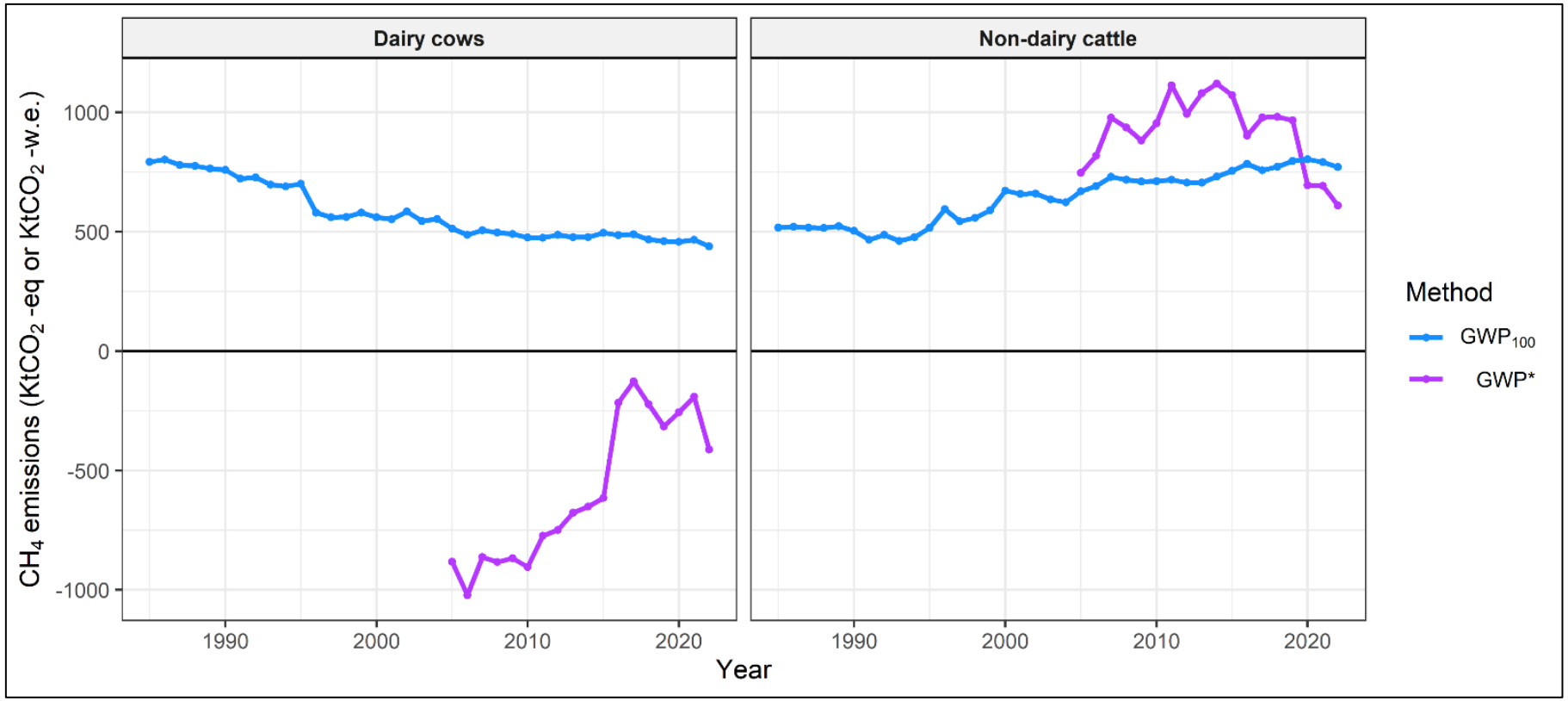
Emissions trends (GWP_{100} vs GWP*)

A) Cattle production (total)



- The **dairy cow**: **a 'cooling' effect**
- The **non-dairy cattle** : **a 'warming' effect**
  - with dairy cows averaging 458 kT CO_2-eq and -279 kT CO_2-w.e. and
  - non-dairy cattle 787 kT CO_2-eq and 788 kT CO_2-w.e
- **The trend** of CO_2-w.e. between 2018 and 2022 **was negative** in all cattle categories

B) Dairy cows and Non-dairy cattle



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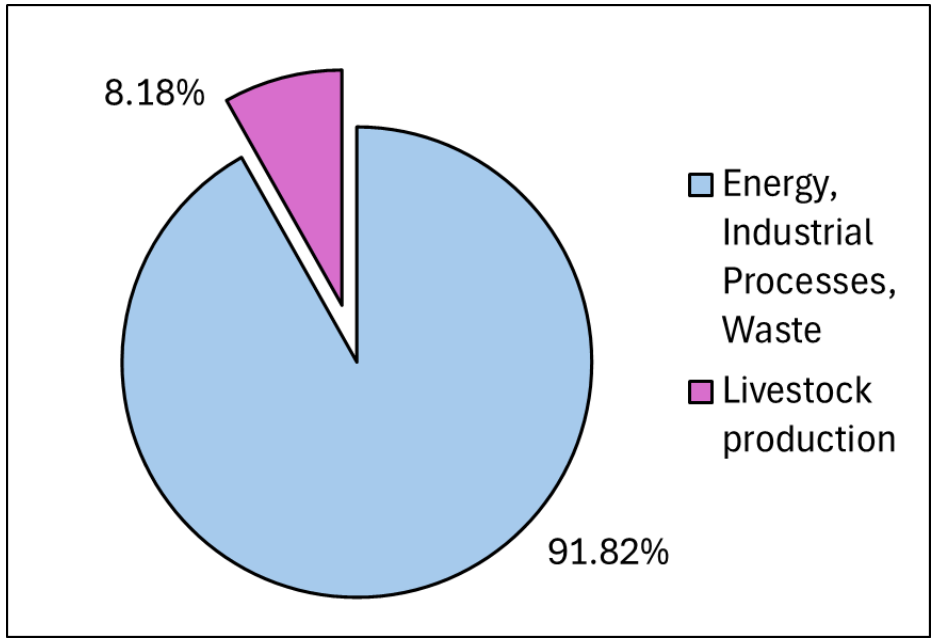
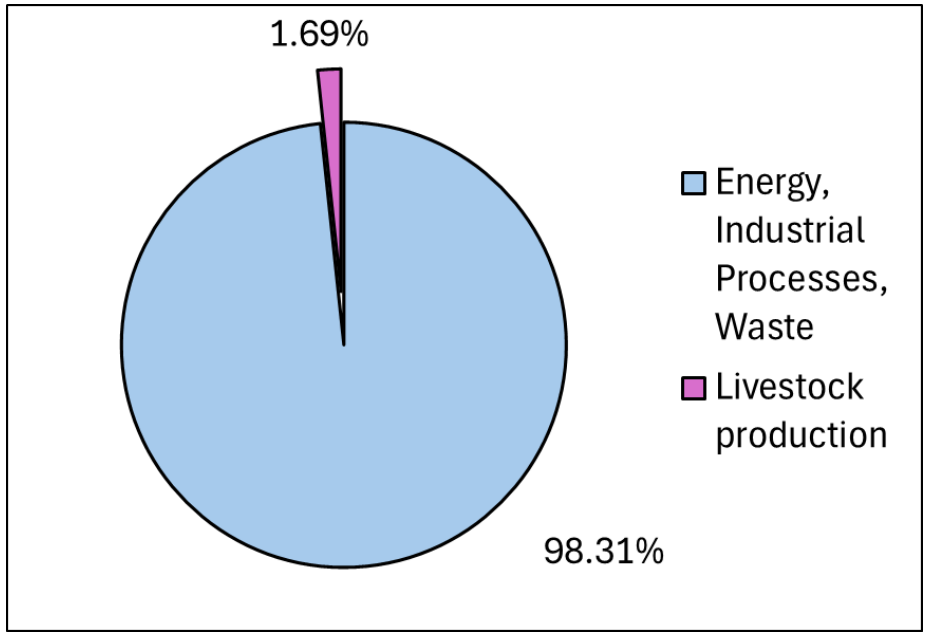
Results

Total emissions[+] (GWP_{100} vs GWP*; average 2018-2022)

A) GWP_{100}



B) GWP*



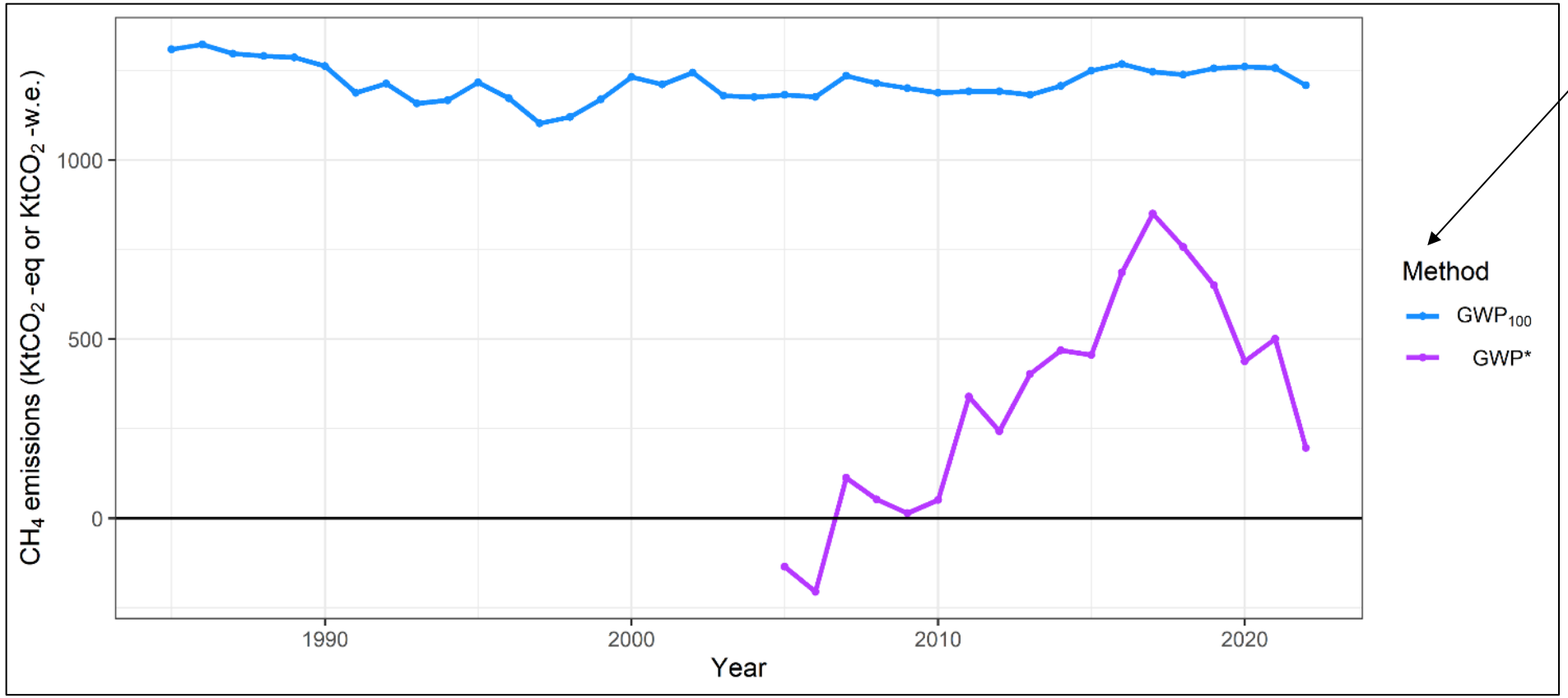
- [+]All anthropogenic emissions in Slovenia when calculated using GWP_{100} and GWP*
- **Overestimation of the climate** impact of **Slovenian** livestock production **by 4.84** times between **2018 and 2022 using GWP_{100} .**

Discussion

Emissions trends (GWP_{100} vs GWP*)

„By comparison expressing methane emissions as CO_{100} equivalent emissions using GWP_{100} overstates the effect of constant methane emissions on global surface temperature by a factor of 3–4„

IPCC (2021), explanation: Lynch et al. (2020)



Discussion

Emissions trends (GWP_{100} vs GWP*)

Knowledge gaps and further work

For more successful advisory and implementation of methane mitigation measures

- **Further identification** of cattle subpopulations with actual '**warming**' effect per:
  - category,
  - breed,
  - geographic region or
  - distinct farms within regions
- **GWP***: more emphasis on the **% of emission change per year** (because of annual differences)
- **GWP*:** scenario simulation

so „How does the dairy sector cope with EU-Green deal“ ?

Take home messages

- The GWP_{100} approach **overestimated** the **climate** impact of **Slovenian cattle production.**
- In the **dairy sector** more **methane** is being **oxidised** than **emitted.**

↓ =

- The **dairy cow** sector: **a 'cooling' effect**, while the **non-dairy cattle**: **a 'warming' effect**.

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Thank you!

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