REGIONAL ASSESSMENT OF A REGIONAL BOTTOM-UP CATTLE AIR POLLUTANTS EMISSIONS INVENTORY AGAINST EUROPEAN EMISSIONS INVENTORIES

M. Morán, J.A. González, M. Dios

Department of Chemical Engineering
University of Santiago de Compostela (Spain)

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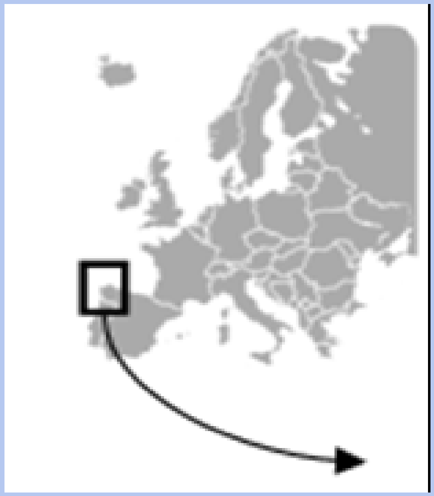
Overview

- Methodology and *EF*s estimation
- GHGs emissions estimation
  - ✓ *CH_4 emission from enteric fermentation*
  - ✓ *CH_4 emission from manure management*
  - ✓ *N_2O emission from manure management*

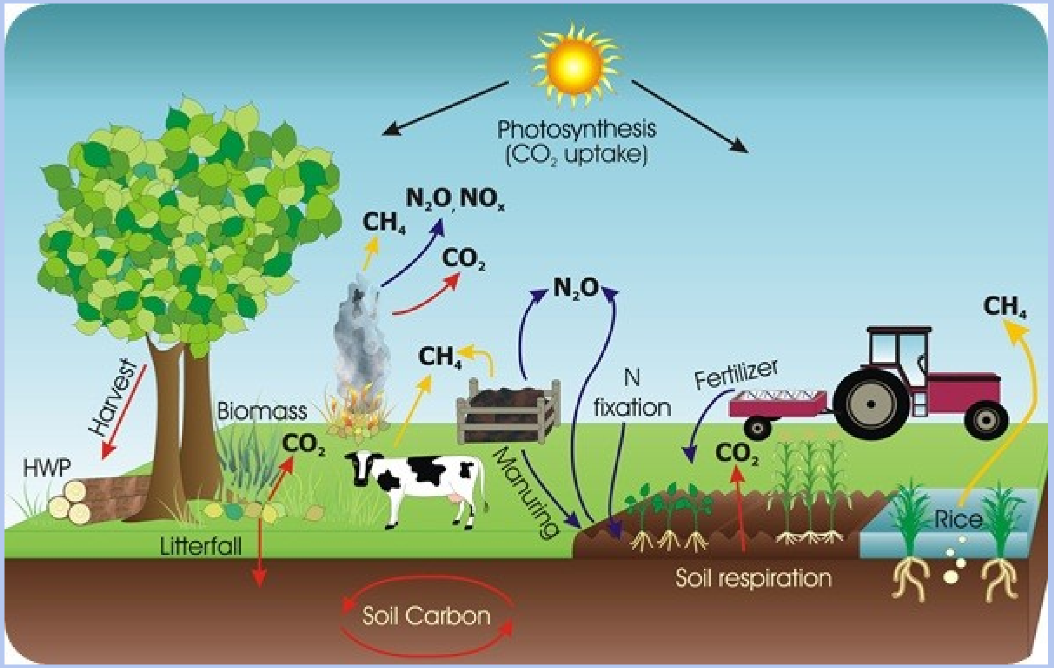


- Ammonia and NMVOC emissions
- Geographical distribution
- Comparison to standard emissions inventories
- Concluding remarks

Introduction

Cattle sector

In Spain, livestock contributes over 35% of CH_4 emissions, of which 60% are from cattle



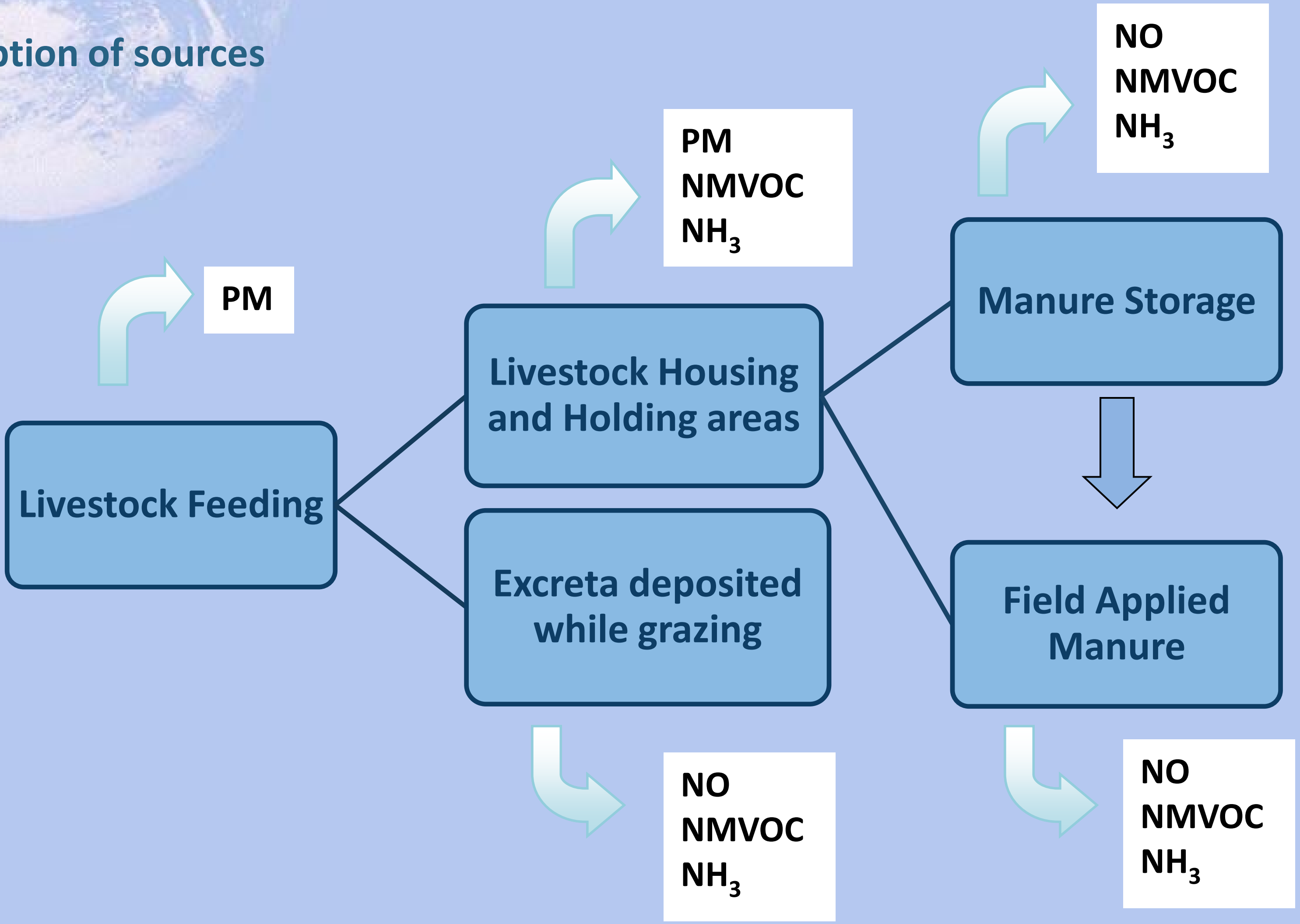
Emissions of pollutants in the cattle sector

Greenhouse Gases (GHGs)	**Contribution of Livestock**
Carbon Dioxide (CO_2)	9%
Methane (CH_4)	35 - 40%
Nitrous oxide (N_2O)	65%
Ammonia (NH_3)	64%

Overview

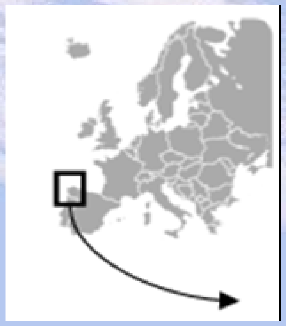
Animal husbandry and manure management

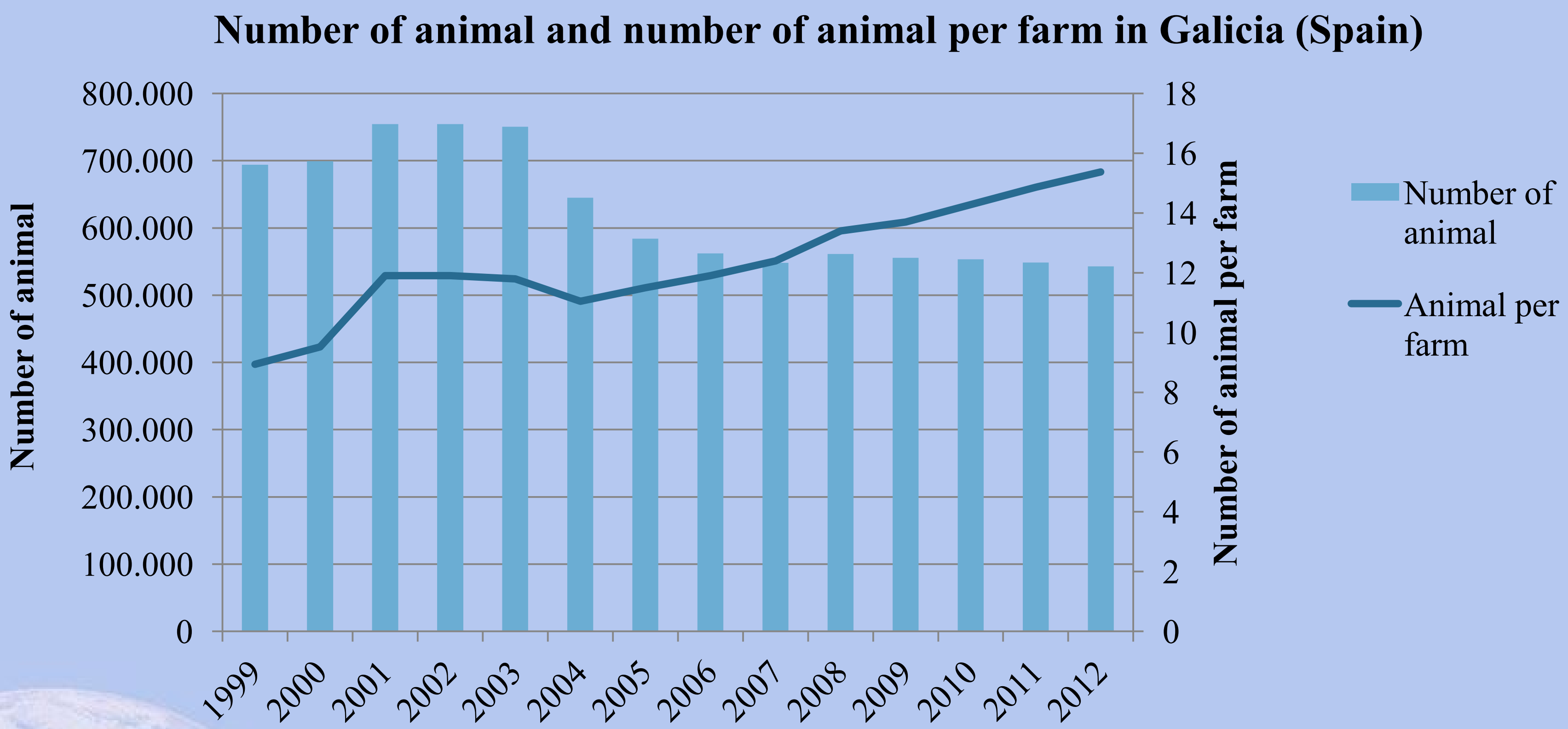
Description of sources



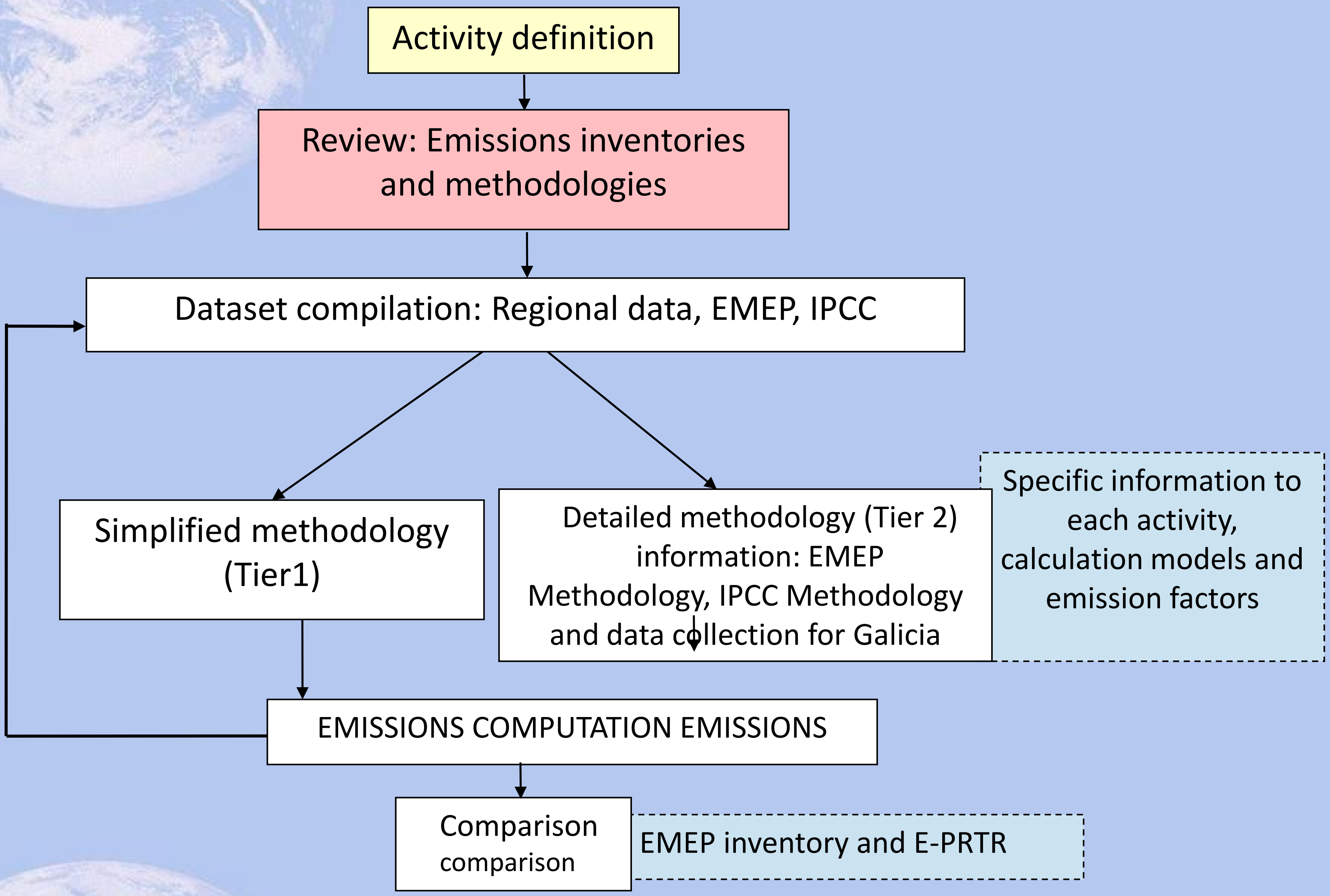
Study region - Galicia

Atlantic coastal region in the NW of Iberian Peninsula: Half of Spanish cattle are located in Galicia





Methodology and *EFs* estimation



GHGs emissions estimation

GHGs emissions (IPCC, 2006) are calculated by multiplying the number of animals (*N*) in each category (*i*) by an appropriate emission factor (*EF*).

$$Emission\ (t/year) = \sum EF \cdot \frac{N_i}{1000}$$

Tier 1 *EFs* are based in constant values

Tier 2 *EFs* depend on the different direct and indirect processes involved in a typical cattle farm, that is, enteric fermentation and manure management and other specific parameters are required: the animal type, the animal productivity, the quality of diet, and the management conditions; particularly, in order to support a more accurate food intake value applied to the estimation of methane production resulting from enteric fermentation.

Ammonia and NMVOC emissions estimation

NH_3 and NMVOC emissions were calculated using the methodology and algorithm provided by the EMEP/CORINAIR Atmospheric Emission Inventory Guidebook

Mass-flow approach was developed to quantify ammonia

LEVEL 2

$$E_{MMS-NO} = \left(E_{storage_{NO_{slurry}}} + E_{storage\_NO\_solid}\right) \cdot 30/14$$

$$E_{MMS-NH3} = (E_{yard} + E_{build_{slurry}} + E_{build_{solid}} + E_{storage_{NH3_{solid}}} + E_{storage_{NH3_{slurry}}} + E_{applic_{\square_{slurry}}} + E_{applic\_solid}) \cdot 17/14$$

NMVOC emissions are calculated by using a single default *EF* value (Hobbs et al., 2004)

Results – GHGs (2009)

CH_4 emissions

Livestock category	Tier 1			Tier 2		
	EF ef	EF mm	Emissions	EF ef	EF mm	Emissions
	$kgCH_4$ $hd^{-1}yr^{-1}$	$kgCH_4$ $hd^{-1}yr^{-1}$	$Gg\ CH_4$ yr^{-1}	$kgCH_4$ $hd^{-1}yr^{-1}$	$kgCH_4$ $hd^{-1}yr^{-1}$	$Gg\ CH_4$ yr^{-1}
Mature Dairy Cow	109	27	50.69	82.65	45.59	47.80
Other Mature Cattle	57	8	22.28	65.18	28.99	32.29
Growing Cattle	57	8	14.8	52.75	33.94	22.04
TOTAL			89.50			102.12

Results – GHGs (2009)

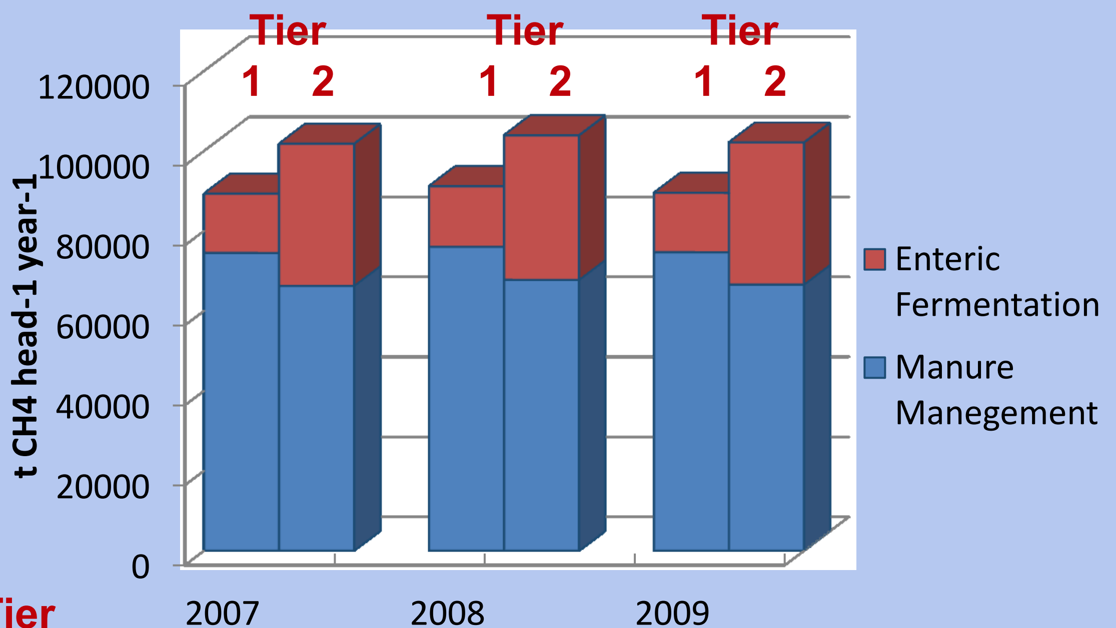
N_2O emissions

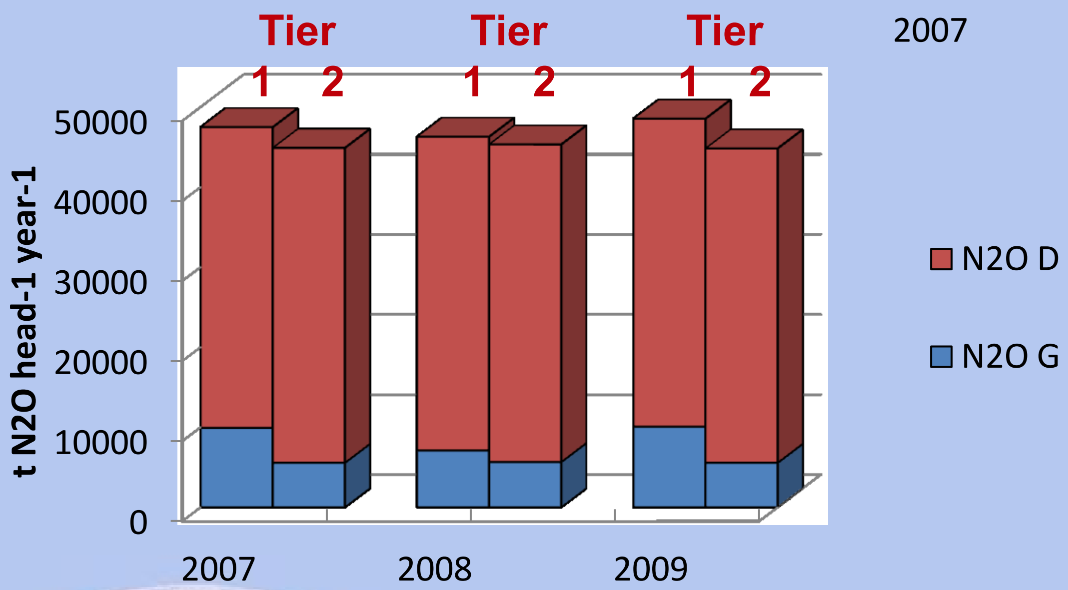
Livestock category	Tier 1 Nint(T) kg N $hd^{-1}yr^{-1}$	Tier 2 Nint (T) kg N $hd^{-1}yr^{-1}$
Mature Dairy Cow	79.72	69.62
Other Mature Cattle	84.65	54.01
Growing Cattle	22.89	65.56

Livestock category	Tier 1		Tier 2	
	Emissions Gg N_2O yr^{-1}	EF mm kg N_2O $hd^{-1}yr^{-1}$	Emissions Gg N_2O yr^{-1}	EF mm kg N_2O $hd^{-1}yr^{-1}$
Mature Dairy Cow	8.25	22.13	0.969	2.6
Other Mature Cattle	33.56	97.90	17.22	50.2
Growing Cattle	6.73	26.47	15.50	61.0
TOTAL	**48.54**		**44.82**	

Results – GHGs annual series

CH_4 emissions





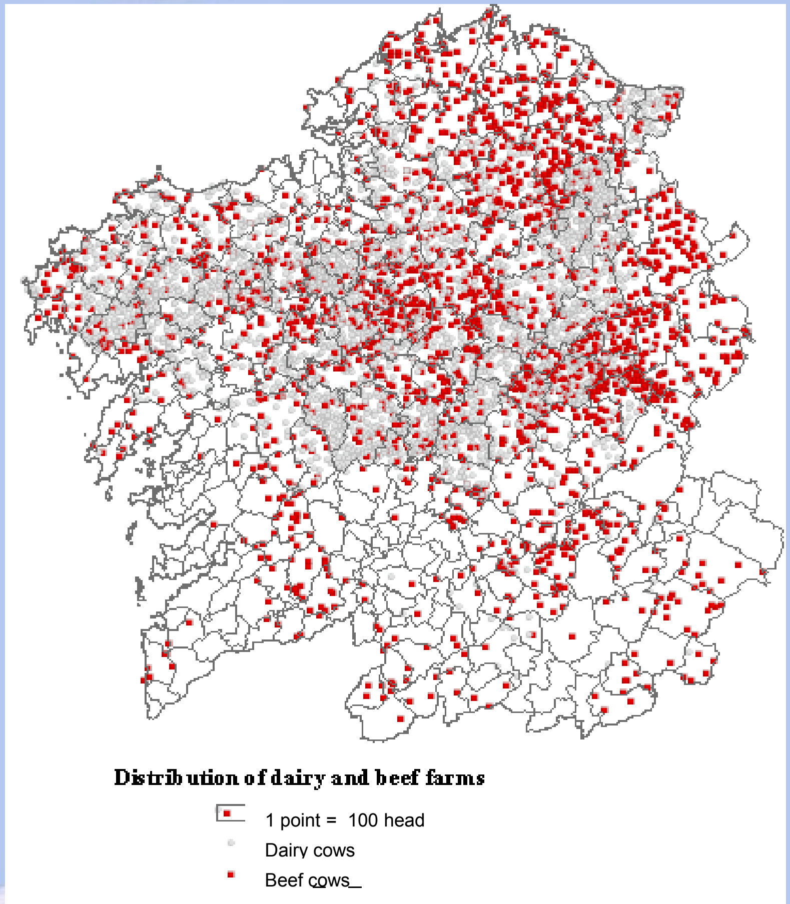
N_2O emissions

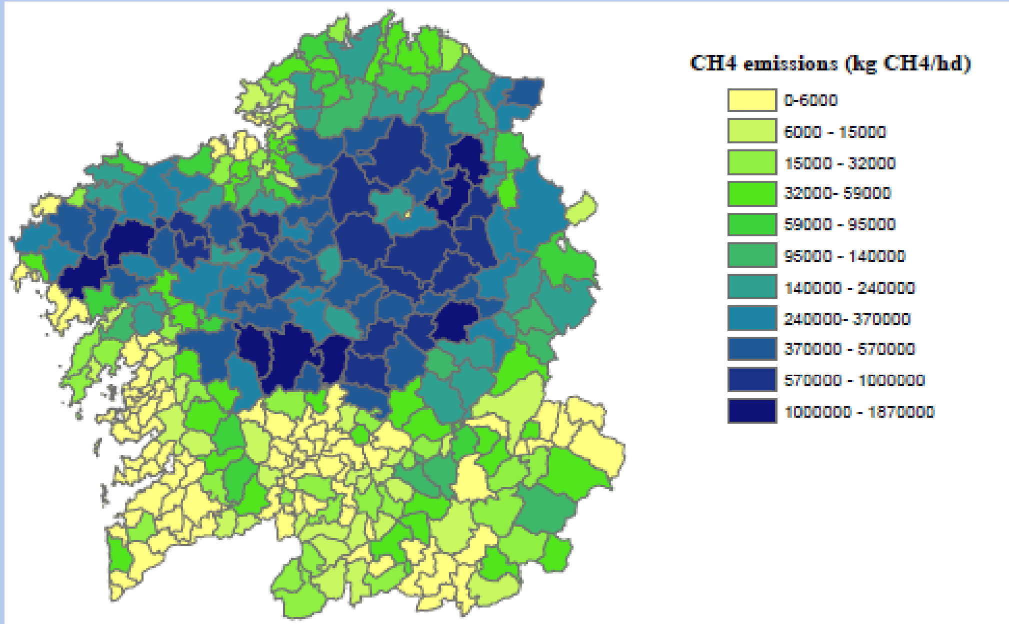
Results – Tropospheric gases (2009)

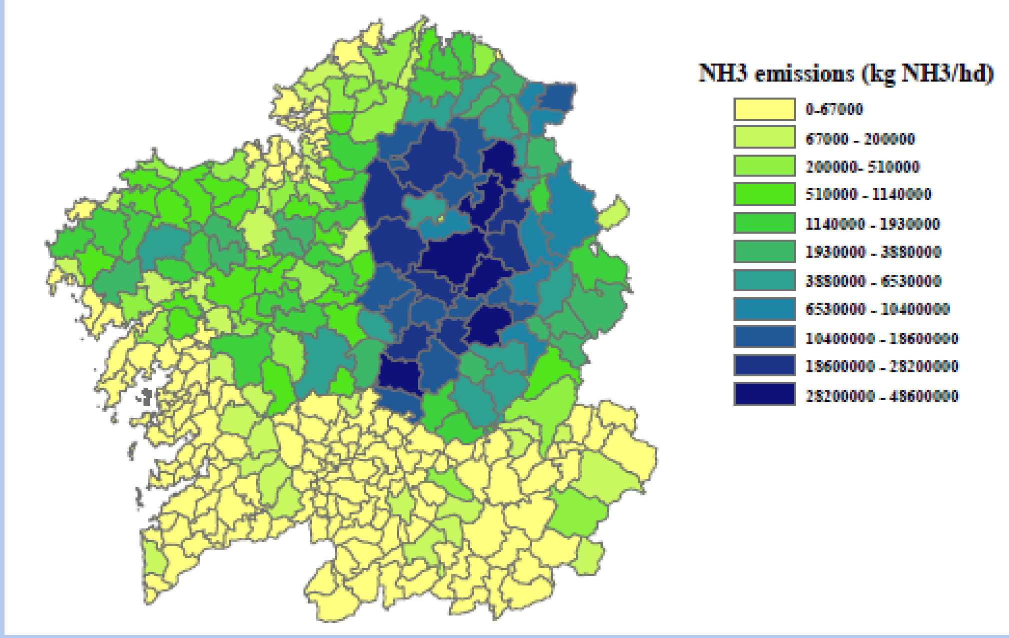
NMVOC and NH_3 emissions

NFR	NFR Name	EF ($kg\ hd^{-1} yr^{-1}$) for NMVOC	NMVOC emissions ($Gg\ NMVOC\ yr^{-1}$)	EF ($kg\ hd^{-1} yr^{-1}$) for NH_3	NH_3 emissions ($Gg\ NH_3 yr^{-1}$) Tier 1	NH_3 emissions ($Gg\ NH_3\ yr^{-1}$) Tier 2
4.B.01.a	Dairy cattle	13.6	5.07	39.3	14.6	13.0
4.B.01.d	Non-dairy cattle	7.4	4.42	13.4	8.0	6.47
	TOTAL		**9.50**		**22.65**	**19.50**

Results - Geographical distribution (2009)



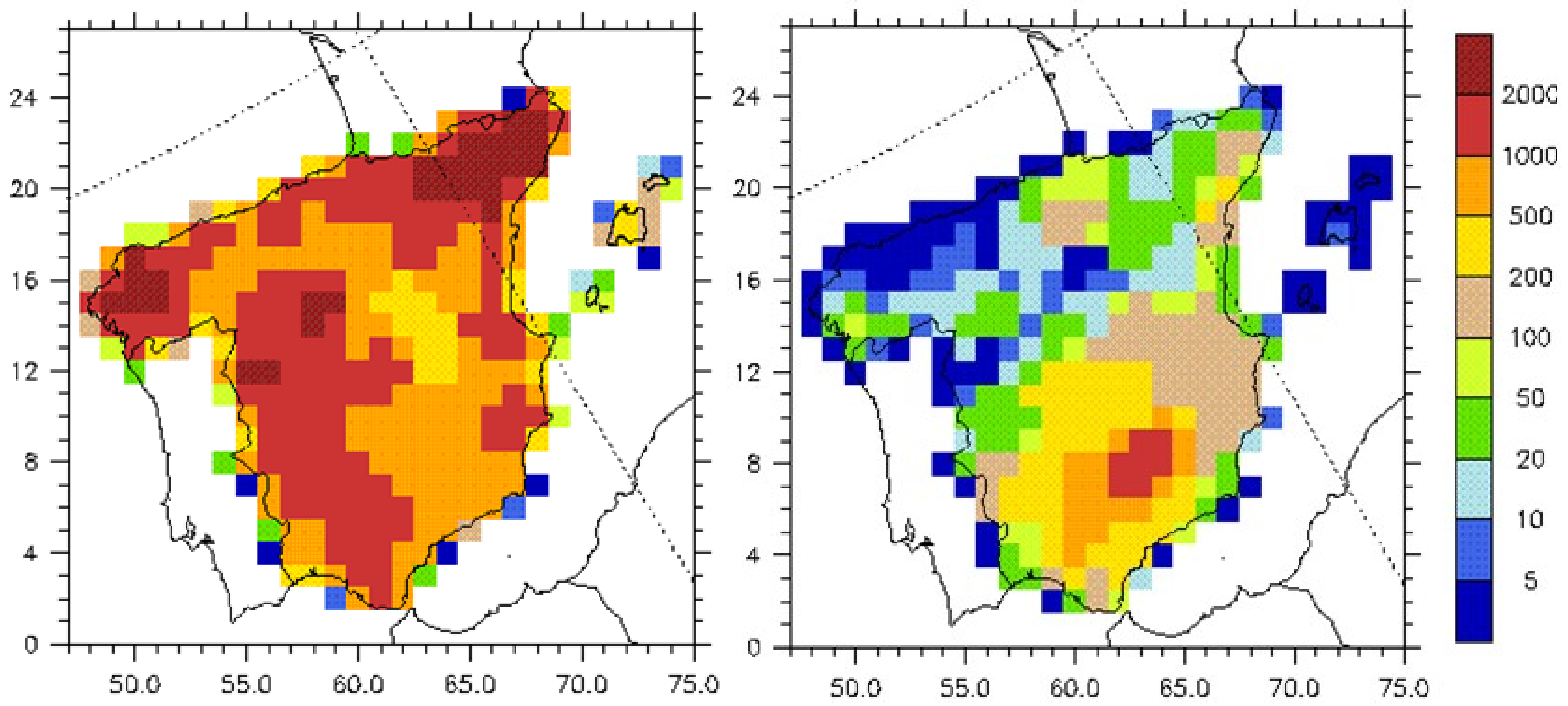




Comparison to standard inventories (2009)

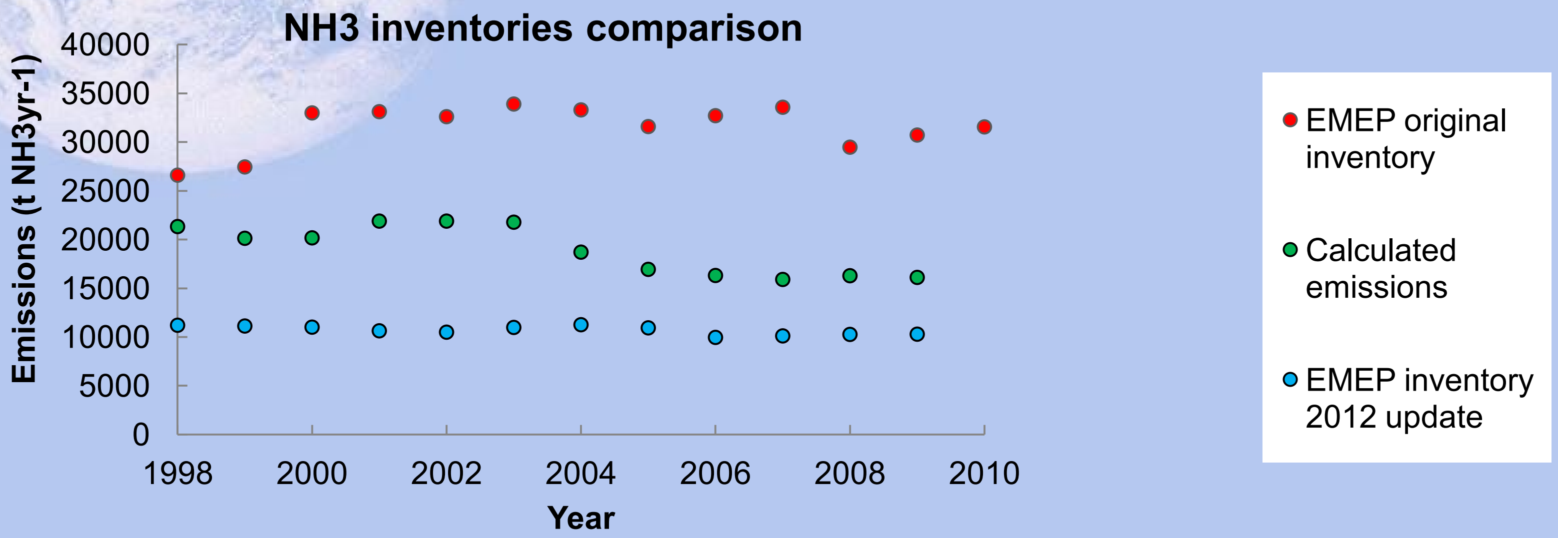
EMEP emissions of NH_3 and NMVOC in tons (t) in 2009
S10 – Agriculture sector (CEIP, 2012)

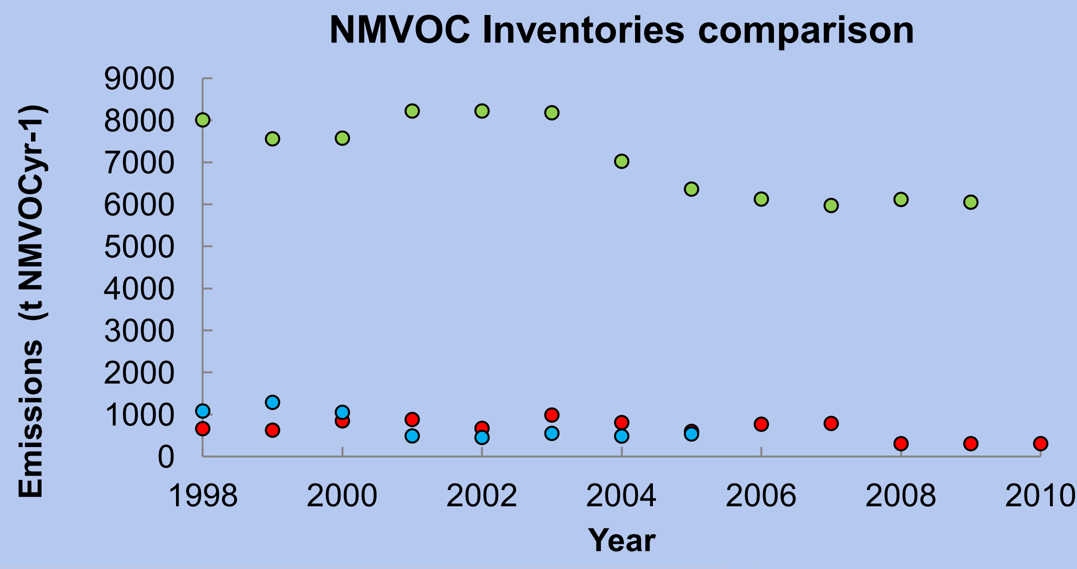
NH3 **NMVOC**



Comparison to std. emissions inventories

Comparison of calculated and EMEP S10 sector NH_3 emissions at Galicia region, considering both original and updated EMEP (June-2012) inventories.





Comparison to standard inventories (2009)

Comparison of E-PRTR emissions (Cathegory 7) with those calculated for cattle in Galicia for the year 2009

	E-PRTR emissions (t·yr^{-1})	Calculated emissions (Tier 2) (t·yr^{-1})
CH_4	108	102120
NH_3	2290.9	19500

Conclusions

- Cattle activities produce significant both GHGs and tropospheric pollutants emissions
- CH_4 emission estimated using Tier 2 (IPCC, 2006) is higher than using Tier 1 (IPCC, 2006). Tier 2 results show that more CH_4 livestock emissions come from enteric fermentation than using Tier 1.
- About N_2O emissions, direct contribution (89%) is the largest component
- Considering GHGs emissions, Global Warming Potential (GWP) from CH_4 and N_2O cattle emissions represents 56% of the total GWP in this region

Conclusions

- Compared to EMEP inventory, NH_3 emissions value is twice the updated S10 EMEP sector emissions, even though S10 sector not only includes cattle
- Differences are even higher when NMVOC emissions are considered, with extremely low S10 EMEP values respect to the calculated NMVOC emissions
- Cattle activities must be included in E-PRTR

Future work

- An extension of these results to Europe depends on the availability and accuracy of data input, specially for Tier 2 method and NH_3 emissions calculation
- A sensitivity analysis of these emissions estimation methods to the different data input should be useful to define the uncertainties associated to these emissions. Also, in order to reduce the required data input
- Currently, we are in collaboration with the GEMAC group, University of Aveiro, to extend these cattle emissions calculations and, also, new S10 EMEP emissions estimations, to Portugal and Galicia: In order to estimate the impact of those emissions in the ozone episodes observed in rural areas

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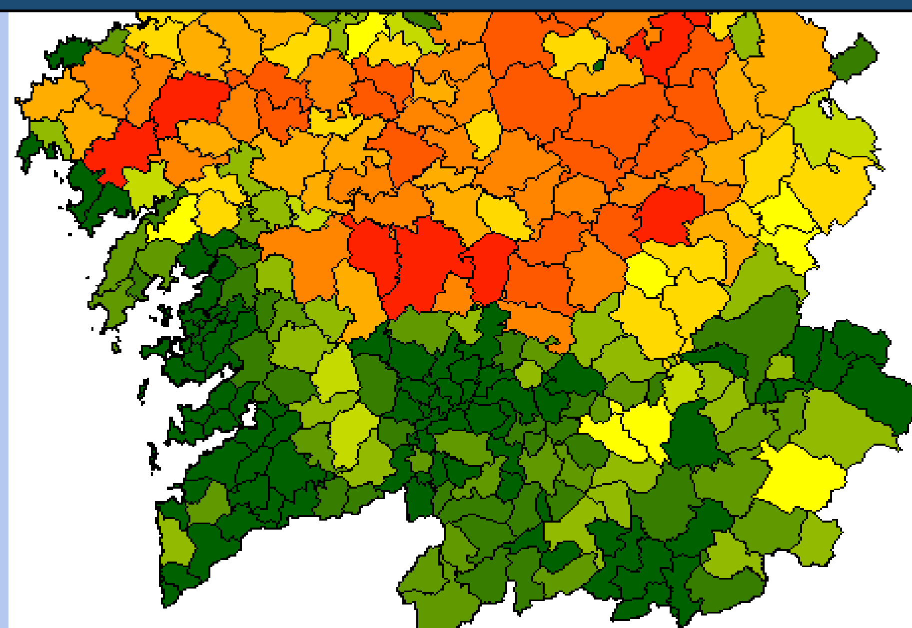

ja.souto@usc.es

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