

Experiences in Denmark

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TFIAM/COST729/NinE

Workshop on integrated modelling of nitrogen

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History

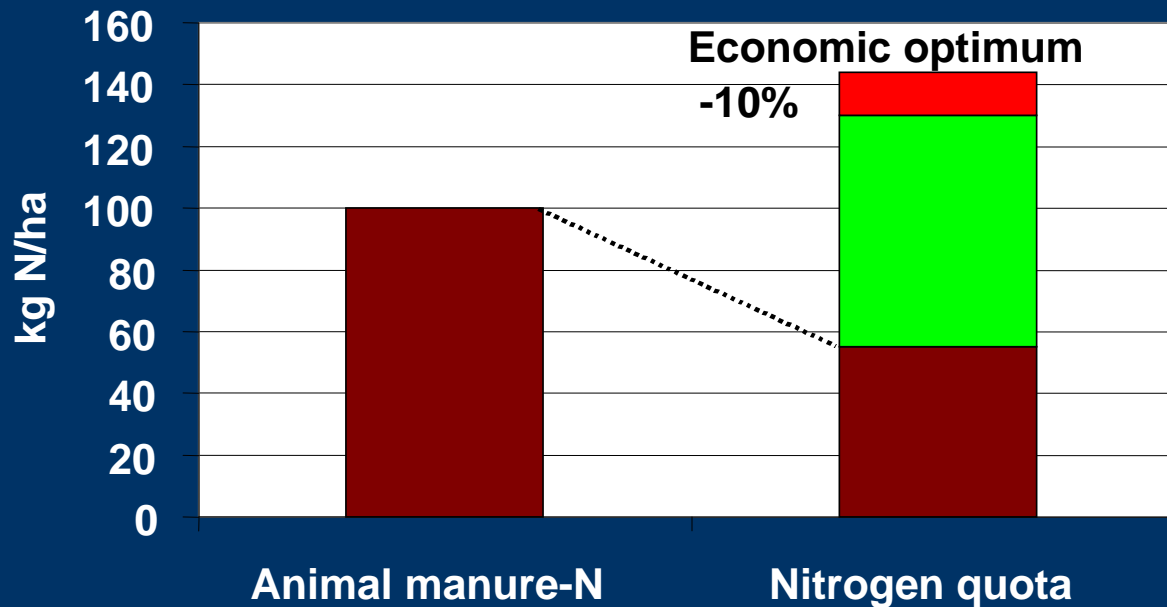
- 1986** Two dead lobsters in the Inner coastal waters
- 1987** First action plan on the aquatic environment, 50% reduction in N leaching by 1998
 - First normative values for N-excretion rates for animals
 - Establishment of a N monitoring grid in soil, 600 sampling plots
- 1989** Monitoring system for air pollutants, six background monitoring stations
- 1997** Annually updated normative figures for N and P
- 1998** Second action plan on the aquatic environment
 - Nitrogen accounting at farm level
 - Maximum N-fertilization rate 10% under economical optimum
 - 9-10 months storage capacity for animal manure
 - 60-75% of the N in animal manure has to be included in the N accounting
- 2000** Action plan on ammonia emission
 - Ban on broadspreading of manure
- 2006** Third action plan on the aquatic environment
 - 13% reduction in leaching by 2013
 - Fixed Danish N quota, app. 400.000 ton N available to the plants
- 2007** 15% reduction in NH₃ emission for enlargements (Base Year 2005)
- 2008** 20% reduction in NH₃ emission for enlargements (Base Year 2005)
- 2009** 25% reduction in NH₃ emission for enlargements (Base Year 2005)



Essential for Denmark: N quota

- Maximum application rate per hectare include both mineral fertiliser and animal manure
- Updated annually and corrected for N_{\min} in the soil in February

Example of N fertilisation quota



Many data are available

- Updated standard N-excretion figures
- EU Land Parcel Information System
- N accounting data for all farms
- EU subsidy data
- Danish Husbandry Database (no. of animals on farm level, daily update)
- Periodic surveys of manure management systems and manure application practice



Standard N-excretion

- Updated annually
- Based on data from agricultural advisory service:
 - 15-20% of all feeding plans for dairy cows
 - 25-30% of all feeding plans for pigs
 - 60-75% of all feeding plans for poultry
 - 100% of all feeding plans for fur animals



Gaseous emissions of N

- N flow approach
- Standard N excretion
- app. 160 animal x housing type combinations
- NH_3 emission from housing
- NH_3 , N_2 , N_2O emission from storage
- NH_3 emission from field-applied manure and fertiliser
- Remainder enters soil
 - Used in estimating NO_3 leaching

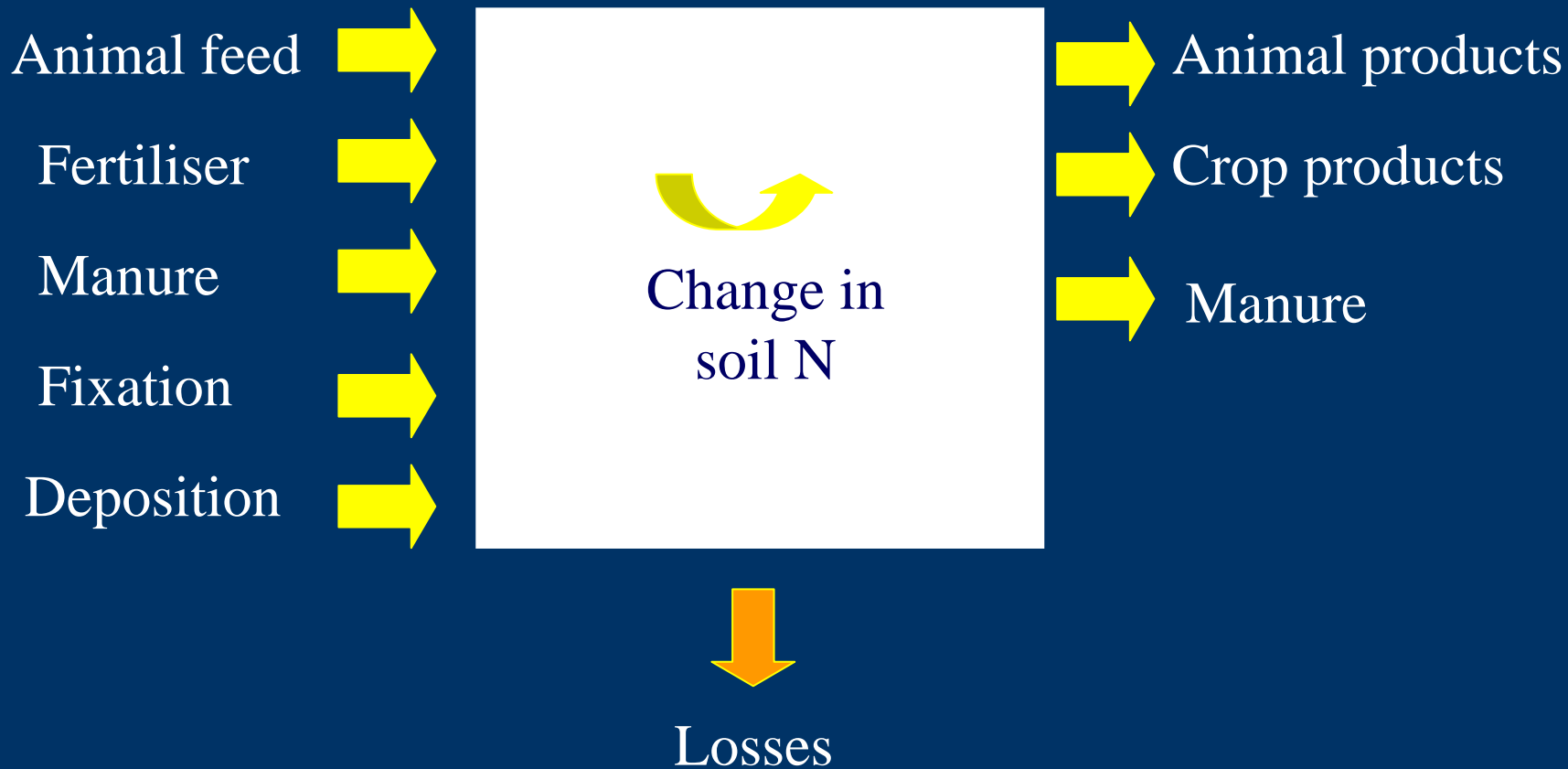


Overall results of the Danish Policy

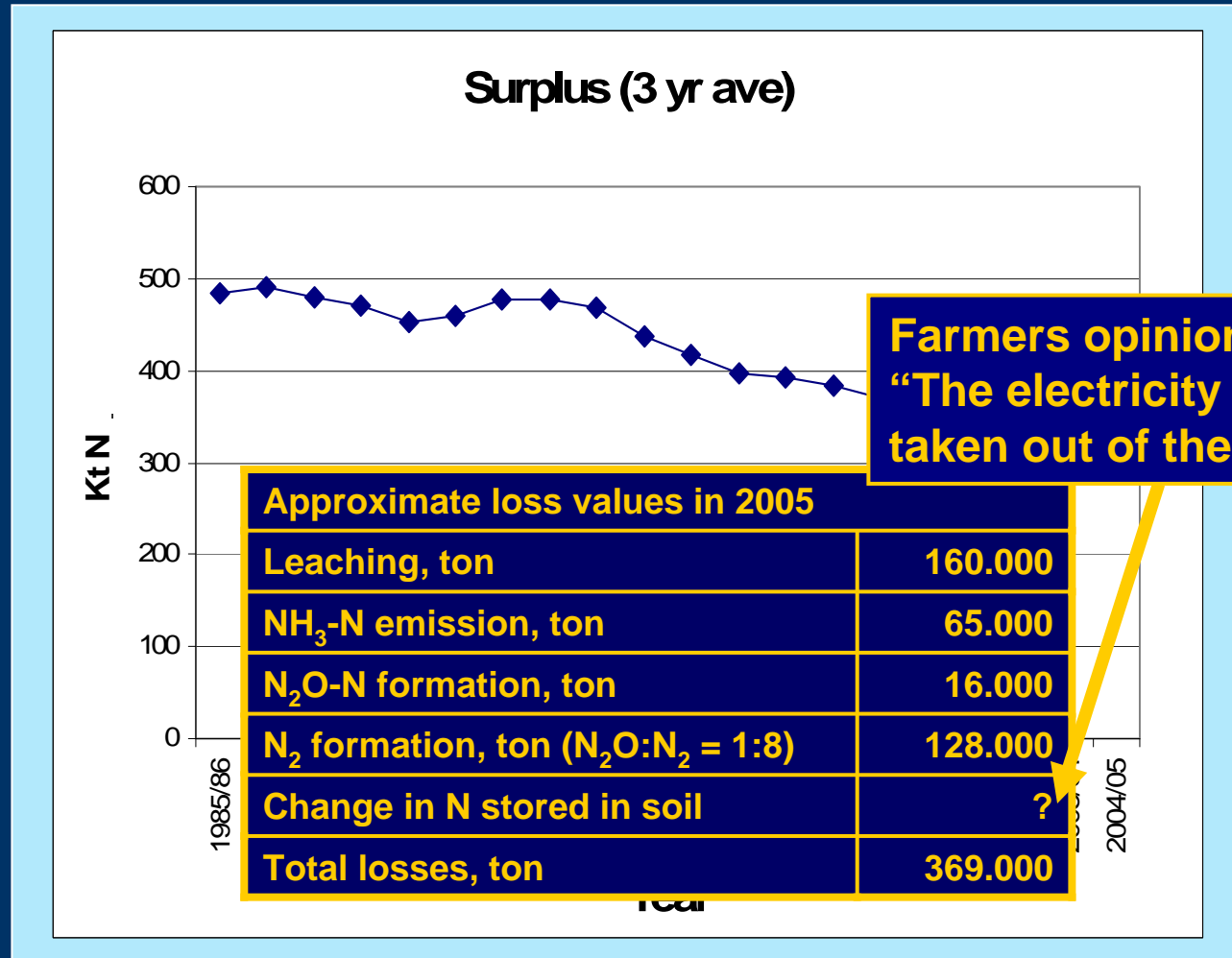
	1989	2006
No. dairy cows	754,000	550,000
Dairy cows - N excretion, Kg N/yr	134.00	137.41
No. produced pigs, mill./yr	15.6	23.4
Slaughter pigs - N excretion, Kg N/produced pigs	4.78	3.03
Total N in manure, ton	295,000	259,000
Total N in mineral fertilizer	377,000	191,800
Leaching from the root zone, ton N/yr	273,700	153,400
Manure application, % in spring	50 %	93 %
Low or no increase in crop yield compared to other countries		
Protein content in winter wheat	App. 11%	App. 10%
NH ₃ emission from manure and grazing, ton NH ₃ -N	79,600	55,200
NH ₃ emission from fertilizers, ton NH ₃ -N	7,400	4,700



National N surplus



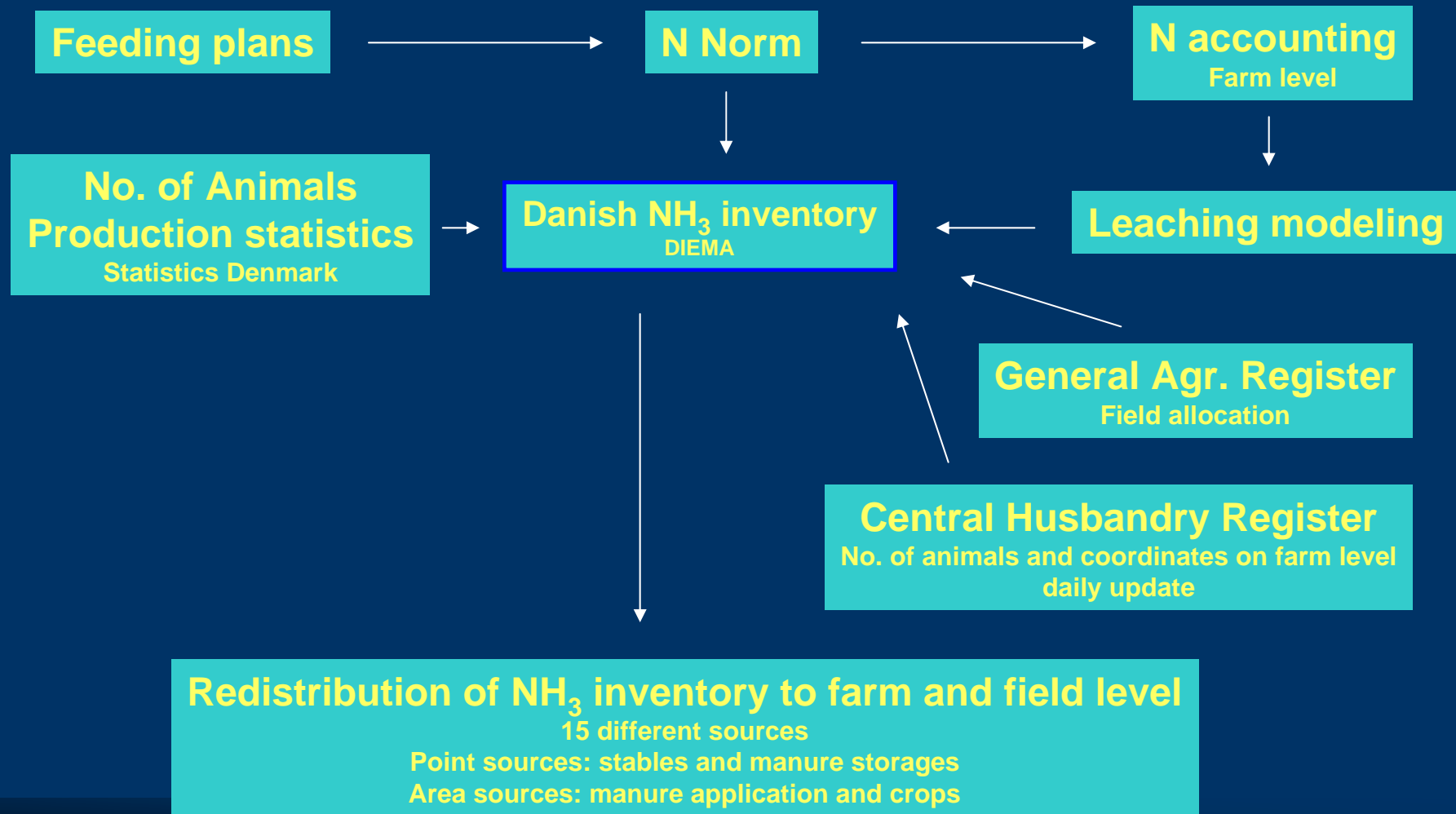
Nitrogen balance for Danish Agriculture



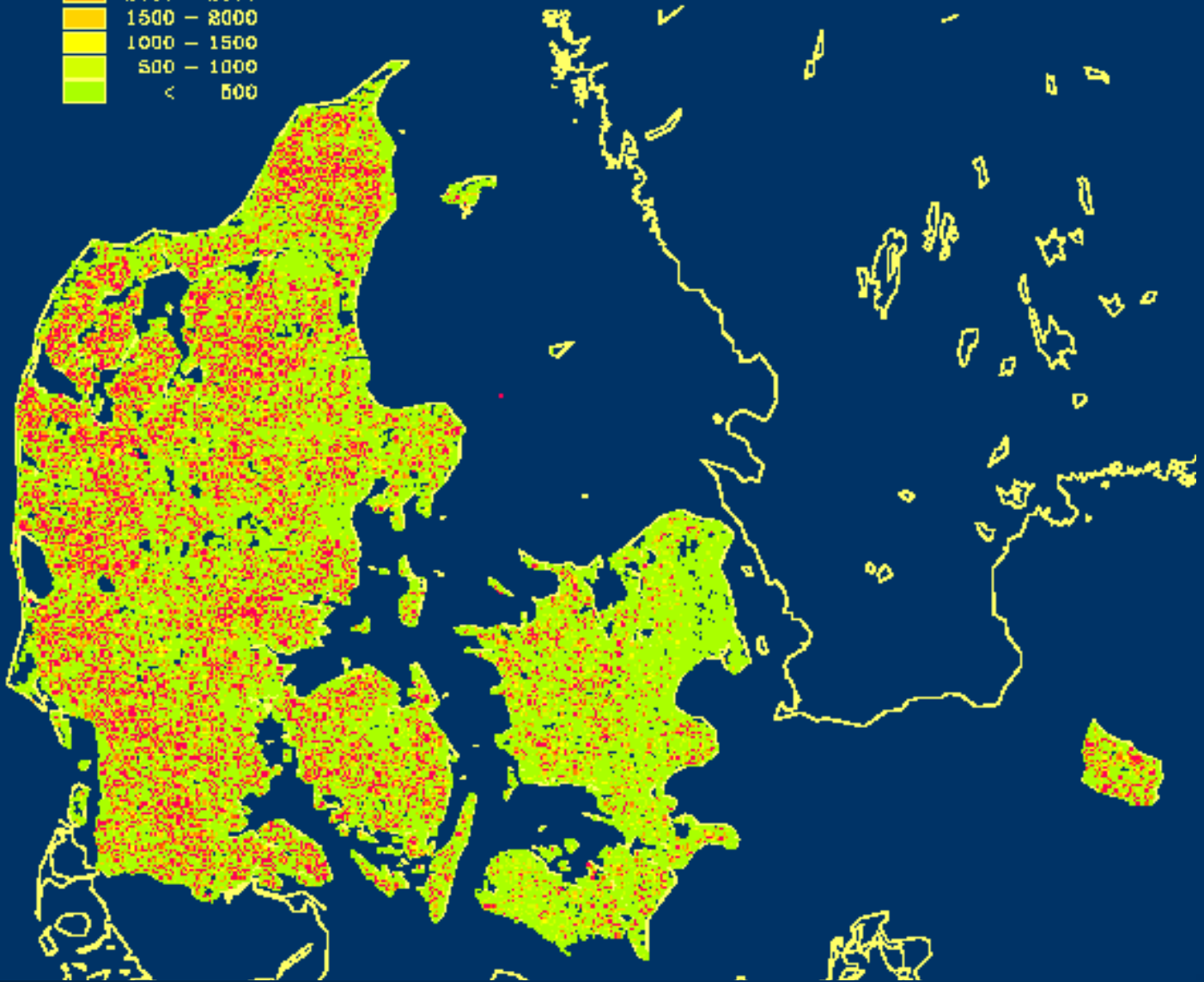
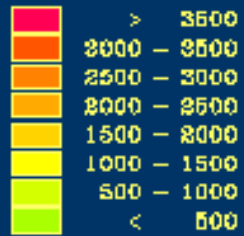
Arne Kyllingsbæk, Faculty of Agr. Sciences, 2006



Disaggregation of Danish Inventory to farm level

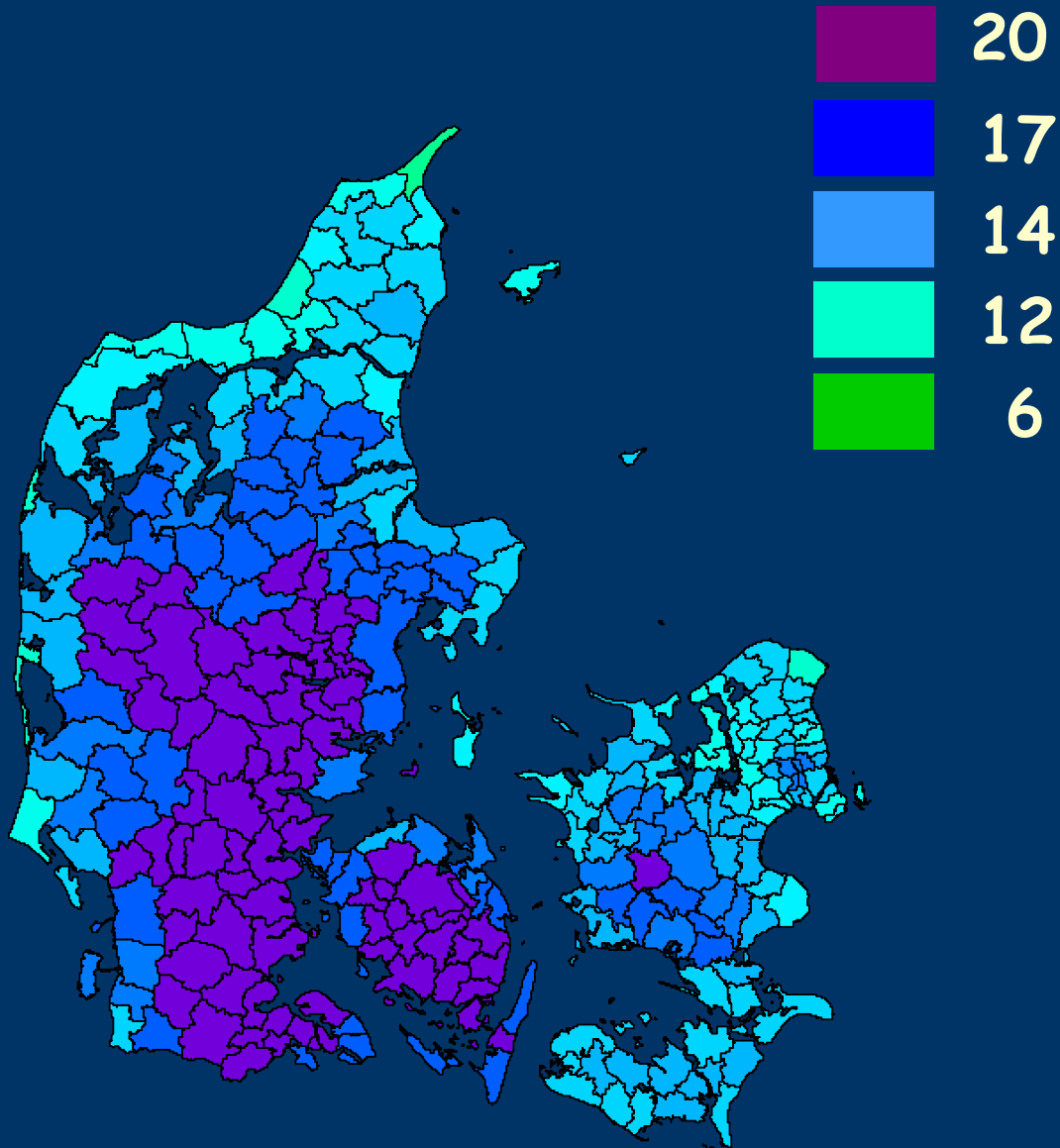


NH₃ emission on farm level



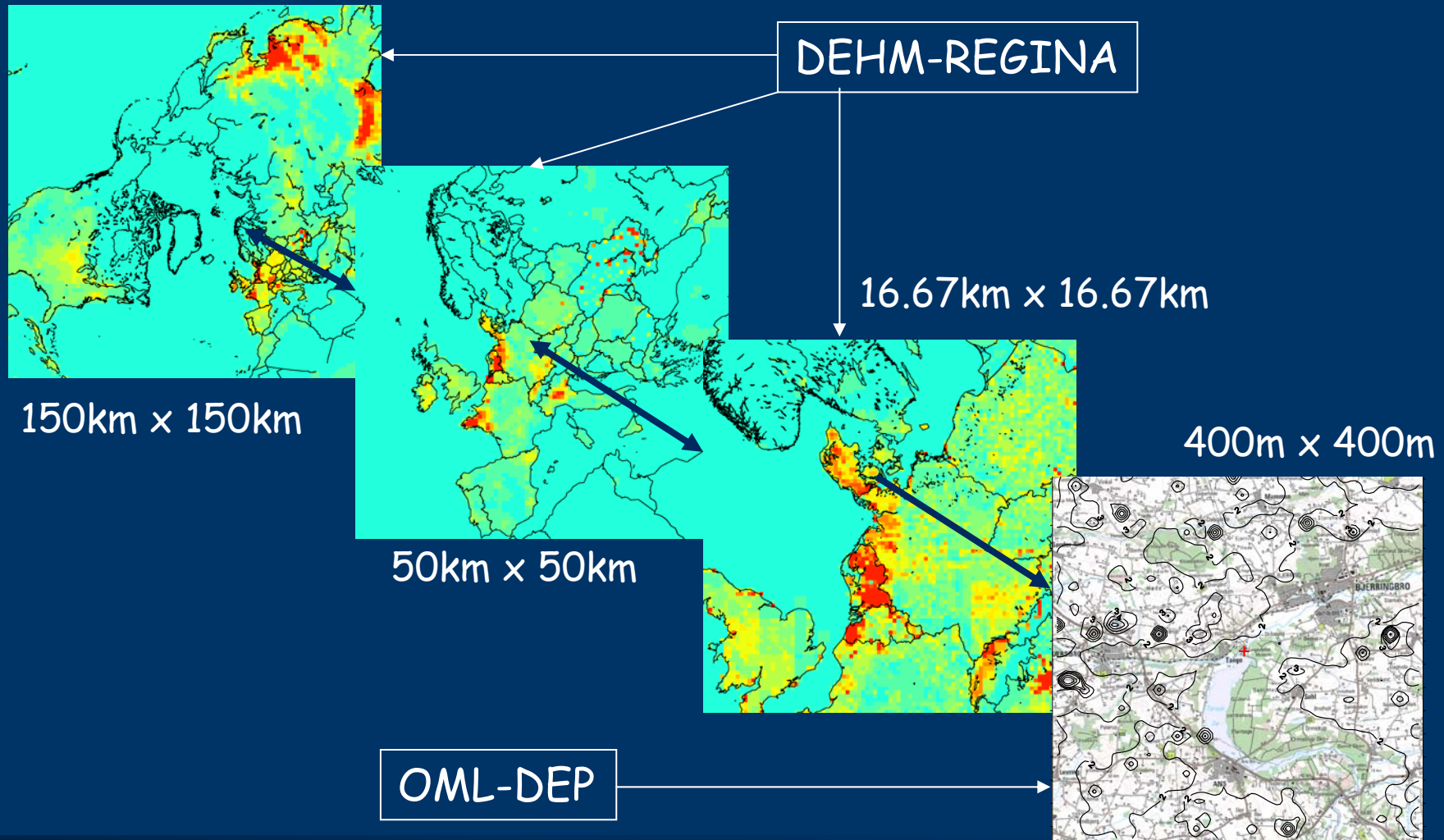
N deposition to the Danish land area kg N/ha

2004



Source: NERI 2005

NH3 modelling on different scales - Coupling regional and local scale

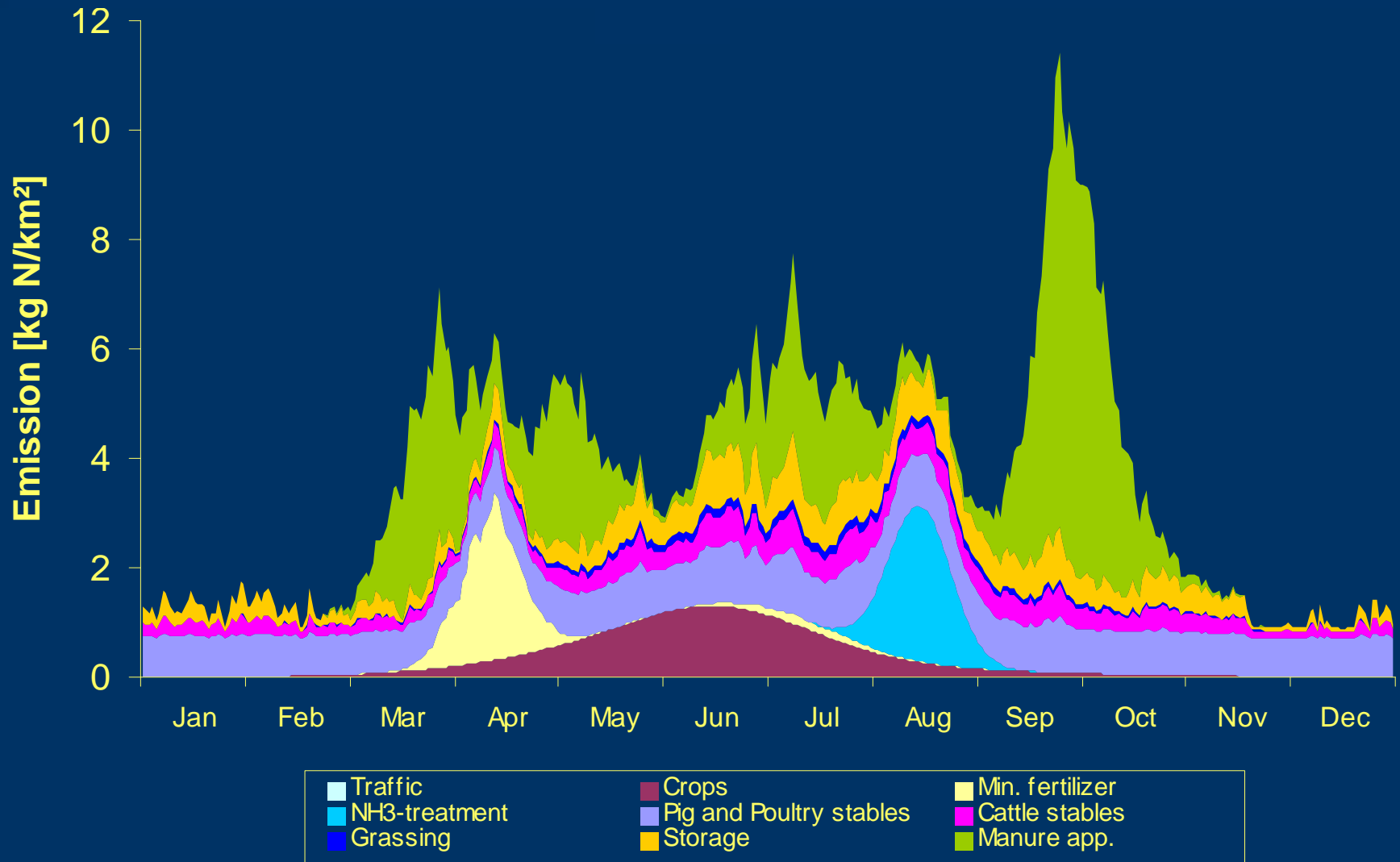


Temporal distribution of NH₃ inventory

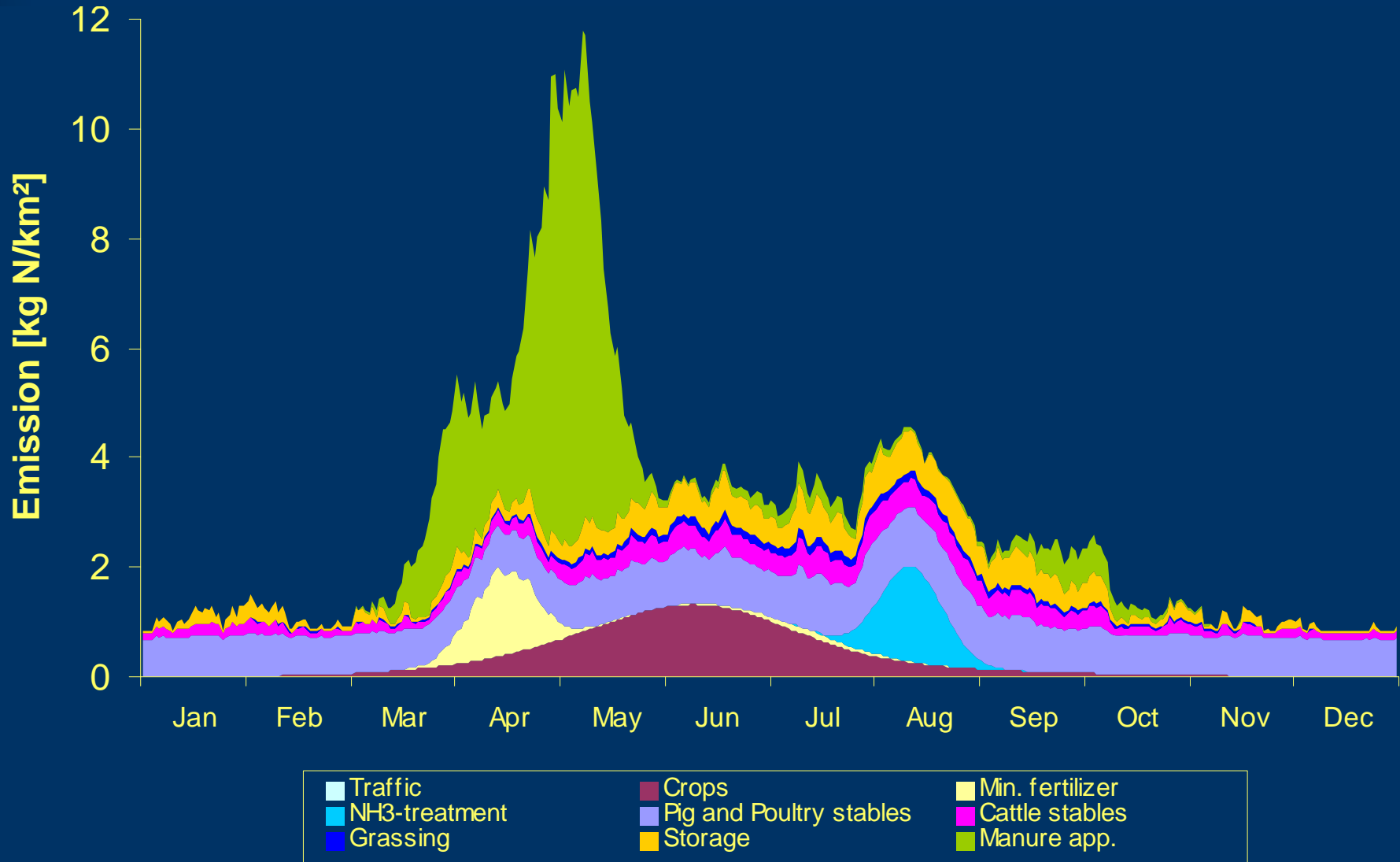
- Emission from housing and storage dependent on daily temperature
- Emission from field applications dependent on degree days/fixed dates
- Crop and grazing emissions dependent on simple crop model.



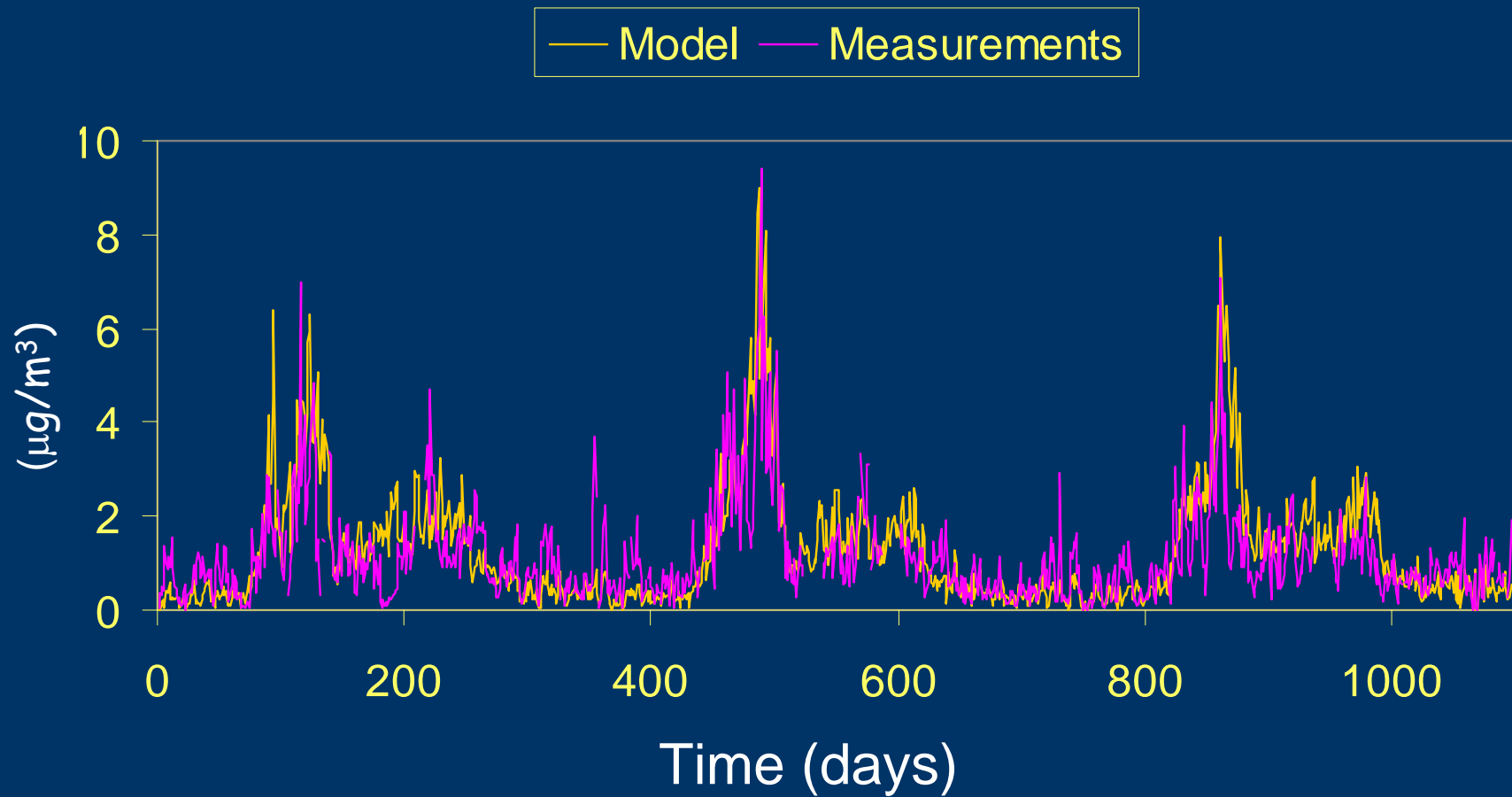
Seasonal variation ammonia emissions 1989 in Tange, DK



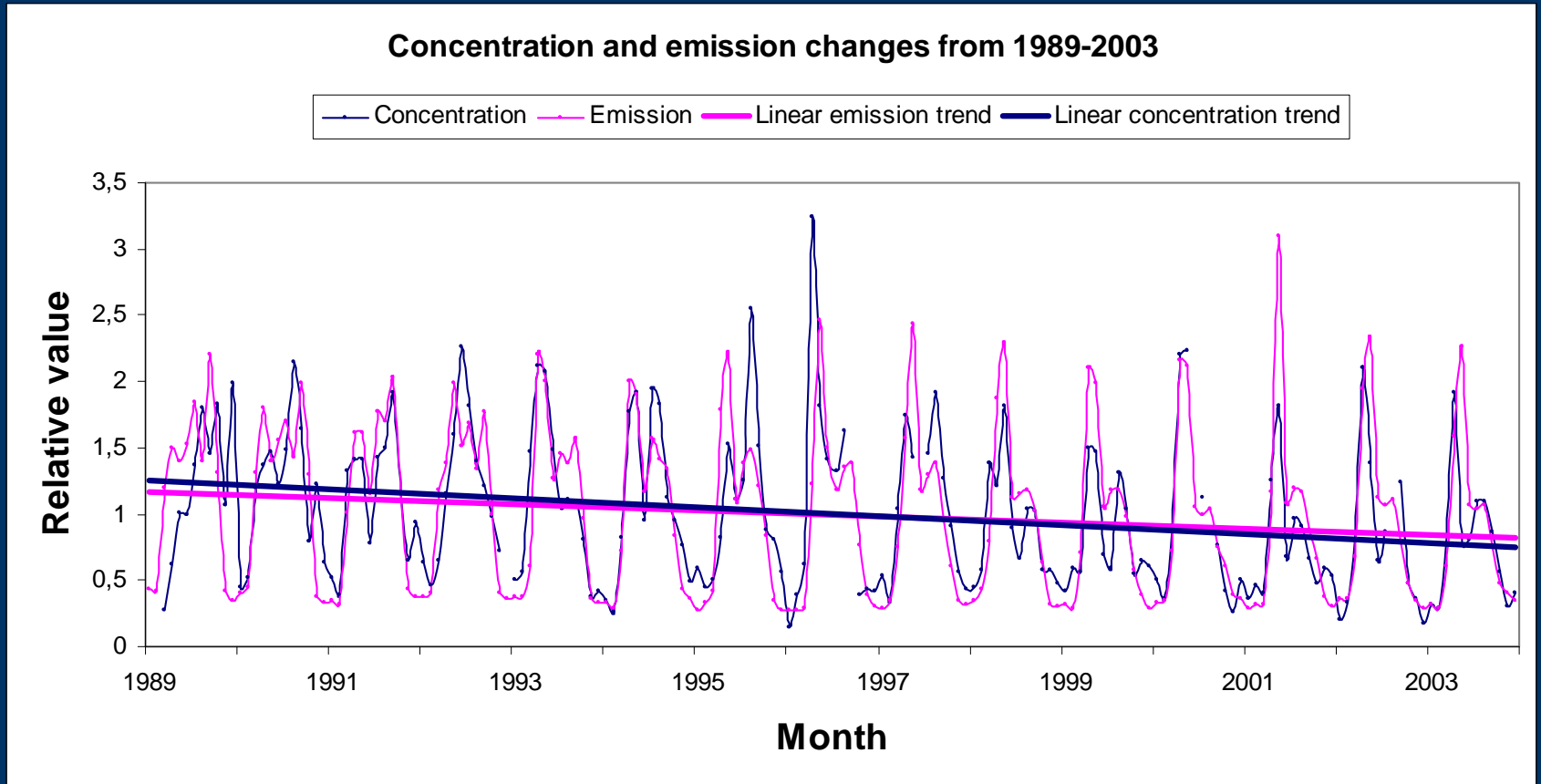
Seasonal variation ammonia emissions 2002 in Tange, DK



NH₃ concentrations at Tange 1999-2001

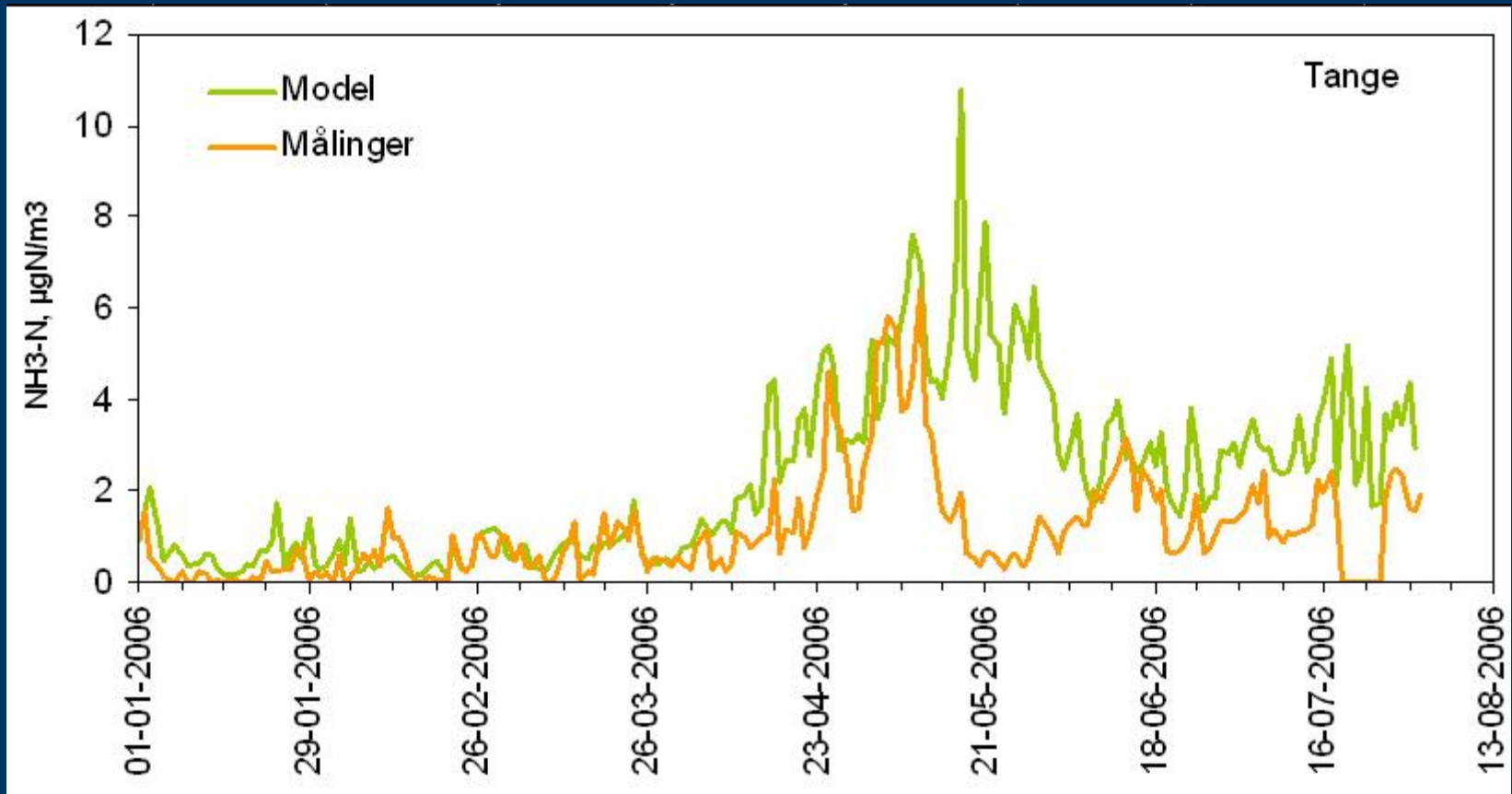


Development in NH₃, 1989-2003



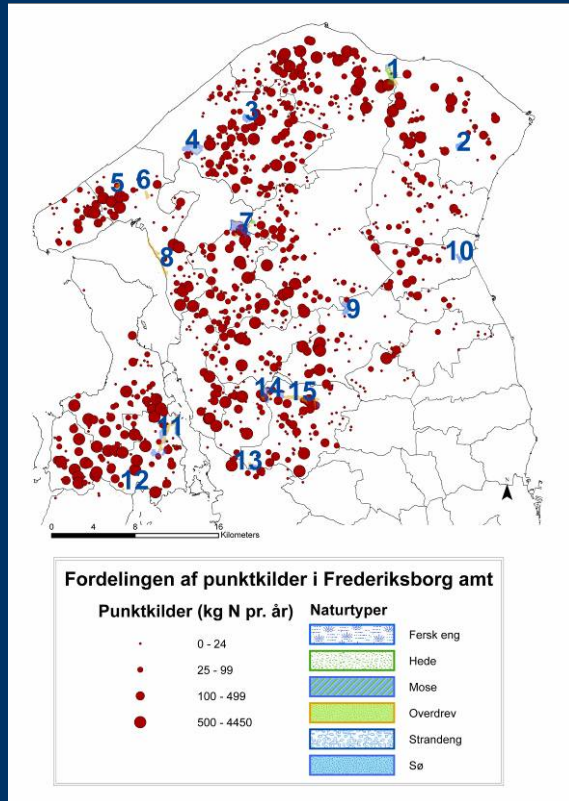
Ambelas Skjøth et al. 2007

NH₃ in 2006 – not so good

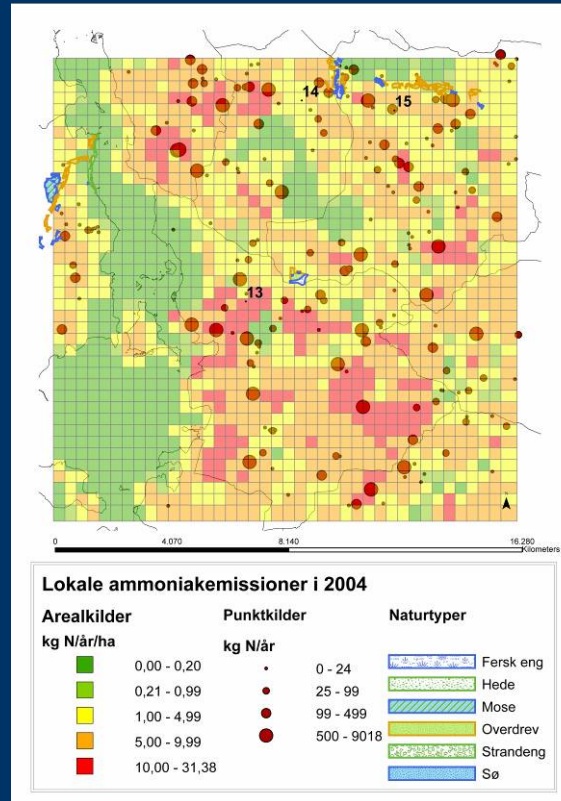


Ellermann et al. 2006

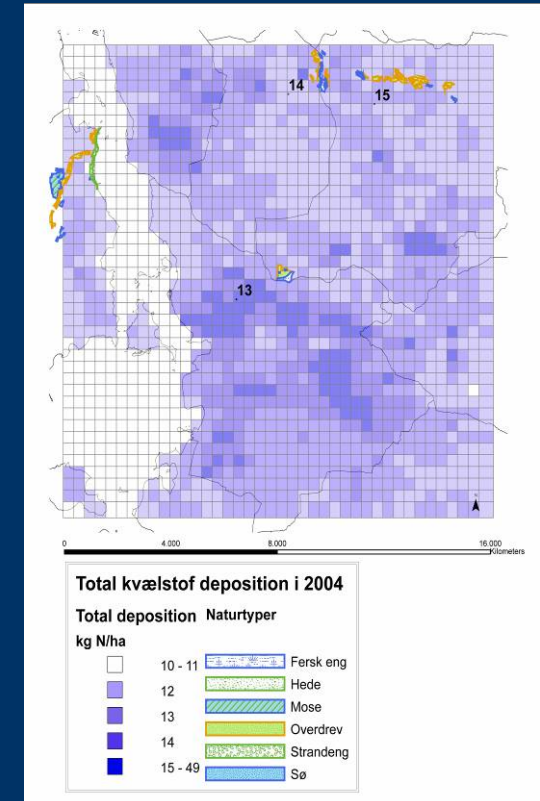
NH₃ modelling used in regulation



Point sources

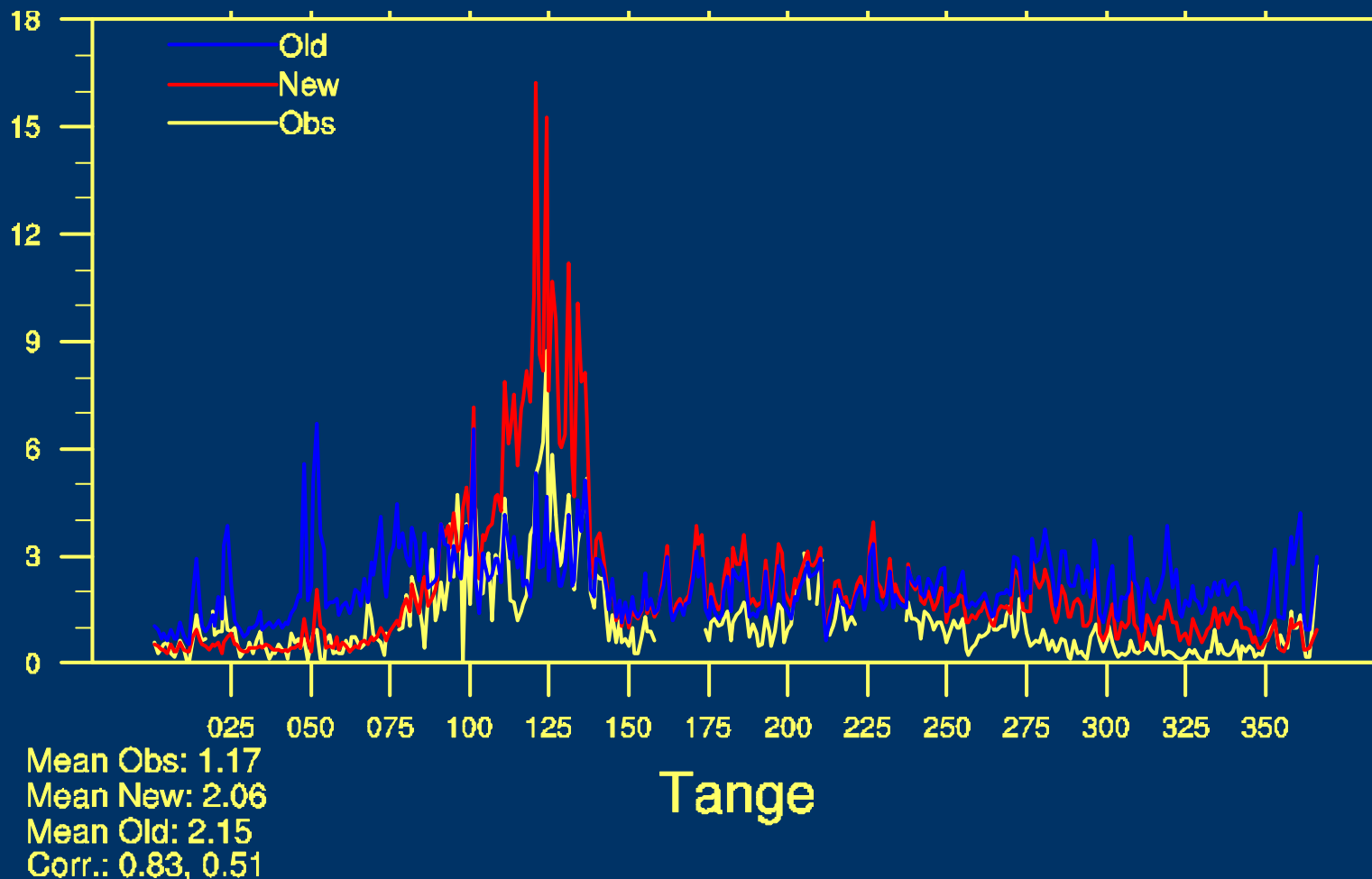


Point and area emissions



Deposition

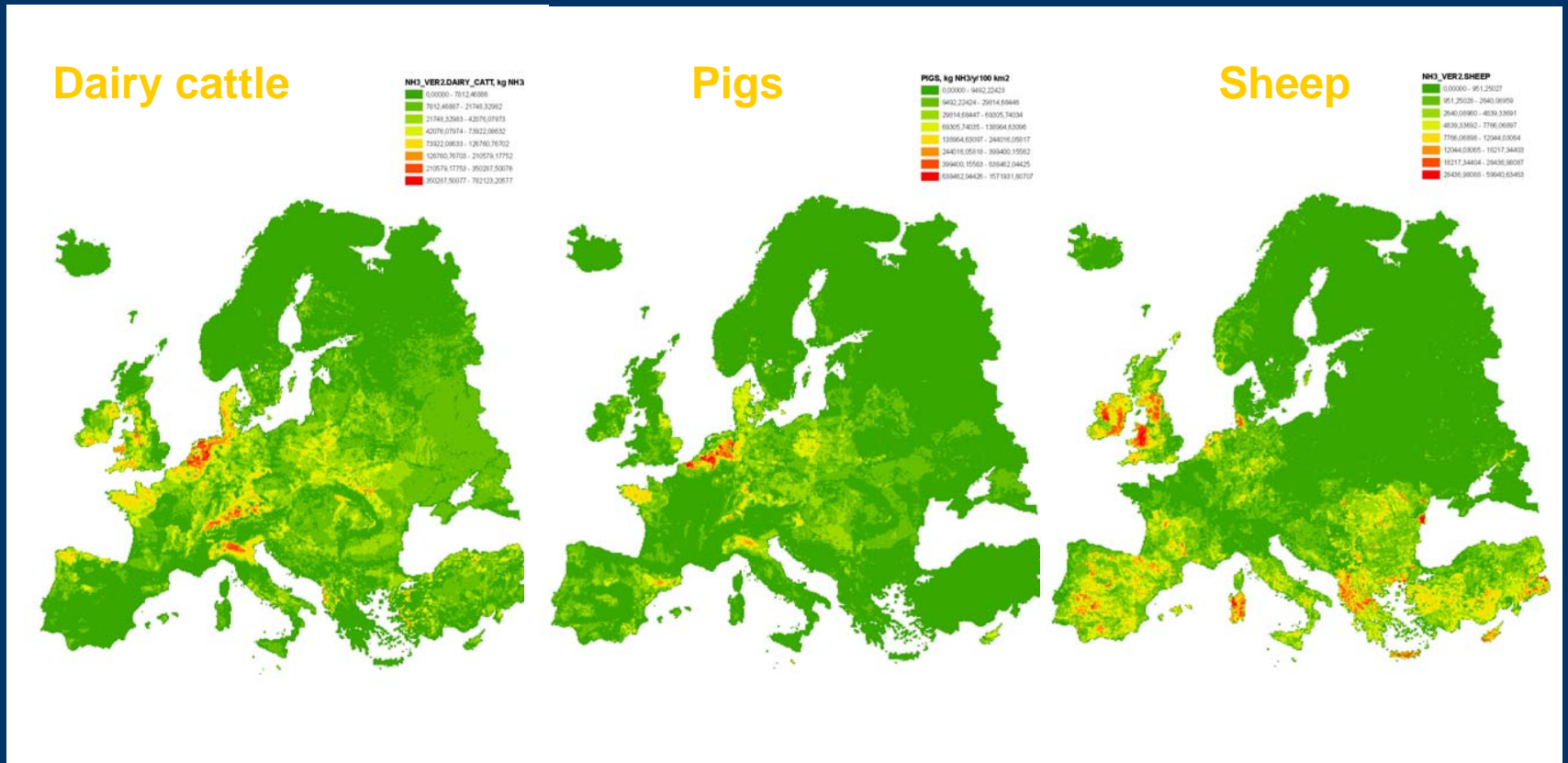
Implementation in the Eulerian EMEP model



Produced by Hilde Fagerli Met.No and EMEP MSC-W



Future: Emissions for Europe will be implemented in the modelling on a 10 km x 10 km grid



Summary

- Action has an effect
- Simple N surplus estimates are very helpful for understanding the N dynamics
- High spatial/temporal resolution modelling is good
 - But can still make progress without it.
- High resolution modelling is necessary to make a really independent validation and verification



High resolution NH₃ emissions

- **Temporal disaggregation of reported national annual emissions**
 - Utilise national knowledge
 - Complies with Convention demands
- **Bottom-up modelling**
 - Dynamic response to abatement scenarios
 - Annual and higher temporal resolution emissions consistent



Include N surplus in CLRTP?

- **Should be an addition to existing limits**
- **Set national limits?**
 - would encourage better N management
 - would require amendment of Convention
- **Alternatively, require reporting of closed national N budget for 3rd stage review**
 - does not require amendment of Convention



Thank you for your attention



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