Air Quality Estimation and Mitigation for Dairies

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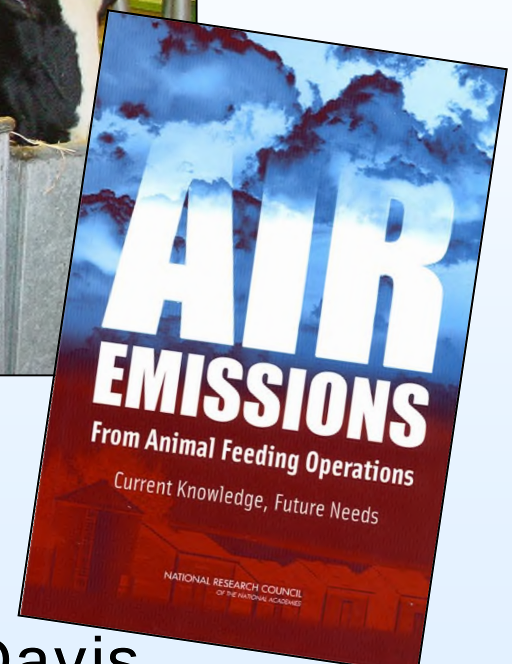
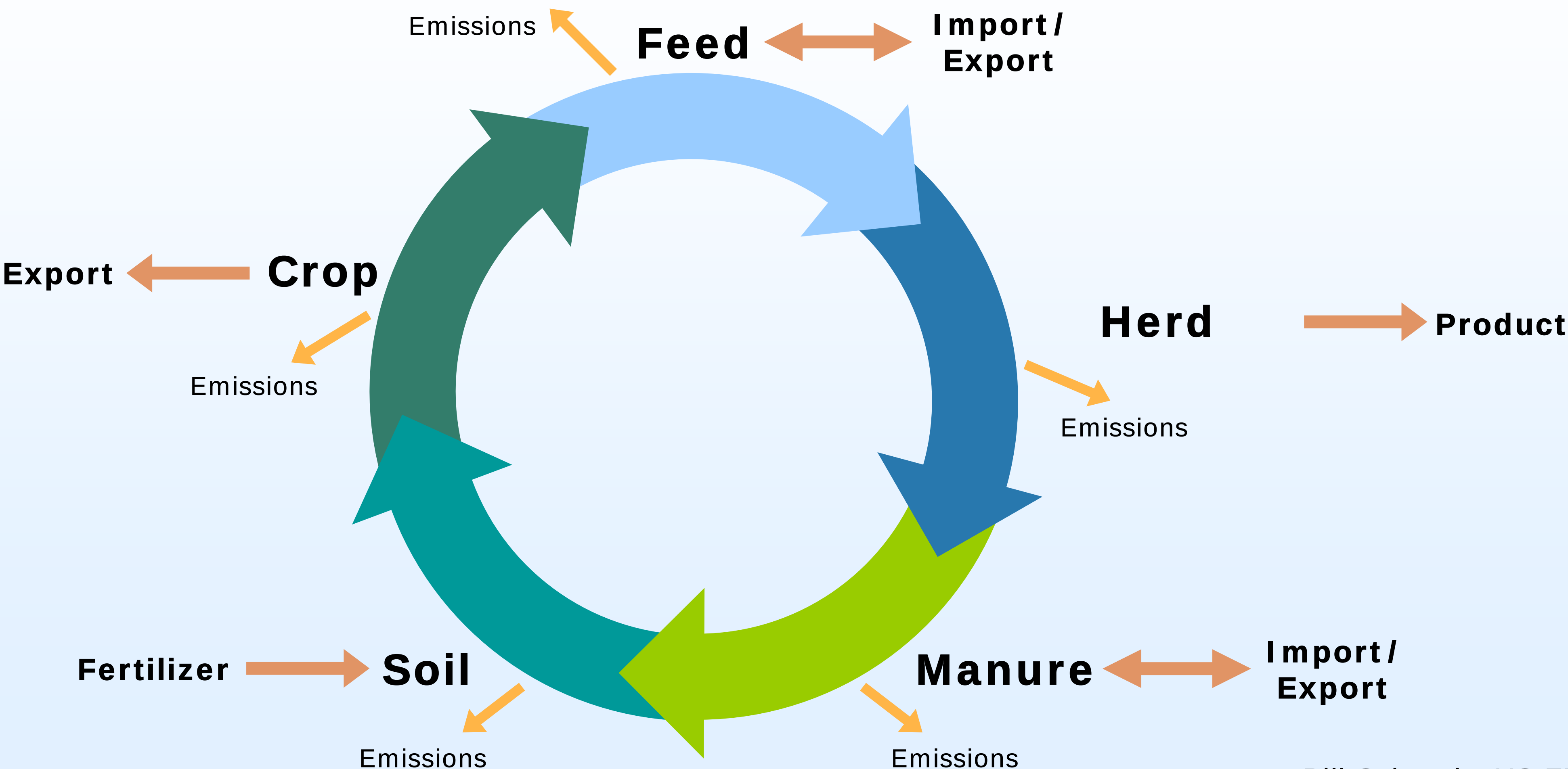


Life Cycle Thinking

- Accounts for site-specific design and management practices as variables and reflects interactions between emission sources
- Reflects mass balance constraints
- Scale specific (e.g., individual AFOs or regional/national scale)



Bill Schrock; US EPA

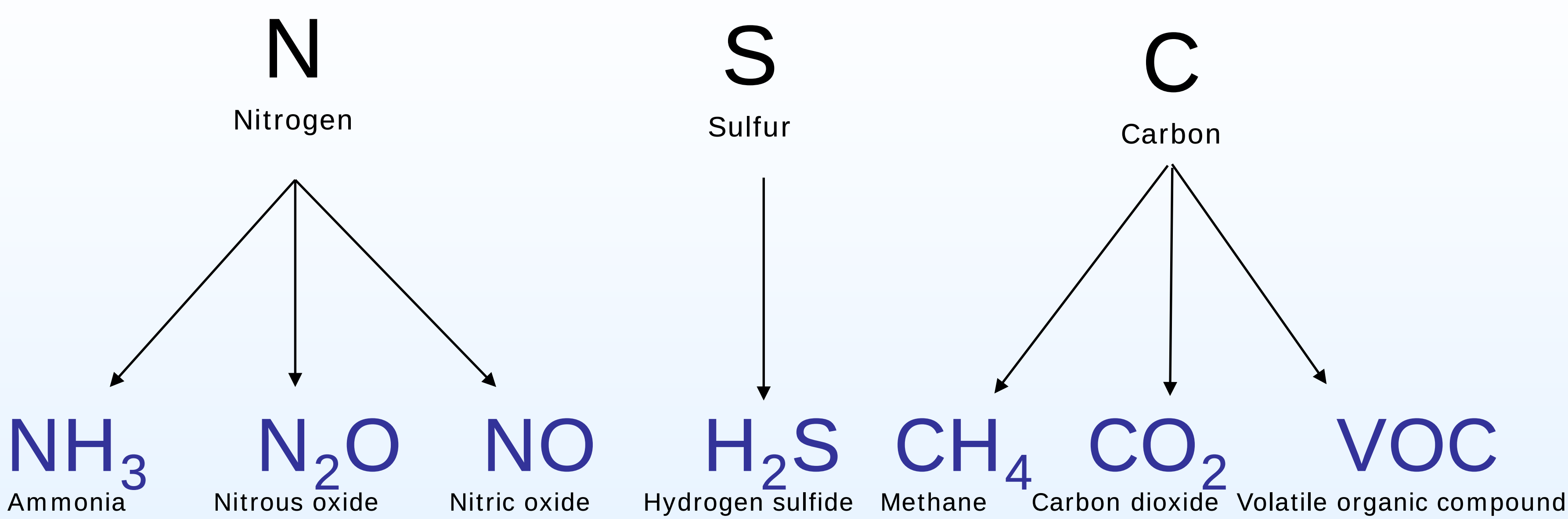
What are the air quality issues?

- National ambient air quality standards (PM, ozone)
- Hazardous air pollutants (e.g., methyl bromide)
- Visibility (regional haze)
- Air deposition (acid rain, nitrification)
- Global climate change (greenhouse gases)
- Odors (nuisance complaints)

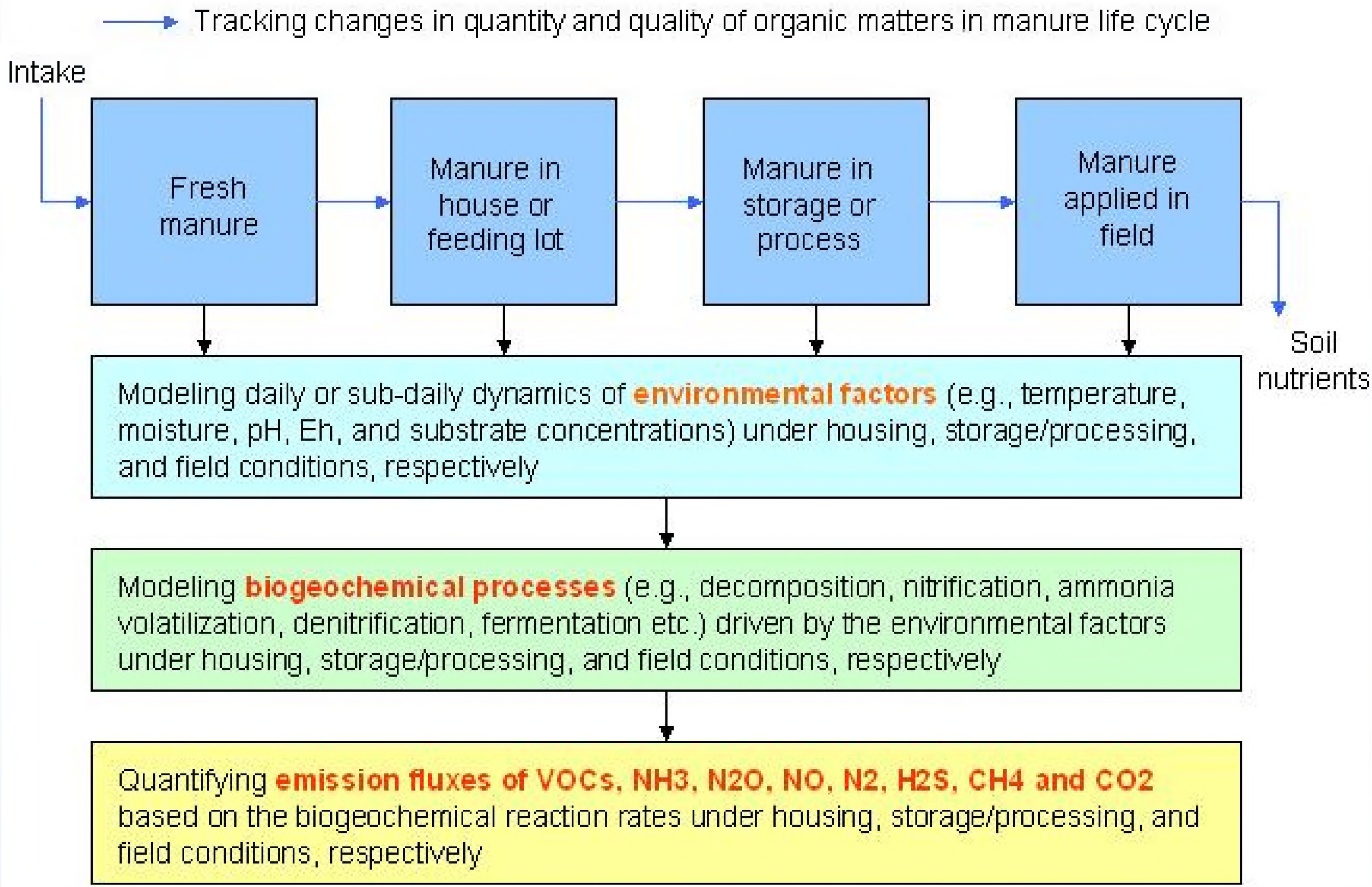
What are the pollutants of concern?

- PM10 (directly formed particles)
- PM2.5 (secondarily formed particles)
- Ammonia (potential PM precursor)
- Volatile organic compounds (ozone precursor)
- Hydrogen sulfide (H_2S)
- Methane (“greenhouse” gas)
- Nitrogen Oxides (NOx, an ozone precursor)

Nutrient elements and related emissions



Modeling Gas Emissions from Life Cycle of Manure



Six Submodels

1. NH_3, CH_4, N_2O and VOC production and emission from animal **housing facilities** driven by housing climate, production of fresh animal manure, and housing management

2. NH_3, CH_4, N_2O and VOC production, consumption and emission under **aerobic storage** (e.g., vented manure stacks, compost, silage face) conditions, driven by quantity and quality of the composted manure mass as well as environmental factors

3. NH_3, CH_4, N_2O, H_2S and VOC production, consumption and emission under **anaerobic storage** (e.g. silage stacks, slurry tank, and lagoon), driven by quantity and quality of stored manure and environmental factors

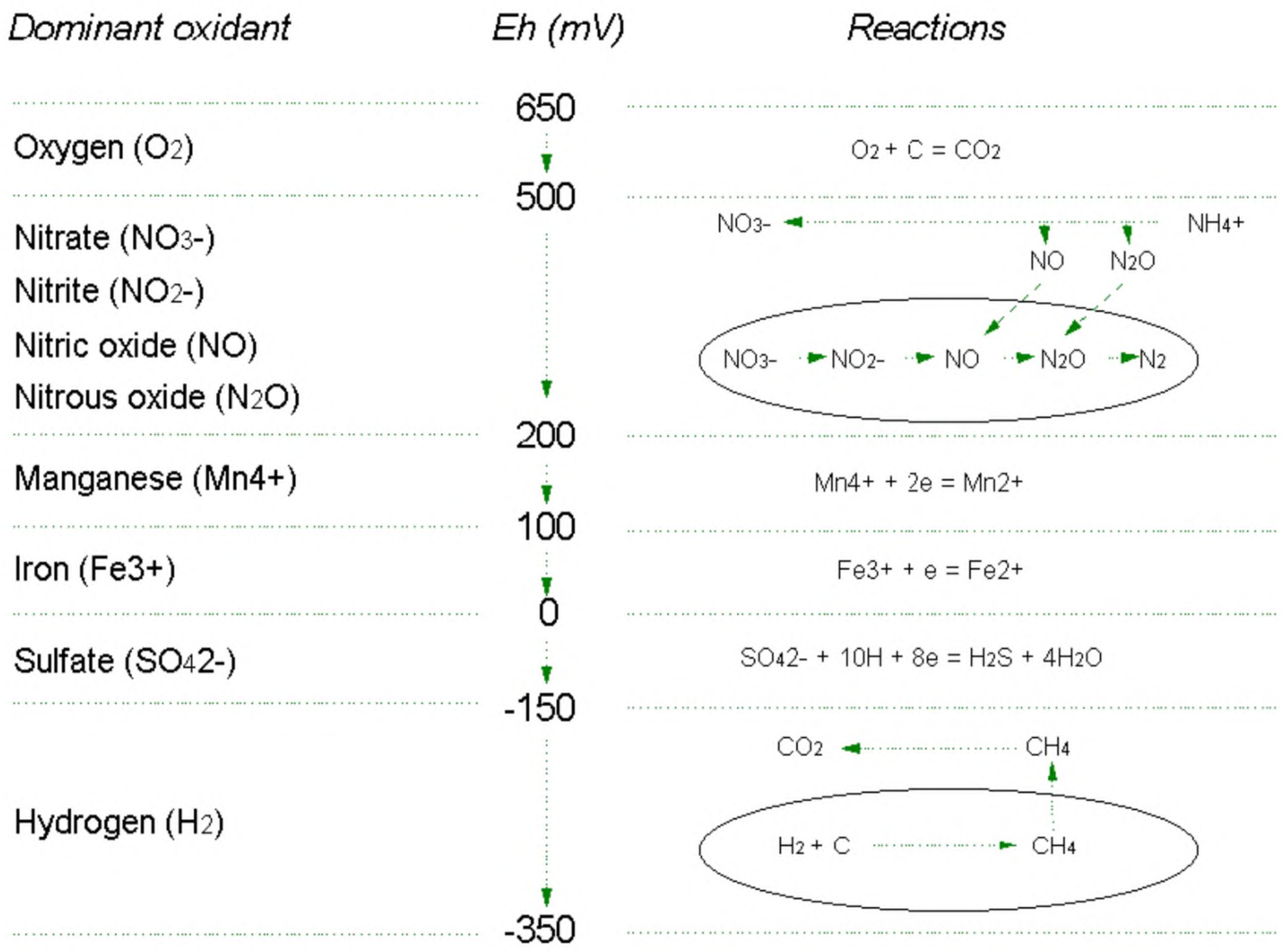
Six Submodels

4. NH_3, CH_4, N_2O and VOC production, consumption and emissions following **field application** of manure, driven by quantity and quality of the manure applied, other farming practices, and environmental factors;

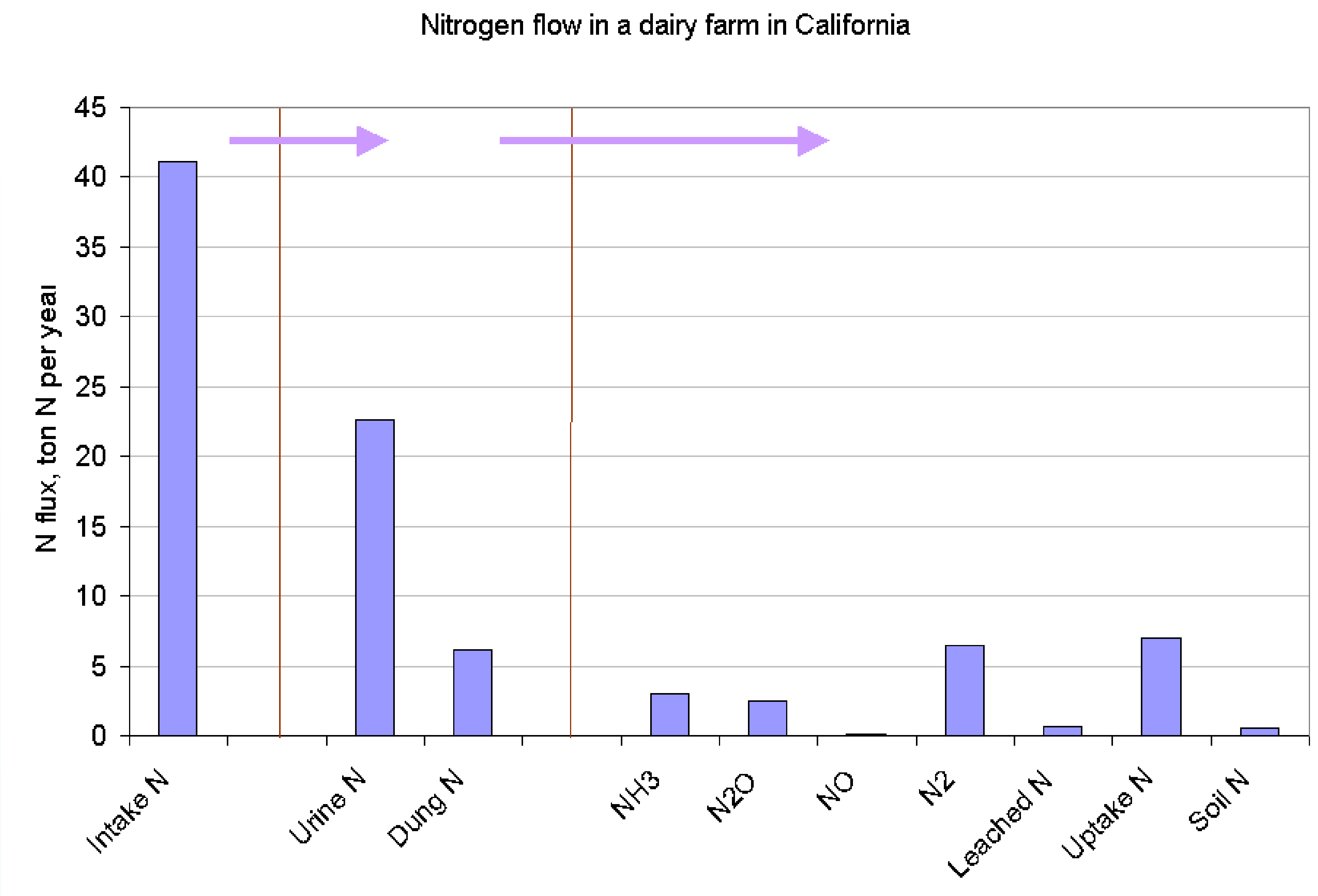
5. **Enteric** CH_4, N_2O and VOC production, driven by quality and quantity of feeding materials as well as animal characteristics;

6. CH_4 and VOC production and consumption during anaerobic digestion under **digester** conditions, driven by quantity and quality of the digested manure as well as environmental factors.

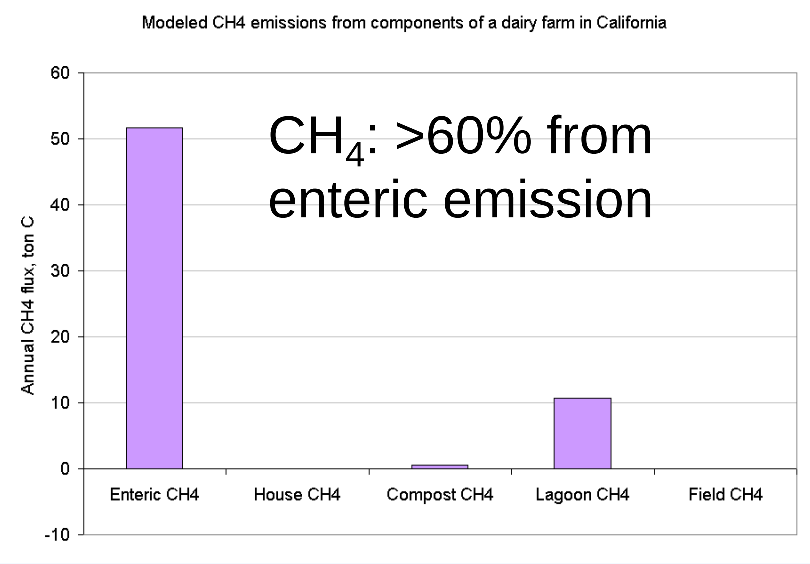
Gas emissions resulting from microbial activity in response to environmental drivers (e.g., pH)

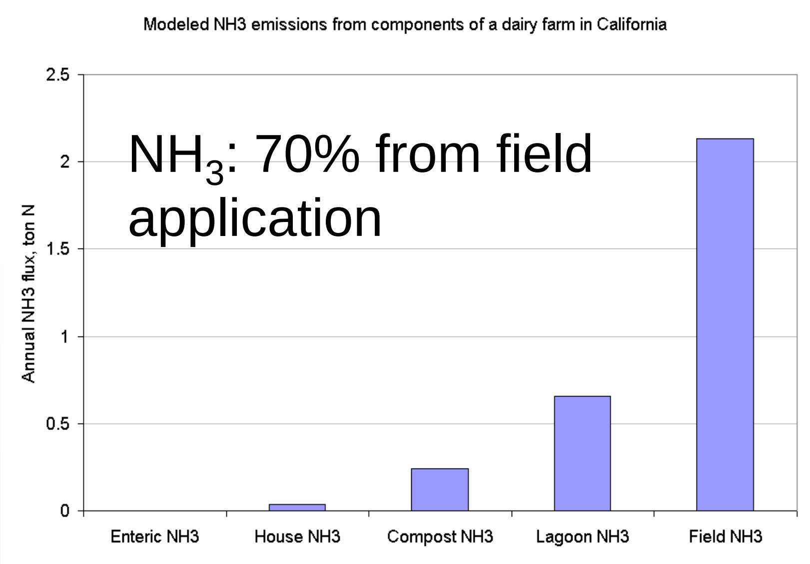


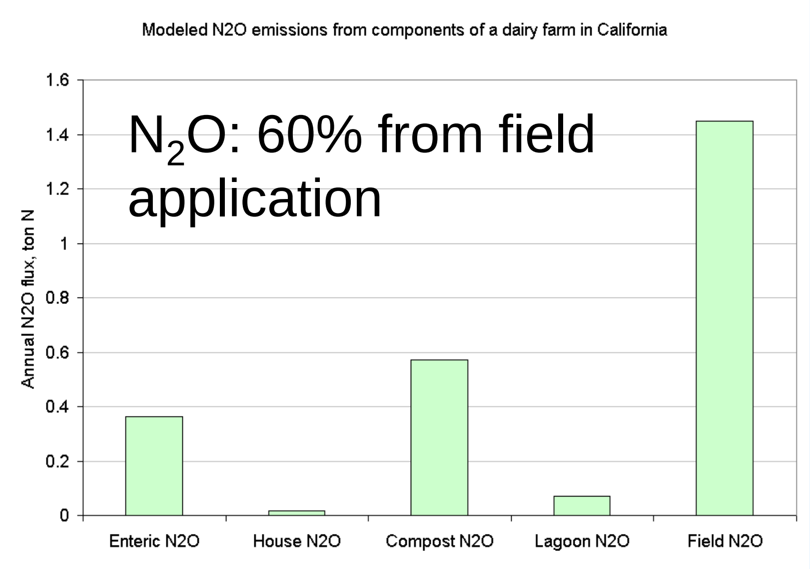
N transport and transformation at farm scale

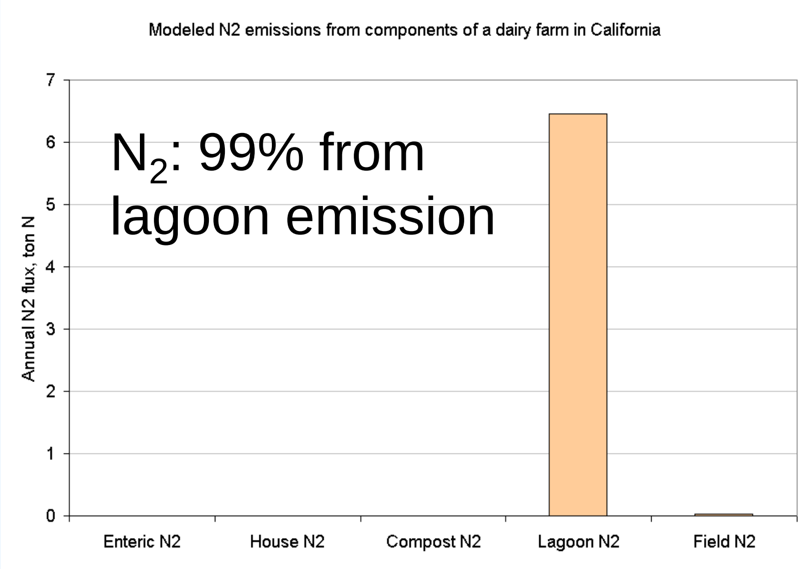


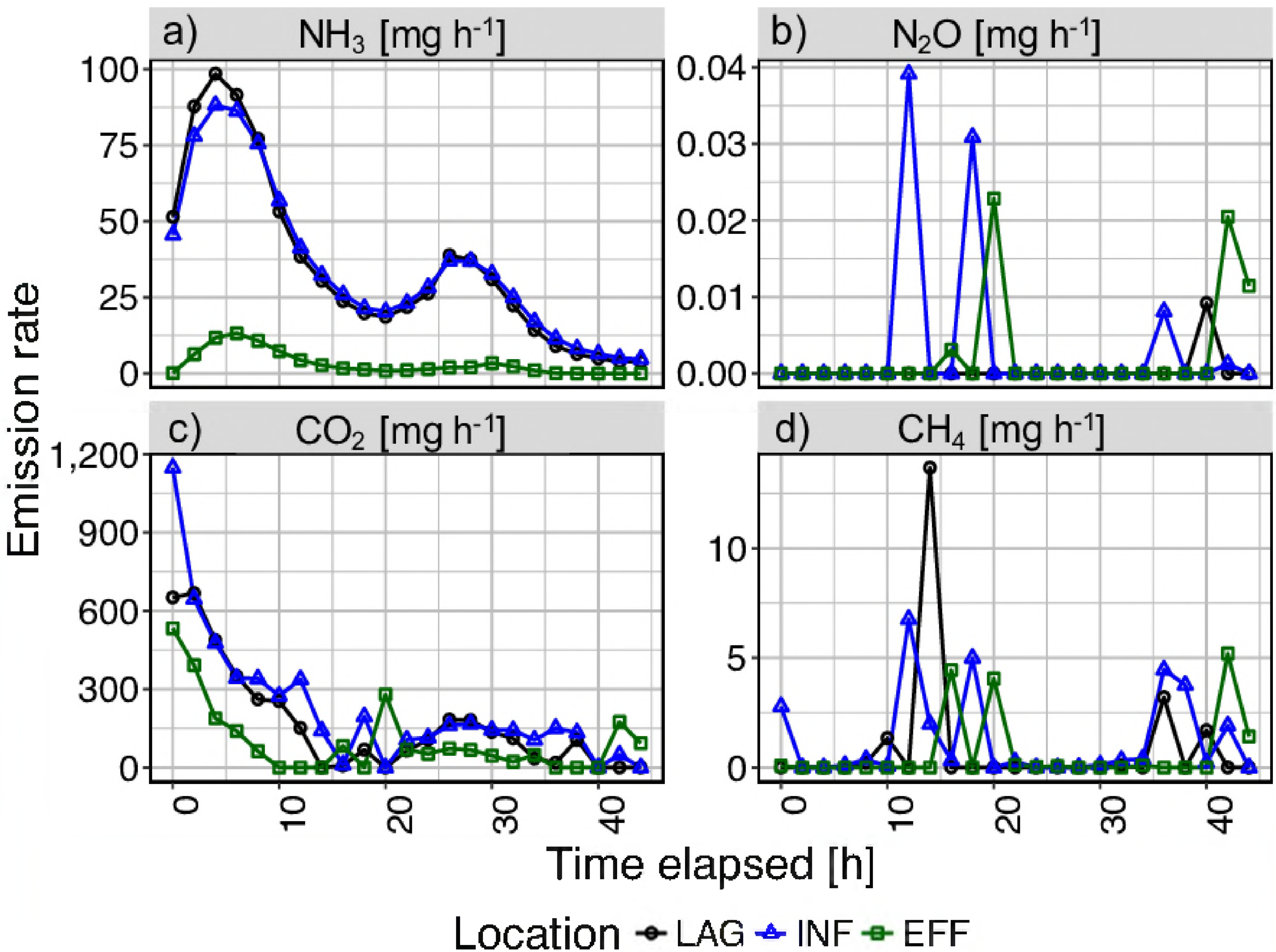
Emissions of CH_4, NH_3, N_2O and N_2 are dominated by different farm components





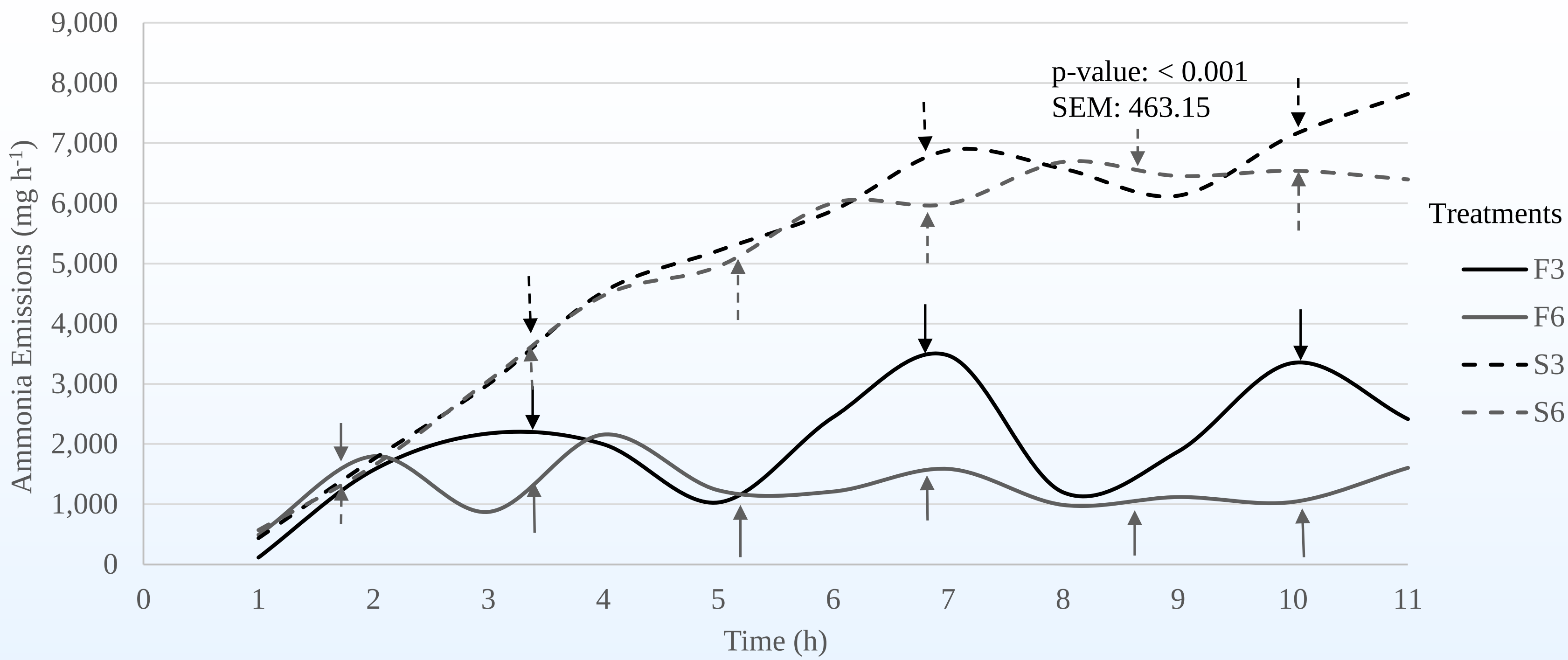


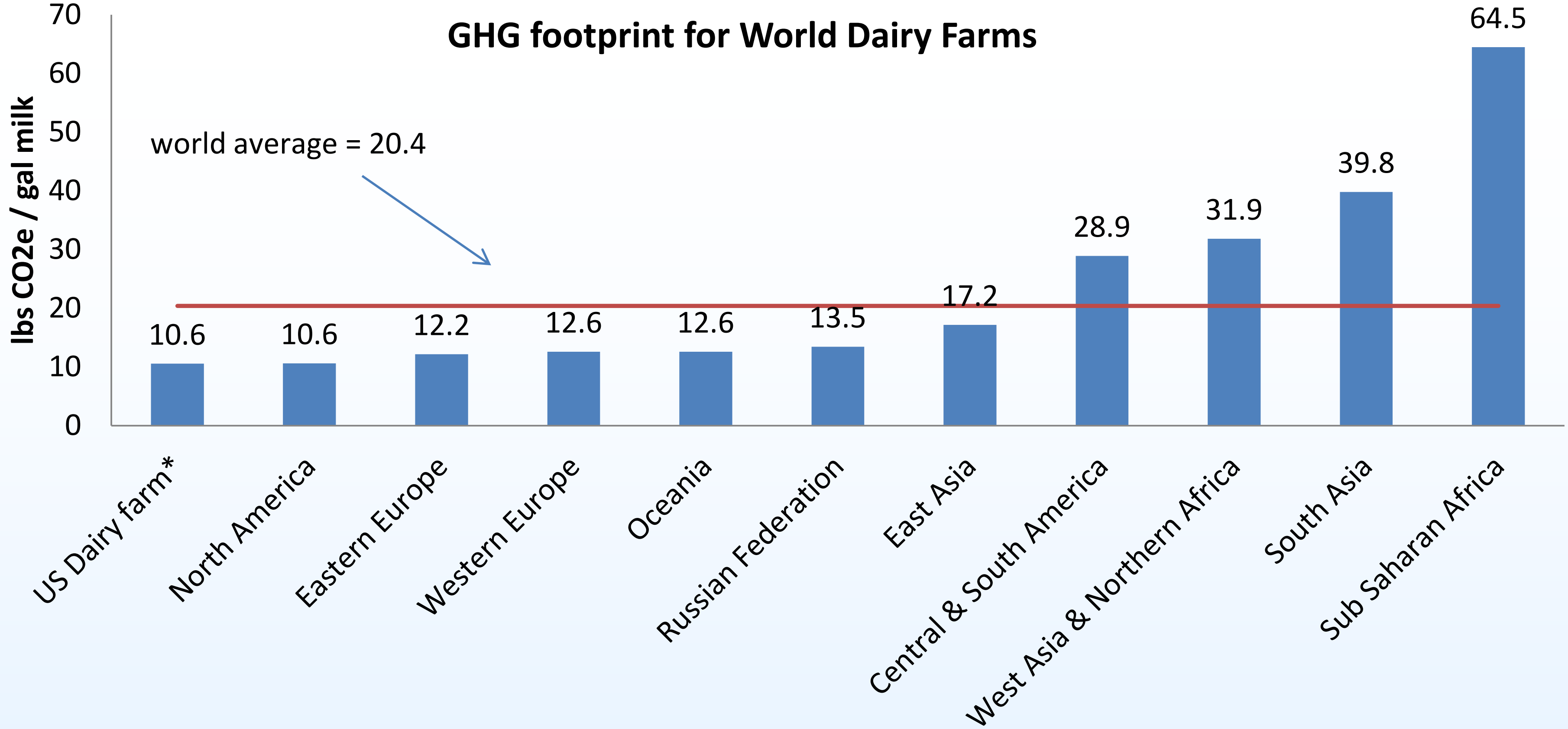




a) NH3 [mg h-1]
b) N2O [mg h-1]
c) CO2 [mg h-1]
d) CH4 [mg h-1]
Emission rate
Time elapsed [h]
Location LAG INF EFF

Freestall emissions FL vs SC





Sources: FAO (2010), for 2007 data; *Univ. Ark (2010), for 2007 data.

Note that different studies should not be compared directly.

Production Efficiency

	Dairy CH_4 emission factor (kg/head/yr)	Milk production (kg/head/yr)
North America	118	6,700
EU	100	4,200
Latin America	57	800
Africa	36	475

(IPCC, 1996)

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