How much does livestock actually contribute to global warming?

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Motivation

- **How much actual warming is due to GHG emissions from livestock?**
  How important is this in the context of the 2°C global warming limit?

  CO₂-equivalent GHG emissions are an imperfect way of comparing actual warming from different GHGs over the 21st century
  - CH₄ has much shorter lifetime than CO₂, doesn’t accumulate
  - Radiative efficiency changes with atmospheric concentrations
  - GWP₁₀₀ is contested in science, policy & farming community

- **Use a detailed climate model to calculate the actual warming due to estimated emissions of CH₄, N₂O and CO₂ from global livestock**
Methods

- **Historical emissions**: direct CH$_4$ and N$_2$O livestock emissions from EDGAR database (~9% of total GHGs); estimates for 1860-1970
  
  CO$_2$: assume 50% of deforestation due to livestock (rough estimate)

- **Future scenarios to 2100**:
  
  ✓ **Business as usual**: FAO projects ~30% growth to 2050; assume moderate further growth that flattens out by 2075
  
  ✓ **Stringent mitigation**: assume livestock emissions 40% below BAU by 2100; consistent with range from global assessment models

- **Climate model**: MAGICC v6, RCP8.5/2.6 emissions for other sectors (as in IPCC 2014; reproduces outputs from complex climate models)
Livestock CH$_4$ emissions (enteric + manure)

BAU: 30% increase in 2050 over 2010 (FAO)
Mitigation: 40% below BAU in 2100

Gernaat et al. 2015, GEC
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Livestock contribution to historical warming

- modelled temperature
- minus CH₄: 0.81°C in 2010
- minus (CH₄ + N₂O): -0.11°C (14%)
- minus (CH₄ + N₂O + CO₂): -0.16°C (19%)
- minus (CH₄ + N₂O + CO₂): -0.27°C (34%)

Year

1860 1880 1900 1920 1940 1960 1980 2000 2020

Temperature (°C, relative to pre-industrial)
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Livestock contribution to future warming

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<thead>
<tr>
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<th>RCP8.5</th>
<th>RCP2.6</th>
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<tbody>
<tr>
<td>Modelled 2100 temp</td>
<td>4.63°C</td>
<td>1.47°C</td>
</tr>
<tr>
<td>- CH₄</td>
<td>0.14°C (4%)</td>
<td>0.18°C (27%)</td>
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<tr>
<td>- (CH₄ + N₂O)</td>
<td>0.23°C (6%)</td>
<td>0.27°C (41%)</td>
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<tr>
<td>- (CH₄ + N₂O + CO₂)</td>
<td>0.34°C</td>
<td>0.43°C</td>
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of the warming 2010-2100

Direct non-CO₂ emissions from livestock could make a major (>40%) contribution to warming between 2010 and 2100

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Conclusions

- Livestock non-CO\textsubscript{2} emissions make a greater contribution to actual warming in 2010 than indicated by GWP (19%, not \sim9\%)

- The importance of livestock emissions for future warming depends on the global emissions scenario:
  - If the world continues with business as usual, livestock non-CO\textsubscript{2} emissions contribute only 6\% to warming between 2010 and 2100 (more than 4.6°C)
  - If other sectors stringently reduce emissions consistent with the 2°C limit, livestock non-CO\textsubscript{2} emissions alone could make up >40\% (0.27°C) of the warming yet to come between 2010 and 2100 – even if livestock emissions are reduced by 40\% below business as usual by 2100
Conclusions

Expanding the mitigation potential for livestock would make a significant contribution to allow the world to achieve the ambitious mitigation goals agreed in Paris in 2015.

Acknowledgements

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