Estimating Differences in Soil Nitrous Oxide Emissions due to Timing of N Fertilizer Application Using a Modified National Inventory Report Approach

. . . . . .

53rd Annual Manitoba Soil Science Society Conference
February 4th and 5th, 2010

Matthew Wiens
Agri-Environment Knowledge Centre
Manitoba Agriculture, Food and Rural Initiatives

Manitoba

- **Introduction**
  - Context
    - GHG emissions in MB: importance of N_2O
    - Situation in MB: common fertilization practices
    - The case for spring N application

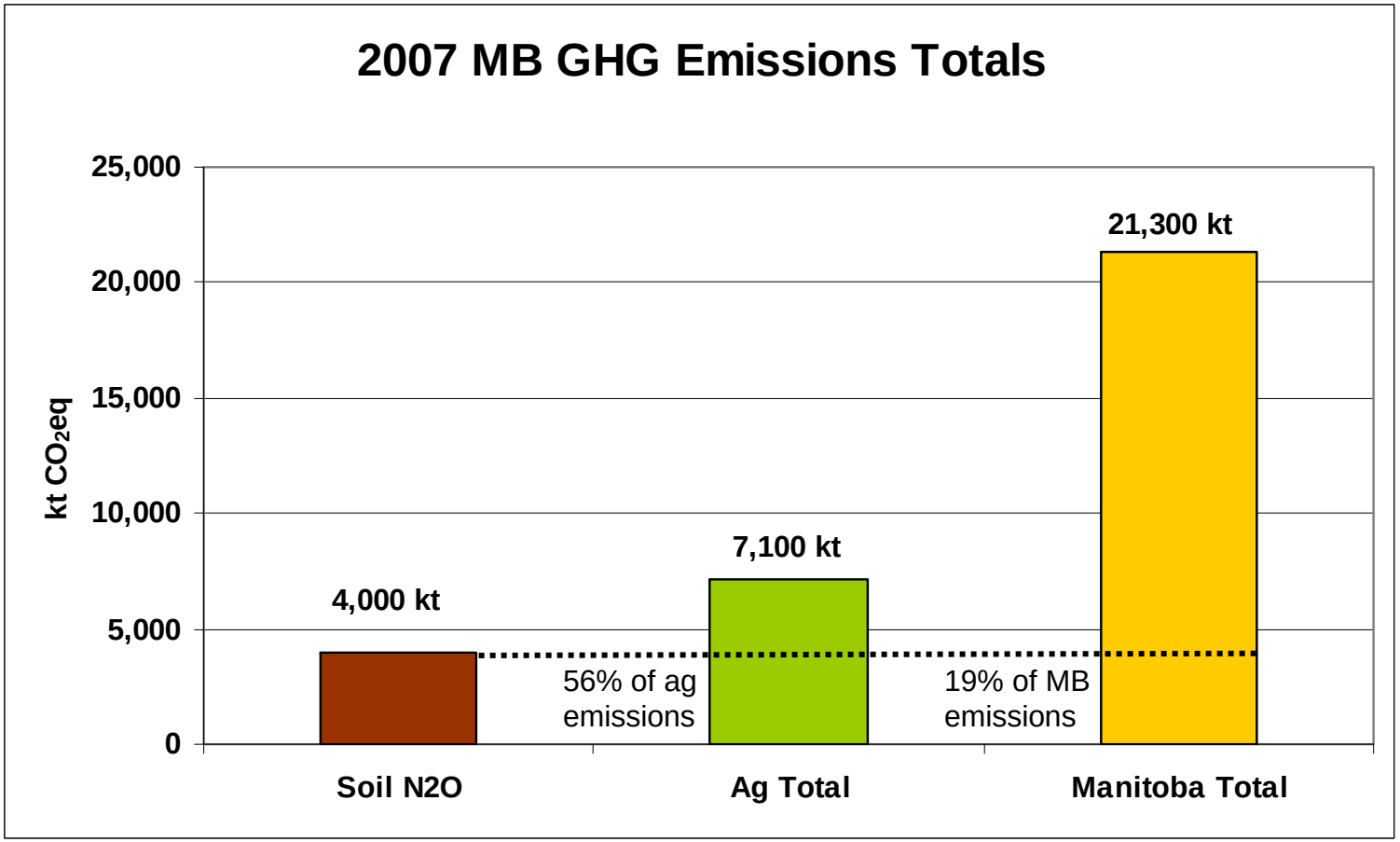
- **National Inventory Report Methodology and Modifications**

- **Potential to Reduce N_2O Emissions in Manitoba**

- **Conclusion**

GHG Emissions in MB:

How much does N_2O from agricultural soils contribute?



Source: Environment Canada. National Inventory Report 1990-2007.

GHG Emissions in MB:

How much does N_2O from agricultural soils contribute?

- ~50% of this 4,000 kt CO_2eq is attributed to synthetic N fertilizer application; manure and crop residues contribute the remainder
- For comparison:
  - Enteric fermentation = 2,200 kt CO_2eq
  - Residential heating = 1,100 kt CO_2eq

- Source: www.cfindustries.com/Products.htm

- Nitrogen fertilizer is often applied in fall in Manitoba.
- 40% of N fertilizer is anhydrous ammonia (based on CFI statistics)

Evidence for reduced N_2O emissions with spring applied N compared with to fall applied N

- Burton, Li and Grant. 2008
- Lemke et al. 2003
- Hao, Chang, Carefoot, Janzen and Ellert, 2001

Indirect evidence

Better N efficiency with spring app vs fall app

- Tiessen et al. 2005
- Ridley. 1975

Table 8. Nitrogen efficiency based on application time and placement.

Time and Method	Relative Values
Spring broadcast	100%
Spring banded	120%
Fall broadcast	80%
Fall banded	100%

How we calculate a reduction

- Assumption:

  10% reduction in N_2O emissions due to shift from fall to spring N application

2009 National Inventory Report Approach

- Base N_2O Emission Factor (EF_{BASE})
- Precipitation/Evapotranspiration (P/PE) May to October
  - Based on 1971 – 2000 long term normals
- $EF_{CT} = 0.022 * P/PE – 0.0048$
- $EF_{BASE} = EF_{CT,\ P/PE=1} * F_{TOPO} + EF_{CT} * (1 – F_{TOPO})$

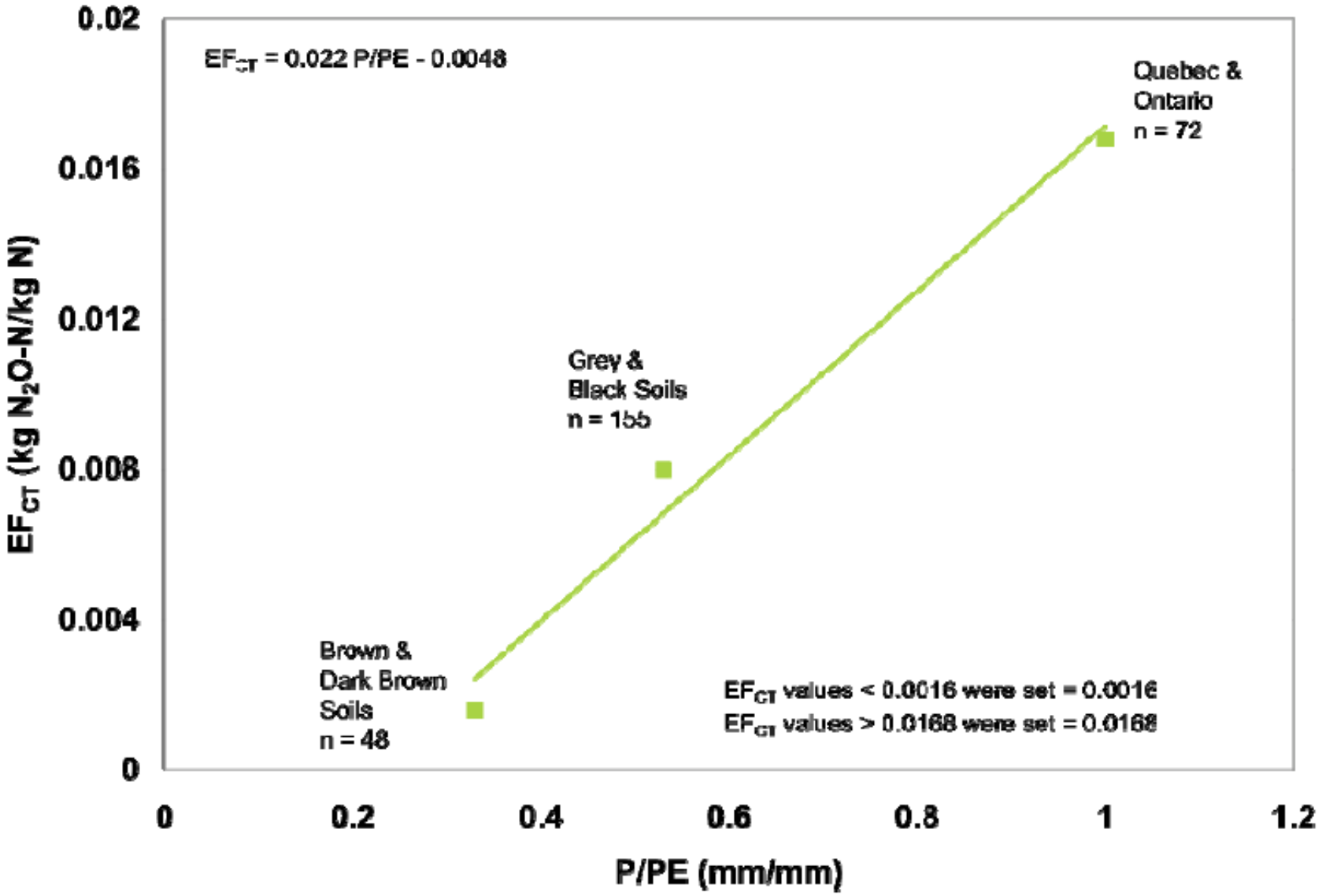
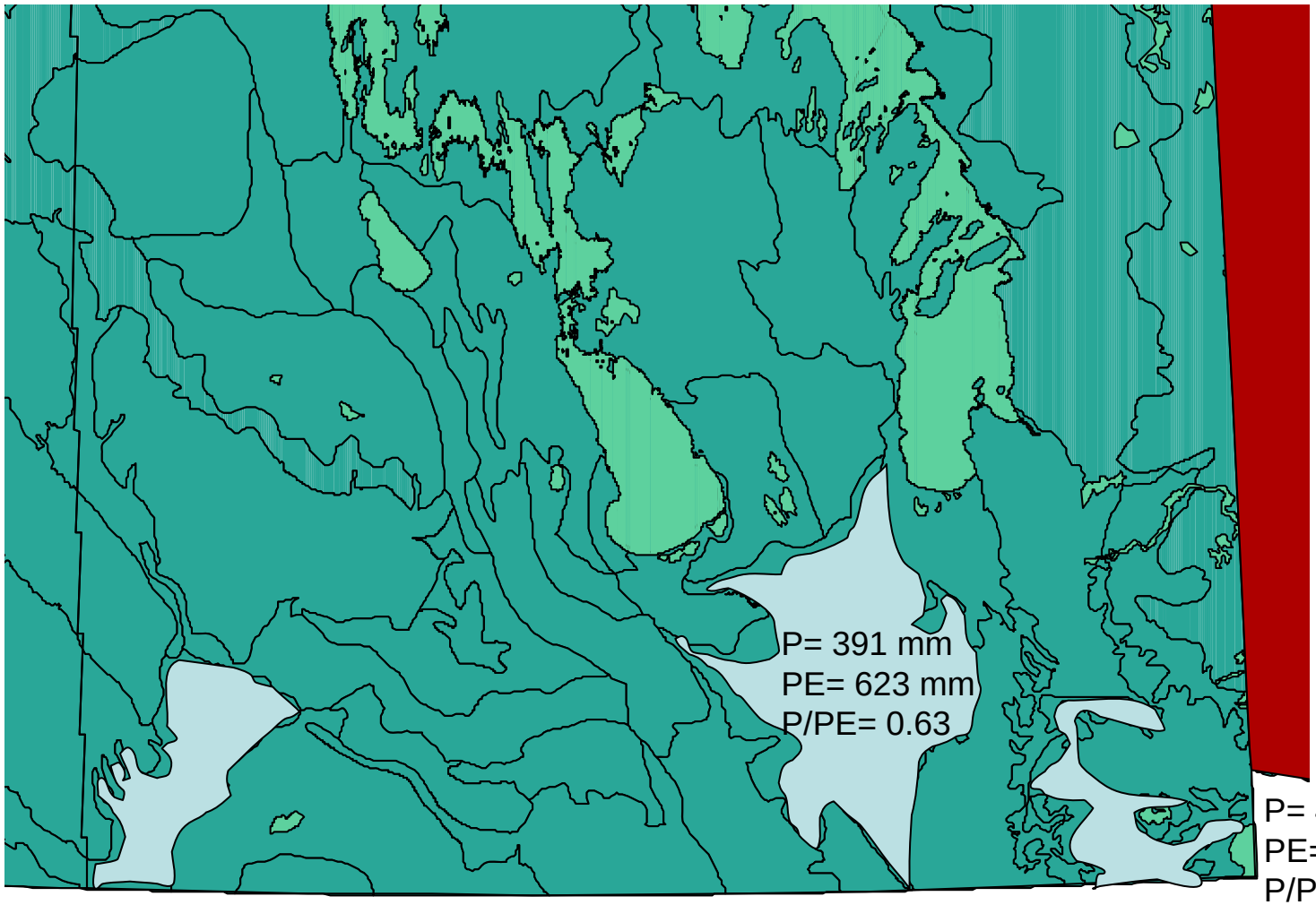


Figure A3-2: EF_{CT} as a Function of Long-term Ratio of Precipitation over Potential Evapotranspiration (P/PE) from 1971 to 2000

Southern Manitoba Ecodistricts



P= 346 mm
PE= 629 mm
P/PE= 0.55

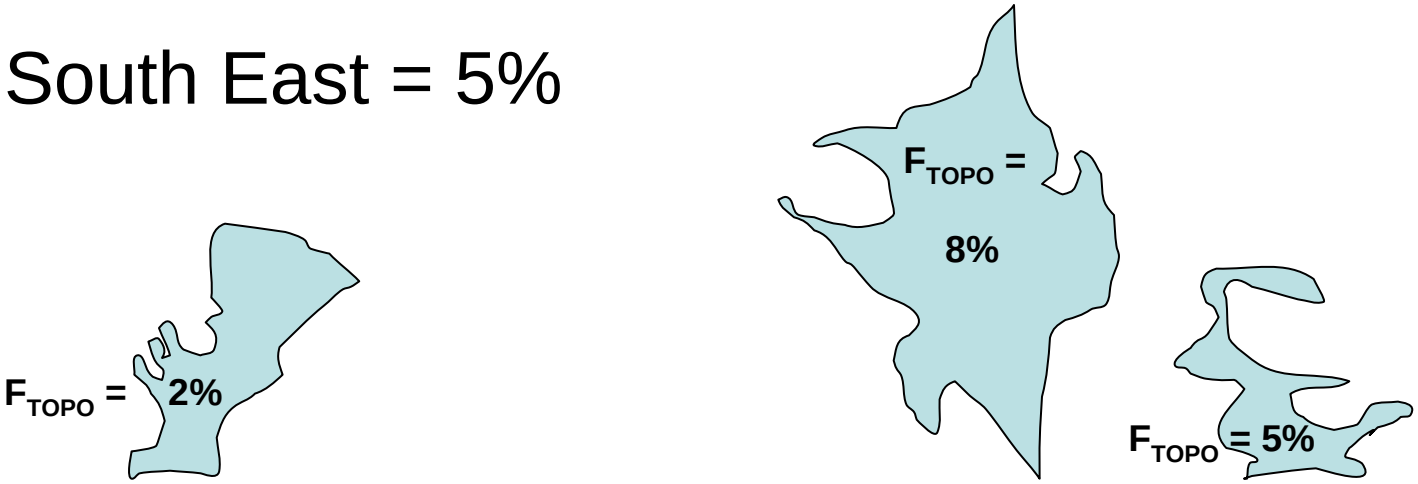
P= 413 mm
PE=587 mm
P/PE= 0.70

2009 National Inventory Report Approach

- Base N_2O Emission Factor (EF_{BASE})
- Precipitation/Evapotranspiration (P/PE) May to October
  - Based on 1971 – 2000 long term normals
- $EF_{CT} = 0.022 * P/PE – 0.0048$
- $EF_{BASE} = EF_{CT,\ P/PE=1} * F_{TOPO} + EF_{CT} * (1 – F_{TOPO})$

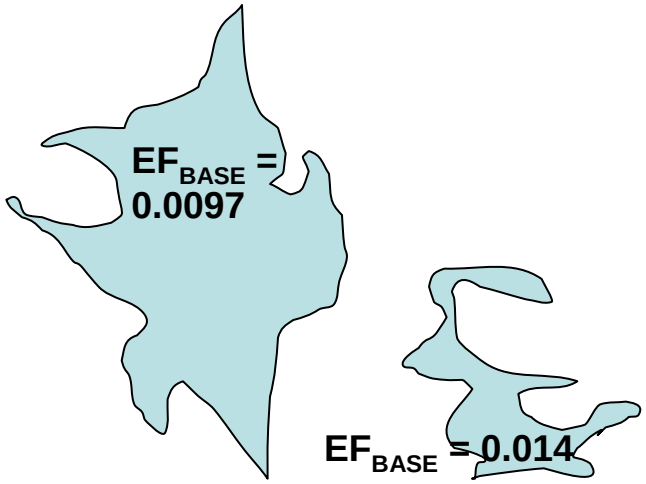
F_{TOPO}

- Fraction of land in the lower section of toposequence
  - South West = 2%
  - Central = 8%
  - South East = 5%



EF_{BASE}

- Amount of applied N lost as N_2O-N
- Units, kg N_2O-N/kg applied N
  - South West = 0.0075
  - Central = 0.0097
  - South East = 0.014



Average Soil N_2O Emission Factor for Manitoba

- Simple average for all of Manitoba ecodistricts: EF_{BASE} = 0.0099 kg N_2O-N/kg N applied
- Average with ecodistricts weighted for proportion of N fertilizer used in the province = **0.0093** kg N_2O-N/kg N applied

GHG Mitigation Potential

- Total reduction potential of ~5% of current fertilizer N_2O emissions
  - Equal to 100,000 tonnes CO_2eq/year in MB

- Progress so far:
  - 65,000 acres
  - 1,800 tonnes CO_2eq/year
  - 62 tonnes/year/farm

Summary and Conclusion

- 10% reduction in N_2O emissions due to shift from fall to spring N application
- Average MB emission factor of **0.0093** kg N_2O-N/kg N applied
- Potential to reduce fertilizer N_2O emissions in MB by ~100,000 tonnes (5% of total)
- About 60 tonnes/year for a 2200 acre grain farm

- **Therefore,** shifting from fall to spring N application holds promise for reducing N_2O emissions from N fertilizer in Manitoba.

Manitoba

Thank You

NERP: Is this a Carbon Offset Opportunity?

- NERP: Nitrous Oxide Emission Reduction Protocol
- Being developed for Alberta Offset System
- Could be adopted across Canada if a national offset system is implemented

Mid-row banders on seeder

Source: www.reducedtillage.ca/article28.aspx