

Issues of measurement depth and tillage on soil C monitoring

Denis Angers

Tillage and N₂O emissions

Philippe Rochette

Agriculture and Agri-Food Canada
Québec



Agriculture and
Agri-Food Canada

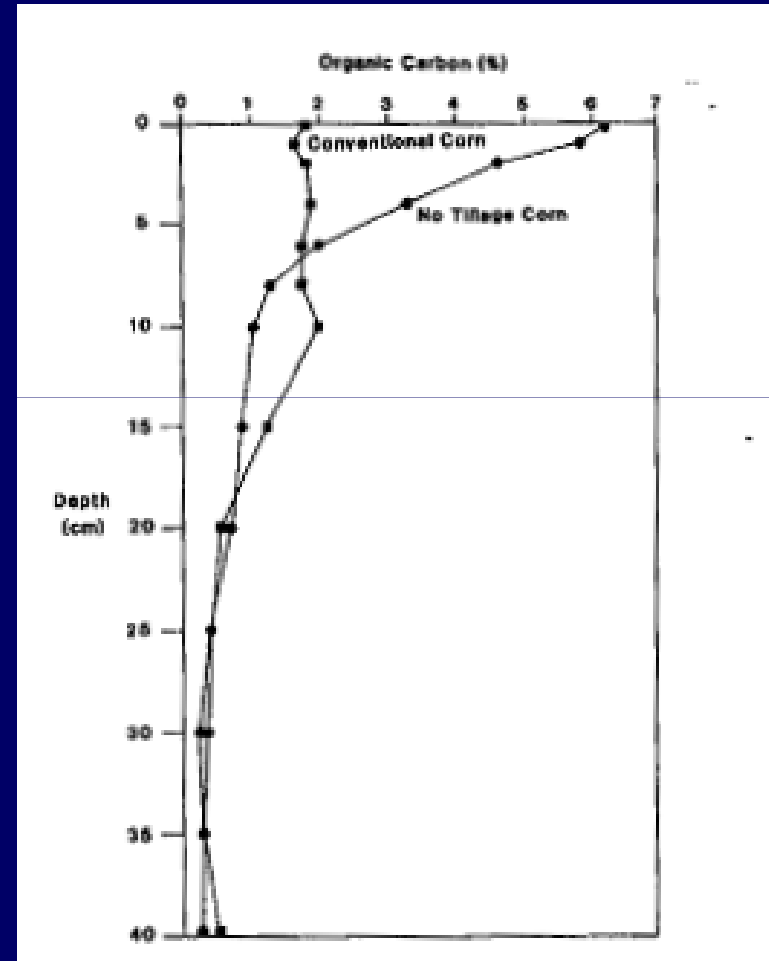
Agriculture et
Agroalimentaire Canada

Measurement depth, tillage and soil C monitoring

Effects of tillage vary with soil depth...

Questions

- Depth of sampling
- Number and thickness of depth increments



Edwards et al. 1988 (Ohio)

Tillage practices vary...

Example, in Canada:

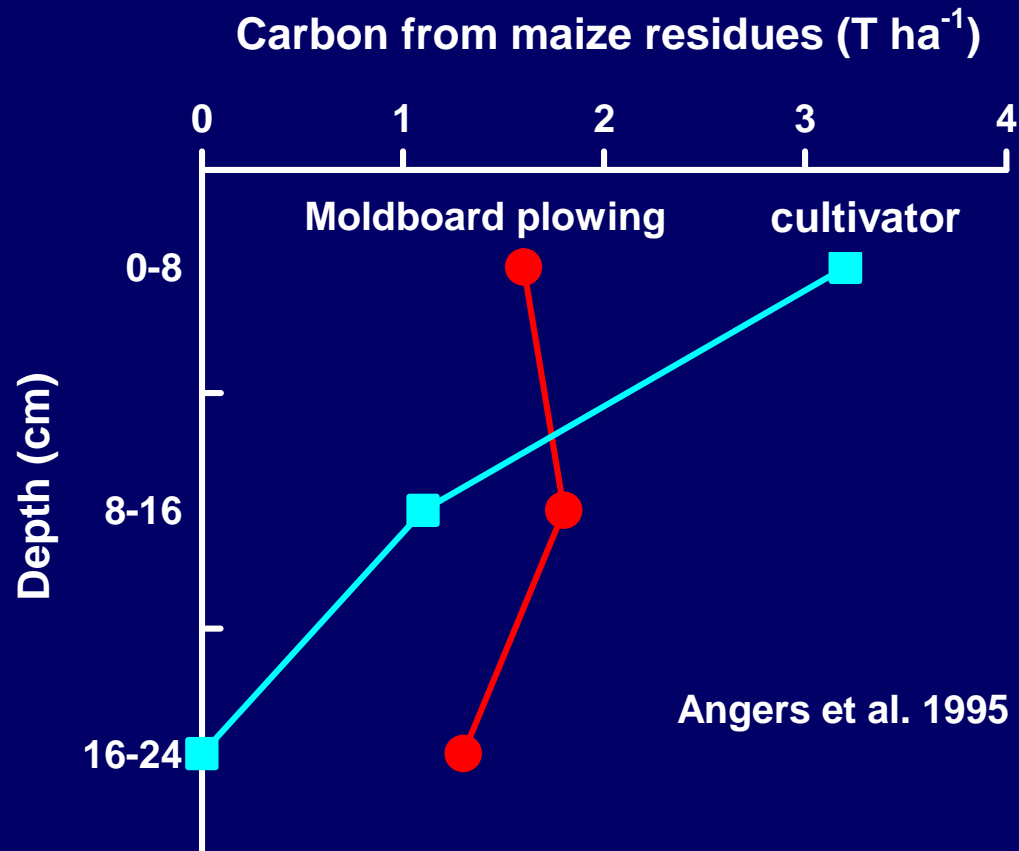
Prairies: Heavy-Duty Cultivator

- <10 cm, no inversion, high speed
- semi-arid climate

East: Moldboard plow

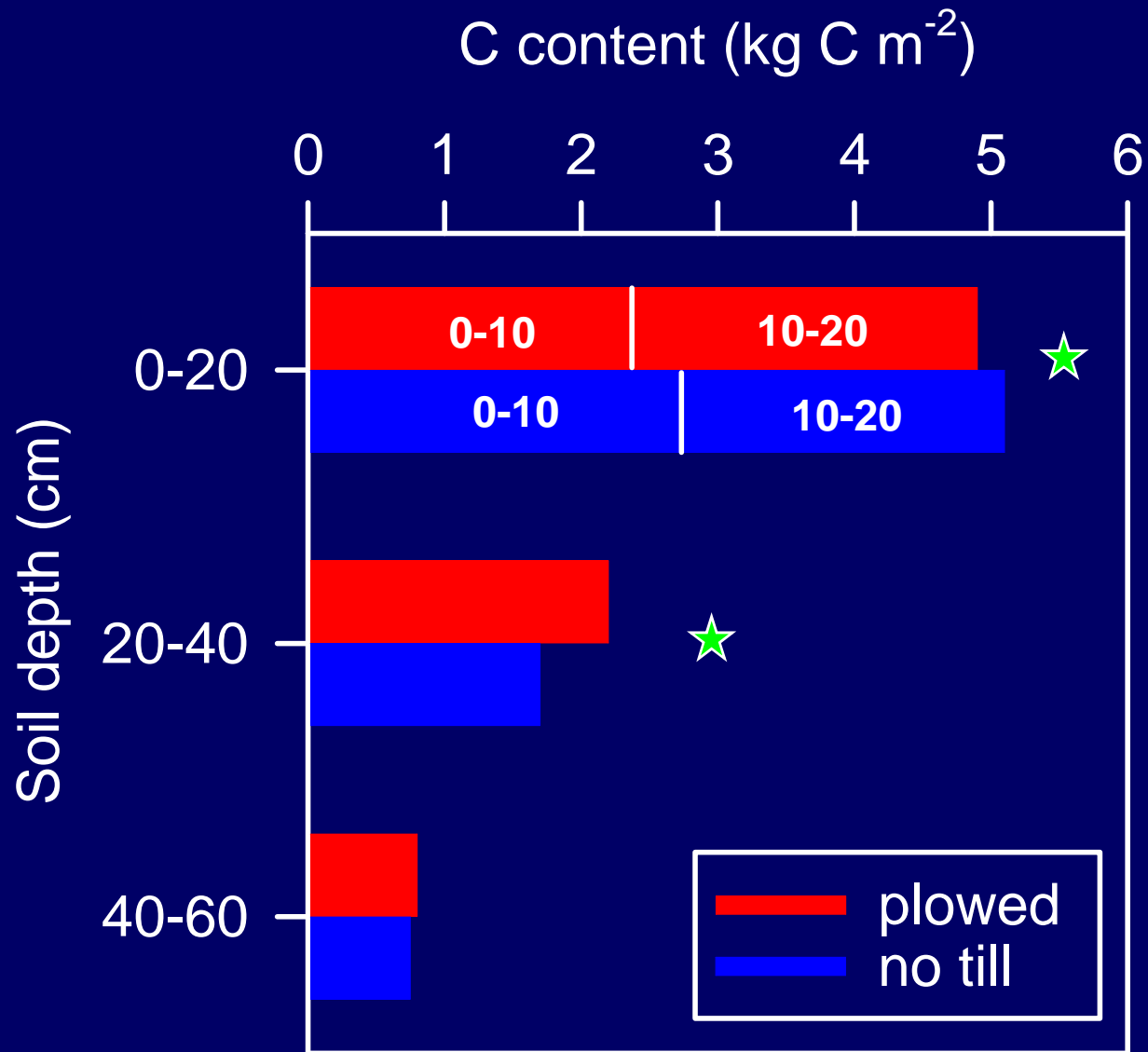
- inversion
- approx. 20 cm (variable), low speed
- moist/humid climate

Depth of residue incorporation varies...



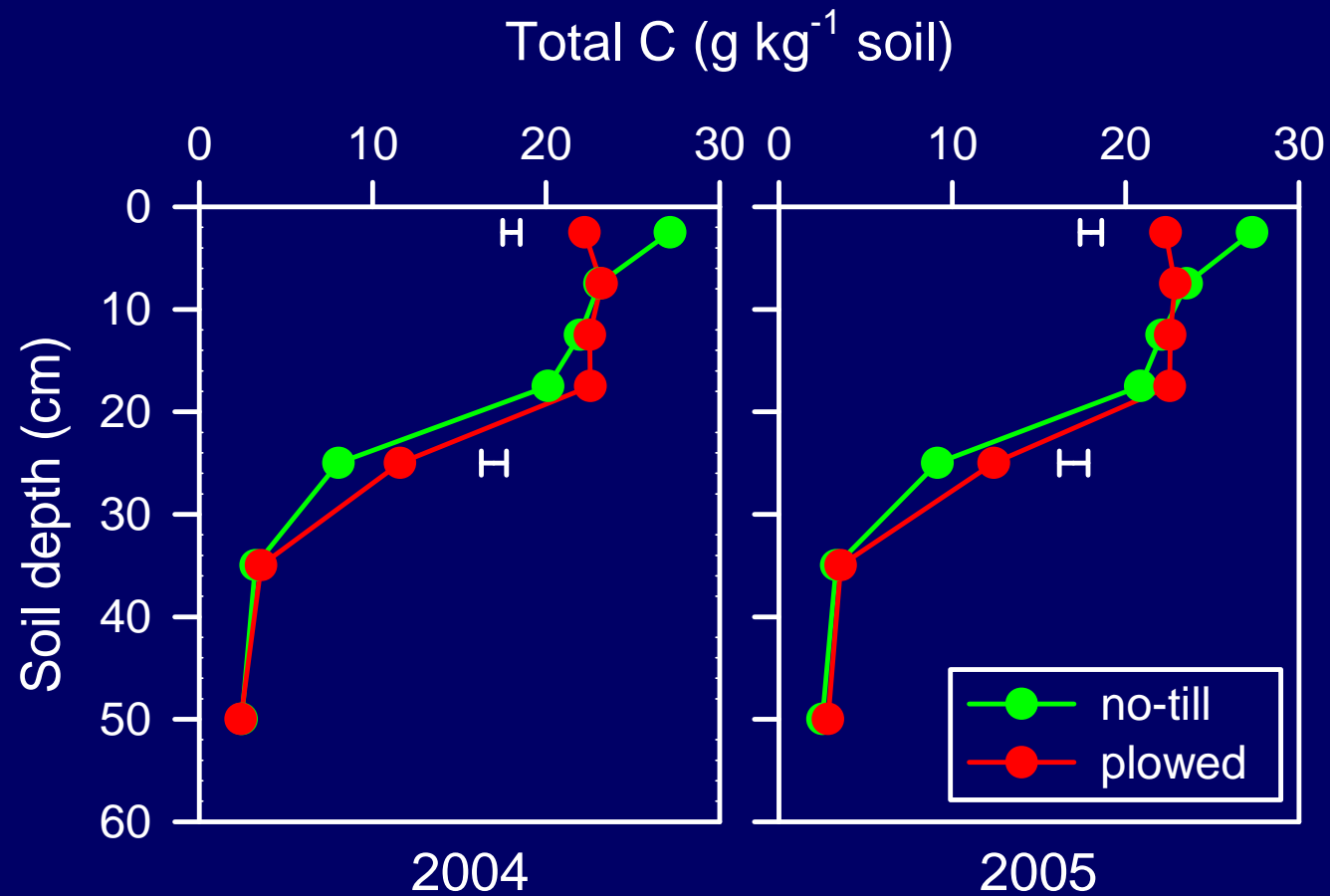
Corn-derived C distribution (using ^{13}C)





- Average of seven sites from Eastern Canada (Angers et al. 1997)

Example from Eastern Canada



Poirier et al. 2009; SSSAJ

Minnesota, 14 yr continuous corn,
Mg C ha⁻¹ cm⁻¹

Depth	NT	MP
0-7.5	4.49*	3.89
7.5-15	4.94	4.66
15-30	3.51	3.17
30-45	2.45*	1.48

Huggins et al., 2007

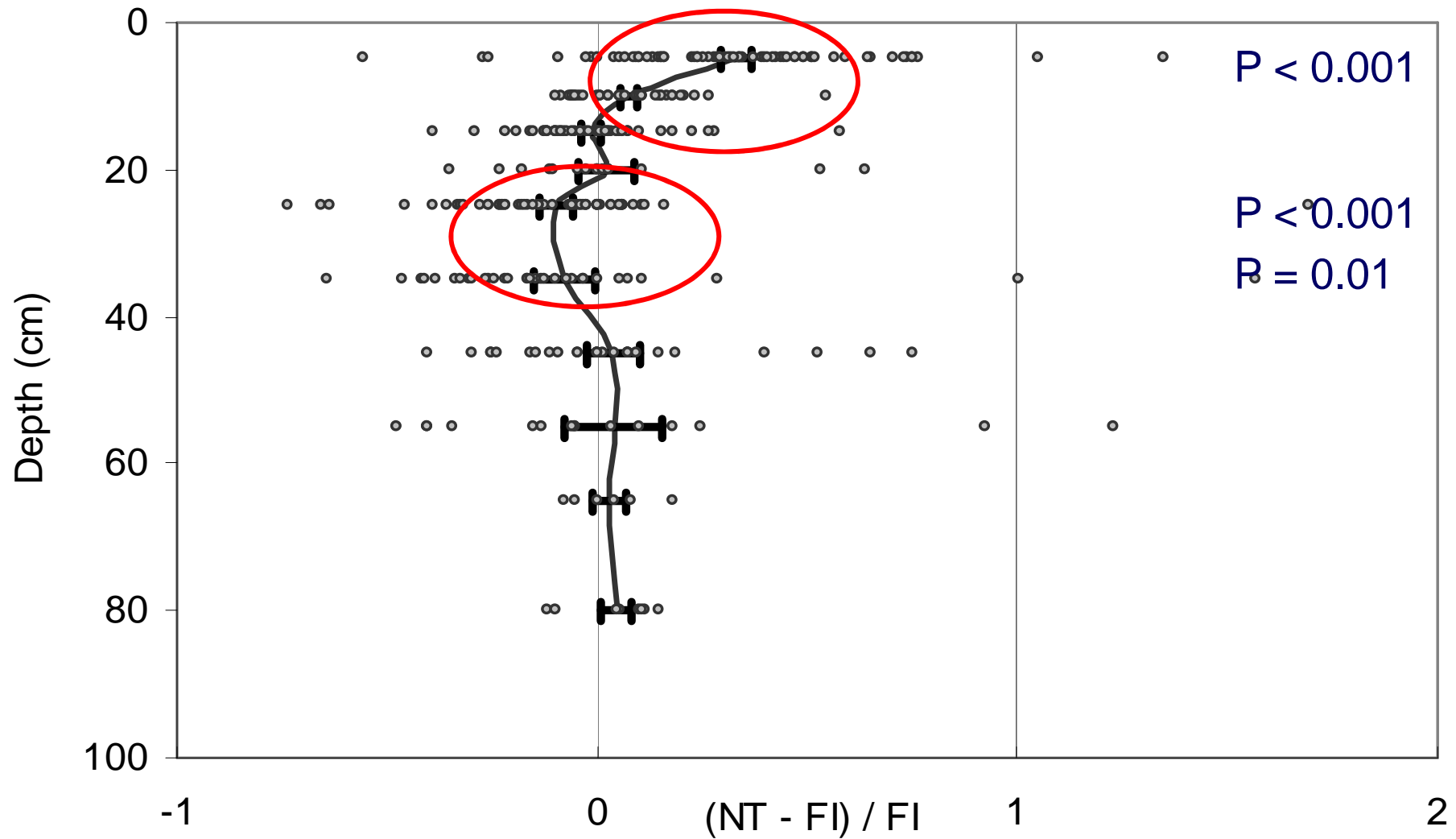
Effects are highly variable
and not always easy to
explain...

-> Meta-analyses

Meta-analysis

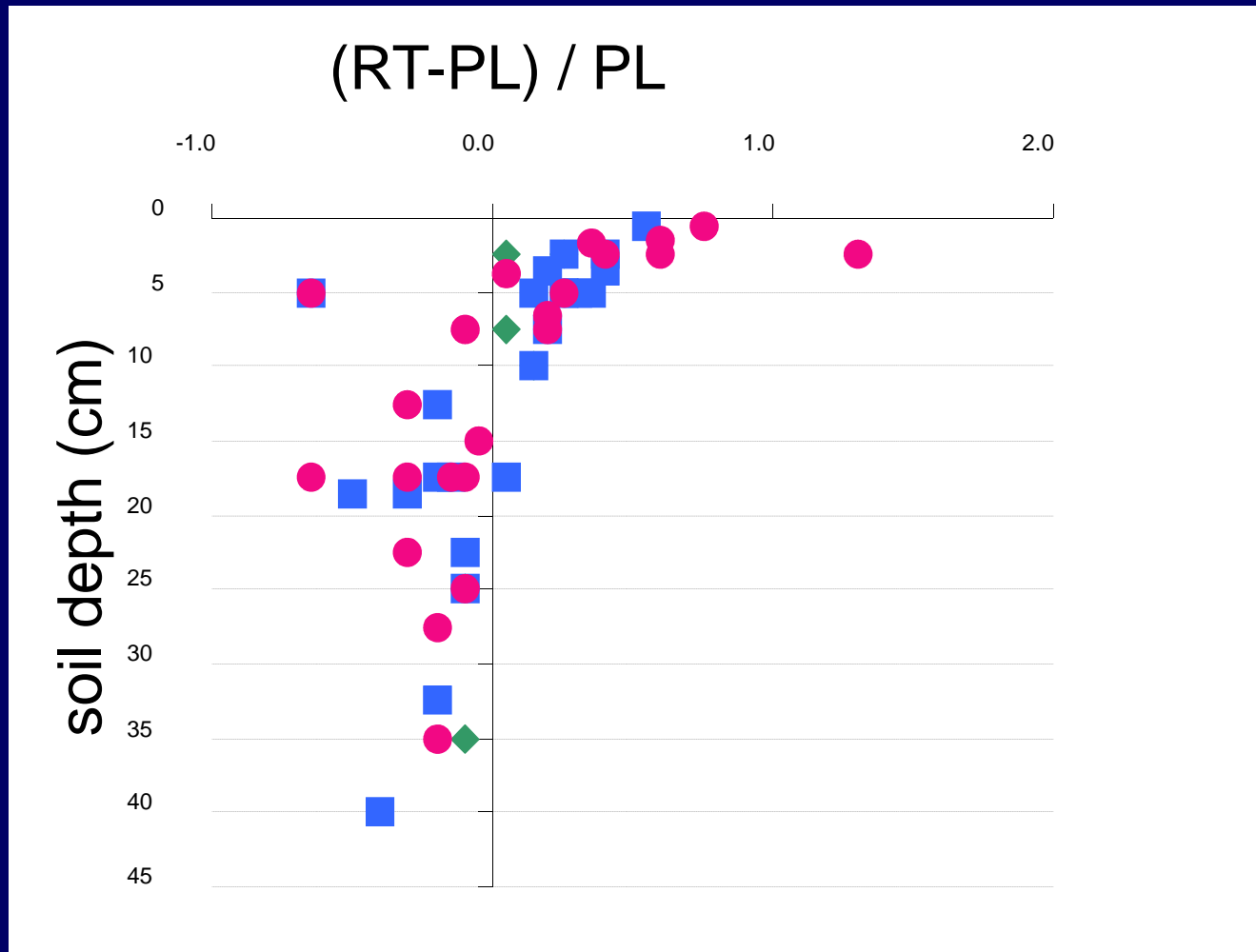
- **Only included studies with**
 - **Inversion tillage vs no-tillage comparisons**
 - **Replicated, randomized**
 - **Sampled soils at ≥ 30 cm depth**
- **28 studies** (67% N. Am., 11% Europe, 11% S. Am.)
- **68 comparisons**
 - **either different sites or crop rotations**
- **320 data points**

Change in SOC under NT relative to Inversion Tillage



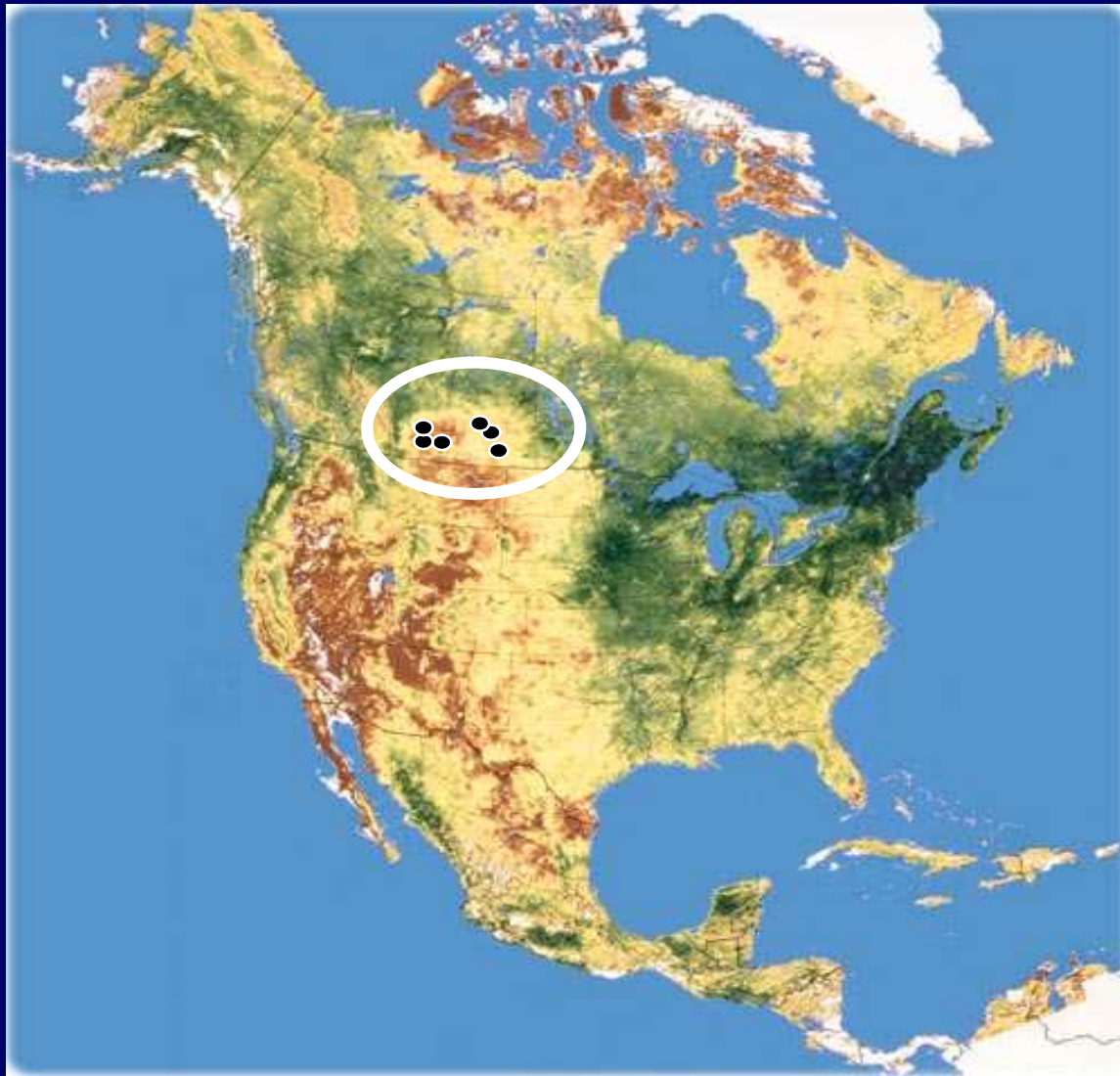
Change in SOM under reduced tillage relative to plowing

Sites from Europe



(de Tourdonnet et al. 2008)

Long-term tillage sites (11 to 30 years)

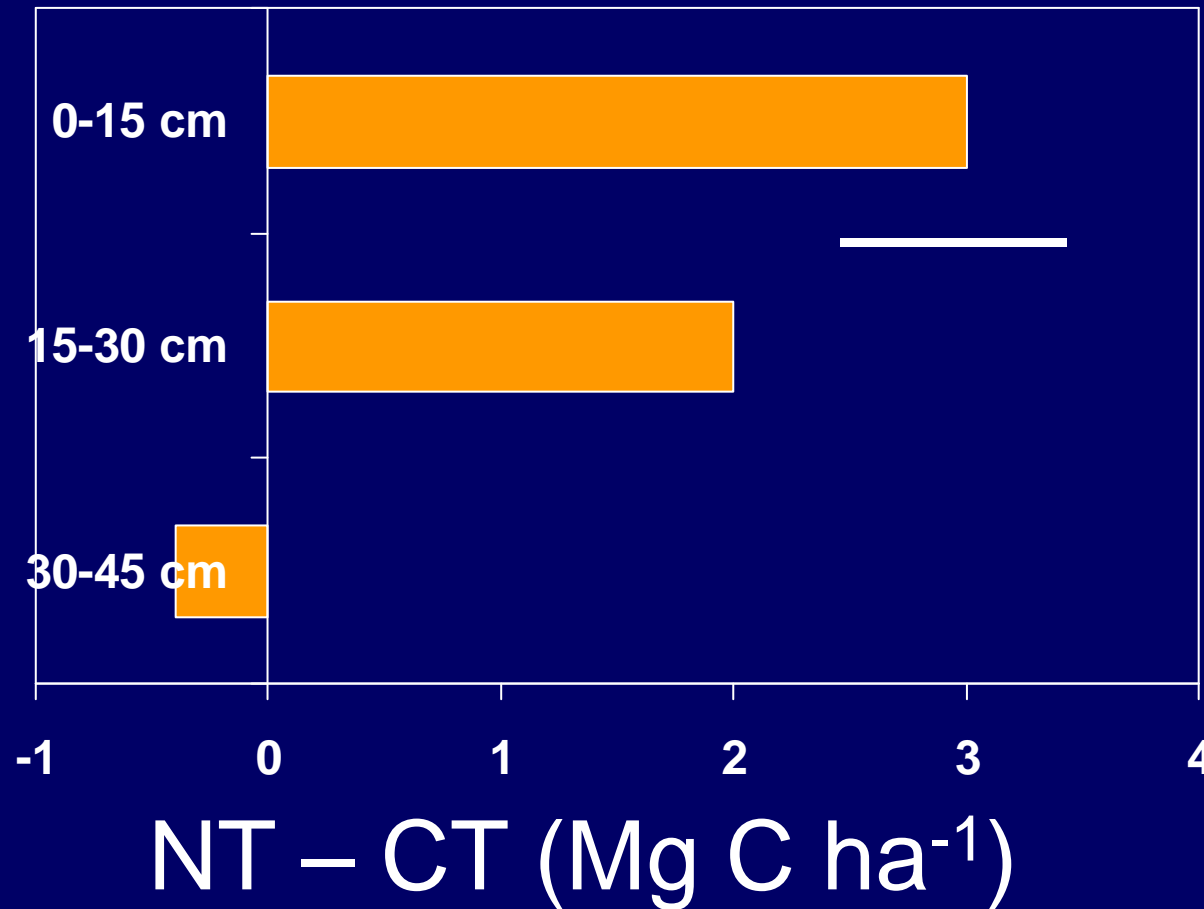


CT is cultivator



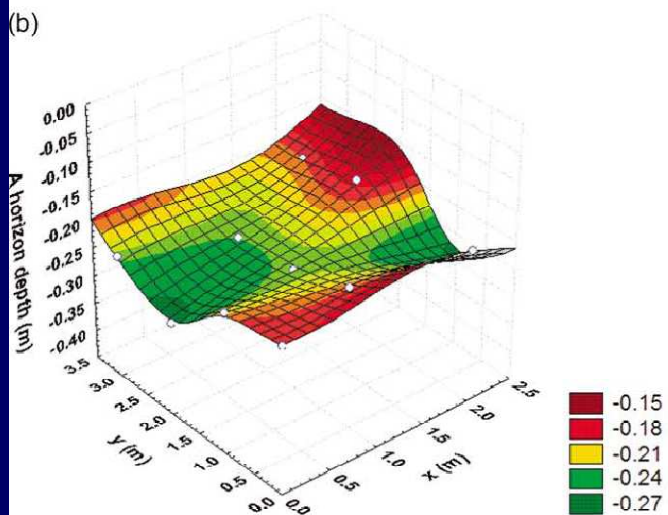
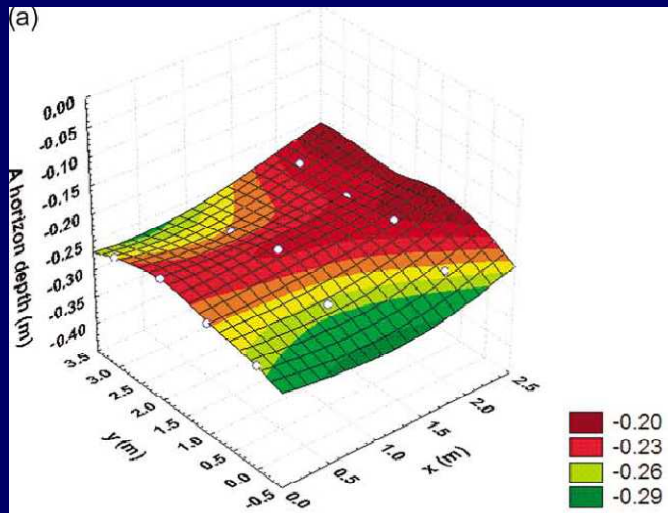
Historically
sampled at
surface (0-15 cm)

Average of 6 long-term sites in Western Canada (11 to 30 years)



Thickness of tilled layer can be highly variable...

...even on level land.



Thickness of A horizon
explained 68% of the
variability in SOC stocks

Chan et al., 2009 CJSS

Considerations for monitoring

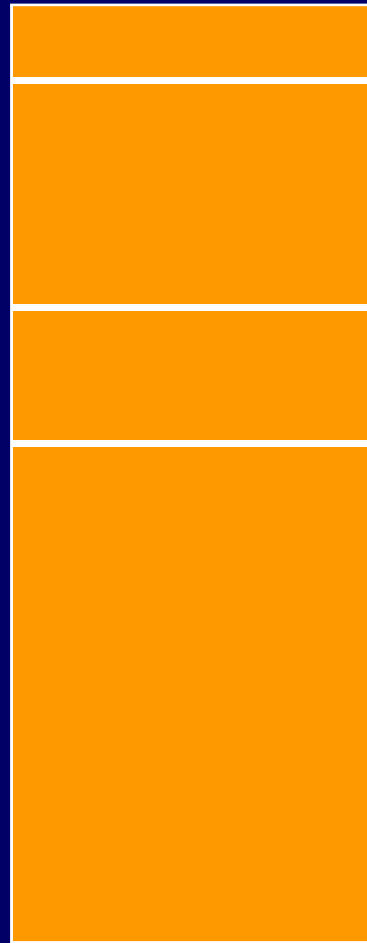
- Depth increments to capture expected changes (very surface, bottom plow layer).
- Wise to sample one layer (10-15 cm) deeper than assumed tillage depth
 - maybe 30-40 cm... with 3 depth increments, especially if monitoring NT

e.g.: if monitoring MP (at 20 cm) and NT

0-5 cm

5-20 cm

20-30 cm



SOC accumulation under NT

Remaining of plow layer (SOC may be lower under NT)

To capture changes below plow layer or its variability



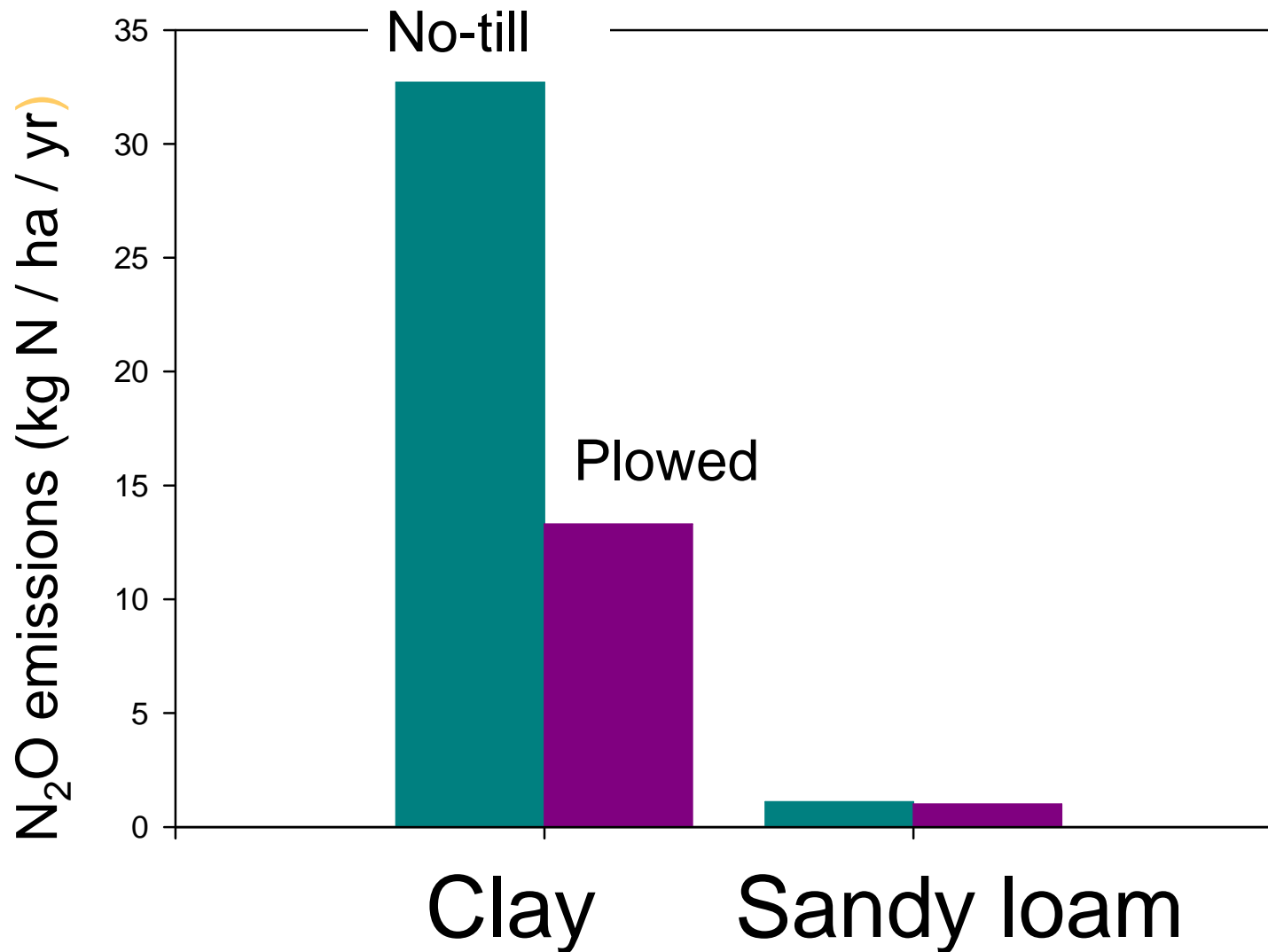
Tillage and N₂O emissions

Question

Does response of N_2O emission to NT vary with soil and climatic conditions?

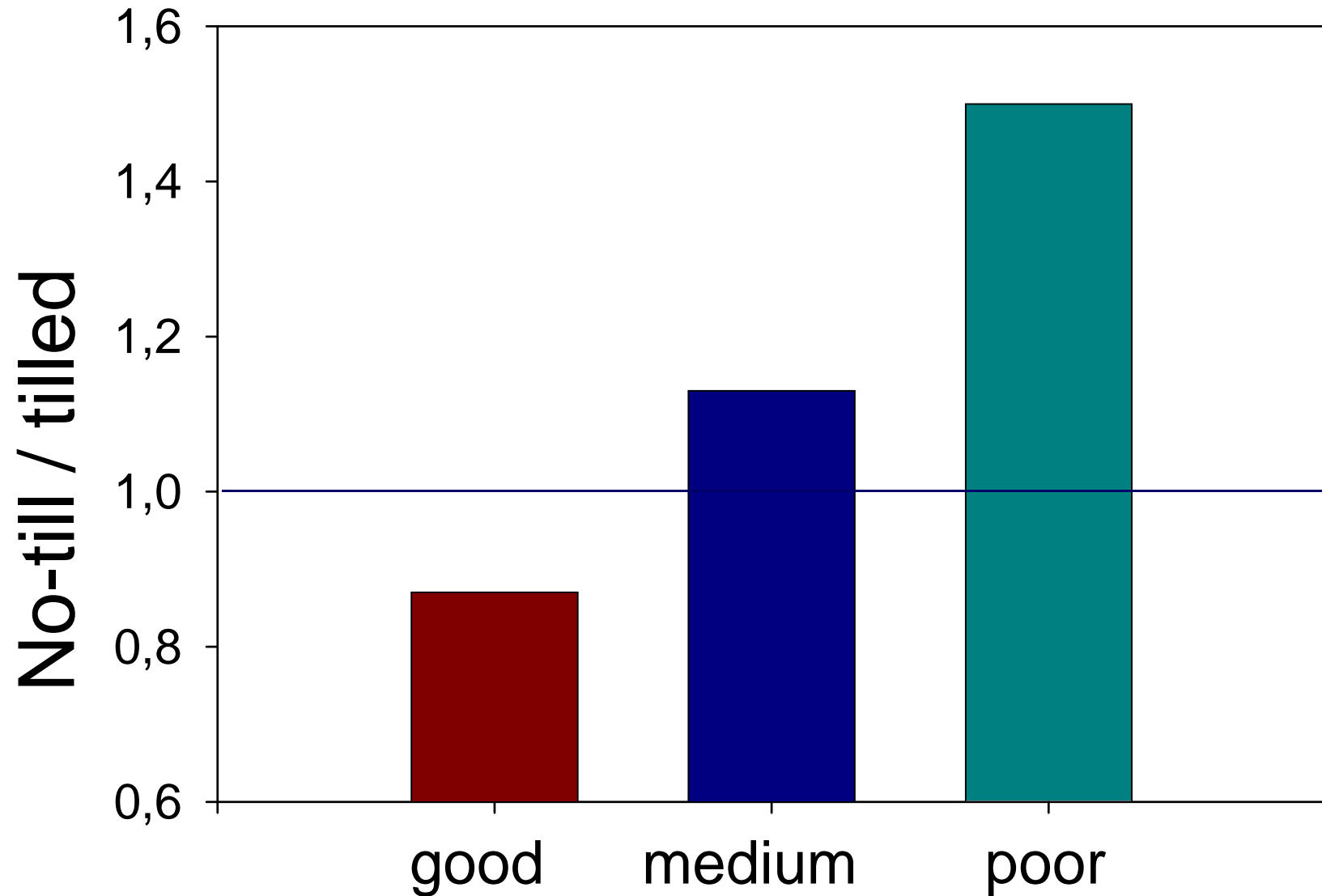
Site-specific study in Eastern Canada

Average of three years



Rochette et al., 2008; SSSAJ

25 studies, 45 site-years



Soil aeration

(Rochette 2008; STR)

Canada's National Ag. GHG Inventory

Contribution of tillage to N₂O emissions is estimated using a coefficient (modifier) =

N₂O fluxes: NT / CT

Prairie region = 0.8

Eastern Canada = 1.1

Rochette et al., 2008; CJSS

So...

- Need to consider differential effect of tillage on N₂O emissions
- Interaction soil x climate
 - Difficult to separate these two effects

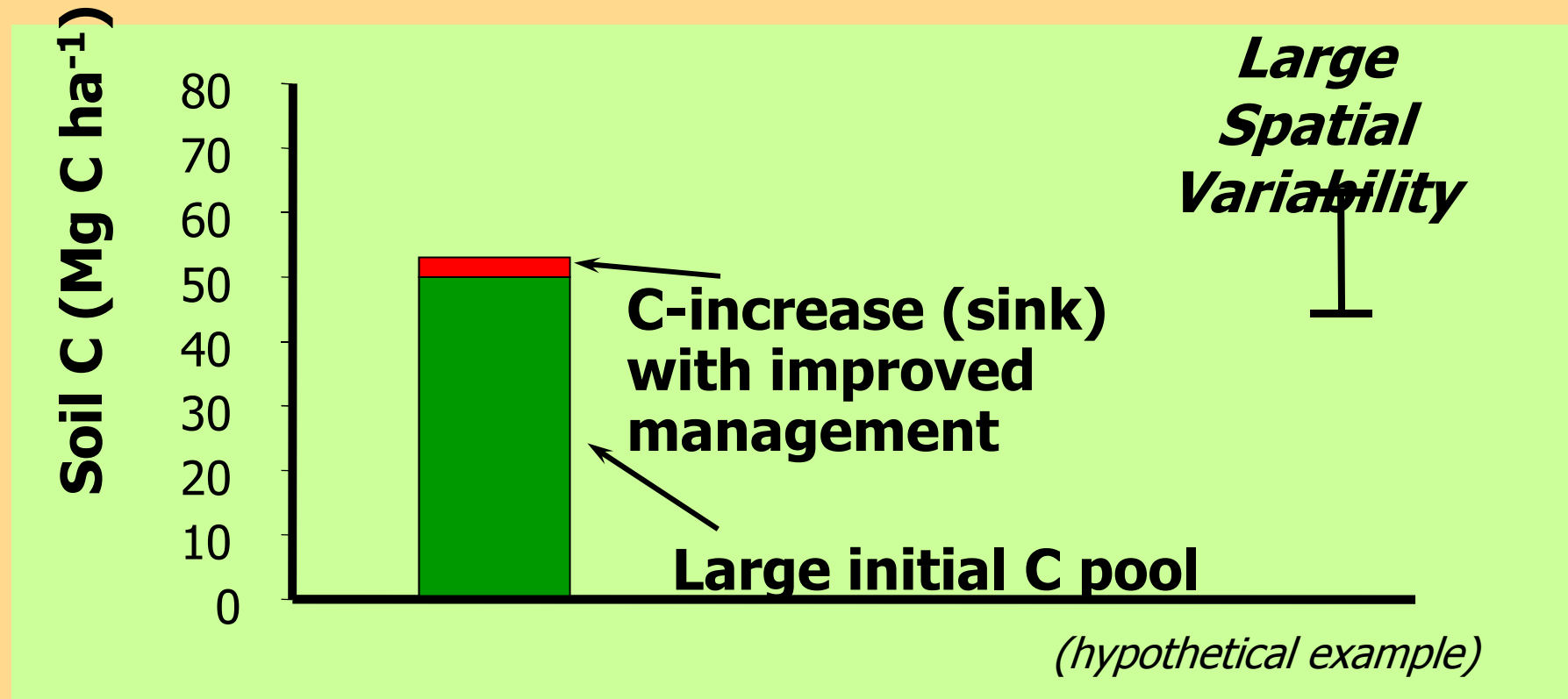
Thanks!

denis.angers@agr.gc.ca

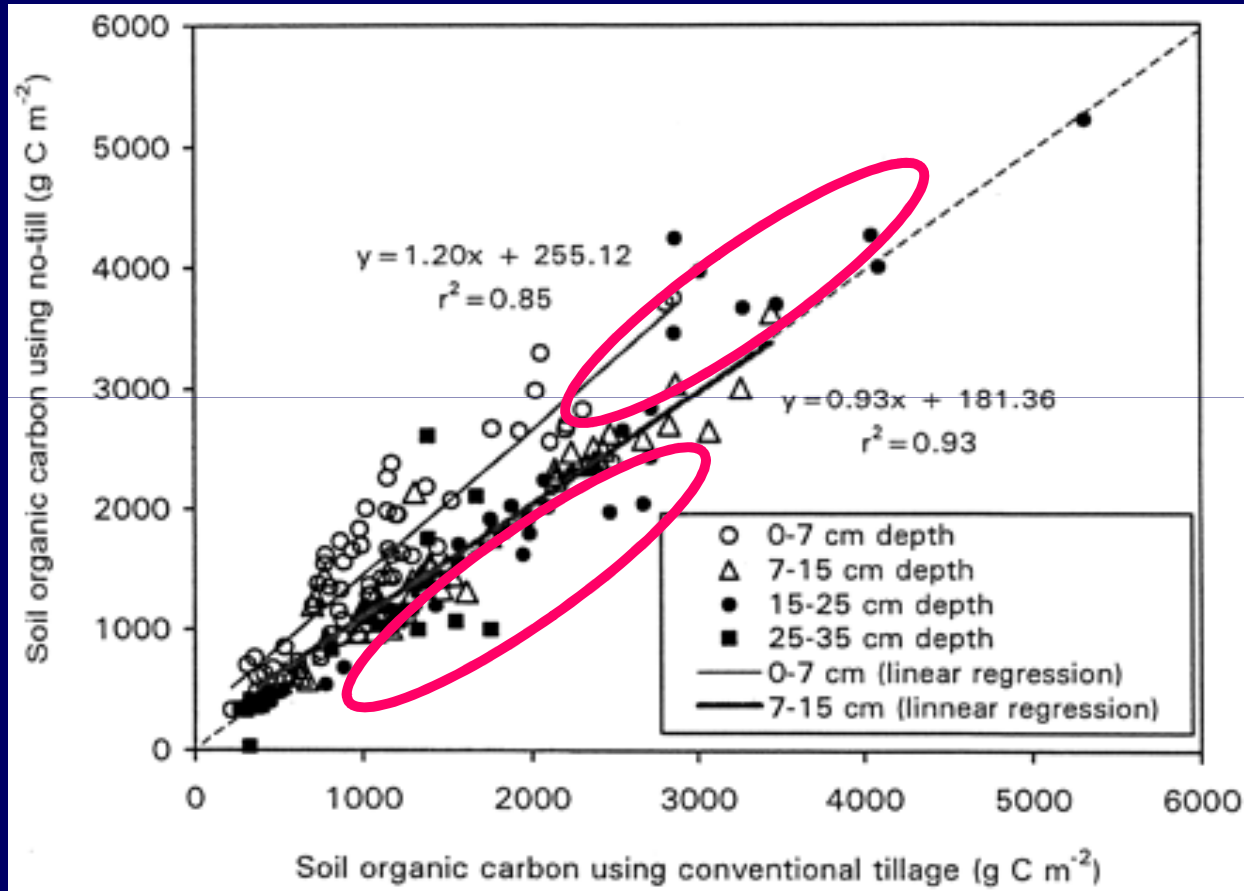
philippe.rochette@agr.gc.ca



Measurement of soil C gain



Meta-analysis of world soils



West and Post (2002)

Cases where effects of NT may
be overestimated if only sample
at surface...

Cases where effects of NT may
be underestimated if only
sample at surface...