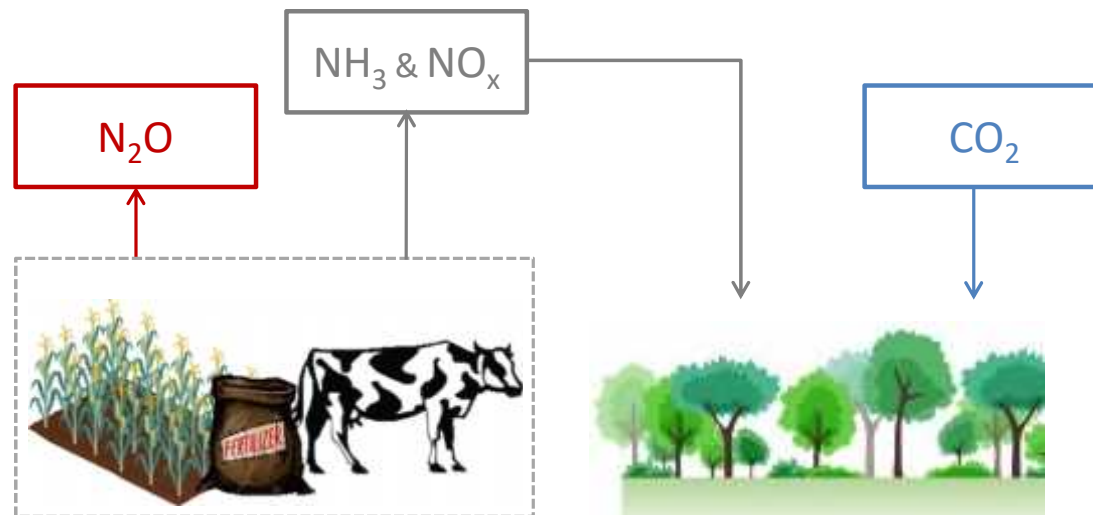


Impact of Nitrogen Use in Agriculture: Does nitrogen-induced forest carbon sequestration offset Nitrous Oxide (N_2O) emissions?

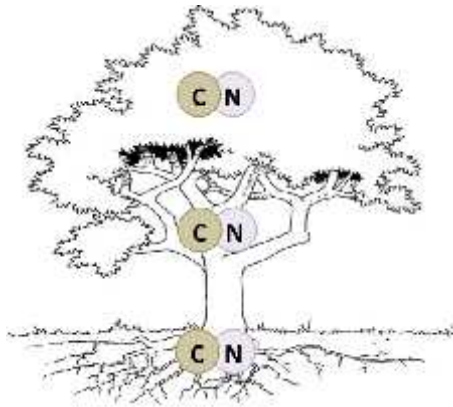


Lena Schulte-Uebbing & Wim de Vries

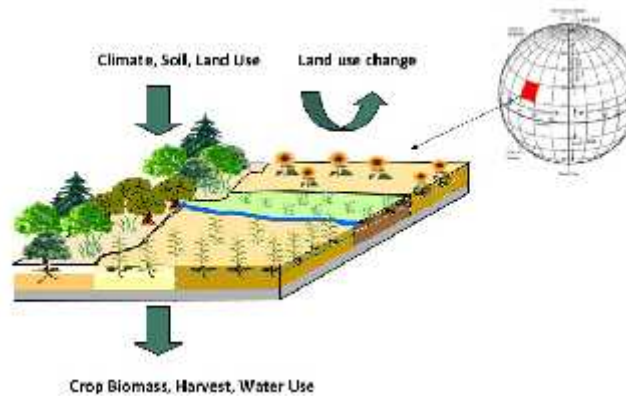
Environmental Systems Analysis group, Wageningen University and Research

Approaches to estimating the N-induced forest carbon sink

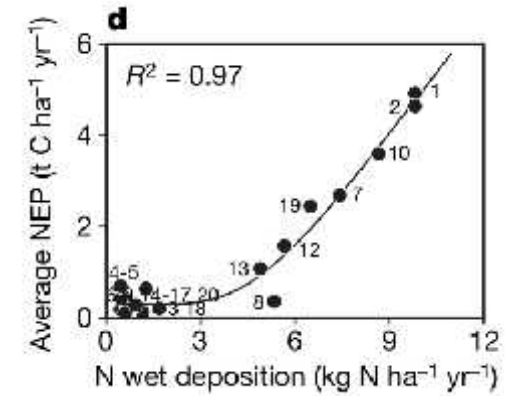
1. Stoichiometric scaling



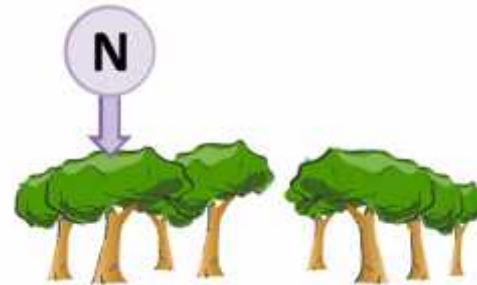
2. DGVMs

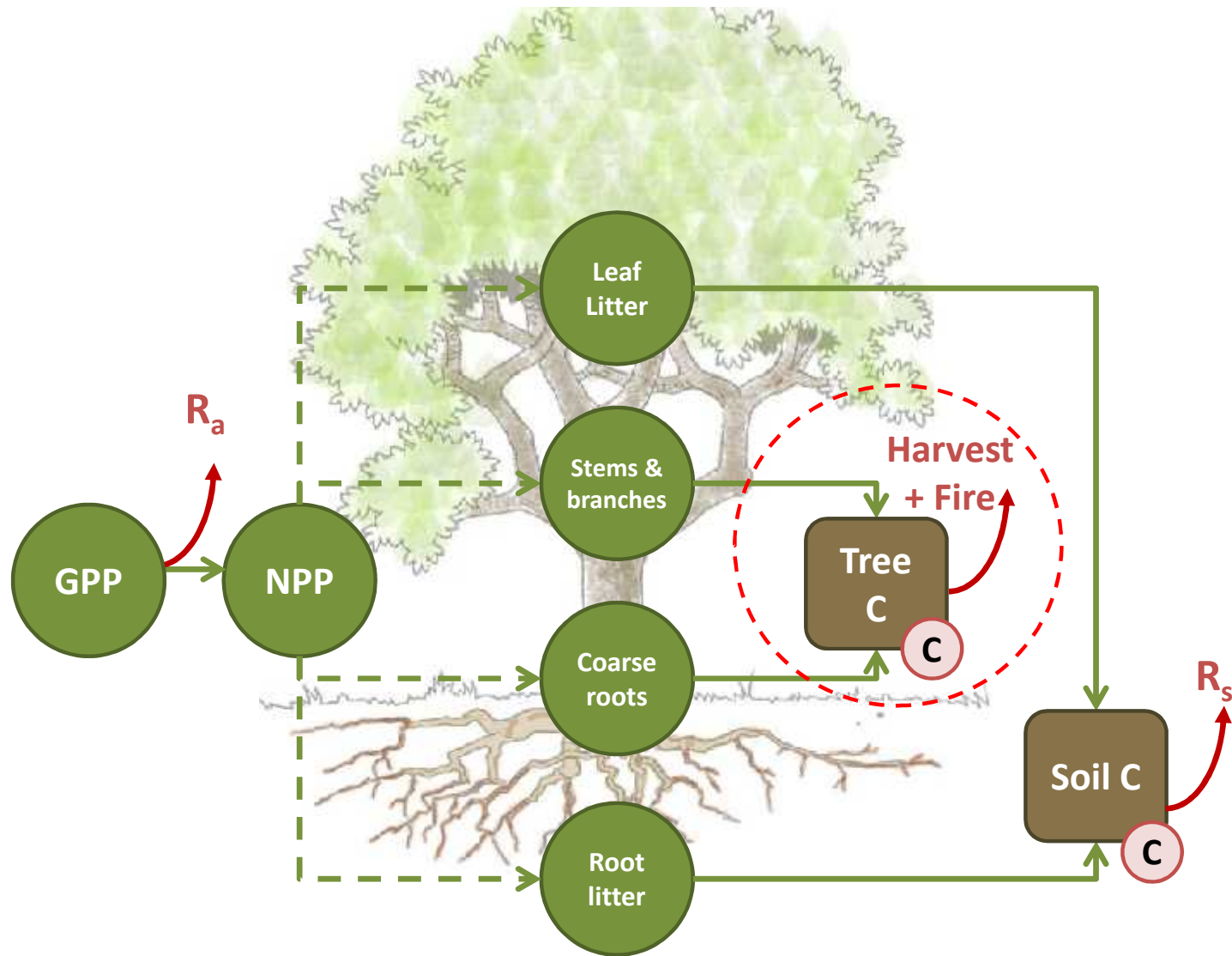


3. Gradient studies



4. Fertilization experiments





Meta-analysis

1. Single-study effect size



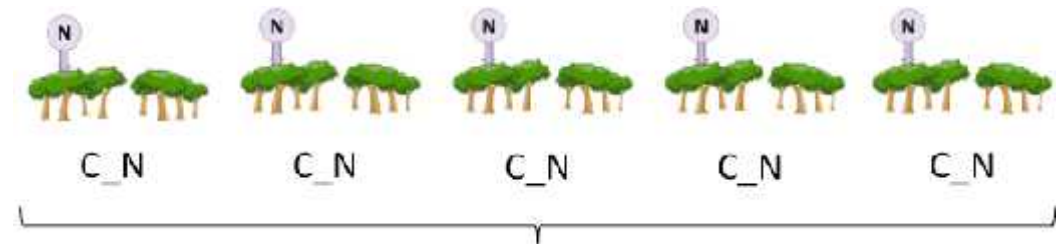
Woody biomass increment in N addition plot [kg C ha⁻¹ yr⁻¹]

Woody biomass increment in control plot [kg C ha⁻¹ yr⁻¹]

$$C_N = \frac{X_N - X_C}{N_{add}}$$

N addition [kg N ha⁻¹ yr⁻¹]

2. Summary effect size

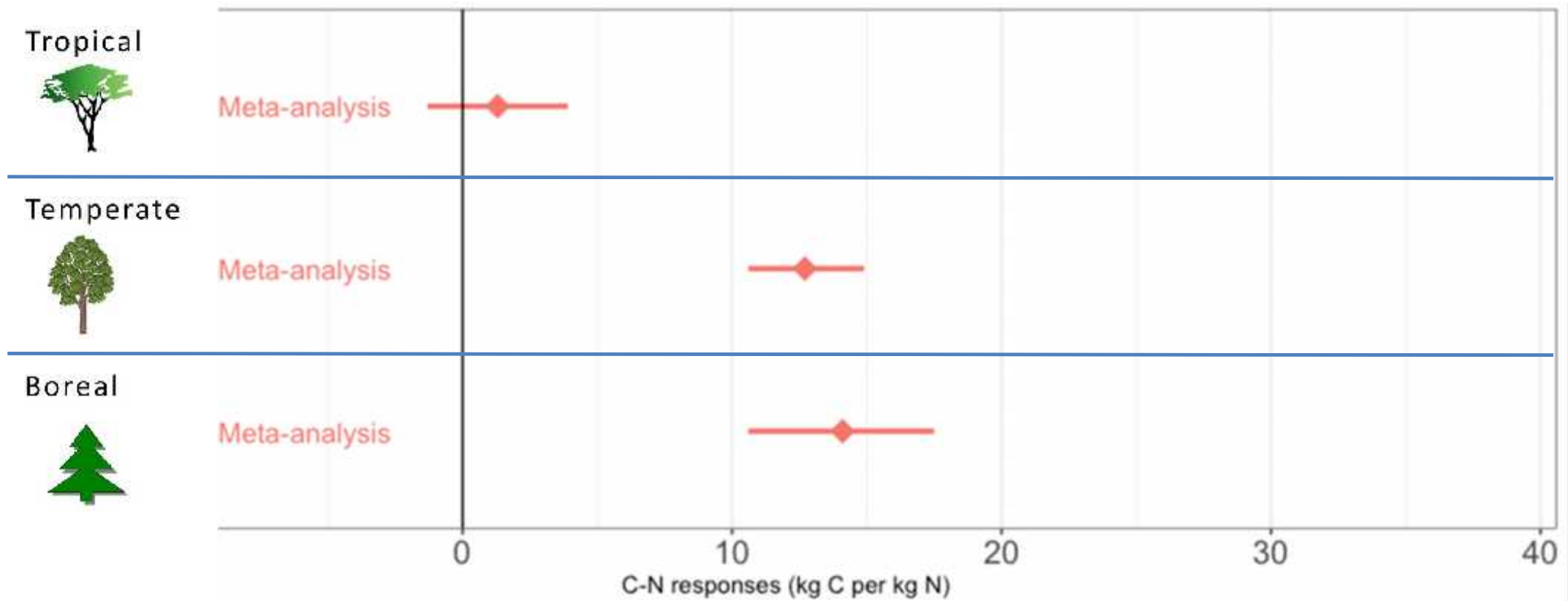


= weighted mean of individual effect sizes

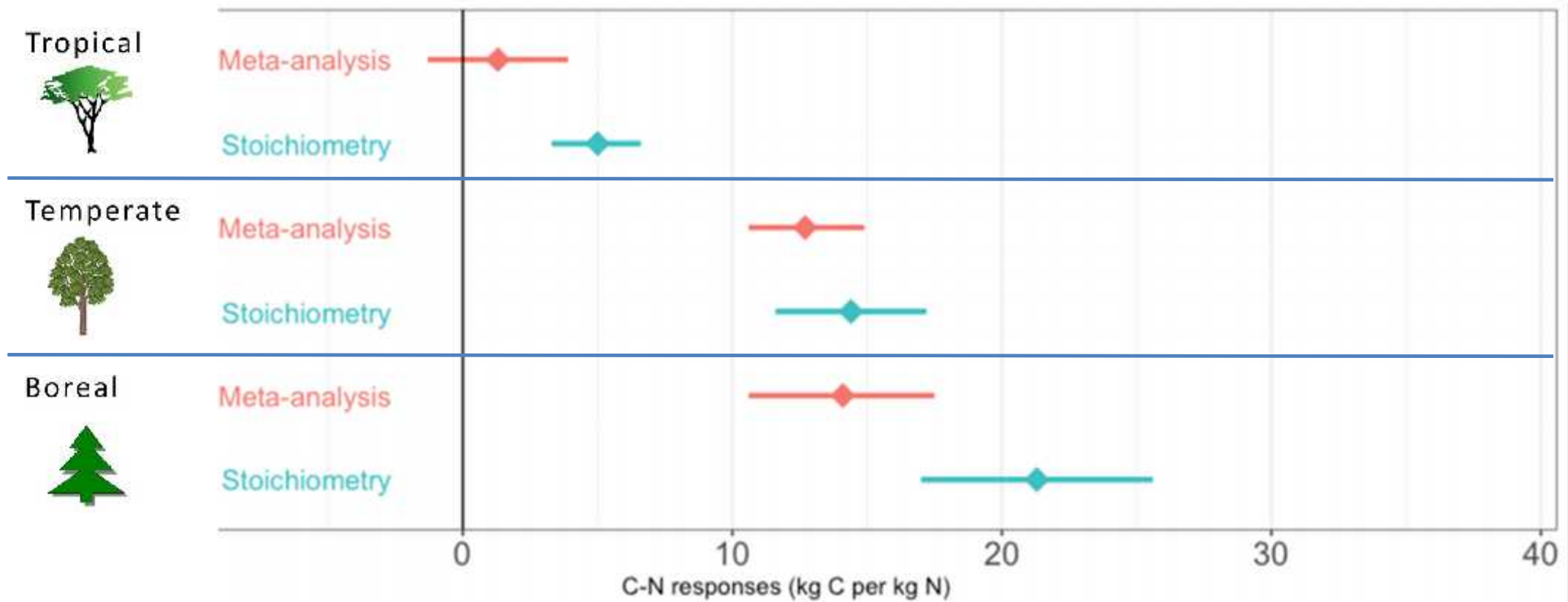
- Does the response vary between forest biomes?



Results (1): C-N response ratios

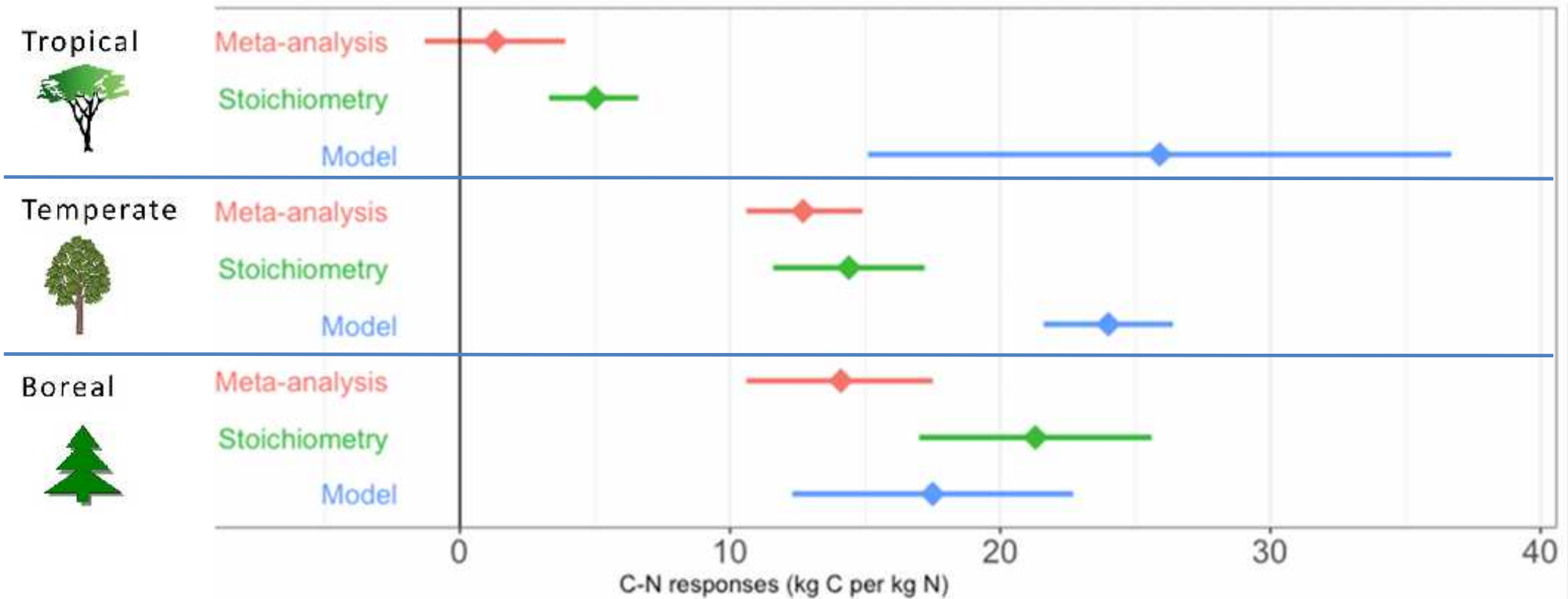


Results (1): C-N response ratios



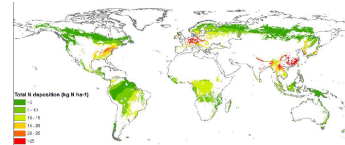
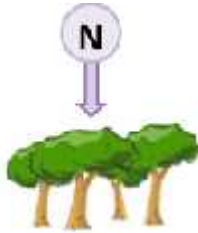
Stoichiometry: de Vries et al. 2014

Results (1): C-N response ratios



Stoichiometry: de Vries et al. 2014, Model: Fleischer et al. 2015

Results (2): Global scaling

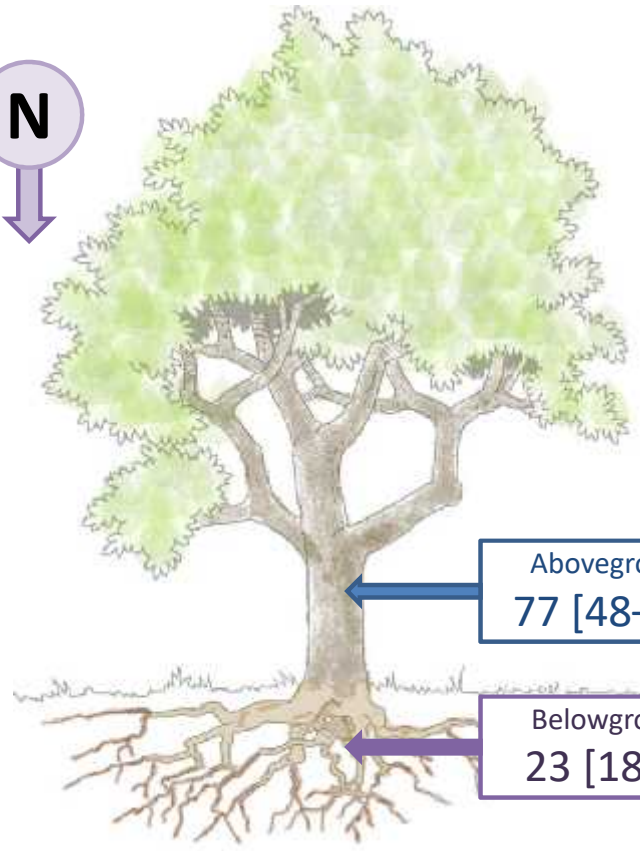


	(1) C–N response [kg C kg N ⁻¹]	(2) NH ₃ deposition ¹ [Tg NH ₃ -N yr ⁻¹]	(3) N-induced woody C sink [Tg C yr ⁻¹]
Tropical (n=17)	1.3 (-1.3–3.9)	6.3	8 (-8–25)
Temperate (n=41)	12.7 (10.6–14.9)	4.2	53 (44–62)
Boreal (n=12)	14.1 (10.6–17.5)	1.1	16 (12–19)
All (n=63)	11.3 (8.7–13.9)	12.1	77 (48–106)

Summary effect sizes for C–N responses per forest biome obtained from the meta-analysis (1), estimates of NH₃ emissions per forest biome (2), and the calculated N-induced C sink expressed in Tg C yr⁻¹ (3). Values shown are means; values in brackets are confidence intervals (± 1 standard error).

¹ NH₃ deposition estimates are based on an overlay of the GLC 2000 and the total deposition of NH₃ at 1 x 1 degree calculated with the TM5 model for the year 2000 (Dentener et al. 2006)





Aboveground woody biomass:
77 [48–106] Tg CO₂-C_e

Belowground woody biomass:
23 [18–29] Tg CO₂-C_e

Soil:
100 [80–133] Tg CO₂-C_e

Direct + indirect⁽¹⁾:
520 [488–870] Tg CO₂-C_{eq} yr⁻¹

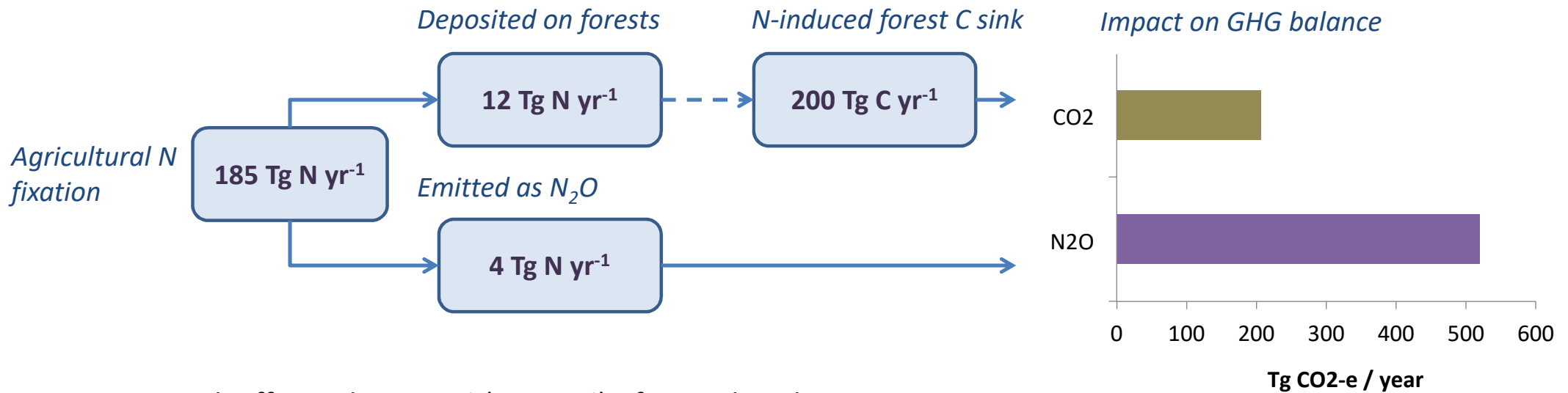
200 [146–268] Tg CO₂-C_e

N₂O



(1) UNEP 2013

Conclusion



- Forest C sink offsets about 40% (28–54%) of agricultural N₂O emissions
- Temperate forests account for more than half of N-induced C sequestration
➤ *response of tropics most uncertain*
- Long-term forest C-N response might be constrained by availability of other nutrients

Estimates of global N-induced C sink

