

Nitrogen cycle in land surface model

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2015 PKU-LSCE Summer School, Shenzhen
Sep 21-25, 2015

Reactive Nitrogen Sources/processes

Biological Nitrogen Fixation (BNF)

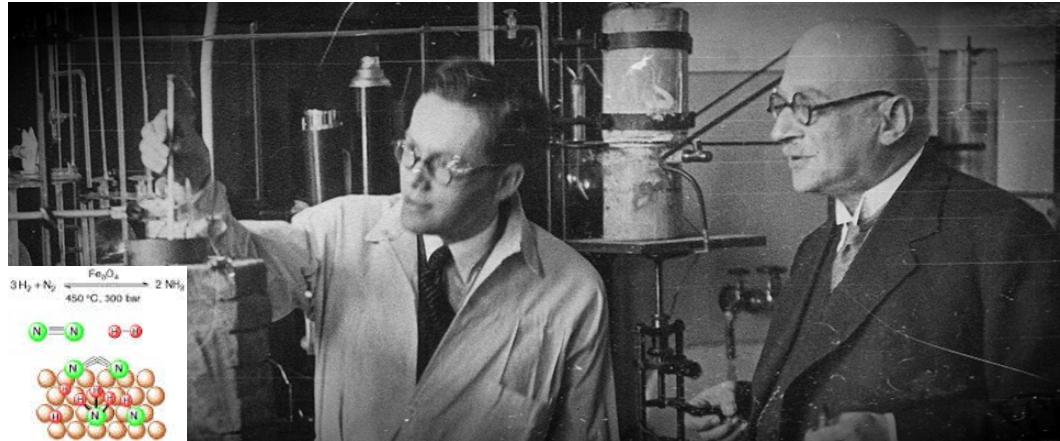


Lightning



Reactive Nitrogen Sources/processes

Haber-Bosch fertilizer

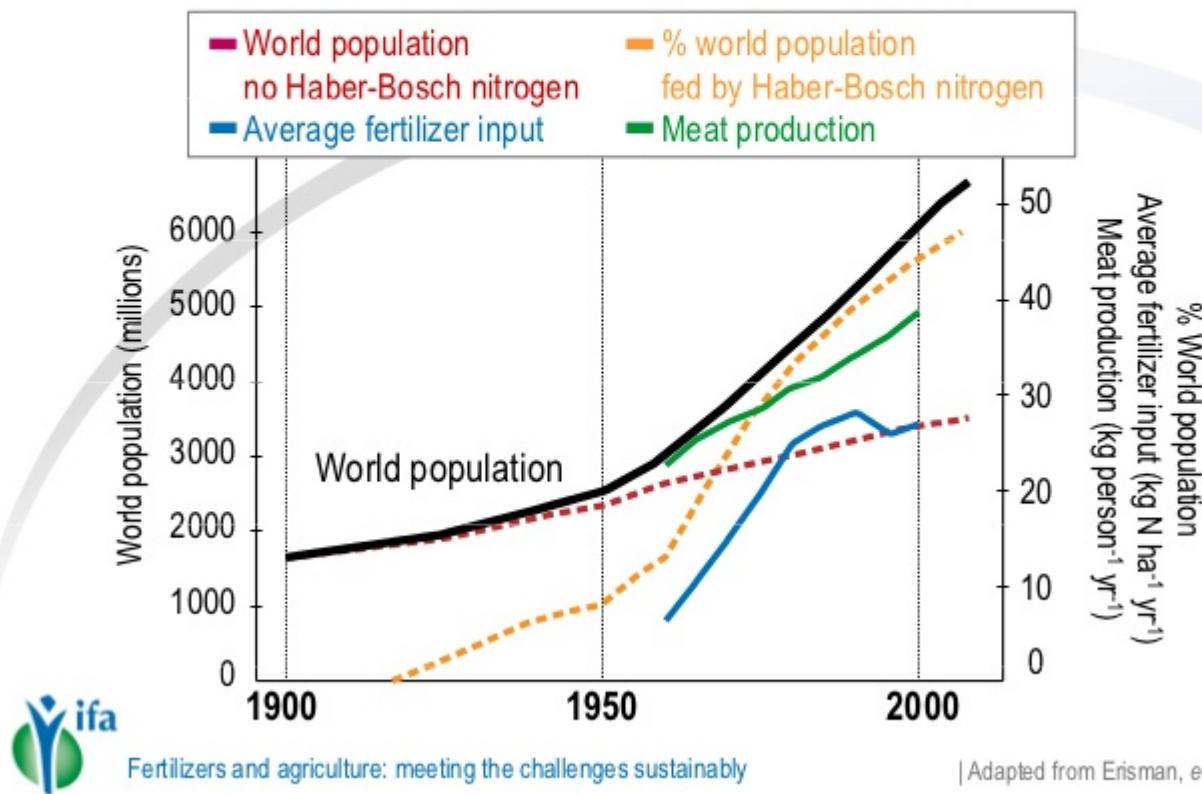


Combustion



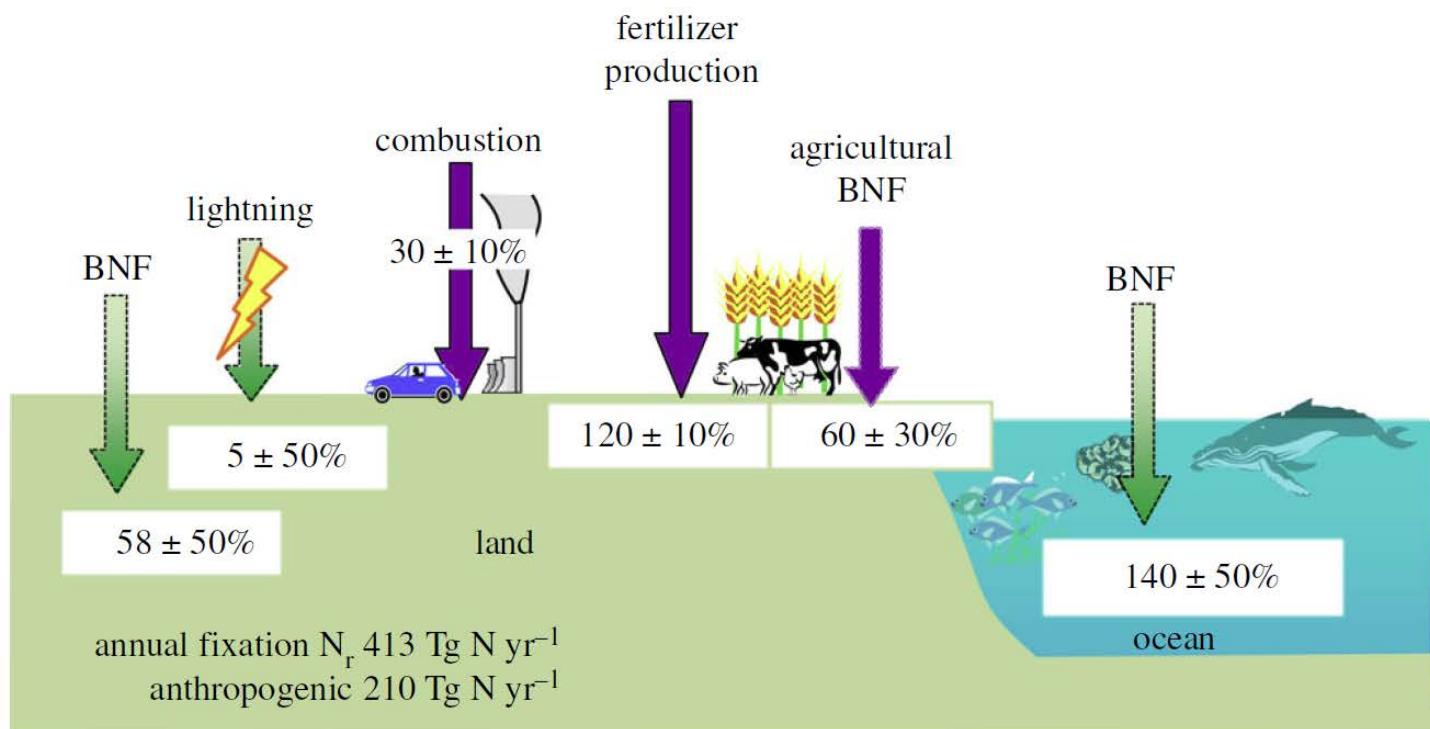
Population Growth vs. Reactive Nitrogen Input

Population trends and nitrogen use during the 20th century



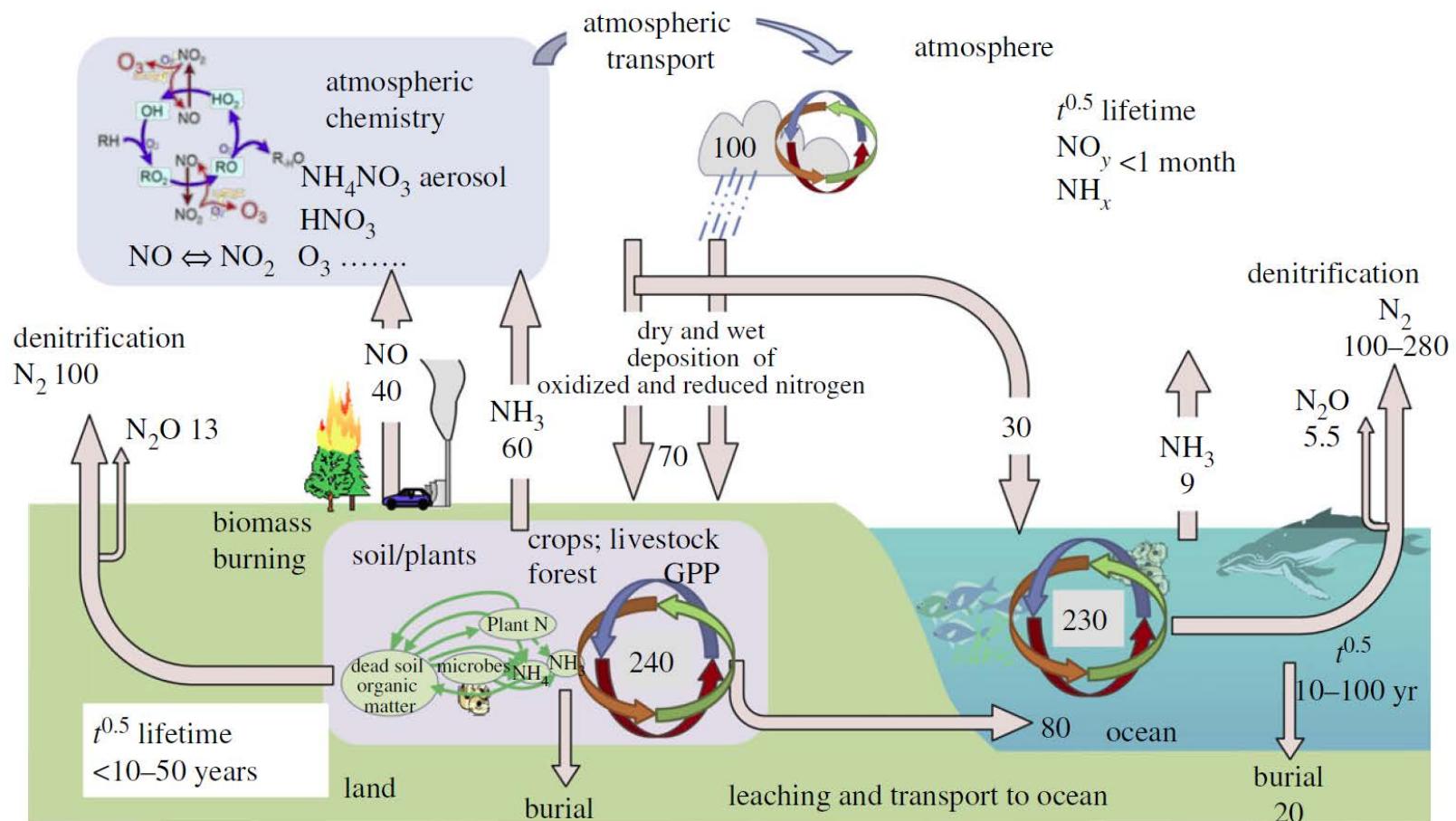
Fertilizers and agriculture: meeting the challenges sustainably

Input Reactive Nitrogen

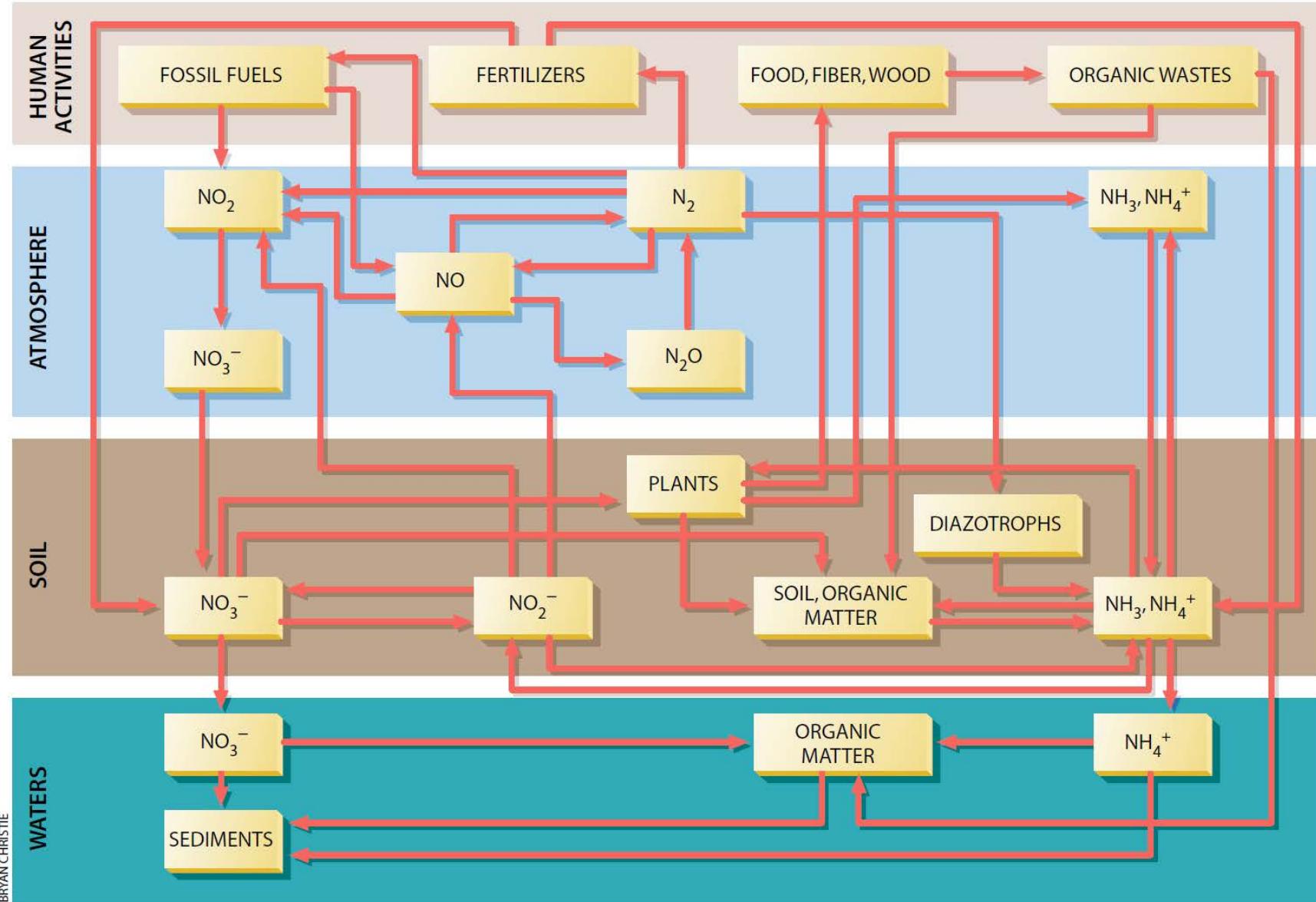


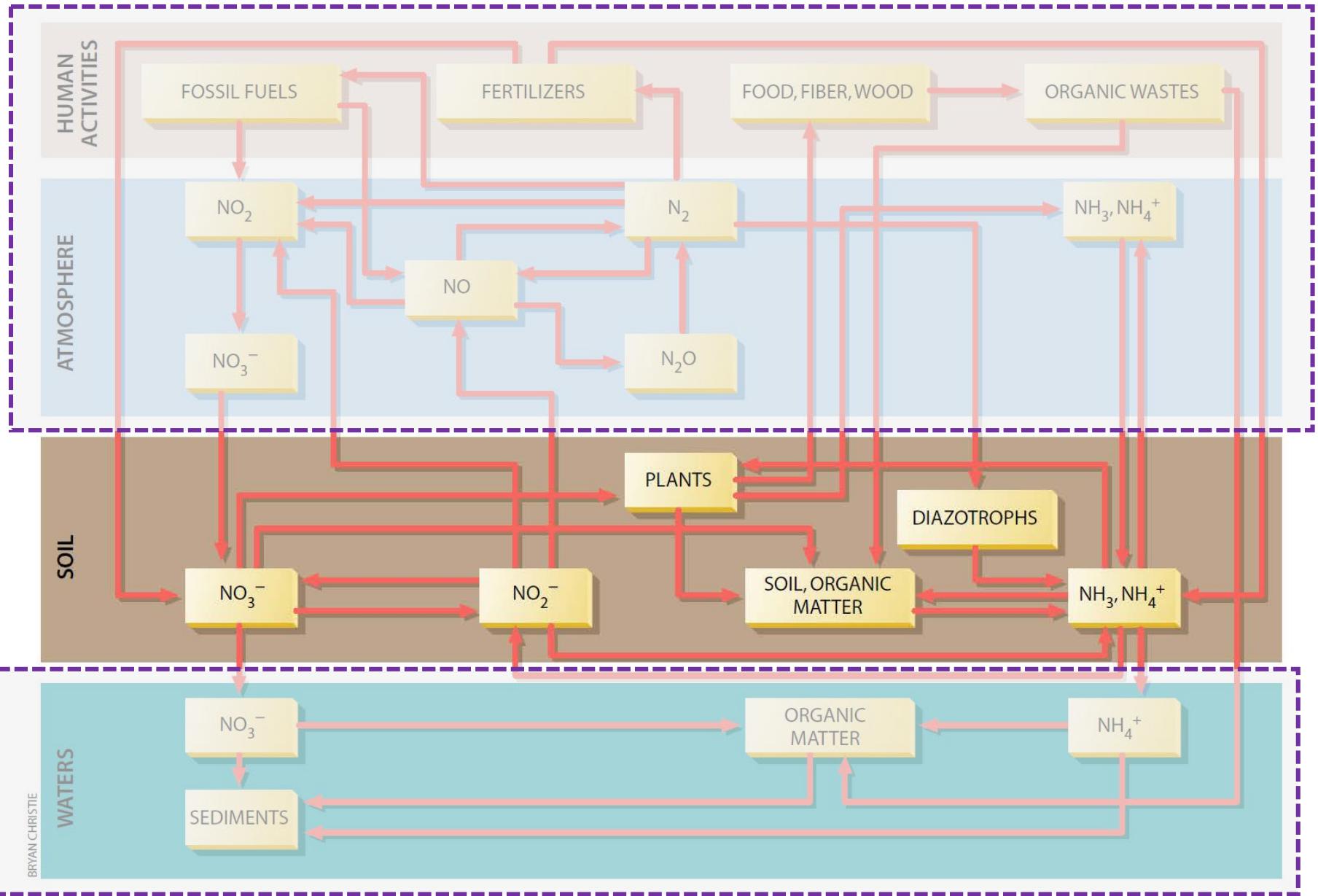
Fowler et al., 2013

Processing and Fluxes of Reactive Nitrogen



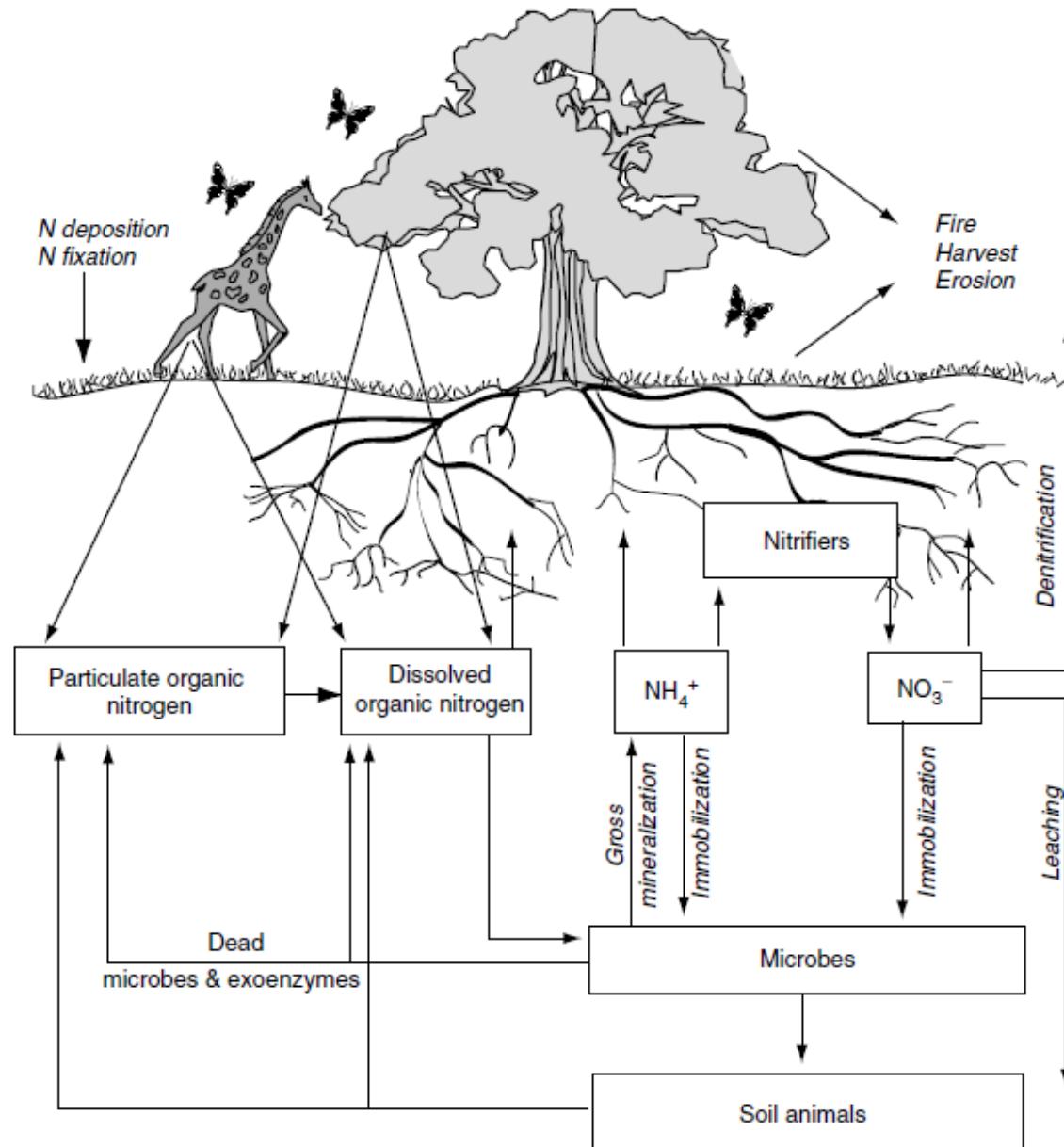
Fowler et al., 2013



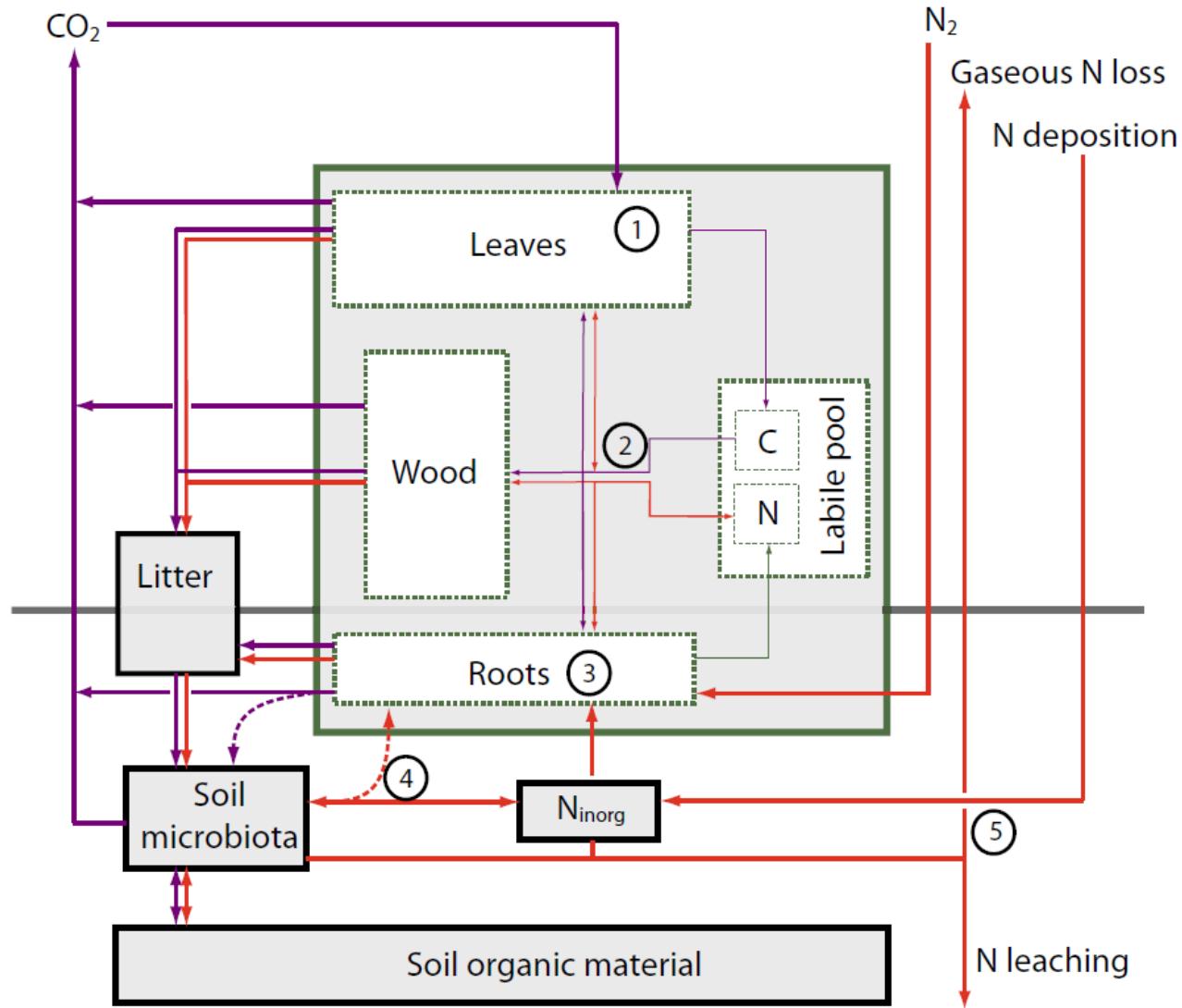


N cycle in land surface model

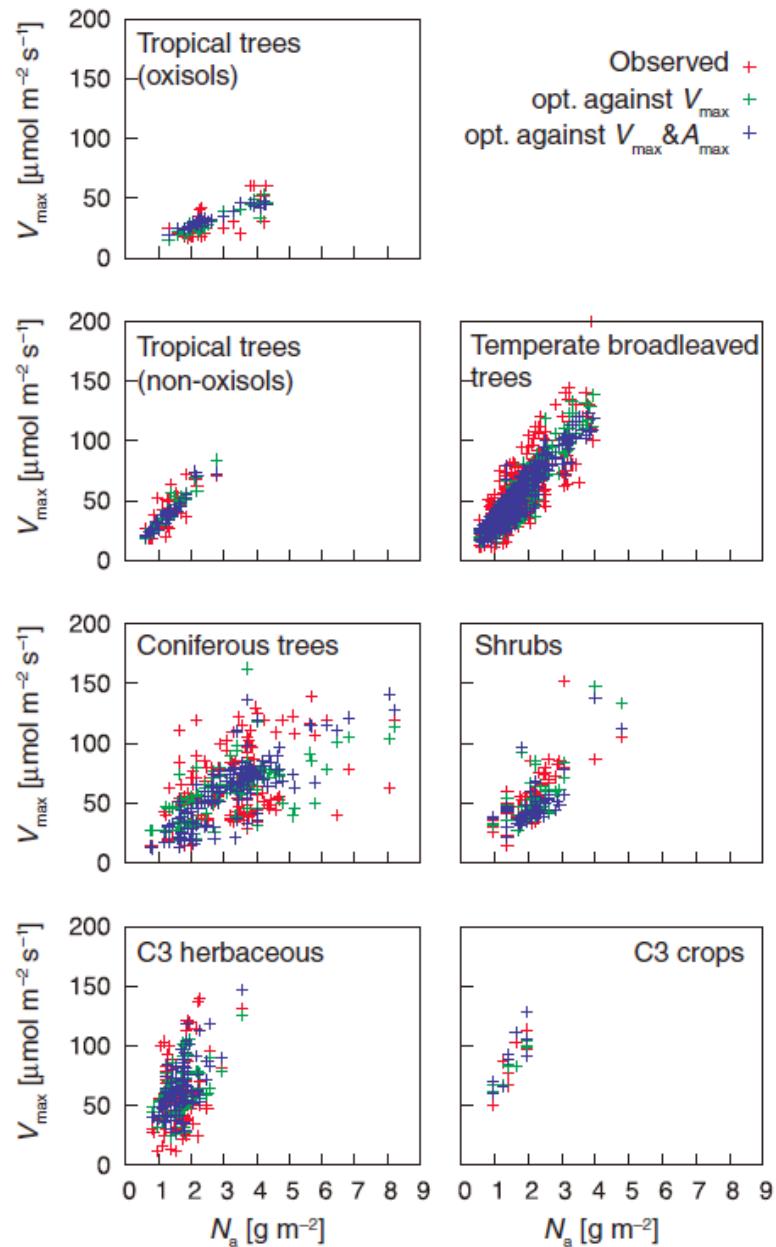
Cartoon of N cycle in terrestrial ecosystem



Scheme of N cycle model

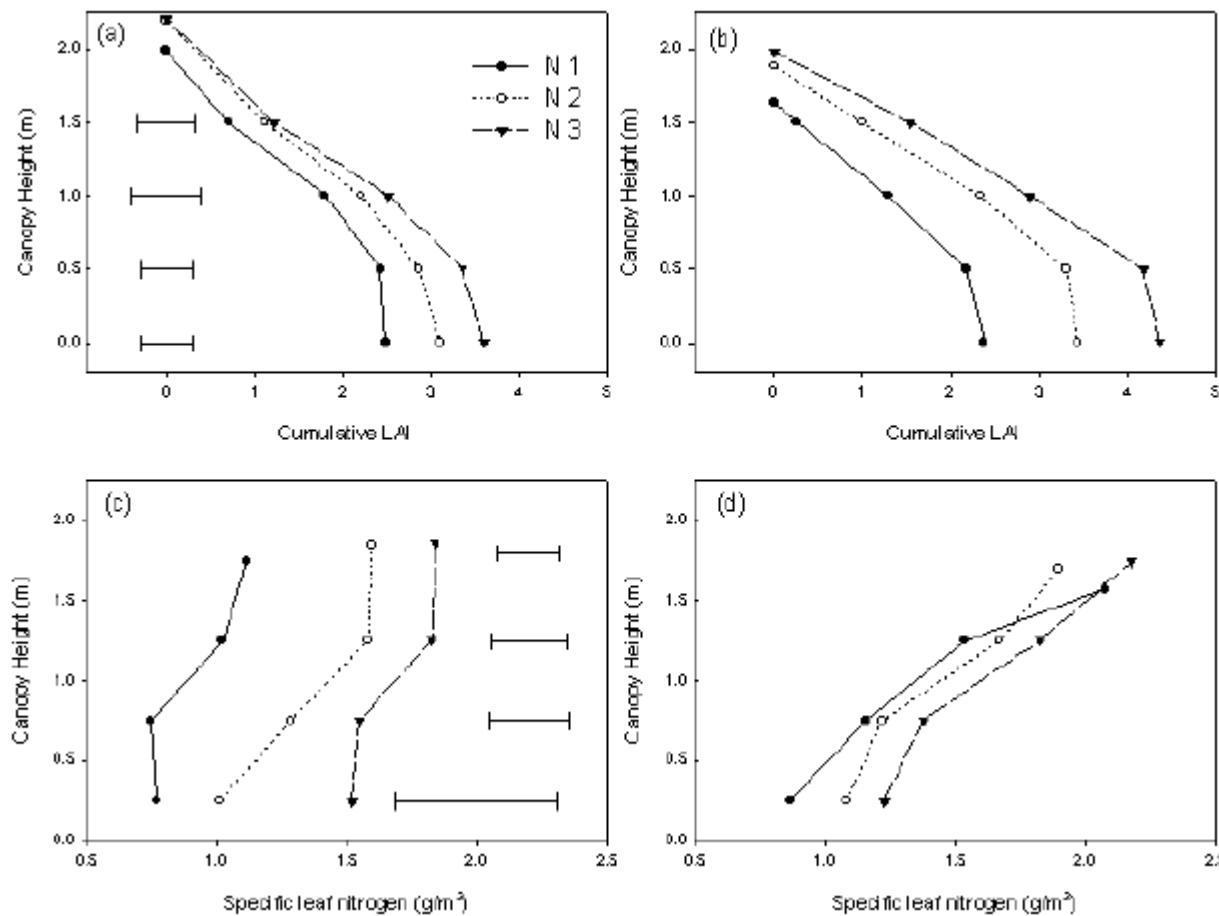


Photosynthesis



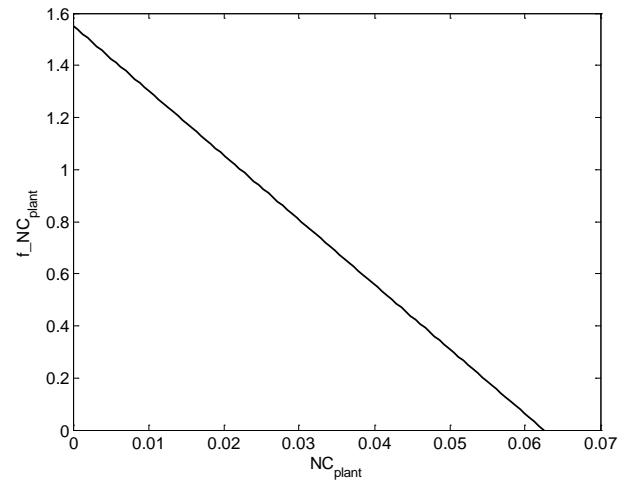
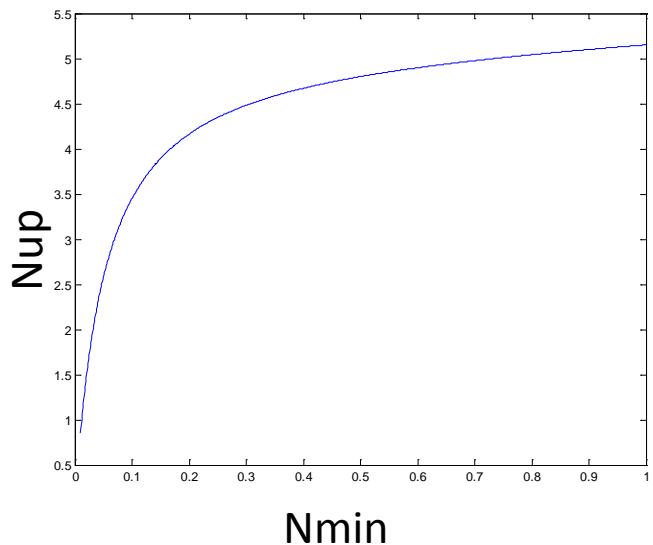
Photosynthesis

Leaf N profile



Plant N uptake

$$N_{up} = v_{max} \times N_{min} \times \left(k_{Nmin} + \frac{1}{N_{min} \times K_{Nmin}} \right) \times f(T) \times f(NC_{plant}) \times C_{root}$$



Nitrogen Allocation and Turnover

$$\frac{\partial N_{lable}}{\partial t} = \sum_{i=NH_4, NO_3} N_{up,i} + \sum_{t=leaf, root} \tau_t \times f_{trans,t} \times N_t - G_N \pm S_N$$

$$G_N = (f_l + \lambda_r \times (f_r + f_f + f_{sg}) + \lambda_{sap} \times f_s) \times (1 + D_{leaf}) \times n_{cleaf} \times (1 - r_g) \times G_C$$

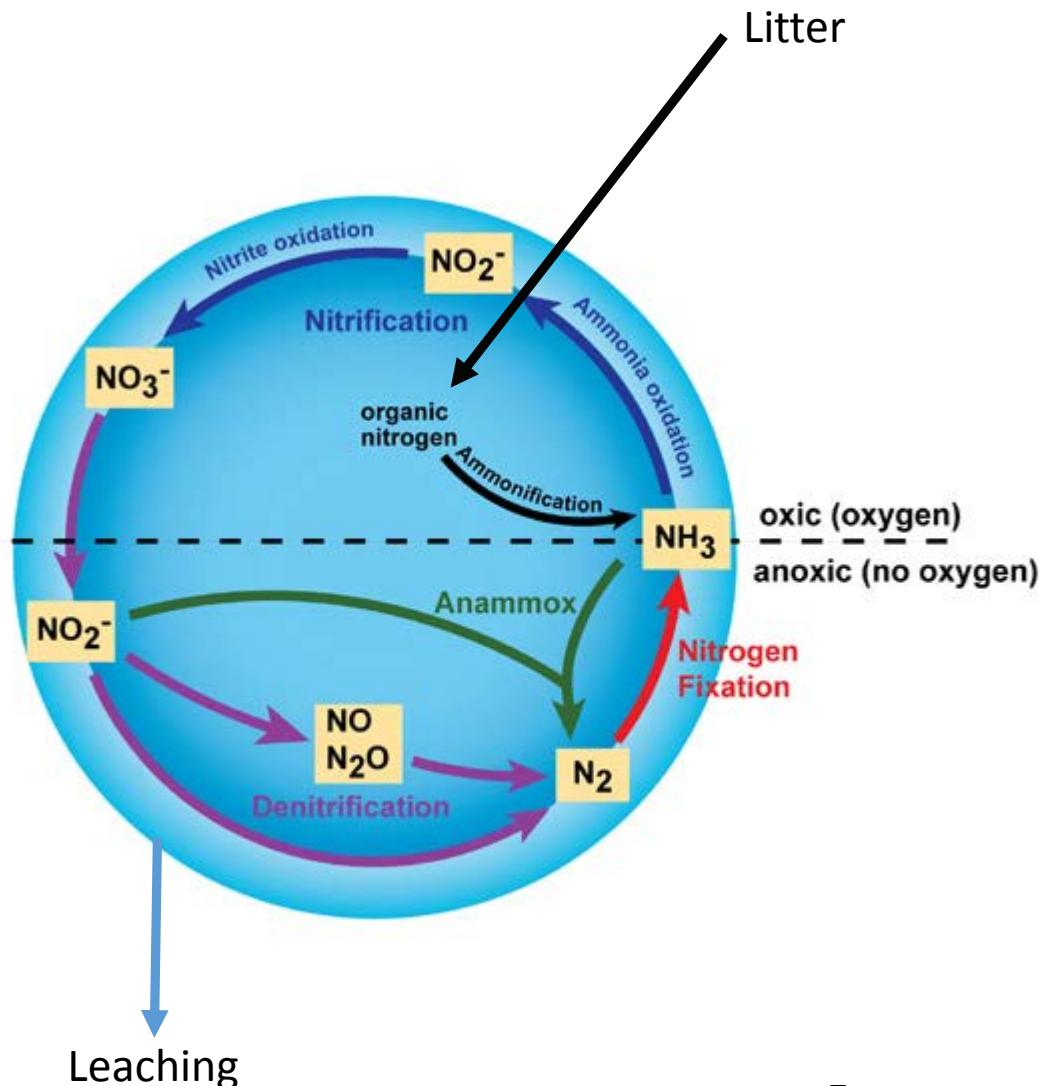
$$n_{scal} = k_{Nalloc} \times \frac{NC_{plant}}{n_{cleaf,ave}}$$

$$D_{leaf} = \begin{cases} N_{lable} < G_N & : D_{max} \times \left(1 - \exp \left[- \left(\frac{2 \times n_{cleaf}}{n_{cleaf,min} + n_{cleaf,min}} \right)^8 \right] \right) \\ N_{lable} \geq G_N & : D_{max} \times \exp \left[- \left(\frac{2 \times n_{cleaf}}{n_{cleaf,min} + n_{cleaf,min}} \right)^8 \right] \end{cases}$$

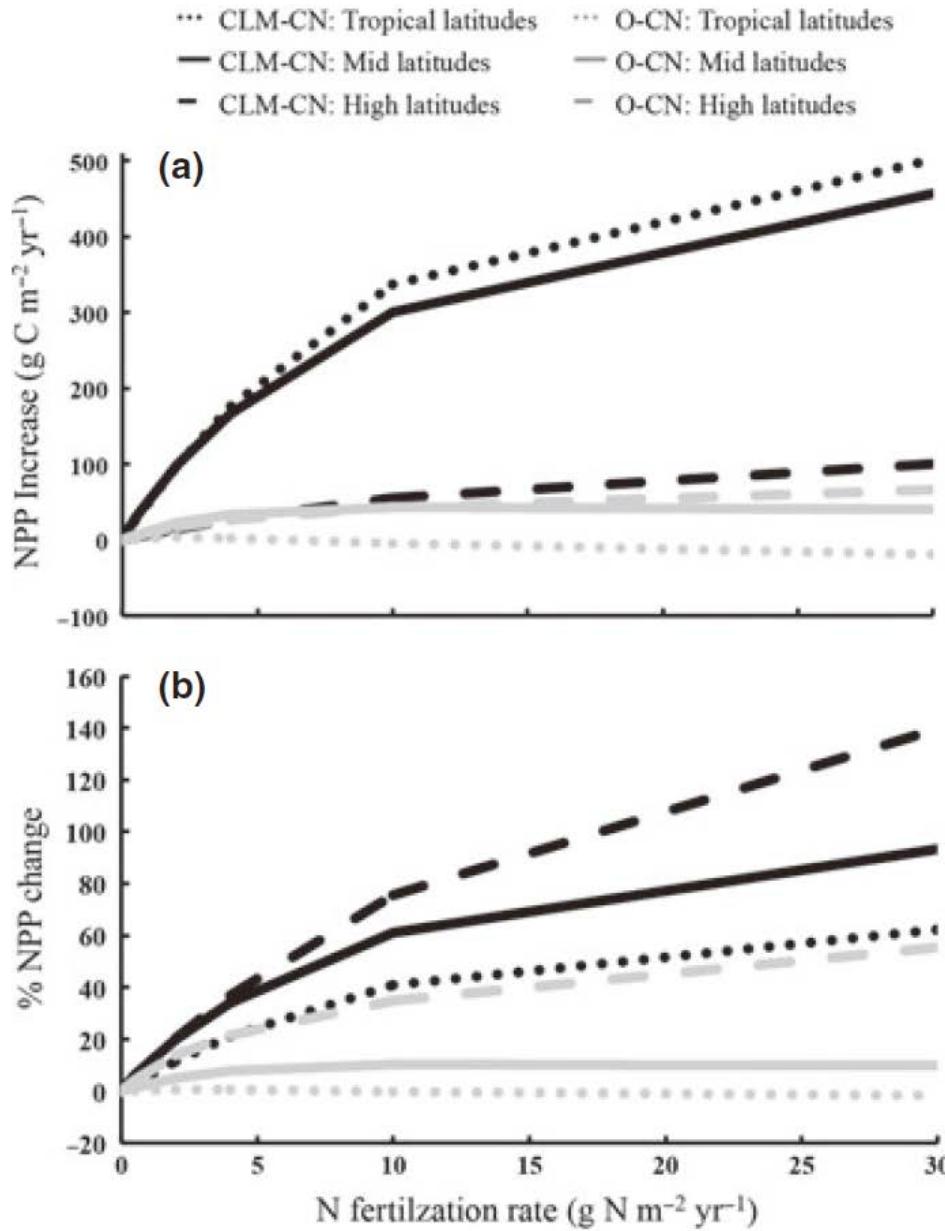
$$n_{lim} = \min \left(1.0, \frac{g_{max} \times N_{lable}}{G_N} \right)$$

Zaehle et al., 2010

Nitrogen in Soil

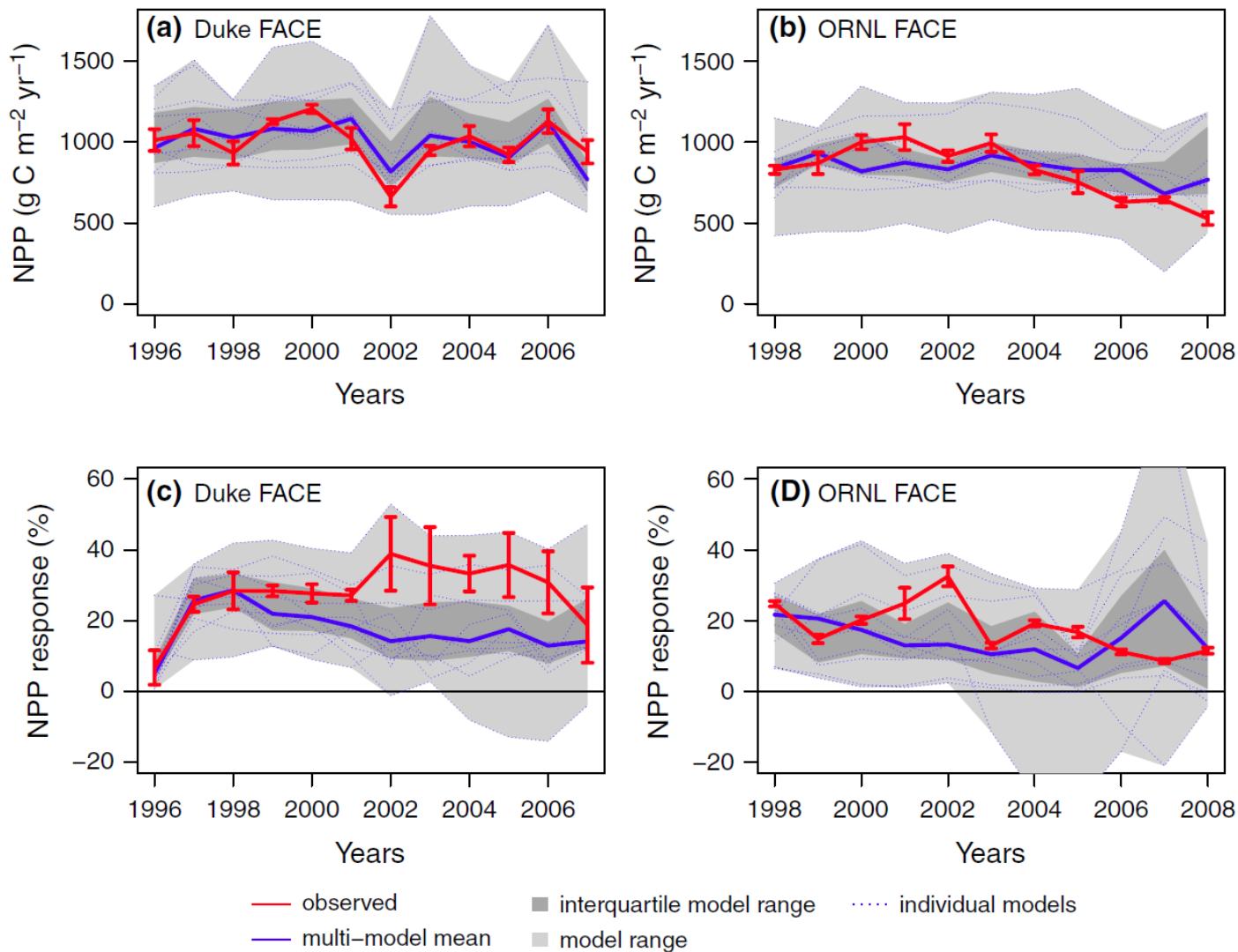


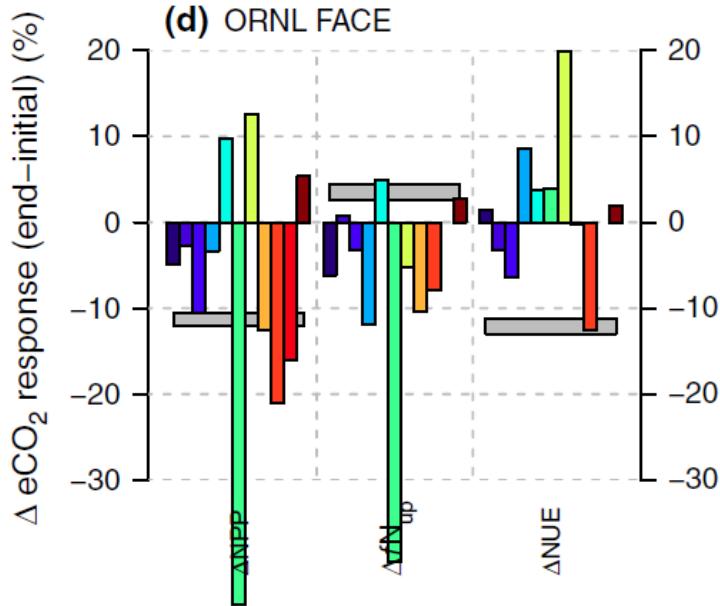
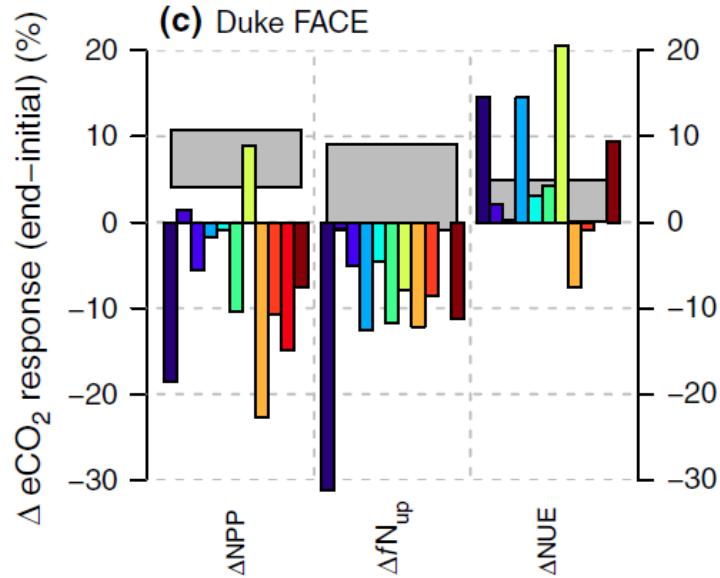
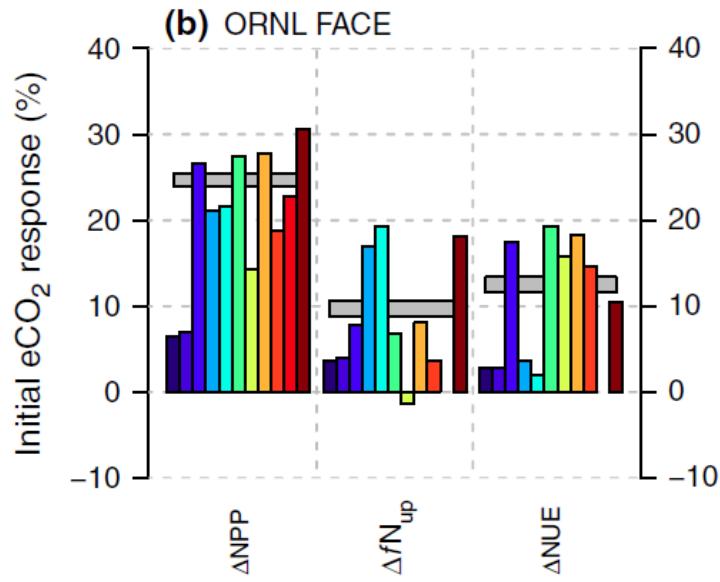
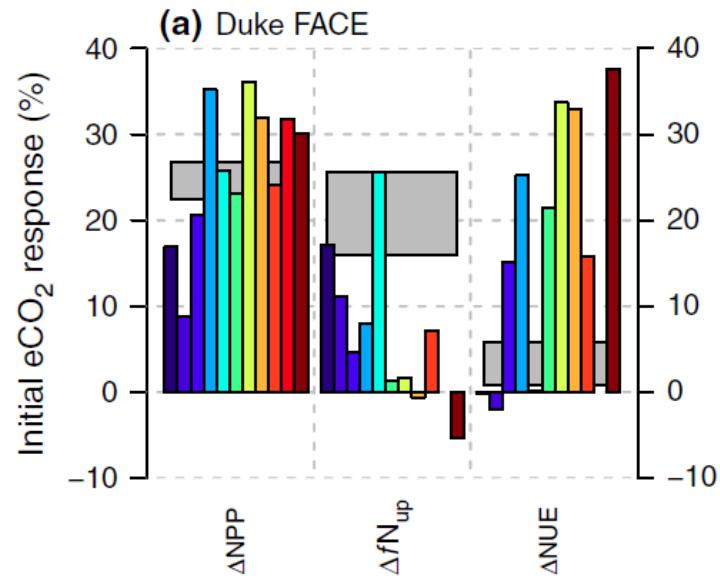
NPP response to N fertilization



C-N Model inter-comparison on FACE

Ambient





Legend:

- OBS
- CLM4
- EALCO
- GDAY
- LPJ-GUESS
- OCN
- TECO
- CABLE
- DAYC
- ED2.1
- ISAM

Zaehle et al., 2014

The Nitrogen Paradox in Tropical Forest Ecosystems

Lars O. Hedin,¹ E.N. Jack Brookshire,¹
Duncan N.L. Menge,^{1,2} and Alexander R. Barron¹

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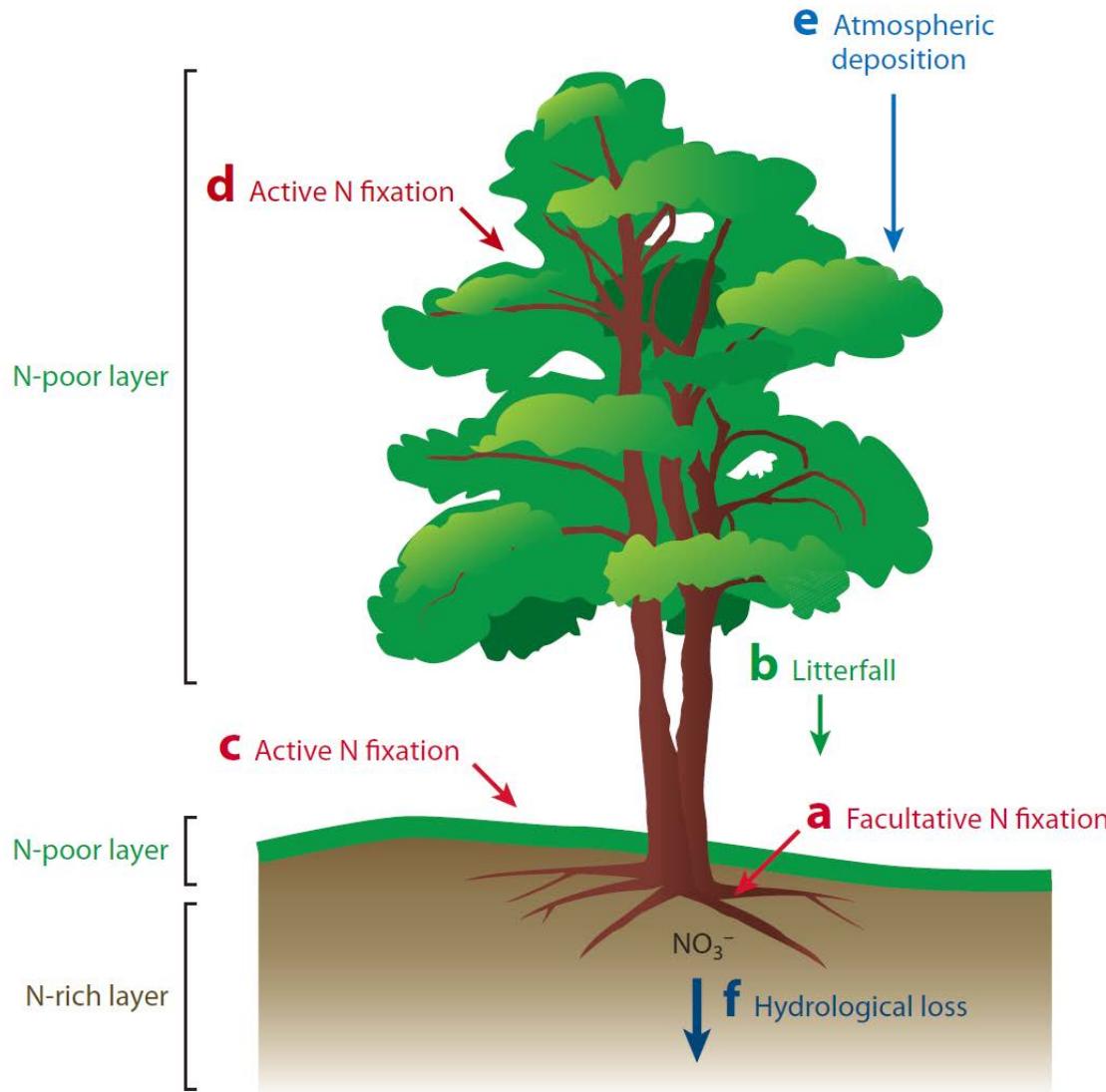
²National Center for Ecological Analysis and Synthesis, Santa Barbara, California 93101

identifies a fundamental contradiction across scales of biological organization: Though BNF can sufficiently resolve the emergence of N richness at the level of ecosystems, the explanation is inconsistent with theoretical expectations of how BNF should function as an adaptive strategy at the level of individual organisms.

BNF

Obligate VS Facultative
Selfless VS Selfish

The Leaky Nitrostat Model



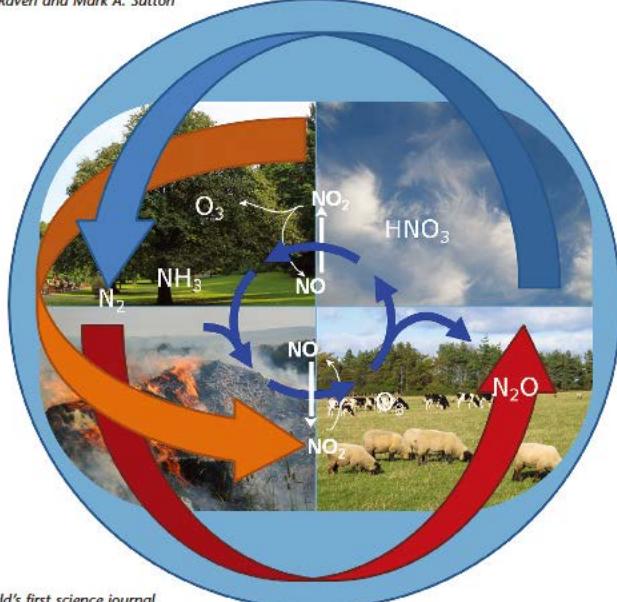
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- Plant uptake
- BNF
- Allocation
- NUE

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Papers of a Discussion Meeting Issue organised and edited by David Fowler, John A. Pyle, John A. Raven and Mark A. Sutton



The world's first science journal

ISSN 0962-8436

volume 368

number 1621

Downloaded from <http://rstb.royalsocietypublishing.org> on September 24, 2015

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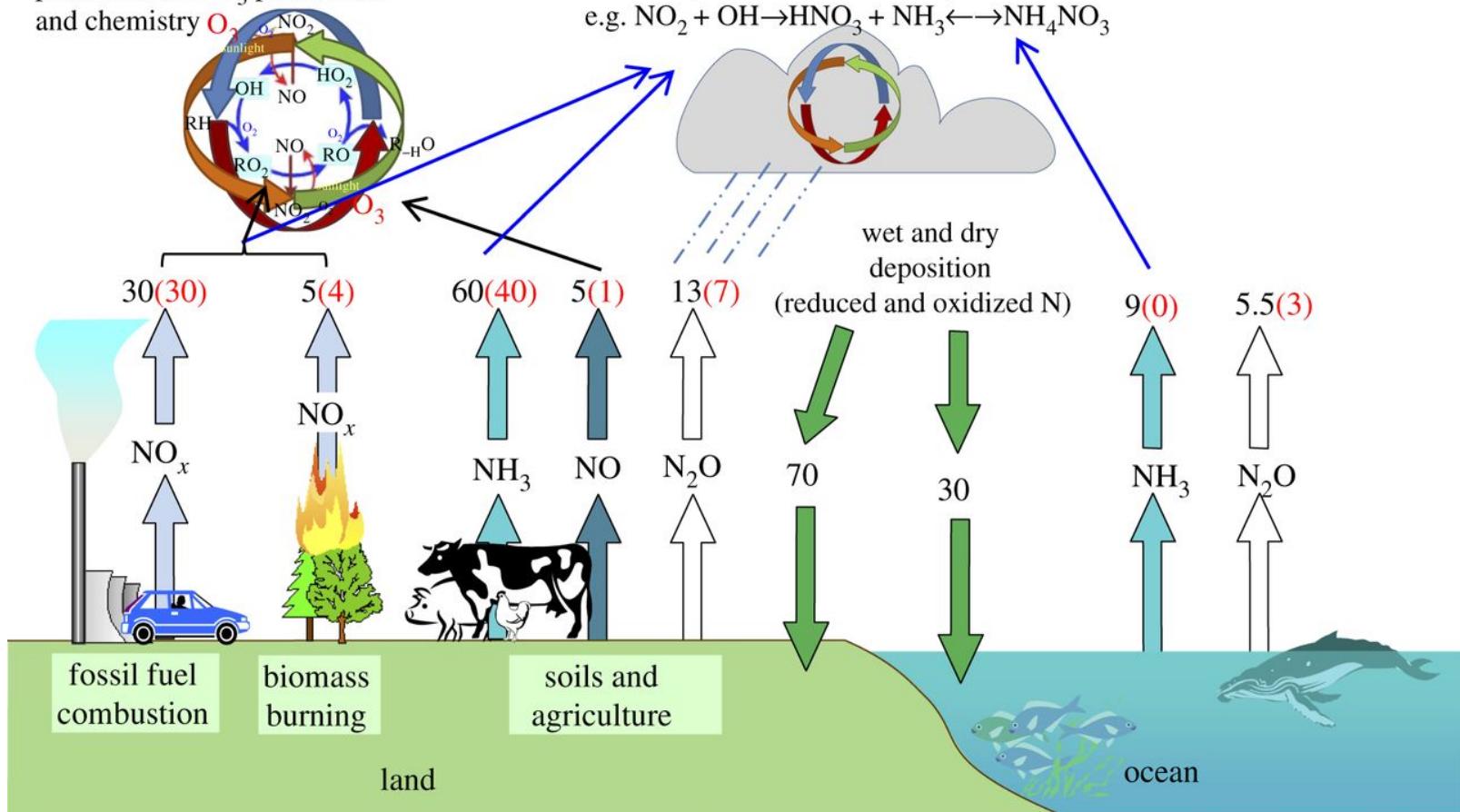
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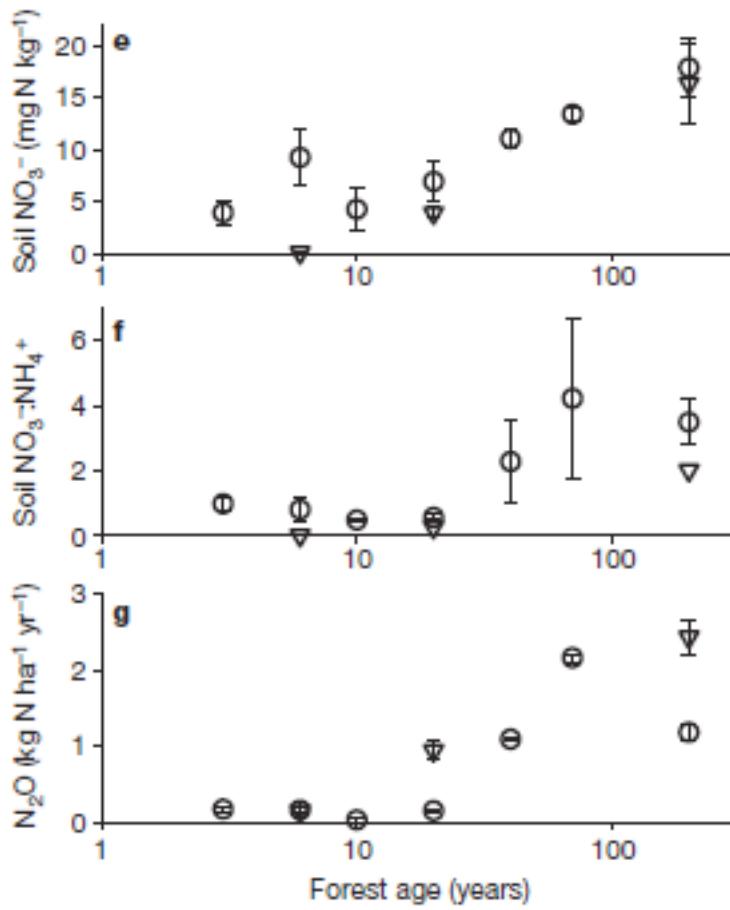
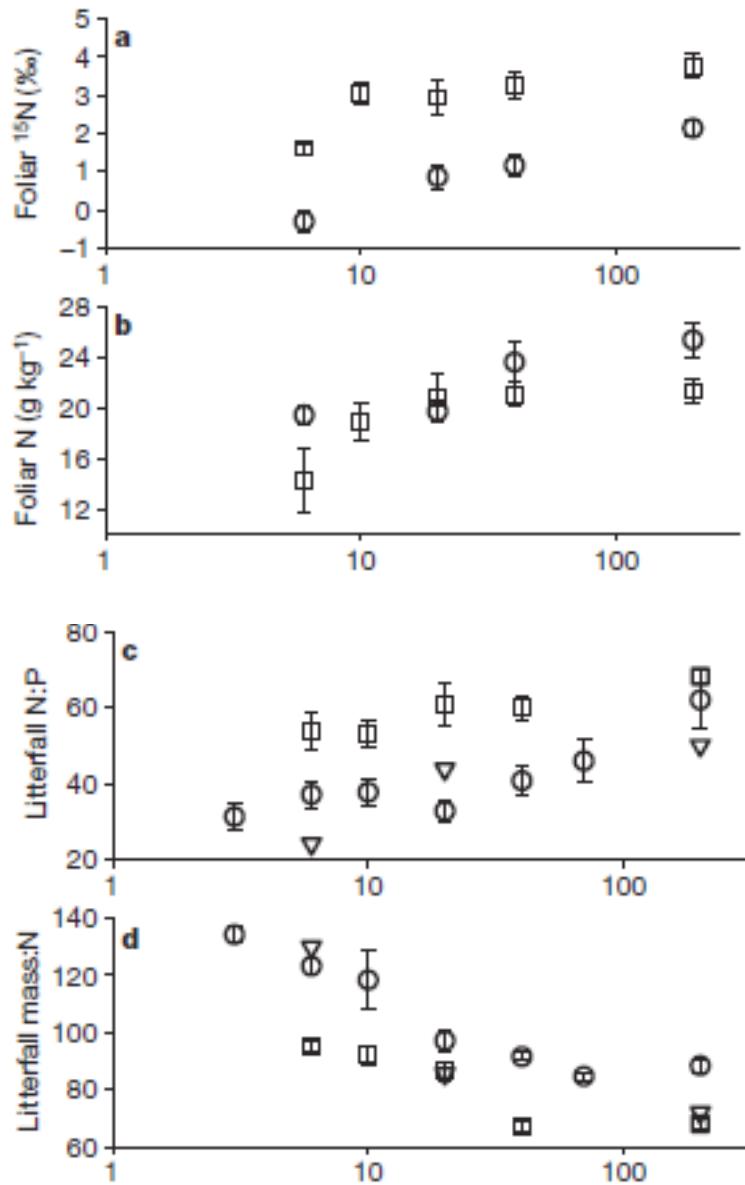
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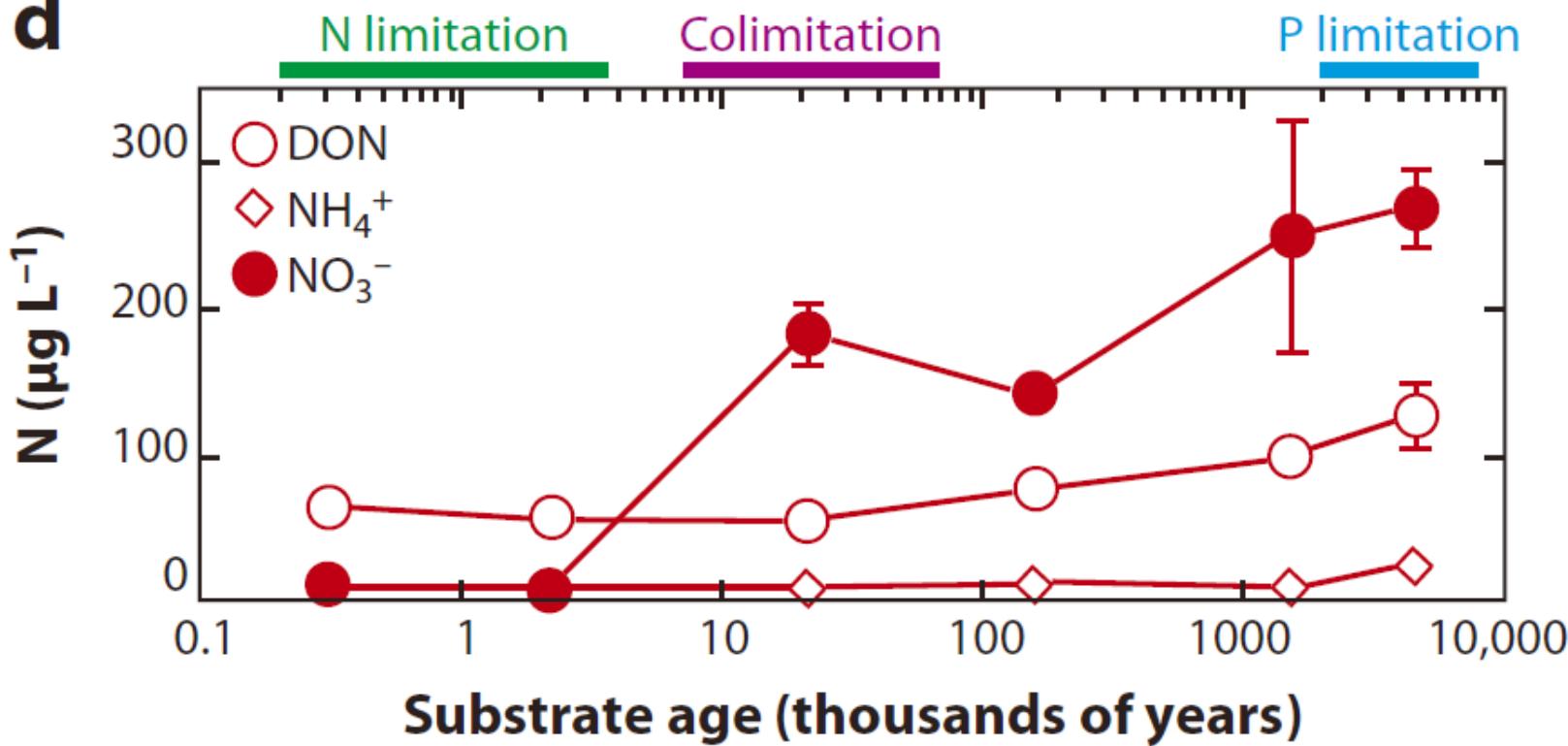
photochemical O₃ production
and chemistry

O₃ (sunlight)
aerosols (in clouds and free air)
e.g. NO₂ + OH → HNO₃ + NH₃ ↔ NH₄NO₃





Davison et al., 2007

d

Hedin et al., 2009