Soils and Climate Change

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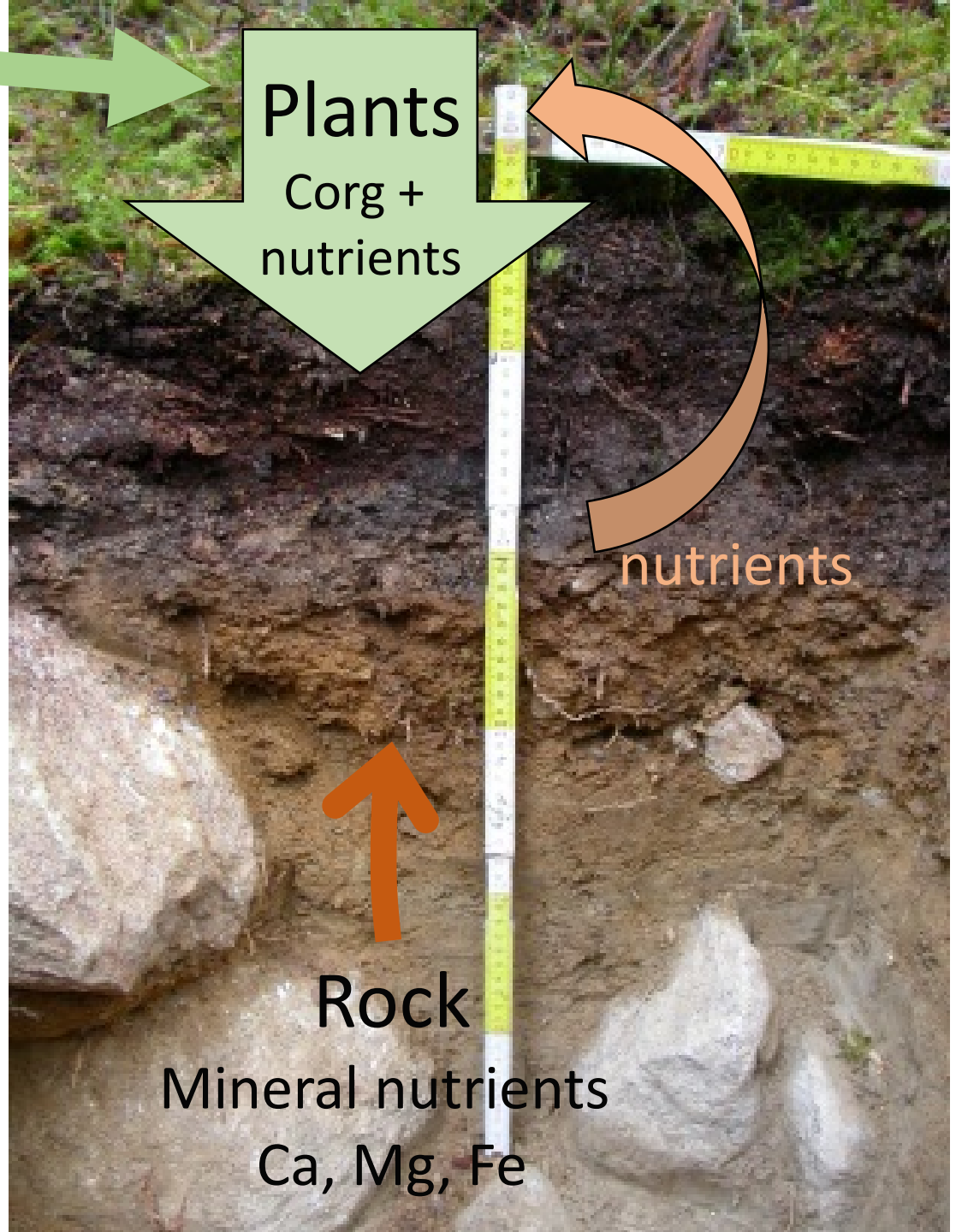
thanks to Marion Schrumpf, MPI-BGC and EAG Schuur, Northern Arizona University

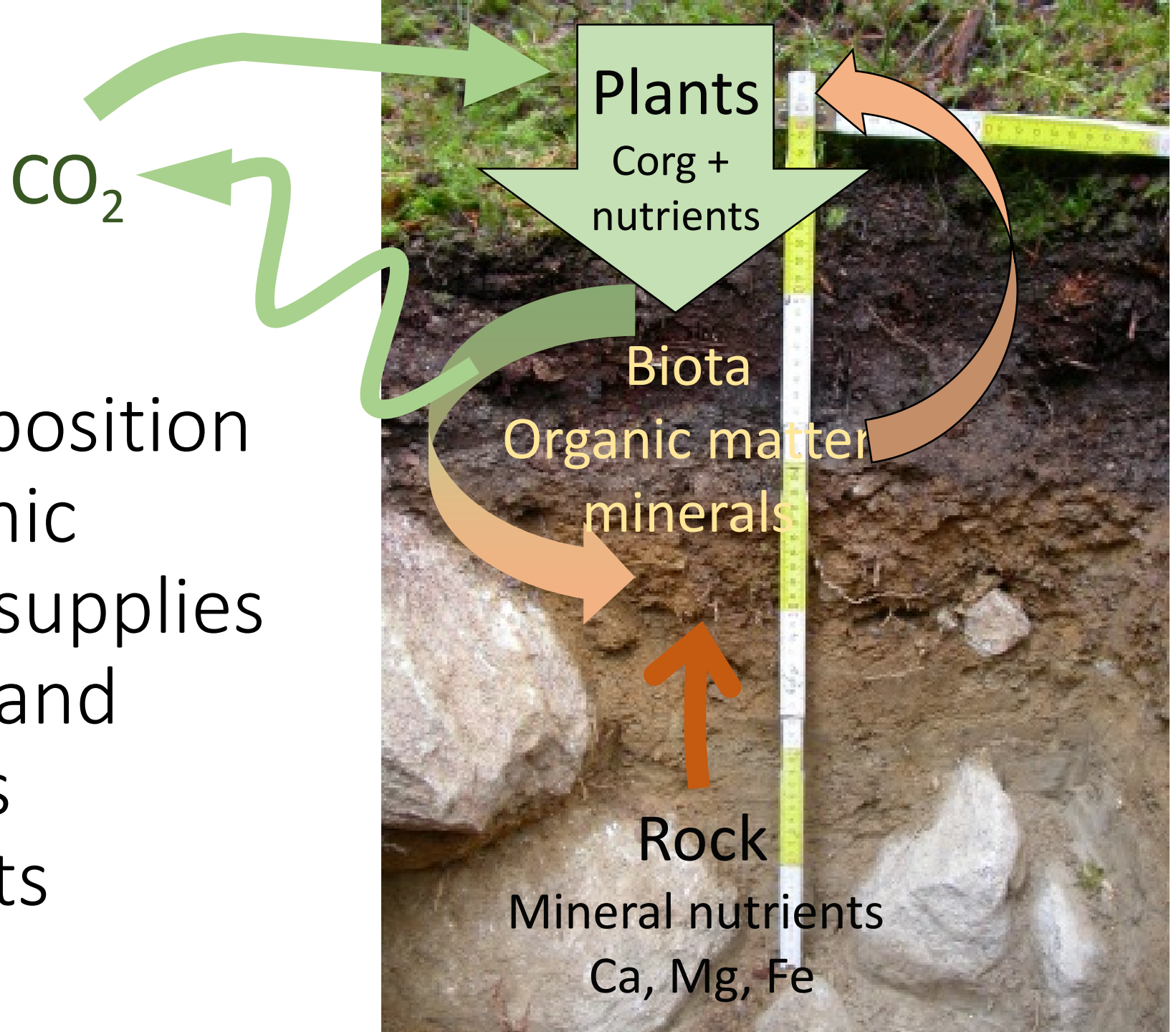


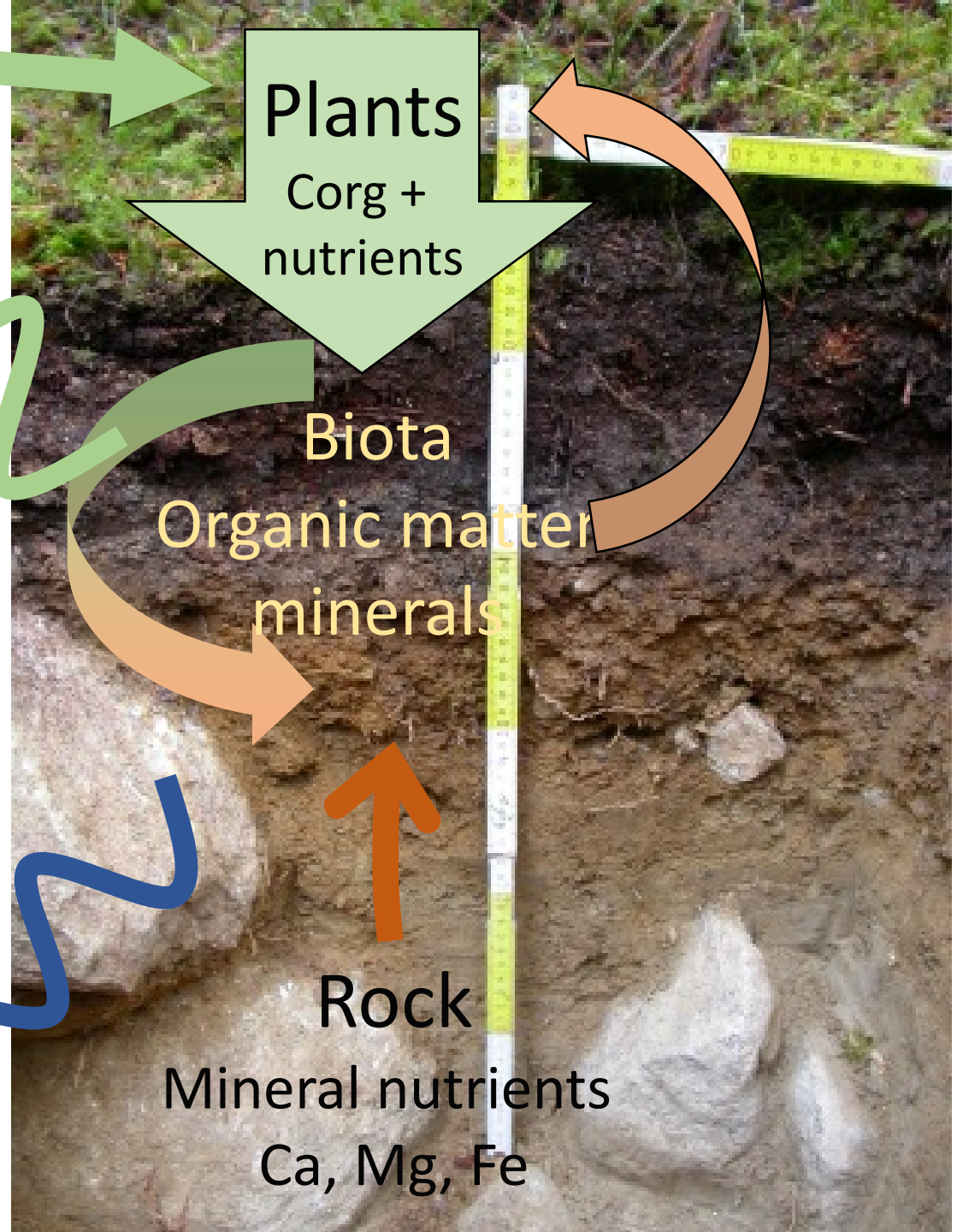

CO_2

Soil develops where rocks meet air, water and biota



Decomposition of organic matter supplies energy and recycles nutrients





CO_2

Greenhouse gases

N_2O ~ 200 x CO_2(eq)

CH_4 ~ 30 x CO_2(eq)

Water
drainage

Properties vary with rock, plants, climate, time




Photos M. Schrumpf

Tropical soil: high inputs, fast decomposition, efficient recycling

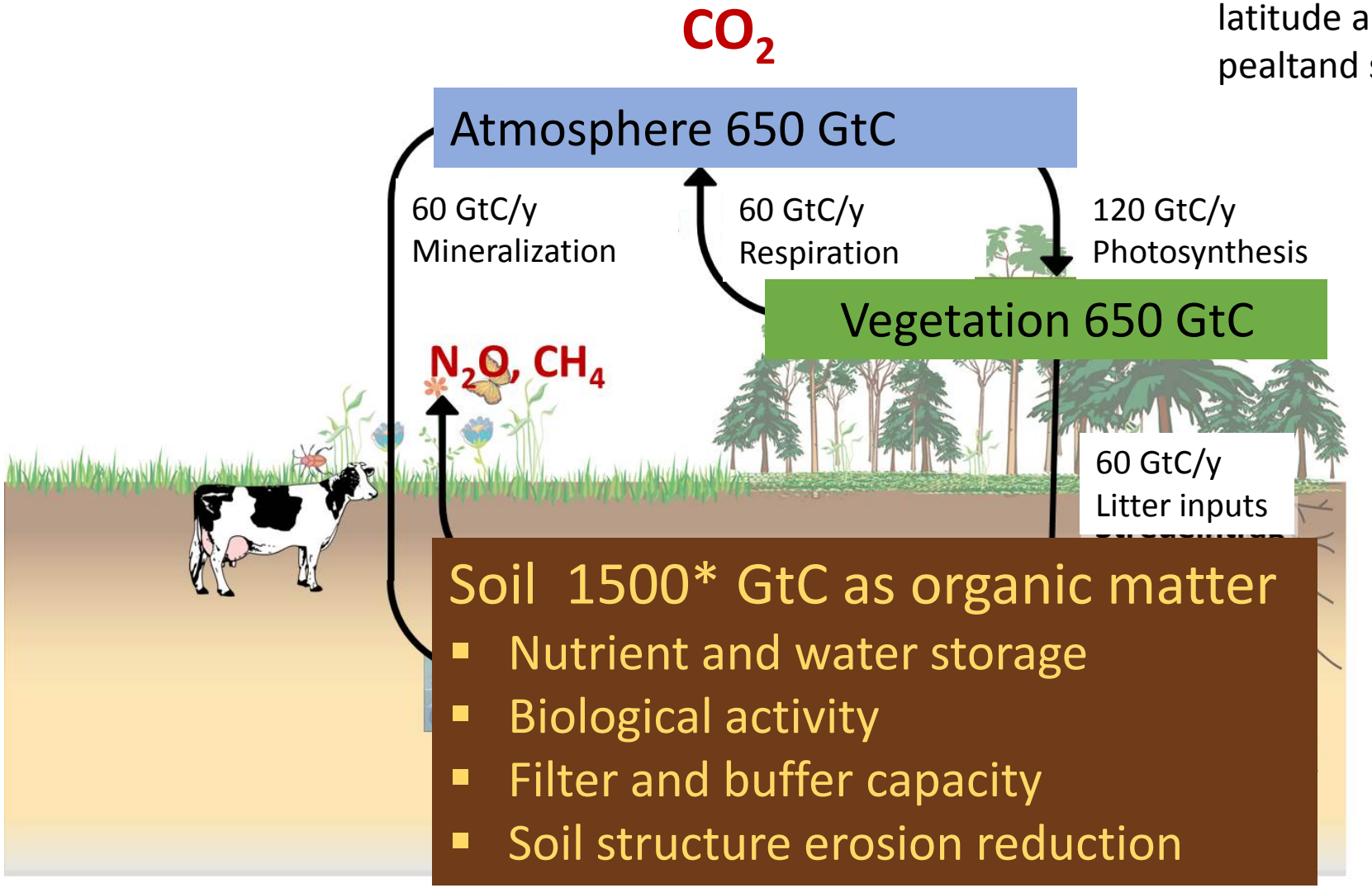
Boreal soil: moderate inputs, slow decomposition, inefficient recycling

Soil role in the global C cycle

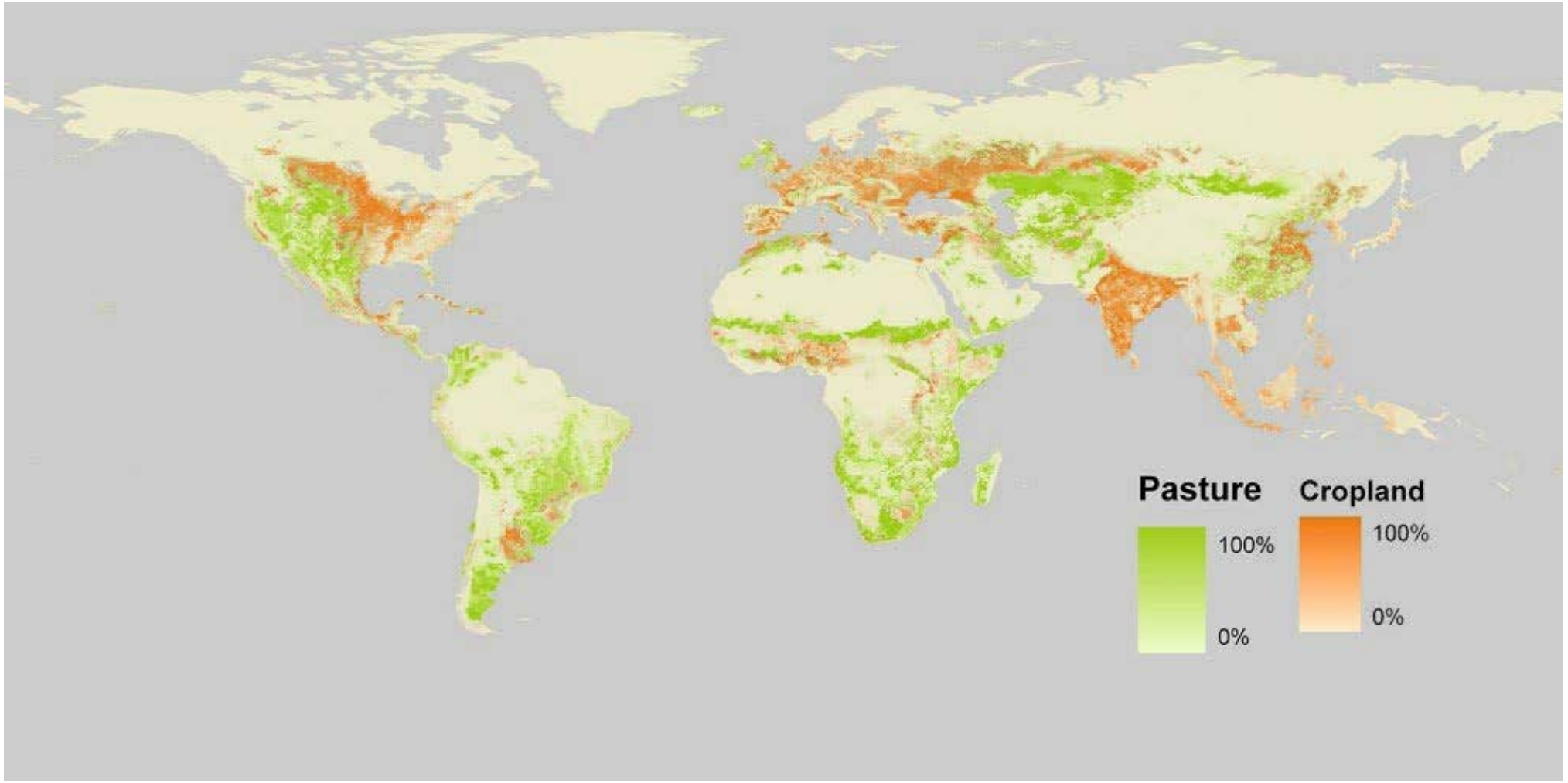
Greenhouse gas emissions

Soil Fertility

Excludes high latitude and pealtand soils



>50% of ice-free land area directly modified by humans



maps from the SAGE 7, Center for Sustainability and the Global Environment at the University of Wisconsin-Madison - http://news.wisc.edu/new-maps-reveal-the-human-footprint-on-earth/#continue

Human land management contributes to climate change by altering soils

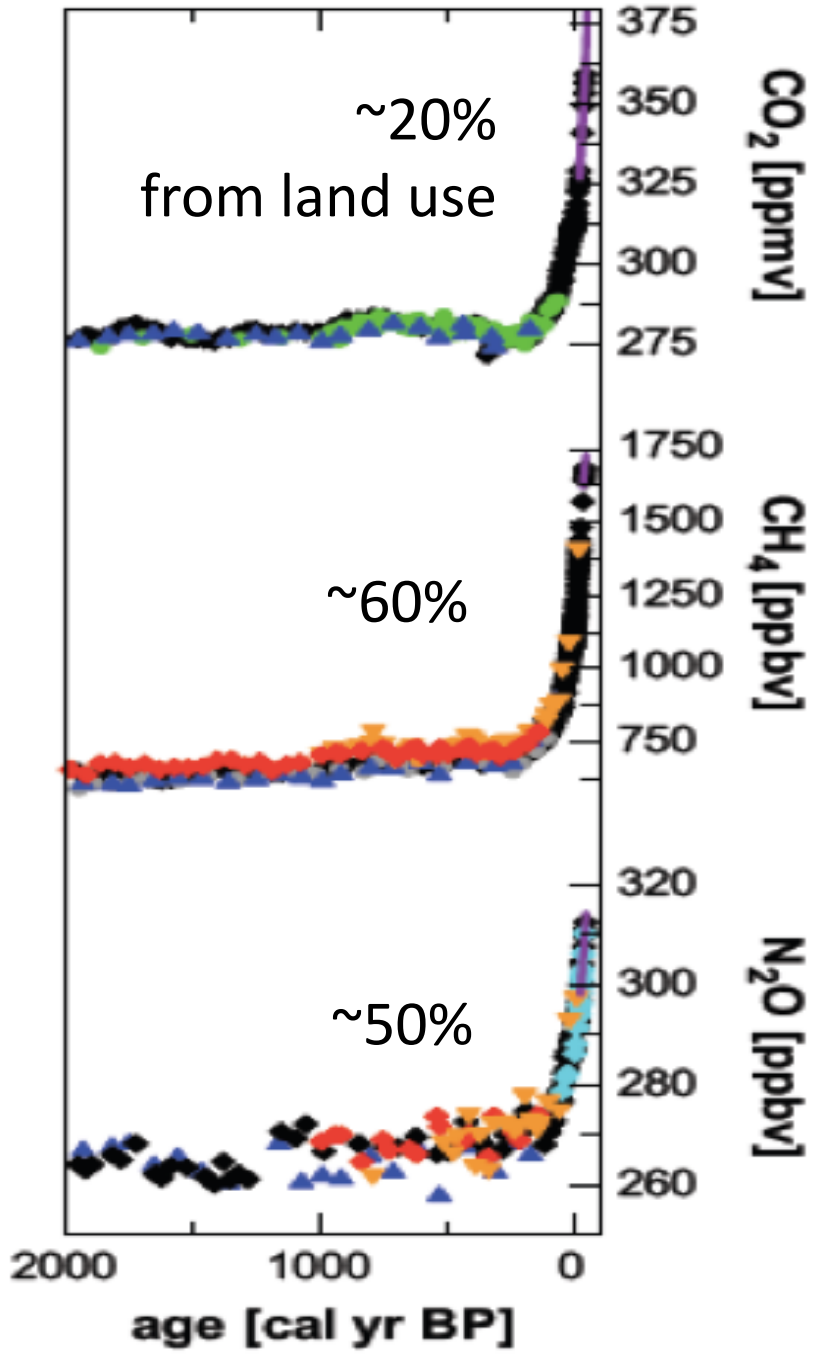
Livestock ➔ increased methane emissions

Reduced inputs ➔ loss of SOM

Fertilizer use ➔ enhanced N_2O emissions

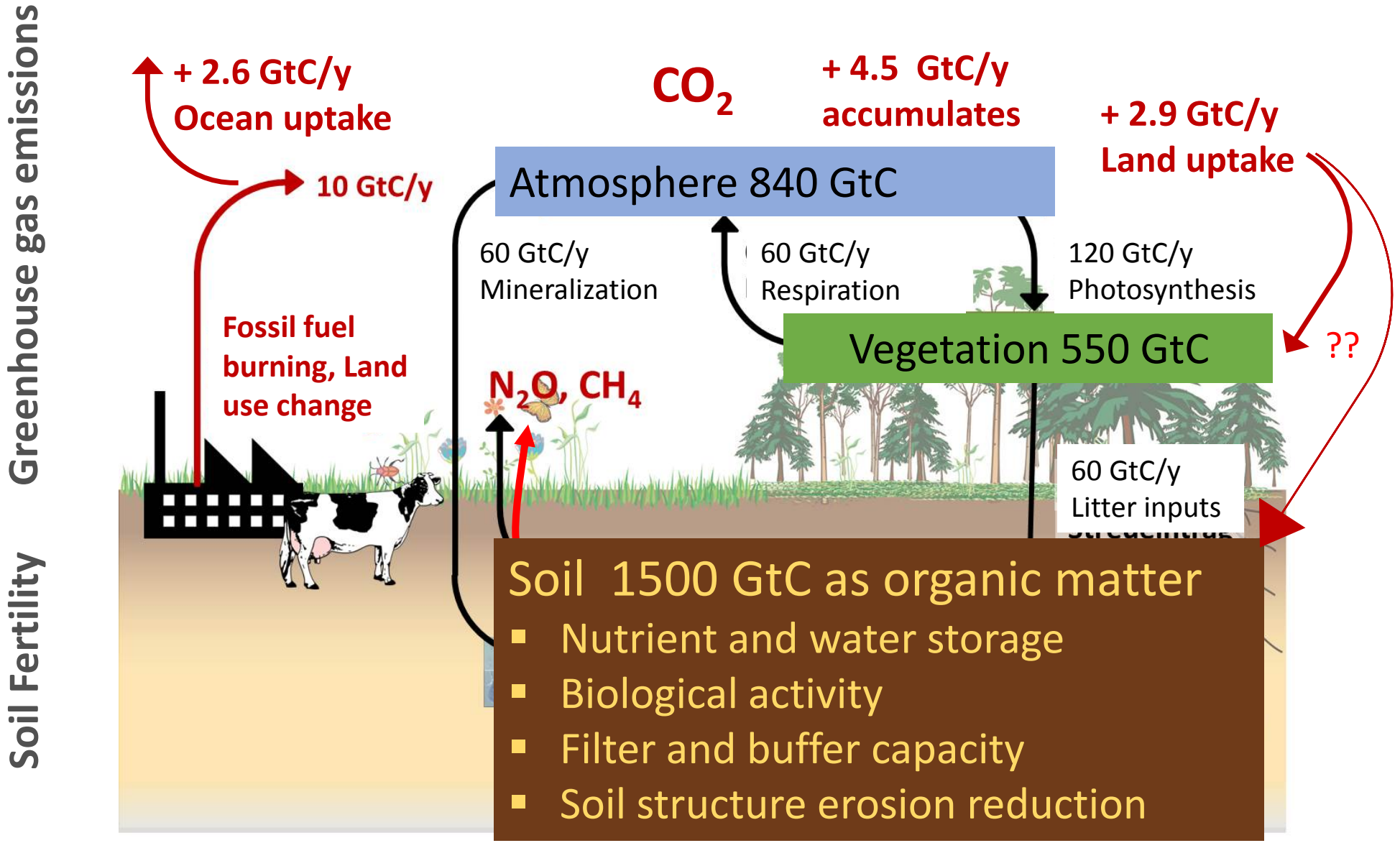
Increases in all three greenhouse gases linked to combined rise of human industry and land conversion in the last century

~25% of current radiative forcing from greenhouse gas increases is traceable to land use emissions

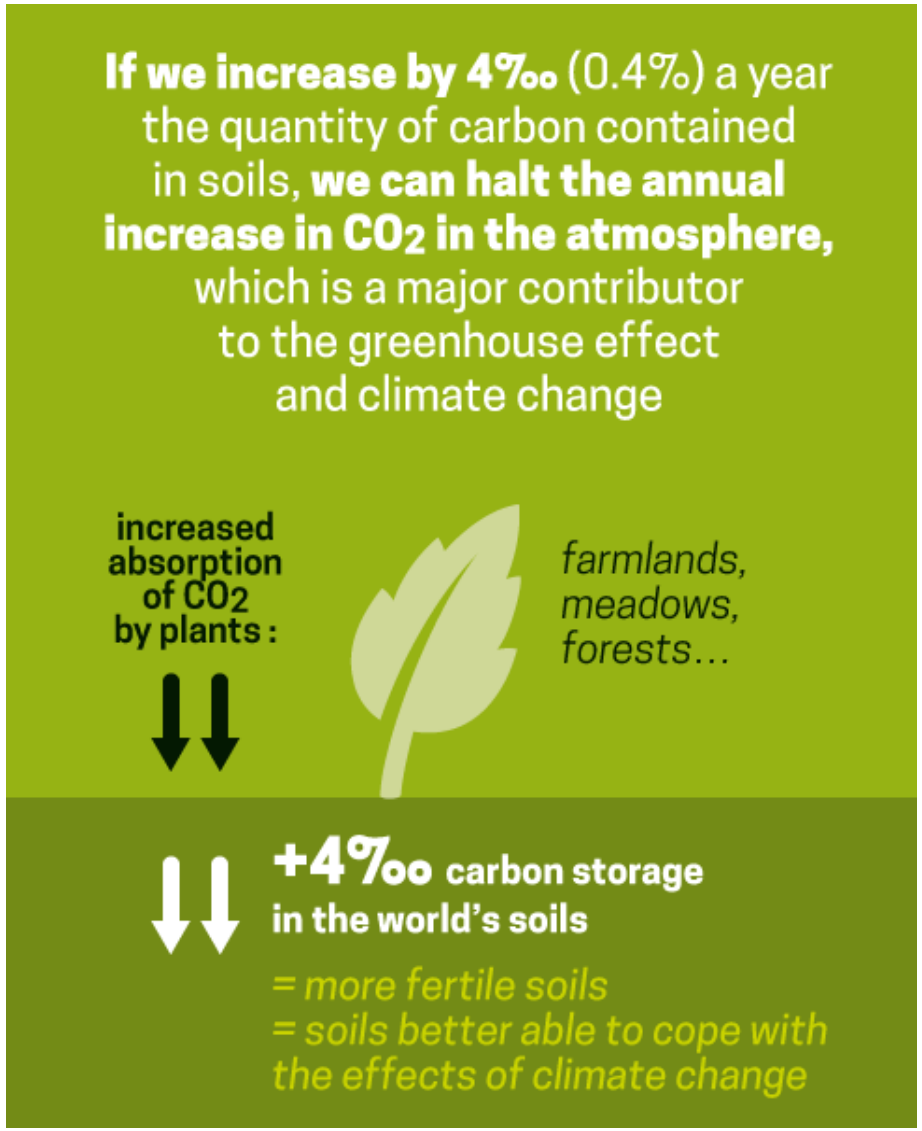


Wanner et al. 2008 Quat.Sci. Rev.
Paustian et al. 2016 Science
P. Smith et al. 2015 Global Change Biol.

The Land Carbon Sink



Can we manage soils to take up even more C ?



International Initiative begun in 2015 qs one action to implement the Paris accords

http://4p1000.org

Mitigation of climate change while meeting global demand for food

- Build up organic matter (put back what was lost)
- Apply fertilizer more efficiently
- Amendments (biochar)

- Alter rice cultivars and crop methods to minimize methane emissions

BUT - What happens to soils in a warmer world?

Rapid warming of the Arctic
Large stores* of frozen organic C

~1300-1600 PgC Hugelius et al 2014

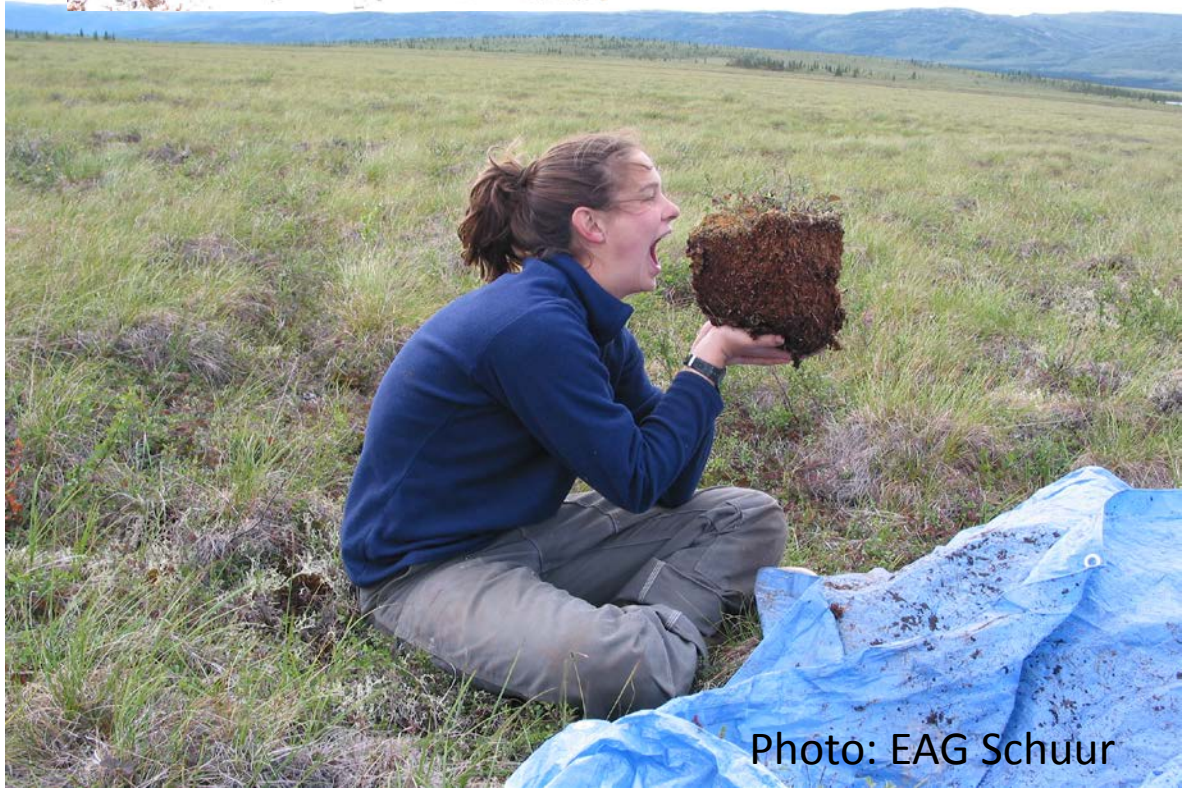
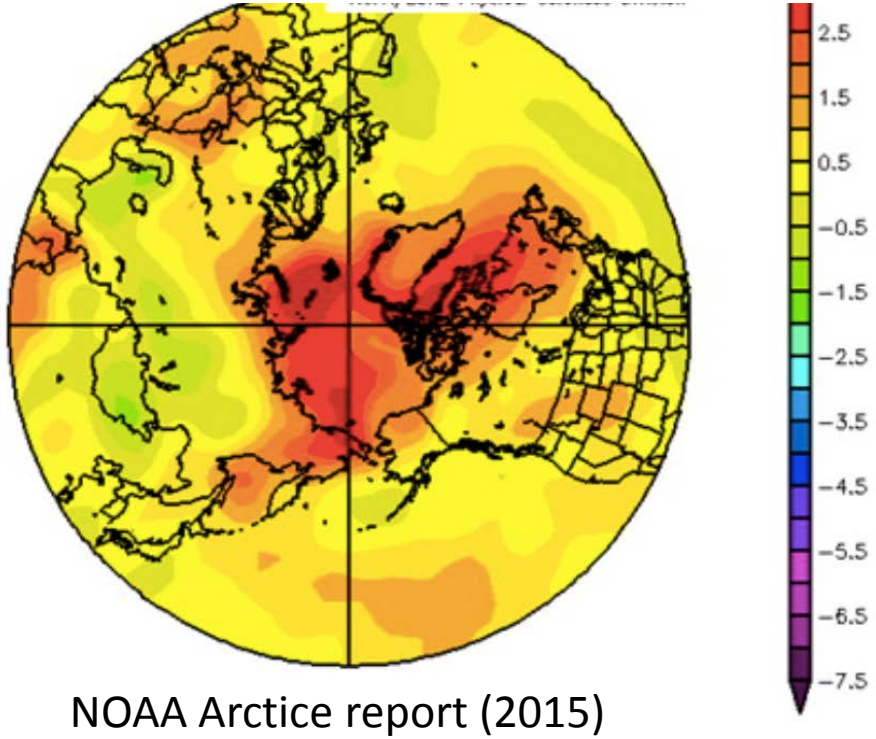


Photo: EAG Schuur

Temperatures in 2009-2014 minus 1984-2000



NOAA Arctice report (2015)

STATE OF THE SCIENCE

5-15 % of permafrost zone soil carbon vulnerable to release as greenhouse gas this century.
(Schuur et al. 2015 Nature)

- Equivalent to 130 to 160 billion tons carbon
- Magnitude similar to current emissions from deforestation

Summary:

- What we do to soils has consequences for the atmosphere and climate
  - Use best science to balance food demand with other soil services
- Uncertainties remain large at global scales
  - **How much do soils contribute to the land C sink?**
  - **How will soil C stores respond to temperature rise?**
- Role of science is both to increase fundamental understanding of how soils operate and to assess management options and tradeoffs