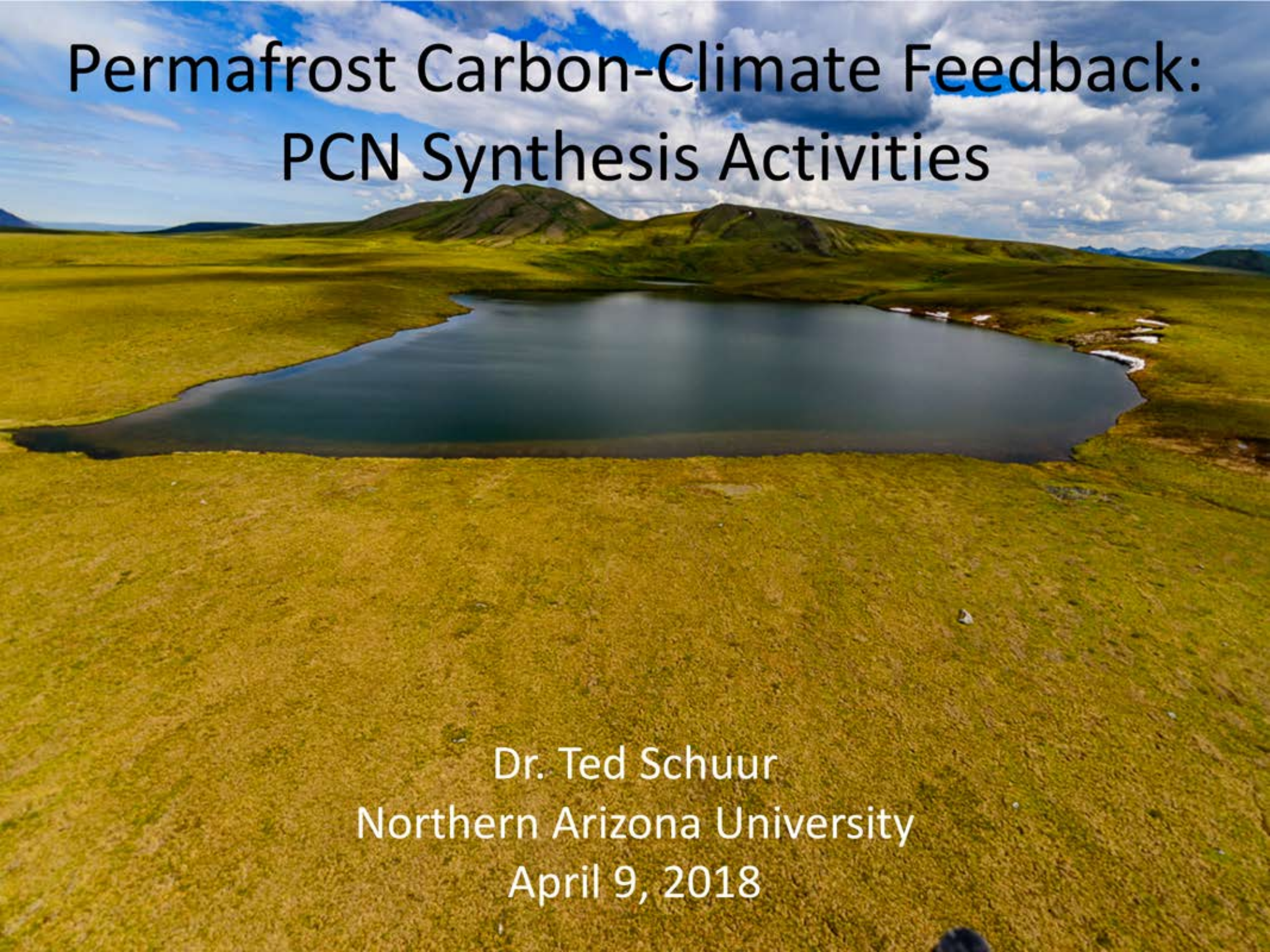
Permafrost Carbon-Climate Feedback: PCN Synthesis Activities



Dr. Ted Schuur
Northern Arizona University
April 9, 2018

Permafrost Carbon Network

Part of the Study for Environmental Arctic Change Program

OBJECTIVE: Produce knowledge through **research synthesis** to quantify the role of permafrost carbon in driving future climate change

BUILT NETWORK: Poised to ingest new observations and deliver synthesis science and outreach products on timeframe needed by decision makers

LEADERSHIP:

PI: Ted Schuur, Dave McGuire, Christina Schädel

Logistics: Brit Myers, ARCUS

Contributors: Steering committee, synthesis leads, the permafrost carbon community, SEARCH executive director & Action Team leads

Current number of

Members: 380+

Institutions: 177

Countries: 24

Permafrost Action Team

Study of Environmental Arctic Change

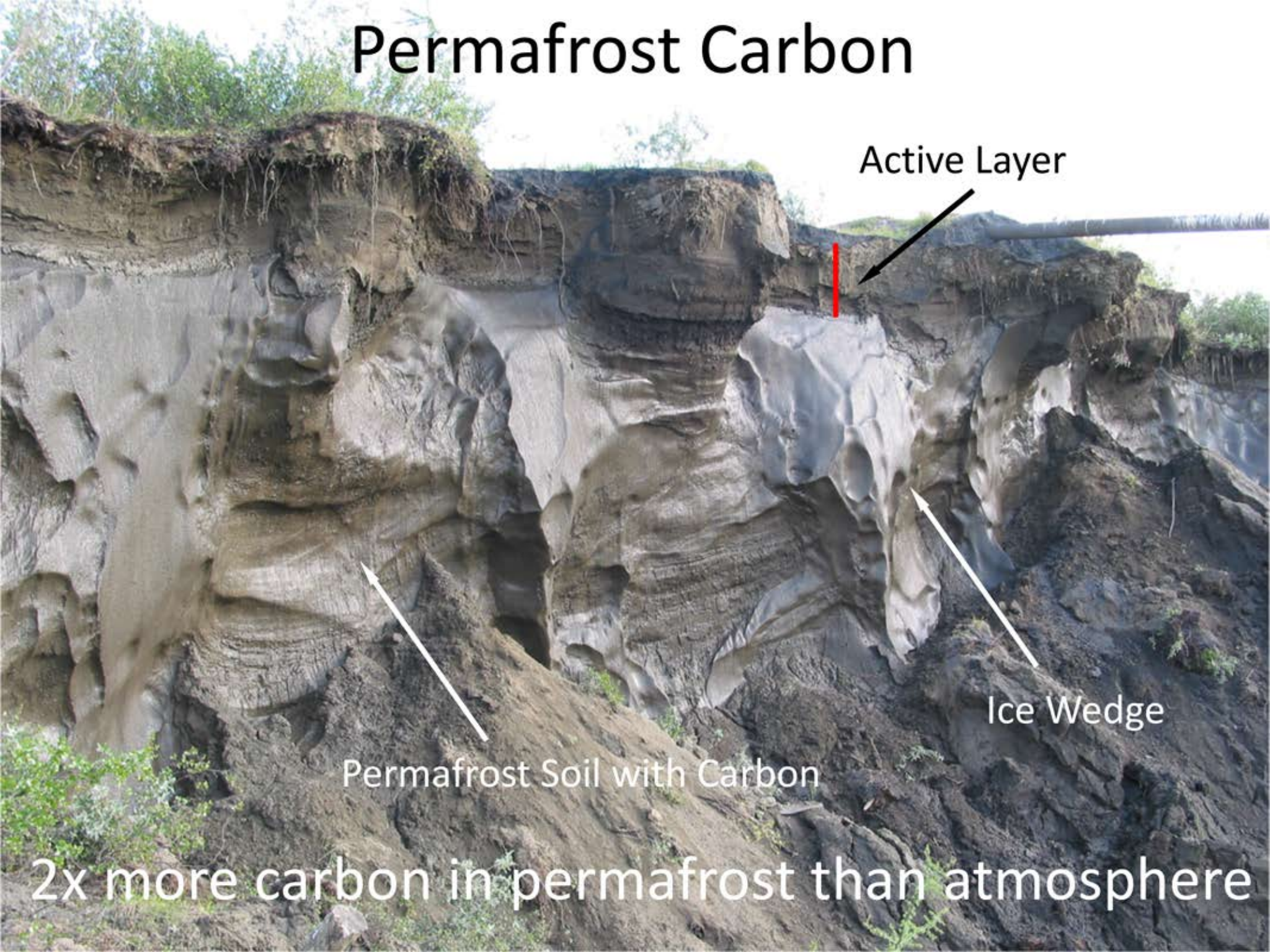
SEARCH

Sea Ice Action Team

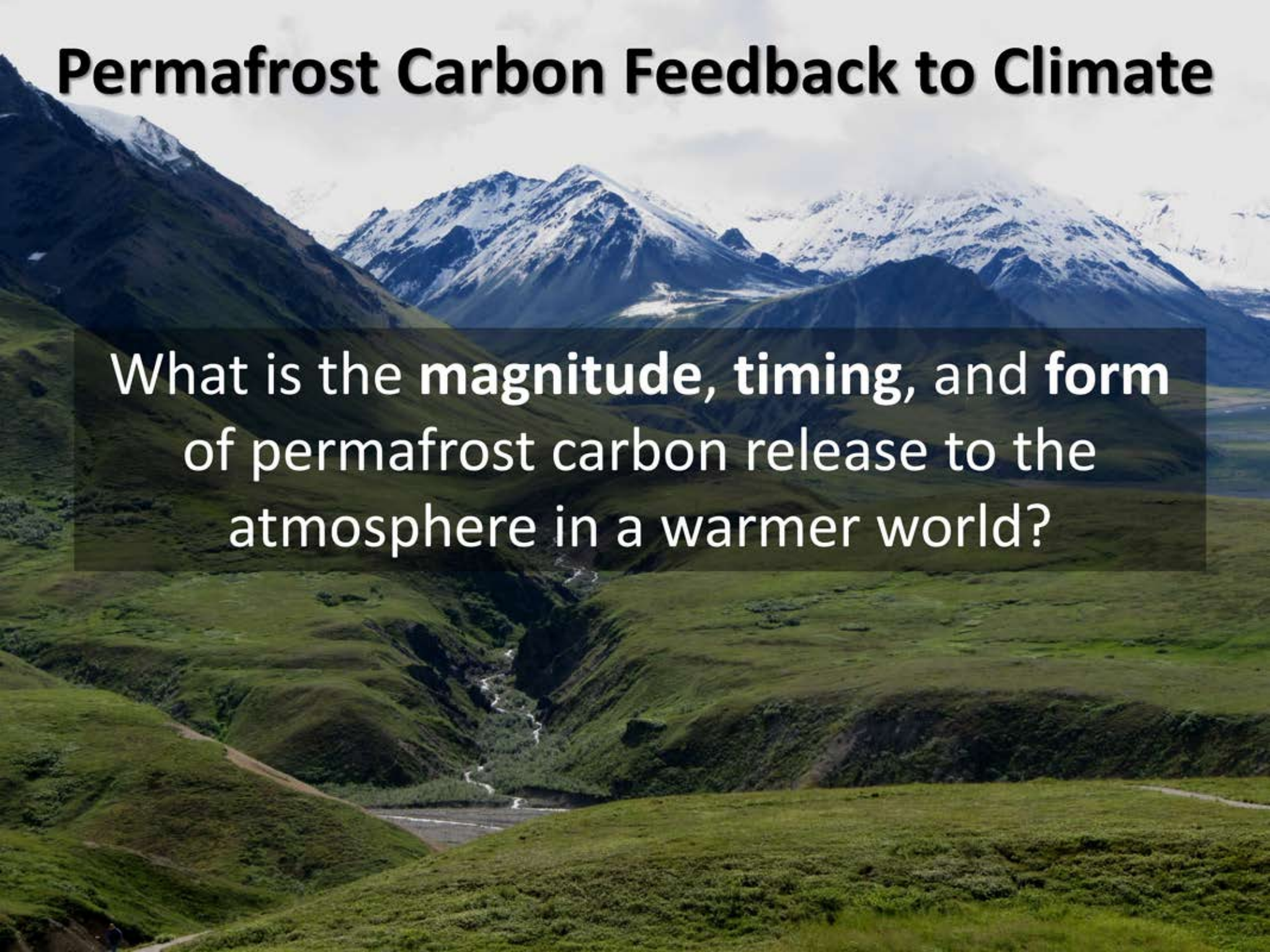
Land Ice Action Team

Permafrost Action Team

Document and Communicate How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems **USING SYNTHESIS SCIENCE**


Permafrost Carbon
Active Layer
Ice Wedge
Permafrost Soil with Carbon
2x more carbon in permafrost than atmosphere

Permafrost Carbon Feedback to Climate



What is the **magnitude**, **timing**, and **form** of permafrost carbon release to the atmosphere in a warmer world?

Soil Carbon (Surface 0-3 m)

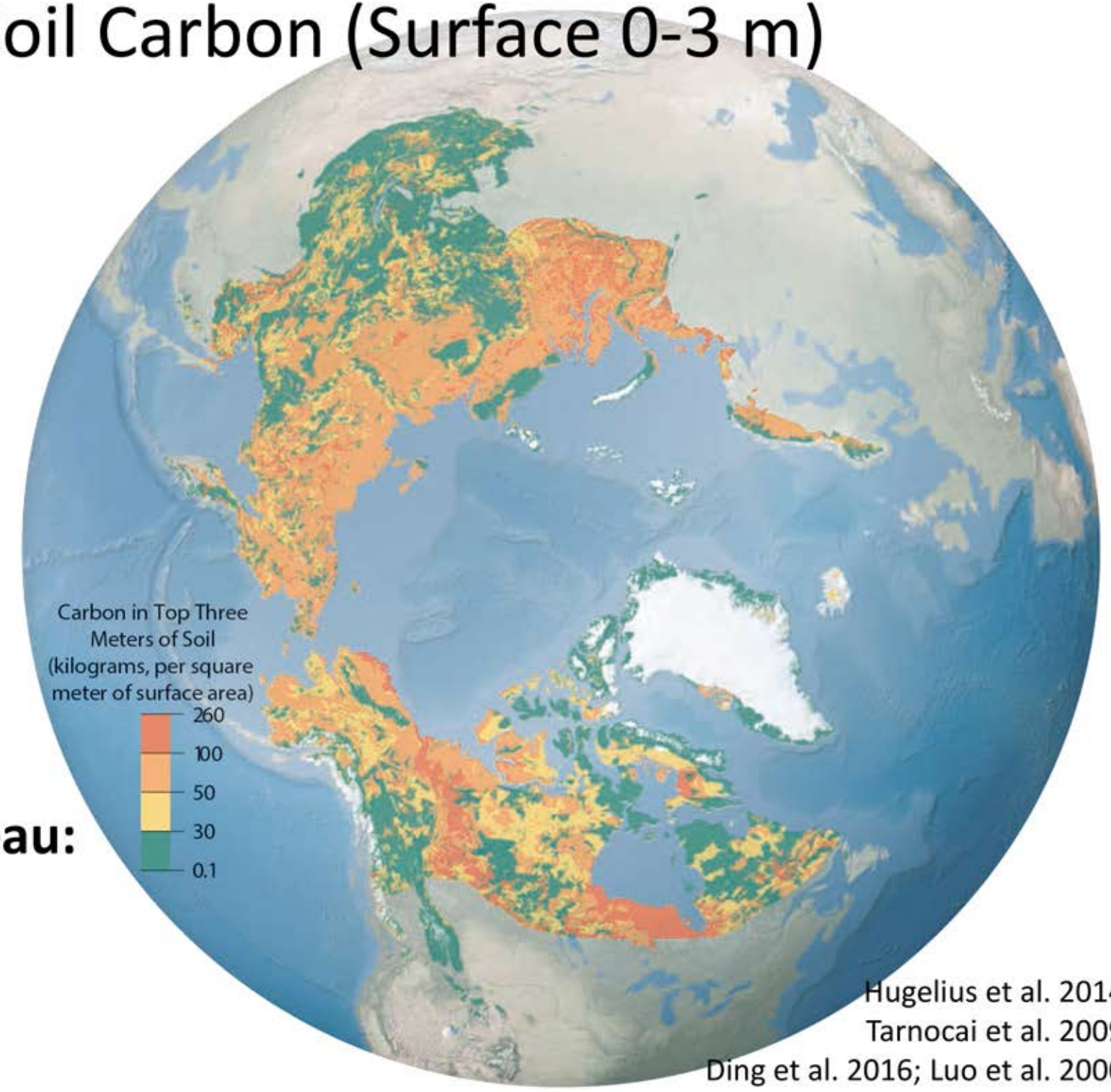
1035

±150 Pg C

33% of Global soil carbon (0-3m)

Tibetan Plateau:
15.3 Pg C

N. China:
20.4 Pg C



Hugelius et al. 2014
Tarnocai et al. 2009
Ding et al. 2016; Luo et al. 2000

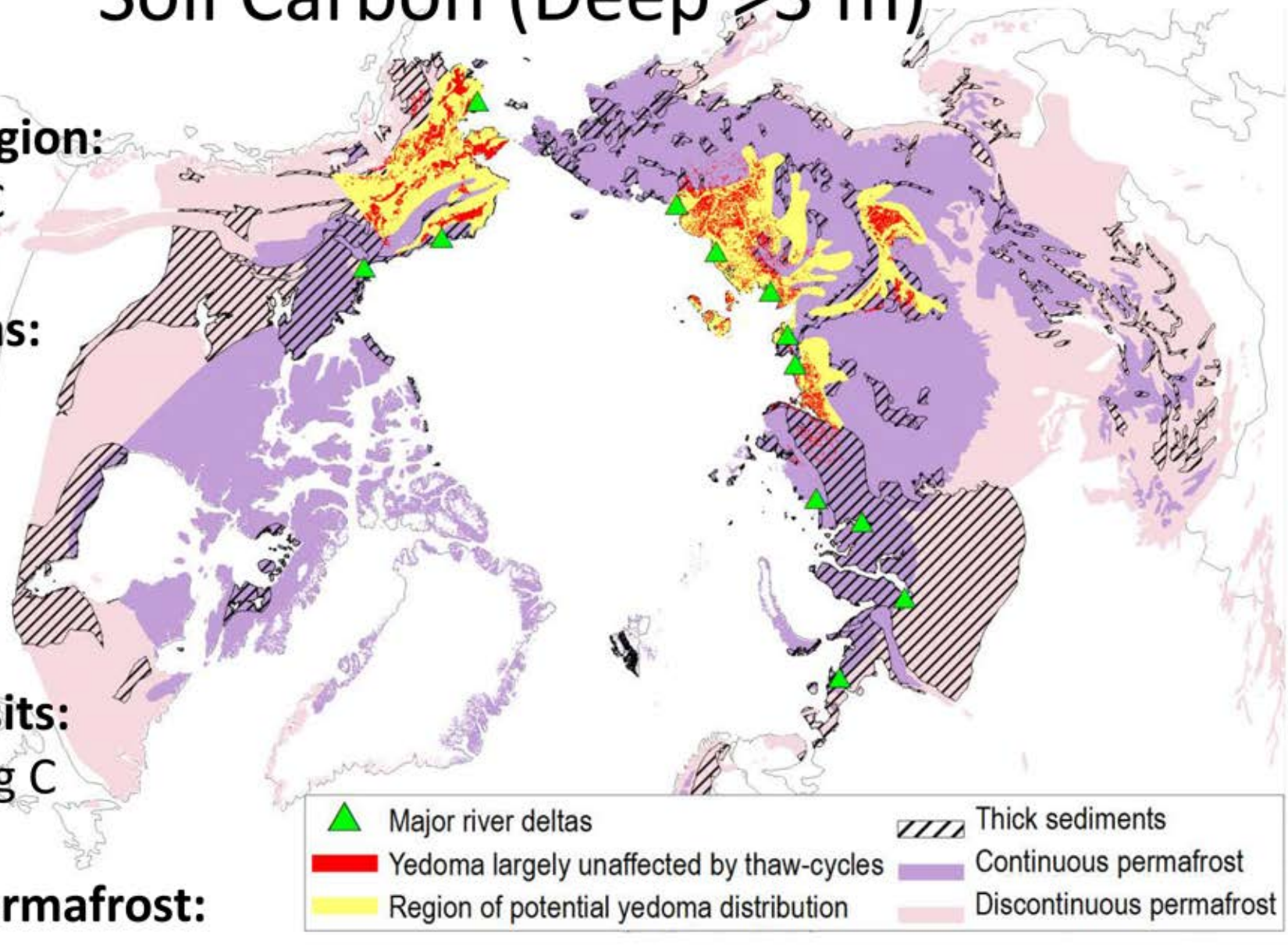
Soil Carbon (Deep >3 m)

***Yedoma Region:**
327-466 Pg C

***Arctic Deltas:**
96±55 Pg C

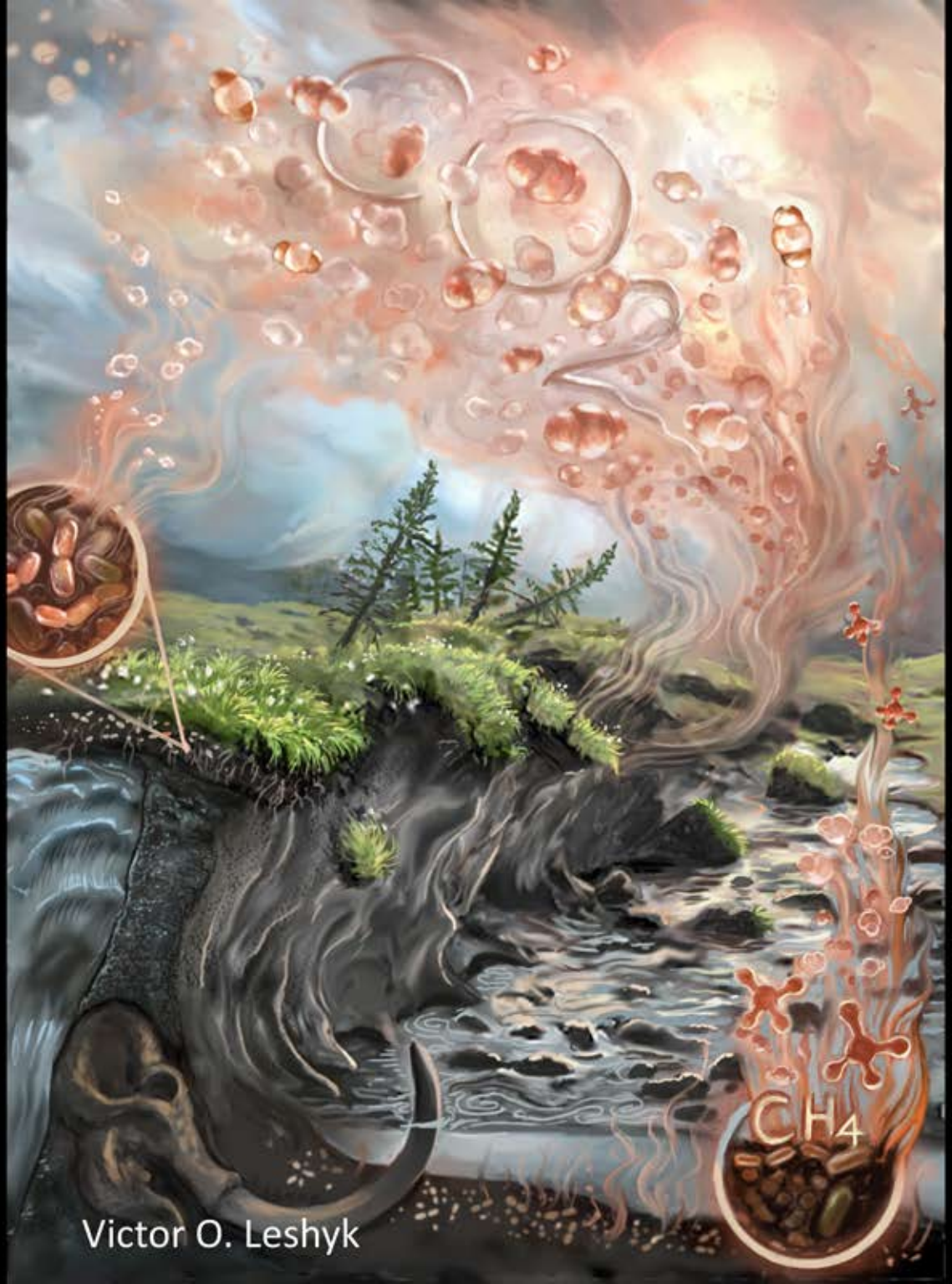
Other Deposits:
~350-465? Pg C

Undersea Permafrost:
? Pg C



Known Permafrost Carbon = 1460-1600* Pg C

Zimov et al. 2006
Hugelius et al. 2014
Strauss et al. 2017
Schuur et al. 2018



Carbon Decomposability

2.1x more carbon with temperature increase of 10°C

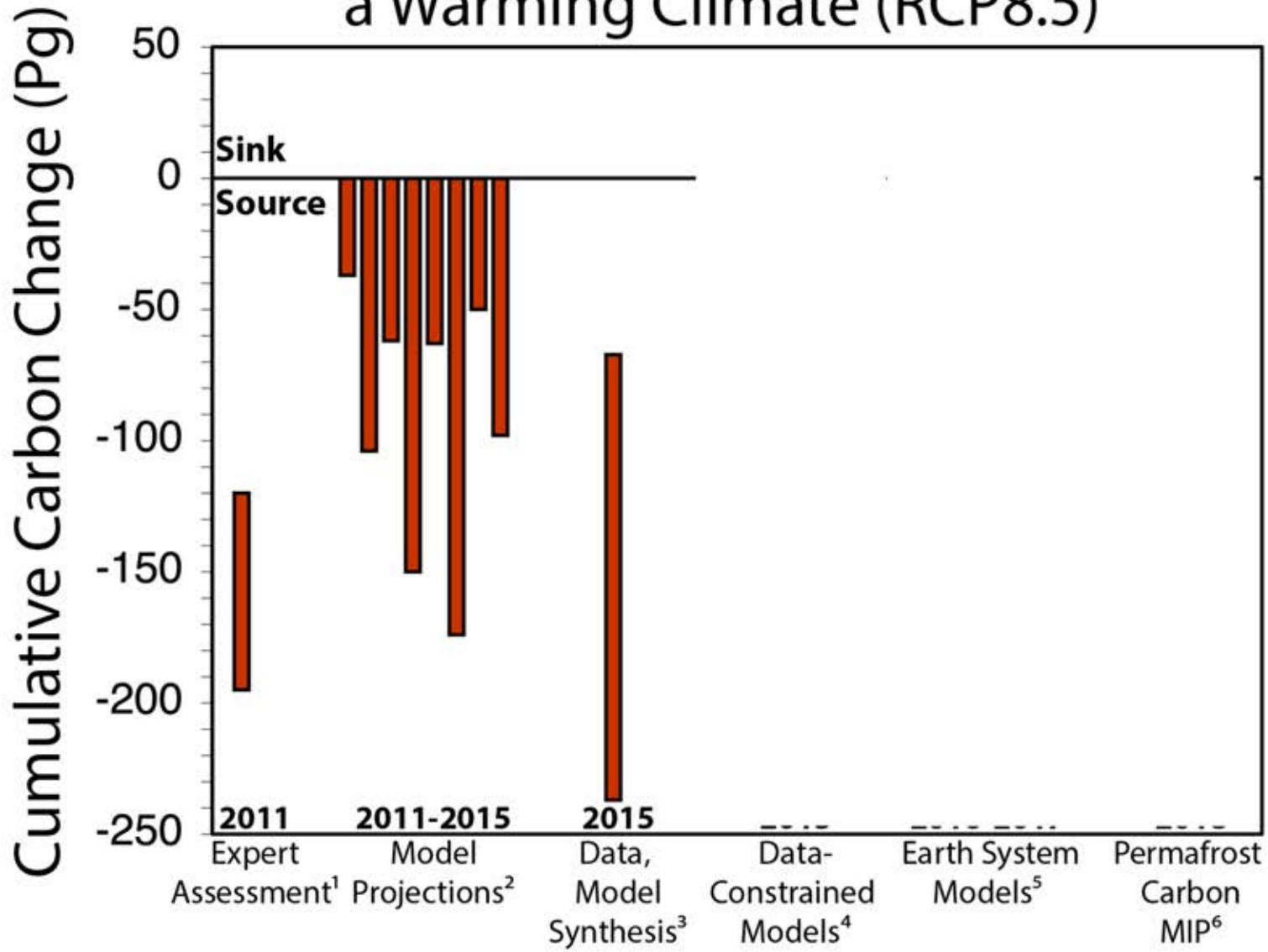
3.4x more carbon under aerobic vs anaerobic

2.1x more accounting for GWP of CH_4

Schaedel et al. 2016

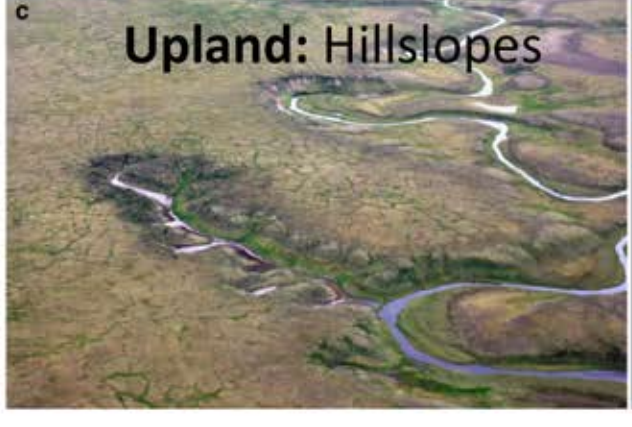
Permafrost Carbon Emissions Synthesis

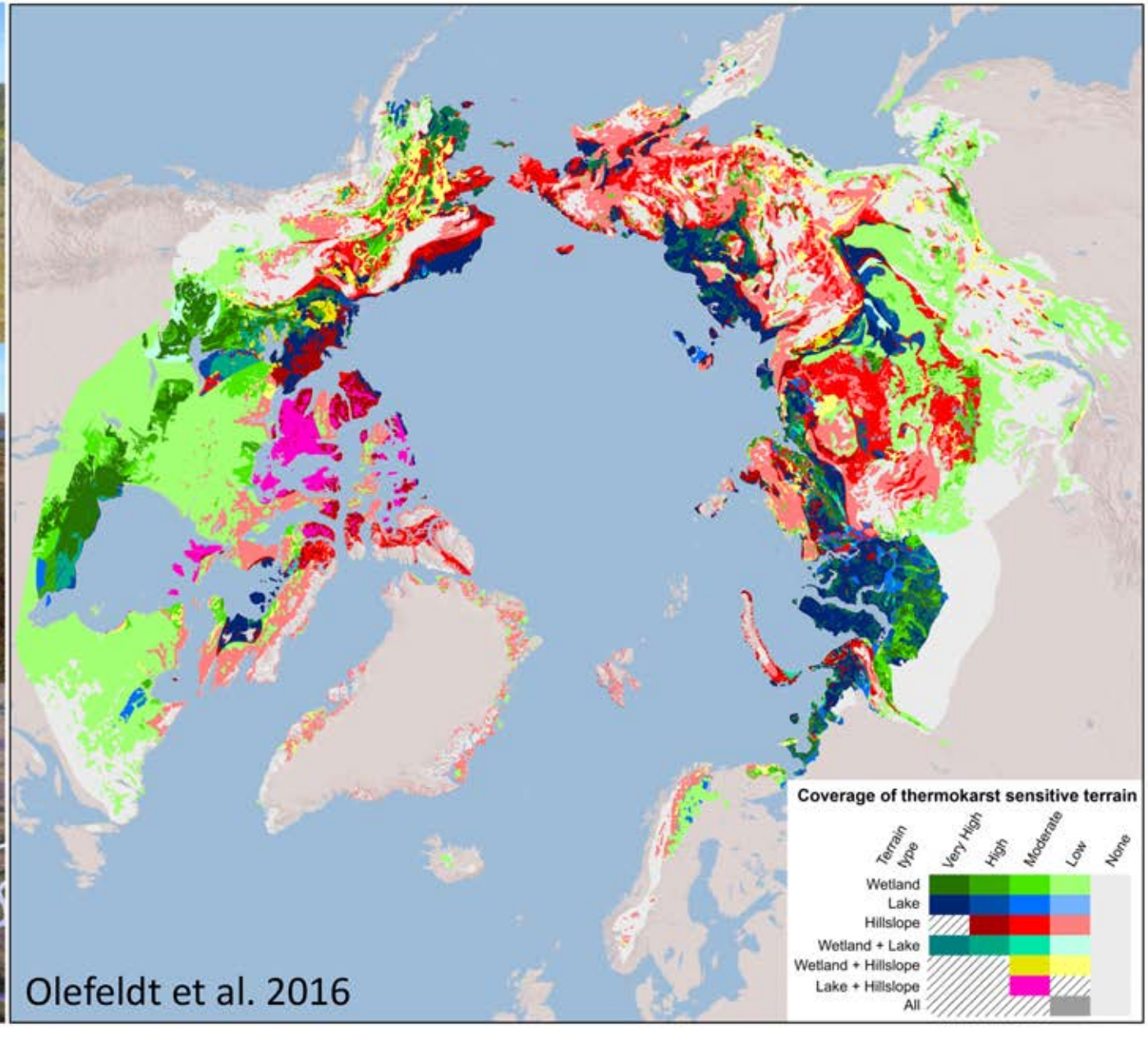
Soil Carbon Change by 2100 in a Warming Climate (RCP8.5)



[1]Schuur et al. 2011 Nature Comment; 2013 Climatic Change; [2]Schaefer et al. 2014 Environmental Research Letters [8 models]; [3]Schuur et al. 2015 Nature; [4]Koven et al. Philosophical Transactions of the Royal Society A 2015; Schneider von Deimling et al. 2015; [5]MacDougall al. 2016; Burke et al. 2017; [6]McGuire et al. 2018

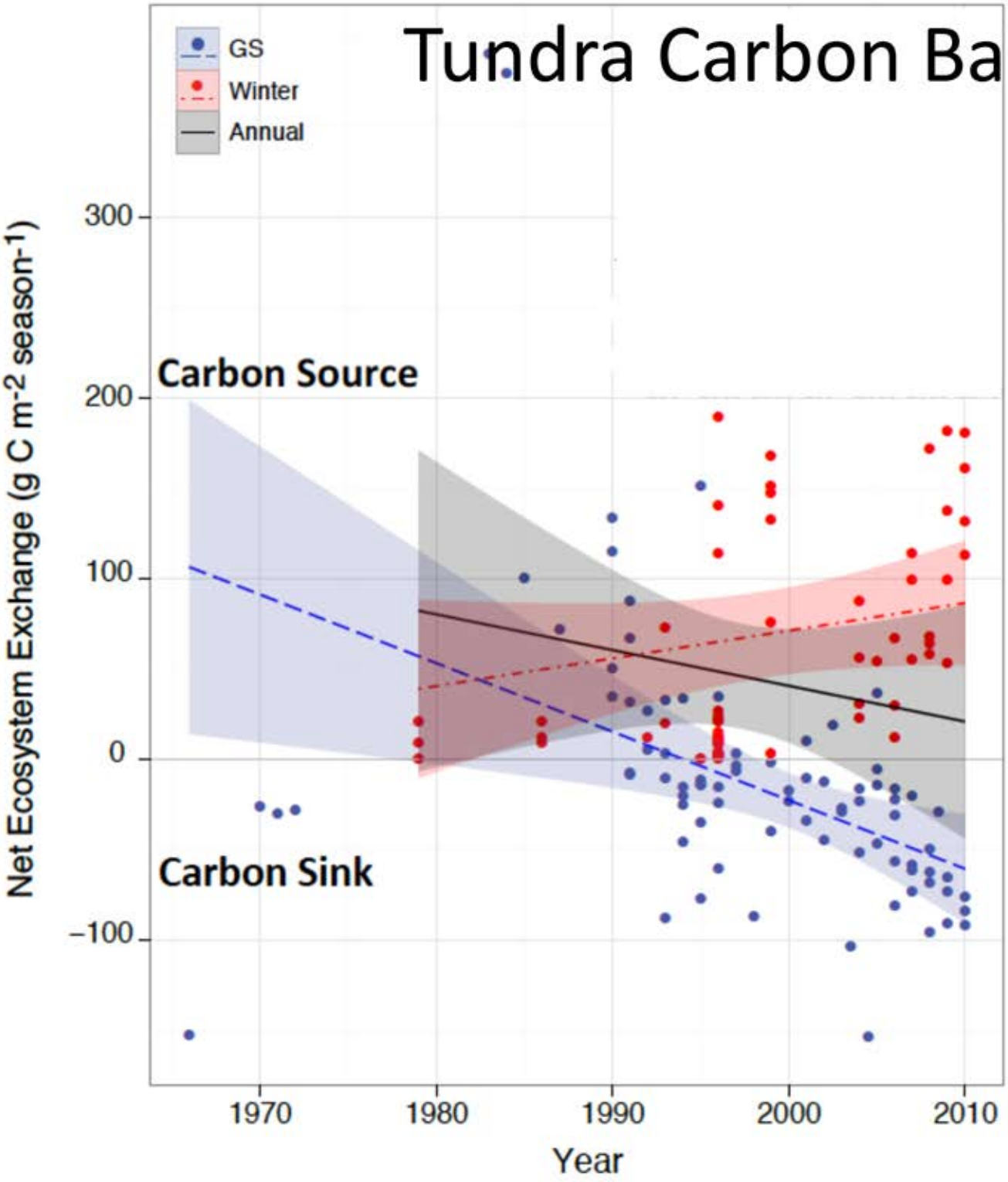
Abrupt Thaw Landscape Distribution





Sensitive terrain = 20% of land area; 50% of soil carbon pool

Tundra Carbon Balance



Growing Season:

- Increasing carbon uptake by plants over time

Winter:

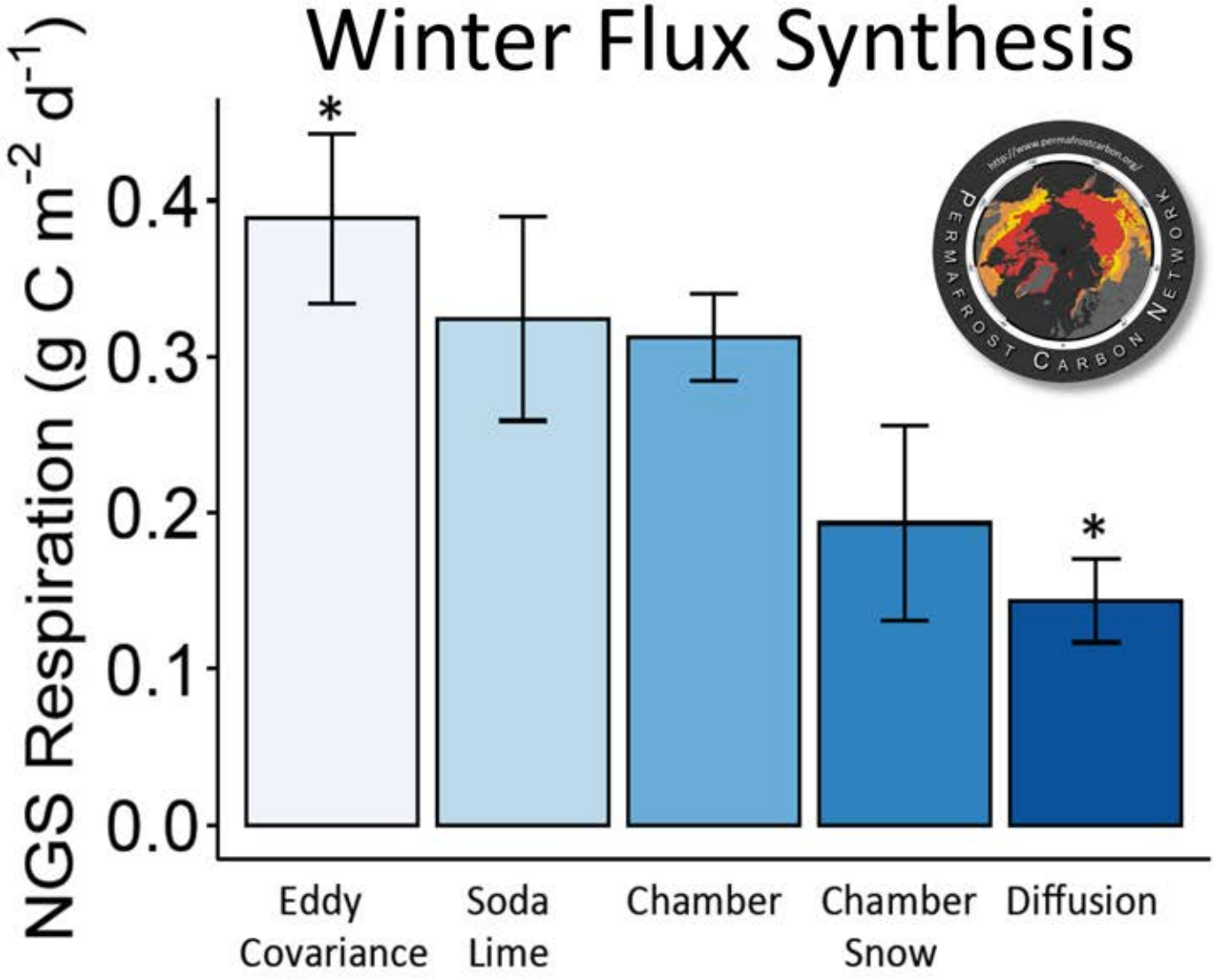
- Increasing carbon release (sensitive to obs period)

Annual:

- Mean carbon source over several decades

Belshe et al. 2013

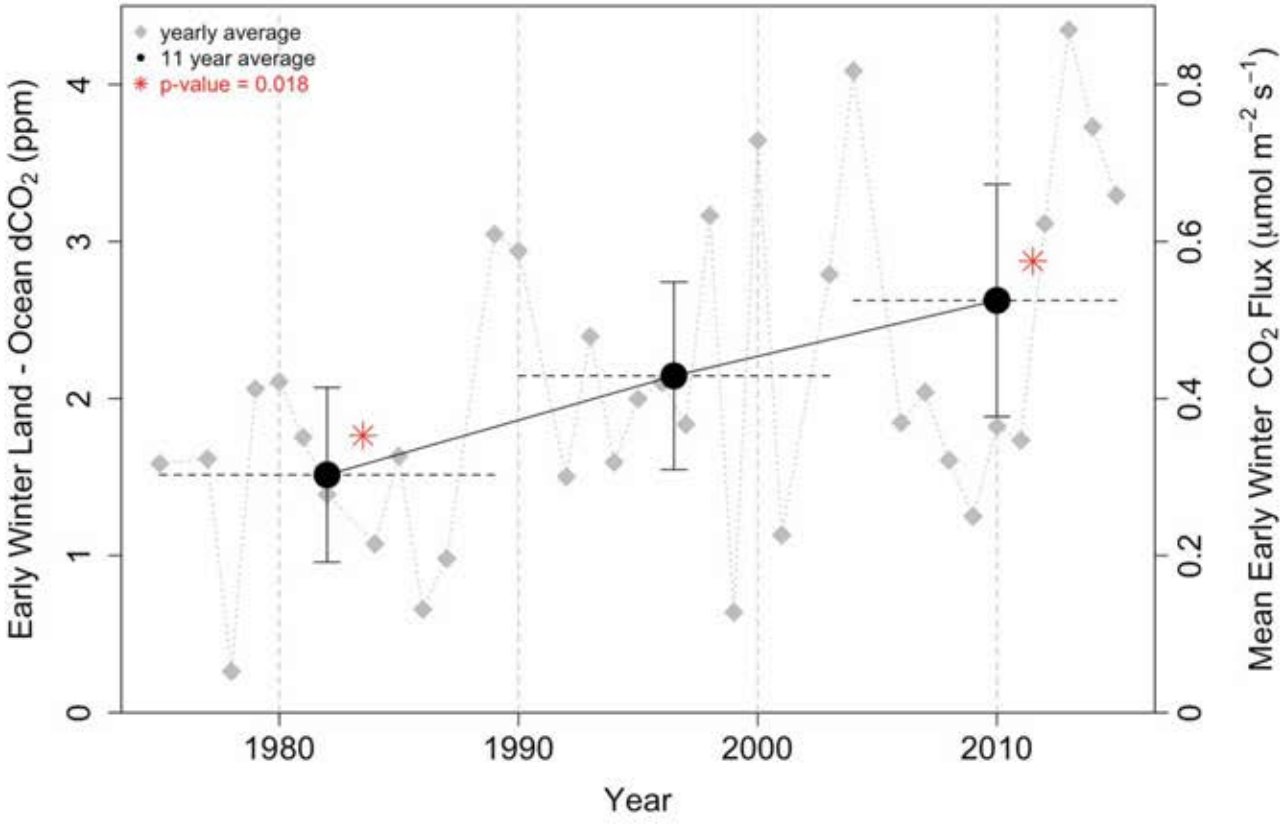
Winter Flux Synthesis



Winter C loss > previously thought

Pulse releases
(fall ‘zero curtain’, winter/spring ‘burps’)

2012-2014 Regional (Alaska) Carbon Loss



Tundra:

- Consistent annual C source

Boreal:

- Neutral to net C sink, but fires offset in part

Regional/Alaska:

- 25±14 Tg C yr^{-1} source

If Alaska represents the permafrost zone = ~0.3 Pg C yr^{-1} source

Commane et al. 2017 PNAS

Permafrost Carbon Key Findings

- Soil carbon pools are an order of magnitude larger than plant carbon, and are climate stabilized
- Soil carbon vulnerable fraction 5-15% by 2100; 10% of pool = 130 Pg C
- Plant carbon uptake will offset, in part, soil carbon loss, but major uncertainty about timing and magnitude between models and measurements
- IPCC special report (SROCC) opportunity to report high level findings to policymakers (cutoff Oct 15, 2018)


http://www.permafrostcarbon.org/
PERMAFROST CARBON NETWORK
-160°
160°
-120°
120°
-80°
80°
-40°
40°
0°