

Satellite Weather And Climate (SWAC)

Cold regions: Permafrost

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Cold Regions Science: PERMAFROST

What are “Cold Regions” and what is the “Cryosphere”?

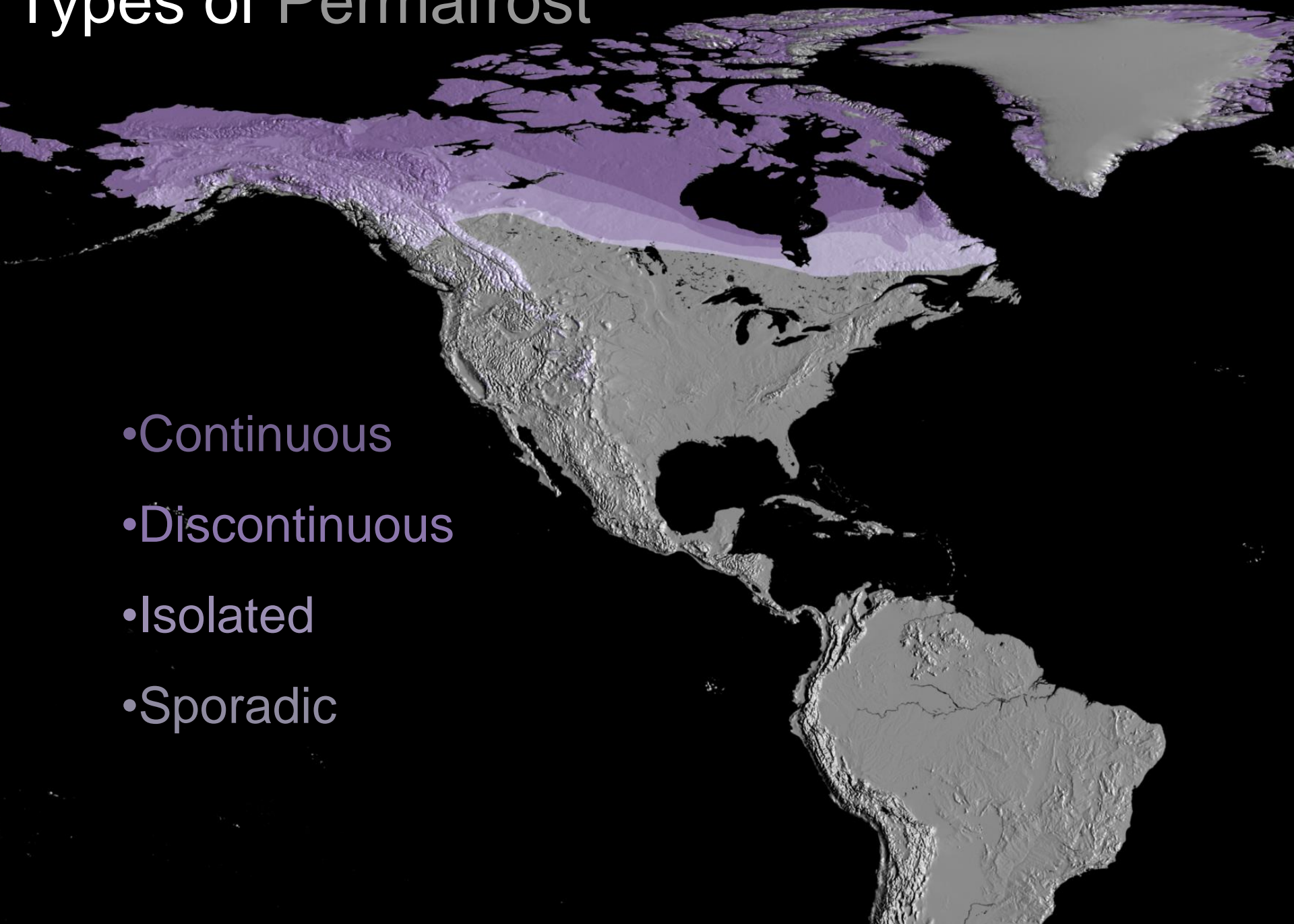
Video courtesy of NASA Earth Observing System (EOS)

Permafrost: Layer of soil or rock, at some depth beneath the surface, in which the temperature has been continuously below 32°F for at least two years.



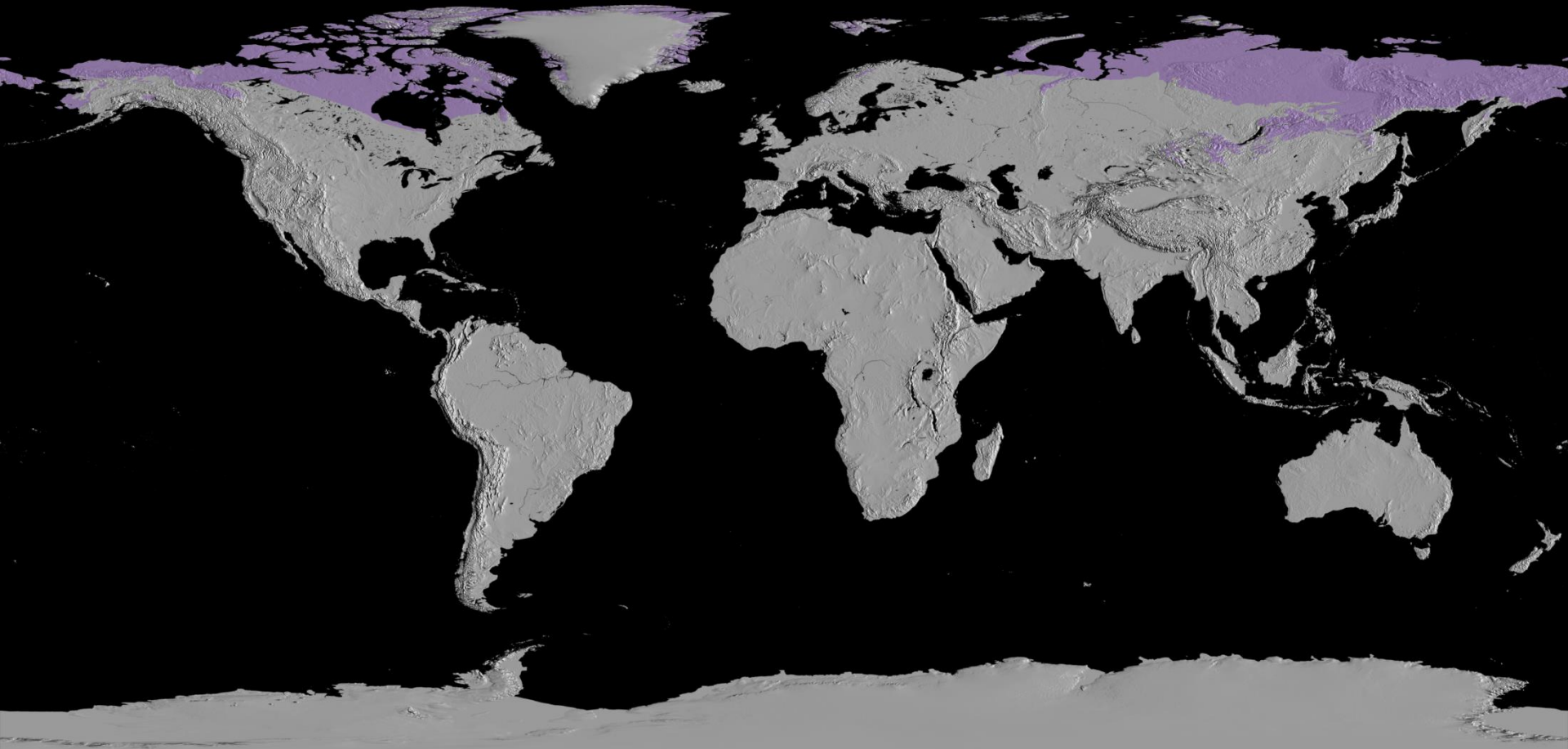
Types of Permafrost

- Continuous
- Discontinuous
- Isolated
- Sporadic



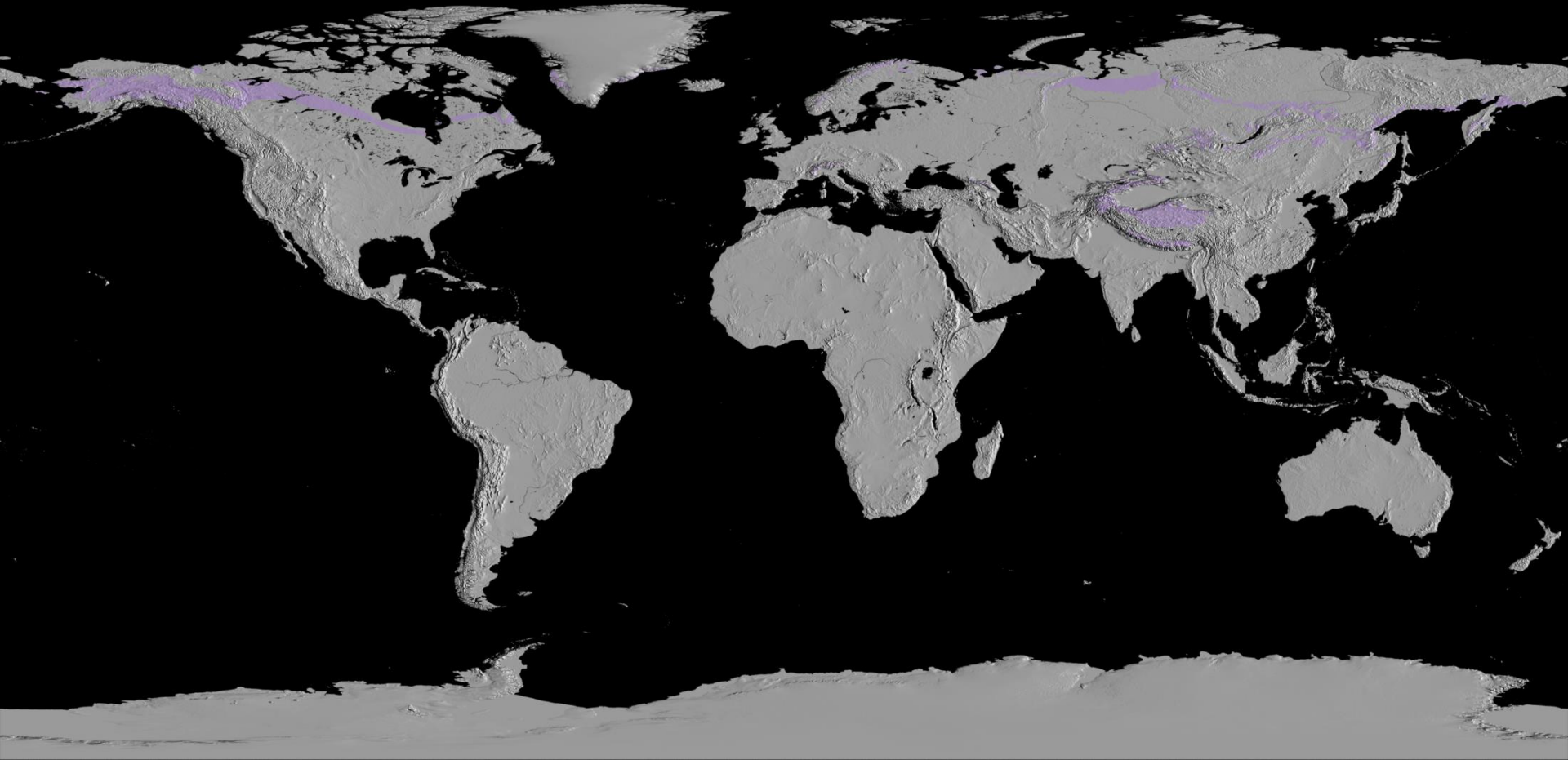
Continuous Permafrost

Forms in areas with a MAAT of less than 24°F independent of aspect and topographical influences.



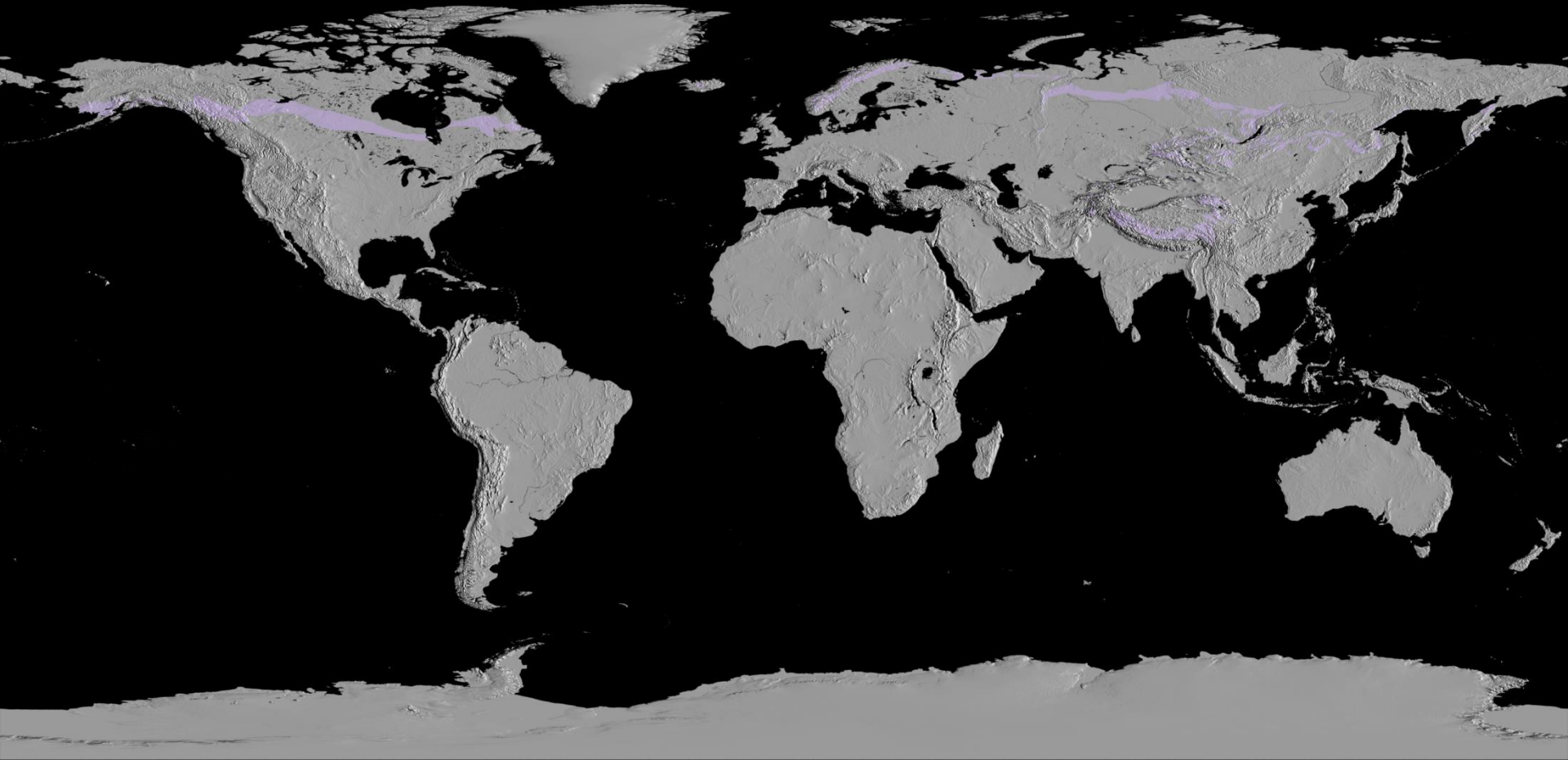
Discontinuous Permafrost

Forms in areas with a MAAT of less than 28°F, but more than 24°F. As the air temperature alone is not enough to cause permafrost formation, this type requires some form of topographical shading, usually mountains with north aspects.



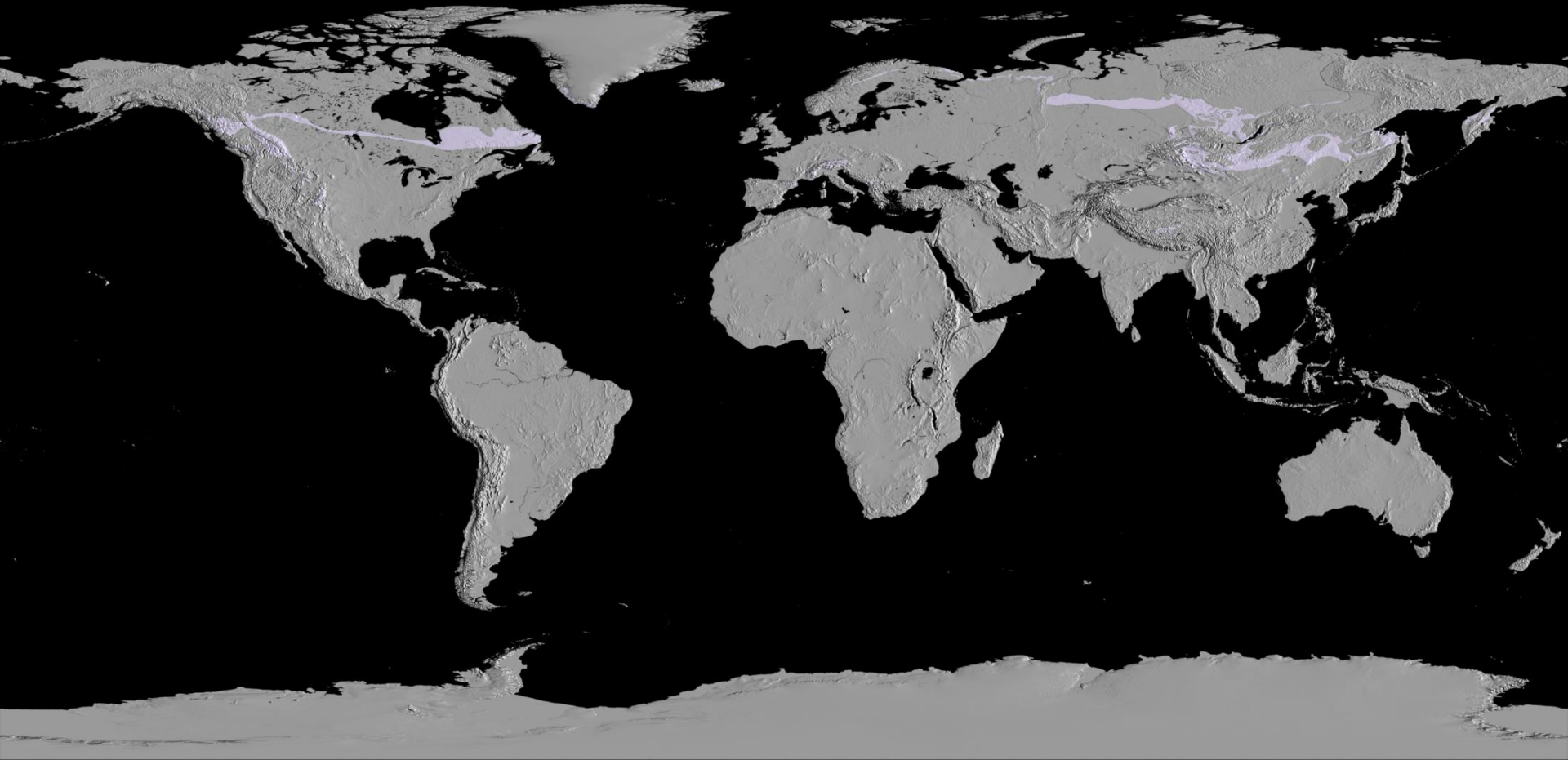
Sporadic Permafrost

Forms in areas with a MAAT of less than 32°F, but more than 28°F. Sporadic Permafrost forms as pockets of ice within peat and under existing ice. This sort of permafrost may also occur in high altitude mountain environments.



Isolated Permafrost

Forms in areas that provide temperatures cold enough for ice production. These patches are often found in higher altitudes that exhibit variability in MAAT, but ultimately support ice retention in certain areas.

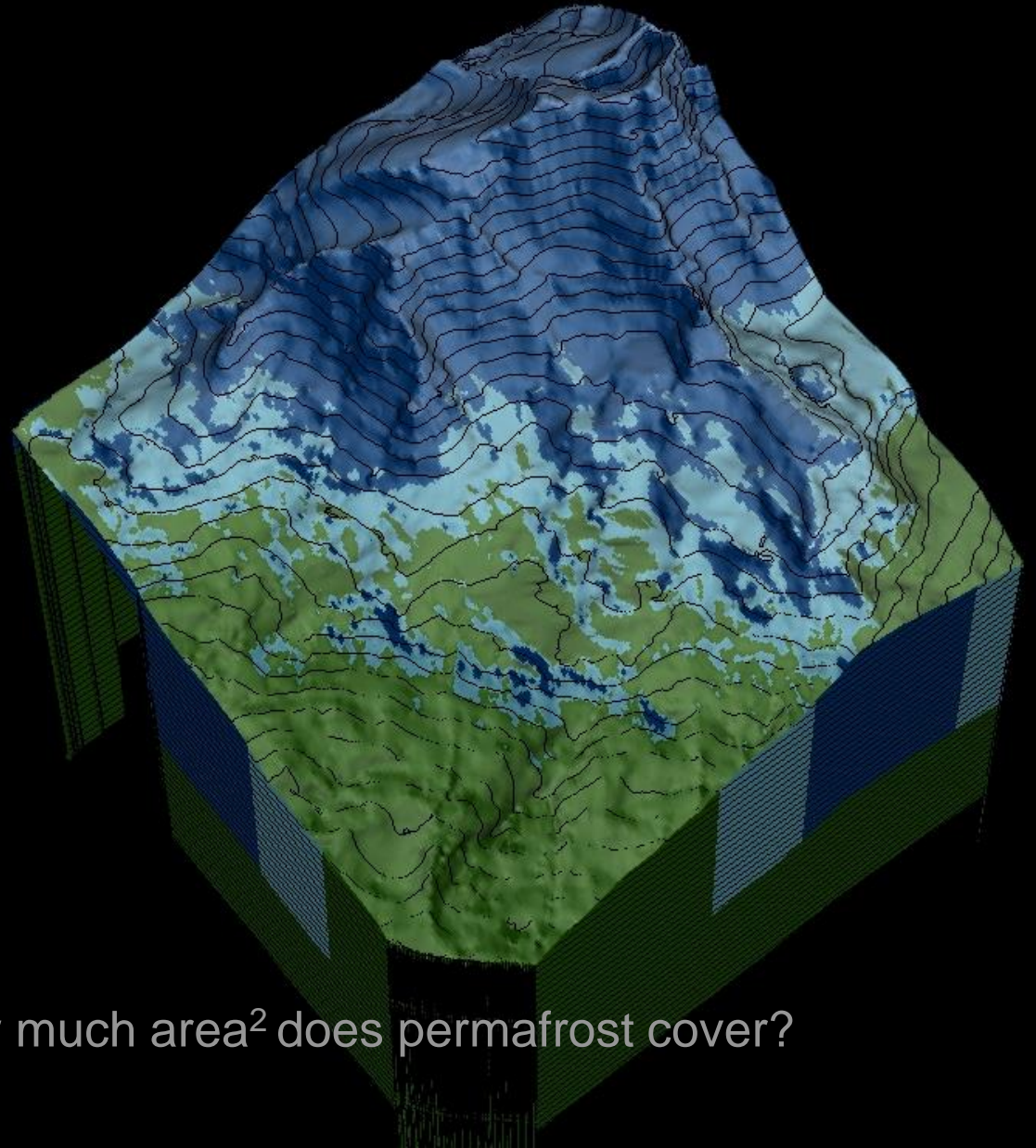




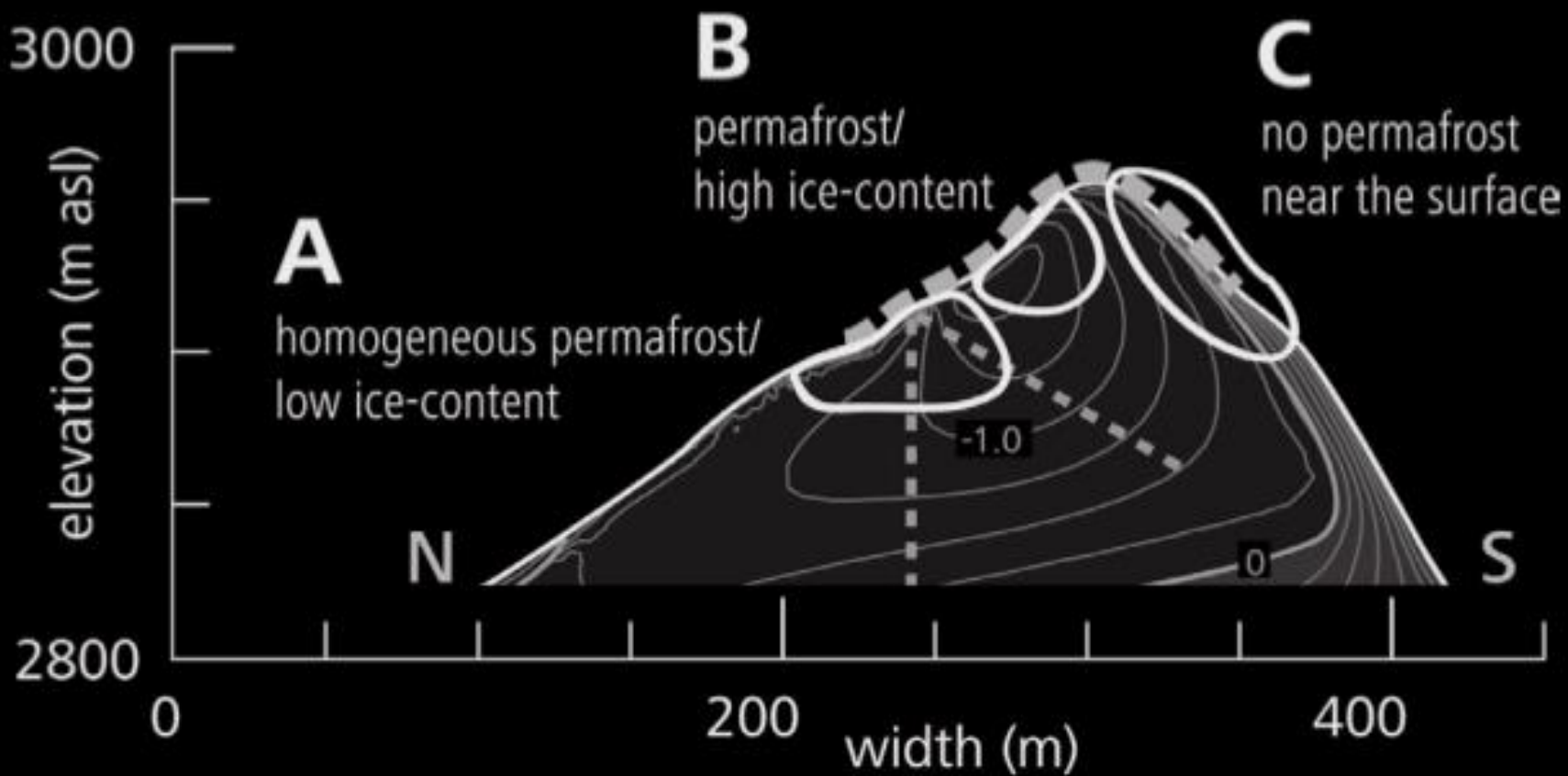
Active Layer

Permafrost

Permafrost: Indicator of Climate

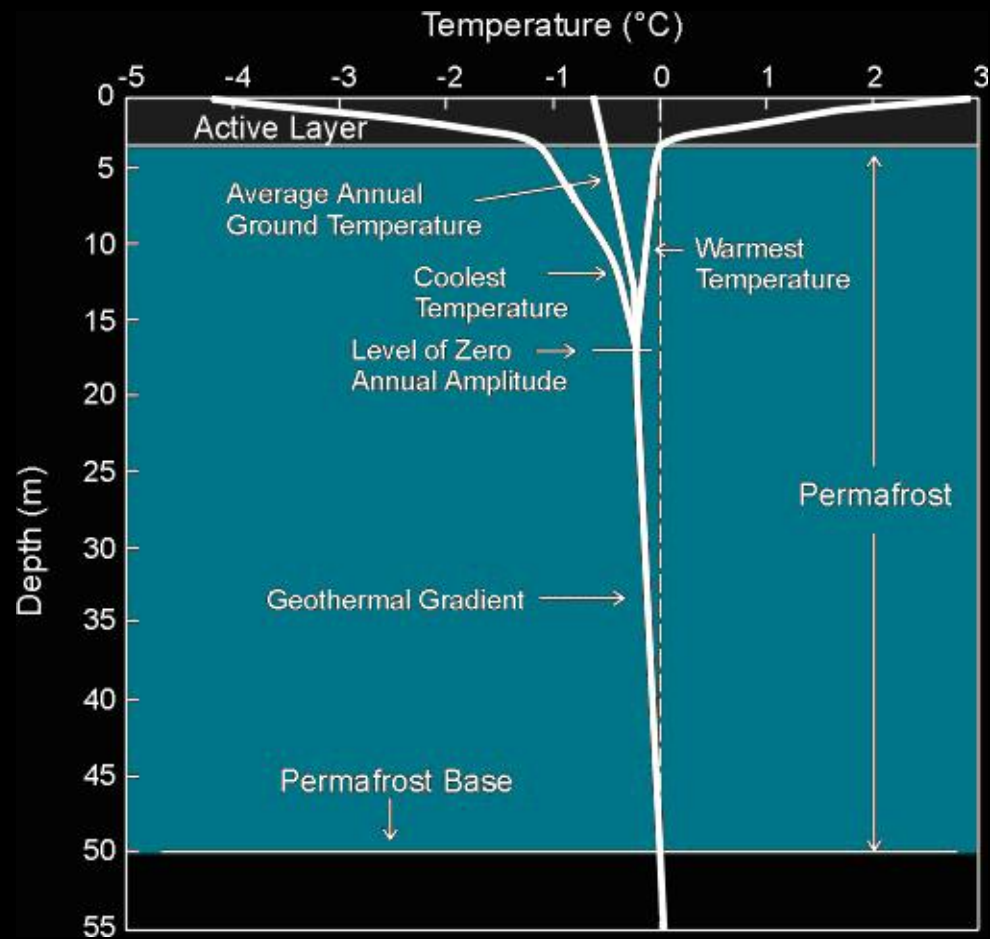


Extent: How much area² does permafrost cover?



Noetzli et al. 2008

Depth

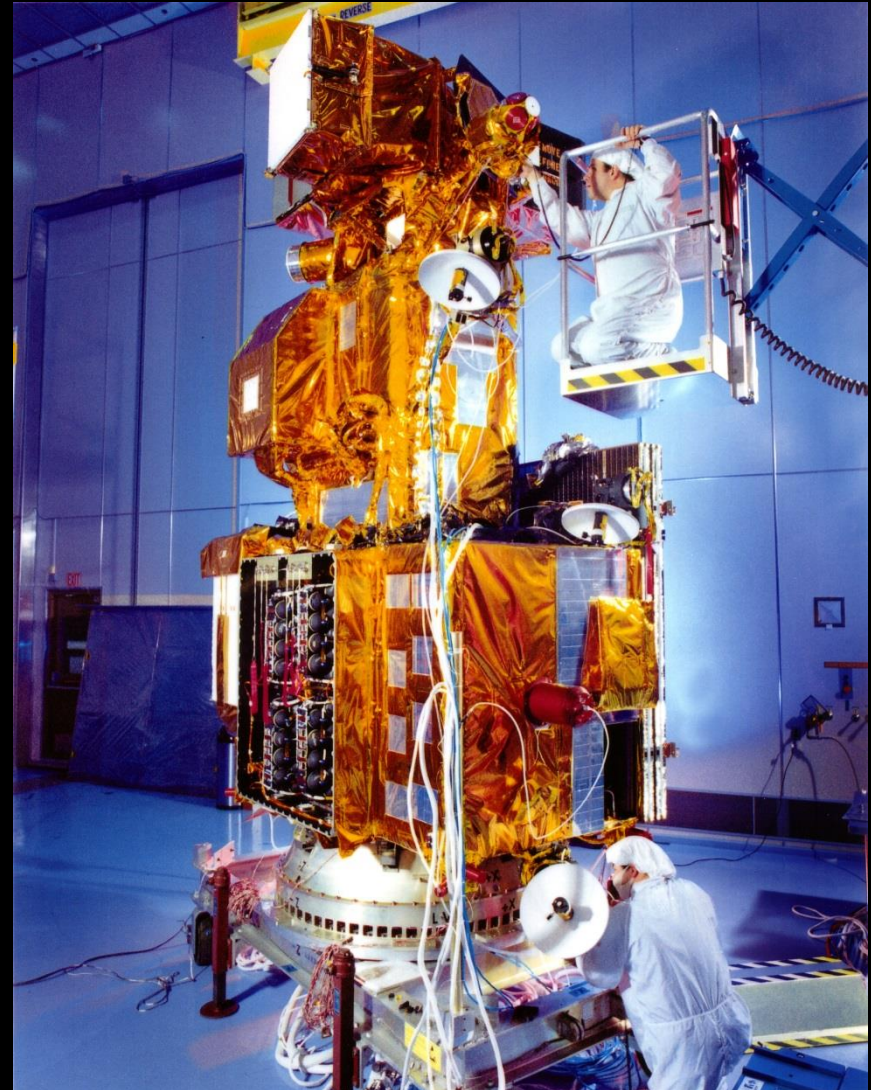


Natural Resources Canada

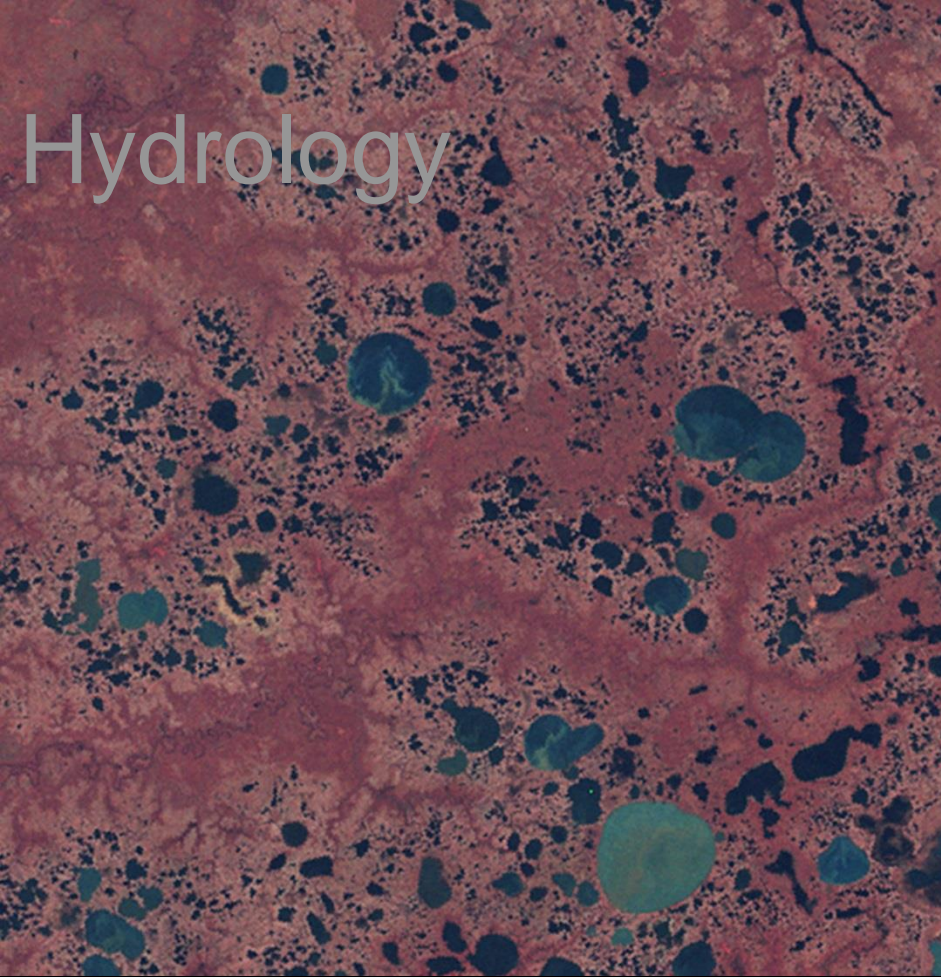
Ground Thermal Regime

Land Surface Change: Permafrost's Response to Climate

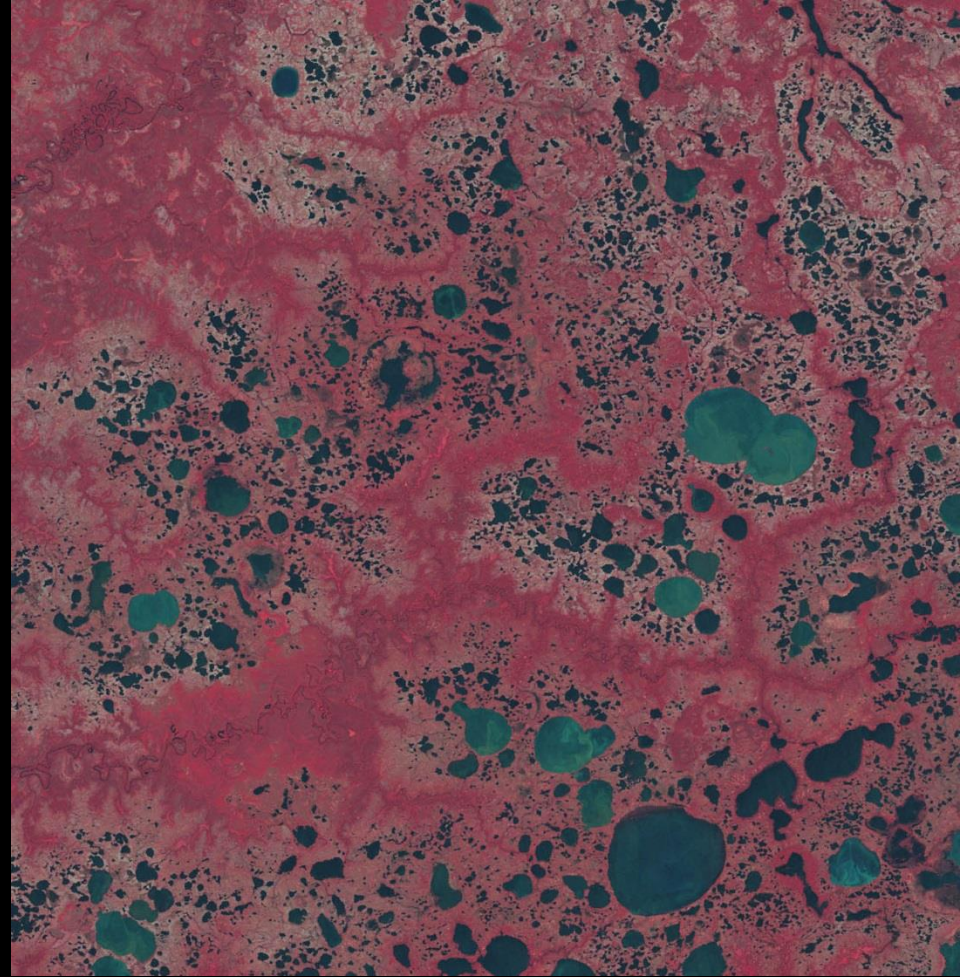
- Hydrologic
- Ecological
- Geologic / Topographic



Hydrology



1973

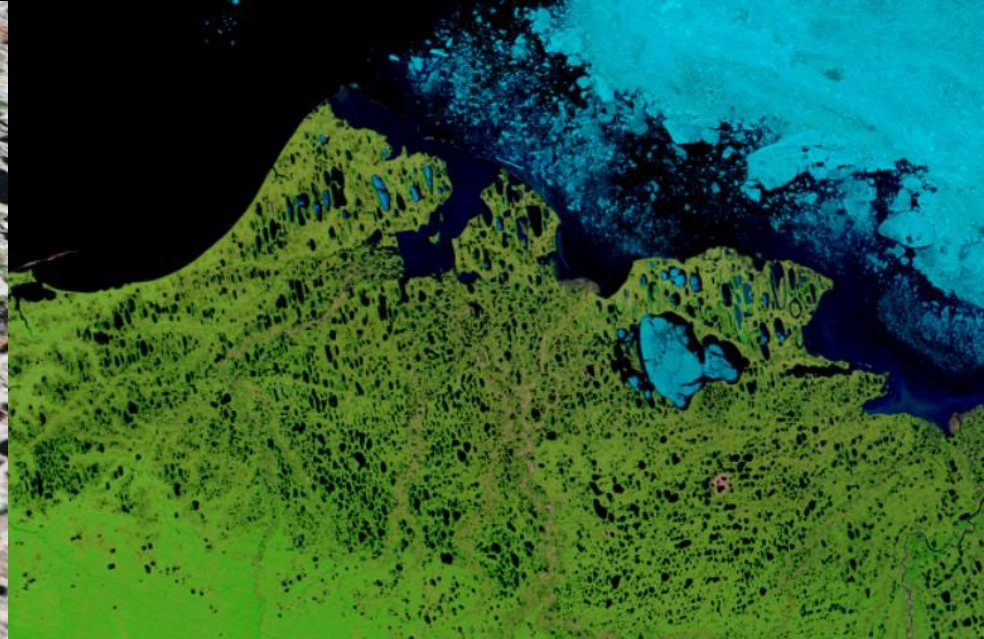


2002

- Surface Hydrology Change (Loss or Gain of Rivers, streams, lakes)
- Turbidity (Increase in “cloudiness” of water)
- Thermokarst

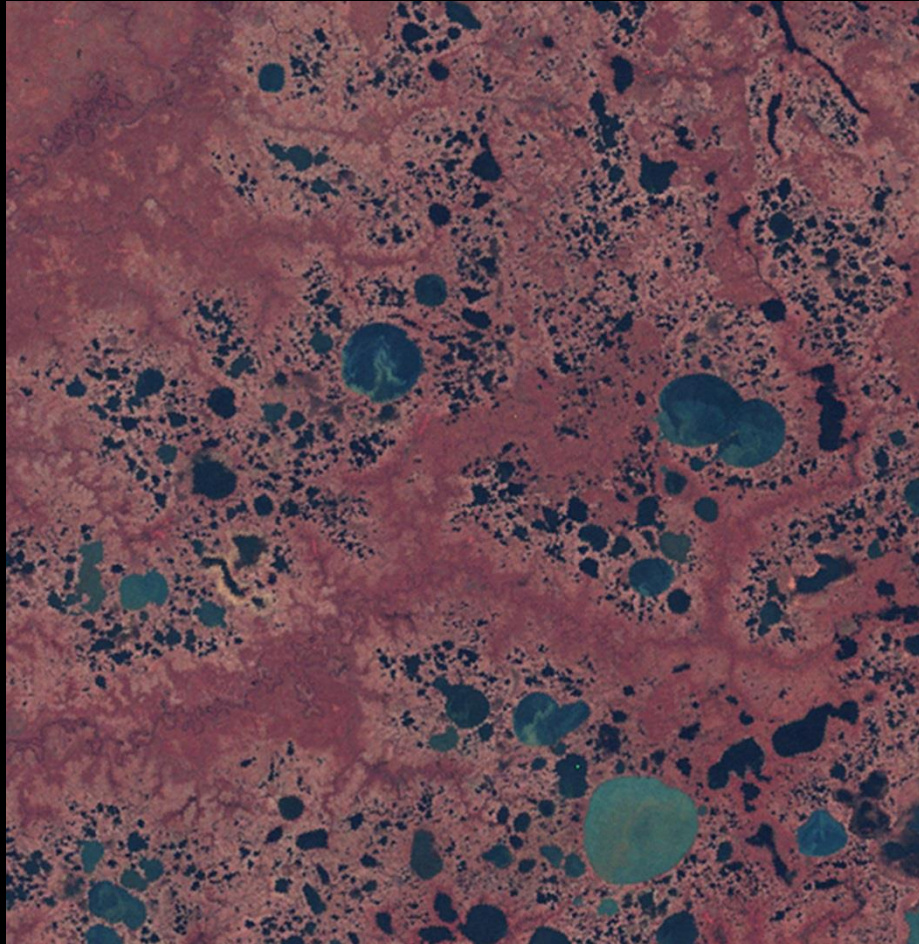
Thermokarst

Marshy areas that form when permafrost thaws, leaving many small lakes and streams on the surface.

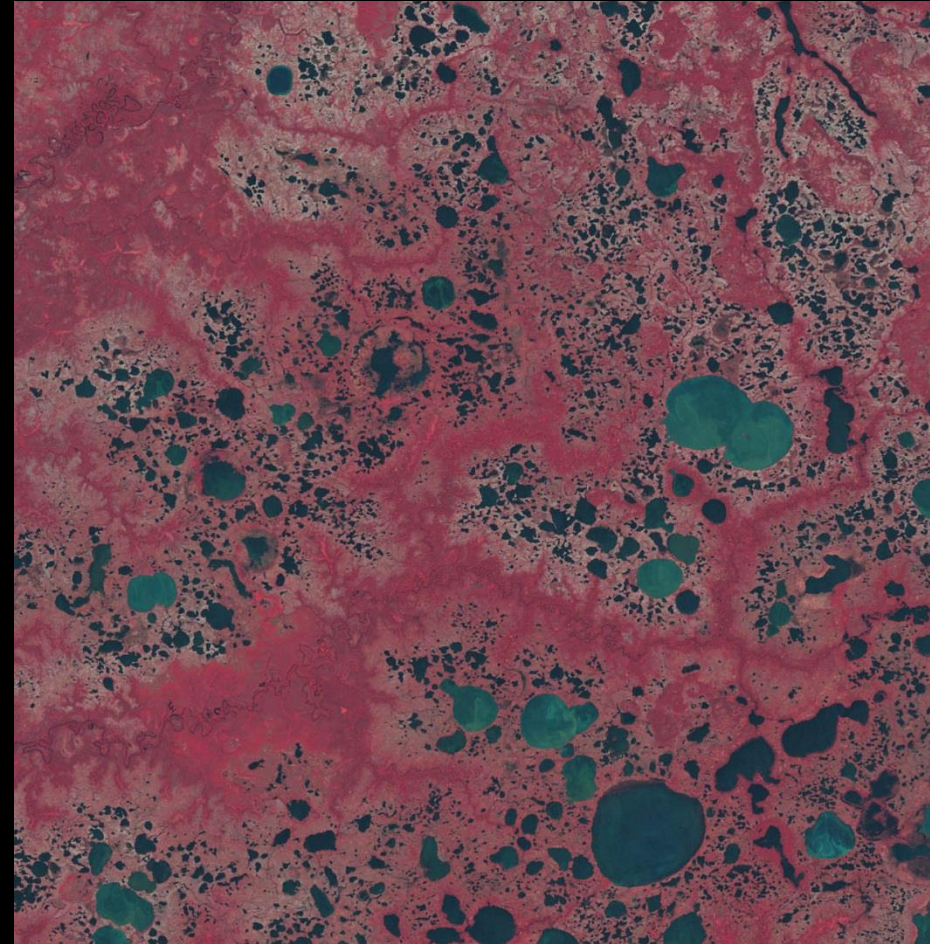


Ecological Changes

- Vegetation Changes: reduction in vegetation stress, entrance of new species
- Eutrophication: algae and micro bacterial invasion of warming lakes



1973



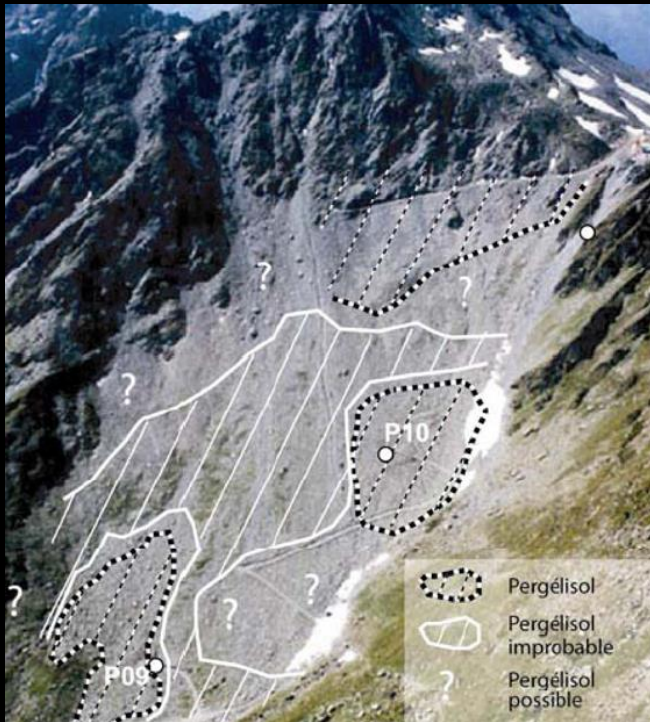
2002

Geologic / Topographic

- Patterned Ground
- Ground Subsidence
- Rock Glaciers
- Landslides



Vladimir Romanovsky

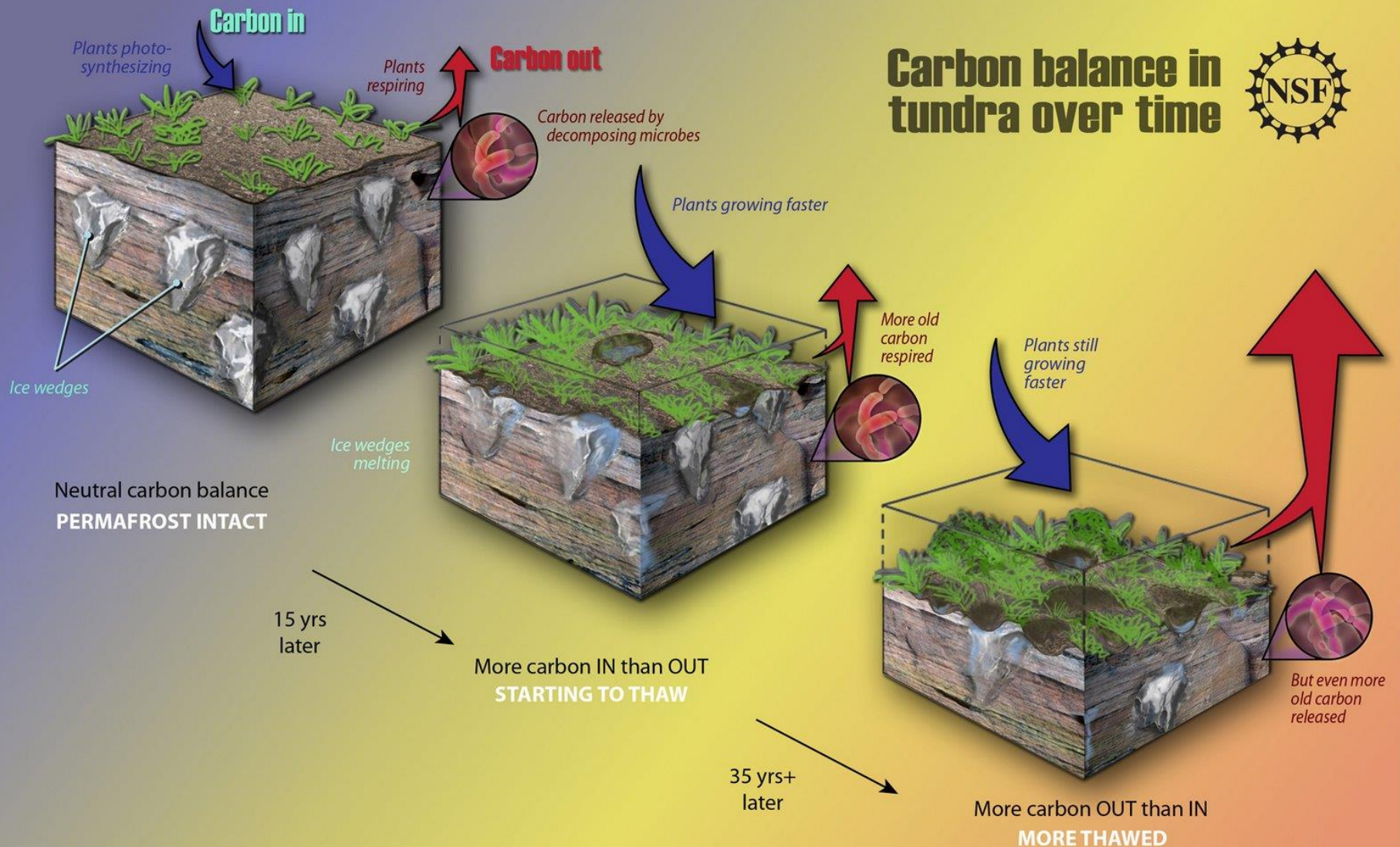


*Université de Fribourg (Sambiel
2006)*

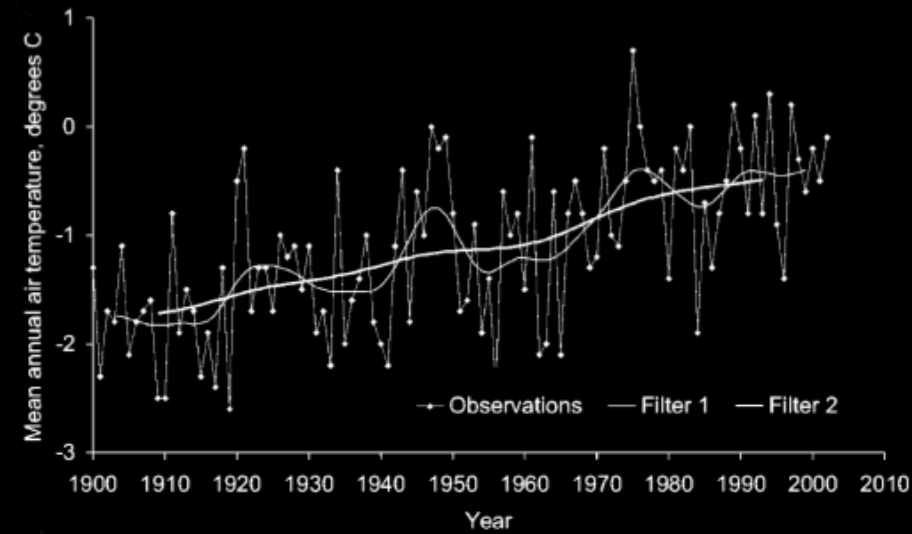


Natural Resources Canada

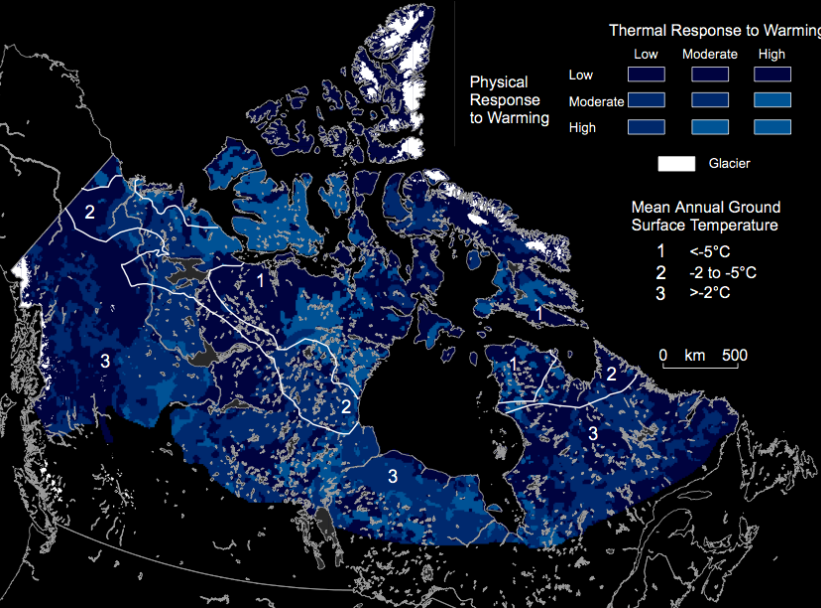
Climate's response to Permafrost



Future Prospectives on Permafrost Thaw

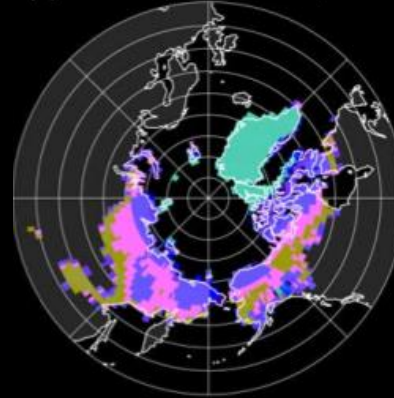


Haeberli and Beniston 1998

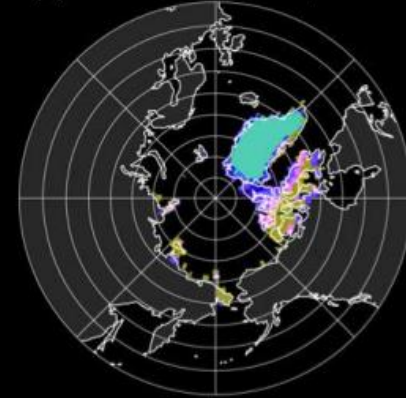


Smith and Burgess 1998

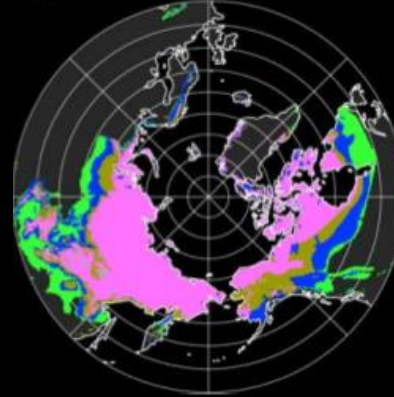
(a) 20thC (1980-1999)



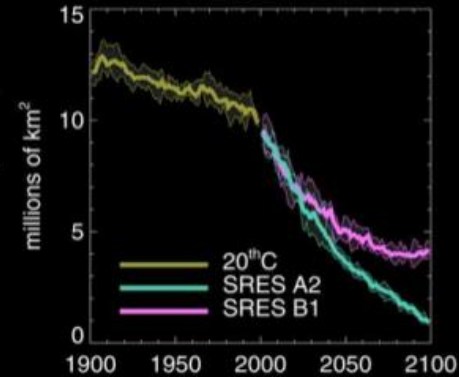
(b) A2 (2080-2099)



(c) Observations



(d) Permafrost Area



Lawrence and Slater 2005

Permafrost Links

<http://nsidc.org/frozenground/index.html>

National Snow and Ice Data Center

<http://gsc.nrcan.gc.ca/permafrost/pdf/wkshpsensitivityposter2.pdf>

Natural Resources Canada

[http://www.eoearth.org/article/Permafrost in the Arctic](http://www.eoearth.org/article/Permafrost_in_the_Arctic)

Encyclopedia of Earth

<http://earthobservatory.nasa.gov/Features/FrozenSoils/>

NASA Earth Observatory

<http://earthobservatory.nasa.gov/IOTD/view.php?id=5713>

NASA Earth Observatory