

# Topic 3: Northern High Latitudes

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## WP 3.2: Permafrost climate linkages - energy, water and carbon balance

- permafrost thawing by 2050
  - permafrost thawing by 2100
  - remaining permafrost, 2100
- future ?  
● present

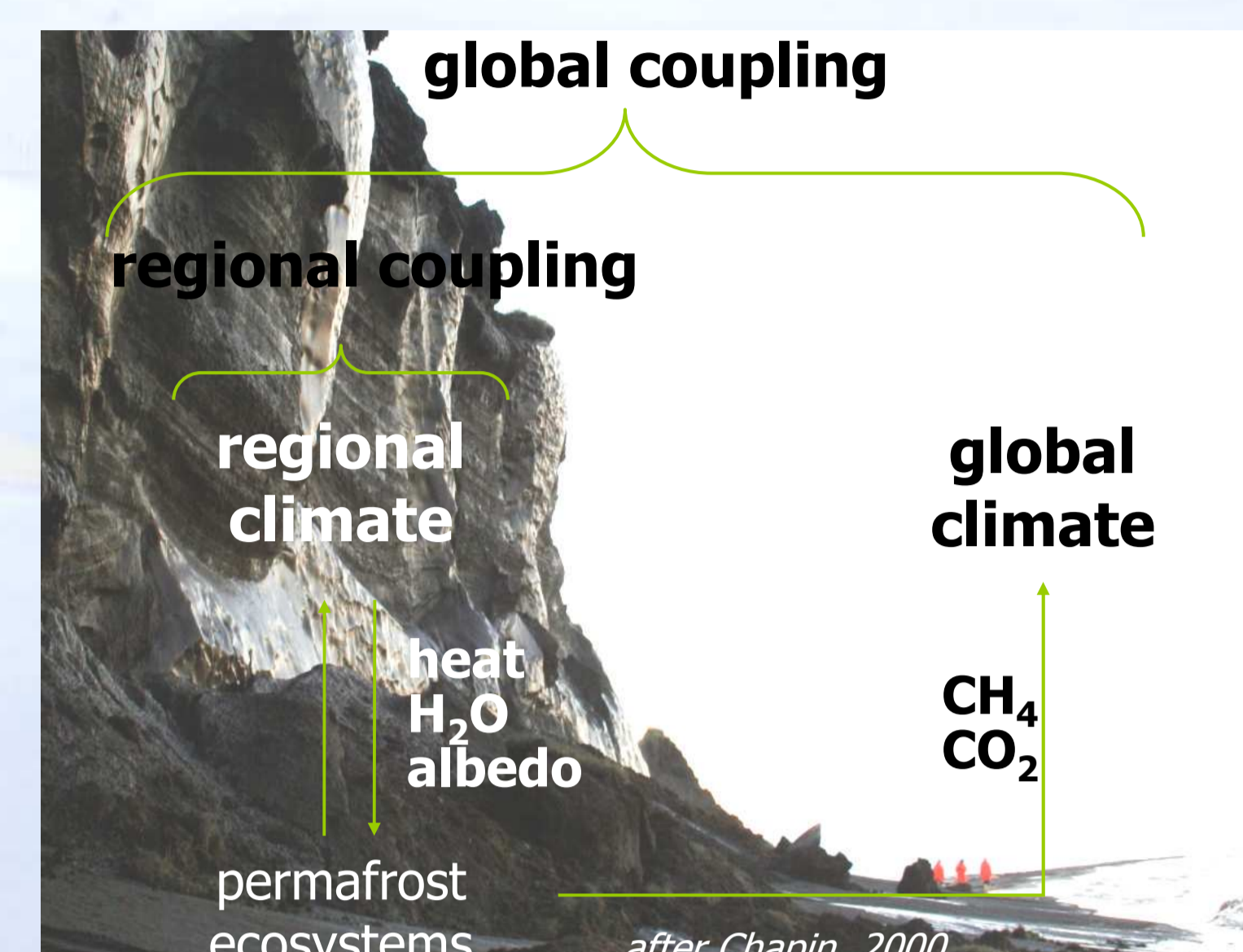


Romanovsky in Los Angeles Times  
Global warming is most pronounced in high-latitudes.

### terrestrial permafrost

**Permafrost** (defined as ground below/at 0°C for at least 2 years) has been identified as one of six indicators of global climate change (World Meteorological Organization, WMO).

**Permafrost** is a key component of the cryosphere through its influence on regional **energy** and **water exchanges**, **greenhouse gas fluxes** and **carbon budgets** – and hence the global climate system. Biological processes such as **microbiological processes**, **organic matter decomposition**, **CO<sub>2</sub>** and **CH<sub>4</sub>** and **N<sub>2</sub>O** fluxes are strongly controlled by the active layer temperature and moisture (the thin layer of soil above the permafrost that experiences annual freeze/thaw).



The high latitude ecosystems play a strong role in the climate system.

process studies / long-term measurement fields / paleoclimate



Juliane Griess and Irina Grodnitskaya (WIK-Krasnojarsk) sampling for microbiology at the Kurungakh drilling site (Lena River Delta).



Russian-German Research Station Samoylov (Lena River Delta, Siberia)



23.08.2010 Samoylov measurement field: "Prime Minister Vladimir Putin visits the sites explored by the Russian and German expedition Lena 2010 and speaks with the research team." (<http://premier.gov.ru/eng/events/news/11882/>)



Konstanze Piel installing a permafrost depth profile (moisture, temperature) in Spitsbergen.



Eddy covariance measurements (energy, water, CO<sub>2</sub>, CH<sub>4</sub>) at the long-term Samoylov measurement field, Siberia, Torsten Sachs.

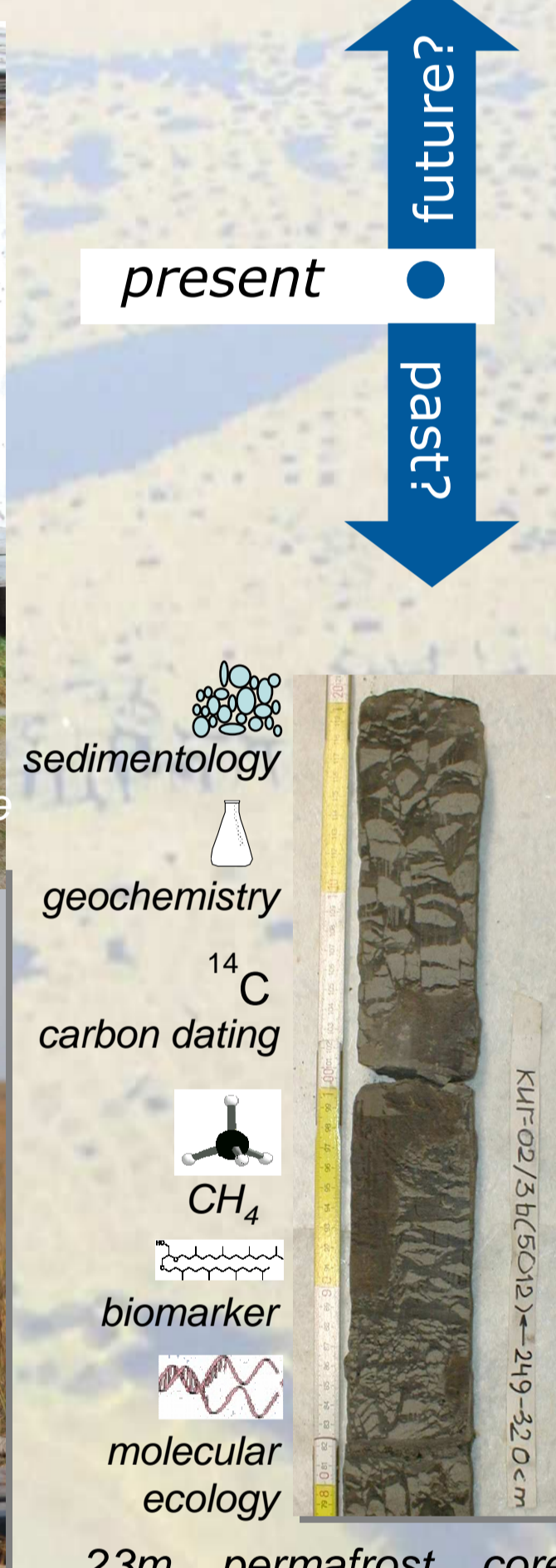


23.08.10 Svetlana Evgrafova (WIK-Krasnojarsk) sampling for methane and CO<sub>2</sub>.



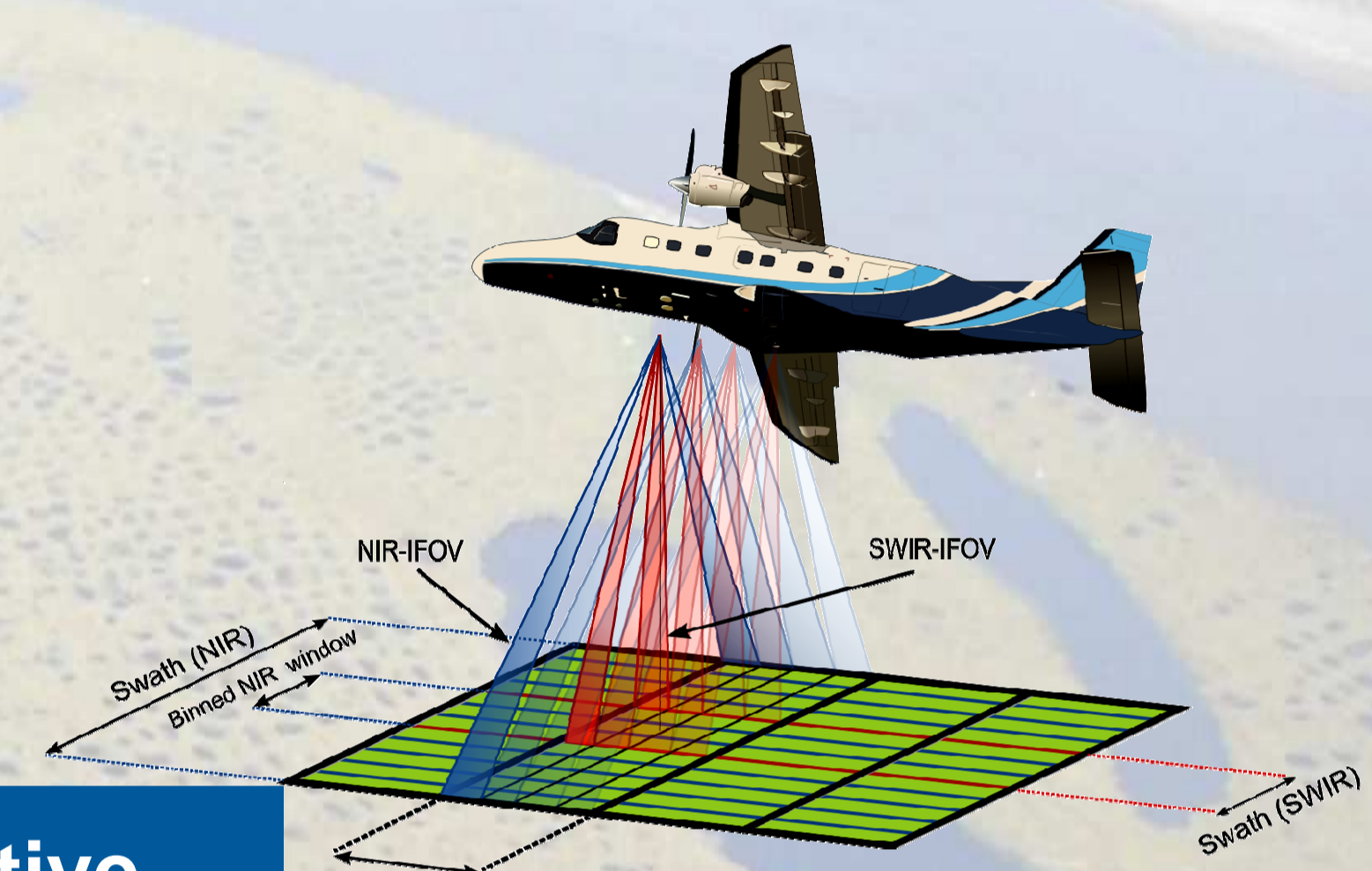
GTN-P Global Terrestrial network for Permafrost  
Initiated by IPA, authorized under GCOS  
1) active layer **CALM** - Circumpolar Active Layer Monitoring  
2) permafrost thermal state **TSP**. IPA's main contribution of the IPA. The TSP data set (snapshot) will serve as a baseline for the assessment of the rate of change of permafrost temperatures and permafrost distribution, and to validate climate model scenarios.

long-term measurement polygon sites for microbiological studies on Samoylov Island since 1998.



23m permafrost core (42kyr) drilled in 2002, Kurungakh (Lena River Delta, Siberia).

to advance our understanding on all spatial and temporal scales of the links and interactions



### innovative remote sensing

**MAMap – Methane Airborne mapper**  
Welcome to the Website of the Project  
**DUE PERMAFROST**  
<http://www.ipf.tuwien.ac.at/permafrost/>

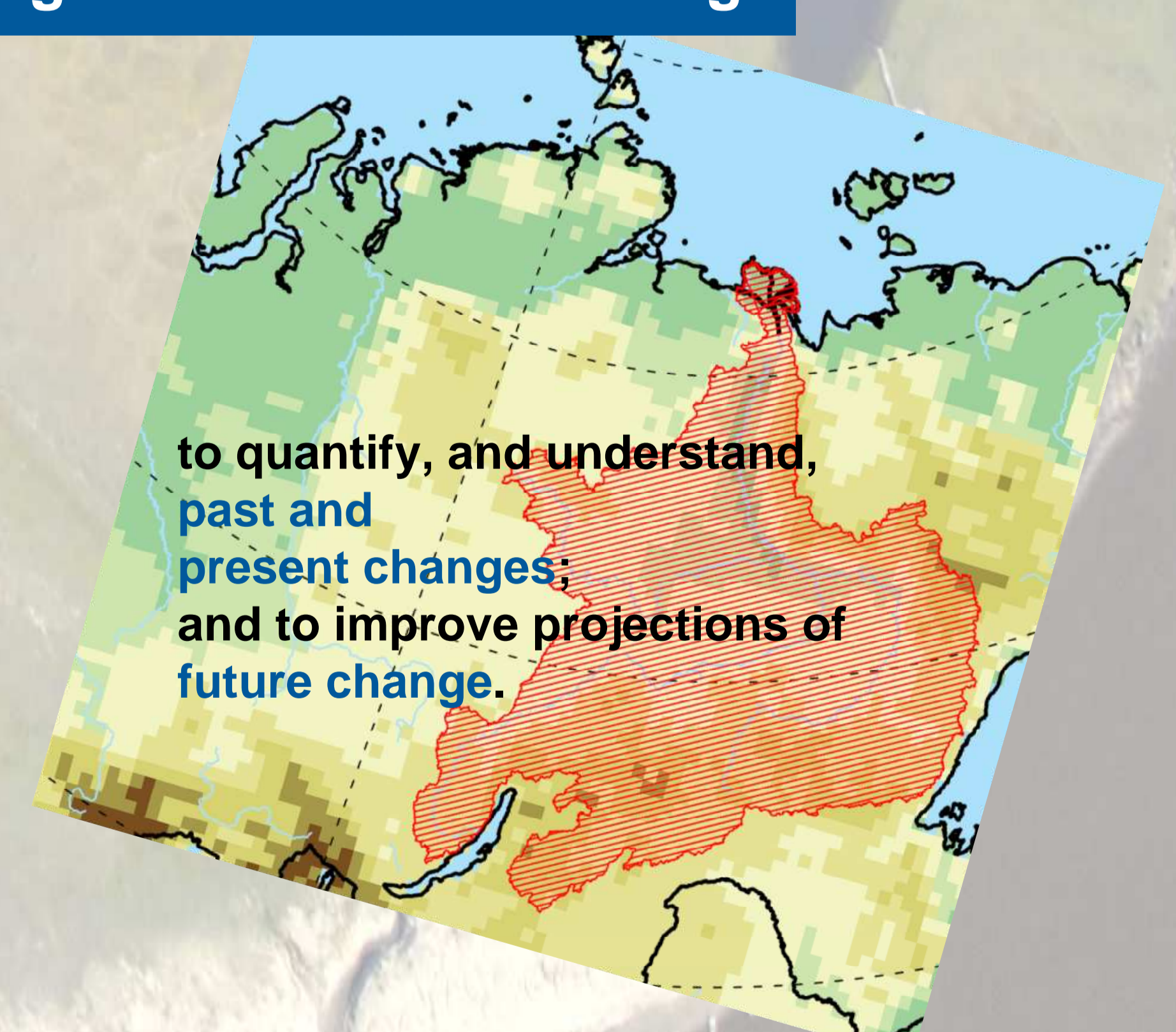
- EO Earth Observation**
- Surface Temperature, Surface moisture & freeze/thaw
  - Surface water
  - Snow from GLOBSnow
  - Landcover & Disturbances from GLOBCover, GLOBCarbon
  - Terrain

primary products: temperature, moisture, freeze/thaw, LAI, ...  
derived products: thermal conductivity frozen/thawed state, ...

### Strategies

- to install and to keep **multi-instrumented long-term measurement fields** at selected sites from the sub-Arctic to the high-Arctic.
- to develop an advanced understanding of **water, energy** and **trace gas fluxes** and **cryotic** and **microbiological** processes involved with permafrost development and decay.
- to deepen the knowledge on **microbial methane cycling community structure** and **function** and their reaction to environmental changes in **past** and **present**.
- to improve the simulation of spatial distribution patterns  
- using operational **Earth Observation ESA DUE PERMAFROST**.  
- of spatial **CH<sub>4</sub>** fluxes using **MAMap**.
- to improve **permafrost-specific modelling** by integrating EO land products.
- to provide a **consistent meteorological data set** at high spatial and temporal resolution using the **regional climate model COSMO-CLM**.

### regional climate modelling



to quantify, and understand, past and present changes; and to improve projections of future change.  
**Regional climate model COSMO-CLM**  
(model of the Consortium for Small-scale Modelling in CLimate Mode)

- We still need process understanding:**
- thermal state of permafrost TSP
  - microbiological processes in past and present
  - carbon turnover in past and present
  - regional linkages of energy, water, trace gas fluxes
  - regional climate linkages

background: Samoylov Island, Lena River Delta