The link between precipitation and recent outbreak of anthrax in North-West Siberia

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Motivation

In 2016, there was an outbreak of anthrax on Yamal Peninsula, North West Siberia. More than 2500 reindeer died, 36 humans were infected with 1 casualty. We analyse the climatic factors causing the disease.

- Permafrost thawing – likely the trigger of the disease. Heat wave of 2016.
- Precipitation in warm season – influencing spread of the disease.

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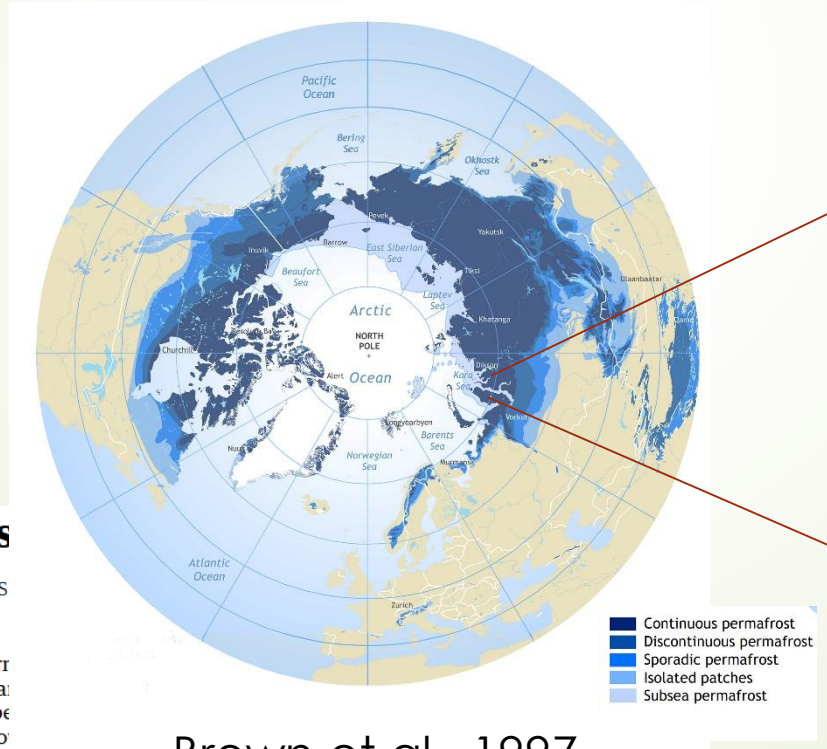
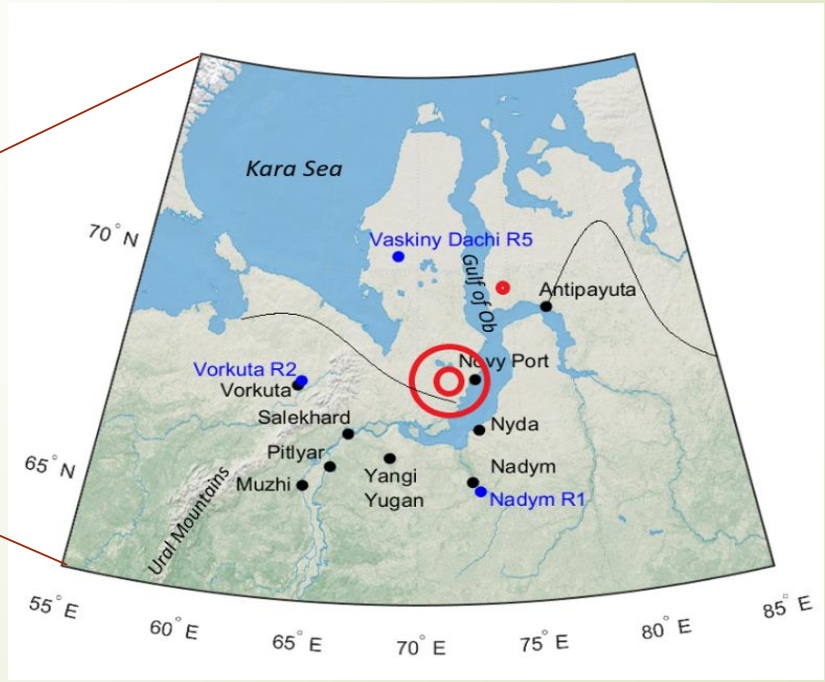
All hell breaks loose as the tundra thaws

A recent heatwave in Siberia's frozen wastes has resulted in outbreaks anthrax and a series of violent explosions

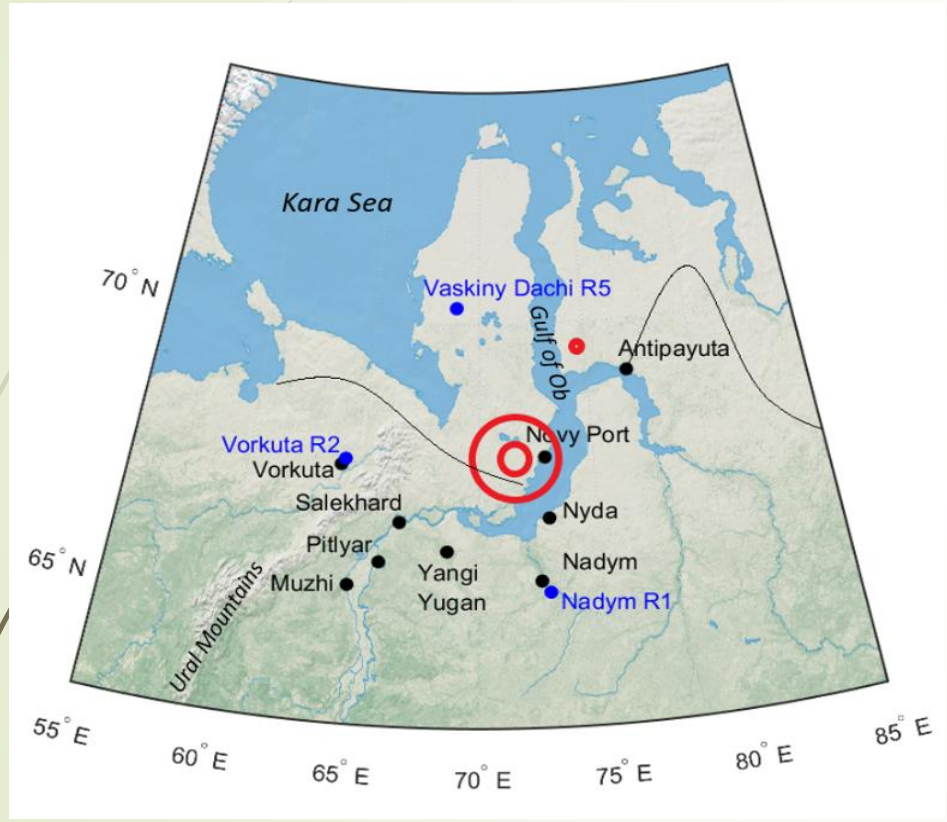
Strange things have been happening in the frozen tundra of northern Last August a boy died of anthrax in the remote Yamal Peninsula, a other infected people were treated and survived. Anthrax hadn't be in the region for 75 years, and it's thought the recent outbreak follo intense heatwave in Siberia, temperatures reaching over 30C that melted the frozen permafrost.



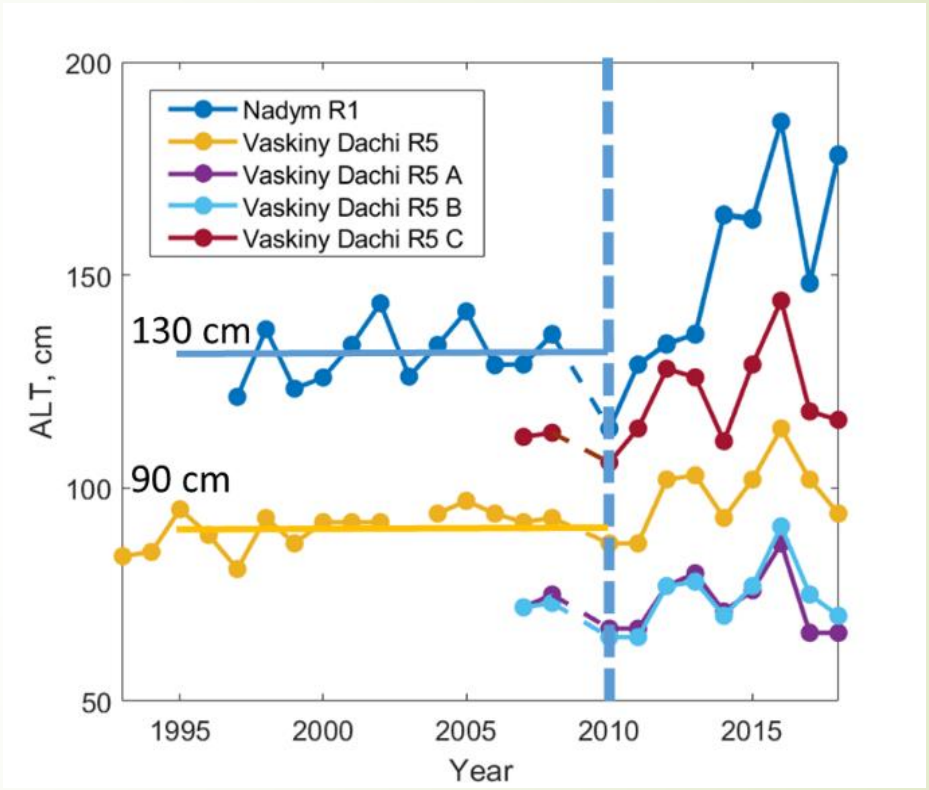
Brown et al., 1997



Dynamics of active layer thickness (ALT)



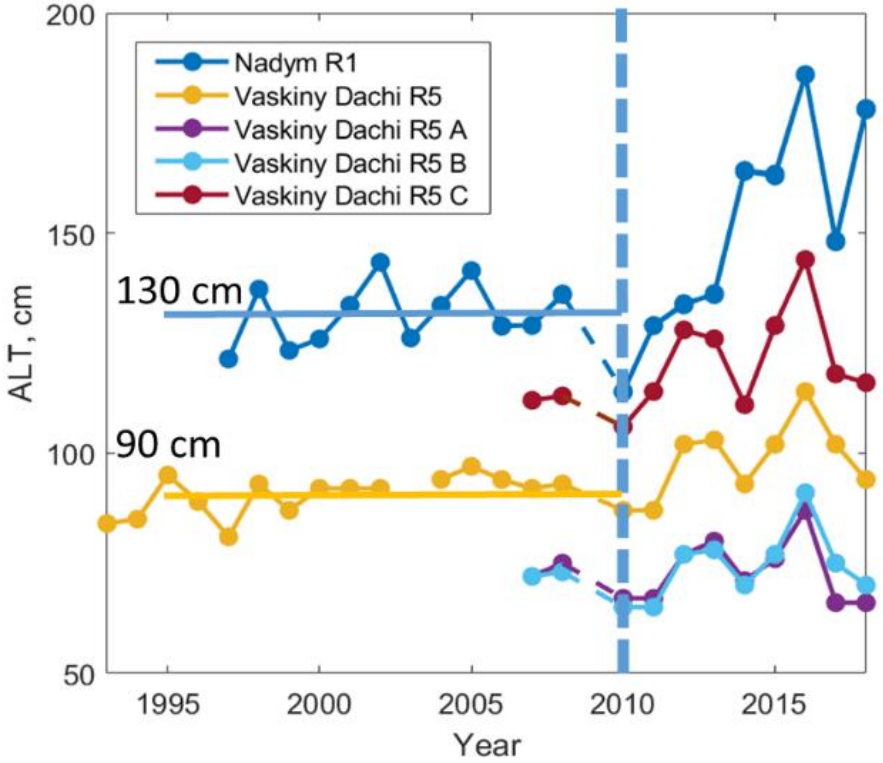
Blue points - CALM sites (Continuous Active Layer Monitoring)



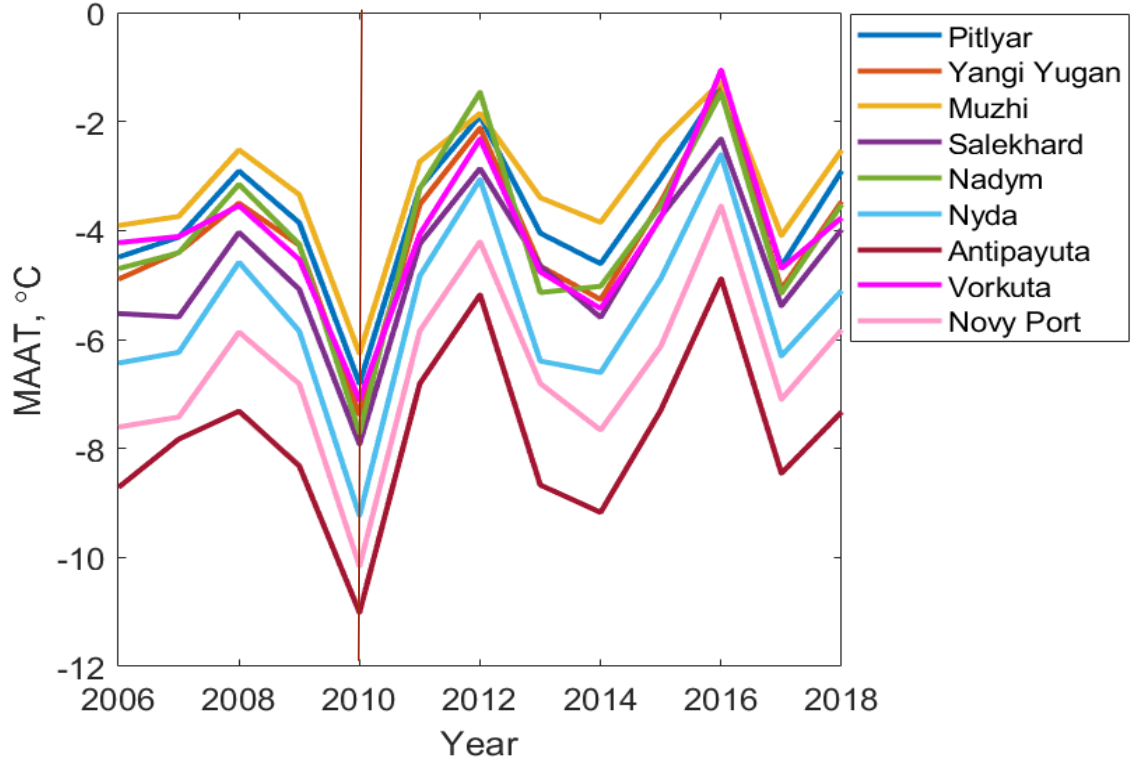
ALT is increasing continuously after 2010, opposite to the hypothesis of the heat wave

Dynamics of active layer thickness (ALT) and temperature

Active layer thickness

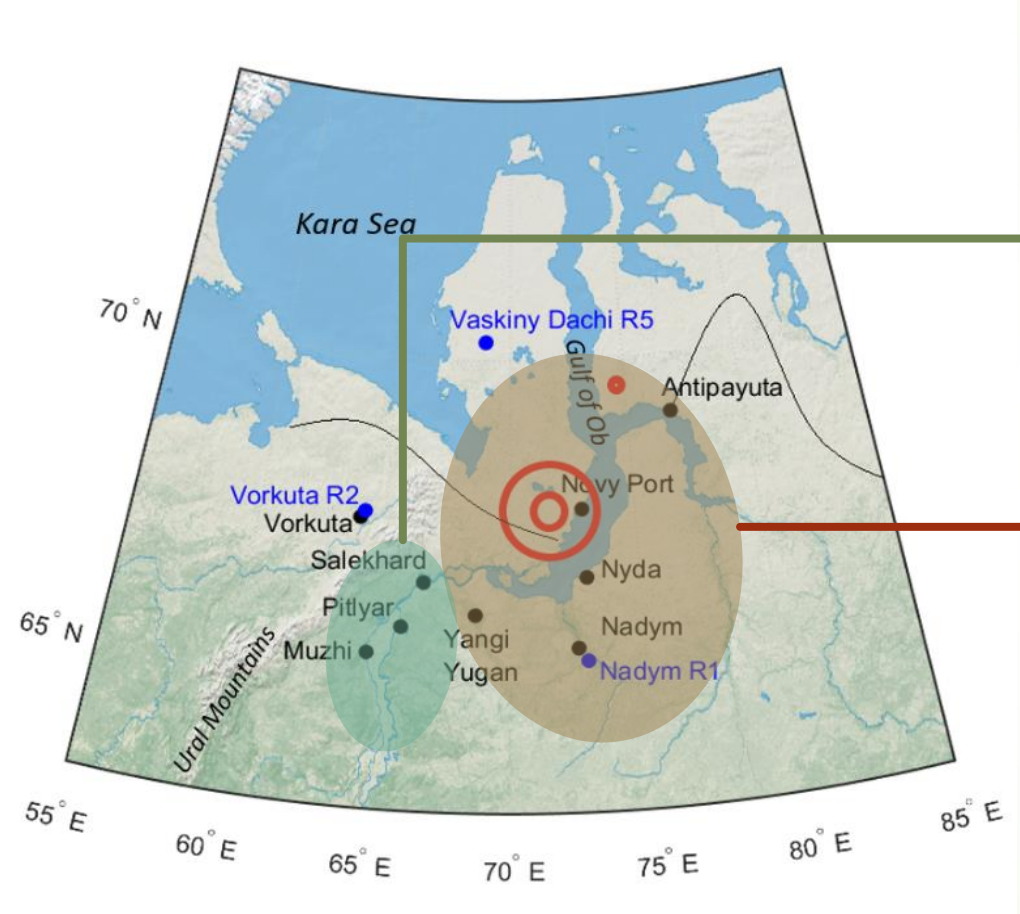


Mean annual air temperature



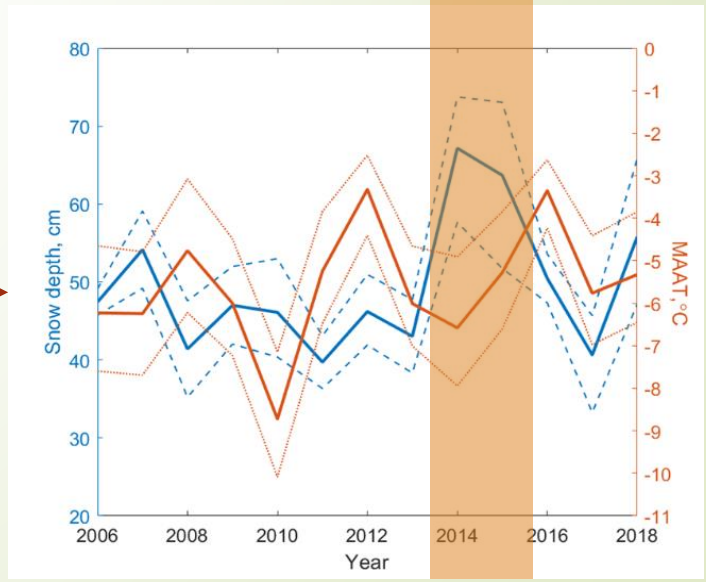
ALT dynamics in Nadym can not be explained solely by air temperature

Dynamics of snow thickness



No increase in snow thickness

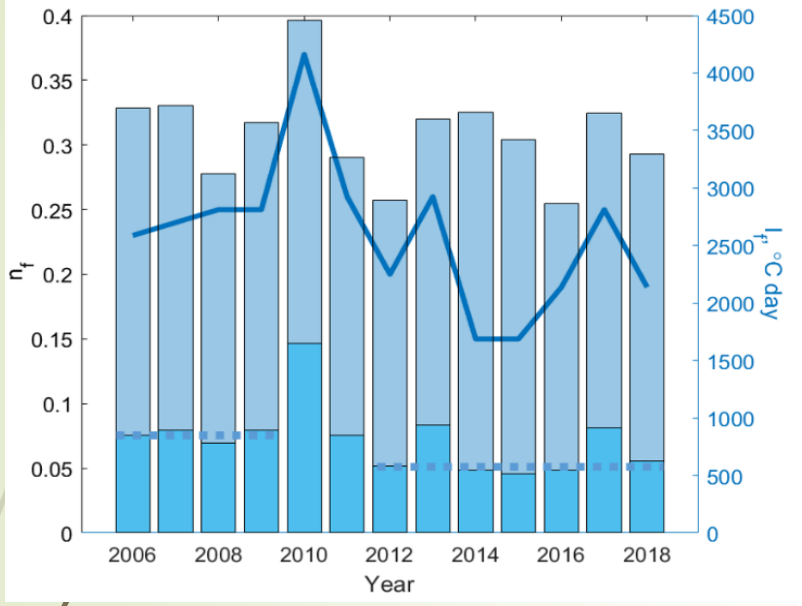
More than 50% increase in snow thickness, 2014-2015



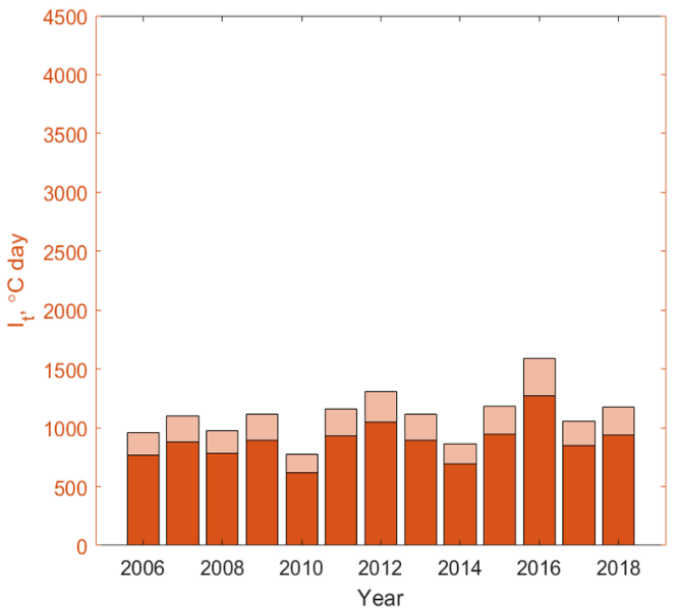
Snow insulates ground surface preventing heat exchange between atmosphere and ground.

Degree-days and ALT, Novy Port

Freezing degree-days



Thawing degree-days



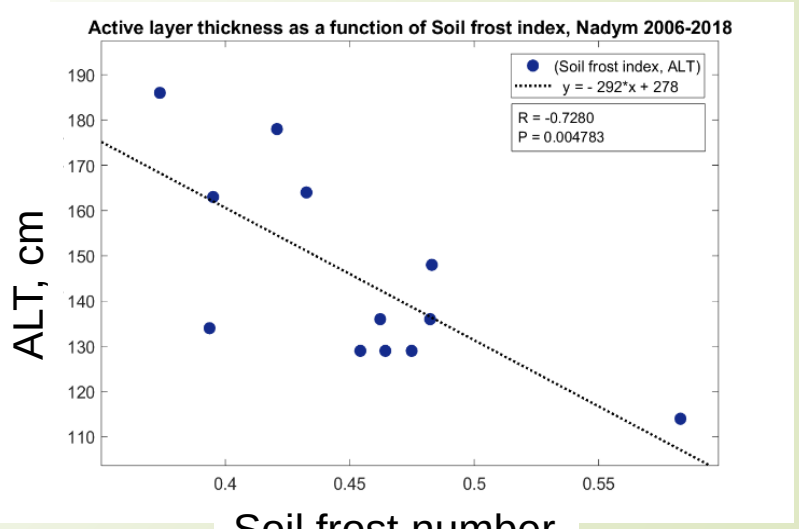
Simple theory: ALT ~ $\sqrt{I_t}$

$$F = \frac{\sqrt{I_f}}{\sqrt{I_f} + \sqrt{I_t}}$$

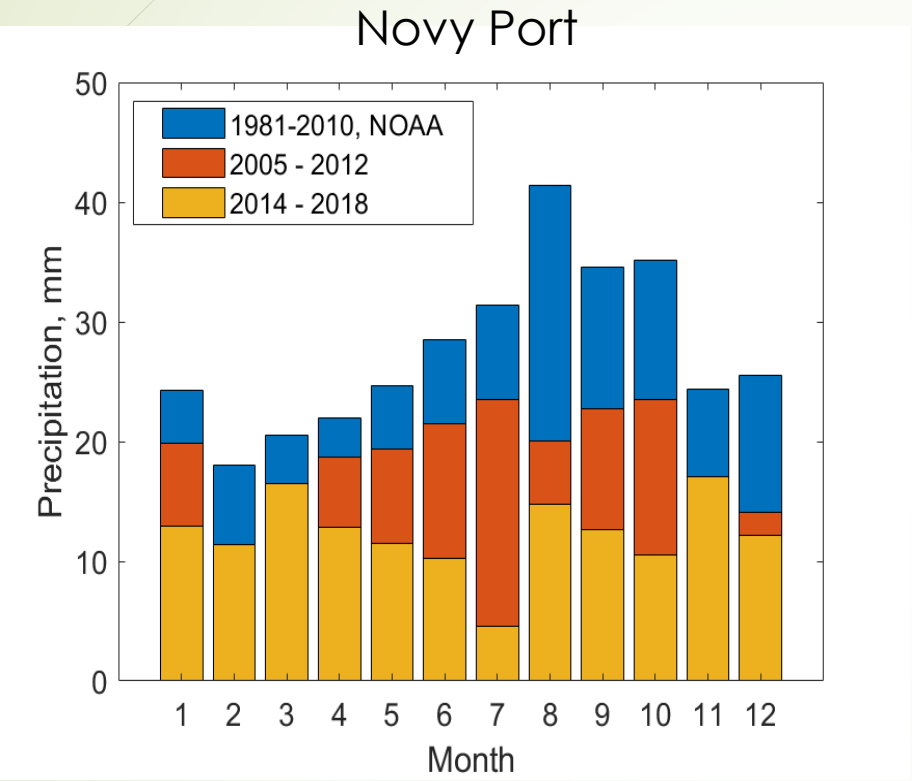
Frost number
(Nelson and Outcart, 1987)
– accounts both for cold and warm seasons

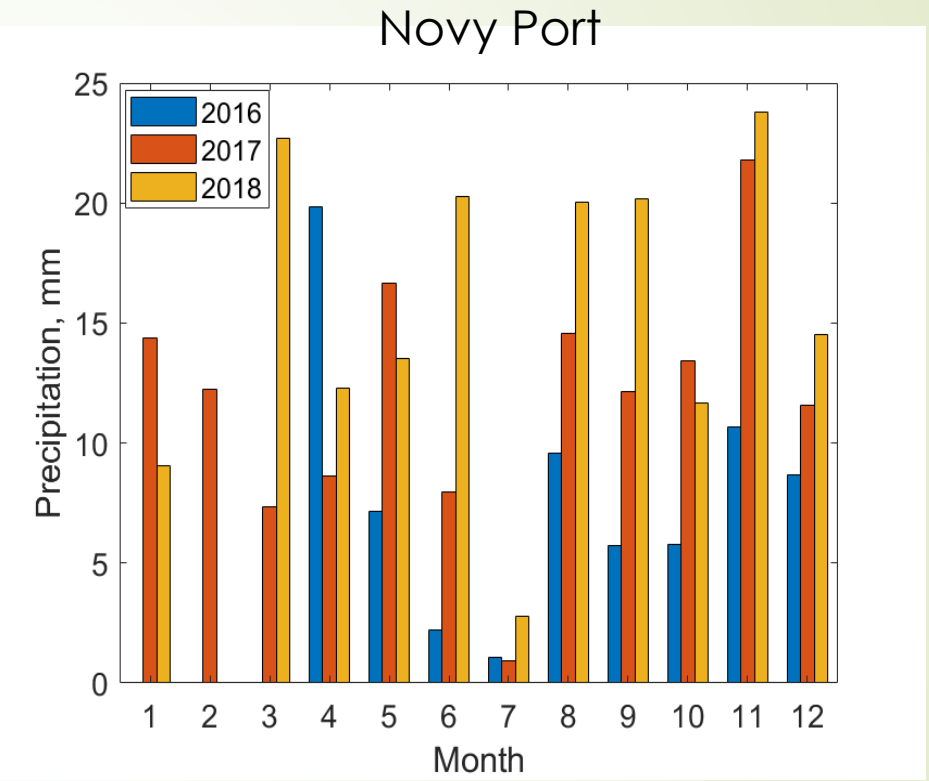
Air degree-days (light colors) - I_t, I_f,
n-factor – dark blue line,
Ground (soil) surface degree-days - (bright colors).

Note decrease in n-factor due to snow thickness in 2014-2015 and mild winter in 2016. -> Decrease in freezing degree-days in 2014-2016.



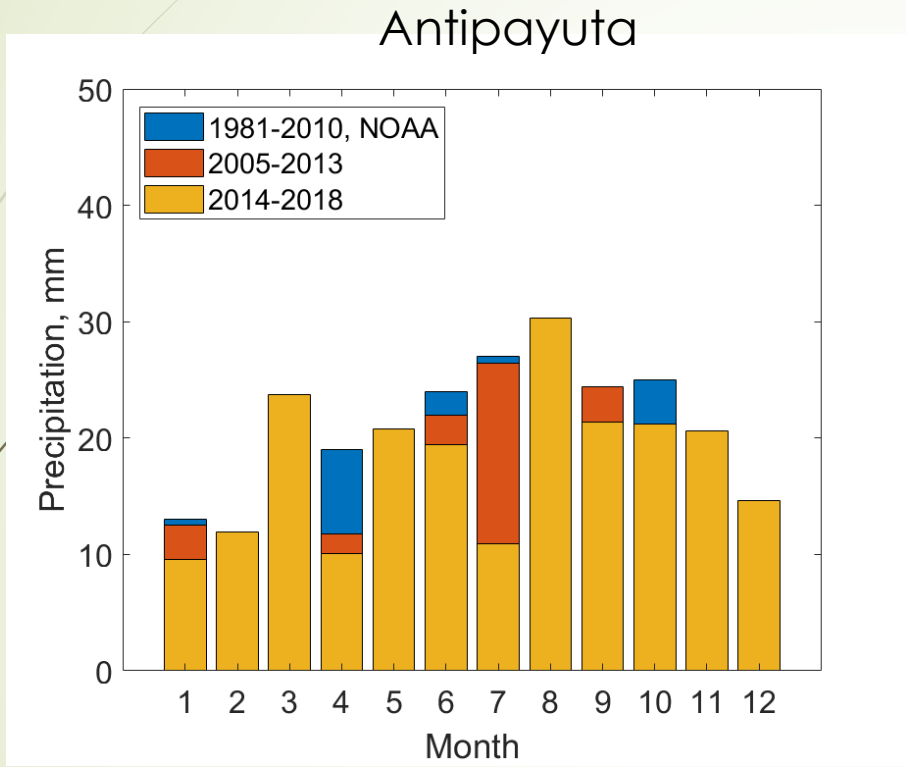
Summer precipitation: Novy Port

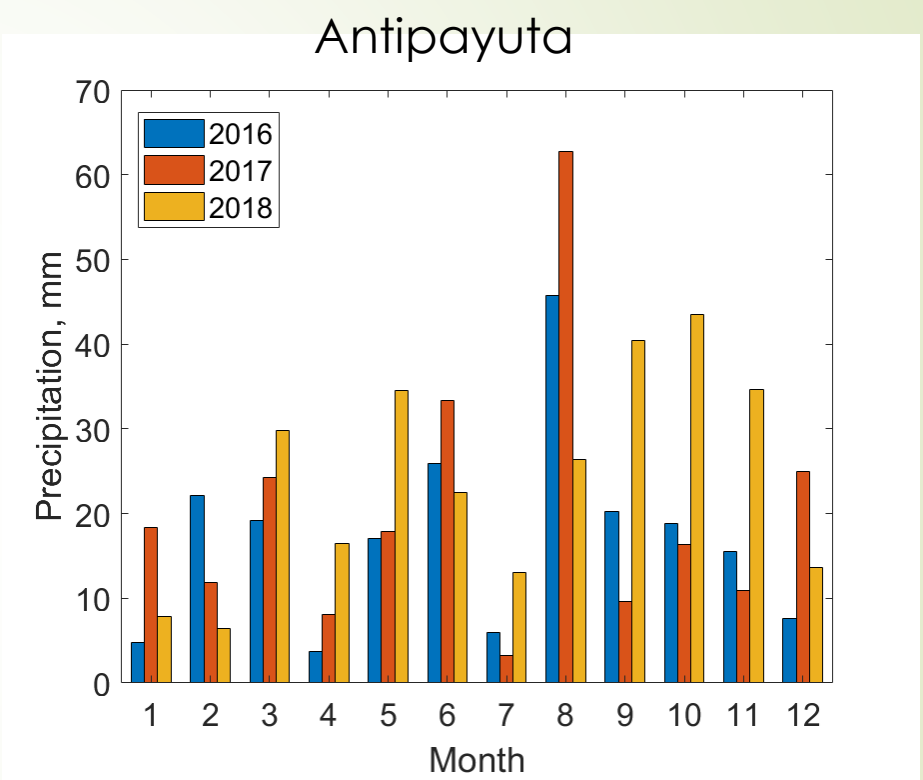




Summer precipitation in July 2016 fell below 10% of the latest climatological normals

Summer precipitation: Antipyuta





Summer precipitation in July 2016 fell below 20% of the latest climatological normals

Conclusions

- **The outbreak of anthrax is a result of the complex interplay of climatic variables occurring during several consequent years – not one 'hot' year**
- Monitoring and preventive measures at the sites with unfavourable conditions - warming, precipitation extremes - are necessary.
- Spatial scale of change in summer precipitation is ca 100 km – difficult to detect in large-scale global models – difficult to predict. **Better observational networks are needed in the remote economically relevant regions.**