Analysis of the vertical structure of atmosphere during the coldest days in Norilsk and Salekhard according numerical simulation

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Abstract: Temperature inversions are ubiquitous feature of the high-latitude climate and can be dangerous for people's health at formation above urban area. It's often impossible to research this phenomenon with measurements so numerical simulation was chosen as method. For estimation of WRF ARW 4.0 reproduction of the vertical structure of atmosphere in Arctic sounding stations in Norilsk and Salekhard were chosen. Numerical experiment was realized for two coldest days during last 10 years for each station. The obtained data was visualized with MATLAB R2017b and then was compared with sounding data.

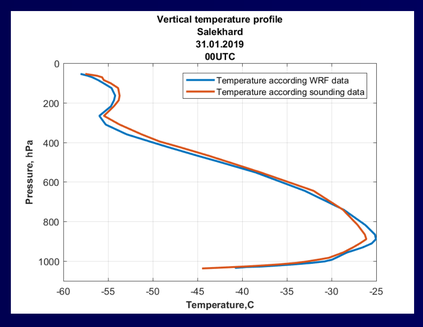
Main issue:

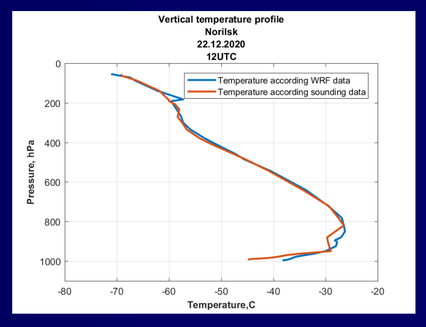
The estimation of model reproduction of the vertical structure of atmosphere in Norilsk and Salekhard

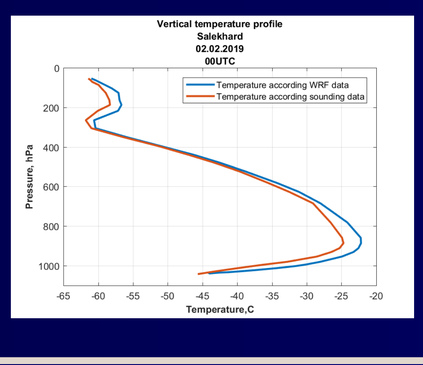
Objectives of the research:

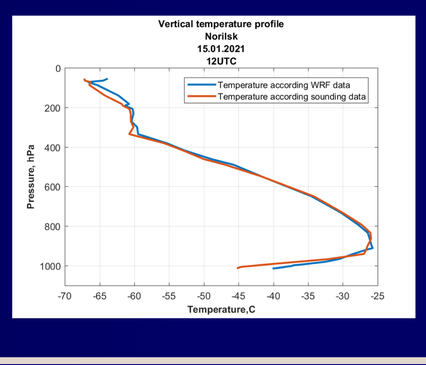
* To select parameterizations that reflect the specifics of the interaction between the atmosphere in the Arctic and the underlying surface
* To select dates and to realize numerical experiments with the mesoscale non-hydrostatic model WRF ARW 4.0
* To visualize results and to calculate the deviation of the model temperature values from the measured ones

VERTICAL STRUCTURE OF THE ATMOSPHERE ACCORDING TO THE WRF ARW 4.0 AND SOUNDING DATA

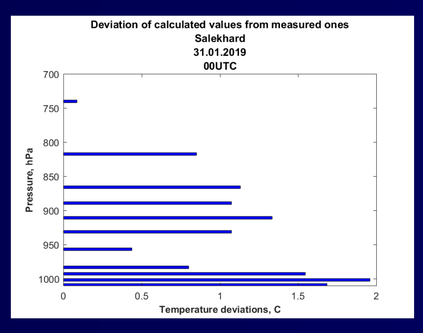


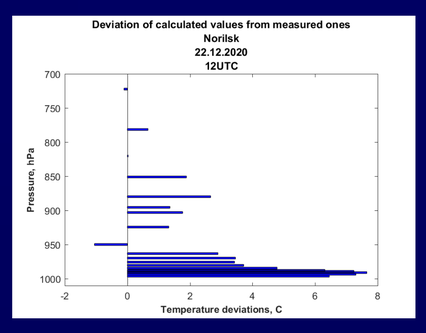


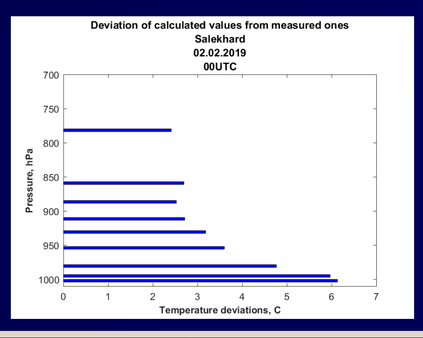


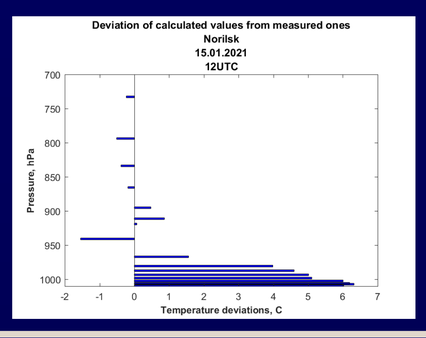


COMPARISON RESULTS OF NUMERICAL EXPERIMENT WITH SOUNDING DATA









CONCLUSIONS

- In case of surface-based temperature inversion, there is maximal model deviation near the surface.
- In case of elevated inversion, there is maximal model deviation near the lower inversion boundary.
- Several inversions in one temperature profile are weakly reproduced by the WRF ARW 4.0 model.
- Difficult relief also adds errors in reproduction.

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DATA AND METHODS

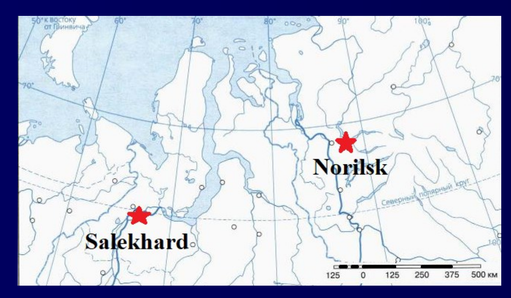
Why Salekhard and Norilsk?

Salekhard

* Climate: **subarctic continental**
* Relief: **flat**
* **Sounding station: yes**

Norilsk

* Climate: **subarctic continental**
* Relief: **near the mountains**
* **Sounding station: yes**

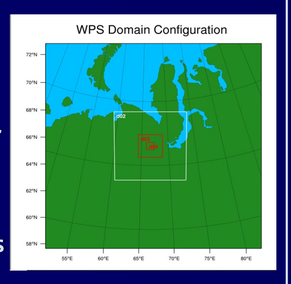


Numerical experiments

The mesoscale non-hydrostatic model WRF ARW, version 4.0

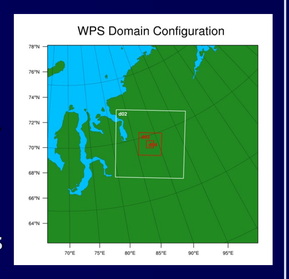
Numerical experiments for Salekhard

* Period: **31.01.2019, 02.02.2019**
* **4 nested domains with common center in 66,53°N 66,66° E**
* Initial and boundary conditions: **reanalysis ERA-5 with 0.25° ×0.25° resolution**
* Domains horizontal grid increments: **18km, 6km, 2km, 0.5km**



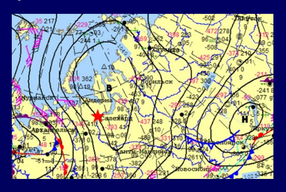
Numerical experiments for Norilsk

* Period: **22.12.2020, 15.01.2021**
* **4 nested domains with common center in 69,32°N 88,22° E**
* Initial and boundary conditions: **reanalysis ERA-5 with 0.25° ×0.25° resolution**
* Domains horizontal grid increments: **18km, 6km, 2km, 0.5km**



Synoptic situation

31.01.2019 00:00 UTC, Hydrometcenter of Russia



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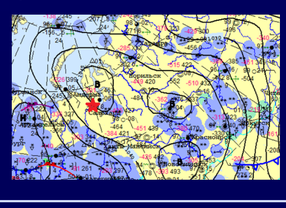

Synoptic situation

22.12.2020 12:00 UTC, Hydrometcenter of Russia

02.02.2019 00:00 UTC, Hydrometcenter of Russia

Parameterizations

Microphysics for domains 1-3: **WSM 5-class scheme**
Microphysics for domain 4: **WSM 6-class scheme**
Cumulus Parameterization**: Kain-Fritsch scheme**
Planetary Boundary Layer: **Bougeault–Lacarrere Scheme**
Surface Layer: **Revised MM5 scheme**
Longwave radiation: **RRTMG scheme**
Shortwave radiation: **RRTMG scheme**
Land-Surface Model: **Noah-MP Land Surface Model**