Using CCI+ Permafrost Data in model evaluation

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Using CCI+ Permafrost Data in model evaluation

- we run a regional climate model over the Arctic
- main point of interest: land-atmosphere feedbacks
- to address our scientific questions, we try to continually improve our model
- to improve our models, we need three things
  1. improved process understanding
  2. accurate boundary parameters
  3. to evaluate our results, we need (spatial) data for comparison

2m air temperature, winter (DJF) average over 1979-2019
• station borehole data from various sources (PL, GTN-P, RosHydroMet, Nordicana D, CALM)

• usual drawbacks of comparing with point data
• difficult to access
• time period and depth coverage very variable among data sets -> difficult to make comparison to models on climate time scale
model evaluation: station data

average 2000-2011, station data from at least 8 years
mean annual ground temperature

20cm depth
320cm depth

active layer thickness

bias

[°C]

-20 -15 -10 -5 0 5

[°K]

0 1 2 3

[m]
model evaluation: example sensitivity study

- goal of sensitivity study: model parameter improvement
- models runs with different soil parameters
- evaluation of model results with in-situ and CCI Permafrost products

reference run

- monthly mean soil temperature for July at 20cm depth
- average over 2000-2017
- data from at least 12 years

experiment run

bias=−6.48, rmse=8.280
bias=−2.10, rmse=3.664
## Model Evaluation: Example Sensitivity Study

- **In-situ Comparison of Monthly Mean Soil Temperature at Different Depths, Average Over 2000-2017**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Reference Run</th>
<th>Experiment Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>Feb</td>
<td>Mar</td>
</tr>
<tr>
<td>20</td>
<td>-0.5</td>
<td>-0.7</td>
</tr>
<tr>
<td>40</td>
<td>-0.4</td>
<td>-0.4</td>
</tr>
<tr>
<td>80</td>
<td>-0.8</td>
<td>-0.8</td>
</tr>
<tr>
<td>120</td>
<td>-1.4</td>
<td>-1.2</td>
</tr>
<tr>
<td>160</td>
<td>-2.2</td>
<td>-2.1</td>
</tr>
<tr>
<td>240</td>
<td>-2.8</td>
<td>-2.9</td>
</tr>
<tr>
<td>320</td>
<td>-2.7</td>
<td>-2.6</td>
</tr>
</tbody>
</table>

**Bias**: 

-2.7

**RMSE**: 4.1
model evaluation: example sensitivity study

- comparison of mean annual ground temperature to CCI Permafrost product v3, 1m depth, average over 2000-2017
model evaluation: example sensitivity study

permafrost extent
color: model run
contour: CCI Permafrost v3

reference run | experiment run

active layer thickness

reference run – CCI Permafrost v3
experiment run – CCI Permafrost v3
sensitivity study with modified soil parameters

- evaluating soil temperatures with in situ data on a monthly time scale shows improved rmse for many months and depths
- evaluation is biased due to uneven spatial distribution of stations
- comparison with spatial CCI Permafrost MAGT shows strong geographical association of biases with latitude and orography
- comparison of modelled permafrost extend and active layer thickness with CCI Permafrost products emphasizes that despite the apparent improvement of the model results, the representation of those variables gets worse