

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2020-363

Anonymous Referee #1

Referee comment on "Estimating subpixel turbulent heat flux over leads from MODIS thermal infrared imagery with deep learning" by Zhixiang Yin et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-363-RC1>, 2021

The authors present a study to solve the mixed pixel problem in the remote sensing of ice surface temperature and ice leads by using convolutional neural network. Then the finer resolution data facilitate the further lead heat flux estimation at a more detailed level. The proposed deep learning-based method outperforms other methods mainly due to its capability of capturing complex nonlinear spatial pattern/relationship between images on different scales. Overall, the study provides a new prospects of lead mapping, but the manuscript in its current state does not meet the standard of the TC. I suggest major revision and the language needs further improvements.

General Comments 1/4

- Most of the study area cover the ice zones, having temperature lower than -2°C (Fig.2 and Fig.12). This might not be appropriate to use the term "sea surface temperature". I suggest to use "Ice surface temperature".
- This experiment was conducted on the Beaufort Sea. Would the model be suitable for other Arctic sea ice regions such as the central Arctic Ocean where the Landsat imagery is lacking? Although the reconstructed SR IST is hard to validated there, it is possible to assess the accuracy of leads map through other source of high resolution dataset such as SAR image.
- In the introduction, has CNN-based SR method ever been used in downscaling thermal infrared images in other regions, for example, in middle latitude areas? I suggest adding some background about it.
- The wind and air temperature are referred at different altitude, any measure on solving the inconsistency? on which height is the turbulent heat flux calculated? Also, the hourly air temperature from ERA5 reanalysis is provided on 0.25° grid (which is not mention in the manuscript). The scale of air temperature data doesn't match with those

of MODIS or Landsat images, therefore potential influence of warm lead surface on the bottom air might be neglected. Uncertainty in this case should be noted.

- Please rewrite the conclusion section, it looks to me that it is more like a discussion.
- I found some long sentences such as Line 60-62, Line 519-520, hard to understand. Suggest authors do professional English editing.

Specific Comments:

- Figure 1: The light color rather than black area represents leads.
- Line 92~94: could the authors elaborate on their decision to not use the NSIDC MOD29 sea-ice surface temperature product directly but instead calculate it themselves?
- The document "Hall and Riggs, 2001" is not cited properly. "Algorithm Theoretical Basis Document (ATBD) for the MODIS Snow and Sea Ice-Mapping Algorithms" has three main contributors and another seven co-authors, thus you should cite this paper as following: Hall, D.K.; Riggs, G.A.; Salomonson, V.V.; Barton, J.; Casey, K.; Chien, J.; DiGirolamo, N.; Klein, A.; Powell, H.; Tait, A. Algorithm Theoretical Basis Document (ATBD) for the MODIS Snow and Sea Ice-Mapping Algorithms; NASA GSFC: Greenbelt, MD, USA, 2001.

Or Hall D.K., Riggs G.A. and Salomonson V.V., 2001. Algorithm Theoretical Basis Document (ATBD) for the MODIS Snow and Sea Ice-Mapping Algorithms. NASA's Goddard Space Flight Center, Greenbelt, MD.,1-45.

- Line 105: As for choosing the retrieval algorithm for sea ice, I recommend to cite a related publication:

Fan, P., Pang, X., Zhao, X., Shokr, M., Lei, R., Qu, M., Ji Q, Ding, M. (2020). Sea ice surface temperature retrieval from Landsat 8/TIRS: Evaluation of five methods against in situ temperature records and MODIS IST in Arctic region. Remote Sensing of Environment, 248(January), 111975. <https://doi.org/10.1016/j.rse.2020.111975>.

- Line112: "manually drawn", what is the criteria in producing the reference lead maps? Is there any physical threshold used here, like that in Lindsay et al. (1995)?

- Line115: why don't you use the 100 m raw data instead of relying on the up-sampled 30 m product?
- Line 174: Is the layer number of very deep residual CNN model a prescriptive constant, or we can adjust them?
- Line 211~213: Does the lead map show consistency with the assumption that the surface temperature all above the freezing point?
- Line 239: The Pearson coefficient is generally represented as "r" instead of "R".
- 6: Suggest to mark the name of corresponding methods in the sub-images or sub-titles.
- Line 284~286: the subsentence after "because" is not the cause, please rephrase this sentence.
- 7: In this figure the labels of both X and Y-axis are not appropriate. As the scatter plots represents the IST between Landsat and SR images, the X and Y-label can be "Reference IST" and "IST from xxx".
- Line309: what about the surface temperature distribution of the lead in the map? Are they all above the freezing point? Same question for the Fig 13.
- Line 397: What is "at a step size of 40"? please clarify.
- 12: Note that Landsat images acquired on 25 April 2018 is partly contaminated by cloud. You also mentioned the red dashed ellipse in Fig. 13c. Could you discuss the impact of the cloud on your method?
- 13: It seems the sub-plots m to x do not maintain the same sizes with the black rectangle r1 to r3. Please make sure they have same size and do not stretch them.