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Interactive comment on "Sensitivity of ice production estimates in Laptev Sea polynyas to the parameterization of subgrid-scale sea-ice inhomogeneities in COSMO-CLM" *by* O. Gutjahr et al.

Anonymous Referee #2

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General comments:

The authors implement a tile-approach into the atmospheric COSMO-CLM model to account for subgrid-scale sea-ice inhomogeneities and examine the impact on estimated sea ice production in the Laptev Sea polynyas. Due to huge differences between sea-ice and open water properties and the linear dependency of energy fluxes on these properties, the implementation of the tile-approach is a significant improvement of the COSMO-CLM model. The configuration of the simulations is complex: 182 daily simulations for each setup with initial conditions based on AMRS-E sea ice

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concentration, PIOMAS sea ice thickness, and MODIS based assumption for polynya sea-ice thickness and sub-grid scale ice thickness. Overall the setup is convincing and promises to give the most realistic results for ice production given the limitations of the very simple sea ice module in COSMO-CLM. In addition to the main finding that the ice production can increase by a factor of 2, the authors discuss a number factors documenting how difficult it is to accurately determine ice production in polynyas.

In spite of the quality of the simulations and the significance of the results major revisions are required. My main concern is that the current manuscript fails to appeal to scientists who are not familiar with polynya processes in the Laptev Sea and/or are not using the COSMO-CLM model. Required background information and motivation (e.g. formation of polynyas, importance of polynya ice production) are missing in the study. The discussion of the results is too restricted to differences with one remote sensing product (Willmes et al., 2011) and potential adjustments of the COSMO-CLM model. What can somebody learn from this study who is not using COSMO-CLM? Prescribing the subgrid-scale ice thickness cannot be the best solution to simulate polynya processes. What are consequence from your study for applying a more complex sea ice model which aims to simulate the processes?

Specific comments:

1. Abstract: too long; too many details about setup; mention that COSMO-CLM is atmospheric model; not clear whether numbers are winter averages or extremes from case studies. Better give numbers from preferred reference run. Last sentence too specific for COSMO-CLM setup (see General Comments.)

2. Introduction: mainly just technical introduction; paragraph about polynyas and their importance missing; mention discrepancy of estimates of polynya ice production from previous studies.

3. Configuration of CCLM / initial conditions: If a model grid point has e.g. SIC = 60 %, is this grid box regarded as polynya box in which 60% of the area is covered by

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ice with a thickness of TIT (10 cm for model run C05wt1) and 40% with a thickness of the subgrid-scale TIT (1 cm for this model run)? Do the ice thickness, TIT and subgrid-scale TIT change during the 24h simulation period?

4. Page 8, line 13: "the turbulent exchange coefficient CH is variable in time": Why? Please write "is a function of . . ."

5. Verification with in situ data: The AWS were deployed over the fast ice and Table 3 and Figure 4 document that there are no significant differences between the sensitivity runs as long SIC > 95 %. Just show results from one simulation (CO5nt) in Table 3. Figure 4 could be omitted in my opinion.

6. Case study on 4 January 2008: The differences in Figure 5 and 6 are quite difficult to spot and at this stage the reader is not aware whether you have a preferred reference run. Might be helpful to change order and to focus just on the preferred run for the case study.

7. Conclusions: Only present numbers from your preferred reference run. Put your results in wider context. See general comment. Add a paragraph about how your results might help to simulate polynya processes using a more complex sea ice model including recent advances of frazil ice modules (e.g. Wilchinsky et al., JPO 2015).

8. Give numbers with adequate decimals in text and tables (e.g. +110% instead of 109.7% in line 11 or 29 km3 instead of 29.05 km3 in line 14).

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