General comments

The authors are attempting to make a step further development of WRF by coupling it with a complex sea ice thermodynamic model (HIGHTSI) in order to improve the WRF performance in the Arctic Ocean.

First the Noah simple sea ice model currently used in WRF is compared HIGHSTI applying SHEBA Camp date set (SIMIP2). This part was entitled as offline sea ice simulation. Then the WRF-Noah and WRF-HIGHSTI are compared by modelling performances carried out for the SHEBA domain (Chuck Sea and Canadian Basin). This part was entitled as online simulation. The authors concluded:

1) WRF-HIGHTSI improves the air-ice coupling provide better surface temperature, upward longwave radiative flux and 2 meter air temperature.
2) WRF-HIGHSTI can improve the seasonal sea ice simulation, but overestimate the annual ice thickness.

Currently the regional climate models (RCM) and the operational numerical weather prediction (NWP) models applied simple sea ice scheme as boundary module. Any research activity toward better representation of sea ice scheme in RCM and NWP deserves attention and encouragement. I believe work done in this MS belongs to this category. Overall, I see descriptions of work are clear and easy to follow. However, the analyses of the results suffer various kinds of structural and technical problems and some proper physical interpretations are missing. So, I recommend the MS to be published after authors carry out a substantial revision in order to improve the quality of this manuscript.

Specific comments

Introduction

I can tell authors made a lot of review in this section, but still I would like to see authors provide a more explicit and clear motivation of this study, i.e. why do we need to improve sea ice scheme in WRF? What are the expected and added values of WRF overall?

Model and data

Section 2.3 presents setup for online simulations and a study domain is given as Figure 2, while Figure 1 is presented after Figure. 2. This is quite odd. I suggest authors revise the structure of the MS and make the text flow more smooth and logic.

Offline simulation of sea ice

Why Noah provided cold bias of ice temperature? Authors stated "the snow depth simulated in Noah is considerably higher than the observation, which can lead to cold bias in the snow layer and upper part of sea ice" But what could be the physical reason behind this phenomenon?

When snow layer is thick, it will introduce strong insulate effect so the ice temperature should be warmer.

How snow is simulated in Noah and HIGHTSI? What kind of external forcing both models applied? Since manuscript targets geoscientific model development, some more modelling technical details should be given.

Online simulation of sea ice

I feel that early section "model setup" should be fitted here for better clarity.

Authors claim "Both WRF-Noah and WRF-HIGHTSI overestimate the sea ice albedo due to the simulation of a too early snow melting over sea ice and the lack of melt-pond effect in summer.

While the empirical estimate of sea ice albedo in WRF-Noah is better tuned for the summer sea ice in the Arctic (Bromwich et al., 2009), the higher upward shortwave radiation in WRF-HIGHTSI results from the overestimation of sea ice albedo"

Are you sure about this? I don't quite understand why "overestimate the sea ice albedo due to the simulation of a too early snow melting over sea ice" When snow melts it will trigger the positive feedback mechanism, i.e. melting will reduce the surface albedo and further enhance the melting. So too early snow melting will make the surface albedo smaller, why overestimate?

In section 2.2 authors started "the sea ice albedo scheme used in HIGTHSI is the same as the "CCSM" scheme used in the Community ICE Model (CICE) model (Collins et al., 2006). This scheme empirically estimates the albedo based on surface temperature, surface air temperature, snow cover and ice thickness" It seems to me that HIGHTSI applied quite advanced surface albedo scheme. Here you claim such albedo scheme overestimates the sea ice albedo?

Why apply a prescribed ice thickness for WRF-HIGHTSI? Is this because you run the WRF-HIGHTSI for 2D domain? What happen if you let HIGHTSI to calculate the ice thickens or is it even possible to do like this?

A prescribed ice thickness in RCF or NWP models is part of the current simplicity and this is a challenge needs to be solved in model development. The current work gives me an impression that WRF-HIGHSTI has a limited value toward big improvement of this aspect even though HIGHSTI is capable to simulate the ice thickness. Can authors provide any recommendations on how to improve this part in the future WRF-HIGHTSI development?

In various parts of the MS authors specifically argued the importance of ice dynamics to the change of sea ice thickness. What is the role of ocean? How important the ice-ocean interaction can affect the sea ice thickness?

Sea ice thickness specification
In one model experiment (THERM), where sea ice thickness was calculated by HIGHTSI, what was the ocean boundary condition applied in this model experiment setup? Why WRF-HIGHTSI in this case can provide smaller bias for seasonal sea ice but larger bias for the annual ice thickness?
A better air-ice coupling should make the atmosphere boundary layer (ABL) forcing more accurate for ice modelling, so I expect HIGHTSI yields better ice thickness

Technical issues
The figure presentations are in general good, but the figure captures can still largely improved, e.g. in Fig. 7 (left) (mid) (bottom) expression is difficult to understand.

Figure 2 shows the model domain, while the results in Figure 5 and 7 have apparently a different domain why?

Authors applied a lot acronyms, it would be better to specify them in a Table.