

Review on “Sea Ice Assimilation into a Coupled Ocean-Sea Ice Model Using its Adjoint”, by Koldunov et al., submitted for publication in The Cryosphere journal.

Page 3, line 25: change “Paremeterization” to Parameterization”.

Page 4, line 15:

You define v as the first guess initial condition. The way the cost function is written, it would seem that you would like v to become as small as possible to reduce the cost function. I think you should define v as the difference between the first guess initial condition and the model state at the beginning of the assimilation window: $v = x_b - x(0)$, where x_b is the first guess (the background) of the model state at the beginning of the assimilation window. It should also be mentioned that the model states at times $t > 0$ are not control variables but are dictated by the strong constraint $x(t) = M(x(0))$, where M represents the forward model.

A similar comment applies to the term with u_m : u_m is defined as the mean atmospheric state. I don't believe you want to make u_m as small as possible to reduce the cost function. Instead, you should define u_m as the difference between the first guess mean atmospheric state and an optimized version.

Again, for the last term in equation (1), same comment applies.

Page 8, line 13: I believe SAT refers to surface atmospheric temperature but it has not been defined to this point.

Page 9, line 10: Please define the sea ice thickness you are using. Is it the average or the effective ice thickness? The average sea ice thickness is defined as the volume of ice divided by the sea ice area. The effective ice thickness is defined as the volume of ice divided by the grid cell area. These 2 quantities are related like this:

$$\text{average ice thickness} = \frac{\text{effective ice thickness}}{\text{sea ice concentration}}$$

In light of this, make sure the comparison between ICESat ice thickness and the model output is done appropriately.

Page 10, line 10: “In June, considerable temperature differences cover a much smaller area...”. Do you mean smaller than in September? Please clarify the sentence.

Page 11, line 4: I guess the “forward simulation” here means the model run before the data assimilation, as it is specified later on the same page on line 19. Is that correct? If possible clarify this in the text.