Effect from polynyas in the Siberian Arctic seas to atmospheric transport of heat and moisture

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The decisive contribution of atmospheric meridional heat transfer (MHT) to the Arctic energy budget to the North of 70° N in winter was established in [3]. It was shown [1,2] that the main MHT in the Arctic in winter enters through the Atlantic sector at 70° N between 0° and 80° E ("Atlantic Gate") in the layer from the surface to 750 hPa. But the question remained of the lack of connection between the fluctuations in the integral transfer of sensible heat through the entire circle of 70° N and an average temperature in the region of 70- 90° N. A possible explanation for this is that the cold air transport from Eurasia through 80-150°E, where in winter south winds prevail, contributes essentially to the calculations of the total influx of sensible heat. But this influx does not have a noticeable effect on the average air temperature at 70-90 ° N due to the influx of heat from a polynya in the Arctic seas. [4]

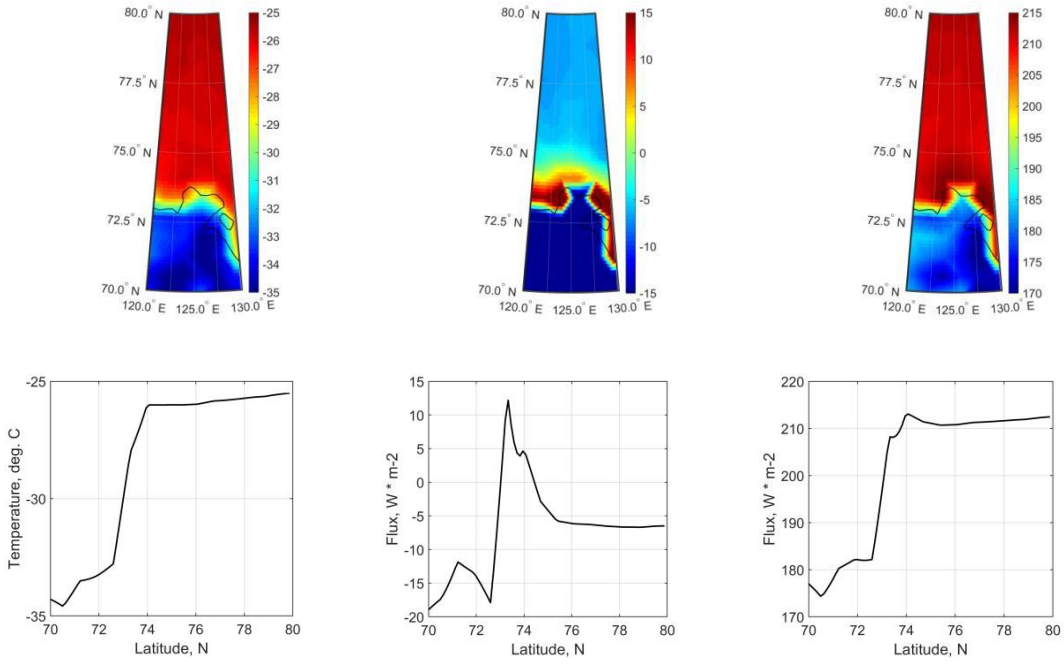
To detect and take into account the temporal variability of the polynya position in the Laptev Sea, the HadleySST daily archive of sea ice concentration data was taken from the Met Office Hadley Center website for the period from 1979 to 2018. Based on the minimum concentrations, it was determined that the polynya considered in this study is between 110-130°E and 73-74° N. To assess the spatial variability of heat and moisture transfers we used the daily data (00 and 12 UTC) from the ERA - Interim reanalysis with a spatial resolution of 0.125x0.125°. The calculation of the meridional heat transport and moisture through 70° N and 74° N was carried out according to the method described in [1-3].

The effect of the polynya on the atmosphere is shown in spatial (latitudinal and longitudinal) profiles of temperature, humidity, and heat balance components . From Table 1, there is a noticeable change in the properties of the air mass when moving northward to 74° N is obvious: in the region of 115-130° E, the air temperature increases, as well as the outgoing longwave flux.

Table 1. Near-surface air temperature (T2M), sensible heat flux (SSHF), outgoing longwave radiation (LWU), meridional heat (TV) and moisture (QV) transport along latitudinal sections at 70 °N (land) and 74 °N (polynya) averaged over 1979 to 2018 in the Laptev sea.

	T2M		SSHF		LWU		QV		TV	
Longitude ° E	land deg.C	polynya deg. C	land W/m^2	polynya W/m^2	land W/m^2	polynya W/m^2	land kg/m/s	polynya kg/m/s	land W/m	polynya W/m
100-110	-32.6	-30.2	-14.8	-11.5	181.7	193.7	0.9	0.4	3.0	1.1
110-120	**-33.2**	**-27.1**	**-22.1**	**14.4**	**183.4**	**212.9**	**0.5**	**1.6**	**1.9**	**4.1**
120-130	**-34.3**	**-26.1**	**-19.0**	**4.7**	**177.0**	**212.6**	**1.0**	**2.3**	**4.3**	**5.8**
130-140	-35.0	-25.6	-12.4	-0.5	175.6	213.2	1.1	1.8	5.9	4.5

In the spatial distribution, the effect of the polynya is noticeable in a sharp change of the meteorological parameters. And in the latitudinal profile, the polynya effect on the parameters during north-directional air transport can be visually assessed. (Fig. 1). Ultimately, we can conclude that winter flow of cold air masses from the continent noticeably heat up over the polynya in the Laptev Sea and with further northward movement over drifting ice continues to warm. The warming effect extends only to the surface air layer from the surface level to 950 hPa. A consequence of the influx of heat from the polynya is the increase in heat transfer to the north in the region of 74° N with respect to the transfer through 70° N (Table 1). In the moisture transfer, it is found that the maximum values fall precisely over the area of the polynya, which is due to evaporation from the open water surface.



a. b. c.

Figure 1. Spatial distribution and latitudinal profile of surface temperature (a.), sensible heat flux (b.), outgoing longwave radiation (c.) from 1979 to 2018 in the Laptev sea region.

This confirms the assumption [1] that the winter transport of cold air from the mainland doesn't have strong cooling effect on the average winter air temperature north of 70 ° N due to the warming effect of the polynya.

References:

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