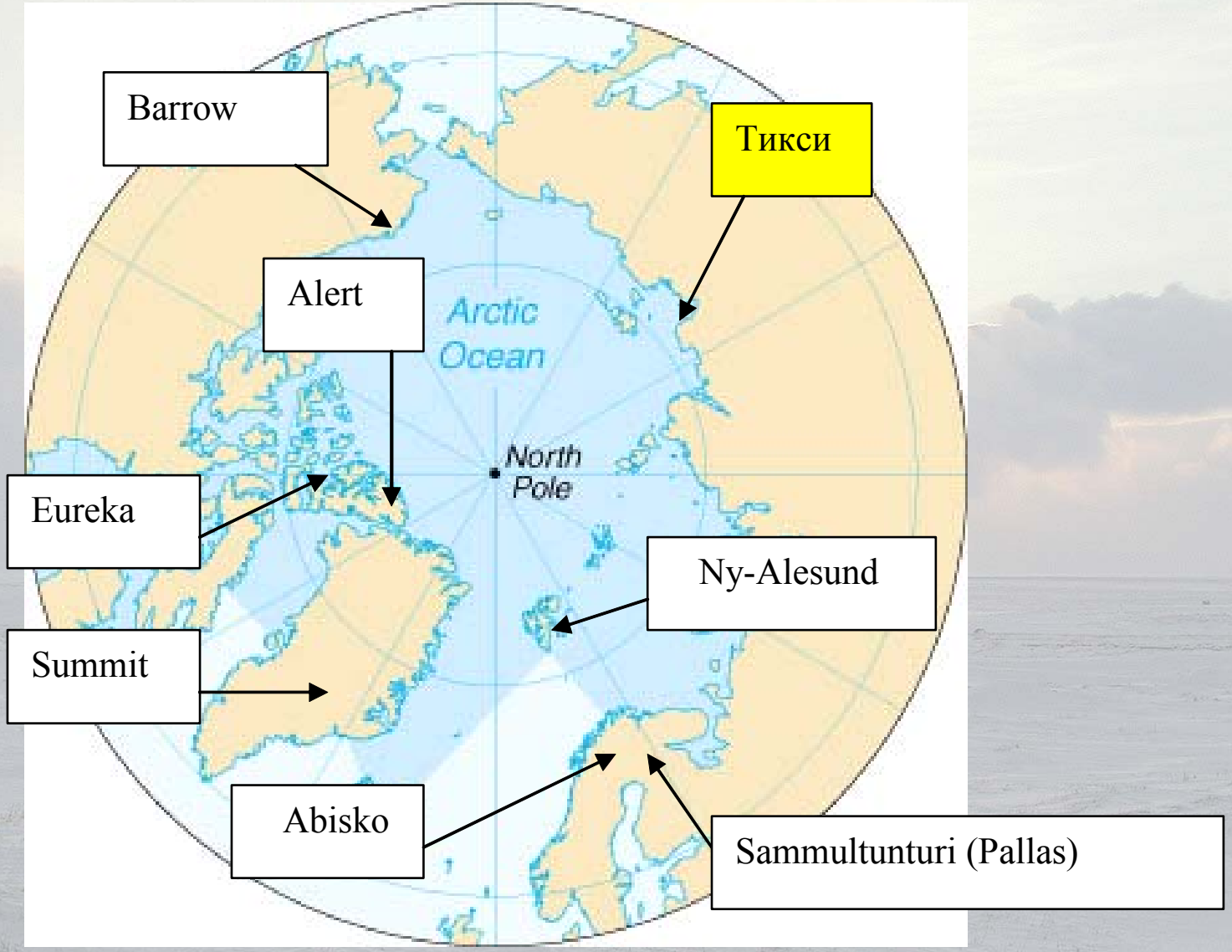
Climate variability in the region of future Tiksi Hydrometeorological Observatory Republic Sakha (Yakutia) Russia

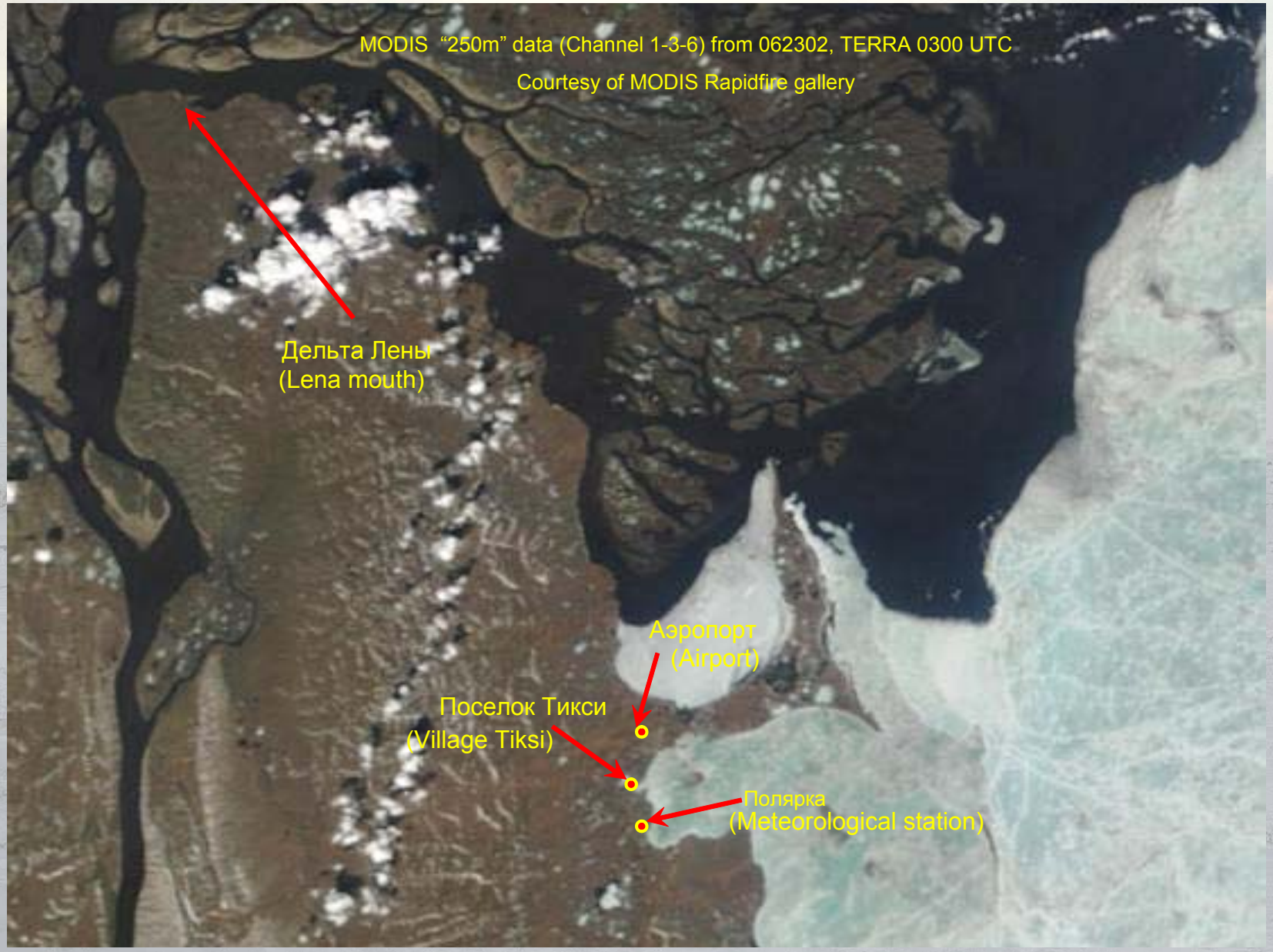
Makshtas A., N. Ivanov, S, Shutilin
Arctic and Antarctic Research Institute, Saint Petersburg, Russia

T. Uttal
NOAA/Earth Systems Research Laboratory, Boulder, Colorado,

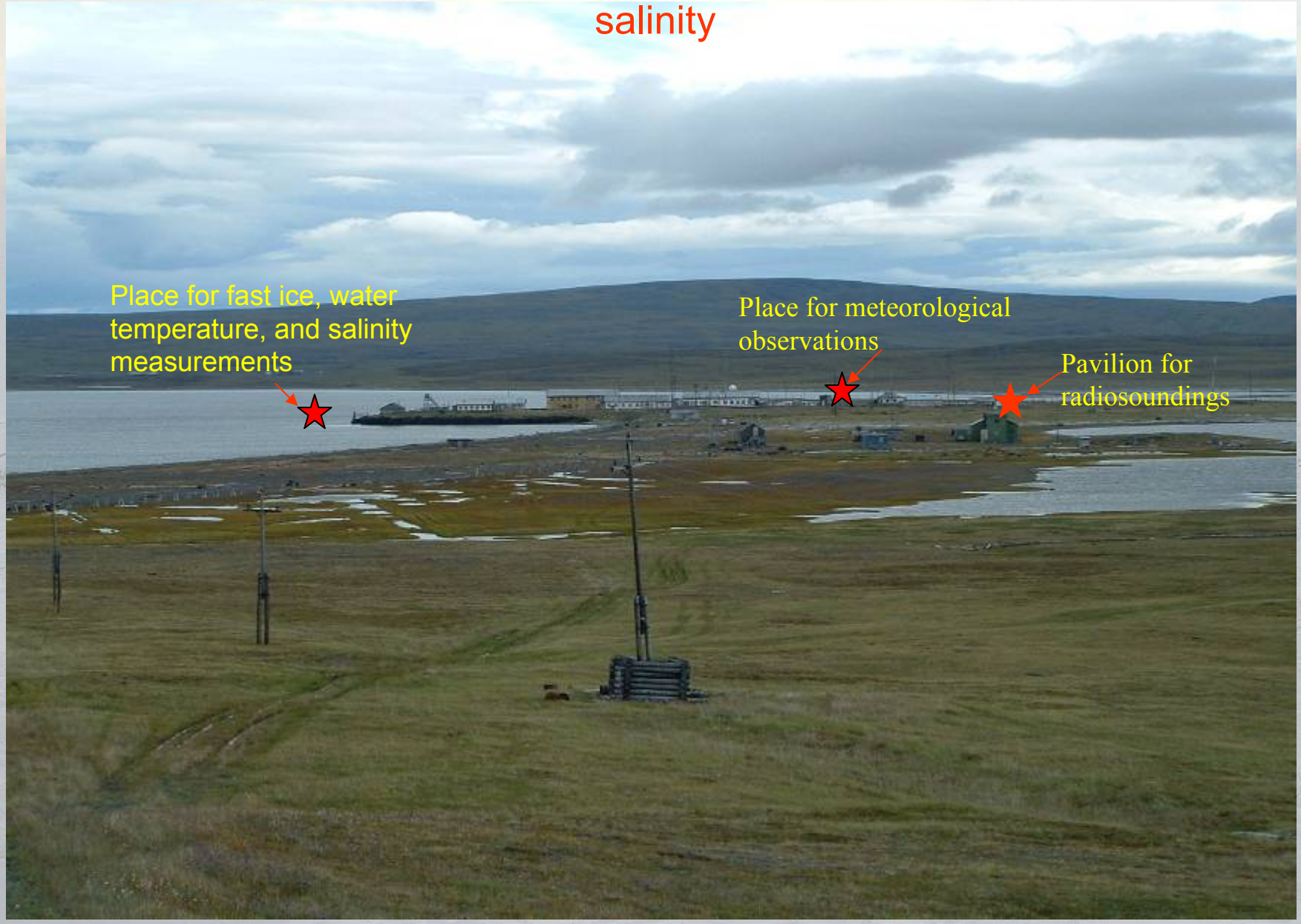


The Tiksi Hydrometeorological Observatory is designed for co-location of observations supporting networks such as BSRN, GAW, UV-NET, CRN, AeroNET, MPLNET and others (including permafrost and other measurements)

View of future Tiksi Observatory in from space



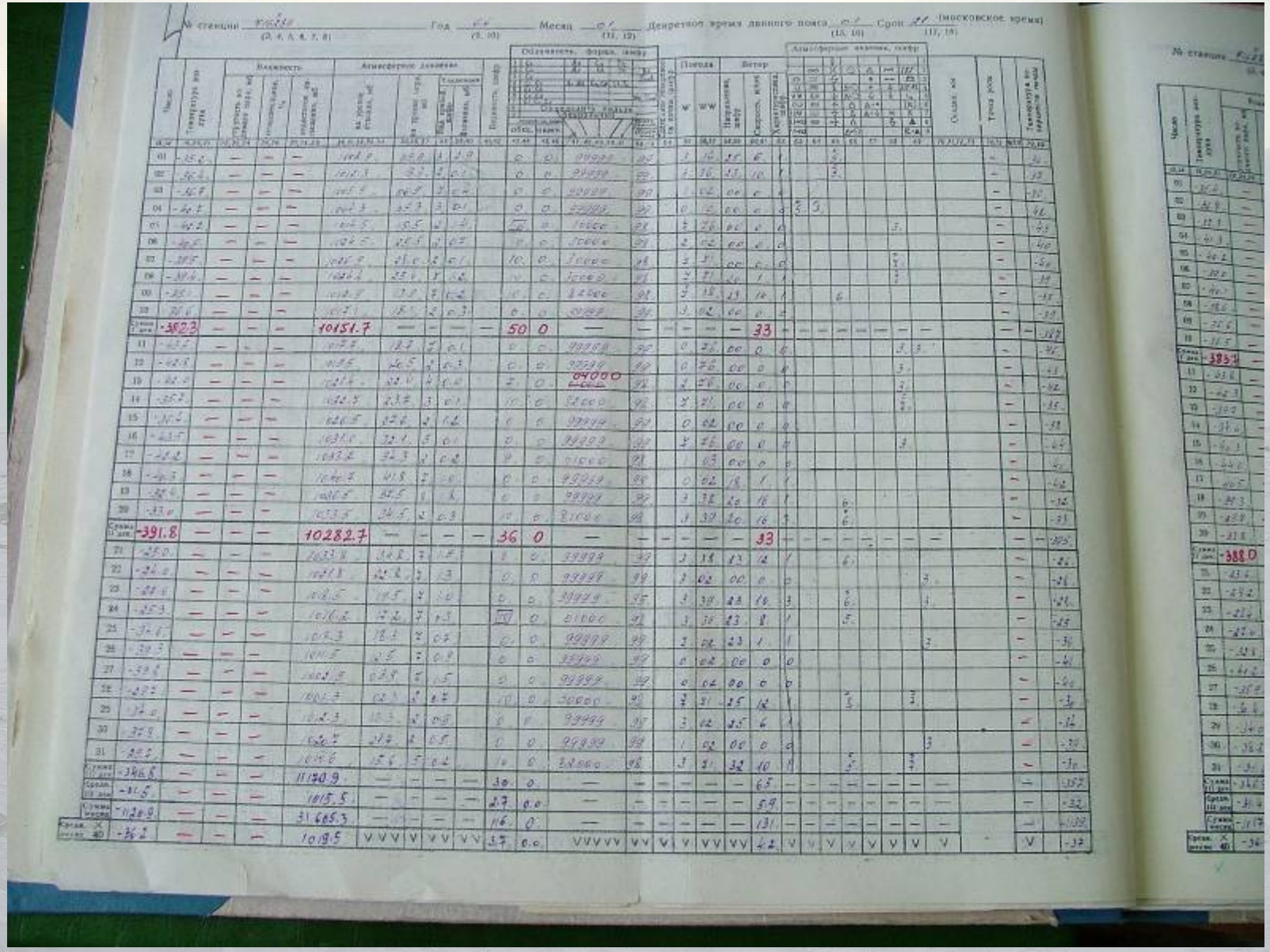
Existing positions of meteorological and radiosounding observations , measurements of fast ice thickness, sea level, water temperature and salinity



Standard surface meteorological observations have been made with consistent methods since 1934

Radiosoundings in “ Polarka” started in 1935 and continue to present

The historical Tiksi data sets have recently been digitized
Example of original table of meteorological data (January 1966)



Data correction

Four steps of Archive corrections had been used for correction of about 1.23 million data prepared from hand written log books, sometimes of low quality, with a lot of improvements. For that EXEL files for each calendar month had been prepared to exclude seasonal variability.

1step. With EXEL graphic presentations of file for each month of each meteorological parameter rough errors had been deleted.

2 step. Mean square deviations of data rows had been calculated to be sure that all rough mistakes had been deleted.

3 step. Graphic analysis of probably wrong information had been done by comparison of dubious data with neighboring data in the same data row.

4 step. After 1-3 steps by number sequence of measured data x_i, i=1,2,…,n the data rows and its sums had been calculated:

$$\delta xi = |xi - xi\text{-}1| \text{ , } i=1,2,\ldots,n\text{-}1$$

$$\overline{\delta}^{*} = \frac{1}{n-1}\sum_{k=1}^{n-1} \delta x_k$$

In case $\delta xi > D\,\overline{\delta}^{*}$ the data with numbers i-1, i, i+1are assumed as doubtful and controlled by logbooks. We used D=5 for step 4.

Additional control had been executed by comparison of maximal daily variation of air surface temperature with data of maximal and minimal thermometers. Despite low accuracy of last measurements 72 mistake of air surface temperature had been found. The same procedure with comparison the values of total and low cloudiness had been made.

MISSING DATA

The number of months with more than 5 days of missing wind speed data is 3 out of 840 months.

The number of months with more than 5 days of missing air temperature data during is 4. There are only 136 days missing air pressure data in entire dataset.

Consequently, using the criteria that data must be present 4 times per day for more than 25 days/month, only 0.5% of the original data had been excluded from statistical calculations

Months with absence of wind speed data (in grey)

Year	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
1937	31	27	31	30	31	30	31	31	30	31	30	31
1938	31	27	31	30	31	30	31	31	30	31	29	31
1939	31	27	31	30	31	30	31	31	30	31	30	31
1941	31	27	31	30	31	30	31	31	30	31	30	31
1942	31	27	31	30	31	30	31	31	30	31	30	31
1943	31	27	31	30	31	30	31	31	30	31	30	31
1945	31	27	31	30	31	30	31	31	30	31	30	31
1946	31	27	31	30	31	30	31	31	30	31	29	31
1947	31	27	31	30	31	30	31	31	30	31	30	31
1949	31	27	31	30	31	30	31	31	30	31	30	31
1950	31	27	31	30	31	30	31	31	30	31	30	30
1951	31	27	31	30	31	30	31	31	30	31	30	31
1953	31	27	31	30	31	30	31	31	30	31	30	31
1954	31	27	31	30	31	30	31	31	30	31	30	31
1955	31	27	31	30	31	30	31	31	30	31	30	31
1957	31	27	31	30	31	30	31	31	30	31	30	31
1958	31	27	31	30	31	30	31	31	30	31	30	31
1959	31	27	31	30	31	30	31	31	30	31	30	31
1960	31	28	11	30	31	30	31	31	30	31	30	31
1961	31	27	31	30	31	30	31	31	30	31	30	31
1962	31	27	31	30	31	30	31	31	30	31	30	30
1964	31	29	31	30	31	30	31	31	30	31	30	28
1965	31	27	31	30	31	30	31	31	30	31	30	30
1972	31	29	31	30	31	30	29	31	30	31	30	31
1982	31	28	-	30	31	30	31	31	30	31	30	31
1994	31	28	31	30	31	30	31	31	30	-	30	-

Example of files, stored in Meteorological Archive

JULday	year	mnnth	day	Ta00	Ta03	Ta06	Ta09	Ta12	Ta15	Ta18	Ta21	Tamax	Tamin
1990	1990	1	1	-24.6	-24.1	-26.1	-25.7	-26.1	-33.3	-32.5	-29.1	-23	-34.7
1990.03	1990	1	2	-28.3	-33.3	-33.9	-33.2	-33.6	-27.3	-30.3	-26.5	-25.9	-34.8

Q00	Q03	Q06	Q09	Q12	Q15	Q18	Q21	Ts00	Ts03	Ts06	Ts09	Ts12	Ts15
0.0006	0.0006	0.0005	0.0005	0.0005	0.0003	0.0003	0.0004	-27	-26	-28	-27	-28	-37
0.0004	0.0003	0.0002	0.0003	0.0003	0.0004	0.0003	0.0004	-32	-36	-36	-37	-38	-30

Ts18	Ts21	Tsmax	Tsmin	NT00	NT03	NT06	NT09	NT12	NT15	NT18	NT21	NL00	NL03
-36	-32	-26	-38	10	10	10	10	6	0	0	0	0	0
-34	-31	-28	-39	0	6	3	4	2	3	0	0	0	0

NL06	NL09	NL12	NL15	NL18	NL21	vi00	vi03	vi06	vi09	vi12	vi15	vi18	vi21
0	0	0	0	0	0	63	97	64	62	80	82	82	82
0	0	0	0	0	0	82	97	83	81	82	80	81	81

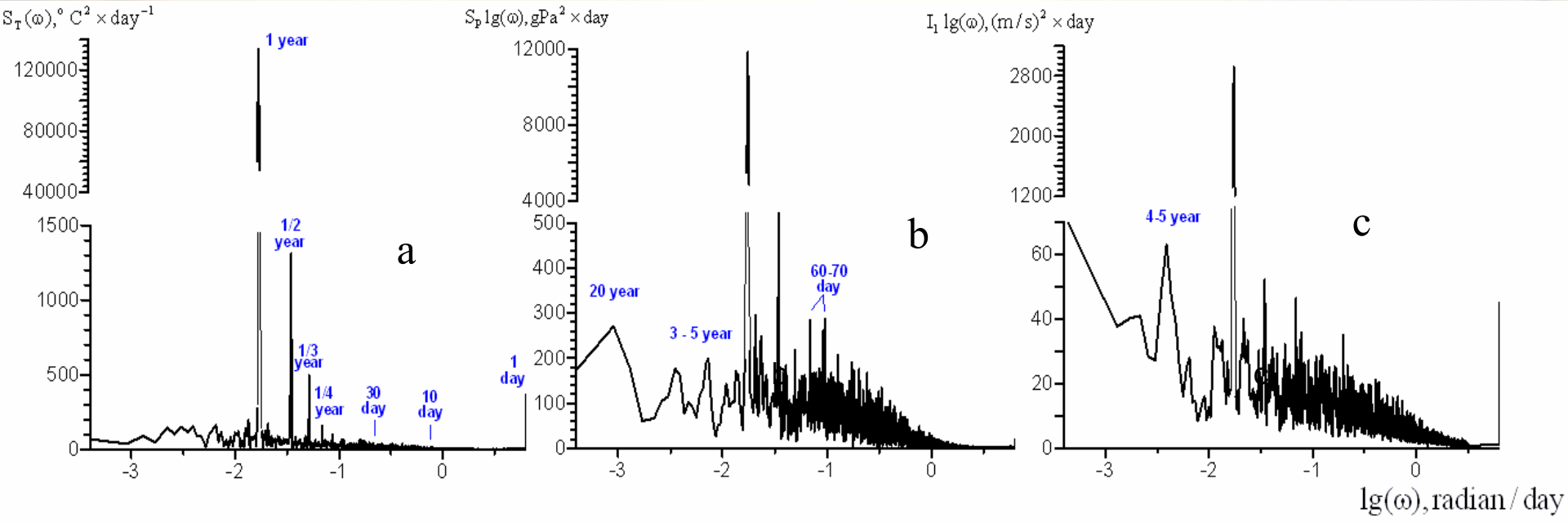
RV00	RV12	slp00	slp03	slp06	slp09	slp12	slp15	slp18	slp21	WD00	W00	WD03	W03
0	0.4	1019.9	1019.9	1020.5	1021	1021.9	1020	1019.7	1019.3	0	0	220	8
0	0	1020.2	1019.8	1019.7	1019.9	1019.9	1022	1021.3	1021	40	3	100	2

WD06	W06	WD09	W09	WD12	W12	WD15	W15	WD18	W18	WD21	W21	hs	so00
250	6	225	6	225	6	205	2	245	2	220	4	2	8
0	0	0	0	0	0	200	3	0	0	220	4	2	8

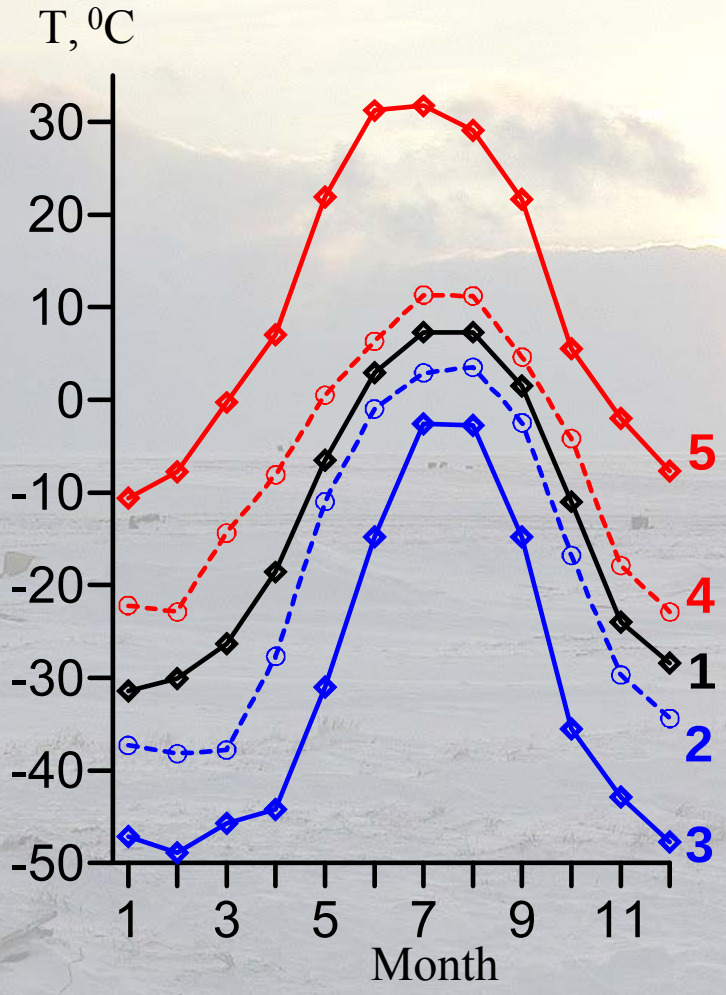
The meteorological archive fir Tiksi will be available on WEB in summer 2008

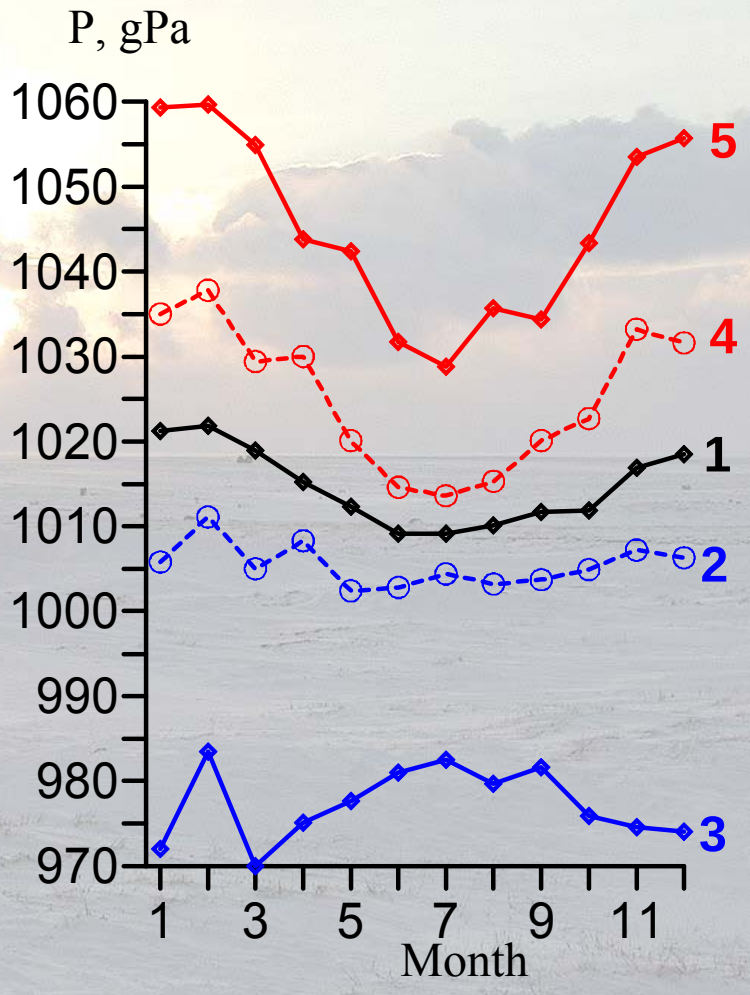
Climate of Tiksi observatory area

Spectral density of multi-year variability of air surface temperature (a), surface pressure (b) and wind velocity (c)

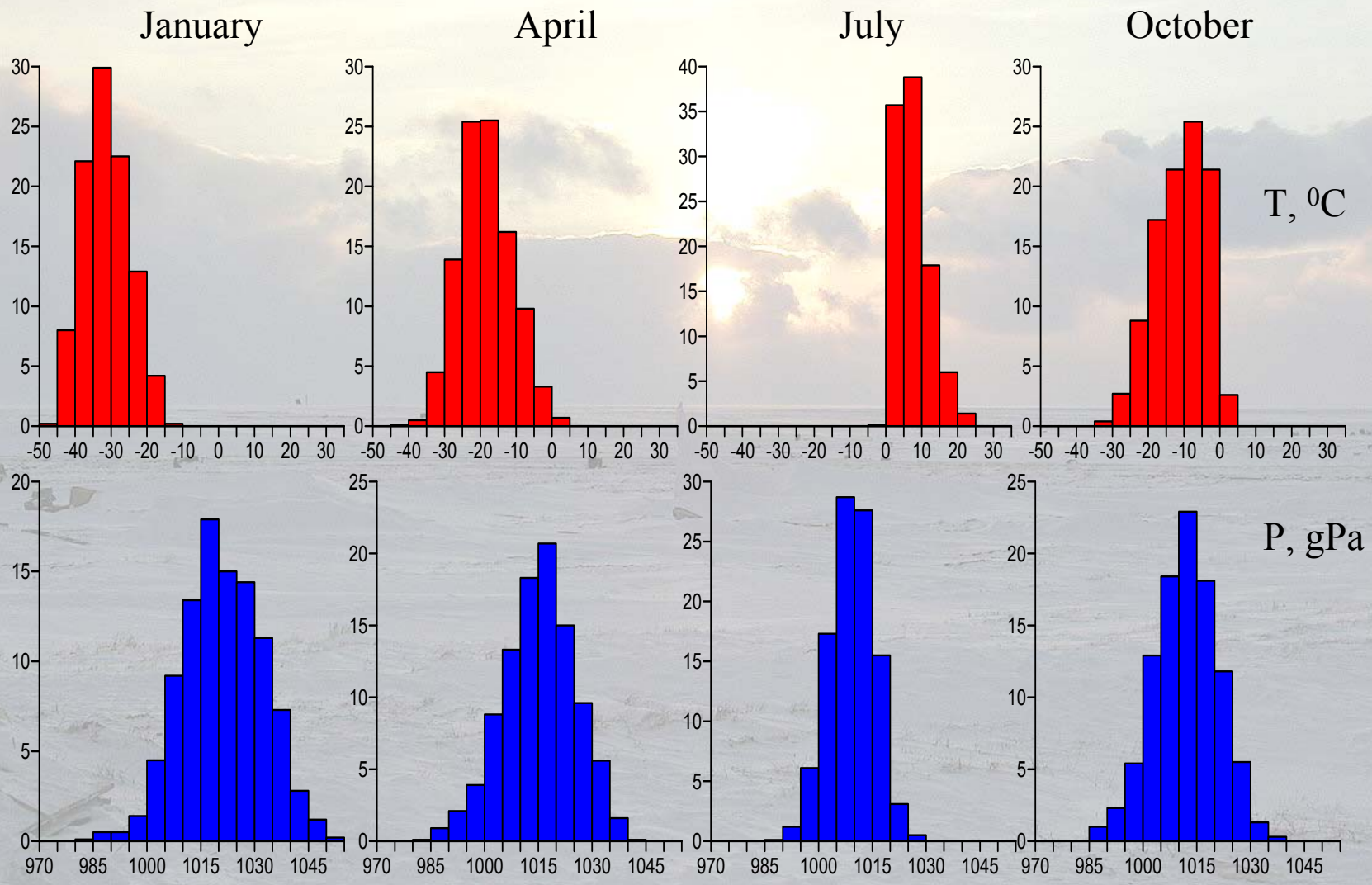


Seasonal variability of monthly means (1) and extremes from daily (3, 5) and monthly (2, 4) averaged data

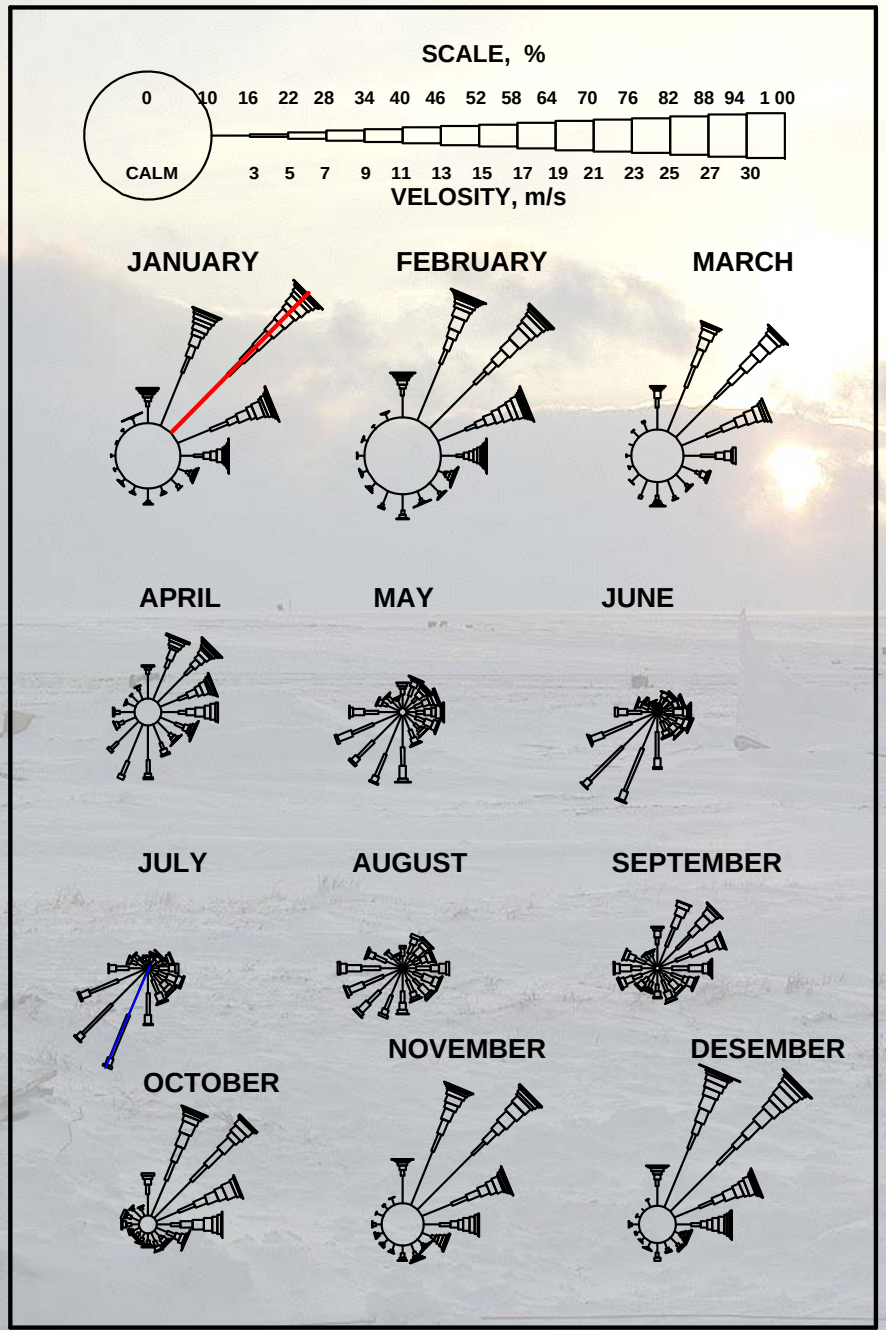




Distribution of air surface temperature and surface pressure (%)



Wind roses in Tiksi (1934 – 2006)



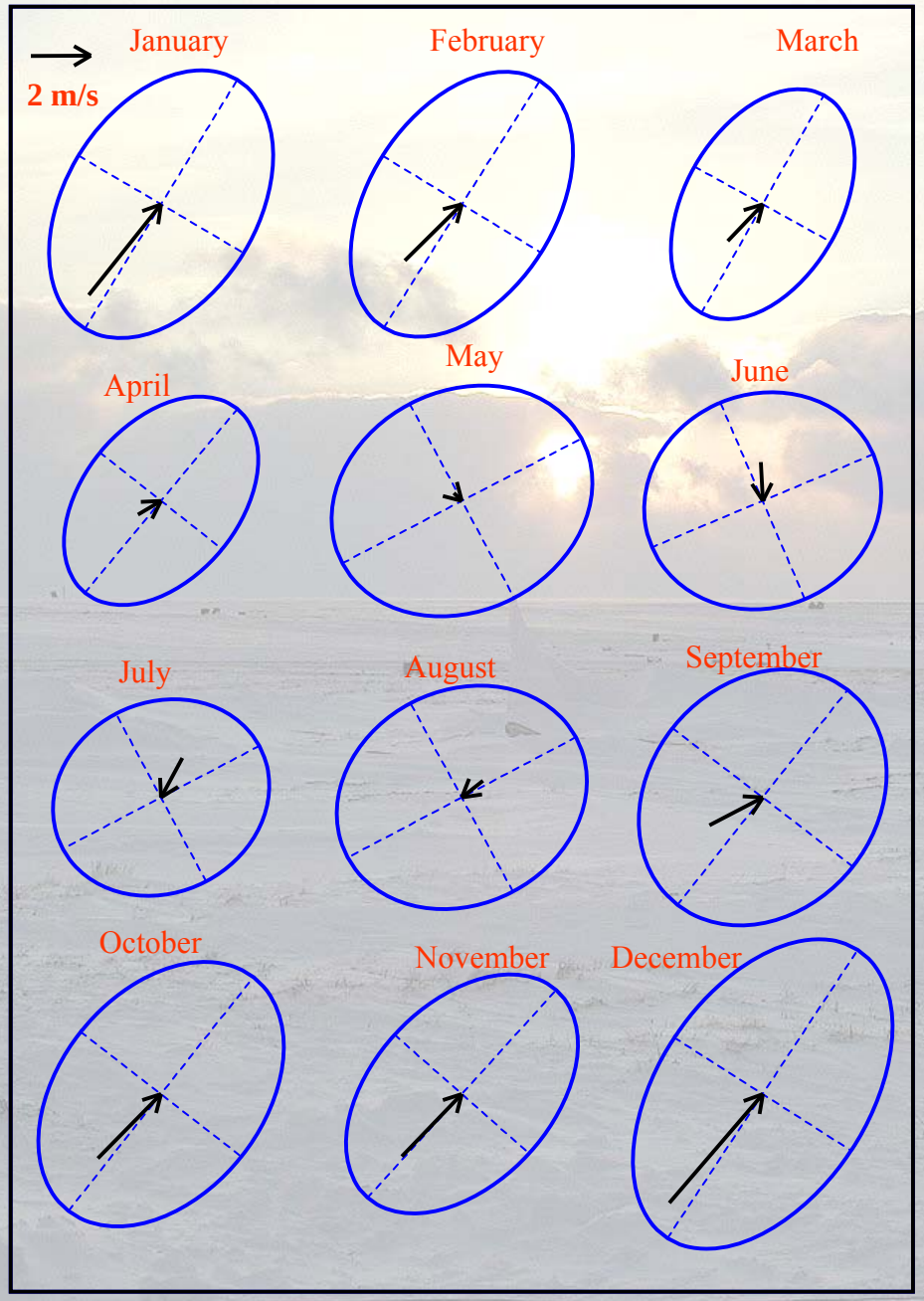
Maximal velocity in winter 40 m/s

Maximal velocity in spring 23 m/s

Maximal velocity in summer 25 m/s

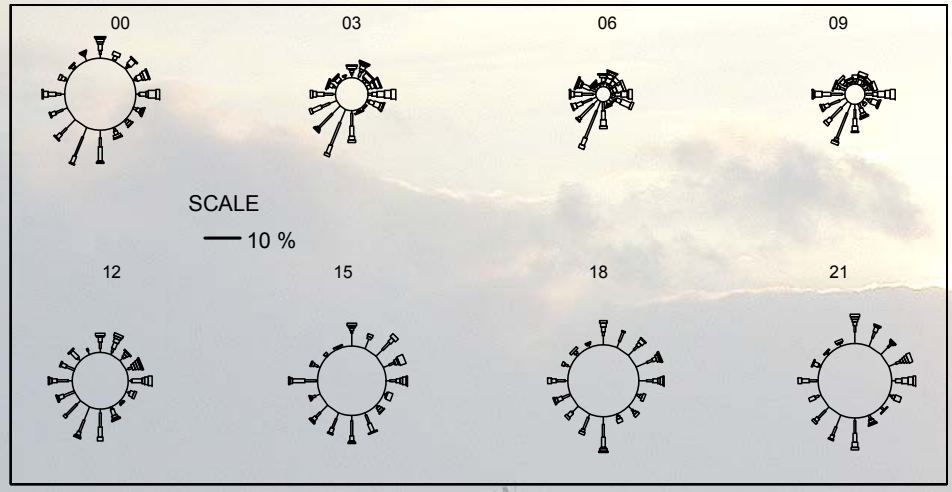
Maximal velocity in autumn 40 m/s

Vector of mean wind velocity and MSD ellipse

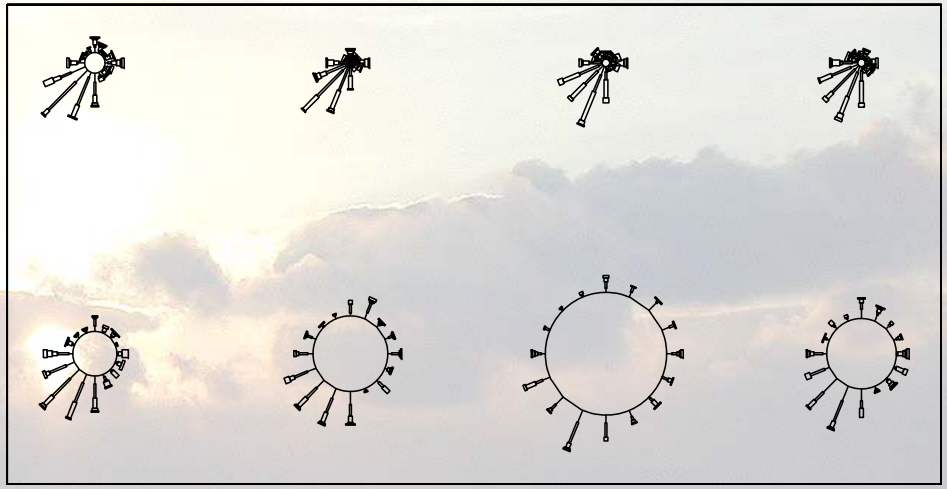


Diurnal variations of wind velocity in Tiksi during summer

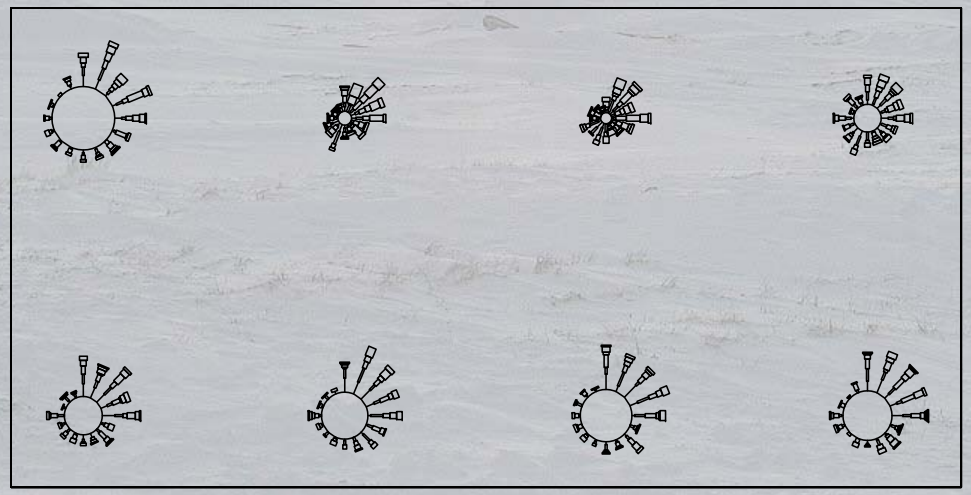
May



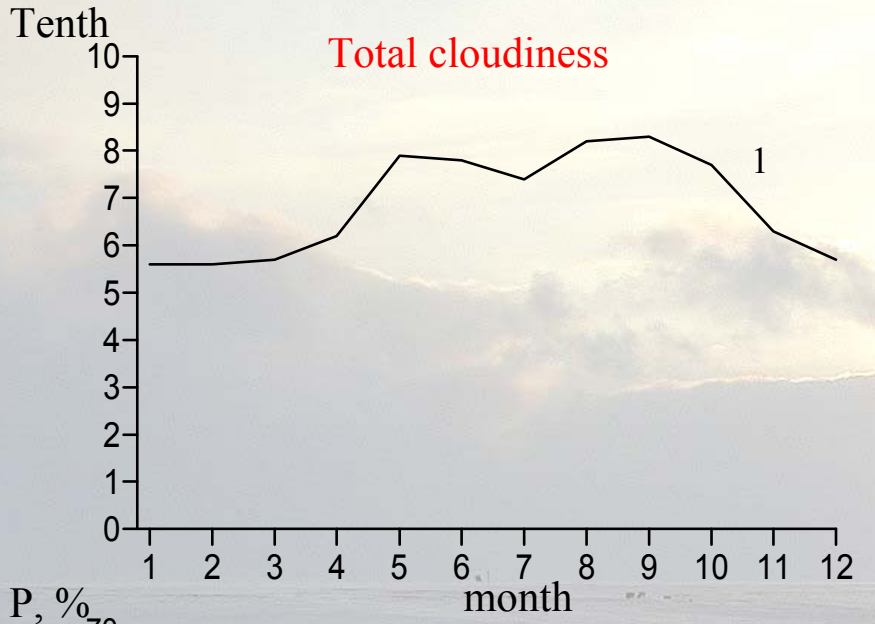
July

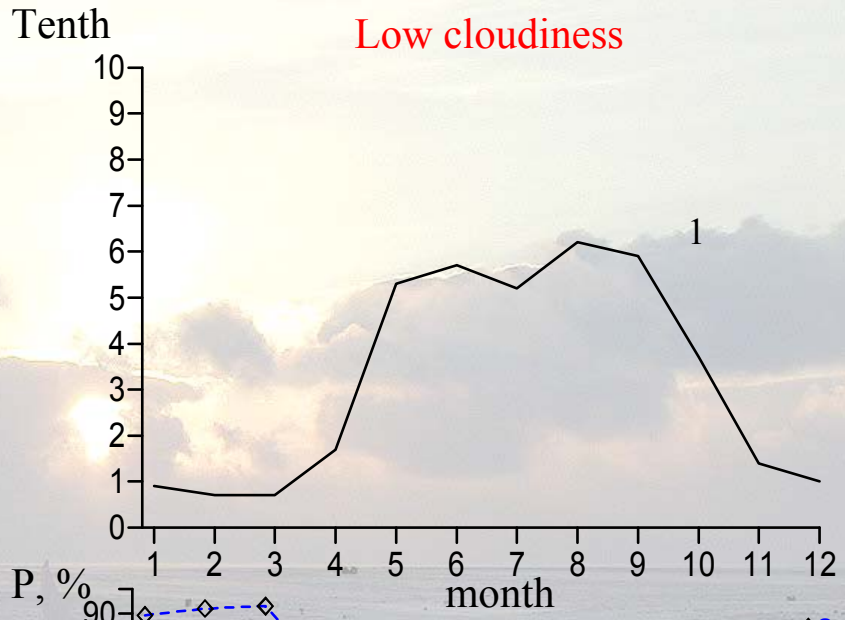


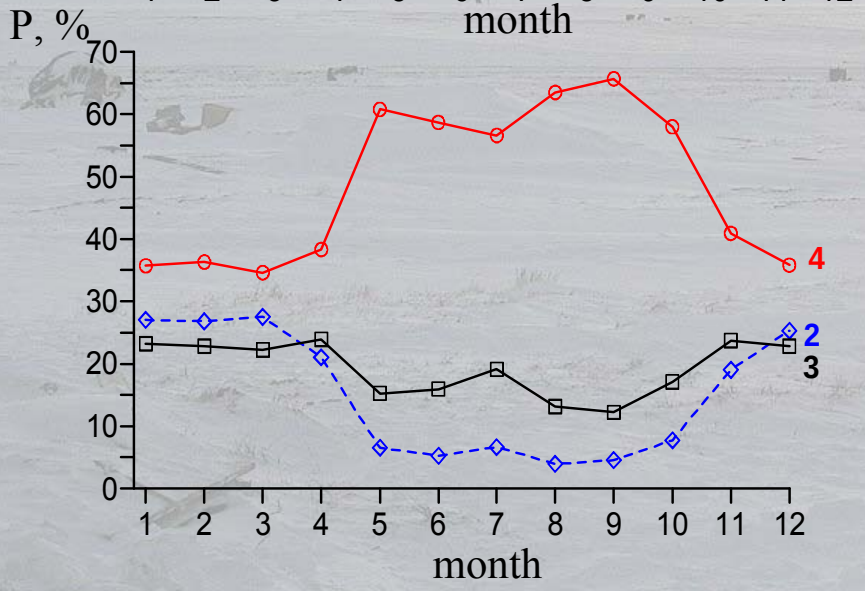
August

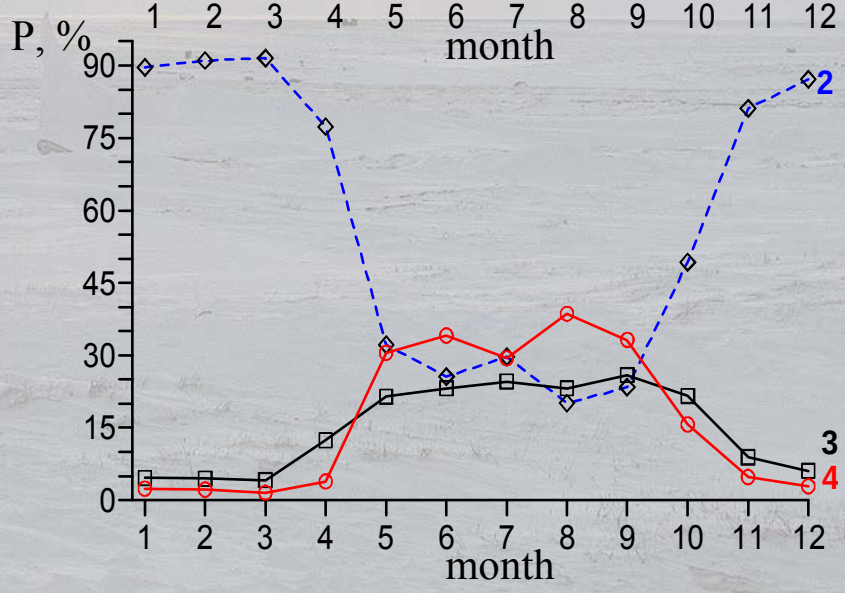


Seasonal variability of multi-year averaged characteristics of cloudiness





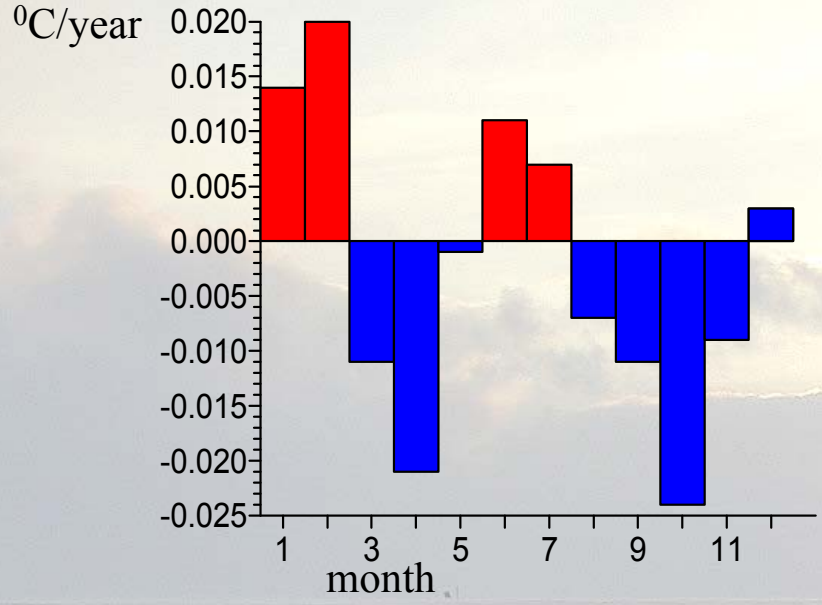


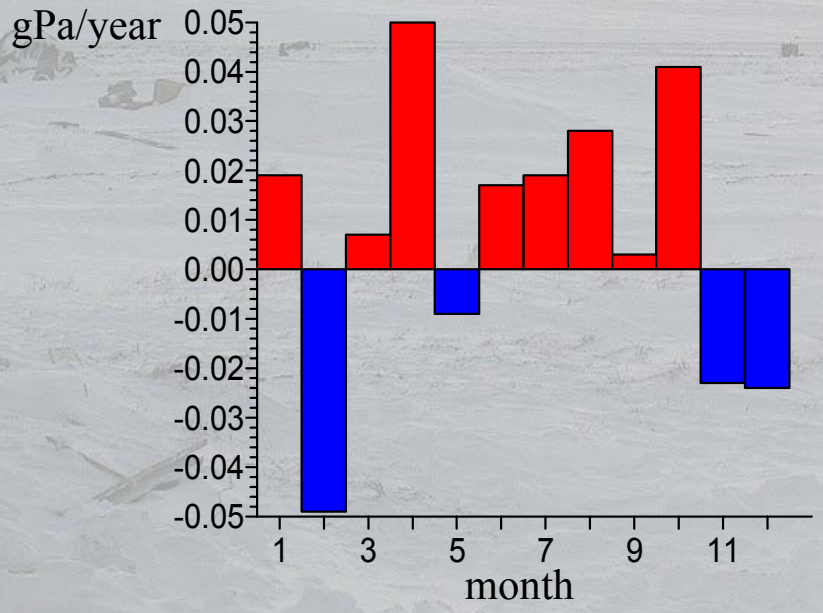


1 – cloudiness, 2 – occurrence 0-3 tenths, 3 –occurrence 4-7 tenths, 4 –occurrence 8-10 tenths

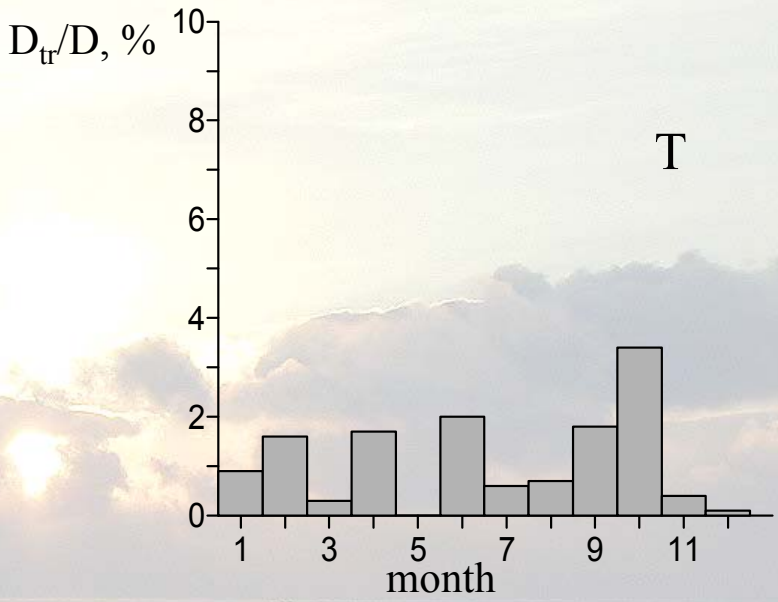
Climate variability of future Tiksi observatory area

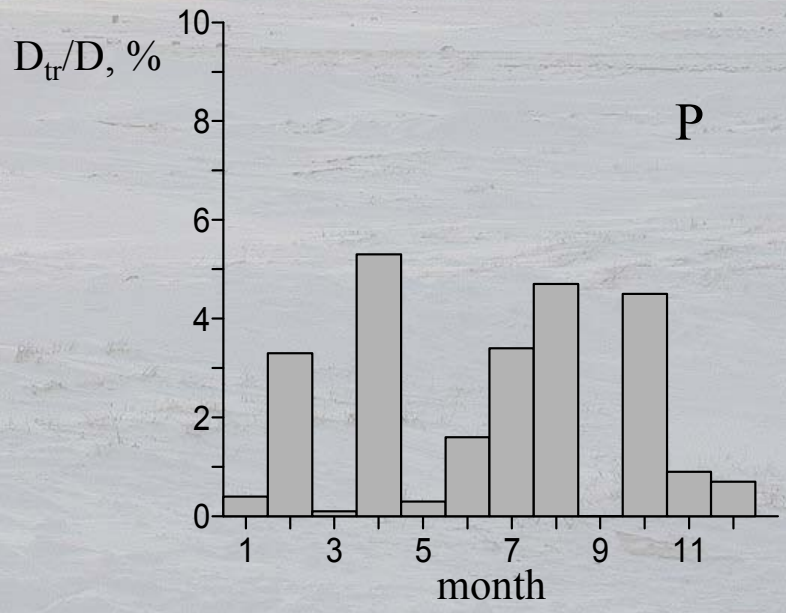
Monthly mean air surface temperature and surface pressure trends



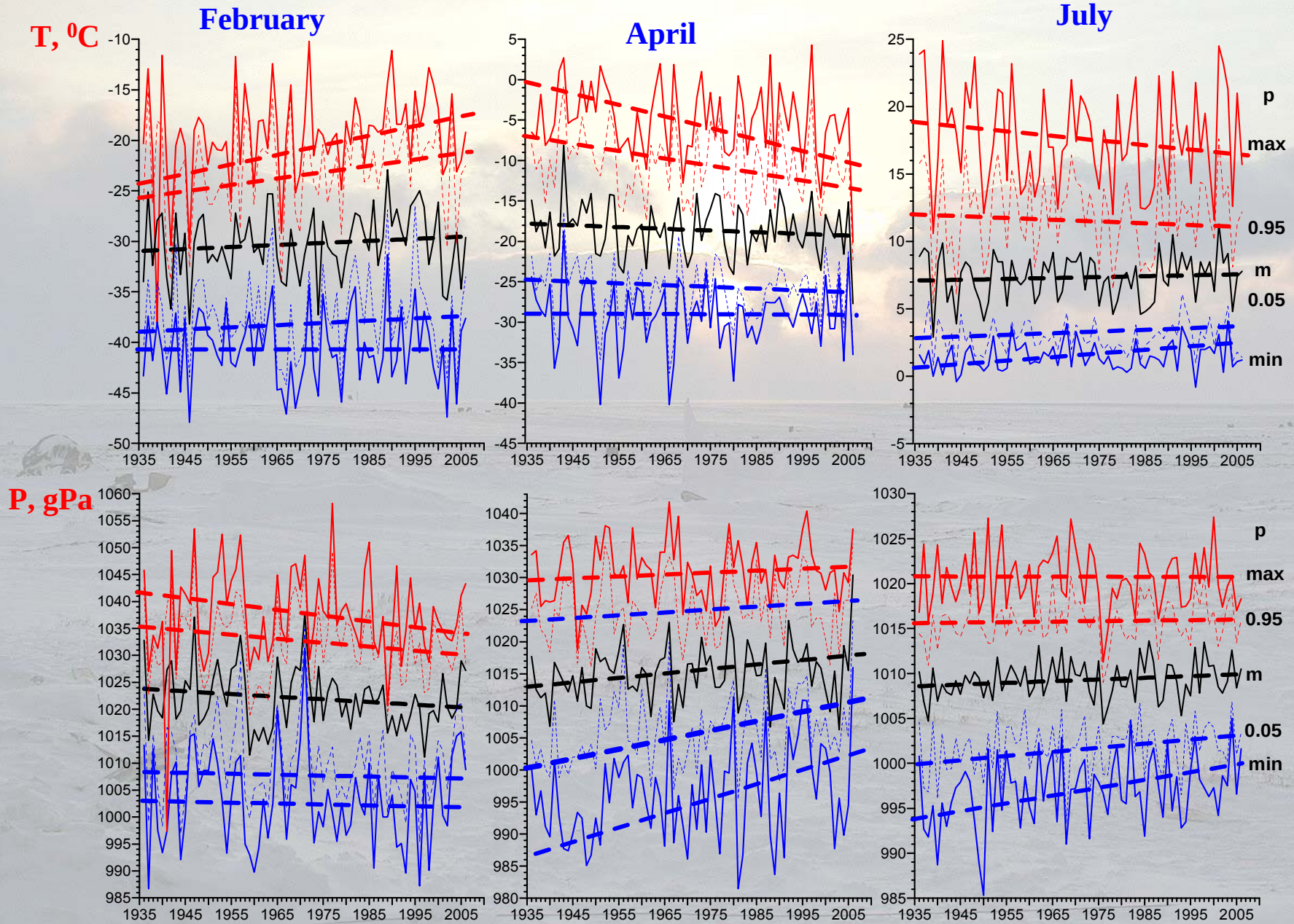


Contribution of trends to MSD

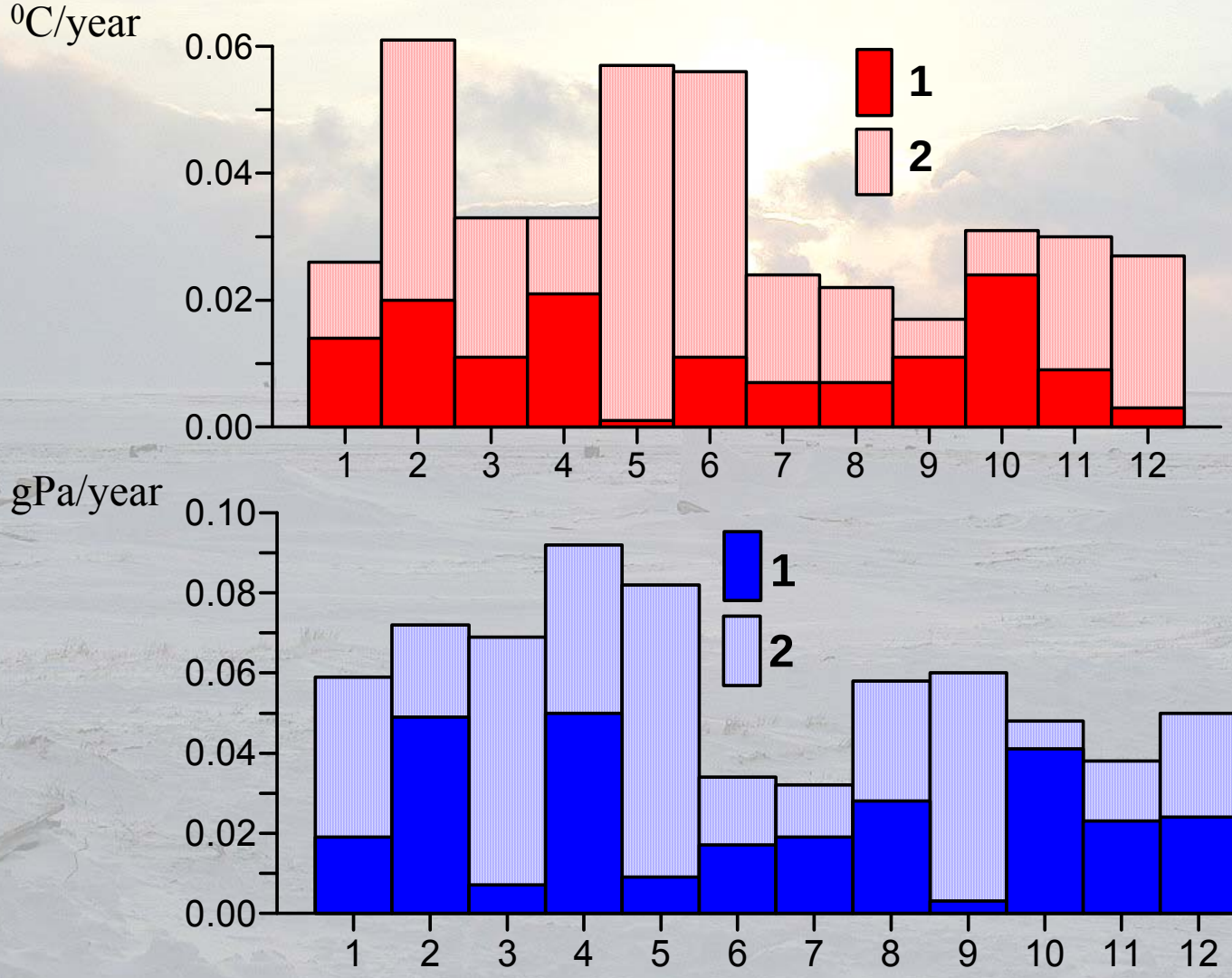




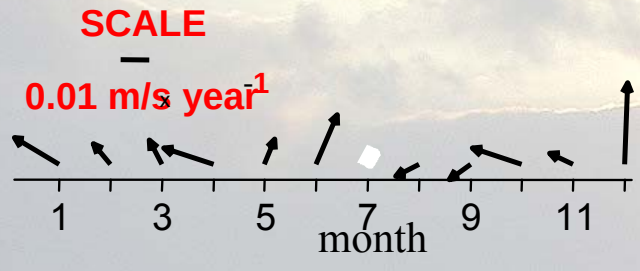
Trends of monthly mean quantile values of air surface temperature and surface pressure

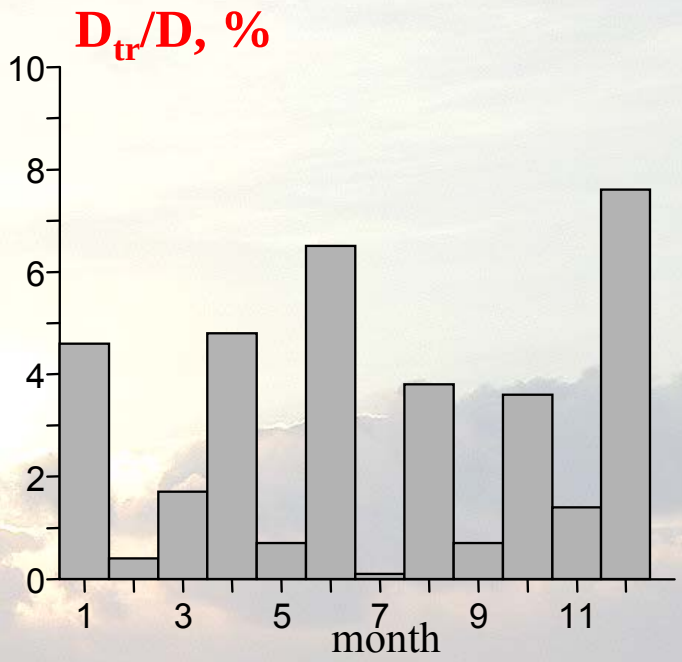


Annual variations of monthly mean absolute values of air surface temperature and pressure trends (1) and corresponding trends of ranges of deviation (2)



Monthly mean wind trends and its relative input to MSD

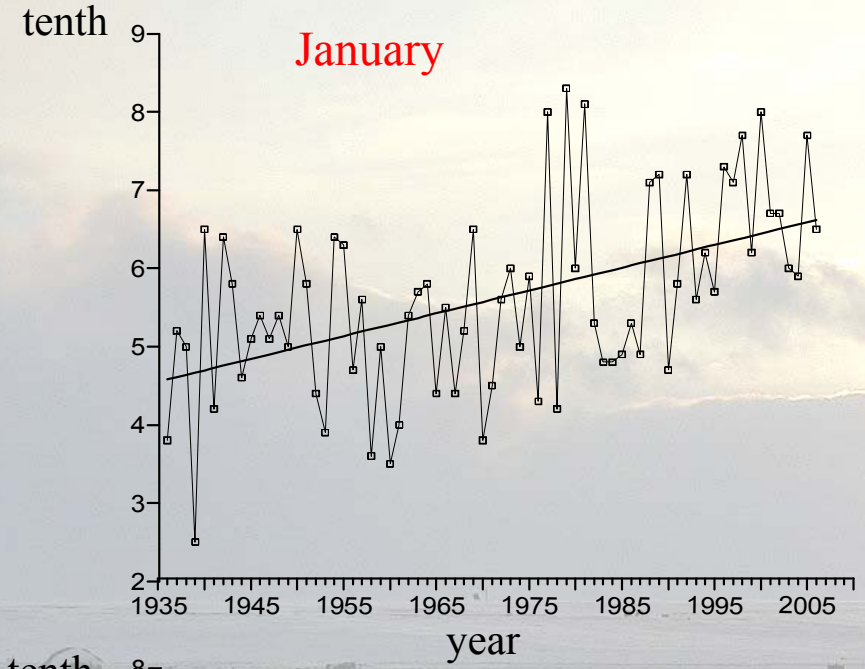


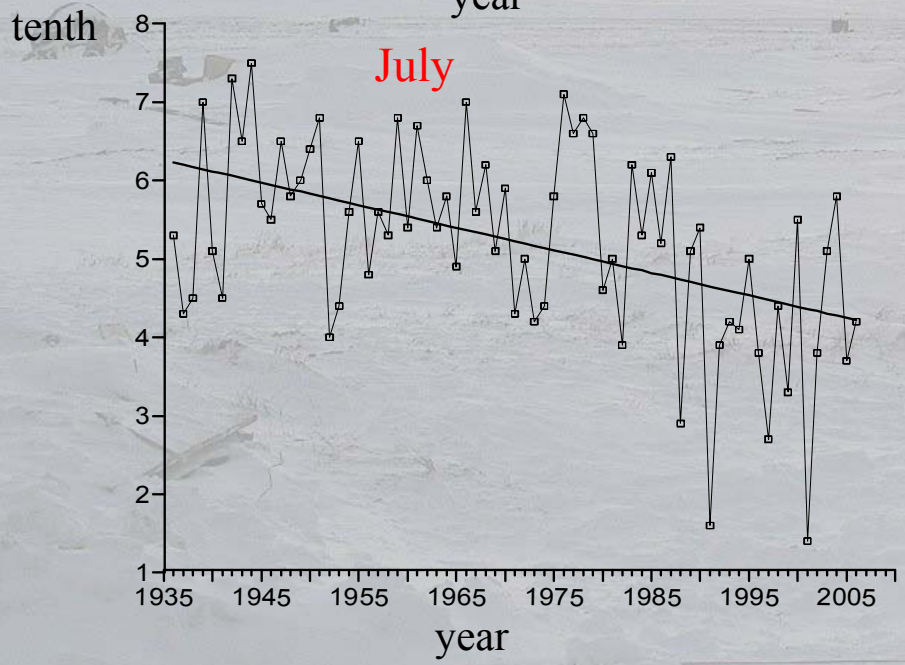


Trends of wind occurrence by direction and velocity in April(%/year)

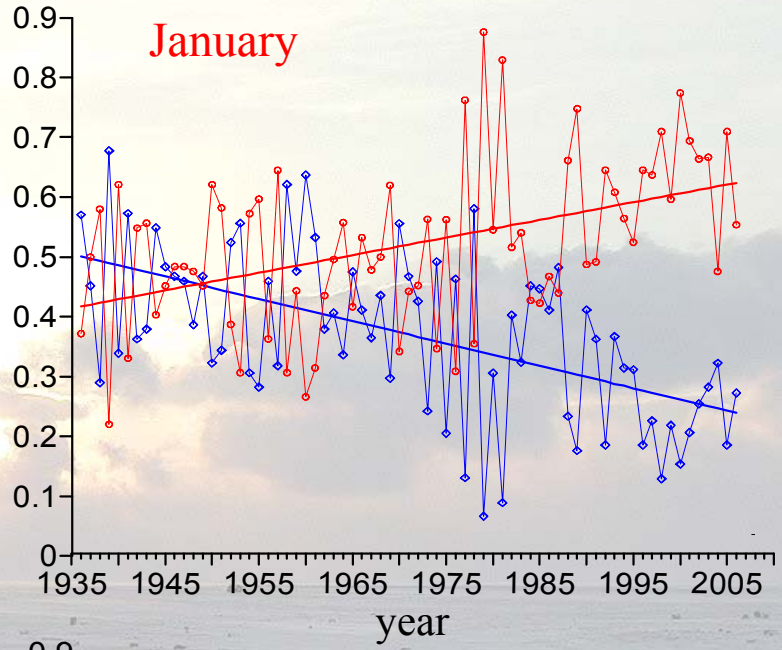
Direction	Calm	1-10 m/s	11-20 m/s	> 20 m/s	All	Mean velocity
North		0.12	-0.01	-		-0.02
East		0.02	-	-	0.02	-0.02
South		0.25	0.02	0.05	0.27	-0.03
West		-0.08	-0.12	-0.07	-0.20	-0.05
All directions	-0.20	0.31	-0.11	-0.03		

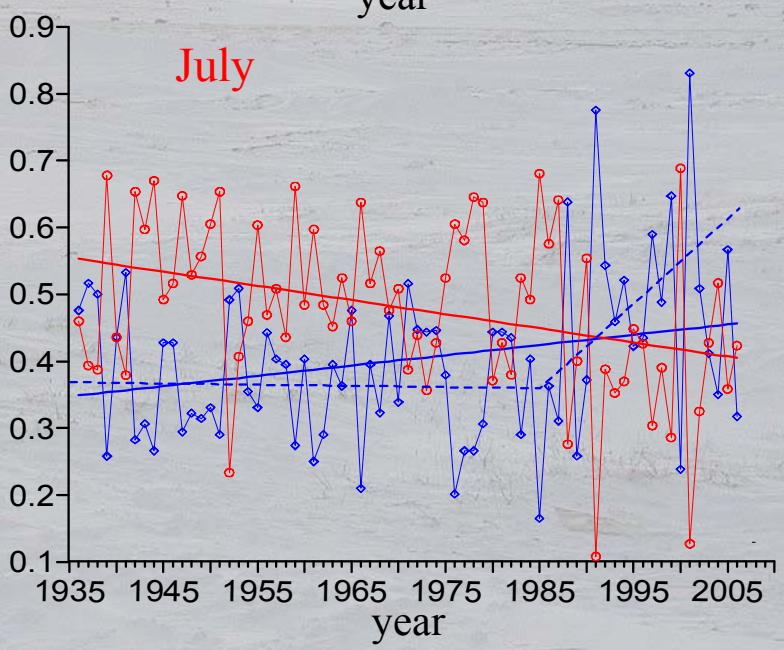
Interannual variability of total cloudiness



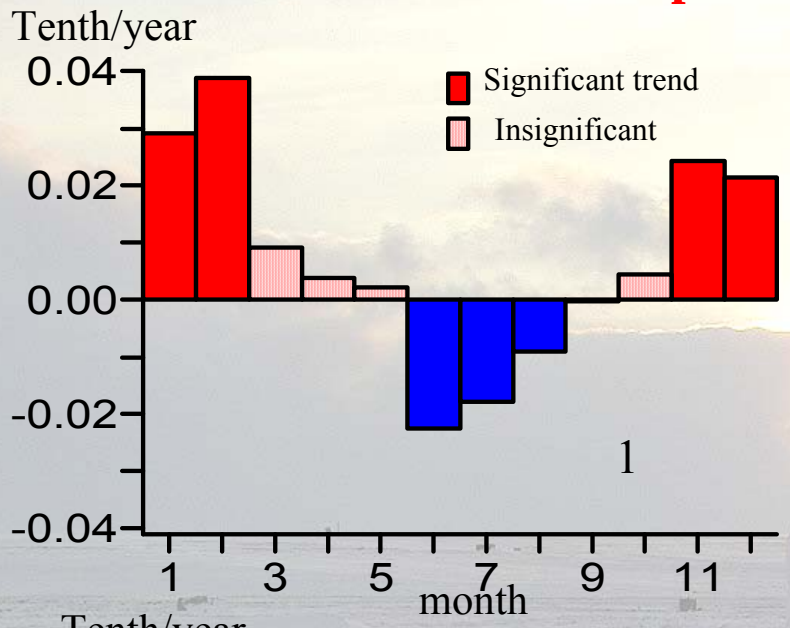


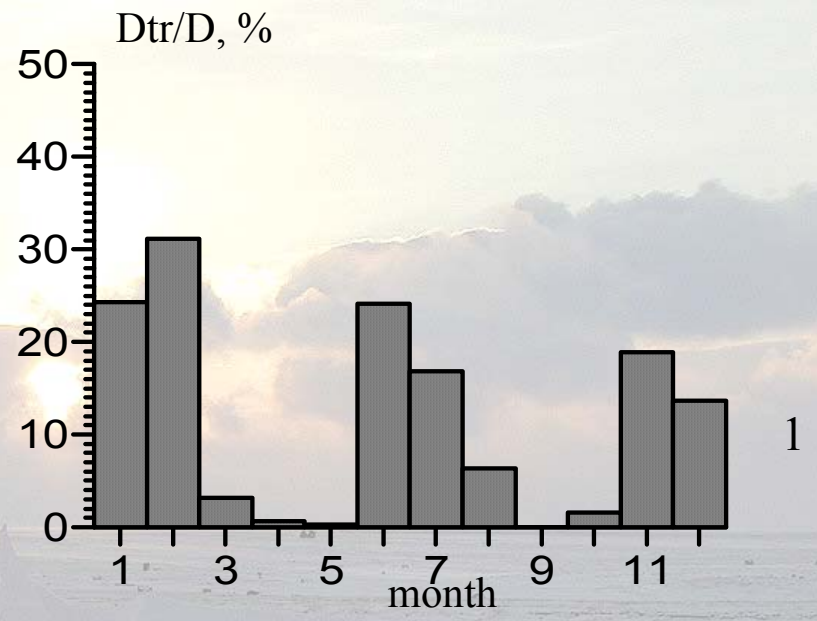
Relative occurrence of clear sky (blue) and overcast (red)

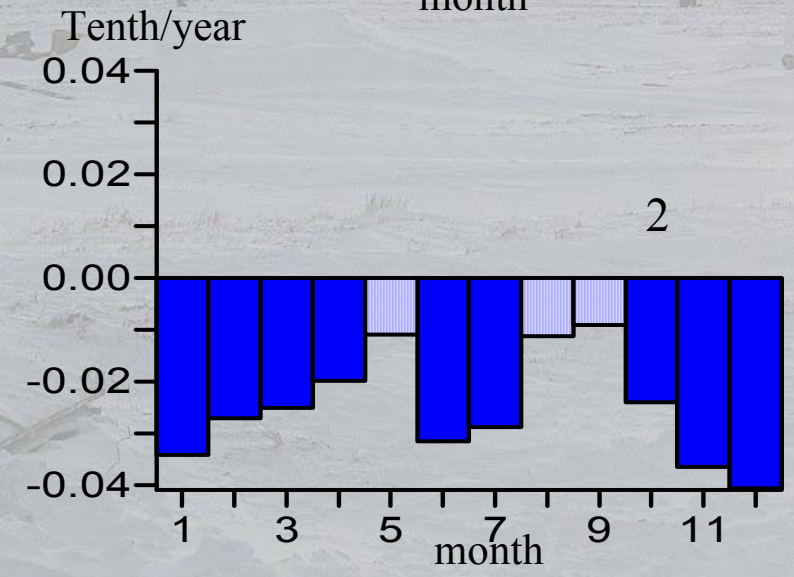


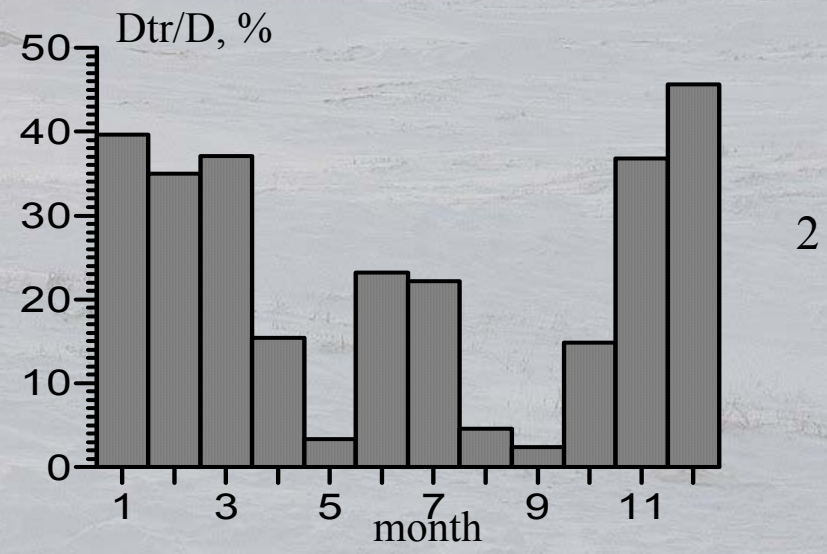


Trend coefficients of total (1) and low (2) cloudiness amount, and its relative input to MSD

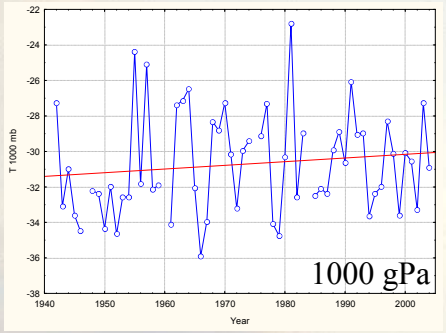


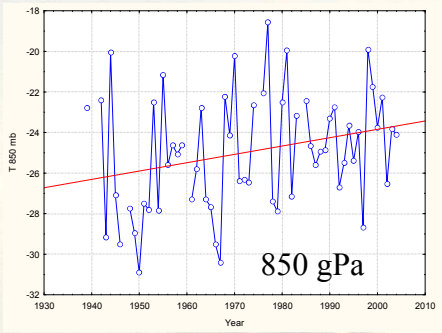


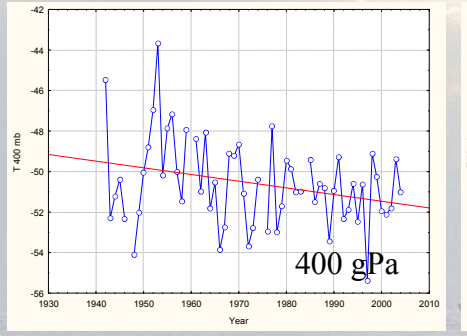


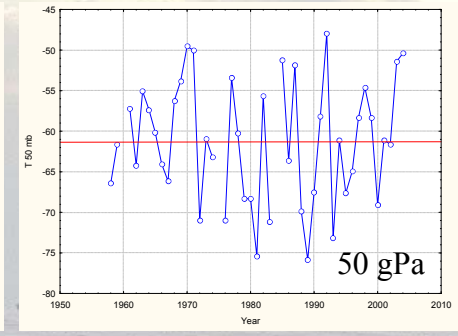


Climate of free atmosphere in Tiksi





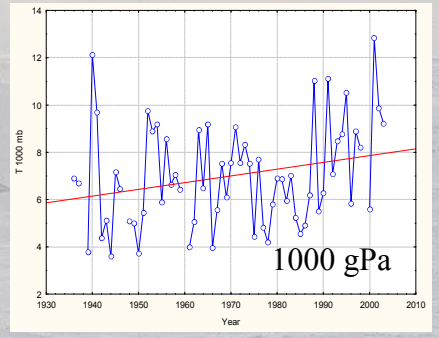


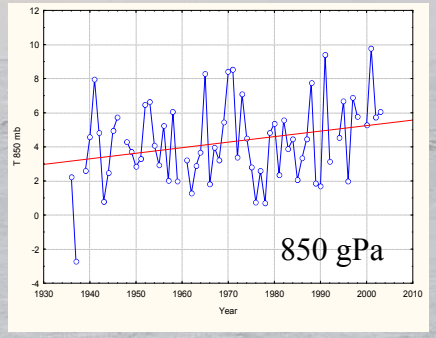


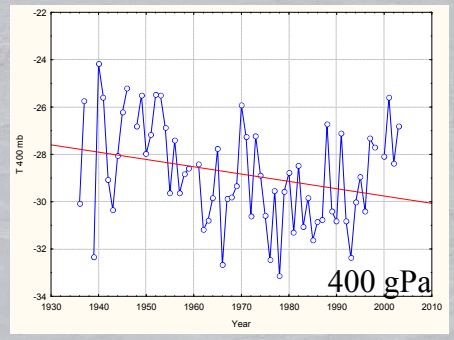
January

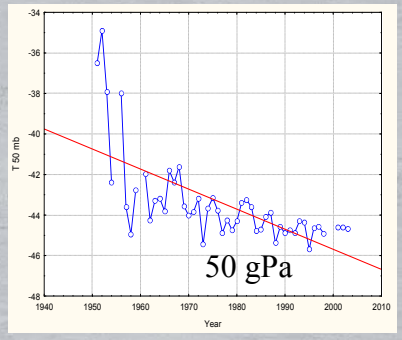
The strong warming in low troposphere and cooling in upper troposphere and low stratosphere, especially during summer, is one of the main peculiarities of climate of free atmosphere in the Tiksi region

July

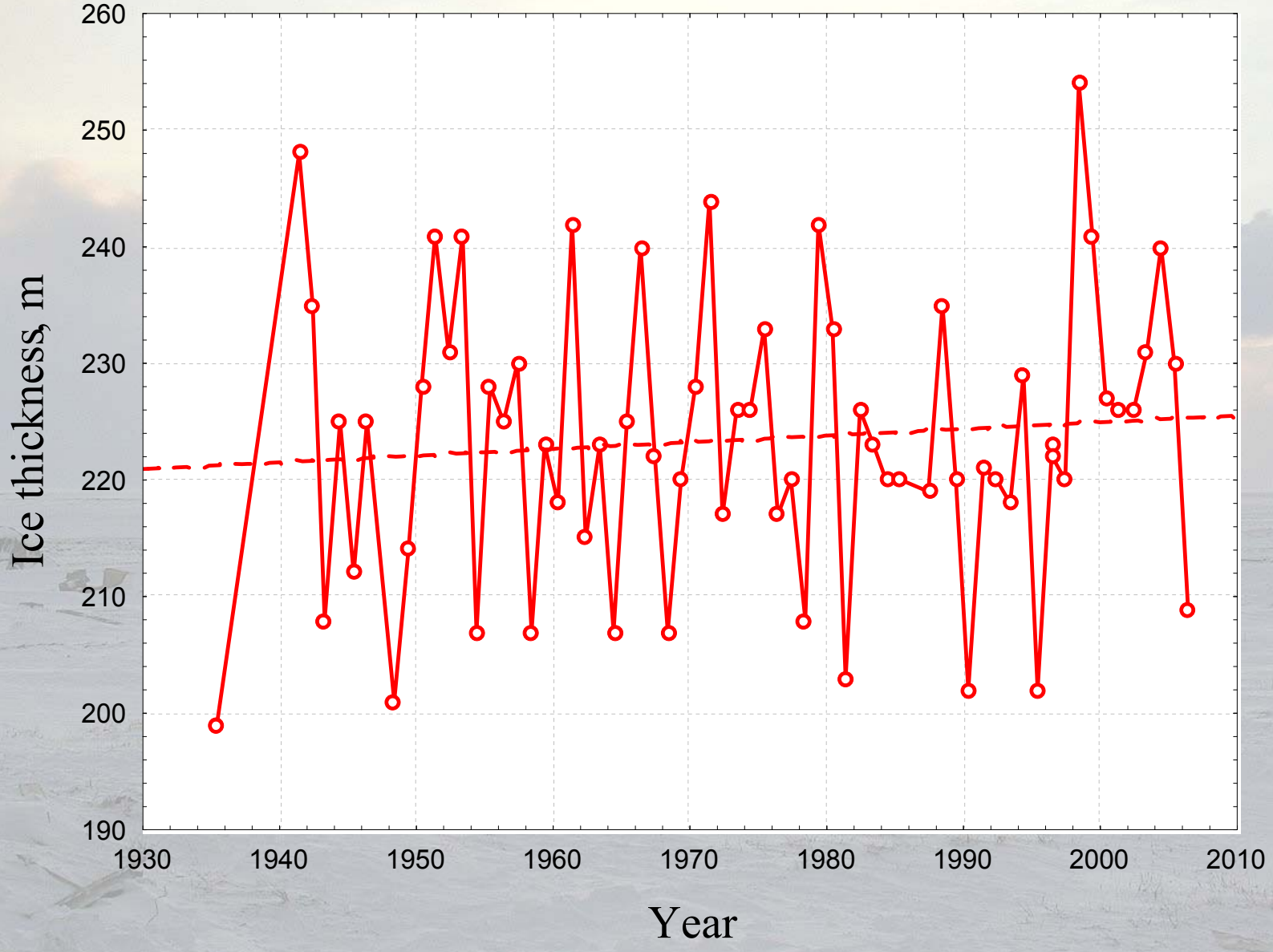




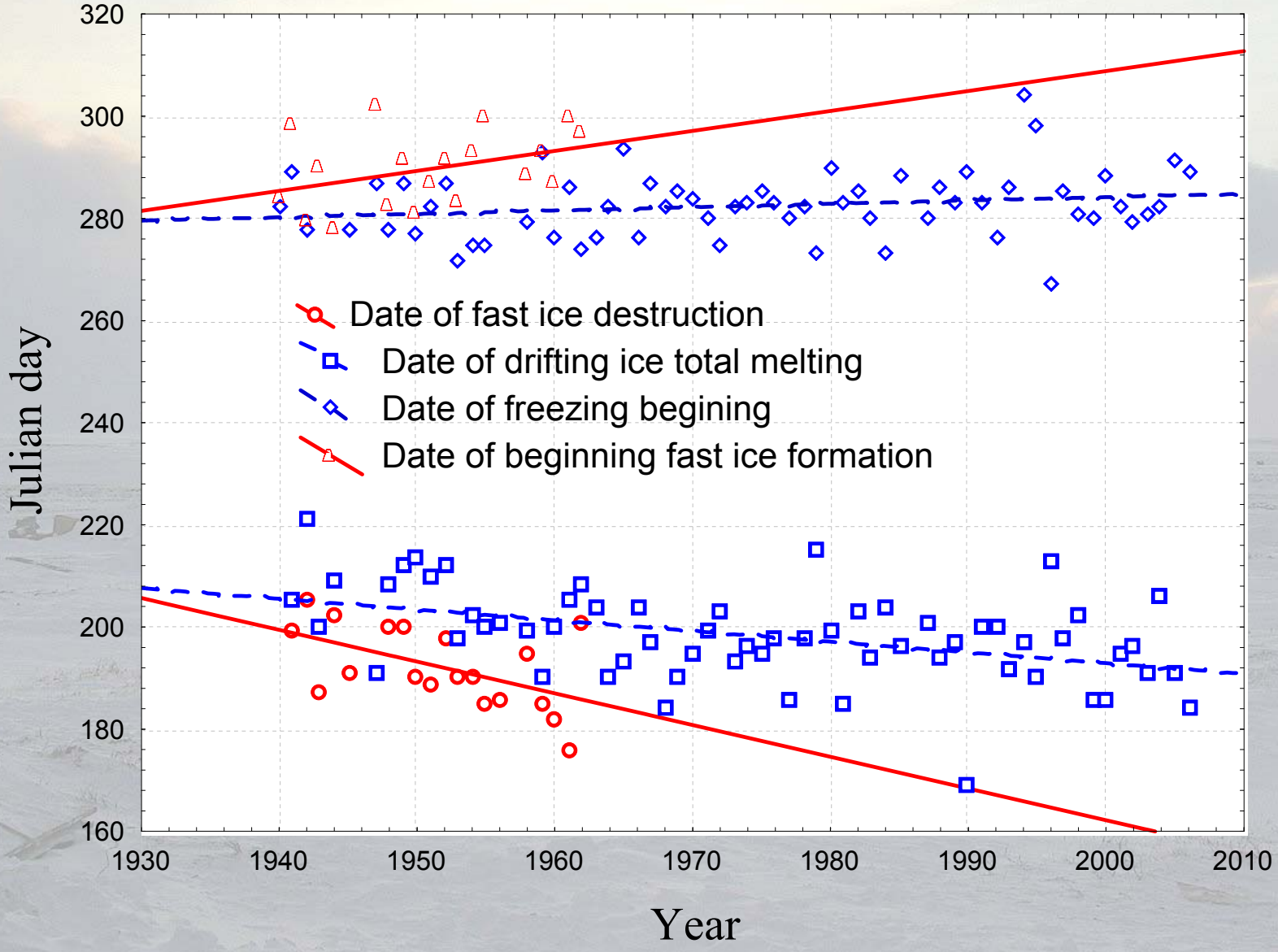




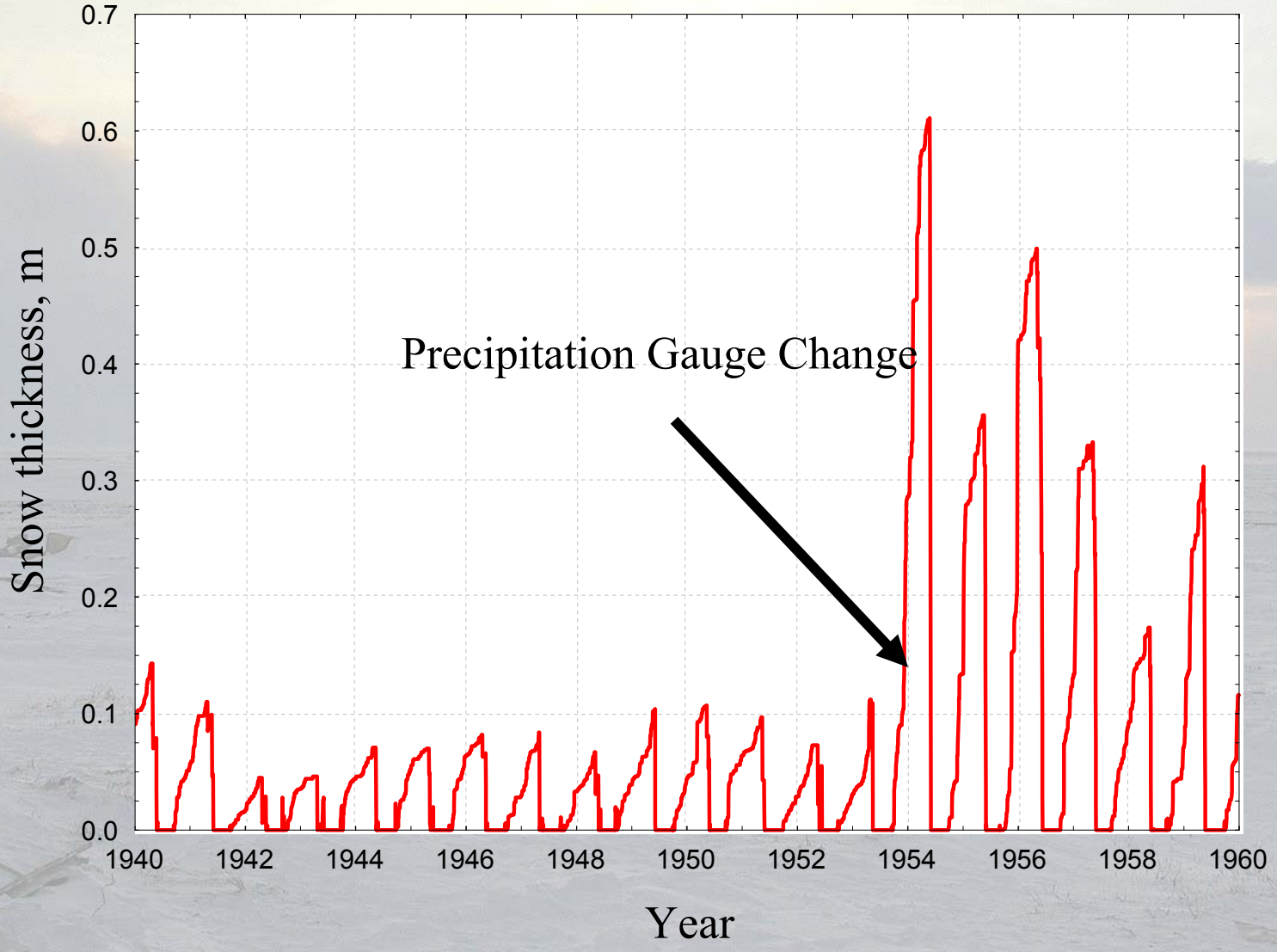
Interannual variability of maximal fast ice thickness



Interannual variability of data of fast and drifting ice formation and destruction



Snow thickness calculated with data about snow precipitation



SUMMARY

A digital archive has been created of the historical Tiksi station data (1934 to present)

Quantile analysis suggests that the influences of synoptic systems on temperature trends is significant

Wind analysis reveals increased southerly winds in Fall, Winter and Spring

Strong trends in cloudiness (increasing in winter and decreasing in summer) have been detected. It could be the reason for positive trends of surface air temperature during these seasons

Sea ice cover in the adjacent Sogo Bay shows significant increase in the length of the ice-free season but also some increases in the fast ice seasonal maximum thickness

These historical data suggest a number of collaborating mechanisms that are contributing to net increases in temperature

The historical data provides guidance for detailed process studies and measurement requirements at the new Observatory

Future plans

- **To prepare Archive of daily mean meteorological data beginning 1909 for polar stations Kazachiya and Kusur, located close to Tiksi**

- **To deploy modernized meteorological and radiosounding stations**

- **To organize observations in frame of the Climate Reference Network (CNR)**

- **To develop procedure of intercomparison and during two years to execute in Tiksi parallel measurements with old and modern meteorological instruments**