Meteorological conditions in the Arctic Ocean in spring and summer 2007 as recorded on the drifting ice station Tara

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Introduction

Meteorological, oceanographic and sea ice measurements were made at the drifting ice station Tara in 2006-2007. Except for automatic buoy measurements and shorter ship cruises, the Tara expedition yielded the only in situ meteorological observations from the central Arctic in spring and summer 2007, in the period preceding the record low sea ice cover. This poster presents the Tara meteorological observations from late March through September 2007. Attention is paid to the air temperature, humidity, wind speed, as well as the shortwave and longwave radiation. These are compared against observations at SHEBA in 1998 and the Russian "North Pole" (NP) drifting stations in 1937-1938 and 1950-1991.

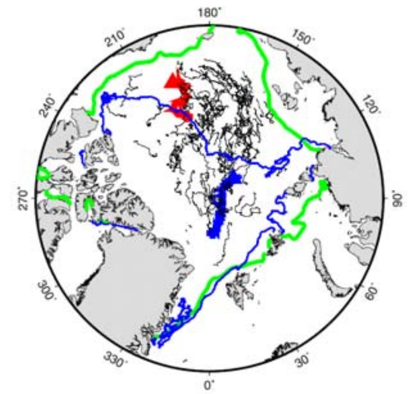

Figure 1. The drift trajectories of Tara (blue), SHEBA (red), and the Russian drifting stations (black) for the period of 23 March –19 September. The triangles mark the beginning and the crosses the end of the Tara and SHEBA trajectories. The sea ice edge on 17 September 2007 is shown as a thin blue line, and the mean September sea ice edge in 1979–1983 as a green line.

Field Observations

The Tara drift started on 3 September 2006. Some meteorological measurements were made from September 2006 to April 2007. The continuous measurements, carried out by TP and EJ, started on 23 March – 2 April and ended on 19 September 2007. We will only address data from this period. The drift trajectories of Tara, SHEBA and the NP stations are presented in Figure 1. The air temperature and wind speed were measured at a 10-m-high weather mast (Aanderaa AWS 2700) at the heights of 1, 2, 5 and 10 m, the air relative humidity at 2 m and wind direction at 10 m. The upward and downward shortwave radiation was measured by a pair of Eppley PSP pyranometers, and the upward and downward longwave radiation by a pair of Eppley PIR pyrgeometers. A Vaisala DigiCORA Tethersonde System was used to measure the vertical profiles of the air temperature, relative humidity, wind speed, and wind direction up to the height of 2 km; the average top height of the soundings was 1240 m. In the period from 25 April to 31 August (129 days), there were 39 sounding days with a total of 95 soundings. Soundings could only be made under wind speeds lower than 15 m/s.

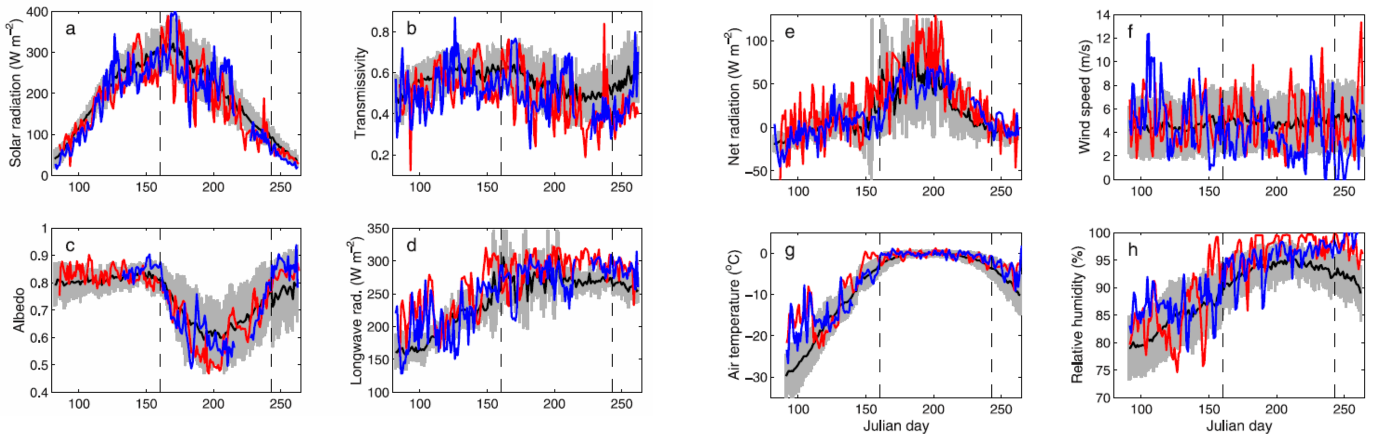

Figure 2. Time series of diurnal means of meteorological observations at Tara in 2007 (blue), at SHEBA in 1998 (red), and at the Russian drifting stations (mean values; black). The standard deviation of the Russian station data (originating from spatial and inter-annual variations) is marked by grey error bars for each day. The dashed vertical lines separate the spring, summer (9 June – 31 August), and fall.

Meteorological Conditions at Tara Compared to SHEBA and the NP Stations

In Figure 2, the diurnal means for the NP stations are averaged over the 31 stations (15 for the radiative fluxes). The high values of downward solar radiation (Figure 2a) at the NP stations in March–April and August–September are related to the high atmospheric transmissivity for shortwave radiation (the ratio of the surface to TOA solar radiation; Figure 2b). This suggests a lower cloud fraction or optically thinner clouds at the NP stations compared to Tara and SHEBA. Albedo differences between the stations were not statistically significant (Figure 2c). Figure 2d suggest largest downward longwave radiation at SHEBA, second largest at Tara, and smallest at the NP stations, but due to the measurement inaccuracies, we cannot conclude on an increase in the downward longwave radiation.

The seasonal evolution of net radiation (Figure 2e) was qualitatively similar at Tara, SHEBA, and the NP stations. The seasonal evolution of the 10-m wind speed differred between the stations (Figure 2f). The Tara drift was approximately three times faster than that of Nansen's Fram. Although the wind speeds were low, we found that the tailwind component favored fast drift. On the basis of the ECMWF operational analysis, during years 1998–2007 in April–September the tailwind component along the Tara trajectory has been stronger only in 2005.
April was 7.0 K warmer at Tara than at the NP stations on average, but in July the mean 2-m air temperature was 0.2°C both at Tara and the NP stations (Figure 2g). In all stations, the date when the relative humidity first exceeds 93–95% coincides with the air temperature reaching 0°C (Figure 2h).

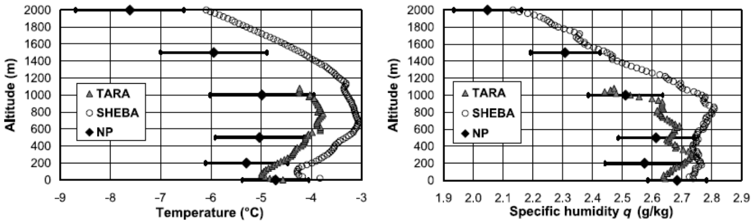

Figure 3. Mean vertical profiles of the air temperature and specific humidity in the period from 25 April to 31 August as observed at Tara in 2007, at SHEBA in 1998, and at the NP stations in 1954–1985. The error bars denote the standard deviation of the NP station data.

The mean vertical profiles based on tethersonde measurements showed a temperature inversion at all stations (Figure 3). It had its base height at 70 m at Tara and 100 m at SHEBA, while the coarse vertical resolution prevents conclusions on the NP data. The inversion top was at 600–800 m both at Tara and SHEBA. At SHEBA, also the mean profile of the specific humidity included a weak inversion with the highest values measured at the height of 840 m. Throughout the lowermost 2 km the highest temperature and specific humidity were observed at SHEBA. This is related to the southernmost location of SHEBA. Throughout the lowermost 1 km the lowest temperatures were observed at the NP stations, although the mean latitude of Tara was higher. The specific humidity at Tara and the NP stations was on average close to each other, but the shape of the profile was different in the lowermost 300–400 m.

Conclusions

Comparisons of the Tara data with observations at the Russian drifting ice stations in 1937–1938 and 1950–1991 and at SHEBA in 1998 indicated that at Tara and SHEBA the atmospheric transmissivity for shortwave radiation was smaller than at the Russian stations, suggesting a higher cloud fraction or optical thickness. Compared to the mean conditions at the Russian stations, at Tara the melting season was twice as long and in April the 2-m air temperature was 7.0°C higher, but in July the 2-m temperature difference disappeared. The Tara tethersonde sounding data suggest that the air temperature at the altitudes of 200–1000 m was approximately 1°C higher than the mean of 1954–1985.

Reference: Vihma, T., J. Jaagus, E. Jakobson, and T. Palo (2008), Meteorological conditions in the Arctic Ocean in spring and summer 2007 as recorded on the drifting ice station Tara, Geophys. Res. Lett., 35, L18706,doi:10.1029/2008GL034681.