Oceanologia (2018) xxx, xxx—xxx

Available online at www.sciencedirect.com

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journal homepage: www.journals.elsevier.com/oceanologia/

ORIGINAL RESEARCH ARTICLE

Climate-related trends and meteorological conditions in the Porsanger fjord, Norway

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Received 25 July 2017; accepted 22 January 2018

KEYWORDS
Arctic;
Norwegian fjord;
Marine meteorology;
Climate change;
Seasonal variability

Summary Climate-related trends and meteorological conditions in the Porsanger fjord, in the vicinity of the Barents Sea, have been analyzed. Meteorological data include wind speed and direction, air temperature (AT) and precipitation from Era-Interim reanalysis (1986—2015) as well as local observations (2006—2015) from Honningsvaag and Lakselv. Statistically significant trends in annual AT means are 0.0485°C year^{-1} near the fjord mouth and 0.0416°C year^{-1} near the fjord head. Wind speed and precipitation data do not reveal any definite trends. Statistical analysis confirms the significant spatial variability of meteorological conditions in the fjord. For example, there are large differences in the annual AT cycle, with respective monthly means for January and July of −8.4 and 12.6°C at Lakselv (fjord head) and −2.5 and 10.1°C at Honningsvaag (fjord mouth). Strong wind events (>12 m s^{-1}) are more frequent at Honningsvaag than at Lakselv. The annual cycle is characterized by stronger winds in winter and seasonality of wind direction. At Lakselv, the dominant wind directions in summer are: N, NNW and S and in winter: S and SSE. At Honningsvaag, the wind directions in summer present strong variability, no fixed pattern being pronounced, whilst the dominant sectors in winter are: S and SSW. Daily cycles in AT and wind speed are also observed. Precipitation at a given location can change by about 30% year-on-year and varies spatially. Estimates of terrigenous water discharge (derived from the E-HYPE model) reveal a seasonal cycle with the maximum discharge in late spring/early summer.

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Peer review under the responsibility of Institute of Oceanology of the Polish Academy of Sciences.

ELSEVIER Production and hosting by Elsevier

https://doi.org/10.1016/j.oceano.2018.01.003

Please cite this article in press as: Cieszyńska, A., Stramska, M., Climate-related trends and meteorological conditions in the Porsanger fjord, Norway. Oceanologia (2018), https://doi.org/10.1016/j.oceano.2018.01.003

1. Introduction

The Arctic is playing a key role in global climate change. An earlier analysis has shown that positive linkage to global warming will dominate in the Arctic for the next 50—100 years (McGuire et al., 2006). The Barents Sea (BS) is a region of great importance for climate change in the Arctic because it lies on the main heat transport pathway in the Equator—Poleward direction (Ådlandsvik and Loeng, 1991; Piechura et al., 2001; Schauer et al., 2002; Smedsrud et al., 2010, 2013). Surface inflows of Atlantic water into the Barents Sea have warmed during the last 30 years by about 0.3°C (Levitus et al., 2009). Russian scientists have documented positive Atlantic Water temperature anomalies (advected through BS) during 2000—2009 with temperatures warmer by 0.5—1.2°C than the mean value based on data from 1951 to 2000 (Boitsov et al., 2012). Moreover, model results point to the significance of sea ice and atmospheric fields in the Barents Sea as possible climate change amplifiers (Goosse and Holland, 2005; Semenov et al., 2009). Rising air and water temperatures are intimately associated with the continuously diminishing sea ice cover (Döscher et al., 2014). The linear trend in ice extent in the Arctic has been estimated at $-4 \pm 0.2\%$ decade^{-1} for 1978—2010, and $-8.3 \pm 0.6\%$ decade^{-1} for 1996—2010 (Comiso, 2012). Since 1996 the Arctic sea ice cover has thus diminished about twice as rapidly as the global rate during 1978—2010. According to Årthun et al. (2012), sea ice reduction in the Barents Sea has been even more significant (about 50% between 1998 and 2008) and has occurred concurrently with the increase in Atlantic heat transport due to both strengthening and warming of the water inflow. Observation-based heat budget calculations (Årthun et al., 2012) show that the heat content, ocean-atmosphere heat fluxes and sea ice cover in the Barents Sea respond to increased heat transport from the Norwegian Sea on a monthly to annual timescale. Another quantity useful in climate change studies is the sea surface temperature (SST). On the basis of the 32-year (1982—2013) National Oceanic and Atmospheric Administration (NOAA) data set, it has been shown that the regionally averaged SST trend in the BS (about 0.03°C year^{-1}) is greater than the global trend. This trend is different at different locations, the highest values (about 0.06°C year^{-1}) being recorded off Svalbard and in coastal regions of the White Sea (Jakowczyk and Stramska, 2014). Trends in coastal regions have not been adequately described, however, even if such regions are of special interest because of increased human activity and important land-ocean interactions.

The present study focuses on one of the largest fjords in Norway, the Porsanger fjord (Fig. 1), which lies in the north of the country, in the coastal zone of the Barents Sea. The main objective was to investigate recent climate-related trends

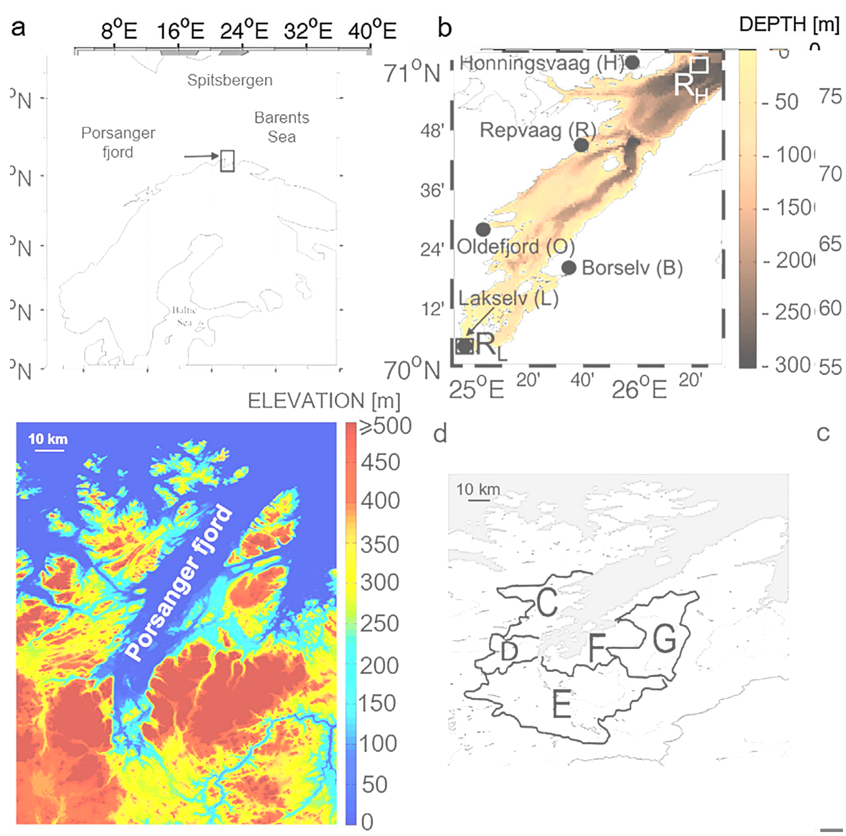

Figure 1 (a) Position of the Porsanger fjord in northern Europe; (b) the fjord's bathymetry showing the Norwegian Meteorological Institute's stations (black dots) and pixels, where data from the Era-Interim reanalysis were extracted (the white square at the fjord mouth — R_H and the black square at the fjord head — R_L); (c) terrain elevation based on the U.S. Geological Survey data (USGS — lta.cr.usgs.gov/GMTED2010); (d) catchment areas (denoted from C to G), where water runoff was estimated using the E-HYPE model data (Swedish Meteorological and Hydrographical Institute, http://hypeweb.smhi.se/europehype/time-series/).

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