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Climatological estimates of precipitation and evaporation over the Baltic Proper based on COADS

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Introduction

Weather observations and measurements made aboard of voluntary observing ships (VOS) have frequently been used to estimate water and energy budgets over the global ocean or parts of the latter. For climatological investigation of these budgets on time scales of decades up to a century VOS reports are the only area-covering source of information from the open ocean. A portion of the COADS data set (Comprehensive Ocean-Atmosphere Data Set, see Woodruff et al., 1987) covering the time period 1964 to 1995 is used here in order to estimate the water balance (evaporation and precipitation) at the surface of the Baltic Proper.

Evaporation

Evaporation is calculated by applying a bulk formula to VOS measurements of sea surface temperature (SST), air- and dewpoint temperature, air pressure and wind speed. The individual approach is applied, that means, evaporation is calculated for each individual set of observations within a VOS report. Various schemes for the bulk transfer coefficient have been suggested during recent years. For this study we rely on those of Large and Pond (1982). Evaporation estimates are corrected in the presence of sea ice using a recently established sea ice data set (Isemer 1998). Measured quantities aboard of VOS are subject to measurement biases and uncertainties some of which have recently been explored with more detail. Corrections of these biases are considered in the present study and include

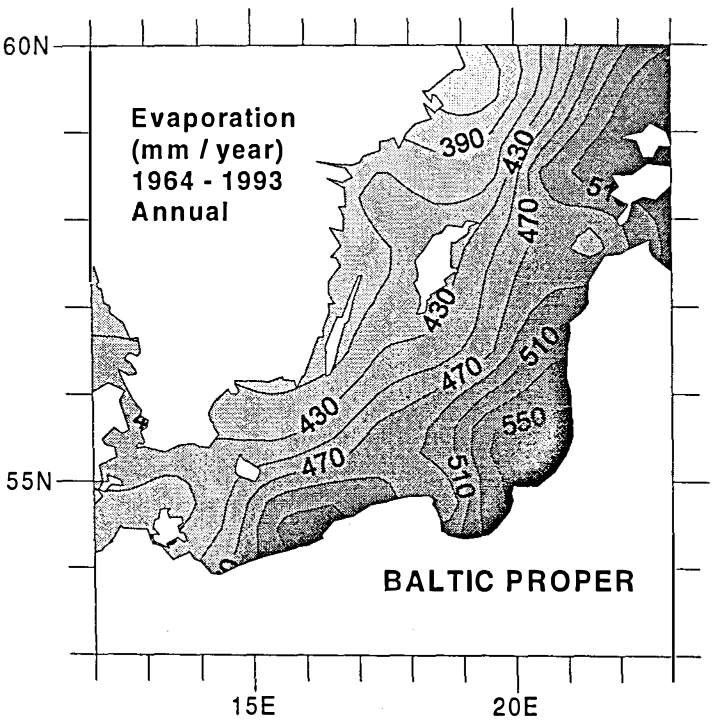

Figure 1: Regional distribution of annual evaporation in the Baltic Proper 1964 to 1995 (mm/year).

- the application of a revised Beaufort equivalent scale to wind speed estimates (Lindau 1994),
- the correction of SST measured by intake thermometers (Kent et al. 1993),
- the correction of a radiation bias of both air- and dewpoint temperature as a function of solar radiation and wind speed (Kent et al. 1993).

The net effect of these corrections is an increase of evaporation of order 10 % in the long-term annual mean compared to the uncorrected estimates. Details will be given at the conference. One remarkable result with respect to evaporation is the east-west difference of evaporation across the Baltic Proper (Figure 1) of order 25 % in the long-term annual mean. This feature is mainly caused by the configuration of the SST and air-temperature fields.

Precipitation

In order to utilise the considerable amount of marine observation from VOS a simple rain algorithm has been derived which uses only the operationally ship-reported meteorological parameters. This method is based on earlier studies by Tucker (1961) and Dorman and Bourke (1978). For the derivation of the algorithm we used daily rain measurements from 24 years aboard of stationary light ships in the German Bight. These vessels were equipped by a conical marine rain gauge exerting only a small flow distortion (Schmidt 1990). Nevertheless, we corrected the unavoidable underestimation of rain amount due to high wind speeds by a formula adopted from Hasse et al. (1997). In our algorithm the monthly mean precipitation is obtained as a function of only two weather code observations: the present weather (ww) and the specific humidity. Applying our algorithm on the light ships' weather and humidity reports, more than 70% of the interannual variability and 96% of the annual cycle's variance can be explained (Figure 2). Global application of this algorithm leads to a good agreement with satellite estimates and reasonable results compared to calculations of evaporation.

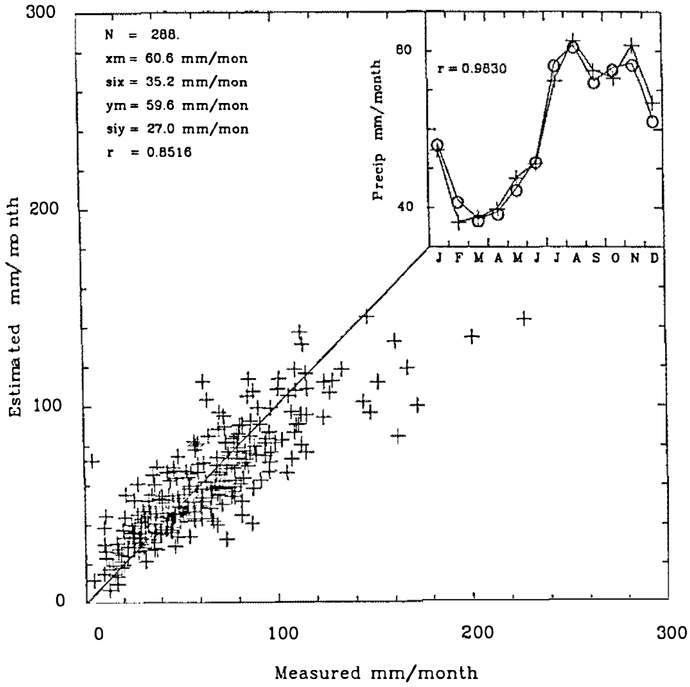

Figure 2: Precipitation for individual months from 1949 to 1972 in the German Bight. Measurements from light vessels are compared to results of the rain algorithm applied to light ships' weather observations and humidity measurements. Small upper right figure gives estimated (O) and measured (+) monthly precipitation averaged over the 24-years period.

The climatological results for evaporation E, precipitation P, and P minus E over the Baltic Proper including measures of seasonal and interannual variability will be presented and discussed at the conference. From the precipitation records established in this study it appears that during the decade of the 1980s the Baltic Proper has received more precipitation than before and in the early 1990s. This causes a change in the sign of P minus E leading to a slightly positive budget for e.g. 1981 to 1994 (Figure 3) but a negative one for e.g. 1964 to 1979.

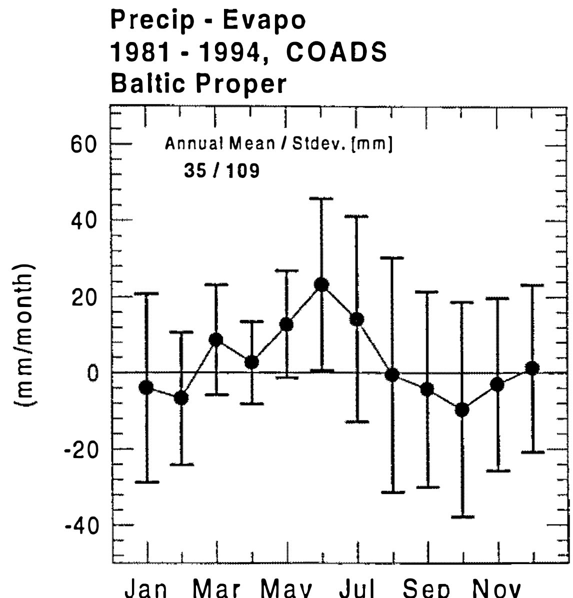

Figure 3: Annual cycle of precipitation minus evaporation at the surface of the Baltic Proper during 1981 to 1994 (mm/month). Vertical bars indicate the standard deviations of the individual monthly means. The long-term annual mean is only 35 mm with an interannual standard deviation of 109 mm.

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