Trends in mechanical energy input into the Northern Hemisphere oceans

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Under a few simplifying assumptions (e.g., constant values for the atmospheric density and the momentum exchange coefficient) the rate at which mechanical energy is transferred from the atmosphere to the ocean is proportional to the cube of the low-level wind speed (*UC*) (e.g., Simmonds 1985). We diagnose the time mean value of this quantity using the 10m winds in the 6-hourly 'reanalysis' set of NCEP/NCAR (Kalnay et al. 1996) over the 39 winters (DJF) 1958-1996 (the year referring to that in which the December fell).

The mean of *UC* in winter is shown in Fig. 1. Over a broad region centred at 40^{o}N in the central Pacific the rate surpasses 1750 m^3s^{-3}. The higher latitudes in the Atlantic are the region over which the mean mechanical energy input is maximised, and especially in the region to the south of Greenland and Iceland.

Many studies have revealed that the climate of the mid and high latitude oceanic regions in the NH appear to be undergoing trends at present. It stands to reason that along with the many changes in NH circulation which have been documented, the mechanical energy flux to the ocean (and consequential changes in sea state) would also be expected to exhibit trends. The trends in the mean of the cube of the wind is shown in Fig. 2 (and those that differ significantly from zero at the 95% confidence level are indicated by stippling). Positive trends are evident in most of the extratropical Pacific and in the Atlantic north of about 40^{o}N and these are significant in a region extending from east of Japan through to south of the Aleutian Islands and in most of the Atlantic north of 50^{o}N (and a maximum trend of 255 m^3s^{-3} $decade^{-1}$ is found to the north of the UK). These trends are consistent with the recent atmospheric and oceanic behaviours documented by Schmith et al. (1998), Carretero et al. (1998), Alexandersson et al. (2000) and Graham and Diaz (2001). Further analysis of these identified trends can be found in Simmonds and Keay (2002).

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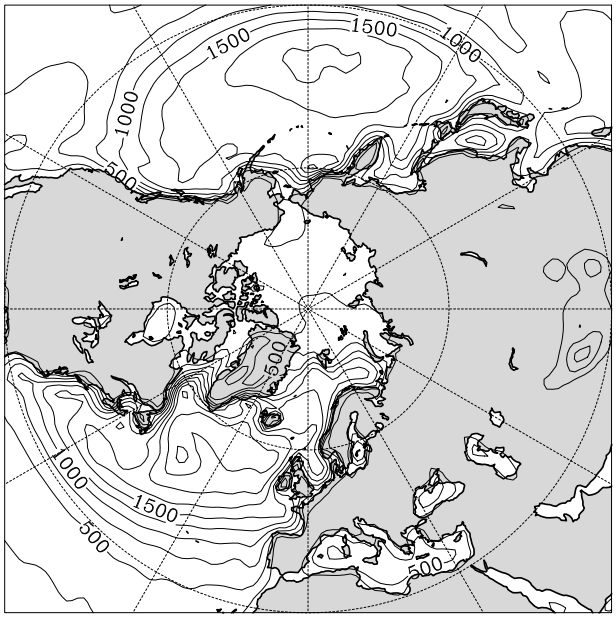

Figure 1: Mean cube of surface wind speed for winter. The contour interval is 250 m^3s^{-3}.

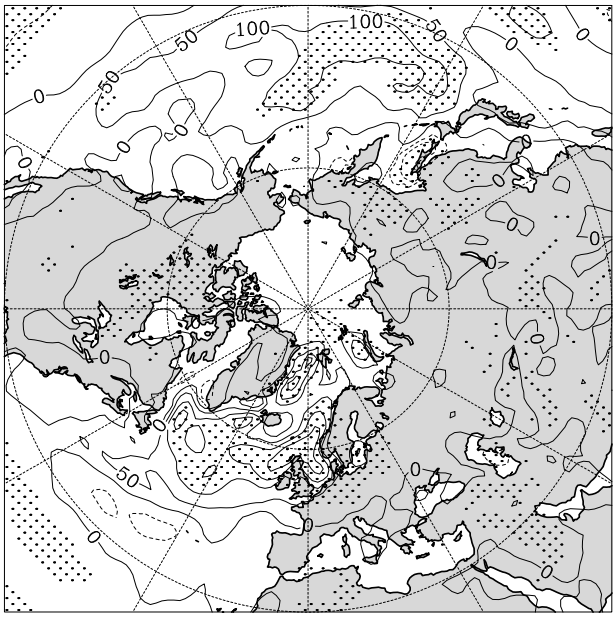

Figure 2: Trends in mean winter *UC*. The contour interval is 50 m^3s^{-3} per decade and regions over which the trends differ significantly from zero (95% confidence level) are stippled.