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COUPLING AN OCEAN WAVE MODEL TO AN ATMOSPHERIC GENERAL CIRCULATION MODEL

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A coupled model, consisting of the WAM ocean wave model and the Atmospheric General Circulation Model ECHAM, is integrated over 390 days under perpetual July conditions. The wave model is forced by the AGCM wind stress, whereas the effect of the ocean waves is transferred to the AGCM in terms of modified surface fluxes of momentum and heat. Newly generated waves (young wind sea) are associated with enhanced surface fluxes.

The coupled model generates realistic wave fields. The coupling is weak in the mean in the Southern Hemisphere storm track, where energetic young waves are present in 20% of the time, and negligible everywhere else.

The atmospheric circulation in the coupled experiment differs from the circulation in a control experiment only in the Southern Hemisphere storm track. The time-mean meridional pressure gradient has steepened and the high-frequency variability, representative for baroclinic disturbances, has shifted poleward and has intensified at high latitudes (Fig. 1).

Young wind sea is generated mostly in the equatorward "frontal" area of a cyclone (Fig. 2). The "front" is connected with the position of strongest horizontal temperature gradient at 850 hPa. In that area the surface winds are maximum and the wave heights are 5-10 m. It is hypothesized that the inhomogeneous distribution of surface roughness below a cyclone, due to the generation of young wind sea, accelerates the poleward movement of a cyclone. At the same time the frequency, or intensity of the storms is enhanced.

The effect of ocean waves on the tropospheric circulation is of moderate relevance for the climatological mean circulation. However, the path of an individual cyclone is affected by the presence of the wave field. Wave growth might thus be a significant proces for weather forecasting.

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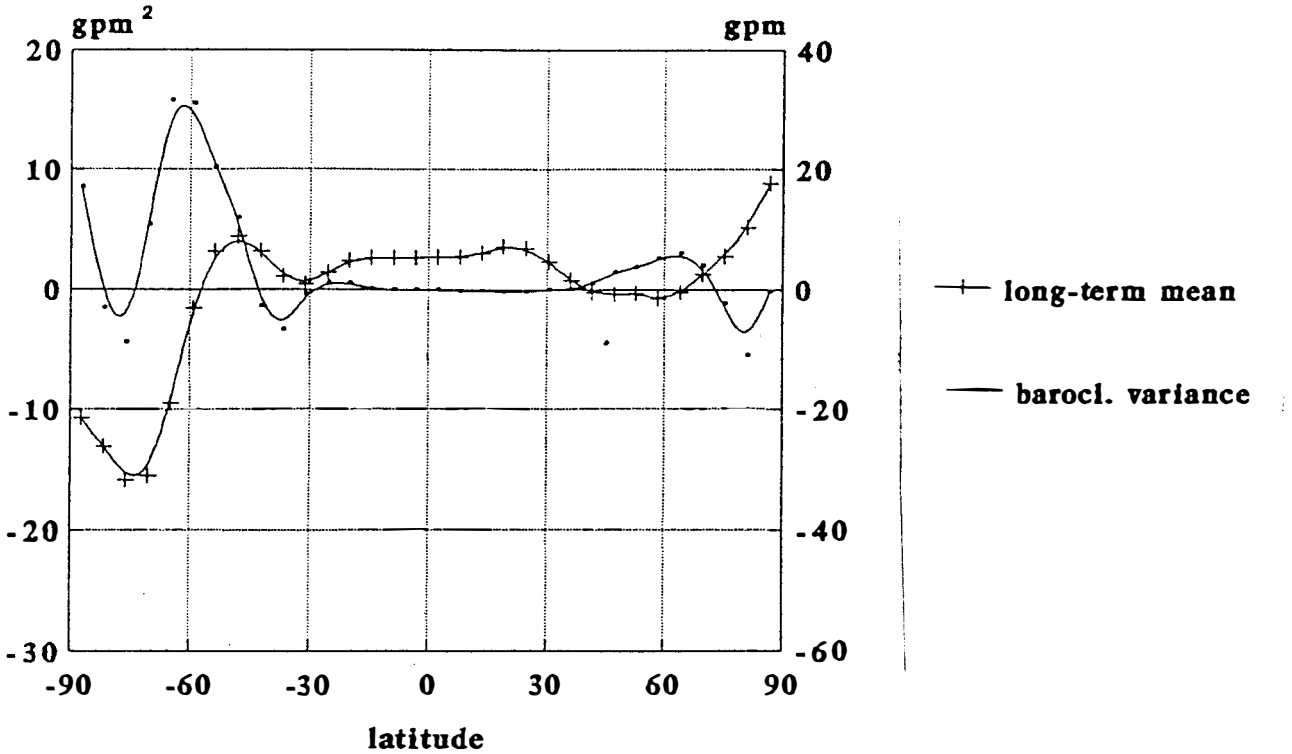

Fig. 1 The difference in the geopotential height (in gpm) and in the 2-15 days band-pass filtered variance of geopotential height (in $(gpm)^2$) at 500 hPa between the coupled wave model-AGCM experiment and a control experiment (zonally averaged, mean over the last 360 days).

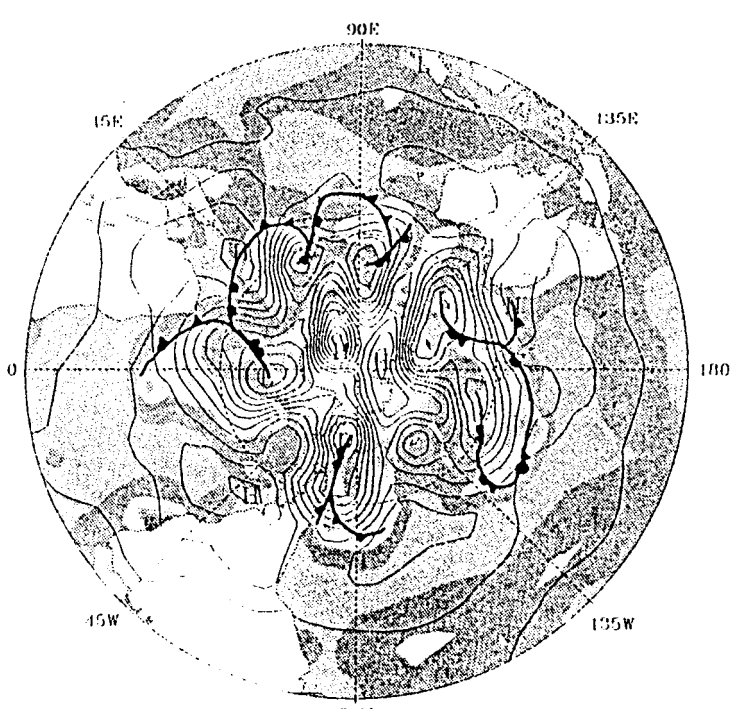

Fig. 2 The sea level pressure (isolines) and the ratio of the wave-induced stress to the total stress (shades) for a randomly chosen 12-hour interval (day 142, 0-12 UTC) in the coupled wave model- AGCM experiment. All values are 12-hourly means. The stress ratio denotes the strength of the coupling, with light shades indicating a 12-hourly mean roughness enhancement of 50-100%. The position of the "fronts", where the stress ratios tend to be relatively high, is indicated.