# AN INTERESTING PROPERTY OF SEA-LEVEL SPECTRA IN THE ADRIATIC

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## Résumé

L'observation du spectre du niveau marin en plusieurs stations de la mer Adriatique et pendant plusieurs années, a permis de mettre en évidence un phenoméne général: dans le domaine des basses fréquences (de 0.02 à 0.002 cph), on mesure des énergies sensiblement plus faibles durant les mois d'été. D'une étude temporale antérieure il apparait que les frequences sus-mentionnées subissent l'influence des facteurs atmospheriques (pression, vent). Les formations atmospériques les plus importantes sont d'une part les cyclones et anticyclones, d'autre part les ondes planétaires atmosphériques. Les variations saisonnières des énergies dans le domaine des basses fréquences ont donc leur origine dans les variations saisonnières de la circulation atmosphérique générale.

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An analysis of seasonal sea-level spectra was done for several stations in the Adriatic and for several years. As an example we present here such spectra for the Rovinj station, year 1978 (Fig. 1).

The spectra were obtained in the following way: from the original seasonal (3 months) time series linear trend was eliminated by least-squares fitting to a straight line, a cosine-taper function was applied and the periodogram was determined via the FFT method. The periodogram was smoothed by taking the mean of 5 points (Fig. 1/A) and 7 points (Fig. 1/B). The 80% confidence limits were determined by standard methods.

The dominant feature of all the spectra on Fig. 1 are the maxima that correspond to diurnal and semidiurnal periods. They are mainly of tidal origin and it is characteristical that the energies connected with diurnal periods are lower than the ones that correspond to semidiurnal periods. That is in agreement with the results of harmonic analysis for the North Adriatic (Defant, 1960).

A part of the energy on diurnal and semidiurnal periods as well as the maximum at period of about 8 hours - which also appears on all the spectra obtained - should be attributed to free oscilations of the Adriatic Sea (Defant, op. cit).

Of a particular interest here is the fact that in the low frequency band (about 0.02 - 0.002 cph) significantly greater energies appear in the winter spectra than in the summer ones. That is visible on both pairs of spectra on Fig. 1, especially on the lower one where more smoothing was applied. Let us stress that the seasonal spectra were compared taking into account the confidence limits.

In order to explain this property of spectra, the origin of energy in the frequency band of interest should be known. From the results of an earlier analysis in time-domain (Penzar et al., 1980) it follows that in this span of frequencies the atmospheric factors (pressure, wind) have a dominant influence on the sea. The most important atmospheric formations are cyclones and anticyclones on the one hand, and planetary atmospheric waves on the other. Therefore, the cause of seasonal changes of energy in the low-frequency band should be sought in seasonal variations of these atmospheric formations.

As it is well known, the Adriatic is situated between subtropical high-pressure zone and mid-latitude belt called also westerlies belt, in which various disturbances of the atmospheric pressure and wind field travel generally from west to east. These zones move throughout the year "cum sole", effecting sharp differences between the summer and winter situations on the Adriatic. In winter the westerlies belt dominates above the Adriatic, with frequent appearance of travelling lows and highs especially in the lower troposphere, as one can clearly see on charts presented by Schedler (1924) and Prostjakov (1968). In summer the westerlies belt moves to the north in front of the subtropical high-pressure zone, along with the corresponding atmospheric formations. The above references show that at that time greater cyclonic and anticyclonic disturbances disappear from the Adriatic.

As far as planetary atmospheric waves of the upper troposphere are concerned, it should be noted that they also belong to the westerlies belt. Therefore they are well developed above the Adriatic

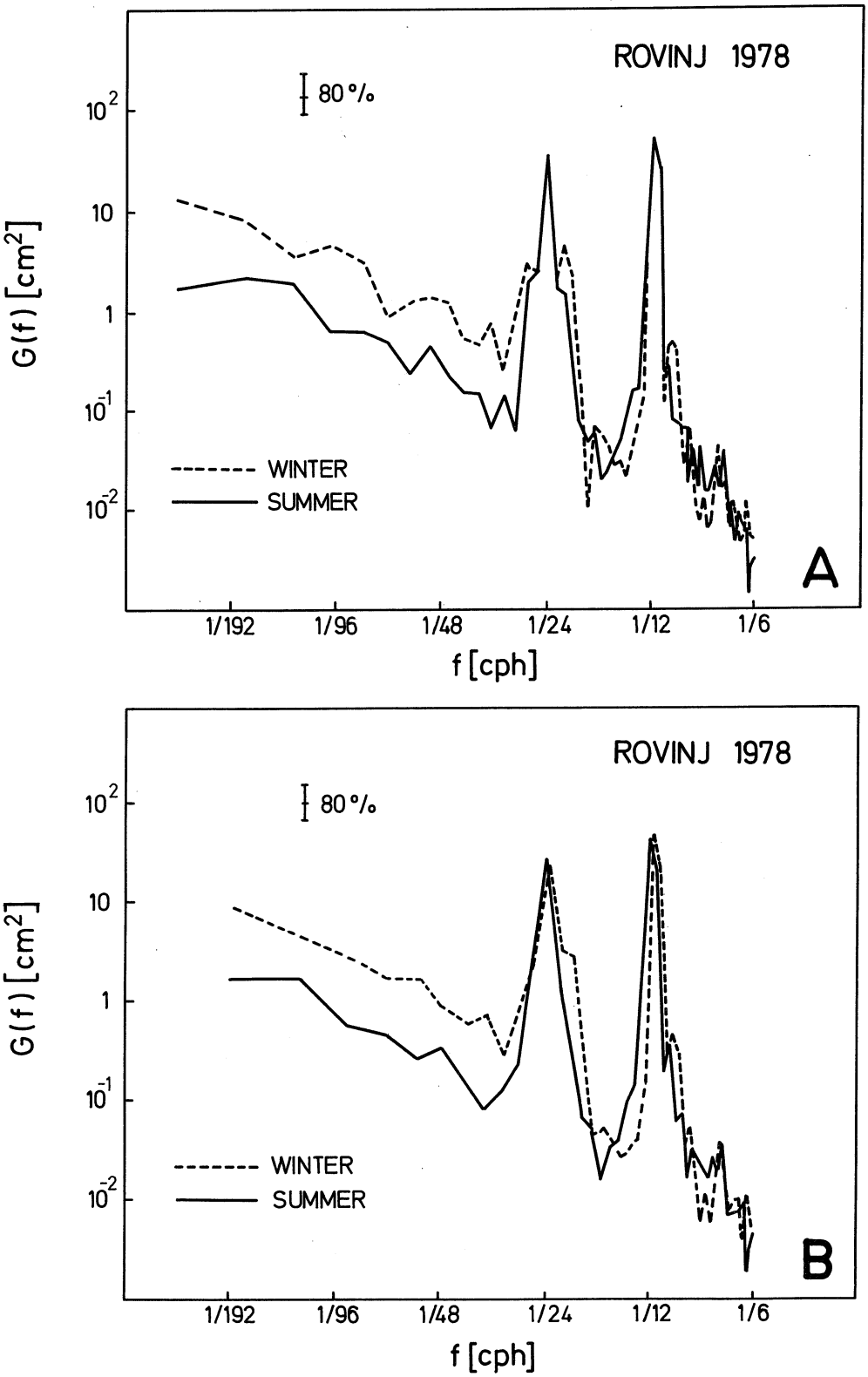


Fig. 1. Seasonal sea-level spectra

in winter, and consequently produce great changes in the height of 500 mb surface, as one can see on charts given by Lahey et al. (1958). In summer the Adriatic is influenced by the subtropical high-pressure zone, which reduces the amplitude of planetary waves. That is why the changes in the 500 mb-surface height significantly diminish (Lahey et al., op. cit).

Doubtlessly, the strength of interchanging cyclones and anticyclones influences the magnitude of pressure and wind changes, while the amplitudes of planetary waves are directly connected with pressure variations. It is easy to conclude that weakening of these atmospheric formations will effect their diminished influence on the sea level, and consequently adequate modifications of the sea-level spectra. At the end we can conclude that seasonal changes of energy belonging to the low-frequency band, on the sea-level spectra in the Adriatic, originate from seasonal variations in the general atmospheric circulation.

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