Inertial Frequency Band Oscillations in the Northern Adriatic

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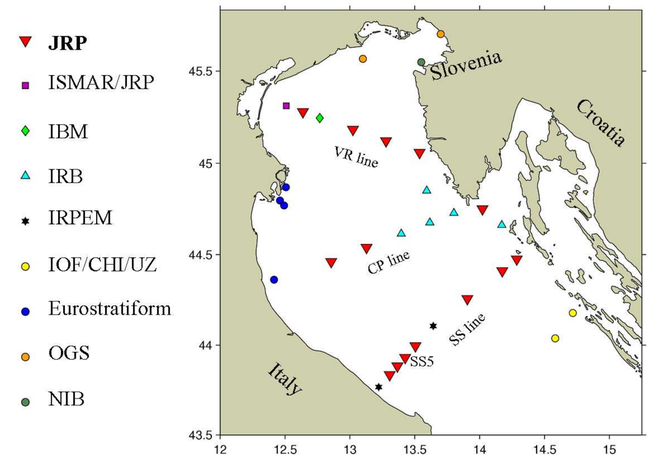
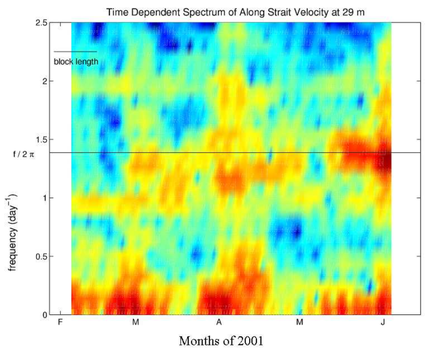


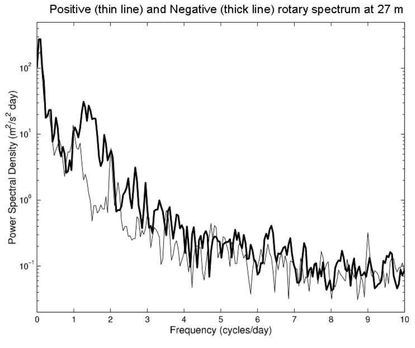
Moored Adriatic Observations

During the winter of 2002/2003, fourteen upward looking, bottom mounted Acoustic Doppler Current Meters (ADCP) were deployed in the northern Adriatic Sea. This was done through a Joint Research Project (JRP) between the U.S. Naval Research Laboratory and the NATO SACLANT Center. A major goal of the project is to improve our understanding of the effects of strong winds on marginal seas. The above map shows the locations of the JRP moorings. This project was a part of a large international collaborative effort studying the Adriatic Sea. Participating in these studies are Italian laboratories (ISMAR, IBM, IRPEM, OGS), Croatian laboratories (IRB, IOF, CHI, UZ), a Slovenian laboratory (NIB), and many other institutions in the U.S. and Europe. Moorings from the JRP and these other efforts were seamlessly integrated together during joint planning meetings to form three major cross-Adriatic mooring lines (VR, CP, and SS). The JRP moorings were recovered in May of 2003 and therefore this poster will present only preliminary results from these moorings. However, from late January to early June of 2001 a single JRP pilot mooring was deployed near the site of mooring SS5. Data from this mooring provide evidence of the importance and variety of inertial band oscillations in the northern Adriatic and provide a starting point for further investigations using the entire suite of JRP moorings.

Observations of Inertial Currents by the Pilot Mooring at SS5

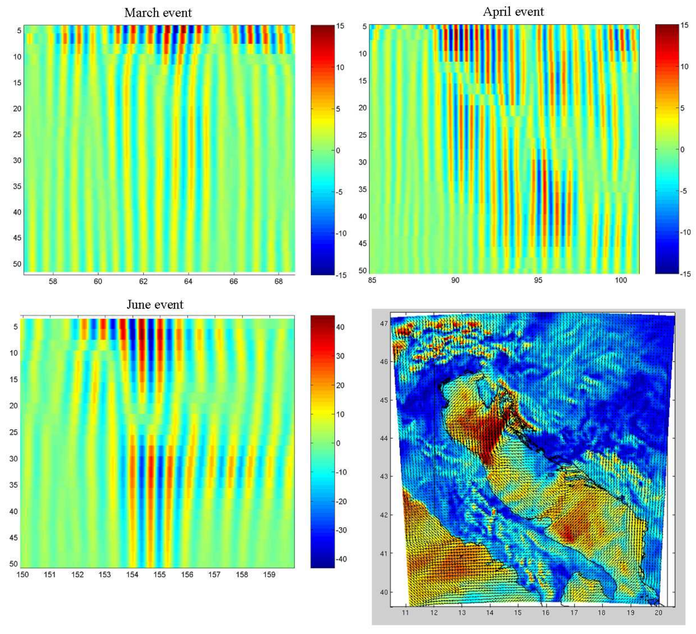
The graphs below present two different ways to examine the spectral energy measured by the pilot mooring at site SS5 in 2001. Inertial band activity occurs in bursts and the energy has a broad peak with significant energy above and below the inertial frequency. This energy is polarized in the clockwise rotary direction as expected.



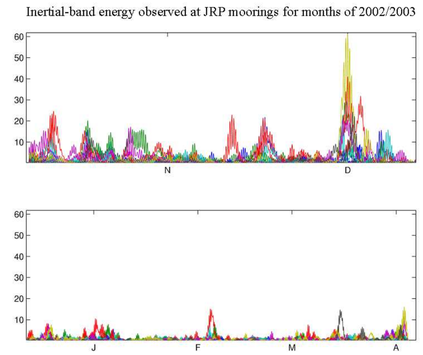


Three Inertial Events at SS5 during 2001

As shown in the time dependent spectrum (bottom of the left column). Inertial band energy in early March, early April, and early June was higher than at other times. This is caused by three velocity events in the record of the pilot mooring. To examine these events the velocity data were band-pass filtered using a fourth order butterworth filter run forward and backward to preserve phase. The cutoff frequencies of 1.2 and 1.9 cycles per day (cpd) were chosen to minimize tidal interference. Shown below are the band-pass filtered east/west velocities for each of the events. Note that the color scale for the June event has more than a doubled scale compared to the other two events. Both the March and April events are associated with bora wind conditions, i.e. strong winds from the northeast blowing in a distinct orography-determined banded pattern over the Adriatic. However the structure of these two events are quite distinct. The March event occurs after the bora winds have occurred during the breakdown of a bora induced low frequency pulse of southeastward current that was also observed by the pilot mooring. The oscillation is strong in the surface layer and weak at depth. The April event occurred in conjunction with the bora-induced low frequency pulse. Oscillations are strong at the surface and at depth and the depth of the minimum amplitude and phase reversal steadily deepens over time. The currents during the June event were the strongest currents recorded by the pilot mooring. Oscillations were strong at the surface and at depth and after a initial period the depth of the minimum amplitude and phase reversal remained constant. This event was associated with a fast moving pulse of winds traveling southward down the axis of the Adriatic, blowing toward the southwest on the eastern side like a bora but turning toward the southeast on the western side of the Sea (an unusual wind for the Adriatic). A snapshot of this wind event is shown from the COAMPS atmospheric model.



COAMPS 4 km winds
(courtesy of Dr. Jim Doyle and Dr. Rich Signell)



Inertial Variability during 2002/2003

In the two figures shown above are the kinetic energy per unit depth of the band-pass filtered currents at 5 meters from the JRP moorings from October to April. The colors represent different moorings. Energy is highest during the fall as numerous inertial events occurred. However, the response varies drastically from one mooring to the next, i.e. during particular events strong oscillations are observed at one mooring while little or no response are observed at other moorings. From event to event the sites of strong and weak response change. During the winter period inertial activity is much reduced but it is still present during a few events. The two panels immediately below show progressive vector diagrams during two of the strong inertial events. These figures further show the remarkable spatial variability that was observed for inertial band oscillations by the JRP mooring array. As part of the JRP, NRL is running the Navy Coastal Ocean Model (NCOM). As of now, this model has been run using the 4 km COAMPS winds up to the end of October 2003. Therefore the bottom two panels show progressive vector diagrams from the JRP moorings and for NCOM for the same inertial event in late October for a preliminary comparison. NCOM produces similar inertial variability along the SS line as the observations but it does not match the observed spatial detail on the CP and VR lines.