Ocean response to the Antarctic Oscillation

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Antarctic Oscillation (AAO), which is characterized by the zero wave number, has large impact on the atmosphere, ocean and sea ice in the Antarctic Ocean at periods from a few days to a hundred years. Further, AAO might be also related with the global warming inferred from the Arctic Oscillation in the northern hemisphere that is related with the global warming. It is important to investigate the dynamical ocean response to the AAO variation for understanding of the earth system.

The variability in the Southern Ocean at periods shorter than one year is characterized by the barotropic response, both from observational and model studies. It is well-known that the sea level variations around Antarctica fluctuate coherently. For the dynamics of the coherent sea level variation around Antarctica, the importance of the north-southward Ekman transport correlated with the AAO variation has been suggested, but only qualitatively. Little is known that the mechanism of the sea level variation around Antarctica. The purpose of this study is to understand the dynamics of the coherent sea level variation quantitatively.

We investigated the dynamics of this dominant feature in the Antarctic Ocean. The coherent sea level variation was reproduced well in the barotropic model incorporating realistic wind stress and bottom topography (Figure 1), and the variability was trapped over the shelf and slope. From simplified analytical solutions, the coherent variations can be explained by the shelf wave forced by coherent wind stress in the alongshore direction. Incorporating a damping term of 5-day timescale, the sum of the analytical solutions at periods from 10 to 200 days well explains the sea level variations around Antarctica (Figure 1).

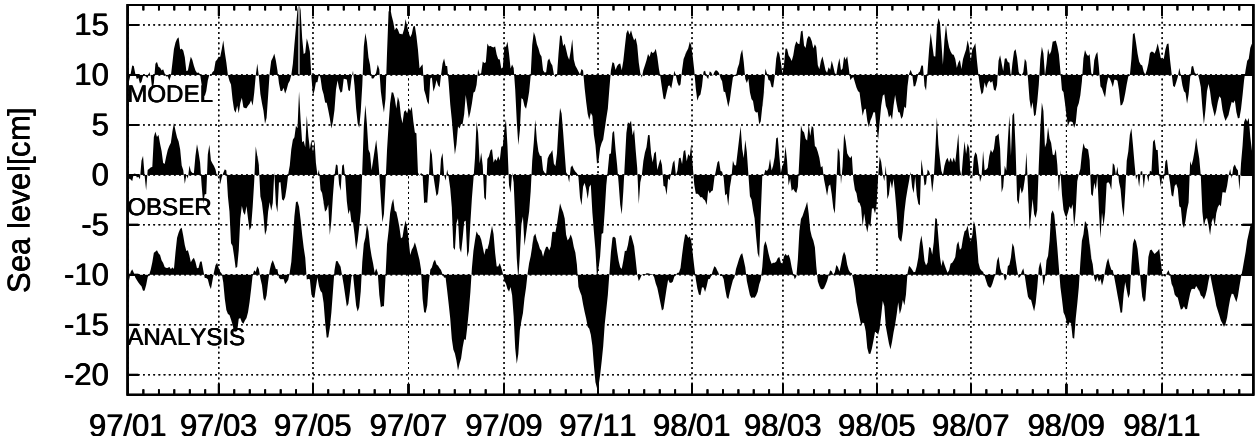

Figure 1: Time series of the sea level from the observational (middle), model (top) and analytical (bottom) results at period shorter than 200 days, for 1997-1998. The observational and model (with an offset of +10 cm) are the leading mode of the coastal sea level. The analytical solution with 5-day damping timescale is shown with an offset of -10 cm.