TRACKING AND SPATIOTEMPORAL CHARACTERISTICS ANALYSIS OF OCEAN WAVE SYSTEMS: A CASE STUDY OF THE SOUTHEAST PACIFIC OCEAN

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INTRODUCTION

Ocean surface waves are typically multimodal and comprised of wind sea and swell trains from different meteorological events. Spectral partitioning techniques allow for the efficient separation and parameterization of wave systems within the spectrum. However, these techniques are primarily applied to point spectrum analysis, and the identified wave systems are typically arranged according to the magnitude of their energy (e.g., wind sea is labeled as 0 and swell systems are labeled as 1-N). This implies that the number of wave systems and the label of the wave system with the same origin are frequently inconsistent in adjacent (temporal/spatial) spectra. Therefore, it is challenging to analyze the spatial and temporal characteristics of a particular wave system from these intricate data. Based on the feature that the parameters of the wave systems originating from the same source (e.g., a storm) have spatial/temporal continuity, the origins of wave systems are tracked back and the wave system with the same origin are clustered to reconstruct the spatiotemporal correlation of wave systems. The accuracy of the wave system tracking results is verified by comparing them with the reanalyzed wind field data.

NUMERICAL SETUP AND VALIDATION

The data is generated from the spectral wave model WAVEWATCH III. The computational domains of the two-way nested oceanic models are shown in Fig. 1. The white dot indicates the position of the measured point, and the red triangle's location acts as a representative point to show the simulated two-dimensional spectrum.

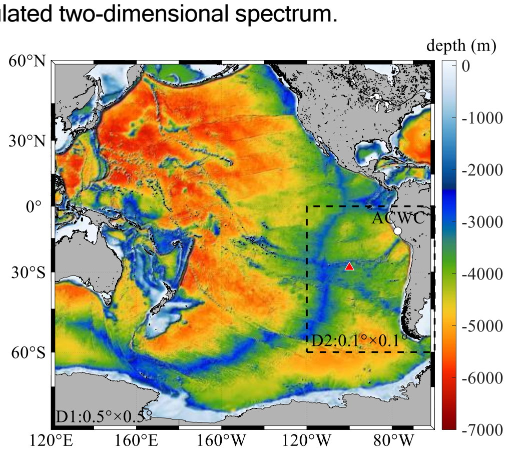

Figure 1 – Computational domains of WW3 for the south-east Pacific Ocean.

Fig.2 compares the observed and modeled wave parameters at the point of ADCP. There are some errors in the simulation of wave direction, which may be derived from the processing of coastal characteristics (e.g., water depth)

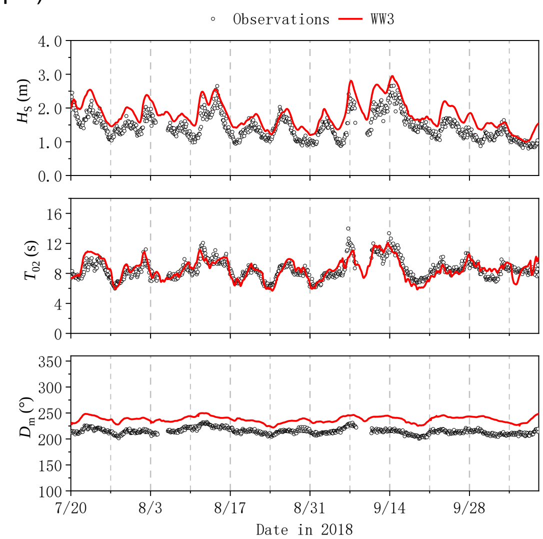

Figure 2 – Comparison of measured (circles) and simulated (line) wave parameters at ADCP.

SPECTRAL PARTITIONING

Spectral partitioning techniques treat the directional wave spectrum as a topological surface and utilize the image processing partitioning algorithm (e.g., watershed) to decompose it into multiple wave systems. In WW3, the method proposed by Hanson and Phillips (2001) is used to detect and separate the wave systems in spectrum. The simulated spectrum at the red triangle in Fig.1 and the outcomes of the spectral partitioning are displayed in Fig.3. It can be clearly seen that three distinct wave systems coexist in the spectrum.

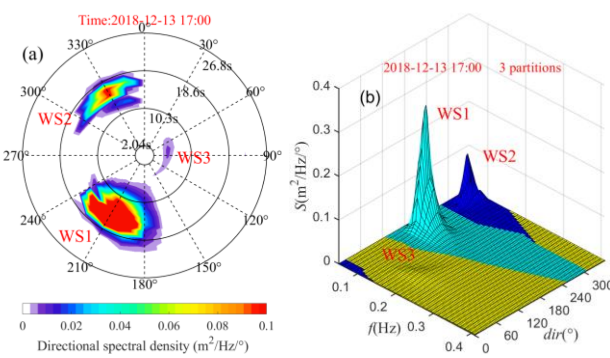

Figure 3 – simulated directional spectra (left) at the red triangle in Fig.1 and the corresponding spectral partitioning results (right).

WAVE SYSTEM TRACKING

The wave directional spectra of all wet computation nodes are partitioned in WW3, outputting the partitioned bulk wave parameters. Wave systems at all grid points can be tracked and clustered base on the spatiotemporal continuity of parameters of the wave system generated by the same meteorological event (Devaliere et al., 2009). Fig. 4 shows the wave tracking results corresponding to Fig.3, where each row relates to one wave system. The results indicate that the three wave systems are generated by the southern hemisphere westerly, the northern hemisphere westerly and the trade wind in the southern hemisphere, respectively.

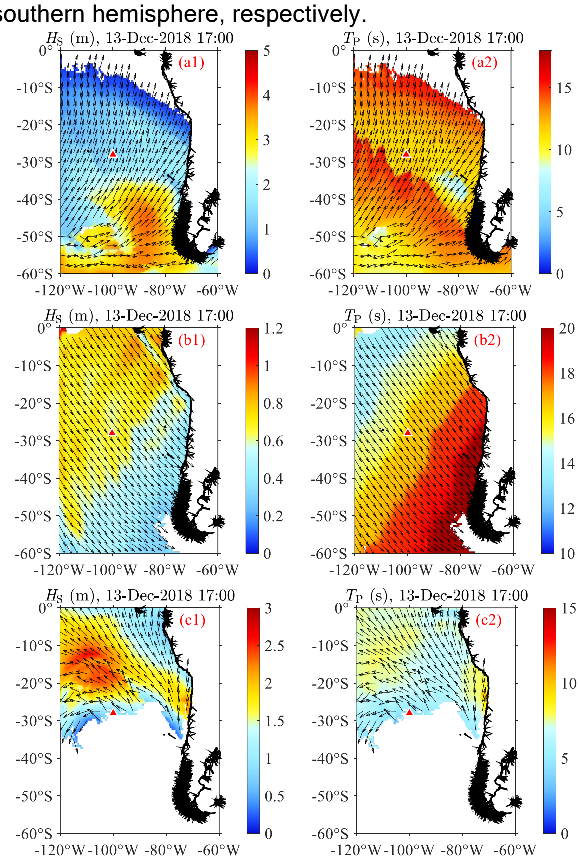

Figure 4 - Distribution of partitioned H_S and T_P for the wave systems at 13 Dec 2018, 17:00 (a) southern hemisphere westerly-generated wave system, (b) wave system from the northern westerly belt, and (c) wave system generated by the southeast trade winds. The wave direction is denoted by uniform arrows. Red triangle indicates the position of the spectrum shown in Fig.3

CONCLUSIONS

(1) Wave systems in the Southeast Pacific Ocean are mainly from the westerly belt in both hemispheres as well as the trade wind zone in the southern hemisphere. (2) The energy of the wave system generated by southern hemisphere westerly declines in boreal winter. In boreal summer, the energy of the wave system origination from the northern hemisphere westerly decreases and tends towards zero. The energy of the wave system generated by the southeast trade winds also varies seasonally, with a maximum in boreal summer.

REFERENCES

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