published a paper in Science that explained this long-standing mystery using new technology and observational data.

This paper utilized ambient seismic noises from broadband stations to derive empirical Green's functions that were used to construct a high-resolution three-dimensional model of the seismic anisotropy of Taiwan. From these images, they found that deformation occurred in both the upper and lower plates, similar to the traditional thick-skinned theory. However, the results also revealed that the deformation mechanisms were completely different in the upper and lower crust, similar to the layered phenomenon described by the thin-skinned model. Therefore, neither of the two traditional theories alone could adequately explain the data.

Instead, the research provided a new orogenic model for Taiwan in which the upper crust is dominated by collision-related compressional deformation, whereas the lower crust experiences convergence-parallel shear deformation. This lower crustal shearing was identified as being driven by the continuous sinking of the Eurasian mantle lithosphere when the surface of the subducted plate is coupled with the orogen (Figure 1).

This paper helped to resolve an important mystery in the geological history of Taiwan. Both the upper and lower crust participate in orogeny, although their deformation mechanisms are completely different. The coupled layered deformation mechanism proposed in this research provides an alternative perspective on mountain building and clearly defines the role of subduction in the formation of the Taiwan mountain belt.

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Associate Professor Yuancheng Gung
Department of Geosciences
ycgung@ntu.edu.tw

Concealed waves under the sea

The life cycle of the world's most powerful internal waves

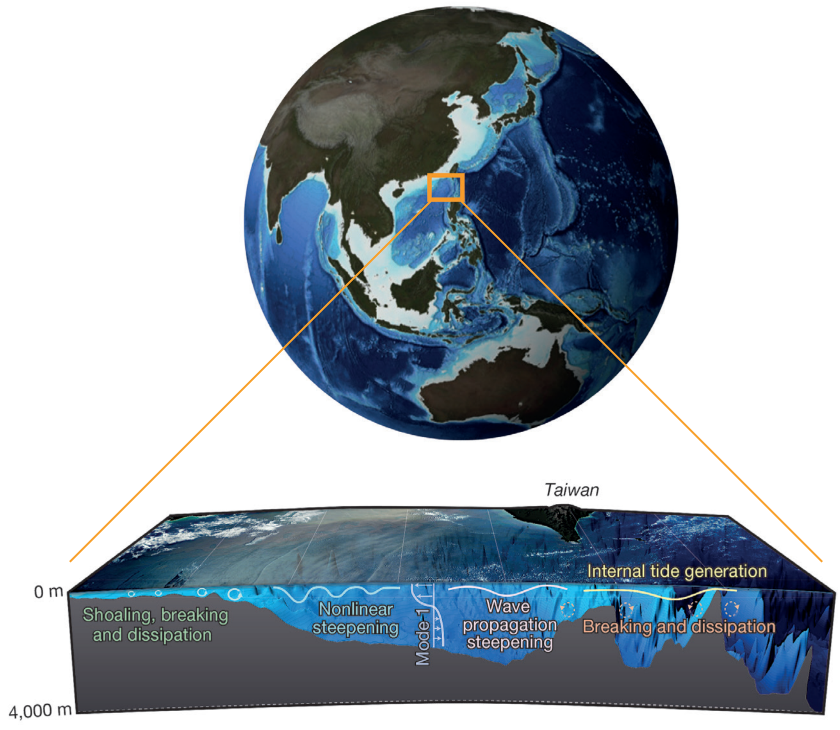
There are two types of gravity waves: surface waves at sea level, which can be observed and enjoyed at the beach, and internal waves, which are hidden beneath the surface. Gravity waves are generated at the interface between two media or because of the different densities of two fluids. The interface between the air and the water gives rise to surface waves. Similarly, internal waves are caused by density stratification due to salinity and/or temperature changes of water. The largest internal waves in the world are located in the South China Sea. However, there has been a lack of data for this region due to the challenges related to underwater research. Nevertheless, the energy pattern of internal gravity waves is a key factor for numerical climate models, emphasizing the need for more detailed studies.

Since 2000 and in collaboration with scientists from the United States, a group from the Institute of Oceanography at National Taiwan University has led a large international project targeting data collection in the South China Sea. Hundreds of researchers, technicians and students have participated in this project, which is supported by the Taiwan Ministry of Science and Technology and the U.S. Office of Naval Research. In May 2015, the achievements of this project were published in Nature, in a paper which was co-authored by 28 researchers from the U.S., Taiwan, Canada, and South Korea. With the help of this study, the life cycle of the largest known internal waves could be deduced.

This study used in situ data from synthetic aperture radars, mooring, pressure-inverted echo sounders, ship stations, and glider tracks to elucidate the mechanism underlying internal waves. The internal waves generated in the Luzon Strait are related to the surface tide, i.e., a combination of semidiurnal (twice per day) and diurnal (once per day) motions, governed by the sun and the moon. As the waves propagated westward through the Kuroshio Current, energy fluxes of approximately 40 kW/m were measured. This number, which is approximately 100 times larger than typical open-ocean values, exceeds the values known from other generation locations around the globe. Additionally, lee wave[1] phenomena were observed at the ridge of the Batanes Islands at ~121°E. The vertical displacement of the ocean layers reaches up to 500 m. At 115°E, the internal waves dissipate and break because of the shoaling effect of the continental shelf.

In this study, the mechanisms of generating, propagating, steepening, and dissipating the largest internal waves of the world were investigated. The large amount of data collected from numerous sources will provide the basis for future international research and numerical climate models.

1. Lee wave: Atmospheric stationary wave generated by the lee side while passing over a mountain.



Life cycle of the internal waves in the South China Sea

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Assistant Professor Ming-Huei Chang
Institute of Oceanography
minghueichang@ntu.edu.tw

Professor Sen Jan
Institute of Oceanography
senjan@ntu.edu.tw

Professor Joe Wang
Institute of Oceanography
wang@oc.ntu.edu.tw

Professor Yiing Jang Yang
Institute of Oceanography
yjyang67@ntu.edu.tw

Professor Tswen-Yung (David) Tang
Institute of Oceanography
(Deceased)