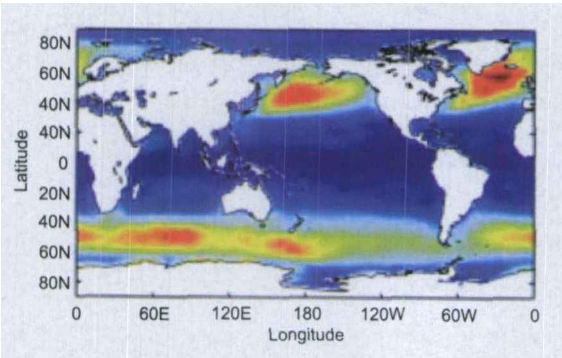
Major Progress in Revealing the Driving Mechanism of the Oceanic General Circulation



Distribution of wind energy input to the surface Ekman Layer.

Prof. Wang Wei at the Ocean University of China has made major progress in revealing the driving mechanism of the oceanic general circulation, and results from his study has been highly praised by experts in the international community of physical oceanography. His study was supported by NSFC through grants "A study of the growth and evolution of surface waves" and "Laboratory experimental study of circulation driven by horizontal differential heating".

In the field of large-scale oceanic circulation there has been a centennial debate on "whether the ocean is a heat engine or not". The heart of the debate is focused on whether the meridian differential heating on the sea surface can drive a stable meridian circulation which penetrates to the whole depth of the world oceans. Since this is closely related to the oceanic general circulation and climate condition on the Earth, it is one of the long-standing puzzles in physical oceanography, which is also a hotly debated issue in physical oceanography.

In order to answer this question, Prof. Wang carried out a series of laboratory experiments in Ocean University of China. Using the most advanced instrument "particle image velocimetry", the circulation driven by horizontal differential heating was systematically measured. Laboratory results indicated that stable circulation always appears in forms of a partial penetrating cell, which is also a solution with minimal energy. The flow appears in forms of self-organized turbulence; in addition, within the parameter range of the experiments the circulation obeys the similarity laws. Extrapolating the results to the global ocean, the total conversion rate from thermal energy to mechanical energy is approximately 1.5 GW, which is too small for sustaining the meridian overturning under the modern climate conditions. Therefore, the world ocean is not a thermal engine, instead, it is a heat conveyor belt driven by external sources of mechanical energy.

Prof. Wang also worked with Prof. Rui Xin Huang (Woods Hole Oceanographic Institution, USA) to explore many other important sources of mechanical energy for the global oceans. Their work provides a much more complete energy diagram for the world oceans, including many sources/sinks of mechanical energy and the decadal variability of these terms. In particular, their study indicated that wind energy input to surface waves may be one of the most important sources of energy driving the global thermohaline circulation. Their study opened up a new direction in large-scale circulation and surface wave by pointing out a clear link between the small-scale surface wave and the large-scale oceanic general circulation; thus, the study of surface wave can be linked to the study of large-scale circulation.

Results from lab experiments on horizontal differential heating were published in the first rate journal in the field of fluid mechanics Journal of Fluid Mechanics. Reviews praised the results highly because these results were obtained from very accurate modern technique of measuring velocity of flow field, and the results are most accurate and reliable. In a commentary essay (Journal Club) published in Nature, Prof. Carl Wunsch (Massachusetts Institute of Technology), a famous physical oceanographer, member of American National Academy of Science, Chairman of the World Ocean Circulation Experiments, praised these results as the most important progress in the field of physical oceanography in

2005.

The results related to energetics of oceanic general circulation were published in Journal of Physical Oceanography and Deep Sea Research. These papers have been widely cited in recent scientific publications. In particular, the two articles about wind energy input to surface waves and Ekman layer have been selected as important progress in physical oceanography and reported in the Bulletin of American Meteorological Society.

(Quoted from 2007 Annual Report)

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Research on 3D Micro-nano Processing Reported on Nature

The latest issue of Nature reported in its Research Highlights (see "Lithography: Luminous Lizards", Nature, Vol. 451, p868, Feb. 21, 2008) that a group of researchers from the Technical Institute of Physics and Chemistry (TIPC), Chinese Academy of Sciences (CAS) achieved the new progress in 3D micro-structures of nanometer composites using the multiphoton nano-processing technology. The related research findings were previously reported online on January 30th by The Journal of Advanced Materials (see Adv. Mater. doi: 10.1002/adma.200702035).

Funded by CAS' Scientific Instrument Project, the research team of organic nano-photonics headed by Prof. Duan Xuanming, one of CAS's "Hundred Elites Program" awardees, successfully and independently developed an ultra-fine fabrication system by means of nano-photonics. By close collaboration with universities and institutes at home and abroad, the team draw attention for developing the fabrication at nano-scale by taking advantages of the direct writing technology with femto-second laser of near infrared wavelength (see Appl. Phys. Lett., 2007, 90, 071106, 131106; 91, 124103). At the same time, the functionality of fabrication materials and the capability of nano-structure were studied and the lasing phenomenon in a 3D nano-wire structure of materials with fluorescence dyes was also observed (see Appl. Phys. A, 2007, 89, 145).

Prof. Duan put forward a new approach to process the 3D microstructure by applying both the light-etching glue prepared from the precursor components of nano-materials and the 3D reprocessing mode by means of in-situ synthesis to fabricate the nano-composites. In this way, the team obtained the nano composites of TiO (see Thin Solid Films, 2004, 453, 518) and CdS in the form of 3D photonic crystals (see the Invited Paper of Appl. Phys. A, 2007, 86, 427) and observed the reinforced photonic band-gap effect in the 3D photonic crystals.

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(Quoted from NSFC Web.)