Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS01-P01 Room:Convention Hall Time:May 23 18:15-19:30

Simultaneous optimization of air-sea exchange coefficients and initial condition around a tropical cyclone with JNoVA

Kosuke Ito[1*], Takuya Kawabata[2], Kazuo Saito[2], Yuuki Honda[3]

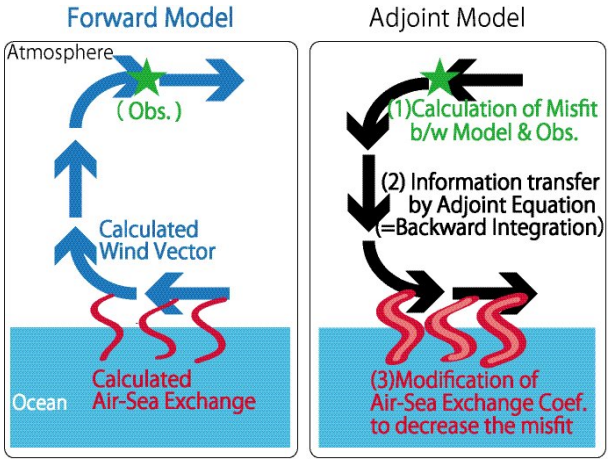
[1]JAMSTEC, [2]MRI, [3]JMA

Uncertainty in the values of air-sea exchange coefficients has a detrimental effect on tropical cyclone (TC) modeling (Emanuel, 1986). Since a TC is one of the most destructive disasters, a method is required to reduce such uncertainty. In this presentation, we first show the feasibility of specifying air-sea exchange coefficients in the high-wind regime by using an idealized variational data assimilation (VDA) system followed by the application to the operational system. Here, air-sea exchange coefficients are chosen as control variables together with the initial conditions.

Figure depicts the procedure for an advection-diffusion equation. Firstly, the misfit between the observation and model result is calculated. Then, the gradient to the air-sea exchange coefficients is formulated using the adjoint model, in which observations located downstream of the flow work in the correction of air-sea exchange coefficients. This approach is applied to the VDA system that uses the axisymmetric model of Rotunno and Emanuel (1987) as its base and the operational one used in Japan Meteorological Agency (JMA) (e.g., Honda and Sawada, 2009). Detailed configurations are found in Ito et al. (2010, 2013).

In our idealized experiment, the air-sea exchange coefficients are successfully improved toward the 'True' values by digesting the pseudo-observations mimicking the dropsonde observations. The updated air-sea exchange coefficients yield persistent improvements in the maximum wind speed and the inner core structures. Without adjustment of the exchange coefficients, the analysis field of the inner-core is contaminated, even if the initial state is modified by the adjoint method. We applied this approach to the operational VDA system for the case of Typhoon Chaba (2010). After some spin-up cycles, the misfit between model results and observational data decreases by 4.1-22.4% relative to the existing system, which adjusts the initial condition alone. The intensity and location of the TC are thereby brought close to those of the corresponding best track produced at JMA. Furthermore, our optimization approach holds the prospect of enhanced track forecast potential.

Keywords: Tropical Cyclone, Data assimilation, Air-sea exchange coefficient



Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS01-P02 Room:Convention Hall Time:May 23 18:15-19:30

Ocean response to typhoons moving toward north in the East China Sea

Takashi Nakano[1*], MATSUURA, Tomonori[2]

[1]Earth Science, University of Toyama, [2]Faculty of Science / Graduate School of Science and Engineering, University of Toyama

1.Introduction

From summer to fall, a lot of typhoons approach Japanese Islands and a part of them moves toward north on the East China Sea (ECS). Ocean responses with the passage of typhoons appear mainly as vertical mixing and upwelling. These phenomena cause to drastically change environment of the upper ocean such as SST (Sea Surface Temperature) decrease, supplement of nutrient-rich from the bottom, and so on. Thus it is important to clarify the ocean response to the typhoon passage. However, there are a few studies for the ocean response as an atmosphere-ocean interaction to the typhoon passage in ECS where the bottom topography is abrupt and the Kuroshio flows along the steep slope.

In this study, we elucidate mechanisms of ocean response to Typhoon SONGDA (2004) that moves toward north on ECS. Moreover, we indicate a unified tendency of the ocean response to typhoon passage in ECS. The ocean assimilation data in Kyushu University (RIAMOM) and GPV(MSM) weather forecasting data are mainly used to analyze upper-ocean and surface winds.

2.Results and Discussion

Typhoon SONGDA (2004) was one of the biggest typhoons in the past passing toward north on ECS. The typhoon entered in ECS on September 5, 2004 18:00 (JST) and departed there on September 7, 2004 9:00 (JST). Focusing on the variation of SST between September 3 and September 9, we find that SSTs in the sea area decrease. The sea state also changes largely after the typhoon enters in ECS. In order to confirm the variations of SSTs due to the passage of typhoon in more detail, we obtained the difference of SSTs between September 7 and September 4. In particular, decreases of SSTs appeared in the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu(Fig.1).

On the remarkable ocean response in the continental slope of ECS, the initial condition of ocean before passage of the typhoon is important. This condition was determined by the geostrophic adjustment of the Kuroshio Current flowing along the continental slope before the typhoon entered in ECS. In the continental slope, cold water upwelled from the lower layer and hence the thickness of surface layer with warm-water became thinner than the surrounding sea. The cooling condition of surface water has been arranged before the passage of typhoon. When the typhoon reached the sea area, the water further upwelled and mixed due to the strong winds and the water temperature reduced prominently. We conclude that above factor causes the significant decrease of the sea temperature.

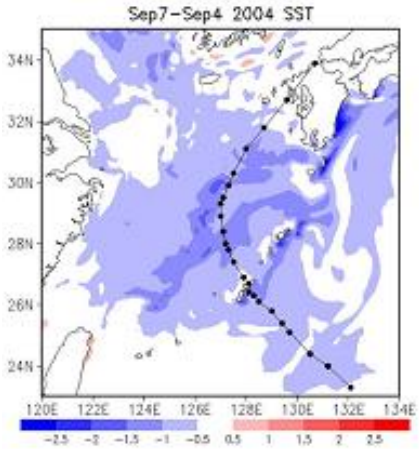
On the other hand, on the sea area from the east coast of Nansei Islands to the east coast of southern Kyushu, the location and the pass of the typhoon were associated with cooling of the sea water. Since the typhoon moved toward north passing ECS, these sea areas were given stress by the southerly winds. The Ekman transport toward east was generated by the southerly winds at the boundary of the line of islands. Then the coastal upwelling was occurred at the eastern side of the islands and the surface water was cooled there.

Moreover, we examined the SST difference due to typhoon passage of all 16 cases in ECS during year 2002 to year 2010 based on the result of Typhoon SONGDA (2004). We also paid attention to the ocean response of the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu. It is found that with high probability, SSTs in these sea areas reduced with passage of typhoons. As a result, we suggest that when typhoons pass toward north on ECS, the SSTs decrease in the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu.

Lastly, we appreciate Research Institute for Applied Mechanics in the Kyushu University and Meteorological Agency in Japan for using the ocean assimilation data and the wind data to carry out the present study.

Keywords: Ocean response, Typhoon, East China Sea, the Kuroshio

AAS01-P02 Room:Convention Hall Time:May 23 18:15-19:30



Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS01-P03 Room:Convention Hall Time:May 23 18:15-19:30

Responses of marine ecosystem to typhoon passages in the western subtropical North Pacific

Ryota Shibano[1*], Atsushi Tsuda[2], Yasuhiro Yamanaka[1]

[1]Faculty of Environmental Earth Science, Hokkaido University, [2]Atmosphere and Ocean Research Institute, University of Tokyo

Strong phytoplankton blooms are occasionally observed around a recurvature point of typhoon tracks in the western subtropical Pacific. These are noteworthy events in subtropical regions where both nutrient concentrations and biological production are persistently low. We investigated the response of phytoplankton to typhoon passage using a numerical model with/without biogeochemical processes. The model reproduced the observed patch-like phytoplankton bloom around a recurvature point of Typhoon Keith in 1997. The strong bloom is caused by the typhoon-centered upwelling of nutrient-rich water from below the euphotic layer, which supplies the nutrients required for phytoplankton growth, resulting in higher chlorophyll-a concentrations. Biogeochemical processes then play essential roles in determining the response after the passage of typhoons in subtropical regions.

Keywords: typhoon, marine ecosystem model, phytoplankton

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS01-P04 Room:Convention Hall Time:May 23 18:15-19:30

Daily observations by profiling floats and numerical simulations on typhoons during 2011-2012 typhoon seasons

Akiyoshi Wada[1*], Tomohiro Uehara[2], Shiro Ishizaki[2]

[1]Meteorological Research Institute, [2]Japan Meteorological Agency

Advances in observational technologies, data assimilation systems and numerical modeling have enabled us to predict tropical cyclones (TC) more precisely. There has, however, been little progress in predicting tropical-cyclone (TC) intensity in spite of the notable improvement in TC track prediction over the decades. The interactions between TCs and the ocean play a crucial role in TC intensification and their incorporation into an atmospheric prediction system would be desired. In order to construct the coupled oceanic and atmospheric TC prediction system, understanding of the TC-ocean interactions is indispensable.

Japan Meteorological Agency deployed three profiling floats to the Northwestern Pacific Ocean on June 2011 and observed the upper ocean everyday during 2011-2012 typhoon seasons in order to seek the possibility of daily variation in temperature and salinity on the improvement of TC predictions. Observations by the three profiling floats could capture TC-induced sea-surface cooling and salinity variation due to precipitation, vertical turbulent mixing and TC-induced advection. The observations were also used to validate results of numerical simulations of T1106 (Ma-on), T1112 (Talas) and others performed by an atmosphere-wave-ocean coupled model. This study presents the effect of salinity variation on TC intensity, intensification and structural change (T1106) and that of sea-surface cooling on T1112 and the generation of subsequent TC.

Keywords: Typhoon, Profiling float, Atmosphere-wave-ocean coupled model