Author's response to comments from Referee #2

We appreciate valuable and constructive comments from the referee.

A key point of the comment from Referee #2 is to re-structure the manuscript more neatly and to make it more focused on what we want to address. We thought Referee #2 sympathized with our view that the data described in the manuscript is valuable as the first continuous time series obtained during the period of the onset of the spring bloom in the study area. Although she (or he) mentioned the role of the ESIW advection in triggering the bloom is not so convincing, the data clearly showed that this was the case at least at the time of our observation, and we explain this more in detail in the following responses to referee's comments.

Comment 1: On the title

We will change the title as follows,

A newly observed physical cause of the onset of the spring phytoplankton bloom in the southwestern East/Japan Sea

Comment 2: On the abstract

We will re-write the abstract to make it shorter but more concentrated.

Also the typo will be corrected, 'variatio' → 'variation'.

Comment 3: On the introduction

We will re-write the introduction to make it clearer on an issue that we like to address. Especially, we will cast a key question, what is the role of the previously documented southward spreading of the ESIW in the spring bloom in the area characterized by shallow pycnocline and energetic circulation.

Comment 4: On the data and methods

We will shorten this part as well, as the referee suggested.

Comment 5: On the results and discussion

1. As the referee suggested, we will revise this part by removing the description of high frequency variations of observed properties and re-structuring other parts. In the results part, all measured properties (atmospheric, physical, and biogeochemical) from the buoy station will be described but focusing on the observed bloom, and the relationship between the onset of the bloom and the uplifting of isotherms, and the comparison of mean properties during the pre-bloom and bloom periods to point out the subsurface cooling and uplift of isotherms during the bloom period. And in the discussion, the ancillary datasets (satellite data and spatial distribution of water properties based on other hydrographic data) will be presented to supplement the single-point mooring observation, to provide reasons for the fluctuating isotherms and uplifting of mean isotherms during the bloom period, and to highlight the importance of the ESIW intrusion in triggering the bloom.

2. Referee #2 suggested to focus on the CF variations at 30 m and at other two layers in the results. The CF data are only available at two depth levels, at 30 m for full 74 days, and at 50 m for only 7 days. And we briefly mentioned the CF at 50 m is about 10 times smaller than the CF at 30 m (P7838, Line 9-10)

3. Referee #2 mentioned "It is hard to believe that anomalously cool water at 100 m could be a solid indicator of ESIW intrusion." Following points, however, strongly suggest the ESIW intrusion occurred in spring at least at the time of the moored measurement in 2010.

(1) Previous studies documented the southward movement of ESIW from the formation region in the northern East/Japan Sea. Two pathways of the ESIW have been suggested, one route is along the western boundary of the East/Japan Sea carried southward by the coastal boundary current, North Korean Cold Current, and the other path of the ESIW toward the south is by subduction process that occurs along the subpolar front. All this information was included in the introduction, and we will add a couple of references on the seasonal and interannual variations of the ESIW.

(2) Temperature range of the ESIW is 1.0~5.0°C as we mentioned in the introduction. Thus the observed cold water with temperature less than 5°C below 50 m (Fig. 10) corresponds to the ESIW. It is obvious that the appearance of colder ESIW and the uplift of isotherms characterized the bloom period (Fig. 11).

(3) Temperature variation at 100 m in the study area from February to April at the time of buoy observation shows an unambiguous cooling in a wide area of the Ulleung Basin (Fig. 14(a)), and the climatological temperature variation at 100 m and 200 m (Fig. 15) corroborates the observed cooling in April, 2010. The cooling of the subsurface water would be due to either Ekman pumping or cold water advection or both. Mean wind stress curl during the pre-bloom and bloom periods differs by about 0.1×10^{-6} N/m^2 in the central UB, then the associated change in the Ekman pumping is about 3.6 m/month which cannot account for the observed shoaling of 5°C isotherm depth by 16.8 m in Table 1. (We will add this estimation to the discussion part.) Hence, we think the observed subsurface cooling resulted from the cold water (ESIW) intrusion.

(4) The observed subsurface temperature (e.g., at 100 m) at the buoy station was anomalously cold, which is also evidenced by the widespread cold anomalies at 100 m in April 2010 (Fig. 14b). The reason for this anomaly is beyond the scope of this paper, and we conjectured in the discussion that it may be associated with the strong negative phase of the Arctic Oscillation during the winter of 2009/2010 since 1950.

Comment 6: Page 7854, Line 17-18, symbols for vertical velocities

The symbol O we used denote an order of magnitude of vertical velocity.