

Response to comments by Referee #1

We are grateful the referee for all comments and suggestions. We have accounted all of them and made the necessary changes in the text.

1. Page 11160, Line 23-24: "This input of IFN can potentially double the level of primary production." Can be reworded as "The input of IFN to Black Sea has potential to enhance level of primary production".

This sentence has been changed to "The input of IFN to the Black Sea has potential to enhance two-fold the level of primary production".

2. Page 11161, Line 6-8: "Yet, this data is exceptionally important for understanding, modeling, and fighting negative effects of anthropogenic eutrophication and other effects in the Black Sea ecosystem." Can be reworded as "Such data are very important for understanding, modelling and assessing negative impacts of anthropogenic eutrophication as well as other effects in the Black Sea ecosystem."

Accepted.

3. Page 11161, Line 17: "Yet, when it comes to ..." can be replaces by "However, in case of ..."

Accepted.

4. Page 11161, Line 19-24: Too long statement. Can be reworded as "Black Sea being surrounded by industrialized areas (or countries), it is obvious as well as highlighted by few studies ((Kubilay et al., 1995; Chaykina et al., 2006; Medinets and Medinets, 2012), the significant influx of IFN via atmospheric wet deposition. However, till date, neither basin-wide magnitude, nor spatial and temporal variations, or aftereffects of this input to the Black Sea has been ever evaluated."

This long sentence has been reworded. "Though scarce published data (Kubilay et al., 1995; Chaykina et al., 2006; Medinets and Medinets, 2012) demonstrate an input of inorganic fixed nitrogen (IFN) with atmospheric precipitations, neither basin-wide magnitude, nor aftereffects of this input to the Black Sea have been ever evaluated".

5. Page 11162, Line 8-14: Again, it's too long statement. Can be divided into two lines.

It's edited. "A number of studies has been completed over the last two decades to show that this source can account for 60% of the total continental supply of IFN to the oligotrophic Mediterranean (Guerzoni et al., 1999), but it may also reach 8% for the highly eutrophic Baltic Sea (Langer et al., 2009). It can level riverine inputs and support a large short term increase in phytoplankton growth under certain meteorological conditions (Spokes and Jickells, 2005)".

6. Page 11162, Line 18: Kubilay et al. (2013) is missing in the reference list.

It's our misprint. It's corrected to Kubilay et al. (1995).

7. Page 11163, Line 4-6: Repeated here from Page 11161, Line 22-24.

It's edited. "Yet, neither published data on spatial variations in the atmospheric input of IFN, nor information on effects of this deposition is available".

8. Page 11163, Line 9-11: 19 % of air parcels are derived from local region. How they can contribute to long-range transport?

It's corrected. "Atmospheric transport in the Black Sea region is dominated by trajectories from

Eastern Europe (38 %), Russia (33 %), local region (19 %), and North Africa (10 %) (Kubilay et al., 1995)".

9. Page 11163, Line 11-14: What I understand here that 90 % of precipitation events have back-trajectories associated with long-range transport (which are crossing anthropogenic IFN emission regions). However, in the next line, the local processes are highlighted. I think, both play significant role in bringing pollutants (in this case IFN) and their delivery to the surface ocean.

We agree with this comment and have reworded this statement. "This means that long-range transport is important for seasonal variations in the content of IFN in the atmosphere and its input to the Black Sea, but local processes of scavenging below clouds on time of precipitation are important for regional spatial and short-term temporal variations".

10. Page 11163, Line 17-22: Objectives can be reworded as: (i) to present multi-annual observational dataset of IFN (: : ..) via wet atmospheric deposition...(ii) : : (iii) : : and (iv) to evaluate impact of IFN deposition to the Black Sea on various time scales.

We agree with this suggestion and reworded this part of the text. "This paper is aimed (i) to present multi-annual observational dataset of IFN (ammonium, nitrate and nitrite) with wet atmospheric deposition in an urban (Sevastopol) and rural (Katsiveli) sites of the Crimean coast of the Black Sea; (ii) to analyze interannual, seasonal, and mesoscale variations in IFN deposition; (iii) to parameterize this deposition; and (iv) to evaluate impact of IFN deposition to the Black Sea on various time scales".

11. Data and Methods: It will be useful to mention rainfall pattern and sample collection procedure at the sampling site. What is the collection period of each samples? Collected sample represent a single or multiple event in a day?

The rainfall pattern is discussed referencing Ivanov and Belokopytov (2013) in section 3.3. Yet, we add information on sample collection. "Wet atmospheric precipitations of every single rain event have been collected. The collection procedure has conformed to requirements of EMEP (EMEP Manual, 2001)."

12. Page 11165, Line 5-18: This should go to Result and discussions.

We consider observational data to keep in section "Data and methods", while results derived from observational data in section "Results and discussions".

13. Page 11165, Line 19-21: Briefly discuss meteorological parameter and their seasonality as they will be used in regression analyses.

We discuss meteorological information important for this paper in section "Results and discussion" following the referenced publication by Ivanov and Belokopytov (2013). There are many published papers and several books to present and discuss meteorological data for the Black Sea in detail. We use that information and apply it for the purposes of our work. Data on precipitation has been found important and it is discussed in section "Results and discussion". Data on wind is less important for in depth analysis and it is mentioned briefly. But it is well presented in the referenced publications, if needed.

14. Page 11168, Line 14-19: Can be reworded.

"Our data are also in good agreement with those reported for the North Sea (Jickells, 1995), the eastern Mediterranean (Cretan) Sea (Guerzoni et al., 1999), and the northern Levantine basin (Kocak et al., 2010)."

15. Page 11169, Line 10-11: Why there is a seasonal variation in the fuel consumption? Is this a local phenomenon near sampling site (Sevastopol)? Or is it attributed to any socio-economic activity?

Fuel consumption is increased on winter time mostly for heating purposes. It's maximum is on February due to local intra-annual variations in temperature.

16. Page 11170, Line 4: Are concentration same for both sites?

It says: "The average concentrations and the ratio of nitrate to ammonium are very the same for Sevastopol and Katsiveli in summer. The average summer concentration of IFN is equal to $1.3 \pm 0.29 \text{ mgN L}^{-1}$ and the ratio of nitrate to ammonium is equal to 1.40." We have found no statistically significant difference between two sites on summer time.

17. Page 11171, Line 19-23: How the concentrations are calculated on spatial scale over Black Sea? Does the contribution from other source region (especially near coast) are considered while extrapolating the IFN concentration?

We used the derived multiple regression equation (section 2.2) and meteorological data (section 2.3) to calculate both concentrations and atmospheric deposition of IFN over the Black Sea. In section 3.2, "We have found that the effect of local sources associated with large cities for typical conditions of Sevastopol is limited to coastal zone within 25 km distance. Despite the fact that local sources have no significant direct effect on off-shore areas of the sea, monitoring of IFN deposition remains important to correctly evaluate the budget of nitrogen in coastal waters near industrial sites. It is specifically true for winter, when these sources are most significant. Thus, the input of IFN to the major off-shore part of the Black Sea can be correctly estimated applying the multiple regression (Eq. 2). This is specifically true and important for open off-shore areas, where direct observations for rain events and sampling are hardly possible."

Technical comments: There are several grammatical errors and typo. Few are mentioned below.

1. Page 11161, Line 2: "... marine environments has Should be "... marine environment have ..."

"The importance ... has been revealed and demonstrated ..." It's all right, unless we miss the point of this comment.

2. Page 11163, Line 8: "... below clouds on ..." should be "... below clouds during ...".

We agree. "... below clouds during atmospheric precipitation ..."

3. Page 11165, Line 6: "... April 2005, accordingly ..." Should be "... April 2005, respectively ..."

We agree. It's "... April 2005, respectively."

4. Page 11167, Line 19: chlorophyll ...

Yes, it is "chlorophyll ..."

5. Page 11168, Line 8: Remove region.

Yes, we agree.