

Answers to Anonymous Referee #1

We thank the referee for the comments regarding our manuscript. Below we provide our answers (shown in italics) to these comments, and if changes were made to the manuscript also the modified text is given, with page and line numbers referring to the ACPD version of the paper.

The manuscript by Nieminen et al. reports on the predictability of new particle formation (NPF) events. Based on weather forecast (relevant parameters are the occurrence of clouds and rain), PM10 concentration (as a proxy for the condensation/coagulation sink), SO₂ concentration (precursor for H₂SO₄) and the air mass history a day is classified either as NPF day, no NPF day or day with a weak possibility of NPF. The algorithm for the decision making is based on long-term measurements at the Hyytiälä/Finland field station. NPF event predictions were made during the PEGASOS (Pan-European Gas-Aerosol-Climate Interaction Study) campaign in central Finland during May and June 2013. The parameters used for the NPF forecast are from the Finnish Meteorological Institute (weather forecasts as well as SO₂ and PM10 from the SILAM (System for integrated modelling of atmospheric composition) air quality model). In addition, HYSPLIT trajectories are used for evaluating the air mass history. NPF forecasts were made three days and one day in advance in order to decide whether Zeppelin flights for NPF measurement should be launched or not. Comparison between predicted and observed NPF events is presented to evaluate the predictability of the method. The authors report that out of 11 NPF events 10 were accurately predicted. The manuscript is very clearly written and shows relevant data. Therefore, I recommend publication of the manuscript after some rather minor points have been addressed.

General remarks:

(1) The authors report that 10 out of 11 NPF event days were correctly predicted. However, Fig. 4 (colored bars) reveals that out of 11 observed NPF events “only” 6 were predicted as NPF event days and 4 were predicted to be undefined days with the possibility of NPF. In addition, 19 days classified as undefined days with the possibility of NPF occurred but only 10 of them were correctly predicted as undefined days and 7 were forecast to be non-NPF days (2 were predicted to be NPF days). The following table gives an overview on the statistics:

	observed (# of days)	“NPF” predicted (# of days)	“undefined” predicted (# of days)	“no-NPF” predicted (# of days)
NPF	11	6	4	1
undefined	19	2	10	7
no-NPF	10	0	2	8
sum	40	8	16	15

We did not predict “undefined” days but rather the occurrence of NPF on the next day to be either (1) certain (NPF day), (2) possible (weak NPF/possibility of NPF), or (3) not possible (non-NPF day). The term “undefined day” is used for the classification of days based on observed particle size distribution evolution. In this regard, those 4 NPF days for which a possibility of NPF was forecasted can be considered successfully forecasted. Out of the 19 days classified as undefined based on DMPS data, those days when NPF or possibility of NPF was forecasted, can also be considered to be successfully forecasted.

We clarified the text on page 2469 lines 7–9 by adding a sentence: “Six of these days were also forecasted to be NPF days, and four to have a possibility of NPF to occur.”

In this regard, could the authors please specify what they ultimately decided in terms of the Zeppelin flights? Was a flight scheduled whenever NPF or an undefined event was predicted? Or was the Zeppelin only launched if a clear NPF day was predicted? As the Zeppelin flights were the motivation to forecast NPF events a bit more information on the actual decisions would be interesting. Maybe the authors could include a third row in Fig. 4 which indicates the Zeppelin flights.

The Zeppelin flights were also used to study other atmospheric phenomena than NPF. Therefore, the number of flight hours available for NPF studies was limited. Also other factors such as too high wind speeds or technical problems sometimes prevented the Zeppelin from flying, although NPF would have been forecasted to occur. As the focus of this technical note is to describe the NPF forecast method, we decided not add more details about the Zeppelin flights into the manuscript.

(2) It is not clear how the HYSPLIT trajectories were used. It is mentioned in section 2.2 (page 2463, line 21) that the trajectories were calculated 96 hours backwards in time but this would not allow making a prediction for the next three days.

The trajectories of the airmasses arriving at each hour to Hyttiälä were followed 96 hours prior to their arrival. Input meteorological data for the back-trajectory calculations was available for the next 8 days from GFS global weather forecasts. This way we were able to calculate the 96 hour forecast back-trajectories arriving at each hour to Hyttiälä during the next 3 days.

We modified the text in the beginning of chapter 2.2 to clarify this (page 2463, starting from line 16): “As input meteorological data for the model, we used the US National Weather Service's Global Forecasting System (GFS) weather forecast data which extends 192 hours forwards in time. The horizontal location accuracy of the air mass trajectory calculations using HYSPLIT has been estimated to be on the order of 10–30% of the total distance the air parcel has travelled (Stunder, 1996; Stohl, 1998; Draxler and Hess, 1998, 2010). We considered trajectories arriving each hour to Hyttiälä at 250-m height above ground calculated 96 hours backwards in time.”

(3) It is mentioned that predictions were made both 3 days and 1 day in advance. How good are the 3 day predictions in comparison to the 1 day predictions?

We have not done comparisons between the accuracy of NPF forecasts done for 3 days in advance and the final NPF forecast for the next day. Typically there were some changes in the forecasts, especially if the general weather situation was changing rapidly (cloudiness and occurrence of rain). In order to clarify that the NPF forecast results presented in the manuscript are from the one day predictions, we added on page 2462 to line 17 the sentence: “All the NPF forecast results presented in this work refer to the final NPF forecasts, i.e. forecasts for the next day.”

Other comments:

page 2461, line 10: please spell out “NT”

We added to the revised manuscript the definition “Neue Technologie” for the term “NT”.

page 2461, line 12: “central”

When referring to a geographical area, “central” should be written with a capital letter as is done in the manuscript.

page 2462, line 3: “Lappalainen et al., 2009”

Corrected.

page 2463, line 5: What values for SO₂ and PM₁₀ were actually used for the forecast if hourly

values are available? Was a forecast made for every hour of the day and then NPF was predicted if the algorithm yielded a positive outcome for just one specific hour, or was an average created somehow?

We paid special attention on the values forecasted by the SILAM model and weather forecasts for the early morning until around noon, as this is the time when NPF typically starts at the Hyytiälä station (see e.g. Dal Maso et al., 2005). We added the following explanation into the sentence on page 2464 lines 11–13: “Thus, our main criteria in forecasting NPF to occur was clear sky conditions, low condensation sink (in practise low PM10 concentration, which was obtained from SILAM) and low relative humidity in the early morning to noon-time, as this is the time when regional NPF events start in Hyytiälä (Kulmala et al., 2013).”

page 2463, line 24: insert blank before “but”
Corrected.

page 2465, line 4: delete the word “only”
We will keep the word “only” here, as we want to emphasize that NP1 is connected with only sulphuric acid proxy concentration while NP2 takes into account both sulphuric acid and oxidized organics proxies.

page 2466, line 20: after “2013”: insert the total number of days (40?) of the campaign as the number of days for certain events is mentioned below
We added the total number of days the campaign lasted, and modified the first sentence of Section 3.1 on page 2466 lines 19–20 to: “The PEGASOS-Zeppelin Northern mission was a 40-day-long measurement campaign between 3 May and 11 June 2013.”

page 2467, line 3: maybe better to write “... a longer period occurred during which transported polluted continental air dominated.”
We agree with the referee that this sentence could be more clear, and modified it into: “At the end of May, a longer period occurred during which more polluted continental air was transported from Central Europe to Hyytiälä.”

page 2467, line 12: remove the word “the”
Done.

page 2468, line 6: remove the word “the” before “Hyytiälä”
Done.

page 2468, line 7: remove the word “the” before “continental”
Done.

page 2468, line 9: remove the word “the” before “central”
Done.

page 2468, line 19: add the word “the” before “beginning”
Done.

page 2469, line 3: please spell out “DMPS” once
We added the full name of the instrument “Differential Mobility Particle Sizer” to this sentence.

page 2469, line 10: add the word “a” before “non-NPF”
Done.

page 2469, line 15: It is mentioned that on 10 days no NPF occurred but only one day was forecast to be an undefined day (28th May). However, there is another day with the same characteristics (17th of May, see Fig. 4).

The referee is correct, both 17th and 28th May were forecasted to have a possibility of NPF but were non-NPF days according to observations. We modified the sentence on page 2469 lines 13–15 to: “On 10 days of the campaign there was no particle formation occurring in Hyytiälä, and these were also forecasted to be non-NPF days, except two days (17th and 28th May) for which a possibility of NPF event was forecasted.”

page 2469, line 23: “24” instead of “23”? please check

The referee is right, 24 is the correct number of days forecasted as either NPF days of possible NPF days. We corrected this in the revised manuscript.

page 2475, table 1: check the unit of the absolute humidity (ppth); parts per thousand should rather be abbreviated as “‰” or be spelled out

We spelled out the ppth notation as “part-per-thousand” in Table 1. We also changed the term “absolute humidity” to “H₂O” in order to avoid possible confusions. The ranges of H₂O, SO₂ and O₃ on NPF and non-NPF days are all given as volume mixing ratios in Table 1.

page 2477, table 3: Could the authors please provide a short summary of the classification (class I and class II) in the manuscript text; a few explanatory sentences are probably sufficient.

We added a short explanation of the NPF classification principles to page 2469, starting on line 5: “On NPF event days a new mode of particles smaller than 25 nm is observed and these particles can be observed growing to larger sizes during several hours. NPF event days are further classified according to the possibility to reliably derive particle formation and growth rates (Class I) or not (Class II). The days when no new sub-25 nm particles were appearing were classified as non-NPF days. Undefined days are those days for which it was not possible to unambiguously determine whether NPF occurred or not.”