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Atmospheric Measurement Techniques Discussions

Interactive comment on "Adaptive neuro fuzzy inference system for profiling of the atmosphere" *by* K. Ramesh et al.

Anonymous Referee #3

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In this paper, temperature and humidity profiles are retrieved from ground based microwave radiometer (MWR) using Adaptive neuro fuzzy inference system (ANFIS) for the region centered around NARL, Gadanki, India. The method has been compared against the artificial neural network retrieval algorithm which has been in use for temperature and humidity profile retrieval from MWR. The retrieval approach using ANFIS is shown to be superior over ANN. The attempt of using ANFIS for retrieval is appreciated and this work also has the potential for publication; however, the authors have to make significant changes to make this paper scientifically appealing. The paper needs to be organized and structured properly and following are some of the major revisions.

Major comments

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Interactive Discussion

Discussion Paper

In general, this paper has to be substantially revised. Many sentences are vague and seem to convey the wrong information. This paper lacks a through literature survey and many facts have been quoted without giving a proper citation. The introduction in this paper is a mix of methodology, results and some general facts, at the same time lacking citations for the previous works which have employed ANFIS for retrieval. This is odd as far as scientific paper writing is concerned. Methodology and results need to be presented under their respective sections and not in the introductory part. Simply doing a google search will help the authors to find papers which can be mentioned in the introduction. Another weakness which I found is the way the ANFIS method has been introduced. Please note that the ANFIS method is just for fine tuning the fuzzy rules and it works similar to ANN. I believe that the retrieval accuracy using Fuzzy logic based retrieval approach is not so different from that of ANFIS. The important part here is the formation of fuzzy rules, relating the MWR brightness temperature to atmospheric temperature and humidity values for each layer in the atmosphere. More effort should be put in to explain this part clearly and concisely. This paper fails to provide adequate information in this regard.

Authors should also mention the source of the algorithm used in this paper. A good explanation of the algorithm and proper citations of similar previous works will improve the paper and also help the readers to understand and use the method. Though it is demonstrated that ANFIS retrieval perform better than ANN, I am afraid that the statistics are not robust enough to convey a meaningful conclusion. I say this mainly because of the low number of data points used in training and validation. I don't think MWR can give useful information under rainy conditions. I strongly suggest a redoing of the retrieval calculations including more number of datasets for the training and validation phases to provide an unbiased estimate of retrieval accuracy. This should be performed for rainy and non-rainy conditions separately. Also, the explanation on setting up of ANFIS algorithm for retrieval is very vague. The authors may improvise on the following,

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The title

Since the work is intended for temperature and humidity profile retrieval and not for profiling the atmosphere, the tile should reflect this.

Abstract

Line 10: What is meant by modelling the profiles of atmospheric parameters? Aren't the MWR measurements used to retrieve the temperature and humidity profiles?

Line 10: In this work ANFIS is not used as a forecast model rather it is used for retrieval. Please change.

Line 20: The error analysis of profiles concludes that the retrieved profiles using ANFIS technique have improved the retrievals substantially; however, retrieval of RH by both techniques (ANN and ANFIS) has limited success > First of all, you are not doing any error analysis on profiles rather it is done on the retrieved profiles. Secondly, it is not clear as to where the ANFIS retrieval has improved? Do you mean temperature retrieval?

Introduction

Page 2718, Line 15: Many nonlinear statistical/evolutionary algorithms are being developed to retrieve the profiles of the atmosphere using MWR. Artificial neural networks (ANNs) are one of them, which are widely used for different types of infrared and microwave sounding instruments > Please provide references. The following sentence should also be provided with reference.

Page 2718, Line 15: The observed profiles of equivalent potential temperatures indicate preconditioning of the vertical column of the atmosphere to be conducive to the occurrence of thunderstorms about 3–4 h prior to their actual occurrence (Fig. 1a) > This is actually a result, so please remove this part to the introductory part of the result section. Also, please mention the source of the profile of potential temperature.

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Page 2718, Line 20: The ANN used in this MWR is useful to train vertical profiles observed at sites using radiosonde observations, microwave radiances and vertical distribution of weighting functions > What is conveyed here? Is it that ANN is trained with an ensemble of profiles and the corresponding MWR brightness temperatures? What is the role of weighting function here please? Do elaborate.

Page 2719: ANFIS is a nonlinear computational intelligent system that adapts itself by forming rules to survive with changing environment and uncertainty > Please note that ANFIS does not form any rules. Basically, it strengthens the relationship between input and output devised through the fuzzy logic approach. Move the following sentences on fuzzy logic and ANFIS to appropriate section in the Methodology part. Instead, a through literature survey on previous studies done with ANFIS can be provided here.

Page 2719: ANFIS tunes a Sugeno-type interface system and generates a single output of a weighted linear combination of the consequents (Jang et al., 2007). Therefore, such methods are useful for retrieving atmospheric profiles based on the passive microwave remote-sensed brightness temperatures at different frequencies observed by MWR > The ANFIS method hasn't even been introduced here and prematurely saying that it generates single output of a weighted linear combination of the consequents will only confuse the reader. This needs to be removed from this part.

Page 2720: These channels are selected based on their sensitivity to the occurrence of thunderstorms over the study site > Under rainy conditions, MWR measurements are not very useful. Then how relevant is the channel sensitivity here?

Page 2720: From available observations, 80% of observations are used for training of ANFIS and 20% of observations are used for the validation of the ANFIS model > Please clarify as to how many data points you have in total and out of this, how many are used for training and validation?

Page 2720: same period of the training data set '???' Lacks clarity and seems vague. Also applicable for all places this appears.

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Page 2721: I have a general suggestion about the structure of the methodology part. The authors could introduce the fuzzy logic part first, providing the details of fuzzy logic and the nature of fuzzy rules used in the present algorithm. Then then could move to detailing the clustering algorithm applied to the dataset. This can be followed briefly by the ANFIS part, the ANFIS model structure. The authors may cite the reference of Jang paper here. But do provide the details of how the inputs and output are handled in the network since the ANFIS network changes premise (input) and consequent (output) parameters during the training phase, which is worth mentioning.

Right now, under section ANFIS, the description on fuzzy logic and ANFIS are mixed up. In this section, some works related to ANFIS are cited which are best placed if moved to the introduction section.

Page 2721, Line 15: The fuzzy logic is used for classification of the input data set in different classes and forms the input to an artificial neural network. Then ANN is used to predict the output based on the training data sets. Thus fuzzy logic controls the way of processing data by its classification to minimize the error in the neural network prediction (Tahmaseb and Hezarkhani, 2010) > Fuzzy logic is not used for the classification of input data, but is used for formulating a relationship between input and output through IF –THEN statements and it does not minimize any error. I think the authors have some real confusion about how the whole formulation works. Please consider rewriting.

Page2721, Line 20: To avoid this, subtractive fuzzy clustering has been used to build the fuzzy rules. This helped in reducing the number of rules, automatically determining the number of clusters by assuming each data point as a potential cluster center and creates clusters based on the density > As I have mentioned earlier, the details on the clustering part should come under fuzzy logic formalism and the explanation could be more elaborative.

Page2722 ANFIS model structure: Again note that the authors have mentioned about

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the fuzzy logic and data clustering here which should be removed. See my comments above about the suggested structure of the methodology.

Page2723: When acronyms are used for the first time in the main text, they should be expanded.

Page2725: You may remove Figure 3 from the paper showing the retrieval performance of the algorithm during the training phase; this doesn't convey any information about the actual retrieval accuracy of the present algorithm. It is not surprising that the network provides the best fit for the training dataset. You may mention this in the text if you like.

Page2725, Line 10: Please note that the RMSE of RH should be in % RH and not in degree Celsius. This is attributed to a relatively higher frequency of observations available over these heights that enabled better learning of the ANFIS algorithm. Why are the numbers of observations different for different heights?

Page2725, Line 20: Figure 4 is not at all clear. How many observations are there for days which are shown in the x-axis and also for what height is this shown?

Note that the MWR channel sensitivity lies within 0-4 km of the troposphere and the degradation of the retrieval accuracy at higher altitudes especially for RH profiles results from lack of information content from these heights. Authors may mention this in the text. The figures 5(d) and 6 (d) show that the biases in temperature and humidly retrieval using ANFIS is not systematic and it is of random nature; at the same time, the ANN retrieval seems to have systematic biases. The reason for this behavior should be mentioned. It would also be appropriate to do a scatter plot between retrieved and observed value which will give an idea about the regions where retrieval performance is good / bad.

Another aspect worth looking into is the impact of clouds on observed MWR brightness temperature and consequently its retrieval. Since the MWR channels are sensitive to temperature and humidity fluctuations with in the boundary layer, the presence of liquid

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clouds do affect the brightness temperature observed in MWR water vapour channels centered around 22 GHz. During June to September, low level clouds (liquid clouds) are persistent over the Indian land region. Therefore, the authors could also think about the impact of liquid clouds on humidity retrieval below 4 km altitude.

Finally, it is also recommended that the authors go for thorough grammatical corrections.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2715, 2014.