Atmos. Meas. Tech. Discuss., 7, C4134–C4139, 2014
www.atmos-meas-tech-discuss.net/7/C4134/2014/

Atmospheric Measurement Techniques
Discussions

Interactive comment on "Forecast indices from ground-based microwave radiometer for operational meteorology" *by* D. Cimini et al.

D. Cimini et al.

domenico.cimini@imaa.cnr.it

Received and published: 9 December 2014

While this paper was very well written and seemed to accomplish its goal of demonstrating the utility of alternate sources of weather forecast indices, there is at least one significant change to the analysis that needs to be completed prior to its publication as a peer-reviewed contribution to the scientific literature.

We thank the reviewer for the careful review and the encouraging feedbacks.
Our replies are shown in red hereafter, while modifications to the text are highlighted in yellow within the revised manuscript.

Major comments:

Much of the analysis of the correlation between radiosonde-derived and microwave radiometer profiler (MWRP) –based forecast indices (FI) centers around the K index. This is not an index that sees widespread operational use. At least in the United States (where I am most familiar with forecast procedures), it's been long since surpassed by other indices that take into account information from many more levels of the atmosphere. The K index requires only five pieces of information: the temperatures at 850, 700, and 500 hPa and the dew point temperatures at 850 and 700 hPa. In terms of data required, this is possibly the simplest severe weather forecast index that there is; even the computationally simpler lifted index (LI) requires multiple observations in the surface layer in order to characterize a surface-based parcel.

We agree with the reviewer that the K index is possibly the simplest severe FI. It is also widely used worldwide. For the above two reasons, the K index has been selected to introduce the results (Fig. 2,3,6,9 of the original manuscript). However, the same analysis is shown for other 8 indices (Fig. 4,5,7,8,10,11 of the original manuscript) and statistical results for 13 indices are given in Tab. 2 and 3 (including CAPE). At the time of writing, we performed a quick survey among few forecasters to investigate which of the many FI available were most desirable. K index and KO resulted to be the most wanted.
In any case, we agree with the reviewer that other convective FI are also widely used and thus we decided to add one Figure (3 of the revised manuscript) and corresponding discussion on CAPE and CIN.

An index that is used far more prevalently is the Convective Available Potential Energy. This index has the advantage of being a vertically integrated parameter that takes into account the state of the atmosphere throughout the depth of parcel ascent. It also has the advantage of being a physical parameter: the vertically integrated buoyant energy associated with a parcel make much more intuitive sense than adding some dew point values to an environmental lapse rate. However, the radiometer did not do a good job of recreating the CAPE values observed by the radiosonde, with correlation coefficients much less for CAPE than for the other FI. I would assume that this is due to the integrated nature of CAPE and the fact that the vertical resolution of the MWRP-derived profile means. I am concerned about the lack of analysis for such an important parameter, one at which the forecasters using operational MWRP-derived FI would be constantly looking. Although the results would not be as promising from the perspective of encouraging radiometer use for operational forecasting, there would be of greater use to the forecasting community.

Agreed. In the revised version, we have added a new Figure (3 of the revised manuscript) showing two 24-hour time series of CAPE for the same cases K index is shown in Fig.2. A new paragraph has been added to discuss the value of CAPE, drawing to similar considerations as for K index. As the reviewer points out, CAPE was already among the FI considered in the first version (Tab.2-3), showing in general (but for 1DVAR in Whistler) lower correlation coefficients than other FI. Note that CAPE statistics are based on a smaller sample, since CAPE by definition is not always determined. We have added this information to Section 4.
We concur with the reviewer that the low/moderate vertical resolution of MWRP retrievals is responsible for most of the difference with respect to radiosonde (smoothing error). The integrated nature of CAPE should help in this regard, as MWRP is most sensitive to integrated quantities (as geopotential height or precipitable water vapor). However, the smoothing error causes uncertainties in the location of the integral boundaries (level of free convection (LFC) and equilibrium level (EL)) which fold into CAPE uncertainty. We have added this information to Section 2.2 and at the end of Section 4.

Furthermore, there was no discussion of convective inhibition (CIN) which is more important to operational forecasting than many of the indices presented.

Agreed. We acknowledge that CIN was not considered in the first version. In the revised version, we have added a new Figure (3 of the revised manuscript) showing two 24-hour time series of CIN and related discussion. Statistics for CIN have been

added to Tab.2-3 and new Table 4.

In addition, there needs to be some discussion about why the 1-DVAR retrievals outperformed the others when it comes to FI values as compared to radiosondes. As stated on p. 6978, the upper-tropospheric observations depend primarily on the NWP output. However, what role did the radiosondes have in calculating the NWP output? Are the 1-DVAR retrievals really the best as compared to the sondes? Instead, are they merely the ones that have the most influence from the radiosonde, in which case the similarity in retrievals would be expected? This point needs to be addressed prior to claiming that 1-DVAR outperforms the others.

The reviewer raises a good point. The NWP output, providing most of the information on upper troposphere to 1-DVAR retrievals, benefits from recent radiosonde data being assimilated. However, other observations focusing on upper troposphere are assimilated as well, such as microwave/infrared satellite soundings and GNSS radio occultation. Thus, radiosondes are not the only source of information on upper troposphere being assimilated into NWP.
In addition, it is worth stressing that the radiosonde observations used for validation are not assimilated into NWP at the time of comparison, so they provide a really independent dataset. We have added this information to Section 3.1. Nevertheless, following the reviewer's suggestion, in the revised manuscript we specify that "1-DVAR provides better agreement with radiosondes than other considered methods" (see Section 3.1).

Minor comments:

p. 6974, line 25: Wagner et al. (2008) delve into the topic of infrared-derived FI and high temporal resolution observations of FI with greater depth than Feltz and Mecikalski (2002): Wagner, T. J., W. F. Feltz, and S. A. Ackerman, 2008: The temporal evolution of convective indices in storm-producing environments, Wea. Forecasting, 23, 786-794.

Thank you for providing this reference, which is now cited and listed among the others.

Tables 2 and 3: Due to the substantial differences in magnitude between the various FI, it is difficult to ascertain which FI are best captured by the MWRP. It would be extremely helpful if an appropriate statistical measure were normalized by the mean value of the FI to give a percentage error.

Agreed. Following the reviewer's suggestion, we have added a new table (Table 4) summarizing the results for all FI, retrieval methods, and data sets. As the normalized statistical measure we adopt the Normalized RMS (NRMS), i.e. RMS divided by the range of observed values. NRMS is little sensitive to the occurrence of zero values and thus it seems appropriate for all FI.

Technical corrections:

p. 6972, line 25. Commercial microwave radiometer profilers, not radiometers profilers

Agreed. Thank you for spotting this typo.

p. 6975, line 6. Delete the word few, or say "a few additional FI."

Agreed.

p. 6975, line 21. radiosondes experience some errors, not suffer of some error sources.

Agreed.

p. 6977, line 13. It has already been stated that the software is proprietary. It doesn't need to be stated again.

Agreed.

p. 6980, line 17. The observatory was already referred to by its German name on page 6978 (line 12). Here it is referred to with an English name. The names should be consistent.

Agreed. In the revised manuscript the observatory in Lindenberg and the relative

acronyms are introduced at the beginning of Section 2. Both the English and German names are given. The acronyms are then used throughout the manuscript.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 6971, 2014.