Response to Referee #1

The reviewer's comments are *in italic* and our response in normal font.

General Comments

The authors present a trend analysis for future projections of seasonal precipitation based on the meteorological drought index, SPI, for Poland. Projections are based on an ensemble of RCM runs, providing high spatial resolution. The projections show an overall increase in precipitation during the winter and a slight decrease in precipitation during the summer, with some model disagreement. The effect of bias correction on these projected trends was evaluated and found to have a small effect, but which is smaller than the variability among GCM/RCM model combinations. The paper is extremely well-written, clear, and easy to understand. It provides high resolution projections and a non-parametric trend analysis of seasonal precipitation for Poland, which is worthy of publication, and asks an interesting research question – whether bias correction affects projections of the drought index, SPI. However, I have two major issues relating to the lack of a focus on drought and insufficient testing regarding bias correction. These are described below. Because of these fundamental issues, I recommend a major revision.

Answer: We thank the reviewer for the encouraging words and helpful comments.

Major comments

I have 2 primary issues with the paper:

1. *The paper claims to be measuring trends in drought and discusses meteorological drought throughout. While the authors use the SPI, a drought index, they measure trends across the entire range of SPI values, which includes both wet and dry anomalies. Thus, the paper really deals with trends in seasonally accumulated precipitation, or general dryness/wetness. For example, extreme rainfall (SPI > 1) events increased in severity or frequency, while drought events (SPI < -1) remained the same, the trend would show an overall increasing trend in SPI, which the authors would incorrectly classify as a decrease in droughts. While overall wetness and droughts are potentially related, they are different and do not have to respond in the same way. The authors cite the study by Rimkus et al. (2012) which did specifically measure droughts, looking at trends in drought "intensity", defined as the sum of negative SPI values for a region. They later begin defining drought thresholds (Page 10341, Line 1), but this is never mentioned again. My recommendation is either to (a) change the title and text to reflect a focus on accumulated precipitation, or (b) focus analysis on drought occurrence, either based on area below a threshold or the sum of SPI below a threshold. The results shown here are interesting in their own right, so either choice would be acceptable.*

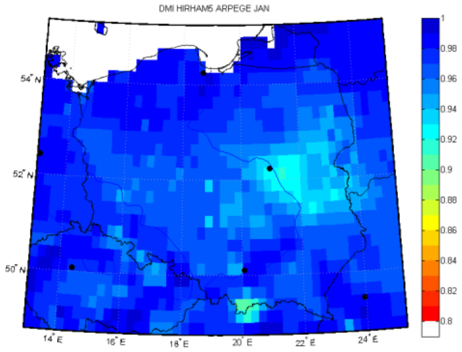
   Answer: This is a very valid point, and as we wish to retain the focus on seasonal wetness vs. dryness, we will change the title as you have proposed, i.e. to "The influence of bias correction on trends in projected seasonally accumulated precipitation under a future climate in Poland". The changes in text are included in the corrected version of manuscript.

2. *The title and much of the text focuses on the effect of bias correction on trends in SPI. I have serious questions with this premise and the conclusions that bias correction has a slight effect on trends in SPI values (Page 10336, Lines 8-11; Page 10350, lines 3-8; Section 3.3). SPI is a normalized index based on quantiles, though it uses a gamma distribution rather than the*

empirical cumulative distribution to calculate them. Thus, SPI uses a similar quantile fitting procedure as bias correction and thus bias correction should have nearly negligible difference. This can be seen in Figure 10, where the differences in significant trend areas are generally within 10% and are generally centered around 0 (except February). The only effect from bias correction should be due to (a) distribution fitting differences, (b) differences at the very extreme values, or (c) the difference between summing months first and normalizing (no bias correction) and first normalizing, summing, and then normalizing again (bias correction). The examples provided (e.g. Maurer and Pierce 2014) deal with bias correcting precipitation, rather than a relative metric like SPI, which is a very different question. Comparing differences between trends in bias-corrected and non-bias corrected SPI values skips the important step of determining whether there is a significant difference in SPI values themselves between the two. Given the above explanation, I doubt there is. In order to support your claim, I recommend quantifying the difference in corrected and non-corrected SPI time series using metrics like correlation, mean squared error, or mean absolute error.

Answer: We present an analysis of the influence of bias correction on trends in precipitation totals and SPI values. We agree that factors such as errors associated with the fitting of the distribution for bias correction will may have an effect on the slope of trend. However, we have also presented an explanation on pages 10352-10353 illustrating how bias correction can change the slope, quite independently of such errors. Our explanation addresses two issues: (i) the effect of bias correction on the trend in the aggregated precipitation and (ii) the effect of that trend on the SPI values. It is shown that the application of bias correction by quantile mapping method does not change the sign of estimated trend of aggregated precipitation but may change the slope. The bias correction also influences the trends in the SPI values. Due to monotonic relationship between the aggregated precipitation and SPI the direction of changes in precipitation is reflected in changes of SPI.

However, following the reviewer's comments, we recognise the importance of distinguishing between changes in the slope due to the fitting of the distribution and due to the bias correction itself. We therefore provide the results of correlation analysis between corrected and uncorrected SPI time series by presenting 12 maps illustrating the Pearson correlation coefficient between raw and corrected SPI 1 for the DMI HIRHAM5 ARPEGE model. For all grid cells and all months the correlation is statistically significant at 5% level.


DMI HIRHAM5 ARPEGE JAN
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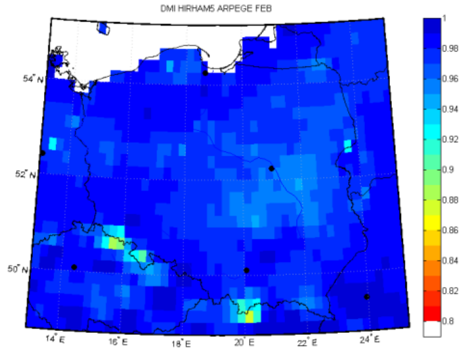
DMI HIRHAM5 ARPEGE FEB
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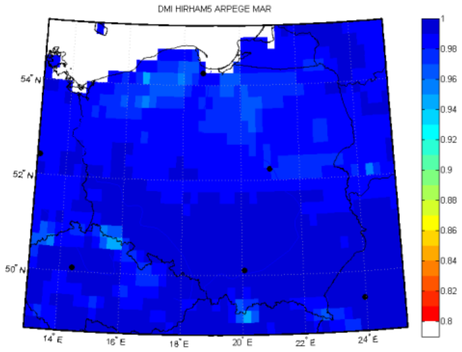
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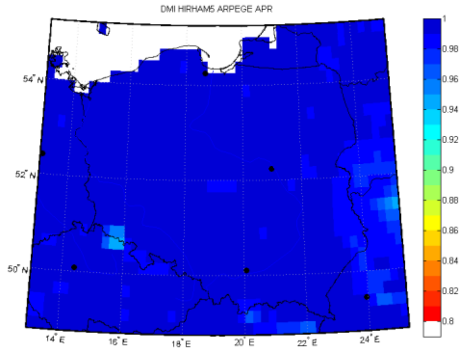
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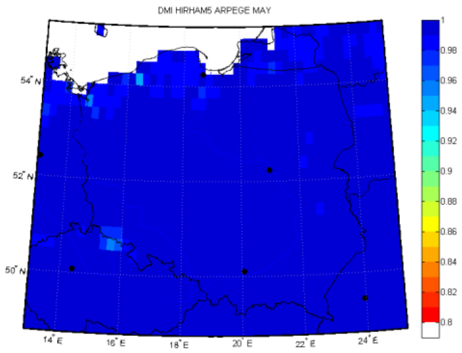
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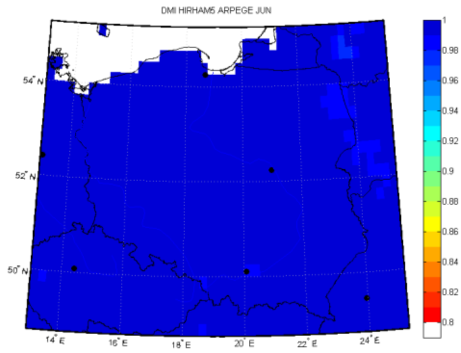
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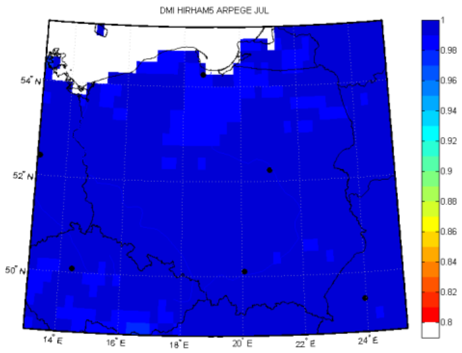
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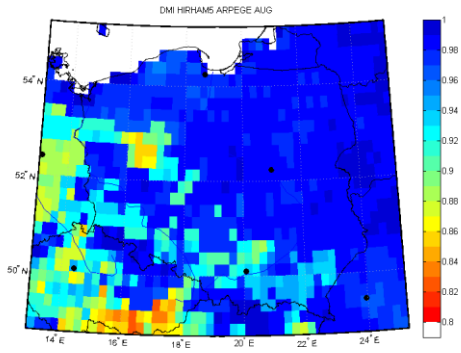
DMI HIRHAM5 ARPEGE AUG
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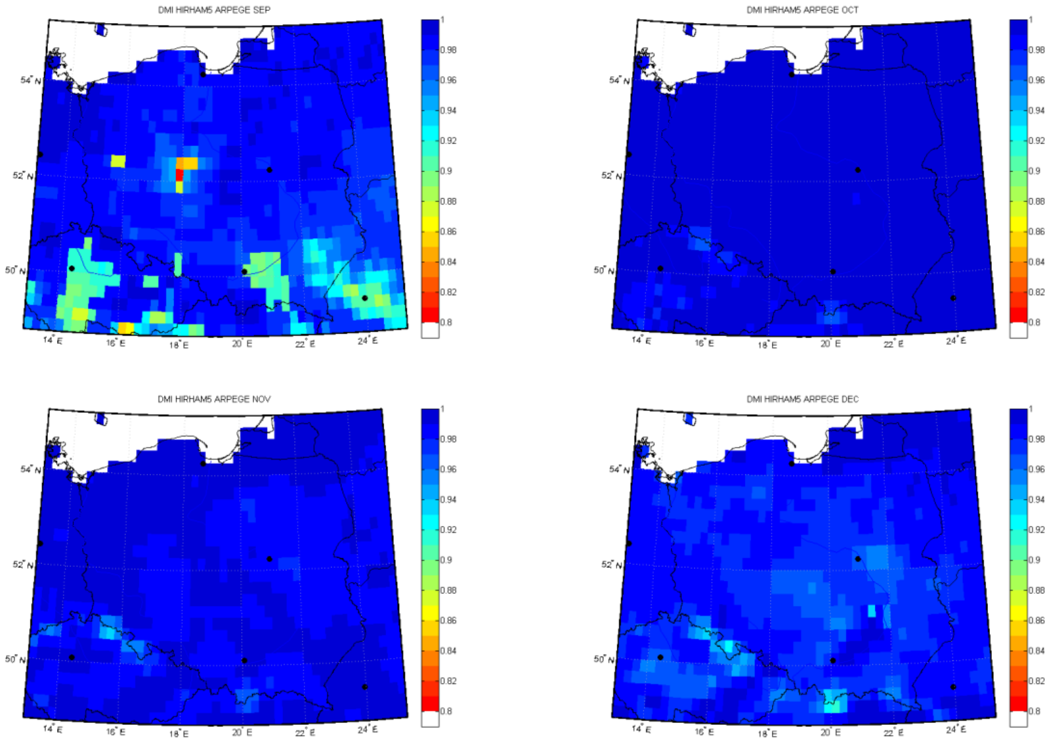


Figure 1 Estimated values of Pearson correlation coefficient between raw and corrected SPI 1 for DMI HIRHAM5 ARPEGE model

The results of correlation for SPI are summarized in the Table 1 and 2. In all cases the correlation coefficient is statistically significant and above 0.8, indicating nearly linear relationship between both indices, which in fact can easily be derived analytically for a specific case The correlation between SPI values for bias-corrected and raw precipitation projections depends on bias correction parameters (eq. 3), i.e., the type of model applied, and the SPI –precipitation transformation, illustrated in Figure 14.

Table 1 Estimated minimum values of Pearson correlation coefficient between raw and corrected SPI 1 for six climate models and 12 months

	GCM	ARPEGE		ECHAM5		BCM	
Index	RCM	DMI HIRHAM	RM51	MPI M REMO	KNMI RAC MO2	DMI HIRHAM	SMHI RCA
SPI 1	JAN	0,9002	0,9043	0,9434	0,9391	0,9134	0,9059
	FEB	0,8718	0,9104	0,9055	0,9252	0,8783	0,8932
	MAR	0,9452	0,9341	0,9502	0,9396	0,9018	0,9551
	APR	0,9436	0,8964	0,9638	0,9589	0,8939	0,9374
	MAY	0,9490	0,8897	0,9343	0,9680	0,9568	0,9711
	JUN	0,9738	0,8544	0,9440	0,9573	0,9582	0,9173
	JUL	0,9749	0,9368	0,9488	0,9698	0,9415	0,9798
	AUG	0,8200	0,9513	0,9436	0,9207	0,9217	0,9614
	SEP	0,8064	0,9730	0,9728	0,9619	0,9260	0,9702
	OCT	0,9601	0,9386	0,9666	0,9529	0,8253	0,9028
	NOV	0,9364	0,9592	0,9619	0,9591	0,9332	0,9161
	DEC	0,9103	0,9492	0,9687	0,9721	0,9138	0,9532

SPI 3	DJF	0,8679	0,9344	0,9580	0,9588	0,9215	0,9157
	MAM	0,9171	0,8450	0,9544	0,9542	0,9187	0,9604
	JJA	0,9376	0,9105	0,9436	0,9664	0,9224	0,9592
	SON	0,8758	0,9429	0,9462	0,9508	0,8788	0,9134
SPI 6	NOV-APR	0,9014	0,9348	0,9534	0,9660	0,9214	0,9220
	MAY-OCT	0,9077	0,9077	0,9369	0,9659	0,8874	0,9626
SPI 12	Calendar year	0,8522	0,8840	0,9450	0,9514	0,8680	0,9360
SPI 24	Two calendar years	0,8651	0,9029	0,9411	0,9479	0,8450	0,9137

Table 2 Estimated mean of Pearson correlation coefficient between raw and corrected SPI 1 for six climate models and 12 months

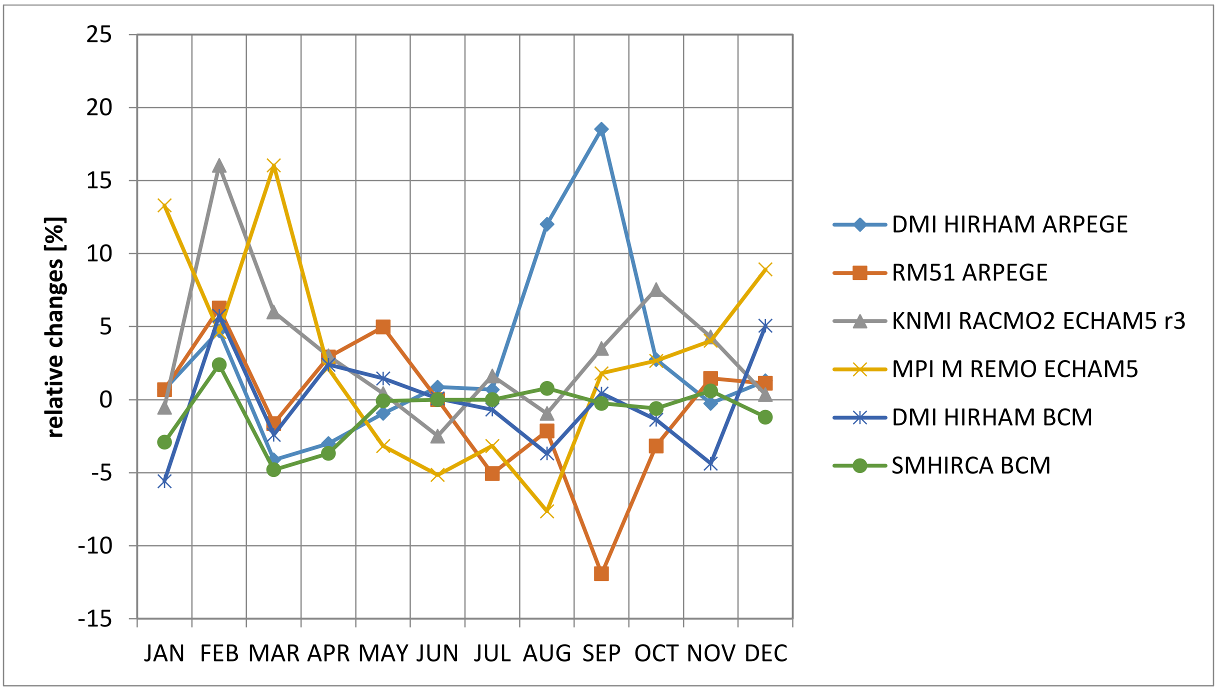
	GCM	ARPEGE		ECHAM5		BCM	
Index	RCM	DMI HIRHAM	RM51	MPIM REMO	KNMI RACMO2	DMI HIRHAM	SMHI RCA
SPI 1	JAN	0,9717	0,9745	0,9832	0,9823	0,9746	0,9694
	FEB	0,9770	0,9758	0,9765	0,9800	0,9728	0,9670
	MAR	0,9874	0,9757	0,9864	0,9861	0,9794	0,9848
	APR	0,9937	0,9529	0,9882	0,9928	0,9870	0,9864
	MAY	0,9948	0,9425	0,9884	0,9936	0,9940	0,9948
	JUN	0,9963	0,9481	0,9908	0,9955	0,9965	0,9882
	JUL	0,9937	0,9744	0,9906	0,9969	0,9916	0,9948
	AUG	0,9639	0,9834	0,9843	0,9860	0,9880	0,9921
	SEP	0,9751	0,9917	0,9962	0,9958	0,9882	0,9931
	OCT	0,9954	0,9845	0,9909	0,9833	0,9707	0,9717
	NOV	0,9904	0,9915	0,9938	0,9885	0,9846	0,9786
	DEC	0,9810	0,9885	0,9947	0,9933	0,9894	0,9884
SPI 3	DJF	0,9703	0,9784	0,9865	0,9831	0,9805	0,9757
	MAM	0,9867	0,9430	0,9839	0,9891	0,9786	0,9880
	JJA	0,9794	0,9680	0,9836	0,9932	0,9866	0,9902
	SON	0,9647	0,9782	0,9848	0,9766	0,9764	0,9802
SPI 6	NOV-APR	0,9770	0,9712	0,9848	0,9874	0,9811	0,9781
	MAY-OCT	0,9620	0,9649	0,9835	0,9860	0,9786	0,9861
SPI 12	Calendar year	0,9392	0,9542	0,9790	0,9806	0,9710	0,9832
SPI 24	Two calendar years	0,9422	0,9559	0,9784	0,9815	0,9727	0,9851

Moderate Comments

1. *Title: Based on the above comments, I recommend adjusting the title to focus more on overall dry/wet trends, rather than on drought and bias correction.*

   Answer: As mentioned above, we wish to change the title of the article to address this issue.

2. *Page 10341, Line 12: It would help if you distinguished between the reference period for bias correction (1971-2000) and the reference period for SPI normalization (1971-2099). It might also be helpful to add these reference periods to Figure 1 to help make this distinction. Tied into the issue of reference periods is your claim that it is better to use the entire period (1971-2099) to normalize SPI values based on Wu et al. (2005). By using the entire time series as a reference period, you force the SPI values to follow a normal distribution; however, it causes difficulties in interpretation when there is a detectable trend in SPI values. For a stationary timeseries, an SPI of 0 means that precipitation is near the median value of the reference period. But, for a non-stationary time series, this refers to the median value along the trend. For instance, if SPI was calculated based on a historical time series (e.g. 1971- 2000), an SPI of 0 would mean that precipitation was "typical" based on the reader's experience. But, using the full time series (1971-2099) with a linearly increasing trend, "typical" conditions should occur sometime around 2035. What the reader considers typical, i.e. historical and current climate conditions, would actually be considered drier than typical, with SPI values less than 0. As stated above, both reference periods allow for a valid analysis of trends as shown in this study, but there may be difficulty with interpretability moving forward.*
   Answer: Following the recommendation of Wu et al (2005) the aggregated precipitation totals from the entire period (1971-2099) were normalized. We agree that that assumption may lead to some difficulties in interpreting the results. The method proposed by the reviewer consists of developing a nonlinear transformation (normalization) for the present period (for example 1971-2000) and further applying that transformation for future climatic conditions. That approach also has some drawbacks. The most important are problems related to the extrapolation the nonlinear relationship for normalization. Future climatic conditions could be different than the observed ones; therefore an application of a relationship based on the present conditions could lead to extrapolation outside the range of observed values. The second problem is related to interpretation of estimated SPI values for changed climatic conditions. The estimates of these values could be outside of the range [-3,3] that ensures comparability of the results. The third problem with the alternative approach is related to shorter time series that could results in errors in the fitting of the distribution and the normalization of the aggregated time series. This problem is mentioned in the work of Wu et al. 2007. They state that having an absolute value of the median smaller than 0.05 guarantees that the middle value of estimated SPI values is not greater than +-0.05.
   In addition, the analysis of SPI values based on the entire time period gives an opportunity to estimate the tendency in changes in the SPI time series, and this is one of principal aims with this work. For these reasons, we wish to retain the approach we have used.
3. *Figure 10: This figure is unclear. Is this a stacked bar graph? If so, each GCM/RCM combination is independent and should not be added together. If they are not being added together, then showing them stacked is confusing. A simple line graph showing each GCM/RCM's progression through time would be more readable.*
   Answer: Updated



Discussion of the results should be expanded. The authors list several papers in the introduction that deal with climate projections and precipitation in Europe. The results show a consensus for wetter winters and generally drier summers, though there is more uncertainty in the summer. How does this compare, for instance, with Rimkus et al. 2012 or Liszewska et al. 2012? You may also compare with results from additional studies listed in the minor comments.

Answer: This expanded discussion will be included in the revised version of the paper

Analysis of the potential impact of climate change on drought in Poland has been addressed by relatively few studies at a regional scale. Rimkus et al. (2012) analysed 50-year trends (1960-2009) under the recent climate and drought projections for the future climate (up to 2100) in the Baltic Sea region using the Standardized Precipitation Index (SPI). For the assessment of the observed climatic conditions, gridded precipitation time series at 1-degree resolution from the Climate Research Unit at the University of East Anglia were used. The trend estimated using a Mann-Kendall test indicated an increase in the SPI values for different time averaging periods over most of the studied area, except for Poland, where decreases were found. Future dryness was projected using COSMO Climate Limited-area Model (CCLM) driven by initial and boundary conditions from ECHAM5/MPI-OM GCM for two emission scenarios (A1B and B1). According to both scenarios, the intensity of drought will likely decline in most of the Baltic Sea area, except in southern areas, including Poland. Following the A1B scenario, drought occurrence will increase in the summer months in the future in those regions. Some of the findings of Rimkus et al. (2012) can be compared with the results presented here. They both include simulations following the A1B emission scenario driven by ECHAM5 GCM. Our results in some aspects (e.g. tendency of changes of annual sum of precipitation) are similar to those presented by Rimkus et al. (2012) but also differences can be noticed. These differences result from different spatial resolution and an application of a different regional climate model.

The analysis of the impact of climate change on drought in Poland, carried out within the framework of the project "Development and implementation of a strategic adaptation plan for the sectors and areas vulnerable to climate change" with the acronym KLIMADA (klimada.mos.gov.pl), indicated that future predictions of annual total precipitation do not show any clear trends (Liszewska et al., 2012). The assessment of trends in seasons shows an increase in winter precipitation (DJF) of up to 20% in the eastern part of Poland and a decrease in summer precipitation in south eastern Poland. In contrast, changes in precipitation in spring and autumn tend to be much smaller (Liszewska et al., 2012). The number of dry days with daily precipitation of less than 1 mm shows an increasing trend. These changes are more pronounced in eastern and south eastern Poland (NAS, 2013). Those findings by Liszewska et al. (2012) are confirmed in this paper.

Analysis of an impact of climate change on drought using a meteorological water balance (defined as the difference between evapotranspiration and rainfall for a given period) for three periods 1971-2000, 2021-2050 and 2071-2100 was carried out by Osuch et al. (2012). The results of the assessment indicate significant differences between projections derived from the different climate models analysed. A comparison of the median of the ensemble of models in these three periods indicates an increase in water scarcity in Poland. These changes are more pronounced in the south eastern part of Poland. Those results confirm the SPI12 analysis outcomes presented in this paper.

Changes in European drought characteristics projected by PRUDENCE regional climate models were studied by Bleckinsop and Fowler (2007). In that work six climate model simulations were analysed following the SRES A2 emission scenario. Similarly to our findings, a considerable model uncertainty due to inter-model variability on regional and local scales was demonstrated. The projections indicate likely decreases in summer and likely increases in winter precipitation. For longer duration droughts, the projections indicate fewer droughts in northern Europe due to larger increases in winter precipitation and more droughts of increasing severity in the south. Our results confirm these general findings with differences due to different emission scenario as well as climate models.

The study by Orlowsky and Seneviratne (2013) presents an analysis of the SPI12 at a continental scale. The results for Central Europe show an increasing trend in median SPI 12. The new study by Stagge et al. (2015) presents an analysis of meteorological drought using the most current climate models (23 simulations) for the three projected emission scenarios (rcp2.6, RCP4.5 and RCP8.5) for Europe at spatial resolution of 0.11 degree (~12.5 km). The meteorological drought was estimated with the help of SPI at 3, 6 and 12 month aggregation periods. In that work the relationship between aggregated precipitation and SPI was developed for the reference period (1971-2000). Then the same transformation was used for future scenarios (2011-2040, 2041-2070, and 2071-2100). The analysis of changes in SPI between future and present periods was conducted with the help of the parametric two sample t-test and the non-parametric Mann-Whitney test. The results indicate that precipitation is likely to increase in central and northern Europe therefore that area is likely to experience fewer precipitation-based droughts. In general, our study confirms the results of Stagge et al. (2015) with some differences due to different climate models, emission scenarios and change estimation methods applied. Our selection of climate models provides larger differences between meteorological projections. In addition, an analysis of SPI at shorter aggregation periods indicated an increasing trend of degree of dryness for summer months and decreasing for winter.

Minor Corrections

1. *Page 10333, Line 10: This should be "intense", not "intensive".*
   Answer: This will be corrected.
2. *Page 10334, Line 26: Because you have access to climatic water balance, it would be interesting in future studies to calculate trends in SPEI (Vicente-Serrano et al. 2010) and compare results to the SPI, a precipitation-based metric. This is not needed for this study, simply a suggestion for the future.*
   Answer: Thank you very much for this suggestion.
3. *Page 10334, Lines 23–26: There are some additional studies that attempt to project meteorological drought in Europe, either using coarse resolution (GCM) or high resolution (GCM/RCM). I suggest you consider some of the following:*
   a. *Blenkinsop, S. and H. J. Fowler (2007): Changes in European drought characteristics projected by the PRUDENCE regional climate models. International Journal of Climatology 27(12):1595-1610.*
   b. *Dai, A. (2013): Increasing drought under global warming in observations and models. Nature Clim. Change 3: 52–58.*
   c. *Orlowsky, B. and S. I. Seneviratne (2013): Elusive drought: uncertainty in observed trends and short- and longterm CMIP5 projections. Hydrol. Earth Syst. Sci. 17(5):1765-1781.*
   d. *Stagge, J.H. , Rizzi, J., Tallaksen, L.M., and Stahl, K. (2015). "DROUGHTRSPI Technical Report No. 25 Future Meteorological Drought Projections of Regional Climate" DROUGHT-RSPI Project .*

   Answer: Thank you very much for the list of additional studies. We wish to include most of these in the corrected version of manuscript.
4. *Page 10335, Line 5: Hydrological drought may also refer to deficits in groundwater or reservoir storage.*
   Answer: Yes, a good point. We will make this correction.
5. *Page 10338, Line 4: The authors should mention that the scenarios are based on AR4 SRES scenarios (presumably) and not the RCP scenarios. This is not a problem, but should be mentioned in the methods.*
   Answer: The following sentence will be added to the manuscript. The A1B emission scenario belongs to SRES family described in the IPCC Special Report on Emission Scenarios (SRES) (Nakicenowic et al., 2000) and used to make projections for the IPCC Third Assessment Report (TAR) and in the IPCC Fourth Assessment Report (AR4).
6. *Page 10340, Lines 11-17: I appreciate the desire to cite all of this research, showing the importance of the SPI. But, I think this is citation list is a little excessive. I recommend trimming it to the most important references*
   Answer: The list of references will be shortened to include the most important recent articles as follows.
   The index is used for both research and operational purposes in over 60 countries (e. g. Bordi et al., 2009; Moreira et al., 2012; Sienz et al., 2012; Gocic and Trajkovic, 2013; Liu et al., 2013; Dutra et al., 2014; Zargar et al., 2014; Jenkins and Warren, 2015; Swain and Hayhoe, 2015; Zarch et al., 2015).
7. *Page 10341, Line 26: These papers discuss the use of normality testing to validate SPI values and check whether zeros cause a failure. They may be useful to cite:*

a. *Kumar MN, Murthy CS, Sesha Sai MVR, Roy PS. 2009. On the use of Standardized Precipitation Index (SPI) for drought intensity assessment. Meteorol. Appl. 16 : 381–389, doi: 10.1002/met.136*
b. *Stagge, J. H., Tallaksen, L. M., Gudmundsson, L., Van Loon, A. F. and Stahl, K. (2015), Candidate Distributions for Climatological Drought Indices (SPI and SPEI). Int. J. Climatol., 35: 4027–4040. doi: 10.1002/joc.4267*
c. *Wu H, Svoboda MD, Hayes MJ, Wilhite DA, Wen F. 2007. Appropriate application of the standardized precipitation index in arid locations and dry seasons. Int. J. Climatol. 27 : 65–79*

Answer: Thank you very much for these suggestions. The recommended references will be cited in the article and the following sentence will be added “Different methods of normality testing of SPI values are reported in the literature, including, for example, the Shapiro-Wilk statistic and absolute value of the median smaller than 0.05 (Wu et al., 2007; Kumar et al., 2009; Stagge et al., 2015)”.

8. *Page 10342, Line 15: It would be good to mention in the text that the MannKendall test operates based on all possible combinations of points. This is mentioned for the Sen slope (Page 10343, Line 17), but should be introduced earlier in this section.*
Answer: We will correct this and add the following sentence “The original Mann-Kendall test for trend is based on a rank correlation test for the observed values and their order in time and operates on all possible combinations of points”.
9. *Page 10347, Line 4 and elsewhere: You refer to figures out of order. In this case, you cite Figure 14 well before Figures 8-13.*
Answer: In that line Figure 7 should be cited and this will be corrected.
10. *Page 10351, Line 6 and elsewhere: Please be specific regarding the subset you are analyzing for longer duration SPI’s. For instance, the SPI 12 is the annual time step, but it appears you are only considering the SPI 12 in December. The full SPI12 time series is a moving window that moves forward monthly (or daily), always looking back 12 months. I assume you are also using December for the SPI24, which should also be specified. The discussion of SPI3 is adequate, stating that you extracted values for February (DJF), May (MAM), August (JJA), and November(SON).*
Answer: Yes, the SPI indexes were calculated using aggregated sum of precipitation following the rule: SPI 3 – DJF the index was extracted for February, MAM the index was extracted for May, JJA the index was extracted for August, and SON the index was extracted for November. In the case of SPI 12 and SPI 24 the indexes were extracted for December.

11. *Table 1: I recommend using two column headings, one showing GCM and another showing RCM. By grouping the trends by GCM, it would be easier to look for trends among the forcing time series.*
Answer: This will be corrected, as in the example we give below.
Table 1. Results of trend analysis using the modified Mann-Kendall method for SPI 1 for one grid cell located close to Bialystok (NE Poland); ↗ - denotes statistically significant positive trend, ↘ - denotes statistically significant negative trend, - denotes no statistically significant trend.

	Bias corrected data	Uncorrected (raw) data

GCM	ARPEGE		ECHAM5		BCM		ARPEGE		ECHAM5		BCM	
RCM	DMI HIRHAM	RM51	MPI M REMO	KNMI RACMO2	DMI HIRHAM	SMHIRCA	DMI HIRHAM	RM51	MPI M REMO	KNMI RACMO2	DMI HIRHAM	SMHIRCA
JAN	-	-	↗	↗	↗	↗	-	-	↗	↗	↗	↗
FEB	↗	-	-	↗	-	-	-	-	-	-	-	-
MAR	-	-	↗	-	↗	↗	-	-	-	-	↗	↗
APR	-	-	-	-	-	-	↘	-	-	-	-	-
MAY	-	-	-	-	-	-	-	-	-	-	-	-
JUN	-	-	-	↘	-	-	-	-	-	↘	-	-
JUL	↘	↘	-	-	↗	-	↘	↘	-	-	↗	-
AUG	↘	↘	-	-	-	-	-	↘	-	-	-	-
SEP	↘	↘	-	↗	-	-	↘	↘	-	↗	-	-
OCT	-	-	-	-	-	-	-	-	-	-	-	-
NOV	-	-	-	-	-	-	-	-	-	-	-	-
DEC	-	-	↗	↗	↗	↗	-	-	↗	↗	↗	↗

12. *Figure 7: Similar to my comment for Table 1, it would be helpful if these models were organized by GCM, rather than alphabetically to see how the GCM forcings differ and how the RCMs modify the forcings.*
    Answer: This will be corrected.

Figure 7. An example of SPI 12 time series for raw data: DMI HIRHAM ARPEGE, RM51 ARPEGE, MPI M REMO ECHAM5, KNMI RACMO2 ECHAM5 r3, DMI HIRHAM BCM, SMHIRCA BCM.