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Twitter and weather services

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Abstract. This work focuses on the analysis of the use of Twitter by different weather services around the world. During the last few years the availability of mobile phones connected to the Internet has become a global reality. Likewise, the use of different social networks has been popularized and extended with different purposes including social communication. In this context most meteorological weather services have been using some of these social tools in order to improve their services for the general public and specific users. Twitter is a social tool that enables users to post messages ("tweets") of up to 280 characters (up to 140 before November 2017), supporting a wide variety of communicative practices. Twitter is an opportunity not only to spread messages without intermediaries, but also interact in real time with users. Here we present a study of different aspects related to the use of Twitter in diverse weather services worldwide and their evolution during the year 2016.

1 Introduction

Weather Services (WS) use different "traditional" tools for meteorological information dissemination, including television, radio, newspaper, phone, e-mail and public/private websites. In recent years, new technologies, and in particular the rapid expansion of social networks, have allowed the transmission of information to be virtually instantaneous and accessible to large segments of population. As a consequence many National WS have developed new communication strategies and incorporated social network tools (YouTube, Facebook, Instagram, Twitter, etc.) for various purposes (Gaztelumendi et al., 2015; Palacio et al., 2014, 2016; Martija et al., 2014). Particularly, some WS utilize Twitter for quick and efficient communication with their audiences, providing frequent remarkable pieces of information routinely including forecast, observations, analysis, etc. (Gaztelumendi et al., 2015).

With more than 300 million monthly active users, more than 100 million users logging in and 500 million tweets sent daily, Twitter is the 5th most popular social media platform in the world (Smart Insights, 2018). Twitter has many add-ons that make it powerful, although the standard remains in 280 character text messages (Tsukayama, 2017) and the ability to provide others with frequent information updates and attached extra information (photos, charts, maps, pdf, etc.). In general, National WS use Twitter for fast and efficient communication with users, including different kind of information such as routine weather forecasts and observations, general weather, climate and scientific information, events communications and others (Gaztelumendi et al., 2015). In many cases, this platform is also used for real time severe weather data dissemination and warnings (Orbe, 2012; Gaztelumendi et al., 2012, 2013, 2015, 2016).

2 Methodology

Based on previously available work (Gaztelumendi et al., 2015; Palacio et al., 2014) and on official World Meteorological Organization information about official WS (WMO, 2017) we have identified the Twitter accounts of different WS operating at national and local levels around the world. During 2016, when the maximum number of characters was 140, we completed daily routine queries through the Twitter search Application Programming Interface (API) and Twitter website in order to collect tweets sent from the most representative WS Twitter accounts. Operational scripts to acquire information for this work are programmed in R

Name	Country	Starting date	% local population following 01/01/2016	% local population following 31/12/2016	# followers 01/01/2016	# followers 31/12/2016	Relative growing rate (%) during 2016	Mean ‰ population following growing rate per month pre 2016	Mean ‰ population following growing rate during 2016	# tweets previous to 01/01/2016	# tweets previous to 01/01/2017	Daily mean # tweets pre-2016	Daily mean # tweets during 2016	Daily mean # Tweets in 2016 (no Reply no RT)	Daily mean # RT in 2016	Daily mean # Replies in 2016	% Retweets from total post	% Replies from total post	% tweets (no Retweet and No Replies) from total post	Daily mean # nonfavorited tweets	Daily mean # favorited tweets in 2016	Daily mean sum of favors in 2016	% favors from total post	Mean favors per favor tweet
KuwaitMet	Kuwait	20/06/2011	0,3	0,4	9.742	12.853	32	0,06	0,07	49.586	82.462	30,4	58,2	58,2	0,0	0,0	0	0	0,1	100,0	54,37	3,86	4	7	1,16
metoffice	United Kingdom	21/01/2009	0,5	0,7	324.615	441.170	36	0,06	0,12	116.700	138.868	46,7	56,5	12,3	0,5	43,7	1,1	71,9	98,9	30,55	25,99	414	50	15,94
NEAsg	Singapore	22/07/2009	3,3	6,4	174.993	337.513	93	0,43	2,13	66.324	85.738	28,6	51,4	51,4	0,0	0	0,01	0	100,0	31,57	19,81	33	39	1,65
dost_pagasa	Philippines	15/10/2010	3,5	5,0	3.390.460	4.837.264	43	0,56	1,07	62.944	79.660	33,6	46,7	46,7	0,0	0	0,04	0,1	100,0	0,19	46,52	524	100	11,26
AEMET_Esp	Spain	04/01/2013	0,1	0,2	59.732	96.803	62	0,04	0,06	14.812	28.170	13,8	36,9	12,6	23,9	0,4	63,8	0,9	36,2	24,79	12,07	87	33	7,23
conagua_clima	Mexico	13/05/2010	0,5	0,6	606.395	771.785	27	0,07	0,10	59.867	71.927	29,5	31,7	31,1	0,5	0	1,5	0,0	98,5	0,63	31,03	426	99	13,73
wwwmeteoit	Italy	14/07/2011	0,0	0,0	25.743	30.199	17	0,008	0,005	22.623	30.446	14,1	21,0	19,7	1,1	0,2	4,5	0,9	95,5	3,05	17,90	73	86	4,09
insivumehgt	Guatemala	26/04/2012	0,5	0,6	77.130	96.934	26	0,12	0,10	13.959	20.845	10,5	17,9	17,7	0,0	0,1	0,1	0,6	99,9	5,89	11,98	28	68	2,37
MetService	New Zealand	28/12/2008	0,7	1,0	32.977	45.365	38	0,09	0,17	13.546	20.406	5,4	17,7	10,0	2,6	5,1	14,0	27,0	86,0	7,53	10,15	37	59	3,62
SAWeatherServic	South Africa	07/11/2011	0,1	0,1	29.122	40.326	38	0,011	0,009	24.077	30.736	16,1	17,3	17,2	0,0	0,1	0,04	0,3	100,0	11,52	5,77	9	32	1,56
Euskalmet	Basque Country	24/06/2011	2,5	4,0	54.707	85.624	57	0,47	0,98	31.037	37.192	19,1	16,5	12,4	4,0	0,0	23,5	0,1	76,5	5,50	10,96	39	67	3,52
infoBMKG	Indonesia	26/01/2010	0,9	1,2	2.230.250	3.022.292	36	0,13	0,24	14.558	20.326	6,8	14,6	13,2	0,2	1,2	2,5	9,0	97,5	1,15	13,49	140	91	10,35
meteofrance	France	14/08/2012	0,0	0,1	19.816	52.423	165	0,01	0,04	5.168	5.168	4,2	14,3	8,5	1,5	4,3	12,2	22,3	87,8	3,77	10,56	136	77	12,86
meteocat	Catalonia	09/09/2010	1,5	1,9	111.174	139.592	26	0,24	0,28	35.931	41.318	18,8	14,2	13,5	0,3	0,4	1,6	2,3	98,4	0,97	13,25	95	93	7,16
PmeMediacen	Saudi Arabia	14/06/2011	0,7	1,0	192.164	269.308	40	0,12	0,20	13.101	18.104	8,0	13,0	12,4	0,4	0,2	3,5	2,0	94,7	1,05	11,98	69	90	5,76
environmentca	Canada	16/01/2010	0,6	0,8	214.421	284.343	33	0,09	0,15	3.135	3.135	1,5	12,2	6,5	5,2	0,5	39,7	3,3	60,3	5,46	6,72	71	57	10,64
MeteoRwanda	Rwanda	05/09/2012	0,0	0,0	1.112	1.762	58	0,002	0,004	7.396	7.396	6,2	10,7	9,0	0,9	0,8	5,2	4,0	94,8	9,40	1,26	2	18	1,32
IMNCR	Costa Rica	09/08/2010	0,4	0,6	20.624	28.229	37	0,07	0,08	8.600	8.600	4,4	10,4	10,0	0,1	0,4	0,6	3,7	99,4	0,93	9,51	63	90	6,65
anumetservice	Antigua and Barbuda	31/05/2011	2,5	3,1	2.235	2.749	23	0,45	0,44	9.498	12.734	5,8	9,9	8,1	1,6	0,2	10,8	2,0	89,2	7,66	2,29	4	27	1,70
WeatherBahrain	Bahrain	05/03/2012	0,8	1,0	10.645	13.529	27	0,18	0,16	19.219	22.786	14,0	9,5	9,2	0,0	0,3	0,2	2,2	99,8	5,52	3,98	7	45	1,68
meteochile_dmc	Chile	03/05/2013	0,2	0,3	36.155	50.162	39	0,06	0,06	11.582	15.175	12,1	9,3	8,9	0,1	0,3	0,8	1,7	99,2	3,10	6,18	15	68	2,44
Senamhiperu	Peru	08/02/2010	0,1	0,1	15.675	22.785	45	0,007	0,015	6.492	6.492	3,1	9,2	8,7	0,3	0,3	3,7	1,8	96,3	4,22	5,03	10	65	2,03
KenyaMetService	Kenia	09/05/2012	0,0	0,0	3.298	4.702	43	0,0017	0,0023	2.219	2.219	1,7	9,2	6,6	2,3	0,3	24,9	2,2	75,1	8,19	1,01	1	19	1,41
NWS	USA	03/01/2012	0,1	0,4	238.154	1.411.496	493	0,02	0,31	9.967	13.109	6,9	7,6	3,6	3,9	0,1	47,6	0,7	52,4	3,88	3,70	175	52	47,29
tma_services	Tanzania	01/10/2012	0,0	0,0	1.418	2.183	54	0,001	0,001	20.086	22.294	17,2	5,7	5,3	0,0	0,3	0,7	4,0	99,3	4,67	1,02	2	21	1,74
TTMetOffice	Trinidad and Tobago	16/07/2012	0,7	0,8	9.338	10.960	17	0,17	0,09	3.335	3.335	2,7	5,3	5,3	0,0	0,0	0,2	0	99,8	3,77	1,53	2	31	1,36
ObservatoryHK	Hong Kong	16/09/2010	0,1	0,1	7.852	9.548	22	0,02	0,02	7.241	7.241	3,8	5,2	5,2	0,0	0,0	0	0	100	3,03	2,21	4	55	1,69
MetEireann	Ireland	15/09/2009	1,6	1,9	75.390	88.169	17	0,22	0,20	9.686	11.691	4,3	4,7	4,7	0,0	0,0	0,7	0,0	99,3	0,16	4,58	18	97	4,03
onamet	Dominican Republic	16/12/2010	2,1	2,6	220.660	268.725	22	0,35	0,33	11.629	12.608	6,4	4,4	3,4	1,1	0,0	36,6	0,0	63,4	1,22	3,23	33	60	10,30
malaysianmet	Malasia	16/02/2010	0,1	0,1	24.048	29.805	24	0,01406	0,01408	6.594	6.594	3,8	4,4	4,4	0,0	0,0	0	0	100	0,90	3,48	9	83	2,49
dmidk	Denmark	24/05/2009	0,5	0,7	26.055	41.804	60	0,06	0,19	4.165	4.165	1,8	4,2	2,4	0,6	1,2	16,4	22,7	83,6	1,46	2,75	19	67	7,07
DWD_presse	Germany	10/10/2011	0,0	0,1	8.892	42.875	382	0,00	0,03	2.340	2.340	1,5	3,9	3,1	0,2	0,6	3,4	10,9	96,6	0,71	3,22	16	85	4,90
meteoroloji_twi	Turkey	07/02/2012	0,1	0,1	42.662	58.932	38	0,012	0,017	9.084	9.084	6,5	3,7	3,4	0,2	0,1	3,5	0,8	96,5	0,25	3,44	75	96	21,79
inamhi	Ecuador	03/12/2010	0,2	0,3	34.199	47.272	38	0,04	0,07	9.336	9.336	5,1	3,6	3,0	0,2	0,4	4,7	10,1	95,3	0,70	2,92	9	81	2,93
meteorologia_av	Venezuela	04/06/2012	0,0	0,0	14.501	17.311	19	0,011	0,006	90.705	91.894	70,5	3,3	3,3	0,1	0,0	1,6	0,7	98,4	2,39	0,95	1	28	1,40
pronosticos_dmh	Paraguay	12/03/2013	0,4	0,5	27.042	35.134	30	0,12	0,07	1.348	1.348	1,3	3,0	3,0	0,0	0,0	0,8	0	99,2	0,04	2,96	29	99	9,65
MeteorologiaUy	Uruagua	16/09/2011	0,4	0,7	13.351	24.965	87	0,08	0,22	2.236	2.236	1,4	3,0	2,9	0,0	0,0	0,9	0,2	99,1	0,19	2,78	17	93	6,19
MetMaldives	Maldives	10/07/2012	0,6	1,3	2.311	5.034	118	0,14	0,50	536	536	0,4	2,6	2,6	0,0	0,0	1,2	0	98,8	0,28	2,35	11	91	4,64
moafbhutan	Buthan	24/03/2014	0,0	0,0	88	162	84	0,01	0,01	1.386	1.386	2,2	2,5	2,5	0,0	0,0	0	0	100,0	2,41	0,09	0,1	5	1,18
SMHI	Sweden	04/03/2009	0,1	0,1	6.413	7.199	12	0,008	0,006	2.270	2.270	0,9	2,0	1,1	0,2	0,7	8,8	22,1	91,2	1,06	0,95	3	53	2,82
ipma_pt	Portugal	06/06/2012	0,0	0,0	861	1.463	70	0,002	0,004	152	152	0,1	1,8	1,8	0,0	0,0	0	0	100,0	1,09	0,69	1	37	1,73
MeteoGalicia	Galicia	25/04/2012	2,0	3,1	54.018	83.253	54	0,36	0,74	3.588	3.588	2,1	1,6	1,6	0,0	0,0	0,1	0	99,9	0,10	1,47	10	95	7,08
meteorologit	Finland	04/09/2009	2,2	2,7	119.323	144.436	21	0,29	0,35	3.470	3.470	1,5	1,5	1,1	0,0	0,4	2,4	22,1	97,6	0,24	1,28	21	87	16,18
Meteorologisk	Norway	20/05/2011	0,1	0,1	4.181	5.338	28	0,02	0,02	1.902	1.902	1,1	1,4	0,6	0,7	0,2	45,4	10,1	54,6	1,04	0,41	1	29	2,46
MSDZIM	Zimbaue	22/08/2013	0,0	0,0	153	268	75	0,0004	0,001	529	529	0,6	1,3	1,3	0,0	0,0	0	0	100,0	1,30	0,03	0,03	2	1,00
meteoschweiz	Switzerland	15/12/2010	0,0	0,0	1.322	2.140	62	0,003	0,007	279	279	0,2	1,3	0,8	0,1	0,3	6,8	13,0	93,2	0,39	0,86	2	70	2,47
KNMI	Holand	11/07/2011	0,3	0,4	45.332	62.664	38	0,05	0,08	178	178	0,1	1,2	1,2	0,0	0,0	0	2,1	100,0	0,15	1,09	5	86	4,47

Figure 1. Summary of some metrics and statistics for followers and tweets considering different aspects about the weather services included in this study. Ordered by mean daily number (#) of messages posted (tweets) during 2016. Cell colors from high values in green to low values in red.

(R core Team, 2014) with extensive use of twitteR package (Gentry, 2016). All the information (text, time, retweets, replies, followers, favorites, etc.) was stored in daily plain text files for each account (more than 17 520 files with more than 314 000 tweets). Other R (Sanchez, 2013) and Excel tools were used for debug, data analysis, text mining, graphs and reporting.

3 Results and discussion

3.1 Total tweets

A tweet is a message (also called a post or an update) distributed on Twitter. The mean number of tweets (for all WS included in the study) per day previous to 2016 was 10.8. During 2016 a general increase to 12.7 was observed, except for the Venezuela or Tanzania case, which showed a significant decrease. KuwaitMet (Kuwait), metoffice (UK), NEAsg (Singapore), dost_pagasa (Philippines), AEMET_Esp (Spain) and conagua_clima (Mexico) posted more than 10 000 tweets during 2016, an average daily update rate up to 30 tweets (see Fig. 1).

The daily post update was very different depending on WS. In the case of the most active WS – KuwaitMet (Kuwait), 58 tweets daily – tweets were mainly automatic posts with current weather information including temperature, wind and precipitation data from different automatic stations. On the other hand the metoffice (UK), with 56 daily tweets on average, posted 43 tweets with replies to specific users promoting direct communication with followers. In the case of NEAsg (Singapore) the daily ratio of 51 tweets mainly consisted of automatic Poiutant Standar Index (PSI) real time information. Dost_pagasa (Philippines) (46 tweets per day) posted weather forecast, thunderstorm information and surveillance information in a formal way. AEMET_Esp (Spain) (36 tweets per day) disseminated weather information, warnings, observation, general information and curiosities. Conagua_clima (Mexico) had 31 tweets per day on average, posting different types of weather forecasts (general, regional, short term, etc.), severe weather warnings, obser-
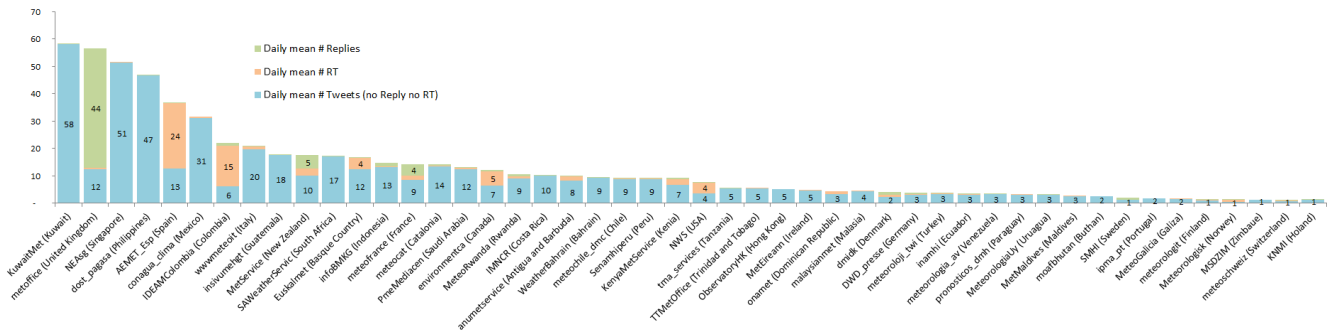
Figure 2. Average daily number (#) of tweets posted by different WS including the proportion of Retweets (RT) and Replies.

vations, curiosities, and educational content in ordinary language.

3.2 Retweets (RT)

A retweet is the way someone can forward another user's tweet to their followers. There are two options: the Twitter Retweet (without adding your own comments), or tweeting with RT (including the option to add your comments) (Boyd et al., 2010). 70 % of the studied counts have a proportion of retweets less than 10 % of the total posts. Six of the WS never retweeted. In the opposite, with more than 60 % of retweets, AEMET_Esp (Spain) had 24 retweets daily on average; IDEAMColombia (Colombia) with 14 corresponding to 63 % of total; and NWS (USA) with 47 % of retweets (see Figs. 1 and 2).

In the AEMET_Esp (Spain) case, retweets came from other AEMET accounts (regional and SINOBAS) and other followers that share weather related comments in some cases with attached photos and videos. In the case of IDEAM-Colombia (Colombia), retweets were in a large proportion from other institutions and new accounts, and in lesser proportion from particular users that shared photos and weather related comments. NWS (USA) retweeted posts from other NWS accounts, NOAA and other USA institutions with weather and environment general information.

Only 127 tweets posted by studied WS were retweeted more than one thousand times. 103 were retweets from other sources with general information, environmental curiosities and climate information. Only 24 cases were self-produced content, mainly due to early warnings in the case of infoBMKG (Indonesia), and some general information in the case of metoffice (UK). The top five with more than 100 000 retweets count were PmeMediacen (Saudi Arabia), retweeting general messages from the Royal Family (@KingSalman, @M_Naif_Alsaud).

3.3 Replies

A reply is a response to something written by someone (a post) on Twitter. Two options are possible: an @reply or

direct message reply (DM). More than 75 % of WS had a proportion of replies of less than 5 % and 13 of them never reply. In the opposite were metoffice (UK), MetService (New Zealand), dmidk (Denmark), meteofrance (France), SMHI (Sweden), meteorologit (Finland) and meteoschweiz (Switzerland), where more than 20 % of total tweets were replies. At the top the metoffice (UK), with a proportion of 72 % of public replies to users, corresponding to 43.7 daily replies on average during 2016 (see Figs. 1 and 2).

Metoffice (UK) replies (more than 70 % tweets posted) consist of direct brief conversations with users solving forecast doubts, giving them direct information about weather conditions on particular locations, or congratulations for shared pictures. In the case of MetService (New Zealand) (27 % of total tweets were replies) dealt with local forecast clarification, appreciation for sharing photos, and solving general weather related curiosities in direct and commonplace language.

3.4 Favorited

Although the sense and real significance of favoriting a tweet is unclear, in this context we consider it as a kind of "like" in the sense of approval or agreement with particular content. The number of times a WS tweet is favorited is around five on average, but ranges from 47 from NWS (USA) and 20 from meteoroloji_twi (Turkey), to less than one in the case of 23 WS postings. Dost_pagasa (Philippines), conagua_clima (Mexico) and metoffice (UK) had more than 200 000 favorites during 2016. Dost_pagasa (Philippines), conagua_clima (Mexico) and metoffice (UK) had more than 400 favorites per day. NWS (USA) had the highest ratio of favorites per tweet (47), but only for 52 % of total favorited tweets (see Figs. 1 and 3). Only 22 tweets were favorited more than 600 times, from meteoroloji_twi (Turkey) (three times), environmentca (Canada) (one time), metoffice (UK) (nine times), NWS (USA) (three times), IDEAM_Colombia (Colombia) (one time), conagua_clima (Mexico) (one time) and infoBMKG (Indonesia) (three times). Just seven of them deal with severe weather or early warnings (including earthquakes and tsunamis), and 15 times with some curiosities and
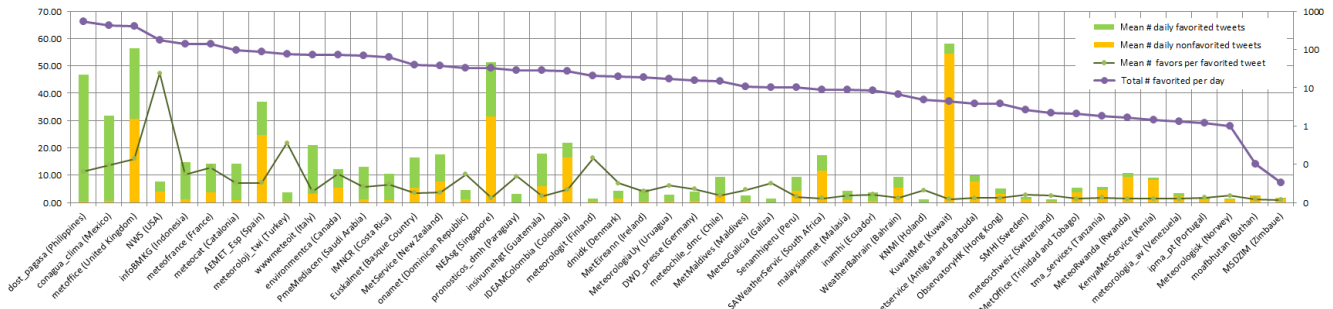
Figure 3. Favorited analysis showing (left) daily averaged values per day during 2016, ratio of favors per favorited tweet and proportion of favorited tweets and (right with logarithmic scale) number (#) of total favorited.
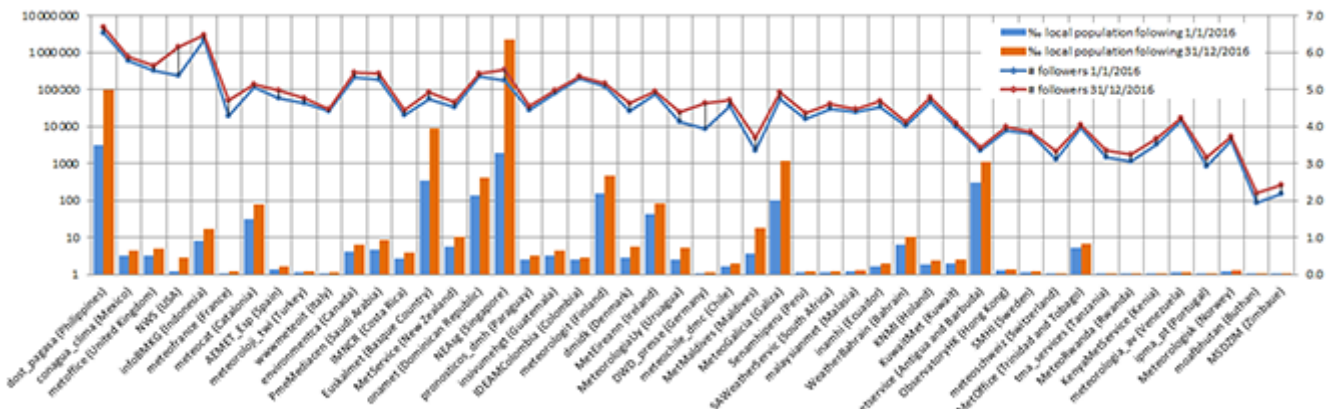

Figure 4. Followers analysis showing number (#) of followers (left with logarithmic scale) and proportion of local population following (right) pre-2016 (blue) and at the end of 2016 (red).

general information. In nearly all the cases attached information is present.

3.5 Followers

Followers refers to anyone who has clicked the Twitter "follow" button to subscribe to another user's messages, simply someone who potentially can receive direct tweets and read them. Just three WS had more than 1 000 000 followers at the end of 2016: dost_pagasa (Philippines), infoBMKG (Indonesia) and NWS (USA). Top three WS with followers in proportion to local population following were NEAsg (Singapore) (6 %), dost_pagasa (Philippines) (5 %), and Euskalmet from the Basque country (4 % population following), with a mean monthly rate of new followers per 1000 inhabitants of 2.1, 1.1 and 1 respectively (see Figs. 1 and 4).

Note that NWS (USA), DWD_presse (Germany) and meteofrance (France) had an increase in followers during 2016 (compared to pre-2016) of 493 %, 382 % and 165 % well above mean growing rate of 60 % (Fig. 1).

4 Remarks and conclusions

The use of Twitter is relatively widespread among weather services all around the world (40 % have an active account)

(Gaztelumendi et al., 2015). The communication strategy, operational routines, information content and relationship with followers are very different depending on country and type of weather service.

Practices for providing content to messages are very diverse. Regarding the degree of human intervention, on one hand there are centers that work with a very high degree of automation by emitting posts with automatic observations at regular times. On the other hand many centers have a null degree of automation elaborating manually the contents. The text of the tweets is also varied. There are centers that use very formal language, while others avoid the technicalities and transmit the information in ordinary, non-formal language. In the case of information about severe weather, the centers that include it (for the most part) usually use formal language to transmit it.

Focusing on relationship with the community of followers, the practices also varied greatly. In regard to retweets, there are some centers that do not retweet anything from other users, while others have ratios greater than 50 % retweets. In the case of replies, something similar happens. There are centers that never respond to users, while others have a high degree of interaction with them – in some cases with very high response rates.

The degree of acceptance of each Twitter service is also heterogeneous. To analyze this aspect, we put the focus on followers and favorites. Favorites are difficult to analyze because they heavily depend on cultural aspects. For acceptance purposes it is interesting to consider the absolute follower numbers with potential audience. This is a complex task where we need to consider multiple aspects such as connected mobile phones availability, general Twitter usage ratios, beginning date of service, language, and general/local character of the particular WS among others. In any case, when we included the country inhabitants as a measure of potential users, we found that some Asian WS accounts and local European WS have the best ratios.

The average number of daily tweets increased by two in 2016, rising to 12.7 at the end of 2016 with a total volume of 1 076 000 tweets sent from the beginning of the different services, for a total volume of followers of 13 311 718. Although some WS accounts activities differ a lot from others, those amounts can be considered representative in general. Nevertheless note that all combined were fall short of ex-president of the United States Barack Obama, who had more than 100 million followers (with just 15 500 tweets posted).

Attracting followers and maintaining them is a very complex task, considering that there is no direct relation between the number of tweets (effort) and the number of followers of an account (reward), even if the posts are non-automatic, interesting, and relevant.

References

Boyd, D., Golder, S., and Lotan, G. :Tweet, Tweet, Retweet: Conversational aspects of retweeting on Twitter, in: IEEE HICSS-43, 6 January 2010, Kauai, HI, 2010.

Gaztelumendi, S., Egaña, J., Otxoa de Alda, K., Hernandez, R., Aranda, J., and Anitua, P.: An overview of a regional meteorology warning system, Adv. Sci. Res., 8, 157–166, https://doi.org/10.5194/asr-8-157-2012, 2012.

Gaztelumendi, S., Orbe, I., Lopez, A., Aranda, J. A., and Anitua, P.: Social media and high impact weather communication in Basque Meteorology Agency, in: 13th EMS/11th ECAM, 9–13 September 2013, Reading, UK, 2013.

Gaztelumendi, S., Martija, M., Principe, O., and Palacio, V. :An overview of the use of Twitter in National Weather Services, Adv. Sci. Res., 12, 141–145, https://doi.org/10.5194/asr-12-141-2015, 2015.

Gaztelumendi, S., Orbe, I., Salazar, O., Lopez, A., Aranda, J. A., and Anitua, P.: Delivery and communication of severe weather events in Basque Country: the Euskalmet case, Adv. Sci. Res., 13, 87–90, https://doi.org/10.5194/asr-13-87-2016, 2016.

Gentry, J.: Package "twitteR", https://cran.r-project.org/web/packages/twitteR/twitteR.pdf, last access: 29 August 2016.

Martija, M., Palacio, V., Príncipe, O., and Gaztelumendi, S.: Meteo adversa y su comunicación vía radio y Twitter, in: XXXIII Jornadas científicas de la AME, 7–9 April 2014, Oviedo, Spain, 2014.

Orbe, I.: Emergencias y medios de comunicación, Publicación de academia vasca de policía y emergencias, Arkaute Akademia, Araba, 2012.

Palacio, V., Martija, M., Príncipe, O., and Gaztelumendi, S.: Servicios meteorológicos y Twitter, in: XXXIII Jornadas de la AME, 7–9 April 2014, Oviedo, Spain, 2014.

Palacio, V., Principe, O., Martija, M., and Gaztelumendi, S.: An overview of the use of Facebook in National Weather Services, Adv. Sci. Res., 13, 145–150, https://doi.org/10.5194/asr-13-145-2016, 2016.

R Core Team: R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria, http://www.R-project.org/ (last access: 28 June 2017), 2014.

Sanchez, G.: Handling and Processing Strings in R, Trowchez Editions, Berkeley, 2013.

Smart Insights: Global social media research summary 2018, https://www.smartinsights.com/social-media-marketing/social-media-strategy/new-global-social-media-research/, last access: 10 May 2018.

Tsukayama, H. : Twitter is officially doubling the character limit to 280, The Washington Post, https://www.washingtonpost.com/news/the-switch/wp/2017/11/07/twitter-is-officially-doubling-the-character-limit-to-280/?utm_term=.11568d8745fa, last access: 7 November 2017.

WMO: National Services, https://public.wmo.int/en/about-us/members/national-services, last access: 27 July 2017.