

Connections among climate deniers on Twitter

Jeremy McGibbon

Introduction

I am defining climate denier accounts as accounts for which over 50% of their tweets (based on reading recent tweets) or their pinned tweet or their profile description fall into one of the “Doubt” categories of Supran and Oreskes (2017). Those categories are:

- Expresses position that the reality of recent global warming is uncertain/undefined, namely ‘it’s not happening’
- Expresses position that the human contribution to recent global warming is uncertain/undefined, namely ‘it’s not us’
- Expresses position that the reality of negative impacts of global warming is uncertain/undefined/exaggerated, namely ‘it’s not bad’
- Expresses position that the difficulties of mitigating global warming are potentially insurmountable and/or exceed the benefits, namely ‘it’s too hard’

These categories express essentially every way in which people attempt to spread doubt about the validity of the scientific consensus on climate change.

The aim of my project is to look at connectivity and tweet behavior of climate denier hub accounts on Twitter. I am defining hubs as accounts with at least 1000 followers. Some questions I answer in this report include:

- Can we find new denier hubs by looking at accounts connected to those hubs?
- Are people who follow denier hubs more likely to follow politically conservative figures?
- Are people who follow one denier hub more likely to follow an additional denier hub?
- What kind of websites do denier hubs link to in their tweets?
- What kind of twitter accounts do denier hubs mention in their tweets?
- What words and phrases commonly appear in tweets by denier hubs, and can we learn anything from them?

Previous work has been done to automatically identify topical experts in Twitter communities such as Bhattacharya et al. 2014 which relies on user lists which have been created by Twitter users. While approaches like this are useful in extending the type of analysis done here to a wide range of communities, it is not necessary for this project. I have expert knowledge and am able to identify climate denier accounts personally, rather than relying on user lists created by others.

Data Model

Below is the entity-relationship diagram of the data I am retrieving from the Twitter API and storing in PostgreSQL for analysis.

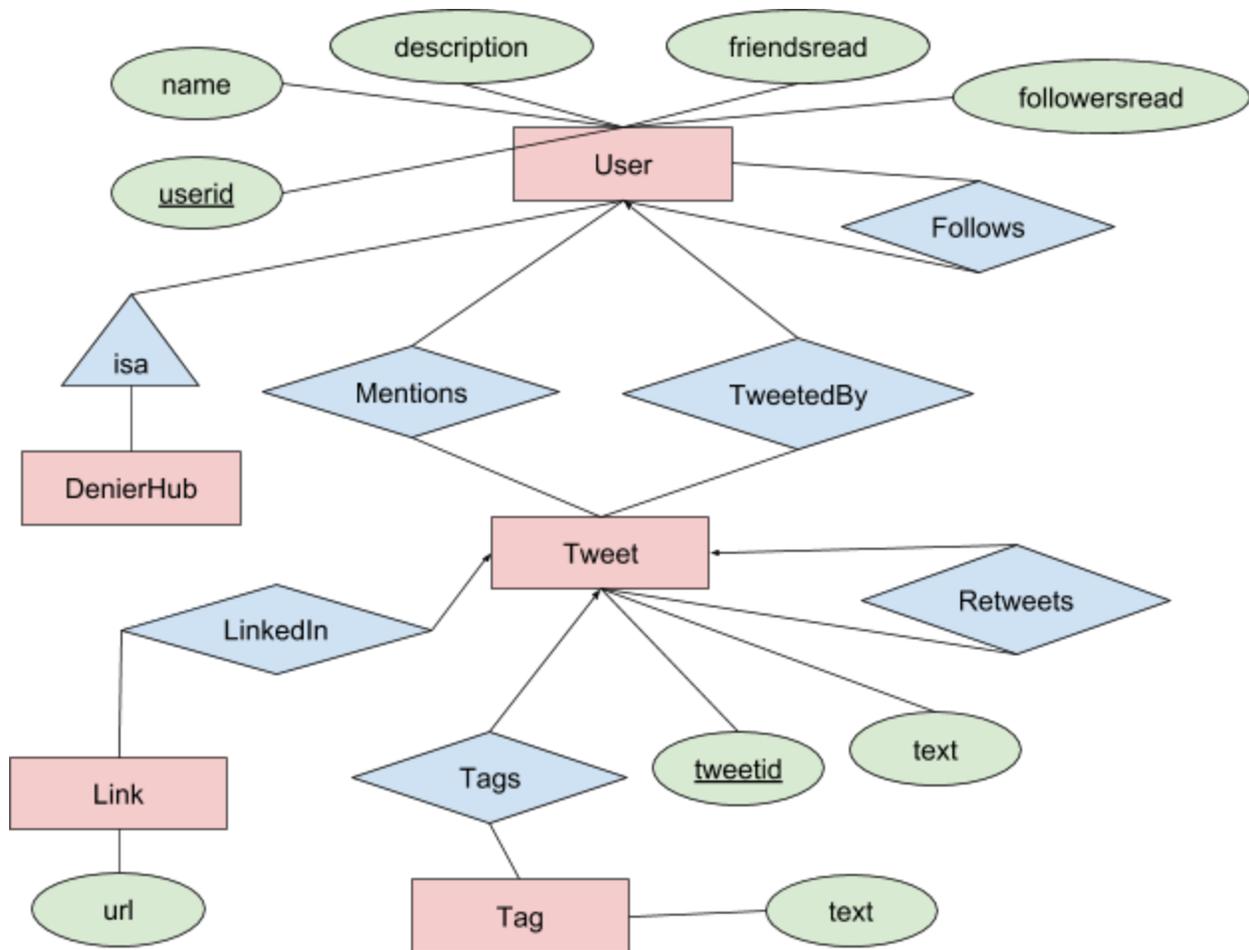


Figure 1: Entity-Relationship model used to store Twitter information

Data Collection

I collected data from the free Twitter web API, and deposited it into a Postgres database on my work computer using SQLAlchemy in Python.

I started with a core list of at least 22 climate denier hub accounts (e.g. [@ClimateDepot](#), [@luisbaram](#), [@ClimateRealists](#)). I stored all accounts following those hubs in a database, which I will refer to from now on as *Followers* (capitalized). For each of those Followers, if they followed and were followed by fewer than 500 accounts, I stored each of those follow connections into the database. This threshold was set to avoid connections from bot, spam, corporate, and public figure accounts. Because there are so many Followers, and due to a data loss event, I was not able to sample all of them by the end of the project. In total I sampled 2599 accounts, out of 90214 total Followers (including ones which exceed the 500 account thresholds). Any results below referring to Followers are based on analysis done on this sample.

For each of the denier hubs, I also stored up to 3200 of their most recent tweets in the database, the maximum allowed by the free Twitter API.

Evaluation

The analysis can be broadly split into two questions: “Who do Followers follow?” and “What do denier hubs tweet?”

“Who do Followers follow?”

Through an SQL query, I extracted the list of the 100 accounts followed by the most Followers. I manually viewed each account, noting political leaning of the account if apparent and writing a short note about who the account is (e.g. “conservative author”, or “news aggregator”, or “POTUS”). Wikipedia was used to determine political leaning if possible. If political leaning was unclear, I did not note one. All of this information can be found in Appendix A.

Above I asked

- *Can we find new denier hubs by looking at accounts connected to those hubs?*

We see the answer is yes. BigJoeBastardi, iowahawkblog and tan123 are all denier hubs which did not appear in my initial sample, but appear in the top 100 most popular accounts among Followers. However, being most popular among Followers on its own is not enough to classify an account as a denier hub. Many of the most popular accounts are conservative figures who do not discuss climate change often enough to be classified as a denier under the chosen criteria, which requires they actively tweet climate denialism.

The next question was:

- *Are people who follow denier hubs more likely to follow politically conservative figures?*

Essentially, yes. Not counting denier accounts (which are all conservative), over two thirds of the top 100 accounts followed by Followers are conservative figures. The first non-conservative, non-denier account to appear is Wikileaks at rank 12, which has been popular among the conservative community since the 2016 US elections. Wikileaks may also be popular because of the link between climate denialism and conspiratorial thinking (Lewandowsky et al. 2015). The next non-conservative, non-denier to appear is NASA at rank 33. The first and only liberal figure to appear in the top 100 list is Barak Obama at rank 44. Unsurprisingly, Donald Trump is the most popular account among Followers.

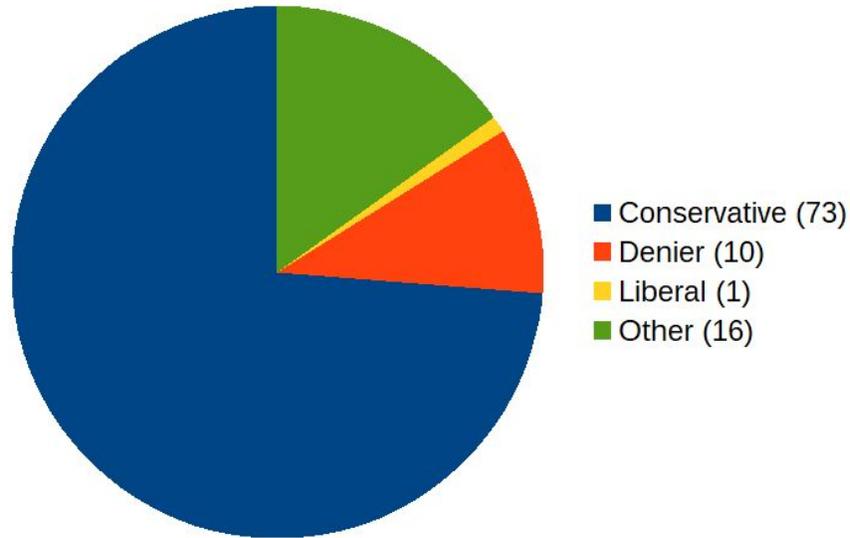


Figure 2: Political leanings of 100 most popular accounts for climate change denier Followers to follow. Denier is listed as a separate category, and only includes accounts that actively promote climate change denial on Twitter. All deniers found were conservative.

The next question on the list is:

- *Are people who follow one denier hub more likely to follow an additional denier hub?*

This can be answered by looking at statistics of what accounts Followers follow. To measure the likelihood that a Follower will follow an additional denier hub, we use the number of denier hubs each Follower follows in addition to the first one. The sum of this number over all deniers averaged over all denier hubs will be equal to $\frac{\text{number of follows} - \text{number of Followers}}{\text{number of Deniser Hubs}}$, where subtracting the number of Followers accounts for the fact that we want to look at the likelihood that an additional denier hub is followed (and not count the first denier hub for each follower). These statistics for denier hubs and other accounts can be seen in Table 1.

Table 1: Statistics of following relationships where Followers follow accounts, comparing denier hubs and all other accounts. Adjusted follows per account is (follows - # of Followers) / accounts.

Type	Accounts	Follows	Follows per account	Adjusted follows per account
Denier Hub	20	4125	206.25	76
Others	237825	471072	1.98	1.97

The adjusted follows per account for denier hubs is almost 40 times as large as it is for other accounts. Clearly Followers are much more likely on average to follow an additional denier account than they are to follow any other account that is followed by Followers.

“What do denier hubs tweet?”

The last three questions relate to the content of the tweets of denier hubs. Let’s begin with

- *What kind of websites do denier hubs link to in their tweets?*

The 100 most commonly linked web domains and counts are available in Appendix B. By far the most commonly linked sites are climate denier sources such as blogs and YouTube videos. Some mainstream news sources are also popular to link, such as The Guardian and CBC, and to a lesser extent the Wall Street Journal. However these make up a very small fraction of the number of tweets. The most popular “mainstream” news source is The Guardian, and accounts for only 0.7% of tweets (between gu.com, theguardian.com, and guardian.co.uk). By contrast, the most popular denier blog Watts Up With That is linked in 6% of tweets. The Wallstreet Journal is linked only 0.06% of the time. So it appears most popular for climate deniers to link to one another over more mainstream sources.

This also appears when we investigate the next question

- *What kind of twitter accounts do denier hubs mention in their tweets?*

The 100 most popularly mentioned users are available in Appendix C. These accounts are overwhelmingly climate deniers. If we count YouTube as a denier (since it is generally mentioned in the context of linking to denier videos), the top 8 mentioned accounts are all climate deniers. The next most popular mention, [cathmckenna](https://twitter.com/cathmckenna), is the Minister of Environment and Climate Change for Canada. 80% of her mentions come from only 2 denier hubs. It is difficult to infer much from the types of account mentioned since mentions occur not only when users discuss one another, but also when replying to each others' tweets. So let's move on to a more interesting question.

There is much room for interpreting the final question,

- *What words and phrases commonly appear in tweets by denier hubs, and can we learn anything from them?*

Using the Python Natural Language Toolkit (NLTK) I counted monogram and bigram occurrences in tweets by the 20 selected climate change denier accounts. Punctuation was removed and text was transformed to lowercase. Stop words from the NLTK English list were ignored, as well as the usernames of the 20 denier accounts, and the strings 'https', 'http', 'rt', 'via', and 'www'. Tags and mentions were also removed. A list of the 100 most common monograms and bigrams in tweets by denier hubs is available in Appendix D.

Unsurprisingly, “climate change” (1786) and “global warming (1657) top the list of most common bigrams. Perhaps more surprisingly is that if you add the mentions for “polar bear” (310) and “polar bears” (229), they form the third most common bigram. When discussing polar bears, the climate deniers commonly discuss how dangerous they are, point to incidents of polar bears attacking people or towns, or argue that polar bears are not threatened by climate change.

There are many other bigrams that similarly reflect common topics used to deny climate change. The “little ice age” (appearing as “little ice” (90) and “ice age” (371)) is commonly discussed to argue that present-day warming is only occurring because we are coming out of the little ice age. Deniers may argue we're about to enter an ice age. “solar activity” (83) is commonly used as an argument to explain warming trends. When deniers talk about past climates (“years ago”,

242), they may say present-day warming is not concerning because in the past CO2 levels have been higher and the planet has been warm or ice-free.

Other bigrams reflect common tactics used by climate change deniers. For example, “record cold” (130) is used when deniers point to specific weather events as evidence against global warming. “looks like” (131) and “good news” (79) are commonly used in condescending and sarcastic statements. Articles promoting awareness of climate change are commonly called “fake news” (152).

The most common monograms can be more difficult to interpret, but reflect some of the same features as the common bigrams. Some monograms appear in one or more popular bigrams, such as “ice” (1444), “climate” (6125), “global” (2588), “warming” (2208), and “change” (2014). The popularity of some words such as “ice” (1444), “solar” (1326) and “snow” (964) are likely due to their relation to certain types of arguments against climate change, for example that it is cold in a certain place, or that the sun is causing the climate to change.

Conclusions

In this project I have found many results in agreement with what is already known about climate denialism. Twitter users who follow climate deniers are more likely to follow conservative figures, likely owing to the close ties between climate denial and conservatism. Users who follow a climate denier are more likely to follow an additional climate denier than they are to follow another given account. Climate deniers refer to one another and link heavily to climate denier blogs and websites, possibly to give the impression of legitimacy of their claims by referring to “outside” sources (which in practice come from a relatively tight group). Bigrams appearing in tweets by deniers are more easily interpreted than monograms, and reflect tactics and ideas that are commonly used to deny human-caused climate change.

The ideas used here could be extended through automation of some of the steps I used. For example, if one could determine the political leaning of a particular account, one could look at the average political leaning of a Follower, or the average political leaning of those who Followers follow, rather than only looking at the tail of the distribution (the most popular accounts). Alternatively, these ideas could be applied to other communities and used for other purposes. For instance, if a climate scientist were to replace the denier hub accounts with climate scientists on Twitter, may be able to use mentions or follow relations to find other climate scientists on Twitter to follow.

References

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Appendix A

There were 2599 total sampled Followers. Here are their most followed accounts. Annotations my own. Bolding to point out non-conservative, non-denier accounts. Here “conservative” is an umbrella term for right-of-center views. Numbers on their own line are to indicate ranking at that position.

Tallies: 73 conservative, 10 denier, 2 liberal, 15 Other

name	count	
realDonaldTrump	1153	Conservative POTUS
wattsupwiththat	740	Denier
EcoSenseNow	735	Denier
POTUS	669	Conservative POTUS
RealJamesWoods	640	Conservative actor
AnnCoulter	581	Conservative author
SteveSGoddard	571	Denier
benshapiro	538	Conservative columnist
PrisonPlanet	537	Conservative editor
TuckerCarlson	533	Conservative TV
10		
ClimateRealists	533	Denier
wikileaks	495	
seanhannity	489	Conservative TV
DineshDSouza	480	Conservative filmmaker, author
michellemalkin	477	Conservative blogger
DRUDGE_REPORT	472	Conservative news aggregator
FoxNews	463	Conservative news
BreitbartNews	455	Conservative news
ClimateDepot	434	Denier
DLoesch	424	Conservative radio host
20		
marklevinshow	421	Conservative TV
jordanbpeterson	418	Conservative professor
IngrahamAngle	416	Conservative TV/radio
scrowder	396	Conservative podcaster
JamesOKeefeIII	388	Conservative filmmaker
MarkSteynOnline	374	Conservative author
KellyannePolls	374	Conservative pundit
greggutfeld	365	Conservative author
SheriffClarke	365	Conservative entrepreneur
RandPaul	354	Conservative politician
30		
Nigel_Farage	349	Conservative politician
tedcruz	346	Conservative politician
NASA	329	

DonaldJTrumpJr		328	Conservative figure
mike_pence		316	Conservative politician
FLOTUS		313	Conservative figure
WhiteHouse		310	Conservative government
BillOReilly		309	Conservative pundit
JudicialWatch		308	Conservative watchdog
DRUDGE		308	Conservative news aggregator
40			
StefanMolyneux		304	Conservative radio host
Lauren_Southern		303	Conservative author
Cernovich		298	Conservative journalist
BarackObama		296	Liberal politician/POTUS
BBCBreaking		295	News
VP		292	Conservative politician
krauthammer		292	Centrist author
Carbongate		288	Denier
PressSec		279	Conservative government
ScottAdamsSays		278	Centrist cartoonist
50			
elonmusk		277	Centrist entrepreneur
JulianAssange		275	Owner of wikileaks
SebGorka		272	Conservative journalist
RealAlexJones		271	Conservative TV
DennisDMZ		270	Conservative comedian
RealBenCarson		270	Conservative politician
Snowden		267	Whistleblower
AllenWest		266	Conservative politician
WSJ		262	News
iowahawkblog		261	Denier (new)
60			
JudgeJeanine		260	Conservative TV
SenTedCruz		258	Conservative politician
TGowdySC		255	Conservative politician
Gavin_McInnes		252	Conservative TV
RubinReport		247	Conservative TV
IvankaTrump		247	Conservative
larryelder		247	Conservative podcaster
DanaPerino		247	Conservative news contributor
ThomasSowell		245	Conservative book quotes
cnnbrk		241	News
70			
dbongino		240	Conservative author
KTHopkins		239	Conservative
brithume		236	Conservative political analyst
TomiLahren		235	Conservative TV
BigJoeBastardi		232	Denier (new)
Heritage		231	Conservative think-tank
Friends0Science		230	Denier

Project_Veritas		230	Conservative video
glennbeck		229	Conservative host
Reuters		229	News
80			
BretBaier		228	Conservative news anchor
curryja		223	Conservative professor
KatiePavlich		221	Conservative news contributor
EricTrump		218	Conservative figure
JohnStossel		217	Conservative journalist
megynkelly		217	Political commentator
nytimes		217	News
tan123		216	Denier (new)
newtgingrich		215	Conservative politician
rushlimbaugh		215	Conservative radio
90			
Judgenap		211	Conservative TV
Ayaan		210	Centrist, opposes Islam
DiamondandSilk		210	Conservative TV/radio
TRobinsonNewEra		207	Conservative politician
SharylAttkisson		207	Investigative journalist
SarahPalinUSA		206	Conservative politician
marcorubio		206	Conservative politician
TheRebelTV		205	Conservative TV
JackPosobiec		205	Conservative author
AP		205	News

The most followed accounts list will over-estimate counts for Deniers that were in the original 20, since their followers were used to create the database. If we only count their followers who also follow at least one other of the original 20 Deniers, we get the following counts for those accounts:

name		count
wattsupwiththat		351
ClimateRealists		334
SteveSGoddard		302
EcoSenseNow		282
ClimateDepot		281
Carbongate		194
Friends0Science		142
CFACT		86
can_climate_guy		39
Cartoonsbyjosh		36
luisbaram		24
sjc_pbs		23
co2science		22
Co2Coalition		19

GrizzlyGovFan		18
GrandSolarMin		13
TempGlobal		12
ToryAardvark		12
RupertDarwall		10
IowaClimate		7

Appendix B

Most commonly linked domains in tweets from denier hubs, with counts of the number of times linked. Taken from 47303 total tweets.

Website	Count
twitter.com	15224
wattsupwiththat.com	2655
youtu.be	1684
ow.ly	949
climatedepot.com	879
wp.me	776
shar.es	443
youtube.com	418
iceagenow.info	304
dlvr.it	301
principia-scientific.org	272
thegwpf.com	261
bit.ly	232
ift.tt	199
gu.com	175
blog.friendsofscience.org	129
polarbearsience.com	123
buff.ly	118
co2science.org	114
dailycaller.com	108
cfact.org	99
dailym.ai	95
realclimatescience.com	94
guardian.co.uk	79
cbc.ca	71
theguardian.com	69
climatechangedispatch.com	64
goo.gl	64
notalotofpeopleknowthat.w	59
ordpress.com	
breitbart.com	57
telegraph.co.uk	53
paper.li	52
shr.gs	52
climatism.wordpress.com	52
eepurl.com	46

toryaardvark.com		46
joannenova.com.au		44
earth.nullschool.net		38
nationalreview.com		38
bbc.co.uk		37
trib.al		36
forbes.com		35
amazon.com		33
notrickszone.com		33
rclutz.wordpress.com		32
wsj.com		30
fb.me		30
stopthesethings.com		30
tinyurl.com		30
independent.co.uk		30

Appendix C

Most commonly mentioned usernames in tweets from denier hubs, with counts of the number of times mentioned. Taken from 47303 total tweets.

Username	Count
StormSignalSA	1364
ClimateDepot	1185
GillesnFio	1184
SteveSGoddard	1114
YouTube	1075
NikolovScience	846
tan123	756
luisbaram	685
cathmckenna	574
wattsupwiththat	567
EcoSenseNow	557
JWSpry	539
bradschrag	459
thegwpcfcom	452
can_climate_guy	356
jkenney	350
cafenetamerica	343
realDonaldTrump	331
JunkScience	331
ILuvCO2	317
theresphysics	302
JayforScience	301
corchem	300
RachelNotley	298
rln_nelson	276
CitronCockatoo	271
john@sullivanp2	269
ScottAdamsSays	263
Vivarn8	255
ClimateRealists	233
markcojuangco	222
ClimateAudit	215
Carbongate	210
curryja	208
1_TMF_	206
BigJoeBastardi	206
Gladfly1	201
miked194765	197
tonydunc	197
Mcschweety	193

drwaheeduddin		187
3GHTweets		177
KiryeNet		176
JamesDelingpole		176
RogTallbloke		170
stevenmosher		168
sideen_dan		163
d_e_mol		162
JustinTrudeau		160
hockeyschtick1		159

Appendix D

Most common monograms and bigrams in tweets from denier hubs, with counts of the number of occurrences. Taken from 47303 total tweets.

Monogram	Count
climate	6125
global	2588
warming	2208
new	2083
change	2014
amp	1668
energy	1481
ice	1444
co2	1381
solar	1326
us	1313
science	1291
one	1232
years	1174
people	1156
like	1153
green	1111
wind	1028
cold	1013
weather	967
snow	964
would	945
trump	895
world	838
year	828
scientists	816
time	784
record	763
good	741
sea	734
arctic	715
video	714
power	704
news	704
get	649
much	649

see		645
2		639
study		636
polar		632
uk		620
could		613
earth		603
great		599
1		598
right		588
know		588
temperature		582
today		579
say		577
think		553
2017		547
carbon		541
coal		536
last		526
obama		512
day		507
data		507
another		506
still		501
make		501
even		500
u		498
says		494
read		493
first		489
temperatures		485
cooling		475
many		472
un		472
going		471
may		465
well		464
report		463
government		460
age		458
oil		449
back		447
go		442

gas		434
way		432
need		432
big		427
want		426
since		424
claim		424
post		419
canada		417
5		415
paris		414
real		394
000		391
c		391
eu		389
made		387
w		386
let		384
democrats		382
really		380
winter		379

Most common bigrams

Bigram		Count
-----+-----		
climate change		1786
global warming		1657
ice age		371
polar bear		310
climate science		293
solar minimum		281
grand solar		270
new video		257
paul homewood		257
sea ice		250
years ago		242
sea level		231
polar bears		229
climate scientists		229
fossil fuels		213
al gore		197
global cooling		191

new post		190
green energy		172
un climate		162
renewable energy		157
fake news		152
level rise		146
new york		145
wind turbines		139
co2 emissions		137
guest essay		137
wind solar		133
looks like		131
record cold		130
climate alarmists		129
extreme weather		126
mini ice		125
climate experts		124
arctic sea		120
natural gas		120
global temperature		118
climate models		111
paris climate		111
solar panels		109
added video		109
video playlist		109
new study		109
northern hemisphere		108
carbon tax		108
president trump		106
wind power		105
fossil fuel		100
heartland institute		90
little ice		90
essay eric		85
man made		84
video heartland		84
solar activity		83
ice free		83
arctic ice		83
climate summit		82
carbon dioxide		80
adapt 2030		80
good news		79

hudson bay		79
eric worrall		78
new paper		77
tell us		76
climate policies		74
wind farms		74
last year		73
next week		73
met office		72
50 years		72
weather climate		71
marc morano		71
carbon taxes		69
must read		69
climate energy		69
white house		67
michael mann		67
et al		67
video adapt		66
wind turbine		66
wind farm		65
solar cycle		65
jet stream		64
energy poverty		64
nuclear power		63
climate alarmism		63
paris agreement		63
bill nye		62
heavy snow		61
susan crockford		61
wind amp		61
30 years		60
climate depot		60
solar wind		60
cold weather		60
ocean acidification		60
hurricane harvey		60
guide climate		59
000 years		59
politically incorrect		59