In [296]:
```
# Natural Language processing Libraries - nltk, spacy, textblob, wordcloud

# NLP - Text data is unsupervised learning data. Text data in form of sentences, paragraphs
# Documents, web, etc.

# Text data needs preprocessing like removing digits, punctuations, special characters,
# emojis, stop words, html links etc.

# Post preprocessing Tokenization which is breaking content into sentences or words.
# Text data must be converted into matrix of numbers.

# Matrix of Numbers will be input for Algorithms like Machine Learning, Deep learning or
# Text Specific
```

In [297]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

import nltk # Natual Language Processing
import re # Regular Expressions Library
import requests # work with urls & web scraping
from bs4 import BeautifulSoup # Web Scraping
```

In [298]:
```
# Webscraping content from pages like reviews, posts, updates, etc.
# html based webscraping is done using html5 library, lxml(open source), etc.
# Only public and open sources web pages scrapped.
```

In [299]:
```
climatewiki=requests.get("https://en.wikipedia.org/wiki/Climate_change")
```

In [300]:
```
climatedf=BeautifulSoup(climatewiki.content,'lxml') # lxml is html type used by wikipedia
```

In [301]:
```
climatetxt=climatedf.getText(strip=True)
```

In [302]:
```
# Preprocessing of text
# Remove punctiations, digits, special characters, hyperlinks, etc.
# Regular expressions library or re library is used for preprocessing. Functions like
# re.sub(), re.split(),re.replace(), etc are used for preprocessing
```

In [303]:
```
# Replace footnote reference [5] with space
climatetxt=re.sub(r'\[d+\]',' ',climatetxt) # \d+ regex for digit
```

In [304]:
```
# Replace text reference in [] brackets with space
climatetxt=re.sub(r'\[w+\]',' ',climatetxt) # \w+ regex for words
```

In [305]:
```
# Replace text reference in () brackets with space
climatetxt=re.sub(r'\(w+\)',' ',climatetxt) # \w+ regex for words
```

In [306]:
```
# Replace digit reference in () brackets with space
climatetxt=re.sub(r'\(d+\)',' ',climatetxt)
```

In [307]:
```
# Replace special characters with space
climatetxt=re.sub('[\(\[].*?[\)\]]',' ',climatetxt)
```

In [308]:
```
# Replace digits with space
climatetxt= re.sub('[0-9]+','',climatetxt)
```

In [309]:
```
climatetxt=re.sub('-','',climatetxt)
```

In [310]:
```
climatetxt=re.sub('\xa0°C','',climatetxt)
```

In [311]:
```
climatetxt=re.sub('\'s','',climatetxt)
```

In [312]:
```
climatetxt=re.sub('.%','',climatetxt)
```

In [313]:
```
# Tokenization - Breaking content into sentences or words
# Sentence Tokenization - Breaking content into sentences, delimiter is full stop
# Word Tokenization - Breaking content into words, delimiter is space
```

In [314]:
```
from nltk.tokenize import sent_tokenize,word_tokenize
```

In [315]:
```
sentences=sent_tokenize(climatetxt)
```

In [316]:
```
len(sentences)
```

Out[316]:
```
1875
```

In [317]:
```
# Text Blob based sentiment analysis generates 2 metrics
# 1) Polarity Score which is a float between -1 to 1. Polarity score is calculated by
# comparing with positive, negative and neutral lexicon of words.
# >0 is Positive, =0 is Neutral and <0 is Negative

# 2) Subjectivity score lies between 0 and 1. Closer to 1 indicates high personal opinion
# without factual information and closer to 0 indicates low personal opinion. Particularly
# looks for adverbs.
```

In [318]:
```
from textblob import TextBlob
```

In [319]:
```
s1=TextBlob("Tendulkar is greatest batsman in cricket")
```

In [320]:
```
s1.sentiment
```

Out[320]:
```
Sentiment(polarity=1.0, subjectivity=1.0)
```

In [321]:
```
s2=TextBlob("Tendulakar score more than 20000 runs in cricket")
```

In [322]:
```
s2.sentiment
```

Out[322]:
```
Sentiment(polarity=0.5, subjectivity=0.5)
```

In [323]:
```
def analyze_sentiment(text):
    analysis=TextBlob(text)
    if analysis.sentiment.polarity>0:
        return 'Positive'
    elif analysis.sentiment.polarity==0:
        return 'Neutral'
    else:
        return 'Negative'
```

In [324]:
```
climatesentence=pd.DataFrame(sentences,columns=['sentence'])
```

In [325]:
```
climatesentence['sentiment']=[str(analyze_sentiment(x)) for x in climatesentence.sentence]
```

In [326]:
```
climatesentence.sentiment.value_counts()
```

Out[326]:
```
sentiment
Neutral     1302
Positive     401
Negative     172
Name: count, dtype: int64
```

In [327]:
```
climatesentence.head()
```

Out[327]:

	sentence	sentiment
0	Climate change WikipediaJump to contentMain m...	Positive
1	For natural historical climate trends, seeClim...	Positive
2	"Global warming" redirects here.	Neutral
3	For other uses, seeClimate change andGlobal w...	Negative
4	TheArctichas warmed the most, and temperatures...	Positive

In [328]:
```
# NLP is all about words or tokens. Words/tokens are fundamental of Text analysis
climatewords=word_tokenize(climatetxt)
```

In [329]:
```
climatewords=[w for w in climatewords if w.isalnum()] # isalnum()-function selects only words
```

In [330]:
```
from nltk.corpus import stopwords
```

In [331]:
```
# Stopwords are words like is, a, an, the, to, etc. that are not required for analysis
english_stopwords=set(stopwords.words("english"))
```

In [332]:
```
# convert words to lowercase as stopwords are in lowercase
climatewords=[w.lower() for w in climatewords]
```

In [333]:
```
# Remove stopwords
climatewords=[w for w in climatewords if not str.lower(w) in english_stopwords]
```

In [334]:
```
# Select words with more than 2 characters
climatewords=[w for w in climatewords if len(w)>2]
```

In [335]:
```
from nltk.probability import FreqDist
```

In [336]:
```
wordfreq=FreqDist(climatewords)
```

In [337]:
```
wordfreq.most_common(50)
```

Out[337]:
```
[('climate', 472),
 ('change', 323),
 ('global', 197),
 ('warming', 173),
 ('retrieved', 138),
 ('emissions', 83),
 ('carbon', 82),
 ('energy', 78),
 ('greenhouse', 73),
 ('temperature', 65),
 ('original', 58),
 ('impacts', 53),
 ('earth', 52),
 ('heat', 50),
 ('surface', 48),
 ('chapter', 47),
 ('world', 44),
 ('research', 44),
 ('science', 44),
 ('gas', 43),
 ('land', 42),
 ('also', 42),
 ('report', 42),
 ('summary', 42),
 ('national', 41),
 ('changes', 40),
 ('ice', 38),
 ('ocean', 38),
 ('may', 38),
 ('united', 37),
 ('years', 35),
 ('would', 35),
 ('use', 34),
 ('nations', 34),
 ('atmosphere', 34),
 ('health', 33),
 ('gases', 33),
 ('adaptation', 33),
 ('increased', 31),
 ('assessment', 31),
 ('countries', 31),
```

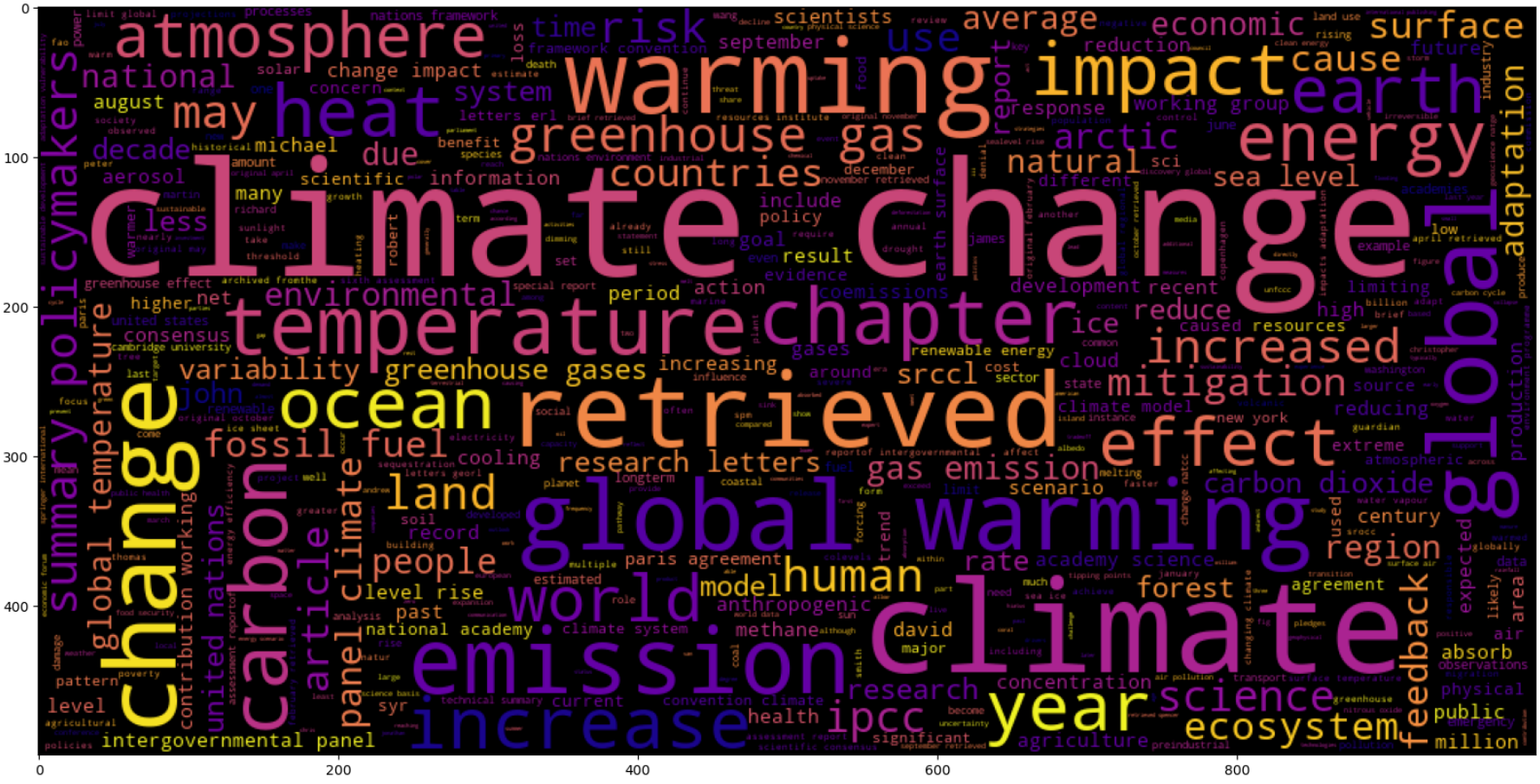
```
('since', 30),
('effect', 30),
('sea', 30),
('policymakers', 30),
('human', 29),
('increase', 29),
('agreement', 29),
('rise', 28),
('ipcc', 28)]
```

In [338]:
```
from wordcloud import WordCloud
```

In [339]:
```
climate_words=(" ").join(climatewords)
```

In [340]:
```
wordcloud=WordCloud(width=1000,height=500,colormap="plasma",
                    max_words=500).generate(str(climate_words))
# Wordcloud helps in identifying frequent words and also check whether preprocessing or
# cleanup done effectively
```

In [341]:
```
plt.figure(figsize=(20,10))
plt.imshow(wordcloud)
plt.show()
```



In [342]:
```
# Post preprocessing text data or words/tokens must be converted into matrix of numbers
# 3 Types of Matrices of Matrices can be created
# 1) Document Term Matrix, 2) Term Document Matrix, 3) Term Frequency Inverse Document
# Frequency(TFIDF) Matrix

# Document Term Matrix – Documents/Sentences in Rows and Terms/Words/Tokens in Columns
# Term Document Matrix – Documents/Sentences in Columns and Terms/Words/Tokens in Rows

# All 3 matrices are sparse matrices(many zeroes) in matrix

# Document term matrix values are frequencies

# For all these matrices words/tokens/terms can be:
# Unigrams – Single Words , Bigrams – Two Words  and Trigrams – Three Words

# CountVectorizer() in sklearn python creates Document Term Matrix
# In below Image Replace word Tweet with Document or Sentence
```

	Tweet 1	Tweet 2	Tweet 3	...	Tweet N
Term 1	0	0	0	0	0
Term 2	1	1	0	0	0
Term 3	1	0	0	0	0
...	0	0	3	1	1
Term M	0	0	0	1	0

Term Document Matrix (TDM)

	Term 1	Term 2	Term 3	...	Term M
Tweet 1	0	1	1	0	0
Tweet 2	0	1	0	0	0
Tweet 3	0	0	0	3	0
...	0	0	0	1	1
Tweet N	0	0	0	1	0

Document Term Matrix (DTM)

In [344]:
```
from sklearn.feature_extraction.text import CountVectorizer
```

In [345]:
```
DTM=CountVectorizer(max_features=50,stop_words="english")
```

In [346]:
```
X=DTM.fit_transform(climatewords)
```

In [347]:
```
pd.DataFrame(X.toarray(),columns=DTM.vocabulary_).head()
```

Out[347]:

	climate	change	temperature	global	rise	surface	impacts	health	emissions	ipcc	...	mitigation	research	countries	adaptation	science
0	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0
1	0	0	0	0	0	0	0	1	0	0	...	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0

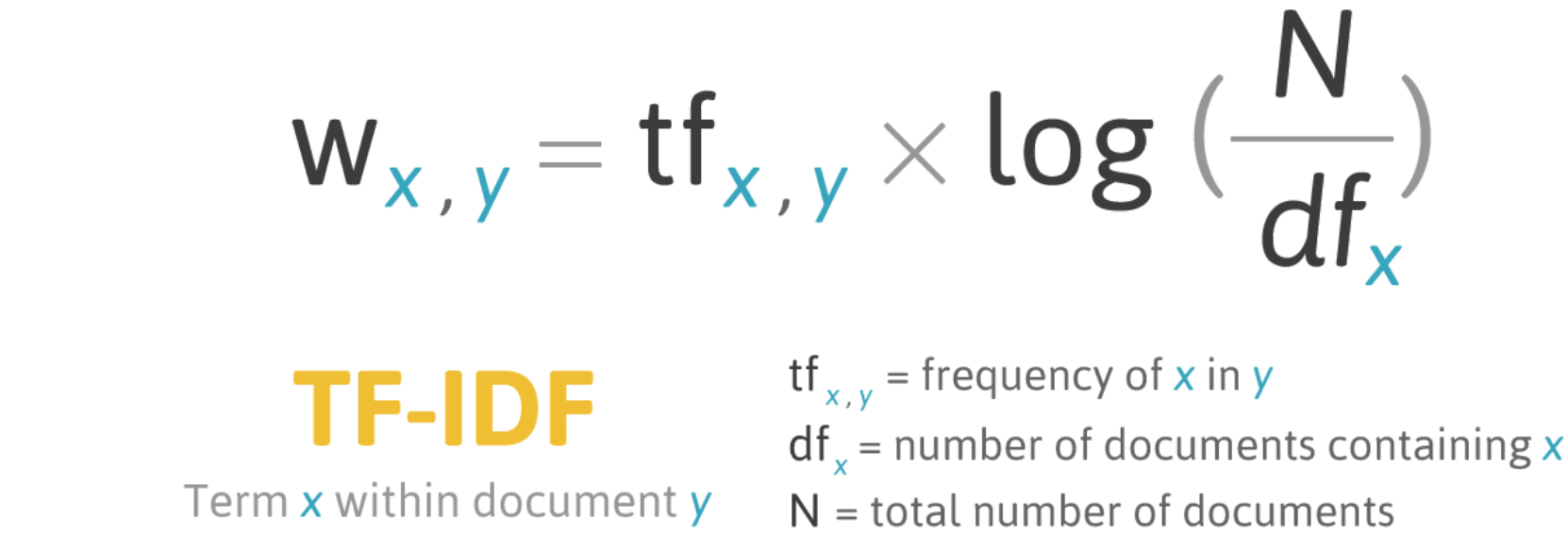
5 rows × 50 columns

In [348]:
```
# Term Frequency Inverse Document Frequency matrix
# D1 - The car is driven on road
# D2 - The truck is driven on highway

# Post preprocessing
# D1 - car, driven, road
# D2 - truck, driven, highway

# TFIDF for car
# Term Frequency of car - 1/3 = 0.33
# Inverse Document Frequency of Car = log(2/1) = log(2)= 0.6931
# TFIDF of car = 0.33 * 0.6931= 0.2310

# TFIDF for driven
# Term Frequency of driven - 1/3*1/3 = 0.33*0.33=0.1089
# Inverse Document Frequency of driven = log(2/2) = log(1)= 0
# TFIDF of driven = 0.1089* 0= 0
```



In [350]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
```

In [351]:
```
stop_words=list(stopwords.words("english"))
stop_words.extend("ipcc ar wg sr ch issn scid et al".split())
```

In [352]:
```
tfidf=TfidfVectorizer(max_features=20,stop_words=list(stop_words),
                      analyzer="word",ngram_range=(2,2))
```

In [353]:
```
X_tfidf=tfidf.fit_transform(climatesentence.sentence)
```

In [354]:
```
pd.DataFrame(X_tfidf.toarray(),columns=tfidf.vocabulary_).head(2)
```

Out[354]:

	climate change	global warming	greenhouse gases	carbon dioxide	greenhouse gas	gas emissions	sea level	united nations	panel climate	retrieved january	research letters	archivedfrom original	retrieved april	pol
0	0.0	0.0	0.0	0.660551	0.0	0.0	0.452835	0.0	0.598844	0.0	0.0	0.0	0.0	
1	0.0	0.0	0.0	0.000000	0.0	0.0	0.000000	0.0	0.000000	0.0	0.0	0.0	0.0	

In [355]:
```
from sklearn.preprocessing import LabelEncoder
```

In [356]:
```
y=LabelEncoder().fit_transform(climatesentence.sentiment)
```

In [357]:
```
from sklearn.linear_model import LogisticRegression
```

In [358]:
```
logisticmodel=LogisticRegression(multi_class="multinomial").fit(X_tfidf,y)
```

In [359]:
```
logisticmodel.score(X_tfidf,y)
```

Out[359]:
```
0.7290666666666666
```

In [360]:
```
logistic_pred=logisticmodel.predict(X_tfidf)
```

In [361]:
```
pd.crosstab(y,logistic_pred)
```

Out[361]:

col_0	1	2
row_0		
0	169	3
1	1291	11
2	325	76

In [ ]: