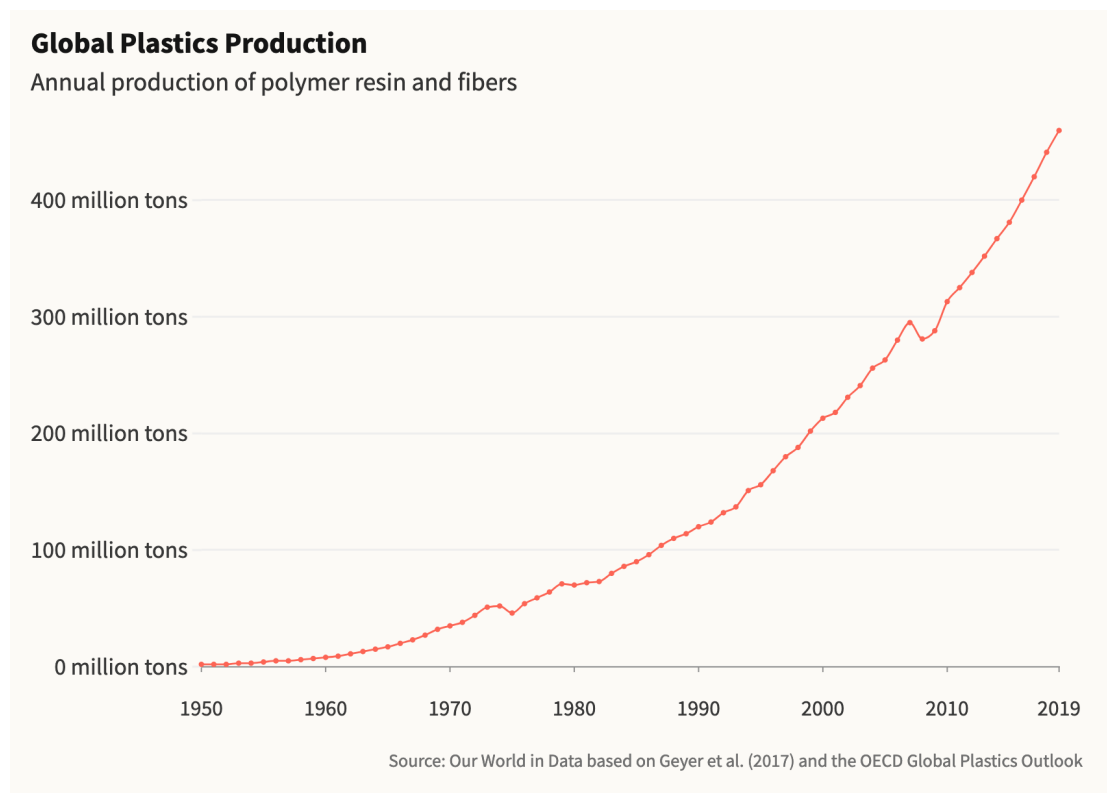


Plastic Proliferation: Spring, 2023

Microplastics Are Filling the Skies. Will They Affect the Climate?

YaleEnvironment360

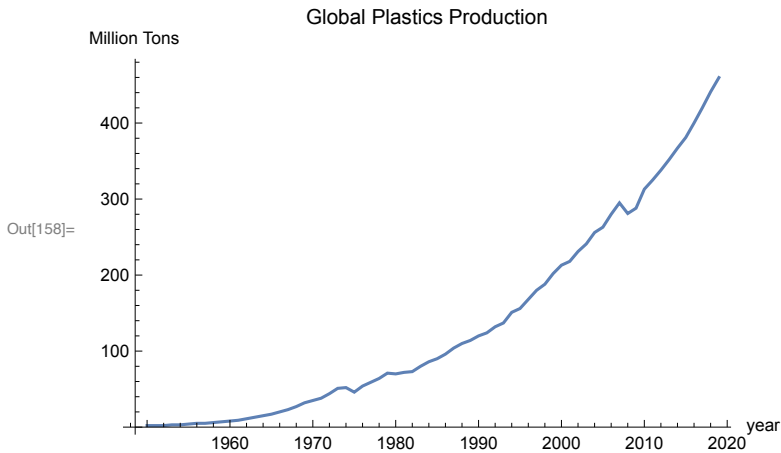
By Nicola Jones • February 1, 2023



Source: Our World in Data based on Geyer et al. (2017) and the OECD Global Plastics Outlook

```
In[53]:= plastics = {2 000 000, 2 000 000, 2 000 000, 3 000 000, 3 000 000, 4 000 000, 5 000 000,
    5 000 000, 6 000 000, 7 000 000, 8 000 000, 9 000 000, 11 000 000, 13 000 000, 15 000 000,
    17 000 000, 20 000 000, 23 000 000, 27 000 000, 32 000 000, 35 000 000, 38 000 000,
    44 000 000, 51 000 000, 52 000 000, 46 000 000, 54 000 000, 59 000 000, 64 000 000,
    71 000 000, 70 000 000, 72 000 000, 73 000 000, 80 000 000, 86 000 000, 90 000 000,
    96 000 000, 104 000 000, 110 000 000, 114 000 000, 120 000 000, 124 000 000, 132 000 000,
    137 000 000, 151 000 000, 156 000 000, 168 000 000, 180 000 000, 188 000 000, 202 000 000,
    213 000 000, 218 000 000, 231 000 000, 241 000 000, 256 000 000, 263 000 000, 280 000 000,
    295 000 000, 281 000 000, 288 000 000, 313 000 000, 325 000 000, 338 000 000, 352 000 000,
    367 000 000, 381 000 000, 400 050 000, 420 052 500, 441 055 125, 459 745 870};
years = {1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959,
    1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971,
    1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983,
    1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995,
    1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007,
    2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019};
data = Transpose[{years, plastics}];
ndata = Length[years];
```

```
In[158]:= pp = ListLinePlot[Transpose[{years, plastics / 10^6}],
    PlotLabel -> "Global Plastics Production", AxesLabel -> {"year", "Million Tons"}]
```



```

In[159]:= nlm = NonlinearModelFit[data, Exp[a + b * (x - 1950)] + c, {a, b, c}, x]
fit[x_] = Normal[nlm]
fit[x]
plot = Plot[fit[x] / 10^6, {x, 1950, 2020},
  PlotStyle -> Black, AxesLabel -> {"year", "Million Tons"}];
Show[pp, plot]

```

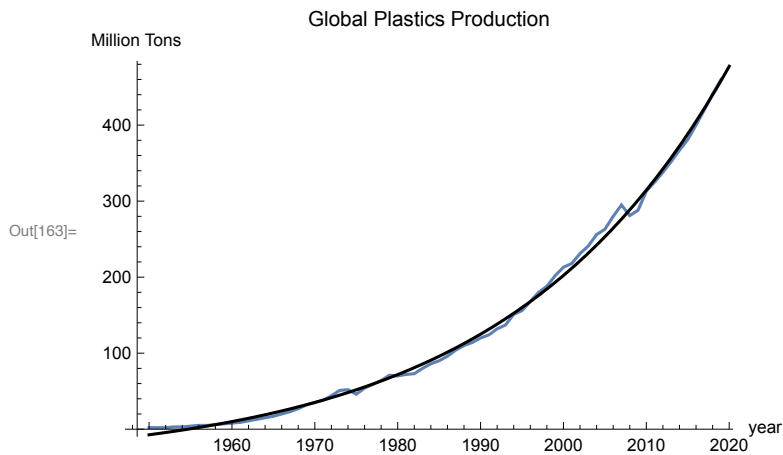
```
Out[159]= FittedModel [ 
$$-4.56569 \times 10^7 + e^{17.4614 + 0.0373384 (-1950 + x)}$$
 ]
```

```
Out[160]= 
$$-4.56569 \times 10^7 + e^{17.4614 + 0.0373384 (-1950 + x)}$$

```

```
Out[161]= 
$$-4.56569 \times 10^7 + e^{17.4614 + 0.0373384 (-1950 + x)}$$

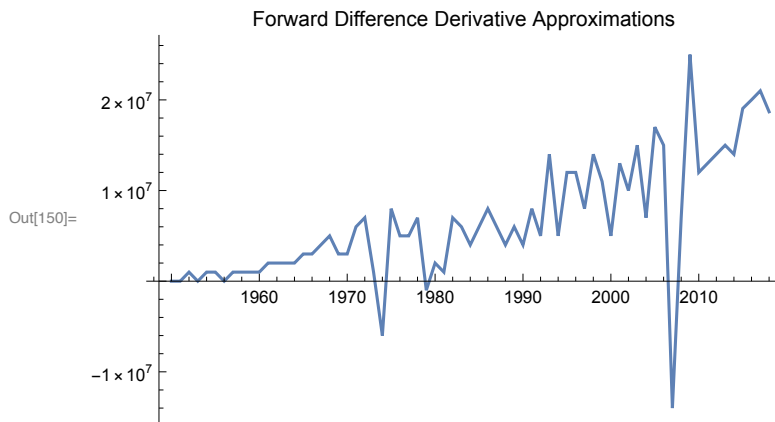
```



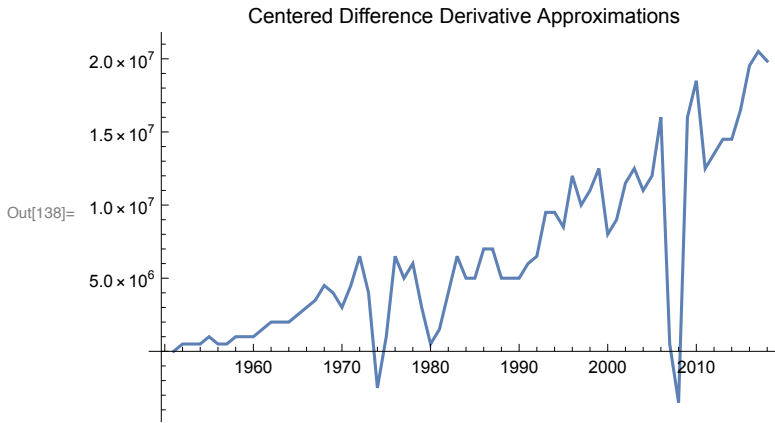
```

In[145]:= forwardPlastic = plastics[[2 ;; ndata]];
backwardPlastic = plastics[[1 ;; (ndata - 1)]];
forwardYears = years[[2 ;; ndata]];
backwardYears = years[[1 ;; (ndata - 1)]];
forwardDiffs = (forwardPlastic - backwardPlastic) / (forwardYears - backwardYears);
pf = ListLinePlot[Transpose[{backwardYears, forwardDiffs}], PlotRange -> All,
  PlotLabel -> "Forward Difference Derivative Approximations"]

```



```
In[136]:= centeredDiffs = (Rest[ forwardDiffs] + Most[forwardDiffs]) / 2.0;
centeredYears = Most[Rest[years]];
pc = ListLinePlot[Transpose[{centeredYears, centeredDiffs}], PlotRange → All,
PlotLabel → "Centered Difference Derivative Approximations"]
```



```
In[153]:= dplot = Plot[fit'[x], {x, 1950, 2020},
PlotStyle → Black, PlotLabel → "Model Derivative Approximations"]
Show[pf, pc, dplot, PlotLabel → "Various Derivative Approximations"]
```

