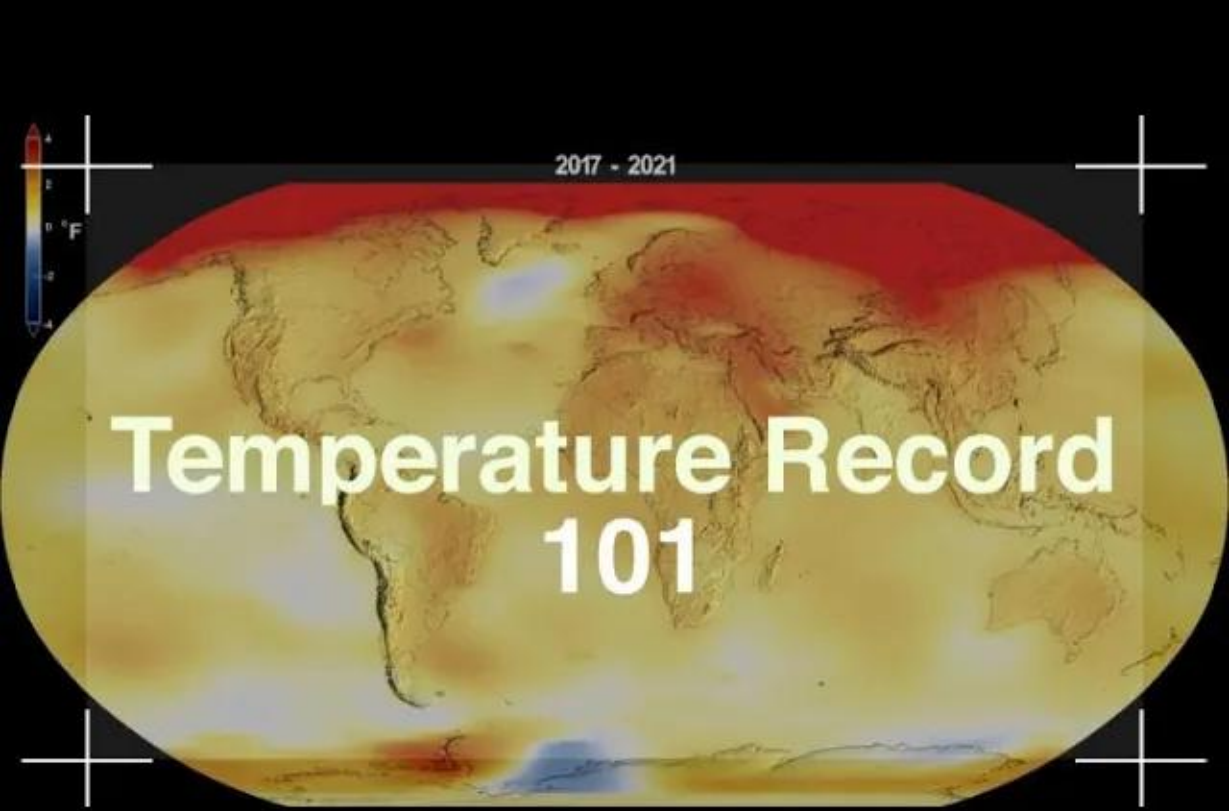
2017 - 2021
°F
Temperature Record
101

1
00:00:00,875 --> 00:00:03,294
In 1988, Dr. James Hansen,

2
00:00:03,670 --> 00:00:08,049
then Director of NASA's Goddard Institute
for Space Studies, stood before the U.S.

3
00:00:08,049 --> 00:00:09,551
Senate and testified that...

4
00:00:09,551 --> 00:00:13,179
Global warming has reached a level such
that we can ascribe

5
00:00:13,179 --> 00:00:16,599
with a high degree of confidence,
a cause and effect relationship

6
00:00:16,808 --> 00:00:19,436
between the greenhouse effect
and observed warming....

7
00:00:19,853 --> 00:00:23,064
It is already happening now.

8
00:00:23,064 --> 00:00:25,233
This last year, 2021,

9
00:00:25,233 --> 00:00:28,862
comes in as the sixth warmest year on record,

10
00:00:28,862 --> 00:00:32,115
and it continues this large

11
00:00:32,323 --> 00:00:34,701
long-term warming that Jim Henson

12
00:00:35,243 --> 00:00:37,454

was detecting even in 1988.

13
00:00:37,787 --> 00:00:42,125
and in 1988, that was also a globally warmest year.

14
00:00:42,667 --> 00:00:46,755
But now that ranks only 28th in the
in the ranking.

15
00:00:46,963 --> 00:00:50,133
And so the warming that we've had since

16
00:00:50,675 --> 00:00:56,765
Jim Hansen's testimony has been dramatic
and totally vindicates

17
00:00:56,973 --> 00:01:00,185
that concern and the warnings
that he put out at that time.

18
00:01:08,318 --> 00:01:10,612
The Goddard Institute for Space Studies,
or GISS

19
00:01:10,612 --> 00:01:14,324
for short, maintains NASA's
record of Earth's surface temperature,

20
00:01:14,449 --> 00:01:17,577
called GISTEMP, that shows a clear and unequivocal

21
00:01:17,577 --> 00:01:20,580
increase in our planet's temperature.

22
00:01:20,580 --> 00:01:22,457
GISTEMP stretches from 1880,

23
00:01:22,457 --> 00:01:25,251
long before NASA's existed,

until the present day.

24
00:01:26,753 --> 00:01:28,379
Now, when you think of NASA, you

25
00:01:28,379 --> 00:01:30,507
probably think of, well, space, right?

26
00:01:31,049 --> 00:01:34,010
And we do lots of work studying Earth from above.

27
00:01:34,010 --> 00:01:37,180
but the GISTEMP record is actually built from the ground up

28
00:01:37,597 --> 00:01:38,431
We collect measurements

29
00:01:38,431 --> 00:01:41,142
taken from weather stations,
Antarctic research stations.

30
00:01:41,392 --> 00:01:44,562
And ships and ocean buoys
all around the planet to understand

31
00:01:44,562 --> 00:01:46,689
what temperature changes
look like globally.

32
00:01:47,482 --> 00:01:49,526
And why does the record start in 1880?

33
00:01:51,736 --> 00:01:54,155
That's the earliest period that we have sufficiently reliable

34
00:01:54,155 --> 00:01:56,407
measurements from ships
and weather stations

35
00:01:56,407 --> 00:01:59,410
in enough places
to be confident in the global record.

36
00:02:00,203 --> 00:02:02,455
Interestingly, it's also shortly
after the time

37
00:02:02,455 --> 00:02:04,457
we call the Industrial Revolution.

38
00:02:04,457 --> 00:02:08,128
when humans started putting significant amounts of carbon dioxide in the atmosphere,

39
00:02:08,711 --> 00:02:09,963
but we'll get back to that later.

40
00:02:10,630 --> 00:02:14,801
There are millions of measurements
over the last hundred and 40 odd years.

41
00:02:15,176 --> 00:02:16,344
We put those together.

42
00:02:16,344 --> 00:02:19,764
We're using data
from literally tens of thousands

43
00:02:19,931 --> 00:02:22,308
of different stations around the world.

44
00:02:22,809 --> 00:02:27,397
We use the information
that's there to create a global picture

45
00:02:27,605 --> 00:02:29,399
of what's happening.

46

00:02:29,399 --> 00:02:31,901
And that gives us a very accurate

47
00:02:32,068 --> 00:02:36,281
estimate of how any year ranks or what the

48
00:02:36,406 --> 00:02:41,995
what the anomaly is for
any one year compared to what happened

49
00:02:41,995 --> 00:02:44,706
in the 19th century or what happened
in the middle of the 20th century.

50
00:02:45,373 --> 00:02:48,501
So we have our statistical reconstruction
of Earth's recent climate.

51
00:02:48,668 --> 00:02:51,004
But in research science,
we like to check our work.

52
00:02:51,754 --> 00:02:53,923
There are a couple of ways
we can do this.

53
00:02:53,923 --> 00:02:57,135
First of all, teamwork. Our colleagues at NOAA, and at other agencies

54
00:02:57,135 --> 00:03:01,306
and universities around the world, also create their own records, and

55
00:03:01,306 --> 00:03:05,018
we can line them up side-by-side, and see just how closely they align.

56
00:03:05,852 --> 00:03:08,396
Everyone's independent climate records
show the same thing:

57

00:03:08,855 --> 00:03:11,316
Earth is warming significantly and rapidly.

58
00:03:12,775 --> 00:03:15,862
And here at NASA, we have an even cooler way to check our work:

59
00:03:15,862 --> 00:03:17,322
space!

60
00:03:17,739 --> 00:03:18,698
Right now, we have more than

61
00:03:18,698 --> 00:03:21,826
two dozen satellites dedicated
just to studying our planet.

62
00:03:23,703 --> 00:03:25,914
Satellites can take measurements of the entire planet,

63
00:03:25,914 --> 00:03:28,583
and line them up with our estimate of global temperature change.

64
00:03:29,792 --> 00:03:30,793
And sure enough,

65
00:03:30,793 --> 00:03:32,754
they also match!

66
00:03:33,254 --> 00:03:36,966
Our measurements from space match up well with what our analysis tell us:

67
00:03:37,091 --> 00:03:40,303
Earth's climate is warming.

68
00:03:40,303 --> 00:03:41,804
The next big question,

69
00:03:42,430 --> 00:03:44,891

why is our planet warming?

70
00:03:44,891 --> 00:03:47,310
Let’s jump back to the Industrial Revolution:

71
00:03:49,103 --> 00:03:51,689
The release of carbon, mostly carbon dioxide

72
00:03:51,689 --> 00:03:54,817
from human activities like driving cars, flying planes, and industrial burning

73
00:03:54,817 --> 00:03:59,072
of fossil fuels is responsible for the majority of climate change.

74
00:03:59,906 --> 00:04:01,950
Carbon exists in stores underground,

75
00:04:01,950 --> 00:04:03,368
as oil, gas and coal.

76
00:04:04,452 --> 00:04:07,789
When we burn it, we release
it into our atmosphere, where it traps

77
00:04:07,789 --> 00:04:08,831
excess heat coming from

78
00:04:08,831 --> 00:04:11,000
the Sun, raising the temperature.

79
00:04:13,253 --> 00:04:14,879
We’ve known for more than a century

80
00:04:14,879 --> 00:04:17,715
that carbon dioxide added to our atmosphere traps

81
00:04:17,715 --> 00:04:19,801
additional heat and is a major contributor

82
00:04:19,801 --> 00:04:21,803
to the greenhouse effect.

83
00:04:21,803 --> 00:04:23,471
So we can also track the

84
00:04:23,471 --> 00:04:25,598
concentration of carbon dioxide in our atmosphere,

85
00:04:25,598 --> 00:04:28,059
the primary cause of the current
climate change.

86
00:04:28,476 --> 00:04:30,561
Both from space -- using NASA satellites like

87
00:04:30,561 --> 00:04:33,982
the Orbiting Carbon Observatories 2 and 3 -- and from the ground.

88
00:04:35,441 --> 00:04:38,569
If you've heard of the Keeling Curve, you're familiar with one of these records:

89
00:04:39,779 --> 00:04:41,281
Researchers have been taking daily

90
00:04:41,281 --> 00:04:44,409
measurements of atmospheric carbon dioxide from Mauna Loa, Hawaii,

91
00:04:44,409 --> 00:04:45,827
since the 1950s.

92
00:04:47,203 --> 00:04:48,413
From space and the ground,

93
00:04:48,413 --> 00:04:49,956
the signal is clear:

94
00:04:49,956 --> 00:04:52,375
There’s a lot more carbon in the atmosphere than there used to be.

95
00:04:55,378 --> 00:04:57,547
Other things have changed too - we’ve chopped

96
00:04:57,547 --> 00:04:59,007
down tropical forests,

97
00:04:59,007 --> 00:05:00,383
caused the ozone hole, and

98
00:05:00,383 --> 00:05:01,301
filled the air with soot, smog and

99
00:05:01,301 --> 00:05:04,554
other kinds of air pollution.

100
00:05:04,554 --> 00:05:06,347
And this is on top of natural variations

101
00:05:06,347 --> 00:05:08,933
caused by the dynamics of the oceans, or volcanoes,

102
00:05:08,933 --> 00:05:11,144
or variations in the Sun’s activity.

103
00:05:11,144 --> 00:05:12,145
And so we can ask whether

104
00:05:12,145 --> 00:05:14,063
it’s human activities warming our planet.

105
00:05:14,564 --> 00:05:15,815
At NASA, we have some big and

106
00:05:15,815 --> 00:05:17,608

powerful computers,

107
00:05:17,608 --> 00:05:20,903
able to make 6.8 trillion calculations per second.

108
00:05:21,321 --> 00:05:23,031
We put these huge supercomputers

109
00:05:23,031 --> 00:05:24,699
to work to recreate Earth’s climate.

110
00:05:25,283 --> 00:05:27,118
So, we have thousands of ideas of

111
00:05:27,118 --> 00:05:29,370
what could naturally cause climate change.

112
00:05:29,370 --> 00:05:32,081
We have 4 billion years of history
where nearly

113
00:05:32,081 --> 00:05:33,458
anything and everything

114
00:05:33,458 --> 00:05:36,002
you could imagine has impacted Earth's climate!

115
00:05:36,794 --> 00:05:38,087
But each of those events have

116
00:05:38,087 --> 00:05:40,173
their own distinct fingerprint which we can

117
00:05:40,173 --> 00:05:43,343
identify a pattern of behavior with natural variability.

118
00:05:43,843 --> 00:05:47,347
Using supercomputers, we can run

simulations of natural climate drivers,

119
00:05:47,722 --> 00:05:51,476
solar energy changes, wobbles in Earth’s orbits, ocean turnover,

120
00:05:51,476 --> 00:05:52,435
volcanic eruptions....

121
00:05:53,061 --> 00:05:55,063
And we can run simulations of human effects.

122
00:05:55,438 --> 00:05:57,190
And what we've seen is...

123
00:05:57,190 --> 00:05:59,650
It's us. There's no way around it.

124
00:05:59,650 --> 00:06:04,030
Looking at the evidence, we're the force
that's enacting these changes.

125
00:06:04,739 --> 00:06:08,534
I am so proud of our ability to understand

126
00:06:08,534 --> 00:06:11,454
the climate, but I'm terrified of what we found.

127
00:06:12,830 --> 00:06:14,874
But it’s not just the causes of climate change.

128
00:06:15,166 --> 00:06:17,543
It’s also the effects.

129
00:06:17,543 --> 00:06:21,172
Because it’s not just about knowing why our planet is warming

130
00:06:21,172 --> 00:06:23,341
it’s also about understanding, and preparing for,

131
00:06:23,341 --> 00:06:25,551
the effects of added warmth.

132
00:06:26,177 --> 00:06:29,347
Measurement of global average temperatures is so important

133
00:06:29,347 --> 00:06:33,393
because it's one of the most direct
indicators of Earth's changing climate.

134
00:06:34,310 --> 00:06:38,439
But the Earth is really a system
of environmental systems, land,

135
00:06:38,481 --> 00:06:43,486
ocean atmosphere and ice, and changes
in one system impact the others.

136
00:06:44,487 --> 00:06:47,949
Our oceans are our first line of defense
in climate change

137
00:06:48,157 --> 00:06:52,662
because they absorb so much of the extra
trapped energy in the Earth system.

138
00:06:52,912 --> 00:06:55,540
We are seeing the impacts
of climate change now.

139
00:06:55,540 --> 00:06:58,960
Now we know that as our climate warms,

140
00:06:59,168 --> 00:07:02,463
wet areas are getting wetter
and dry areas are getting drier.

141
00:07:02,797 --> 00:07:05,591

For example, we see more intense snowstorms.

142
00:07:05,591 --> 00:07:10,888
We see slower hurricanes that are causing
more precipitation that inundate land.

143
00:07:11,264 --> 00:07:14,725
And we have more extreme precipitation
in the form of atmospheric rivers

144
00:07:15,309 --> 00:07:18,438
that come from the Pacific
and reach our West Coast.

145
00:07:18,855 --> 00:07:22,150
The oceans are observing a large amount
of heat because of climate change.

146
00:07:22,525 --> 00:07:26,320
And once that heat is in the ocean,
it actually travels all around the planet

147
00:07:26,320 --> 00:07:27,697
because of the ocean currents.

148
00:07:27,697 --> 00:07:32,118
And that has impacts on local weather and long-term climate.

149
00:07:32,660 --> 00:07:33,911
As the planet warms.

150
00:07:33,911 --> 00:07:37,457
It's not just the ocean
that's warming, it's also the ice

151
00:07:37,457 --> 00:07:40,084
that sits in the ocean and on land.

152
00:07:40,668 --> 00:07:45,756

The ice on land being warmed increases
melting, which is increasing freshwater

153
00:07:45,756 --> 00:07:50,845
input into the polar oceans and causing
sea levels to rise across the globe.

154
00:07:51,012 --> 00:07:53,681
So as the climate is changing,
we really are

155
00:07:54,015 --> 00:07:56,893
seeing a lot of changes
to the environment up in the Arctic.

156
00:07:58,811 --> 00:07:59,937
We're seeing more permafrost

157
00:07:59,937 --> 00:08:02,982
thaw when it's warmer up there,

158
00:08:04,150 --> 00:08:07,069
the warmer air temperature can lead
to warm ground temperature

159
00:08:07,069 --> 00:08:10,615
and we get that thawing
of that permafrost layer.

160
00:08:10,615 --> 00:08:11,866
We're finding that the fire season

161
00:08:11,866 --> 00:08:15,578
is being exacerbated by longer periods
of drought and decreased snowfall.

162
00:08:15,870 --> 00:08:20,374
Knowing that our climate is changing due
to human activities means that we know how

163
00:08:20,374 --> 00:08:24,545
to lessen the effects of future warming
and knowing how we know

164
00:08:24,545 --> 00:08:27,882
what causes climate change confirms
that our efforts would be meaningful.

165
00:08:28,549 --> 00:08:30,801
The situation is serious,
but it's not hopeless.