1
00:00:11,110 --> 00:00:09,110
the earth is a complex system and

2
00:00:12,870 --> 00:00:11,120
scientists are continually investigating

3
00:00:13,990 --> 00:00:12,880
the intricate workings of our home

4
00:00:15,749 --> 00:00:14,000
planet

5
00:00:17,109 --> 00:00:15,759
part of what makes the earth so unique

6
00:00:18,710 --> 00:00:17,119
is its climate

7
00:00:20,470 --> 00:00:18,720
many scientists are concerned that

8
00:00:22,390 --> 00:00:20,480
earth's climate is changing at an

9
00:00:24,070 --> 00:00:22,400
unprecedented rate

10
00:00:25,589 --> 00:00:24,080
how do scientists study how warm the

11
00:00:27,029 --> 00:00:25,599
planet is

12
00:00:28,470 --> 00:00:27,039
here's a look at the tools nasa

13
00:00:30,550 --> 00:00:28,480

scientists use to take earth's

14
00:00:32,150 --> 00:00:30,560
temperature

15
00:00:34,870 --> 00:00:32,160
models are powerful tools for

16
00:00:37,030 --> 00:00:34,880
understanding earth's complex systems

17
00:00:39,190 --> 00:00:37,040
to create a model scientists must first

18
00:00:41,990 --> 00:00:39,200
characterize a system by identifying the

19
00:00:43,750 --> 00:00:42,000
processes that govern its evolution

20
00:00:45,750 --> 00:00:43,760
those processes are represented by

21
00:00:47,750 --> 00:00:45,760
equations and are solved on powerful

22
00:00:49,910 --> 00:00:47,760
computers

23
00:00:51,270 --> 00:00:49,920
this animation comes from an atmospheric

24
00:00:53,350 --> 00:00:51,280
assimilation

25
00:00:55,750 --> 00:00:53,360
it uses observations of temperature

26
00:00:58,630 --> 00:00:55,760
moisture and winds to provide a picture

27
00:01:00,549 --> 00:00:58,640
of earth's hydrological cycle

28
00:01:02,950 --> 00:01:00,559
once a model is in place the resulting

29
00:01:04,390 --> 00:01:02,960
simulation must be proven to match real

30
00:01:06,310 --> 00:01:04,400
world measurements

31
00:01:07,990 --> 00:01:06,320
well models are important for the

32
00:01:10,310 --> 00:01:08,000
scientific community because they

33
00:01:13,030 --> 00:01:10,320
capture really the essence and basic

34
00:01:14,710 --> 00:01:13,040
understanding that we have of how our

35
00:01:16,789 --> 00:01:14,720
system works

36
00:01:18,390 --> 00:01:16,799
on a lot of different time scales and

37
00:01:20,550 --> 00:01:18,400
space scales for a lot of different

38
00:01:23,109 --> 00:01:20,560

applications from weather all the way

39
00:01:25,990 --> 00:01:23,119
through to climate

40
00:01:27,910 --> 00:01:26,000
in the 1970s dr james hansen and

41
00:01:29,990 --> 00:01:27,920
colleagues at nasa built a simple

42
00:01:32,069 --> 00:01:30,000
climate model to simulate how changes in

43
00:01:34,950 --> 00:01:32,079
the atmosphere cause earth's average

44
00:01:37,030 --> 00:01:34,960
temperature to change over time

45
00:01:39,590 --> 00:01:37,040
hansen's early climate model showed that

46
00:01:42,389 --> 00:01:39,600
both human and natural activities could

47
00:01:44,630 --> 00:01:42,399
force earth's climate to change

48
00:01:47,190 --> 00:01:44,640
the model revealed that natural forcings

49
00:01:49,429 --> 00:01:47,200
like volcanic eruptions or changes in

50
00:01:51,749 --> 00:01:49,439
the sun's activities tend to go up and

51
00:01:53,910 --> 00:01:51,759
down over long periods of time

52
00:01:57,749 --> 00:01:53,920
but human forcings from greenhouse gas

53
00:01:59,910 --> 00:01:57,759
emissions are steadily increasing

54
00:02:02,389 --> 00:01:59,920
hansen's early simulation revealed that

55
00:02:04,550 --> 00:02:02,399
human forcings on climate would dominate

56
00:02:06,870 --> 00:02:04,560
in the future but he needed real-world

57
00:02:09,510 --> 00:02:06,880
temperature data on a global scale to

58
00:02:11,350 --> 00:02:09,520
determine when

59
00:02:13,030 --> 00:02:11,360
the most reliable measurement of global

60
00:02:15,270 --> 00:02:13,040
temperature came from weather stations

61
00:02:16,869 --> 00:02:15,280
scattered around the globe

62
00:02:18,630 --> 00:02:16,879
hanson knew that weather fluctuations

63
00:02:20,869 --> 00:02:18,640

would cause short-term changes at

64
00:02:23,350 --> 00:02:20,879
individual stations but he reasoned that

65
00:02:25,350 --> 00:02:23,360
taking averages over several years and

66
00:02:27,110 --> 00:02:25,360
appropriately weighting each station's

67
00:02:30,550 --> 00:02:27,120
data would deliver meaningful

68
00:02:35,190 --> 00:02:33,110
a consistent trend of warming is visible

69
00:02:37,589 --> 00:02:35,200
in both the global temperature data and

70
00:02:39,509 --> 00:02:37,599
the global climate model

71
00:02:42,790 --> 00:02:39,519
we have a pretty good understanding now

72
00:02:44,710 --> 00:02:42,800
of how sensitive the climate is to

73
00:02:46,710 --> 00:02:44,720
the increases in greenhouse gases this

74
00:02:48,790 --> 00:02:46,720
comes particularly from

75
00:02:51,190 --> 00:02:48,800
the history of the earth i mean our

76
00:02:52,949 --> 00:02:51,200
climate models give us an answer too but

77
00:02:55,350 --> 00:02:52,959
there there are a lot of uncertainties

78
00:02:58,470 --> 00:02:55,360
in the climate models the challenges

79
00:03:00,710 --> 00:02:58,480
associated with modeling a manifold the

80
00:03:02,869 --> 00:03:00,720
earth really acts as a system you know

81
00:03:05,589 --> 00:03:02,879
the ocean interacts with the atmosphere

82
00:03:08,630 --> 00:03:05,599
interacts with the land surface so

83
00:03:11,509 --> 00:03:08,640
representing all of this sort of complex

84
00:03:14,790 --> 00:03:11,519
system really are a major challenge

85
00:03:16,229 --> 00:03:14,800
in 2008 nasa plans to launch glory a

86
00:03:19,030 --> 00:03:16,239
mission that will measure two key

87
00:03:20,949 --> 00:03:19,040
climate forcings solar irradiance and

88
00:03:22,630 --> 00:03:20,959

atmospheric aerosols

89
00:03:25,830 --> 00:03:22,640
these measurements will help to improve

90
00:03:27,750 --> 00:03:25,840
the accuracy of global climate models

91
00:03:29,910 --> 00:03:27,760
nasa missions like glory will help

92
00:03:31,910 --> 00:03:29,920
scientists fine-tune their understanding

93
00:03:34,229 --> 00:03:31,920
of earth's climate providing a more