Global Climate Models

How scientists simulate the climate system and project future climate scenarios
Scientists observe & measure all the factors that are known to influence Earth’s climate.
Scientists apply that knowledge to a scaled-down, computer simulation of the planet: a global climate model.

Modelers represent Earth’s surface and atmosphere as a virtual world made up of interacting, three-dimensional boxes.
Physical characteristics and processes that occur in each box are cataloged.
Mathematical equations that represent the physical characteristics and processes are entered for each box.
Equations are converted to computer code and climate variables are set.

if (diagts .and. eots) then
  do 1500 m=1,nt
    do 1490 k=1,km
      fx = cst(j)*dxt(j)*dzt(k)/(c2dttts*dtxcel(k))
    do 1480 i=2,intm1
      boxfx = fx*dxt(i)*fm(i,k,jc)
      sddt = (ta(i,k,m)-t(i,k,jc,nm,n))*boxfx
  svar = (ta(i,k,m)**2-t(i,k,jc,nm,n)**2)
      boxfx
    n = 0
    termbt(k,1,n,n) = termbt(k,1,m,n) + sddt
    tvar(k,m,n) = tvar(k,n,n) + svar
    n = nhreg*(mskkr(k)-1) + mskhr(i,j)
  if (n .gt. 0 .and. mskhr(i,j) .gt. 0) then
    termbt(k,1,m,n) = termbt(k,1,n,n) + sddt
    tvar(k,n,n) = tvar(k,n,n) + svar
A supercomputer solves all the equations, passing results to neighboring boxes and calculating the next set of initial conditions.
Models are tested and refined by simulating past climate then checking how well the results match observations.
Models that successfully approximate past climate are considered valid for modeling future scenarios.
Climate models project temperature increases for various carbon dioxide emission scenarios

Studies suggest that a further increase of only 2°F would lead to severe, widespread, and irreversible impacts on Earth’s environment.\textsuperscript{1,2,3}

IPCC models successfully simulated climate conditions from 1900 to 2000.
Research groups around the world have developed a range of respected climate models. Modeling groups also work together, averaging results from their models with other models that used the same initial conditions. These multi-model results are called “ensembles.”
We can use climate models to link effects to their causes.

Observations relative to 1901-1950 average
Models predict how global average temperatures would have changed due to natural forces only

![Temperature anomaly graph](IPCC, 2007, SPM)

- Model predictions for natural forcings
- Observations relative to 1901-1950 average
Models attribute global warming mainly to human origins

IPCC, 2007, SPM
The pattern holds true on every inhabited continent

Model predictions for natural & human forcings
Model predictions for natural forcings
Observations relative to 1901-1950 average

IPCC, 2007