

Lesson 14
The Butterfly Effect
蝴蝶效应

First listen and then answer the following question.
听录音，然后回答以下问题。

Why do small errors make it impossible to predict the weather system with a high degree of accuracy?

Beyond two or three days, the world's best weather forecasts are speculative, and beyond six or seven they are worthless.

The Butterfly Effect is the reason. For small pieces of weather -- and to a global forecaster, small can mean thunderstorms and blizzards -- any prediction deteriorates rapidly. Errors and uncertainties multiply, cascading upward through a chain of turbulent features, from dust devils and squalls up to continent-size eddies that only satellites can see.

The modern weather models work with a grid of points of the order of sixty miles apart, and even so, some starting data has to be guessed, since ground stations and satellites cannot see everywhere. But suppose the earth could be covered with sensors spaced one foot apart, rising at one-foot intervals all the way to the top of the atmosphere. Suppose every sensor gives perfectly accurate readings of temperature, pressure, humidity, and any other quantity a meteorologist would want. Precisely at noon an infinitely powerful computer takes all the data and calculates what will happen at each point at 12.01, then 12.02, then 12.03...

The computer will still be unable to predict whether Princeton, New Jersey, will have sun or rain on a day one month away. At noon the spaces between the sensors will hide fluctuations that the computer will not know about, tiny deviations from the average. By 12.01, those fluctuations will already have created small errors one foot away. Soon the errors will have multiplied to the ten-foot scale, and so on up to the size of the globe.

JAMES GLEICK, Chaos

New words and expressions 生词和短语

- forecast
- n. 预报
- speculative
- adj. 推测的
- blizzard
- n. 暴风雪
- deteriorate
- v. 变坏
- multiply
- v. 增加
- cascade
- v. 瀑布似地落下
- turbulent
- adj. 狂暴的
- dust devil
- 小尘暴，尘旋风
- squall

- n. 暴风
eddy
- n. 旋涡
grid
- n. 坐标方格
sensor
- n. 传感器
humidity
- n. 温度
meteorologist
- n. 气象学家
Princeton
- n. 普林斯顿（美国城市名）
New Jersey
- n. 新泽西（美国州名）
fluctuation
- n. 起伏，波动
deviation
- n. 偏差

参考译文

世界上最好的两三天以上的天气预报具有很强的猜测性，如果超过六七天，天气预报就没有了任何价值。

原因是蝴蝶效应。对于小片的恶劣天气 -- 对一个全球性的气象预报员来说，“小”可以意味着雷暴雨和暴风雪 -- 任何预测的质量会很快下降。错误和不可靠性上升，接踵而来的是一系列湍流的徵状，从小尘暴和暴风发展到只有卫星上可以看到的席卷整块大陆的旋涡。

现代气象模型以一个坐标图来显示，图中每个点大约是间隔 60 英里。即使是这样，有些开始时的资料也不得不依靠推测，因为地面工作站和卫星不可能看到地球上的每一个地方。假设地球上可以布满传感器，每个相隔 1 英尺，并按 1 英尺的间隔从地面一直排列到大气层的顶端。再假定每个传感器都极极端准确地读出了温度、气压、湿度和气象学家需要的任何其他数据。在正午时分，一个功能巨大的计算机搜集了所有的资料，并算出在每一个点上 12: 01、12: 02、12: 03 时可能出现的情况。

计算机无法推断出 1 个月以后的某一天，新泽西州的普林斯顿究竟是晴天还是雨天。正午时分，传感器之间的距离会掩盖计算机无法知道的波动、任何偏离平均值的变化。到 12: 01 时，那些波动就已经会在 1 英尺远的地方造成偏差。很快这种偏差会增加到尺 10 英的范围，如此等等，一直到全球的范围。