大氣科學概論課後報告(第 10 週)

系級:大氣一 學號:B13209015 姓名:楊承翰

A、 上課重點整理

In class this week, we learned the predictability of weather and atmospheric observation. The teacher started with a simple example to introduce “Climatological background field” and “Chaos”.

In the part of atmospheric observation, we start with the history of observation of atmosphere.

a、 大氣可預報度(曾開治老師)-

Why The Weather is Unpredictable-From the Lens of Chaos and Climate:

- How is the effective prediction?
  Compare with climatological background!
- Different forecasts converge to the climatological background field over different time.
- The upper boundary and lower boundary of predictability is determined by climatology.
- Because earth rotates, the curve of outgoing longwave radiation is not a flat line.
- First concept of chaos: Henri Poincaré-three body problem
- Chaos theorem: Edward Lorenz
- Using probability density function describe uncertainty of forecast: Joseph Liouville
- Write the mathematical formula to describe entropy of information $E = -\int \rho \ ln \rho \, ds$: John von Neumann and Claude Shannon
- Difference between ensembles in short time interval: chaos caused
  Change of ensembles in long time interval: climate changing

b、 大氣觀測(林博雄老師)-大氣觀測:

- John Dalton wrote the first meteorological observation
- 1930-radiosonde → 1947-radar → 1960s-rocket and satellite → 1970s-wind profiler → 2000s-wind lidar

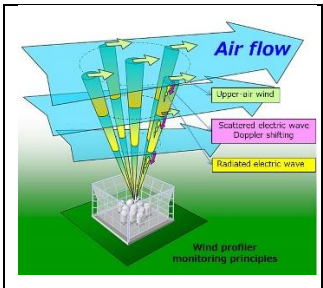

Fig.1
wind profiler and how does it work

source:
Japan Meteorological Agency
(https://www.jma.go.jp/jma/en/Activities/windpro/windpro.html)

- Optical technology and AI leading to smaller scale observation.
- The World Meteorological Organization, WMO, established the meteorological observation standards and the Global Telecommunication System, GTS, which improve the observation and data exchanging.

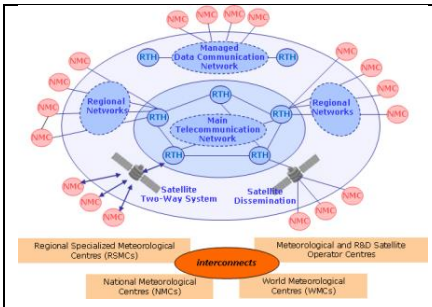

Fig.2
GTS

source:
World Meteorological Organizaation (https://community.wmo.int/en/activity-areas/global-telecommunication-system-gts)

- We can observe typhoons with Reconnaissance and Surveillance.

B、 問題討論

a、 Whether upper boundary of forecast can be increased when technology improving?
As in the above key point of class, upper boundary of forecast is determined by climatology, therefore, I think it doesn't increase when technology advances. (because they are two different things!)
But we may be able to slow down the rate that it reaches the upper boundary with advanced technologies.

b、 If the density of observations on land is more than those on ocean? Could it affect our understanding about the details of large-scale atmospheric circulation?
I think the observations on ocean are indeed less than those on land, and it also increases the difficulty of understanding the details of large-scale circulation. However, we still use buoys, ships and satellites to increase ocean-base observation data.

C、 心得感想

I have heard of the chaos and Butterfly effect before the class, but I didn't really know the concept and its effect on weather prediction. After the class, I learned the basic concept of how chaos affects predictability and what things determine the upper boundary of predictability. I think the relation between unpredictability and weather forecast is an interesting but difficult issue.
In the part of meteorological observation, I know the history of meteorological tools and learn the importance of WMO.
After class this week, I realize that atmospheric science is a multi-field based on vast amounts of data and experiences from physics, chemistry and technology.

D、 參考資料

- Figure 1: Japan Meteorological Agency
  https://www.jma.go.jp/jma/en/Activities/windpro/windpro.html
- Figure 2: World Meteorological Organization
  https://community.wmo.int/en/activity-areas/global-telecommunication-system-gts