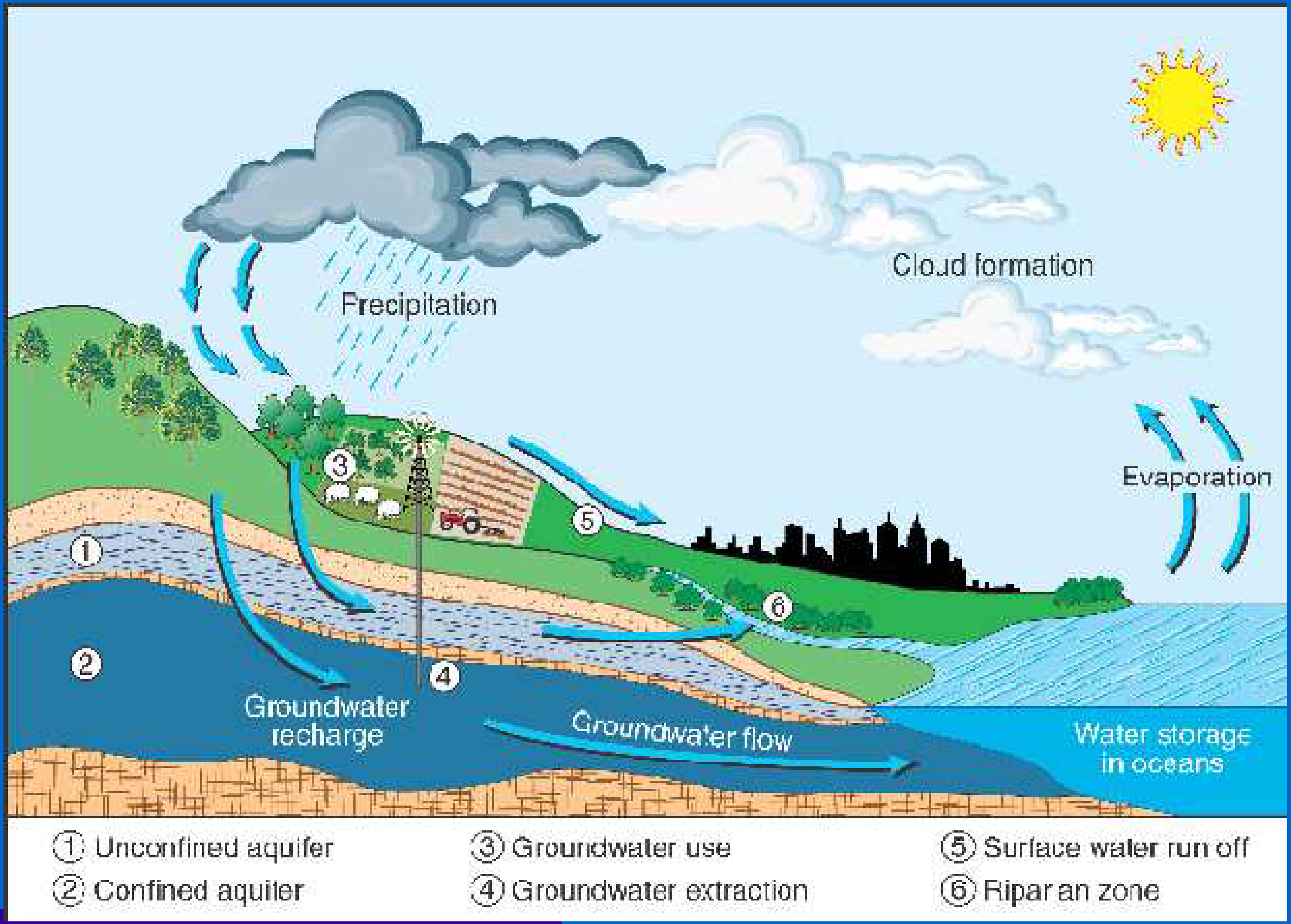
The Hydrological Cycle

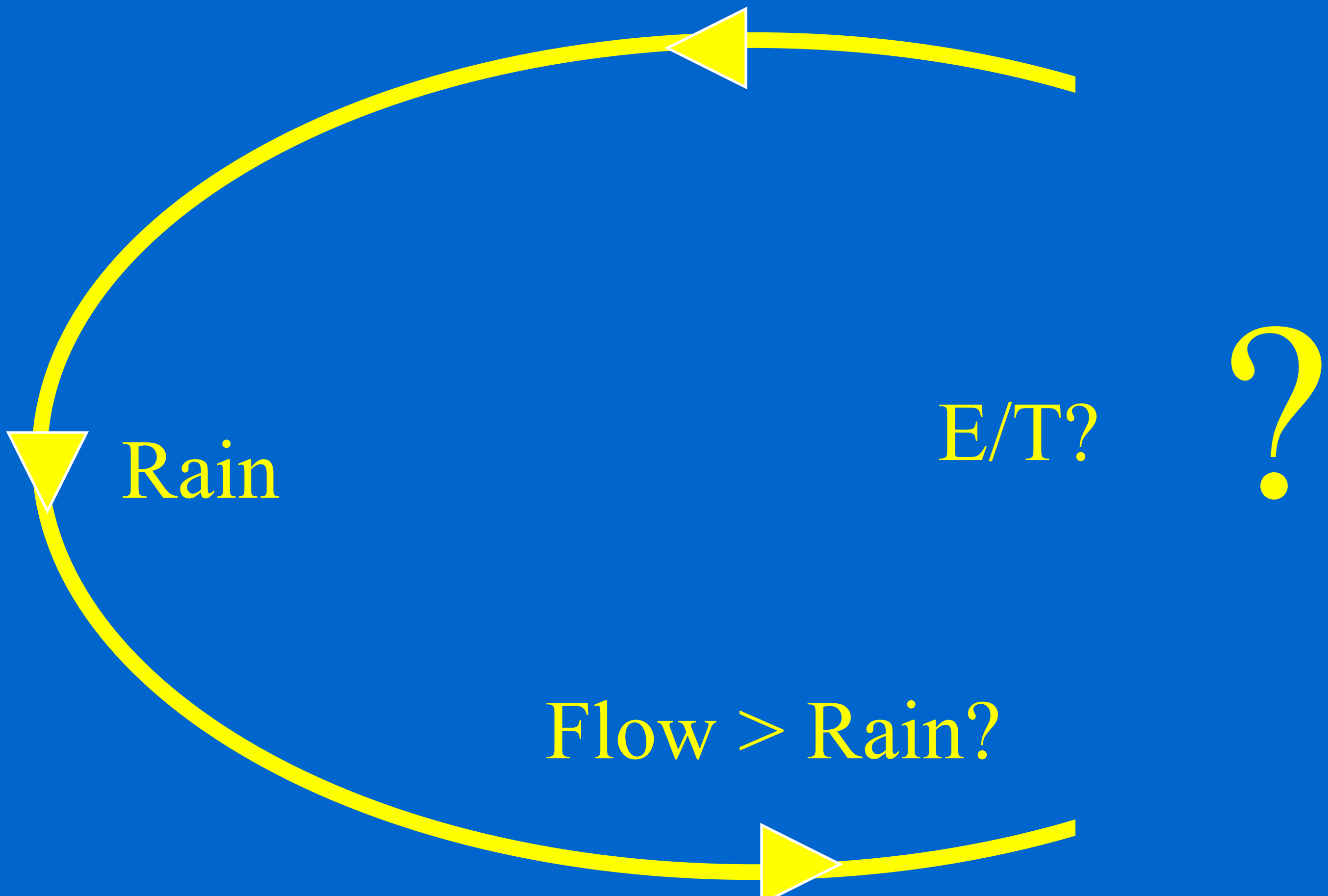
Overview

- A very brief history of hydrology
- Relevance to training course
  - Surface water & groundwater
    - a single resource
  - Climate
    - Variability
    - Change
- Oceanic perspective

Typical representation



Not immediately obvious



Historical developments.

- Greek philosophers (500 BC)
  - Aware of underground water
  - Failed to appreciate significance of rain
  - Relied on reasoning without observation
  - Hypothesis of "underground condensation"
- Misunderstanding persisted for centuries

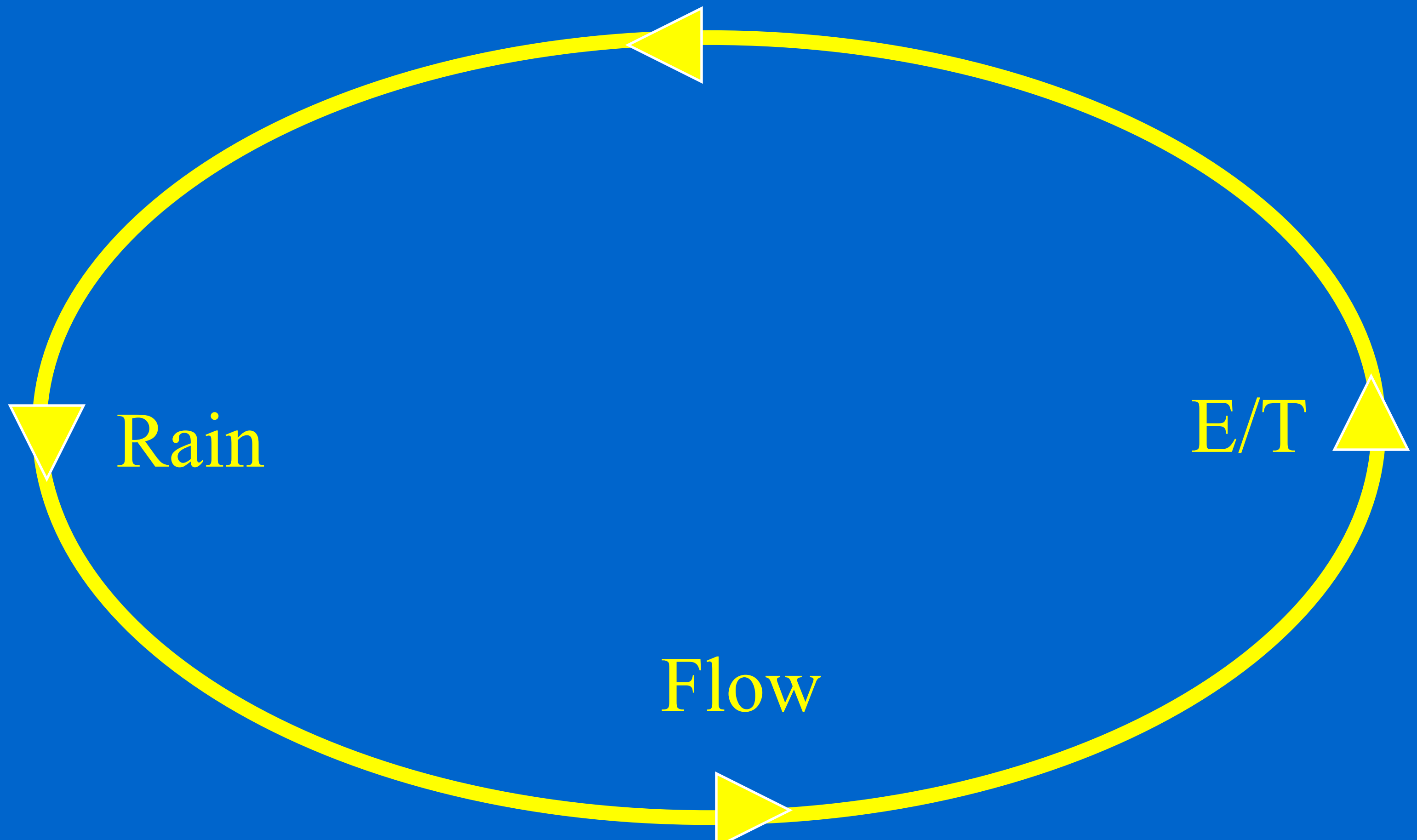
Historical developments..

- Leonardo da Vinci (1452-1519)
  - Made hydrological observations
  - Developed a concept of a hydrological cycle
  - Included evaporation and precipitation, but
  - Still underestimated the role of rainfall & suggested that rivers were fed from the sea via underground veins

Historical developments…

- Seventeenth century
  - French scientists produced evidence that rainfall could account for observed river flow
  - Edmund Halley (1656-1742) measured evaporation but still retained belief in underground mechanism
  - John Dalton (1760-1844) correctly described the complete hydrological cycle based on his quantitative hydrological and meteorological observations.

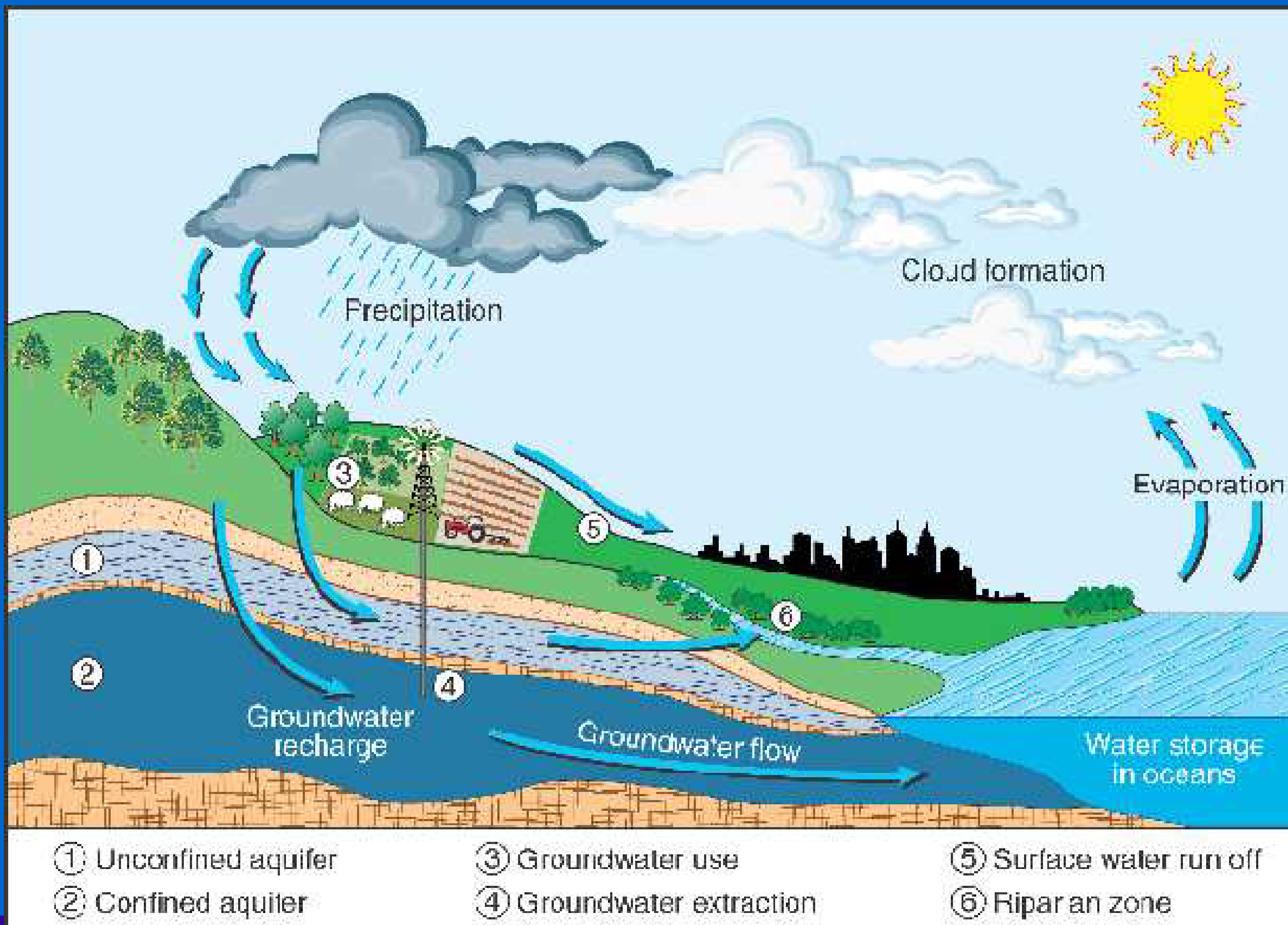
The completed cycle



Lessons from the brief history

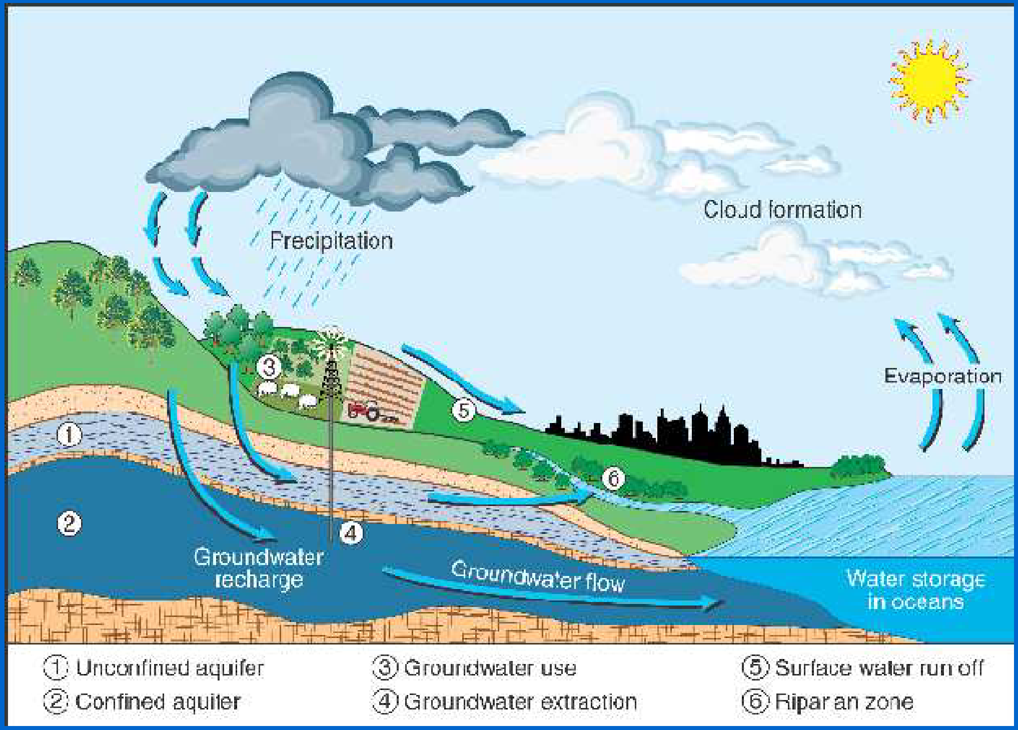
- Though the hydrological cycle now seems an obvious and simple concept this was not always the case
- Development of a complete and rational theory depended on systematic observations and analysis
- Despite developments of complex computer models, data collection, data processing and analysis continue to provide the foundation for the science of hydrology

Back to the present



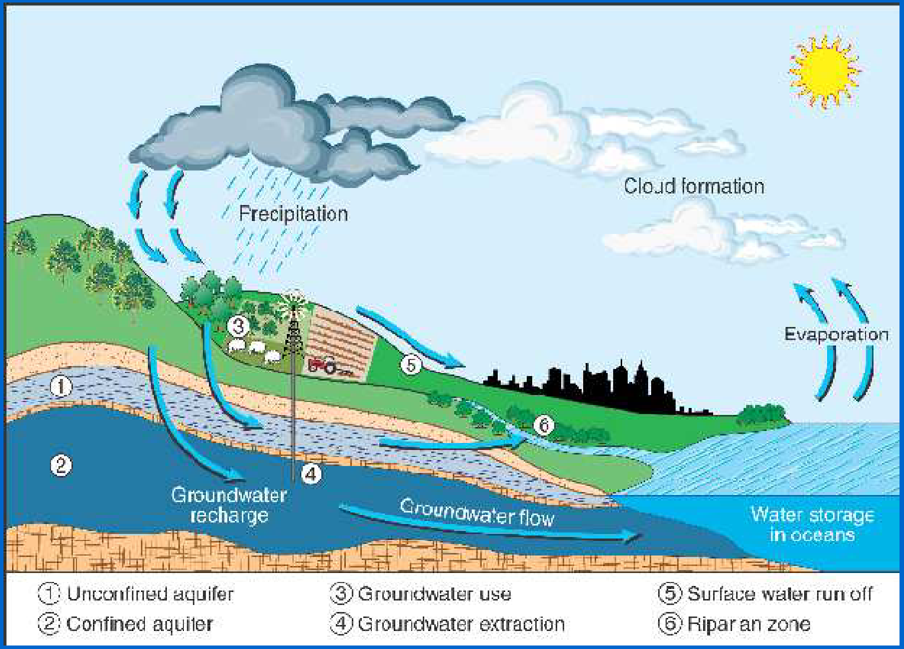
Strengths of the cycle concept

- Describes spatial variability of flow and storage
- Emphasizes inter-connection of components
- Reinforces that "Everyone lives downstream"



Weaknesses

- Implies a smooth and continuous process
- Suggests a self-contained system
- Does not portray the variability which produces the extremes of flood & drought



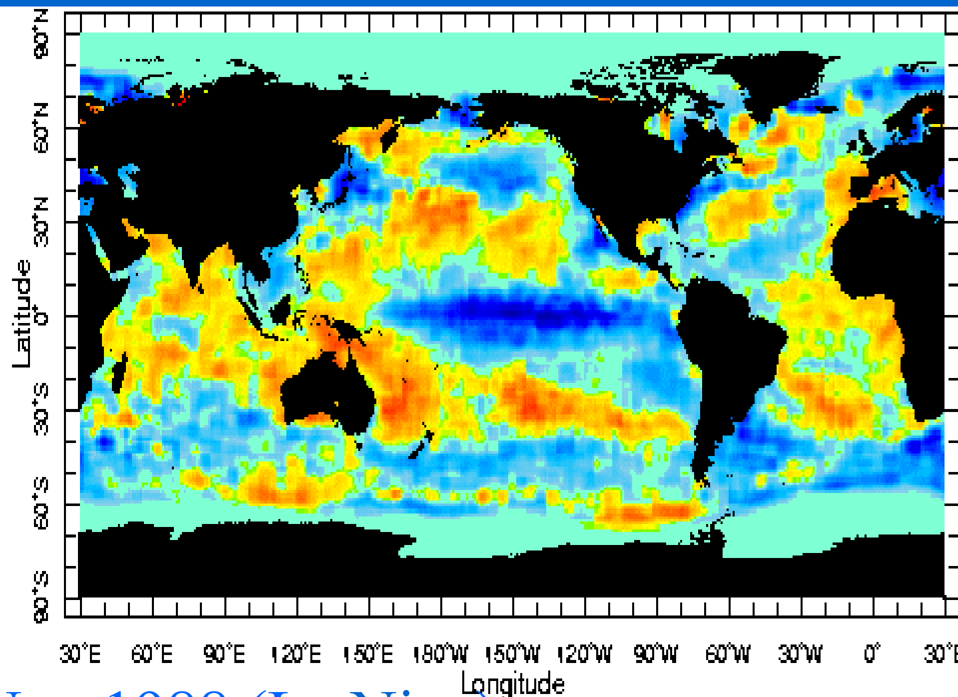
But….

- Implies a smooth and continuous process
- Suggests a self-contained system
- Does not portray the variability which produces the extremes of flood & drought

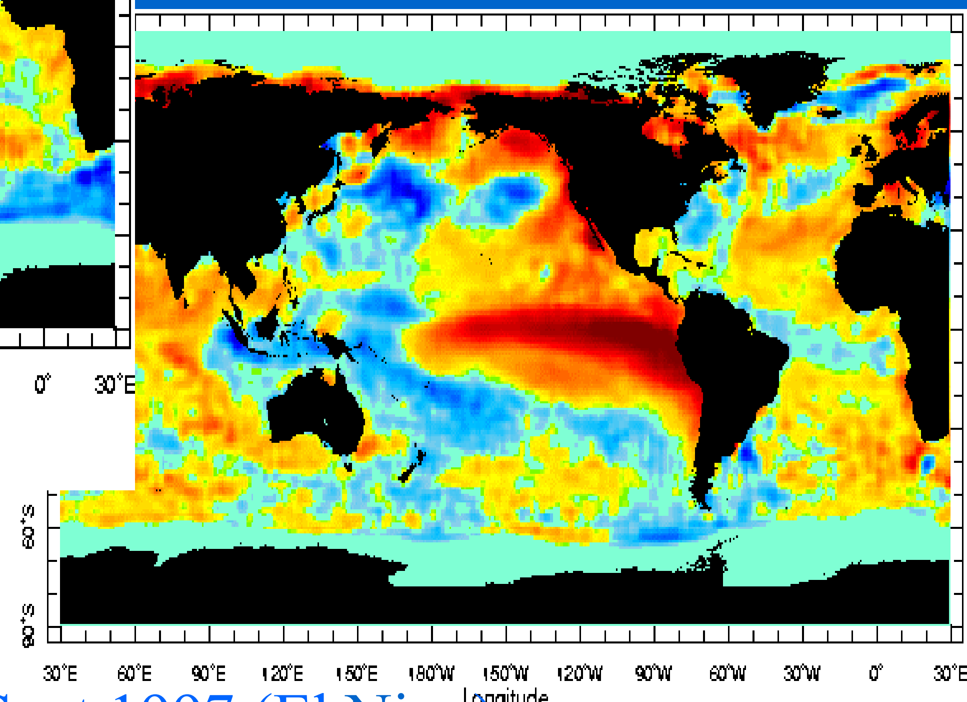
- The process is actually highly complex
- The hydrological cycle is driven by climate
- Without variability hydrologists would by now have run out of a job

Climate drivers

Sea-surface temperatures



Nov 1988 (La Nina)



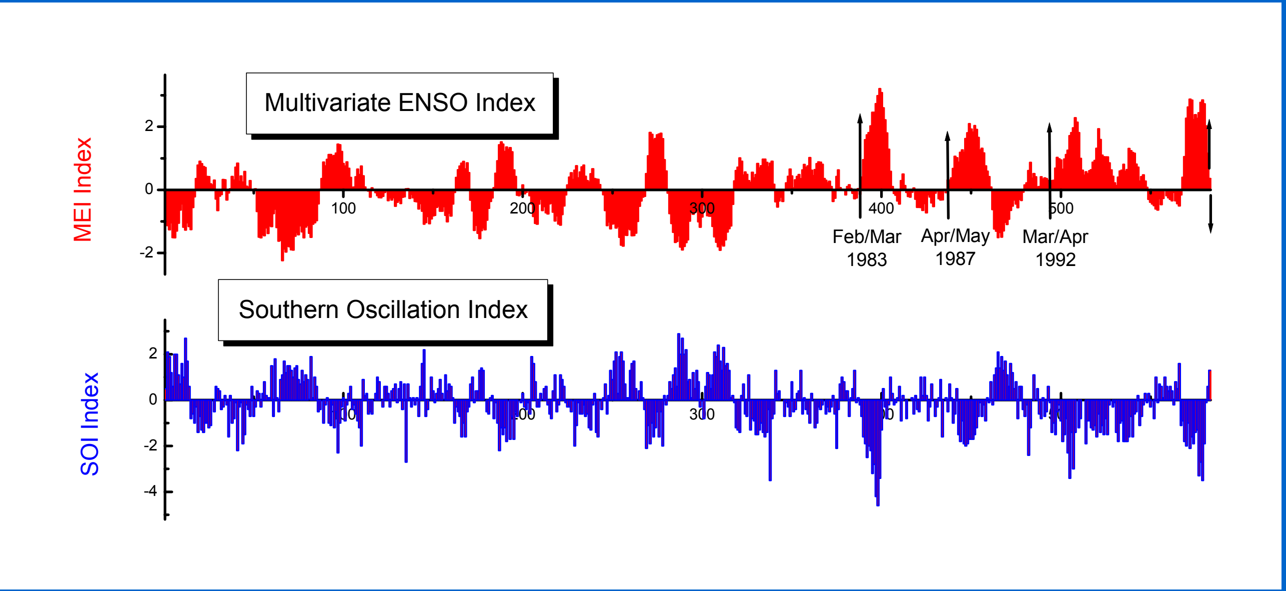
Sept 1997 (El Nino)

El Niño-Southern Oscillation

- Two components
  - Tropical ocean
  - Atmosphere
- Oceanic part (El Niño) revealed by sea-surface temperatures
- Atmospheric part (Southern Oscillation) related to sea-level pressure
- Coupled oscillation is ENSO – a major planetary influence on the hydrological cycle

ENSO

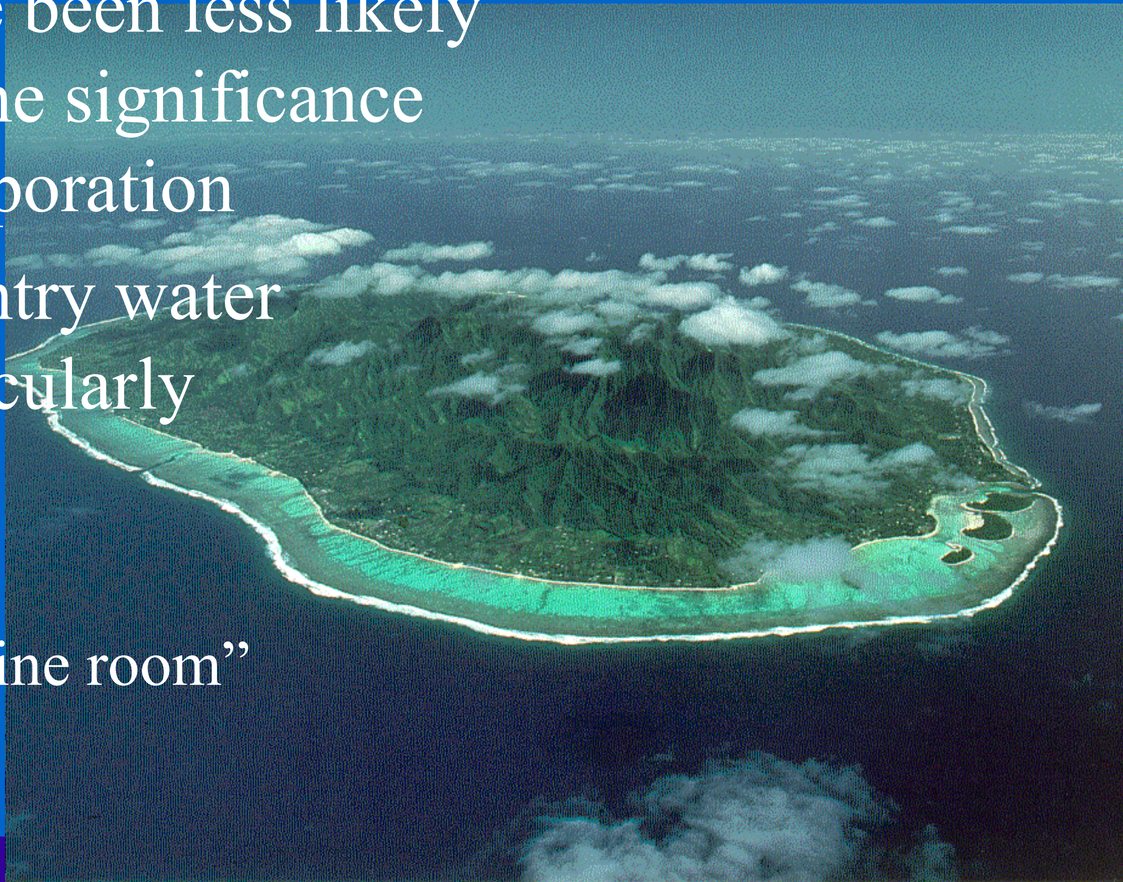
- Continuing efforts to observe and understand the ocean-atmosphere system is likely to lead to improved seasonal climate forecasting in the future



Oceanic viewpoint

Oceanic viewpoint

- Tempting to believe that Pacific people would have been less likely to underestimate the significance of rainfall and evaporation
- Pacific Island country water resources are particularly vulnerable
  - Small size
  - In the ENSO “engine room”



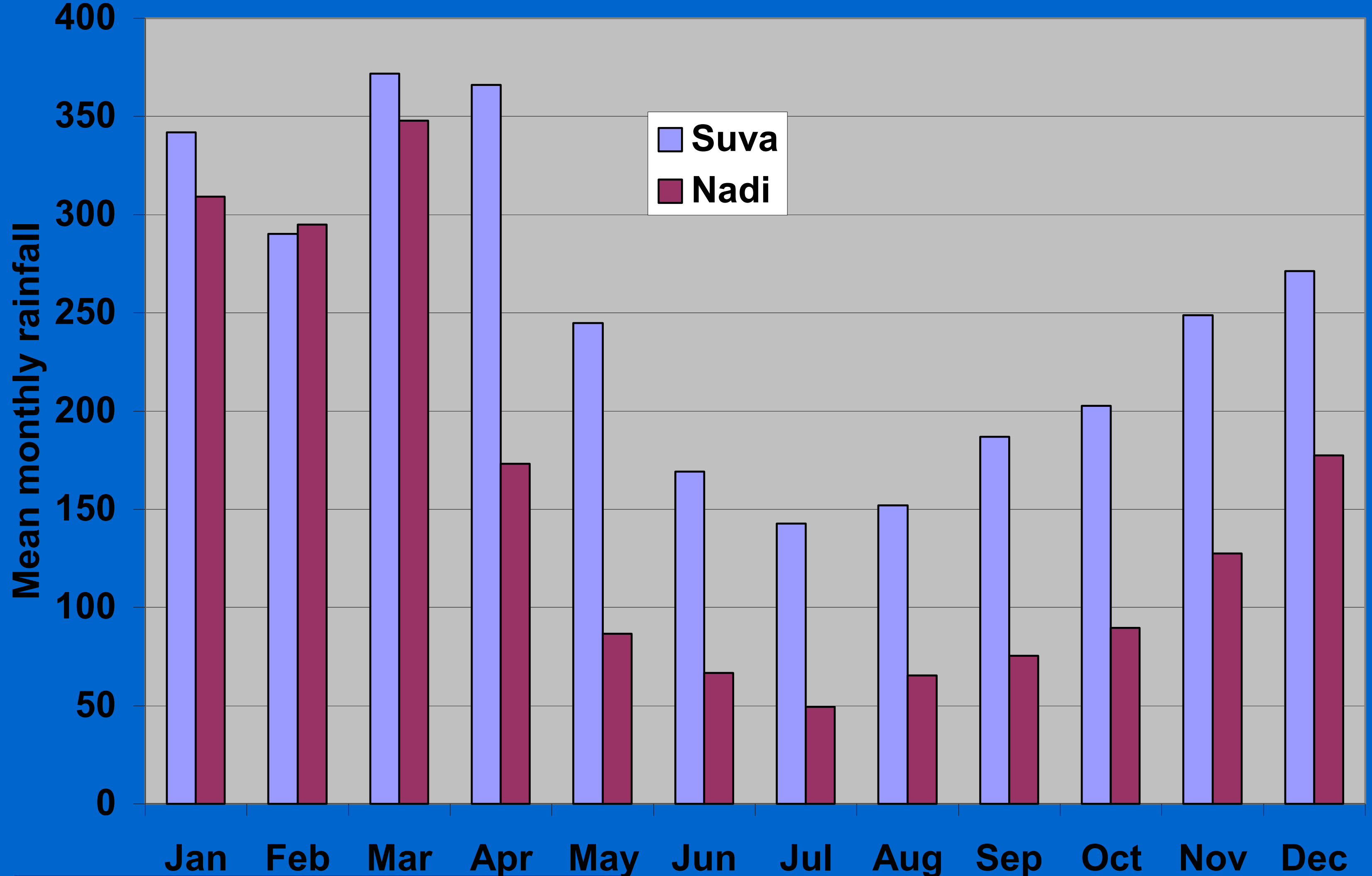
Conclusions

- The hydrologic cycle portrays the inter-connectedness of water in its various forms
- Hydrologic variability (floods & droughts) show that the cycle does not behave in a steady and self-contained way
- Climatic variability drives the variability we observe in hydrology
- Observation – data collection, analysis and interpretaion continue to be the foundation of modern hydrology

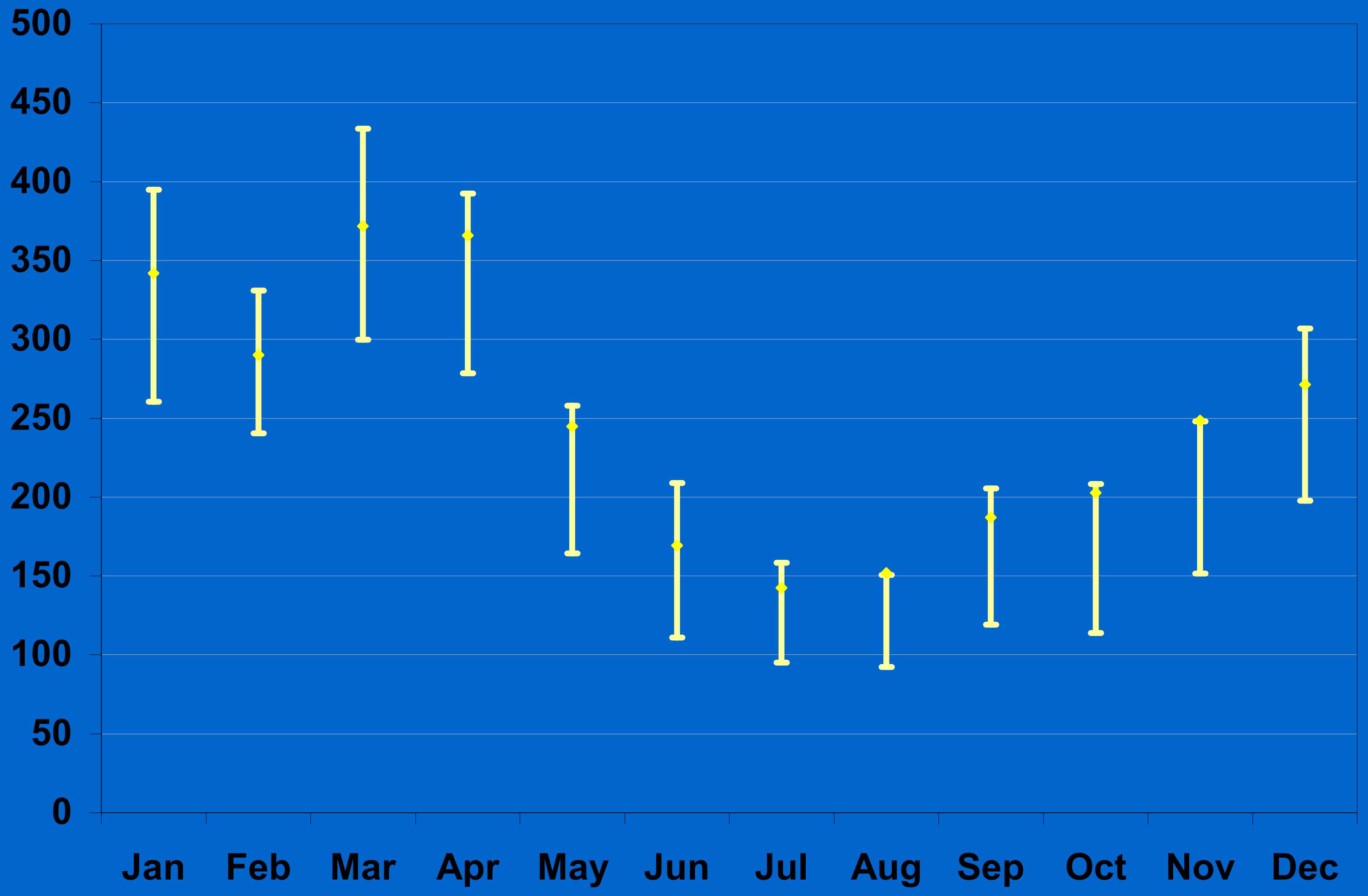
An exercise with climate data

- Monthly rainfall from Nadi and Suva (1942 to the present)
- Use Excel to compare the seasonal variability of rainfall on either sides of Viti Levu

Mean monthly rainfall



Suva – mean (33 & 67 percentile)



Suva – hyetograph