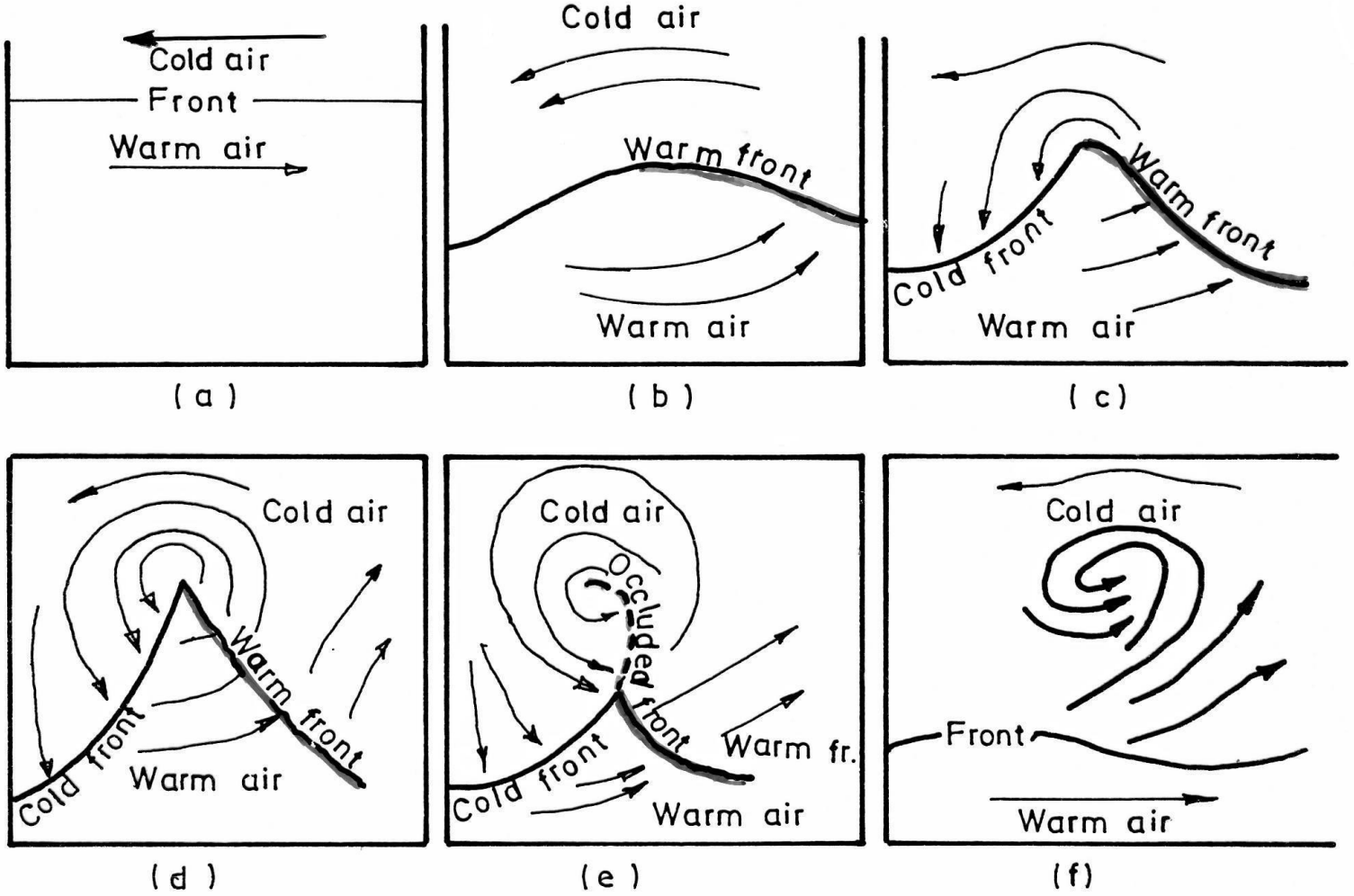
Front

The border between air masses of different temperature, pressure and moisture content is called a front.

There are two types of front

- cold front
- warm front


Cold air
Front
Warm air
(a)
Cold air
Warm front
Warm air
(b)
Warm front
Cold front
Warm air
(c)
Cold air
Warm front
Cold front
Warm air
(d)
Cold air
Occluded front
Warm fr.
Cold front
Warm air
(e)
Cold air
Front
Warm air
(f)

Storms

There are four types major of storms

- Convective storms
- Orographic storms
- Cyclonic storms
- Tropical storms

- Convective storms

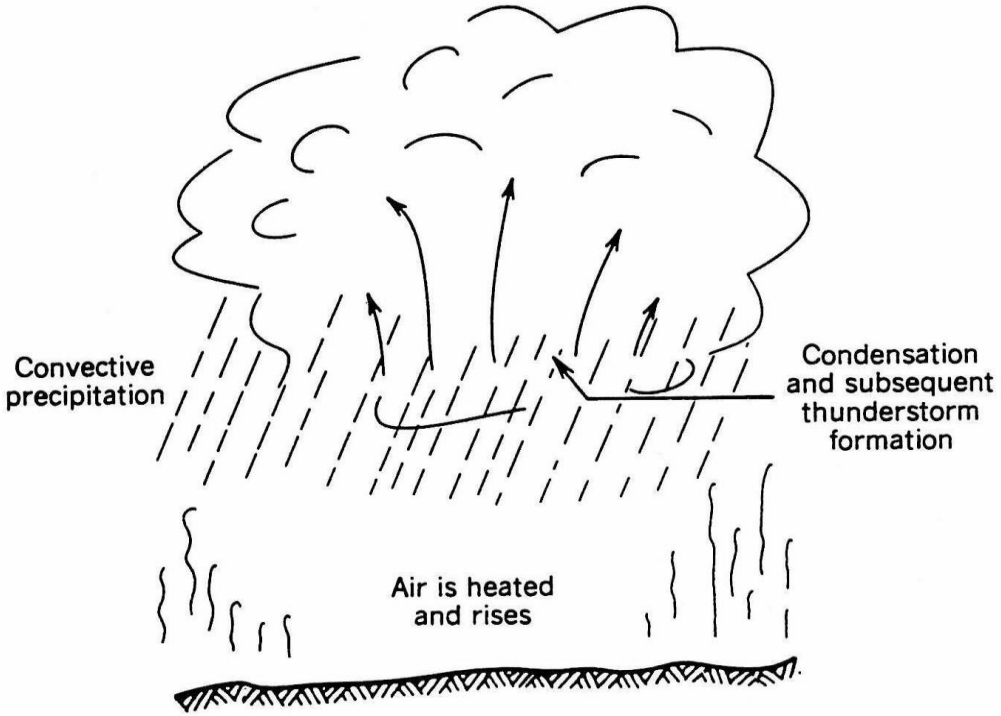
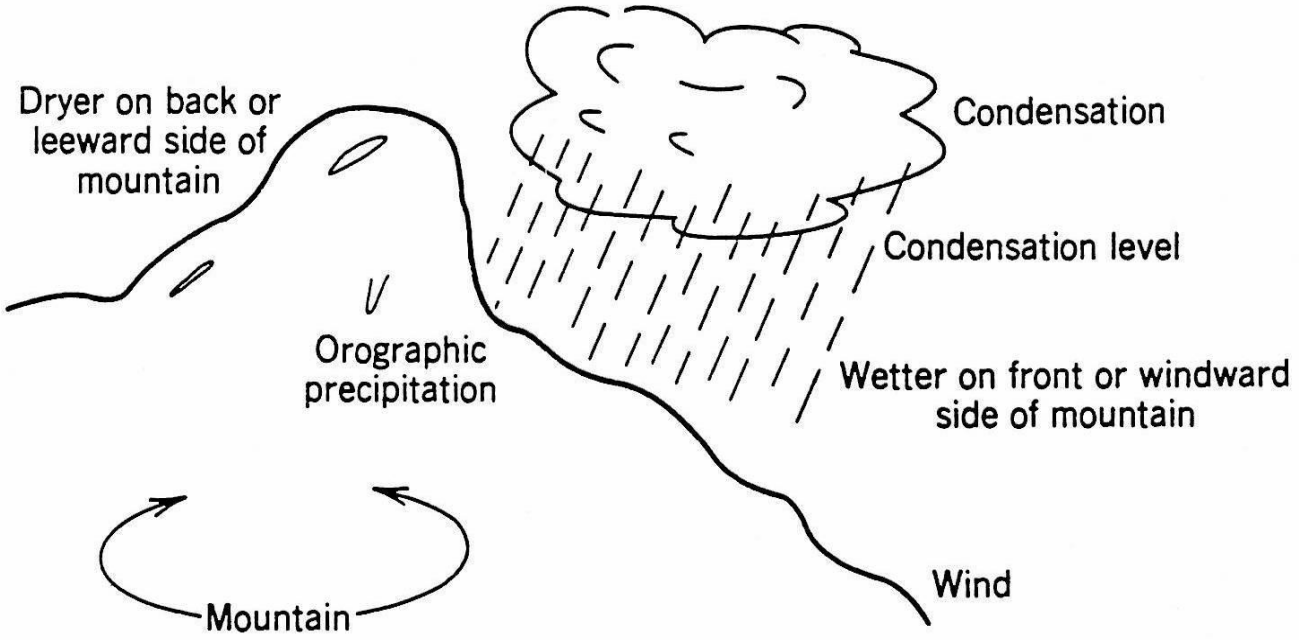


FIGURE Convective storm.

Convective storm.

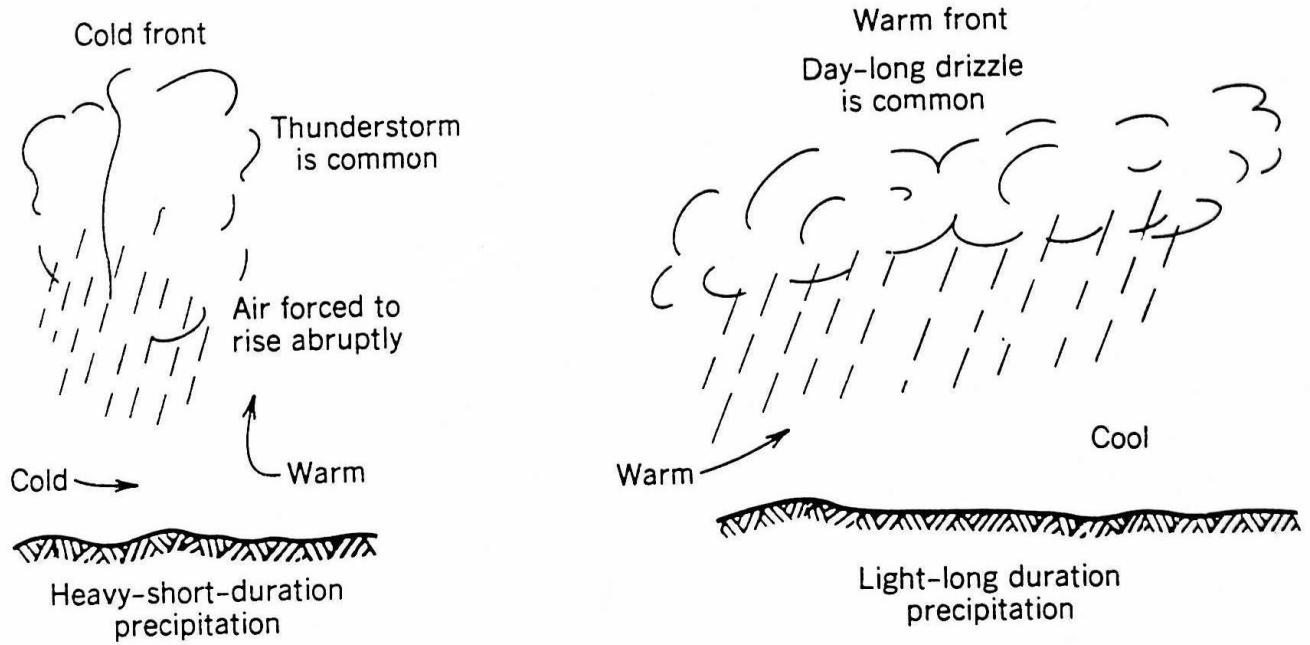
- Orographic storms



Orographic storm.

FIGURE Orographic storm.

- Cyclonic storms



Cyclonic storms in mid-latitude.

FIGURE Cyclonic storms in mid-latitude.

Water vapor

The amount of water vapor can be expressed as the pressure that vapor would exert in the absence of other gases, and is known as vapor pressure

Lapse Rate

The variation of temperature with altitude is known as lapse rate (9.80^{o} C/Km)

Relative humidity

$$f = 100\frac{e}{e_s}$$

e = actual vapor pressure (m bar)

e_s = saturated vapor pressure (m bar)

Saturated vapor pressure at the ground

$$e = 611 \exp\left(\frac{17.27T}{237.3+T}\right)$$

where,

T = Temperature in ^{0}C

e = Saturated vapor presence in kpa

Specific humidity at the ground surface

$$f_v = 0.622 \frac{e}{p} \; ; \; p = 101.3 kpa$$

Wind

Temperature

Climate of Bangladesh

Temperature

- Maximum temperature : last week of March and of April (30.4^{o} C – 36^{o} C)
- Due to monsoon rain temp. : June to October (around 31^{o} C – 34^{o} C)
- Lowest temp. : November to December (8 – 9^{o} C) (minimum 2^{o} C)
- temperature ranges : February to March (27 -31^{o} C)

Rainfall

Three main sources of rainfall

- the western depression of winter
- The early summer thunderstorms known as Nor'westers
- The summer rains known as monsoons.

Fog Mist dew

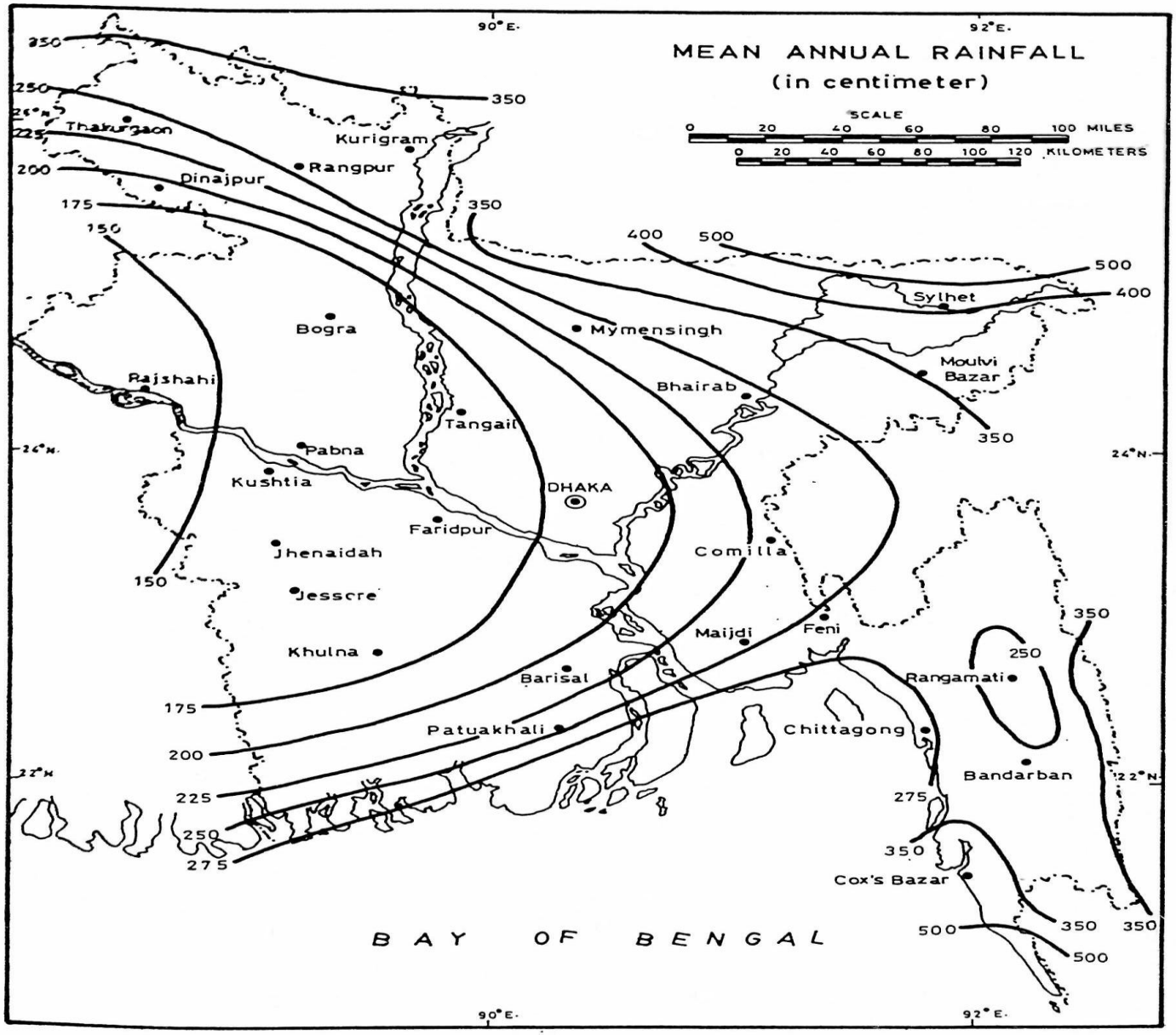
- November to march

Humidity

- humidity is high throughout the year
- march and April are the least humid months

Winds

- November to February : Wind direction is mostly from north
- March to May : Southerly, south – westerly
- June to September : South, south – easterly, easterly


MEAN ANNUAL RAINFALL
(in centimeter)
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E.
92°E.
26°N.
24°N.
22°N.
Thakurgaon
Kurigram
Rangpur
Dinajpur
Bogra
Rajshahi
Pabna
Kushtia
Tangail
DHAKA
Faridpur
Jhenaidah
Jessore
Khulna
Barisal
Patuakhali
Mymensingh
Sylhet
Moulvi Bazar
Bhairab
Comilla
Maijdi
Feni
Rangamati
Chittagong
Bandarban
Cox's Bazar
350
400
500
250
275
225
200
175
150
BAY OF BENGAL

The Residence Time

The residence time T_r is the average duration for a water molecule to pass through 2 subsystem of the hydrologic cycle. It is calculated by dividing the volume of water S in storage by the flow rate Q.

$$T_r = S/Q$$

TABLE 1.1.2
Global annual water balance

		Ocean	Land
Area (km^2)		361,300,000	148,800,000
Precipitation	(km^3/yr)	458,000	119,000
	(mm/yr)	1270	800
	(in/yr)	50	31
Evaporation	(km^3/yr)	505,000	72,000
	(mm/yr)	1400	484
	(in/yr)	55	19
Runoff to ocean			
Rivers	(km^3/yr)	–	44,700
Groundwater	(km^3/yr)	–	2200
Total runoff	(km^3/yr)	–	47,000
	(mm/yr)	–	316
	(in/yr)	–	12

Table from World Water Balance and Water Resources of the Earth, Copyright, UNESCO, 1978

TABLE 1.1 ESTIMATED WORLD WATER QUANTITIES

Item	Area (M km^2)	Volume (M km^3)	Percent total water	Percent fresh water
1. Oceans	361.3	1338.0	96.5	–
2. Groundwater				
(a) fresh	134.8	10.530	0.76	30.1
(b) saline	134.8	12.870	0.93	–
3. Soil moisture	82.0	0.0165	0.0012	0.05
4. Polar ice	16.0	24.0235	1.7	68.6
5. Other ice and snow	0.3	0.3406	0.025	1.0
6. Lakes				
(a) fresh	1.2	0.0910	0.007	0.26
(b) saline	0.8	0.0854	0.006	–
7. Marshes	2.7	0.01147	0.0008	0.03
8. Rivers	148.8	0.00212	0.0002	0.006
9. Biological water	510.0	0.00112	0.0001	0.003
10. Atmospheric water	510.0	0.01290	0.001	0.04
Total : (a) All kinds of water	510.0	1386.0	100.0	
(b) Fresh water	148.8	35.0	2.5	100.0

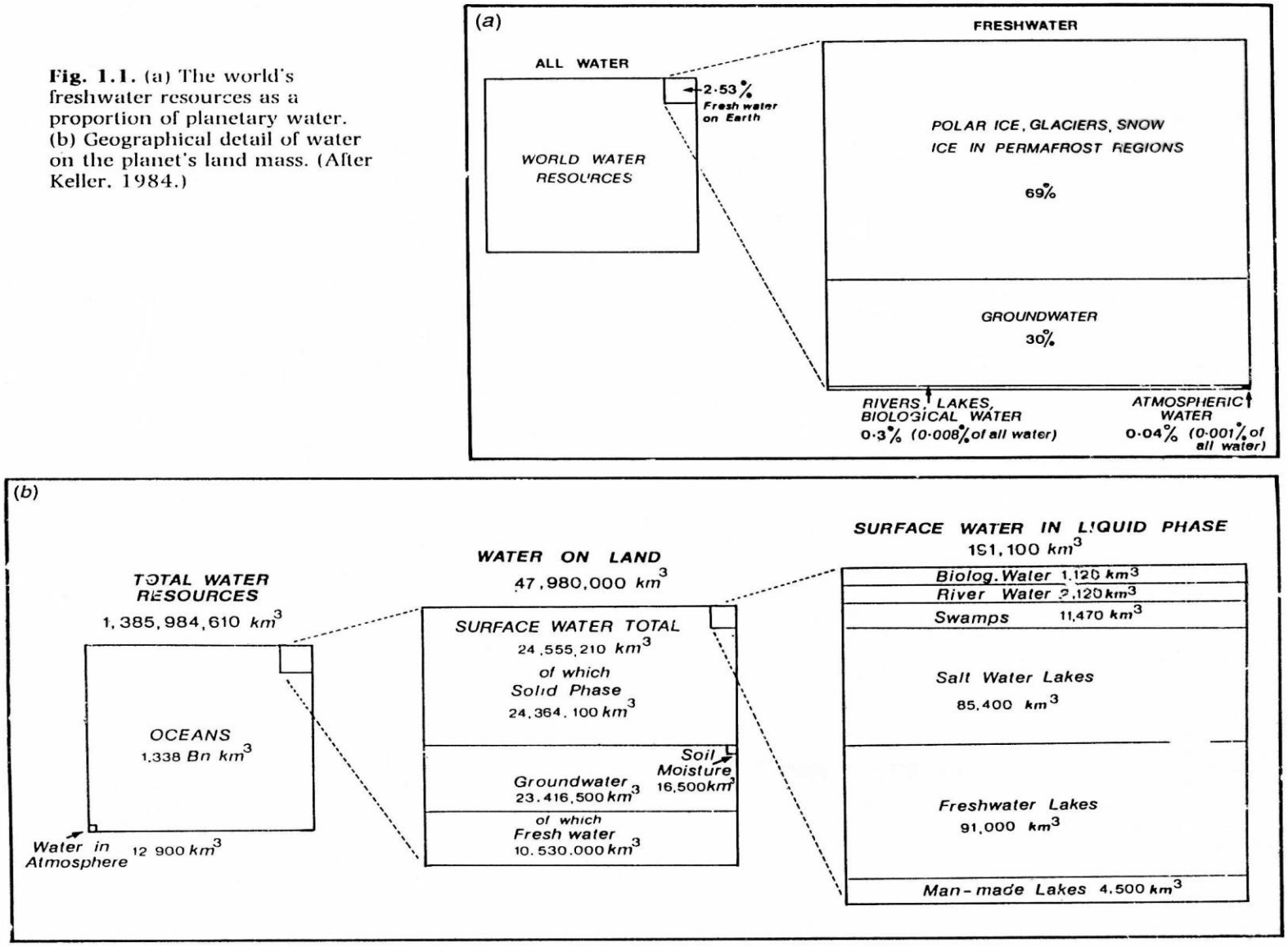


Fig. 1.1. (a) The world's freshwater resources as a proportion of planetary water. (b) Geographical detail of water on the planet's land mass. (After Keller, 1984.)

Example :

Estimate the residence time of global atmospheric moisture.

Solution :

The volume of atmospheric moisture = 12,900 Km^3

The flow rate of moisture from the atmosphere as precipitation = ocean + land

= 458,000 + 119,000

= 577,000 Km^3 / yr

$Tr = S/Q$

= 12,900 / 577,000

= 0.022 yr

= 8.2 days

The very short residence time for moisture in the atmosphere is one reason why weather cannot be forecast accurately more than a few days ahead

Example :

Assuming that all the water in the oceans is involved in the hydrologic cycle, calculate the average residence time of ocean water