Atmospheric and Oceanic Dynamics I

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Instructor: Zhaoru Zhang (张召儒)

Assistant: Yuanjie Chen (陈元杰, chenyuanjie@sjtu.edu.cn)

zrzhang@sjtu.edu.cn

Room 123, School of Oceanography

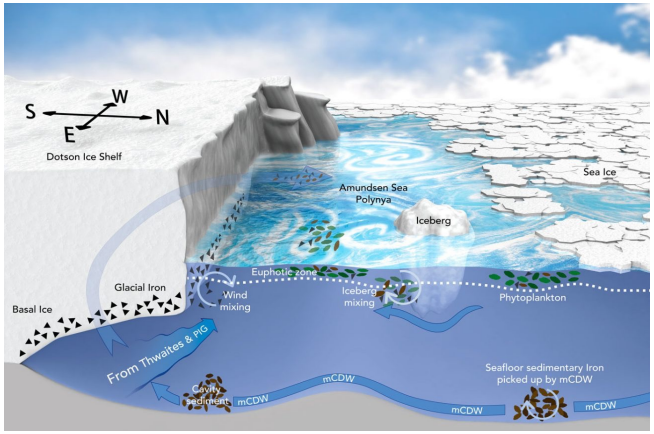
上海交通大學 SHANGHAI JIAO TONG UNIVERSITY

张召儒 （长聘教轨副教授）

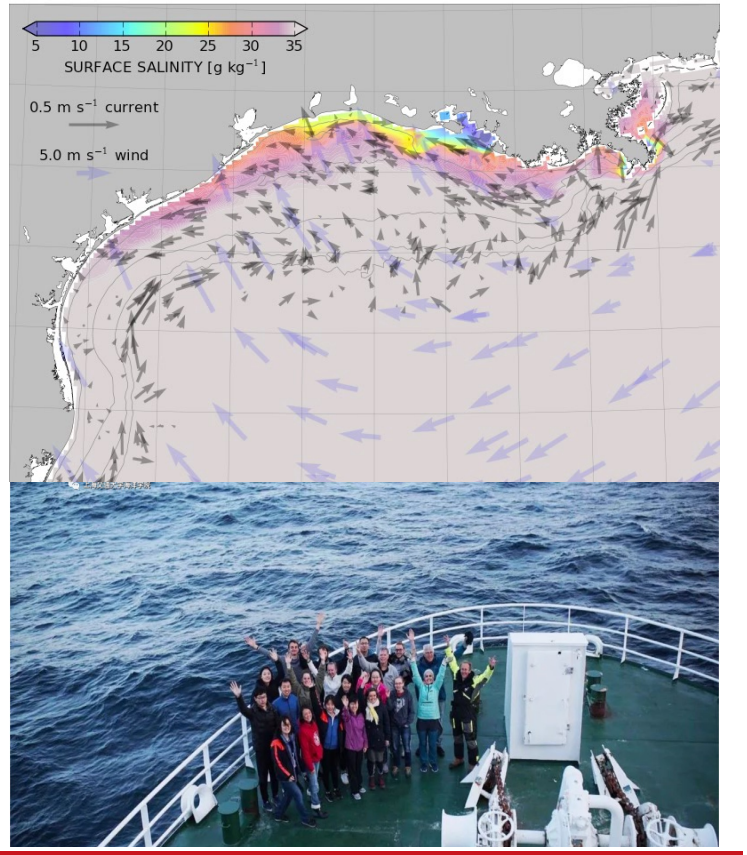
研究方向：

- 极地海洋-海冰-大气相互作用
- 近海动力学
- 海洋物理-生态耦合过程

极地海-冰-气相互作用



近海动力学及其生态效应

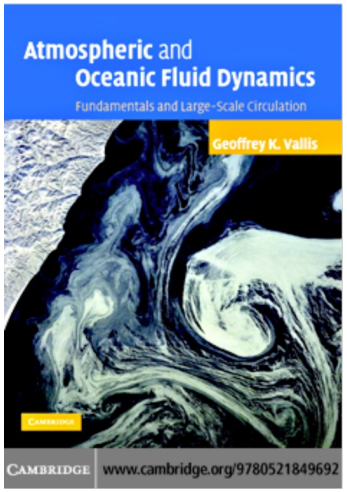


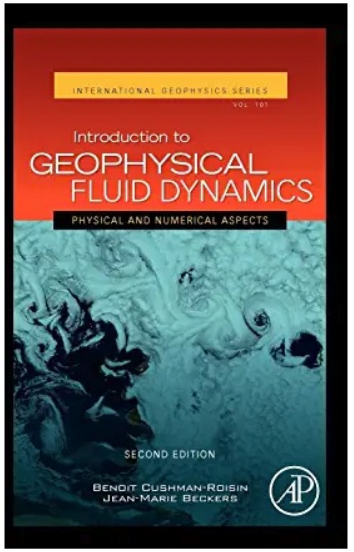
海上科考经历：

- 多重压力下中国南海与挪威海北部陆坡生物资源与生态系统动力学的比较研究，亚北极挪威海调查航次（2019）
- 长江冲淡水的对流、扩散与物质转换综合过程项目航次 （2017，2019）
- 长江口海域共享调查航次 （2020）

Textbooks

- **Vallis, Geoffrey K. *Atmospheric and oceanic fluid dynamics*. Cambridge University Press, 2017.**
- **Benoit Cushman-Roisin and Jean-Marie Beckers. *Introduction to geophysical fluid dynamics: physical and numerical aspects*. Vol. 101. Academic Press, 2011.**
- Pedlosky, Joseph. *Geophysical fluid dynamics*. Springer, 2013.
- Gill, Adrian E. *Atmosphere—ocean dynamics*. Elsevier, 1982.
- Holton, James R., and Gregory J. Hakim. *An introduction to dynamic meteorology*. Vol. 88. Academic press, 2012.





Prerequisites

Courses: *Fluid Dynamics, Introduction to Oceanography*

- Math

  All mathematical methods and tools
  Scalar, vector, tensor, ODE, PDE

  Elements of Geophysical Fluid Mechanics, Stephen M. Griffies, 2022

  Fluid Mechanics (Chapter 2), Pijush K. Kundu, Ira M. Cohen and David R. Dowling, 2012

- Physics

  Newton's Laws, Thermodynamics, Fluid dynamics

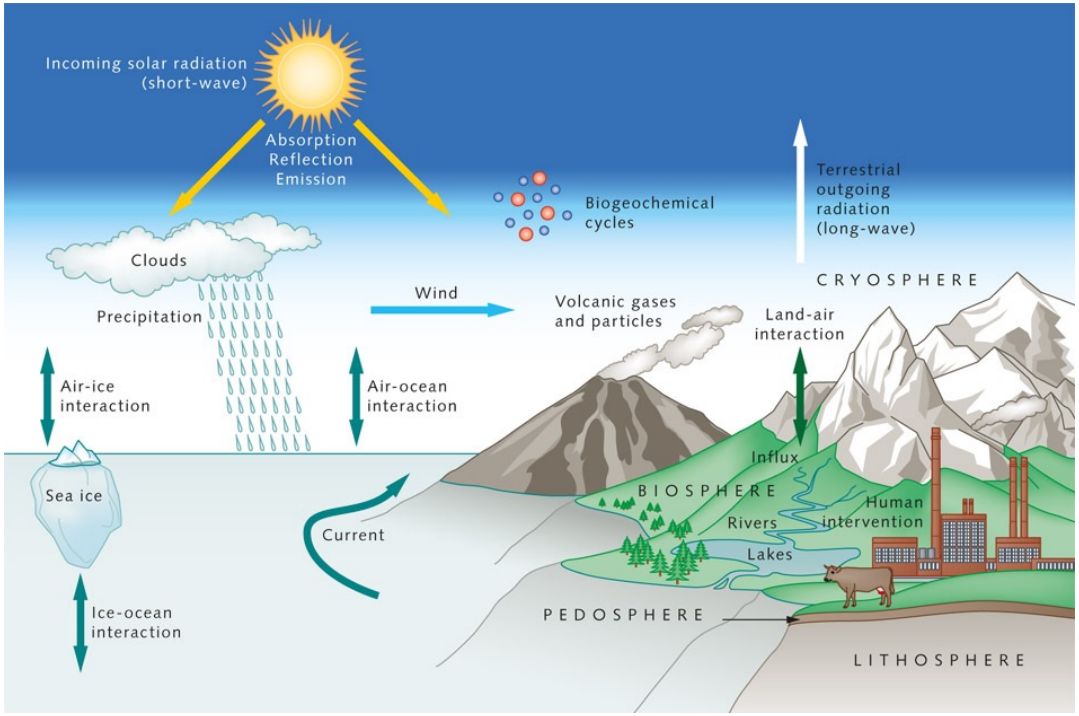
- Computer

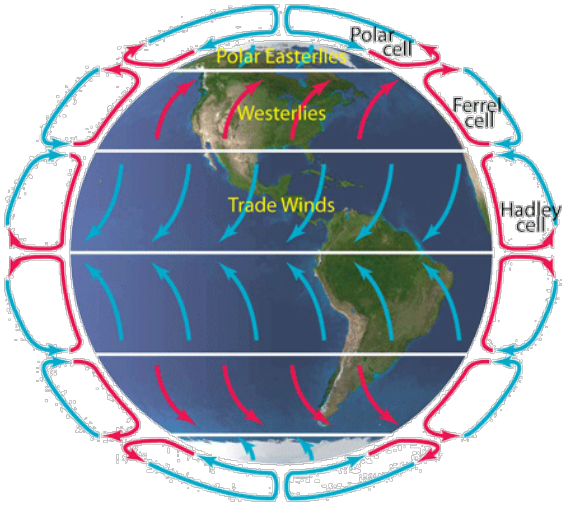
  Matlab, Python, Fortran

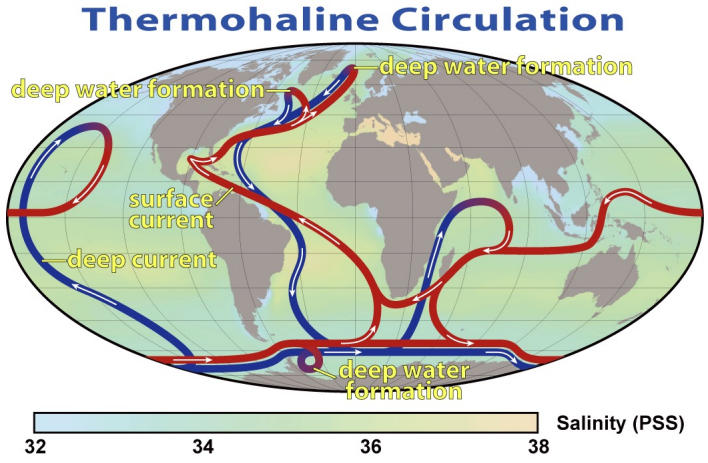
Grading

- Class performance (10%)
- Homework (30%)
- Midterm exam (30%)
- Final exam (project, 30%)

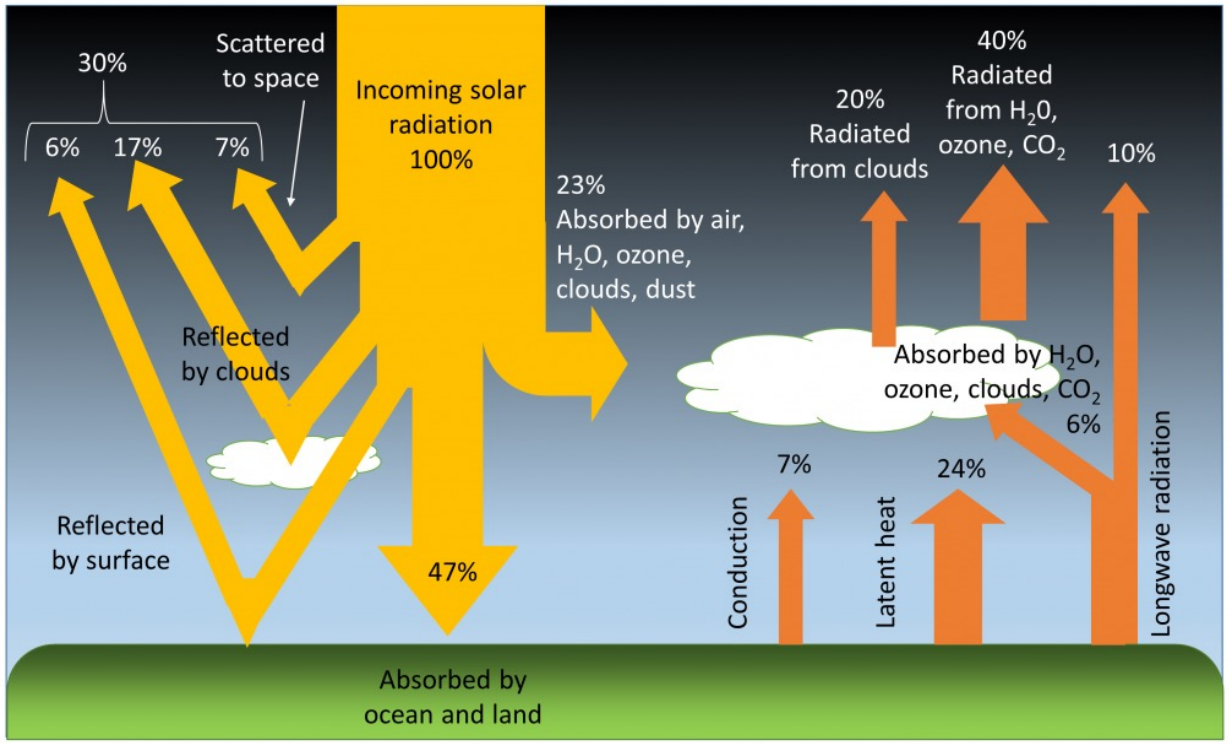
The Earth climate system







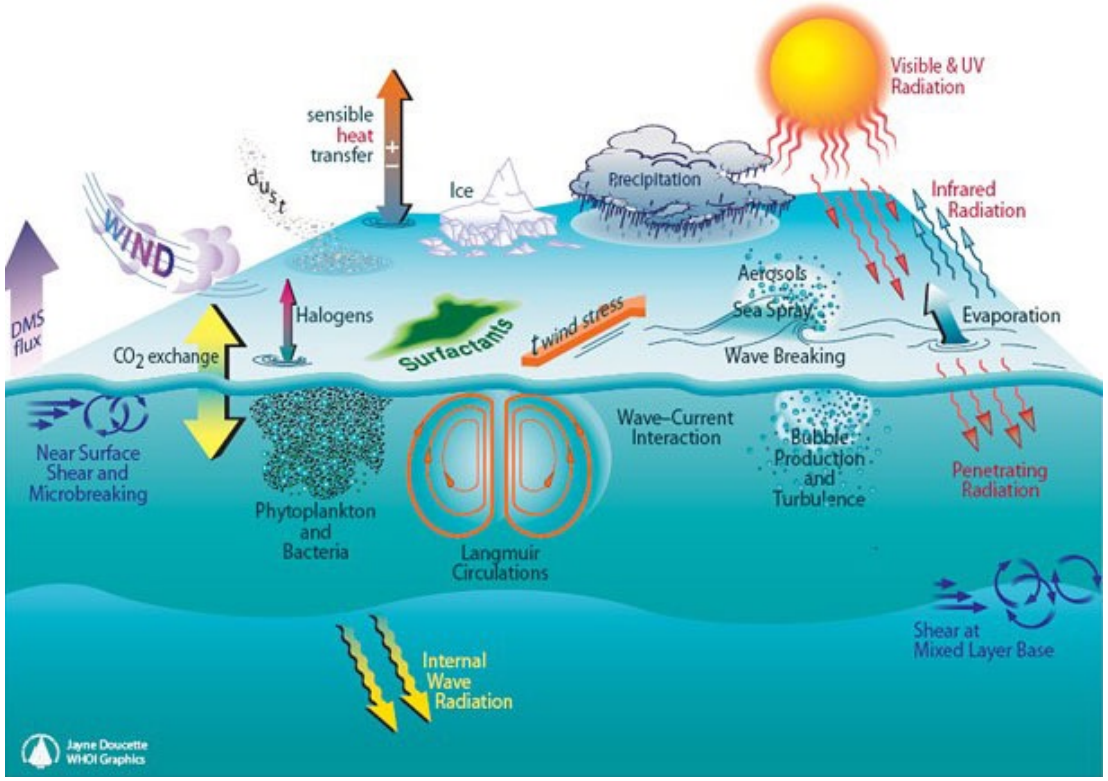
The Earth's surface heat budget



Specific HeatCapacities for Common Materials at 20°C	
Material	Specific Heat Capacity,J/g°C
Air	1.00
Aluminum	0.895
Asphalt	0.92
Brass	0.380
Carbon dioxide	0.832
Copper	0.387
Ethyl alcohol	2.45
Gold	0.129
Granite	0.803
Iron	0.448
Lead	0.128
Sand	0.29
Silver	0.233
Stainless steel	0.51
Water (liquid)	4.18
Zinc	0.386

Most of the solar energy is stored in the ocean

Driving forces for the atmosphere and ocean

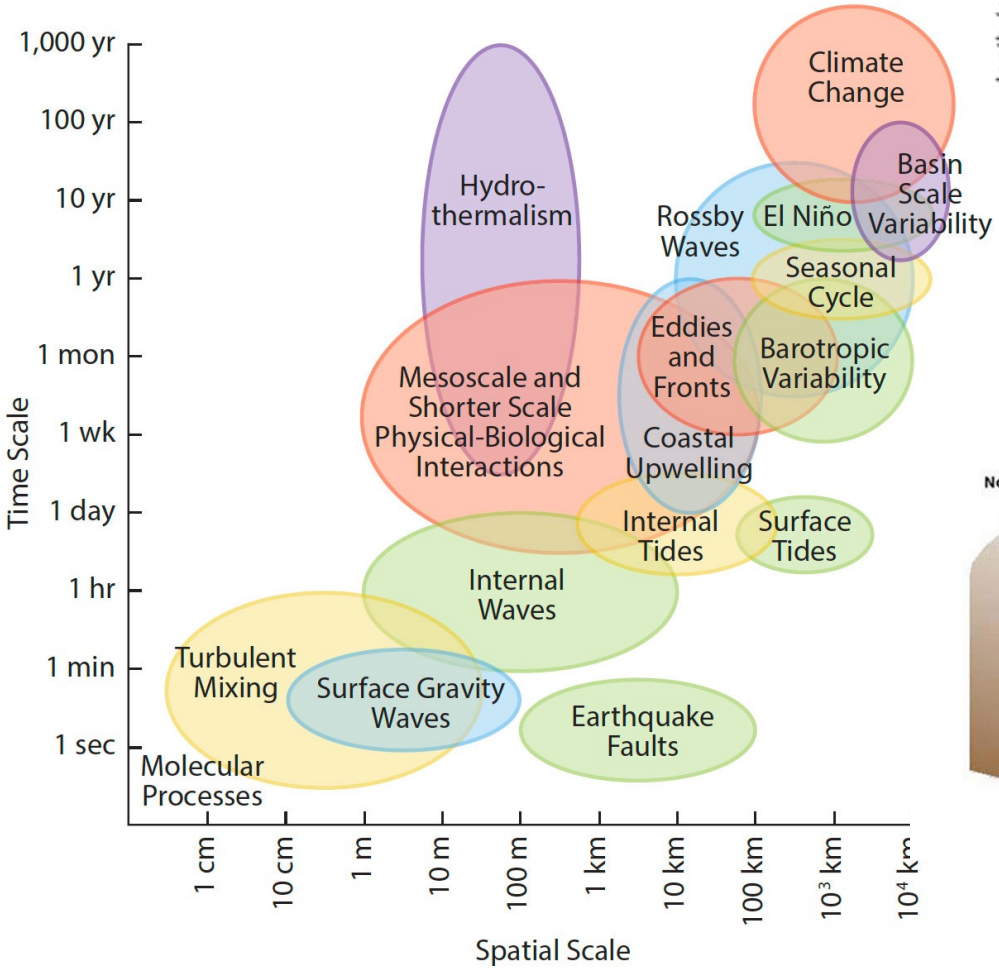


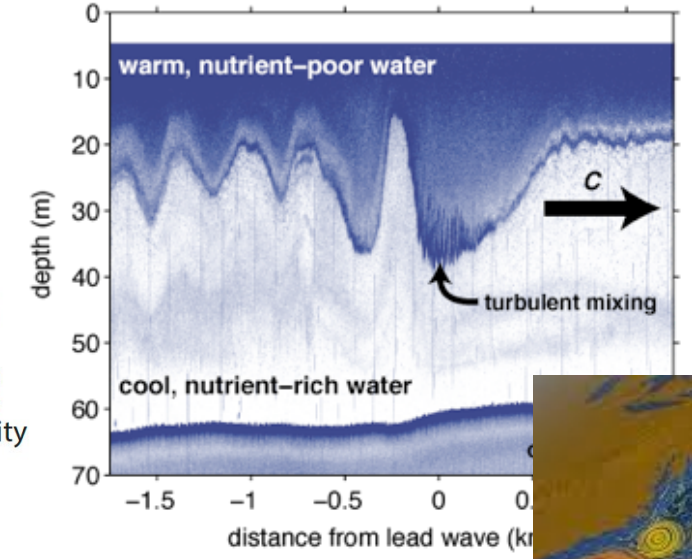
https://www2.whoi.edu/site/casimas/

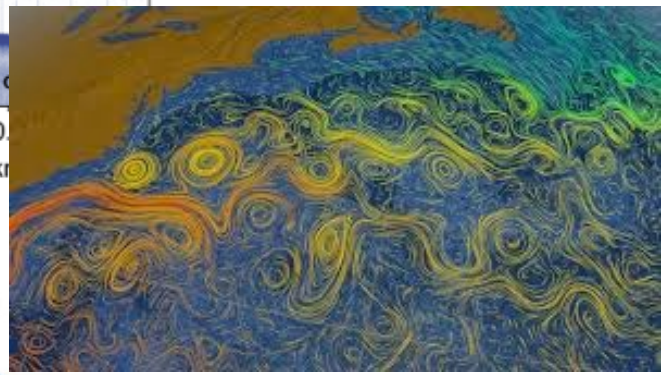
The ocean stores incoming energy from the sun and then transfers heat and moisture to the atmosphere that fuels its circulation

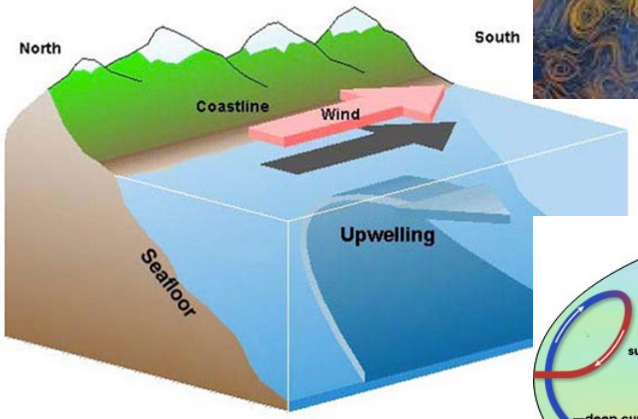
Once in motion, the atmosphere drives additional ocean circulation through the exchange of momentum across the air-sea interface that drives waves and currents

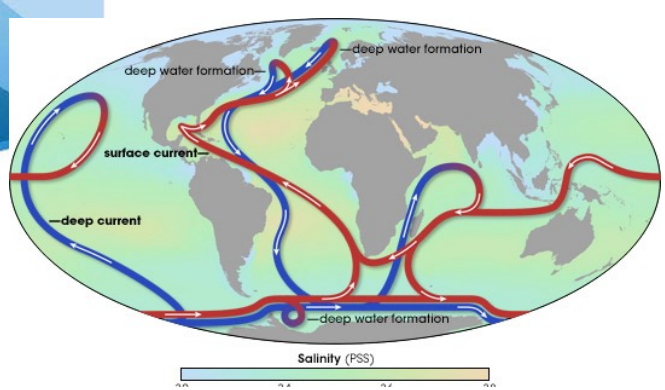
Scale of motions in the ocean



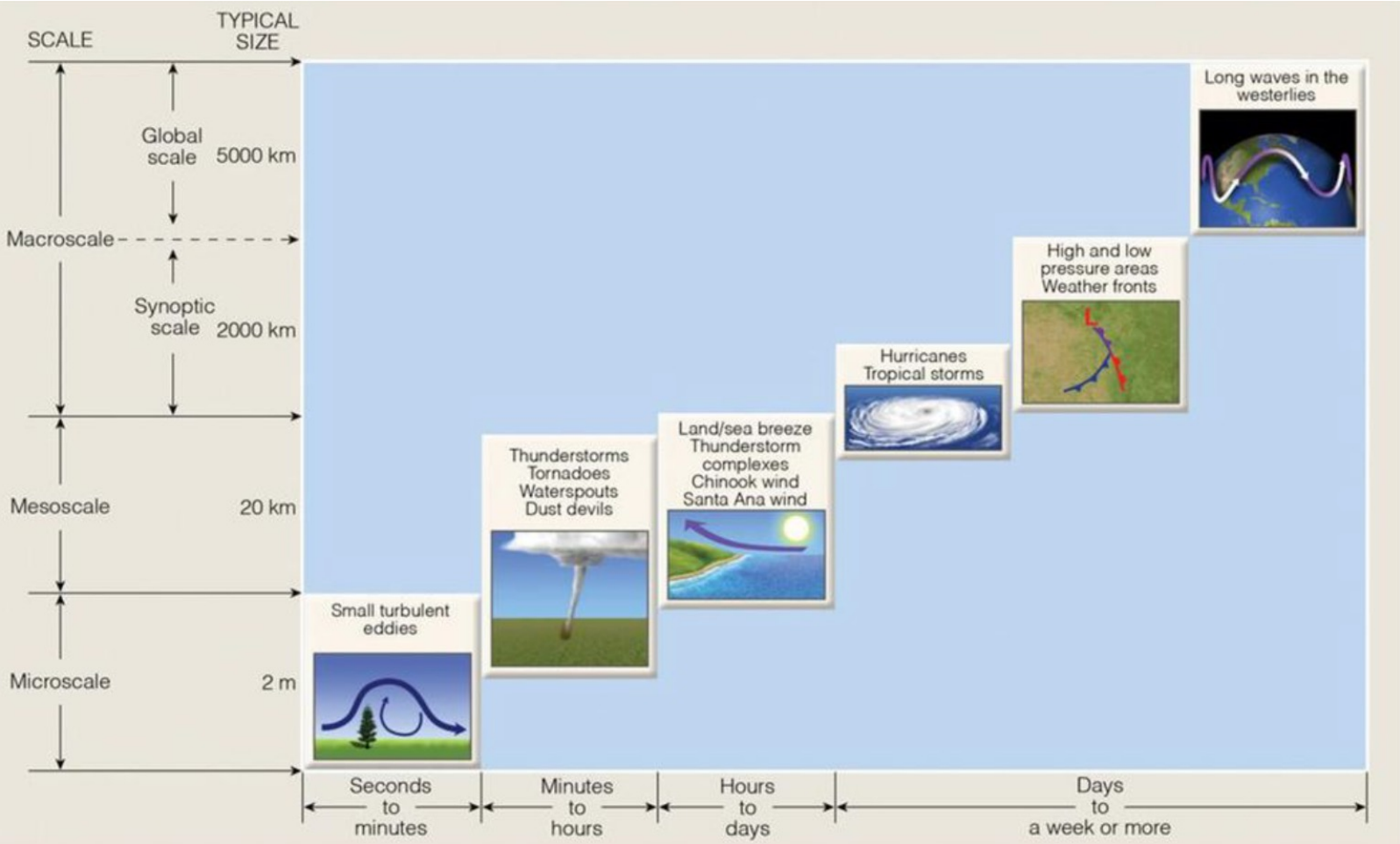








Scale of motions in the atmosphere



Differences between ocean and atmosphere

1. The atmosphere is more thermodynamically driven (solar energy and air-sea heat fluxes), while the ocean is both dynamically (wind stress) and thermodynamically driven.

2. Oceanic motions are generally **slower and more confined** than their atmospheric counterparts

3. A number of oceanic processes are caused by **lateral boundaries** (like basin-scale circulations and coastal upwelling), while lateral boundaries do not exist for the atmosphere

4. The oceanic motions are strongly dependent on salinity, while the atmospheric motions are strongly dependent on moisture (cloud, precipication)

5. Seawater can be treated as **incompressible** fluid, while air cannot.