



第一章:

大气环流概述

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大气环流概述

Reference reading:

PO Chapter 5.1-5.2; James Chapter 2.2, 2.4



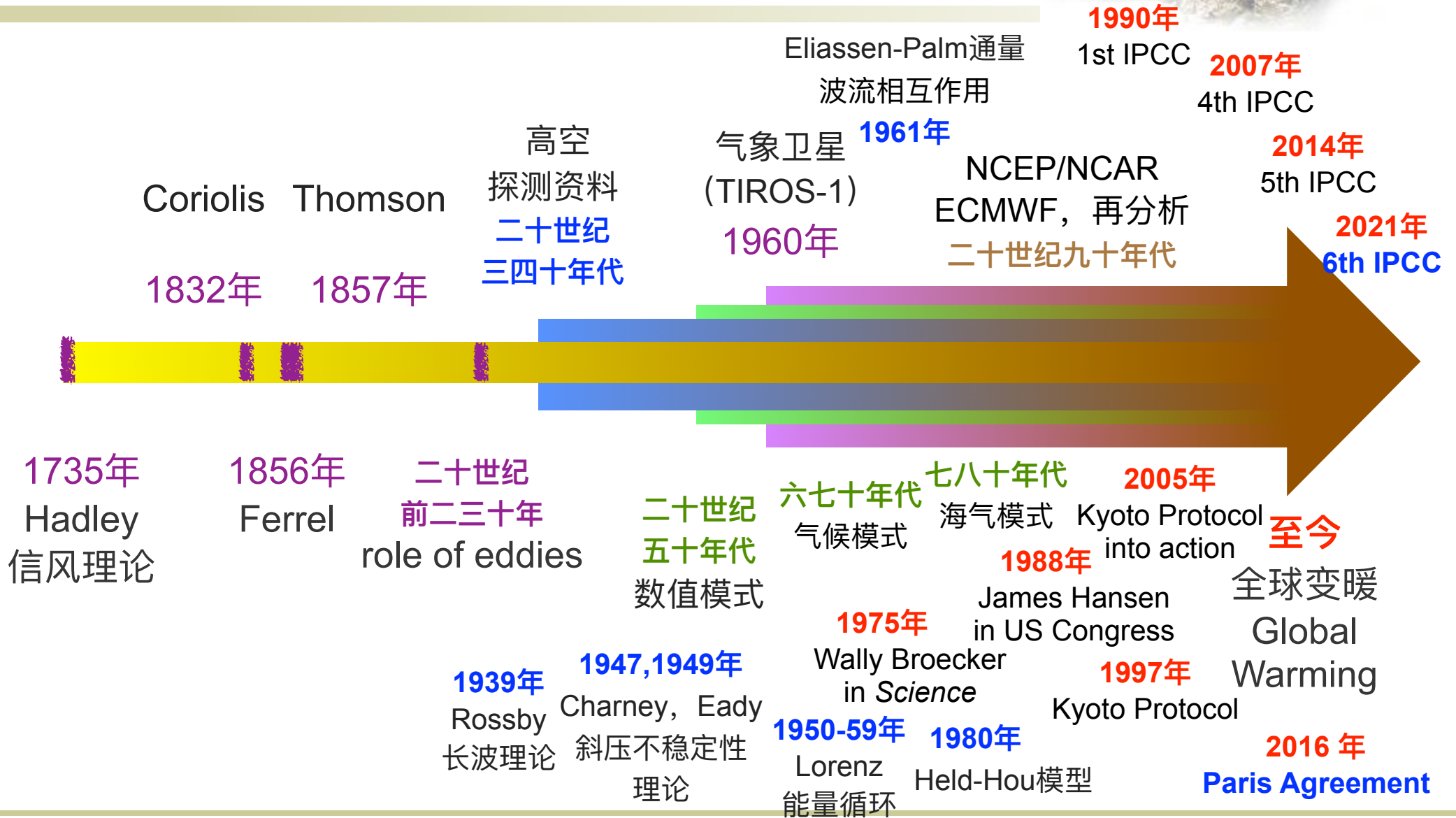
大气环流概述



- 历史回顾
- 内容简介
- 观测资料
- 资料处理与分析
- 再分析资料
- 分析方法



大气环流概述 - 历史简介





大气环流概述 - 历史简介



Coriolis 1832年
Thomson 1857年

高空探测资料
二十世纪三四十年代

气象卫星 (TIROS-1)
1960年

Eliassen-Palm 通量
波流相互作用



1990年
1st IPCC
2007年
4th IPCC

2014年
5th IPCC

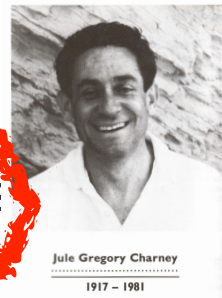
2021年
6th IPCC

1735年
Hadley
信风理论

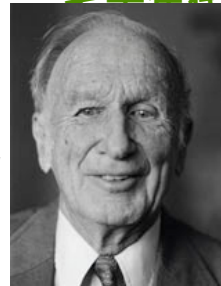
1856年
Ferrel



1939年
Rossby
长波理论

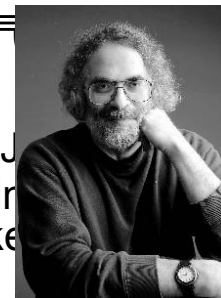


1947, 1949年
Charney, Eady
斜压不稳定性理论



1950-59年
Lorenz
能量循环

六七十年代
七八十年代



1980年
Held-Hou 模型

2005年

至今
Kyoto Protocol
Paris Agreement

全球变暖
Global Warming

2016年
Paris Agreement



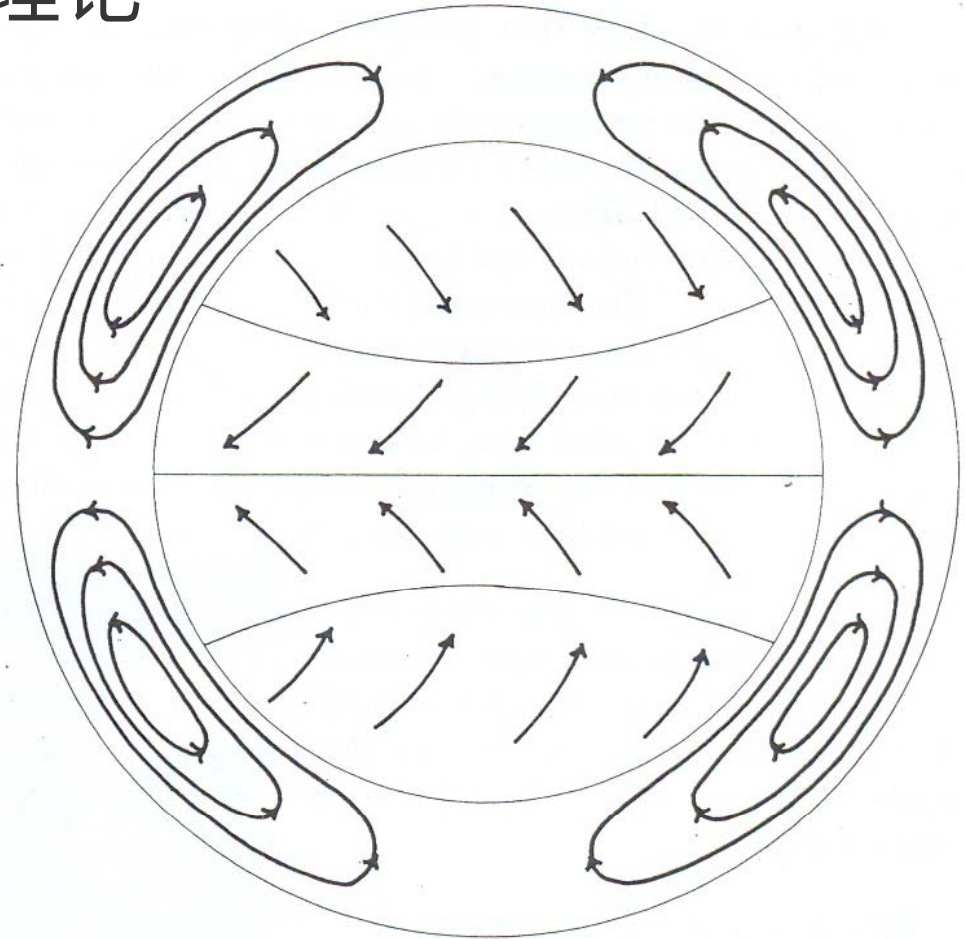
大气环流概述 - 历史简介



"On the Cause of the General Trade Winds,"
in the *Philosophical Transactions of the Royal Society*.

■ 1735年, Hadley 信风理论

- **Motivation:** explain the easterly (northeasterly) trade winds of the tropics and the prevailing westerly (northwesterly) of midlatitudes.
- **Single cell:** solar heating in low latitudes lead to rising motion near the equator and sinking near the poles, with equatorward motion at low levels and poleward motion aloft.
- Conservation of **absolute velocity:** the equatorward motion at low levels turns westerly when arriving at high latitudes and forms the trade wind.





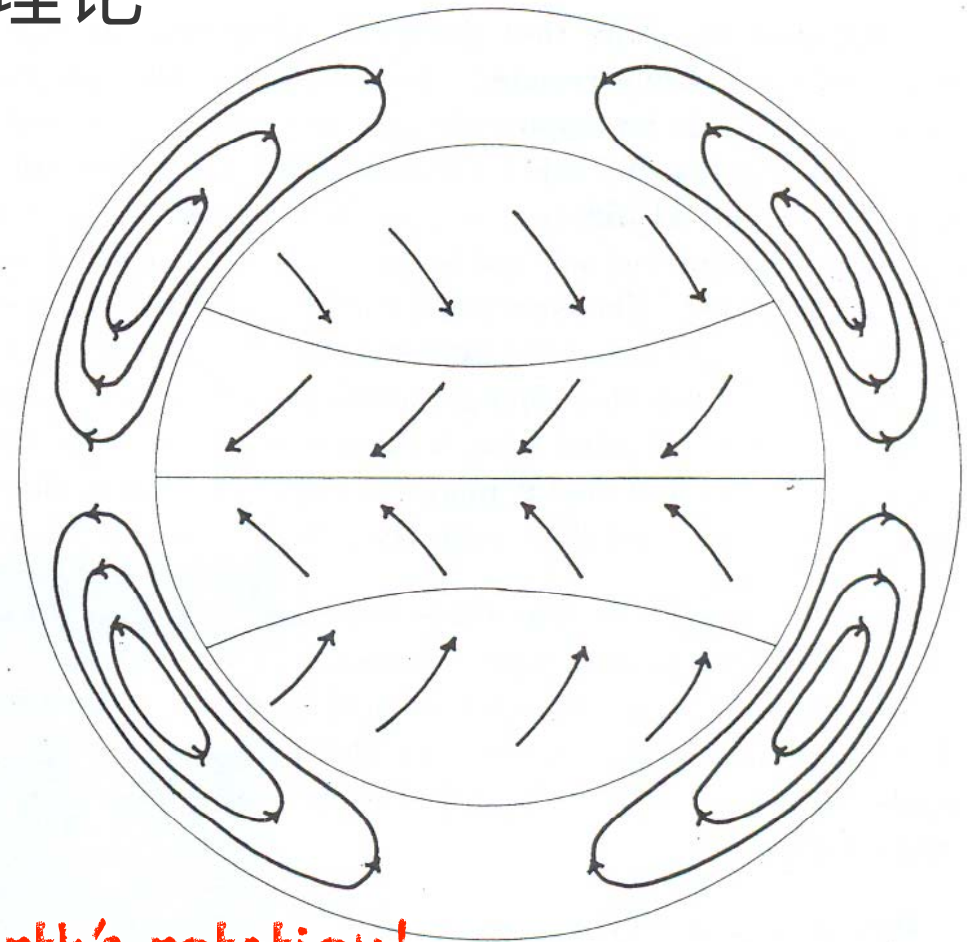
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Understanding the effect of earth's rotation!



大气环流概述 - 历史简介



- **Coriolis 1832.** Memoire sur le principe des forces vives dans les mouvements relatifs des machines. (On the principle of kinetic energy in the relative movement of machines.) *J. Ec. Polytech*, 13, 268-301.
- **Coriolis 1835.** Memoire sur les equations du mouvement relatif des syst\`emes de corps. (On the equations of relative motion of a system of bodies. *J. Ec. Polytech.*, 15, 142-154.



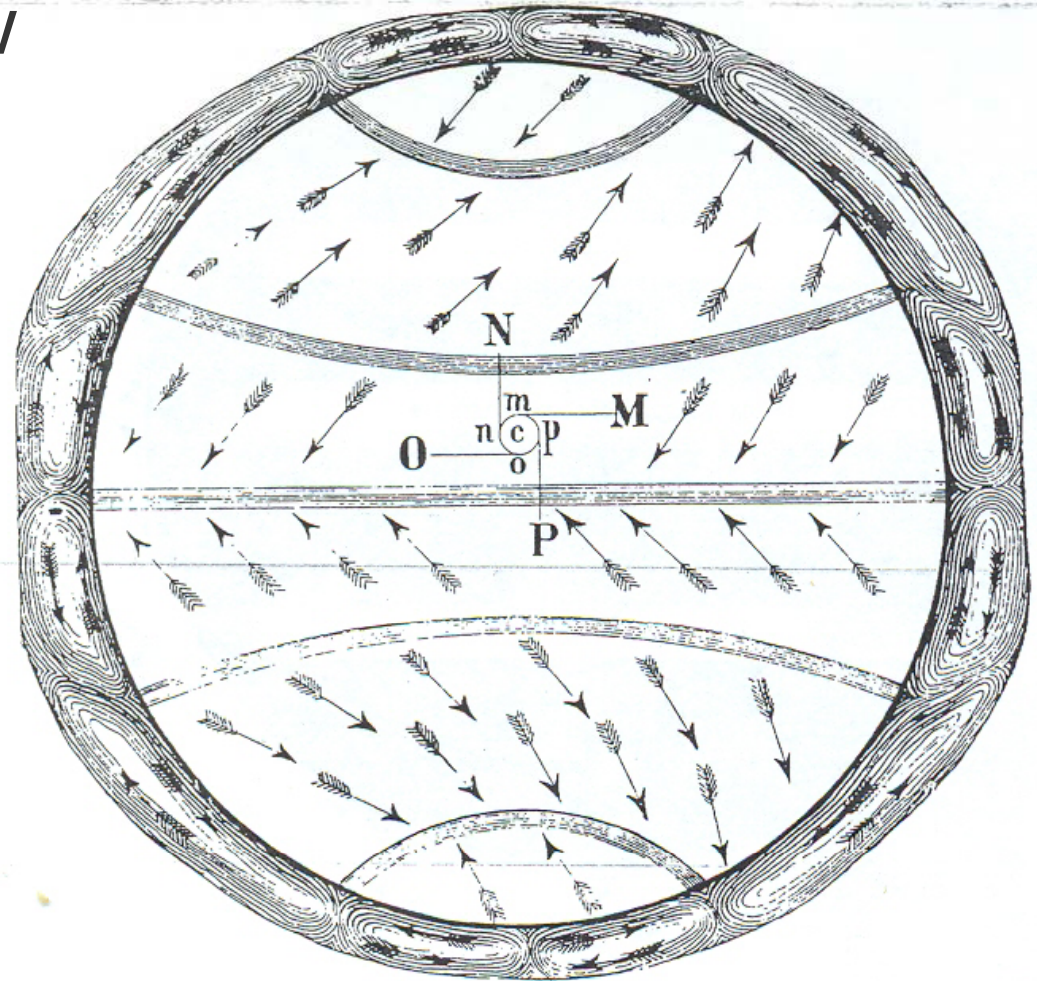
Gaspard-Gustave de Coriolis
1792-1843



大气环流概述 - 历史简介



- 1856年, Ferrel's view
- Observed **southwesterly** challenged Hadley's theory;
- **Three-cell circulation**, close to current views of earth's general circulation.

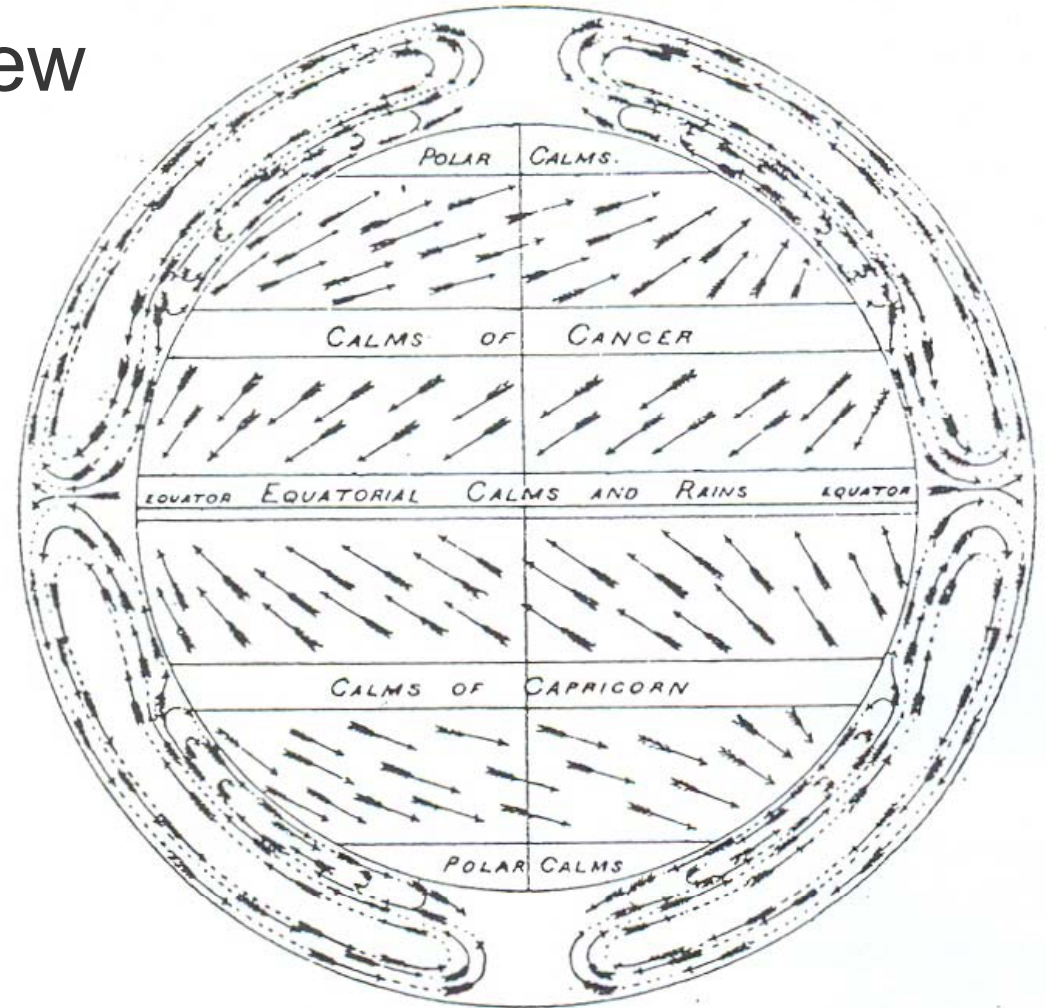




大气环流概述 - 历史简介



- 1857年, Thomson's view
- Still a **single direct cell** in the upper troposphere;
- In the lower levels of middle and higher latitudes, a **shallow indirect cell** with poleward flow near ground and equatorward flow in the intermediate levels.



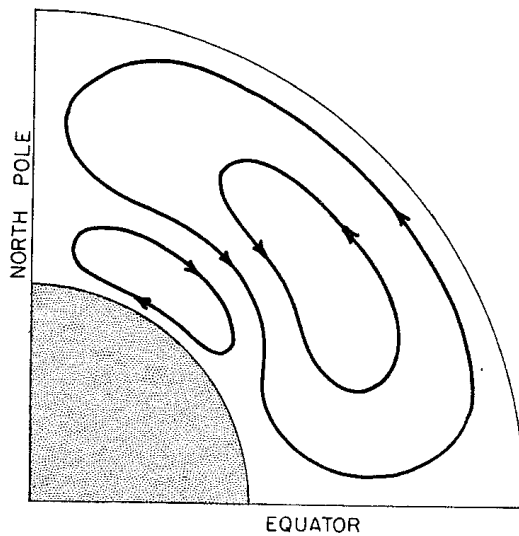


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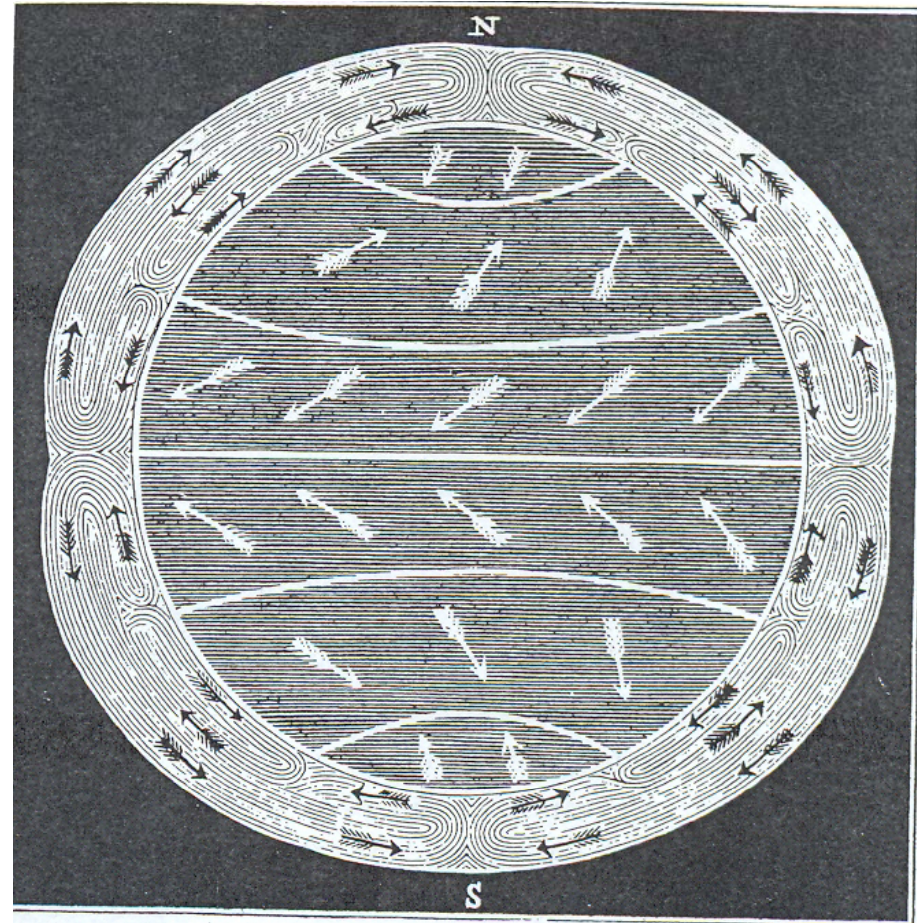


1859年, Ferrel's second view

Close to Thomson's view, except for a polar cell in high latitudes.



Ferrel-Thomson's circulation



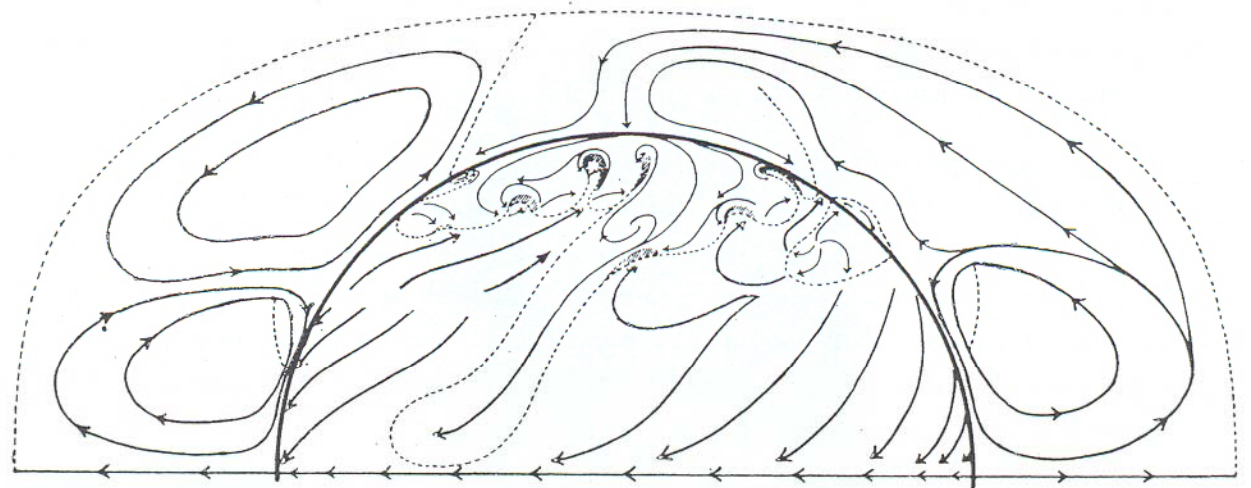


大气环流概述 - 历史简介



■ The role of eddies?

- **Bigelow(1902)**, the effect of cyclones should be taken into account.
- **Defant (1912)**, eddies transport heat to higher latitudes.
- **Jeffreys (1926)**, eddies transfer angular momentum.
- **V. Bjerknes (1937)**, Ferrel-Thomson's circulation is unstable to eddies.



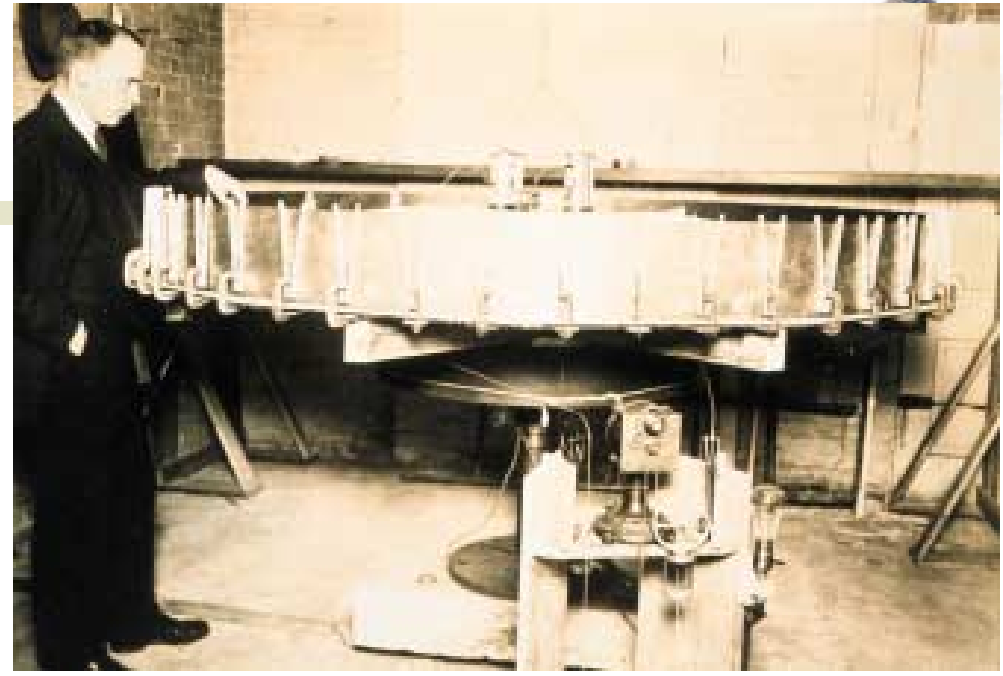


Rossby 波



Carl-Gustaf Arvid Rossby

.....
1898 – 1957



1939]

JOURNAL OF MARINE RESEARCH

39

**RELATION BETWEEN VARIATIONS IN THE INTENSITY
OF THE ZONAL CIRCULATION OF THE ATMOSPHERE
AND THE DISPLACEMENTS OF THE SEMI-
PERMANENT CENTERS OF ACTION***

By

C.-G. ROSSBY AND COLLABORATORS

Massachusetts Institute of Technology

This paper attempts to interpret, from a single point of view, several at first sight independent phenomena brought into focus through the synoptic investigations carried on at the Massachusetts Institute of Technology during the last few years. Since this interpretation is very largely based on a consideration of the changes in vorticity which must occur in vertical air columns which are displaced from one latitude to another and since such vorticity changes play a fundamental role also in Ekman's general ocean current theory (1932), the results would appear to be of enough interest to physical oceanographers to warrant their publication in this journal. The particular phenomena brought out in the course of our studies are listed below.



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- Currently most-accepted view

