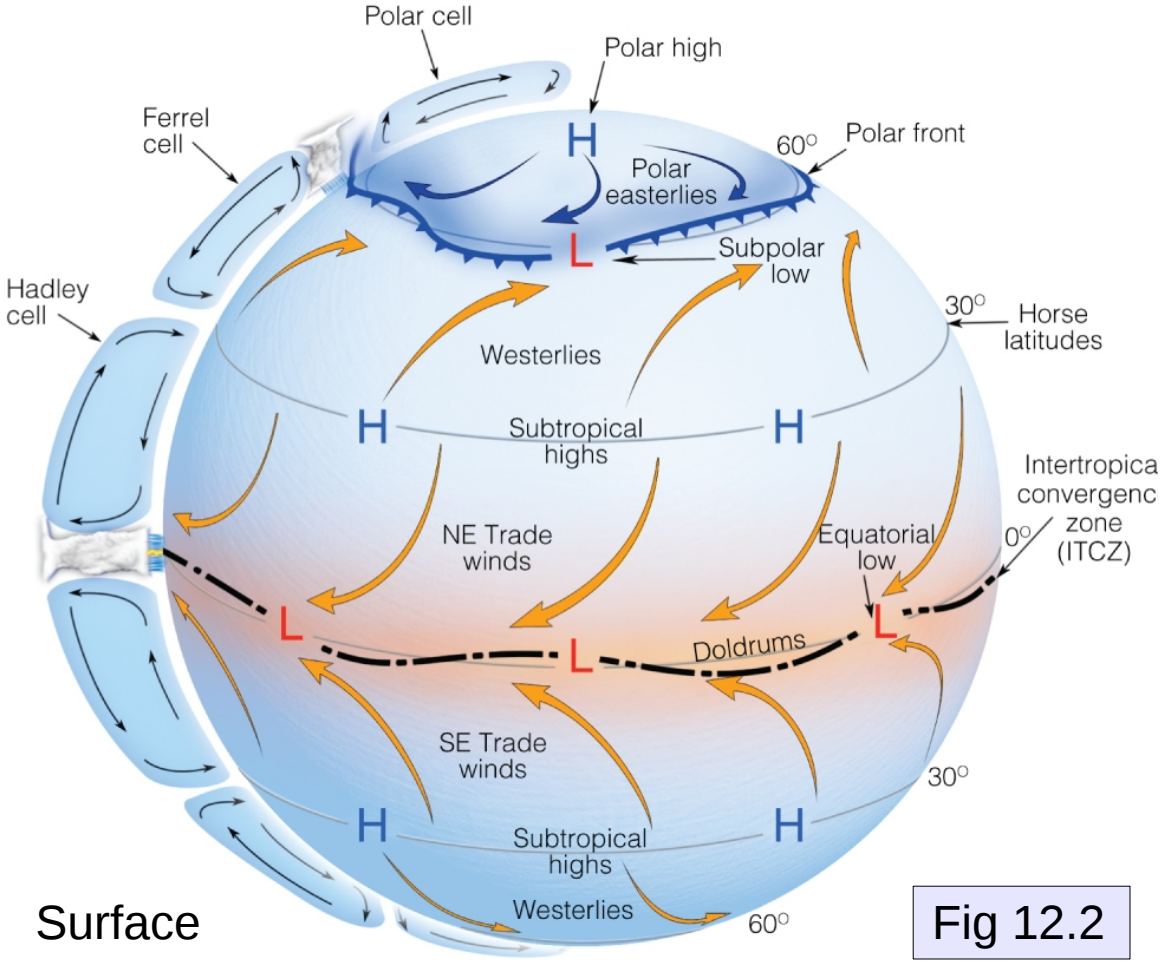
EAS270_Ch12_GenCirc_A.odp
JDW, EAS U.Alberta, last mod. 22 Nov. 2016

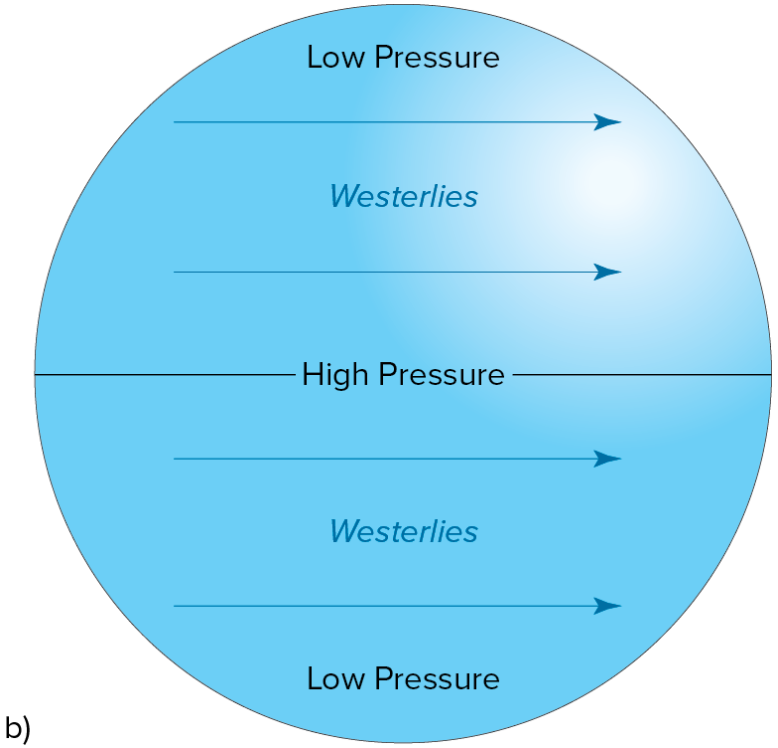
Figures below: idealized pattern (3-cell model) of annually-averaged pressure and winds, assuming a uniform terrestrial surface and that the subsolar point runs perpetually along the equator. (Due to the assumed symmetry, no zonal gradients.)

Orientation of the *surface* winds is consistent with the action of the Coriolis force and PGF

- NE polar winds
- NE trade winds
- SW midlat winds



Surface

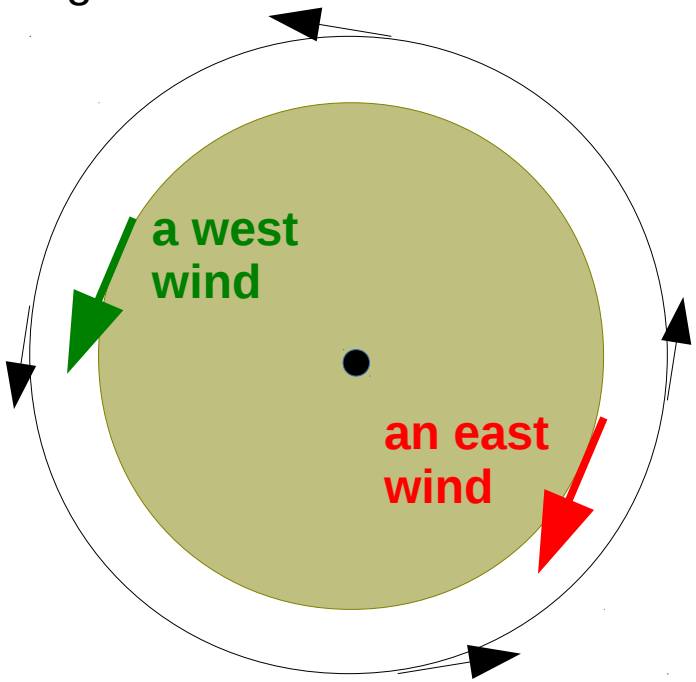


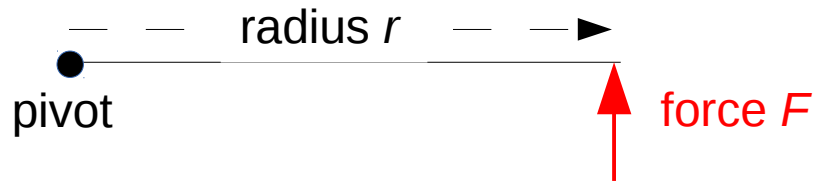
b)

Aloft

Fig 12.2

Earth, viewed from above the N. pole.
Convention: earth has *positive* angular momentum *L*.





Torque [Nm]: $\Gamma = F\ r$

- an **easterly surface wind** exerts a torque on the earth such as to *slow* earth's rotation – this exchange adds angular momentum to the atmos.
- a **westerly surface wind** exerts a torque on the earth such as to *speed up* earth's rotation – subtracting ang. mtm from atmos
- over the globe there occur (partly compensating) regions of easterly and regions of westerly surface winds**

Only the *zonal (i.e. east-west)* component of the surface wind can exert a torque about earth's rotation axis (because earth's spin axis defines what we mean by "zonal")

Torque exerted on earth by an east wind is clockwise (seen from above the N. pole) – and (action/reaction) the rotating earth exerts an anti-clockwise torque on an easterly wind

earth's rotation rate undergoes short term fluctuations, but these average out to give a steady rate. Thus the net torque exerted by surface winds must balance ***close to* zero even in the short term (say, 24 hours). The (actual) slight imbalance alters earth's daylength, and this can be detected and is one criterion for accuracy of weather models

Recall we're defining positive angular mtm as having the same sense as earth's angular mtm – anticlockwise seen from above the N. pole

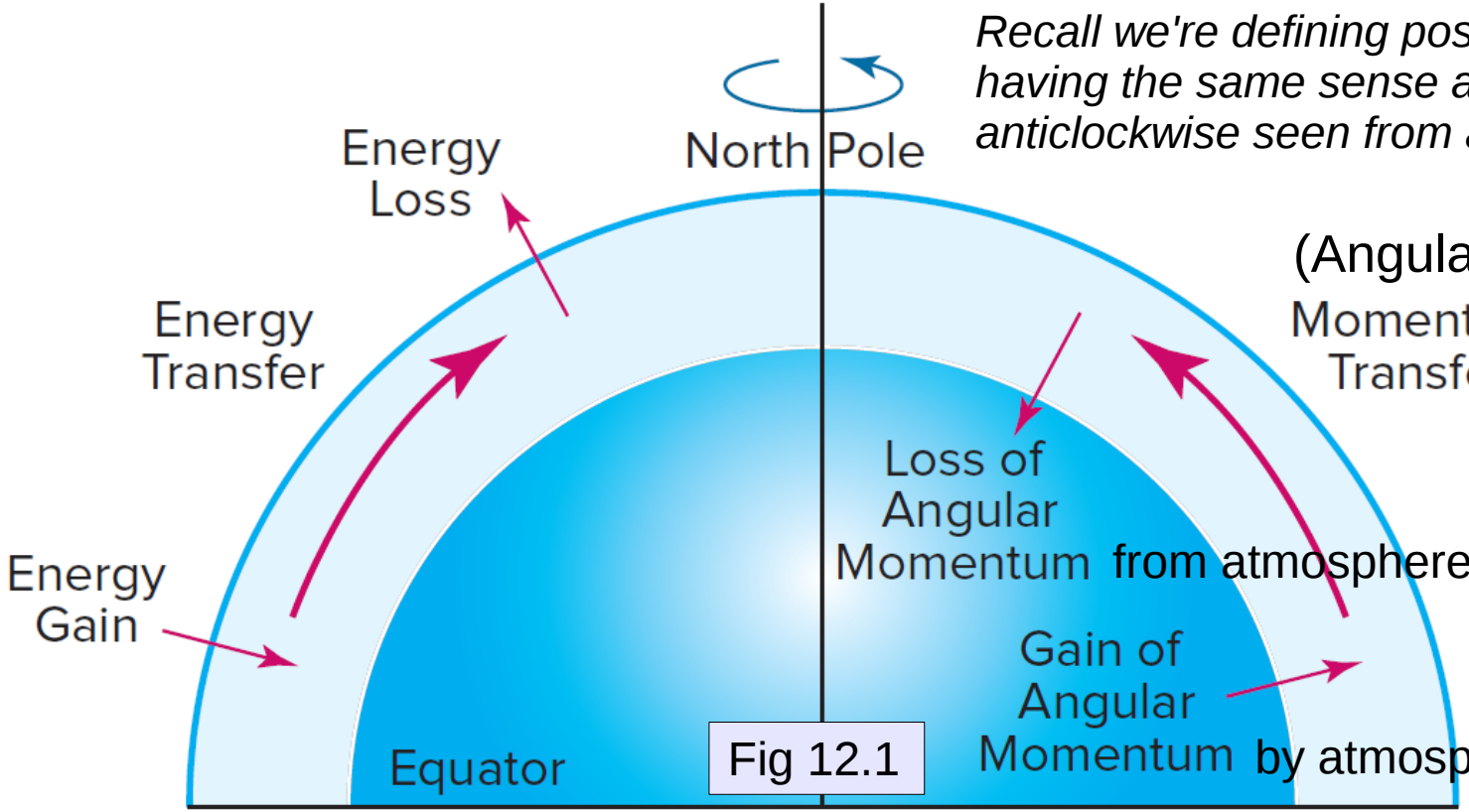


Fig 12.1

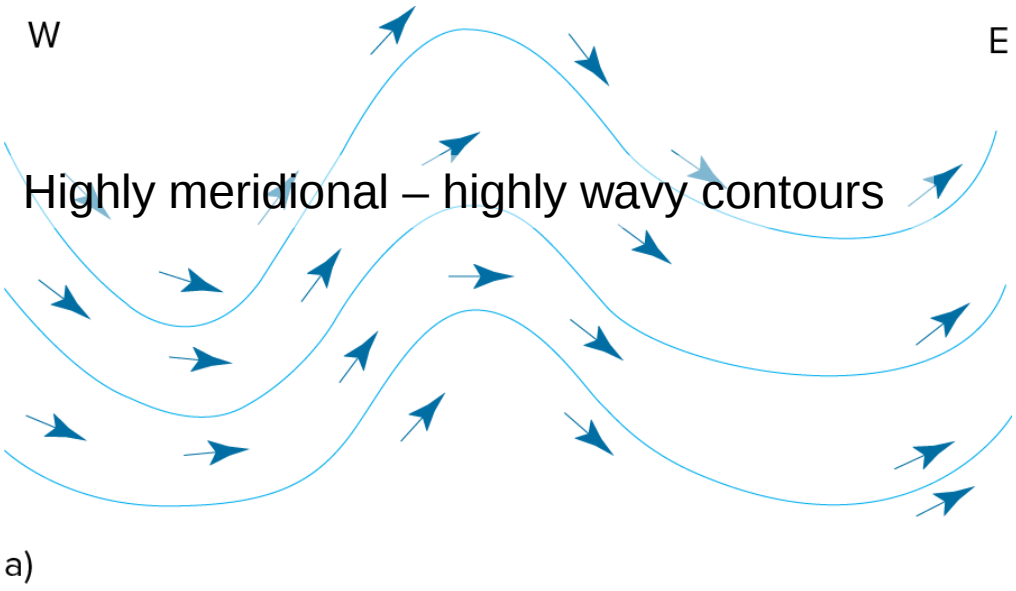
Zonal component of surface wind is westerly

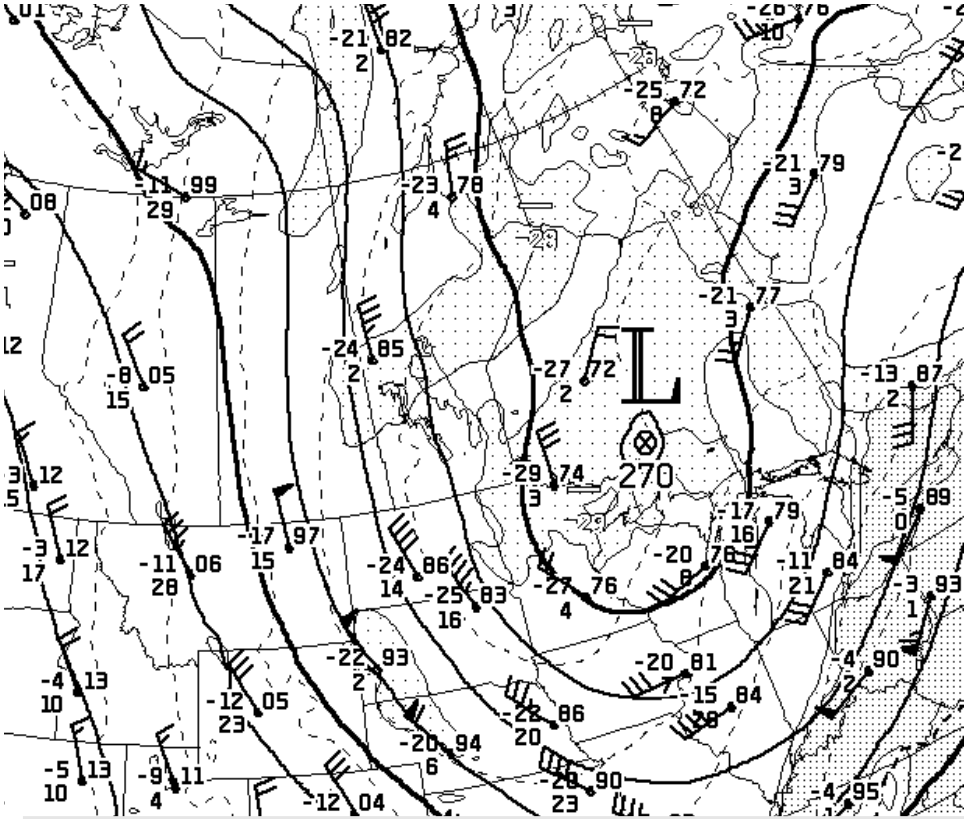
Zonal cmpnt. E

- a decelerating torque about earth's spin axis is exerted on the earth by the trade winds and polar easterlies
- this is balanced by an accelerating torque on earth exerted by mid-latitude westerlies
- meridional (i.e. north-south/south-north) flows transfer energy and angular momentum from low to high latitudes
- meridional flow is associated with the weather systems: surface highs and lows, troughs and ridges aloft. These are sometimes referred to as the "eddies"

STOPPED HERE WED. 23 NOV.

Note: *this is a qualitative, subjective descriptor*





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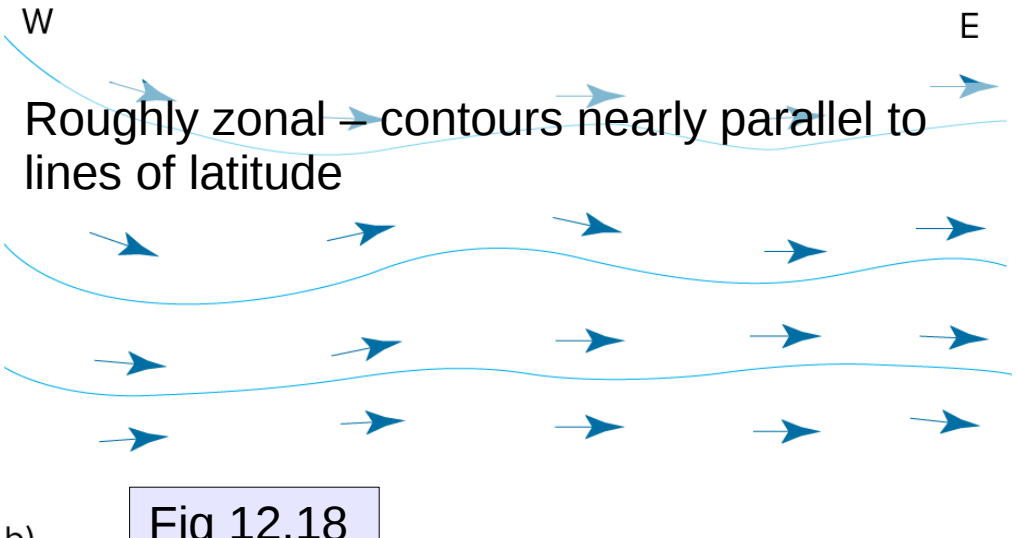


Fig 12.18

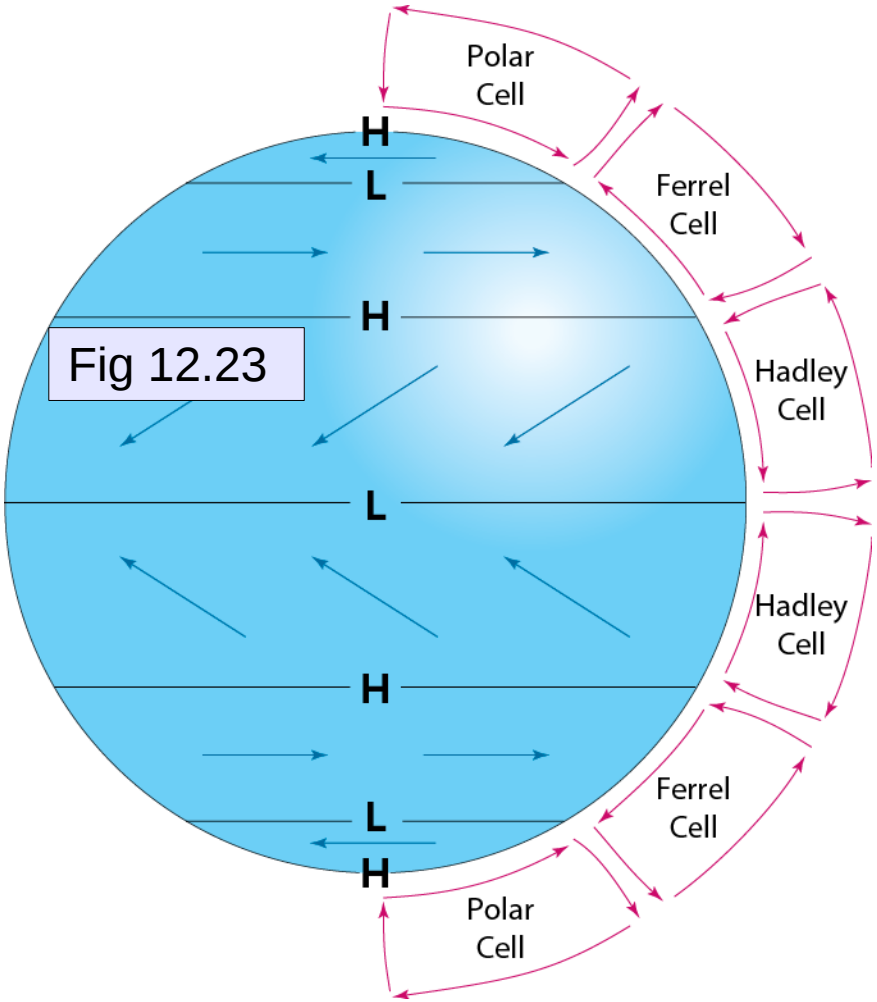


Fig 12.23

Hadley cell driven by equatorial convection

Polar cell driven by negative buoyancy of cold air (polar sink)

- Equatorial lows
- Subtropical highs
- Sub-polar lows
- Polar high

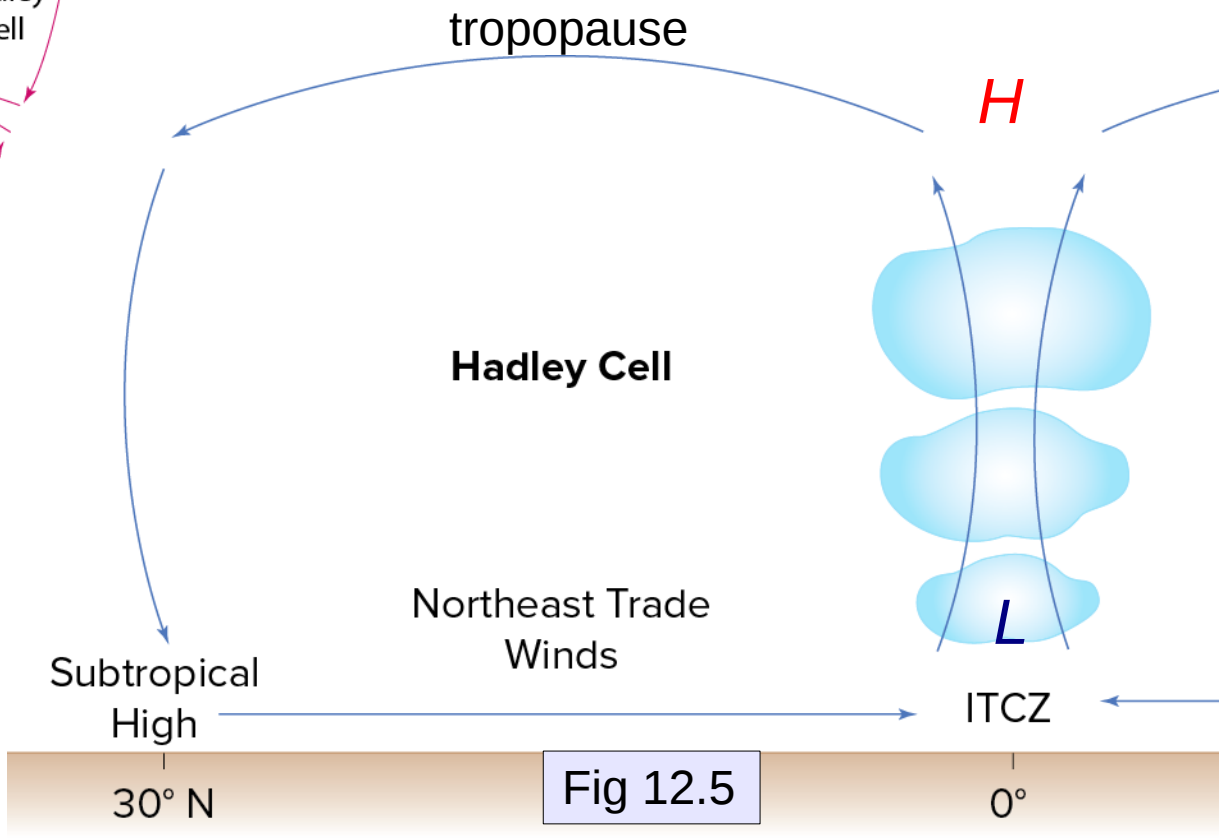


Fig 12.5

Polar lows: Aleutian, Icelandic ("cells")

Subtropical highs: Pacific, Bermuda, weak in winter

Continental thermal highs: Cdn, Siberian

SFC WIND • PRESSURE (sea level corrected)

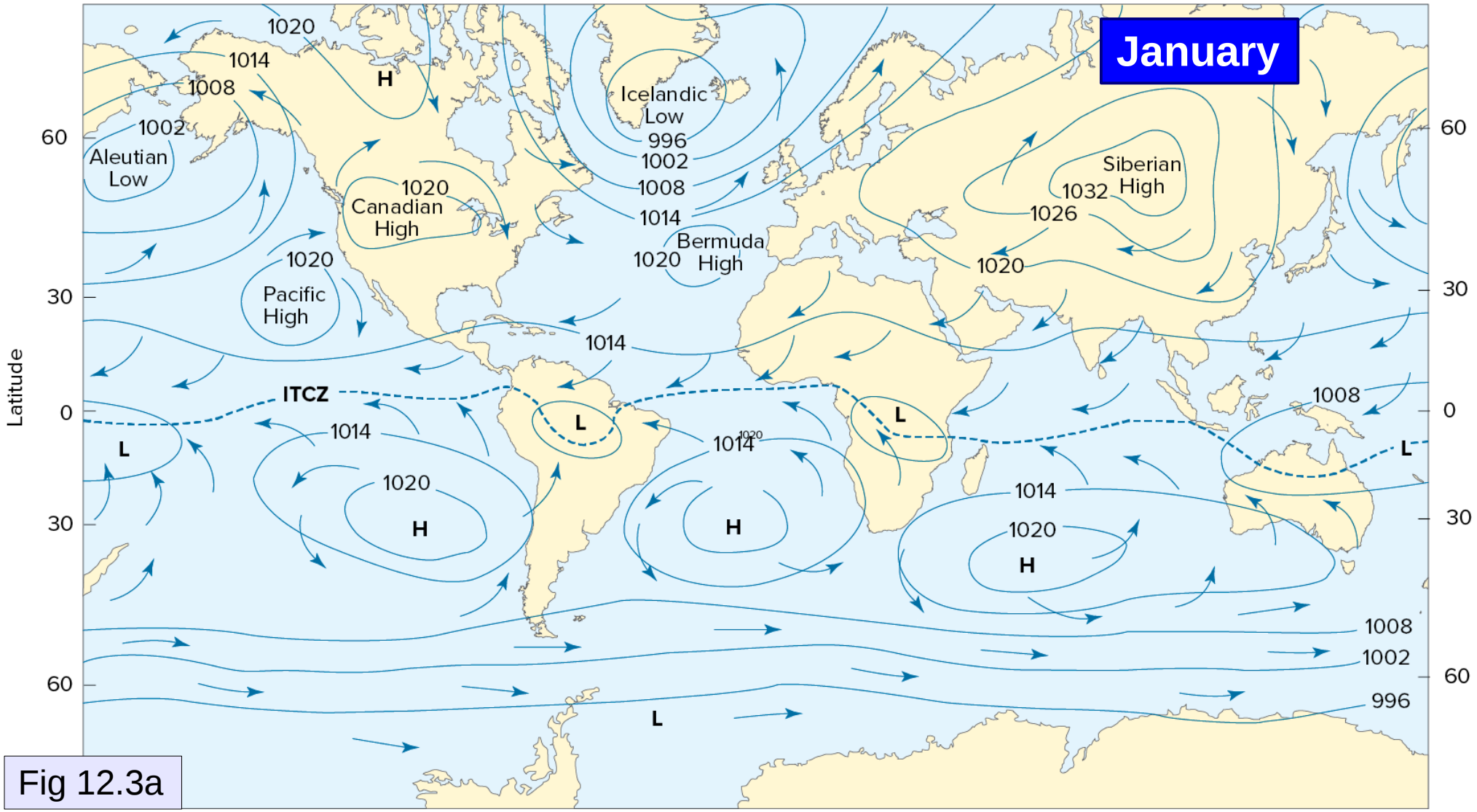


Fig 12.3a

Aleutian low has disappeared, Icelandic low weakened

N. hemisp. subtropical highs much more dominant than during N. hemisp. winter

Continental thermal high over Australia; continental thermal lows over SW. US & over Asia

S. hemisph. subpolar low a band

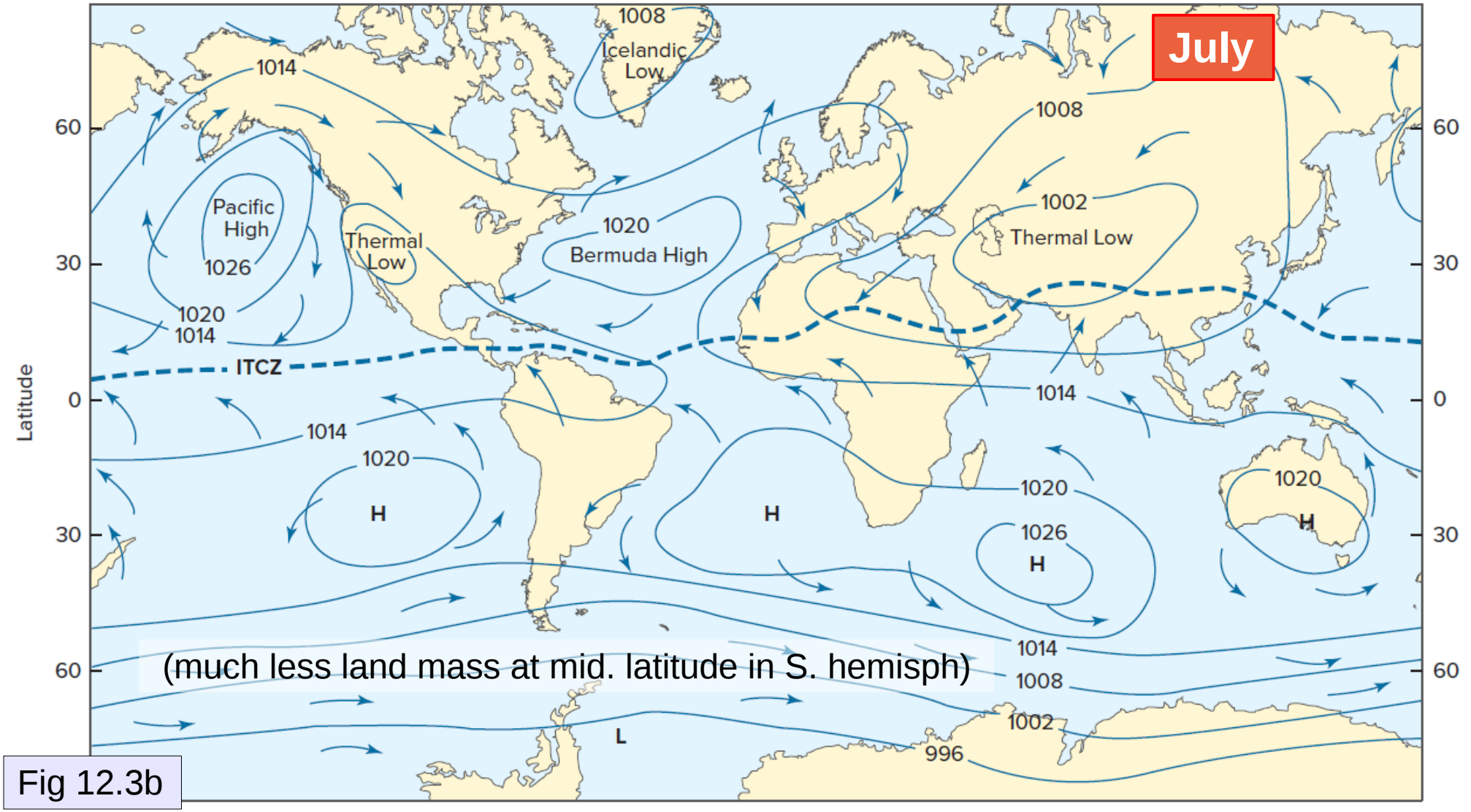


Fig 12.3b

Stronger height gradients in middle latitudes than at low or high latitudes

Strongest climatological winds in middle latitudes

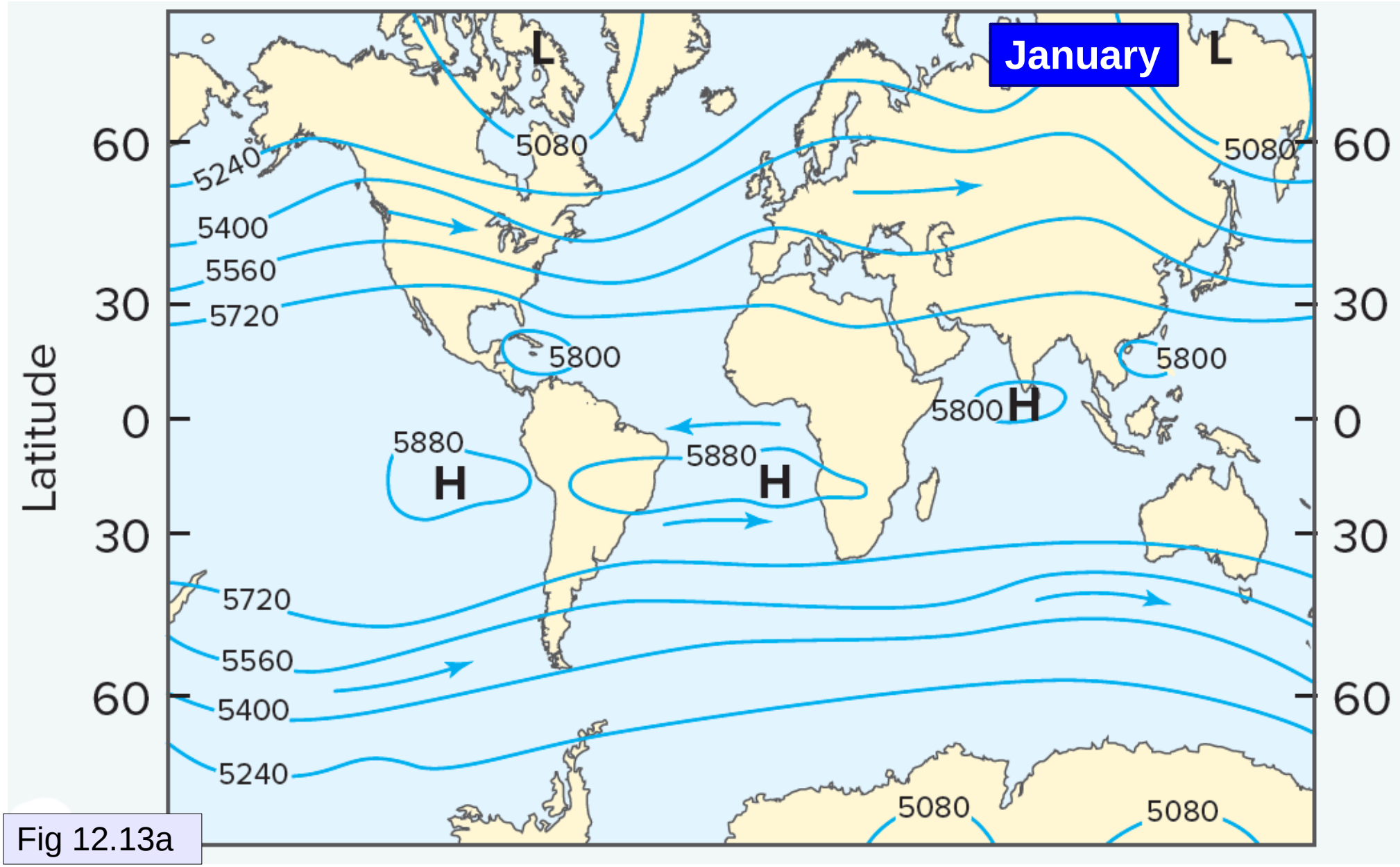


Fig 12.13a

Stronger height gradient – therefore stronger westerlies – in the S. hemisphere

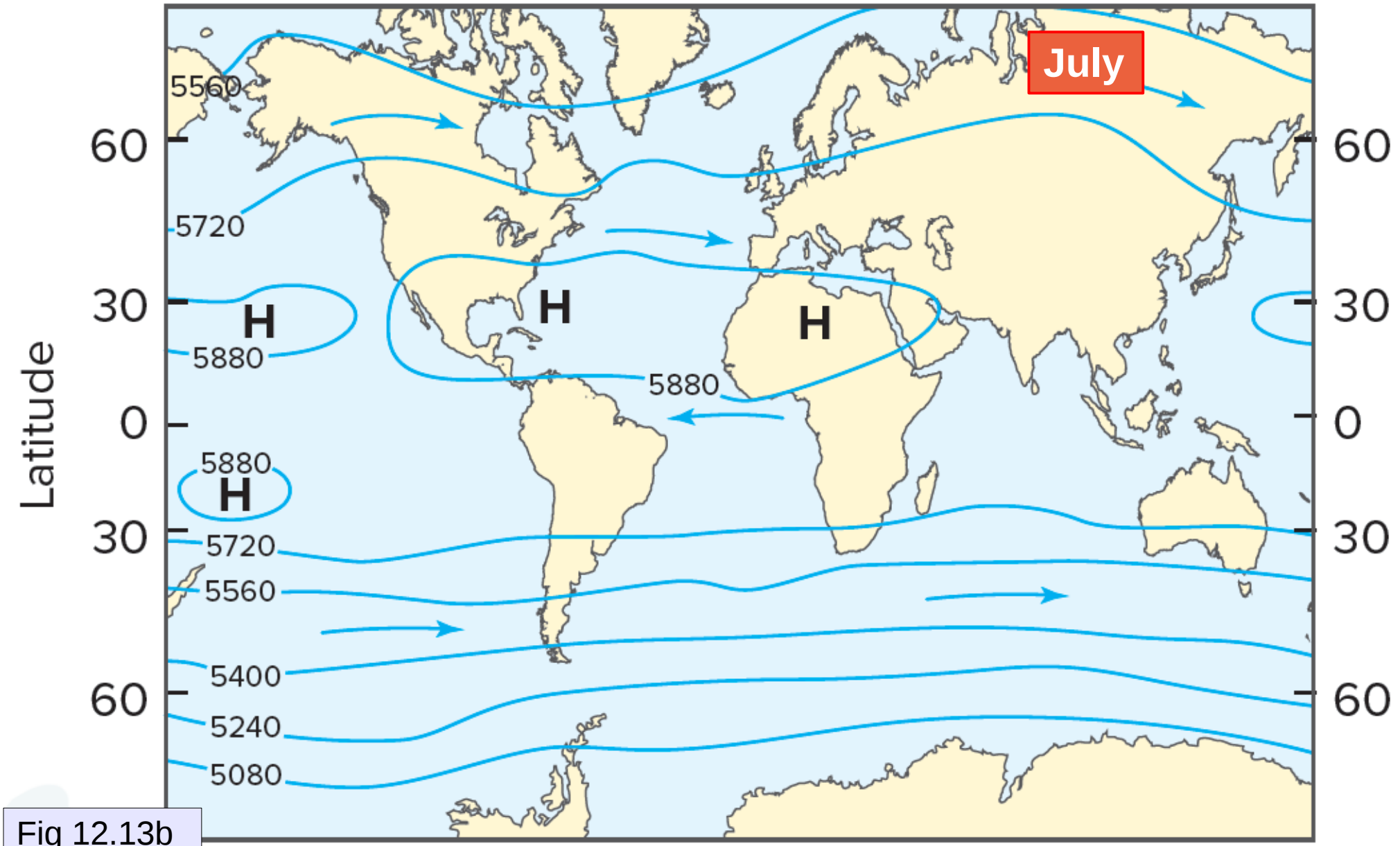
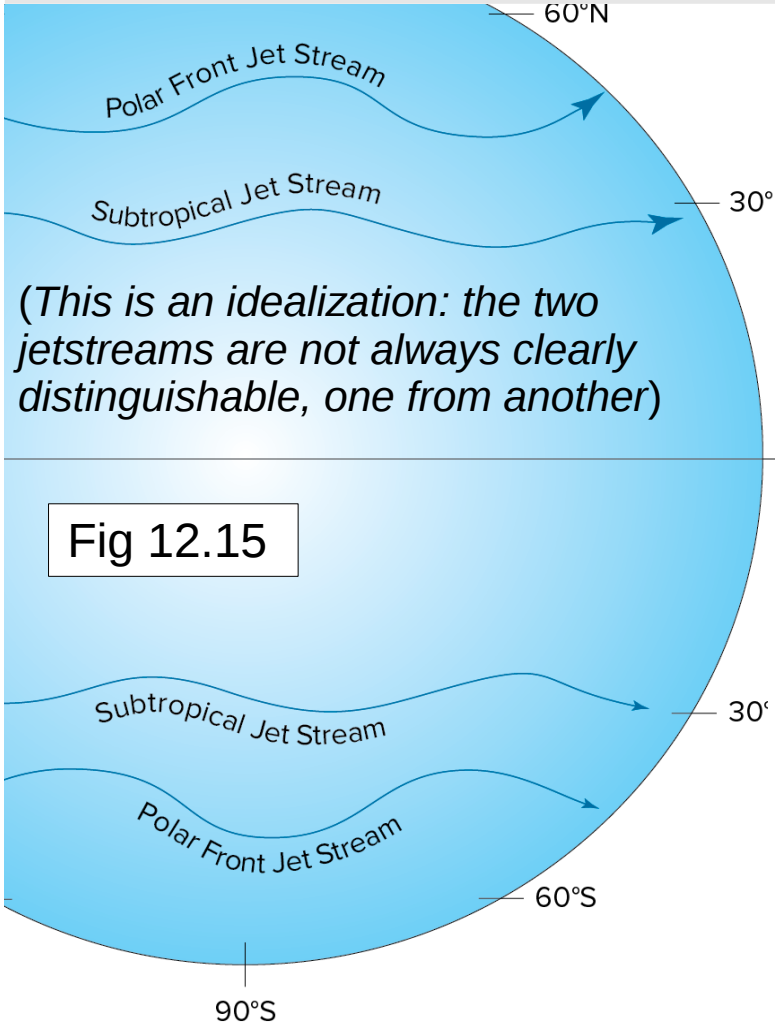


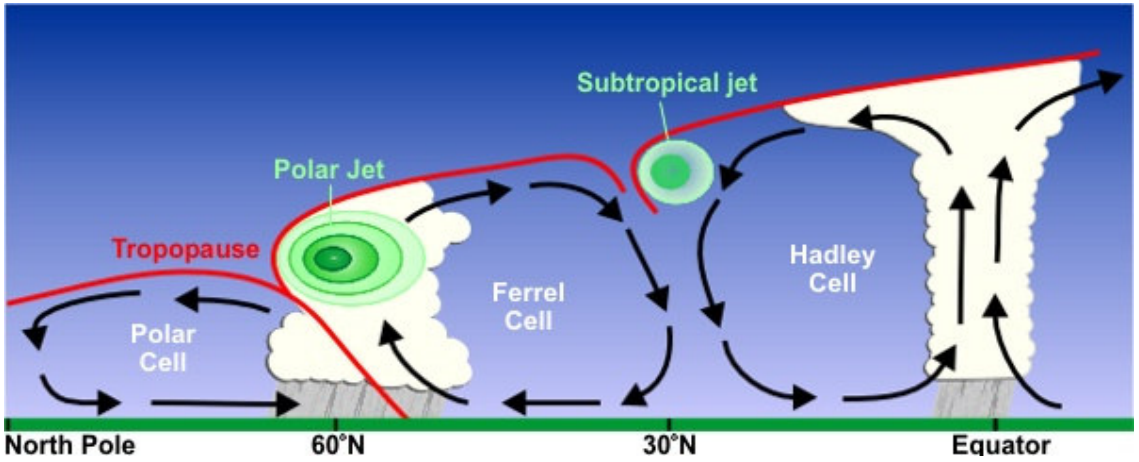
Fig 12.13b



(*This is an idealization: the two jetstreams are not always clearly distinguishable, one from another*)

Fig 12.15

Discontinuous band some 150-500 km wide, a few km deep, meandering between about 40-60°



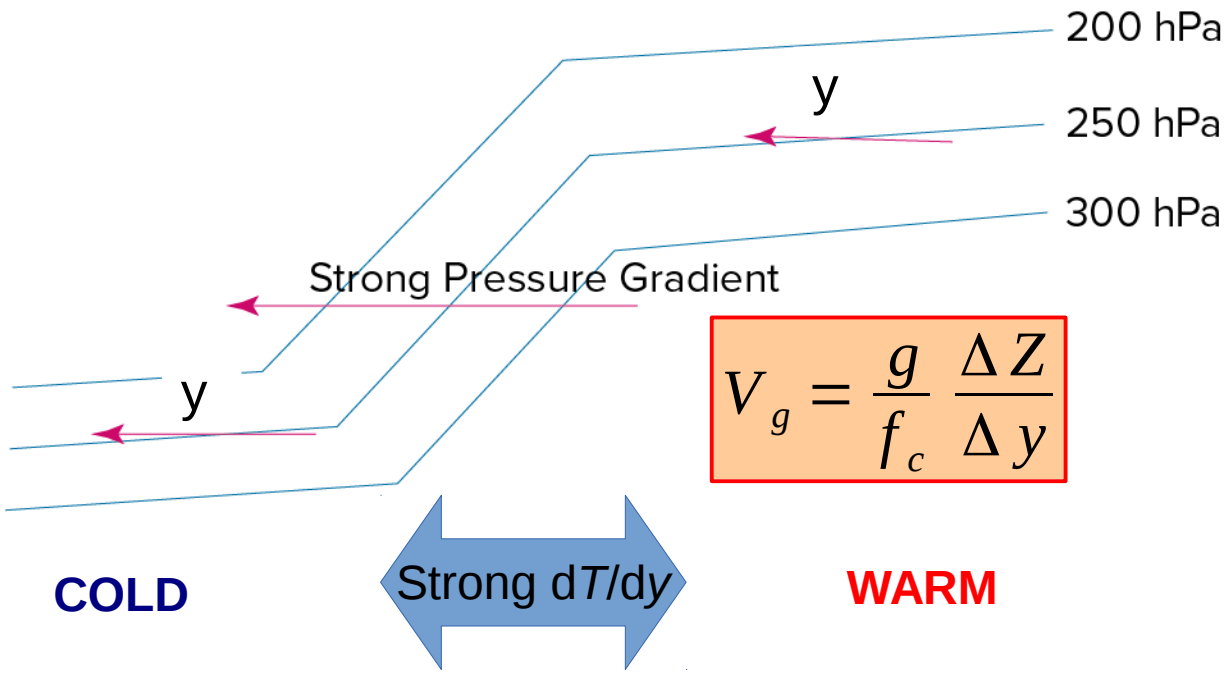
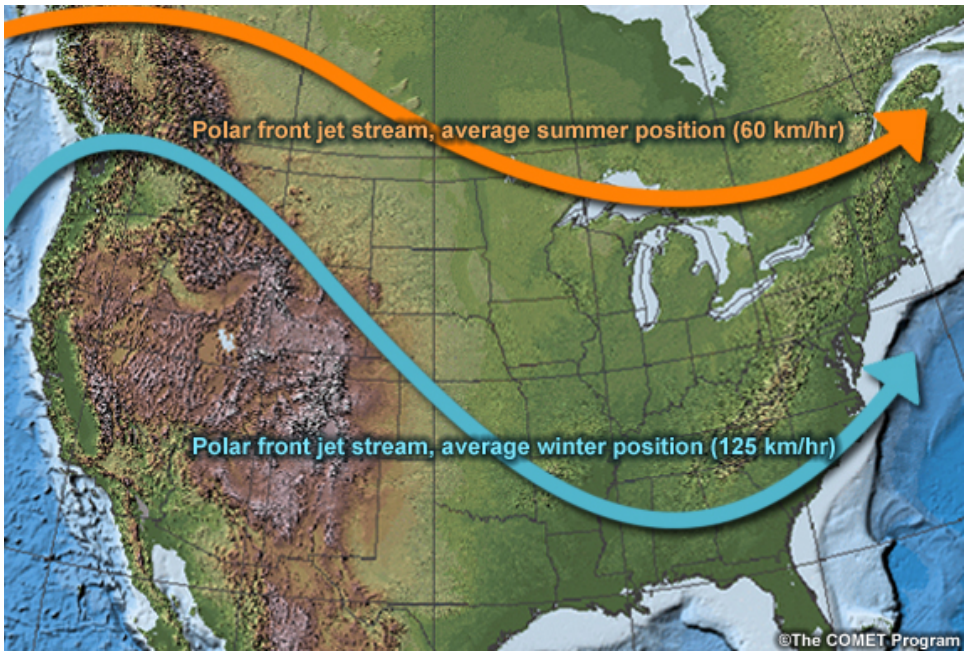


Fig 12.20

Jetstream is associated with the polar front – a discontinuous zone where $\Delta T/\Delta y$ is very steep, and therefore so (also) is the height gradient $\Delta T/\Delta y$ steep



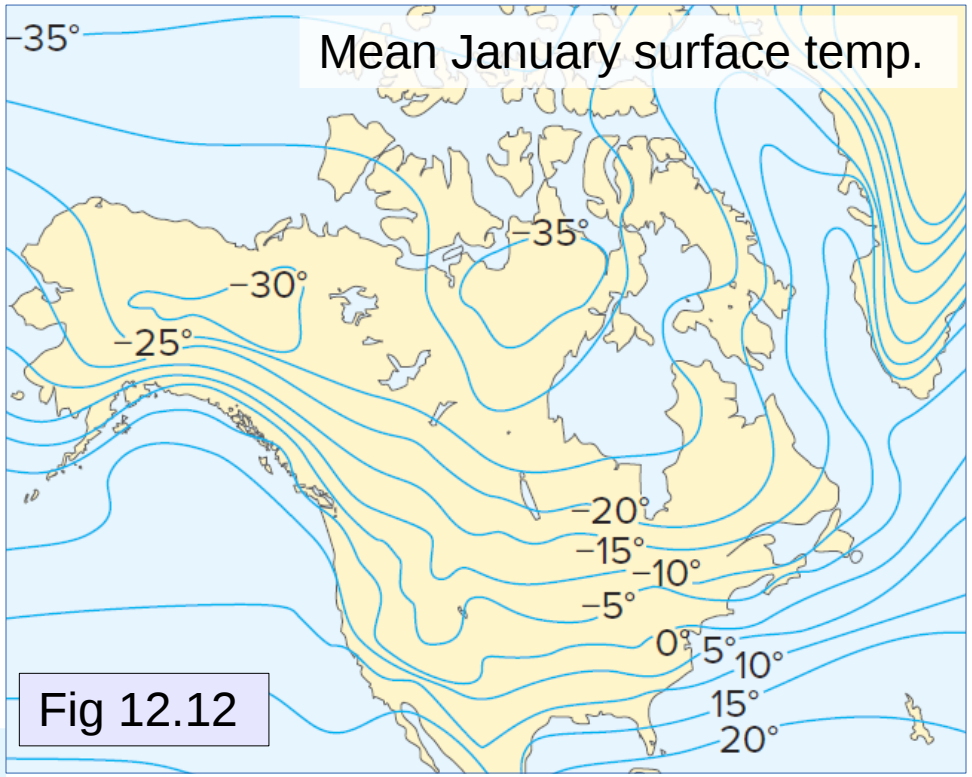


Fig 12.12

Mean path of the polar jetstream in March 2012 – highly meridional. It was unseasonably cold in western Canada, and warm in the east

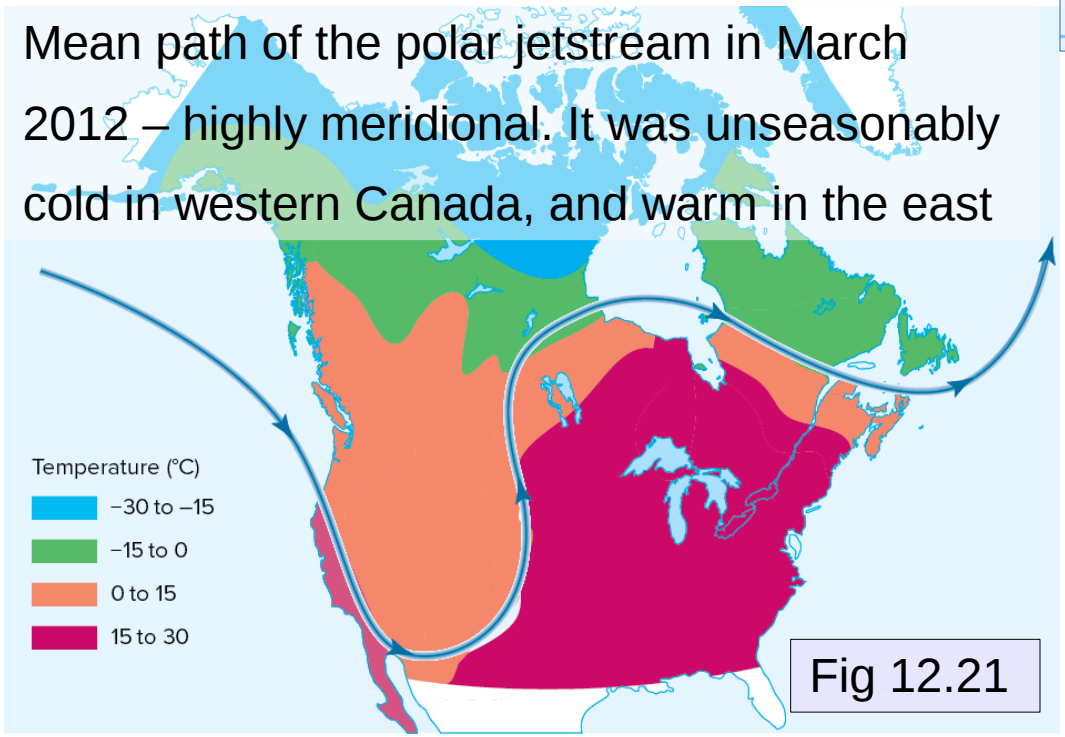
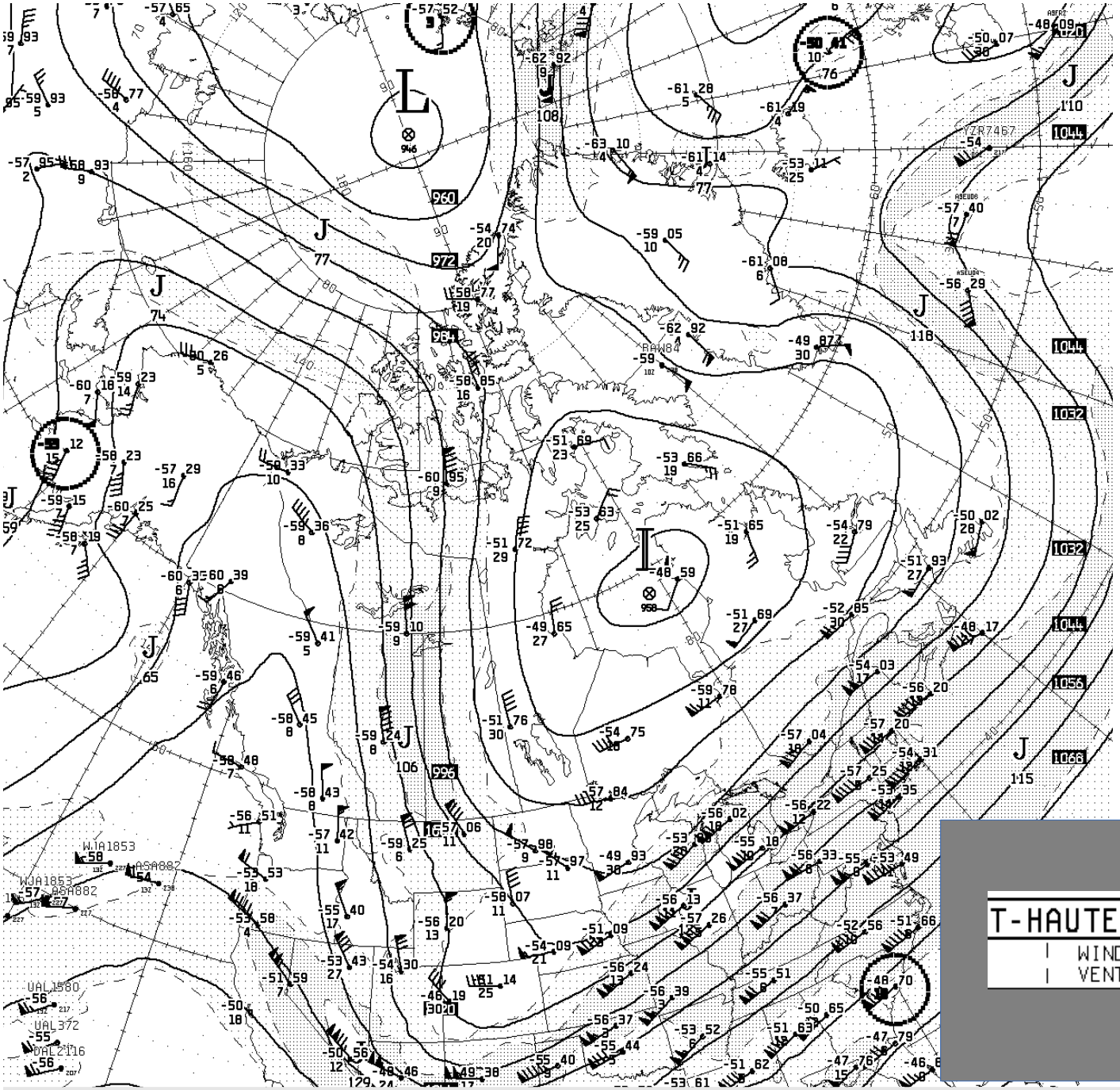


Fig 12.21

As we ascend, thermal wind keeps turning the actual wind towards itself. High up, actual and thermal wind parallel over much of globe, with cold air on the left in N. hemisph

The jet is aligned with cold air on its left: thus aligned with thickness contours



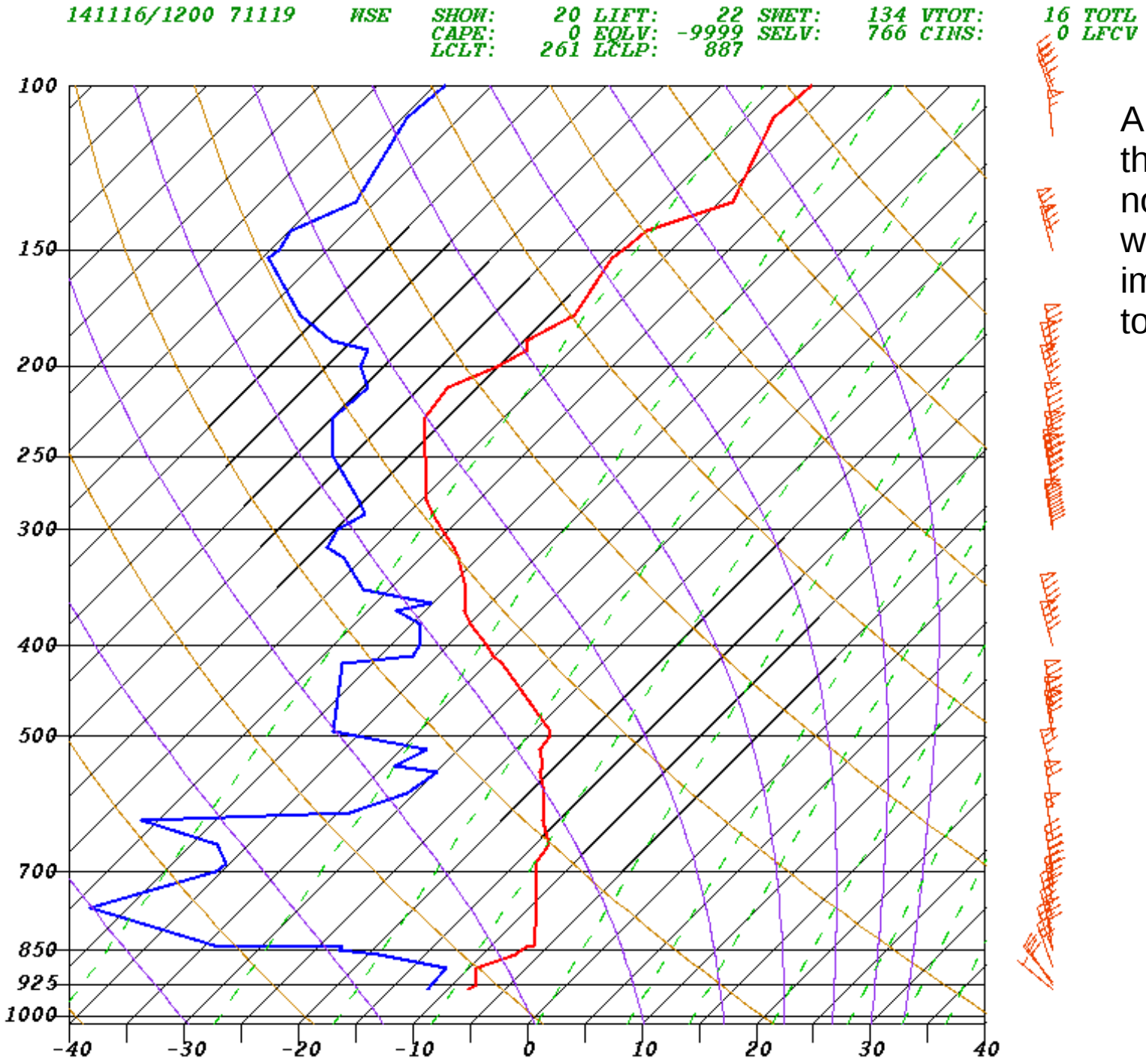
Example of an arctic outbreak

J identifies a jet “core”

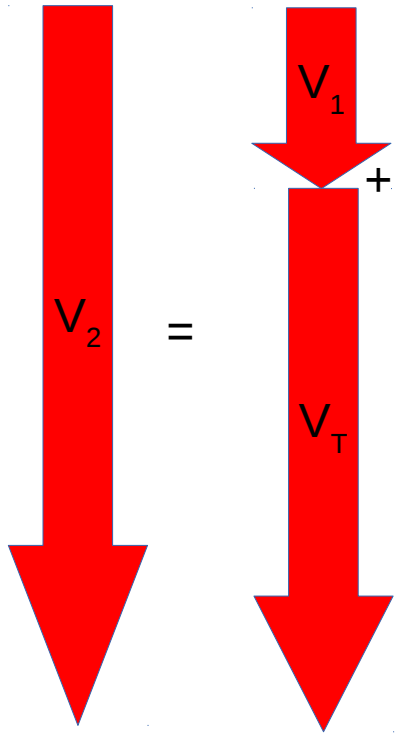
Jet core runs over C. Alberta down from the high arctic

System over Hudson Bay often named the “Arctic vortex”

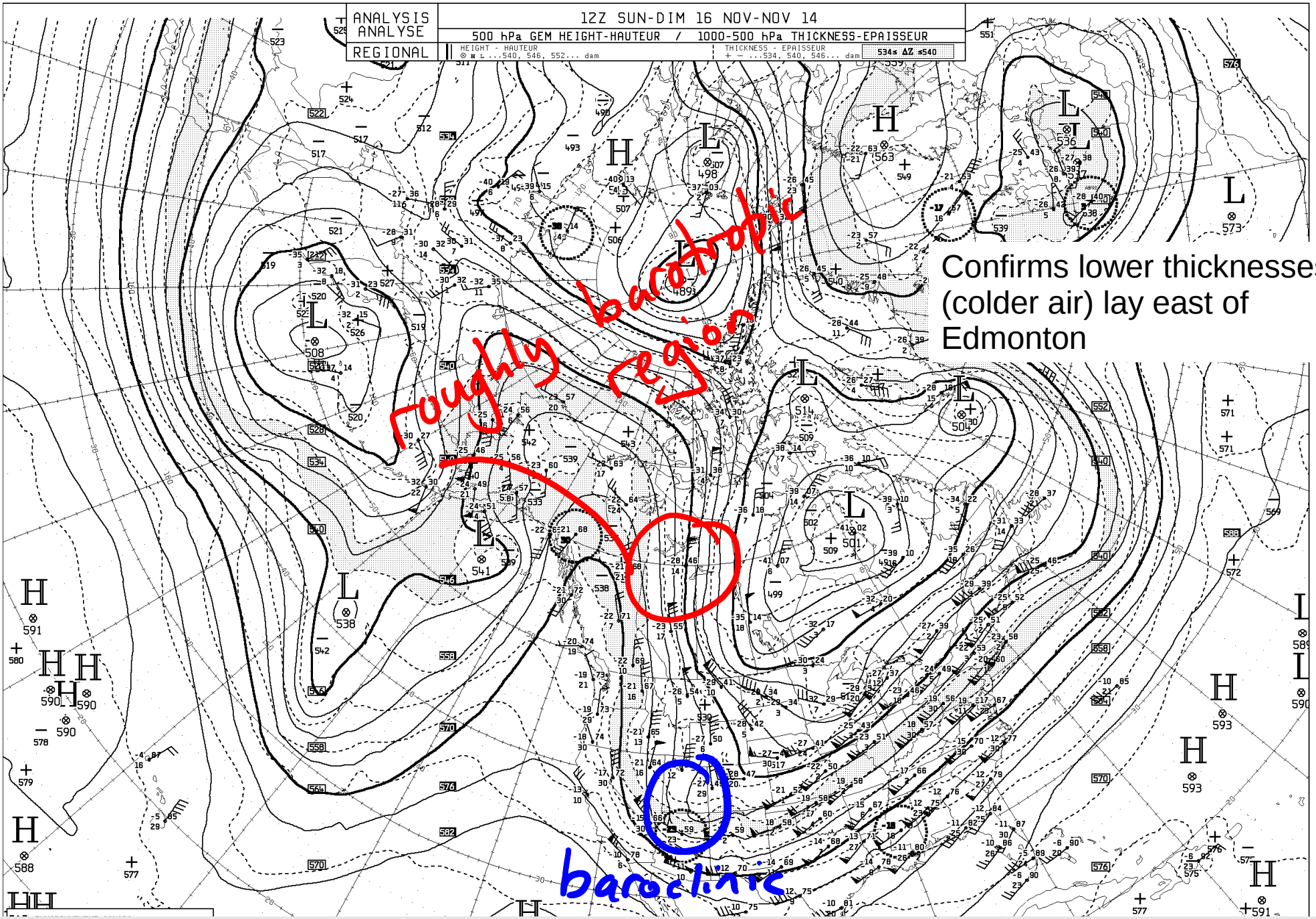
CMC 250 hPa analysis 12Z Sunday 16 November 2014



Above about 850 hPa the thermal wind is a northerly – aligned with the jetstream – implying colder air lay to Edmonton's east...

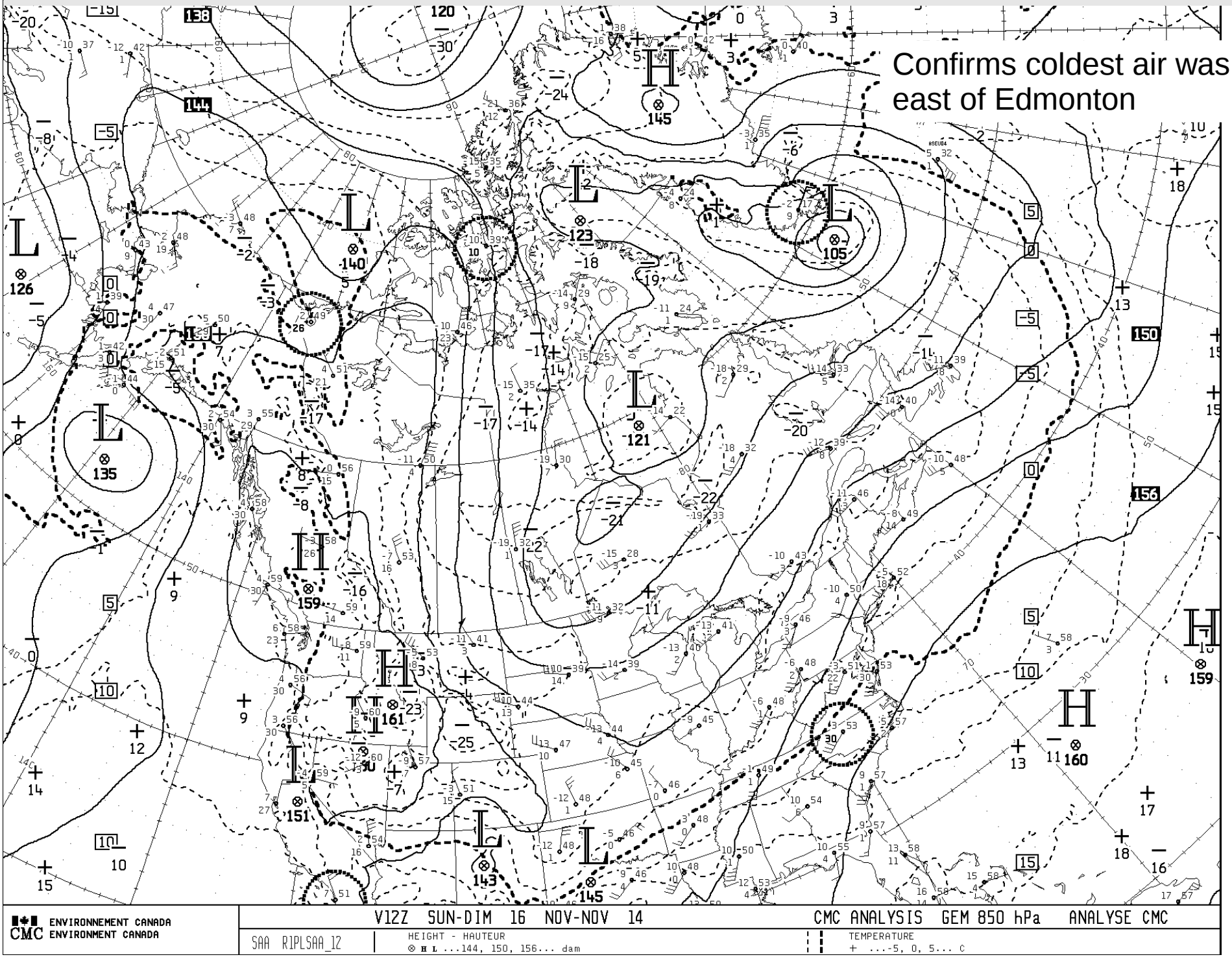


Ch12. Is the location of the colder air consistent with the thermal wind over Edmonton? 14/15



CMC 500 hPa analysis 12Z Sunday 16 November 2014

Ch12. Is the location of the colder air consistent with the thermal wind over Edmonton? 15/15



Topics/concepts covered

- climatological surface pressure systems – names and locations
- 3-cell model
- torque of the zonal wind component upon the earth
- observed climatology of surface pressure and wind
- climatological upper flow
- the polar jetstream
- thermal wind diagnosed from sounding, confirming cold air lying to the right of the thermal wind vector