EAS270, "The Atmosphere" Mid-term Exam 1 Nov. 2010

Professor: J.D. Wilson Time available: 50 mins Value: 20%

Instructions: For all 30 multi-choice questions, choose what you consider to be the best (or most logical) option. Use a pencil to mark that choice on the answer form. ***You may keep this exam***.

1. Radiation fog is caused by the ground's cooling by net loss of ____ . It is most probable under ____ skies and ____

   (a) shortwave radiation; cloudy; calm wind
   (b) longwave radiation; clear; very light wind ✓✓[85% correct; p159; Lec13 slide 20]
   (c) latent heat; clear; calm wind
   (d) water vapour; cloudy; warm wind
   (e) water vapour; clear; very light wind

2. Air cooling due to adiabatic ascent is the key factor in ____ fogs

   (a) advection
   (b) upslope ✓✓[74% correct; p161; ; Lec13 slide 20]
   (c) radiation
   (d) precipitation
   (e) steam

3. As a frost protection strategy for a valuable crop the effectiveness of ____ depends on the existence of particular and conducive ('helpfully contributing') meteorological conditions, specifically the presence of ____

   (a) wind machines; a ground-based inversion ✓✓[64% correct; p183; Lec16, slide 10]
   (b) wind machines; an absolutely unstable ground-based layer
   (c) oil-burning smudge pots; a strong wind
   (d) oil-burning smudge pots; a layer of nimbostratus
   (e) water droplet sprayers; a ground-based layer in which relative humidity is 100%

4. The Saturated Adiabatic Lapse Rate (SALR) is roughly 0.5°C/100 m at low levels, but far aloft it is about ____ . The smaller value near ground is due to ____

   (a) 2°C/100 m; stable stratification
   (b) 2°C/100 m; a nocturnal inversion
   (c) 1°C/100 m; weaker winds near ground
   (d) 1°C/100 m; latent heat released in rising parcels ✓✓[67% correct; p156; Lec13, slide 15]
   (e) 1°C/100 m; buoyancy of moist rising parcels

5. The abundance of natural and anthropogenic cloud condensation nuclei in the atmosphere ensures that ____

   (a) cloud droplets remain unfrozen (as supercooled liquid) to temperatures far below 0°C
   (b) it is possible to augment rainfall by "seeding" cold clouds with artificial ice nuclei
   (c) condensation does not occur until a level of supersaturation of about 120%
   (d) condensation usually occurs at relative humidities as low as about 70%
   (e) condensation usually occurs at relative humidities between 98% and 100.1% ✓✓[52% correct; p164]

6. The environmental lapse rate (ELR) in a ground-based layer during exceptionally windy and dry conditions will be ____

   (a) approximately the same as the dry adiabatic lapse rate (DALR) ✓✓[45% correct; Lec8, slide 7; Lec12, slide 3; Lec15, slide 8]
   (b) approximately the same as the moist adiabatic lapse rate (SALR)
   (c) zero, ie. the layer will be isothermal
   (d) that of a very strong inversion (temperature increasing with increasing height)
   (e) unconditionally unstable, the temperature decreasing with increasing height at a rate far exceeding the dry adiabatic lapse rate

7. If air temperature increases with increasing height by 5°C per 100 m in a given layer, this layer is ____

   (a) statically neutral
   (b) absolutely (=unconditionally) unstable
   (c) absolutely (=unconditionally) stable ✓✓[50% correct; p174]
   (d) conditionally unstable
   (e) conditionally stable

8. If a layer of the atmosphere remote from ground became absolutely unstable, ____ would promptly adjust that layer back towards ____

   (a) spontaneous convective mixing; neutral stability ✓✓[57% correct; Lec15, slide 9]
   (b) spontaneous convective mixing; unconditionally stable stratification
   (c) molecular conduction; neutral stability
   (d) molecular conduction; unconditionally stable stratification
   (e) latent heat of condensation; an isothermal state

9. Of the clouds listed, ____ is most likely to generate a high precipitation rate

   (a) Cirrus
   (b) Cumulonimbus ✓✓[81% correct]
   (c) Altocumulus
   (d) Nimbostratus
   (e) Altostratus

10. A weak sun visible (without halo) through a featureless sheet of gray cloud is often a good indication of ____ clouds.

    (a) stratocumulus
    (b) altostratus ✓✓[78% correct; p187-8]
    (c) nimbostratus
    (d) cirrostratus
    (e) cumulonimbus

11. After a mid-latitude lake freezes over completely, downwind lake-effect snow is likely to ____

    (a) melt
    (b) form a layer over the ice
    (c) be more severe
    (d) be more frequent
    (e) cease to occur ✓✓[81% correct]

12. If a parcel of dry air had a temperature of 20°C when at height $z = 0$, then if it were lifted adiabatically to $z = 700$ m and then sank back down adiabatically to $z = 500$ m, its temperature would be ____

    (a) 15°C ✓✓[77% correct]
    (b) 20°C
    (c) 25°C
    (d) 27°C
    (e) 29°C

13. The three "cells" of the idealised climatological circulation on an ocean-covered rotating earth are, in order of their distance away from the equator ____

    (a) Equatorial, Ferrel, Walker
    (b) Equatorial, Coriolis, Pascal
    (c) Ferrel, Hadley, Walker
    (d) Hadley, Ferrel, Polar ✓✓[95% correct; p229]
    (e) Ferrel, Hadley, Polar

14. To determine the location of the jetstream(s) over Canada, one would examine the CMC analysis for the ____ hPa level

    (a) surface
    (b) 850
    (c) 700
    (d) 500
    (e) 250 ✓✓[23% correct; Lec19, slide 23]

15. The prevailing surface winds in the "ITCZ" are known as the ____

    (a) mid-latitude westerlies
    (b) polar easterlies
    (c) tradewinds ✓✓[82% correct; p231]
    (d) equatorial westerlies
    (e) polar westerlies

16. The ocean surface temperature in the eastern equatorial Pacific is markedly above normal (positive temperature anomaly) during ____

    (a) a La Nina
    (b) an El Nino ✓✓[93% correct; p256]
    (c) a Peruvian current
    (d) a Foehn wind
    (e) a Hadley cell

17. High amplitude Rossby waves imply significant ____ flow and cause regions of ____ aloft

    (a) zonal; convergence/divergence
    (b) meridional; convergence/divergence ✓✓[71% correct; p241]
    (c) zonal; supercooled cloud droplets
    (d) meridional; cloud condensation nuclei
    (e) Coriolis; winds

18. The "Ekman spiral" refers to ____

    (a) turning of the direction of current with depth in the ocean surface boundary layer ✓✓[94% correct; p244]
    (b) the characteristic motion of a tumbling asymmetric hailstone
    (c) the trajectory of small cloud droplet as a much larger droplet impinges from above
    (d) the pattern of surface winds about a lee trough
    (e) a pattern of the fall streaks associated with cirrus cloud

19. Climatologically, the midlatitude westerlies aloft are ____ in winter. This is due to ____

    (a) weaker; more steeply equator-poleward sloping isobaric surfaces
    (b) weaker; more gently west-eastward sloping isobaric surfaces
    (c) stronger; more gently west-eastward sloping isobaric surfaces
    (d) stronger; more steeply equator-poleward sloping isobaric surfaces ✓✓[82% correct; p236; Lec11, slide 5]
    (e) meridional; weaker equator-pole temperature contrast

20. The Southern Oscillation is ____

(a) driven "externally" by a change in solar radiative output
(b) driven "externally" when volcanic aersols alter planetary albedo
(c) a natural ("internal") oscillation of the atmosphere-ocean system ✓✓[90% correct; p260; Lec21]
(d) due to irregularities in the rotation rate of the earth
(e) able to be predicted computationally by a circulation model of the ocean (alone)

21. Persistent light precipitation is associated with ____ cloud whereas short-lived but intense precipitation is associated with ____ cloud

(a) deep stratiform; deep cumuliform ✓✓[48% correct]
(b) deep cumuliform; shallow stratiform
(c) shallow stratiform; deep stratiform
(d) shallow cumuliform; deep cumuliform
(e) cool or cold; warm

22. CMC provides web access to false colour GOES infra-red (10.7μm) satellite images, colours that relate to the *intensity* of received radiation. Photons captured by the radiometer have been emitted from earth's surface, or (if cloudy) from the uppermost deck of clouds. The scale range for radiation intensity (low → intermediate → high) is ____ , with the intensities encoded red corresponding to ____ clouds

(a) red → white → green; warm
(b) red → white → green; cold ✓✓[28% correct; Lec17, slide 2; Lec21, slide 4]
(c) green → white → red; warm
(d) green → white → red; cold
(e) white → green → red; warm

23. The elevated base of a subsidence inversion distinguishes it from a radiation inversion. A subsidence inversion is common ____

(a) on the upwind edge of large lakes
(b) along coastlines
(c) over warm ocean currents
(d) on winter mornings after a cloudless, still night
(e) on the lee (downwind) side of mountain ranges ✓✓[77% correct; p182]

For the remaining questions, please refer to the attached charts.

24. Heavy short-dashed lines on the skew T-log p diagram (Figure 1) identify several families of reference curves. The family of dry adiabats is represented by line ____

(a) A
(b) B ✓✓[89% correct; Lec12, slide 5; Lec 13, slide 16]
(c) C
(d) D
(e) E

25. Layer L1 should be classified as ____

(a) absolutely unstable (b) absolutely stable (c) conditionally unstable
(d) conditionally stable (e) neutral with respect to dry adiabatic motion ✓✓[67% correct]

26. Referring to Fig.(2), on the basis of the pressure tendencies one would expect this storm will probably ____

(a) remain stationary with its central pressure increasing
(b) move towards the northeast ✓✓[43% correct; Lec20, slide 2]
(c) move towards the southeast (d) move towards the southwest

27. Again referring to Fig.(2), the solid black station circles mean ____ . The double dots denoting "present weather" (to left of many of the the station circles) mean ____

(a) stratus; intermittent snow
(b) stratocumulus; steady snow
(c) nimbus; steady rain
(d) rain; calm
(e) overcast sky; steady rain ✓✓[95% correct; Lec 20, slide 2]

28. Referring to Fig.(3), at the locations respectively designated (**A**, **B**) ____ advection is occurring

(a) warm; warm
(b) cold; cold
(c) warm; cold ✓✓[54% correct; Lec15, slide 4; Lec20, slide 5; advection.pdf, slide 5]
(d) cold; warm
(e) horizontal; vertical

29. Referring to Figure (4), the heavy black line denotes a ____ . In the quadrilateral designated **A** straddling the eastern border of Manitoba, ____ thickness advection is occurring.

(a) Rossby wave trough; warm ✓✓[57% correct; Lec20.pdf, slide 6]
(b) Rossby wave trough; cold
(c) Rossby wave ridge; warm
(d) Rossby wave ridge; cold

30. Figures (5, 6) contrast two characteristic Alberta winter weather scenarios. Which of the descriptions below is **false**? (i.e. in which case has a valid contrast been *stated in the reverse order*?)

(a) Fig. (5) western prairies invaded by cold air washed in by passing storm; Fig. (6) mild air advected over prairies by offshore low
(b) Fig. (5) ridge of high surface pressure in Alberta in wake of storm; Fig. (6) lee trough in Alberta due to SW current aloft over Rockies
(c) Fig. (5) Edmonton's thickness exceeding 546 dam; Fig. (6) Edmonton's thickness less than 534 dam ✓✓[81% correct; *integration* of concepts from weather discussions]
(d) Fig. (5) intense storm over central Canada with little or no zonal flow over the Rockies; Fig. (6) intense storm moving onshore off the Pacific with strong flow into Alberta over the Rockies

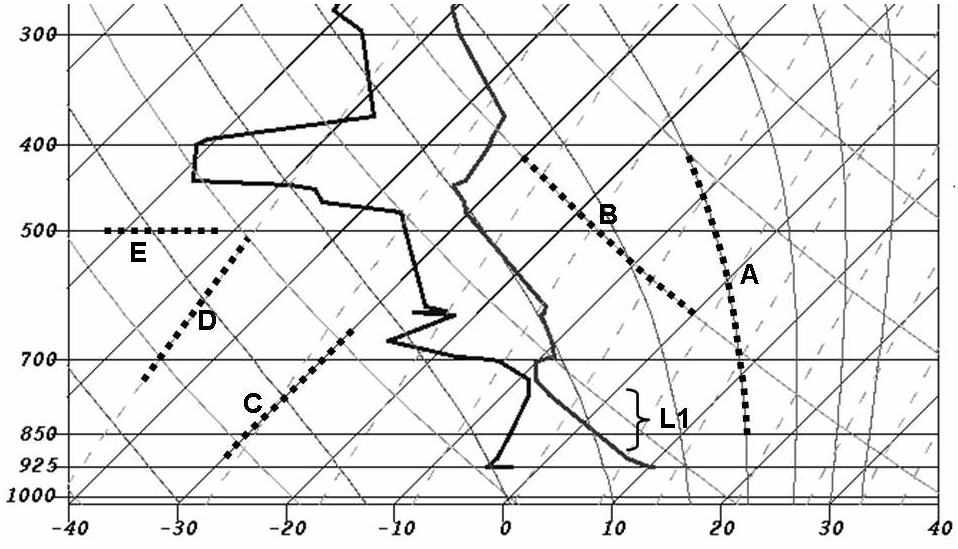

Figure 1: Thermodynamic chart.

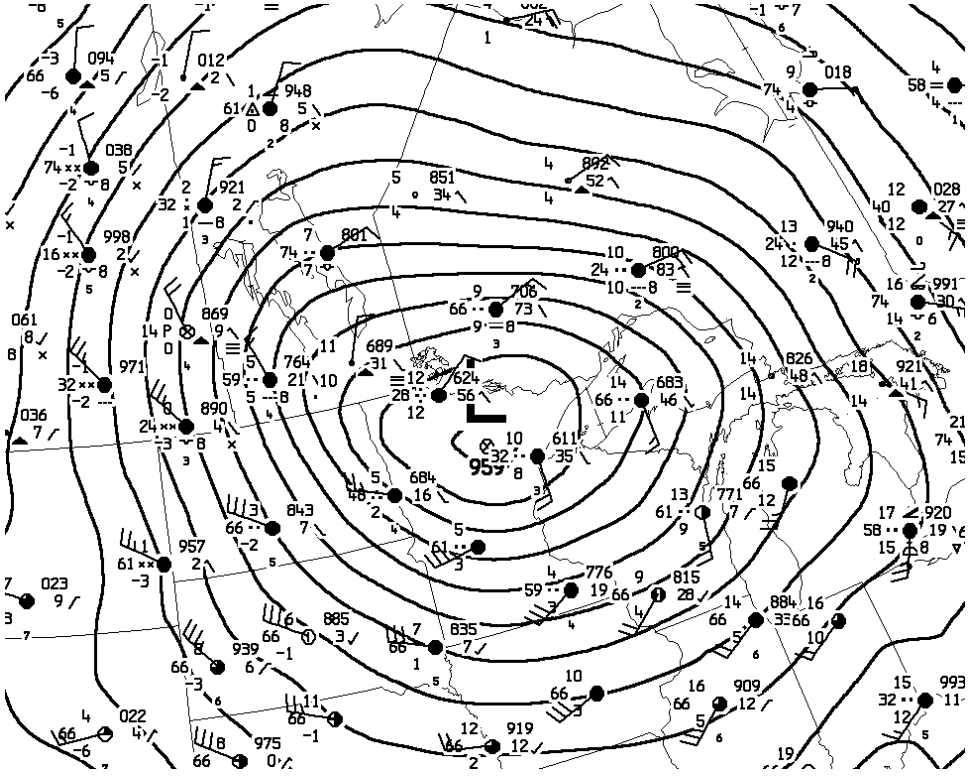

Figure 2: CMC surface analysis 18Z Oct. 26, 2010 (cropped). As an aside, the central pressure of this storm is exceptionally low and garnered much media attention.

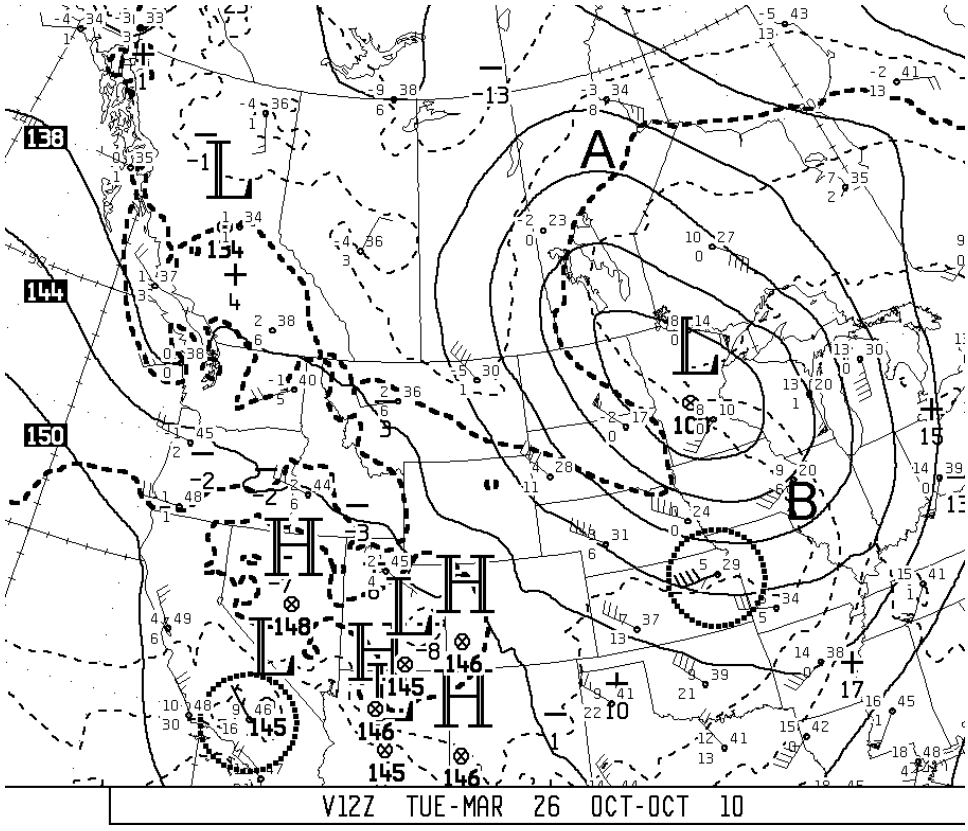

Figure 3: CMC 850 hPa analysis, 12Z Oct. 26, 2010.

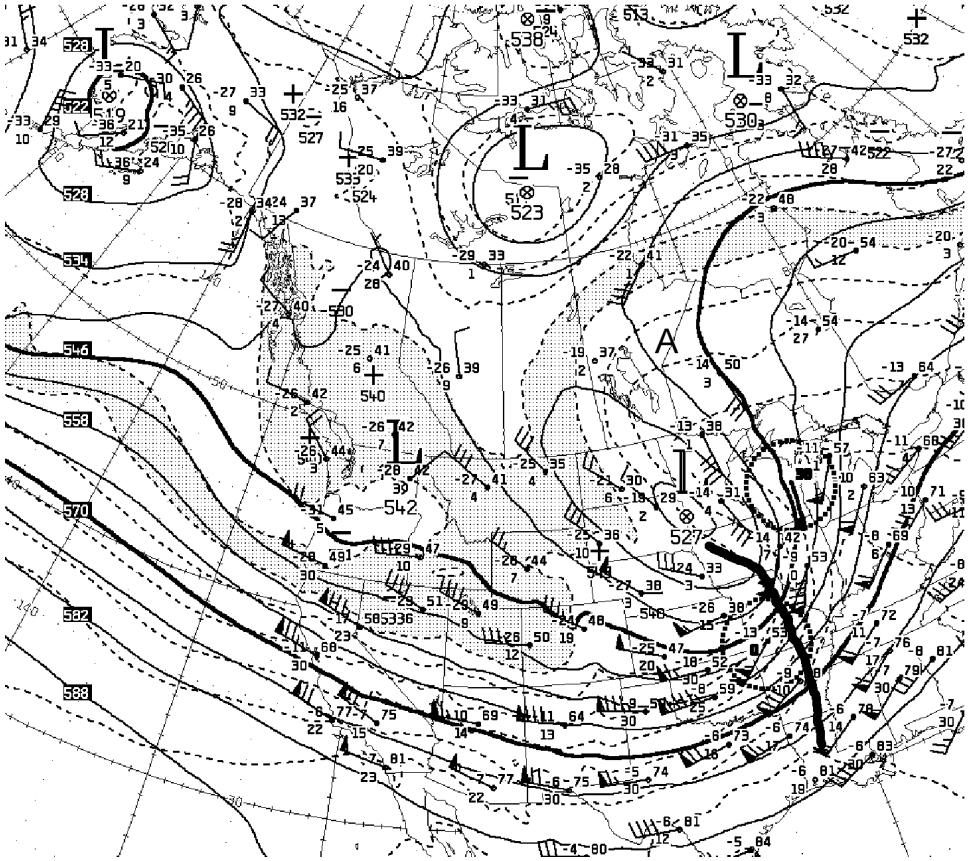

Figure 4: CMC 500 hPa analysis, 12Z Oct. 26, 2010. Stippled zone is $\Delta z_{1000-500}$ thickness band.

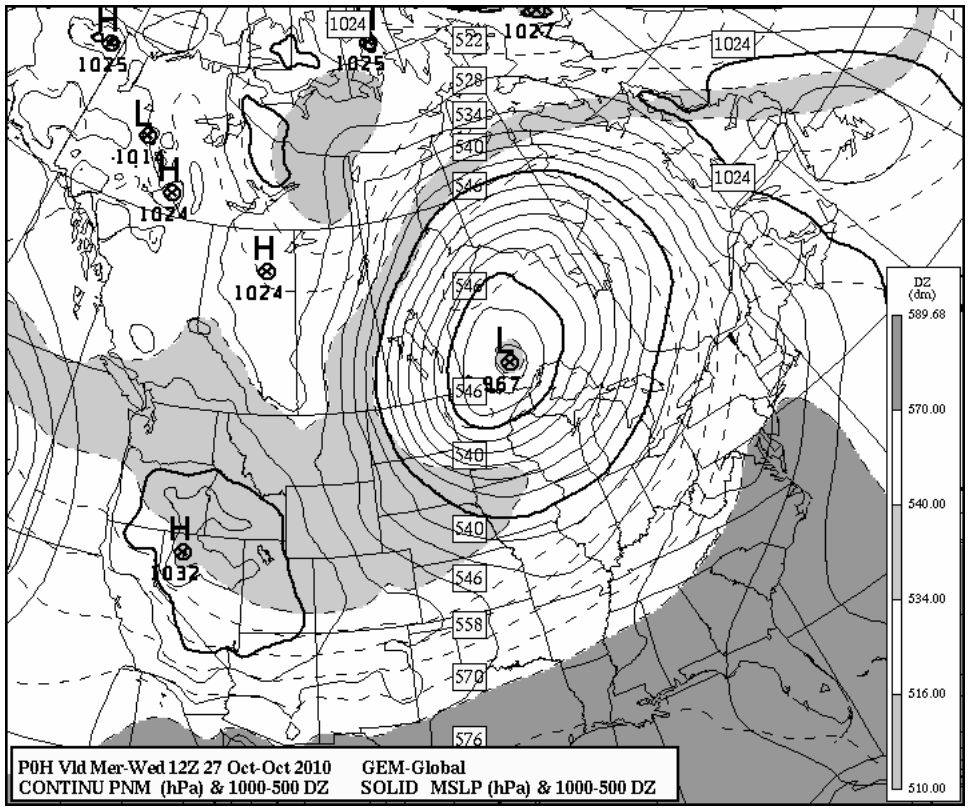

Figure 5: CMC GEM Global 0h prog (i.e. analysis) valid 12Z Oct. 27, 2010. Sea-level pressure and $\Delta z_{1000-500}$ (thickness). The light grey zone marks the $540 - 534$ dam thickness band.

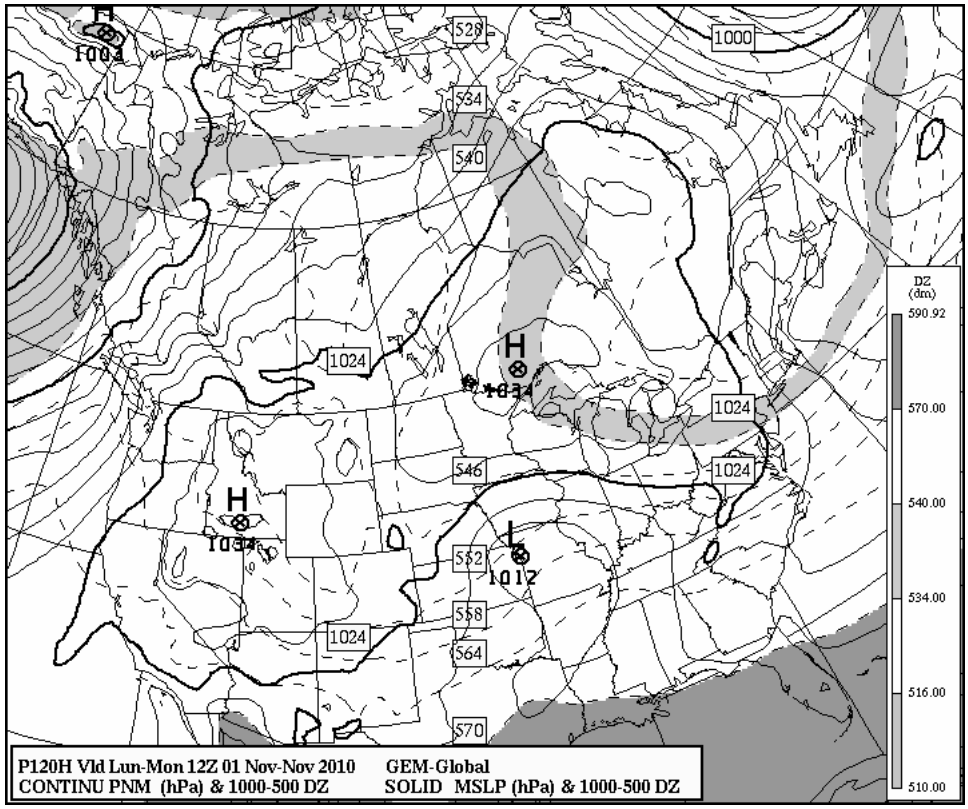

Figure 6: CMC GEM Global 120h prog valid 12Z Mon Nov. 1, 2010. Sea-level pressure and $\Delta z_{1000-500}$ (thickness). The light grey zone marks the $540 - 534$ dam thickness band.