EAS270, "The Atmosphere" Quiz 3 21 Nov., 2011

Professor: J.D. Wilson Time available: 25 mins Potential Value: 10%

Instructions: 15 questions. You may keep this quiz.

1. Which state of the coupled atmosphere-ocean (A-O) system corresponds to a positive ocean surface temperature anomaly in the eastern equatorial Pacific?
   (a) meridional mid-tropospheric flow at southern midlatitudes
   (b) zonal mid-tropospheric flow at northern midlatitudes
   (c) La Nina
   (d) El Nino ✓✓[p258; slide 4, lecture 20]
   (e) Santa Ana winds

2. Which statement regarding the El Nino–Southern Oscillation (ENSO) is correct?
   (a) ENSO is driven "externally" by a change in solar radiative output
   (b) ENSO is driven "externally" when volcanic aersols alter planetary albedo
   (c) ENSO is an "unforced" (i.e. natural or "internal") oscillation of the A-O system ✓✓[p260; slide 12, lecture 19]
   (d) ENSO is a consequence of irregularities in the rotation rate of the earth
   (e) ENSO may be predicted computationally by a model of ocean circulation

3. Which option best states the necessary conditions for a sea breeze?
   (a) Strong land-sea surface temperature contrast, high coastal topography inducing lift
   (b) Strong boundary-layer wind lifted over coastal topography
   (c) High humidity, weak synoptic-scale wind
   (d) Weak synoptic-scale wind, sea surface warmer than land surface
   (e) Weak synoptic-scale wind, sea surface colder than land surface✓✓[p253 & slide 4 lecture 19]

4. The frontal boundary between an advancing cold airmass and the warm airmass has a gentle slope of about 1:100. If one were to move 100 km into the cold air along a line perpendicular to the front, how high above the surface would the front be found?
   (a) 10 m
   (b) 100 m
   (c) 1000 m✓✓[p283; slide 15 lecture 21]
   (d) 10 km
   (e) 100 km

5. The standard MSC (Meteorological Service of Canada) analyses for the mandatory levels provide some information that can identify/locate fronts. Which of the listed *source—clue* associations is **false**?

   (a) surface analysis — temporal pressure trends
   (b) surface analysis — location of trough
   (c) surface analysis — spatial variation of wind, temperature and/or dewpoint
   (d) 850 hPa analysis — belt of tightly-spaced isotherms
   (e) 850 hPa analysis — vertical motion signalling ascent of warm conveyor belt✓✓[MSC 850 hPa analysis *does not give vertical motion*]

6. Which airmass is liable to have the highest lifting condensation level (LCL) in the middle of the day?

   (a) cP
   (b) cT ✓✓[pp276-277; slide 6 lecture 21]
   (c) mP
   (d) mT
   (e) cA

7. Let $A(t)$ be the area at time t of a small element of the 700 hPa surface near P, and let $A(t+\Delta t) = A(t)+\Delta A$ be the area of that element at time $t+\Delta t$. If horizontal divergence is occurring at P, which statement best describes the change ΔA in area?

   (a) $\Delta A = 0$
   (b) $\Delta A > 0$✓✓[slide 7 lecture 24]
   (c) $\Delta A < 0$
   (d) insufficient information provided to determine sign of ΔA
   (e) P must lie downstream of a ridge axis

8. Which statement is **incorrect**?

   (a) temperature advection is synonymous with "baroclinicity"
   (b) in a "barotropic" atmosphere, isotherms run parallel with height contours
   (c) shortwaves only occur in a barotropic region of the atmosphere✓✓[pp312-313; slide 13 lecture 24]
   (d) Rossby wave trough axes coincide with relative vorticity maxima
   (e) where temperature advection is occurring, isotherms intersect height contours

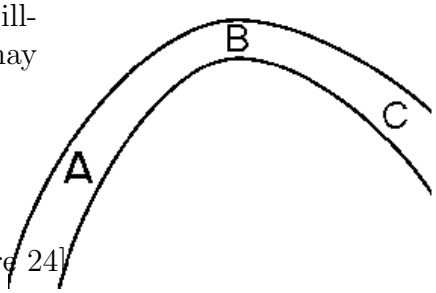
9. The vorticity theorem states

$$\frac{\Delta\zeta}{\Delta t} = -\zeta \text{ div} ,$$

   where "div" is the horizontal divergence and the left hand side is the rate of change of ζ following a parcel of air. Which statement correctly identifies ζ?

   (a) ζ is the horizontal convergence
   (b) ζ is the rate of change of area
   (c) ζ is the earth vorticity
   (d) ζ is the relative vorticity
   (e) ζ is the absolute vorticity✓✓[pp305-306; slide 8 lecture 24]

10. As a parcel of air rounds a northern hemisphere ridge (see illustration of 500 hPa height contours) its absolute vorticity may evolve. Which statement is true?



    (a) from A to B the earth vorticity decreases
    (b) from A to B relative vorticity increases
    (c) absolute vorticity is a maximum at B
    (d) relative vorticity is negative at B ✓✓[p308; slide 6 lecture 24]
    (e) Geostrophic wind speed is larger at C than at B

11. Which statement is **not true**?

    (a) buoyancy in the ocean is determined by both temperature and salinity
    (b) coastlines represent lateral boundaries not present in the atmosphere
    (c) being a gas, the atmosphere cannot exert a drag on the ocean ✓✓[p242; slide 7 lecture 19]
    (d) the ocean surface boundary layer and atmospheric boundary layer both feature a current (or wind) whose direction varies with depth (height)
    (e) the direction of ocean surface currents differs from the surface wind direction

12. According to the Polar Front Theory, genesis of midlatitude storms takes place on a front. Which further factor is now considered essential?

    (a) upper level convergence
    (b) upper level divergence ✓✓[p319; slide 16 lecture 24]
    (c) subsidence in the lee of mountains
    (d) an upslope surface wind
    (e) high relative humidity

For the remaining questions, please refer to the attached weather analyses/charts.

13. On Figure (1) a "trowal" (trough of warm air aloft) is visible in the lee of the Alberta Rockies. What atmospheric process caused this feature?

    (a) subsidence in the lee of the Rockies ✓✓[slide 2 lecture 20 (see also an unnumbered slide of lecture 19 and an unnumbered slide of lecture 21)]
    (b) divergence aloft
    (c) convergence aloft
    (d) a jet stream
    (e) cyclogenesis on the polar front

14. Which statement regarding weather near the point marked **P** on Figure (1) is correct?

    (a) cold advection is occurring
    (b) warm advection is occurring ✓✓[pp312-313; file "advection.pdf" of lecture on 26 Oct.]
    (c) dewpoint temperature is about 8°C
    (d) pressure has changed by 3.2 hPa in the past three hours
    (e) the wind at 850 hPa is calm

15. In reference to the weather situation depicted by Figure (2), weather forecasters noted that an arctic ridge had built down into southern Alberta. An overcast sky producing steady light snowfall was reported at Calgary (i.e. the station in SW Alberta). Regarding the cause of the observed weather at Calgary, which statement is unambiguously supported by the *available evidence* (i.e. Figure 2)?

    (a) Calgary's snow was caused by the storm in the NW territories
    (b) Rising sea-level corrected pressure implies compression, which results in condensation
    (c) "Wedging" of the cold air of the arctic ridge underneath milder air in the south of the province certainly was not a factor
    (d) Calgary's snow was a result of overnight radiative cooling
    (e) An upslope (NNE) surface wind at Calgary was probably a factor ✓✓[unambiguously indicated]

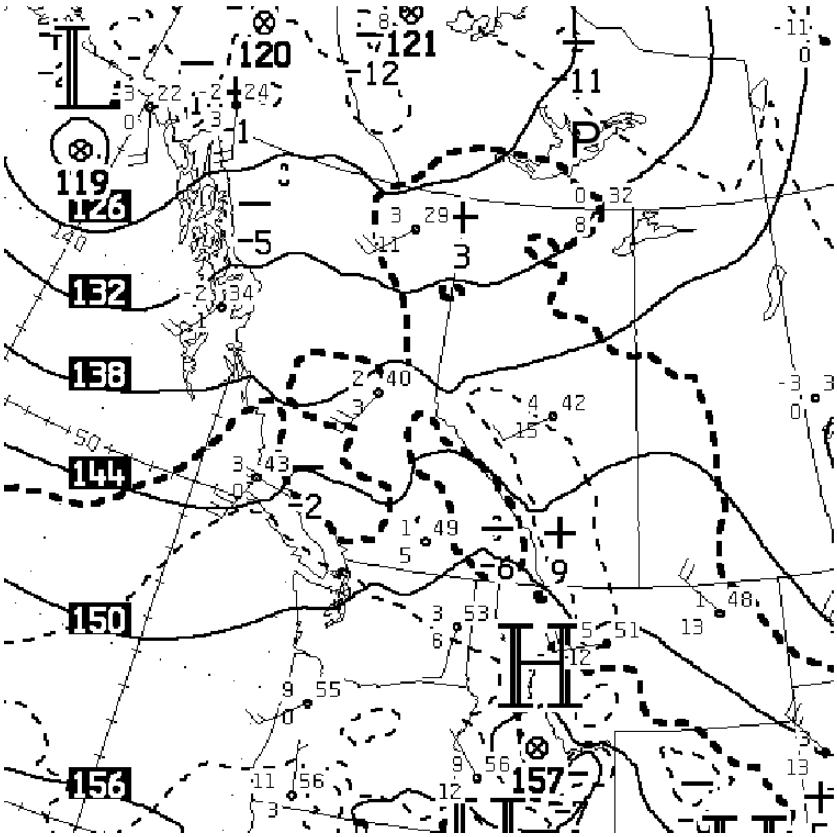


Figure 1: MSC 850 hPa analysis for 12Z on 30 October 2011.

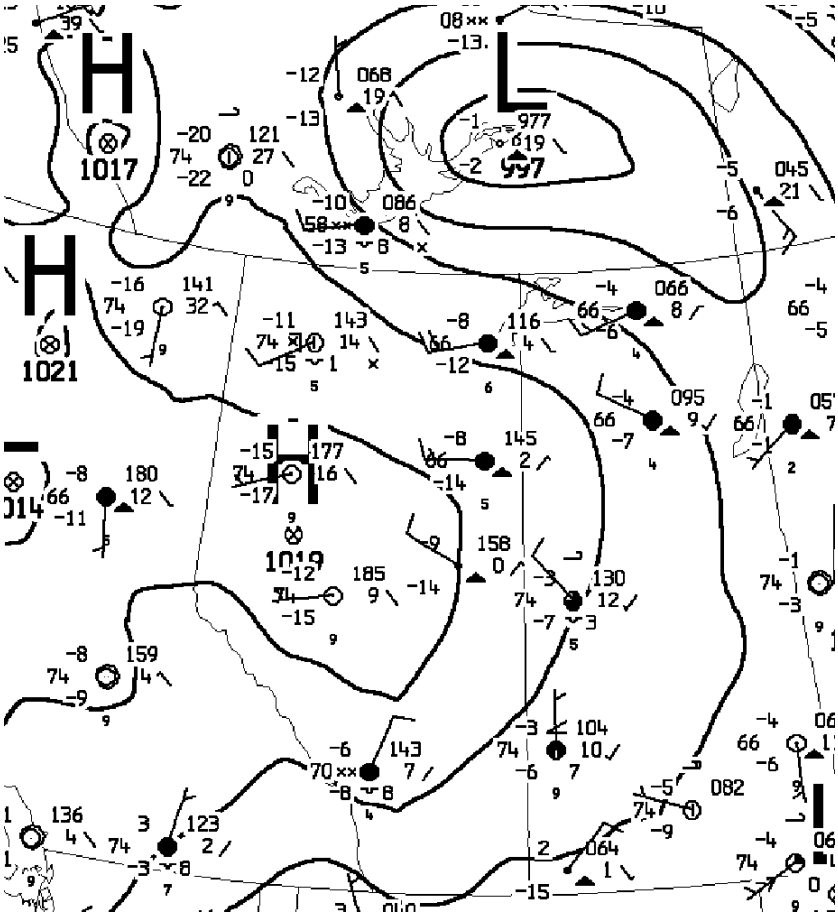


Figure 2: MSC surface analysis for 12Z on 4 November 2011.