ATSC 201 . Fall 2022
Prof. Roland Stull

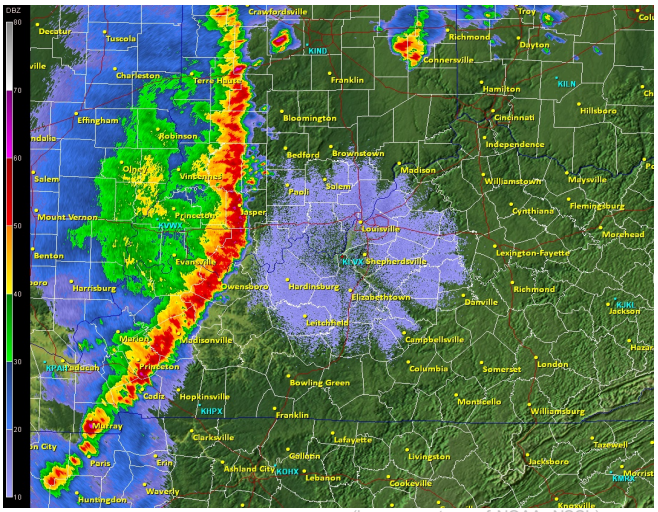
Final Exam
Open books, notes, laptop, ipad, calculator.
Form A

Name: _____

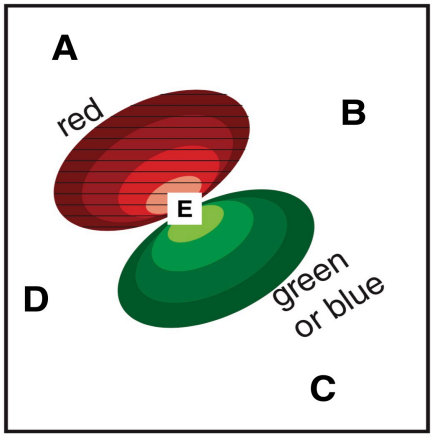
Student Number: _____

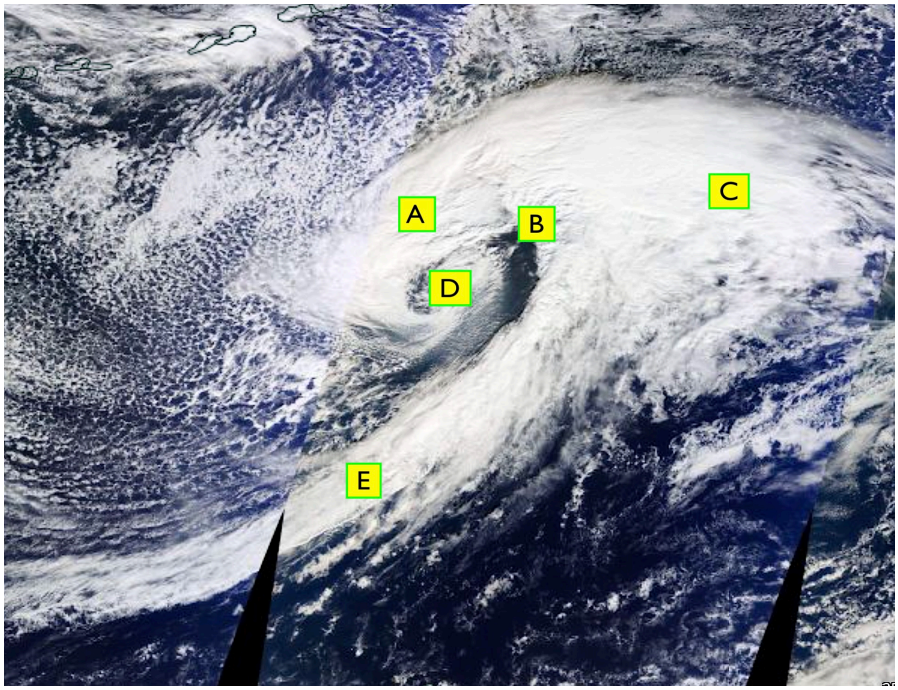
Put your answers on the "bubble sheet", unless otherwise instructed in the question. Turn in ALL question and answer sheets.
120 points total, or roughly 1 point per minute. The bubble sheet will be marked by computer.

Exercise	points	
1	2	The most dominant clouds over UBC at the start of this exam are: A) cirrus, cirrostratus, and/or cirrocumulus B) altostratus and/or altocumulus C) stratus and/or nimbostratus D) cumulus (humilis, mediocris, congestus, or cumulonimbus) E) clear, sky obscured, stratocumulus, or other
2	2	The dominant storm feature in the weather radar reflectivity image at right is: A) Bow echo B) Weakly-forced (airmass) thunderstorm C) Bright Band D) Squall Line E) Hurricane
3	4	A radar reflectivity value of 50 dBZ is how many times stronger than a dBZ value of 30 dBZ? A) 2 B) 20 C) 30 D) 50 E) 100
4	4	If the Doppler radar image at right is showing an anticyclonically rotating supercell thunderstorm centered at location E, then where is the radar likely located? (assume Northern Hemisphere) A B C D E
5	2	Using the satellite image below, the Low-pressure center is likely located at: A B C D E
6	4	Using the satellite image below, warm-frontal clouds are most likely located at: A B C D E



(image courtesy of NOAA NSSL)





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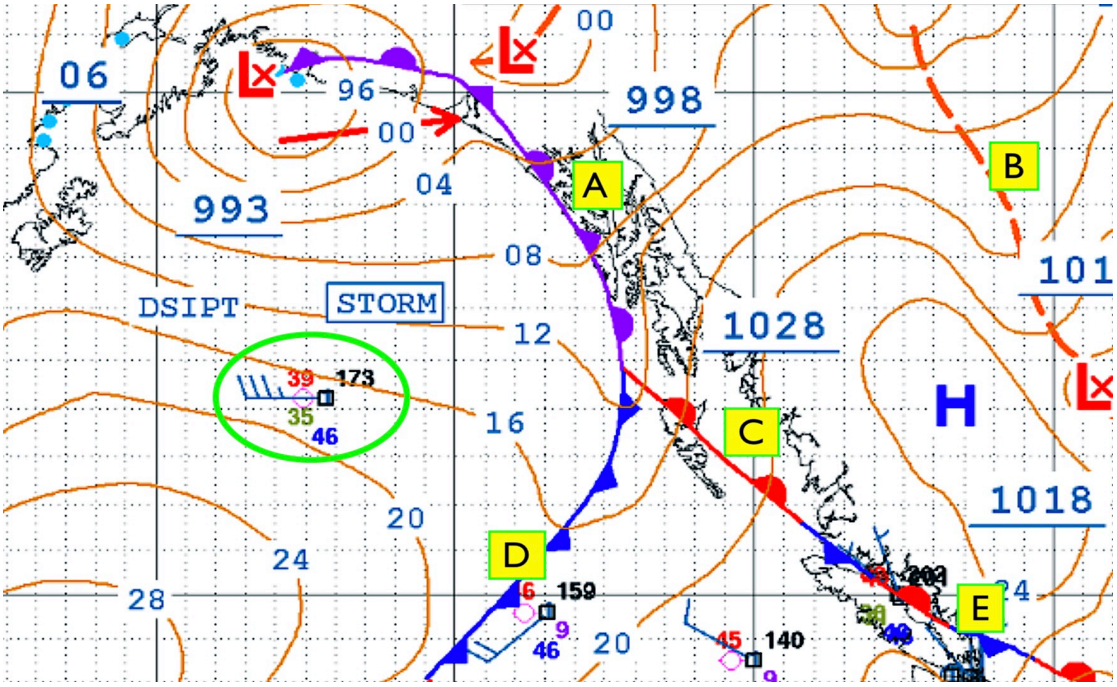

7 [4] In the weather-map image above, a non-frontal trough axis is indicated at which location?
A B C D E

8 [2] In the weather-map image above, a stationary front is at which location?
A B C D E

9 [4] In the weather-map image above, which location is likely to have both stratiform and cumuliform clouds?
A B C D E

10 [4] For the weather observation data circled in green on the map above, which is correct regarding the reported temperature and dewpoint (T, Td). (Note, both are in °F on this map)
A) 46, 39 B) 46, 35 C) 39, 35 D) 46, 17.3 E) 39, 17.3

11 [4] For the weather observation data circled in green on the map above, which is correct regarding the wind direction and speed (alpha, M). Assume the respective units are (knots, °).
A) 90, 35 B) 90, 15.5 C) 173, 35 D) 270, 15.5 E) 270, 35

12 [4] For the weather observation data circled in green on the map above, which is correct regarding the reported pressure P in units of (kPa)?
A) 917.3 B) 91.73 C) 939.0 D) 101.73 E) 1017.3

13 [8] Suppose the sea-level pressure in the eye of a typhoon is 91 kPa, compared to surrounding ambient sea-level pressure of 100 kPa. For an idealized tropical cyclone model, what value of tangential wind speed (Mtan, in m/s) would you expect at a radial distance (R) of 4 times the eyewall radius (Ro)?
A) 15 B) 30 C) 45 D) 60 E) 120

14 [4] Comparing tropical and extratropical cyclones in the Northern Hemisphere, which statement is FALSE?
A) both have low central pressure at sea level
B) both have winds that circulate counterclockwise around the center of the cyclone
C) both require divergence of air aloft to maintain the central pressure at sea level
D) both have warm cores
E) both can be triggered and strengthened by waves in the atmosphere

15 [4] Which corresponds to the fastest surface winds, comparing the Enhanced Fujita (EF) scale with the Saffir-Simpson (SS) wind scale?
A) EF2 B) EF3 C) EF4 D) SS4 E) SS5

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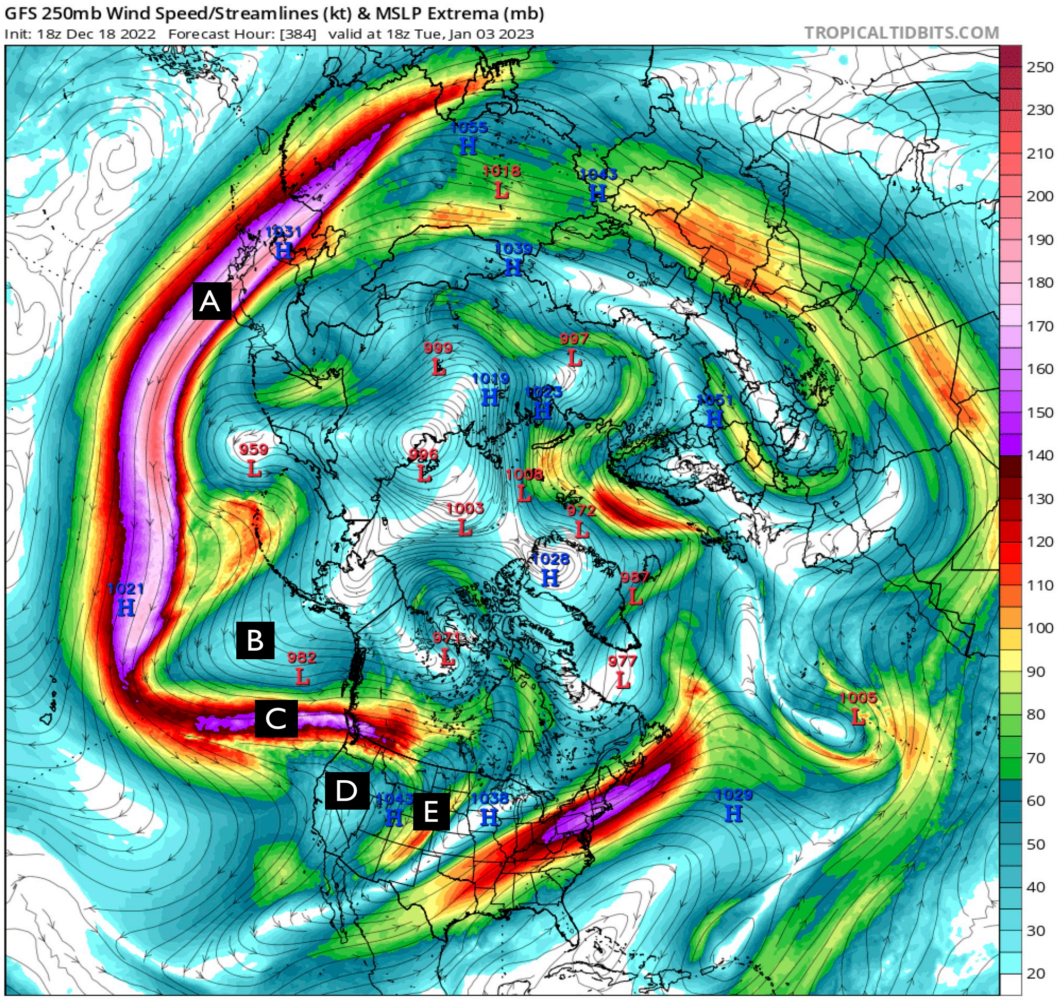

16 [4] For the N. Hemisphere wind & streamline 25 kPa weather map above, mostly zonal flow is at/near
A B C D E

17 [2] For the weather map above, the location of strong north-to-south meridonal flow is at/near
A B C D E

18 [2] For the weather map above, a ridge axis is located at/near
A B C D E

19 [2] For the weather map above, a trough axis is located at/near
A B C D E

20 [2] For the weather map above, a likely location for cyclogenesis is
A B C D E

21 [8] Suppose the geostrophic wind is zero at sea level, and is 100 m/s from the west at z = 10 km altitude.
Assume dry air of temperature 0°C at a latitude where the Coriolis parameter is $f_c = 1 \times 10^{-4}\ s^{-1}$.
The likely horizontal temperature gradient that caused this shear in the geostrophic wind is approximately
A) $\Delta T/\Delta x$ = 28°C/1000km B) $\Delta T/\Delta y$ = 28°C/1000km C) $\Delta T/\Delta x$ = –28°C/1000km
D) $\Delta T/\Delta y$ = -28°C/1000km E) $\Delta T/\Delta z$ = 2.8°C/km

22 [4] If a tropical cyclone were to translate to the equator, then
A) the storm would strengthen, due to the warmer ocean waters there
B) the storm would die, due to the light winds and calm seas
C) the storm would strengthen, due to the Ekman transport in the ocean
D) the storm would die, due to the zero Coriolis force there
E) the storm would strengthen, because it would be fed by moisture from both the N. and S. hemispheres.

Exercise points

23 [4] Weather systems over British Columbia generally move from west to east. The name of the general circulation pattern that causes this is
A) Hadley cell B) Polar cell C) ITCZ
D) Monsoon E) Rossby waves

On the next page are SOUTHERN HEMISPHERE weather maps of sea-level pressure, & surface air temperature.
First, analyze (i.e., draw isopleths on) those maps as specified above each map.
Next, determine the frontal zones, wind directions, fronts, & locations of the max and min of pressure & temperature.
Then, use your analyses to answer questions 24 - 29.
Locations on the map are indicated by their grid cells. For example, the most northwestern grid cell is A1.

24 [4] A mid-latitude cyclone is centered near cell
A) J1 B) E6 C) C10 D) H4 E) C3

25 [4] A frontal zone is near cell
A) J2 B) A5 C) B10 D) H3 E) C4

26 [6] At location F4, the surface wind direction is roughly
A) 330° B) 150° C) 175° D) 250°
E) (no direction, or variable direction, because the wind speed is nearly calm)

27 [6] Cold air advection is happening near cell
A) H2 B) I6 C) G9 D) B6 E) J1

28 [4] At location H9, the clouds you would expect are
A) stratiform B) mammatus C) cumulus congestus or cumulonimbus
D) cumulis humilis or cumulus mediocris E) lenticular

29 [4] A warm front is near cell
A) C4 B) H7 C) E4 D) J4 E) C10

30 [8] At 60°N, a barotropic Rossby wave has a wavelength of 10,000 km. It is embedded within a general circulation with winds from the west at Uo = 20 m/s. Find the phase speed of the Rossby wave relative to the ground (c) .
A) 20 m/s B) 9 m/s C) nearly 0 m/s D) -9 m/s E) -20 m/s

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Pressure (kPa): Draw isobars for 106, 104, 102, 100, 98 kPa.

	A	B	C	D	E	F	G	H	I	J
1	102.5	102.1	102.2	102.5	103.0	104.0	104.6	105.2	106.0	107.0
2	102.3	101.0	101.0	102.0	102.5	103.0	104.0	104.8	105.8	106.0
3	102.1	101.0	100.0	100.2	101.5	102.6	103.0	104.0	104.8	105.0
4	102.0	101.0	99.9	99.0	100.0	101.0	102.0	102.8	103.8	104.0
5	102.0	101.0	99.8	97.8	98.0	99.5	100.7	102.0	102.2	102.4
6	102.0	100.9	99.7	98.0	96.5	98.0	99.0	100.4	101.8	102.2
7	102.1	101.0	100.0	98.5	97.5	97.8	98.0	99.5	101.0	102.1
8	102.2	101.5	100.5	100.0	99.5	99.8	100.0	101.0	101.7	102.3
9	102.5	102.0	101.7	101.6	101.5	101.6	101.7	102.0	102.3	102.5
10	103.0	102.5	102.3	102.2	102.1	102.2	102.3	102.4	102.5	102.6

Temperature (°C): Draw isotherms for +4, +2, 0, -2, -4, -6, -8, -10 °C

	A	B	C	D	E	F	G	H	I	J
1	-2.0	0.3	1.0	1.5	2.0	2.7	3.3	4.0	4.5	5.0
2	-3.5	-2.0	0.5	1.0	1.5	2.0	2.7	3.3	4.0	4.5
3	-4.5	-4.3	-2.0	0.0	1.0	1.5	2.0	2.7	3.3	4.0
4	-5.0	-6.5	-5.0	-1.9	-0.3	0.3	1.0	1.8	2.2	3.0
5	-6.0	-7.1	-6.8	-5.0	-1.8	-1.0	-0.2	0.7	1.4	2.0
6	-7.0	-7.8	-8.0	-8.0	-4.0	-2.2	-1.0	-0.2	0.5	1.0
7	-8.0	-8.5	-9.0	-8.5	-6.0	-4.0	-3.0	-2.0	-1.5	0.0
8	-9.0	-9.8	-10.0	-9.5	-9.0	-8.5	-8.0	-7.0	-6.0	-5.0
9	-10.0	-10.5	-10.5	-10.0	-9.5	-9.0	-8.5	-8.0	-7.0	-6.0
10	-10.5	-11.0	-11.0	-11.0	-10.0	-9.4	-8.7	-8.0	-7.2	-6.7

-- end of exam --