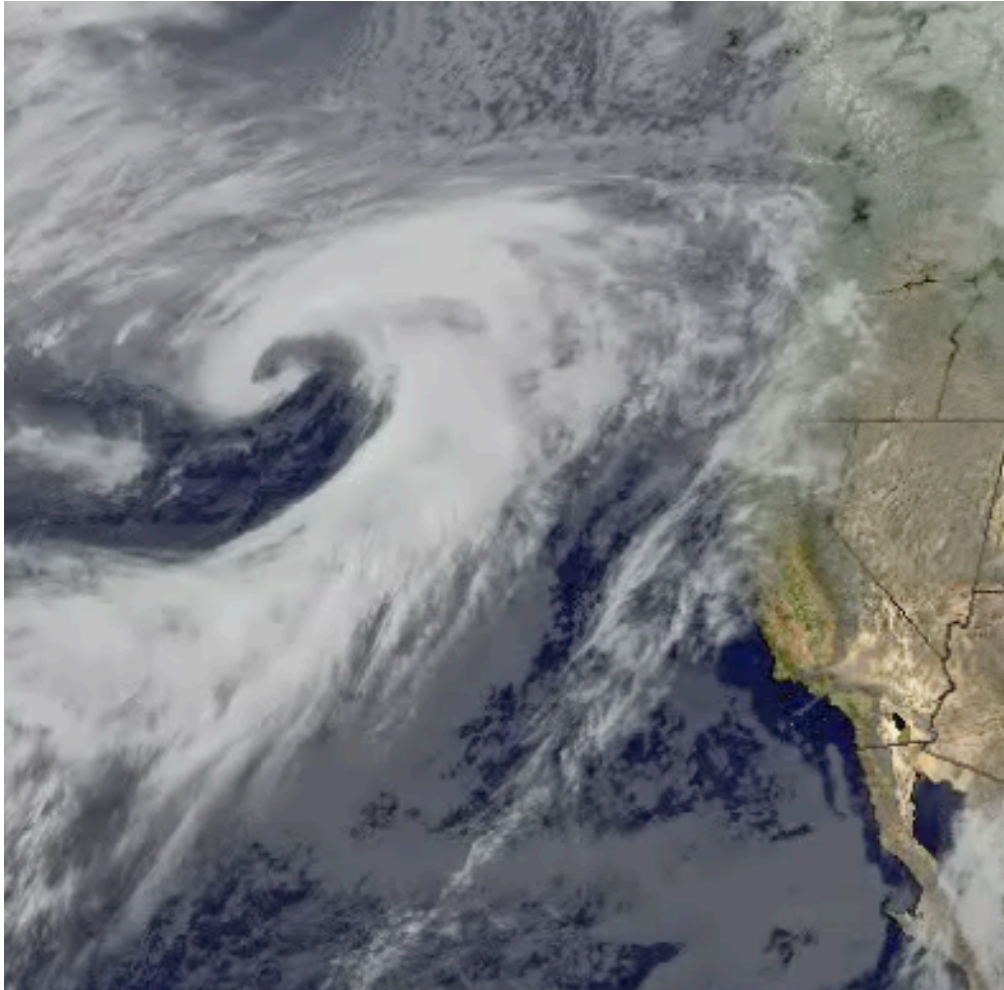


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1. (6 points) For the attached satellite image, showing the Pacific Ocean off the west coast of N. America.
- a) Draw on this image the **fronts** and **pressure centers** associated with this cloud pattern.
 - b) Write on this map the airmass abbreviation that is likely at: (i) top center, (ii) bottom center of the map.



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2. (3 points) a) List **advantages** of a **polar orbiting** satellite relative to a geostationary satellite?

(very short answer):

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3. (2 points) What type of clouds were outside today above UBC just before the start of this exam? Why?

(very short answer):

.....

4. (9 pts). Topic: Rossby waves.

a) What is a Rossby wave? (very short answers)

(b) What causes it?

(c) Why is it important for Canadian weather?

.....

5. a) (1 point) A wavelength of $2 \mu\text{m}$ corresponds to which band (circle one):

[microwave , infrared , visible , ultraviolet , X rays]

b) (8 pts) For that wavelength, if a satellite measures a radiance of $10^{-5} \text{ W m}^{-2} \mu\text{m}^{-1} \text{ sr}^{-1}$, then what is the value of brightness temperature (K)?

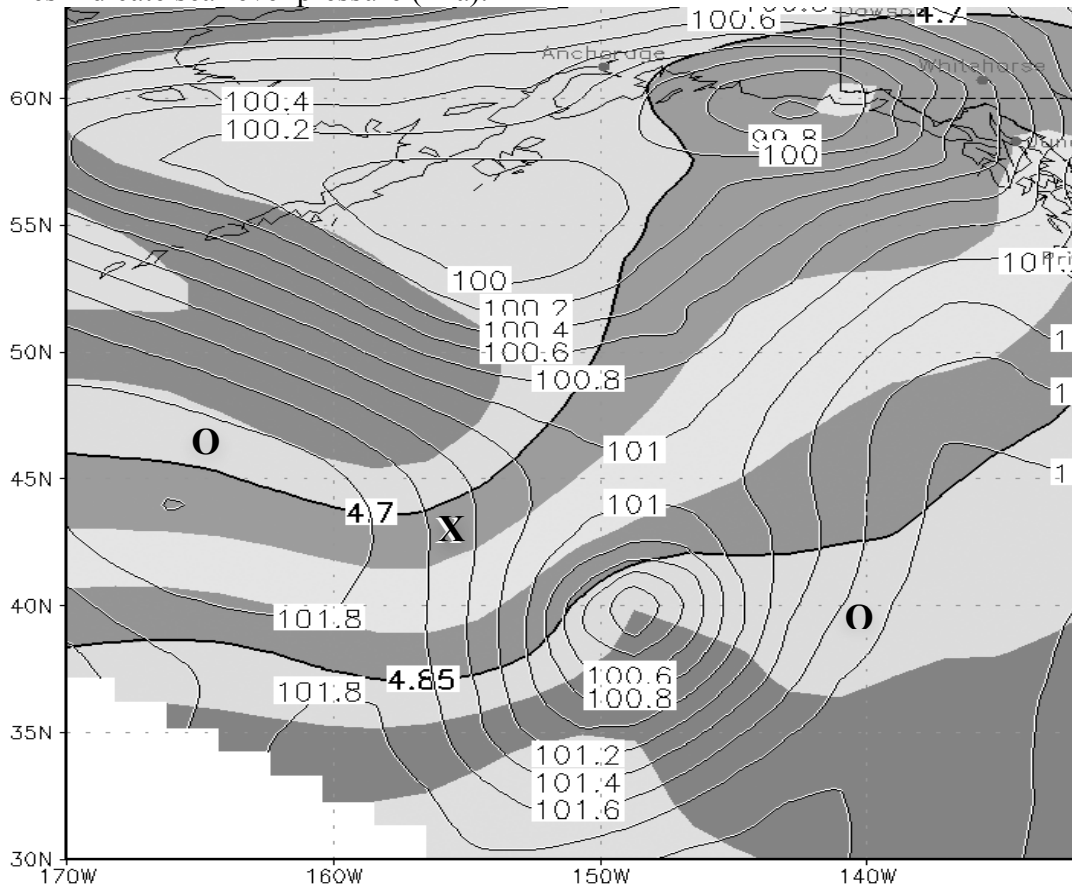
(show your calculations):

c) (3 pts) For that brightness temperature, at what approximate height (km) in a standard atmosphere would you expect to see that temperature?

(very short answer):

.....

6. Given the chart below showing thickness (km) between the 100 to 50 kPa isobaric surfaces. The grey shading indicates bands of constant thickness (colder to the northwest; warmer to the south center). The thin black/white lines indicate sea-level pressure (kPa).



- a) (2 pts) At each of the 2 “O” locations on the thickness chart, draw a thermal wind vector, using longer arrows for stronger thermal winds.
- b) (6 pts) At the “X” on the thickness chart, draw: (i) thermal wind vector (using a solid line for the arrow shaft); (ii) Near-surface theoretical geostrophic/gradient wind vector (using an arrow with a dashed-line shaft), and (iii) with a double shaft arrow indicate the likely geostrophic wind vector at 50 kPa.

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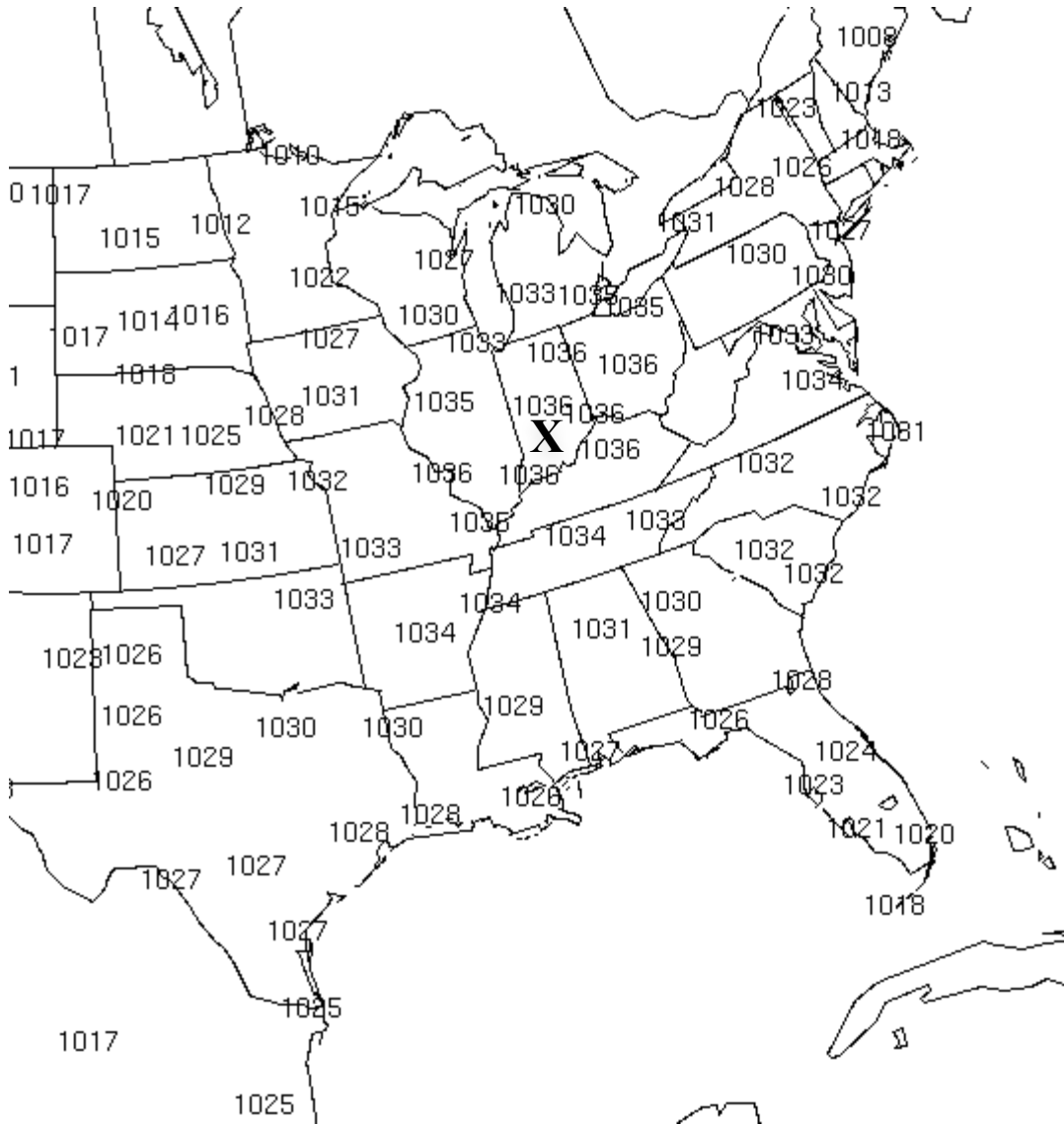
7. (6 pts) Cold air flows through a short gap in the Coast Mountains during winter. The cold air is dry, and has a vertically uniform potential temperature that is 20°C colder than the air above. This cold layer of air is 500 m thick. If the average virtual temperature of that system is 260 K, then what is the maximum wind speed of cold air you would expect to flow through that gap?

(show your calculations):

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8. a) (12 pts) Analyze the isobars on this weather map of sea-level pressure. Note that this map has pressures in units of hPa. Thus 1000 hPa = 100.0 kPa. Draw isobars for $P = 102.0, 102.5, 103.0, 103.5$
- b) (1 pt) Label high-pressure centers with "H", and low-pressure centers with "L", if any.
- c) (3 pts) What weather do you anticipate to be happening at the "X" on the weather map?

(very short answer):



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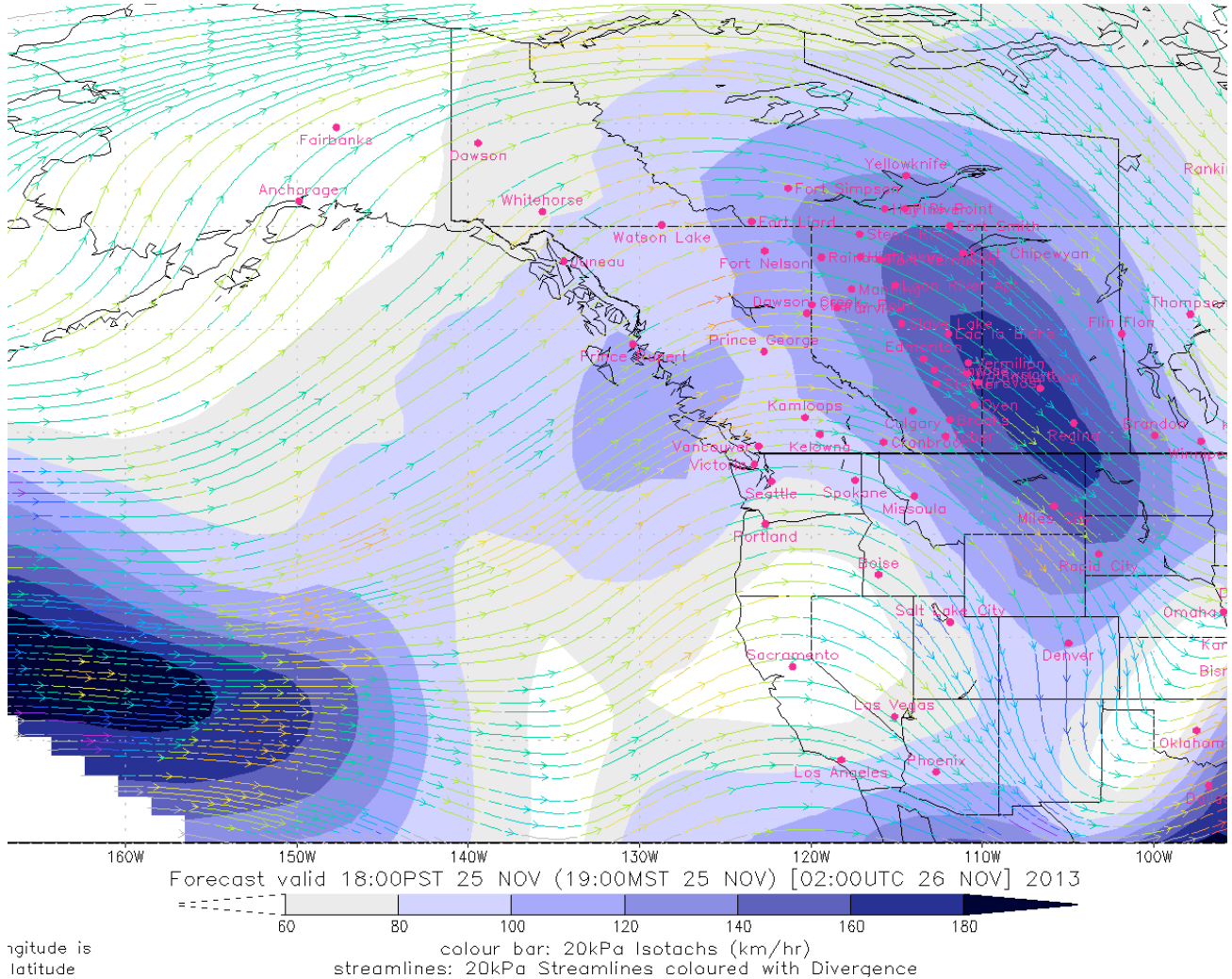
9. (7 pts) At latitude 55°N the beta parameter is $1.31 \times 10^{-11} \text{ m}^{-1} \text{ s}^{-1}$. Given a background jet stream of 50 m/s, what is the speed relative to the ground of a barotropic Rossby wave of wavelength 10,000 km? (show your calculations)

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10. a) (4 pts). On the weather map below showing isotachs (shaded) at the jet-stream level (20 kPa), write the letter "D" at 4 places where you expect the jet stream to cause divergence aloft.

b) (3 pts) Those locations from part (a) favour cyclogenesis at the earth's surface. Why is cyclogenesis NOT favoured at the other locations?

(very short answer):



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11. (4 pts) For hurricanes (typhoons, tropical cyclones):

(a) Why don't they form at the equator?

b) Why is a warm sea-surface needed for hurricanes to exist?

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12. (10 pts) Why does the Earth's atmosphere have 3 dominant circulation bands in the Northern Hemisphere?
(as outline of key points. Not essay.)