Homework–Module 2 Name: KEY

1) The length of day has steadily increased throughout the earth's history. Geological evidence[1] suggests that it was only 21.9 hours 620 million years ago (Mya). In other words, the earth rotated nearly 10% faster 620 Mya. If we assume the earth's atmosphere had the same temperature distribution then as it does now (which it did not), what change in the geostrophic wind speed would you expect 620 Mya ago relative to today's conditions over the middle latitudes? Use concepts of chapter 6 of the textbook to defend your answer. There is a 600-character limit to the fill box of each problem.

Thought progression:
-Same temperature distribution would yield the same pressure field and PGF.
-Same PGF 620 Mya as today would require the same Coriolis force as today to establish geostrophic balance.
-Since Coriolis force is product of earth's rotation rate times wind speed, a 10% faster rotation rate would require a 10% slower wind to produce the geostrophic balance.
-Hence, one would expect slower wind speeds.

The most recent assessment from International Panel on Climate Change (IPCC 2103) states that during the next 20 years (2016-2036; see Fig. 11-10 of AR5-WG1), the average surface temperatures over high latitudes of the wintertime Northern Hemisphere are expected to warm by 3˚C, which is more than any other region of the world. On the other hand, the tropics are expected to warm the least, 1˚C or less. If the IPCC temperature projections materialize, it follows that weather features of the global circulation during northern hemisphere winter would change too. Answer the last two questions based on the IPCC projections.

2) What changes in the intensity (i.e. average speed) of the polar jet stream (increase or decrease) would you expect if the polar troposphere warms 2˚C more than the tropics? Explain your answer using concepts of module 2. Material in chapter 6 of the textbook should prove most useful.

Thought progression:
-More warming in polar regions than the tropics would decrease the north-south temperature difference.
-Weaker N-S temperature gradient would yield a weaker N-S pressure gradient.
-Weaker PGF requires a smaller Coriolis force to establish geostrophic balance.
-Smaller Coriolis force means slower winds.

3) What changes in the intensity and frequency of extratropical cyclones during winter might you expect if the tropics-to-pole temperature difference decreases by 2˚C? Again, explain your answer using concepts of module 2. Material in chapters 6 and 8 of the textbook are needed to answer the problem.

Thought progression:
-Horizontal temperature differences are the energy reservoir from which extratropical cyclones form.
-A weaker N-S temperature means that less potential energy would be available to develop extratropical cyclones.
-It follows that cyclones, on average, would be weaker (ignoring the impact of changes in moisture!) and fewer in number with a reduced temperature gradient.

[1] https://www.scientificamerican.com/article/earth-rotation-summer-solstice/