ATMO 1300 Exam 2 Review

Short Answer

1. What are some of the common surface variables that we measure and how many of them are automated? Describe some of the different instruments used to measure humidity and wind speed.

- Temperature – thermometers – can be automated
- Humidity – hygrometers – can be automated
    - Capacitance, varies with humidity
    - Psycrometer, used the limit of the evaporative cooling of water which varies based on temperature and the amount of water in the atmosphere
    - GPS, uses the change of speed of radio waves
    - Dew point hygrometer, cools an object until dew forms
- Pressure – barometers – can be automated
- Wind direction / speed – anemometers / vanes – can be automated
    - Cup anemometer – uses rate of spin of cups in horizontal wind
    - Propeller anemometer – uses rate of spin of a propeller
    - Sonic anemometer – uses the change in the speed of sound
- Precipitation – rain gauges – can be automated
- Snow depth – Not automated

2. What are the two orbits for satellites? Are they direct or indirect measurements? Active or passive? What are the three most-used types of imagery that we discussed and what do we use each one for?

- Geosynchronis/Geostationary and Low Earth Orbiting
- Indirect, passive
- Visible – reflection of sunlight off ground/cloud tops
- IR – emission of longwave radiation from the earth and clouds, higher clouds = colder temperatures = less emission, occurs day/night
- Water vapor – long wave emission by upper-level water vapor, occurs day/night, useful for upper level flow

3. What about RADAR? What do we “see" with radar and what is the Doppler effect?

- Indirect, active
- We see the backscatter or reflectivity of objects in the air (like raindrops, hail, etc) by radio waves. Larger objects = more backscatter
- Doppler effect: change in frequency of waves depending on the motion of the object emitting/reflecting the wave. An object moving towards you/the radar will emit/reflect waves with a higher frequency. Only applies in motion towards and away, any other motion will not be detected.

4. Describe how the single cell (Hadley) model works. Where do low and high pressures reside? Where is the rising and sinking motion? How does the air at the surface and aloft move, relative to areas of the globe? Why doesn't this model fit in reality?

- Low pressure at the equator, where strong heating produces rising air motions
- High pressure at the pole, where weak heating and poleward moving air begins to sink
- Pressure gradient force from the pole to the equator, at the surface, produces flow at the surface from the poles to the equator. This reverse is true aloft, air moves from the equator to the poles.
- This model doesn't fit in reality because it requires Earth to be covered completely in water, the sun to always be over the equator, and the Earth can't rotate, none of which are true in reality.

4. Describe what happens in the three-cell model of atmospheric circulations. What does this mean for the global distribution of rainfall, surface pressure and surface winds? Where do the jets form? Is this pattern constant or does it change?

- 0 ° - L
  - Light surface winds – **Doldrums**
  - Convection "Hot Towers" which strengthens the pressure gradient – **Inter-Tropical Convergence Zone**, lots of rain
  - Motion spreads outward at the top of the troposphere
- 0 ° -30° (Hadley cell)
  - Strong, warm westerlies aloft from 0°
  - Generally steady easterlies at the surface – **Trade Winds** because air is moving from 30° to 0°
- 30 ° - H
  - Large temperature and pressure gradients aloft – **subtropical jet**
  - Sinking motion – **sub-tropical highs**: warm, weak surface winds, **Horse Latitudes** and deserts
- 30 °-60°
  - Warm **westerlies** at the surface from 30° encounters cold air from the poles
  - Aloft air moves south
- 60° - L
  - **Polar front** at the surface from mix of warm southern air and cold polar air
  - **Polar front jet** aloft
  - Upward motion and rain
- 60 ° -90°
  - Surface **Polar Easterlies** as air move south
  - Aloft air moves north
- 90 ° - H
  - High pressure, sinking air, little precip over poles

- Actual locations/strengths depend on season/land cover

5. What is a Rossby Wave? Why do these matter?

- Large waves in the upper atmosphere
- Aid in redistributing energy
- Also important for forecasting mid-latitude cyclones

6. What are the three atmospheric flow patterns (Rossby waves) we discussed? Describe their orientation and how they contribute or inhibit energy transfer.

- Zonal: West to east orientation which inhibits transfer of energy to/from the poles and equator
- Meridional: More north-south orientation. Allows for warm air to move north and cold air to move south
- Split: Combination of zonal and meridional. Cuttoff lows and highs are still able to transfer energy but not as efficiently as strictly meridional flow.

6. Describe the difference between the different types of fronts. Which types of airmasses are typically involved in this area? In the majority of the US?

- Cold front
    - Cold air advancing on warm air (typically cP on mT in US, sometimes cT here)
    - Decrease in temperature, low pressure along frontal zone, decrease in dew point, gusty winds shift towards the north, shallow "nose" of air, narrow area of clouds along the front
- Warm front
    - Warm air advancing on cold air (typically mT on cP)
    - Increase in temperature, moisture, low pressure along frontal zone, calm winds shifting towards the south, overrunning of warm air over cold air (shallow slope), long region of clouds ahead of the front, move slowly
- Stationary front
    - Boundary between cold and warm air that is not moving (typically mT and cP, often cT here)
- Occluded front
    - Cold air advancing on cool air (cP)
    - "Cold front catching up to a warm front"
    - Warm air displaced upward
- Dry line
    - Boundary between dry and moist air (cT and mT)
    - Location varies a lot with day/night
    - Moving east: decrease in dew point, winds shift towards the west, decrease in clouds, may have convection along the boundary

7. What two requirements are needed to create the source region for an air mass? How are air masses modified as they move away from source regions?

- A uniform surface and light winds
- Modification may occur as heat/moisture is exchanged with the underlying surface and/or mechanical lifting

8. Describe the lifecycle of an Extratropical Cyclone according to the Norwegian cyclone model. Where in the US do these cyclones form?

- Birth/Cyclogenesis
  - Cyclonic wind shear along zonal front causes kink in flow
  - Frontal wave
- Deepening / Young Adult
  - Fronts are strong but no occlusion: open wave
  - Baroclinic instability, strong jet, mountains
  - Warm sector between cold and warm front
  - Lowering pressure of the cyclone
- Mature
  - Occluded Front
  - Lowest pressure and strongest winds
- Death
  - Occlusion cuts off the center from warm sector air
  - Pressure begins to rise
- Eastern slope of the Rockies (Alberta Clippers in Canada that hit the Great Lakes, Panhandle Hooks over TX/OK), Great Basin, Gulf of Mexico, Carolinas (nor'easters)

9. What are the layers of the ocean? Why do we care what the ocean is doing? What type of currents do we see around North America? Which transport warm water?

- Surface layer, Thermocline, Deep Layer
- Also redistributes energy, large impact on weather
- California current (cold), Gulf Stream (warm), Loop Current (warm), Labrador Current (cold)

10. Describe the areas of a hurricane and the overall motion of air. Where are the strongest winds? The highest surge? Tornado development?

- Eye – low pressure in the center sometimes with sinking motion, clear
- Eye wall – most intense region of convection around the eye
- Outer rain bands – other convection surrounding the hurricane
- Winds – strongest in the eyewall and on the right side of motion
- Surge – strongest on the right side of motion
- Tornadoes – mostly in the outer rain bands

11. What are the stages of development of a hurricane? What requirements need to be met for it to get a name? How do we rate hurricane?

- Disturbance – region of convection but no significant low pressure
- Depression – closed circulation, numbered
- Storm – winds at least 39 mph, named
- Hurricane – winds at least 74 mph, rated by wind speeds on the Saffir-Simpson scale

12. How do monsoon circulations form? What are the two common "stages" of the circulation?

- Thermal lows (lows due to strong heating of the earth's surface) "pull" in warm, moisture air from the ocean over the already unstable land surface.
- Winter and summer monsoons have different pressure characteristics that determine how the air flows. During the winter, cold air temperatures over land will dictate that high pressure is entrenched. Generally, there is lower pressure towards the equator so air will flow from the land surface out over land. During the summer, the process listed in the above bullet is present. Heating induces low pressure over land and air flows from the ocean over land and can be lifted due to strong convection processes, helping to produce clouds and precipitation.

13. What is upwelling? How does it impact economies of coastal regions? What ENSO cycle is it most common with?

- Upwelling is the process of colder, deeper ocean waters replacing surface ocean water near coastlines, especially the western coasts of land-masses (eastern portions of the ocean).
- Deeper ocean waters are rich in nutrients for plant/fish life. Without upwelling, those organisms don't receive the feed they need.
- It is most common with La Nina, when trade winds relax due to a reduced PGF across the Pacific, and surface water along the coasts is not transported away from the coasts as much.

Fill in the Blank

14. We use **radiosondes** to take direct measurements of the upper atmosphere.

15. **Passive** sensors just receive energy while **active** sensors both transmit and receive energy to take **indirect** measurements.

16. Global circulations result from the **uneven** heating of the Earth's surface.

17. The single-cell model also known as the **Hadley cell** has an energy **surplus** at the equator with **upward** motion and **low** pressure at the surface, resulting in **northerly** surface winds between the poles and the equator in the Northern Hemisphere. The does not occur in actuality because of the **Coriolis** force.

18. The **ITCZ** is a region of low pressure and rising motion, resulting in a large area of precipitation near the equator. Near this region there are also **calm** surface winds which are referred to as the **Doldrums**.

19. **Monsoon** circulations, which commonly bring rain to a region, are caused by **thermal lows**.

20. Winds tend to increase with **increasing** altitude and **increasing** latitude. There are also stronger winds during the **winter** season when temperature and pressure changes in the horizontal are **greater**.

21. **Zonal** flow is wind which flows **west-east** and results in cold air staying poleward. **Meridional** flow transports more energy. **Split** flow is a mix of the two.

22. **Shortwaves** are embedded in **Rossby** waves and are packets of energy and vorticity that may act as a foci for severe weather.

23. A dry air mass is called **continental**, while a moist air mass is called **maritime**. Warm air masses are **tropical**, cold air masses are **polar** and extremely cold air masses are **arctic**.

24. The **deepening or young adult** stage of a cyclone happens when there are warm and cold fronts, separated by the **warm sector**, but no occlusions.

25. A cyclone typically has the lowest pressure and highest winds in the **mature** stage, characterized by the presence of an **occluded** front.

26. An intensifying low pressure center tilts **westward** with height, because that signifies **more** divergence aloft.

27. The strongest winds in the jet stream are called the **jet streak**.

28. **Vorticity** is a measure of rotation in the atmosphere. **Positive** changes with time aloft are associated with upward motion and upper-level **divergence**.

29. A **gyre** is a large oceanic current, which rotates **clockwise** in the northern hemisphere.

30. **Upwelling** occurs when cold water below the surface of the ocean is brought to the surface. **El Nino/La Nina** is a large climate event which is determined by the amount of this process in the **Pacific** Ocean.

31. **Hurricanes** are intense tropical cyclones.