**Forecasting problem for ATMS 410, Fall 2023; Seasick in the Pacific**

Background:

A freighter ship carrying a valuable cargo of seafood has left the Port of Tacoma and is headed for a port on the eastern shore of Japan. Unfortunately, an oceanic cyclone has developed near Japan and could potentially threaten the ship. The owner of the ship is soliciting strategies for maximizing profits under difficult weather conditions. The ship is currently located at 45oN, 170oE and is seeking to reach the port at 35oN, 140oE. Under “ideal” conditions, the ship (moving at a top speed of 50 km/h) can reach the port from this location in 56 hours. Your job is to forecast the track of the oceanic cyclone, whether or not the cyclone intensifies, and map out the optimal route to “maximize profits” for the ship owner.

The challenges are primarily caused by wind and waves. Wind speeds exceeding 15 m/s create huge waves that can sink the ship in six hours when the bilge pumps are working at full capacity. Hence, you’ll want to choose a route in which the ship is not in a region experiencing winds greater than 15 m/s for more than six hours. Also, a headwind slows down the ship from its top speed of 50 km/h and a tailwind can help the ship to move faster than its top speed. If the winds are blowing opposite to the direction that the ship is headed (headwind) at 30 km/h, the ship will only be able to move at a surface speed of 20 km/h. Assume that a wind blowing across the ship (perpendicular to its heading) has no impact on the ship course or speed.

Finally, the seafood cargo has a limited “shelf life” and is only marketable if it remains at sea for less than 76 hours from the ship’s initial location. If the ship reaches port 76 hours after departing from its initial position, the trip ends up with no profit. Each hour beyond the 56 hour trip from the initial ship position eats up $30,000 in profits.

Tools:

You’ll be using the approximate form of the Petterssen Development Equation as the basis for making your oceanic cyclone track and intensification forecast. Unfortunately, the numerical guidance (model output) available had some “gaps” in the data fields due to a power outage and your private forecasting company has access to only a few hardcopy maps. As you’ll find posted on the course web page, you have access to the predicted 500 hPa wave from the initial time (1200 UTC Day#1, F00) through the final time (0600 UTC Day#2, F42) available every six hours with various fields overlaid on the 500 hPa maps. You also have various 1000 hPa maps available *only at the initial time*.

You have maps of the advection of geostrophic absolute vorticity (GAVA), and maps ***related to*** the laplacian of thickness advection (LTHAD), the laplacian of adiabatic heating/cooling (LAD), and the laplacian of diabatic heating/cooling (LDIA). You can calculate GAVA and ‘nearly’ LTHAD exactly (at the predicted position of the 1000 hPa cyclone center), multiplying the latter (‘nearly’ LTHAD) by “g/*f* ” to get LTHAD and you can determine the sign (“+” or “”) of LAD and LDIA. Assume that the absolute magnitude of LAD is always 85% of LTHAD and that the absolute magnitude of LDIA is always 70% of LAD. Also, assume that the static stability parameter is everywhere a positive **constant**.

Maps posted on the final project web site are Mercator projection having the following limits (lower-left lat/lon, upper-right lat/lon) “20;105;65;-165” and have been plotted via GARP. Labels located just above the map links on the final project web site should be considered accurate, while those at the bottom of the GARP maps are NOT always an accurate description of the plotted fields.

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The winning proposal:

Your optimal route will be evaluated according to monetary and scientific standards. The monetary standard will rest solely on how much profit your route “wins” for the ship owner. The monetary standard is secondary to the scientific standard. The anticipated profit is meaningless if the optimal route assumptions are based on a bad weather analysis and forecast. The scientific evaluation will depend on how well your private forecast company:

(1) estimates the 1000 hPa geostrophic relative vorticity tendency (GRVT)

(2) converts 1000 hPa GRVT into a 1000 hPa geopotential height tendency at the 1000 hPa cyclone center [Project#9 case study may help calibrate this conversion]

(3) predicts the track of the 1000 hPa cyclone center

(4) how the changing intensity of the cyclone impacts near surface wind speeds in the cyclone [geostrophic balance assumption might help with this, assume that the actual wind speed is 90% of the geostrophic wind speed]

(5) near surface wind impacts

a. impact of headwinds/ tailwinds on ship speed

b. impact of wind-forced waves on ship survivability

Each group can submit only **one** solution as a part of your optimal ship route proposal. Good luck!!

🡪 Written report of *no more than* ten pages (double-spaced) containing a description of your solution including your projected profits for the ship owner and the methodology and results addressing scientific issues (1)-(5) above, to be written by the non-presenting member of your group.

🡪 A 15 minute PowerPoint presentation describing your solution (“making the pitch!”). Two members (one member) of each group participate(s) in the presentation for groups having three (two) members. A part of every winning “pitch” is to directly address doing something (the profits realized by buying into your analysis, prediction, and recommended optimal ship route) rather than doing nothing (the cost of sailing directly from the initial ship location to the Japanese port).

<http://www.youtube.com/watch?v=Q8jhb5NnADM>