Assignment 5: Air Transportation Systems Analysis

Date Due: October 5, 2020 Instructor: Trani

Problem 1

Use the data for the transport aircraft similar to the Boeing 787-8 (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m) to answer the following questions.

a) Calculate total drag produced by the aircraft at three speed conditions at FL 380: a) Mach 0.78, b) Mach 0.81 and c) Mach 0.83. Assume straight and level flight conditions and the mass of the vehicle is 205,000 kg. Assume ISA atmospheric conditions in your calculations.

b) Estimate the fuel consumption for each flight condition given in part (a).

c) Estimate the parameter L/D for the three conditions in part (a). Comment on the observed trends.

d) Find the optimal (L/D * M) value (M here is the true mach number) for this aircraft cruising at FL380. The factor L/D * M is an important parameter to estimate the maximum range for a turbofan engined aircraft.

Problem 2

Use the data for the transport aircraft similar to the Boeing 787-8 (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m) to answer the following questions.

a) Use the Breguet Range equation to estimate the maximum cruise range of the aircraft at FL370. Assume the aircraft arrives the Top of climb point TOC point with a mass of 215,000 kgs and the fuel available at that point for cruise is 77,000 kilograms (i.,e., mass at TOD would be 138,000 kg). Use the cruise mid-point aircraft mass to calculate the L/D ratio used in the Range equation.
b) Improve the solution to part (a) by performing a numerical analysis similar to that shown on page 83g of the Aircraft Performance notes 2. Use eight cruise segments in your refines analysis. Tabulate the fuel consumptions and aircraft mass at each point in the numerical calculation.
c) Compare the range estimates of part (a) and (b). How accurate is the Breguet range equation using the mid-point method?

Problem 3 (For CEE 5614 Students Only)

Use the Boeing 737800 class aircraft file from the web site (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m). An airline performs a flight from Santo Domingo, Dominican Republic to New York (JFK) (see Figure 1).

a) Use the unrestrictedClimbAnalysis.m Matlab script to estimate the mass of the aircraft at the Top of Climb (TOC) point. The aircraft takeoff weight is 74,000 kg. which includes 19,000 kg of fuel. Use the default climb speed profile provided in the aircraft data file. Use ISA+15 atmospheric conditions in your climb calculations (Santo Domingo has summer temperatures well above ISA conditions). Select the TOC altitude (1,000-foot intervals allowed) so that the aircraft at the TOC point has an initial 400 ft/min climb capability at the TOC point. Find the fuel used to reach the selected TOC altitude.

b) Estimate the fuel used in cruise for this flight if the airline dispatch office recommends cruising at Mach 0.78 cruise Mach Number. Assume the cruise altitude does not change. For this calculation assume the pilot estimates starting the descent 135 nm before arriving to New York (this allows you to calculate the cruise distance).

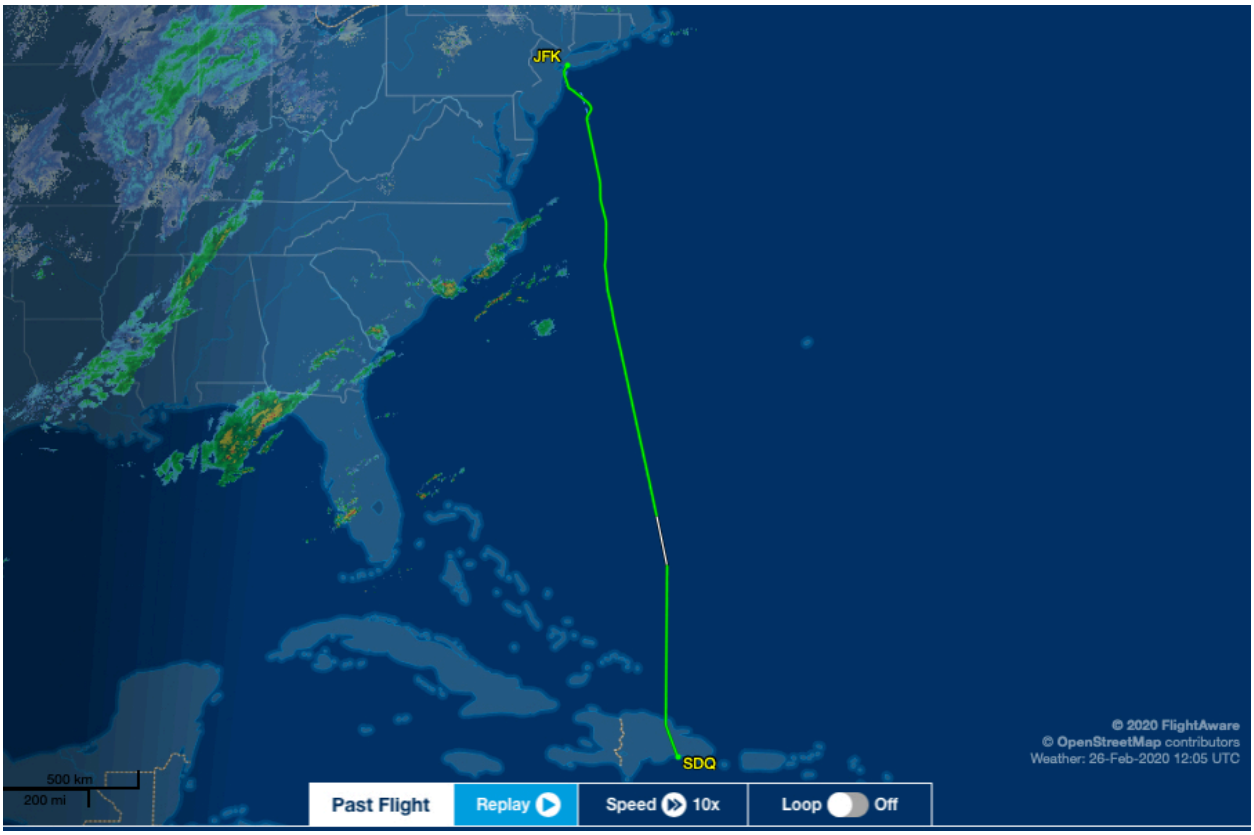

Figure 1. Sample Flightware Flight Track from SDQ to JFK.