ASEN5050 - STK Lab #1
Due 11 am October 1, 2015

Name: John Clouse

All partners' names: ______________________________

You will need to download grace.tce to complete the lab. Find it here:
(Note: be sure to save-as .tce)

http://ccar.colorado.edu/ASEN5050/ASEN5050/STK_files/
(ignore the other files, many are not up-to-date)

Set Epoch

Open STK 10 and create a new scenario by clicking "Create a Scenario" or choosing (**File -> New**).

Enter name and description in **New Scenario Wizard**. Select location to save scenario. It is important to save each individual scenario in its own directory to avoid file conflicts!

(if you closed the "New Scenario Wizard", then select the scenario in the Object Browser and hit its Properties menu to modify the following:)

Enter the following data for the timeframe:
Start: 12 Sept 2014 00:00:00 UTCG
Stop: 13 Sept 2014 00:00:00 UTCG
Click OK.
Wait for STK to launch the scenario, which may take a minute.

Note: it is a good idea in STK to save. Save frequently, and be sure that this scenario is in its own directory! Get into this save-often habit.

Create Ground Stations

Use the initial "Insert STK Objects" pop-up box to insert four Facilities (or select **Insert** under the main menu and click **New)**. In the object catalog, select "Facility," then choose "Insert Default" from the right column. Finally hit the button "Insert…" to insert it. Repeat this for a total of 4 ground stations, and rename them to match the list below. Then double-click each facility, select **Basic**, and enter the Geodetic coordinates given (be sure altitude units are in meters).

a) Baikonur Cosmodrome	Lat: 45.63°	Lon: 63.26°	Alt: 0 m
b) Perth	Lat: -31.80°	Lon: 115.89°	Alt: 22.16 m
c) Madrid	Lat: 40.44°	Lon: -3.95°	Alt: 664.42 m
d) KSC	Lat: 28.45°	Lon: -80.55°	Alt: 0 m

Create Satellites

a) Create two satellites from orbital elements.

Add a satellite in the browser by selecting the "Insert" option of the top menu, selecting "New…" and then selecting "Satellite" in the Scenario Objects field on the left. There are many ways to insert a satellite, select "Define Properties" and hit "Insert…".

This will likely bring up the satellite's Properties menu. When you get a chance, rename the satellite by right-clicking on the satellite in the main Object Browser of the scenario (not the pop-up menu). Call it "LEO"

If you close the Properties pop-up menu, you can re-open it by double-clicking the satellite. In the pop-up menu, bring up the "**Basic**/**Orbit**" sub-menu. Set the following options, or make sure that they are already set properly:

- Propagator: TwoBody
- Coord Type: Classical (i.e., Keplerian two-body orbital elements)
- Coord System: ICRF
- Orbit Epoch: 12 Sept 2014 00:00:00.000 UTCG

Set the following orbital elements:
$a = 6788.137$, $e = 0.01$, $i = 28.5$, $w = 0.0$, $\Omega = -80.55$, $\nu = 0$
Hit OK.

A ground track should appear in the 2D Graphics window; the orbit should appear in the 3D Graphics window. If they don't, hit the red "Reset" button in the time-controls bar of the menu (next to the Play, Pause, etc. buttons!).

1. Use this space to calculate the period of the orbit

   sqrt(6788.137^3/3.986e5)*2*pi = 5565.9 sec

What is the period calculated by STK (in sec)? 5565.92 sec

Note: STK offers many ways to get this data. One easy way is to look in satellite's Properties window (where you just inputted the orbit), and change the Semi-Major Axis to Period.

2. Use this space to calculate the r_p of this orbit:

   rp = 6788.137*(1-0.01) = 6720.3 km

What is the r_p calculated by STK (in km)? 6720.26 km

Note: Same note as above, but now change the Eccentricity to Perigee Radius.

Now add another satellite to your browser. We will use the same coordinates from Homework 3, so call it **HW3**. In the **Basic/Orbit** tab, select **Cartesian** as the Coordinate type with ICRF as the system. Enter the Cartesian coordinates:

r = [-5633.9, -2644.9, 2834.4] km, v = [2.425, -7.103, -1.800] km/s.

Animate your satellites using the time controls in the top menu bar.

3. In your homework, you calculated (or will calculate) the orbit's classical orbital elements (pre-populated below). How do these compare to the values calculated by STK? This time, use another tool from STK to get these answers. Right-click on "HW3" and select "Report & Graph Manager…". With HW3 highlighted in the upper-left, generate a Report (or Graph, Dynamic Display, whatever!) about the Classical Orbit Elements. If you change vx (x-velocity) to 2.4 km/s, how does this affect your results? What if you change vy to -7.0 km/s (changing vx back to 2.425 km/s)?

Element	*HW3*	*STK*	*STK, vx = 2.4*	*STK, vy = -7.0*
a	6993.499 km	6993.50 km	6978.73 km	6819.69 km
e	0.0221145	0.022114	0.020279	0.005556
i	28.402 deg	28.40 deg	28.45 deg	28.43 deg
RAAN	82.522 deg	82.52 deg	82.36 deg	82.43 deg
AoP	118.251 deg	118.25 deg	110.56 deg	240.15 deg

b) Create two satellites using the Orbit Wizard.

You can either "Insert" a satellite via the Orbit Wizard, or you can add a satellite in any way, and then call up the Orbit Wizard to redefine it via the "Satellite" main menu. Create a Sun

Synchronous orbit with an altitude of 500 km and a local time of descending node of 12:00:00.00 HMS. Name the satellite **SunSync**, and click OK.
Double-click the **SunSync** satellite. Under the **2D Graphics/Lighting** tab, turn on Sunlight and Penumbra. Close this. Now, go to the 3D Graphics window, select the **Globe Manager**  button in the upper-right part of the 3D Graphics menu. Right-click **Earth**, select **Solar** and activate Subsolar Point, the Solar Terminator, and Penumbra. In the 3D Graphics window, a dot representing the sun should appear, and a yellow line should indicate the terminator. Animate the scenario and watch the **SunSync** satellite.

1. Can you see why this orbit is called "sun synchronous"? Describe how the geometry between the SunSync satellite's orbit and the Sun's vector changes or remains constant.

   The satellite always passes at local noon or local midnight. The orbit plane remains constant wrt the sun vector.

Use the Orbit Wizard to create a satellite named **Molniya** that has a molniya orbit with an apogee longitude of -100 deg and a perigee altitude of 550 km. Hit OK. Animate the scenario.

2. What is the inclination of the Molniya satellite's orbit? 63.32 deg

3. What is the difference between its r_p and r_a? 46178 - 6928 = 39250 km

4. Why is the Molniya orbit special? Look at its ground track.

   It spends a lot of time over two northern-hemisphere locations

(Save!)

c) Add the Hubble Space Telescope from the STK satellite database.

With your scenario highlighted in the object browser window, click the **Insert** Menu and select a Satellite from the **Standard Object Database**. In the Satellite Database window, activate the Local tab, turn on the **Common Name** option and type **Hubble*** in the text box to the right of the field. Click the **Search**... button. Select the satellite and click insert to create it. The browser and map windows should be updated automatically (Hit the reset button).

Back in the "Local" tab again, notice the "Advanced Filter" button. Using the Satellite database **Advanced Filter**, answer the following questions:

1. How many Mexican satellites (including inactive) are in the database? The Owner of these satellites is labeled "MEX". You should find more than 6. 6

2. What is the name of one or more ESA navigation satellites? GALILEO IOV-1

GALILEO IOV-2

Importing Element Sets and Visualization

Create a new Default satellite and name it "Grace". Access the satellite **properties** (double click or right click). Under the **Orbit** tab change the propagator to **SGP4.** Identify the satellite by searching the STK database – select **Grace-1**. Now change the TLE source to **Define/Import Elements.** Find and add your downloaded grace.tce file and select OK. Select **3D Graphics** window and select the "eye" button identified as *View From/To.* Change your viewer position to satellite's perspective and view its path around the earth (perspective: from Grace to Grace). Do this by choosing the satellite's name under **View From** and clicking **Apply**. Animate your satellite and adjust the perspective using your mouse. Zoom in and take a look at the model!

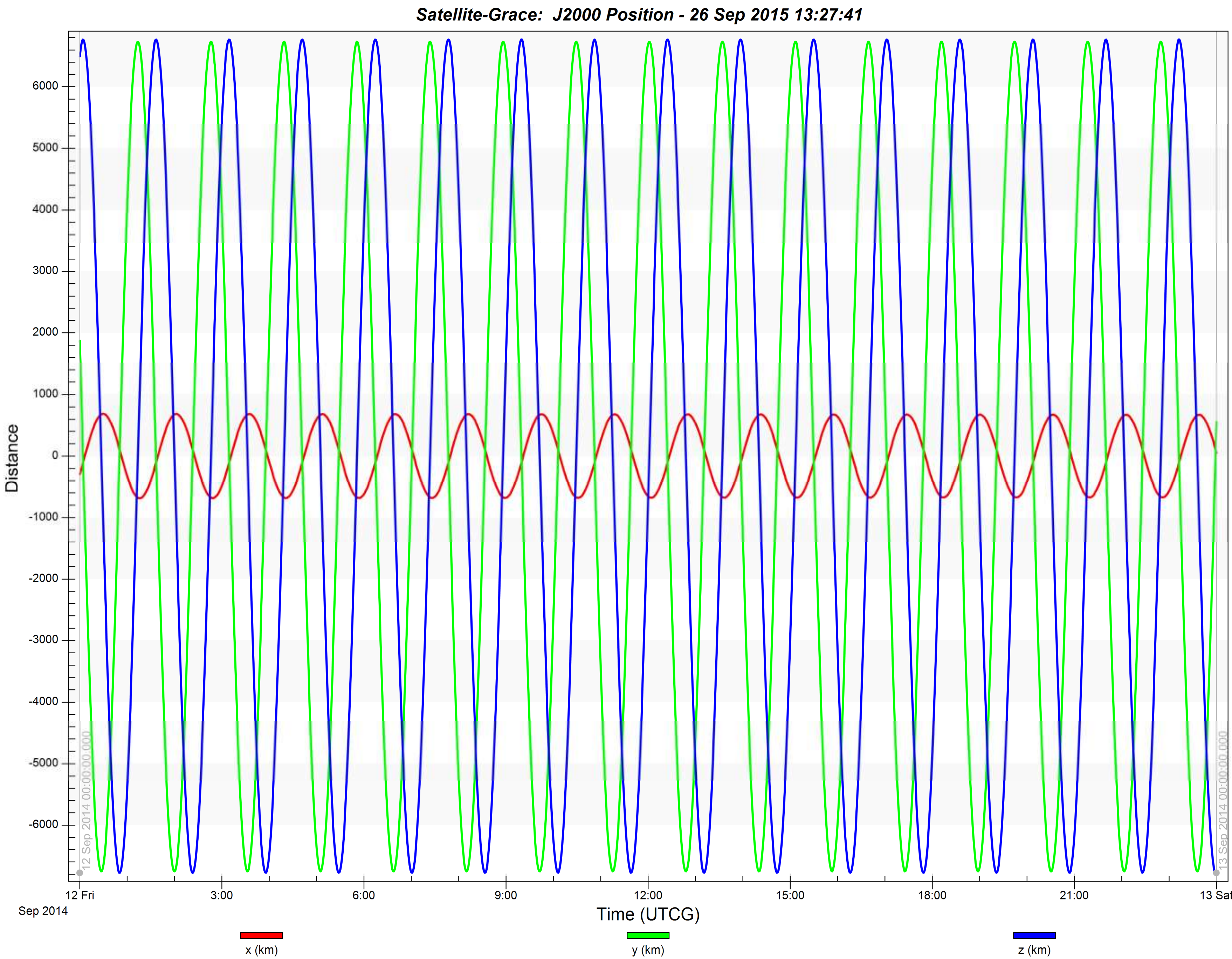
Generate separate plots of the position and the velocity in J2000 ECI coordinates by highlighting the satellite and selecting the **Report & Graph Manager** (top menu or right click satellite). In order to customize the plot you will right click the **J2000 Position Velocity** style and choose to **duplicate** it.

You can now select/deselect which parameters to plot from the menu on the left. For your first plot, use Cartesian Position-J2000-x, -y, and -z, for the y-axis (remove vx, vy, vz from the y2-axis). Label your axes "Time" and "Distance." Return to the previous menu and select **generate**. Repeat these steps to plot Cartesian Velocity-J2000-x, -y, and -z for your satellite, and rename your axes appropriately.

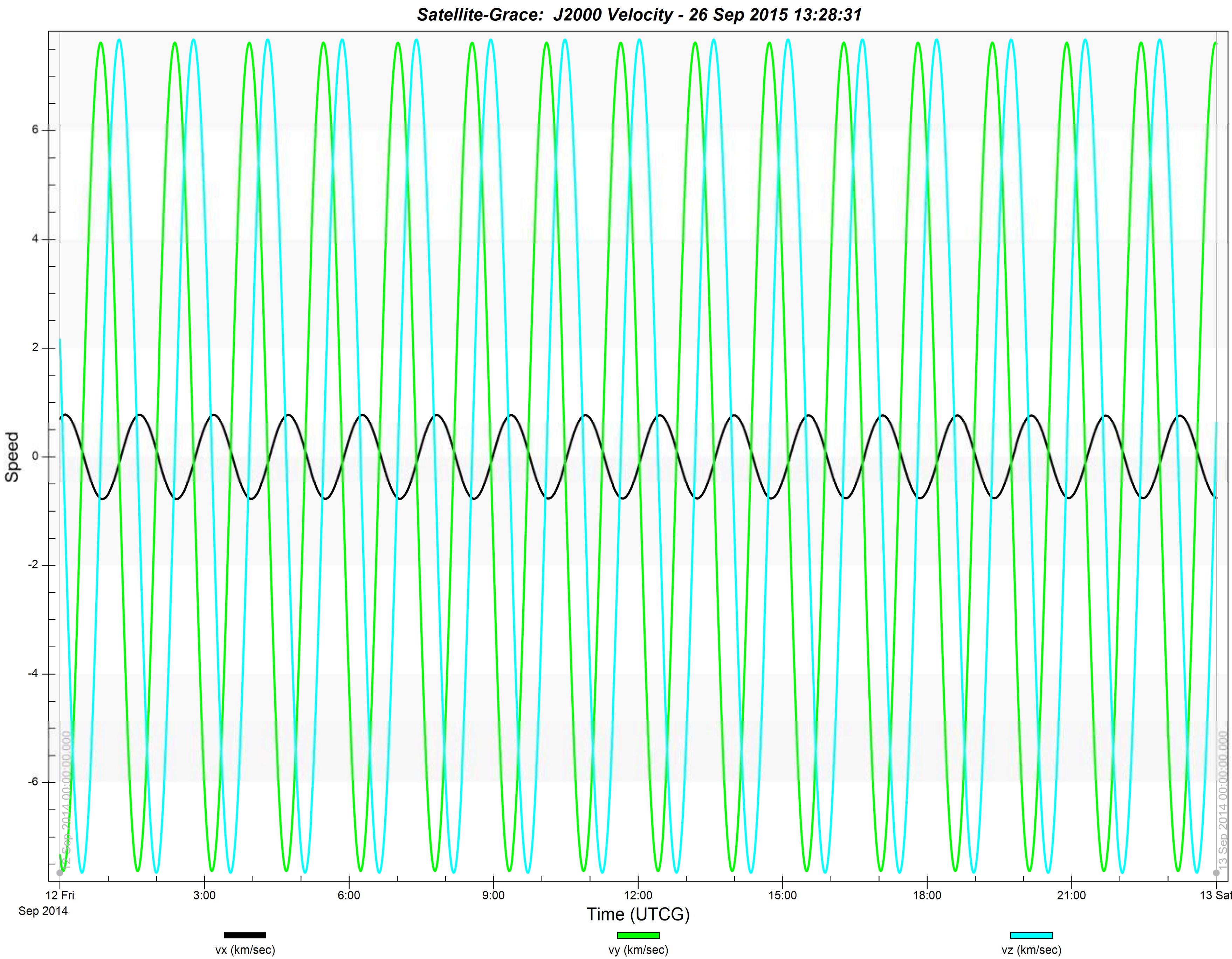
Print copies of your position and velocity graphs and include them with this write-up.

Animate Your Satellites

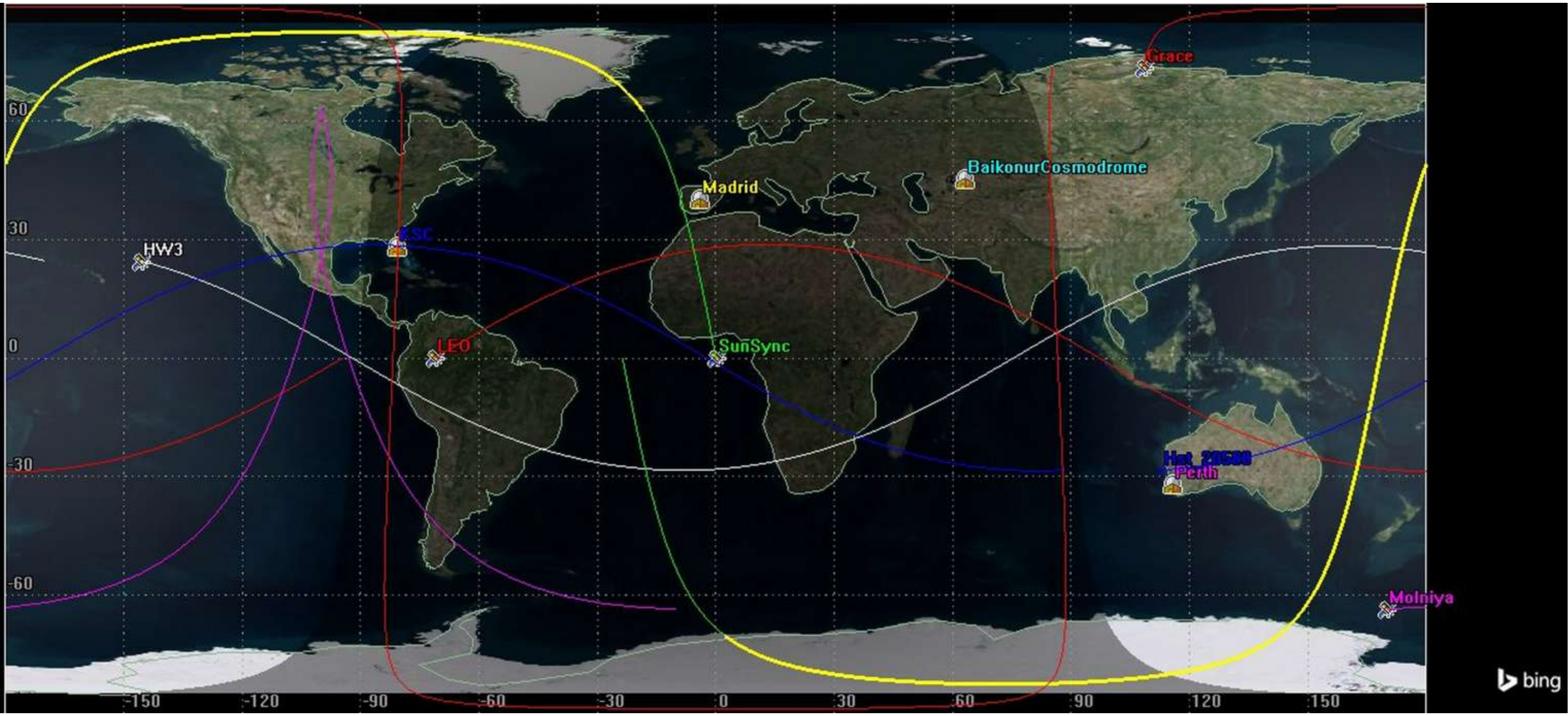
Animate your satellites. Look at both the ground track and Earth-view. Notice how the character of the orbit changes the speed and position of the satellites. Print out a copy of your ground tracks and staple it to this paper.



Satellite-Grace: J2000 Position - 26 Sep 2015 13:27:41
Distance
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
12 Fri
Sep 2014
3:00
6:00
9:00
12:00
15:00
18:00
21:00
13 Sat
Time (UTCG)
12 Sep 2014 00:00:00.000
13 Sep 2014 00:00:00.000
x (km)
y (km)
z (km)



Satellite-Grace: J2000 Velocity - 26 Sep 2015 13:28:31
Speed
6
4
2
0
-2
-4
-6
12 Fri
Sep 2014
3:00
6:00
9:00
12:00
15:00
18:00
21:00
13 Sat
Time (UTCG)
12 Sep 2014 00:00:00.000
13 Sep 2014 00:00:00.000
vx (km/sec)
vy (km/sec)
vz (km/sec)



Grace
BaikonurCosmodrome
Madrid
KSC
HW3
LEO
SunSync
Hot_20G00
Perth
Molniya
60
30
0
-30
-60
-150
-120
-90
-60
-30
0
30
60
90
120
150
bing