Science_Flight_20151124

November 24, 2015

In this report, we'll review the science flight of the ER-2 starting on 11/24/2015. This was a ~7-h flight that overflew both orographic snowfall as well as post-frontal convective clouds and precipitation. First, let's import all the needed modules and ingest and process the raw data.

In [1]:
```
from __future__ import print_function
import numpy as np
import matplotlib.pyplot as plt
import datetime as dt
import os
import glob
import pyart
import rawpyampr
import pyampr
from awot.graph.common import create_basemap
from awot.graph.flight_level import FlightLevel
from pyart_tools import plot_list_of_fields
%matplotlib inline
```

In [2]:
```
import warnings
warnings.filterwarnings('ignore')
def delete_file(fname):
    try:
        os.remove(fname)
    except:
        pass
```

In [3]:
```
datadir = './'
files = glob.glob(datadir + '*.dat')
print(files)
fname = os.path.basename(files[0])[:-4]
```

```
['./AMPR-20151124-145455.dat', './AMPR-20151124-192426.dat']
```

In [4]:
```
payload = rawpyampr.ampr_payload.AMPR_Payload(files)
l1file = fname + '_L1.nc'
l2file = fname + '_L2.nc'
delete_file(l1file)
payload.writeLevel1B(l1file)
L1B = rawpyampr.ampr_level1b.AMPR_QC(l1file)
delete_file(l2file)
L1B.writeLevel2B(l2file)
```

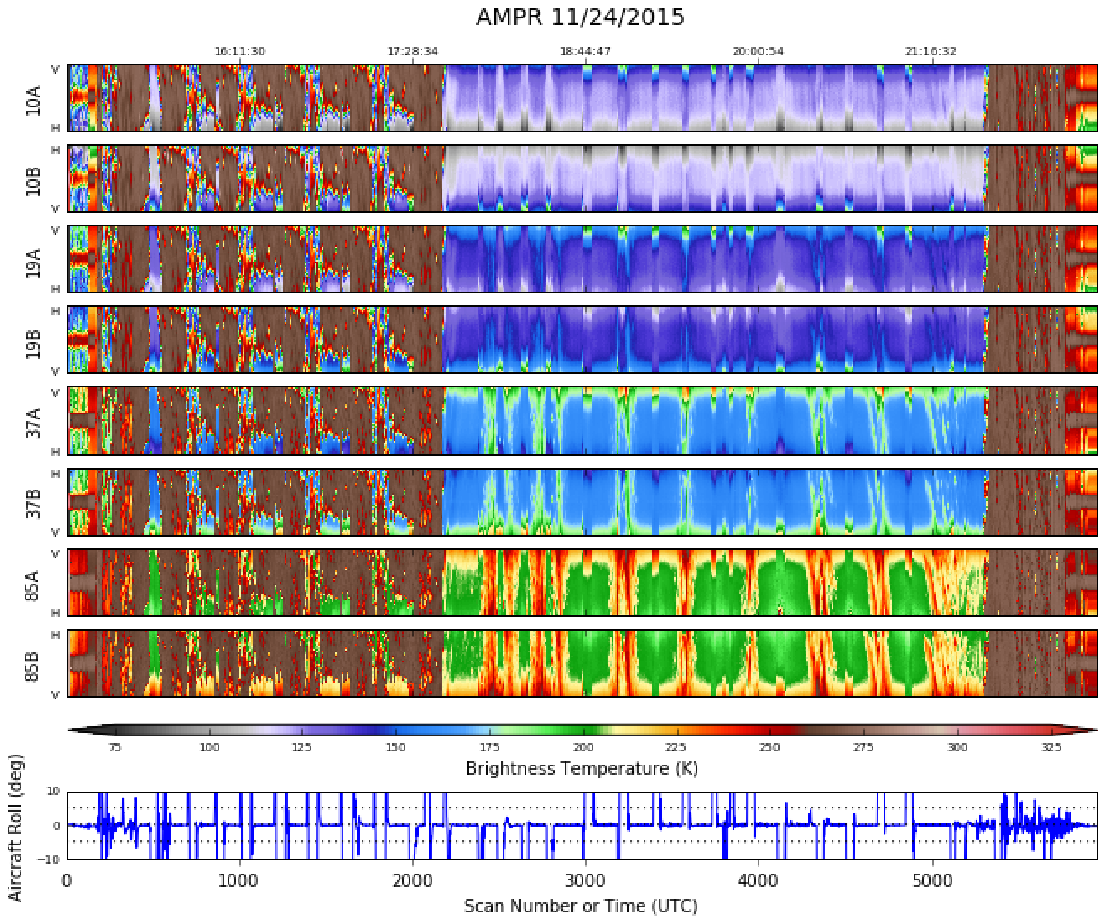
```
All of file: ./AMPR-20151124-145455.dat Read Successfully
End of data stream reached
```

```
All of file: ./AMPR-20151124-192426.dat Read Successfully
End of data stream reached
Interpreting Navigation Records as: IWG1
 No navigation file found
Navigating pixels using internal recording of nav data.
Number points to converge: 4
Writing to output file:  AMPR-20151124-145455_L1.nc
Found Navigation Data!
Writing to output file: AMPR-20151124-145455_L2.nc
File containing water fraction not on path
```

Now we are ready to read in and display the L2 geolocated brightness temperatures.

```
In [5]: data = pyampr.AmprTb(l2file)
        data.plot_ampr_channels()
```

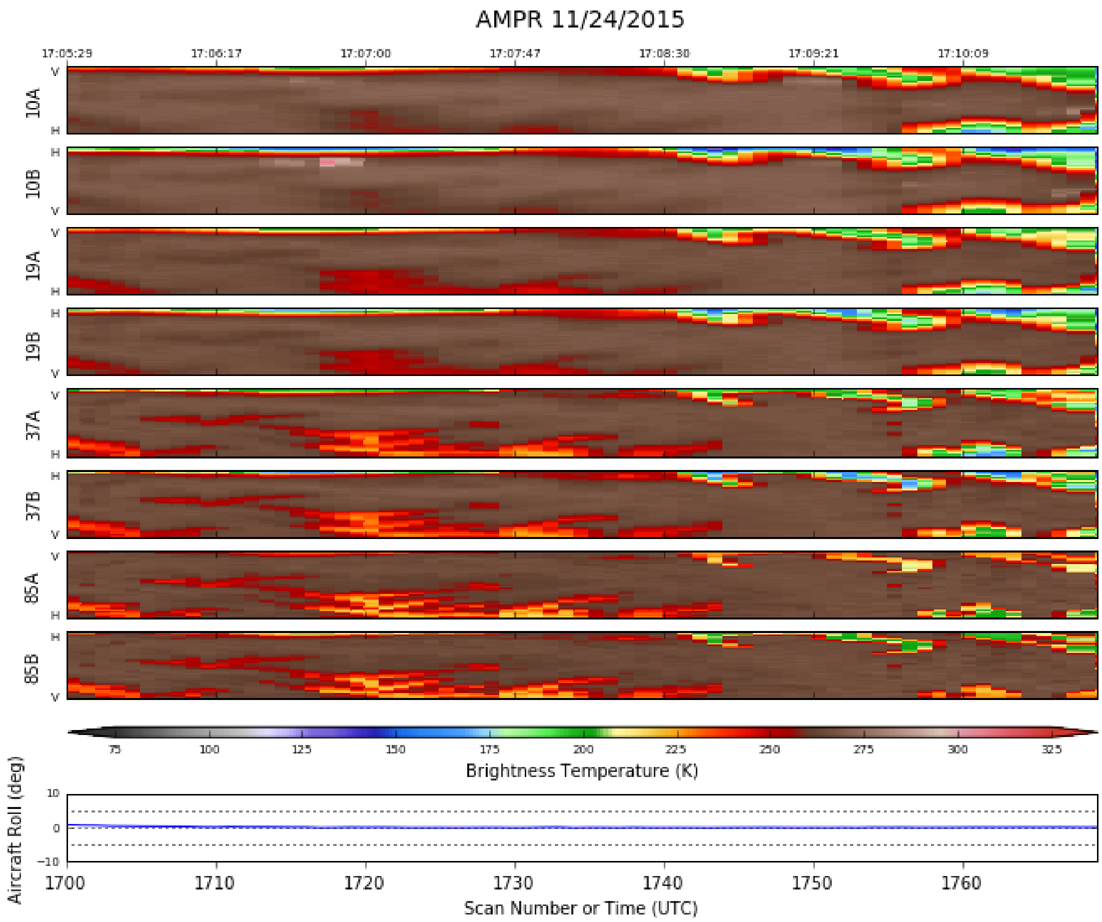
```
********************
read_ampr_tb_level2b(): Reading AMPR-20151124-145455_L2.nc
Assuming OLYMPEX data structure.
Change to proper project if incorrect, otherwise errors will occur.
Currently available field projects: OLYMPEX, IPHEX, MC3E, TC4, TCSP, JAX90, COARE,
CAMEX1, CAMEX2, CAMEX3, CAMEX4, TRMMLBA, KWAJEX, TEFLUNA, FIRE3ACE, CAPE
Default: project = 'OLYMPEX'
Found Navigation Data!
(5954,)
********************


********************
plot_ampr_channels():
Available scans = 1 to 5954
Available times = 14:54:59 - 22:29:07
********************
```



Overall, this looks really good. All channels behaved well. I think there was a few second outage of a few channels early in the flight and that's about it. Thus, we can mainly just focus on the science. To start, let's look at a particular orbit that occurred during the early portion of the flight, when the ER-2 was sampling snowfall over the mountains.

```
In [8]: data.plot_ampr_channels(scanrange=[1700, 1770])
```

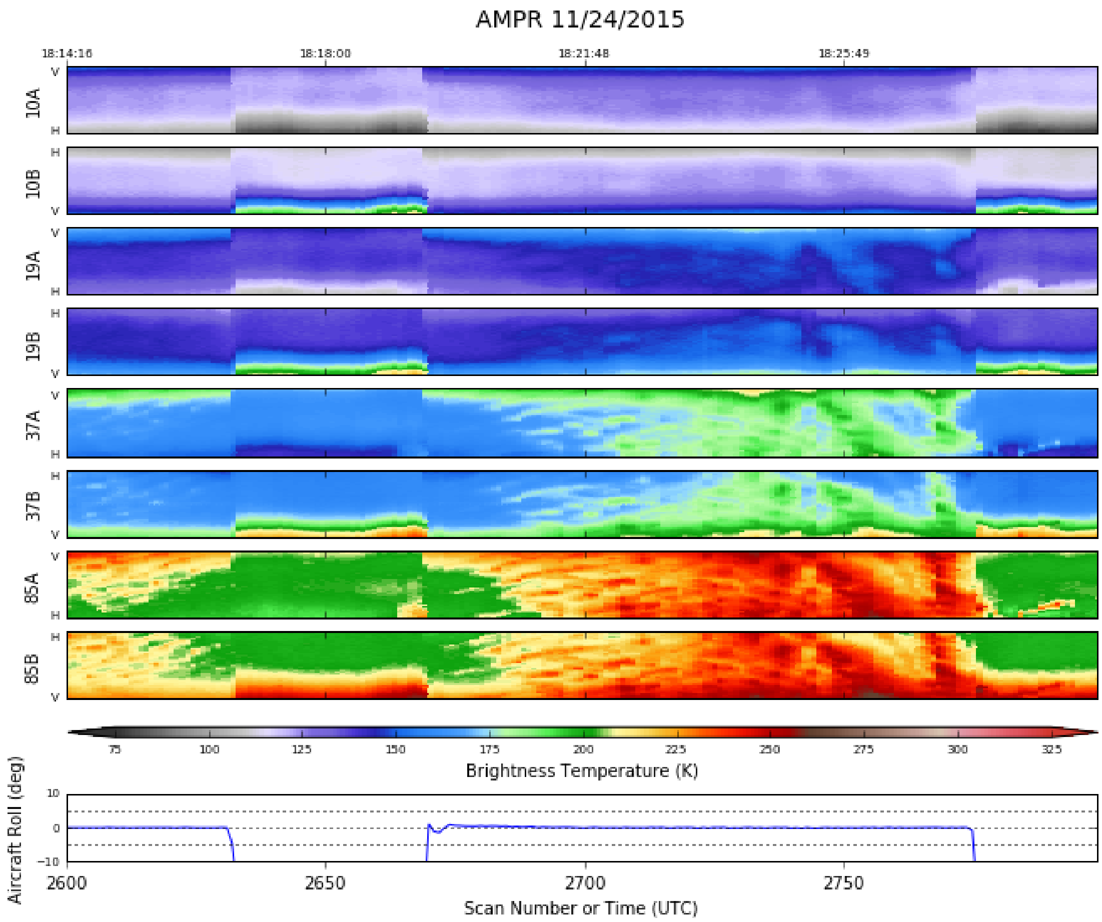
```
********************
plot_ampr_channels():
Available scans = 1 to 5954
Available times = 14:54:59 - 22:29:07
********************
```



This ˜5-min period is pretty typical of the entirety of the Hurricane Ridge portion of today's flight. AMPR saw the land surface and the ocean surface, and not much more. Shallow, light frozen precip just isn't what the instrument is good at. So let's move on to the offshore portion of today's flight.

```
In [10]: data.plot_ampr_channels(scanrange=[2600, 2800])
```

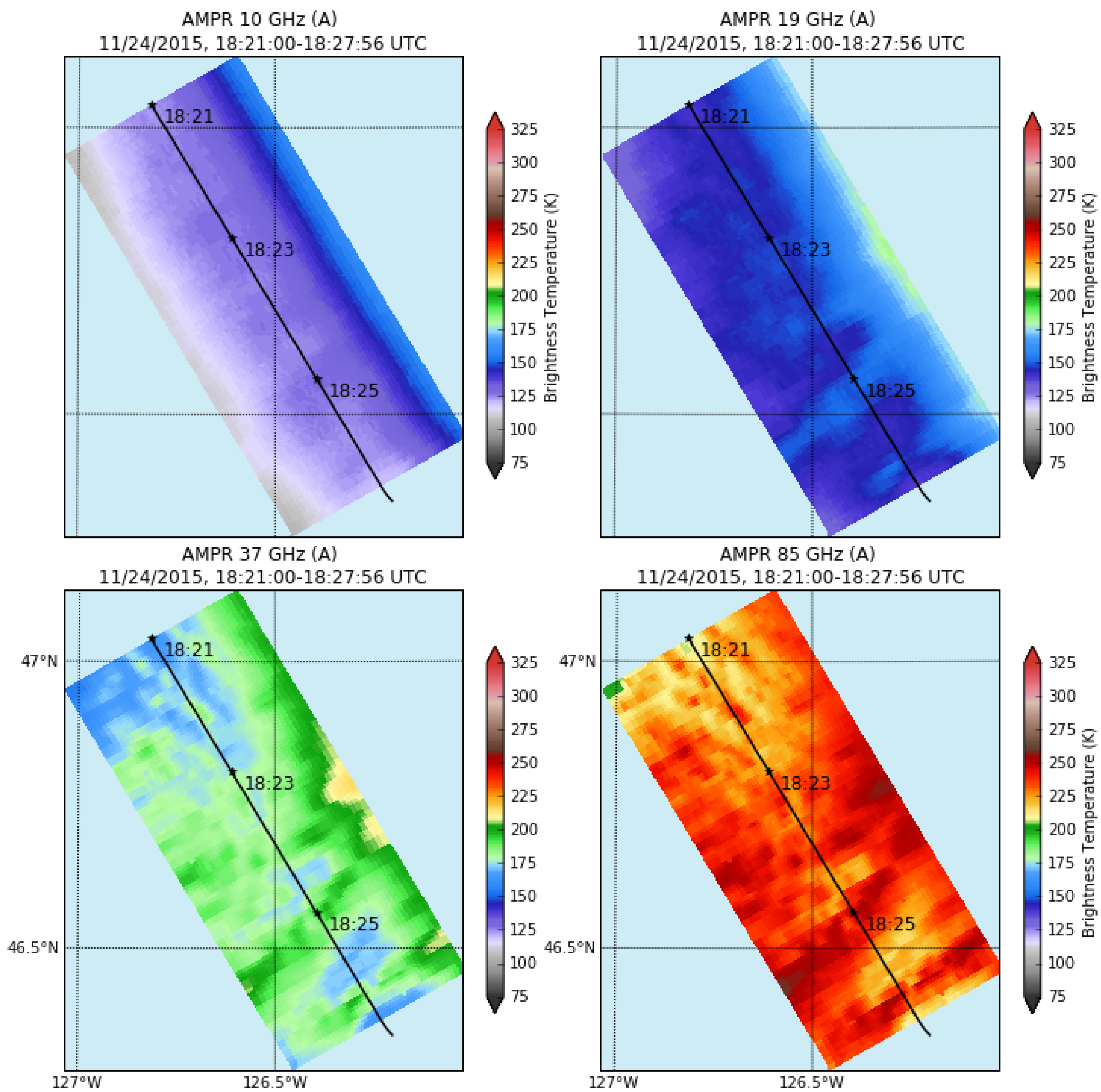
```
********************
plot_ampr_channels():
Available scans = 1 to 5954
Available times = 14:54:59 - 22:29:07
********************
```



This is pretty typical of the oceanic portions of today's flight - When AMPR was viewing clouds it saw substantial emission signatures at 85 and 37 GHz, and often even down to at least 19 GHz. Let's inspect this leg between ~1821-1827, because it was very typical of the overall scenario.

In [14]:
```
# Import the ER-2 nav into AWOT (https://github.com/nguy/AWOT)
# This simplifies plotting the track with time stamps
flight = pyampr.read_aircraft_nav_into_awot(data)
tst = '18:21:00'
ted = '18:28:00'
start = '2015-11-24 ' + tst
end = '2015-11-24 ' + ted
offs = (0.03, -0.03)

fig, [[ax1, ax2], [ax3, ax4]] = plt.subplots(2, 2, figsize=(10, 10))
stuff = data.plot_ampr_track(
    '10a', timerange=[tst, ted], ax=ax1, grid_labels=False,
    maneuver=False, meridians=0.5, parallels=0.5,
    colorbar_label=True, fig=fig, return_flag=True, resolution='l')
f2 = FlightLevel(flight, basemap=stuff[2])
```

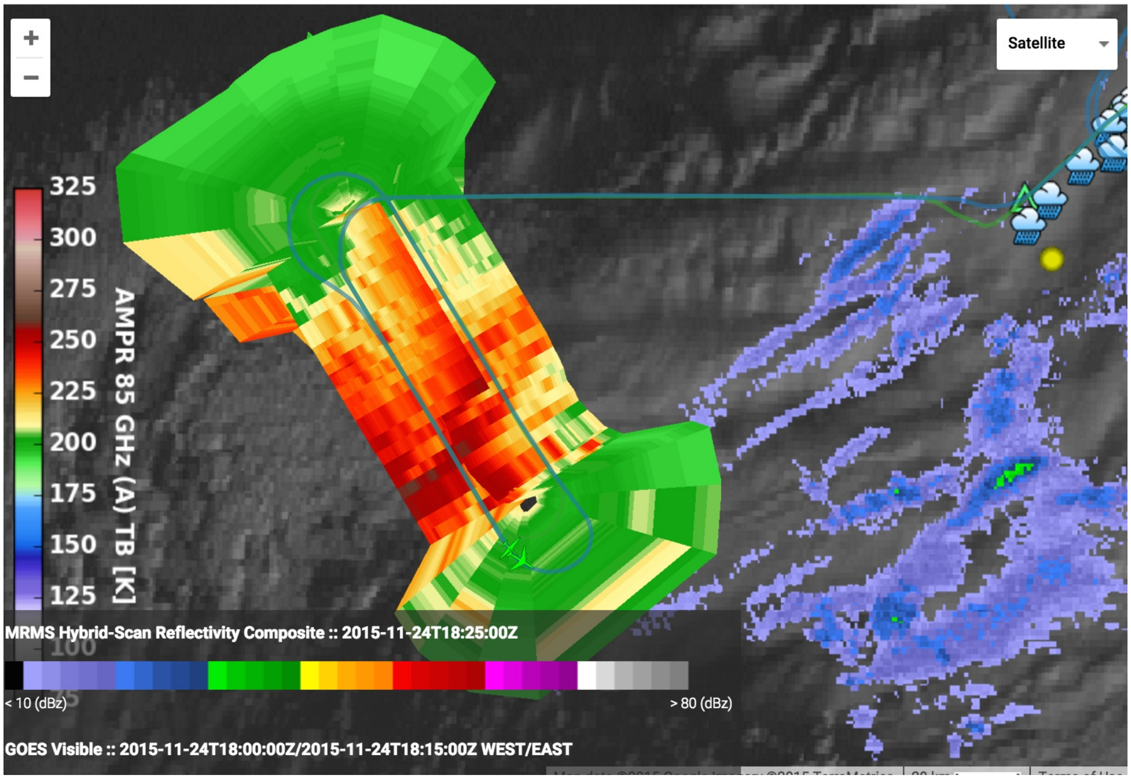
```
f2.plot_trackmap(min_altitude=50., lw=2.5, start_time=start,
                 end_time=end, ax=stuff[1])
f2.time_stamps(start_time=start, end_time=end,
               labelspacing=30, ax=stuff[1], label_offset=offs)
data.plot_ampr_track(
   '19a', timerange=[tst, ted],
    maneuver=False, meridians=0.5, parallels=0.5,
    ax=ax2, fig=fig, grid_labels=False, basemap=stuff[2])
f2.plot_trackmap(min_altitude=50., lw=2.5, start_time=start,
                 end_time=end, ax=ax2)
f2.time_stamps(start_time=start, end_time=end,
               labelspacing=30, ax=ax2, label_offset=offs)
data.plot_ampr_track(
    '37a', timerange=[tst, ted],
    maneuver=False, meridians=0.5, parallels=0.5,
    ax=ax3, fig=fig, colorbar_label=False, basemap=stuff[2])
f2.plot_trackmap(min_altitude=50., lw=2.5, start_time=start,
                 end_time=end, ax=ax3)
f2.time_stamps(start_time=start, end_time=end,
               labelspacing=30, ax=ax3, label_offset=offs)
data.plot_ampr_track(
    '85a', timerange=[tst, ted],
    maneuver=False, meridians=0.5, parallels=0.5,
    ax=ax4, fig=fig, grid_labels=True, basemap=stuff[2])
f2.plot_trackmap(min_altitude=50., lw=2.5, start_time=start,
                 end_time=end, ax=ax4)
f2.time_stamps(start_time=start, end_time=end,
               labelspacing=30, ax=ax4, label_offset=offs)
plt.tight_layout()
```



The 85 GHz channel saw a lot of emission from this system, with 37 GHz (and also 19 GHz) also responding to the weakly precipitating cumuliform clouds. Let's examine the overall situation at this time.

```
In [19]: from IPython.display import Image
         Image('/Users/tjlang/Documents/PMM/OLYMPEX/FlightDirector/20151124/ss_1828.jpg')
```

```
Out[19]:
```



The above is an MTS image that contains AMPR realtime imagery, MRMS radar reflectivity, and GOES visible imagery. The ER-2 (supported by the DC-8) is flying over a region of non- or weakly precipitating cumuliform clouds, and AMPR is sensing these at multiple frequencies. With both the DC-8 and ER-2 combined we have a broad dataset for examing these clouds in greater detail, an important ACE/RADEX objective.

To sum up, this was an interesting dataset from AMPR. Early on in the flights AMPR didn't see much cloud/precipitation signal, but later that signal was quite important. Data quality looks excellent regardless. What's interesting is that radars (e.g., APR, NPOL) saw very low-altitude (< 1 km MSL) bright-band signatures in these maritime clouds, indicating that the liquid (i.e., emission) phase may have involved a very shallow layer above the ocean's surface. Truly, a very unique combined dataset was obtained today.

```
In [ ]:
```