Science_Flight_20151212

December 13, 2015

In this report, we'll review the science flight of the ER-2 starting on 12/12/2015. This was a ~4-h flight that sampled heavy stratiform precipitation with some embedded convection. First, let's import all the needed modules and ingest and process the raw data.

```python
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
        import dualpol
        from copy import deepcopy
        from IPython.display import Image
        from awot.graph.common import create_basemap
        from awot.graph.flight_level import FlightLevel
        from pyart_tools import (
            plot_list_of_fields, list_nexrad_files, read_nexrad_aws)
        %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-20151212-131632.dat', './AMPR-20151212-174639.dat', './AMPR-20151212-214014.dat']
```

```python
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-20151212-131632.dat Read Successfully
End of data stream reached
All of file: ./AMPR-20151212-174639.dat Read Successfully
End of data stream reached
All of file: ./AMPR-20151212-214014.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-20151212-131632_L1.nc
Found Navigation Data!
Writing to output file: AMPR-20151212-131632_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-20151212-131632_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!
(3823,)
********************


********************
plot_ampr_channels():
Available scans = 1 to 3823
Available times = 13:16:36 - 22:16:40
********************
```

AMPR 12/12/2015
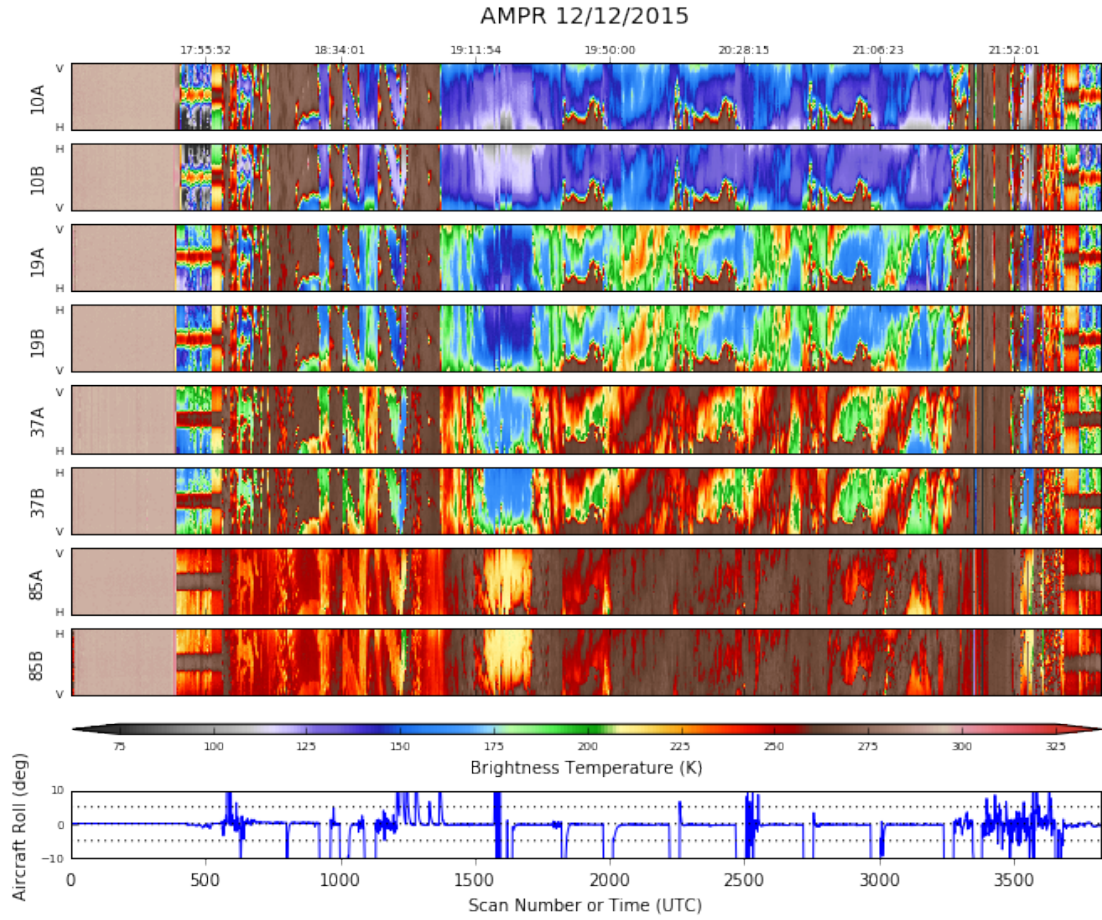
The early part of the chart consists of engineering test data, which is why the channels look so uniform before the flight. Late in the flight, as the ER-2 began to descend, there was a reset of the instrument computer. Let's take a look at that really quickly.
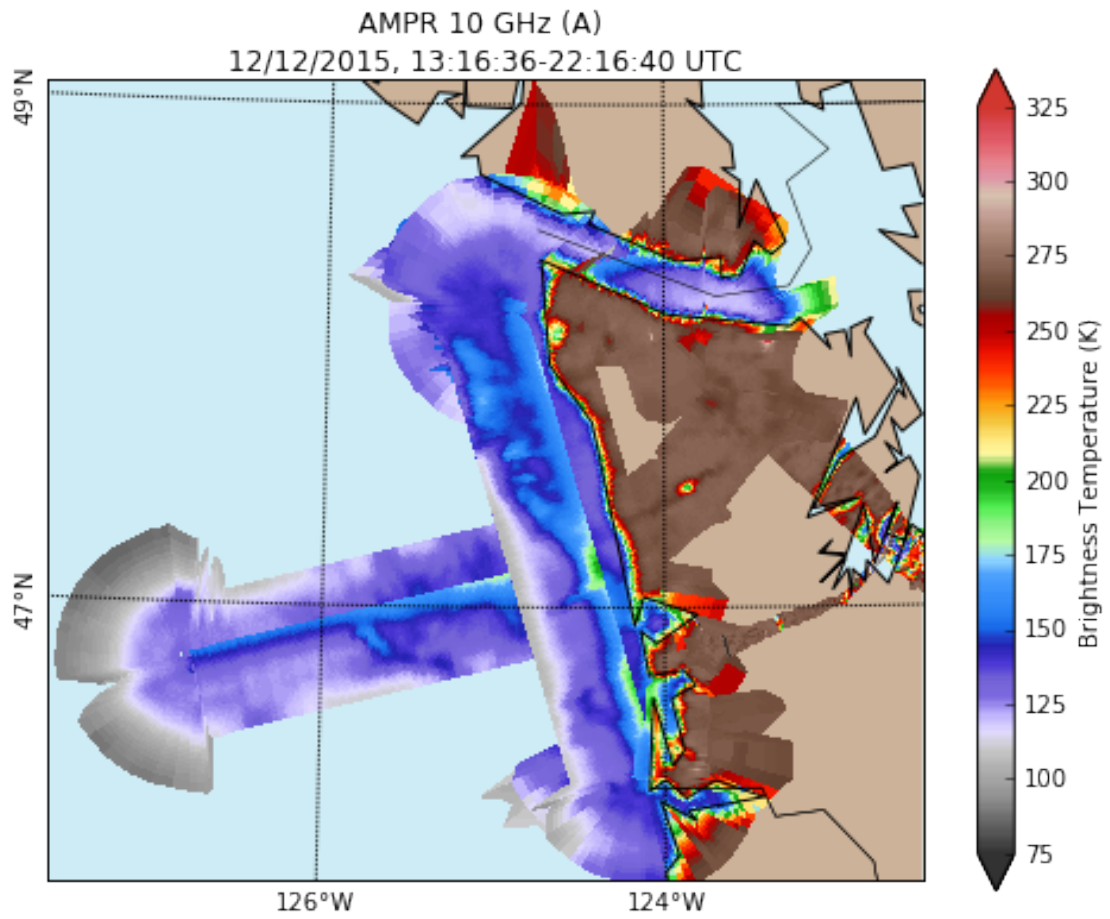
```
In [62]: data.plot_ampr_channels(scanrange=(3300, 3400))
```

```
********************
plot_ampr_channels():
Available scans = 1 to 3823
Available times = 13:16:36 - 22:16:40
********************
```
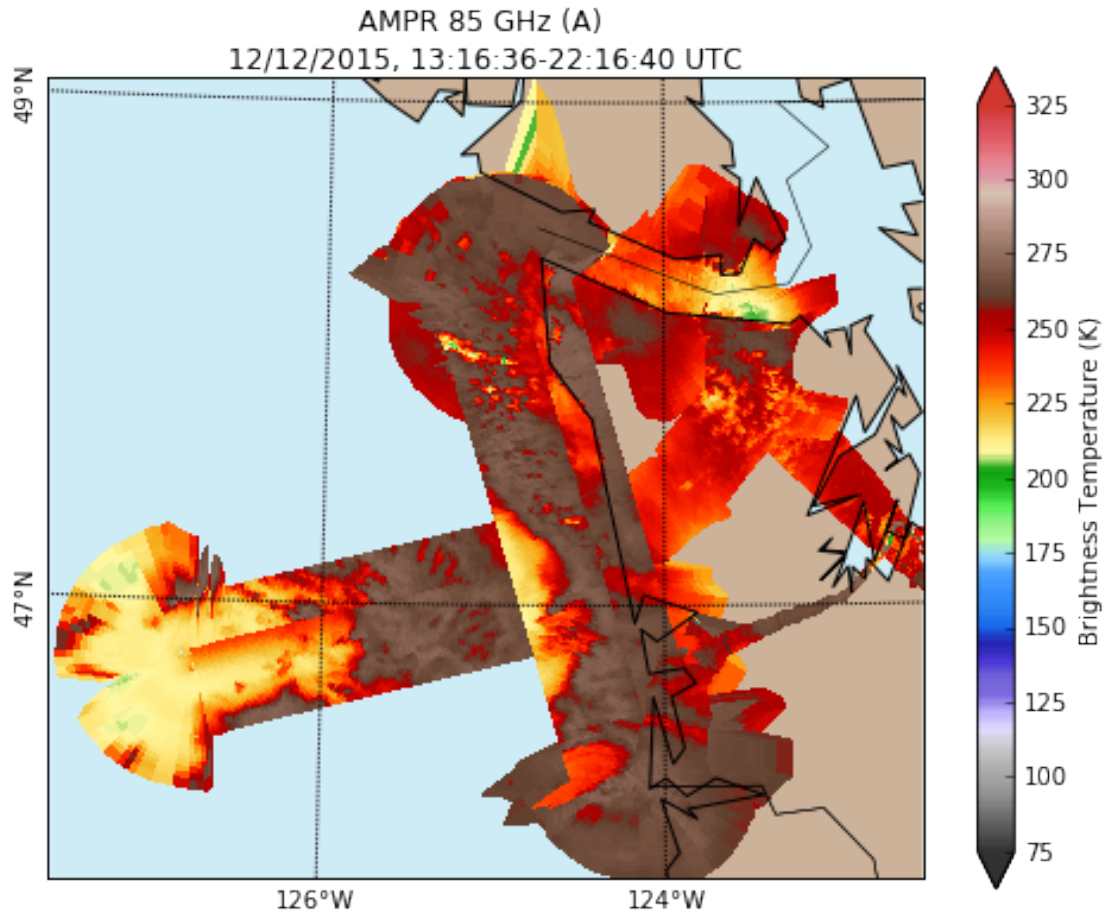
3

AMPR 12/12/2015
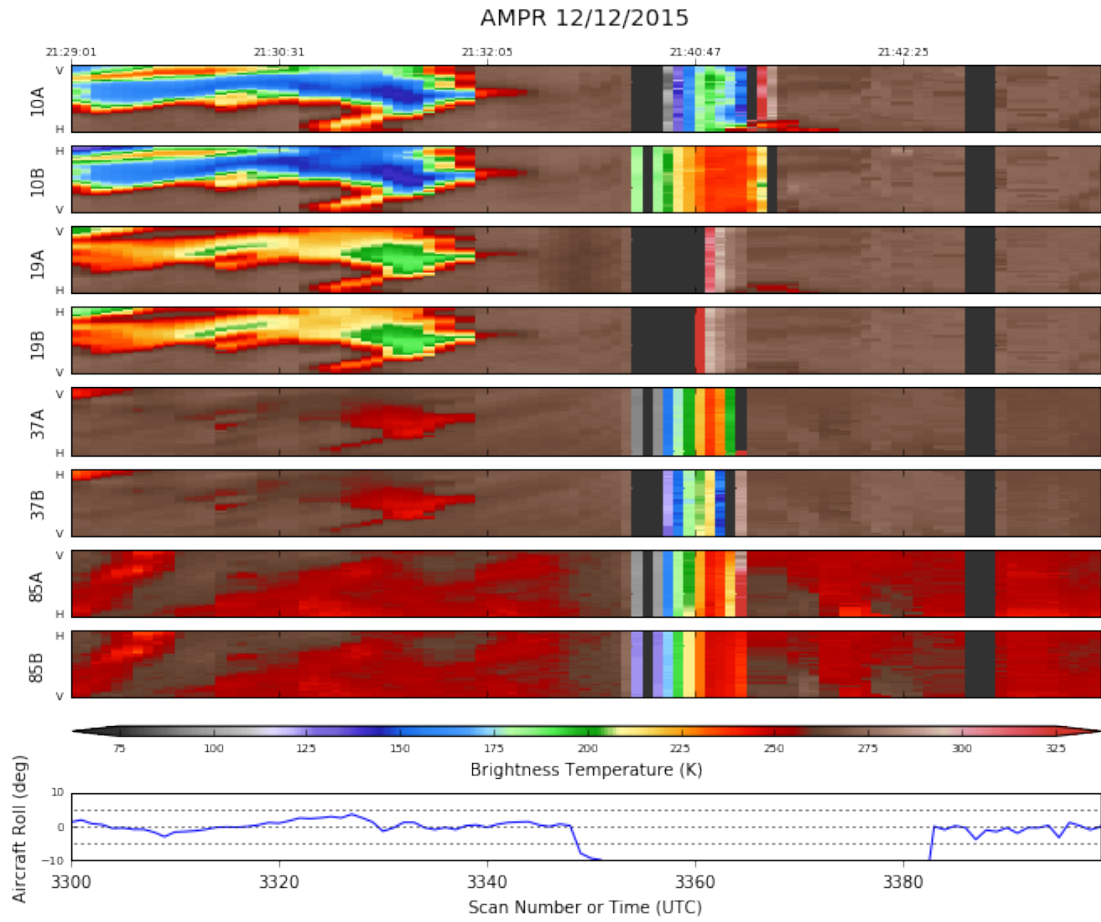
Based on the timing gap around 2140, I'd say we lost about 5-6 min of data. Alright, let's look at the flight in total, focusing on 10 and 85 GHz.

```
In [54]: data.plot_ampr_track('10a')
```

AMPR 10 GHz (A)
12/12/2015, 13:16:36-22:16:40 UTC

In [55]: data.plot_ampr_track('85a')

AMPR 85 GHz (A)
12/12/2015, 13:16:36-22:16:40 UTC

Wow, those are some really large TBs at 85 GHz. Now, 85 GHz has had some occasional noise floor issues this campaign, especially the A channel. Can we convince ourselves these values are real?
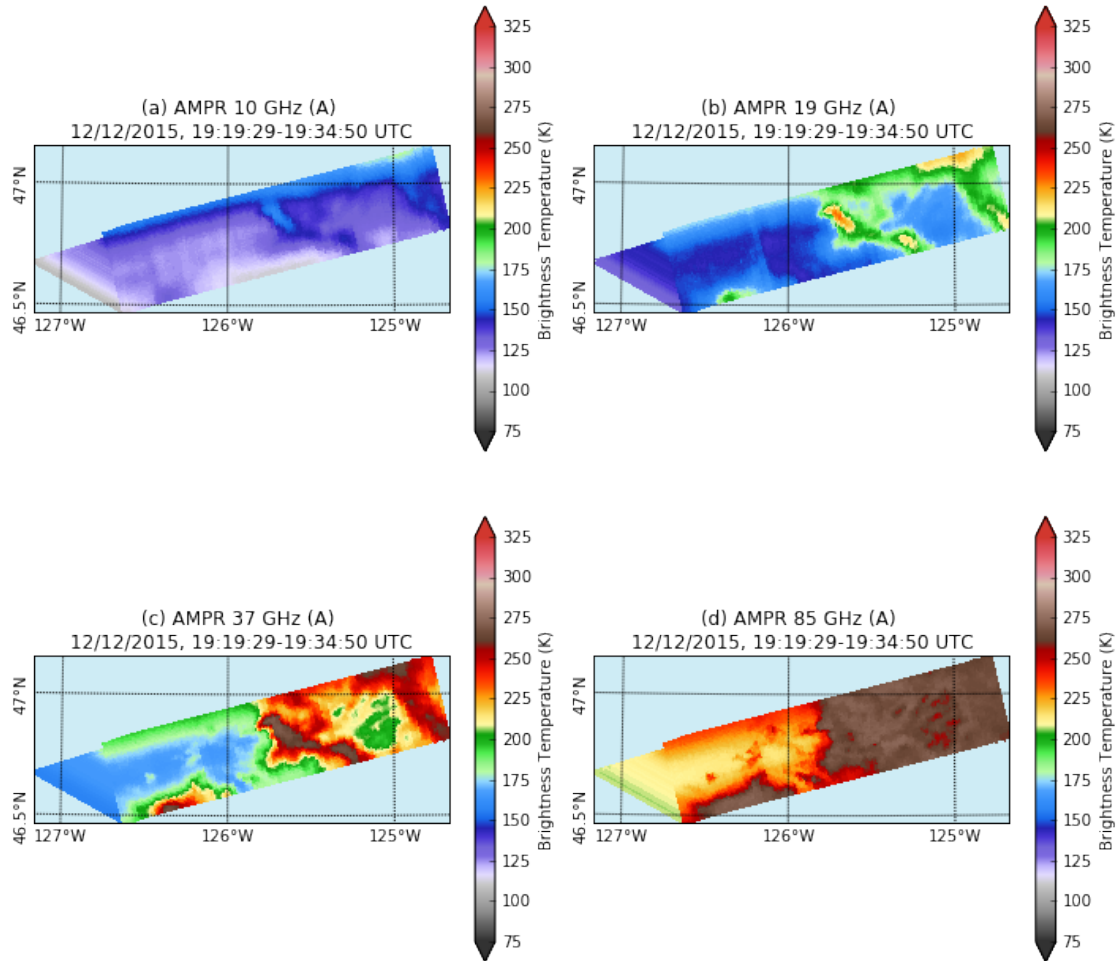
```
In [6]: data.plot_ampr_channels(scanrange=[1500, 2500])

********************
plot_ampr_channels():
Available scans = 1 to 3823
Available times = 13:16:36 - 22:16:40
********************
```

AMPR 12/12/2015
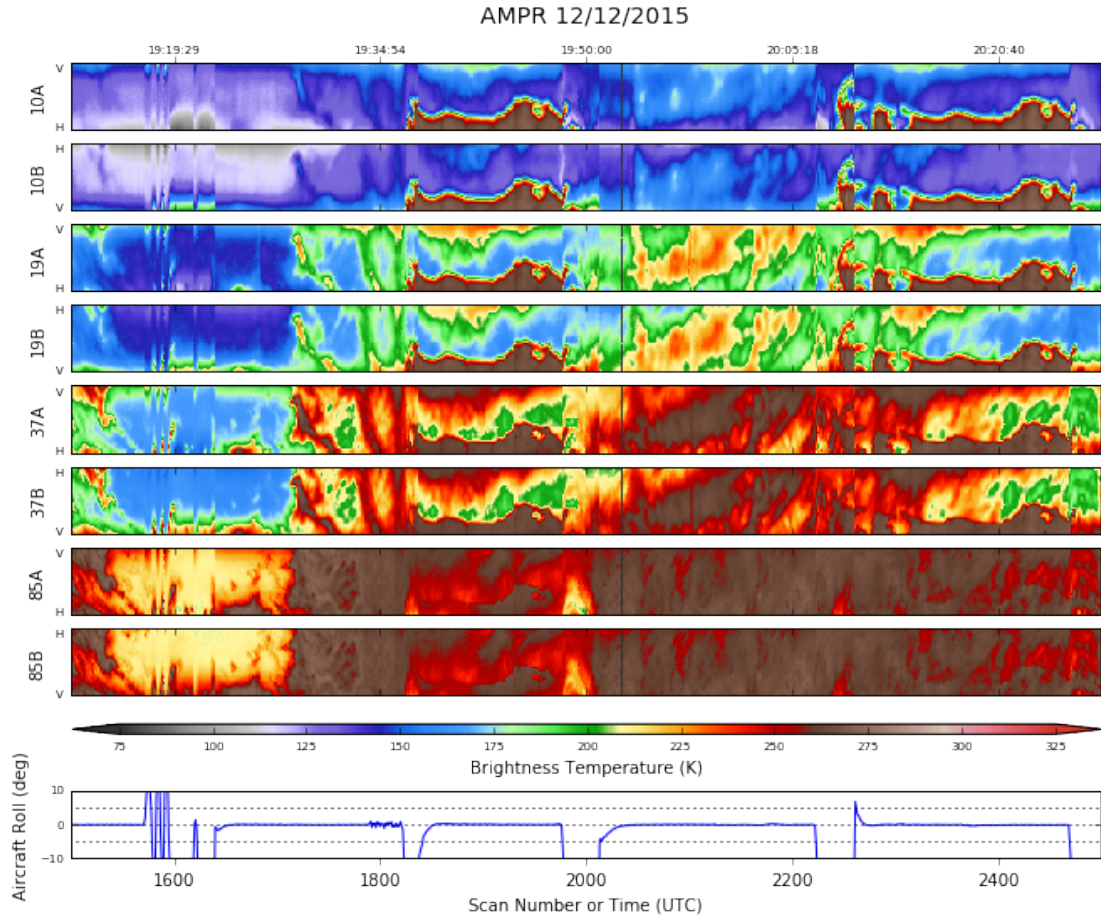
Yeah, these are land-surface-class TBs for 85 GHz. But note that we see similar peak values at 37 GHz, and 10 and 19 GHz have high TBs as well, especially during 1950-2000 GHz. Dave Simmons checked the instrument gains and eveything looked fine. Let's take a closer look at the geolocated data during the period above.
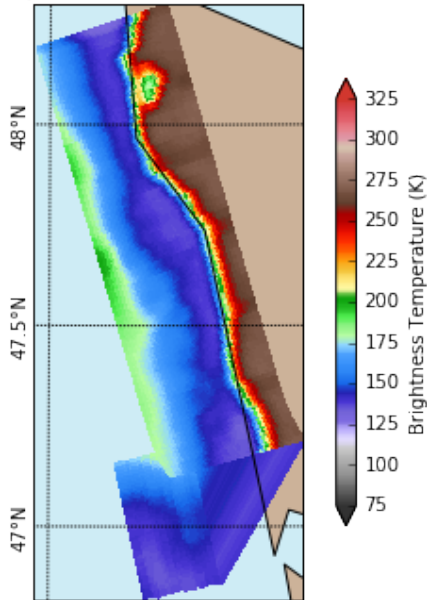
```
In [7]: display = data.plot_ampr_track_4panel(
            chan='a', scanrange=[1600, 1800], maneuver=False, return_flag=False,
            meridians=1, parallels=0.5, show_grid=True)
```

(a) AMPR 10 GHz (A)
12/12/2015, 19:19:29-19:34:50 UTC

(b) AMPR 19 GHz (A)
12/12/2015, 19:19:29-19:34:50 UTC

(c) AMPR 37 GHz (A)
12/12/2015, 19:19:29-19:34:50 UTC

(d) AMPR 85 GHz (A)
12/12/2015, 19:19:29-19:34:50 UTC

Now a little bit later . . .

```
In [8]: display = data.plot_ampr_track_4panel(
            chan='a', scanrange=[1800, 2000], maneuver=False, return_flag=False,
            meridians=1, parallels=0.5, show_grid=True)
```
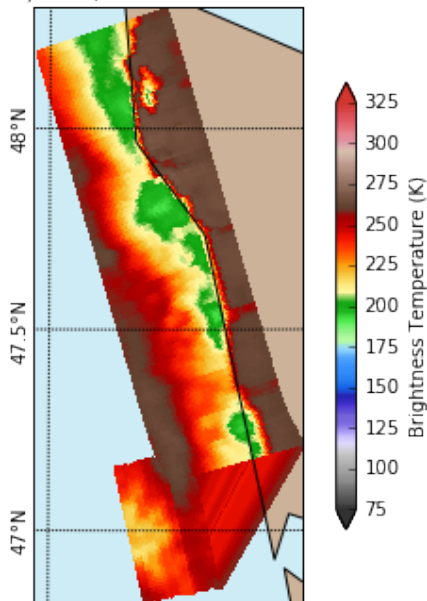
(a) AMPR 10 GHz (A)
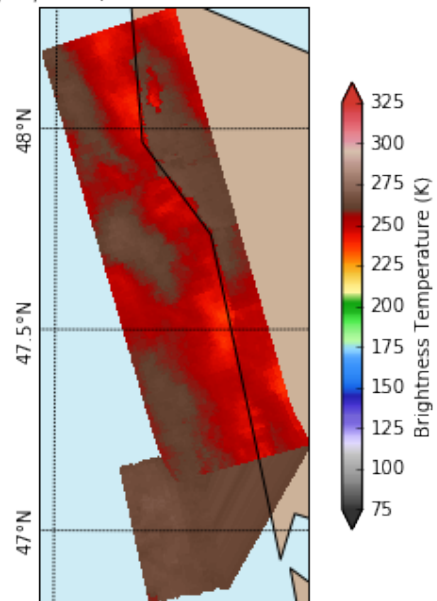12/12/2015, 19:34:54-19:49:57 UTC

(b) AMPR 19 GHz (A)
12/12/2015, 19:34:54-19:49:57 UTC
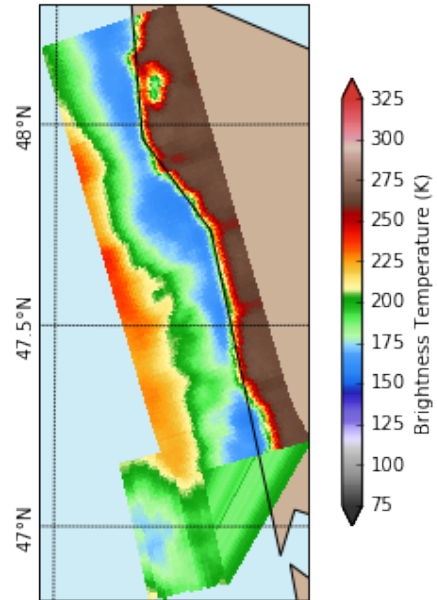
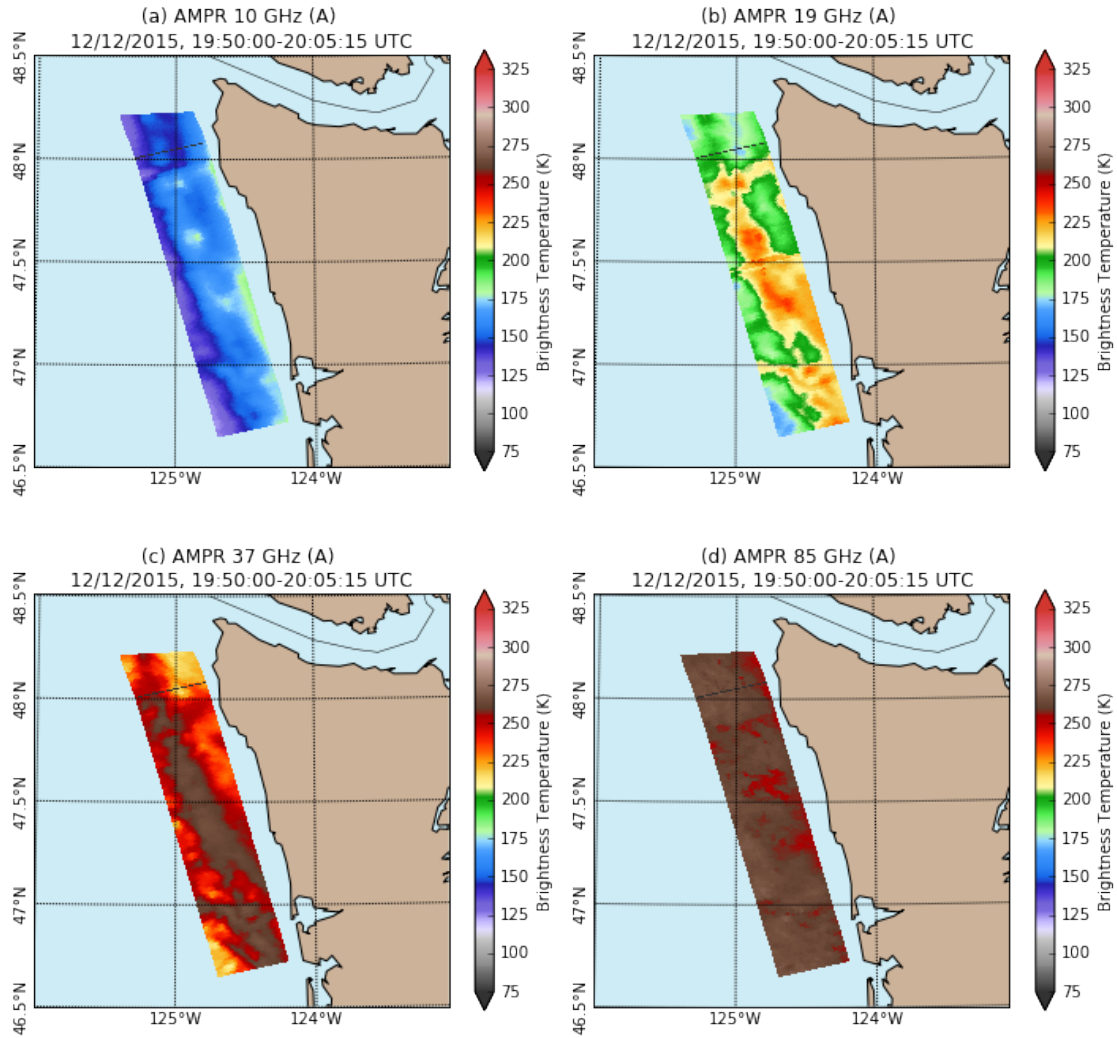(c) AMPR 37 GHz (A)
12/12/2015, 19:34:54-19:49:57 UTC

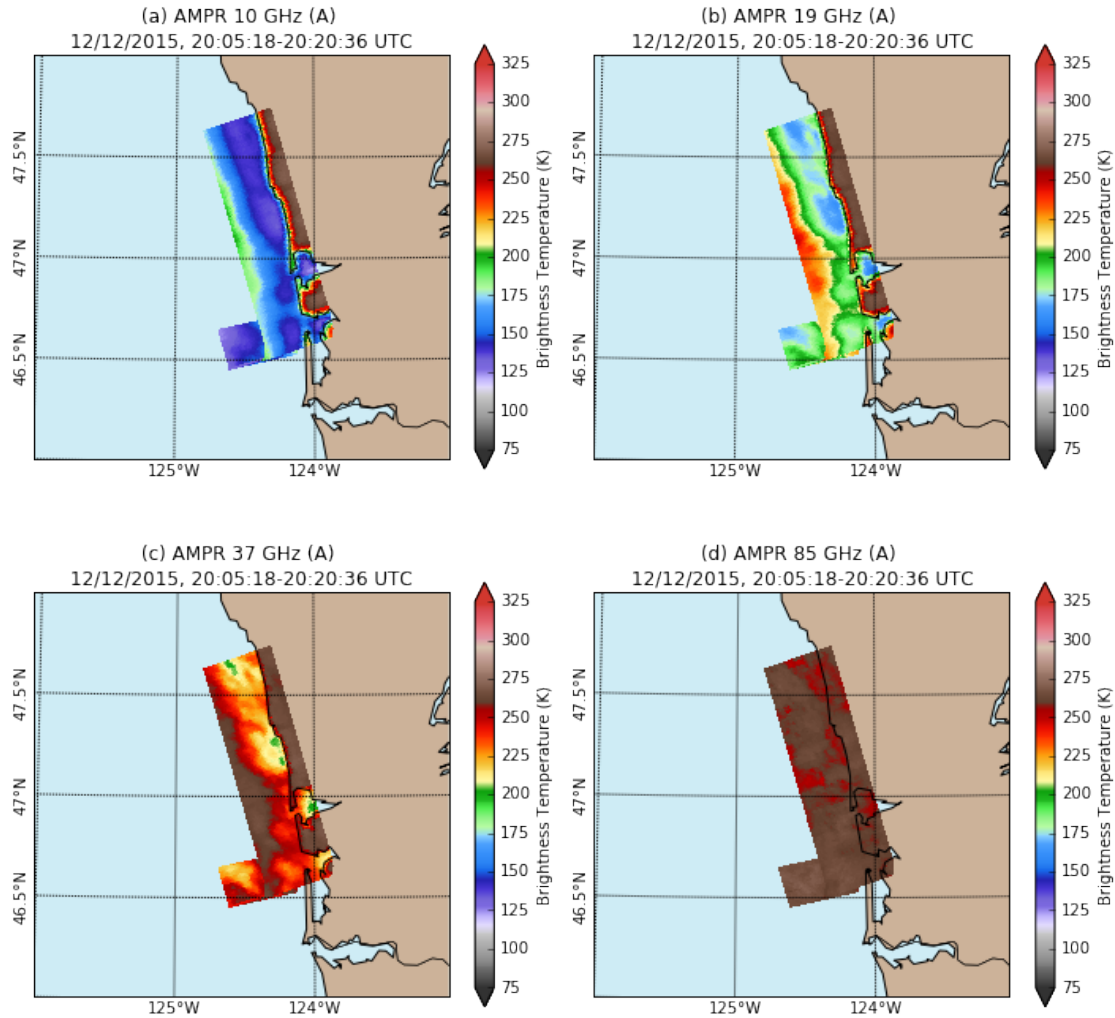(d) AMPR 85 GHz (A)
12/12/2015, 19:34:54-19:49:57 UTC

Later still ...

```
In [69]: display = data.plot_ampr_track_4panel(
            chan='a', scanrange=[2000, 2200], maneuver=False, return_flag=True,
            meridians=1, parallels=0.5, show_grid=True, resolution='i',
            lonrange=[-126, -123], latrange=[46.5, 48.5])
```

9

(a) AMPR 10 GHz (A)
12/12/2015, 19:50:00-20:05:15 UTC

(b) AMPR 19 GHz (A)
12/12/2015, 19:50:00-20:05:15 UTC

(c) AMPR 37 GHz (A)
12/12/2015, 19:50:00-20:05:15 UTC

(d) AMPR 85 GHz (A)
12/12/2015, 19:50:00-20:05:15 UTC

Even later

```
In [19]: display = data.plot_ampr_track_4panel(
            chan='a', scanrange=[2200, 2400], maneuver=False, return_flag=True,
            meridians=1, parallels=0.5, show_grid=True, resolution='i',
            lonrange=[-126, -123], latrange=[46, 48])
```

(a) AMPR 10 GHz (A)
12/12/2015, 20:05:18-20:20:36 UTC

(b) AMPR 19 GHz (A)
12/12/2015, 20:05:18-20:20:36 UTC

(c) AMPR 37 GHz (A)
12/12/2015, 20:05:18-20:20:36 UTC

(d) AMPR 85 GHz (A)
12/12/2015, 20:05:18-20:20:36 UTC

OK, clearly there is a coherent enhanced TB signal across multiple channels during these offshore passes. What does the local NEXRAD have to say?

```
In [12]: radlist = list_nexrad_files(2015, month='12', day='12', station='KLGX')
         # print(radlist)
         radar = read_nexrad_aws('KLGX20151212_195931_V06.gz')

In [53]: lonrange = [-126, -123]
         latrange = [46, 48.5]
         fig = plt.figure(figsize=(12, 7))
         ax = fig.add_subplot(121)
         d.plot_ppi_map('REF', 1, vmin=0, vmax=75, cmap='pyart_NWSRef',
                        min_lat=latrange[0], max_lat=latrange[1],
                        min_lon=lonrange[0], max_lon=lonrange[1],
                        ax=ax, fig=fig, resolution='i', colorbar_flag=False)
         plt.colorbar(d.plots[-1], ax=ax, label='Reflectivity (dBZ)', shrink=0.6)
         ax = fig.add_subplot(122)
         data.plot_ampr_track(
```
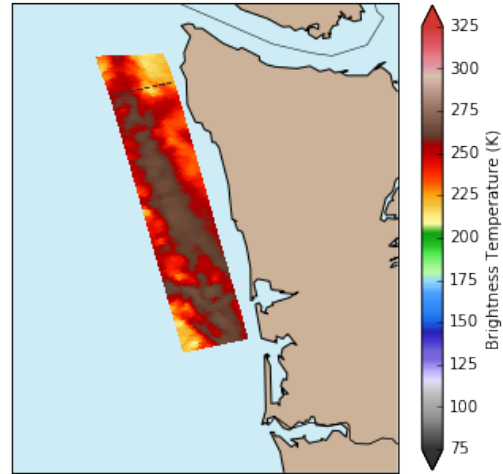
```
      '37a', scanrange=[2000, 2200], maneuver=False, basemap=d.basemap,
      ax=ax, fig=fig, show_grid=False)
```


KLGX 0.5 Deg. 2015-12-12T19:59:50.791000Z
Equivalent reflectivity factor
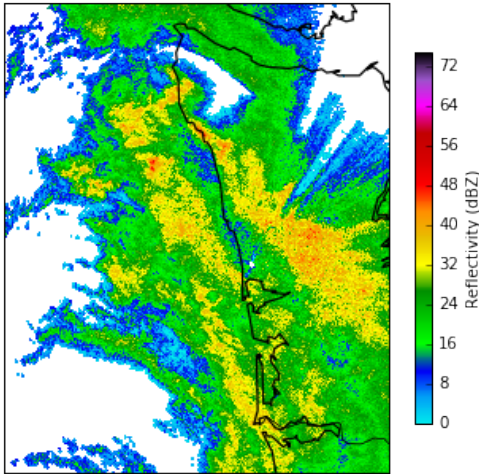
AMPR 37 GHz (A)
12/12/2015, 19:50:00-20:05:15 UTC

Well, the strong stratiform precipitation (with some embedded convection) offshore seems to correspond with enhanced 37 GHz emission TBs. But this signal is strong even at 19 GHz ...

```
In [68]: lonrange = [-126, -123]
         latrange = [46, 49]
         fig = plt.figure(figsize=(10, 10))
         ax = fig.add_subplot(111)
         d1 = pyart.graph.RadarMapDisplay(radar)
         d1.plot_ppi_map('REF', 1, vmin=0, vmax=75, cmap='pyart_NWSRef',
                     min_lat=latrange[0], max_lat=latrange[1],
                     min_lon=lonrange[0], max_lon=lonrange[1],
                     ax=ax, fig=fig, resolution='i', colorbar_flag=False)
         plt.colorbar(d1.plots[-1], ax=ax, label='Reflectivity (dBZ)', shrink=0.6)
         data.plot_ampr_track(
             '19b', scanrange=[2000, 2200], maneuver=False, basemap=d1.basemap,
             ax=ax, fig=fig, show_borders=False, meridians=1, parallels=0.5)
```
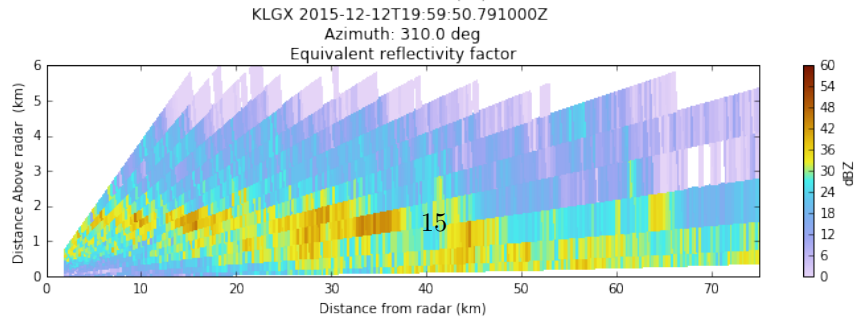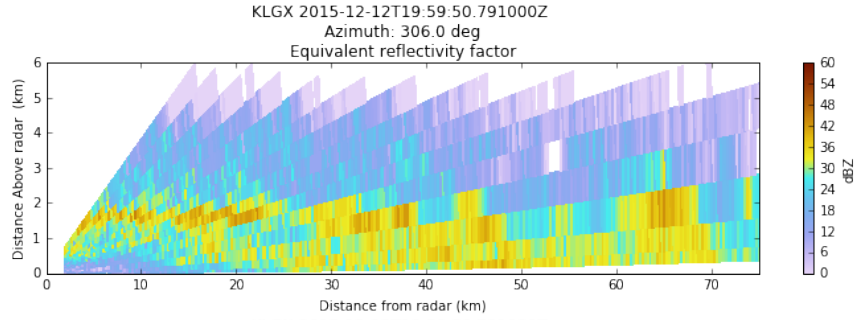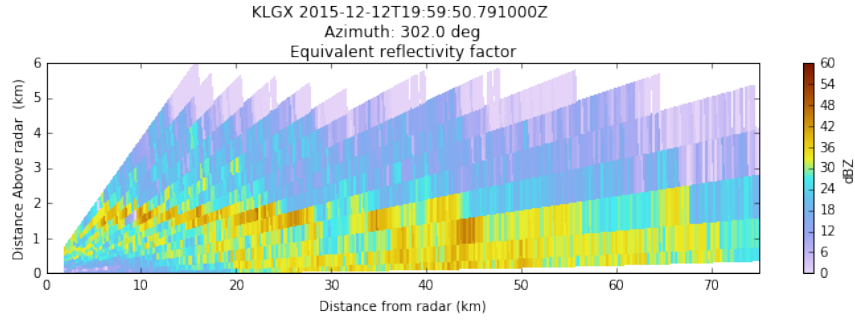
AMPR 19 GHz (B)
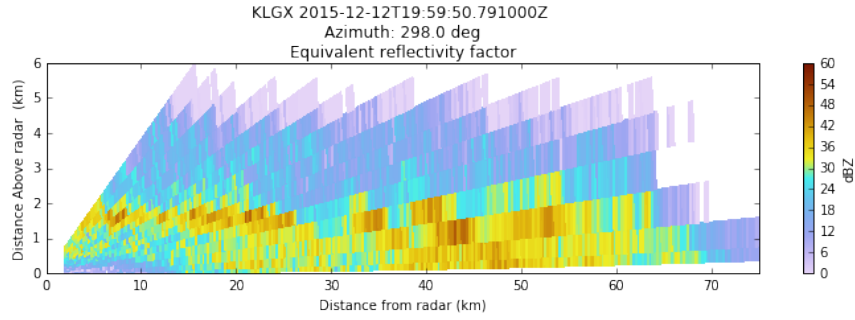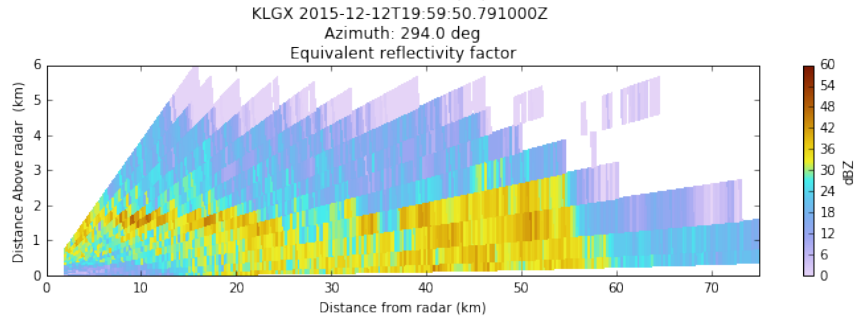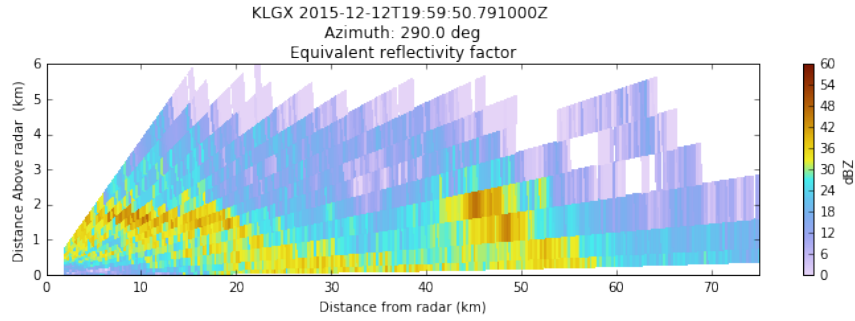12/12/2015, 19:50:00-20:05:15 UTC
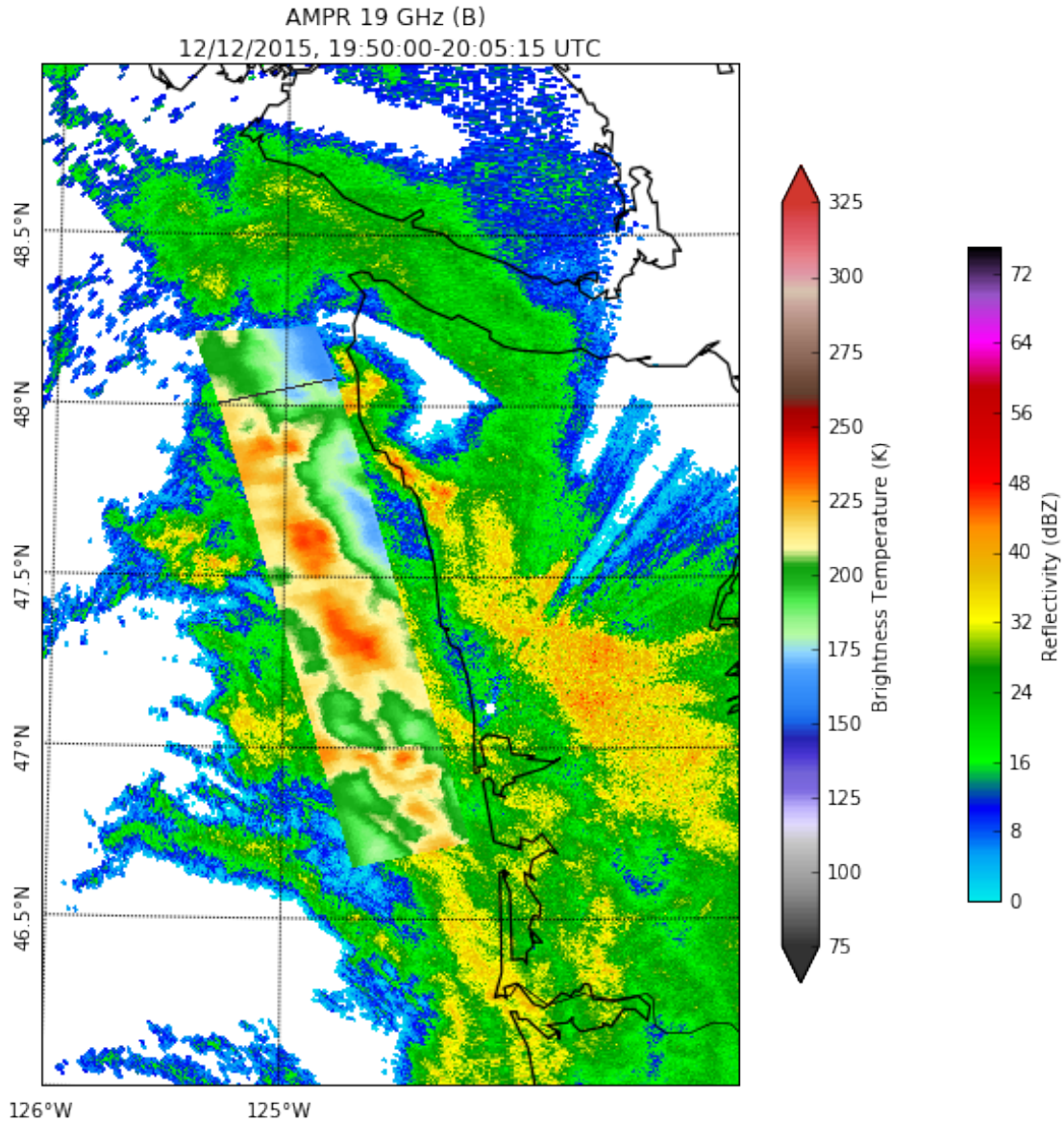
OK, what about the vertical structure of this precipitation? Let's not do the obvious and look at NPOL RHIs. Instead, since the data are already loaded let's look at faux-RHIs from KLGX, focusing on the strong echoes in the NW sector, just for kicks . . .

```
In [64]: azimuths = 290 + 4 * np.arange(6)
         rnglim, htlim, reflim = (0, 75), (0, 6), (0, 60)

         fig, (axXS1, axXS2, axXS3, axXS4, axXS5, axXS6) = \
             plt.subplots(6, 1, figsize=(10, 20))

         disp = pyart.graph.RadarDisplay(radar)
         disp.plot_azimuth_to_rhi('REF', azimuths[0], cmap='pyart_LangRainbow12',
                             vmin=0., vmax=60., colorbar_label='dBZ', ax=axXS1)
```

```
disp.set_limits(rnglim, htlim, ax=axXS1)
disp.plot_azimuth_to_rhi('REF', azimuths[1], cmap='pyart_LangRainbow12',
                         vmin=0, vmax=60, ax=axXS2, colorbar_label='dBZ')
disp.set_limits(rnglim, htlim, ax=axXS2)
disp.plot_azimuth_to_rhi('REF', azimuths[2], cmap='pyart_LangRainbow12',
                         vmin=0, vmax=60, colorbar_label='dBZ', ax=axXS3)
disp.set_limits(rnglim, htlim, ax=axXS3)
disp.plot_azimuth_to_rhi('REF', azimuths[3], cmap='pyart_LangRainbow12',
                         vmin=0, vmax=60, ax=axXS4, colorbar_label='dBZ')
disp.set_limits(rnglim, htlim, ax=axXS4)
disp.plot_azimuth_to_rhi('REF', azimuths[4], cmap='pyart_LangRainbow12',
                         vmin=0, vmax=60, colorbar_label='dBZ', ax=axXS5)
disp.set_limits(rnglim, htlim, ax=axXS5)
disp.plot_azimuth_to_rhi('REF', azimuths[5], cmap='pyart_LangRainbow12',
                         vmin=0, vmax=60, ax=axXS6, colorbar_label='dBZ')
disp.set_limits(rnglim, htlim, ax=axXS6)
plt.tight_layout()
```

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 290.0 deg
Equivalent reflectivity factor

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 294.0 deg
Equivalent reflectivity factor

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 298.0 deg
Equivalent reflectivity factor

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 302.0 deg
Equivalent reflectivity factor

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 306.0 deg
Equivalent reflectivity factor

KLGX 2015-12-12T19:59:50.791000Z
Azimuth: 310.0 deg
Equivalent reflectivity factor

15

The brightband just below 2 km shows up even in these coarse pseudo-RHIs. Then, further offshore, we see strong reflectivities even to the ocean surface. However, overall the precipitation system is relatively shallow and there are no indications of substantial graupel, etc. that might cause ice scattering. Maybe it's not so surprising to see such high microwave TBs?

OK, but what about earlier in the flight, when the ER-2 was far offshore? As it turns out, the KLGX radar didn't see much out there despite the enhanced 85-GHz TBs.

```
In [60]: lonrange = [-127, -123]
         latrange = [46, 48.5]
         fig = plt.figure(figsize=(12, 7))
         ax = fig.add_subplot(121)
         d.plot_ppi_map('REF', 1, vmin=0, vmax=75, cmap='pyart_NWSRef',
                        min_lat=latrange[0], max_lat=latrange[1],
                        min_lon=lonrange[0], max_lon=lonrange[1],
                        ax=ax, fig=fig, resolution='i', colorbar_flag=False)
         plt.colorbar(d.plots[-1], ax=ax, label='Reflectivity (dBZ)', shrink=0.6)
         ax = fig.add_subplot(122)
         data.plot_ampr_track(
             '85a', scanrange=[1650, 1700], maneuver=False, basemap=d.basemap,
             ax=ax, fig=fig, show_grid=False)
```
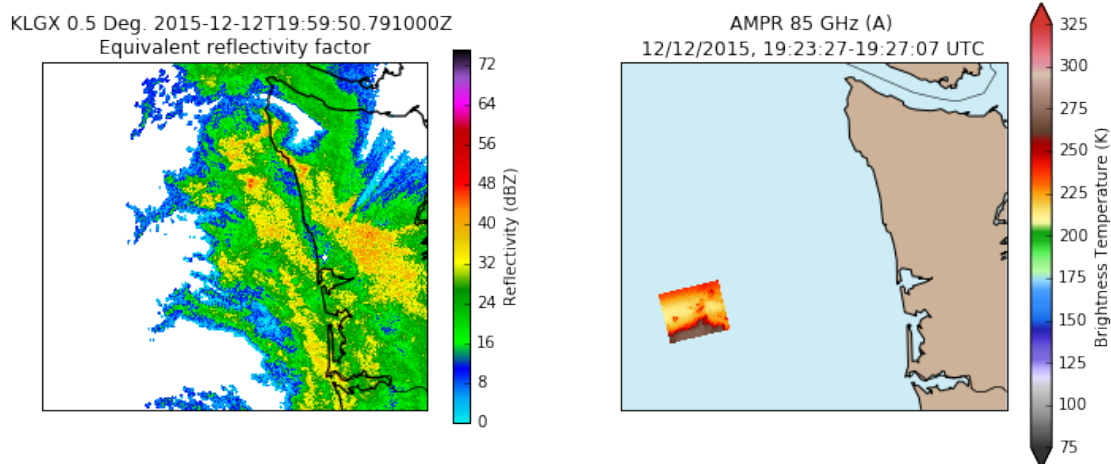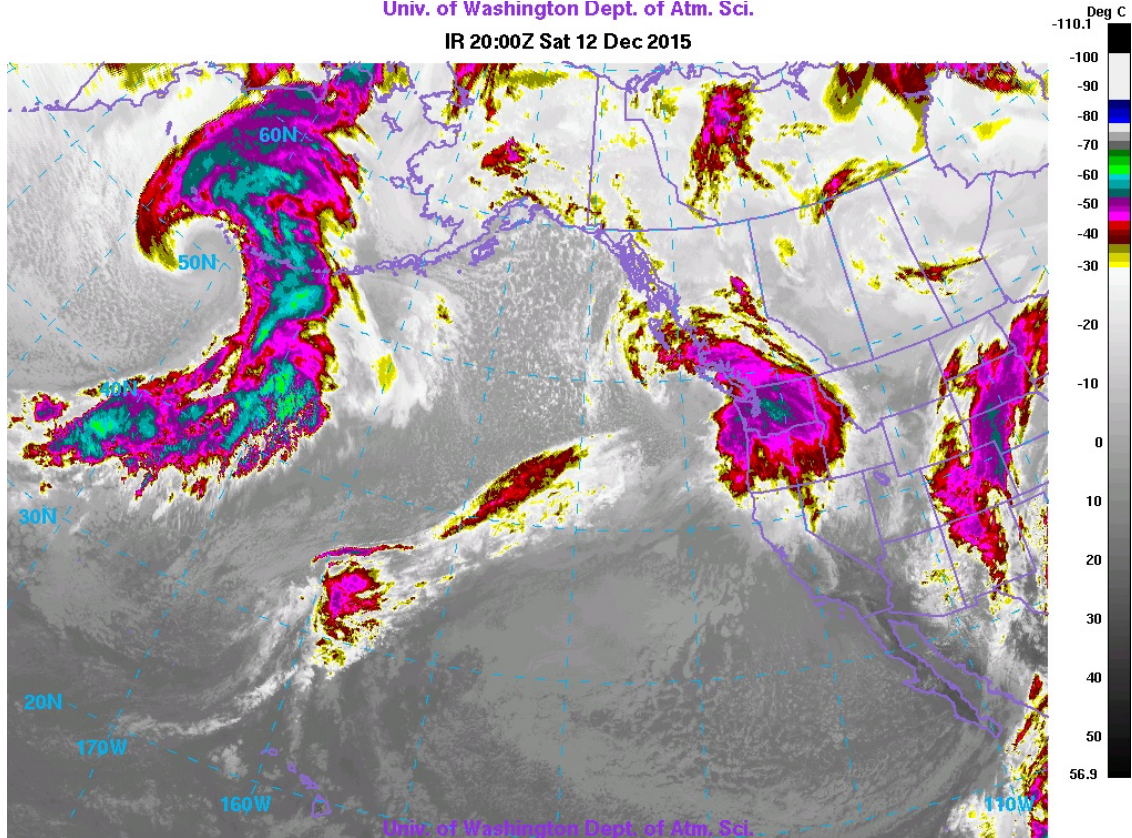

These are rather high TBs if this is truly "open water." But maybe there's thick cloud? Let's check the GOES IR around this time . . .

```
In [3]: Image('ops.goes_west.201512122000.ir_4km.png')
```

Out[3]:

Univ. of Washington Dept. of Atm. Sci.
IR 20:00Z Sat 12 Dec 2015

Yep, pretty thick cloud out there, off the coast of NW WA. So, not so surprising the microwave TBs were higher than one might expect over the open water. Thus, we tentatively conclude no significant QC issues with AMPR today, except for the reset as the ER-2 began to descend. We'll continue to look into this, however.

In [ ]:

In [ ]: