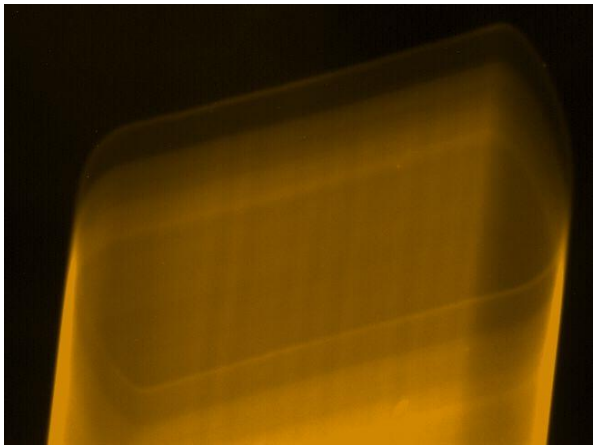

2nd Science Report DEEPWAVE Lidars
05 July 2014

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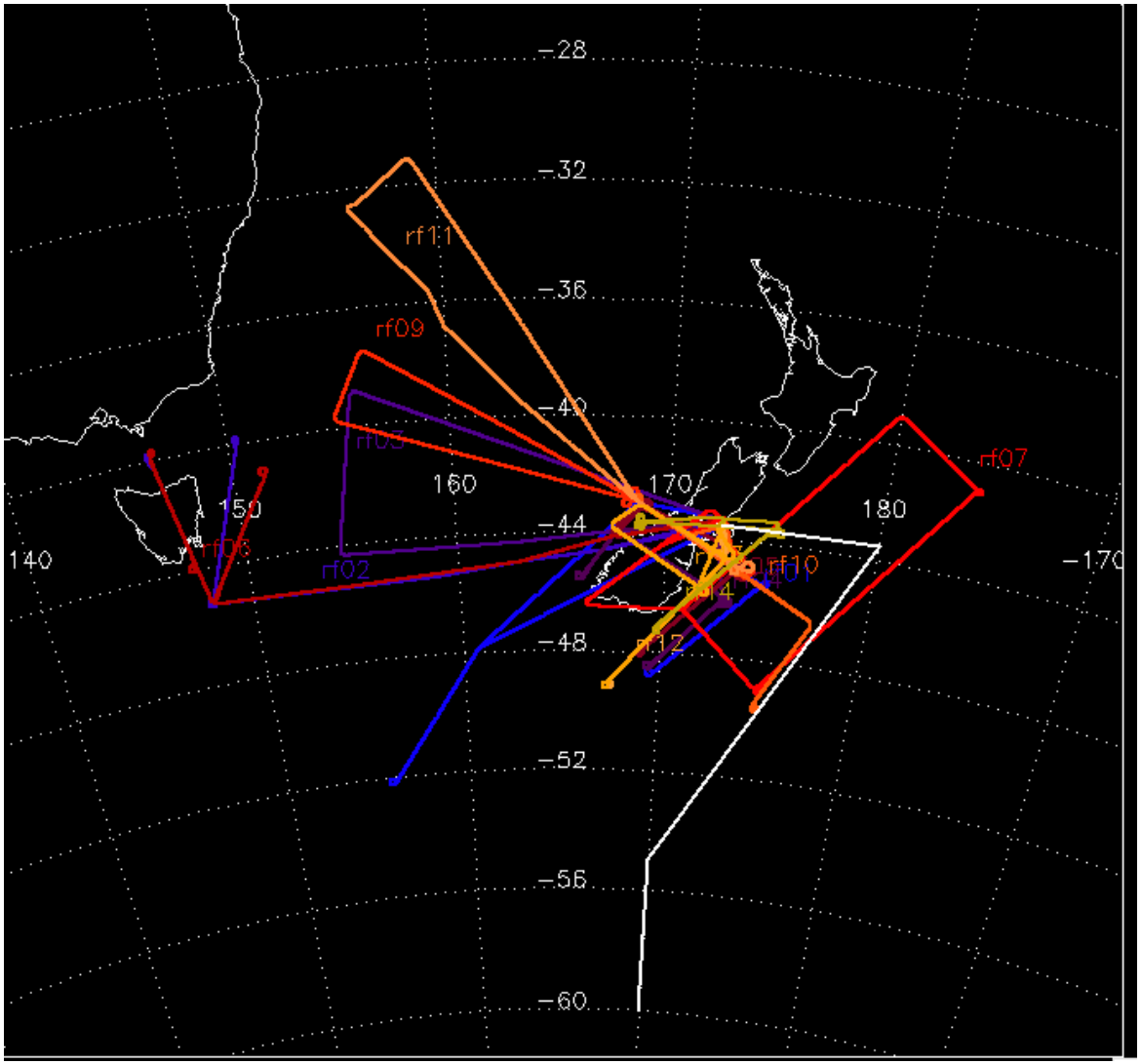
July 5, 2014

Science Goals

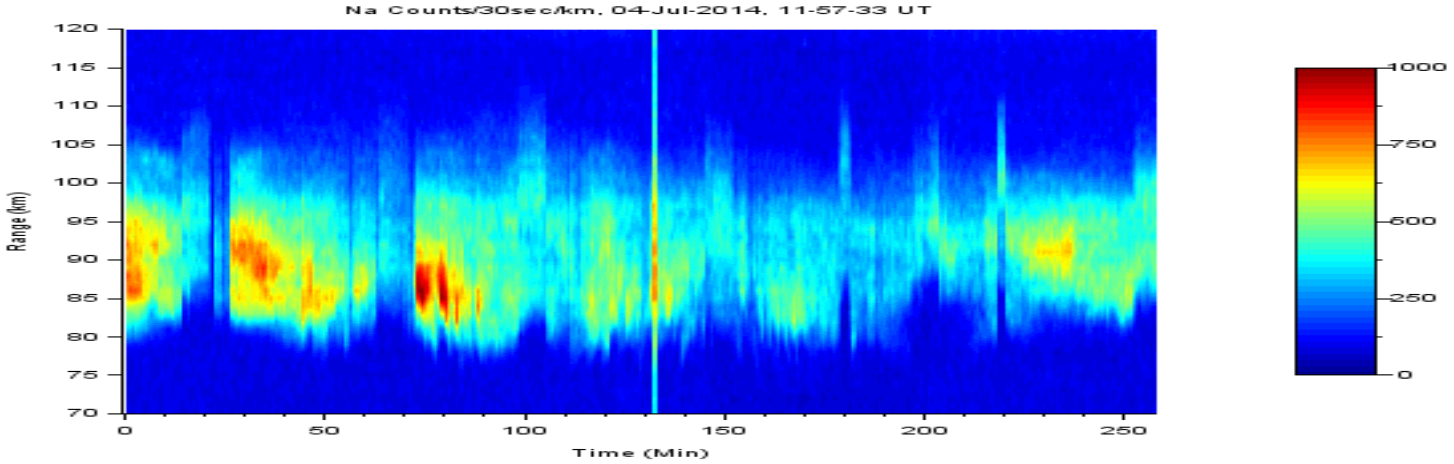
- Deep mountain wave propagation:
  - Many examples of likely trapped waves
  - Possible anti-correlation between tropospheric trapped waves and mesopause response, need to quantify
  - RF16**:** strong response both at 12km (V=9m/s) and mesopause Na/OH signals
    - Need to look at middle atmosphere lidar and satellite data to establish firm link
- Southern jet/storm GW hot spot
  - Some examples of possible convective forcing in flights to east and west
  - Rf17 and flights next week to the south should give more data

Science Goals



Data Products

- Na density:
  - Layer from 80-105km with sharp bottom side gradient
  - Good tracer of short period GW activity
  - Shows GW presence and vertical structure
  - Difficult to quantify due to Na chemistry
  - Useful data all flights except rf01 (no viewport), rf15 (daytime)
  - Real time plots in data catalog starting rf16
    - Turns produce a vertical shift in real-time plots
    - Star, moon, laser issues produce vertical stripes in plots



Data Products

- Mesopause temperatures from Na beams
  - More quantitative but doesn't resolve all the waves
  - Spectral measurement, does not assume hydrostatic equilibrium
  - Pulsed Na beam has better altitude but worse time resolution
    - We will show preliminary temperatures from this beam
  - Scanned beam has more signal but lower altitude resolution
    - Still working on analysis code
  - Cross talk between pulsed and scanned Na beam fixed between rf08 and rf09, temperatures more accurate after this
  - Useful data rf09-rf14, rf16
  - Measured crosstalk signal, so data from rf02-rf08 may be correctable

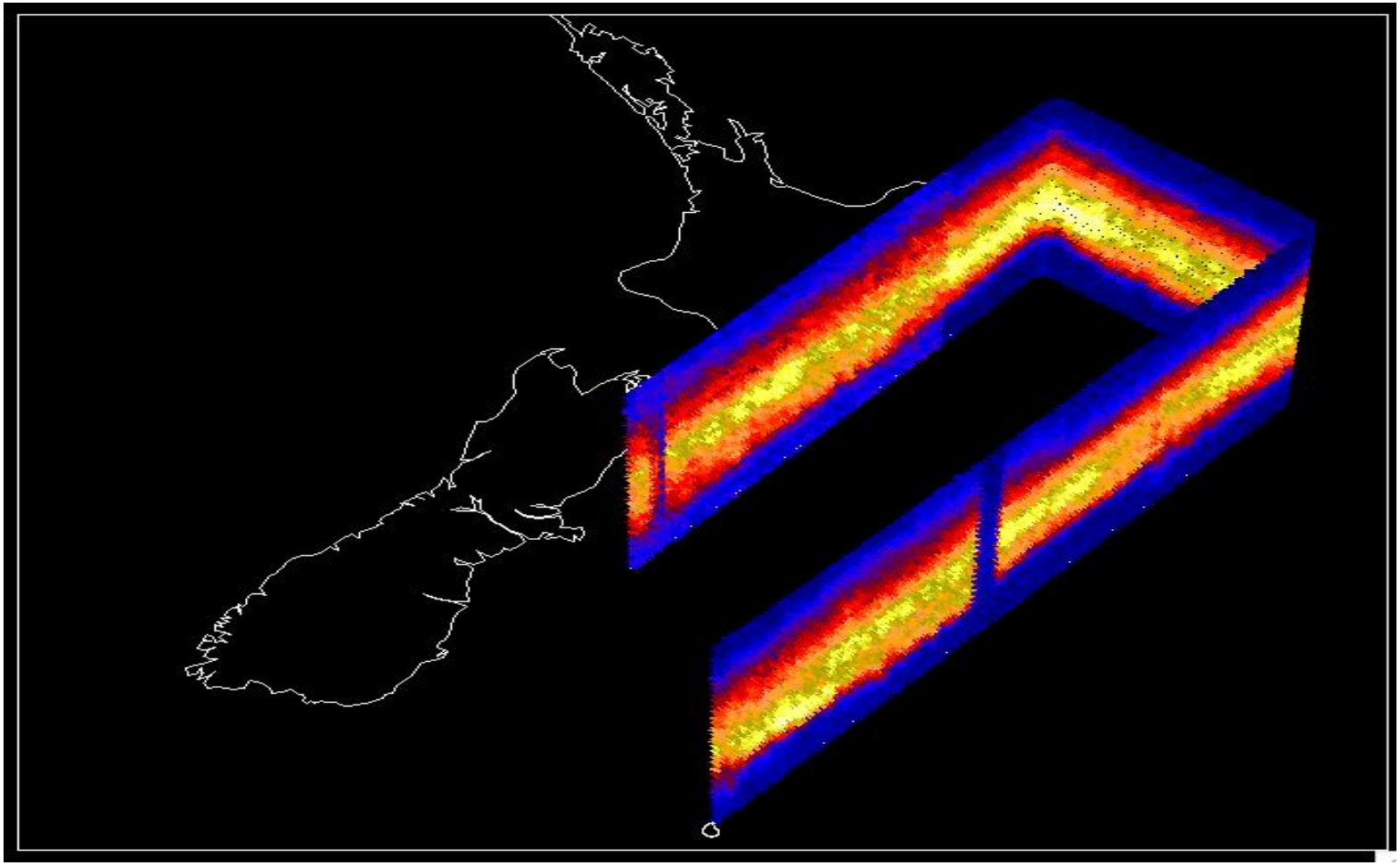
Data Products (cont)

- Temperatures and densities in upper stratosphere/mesosphere
  - Measure total density with UV beam, integrate density to get temperature from assumed temperature start point at top of profile
  - Start point affects top 1-2 scale heights
  - Aerosols limit bottom of profile to 25-30km
  - 25-75km coverage integrating whole flight (~5 hours)
  - 25-65km coverage with 30 min integration
  - 1K error at 40km with 2 min integration
  - Can look at signal variations (density/aerosol layers/high cirrus/PSC) at high resolution (200m hor., 37m vert.) from 15-25km
  - Good data all flights except rf01 (no viewport), rf03 (bad connection in UV receiver), rf15 (daytime)

Data Products (cont)

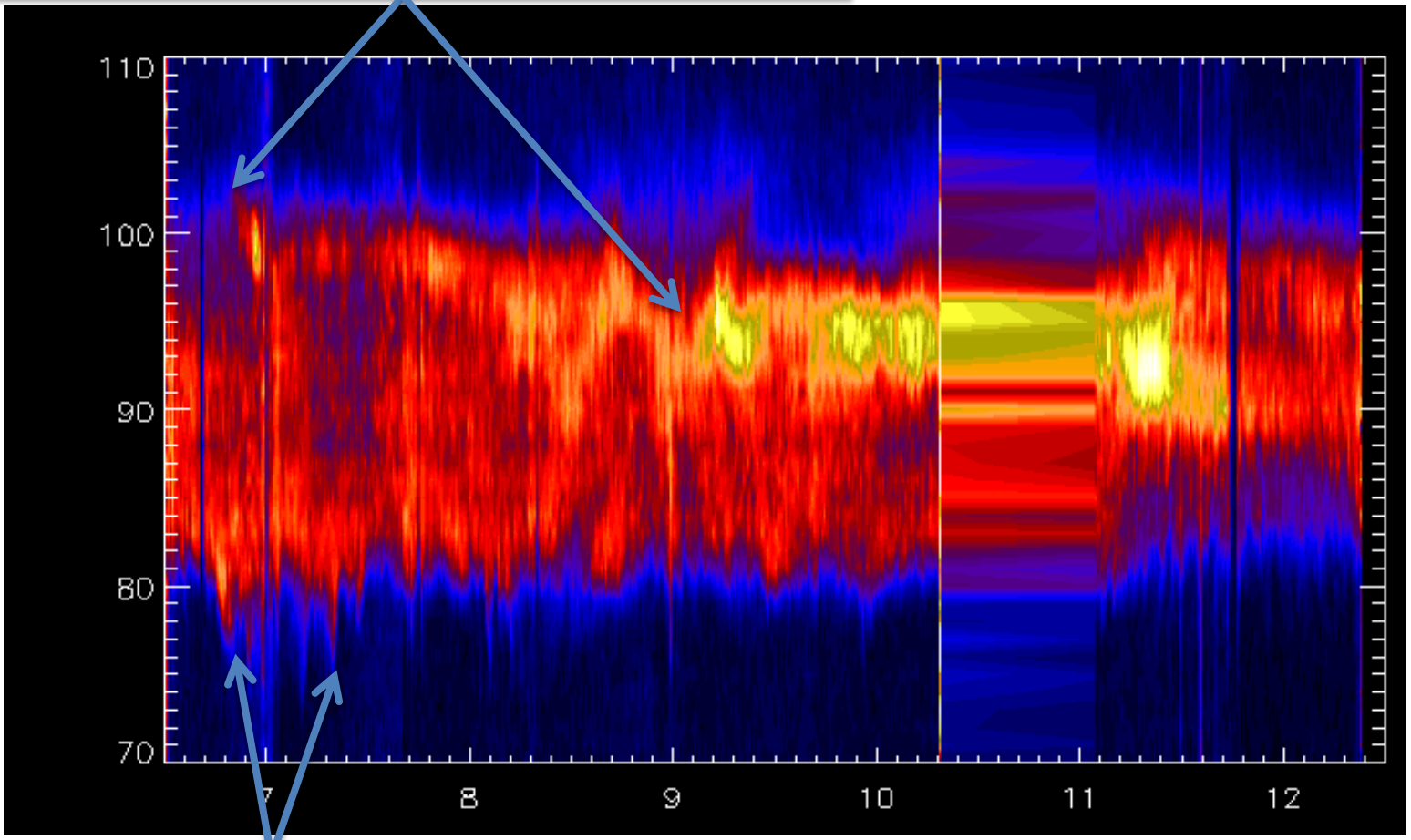
- Vertical winds 15-25km from Double-Edge filter
  - Filter has taken data rf02-rf14, rf16 with expected signal levels
  - First deployment of this technique, data analysis program not finished
  - Laser frequency control not as good on the airplane as on the ground (vibration, turbulence) or during test flights (hanger)
  - Will likely only see large wave events (>+-3 m/s)

Na Density: rf07



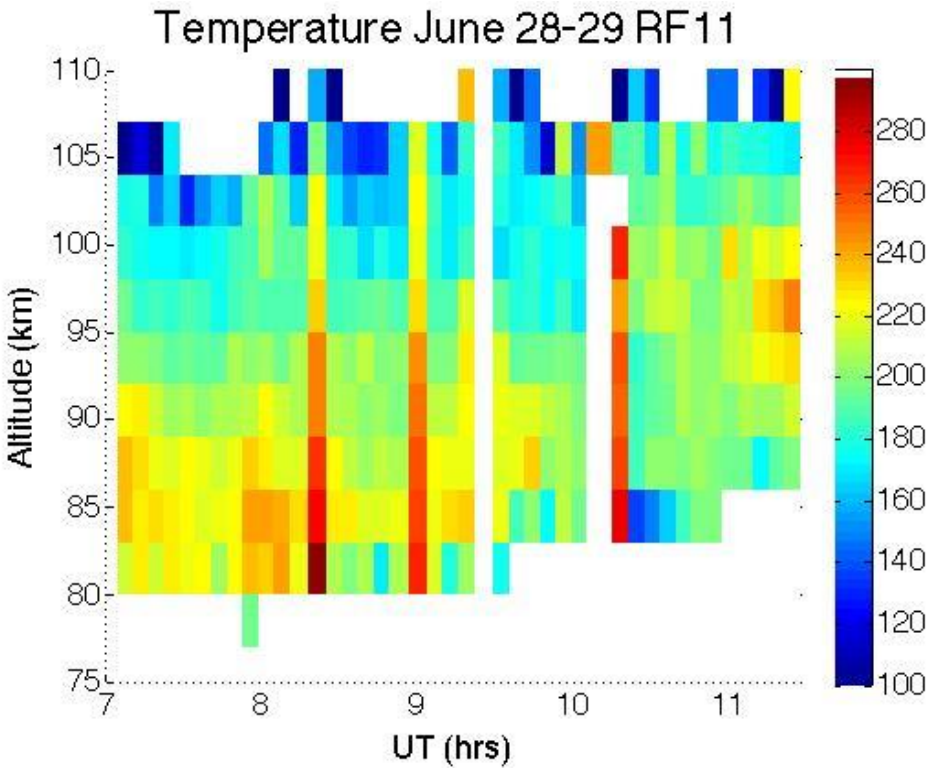
Waves in Na Density: rf12

Possible sporadic Na layer: ionospheric coupling



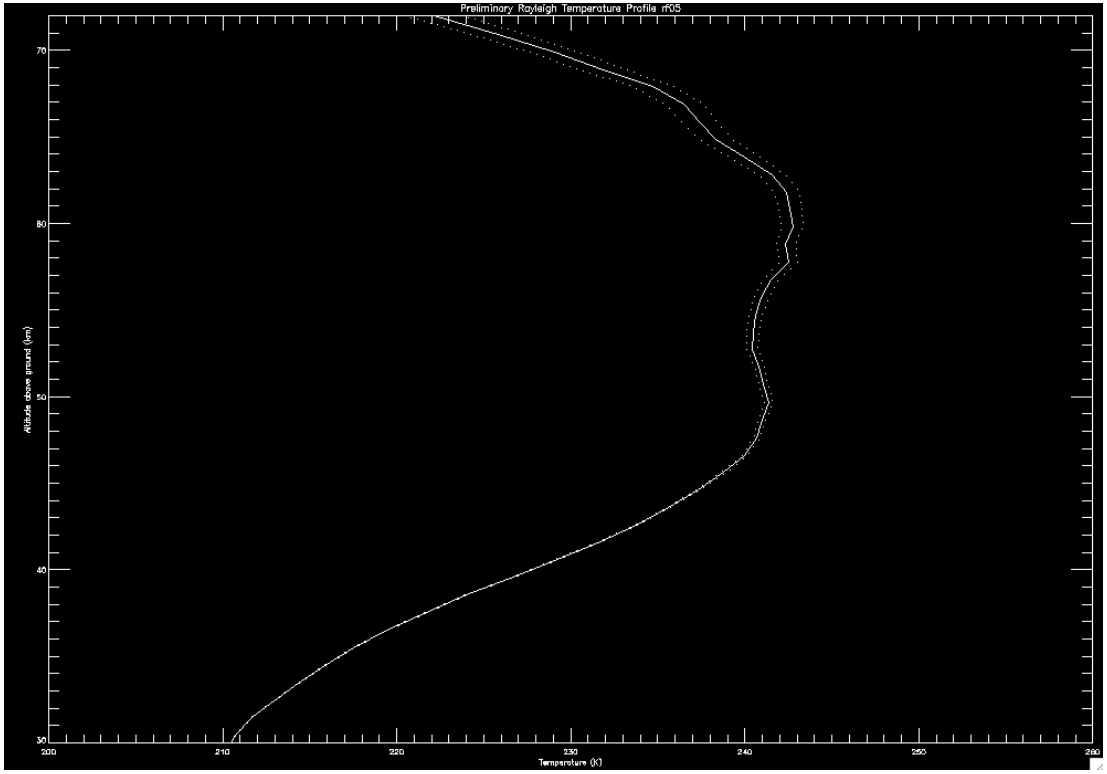
Repeated Structures
East and west of CHC
and over ocean

Na Temperatures, RF11



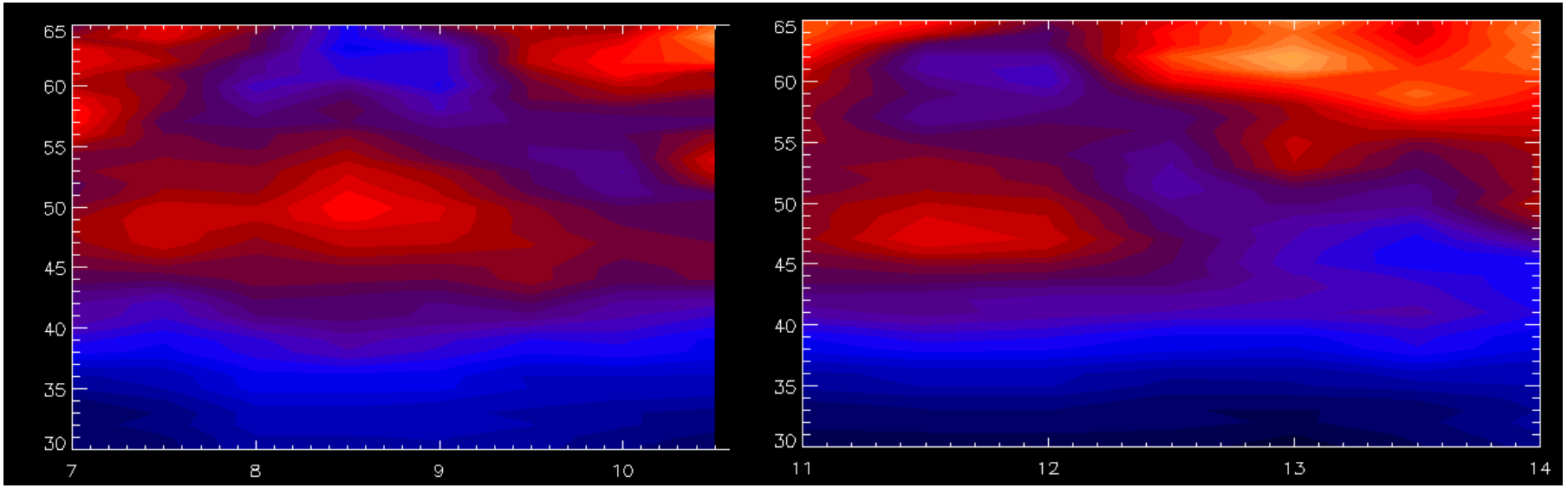
- Low power Na beam
- High winter mesopause
- Similar T variation at 87 km as TMapper
- Still working on calibration/analysis for high power scanned beam

Rayleigh Temperature: RF05



- RF05, 16 June 2014 integrated over entire flight path, plot range 30-72km altitude
- Shows double stratopause profile over a wide area

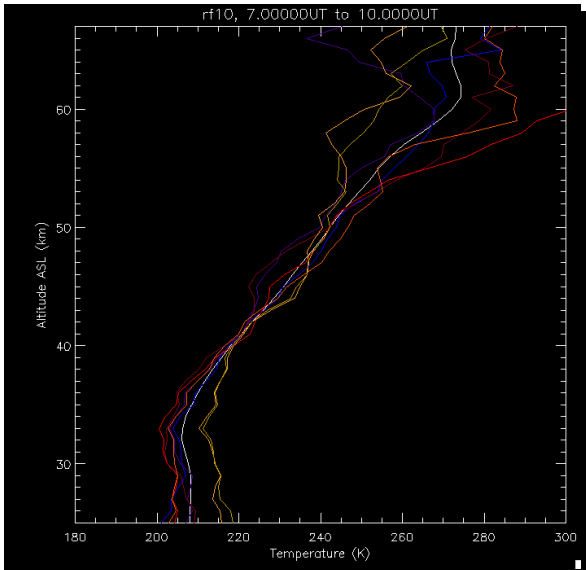
Rayleigh Temperature: RF07



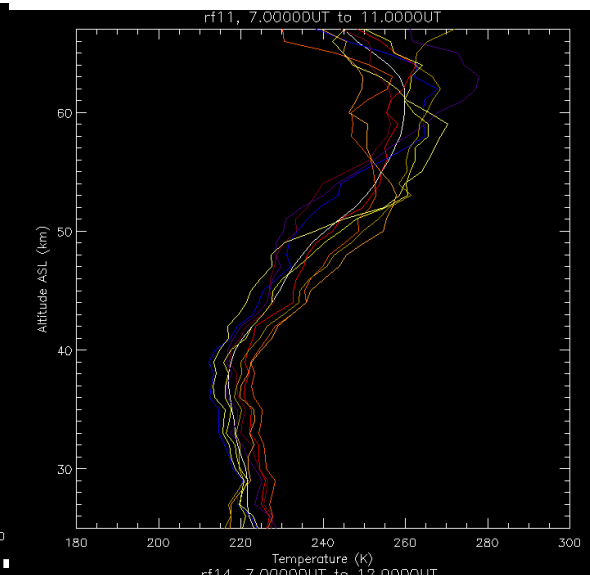
- RF07, 19 June 2014, 30 min integrations, 7-14UT
- Two temperature minima moving down separated by 3.5 hours
- Does not correlate with horizontal distance on several repeated tracks
- Likely due to 30km vertical wavelength, large horizontal scale wave

Temperatures 25-65km rf10-16, 7-12UT

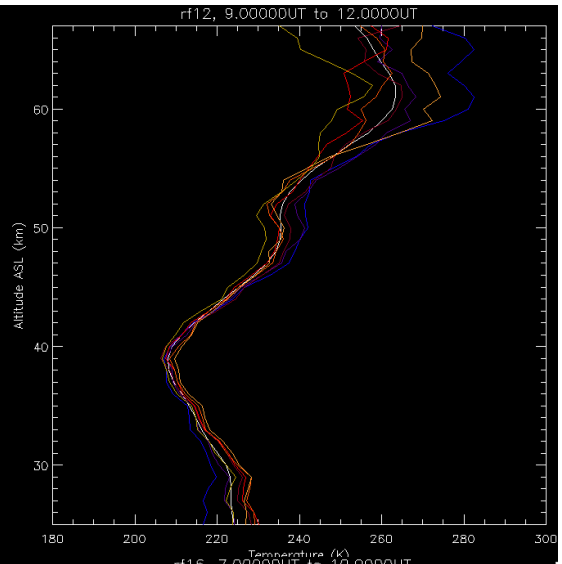
rf10, 25 June, 7-12 UT

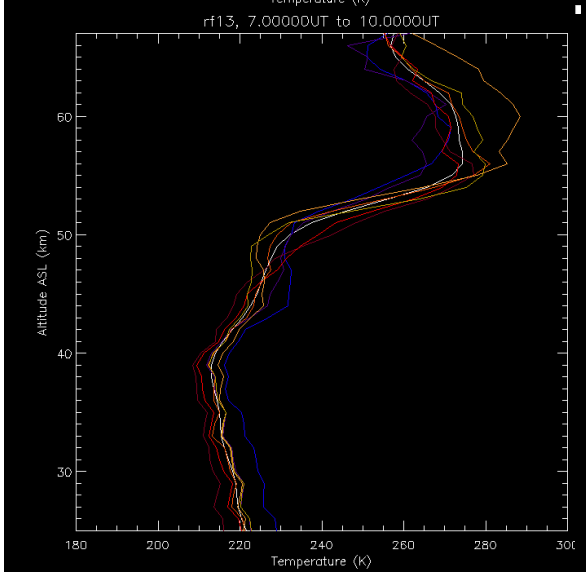


rf11, 28 June, 7-11 UT

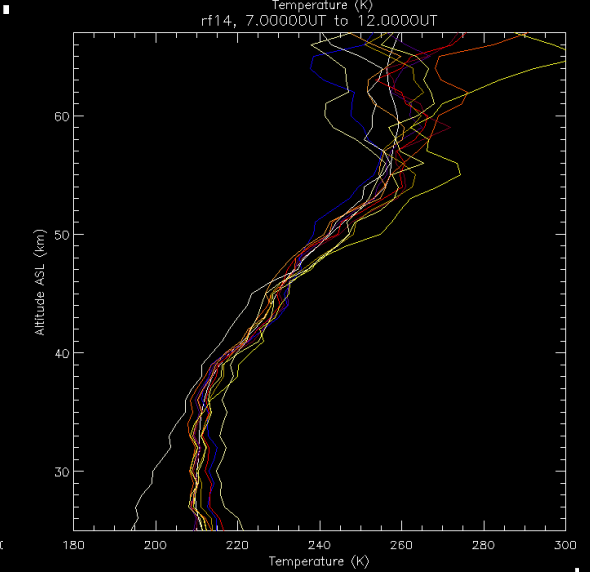


rf12, 29 June, 9-12 UT

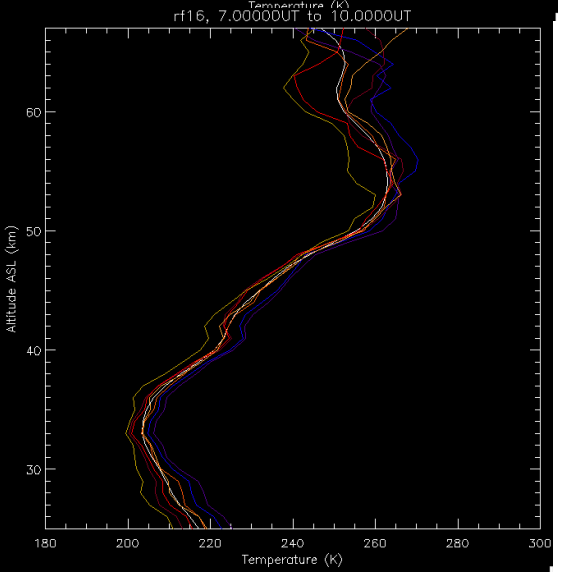




rf13, 30 June, 7-10 UT



rf14, 01 July, 7-12 UT



rf16, 04 July, 7-12 UT

Conclusions

- Same small scale waves observed in both Na and Tmapper data at the mesopause
  - Combined dataset can define horizontal and vertical structure of the waves
  - Some over mountains, some over oceans, need to connect to lower atmosphere sources
- Substantial changes in upper stratosphere/mesosphere temperature structure from day to day and over the course of a night
  - How does this affect small scale wave propagation from lower to upper atmosphere?
  - Will combine with radiosondes, DWS, MTP, and Na/OH temperatures to get almost complete temperature profiles from the 0 to 105 km