Data Analysis and Quality Control for NOAA's Hydrometeorological Testbed Program

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Introduction

- Senior at Penn State University
- Pursuing degrees in meteorology and energy business and finance
- Interned in Boulder, CO at the Earth Systems Research Laboratory – Physical Sciences Division (NOAA's Office of Oceanic and Atmospheric Research)


PennState
PENN STATE
3
DOWN
TO GO
6:29
BALL ON
BUFFALO
3
QTR
2
We Are
Penn State!
TOYOTA
PHEAA
PEPSI
MERCURY
PENN STATE

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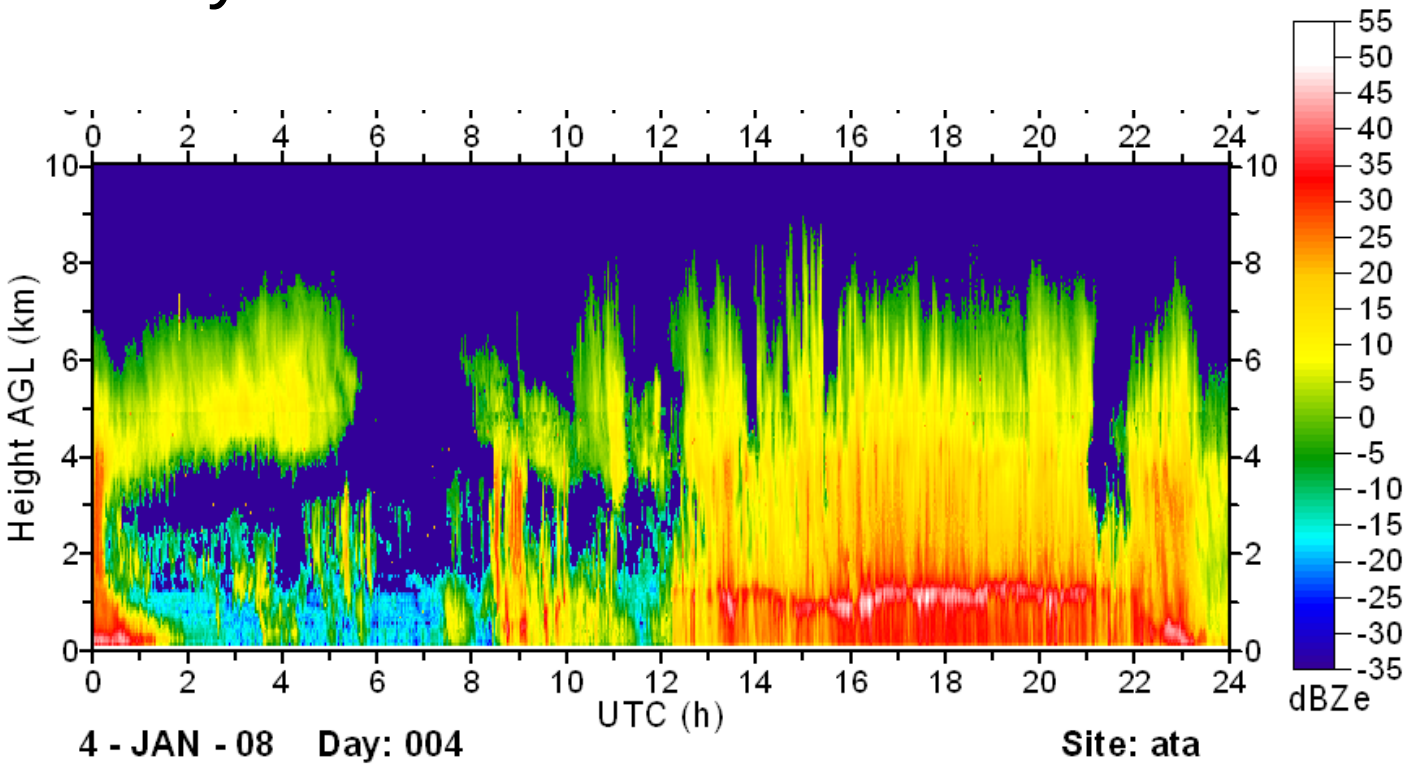
Outline

- Precipitation and brightbands
- Hydrometeorological Testbed (HMT) Program
- Rainfall process partitioning
- Visualizing BB data
- Why this is important…

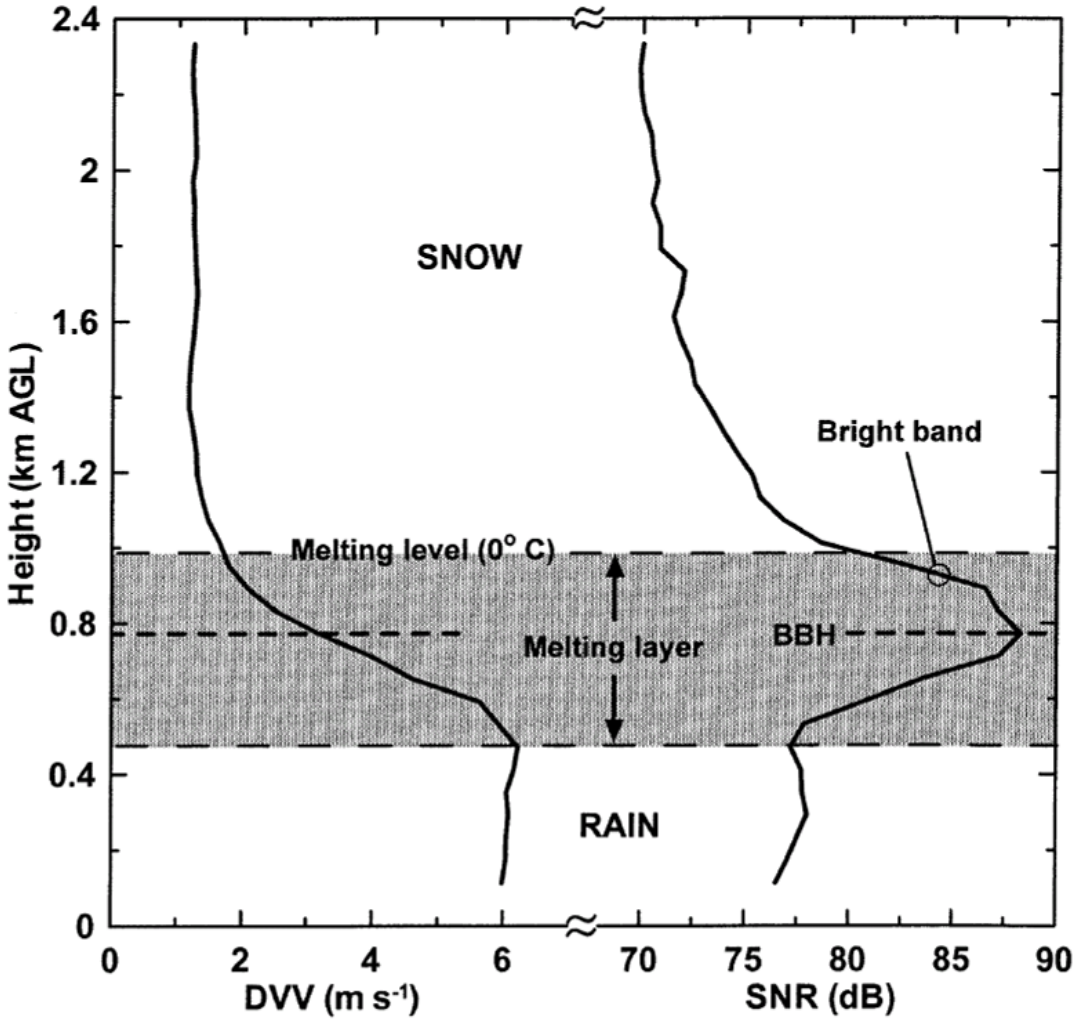
What is a brightband?

- A brightband is a layer of enhanced radar reflectivity.



Precipitation 101

- Precipitation that has a radar brightband starts as snow.
- It melts on its way to the surface.
- The brightband height can be used as a proxy for snow level.



4 August 2008

White et al., 2002, Journal of Atmospheric and Oceanic Technology

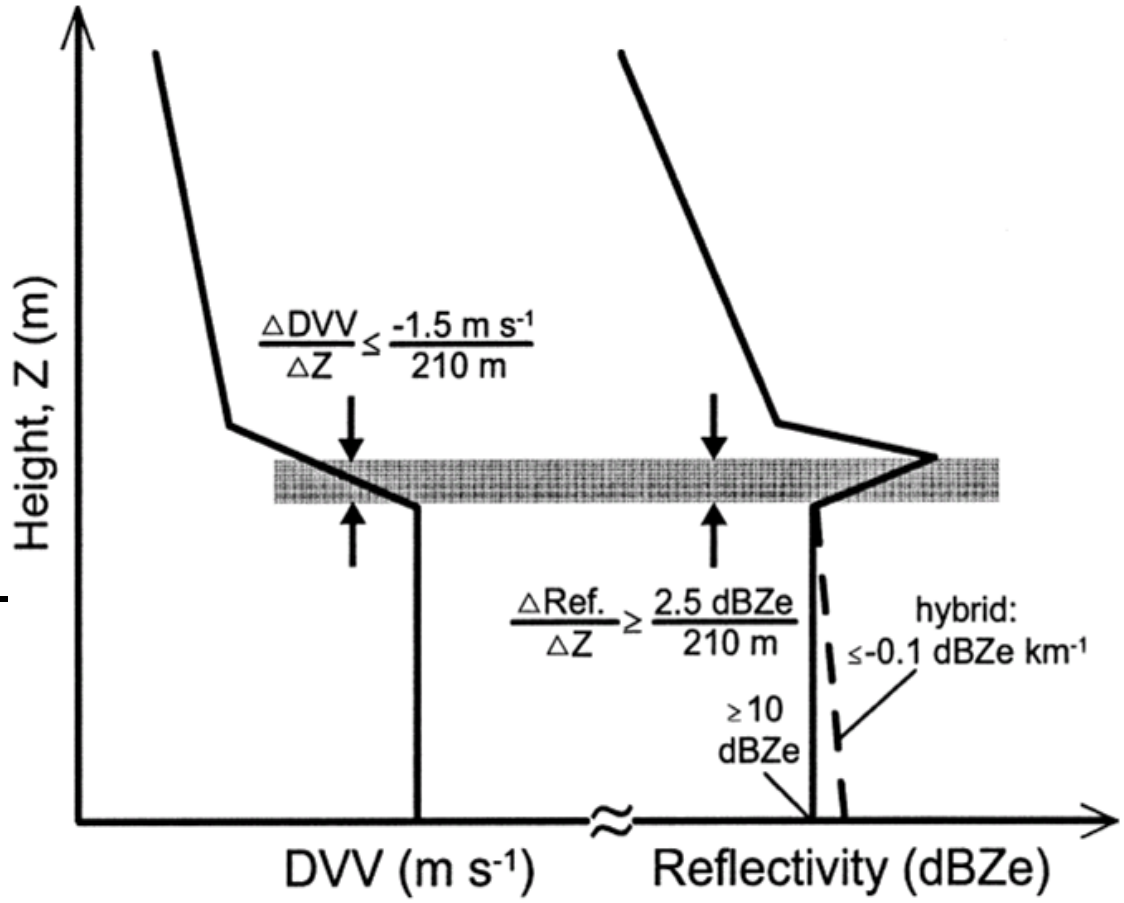
NOAA's HMT Program

- Providing near real time snow level data can help improve runoff/flooding forecasts.
- Snow level information is also important for emergency response crews, road maintenance, ski industry, etc.

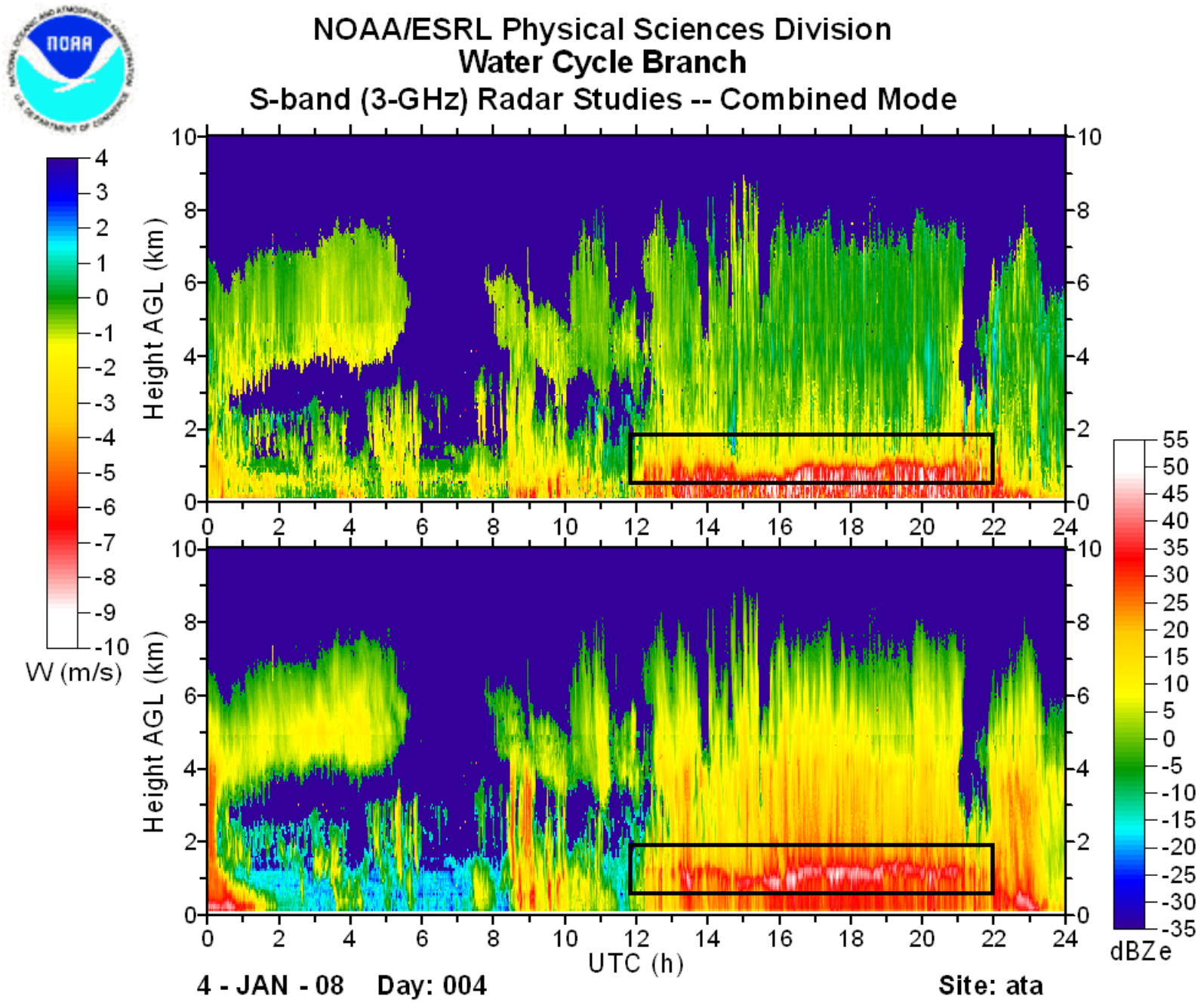
Rainfall Process Partitioning

Over 210 meters…

- Increase in reflectivity – at least 2.5 dBZ
- Decrease in vertical velocity – at least 1.5 m/s



White et al., 2003, Journal of Hydrometeorology


NOAA/ESRL Physical Sciences Division
Water Cycle Branch
S-band (3-GHz) Radar Studies -- Combined Mode
Height AGL (km)
Height AGL (km)
UTC (h)
W (m/s)
dBZe
4 - JAN - 08 Day: 004
Site: ata

Rainfall Process Partitioning

	A	B	C	D	E	F	G	H	I	J
1	6	0	30	1.778	15	11	0	11	-9.999	warm
2	6	30	100	2.032	15	6	0	6	-9.999	warm
3	6	100	130	1.524	15	6	0	6	-9.999	warm
4	6	130	200	1.016	15	2	0	2	-9.999	warm
5	6	200	230	0.508	15	0	0	0	-9.999	neither
6	6	230	300	0.762	15	4	0	4	-9.999	warm
7	6	300	330	0.254						
8	6	330	400	0.508	15	0	0	0	-9.999	neither
9	6	400	430	0.254						
10	6	430	500	0.508	15	2	1	1	0.442	cold
11	6	500	530	1.016	15	12	0	12	-9.999	warm
12	6	530	600	1.016	15	12	0	12	-9.999	warm
13	6	600	630	1.778	15	15	0	15	-9.999	warm
14	6	630	700	1.778	15	15	0	15	-9.999	warm
15	6	700	730	1.778	15	12	2	10	2.032	warm
16	6	730	800	1.524	15	5	0	5	-9.999	warm
17	6	800	830	1.27	15	0	0	0	-9.999	neither
18	6	830	900	0.508	15	0	0	0	-9.999	neither
19	6	900	930	0.254						

- If the algorithm detects a brightband in 50% or more of the profiles, it is labeled “cold.”

Quality Control

- Compare
  - Tables of warm/cold rain
  - Reflectivity plots
  - Time series of temperature

Rainfall Process Partitioning

	A	B	C	D	E	F	G	H	I	J
1	6	0	30	1.778	15	11	0	11	-9.999	warm
2	6	30	100	2.032	15	6	0	6	-9.999	warm
3	6	100	130	1.524	15	6	0	6	-9.999	warm
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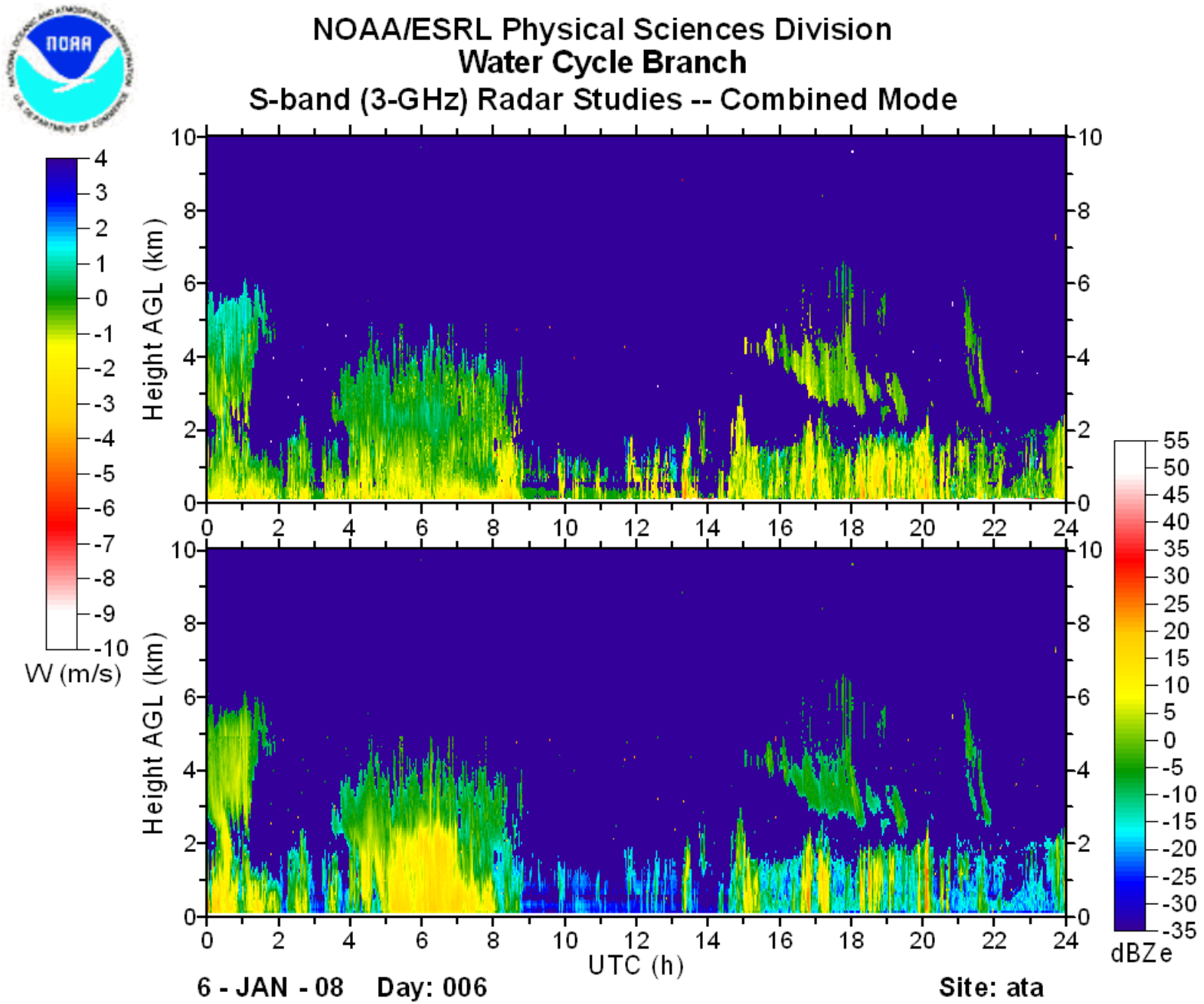
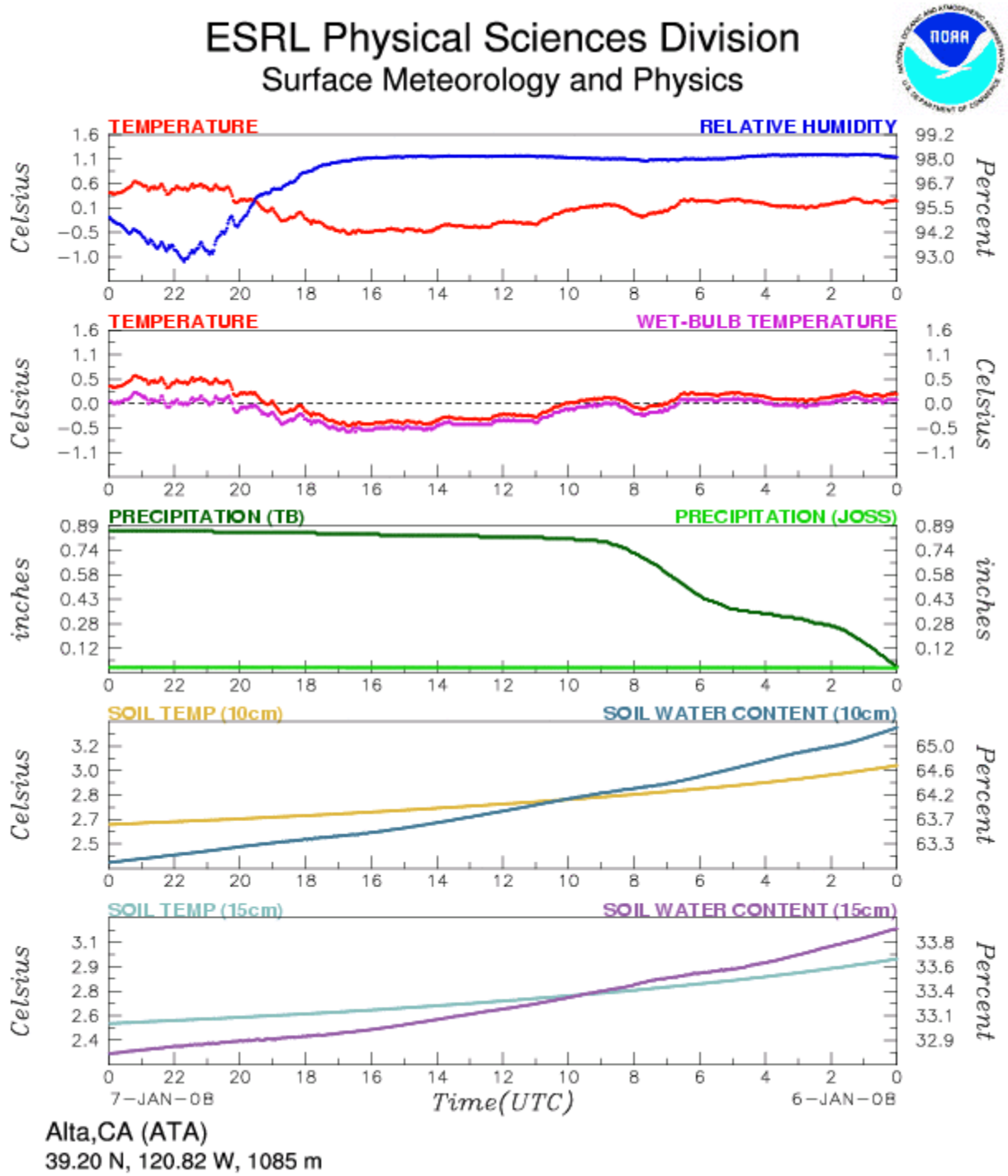

NOAA/ESRL Physical Sciences Division
Water Cycle Branch
S-band (3-GHz) Radar Studies -- Combined Mode
W (m/s)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
Height AGL (km)
0
2
4
6
8
10
12
14
16
18
20
22
24
UTC (h)
dBZe
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
6 - JAN - 08 Day: 006
Site: ata


ESRL Physical Sciences Division
Surface Meteorology and Physics
TEMPERATURE
RELATIVE HUMIDITY
Celsius
Percent
TEMPERATURE
WET-BULB TEMPERATURE
Celsius
Celsius
PRECIPITATION (TB)
PRECIPITATION (JOSS)
inches
inches
SOIL TEMP (10cm)
SOIL WATER CONTENT (10cm)
Celsius
Percent
SOIL TEMP (15cm)
SOIL WATER CONTENT (15cm)
Celsius
Percent
7-JAN-08
Time(UTC)
6-JAN-08
Alta,CA (ATA)
39.20 N, 120.82 W, 1085 m

Why do we study NBB rain?

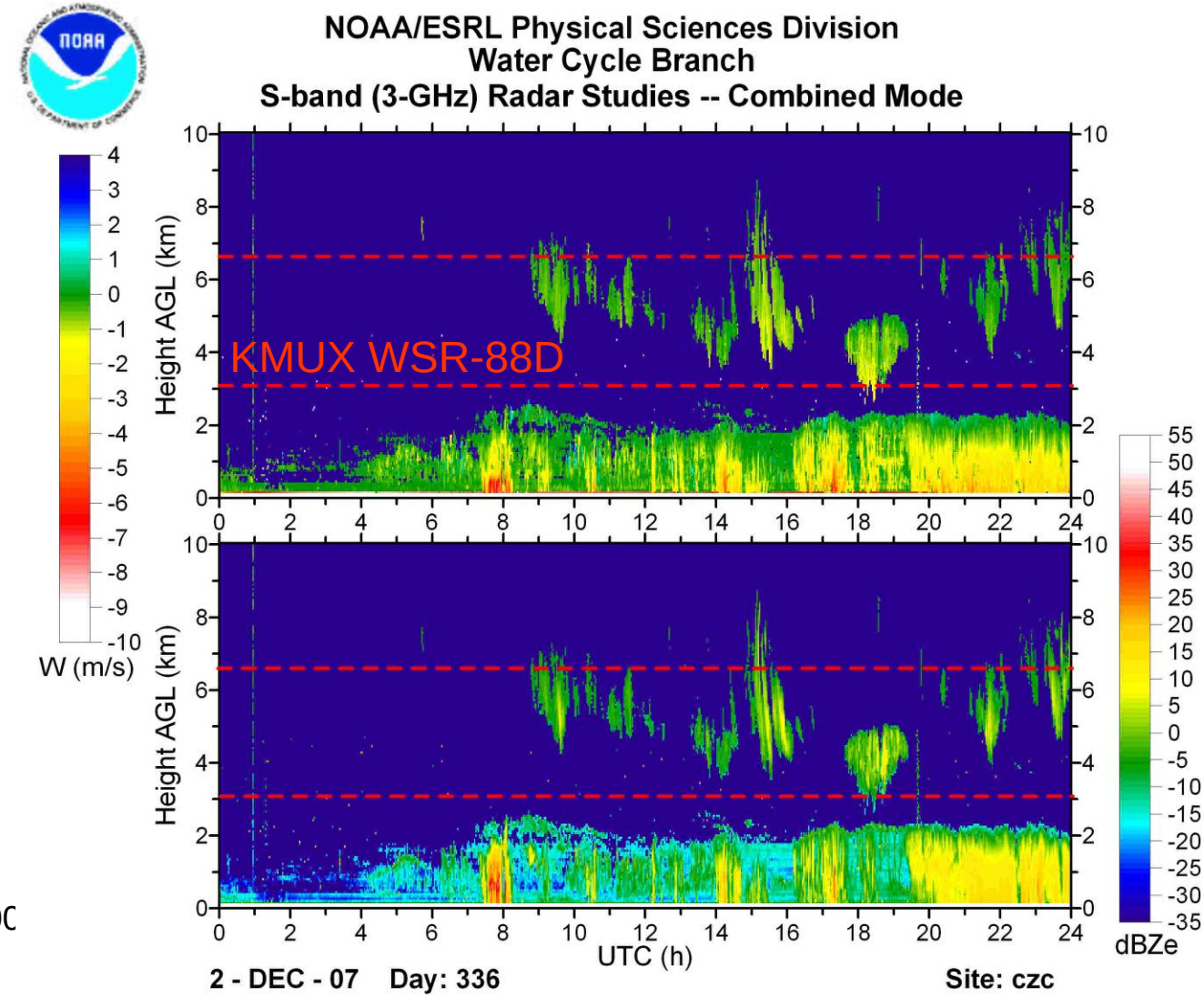
- Nonbrightband rain contributes up to 45% of total rainfall…

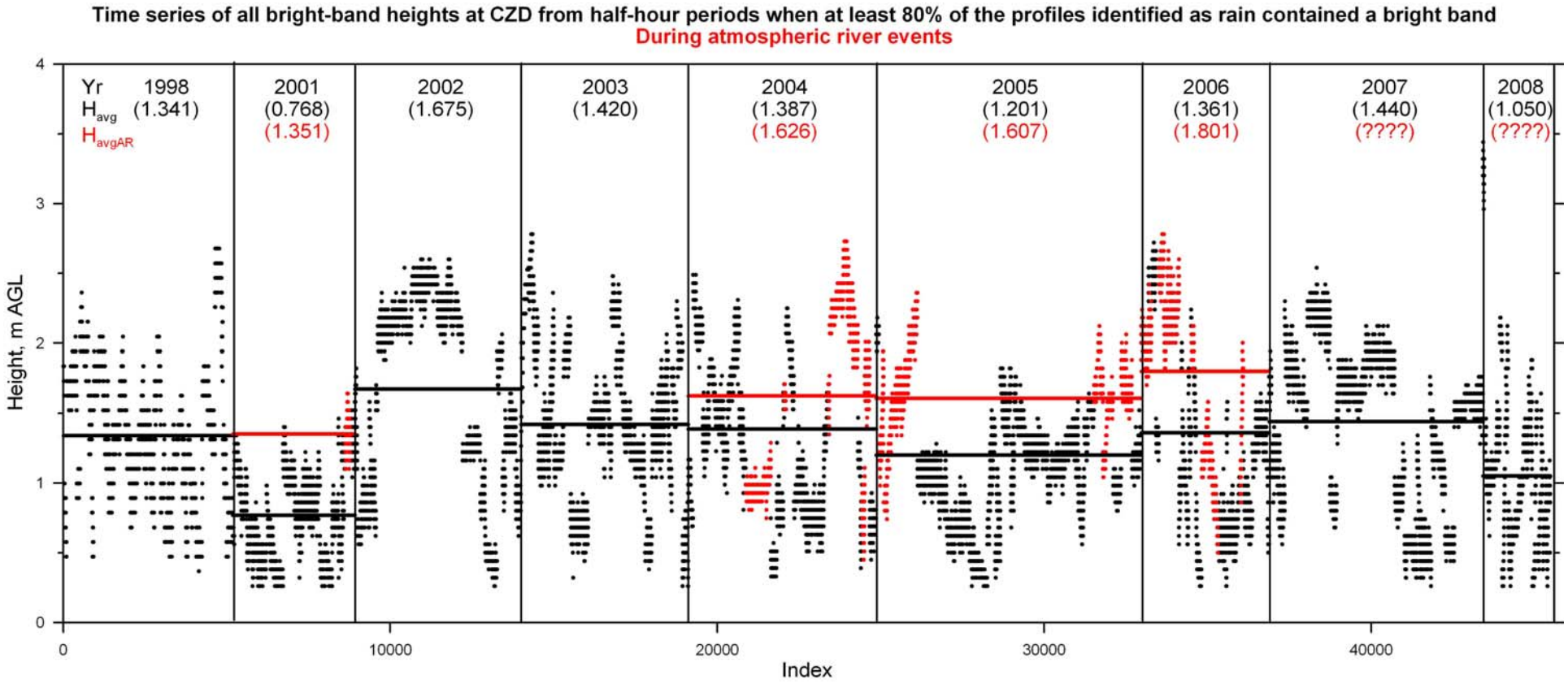
Table 2. Number of operating days for each S-band radar, and rainfall (mm) for the various rainfall types at each of the S-band sites.

Location and Year	# op. days	Total	Rain-fall per day	NBB	BB	Cold	Collision-coalesce	Con-vec-tive	Msg. due to ice/snow issues
CZD-98	90	1841.2	20.5	513.0	1097.0	292.0	1318.0	133.0	35.1
CZD-01	56	662.9	11.8	101.6	415.0	153.9	362.7	41.4	69.9
BBY-01	56	284.5	5.1	63.2	173.0	108.2	128.0	22.1	0.0
MBO-01/02	60	617.2	10.3	74.2	341.2	232.7	182.7	1.8	124.7
CZD-01/02	112	748.8	6.7	339.4	307.8	18.5	628.7	31.5	4.8
GVY-02	82	321.6	3.9	105.4	191.2	94.7	201.9	2.3	8.1
CZD-02/03	122	1343.9	11.0	532.9	768.0	13.5	1215.9	53.6	2.8
CZD-03/04	100	1161.0	11.6	469.7	560.6	288.8	741.4	81.3	0.0
BBY-03/04	103	571.8	5.6	180.1	292.3	123.4	349.0	65.0	0.0
CZD-04/05	142	776.7	5.5	202.7	417.1	52.8	566.9	72.4	12.4
CZD-05/06	162	2166.4	13.4	743.5	1027.2	151.1	1619.5	222.0	34.8
ATA-05/06	131	1987.6	15.2	292.9	1014.0	495.0	811.8	78.0	458.2
CZD-06/07	151	954.5	6.3	333.8	450.6	48.5	735.8	88.6	19.8
ATA-06/07	187	1058.7	5.7	194.6	442.5	308.4	328.7	23.6	315.7
CZD-07/08	141	1203.9	8.5	328.7	717.8	116.6	929.9	86.9	17.5
ATA-07/08	132	713.2	5.4	48.3	230.6	184.9	49.3	1.0	349.0
CFC-07/08	160	664.2	4.2	54.6	302.5	200.2	157.0	4.8	111.5

Neiman et al., 2005, MWR

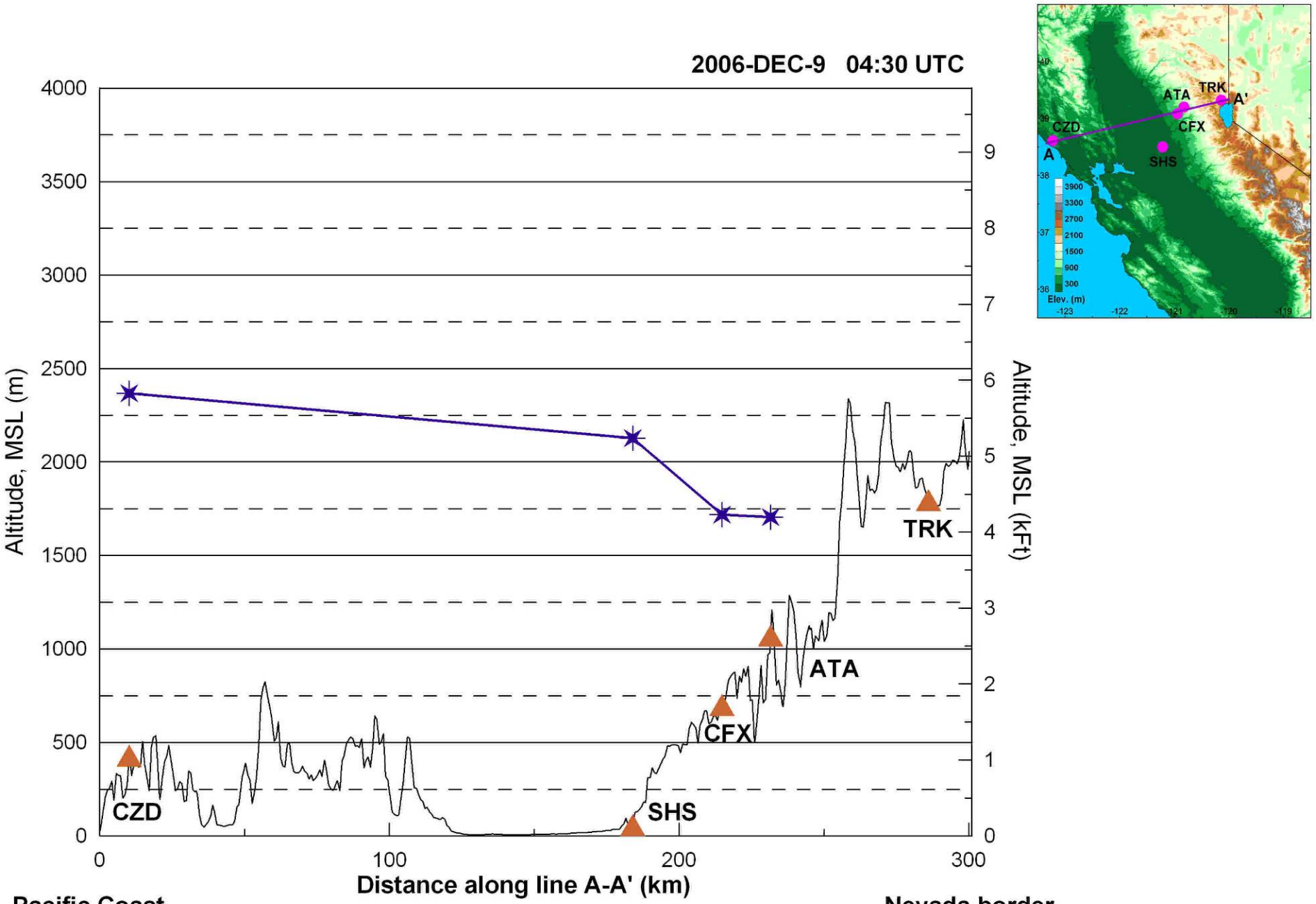
…and we can't see it.

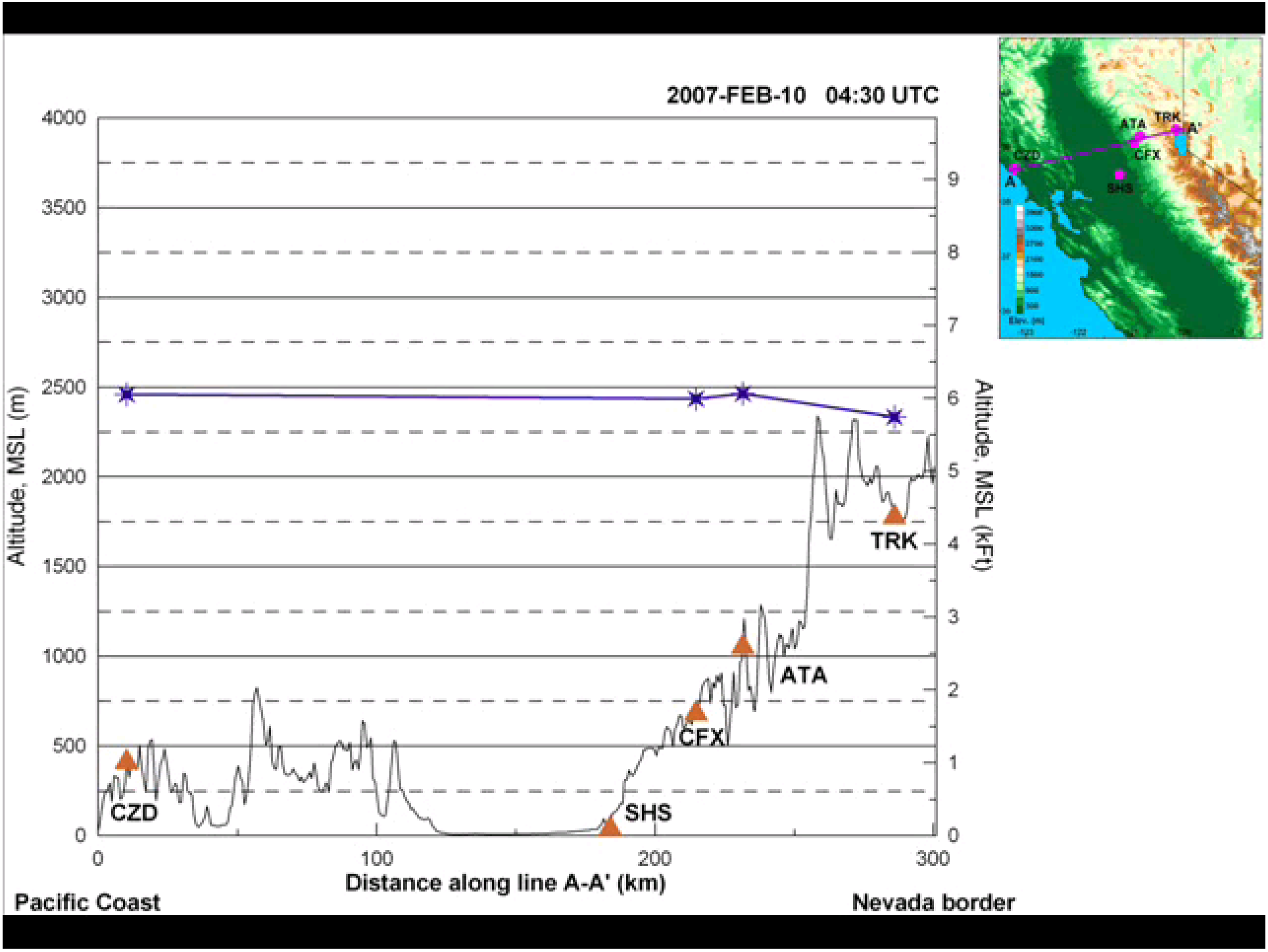



Time series of all bright-band heights at CZD from half-hour periods when at least 80% of the profiles identified as rain contained a bright band
During atmospheric river events
Yr 1998
H_{avg} (1.341)
H_{avgAR}
2001
(0.768)
(1.351)
2002
(1.675)
2003
(1.420)
2004
(1.387)
(1.626)
2005
(1.201)
(1.607)
2006
(1.361)
(1.801)
2007
(1.440)
(????)
2008
(1.050)
(????)
Height, m AGL
Index
0
1
2
3
4
0
10000
20000
30000
40000

Plotting Snow Level Variability

- Learned a new object-based language for use with Golden software (Grapher)
- Wrote script to create two templates and to plot horizontal variability in brightband height
- These plots can be used to look for correlations between the sites on the coast, or in the valley, versus the mountainous sites.


2006-DEC-9 04:30 UTC
Altitude, MSL (m)
Altitude, MSL (kFt)
Distance along line A-A' (km)
CZD
SHS
CFX
ATA
TRK
A
A'
Pacific Coast
Nevada border
Elev. (m)


2007-FEB-10 04:30 UTC
Altitude, MSL (m)
Altitude, MSL (kFt)
Distance along line A-A' (km)
Pacific Coast
Nevada border
CZD
SHS
CFX
ATA
TRK
A
A'
0
500
1000
1500
2000
2500
3000
3500
4000
0
100
200
300
1
2
3
4
5
6
7
8
9

Next Steps

- Graduate in May 2009
- Work in the field (research or private industry)
- Attend graduate school

Summary

- A brightband is a layer of enhanced radar reflectivity.
- The brightband height is the altitude of the maximum in radar reflectivity, and is used to approximate the snow level.
- Rainfall process partitioning identifies periods of brightband and nonbrightband rain.

Summary

- Plots of reflectivity were used to:
  - QC rainfall process partitioning.
  - QC brightband heights.
- I created plots of brightband height variability.

Acknowledgements

- Partners in crime:
  - Allen White
  - Dan Gottas, David Kingsmill, Paul Neiman, Bob Zamora

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Bibliography

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- White, Allen B., James R. Jordan, Brooks E. Martner, F. Martin Ralph, and Bruce W. Bartram. "Extending the Dynamic Range of an S-Band Radar for Cloud and Precipitation Studies." Journal of Atmospheric and Ocean Technology 17 (2000): 1226-1234.