

Yale Vertically Pointing Radar in T-Rex: Preliminary Analysis

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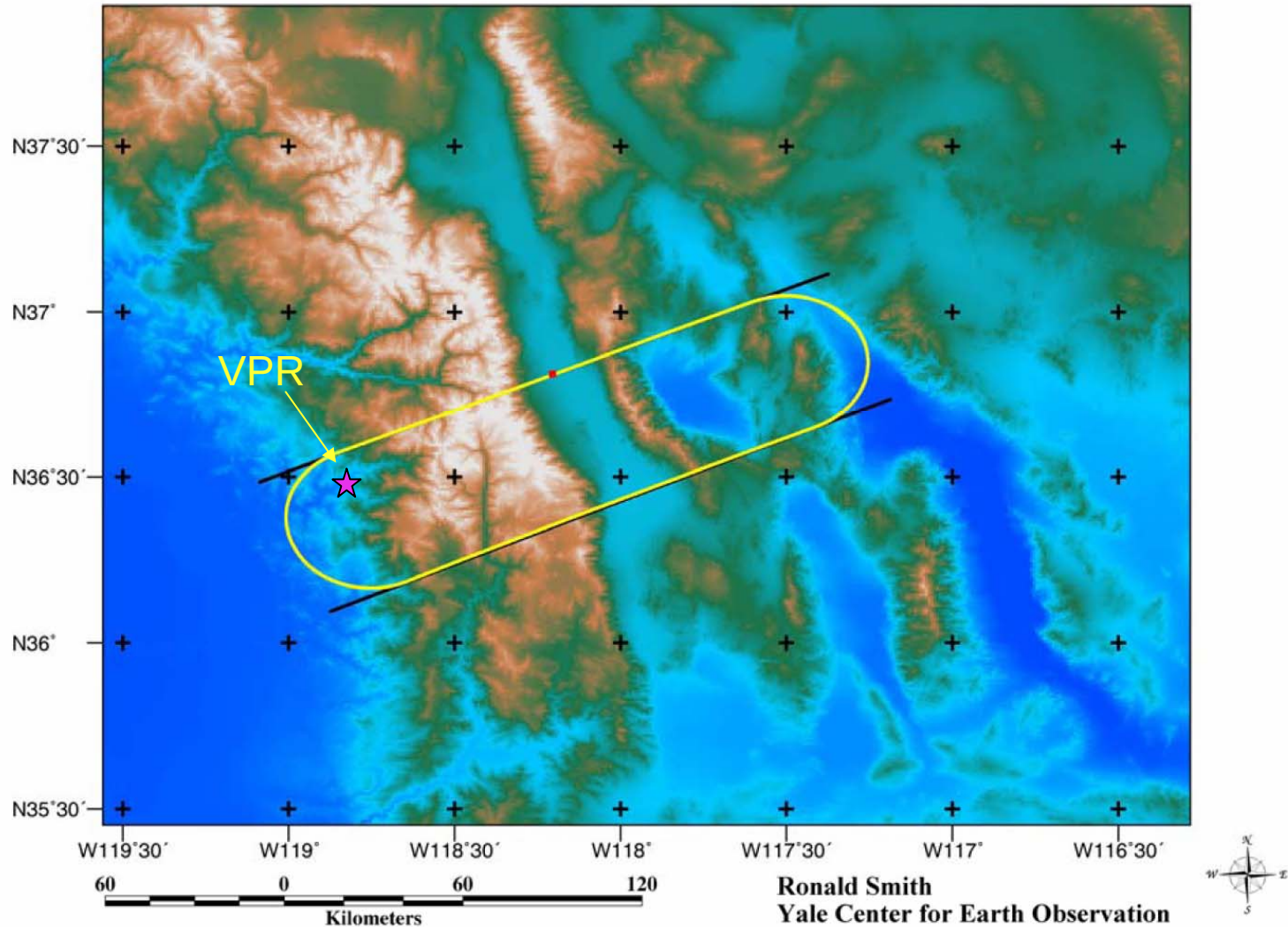
Yale Geology & Geophysics

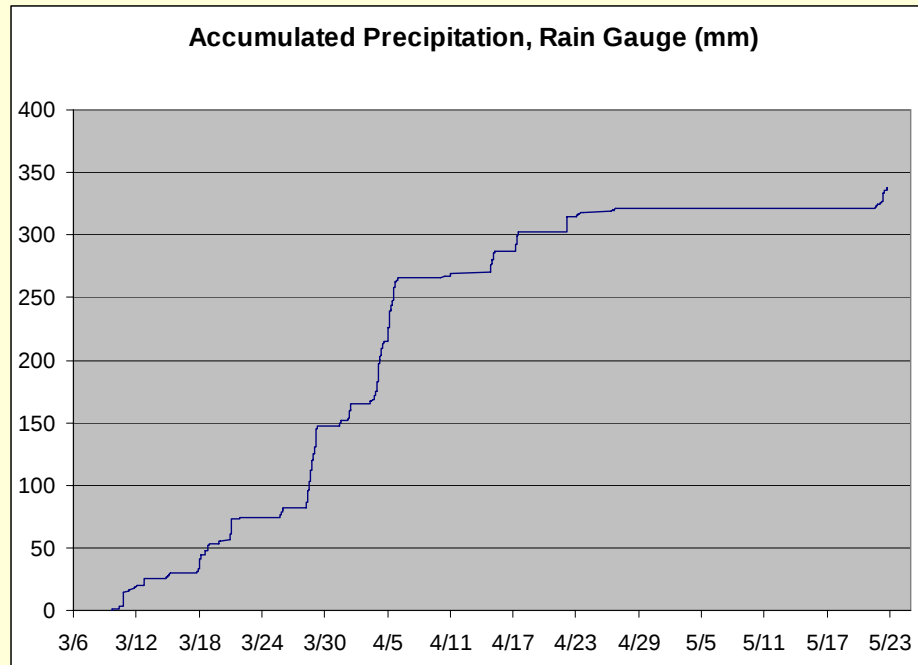
11 March 2008

- METEK vertically pointing radar was deployed in western foothills of Sierra Nevada range from 3/19/2006-5/31/2006 during T-Rex Phase II
- Accompanied by an Onset tipping bucket rain gauge



T-Rex GV Flight Track

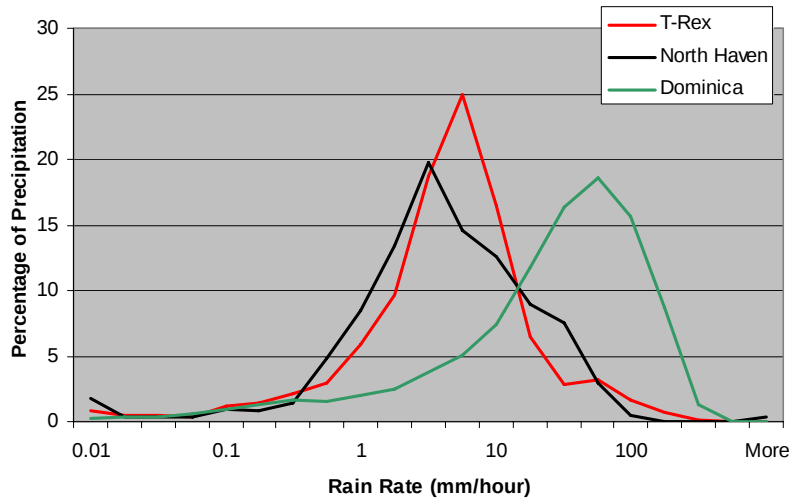




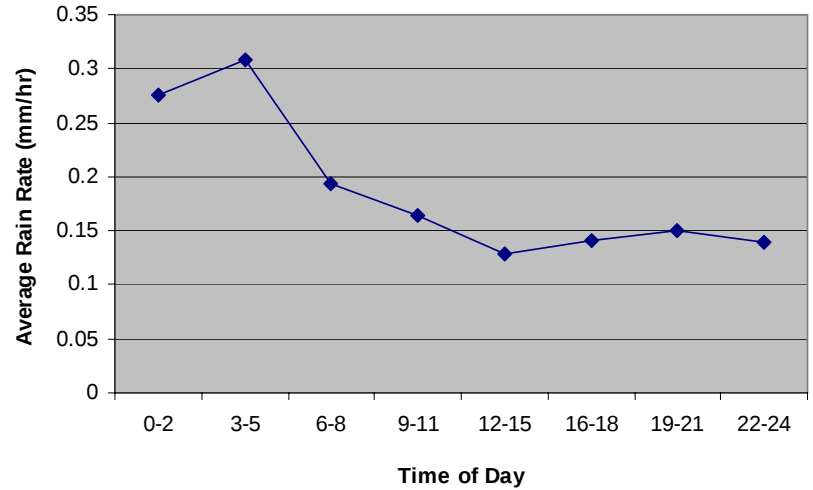
Event	Beginning (PST)	End (PST)	Duration (hr)	Precip. (mm)	Nearest IOP
1	3/20 23:52	3/21 4:52	5	17.2	5: 3/20 6:00 - 3/20 16:00
2	3/25 16:35	3/26 0:40	8	8.0	6: 3/24 12:00 - 3/25 21:00
3	3/28 6:00	3/29 8:33	26.5	64.8	7: 3/28 3:00 - 3/28 11:00
4	3/31 8:57	4/1 12:32	27.5	17.8	8: 3/31 3:00 - 4/01 11:00
5	4/03 8:29	4/06 0:36	64	99.4	-
6	4/14 21:26	4/15 5:20	8	16.6	13: 4/15 12:00 - 4/17 0:00
7	4/17 4:49	4/17 11:57	7	14.8	13: 4/15 12:00 - 4/17 0:00
8	4/22 3:47	4/23 5:31	25.5	14.8	14: 4/21 0:00 - 4/21 16:00
9	5/21 14:21	5/22 18:41	28.5	16.2	-

Rain Gauge Statistics

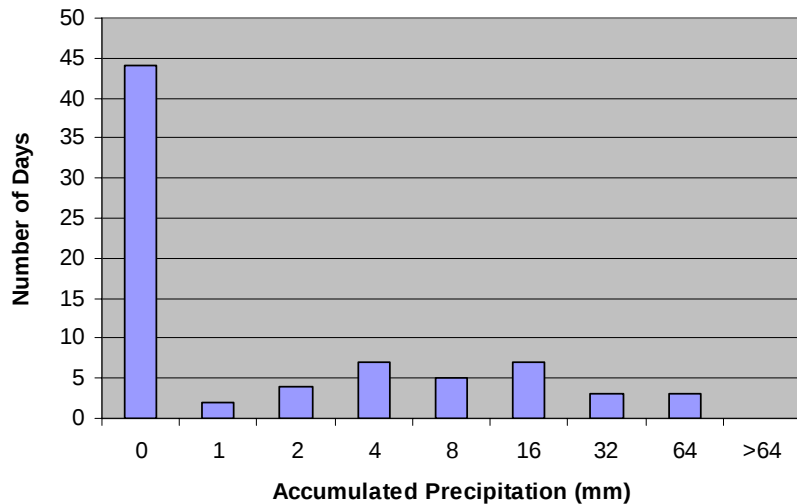
Rain Rate Distribution



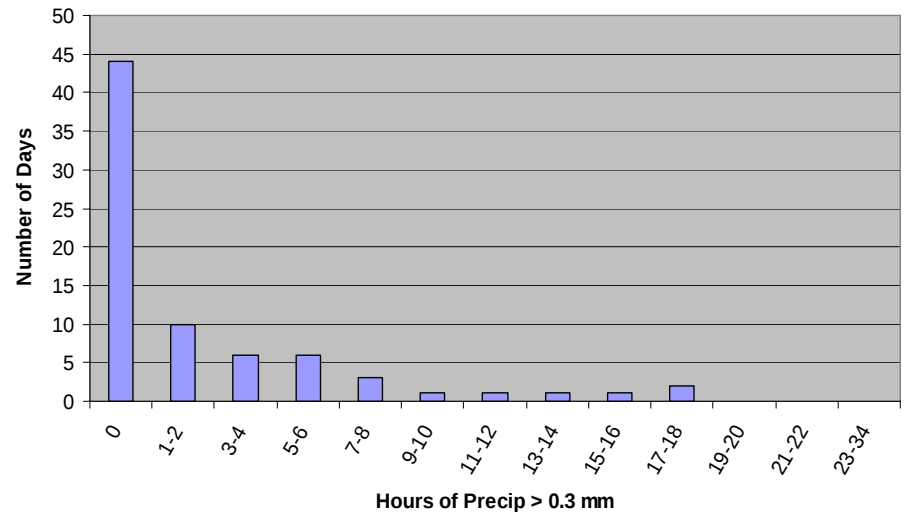
Diurnal Rain Rate Averages



Histogram of Daily Accumulated Precipitation



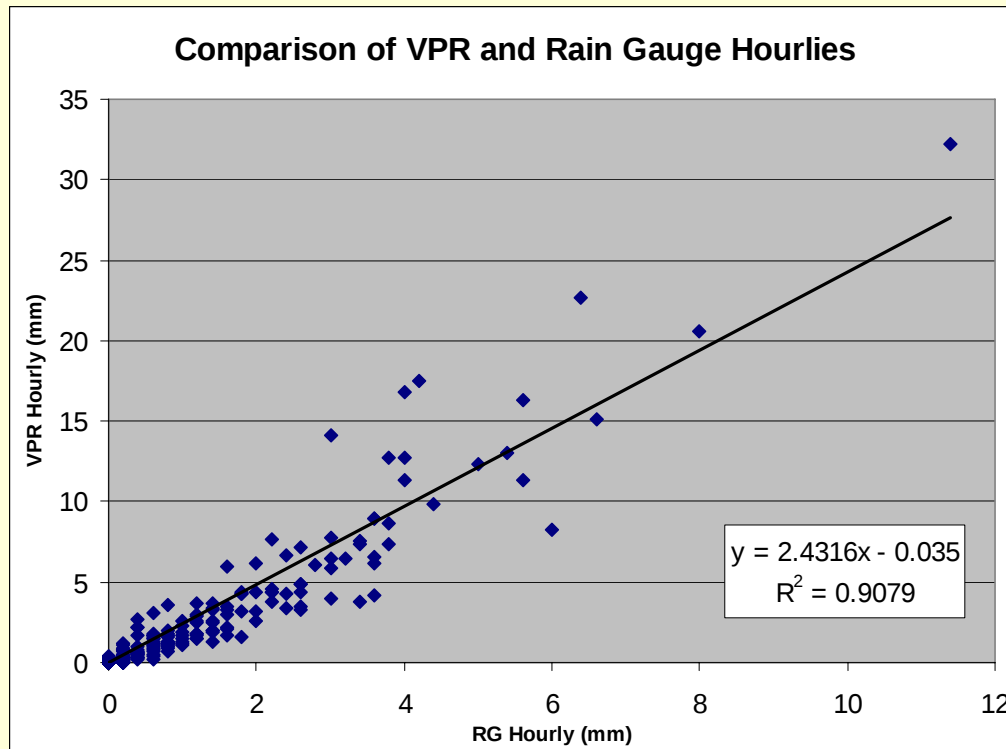
Duration of Daily Precipitation



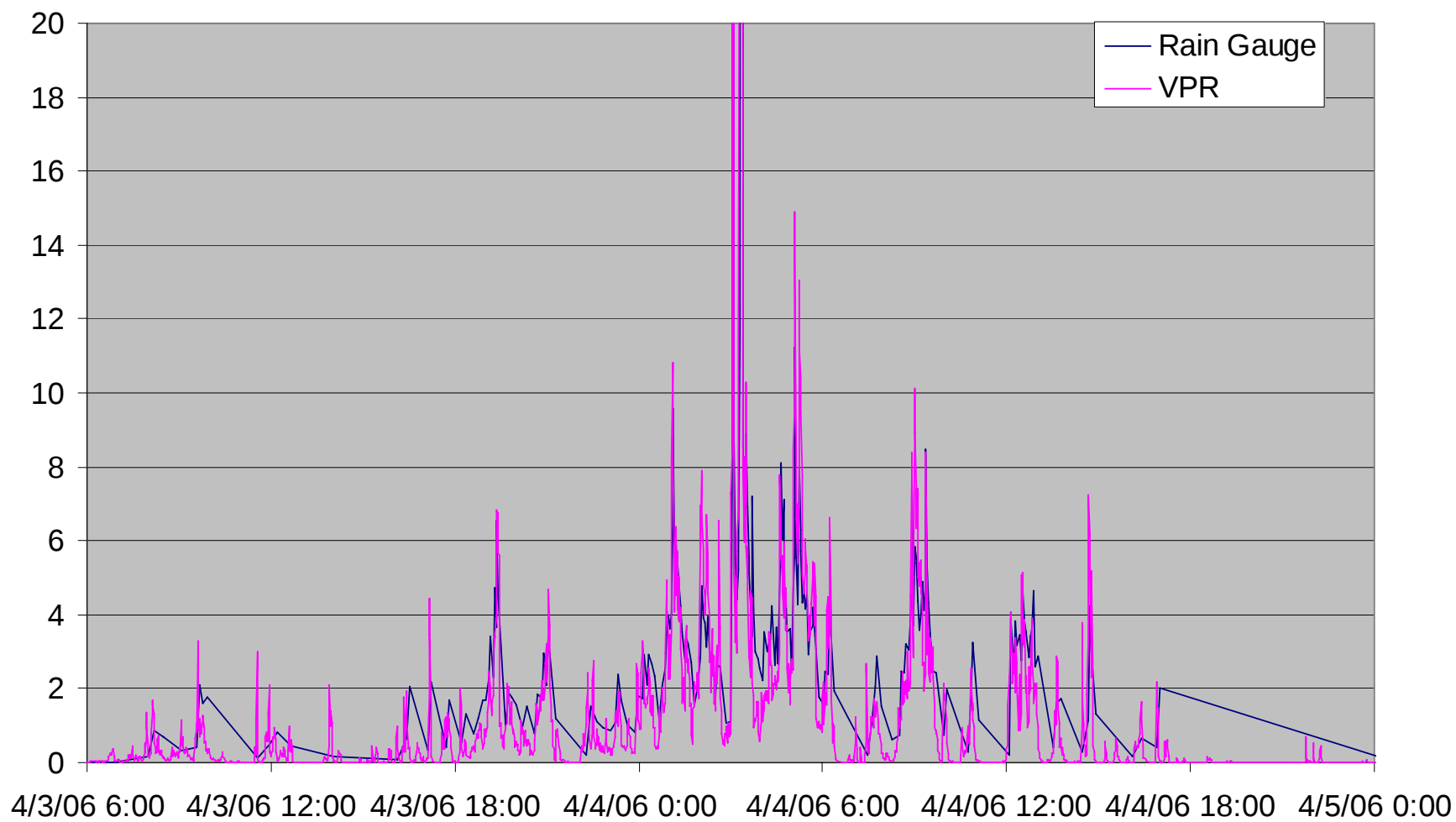
Vertically pointing radar:

- Uses frequency modulation to obtain high time resolution data from a single vertical line through atmosphere.
- Uses Doppler shift to obtain velocity and drop size distributions of hydrometeors.
- For our data, the vertical range was 6000 m. The vertical resolution was 200 m and time step was 1 min.

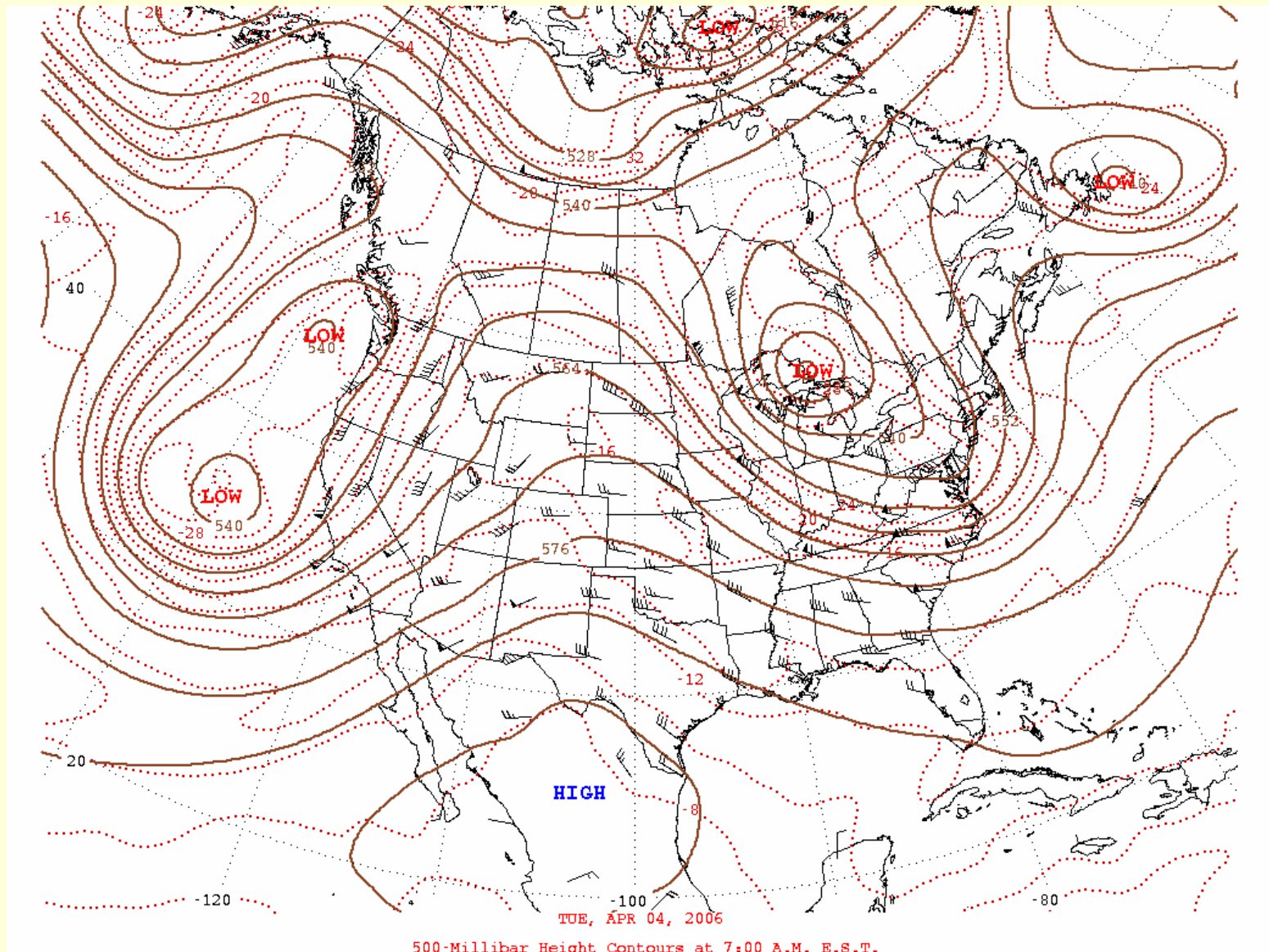
- Radar-measured rain rates correlated well with the rain gauge, but overestimated by a factor of ~2.5



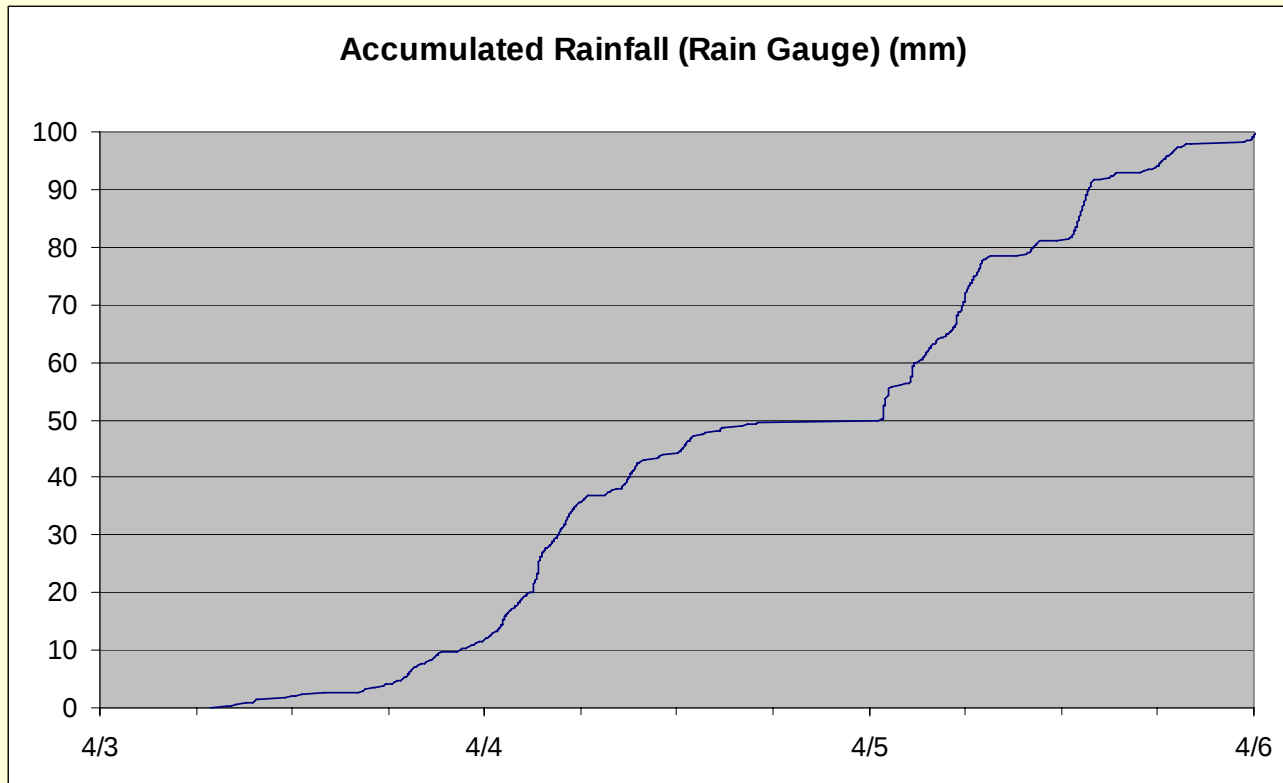
Instantaneous Rain Rates (mm/hr)



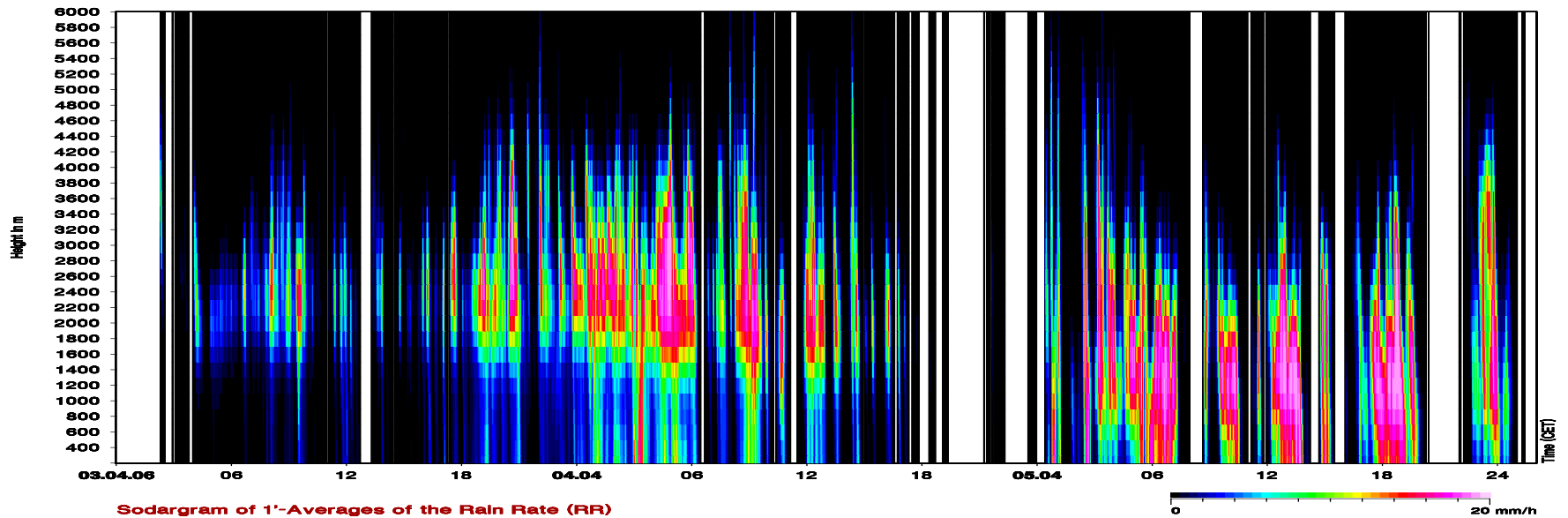
4/3-4/6 Rain Event



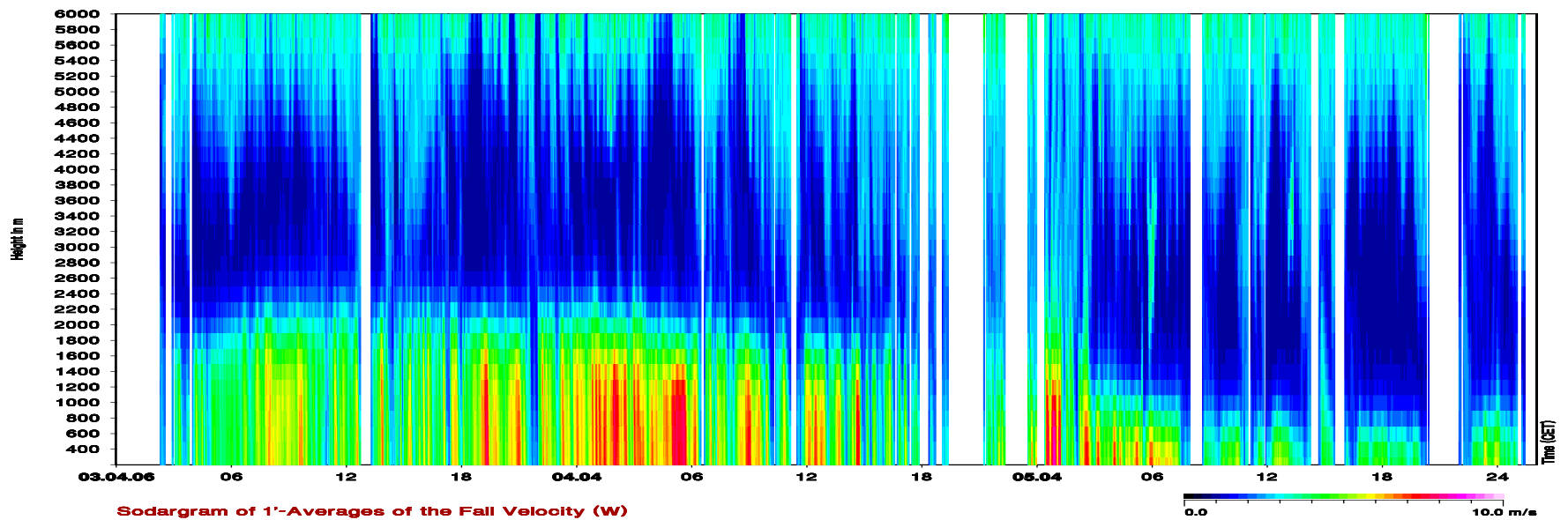
4/3-4/6 Rain Event



Rain Rates



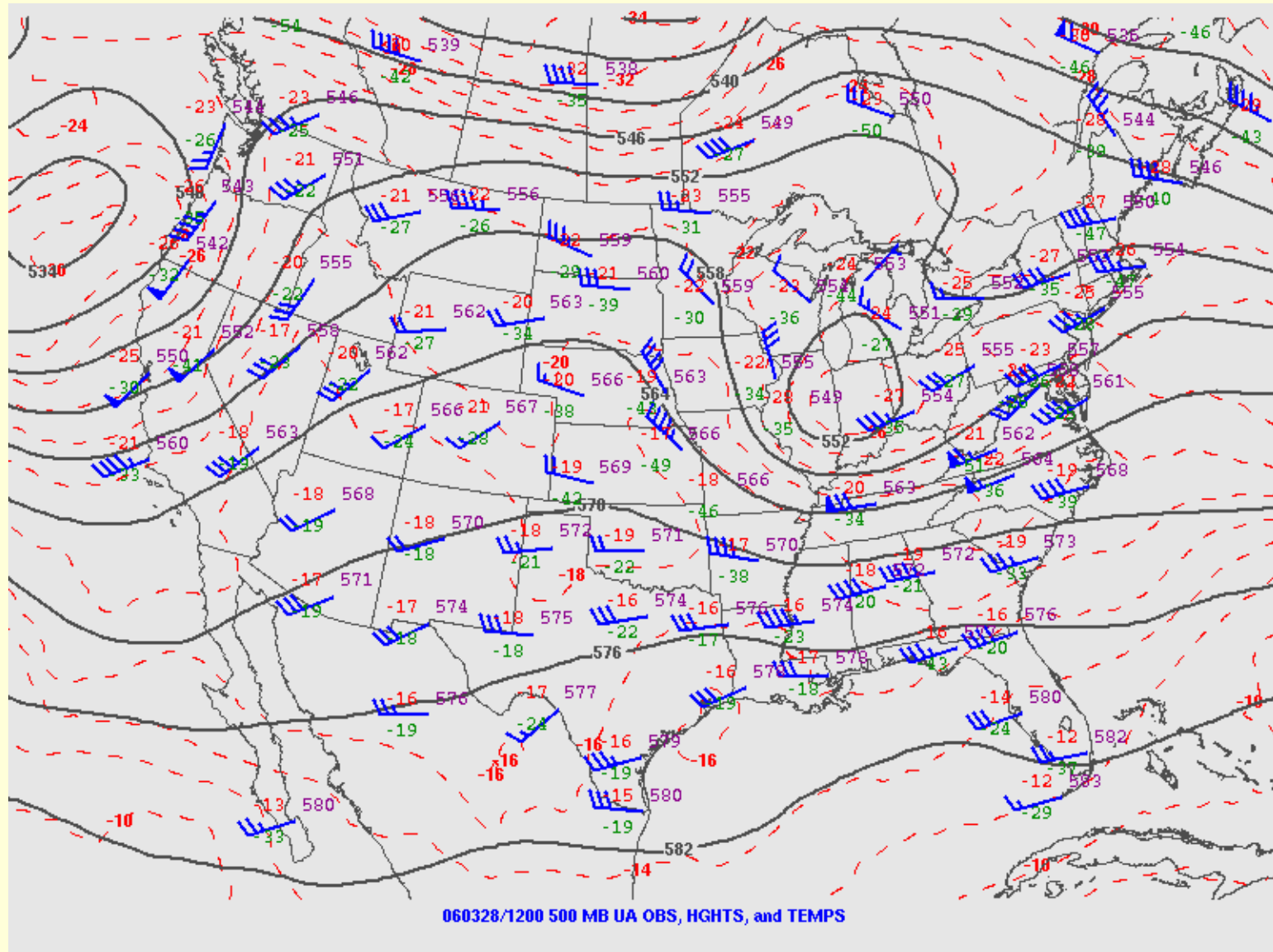
Mean Fall Velocity



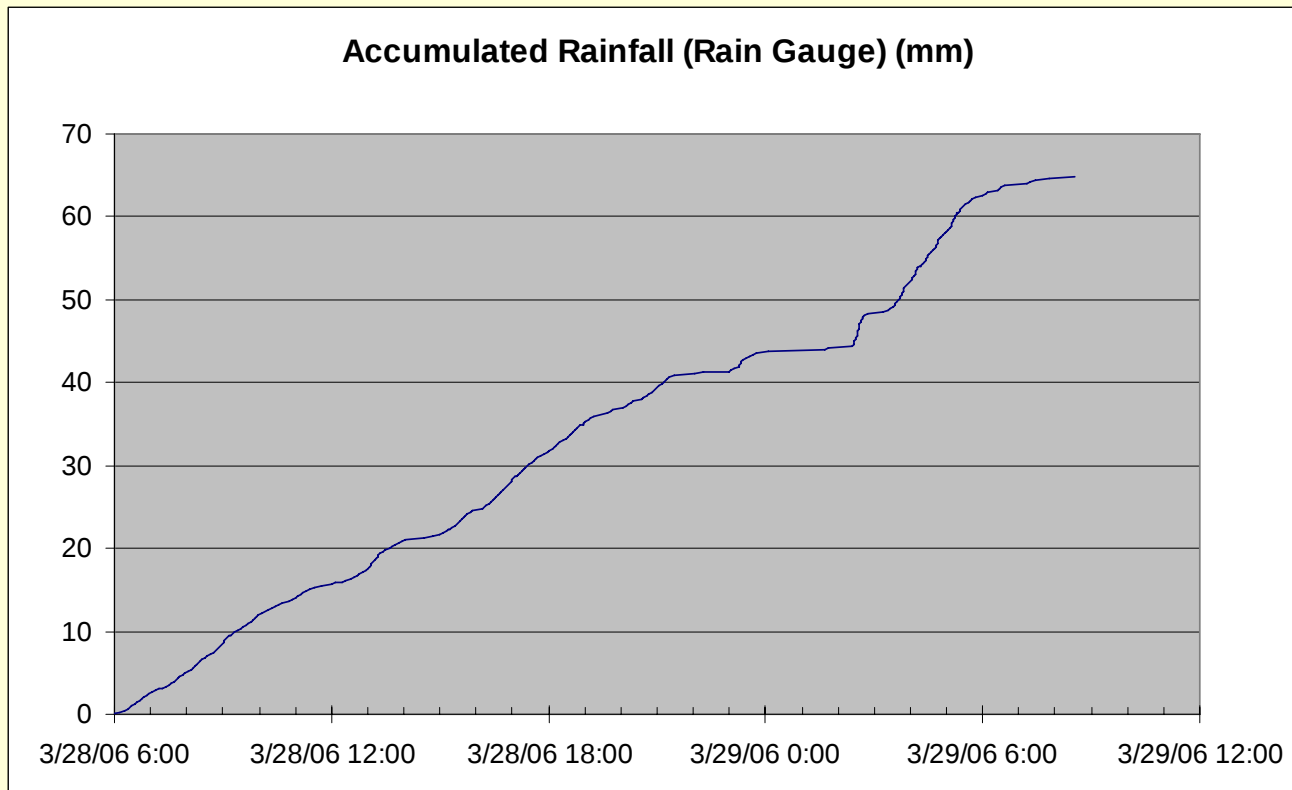
METEK

METEK

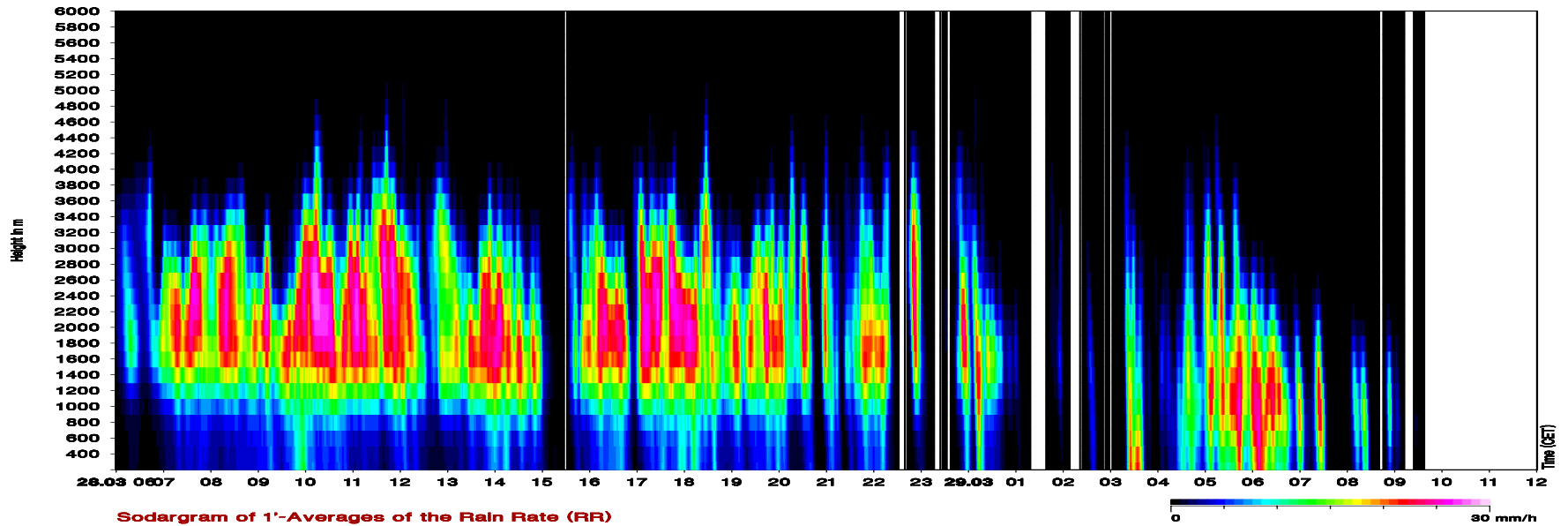
3/28-3/29 Rain Event



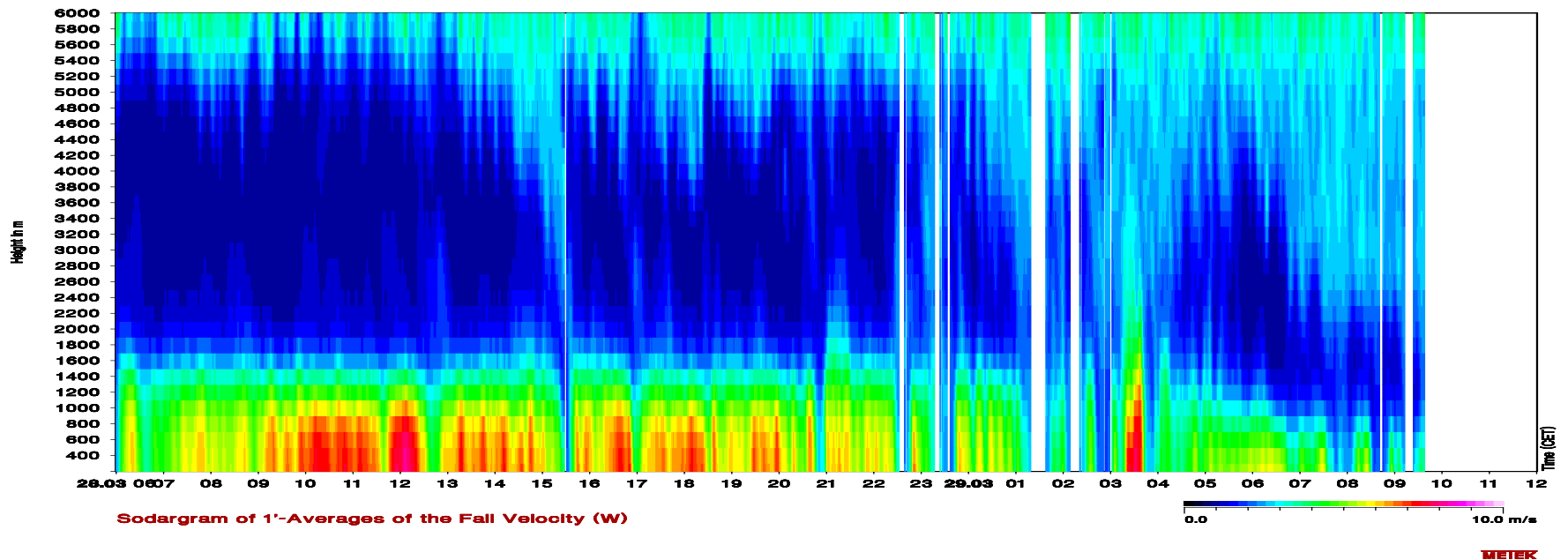
3/28-3/29 Rain Event



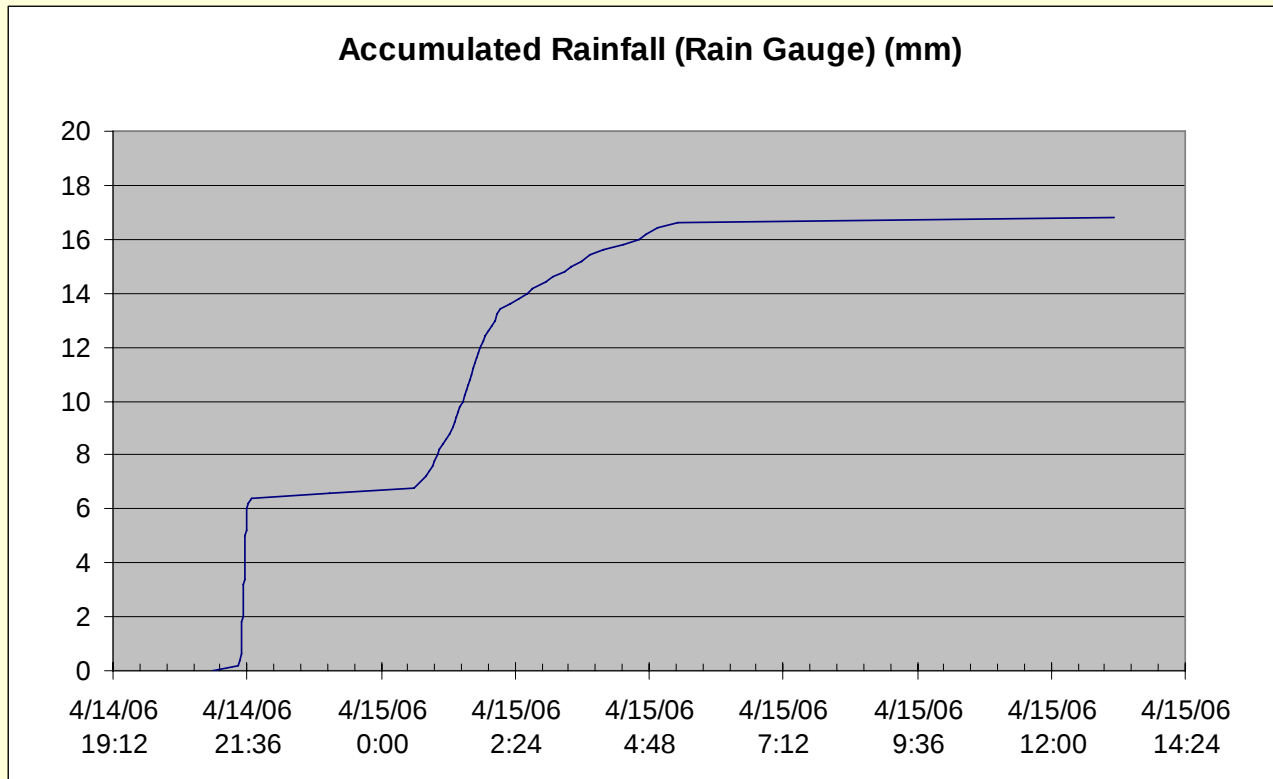
Rain Rates



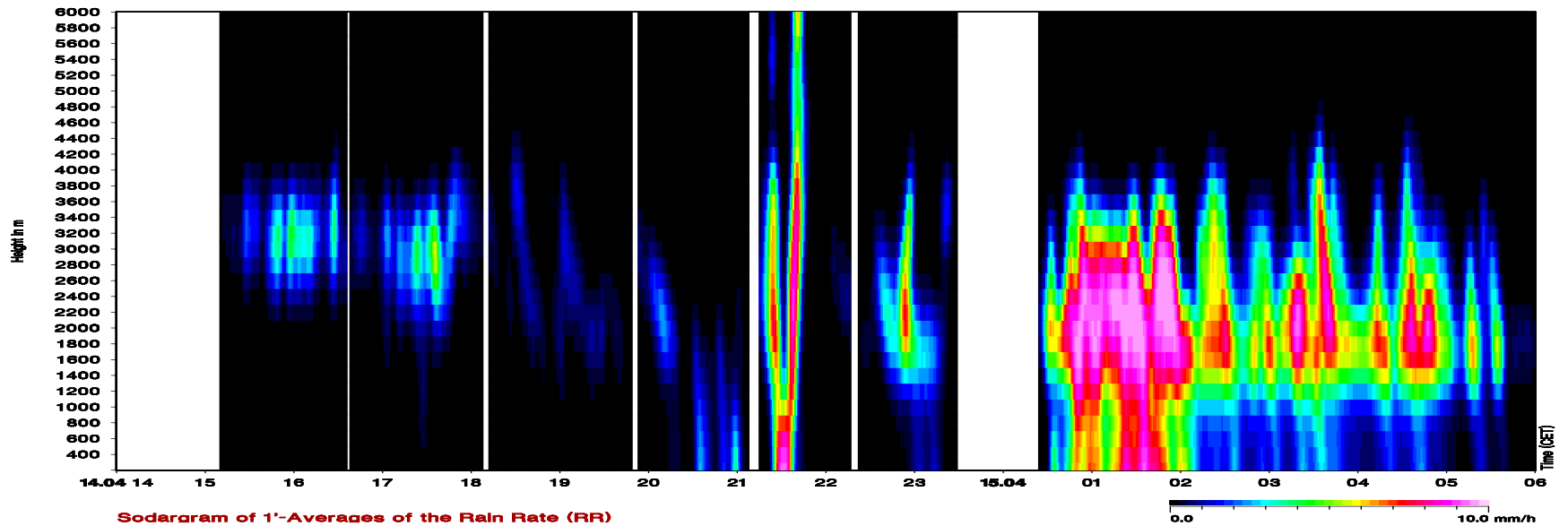
Mean Fall Velocity



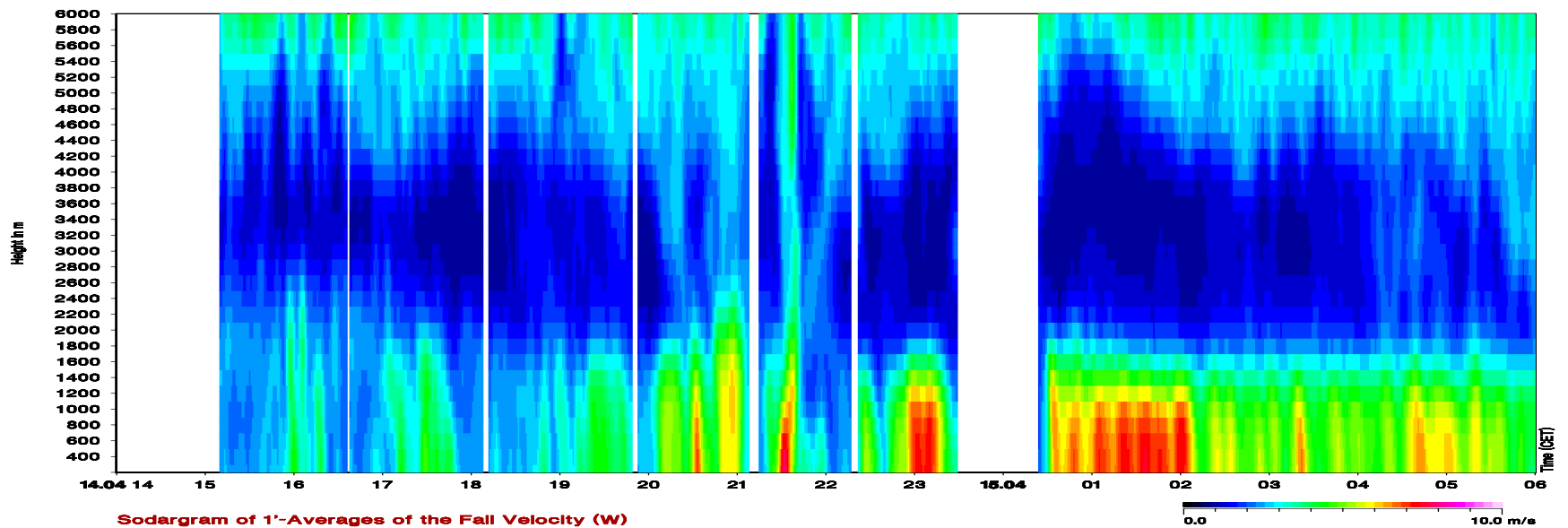
4/14-15 Rain Event



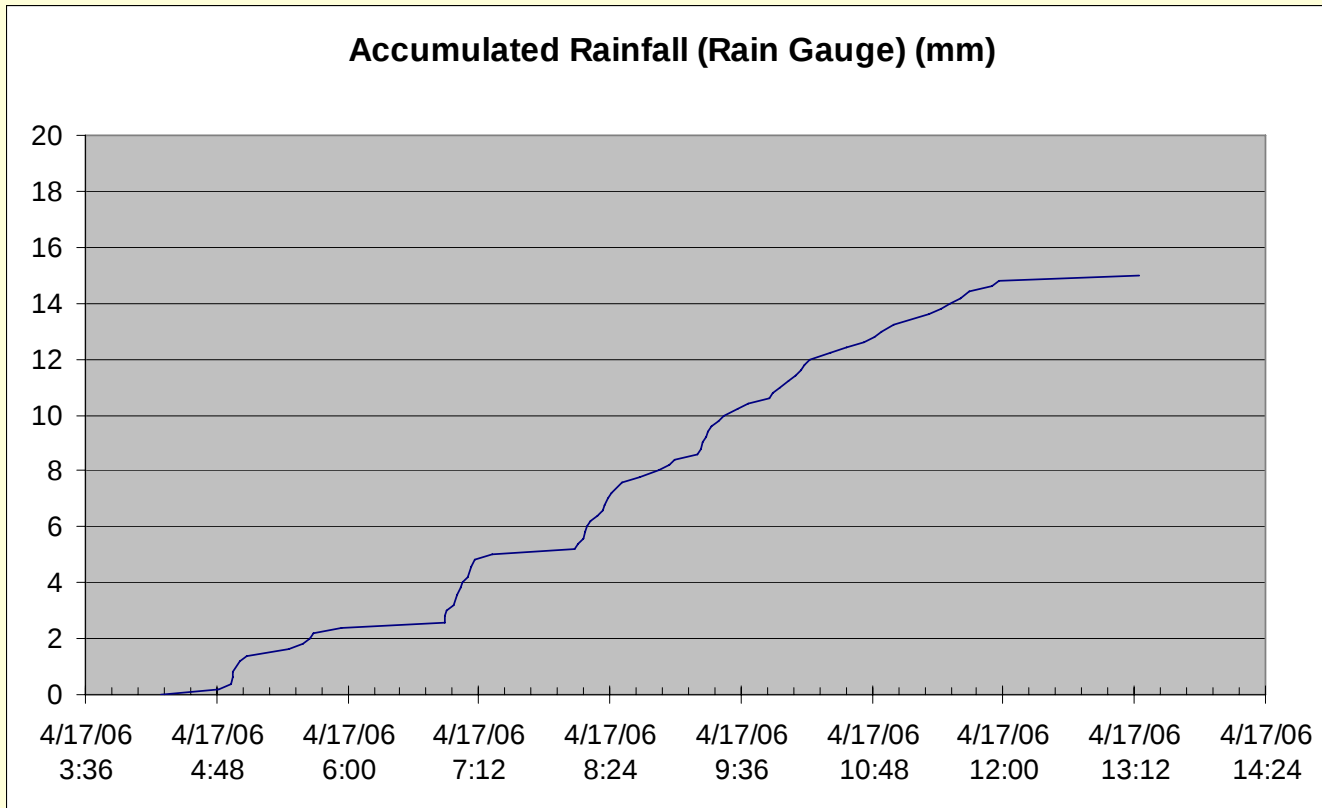
Rain Rates



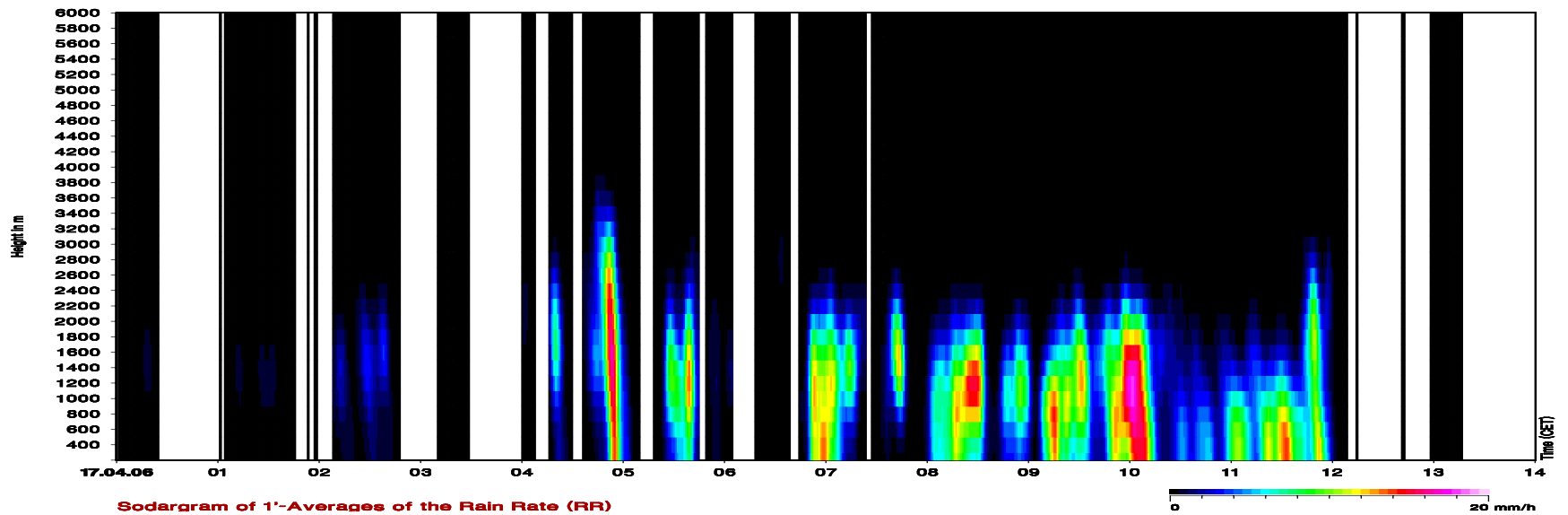
Mean Fall Velocity



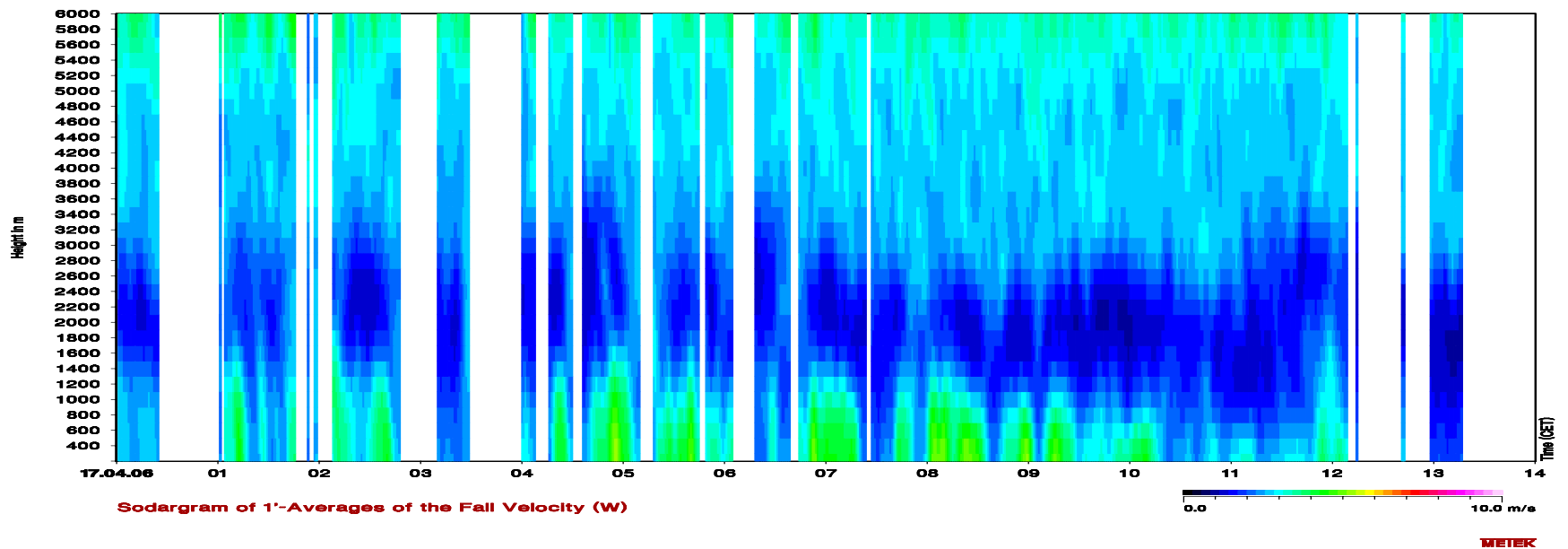
4/17 Rain Event



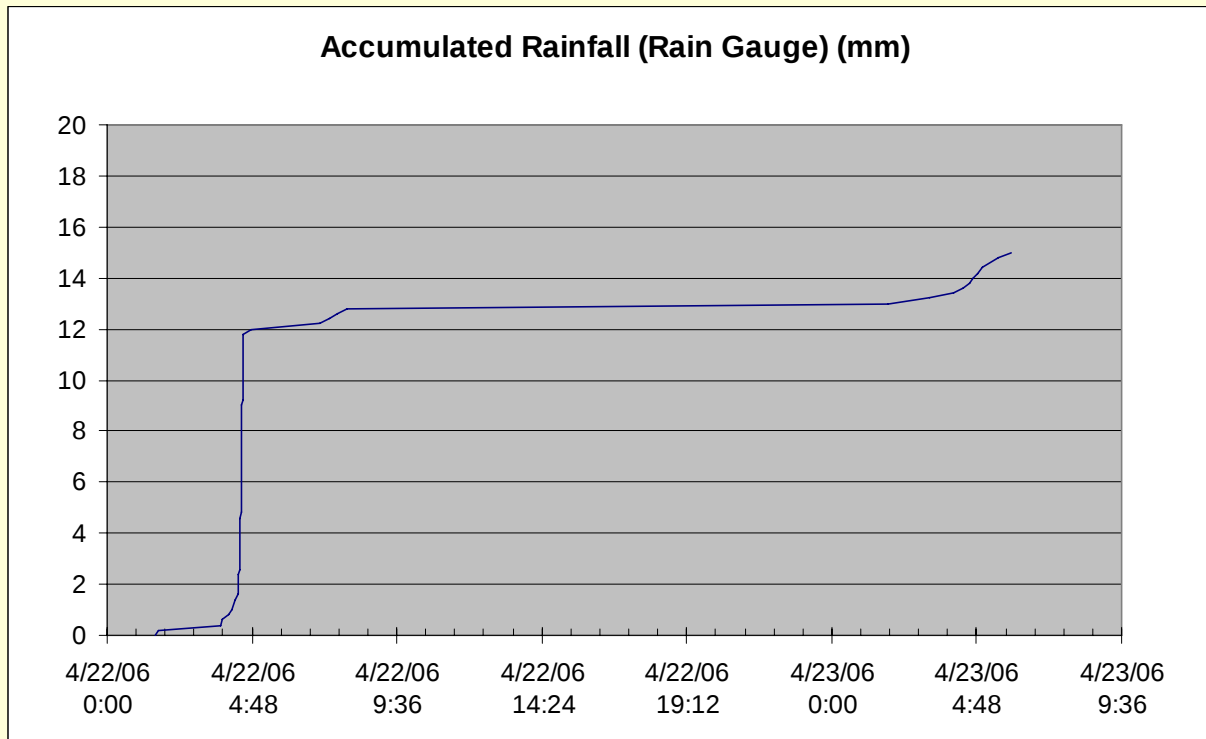
Rain Rates



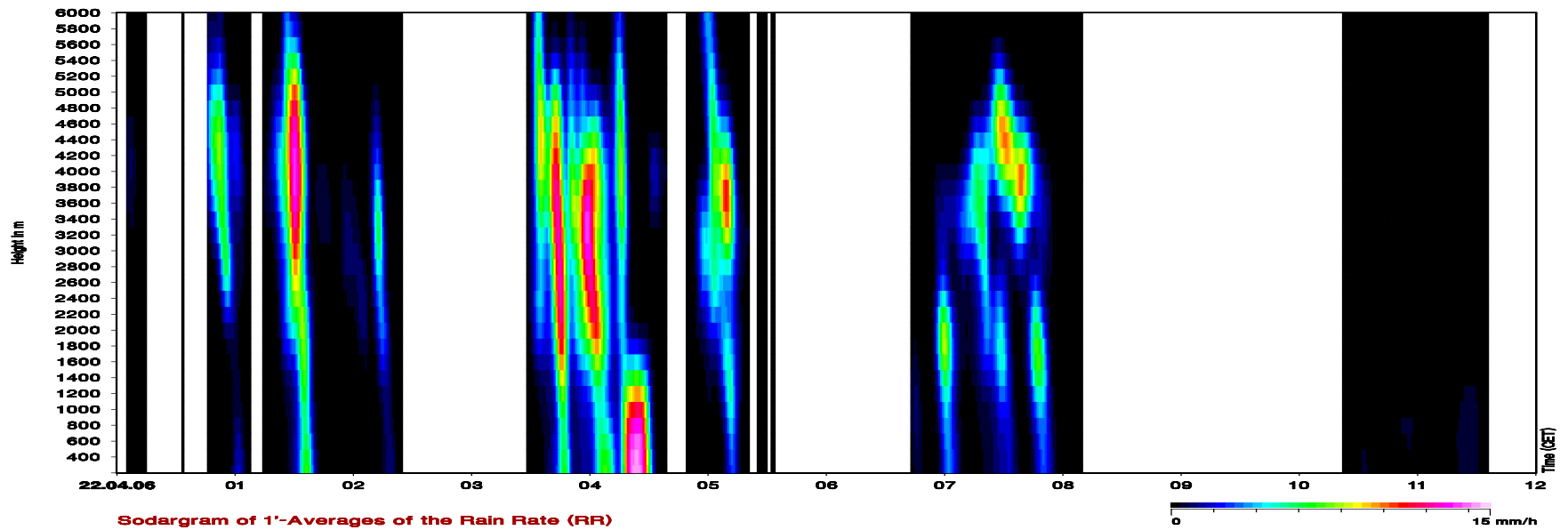
Mean Fall Velocity



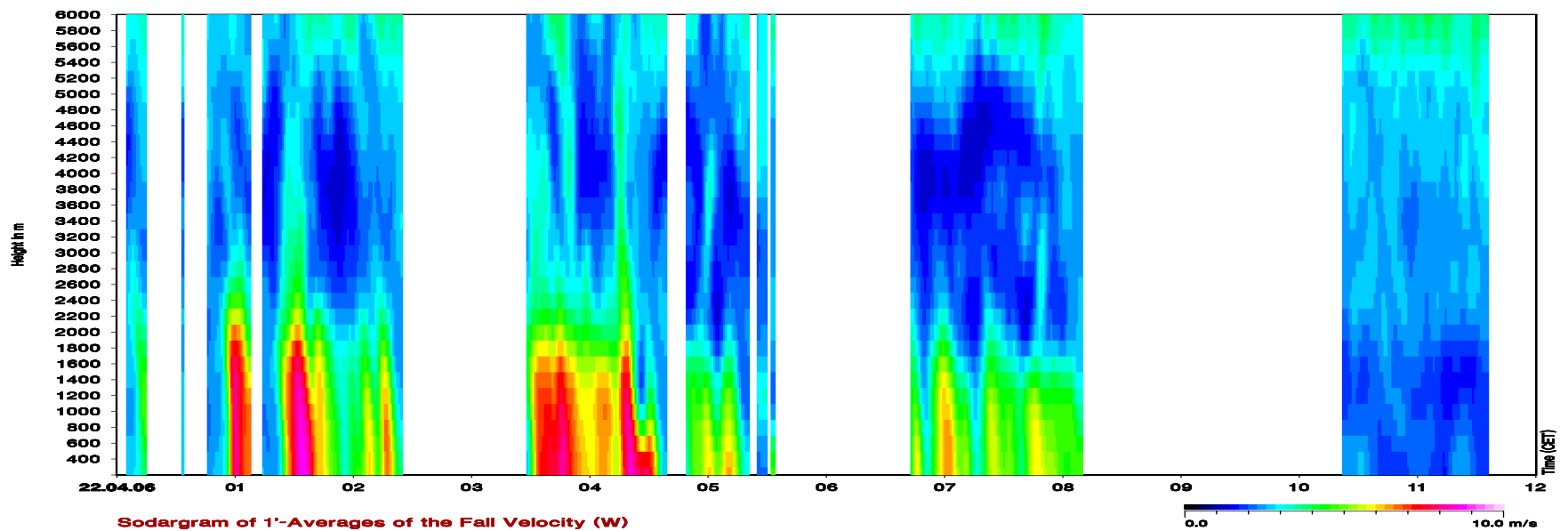
4/22 Rain Event



Rain Rates



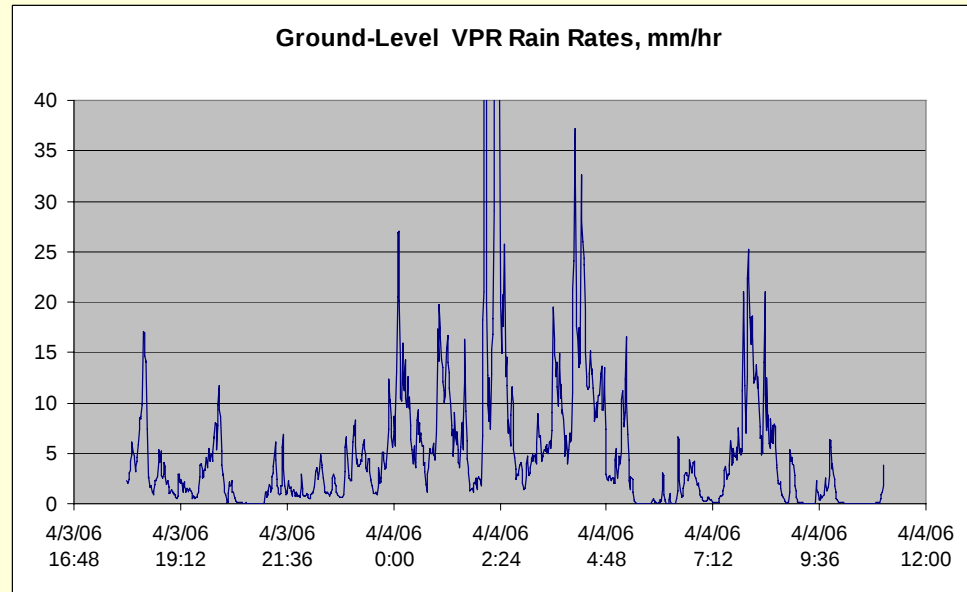
Mean Fall Velocity



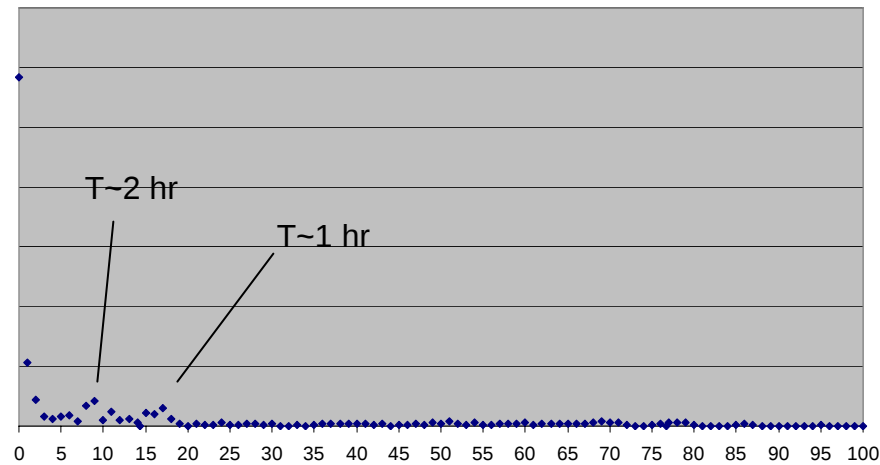
METEK

METEK

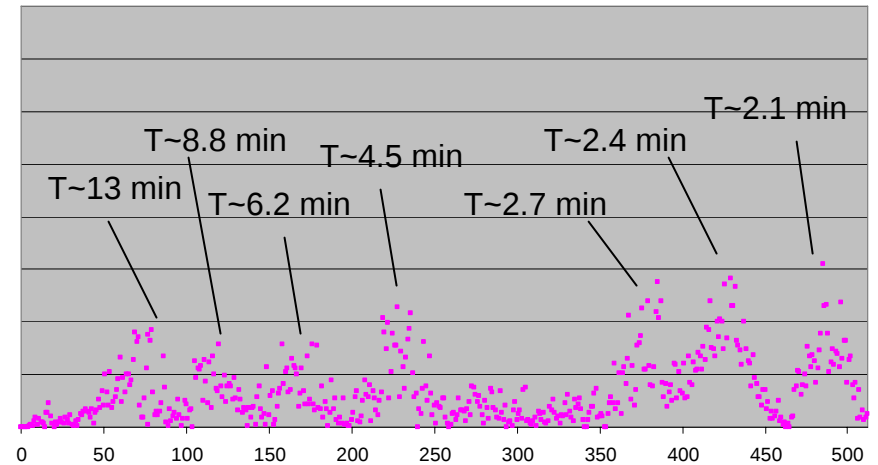
Spectral Rain Rate Analysis



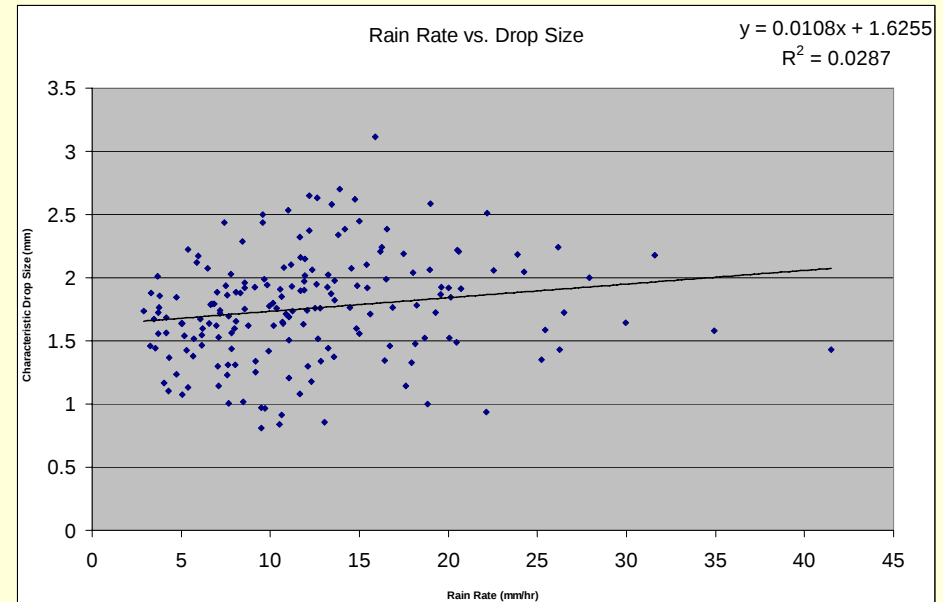
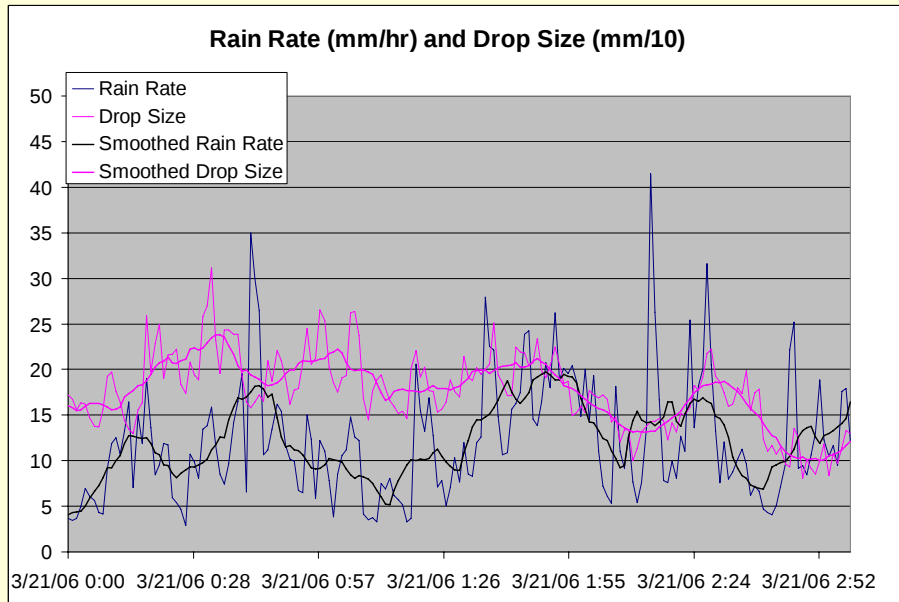
Fourier Series - $|C_m|^2$



Fourier Series - $|C_m|^2 * k_m^2$



Rain Rate vs. Drop Size



Preliminary Conclusions:

- Except for a calibration constant, VPR rain rate estimates agree with the rain gauge
- VPR has better time resolution than rain gauge
- VPR attenuates strongly in heavy precipitation
- Spectral analysis of radar rain rate suggests fluctuations on a period of 2-13 minutes as well as 1-2 hours

Future Work:

- Determine correlation of mean drop size with rain rate
- Analyze shape of drop size distribution versus height/time
- Compare VPR data with other data from T-Rex IOPs

Acknowledgements:

- Bob Allen
- Yanping Li