Characterizing short time-scale vector wind changes using 50 MHz Doppler Radar Wind Profiler observations

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Introduction

- KSC Weather asked MSFC Natural Environments (MSFC/NE) to characterize short timescale vector wind changes using 50 MHz Doppler Radar Wind Profiler (D50) data.
- MSFC/NE will provide results to KSC Weather, who will then provide to various launch programs as an informational tool to highlight risks of using balloon measurements alone for day of launch wind biasing and verification.
- Basic methodology was developed through consultations between MSFC/NE and KSC Weather: using D50 archive, identify wind pairs with given time deltas, subset by season, and compute population statistics of vector wind changes for various height domains within the profiles.

D50 Database

- Period of Record: 8-18-1997 through 1-31-2013
- # Records: 1 086 816
- Temporal sample spacing: 5 minutes nominal
- Vertical resolution: 150 m
- Vertical domain: ~2 – 18.6 km
- Archive QC: Barbre' 2012
- Additional QC: 68 profiles were removed due to convective influences producing very large vector wind changes.

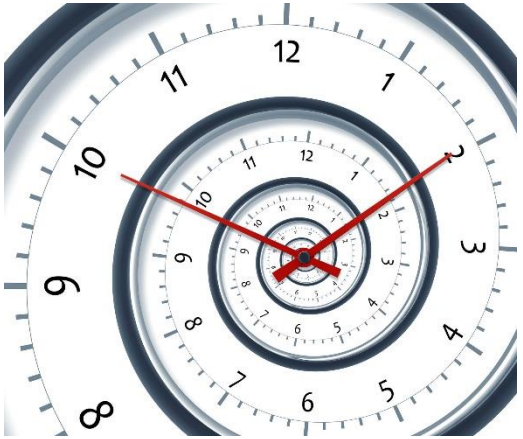
Barbré, R.E.: 2012. Quality Control Algorithms for the Kennedy Space Center 50-MHz Doppler Radar Wind Profiler Winds Database. J. Atmos. Oceanic Technol., 29, 1731–1743.

Season Subsets

- Annual
- Winter: Dec, Jan, Feb, Mar
- Summer: Jun, Jul, Aug, Sep
- Transition: Apr, May, Oct, Nov

Time Delta Subsets

- 5 minutes
- 10 minutes
- 15 minutes
- 20 minutes
- 25 minutes
- 30 minutes
- 45 minutes
- 60 minutes
- 75 minutes
- 90 minutes
- 120 minutes



Height Domain Subsets

- Full profile
- Below 4 km
- 4-6 km
- 6-8 km
- 8-10 km
- 10-12 km
- 12-14 km
- 14-16 km
- 16-18 km
- Above 18 km

Statistical Parameters

For each height domain of each profile pair, the maximum computed vector wind change is saved as a sample data point. Then, for each season/time delta/height domain data bin, the aggregated samples are used to compute distribution statistics.

- Vector wind changes corresponding to cumulative distribution probability levels of 0.5, 0.9, 0.95, 0.99, and 0.99865.
- Maximum vector change.
- Mean vector change.
- Standard deviation of vector change.
- Total number of cases (profile pairs).
- Numbers of cases with vector changes greater than 10, 20, 30, and 40 m/s.

Example: Individual case tables

```
Season:          Annual
Time delta:      5 minutes
Height domain:   All heights
All VC values shown are in units of m/s
All N values shown are integer counts

     VC(P=0.5):      3.51
     VC(P=0.9):      6.14
    VC(P=0.95):      7.31
    VC(P=0.99):     10.04
VC(P=0.99865):     14.02
       Max VC :     29.63
      Mean VC :      3.93
      STDV VC :      1.77
      N(Total):    377142
      N(VC>10):      3855
      N(VC>20):        91
      N(VC>30):         0
      N(VC>40):         0
```

10 height domains x 11 time deltas x 4 seasons = 440 separate tables

Example: Season as independent variable

Time delta: 30 minutes
Height domain: 12-14 km
All VC values shown are in units of m/s
All N values shown are integer counts

	Season			
	Annual	Winter	Summer	Trans
VC(P=0.5):	4.23	4.57	3.90	4.21
VC(P=0.9):	6.80	7.19	6.33	6.75
VC(P=0.95):	7.84	8.22	7.37	7.76
VC(P=0.99):	10.29	10.66	9.91	10.20
VC(P=0.99865):	13.66	14.26	13.12	13.38
Max VC :	26.19	24.06	25.40	26.19
Mean VC :	4.55	4.87	4.23	4.52
STDV VC :	1.76	1.81	1.67	1.74
N(Total):	610162	211733	192670	205759
N(VC>10):	7393	3213	1826	2354
N(VC>20):	46	34	4	8
N(VC>30):	0	0	0	0
N(VC>40):	0	0	0	0

10 height domains x 11 time deltas = 110 separate tables

Example: Time delta as independent variable

Season: Trans
Height domain: 8-10 km
All VC values shown are in units of m/s
All N values shown are integer counts

	Time Delta (minutes)										
	5	10	15	20	25	30	45	60	75	90	120
VC(P=0.5):	1.53	2.12	2.59	2.80	3.02	3.27	3.77	4.18	4.55	4.89	5.51
VC(P=0.9):	2.92	3.81	4.47	4.94	5.30	5.64	6.48	7.13	7.72	8.31	9.38
VC(P=0.95):	3.58	4.61	5.32	5.92	6.30	6.67	7.65	8.38	9.10	9.75	11.02
VC(P=0.99):	5.40	6.71	7.44	8.30	8.78	9.22	10.53	11.57	12.55	13.52	15.20
VC(P=0.99865):	8.22	9.73	10.34	11.31	12.06	12.72	14.58	16.30	18.27	19.85	21.71
Max VC :	19.70	19.71	30.97	19.05	21.40	32.12	31.33	30.27	35.14	39.31	45.99
Mean VC :	1.77	2.39	2.87	3.12	3.36	3.61	4.16	4.60	5.00	5.37	6.07
STDV VC :	0.99	1.19	1.31	1.47	1.55	1.63	1.86	2.03	2.22	2.39	2.68
N(Total):	124975	140377	259932	111382	127238	205759	195545	223358	201769	169983	177278
N(VC>10):	48	165	436	376	604	1293	2578	4735	6368	7530	13598
N(VC>20):	0	0	6	0	1	15	36	90	164	219	410
N(VC>30):	0	0	1	0	0	1	1	1	16	27	39
N(VC>40):	0	0	0	0	0	0	0	0	0	0	9

10 height domains x 4 seasons = 40 separate tables

Example: Height domain as independent variable

Season: Winter
Time delta: 120 minutes
All VC values shown are in units of m/s
All N values shown are integer counts

	Height Domain (km)								
	All	< 4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	> 18
VC(P=0.5):	9.64	4.19	4.77	5.28	5.93	6.82	7.10	6.86	6.88	5.38
VC(P=0.9):	14.31	7.80	8.47	9.39	10.46	11.32	10.85	10.19	9.98	8.50
VC(P=0.95):	16.53	9.44	10.27	11.32	12.75	13.48	12.39	11.48	11.12	9.63
VC(P=0.99):	22.58	13.56	15.37	17.13	18.67	18.90	15.94	14.37	13.63	12.21
VC(P=0.99865):	31.50	19.80	24.09	27.19	26.75	25.12	20.89	18.29	16.78	15.37
Max VC :	48.63	37.24	40.08	48.63	39.45	40.37	36.08	30.84	25.82	26.32
Mean VC :	10.35	4.74	5.39	5.97	6.66	7.48	7.55	7.21	7.17	5.69
STDV VC :	3.35	2.50	2.69	3.02	3.23	3.17	2.61	2.30	2.15	2.15
N(Total):	187837	187837	187837	187837	187837	187837	187837	187837	187837	187837
N(VC>10):	83439	7477	10425	14978	21939	30031	27785	20753	18555	7440
N(VC>20):	3573	229	549	966	1363	1358	368	89	36	27
N(VC>30):	350	18	70	156	114	60	16	2	0	0
N(VC>40):	32	0	1	30	0	1	0	0	0	0

11 time deltas x 4 seasons = 44 separate tables

Summary

- MSFC/NE has performed an analysis of short timescale vector wind changes using D50 data.
- Results are being delivered to KSC Weather to help launch programs understand the risks of short-timescale wind changes that would not be observed using typical day of launch balloon schedules.