Status: CL31 Ceilometer Meteorological Comparison Evaluation

Presented to the

ASOS Test Review Board

NWS/OPS24

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Outline

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Purpose

- Assess functional comparability of ASOS algorithm output from CL31 and CT12K in weather conditions critical for aviation safety

Evaluation Objectives

- Ensure cloud reports (heights and amounts) are similar to CT12K in conditions critical for aviation safety
- Document an significant differences in cloud reports between CL31 and CT12K
- Significant Differences will be included in a Technical Implementation Notice (TIN) for distribution to the user community
- TIN will be distributed in advance of each switchover of the CL31 as the primary sensor on ASOS

Evaluation Parameters:

- Height Range (feet) CT12K to CL31
- RMSD Range (feet) CT12K to CL31
- Sky Coverage Amounts

Height Range (Feet) CL31 Compared to CT12K

AVIATION FLIGHT CATEGORY	HEIGHT (FT) (Cloud or Ceiling)	HEIGHT DIFFERENCE (FT)
LIFR	H <500	± 100
IFR	500 ≤ H <1000	± 100
MVFR	1000 ≤ H< 3000	± 100
VFR	3000 ≤ H < 5000	± 500
VFR	5000 ≤ H ≤ 12000	± 1000

RMSD Range (Feet) CL31 Compared to CT12K

Height Range	Aviation Flight Category	Comparable	Some Differences	Significant Differences	Great Differences
CLR					
H < 500	LIFR	0 - 100	101 – 300	301 - 500	> 500
500 ≤ H < 1000	IFR	0 - 100	101 – 300	301 - 500	> 500
1000 ≤ H < 3000	MVFR	0 - 100	101 – 300	301 - 500	> 500
3000 ≤ H < 5000	VFR	0 - 500	501 – 1000	1001 - 1500	>1500
5000 ≤ H ≤ 12000	VFR	0 - 1000	1001 – 2000	2001 - 3000	>3000

Amount Range CL31 Compared to CT12K

ALGORITHM CLOUD AMOUNT (OPERATIONAL)	SKY COVER (OCTANTS)	ALGORITHM CLOUD AMOUNT (TEST)
CLR	0	CLR-FEW
FEW	1/8 - 2/8	CLR-FEW-SCT
SCT	3/8 - 4/8	FEW-SCT-BKN
BKN	5/8 – 7/8	SCT-BKN-OVC
OVC	8/8	BKN-OVC
VV	8/8	OVC-VV

Assumptions and Limitations:

- No reference or “truth”
- CL31 and CT12K may produce different cloud reports in similar conditions due differences in sensor design
  - Data Analysis team will evaluate and explain differences on an as needed basis
  - Example: VV conditions, precipitation

Comparison Cases (Matrix)

Height Range	Aviation flight rule	CLR	FEW	SCT	BKN	OVC	VV	WIND >25KTS
CLR	VFR	16						
H <500	LIFR		5	5	15	15	10	1
500 ≤ H <1000	IFR		5	5	15	15	10	3
1000 ≤ H< 3000	MVFR		5	5	15	15	10	2
3000 ≤ H < 5000	VFR		4	4	10	10		
5000 ≤ H ≤ 12000	VFR		3	3	10	10		
TOTAL (225)		16	22	22	65	65	30	5

Comparison Cases and Analysis (Precipitation Types):

Heights: <3000 FT Amounts: BKN, OVC, VV	RAIN	RAIN	SNOW	SNOW	FOG MIST Drizzle	No Precip (NP)	High Winds
Precip Type	RA/+RA/ FZRA	-RA -FZRA	SN/+SN	-SN	FG BR DZ FZFG/FZDZ	NP	>25 KT
# CASES LIFR (41)	4	6	2	3	5	20	1
IFR (43)	4	6	2	3	5	20	3
MVFR (42)	4	6	2	3	5	20	2
Total (125)	12	18	6	9	15	60	5

Evaluation Results (83 cases)

Height Range	Aviation Flight Category	CLR	FEW	SCT	BKN	OVC	VV	WIND >25kts
CLR		16	X	X	X	X	X	X
H < 500	LIFR	X		1	1		4	
500 ≤ H < 1000	IFR	X	1			3		
1000 ≤ H < 3000	MVFR	X	2		2	17		
3000 ≤ H < 5000	VFR	X	1		4	7	X	X
5000 ≤ H ≤ 12000	VFR	X	3	1	10	10	X	X
TOTAL		16	7	2	17	37	4	

Evaluation Results (29 cases)

Heights: < 3000 FT Amounts: BKN, OVC, VV	RAIN	RAIN	SNOW	SNOW	FOG/HAZE/MIST/ DRIZZLE	No Precipitation	Winds > 25kts
Precipitation Type	RA/+RA/ FZRA	-RA/ -FZRA	SN/+SN	-SN	FG/HZ/BR/DZ/FZDZ	NP	--
# cases for LIFR					5		
# cases for IFR					1	3	
# cases for MVFR		6			1	13	
Total		6			7	16	

Case Study: VV

- September 30, 2008 – SFSC –shallow fog
- VV LIFR HZ
- CT12K – VV001, BKN011
- CL31 – SCT001,VV005, VV006
- Human Ob - VV006 or VV011
- Visibility – 0.38 mi

Case Study: Light Rain

- October 28, 2008 – SFSC Light rain
- CT12K 3500FT – 4000FT
- CL31 5000FT-7000FT
- Cloud Height Differences ~2000-2500 FT

Why are CT12K and CL31 cloud heights different?

- Known issue with CT12K (optics) in precipitation and vertical visibility conditions
- CT12K has:
  - strong back scatter of laser beam from precipitation
  - contrast threshold (5%)
  - focal length of lens (5.91”) – “sees” a larger horizontal path of the sky – more susceptible to noise from precipitation and multiple back scattering
  - large beam spread
  - large diameter of receiver optics
  - higher height of full beam overlap due to biaxial design (separate receiver and transmitter) –causes more calibration wander, need gain adjustment

Why are CT12K and CL31 cloud heights different?

- CL31 has an “improved optical design”
- Less backscatter of laser beam in precipitation/VV
- Lower contrast threshold – less sensitive to back scatter from precipitation and obscurations (VV)
- Larger focal length of lens (11.8”) – “sees” a smaller horizontal path of the sky

Why are CT12K and CL31 cloud heights different?

- Smaller beam spread
- Smaller diameter of receiver optics
- Single lens transmitter/receiver
- Beam overlap immediate
- Slight tilt of ceilometer (2-5degrees) allows more penetration in precipitation less reflection off flat raindrops

Why are CT12K and CL31 cloud heights different?

- The improved optics allow the CL31 to penetrate though the precipitation and VV to return a higher cloud height

OT&E

- If ATRB votes to proceed to OT&E:
  - expand Evaluation to selected 8 OT&E sites
  - will allow evaluation to get the desired number of 225 cases
  - allow further investigation of differences between CT12K and CL31 especially in winter precipitation

8 OT&E Sites for Expanded Evaluation

1 CAR - Caribou, ME
2. GDP - Guadalupe Pass, TX
3. BIS - Bismarck, ND
4. JKL - Jackson, KY
5. PHX - Phoenix, AZ
6. HIO - Portland, OR
7. FAI - Fairbanks, AK
8. ITO - Hilo, HI

Schedule:

- If ATRB votes to go to OT&E:
- OT&E will start on November 17
- Evaluation will expand to 8 OT&E sites once installation is complete at those sites
- Decision (January/February 2009): switch CL31 to operational sensor?
- End: Spring 2009 (Final Report) at conclusion of OT&E