Photo courtesy of Vanda Grubisic; DRI

University of Wyoming
WWDC 2009

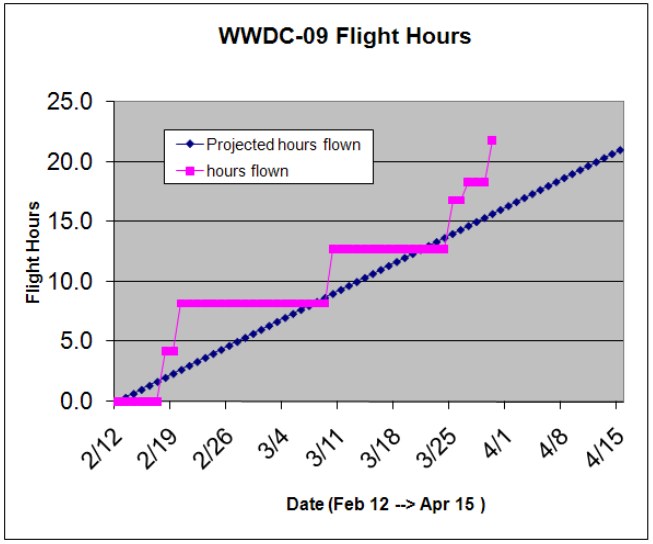
Wyoming Water Development Commission (Experiment)

February 12 2009 - April 12 2009

Coincident with WAICO09

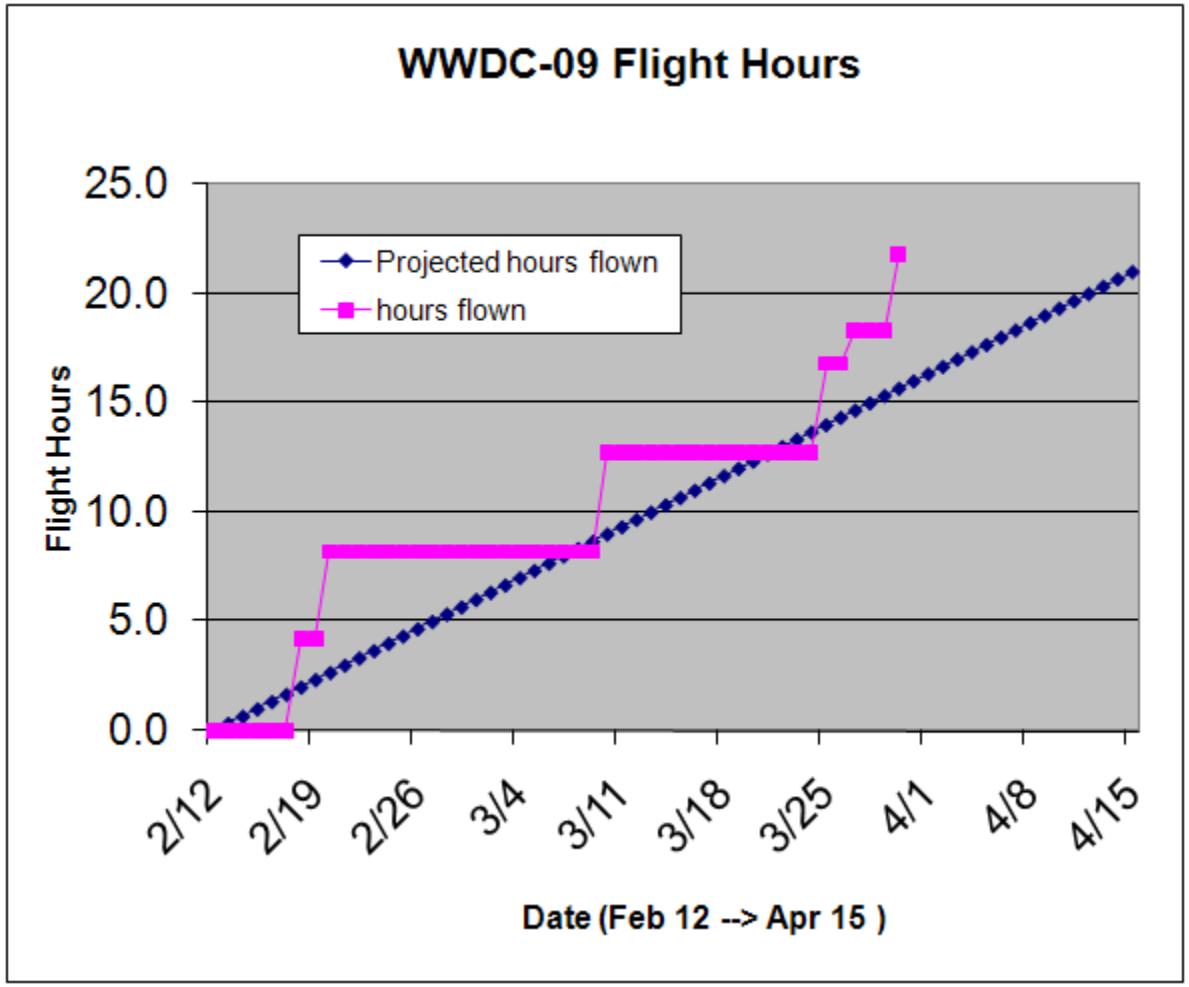
UWKA Web Page

- Contacts
- KingAir (UWKA) Data
- Radar (WCR) Data
- Lidar (WCL) Data



Date (*.kml)	Flight #	Status	Times (UTC)	Hours	Crew/Notes
Post project notes					
24 Apr 2009	Data reprocessed and tagged wwdc09_qc3. There was an error in the calculations of vertical wind.				
Research Flights					
30 Mar	RF05		1658-2025	3.5	B Wadsworth M Kovilakam L Oolman

25 Mar	RF04		1549-1947	4.1	B Wadsworth Y Yang L Oolman
10 Mar	RF03	westerly flow over Snowies, WDIR~280 deg, fairly clouds, tops aroun 15-15 kft. Clouds transitioned from from layer-type orographic to more cumuliform by the end of flight. Moderate turbulence for last 1-2 sets of ladders. First flight with manifold system on the Up lidar (WCL-I); appears to have increased solar background.	1351-1813	4.5	B Wadsworth Y Wang J French
20 Feb	RF02	WNW flow over Snowies, WDIR~300 deg, Deep clouds, strong returns from radar and both lidars. First WWDC with WCL-II. Aborted early due to bad weather conditions at LAR and CYS, diverted to Ft. Collins/Loveland, Returned to LAR later in evening (no data in ferry back). Completed 3 full ladder patterns over Snowies prior to abort of mission.		3.5 0.5	B Wadsworth Q Maio J French
18 Feb	RF01	WNW flow over Snowies, WDIR~300 deg, Stable, stratiform clouds, relatively shallow, with tops <14 kft on downwind side, ~15-17 kft on upwind side. NO WCL-II, EdgeTech chilled mirror not working (Auto Balance Control?), Licor turned on late (~15 minutes into flight).	1617 - 2024	4.2	B Wadsworth B Geerts J French
Test Flights					
Total Flight Hours				21.8	


WWDC-09 Flight Hours
25.0
20.0
15.0
10.0
5.0
0.0
Flight Hours
Projected hours flown
hours flown
2/12
2/19
2/26
3/4
3/11
3/18
3/25
4/1
4/8
4/15
Date (Feb 12 --> Apr 15)

Project WWDC-09 – Flight 5

Crew : B. Wadsworth, L. Oolman and M. Kovilakam (note-taker)

WCR was slow to start up. WCR was run in profiling / VPDD mode at 15 m gate interval, 3000 m up, 3000 m down, 3000 m slant down. Flight level 14 kft at all times. Up and downlooking lidar available. This is the only WWDC flight with the downlooking lidar behind a low-depolarization glass.

take-off: 165730 UTC: Wheels up

Parallel Leg : orientation 305° magnetic, 316° true
170948 : GLEES

5 Leg Ladder

172402 : WW1A
173036 : WW1 B
173153 : WW2B
173824 : WW2A
173946 : WW3A
174622 : WW3B
174752 : WW4B
175424 : WW4A
175552: WW5A
180230: WW5B

generators were turned on at:
MB03 Turpin Reservoir--17:50 UTC
MB04 Mullison Park--17:52 UTC
MB05 Barretts Ridge--17:54 UTC
They remained on for the duration of the flight

Parallel legs: two, both with orientation 316° true

181141 : GLEES
181621 : Turn back (change of WCR file)
181900 : Track back in to GLEES
182400 : GLEES

3 Leg ladder

i):
183607: WW1B
184220: WW1A

184356: WW2A
185035: WW2B
185156: WW3B
185833: WW3A

ii) :
190030: WW1A
190707: WW1B
190841: WW2B
191516: WW2A
191640: WW3A
192318: WW3B (change of WCR file)

iii):
192500: WW1B
193120: WW1A
193242: WW2A
193930: WW2B
194059: WW3B
194728: WW3A

iv):
194928: WW1A
195628: WW1B (change of WCR file)
195808: WW2B
200436: WW2A
200553: WW3A
201259: WW3B

Break-off and return to LAR

Generator OFF times are:
MB03 Turpin 2111 (UTC)
MB04 Mullison Park 2115
MB05 Barrett Ridge 2117

Project: WWDC-09

Crew: B. Wadsworth
L. Oolman
Y. Yang

Preflight:
There appears to have deep clouds over the snowy range and lee wave clouds. High clouds are moving in. Planned takeoff 16Z (10 AM local).

Flight:
154924: WHEELS UP

Parallel Leg:
160125: GLEES
160805: end of the parallel leg, 18miles from GLEES

5 Leg Ladder (1):
161325: WW1A, in cloud
161922: WW1B, change data files
162058: WW2B, first very low LWC, and then a little more LWC
162755: WW2A
162920: WW3A
163513: WW3B
163642: WW4B
164355: WW4A
164519: WW5A
165118: WW5B
End 5 Leg Ladder, 165457: change files

Parallel Legs:
170222: GLEES
170758: Track back in
171039: Track back in to GLEES
171456: GLEES
End Parallel Legs

3 Leg Ladder (1):
172517: WW1B
173239: WW1A
173355: WW2A
173950: WW2B
174122: WW3B
174838: WW3A

End 3 Leg Ladder

3 Leg Ladder (2):
175036: WW1A
175636: WW1B
175838: WW2B
180518: WW2A
180642: WW3A, there is precipitation
181227: WW3B
End 3 Leg Ladder

3 Leg Ladder (3):
181442: WW1B
182154: WW1A
182321: WW2A
182905: WW2B (182940: file change)
183036: WW3B
183738: WW3A
End 3 Leg Ladder

3 Leg Ladder (4):
183937: WW1A
184535: WW1B
184707: WW2B
185415: WW2A
185536: WW3A
190127: WW3B
End 3 Leg Ladder

3 Leg Ladder (5)
190355: WW1B
191108: WW1A
191225: WW2A
191818: WW2B
191955: WW3B
192710: WW3A
End 3 Leg Ladder

To GLEES

Parallel Leg: Last downwind leg
193140: more cloud, thicker and denser
193450: GLEES
End Parallel Leg

Flight and Debrief Notes:
JF

Project: WWDC-09
Flight: RF03
File: 20090310a

Crew:
B. Wadsworth
Y. Wang
J. French
LOD:
B. Glover

Preflight:
Morning flight, appear to have relatively shallow clouds over the Snowy Range; winds a bit ore westerly than previous flights, expect transition to cumuliform clouds over the course of the flight, winds at LAR should pick up during flight, VERY COLD

First flight with manifold system for up lidar (WCL-I).

Planned takeoff 14Z (8 AM local)

Flight Profile:
1. Takeoff from LAR head to point at FL140 on 90magnetic from GLEES
2. Leg at FL140 against into (parallel) wind over GLEES, hdg 270 magnetic
3. Setup for 1 ladder pattern for 5 legs, FL140
4. Two (2) passes parallel and anti-parallel to wind across GLEES
5. Setup for 5 sets of 3 leg pattern (SErn-most legs) over Snowies
6. One last parallel wind pass over GLEES

1341 Z: 170/06 T-17/TD-19, FEW 010, SCT 012

Flight:

1351 WHEELS UP

1357 FL140

13-57-34 WCR new file, Up/DD

1358 manual ABC on Edgetech, both lidars are operational and collecting data

1402 ABC complete

Parallel Leg

1405 online 270 magnetic through GLEES, more or less parallel to wind, pretty much on top of clouds, in clear air, WCL-I shows strong depolarization(??)
1415 end leg

5 Leg Ladder (1)

142120 leg 1, start out of cloud, 1424 into liquid cloud, about middle of leg
142715 end leg 1
14-27-41 WCR new file, Up/DD
142915 leg 2, a bit past point before we are lined up on the line, more liquid on this leg
143620 end leg
143745 leg 3
144330 end leg
144530 leg 4
145245 leg 5
150015 end leg

End 5 Leg Ladder

Restart WCL-I and WCL-II files
15-00-40 WCR new file, Up/DD

Parallel Legs

150830 leg into wind
151950 end leg
152320 leg with wind
153015 end leg

End Parallel Legs

Restart WCL-I and WCL-II files
15-31-11 WCR new file, Up/DD

3 Leg Ladder (1)

153730 leg 1
154515 end leg
154650 leg 2
155225 end leg
155405 leg 3
160145 end leg

End 3 Leg Ladder

Restart WCL-I and WCL-II files
16-02-42 WCR new file, Up/DD

3 Leg Ladder (2)

160430 leg 1
160955 end leg

161140 leg 2
161930 end leg
??????? leg 3
162650 end leg
End 3 Leg Ladder

Restart WCL-I and WCL-II files
16-27-35 WCR new file, Up/DD

3 Leg Ladder (3)
162940 leg 1
163720 end leg
163850 leg 2
164430 end leg
164645 leg 3
165420 end leg
End 3 Leg Ladder

Restart WCL-I and WCL-II files
16-55-14 WCR new file, Up/DD

3 Leg Ladder (4)
165730 leg 1
170220 end leg
170403 leg 2; 170814 WCL-I laser shutoff due to turbulence…restarted
171200 end leg
171330 leg 3
171915 end leg
End 3 Leg Ladder

Restart WCL-I and WCL-II files
17-19-33 WCR new file, Up/DD

3 Leg Ladder (5)
1723 leg 1; ~172629 WCL-I laser shutoff (turb); ~172902 laser back on
173045 end leg
173230 leg 2
173820 end leg
174040 leg 3
174800 end leg
End 3 Leg Ladder

Parallel Legs
175230 on line about 7 mi. NW of GLEES (abbreviated leg due to fuel); WCL laser up/dn due to turbulence
??????? end leg

<u>End Parallel Legs</u>

RTB

1813 WHEELS DOWN

Postflight:

Identified aircraft issues:

1. *None*

Identified ground issues:

1. *none*

Identified science instrument issues:

1. During 3 leg ladders especially but noted on mos (all??) ladder patterns, depolarization for up lidar (WCL-I) would change like a “switch” according to heading of the aircraft; maybe something to do with sun angle?? Found in data following flight that background is much high than normal…this could be due to reflection off the manifold??
2. Nadir door did not close all the way…following landing appeared to be due to ice buildup on the door
3. Nearing landing lost mouse control at third seat…could not use mouse on any of the computers. After flight surmised the mouse itself died, changed out mouse prior to next flight.
4. *No other known issues*

Flight and Debrief Notes:
JF

Project: WWDC-09
Flight: RF01
File: 20090220a

Crew:
B. Wadsworth
Q. Maio
J. French
LOD:
D. Lukens

Preflight:
Second flight of day, first flight was test/research flight for WAICO, testing changes to downward lidar (WCL-II).

WNW flow over Snowies, clouds look much deeper than previous WWDC flight (RF01).

All instruments operational, Edgetech chilled mirror did not look good on last flight, osciallating behavior, even after manual auto balance control in-flight.

Flight profile:
1. Climb to 14kft at point near Sheep Mountain, make parallel to wind pass over Glees (hdg 285 M)
2. Following parallel pass, Circle back to complete (2) "ladder" patterns (during time seeders are off).
3. Make parallel wind pass in opposite direction of (1), hdg: 125 M.
4. Complete (2) "ladder" patterns (during time seeders are on).
5. Make final parallel wind pass, hdg: 125 M.

Expect 2130 Z takeoff

2113 Z: 270/31G40, Few 085, 00C/-13C, 29.87

Flight:

2124 Wheels up

21-29-02 WCR new file, Up/DD

2131 all instruments are up and operational

Setup for first parallel leg
213504 begin parallel leg 1 at FL140, hdg 285 mag

2137 begin manual ABC on Edgetech; incloud with max LWC 0.3 g/m3

2144 end parallel leg 1

Setup for pattern1
Shutdown WCL-II from front panel (scientist needs to watch data system); start WCL-II control from laptop in back of aircraft

Ladder Pattern 1
215450 start leg 1, in cloud, light icing, LWC 0.2 g/m3
2201 end leg 1, smooth air, ice cloud on this (east) side of snowies
~220315 start leg 2
2210 end leg 2, much less liquid this pass

22-10-35 WCR new file, up/DD

221130 start line 3
221730 end line 3
221900 start line 4
2226 end line 4, cloud tops lowering as we move to the NW
222722 start line 5
222330 end line 5
End Pattern 1

Ladder Pattern 2
22-36-41 WCR new file, up/DD
New WCL-I and new WCL-II file

2237 start line 1
224430 end line 1
224550 start line 2
225150 end line 2
225330 start line 3
230030 end line 3
2302 start line 4
2308 end line 4
230930 start line 5
231618 end line 5
End Pattern 2

New WCL-I and WCL-II files
23-16-51 WCR new file, up/DD

Setup for 2nd parallel leg, 15 mi NW of GLEES
232250 on line, hdg 124 mag
232615 end parallel leg
Setup for pattern 3

Ladder Pattern 3
Checking ASOS at beginning of pattern, ¼ mi. vis at CYS, ½ mi. vis. At LAR—will keep close eye on weather at both locations, may need to go home early….
223240 start line 1, passing through strong "cell"
2339 end line 1
234030 start line 2
234711 end line 2
234820 start line 3
235440 end line 3
235620 start line 4 ----WEATHER not getting better in LAR or CYS
000250 end line 4
0004 start line 5
0010 end line 5----need to abort and head back to LAR; currently LAR is below mins, as is alternate; if does not come up in time, will divert to some place on front range.
End Pattern 3

After ~10 minutes holding, LAR still under mins, decide to divert to Ft Collins/Loveland.

0045 Wheels down

Flight back to LAR after 2 hours at Ft. Collins/Loveland…do not turn on data system…

Postflight:
Identified aircraft issues:
1. Icing on stall warning tab…tab is completely iced over, needs to be fixed prior to next flight.
2. On ground in Ft. Collins…maybe should have checked for hangar when we put on ground, we could have ended up stuck there overnight when snow squall moved through; luckily no ice sticking to aircraft.

Startup issues:
1. None

Science/Flight Pattern Issues:
1. None

Identified science instrument issues:
1. Chilled mirror looked better, we were in cloud entire flight.

Project: WWDC-09
Flight: RF01
File: 20090218a

Observations from flight Scientist: B Geerts.

1. Little turbulence was felt throughout the flight. Little change in snowfall & cloud patterns occurred during the 4 hour period. While cloudiness and light snowfall persisted in a band north of the mountain range (outside of the flight area), little cloudiness seemed to advect over the mountain, i.e. the clouds seemed to be mostly orographic. Caveat: the upstream environment (towards 296 degrees true) was poorly characterized, only the first parallel leg extended far upstream (19 nm from GLEES) without clearing out of cloudiness and WCR echoes. Still, even that distance is not past the complex of the Med Bow Range, it just went past Kinnock Peak.

2. Cloud tops appeared to be up to 1 km above flt level, mostly near the west end of the ladder legs. Radar echoes generally were above the terrain (ranging to above flt level) near the west end, and hugging the terrain (but mostly below flt level) at the east end, suggesting that the low-level flow was more westerly than 296T (maybe even south-westerly). Some thin cirrus clouds were intermittently present, sometimes even cirrostratus. The WCR did not detect any echo above radar tops (up to 1 km above flight level), except on one occasion (~1804Z), when cirrus was seen near the max recorded range of 3 km above flt level.

3. (post-flight info from WMI) AgI generator turn-on times:

02/18/2009 18:10:37Z MB04 Mullison Park

02/18/2009 18:11:33Z MB05 Barrets Ridge

02/18/2009 18:08:37Z MB03 Turpin Reservoir

All Med Bow & Sierra Madre generators had been off since 13:30Z or earlier.

4. The upstream albedo appeared rather high (extensive snow cover in the valley towards Rawlins)

Flight and Debrief Notes:
JF

Project: WWDC-09
Flight: RF01
File: 20090218a

Crew:
B. Wadsworth
B. Geerts
J. French
LOD:
D. Lukens

Preflight:
First research flight for WWDC.
Sfc to flight level wind direction roughly 300 deg (true). Satellite shows relatively isolated clouds over Snowies, visually clouds do not appear overly deep, nor do they appear convective at all.

No WCL-II (not installed)
Problems with Chilled Mirror on last flight, head disassembled/reassembled prior to this flight.

Flight profile:
1. Climb to 14kft at point near Sheep Mountain, make parallel to wind pass over Glees (hdg 285 M)
2. Following parallel pass, Circle back to complete (2) "ladder" patterns (during time seeders are off).
3. Make parallel wind pass in opposite direction of (1), hdg: 105 M.
4. Complete (2) "ladder" patterns (during time seeders are on).
5. Make final parallel wind pass, hdg: 105 M.

Expect 1615 Z takeoff

1604Z: 206/14, Few 065, BKN 085, 03C/-12C, 29.89

Flight:

1617 Wheels up

1624 @ 14 kft, beginning line 1, parallel to wind through Glees, hdg: 285 mag, WCR and WCL-I operational; WCR: 16-21-18 up/DD

1627 gast pump (CPC) did not come on at takeoff, switch on power strip (28 VDC) not turned on

1629 Licor turned on (late…operator oversight)

1636 end parallel line, setup for ladder pattern 1.

Ladder Pattern 1
1645 on line 1, incloud on west side, above cloud on east side
164845: adjust to return to line, wind drift
165310 end line 1
16-52-35 WCR new radar file
165430 on line 2, 2kft below tops (west side)
1702 end line 2
1705 on line 3, some LWC on west side (~0.15 g/m3)
Appears chilled mirror is out to lunch
1712 end line 3
171515 on line 4
172230 end line 4
172525 on line 5
173215 end line 5
End Pattern 1

17-33-01 WCR new radar file

Ladder Pattern 2
173615 on line 1, east end and above cloud tops
174415 end line 1
174715 on line 2
1754 end line 2
175630 on line 3
180340 end line 3
180530 on line 4
181210 end line 4
18-12-31 WCR new radar file
1814 on line 5
1821 end line 5
End Pattern 2

Setup for Parallel leg
182530 on line, hdg 105 mag, through Glees
182915 end parallel leg (note: not as far upwind as first parallel leg)
Setup for pattern 3

18-31-37 WCR new radar file
New WCL-I file

Ladder Pattern 3
183420 start leg 1; extra maneuvering at start to get aircraft level on this leg, maneuvering complete by 183508
184130 end leg 1
1843 start leg 2
184930 end leg 2
185115 start leg 3
185815 end leg 3
185945 start leg 4
190620 end leg 4
190750 start leg 5
1915 end leg 5
End Pattern 3

19-16-37 WCR new radar file
New WCL-I file

Ladder Pattern 4
191850 start leg 1
192545 end leg 1
192710 start leg 2
193440 end leg 2
193602 start leg 3
194230 end leg 2
194350 start leg 4
195112 end leg 4
195230 start leg 5
195905 end leg 5
End Pattern 4

Setup for final parallel leg
19-59-47 WCR new radar file

2004 start parallel leg, heading 105 magnetic
2010 end parallel leg

RTB

2021 Chilled mirror comes back up just prior to landing
Near end of flight, VCR stopped and rewound

Wheels down

Postflight:

Identified aircraft issues:

1. No aircraft issues

Startup issues:

1. Need to have aircraft outside with power 55-60 minutes prior to takeoff time, possibly even more when downward lidar is installed. Push pre-flight brief to 1:20 or 1:25 prior to flight to allow enough time to transition to “active” and pullout aircraft

Science/Flight Pattern Issues:

1. Quicker turns at end of each leg (as was done in pattern 3 and 4) are preferable to allow ample time for completion of 4 patterns and 3 parallel legs

Identified science instrument issues:

1. Licor turned on late (~15 minutes into flight, operator oversight…)
2. CPC gast pump did not get power when turned on initially, power strip 28 VDC was turned off, noticed ~15 minutes into flight
3. EdgeTech chilled mirror quit working ~30 minutes into flight, came back at very end. Initial thought was icing of button, conversation with Edgetech following flight and detective work by engineering group indicates likely problem is auto balance control that occurs at startup. Will try manual ABC at altitude in next flight.
4. VCR recording stopped and rewound at very end of flight, just prior to landing; engineering will clean VCR prior to next flight.