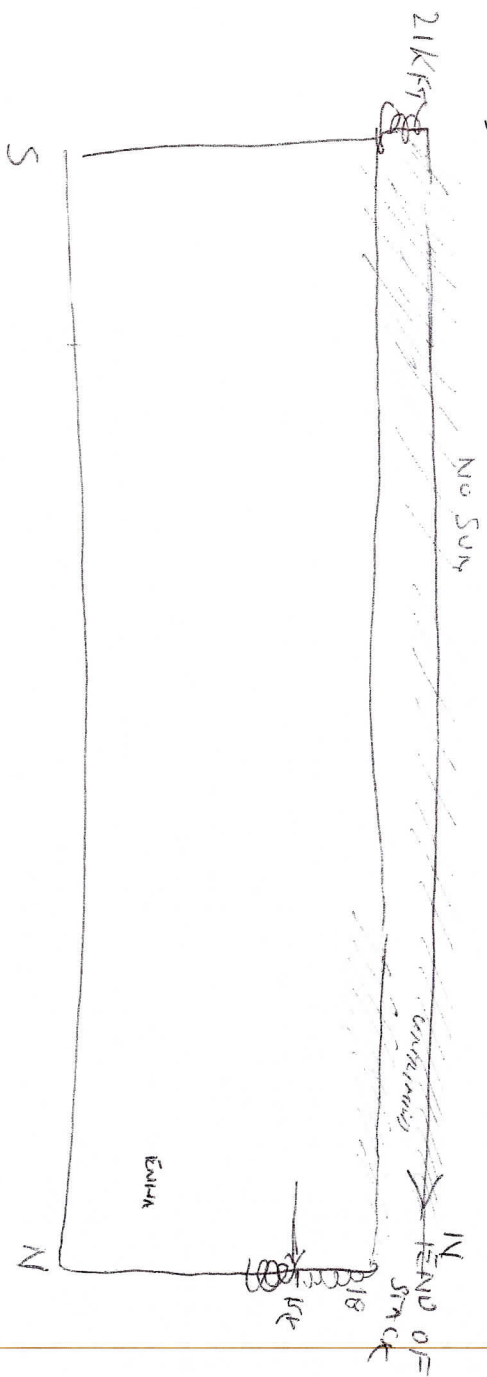
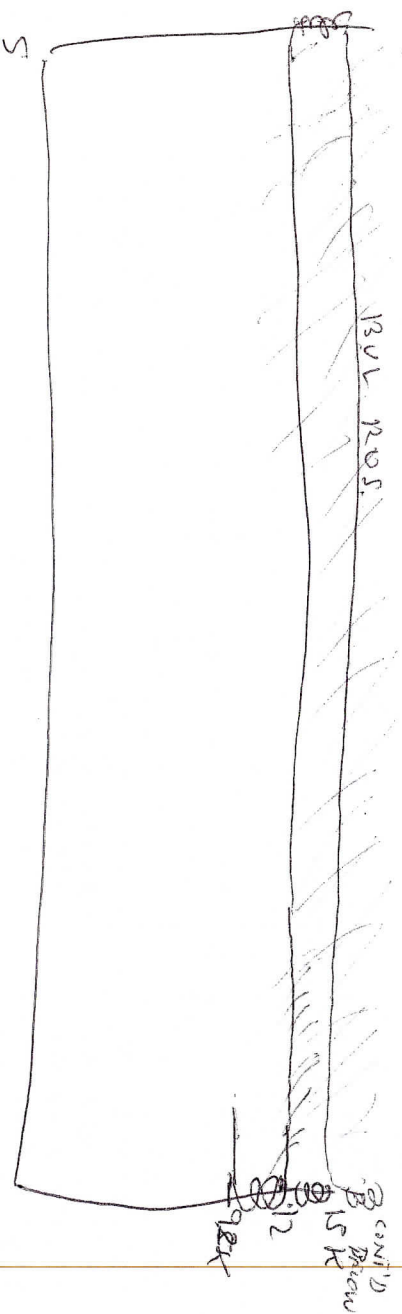
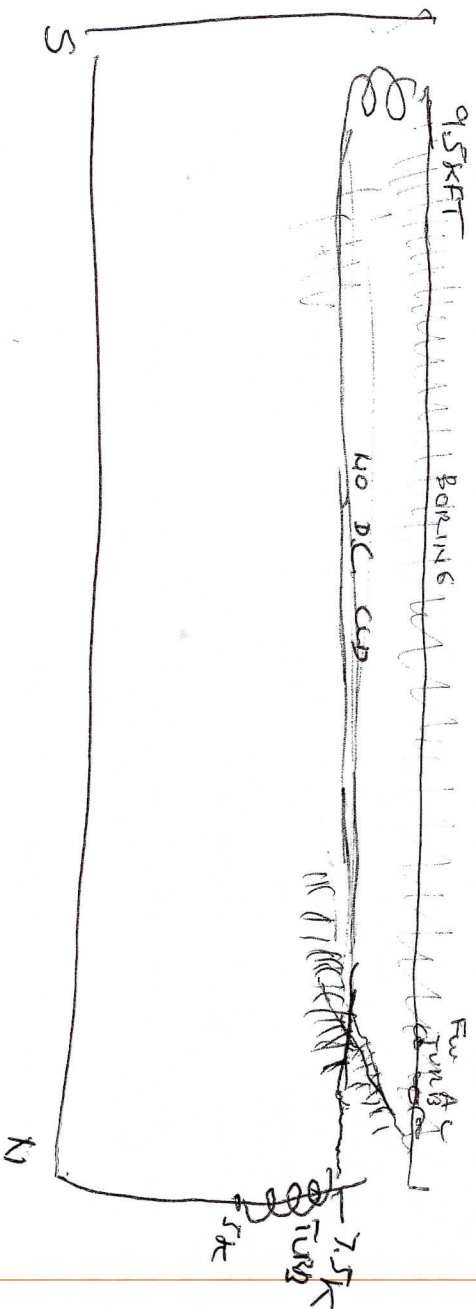
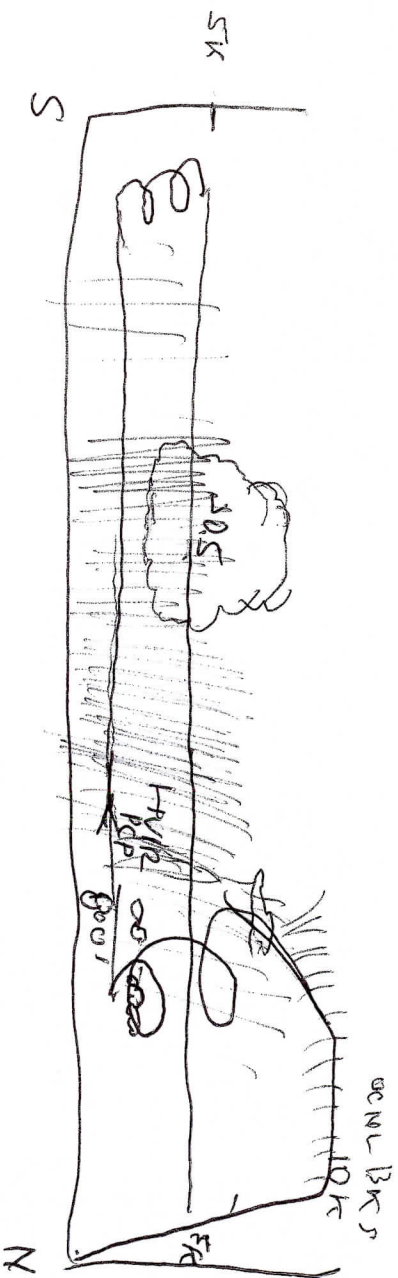
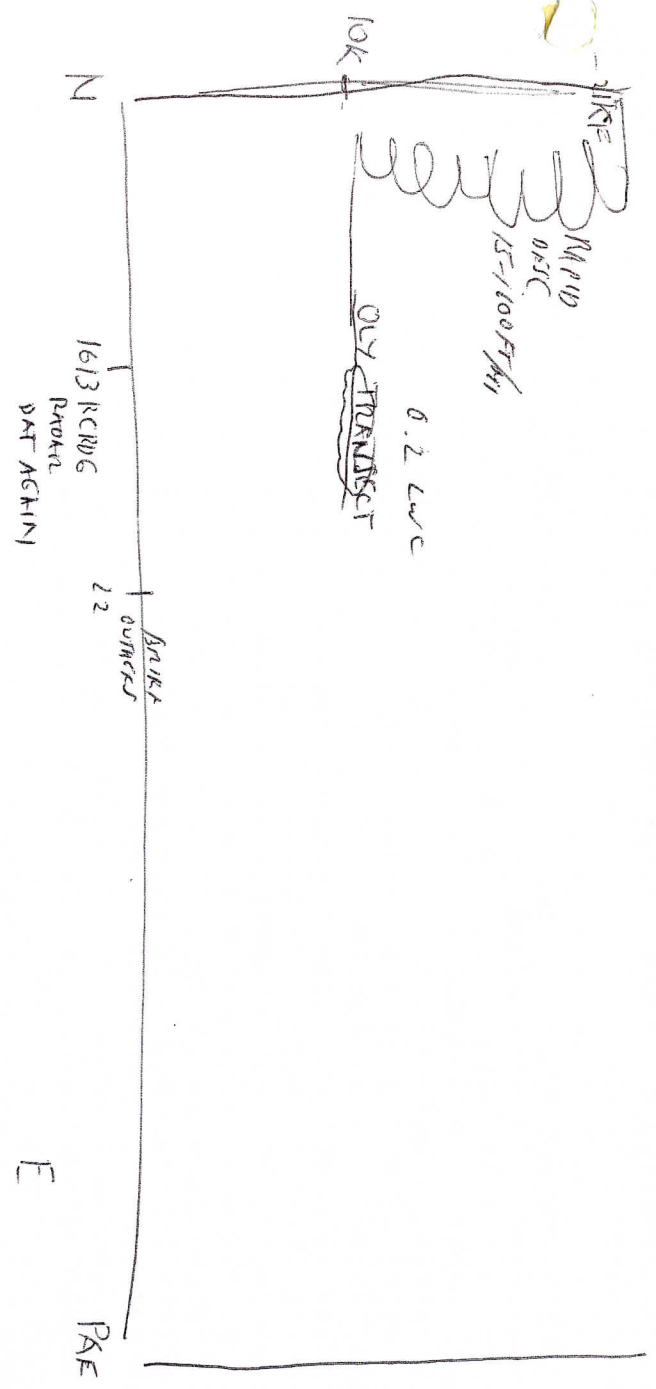


# Aircraft Flight Log for the University of Washington, Cloud and Aerosol Research Group

Date 1-20-01	Flight Number 1853	Experimental Observations	
Project name IMPROVE D=3:22			
Engines on time 2128 UTC	Engines off time <del>0030</del> 0030 UTC	<p>FLEW IN E-W BAND PLVD TO BE WARM ENTL IN NATURE. DREPP STFM CLOS W TOPS &gt; 30K (EST) WITH INITIAL REN IEGMD CONV SAMPLED BIED. CLO BA F AGAIN IN SK LEG. THEREAFT, SYST. WAS QUASI-STDY STATE, NO LWC, + DRY X-TALS + AGGS OVR WHOLE LEGS. MUG STACK PATTERN - LEGS XTNDRD FARTHER N EACH TIME.</p>	
Departure airport HQM	Arrival airport PAE		
Flight Scientist signature New Bond / A. Rangno		<p>SUN PSN NOT DETECTABLE = S HI CLO TOPS PROBABLY <math>\approx</math> 3 KM ABV A/C 21KFT</p>	
Pilot signature JC			
Surface met. & visual obs. at takeoff E40 + R-C16 LWA SW-W		<p>Ac As Ns Sc St Cu Cb</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Clouds sampled</p>	
Research crew BOND GRAY SPURGEON RANGNO			
Equipment failure		<p>LTR CHANGE NOTED</p>	

(ROUGH NOTES ATTACHED)





Flight 1853  
January 20, 2001  
Voice Transcriptions\*  
IMPROVE

1:40 PM

AR: (This is the 2nd flight today.) Took off in light rain at Hoquiam. The sky looking very typical, nimbostratus, visibility lowering to below 10 nautical miles about the time we took off.

1:41 PM

AR: Picked up some clear icing on the climb out here. Can't get the laptop started. We do have some droplet clouds down below the aircraft. We appear to be flying in precipitation. Occasional droplet clouds still.

DS: The data system is up and running now.

1:43 PM

AR: Don, did we record anything between takeoff and now?

DS: Negative. I didn't get the power until I went up and turned it on myself.

AR: Okay. I'll keep that in mind.

1:44 PM

DS: They're a little busy up there. I went to go and check and they said go ahead and do it, so I did it.

LS: Nick, this is Larry. Are you up?

NB: Yes. I'm here.

LS: It looks like about 4,000 ft is as low as they're probably going to let us go down there IFR.

NB: Okay. If that's that, that's that. The lower the better, but that's the way it goes. Our southern point right now, like I was saying, we'd basically want to work

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\* AR = Art Rangno, DS = Don Spurgeon, EC = Eric Cooper (pilot), GG = Grant Gray, LS = Larry Sutherland (pilot), NB = Nick Bond

along the 124°15' W longitude line and right now our southern point is at 45°20' N.

LS: I've got all that and is 4,000 ft going to be okay for you?

NB: Yes. 4,000 ft would be okay, but if we can get even 3,000 ft would help if we can do it.

LS: Okay. I'll have to negotiate.

1:47 PM

NB: We anticipate the north point on our kind of stack will be approximately 46°30' and so that would be basically we'd be running along that 124°15' line between 45°20' and 46°30'.

LS: Okay. The 46°30' would be your north point and the 124°15'.

NB: That's correct.

LS: You say the south point was...

NB: 45°20'.

LS: 45°20'.

1:48 PM

AR: These winds look a little strange.

NB: Yes. They're exceedingly light.

AR: The winds are kind of flopping around here at 3 to 10 or 8 knots or so out of the southwest suggesting that maybe something went by at 700 mb. So we're flying in precipitation. We don't seem to have any droplets here. From time to time the visibility is a little higher looking down the wings, that is beyond the wings, indicating holes in this precipitating system at least in the last 5 min or so.

NB: Larry, Nick here.

LS: Go ahead Nick.

NB: Yes. If we could start, I see we are dropping down. Okay. No problem. You're way ahead of me.

LS: We're going to do a 360 to get down to 4,000 ft and then start our track.

1:50 PM

AR: Continuing to have intermittent noise problems with the HVPS, the broken line running along the bottom of the imagery. Just now picked up some turbulence. Had a little bump there.

1:51 PM

AR: In-between layers here at 7,000 ft approaching a little cloud top here, but I do see through a hole lower clouds. Above us it is more of an unfeatured solid lightly precipitating layer.

1:52 PM

LS: Nick, it looks like we're going to be able to get down to VFR. How low do you want to go?

NB: Well, I guess 1,000 ft would suit me fine.

LS: Okay.

1:53 PM

AR: Spiraling down between broken stratus fractus clouds here at 2,500 fms-alt. It's a little bumpy underneath. Cloud bases here at about +5°C. White caps suggesting about 15 to 20 knots on the surface. No real significant precip anywhere in this end of the line or whatever it is we're going to be studying. We have overcast altostratus cloud essentially dropping some very light precipitation down to the surface. It's falling through a couple of scattered to broken lower layers, none of which have much depth.

1:56 PM

AR: Back behind me I can almost see the radar. It's probably out about 10 to 15 miles back off around 7 to 8 o'clock. Now we're taking our heading down the track and indeed the rain and the ceilings do lower in this direction.

LS: Nick, we're down to 1,000 ft and we're slowing up to research.

NB: Sounds good.

1:57 PM

NB: Art, I think you'll be happier about the winds now.

AR: Yes. That looks a little more like it, doesn't it? I can't quite understand why they were so light up there. I can't image that was real.

NB: Yes. That's a bit of a puzzle. I can appreciate them being stronger down here, but still that they were essentially calm up there is kind of weird.

AR: It looks like there's a clearing in the distance off the right wing now.

1:58 PM

AR: Don, the 2-D is on the friz as well.

NB: Say Larry, it's getting pretty warm back here again.

LS: Okay.

2:00 PM

DS: It kind of looks like, Art, it might have got something down inside it.

AR: Yes. I was thinking that during that fairly rapid descent. Sometimes it doesn't like that and maybe that's a problem. Maybe it will dry out here in a bit.

2:01 PM

NB: Everybody, I'm going to check in with the radar. So I'll be out of contact for a bit here.

2:02 PM

DS: Art, the 2-DC is back up.

AR: Right. It came back to life about 2 to 3 min ago I guess.

DS: Yes. The HVPS on the other hand is another matter. It's not coming up this time.

AR: It was working just a little bit ago.

DS: Yes. Then the computer system crashed and I haven't been able to get it started again.

2:05 PM

NB: Larry, Nick here.

2:06 PM

LS: Go ahead Nick.

NB: I just talked with the radar. They have a new south point for us that is not nearly as far south as we had first anticipated. Now they want us to basically turnaround 45°55' along that same longitude line.

LS: Okay.

NB: We can anticipate a climb up to something like 5,500 or 6,000 ft and then return north a little bit past where we came down low, but maybe something like 46°40' or so.

LS: Okay. I'm just entering this point now. I'll have to get back to you. I'm kind of busy right now.

2:07 PM

AR: Continuing to fly in light maybe moderate rain. Visibility down out beyond the wings maybe 3 or 4 kilometers and heavier off the left wing.

LS: Nick, I've got time now. What do you need?

NB: Yes. This is to be kind of confirmed on our way back north, but our north point will be a bit north of where we started this low-level run. It will probably be something like 46°45'.

LS: Okay. 46°45'. Would you mind if we move about 3 miles further west?

NB: No.

LS: Okay.

NB: In fact according to Mark, he would have preferred we had been in that Whiskey 570 area, so this is fine to move a little west.

AR: Thin spot in the clouds overhead. The sky brightened a bit. Four scud clouds visible in the dome overhead the plane. It looks like heavier precip again ahead as we move toward a bit of an east-west dark line here. It looks like the precip is going to pick up quite a bit here in the next 30 s or so.

LS: Nick, what altitude do you want to go back northbound?

NB: That's probably going to be at 5,500 or 6,000 ft.

LS: Okay.



NB: Then we will want to do them at basically 2,000-ft intervals.

LS: Okay.

AR: There's some indication of convection in here, Nick. There is kind of a heavier shaft of rain in this general region and kind of dark bases as you see going by over there.

NB: Yes. I was noticing the same thing. Yes. It's really kind of pounding my window here, so this is great. For what it's worth, John told us that our turnaround point at 45°55' wasn't going to be at the end of the precip, but just the place that they want us to be. So obviously we're hitting the heavier stuff here. Say, it's okay if the plane gets wet, isn't it?

AR: Yes.

2:11 PM

LS: Nick.

NB: Yes. Go ahead.

LS: We might have to go northbound at this altitude until we get a hole to get up through because he's not going to give us an IFR clearance until we get above 4,000 ft.

NB: Okay. That's fine. Rather than coming back right at the same place we've been, I guess until we can get a clearance, I'd prefer to keep heading south.

LS: Okay. I do think it's starting to break up a little bit down here. We might be able to get up to it.

NB: Okay.

2:12 PM

NB: Art, you might find it interesting that in that kind of heavier precip there was obviously some low-level convergence with the winds. Wait. Check that. Well the winds were more from the south on the south side of it, but maybe a little weaker. So anyway there was a bit of a wind signature to it.

AR: I'll be darned. Now that we have good winds, we can actually look for that sort of thing. I've also noticed that as we head toward California the temperature has been rising a little bit.

2:14 PM

LS: Nick, I think I can cool it down if I can increase my speed a little bit. Is there any restriction on what speed you need?

NB: No. A little faster would be fine. That would be okay. Yes, Larry, that would be fine to increase the speed a little bit. It does look like, of course, it's opening up for kind of rising up here, but it's a good thing we're near our point.

LS: Yes. I think we'll swing over a little bit toward the shore over there about our 10 o'clock and start a climb and get a hold of Center and get back on an IFR. But I don't think we can get an IFR, well maybe he'll give us one at 4,000 ft out here. I don't know.

NB: Yes. On this return leg if 5,500 or 6,000 ft would be fine.

LS: Okay.

2:15 PM

AR: In some sense that is the best-defined singular feature that we've been tracking out here for several flights.

2:16 PM

DS: It looks like the CPI is going to be dead for this flight.

AR: Do you know what happened, Don? Did it just not come up?

DS: It came up initially, but since the computer crashed I've not been able to get the darn thing to start since.

AR: That's too bad.

2:17 PM

AR: Do we have \_\_\_\_\_ files? It's not wanting to start up because the disk is full or something.

DS: No. I cannot get a background.

2:18 PM

DS: The only thing I could try doing would be tearing everything apart and seeing if something has come loose inside and I'm a little reluctant to do that when we're

flying because I don't to drop something down inside and really burn something up.

AR: Roger. So you're saying that when you turned the computer off and then restarted it that it doesn't come up or that the program itself doesn't work?

DS: Everything is working, but it's not getting a background. It will not start sampling and acquiring. It's acting like either the card is not working quite correctly or it's not being set up correctly.

LS: Nick, we're back on an IFR clearance and I've got a block from 5,000 to 8,000 ft.

NB: Sounds good. So let's tentatively head up to 5,500 ft. That should be pretty good.

LS: Okay.

AR: Okay Don. I've got you.

DS: Or something has come loose inside.

AR: You don't think the camera has gone bad on us?

DS: I don't see why it would especially considering it did function when I first started it on this flight and then something happened again, the computer crashed and I've not been able to make it work since then.

AR: Not the program but the computer crashed.

DS: The computer crashed, not the program, the computer crashed.

2:20 PM

AR: Underflying precipitating I guess it would be nimbostratus in this case. Not much cloud detail overhead. Back behind us we have some stratocumulus looking like it's trying to mass into something perhaps a new amplified rain area. Out ahead we're chasing our northward moving somewhat cellular heavier rain area that we flew through at about 8,000 ft.

2:21 PM

LS: Nick, we're on track now at 5,500 ft.

NB: Yes. We're doing good here. I think this is a good level for us. Of course, our ground speed is pretty quick here, so I'll be calling the radar to confirm that north point.

LS: Okay. I've got 33 miles to go.

AR: Larry, can we cut it closer to research speed?

LS: Yes. We sure can.

AR: Thanks.

LS: I was trying to cool it off.

AR: Roger. That's a good effort, but probably for us it will be a little better if we're down closer to that research speed and keep our measurements as good as they can be. Thanks.

DS: I have one thought on the CPI and I'm going to give it a try. If it doesn't work, I'll have to think about it.

AR: Have at it.

2:23 PM

NB: Larry, Nick here.

LS: Go ahead Nick.

NB: Our north point I have a new point for that and that's 46°38', just a tad south of where I first suggested, and then we'd come back down again at 45°55' as before. So when we get to the north here, we'll climb another 2,000 ft to 7,500 ft and retrace toward the south.

LS: Okay. You were stepped on for that north point there. Give it to me again.

NB: Sorry. 46°38'.

LS: Okay.

2:25 PM

AR: I'm back in the bubble. After conferring with Don on the CPI malfunction, it is now running. I'm not really sure exactly what it was that was done, but anyway while he was moving around on the advanced settings all of a sudden sprung to life and there you go. We just past through that major core that we're starting for this leg. Lots of good imagery on the HVPS. Finally it looks like we're in something. There are lots of big images. The other thing is the liquid water content went way up to over half gram and so that's another good sign of an active

lifting zone. I say when we went into it it looked a little convective almost like a soft cumulonimbus.

DS: Got some big stuff out there this time.

AR: Yes. This is definitely more like it.

2:29 PM

NB: Say, Grant, are you there? Or Art maybe or Don maybe you could answer this. Is the radar being recorded?

DS: Yes. If you want to talk to him, he's on "chat."

NB: No big deal.

AR: The first recording started toward the end of that first flight today Grant told me.

NB: That's right. Thanks.

2:30 PM

DS: Nick. Grant will have it recording shortly. He's still working on the software and the hardware. It recorded one already and then stopped and he has a few things to do before he can put it in continuous record mode.

2:31 PM

NB: We're getting pretty close to our turnaround point. It looks pretty good.

2:33 PM

AR: I think we're out of precip. If you do want to cut it a little short, I don't know how much further we're going, Nick.

NB: Yes. I think we're just about at the end of this leg.

2:35 PM

NB: Larry, Nick here.

LS: Go ahead Nick.

NB: This would be a good time as any to climb up to 7,500 ft and return south.

LS: Okay. Here we go.

GG: We're recording radar data, but this is really a hokey piece of software. We're recording it at 5 MHz and we can average 2 or 3 samples to get one sample to cut the noise down a little bit. We can't do gate to gate averaging on this machine. It's not giving an option.

DS: Is that option software or hardware edition?

LS: Nick, did you get some good stuff in that last leg?

NB: Yes. That was great. Basically the whole leg was in really good stuff. So we've really got these endpoints, I think, nailed down pretty well.

LS: Okay.

NB: Art, I don't know if you noticed that there was quite a bit of chop and a sudden decrease in the wind on the north side of that band.

AR: Right. Just in here, exactly. I didn't see any decrease in the wind, but how much of a decrease was it? Maybe you can refresh me. It still looked like it was 30 knots or something.

NB: It went from 20 meters per second to like 12 meters per second.

AR: I missed that.

2:37 PM

AR: This north end appears to be mainly stratiform. We're not having any convection that we saw toward the steady south end of this thing. That is sort of the middle center south. Lofted stratiform again at the very south end. I'm going to look for a pump of liquid water here in the next few minutes.

NB: So Art, did you notice the winds now are down to about 6 meters per second or so?

AR: Roger. Absolutely, that's pretty darn interesting and it gives maybe credibility to those winds at 10,000 ft that were so low.

NB: Yes. I'm going to call up the radar just to say boo and so I'll be out of touch here for a bit.

DS: You can let him know that we've got the HVPS going too.

AR: I'm not used to looking at winds that I trust.

DS: Trust us, Art, trust us.

AR: But this goes back before STORM-FEST and back there in the '80s and long before that you just couldn't trust our winds.

DS: Well we made some improvements.

AR: Yes, because not even Jack could get us the right winds.

DS: Different sets of equipment and different sets of software now.

AR: Yes.

2:42 PM

DS: Art, if you notice the 2-D or anything going bad, let me know. I may drift off here shortly. The hamburger is just catching up to me.

AR: Yes. I know exactly what you mean, Don. I kind of feel the same way myself. When we're in-cloud the whole time I don't think it's very interesting.

DS: Yes. It puts you in a hypnotic state the drops going past you.

2:43 PM

AR: We've not seen that increase in liquid water. I'm a little surprised by that at this point whether we are trying to intercept a cell again, which is a little bit what it appeared like, that has now moved out of the geographic line that we are flying.

2:44 PM

NB: Larry, Nick here.

LS: Go ahead.

NB: This band that we're doing very good work in is moving pretty rapidly to the north and so our south point now is 46° 15' and I imagine our north point will kind of be slightly northward also.

LS: Okay. I'll get that in there.

GG: Art, which way would you like the antenna pointing, down?

AR: Do we have it pointing up?

GG: It's down at the moment.

AR: Right. Can we go upward?

GG: You got it.

AR: Thanks a lot for reminding me.

NB: For you guys information, John is very pleased with your efforts in getting everything working and he just wants to have me express that to you.

DS: Thank you much.

AR: I think Grant, Tom and Don are the heroes there. Me, I just come along for the ride.

NB: Art, in the continuing saga, the winds now they are approaching 20 meters per second again. So there's a lot of convergence here is basically what we're seeing. They're extending well up there. I bet these tops are really growing pretty high because there's still a lot forcing them right now.

AR: Yes. They're several kilometers above the flight level, so they're up there all right. The other thing I was talking to the radar when this happened, but winds were actually about 215 to 200 for awhile as well. I was just going to bring that up that there seemed to be some kind of a wind shift, although the temperature didn't do anything. I'm not sure how real that was.

NB: Yes. I've noticed the same thing. I would have expected that there would have been kind of more easterlies to the north and the westerlies to the south, but that's not the case. It's almost kind of anticyclonic curvature.

2:47 PM

LS: Do you want 9,500 ft on the next northbound leg?

NB: That's correct.

LS: Okay.

AR: The other thing that I'm beginning to think about is when we went southbound. Before, I remember, it looked kind of cellular. I think in our offset and maybe because it was cellular, it looks like we're missing that nice really heavy precip core that we went through on the way down south earlier.

NB: Yes. I'm not sure what if anything we should do about that. It's just kind of one of those things.



AR: Roger. Changes are it moved way out of an area that we couldn't sample anyway, but I kept looking for that big liquid water signature. We had half a gram on that last pass. So I figured turning around we'd probably go back through it, but then I remember the offset plus the translation of the darn thing and it being cellular. We just seem to be more of in a stratiform region rather than a convectively enhanced region right now.

2:49 PM

NB: So Art, at what temperature do the plates form?

AR: About  $-10^{\circ}\text{C}$  to say  $-12^{\circ}$  or  $-13^{\circ}\text{C}$ .

NB: Okay, because on the CPI I'm occasionally seeing one that looks like almost a perfect hexagon.

AR: I just saw one on the 2-D probe here as a matter of fact almost a millimeter in size, which was a little unusual to have one that big. So that means virtually no liquid water maybe barely ice saturated in this region.

2:50 PM

AR: I guess we reached our endpoint?

NB: Yes. That's correct.

AR: That might go with the thinning of the cloud that we saw in this area at lower levels. That kind of stuff in the evaporation mode on the way down not quite making it or barely making it.

2:51 PM

AR: The radar suggested cloud tops are about 4 kilometers above the flight level.

NB: That's really a lot deeper than we were looking at at the start. The radar was talking about 5 kilometers total at the most.

2:52 PM

AR: That's correct. It's 5 nanoseconds so that would be okay then my estimate.

2:53 PM

LS: Nick, it looks like we're going to hold here at 9,000 ft.

NB: Okay. If we could do the run at 9,000 ft that would be fine.

LS: Okay.

AR: The HVPS is gone on its head again. It seems like it really does not like temperature and pressure changes because it doesn't matter whether we go up or down. It seems like something bad happens.

DS: There it goes. I think the airflow deposits something on one of the lenses when you're going up and down because of the way its positioned.

AR: Okay.

DS: That's what it looks like anyway.

2:54 PM

LS: Nick, we're going to have 9,500 ft going back.

NB: That's great. We're going to want to continue going up above there. So I don't know if you have a new block or not.

LS: I'll have to get it.

2:55 PM

NB: I'm going to check in with the radar now, so I'll be offline here for a bit. Larry, Nick here.

LS: Go ahead Nick.

NB: Our new north point is 46°47', so just kind of slide north here. I've talked to him about at what kind of interval we want to do this stack, if we want to maybe go to 3,000 ft intervals, but certainly we'll want to go up higher. Maybe if we could go to 12,000 ft on this next one that would be good.

LS: Okay.

2:58 PM

AR: That leg like the previous leg was in stratiform conditions. No noticeable changes in crystal type or any other structural feature at least that I could tell from the bubble. Some aggregates and they look unrimmed. Everything seems to be working fine. The temperature running around -7.6° to -8°C and we haven't been hitting any liquid water.

3:00 PM

AR: A little turbulence now just a tiny bit as we pick up a little liquid water cloud. I saw it going by the wing. Yes, there's a little more. The sky darkening ahead a bit overhead suggesting some liquid water up there.

3:04 PM

GG: Don, if you're alive go to "chat."

AR: Nick, as those winds drop off they're pretty spectacular.

NK: Yes. The convergence on the back edge here. That's kind of interesting.

AR: Yes. They're really swinging around too as you say in an anticyclonic gyre here across this little system.

NK: And again some turbulence here. I presume it's kind of just the updrafts here just kind of cellular in nature.

AR: Roger. When I first felt them, I wasn't thinking about the wind speed so much as looking for droplets going by the wing, some fog going by the wing, because we had hit some liquid water cloud, which we did hit. The liquid water content is so low it's stuff that's formed and kind of stratified at this level. It's not coming up from deeply below us probably 10s of meters or 100 meters maybe judging by the extremely low liquid water content thus far anyway.

LS: Nick, we're at 12,000 ft now and heading back southbound. I suppose you've got a new southern coordinate for us?

NK: Yes. Tentatively it's still 46°15', but I'll check in right now.

LS: You've got to be aware that Whiskey 237 starts up there at 4705, so we can't accept anything more for that.

NK: Got you.

3:06 PM

AR: Once again as we start to climb the HVPS decides to not work anymore.

3:07 PM

NK: I'll talk to the radar now, so I'll be offline for a minute.

3:08 PM

AR: Continuing a fall of largely unrimmed aggregates and single crystals and their fragments. Those are aggregates of what looks like dendritic types.

3:09 PM

AR: Don, do you want to see if you can restart the HVPS?

DS: Hit the end key on your program because it's still running on mine.

AR: Thanks. I appreciate that. I forgot the "end" key. Yes that did it. Thank you.

3:10 PM

AR: Oops, 2-D is stuck.

DS: Mine appears to still be running here.

NB: Yes. It looks okay here.

DS: So why don't you stop and restart that application.

AR: Do you notice how it's localized to Art?

DS: It's another one of the Art effects. How many collisions are they getting back there on your hub?

3:12 PM

DS: You're getting a few collisions on your output, Art, you might try unplugging your computer and plugging it into one of the other output ports back there and see if makes a difference.

AR: Okay. This is actually the first day that this has happened where I've actually had to just close an application for no reason and then have it work when it restarts, which did happen here with the 2-D. It's working fine.

NB: Larry, Nick here.

LS: Go ahead.

NB: I have a new southern point for you, 46°25'.

LS: Okay. 46°25'.

NB: Right. We'll start doing these intervals at 3,000-ft segments, so at that point we can climb to 15,000 ft and return north. One thing that we might want to look

into is if we can wiggle a little bit farther east, essentially toward the Binet site, as this band keeps working north. So far that Whiskey 237A area isn't going to be a problem, but it might be in a half-hour.

LS: Okay. We can work east of that at this altitude it won't be a problem.

NB: Yes. That's probably what we'll end up doing, but we'll see.

LS: Okay.

3:15 PM

LS: Nick, how's this here if we move our line 5 miles to the east so we can avoid Whiskey 237 and continue working this thing up north?

NB: Yes. That sounds good.

LS: Okay.

NB: We might as well kind of do that shift while we're in a turn or something and not during one of these legs.

LS: Okay. Should we move that northern border about 10 miles north? That's what we've been doing each time.

NB: Yes. I think that's sensible. It seems like it's moving north at about the same clip, so that's a good idea.

LS: Okay.

3:18 PM

LS: Nick, you did say you wanted 15,000 ft on this next leg, didn't you?

NB: That's correct.

3:21 PM

AR: We've got the radar in the downward position and don't have to just look at the steady state crystals that we've been flying in to know the flight's boring, but in the downward pointed radar there is an enhanced area due to the bright band on the radar display showing that it's a boring stratiform.

LS: Nick, we're going to be about a 1,000 ft short of 15,000 ft entering the leg. Is that okay?

NB: Yes. That's fine.

LS: Okay.

AR: Nick, I'm going to be sleeping in the back now.

NB: For this experiment, boring is good, right?

AR: I guess so. Actually it probably is good because there is steady state, you know. What we get to at cloud top is probably what produced these crystals instead of like this morning where there would be some question.

3:23 PM

LS: Nick, we're at 15,000 ft and we've got 29 miles to go to the point.

NB: Okay. We can tentatively head 10 miles north of our last turnaround.

LS: Yes. I had that already plugged in for another 13 miles.

3:24 PM

AR: Larry, are we pressurized today? I presume we are.

LS: Yes we are. The cabin is about 7,000, Art.

AR: Thanks Larry.

NB: I'll be checking in with the radar now. I'll be offline for a bit.

LS: Nick, Center wants to know how long we're going to be out here just for his planning purposes.

NB: Okay. That's one thing I'll ask about. I know we'd like to do another kind of set of legs where at least we'd be going down at 18,000 ft and coming back at 21,000 ft and beyond that point I'll ask about that.

LS: Okay. With all this anti-ice on, we might not be able to make 21,000 ft, but we'll give you what we can.

NB: Okay. That's a good point. What do you think we can make?

LS: 19,000 or 20,000 ft would be estimate right now. But it's kind of cold out there so we'll see.

NB: Okay.

3:26 PM

DS: Would either of you like some coffee up there?

LS: Nick, the Center says Whiskey 237 is open.

DS: He got that.

AR: There's low temperature crystals in here by the way. Bullet rosettes should be forming at temperatures below  $-30^{\circ}\text{C}$ .

3:28 PM

NB: Larry, Nick here.

LS: Go ahead Nick.

NB: Yes. I overhead that Whiskey 237A area is open. If that's the case, I guess we'd like to continue basically along this longitude if that's okay.

LS: Okay. So we'd move back out to the left about 5 miles?

NB: Yes. Just the next time you do a turn you might do a kind of left turn then. Our new northern point is  $47^{\circ}0'$ .

LS: Okay. That's what I had.

NB: Well sometimes it works out.

LS: Yes.

NB: Then we'll return at 18,000 ft and then see how high we can go for our final leg. That will probably do it for us. So I don't know timing-wise what that means, but you can tell the Center tentatively that's about how long we'll be out here.

LS: Okay.

NB: Art, Nick here.

AR: Roger Nick.

NB: I've just been talking with John. He was thinking try to get up as high as you can. See if we can get where these crystals were formed. He said, at that point we're probably done for the day unless we missed something. I don't think we really missed anything on the way up. Can you imagine anything we really missed?

AR: No, not a thing, Nick. The only thing that was different was that one pass where we were in that high liquid water area where we sort of had this cellular convective substructure in the stratiformed band, but we didn't get after that. In other words, the microstructure is going to be a little bit different after that point, because that thing apparently is isolated and moved inland or off to the northeast or something. So whatever level that was at might not have been quite representative of the stuff that we're in now is like.

NB: Right.

AR: I'm not sure I'm making any sense, but it's probably just all ice and melting level and maybe some stratocumulus at the bottom below us. Whereas before we did have that little cell that was kind of enhancing the stratiform. We saw some crystals that were the size of saucers there.

NB: Right. Now was that on our lowest level pass?

AR: That was before the freezing level. I think it was at 5 K.

NB: That's right, the first one above the freezing level.

3:32 PM

AR: I don't know if we're starting to pass inland a little bit here. One thing I'm noticing not with the downward pointed radar looking at it on the oscilloscope, but there is quite an increase in echo around 2 to 5 K above the ground. It doesn't look like a bright band to me, but it looks like it might be a seeder-feeder kind of thing. As we head toward the land maybe there is some stratocumulus that's plumped up below us that's contributing either separate precip or a lot of accretion to what's fallen down in it.

3:40 PM

NB: I'm going to check in with the radar now, so I'll be offline for a bit.

3:41 PM

NB: Larry, Nick here.

LS: Go ahead Nick.

NB: Our new south point is 46°38' on this leg, so not too much farther.

LS: Okay.



NB: Then we'll want to kind of go north again at max altitude again about 10 miles past that previous point the 47° even, so I'd say 47°10'. Then that would be it except that we'd like to do the Olympic transect on the way back in. So kind of approach Paine Field from the north.

LS: Okay. We can do that.

NB: If you want I can get you the waypoints for that Olympic transect.

LS: Well, we're starting at right about 47° and I think it's about 123°30 isn't it?

NB: Hang on. I can look it up. Yes. The standard one is 47°14' N/123°57' W.

LS: Okay. 47°14' and 123°57' and what's the north one?

NB: It's 48°8' and 122°56'.

LS: Okay. We'll plan on that.

3:45 PM

DS: Art?

AR: Roger. Go ahead Don.

DS: I've got the CPI going again. I think there's some kind of a memory hole in that particular part of the application. I think we need to leave that part of the application alone as much as possible except right at the very beginning unless you're right at the edge of the memory of what this thing has. It's new software. I'm not sure what's going on there, but it's crashed on me a dozen times when I've gone to touch that one particular one after it has ran for awhile.

AR: I've looked at what the advanced control and settings where and looked at some of the settings to see what was going on.

DS: That's what I mean. I think we need to leave that one alone after it has ran for awhile because every time I've touched it I've either crashed the computer or crashed the software after it's ran for awhile.

AR: I think when it's first processing everything is okay. But I think maybe Grant pointed out that the images were truncated and I was thinking maybe the same thing after I started watching it, but there's something called a \_\_\_\_\_ pad or something that allows you to see more of the photographed crystals.

DS: Okay.

AR: That's what I was looking at. I wasn't going to change anything until I get the manual out, but that's what I was thinking.

DS: This settings one I think you might be able to set it from there as well.

AR: I wasn't going to set it, but I was just going to make note of the setting because in post-processing they look okay, but it does seem like you're looking at some of the zoomed view of the crystals out there presently in real-time.

DS: Okay.

GG: This is ridiculous we've just filled up the disk again.

3:50 PM

AR: What was that Grant?

GG: It quit taking radar data. It just filled up the disk again.

3:51 PM

LS: Guys, the cabin is up at 10,000 ft. If you want oxygen, we'll give it to you.

NB: I think I'm okay. We're not going to be long here. This run especially with these tail winds won't take long at all.

LS: Right.

3:53 PM

NB: I'll be checking in with the radar now, so temporarily offline.

LS: Okay. Before you go, Nick, after this next point, can we take a hard altitude of 10,000 ft?

NB: Yes. That's fine. Tentatively let's continue along this track 47°10' and then we'll be done with this stack. For the Olympic transect, I forget whether it's 10,000 ft or 12,000 ft we want to be at for that one.

LS: Okay. Center kind of blocked you there, but it's 10,000 or 12,000 ft. Which one do you want?

NB: We want the one that you can deliver. I think it might be 12,000 ft along that route, but if it were 10,000 ft it would be better.

LS: Okay.

3:56 PM

AR: A note here, no disc of the sun visible at 21,000 ft, which is really indicating a very deep ice cloud.

3:57 PM

AR: Qualifying that very deep, I didn't do a very good job on that, but it would be at least 2 kilometers and more likely 3 kilometers of ice cloud above us to block the sun like that in my experience.

NB: I'm back. Like I said if we could continue on this track 47°10' and then do a right turn to Humptulips and the start of the Olympic transect. Again, I'll look it up in the Ops Plan, but I'll make sure that we're at the right level for that.

LS: Center has approved us at 10,000 ft. That's fine with us. You want to be at 10,000 ft starting the run?

NB: That's correct.

LS: Okay. About another 5 miles and we'll make our turn and try to get her down to 10,000 ft for you.

DS: So we're not going back the other direction this time?

4:00 PM

NB: Larry, I'm just looking in the Ops Plan here and it says the pass over the Olympics should be at the minimum altitude allowed by IFR conditions, which of course is 2,000 ft above the highest terrain. I presume that's 10,000 ft.

AR: I think it's 2,000 ft and 5 miles.

LS: Standby 1.

NB: Art, you're correct, anything within 5 miles of that line.

AR: I think you're right, Nick, that it is 10,000 ft at that point along that particular leg. I think Mt. Olympus, which is close to 9,000 ft, is a little off to the west.

4:01 PM

LS: Nick, I see it's only 12 miles over there to your start point, so we're going to have to do some 360s to get down.

NB: Okay. That's fine.

AR: I'm looking at the radar depiction in the downward mode. It looks like there's a thin spot suggesting that little of this precipitation in this ice cloud is getting down to the ground. Then the echo picks up possibly the remnant of these ice crystals...

TAPE 1, SIDE 1 END

AR: ...dizzle going on either an enhancement of the precip falling into it or a separate precip mechanism or both.

4:04 PM

LS: Nick, 10,000 ft is going to be okay through there.

NB: Okay. Sounds good.

LS: The highest terrain clearance in there is 8,100 ft and that's 400 ft above the highest obstacle, so at 10,000 ft that's going to give us at least 2,300 to 2,400 ft of the highest in the block.

NB: Okay. Sounds good.

4:06 PM

AR: Our descent is taking its toll on the 2-D cloud probe.

4:07 PM

DS: I just had to give it a little kick in the rear.

AR: Good job. I see the HVPS is flat lining again.

DS: Yes. We're getting awfully small stuff for it.

AR: Every time we change altitude, even when we're going up, it seems to go on its ear and certainly here it is again.

DS: Yes.

AR: Ice crystals would be showing up.

DS: Yes they would. It must be getting condensation on it.

4:08 PM

DS: Yes. There's a few of those up in channels 11, 12, 13, 14, 15 and OAP-200X.

4:09 PM

AR: You might keep an eye on the CPI because it may act up as well.

DS: It seems to be doing okay.

AR: Larry, what was our descent rate in this fall here?

LS: You know I wasn't watching it, Art, but it was probably about 1,500 to 1,600 ft per minute.

AR: Thank you.

4:10 PM

DS: There's your HVPS back.

AR: Yeah!

LS: Nick, we're just coming up on Humptulips right now at 10,000 ft.

NB: Yes. It looks good and you have that endpoint there at Protection Point or whatever it's called.

LS: Sure have.

NB: Well the last time we did this it wasn't very bouncy, but there is the potential again for that. So we're going over a little bit east of where we went before over kind of steeper terrain there on the north side. So again we should probably be in our seatbelts in the latter part of this leg.

AR: Roger that. These winds, I don't know if they'll hold up, 10 knots maybe we'll get by with something here.

4:12 PM

DS: From here we're going to head straight to Paine Field after we're done with this leg?

AR: Yes. That's the plan.

4:13 PM

GG: We're recording data again on the radar.

4:14 PM

AR: Picking up a little liquid water here, stratiform layer, droplet concentrations 17-20, liquid water 0.1. I can't tell the depth. Picking up a little chop with it. It looks like separate stratiform layer below this flight level. Definitely lower stratocumulus layer just visible through precipitation below the aircraft. Estimating at least 2,000 ft below aircraft.

4:17 PM

AR: Noise on the HVPS in the form of a horizontal broken line as evidence by that. Everything else seems to be working okay. Again, little wisps of liquid water cloud here. Actually pieces of altocumulus embedded in this stratiform precipitation. Wind speeds have been increasing here. They are up to over 20 knots from 205-207. Along this leg they were southeasterly about 10 knots at the beginning of the leg. So I'm not sure that was real winds.

4:19 PM

AR: Along with the occasional liquid water they are picking up a little bit of clear icing. It's actually kind of between clear and rim and that is on the forward part of the bubble.

LS: How's this track looking to you, Nick?

NB: It looks good. On my little map it looks like you're headed right toward the point.

LS: Okay.

AR: Just recently we started to pick up some pretty steady droplet cloud and liquid water in the 0.1 to 0.2 range.

LS: GPS says we're about 200 ft right at track here, Nick.

NB: That's pretty good shooting.

4:21 PM

AR: We seem to have lost our liquid water cloud now.

4:22 PM

AR: You've probably already noticed this, Nick, because I'm not used to looking at winds, but they have really been increasing here from the south end to the north

end of this as we go over the higher terrain with the compressed streamlines I guess.

NB: Yes. I think that's exactly what's happening. You're kind of constricting the flow and so that's a lot of it. So now we're up to 18 meters per second. For what it's worth, the CPI is temporarily kind of on the fritz.

AR: Yes. The 2-D is not looking so hot right now either.

4:24 PM

AR: It's back now, the 2-D that is.

NB: Yes. Don kind of did his reset magic.

AR: Now the HVPS is on the fritz. Maybe it's momentary. Okay. The radar thinks we're going over lower terrain pretty rapidly here. It's gone back up again.

NB: Yes. My guess is we've past the main part.

AR: In fact, we just went over the highest peak of all just a second ago and now it's dropped about a kilometer over the last 10 s.

NB: And you can see it opening up ahead. It's pretty. Look down there, snow.

AR: Gosh, that was spectacular watching that radar respond to that last peak and then drop far away like mad. Fortunately we maybe we bypassed another turbulence bullet.

NB: There is certainly no sign of any lee waves here or anything.

AR: Off the right wing there is something aloft. That certainly would be a lenticular in the lee of the Olympics. There's something fairly ominous off the left wing to dead ahead. You can see some of that over there. I wonder if this is a westerly wind shift coming down the Strait. Maybe this is that wind shift line finally pushing in here. I can't think of why there would be such a heavy line in the middle of the Strait like this. Nick, maybe you've had more experience in these areas of storms in the lee of the Olympics. My experience is mostly in cumulus days.

NB: Right. I can't imagine that that wind shift that we were flying before lunch is in here.

AR: You're probably right. Actually I see now it's not low cloud it's virga. So there's probably going to be some bumps ahead.

4:27 PM

AR: I certainly spoke too soon about missing any turbulence bullet as we start getting some light turbulence here.

4:28 PM

AR: And along with that huge drop off in the winds.

DS: Got all the probes working again, Art.

AR: Thank you Don, what a guy.

NB: I'm surprised how much precip we're in here.

AR: According to the radar it's not getting to the ground, but it is impressive up here considering you'd think it would move down slope enough to eliminate this stuff.

4:29 PM

LS: Nick, 2 miles to go and then we're going to head for Paine Field.

NB: Sounds good. Say Art, do you want to do your wrap now and then I'll do mine or vice versa?

4:32 PM

NB: Hey Art, are you there?

AR: Yes I am now.

NB: I can do my summary and then you can do yours or vice versa.

AR: Okay. I'll give a little summary.

TO SUMMARY

#### Summary of UW Flight 1853

AR: On this flight we flew southbound to intercept what was perceived as a east-west more or less oriented band and I'll concentrate from here on on the microstructure. We flew below cloud base. All we had at cloud base was a few ragged stratus fractus clouds, no real seeder-feeder going on until a little bit toward the middle of this band when we intercepted and flew under a bunch of heavier precip. It was almost coming from a soft or what I would sometimes call a soft cumulonimbus where there is embedded convection and there is kind of a rain



shaft-look to the precip as you come up to it. A cumuliiform-looking cloud base, dark cloud base, amid the sort of diffuse stratiform nimbostratus base and indeed when we went back northbound and intercepted that at 5,000 ft we entered a lot of liquid water and that was just above the freezing level, lots of large snowflakes, heavy precipitation. It was probably light to moderate precipitation down at the ground. Anyway moderate to even heavy snow aloft and probably the biggest flakes we've seen imaged by the HVPS. Then we continued to do legs after that, but because we were flying legs that were geographically anchored at that particular cell feature moved away and then the whole rest of the flight was simply what appeared to me to be unrimmed aggregates, single crystals fragments and so forth. These habit kind of mutated with the temperature. Lots of dendritic-type aggregates in the  $-15^{\circ}$  I think it was or  $-17^{\circ}$ . Then just above that we started seeing bullet rosettes, which actually were crystals falling down from cirrus levels at the  $-30^{\circ}$  and lower temperatures. Going along with that when we got to our highest flight level of 21,000 ft, the disc of the sun was not visible, which in the daytime means that that cloud is at least 2 kilometers above the aircraft and probably more like 3 kilometers. I'll just cut it right there.

**NB:** From the met side like Art said, it was a warm frontal perhaps a deformation zone rainband that we were flying through. What we did was the moving stack pattern oriented north-south. Our legs included a low-level leg at 1,000 ft and then the legs above the freezing level at 5.5, 7.5, 9.5, 12, 15, 18 and 21,000 ft. On the south side of that zone, the winds tended to be stronger from 200 at 15 to 20 meters per second or even a little higher. Quite a bit weaker winds on the north side of the band something like 6 or 10 meters per second and a little bit more of a westerly component. There was some noticeable turbulence on the north side of that band at a relatively abrupt shift in the winds. After doing that moving stack pattern we lined up for the Olympic transect from Humptulips to Protection Point and ran that at 10,000 ft. We had winds from 210 at roughly 12 meters per second initially speeding up to something like 16 or 18 meters per second just on the windward side or at the top of the terrain. Then weakening dramatically to something like 5 to 8 meters per second in the lee. There was pretty steady precip and both substantial cloud liquid points and supercooled liquid droplets along most of the way. There wasn't that noticeable of a clearing in the lee except for at low levels. Over.

**AR:** Grant, do you want to say anything about the radar.

**GG:** Yes. We finally got the digitizer card installed for the 35 GHz radar and we're using some rather crude software supplied by the vendor. We'll replace that with some QNX software later on so we can integrate the whole thing into our data system. We were recording some data upward and downward looking and various resolutions up to 5 MHz, usually at 1 MHz. It seemed to working fairly well. The digitizer by Gage does a superb job of digitizing. It's just a little difficult to control because it wasn't really built for this application. However, I'm sure we can work out the difficulties and it will work better in the future.

AR: Roger. I guess we can turn the radar off now.

GG: Roger that.

4:38 PM

DS: Is it okay to shut the CPI down now or do you want to keep it going for a while longer?

AR: Don, do you like when shutting down the computer, QNX, with all the windows running or close each application?

DS: It doesn't make any difference. That's an actual operating system. It doesn't die if you do something that's not expected.

AR: What do you know about that!

DS: It's just the Microsoft Windows stuff that's a pain in the neck sometimes.

AR: Yes.

DS: I just stopped the program and it just crashed the computer.

AR: It's a touchy thing.

DS: Windows NT is supposed to be their better one over the 95 and 98 series.

AR: I guess so. That's what they get for writing 8 million lines of code.

GG: We were told something rather humorous and that was that the big developers for NT actually ran LINUX when they wanted to get something done.

AR: I've heard similar stories that so and so used a Macintosh for example.

DS: We were talking to somebody who actually knows the programmers inside of Microsoft. So it's only second hand.

AR: Right. Same here. I'm going to go sit in the back. I'll be off the headset now.

NB: Larry, do you want me in the back? I'm in the flight scientist seat.

4:41 PM

DS: How long do you want me to keep this stuff running as far as landing is concerned?

NB: You can shut it down at your convenience. This doesn't matter.

DS: Okay.

4:42 PM

GG: Are you going to keep the computers up during landing, Don?

DS: No. He said I can cut it off now.

GG: Just the computers.

DS: Yes. I'll keep them on.

GG: I need to transfer some files.

DS: Likewise.

4:43 PM

GG: I've got things cut down to where it's only writing about 5 kilobit files, so things ought to last a bit longer next time.

DS: Yes. What did you have to do?

GG: That's the scary thing. I don't know.

DS: It's magic software that doesn't have any instructions or anything else.

GG: I smiled sweetly at it.

DS: Got you.

4:45 PM END OF TAPE