2019 FIREX-AQ NOAA Twin Otter Teleconference

November 27, 2018

1. Instrument list, payload layout and updates
2. Deployment schedule
3. Logistics and operation
4. Needed information from investigators

Twin Otter Instruments

Instrument	Position	Species Measured	Investigators	Institution
Picarro CRDS	1	CO, CO_2, CH_4, H_2O	Colm Sweeney	NOAA ESRL GMD
AIMSS Met Probe / Differential GPS	1	RH, Temp, Pres, Winds, GPS, flight data	Mike Robinson Steve Brown	NOAA ESRL CSD
Tenax cartridge autosampler	1	Speciated VOC	Kelley Barsanti Lindsey Hatch Avi Lavi	UC Riverside
I^- ToF CIMS	2	Acids (HNO_3, HONO, Organics), acid gases (N_2O_5, $ClNO_2$), Oxygenated organics, Organic nitrates, Halogens	Joel Thornton Brett Palm Carley Fredrickson Zach Decker	University of Washington / NOAA
Aerosol mass spectrometer, UHSAS	3	Aerosol composition + size distributions	Ann Middlebrook Ale Franchin Kathy Hayden Shao-Meng Li	NOAA ESRL CSD Environment Canada
Brown carbon PiLS	4a	Spectrally resolved aerosol absorption	Rebecca Washenfelder	NOAA ESRL CSD
Chemiluminesence	4b	NO, NO_2, O_3 (O_3 location still TBD)	Andy Weinheimer Denise Montzka Geoff Tyndall Frank Flocke	NCAR

Additions – TRAC Sampler, Alex Laskin Purdue

TRAC sampler for collection of individual particles for spectro-microscopy analysis

Weight: 10 lbs; Dimensions: H7”xW6.5”xD5.5”
Input Voltage = 12-20VDC
Power Supply Current Requirement = 1.5A
Peak Current Draw = 1A
Steady State Current Draw: 250mA

- Automated, pre-programed sampling onto microscopy substrates:
- Up to 560 substrates can be loaded.
- Has been flown on board of research aircrafts before (see example papers listed below)
- the shortest time in previous airborne missions was 2 min/sample

TRAC sampler for collection of individual particles for spectro-microscopy analysis

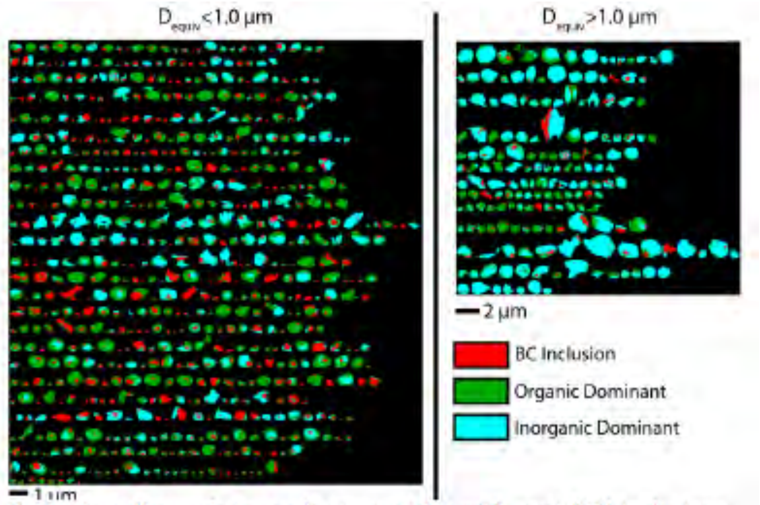


Figure 6. Collage of atmospheric particles with soot (BC) inclusions sampled during the *CARES* 2010 field study. Ref. (17)

- Electron and X-ray spectro-microscopy characterization of particle composition and their internal structures
- data on particle-type contributions in overall particle ensembles
- Composition and mixing state of individual particles, complementing real-time optical and AMS measurements
- Parameterization of mixing state based on entropy metrics of *Riemer and West*
- Hygroscopic transformations of sampled particles can be also probed

Examples of our previous studies of aircraft-collected particles

Hiranuma et al, 2013 https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/jgrd.50484

Laskin et al, 2012 https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2012JD017743

Twin Otter Payload Spreadsheet

Instrument	Power (kVA)	Weight (lbs)	Deployed ? (1 = yes)	Deployed Weight (lbs)	Deployed Power (kVA)	Position	Notes
AMS	1.1	415	1	415	1.1	3	From Environment Canada, Jan 25
Iodide ToF CIMS	1.1	380	1	380	1.1	2	UWFPS Weight
NCAR NO, NO2	1.1	486	1	486	1.1	4b	From Andy Weinheimer, Jan 10
CL O3		65	1	65	0	TBD	Weight not inlcuded above, electrical included
BrC PiLS	0.42	106	1	106	0.42	4a	Does not include rack weight (flying in station 4 2-bay rack, included in NCAR weight
CO, CO2, CH4, H2O	0.2	52	1	52	0.2	1	Confirmed loan from Colm Sweeney, weight confirmed w/mini pump
Met Probe	0.1	7	1	7	0.1	1	
Data Acquisition	0.1	10	1	10	0.1	1	
UPS	0	33	1	33	0	1	33 lbs = 770 W / 1000 VA / 1U Li Ion UPS, 87 lbs to go to 2700 W / 3000 VA / 2U
UCR VOC Sampler	0.2	30	1	30	0.2	1	Weight remains an estimate
POPS	0.2	10	0	0	0		Estimate
UHSAS	0.1	49	0	0	0		UWFPS Weight
UV O3		20	0	0	0		NOAA 2B Instrument
CRD-PAS	0.5	120	0	0	0		
Equipment Subtotal	**5.12**	**1783**	**10**	**1584**	**4.32**		
Pilots		360	1	360			2 pilots
Scientists		360	1	360			2 operators
Life raft		70	0	0			
Crew Subtotal		**790**		**720**			
Total	**5.12**	**2573**		**2304**	**4.32**		
Available	4 kVA 115 VAC	**2200**		**2200**			From Lindsey Norman, September 2016, Allows 2.75 hr (actual 3 hr) flight duration
	~3 kVA 28 VDC						Bill Dubé suggests actual power limit closer to 5 kVA total, rather than 7
	up to 7 kVA						

Final Mechanical Layout for Twin Otter

Picarro
VOC Sampler
Met Probe
Flight Scientist Laptop
TRAC Sampler
UPS

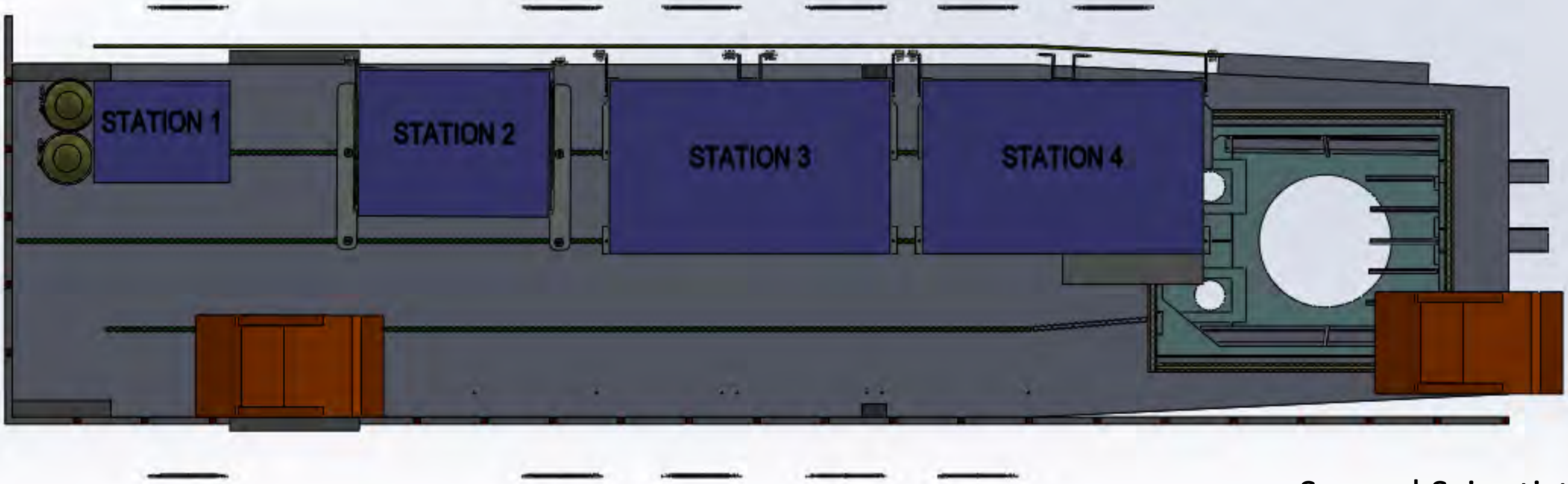
I^- CIMS

AMS

BrC
PiLS

NO
NO_2

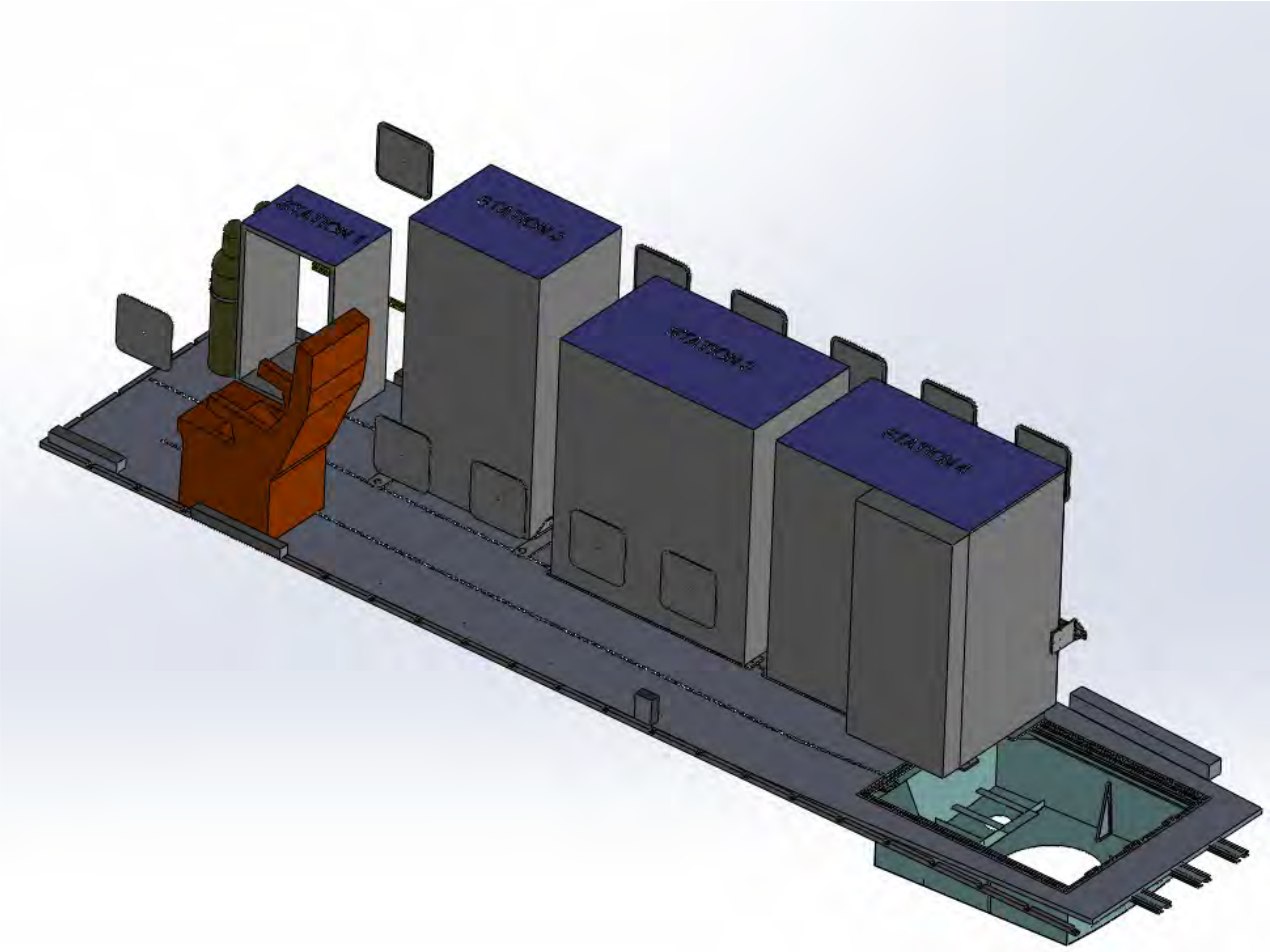
CL
Pump



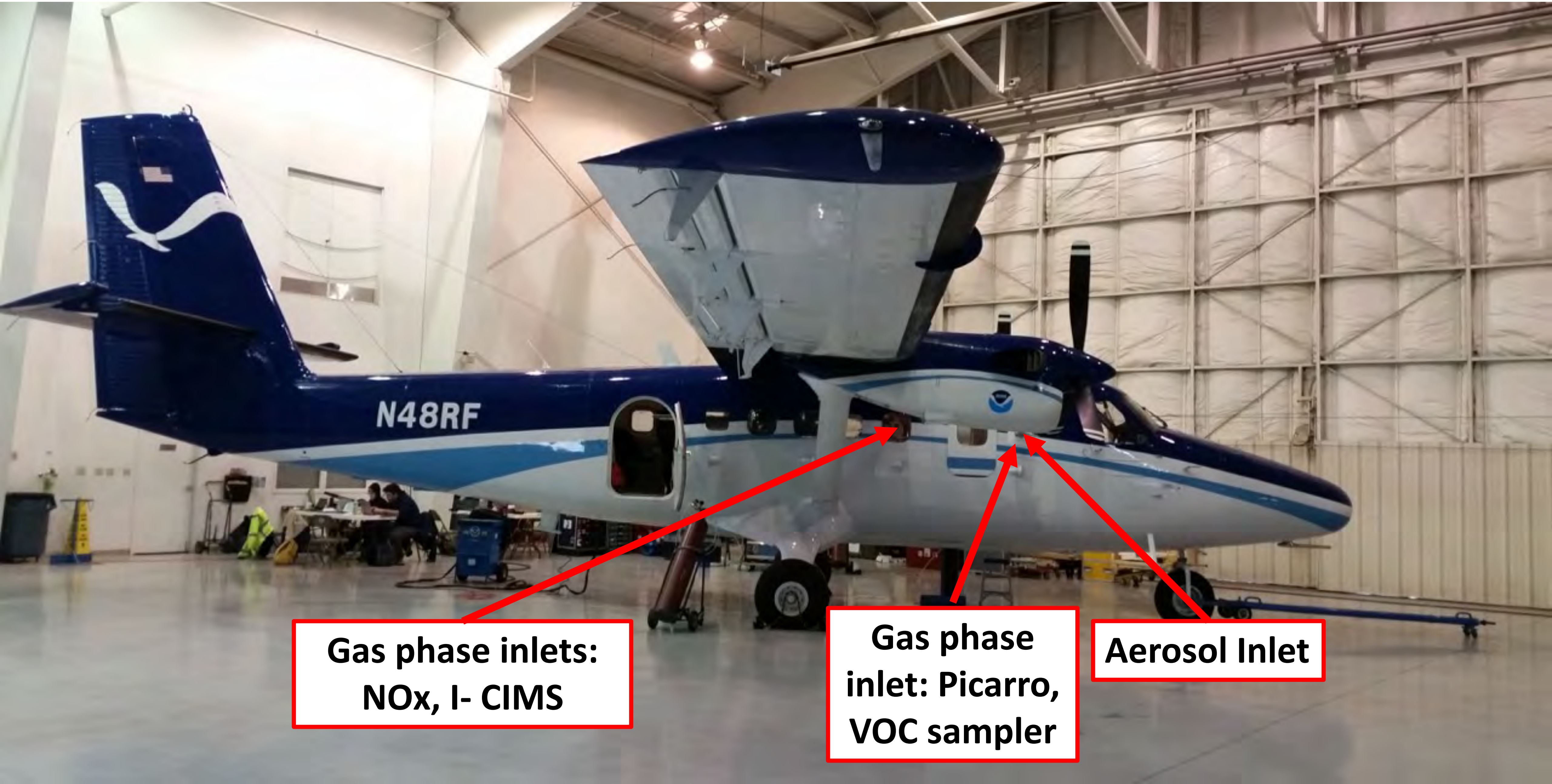
Flight Scientist

Second Scientist
Jump Seat

Final Mechanical Layout for Twin Otter



Location of Inlets



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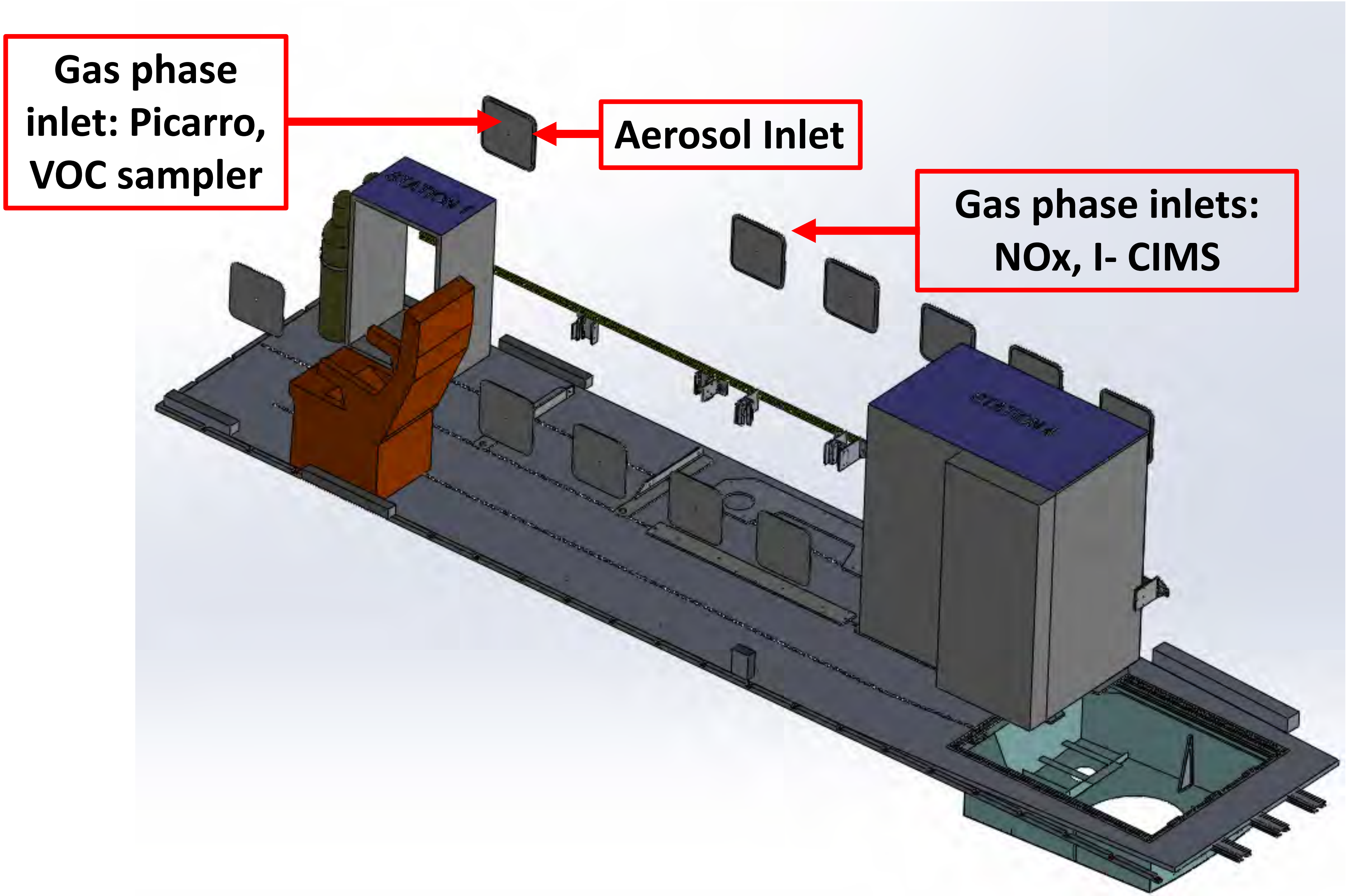


Current Payload Concerns

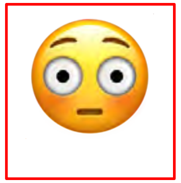
Status

1. Volume – Available rack space for all instruments

2. Payload weight – Current estimate at 1584/1500 lbs = 106%
   - Extra 84 lbs = ~8.5 minutes of flight time

3. Electrical load – Current budget at 4.12/5.0 kVA = 82%

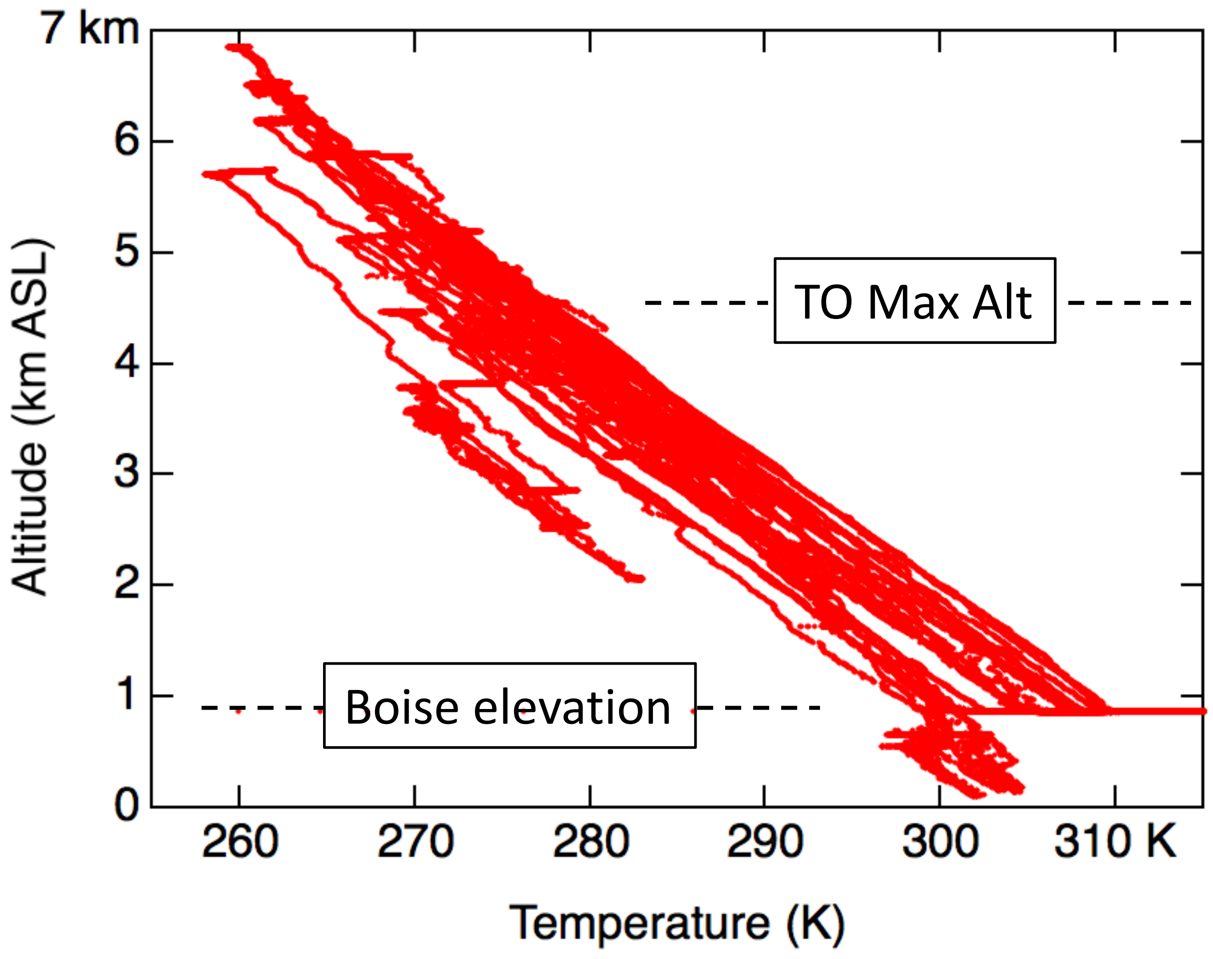
4. Heat management – Large unknown !
   - Simple model of inside T as a function of outside T suggest 40 C or above is possible



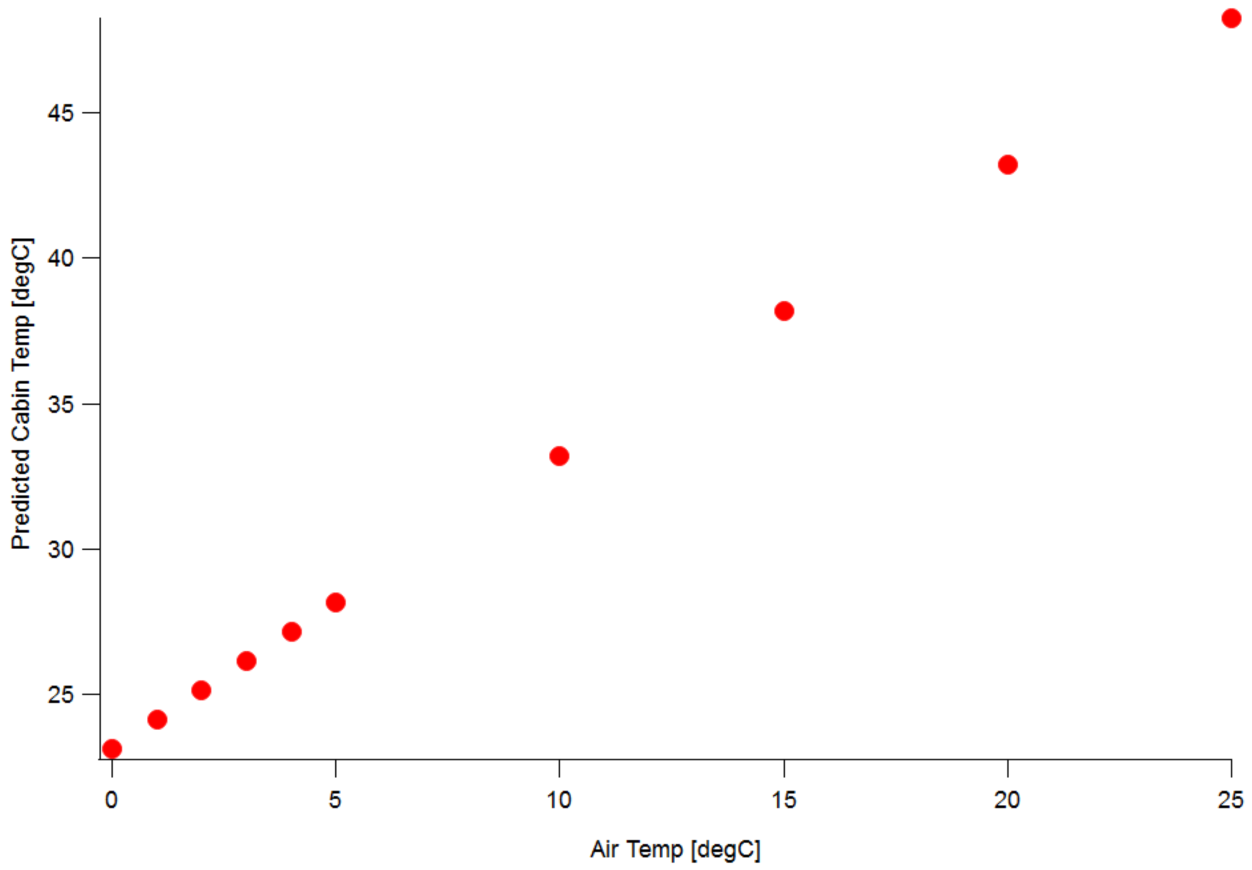
   - LT Jake Blaauboer (new point of contact at AOC for this project) will help to provide better estimates, but thinks this is manageable
   - We need information about the max allowable temperatures for each instrument

Expected Ambient and Aircraft Cabin Temperatures

Temperature vs altitude data from WE-CAN



Simple model of cabin temperature for FIREX-AQ power dissipation



Deployment Schedule

July 15: Project Start Date

July 17 – 26: Integration at Research Aviation Facility (RAF), Broomfield CO

July 29 – 31: Test flights and transit to Boise

August 2 – September 7: Research flights

September 9-11: Transit to and de-installation at RAF

September 12: Project End Date (Last possible date, may end sooner)

180 flight hours on the schedule (!)

2019 JULY

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15 Transit from Lakeland to RAF	16	17 Sta. 1 & 2	18 Sta. 1 & 2	19 Sta. 3 AMS	20
21	22 Sta. 3 AMS	23 Sta. 4a BrC PiLS	24 Sta. 4a BrC PiLS	25 Sta. 4b NOx	26 Sta. 4b NOx	27
28	29 Test Flight #1	30 Test Flight #2	31 Transit RAF to Boise		First Research Flight	

July 15-16: Transit from Lakeland, FL to Broomfield, CO (RAF)

July 17-18: Stations 1 & 2 Integration (Picarro, VOC sampler, Met probe / GPS, I^- CIMS)

July 19, 22: Station 3 Integration (AMS)

July 23-24: Station 4 Integration (BrC PiLS) + CL O_3

July 25-26: Station 5 Integration (NO_x)

July 29, 30: Test flights

July 31: Transit from Broomfield, CO to Boise, ID

August 2: First research flight

2019 AUGUST

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2 First Research Flight	3 Daytime Flights
4	5	6	7 Daytime Flights	8	9	10
11	12	13	14 Daytime Flights	15	16	17
18	19 DC-8 Departs Boise	20	21 Night Flights	22	23	24
25	26	27	28 Night Flights	29	30	31

August 2: First research flight possibility

August 2 – 19: Emphasis on daytime flights for best coordination with DC-8

August 19: DC-8 departs Boise for Salina

August 19 – September 7: Emphasis on night flights

2019 SEPTEMBER

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4 Night Flights	5	6	7 Last Research Flight
8	9 Transit Boise to RAF	10 De-installation of instruments, RAF	11	12 Transit RAF to Lakeland	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

September 7: Last possible research flight

September 9: Transit from Boise, ID to Broomfield, CO (RAF)

September 10-11: De-installation of instruments

September 12: Twin Otter departs RAF

Flight Hours

Total flight hours = 180

Transits + Test flights = 20

Research flight hours = 160

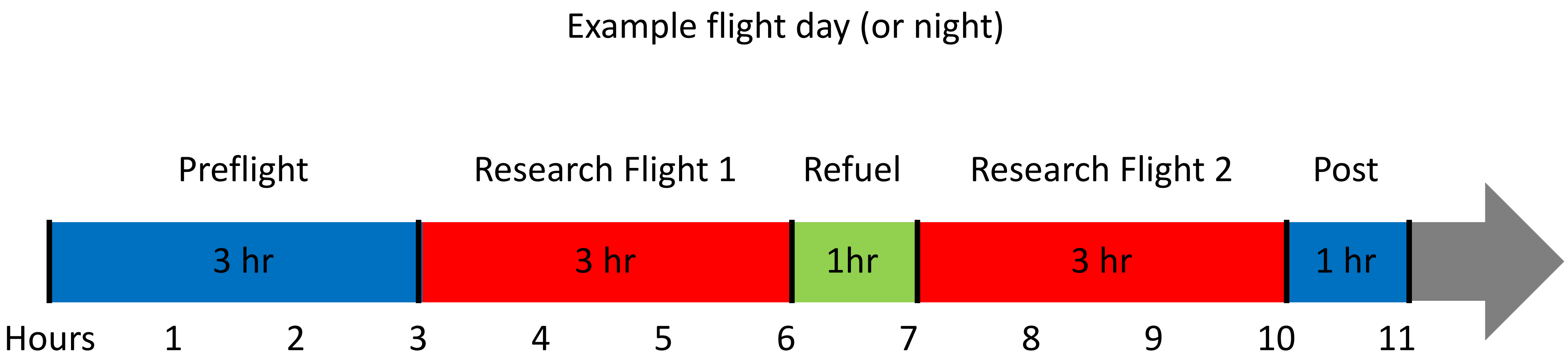
Single flight day, up to 8 hours , 160 / 8 = 20 flight days

38 days in Boise

Approximately 1 flight day every 2 days

This is ambitious! We may not be able to make use of all 180 hours

Back to Back Research Flights



- 11 hour day for scientists, less for pilots, 6 hours of flight time
- This was our standard schedule during the Utah 2017 campaign

Flight Planning & Logistics

- Twin Otter endurance = 3 hours, insufficient to reach fires unless they are in the immediate vicinity of Boise

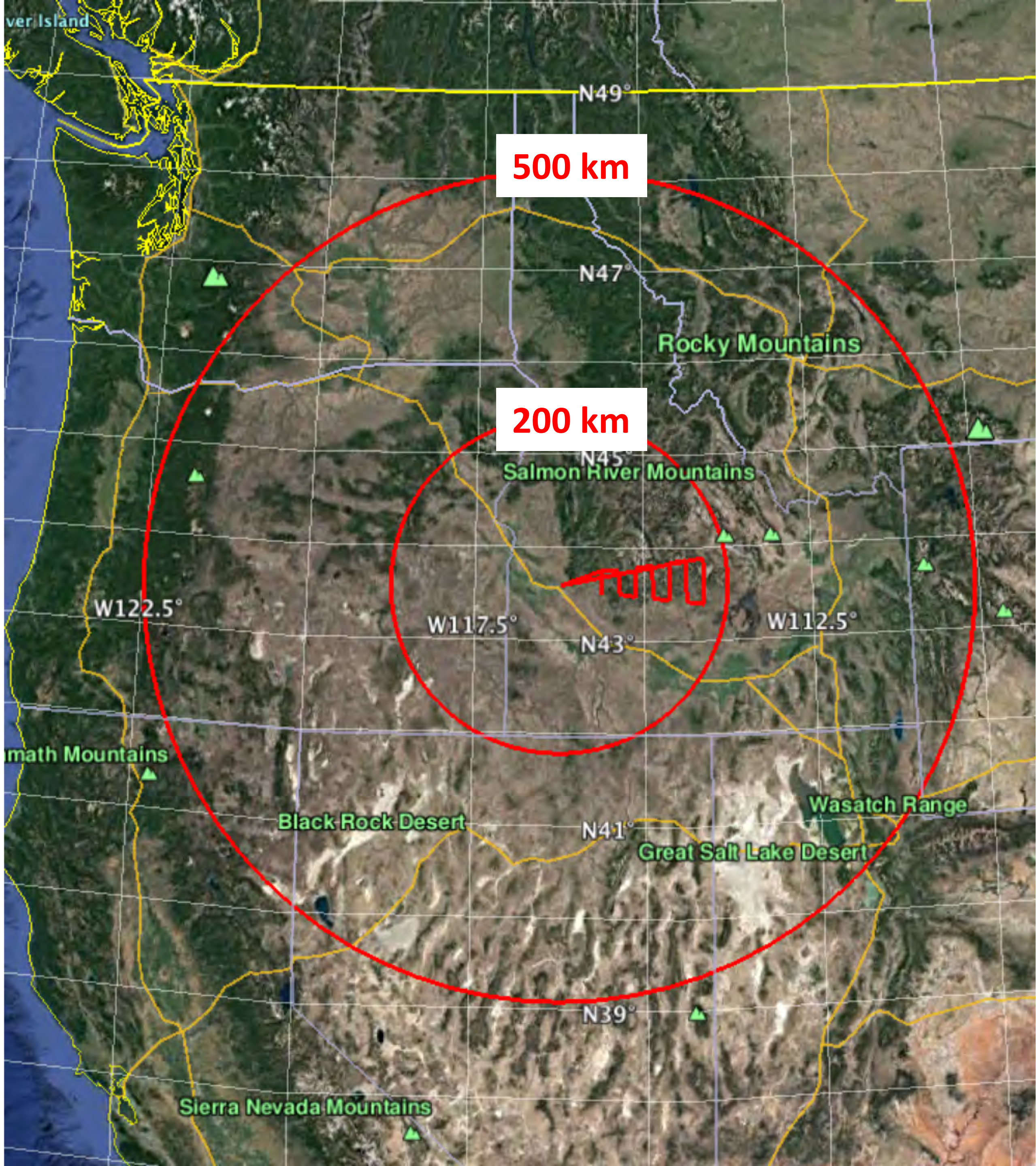
- Twin Otter can ferry >500 km (3 hours)

  Salt Lake City, Missoula, Oregon, Washington should easily be within range for 500 km ferry flights

  Shorter ferry flights (<200 km) requiring only 1 hour have a more limited range of accessible airfields from Boise

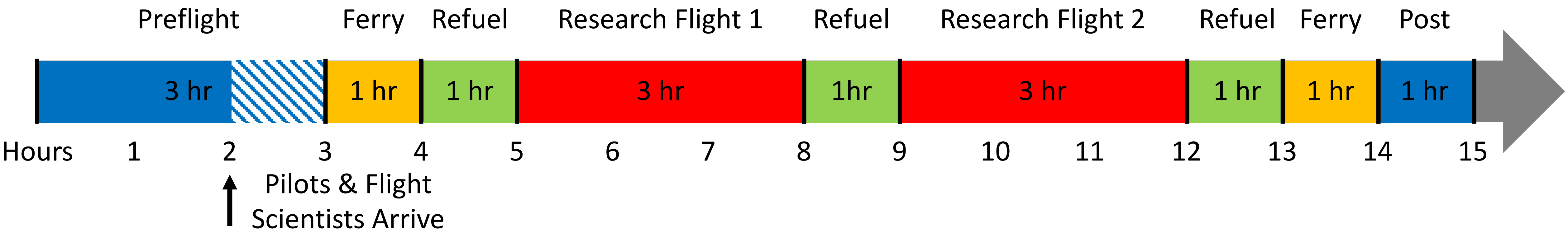
- Sampling from airfields remote to Boise possible either as multi-day or single day deployments

- Support truck with equipment may be required for multiple day deployments



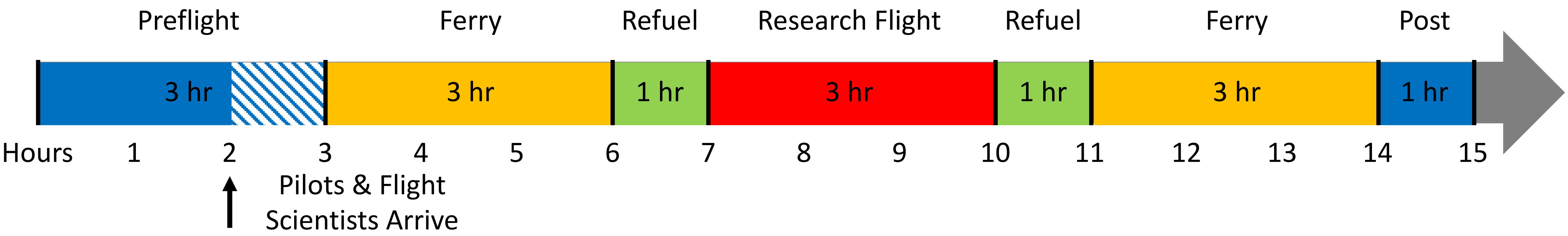
Flight Planning & Logistics with Ferry Flights

Example single day flight schedule with short ferry (1 hour):



- 13 hour day for flight scientists and pilots (limit = 16), 8 hours of flight time (limit = 12)
- Could be supported with a ground truck that drives to remote location with equipment & ground personnel

Example single day flight schedule with long ferry (3 hours):



- 13 hour day for flight scientists and pilots, 9 hours of flight time
- May incorporate some sample time into the ferry flights depending on ferry distance / length

Logistical Planning

1. Heat load management
   - Air conditioning carts on the ground – how big and how many ?
   - Heat management in the air using venting, higher altitude flying, etc.
   - Heat management during taxi, and during land and re-fuel events !!

2. Protocol for landing and refueling
   - Best if we can do this *without* a support truck driving to a remote airfield
   - Need to work with AOC and scientists to develop protocol to keep instruments running

3. Develop list of target airfields for remote operations from Boise
   - Determine which airfields can support these operations within 2.5 hour transit from Boise
   - May be a short list! Will simplify flight planning, but may limit fires we can sample

4. Contingency for operation at airfield other than Boise
   - If hot spots are not in Idaho, we may need to relocate (Broomfield, Salt Lake City, Missoula, Northern California, Oregon, Washington)
   - Hopefully we will determine this prior to deployment to Boise

5. Coordination between the in-situ and remote sensing Twin Otters

Information Needed from Investigators

1. Power management
   - We will be purchasing a UPS shortly – we need to know your maximum power on UPS need

2. Heat management
   - What is the max temperature that your instrument can operate under?

3. Pump capacity (related to above)
   - For all large instruments, is it possible to reduce pump size and / or share with others ?

4. Instrument standby mode
   - Helpful to put instruments into lower power “standby” during landing / refueling
   - Does your instrument have such a state?
   - Detailed procedure for putting instrument into and taking it out of standby

The above is needed most for the four large instruments

I^- CIMS
AMS
BrC PiLS
Chemiluminesence

Questions & Comments