



Utilizing UAS in support NOAA river ice breakup forecasting in Alaska

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River forecasting background of ice conditions in Alaska and events

- NOAA UAS River Forecasting Workshop (2/2012)
- Galena flood (5/2013)
- NOAA UAS Arctic and River Forecasting Workshop (9/2014)
- Alaska Center for UAS (ACUASI) deployed to Circle (4/2016).



Galena on the bank of the Yukon River



Galena flood

The reports recommendations regarding river break-up

- NOAA 1st workshop data requirements:
 - Ice flow- size, motion- near real-time
 - Ice Jams height in near real time
 - Water Inundation /flooding
 - Jam location, thickness, height
- NOAA 2nd workshop
 - Lack of data (Carven Scott)
 - Cover an area that is 20 times larger that average NWS in the lower 48
 - Very sparse precipitation and river gauges in Alaska
 - Need real time data
 - In the case of an ice jam
 - Height of ice jam
 - Longitudinal extent of ice jam
 - Water height above and below the ice jam
 - Requirements for UAS
River ice information , channel ice conditions, ice movement, ice structure, ice jams

Alaska Hydrology UAS requirements

- Geophysical questions related to river ice
 - General ice condition along the river
 - Location of breakup front
 - Presence and severity of current flooding
 - Ice integrity
 - Locations of strain and stress
- Community reconnaissance (+/- 20 miles above and below the town)

**Galena flood

Alaska Hydrology UAS requirements

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- Community reconnaissance (+/- 20 miles above and below the town)
- DEM around villages for better flood modeling

Spring breakup timeline

- Mission overview (April 5)
 - Yukon rive at Circle
 1. On the road system
 2. NWS/DHSEM river-watch team fly that stretch
 3. Compliment large fix wing mapping by Dr. Jessica Cherry
 4. Circle has experienced flooding due to ice jams in the past.
 5. Yukon river is wide an adequate to compare with new satellite data sets
- Alaska Center for UAS Integration (ACUASI): deployed fix wing and rotor craft
 - Maximum endurance of about 40 minutes
 - Maximum cruising velocity 33 mph
 - Potential of total distance to cover 20 miles
 - But- FAA limitation to UAS within line of sight ≈2 miles
- **Proposed schedule**
 - **Budget enabled about three operation days**
 - **Breakup running 1-2 weeks early (average May 10, earliest April 30)**
 - **Five days notice (from the time ice breaks in Eagle)**

Continue

- Data collection requirements:
 - Multiple sensor Infrared
 - Visible- orthomosaic and DEM (structure from Motion)
 - Multiple flights over several days are important to NWS to get a time series of data and observe differential changes in ice conditions.
 - NWS interested in observing pre-breakup signatures (thermal and elevation changes) that are directly related to ice movement (breakup), to improve lead time for forecasting ice breakup, and ultimately ice jams and ultimately flooding.
 - Would to like to improve DEM of the Circle area for flood prediction

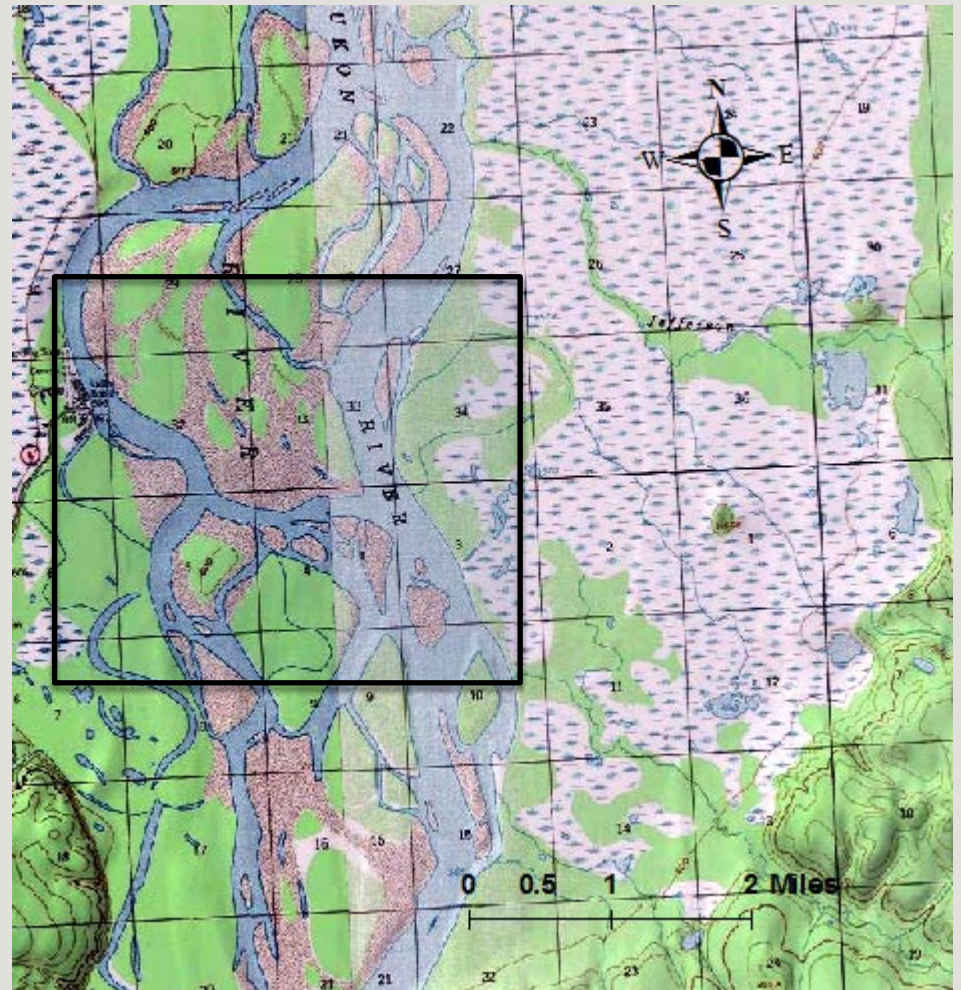
Supporting Aircrafts

- Responder-
 - Single rotor electrical craft
 - Payload several pounds
 - Cruising speed 30 mph
 - Endurance 40 min
- Aeromapper
 - Fix wing
 - Payload: Close to a pound
 - Cruising speed 30 mph
 - Endurance 40 min



Continue chronology

- Defining Area of Interest (AOI)
About 3X3 square miles

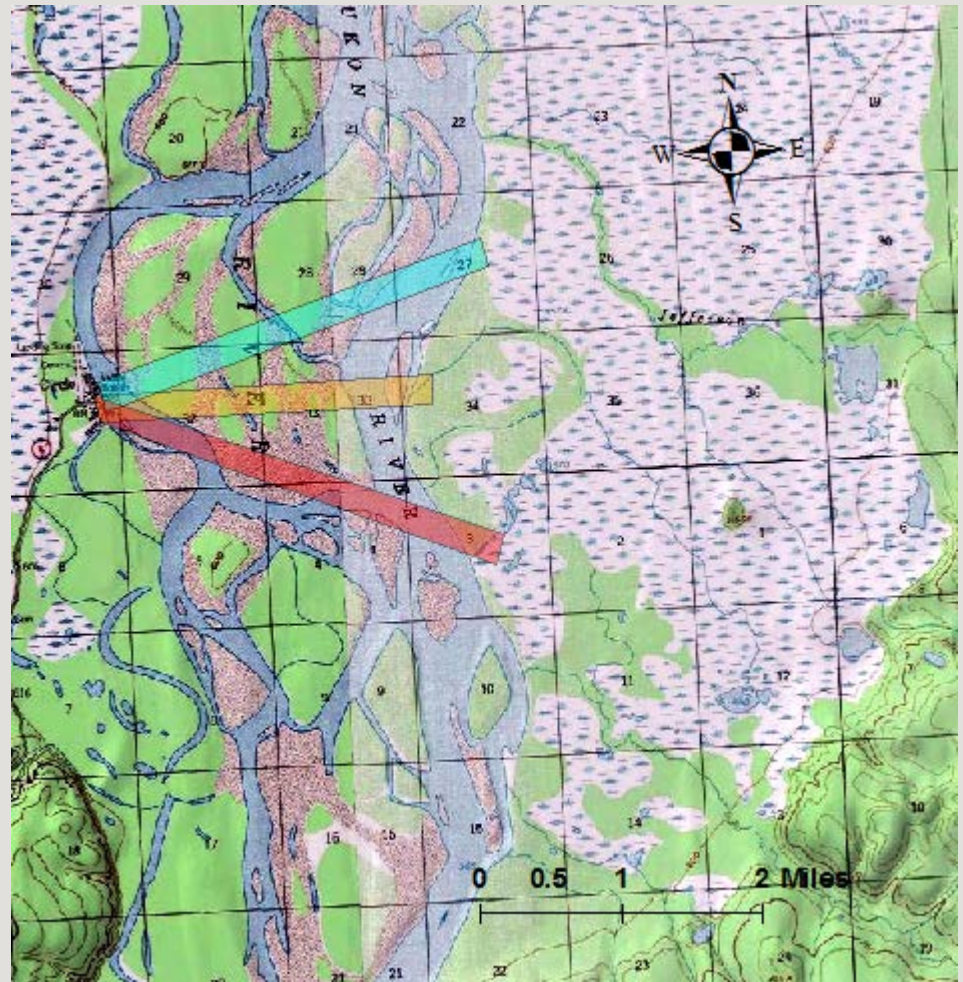


Mission Spread Sheet

	X	Y	Total pixels	Transects		
Number of pixels in	6000	4000	24000000	Long side transect width	70.10 m	70.10
Size of the sensor	23	16.5 mm	(Wiki)	# of transects	68.87 n	68.87
Size of the pixel	3.833333	4.125 μm				
Focal Length	24	24 mm		Flight Profile		
				Velocity	55.00 Km/h	
				Velocity	916.67 meter/min	
Field of view				Velocity	15.28 m/s	
At altitude	121.92 meters			Velocity	34.375 mph	
Altitude in feet	400 Ft			Total flight path (n transects+ 1	342162.21 m	
Field Of View	51.20438	37.94082 °		Total Flight path	342.16 Km	116 m
				Mission duration (based on airc	373.27 minutes	0.116
Foot print	116.84	83.82 m		Camera intervalometer		0.0725
Foot print	38.94667	27.94 ft		Inetervelometer (often we cho	2 sec	
pixels/m	34.23485	71.58196		Advance during one lapse (base	16.76 m	
Centimeters/pixel	2.921	1.397		Maximum V	8.38 m/s	
#pixels per square	2450.60				30.1752 km/hr	
AOI					18.8595 mph	
Length	3 miles	4828.044 m		Data size		
Width	3 miles	4828.044 m		Number of pictures	11198.04	
Area	9 Mile^2	23.30978 Km^2				
Overlap						
Froward Overlap	0.8 Y					
Side overlap	0.6 X					

Continue chronology

- Defining Area of Interest (AOI)
About 3X3 square miles
- Break down the AOI into three
AOI : 2 X0.25 square miles
 - Priority 1
 - Priority 2
 - Priority 3



Sequence of events

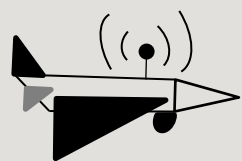
- April 22 Break up in Dawson
- April 24, 8 pm Ice broke in Eagle
- April 26, Mission readiness and deploy within 48 hr.
- April 28, 8:00 am departed UAF (Fairbanks)
 - 12:00 stuck be a flooded road section
 - 15:00 reach Circle
 - 18:00 Flight priority 1
- April 29
 - Morning fly priority 2
 - Noon fly priority 2
 - Evening fly priority 2 -about an hour after landing the ice broke

Data Scheme (after each flight)

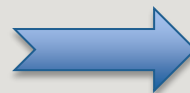
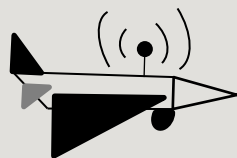
UAF Geophysical
Institute Server

ERMA server

Data
recipient



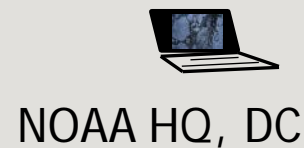
30 min



4 hrs



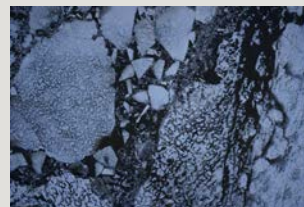
Ortho mosaic and
3D modeling of
river ice



NOAA HQ, DC



RFC Anchorage ,
AK



ERMA server host

The screenshot displays the ERMA Arctic web application interface. The browser address bar shows the URL: <https://erma.noaa.gov/arctic/erma.html#/?x=-144.00698&y=65.82120&z=13&layers=4+9751+9890+16655>. The page title is "ERMA® Environmental Response Management Application Arctic". The interface includes a search bar for layers, folders, and bookmarks, and a "Geographic Search" button. The main map area shows a satellite view of a river delta with several colored overlays: a blue line, an orange rectangle, and a red line. The right-hand side features a "Layers" panel with a list of data layers, including "Blank", "Admin Boundaries & Reference Features", "Federal Agency Regions & Offices", "Geopolitical Boundaries", "Place Names and References", "Grids & Graticules", "Managed Areas", "Land Management & Ownership", "Marine Jurisdictions", "Bathymetry & Hydrology", "Environmental Quality & Monitoring", "Marine Debris", "Imagery & Remote Sensing", "GOES Imagery", "Natural Resources, Habitats, & Managed Areas", "Navigation & Marine Infrastructure", and "Public Safety & Infrastructure". The "Imagery & Remote Sensing" section is expanded, showing options like "RGB Aerial Imagery (2014) (NOAA)", "CIR Aerial Imagery (2014) (NOAA)", "RGBN Aerial Imagery (2014) (NOAA)", "USGS Orthoimagery 1 Foot Scale", "Alaska Imagery - Best Data Available (Alaska Mapped, SDMI)", "Alaska Landsat - panchromatic (Alaska Mapped)", "Alaska Landsat - pseudo-color, 15-m (Alaska Mapped)", "AK Color Infrared Orthos, 2.5-m (SDMI, GINA)", "AK Panchromatic Orthos, 2.5-m (SDMI, GINA)", and "AK True Color Orthos 2.5-m, (SDMI, GINA)". The "GOES Imagery" section is also expanded, showing "Blue Marble Imagery - January". The bottom left corner of the map area includes a scale bar (500 m, 1000 m) and the "Google" logo. The bottom right corner of the map area includes the text "Map data ©2016 Google Imagery ©2016 DigitalGlobe, Landat | Terms of Use | Report a map error".

Plotting some of the data on ERMA

The screenshot shows the ERMA Arctic web application interface. The main map displays a satellite view of a river delta with several data layers overlaid, including a central path marked with red diamonds and purple lines. The interface includes a search bar, navigation tools, and a layers panel on the right. A small window in the foreground shows a photo of a geotag with the URL: <https://erma.noaa.gov/arctic/erma.html#/?x=-144.00698&y=65.82120&z=13&layers=4+9751+9890+16655+16693+16697+16695+16702>. The status bar at the bottom shows the scale (1:22K), zoom level (13), and location (65.81199°, -143.98827°).

ERMA® Environmental Response Management Application Arctic

Information | Help | Recent Data | Search Layers, Folders, and Bookmarks | Geographic Search

Layers | Legend | Query Tools | Download | Print

- clear all collapse all
- Imagery & Remote Sensing
 - RGB Aerial Imagery (2014) (NOAA)
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 - RGBN Aerial Imagery (2014) (NOAA)
 - USGS Orthoimagery 1 Foot Scale
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 - AK True Color Orthos 2.5-m, (SDMI, GINA)
- GOES Imagery
 - Blue Marble Imagery - January
- Natural Resources, Habitats, & Managed Areas
- Navigation & Marine Infrastructure
- Public Safety & Infrastructure
- Response Planning
- Weather, Oceanography, & Natural Hazards
- Incidents & Drills
 - ResponseLink Hotlines
 - EPPR MOSPA Exercise Planning Workshop
 - Arctic Technology Demonstration (2015)
 - Arctic Shield 2014
 - UAF ARCTREX Study (Sept 2015)
 - UAF ARCTREX Study (Sept 2014)
 - Alaska River Watch UAS Rapid Response
 - UAS Photo Locations 2016 04 29
 - Alaska River Watch UAS 20150429 path
 - UAS Photo Locations 2016 04 28
 - Circle UAS Mosaic 20160428
 - Circle UAS Mosaic 20160428
 - Alaska River Watch UAS 20160428 path
 - Alaska River Watch - Circle Priorities
- FEMA Active Incidents
- ERMA Drawings

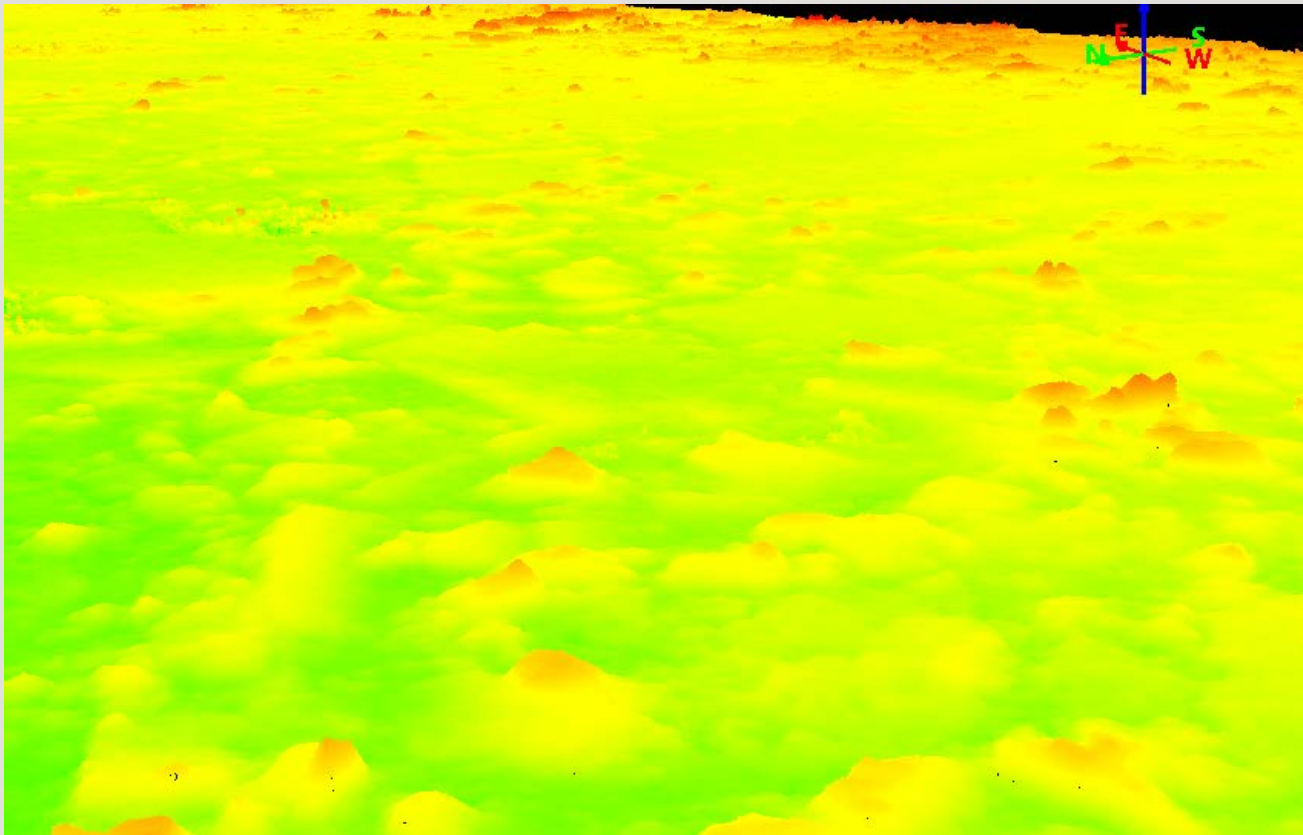
Scale: 1 : 22K | Zoom Level: 13 | Location: 65.81199°, -143.98827°

UAF UNIVERSITY OF ALASKA FAIRBANKS

Ice blocks point cloud

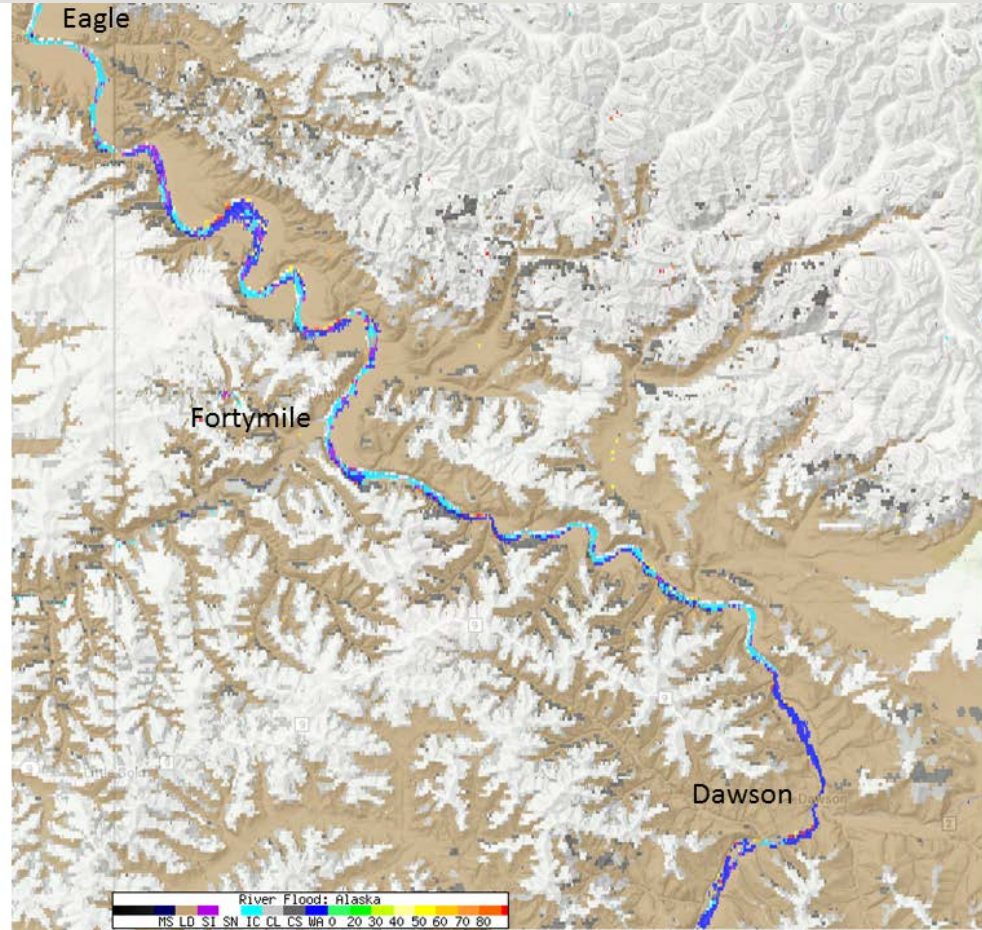


Ice Blocks Point Cloud



VIIRS data products (Dr. Sanmei Li)

Flood Map:
04/24/16



Responder surveying the Yukon river ice



Working closely with local school



Notes and conclusion

- ACUASI deployed within 48 hours- aircraft was in the air within 60 hours
- Data was provided to ERMA almost real time (<60 min from landing)
- For each discussed scenario, in the NOAA reports, research and practice need to take place in order to be effective in responding to a disaster (NSF, Homeland Security)
- Future missions should be deployed at similar altitude to manned airborne
- Motion Video- Although motion video is making large strides into a useful geospatial tool. The file is often big, requires human interpretation, and hard to compare two data sets of different time.
- Data products such as the ice/liquid by are often very compact and the easiest to send under poor communication protocol.
 - Perhaps ACUASI find a grant to develop a small payload to produce similar data product to the VIIRS data set
- A report is in the work(comparison to the SUOMI VIIRS ice/water product)

Special Thanks

- Robbie Hood and John Coffey (JC) for the support in developing UAS support in Arctic and river monitoring.
- Circle School
- ACUASI engineering and logistical support
- The university of Alaska Fairbanks and the Geophysical Institute

Reference

- UAS RFC Workshop Summary final
<https://drive.google.com/open?id=0B6vqMOQTeLkIZVFQV21SemJWSTFrUnUtYk90QWIoNDRiVU9v>
- UAS RFC Workshop II Report
<https://drive.google.com/open?id=0B6vqMOQTeLkINKxiMDRhcnJ1UU9vdUJJRIBhTIdjZWFPNG9N>

