AMSRIce06 Aerial Photographs

Summary
This data set contains photographs of sea ice in the Chukchi and Beaufort Seas of the Arctic Ocean, and of snow cover off the northern coast of Alaska, USA. Photographs were taken from a P3 aircraft during six days in March 2006 using two Kodak digital DC4800 cameras. The images are available in Joint Photographic Experts Group (JPEG) file format. Also included are ASCII text files containing processing scripts, Global Positioning System (GPS) time data, and GPS data stream information. This data set is part of the joint in situ and aircraft AMSRIce06 campaign. The total volume of this data set is approximately 12 gigabytes. All files are available via FTP.

These data were collected as part of a validation study for the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E). AMSR-E is a mission instrument that was launched aboard the NASA Aqua Satellite on 04 May 2002.

Citing These Data
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The following example shows how to cite the use of this data set in a publication. List the principal investigators, year of data set release, data set title, and publisher.

Krabill, William B. 2010. *AMSRIce06 Aerial Photographs.* Boulder, Colorado USA: NASA DAAC at the National Snow and Ice Data Center.

Overview Table

Category	Description
Data format	JPEG image files ASCII text files
Spatial coverage	Southernmost Latitude: 64.819206° Northernmost Latitude: 76.873827° Westernmost Longitude: -168.306548° Easternmost Longitude: -147.861868°
Temporal coverage and resolution	18, 20, 21, 22, 24, 25 March 2006 Every 5-10 seconds
File naming convention	File names vary; refer to Table 1 for more information.
File size	JPEG Image Files: 0.5 - 1.5 MB ASCII Text Files: 1 - 300 KB
Parameter(s)	Snow Cover Ice Extent Ice Roughness
Procedure for obtaining data	Data are available via FTP.

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1. Contacts and Acknowledgments:

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2. Detailed Data Description:

JPEG File (.jpg) Format:
To view the images taken for each day in sequential order, go to the `sequential` directory under each date directory, such as `20060320`.

This contains symbolic links to all of the images taken for that day with names that put them in the correct order. Note: when CAMBOT is operated in parallel mode, both cameras alternate between each image. This allows for a new image every five seconds as it takes each camera ten seconds to fully process the image.

The `mitchell.idt` file shows where the images for that day were taken.

Below the `sequential` subdirectories is one more subdirectory, `small`. These images have been reduced from 2160 x 1440 to 800 x 533 for faster viewing. They also have the position, heading, and speed of the aircraft in the lower left corner of each image. In addition, they have that information in the JPEG comment field which could be extracted via a program for future processing.

The images were processed with:
    small   : ImageMagick-5.5.4

For a description of the `gps.txt` file, which correlates the GPS data to the images, refer to the Field Definitions for the `gps.txt` File section of this document.

Continuous Airborne Mapping By Optical Translator (CAMBOT) File Format:
Among the ASCII text files provided for this data set are .cam files. The CAMBOT system was used to automatically take down-looking digital images with an associated latitude/longitude position. For more information regarding the CAMBOT system, refer to the Data Acquisition and Processing section of this document.

The .cam files accompany nadir-viewing photographs and were created during the processing of the laser data. The .cam files are useful for interpreting the nadir-viewing photographs.

An example of a few columns of a .cam file is shown here:

```
77322.74430 -68.738735 294.492330 1393.92  988.10  405.82 -1.888979  5.240478 31.431880
77322.79451 -68.738678 294.492422 1393.69  988.29  405.40 -1.910360  5.070164 31.320796
77322.84453 -68.738622 294.492513 1393.46  987.79  405.67 -1.925300  5.040712 31.288781
```

Where the fields are defined as:
1. Time of day (secs) - (in either GPS or UTC?)
2. Latitude (deg)
3. Longitude, east (deg)
4. Aircraft altitude (m) - position of camera above WGS84 ellipsoid
5. Altitude of aircraft above ground (m)
6. Surface height (m) - WGS84 elevation of ground topography measured by laser
7. Pitch of aircraft (degrees)
8. Roll of aircraft (degrees)
9. Heading of aircraft (degrees)

Source Files:
The directories labeled `Source` contain many of the programs and scripts used in the post-processing of the images and are included mostly for reference.

File Naming Convention:
The data files employ a variety of naming conventions. The most common file name variables are described in Table 1.

Table 1. Description of File Name Variables

Variable	Description
YYYY	4-digit year
MM	2-digit month
DD	2-digit day
HH	2-digit hour
MM	2-digit minute
SS	2-digit second
usb-fce0-1.2	Camera 1; Linux distinguishes between cameras 1 and 2 by using the unique USB port name.
usb-fce0-1.3	Camera 2; Linux distinguishes between cameras 1 and 2 by using the unique USB port name.
.jpg	Indicates this is a JPEG file
.txt	Indicates this is a text file
.cam	Indicates this is a CAMBOT text file
.pdf	Indicates this is a Portable Document Format (PDF) file
.compare.md5	Indicates this is an MD5 checksum value file

File Size:
JPEG image files range from approximately 0.5 to 1.5 megabytes. ASCII text files range from approximately one to 300 kilobytes.

Spatial Coverage:
Southernmost Latitude: 64.819206°
Northernmost Latitude: 76.873827°
Westernmost Longitude: -168.306548°
Easternmost Longitude: -147.861868°

Temporal Coverage:
Photographs were acquired on 18, 20, 21, 22, 24, and 25 March 2006.

Temporal Resolution:
Photographs were taken every five to ten seconds.

Parameter or Variable:
This data set is comprised of aircraft images of snow cover and sea ice taken in support of the AMSRIce06 campaign.

3. Data Access and Tools:

Data Access:
Data are available via FTP at:
ftp://sidads.colorado.edu/pub/DATASETS/AVDM/data/cryosphere/AMSRIce06/aircraft/nsidc0459_AMSRIce06_Photos_v01/

Software and Tools:
Any image-processing software can be used to view the images; any word-processing program or Web browser is sufficient for viewing the text files.

4. Data Acquisition and Processing:

The CAMBOT system was used to automatically take down-looking digital images with an associated latitude/longitude position.

The CAMBOT system is comprised of:
- a Dell laptop running Redhat linux,
- 2 Kodak DC4800 digital cameras,
- a GPS NMEA source,
- various programs and scripts.

CAMBOT operates in two modes, sequential and parallel. In sequential mode, one camera is operated at a time, giving a continuous rate of one image every 10 seconds. After the compact flash card in the camera fills, the system switches to the next camera while the previous camera is transferring the images to the computer. In parallel mode, both cameras are used simultaneously, giving a rate of one image every five seconds. However, no images can be taken while both cameras transfer their images, a process that takes several minutes.

Each time CAMBOT is run, it creates a directory in YYYYMMDD_HHMM format for all of the files for that session. To log the GPS and photo information, it then creates the files:

gps.YYYYMMDD_HHMMSS
photo.YYYYMMDD_HHMMSS

Two sub-directories, named `usb-fce0-1.N`, are created to store the images from each camera. These files are then used during post-processing to correlate the images with the GPS data.

The first step is to extract the time information from each image and write it into a 'time.txt' file in each of the sub-directories with the images.

The next step is to create the 'picture.txt' file by combining the GPS and photo log files (both have computer time as the first word) and parsing that together with the 'time.txt' files to link the images with the data.

Next, the `picture.text` file is processed to generate a `gps.txt` file. This is the distilled information that provides the image file names with their position. Field definitions for the `gps.txt` are as follows:

Field Definitions for the `gps.txt` File:

    Field 1: camera/photoname
        : usb-fce0-1.1/dcp_0785.jpg
        : camera is actually which USB port that the photo came from.

    Field 2: date
        : 2002/05/20

    Field 3: time
        : 11:20:06

    Field 4: latitude
        : 80.912680

    Field 5: longitude
        : 24.370585

    Field 6: delta time in seconds between images
        : 5.000002
        : 5 seconds indicates we were running in stutter mode.
        : each camera is only capable of taking a photo every
        : 10 seconds, so we use both to get a 5 second rate.

    Field 7: delta distance in nautical miles
        : 0.372076
        : a rough calculation based on the lat/long of the previous
        : and current photos.

    Field 8: bearing in degrees between photos
        : 87.364984
        : useful for determining if the plane was turning.

    Field 9: speed, knots
        : 267.894385
        : distance/time. useful for determining why there
        : was no overlap in images, although one also needs
        : altitude to fully determine that.

There are 2 separate cameras, each on a separate USB port. Linux identifies each port by the `usb-fce0-1.1`, which then helps to identify which camera was taking the picture.

Notes Regarding the Field of View Test:
On 21 November 2000, the N159 hanger door was selected as a target to measure the field of view of the Kodak DC4800 camera. The target was adjusted so that the viewfinder showed only the width of the hanger door. Next, an image was acquired of the north N159 hanger door to ensure that the image showed the same area as the viewfinder.

The distance from the camera to the center of the hanger doors was 38 meters.

The distance across the hanger door was 48.8 meters:

$\tan A = 24.4/38 = 0.642$

A=32.7 degrees

The image size is 2160 by 1440 pixels, so the vertical size should be 1440/2160=.667.

.667 * 32.7 degrees = 21.8 degrees

The image should contain the laser scan if aligned properly.

At 2000 feet, the image would contain:

.642 * 2000 =1280 *2 feet=2560 feet across and

.667*2580=1710 along track

if we want to have 20% overlap then .8 * 1710 = 1370

pictures every 1370 feet

at 120 knots (138 mph) (moving 233 feet/sec)

1370/233= 5.88 sec (80%)
           6.61 sec (90%)

no overlap 1710/233=7.34 sec.

Letter to Data Users:
Jim Yungel   *05 November 2005*

The camget system was developed as a low cost ancillary system to replace our NASA ATM video cameras. The video cameras (even so called "digital video") result in lo-res images that need projected on TV style monitors, and do not result in digital images that can be searched by computer programs and displayed on computer screens.

Since we wanted searchable digital images to replace the video cameras, we developed an alternative. Rather than buying and operating an expensive digital photogrammetry system (difficult to fit in the small aircrafts with our ATM system), we used two low-cost Kodak digital cameras that could be commanded to take images and also could "listen" to the GPS data stream. The camget "raw data" file result is basically three pieces of information:

1) higher res (than video) jpeg images
2) a file containing a list of images taken and GPS time
3) a file containing GPS data stream info

We process this data several ways to provide searchable databases of images (some of smaller size) that we can use to answer questions about ATM data. We do not correct the camget data for pitch/roll or geo-reference the camget data as it's never been necessary for the limited use we have for the images. The uncorrected images have always satisfied our needs for checking ATM data, and have been a very good replacement for downward-looking video cameras.

But some of our data customers have expressed a desire to try to geo-reference the images. Since the ATM system has a better GPS traj (obtained by differential GPS) than the NEMA GPS data recorded by camget, and the ATM also has pitch, roll, and heading data as measured by the Litton laser gyro we can go through that data and produce the .cam files. The .cam file contains this higher quality GPS data, pitch roll and heading, and times.

What our customers attempt to do is match the camget photo times with the information in the detailed .cam files and correct for pitch roll heading and produce geo-referenced images. We have not attempted this ourselves.

I think this can be carried out in a rough sense, but when one would get down to fine detail, there's several minor factors to overcome.

There are a number of other minor factors involved, particularly in that the camget cameras are not mounted in a photogrammetric style frame that is referenced to the INS (but are securely mounted to the airframe as is the INS) This means there is a small mounting bias between the camera's actual pitch roll and heading and the measured laser gyro pitch roll and heading. This bias should be consistent during missions in the same year, but will change year to year. Also there are two cameras used in the camget system and this bias will be different between cameras.

There are also some minor timing issues with time tagging the images. The image times depend on commanding the camera and reading the GPS data steam. There is some question of the exact time the digital camera shutter opens. Lab tests indicated that the shutter time of the cameras was fairly consistent and predictable and that's how we ended up with the times for each image, but this was "good enough" for our uses.

One other note:

The two camget cameras alternate taking photos on the P3. This was necessary to take photos fast enough for P3 speeds and have some chance of overlap between images. The downside is that there are 10 minutes gaps when the two cameras memory card fill up and the images are downloaded to the laptop controlling the cameras. On the Twin Otter aircraft which flies slower, we can run one camera at a time and avoid gaps by having the other camera take over as the first camera fills up.

The best results I have seen to date though are by folks using "feature mapping" to join camget images together, and then matching that larger image to our laser elevation data.

I wasn't sure what end result you have in mind for the camget data, but felt that you should have this background info to know just how far to push this. In a rough sense, the images can be corrected to some level (maybe good enough for whatever you want to do). At some level you may encounter problems related to what I discussed above.

Hope this is of some help, and keep us informed of your progress.

-Jim

5. References and Related Publications:

For more campaign maps and more information on AMSRIce06, visit the Goddard Space Flight Center (GSFC) Sea Ice Remote Sensing: Arctic 2006 Web page at: http://polynya.gsfc.nasa.gov/seaice_arctic2006.html.