Alaska
Geographic
Data
Committee

USGS Task Order, Alaska DEM – Phase II
Alaska DEM Funding and Implementation Plan

Critical Terrain Data Requirements for Resource Development In Alaska

David F. Maune, Ph.D., PSM, PS, GS, CP, CFM
Dewberry
8401 Arlington Blvd.
Fairfax, VA 22031
Tel: (703) 849-0396
Email: dmaune@dewberry.com

Alaska DEM Whitepaper

Alaska Geographic Data Committee

Alaska Mapped

Digital Elevation Model (DEM) Data for the

Alaska Statewide Digital Mapping Initiative (SDMI)

September 18, 2008

Prepared by:
David F. Maune, PhD, PSM, PS, GS, CP, CFM
Dewberry
8401 Arlington Blvd.
Fairfax, VA 22031-4666

Dewberry

- Statewide need for DEMs (DTMs & DSMs) with vertical accuracy equiv. to 20-ft contours, based on needs for aviation safety & other user applications (e.g. orthos)
- Airborne IFSAR = most cost-effective & timely solution for DEMs & geoid model statewide

Other Alaska DEM User Applications

Environmental Assessments

- Coastal erosion
- Wildfire modeling
- Watershed management
- Floodplain management
- Tidal inundation
- Sea level change
- Natural disasters
- Search & rescue

Resources Development

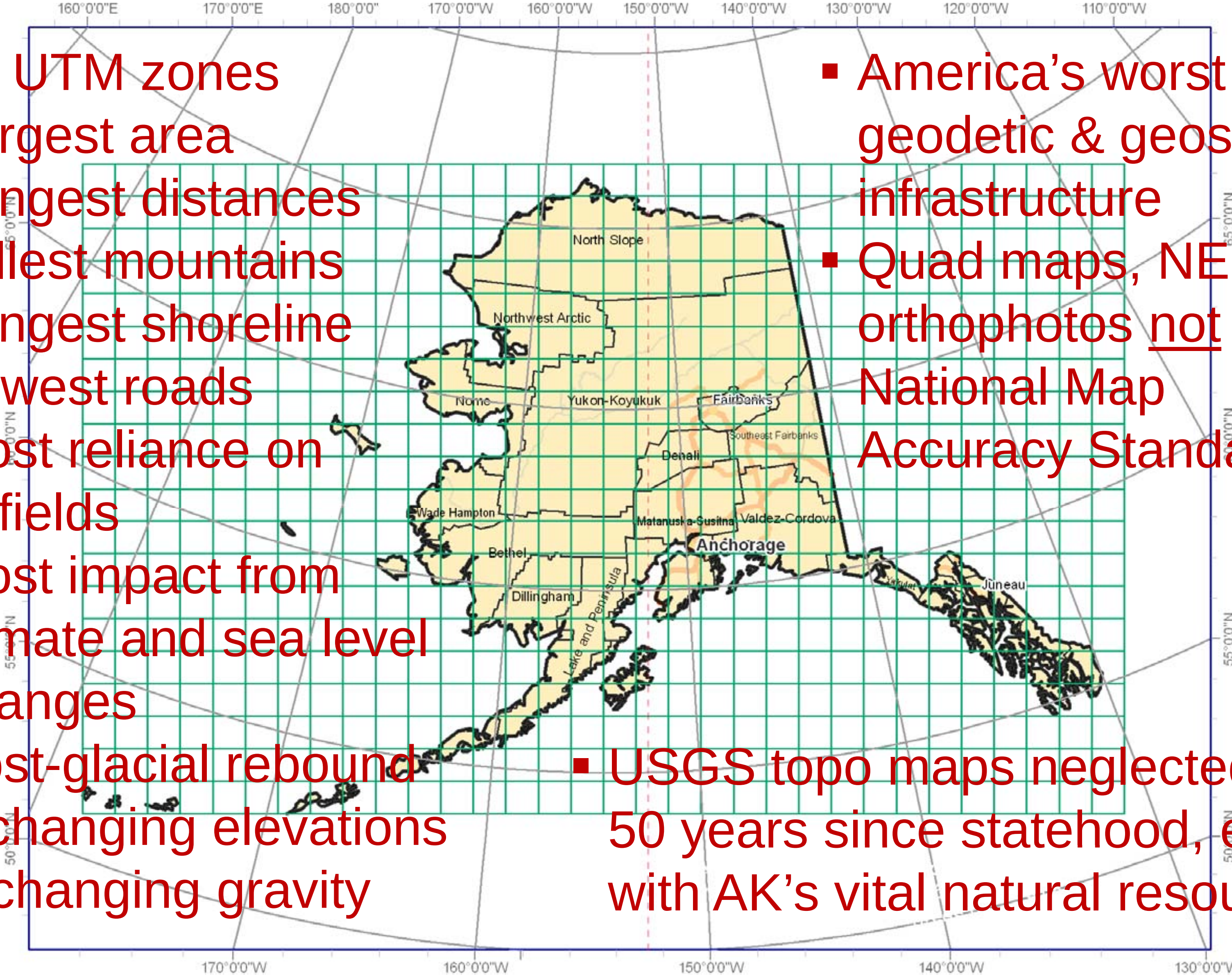
- Mining & timber
- Oil & gas exploration
- Pipeline construction
- Fisheries & wildlife
- Navigable streams & waterways
- Pre-engineering assessments
- Claims mitigation

2^{nd} Edition, 2007

1. Introduction to DEMs, 3-D Surface Modeling, Tides
2. Vertical Datums
3. Accuracy Standards
4. National Elevation Dataset
5. Photogrammetry
6. IFSAR
7. Topographic & Terrestrial Lidar
8. Airborne Lidar Bathymetry
9. Sonar
10. Enabling Technologies
11. DEM User Applications
12. DEM Quality Assessment
13. DEM User Requirements
14. Lidar Processing & Software
15. Sample Elevation Datasets

Why Alaska is Different and Changing

Ships can now transit N. Atlantic ↔ N. Pacific around N. Slope



- 10 UTM zones
- Largest area
- Longest distances
- Tallest mountains
- Longest shoreline
- Fewest roads
- Most reliance on airfields
- Most impact from climate and sea level changes
- Post-glacial rebound = changing elevations & changing gravity

- America's worst geodetic & geospatial infrastructure
- Quad maps, NED, orthophotos <u>not</u> to National Map Accuracy Standards

- USGS topo maps neglected for 50 years since statehood, even with AK's vital natural resources

Alaska Geoid errors ≈ 2 meters
(All other states: ± 2 cm)

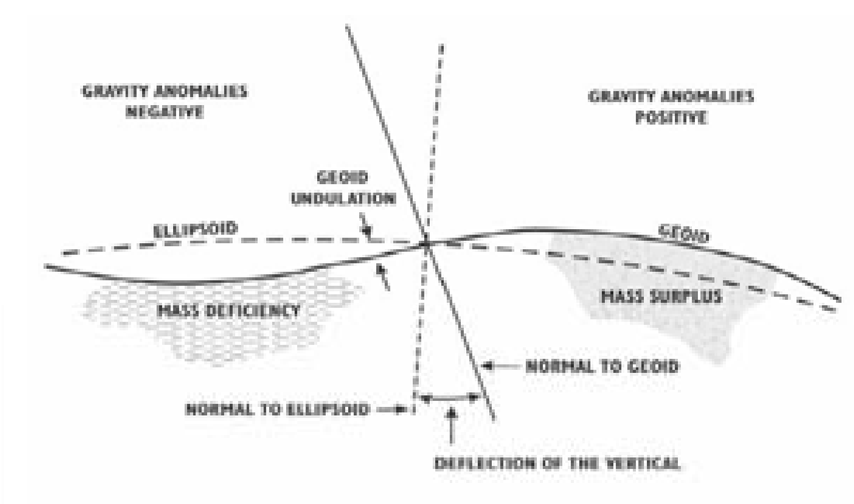


Figure 3. Ellipsoid, geoid, and geoid undulation (geoid height).

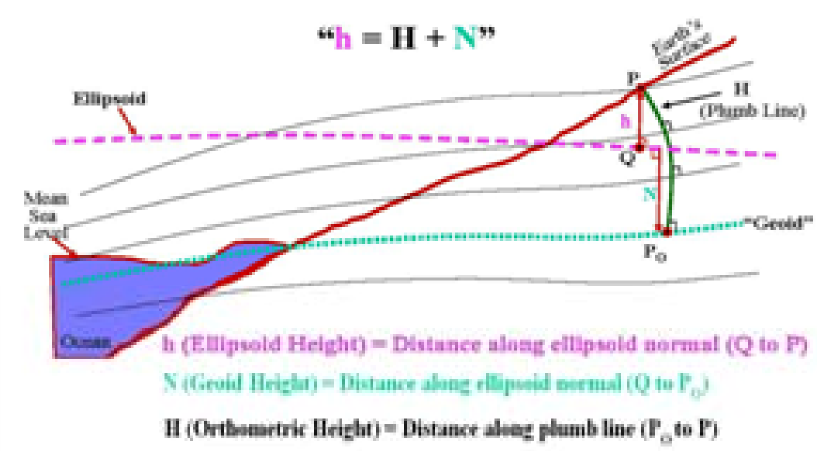
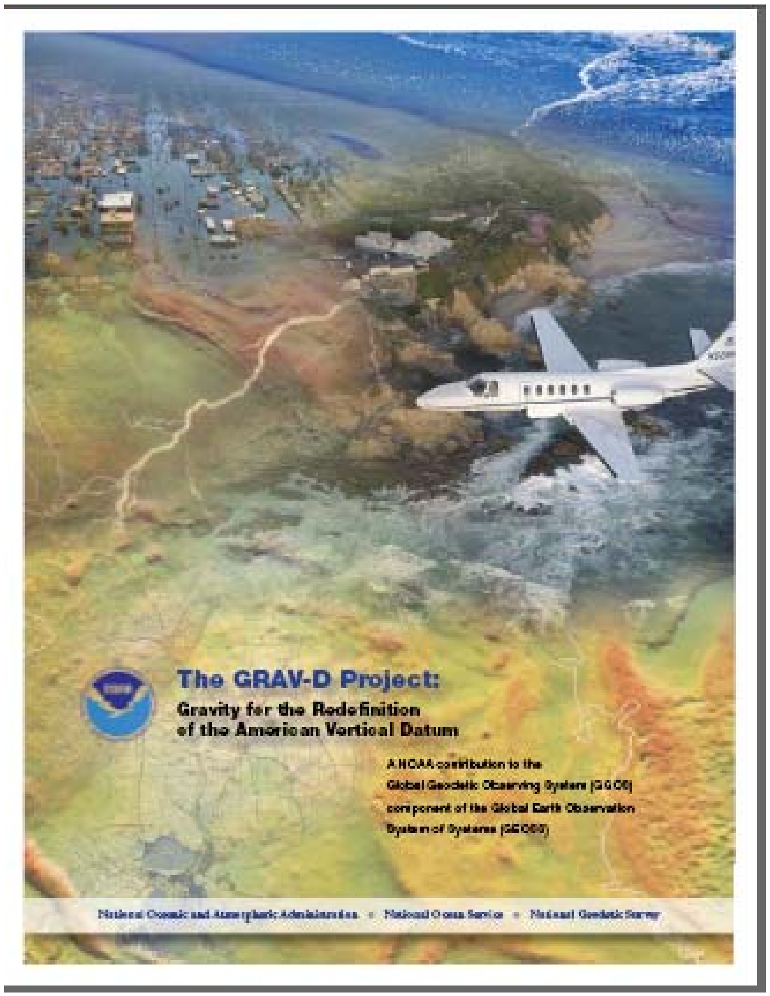


Figure 4. Geodetic formula for conversions between ellipsoid heights and orthometric heights.

Campaign I: High-Resolution Snapshot of Gravity



Phase I: Testing

Phase II: Operational Data Collection

1. Alaskan littoral regions excluding Aleutians
2. Southern Alaska
3. CONUS littoral regions
4. Hawaii & Aleutians
5. Inland CONUS
6. Northern Alaska

NO DEDICATED FUNDING

Sparse CORS Network in Alaska

Receiver Sampling Rate

1 sec **5 sec** **10 sec** **15 sec** **30 sec** **Show All** **Show Decommissioned Sites**

Alaska compared with other States

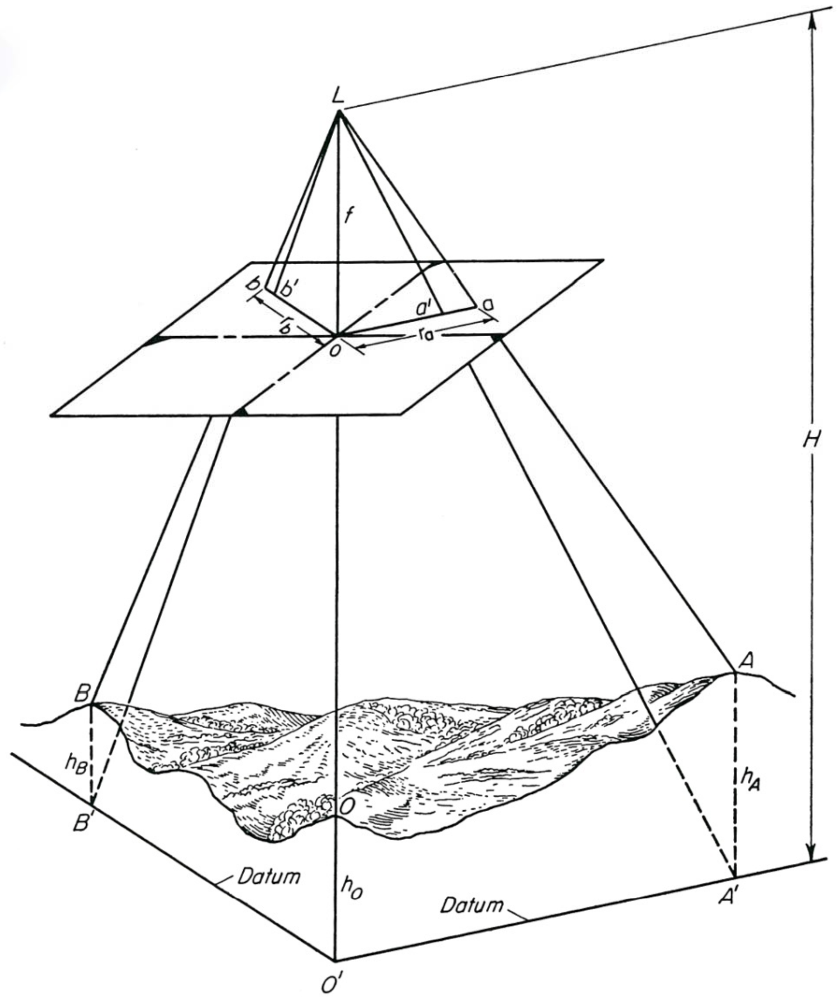
- Smaller scale (1:63,360) topographic quads in Alaska, and many do <u>not</u> satisfy National Map Accuracy Standards (NMAS)
- National Elevation Dataset (NED) has huge errors:
  - **Horizontal errors: several miles in some places (errors are 100 times larger than per NMAS)**
  - **Vertical errors: hundreds of meters too low**
- Few roads; rely on air transportation; even the state capitol, Juneau, is not accessible by road.
- Aeronautical charts, DEMs and eTOD data are critical to all aviators, including DOD and DHS statewide.
- Cannot accurately orthorectify images using the NED

Quotes from experienced pilot who lost many pilot friends in Alaska aviation accidents

- "On the track from Fairbanks to Kobuk, there is a mountain that is 3,000 feet higher than in the sectional aeronautical map … absolutely certain it is more than two miles displaced. It was very impressive, if flying IFR and trusting the map we would have flown right into it."

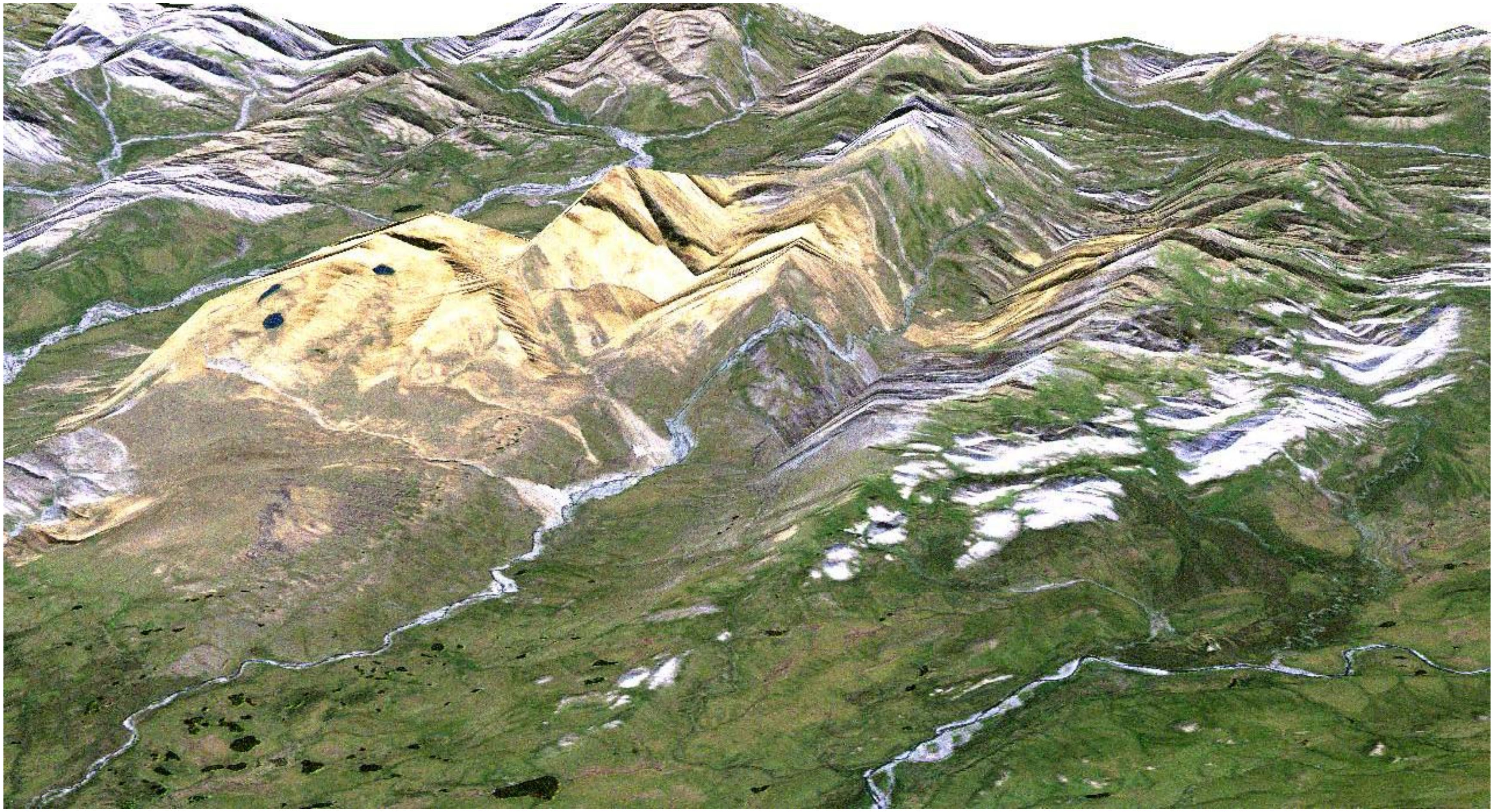
- "You'll find most mountains 300 feet too small."
- "Wolverine Mountain and Angutikada Peak are 'way off' in the sectionals."
- Appendix B in whitepaper provides many other examples.

Alaska orthorectification problems



- Normally images can be "draped" over a DEM from the NED for orthorectification
- Won't work in Alaska when NED errors are:
  - 100's of meters vertical
  - 1,000's of meters horizontal
- Need to first correct Alaska NED …

… to avoid this kind of problem (Western Alaska)



Kevin Engle – UAF GINA: http://www.gina.alaska.edu

User Group 1: Aviation Safety

Interviewed

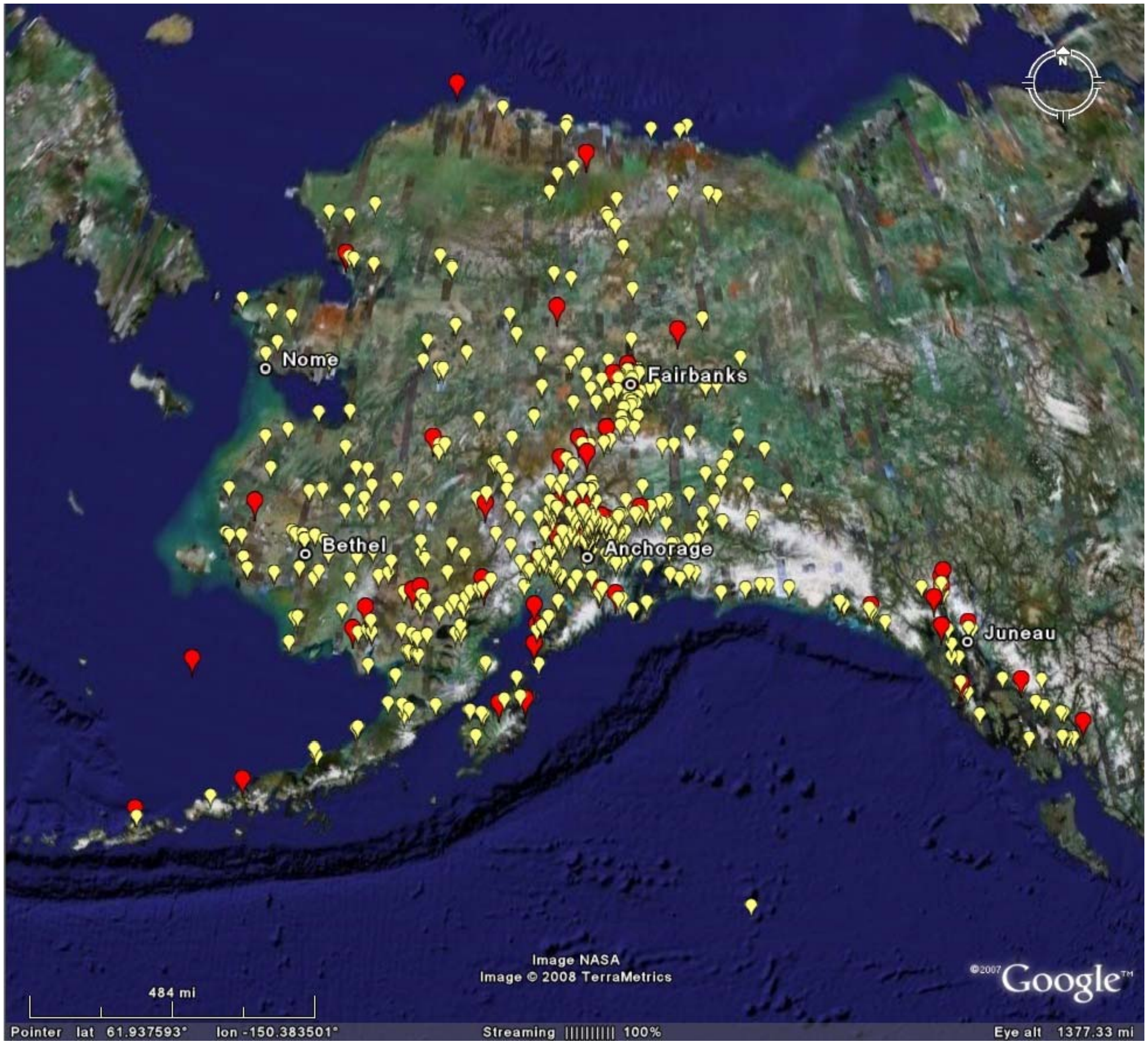
- Steve Colligan
- Lars Gleitsmann
- Nick Mastrodicasa
- George Sempeles (FAA)

Mid-accuracy (20-ft) equivalent contour accuracy is required for Alaska Area 2 IFR sites

Alaska Applications/Benefits

- FAA compliant Electronic Terrain and Obstacle Database (eTOD) required for navigation in Alaska during extensive periods of limited visibility where Instrument Flight Rules (IFR) are used.
- 20- ft contour accuracy DSMs and DTMs needed for Aviation Safety in Area 2 terminal control areas for airfields throughout Alaska
- 200-ft contour accuracy (or better) DSMs and DTMs statewide for Area 1 requirements
- Terrain avoidance; mountain passes, float plane needs are unique for Alaska

Fatal (red) & non-fatal accidents (2001-2005)



ICAO Area 1 and Area 2 standards

Because the Shuttle Radar Topography Mission (SRTM) did not collect elevation data north of 60° north latitude, and because of the major known horizontal and vertical errors in the NED, the U.S. currently does not satisfy the relatively simple Area 1 standard in Alaska (equivalent to 200-ft contour accuracy).[1] Neither is the U.S. prepared to satisfy the more-demanding Area 2 standard in Alaska (equivalent to 20-ft contour accuracy) which pertains to IFR site terminal control areas (circles with radius of 45 Km).

---

[1]During user interview on August 5, 2008, Mr. George P. Sempeles, FAA ATOR-R, Aeronautical Information Services, Cartographic Standards, stated that there is a serious lack of reliable elevation data in Alaska and that he agreed with the concerns raised by the Alaska aviation community. He stated that the area of Alaska north of 60° north latitude does not comply with ICAO Area 1 standards and that elevation data equivalent to airborne IFSAR statewide would be needed to bring Alaska into conformance with Area 2 standards, stating that it makes no sense to have high accuracy elevation data within those circles and low accuracy elevation data elsewhere.

ASTER GDEM may satisfy "Area 1" but not "Area 2" requirements.

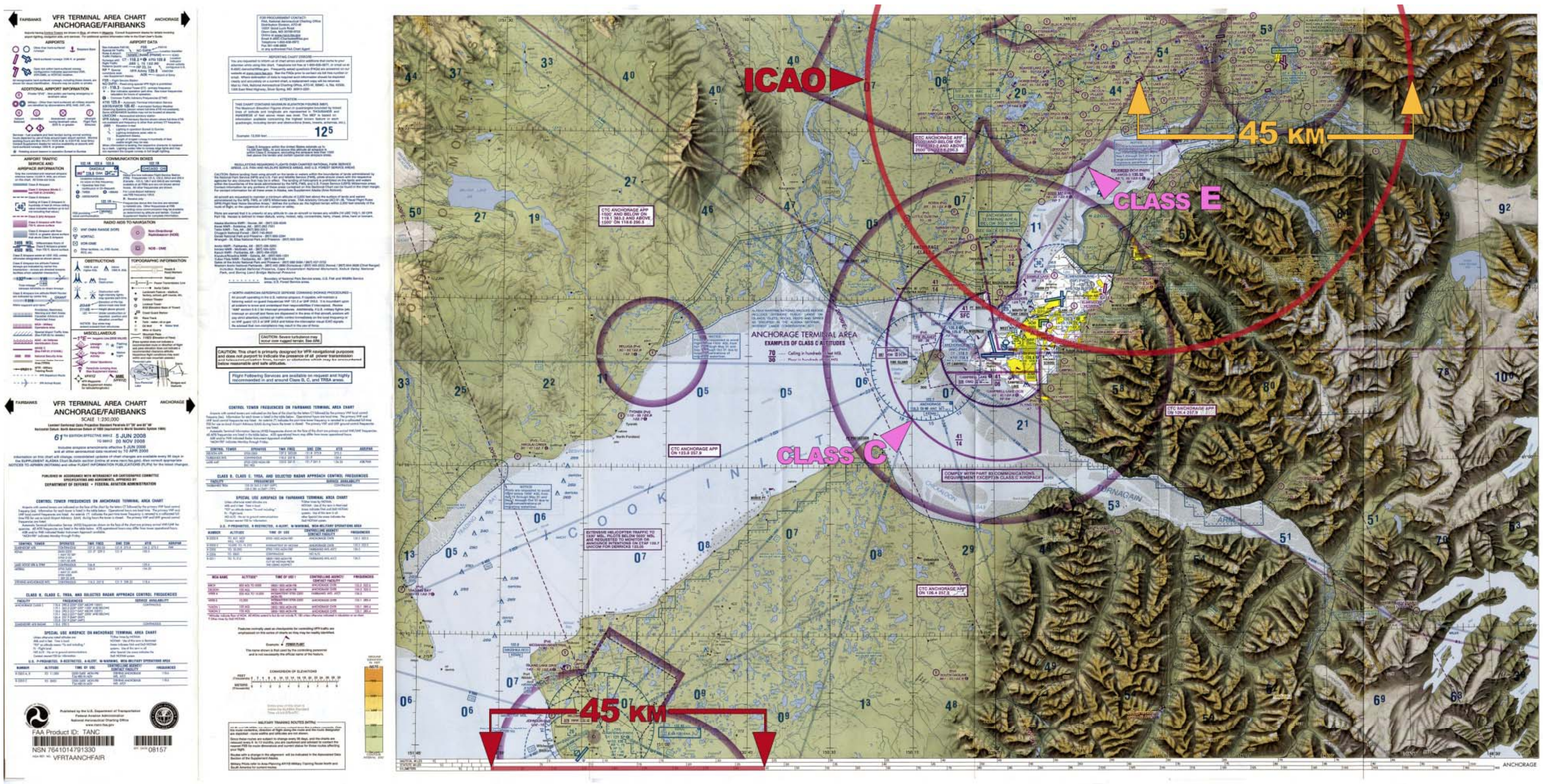
Alaska satisfies neither Area 1 nor Area 2

To satisfy identified user requirements for eTOD data, while taking into account cost-effectiveness, acquisition methods and data availability, the data are to be provided according to four basic coverage areas:

- Area 1 has a coverage over the whole territory of a state or country, including aerodromes/heliports.
- Area 2 covers the established terminal control areas, not exceeding a 45 km radius from the aerodrome reference point (ARP), to coincide with the existing specification for the provision of topographical information on the Aerodrome Obstacle Chart.
- Area 3 covers the area which is within the specified distances from the edges of a defined aerodrome or heliport surface movement area.
- Area 4 is restricted for use only for those runways where precision approach Category II or III operations have been established.

ICAO Doc 9881 provides the minimum user requirements applicable to the origination and publication of terrain data from creation through the entire life cycle of the data. It provides a minimum list of attributes associated with the terrain data and a description of associated errors that may need to be addressed. Any data processing must be accomplished in accordance with known and established quality processes and procedures.

VFR Terminal Area Chart showing red circle within which DEM w/20-ft contour accuracy would be required when landing under IFR conditions at the Wasilla Airport



What is the eTOD?

The Electronic Terrain and Obstacle Database (eTOD) is an internationally agreed-on standard to provide a accurate terrain database for safe flying and navigation under Instrument Meteorological Conditions (IMC) when pilots cannot see the terrain at all due to night and clouds or other weather such as heavy rain and snowfall.

When Visual Flight Rules (VFR) cannot be safely followed, and especially during emergency air evacuations at remote villages, aviators then operate under Instrument Flight Rules (IFR) designed to keep aircraft from unintentionally flying into obstacles due to navigation errors.

The need for elevation data to create a reliable and compliant FAA eTOD for navigation in Alaska, during periods of limited visibility, has never been greater. IMC flying conditions have to be coped with in Alaska on a regular basis for airfields throughout the state, even for airfields that are not part of the FAA's 148 IFR sites. Accurate DEMs are vital for flight planning, terrain avoidance, transiting through mountain passes, and landing of float planes on rivers and other water bodies. DEMs are also used for pilot training and simulators.

Goal: To minimize Controlled Flight Into Terrain (CFIT), a serious problem in Alaska.

Terrain data for eTOD

Note: Obstacles require “boots on the ground” surveys

Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information (Doc 9881)

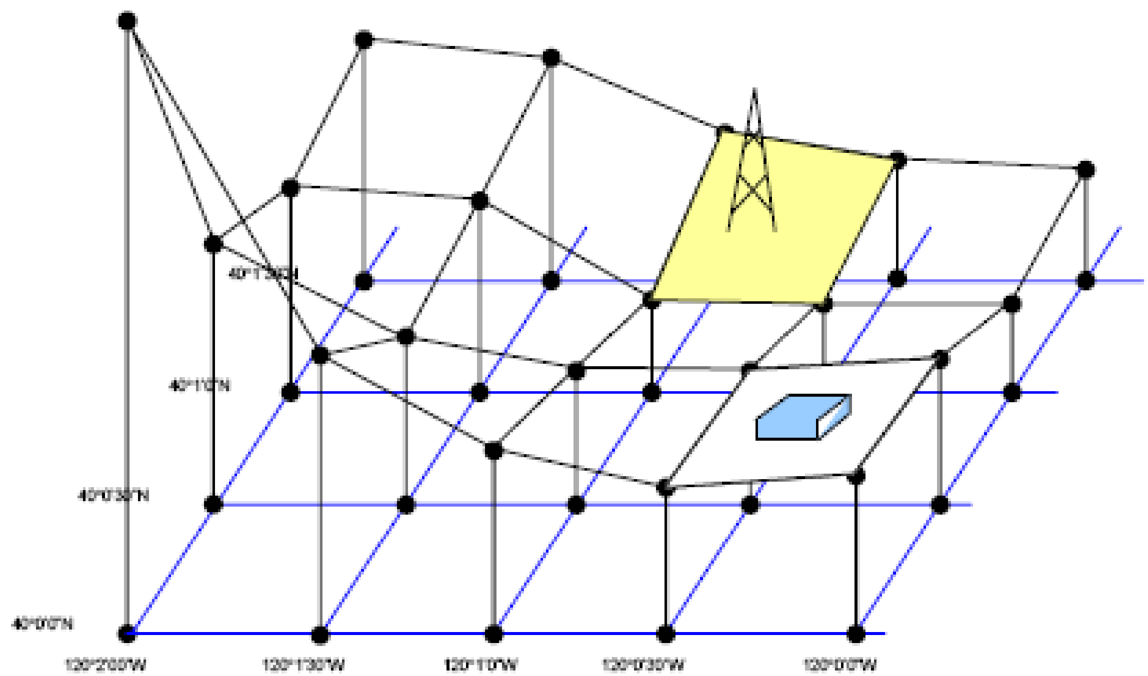


Table 2. ICAO DEM Requirements

ICAO	Area 1 Standards	Area 2 Standards
Post Spacing	3-arc-seconds (≈90 meters)	1-arc-second (≈30 meters)
Vertical Accuracy (LE90)	30 meters	3 meters
Equivalent Contour Interval	60 meters (200 ft)	6 meters (20 ft)
Vertical Resolution	1 meter	0.1 meter
Horizontal Accuracy (CE90)	50 meters	5 meters
Confidence Level	90%	90%
Compliance Date	November 20, 2008	November 20, 2010

In addition to SRTM (south of 60° north latitude) entire world may satisfy this Area 1 requirement when ASTER GDEM data is available

But what about Area 2 requirements in 2010?

ICAO Area 2 vs. DTED Level 2

- I asked George Sempeles of FAA to explain ICAO Area 2 requirements — compared with DTED Level 2 that NGA provides for airfields worldwide

Response from George Sempeles, FAA

- The Standard & Recommended Practices (SARPS) recorded in the Annexes to the ICAO convention are designed to be minimum civil aviation safety standards the world *should* adhere to. *Should* means the Annexes are not binding on any signatory State (country), and States have the option to file SARP differences with ICAO and advertise those differences in the States' Aeronautical Information Publication (AIP).

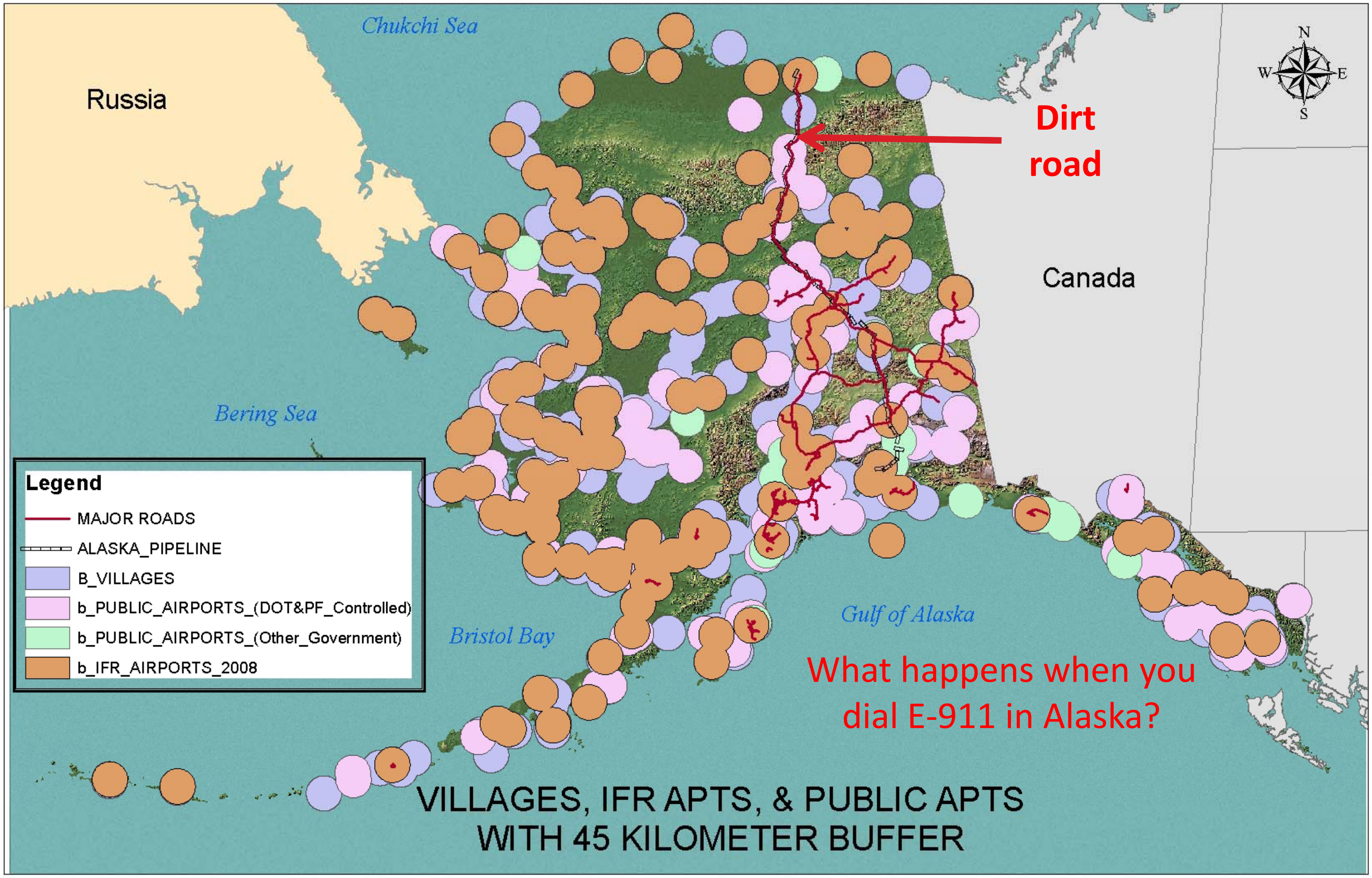
FAA comments (continued)

- (Q) Why are the Area 2 terrain accuracy requirements so accurate compared to DTED level 2?
- (A) The answer lies with the intention of Area 2. Area 2 is defined as the Terminal Control Area (TCA) of an aerodrome ... where aircraft are rapidly approaching the surface of the earth and man made obstacles, requiring greater detail of both features in order to develop Instrument Approach Procedures (IAP). Greater detail in the TCA is also required to develop missed approach, One Engine Inoperative (OEI) contingency planning, Standard Instrument Departure (SID), and Standard Terminal Arrival (STAR) procedures. According to FAA airport obstruction survey specifications, data contained in DTED level 2 would be considered not accurate enough to develop US civil procedures.

FAA comments (continued)

- In the lower 48 States, the majority of the US low altitude airspace is legally terminal airspace. So, to satisfy the ICAO SARPS, all of CONUS should be surveyed to at least Area 2 accuracies.
- As of today, the ICAO SARPs are written to include Area 2 requirements at aerodromes with IFR operations. Outside those areas, Area 1 data is required which represents the minimum requirements collectively. I tried that logic in the lower 48 and found it's more expensive to survey the IFR airports individually verses surveying the entire continental US. Judging by the distribution of IFR aerodromes in Alaska, I believe the same holds true in Alaska. I would ask InterMap and find out the price for surveying 148 widely dispersed 45 kilometer circles verses the entire state. I think you'll find it less expensive to collect it all.

148 IFR Airfields plus emergency sites



Vertical Accuracy Requirements

DEM User Groups	High-accuracy 10' and better contour accuracy (Airborne LiDAR)	Mid-accuracy 20' to 30' contour accuracy (Airborne IFSAR)	Low-accuracy 40' and worse contour accuracy (Satellite Sensors)
Alaska Aviation		20' contour accuracy ICAO Area 2 standard	200' contour accuracy ICAO Area 1 standard
Alaska DCCED	2' contour accuracy		
Alaska DGGS	2' & 10' contour accuracy		50' & 100' contour accuracy
Alaska DNR			40' contour accuracy
Alaska DOT	4' & 10' contour accuracy		
Alaska University Users	2' & 10' contour accuracy	30' contour accuracy	50' contour accuracy
BLM		20' contour accuracy	
DOD		20' contour accuracy	
NGA			50' contour accuracy
NOAA[8]	2' contour accuracy	20' contour accuracy	40' contour accuracy
NPS			40' contour accuracy
NRCS			40' contour accuracy
USFS		20' contour accuracy	
USGS	10' contour accuracy ("ideal")	20' contour accuracy ("preferred")	40' contour accuracy ("acceptable")

NRCS & USFS (Alaska) DEM Uses

- **Natural Resources Conservation Service (NRCS)**: Ted Cox. DEMs are used for orthorectification of digital imagery and for analyses of slope and aspect for the following applications: soil surveys, landscape modeling of geomorphic land forms, natural resources inventories, and engineering applications such as emergency watershed analyses. NRCS requirements can be satisfied with elevation data equivalent to 40-foot contours. NRCS Soil Survey Areas and Areas of primary interest within Roaded Corridors would be very useful to have DTM with a 5-10 meter posting. Remainder of State – a 20 meter DSM suitable for ortho-rectification to NMAS 24k.
- **U. S. Forest Service (USFS)**: Mark Riley, Jim Schramek, Joe Calderwood. DEMs are used for orthorectification of digital imagery, for hydrology, and for diverse forestry analyses to include slope and aspect, study of forest health (e.g., causes of yellow cedar decline), for determination of tree heights (DSM elevations minus DTM elevations), biomass and wildfire modeling. USFS requirements for DSMs and DTMs can be satisfied with elevation data from airborne IFSAR, i.e., equivalent to 20-foot contours.

Vertical Accuracy of Airborne IFSAR Options

Competing Airborne IFSAR Systems	Slope: 0° to 10° (Accuracy$_z$ at 95% confidence level)	Slope: 10° to 20° (Accuracy$_z$ at 95% confidence level)	Slope: 20° to 30° (Accuracy$_z$ at 95% confidence level)
Intermap's STAR-3/4/5/6			
Type III DSM	6 m ≈33-ft contour accuracy	9 m ≈50-ft contour accuracy	12 m ≈66-ft contour accuracy
Type II DSM	1.8 m ≈10-ft contour accuracy	3 m ≈17-ft contour accuracy	4 m ≈22-ft contour accuracy
Type II DTM (untested, assumed equal to DSM)	1.8 m ≈10-ft contour accuracy	3 m ≈17-ft contour accuracy	4 m ≈22-ft contour accuracy
	Flat Terrain Yahoo County, MS	**Moderate Terrain Southern California**	**Rolling Terrain Southeast Asia**
Fugro EarthData's GeoSAR X-band DSM	1.8 m ≈10-ft contour accuracy	1.86 m ≈10-ft contour accuracy	8.78 m ≈49-ft contour accuracy
P-band DTM	≈10-ft contour accuracy	≈10-ft contour accuracy	≈49-ft contour accuracy
	P-band foliage penetration (10-20m typical) is slope and foliage dependent		

Vertical Accuracy of Satellite Options

Competing Satellite Sensor Systems with contour interval (CI) accuracy	Slope: 0° to 20° Accuracy$_z$ at 95% confidence level and equivalent CI	Slope: 20° to 40° Accuracy$_z$ at 95% confidence level and equivalent CI	Slope: >40° Accuracy$_z$ at 95% confidence level and equivalent CI
ASTER Global DEM	20m (110-ft CI)	Unavailable	Unavailable
GeoEye's IKONOS, 1-arc-sec w/o GCPs 0.2-arc-sec w/1 GCP per stereo model	24 m (132-ft CI) 16.7 m (92-ft CI)	Unavailable	Unavailable
Digital Globe's WorldView-1, w/o GCPs	8 m (44 ft CI)	Unavailable	Unavailable
Spot Image Corp's SPOT-5, w/o GCPs	11.9 m (66-ft CI)	21.4 m (118-ft CI)	35.7 m (197-ft CI)
ASRC's Cartosat-1 w/9 GCPs/scene	6-9 m (33-50 ft CI)	10-20 m (55-110 ft CI)	Unavailable
MDA's Radarsat-2, w/minimal GCPs (see mode explanations below)	Slope: 0° to 20°	Slope: 20° to 40°	Slope: >40°
— Multi-Look Fine (MLF) beam mode	0-10°: 8m (44-ft CI) 11-20°: 12m (66-ft CI)	21-30°: 15m (83-ft CI) 31-40°:17m (94-ft CI)	20m (110-ft CI)
— Ultra Fine (UF) beam mode	0-10°: 6m (33-ft CI) 11-20°: 8m (44-ft CI)	21-30°: 11m (61-ft CI) 31-40°: 12m (66-ft CI)	15m (83-ft CI)

ASTER GDEM now being evaluated but won't satisfy 20-ft CI need

Strengths/Weaknesses of Optical Imagery

- <u>Neither</u> day/night <u>nor</u> all-weather
- Photogrammetry produces both orthophotos and DEMs
  - DSMs produced by automated image correlation
  - DTMs produced by manual compilation, more expensive
- Difficult to accurately maps glaciers and mountains with perpetual snow cover.
- Airborne imagery: With good base/height ratio, DTM vertical accuracy comparable to 1-ft to 20-ft contours, but expensive
- Satellite imagery: Most options are DSMs only and not DTMs. Vertical accuracy comparable to 50-ft contours (very expensive, with lots of GCPs) to 200-ft contours (less expensive, w/o GCPs).

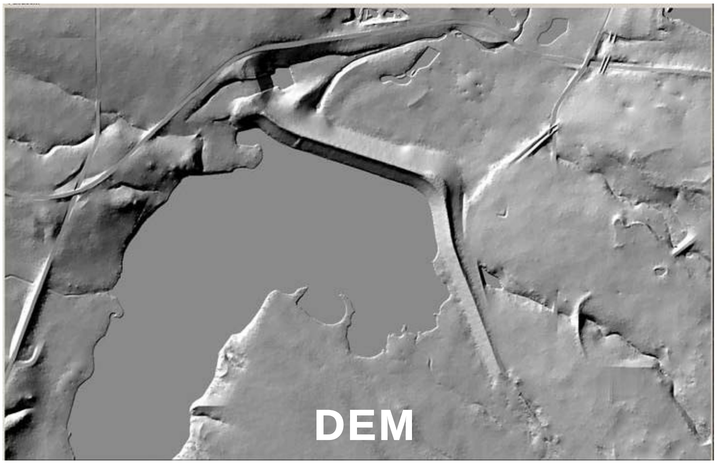
Strengths/Weaknesses of LiDAR

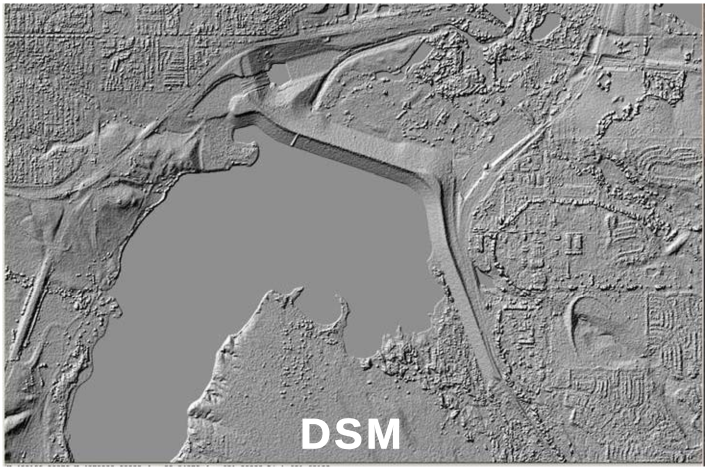
- Day/night, but not all-weather; must be cloud free
- Single laser pulses penetrate through or between trees
- Most accurate option for DTMs in dense forests and vegetation
- Most accurate elevation differences between DSM and DTM for forestry applications.
- Ideal for 1-ft to 2-ft contour accuracy requirements
- Can accurately map mountains with perpetual snow cover; tested in Greenland
- May be unaffordable statewide; but Government (NASA) may fly Alaska's major shorelines to satisfy topo/bathy needs.

Strengths/Weaknesses of IFSAR

- Both day/night and all-weather
- Flies at 35,000 to 40,000 feet AGL, perfect for GRAV-D
- Ortho-rectified radar images (ORI), plus DSMs and DTM, ideal for 10-ft to 20-ft contour accuracy
- Intermap produces DTMs by editing of DSM; Fugro EarthData produces DTMs from P-band IFSAR
- Intermap may have licensing issues; no Fugro issues
- Significantly less expensive than either airborne LiDAR or airborne imagery solutions
- Radarsat-2 has the least expensive option, but the DSM combined accuracy is equivalent to 83-ft contours
- Maps glaciers and mountains with perpetual snow cover

IFSAR DTM, DSM, ORI





- Assume Alaska orthos will be color (RGB) or 4-band
- Could register satellite imagery to ORI to improve positional accuracy with minimal GCPs

Airborne IFSAR Considerations

In addition to satisfying all statewide requirements, because their aircraft fly at altitudes between 35,000 and 40,000 feet, IFSAR aircraft could potentially be fitted to accommodate the National Geodetic Survey's GRAV-D sensor and operator in order to simultaneously collect gravity data for improving the geoid height model so desperately needed in Alaska.

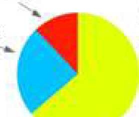
- Intermap Technologies appears to have a competitive advantage by having more flexibility with a larger fleet of aircraft, and it has proven experience for large, successful projects in production of NEXTMap USA, NEXTMap Britain, and NEXTMap Europe.
- Fugro EarthData appears to have a competitive advantage because of GeoSAR's X-band and P-band sensors that may be superior for accurate mapping of both the DSM and DTM in forested regions, and images the terrain with about 4x redundancy from multiple look directions to minimize shadow & layover.

Airborne IFSAR Conclusion

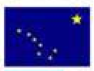
An IFSAR hybrid IFSAR solution should be considered in order to benefit from the advantages of both Intermap and Fugro EarthData. Discriminating factors should include:

- Comparative costs, including licensing
- Technical advantages of X-band and P-band for different areas
- Plans to minimize and mitigate artifacts from layover/shadow
- Past performance (satisfied clients?)
- Whether or not the IFSAR aircraft could simultaneously accommodate a NGS gravimeter and operator in order to also support the GRAV-D program by collecting gravity data along the same flight lines, etc. as the IFSAR data collection.

Who Owns/Manages Alaska?



Russian traders arrived in Alaska in the mid-1700's and established small, scattered trading posts and settlements. Alaska Natives (the Eskimo, Indian, and Aleut peoples) continued as the primary landowners during this period of Russian occupation. On October 18, 1867, Russia sold Alaska to the United States government. As a result, the federal government owned the Alaska Territory, approximately 373 million acres -about one-fifth the size of the rest of the U.S.



State of Alaska - 89.8 million acres

Under the terms of the Alaska Statehood Act of 1959, the federal government granted the new state 28% ownership of its total area. Approximately 103,350,000 acres were to be elected under three types of grants:

1) Community - 400,000 acres

2) National Forest Community - 400,000 acres

3) General - 102,550,000 acres

Additional territorial grants, for schools, university and mental health trust lands, totaling 1.2 million acres were confirmed with statehood.

All grants combined gave the State of Alaska approximately 105 million acres. To date, 89.9 million acres has been granted, with the balance expected to be granted by 2009.

ANCSA Native Corporation (Private)
39.3 million acres

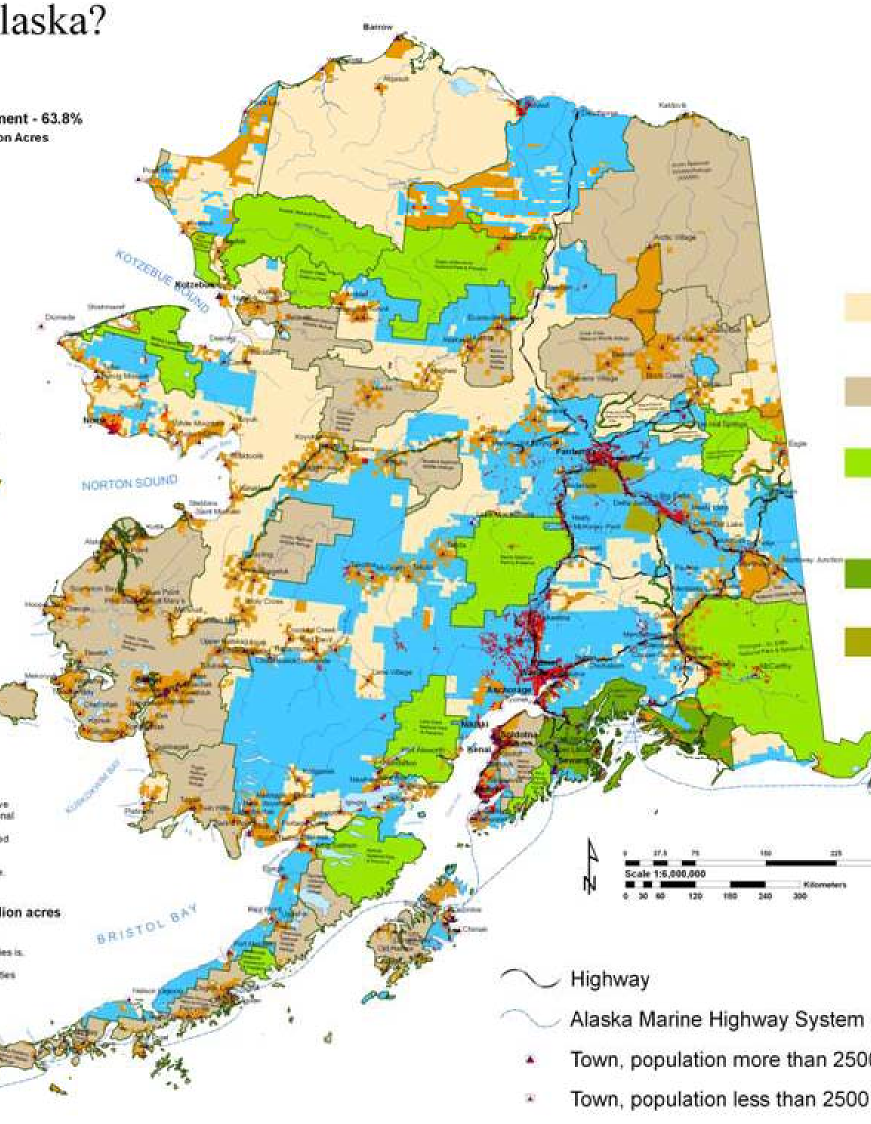
On December 18, 1971, P. L. 92-203, the Alaska Native Claims Settlement Act was signed into law. The purpose of ANCSA was to legislate the terms by which Alaska Natives could acquire title to their lands. This claim had been unresolved for more than 100 years since the United States purchased Alaska from Russia in 1867.

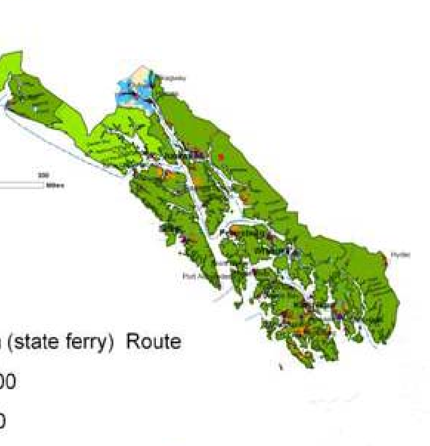
Native lands are private lands. ANCSA mandated the creation of regional and village Native corporations to manage 44 million acres and payment of one billion dollars. Thirteen regional corporations were created for the distribution of ANSCA land and money. Twelve of those shared in selection of 16 million acres, the thirteenth corporation, based in Seattle, received a cash settlement only. 224 village corporations, of 25 or more residents, shared 26 million acres. The remaining acres, which include historical sites and existing native-owned lands, went into a land pool to provide land to small villages of less than 25 people. To date, 39.3 million acres have been transfered to ANCSA corporations.

Non-ANCSA Private & Local Government - 5.9 million acres

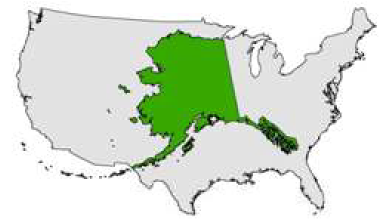
Land in private ownership (other than Native land) comprises less than one percent of the total land in Alaska. Much of the best land for development around Alaska's communities is, or will be, privately owned. Private land development meets people's needs by providing places to live, work, shop and recreate. It also provides a tax base for cities and communities to help support public services.

Because local governments in Alaska have individual methods of transfering land into private ownership, land currently owned by them is grouped into this catagory.





Alaska is one-fifth the size of the conterminous 48 states.



Bureau of Land Management - 82.5 million acres
In Alaska, BLM's focus is conveying land, wildland fire management, overseeing the Joint Pipeline Office (a partnership with the state and other federal agencies with oversight responsibility of the Trans-Alaska Pipeline), and responding to the public demand for use of the land they manage.

U.S. Fish & Wildlife Service - 78.8 million acres
The USFWS manages 16 wildlife refuges in Alaska. The two largest are the Yukon Delta National Wildlife Refuge and much storied Arctic National Wildlife Refuge (ANWR), both of which are approximately 19 million acres.

National Park Service - 52.4 million acres
There are eight national parks in Alaska, including the five largest in the national park system:
Wrangell-St. Elias National Park & Preserve - 13,175,901 acres
Gates of the Arctic National Park & Preserve - 8,472,506 acres
Denali National Park & Preserve - 6,075,030 acres
Katmai National Park & Preserve - 4,093,229 acres
Lake Clark National Park & Preserve - 4,030,025 acres

U.S. Forest Service - 22.4 million acres
The USFS manages two National Forests in Alaska. The Tongass NF, 16.9 million acres, and the Chugach NF, 5.5 million acres are the two largest national forests in the U.S. The USFS manages these lands for a wide range of goods and services while conserving and protecting them.

Department of Defense - 1.7 million acres
Dept. of Defense lands in Alaska provide for a unique training environment, most notably at the Northern Warfare Training Center in the Tanana Valley in the interior

Maps produced by the
Alaska Dept of Natural Resources
Division of Forestry

Alaska Upland Land Ownership/Management (Statewide total ≈ 1.8 million Km^2)

Whose problem is it?

All of us; we need funding partners

	Million acres	Km^2	% of total
State of Alaska	89.8	363,408	24.1
BLM	82.5	333,866	22.1
USF&WS	78.8	318,892	21.1
NPS	52.4	212,055	14.1
ANCSA	39.3	159,041	10.5
USFS	22.4	90,650	6.0
Other private	5.9	23,876	1.6
DoD	1.7	6,880	0.5
TOTALS	**372.8**	**1,508,668**	**100.0**

Met with NDOP and NDEP in August

An additional 65 million acres of Tide and Submerged Lands are mapped for offshore drilling activities and sea ice monitoring.

Consensus points from NDOP & NDEP

We have no time to waste

- ICAO Area 1 Requirements: 11/20/2008
- ICAO Area 2 Requirements: 11/20/2010
- Other statewide user requirements: Immediate
- Alaska's mapping needs have been neglected for 50 years; unmet needs in Alaska are dire, especially aviation safety

We must remain true to Alaska's requirements

- 20' contour accuracy or better
- Both DSM and DTM, especially mountain peaks, ridgelines and hydrology
- Technology that overcomes adverse weather conditions
- Technology that maps snow-capped mountains & glaciers
- Technology that is cost-effective

We must find timely, cost-effective solution

- Only airborne mapping options can satisfy AK's technical and accuracy requirements
- Airborne IFSAR costs are significantly less than airborne LiDAR or photogrammetry
- Multiple contracting options are available to obtain the most cost-effective solution for timely delivery of quality products
- Need both federal and state funding

Other points not time-critical

We have time to reach consensus elsewhere

- Data acquisition and post-processing can proceed if we choose ellipsoid heights and Alaska Albers, for example, knowing that NED will be provided as geographic coordinates in ESRI grid format
- Other issues can be resolved while data are being acquired and processed

What other requirements should be satisfied? How? By whom?

- Will GINA serve multiple datasets to the public?
- Will GINA provide orthometric heights that change with new geoid models?
- Will GINA provide GeoTiff and/or other file formats
- Who will perform hydro-enforcement of DTM? How? Who pays?
- Who will filter DTM so roads are smooth on orthophotos? How? Who pays?

We must find cost-effective solution

- Answers to these questions may depend on available funds and contract costs for data acquisition & processing
- If available funds are inadequate to pay for everything as part of major contract, get data acquired and DSM/DTM delivered ASAP; then determine if those responsible for land management pay for hydro-enforcement, etc. if needed for their areas of responsibility.

USGS Task Order:
Alaska DEM Initiative – Phase II

Alaska DEM Funding & Implementation Plan

- Executive Summary
- Agency Executive Leadership Communications, incl. DOI (USGS, BLM, NPS, F&WS, BIA); DOD (NGA); DHS; NGS; FAA; USDA (USFS, NRCS, FSA); State of Alaska
- Initiative Plan, incl. FGDC coordination and Agency Executive Leadership coordination
- Brief 2/27/09 at Alaska Mapping Conference

Need Funding Partners to solve a common need

Department of Interior (DOI)

- On January 27, 2009, Dave Maune and Phil Thiel met with and briefed Karen Siderelis, Associate Director for Geospatial Information and Chief Information Officer for DOI, and Kenneth Shaffer, Deputy Staff Director of the Federal Geographic Data Committee (FGDC), to discuss DOI funding support for the Alaska DEM.
- Ken arranged for Dave to brief the FGDC Coordinating Committee on February 3, 2009.
- Karen arranged for Dave to brief the national geospatial coordinators from all the DOI Bureaus plus other key personnel on February 19, 2009.

FGDC Coordination Committee Attendees

Ivan DeLoatch - FGDC	Don Buhler - BLM
Ken Shaffer - FGDC	Jeff Booth - DHS
John Mahoney - FGDC	David LaBranche - DOD
Lew Sanford - FGDC	David Morehouse - DOE
Milo Robinson - FGDC	Rani Balasubramanyam - DOJ
Pat Phillips - FGDC	Wendy Blake Coleman - EPA
Vaishal Sheth - FGDC	Donald Draper Campbell - FCC
Wonkus Baek - FGDC	Doug Vandegraft - FWS
Bonnie Gallahan - FGDC	Bill Wilen - FWS
Gita Urban Mathieux - FGDC	Bill Burgess - NSGIC
Vicki Lukas - USGS	Rhett Rebold – OSD/DISDI
Carol Giffin - USGS	Trisha Christian - SBA
Charles Hickman - USGS	Randy Fusaro - USCB
Rob Dollison - USGS	Shirley Hall - USDA
Mike Lee – USGS/DHS	Dennis Crow - USDA
Catherine Nolan – Grant Thornton	Marissa Capriotti - USDA
Phil Thiel - Dewberry	Ralph Crawford - USFS

Don Campbell has thousands of tower sites in AK with coordinates for QA/QC

U.S. Geological Survey (USGS)

- On February 5, 2009, Dave Maune met with and briefed Kari Craun, Director, National Geospatial Technical Operations Center (NGTOC)
- On February 4, 2009, Kari Craun gave a briefing on The National Map to Dave Maune and other members of the National Geospatial Advisory Committee (NGAC).

The National Map FY08 Data Partnerships

	NGP Partnership and Mapping Contracts Funding	Partner Funding	Total Project Cost	Leveraging Ratio
Imagery	$1,596,902	$30,440,552	$32,037,454	20.1
Elevation	$2,239,364	$21,326,959	$23,566,322	10.3
Hydrography	$423,766	$1,033,766	$1,457,532	3.4
Names	$253,749	$253,749	$378,749	1.5
Transportation	$512,758	$6,559,542	$7,072,300	13.8
Structures	$329,528	$319,295	$648,823	2.0
Boundaries	$20,000	$20,000	$40,000	2.0
NSDI	$311,845	$414,359	$726,204	2.3
TOTAL	$5,687,912	$60,368,222	$65,927,384	11.6

John Wesley Powell, 2nd Director of USGS

Testimony to Congress on December 5, 1884

"A Government cannot do any scientific work of more value to the people at large, than by causing the construction of proper topographic maps of the country"

This statement remains true today in Alaska where resource management and development are critical

The National Map

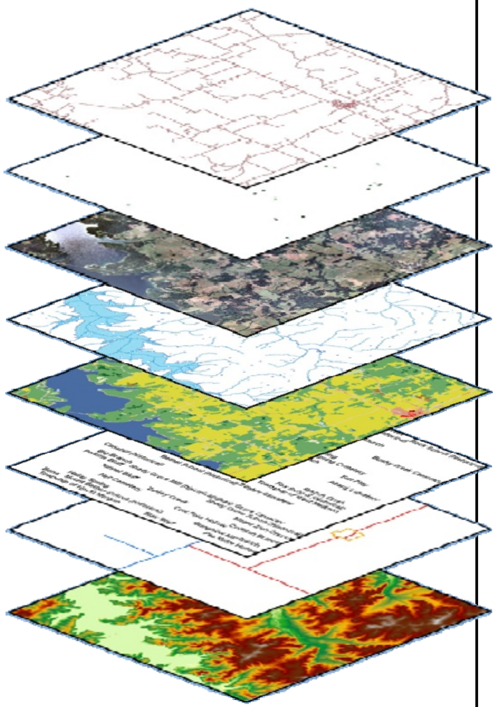
The National Map is a collaborative effort to deliver topographic information for the nation

The goal of *The National Map* is to be the nation's source for trusted topographic data and maps online and in print

The National Map

The National Map

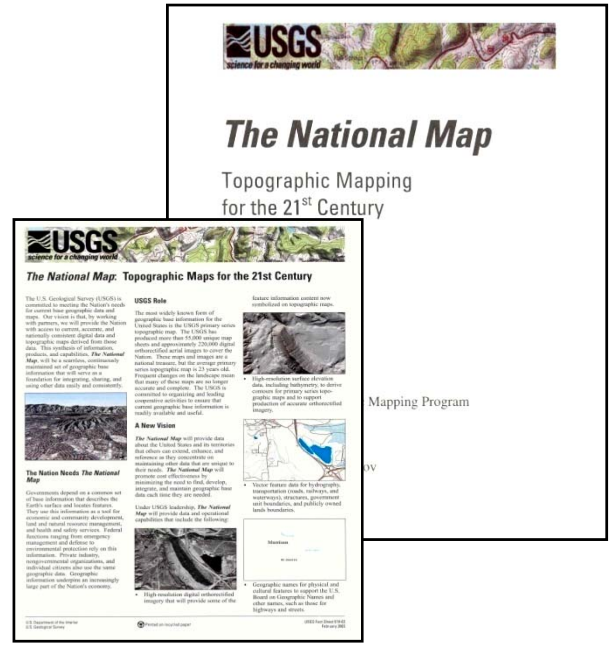
- *The National Map* contributes to the NSDI
- *The National Map* includes eight data layers: orthoimagery, elevation, hydrography, land cover, geographic names, transportation, structures, and boundaries
- Public domain data to support
  - USGS topographic maps at 1:24,000-scale
  - Products and services at multiple scales and resolutions
  - Analysis, modeling and other applications at multiple scales and resolutions
- *The National Map* is built on partnerships and standards

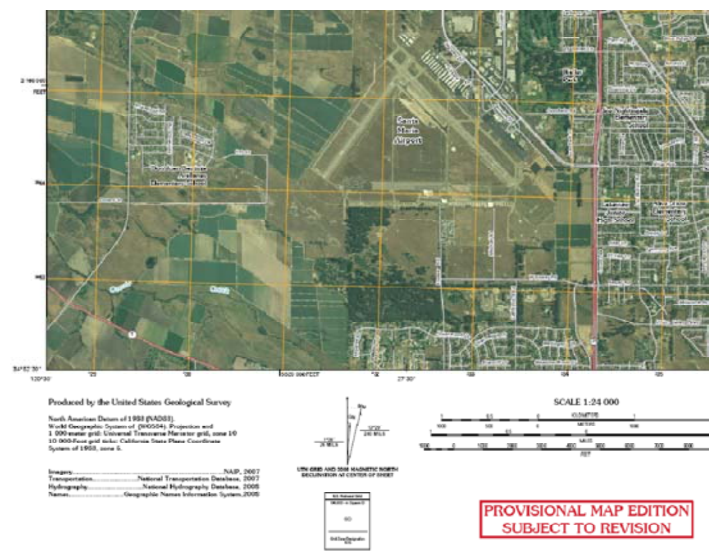


The National Map

The National Map

- Seamless, continuously maintained, <u>nationally consistent</u> base topographic data
- Developed and maintained through partnerships
- Available on-line
- Source for products and services
- e-Topo Image Map





Overall Strategy

- Create next-generation USGS topographic maps
- 3 year revision cycle following NAIP
- Source data from *The National Map* databases
  - National Transportation Dataset (from Census initially)
  - Names (GNIS, NHD)
  - Cartographic features (Grids, quad level metadata)
- Initial product will be basic e-Topo Image Map content
  - Image background
  - Roads
  - Names
  - 1:24,000-scale layout
- Map Product evolution
  - Data layers will be added as they become available and technical processes are in place
  - Elevation data (contours) and Hydrography highest priority

Product Characteristics
(It's not your grandfather's topographic map)

- The product is a plottable digital image. It is neither a GIS dataset nor a traditional paper map, but a new kind of hybrid.
- The physical format is GeoPDF, an unpublished and proprietary format that can only be read by specific proprietary software.
- The PDF is layered and georeferenced, giving the dataset some limited GIS characteristics.

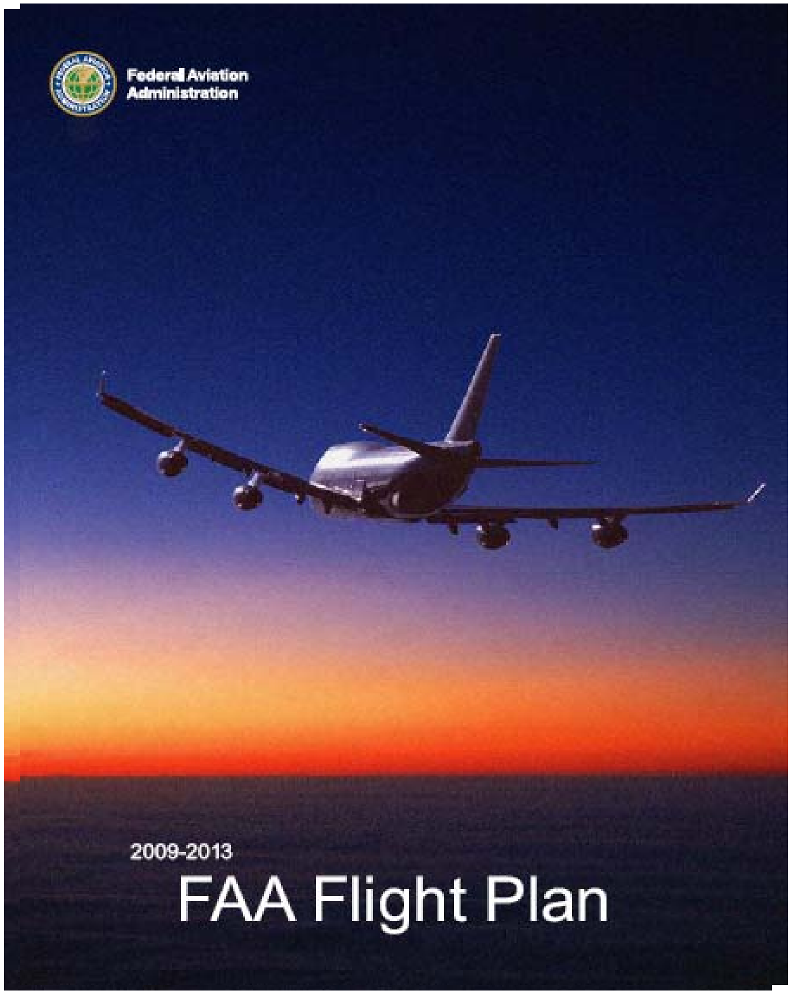
Federal Aviation Administration (FAA)

On February 11, 2009, Dave and Phil met with and briefed:

- Dick Powell, Manager, Aeronautical Information Services, FAA
- Mark Howard, Manager, Aeronautical Survey Program, NOAA
- George Sempeles, Aeronautical Information Management Quality Assurance, FAA
- Christopher Criswell, Cartographer, Aeronautical Information Services, FAA
- Adam Edmondson, Cartographer, NACO, FAA
- Nathaniel Hersh, Cartographer, NACO, FAA

FAA's Strategic Plan

Alaska is listed 8 times; no other state is listed



INCREASED SAFETY

Our goal is to achieve the lowest possible accident rate and constantly improve safety.

Our first commitment is to safety. The proof of our ability to maintain that focus is in the actual safety record itself. In fiscal years 2007 and 2008, there were no commercial passenger fatalities on commercial flights in the U.S. Knowing this, the issue facing FAA comes in the form of a simple question with an exceedingly complex answer: When a system is so safe, how do you know where to place your focus to keep it that way? With more passengers flying than ever, and fuel prices forcing airlines to look for ways to save money, the test has never been more daunting.

To address this challenge, we're moving away from the anecdotal approach to safety and instead using data-analysis to prevent accidents before they happen. Safety Management Systems (SMS) are being put in place that allow us to examine the data of what's actually happening in the system. With SMS, we examine that data to isolate the trends that very well could become the precursors to accidents themselves. Three of the agency's largest lines of business—Air Traffic, Aviation Safety and Airports—have these programs under way.

These efforts complement other areas of focus, such as the "Call to Action" we placed to industry regarding runway safety. We used the data that had been accumulated with our Safety Management System to isolate trends. With that information, we met with chief pilots, put new technology in place, and revamped airport signage to increase the levels of safety on the runway.

Even though commercial aviation draws most of the headlines, we remain diligent in our efforts to work with the pilots who form the backbone of General Aviation (GA). The FAA continues to work jointly with the Alaska aviation community through a number of organizations and safety programs such as: the Medallion Foundation, Alaska Air Carriers Association, Alaska Airman's Association, FAA Safety Team, and Circle of Safety. In addition to these training and education efforts, we're using new technology in Alaska, such as the satellite-based Capstone navigation and terrain awareness avionics. We're also installing 221 additional weather cameras throughout the state. These weather cameras prove that a picture that is indeed worth a thousand words and are a real-time depiction of what's happening throughout the state. The Alaskan pilot now has go/no go information that was previously unavailable.

In addition, we're using ADS-B to solidify the use of satellite surveillance in Alaska. The breadth of the geography there makes the use of radar virtually impossible. Satellites aren't encumbered by terrain. The situational awareness benefits provided by the improved surveillance, broadcast services, and improved avionics has proven to be a great success; preliminary data indicates a projected 47 percent drop in the fatal accident rate for aircraft equipped with ADS-B in Southwest Alaska.

As a result of that success, we are transferring the lessons learned in Alaska to the Gulf of Mexico, another location in which radar coverage is limited. We are increasing our outreach and training to general aviation pilots to increase their skills and awareness.

We're making similar advances to air traffic control safety. The establishment of "proximity events" last year was a recognition that our focus should be on the more serious operational errors and not on those that present little or no safety risk. Training programs and better automation will help us meet our goal in FY 2009.

The section that follows identifies the measures and initiatives we have in place to improve safety. Because we always look toward continuous improvement, we have updated our safety measures and initiatives. For example, we've put in place a new metric to collect and share information from multiple programs, including the Aviation Safety Information Analysis and Sharing (ASIAS) program and the new Air Traffic Safety Action Program. We're spreading safety data as far and wide as we can. There can be no secrets in safety, and everyone including and especially the passenger, benefits with this approach.

We accelerated the expansion of the Air Transport Oversight System (ATOS) for the airlines. We're blending the oversight data ATOS is providing with our other data sources to enhance our ability to detect nationwide trends and provide a better perspective on the health and safety of the aviation system.

It is not a coincidence that we are in the safest period in the history of aviation. It took a lot of hard work and dedication from our employees, the aviation industry and external stakeholders to get us here. The system is the safest it has ever been, and we will continue to work to keep it that way.

Even though commercial aviation draws most of the headlines, we remain diligent in our efforts to work with the pilots who form the backbone of General Aviation (GA). The FAA continues to work jointly with the Alaska aviation community through a number of organizations and safety programs such as: the Medallion Foundation, Alaska Air Carriers Association, Alaska Airman's Association, FAA Safety Team, and Circle of Safety. In addition to these training and education efforts, we're using new technology in Alaska, such as the satellite-based Capstone navigation and terrain awareness avionics. We're also installing 221 additional weather cameras throughout the state. These weather cameras prove that a picture that is indeed worth a thousand words and are a real-time depiction of what's happening throughout the state. The Alaskan pilot now has go/no go information that was previously unavailable.

In addition, we're using ADS-B to solidify the use of satellite surveillance in Alaska. The breadth of the geography there makes the use of radar virtually impossible. Satellites aren't encumbered by terrain. The situational awareness benefits provided by the improved surveillance, broadcast services, and improved avionics has proven to be a great success; preliminary data indicates a projected 47 percent drop in the fatal accident rate for aircraft equipped with ADS-B in Southwest Alaska.

As a result of that success, we are transferring the lessons learned in Alaska to the Gulf of Mexico, another location in which radar coverage is limited. We are increasing our outreach and training to general aviation pilots to increase their skills and awareness.

Again, only Alaska is mentioned by FAA

OBJECTIVE 1

Reduce commercial air carrier fatalities.

OBJECTIVE 2

Reduce general aviation fatalities.

Performance Targets

- Reduce the fatal accident rate per 100,000 flight hours by 10 percent over a 10-year period (2009-2018).
- By the end of FY 2009, reduce accidents in Alaska for general aviation and all Part 135 operations from the 2000-2002 average of 130 accidents per year to no more than 99 accidents per year. This measure will be converted from a number to a rate at the beginning of FY 2010.

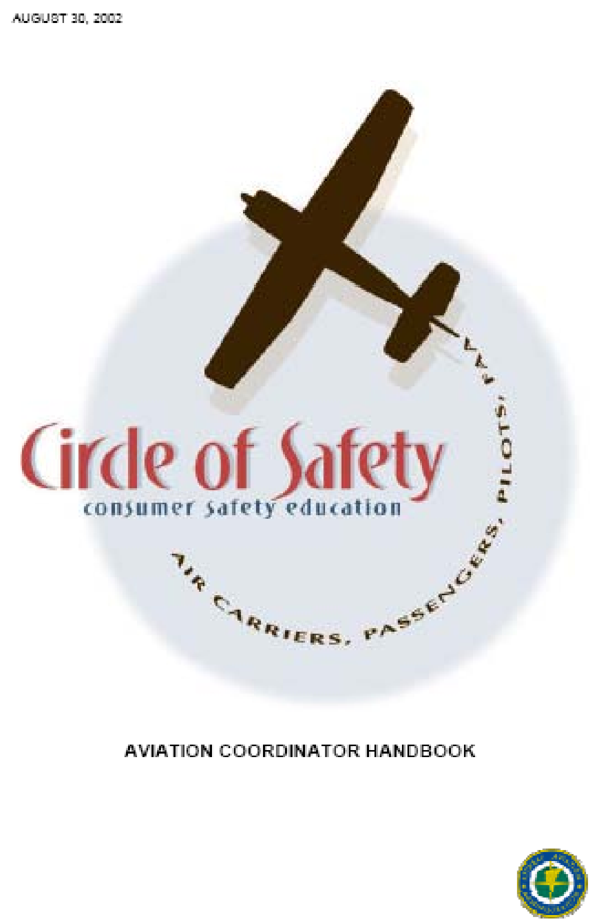
Strategy

Expand and accelerate implementing safety and air navigation improvement programs in Alaska.

Initiatives

- Achieve full operational capability of WAAS by completing all hardware and software changes needed to complete the system.
- Continue to optimize weather camera benefits and explore alternative technologies.
- Support the Medallion, Circle of Safety, and Alaska Flight Service Safety programs.

Circle of Safety Handbook



- "According to 'Alaska CFIT Accidents'[3] between 1990 and 1998 aviation accidents in Alaska caused 100 occupational pilot deaths. This is equivalent to an occupational fatality rate of 430/100,000/year, approximately 86 times the occupational fatality rate for all workers in the United States[4] and nearly five times the national fatality rate for all commercial pilots.[5] Additionally, this is almost 24 times the rate for other Alaskan workers,[6] making flying the highest-risk occupation in Alaska."

Circle of Safety
Appendix F

- "The high occupational pilot fatality rate in Alaska and the high fatality rate associated with CFIT crashes reinforce the importance of addressing this type of crash and examining the associated risk factors. Understanding all the factors that result in a pilot flying a properly functioning aircraft into terrain could help in the design of appropriate interventions at multiple levels within aviation and ultimately result in the reduction of commercial aviation fatalities. "

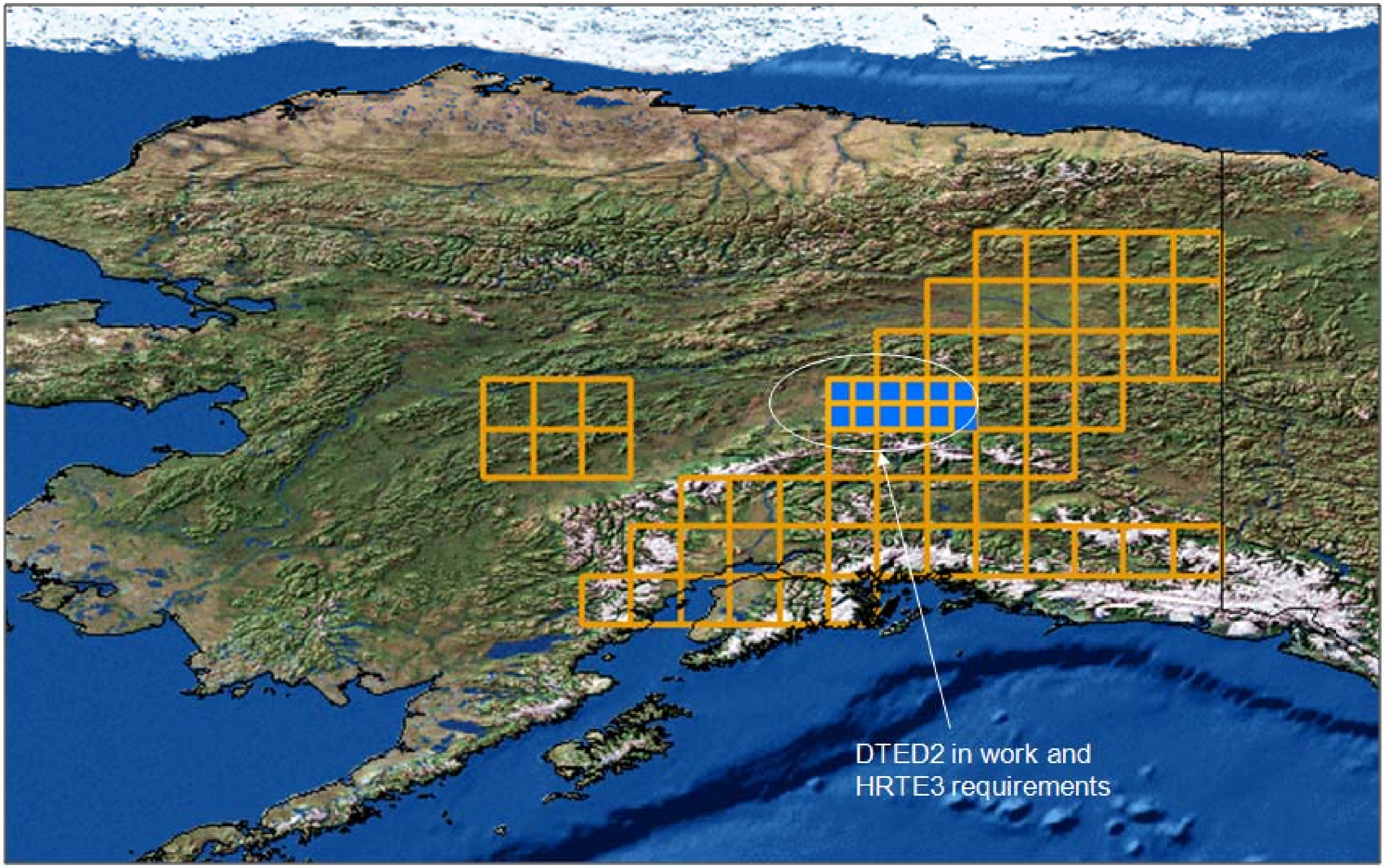
- "Most CFIT crashes are attributed to "pilot error" … These crashes occur when failures occur at all levels, and backup safeguards are inadequate, resulting in the pilot flying the aircraft into a situation in which he is not aware of his surroundings."
- **ICAO Area 1 and Area 2 eTOD standards were developed to minimize the risk of CFIT crashes, and Alaska is the only state currently in non- compliance with these ICAO requirements.**

National Geospatial-Intelligence Agency (NGA)

On February 11, 2009, Dave and Phil met with and briefed:

- Steve Wallach, Technical Executive
- Scott Robertson, Chief of Staff, Technical Executive
- William Mullen, Staff Officer, Office of the Technical Executive
- Laura Wright Hall, Staff Officer, Office of the Technical Executive
- Jane Dickerson, Deputy Director, Office of Americas
- Barry Heady, Source Assessment & Global Foundation Group
- Joseph Purk, Deputy Director, Aeronautical Services
- Kraig Harms, SRTM DTED Program Manager
- Dale Hutchinson, NORTHCOM

DTED2 Requirements: NORTHCOM, Army and Air Force



ICAO Area 2 Requirements Compared with DTED Level 2

	ICAO Area 2 Standards	DTED Level 2
Post Spacing	1-arc-second (≈30 meters) latitude & longitude	1-arc-second (latitude) 2-4 arc-seconds (longitude)[1]
Vertical Accuracy (LE90)	3 meters	18 meters
Equivalent Contour Interval	6 meters (20 ft)	36 meters (118 ft)
Vertical Resolution	0.1 meter	1 meter
Horizontal Accuracy (CE90)	5 meters	23 meters
Confidence Level	90%	90%

[1] DTED2 has variable post spacing north of 50° North Latitude

[2] NGA states that accuracy values listed for DTED1, DTED2 and DETE3 are specification accuracy. The actual absolute accuracy varies, based on when it was produced and the source/method used. For example, the absolute vertical accuracy of DTED2 ranges from 8-34 meters (LE90), compared with 18 meter specification accuracy for DTED2. DTED2 produced from good stereo imagery is believed to be nearer the better end of the range specified here, i.e., closer to an LE90 of 8 meters (16 meter or 50-foot contour accuracy)

Take Aways

- **Wide variety of DTED – Levels 1 and 2 data available over Alaska**
  - Various sources
  - Working with USGS to ensure best data is made available
- **Limited NGA requirements for DTED over Alaska**
  - 54 DTED 2 cells
  - 12 DTED 3 quarter cells
  - Working to produce through contract production
- **Initial results show artifacts in Aster DEM data**
  - Working with USGS, evaluating 270+ cells OCONUS
  - Still early in evaluation

NGA Comments

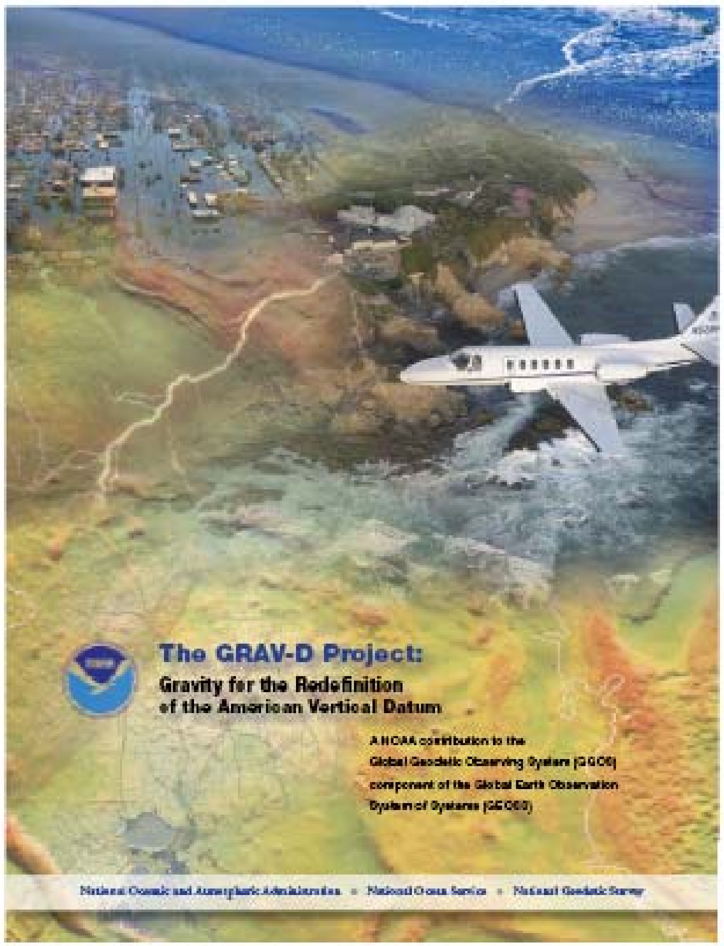
- NGA indicated that they are trying to make as much of their Alaska DTED as possible available to all users, not just the military. However, they indicated that there are some issues in NGA's DTED production from commercial satellite and/or airborne imagery that sometimes have licensing restrictions. NGA supported the idea of simultaneous acquisition of airborne IFSAR and gravity data and NGA has a desire for improved gravity data over parts of Alaska. NGA stated that they would consider partnering (pooling resources) to acquire higher resolution/accuracy DEMs and gravity data, if it did not cost more and would not delay the production and delivery of required DTED data to US Northern Command.

National Geodetic Survey (NGS)

On February 12, 2009, Dave and Phil met with and briefed:

- Juliana Blackwell, Director, NGS
- Vicki Childers, GRAV-D Project Manager (PM)
- Daniel Roman, GRAV-D/Geoid Team Lead
- Renee Shields, National Height Modernization Program PM
- Chris Parrish, Remote Sensing, Physical Scientist
- Mark Howard, Aeronautical Survey PM

The GRAV-D Project



Phase I: Testing

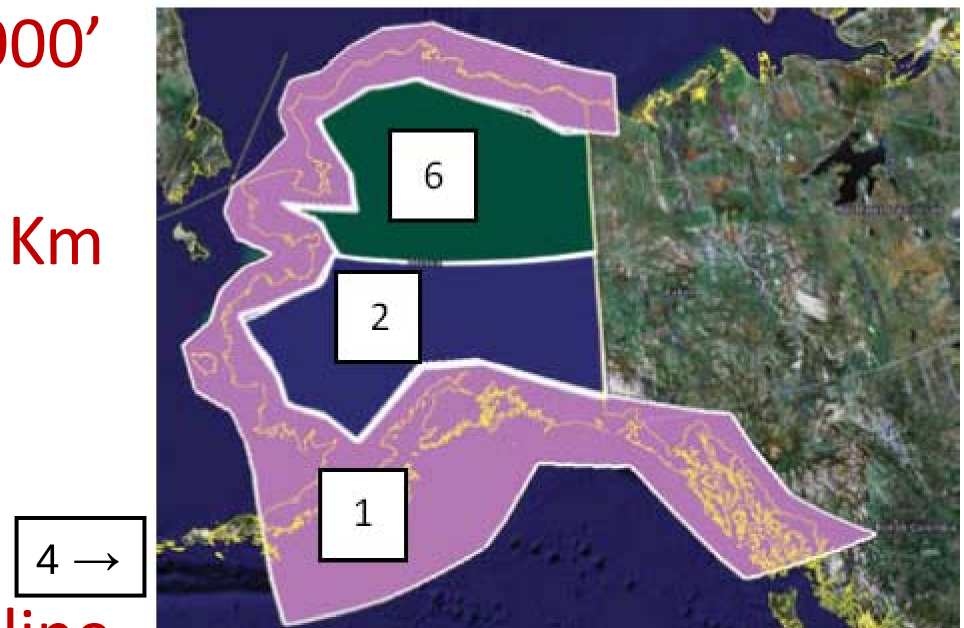
Phase II: Operational Data Collection

1. Alaskan littoral regions excluding Aleutians
2. Southern Alaska
3. CONUS littoral regions
4. Hawaii & Aleutians
5. Inland CONUS
6. Northern Alaska

Current budget request: $37M over 10 years

GRAV-D Gravity Collection Priorities

- Flying height: 35-40,000' AMT
- Flightline spacing: 10 Km
- Speed: 280 knots
- Acquire gravity an additional 150-200 Km beyond the shoreline



- Acquisition of gravity on the same aircraft as the IFSAR acquisition avoids the need for duplicate flights and saves considerable costs

U.S. Department of Agriculture (USDA)

On February 17, 2009, Dave and Phil met with and briefed:

- William Belton, USFS, Asst. Remote Sensing Program Manager
- Tommie Parham, NRCS, Director, Resources Inventory & Assessment Division
- Shirley Hall, FSA, GIS Program Manager
- Jeff Bloomquist, FSA, GIS Coordinator

USDA will attempt to obtain $3.6M in funding over 2-3 years, but would prefer 5 years.

They expect to have difficulty getting approval within USDA unless they can certify that USGS, BLM, FWS, NPS, FAA, DOD, NOAA, etc. are agreeing to fund specific amounts.

Department of Homeland Security (DHS)

On February 18, 2009, Dave Maune had a discussion with Jeff Booth, Director, Geospatial Management Office, Office of the CIO, Applied Technology, DHS who had previously seen Dave's presentation. Jeff had sent information to DHS agencies:

- Customs and Border Patrol (CBP): Alaska not an issue
- U.S. Coast Guard: Coastal areas could be of interest
- FEMA Mitigation: IFSAR has been used elsewhere for flood studies in remote areas
- Doubtful that DHS would support financially

Department of Interior (DOI)

Enterprise Geographic Information Management (EGIM)

On February 19, 2009, briefed EGIM team:

- Bob Pierce, DOI & USGS, Washington, DC
- Lee Fahrner, EGIM PMP, Washington, DC
- Lorri Peltz-Lewis, DOI & BOR, Sacramento, CA
- Jacque Fahsholtz, USGS, Boise, ID
- Debra Dinville, BLM, Denver, CO
- Tom Chatfield, BLM, Denver, CO
- David Duran, NPS, Denver, CO
- Lenny Coates, MMS, New Orleans, LA
- Chris Lett, USFWS, Denver, CO

Alaska DEM, “shovel-ready”

Obama eyes 'shovel-ready' fixes in a long recovery

Updated 12/8/2008 1:15 AM | Comments 2,455 | Recommend 58 E-mail | Save | Print | Reprints &

By Fredreka Schouten, USA TODAY

WASHINGTON — President-elect Barack Obama said Sunday that the nation's economic troubles likely will deepen, but he promised to deliver a vast government spending program to spur growth.

"Things are going to get worse before they get better," Obama said on NBC's *Meet the Press*.