High Latitude Proving Ground: Alaska experiment

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Goals of the Alaska Experiment

- improve accuracy and timeliness of forecasts and warnings (Alaska's severe weather)
- demonstrating several GOES-R baseline and Option-2 products including 1. Volcanic Ash and SO2, 2. cloud phase, 3. cloud/snow discrimination, 4. low fog and cloud, 5. snow cover (Fall 2010)
- maximize research-to-operations with feedback from WFOs, RFC, AAWU
- build relationships between each key product development team and the forecasters within the NWS Alaska region

End Users

- Weather Forecast Offices (Fairbanks, Juneau, Anchorage)
- River Forecast Center (Anchorage)
- Alaska Aviation Weather Unit (Anchorage)
- Other agency partners (National Park Service, Dept of Energy)

Example Applications

- Snow melt river flooding
- Park Service/conservation
- Hydro-electric power management
- Aviation safety
- Applied science

Volcanic Ash & SO_2

•GOES-R Volcanic Ash Products - all will be generated using MODIS in near-realtime at UAF.

•UAF will distribute the products to the Anchorage VAAC

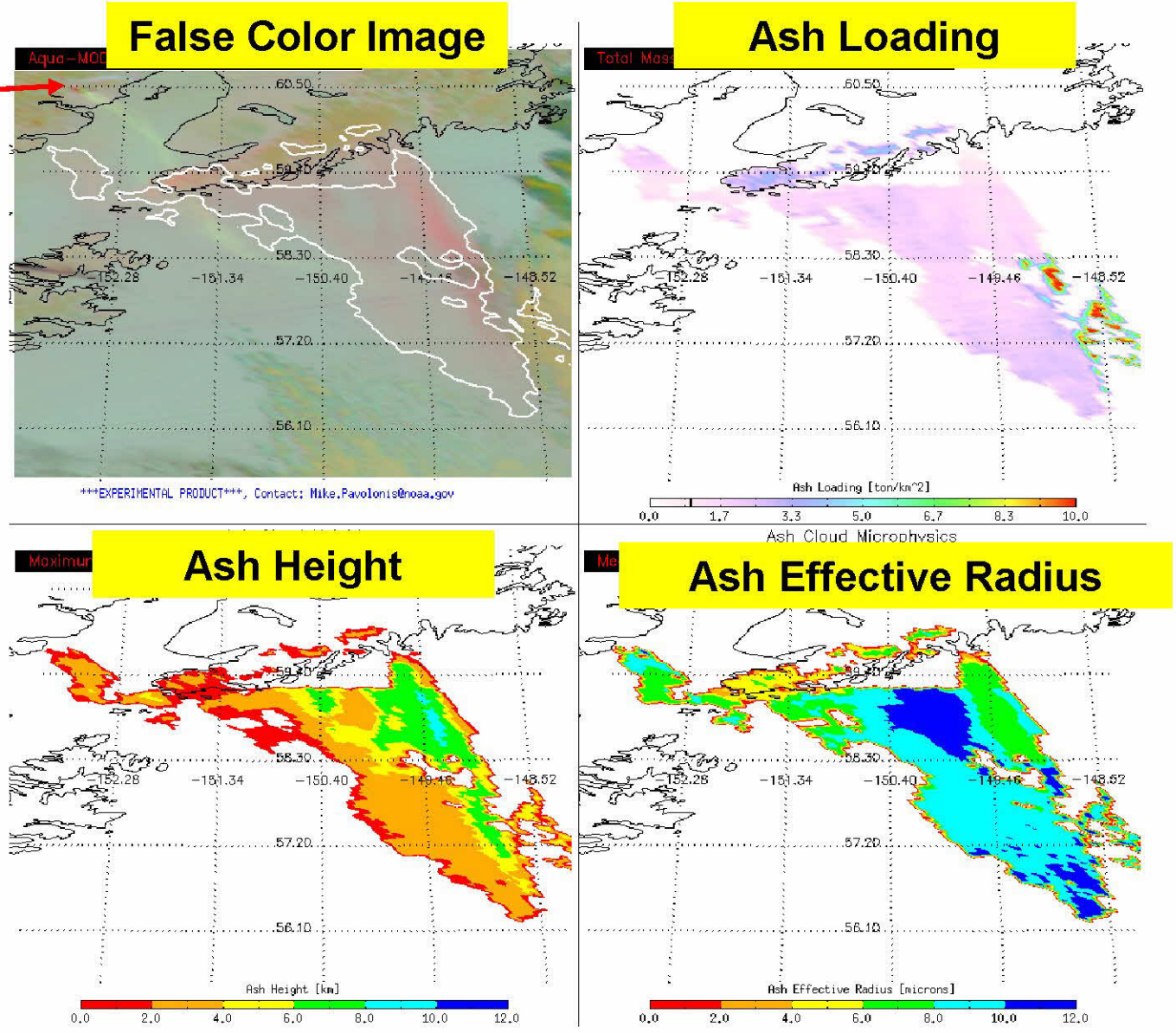
******Products are produced day and night***

Product	Accuracy Specification	Operational Significance
Ash cloud height	3 km	-Determining if ash is at cruising altitudes -Dispersion model initialization
Ash mass loading	2 ton/km^2	-Determining if ash exceeds engine tolerance (if defined) -Dispersion model initialization
Ash effective particle radius	Not a required product, but is automatically produced by retrieval algorithm	-Estimating ash fallout time -Dispersion model initialization

Example GOES-R Volcanic Ash Products

Redoubt (4/4/2009 22:35 UTC)

Redoubt



Ash Height Validation

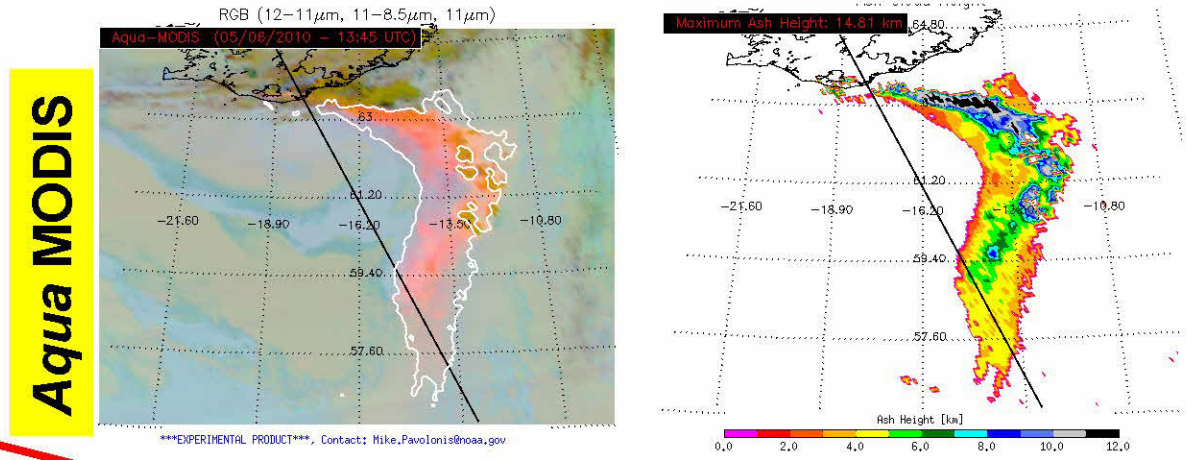
Eyjafjallajokull

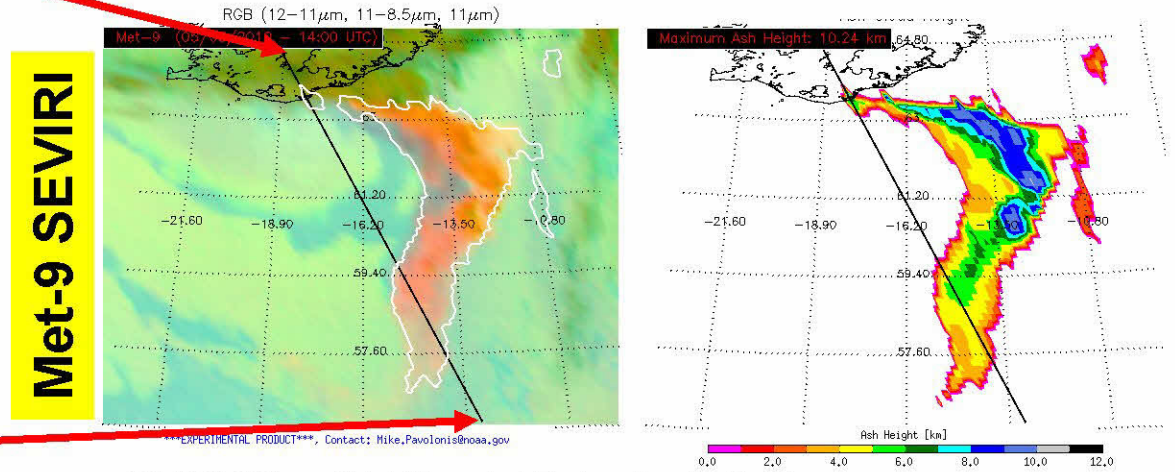
May 6, 2010 (13:45 UTC)

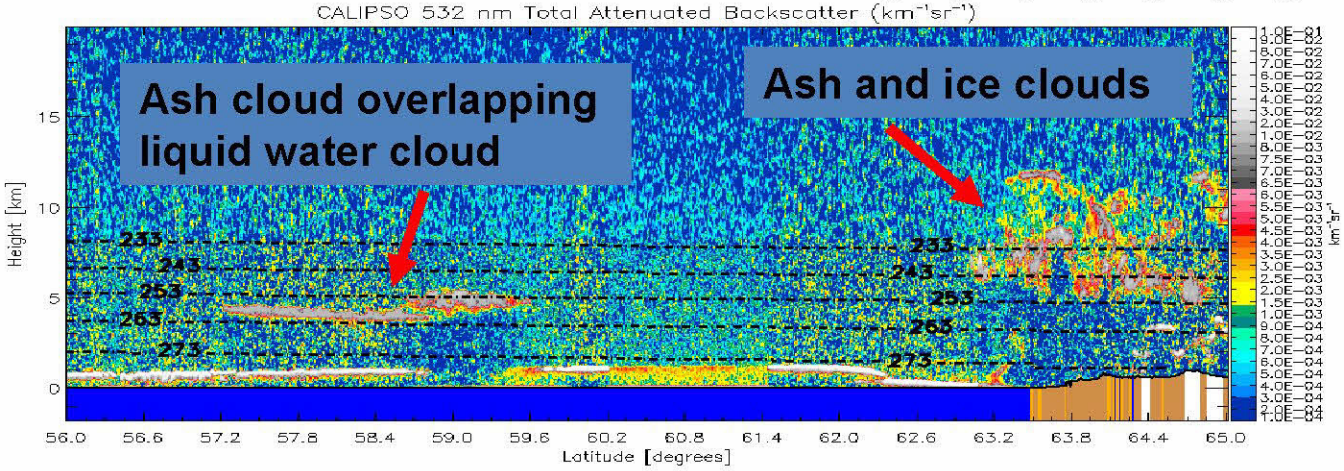
End **of CALIOP cross section**

Start **of CALIOP cross section**

CALIOP 532 nm total attenuated backscatter

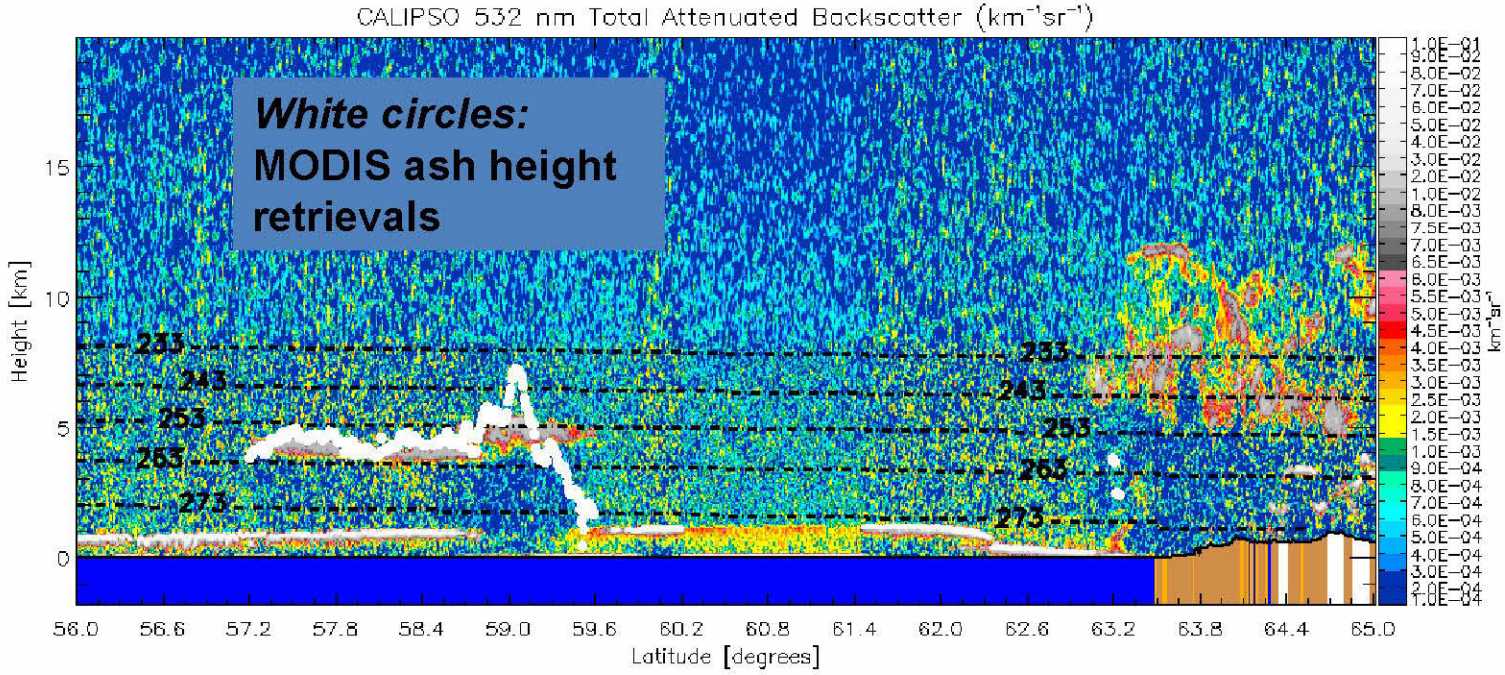




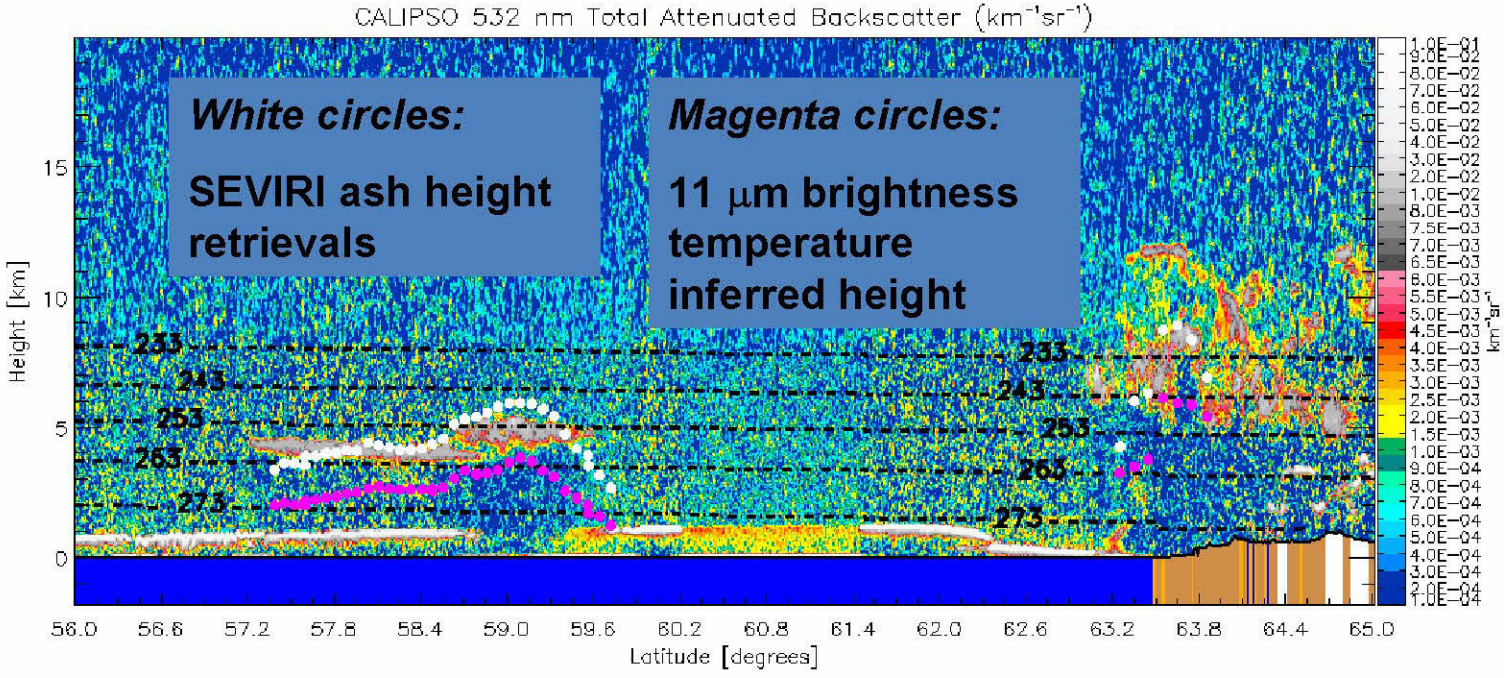


Ash Height Validation: May 6, 2010 (13:45 UTC)

Aqua MODIS



Met-9 SEVIRI



- **GOES-R SO_2 Product - will be generated using MODIS in near-realtime at UAF.**
- **UAF will distribute the product to the Anchorage VAAC**

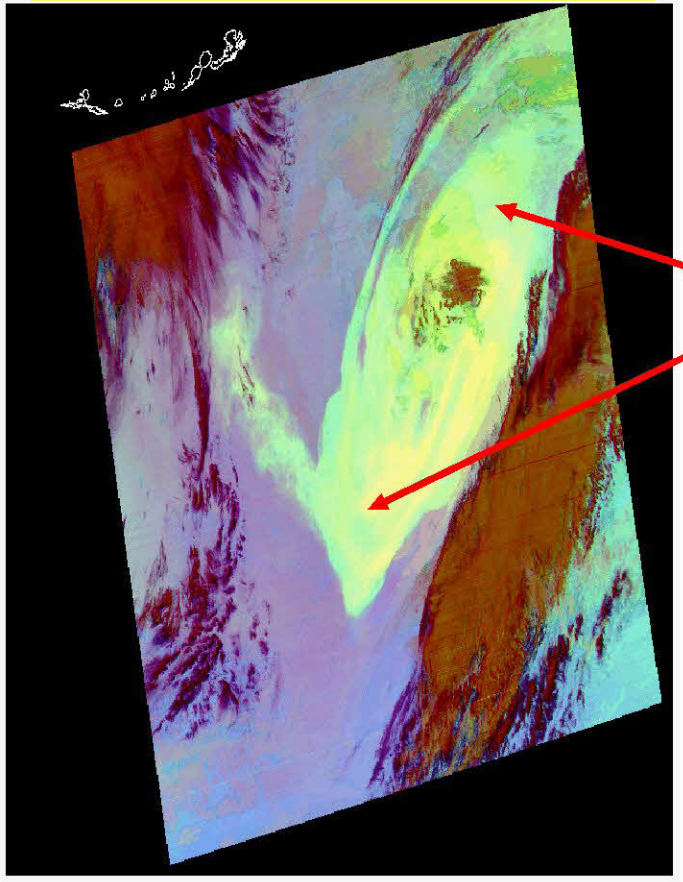
******Products are produced day and night***

Product	Accuracy Specification	Operational Significance
SO_2 Detection	70% correct detection when column loading exceeds 10 DU	-Determining if SO_2 loading in excess of 10 DU is present

Example GOES-R SO_2 Product

Kasatochi (8/9/2008, 2355 UTC)

False Color Image

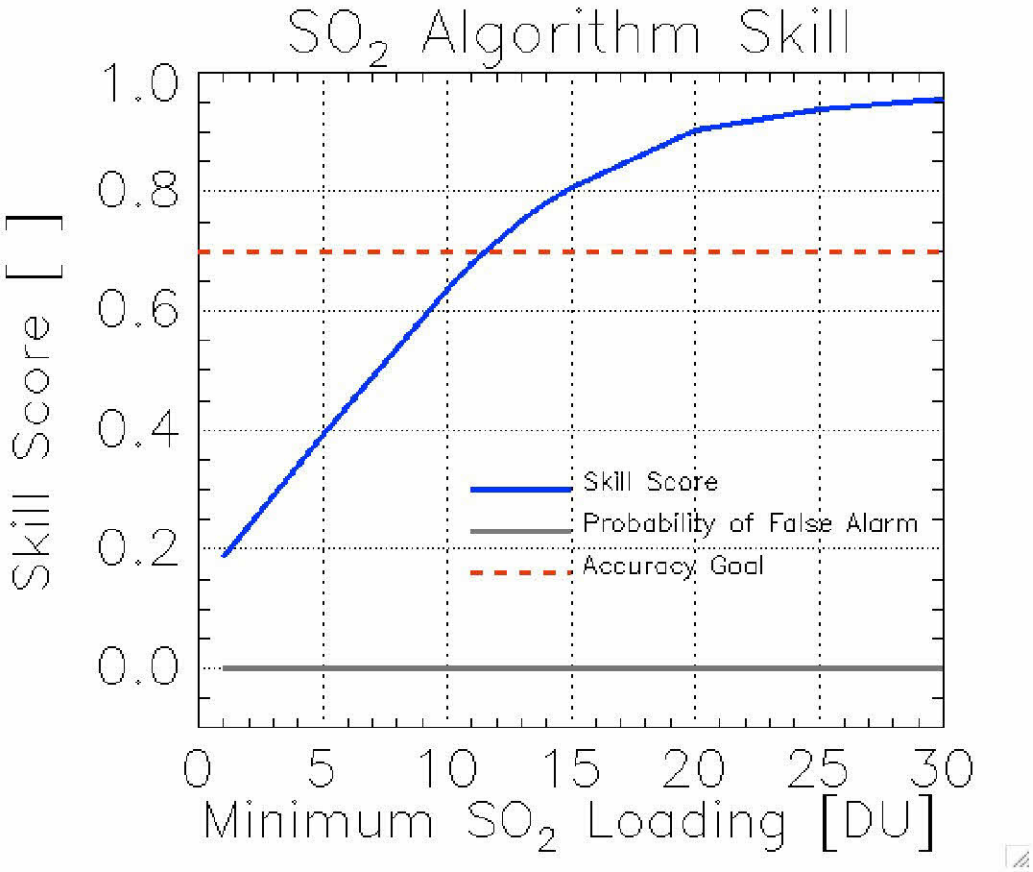


SO_2 Cloud

GOES-R SO_2 Mask

GOES-R SO_2 Validation

- The GOES-R SO_2 detection product agrees well with SO_2 detected using hyperspectral UV measurements when the SO_2 loading is 10 DU or greater.
- A skill score of 1.0 indicates perfect agreement with UV SO_2.



Cloud Phase

- liquid water, supercooled liquid water, mixed phase, and ice
- Potential applications of the cloud top phase product are (but not necessarily limited to):
  1. Assessing aircraft icing potential
  2. Assessing freezing rain/drizzle potential
  3. Diagnosing cloud top glaciation in growing cumulus clouds
  4. Diagnosing cirrus cloud cover, including cirrus which overlap lower cloud layers
- GOES-R Cloud Type product provides more detailed cloud phase information, including multi-layered cloud detection and information on ice cloud opacity.

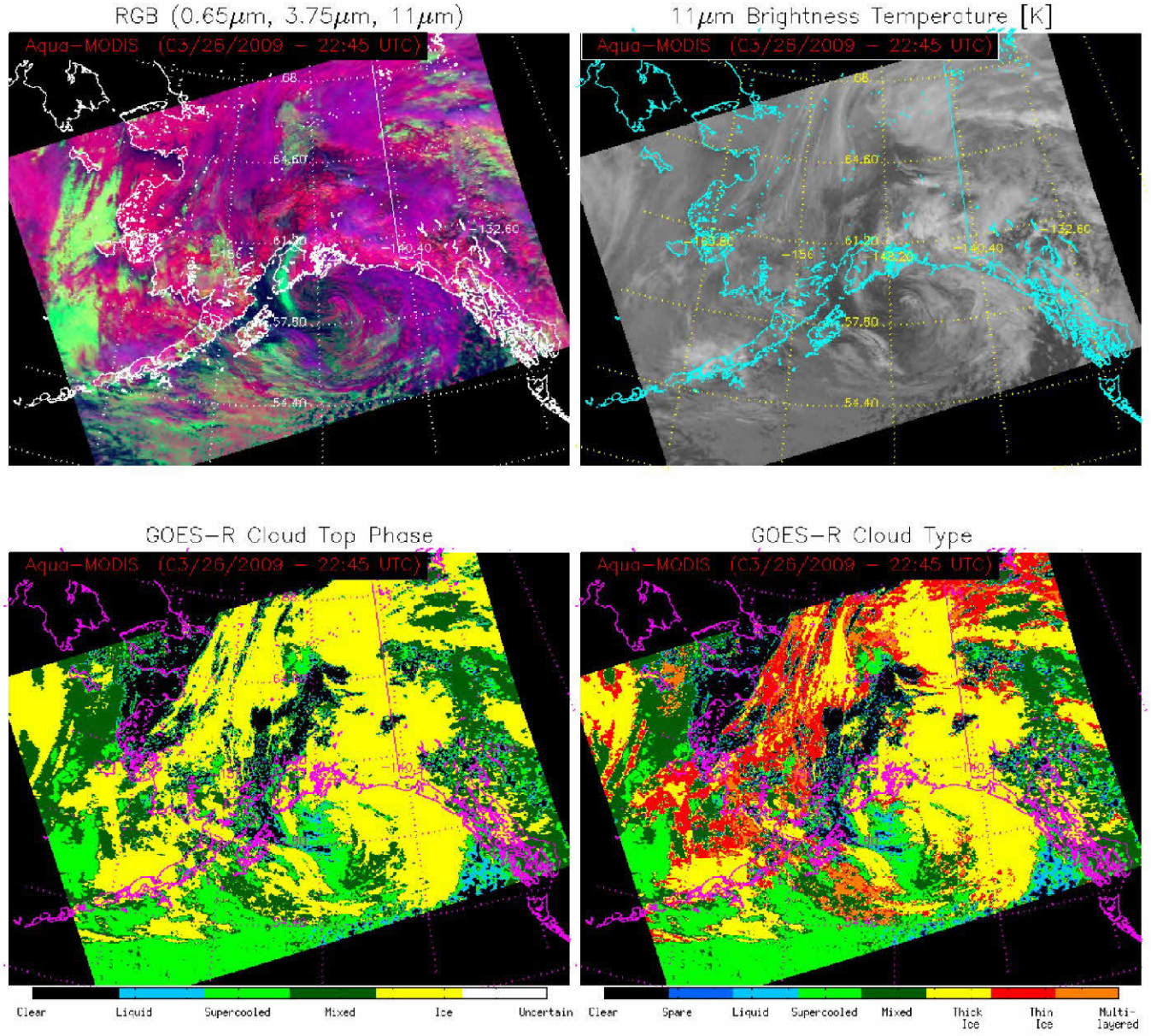


Figure 1: Example GOES-R cloud top phase and cloud type products generated using *Aqua* MODIS data from March 26, 2009 at 22:40 UTC. A false color image (top left panel), an IR image (top right panel), the GOES-R cloud phase product (bottom left panel), and the GOES-R cloud type product (bottom right panel) are shown.

Cloud/snow Discrimination

- GOES-R Advance Baseline Imager (ABI) cloud mask attempts to distinguish between cloud and snow
- The initial information on the presence of snow comes currently from the Interactive Multisensor Snow and Ice Mapping System (IMS) snow product
- when the spectral information allows, the Normalized Difference Snow Indices (NDSI) values are computed
- Thresholds are applied to these tests to reclassify IMS snow-free pixels as potentially snow covered. In the end, pixels considered to be snow covered are ignored by cloud mask tests known to be sensitive to the presence of snow. Lastly, the cloud mask performs a special daytime test over snow-covered pixels with the specific purpose of detecting water-phase clouds over snow.

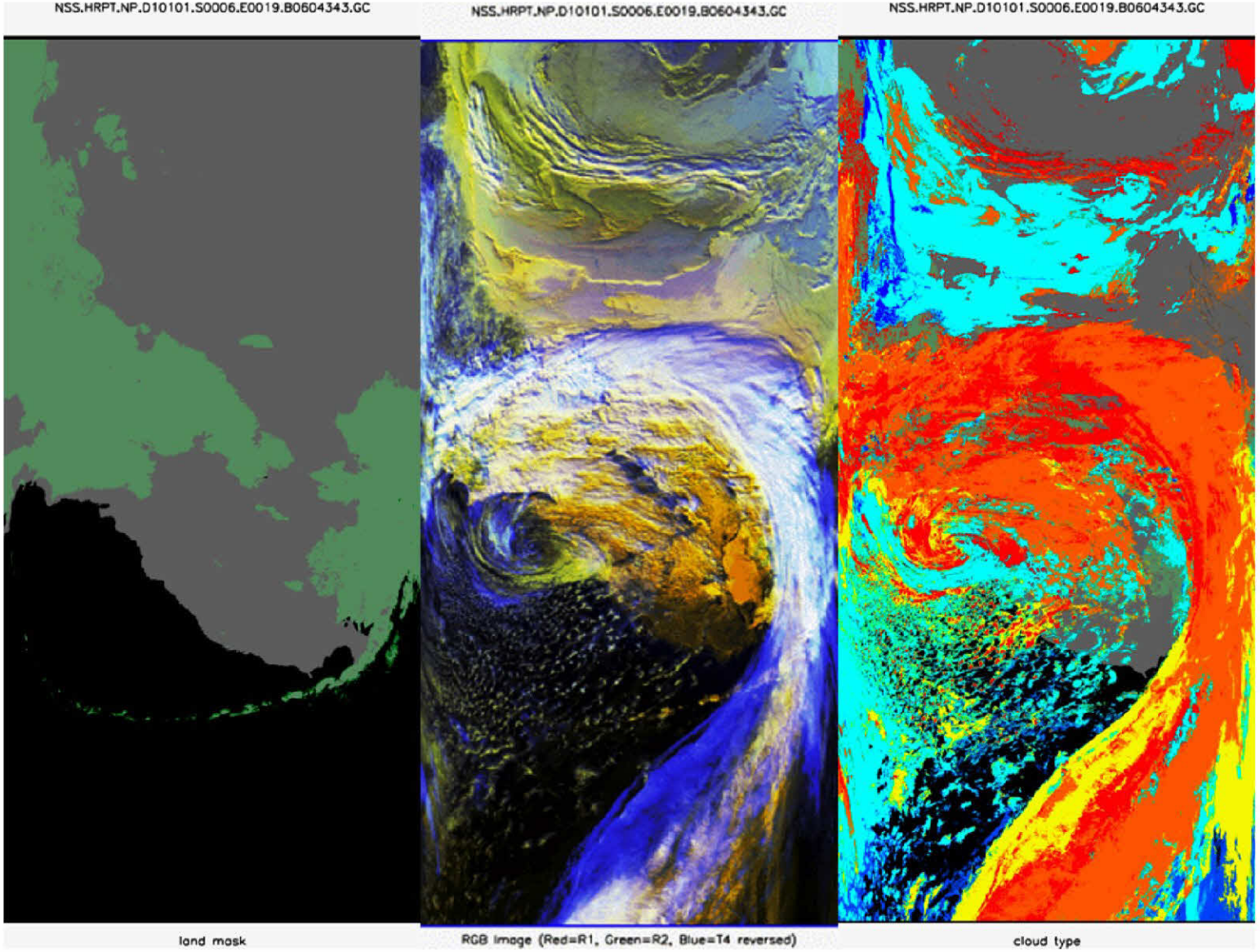


Figure 1. Example of snow/cloud discrimination in the GOES-R AWG cloud mask (here applied to AVHRR). Figure on the left shows the snow cover from IMS (grey color). The middle figure shows a false color image. Figure on the right shows a derived cloud type (water phase clouds appear in blue and green; ice phase clouds appear as yellow and orange.)

Low Fog and Cloud

- The GOES-R fog/low cloud detection product is designed to quantitatively identify clouds that produce Instrument Flight Rules (IFR) or Low Instrument Flight Rules (LIFR) conditions (ceiling < 1000 ft (305 m)). The aviation flight rule categories are defined in the table below. The GOES-R fog detection is expressed as a probability.

Table 1: Aviation flight rules

Flight Rule	**Ceiling**
Visual Flight Rules (VFR)	> 3000 ft (914 m)
Marginal Visual Flight Rules (MVFR)	1000 ft (305 m) – 3000 ft (914 m)
Instrument Flight Rules (IFR)	500 ft (152 m) – 1000 ft (305 m)
Low Instrument Flight Rules (LIFR)	< 500 ft (152 m)

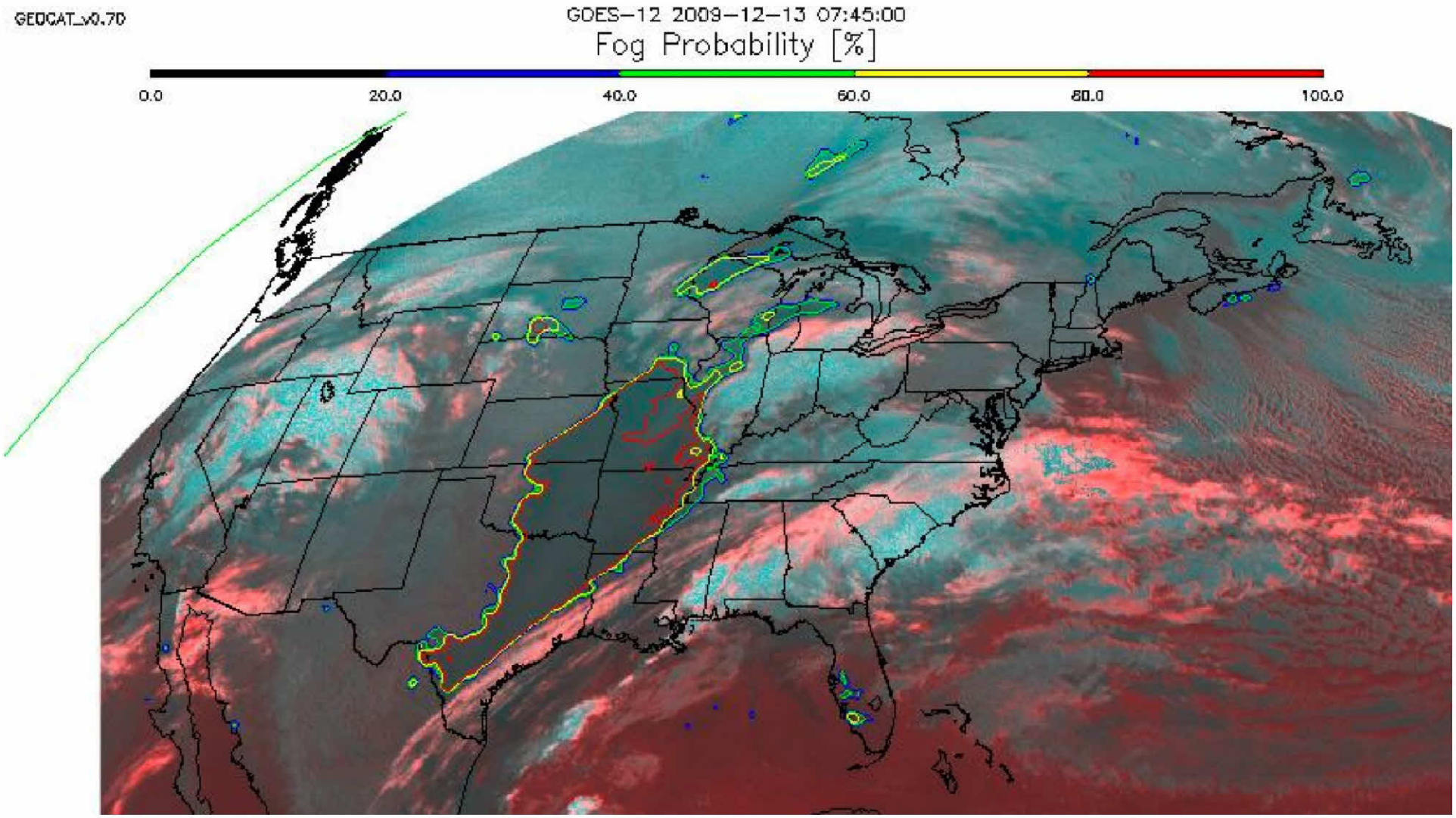
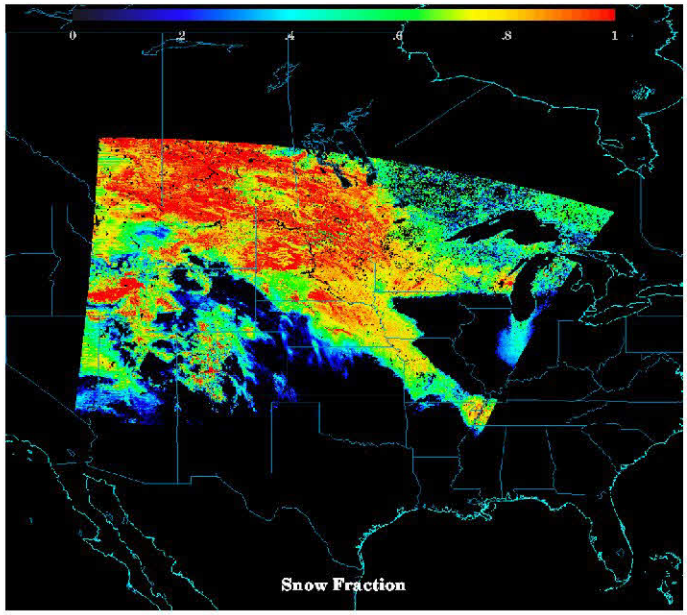


Figure 1: An example of the GOES-R fog detection product generated using GOES-12 on December 13, 2009 at 07:45 UTC. The satellite derived fog probability is denoted by the color contours overlaid on the false color image.

Snow Cover (starting Fall 2010)

- fractional snow cover (FSC) algorithm for GOES-R, called "GOESRSCAG" (GOES-R Snow Covered Area and Grain size)
- support forecasts, RFC, and climate



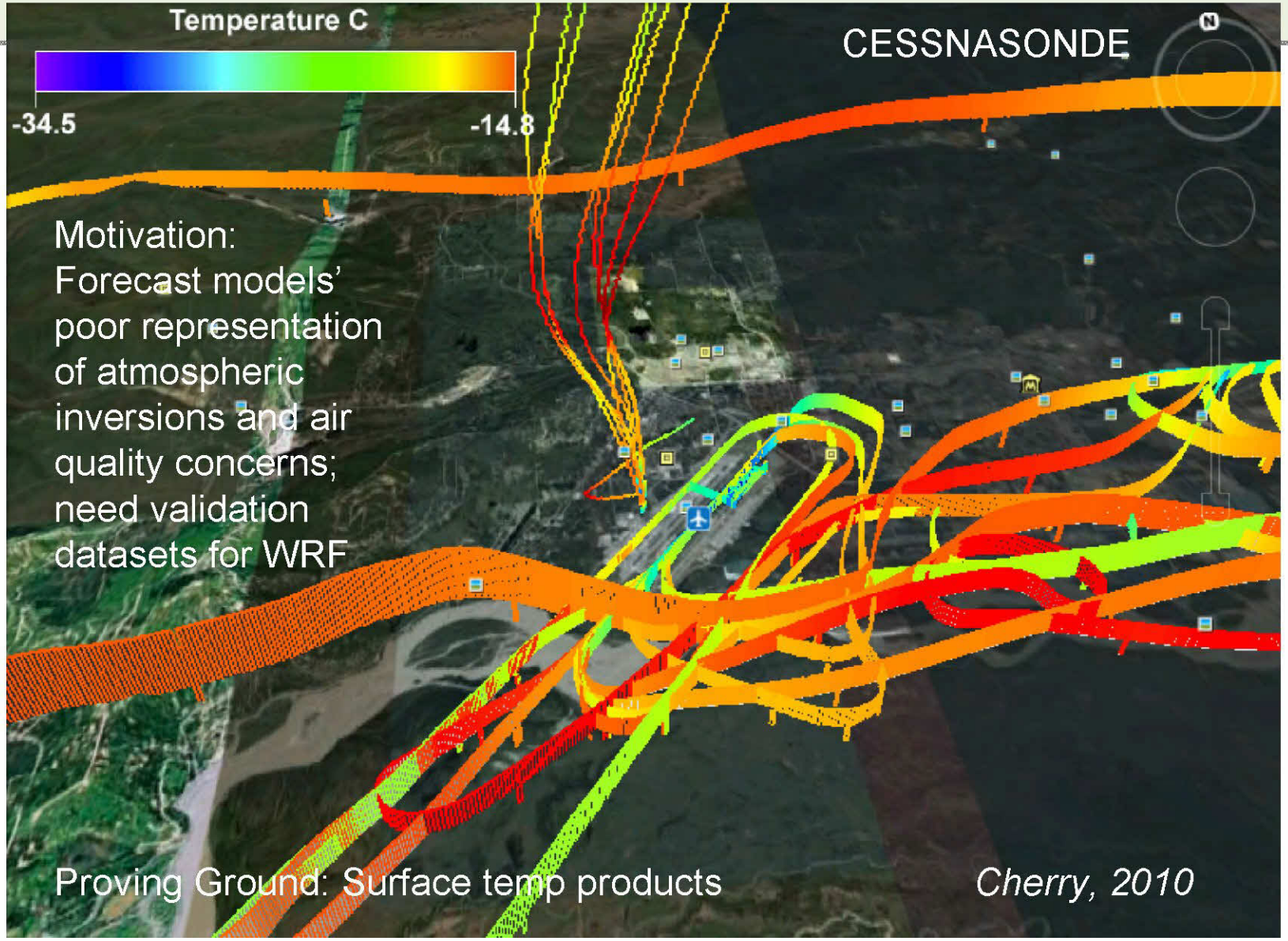
GOESRSCAG processing of proxy ABI data from MODIS, March 1, 2009

Applied Science Components

- Leveraging partnerships between NESDIS, WFO, River Forecast Center, University of Alaska Fairbanks (UAF), Alaska Aviation Weather Unit, and Geographic Information Network for Alaska (GINA)
- Examples: Inversion forecasting, North Slope Tundra Travel forecasting/nowcasting, Cold Mountain Hydropower seasonal forecasting, Weather and Ash nowcast reports in the Cockpit, physics behind hydrology change

Applied Science Components

Inversion study with SCEP masters' student



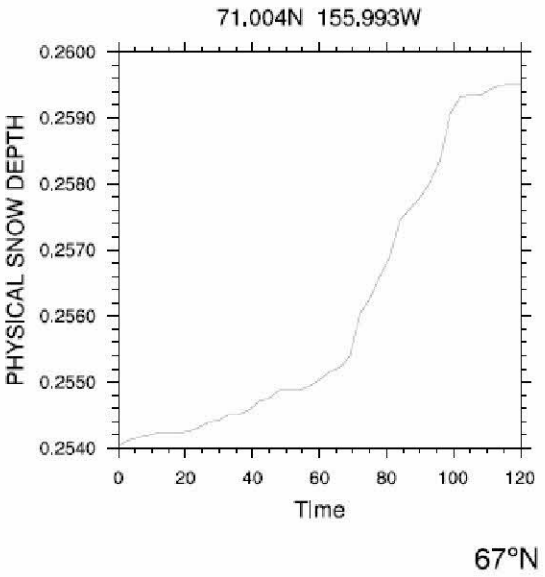
Applied Science Components

WRF snow modeling project with Civil Eng masters' student

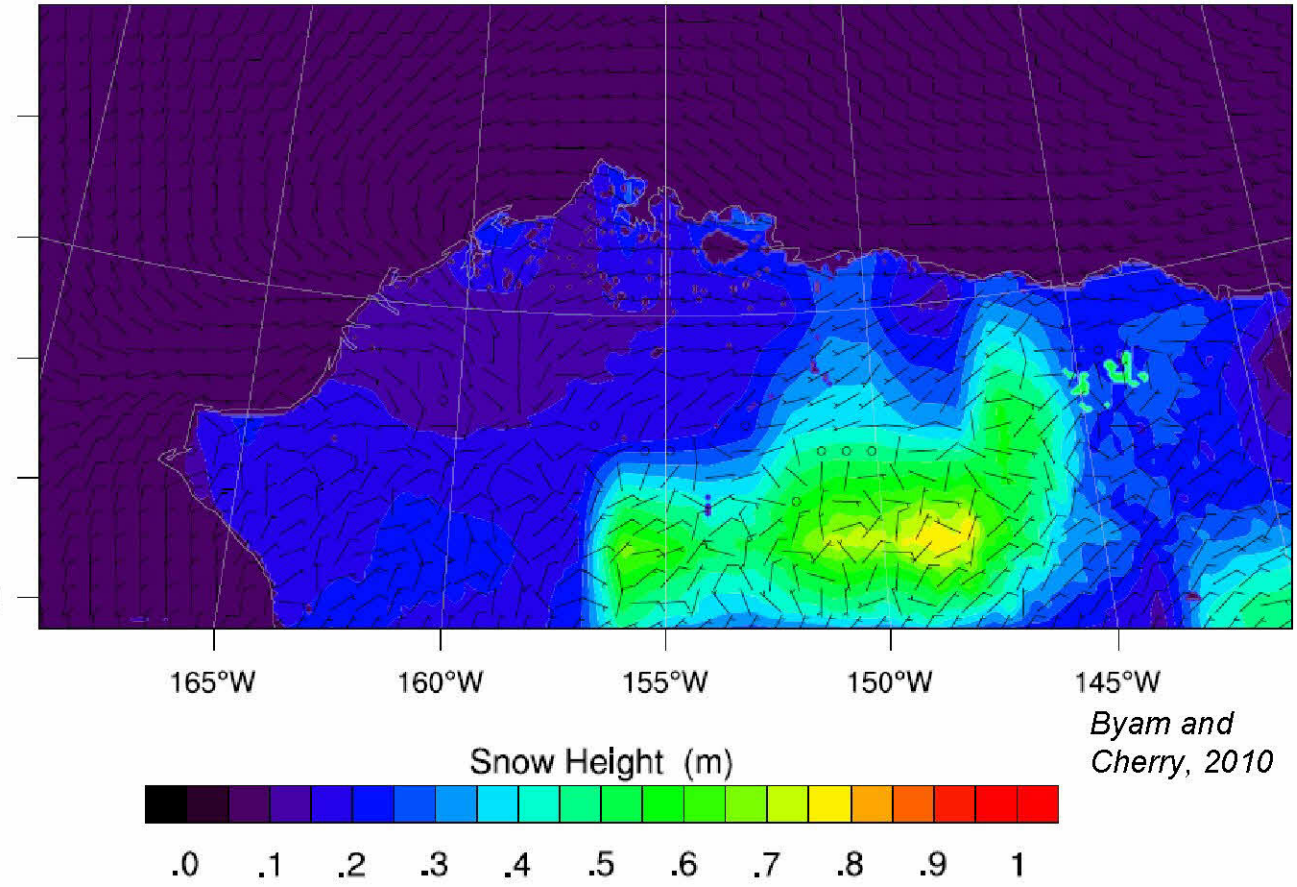
Proving Ground: Surface snow and wind products

Applied Science Components

WRF snow modeling project with Civil Eng masters' student



Observed depth at this site: d_{snow} = 0.2286 m



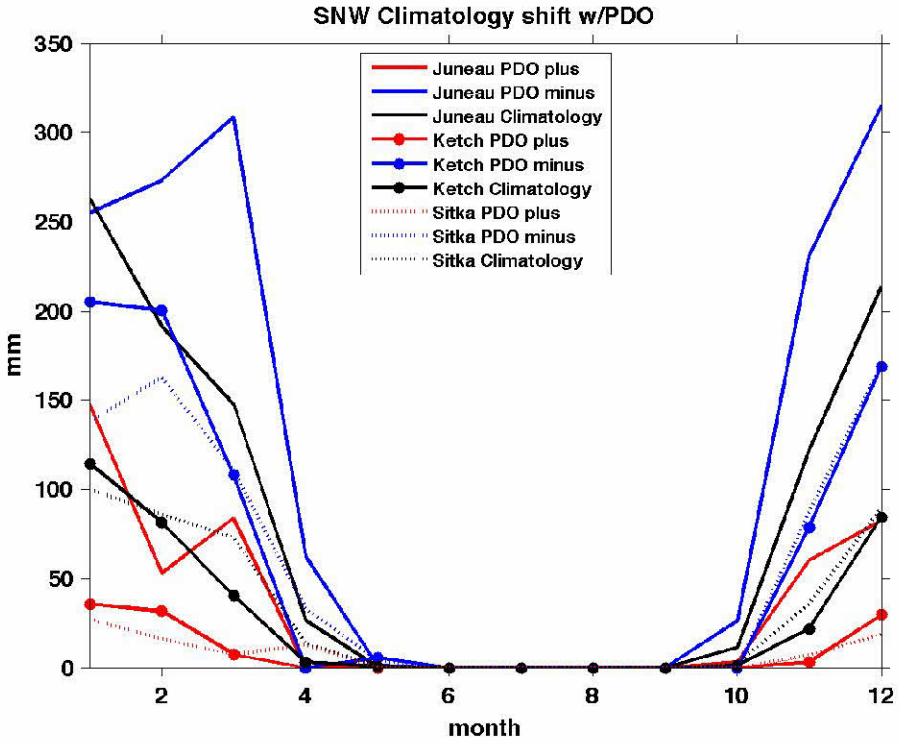
Byam and Cherry, 2010

Evaluating snow distributions in NOAH and RUC LSMs in WRF, compared to in situ networks; driving blowing snow model with WRF (w/CIRA)

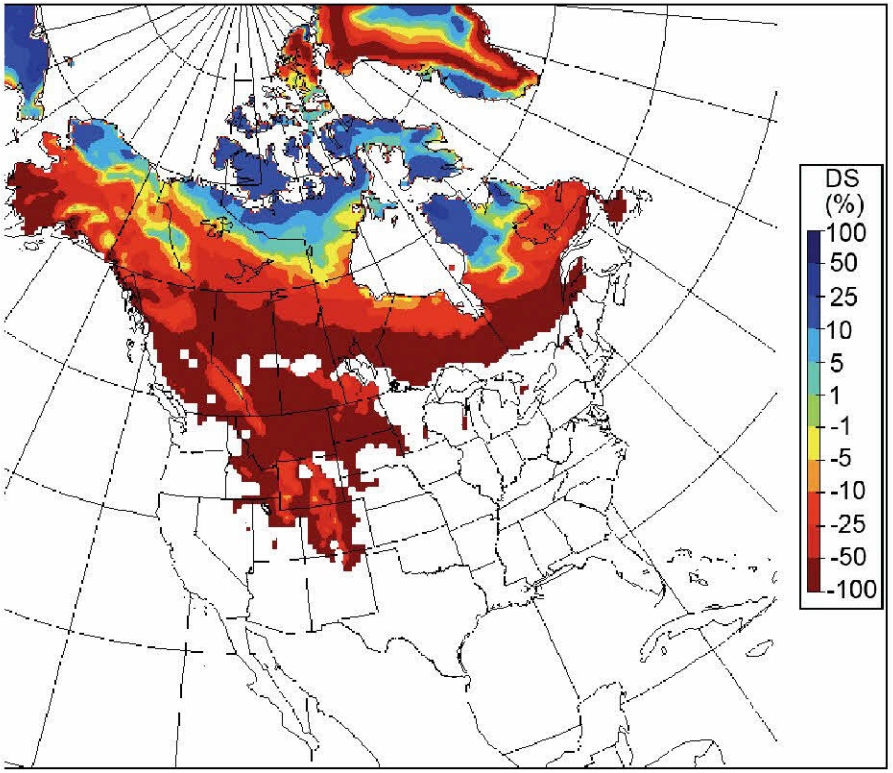
Applied Science Components

Snow hydrology modeling & assimilation project with Civil Eng PhD student

Builds on our NOAA-NMFS funded study on the Impacts of Climate Variability and Change



Cherry, et al. 2010



IPCC, 2007 (AR4)

Plans to scope GOES-R snow cover product for SEAK, collaboration w/CIRA

Applied Science Components

New Collaboration w/Peter Webley, Alaska Volcano Observatory

Improving Weather and Ash information in the cockpit for General Aviation (even the small guys/gals)

Applied Science Components

Physics Behind Long-term Changes in Flood & Drought Frequencies

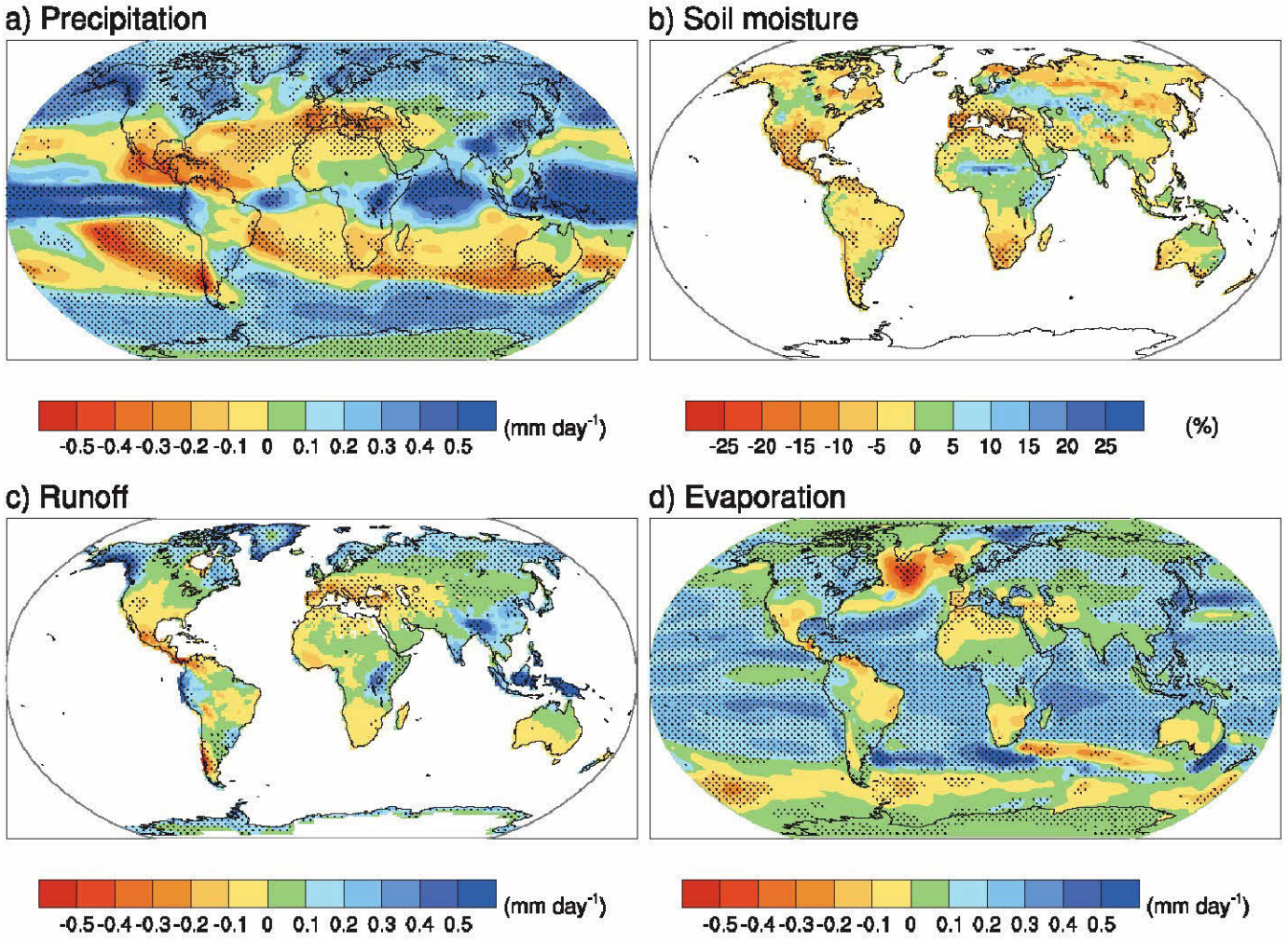
Major changes in the Arctic water cycle

- Thawing permafrost, glaciers
- Changes in Subsurface storage
- Changes in large-scale atmospheric transport
- Changes in moisture fluxes associated with the opening of the sea ice pack
- Changes in vegetation types that affect ET & fractionation of isotopes
- Changes in summertime water recycling patterns associated with land surface drying, which is associated with changes in permafrost

AK RFC, 2009

Applied Science Components

Physics Behind Long-term Changes in Flood & Drought Frequencies



IPCC projected water cycle changes (missing permafrost, glacier, dynamic veg feedbacks)

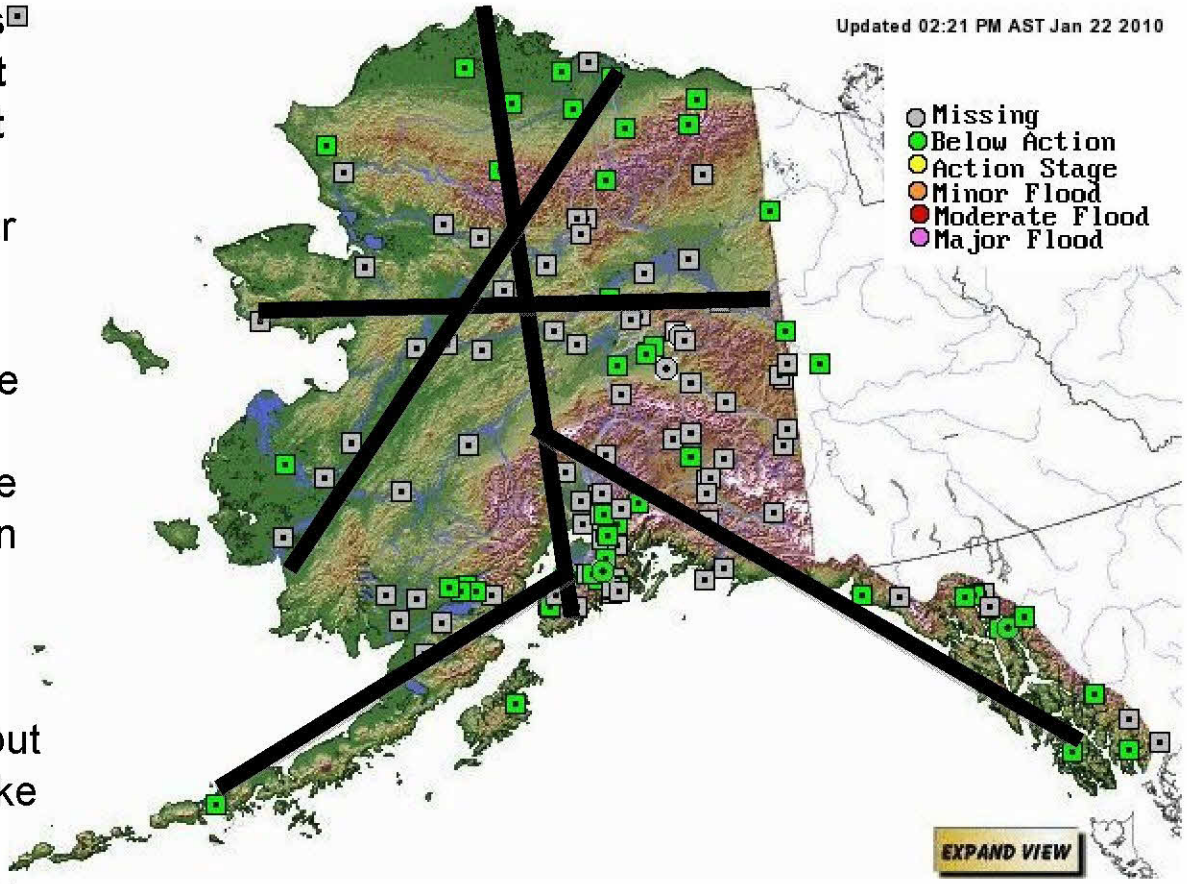
Meehl et al., 2007

Applied Science Components

Physics Behind Long-term Changes in Flood & Drought Frequencies

PACMAN NSF-funded Project is an AK-HI collaboration aimed at water science and management

- Creation of water isotope atlas for the state by flying a water vapor analyzer on an aircraft
- Science questions are the source regions for precipitation, water budgets of surface waters, and the role of different types of vegetation in fractionating isotopes
- Parallel study by David Noone's group for Hawaii
- Stable isotopes have now been put into some of the climate models like CCSM
- Existing map of water isotopes for surface water bodies in AK



NWS RFC Alaska-Pacific

Proving Ground product: Total Precipitable Water

Applied Science Components

- Upcoming American Meteorology Society Polar meetings:
  - Boston, May 2011
  - ?, 2013
- Proving Ground special session?

Organizations
Roles and Responsibilities

- UAF/GINA/CIFAR = real-time capture, process, and distribute satellite products
- UW/CIMSS, CU/CIRA = provide algorithms, guidance, and interaction
- High Latitude Proving Ground Coordinator = liaison, feedback
- NWS Forecasters: WFOs, River Forecast Center, Alaska Aviation Weather Unit = test and evaluation

Schedule

- Begin March 2010
  - Identify products
  - Identify AWG Leads
- Begin April-May 2010
  - Draft an Operations Plan
  - Ak receive and integrate GOES-R algorithms
- Begin June-July-August 2010
  - Produce demonstration products
  - Distribute products
  - Capture and provide Forecaster and user feedback
- Begin next experiment Oct 2010

Day in the life of the Experiment

- GINA captures, processes, products real-time using AWG algorithms
- GINA provides products to Fairbanks WFO
- Fairbanks WFO loads products into AWIPS system
- Products available for integration into the forecast process
- SOO/DOH maintain records of evaluation/saves some events for case studies
- SOO/DOH provides evaluations to the liaison

Problems/Issues/Discussion

- Some developers prefer to process and distribute their product for a period of time before handing off capture, processing to GINA

- Training material for forecasters sometimes available sometimes not

- Desire to develop a regional product (i.e. plains snow depth adapted to North Slope tundra)

- Eight bit restriction of AWIPS I; full migration to AWIPS 2

- Sparse 'Ground truth' sites, of those that exist, some are in UAF network, not NWS, associated liability