



# The GOES-R AWG Cloud Top Phase Product

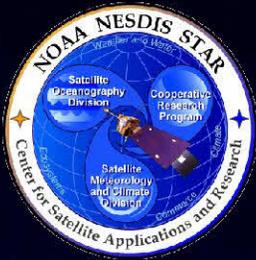
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**Justin Sieglaff (UW-CIMSS)**



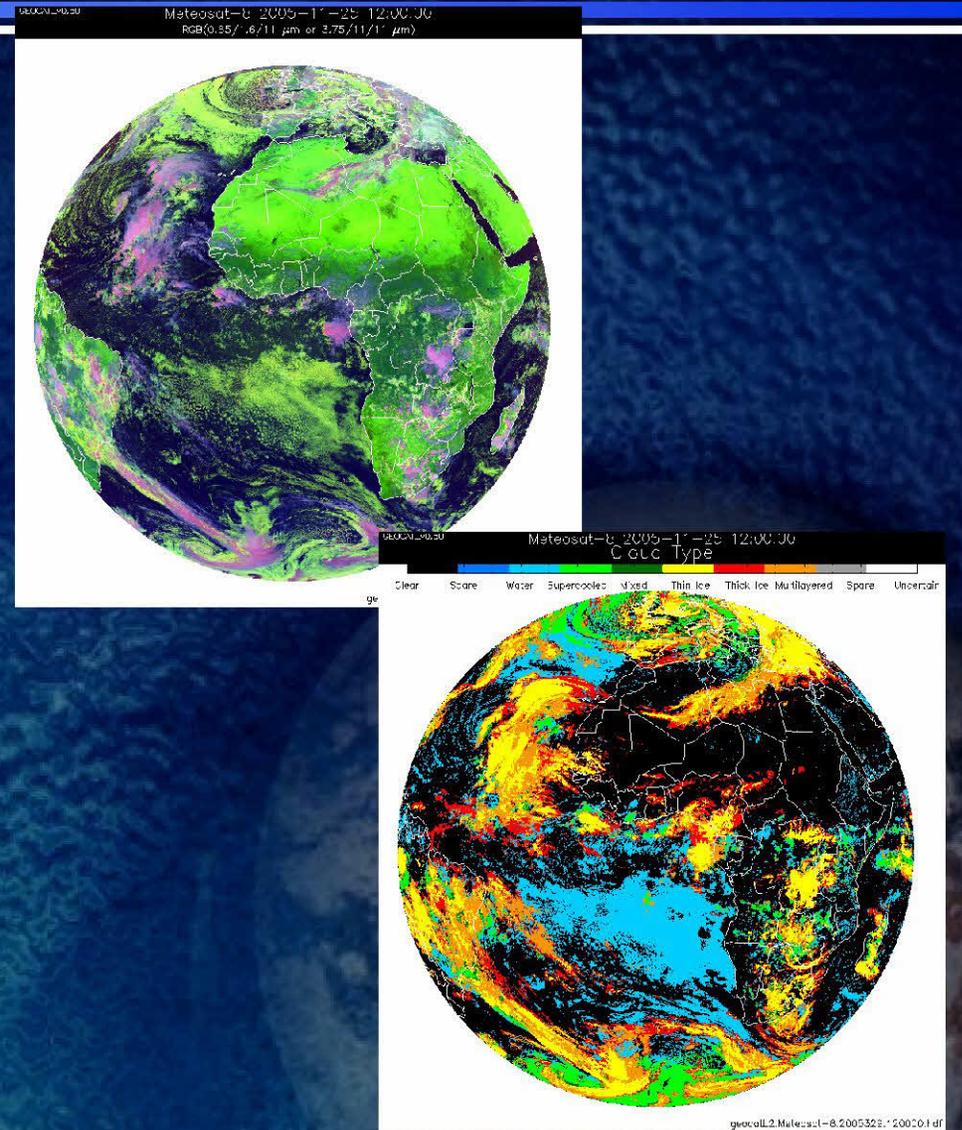
# Outline

- **Introduction to the GOES-R AWG Cloud Top Phase and Cloud Type Products**
- **Known Limitations**
- **Examples**
- **PG Plans**



# Algorithm Summary

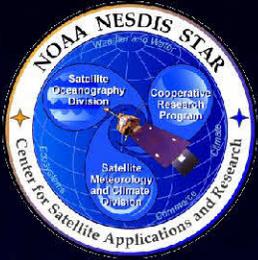
- Only infrared channels (7.3, 8.5, 11, and 12  $\mu\text{m}$ ) are used so the results are consistent day and night.
- Effective absorption optical depth ratios ( $\beta$ -ratios) are used to determine cloud type (liquid water, supercooled liquid water, mixed phase, opaque ice, semi-transparent ice, and multilayered clouds) (e.g. Pavolonis 2010).
- The cloud phase (liquid water, supercooled liquid water, mixed phase, and ice) is determined from the cloud type output (ice = opaque ice, semi-transparent ice, and multilayered clouds).





# Algorithm Output (cloud phase)

Category	Description	Value
Clear	Clear cloud mask output	0
Liquid Water	Liquid water clouds with a temperature $> 273$ K	1
Supercooled Water	Liquid water cloud with temperature $< 273$ K	2
Mixed Phase	High probability of containing both ice and liquid water near cloud top	3
Ice	All ice topped clouds	4



# Algorithm Output (cloud type)

Category	Description	Value
Clear	Clear cloud mask output	0
Spare	Spare category	1
Liquid Water	Liquid water clouds with a temperature $> 273$ K	2
Supercooled Water	Liquid water cloud with temperature $< 273$ K	3
Mixed Phase	High probability of containing both ice and liquid water near cloud top	4
Optically Thick Ice	Opaque clouds with glaciated cloud tops	5
Optically Thin Ice	Optically thin clouds composed entirely of ice	6
Multilayered Ice	Semi-transparent ice cloud overlapping a lower, opaque cloud layer	7

# Primary Limitations

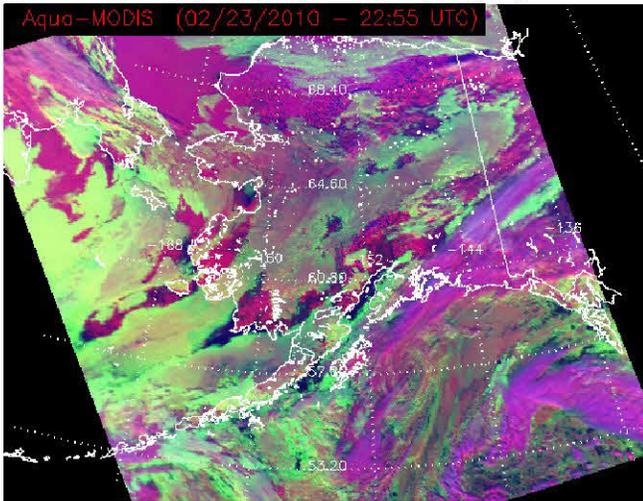
- **Only the cloud phase of the highest cloud layer can be determined.**
- **Optically thin supercooled liquid water and mixed phase clouds may be misclassified as warm liquid water clouds.**
- **Very small scale shallow cumulus fields (sub-pixel in nature) may be misclassified as thin ice.**

# Cloud Top Phase Applications

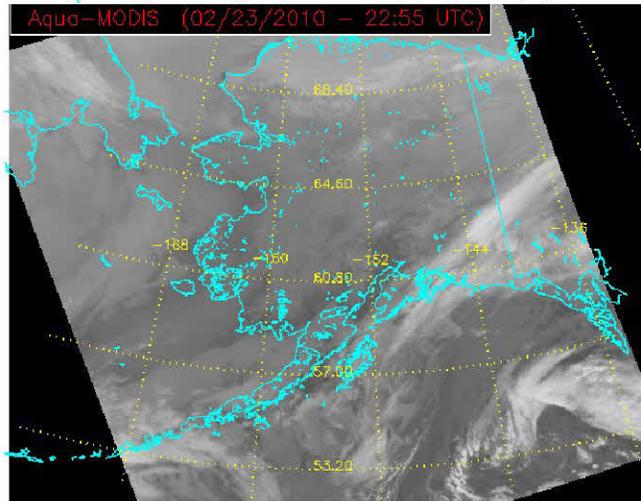
- The cloud top phase and cloud type products can aid in interpreting complex cloud systems.
- The cloud phase algorithm is needed by the cloud height, cloud optical properties, fog, and aircraft icing algorithms.
- The cloud phase product can be used to put the icing product into context (aid in interpretation).
- Assess freezing rain/drizzle potential and seeder feeder potential
- Diagnose cloud top glaciation in growing cumulus clouds

# Aqua-MODIS (February 23, 2010, 22:50 - 22:55 UTC)

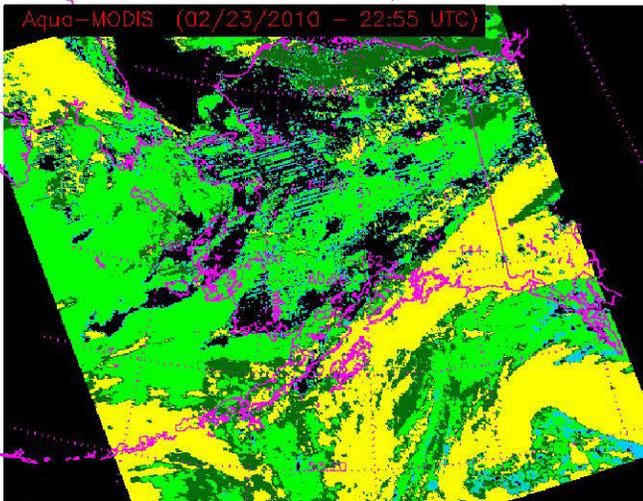
RGB (0.65 $\mu\text{m}$ , 3.75 $\mu\text{m}$ , 11 $\mu\text{m}$ )



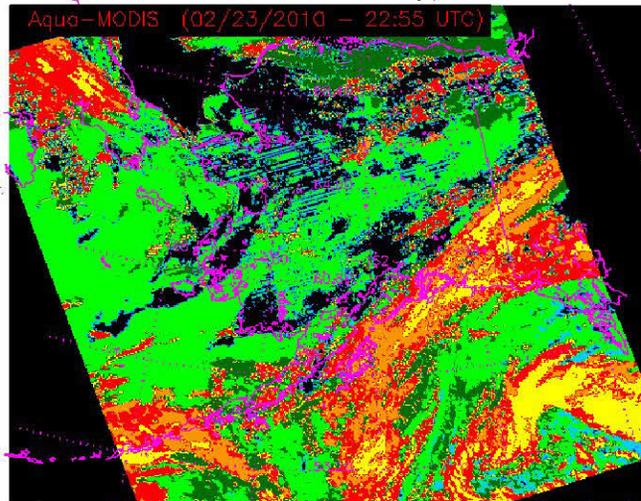
11 $\mu\text{m}$  Brightness Temperature [K]



GOES-R Cloud Top Phase



GOES-R Cloud Type

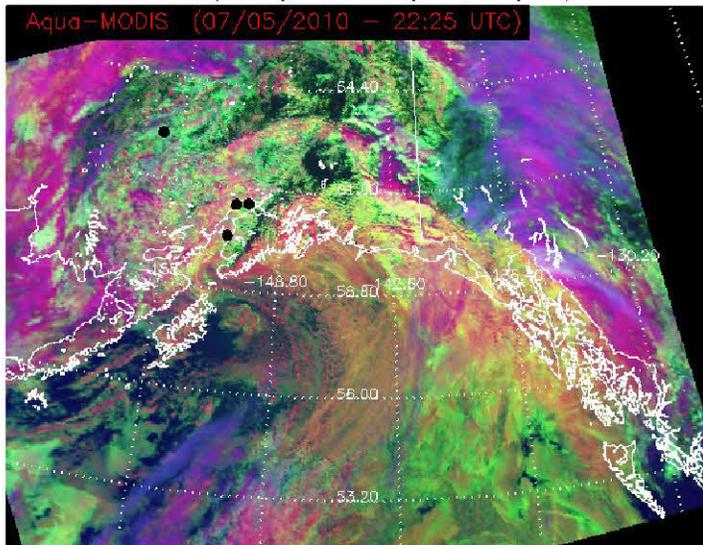


Clear Liquid Supercooled Mixed Ice Uncertain Clear Sparse Liquid Supercooled Mixed Thick Ice Thin Ice Multi-layered

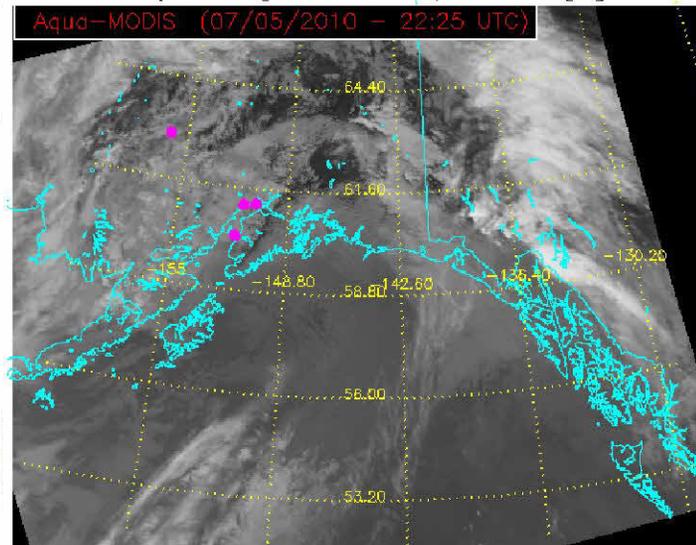
- More often than not, the Alaska region is dominated by complex cloud systems.
- The GOES-R cloud phase/type products can aid in interpreting satellite imagery

# Aqua-MODIS (July 05, 2010, 22:25 UTC)

RGB (0.65 $\mu$ m, 3.75 $\mu$ m, 11 $\mu$ m)

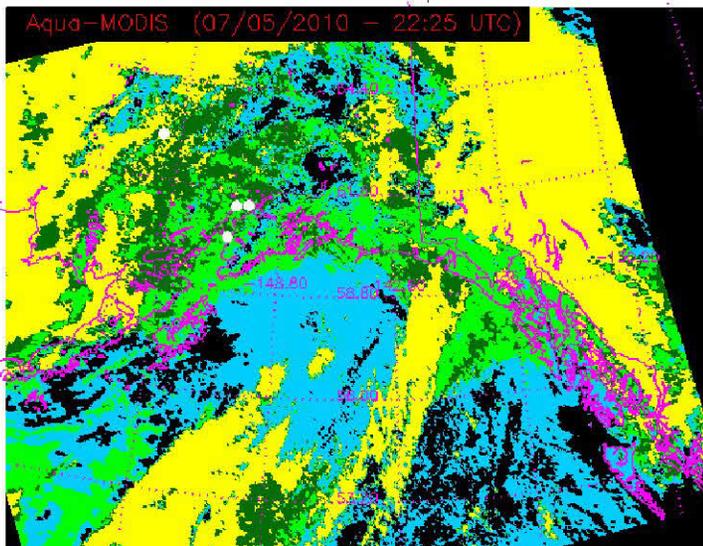


11 $\mu$ m Brightness Temperature [K]



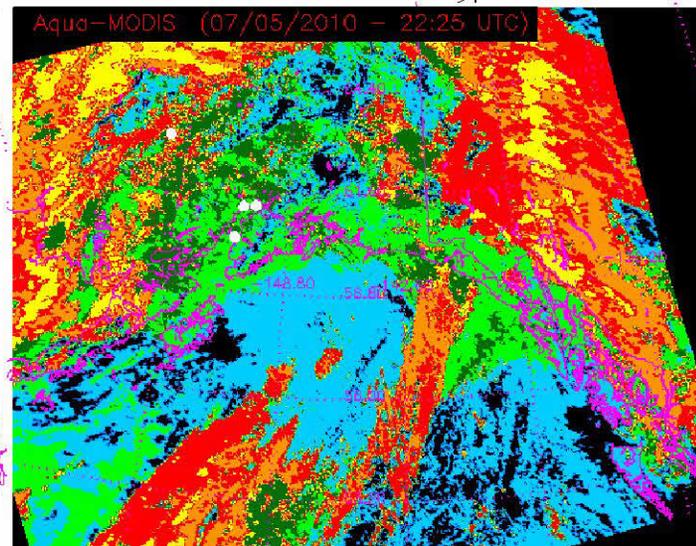
•All pilot reported occurrences of aircraft icing are coincident with supercooled liquid water or mixed phase clouds.

GOES-R Cloud Top Phase



Clear Liquid Supercooled Mixed Ice Uncertain

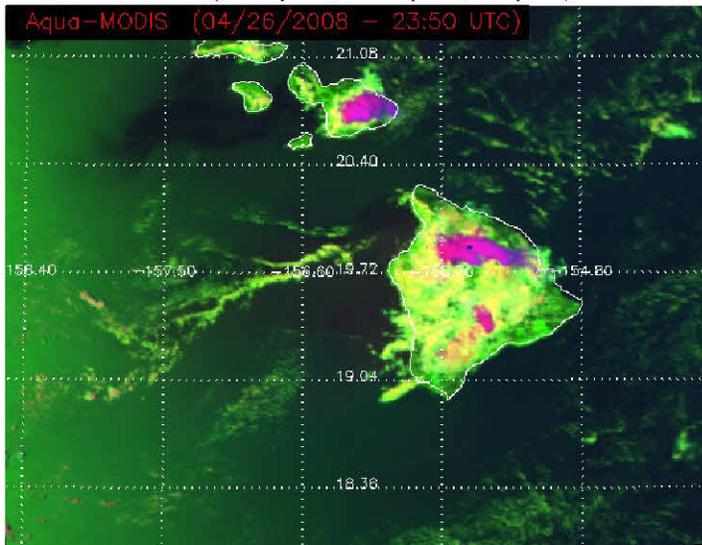
GOES-R Cloud Type



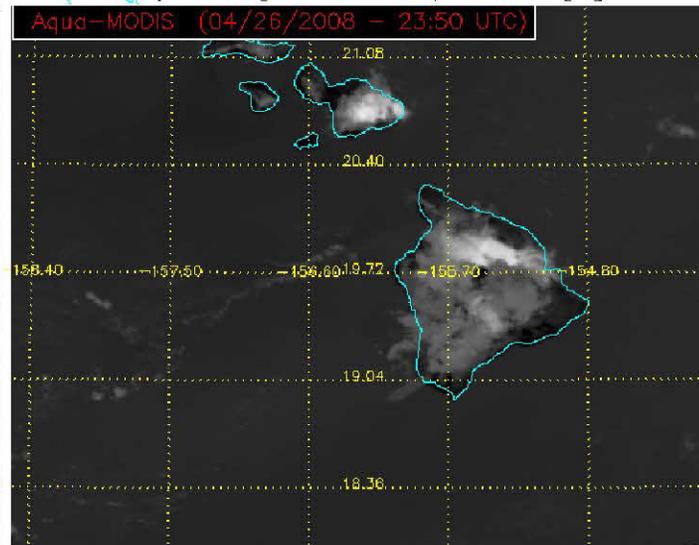
Clear Spare Liquid Supercooled Mixed Thick Ice Thin Ice Multi-layered

# Aqua-MODIS (April 26, 2008, 23:50 UTC)

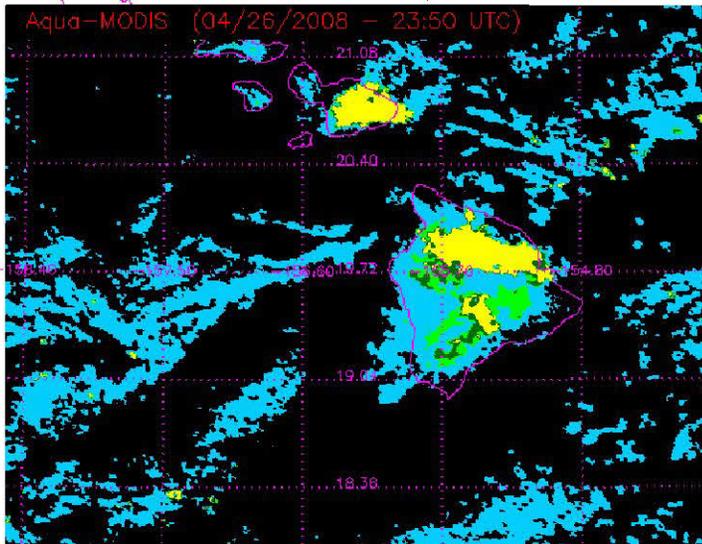
RGB (0.65 $\mu\text{m}$ , 3.75 $\mu\text{m}$ , 11 $\mu\text{m}$ )



11 $\mu\text{m}$  Brightness Temperature [K]

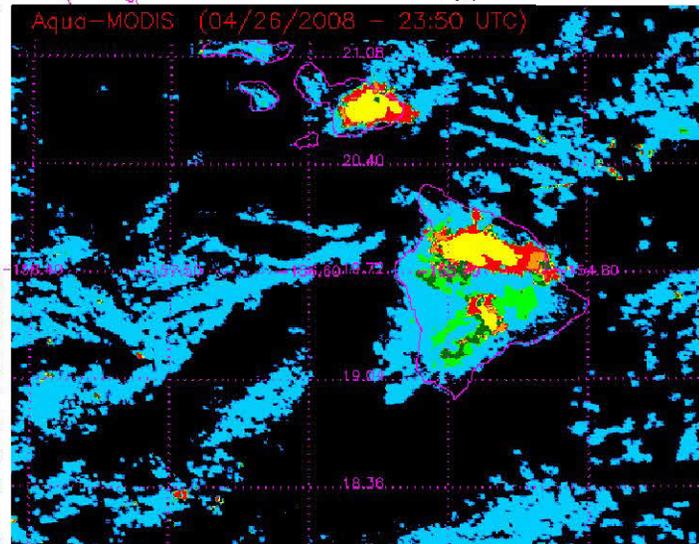


GOES-R Cloud Top Phase



Clear    Liquid    Supercooled    Mixed    Ice    Uncertain

GOES-R Cloud Type



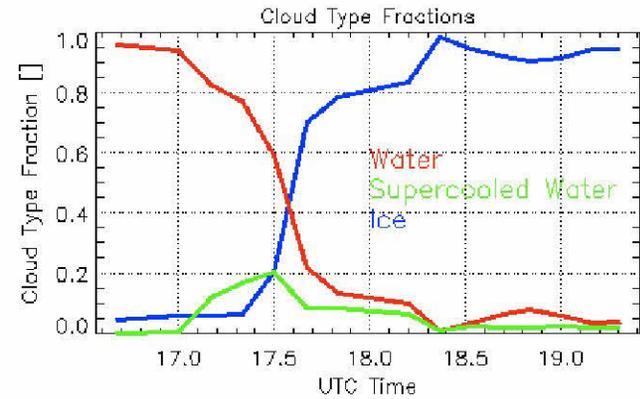
Clear    Sparse    Liquid    Supercooled    Mixed    Thick Ice    Thin Ice    Multi-layered

***GOES-11 (April 26 - 27, 2008)***

**Capturing developing convection over Hawaii**

QuickTime™ and a  
decompressor  
are needed to see this picture.

***Cloud top phase trends  
are useful for monitoring  
convection.***



QuickTime™ and a  
decompressor  
are needed to see this picture.

**Water, Supercooled Water, Mixed Phase, Thick Ice, Thin Ice, Multilayered**

# Current PG Plans

- **The GOES-R cloud phase and type products (from MODIS) will be evaluated by the NWS in Alaska this fall.**
- **All products will be viewable in AWIPS, NAWIPS, and McIDAS.**