U.S. NAVAL RESEARCH LABORATORY

Understanding the Sensitivity of GOES ABI 1.378 um Daytime Radiances to Thin Cirrus Cloud Presence

Simone Lolli[1,3]

Erica K Dolinar[2], Dave Peterson[2], James R. Campbell[2]

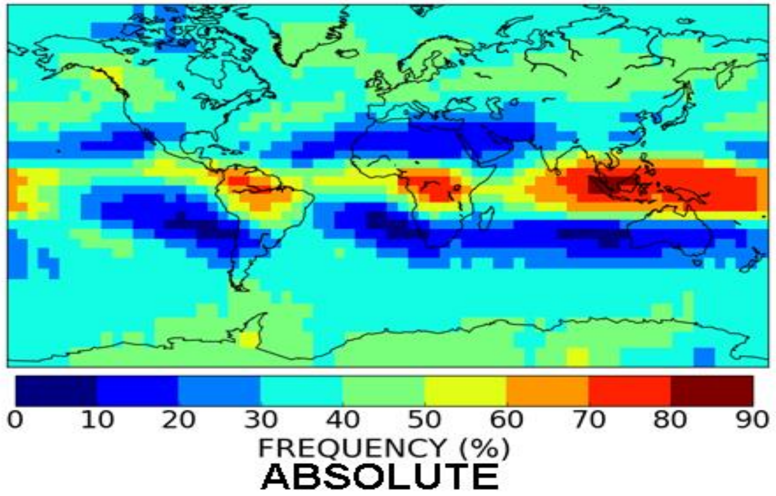
[1]CNR-IMAA, Istituto di Metodologie per l'Analisi Ambientale, Tito Scalo, Italy
[2]US Naval Research Laboratory, Monterey, CA, USA
[5] SSAI-NASA Goddard Space Flight Center, Greenbelt, MD, USA

ASEE imaa SSAI NASA Goddard SPACE FLIGHT CENTER

Introduction

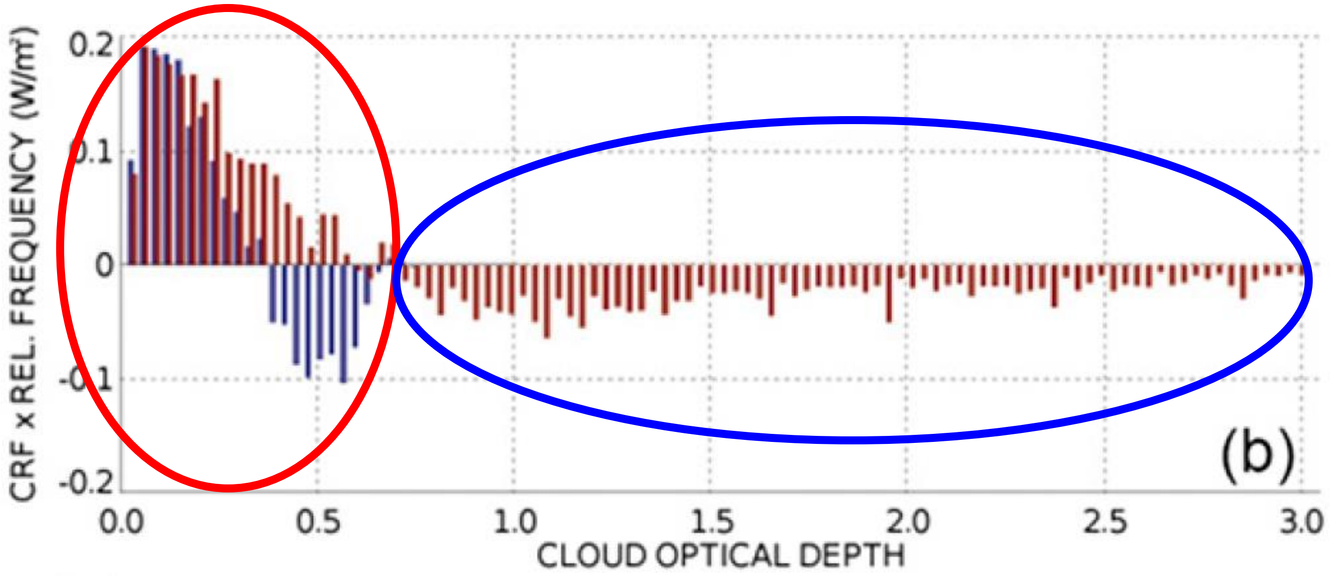
- Cirrus are the most common cloud type in Earth's atmosphere
- The impact of cirrus on the Earth radiation budget is being reimagined with the introduction of satellite-based lidar
- The estimated global cloudiness has increased from 68% to 75% due to the enhanced detectability of thin cirrus ($\tau < 0.3$) by satellite lidar; cirrus amount almost doubled (24 – 40%)

How well/consistent are cirrus resolved from GEOStationary Satellites?



The Radiative Effects of Thin Cirrus (REThinC)

- **Cirrus clouds are unique in that they are the only cloud that can induce either a positive or negative daytime TOA net forcing**



One year (2012) of ground-based MPL data @ Greenbelt, MD, USA
Campbell et al. (2016)

- The REThinC field campaign is designed to observe the microphysical and radiative properties of thin cirrus clouds to:
  - Develop better ice microphysical parameterizations for NWP models
    - **Leverages lidar-derived extinction, IWC, De, and T**
  - Re-evaluate the climate impact of cirrus

Motivation

- Translucent (thin) cirrus (ice) clouds are difficult to resolve with traditional passive radiometric imagers at increasingly tenuous cloud transmission levels.
- Remote sensing retrievals are mostly predicated on clear skies
- Unscreened thin cirrus clouds become a retrieval <u>biasing</u> agent

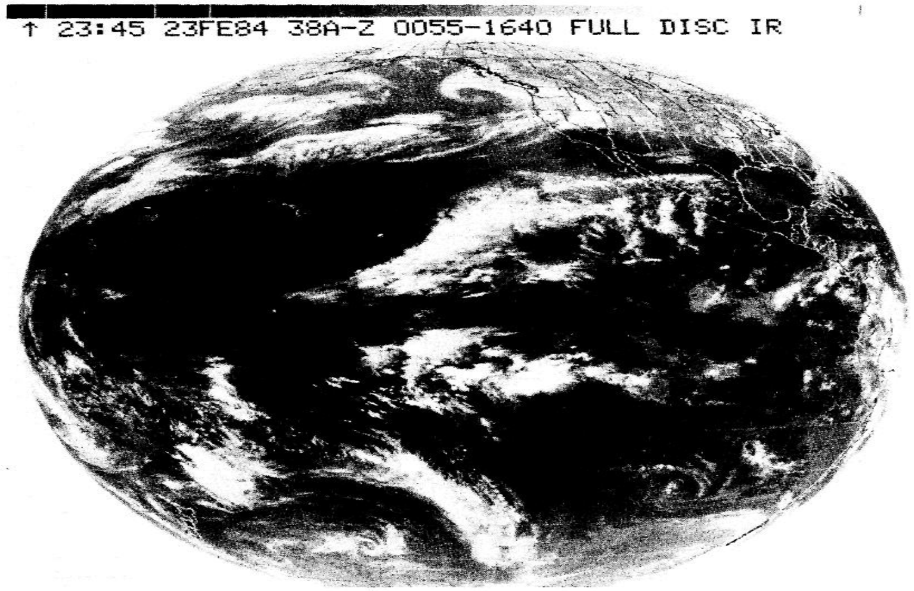
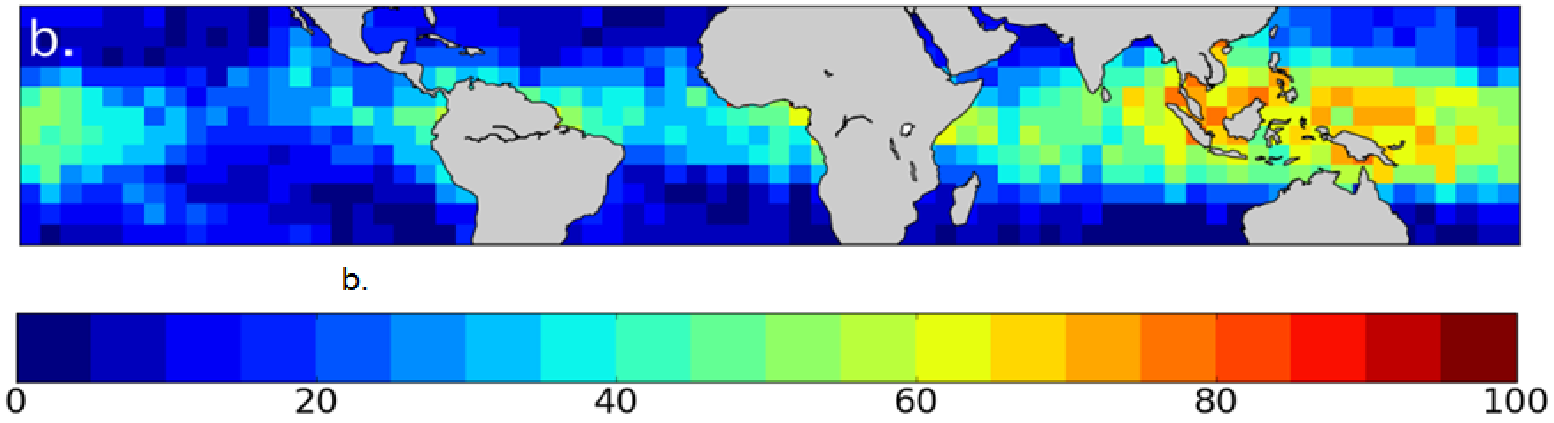
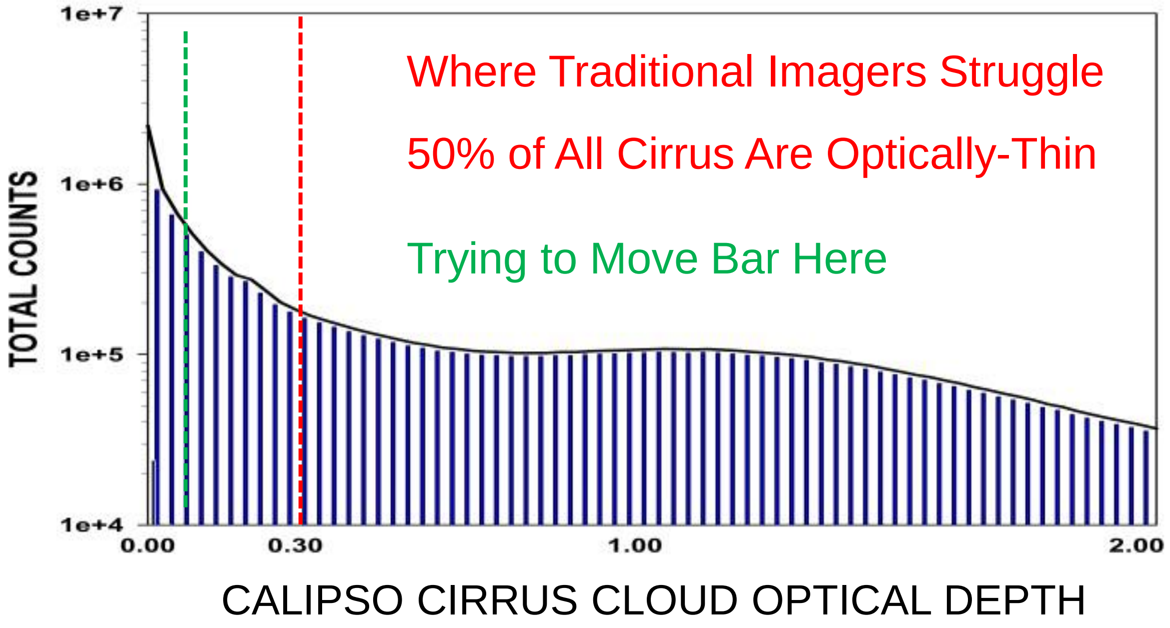


FIG. 1. Full disc IR picture at 2345 GMT 23 February 1984.

Unscreened Cloud Contamination of Satellite Remote Sensing Retrievals

~25% Tropical Cirrus Cloud SST Contamination Rate in MODIS





SENSOR	COLD SST BIAS
MODIS	0.84°C
AVHRR	0.92°C
VIIRS	1.00°C

Nearly five times current SST DA error budget in ocean models (~ 0.2°C)

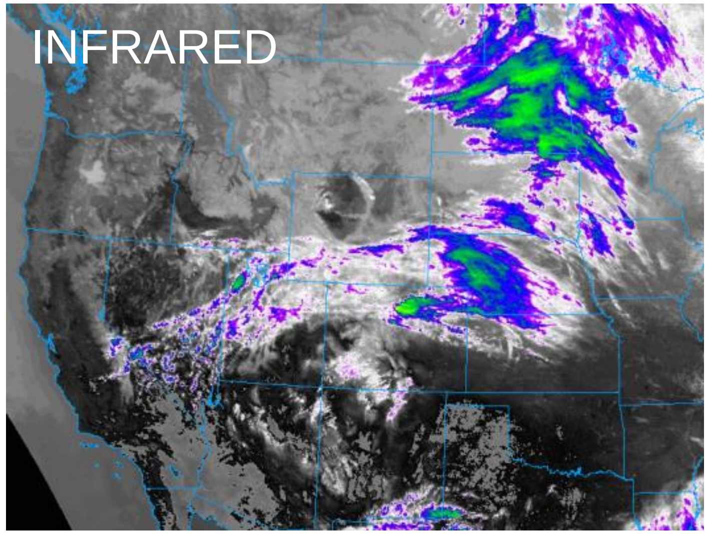
Ocean model SSTs ~ 0.15°C cold in buoy matchups

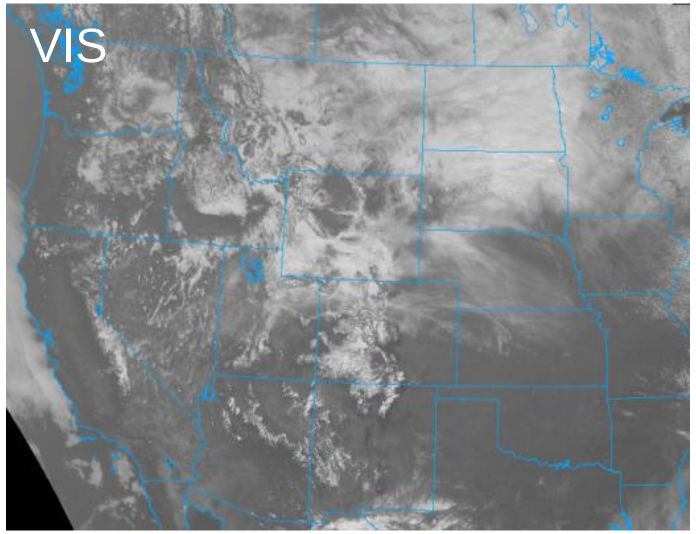
Most satellite METOC remote sensing retrievals predicated on clear skies

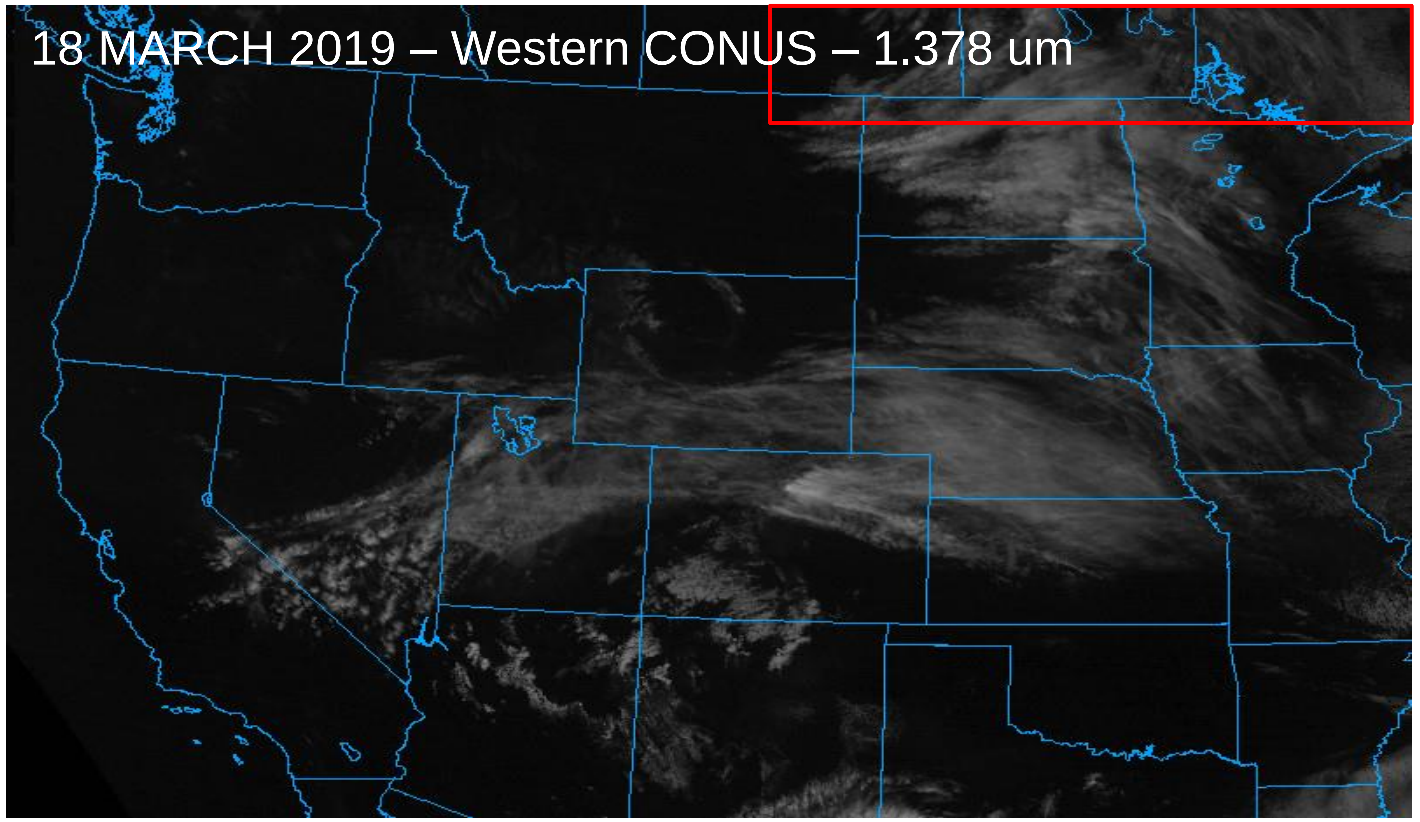
- '*Apparent*' clear-sky rate: 33%
- True clear-sky rate: 25%

Marquis et al. 2018 - JAOT

Developing a Operational Solution







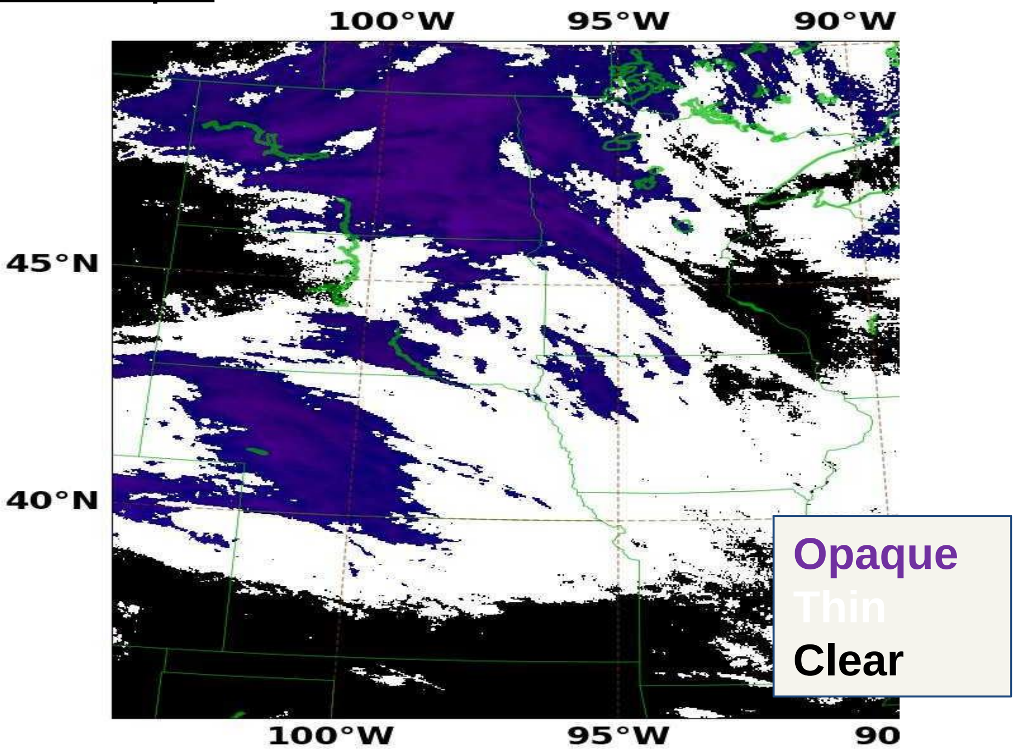
1.378 µm GOES ABI daytime "cirrus" channel based on water vapor absorption

- Cirrus clouds stand out vs. increasingly opaque background below them

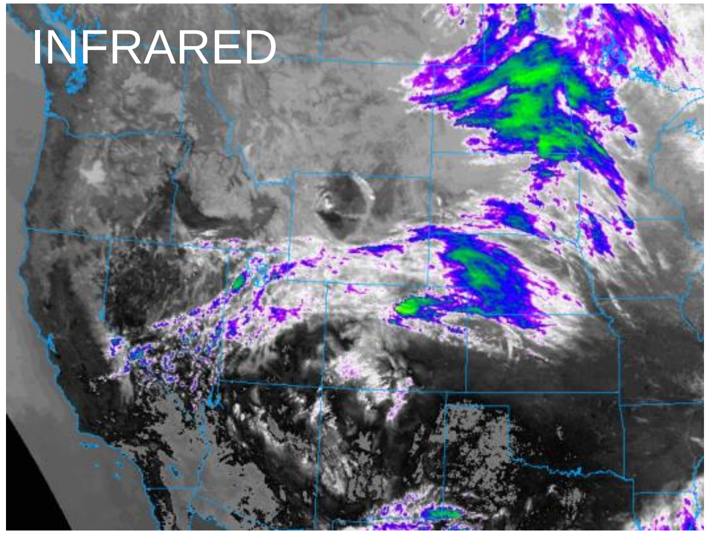
What is the lower detection limit?

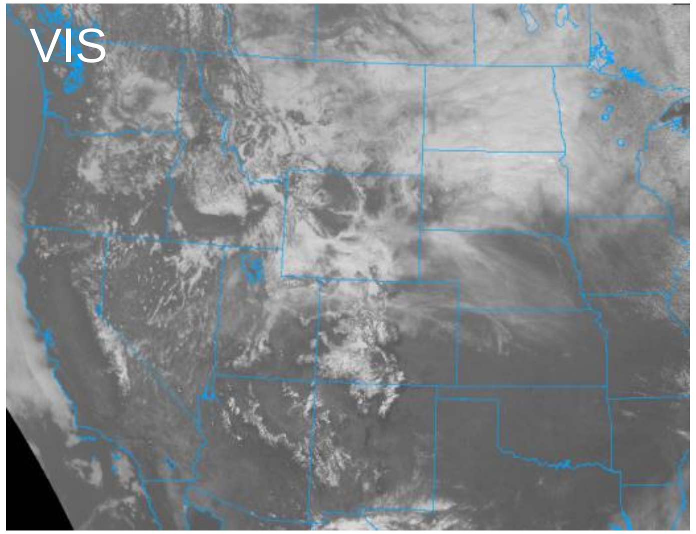
What is the regional sensitivity?

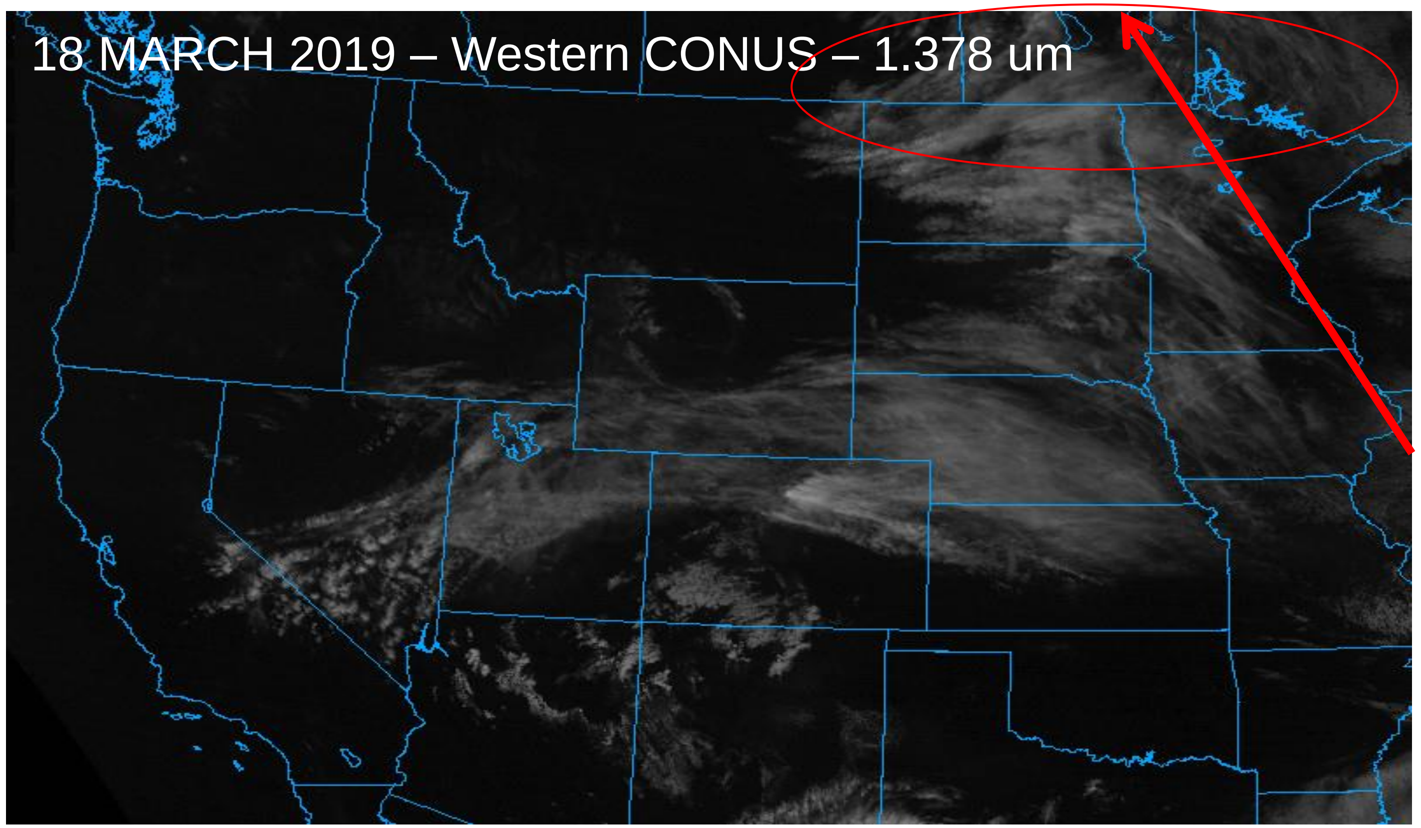
Mask Example



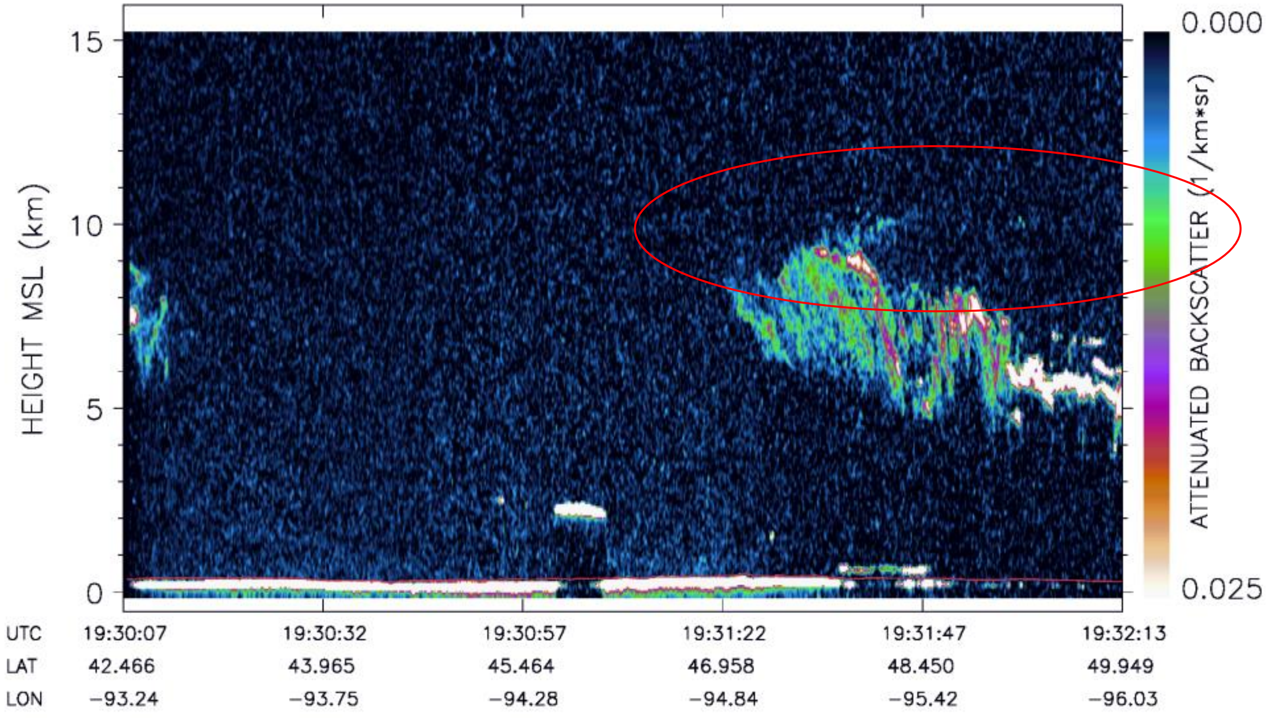
Developing a Operational Solution







Through NASA CALIOP collocation (2017 – present) will derive radiance thresholds for 1.378 um cloud detection in GOES-16 & 17 images

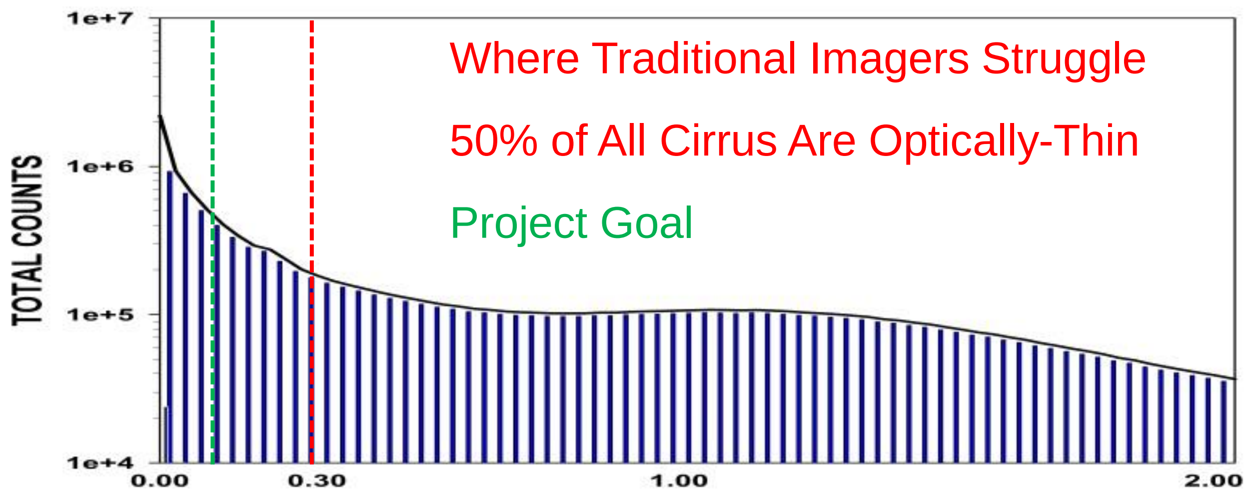


Summary & Primary Open Research Questions

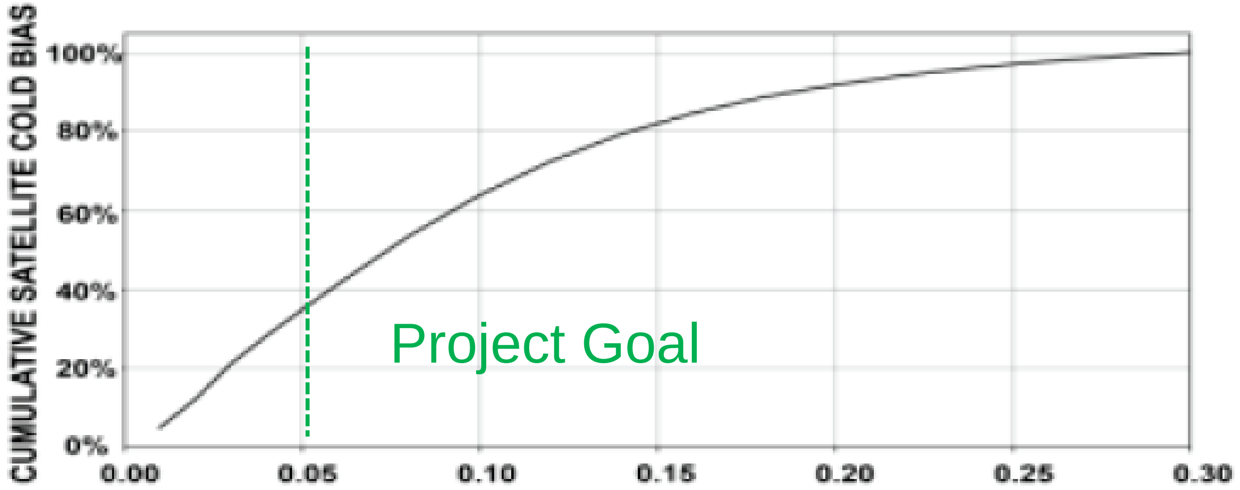
We are developing an operational mask product for thin cirrus clouds from geostationary near-IR observations. (GOES-16 and 17)

1. What is the lower limit in detecting cloud?
2. How sensitive is the algorithm regionally?
   - Column water vapor
   - Over complex terrain
3. How much bias is suppressed in METOC remote sensing retrievals based on integrated cirrus mask/microphysics?

THANK YOU FOR YOUR ATTENTION



CALIPSO CIRRUS CLOUD OPTICAL DEPT



SST-CONTAMINATING CLOUD OPTICAL DEPTH