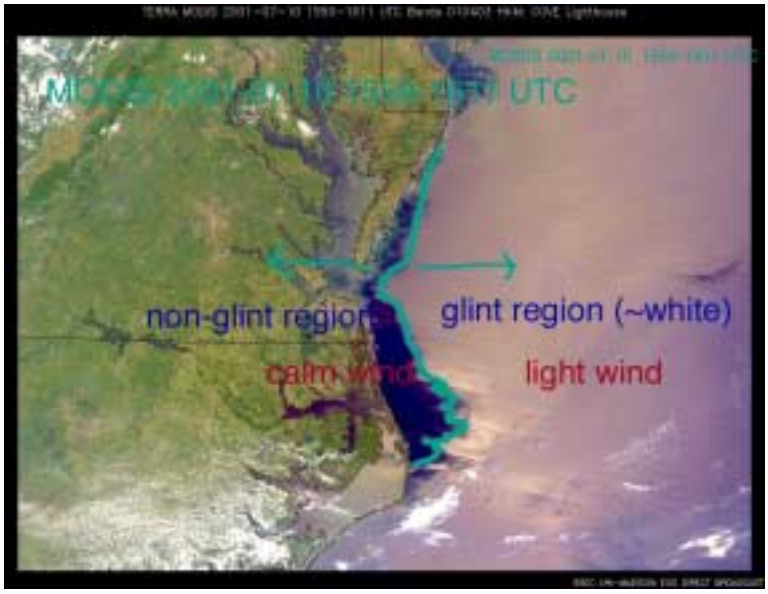
Stealth Sun Glint Shows Importance of Surface Wind Measuements for BRDF

Fred Rose pointed out the glaring signature of sun glint in MODIS (first image below in color) for 10 July 2001, our first day in CLAMS. Most of the bright, blue-white at sea is glint, rather than cloudiness. There is no glint from GOES (second image in black and white), which has a different geometry. But why is there no glint for ~50km off the coast in the MODIS color image (the region where the sea remains blue)? We reason that the effect is due to near calm winds on the coast. Calm yields a sea that reflects like a mirror; as invisible as a stealth aircraft (blue sea at coast on left), for which angle of incidence equals angle of reflection. This dramatic illustration stresses the importance of wind measurements for the proper interpretation of ocean observations of BDRF.

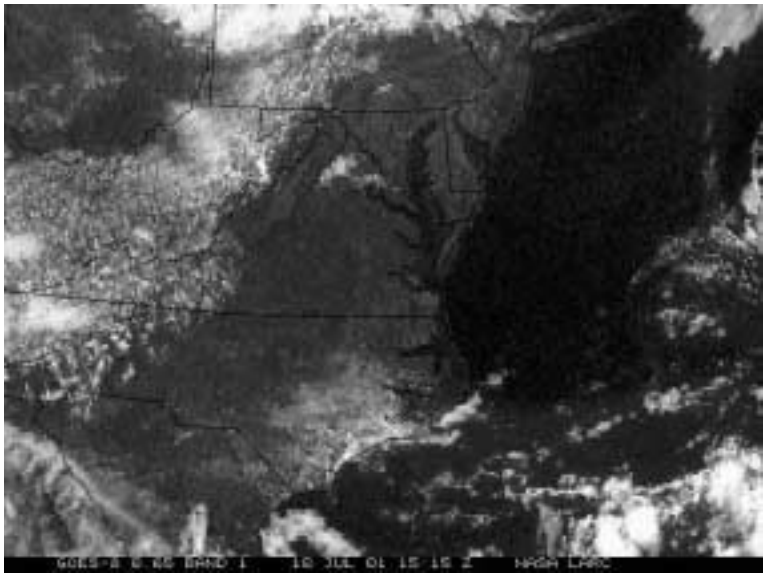


MODIS RGB image showing sun glint

2001-07-10
1559-1611 UTC

CLAMS URL
"Aircraft" -> "CAR"

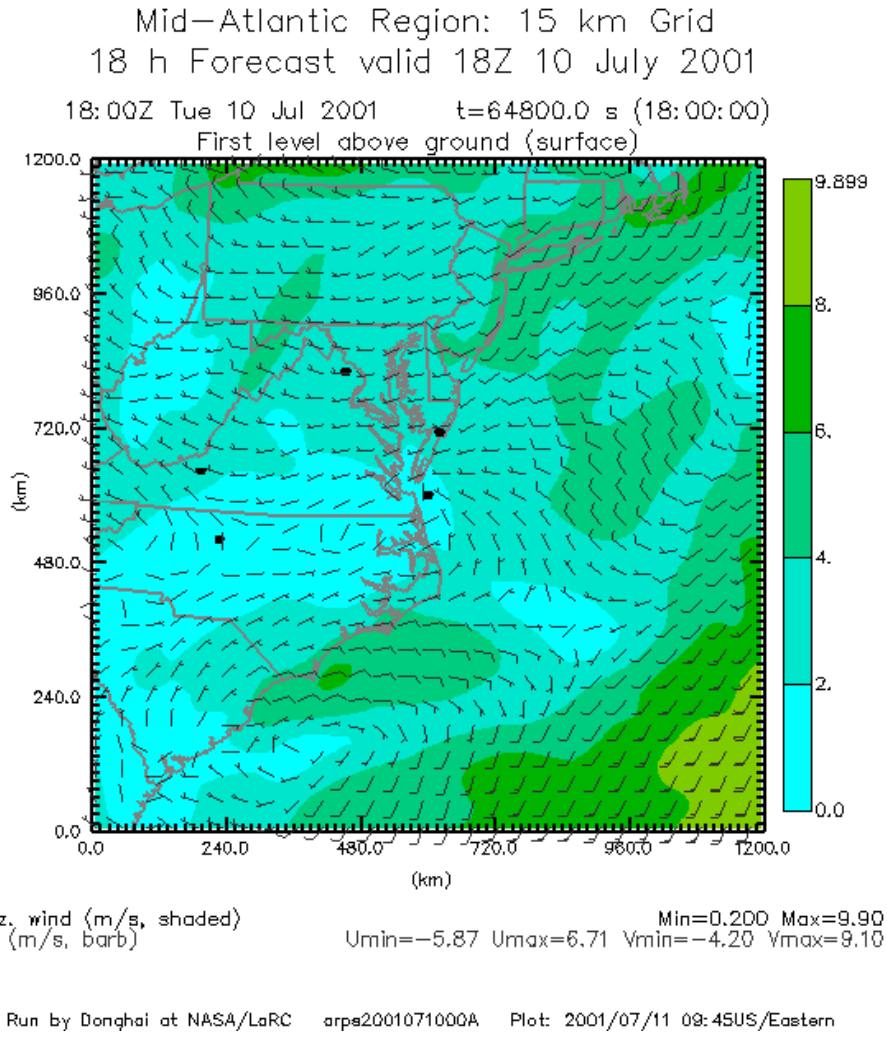
Bigger image at end of memo.



GOES-8 0.65 band 1
2001-07-10
1515 UTC

CLAMS URL
"Satellite" ->
Display Historical

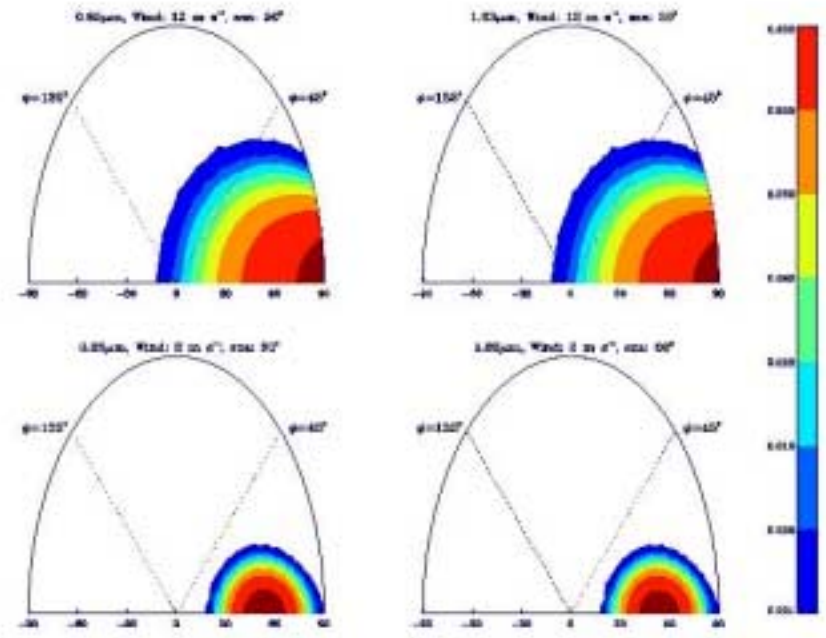
Here is the surface wind field from Donghai Wang s mesoscale model (15 km resolution):



The area of the sea with no glint (blue coastal water in the MODIS image) corresponds to a minimun area of wind speed in the model above. From the COVE surface met data, we find a wind speed of only 0.5 m sec-1 at 1600 UTC on 2001-07-10. The NOAA record was 1.0 m sec-1 at COVE. COVE is at the border of the blue, no-glint region in the MODIS image. At the buoy 44014, located further east 64nm from Virginia Beach, the wind speed increased to a whopping 2.0 m sec-1 with gusts to 3.0 m sec-1. That increased wind evidently led to more capillary wave action and a Cox-Munk spreading out of the cone of

reflected SW from the sea surface. Note that the model (15 km resolution) in this case made an 18 hour forecast. Operationally, it is run for CLAMS only once a day, based on 00 UTC data. In post analyses, such a long forecast run would not be used. It may also be possible to use a 5 km resolution version.

Here s an illustration of the effect of wind speed on BDRF using Yongxiang Hu s discrete ordinate calculations for a Cox-Munk ocean at 0.65 (left) and 1.63 (right) micron. In the lower panel, the wind speed is 2 m sec-1; the reflected beam has already spread about a cone of +/- 35 deg. In the upper panel, the wind speed is 12 m sec-1; the cone is wider, AND the direction of peak reflectance has shifted considerably toward the horizon. For wind speeds below 2 m sec-1, the cone of reflection should be quite small. Hu s model thus explains the MODIS image.



Charles Gatebe s CAR data for 2001-07-10 indicates about 10 measurements of BRDF. They are circles in the flight diagram on www-clams.larc.nasa.gov/clams/ with a click to Aircraft and then CAR . The reflected images in the BRDFs on the web page suggest successively greater blurring during a portion of the flight. Is the increased blurring a signal of the eastward movement of the flight circles, toward water with higher surface wind speeds?

Notes on how to find detailed background information on David Rutan s CLAMS URL (www-clams.larc.nasa.gov/clams/) follow:

An archive of D. Wang s high resolution model output is on the CLAMS URL (CLAMS Mesoscale Forecast Model -> Forecast Archive by Date). The route to the COVE met data is very long: (from CLAMS URL, seek Related Links -> CAVE -> Useful Links -> COVE -> Validation Data Access -> select COVE -> hit Continue -> select Jul 01 -> Day 191 -> Processed data and Continue -> Wind Speed and Continue -> NO and Continue -> Data Files). To obtain the buoy data from the CLAMS URL, hit CLAMS Forecasts -> scroll down to Forecast Links -> and select the buoy you want; after waiting ~ 30 sec, scroll down to Real Time Data in tabular form for the last forty-five days at the bottom.

A larger version of the MODIS image is attached below. For better image, see www-clams.larc.nasa.gov/clams/ hit Aircraft, then hit CAR.

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