# Sub-Field-of-View Radiative Transfer for the Advanced Technology Microwave Sounder


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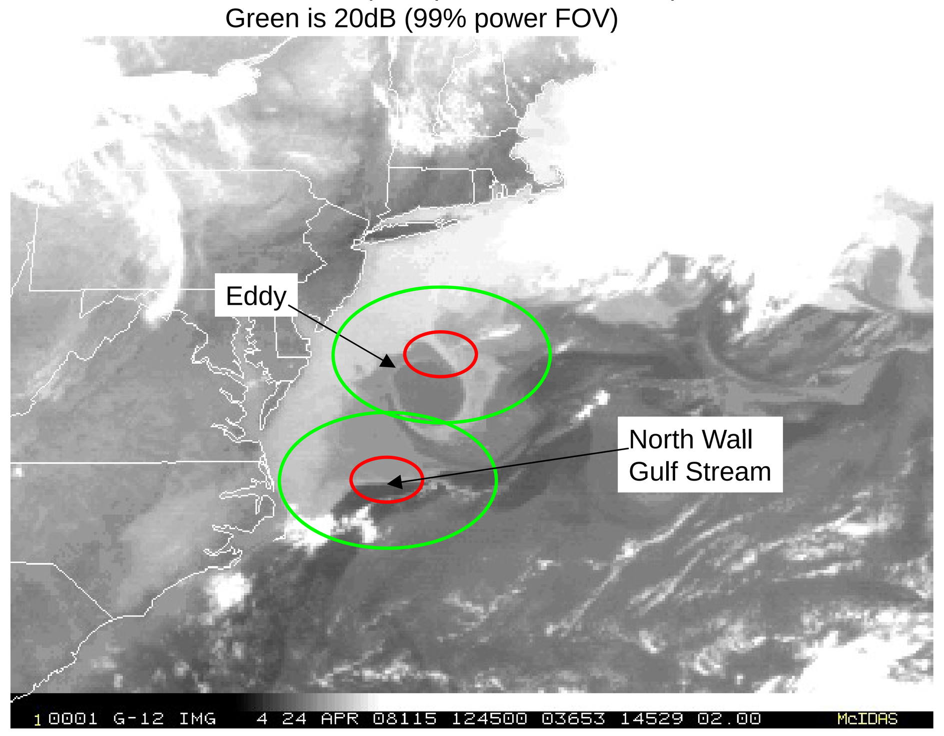
## 1

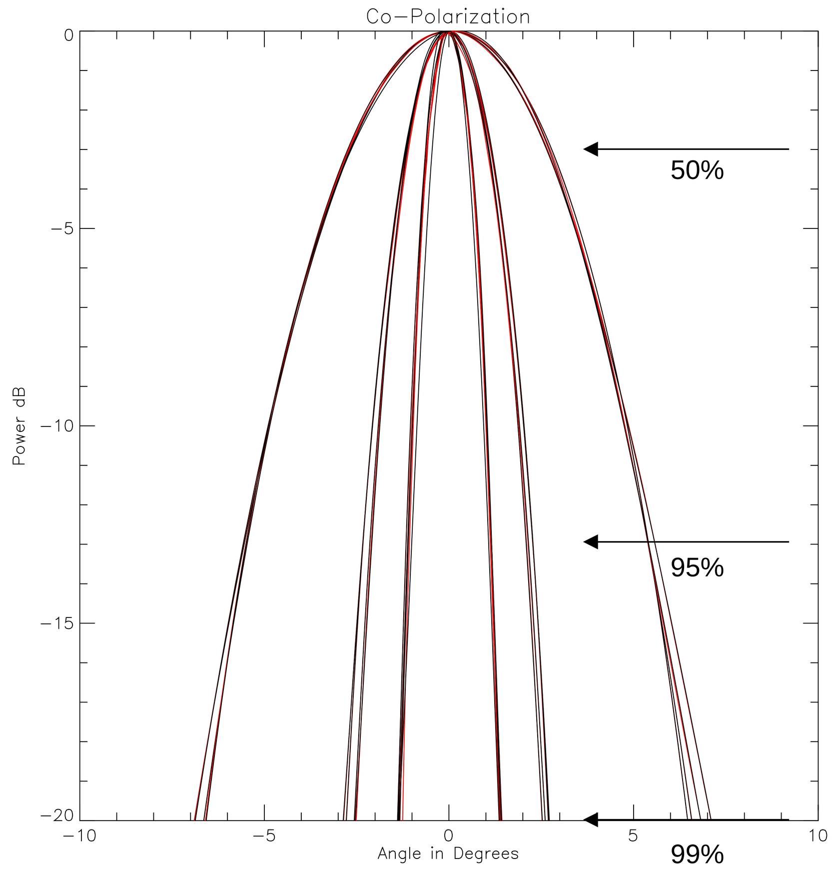
**Introduction**

Radiative transfer with channels that 'see' the surface is problematic because of emissivity and skin temperature uncertainties. This is especially true of inhomogeneous backgrounds, including coastlines, large rivers, mountainous regions, and even regions of high ocean temperature gradients (e.g. north wall of Gulf Stream). A possible solution might be the ability to integrate high resolution databases within a given field-of-view, and perform multiple radiative transfer within the field of view, weighed and integrated according to the antenna beam power.

Inhomogeneous ocean surface
Red is 3dB (50% power nominal FOV)
Green is 20dB (99% power FOV)




## 2

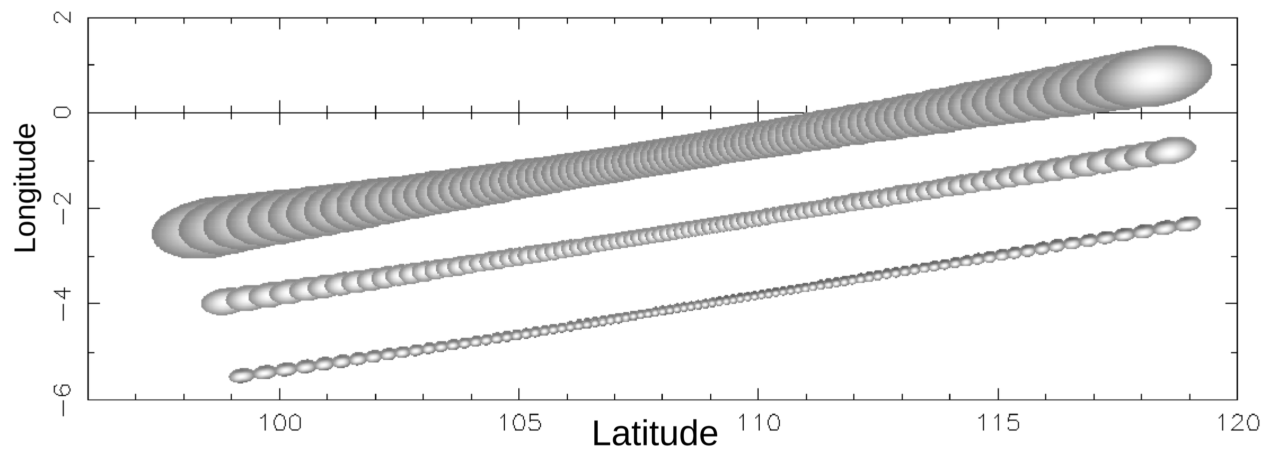



ATMS Antenna patterns were normalized by adding (negative) maximum value of each pattern to all values. Each channel is fitted separately. Best fit to the eye is with a 7th order polynomial (solid, crosstrack, dashed along track)

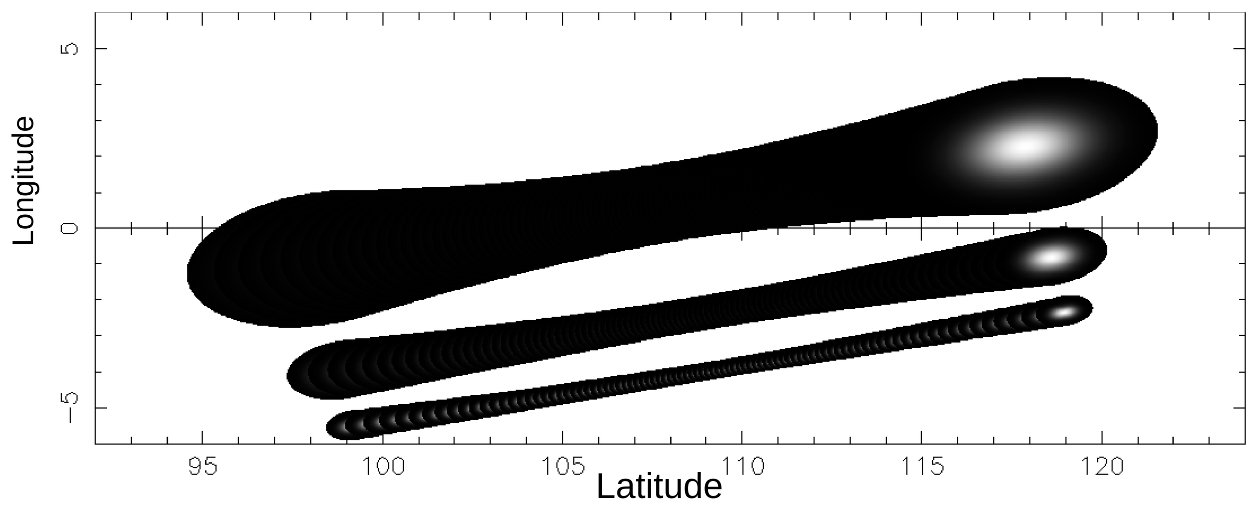
99% power inside the fov is at -20 dB. This is approximately 3.3, 6.6 and 15.6 deg wide, versus 50% power inside the FOV at -3dB which is the nominal FOV sizes are 1.1, 2.2 and 5.2 deg.

The solid fit line fits almost exactly over the data.
The dashed fit line is almost as good.

## 3



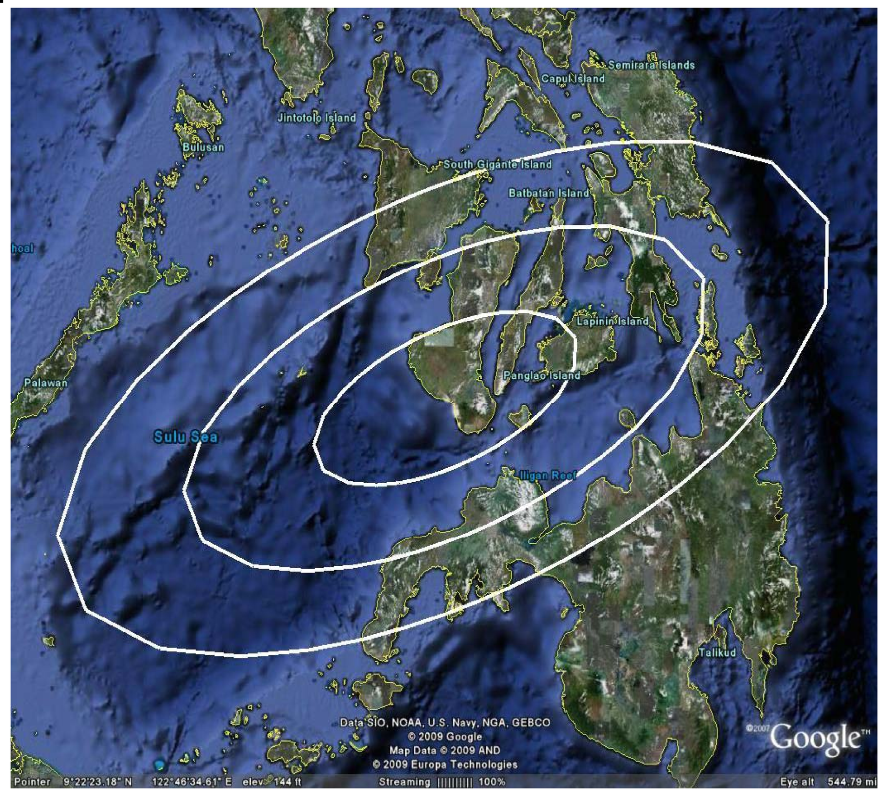

50% power fields of view



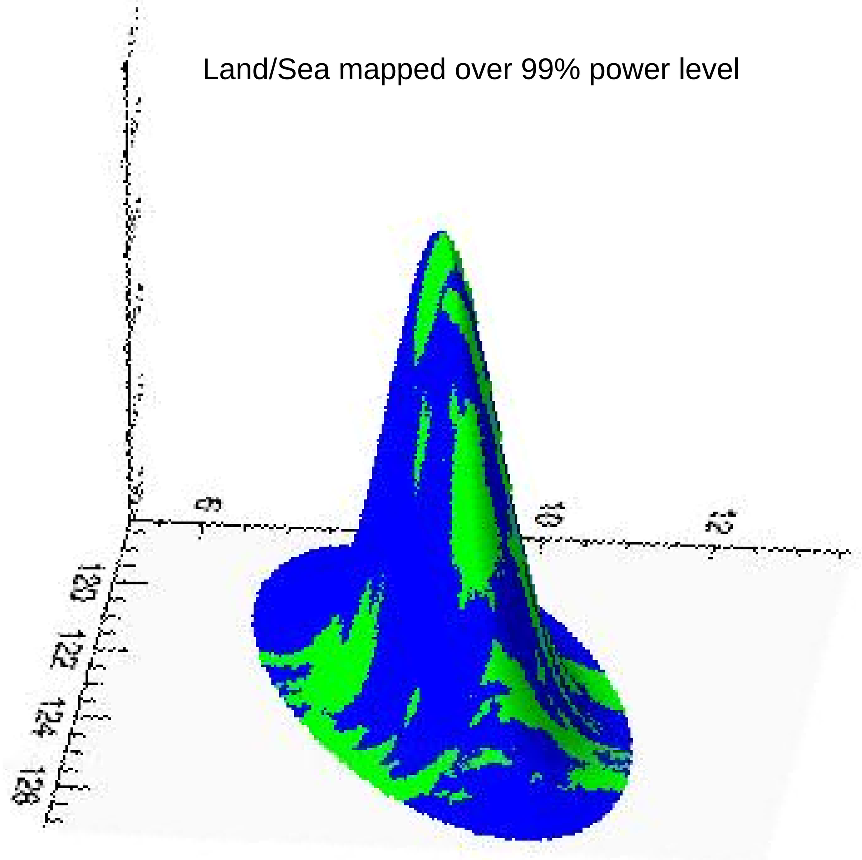

99% power fields of view

## 4

5.2 degree fov for 50%, 95% and 88% power




Land/Sea mapped over 99% power level



## 5

Power Fraction = Fraction of total antenna power within FOV allocated to each surface type

$$T_B = \frac{\int_A \Phi(A) T_R(A) dA}{\int_A \Phi(A) dA} \qquad \hat{\Phi} = \frac{1}{\int_A \Phi(A) dA}$$

$\Phi(A)$ is antenna pattern
$T_R$ is radiant temperature

$$= \hat{\Phi} \int_L \Phi(L) T_R(L) dL + \hat{\Phi} \int_S \Phi(S) T_R(S) dS$$

Using constant land and sea temperature within the field of view we get

$$= T_{RL} \hat{\Phi} \int_L \Phi(L) dL + T_{RS} \hat{\Phi} \int_S \Phi(S) dS$$

Land Power Fraction    Sea Power Fraction

TB_land = 280 TB_sea = 210

| % Power | Land Fraction | Sea Fraction | Land Power Fraction | Sea Power Fraction | Tb |
|---|---|---|---|---|---|
| 50% | 0.476 | 0.524 | 0.491 | 0.509 | 244.39 |
| 95% | 0.329 | 0.671 | 0.405 | 0.595 | 238.36 |
| 99% | 0.269 | 0.731 | 0.397 | 0.603 | 237.80 |

This example shows the difference in computed antenna temperature for three different FOV sizes. The difference between using the nominal 3dB (50% power) and the 20dB (99% power) is over 7K.
Conclusion: If one is to perform inhomogeneous radiative transfer, then one should integrate over the largest area possible.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