Ocean Data Coverage Sensitivity to Air Mass Fraction and Coastal Scanning Requirements

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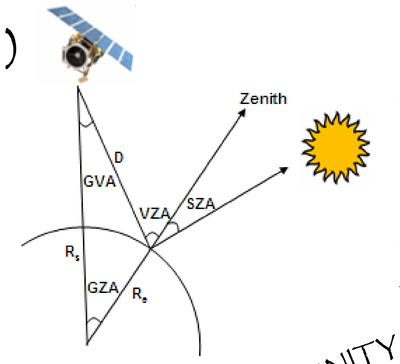
Geostationary satellites have a fixed view of Earth for the duration of their mission, so careful consideration must be given to the selection of orbital position and sensor orientation in order to optimize data coverage.

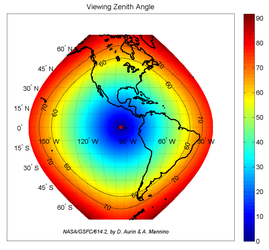
The effective coverage for the GEO-CAPE Coastal Ecosystem sensor is determined by the satellite's position (assumed here to be 0°N 95°W), the sensor's viewing angle (GVA), and the solar zenith angle (SZA) which determines light availability (Figs. 1,3). Air mass fraction (AMF) is an index of the atmospheric contribution to the top of atmosphere reflectance signal, and is calculated from VZA and SZA:

$$AMF = \frac{1}{\cos(VZA)} + \frac{1}{\cos(SZA)}$$

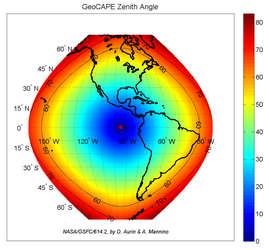
1)



2) Viewing Zenith Angle (VZA)



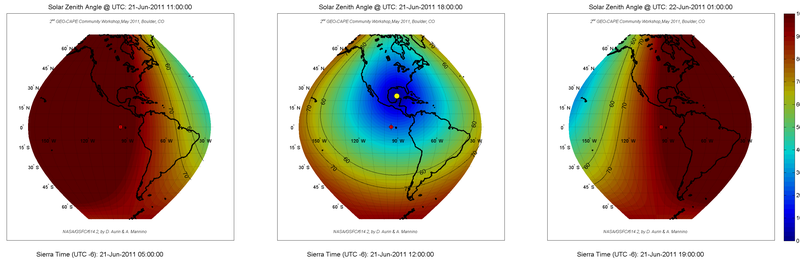
GEO-CAPE Zenith Angle (GZA)

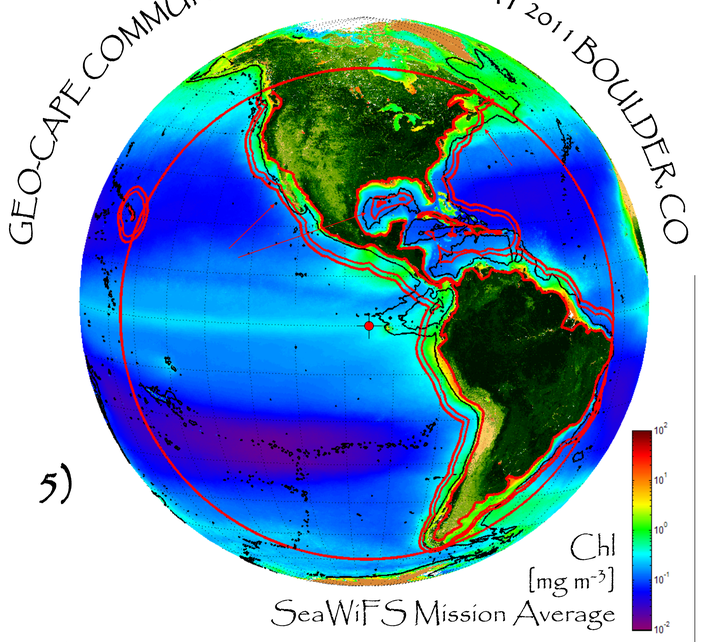


VZA approaches GZA as GZA goes to zero, and diverges with increasing angles (Fig. 1 & 2).

Based on heritage experience with SeaWiFS and MODIS, ocean color data should be retrievable within **60° GZA** (Fig. 2, and red countour line in Figs. 4 & 5), for **AMF< 4** and likely for AMF< 5.

3) Solar Zenith Angle (SZA), Northern Summer Solstice





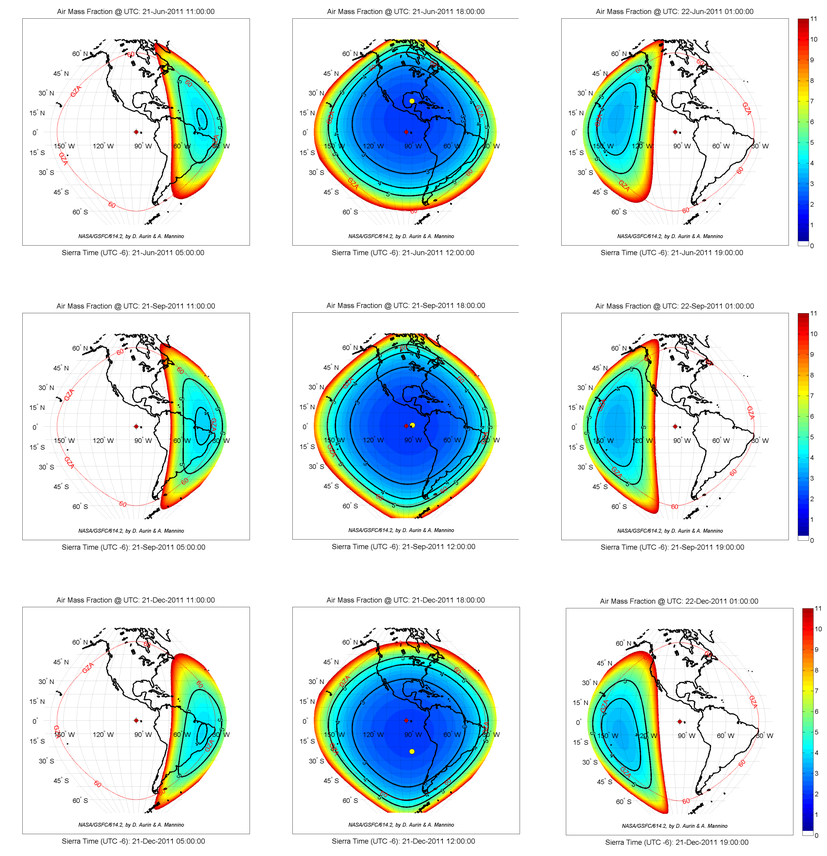
5)

Chl [mg m^{-3}]
SeaWiFS Mission Average

Figure 5 shows distances of 375 and 500 km from either shorelines or inland shoreward boundaries within the GZA 60° threshold (red circle, diameter 13,334 km). These two distances represent two potential instrument swath widths. In the Gulf of Mexico, the broader swath incorporates nearly the entire Gulf, while the 375 km swath only captures about half. In regions where the shoreward boundary has been moved a significant distance inland to capture estuarine systems, such as Baja Mexico and Nova Scotia, the narrower swath often overlaps the outer shoreline, while the 500 km swath remains offshore. Both swaths generally extend beyond the continental slope (shown here as a black contour at 2,500 m depth), and generally capture the near shore, high chlorophyll regions.

Maps of AMF for the summer and winter solstices (Fig. 4, top and bottom rows) and autumnal equinox (middle row) show that placement of the GEO-CAPE Coastal Ecosystem sensor over the equator at 95 W provides at least partial coverage of South American coastal waters starting as early as ~ 0500 (Sierra Time, ST=UTC-6). Coverage begins in North American coastal waters ~0700 ST (not shown) and extends until ~1800 ST. Northernmost (southernmost) coverage extends between ~40 N (~40 S) in the northern (southern) winter and ~50 N (~50 S) in the northern (southern) summer. This translates into coverage as far north as New Jersey on the east coast and Northern California on the west coast during the northern winter, and as far south as Buenos Aires, Argentina and Valparaiso, Chile during the southern winter.

4)



Coverage of any one region in the mid- to low-latitudes extends to ~6 (~8) hours in winter (summer). Small offshore regions of the Atlantic and Pacific are available as early as ~0500 and as late as ~1930 ST throughout the year. Compromises associated with E/W placement of the sensor are clear from Figure 4. Placing the sensor further east would capture the entirety of the S. American coastal zone; further west would capture the Pacific Northwest of the U.S. year-round. The advantages of improving the atmospheric algorithm to extend to AMF < 5 are also apparent from the figure. Whereas E/W coverage limitation associated with AMF < 4 corresponds closely to the 60°GZA threshold, extending coverage to AMF < 5 may extend E/W coverage by ~1,400 km near the equator.