# Remote Sensing

- List some of the **advantages** & **disadvantages** of Remote Sensing in ocean/coastal research?

| Advantages | Disadvantages |
|---|---|
| • surface temperature, concentration of salt and gases control exchanges of energy and materials between ocean and atmosphere controlling global ocean/atmosphere heat engine and biogeochemical cycles<br>• Top 1 meter of ocean has same heat content as entire atmospheric column, thus ocean's important role in air-sea interactions, weather and climate processes<br>• Rapidity of survey (synoptic coverage) over large areas. Synoptic = pictures at one point in time.<br>• R.S. useful in areas where in-situ measurements difficult or impossible<br>• Time sequence useful for process studies & for selection of in-situ measurement stations (global & regional ocean observations)<br>• Long-term monitoring of remote areas and global ocean<br>★ Measurements do not interfere with ocean processes | • Measurements restricted to surface or near surface; no information on vertical structure<br>• Cannot measure all desired variables<br>• Measurements often less accurate than in-situ data<br>• Surface verification often necessary<br>• Cloud contamination for emitted and reflected E.R. |

- **Geophysical parameters** retrieved by SATELLITE.
  - **Mixed-layer temperature**
  - **Skin Temperature**
  - **Surface winds**
  - **Wave height**
  - **Wave spectra**
  - **Internal waves**
  - **Surface slicks**

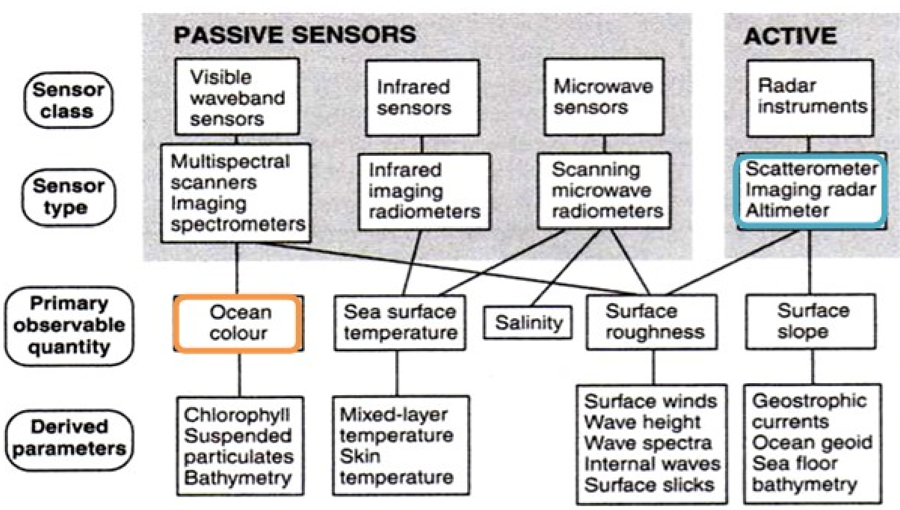



**Figure 2.5.** Schematic illustrating the different remote sensing methods and classes of sensors used in satellite oceanography, along with their applications.

- Figure taken from Robinson's 2004 book
- Details the different parts of the spectrum & what we use them for
- Ocean color usually refers to just Chlorophyll A
- Scatterometer measures winds
- Imaging Radar is synthetic and gives a raster image
- Altimeter can be used to measure the change in the seafloor

### What depth of water does SST represent?

*Depends upon many things:*

- *water mass*
- *season*
- *preceding wind*
- *preceding current*
- *preceding wave history*
- *etc.*

Generally speaking, the surface mixed layer:

- 1 to 50 m (depending on water mass)

### SST can be influenced by:

- diurnal changes (sun)
- wind-related changes (mixing, heat fluxes)
- seasonal changes (radiation, heat fluxes)
- atmospheric processes (volcanic dust, African dust, aerosols)

| | SST quantification | Salinity (SSS) quantification |
|---|---|---|
| **Advantages** | - No scattering by the atmosphere or aerosols, haze, dust, etc in clouds<br>- Its effectively an "all weather" system (meaning its not affected by clouds) | - Salinity controls density in coastal regions, especially where there's river discharge<br>- Changes in salinity are caused by events occurring at the surface, such as evaporation, precipitation, ice melting, and river discharge<br>- Understanding salinity is the first step in understanding the effects on ocean density and circulation |
| **Disadvantages** | - Thermal emission is very weak at these longer wavelengths (emissivity = 0.3-0.5, not 1)<br>- a large field of view must be used to overcome noise levels → low spatial resolution<br>- the emissivity varies with dielectric properties of sea water and surface roughness<br>- dielectric constant varies with temperature, salinity, and e.m. frequency → must know SSS to get SST | - Precise knowledge of the incidence angle of radiation beam is needed<br>- Thus aircraft orientation information is needed<br>- Galactric background radiation must be included into the retrieval algorithm<br>- There's large uncertainties with retrieval:<br>• Surface roughness effects<br>• Wind speed<br>• Fetch<br>• Surfactants<br>- dielectric constant varies with temperature, salinity, and e.m. frequency → must know SST to get SSS |

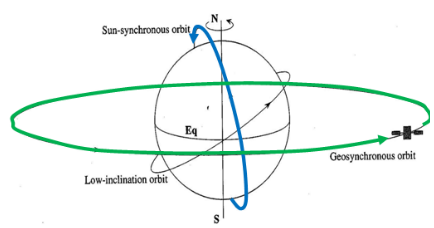
# Remote Sensing

## **Polar-orbiters vs. geostationary:** advantages & disadvantages, and examples of each

Know **specifications** for **NOAA AVHRR** and **GOES GVAR** sensors

| Satellite | POES<br>(Polar Orbiting Environmental Satellites) | GOES<br>(Geostationary Orbiting Environmental Satellite) |
|---|---|---|
| Sensor | **AVHRR** (Advanced Very High Resolution Radiometer) | **GVAR** (GOES Variable Sensor) |
| Orbit type | Near Polar, **sun-synchronous** | **Geostationary** |
| Launched | NOAA-6 in 1979, through NOAA-18 in March 2005 | GOES-8 in 1994, through GOES-12 in 2003 |
| Altitude | **835-850 km** | **35,788 km** |
| Inclination (I) | I = 98.8° **I = ~100°** | **I = 0°** |
| Orbit | **Retrograde** (b/c I > 90°) | |
| Period (T) | T = 102 min (orbits/day = 14.2) | T= 23.93 hr = 1 sidereal day |
| Swath Width | ~ 2,580 km | Variable from CONUS to Full Earth Disc |
| Radiometric resolution | 10 bits | 10 bits |
| Repeat Interval | Twice daily (day/night), 11 day exact repeat | Less than or equal to 15 minutes |
| Advantages | - **Same daily equatorial crossing time** (ex. NOAA AVHRR, Aqua MODIS)<br>- **High Spatial Resolution**<br>- They alone provide a regular sampling cycle of each point on the Earth and can be maintained in stable orbit for a lifetime of several years<br>- Needed because of atmospheric drag, equatorial bulge, bumpiness of earth's gravitational field, and the effect of the sun and moon on gravitation | - Satellite revolves with the earth, continuously looks over large areas<br>- Sensor can **view the same area continuously** (0-60°N & S)<br>- Constant image geometry, image navigation not usually necessary because satellite is stationary<br>- **Excellent Temporal resolution** (repeat coverage); GOES GoM every 15 min from 2 different image views (NH & CONUS)<br>- **Synoptic coverage over very large areas** (full disk, NH) global coverage possible in < 1 hr! |
| Disadvantages | - degraded resolution at margins (**limb effect**) because of the curvature of the earth<br>- **cylindrical distortion**<br>- **low temporal resolution** away from the poles<br>- **variable geometry** 1.1 x 1.1 at nadir & 3.5 x 1.5 at margins (area x4.4)<br>- varying amount of atmosphere varying amount of light across swath | - they are **restricted to the equator**, they can't see very high-latitude locations<br>- Orbit affected by equatorial bulge of earth and gravitational pull of sun and moon, counteract with engines<br>- Spatial resolution poor over all in comparison with polar orbiters (thermal is 4x4, water vapor is 6x6) |

| Spectral Interval | | Channels | | Description |
|---|---|---|---|---|
| | μm | POES AVHRR | GOES GVAR | |
| Visible (VIS) | 0.4 – 0.7 | 1 | 1 | Red Visible, used for **suspended sediments** |
| Near-IR (NIR) | 0.7 – 3.0 | 2 | | Photo-IR used for **terrestrial vegetation** |
| MID-IR (MID) | 3.0 – 5.0 | 3 | 2 | Used **only at night** for surface temperature detection |
| Moisture | 6.0 – 8.0 | | 3 | Used for **water vapor detection** in the visible spectrum |
| Thermal (TIR) | 8.0 – 12.5 | 4 & 5 | 4 & 5 | SST, MCSST & brightness temperatures (ch. 4) |
| $CO_2$ temp | 12.5 - 14 | | 6 | |




### POES AVHRR

| Channel | Spectral Interval (μm) | Spatial Resolution (km) |
|---|---|---|
| 1. Red visible (used for suspended sediments) | 0.58 - 0.68 | 1.1 |
| 2. Photo IR (used for terrestrial vegetation) | 0.73 - 1.1 | 1.1 |
| 3. Mid-IR (used only at night) | 3.55 - 3.9 | 1.1 |
| 4. Thermal IR | 10.30 - 11.3 | 1.1 |
| 5. Thermal IR | 11.50 - 12.5 | 1.1 |

### GOES GVAR

| Channel number | Spectral Interval (μm) | Spatial Resolution (km) |
|---|---|---|
| 1. Visible- red | 0.52 - 0.72 | 1 |
| 2. Mid-IR | 3.78 - 4.03 | 4 |
| 3. Moisture | 6.47 - 7.02 | 4 (GOES-12) |
| 4. Thermal IR | 10.20 - 11.20 | 4 |
| 5. Thermal IR | 11.50 - 12.50 | 4 (GOES-8/10) |
| 6. $CO_2$ temp | 12.9 - 13.8 | 8 (GOES-12) |