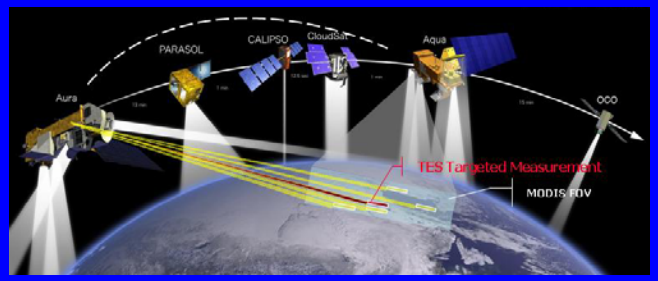
Third International Conference on Early Warning

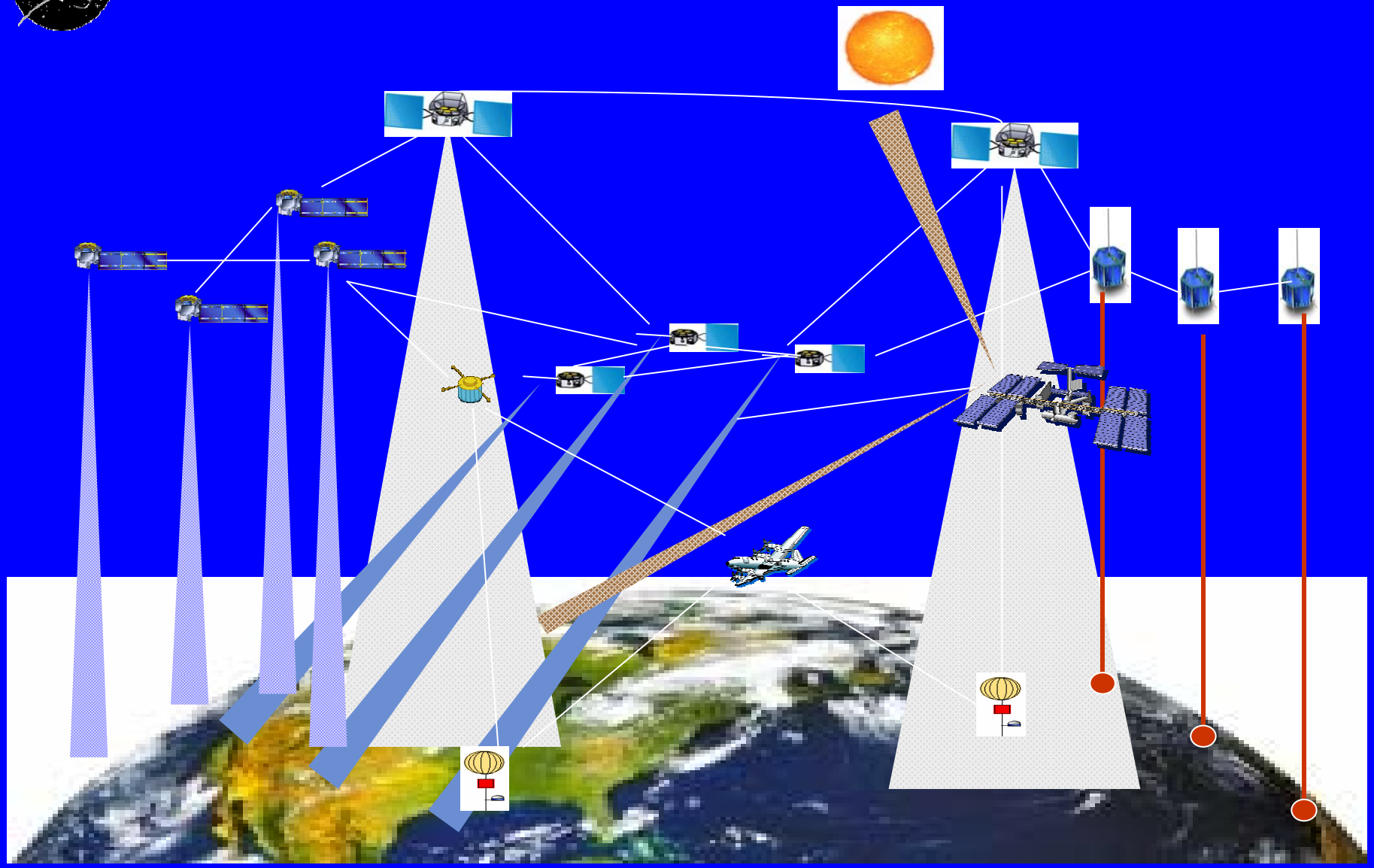
Bonn, Germany
March 27-29, 2006



Acquiring Comprehensive Observations using an integrated Sensor Web for Early Warning

Shahid Habib, *D.Sc., P.E.*
NASA Goddard Space Flight Center
Greenbelt, Maryland

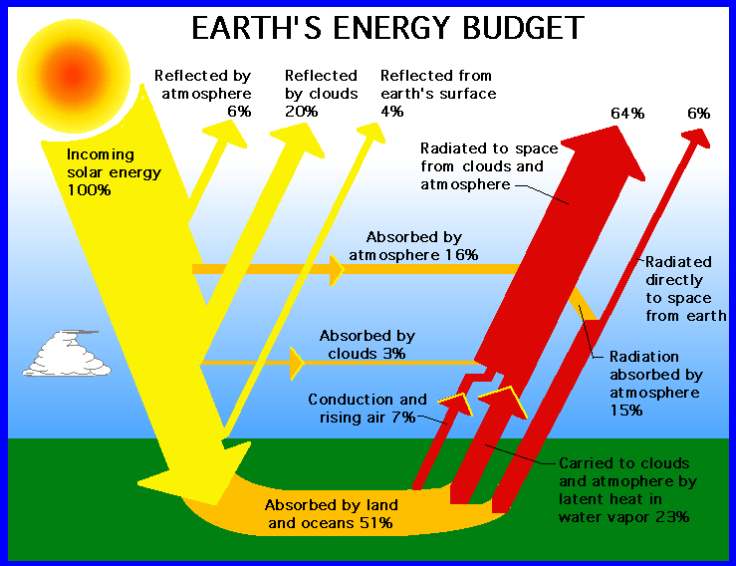
Steve Ambrose
NASA Headquarters
Washington, DC

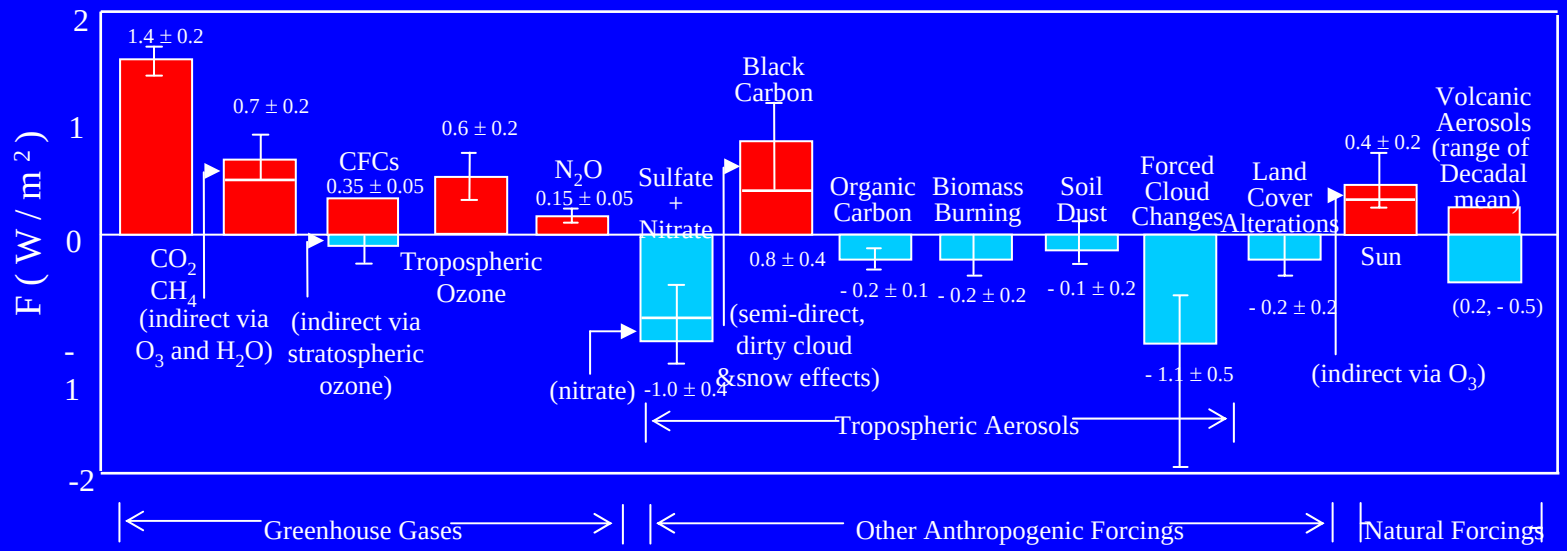


Contents

- Background
- Science and Natural Disasters
- Observing Systems
- Applications
- Summary

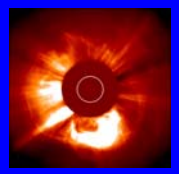
What Drives Our Planet?

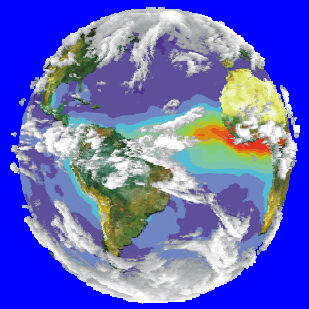




Re: J. Hansen/NASA GISS

Sun and Earth Science





Biosphere changes
- Land cover Land use
- Coastal zone erosions
- Carbon cycle

Weather Phenomena
- Precipitation
- Cloud cover
- Sea surface winds
- Tropospheric winds
- Hurricanes

Atmospheric chemistry
- Pollutants
- Transport phenomena
- Aerosols

Contribute to Natural or Anthropogenic Disaster Phenomena

Heliosphere
- Magnetic Field
- Atmosphere
- Plasma
- Radiation
- Solar Winds
- Energetic Particle

Climate system
- Transient climate
  - El Nino
  - Soil Moisture
  - Sea surface winds
- Long term – Radiation balance

Oceans
- Productivity and ocean color
- Carbon sequestering
- Salinity
- Sea Surface Temperature
- Global water cycle

Solid Earth
- Magnetic field
- Gravity
- Surface topography
- Surface transformation

Natural Disasters

Direct

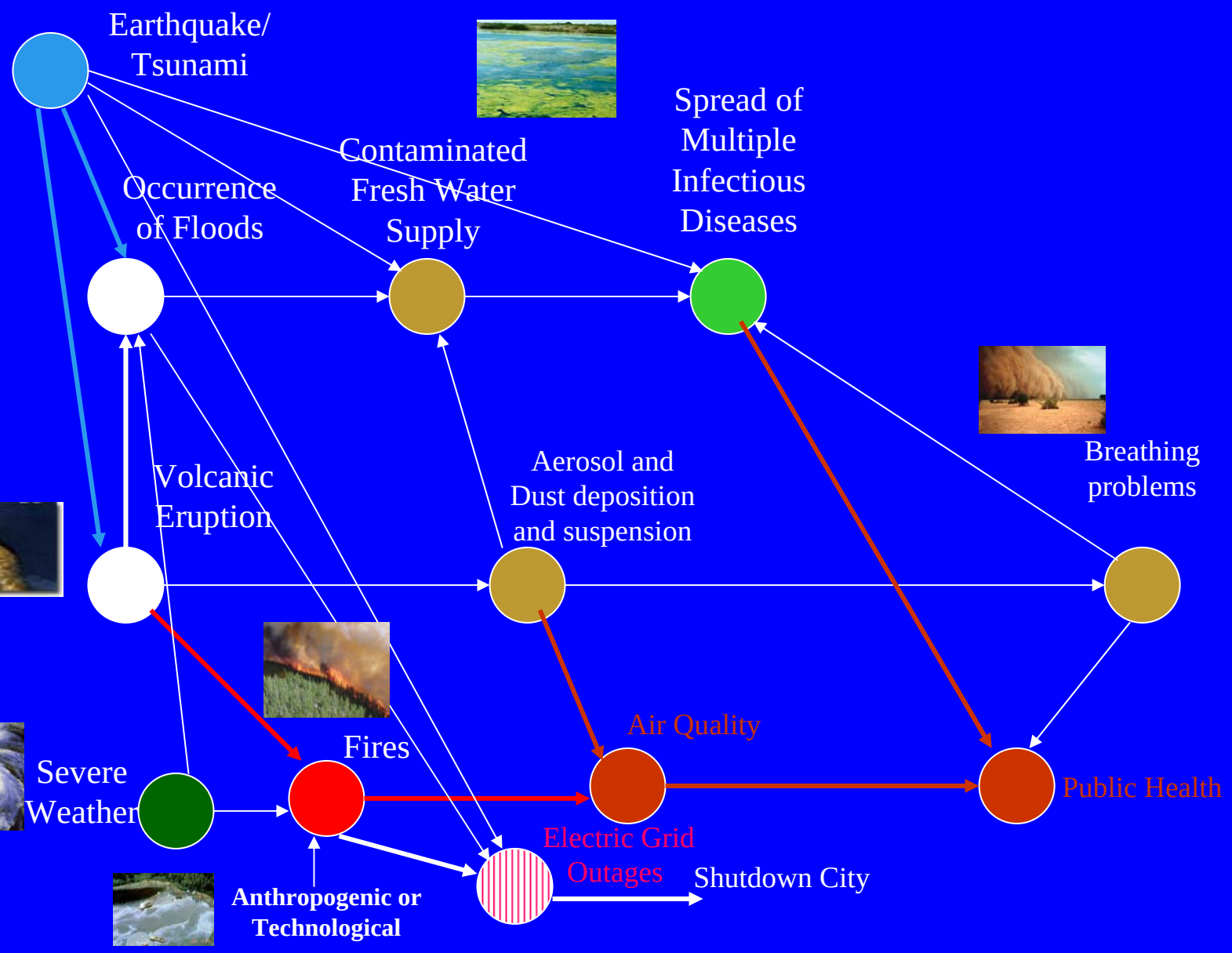
- Earthquakes
- Volcanoes
- Tsunamis
- Hurricanes or Typhoons
- Landslides
- Floods
- Tornadoes
- Severe Weather
- Drought
- Fires
- Dust Storms
- High Winds

Indirect

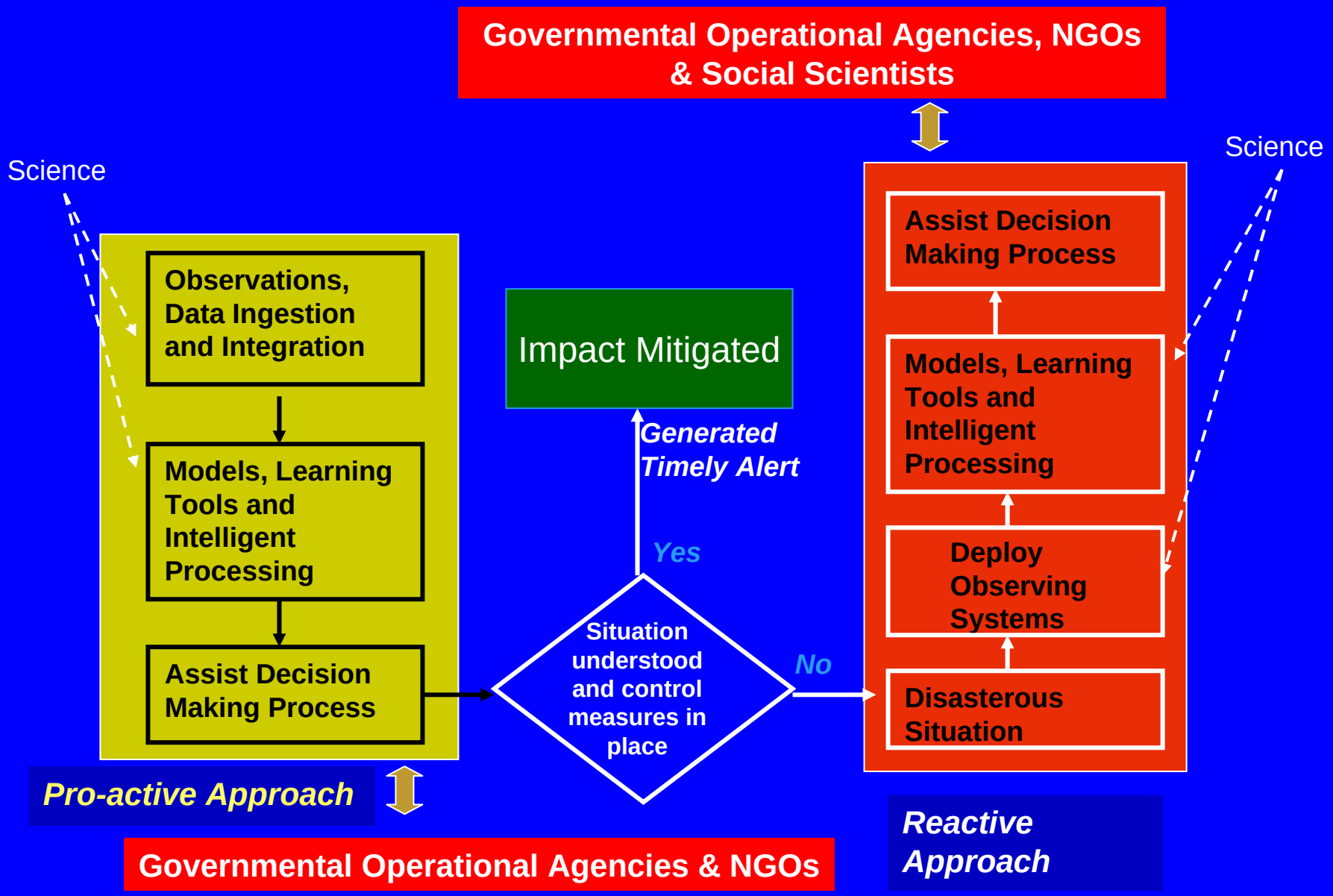
- Public Health
- Air Quality
- Invasive Species

Consequential

Natural Disasters can Feed Other Disasters



Preparedness to Prediction to Prevention

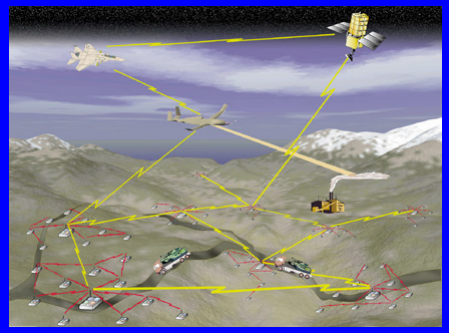


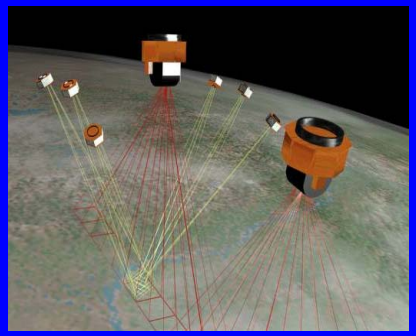
Venn Diagram of Sensor

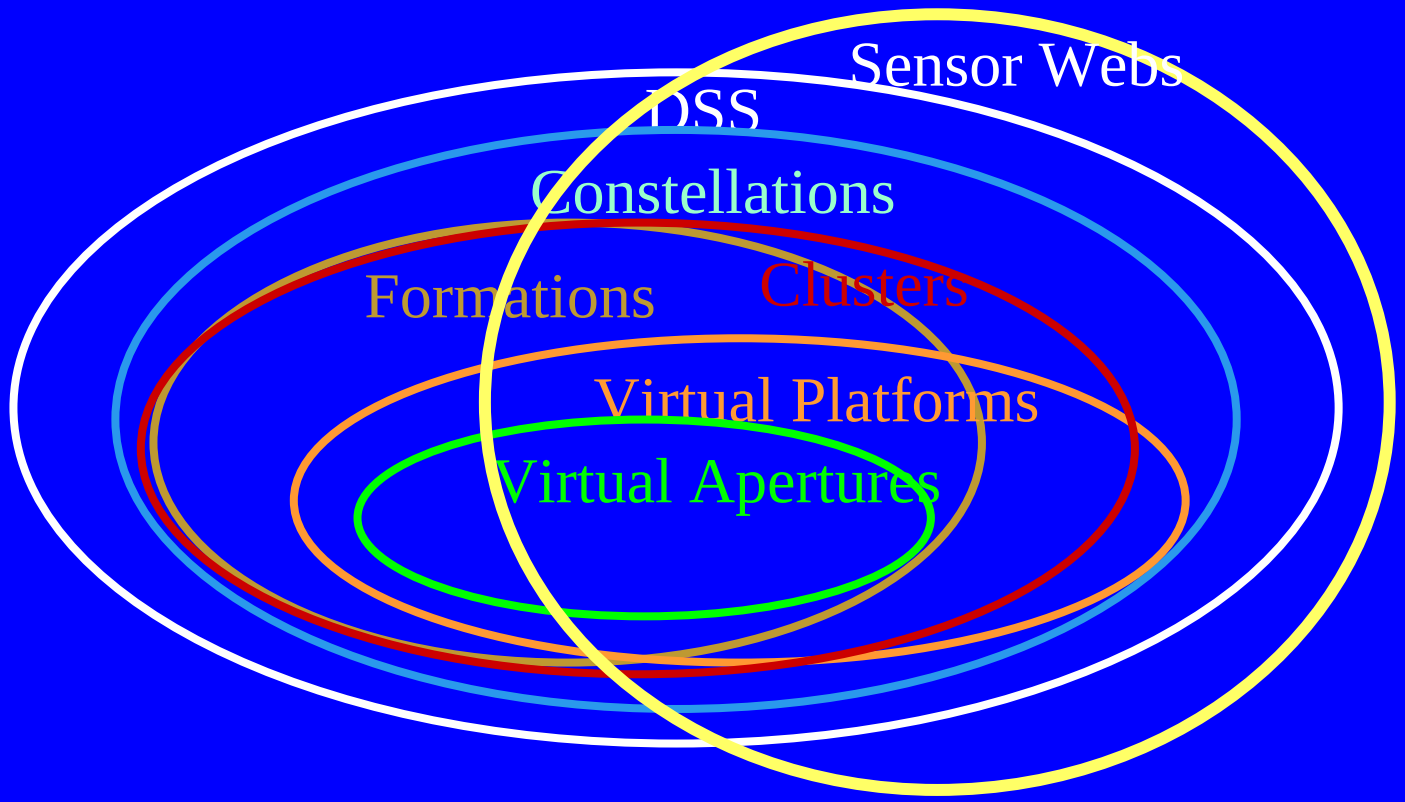
In situ
Airborne
Space based →

Remote Sensing Technologies
Passive (UV, Visible, IR, Microwave)
Active (Radar, SAR, Lidar)

→ High temporal resolution
High spatial resolution
High spectral resolution







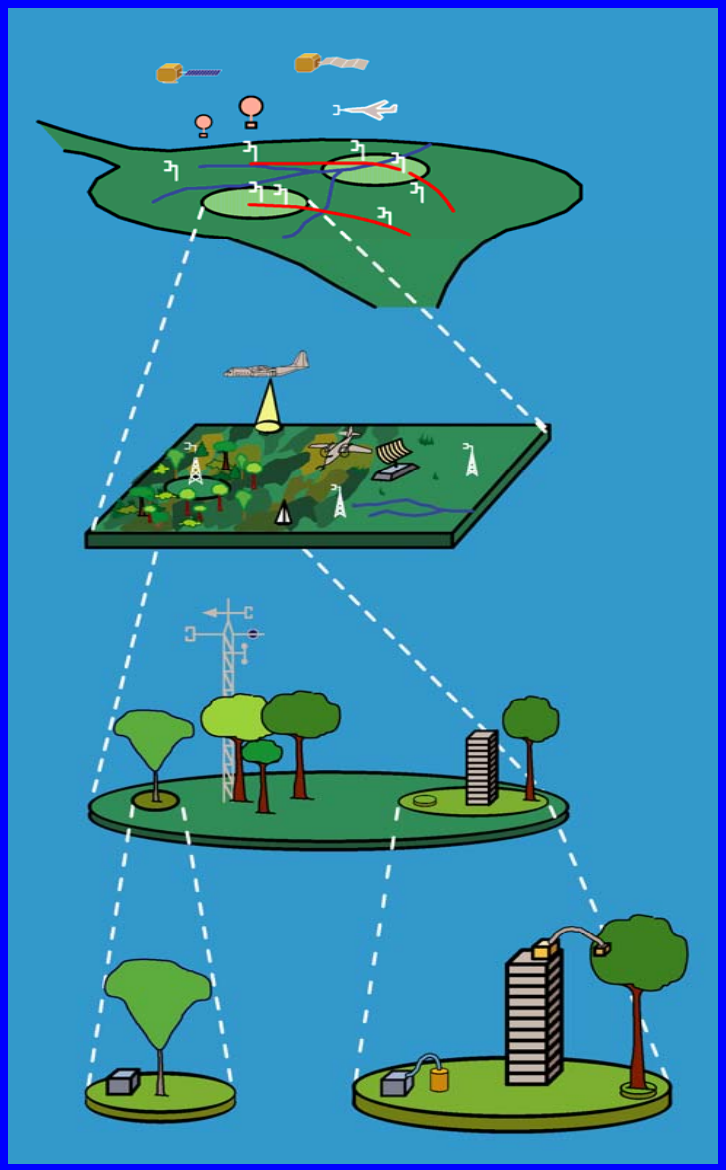
Why Multiple Sensors and Vantage Points

Satellites 100 - 10,000 km

Airplanes 1 - 100 km
Study Areas

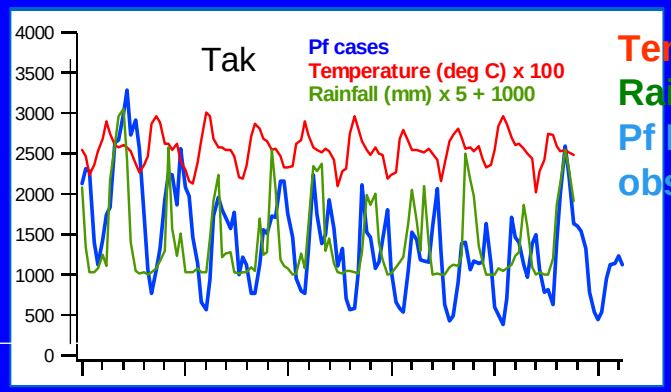
Towers ~ 1 km
Flux Tower Sites

In situ platforms 1 - 100 m
Process Study Plots
Validation Sites



Validation Sites Process Study Plots

Mekong Malaria in Tak, Thailand

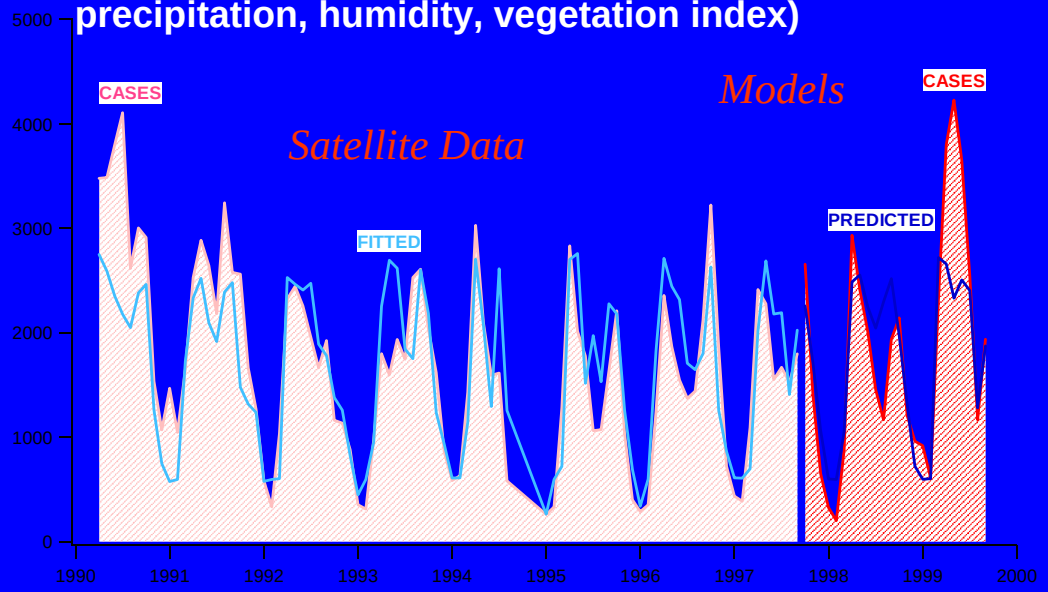


Temperature--satellite
Rainfall--satellite
Pf Parasite—field observations

Satellite Vegetation Data used for Insecticide Planning

Field data

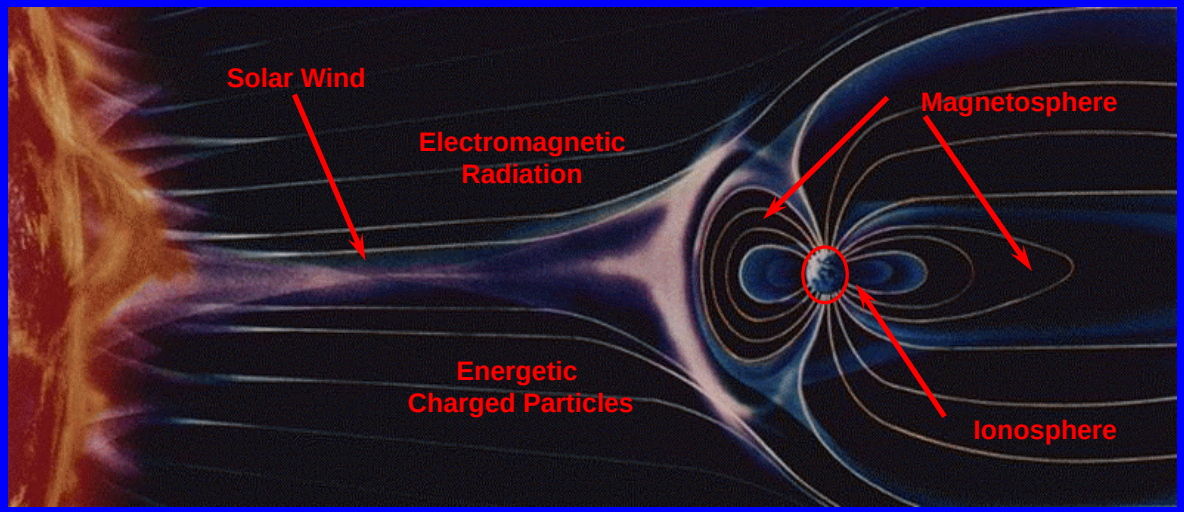
2-Year Prediction of Malaria Cases Based on Environmental Parameters (temperature, precipitation, humidity, vegetation index)

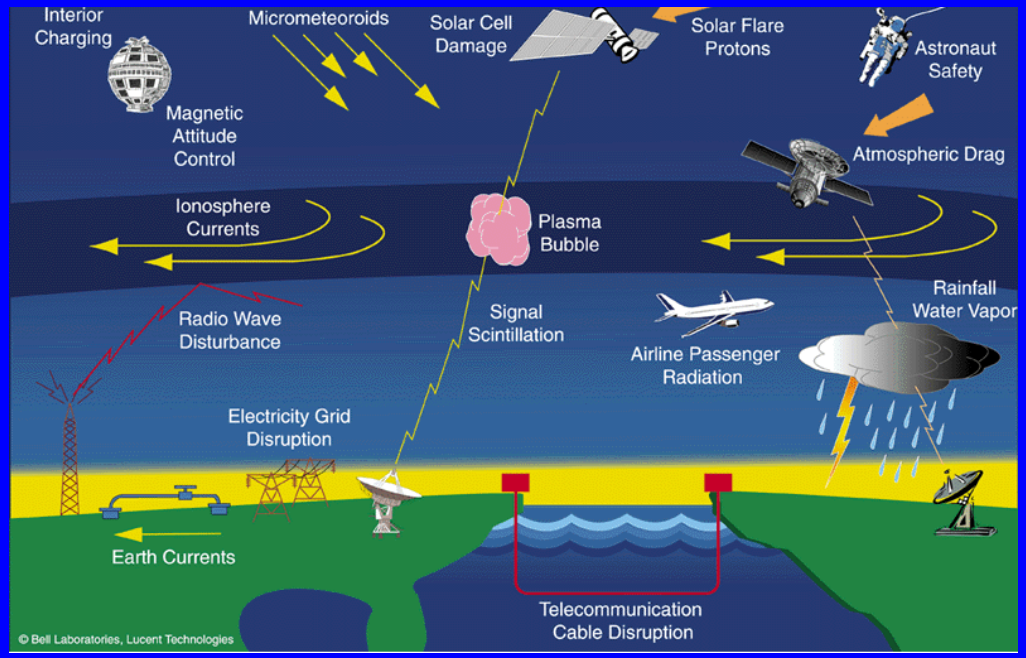


- Surface Hydrology
- Climate Prediction

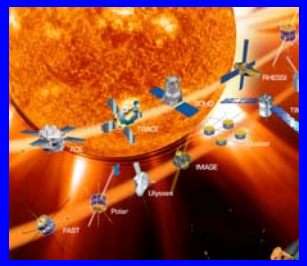
- Vector Habitat
- Transmission
- Risk Prediction

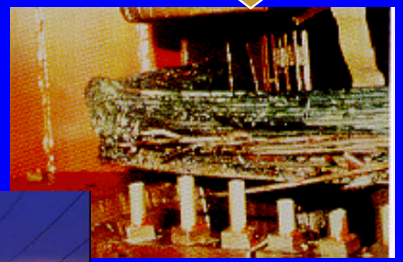
Near-Earth Space Weather Effects





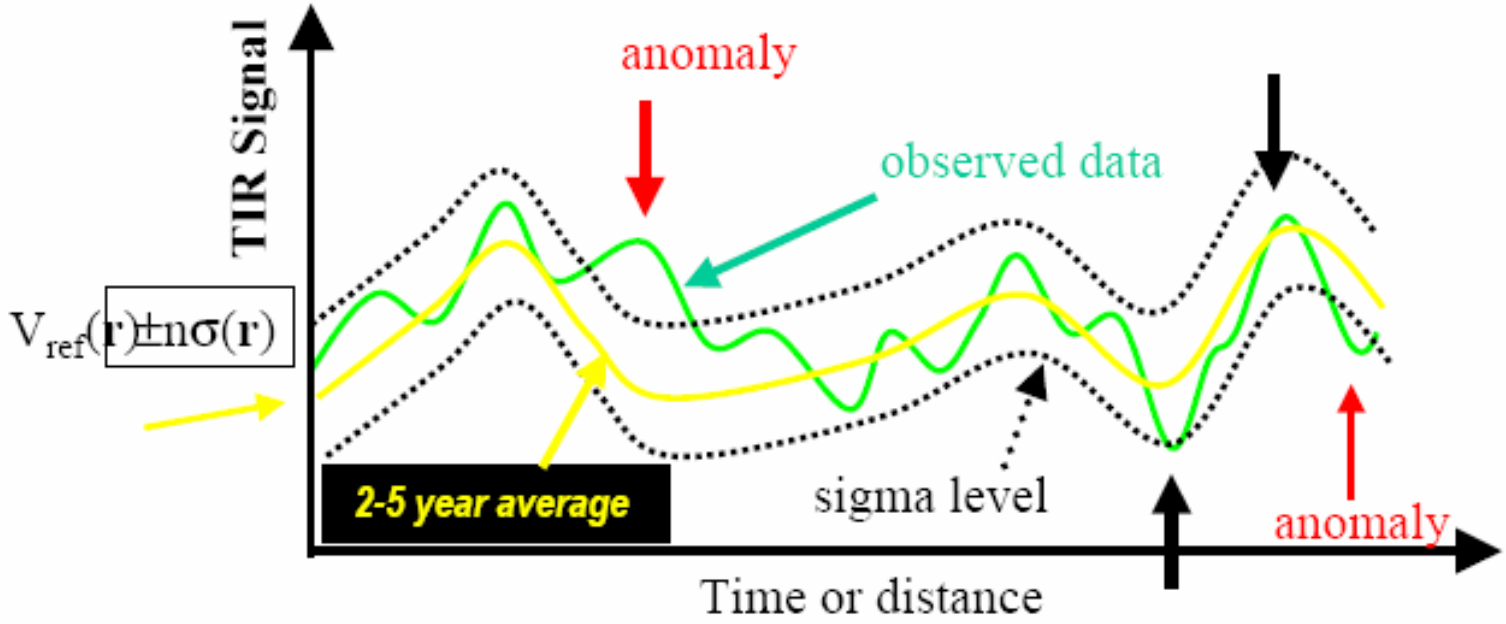
SOHO, ACE and EPRI Ground Sensors





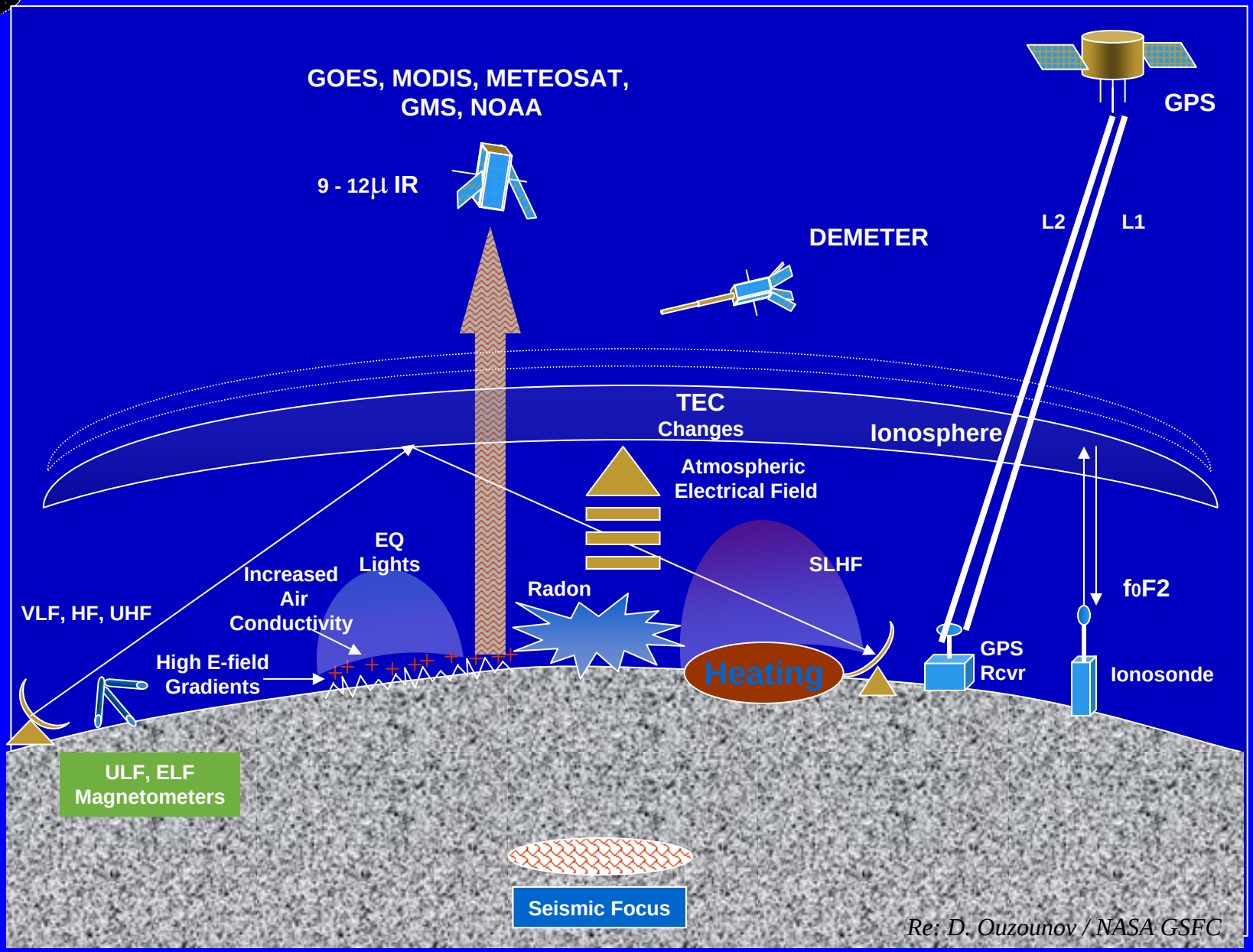
Thermal Anomaly prior to Earthquake Occurrence

- normally appear 4-20 days before an earthquake;
- affects area of several thousands or tens of thousand square km;
- displays a positive or negative deviation of > 2-4° C;
- disappears a few days after the event;
- variable shape – temporal and spatial dynamics

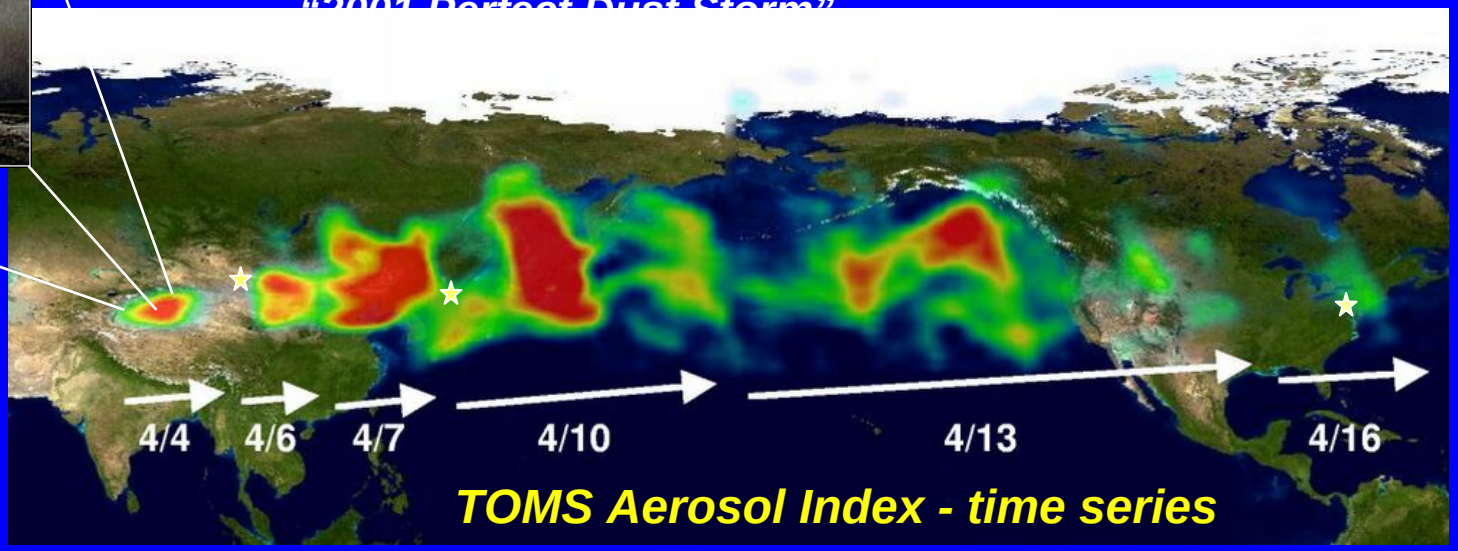


NASA GSFC, Dec 21, 2005, D.Ouzounov

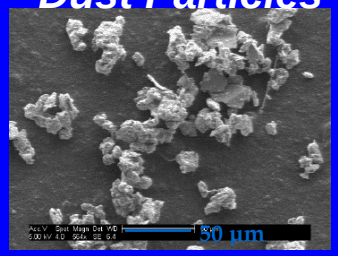
Multi-Sensor Detection .. *Thermal, Electric and magnetic fields*

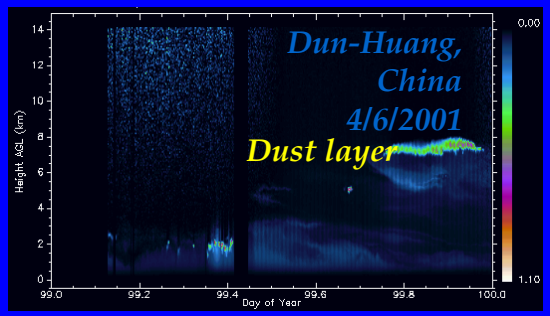


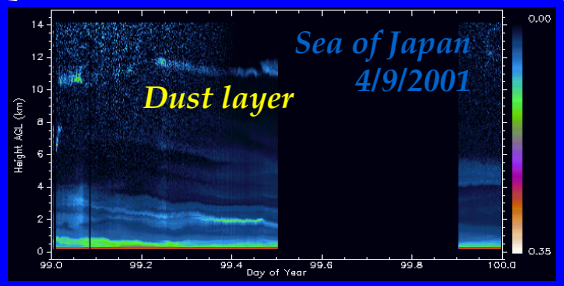
Asian Dust & microbes? Long Range Transport

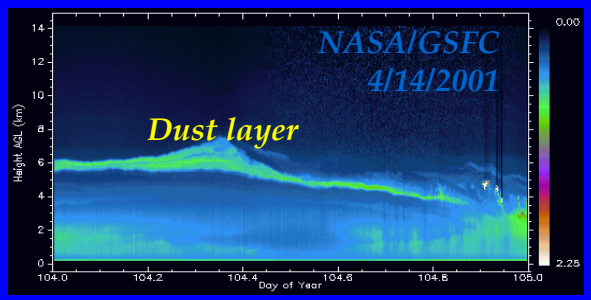


Dust Particles



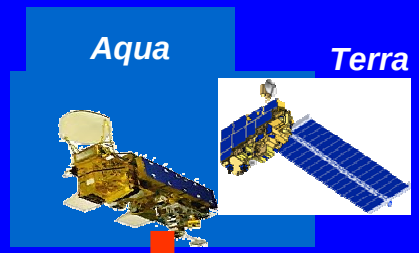


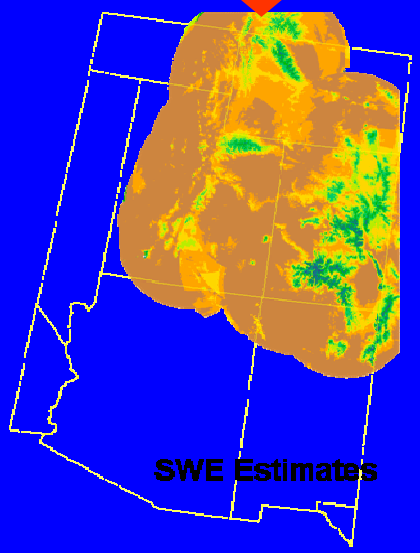




Lidar Profiling

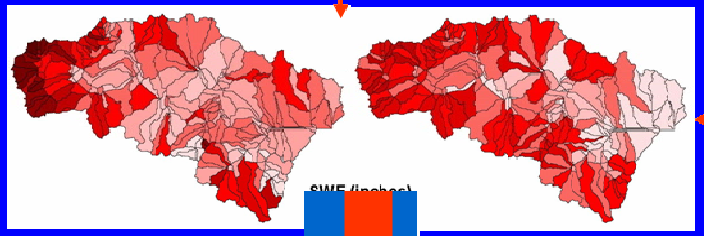
Floods – a serious threat

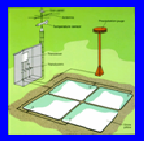




Field Measurements

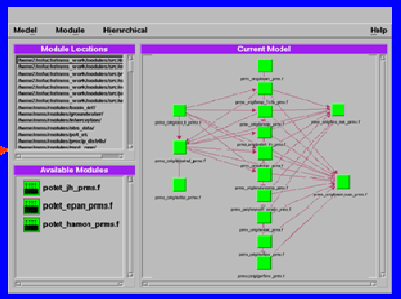
(BOR)





SNOTEL Ground Data

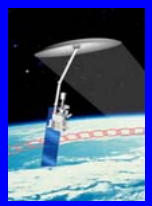
(NOAA)



Hydrologic Model

Water Resources Applications

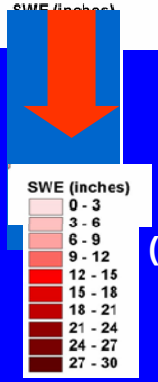
SMOS



Hydros

Land Models

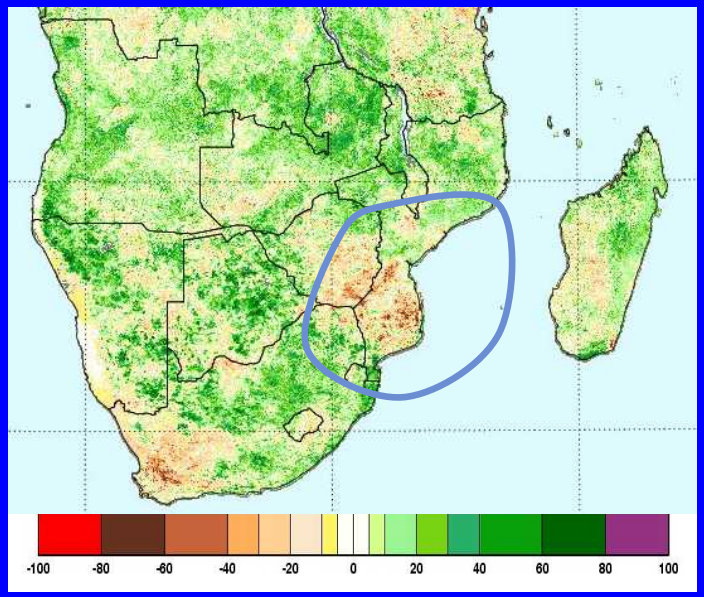
Floods



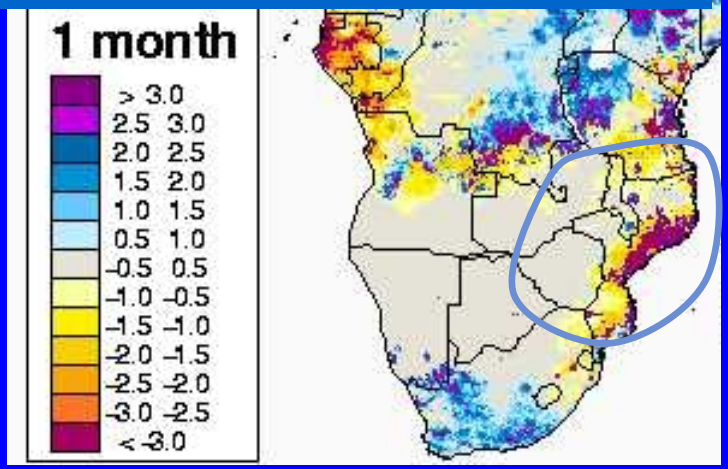
(NASA)

Regulating Reservoirs

Drought in Mozambique



Standardized Precip. Index



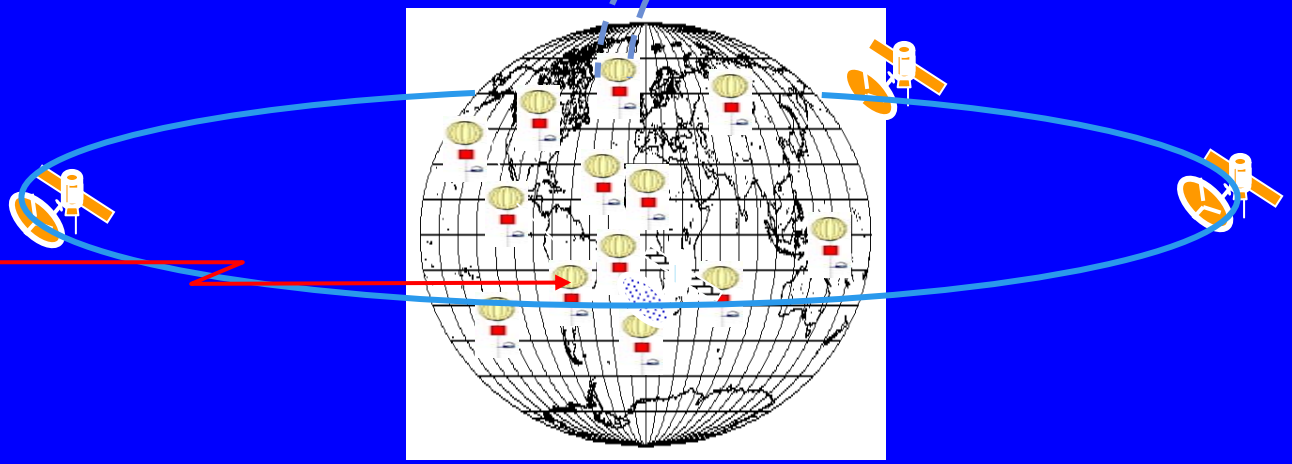
Satellite	Sensor	Observations/ Products
Terra/Aqua	MODIS	NDVI, Fire prod, H_2O Vapor
TRMM	Precip.Radar	Precipitation Data
POES	AVHRR AMSU-B	NDVI data from 1981 Humidity fields
JASON-1, TOPEX/	Altimeter	Reservoir and Lake levels

Model	Organization	Products
NCEP ETA model, NCEP/NCAR Reanalysis I/II	NCAR	Predicted Precipitation, Winds, pressure, relative humidity
TRMM Multiple Precip. Analysis	NASA	Tropical Precipitation
Rainfall Estimate, CMORPH	NOAA	Precipitation over Africa, Central America, Asia
ENSO phase and predictions	IRI/Columbia University	SST anomalies and ENSO forecast

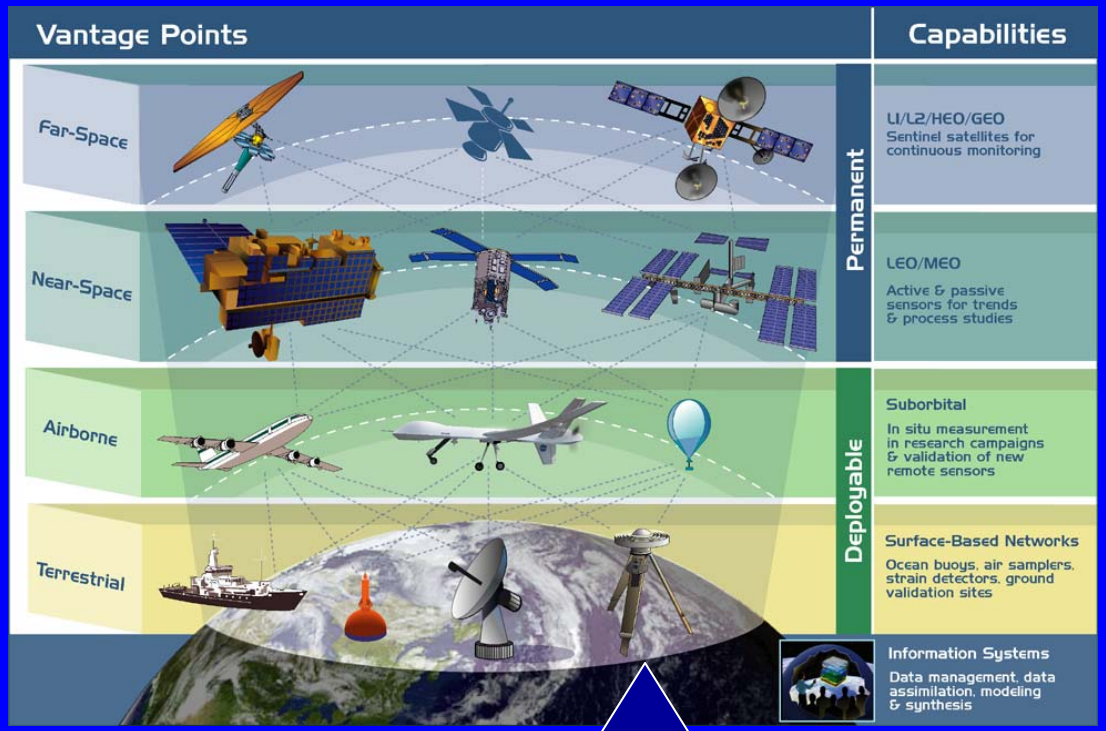
Re: June 9-15, 2005, Famine Early Warning System Network (FEWSNET)

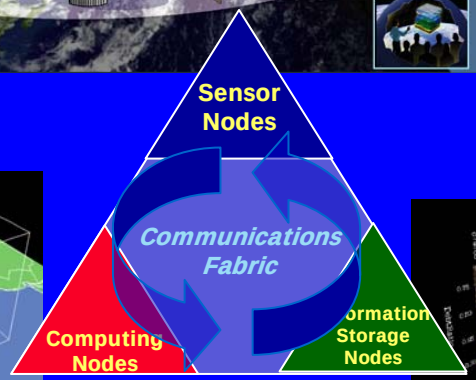
Dedicated Zonal Observers

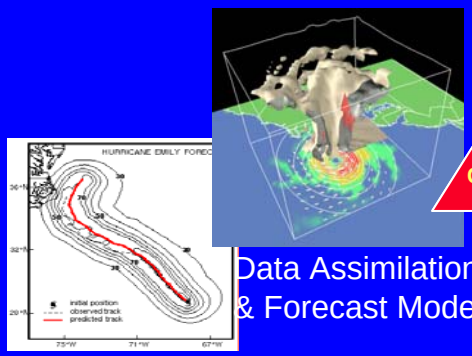
Ultra Long Duration Balloons (ULDBs)
40,000m for > 6 months



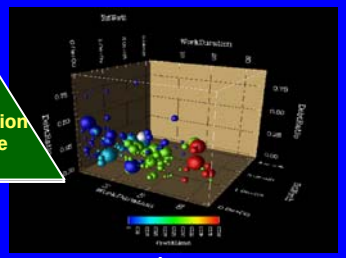
Notional Integrated Observing System







Data Assimilation & Forecast Models



Data Warehouses & Data Mining

Summary

- Observing systems should be science driven --- closely coupled with natural disasters
- No single entity can take on this responsibility --- pooling of resources is critical
- Must capitalize on using existing sensors to solve critical societal problems
- Both observing platforms/sensors and models are integral to forming a sensor web
- Complex phenomena e.g., earthquakes, floods, drought and more can benefit from additional observations and assimilation techniques to further our understanding