Conceptual Earth Ecosystem Model

A product of the Northern Gulf Institute

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Earth Ecosystems

Earth System Models are a class of models that integrate components and processes beyond the physical, dynamical systems present in climate models, with the intention of accurately representing the complex human, natural, chemical, and physical interactions that contribute and respond to climate.


Earth Ecosystem Models are a class of models that integrate and quantify the complex human, natural, chemical, and physical interactions of ecosystems as they respond to human and natural perturbations.

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Aquascapes = Watershed + Waterspread
Trans-Aquascape Considerations

- Atmospherics
- Social Systems
- Economics
- Ecosystems
- Infrastructure
“Aquascape”

• A complete hydrologic footprint, including:
  – Watershed – an area of the earth’s surface from which water flows downhill to a single outflow point.
  – Water-spread – the coastal and ocean area over which the watershed’s flow spreads and ocean forcings affect coastal and upstream waters.

• Expansive view required by the holistic nature of water resources and the systems which depend on water -- ecosystems, economic communities, social systems and their infrastructure.
The Earth System Perspective: Level 1

- **Human:** Social & Infrastructure Systems
- **Biotic:** Ecosystems
- **Physical:** Climate, Water & Landscape Systems

Information
Level 2 Framework

Information

- Matter
- Energy
- States
- Processes
- Fluxes
Weather & Climate Level 3

Natural & Anthropogenic Drivers

Long Term Climate

Short Term Climate

ENSO, NAO

Estuarine, Coastal, Basin Oceanography

Temperature (t), Waves (t)

Hydrology

Runoff & Groundwater (t)

4-D Atmospheric Pressure

4-D Winds

4-D Temperature

4-D Moisture (Clouds, Precipitation, Humidity)
For land & water surfaces – from the watershed to the sea
Estuarine, Coastal, & Gulf Oceanography Level 3

Weather
- sfc. momentum flux
- sfc. heat flux
- sfc. moisture flux
- sfc. pressure (t)

Estuary, Coastal, Basin 3D Geometry
- Shape, topography
- Bathymetry

Astronomical Tides
- Sea Level (t)
- 4-D Currents

Hydrology
- Runoff & Groundwater (t)

4-D Currents
- Sfc. Waves
- 4-D Temperature
- 4-D Salinity

Water Level (t)

Sed. Tran.

Gulf

Coastal

Estuary
Water Quality Level 3

For waterbodies – streams, rivers, lakes, reservoirs, estuaries and coastal waters – from the land to the sea.

Inorganic Nutrients and Organic Material Loads and/or Gas Exchange

Dissolved Oxygen

Nutrients and Organic Materials

Aquatic Plants (phytoplankton, periphyton, macrophytes)

Sediment Biogeochemistry

From Tides, Currents, Transport

Water Column (Advective and Dispersive) and Sediment Transport

From Hydrology, Atmosphere, Other Waterbodies

Nutrient and Organic Material Loads and/or Gas Exchange

Human Alteration
Foodweb – Level 3

For waterbodies – streams, rivers, lakes, reservoirs, estuaries and coastal waters – from the land to the sea

From water quality & hydro
- Nutrients, do, temp, salinity

Habitat & assemblage movement

Primary production

Secondary production

Assemblage structure

Fish Assemblages

Human Alteration

Food Web
Ecosystem Level 3

From Hydrology/ECGO/Weather
transport vectors, light penetration, temperature, salinity, total suspended solids

From Water Quality
Nutrient and organic material load, dissolved oxygen level, biogeochemical interchange

From Human activities
Fishing pressure, habitat degradation (?)
Ecosystem Services

For a Habitat or Species

Bio-physical Functioning → Ecological Functioning → Ecosystem Services Generated from Ecological Functioning

Constituents of Well-Being

Security
- Personal Safety
- Resource Access
- Secure from Disasters

Material
- Livelihoods
- Food
- Shelter

Health
- Strength
- Feeling Well
- Clean air & Water

Social Relations
- Social cohesion
- Mutual respect
- Ability to help others

Freedom of Choice and Action
Opportunity to achieve what an individual values doing and being
Processes and Models

- **Weather:** GCM & Downscaling
- **Hydrology:** (HSPF, GSSHA, etc.)
- **Hydraulics:** (ADH, NCOM, FVCOM, etc.)
- **Water Quality:** (WASP, ICM, etc.)
- **Ecosystems:** (Ecopath, Atlantis, TroSim, etc.)
- **Economic & Social**