INTEGRATED COMPARTMENT MODEL (ICM)

- **ICM-LAVegMod**
  - Models coverage of 43 vegetation species and bareground

- **ICM-Morph**
  - Models elevation changes across all wetlands and open water

Example from the land use land cover dataset in the Wax Lake Delta region. Different colors represent different vegetation coverages.
INTEGRATED COMPARTMENT MODEL (ICM)

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  - Maddie Foster-Martinez

- **ULL**
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  - Scott Duke-Sylvester

- **LSU**
  - Kristin DeMarco

ICM-LAVegMod

- Original Developers:
  - Jenneke Visser
  - Scott Duke-Sylvester

- Additional Developer:
  - Maddie Foster-Martinez

ICM-Morph

Original Developer:
- Brady Couvillion

- Additional Developer:
  - Eric White
INTEGRATED COMPARTMENT MODEL (ICM)

- ICM-LA VegMod
  - Models coverage of 43 vegetation species and bareground
  - Operates on a 480 m x 480 m grid (boxes)

- ICM-Morph
  - Models elevation changes
  - Operates on a 30 m x 30 m grid (cells)

Example from the land use land cover dataset in the Wax Lake Delta region. Different colors represent different vegetation coverages.
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Example from the land use land cover dataset in the Wax Lake Delta region. Different colors represent different vegetation coverages. White lines show the ICM-LAVegMod grid.
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  - Models coverage of 43 vegetation species and bareground
  - Operates on a 480 m x 480 m grid (boxes)

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Example from the land use land cover dataset in the Wax Lake Delta region. Different colors represent different vegetation coverages. White lines show the ICM-LAVegMod grid.
INTEGRATED COMPARTMENT MODEL (ICM)

- ICM-LAVegMod
  - Models coverage of 43 vegetation species and bareground
  - Operates on a 480 m x 480 m grid (boxes)

- ICM-Morph
  - Models elevation changes
  - Operates on a 30 m x 30 m grid (cells)
  - 256 ICM-Morph cells in every ICM-LAVegMod box

Example from the land use land cover dataset in the Wax Lake Delta region. Different colors represent different vegetation coverages. White lines show the ICM-LAVegMod grid. Black lines show the ICM-Morph grid.
ICM-LAVEGMOD
SPECIES MODELED

**Flotant**
- Eleocharis baldwinii
- Panicum hemitomon

**Bottomland Hardwood**
- Quercus laurifolia
- Quercus lyrate
- Quercus nigra
- Quercus texana
- Quercus virginiana
- Ulmus americana

**Swamp Forest**
- Nyssa aquatica
- Salix nigra
- Taxodium distichum

**Fresh Marsh**
- Colocasia esculenta
- Morella cerifera
- Panicum hemitomon
- Sagittaria latifolia
- Zizaniopsis miliacea

**Intermediate Marsh**
- Cladium mariscus
- Eleocharis cellulose
- Iva frutescens
- Paspalum vaginatum
- Phragmites australis
- Polygonum punctatum
- Sagittaria lancifolia
- Schoenoplectus californicus
- Typha domingensis

**Salt Marsh**
- Avicennia germinans
- Distichlis spicata
- Juncus roemerianus
- Spartina alterniflora
- Uniola paniculate
- Strophostyles helvola
- Sporobolus virginicus
- Spartina patens
- Solidago sempervirens
- Panicum amarum
- Baccharis halimifolia

**Brackish Marsh**
- Schoenoplectus americanus
- Schoenoplectus robustus
- Spartina cynsuroides
- Spartina patens

**Salt Marsh**
- Avicennia germinans
- Distichlis spicata
- Juncus roemerianus
- Spartina alterniflora
- Uniola paniculate
- Strophostyles helvola
- Sporobolus virginicus
- Spartina patens
- Solidago sempervirens
- Panicum amarum
- Baccharis halimifolia
ICM-LAVEGMOD: SPECIES ATTRIBUTES

• Each vegetation species has four attributes:
  • Probability of mortality given environmental conditions
  • Probability of establishment given environmental conditions
  • FFIBS value (salinity value)
  • Dispersal class

• Attributes are set inputs and do not change over time
ICM-LAVEGMOD: SPECIES ATTRIBUTES
MORTALITY AND ESTABLISHMENT TABLES

• Every vegetation species has a probability of mortality and probability of establishment
• These probabilities are based on CRMS data
• The probabilities for Bottomland Hardwood species are determined by the ground elevation
• The probabilities for all other species are determined by the mean annual salinity and the water level variability
ICM-LAVEGMOD: SPECIES ATTRIBUTES

SPECIES ATTRIBUTES: MORTALITY AND ESTABLISHMENT TABLES

- Example from black mangrove (*Avicennia germinans*)

![Mortality and Establishment Diagrams](chart.png)
ICM-LAVEGMOD: SPECIES ATTRIBUTES

FFIBS SCORE

• Every vegetation species is given a value based on salinity regime

• A FFIBS score is calculated for each ICM-LAVegMod grid box

• The FFIBS score is an average of the FFIBS values weighted by the area occupied by each species
ICM-LAVEGMOD: SPECIES ATTRIBUTES

DISPERAL CLASS

- The dispersal class describes how far a species can spread as conditions change.
- Three classes:
  - Low = Can move 1 box
  - Medium = Can move 2 boxes
  - High = Can move anywhere
- The ability to establish on bareground is based off both establishment probability and how abundant the species is in the area.

Example from the land use land cover dataset. Different colors represent different vegetation coverages. Black lines show the ICM-LAVegMod grid. The blue box bounds the spread area for low dispersal class species, and the purple box bounds the spread for medium dispersal species.
ICM-LAVEGMOD: INITIAL CONDITIONS

- Map of 2018 land use land cover (LULC) is used to create the initial vegetation coverages (10 m resolution)
- The coverage of every species is summed in each ICM-LA VegMod grid box

Example from the land use land cover dataset. Different colors represent different vegetation coverages. Black lines show the ICM-LA VegMod grid.
ICM-LAVEGMOD: INITIAL CONDITIONS

- Map of 2018 land use land cover (LULC) is used to create the initial vegetation coverages (10 m resolution)
- The coverage of every species is summed in each ICM-LAVEgMod grid box

Pie charts represent the coverage percentages of every species within each ICM-LAVEgMod grid box.
ICM-LAVegMod: Initial Conditions

- Map of 2018 land use land cover (LULC) is used to create the initial vegetation coverages (10 m resolution)
- The coverage of every species is summed in each ICM-LAVegMod grid box
- ICM-LAVegMod keeps track of coverage percentages
- ICM-Morph keeps track of where the vegetation is within each ICM-LAVegMod grid box

Pie charts represent the coverage percentages of every species within each ICM-LAVegMod grid box.
ICM-LAVEGMD: PROCESSES
ONE YEAR OF MODEL PROCESSES FOR ONE GRID BOX

- Water
- COES
- PAHE
- SALA2
- TYDO
ICM-LAVEGMOD: PROCESSES
ONE YEAR OF MODEL PROCESSES FOR ONE GRID BOX

TYDO = cattail

SALA2 = arrowhead

COES = elephant ear

PAHE = maidencane

Water
ICM-LAVEGMOD: PROCESSES
DETERMINE LAND CHANGES FROM ICM-MORPH

- ICM-Morph determines if land was lost, gained, or remained the same in every ICM-LAVegMod grid box
- Compare the %water from ICM-Morph to the current %water in the grid box
ICM-LAVEGMOD: PROCESSES
DETERMINE LAND CHANGES FROM ICM-MORPH

- ICM-Morph determines if land was lost, gained, or remained the same in every ICM-LAVegMod grid box
- Compare the %water from ICM-Morph to the current %water in the grid box
- For this example, land was gained: water coverage is reduced and new bareground is created
ICM-LAVEGMOD: PROCESSES
HIGH DISPERSAL SPECIES CAN ESTABLISH

- The probability of establishment is determined for each species in the high dispersal class
- The probability of establishment is determined by the annual salinity and the water level variability
ICM-LAVEGMOD: PROCESSES
HIGH DISPERSAL SPECIES CAN ESTABLISH

• The probability of establishment is determined for each species in the high dispersal class

• The probability of establishment is determined by the annual salinity and the water level variability

• For this example:
  • Annual salinity = 0.8 ppt
  • Water level variability = 0.12 m
  • Limited species selection for simplicity
ICM-LAVEGMOD: PROCESSES
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ICM-LAVEGMOD: PROCESSES

MORTALITY

• The probability of mortality is determined for every species by the annual salinity and the water level variability

• The probability of mortality is directly applied to reduce the coverage

• For this example:
  • Annual salinity = 0.8 ppt
  • Water level variability = 0.12 m
  • Limited species selection for simplicity
ICM-LAVEGMOD: PROCESSES

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The probability of mortality is determined for every species by the annual salinity and the water level variability.

The probability of mortality is directly applied to reduce the coverage.

For this example:
- Annual salinity = 0.8 ppt
- Water level variability = 0.12 m
- Limited species selection for simplicity
• The probability of establishment is determined for every species by the annual salinity and the water level variability.

• The probability of establishment is not directly applied.

• The available new bareground is distributed between the species based on:
  • Establishment probability
  • Presence in the surrounding grid boxes
ICM-LAVEGMOD: PROCESSES

ESTABLISHMENT

• The available new bareground is distributed between the species based on:
  • Establishment probability
  • Presence in the surrounding grid boxes

• For this example:
  • Annual salinity = 0.8 ppt
  • Water level variability = 0.12 m
  • Limited species selection for simplicity

Diagram: Pie chart showing distribution of new bareground among species (TYDO, PHAUC7, SALA2, COES, PAHE).
ICM-LAVEGMOD: PROCESSES

ESTABLISHMENT

• The available new bareground is distributed between the species based on:
  • Establishment probability
  • Presence in the surrounding grid boxes

• For this example:
  • Annual salinity = 0.8 ppt
  • Water level variability = 0.12 m
  • Limited species selection for simplicity
ICM-LAVEGMOD: PROCESSES
ACUTE SALINITY STRESS

- If the salinity was greater than 5.5 ppt for 2 weeks, then the freshwater marsh are removed completely from the grid box.
ICM-LAVEGMOD: PROCESSES
ACUTE SALINITY STRESS

- If the salinity was greater than 5.5 ppt for 2 weeks, then the freshwater marsh are removed completely from the grid box.
ICM-LAVEGMOD: PROCESSES
ACUTE SALINITY STRESS

• If the salinity was greater than 5.5 ppt for 2 weeks, then the freshwater marsh are removed completely from the grid box

• If nothing is able to establish on new bareground, the next year it becomes old bareground
**ICM-LAVEGMOD: PROCESSES**

**FFIBS SCORE**

- The FFIBS score is an average of the FFIBS values weighted by the area occupied by each species.

- For this example:
  - PHAU7 = 2.75
  - TYDO = 2.75
  - SALA2 = 0.25
  - PAHE2 = 0.25
  - COES = 0.25

  FFIBS score → 0.8
ICM-LA VegMod TO ICM-Morph

PASS INFORMATION

ICM-LA VegMod

• FFIBS score
• New bareground coverage
• Old bareground coverage
• Flotant loss

ICM-Morph
ICM-MORPH PROCESSES
SIDE VIEW OF ICM-MORPH GRID
ICM-MORPH PROCESSES
SIDE VIEW OF ICM-MORPH GRID

Upland
ICM-MORPH PROCESSES

SIDE VIEW OF ICM-MORPH GRID

- Upland
- Vegetated wetland
ICM-MORPH PROCESSES

SIDE VIEW OF ICM-MORPH GRID

Upland

Vegetated wetland

New bareground

Old bareground
ICM-MORPH PROCESSES
SIDE VIEW OF ICM-MORPH GRID

- Upland
- Vegetated wetland
- New bareground
- Old bareground
- Annual mean surface water elevation
- Water bottom too deep for vegetation establishment
ICM-MORPH PROCESSES
MINERAL SEDIMENT DEPOSITION

• Amount of mineral sediment deposition is determined by the maximum water surface elevation
• Evaluated monthly
ICM-MORPH PROCESSES
MINERAL SEDIMENT DEPOSITION

- Amount of mineral sediment deposition is determined by the maximum water surface elevation
- Evaluated monthly

Cumulative mineral sediment deposition

Monthly maximum water surface elevation

Monthly mineral sediment deposition

Cumulative mineral sediment deposition
ICM-MORPH PROCESSES
ORGANIC ACCRETION

• Amount of organic accretion is determined by the habitat type (weighted FFIBS score)
• Evaluated annually
ICM-MORPH PROCESSES

ELEVATION LOSS

- Deep and shallow subsidence is spatially variable
- Old bareground is lowered (compaction)
- Evaluated annually
ICM-MORPH PROCESSES

OUTPUTS

- Elevations are updated and evaluated to determine land/water
- Depth threshold between land/water varies with salinity
ICM-MORPH TO ICM-LAVeGMod

PASS INFORMATION

- Land and water coverages
ICM-MORPH TO ICM-LAVEGMOD

PASS INFORMATION

ICM-Morph

• Land and water coverages

ICM-Hydro

• Elevation

ICM-LAVegMod
ICM PROCESSES

• Evaluated annually

ICM-Hydro

ICM-Morph

ICM-LAVegMod
ICM QA/QC

- Model output is examined across the coast
  - 365 CRMS stations
  - 250 spread throughout the ecoregions
  - 15 transects (76 sites total)
  \[ \rightarrow 691 \text{ sites} \]

Example transect of observation sites north of Lake Cataouatche.
MORE INFORMATION ON ICM

• ICM-LAVegMod
  • Visser et al. (2013)
  • Visser & Duke-Sylvester (2017)

• ICM-Morph
  • Couvillion et al. (2013)
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Thank you for your attention!