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GENII: Environmental Concentrations

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Define the Assessment Question!

- Features, events, and processes (FEPs)
- Exposure Scenarios: A scenario is a conceptual model that describes patterns of human activity, events, and processes that result in radiation exposure to people.
- Pathways of exposure
  - External
  - Inhalation
  - Ingestion

Plant and Animal (Terrestrial) Models

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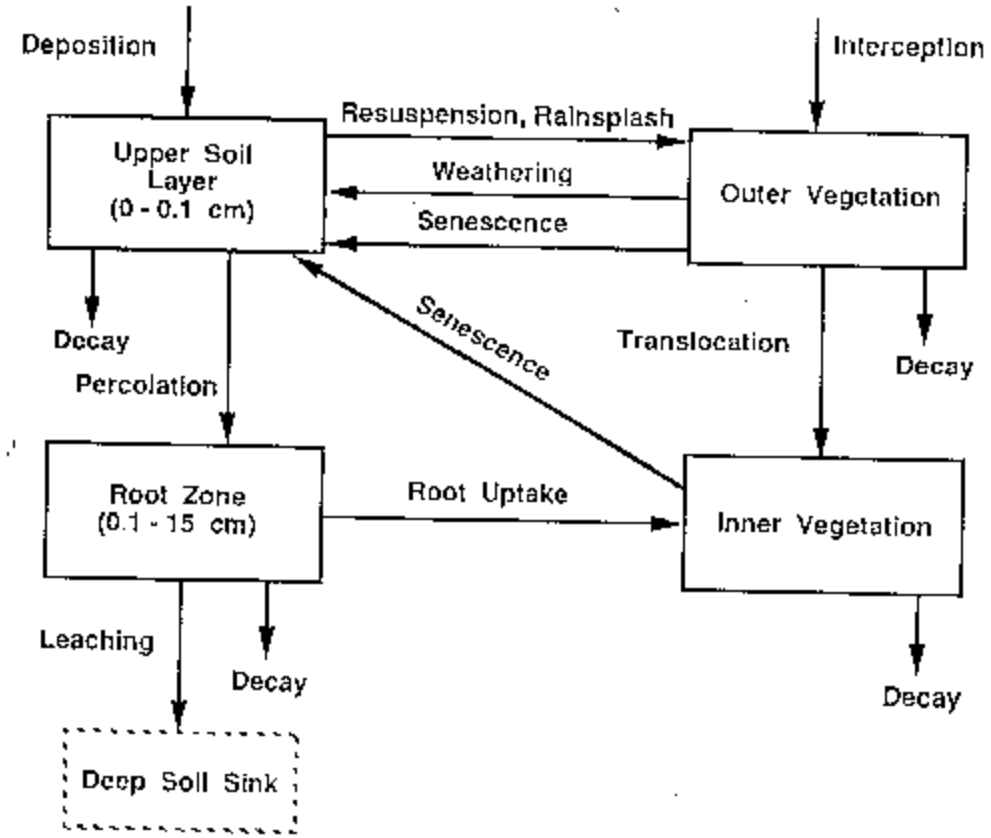
Terrestrial Transport & Accumulation Models

- Different methods must be applied to different questions
- Model selection depends on:
  - Spatial scales
  - Temporal scales
  - Available data
- Models may be dynamic or steady-state

Dynamic Soil and Vegetation Compartments



Modeling Assumptions

- Climate
- Future land use
- Human activities
  - Behavior
  - Food consumption
  - Mobility

Terrestrial Scenarios

- Intrusion (drilling, excavation, archeology)
- Farming (gardening)
- Industrial
- Residential
- Recreational (fishing, hunting, swimming)
- (Anything people can do anywhere)

External Exposure - Air

- Infinite plume
  - Plume large enough that edge effects negligible
  - Energy emitted = energy absorbed per unit volume
- Finite plume
  - Dose is a function of plume dimensions
  - Point-kernel space integration
  - Approaches infinite plume at long distances

External Exposure – Soil and Sediment

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- Air & Irrigation deposition
  - Infinite plane or slab approximation
  - Detailed shielding calculation for indoors vs outdoors
- Sediment buildup
  - Shore width factor (correction to infinite plane)

Soil Ingestion

- Inadvertent ingestion
  - Generally small amounts
  - Higher in children than adults
  - Generally higher in “indigenous peoples”
  - Generally only important for radionuclides of very low environmental mobility
  - Generally <100 mg/day

Biotic Transport

- Buried-waste to surface transport
  - Plant roots
  - Burrowing animals

Food Chain Pathways

- Vegetation uptake
  - Air-to-plant deposition
  - Water-to-plant deposition
  - Soil-to-plant uptake
- Animal uptake
  - Plant-to-animal-product transfer
  - Water-to-fish uptake

Air-to-Plant Deposition

- Deposition “velocity”
- Interception fraction
- Weathering/retention
- Translocation

Deposition Velocity

- Depends on:
  - Windspeed
  - Plant cover
  - Humidity
  - Particle size
  - Chemical interactions

Interception Fraction

- Depends on:
  - Biomass (mass of plants per unit area)
  - Leaf area index
  - Day/night
  - Leaf type

Weathering / Retention

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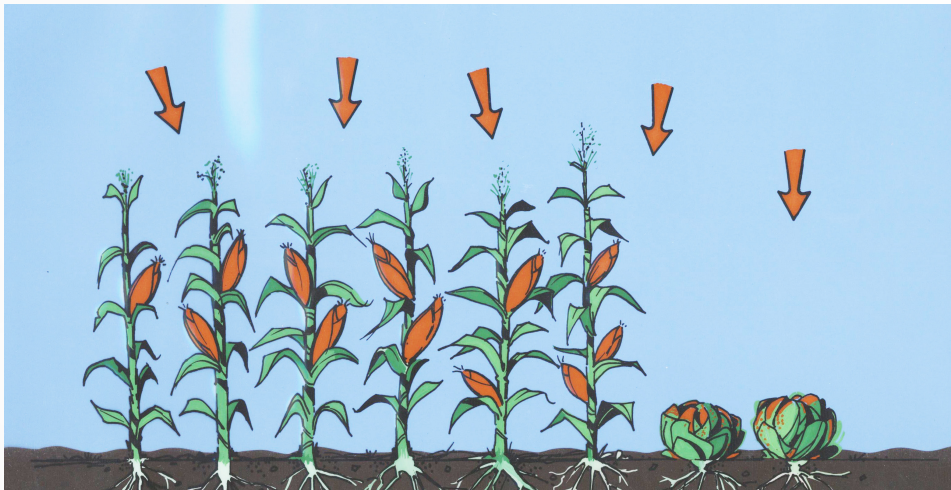
- Depends on:
  - Leaf type
  - Rainfall
  - Volatilization
  - Plant growth

Translocation

- Depends on:
  - Species of plant
  - Chemical form
  - Radionuclide



Water-to-Plant Deposition

- Interception fraction
- Splashup
- Weathering
- Translocation

Soil-to-Plant Uptake

- Generally treated with a concentration ratio:
- CR = [Ci/kg plant per Ci/kg of soil]
  - Wet or dry plant?
  - Species
  - Soil characteristics (Kd?)
  - Analog concentrations
  - Rooting depth

Plant Roots

- Alfalfa roots to 10 meters
- High CR nuclides preferentially moved
- Plant litter accumulates on surface

Plant-to-Animal Products

- Generally treated with a transfer factor
- Fm = [Ci/L milk per Ci/day ingested]

  - Vegetation density
  - Season/temperature
  - Stable element intake
  - Stage of lactation

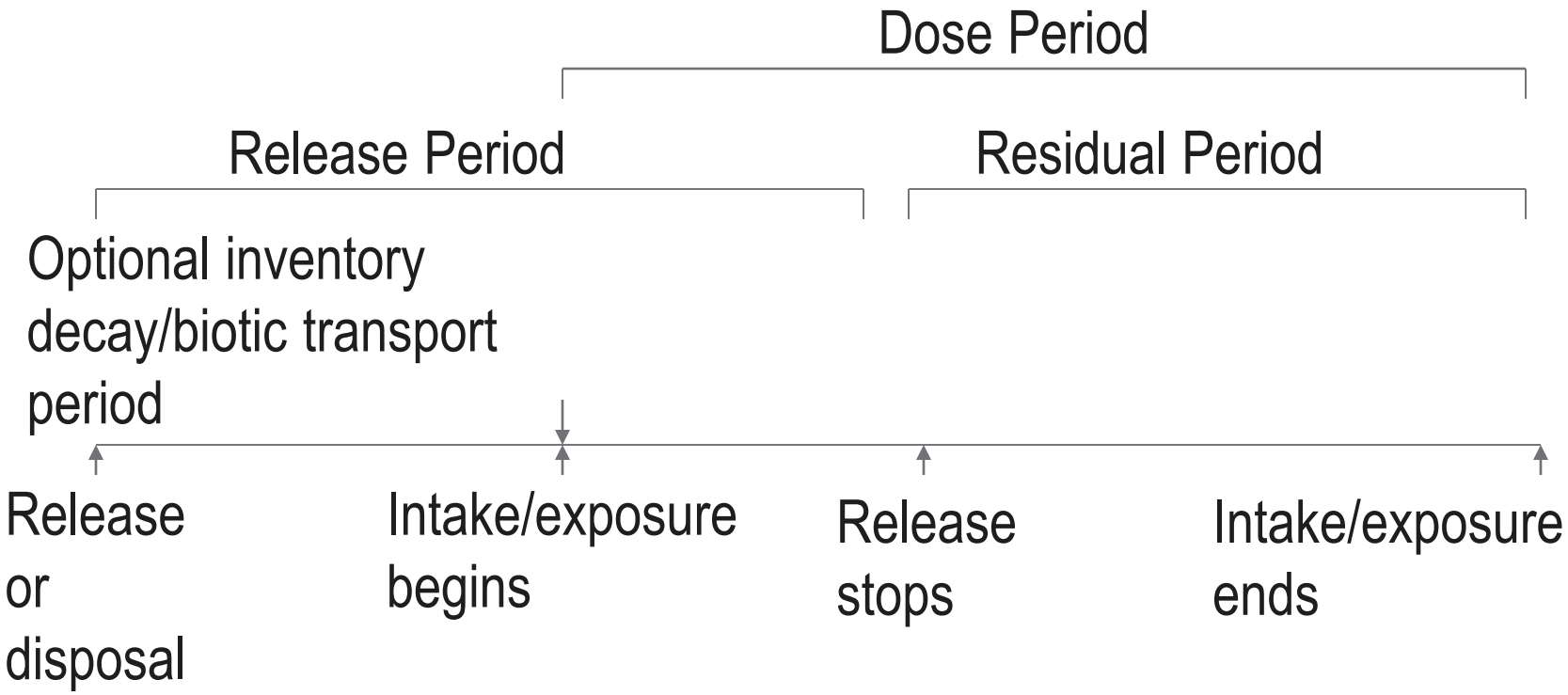
Water-to-Fish Uptake

- Generally treated with a bioaccumulation factor (bioconcentration factor)
- BF = [Ci/kg fish per Ci/L water]
  - Temperature
  - Salinity
  - Stable element concentration
  - Species

Modifying Factors

- Holdup time - harvest to consumption
- Food preparation losses - washing
- Water treatment plants - filtration
- Food distribution networks

GENII V.2 Time Line



GENII "Exposure" Module

Exposure_Pathways

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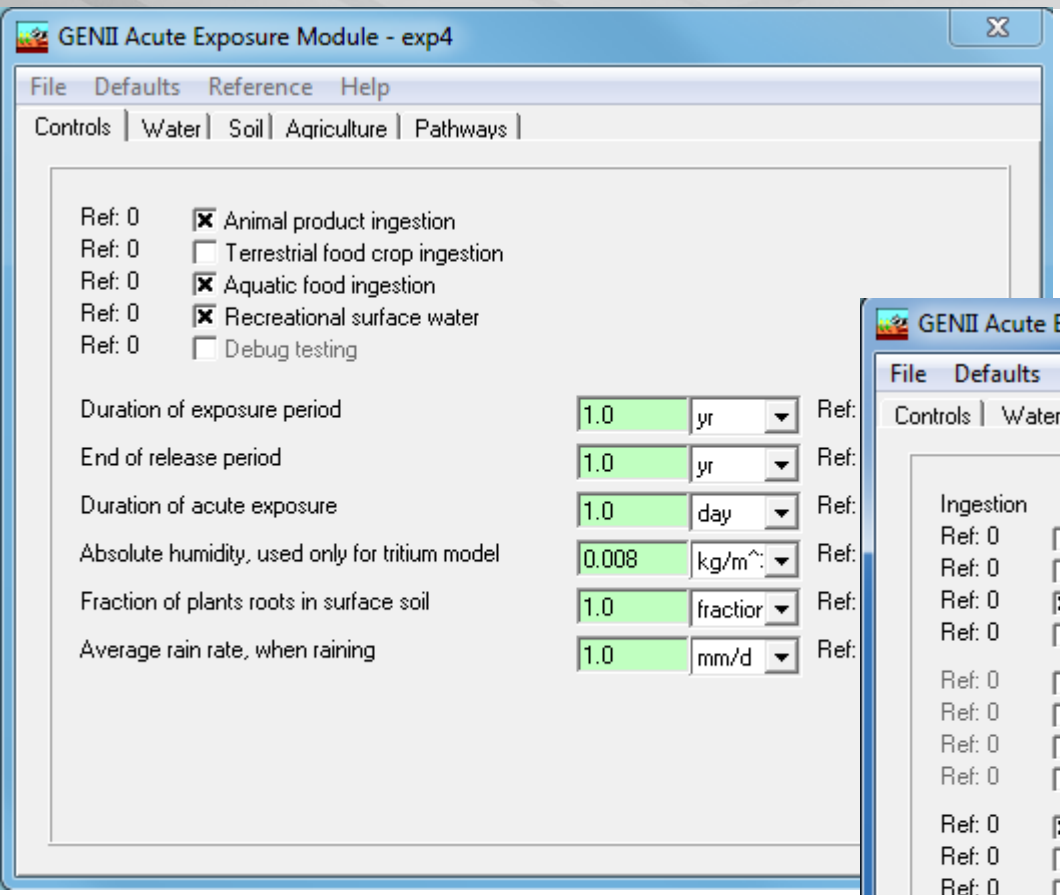

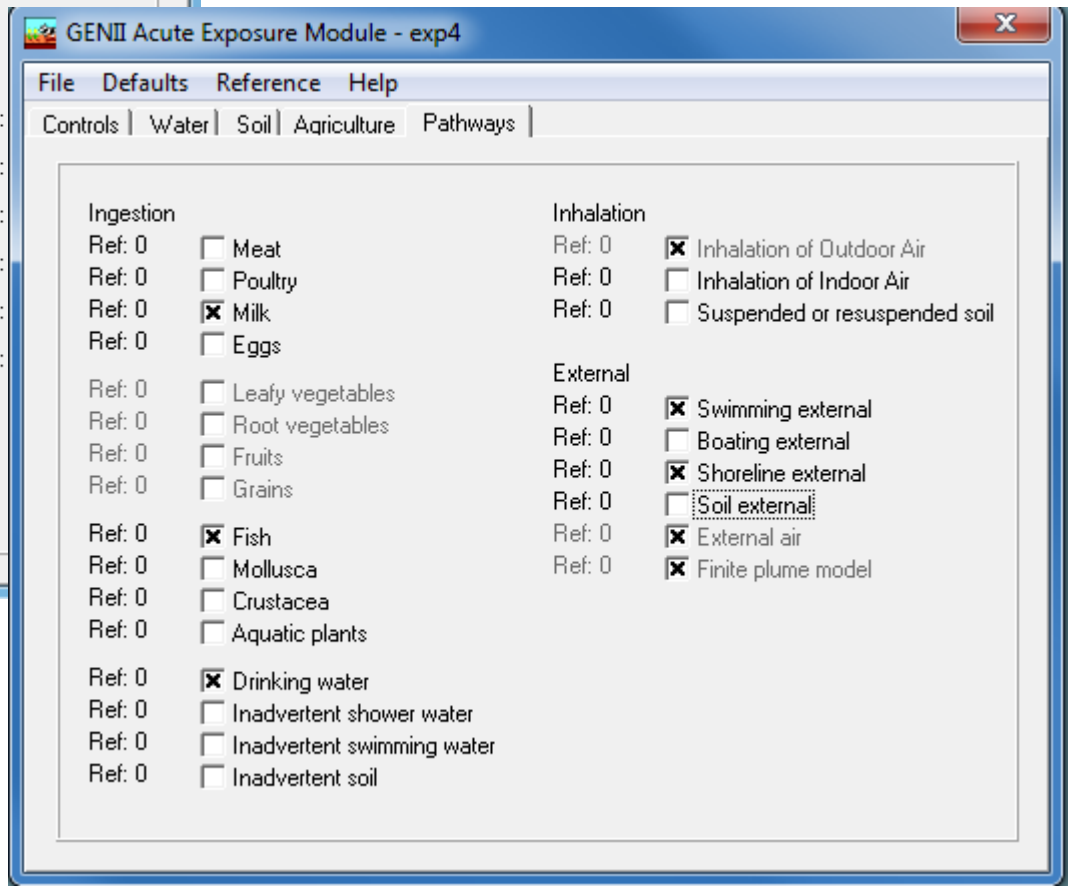

Human Exposure Pathways

- External
  - Transported air
  - Soil
  - Swimming
  - Shoreline
- Inhalation
  - Transported air
  - Resuspended soil
  - Volatilized indoor air pollutants from water

Human Exposure Pathways

- Ingestion
  - Leafy vegetables
  - Other vegetables
  - Fruit
  - Grain
  - Meat
  - Milk
  - Poultry
  - Eggs
  - Fish
  - Crustaceans
  - Molluscs
  - Water plants
  - Drinking water
  - Shower water
  - Swimming water
  - Soil

This module requires a lot of data…

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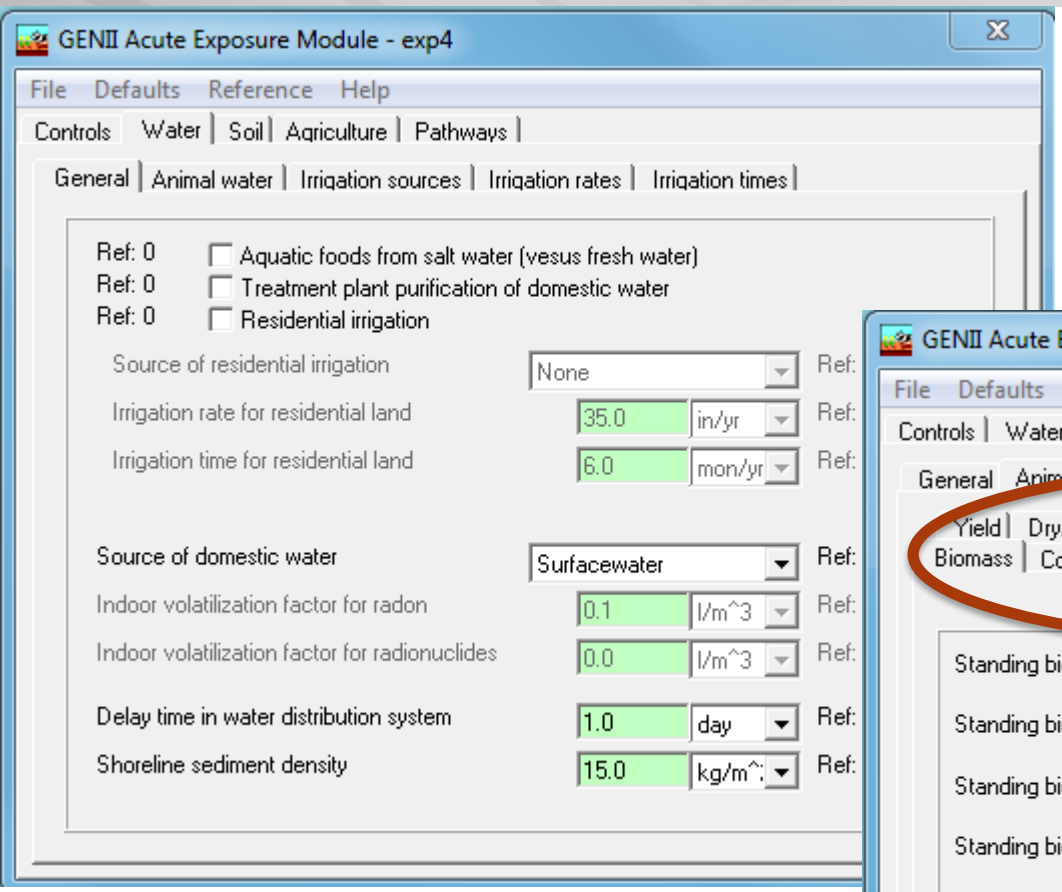

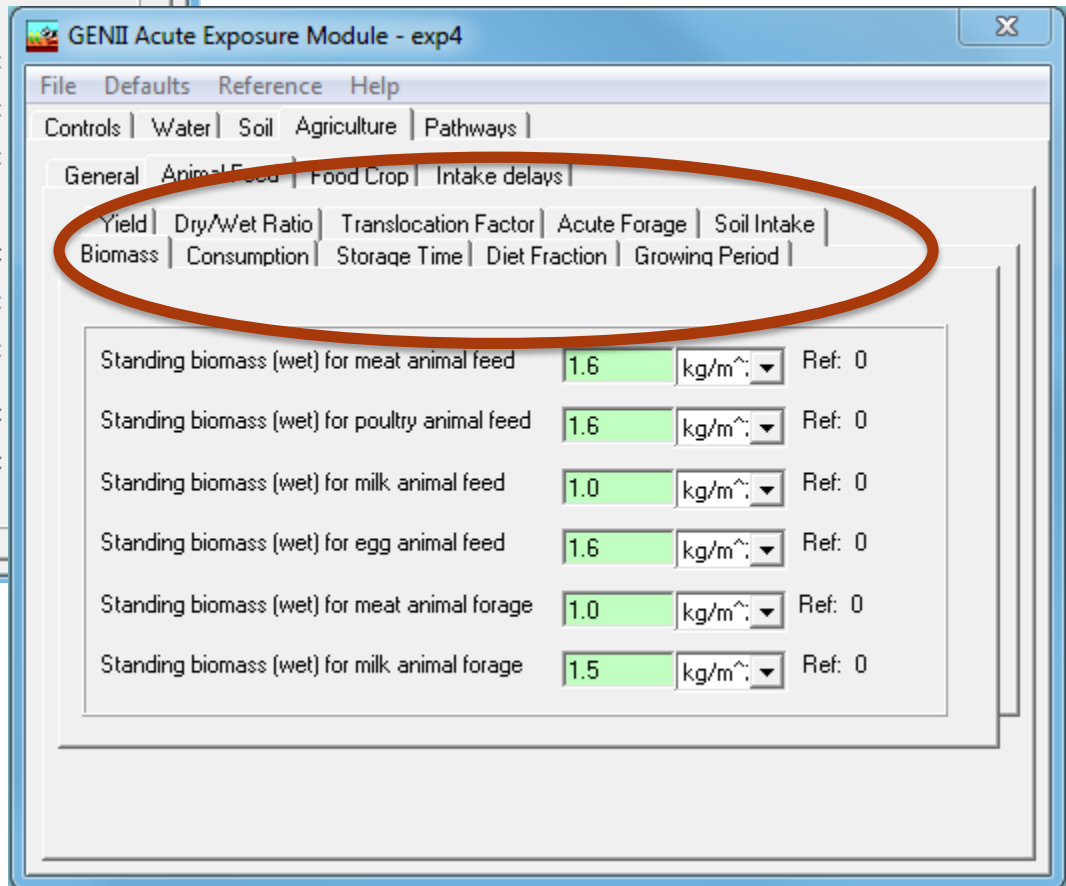

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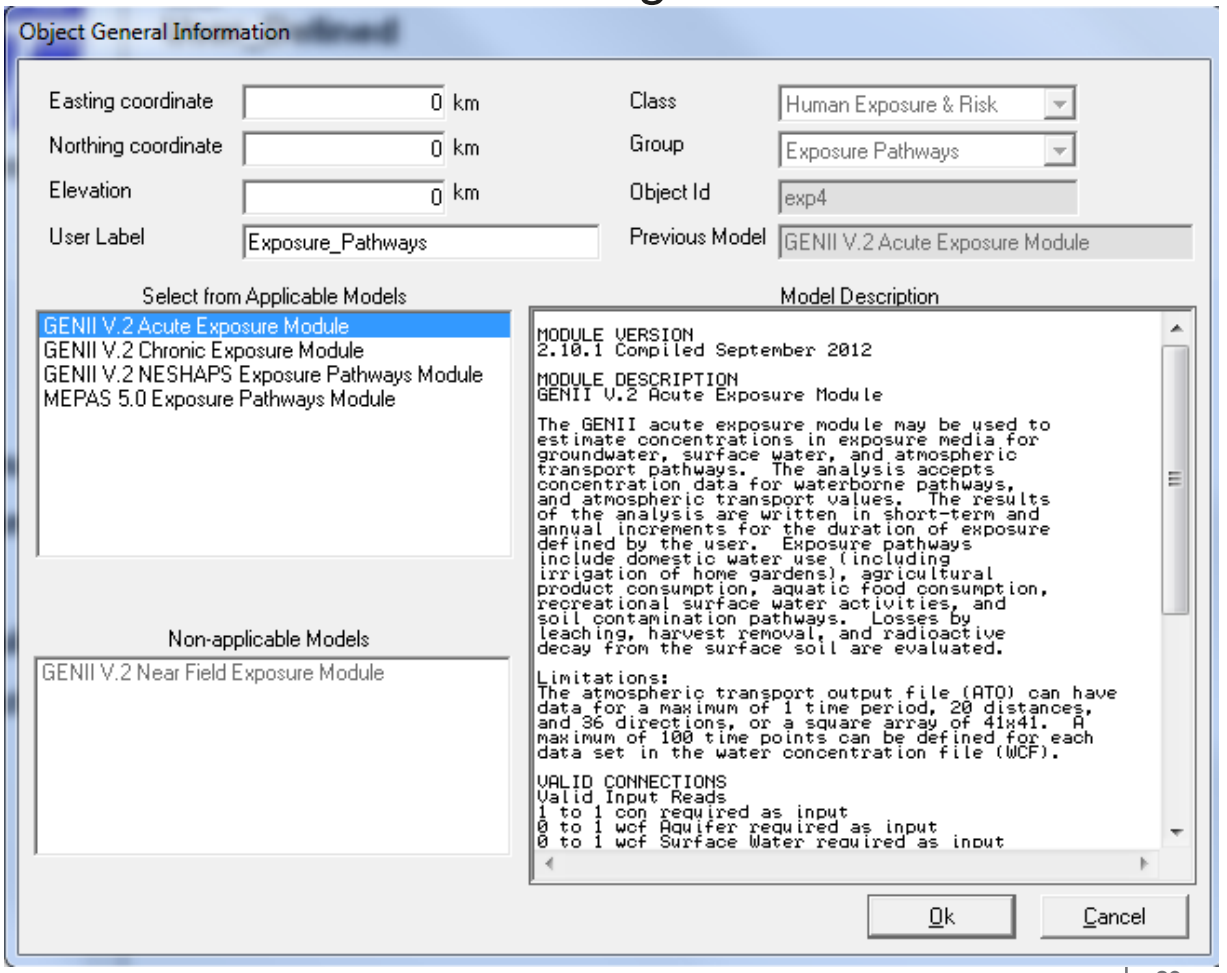
GENII: Accident Model – 4 Seasons

- Selected earlier, when the module scenario is being defined



GENII V.2 Acute-Deposition Food Pathways

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- GENII V.2 presents results for 4 seasons (Winter/spring/summer/autumn)
- "Seasons" are surrogates for complex sets of underlying assumptions about plant growth, weathering, uptake, and time-to-harvest
- Selection of season depends on meteorological input (this is related to the uncertainty capability)
- *Seasons below the equator are reversed!*

  A minor change in an external file to adjust…