BIOTRAN MODEL

Authors: W. J. Wenzel, A. F. Gallegos, and J. C. Rodgers*
Groups: Environmental Surveillance, HSE-8; *Life Sciences Division, LS-6
Funding Organization: Los Alamos National Laboratory

The BIOTRAN[1] model was developed at Los Alamos to help predict short- and long-term consequences to man from releases of radionuclides into the environment. It is a dynamic model that simulates on a daily and yearly basis the flux of biomass, water, and radionuclides through terrestrial and aquatic ecosystems. Biomass, water, and radionuclides are driven within the ecosystems by climate variables stochastically generated by BIOTRAN each simulation day. The climate variables influence soil hydraulics, plant growth, evapotranspiration, and particle suspension and deposition. BIOTRAN has 22 different plant growth strategies for simulating various grasses, shrubs, trees, and crops. Ruminants and humans are also dynamically simulated by using the simulated crops and forage as intake for user-specified diets. BIOTRAN has been used at Los Alamos for long-term prediction of health effects to populations following potential accidental releases of uranium[2] and plutonium.[3,4]

BIOTRAN has been restructured into manageable structured subroutines. All variables and their units have been defined and code logic charts have been made. Graphical output for each subroutine both during and after an execution has greatly increased the efficiency of using BIOTRAN. The streamlined graphical output allows the user to scan output quickly, instead of reviewing long tables of numbers. This is particularly useful for three-dimensional analysis of radionuclide flow in soils and between lake water layers.

Three new subroutines have recently been developed for BIOTRAN. HUMTRN[5] is a human dynamic physiological and metabolic model that simulates male and female intake, organ uptake, and radiation doses in age groups. Simulated crops, meat, and daily air radionuclide concentrations from BIOTRAN become intake to humans on a user-specified diet. Daily intake of food and water are adjusted by HUMTRN based on amount of physical activity, growth, age, sex, and food availability from BIOTRAN.

The soil hydrology and irrigation model, WATFLX, was developed based on Hillel's Darcy equation[6] for movement of water in silt, sand, and clay. Soil is modeled as layers. Each layer is considered a unit contributing to the evapotranspiration losses for the plant in the soil profile. Uptake is simulated to occur as a function of the root biomass in each soil layer simulated.

Limnetic nutrient and radionuclide cycling in multiple fresh-water lake layers is modeled in the AQUAT subroutine as a function of daily solar radiation intensity and plankton kinetics. AQUAT will later be coupled with a shoreline (littoral) model to develop the transition terrestrial/aquatic coupling needed for BIOTRAN.

Several areas of BIOTRAN development are in progress. The Los Alamos health effects model, REPCAL,[7] is being analyzed for addition to HUMTRN/BIOTRAN. It will allow age- and sex-specific cancer mortality to be simulated dynamically. At present BIOTRAN predicts uranium and plutonium transport and consequences to humans. BIOTRAN is being changed to follow cesium as well as strontium environmental transport. With the addition of these elements, a major addition to BIOTRAN will be required, namely, mineral cycling. Once mineral and nutrient cycling for Ca, K, P, N, and Si is complete, then extensions to more elements and even organic compounds could be rapidly developed as the need arises.

References

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MEASUREMENT AND MODELING OF GAMMA-ABSORBED DOSES DUE TO ATMOSPHERIC RELEASES FROM LOS ALAMOS MESON PHYSICS FACILITY

Authors: B. M. Bowen, A. I. Chen, W. A. Olsen, and D. M. Van Etten
Group: Environmental Surveillance, HSE-8
Funding Organization: Los Alamos National Laboratory

Introduction

Portable, high-pressure ionization chambers (HPICs) measure short-term gamma radiation levels caused by air activation products from the Los Alamos Meson Physics Facility's (LAMPF)

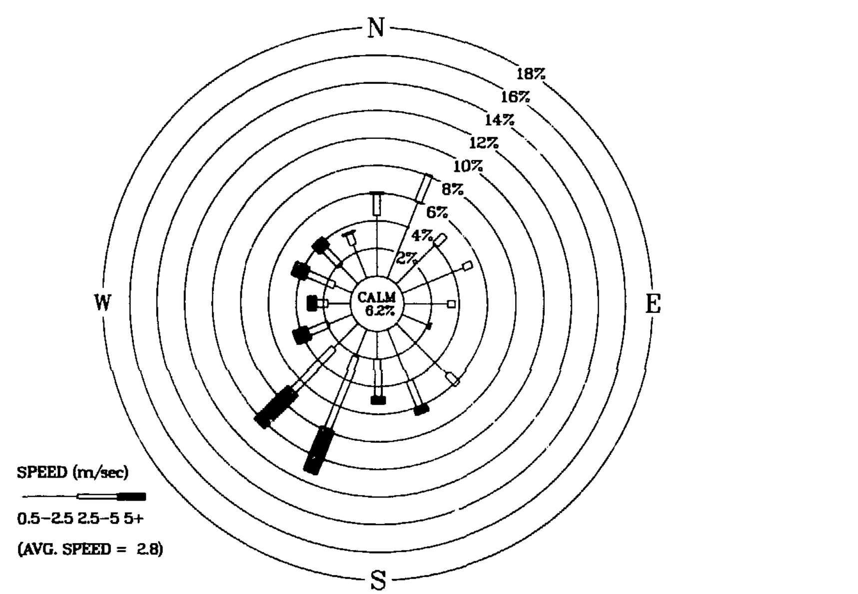

FIGURE 22. Wind rose for nearest off-site location from Los Alamos Meson Physics Facility's 1983 operating cycles (January 1 to February 8 and September 8 to December 31).