Nitrogen applied to the surface of land for agricultural purposes represents a significant source of reactive nitrogen (Nr) that can either volatilize as ammonia (NH3), run-off during rain events or form plant useable nitrogen in the soil. My research examines how the size of each nitrogen pathways varies as environmental conditions change. As a model system, the NH3 emissions from seabirds were used to examine the effect of weather on NH3 volatilization. To do this, a bioenergetics model was used in conjunction with a dynamic seabird-specific (GUANO) model to estimate NH3 emissions in a range of climates. Field measurements of NH3 emissions at seabird colonies in various climates were used to validate model output. The results present a range of percentage excreted nitrogen that volatilizes (Pv) of 0.4 % to 70.6 % in response to climatic differences. This model is developed further and used to predict NH3 emission, Nr run-off and soil Nr from agricultural Nr sources within the Community Earth System Model (CESM). Using this climate dependent approach, the estimated global nitrogen pathways from agriculture are 30.1, 55.5 and 107.5 Tg N per year for NH3 emission, soil Nr and Nr dissolved during rain events, respectively. Being able to predict these pathways is environmentally important when trying to understand the current impact of agriculture as well as how nitrogen pathways may change as fertilizer use increases in future coupled with a changing climate.