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Lost in Space: Understanding the consequences of unknown or incorrect datums in applications of climate and other geosciences analysis

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For global climate modeling based on a unit sphere, the positional accuracy of transformations between "real earth" (ellipsoid or geoid based) coordinates and the spherical earth coordinates is almost irrelevant, due to the coarse precision of the global model processing and results. Consequently, many unit-sphere-modeling processes are driven by data using real-earth lat-lon coordinates without consideration of the data's datum. However, many users of climate model results for climate-sensitive analysis can be affected by the errors introduced when transforming spherical earth coordinates back to ellipsoidal coordinate reference systems (datums) for use in Geographic Information Systems (GIS) and other applications. Studies of weather and climate effects on coastal zones, water resources, agriculture, biodiversity, and other critical domains typically require positional accuracy on the order of several meters or less. While it may be understood that climate model results using spherical earth coordinates could not possibly approach that accuracy, observed data used in downscaling climate model results are georeferenced precisely. Spheroid-to ellipsoid transformations on downscaled climate or observed atmospheric data like radar indicated rainfall actually compound errors already in the coordinate data if one applies spheroid-to-ellipsoid transformations when no ellipsoid-to-spheroid transformations were applied to input observational data. This points to a bigger problem than just knowing and applying the right transformations. The basic issue is that the geodetic datum is often not specified or disregarded on input data streams, or (even if considered) preserved through processing to be reflected accurately in the outputs. Consequently, positional errors of 15-20 km can occur in regional and local-scale applications. This is especially an issue for scientists with little understanding of the considerations and mathematics involved in geodetic coordinates and transformations. However, there are some simple and fundamental steps that can be taken to keep these issues transparent to those not trained in geographic information science. The primary issue is that Latitude-Longitude coordinates are not unique units of measure. Latitude and longitude are demarcations on a model of the earth, normally an ellipsoid. Several hundred models have been defined and about forty different models remain in daily use. A geodetic datum is defined by selecting a mathematical model of the earth's shape and real world positions to tie latitude and longitude origins to (prime meridian and poles). Datums are used for horizontal (lat-lon), vertical (elevation), or both types of measurements. Many times, datums are defined locally, rather than globally, to more accurately fit the regional earth shape. If the model or its prime meridian are changed, that is if the geodetic datum is changed, the values of latitude, longitude and elevation at a given real world point will change. For coordinate values to be unambiguous, the datum to which they are referenced must be identified. Once identified, the datum must be preserved and communicated through stages of processing steps, so that any given downstream process can determine what, if any, transformations or other corrections may be needed. For example, in order to directly compare different spatially-indexed data sets, they must use (or be transformed to) the same datum. The poster will illustrate these issues, and suggest ways of accomplishing interdisciplinary coordination to address them.