

IsoMAP Quick Guide

The following sections will guide you through the basic functionality available in the IsoMAP beta release. To get started, visit the site at <http://isomap.org>. One important note: the initial version of the site is compatible with all current browsers **except** Internet Explorer. We are working on IE compatibility and will let you know when this is available.

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Account Setup

In order to use IsoMAP you need a user account. The account system is easy to use, secure, and lets you save and organize your own work or selectively share it with other users at your discretion. Account setup is quick and easy – simply visit the IsoMAP homepage and click on the “Create User Account” link in the login area at the upper right corner and follow the directions.

A screenshot of a web form for creating a user account. At the top, a blue circular icon is followed by the text: "Please fill out your user information and an e-mail will be sent to you with activation details." Below this are several input fields: "User Name:", "Full Name:", "Email Address:", "Organization:", "Password:", and "Confirm password:". At the bottom of the form are two buttons: "Save" and "Cancel".

Main Tabs

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The IsoMAP website includes three primary areas that can be accessed using the level 1 menu tabs.

About IsoMAP Precipitation Model My Jobs

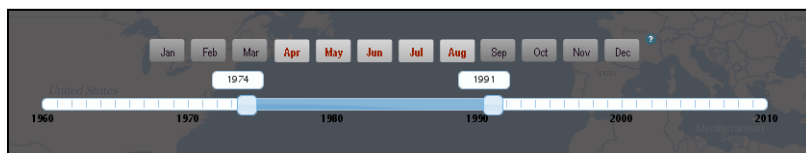
About IsoMAP includes general information pages. *Precipitation Model* hosts the functionality for developing and exploring precipitation isotope models and maps, and is described in more detail below. A detailed description is also provided for *Assignment Model*, which provides tools for mapping the likely geographic origin of samples based on their isotopic composition. *My Jobs* allows you to view and manage a list of projects you have developed within the IsoMAP system.

Precipitation Model

Under the *Precipitation Model* tab you will find four sub-headings that allow you to work through the process of creating and exploring precipitation isotope models and maps. Within IsoMAP we have divided the process of creating an isoscape into two steps: *Develop a Model*, which allows you to parameterize and optimize a statistical model for precipitation isotope ratios that is specific to your project or interests, and *Make a Map*, which allows you to use a model to produce a precipitation isoscape for a region and time of your choosing. Each of these steps is accompanied by a visualization tool. *Explore Models* allows you to browse or search for models in the IsoMAP system and view documentation and statistical output related to the models. *Display Map* lets you browse or search for isoscapes and display them using an interactive map display.

Develop a Model

This module allows you to parameterize and optimize a statistical model for precipitation isotope ratios that is specific to your project



or interests. The module, like most IsoMAP modules, consists of a series of steps (a “workflow”) designated by the workflow control boxes across the top of the screen. Each step requires some input from you, the user, and you are intended to progress through the workflow from left to right (although it’s OK to backtrack!). If you ever want to review the choices you made in a particular step you can simply hover your cursor over the corresponding control.

1) In *Select Temporal Range* you choose the time interval that you would like to model. Use the slider to select a single year or a range of years that you are interested in. Select the months that you would like to work with by clicking. Click and drag or use ‘control-click’ to select multiple months. Keep in mind that the model will be fit to data from the IsoMAP database. These data are derived from a number of sources, but records from the IAEA’s [GNIP program](#) representing the time interval **1960 – 1999** currently represent the majority of the data. As a result, data quantity will be limited if you make selections outside of this range of years. Once you have made year and month selections a green ‘advance’ arrow will appear in the workflow control box at the top of the screen. Click the arrow to advance to the next step.



2) In *Select Spatial Range* you can choose a geographic region from within which you would like to extract data for developing your model. Click the 'use world as default' icon in the workflow control box or click on map once to start drawing a new rectangular bounding box and a second time to stop. You can zoom in or out or pan the map view by clicking, holding, and dragging the map. If you don't like your choice you can repeat the spatial range selection by clicking again on the map to start drawing a new box. Click the advance arrow to submit your selection and move on.

3) IsoMAP precipitation models predict the isotopic composition of precipitation as a



function of geographic location and one or more environmental variables. The *Select Datasets* step provides you with a list of possible environmental variables and data sources for your model. Make your selections working from left to right, first selecting the variable you want to use (e.g., "Ave. Temp." for average temperature), then the source from which the data will be obtained (we've compiled a number of data sources to give you options), and finally the form or forms of the variable you'd like to use (e.g., you can select both "t" and "t^2" if you'd like to use a second-order polynomial of temperature as a predictor). A red icon in indicates that you haven't finished the data selection process. Once your selections are complete for a particular variable you will see a green check mark icon. You also need to select what isotopic parameter (dependent variable) you want to model. IsoMAP precipitation models are specific to either $\delta^2\text{H}$ or $\delta^{18}\text{O}$ values. Select one of these using the radio buttons at the top of the page and you should see the advance arrow appear in the workflow control box.

When you click the advance arrow from this step IsoMAP will take a moment to check its database and determine how much data is available based on your selections. In order to



proceed we must be able to calculate values for the precipitation isotope ratios and your selected independent variables for at least 15 stations. If you get a 'success' message you are good to go. If not, backtrack and modify your selections to be less restrictive, and then try again. As a general rule, if you are working in the time range between 1960 and 1999 you should be able to develop models for most any continental-sized geographic region.

4) The final step is to submit your job. Use the workflow control box to give your project a name (avoid special characters) and type a description that will help you identify the job. When you click the advance arrow from this step your job will be submitted. At this point the specifications of your model and the necessary data extracted from the IsoMAP database are compiled and sent to the TeraGRID for calculation. You can monitor your job's progress from the *My Jobs* tab.

Explore Models

When you develop a precipitation isoscape model, IsoMAP actually tries to fit two different model types using the selected parameterization and data. The first is a standard multiple regression model, which describes the relationship between the independent and dependent (isotope) variables you selected. The second model type is a geostatistical model, which describes the data based on the independent



variable values plus the spatial correlation structure of the dataset. In the *Explore Models* module you can select models and the statistical characterization of different models, allowing you to evaluate model quality and compare multiple models.

Start by browsing or searching for models you'd like to look at. The search functionality is limited at this point, but you can conduct simple searches using logical operators such as ">", "<", and "*". You can click on a job in the search results table at any point and the statistical summaries will be displayed on the right side of the screen.

The results section begins with a summary description of the model, including information on the variables used and spatial and temporal extents. Below this section you will find the statistical summaries for the statistical (regression) and geostatistical models. Results are partitioned into tables according to different statistical tests and metrics. Depending on the results of the regression analysis a particular model may or may not have geostatistical results – the geostatistical model is only investigated if the isotopic data shows significant spatial autocorrelation (Moran's I test).

Model Information

Model type: precipitation
 Dependent variable: d2h
 Longitude range: -180 to 180
 Latitude range: -90 to 90
 Year range: 1961 to 1999
 Months range: 5, 6, 7, 8
 Number of stations: 423
 Independent variable 1 : minimum temperaturesquared
 variable source : cru_processed_point
 Independent variable 2 : minimum temperature
 variable source : cru_processed_point
 Independent variable 3 : precipitation
 variable source : cru_processed_point

[Metadata XML download](#)

Regression Model

Anova

Variable	df	SS	MS	f-value	p-value
tmn_t^2	1	90527.3	90527.3	146.285	0
tmn_t	1	121889	121889	196.963	0
pre_p	1	5683.95	5683.95	9.18482	0.00259159
Error	419	259295	618.842	-	-
Total	422	477395	-	-	-

Make a Map

This module allows you to use an existing IsoMAP precipitation isotope ratio model (either one you created or one created and published by another user) to produce precipitation isoscapes. It operates almost identically to the *Develop a Model* workflow, so you should refer to that section for details, we'll just hit the high points and differences here.

1) In this workflow you start by selecting the model from which you want to create your precipitation isoscape. You can search or browse for models in the *Search* step. When you click on an entry in the list of available models you will see basic information describing the model (e.g., is it a $\delta^2\text{H}$ or $\delta^{18}\text{O}$ model? for what temporal and spatial extents was the model developed?). Any time you have a model selected you can click the advance arrow to move to the next step in the workflow.

2) The *Select Temporal Range* step works identically to that in the *Develop a Model* workflow, with the only exception being that we suggest default selections based on the range of years and months selected when the model you are using was developed. You can change these if you'd like to apply the model to a different time period, but be aware that in this case your map will represent an extrapolation of relationships calibrated for one time period to another.

3) *Select Spatial Range* operates exactly as in the *Develop a Model* workflow, but again a default selection is provided based on the model in use.

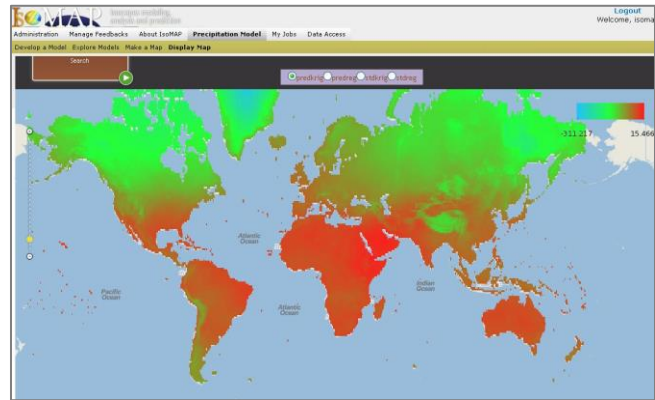


4) The *Select Datasets* step is similar to that in the *Develop a Model* workflow, but because you are working with an existing model many of the choices have already been made for you. Here all you need to do is select data sources from which the independent variable values are taken. These data sources are all ‘rasters’ (regular grids of values). The mapping algorithm will operate on the data from these grids, calculating a predicted isotope surface based on the independent variable values at each grid cell. As a result, the selections you make here will determine the spatial resolution of the isoscape you produce – IsoMAP will automatically identify the coarsest-resolution grid among your selections and (if necessary) resample all data to that resolution. As before, when you click the advance arrow our database will check for available data before prompting you to proceed.

5) Job submission in this workflow is identical to that in *Develop a Model*.

Display Map

The *Display Map* module allows you to select and display the precipitation isoscapes that you have produced (or another user has produced and published) within IsoMAP. The module consists of a single-step workflow – simply search or browse to identify a job, click on it to view the basic documentation, and click the advance arrow to display the map in the portal’s web-GIS interface. Each job has either 2 or 4 maps associated with it,



which can be selected using the radio buttons in the banner at the top of the map screen. These maps represent the predictions and standard deviations associated with the statistical (regression) and geostatistical (kriging) models formulations used in the map development project. Each map layer is accompanied by a color-scale legend, and the color scale dynamically adjusts as you zoom in/out or pan about the map, allowing you to more closely explore your results. If you’d like to view the maps associated with a different job just click on the workflow control at the top of the map screen and select the job you are interested in.

Assignment Model

Under the *Assignment Model* tab you will find three sub-headings that allow you to use existing IsoMAP precipitation isoscape to constrain the origin of samples based on their measured isotopic composition. The model algorithm evaluates the similarity between sample values and the mapped isotopic value at each gridcell on the isoscape, taking into account uncertainties in both the sample and isoscape values. *Assignment* and *Batch Assignment* allows you to select isoscapes, refine the spatial extent of these layers, and enter data for the sample or samples you would like to analyze. *Display Assign* is identical to other map display interfaces in IsoMAP, and allows you browse or search for likelihood of origin maps created using the Assignment tools and display them using an interactive map display.

Assignment

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This module allows you to use an existing IsoMAP precipitation isoscape (either one you created or one created and published by another user) and your own data to produce maps showing the relative likelihood that a sample originated at different geographic locations. It operates similarly to the *Develop a Model* and *Make a Map* precipitation workflows, and you can refer to the description of those modules for details.

1) The workflow starts with a *Search* step that is structured identically to that in the other workflows. The only difference here is that you will be searching for and selecting a precipitation map job rather than a precipitation model job. When you click on an entry in the list of available maps you will see basic descriptive information (e.g., is it a $\delta^2\text{H}$ or $\delta^{18}\text{O}$ map? for what temporal and spatial extents was the model developed?) and have the opportunity to download comprehensive documentation in the form of the job's xml metadata file. Any time you have a model selected you can click the advance arrow to move to the next step in the workflow.

2) *Select Spatial Range* operates as in the other workflows, with one important difference. A default spatial selection is provided based spatial bounds of the map selected in the previous step, and although you can select a smaller region contained within the original default selection (i.e. to restrict the assignment calculations to a sub-region of the isoscape) you cannot extend the spatial selection beyond the bounds of the default. Currently IsoMAP only supports rectangular (in latitude/longitude space) spatial boundaries.

3) In *Enter Parameters* you are prompted to enter isotopic values for the sample for which you would like to map likely geographic origins. Two numerical values are required – the observed value for the sample, converted to the estimated precipitation $\delta^2\text{H}$ or $\delta^{18}\text{O}$ value at the site of sample origin if necessary, and an estimate of the uncertainty (1 standard deviation) of the 'observed' value. Currently IsoMAP requires the user to conduct any translation necessary to convert measured sample values into equivalent environmental water values and propagate the error involved in sample measurements and conversion of values. Published models for translation are available for a number of substrates (e.g., feathers from different groups of birds, butterfly wing tissue, human hair, human teeth, milk), but please be aware that the details of the conversion equation used can have a significant impact on the results. We encourage you to research and carefully consider the assumptions and limitations inherent to these models. In addition, please ensure that you are using sample values for the same isotope system represented by the selected isoscape ($\delta^2\text{H}$ or $\delta^{18}\text{O}$). Once valid values are entered for both parameters IsoMAP will display the green advance arrow.

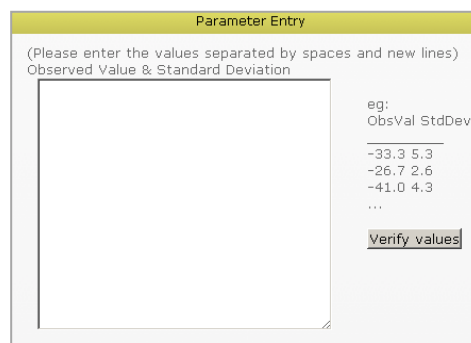
4) Job submission in this workflow is identical to that in the other workflows.

Batch Assignment

This module is identical to the *Assignment* module with the exception that it allows you to map the likelihood of origin for a population of samples rather than that of a single sample. The steps in the workflow are:

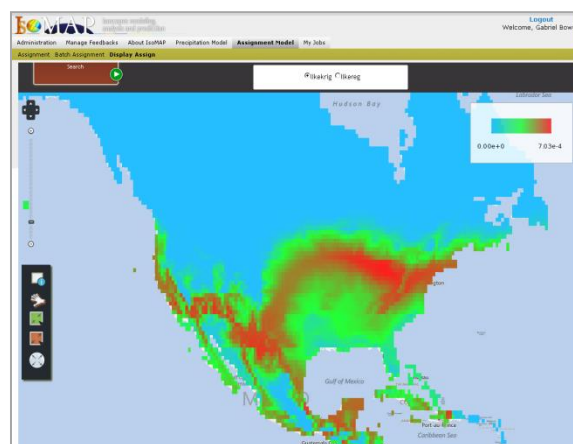


- 1) *Search* for and select a precipitation isoscape, as described above.
- 2) *Select Spatial Range*, either using the default value or a selecting subset of isoscape's range if desired.
- 3) *Enter Parameters*, including the environmental water isotope ratio and estimated uncertainty therein for each sample. Parameter values are entered in this workflow as a series of white-space separated values, and can be typed or cut-and-pasted into the text box. Once your data are entered, click the "Verify values" button to conduct a formatting check, which if successful will enable the green advance arrow.
- 4) Job submission in this workflow is identical to that in the other workflows.



Display Assign

This module works identically to the *Display Map* module under the *Precipitation Model* tab. In this case, the *Search* function shows only maps resulting from jobs conducted within the *Assignment Model* tab. When selected, any successfully completed job should show either one or two map layers, selectable using radio buttons in the workflow banner near the top of your browser window. These maps represent the relatively likelihood that the sample or population of samples for which data were entered originated at any given gridcell within the selected geographic area.



Pan, zoom, and dynamic rescaling functions are available here just as in the *Display Map* module.

Plant Model

Under the *Plant Model* tab you will find two sub-headings that allow you to work through the process of creating and exploring leaf water isotope models and maps. The workflow and logic are similar to that already described in the precipitation and assignment models. Within IsoMAP we have divided the process of creating a leaf water isoscape into two steps: *Map Plant Water*, which allows you to identify a base precipitation map to use as plant source water, select climate layers from within IsoMAP to drive the model, and simultaneously parameterize and optimize three modified leaf water enrichment models. These models are then run as raster calculations in IsoMAP. *Display Map* allows you to display the resulting leaf water map and of course the output files are downloadable and shareable as for all other IsoMAP products. Each of these steps is accompanied by a visualization tool.

Map Plant Water

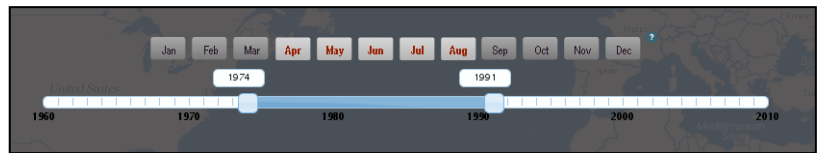
This module allows you to make some parameterization decisions for the three leaf water models. These models are structured as described in West et al. (2008) and include the core "Craig-Gordon" model, as



well as formulations of the "Péclet" and "Two-Pool" models. The module, like most IsoMAP modules, consists of a series of steps (a "workflow") designated by the workflow control boxes across the top of the screen. Each step requires some input from you, the user, and you are intended to progress through the workflow from left to right (although it's OK to backtrack!). If you ever want to review the choices you made in a particular step you can simply hover your cursor over the corresponding control.

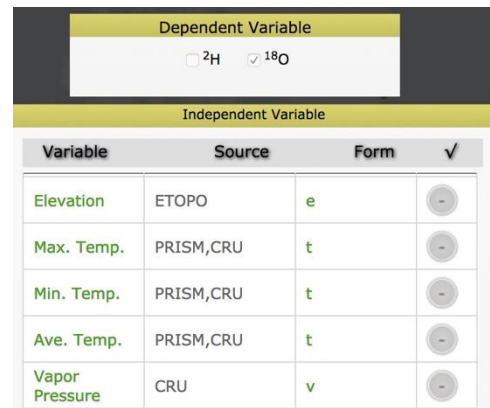
1) In Search you can select from precipitation isoscapes you have created or that others have made public to serve as the source water layer. The use of the precipitation layer in this way assumes that plant water reflects modeled precipitation. This is most likely to be a reasonable assumption for more deeply-rooted plants, although it is up to the user to decide if this represents a reasonable assumption or not. Once you have made your precipitation map selection, a green 'advance' arrow will appear in the workflow control box at the top of the screen. Click the arrow to advance to the next step.

2) In Select Temporal Range you choose the time interval that you would like to model. The temporal extent of the selected precipitation isoscape is loaded by default. If you



would like to make changes, use the slider to select a single year or a range of years that you are interested in. Select the months that you would like to work with by clicking. Click and drag or use 'control-click' to select multiple months. Note that the calculations assume fixed source water (the precipitation map already selected) and make leaf water enrichment calculations for each month selected, then provide the mean leaf water isotopic composition over the months/years selected. Once you have made year and month selections a green 'advance' arrow will appear in the workflow control box at the top of the screen. Click the arrow to advance to the next step.

3) In Select Spatial Range you can choose a geographic region from within which you would like to extract data for developing your model. The extent of the selected precipitation isoscape is loaded as the default. If you would like to restrict your spatial range to a subregion within the precipitation isoscape's extent click once on the map to start drawing a new bounding box and a second time to finish your selection. You can zoom in or out or pan the map view clicking, holding, and dragging. If you don't like your choice you repeat the bounding box selection process by clicking on the map to start drawing the new box. Click the advance arrow to submit your selection and move on.



4) In Select Datasets you select climate data for IsoMAP to use. Notice that the precipitation layer dependent variable is already selected based on your prior precipitation layer selection. Currently IsoMAP makes two climate data sources available depending on spatial extent (CRU globally, PRISM for USA only). Also note that there is only one "form" of the data in the current release, so these are all also



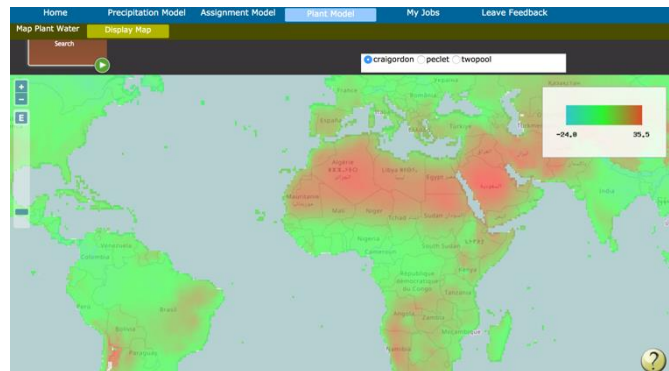
pre-selected. Once your selections are complete for a particular variable you will see a green check mark icon. Click the advance arrow to submit your selection and move on.

5) In Enter Parameters you make decisions about values for model constants. These include (for the Two Pool model) Fraction Unenriched, (for the Péclet model) Effective Path Length, Reference Stomatal Conductance (a modifier for stomatal response to VPD), an Air Temperature Modifier (where air temperature is increased by that fraction of the mean daily range, and a Leaf Temperature Modifier that calculates leaf temperature as a specified fraction of air temperature. The final selection concerns kinetic fractionation associated with transpiration. Two literature values have been reported and there remains some discussion about their validity. IsoMAP allows the user to select from either the Cappa values or those previously published by Merlivat. The user can also input their own values for α_k and α_{kb} . Once your selections are complete for a particular variable you will see a green check mark icon. Click the advance arrow to submit your selection and move on.

6) The final step is to submit your job. Use the workflow control box to give your project a name (avoid special characters) and type a description that will help you identify the job. When you click the advance arrow from this step your job will be submitted. At this point the specifications of your model and the necessary data extracted from the IsoMAP database are compiled and sent to the TeraGRID for calculation. You can monitor your job's progress from the *My Jobs* tab.

Display Plant

This module allows you to visualize the resulting leaf water isotope map. Simply select the model version and model formulation (Craig-Gordon, Péclet, or Two Pool) and click the green arrow to display. Once displayed you may toggle between the three models.



Final Comments

IsoMAP allows you to browse your results and do certain types of work with your results directly within



the browser interface, and will archive your work on our servers. In many cases you may want to download your results for reference or further analysis on your local computer system. You can access the metadata documenting your jobs and a “.tar” archive containing all of the data files, results files, documentation, and visualization products (e.g., map grids) through the *Download* column on the *My Jobs* page. In addition, you will find download links for metadata and results whenever you select a job in *Search* interfaces within the *Precipitation Model* and *Assignment Model* tabs. These links allow you to identify and download results using the search interface, and also allow you to access results for jobs that have been created and shared by other IsoMAP users.

IsoMAP is made possible by support from the U.S. National Science Foundation



Reference Table for Some Shorthand Terms Used in the IsoMAP Workflows

Location/Step	Term	Meaning
Select Datasets	STATION	Physiographic or climate data measured at isotope monitoring station
Select Datasets	CRU	Gridded climate data from the Climate Research Unit of the University of East Anglia
Select Datasets	PRISM	High-resolution gridded climate data from the PRISM group at Oregon State University
Select Datasets	ETOPO	Digital elevation data from the NOAA NGDC
Select Datasets	GRID	Gridpoint center latitude and longitude values
Display Map	predkrig	Isoscape prediction map from the geostatistical model
Display Map	predreg	Isoscape prediction map from the statistical model
Display Map	stdkrig	Prediction standard deviation map from the geostatistical model
Display Map	stdreg	Prediction standard deviation map from the statistical model
Display Assign	likekrig	Relative likelihood of origin map based on geostatistical isoscape
Display Assign	likereg	Relative likelihood of origin map based on statistical isoscape

