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%SL_eq_freshwater_fluxes - calculate time series of freshwater fluxes
%
% Syntax:  SL_eq_freshwater_fluxes
% WARNING: This function will clear the workspace and close existing plots
%
% Inputs:
%   Read from data file (DATA.xlsx) assumed to be on MATLAB path
%
% Outputs:
%   Plots of inut time series and calculated freshwater fluxes
%
% Other m-files required: none
% Subfunctions: none
% MAT-files required: none
%
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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all %clear the Workspace
close all %close all figure windows
clc %clear the command window

%% LOAD SEA LEVEL TIME SERIES AND ASSOCIATED UNCERTAINTIES
RAWDATA=xlsread('DATA.xlsx','Sheet1','A3:C523'); %read EXCEL file
A = RAWDATA(:,1); %Age [ka BP]
SL = RAWDATA(:,2); %Sea-level [m kyr-1]
E = RAWDATA(:,3)./2; %standard deviation of sea level [m kyr-1]

%% PROPERTIES OF THE WORLD OCEAN (from Eakins & Sharman, 2010)
area = (3.619e8*1e6); %Ocean area in m^2
s = 3.15569e7*1e3; %number of seconds in 1 kyr
SL_rate=SL/s*area*1e-6; %convert freshwater flux to Sverdrups (Sv)
E_rate=E/s*area*1e-6; %convert flux uncertainty to Sverdrups (Sv)

%% SET UP THE TIMESERIES BINS
Wbin=0.5; %defines the size of the bins in kyr
Nbin = floor((max(A)-min(A))./Wbin); %total number of bins
Cbin = ((min(A)+0.5*Wbin):Wbin:(max(A)-0.5*Wbin))'; %bin centers

%% BIN THE TIMESERIES TO FIND MEANS
SL_rate_bar=NaN(Nbin,1); %preallocate vector for SL_rate_bar
E_rate_bar=NaN(Nbin,1); %preallocate vector for E_rate_bar

for i=1:Nbin %loop through each bin
    idx = find(A>=Cbin(i)-0.5*Wbin & A<=Cbin(i)+0.5*Wbin); %bin limits
    if ~isempty(idx)
        w = 1./E_rate(idx).^2; %reciprocal variance weights
        SL_rate_bar(i)=sum(SL_rate(idx).*w)/sum(w); %weighted mean
        E_rate_bar(i)=1/sqrt(sum(w)); %uncertainty on weighted mean
    end
end

SL_rate_bar=SL_rate_bar(~isnan(SL_rate_bar)); %remove empty (NaN)rows
E_rate_bar=E_rate_bar(~isnan(E_rate_bar)); %remove empty (NaN)rows

%% PLOT INPUT TIMESERIES
figure
subplot(2,1,1,'fontsize',16) %axes for original time series
fill([A;flipud(A);A(1)],[SL-2*E;flipud(SL+2*E);SL(1)-2*E(1)],...
    [0.75 0.75 0.75],'edgecolor','none') %2*SD error envelope
hold on
plot(A,SL,'ob-','markerfacecolor','y','color'...
    ,'r','linewidth',1) %plot time series

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set(gca,'xlim',[100 165],'xtick',100:5:165) %setup x-axis
set(gca,'ylim',[-15 35]) %setup y-axis
set(gca,'tickdir','out','xminortick','on','yminortick','on') %adjust ticks
xlabel('Age (ka BP)') %x-axis label
ylabel('\delta_{RSL}/\delta_t (m kyr^{-1})') %y-axis label

%% PLOT BINNED FRESHWATER FLUXES
subplot(2,1,2,'fontsize',16) %axes for freshwater flux time series
[x12,y12]=stairs(Cbin(:,1)-Wbin*0.5,SL_rate_bar-2*E_rate_bar); %lower error
[x21,y21]=stairs(Cbin(:,1)-Wbin*0.5,SL_rate_bar+2*E_rate_bar); %upper error
fill([x12;flipud(x21);x12(1)],[y12;flipud(y21);y12(1)],...
    [0.75 0.75 0.75],'edgecolor','none') %2*SD error envelope
hold on
stairs(Cbin(:,1)-Wbin*0.5,SL_rate_bar,...
    'linewidth',1,'color','r') %plot time series
set(gca,'xlim',[100 165],'xtick',100:5:165) %setup x-axis
set(gca,'ylim',[-0.2 0.4]) %setup y-axis
set(gca,'tickdir','out','xminortick','on','yminortick','on') %adjust ticks
xlabel('Age (ka BP)') %x-axis label
ylabel('Freshwater Flux (Sv)') %y-axis label

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