%Hydrogeology Homework 3 / Physics Society MATLAB Tutorial (Fall 2012)

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%Please do not reproduce without author's consent.

%This script is a solution to the following problem

%(abridged and used with permission):

% How does the hydraulic head of an aquifer respond over time and space

% to a sudden drop of 5m on the left boundary from its flat initial

% starting value of 150m above sea level. Use the initial conditions

% listed below and choose a timestep equal to the stability criterion.

%Problem credit: Dr. George Roadcap

%Solution credit: Ryan Swindeman

%This script makes use of the user-made function varycolor by Daniel Helmick.

%Please read the license provided with this function.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

close all

clear all %deletes any (old) variables

clc %clears the screen

%Set initial conditions

drop=5;

x=10000; %m (length of the aquifer between the boundary walls)

h\_ini=150; %m (initial head)

Ss=10.^(-6); %1/m (specific storage)

K=10^(-6); %m/s (hydraulic conductivity)

m=9; %(number of nodes) <- Increase this for better resolution

%Set the starting head

h(1,1)=h\_ini-drop; %right boundary

h(1,2:11)=150; %left boundary

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%Calculate stuff

dx=x./(m+1); %space between nodes (m)

dt=(dx.^2)\*Ss/(2\*K);

display(['dx= ',num2str(dx),' m'])

display(['dt= ',num2str(dt/3600/24),' days']) %timestep (days)

%The fun part!

n=1; %time

i=1; %location

for n=1:500

 h(n+1,1)=h(1,1);

 h(n+1,11)=h(1,11);

 for i=2:m+1

 h(n+1,i)= 1/(dx.^2)\*(h(n,i+1)+h(n,i-1) -2\*h(n,i))\*dt\*K/Ss +h(n,i);

 end

end

h

% H %selected h values every 60 days

 H=[h(1,:);h(12,:);h(23,:);h(34,:);h(45,:);h(56,:);h(67,:)];

 {'years', 'left bdy', 'i=2', 'i=3', 'i=4', 'i=5', 'i=6', 'i=7', 'i=8', 'i=9', 'i=10', 'right bdy'}

 t=[0,2/12,4/12,6/12,8/12,10/12,1];

 [t',H]

 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

 %make some plots

 [lr,lc]=size(H);

 hold on

 ColorSet=varycolor(lr);

 for j=1:lr

 P(j)=plot([0:10],H(j,:));

 set(P(j),'Color', ColorSet(j,:))

 end

 title('Hydraulic Head across the Aquifer')

 xlabel('Lateral distance (in km)')

 ylabel('Height (in m)')

 axis([0,10,145,150.25])

 L=legend(P,'0 days','60 days','120 days','180 days','240 days','300 days','360 days');

 set(L,'location','SouthEast')

 p=1:300;

 hold off

 figure

 Q1=plot(5.787\*p,h(1:length(p),6));

 hold on

 Q2=plot([1:900],147.5\*ones(1,900),'r');

 title('Hydraulic Head vs Time at Midpoint of Aquifer')

 xlabel('Time (days)')

 ylabel('Height (m)')

 axis([0,900,147,150])

 legend([Q1,Q2],'Head','Horizontal asymptote')

 hold off

 index=1;

 [or,oc]=size(h);

 figure

 for index=1:or

 ee(i)=plot([0:10],h(index,:));

 title('Hydraulic Head as a function of time')

 ylabel('Height (m)')

 xlabel('Horizontal position (km)')

 getframe;

 end

 title('Hydraulic Head as a function of time')

 ylabel('Height (m)')

 xlabel('Horizontal position (km)')

%clean up the workspace

clear ColorSet K L P Q1 Q2 ans i j lc lr m n p str t x h\_ini drop oc or index