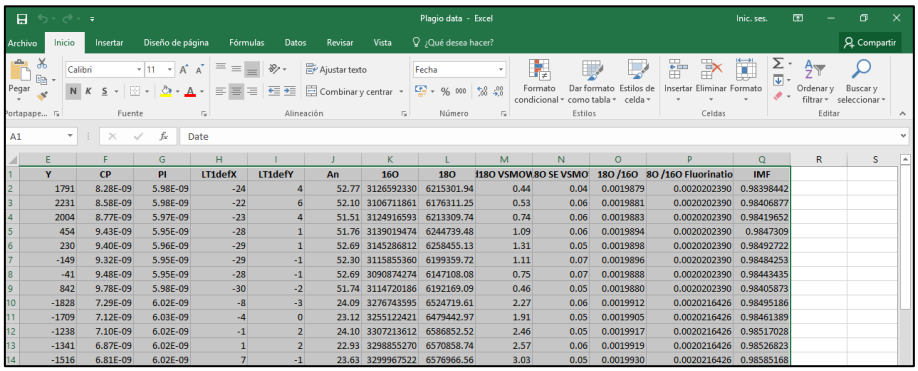
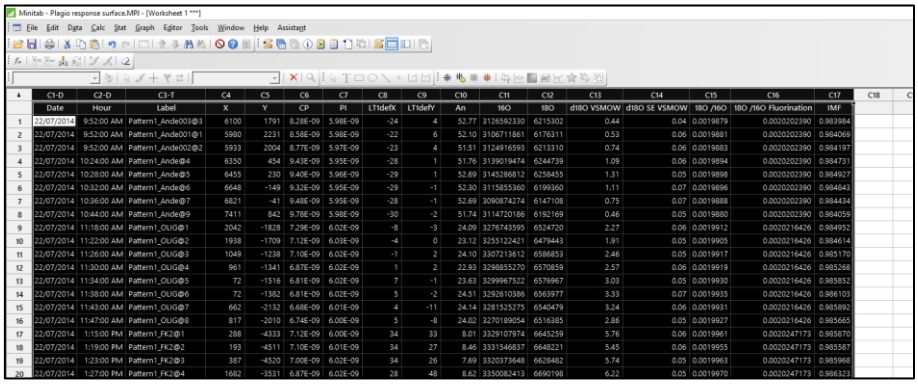
This electronic supporting information *S4* contains the main steps for fitting a response surface model using Minitab 17 (Minitab Inc.).

This process was used in "Predicting instrumental mass fractionation (IMF) of stable isotope SIMS analyses by response surface methodology (RSM)" by Fàbrega et al.

1. Copy and paste the SIMS data and IMF calculations from your spreadsheet to Minitab 17.

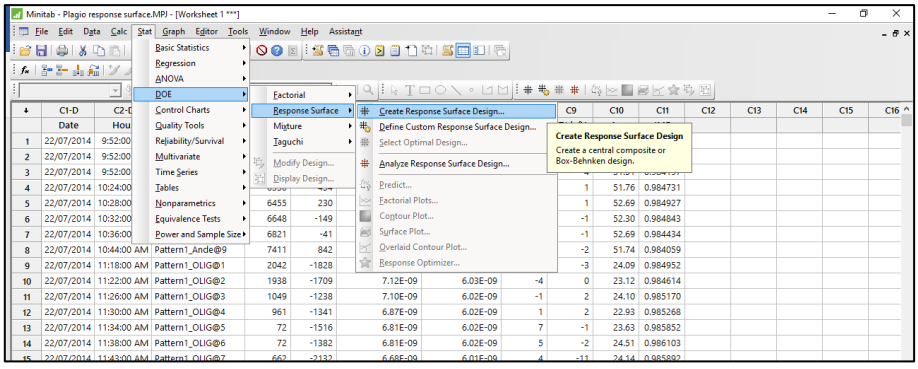


	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Y	CP	PI	LT1defX	LT1defY	An	16O	18O	I18O VSMOW	8O SE VSMO	18O /16O	8O /16O Fluorinatio	IMF		
2	1791	8.28E-09	5.98E-09	-24	4	52.77	3126592330	6215301.94	0.44	0.04	0.0019879	0.0020202390	0.98398442		
3	2231	8.58E-09	5.98E-09	-22	6	52.10	3106711861	6176311.25	0.53	0.06	0.0019881	0.0020202390	0.98406877		
4	2004	8.77E-09	5.97E-09	-23	4	51.51	3124916593	6213309.74	0.74	0.06	0.0019883	0.0020202390	0.98419652		
5	454	9.43E-09	5.95E-09	-28	1	51.76	3139019474	6244739.48	1.09	0.06	0.0019894	0.0020202390	0.9847309		
6	230	9.40E-09	5.96E-09	-29	1	52.69	3145286812	6258455.13	1.31	0.05	0.0019898	0.0020202390	0.98492722		
7	-149	9.32E-09	5.95E-09	-29	-1	52.30	3115855360	6199359.72	1.11	0.07	0.0019896	0.0020202390	0.98484253		
8	-41	9.48E-09	5.95E-09	-28	-1	52.69	3090874274	6147108.08	0.75	0.07	0.0019888	0.0020202390	0.98443435		
9	842	9.78E-09	5.98E-09	-30	-2	51.74	3114720186	6192169.09	0.46	0.05	0.0019880	0.0020202390	0.98405873		
10	-1828	7.29E-09	6.02E-09	-8	-3	24.09	3276743595	6524719.61	2.27	0.06	0.0019912	0.0020216426	0.98495186		
11	-1709	7.12E-09	6.03E-09	-4	0	23.12	3255122421	6479442.97	1.91	0.05	0.0019905	0.0020216426	0.98461389		
12	-1238	7.10E-09	6.02E-09	-1	2	24.10	3307213612	6586852.52	2.46	0.05	0.0019917	0.0020216426	0.98517028		
13	-1341	6.87E-09	6.02E-09	1	2	22.93	3298855270	6570858.74	2.57	0.06	0.0019919	0.0020216426	0.98526823		
14	-1516	6.81E-09	6.02E-09	7	-1	23.63	3299967522	6576966.56	3.03	0.05	0.0019930	0.0020216426	0.98585168		

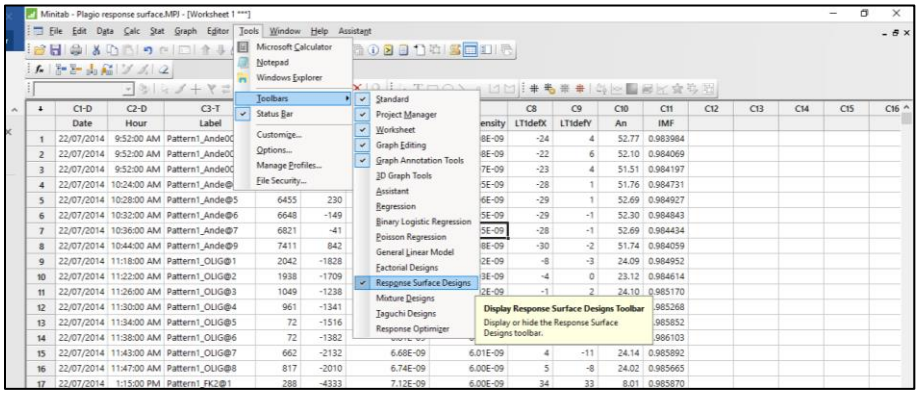


	C1-D	C2-D	C3-T	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C
	Date	Hour	Label	X	Y	CP	PI	LT1defX	LT1defY	An	16O	18O	d18O VSMOW	d18O SE VSMOW	18O /16O	18O /16O Fluorination	IMF		
1	22/07/2014	9:52:00 AM	Pattern1_Ande001@3	6100	1791	8.28E-09	5.98E-09	-24	4	52.77	3126592330	6215302	0.44	0.04	0.0019879	0.0020202390	0.983984		
2	22/07/2014	9:52:00 AM	Pattern1_Ande001@1	5980	2231	8.58E-09	5.98E-09	-22	6	52.10	3106711861	6176311	0.53	0.06	0.0019881	0.0020202390	0.984069		
3	22/07/2014	9:52:00 AM	Pattern1_Ande002@2	5933	2004	8.77E-09	5.97E-09	-23	4	51.51	3124916593	6213310	0.74	0.06	0.0019883	0.0020202390	0.984197		
4	22/07/2014	10:24:00 AM	Pattern1_Ande@4	6350	454	9.43E-09	5.95E-09	-28	1	51.76	3139019474	6244739	1.09	0.06	0.0019894	0.0020202390	0.984731		
5	22/07/2014	10:28:00 AM	Pattern1_Ande@5	6455	230	9.40E-09	5.96E-09	-29	1	52.69	3145286812	6258455	1.31	0.05	0.0019898	0.0020202390	0.984927		
6	22/07/2014	10:32:00 AM	Pattern1_Ande@6	6648	-149	9.32E-09	5.95E-09	-29	-1	52.30	3115855360	6199360	1.11	0.07	0.0019896	0.0020202390	0.984843		
7	22/07/2014	10:36:00 AM	Pattern1_Ande@7	6821	-41	9.48E-09	5.95E-09	-28	-1	52.69	3090874274	6147108	0.75	0.07	0.0019888	0.0020202390	0.984434		
8	22/07/2014	10:44:00 AM	Pattern1_Ande@9	7411	842	9.78E-09	5.98E-09	-30	-2	51.74	3114720186	6192169	0.46	0.05	0.0019880	0.0020202390	0.984059		
9	22/07/2014	11:18:00 AM	Pattern1_OLIG@1	2042	-1828	7.29E-09	6.02E-09	-8	-3	24.09	3276743595	6524720	2.27	0.06	0.0019912	0.0020216426	0.984952		
10	22/07/2014	11:22:00 AM	Pattern1_OLIG@2	1938	-1709	7.12E-09	6.03E-09	-4	0	23.12	3255122421	6479443	1.91	0.05	0.0019905	0.0020216426	0.984614		
11	22/07/2014	11:26:00 AM	Pattern1_OLIG@3	1049	-1238	7.10E-09	6.02E-09	-1	2	24.10	3307213612	6586853	2.46	0.05	0.0019917	0.0020216426	0.985170		
12	22/07/2014	11:30:00 AM	Pattern1_OLIG@4	961	-1341	6.87E-09	6.02E-09	1	2	22.93	3298855270	6570859	2.57	0.06	0.0019919	0.0020216426	0.985268		
13	22/07/2014	11:34:00 AM	Pattern1_OLIG@5	72	-1516	6.81E-09	6.02E-09	7	-1	23.63	3299967522	6576967	3.03	0.05	0.0019930	0.0020216426	0.985852		
14	22/07/2014	11:38:00 AM	Pattern1_OLIG@6	72	-1382	6.81E-09	6.02E-09	5	-2	24.51	3292610386	6563977	3.33	0.07	0.0019933	0.0020216426	0.986103		
15	22/07/2014	11:43:00 AM	Pattern1_OLIG@7	662	-2132	6.68E-09	6.01E-09	4	-11	24.14	3281525275	6540479	3.24	0.06	0.0019931	0.0020216426	0.985892		
16	22/07/2014	11:47:00 AM	Pattern1_OLIG@8	817	-2010	6.74E-09	6.00E-09	5	-8	24.02	3270189054	6516385	2.86	0.05	0.0019927	0.0020216426	0.985665		
17	22/07/2014	1:15:00 PM	Pattern1_FK2@1	288	-4333	7.12E-09	6.00E-09	34	33	8.01	3329107974	6645259	5.76	0.06	0.0019961	0.0020247173	0.985870		
18	22/07/2014	1:19:00 PM	Pattern1_FK2@2	193	-4511	7.10E-09	6.01E-09	34	27	8.46	3331546837	6648221	5.45	0.06	0.0019955	0.0020247173	0.985587		
19	22/07/2014	1:23:00 PM	Pattern1_FK2@3	387	-4520	7.00E-09	6.02E-09	34	26	7.69	3320373648	6628482	5.74	0.05	0.0019963	0.0020247173	0.985968		
20	22/07/2014	1:27:00 PM	Pattern1_FK2@4	1682	-3531	6.87E-09	6.02E-09	28	48	8.62	3350082413	6690198	6.22	0.05	0.0019970	0.0020247173	0.986323		

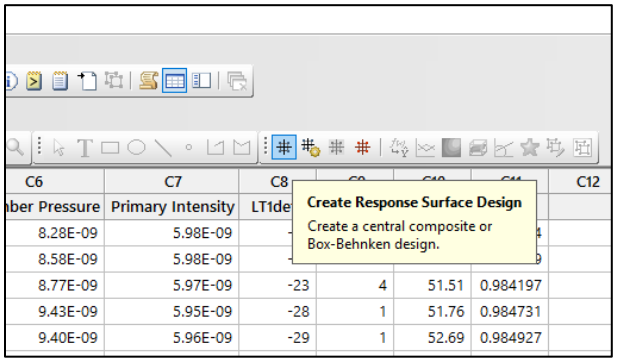
2. Go to *Stat*, *DOE (Design of Experiments)*, *Create a Response Surface Design*.



3. If desired, a Response Surface Design toolbar can be created in *Tools*.

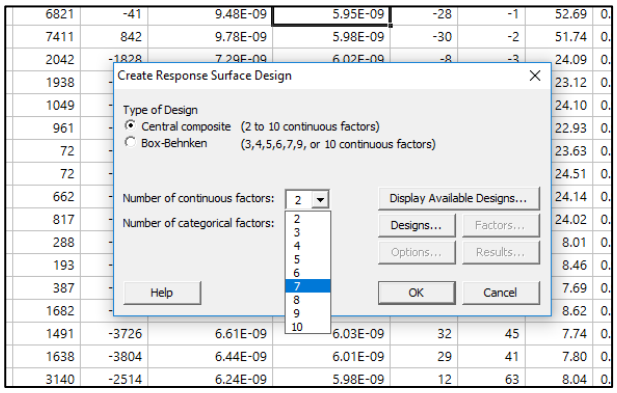


4. Select *Create Response Surface Design*.

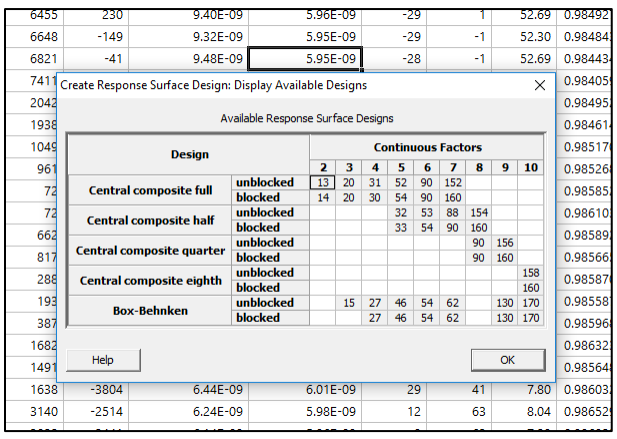


C6	C7	C8			C12
ber Pressure	Primary Intensity	LT1de			
8.28E-09	5.98E-09				
8.58E-09	5.98E-09				
8.77E-09	5.97E-09	-23	4	51.51	0.984197
9.43E-09	5.95E-09	-28	1	51.76	0.984731
9.40E-09	5.96E-09	-29	1	52.69	0.984927

5. Introduce the number of continuous factors (predictor variables).

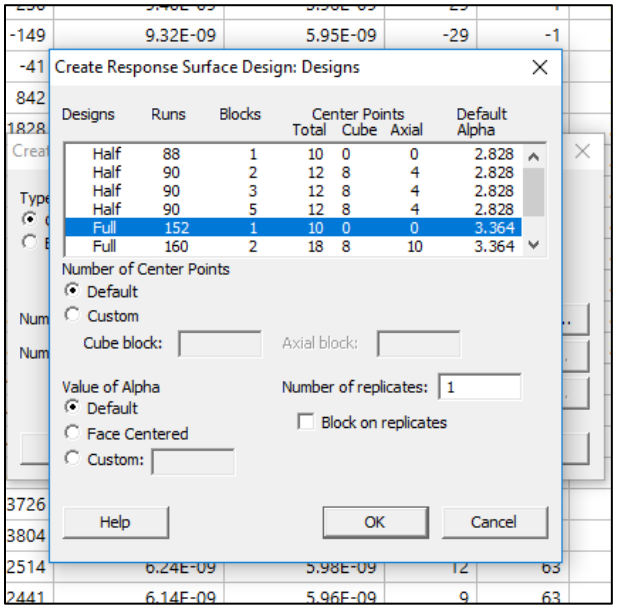


6. Look at the *Available Designs* proposed by Minitab.

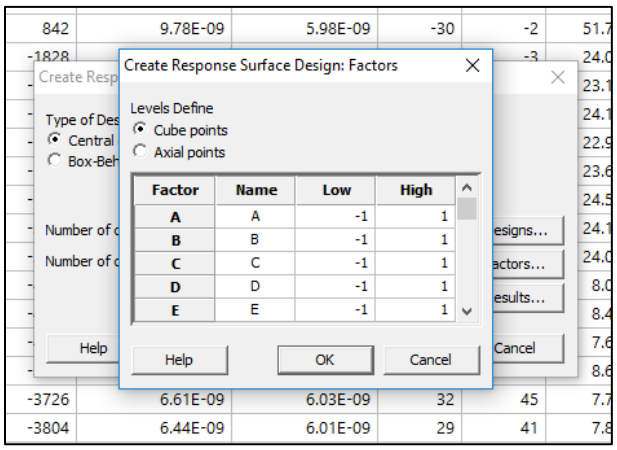


Design		Continuous Factors								
		2	3	4	5	6	7	8	9	10
Central composite full	unblocked	13	20	31	52	90	152			
	blocked	14	20	30	54	90	160			
Central composite half	unblocked				32	53	88	154		
	blocked				33	54	90	160		
Central composite quarter	unblocked							90	156	
	blocked							90	160	
Central composite eighth	unblocked									158
	blocked									160
Box-Behnken	unblocked		15	27	46	54	62		130	170
	blocked			27	46	54	62		130	170

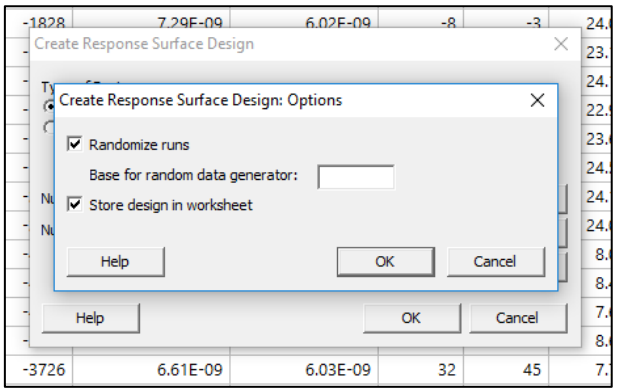
7. Choose one of the proposed *Designs*.



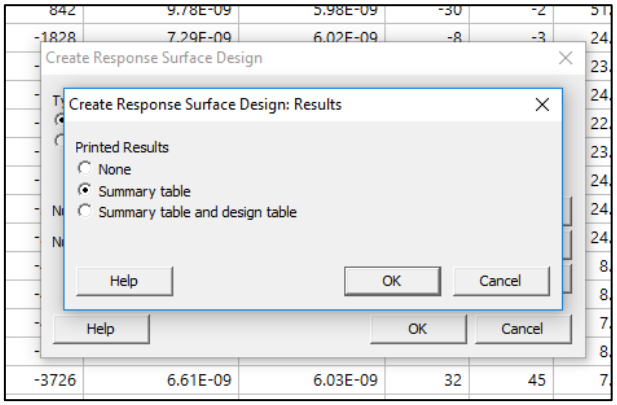
8. Define the *Factors*.



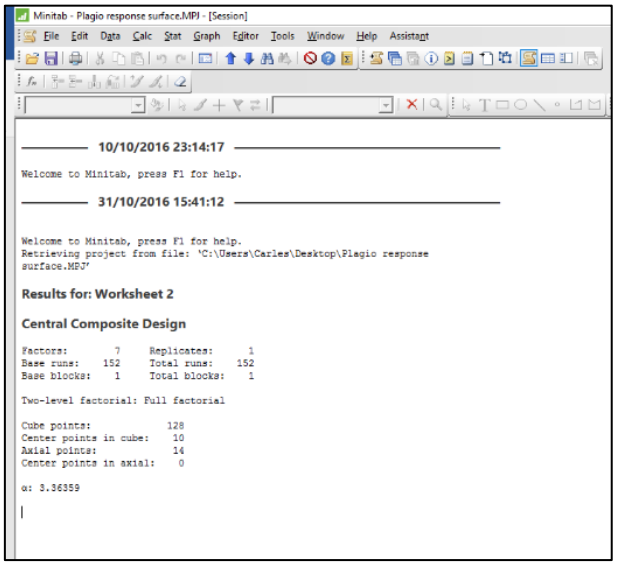
9. Define the *Options*:

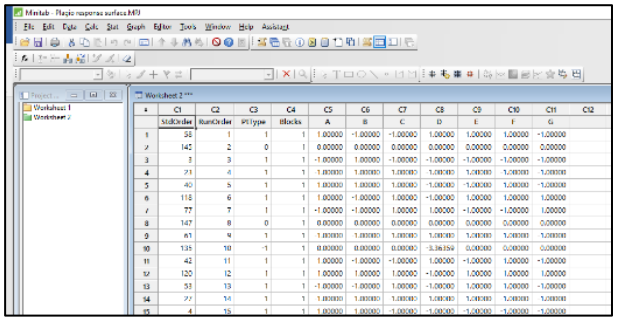


10. Define the *Results*.

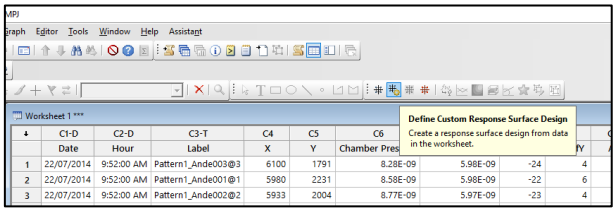


11. Click OK - OK and Minitab will generate the specified Response Surface Design. The design appears in the *Session Window*, and the *Matrix Design* appears in the newly created *Worksheet 2*.

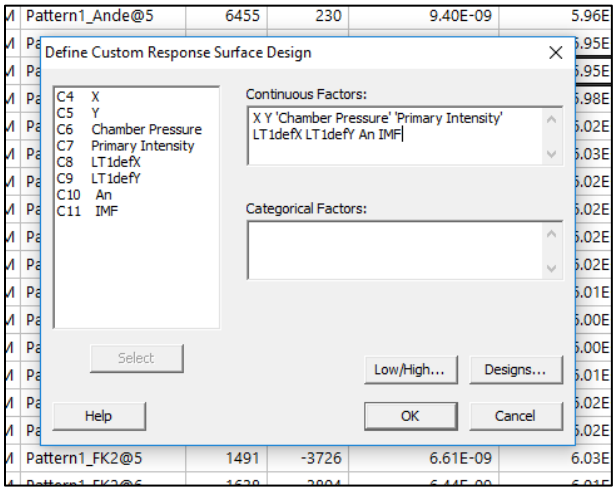




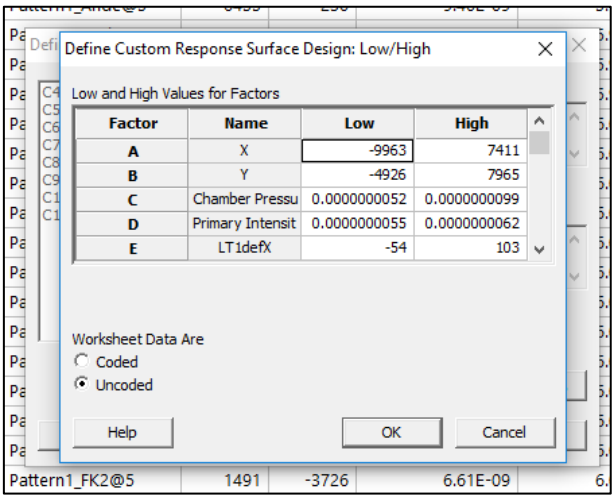
12. Go back to the *Worksheet 1* (SIMS data). Select *Define Custom Response Surface Design*.



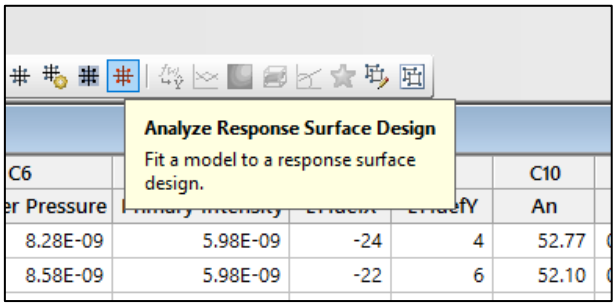
13. With double click, select the *Continuous Factors* (predictor variables) from the left.



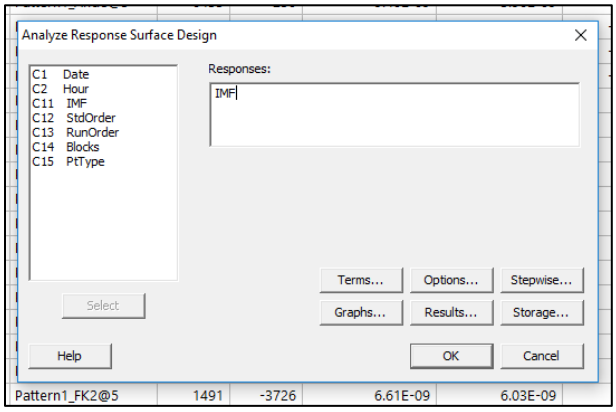
14. Define the *Low* and *High Values* for the *Factors*.



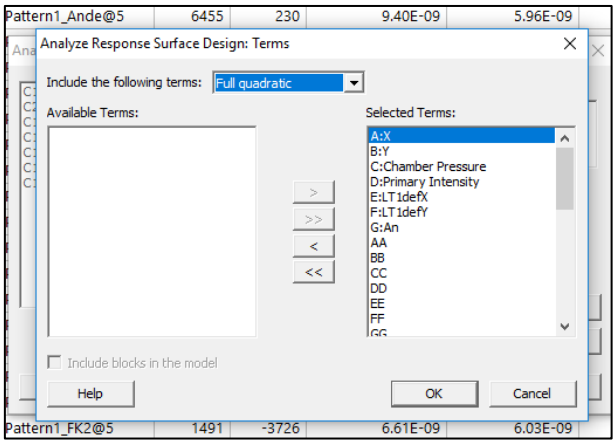
15. Go to *Analyze Response Surface Design*:



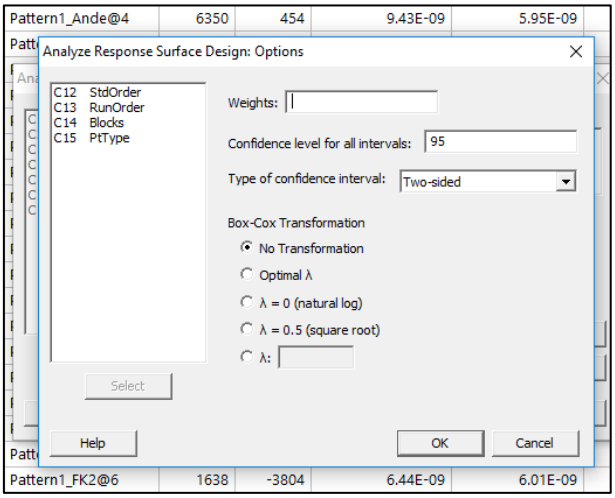
16. Introduce the *Response*. In this case IMF.



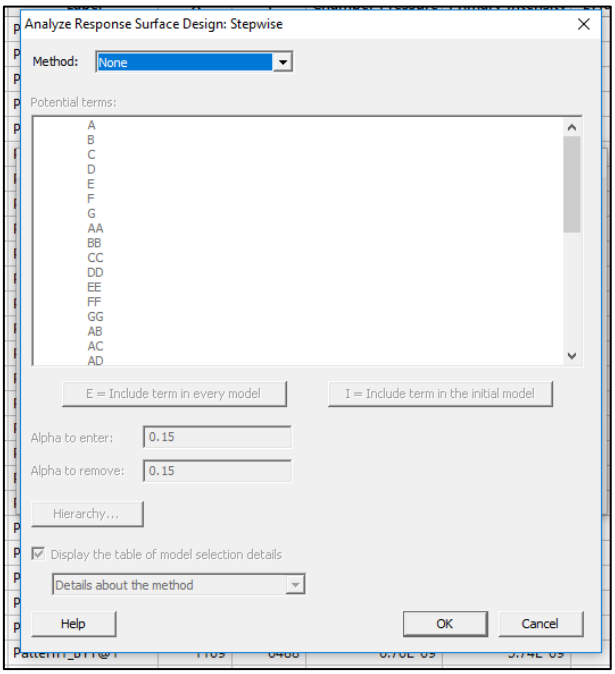
17. Select the initial model *Terms*.



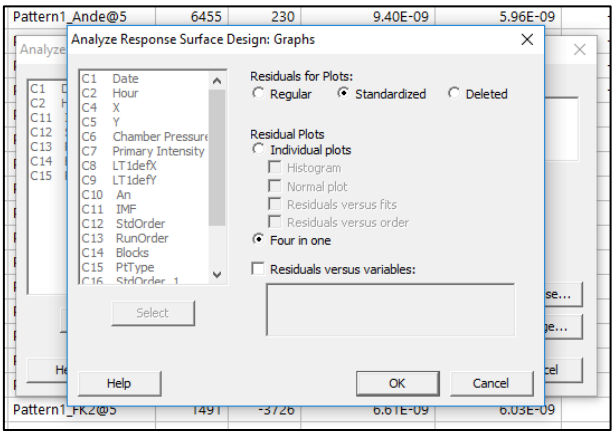
18. If desired, in *Options* you can weight and transform the variables.



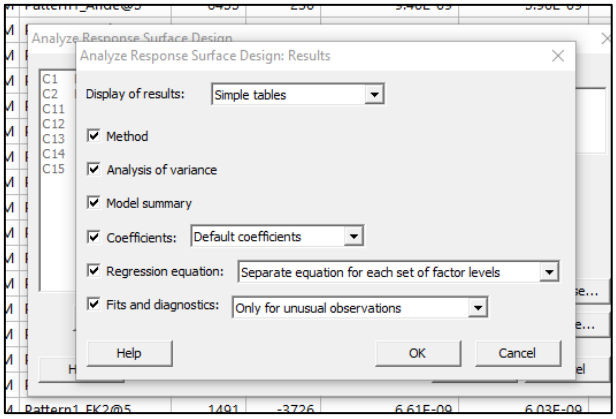
19. If desired, in Stewise you can select an automatic stepwise selection method of the model terms (we recommend None).



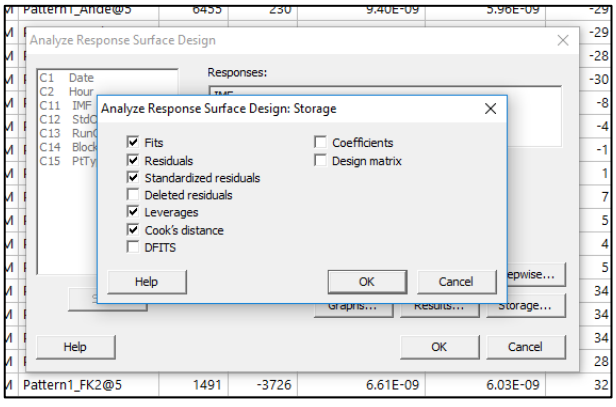
20. In Graphs, it is recommended to select *Standardized residuals* and *Four in one*:



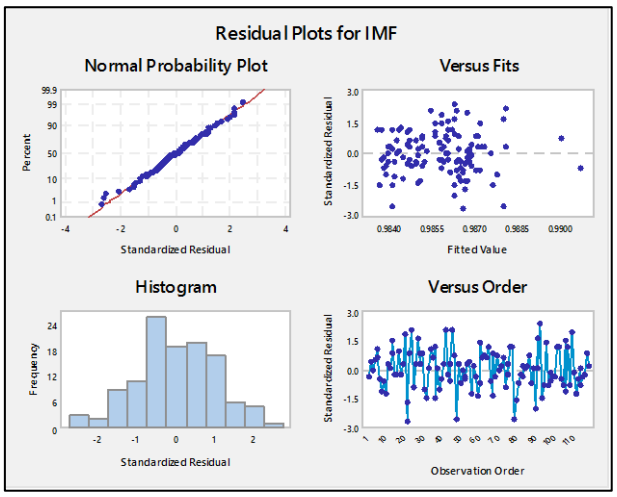
21. In *Results*, choose the results you want to visualize.



22. In *Storage*, choose (recommended) *Fits*, *Residuals*, *Standardized Residuals*, *Leverage* and *Cook's distance*. The values will be stored in the *Worksheet 1* in the final columns of the right. Click *OK* - *OK* and Minitab will create the starting **Response Surface Model**.



23. Check the *Residual Plots*:

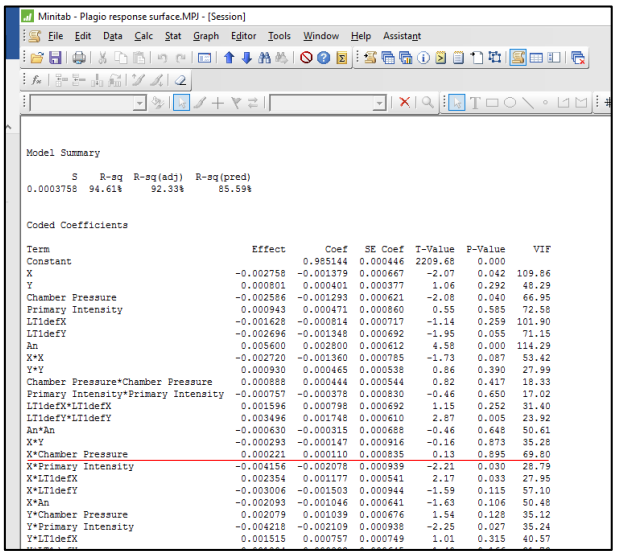


24. Check the *Leverage (HI)* and *Cook's distance (COOK)* of the model points looking for high influential observations.

Plagioclase database ***

	C21	C22	C23	C24	C25	C26	C27	C28	C
	PtType		FITS	RESI	SRES	HI	COOK		
1	1		0.984775	-0.0007906	-1.85511	0.096418	0.022951		
2	1		0.984560	-0.0004911	-1.15153	0.095350	0.008735		
3	1		0.984602	-0.0004053	-0.94974	0.094198	0.005863		
4	1		0.984524	0.0002066	0.49105	0.119493	0.002045		
5	1		0.984558	0.0003695	0.87911	0.121358	0.006672		
6	1		0.984531	0.0003120	0.74413	0.125601	0.004971		

25. In the *Session Window*, Minitab shows the *statistics of the model.* Check the *Model Summary*, which contains the statistics *S*, *R-sq* (R^2), *R-sq adj.* (adjusted R^2) and *R-sq pred.* (prediction R^2). From the *Analysis of Variance*, decide the first term that shouldn't stay in the model, using as elimination criteria the *p-value*, the *VIF* or your background knowledge. In this example, the first term eliminated from the model will be *X*Chamber Pressure*, because it displays the highest *p-value* (*0.895*) of all the terms.



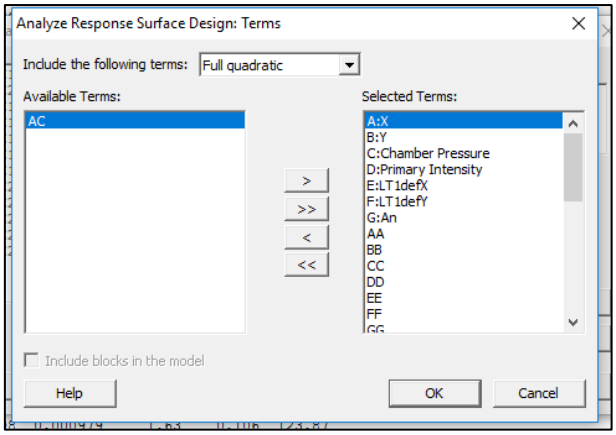
Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0003758	94.61%	92.33%	85.59%

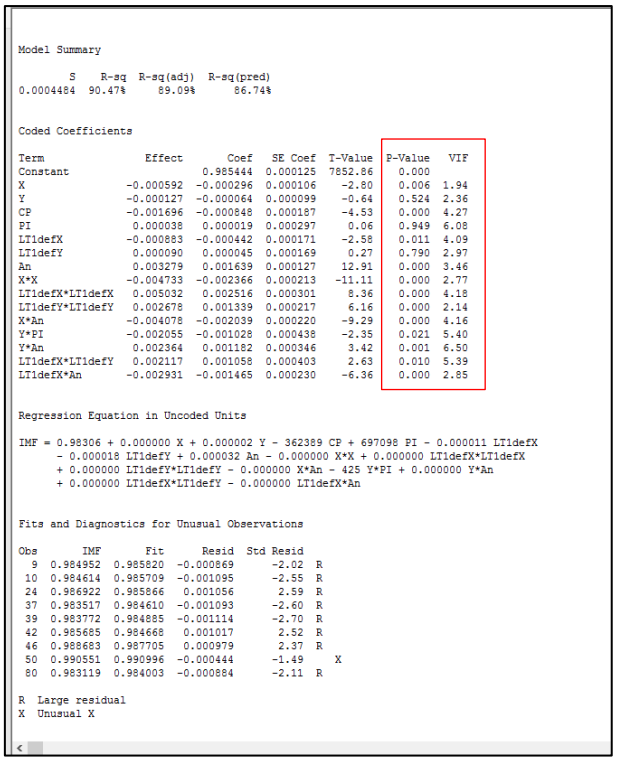
Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		0.985144	0.000446	2209.68	0.000	
X	-0.002758	-0.001379	0.000667	-2.07	0.042	109.86
Y	0.000801	0.000401	0.000377	1.06	0.292	48.29
Chamber Pressure	-0.002586	-0.001293	0.000621	-2.08	0.040	66.95
Primary Intensity	0.000943	0.000471	0.000860	0.55	0.585	72.58
LTidefX	-0.001628	-0.000814	0.000717	-1.14	0.259	101.90
LTidefY	-0.002696	-0.001348	0.000692	-1.95	0.055	71.15
An	0.005600	0.002800	0.000612	4.58	0.000	114.29
X*X	-0.002720	-0.001360	0.000785	-1.73	0.087	53.42
Y*Y	0.000930	0.000465	0.000538	0.86	0.390	27.99
Chamber Pressure*Chamber Pressure	0.000888	0.000444	0.000544	0.82	0.417	18.33
Primary Intensity*Primary Intensity	-0.000757	-0.000378	0.000830	-0.46	0.650	17.02
LTidefX*LTidefX	0.001596	0.000798	0.000692	1.15	0.252	31.40
LTidefY*LTidefY	0.003496	0.001748	0.000610	2.87	0.005	23.92
An*An	-0.000630	-0.000315	0.000688	-0.46	0.648	50.61
X*Y	-0.000293	-0.000147	0.000916	-0.16	0.873	35.28
X*Chamber Pressure	0.000221	0.000110	0.000835	0.13	0.895	69.80
X*Primary Intensity	-0.004156	-0.002078	0.000939	-2.21	0.030	28.79
X*LTidefX	0.002354	0.001177	0.000541	2.17	0.033	27.95
X*LTidefY	-0.003006	-0.001503	0.000944	-1.59	0.115	57.10
X*An	-0.002093	-0.001046	0.000641	-1.63	0.106	50.48
Y*Chamber Pressure	0.002079	0.001039	0.000676	1.54	0.128	35.12
Y*Primary Intensity	-0.004218	-0.002109	0.000938	-2.25	0.027	35.24
Y*LTidefX	0.001515	0.000757	0.000749	1.01	0.315	40.57

26. Go back to *Terms* (Crtl+E) and move the term decided in Step 25 (*X*Chamber Pressure in the example)* from the list of *Selected Terms* to the list of *Available Terms*.



27. Click *OK-OK* and run the model again. Repeat the backward selection process of steps 23-24-25-26 until a satisfactory model is reached. Most of the terms remaining in the final model should be significant for the regression (*p-value≤0.05)* and present low multicollinearity (*VIF≤10)*. The single terms of a hierarchical model can be no significant (*p-value≥0.05)*.



Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0004484	90.47%	89.09%	86.74%

Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		0.985444	0.000125	7852.86	0.000	
X	-0.000592	-0.000296	0.000106	-2.80	0.006	1.94
Y	-0.000127	-0.000064	0.000099	-0.64	0.524	2.36
CP	-0.001696	-0.000848	0.000187	-4.53	0.000	4.27
PI	0.000038	0.000019	0.000297	0.06	0.949	6.08
LT1defX	-0.000883	-0.000442	0.000171	-2.58	0.011	4.09
LT1defY	0.000090	0.000045	0.000169	0.27	0.790	2.97
An	0.003279	0.001639	0.000127	12.91	0.000	3.46
X*X	-0.004733	-0.002366	0.000213	-11.11	0.000	2.77
LT1defX*LT1defX	0.005032	0.002516	0.000301	8.36	0.000	4.18
LT1defY*LT1defY	0.002678	0.001339	0.000217	6.16	0.000	2.14
X*An	-0.004078	-0.002039	0.000220	-9.29	0.000	4.16
Y*PI	-0.002055	-0.001028	0.000438	-2.35	0.021	5.40
Y*An	0.002364	0.001182	0.000346	3.42	0.001	6.50
LT1defX*LT1defY	0.002117	0.001058	0.000403	2.63	0.010	5.39
LT1defX*An	-0.002931	-0.001465	0.000230	-6.36	0.000	2.85

Regression Equation in Uncoded Units

```
IMF = 0.98306 + 0.000000 X + 0.000002 Y - 362389 CP + 697098 PI - 0.000011 LT1defX
      - 0.000018 LT1defY + 0.000032 An - 0.000000 X*X + 0.000000 LT1defX*LT1defX
      + 0.000000 LT1defY*LT1defY - 0.000000 X*An - 425 Y*PI + 0.000000 Y*An
      + 0.000000 LT1defX*LT1defY - 0.000000 LT1defX*An
```

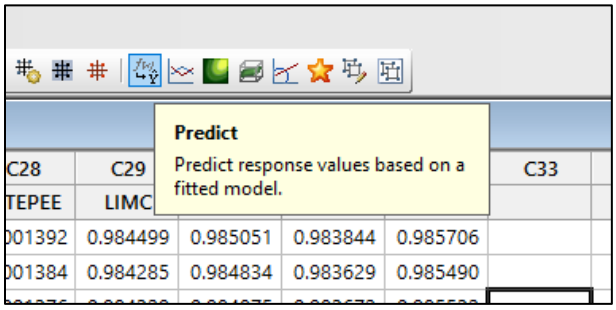
Fits and Diagnostics for Unusual Observations

Obs	IMF	Fit	Resid	Std Resid	
9	0.984952	0.985820	-0.000869	-2.02	R
10	0.984614	0.985709	-0.001095	-2.55	R
24	0.986922	0.985866	0.001056	2.59	R
37	0.983517	0.984610	-0.001093	-2.60	R
39	0.983772	0.984885	-0.001114	-2.70	R
42	0.985685	0.984668	0.001017	2.52	R
46	0.988683	0.987705	0.000979	2.37	R
50	0.990551	0.990996	-0.000444	-1.49	X
80	0.983119	0.984003	-0.000884	-2.11	R

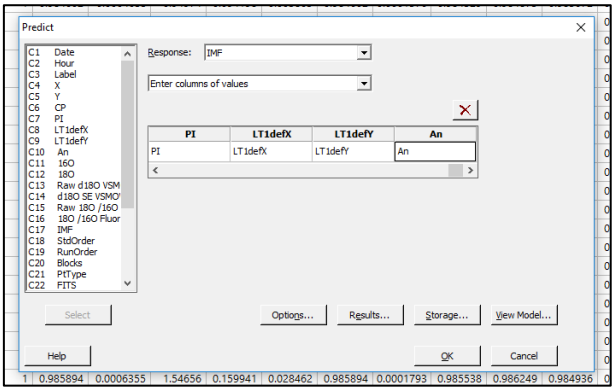
R Large residual
X Unusual X

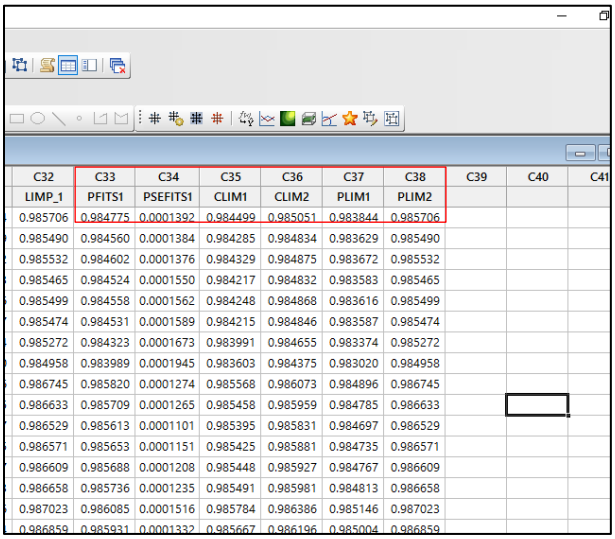
28. Check the *Leverage* and *Cook's distance* of the model points to ensure that the final fitted model does not contain highly influential points.

29. Go to *Predict*.

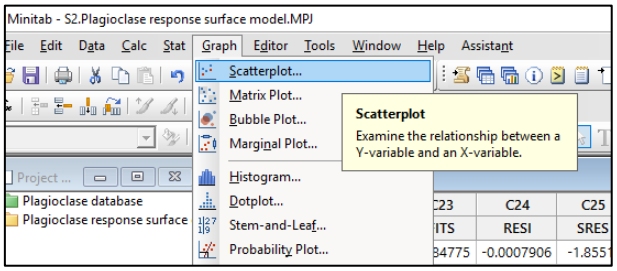


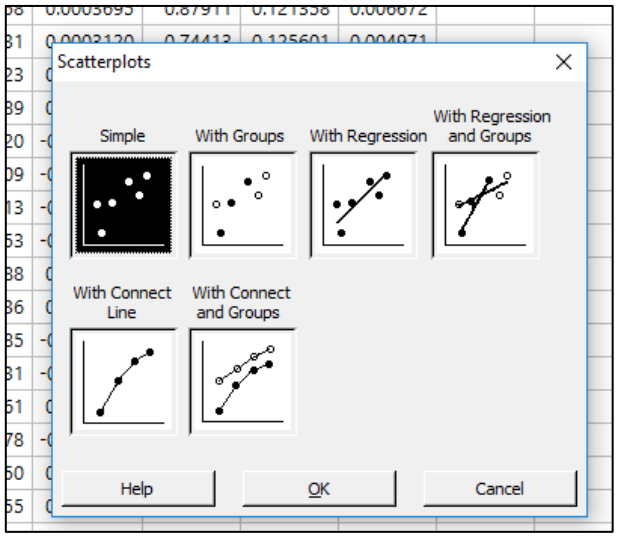
30. Enter the columns of values for prediction. The predicted values will be stored in the final columns of the right:

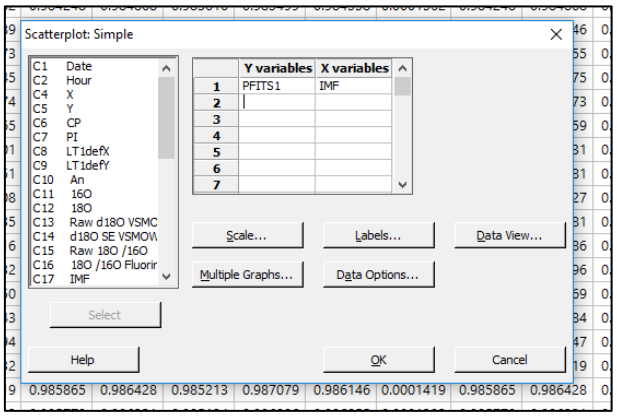


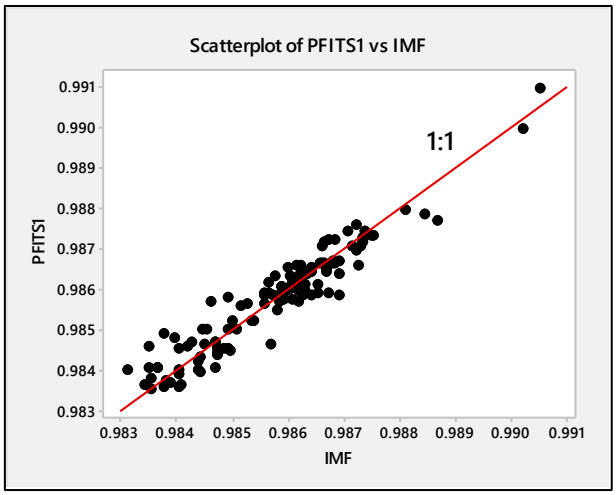


31. Generate the scatterplot of the predicted vs. the actual IMF values. The points should follow a 1:1 slope.

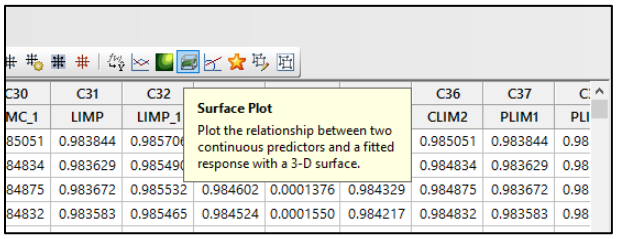


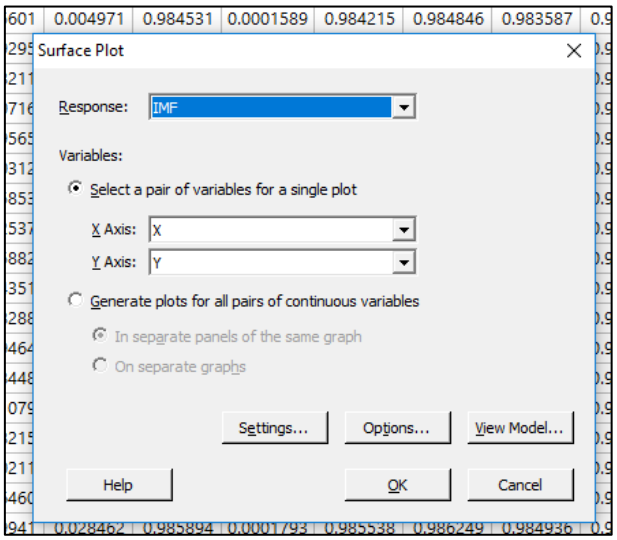


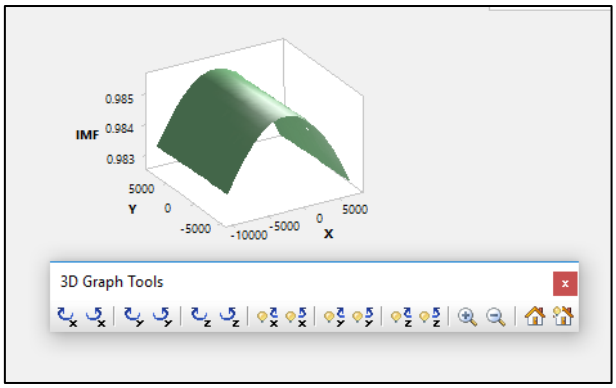




32. If desired, you can generate 3D surfaces or contour plots to visualize de behavior of the response respect to different pairs of predictor variables.







The 3D surfaces can be rotated with the *3D Graph Tools* toolbar.

33. A double click on each part of the graph (surface, axis, title…) opens the respective edition window.