

Faglig rapport fra DMU nr. 685, 2008

Analyse af miljøtilstanden i Mariager Fjord fra 1986 til 2006

Empirisk modellering af miljøtilstanden

Stiig Markager

Marc Bassompierre

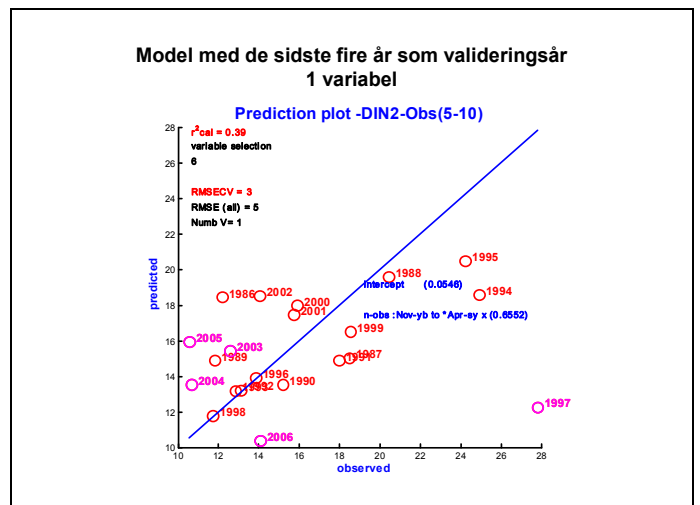
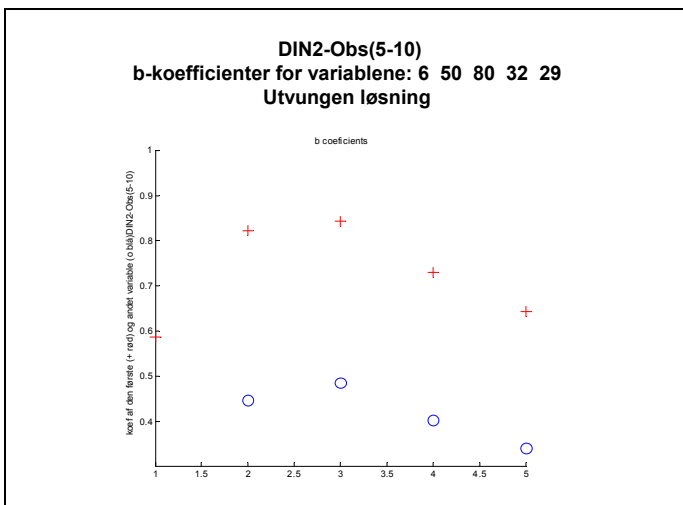
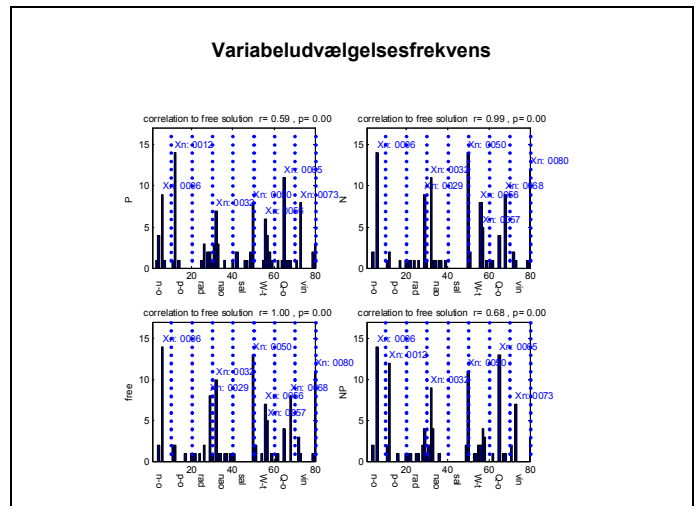
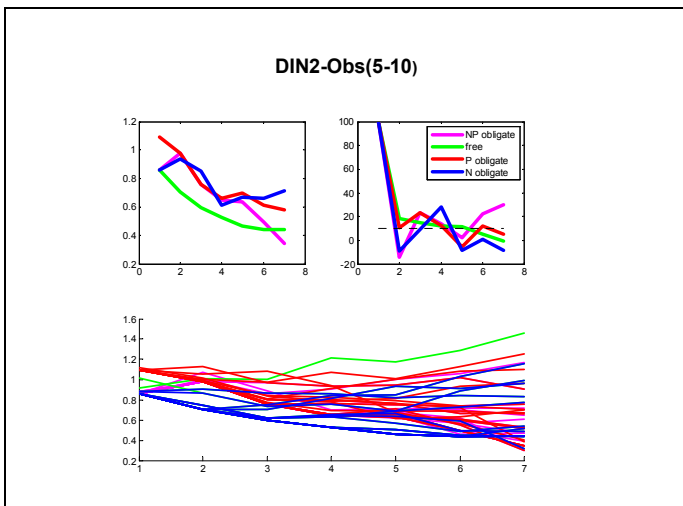
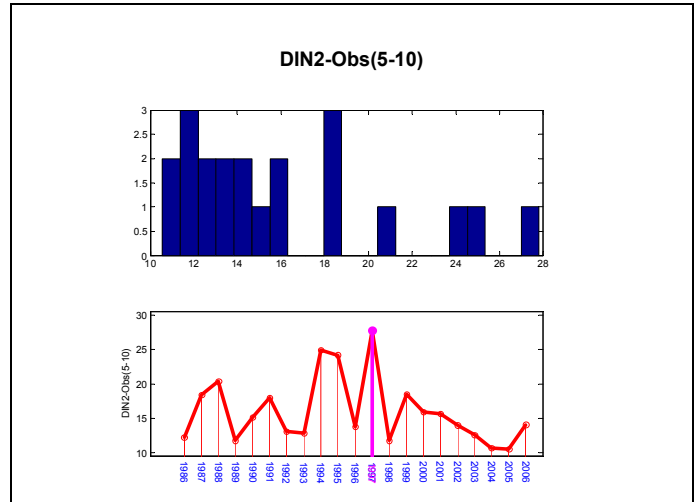
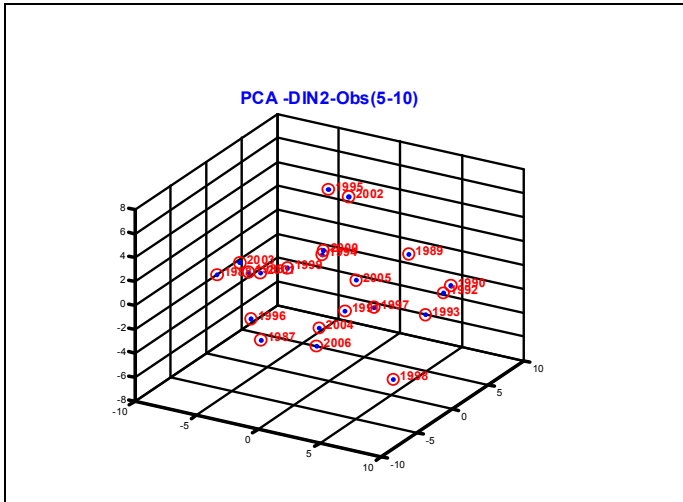
Ditte L. Jansen Petersen

Bilag 1 Empiriske modeller

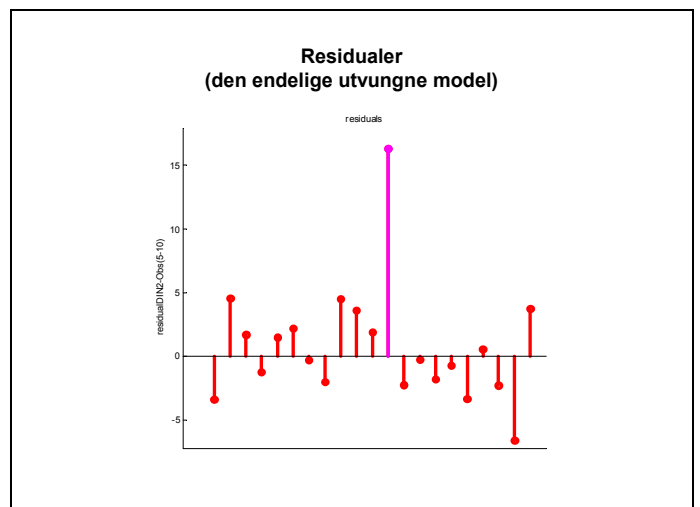
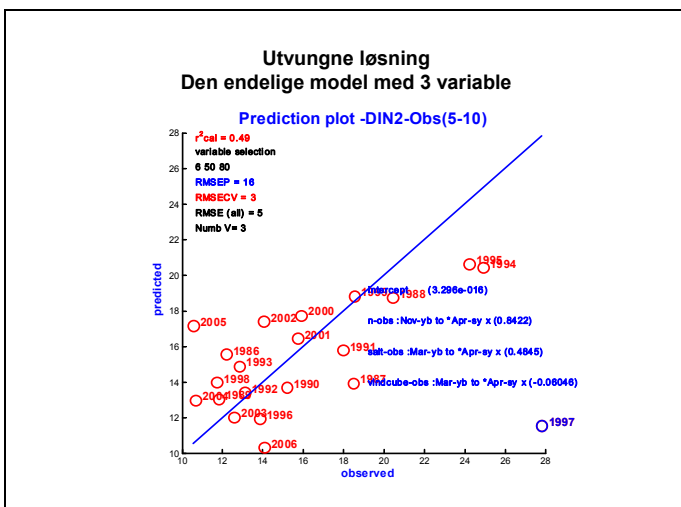
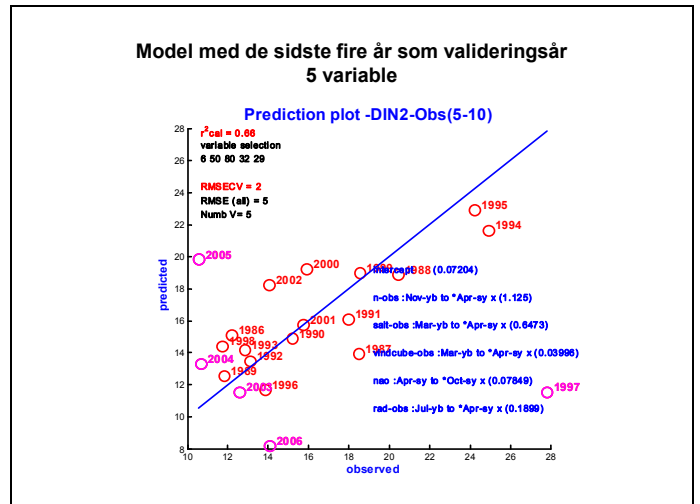
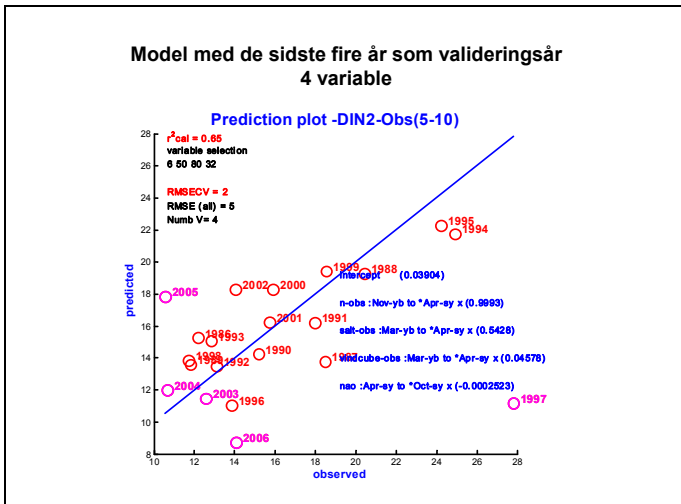
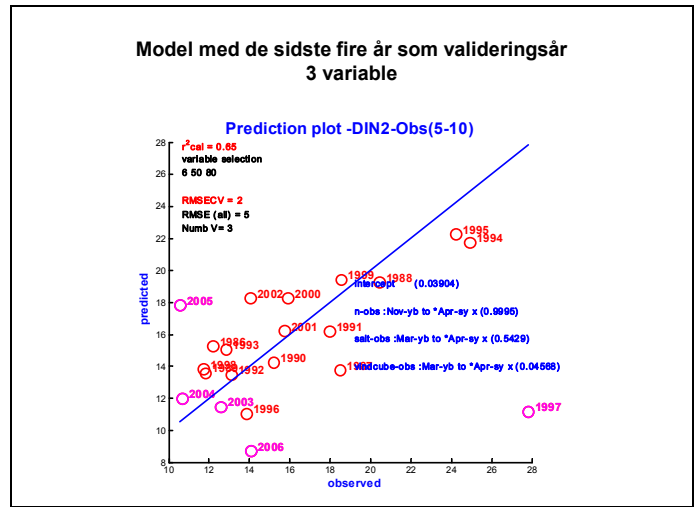
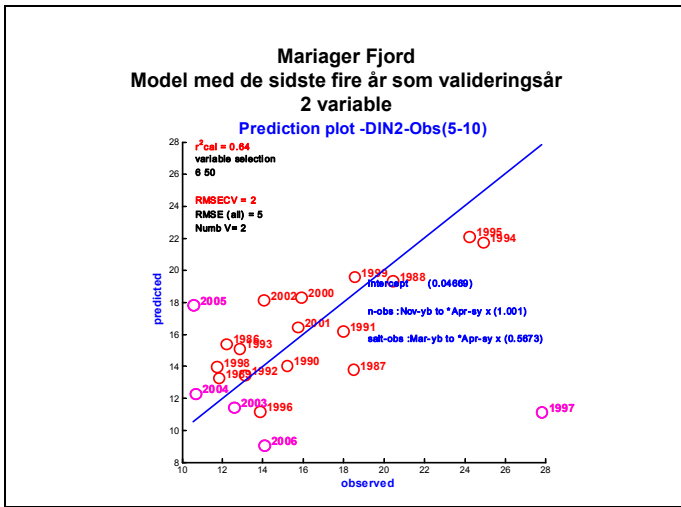
- Bilag 1.1 Mariager Fjord DIN2- og DIP2-modellering
- Bilag 1.2 Mariager Fjord Kd1- og Kd2-modellering
- Bilag 1.3 Mariager Fjord PA1- og PA2-modellering
- Bilag 1.4 Mariager Fjord Sd1 - og Sd2-modellering
- Bilag 1.5 Mariager Fjord TN- og TP-modellering

[Tom side]

Mariager Fjord – DIN2-modellering

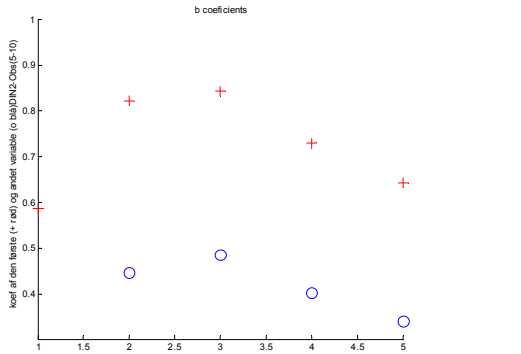


Mariager Fjord – DIN2-modellering

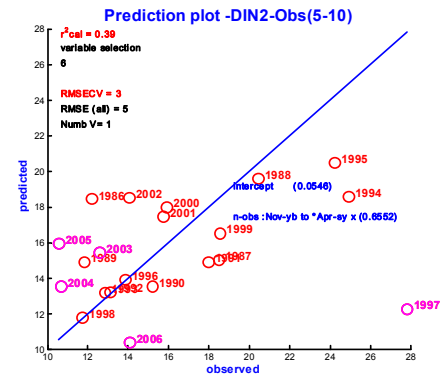


Mariager Fjord – DIN2-modellering

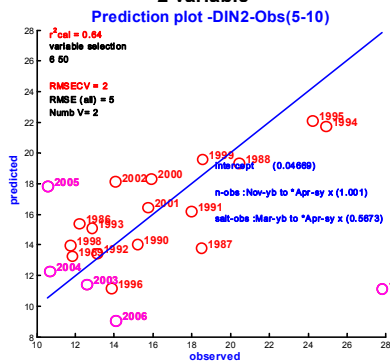
b-koefficienter for variablene: 6 50 80 32 29
N-tvungen løsning



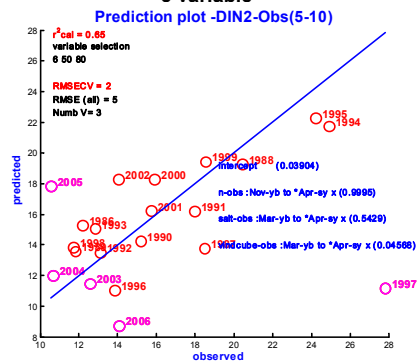
Model med de sidste fire år som valideringsår
1 variabel



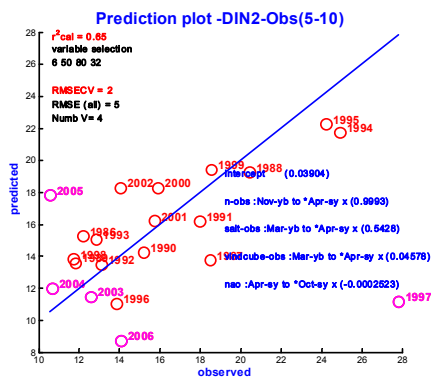
Mariager Fjord
Model med de sidste fire år som valideringsår
2 variable



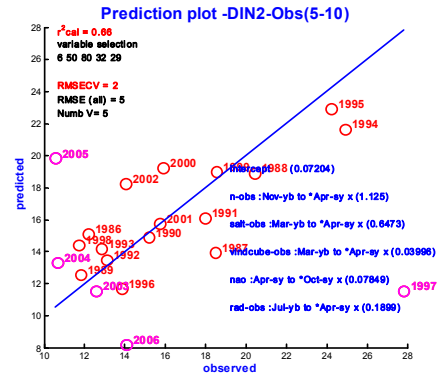
Mariager Fjord
Model med de sidste fire år som valideringsår
3 variable



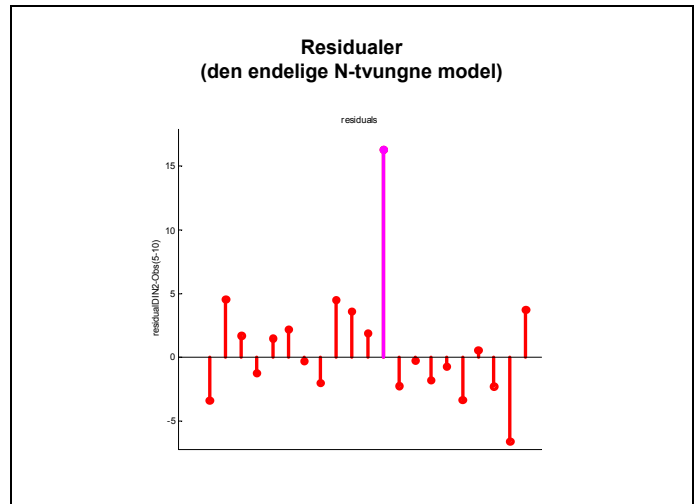
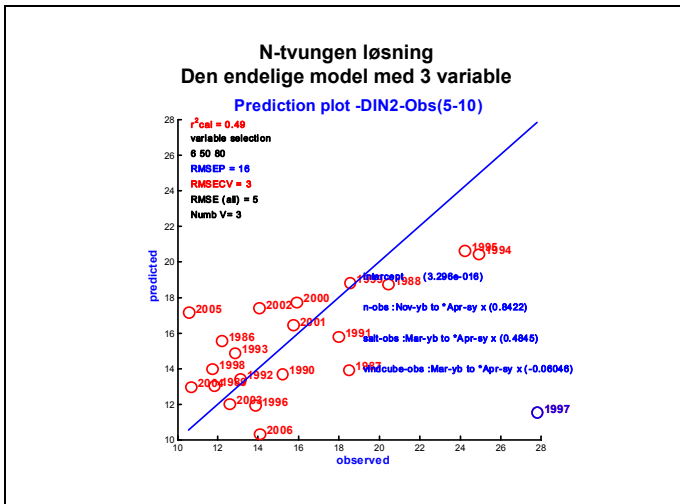
Model med de sidste fire år som valideringsår
4 variable



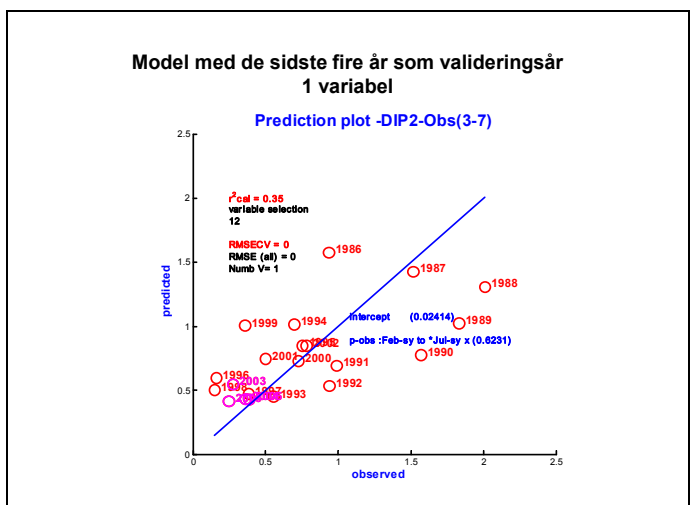
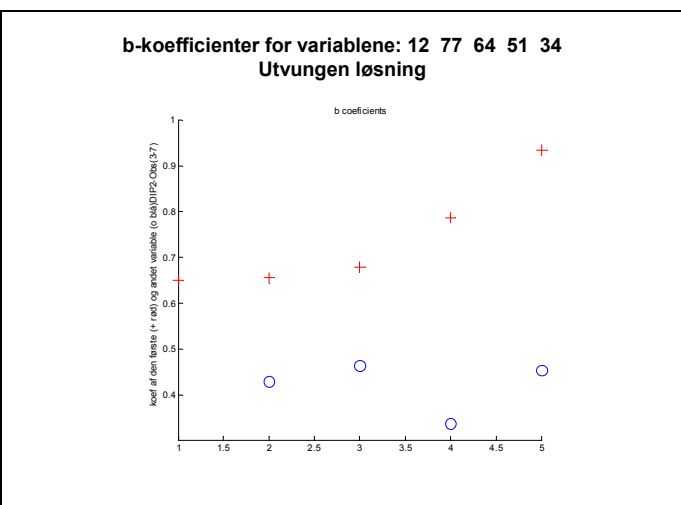
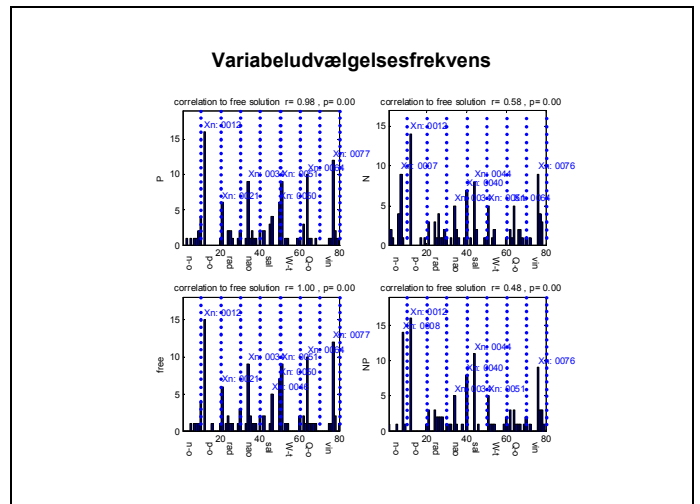
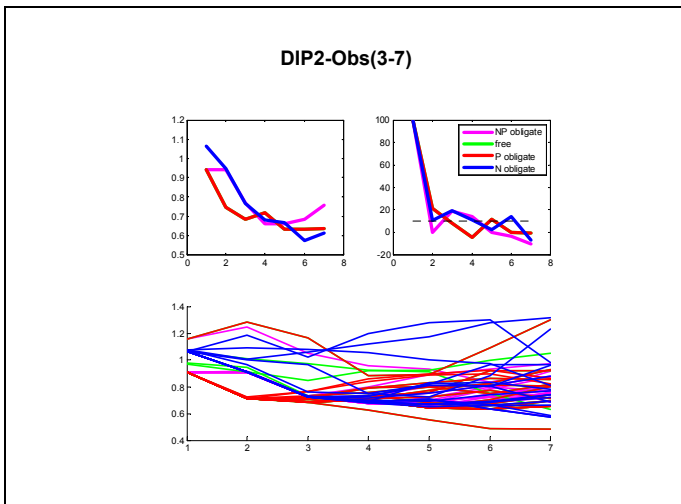
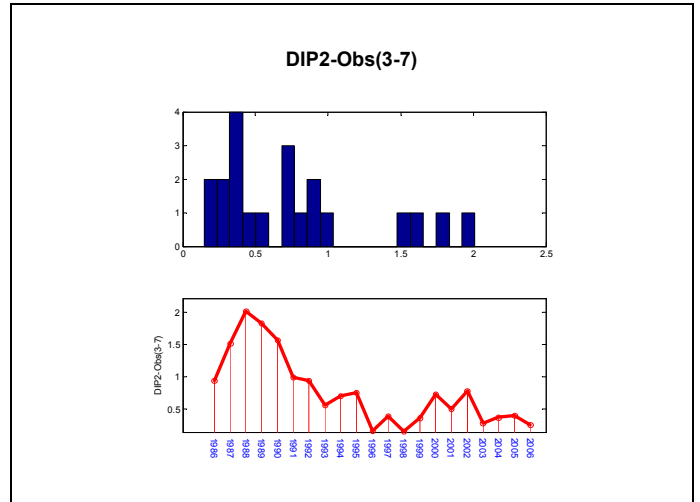
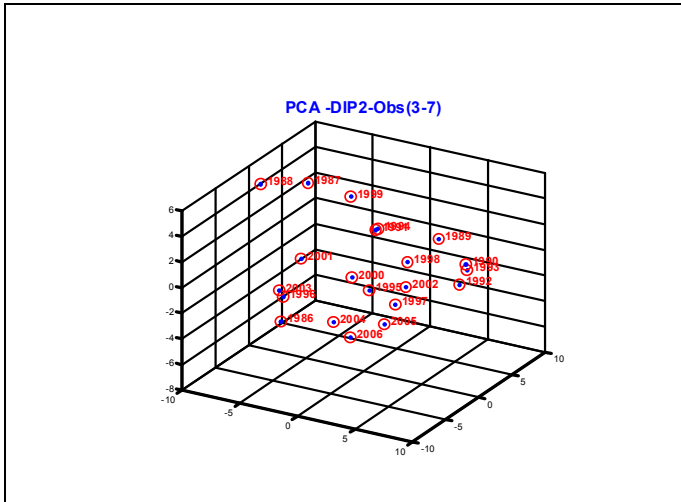
Model med de sidste fire år som valideringsår
5 variable



Mariager Fjord – DIN2-modellering

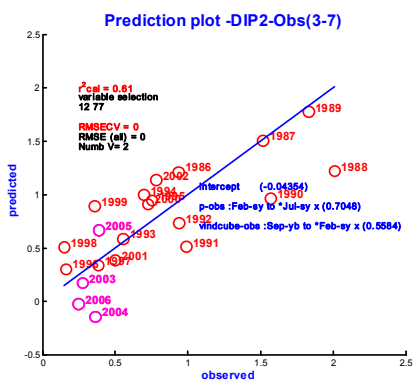


Mariager Fjord – DIP2-modellering

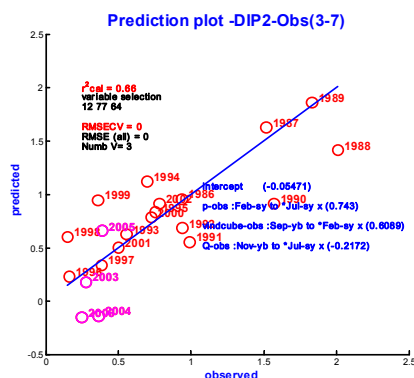


Mariager Fjord – DIP2-modellering

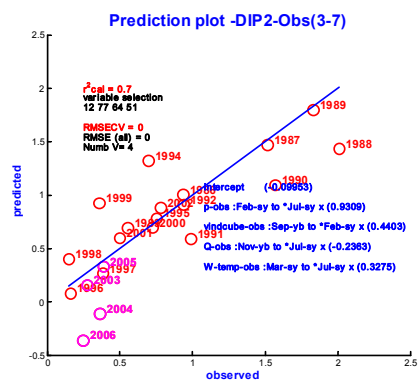
Model med de sidste fire år som valideringsår
2 variable



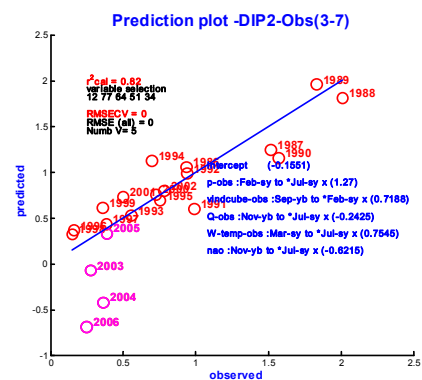
Model med de sidste fire år som valideringsår
3 variable



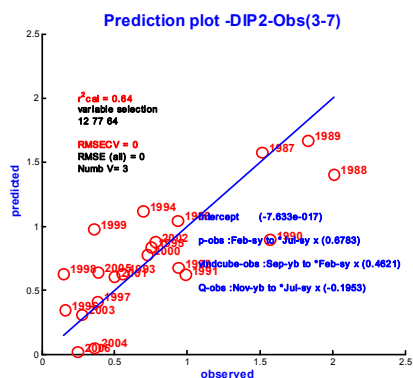
Model med de sidste fire år som valideringsår
4 variable



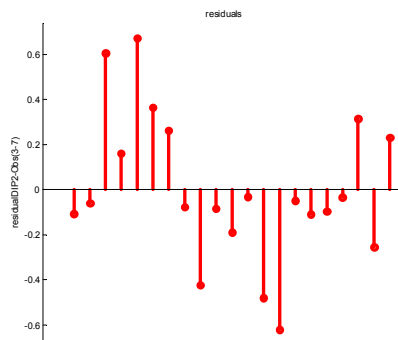
Model med de sidste fire år som valideringsår
5 variable



Utvungen løsning
Den endelige model med 3 variable

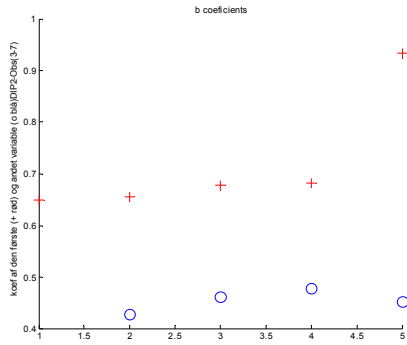


Residualer
(den endelige utvungne model)

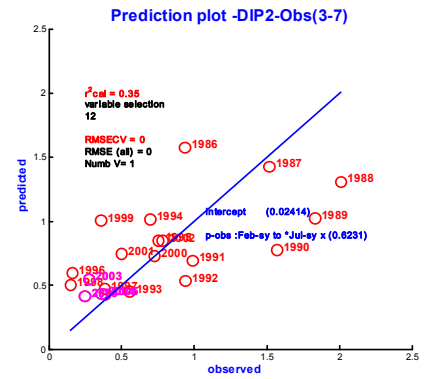


Mariager Fjord – DIP2-modellering

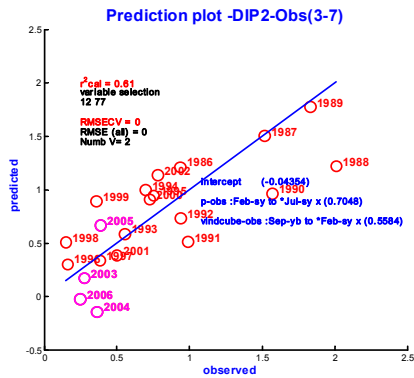
b-koefficienter for variablene: 12 77 64 34 51
P-tvungen løsning



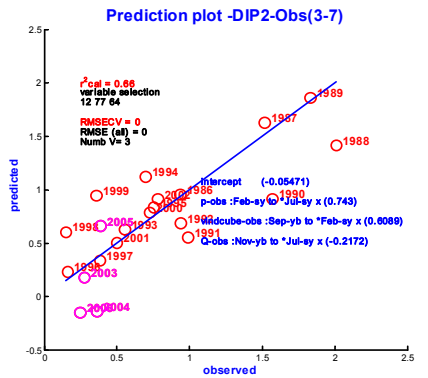
Model med de sidste fire år som valideringsår
1 variabel



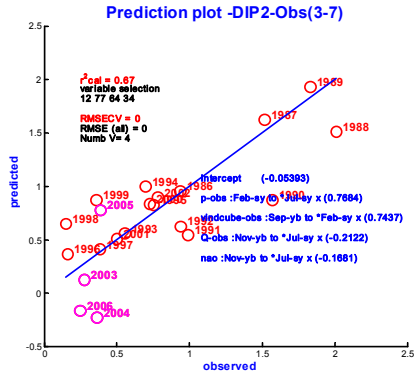
Model med de sidste fire år som valideringsår
2 variable



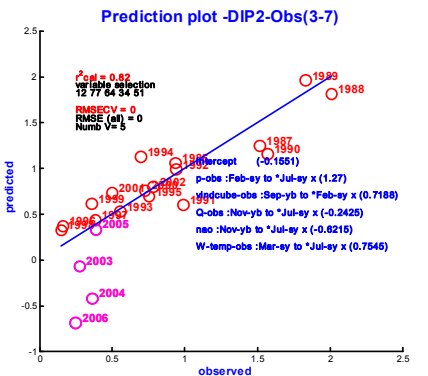
Model med de sidste fire år som valideringsår
3 variable



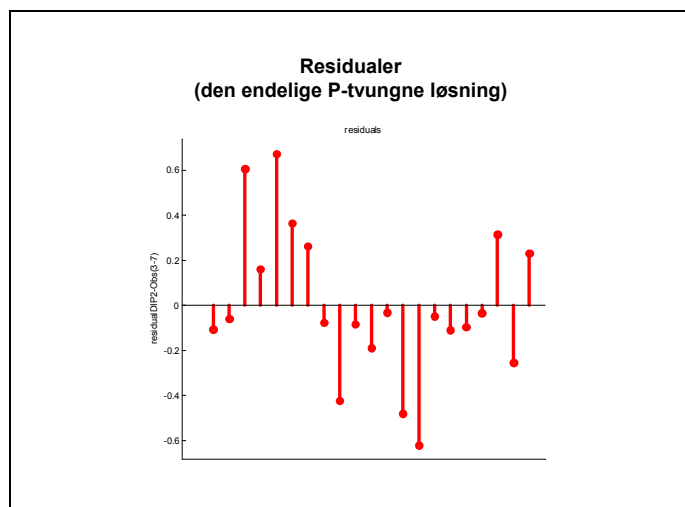
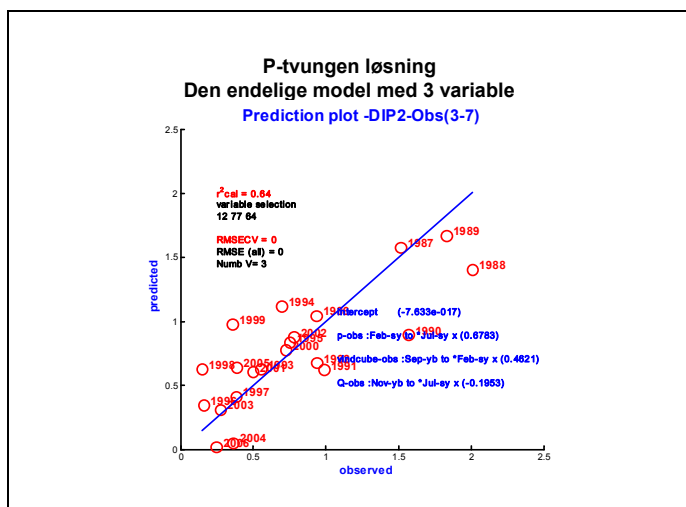
Model med de sidste fire år som valideringsår
4 variable



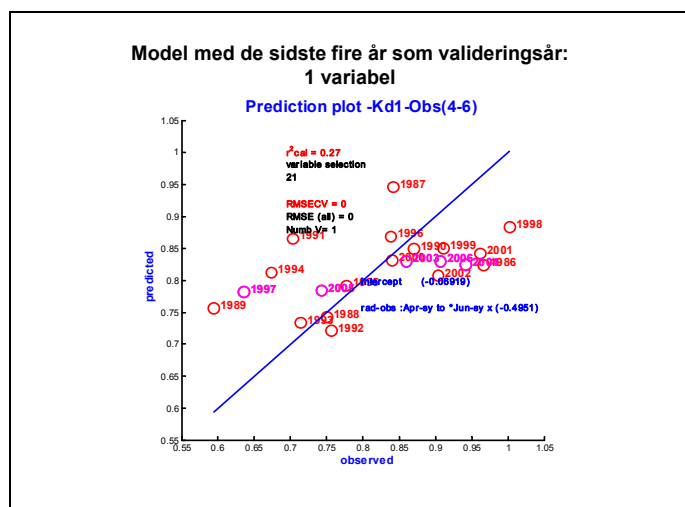
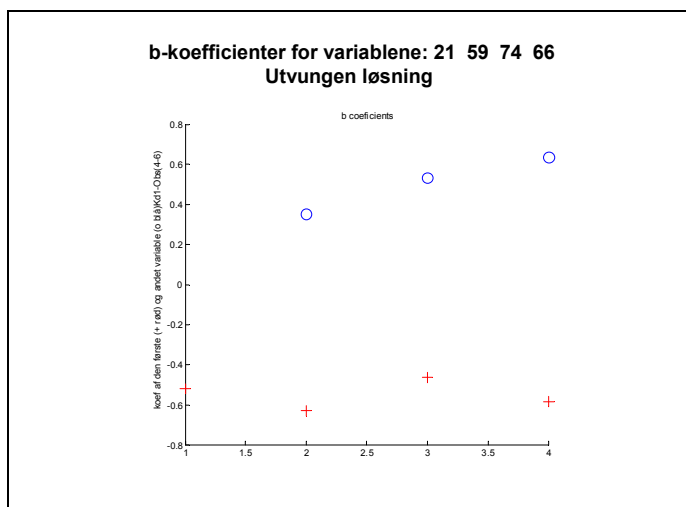
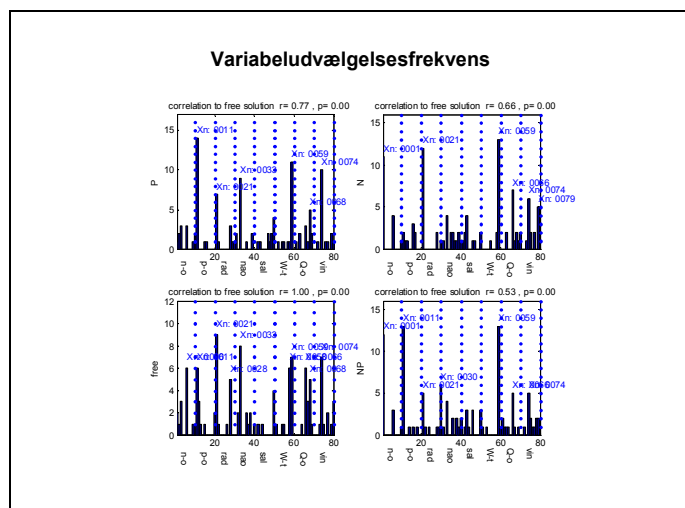
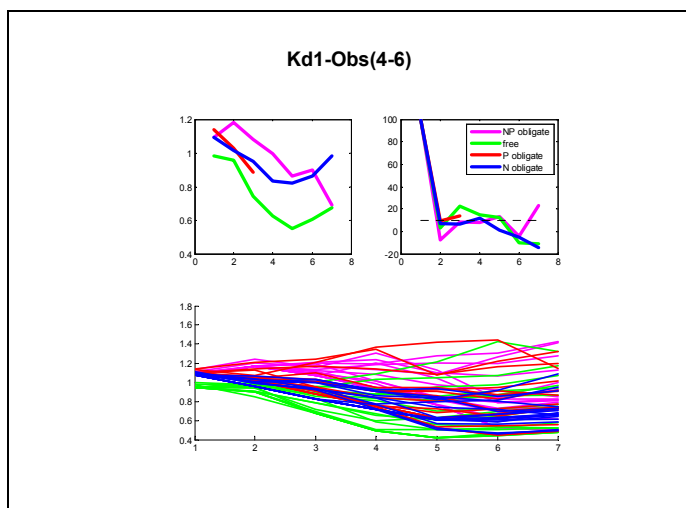
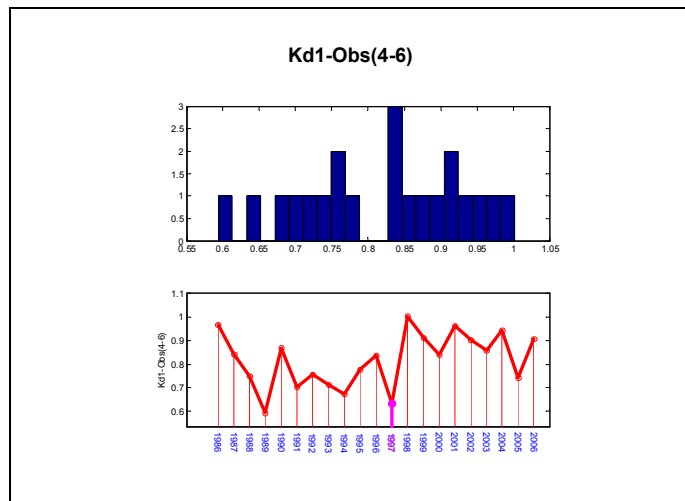
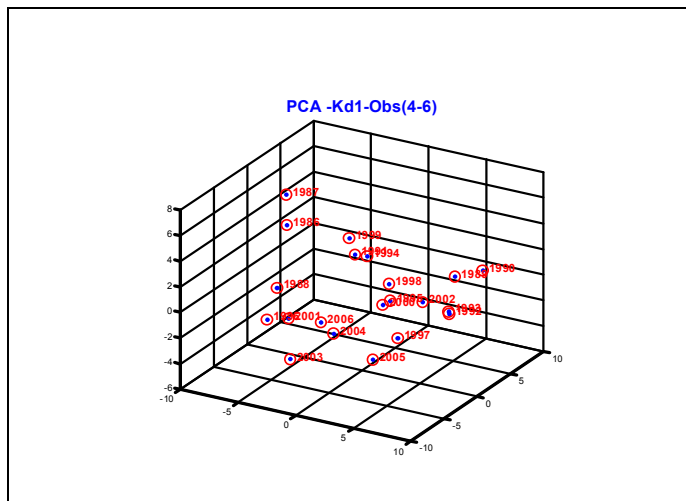
Model med de sidste fire år som valideringsår
5 variable



Mariager Fjord – DIP2-modellering

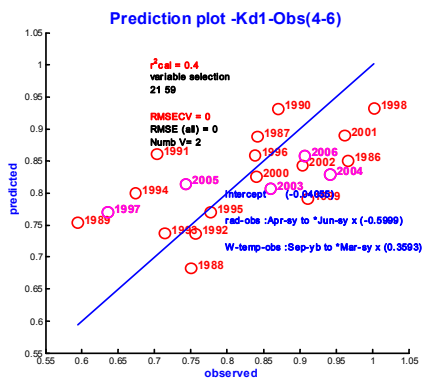


Mariager Fjord - Kd1-modellering

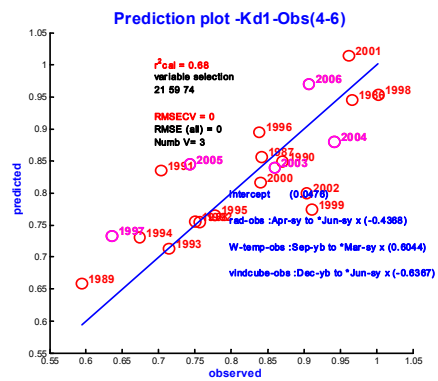


Mariager Fjord - Kd1-modellering

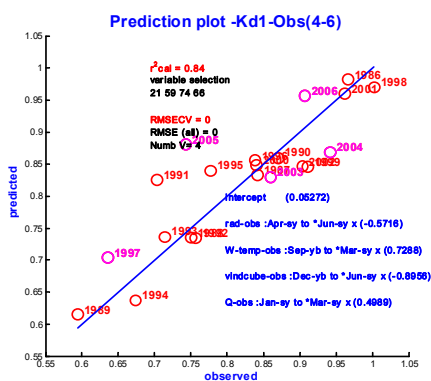
Model med de sidste fire år som valideringsår:
2 variable



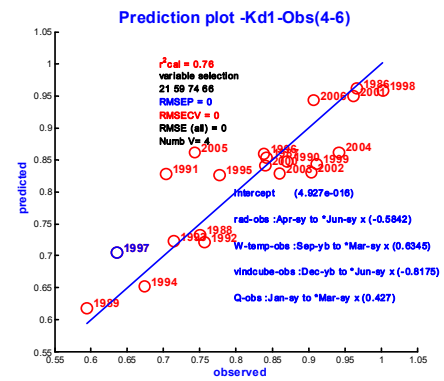
Model med de sidste fire år som valideringsår:
3 variable



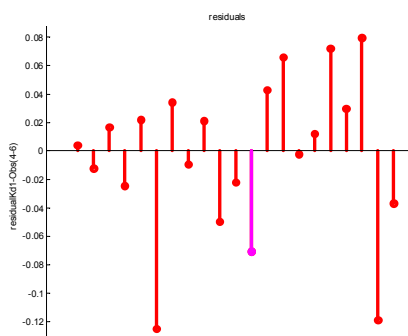
Model med de sidste fire år som valideringsår:
4 variable



Utvungne løsning
Den endelige model med 4 variable

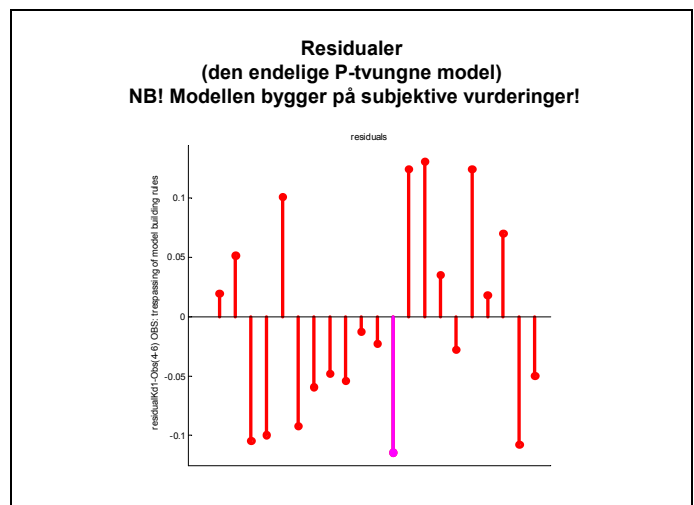
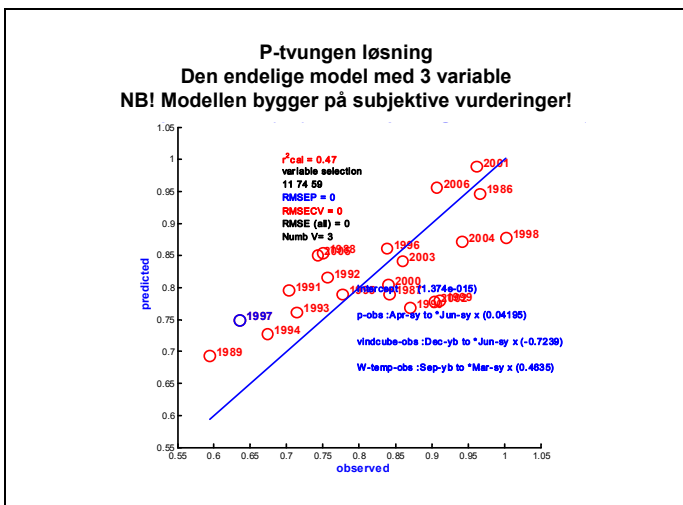
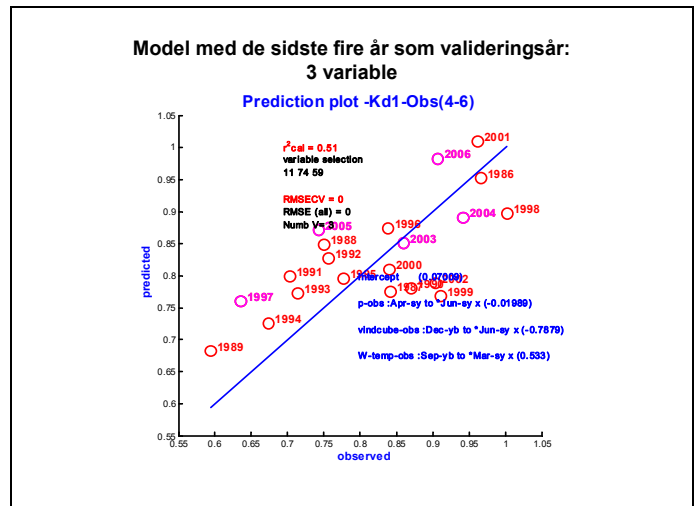
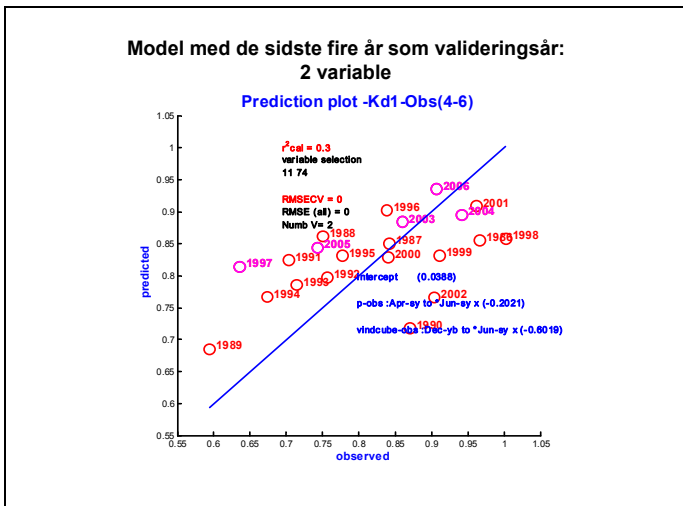
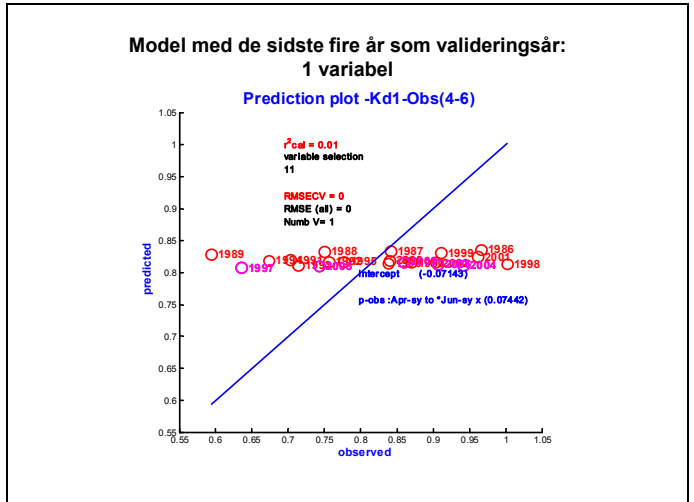
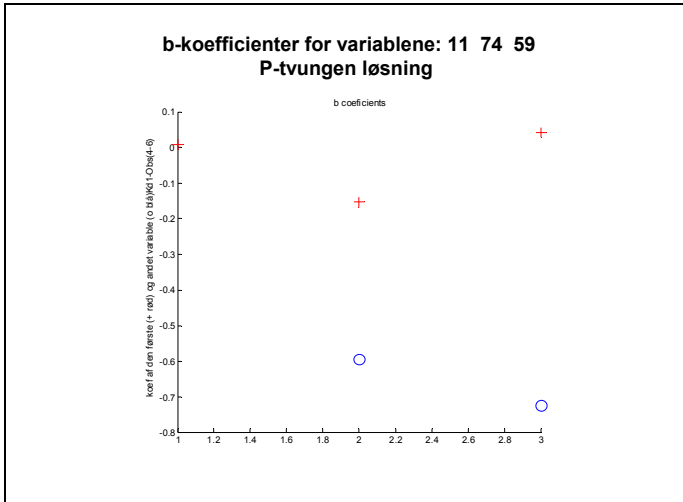


Residualer
(den endelige utvungne model)



Outlier: 1997
Den utvungne løsning peger hverken på N- eller P-tilførsel som vigtige variable!

Mariager Fjord - Kd1-modellering



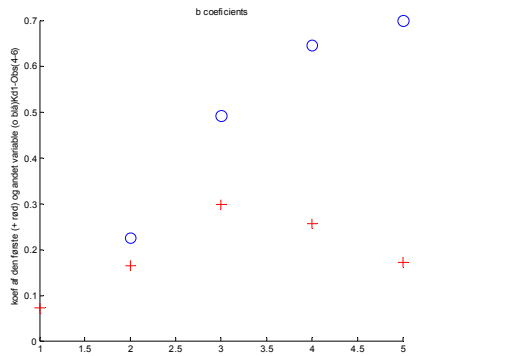
Mariager Fjord - Kd1-modellering

Outlier: 1997

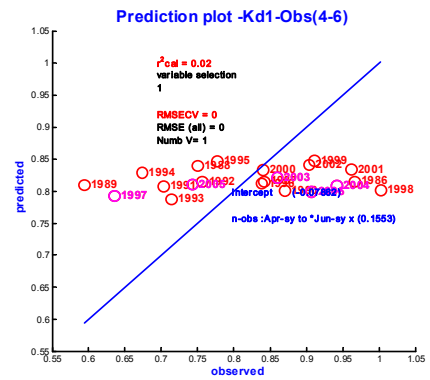
**Den P-tvungne løsning ligger langt fra den
utvungne, objektive løsning**

Mariager Fjord - Kd1-modellering

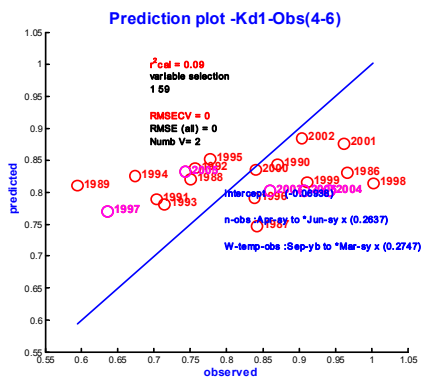
b-koefficienter for variablene: 1 59 21 74 66
N-tvungen løsning



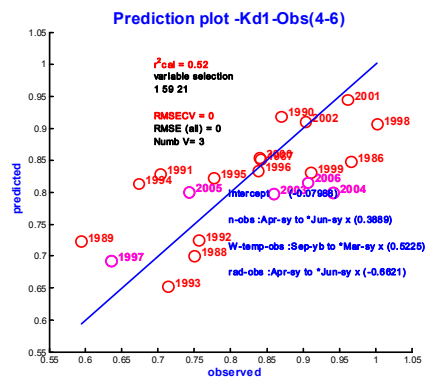
Model med de sidste fire år som valideringsår:
1 variabel



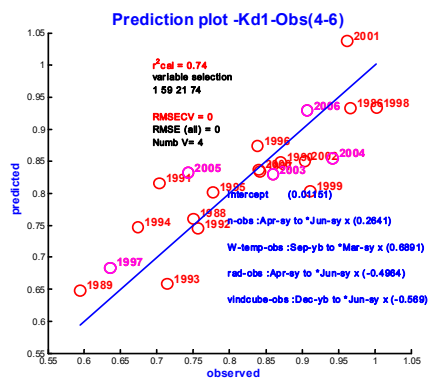
Model med de sidste fire år som valideringsår:
2 variable



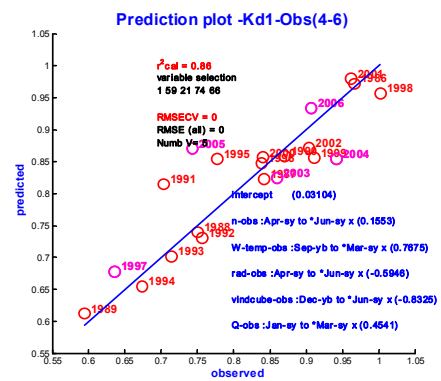
Model med de sidste fire år som valideringsår:
3 variable



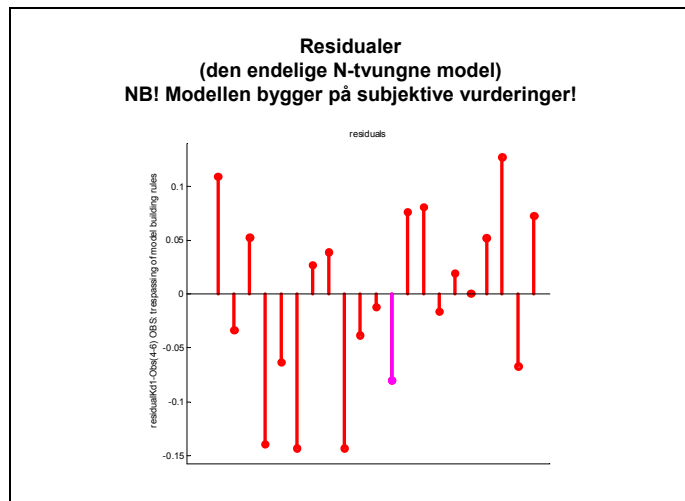
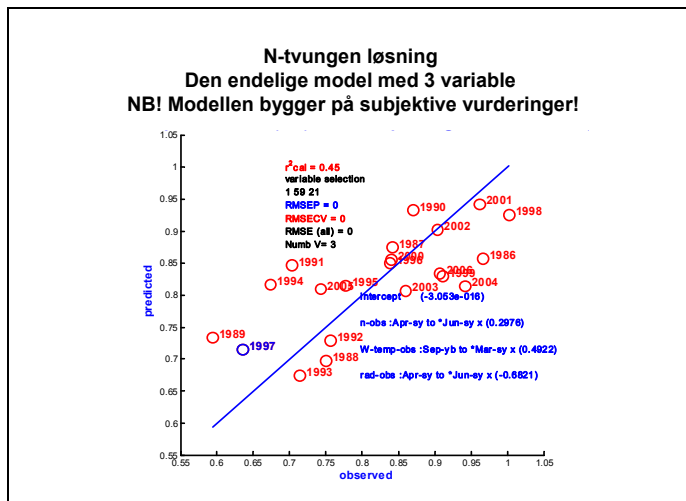
Model med de sidste fire år som valideringsår:
4 variable



Model med de sidste fire år som valideringsår:
5 variable



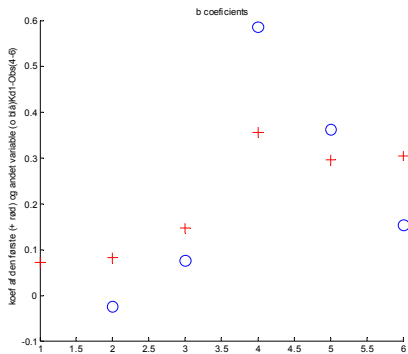
Mariager Fjord - Kd1-modellering



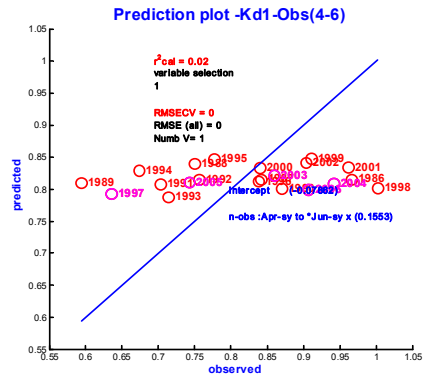
Outlier: 1997
Den N-tvungne løsning ligger langt fra den
utvungne, objektive løsning

Mariager Fjord - Kd1-modellering

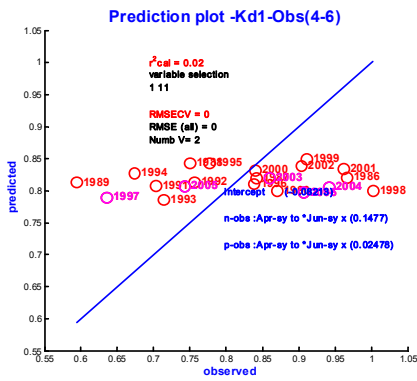
**b-koefficienter for variablene: 1 11 59 30 74 21
N- & P-tvungen løsning**



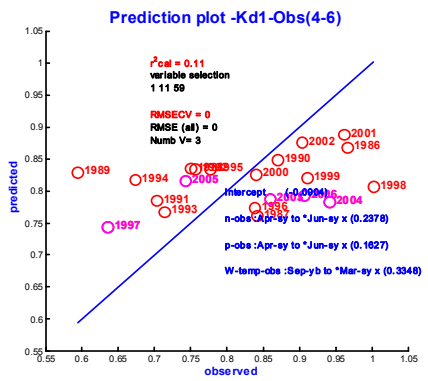
**Model med de sidste fire år som valideringsår:
1 variabel**



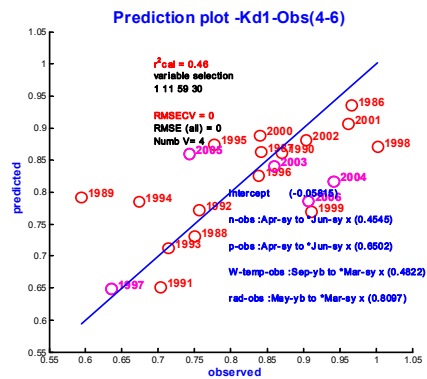
**Model med de sidste fire år som valideringsår:
2 variable**



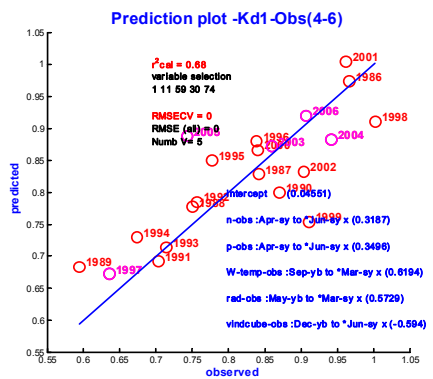
**Model med de sidste fire år som valideringsår:
3 variable**



**Model med de sidste fire år som valideringsår:
4 variable**

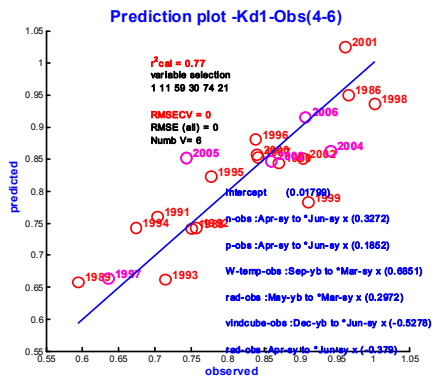


**Model med de sidste fire år som valideringsår:
5 variable**

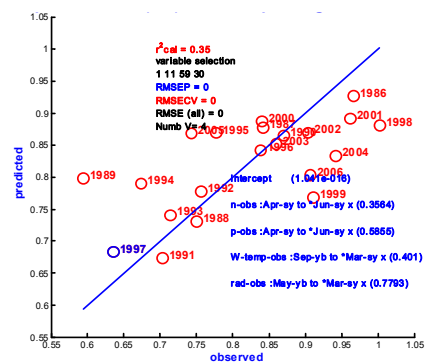


Mariager Fjord - Kd1-modellering

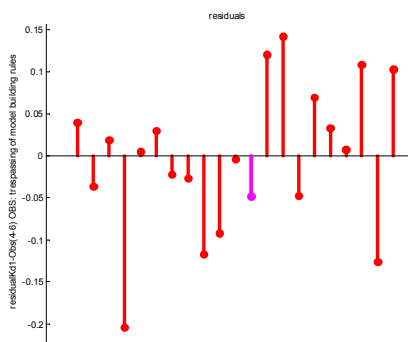
Model med de sidste fire år som valideringsår:
6 variable



N- & P-tvungne løsning
Den endelige model med 4 variable
NB! Modellen bygger på subjektive vurderinger!

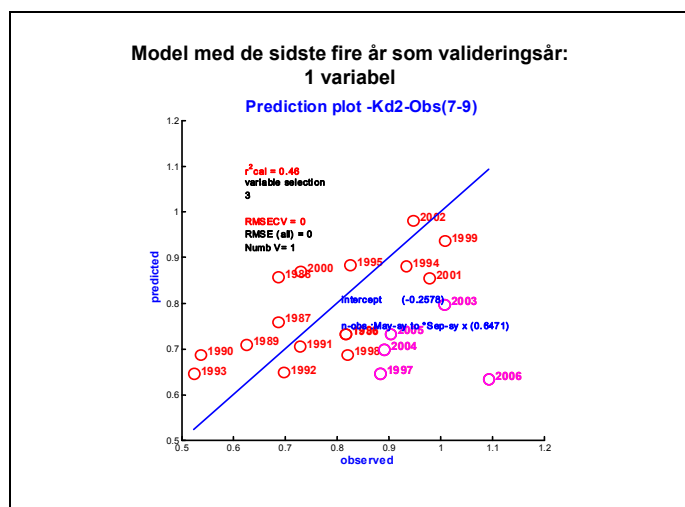
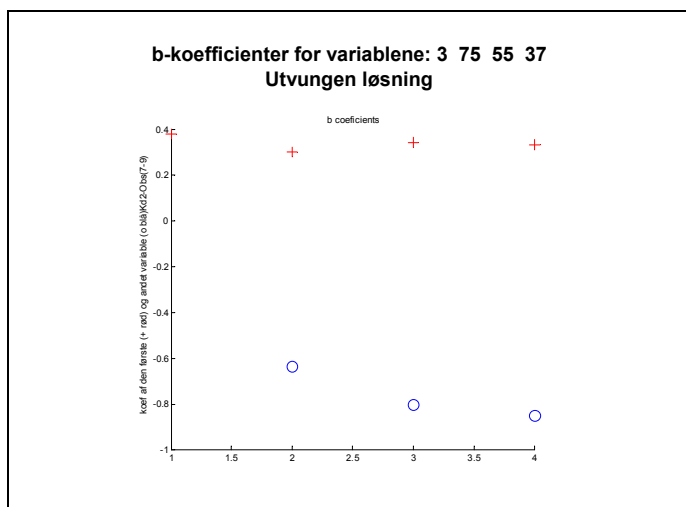
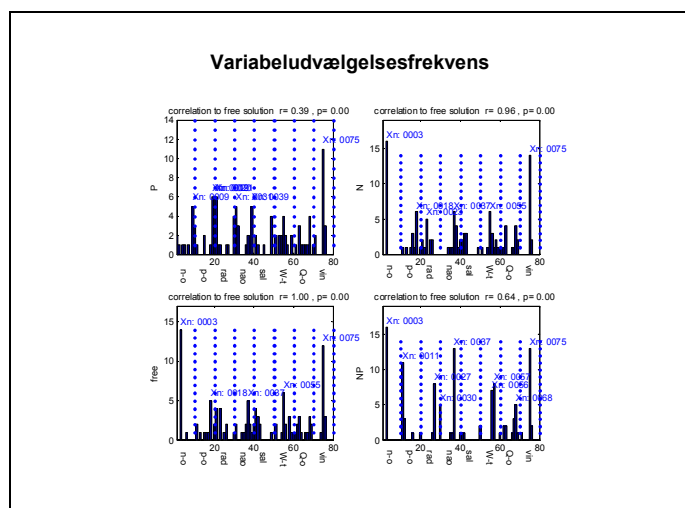
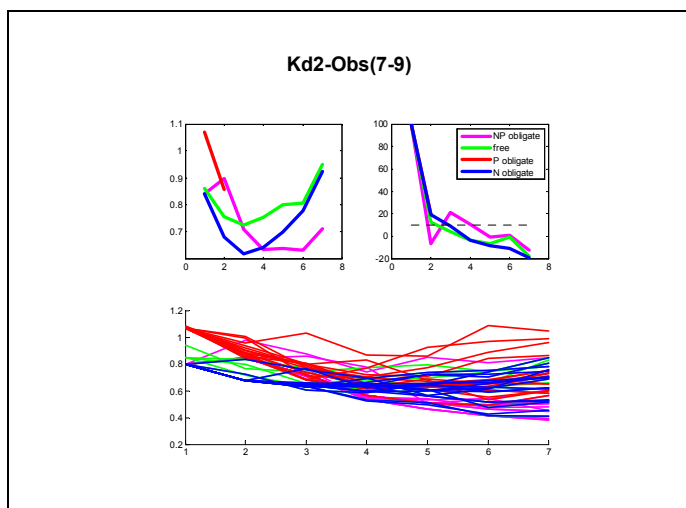
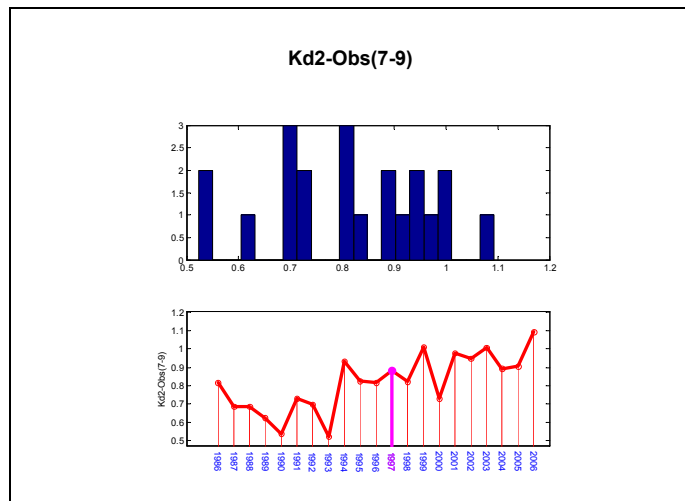
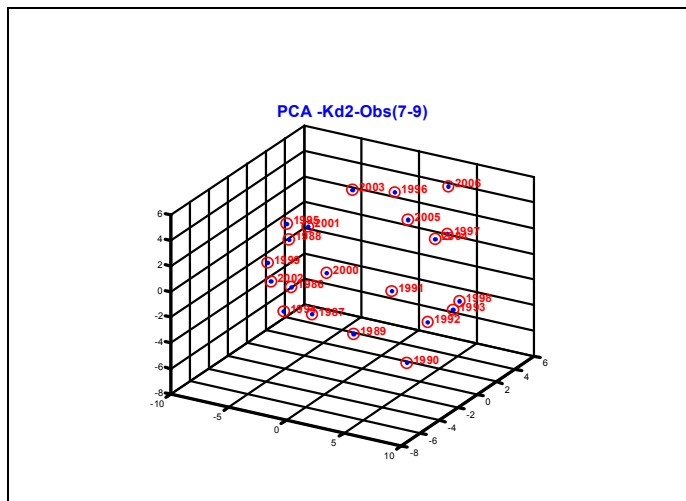


Residualer
(den endelige N- & P-tvungne model)
NB! Modellen bygger på subjektive vurderinger!

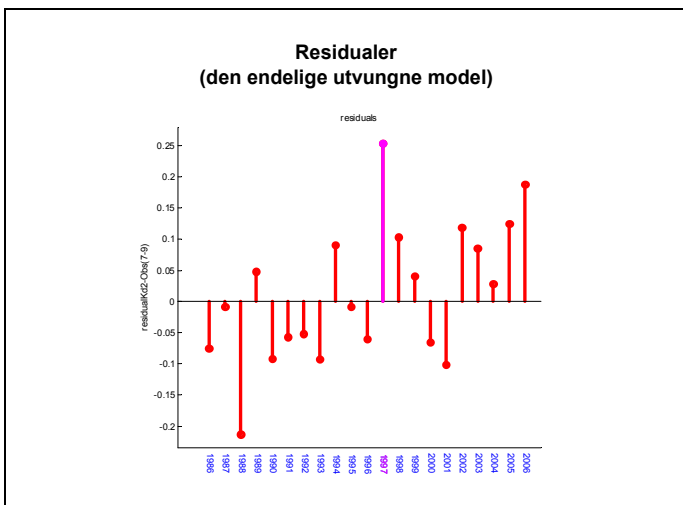
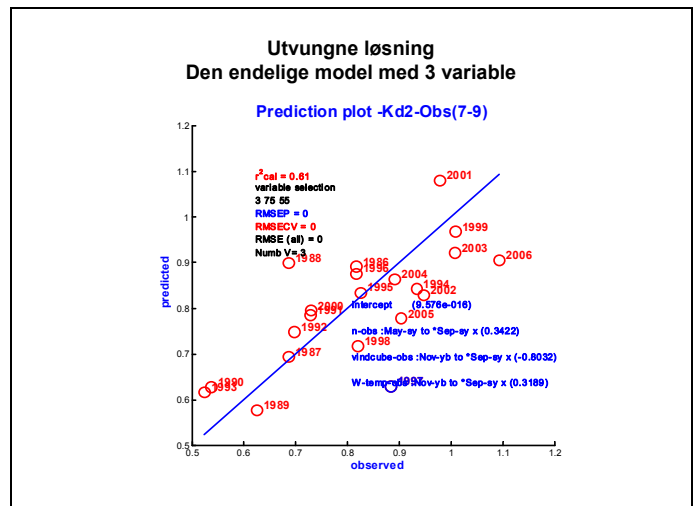
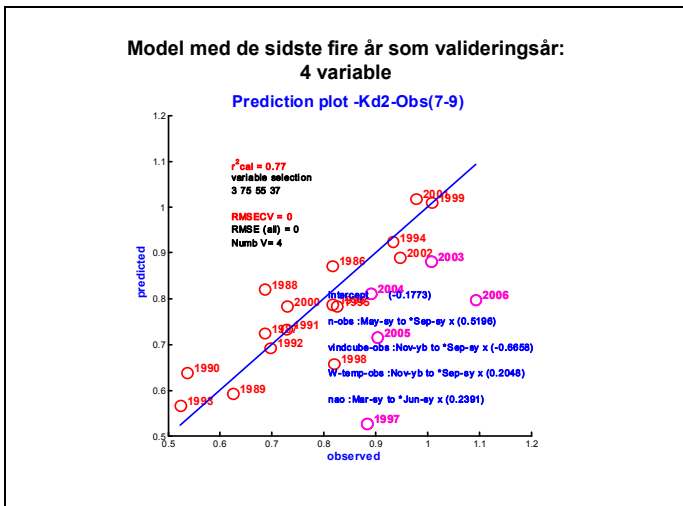
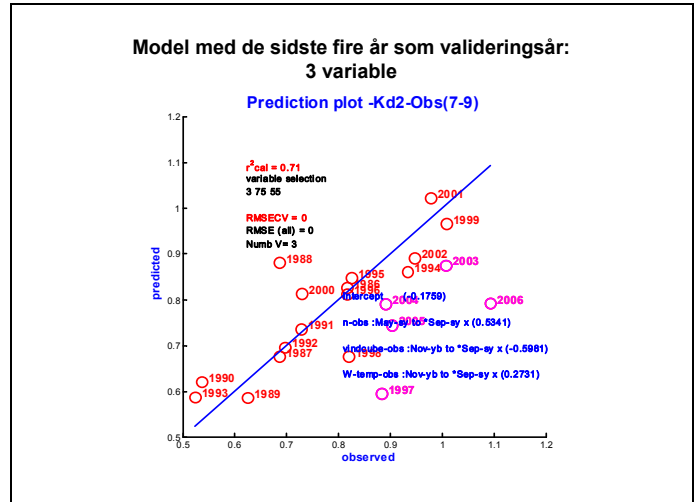
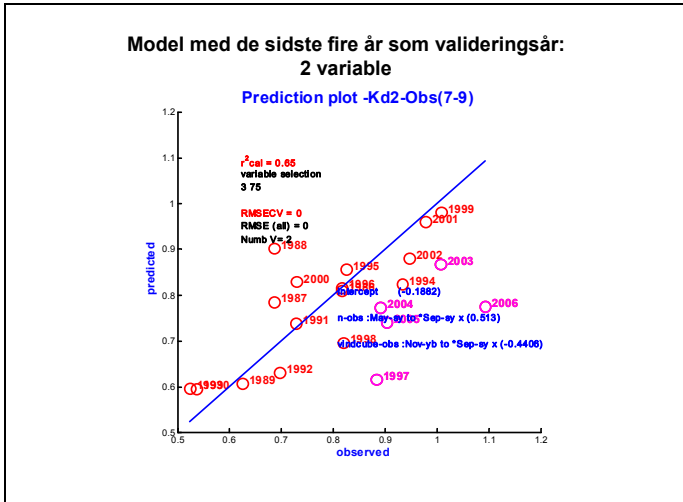


Outlier: 1997
Den N- & P-tvungne løsning ligger langt fra den utvungne, objektive løsning men måske alligevel den mest anvendelige som forvaltningsværktøj?

Mariager Fjord - Kd2-modellering

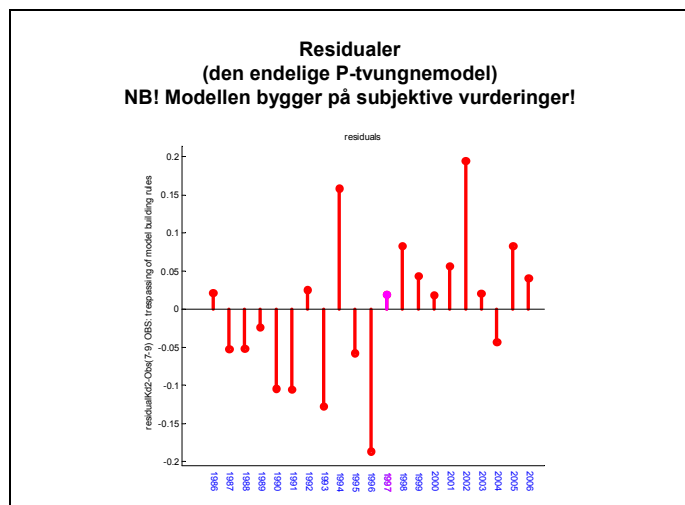
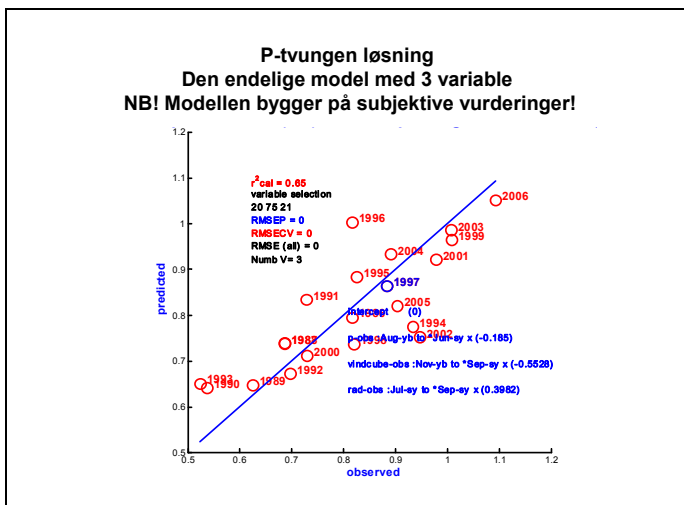
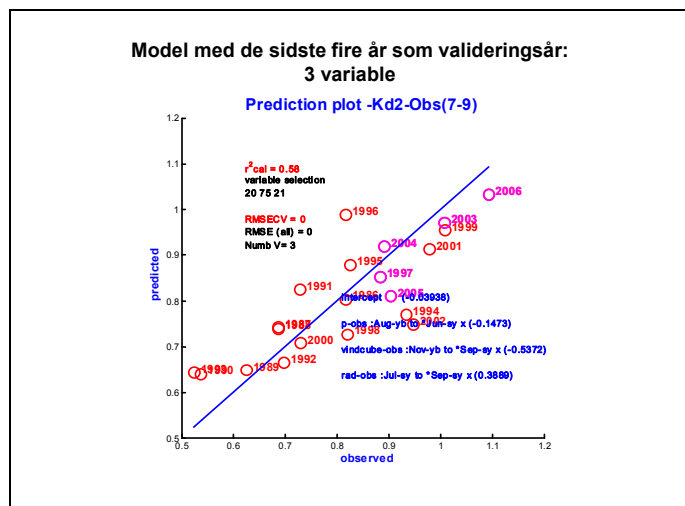
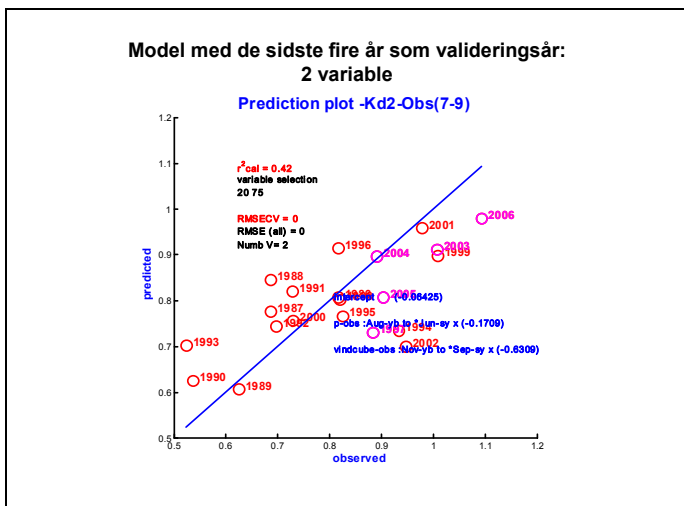
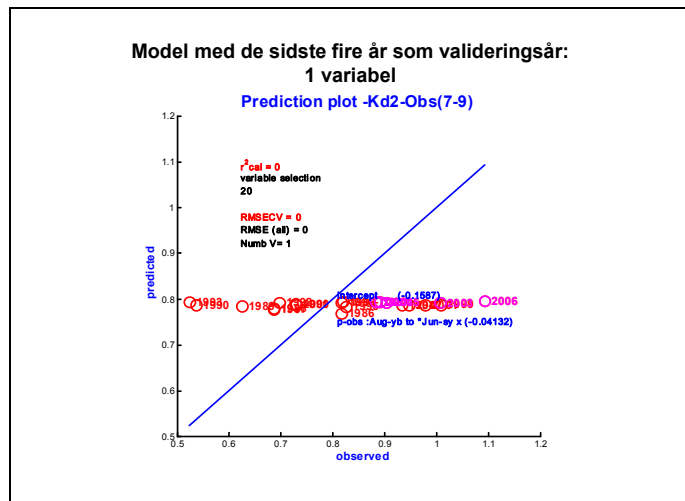
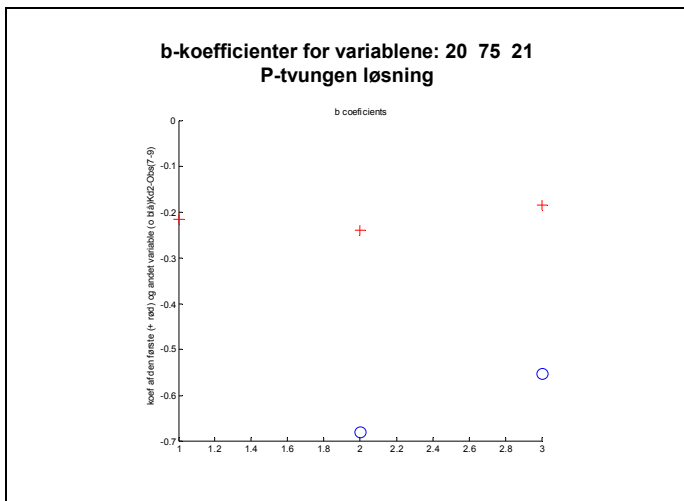


Mariager Fjord - Kd2-modellering



Outlier: 1997
 Den utvungne løsning giver N som vigtigste variabel
 NB! De sidste år i perioden viser en trend!

Mariager Fjord - Kd2-modellering

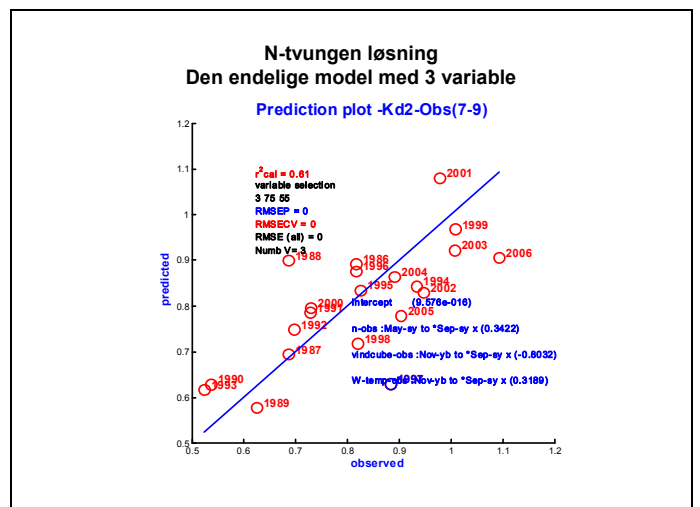
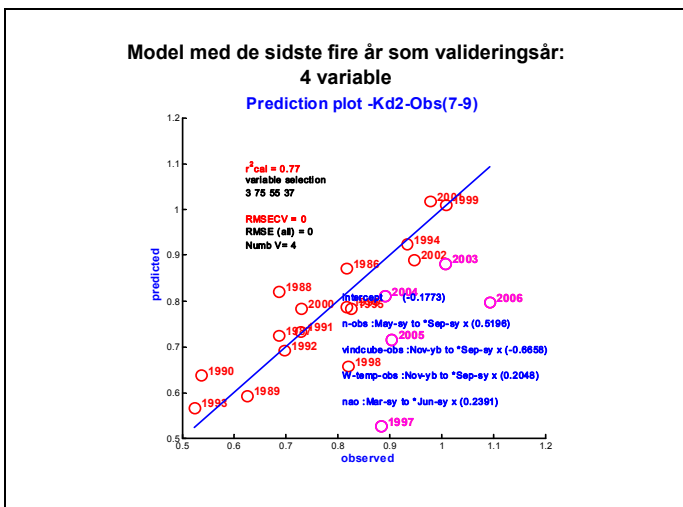
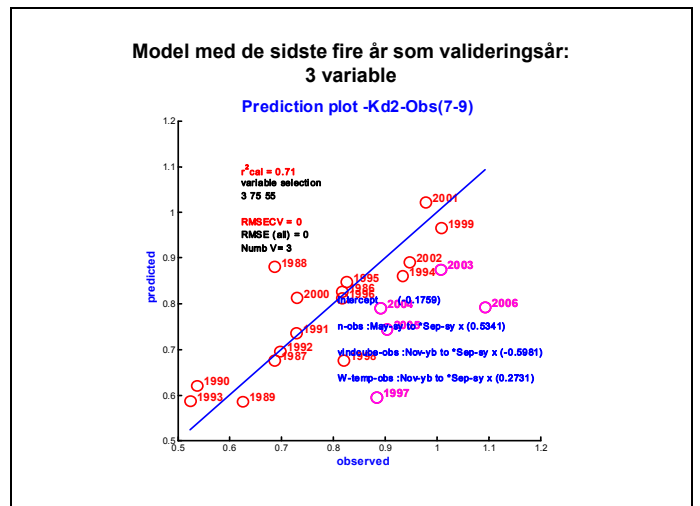
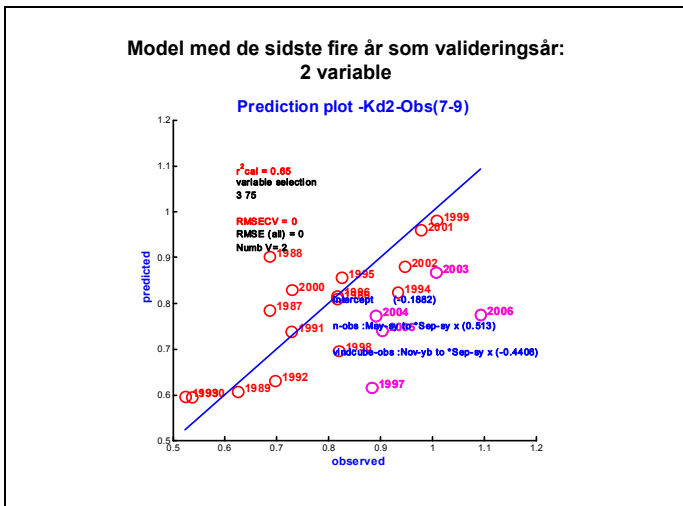
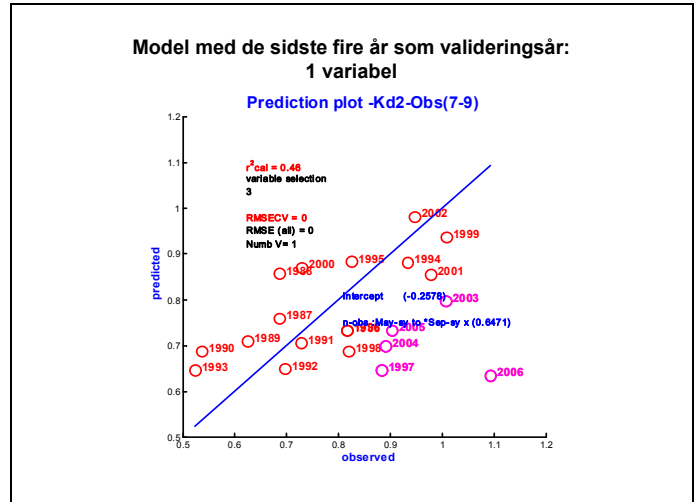
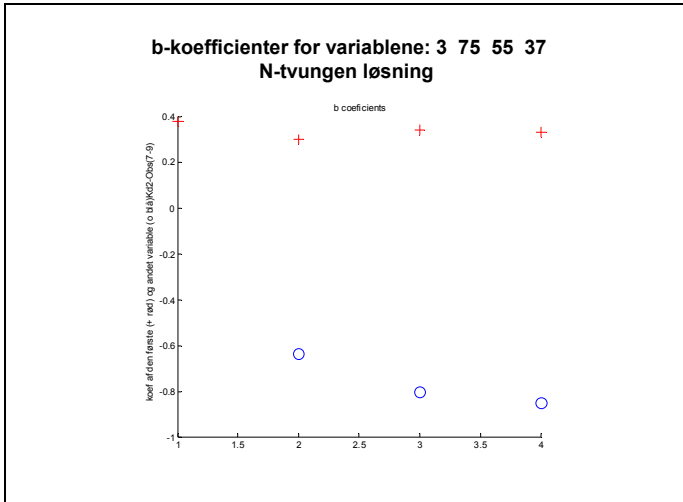


Mariager Fjord - Kd2-modellering

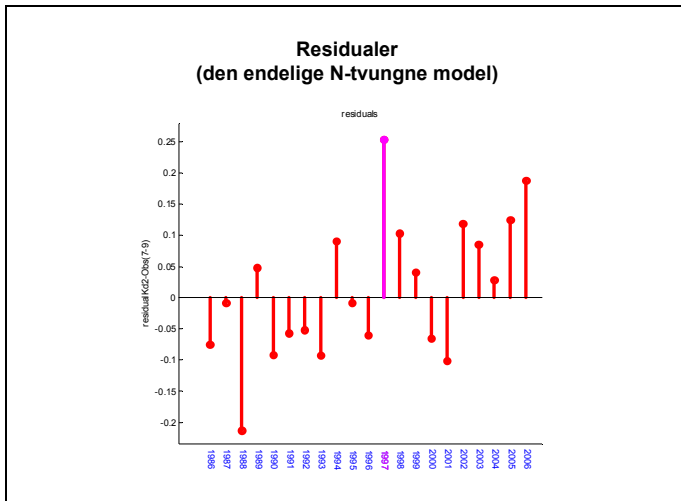
Outlier: 1997

**Den P-tvungne løsning ligger langt fra den
utvungne, objektive løsning**

Mariager Fjord - Kd2-modellering



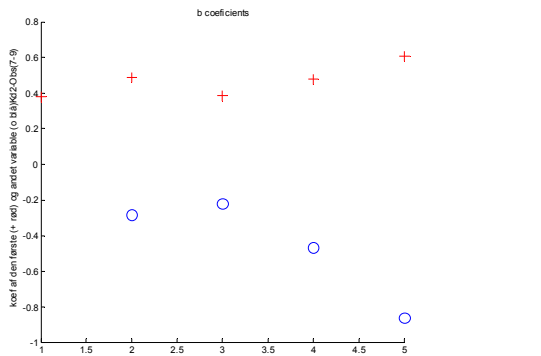
Mariager Fjord - Kd2-modellering



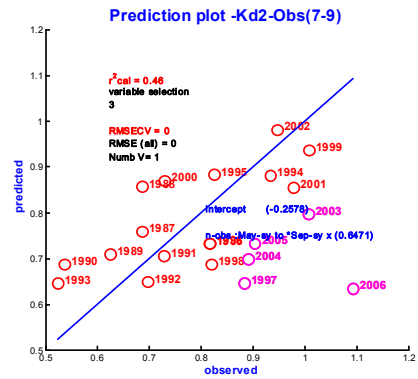
Outlier: 1997
Den N-tvungne model er ækvivalent med den
utvungne løsning
En god forvaltningsløsning

Mariager Fjord - Kd2-modellering

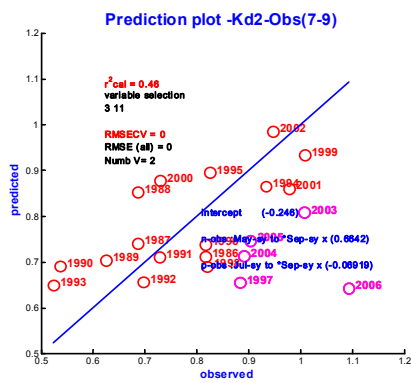
**b-koefficienter for variablene: 3 11 75 37 57
N- & P-tvungen løsning**



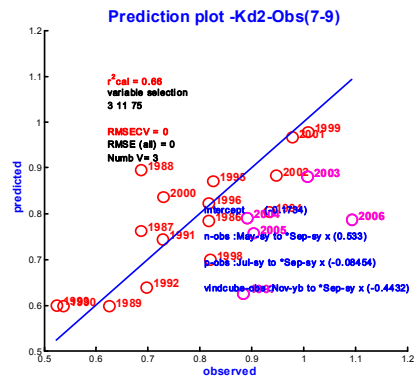
**Model med de sidste fire år som valideringsår:
1 variabel**



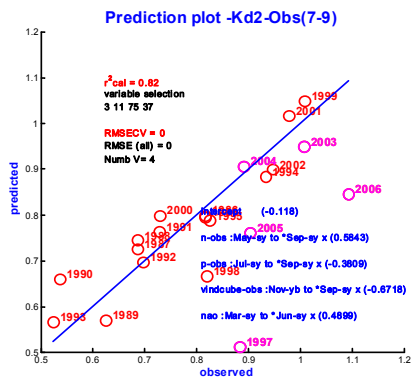
**Model med de sidste fire år som valideringsår:
2 variable**



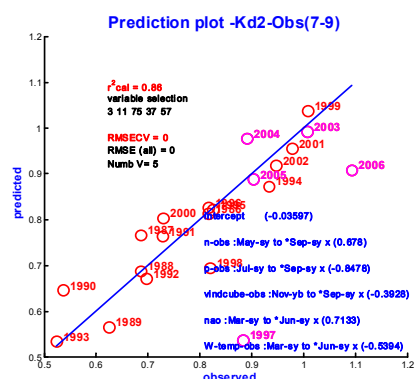
**Model med de sidste fire år som valideringsår:
3 variable**



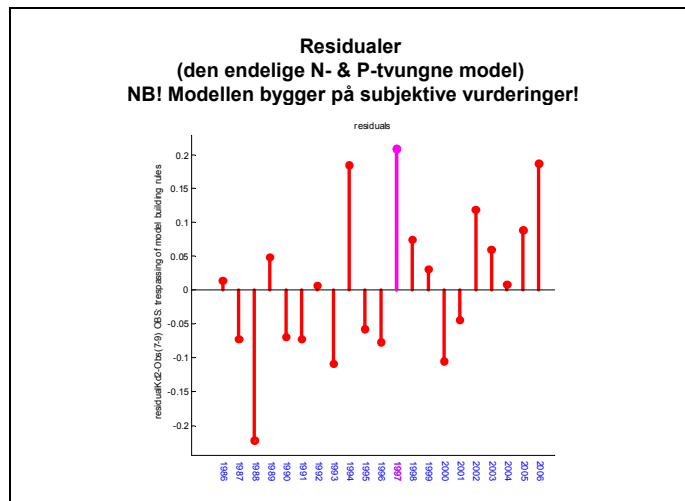
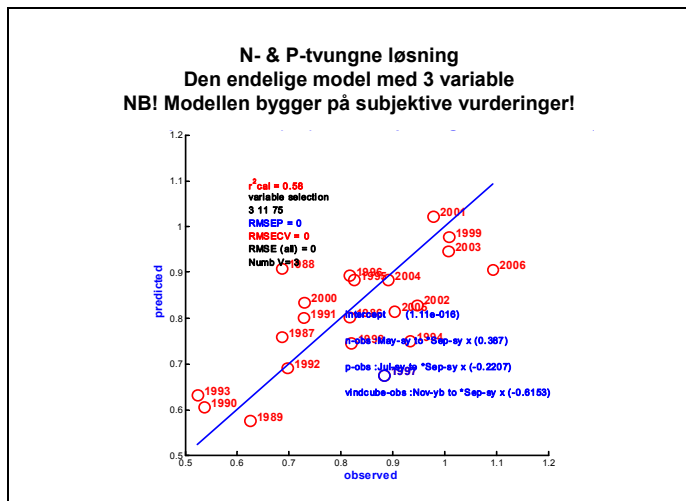
**Model med de sidste fire år som valideringsår:
4 variable**



**Model med de sidste fire år osm valideringsår:
5 variable**

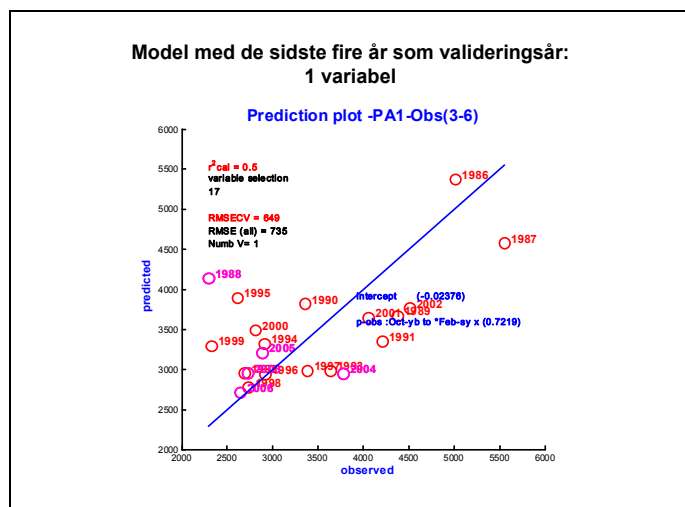
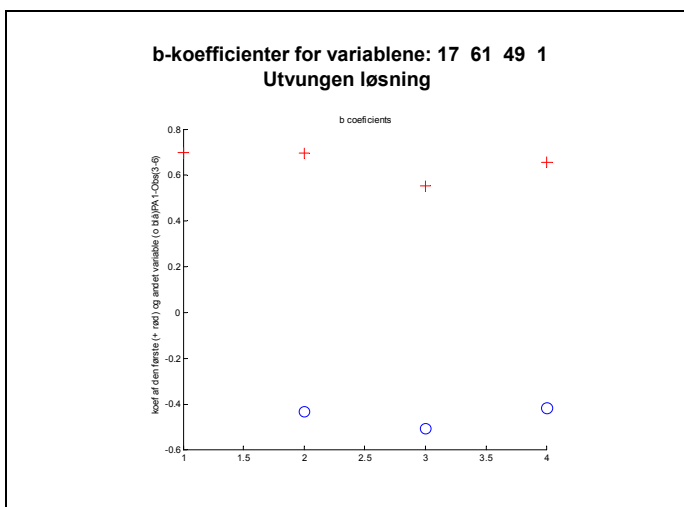
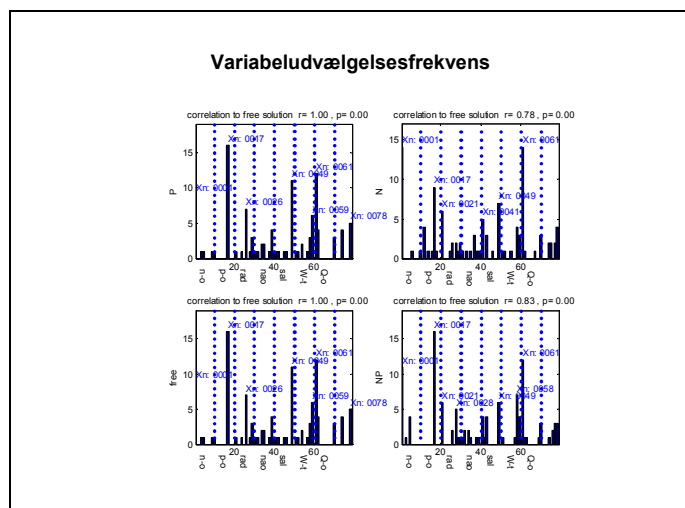
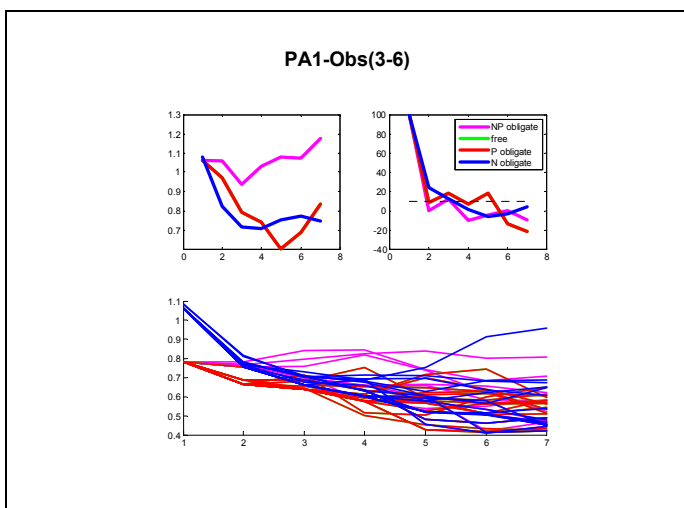
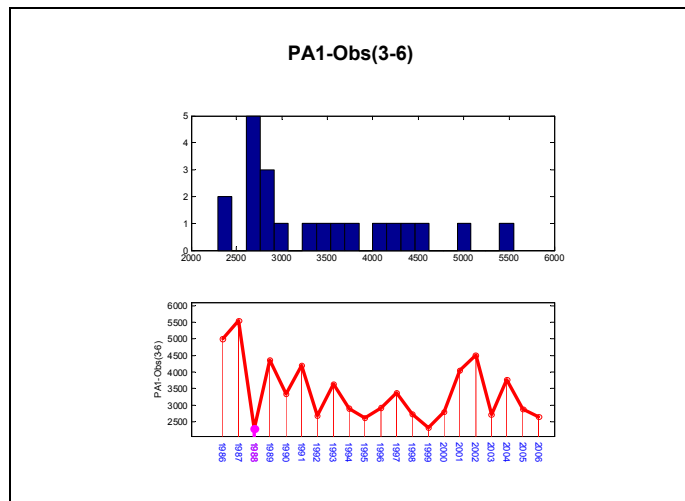
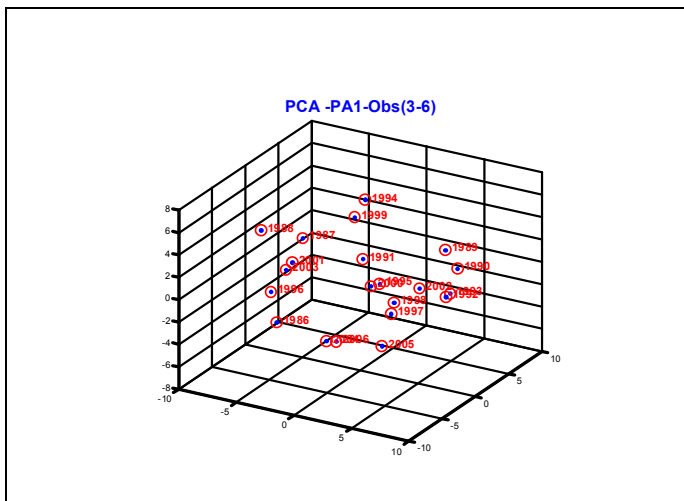


Mariager Fjord - Kd2-modellering

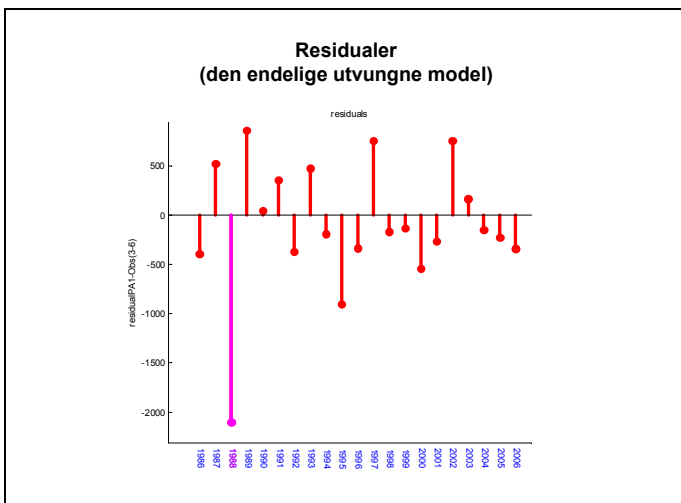
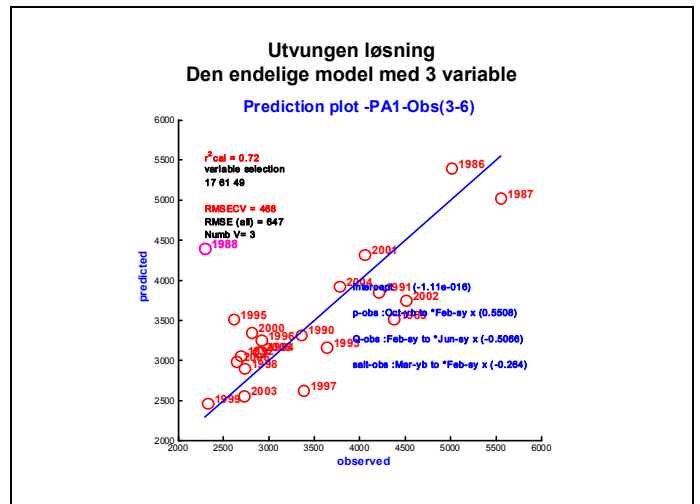
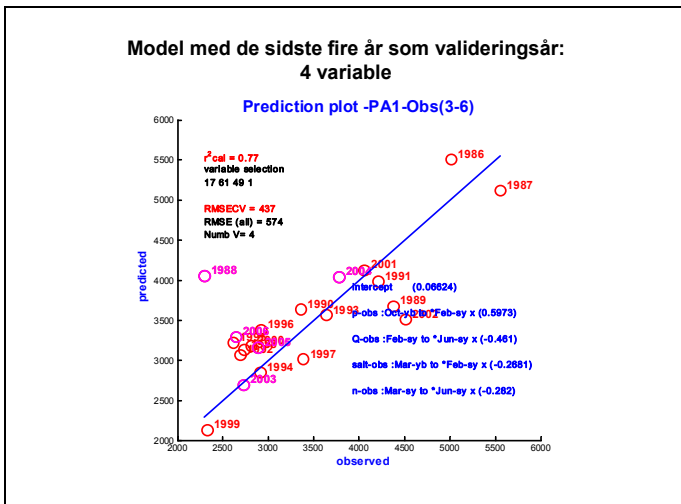
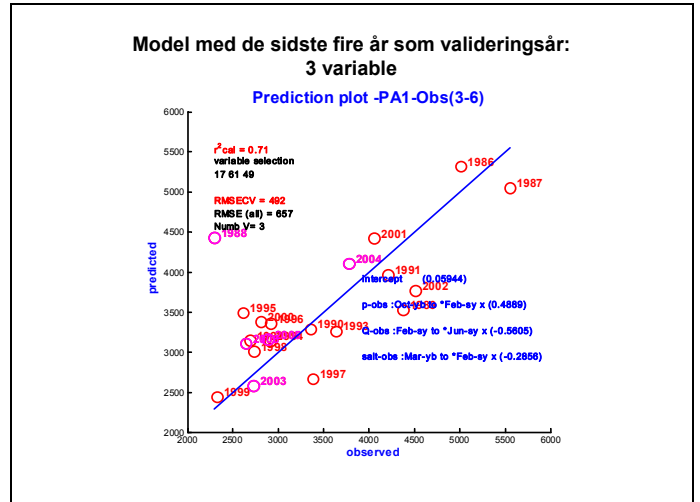
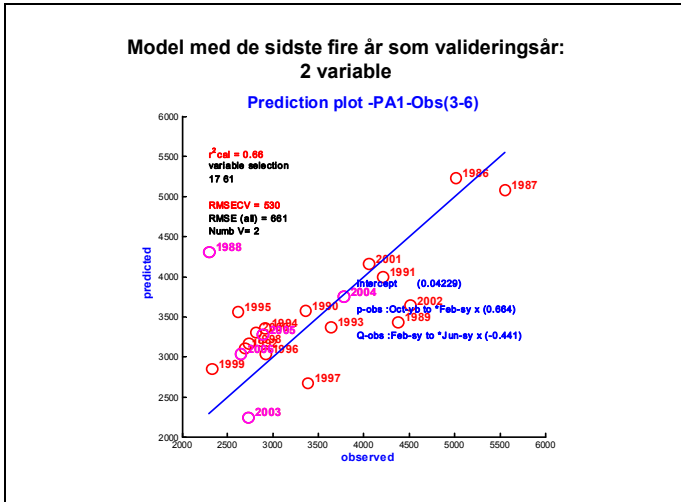


Outlier: 1997
N- & P-tvungne løsning ligger langt fra den utvungne, objektive løsning

Mariager Fjord – PA1-modellering



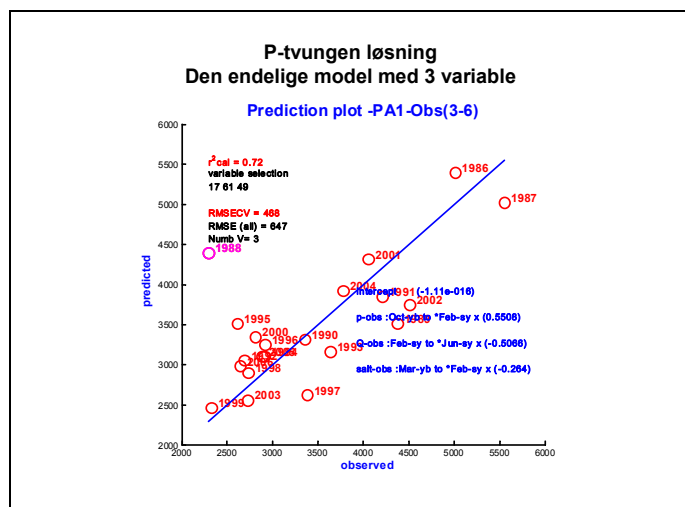
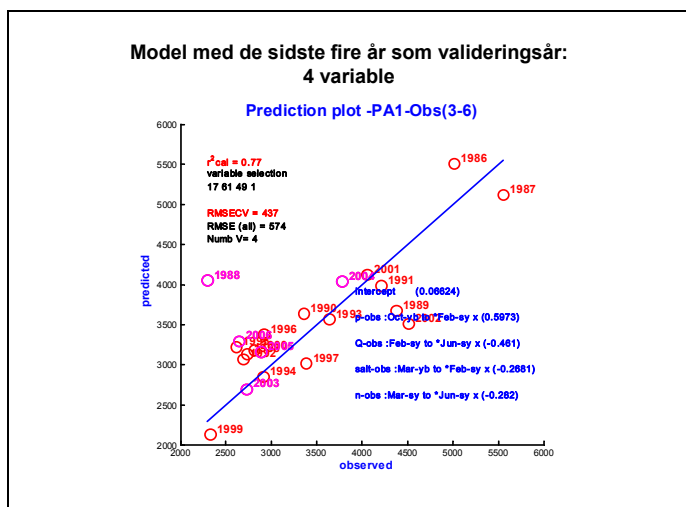
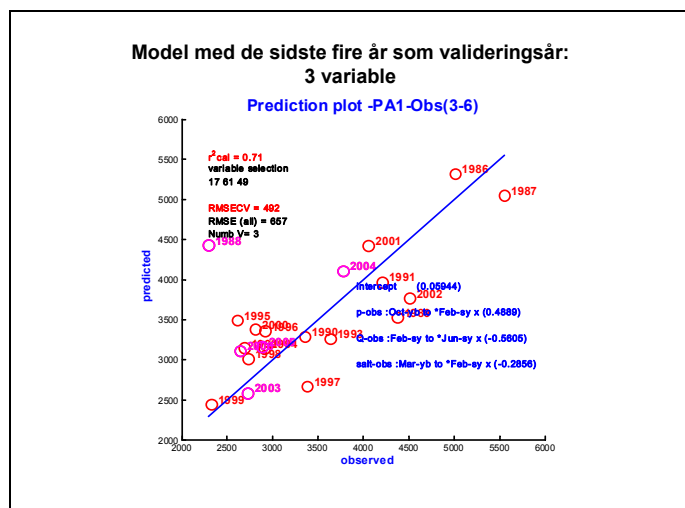
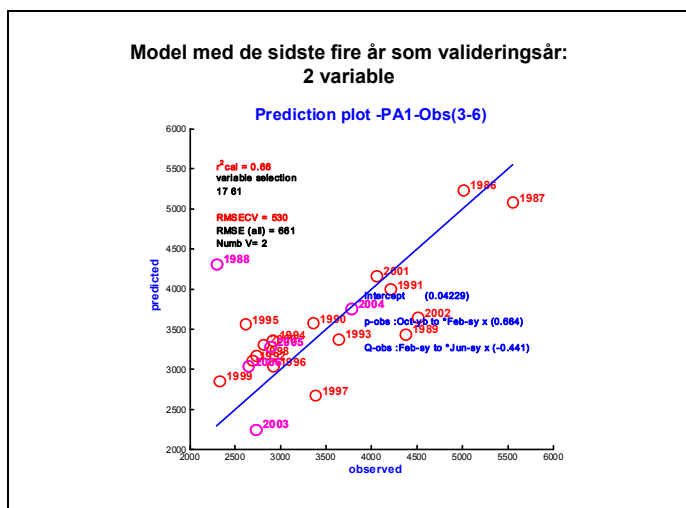
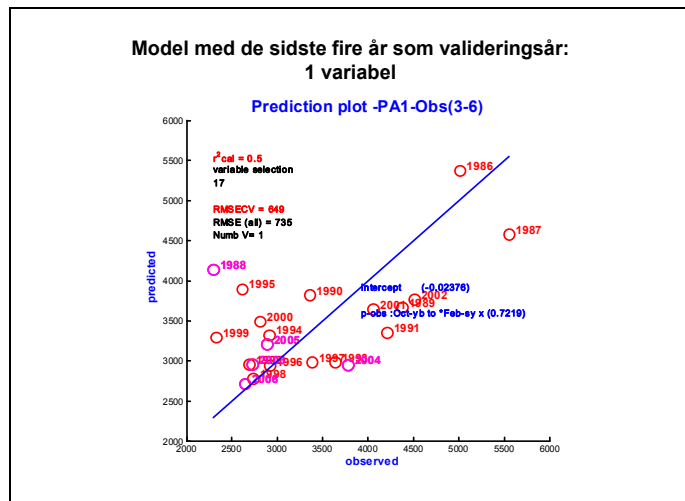
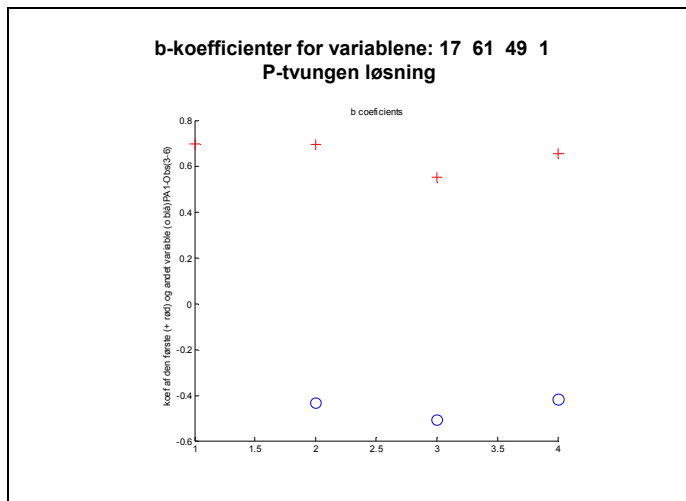
Mariager Fjord – PA1-modellering



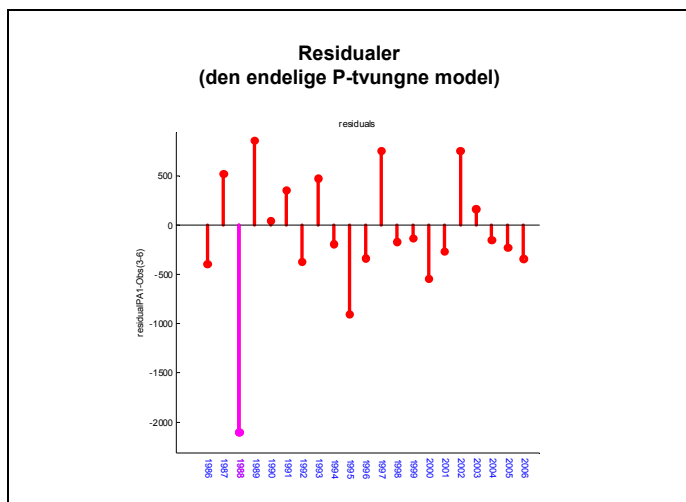
Outlier: 1988

Den utvungne, objektive løsning peger på P-tilførsel

Mariager Fjord – PA1-modellering

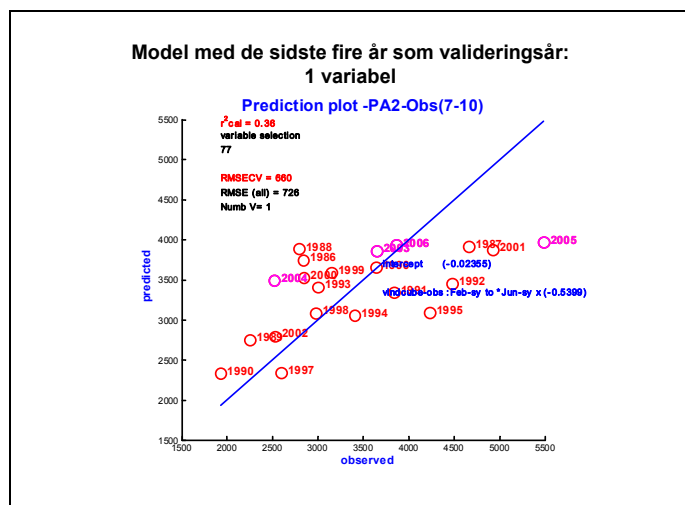
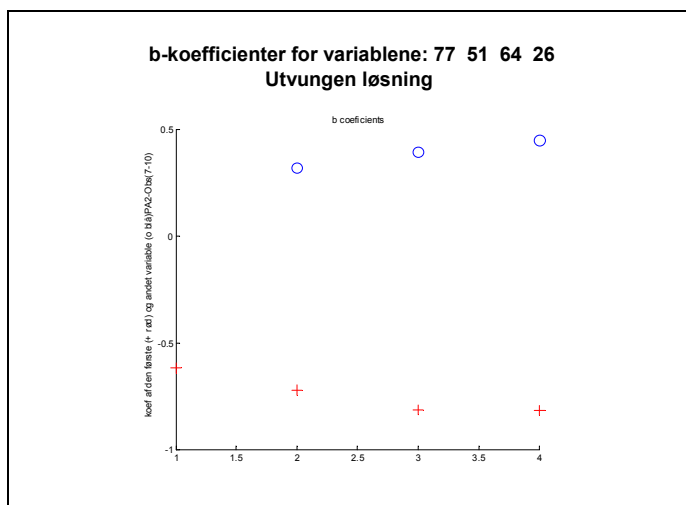
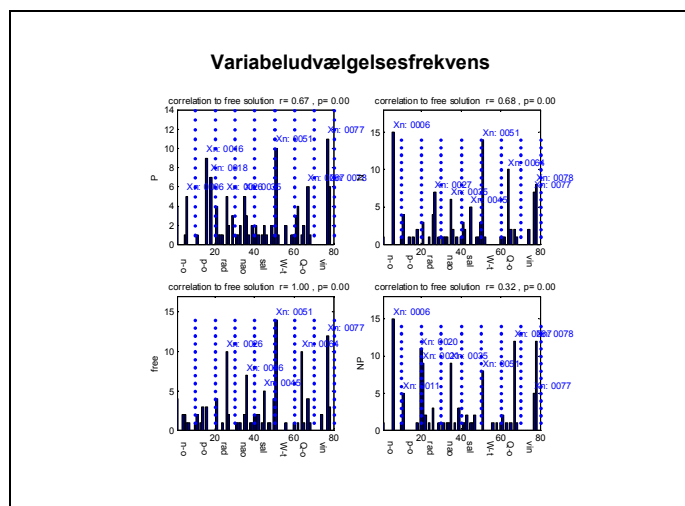
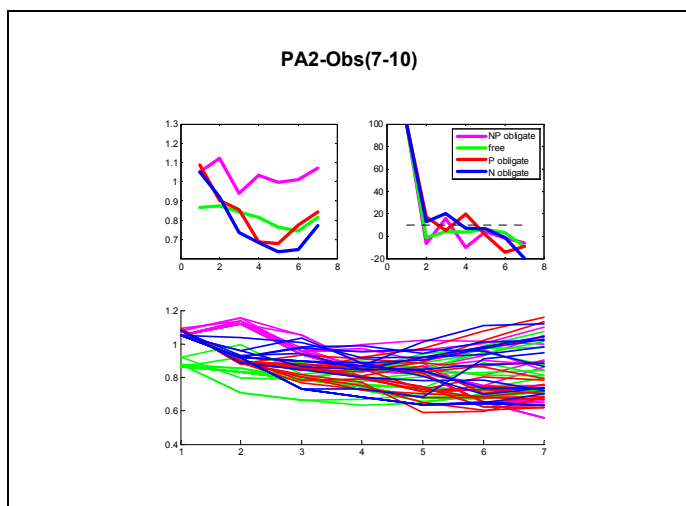
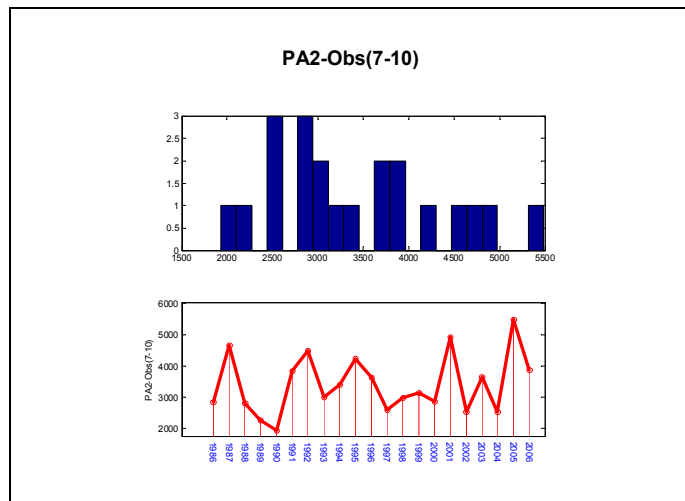
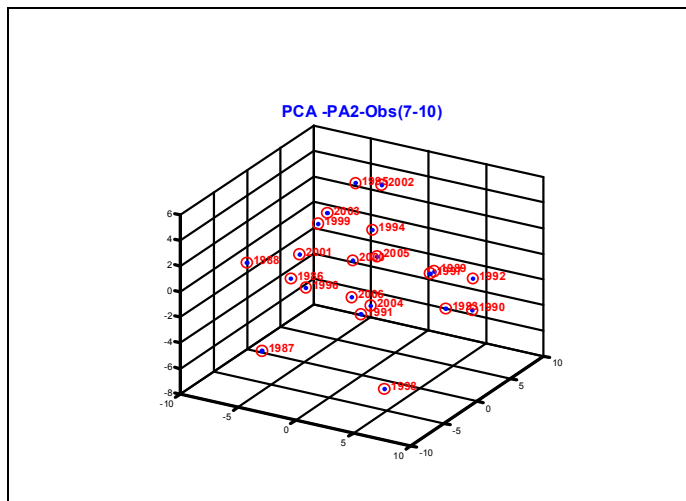


Mariager Fjord – PA1-modellering

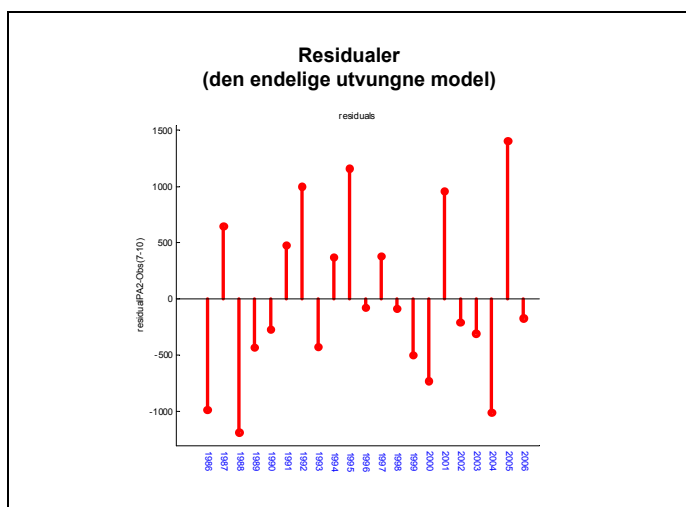
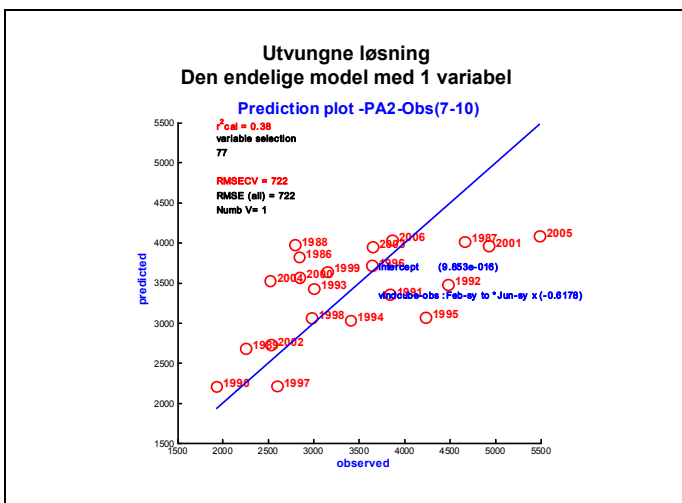
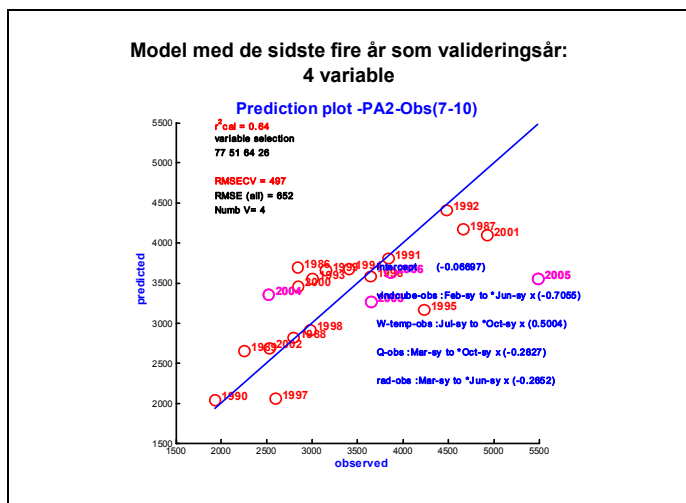
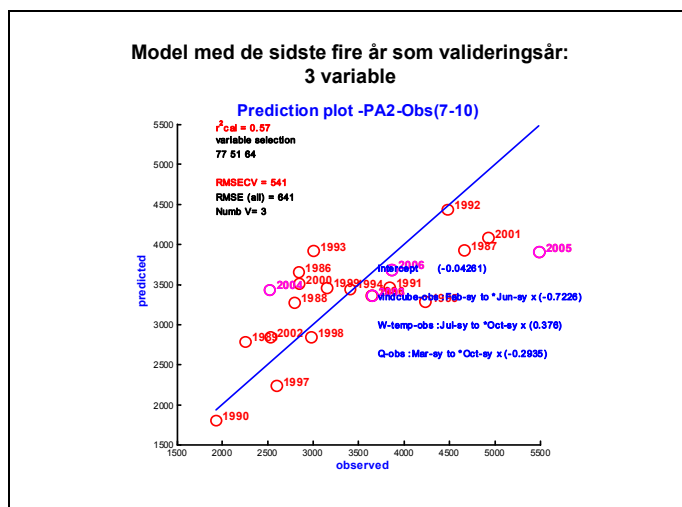
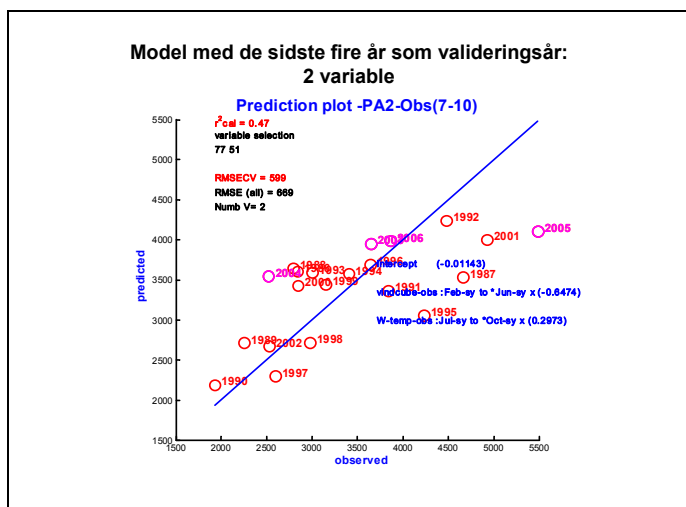


Outlier: 1988
Den P-tvungne løsning er ækvivalent med den
utvungne, objektive løsning

Mariager Fjord – PA2-modellering



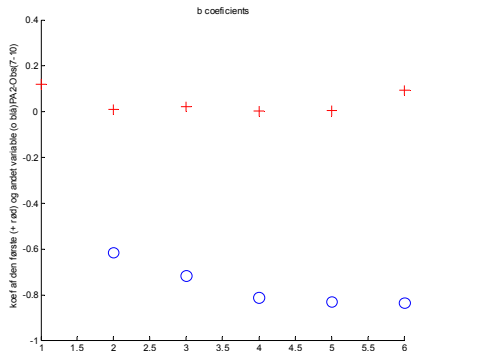
Mariager Fjord – PA2-modellering



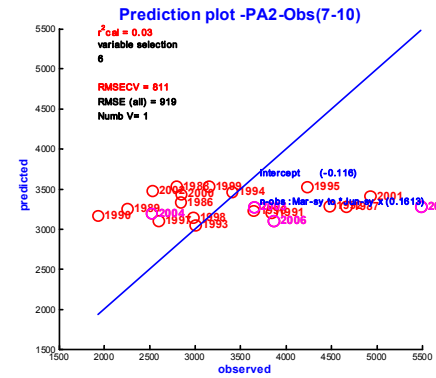
Den utvungne, objektive løsning giver ingen oplagte variable

Mariager Fjord – PA2-modellering

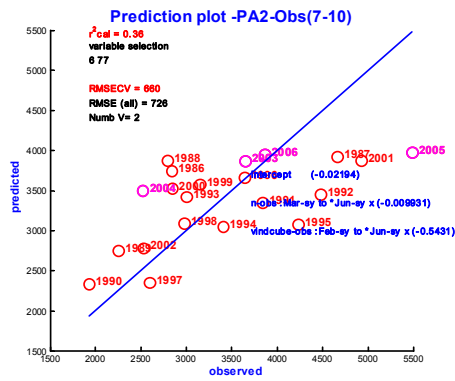
b-koefficienter for variablene: 6 77 51 64 27 20
N-tvungen løsning



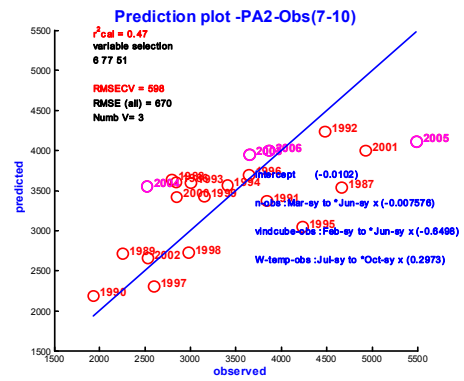
Model med de sidste fire år som valideringsår:
1 variabel



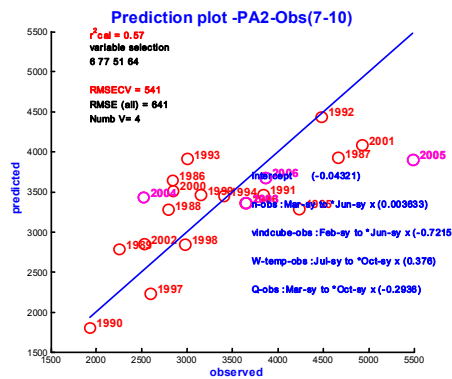
Model med de sidste fire år som valideringsår:
2 variable



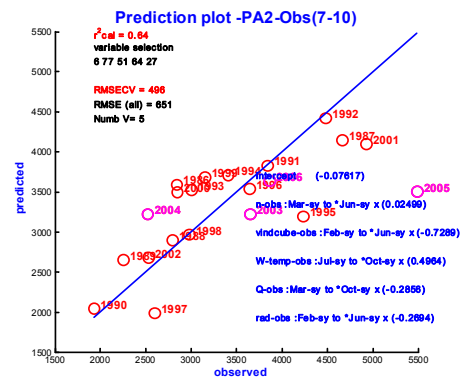
Model med de sidste fire år som valideringsår:
3 variable



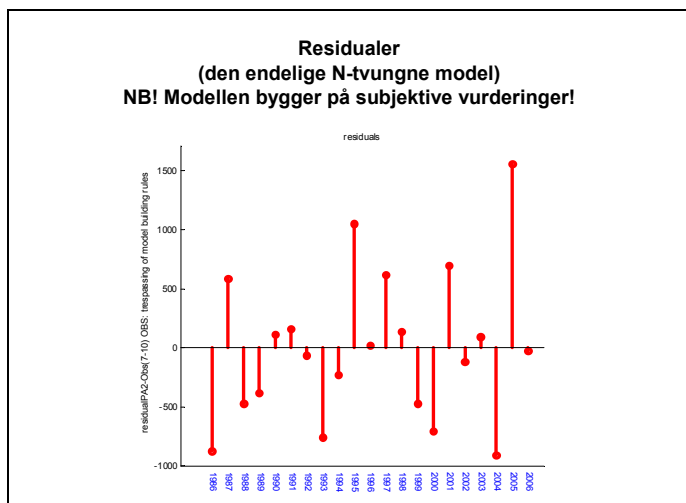
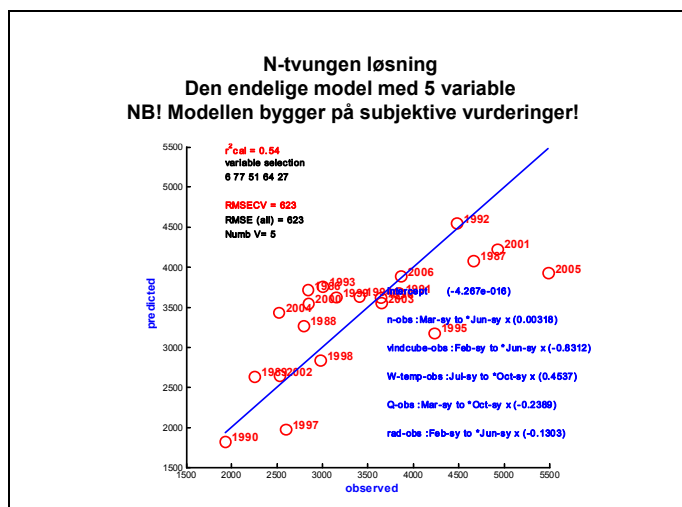
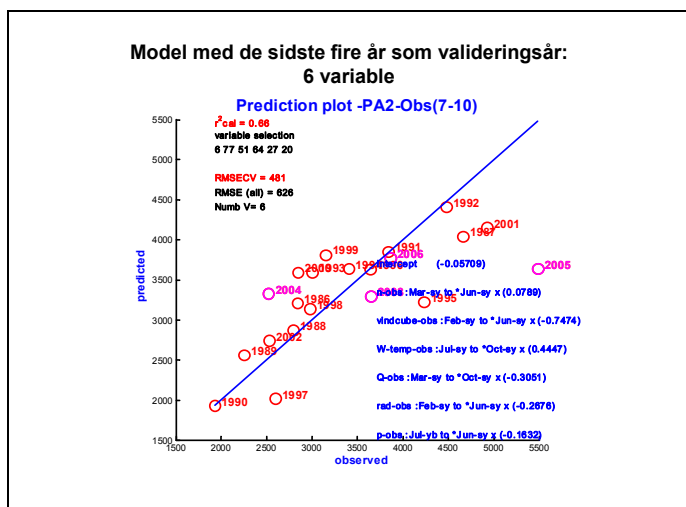
Model med de sidste fire år som valideringsår:
4 variable



Model med de sidste fire år som valideringsår:
5 variable



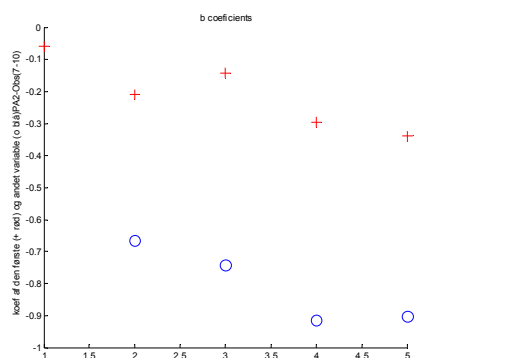
Mariager Fjord – PA2-modellering



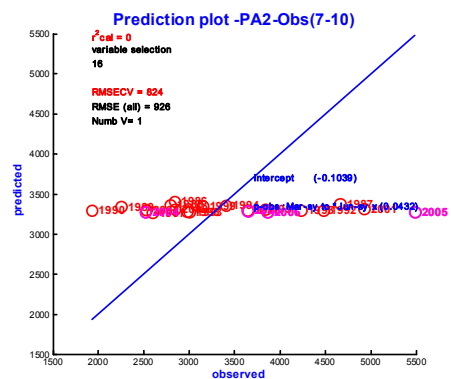
Den N-tvungne model giver ingen oplagte variable

Mariager Fjord – PA2-modellering

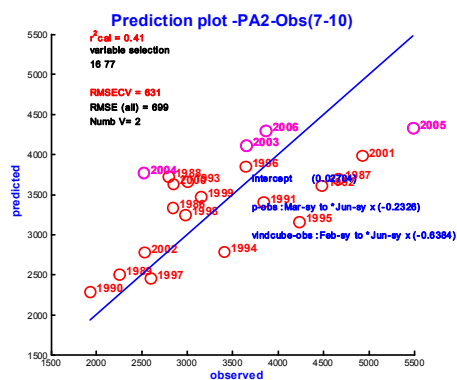
b-koefficienter for variablene: 16 77 51 61 6
P-tvungen løsning



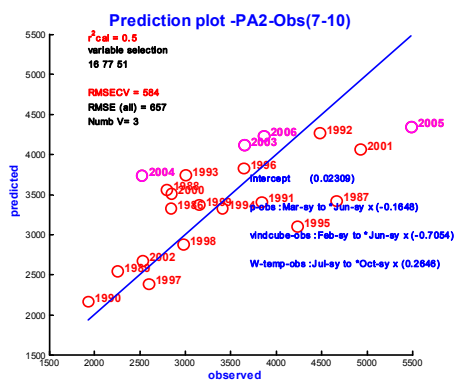
Model med de sidste fire år som valideringsår:
1 variabel



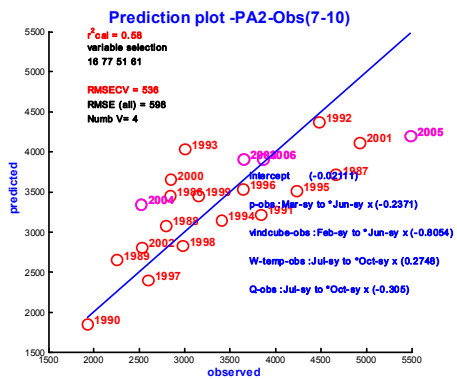
Model med de sidste fire år som valideringsår:
2 variable



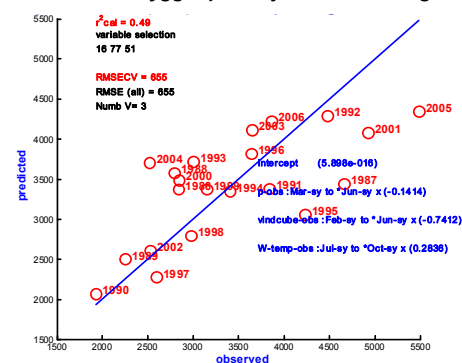
Model med de sidste fire år som valideringsår:
3 variable



Model med de sidste fire år som valideringsår:
4 variable

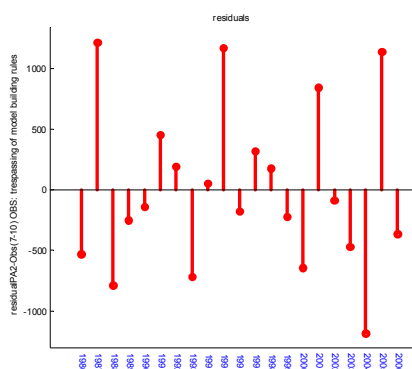


P-tvungen løsning
Den endelige model med 3 variable
NB! Modellen bygger på subjektive vurderinger!



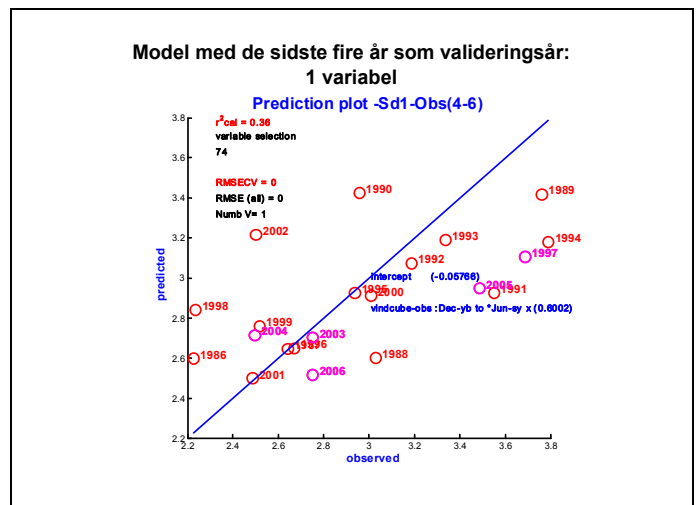
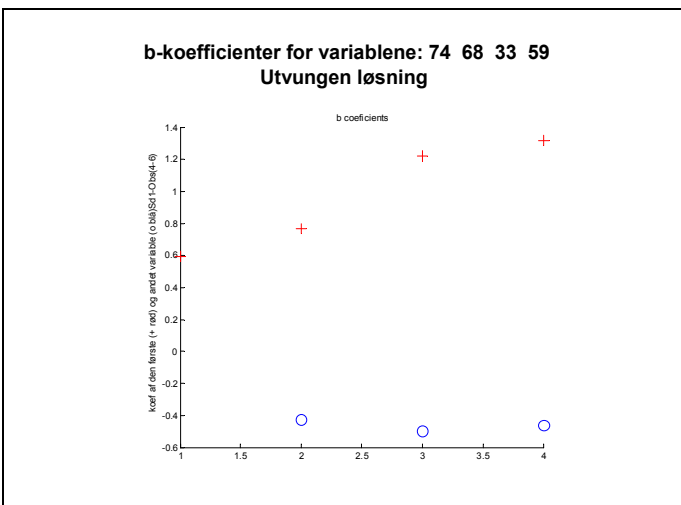
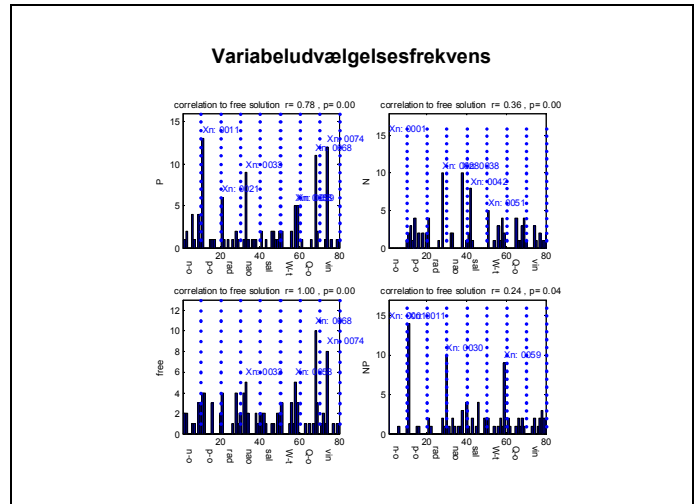
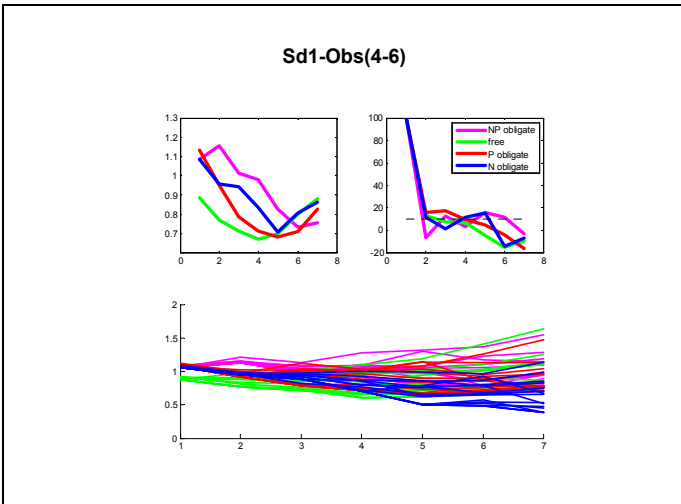
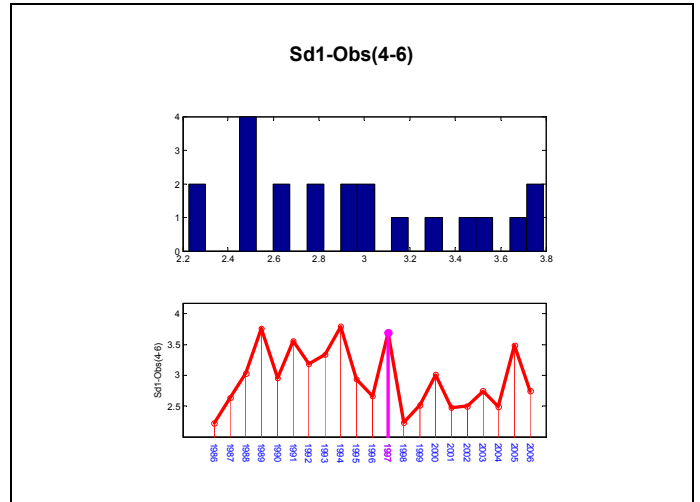
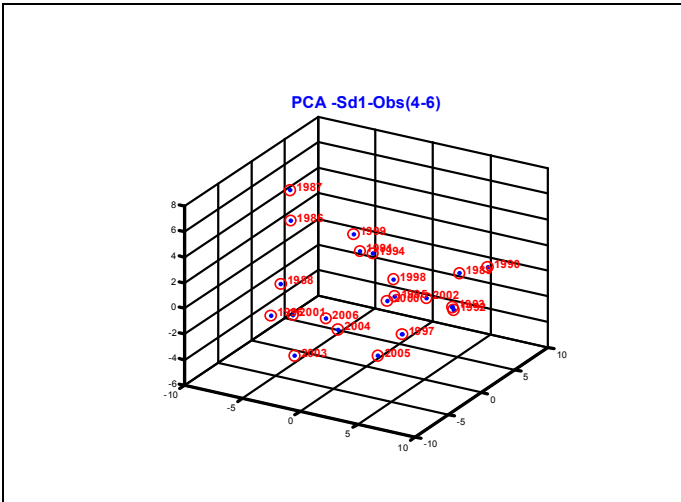
Mariager Fjord – PA2-modellering

Residualer
(den endelige P-tvungne model)
NB! Modellen bygger på subjektive vurderinger!

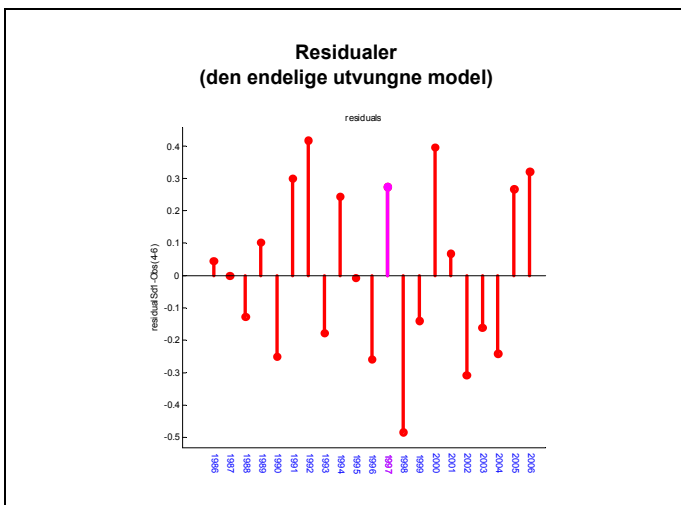
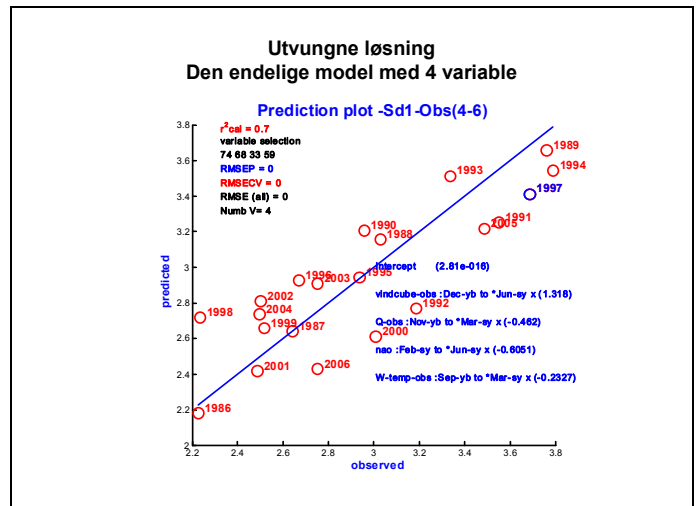
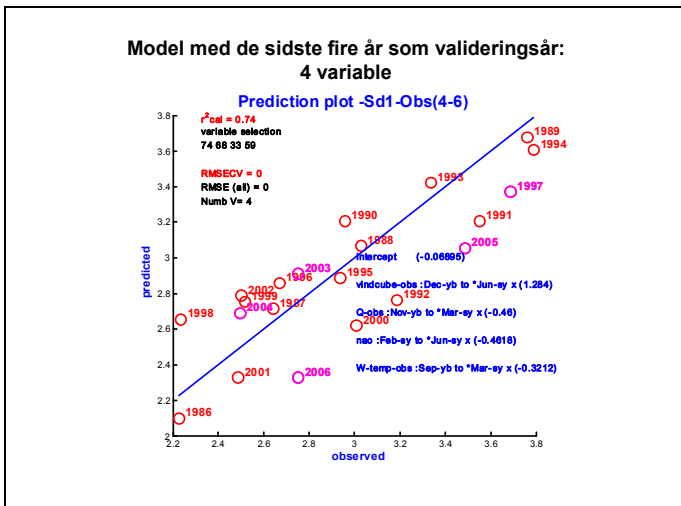
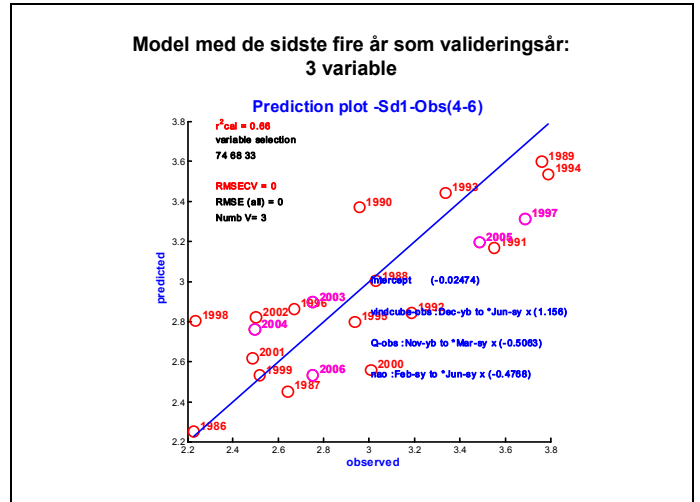
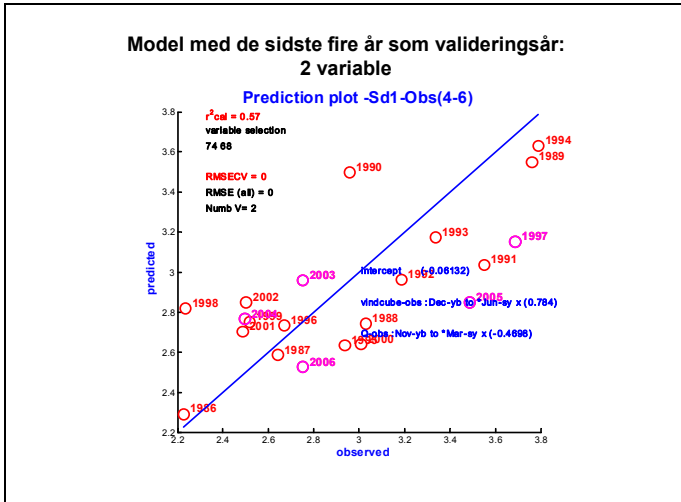


Den P-tvungne model giver ingen oplagte løsninger

Mariager Fjord - Sd1-modellering



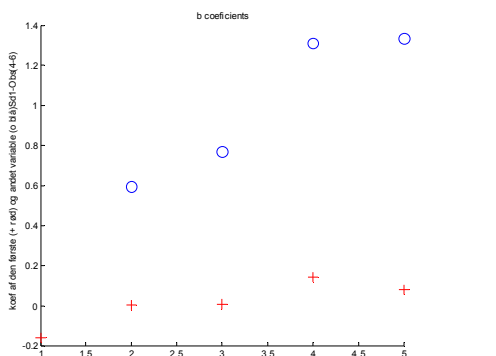
Mariager Fjord - Sd1-modellering



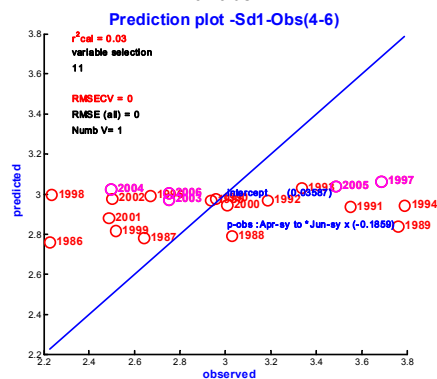
Outlier: 1997
Den utvungne løsning peger hverken på N- eller P-tilførsel som vigtige variable

Mariager Fjord - Sd1-modellering

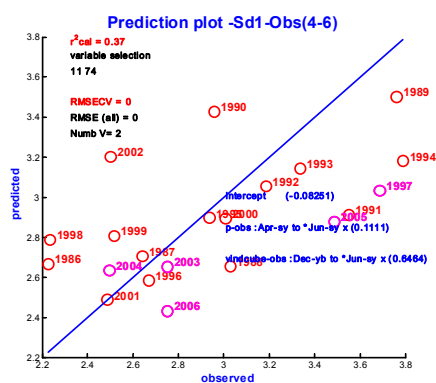
b-koefficienter for variablene: 11 74 68 33 58
P-tvungen løsning



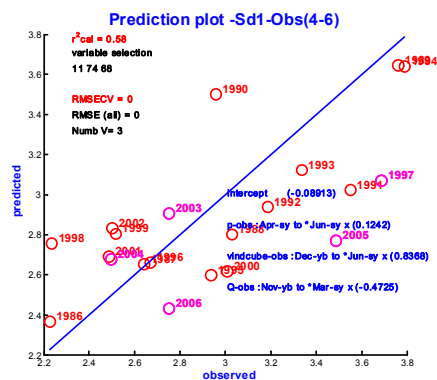
Model med de sidste fire år som valideringsår:
1 variabel



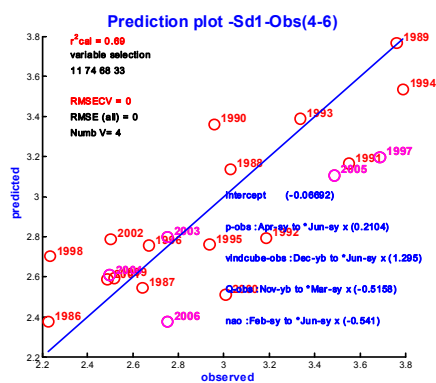
Model med de sidste fire år som valideringsår:
2 variable



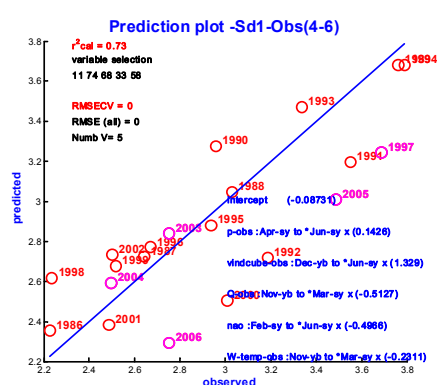
Model med de sidste fire år som valideringsår:
3 variable



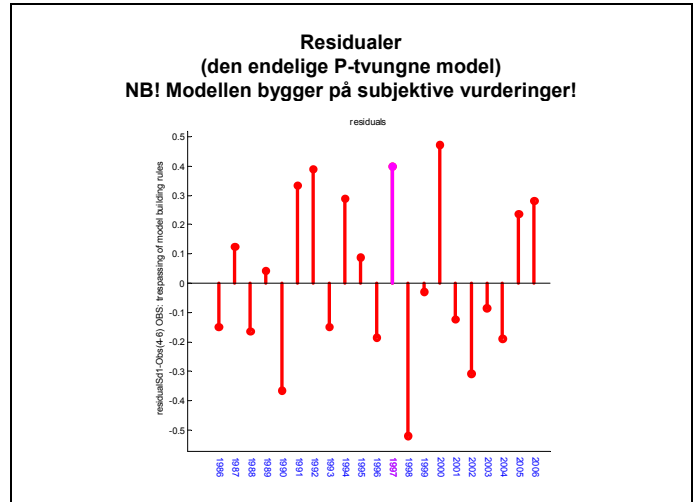
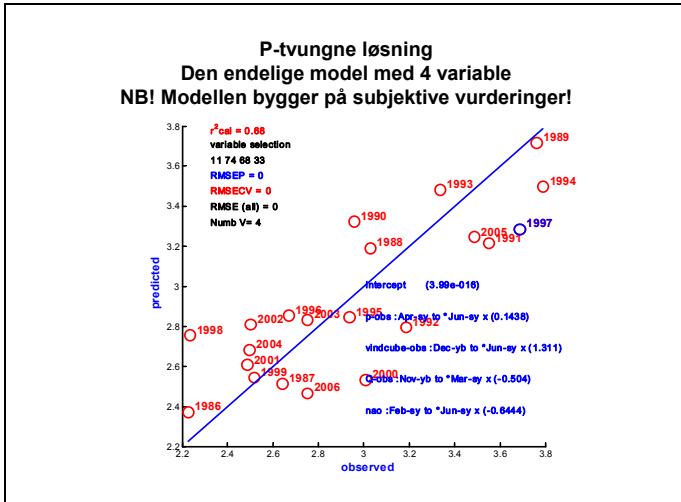
Model med de sidste fire år som valideringsår:
4 variable



Model med de sidste fire år som valideringsår:
5 variable

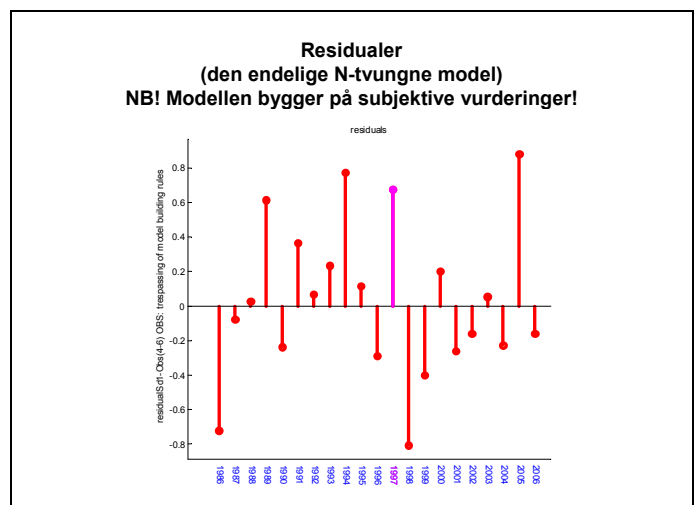
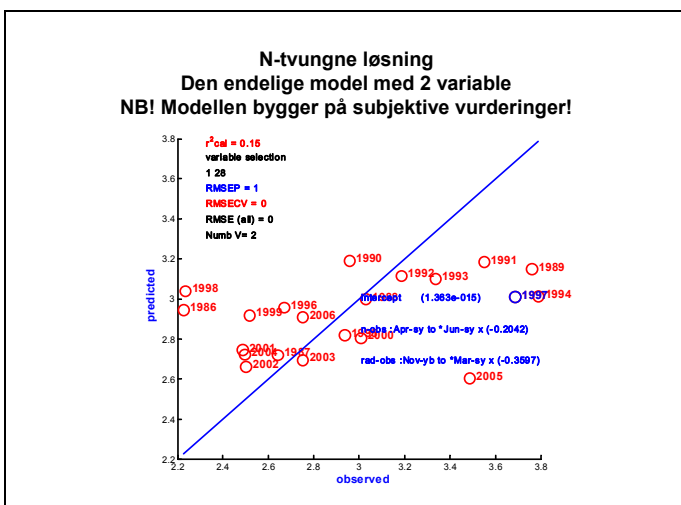
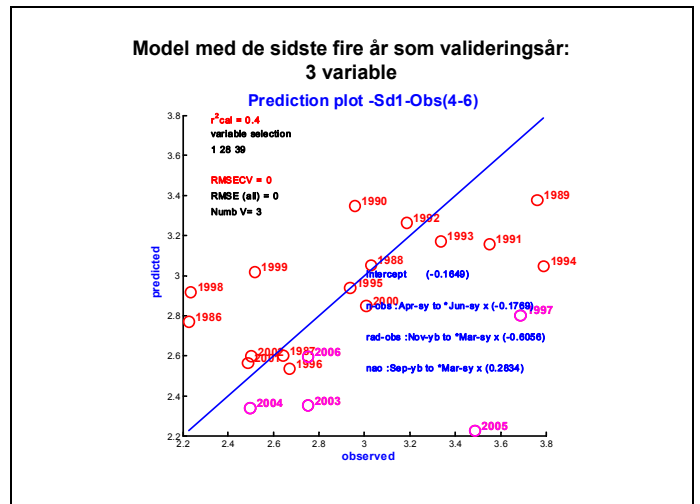
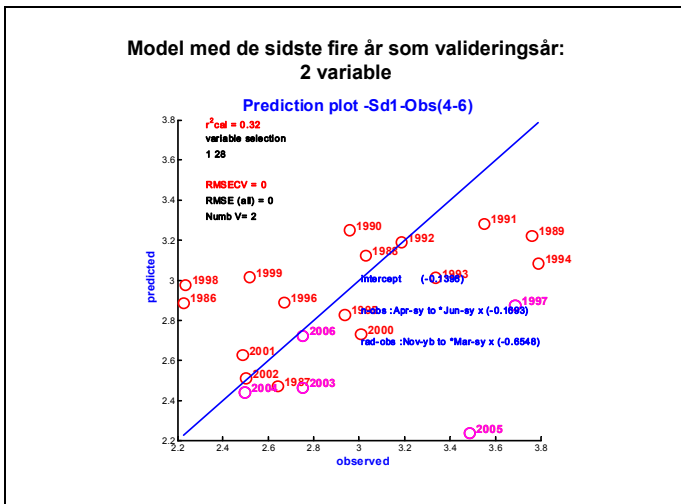
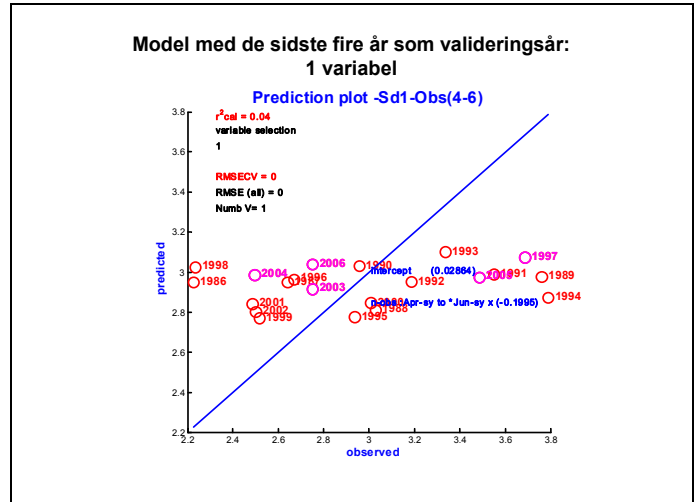
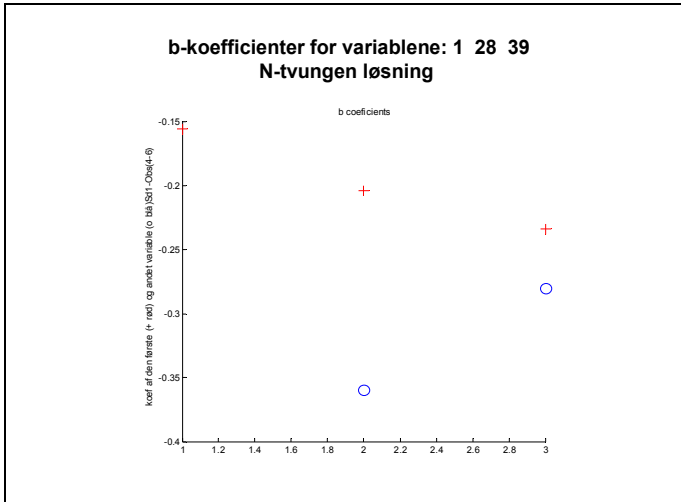


Mariager Fjord - Sd1-modellering



Den P-tvungne løsning ligger et stykke fra den utvungne, objektive løsning.
1997 er her betragtet som outlier men er ikke en egentlig outlier

Mariager Fjord - Sd1-modellering

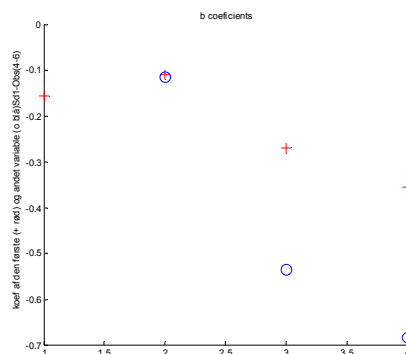


Mariager Fjord - Sd1-modellering

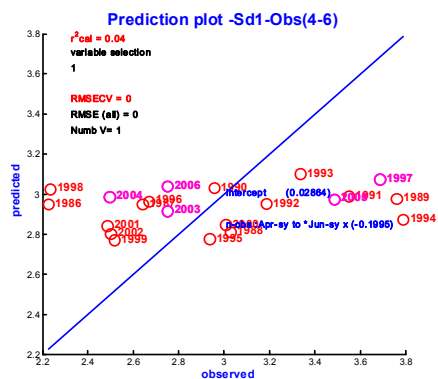
Den N-tvungne løsning ligger langt fra den
utvungne, objektive løsning.
1997 er her betragtet som en outlier men er
ikke en egentlig outlier

Mariager Fjord - Sd1-modellering

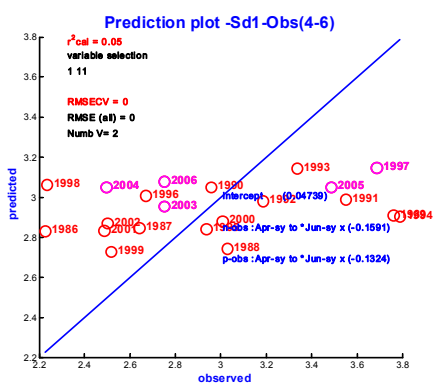
**b-koefficienter for variablene: 1 11 30 59
N- & P-tvungen løsning**



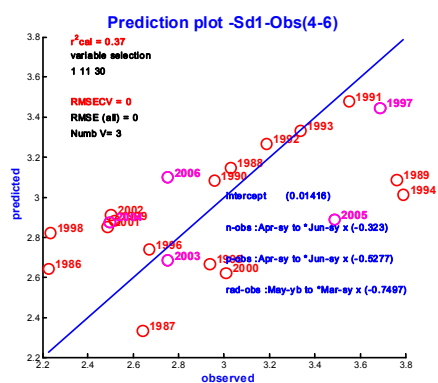
**Model med de sidste fire år som valideringsår:
1 variabel**



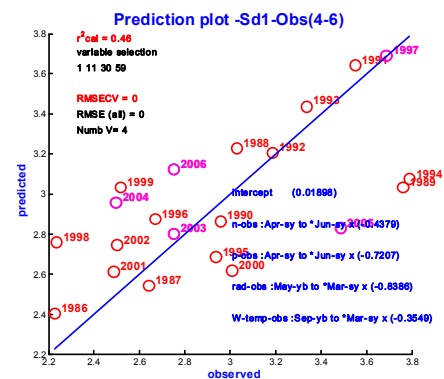
**Model med de sidste fire år som valideringsår:
2 variable**



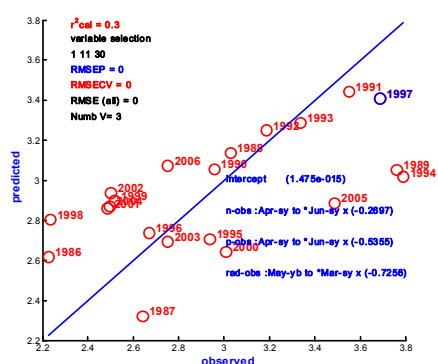
**Model med de sidste fire år som valideringsår:
3 variable**



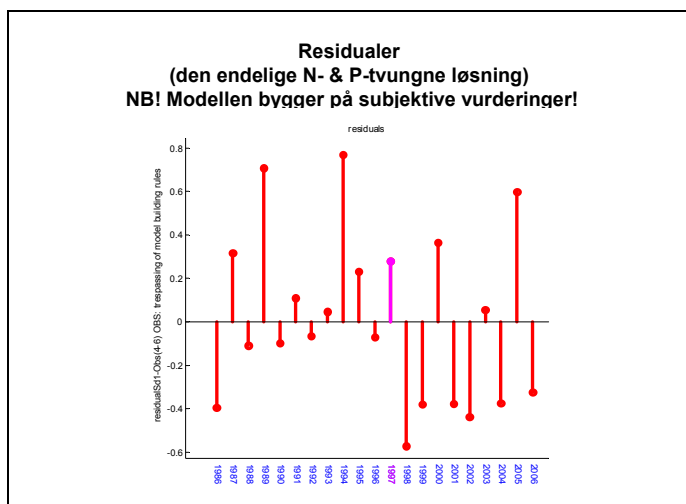
**Model med de sidste fire år som valideringsår:
4 variable**



**N- & P-tvungne løsning
Den endelige model med 3 variable
NB! Modellen bygger på subjektive vurderinger!**

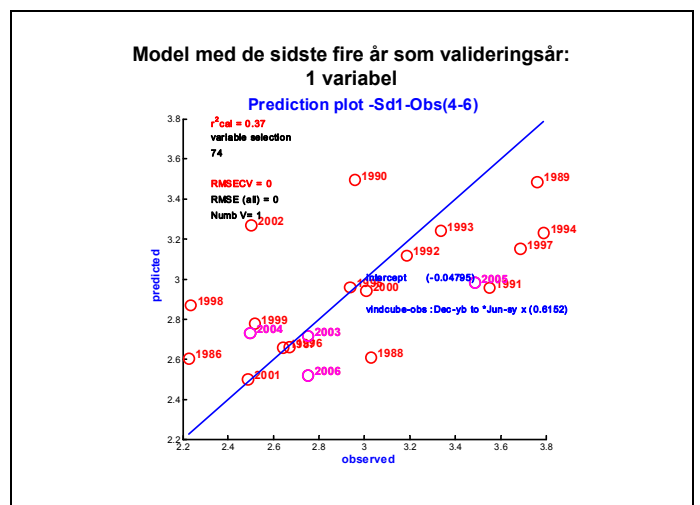
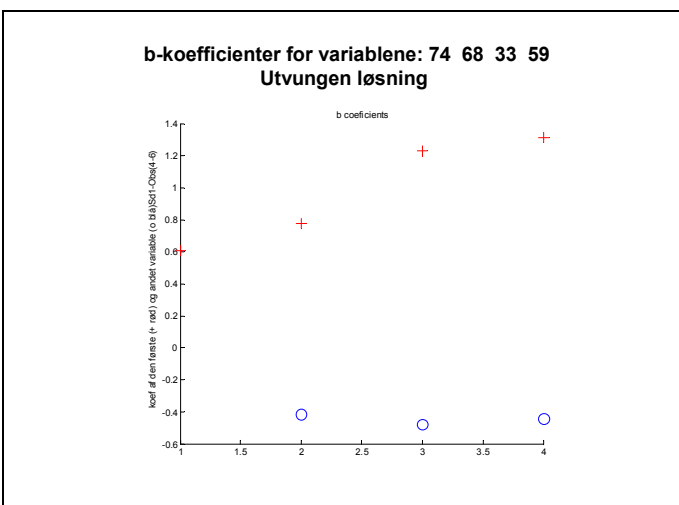
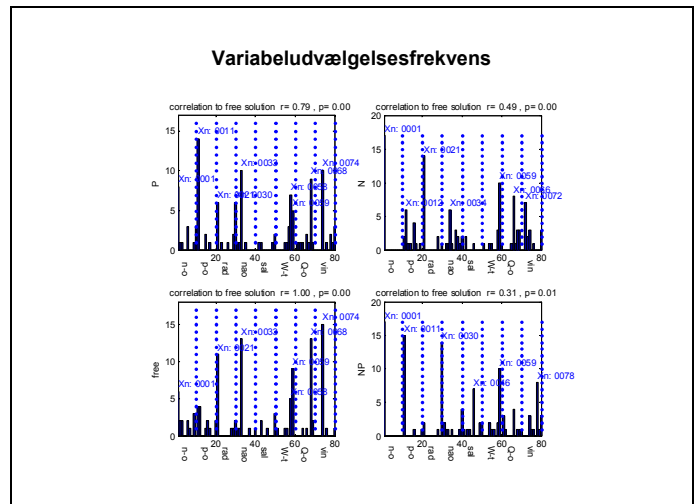
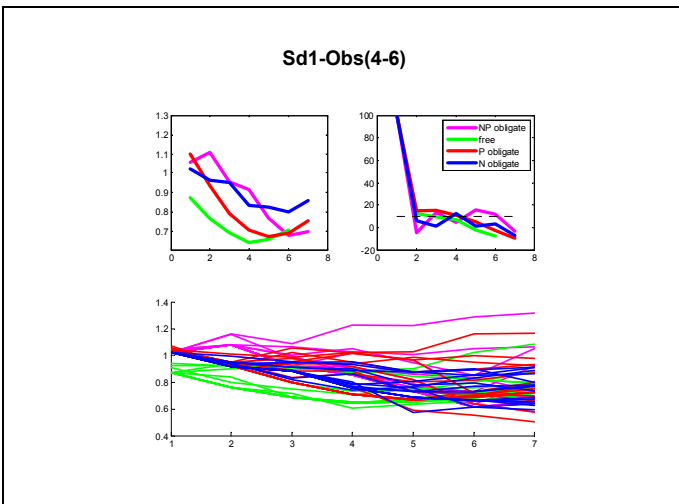
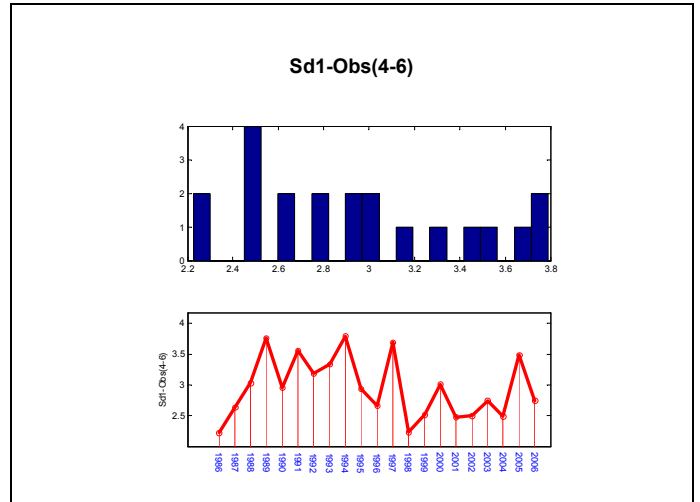
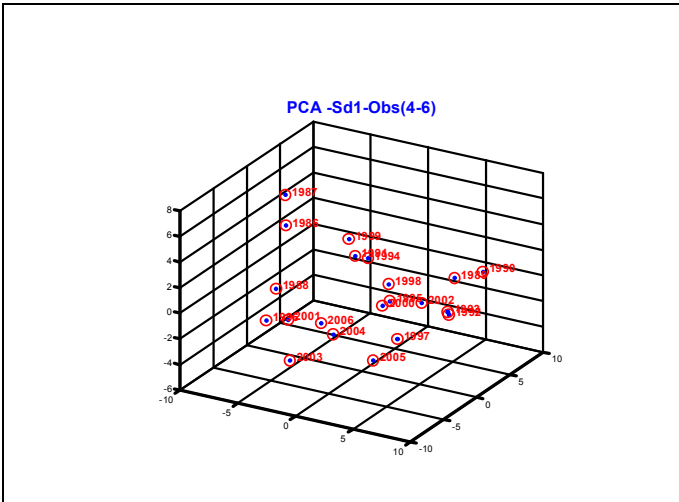


Mariager Fjord - Sd1-modellering

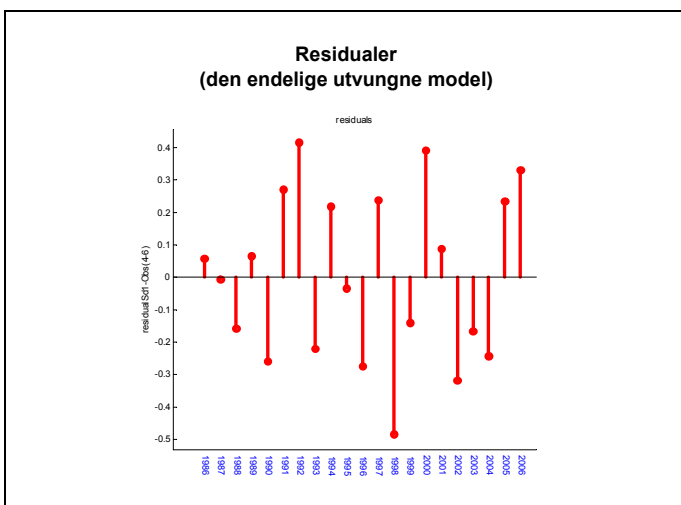
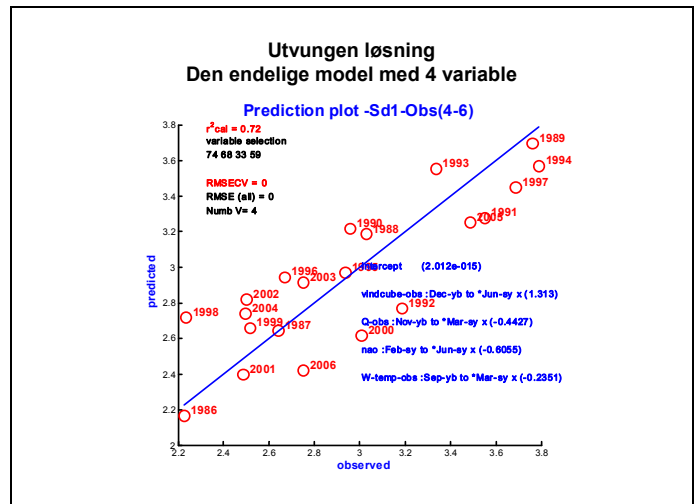
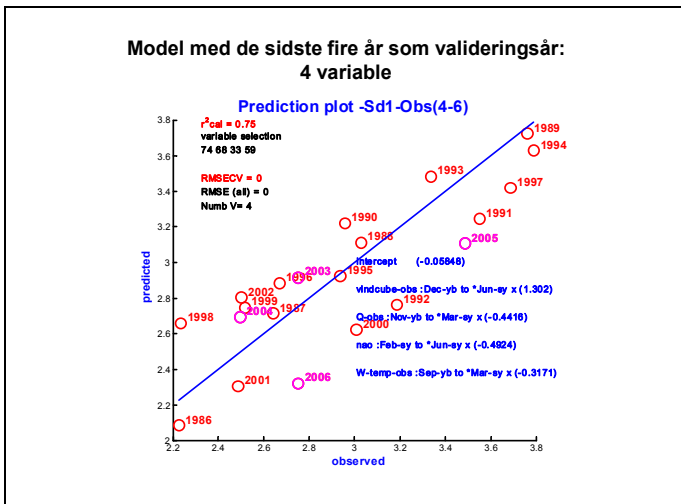
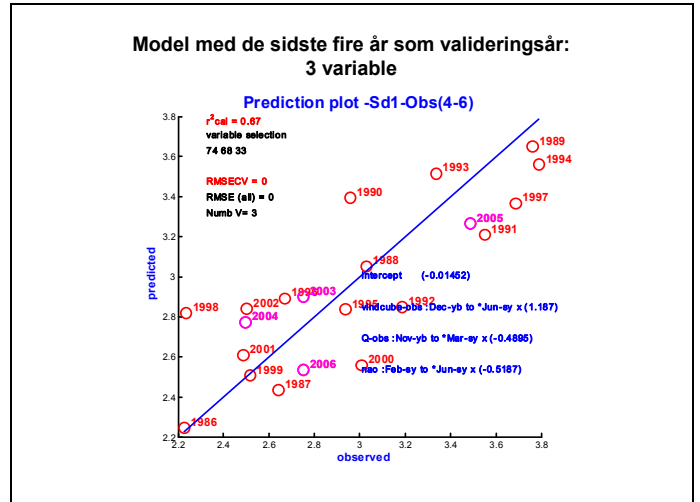
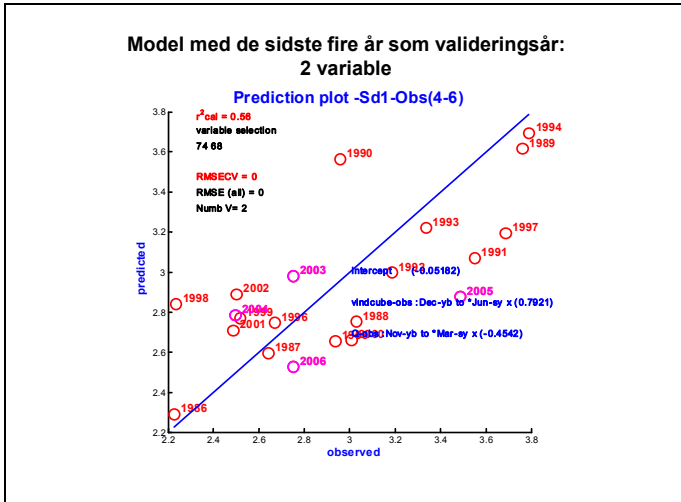


Den N- & P-tvungne løsning ligger langt fra den
utvungne, objektive løsning.
1997 er her betragtet som en outlier men er
ikke en egentlig outlier

Mariager Fjord - Sd1-modellering



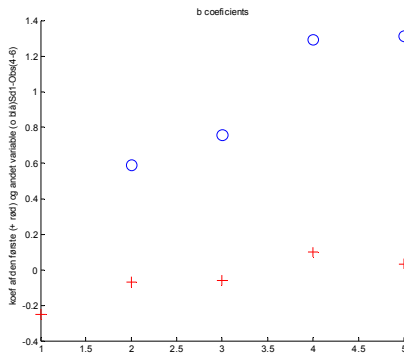
Mariager Fjord - Sd1-modellering



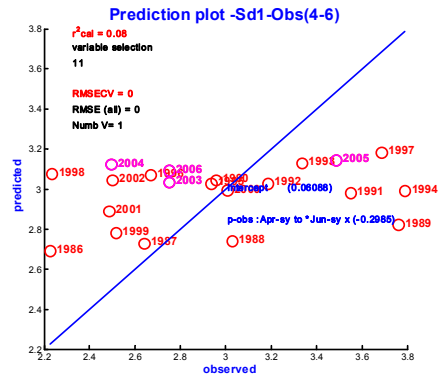
Ingen outlier
Den utvungne løsning peger hverken på N- eller P-tilførsel som vigtige variable

Mariager Fjord - Sd1-modellering

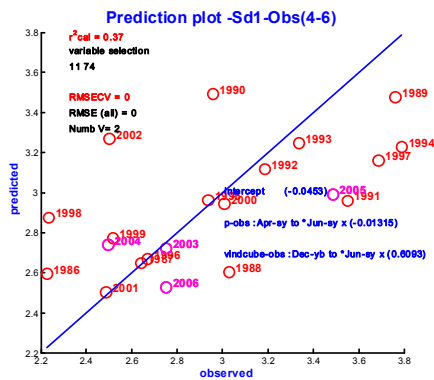
b-koefficienter for variablene: 11 74 68 33 58
P-tvungen løsning



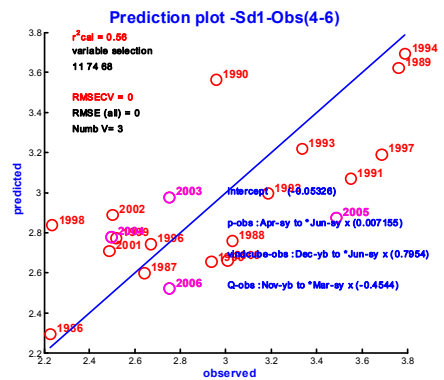
Model med de sidste fire år som valideringsår:
1 variabel



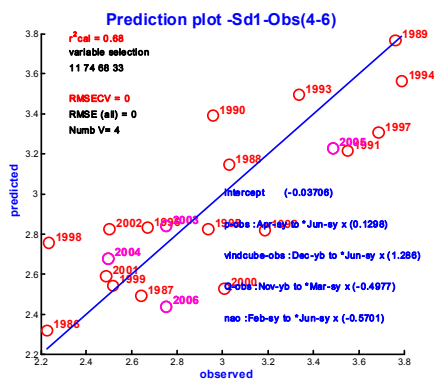
Model med de sidste fire år som valideringsår:
2 variable



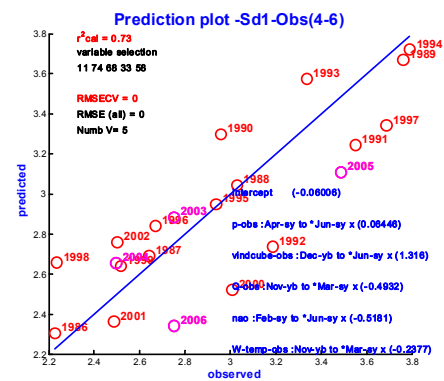
Model med de sidste fire år som valideringsår:
3 variable



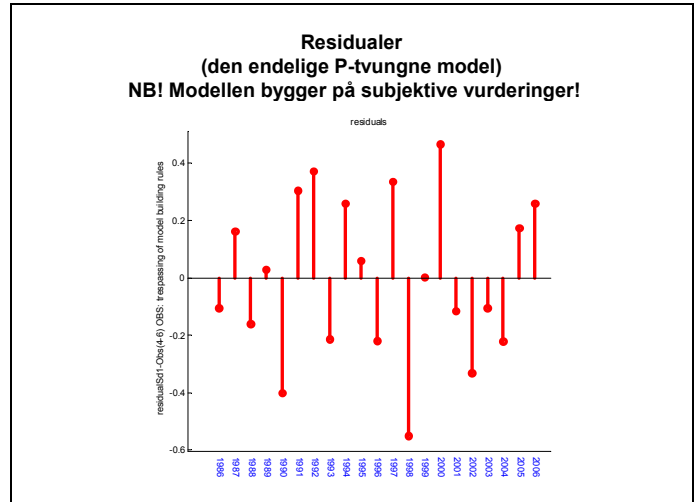
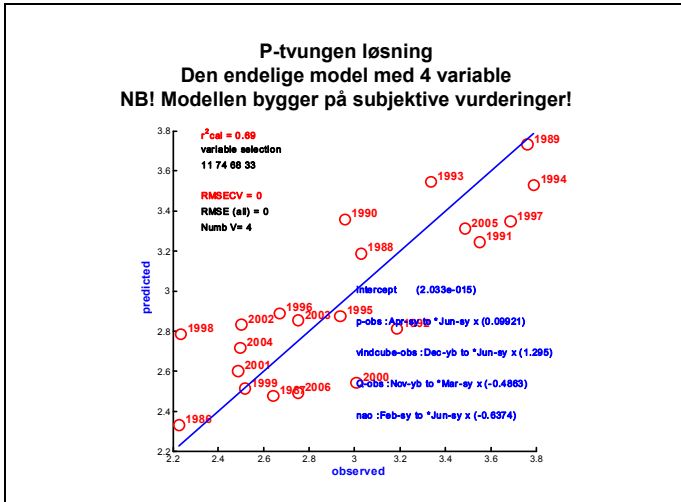
Model med de sidste fire år som valideringsår:
4 variable



Model med de sidste fire år som valideringsår:
5 variable

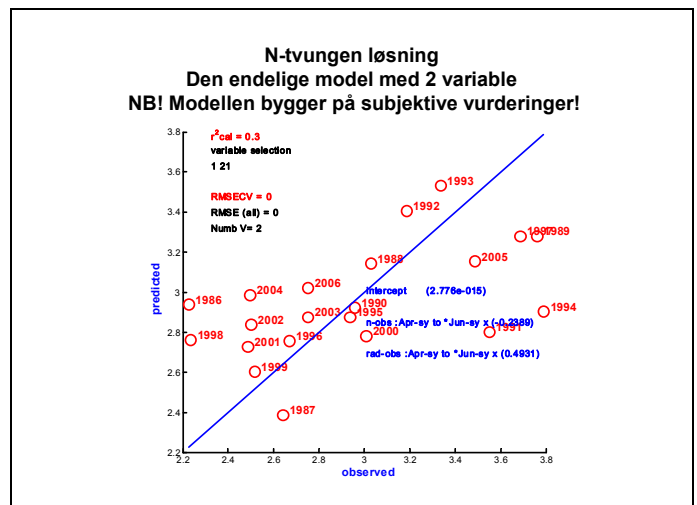
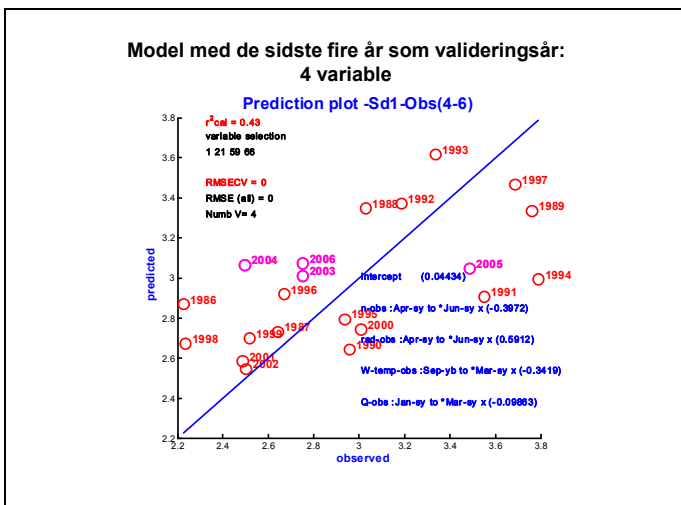
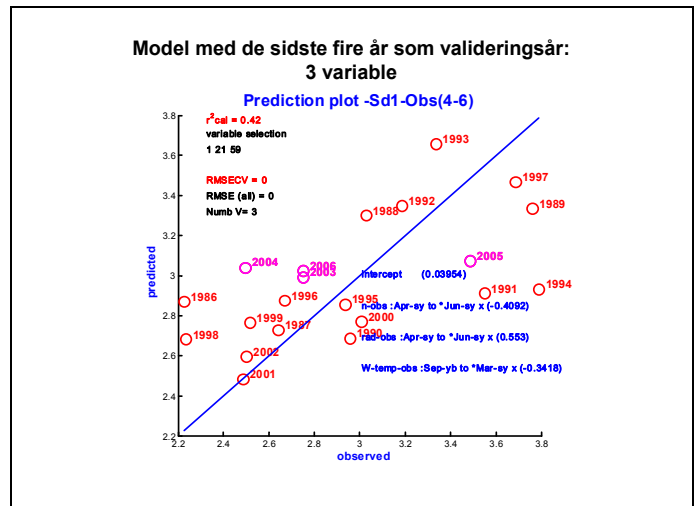
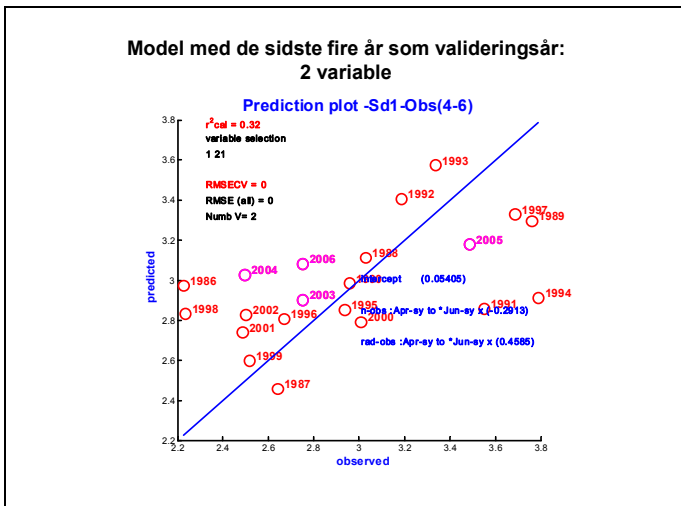
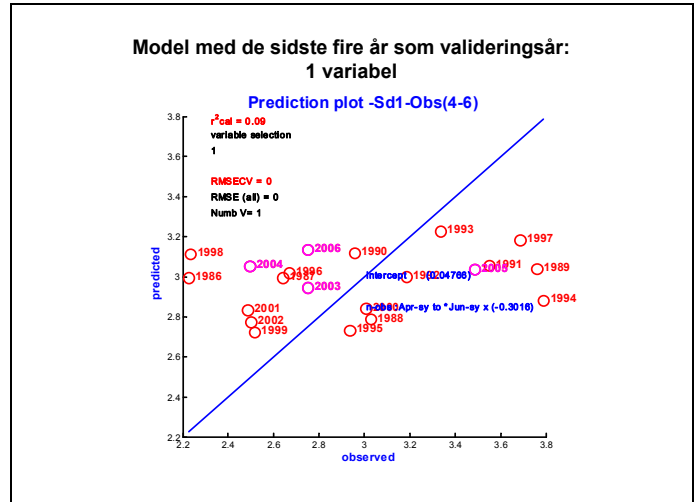
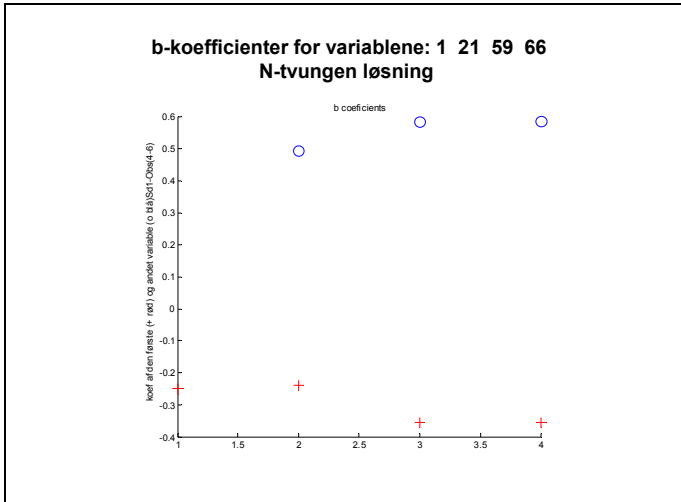


Mariager Fjord - Sd1-modellering



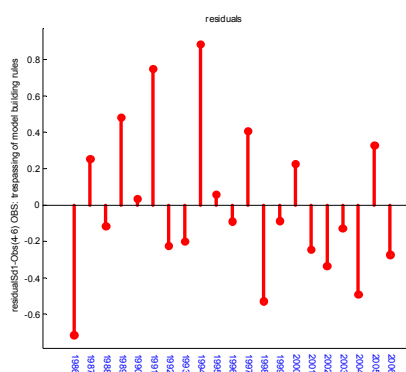
Ingen outlier
P-tvungne løsning ligger relativt langt fra den
utvungne, objektive løsning

Mariager Fjord - Sd1-modellering



Mariager Fjord - Sd1-modellering

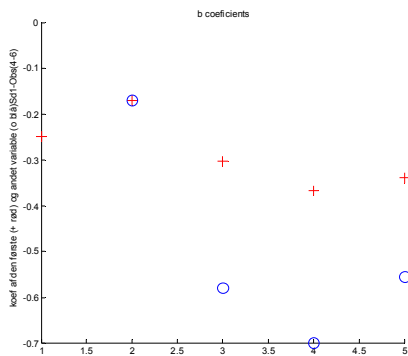
Residualer
(den endelige N-tvungne model)
NB! Modellen bygger på subjektive vurderinger!



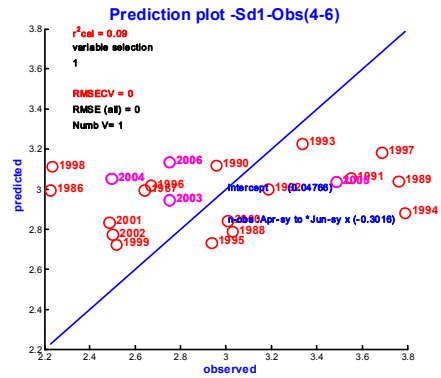
Ingen outlier
Den N-tvungne model ligger langt fra den
utvungne, objektive løsning

Mariager Fjord - Sd1-modellering

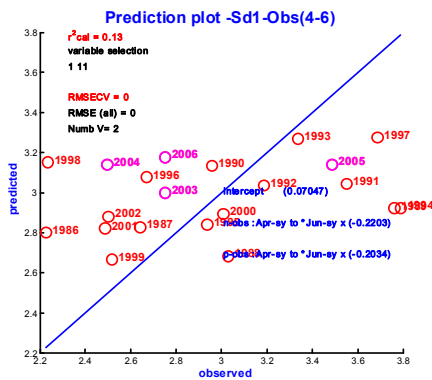
**b-koefficienter for variablene: 1 11 30 59 78
N- & P-tvungen løsning**



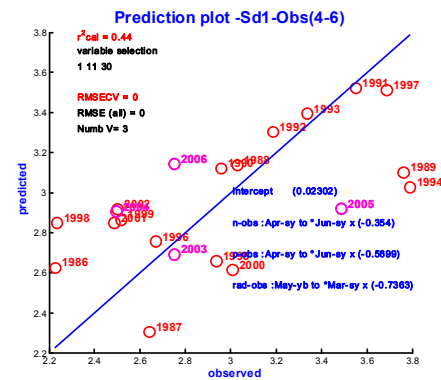
**Model med de sidste fire år som valideringsår:
1 variabel**



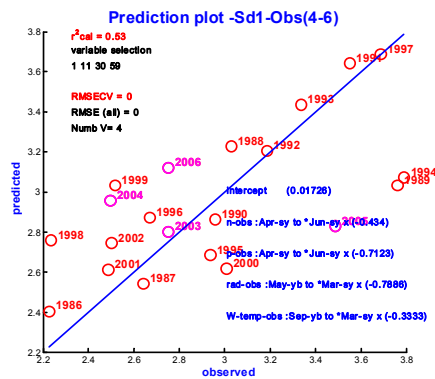
**Model med de sidste fire år som valideringsår:
2 variable**



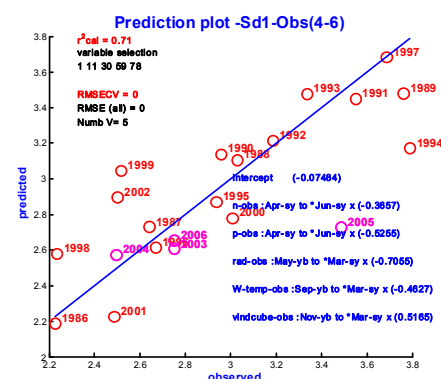
**Model med de sidste fire år som valideringsår:
3 variable**



**Model med de sidste fire år som valideringsår:
4 variable**

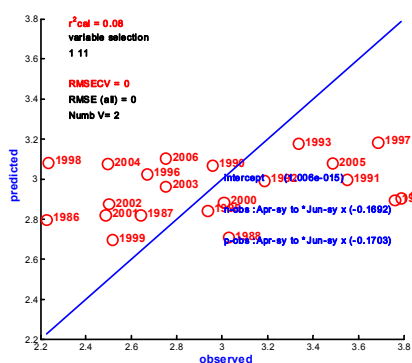


**Model med de sidste fire år som valideringsår:
5 variable**



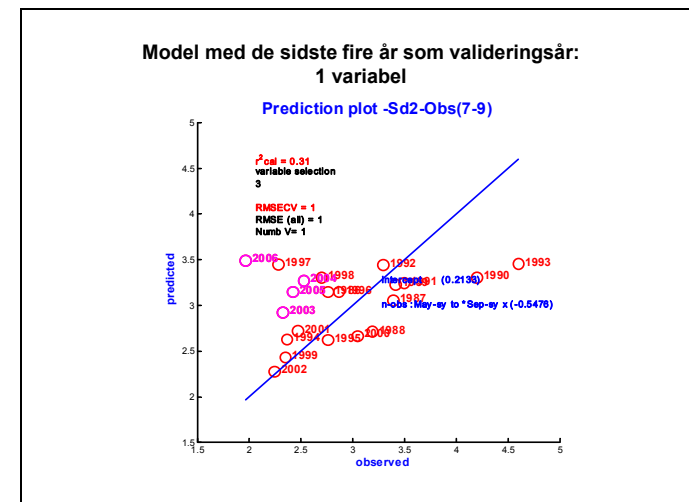
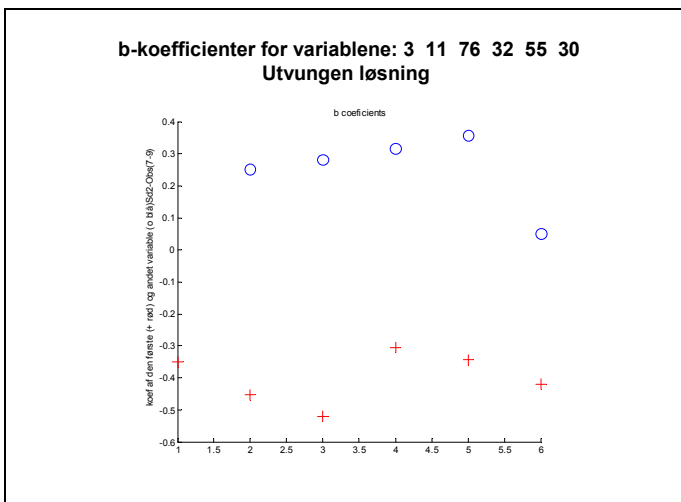
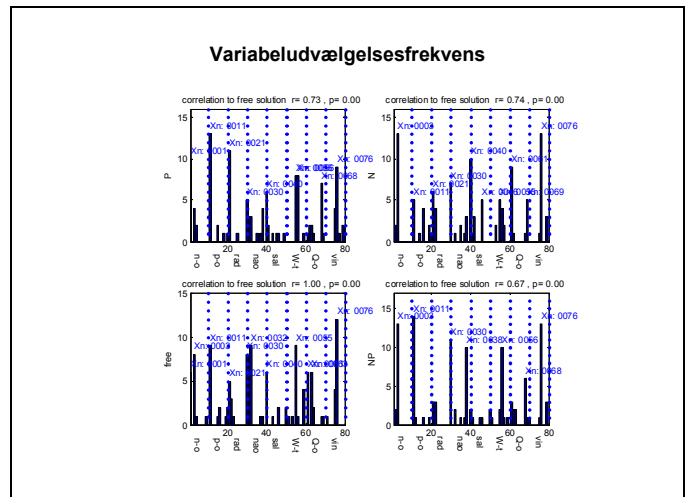
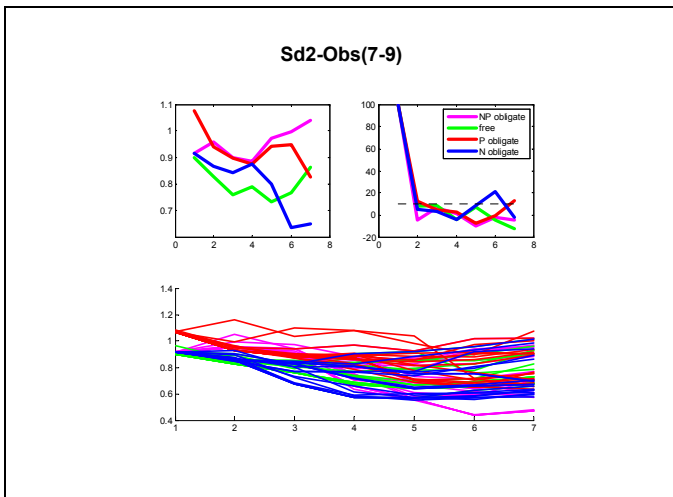
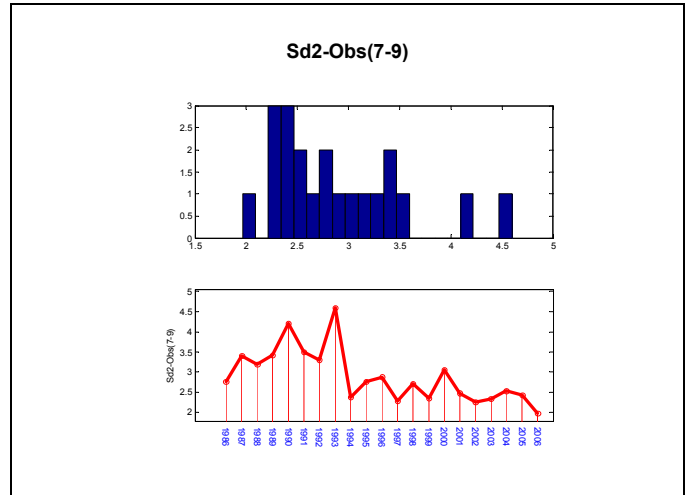
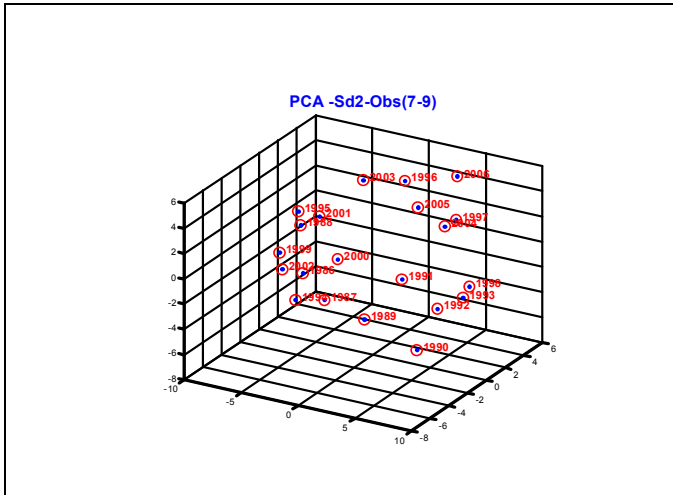
Mariager Fjord - Sd1-modellering

N- & P-tvungen løsning
Den endelige model med 2 variable
NB! Modellen bygger på subjektive vurderinger!

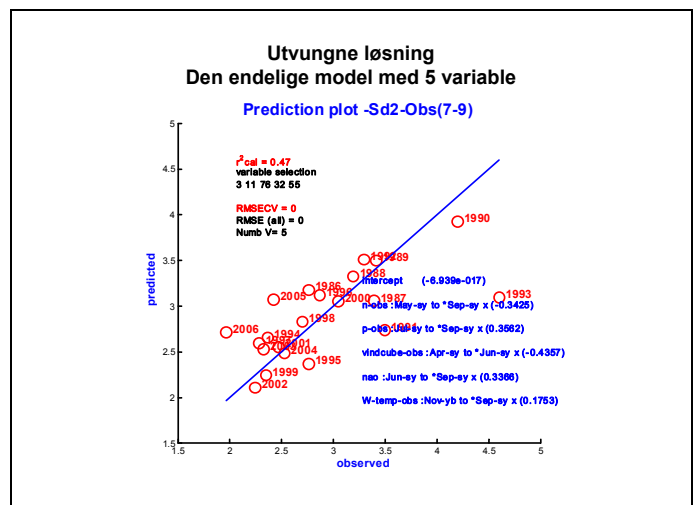
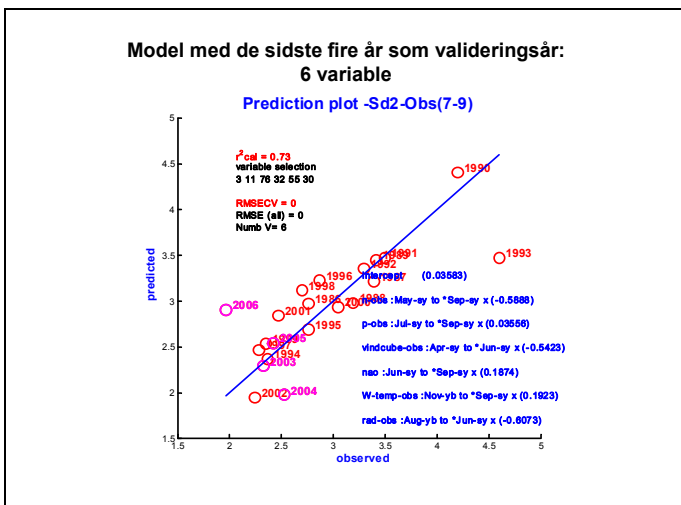
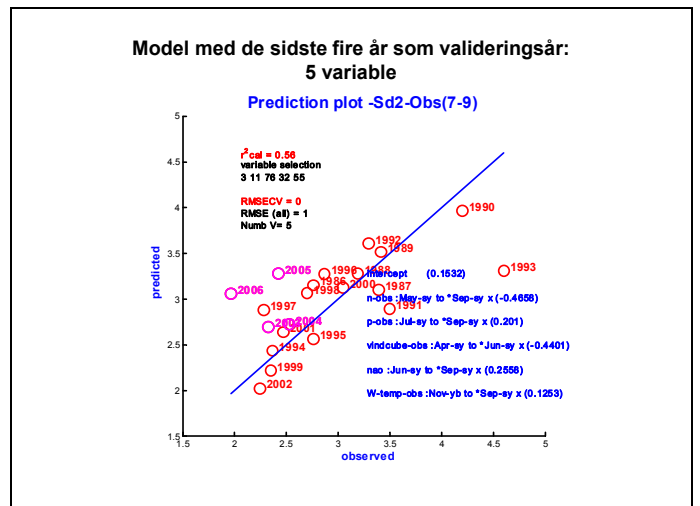
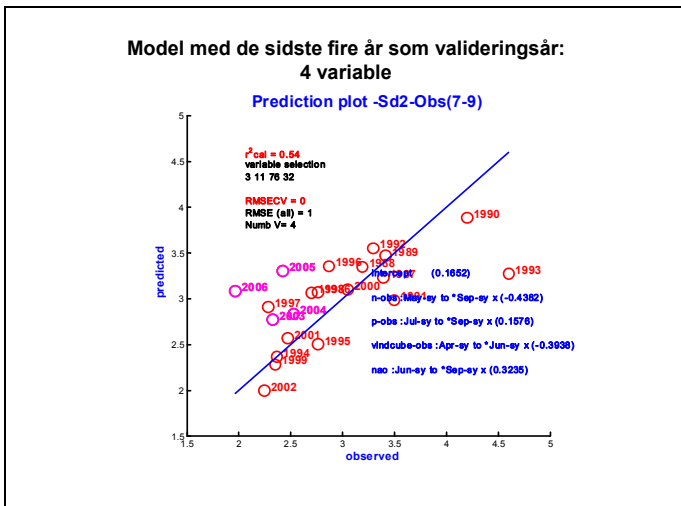
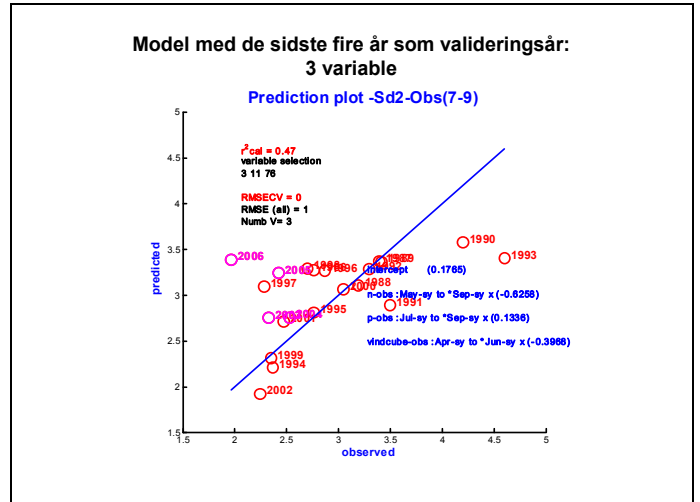
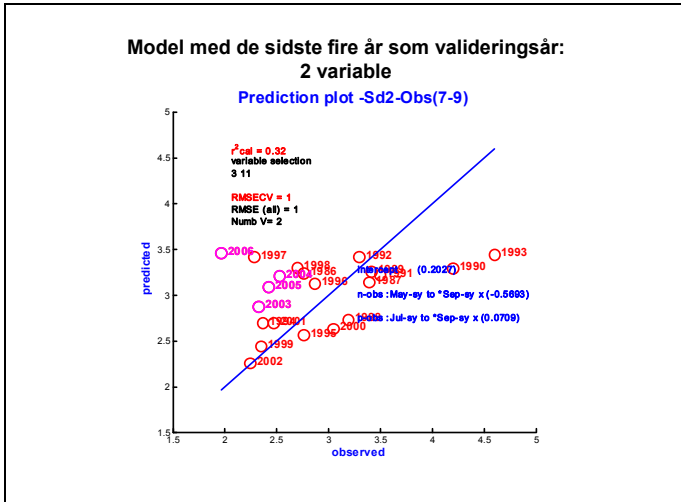


Ingen outlier
N- & P-tvungne model ligger langt fra den
utvungne, objektive løsning

Mariager Fjord - Sd2-modellering

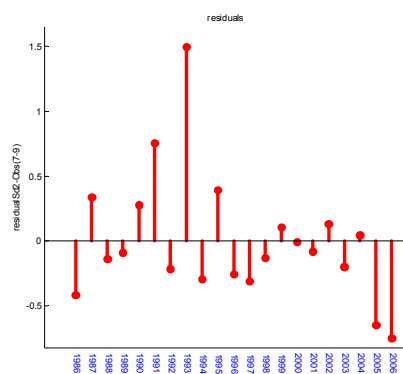


Mariager Fjord - Sd2-modellering



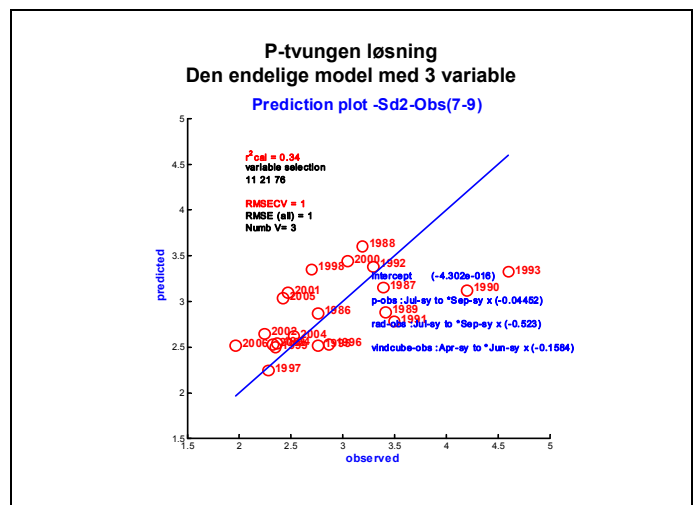
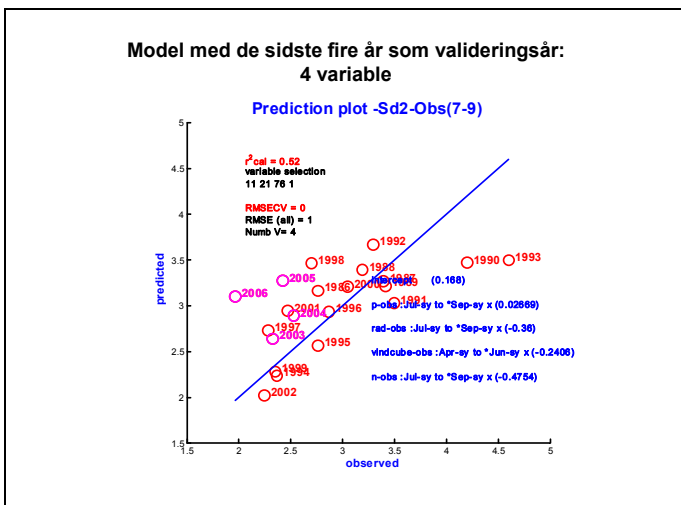
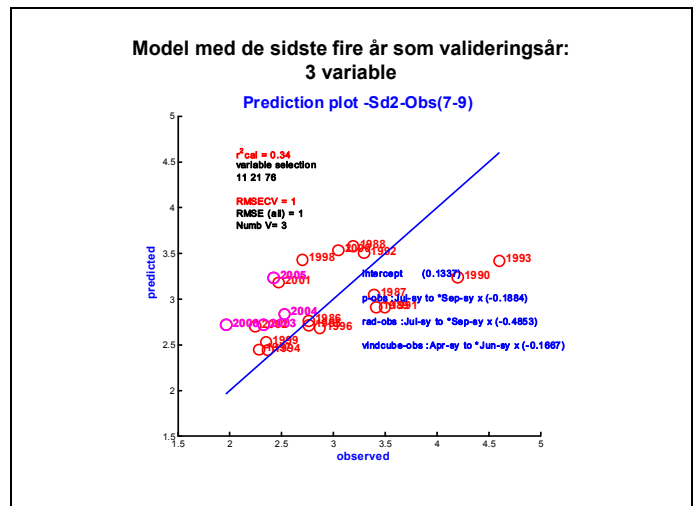
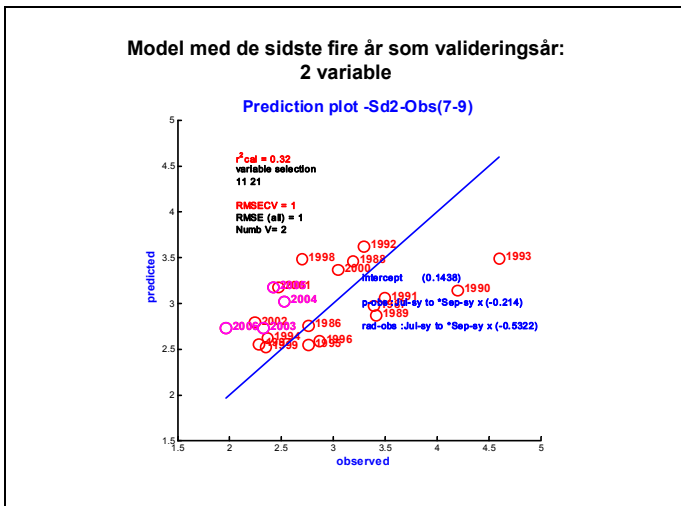
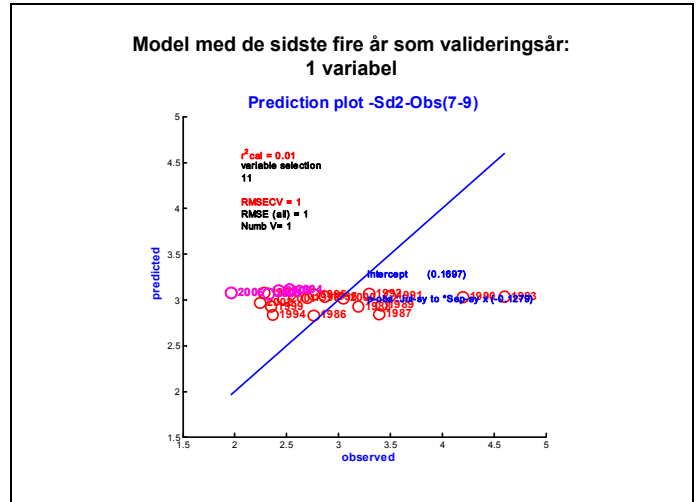
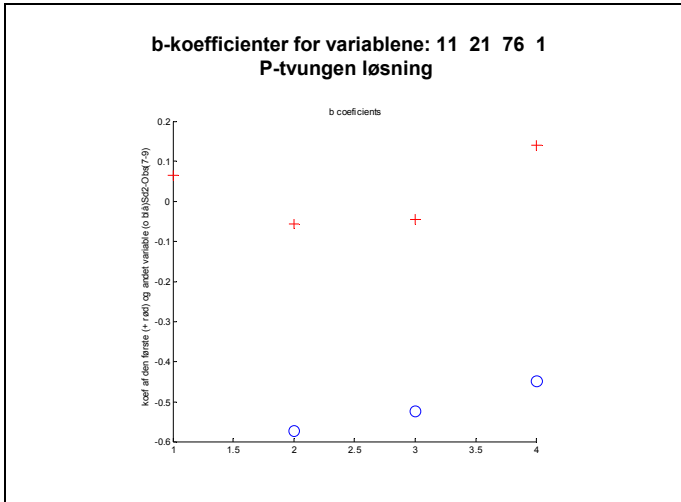
Mariager Fjord - Sd2-modellering

Residualer
(den endelige utvungne model)

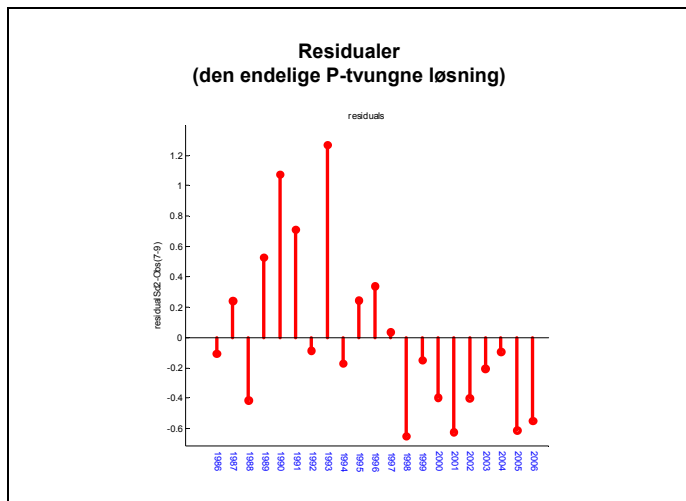


Den utvungne løsning peger på N- og P-tilførsel

Mariager Fjord - Sd2-modellering

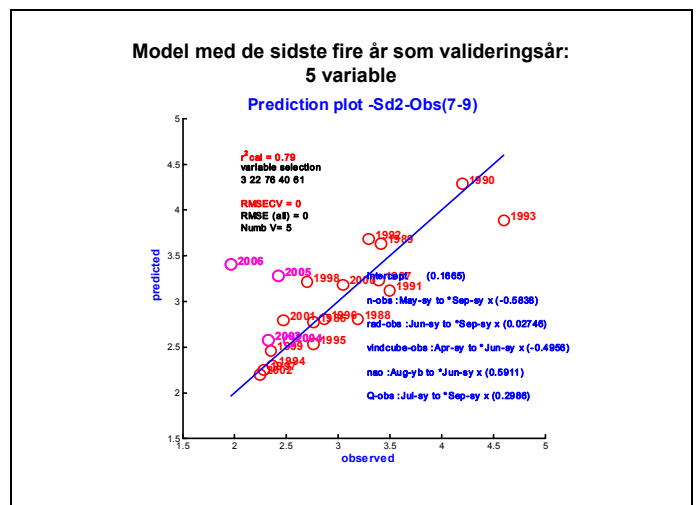
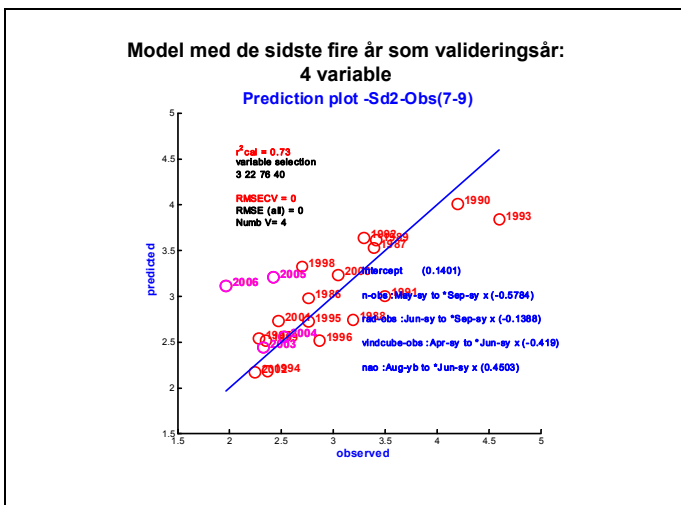
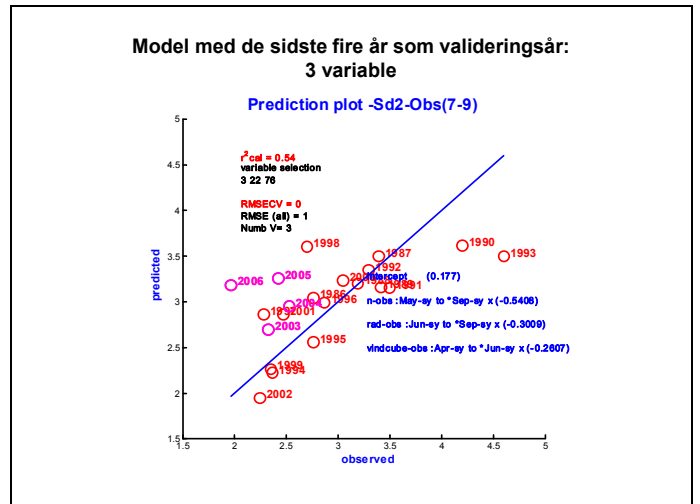
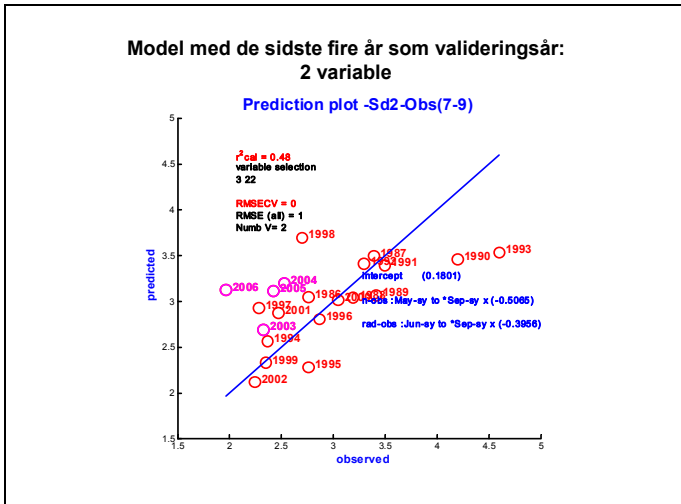
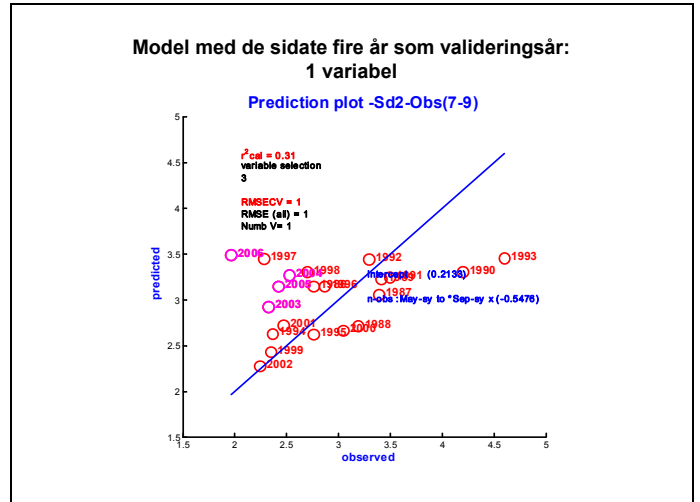
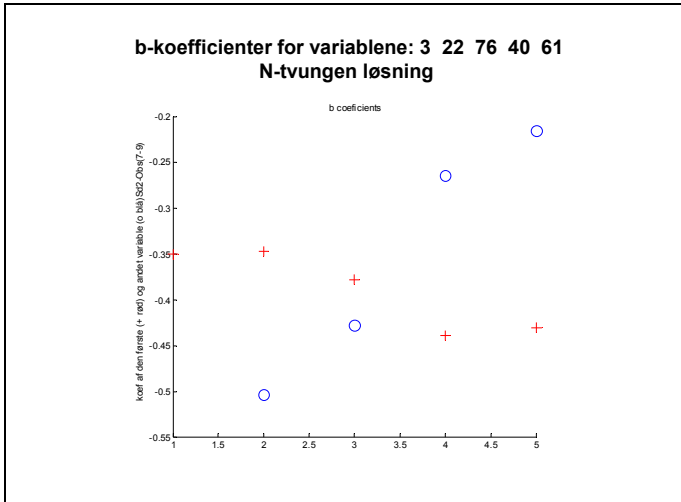


Mariager Fjord - Sd2-modellering

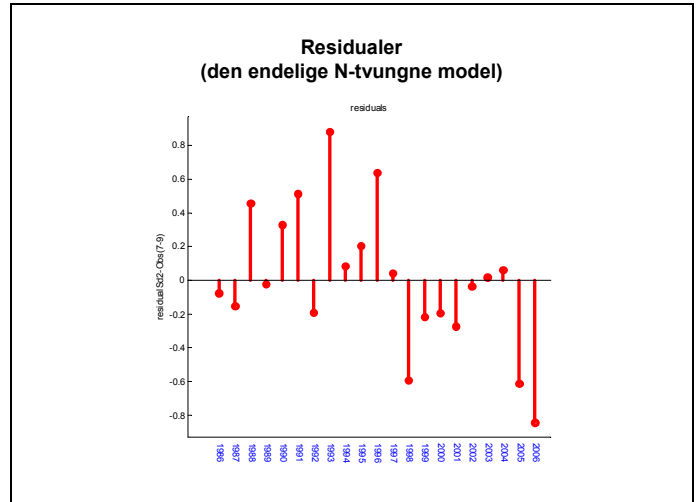
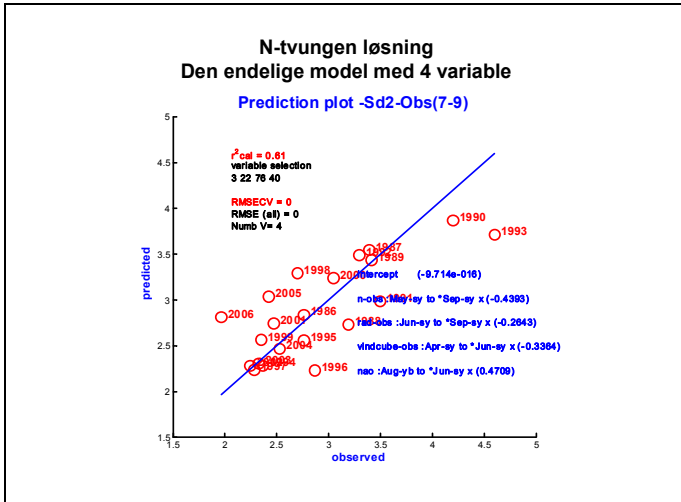


Den P-tvungne model er ikke anvendelig som forudsigelsesværktøj

Mariager Fjord - Sd2-modellering



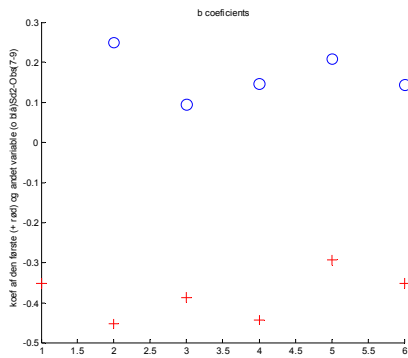
Mariager Fjord - Sd2-modellering



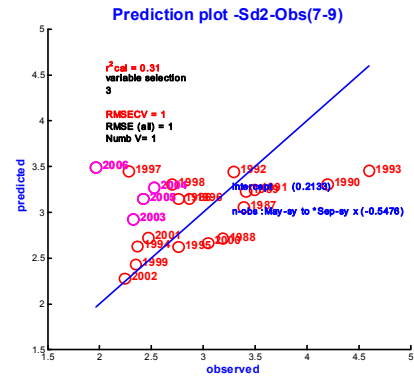
Den N-tvungne løsning giver en svag model
med negative koefficienter for N-tilførslen

Mariager Fjord - Sd2-modellering

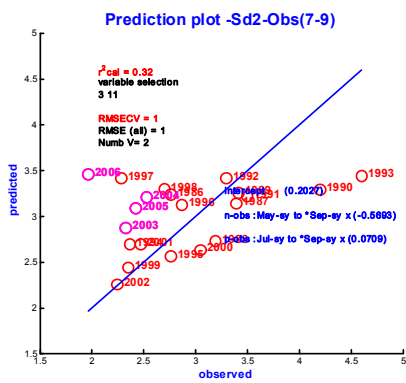
**b-koefficienter for variablene: 3 11 22 76 31 38
N- & P-tvungen løsning**



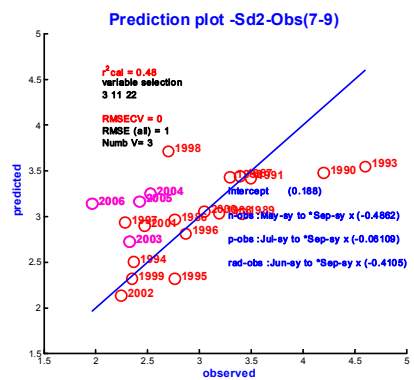
**Model med de sidste fire år som valideringsår:
1 variabel**



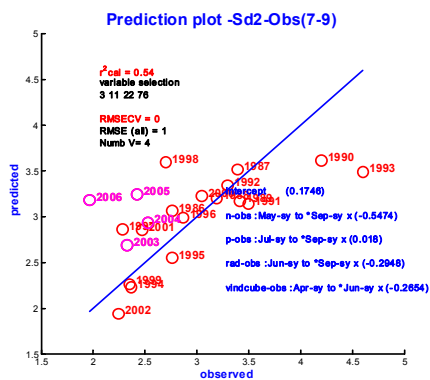
**Model med de sidste fire år som valideringsår:
2 variable**



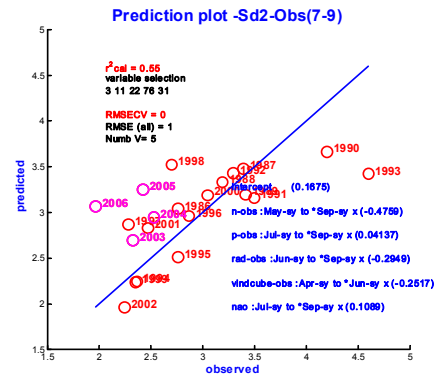
**Model med de sidste fire år som valideringsår:
3 variable**



**Model med de sidste fire år som valideringsår:
4 variable**

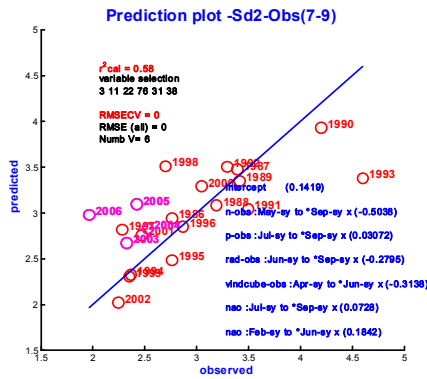


**Model med de sidste fire år som valideringsår:
5 variable**

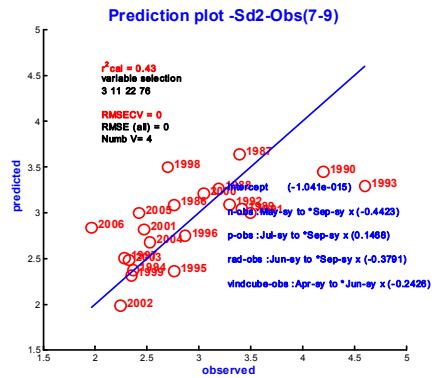


Mariager Fjord - Sd2-modellering

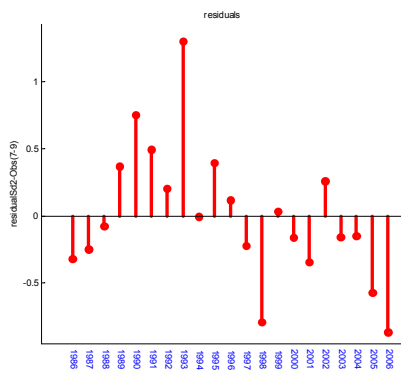
Model med de sidste fire år som valideringsår:
6 variable



N- og P-tvungne løsning
Den endelige model med 4 variable



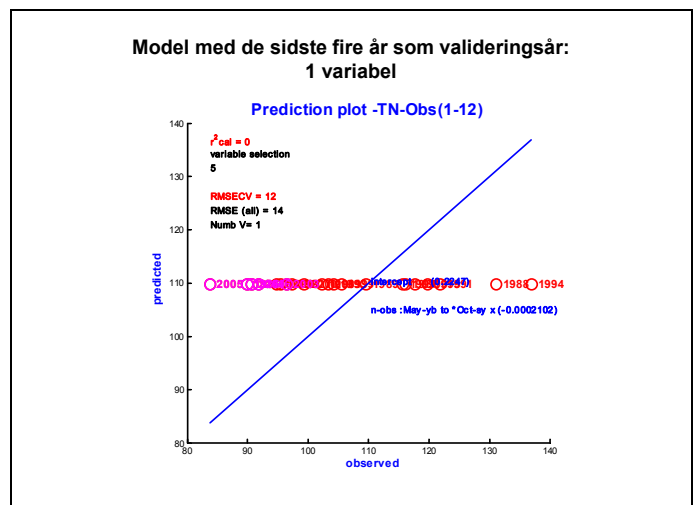
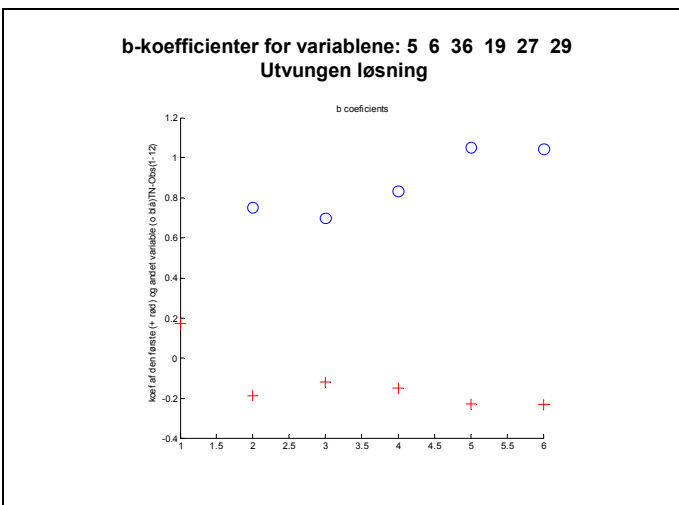
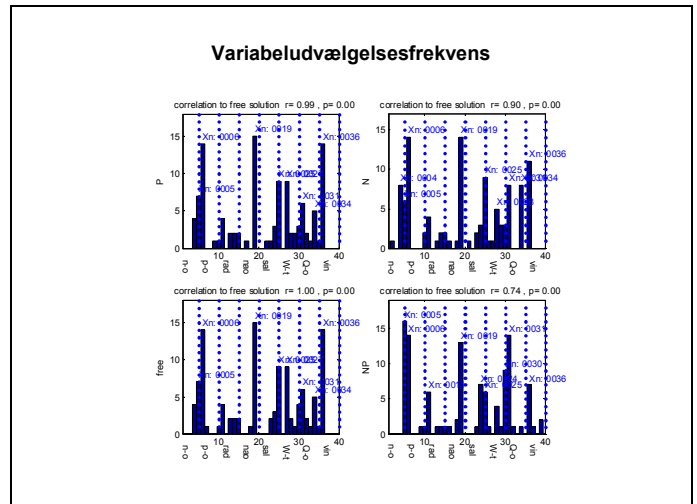
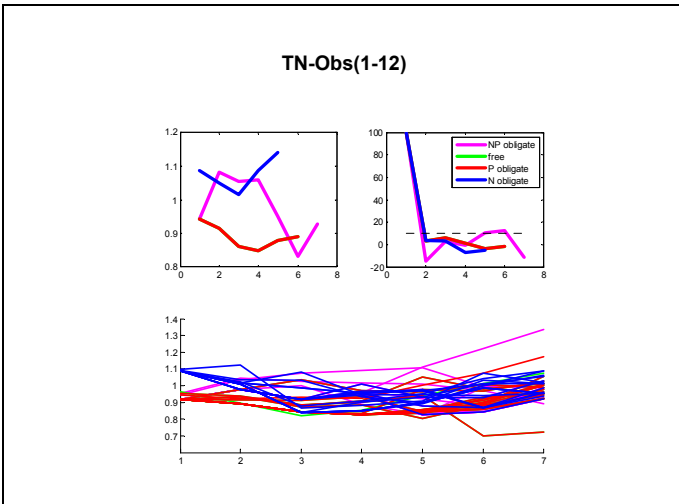
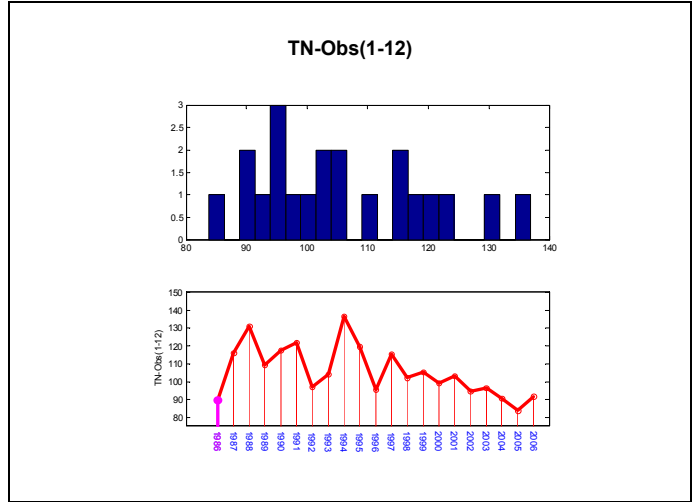
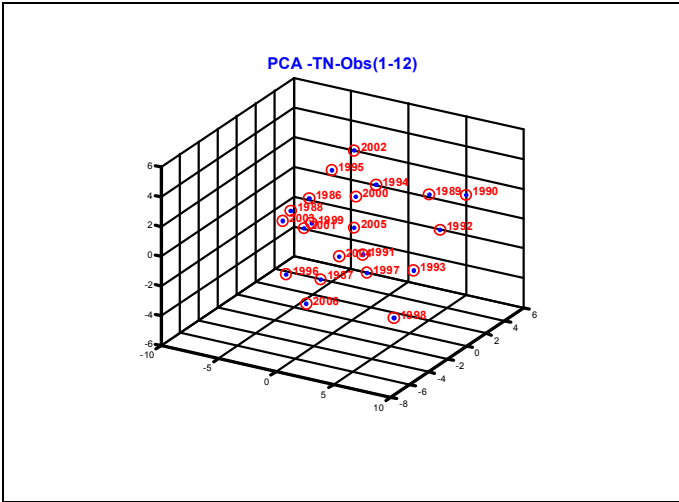
Residualer
(den endelige N- & P-tvungne model)



Den N- & P-tvungne løsning giver en svag model med negative koefficienter for N-tilførslen

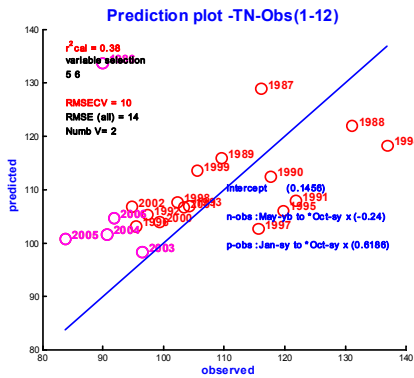
[Tom side]

Mariager Fjord - TN-modellering

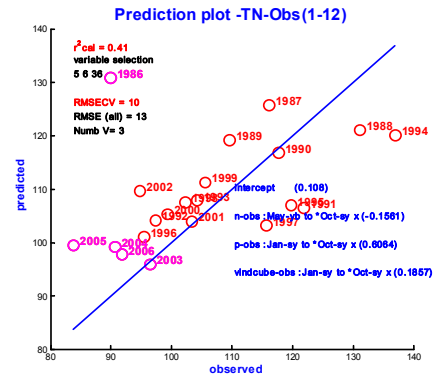


Mariager Fjord - TN-modellering

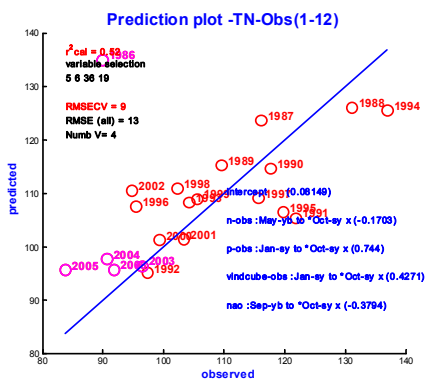
Model med de sidste fire år som valideringsår:
2 variable



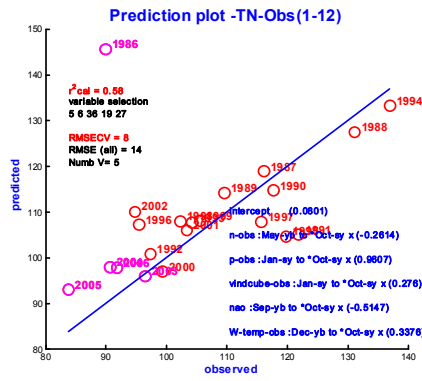
Model med de sidste fire år som valideringsår:
3 variable



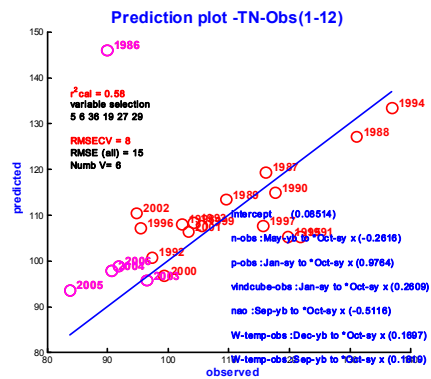
Model med de sidste fire år som valideringsår:
4 variable



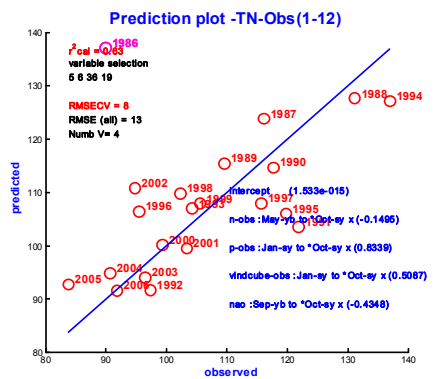
Model med de sidste fire år som valideringsår:
5 variable



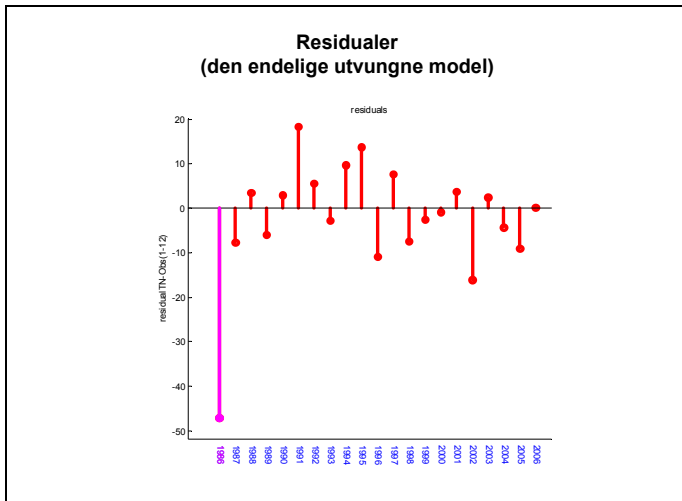
Model med de sidste fire år som valideringsår:
6 variable



Utvungne løsning
Den endelige model med 4 variable



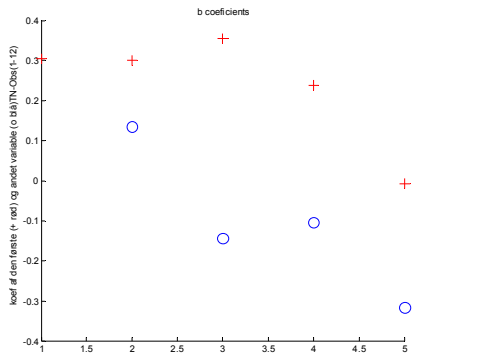
Mariager Fjord - TN-modellering



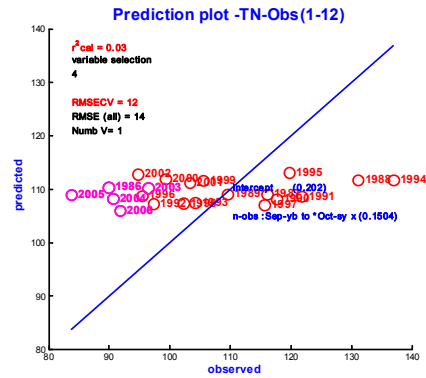
Outlier: 1986
Den objektive utvungne løsning giver, at P-tilførsel er vigtigere end N-tilførsel!

Mariager Fjord - TN-modellering

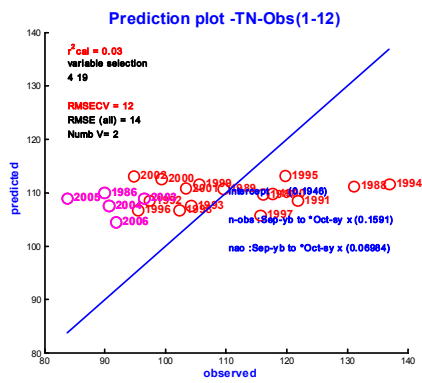
**b-koefficienter for variablene: 4 19 36 34 6
N-tvungen løsning**



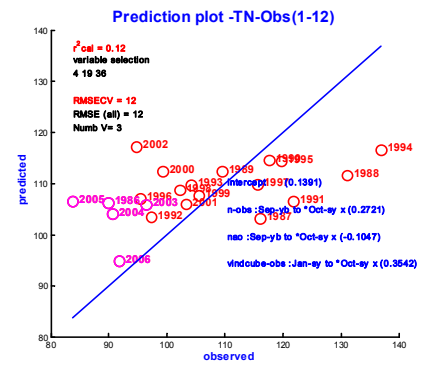
**Model med de sidste fire år som valideringsår:
1 variabel**



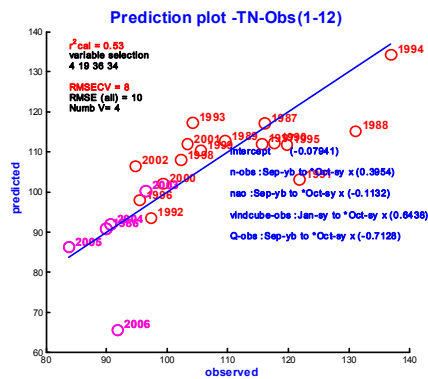
**Model med de sidste fire år som valideringsår:
2 variable**



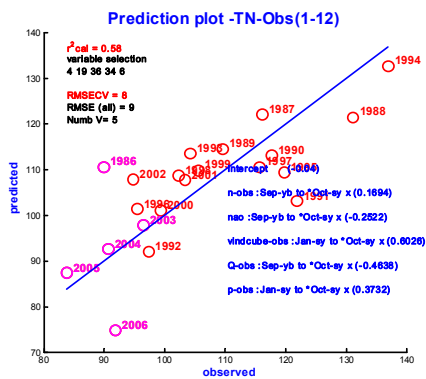
**Model med de sidste fire år som valideringsår:
3 variable**



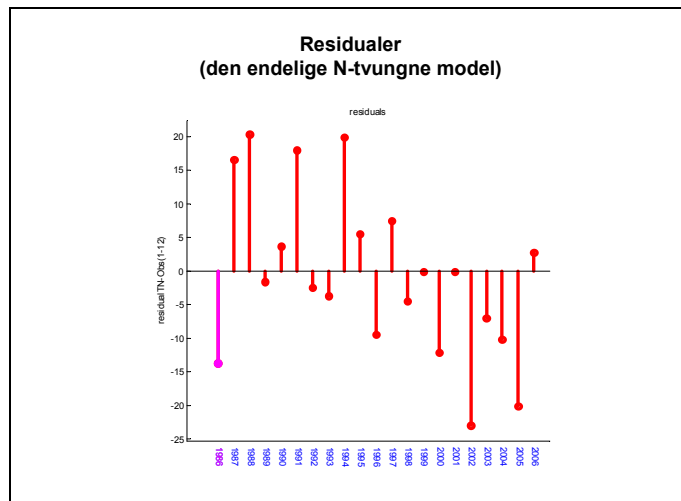
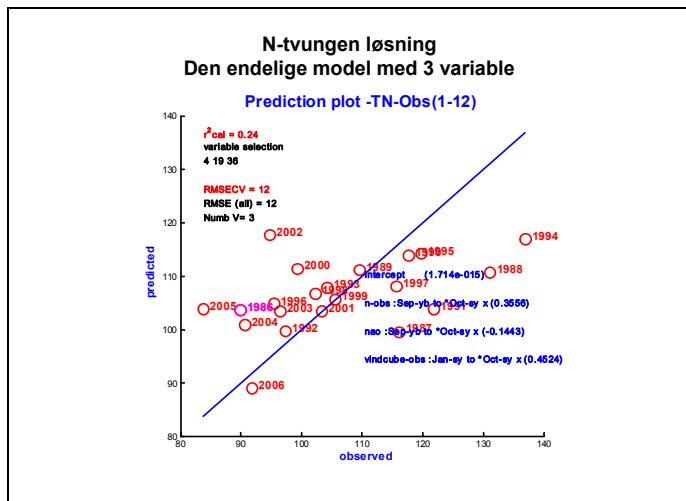
**Model med de sidste fire år som valideringsår:
4 variable**



**Model med de sidste fire år som valideringsår:
5 variable**

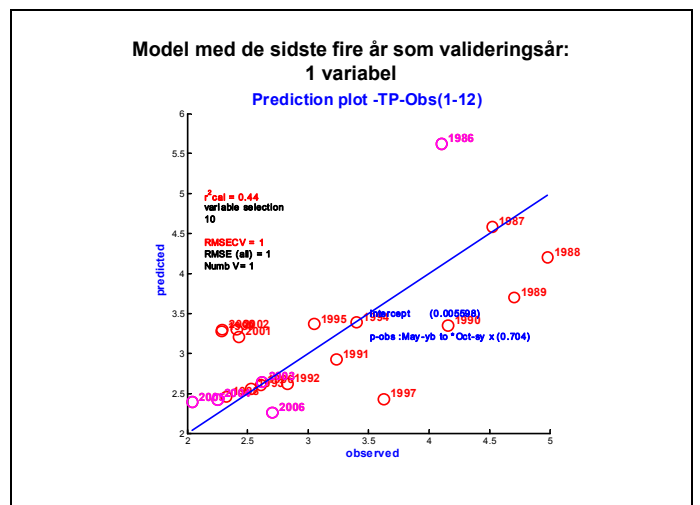
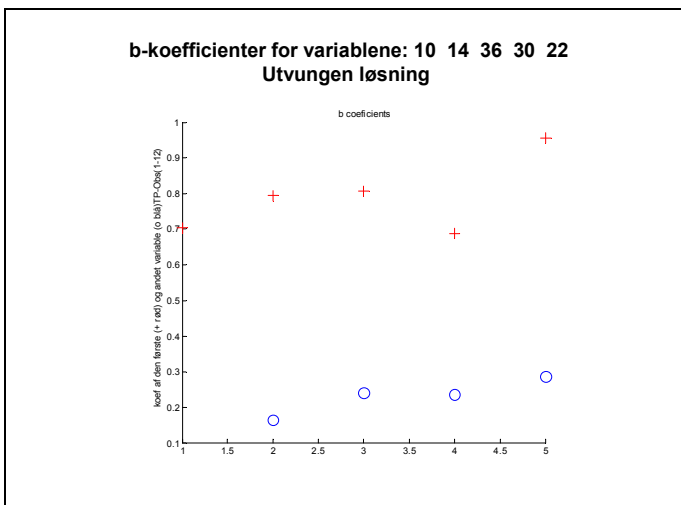
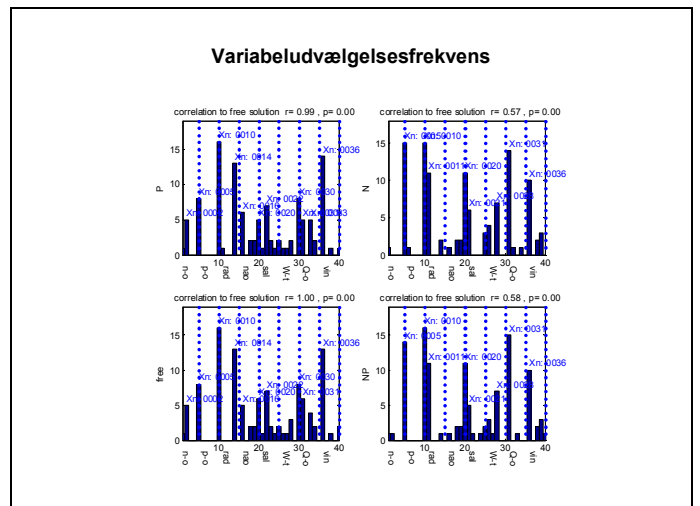
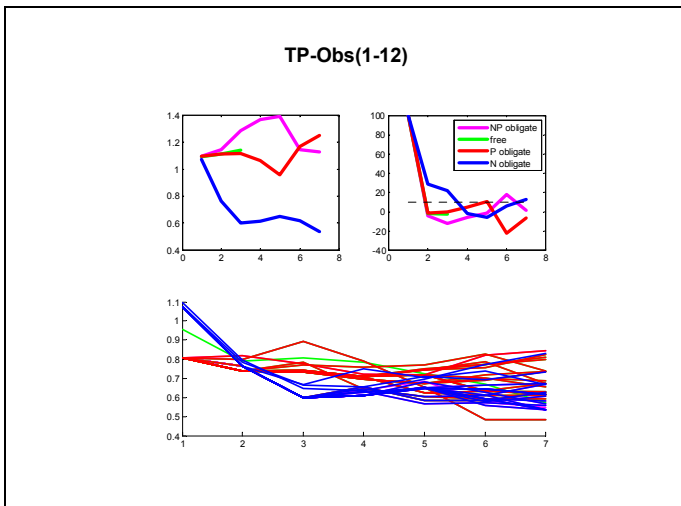
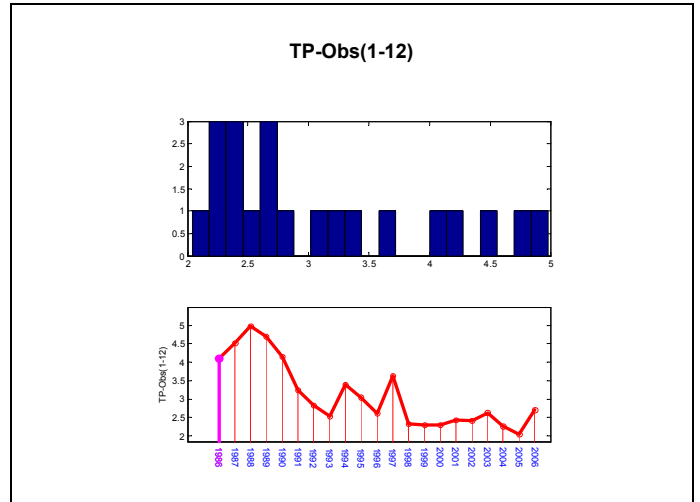
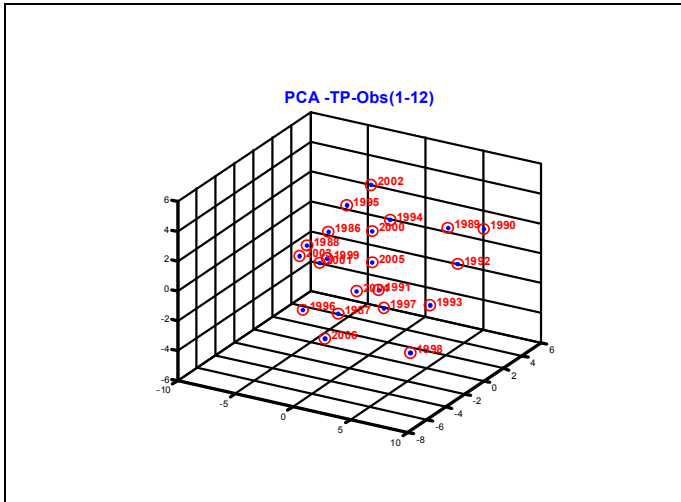


Mariager Fjord - TN-modellering

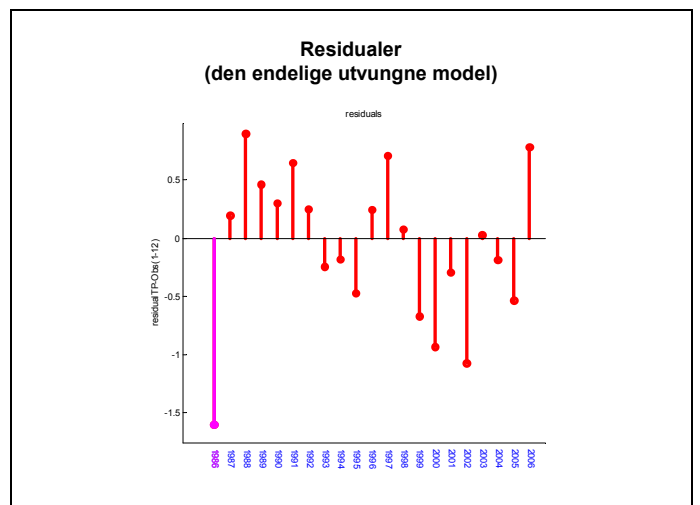
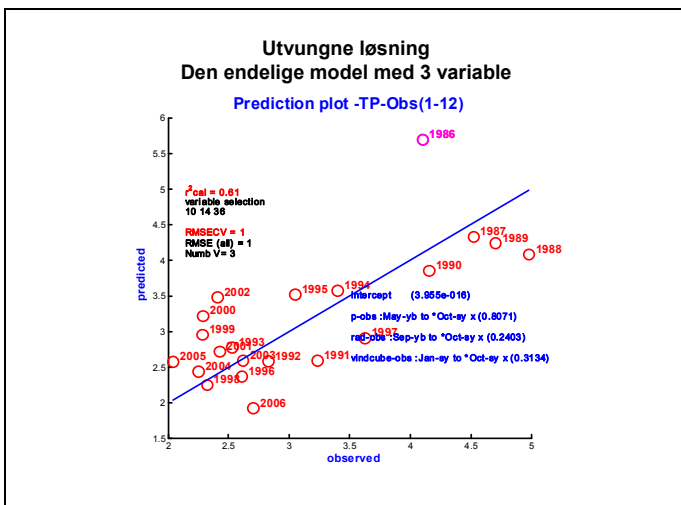
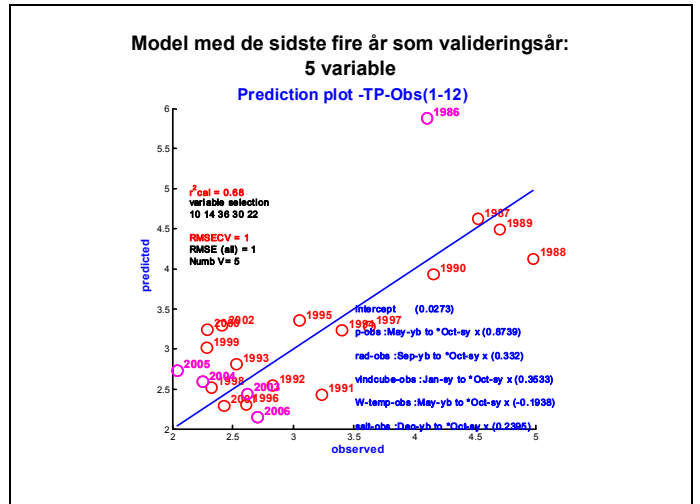
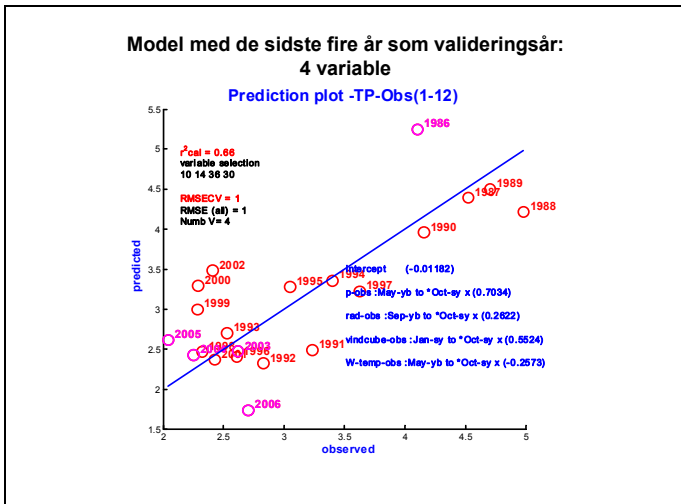
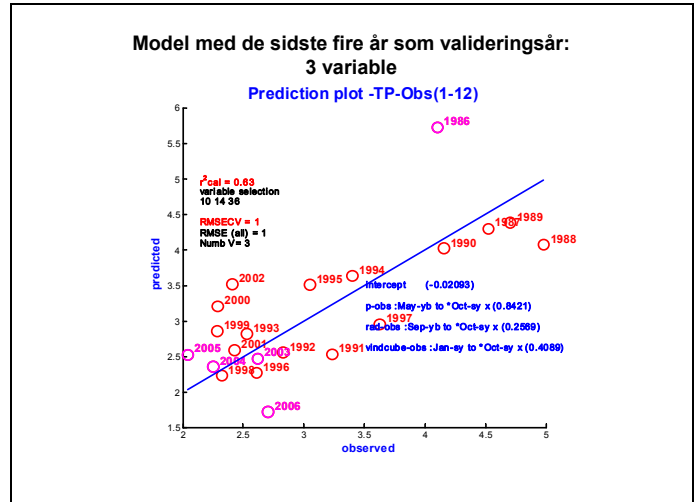
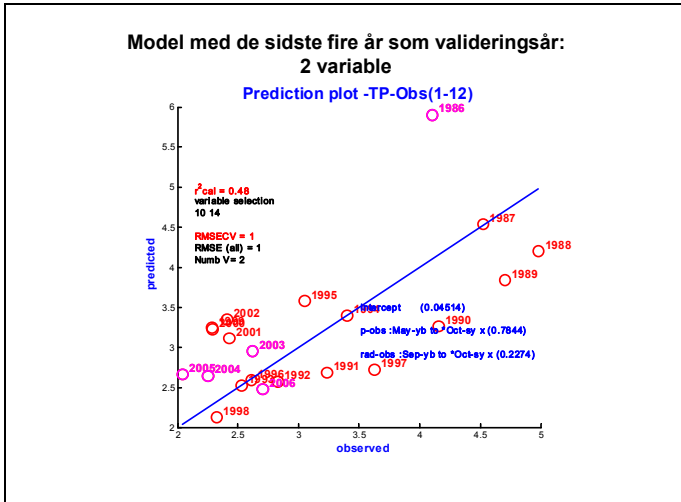


Outlier: 1986
En meget svag N-tvungen model

Mariager Fjord - TP-modellering



Mariager Fjord - TP-modellering



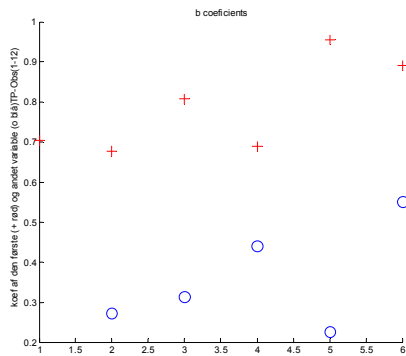
Mariager Fjord - TP-modellering

Outlier: 1986

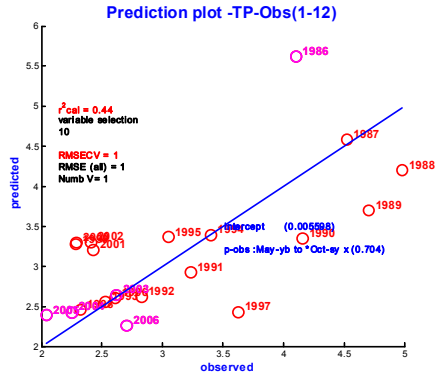
Den objektive, utvungne løsning giver P-tilførsel som vigtigste variabel

Mariager Fjord - TP-modellering

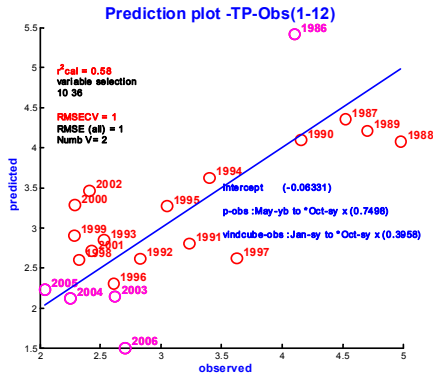
b-koefficienter for variablene: 10 36 14 30 22 5
P-tvungen løsning



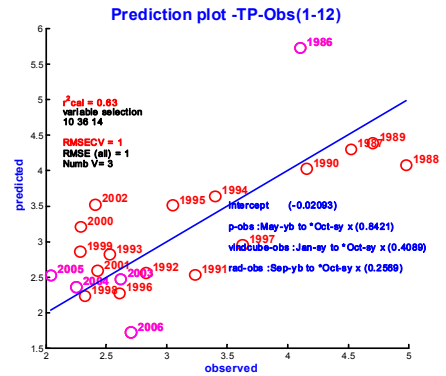
Model med de sidste fire år som valideringsår:
1 variabel



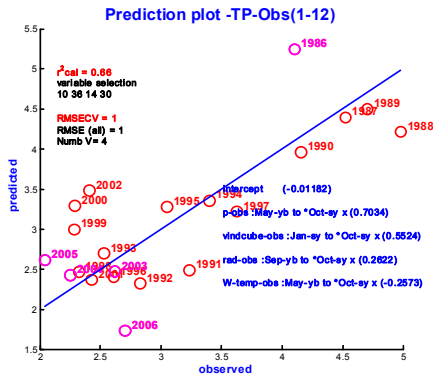
Model med de sidste fire år som valideringsår:
2 variable



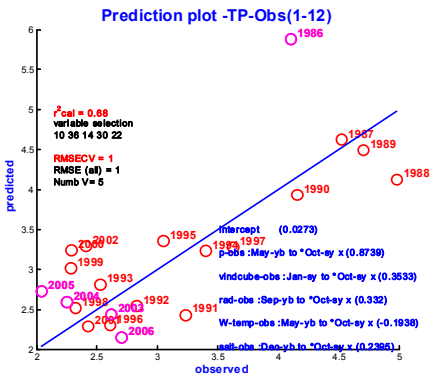
Model med de sidste fire år som valideringsår:
3 variable



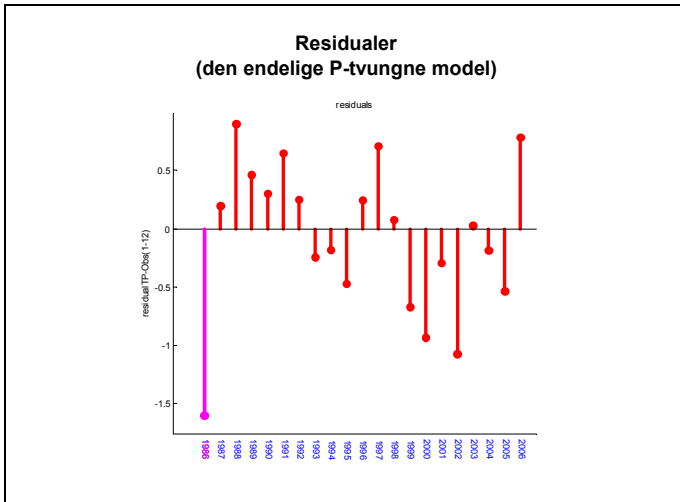
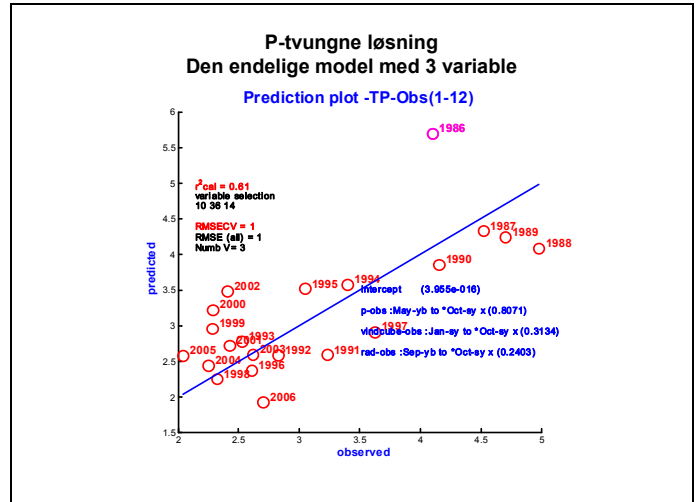
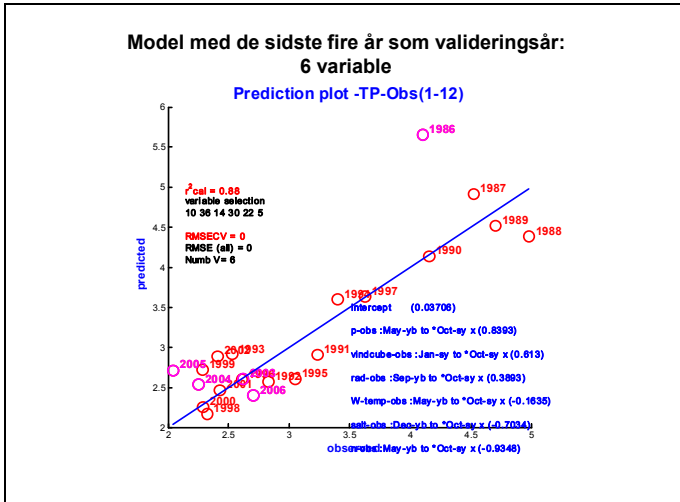
Model med de sidste fire år som valideringsår:
4 variable



Model med de sidste fire år som valideringsår:
5 variable



Mariager Fjord - TP-modellering



Outlier: 1986
Den P-tvungne løsning er ækvivalent med den utvungne løsning