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MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO
AEMet Agencia Estatal de Meteorología

COST733
WG4

Links between NAO phases and CTs classifications

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Outline

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Goal

- To establish a ranking of atmospheric circulation classifications according to their discrimination power of the North Atlantic Oscillation (NAO) phases.
- In the frame of WG4 ‘Testing methods for various applications’.

Introduction

- The main interest of the study: the joint use of two general circulation approaches, modes of variability and circulation classification methods, which usually are studied in a separate way
- Their relationship will allow us to establish a ranking using a large set of circulation classifications
- The results might help to elucidate the relative merits of the most complete set of Circulation Type (CT) classifications based on the COST733 software developed by (Philipp et al. 2010)

CTs vs modes of variability

- It is important to make a distinction between the concepts of CTs and modes of variability.
- Modes of variability are usually defined by means of Principal Component Analysis (PCA) and have been characterized in terms of both space-stationary and time fluctuating structures (Wallace and Gutzler 1981; Barnston and Livezey 1987; Monahan et al. 2000).
- A circulation field can then be approximated by a linear combination of several modes of variability, which can be seen as main building blocks, of which the atmospheric circulation is composed (Huth et al. 2008).

Circulation type approach

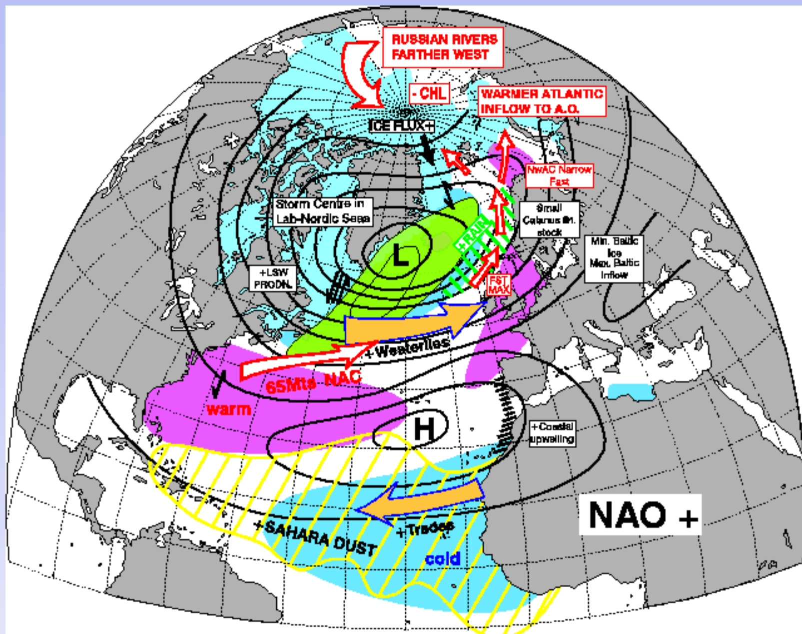
- In circulation type approach, however, we have a time series when each day is assigned to a given CT, being the spatial pattern of a CT, the average field of the days belonging to this CT.

Why NAO?

- The NAO is a large-scale circulation pattern, statistically and physically robust, that characterizes northern hemisphere climate variability (Branstator 2002; Hurrell et al., 2001,…)

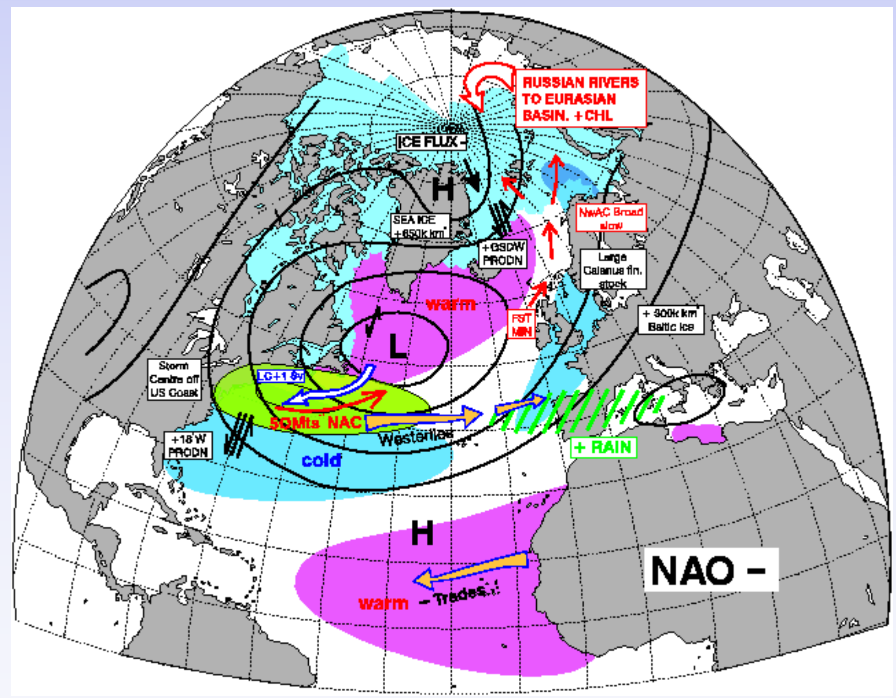
- The NAO is a measure of the strength of the Icelandic Low and the Azores High and it accounts for much of the precipitation variability over the Euro-Atlantic area.

North Atlantic Oscillation



NAO phases

(D. Stephenson)



Data

- A subset of classifications of COST733 catalogue version 2.0 corresponding to ~9 classes.
- Daily NAO index has been obtained from the Climate Prediction Center (CPC) derived using the Rotated Empirical Orthogonal Functions technique (Barnston and Livezey, 1987).
- Extended winter (December, January, February and March) for the period 1957-2002
- The spatial domain: D00

COST733 cat v2.0

THR	GWT
	JCT
	LIT
	WLK
PCA	PCT
	KRZ
	PXE
	PTT
LDR	LND
	ERP
	KIR
OPT	CKM
	CAP
	SAN
	PXK

COST733 cat v2.0

Method

Number of classes

Temporal scale

CKM09_YR_S01_SP-Z5-YS-K5_D00.txt

Sequence length

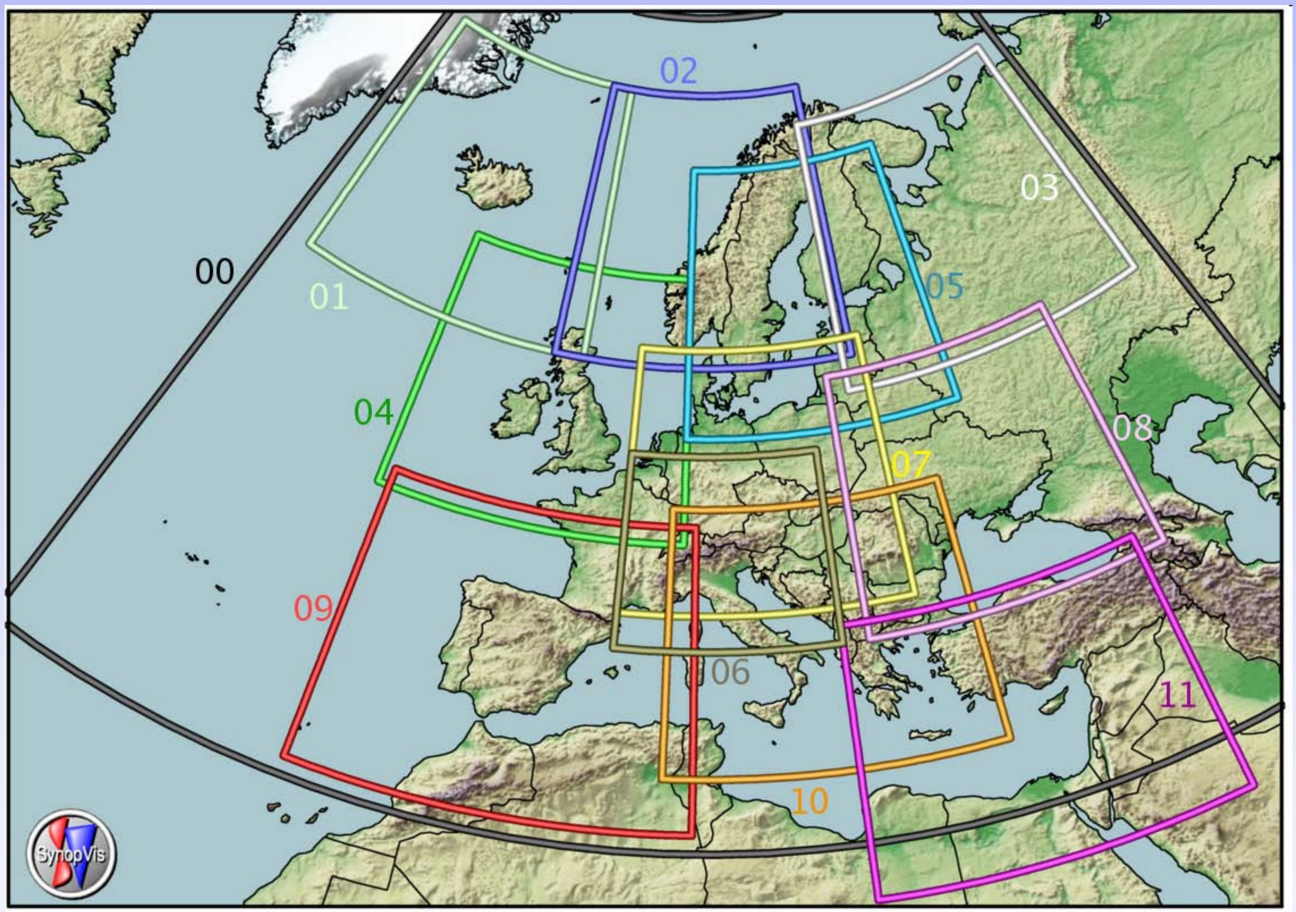
Parameters used

Domain

Nomenclature

- YR : Full year
- SE : Seasonal (i.e. 7 types for Winter (DJF), Spring (MAM), Summer (JJA), Autumn (SON) respectively
- S01 : Single day classifications
- S04 : 4-day classifications
- SP Mean Sea Level pressure
- Z1 1000 hPa geopotential height
- Z9 925 hPa geopotential height
- Z8 850 hPa geopotential height
- Z5 500 hPa geopotential height
- K5 Thickness between 500 hPa and 850 hPa geopotential height
- YS Vorticity of the MSLP field
- Y9 Vorticity of the 925 hPa GPH level
- Y5 Vorticity of the 500 hPa GPH level
- U7 zonal wind component at the 700 hPa GPH level
- V7 meridional wind component at the 700 hPa GPH level

Spatial domains



Methodology

- Standardization of the winter daily NAO index from the Climate Prediction Center (CPC) and selection of NAO+ and NAO- phases.

- For each circulation type (CT) and each classification, computation of the days which are in NAO+ and NAO- phases.

- Computation of the X^2 statistics.

X^2 statistics

The X^2 statistics:

$$\chi^2 = \sum_{i=1}^{I} \left(k_i - N p_i^{teor}\right)^2 / \left(N p_i^{teor}\right)$$

$p_i^{teor} = (n_i/N)*(K/N)$

k_i number of days of NAO+ (NAO-) for each CT and classification

n_i total number of days for each CT and classification

K total number of days NAO+ (NAO-)

N total number of days for the period Dec 1957 to Mar 2002 (5156 days)

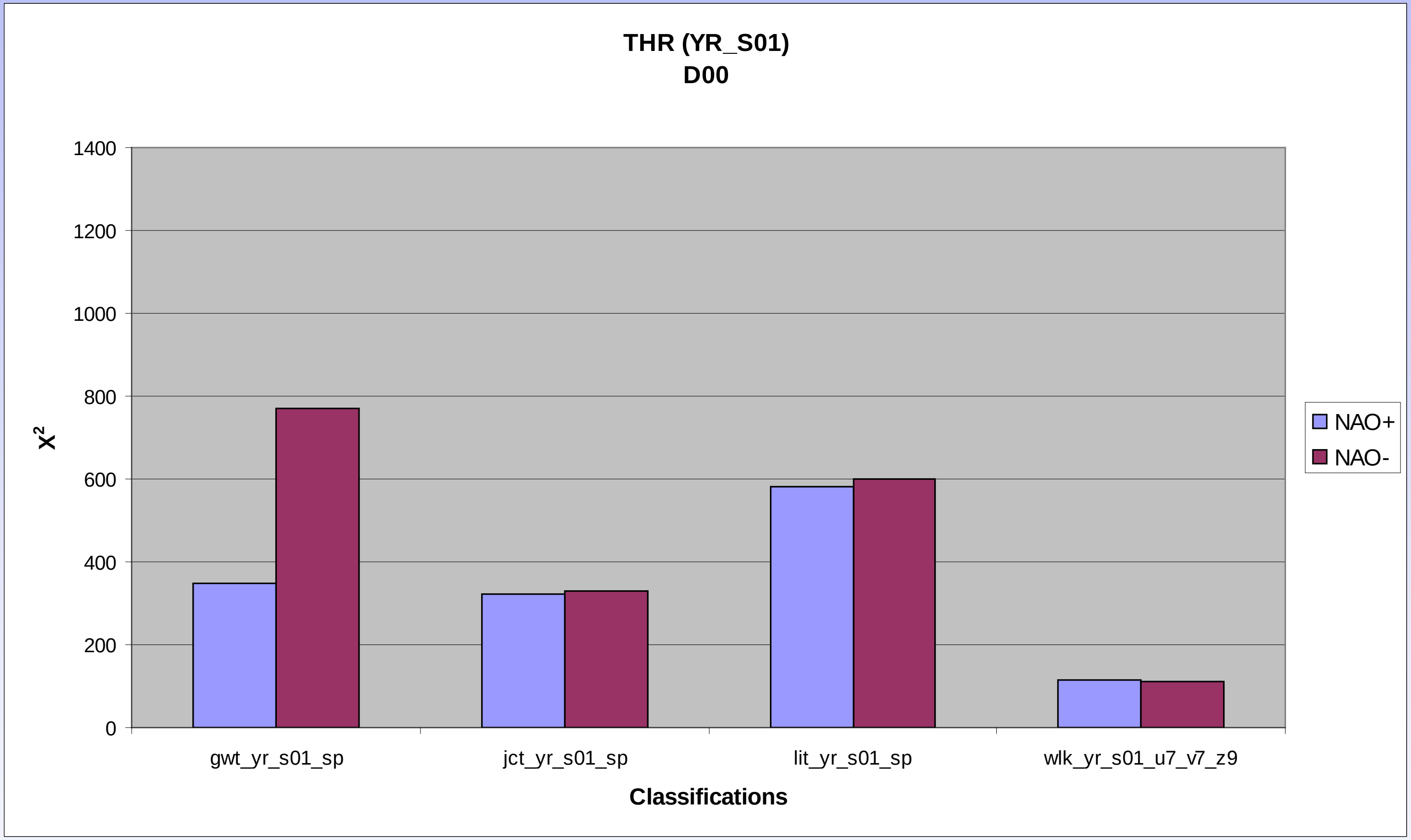
I number of CTs for each classification

Criteria: the higher values of X_2 the best discrimination

D00-C09

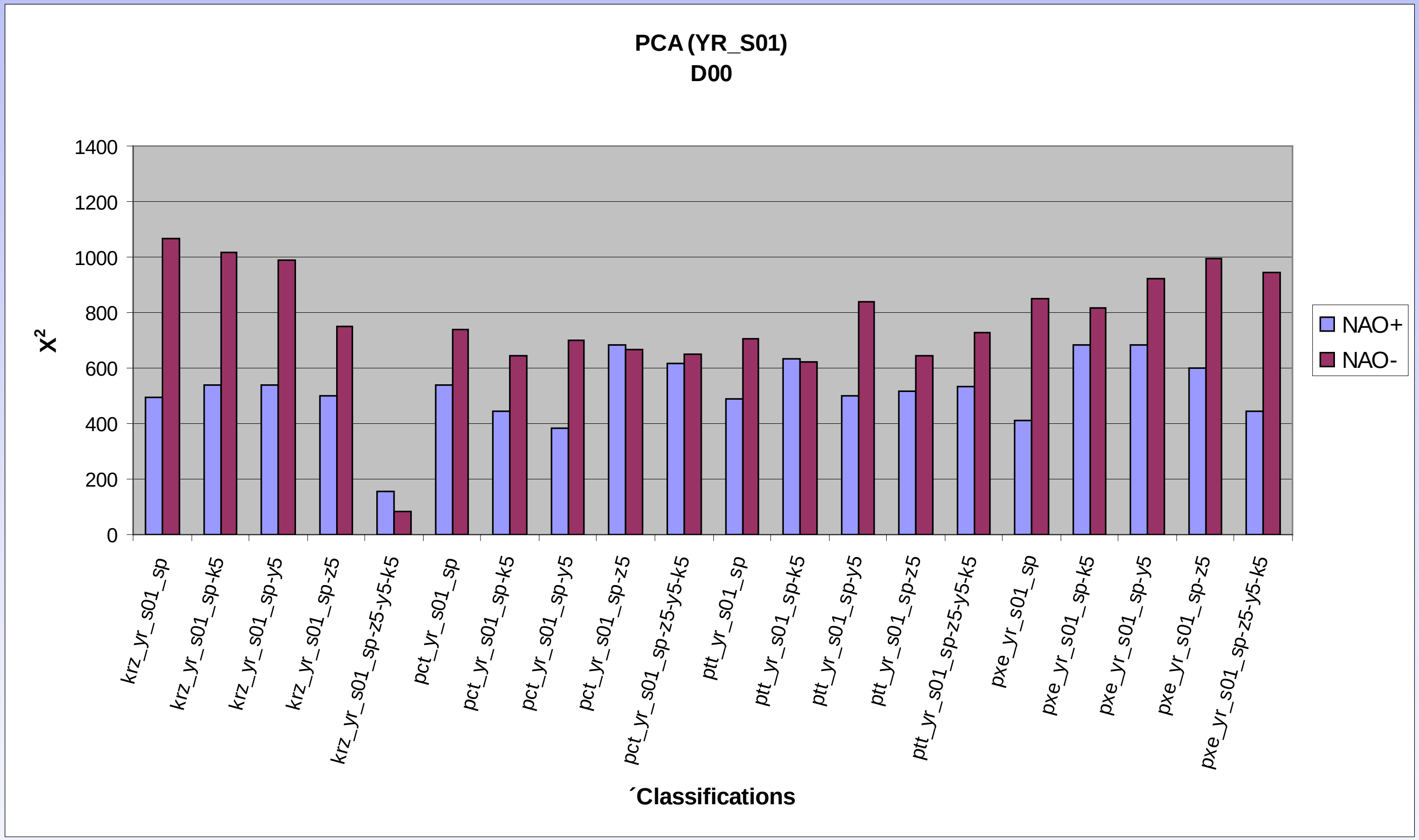
S01

YR_S01

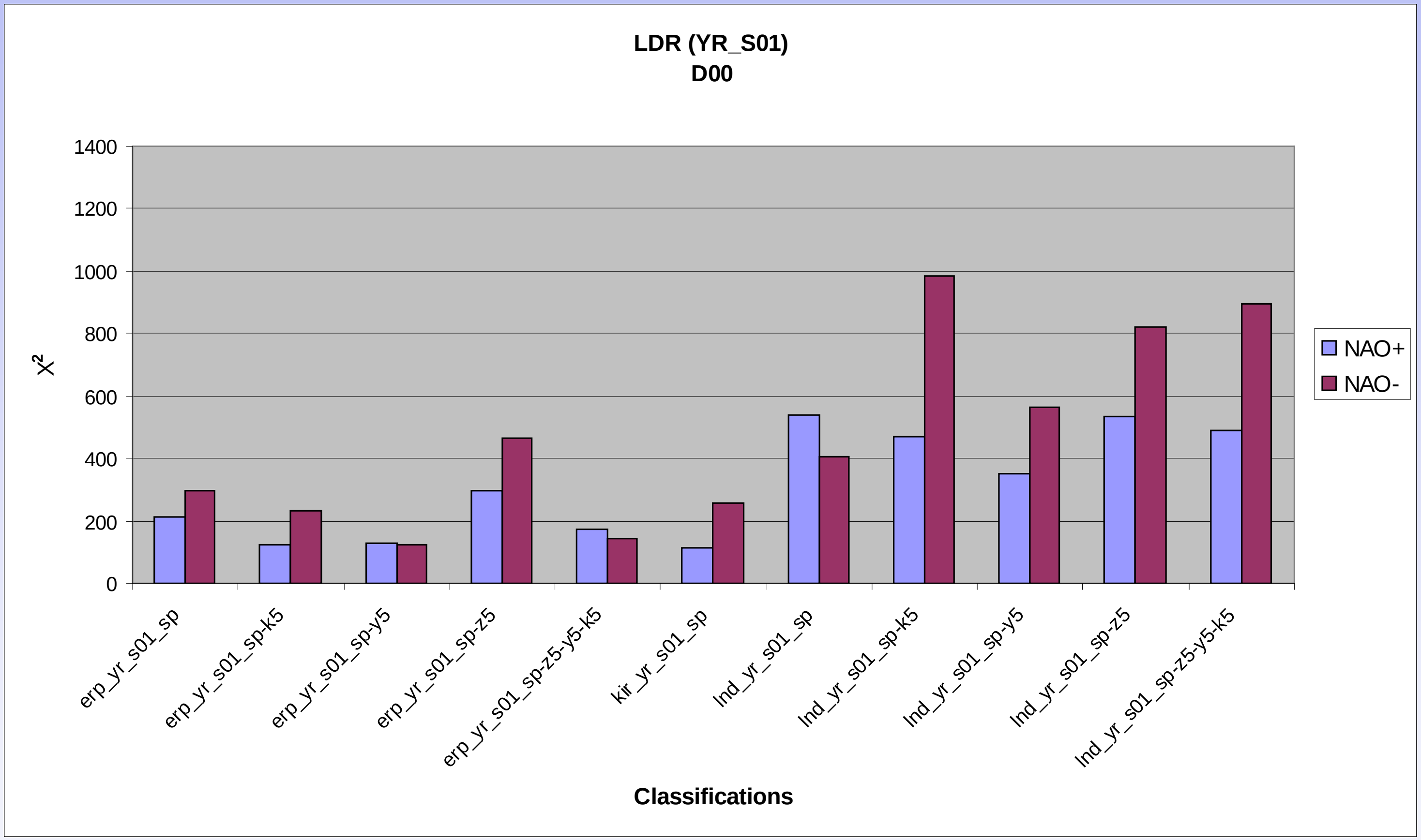


THR (YR_S01)
D00
1400
1200
1000
800
600
400
200
0
X2
NAO+
NAO-
gwt_yr_s01_sp
jct_yr_s01_sp
lit_yr_s01_sp
wlk_yr_s01_u7_v7_z9
Classifications

YR_S01

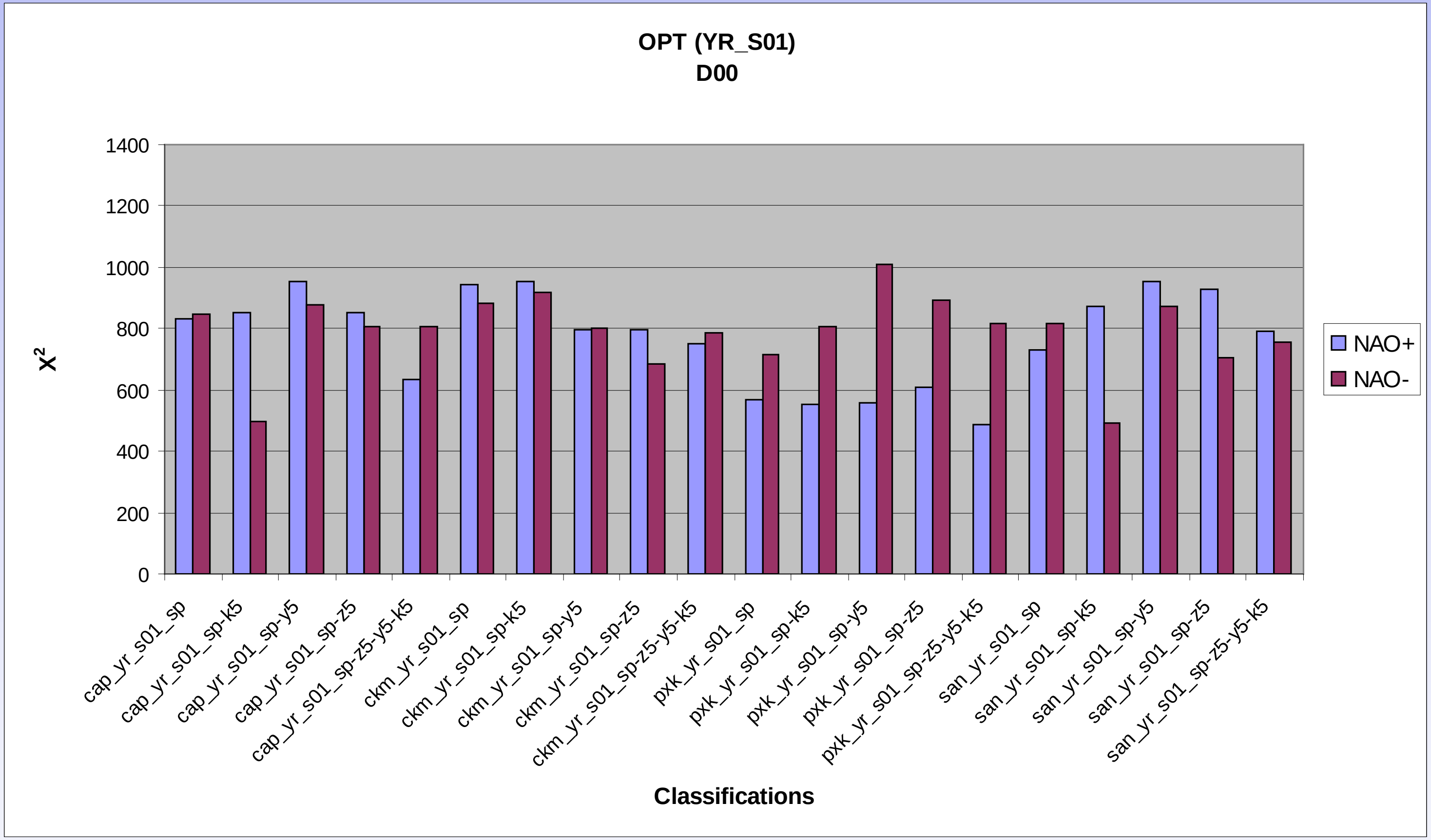

PCA (YR_S01)
D00
X²
1400
1200
1000
800
600
400
200
0
NAO+
NAO-
krz_yr_s01_sp
krz_yr_s01_sp-k5
krz_yr_s01_sp-y5
krz_yr_s01_sp-z5
krz_yr_s01_sp-z5-y5-k5
pct_yr_s01_sp
pct_yr_s01_sp-k5
pct_yr_s01_sp-y5
pct_yr_s01_sp-z5
pct_yr_s01_sp-z5-y5-k5
ptt_yr_s01_sp
ptt_yr_s01_sp-k5
ptt_yr_s01_sp-y5
ptt_yr_s01_sp-z5
ptt_yr_s01_sp-z5-y5-k5
pxe_yr_s01_sp
pxe_yr_s01_sp-k5
pxe_yr_s01_sp-y5
pxe_yr_s01_sp-z5
pxe_yr_s01_sp-z5-y5-k5
´Classifications

YR_S01



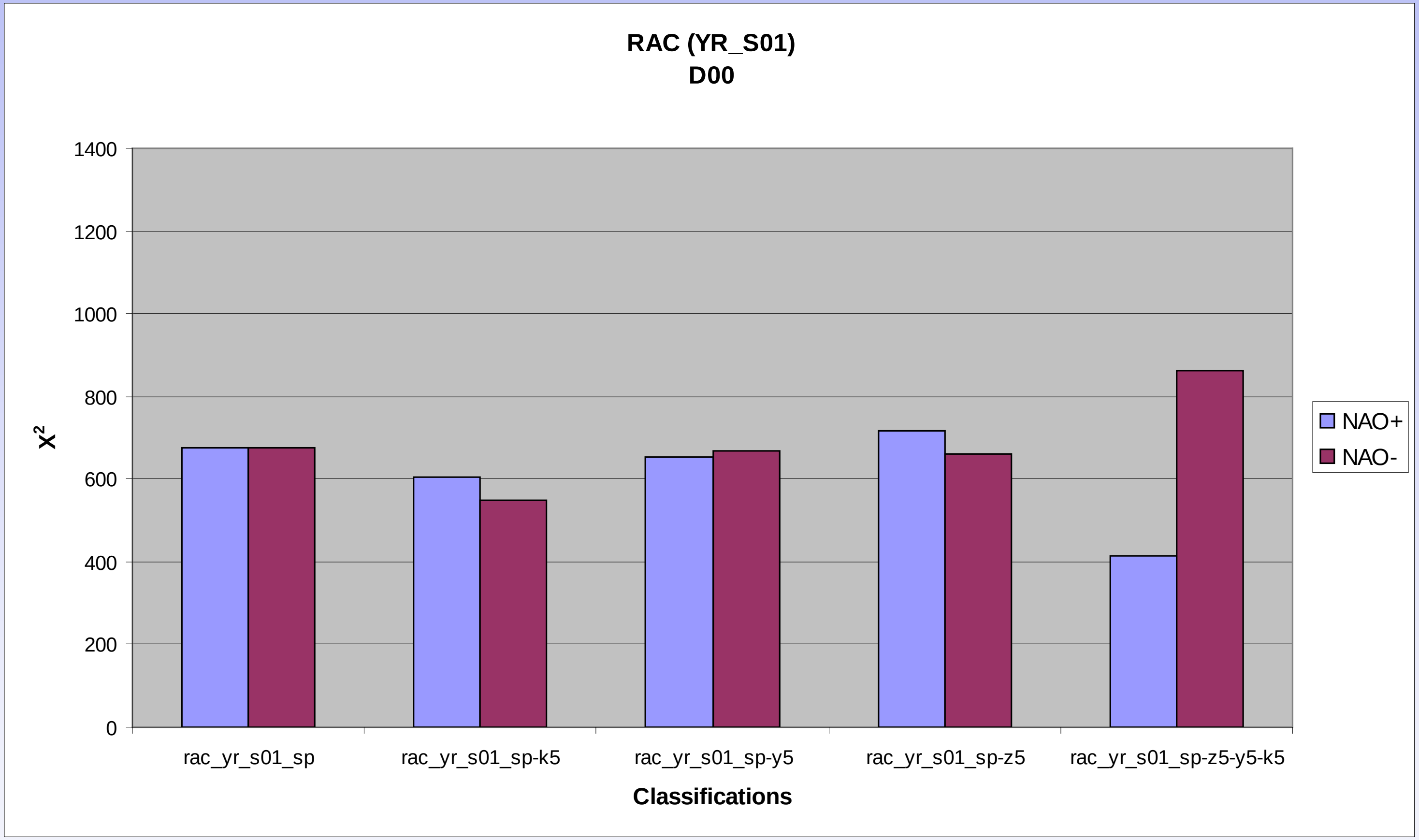
LDR (YR_S01)
D00
1400
1200
1000
800
600
400
200
0
X²
erp_yr_s01_sp
erp_yr_s01_sp-k5
erp_yr_s01_sp-y5
erp_yr_s01_sp-z5
erp_yr_s01_sp-z5-y5-k5
kir_yr_s01_sp
lnd_yr_s01_sp
lnd_yr_s01_sp-k5
lnd_yr_s01_sp-y5
lnd_yr_s01_sp-z5
lnd_yr_s01_sp-z5-y5-k5
Classifications
NAO+
NAO-

YR_S01



OPT (YR_S01)
D00
1400
1200
1000
800
600
400
200
0
X²
cap_yr_s01_sp
cap_yr_s01_sp-k5
cap_yr_s01_sp-y5
cap_yr_s01_sp-z5
cap_yr_s01_sp-z5-y5-k5
ckm_yr_s01_sp
ckm_yr_s01_sp-k5
ckm_yr_s01_sp-y5
ckm_yr_s01_sp-z5
ckm_yr_s01_sp-z5-y5-k5
pxk_yr_s01_sp
pxk_yr_s01_sp-k5
pxk_yr_s01_sp-y5
pxk_yr_s01_sp-z5
pxk_yr_s01_sp-z5-y5-k5
san_yr_s01_sp
san_yr_s01_sp-k5
san_yr_s01_sp-y5
san_yr_s01_sp-z5
san_yr_s01_sp-z5-y5-k5
Classifications
NAO+
NAO-

YR_S01

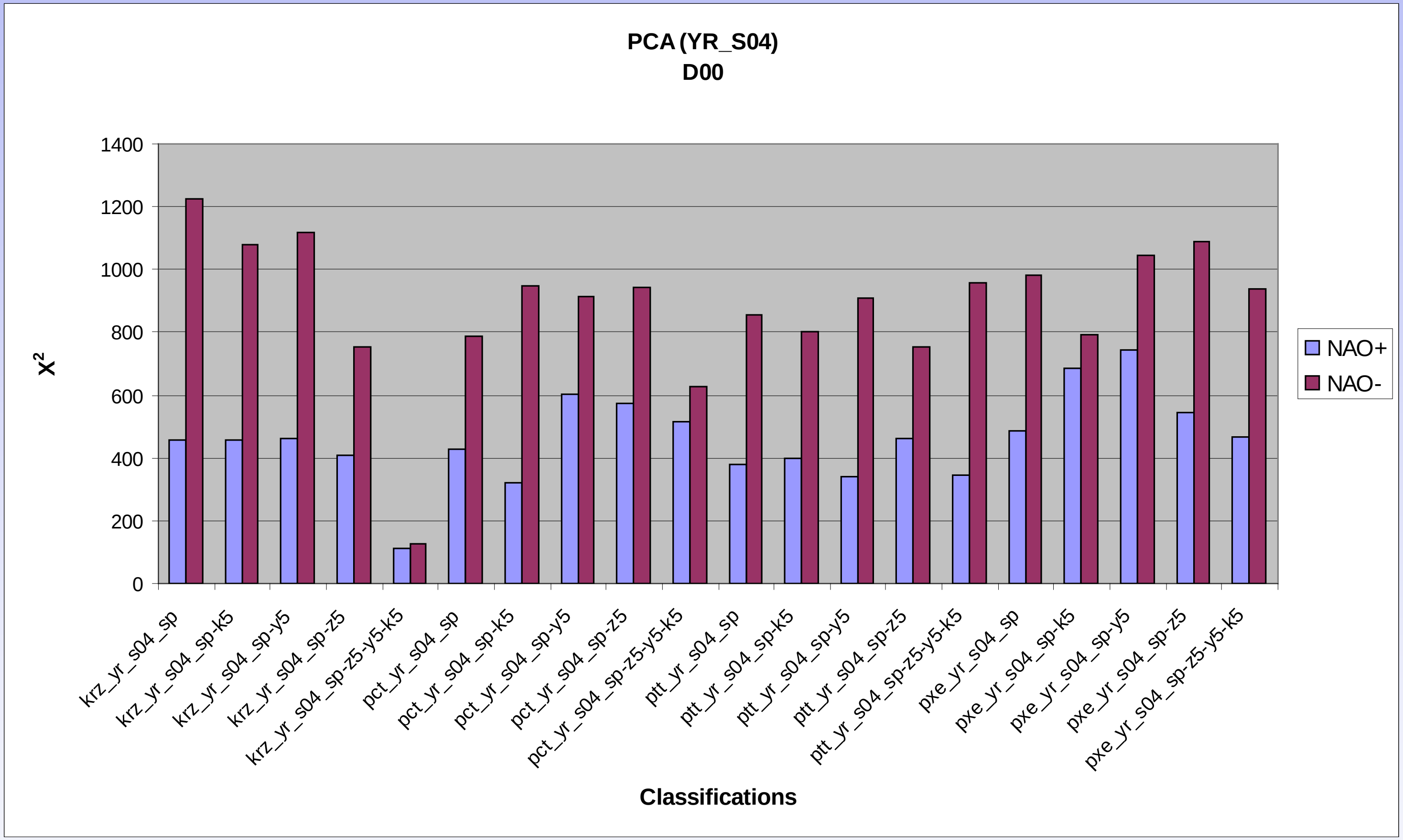


RAC (YR_S01)
D00
1400
1200
1000
800
600
400
200
0
X^2
NAO+
NAO-
rac_yr_s01_sp
rac_yr_s01_sp-k5
rac_yr_s01_sp-y5
rac_yr_s01_sp-z5
rac_yr_s01_sp-z5-y5-k5
Classifications

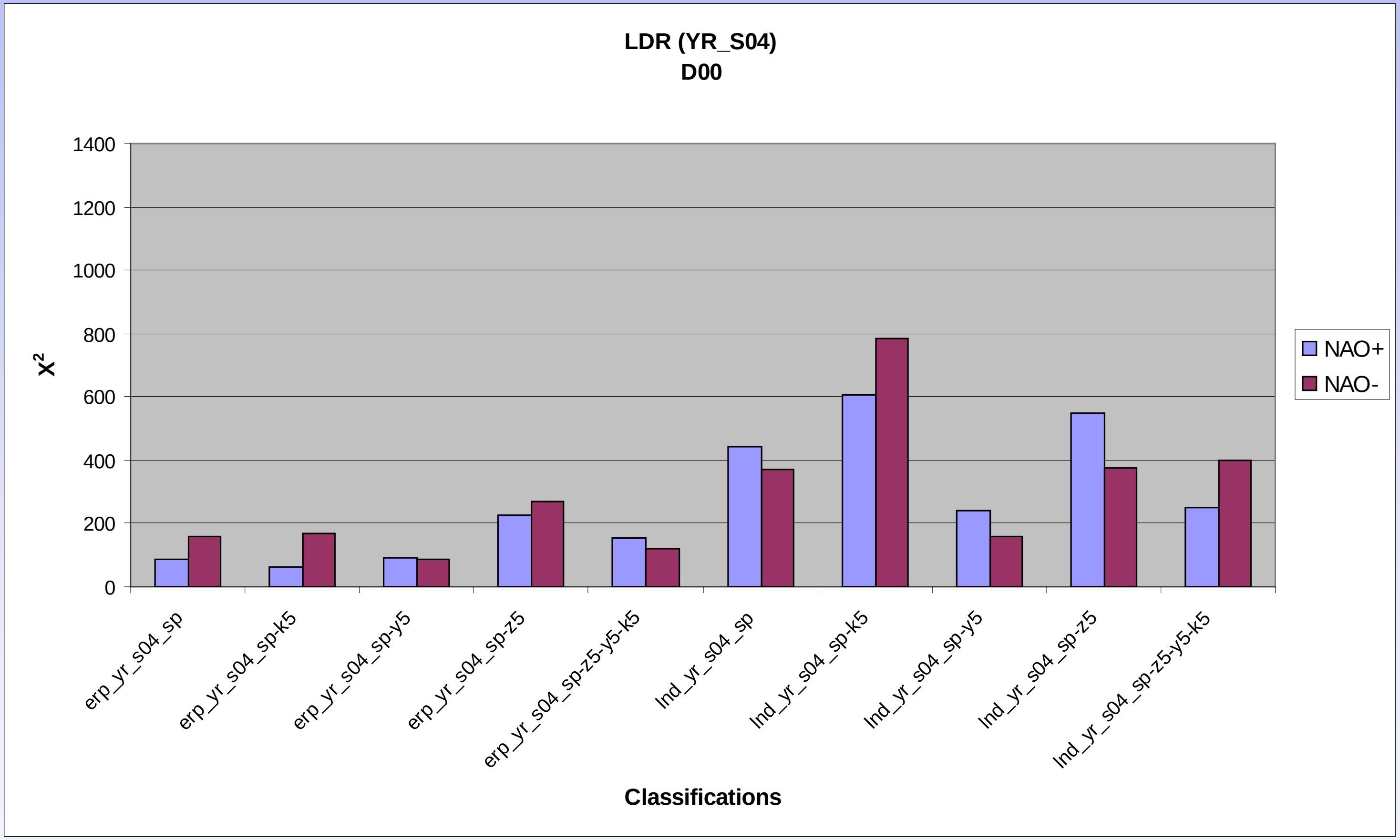
D00-C09

S04

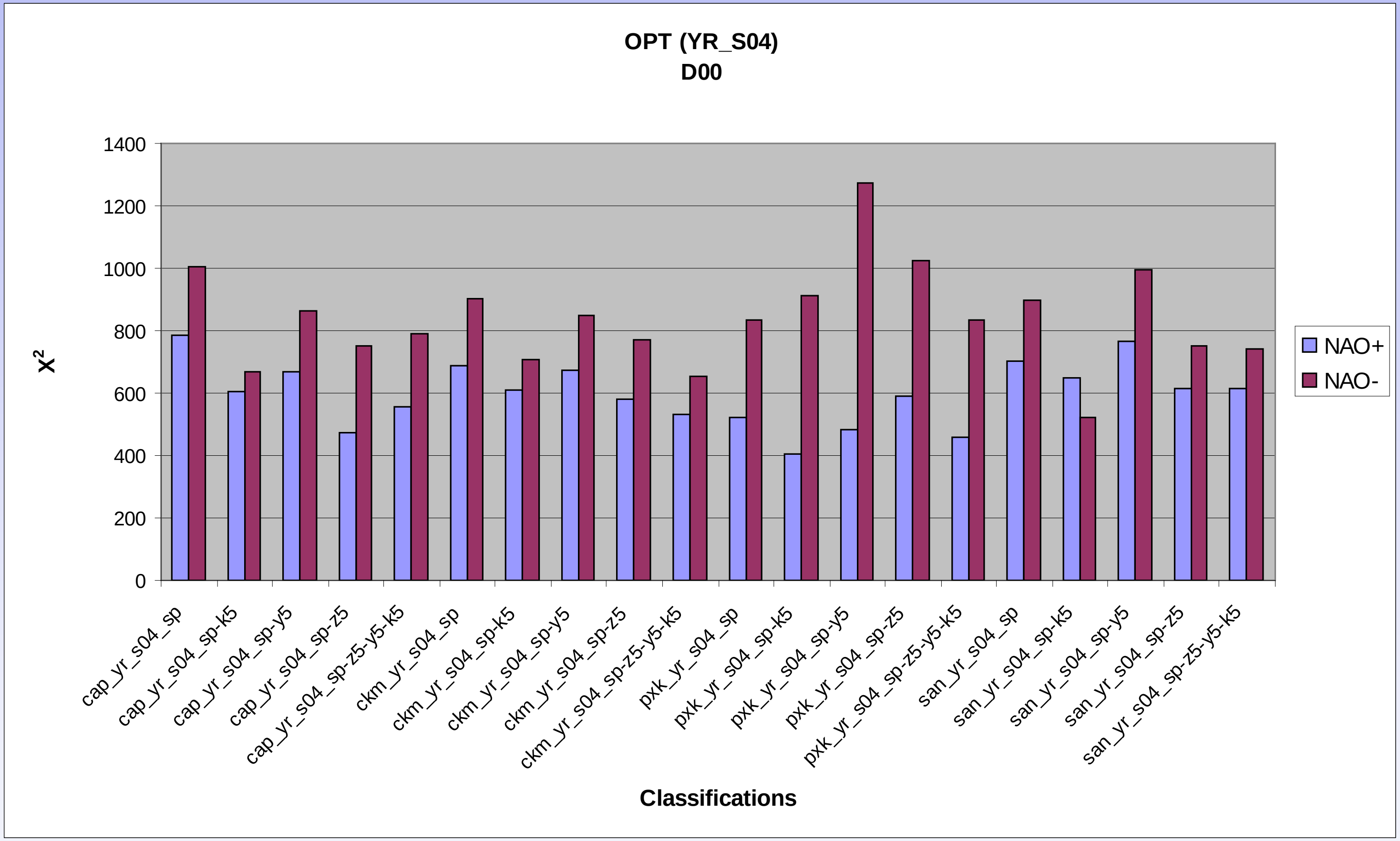
YR_S04


PCA (YR_S04)
D00
1400
1200
1000
800
600
400
200
0
X^2
NAO+
NAO-
krz_yr_s04_sp
krz_yr_s04_sp-k5
krz_yr_s04_sp-y5
krz_yr_s04_sp-z5
krz_yr_s04_sp-z5-y5-k5
pct_yr_s04_sp
pct_yr_s04_sp-k5
pct_yr_s04_sp-y5
pct_yr_s04_sp-z5
pct_yr_s04_sp-z5-y5-k5
ptt_yr_s04_sp
ptt_yr_s04_sp-k5
ptt_yr_s04_sp-y5
ptt_yr_s04_sp-z5
ptt_yr_s04_sp-z5-y5-k5
pxe_yr_s04_sp
pxe_yr_s04_sp-k5
pxe_yr_s04_sp-y5
pxe_yr_s04_sp-z5
pxe_yr_s04_sp-z5-y5-k5
Classifications

YR_S04

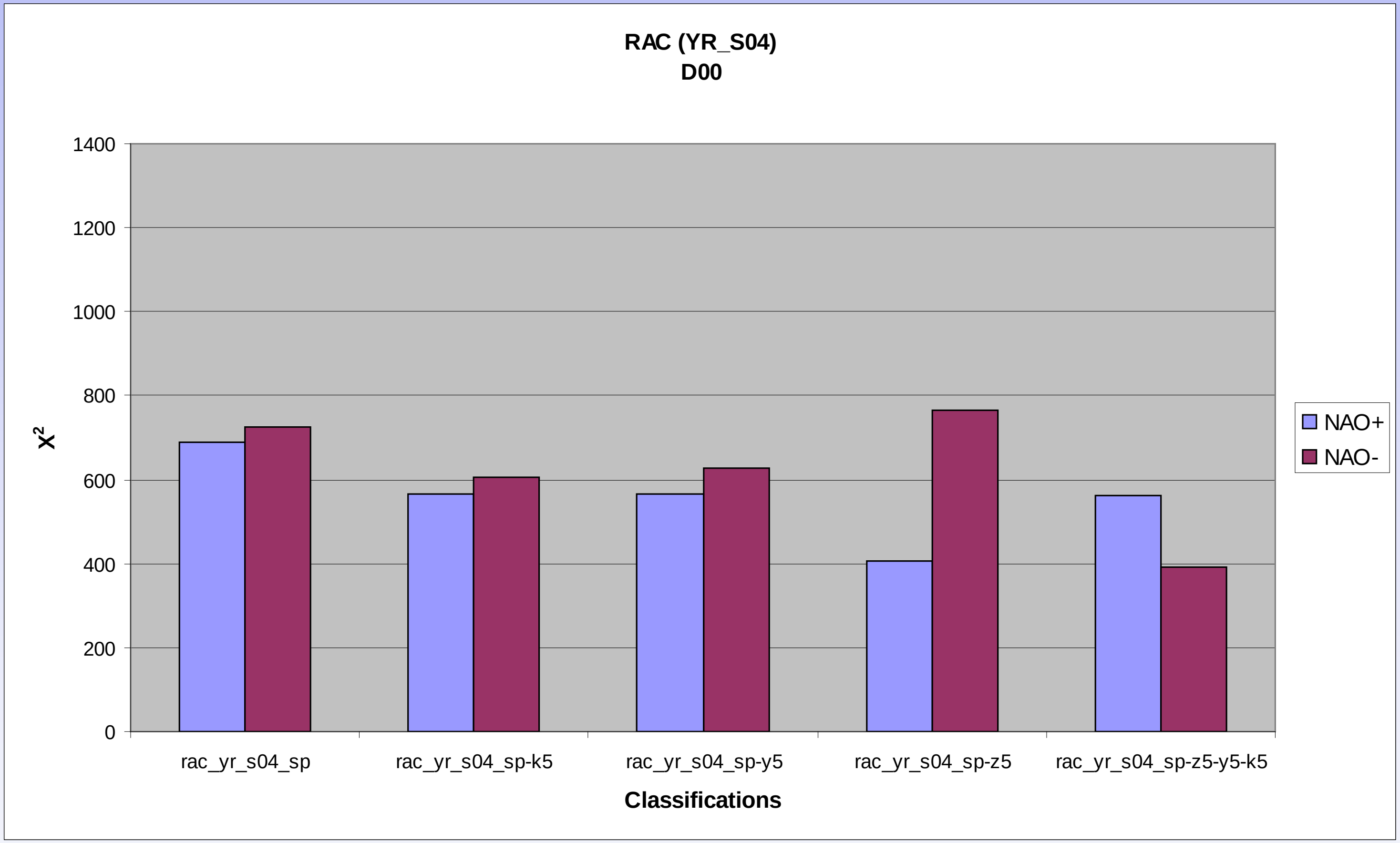

LDR (YR_S04)
D00
1400
1200
1000
800
600
400
200
0
X^2
NAO+
NAO-
erp_yr_s04_sp
erp_yr_s04_sp-k5
erp_yr_s04_sp-y5
erp_yr_s04_sp-z5
erp_yr_s04_sp-z5-y5-k5
lnd_yr_s04_sp
lnd_yr_s04_sp-k5
lnd_yr_s04_sp-y5
lnd_yr_s04_sp-z5
lnd_yr_s04_sp-z5-y5-k5
Classifications

YR_S04



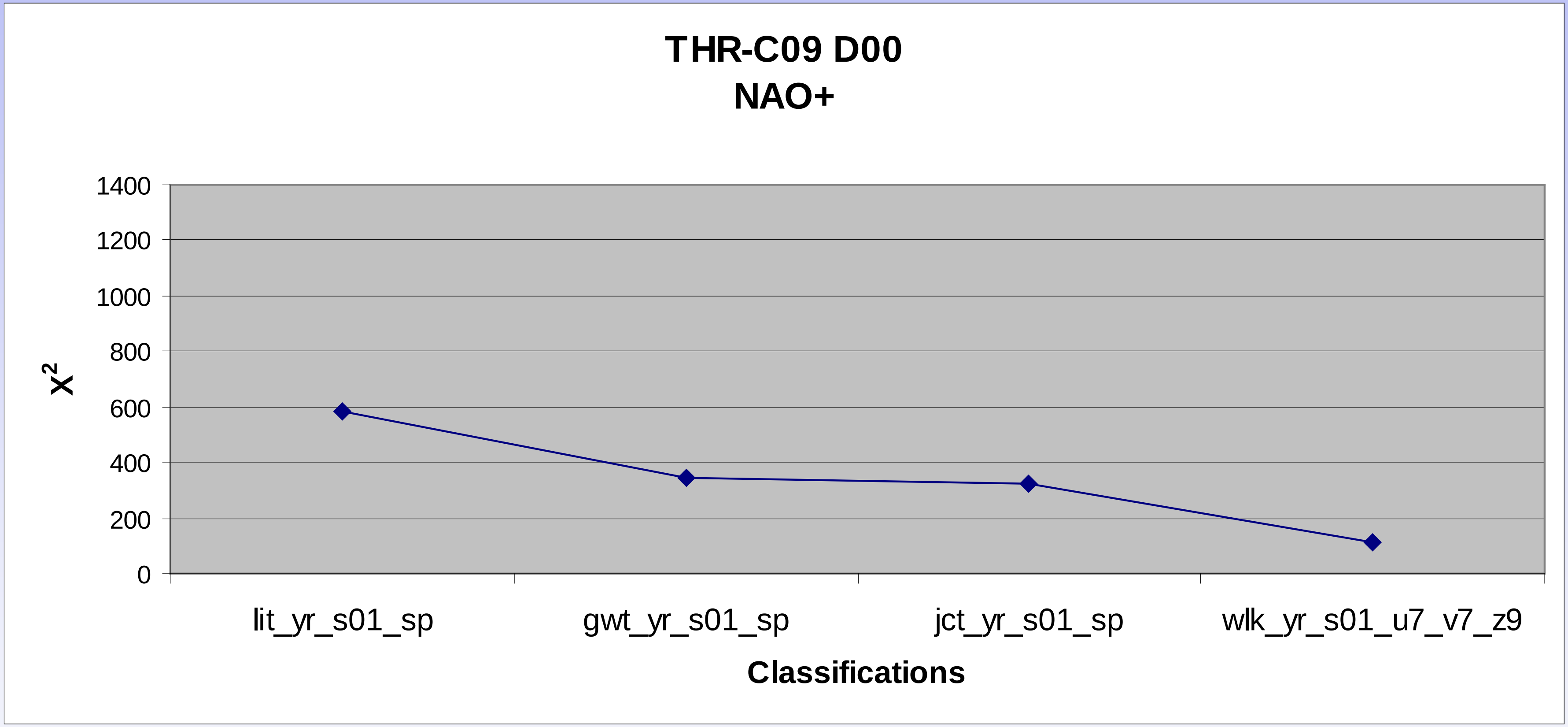
OPT (YR_S04)
D00
1400
1200
1000
800
600
400
200
0
χ^2
NAO+
NAO-
cap_yr_s04_sp
cap_yr_s04_sp-k5
cap_yr_s04_sp-y5
cap_yr_s04_sp-z5
cap_yr_s04_sp-z5-y5-k5
ckm_yr_s04_sp
ckm_yr_s04_sp-k5
ckm_yr_s04_sp-y5
ckm_yr_s04_sp-z5
ckm_yr_s04_sp-z5-y5-k5
pxk_yr_s04_sp
pxk_yr_s04_sp-k5
pxk_yr_s04_sp-y5
pxk_yr_s04_sp-z5
pxk_yr_s04_sp-z5-y5-k5
san_yr_s04_sp
san_yr_s04_sp-k5
san_yr_s04_sp-y5
san_yr_s04_sp-z5
san_yr_s04_sp-z5-y5-k5
Classifications

YR_S04

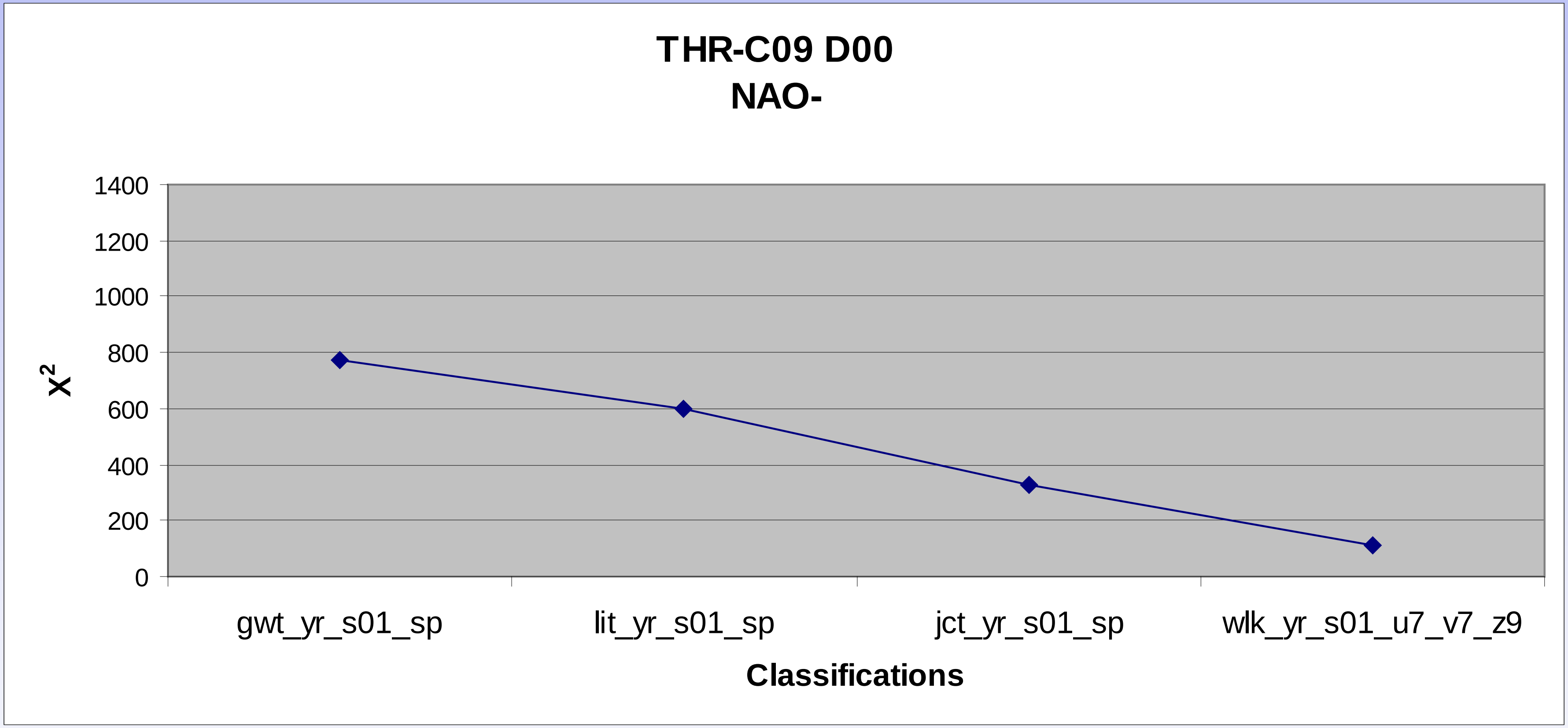


RAC (YR_S04)
D00
1400
1200
1000
800
600
400
200
0
χ²
rac_yr_s04_sp
rac_yr_s04_sp-k5
rac_yr_s04_sp-y5
rac_yr_s04_sp-z5
rac_yr_s04_sp-z5-y5-k5
Classifications
NAO+
NAO-

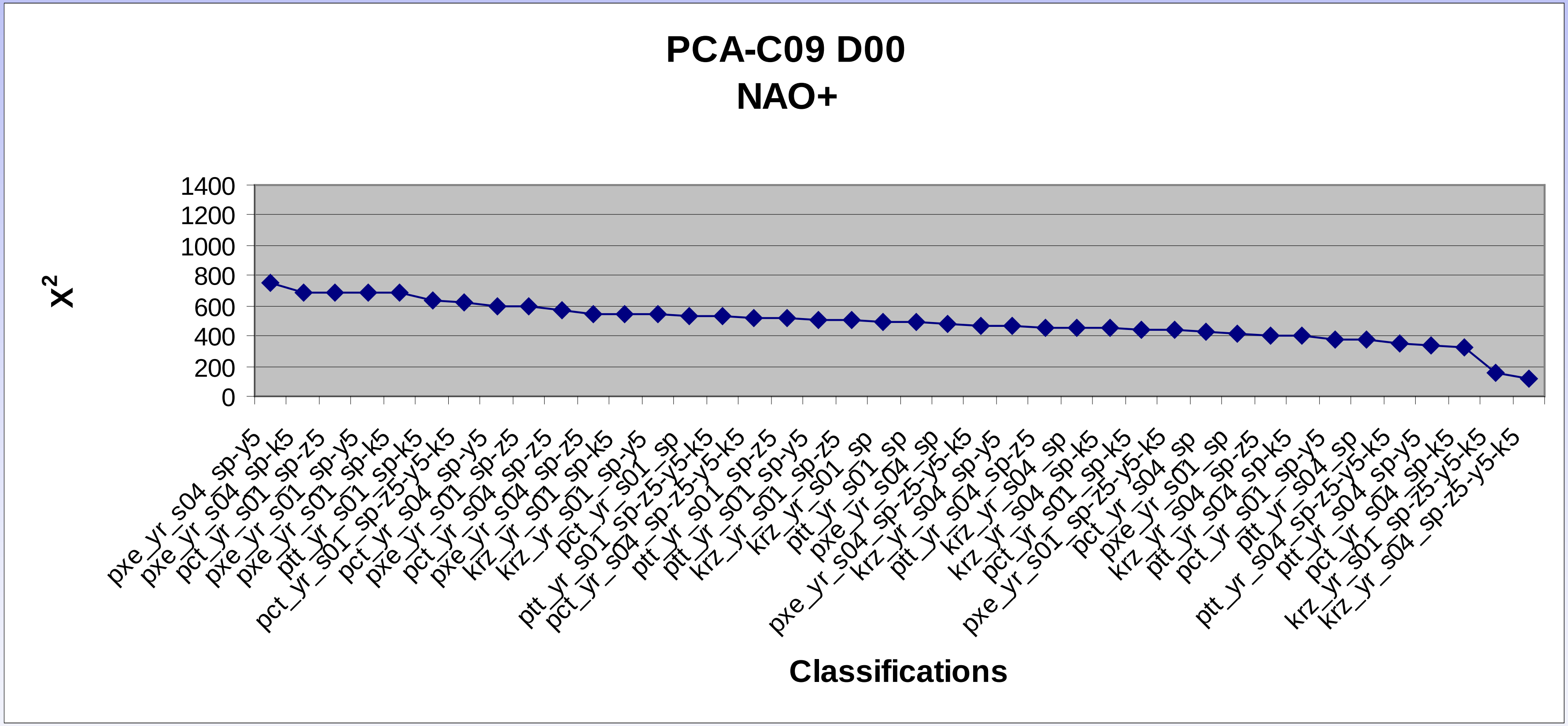
Ranking THR (NAO+)



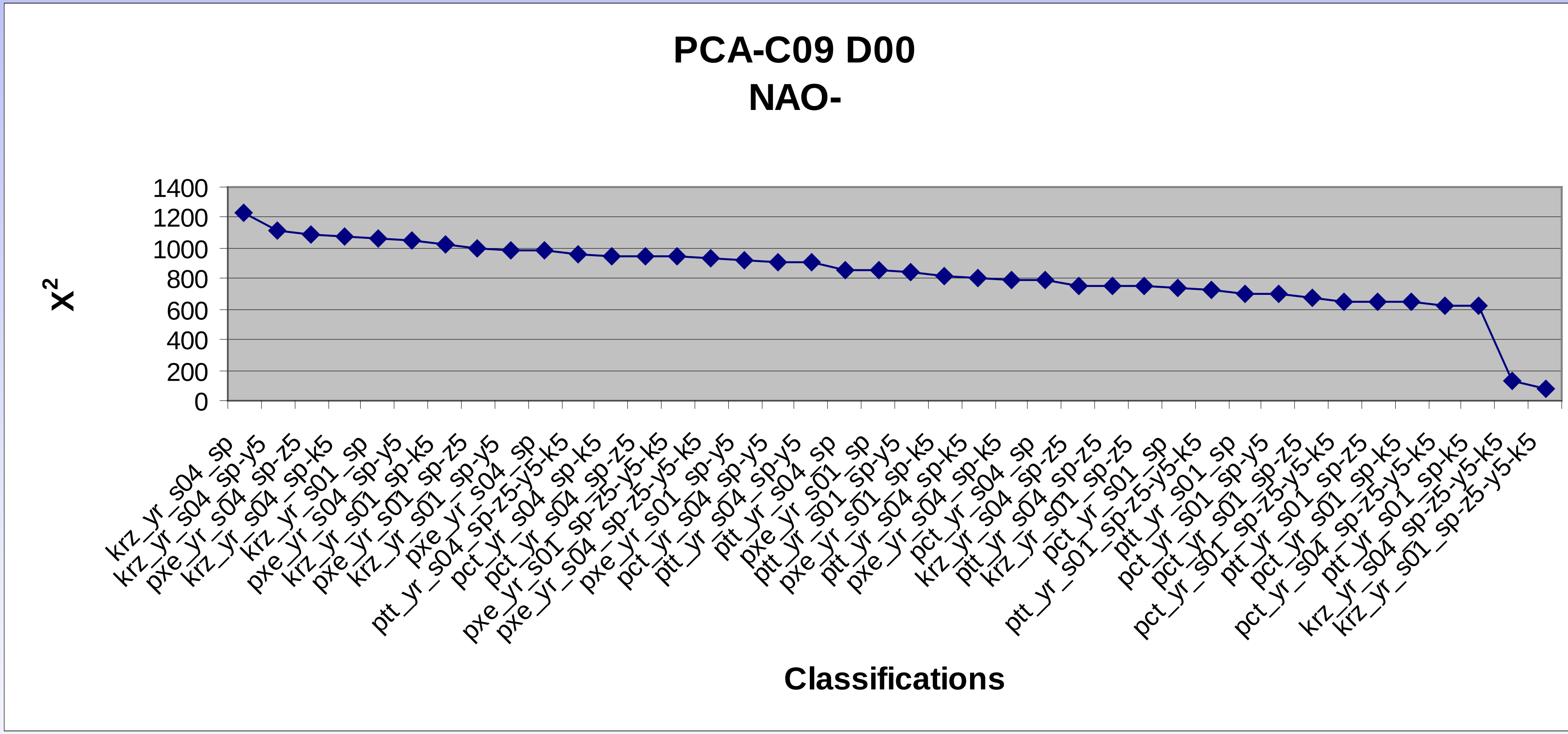
Ranking THR (NAO-)



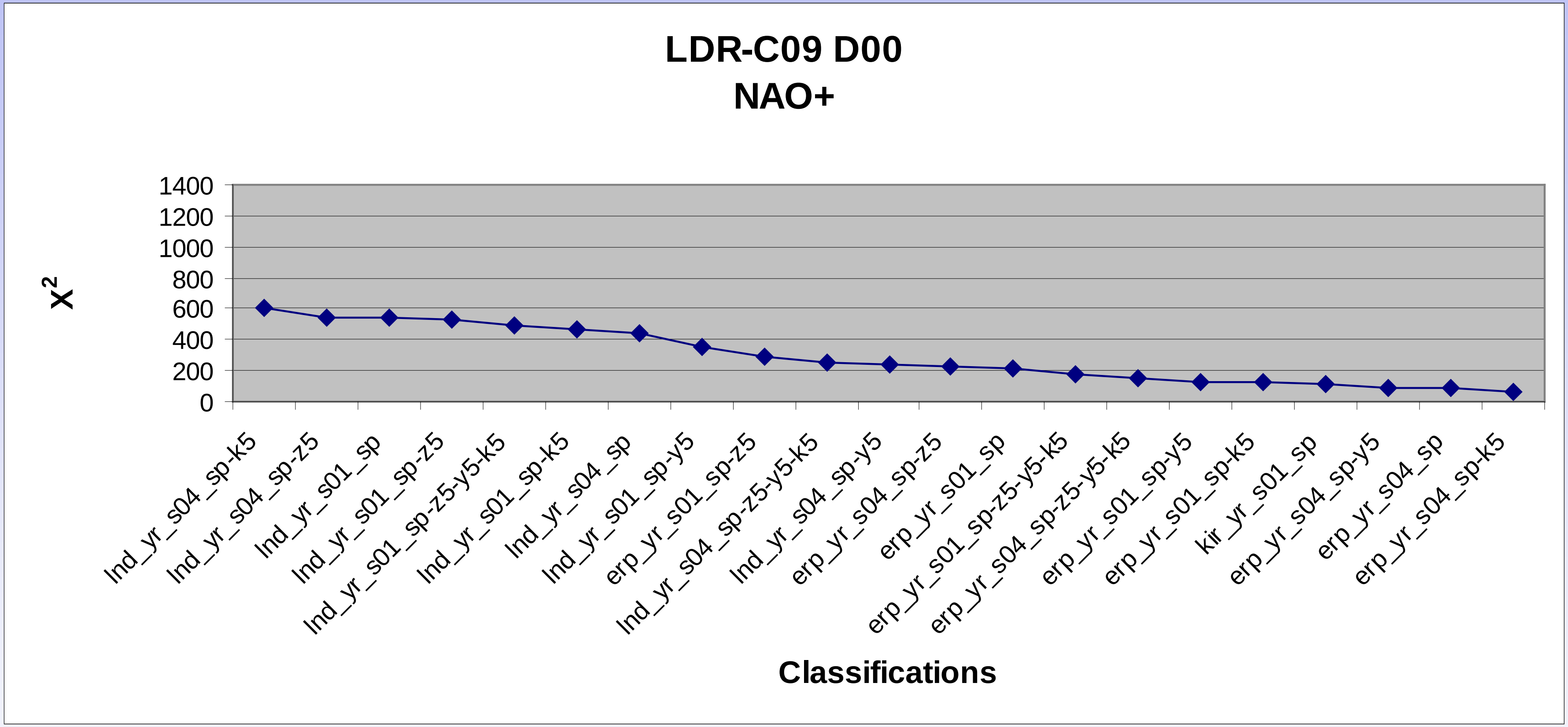
Ranking PCA (NAO+)



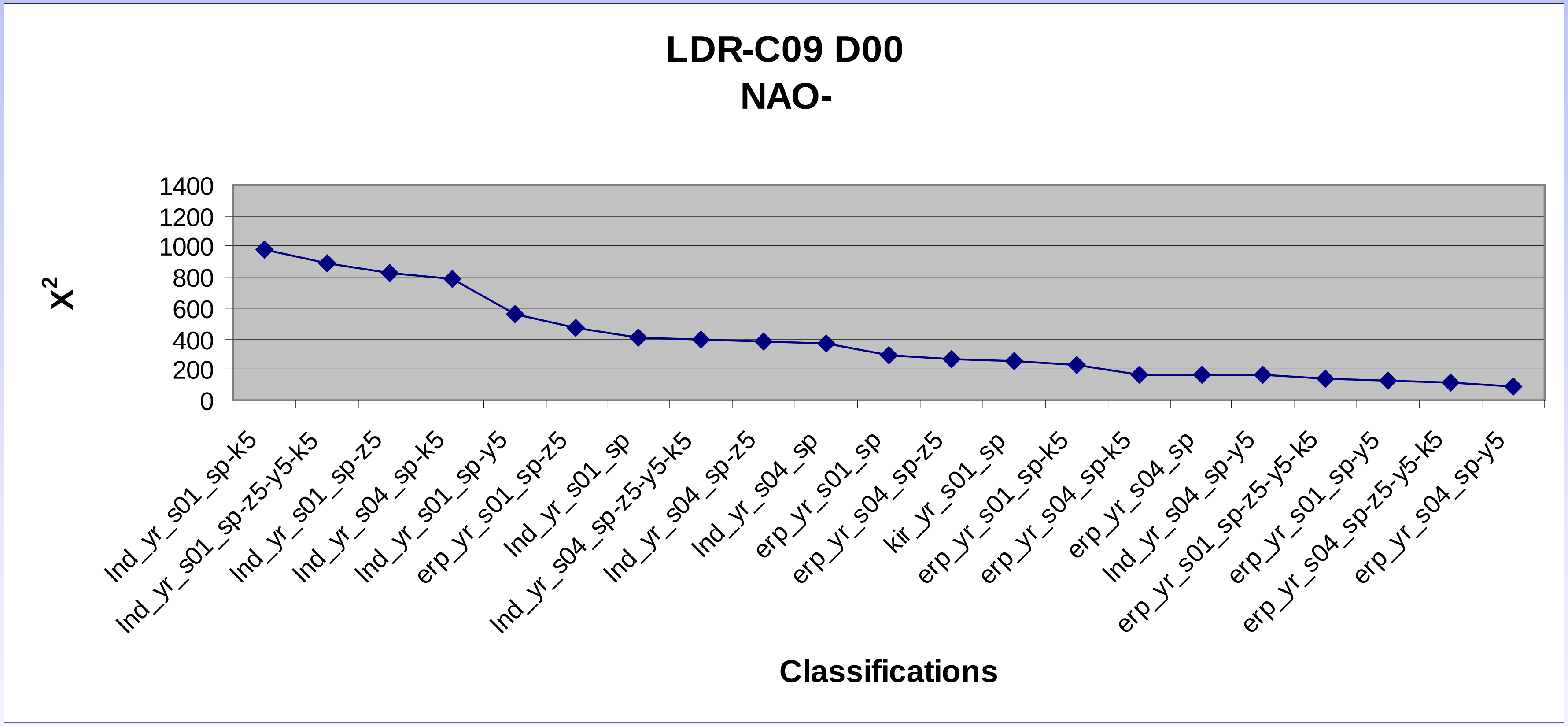
Ranking PCA (NAO-)



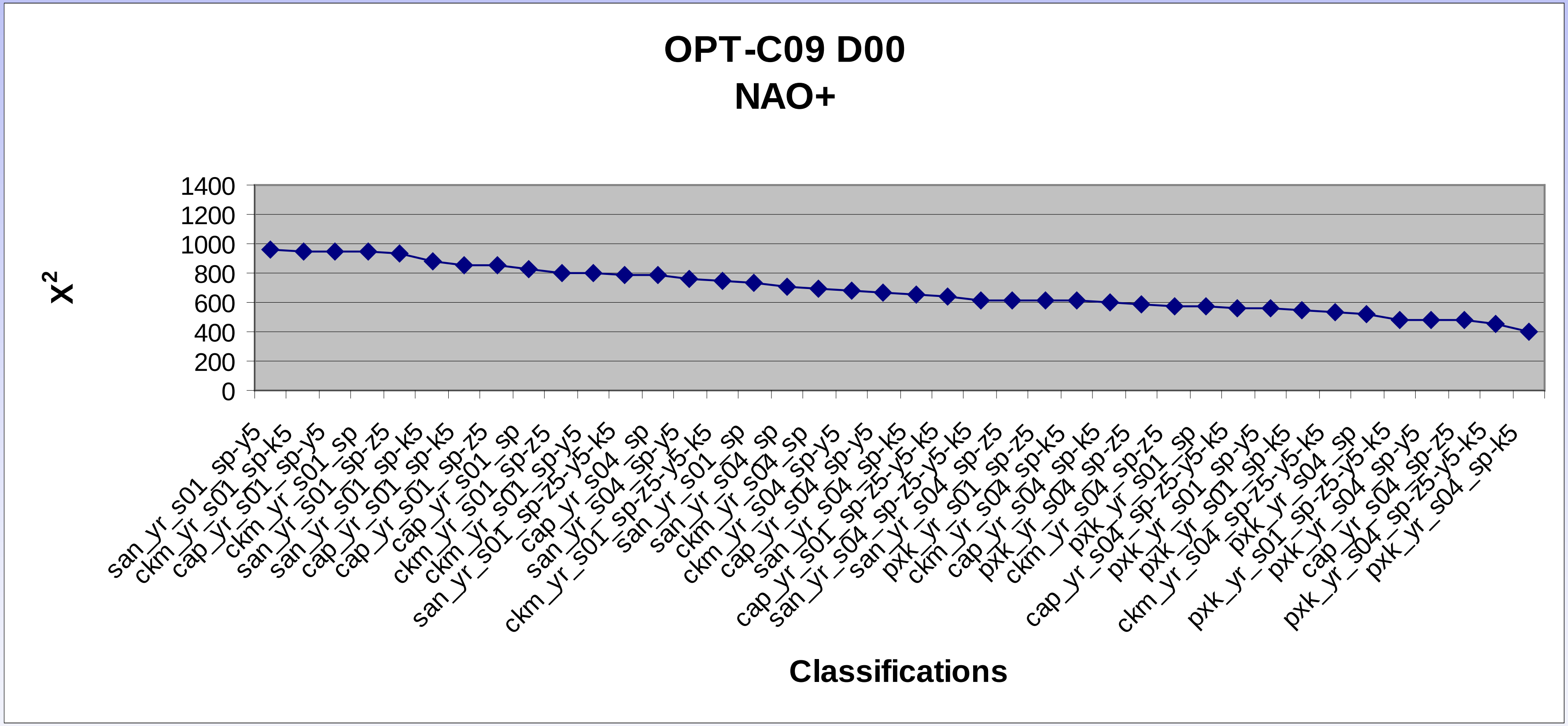
Ranking LDR (NAO+)



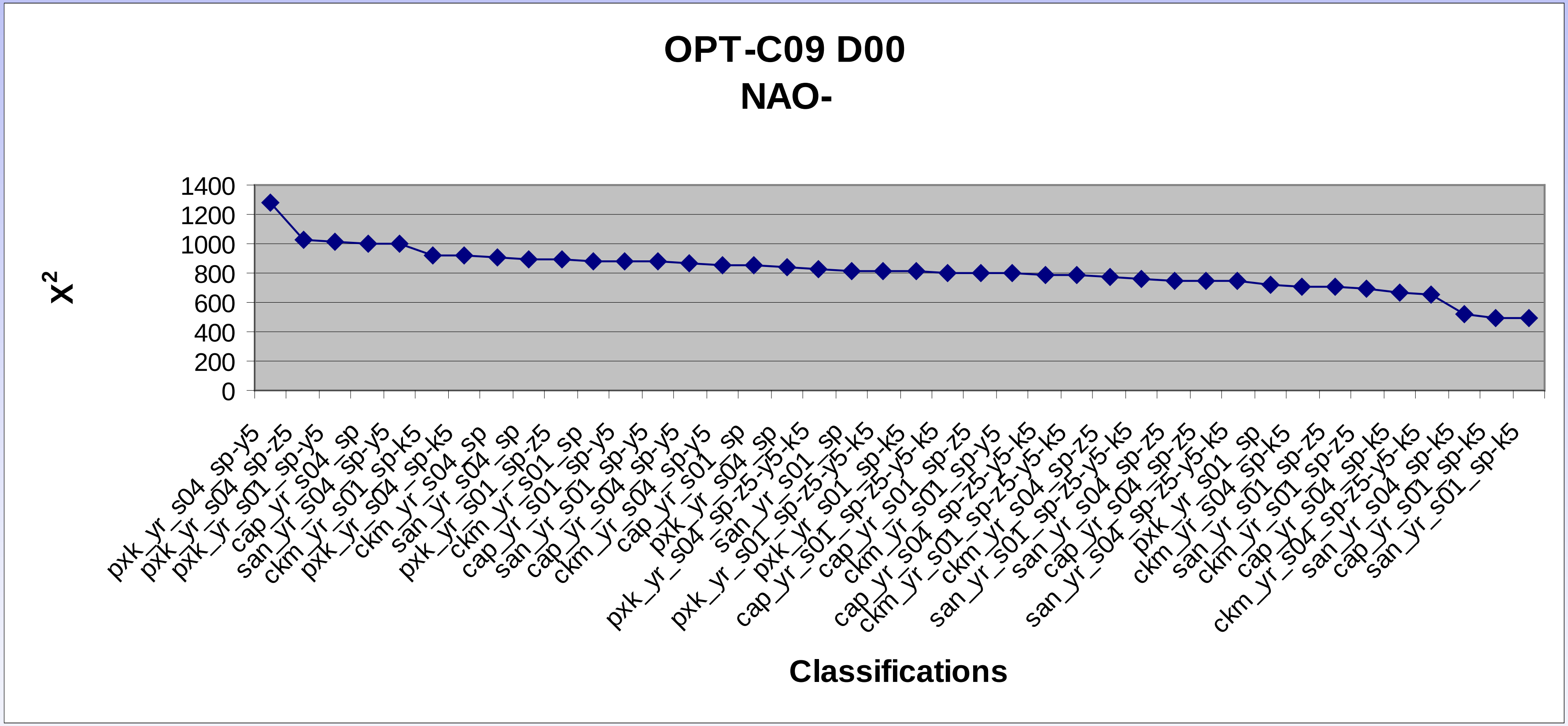
Ranking LDR (NAO-)



Ranking OPT (NAO+)



Ranking OPT (NAO-)



Summary

- Main emphasis: impact of dealing with different input variables and sequencing.

- As a general rule, $\chi 2$ values are larger for NAO- than for NAO+. Broadly speaking, results confirm what was found in version 1.2.

- For NAO+, the best performance corresponds to OPT methods. The best classifications are SAN, CKM and CAP, single days, prevailing SPY5 and SPK5 combinations. The worst are PXK, 4-days sequencing length.

Summary (2)

- For NAO-, the best performance encompasses OPT and PCA families of algorithms.
- In OPT, the best classification is PXK, 4-day sequencing length, SP-Y5 and SPZ5 combination. The worst classifications are CAP and SAN, single day, and SP-K5 combination of variables.
- PCA, the best classifications are KRZ, 4-day sequencing length. The worst classifications are KRZ, single day and 4-day sequencing length when considering the combination of all variables.

Summary (3)

- The worst classifications are WLK from (THR) and ERP from LDR methods. With respect to version 1.2, KIR has slightly improved; this could be attributed to the different thresholds used in both versions of the catalogues.

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Thank you for your attention!