MOS BASED ON THE ALADIN NUMERICAL MODEL

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.. *a short history...*

- Objective interpretation of the output of NWP models started at the NIMH, in **1989** with a **PP** approach, for the extremes temperatures, using **ECMWF** output model.
- **1993** **PP** techniques were developed using **ECMWF** model for the extremes temperatures
- **1997,1998,2001** **MOS** and **PP** techniques were developed using **ARPEGE** model for five predictands:temperatures, wind,cloudiness and precipitations.

  This work has be done in co-operation with Meteo France AS team.
- **2000, 2002**- **MOS** techniques were developed using **ALADIN** model
- These models are *updated* every *two years*.

System design

Predictands:

- **3-h spot 2m temperature and the extremes temperatures**
- **3-h wind direction and speed(three predictands-west and south vector components, and the scalar speed)**
- **3-h total cloud cover**
- **6-h total precipitation**

Using:

- **Base and derived predictors from :**
  - **ALADIN - Bucharest Model**

The MOS_MLR model

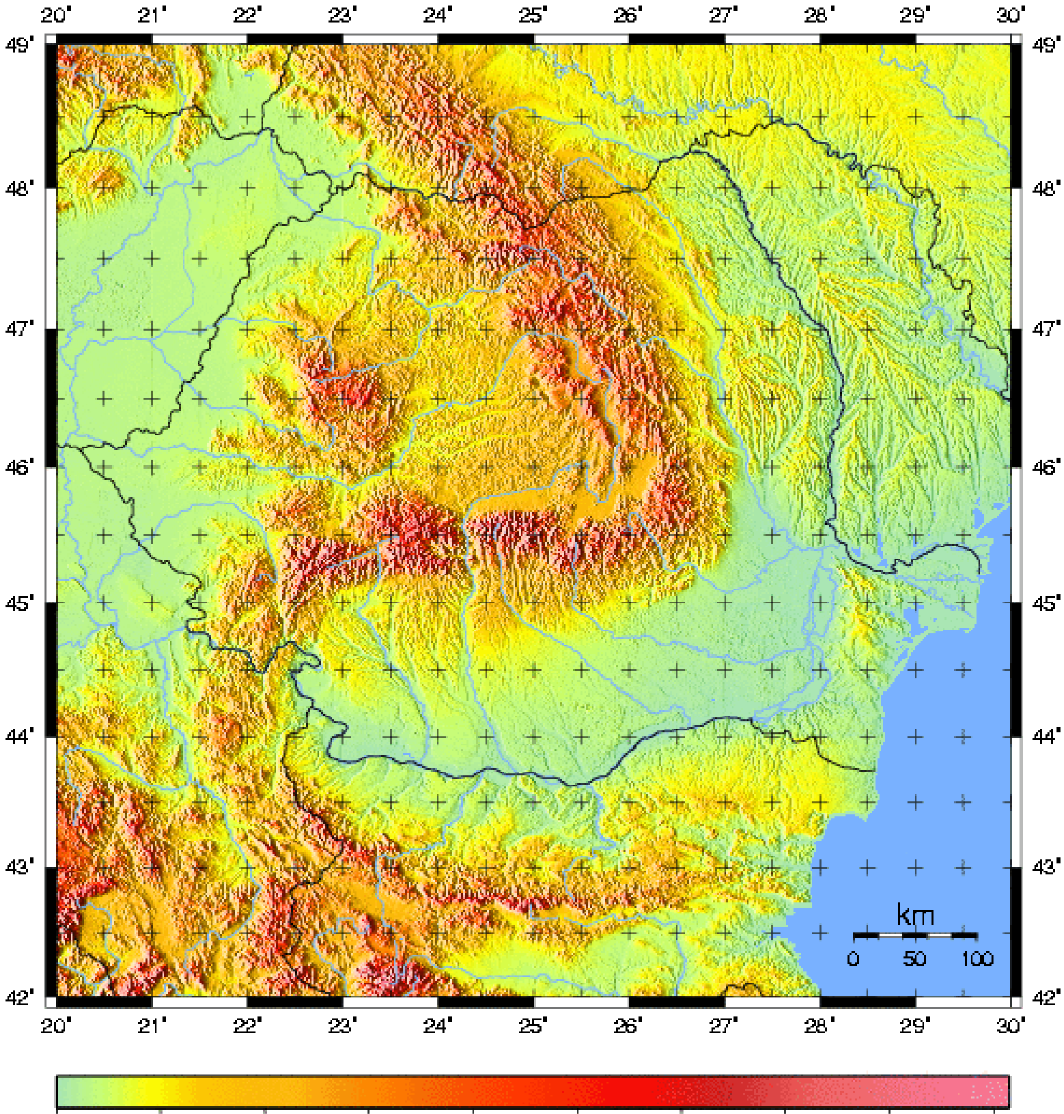
- The MOS method
- uses *Multiple Linear Regression* - MLR
- equations for each station and for each time ranges
- the predictors - in *16 grid points* around the station
- *canonical final predictors* are calculated from the initial predictors through Canonical Analysis
- predictors selection - *Stepwise*
- the index of quality - *RMSE*

The MOS_MDA model

- the method *MOS*
- uses *The Discriminant Analysis*- MDA
- equations are developed for each station and for each time ranges
- the predictors are calculated in *16 grid points* around the station
- *canonical final predictors* are calculated from the initial predictors through Canonical Analysis
- the selection method - *Stepwise*
- the index of quality - *The Mahalanobis Distance*

- 140 meteorological stations
- *The Analysis Array*
  $20°E$ și $30°E$, $49°N$ și $42°N$.
- *The model grid* - 0.1 * 0.125 degrees.
- *The analysis period*

Development sample	1st of oct. 2000 - 1st of oct 2002
Test sample	1st of oct 1999 - 1st of oct. 2000


20° 21° 22° 23° 24° 25° 26° 27° 28° 29° 30°
49° 48° 47° 46° 45° 44° 43° 42°
km
0 50 100

TEMPERATURE

The Predictand Variable - 2m Temperature

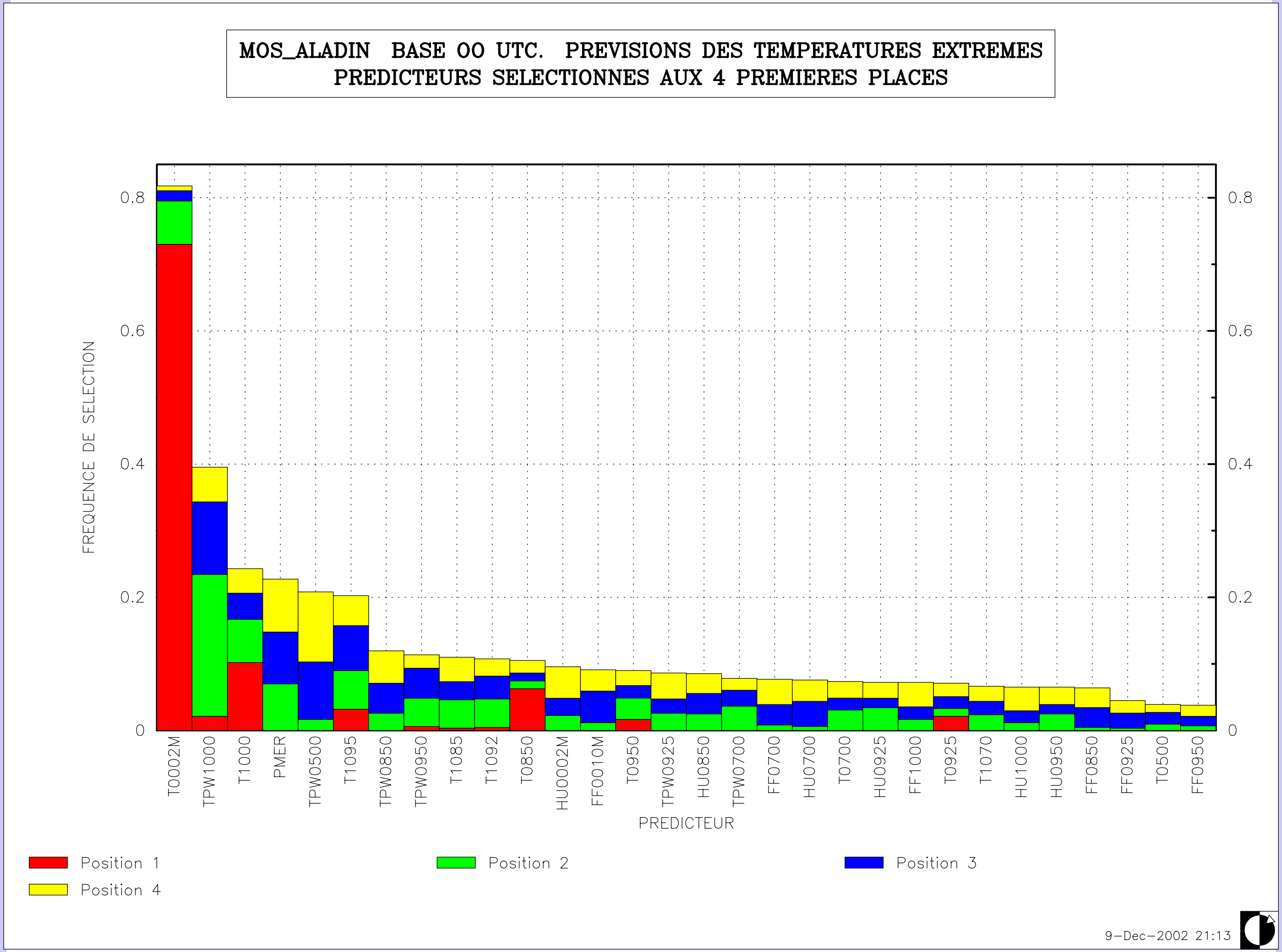
- 3-h spot temperature
- maximum
- minimum

The Most Important Predictors:

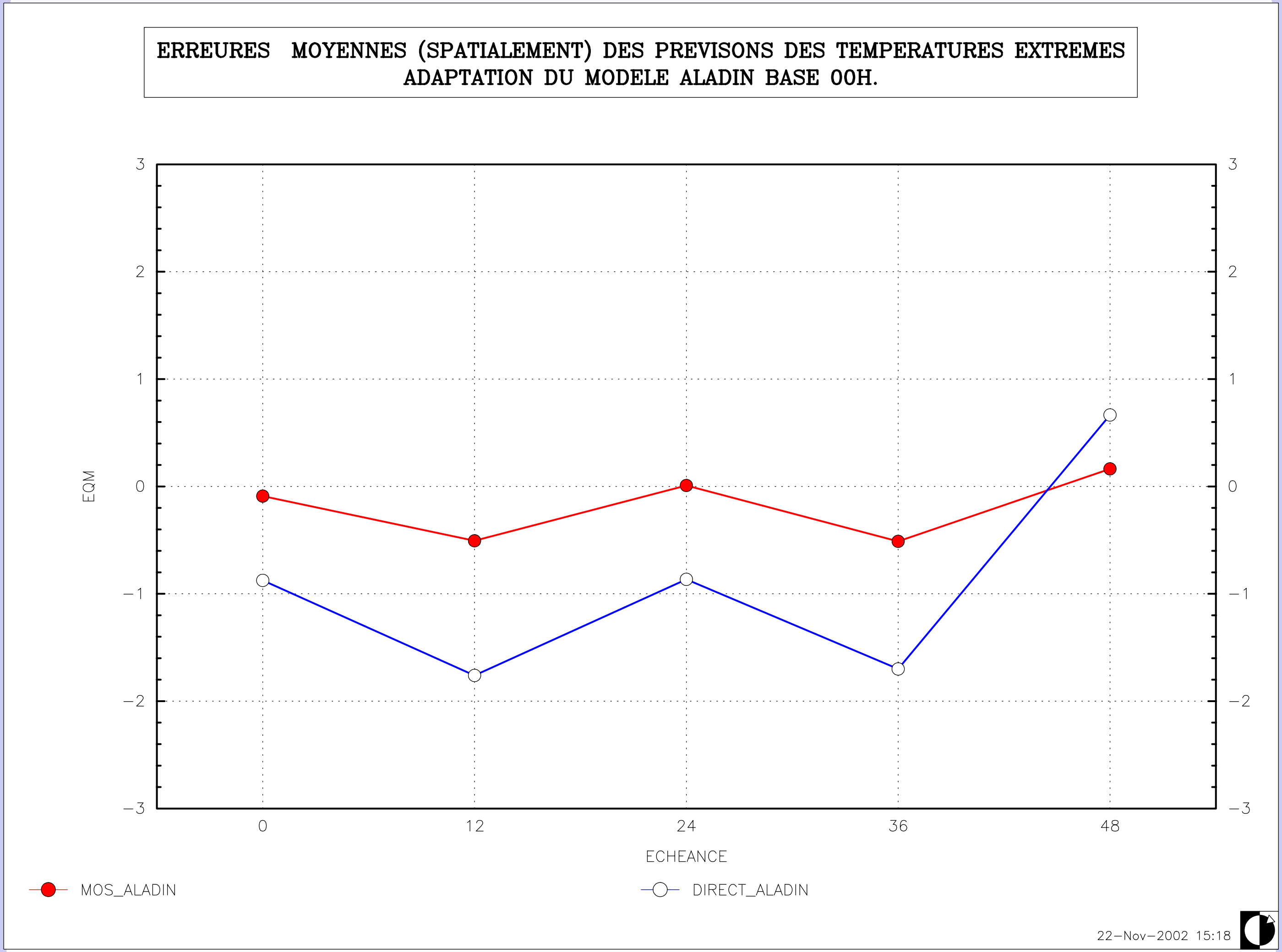
- *For Very Short Time Projections 0 - 12 hrs.*
  - The Temperature at 2m forecasted by the Numerical Model
  - The DewPoint Temperature
  - The Wind Speed at 10m
  - The Air Moisture in the Boundary Layer
- *For Time Projections at a 1 - 2 days Period*
  - the temperature gradient: 1000 - 850 mb, 850 - 700 mb, or 1000 - 500 mb
  - the temperatures at the standard levels of the atmosphere
  - the moisture at the lower levels of the troposphere

Predictors used

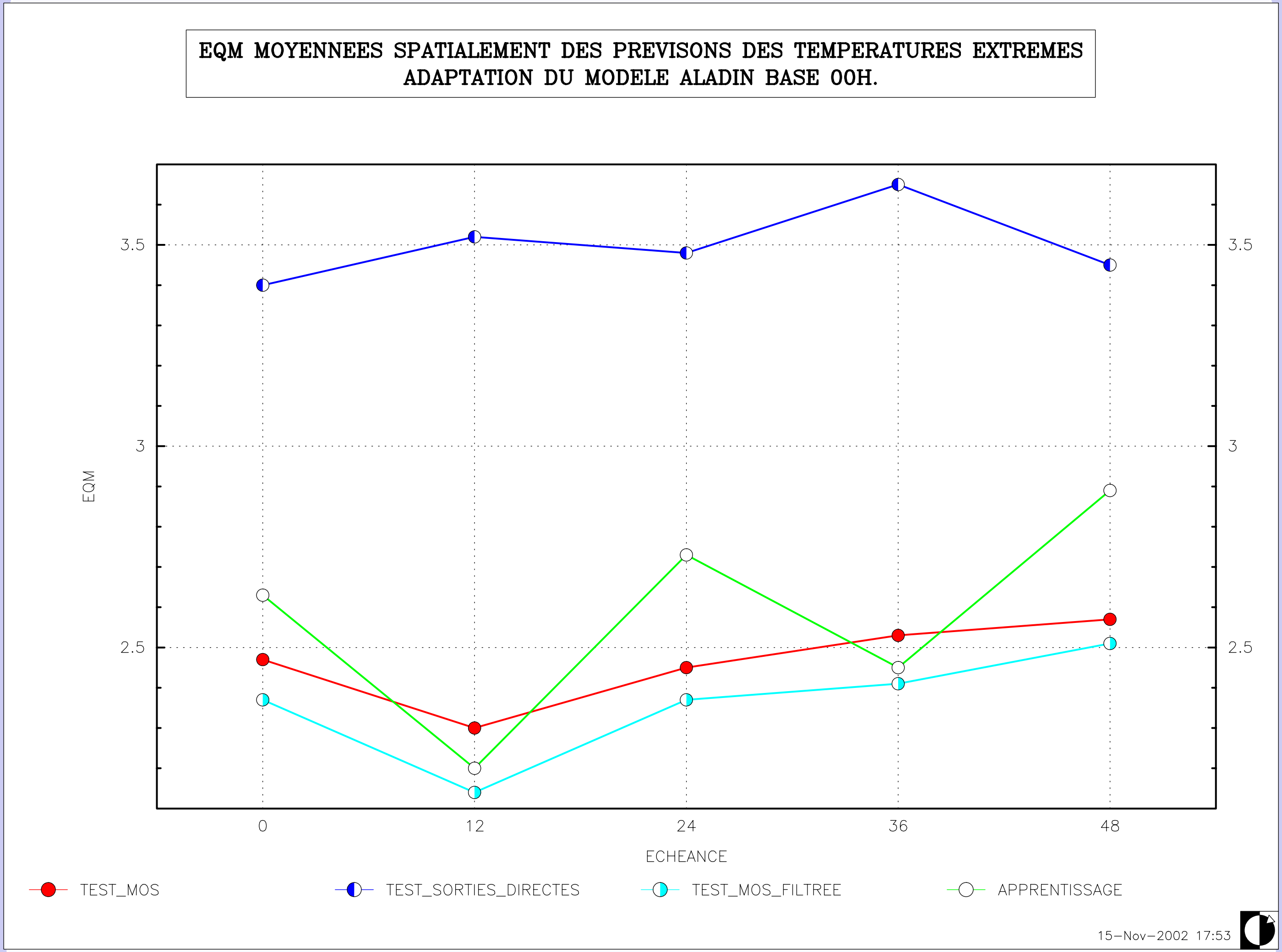
T0002M T1000 T0950 T0925 T0850 T0700 T0500
TW1000 TW0950 TW0925 TW0850 TW0700 TW0500
PMER HU0002M HU1000 HU0950 HU0925 HU0850 HU0700
FF0010M FF1000 FF0950 FF0925 FF0850 FF0700



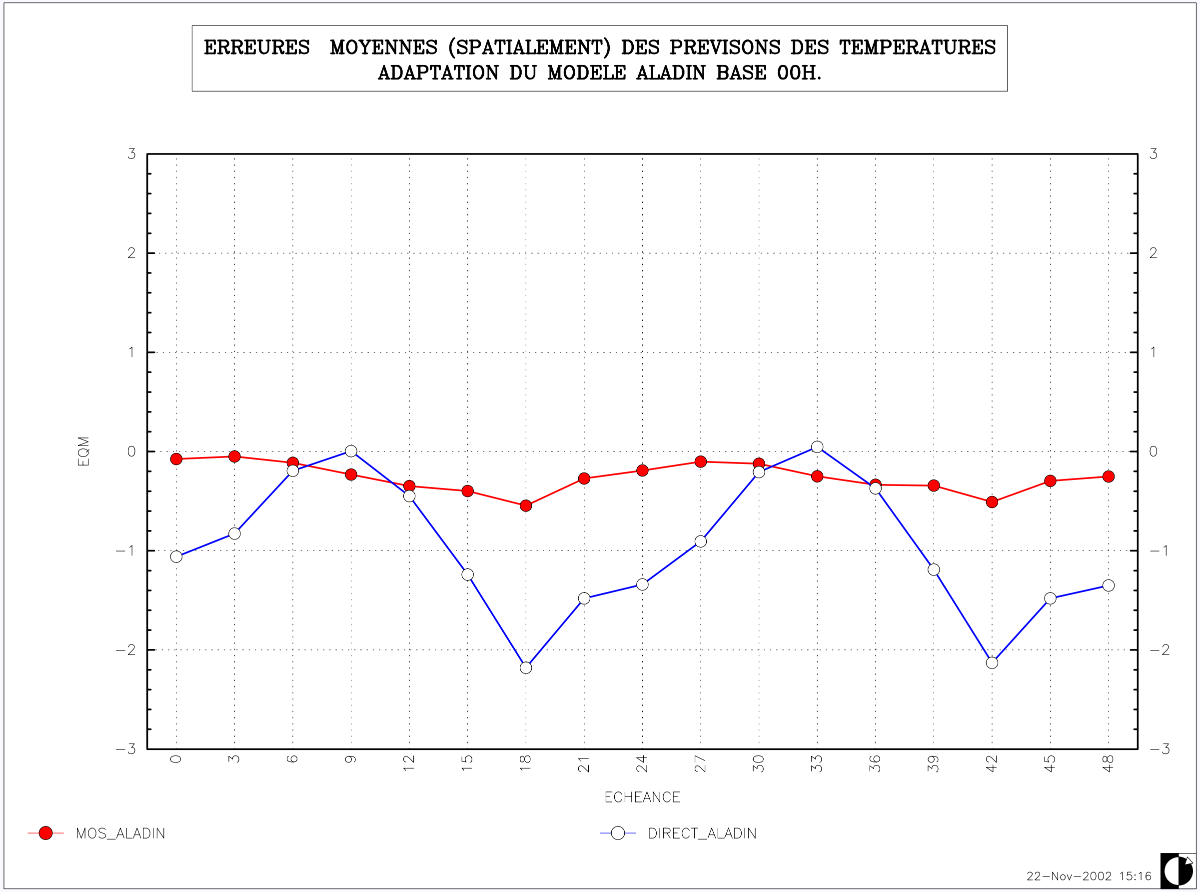
Frequency of selection of predictors. All stations and all time ranges



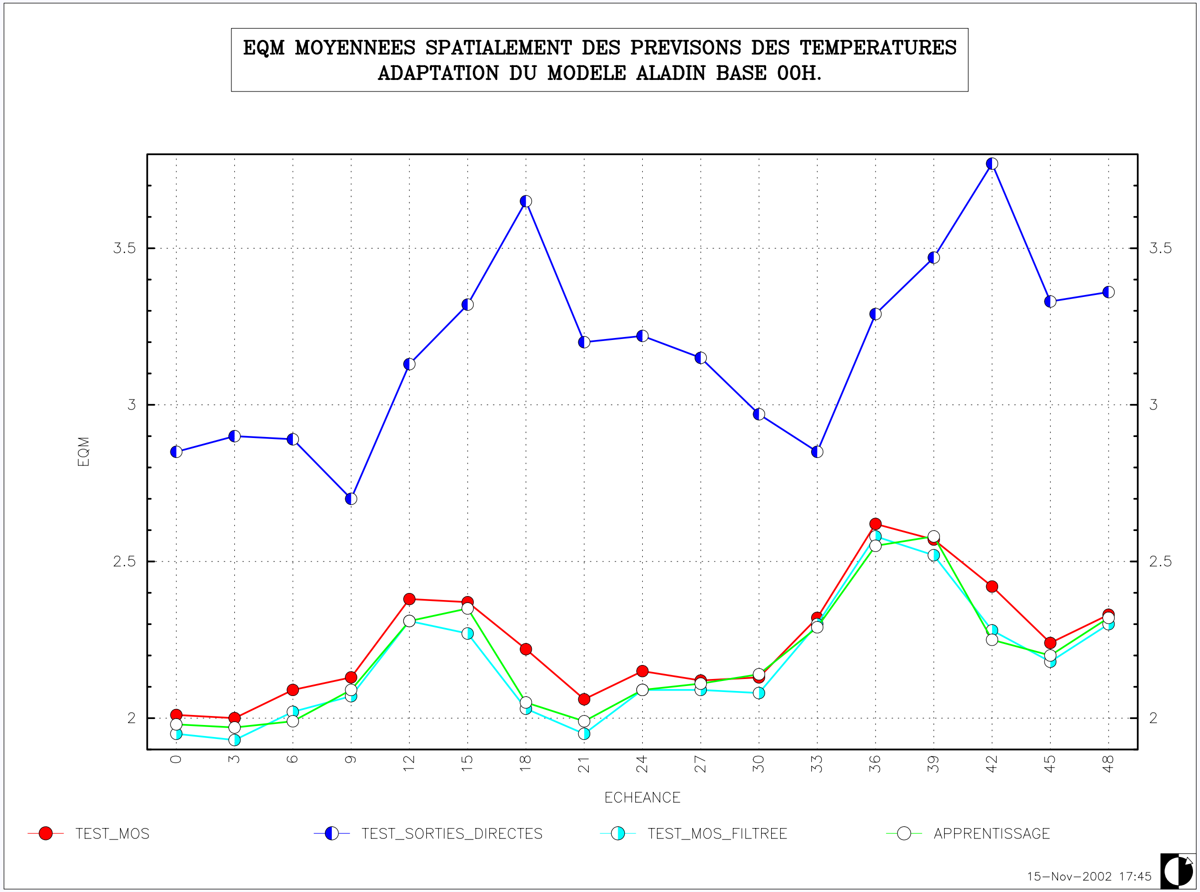
Extreme Temperatures. Mean errors. Spatial Forecast Averages



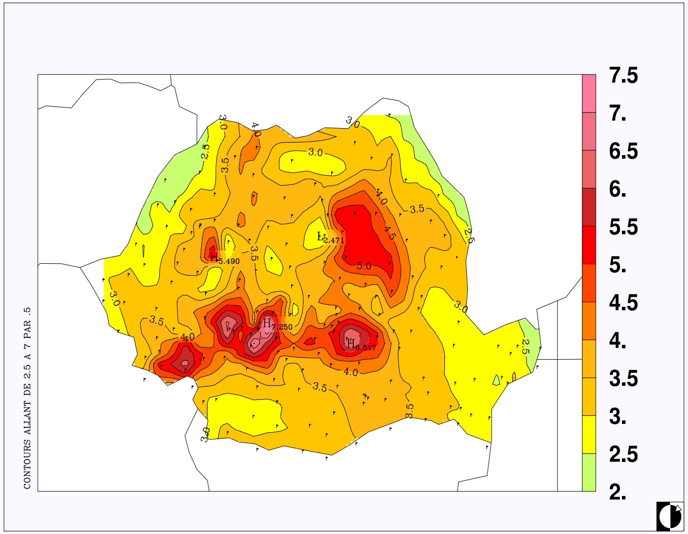
Extremes Temperatures.RMSE. Spatial Forecast Averages



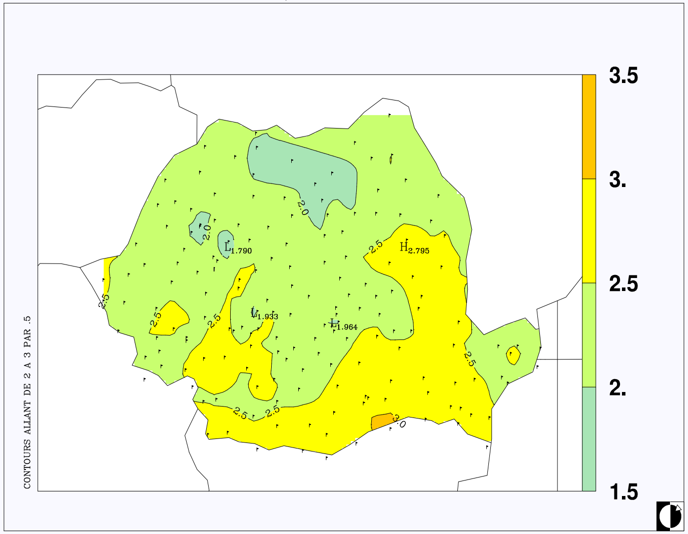
3-h temperatures. Mean errors. Spatial Forecast Averages



3-h Temperatures. RMSE. Spatial Forecast Averages



RMSE. Tmax. T+36h.The ALADIN Model.



RMSE. Tmax. T+36h. The Statistical Model.

WIND

3-h wind direction and speed (three predictands - west(U) and south(V) vector components, and the scalar speed(FF))

Influences

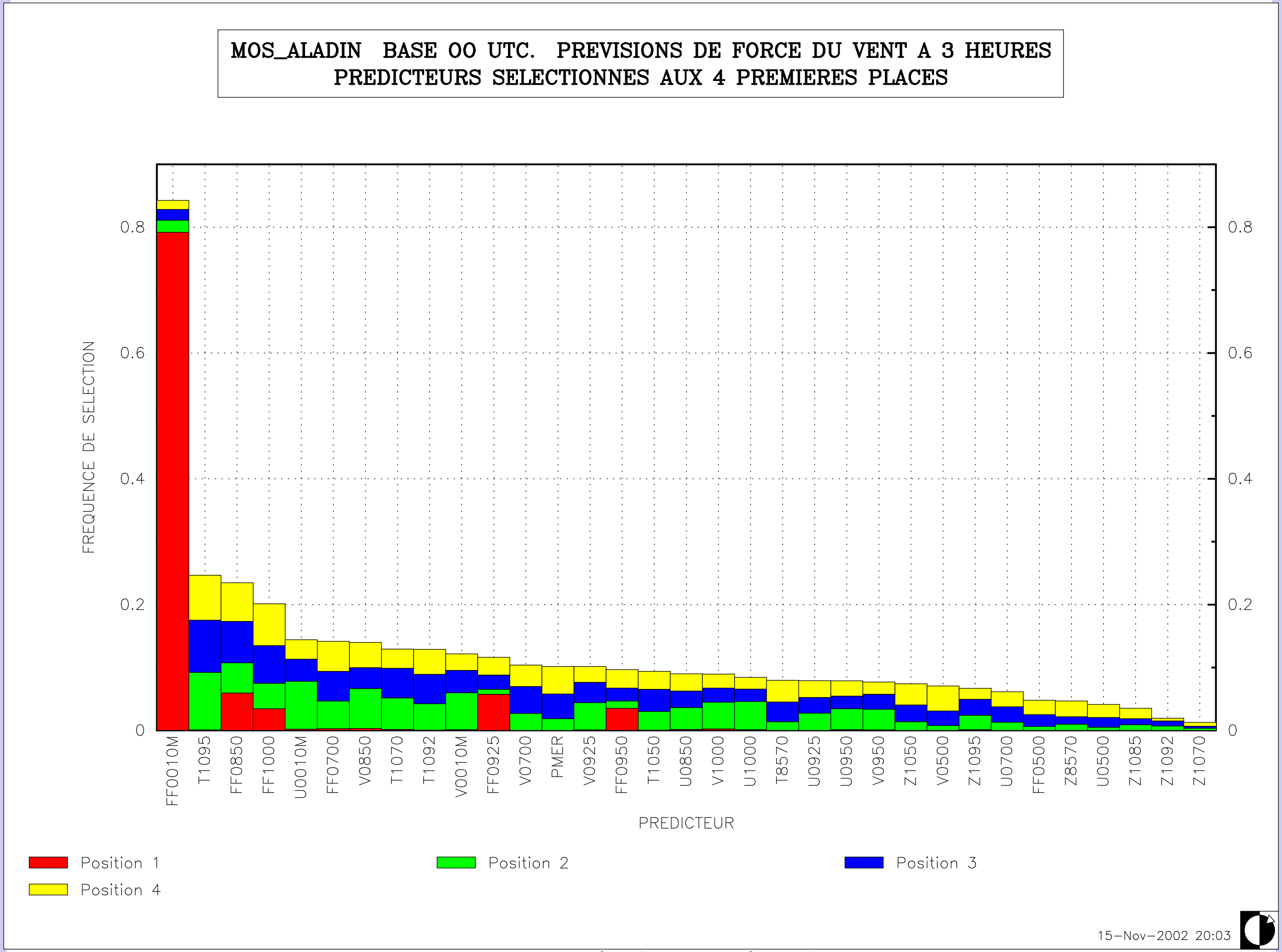
- *the local topography*
- *mezoscalar termic circulation*
- *the combined orographic and termic effect*

Predictors used

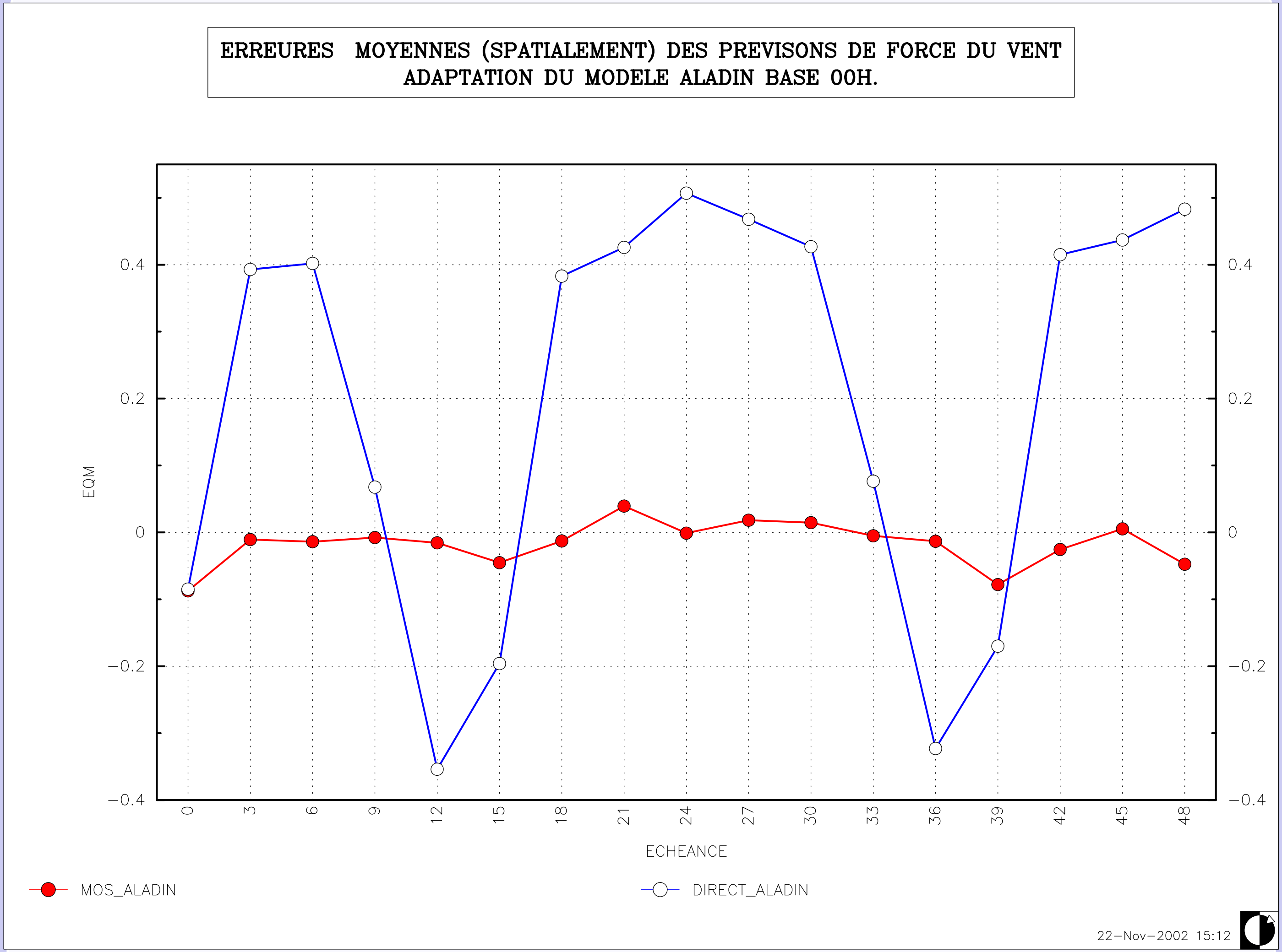
U0010M V0010M FF0010M PMER U1000 V1000 FF1000 U0950 V0950 FF0950 U0925
U0925 V0925 FF0925 U0850 V0850 FF0850 U0700 V0700 FF0700 U0500 V0500 FF0500
FF0500 Z1095 Z1092 Z1085 Z1070 Z1050 Z8570 T1095 T1092 T1070 T1050 T8570

	Classes limits for FF
"Good" forecast	$\Delta FF <= 2.0 m/s$
"Medium" forecast	$2.0 m/s < \Delta FF <= 4.0 m/s$
"Worst forecast"	$\Delta FF > 4.0 m/s$

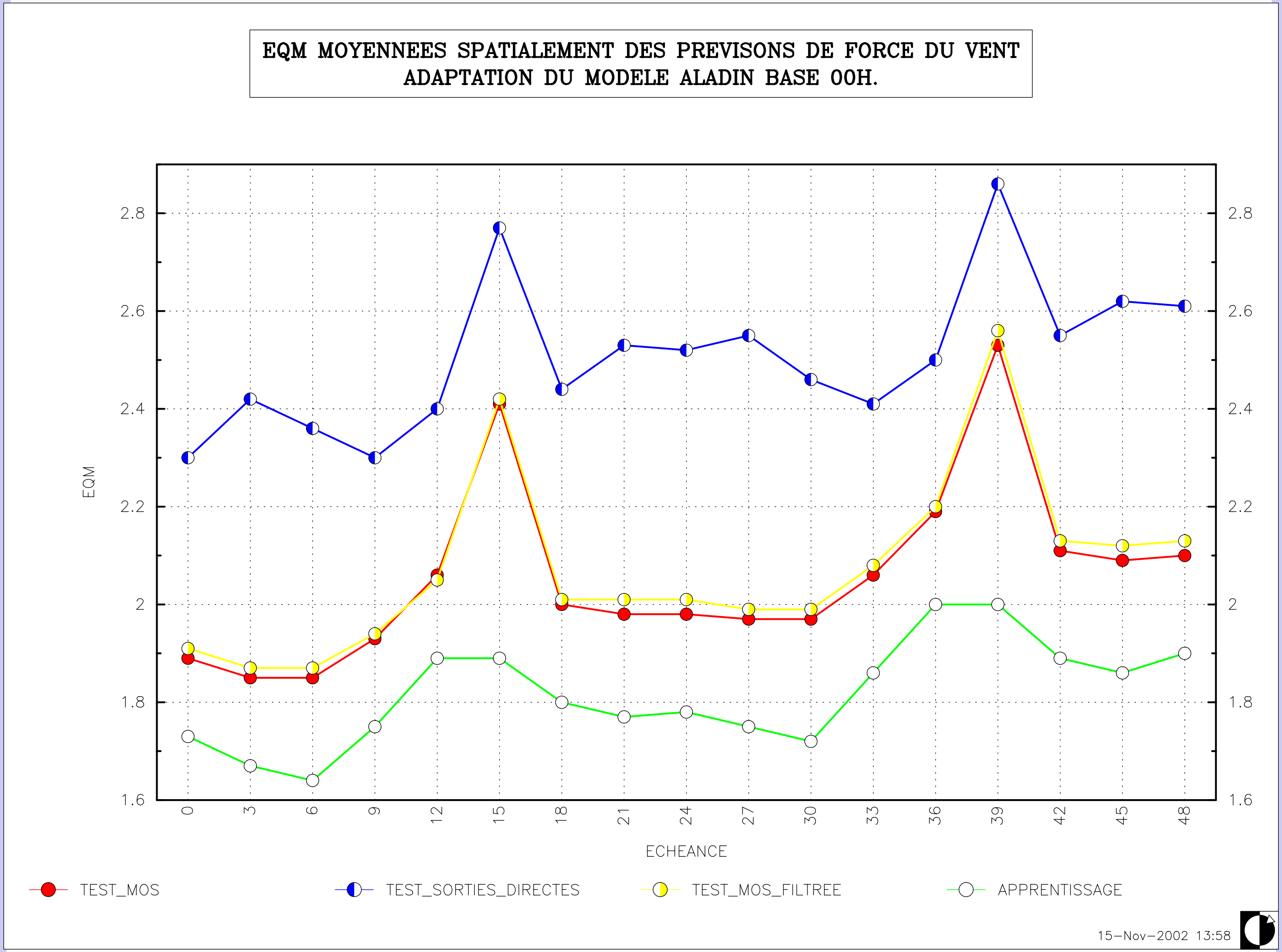
	Classes limits for DD(degrees)
"Good" forecast	$\Delta DD <= 30$
"Medium" forecast	$30 < \Delta DD <= 60$
"Worst" forecast	$\Delta DD > 60$



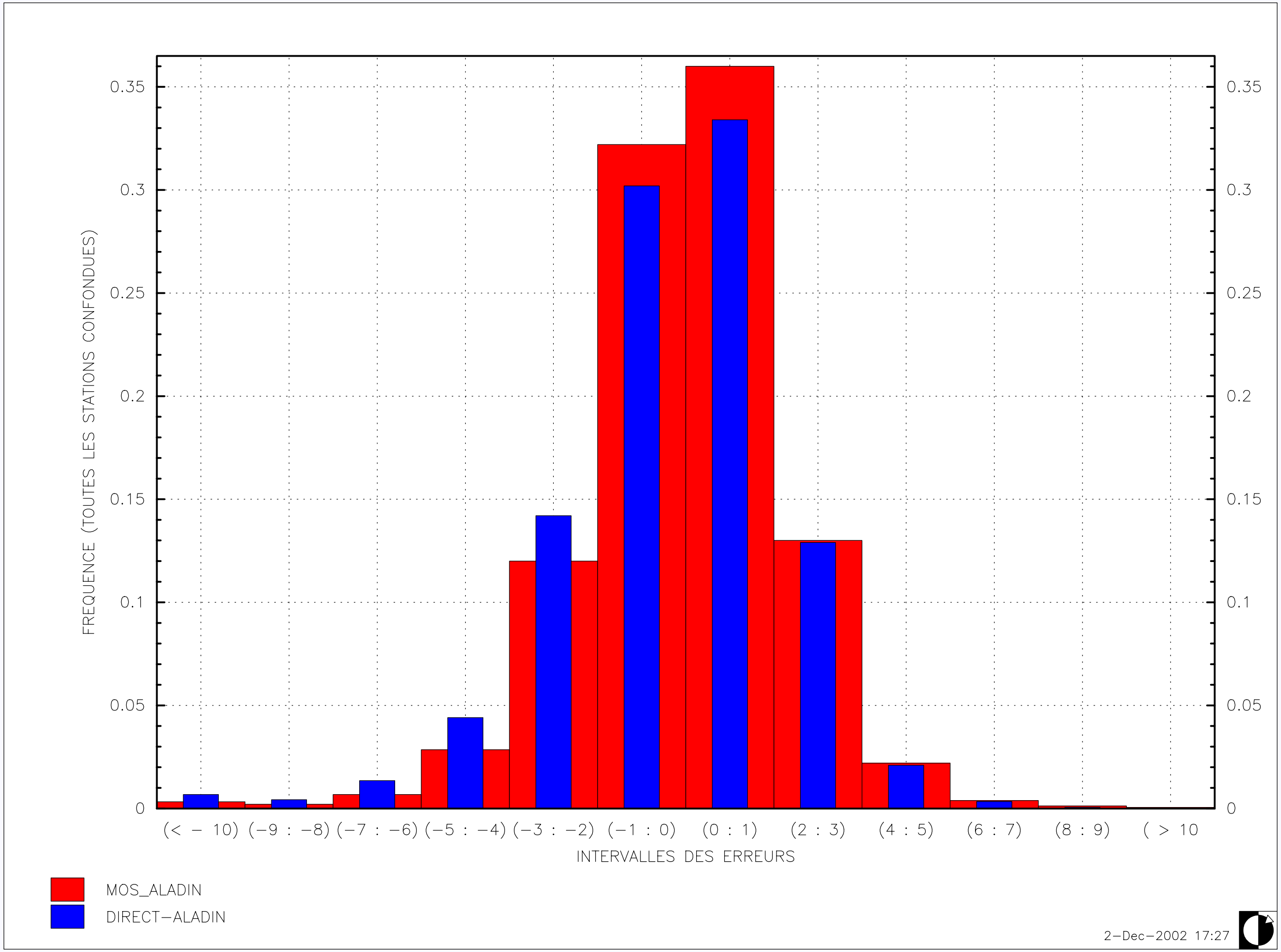
FF. Frequency of selection of predictors.



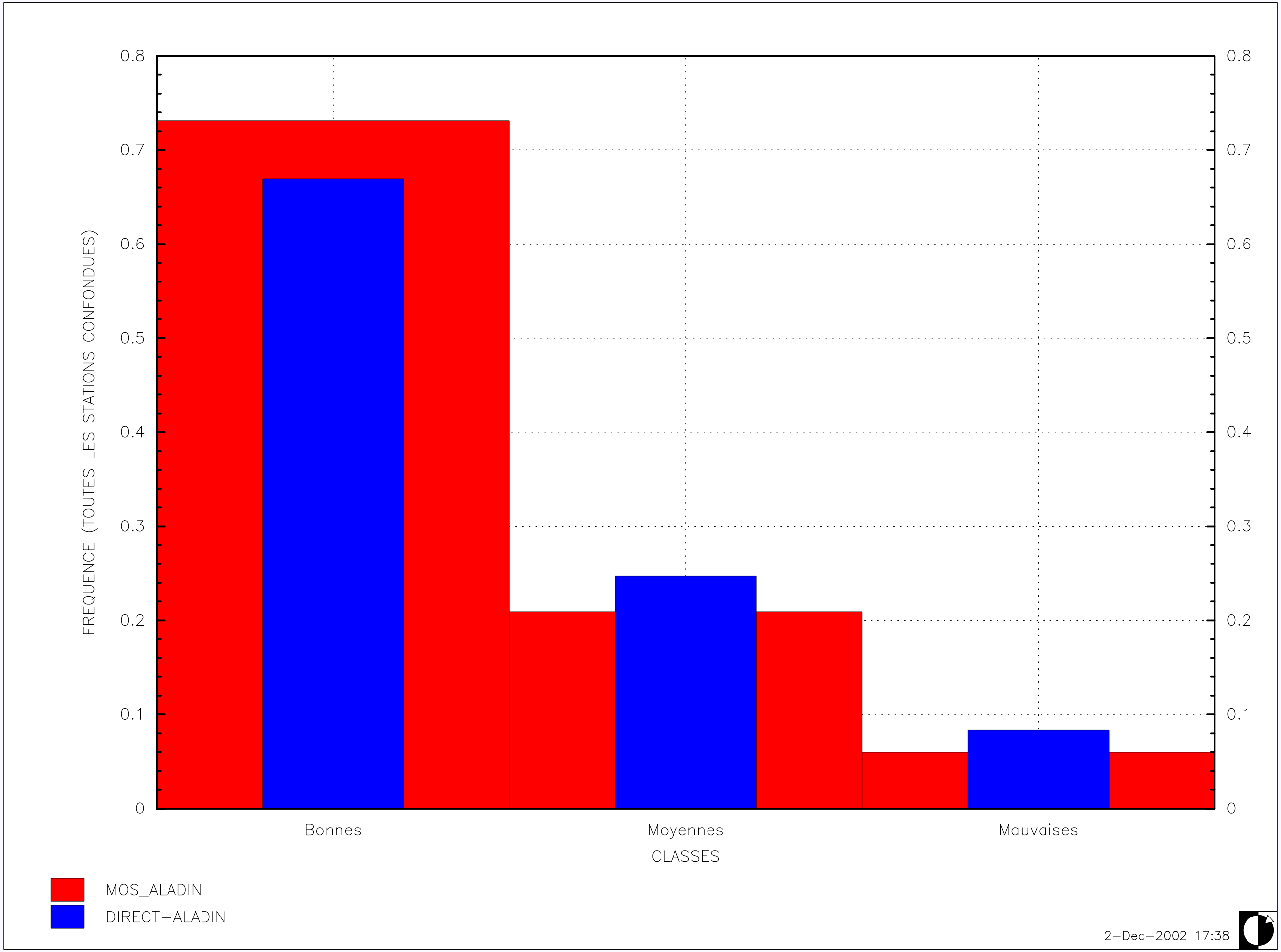
Mean Errors. FF. Prediction spatial averages



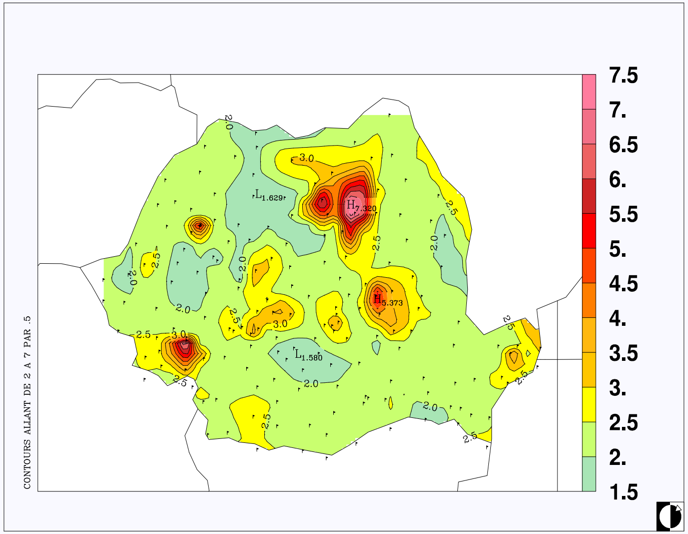
RMSE. FF. Prediction spatial averages



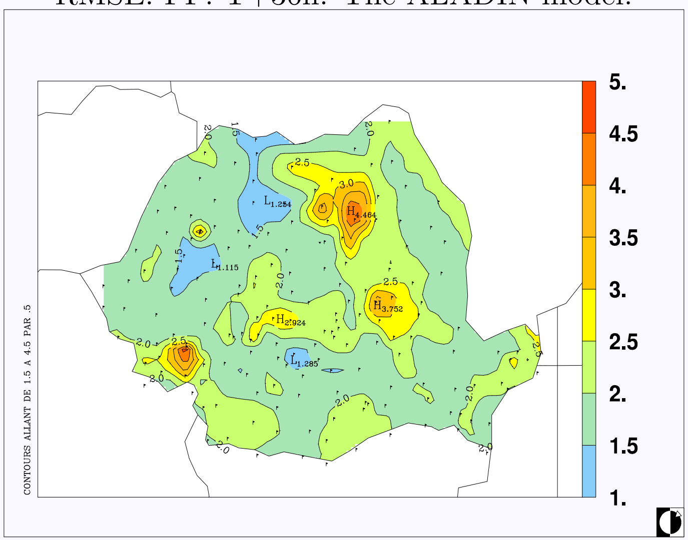
Quality of FF forecasts. FF.



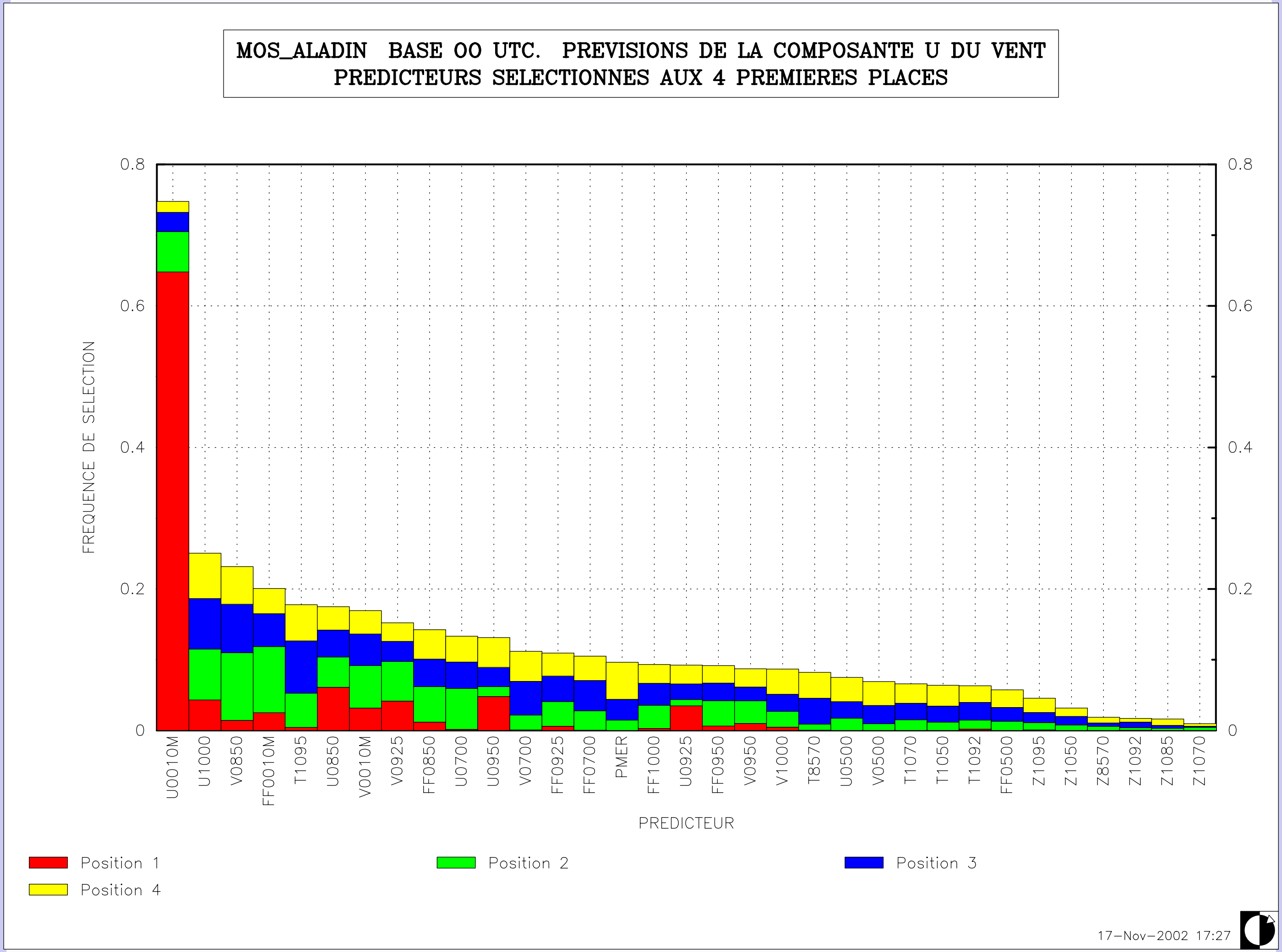
Quality of FF forecasts. FF.



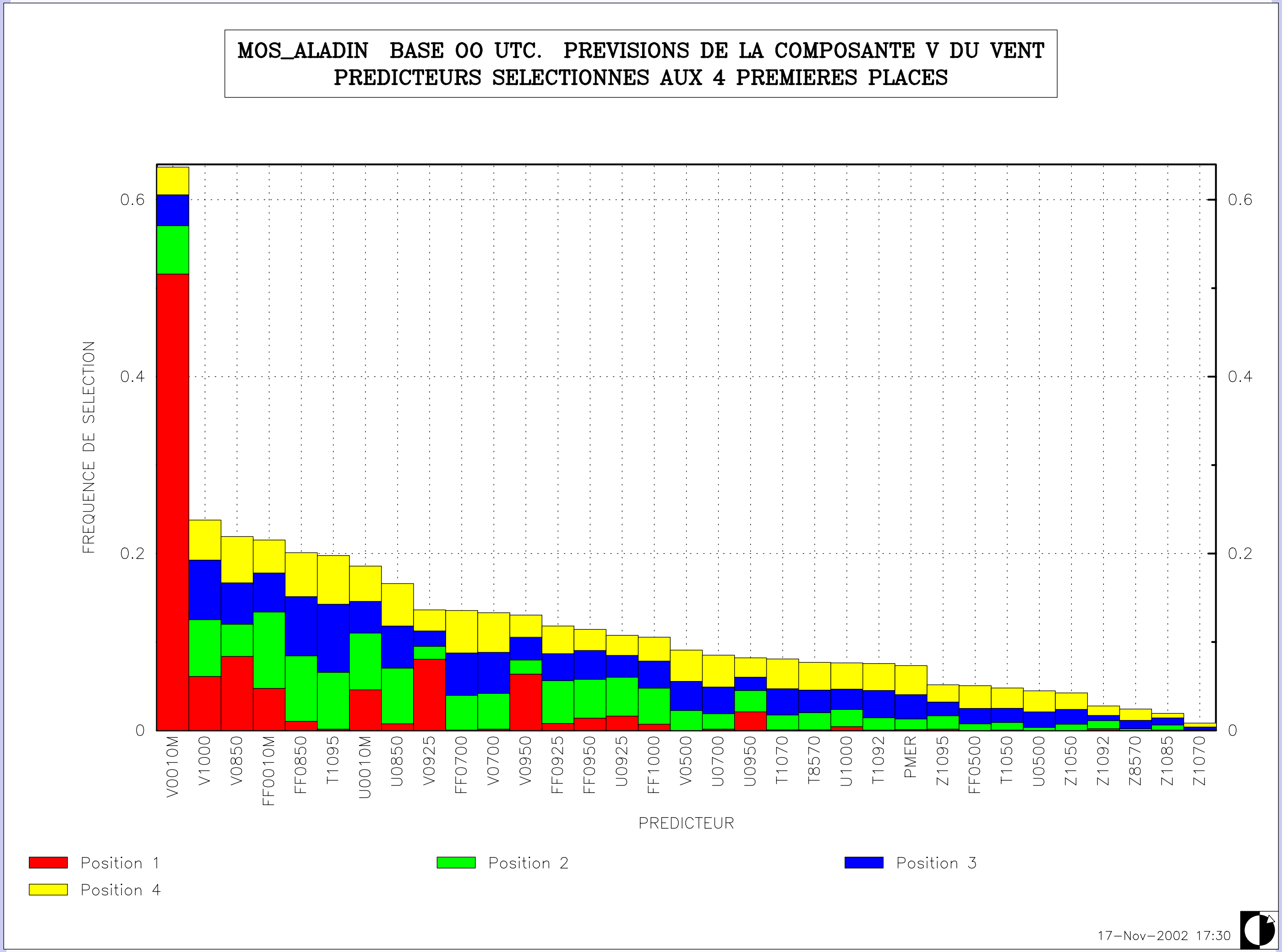
RMSE. FF. T+36h. The ALADIN model.



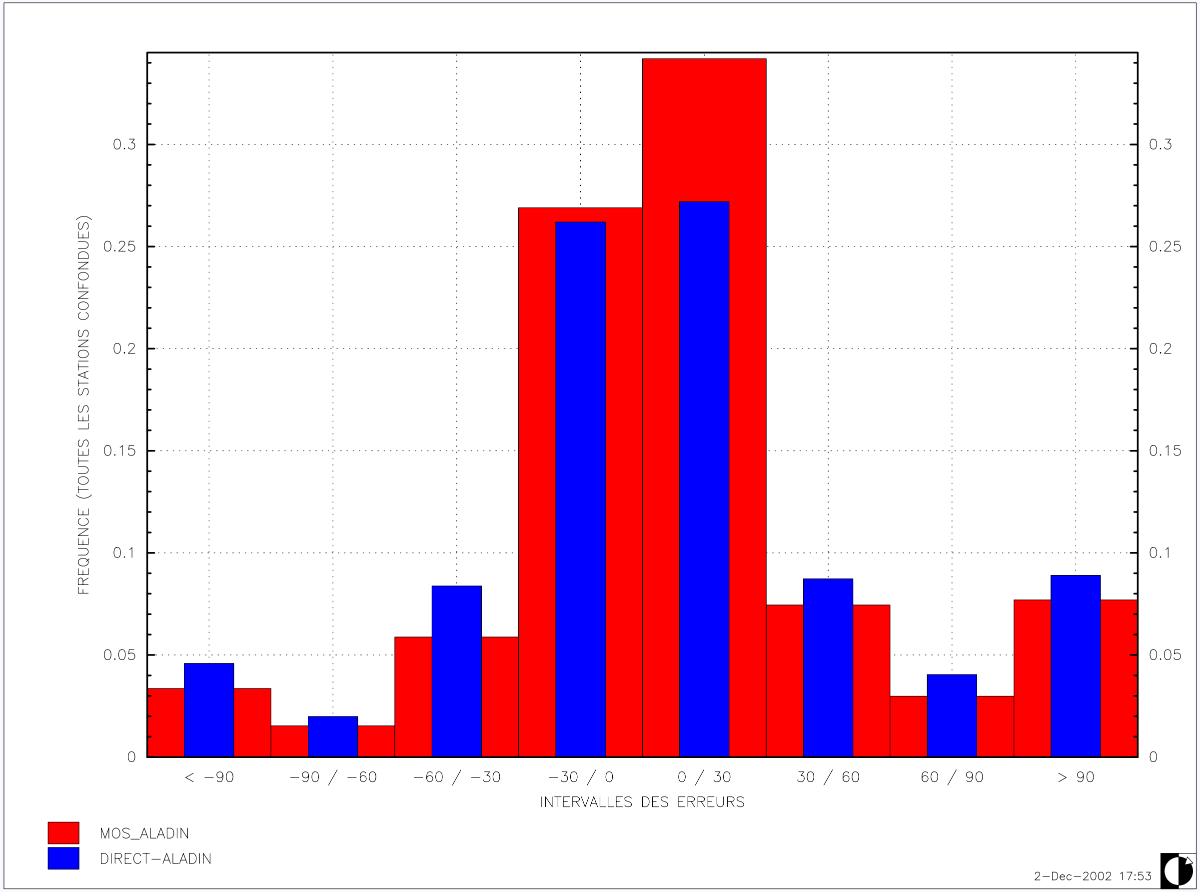
RMSE. FF. T+36h. The Statistical model.



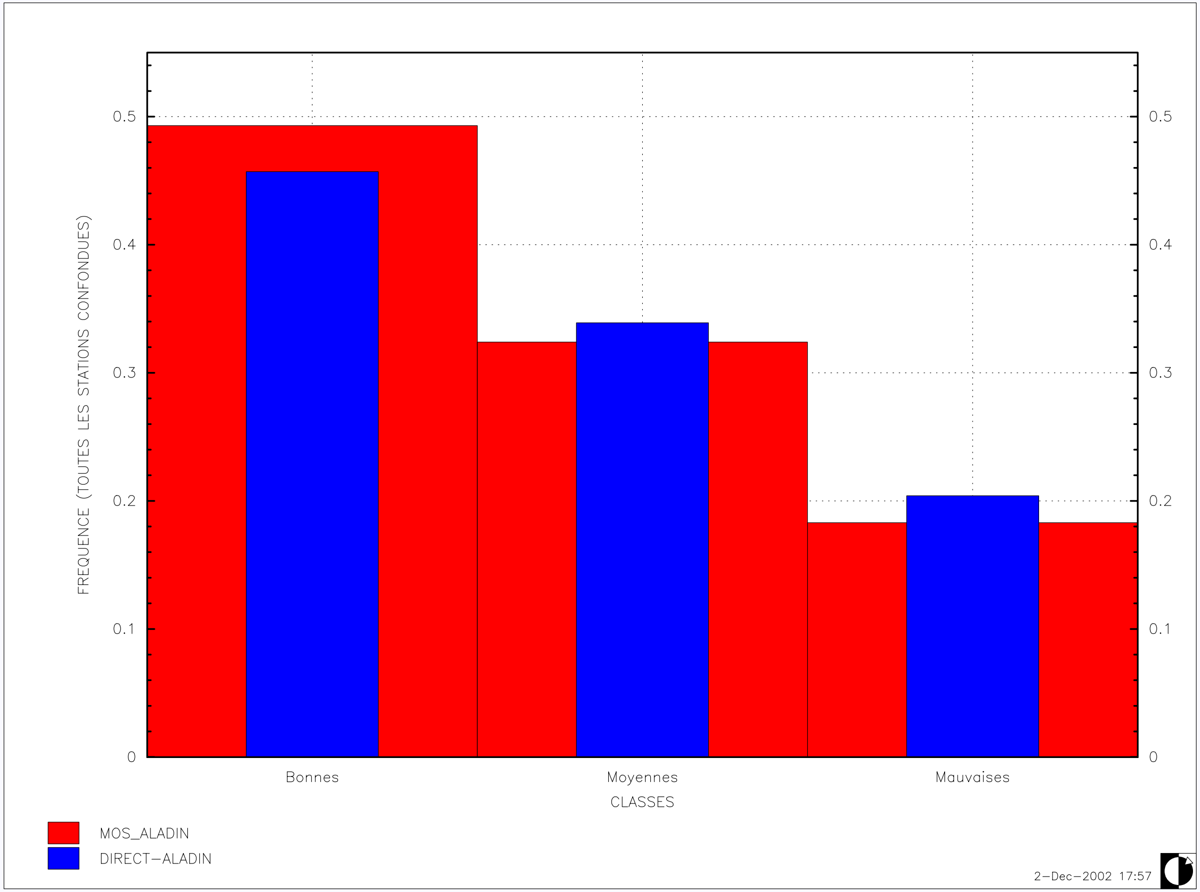
U. Frequency of selection of predictors.



V. Frequency of selection of predictors.



Quality of the forecasts. Wind direction



Quality of the forecasts. Wind direction

CLOUDINESS

The Predictand Variable- The Total Cloudiness

Potential Predictors:

- *Large scale arrays*
  - temperature, geopotential, moisture at 1000, 925, 850, 700, 500 hPa
  - vertical speeds at 850, 700, 500 hPa
  - wind at 1000, 925, 850, 700, 500 hPa
- *Parameters describing the boundary layer*
  - the low pressure at the sea-level
  - the equivalent potential temperature in the limit layer
  - the wind at 10m

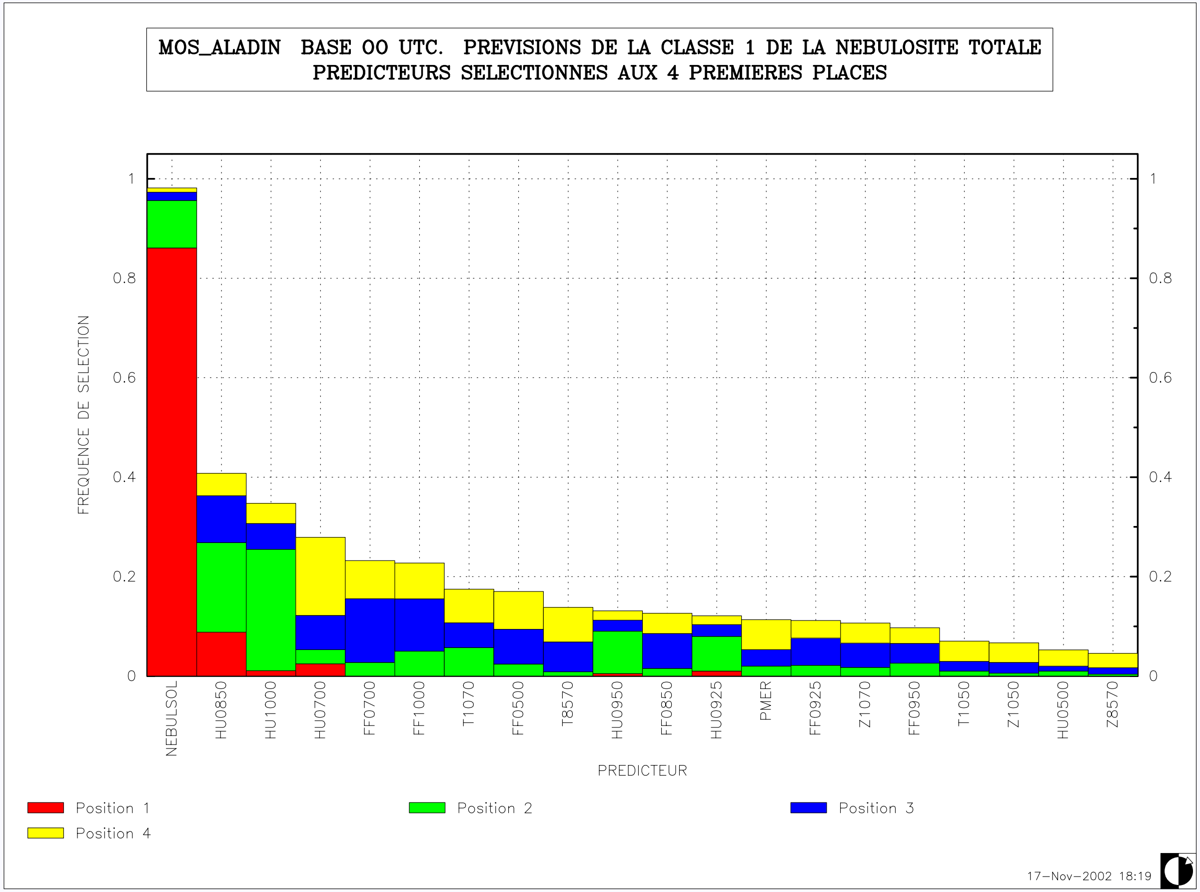
Models used MDA:

		Classes limits
Classe 1	Clear, thin scattered, thin broken	NT < 30%
Classe 2	Scattered, Broken	30% => NT < 70%
Classe 3	Overcast	NT => 70%

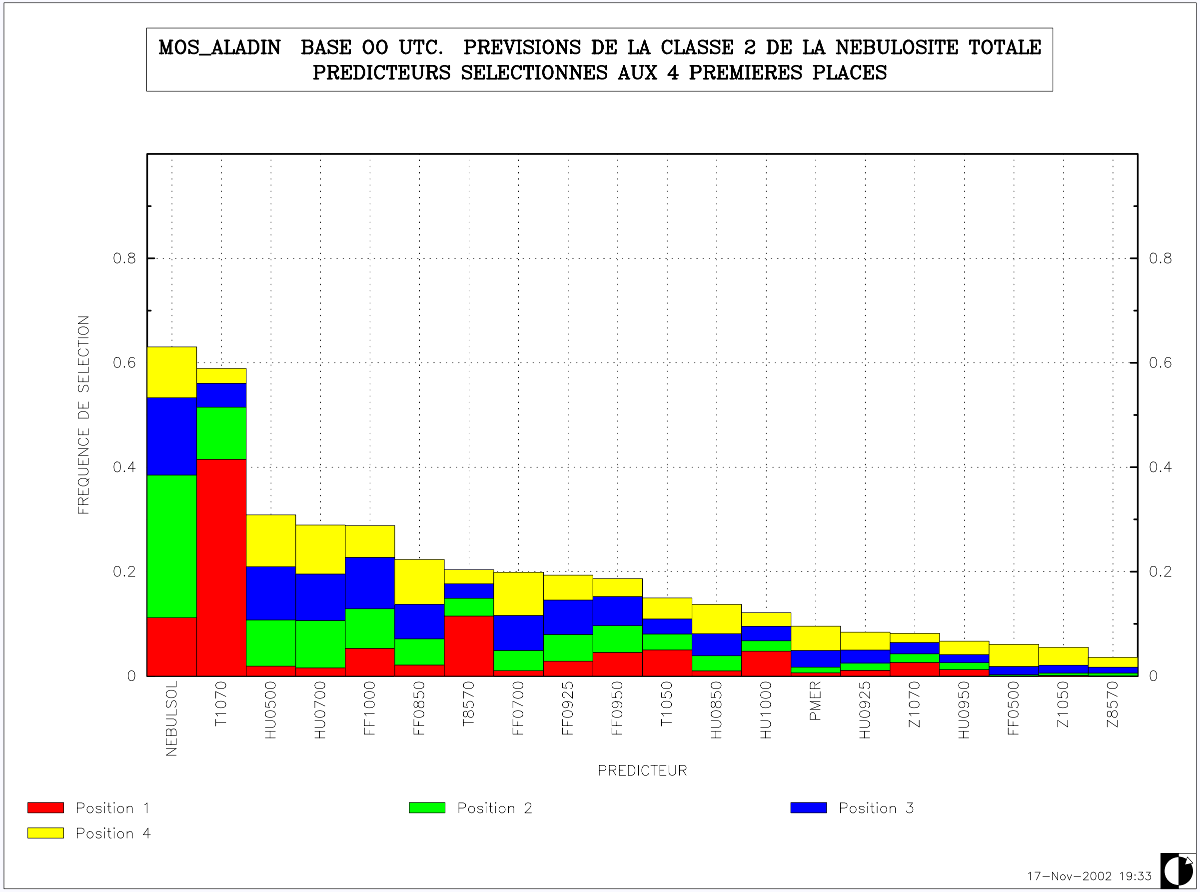
- A discriminant analysis was performed for each category, separately.
- Finally, the decision of the forecasted category was made using maximum vraisamblance criteria.

Predictors used:

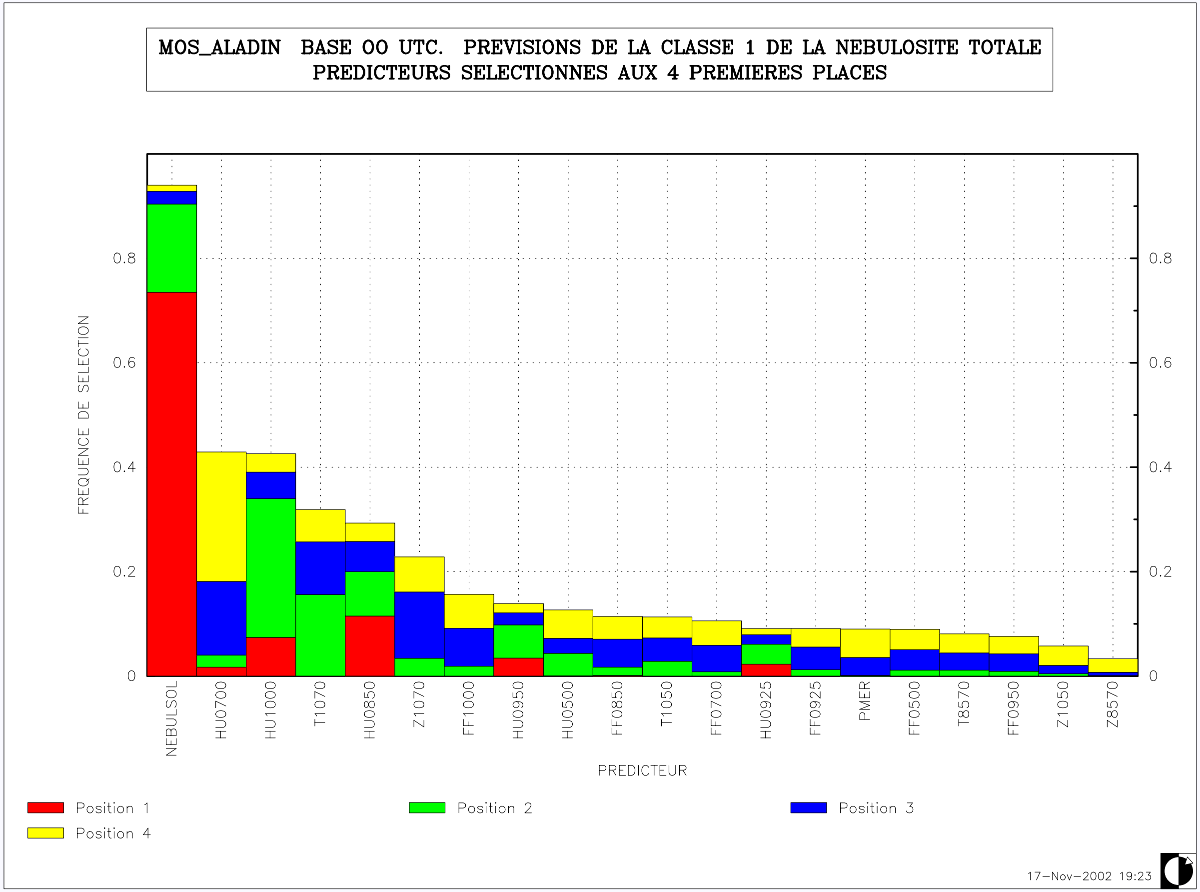
NEBULSOL HU1000 HU0950 HU0925 HU0850 HU0700 HU0500 FF1000 FF0950 FF0925
FF0925 FF0850 FF0700 FF0500 Z1070 Z1050 Z8570 T1070 T1050 T8570 PMER



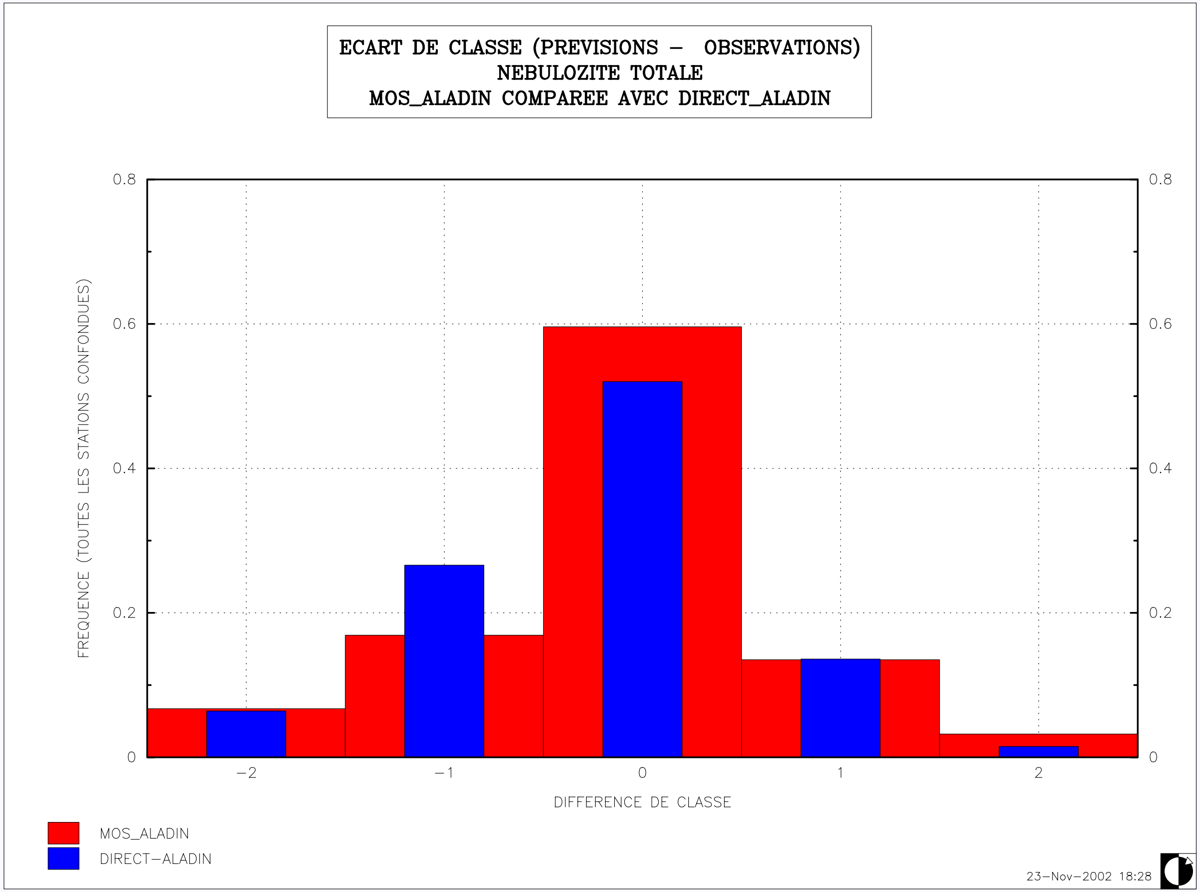
Frequency of selection of predictors. Classe 1

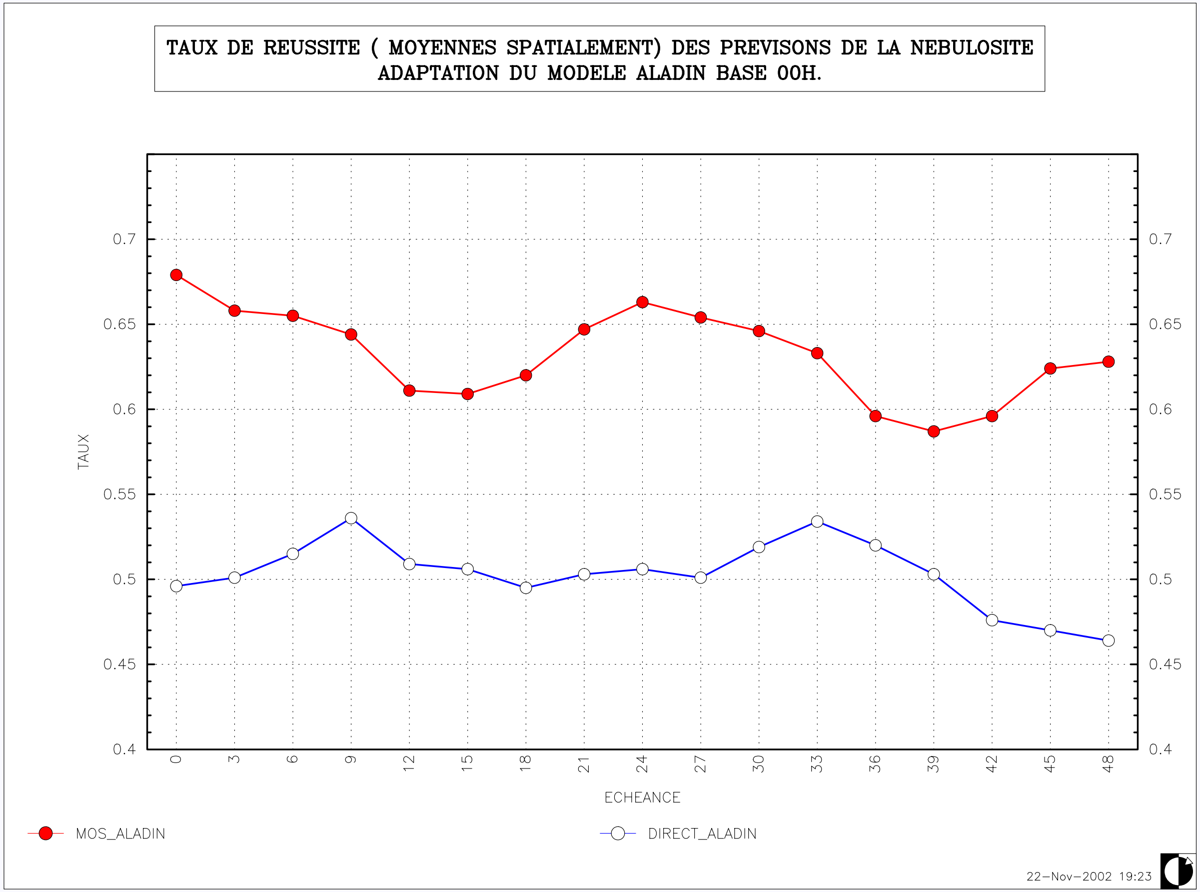


Frequency of selection of predictors. Classe 2

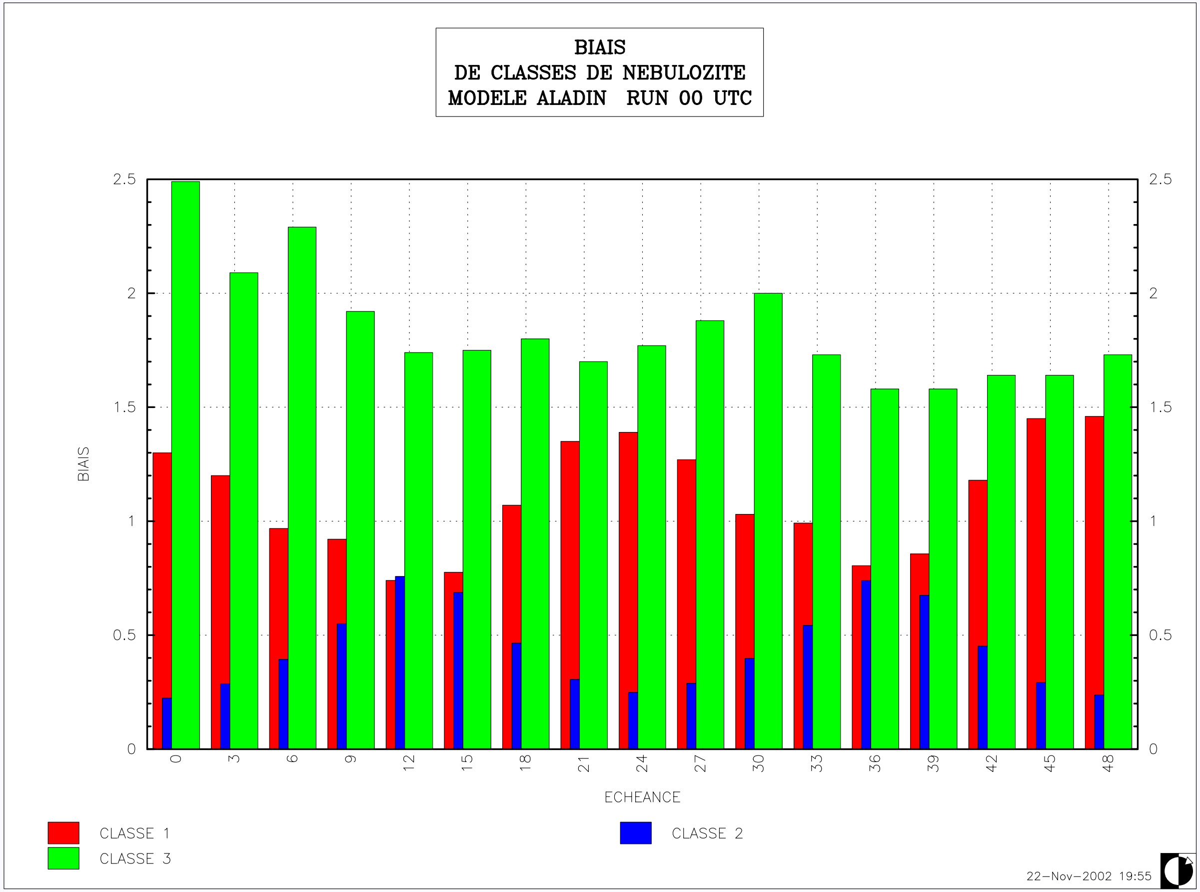


Frequency of selection of predictors. Classe 3

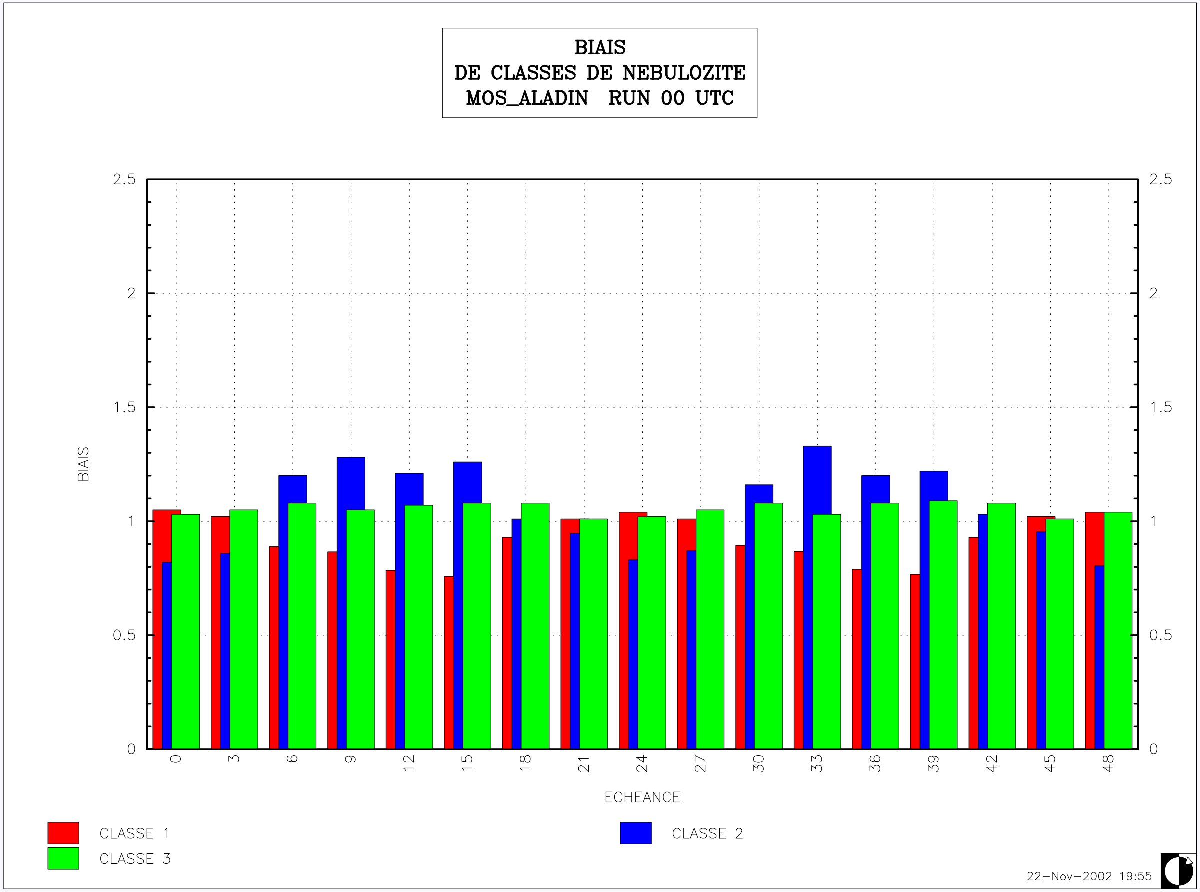

ECART DE CLASSE (PREVISIONS – OBSERVATIONS)
NEBULOZITE TOTALE
MOS_ALADIN COMPAREE AVEC DIRECT_ALADIN
0.8
0.6
0.4
0.2
0
FREQUENCE (TOUTES LES STATIONS CONFONDUES)
−2
−1
0
1
2
DIFFERENCE DE CLASSE
MOS_ALADIN
DIRECT−ALADIN
23−Nov−2002 18:28


TAUX DE REUSSITE (MOYENNES SPATIALEMENT) DES PREVISONS DE LA NEBULOSITE
ADAPTATION DU MODELE ALADIN BASE 00H.
TAUX
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
ECHEANCE
MOS_ALADIN
DIRECT_ALADIN
22−Nov−2002 19:23

Hit Rate.



Bias. Direct Model Output.


BIAIS
DE CLASSES DE NEBULOZITE
MOS_ALADIN RUN 00 UTC
BIAIS
ECHEANCE
0
0.5
1
1.5
2
2.5
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48
CLASSE 1
CLASSE 2
CLASSE 3
22-Nov-2002 19:55

Bias. MOS.

PRECIPITATIONS

The Predictand Variable - Precipitations

The Meteorological "Precipitations" parameter has three main characteristics:

- *YES/NO*
- *Quantity*
- *Form*

Within the statistical models this parameter can be treated as:

- *binar predictand* - YES/NO, classes of the precipitations quantity.
- *continuous predictand*, which leads to considering all the precipitation quantity values

Potential Predictors:

- *the average relative moisture in the 1000 - 500 mb layer,*
- *the precipitations forecasted by the dynamic model*
- *the atmopsherical stability*

Class	Definition	Limits(mm)
Class 1	No precipitations	$Q < 0.2$
Class 2	Weak Precipitations	$0.2 \leq Q < 2.0$
Class 3	Moderate to Heavy precipitations	$Q \geq 2$

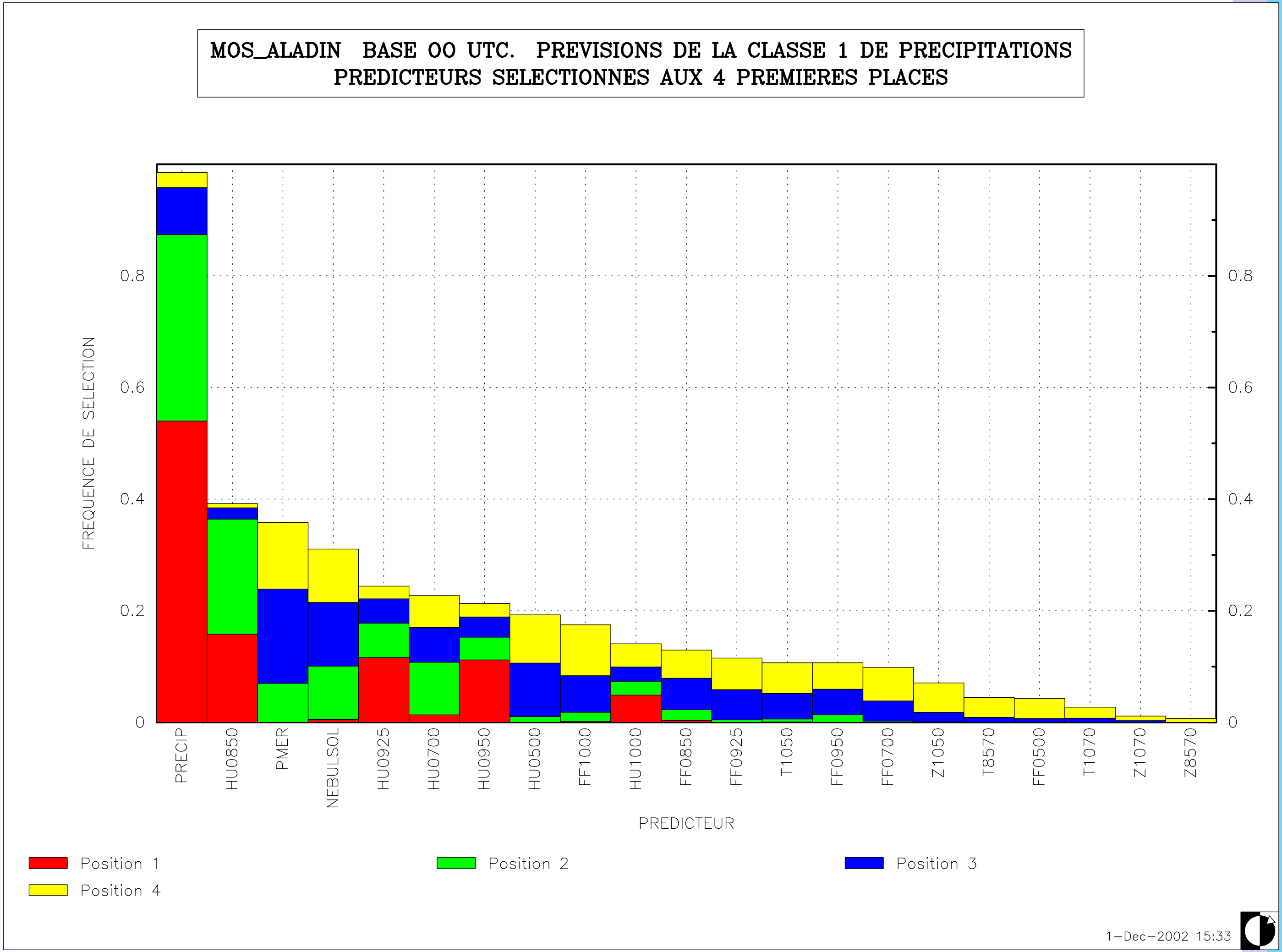
The Methodology used:

- MOS_MDA in three classes.

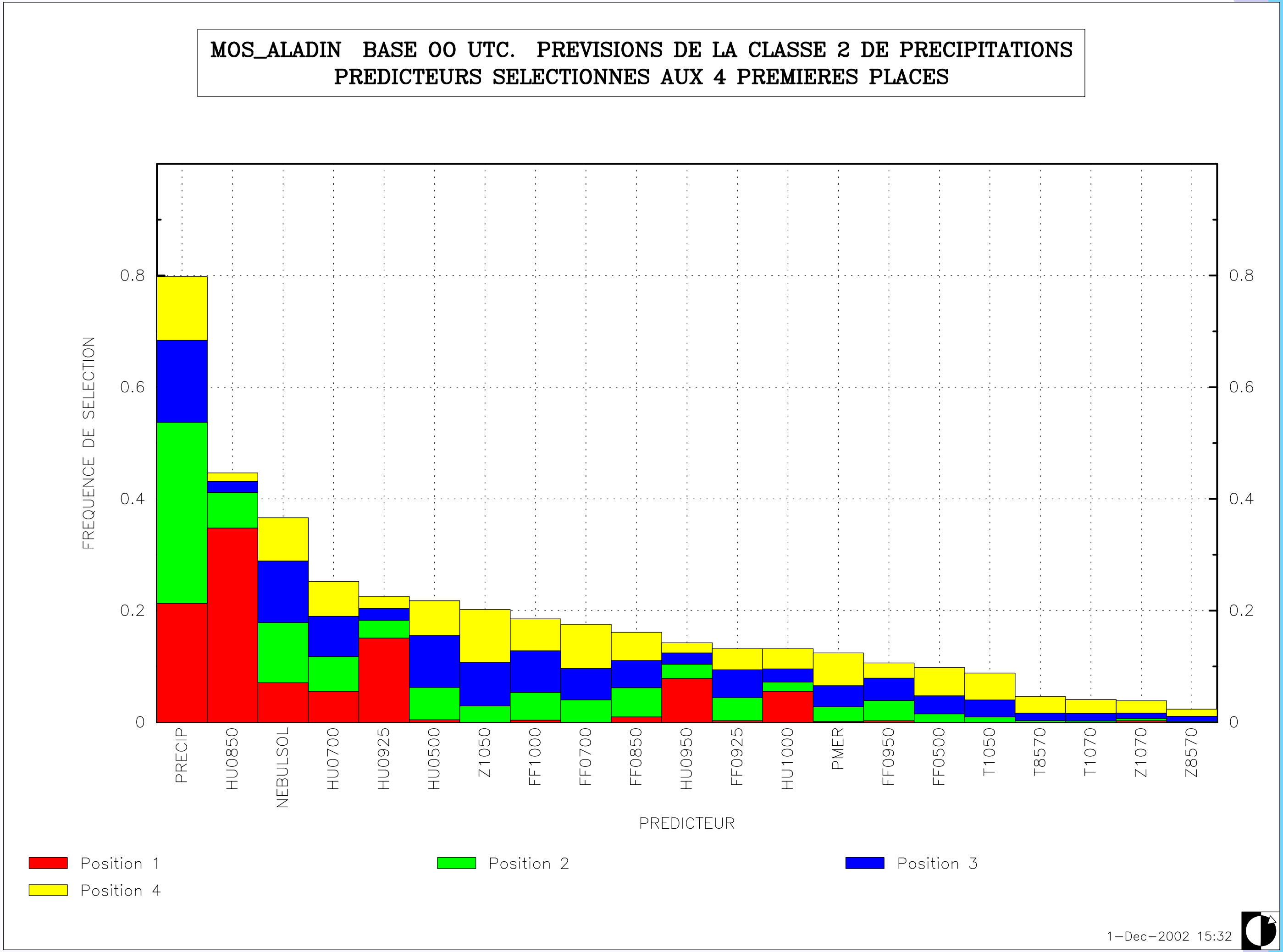
Predictors used

PRECIP NEBULSOL HU1000 HU0950 HU0925 HU0850 HU0700 HU0500 FF1000 FF0950

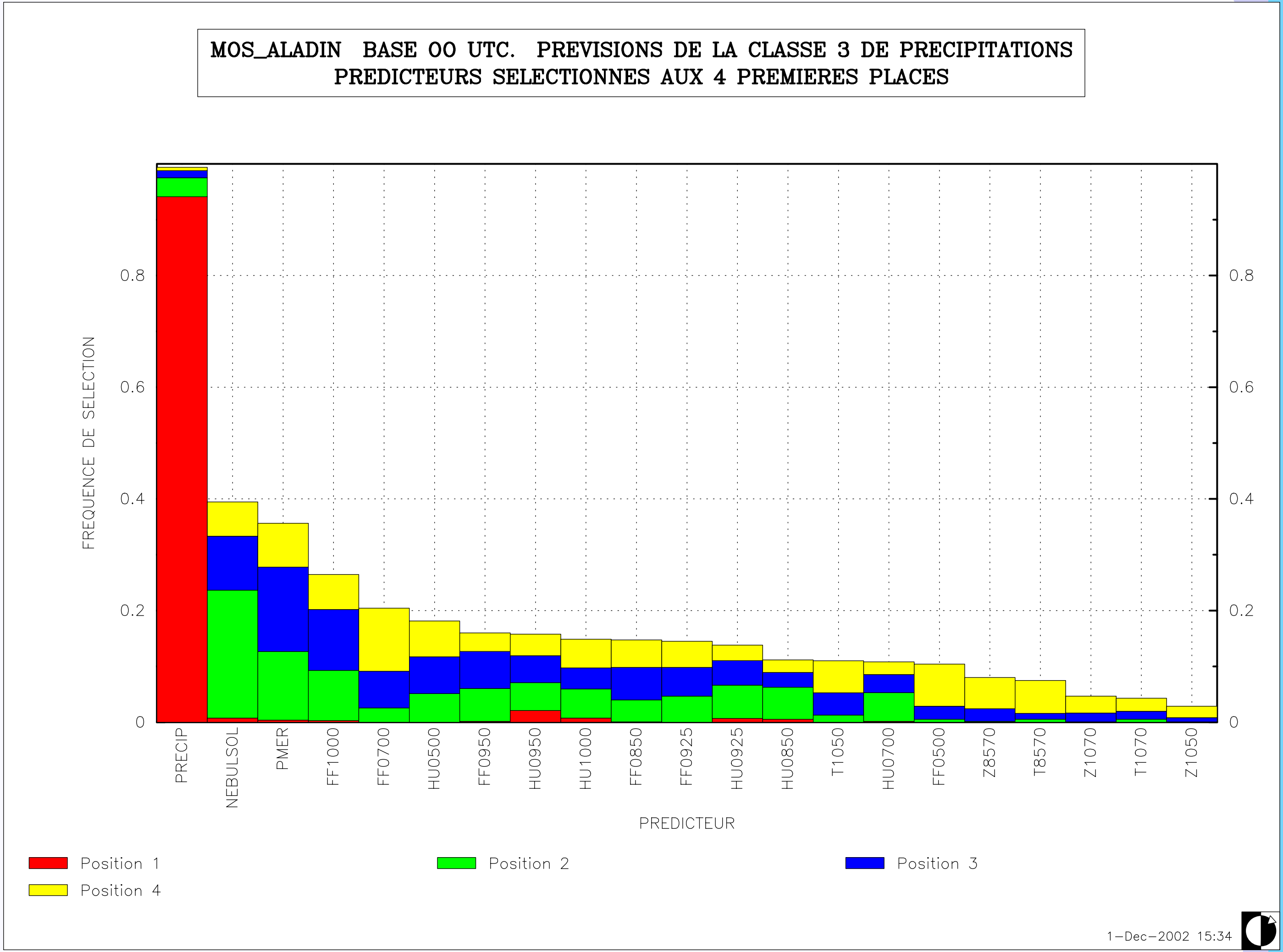
FF0925 FF0850 FF0700 FF0500 Z1070 Z1050 Z8570 T1070 T1050 T8570 PMER



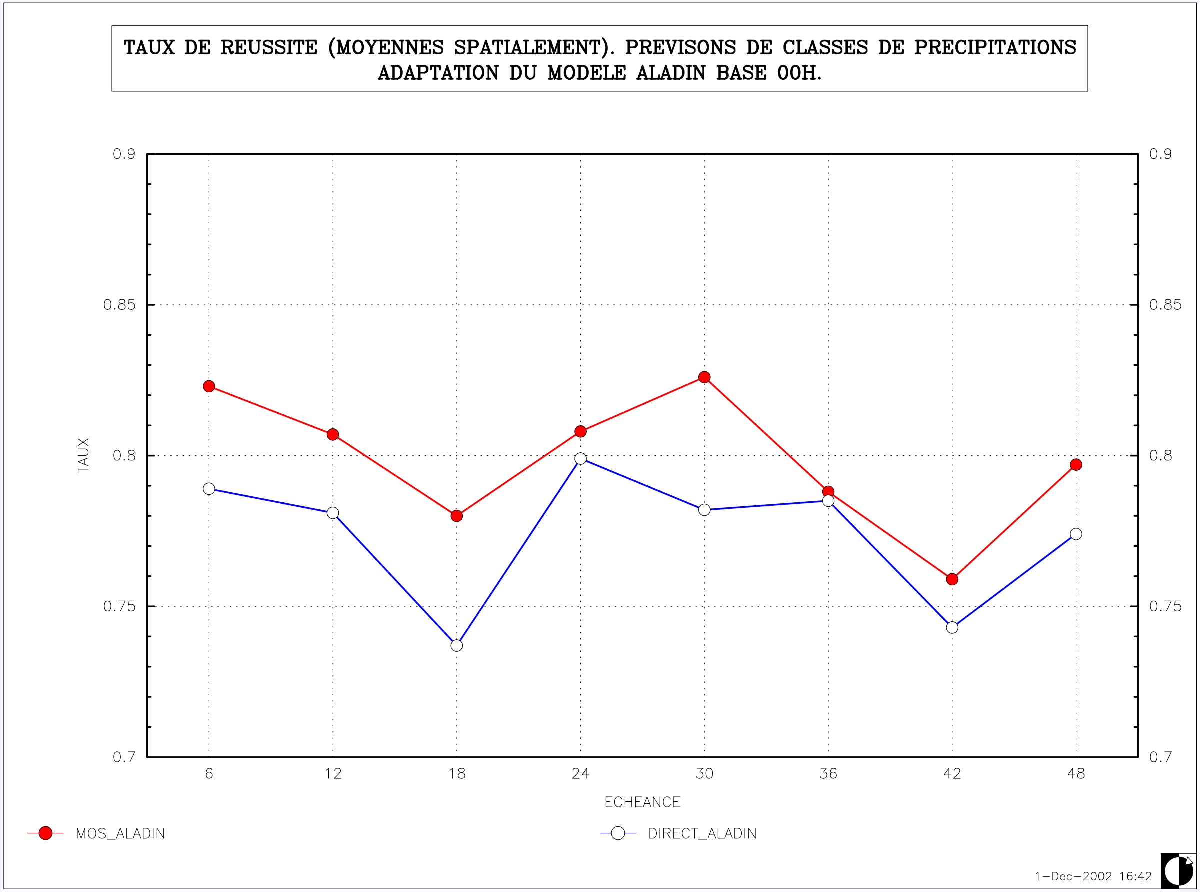
Frequency of selection of predictors. Category 1



Frequency of selection of predictors. Category 2.

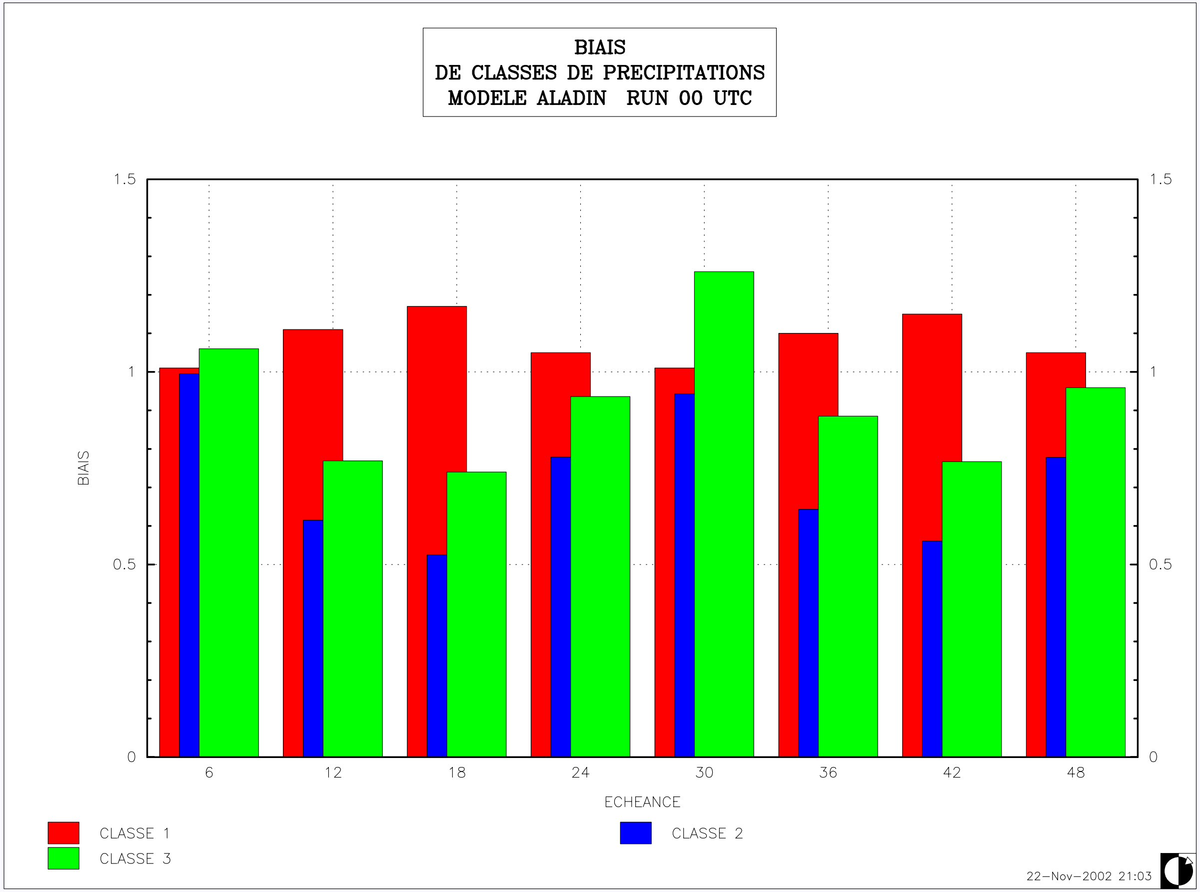


Frequency of selection of predictors. Category 3.

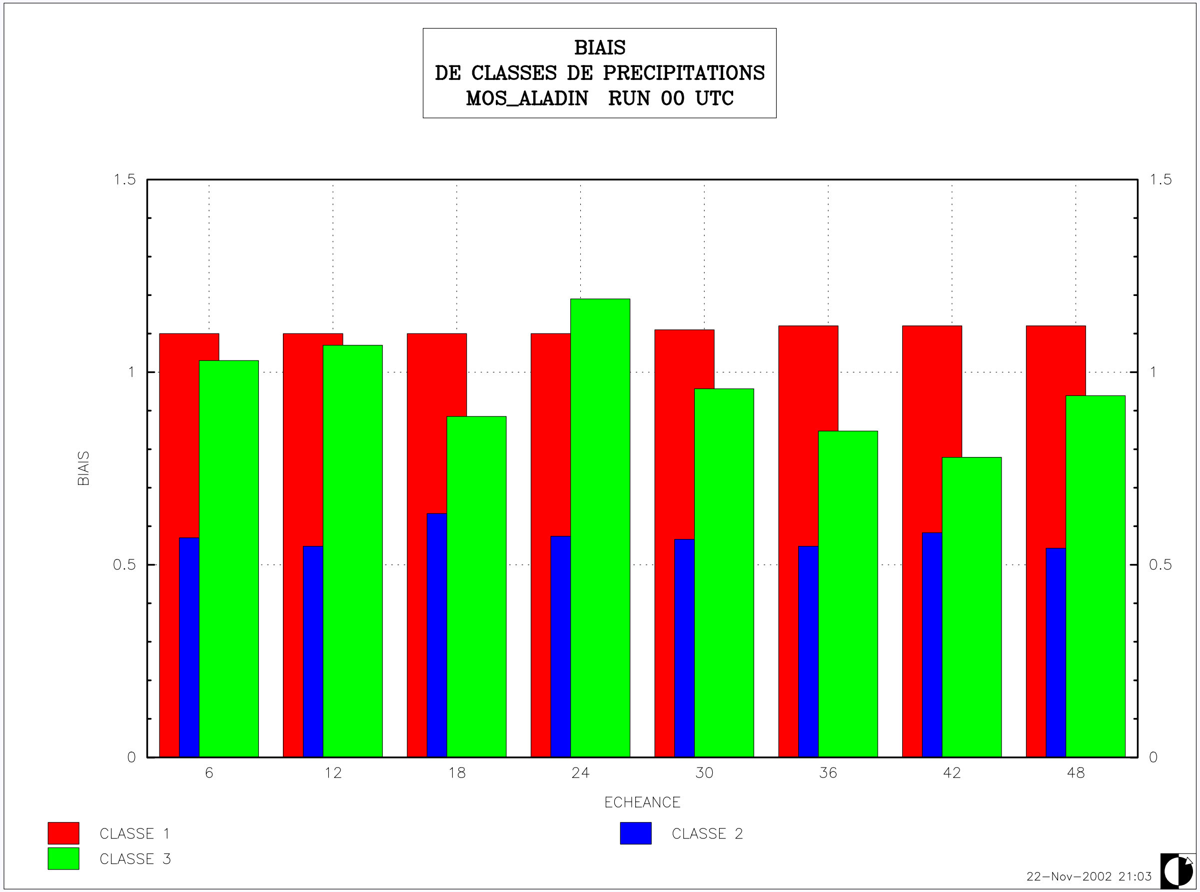


TAUX DE REUSSITE (MOYENNES SPATIALEMENT). PREVISONS DE CLASSES DE PRECIPITATIONS
ADAPTATION DU MODELE ALADIN BASE 00H.
0.9
0.85
0.8
0.75
0.7
TAUX
6
12
18
24
30
36
42
48
ECHEANCE
MOS_ALADIN
DIRECT_ALADIN
1-Dec-2002 16:42

Hit Rate.



Bias. Direct Model Output.


BIAIS
DE CLASSES DE PRECIPITATIONS
MOS_ALADIN RUN 00 UTC
1.5
1
0.5
0
BIAIS
6
12
18
24
30
36
42
48
ECHEANCE
CLASSE 1
CLASSE 2
CLASSE 3
22–Nov–2002 21:03

Bias. MOS.

CONCLUSIONS

This Paper describes:

- **The design and**
- **The Results**

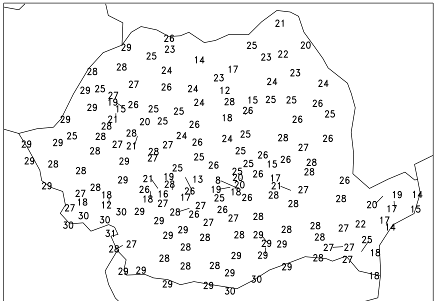
of a new operational MOS_ALADIN system

We are processing by MOS_RLM and MOS_MDA, five predictands:

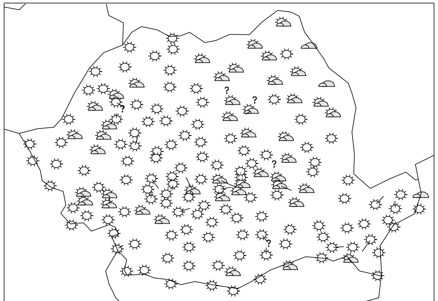
- **2m temperature**
- **Wind (direction and speed)**
- **Total Cloudiness**
- **Cumulated Precipitations within a 6 hour period**

- The present statistical operational system generates a complete array of weather element guidance in support of the 6 to 48-h.
- Forecasts of weather elements are disseminated **twice daily** during the 0000 and 1200 UTC forecasts cycles using ALADIN dynamical models.
- Results for MOS forecasts based on the independent data showed considerable improvment skill over Direct Model Output, for all time projections for **temperatures** and for **wind**.
- Diferences in skill exist between stations in all types of forecast. They may be associated with many factors.
- On the basis of the results presented, it is obvious that remains considerable room for improvement in forecasting total cloudiness and quantitative precipitation, especially amounts exceeding 2.0 mm, or rare events.
- The forecaster in charge has a important mission: to make the consensus forecast using all the informations available.

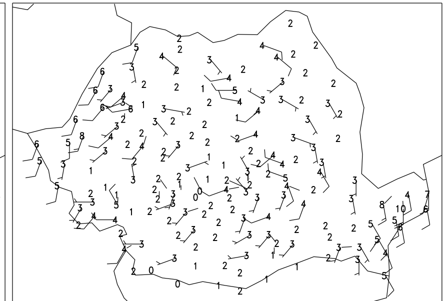
I.N.M.H. – REALIZATA IN 30/04/03 04:25



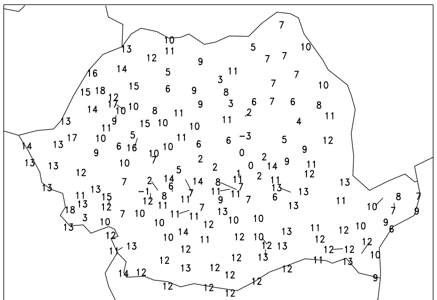
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 101
TEMPERATURA MAXIMA J PENTRU MIE 30/04/03



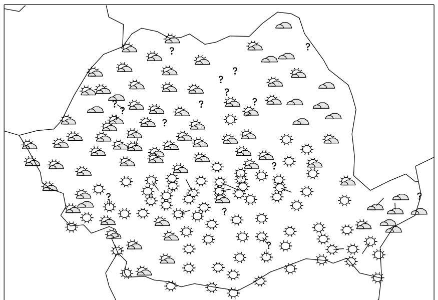
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 104
NEBUL/PRECIP J 12H VALID MIE 30/04/03 12H



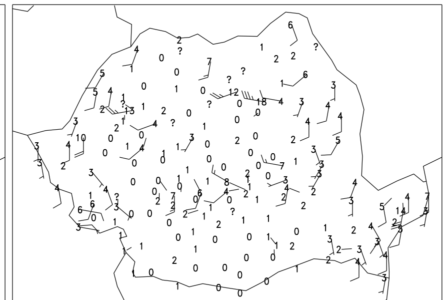
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 107
VINT (VAL. IN M/S) J 12H VALID MIE 30/04/03 12H



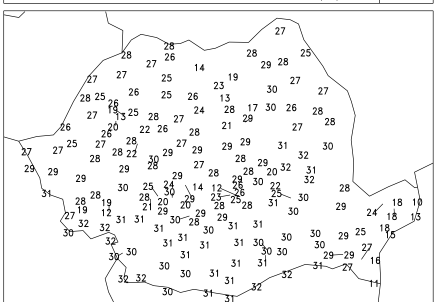
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 102
TEMPERATURA MINIMA J+1 PENTRU JOI 01/05/03



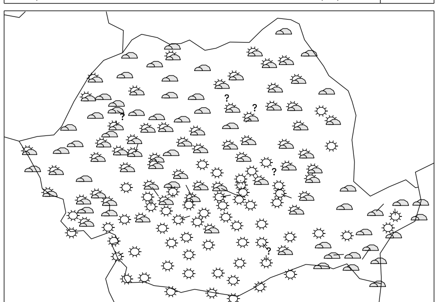
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 105
NEBUL/PRECIP J+1 00H VALID JOI 01/05/03 00H



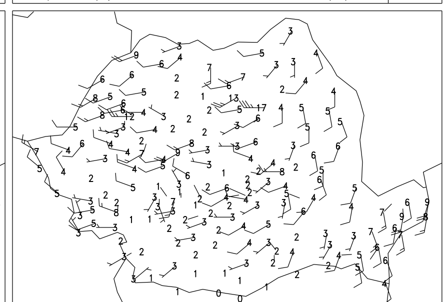
MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 108
VINT (VAL. IN M/S) J+1 00H VALID JOI 01/05/03 00H



MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 103
TEMPERATURA MAXIMA J+1 PENTRU JOI 01/05/03



MODEL STATISTIC ALADIN (MOS VER. NOV 20002 BAZA MIE 30/04/03 00H 106
NEBUL/PRECIP J+1 12H VALID JOI 01/05/03 12H



MODEL STATISTIC ALADIN (MOS VER. NOV 2002) BAZA MIE 30/04/03 00H 109
VINT (VAL. IN M/S) J+1 12H VALID JOI 01/05/03 12H

Acknowledgements

This work was suported by the research fund for science promotion from METEO FRANCE.

The autor is grateful to the METEO FRANCE/DP/DPrevi/Compas/AS, especially to Serge FARGES and Frederic ATGER for giving practical support and for helpful discussion.

Thank you for your attention!