

INTRODUCTION

THE REQUENA-UTIEL AQUIFER

- Currently mined for vineyard (DO Utiel-Requena), olive and almond trees
- Recently declared in bad quantitative status (piezometric decline)
- A yearly pumping cap depending on the precipitation is set by the RBA

NEED

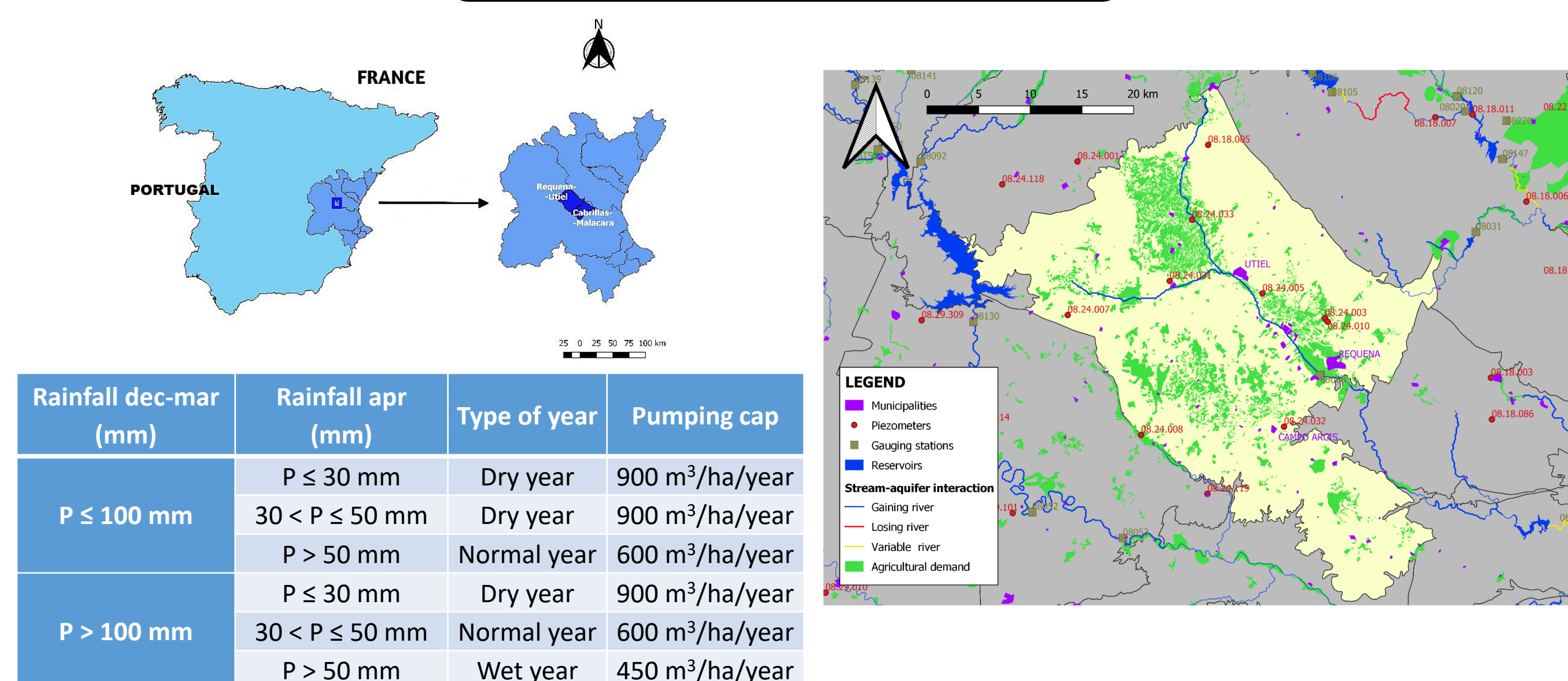
- Foresee beforehand the type of year to schedule pumping and crop production

GOAL & APPROACH

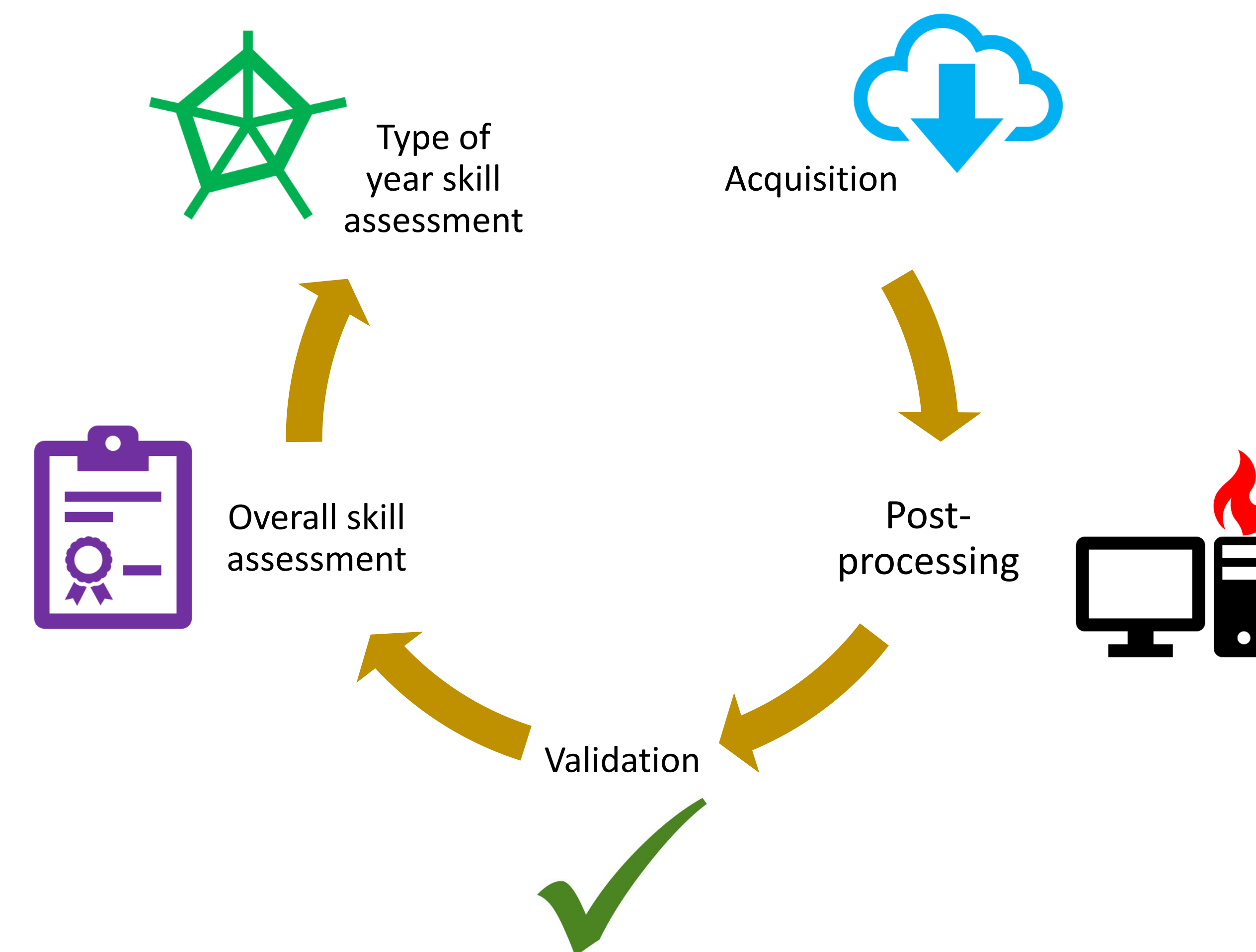
GOAL: Analyse the ability of seasonal meteorological forecasts from the Copernicus C3S to anticipate the type of year in the Requena-Utiel irrigated areas

APPROACH: month-dependent post-processing with linear scaling (refence: Spain02 dataset), general skill assessment and type-of-year skill assessment

CASE STUDY



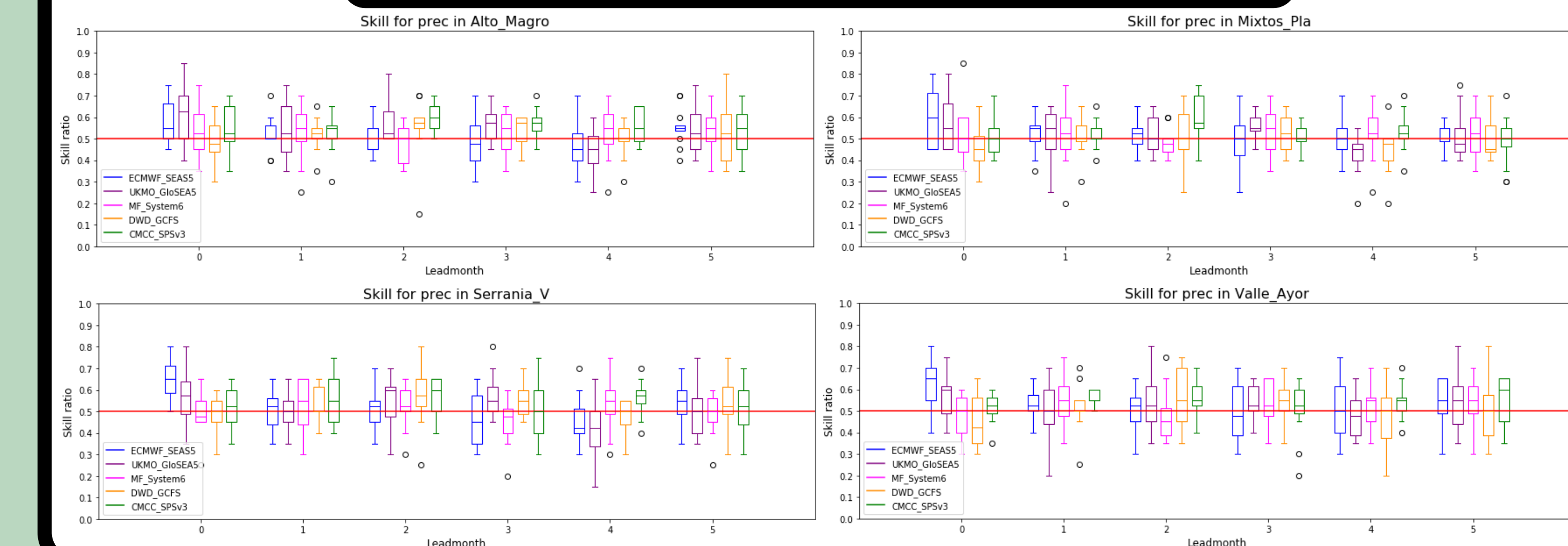
METHODOLOGY



EXPERIMENTAL SETUP

- Analysis period: 1995 – 2015, from November 1st to April 1st
- Forecast products: ECMWF SEAS5, UKMO GloSEA5, MétéoFrance System6, DWD GCFS and CMCC-SPS
- Post-processing method: month-dependent linear scaling
- Reference dataset: [Spain02 v5](#)
- Index for validation and overall skill assessment: Mean Absolute Error (MAE)
- Index for type of year skill assessment: hit ratio (%)

OVERALL SKILL RESULTS



TYPE OF YEAR SKILL RESULTS

	ALTO MAGRO	MIXTOS PLANA	SERRANIA VALENCIA	VALLE DE AYORA
DRY	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS
NORMAL	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS
WET	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS	GO TO RESULTS

CONCLUSIONS

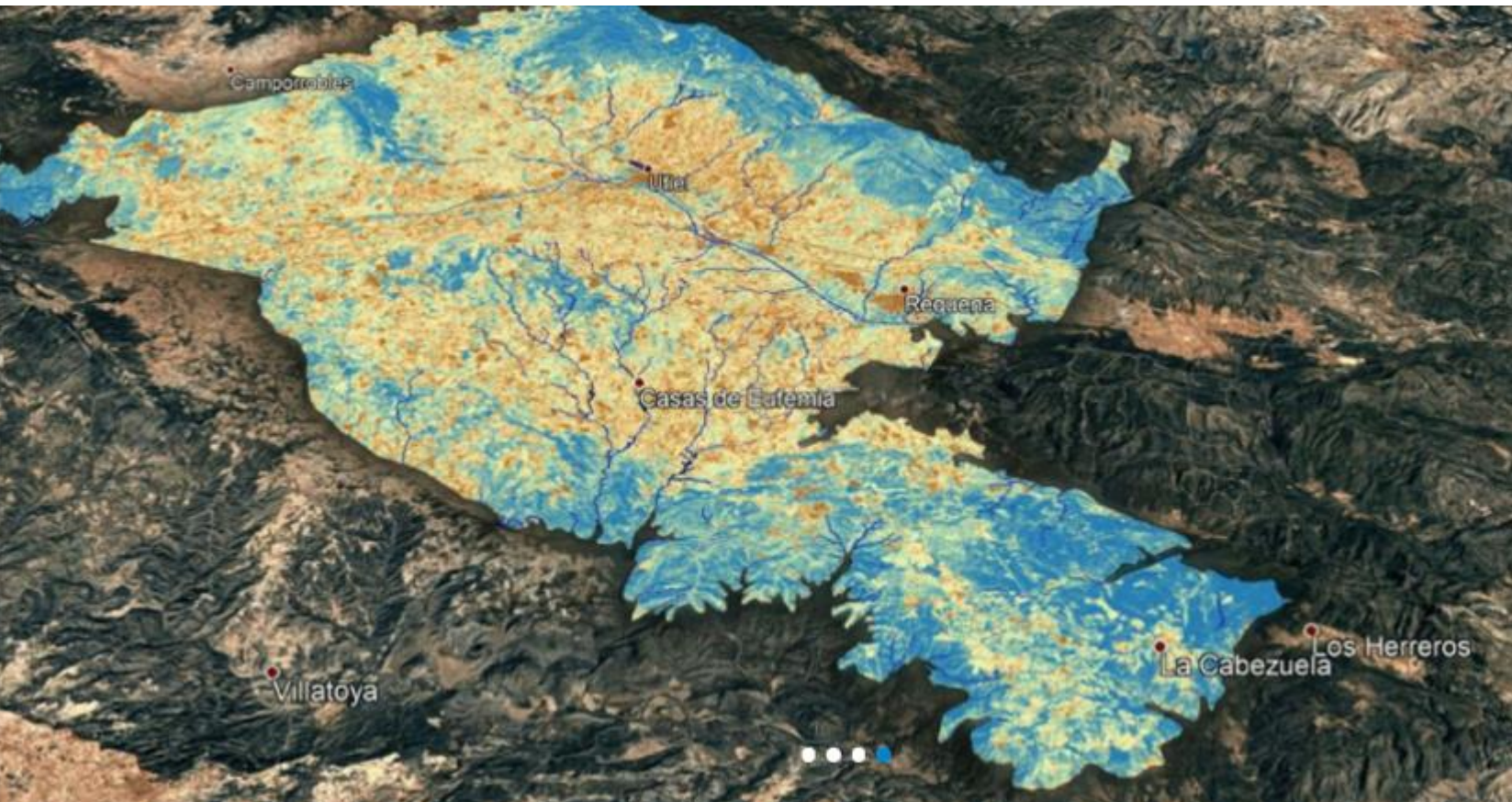
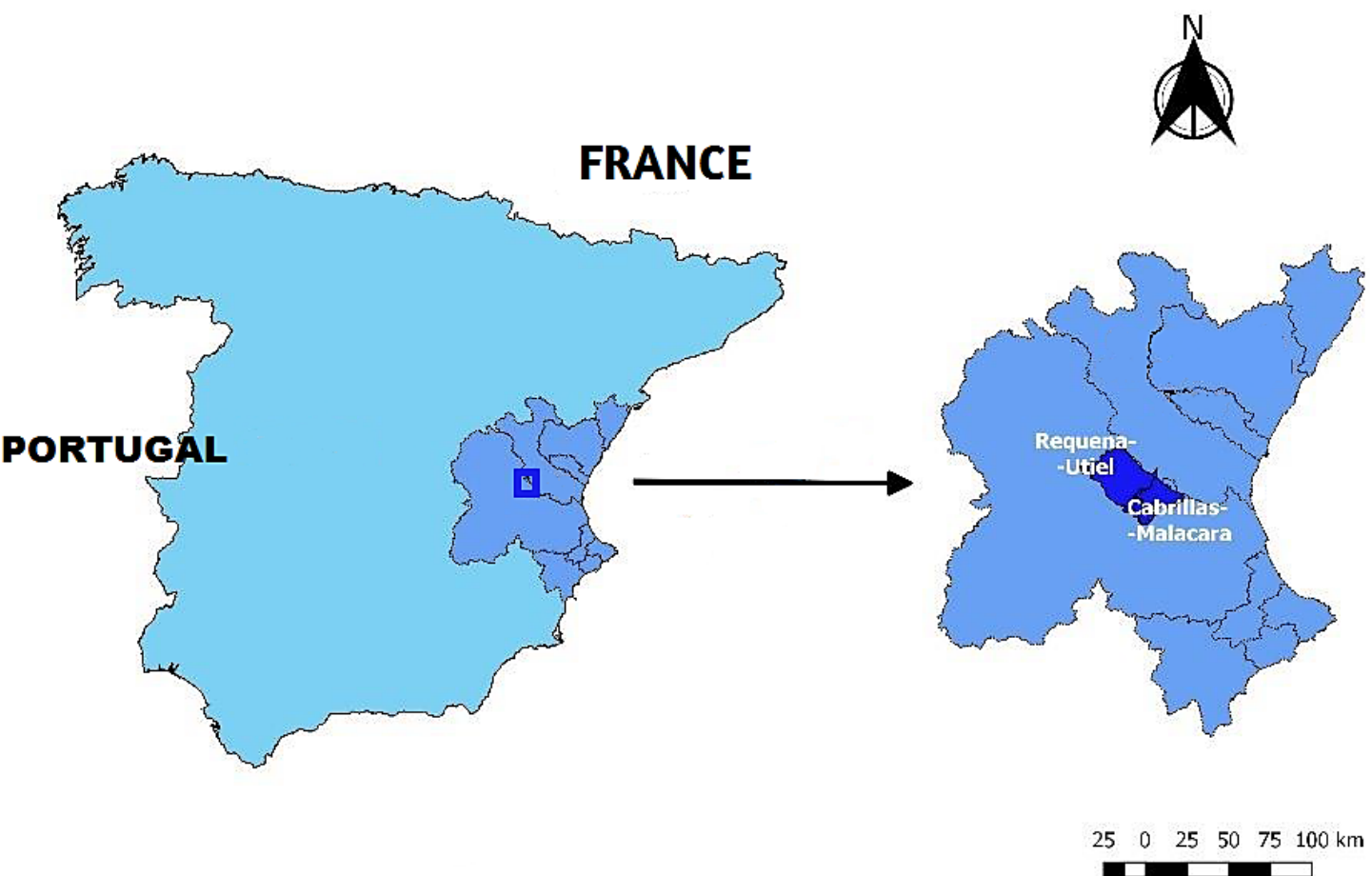
- In general, the type of year can only be safely anticipated in April 1st
- Some services have skill in predicting some particular types of year even in Nov
- Dry years are easier to predict than normal and wet years
- There is a direct relationship between the strength of the signal and the skill

FORECASTING GROUNDWATER PUMPING CAP IN AN OVEREXPLOITED MEDITERRANEAN AQUIFER USING SEASONAL METEOROLOGICAL FORECASTS FROM COPERNICUS CLIMATE CHANGE SERVICE

Adria Rubio-Martin, Hector Macian-Sorribes, Esther Lopez-Perez, Alberto Garcia-Prats, Juan Manzano-Juarez, Miguel Angel Jimenez-Bello, and Manuel Pulido-Velazquez

CASE STUDY: THE REQUENA-UTIEL AQUIFER

LOCATION AND FEATURES



Rainfall dec-mar (mm)	Rainfall apr (mm)	Type of year	Pumping cap
P ≤ 100 mm	P ≤ 30 mm	Dry year	900 m³/ha/year
	30 < P ≤ 50 mm	Dry year	900 m³/ha/year
	P > 50 mm	Normal year	600 m³/ha/year
P > 100 mm	P ≤ 30 mm	Dry year	900 m³/ha/year
	30 < P ≤ 50 mm	Normal year	600 m³/ha/year
	P > 50 mm	Wet year	450 m³/ha/year

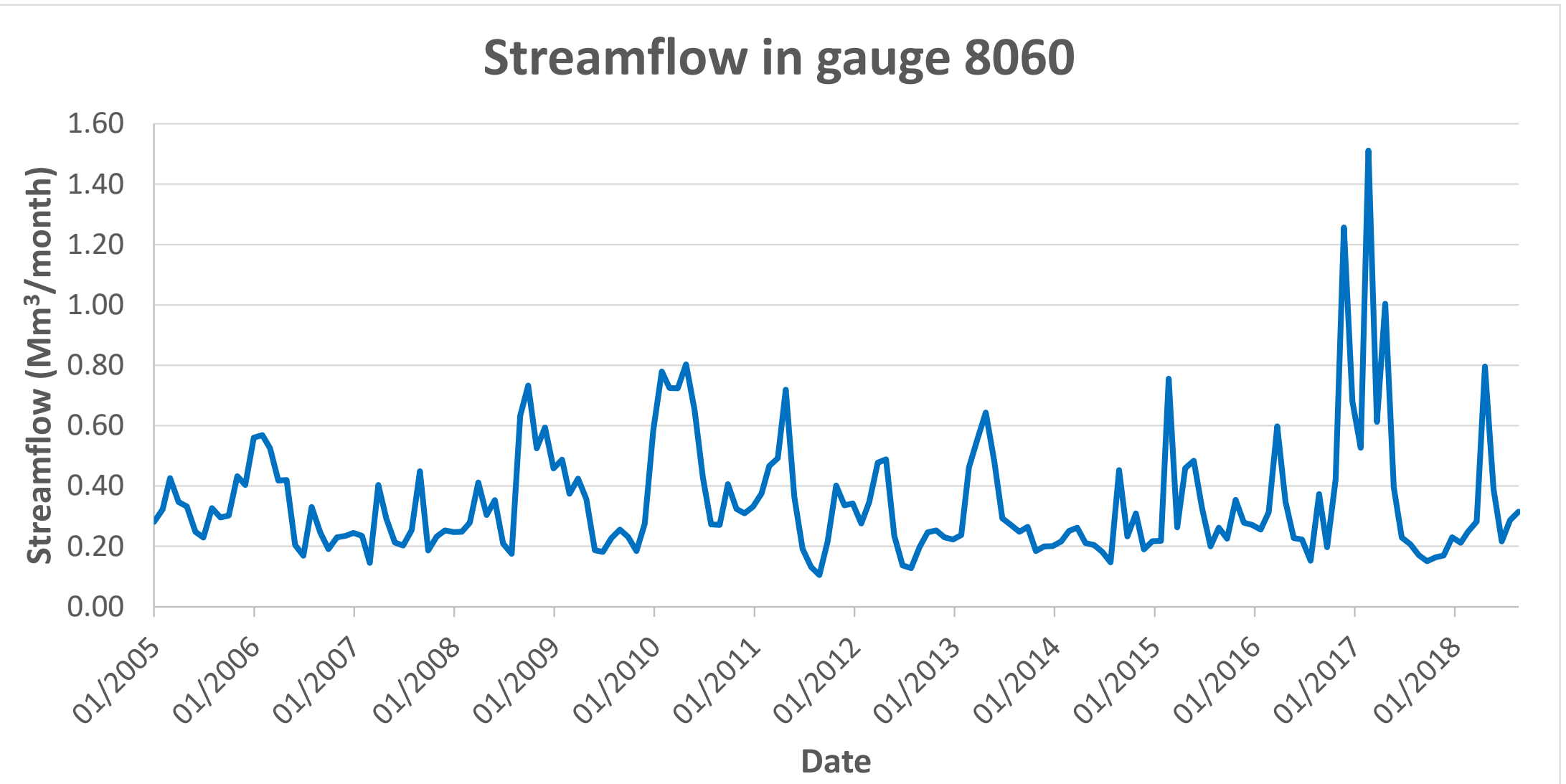
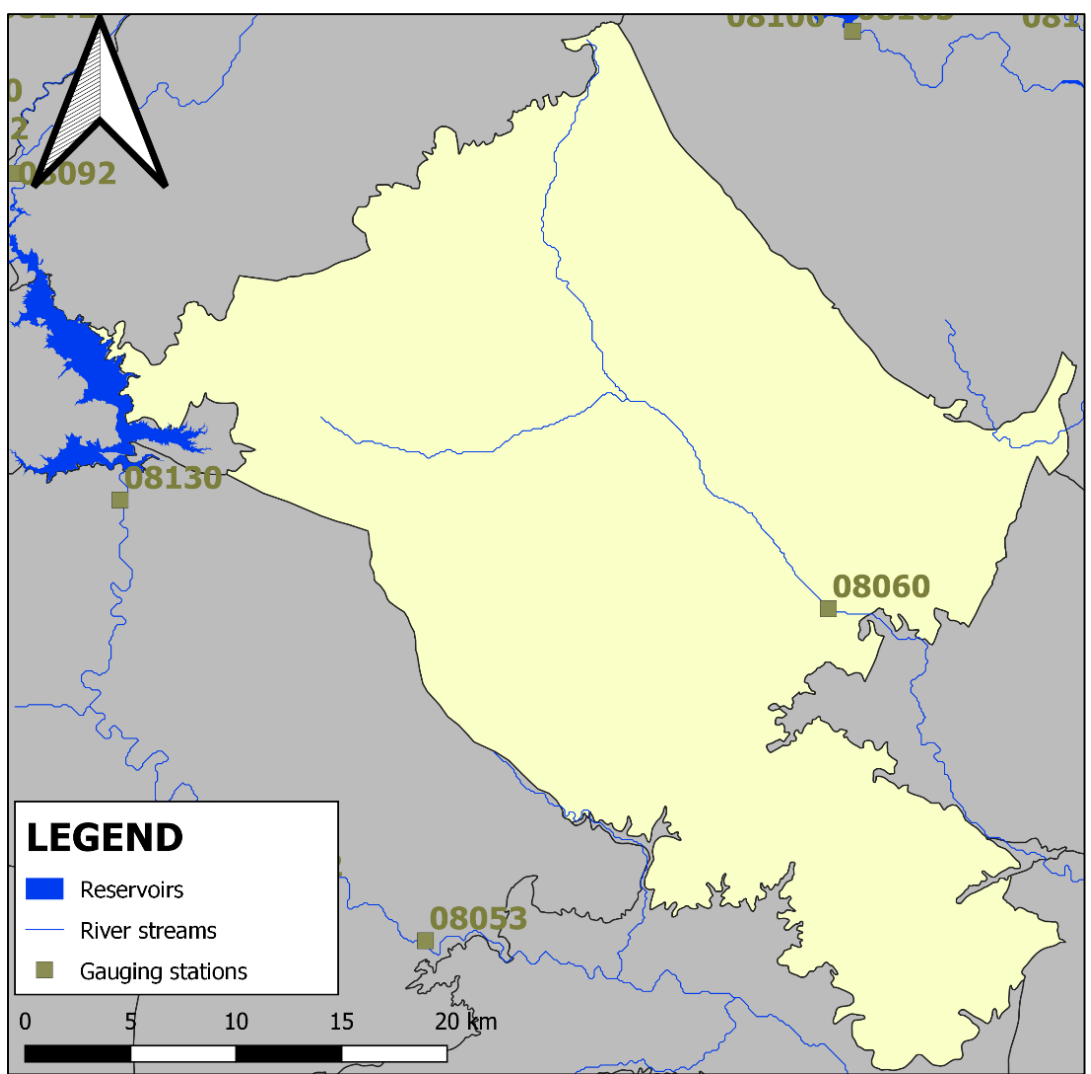
- **AREA:** 988 km²
- **IRRIGATED AREA:** 25 ha
- **TOPOGRAPHY:** Plateau
- **RECHARGE:** Rainfall and irrigation returns
- **CROP TYPES:** Vineyard, almond and olive trees
- **GOVERNANCE:** Central Board of Water Users and Jucar River Basin Authority
- **MANAGEMENT:** Pumping cap according to the type of year (dry, normal and wet)

The Requena-Utiel aquifer was declared in **bad quantitative status** by the water authority of the basin in 2015. A management plan was developed in 2016 in order to improve the quantitative status of the aquifer and to guarantee its sustainable exploitation.

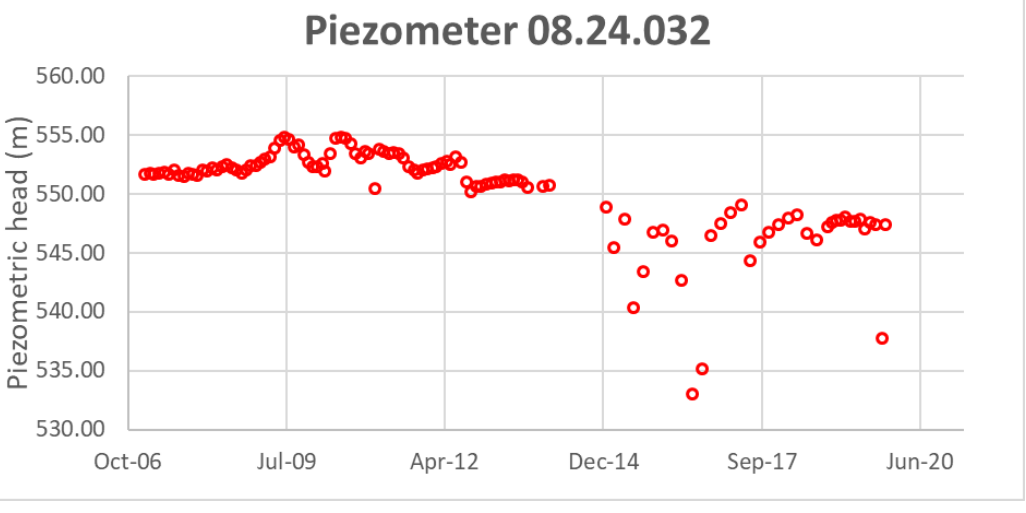
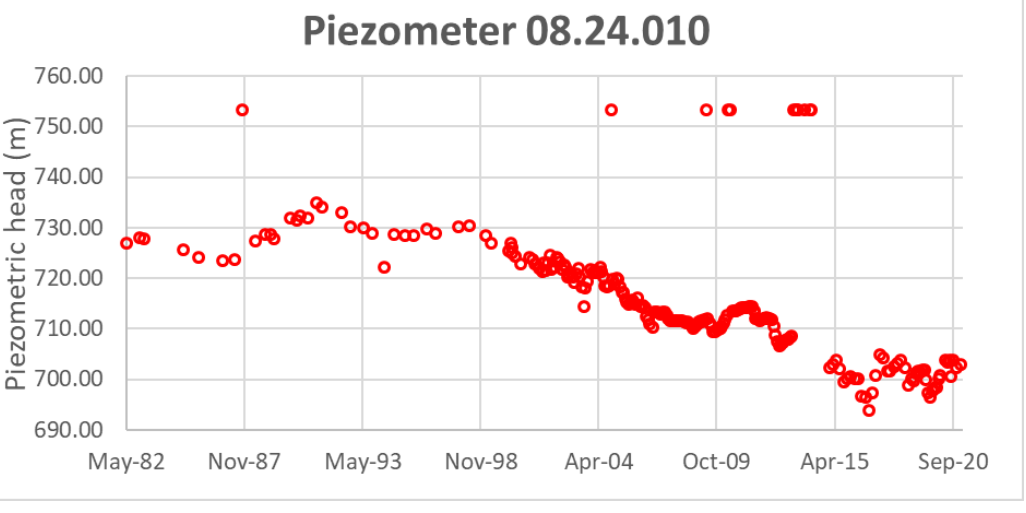
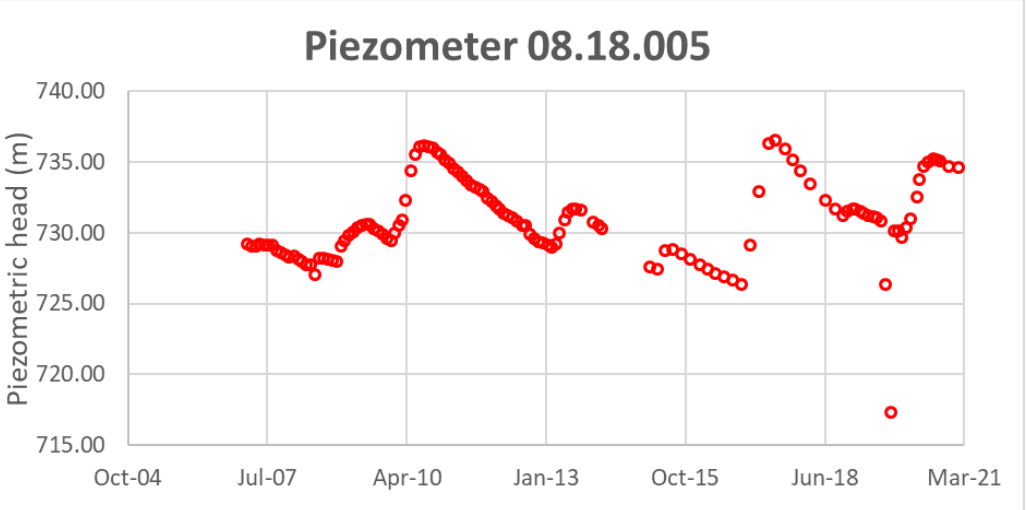
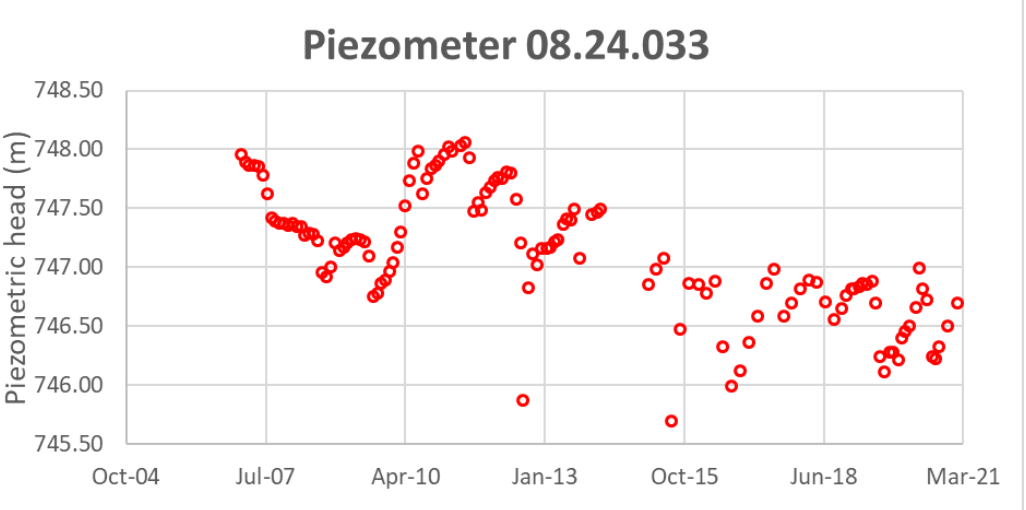
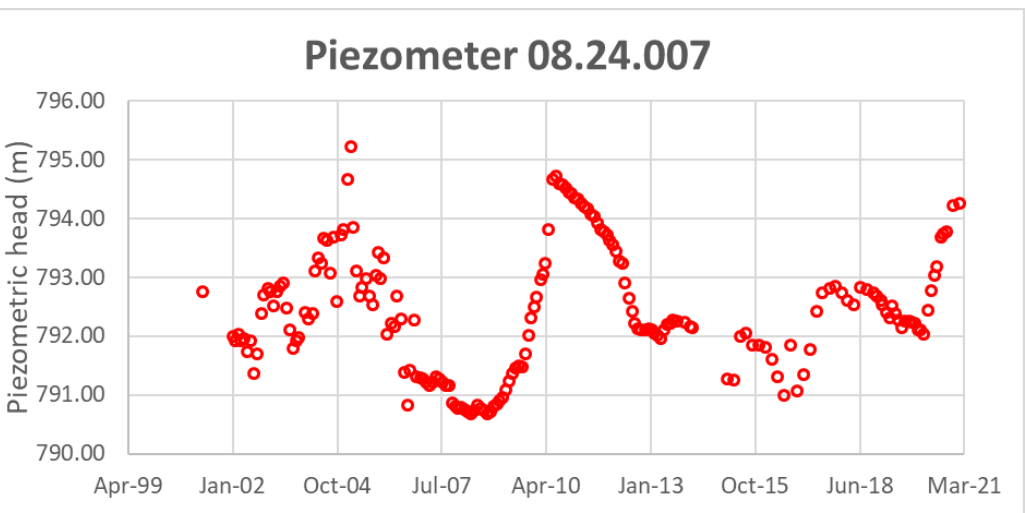
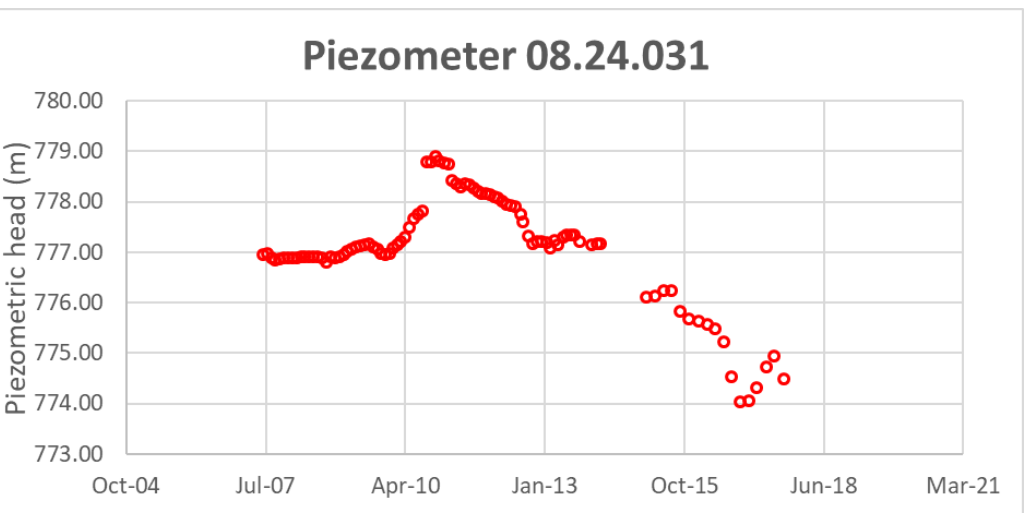
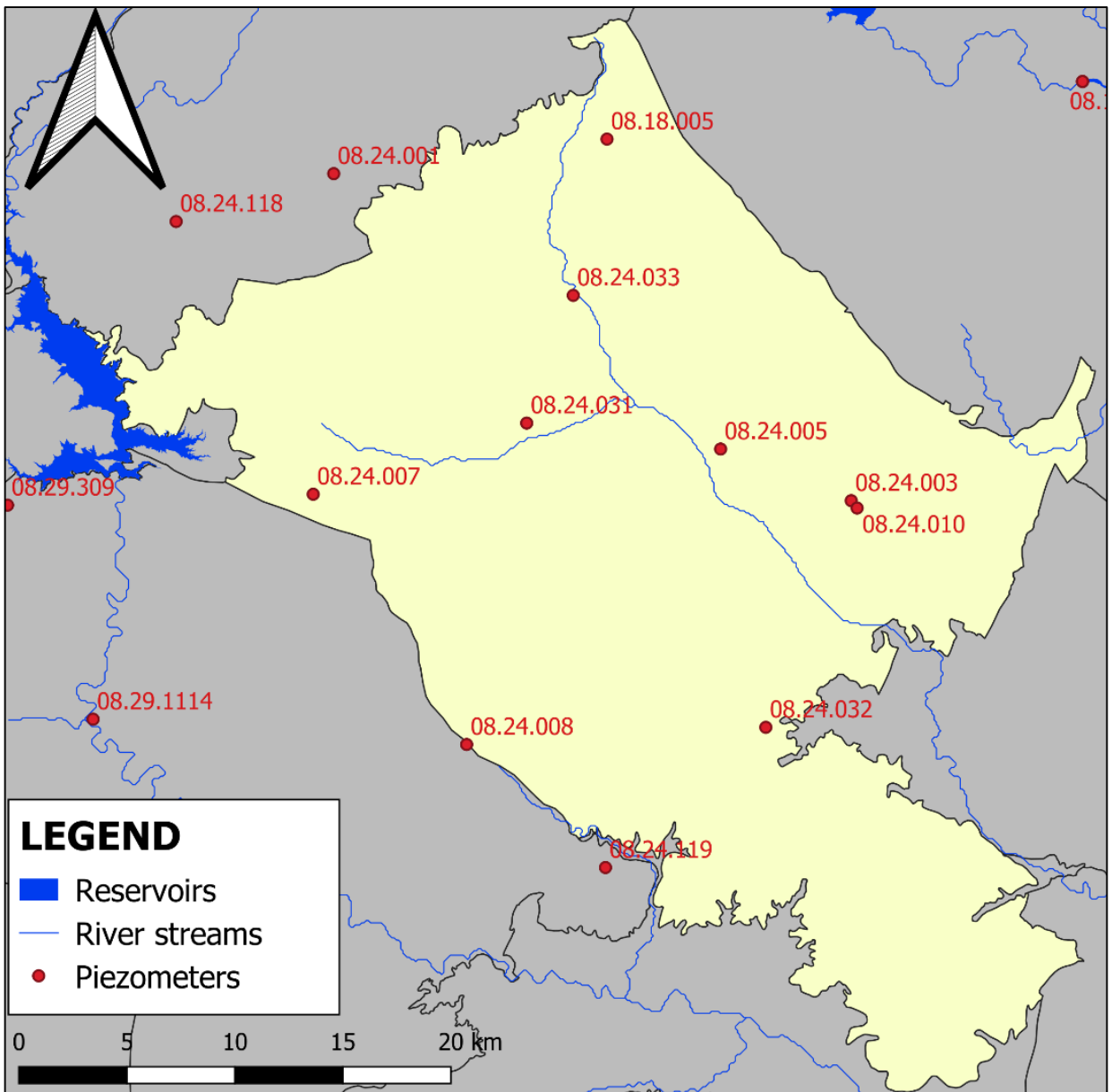
Since then, users have created a Central Board of Water Users and researchers are striving to provide them with tools and data to improve the management and knowledge of the aquifer.

WATER RESOURCES

SURFACE WATER



GROUNDWATER



METHODOLOGY

ACQUISITION

- Seasonal forecasts source: Climate Data Store of the Copernicus Climate Change Service (C3S, <https://cds.climate.copernicus.eu#!/home>)
- Reference data source: Spain02 v5 gridded dataset (<http://www.meteo.unican.es/datasets/spain02>)
- Seasonal forecasts retrieved using the CDS API and automatically parsed to the case study area through a Python script
- Reference data retrieved from direct download and automatically parsed to the case study are through a Python script

VALIDATION AND SKILL INDICES

- Index: Mean Absolute Error (MAE)

$$MAE_t = \frac{1}{N} \sum_{i=1}^N |F_{t,i} - O_t|$$

- t: time step
- i: ensemble member
- N: ensemble size
- F: forecast
- O: observation

- Skill score: Mean Absolute Error Skill Score (MAESS)

$$MAESS_t = 1 - \frac{MAE_{F,t}}{MAE_{B,t}}$$

- F: given forecasting system
- B: benchmark forecast

OVERALL SKILL ASSESSMENT

- Benchmark alternative: no forecasts (using the probability distribution functions of the meteorological observations)
- Analysis performed by agricultural demands, month, leadmonth and forecasting service
- Forecasts show skill for a given demand, month and leadmonth if the skill score tends to take positive values

POST-PROCESSING

- Method: product and month dependent linear scaling ([Crochemore et al., 2016](#))

$$Post - processed = a + b * raw$$

- Adjustment of linear scaling coefficients: Non-linear programming using Python (scipy optimize library)

VALIDATION

- Goal: measure the impact that post-processing has on the forecasting skill
- Process:
 - Calculus of indices before and after post-processing
 - Calculation of skill scores for post-processing forecasts using raw forecasts as benchmark
 - Analysis of skill scores
 - Decision: accept current post-processing or reformulate it

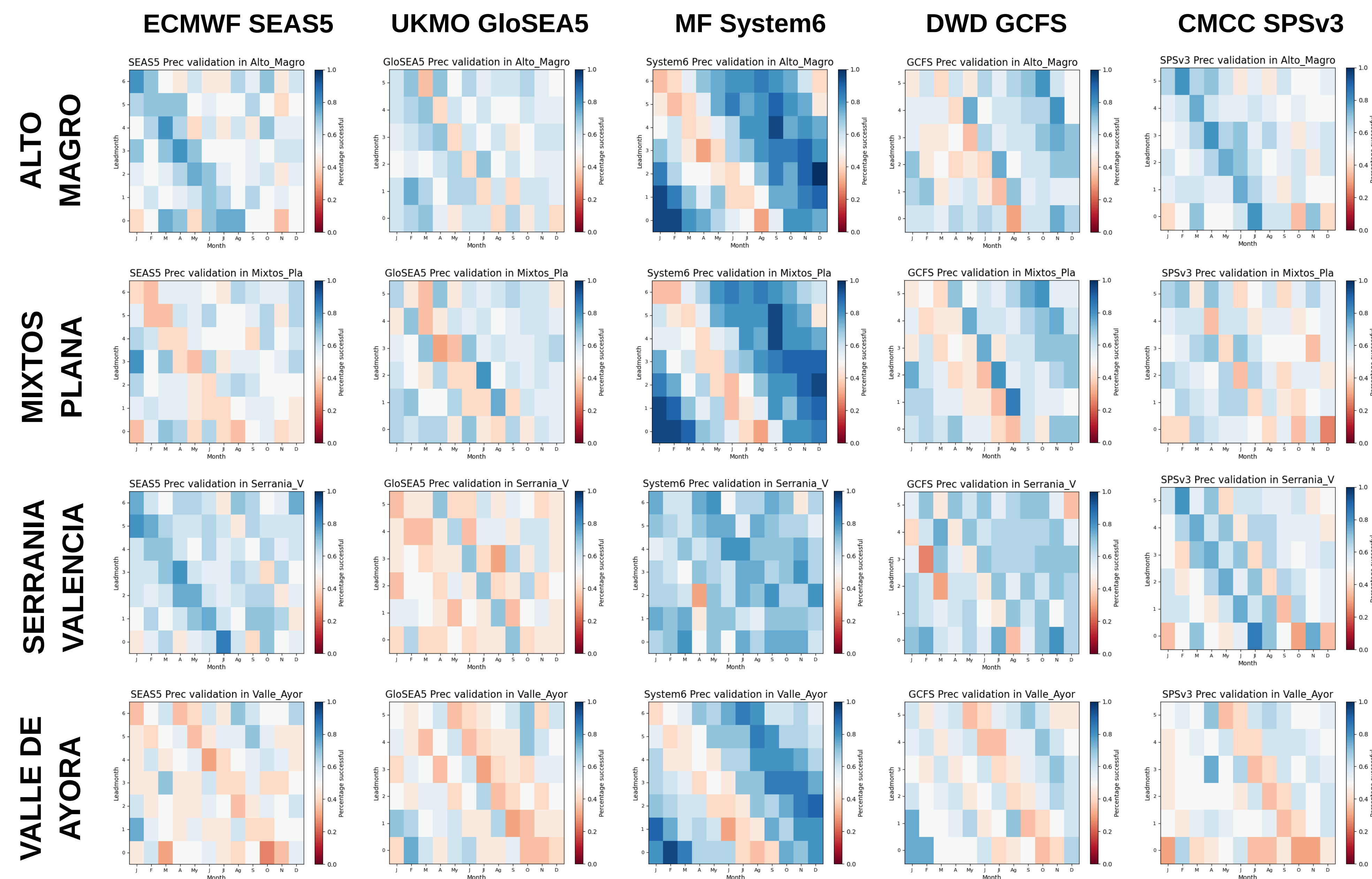
[Go to validation results](#)

TYPE OF YEAR SKILL ASSESSMENT

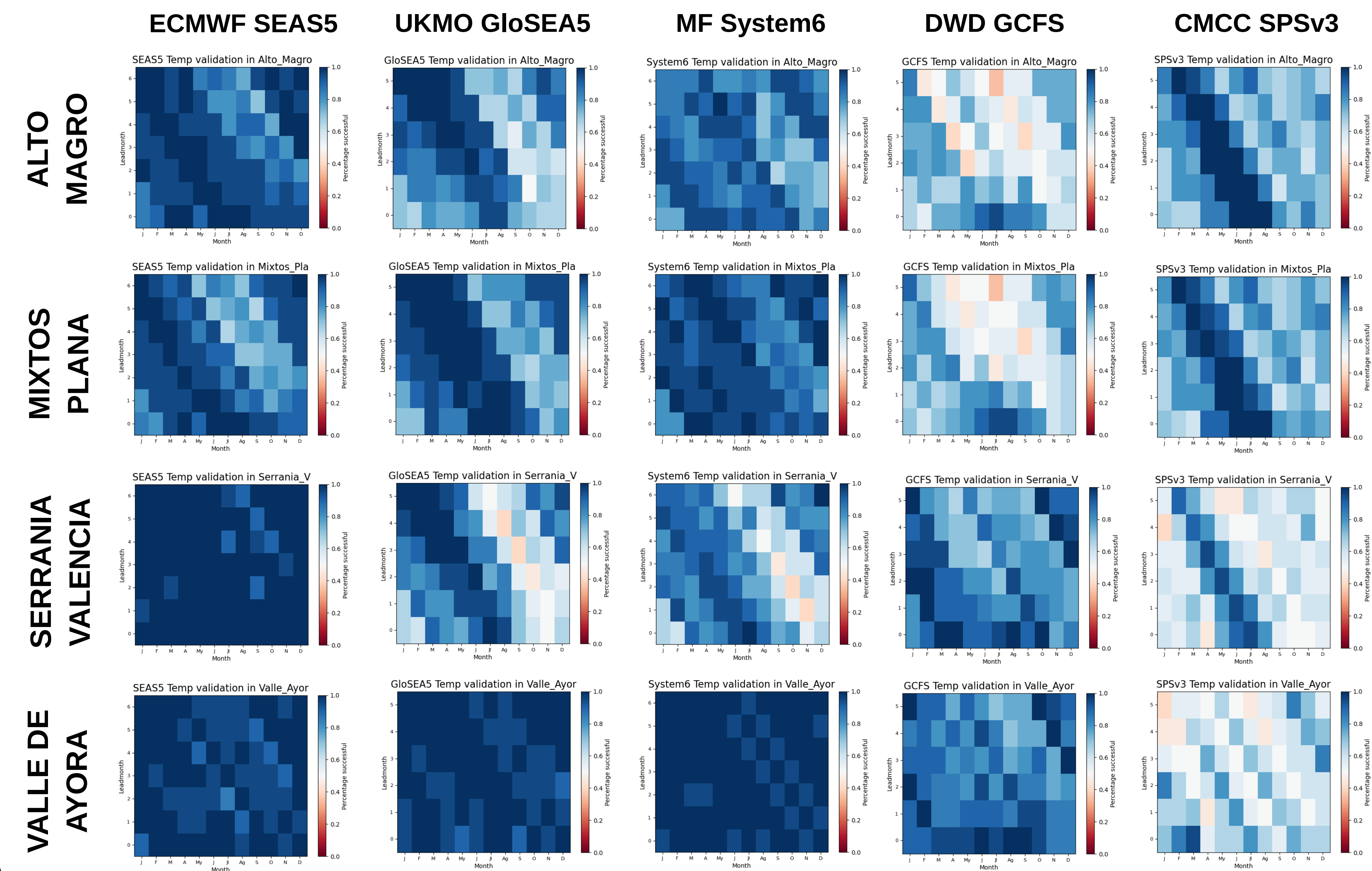
- Analysis performed for forecasts starting from November (6 months in advance) to April (1 month in advance), by agricultural demand and service
- Analysis made by type of year (dry, normal, wet) and thresholds to decide (None, 50% of ensemble members, 55%, 60%, 65%, 70%, 75%). If threshold is not met, no decision is made
- Score: hit ratio (percentage of years in which the type of year is adequately forecasted)
- Forecasts show value if hit ratio is higher than 50%

VALIDATION RESULTS

PRECIPITATION



TEMPERATURE

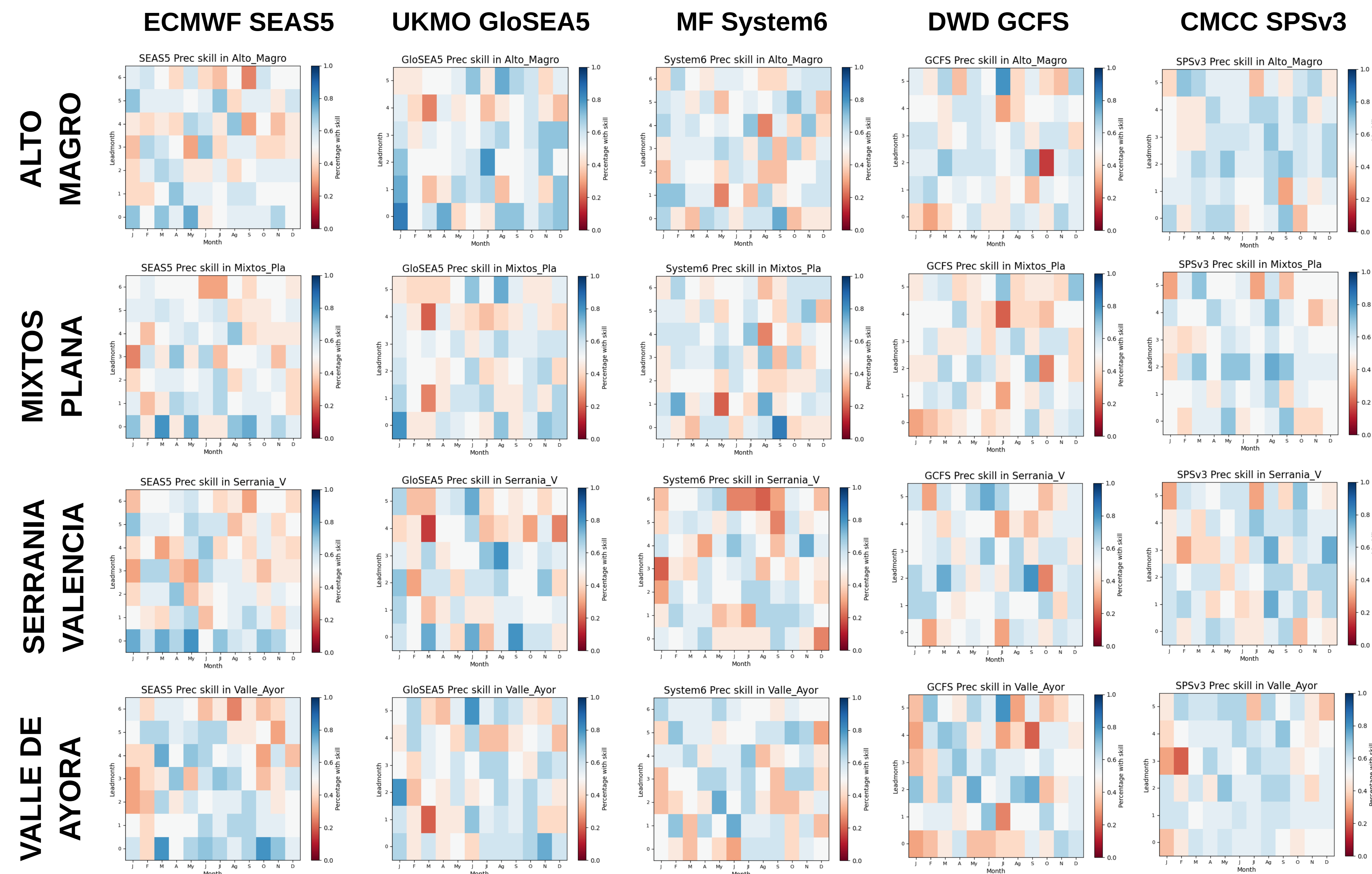


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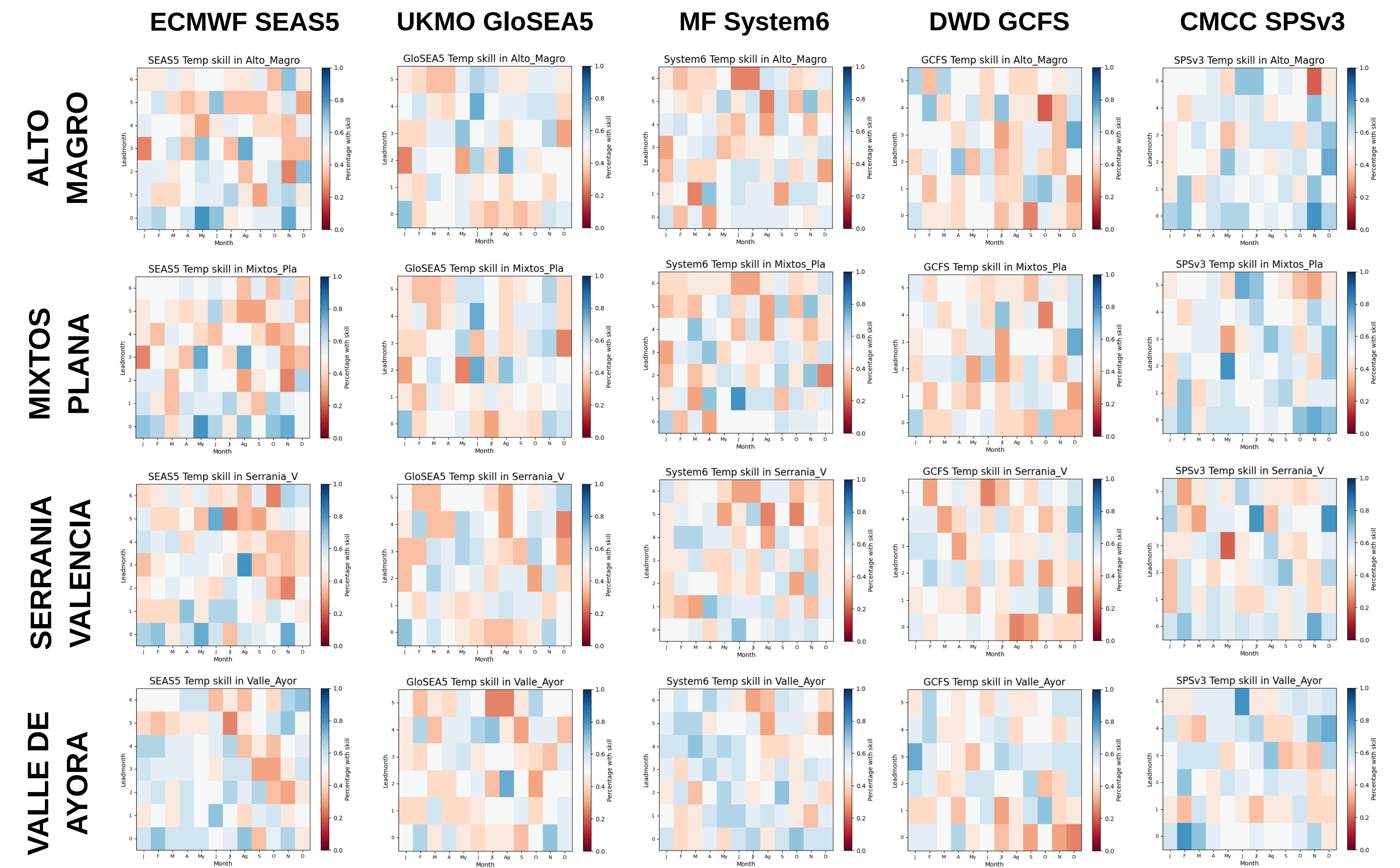
¹ Universitat Politècnica de València, Research Institute of Water and Environmental Engineering (IIAMA)

OVERALL SKILL RESULTS

PRECIPITATION



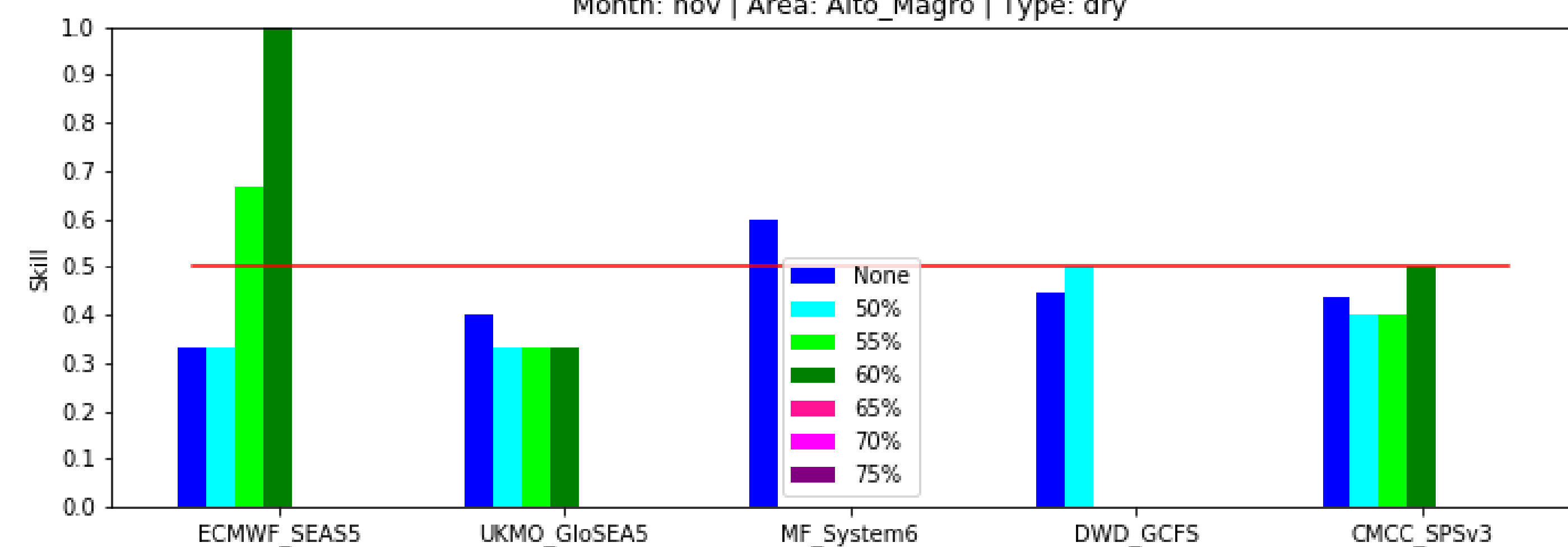
TEMPERATURE



TYPE OF YEAR SKILL RESULTS: DRY YEAR FORECASTING IN ALTO MAGRO DEMAND

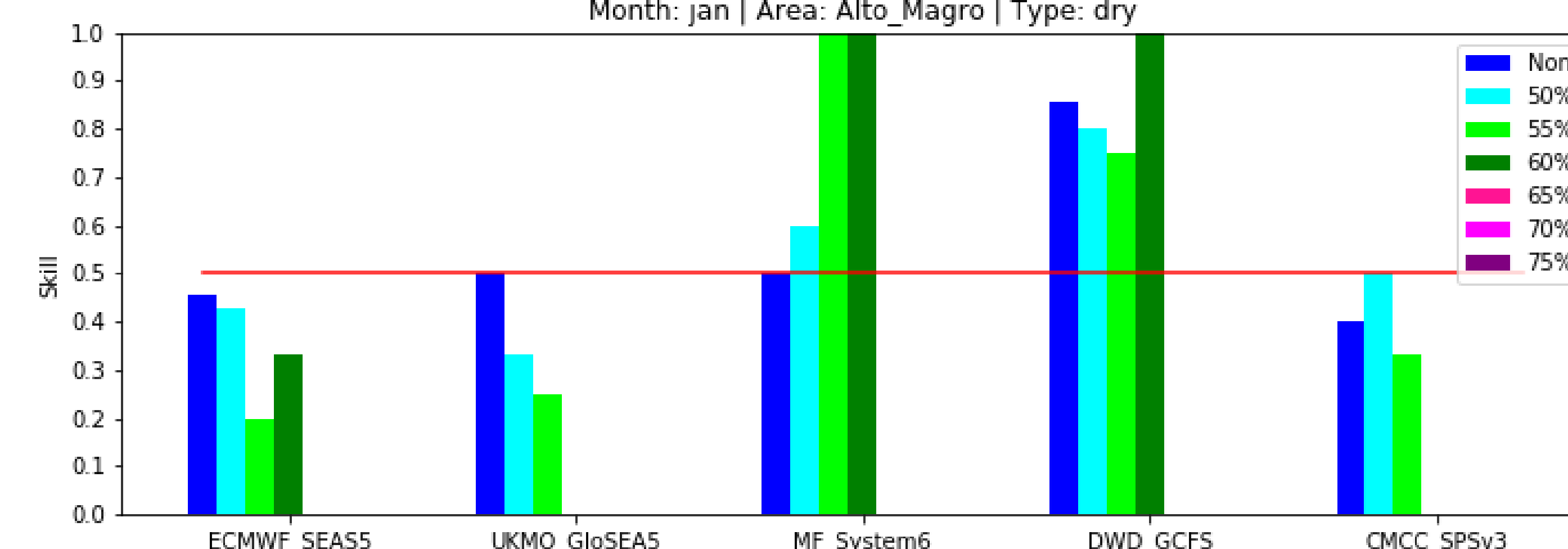
NOVEMBER

Month: nov | Area: Alto_Magro | Type: dry



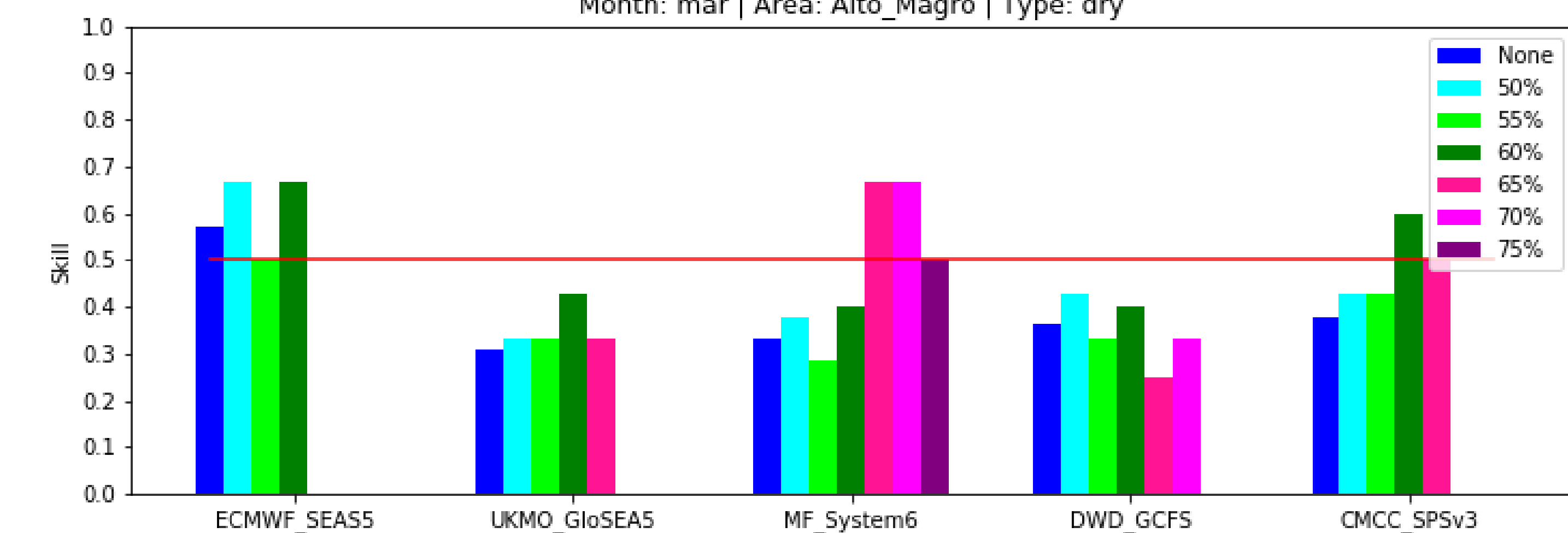
JANUARY

Month: jan | Area: Alto_Magro | Type: dry



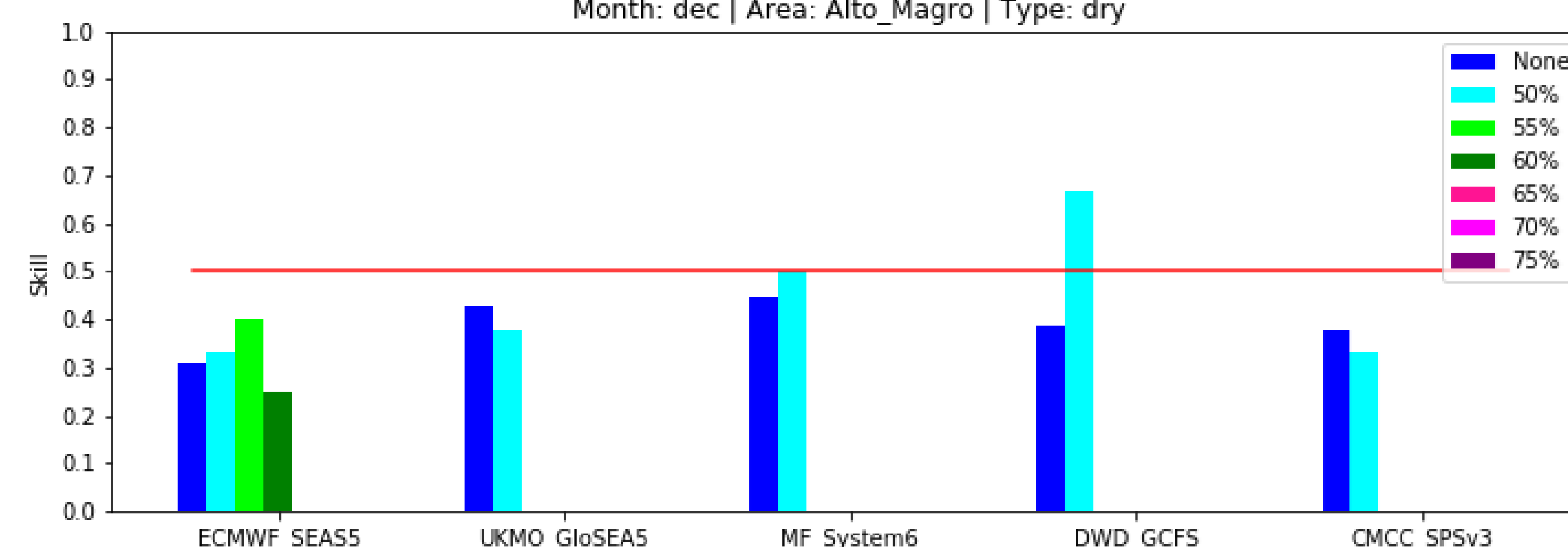
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Month: mar | Area: Alto_Magro | Type: dry



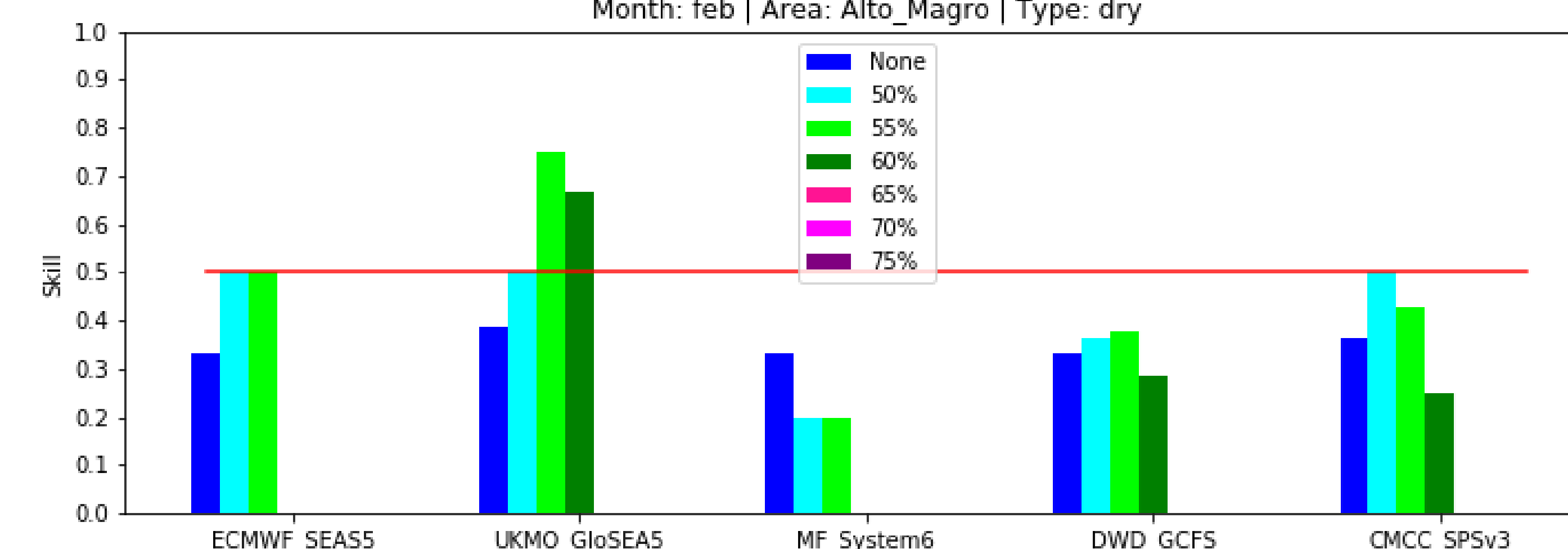
DECEMBER

Month: dec | Area: Alto_Magro | Type: dry



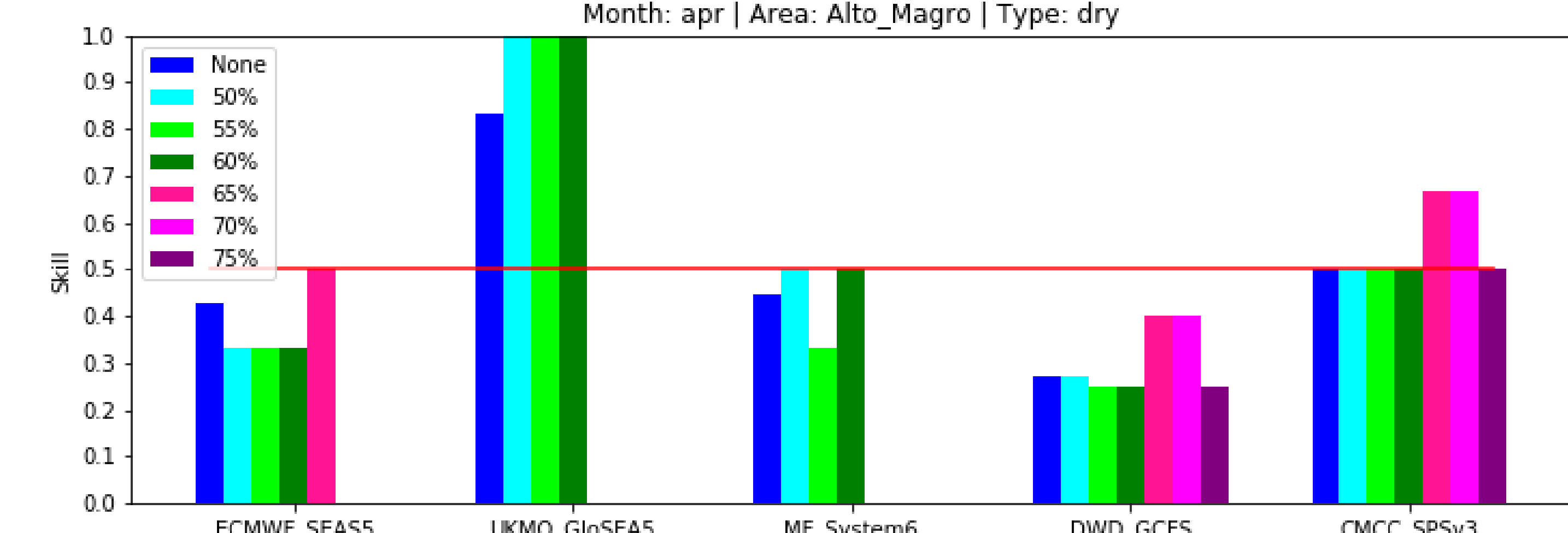
FEBRUARY

Month: feb | Area: Alto_Magro | Type: dry



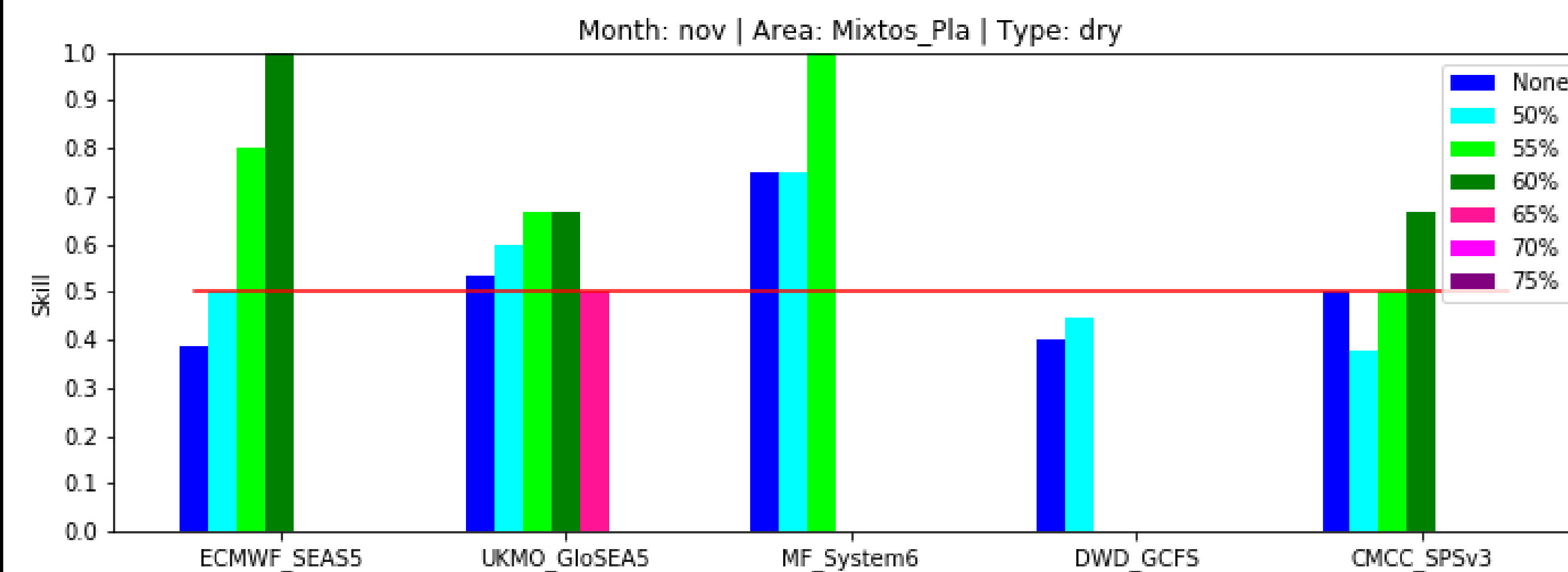
APRIL

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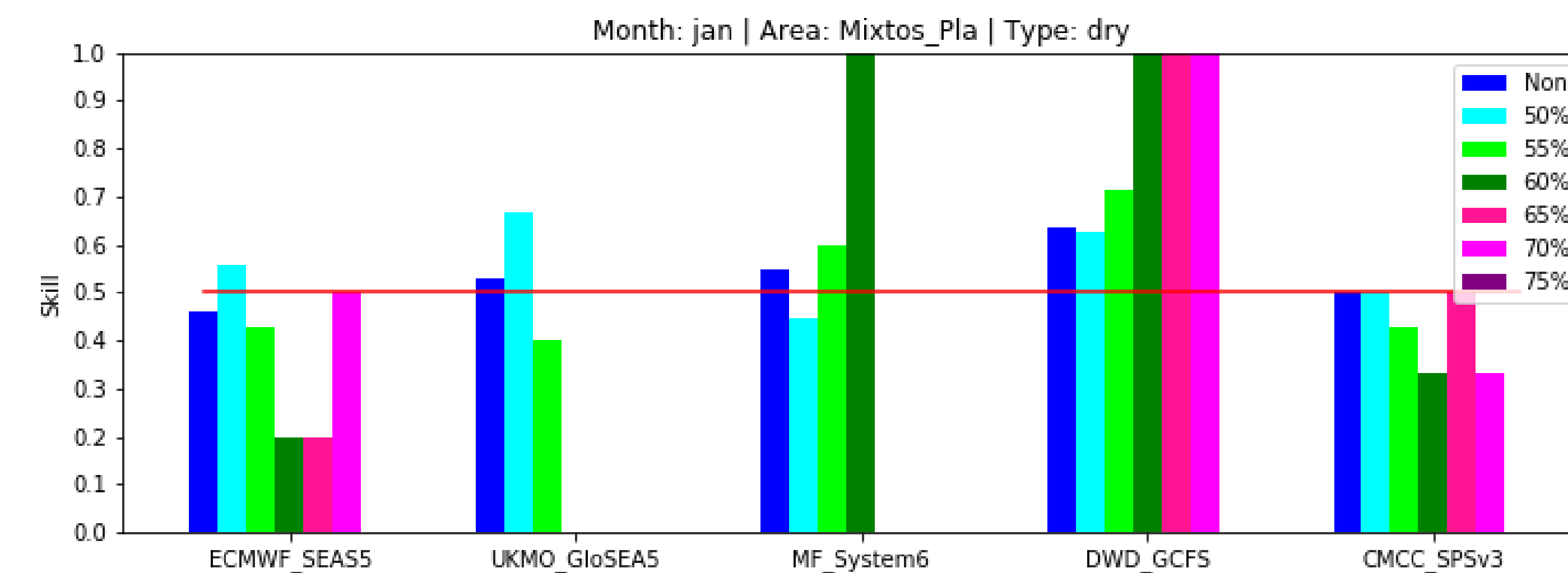


TYPE OF YEAR SKILL RESULTS: DRY YEAR FORECASTING IN MIXTOS PLANA DEMAND

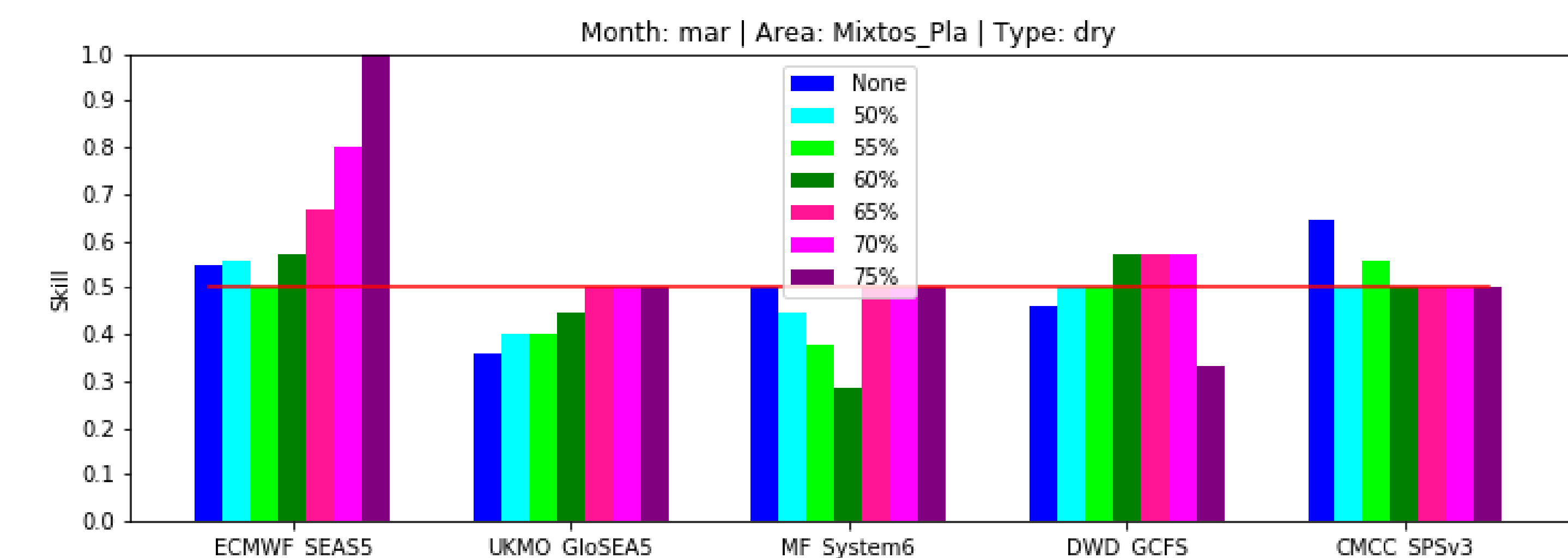
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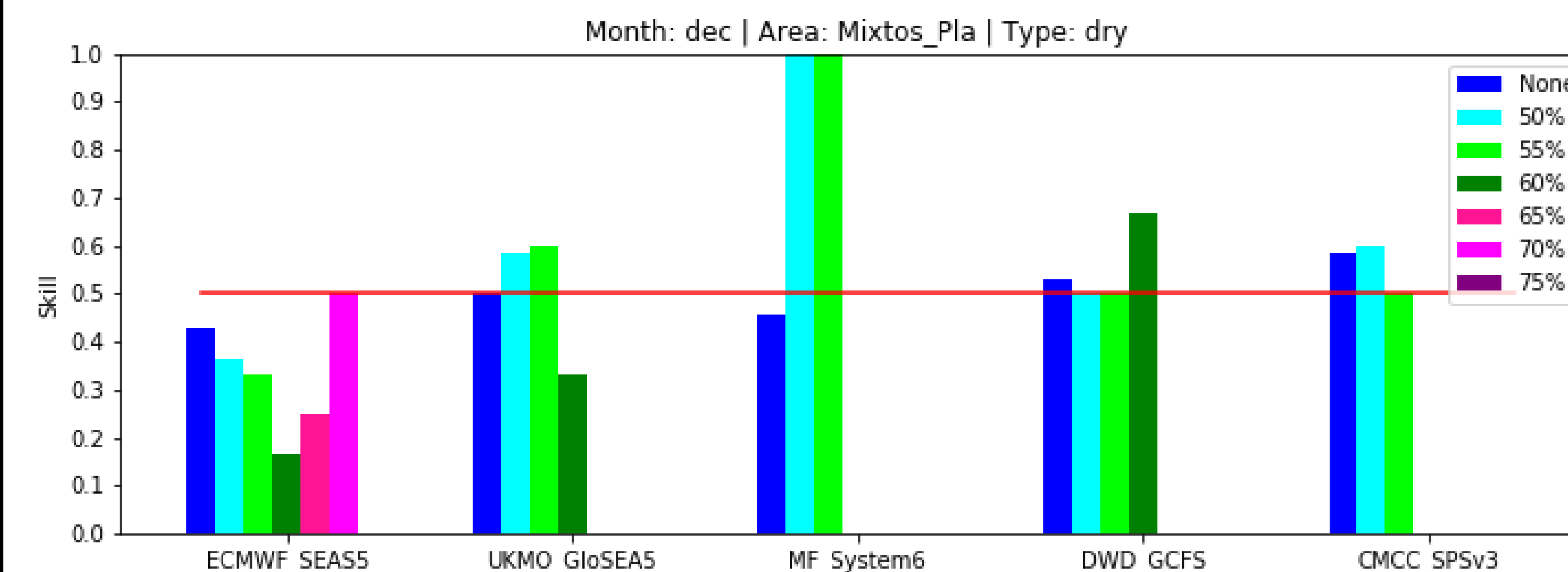
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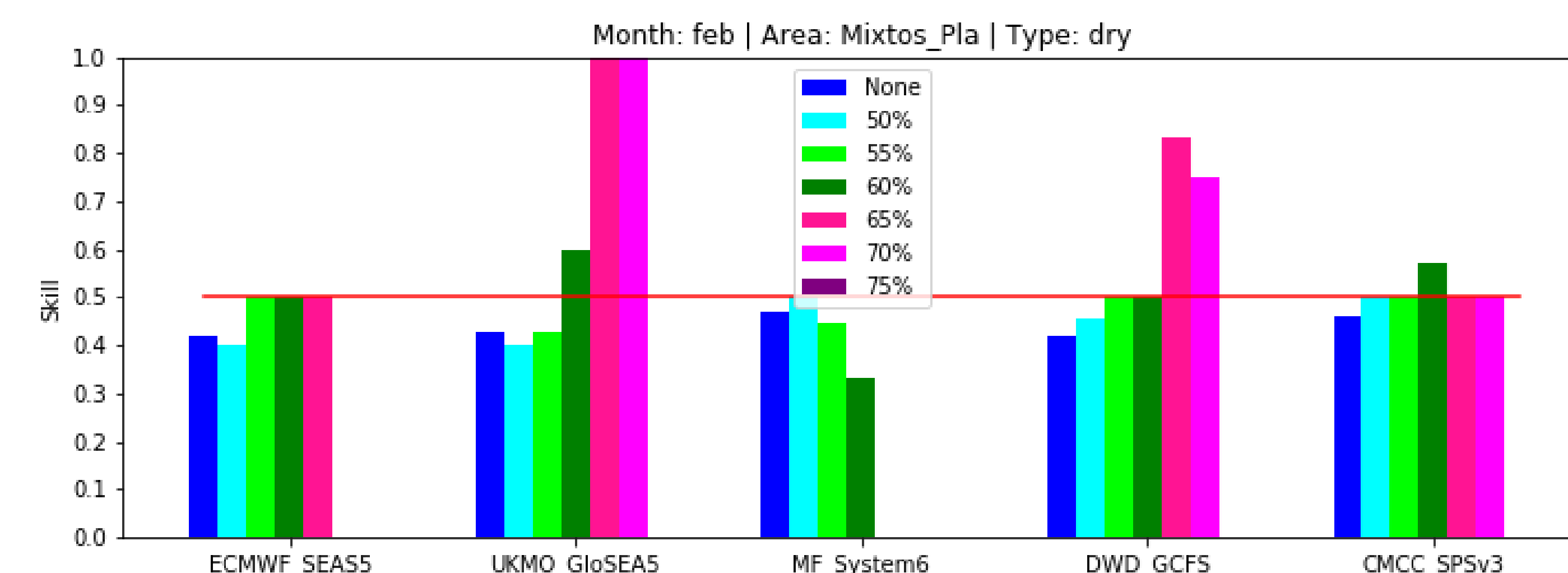
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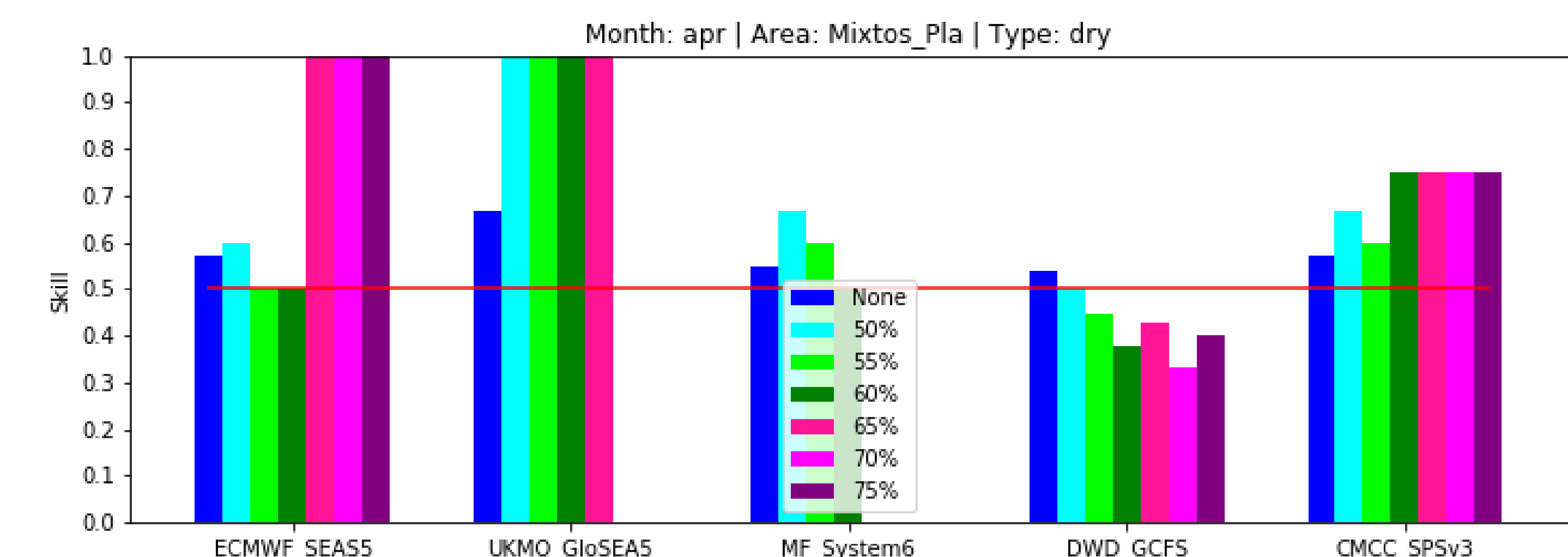
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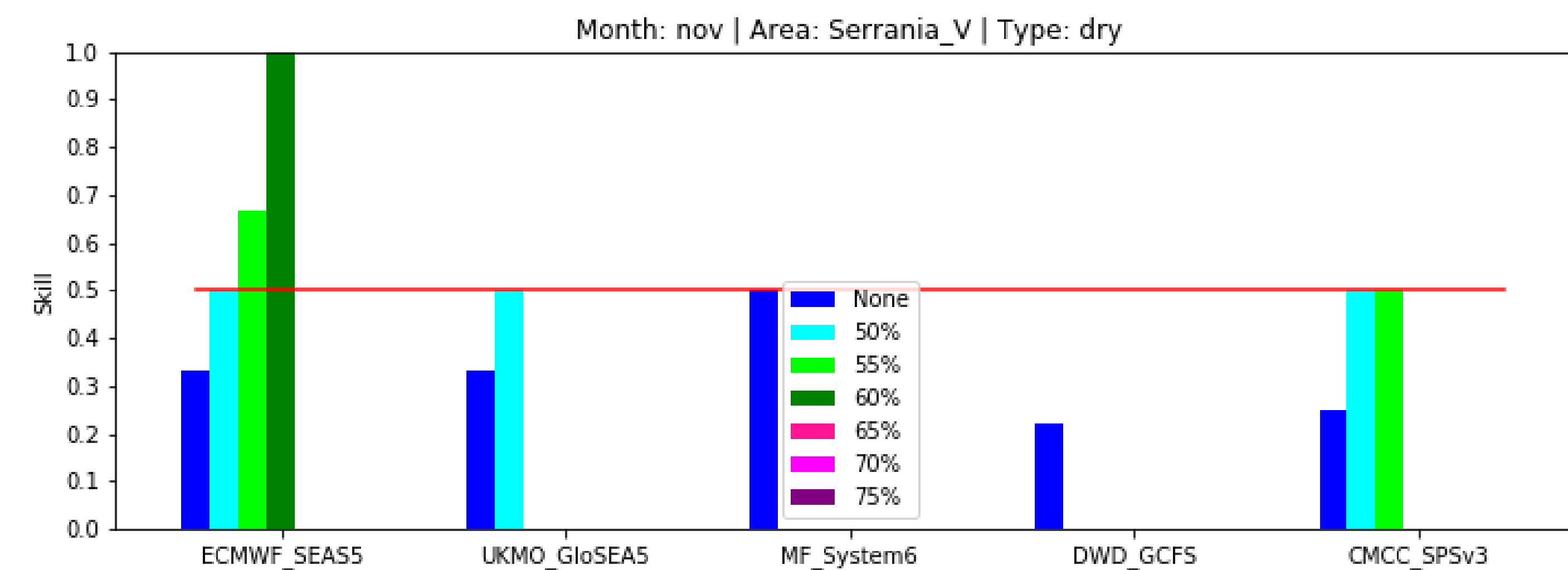


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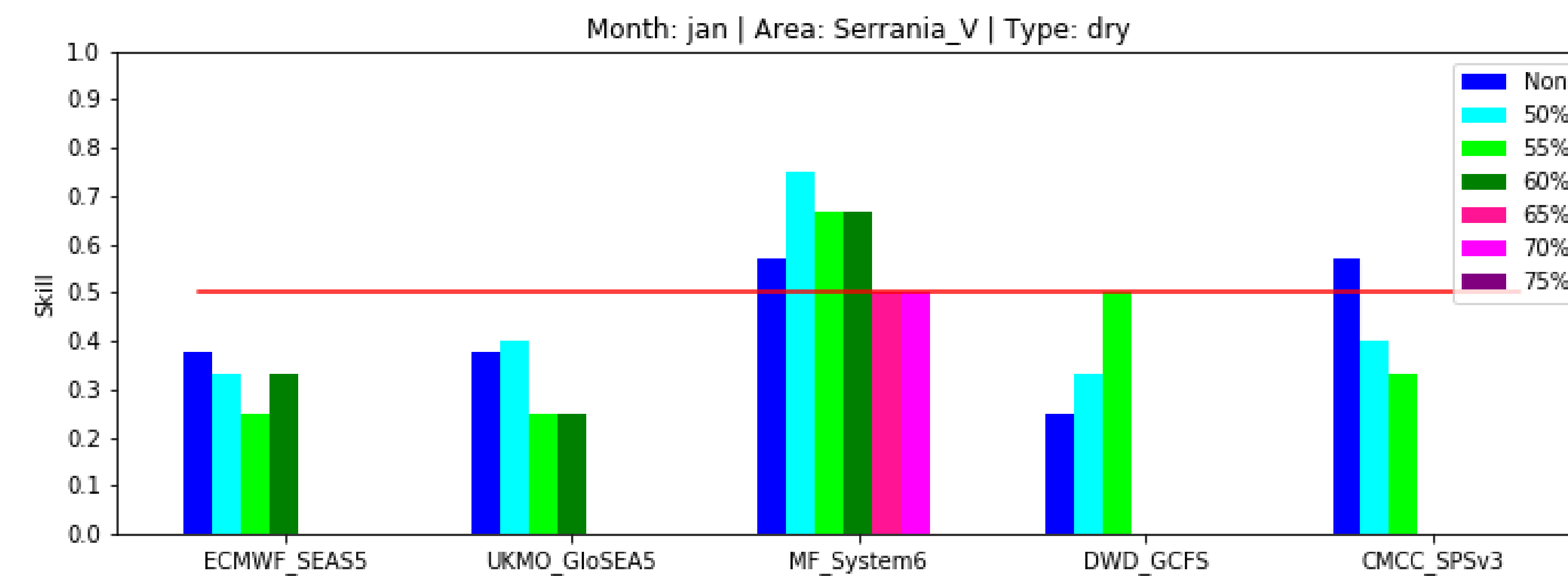


TYPE OF YEAR SKILL RESULTS: DRY YEAR FORECASTING IN SERRANÍA VALENCIA DEMAND

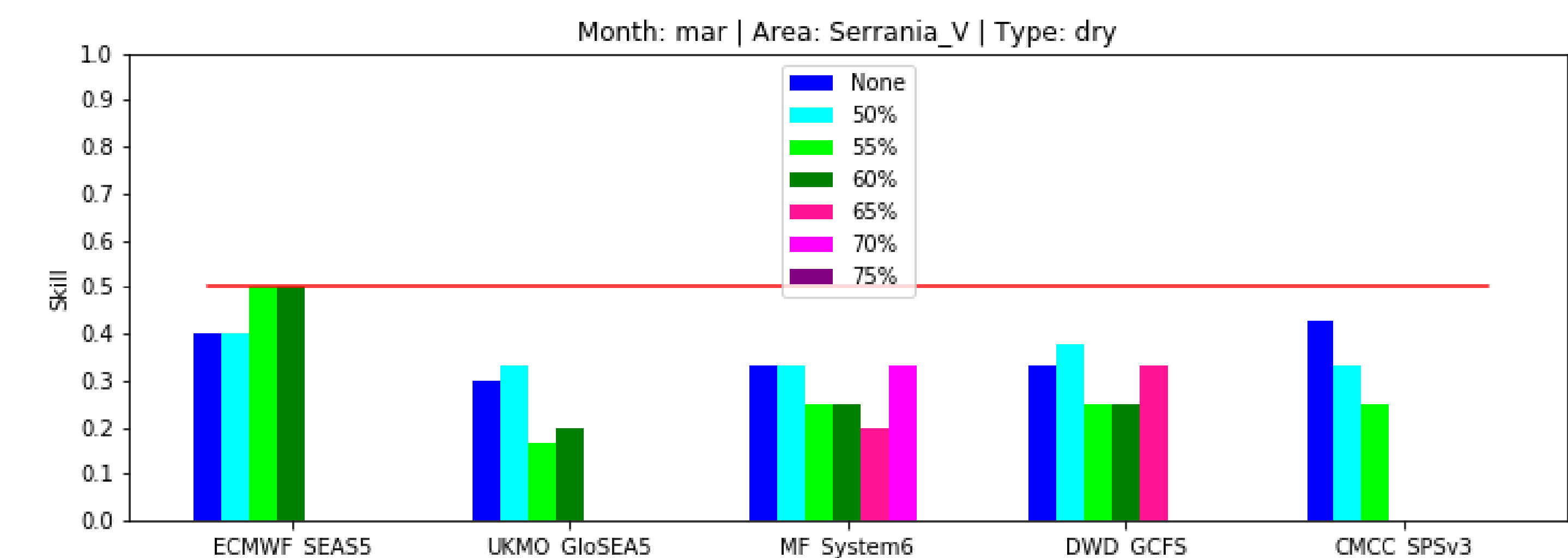
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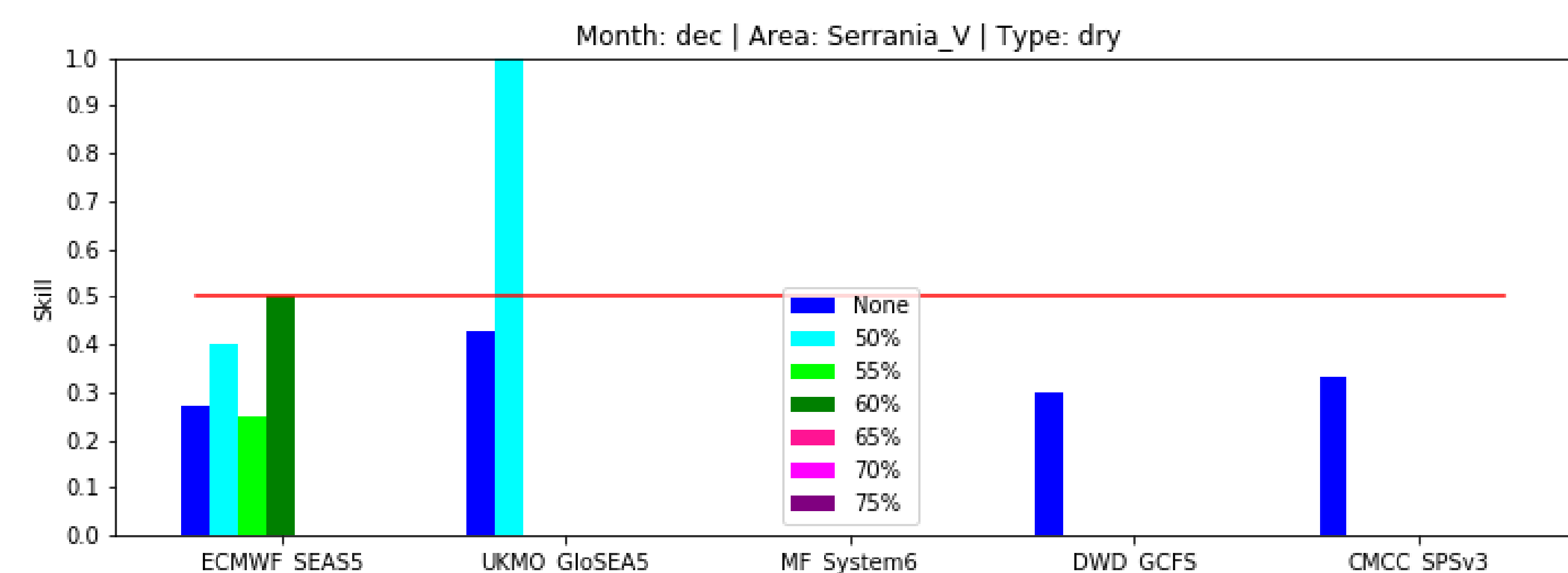
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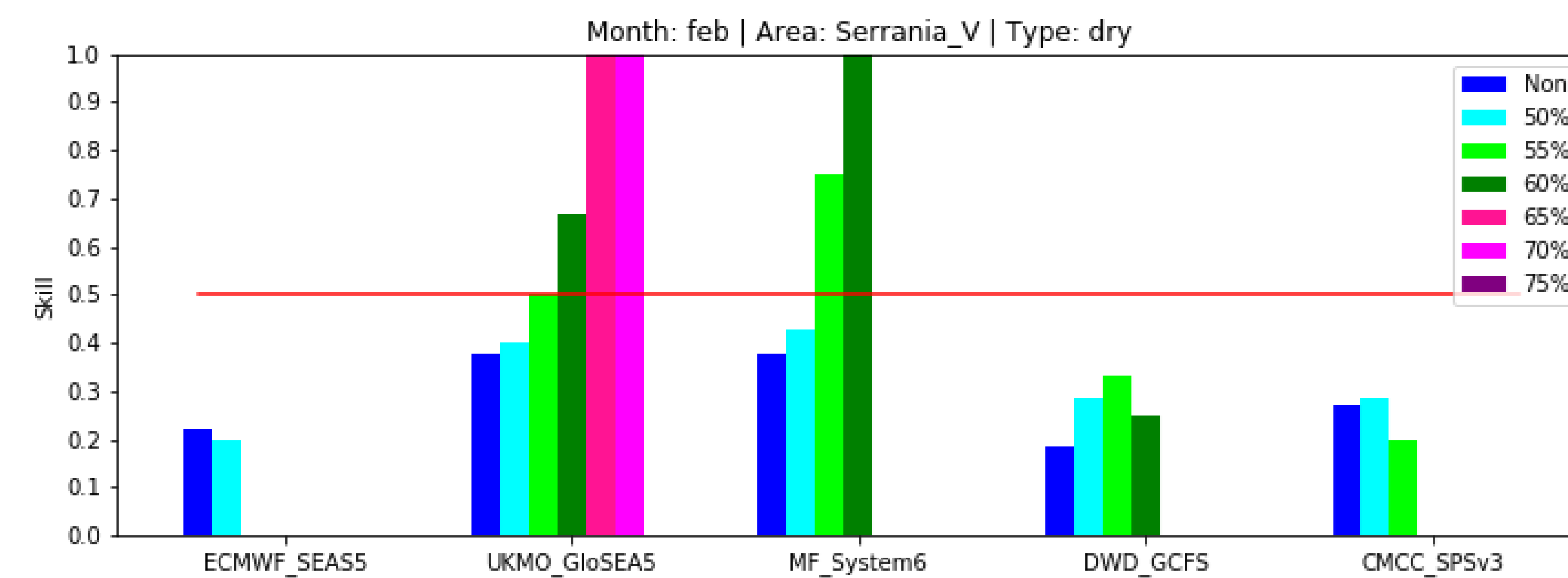
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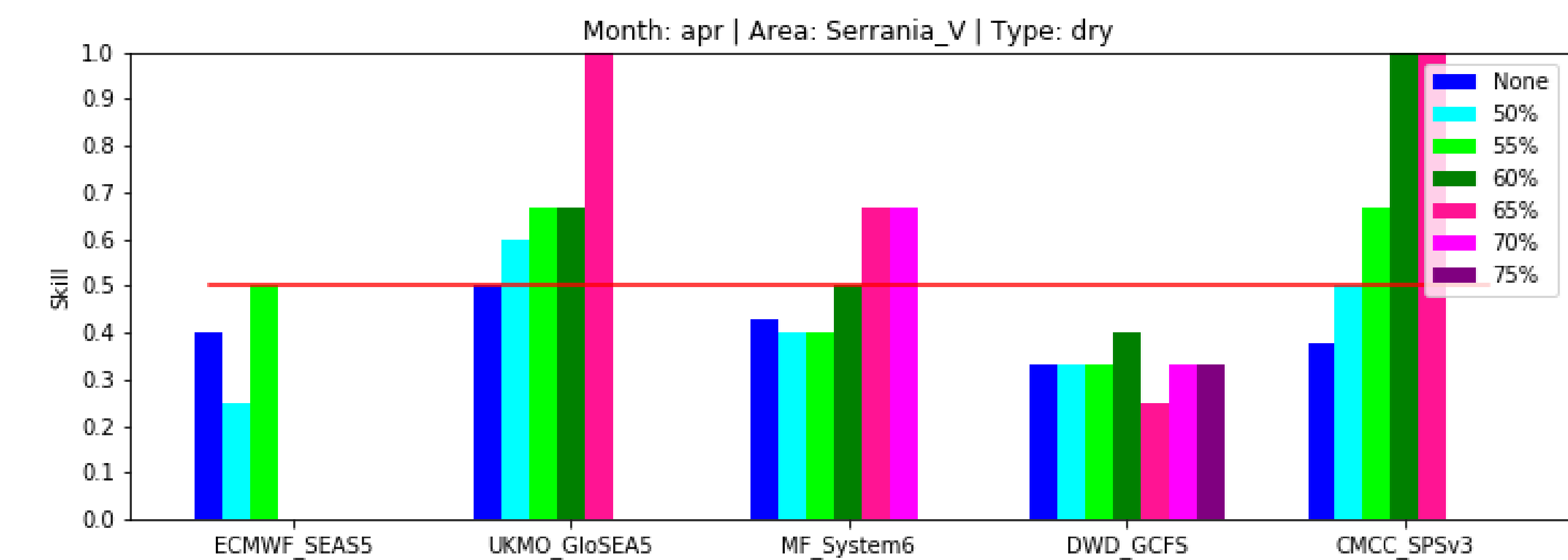
DECEMBER



FEBRUARY

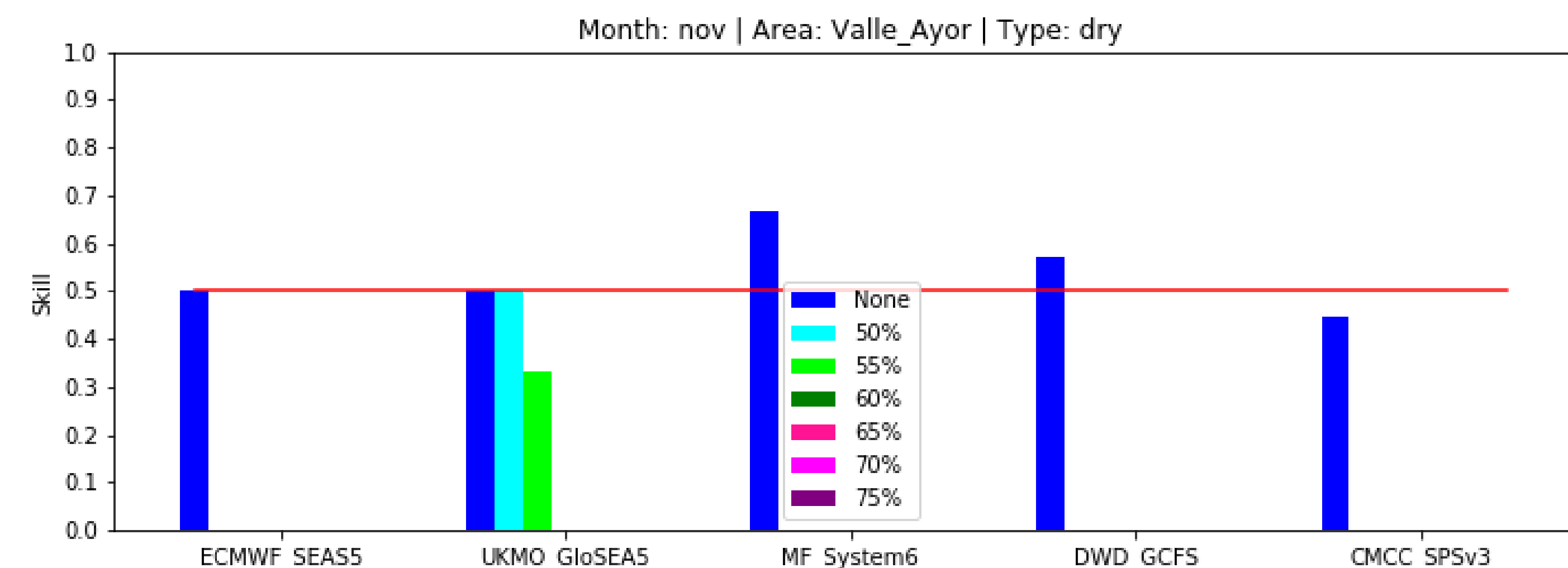


APRIL

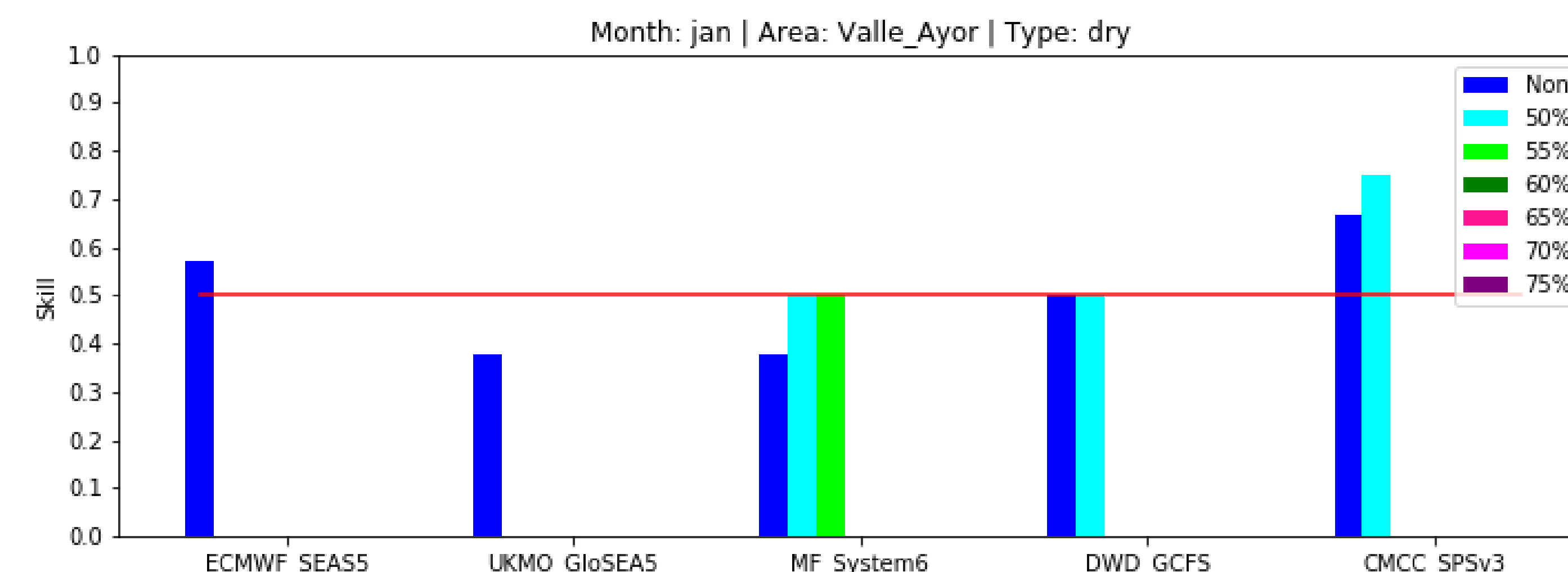


TYPE OF YEAR SKILL RESULTS: DRY YEAR FORECASTING IN VALLE DE AYORA DEMAND

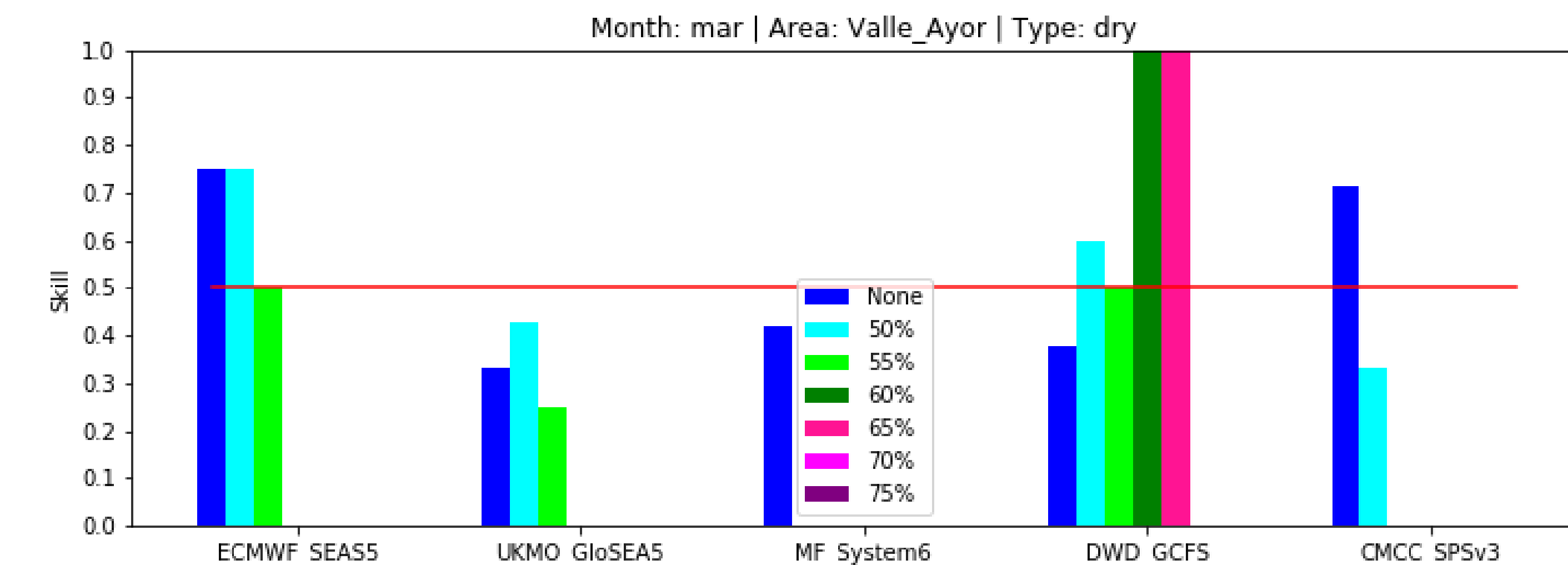
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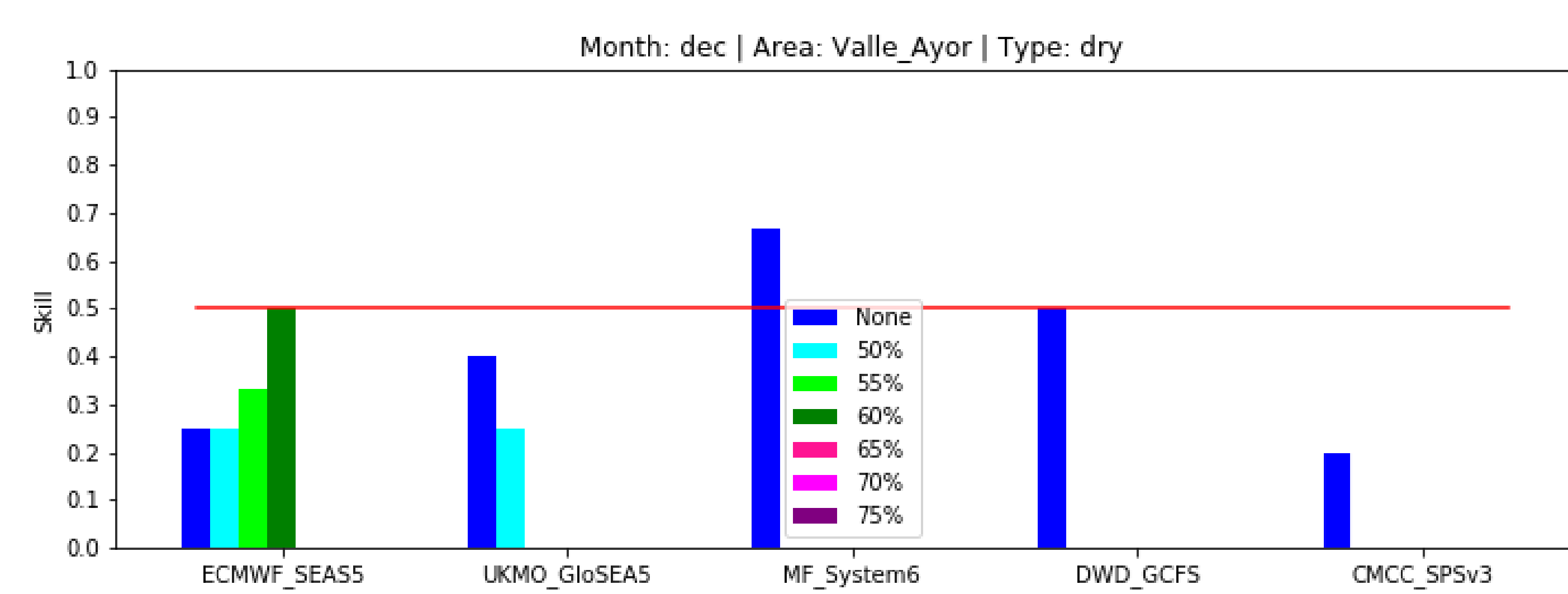
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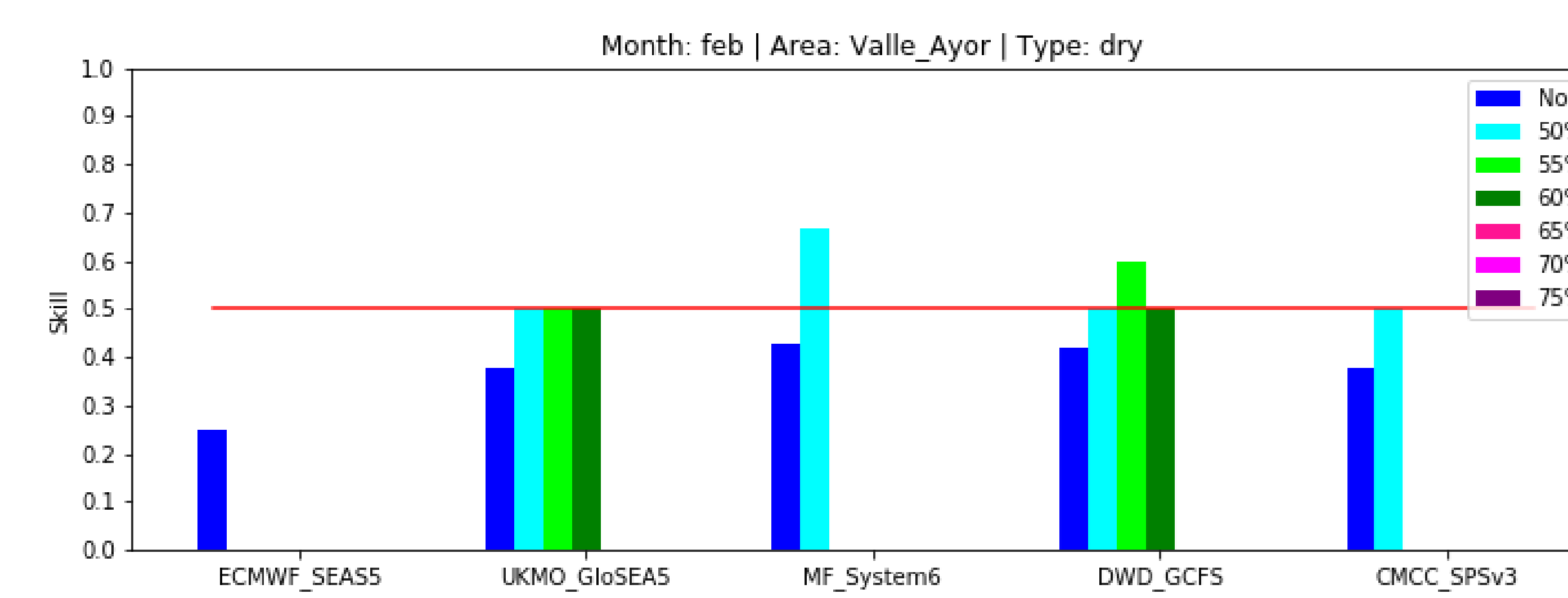
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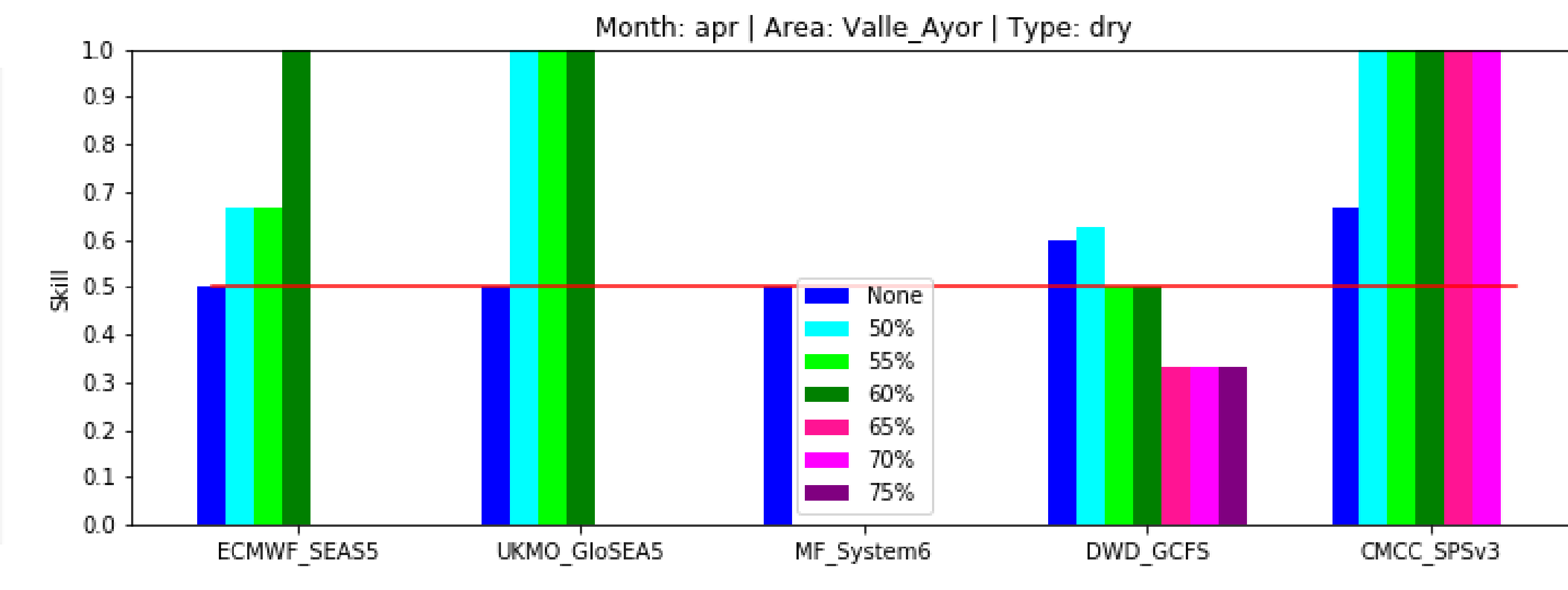
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FEBRUARY



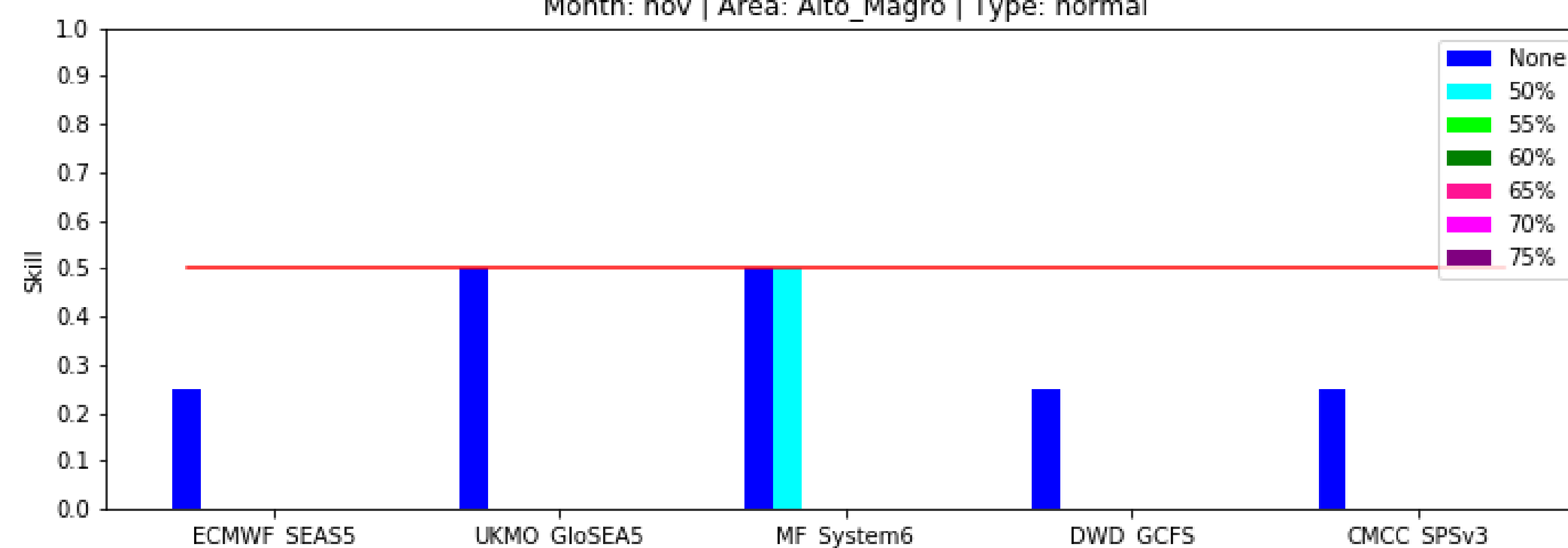
APRIL



TYPE OF YEAR SKILL RESULTS: NORMAL YEAR FORECASTING IN ALTO MAGRO DEMAND

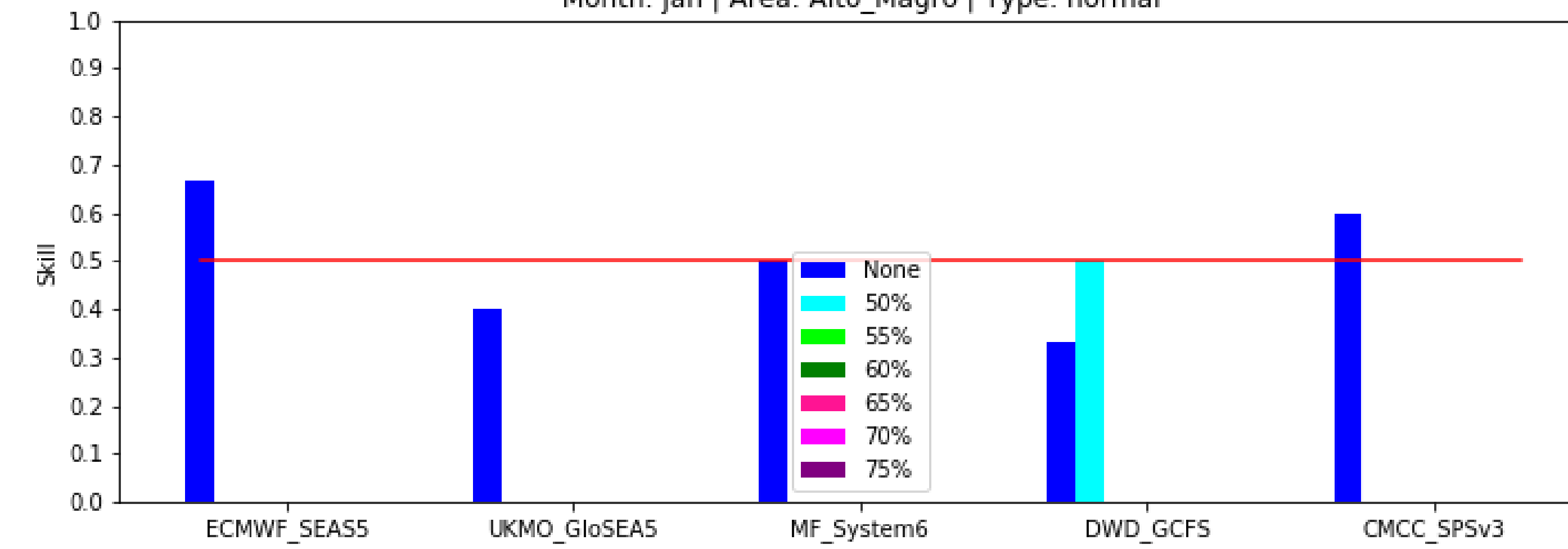
NOVEMBER

Month: nov | Area: Alto_Magro | Type: normal



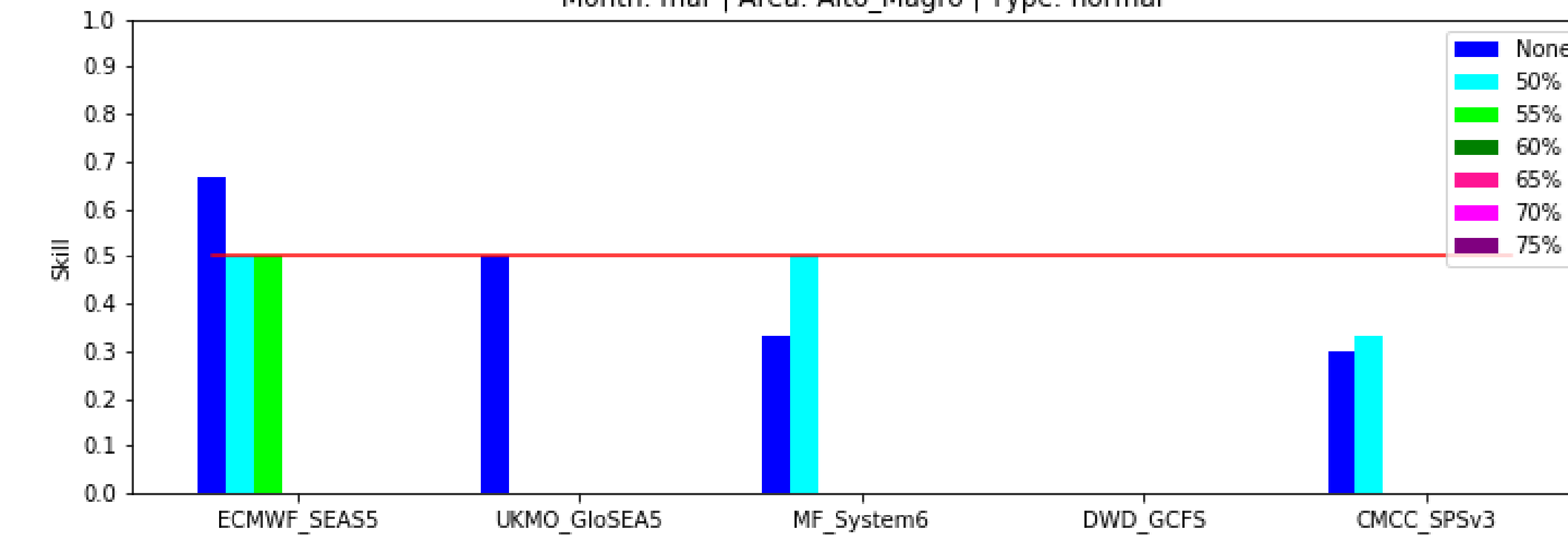
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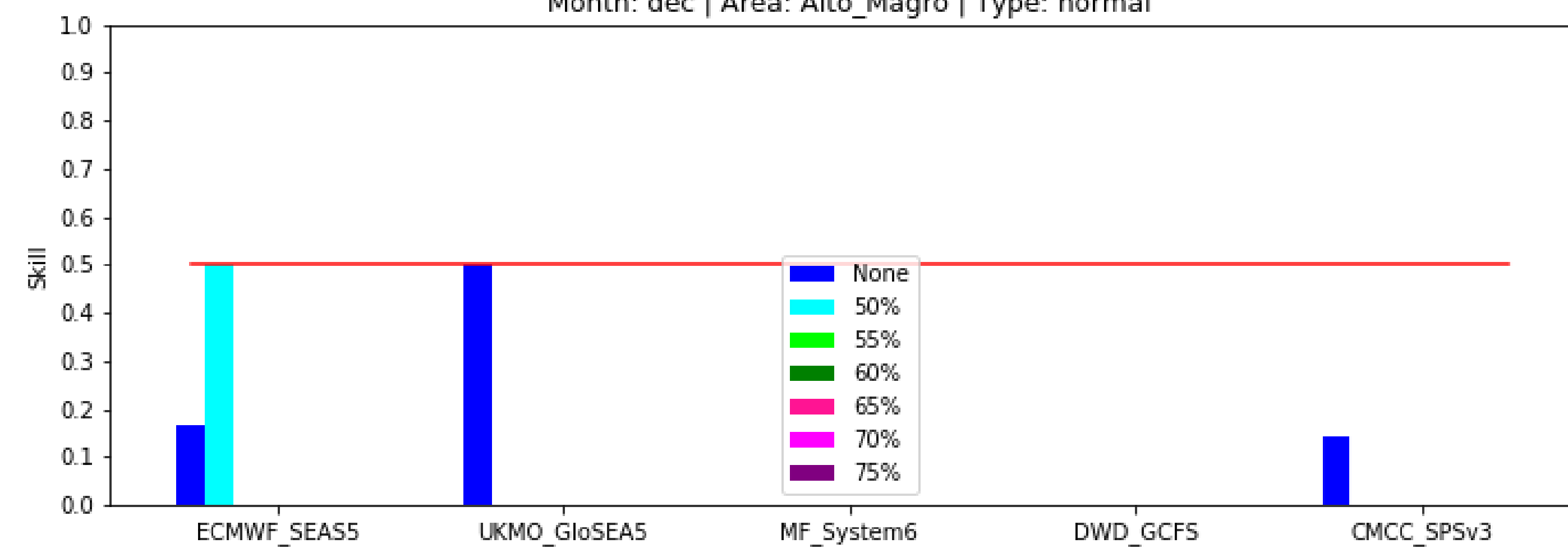
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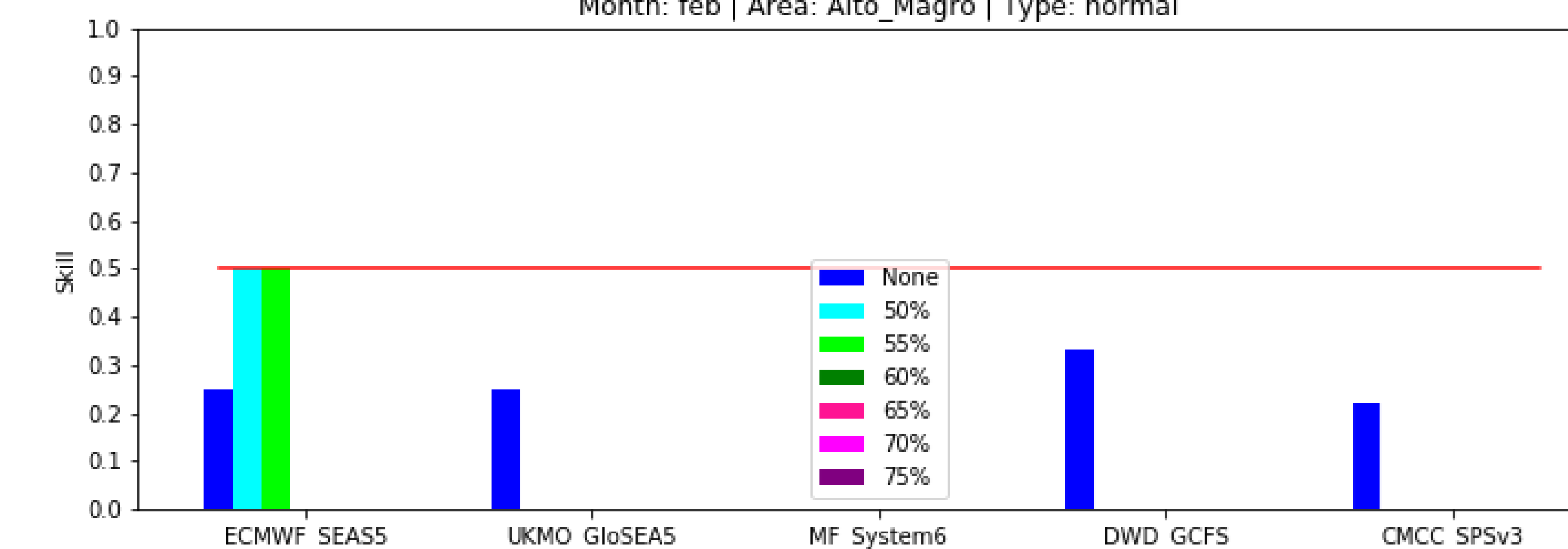
DECEMBER

Month: dec | Area: Alto_Magro | Type: normal



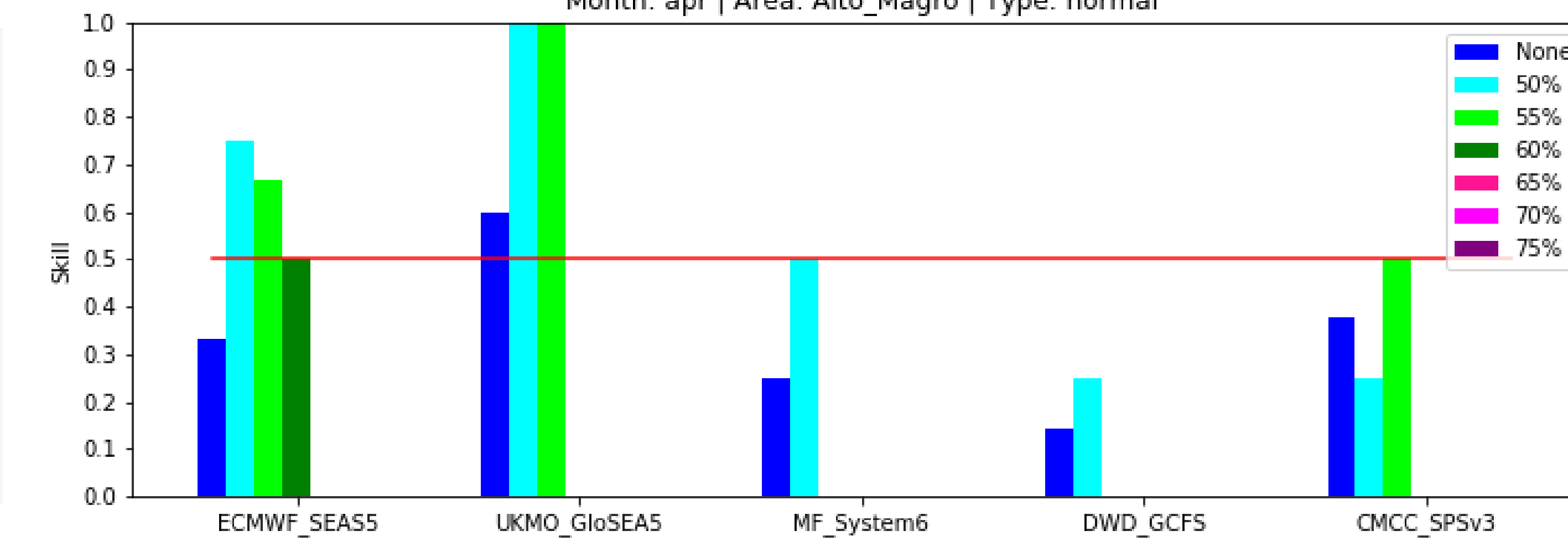
FEBRUARY

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APRIL

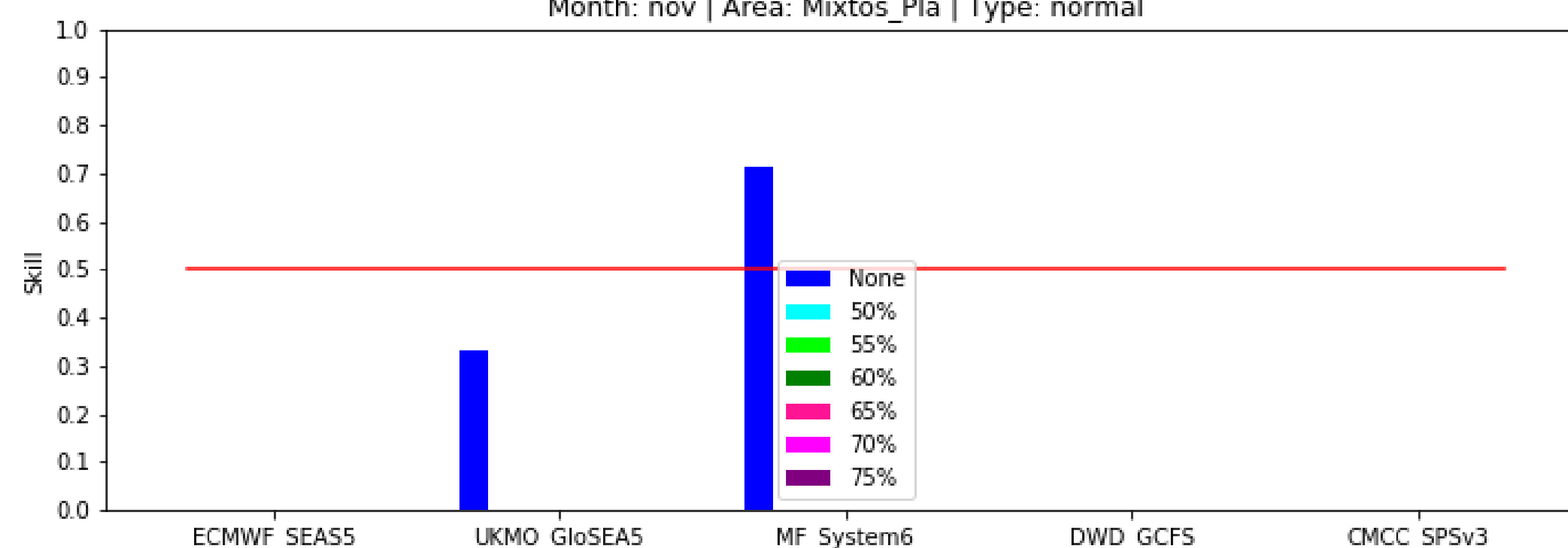
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TYPE OF YEAR SKILL RESULTS: NORMAL YEAR FORECASTING IN MIXTOS PLANA DEMAND

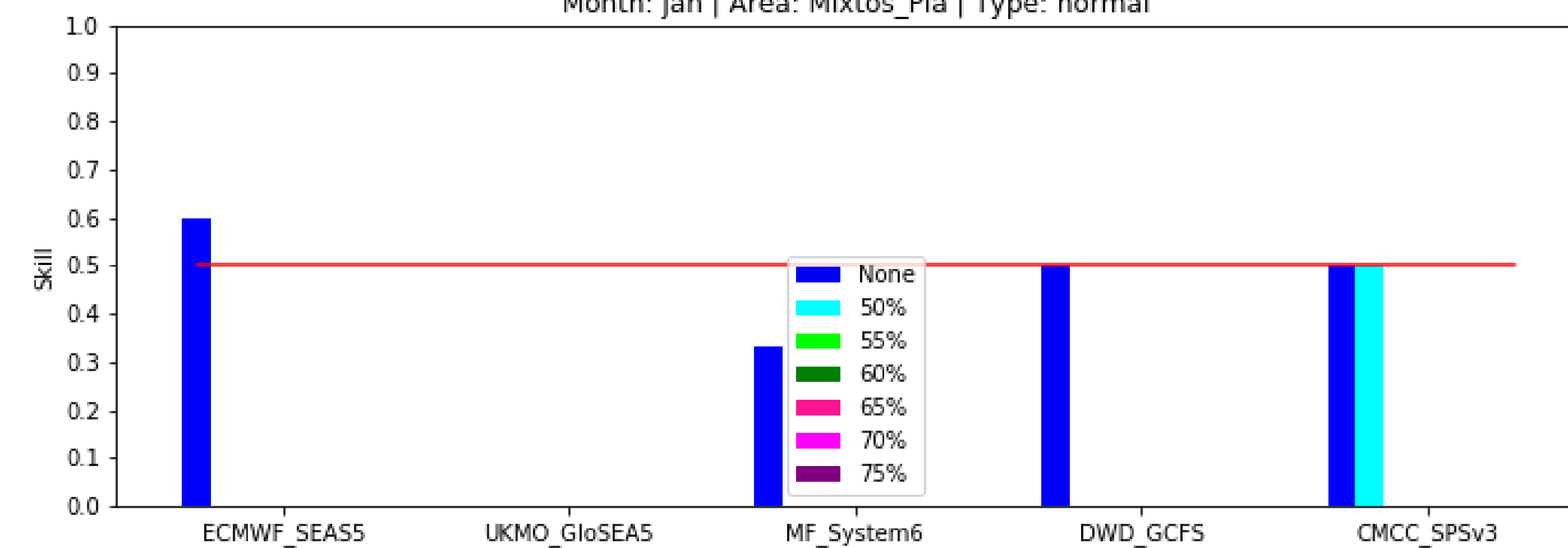
NOVEMBER

Month: nov | Area: Mixtos_Pla | Type: normal



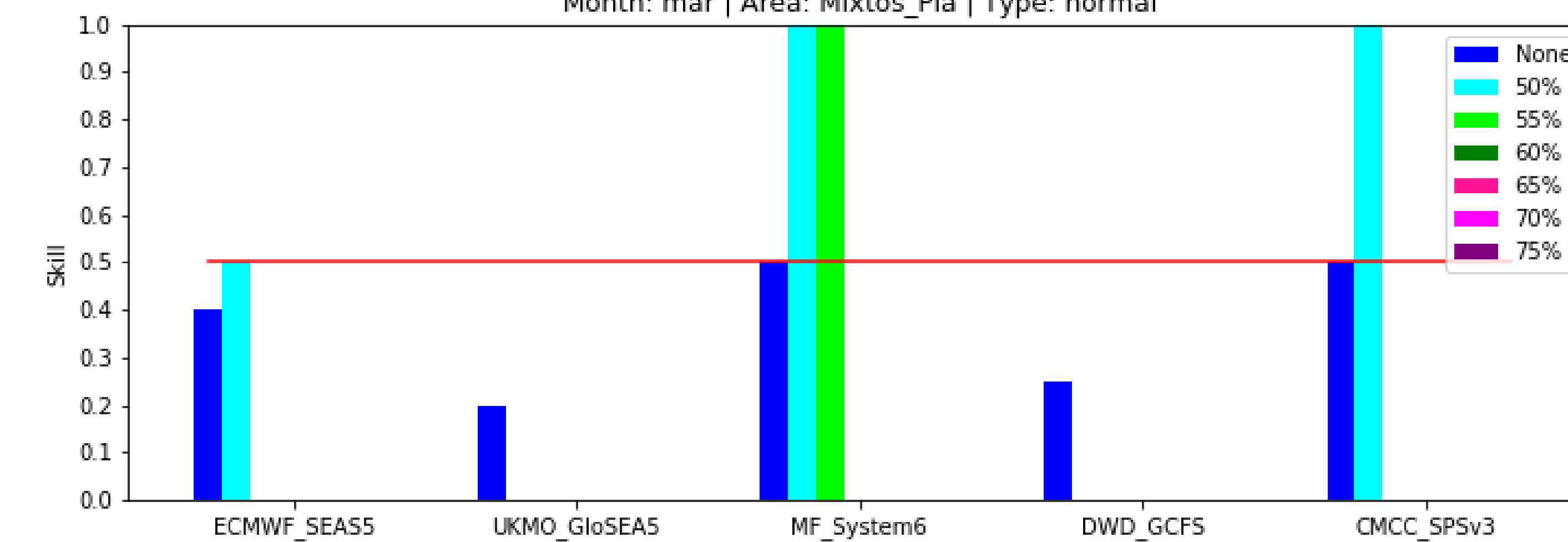
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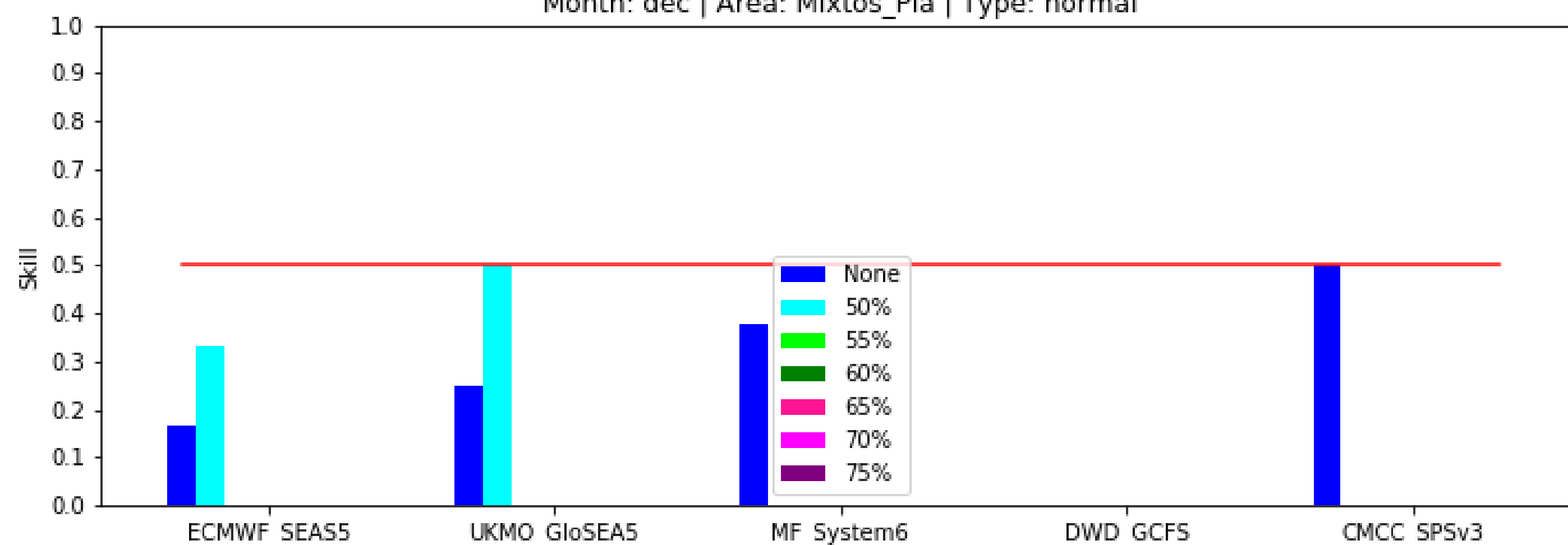
MARCH

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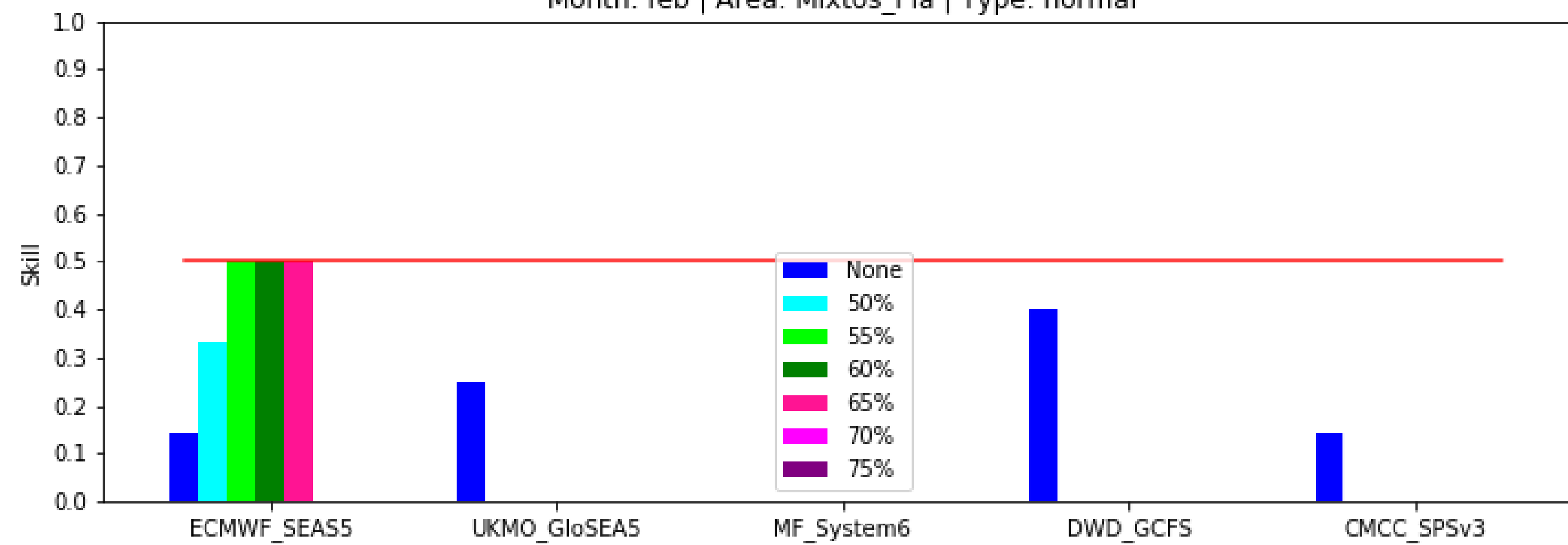
DECEMBER

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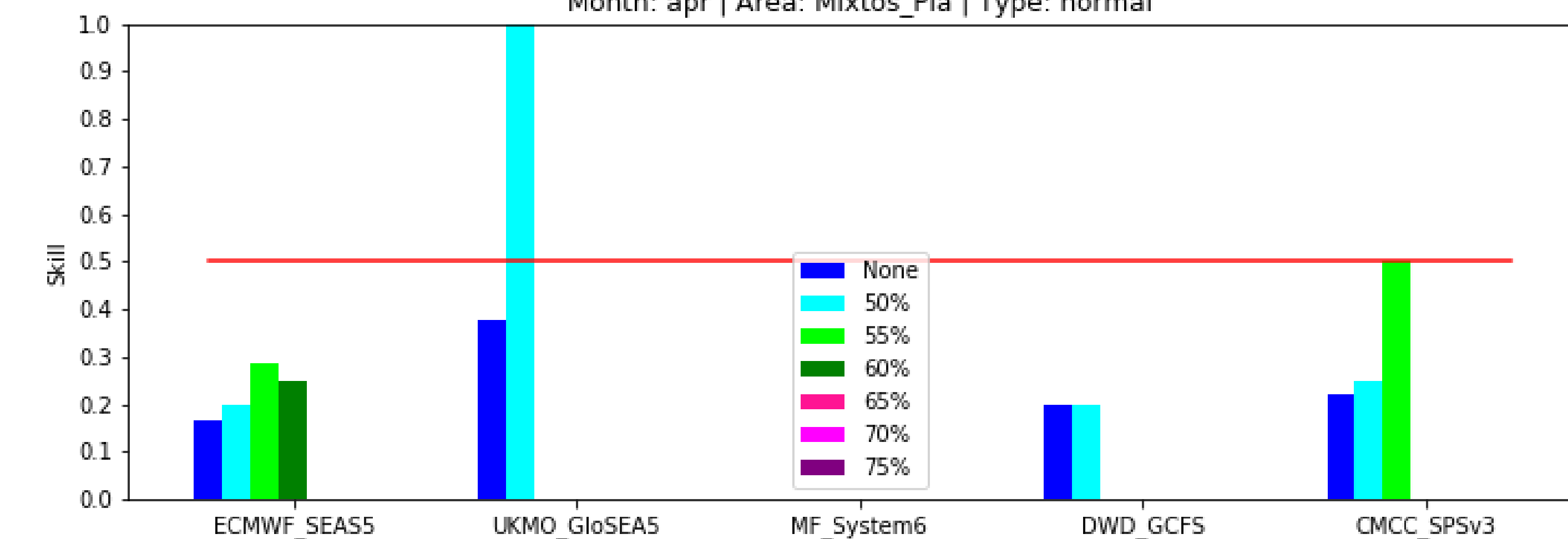
FEBRUARY

Month: feb | Area: Mixtos_Pla | Type: normal



APRIL

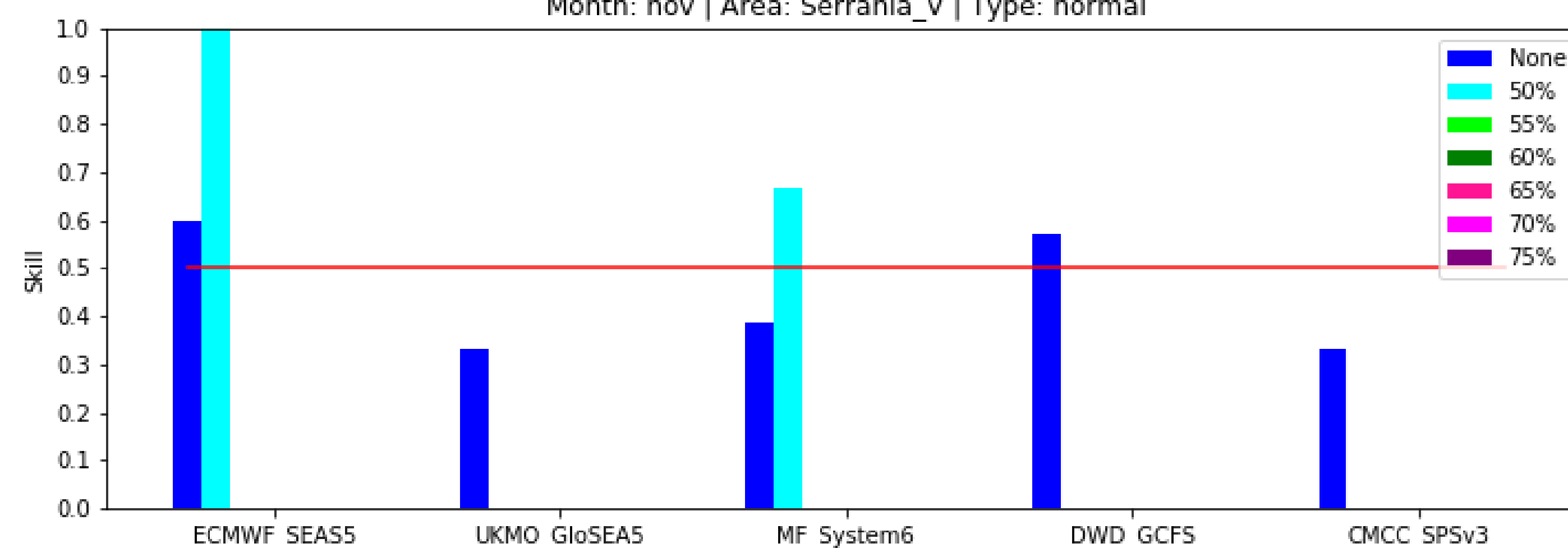
Month: apr | Area: Mixtos_Pla | Type: normal



TYPE OF YEAR SKILL RESULTS: NORMAL YEAR FORECASTING IN SERRANÍA VALENCIA DEMAND

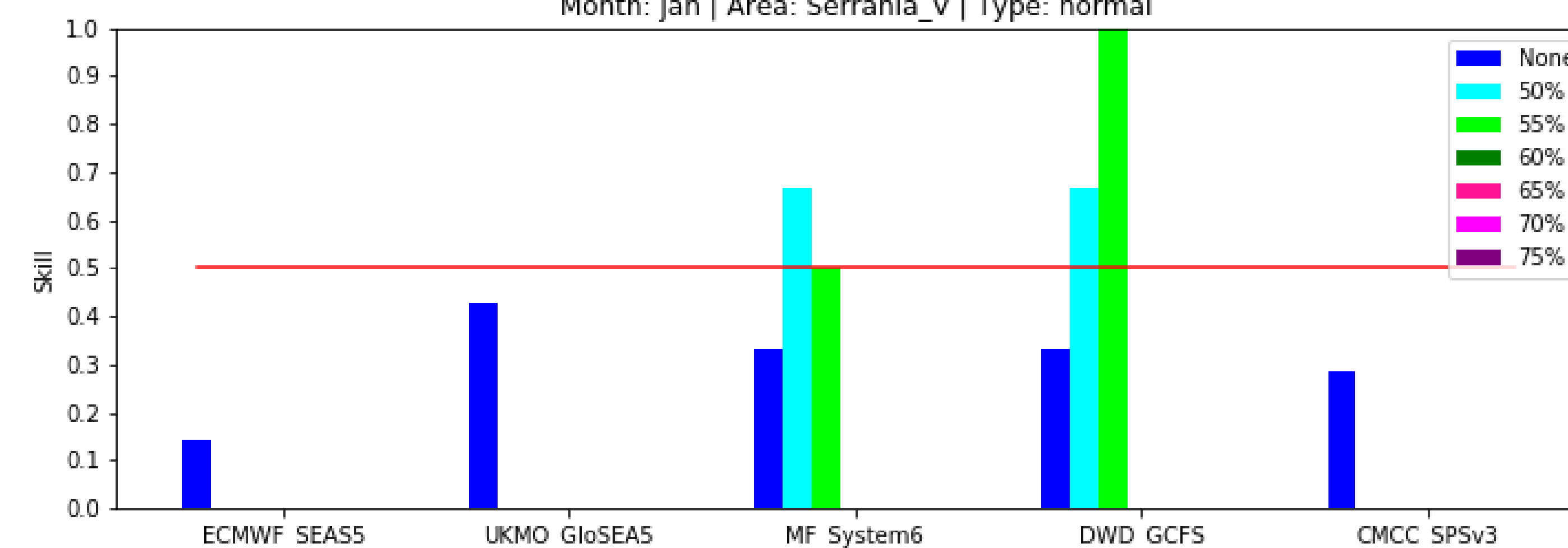
NOVEMBER

Month: nov | Area: Serrania_V | Type: normal



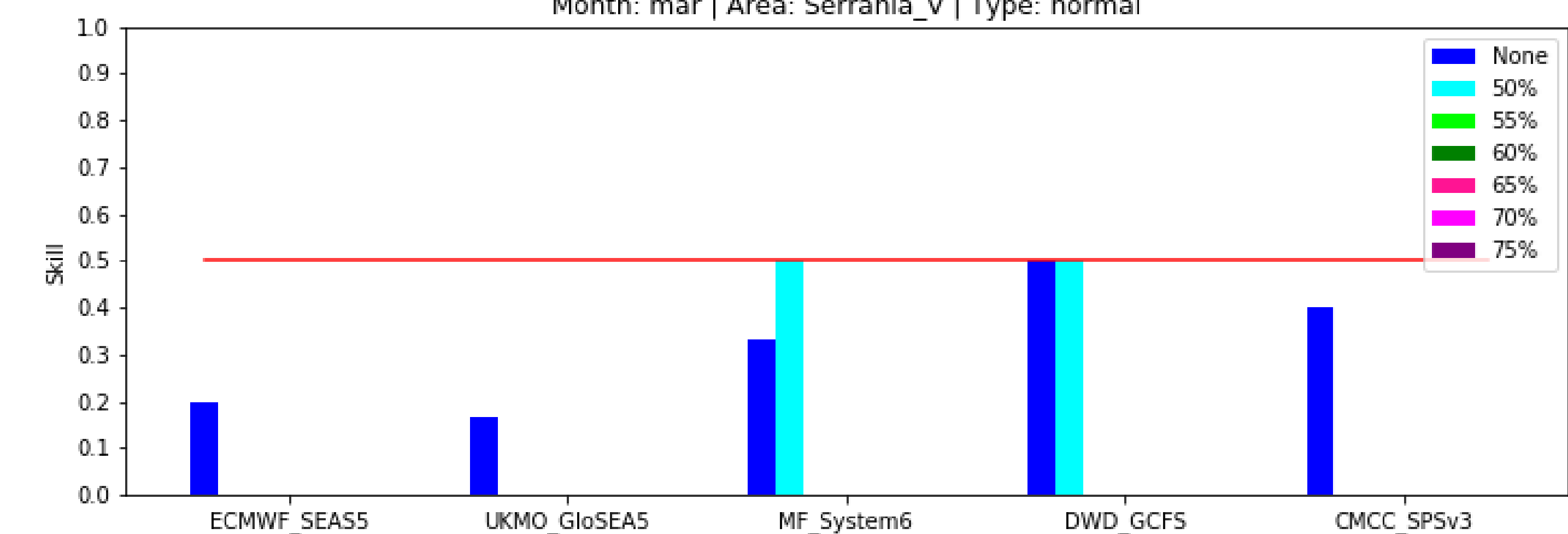
JANUARY

Month: jan | Area: Serrania_V | Type: normal



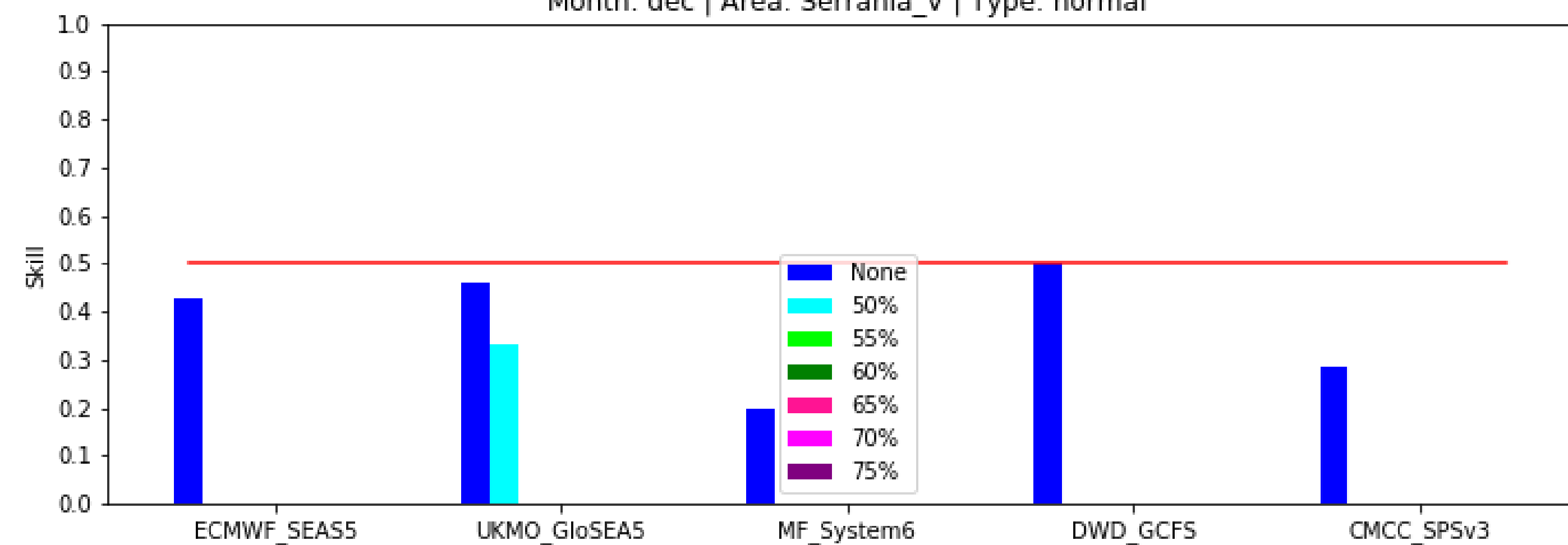
MARCH

Month: mar | Area: Serrania_V | Type: normal



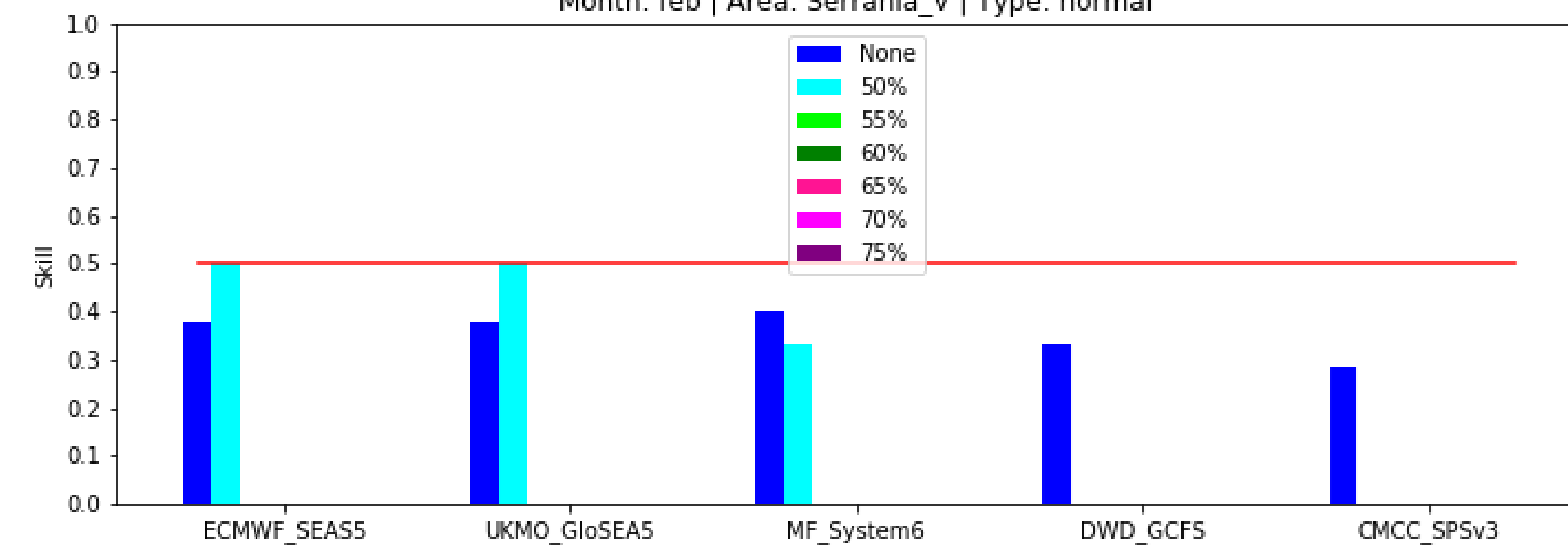
DECEMBER

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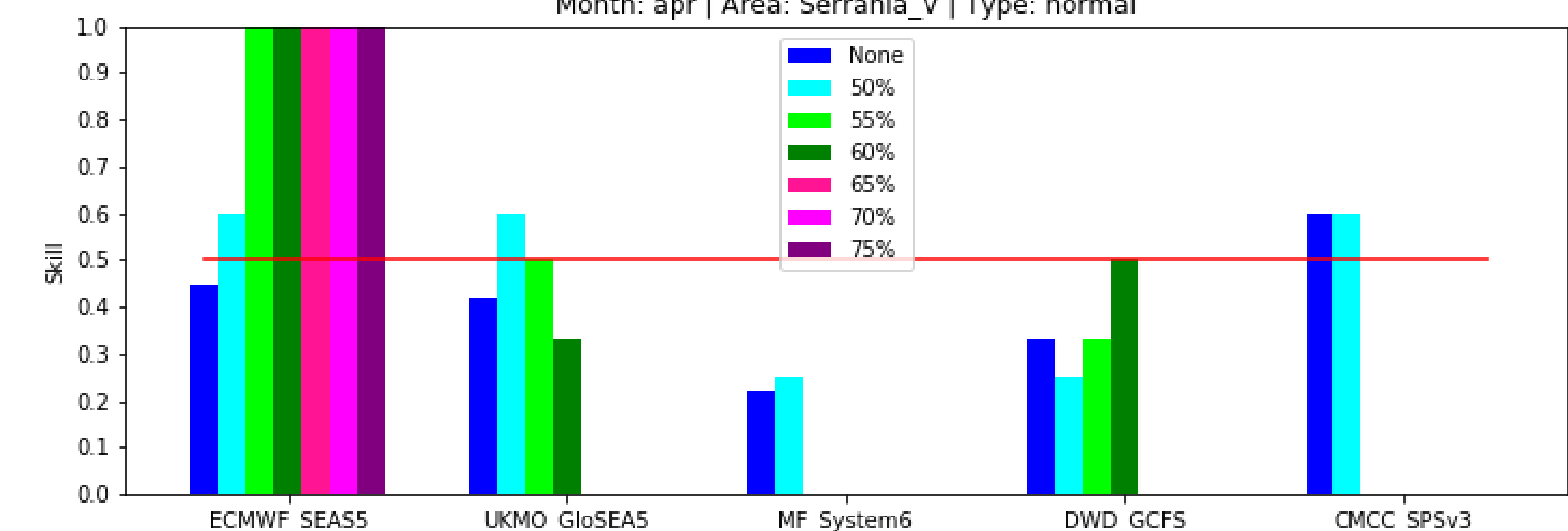
FEBRUARY

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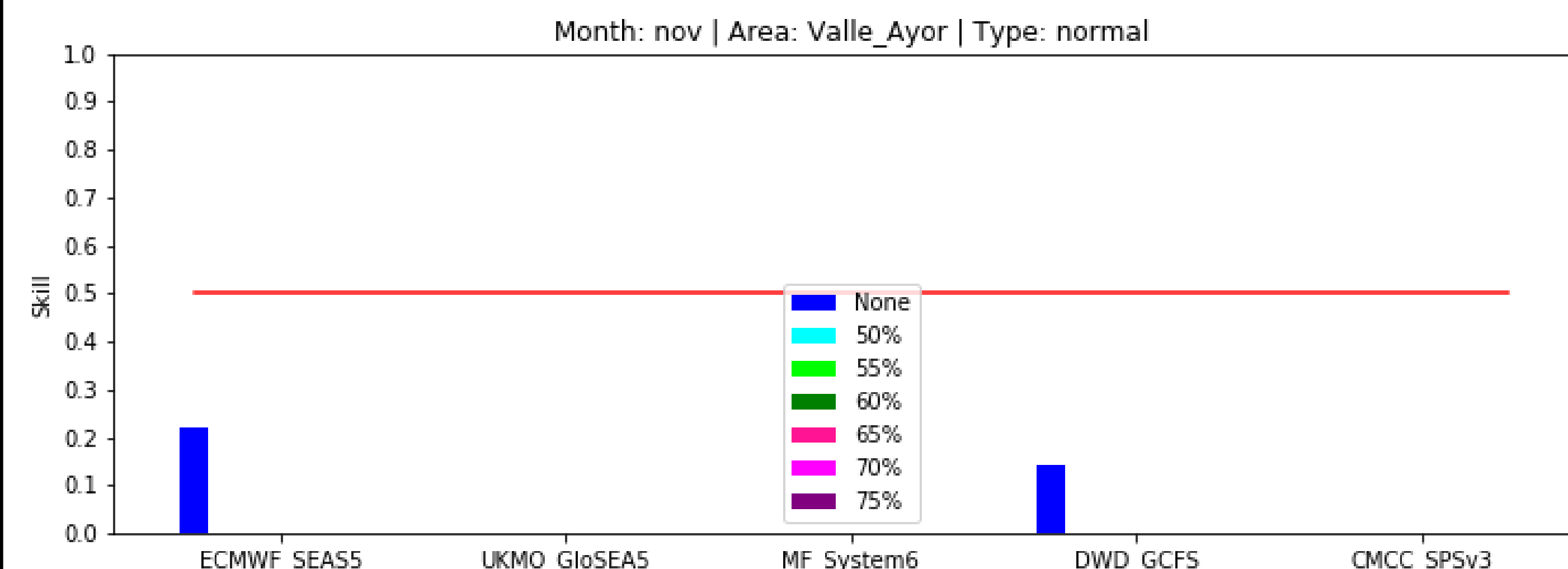
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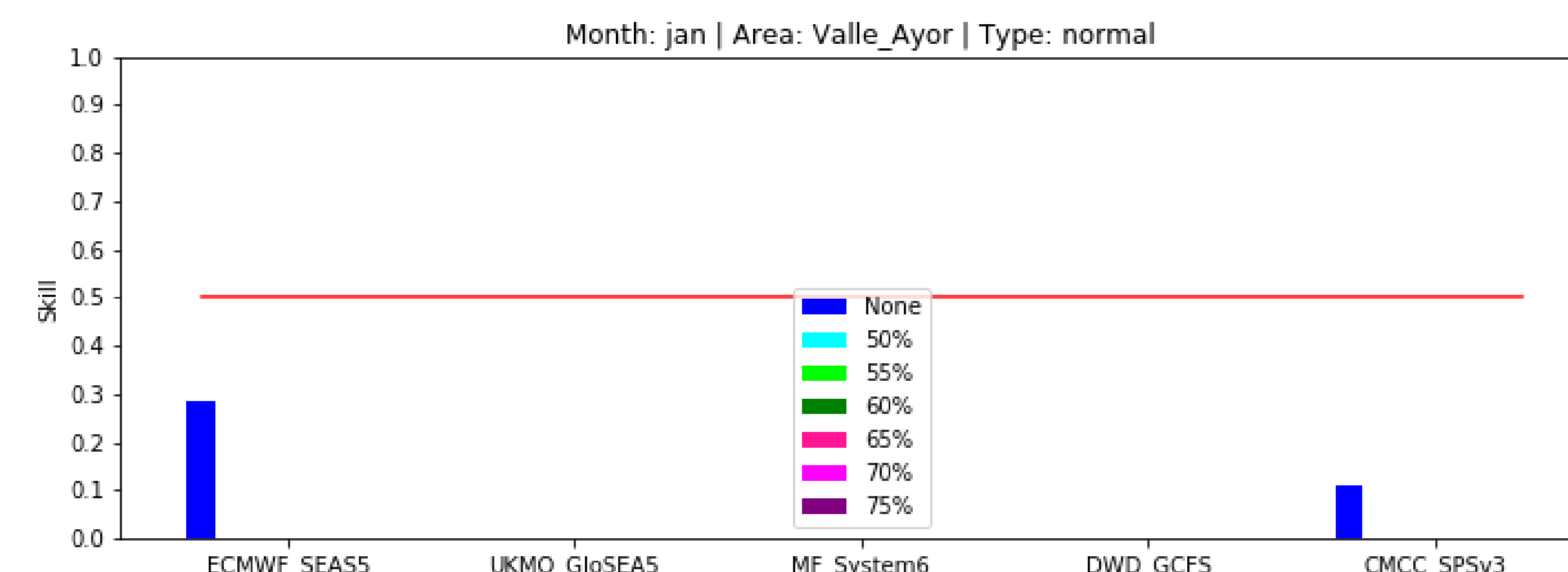


TYPE OF YEAR SKILL RESULTS: NORMAL YEAR FORECASTING IN VALLE DE AYORA DEMAND

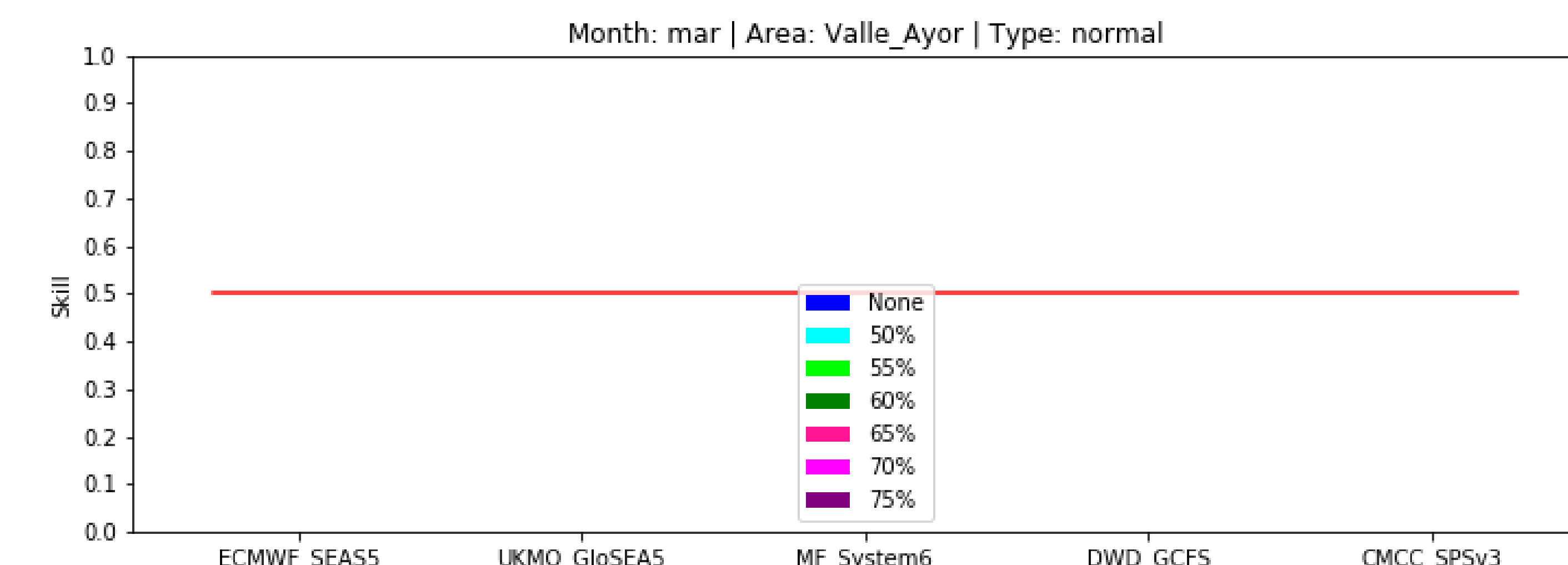
NOVEMBER



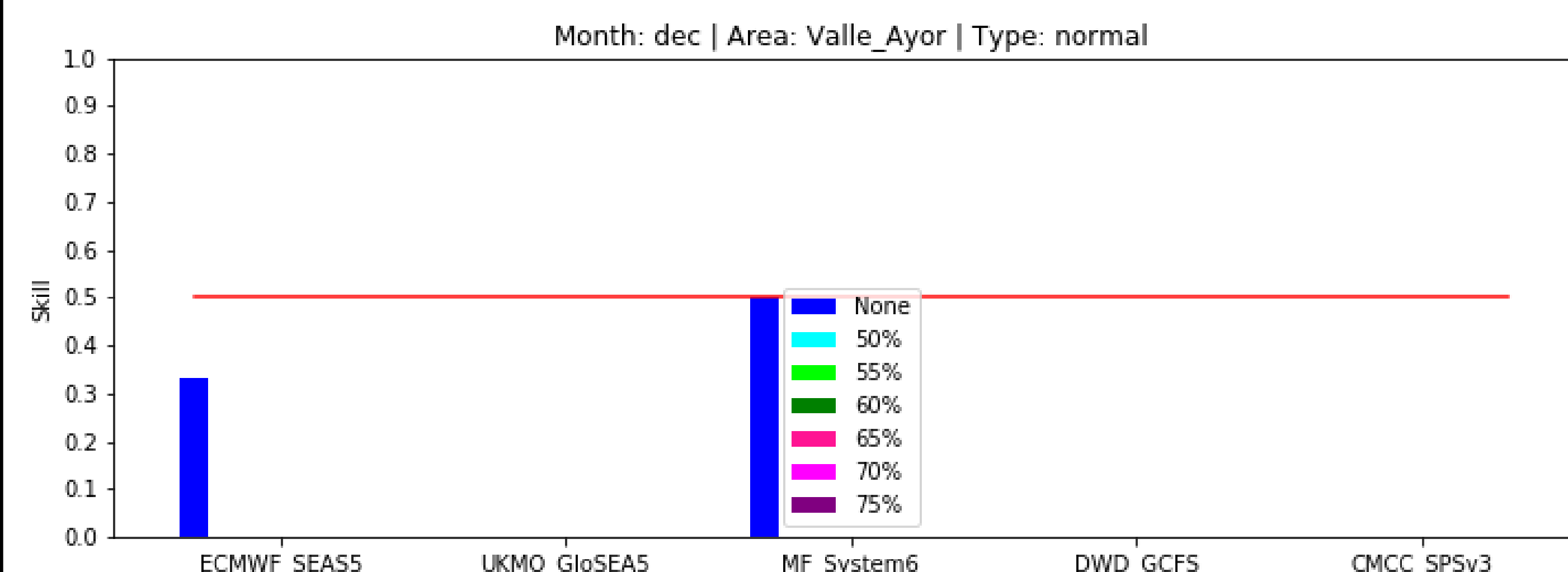
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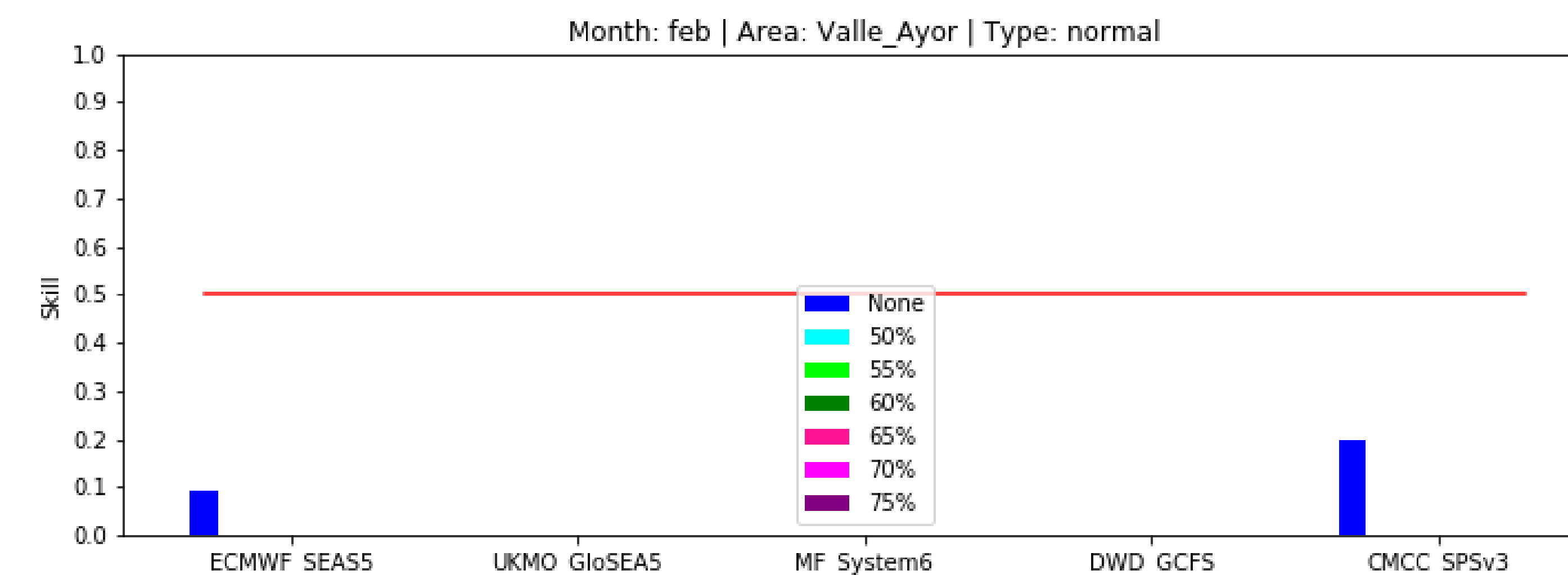
MARCH



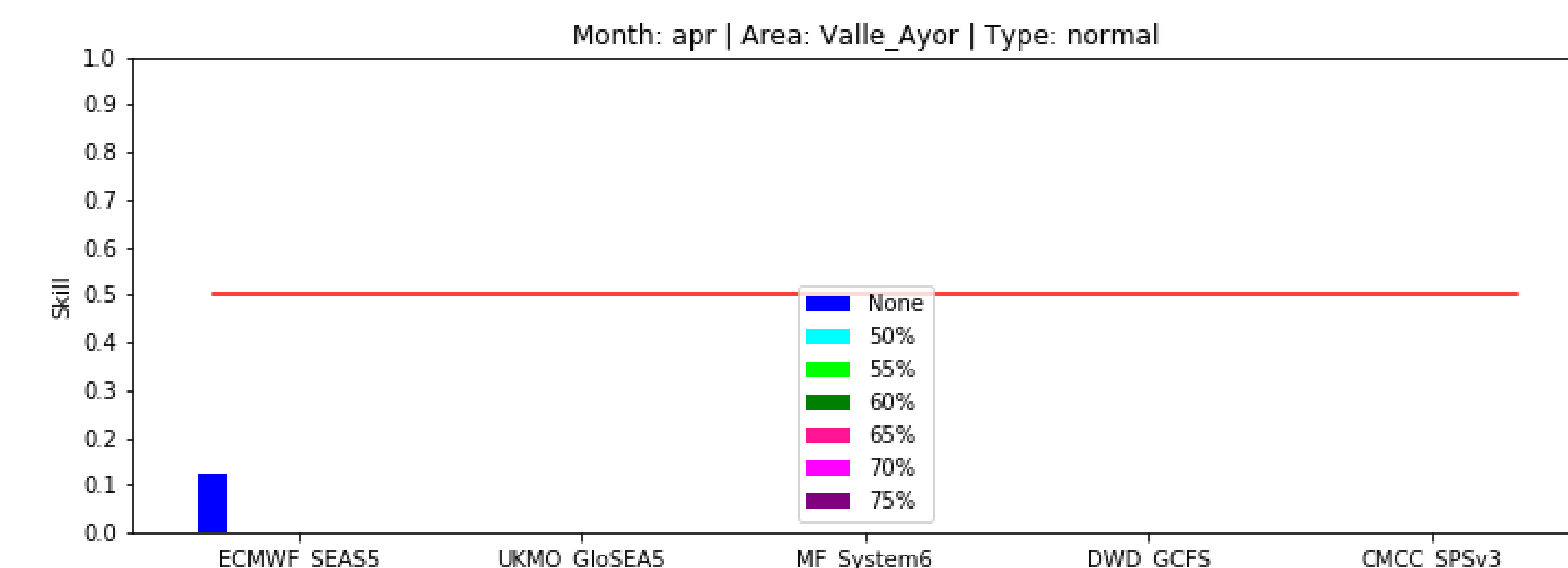
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FEBRUARY



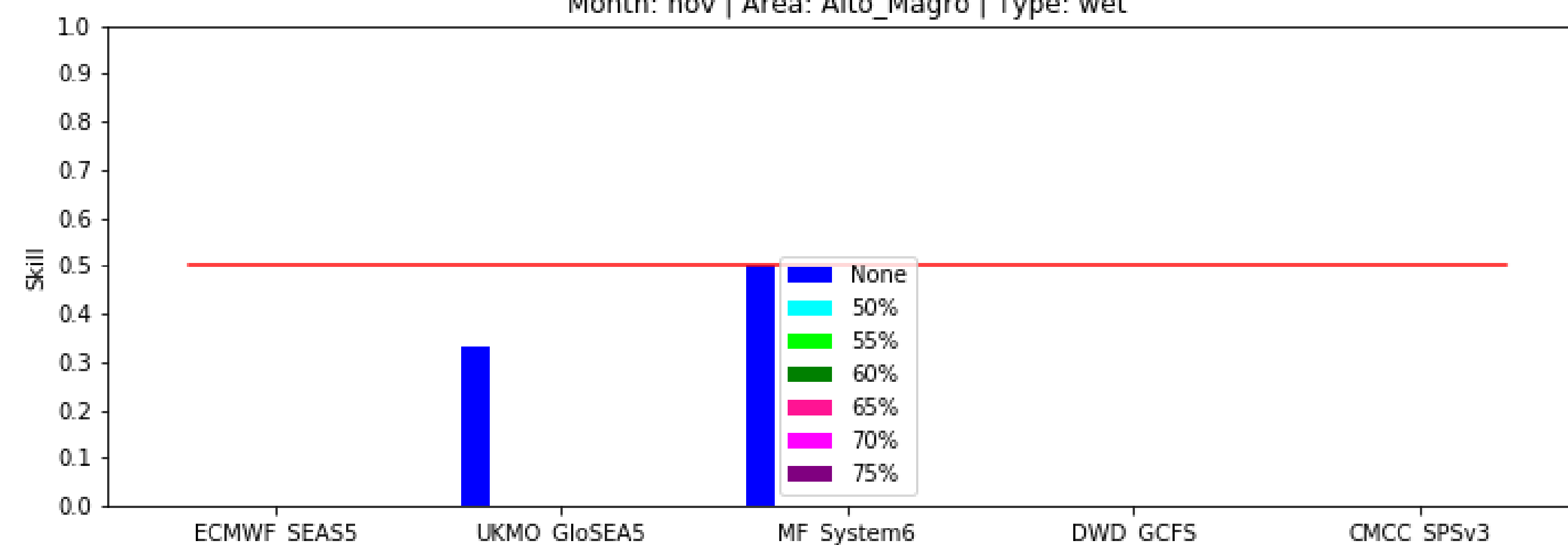
APRIL



TYPE OF YEAR SKILL RESULTS: WET YEAR FORECASTING IN ALTO MAGRO DEMAND

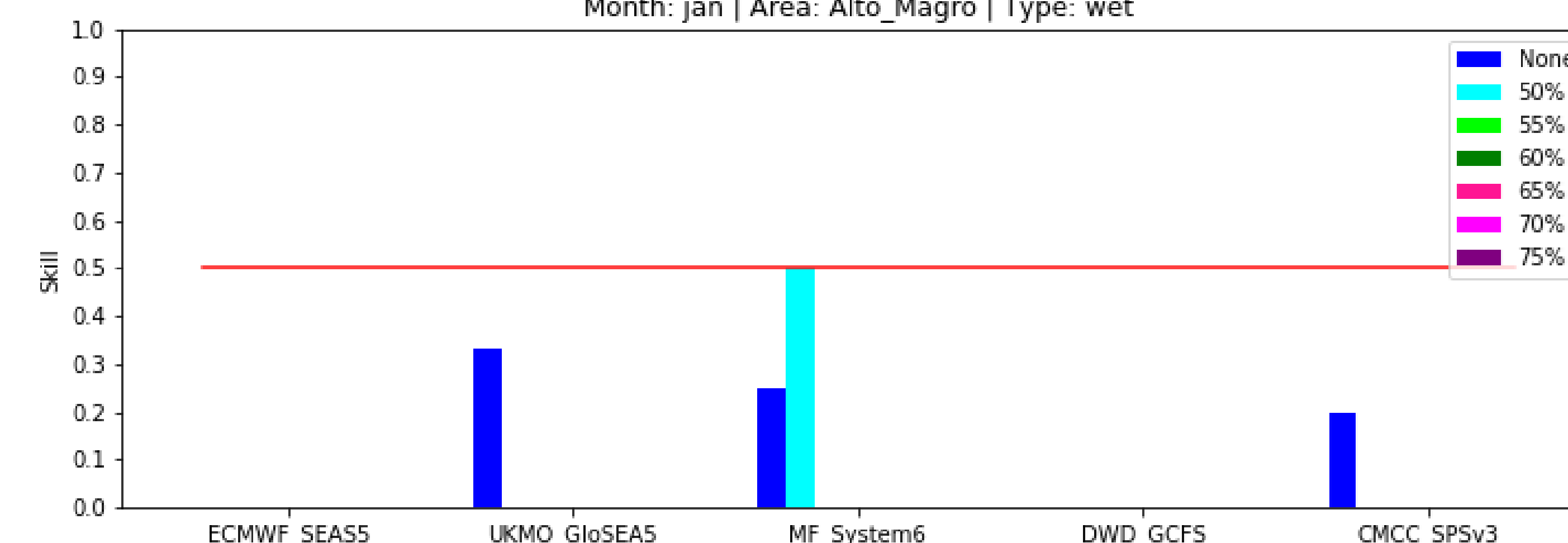
NOVEMBER

Month: nov | Area: Alto_Magro | Type: wet



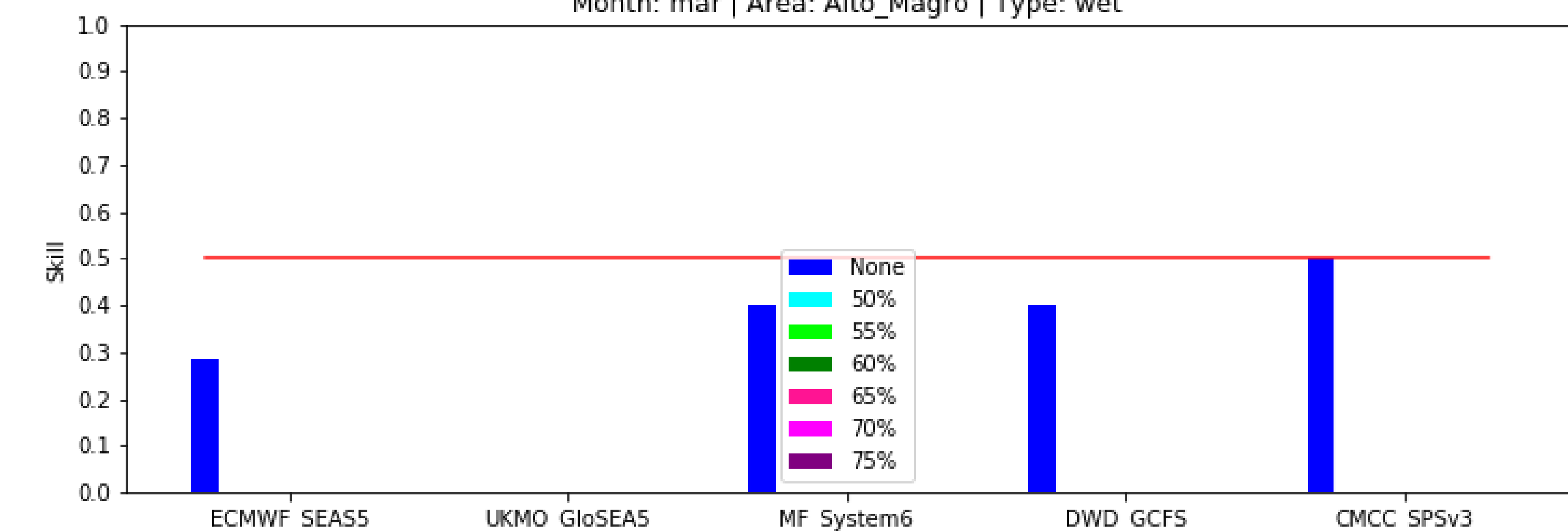
JANUARY

Month: jan | Area: Alto_Magro | Type: wet



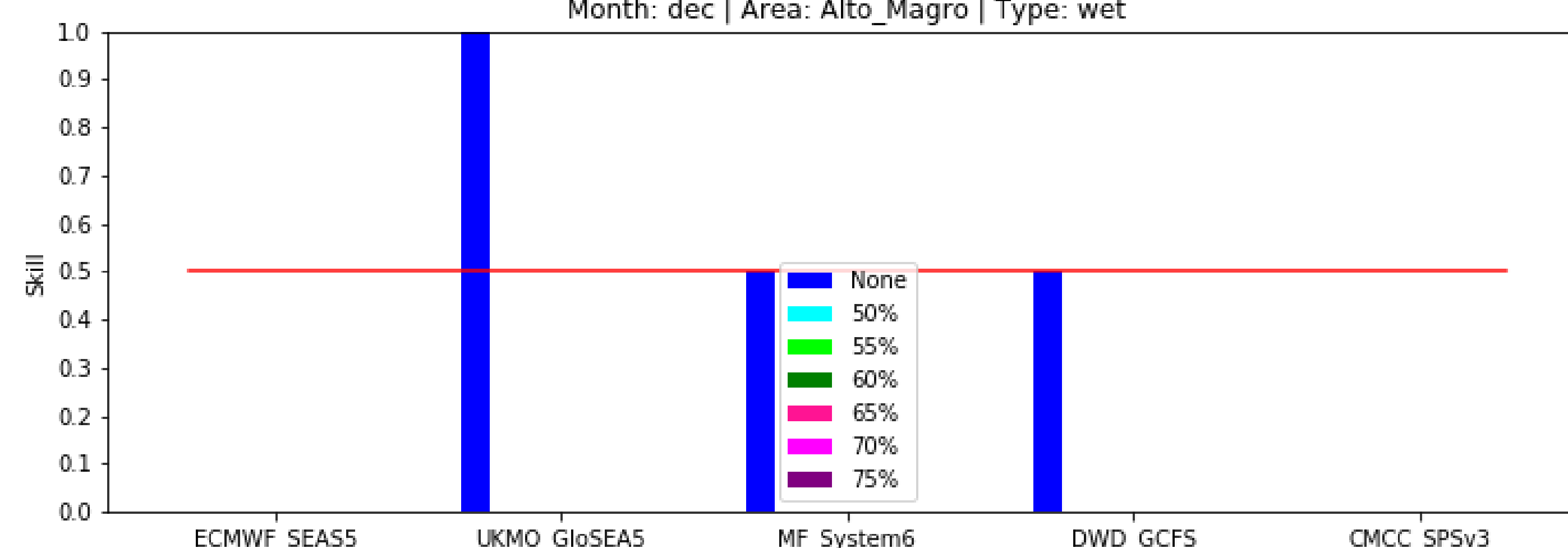
MARCH

Month: mar | Area: Alto_Magro | Type: wet



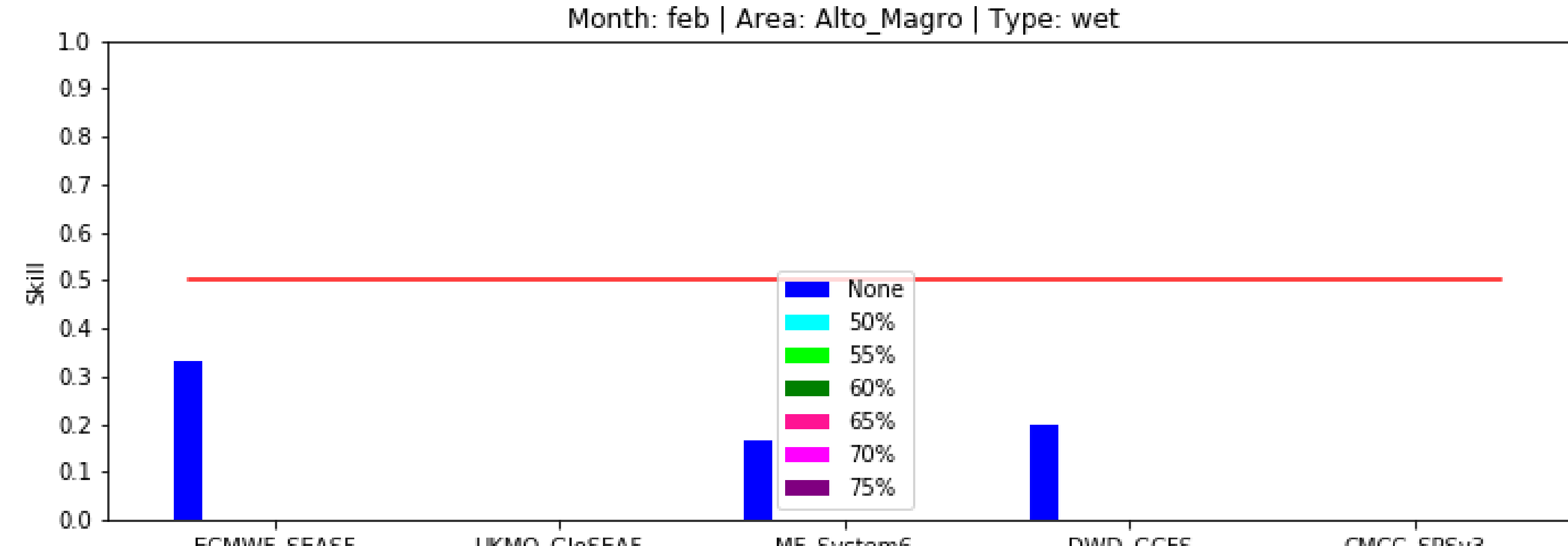
DECEMBER

Month: dec | Area: Alto_Magro | Type: wet



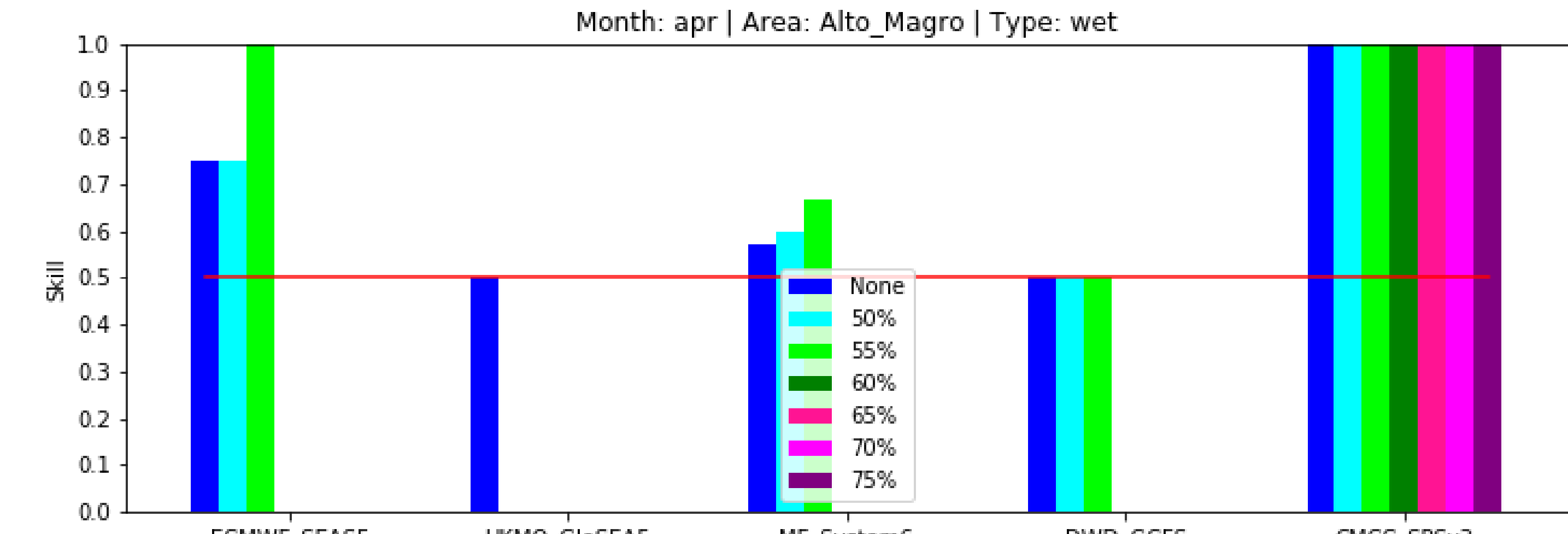
FEBRUARY

Month: feb | Area: Alto_Magro | Type: wet



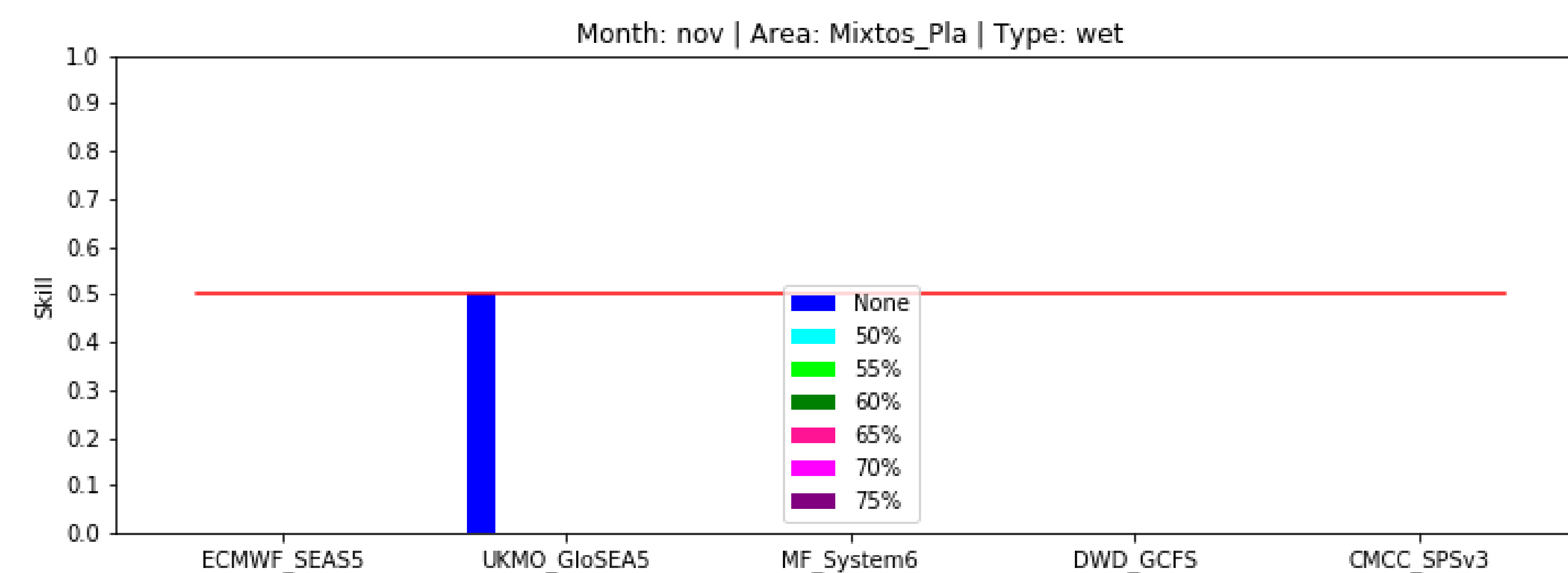
APRIL

Month: apr | Area: Alto_Magro | Type: wet

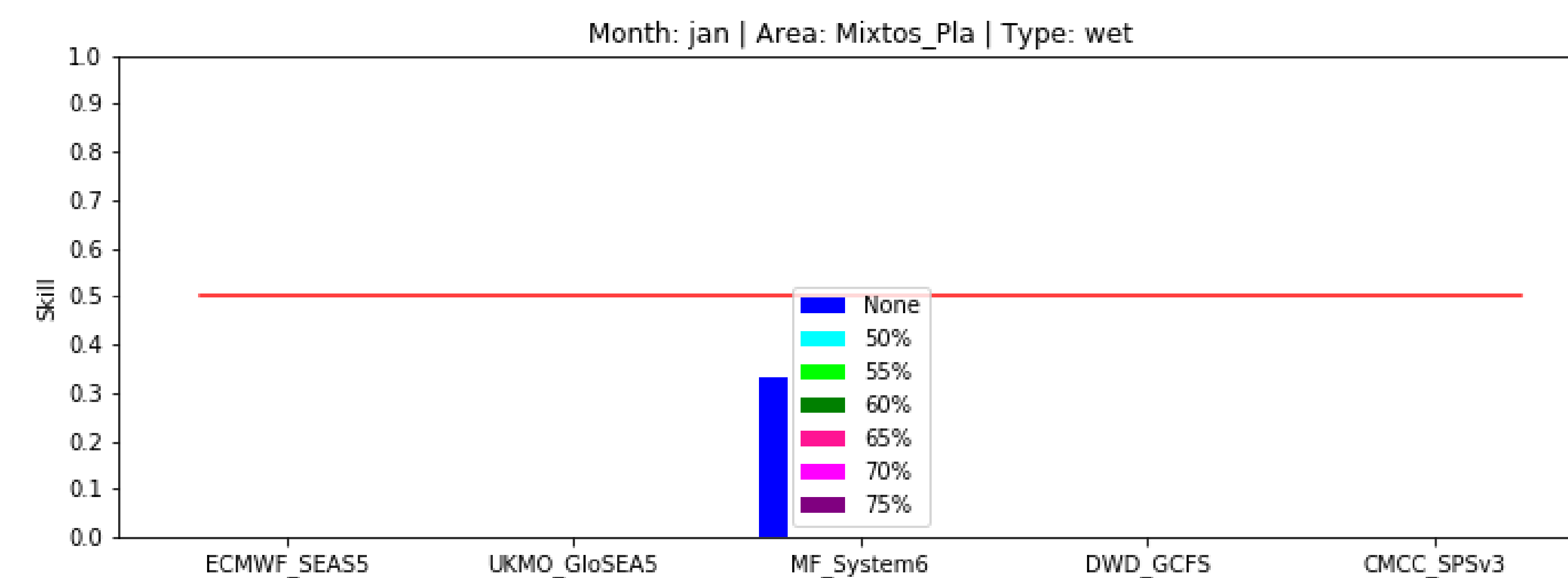


TYPE OF YEAR SKILL RESULTS: WET YEAR FORECASTING IN MIXTOS PLANA DEMAND

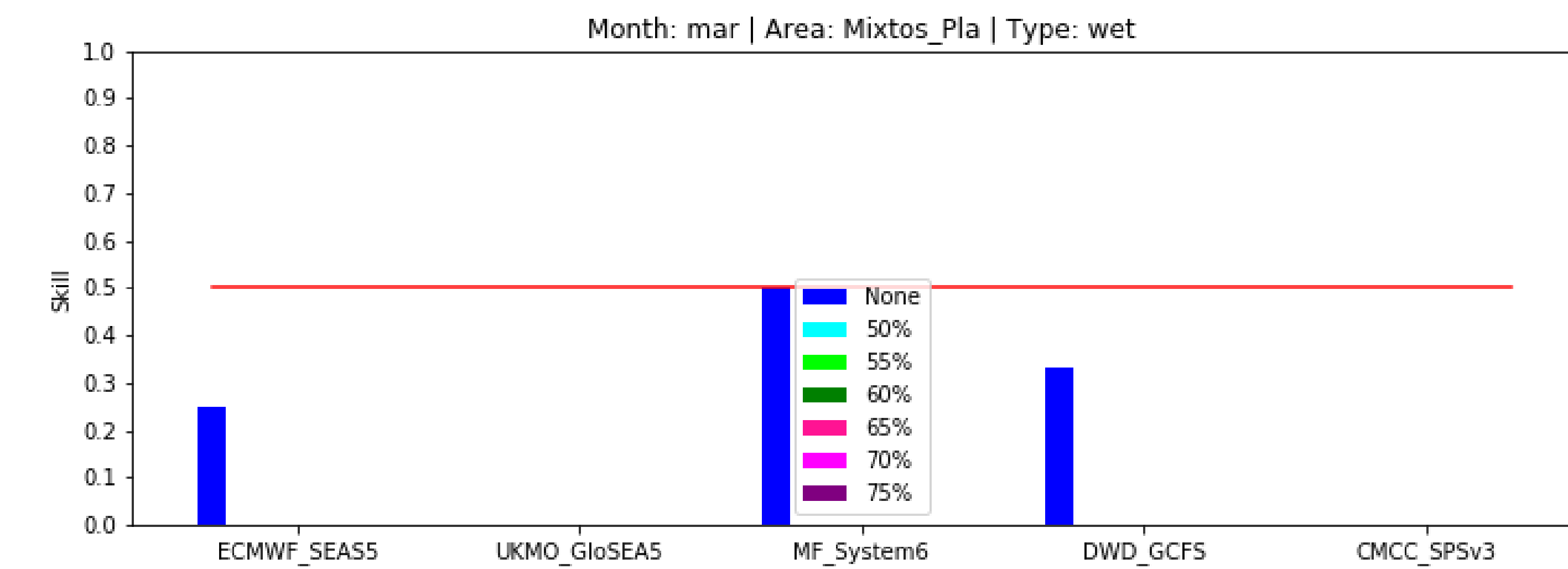
NOVEMBER



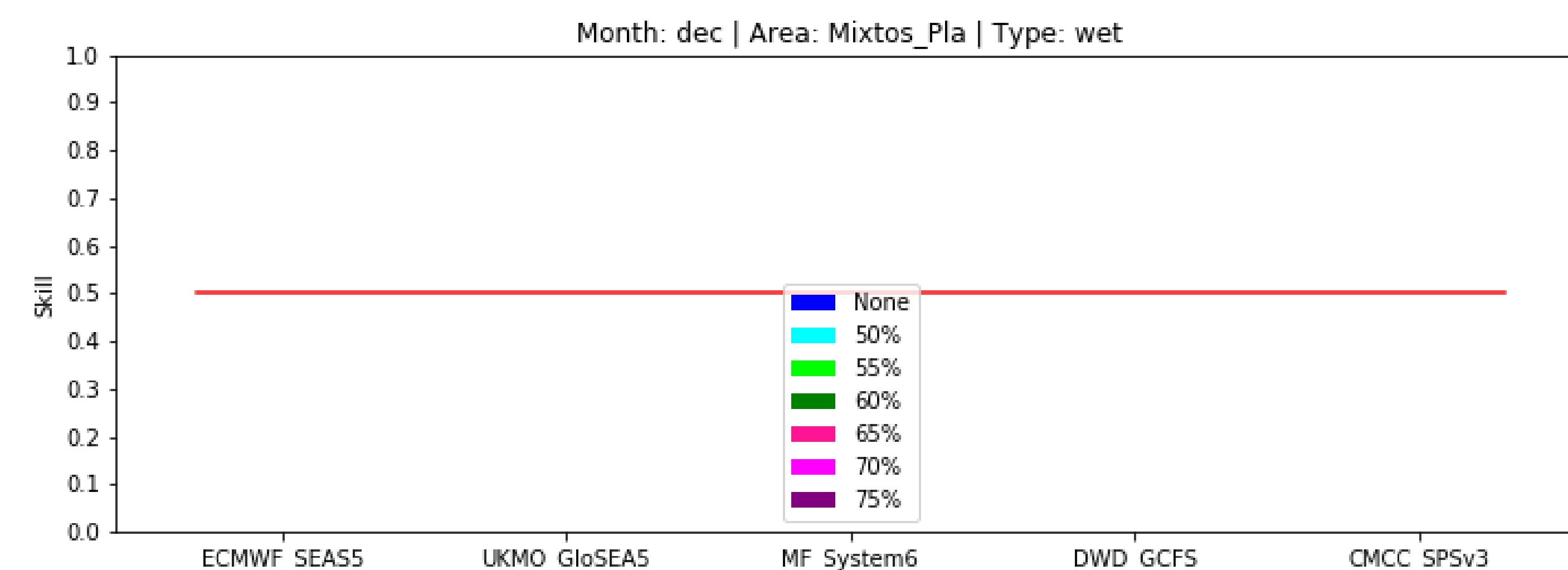
JANUARY



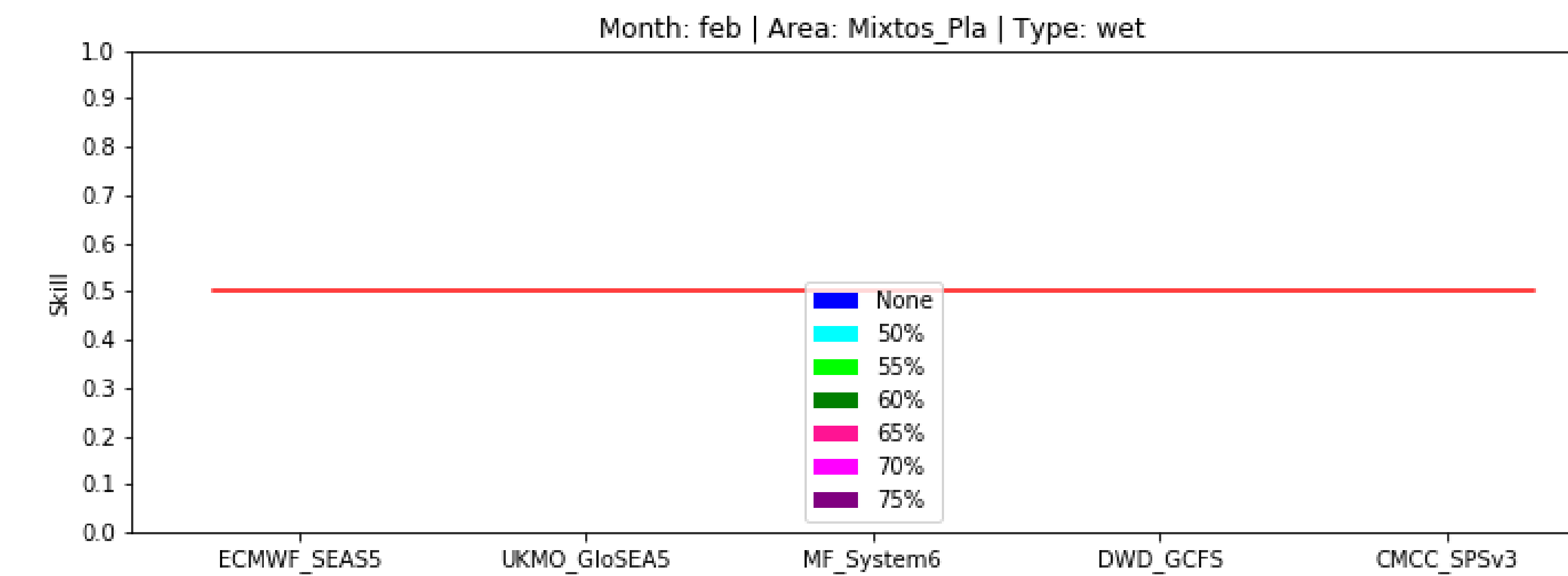
MARCH



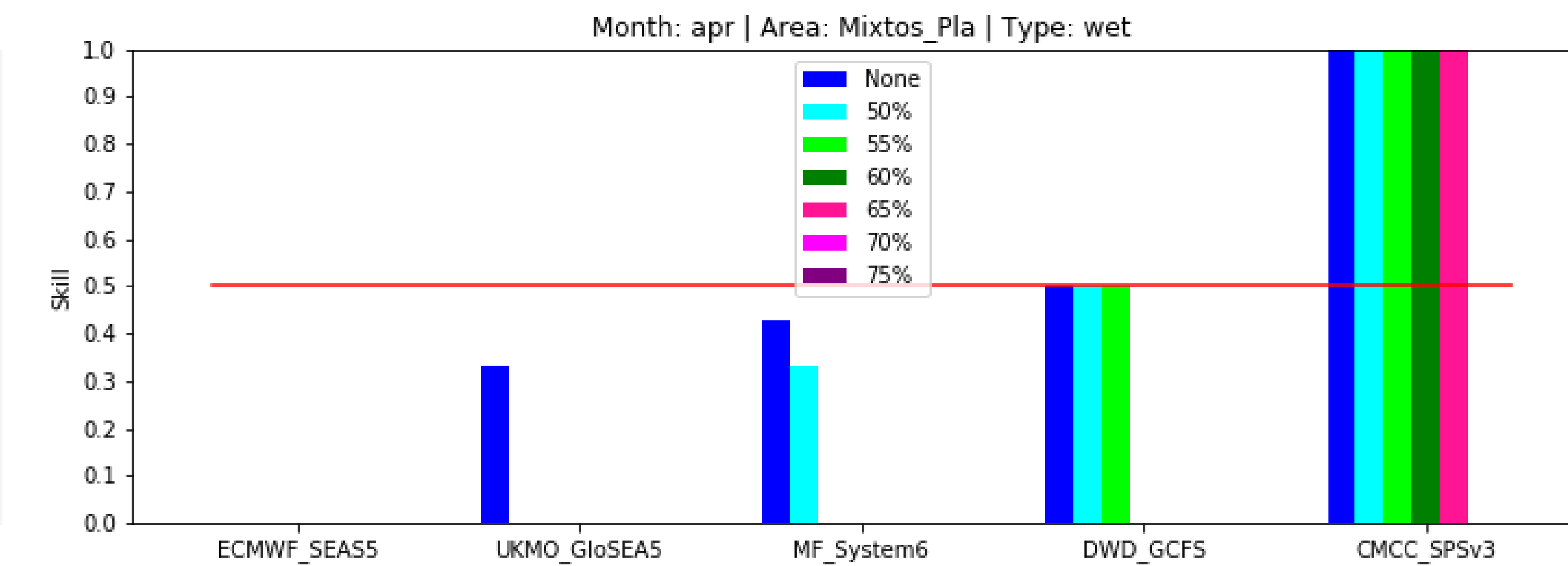
DECEMBER



FEBRUARY

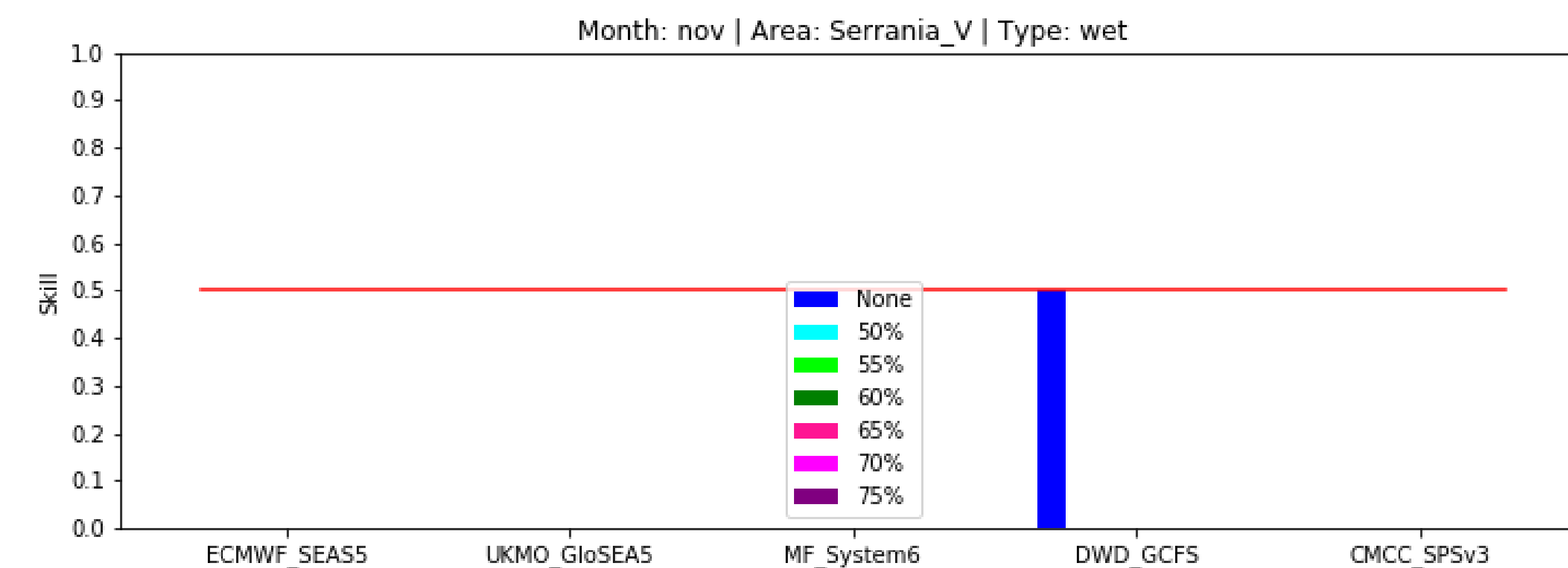


APRIL

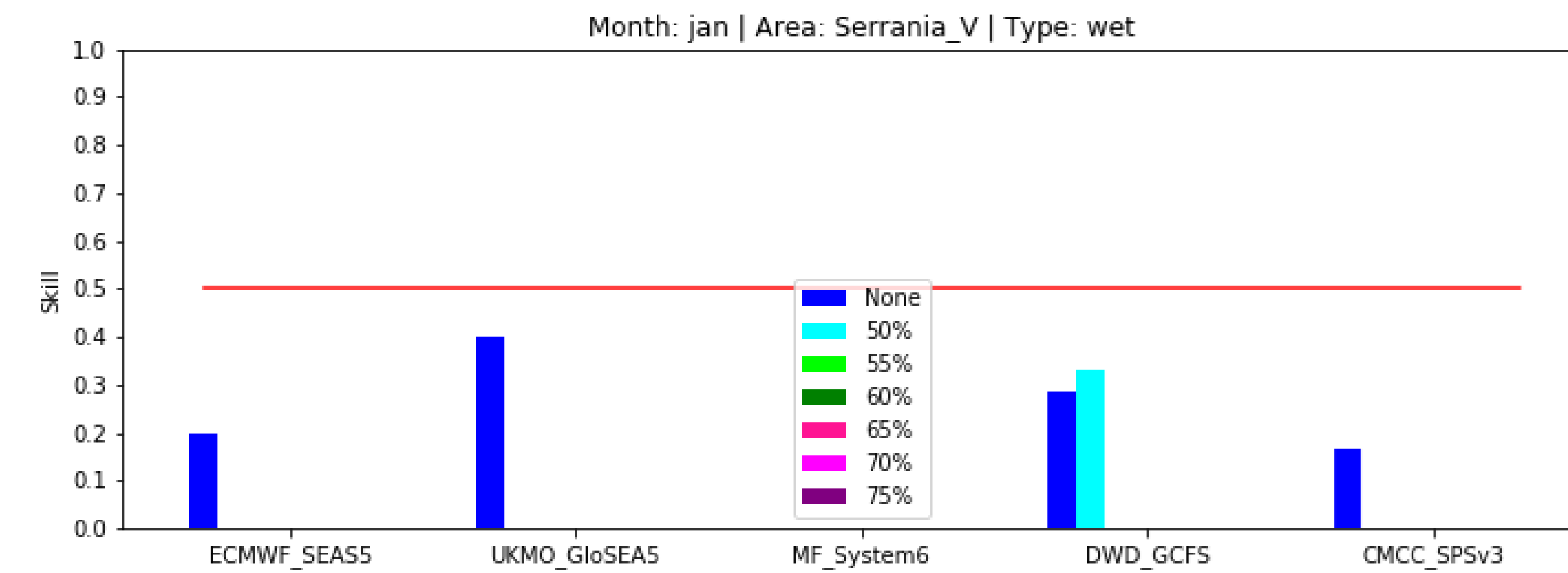


TYPE OF YEAR SKILL RESULTS: WET YEAR FORECASTING IN SERRANÍA VALENCIA DEMAND

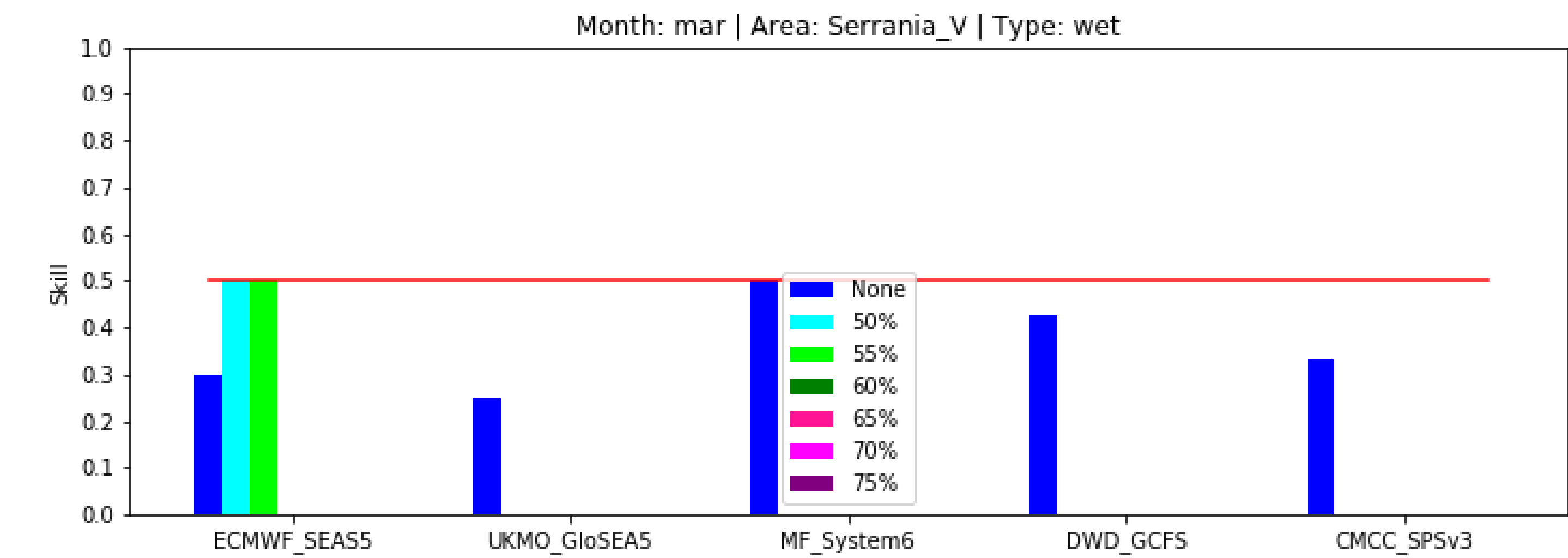
NOVEMBER



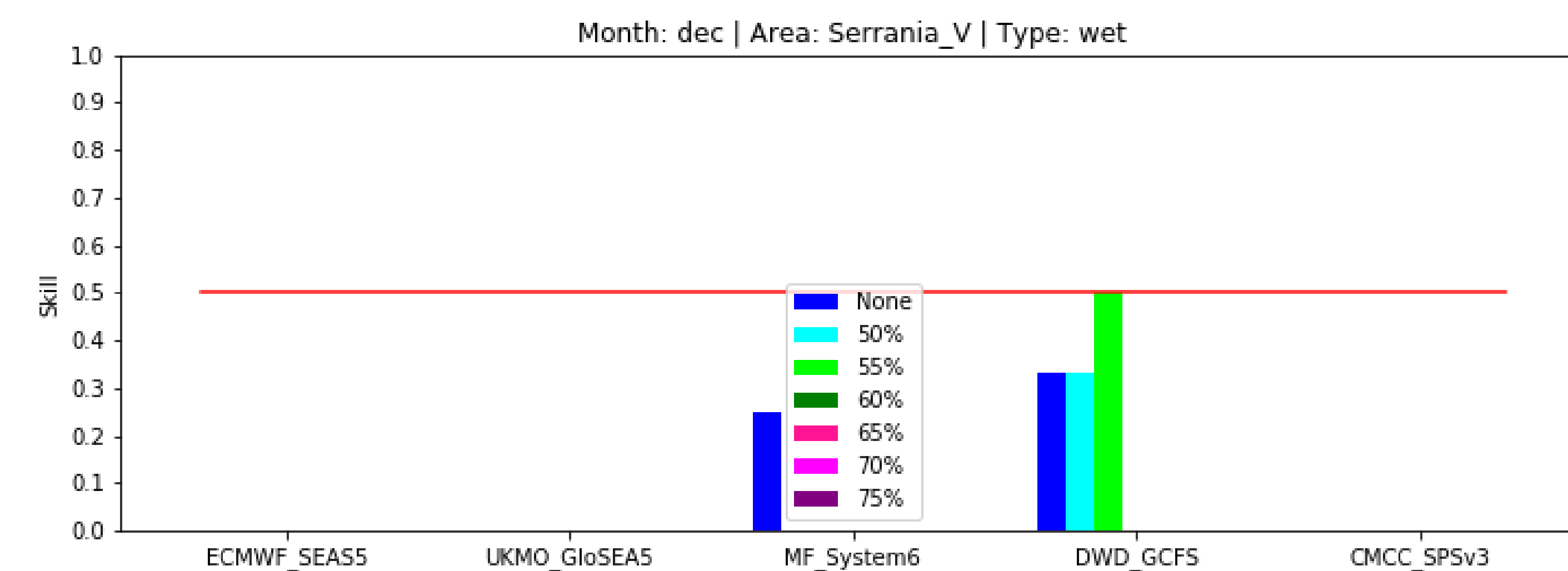
JANUARY



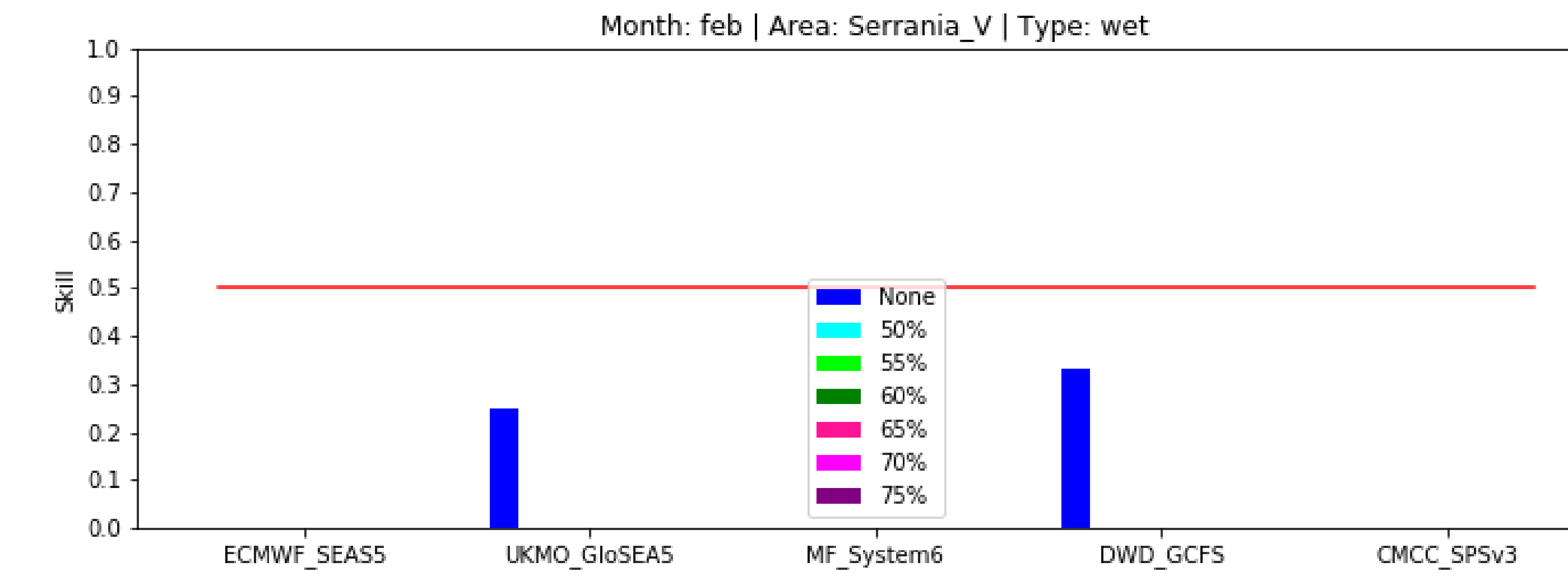
MARCH



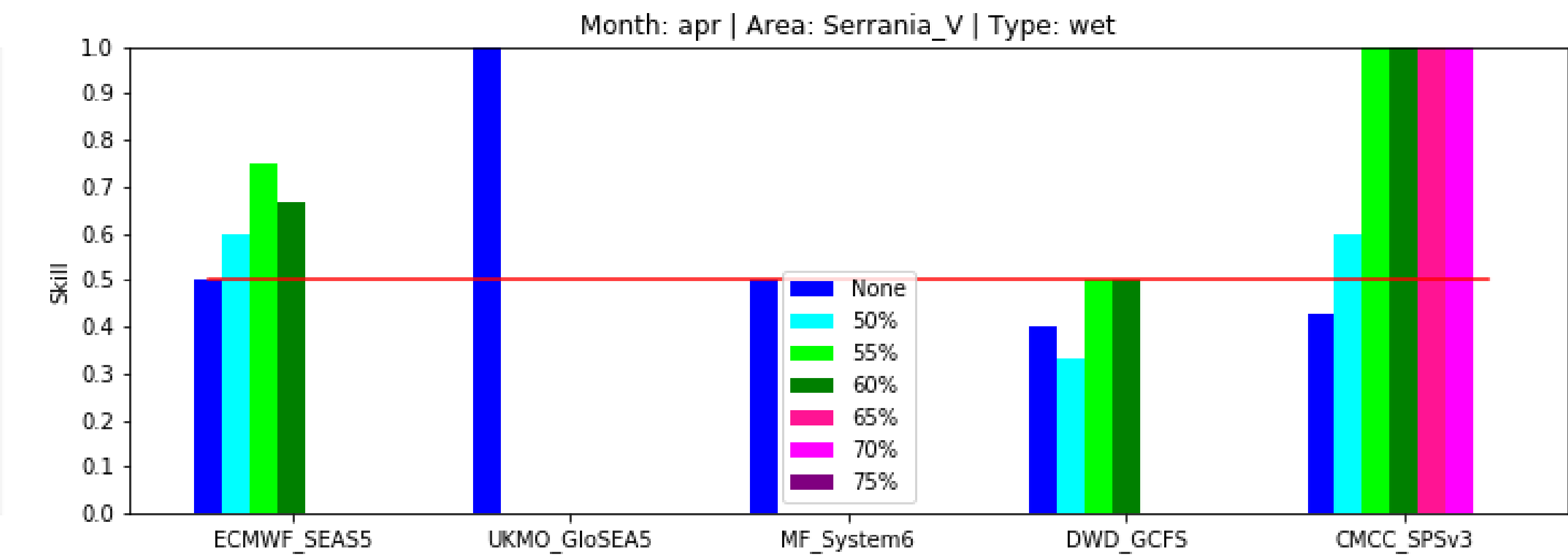
DECEMBER



FEBRUARY

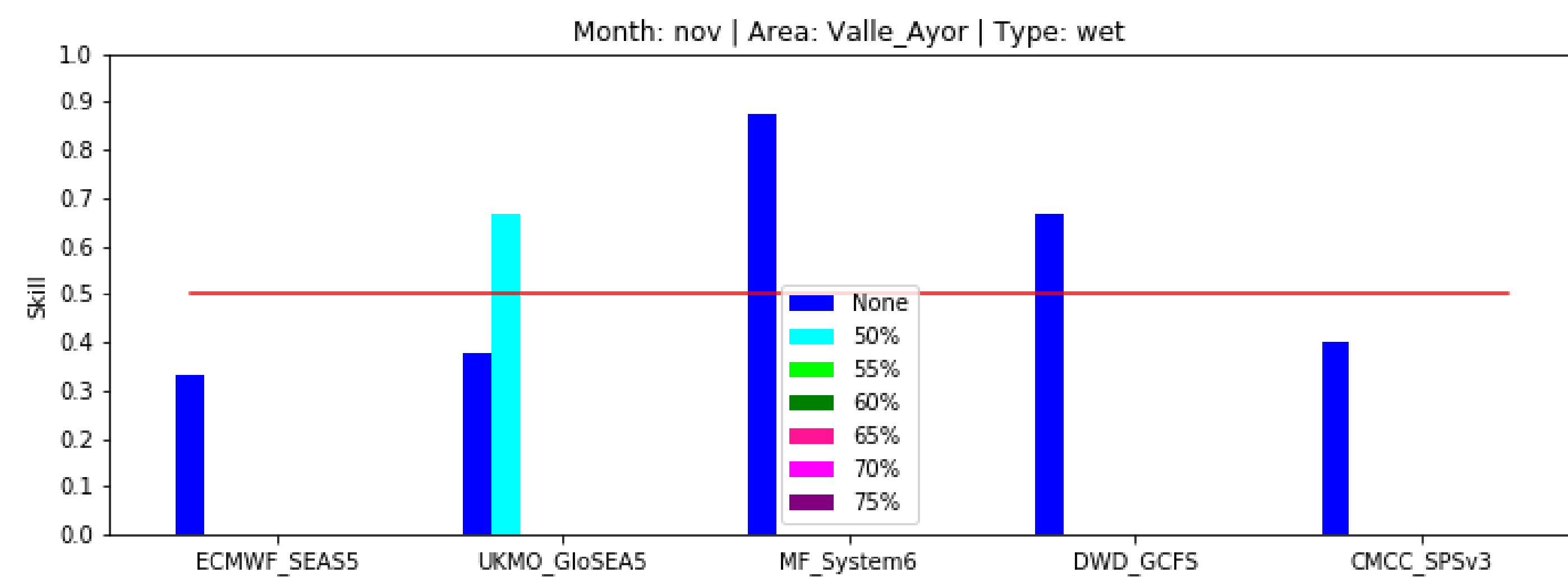


APRIL

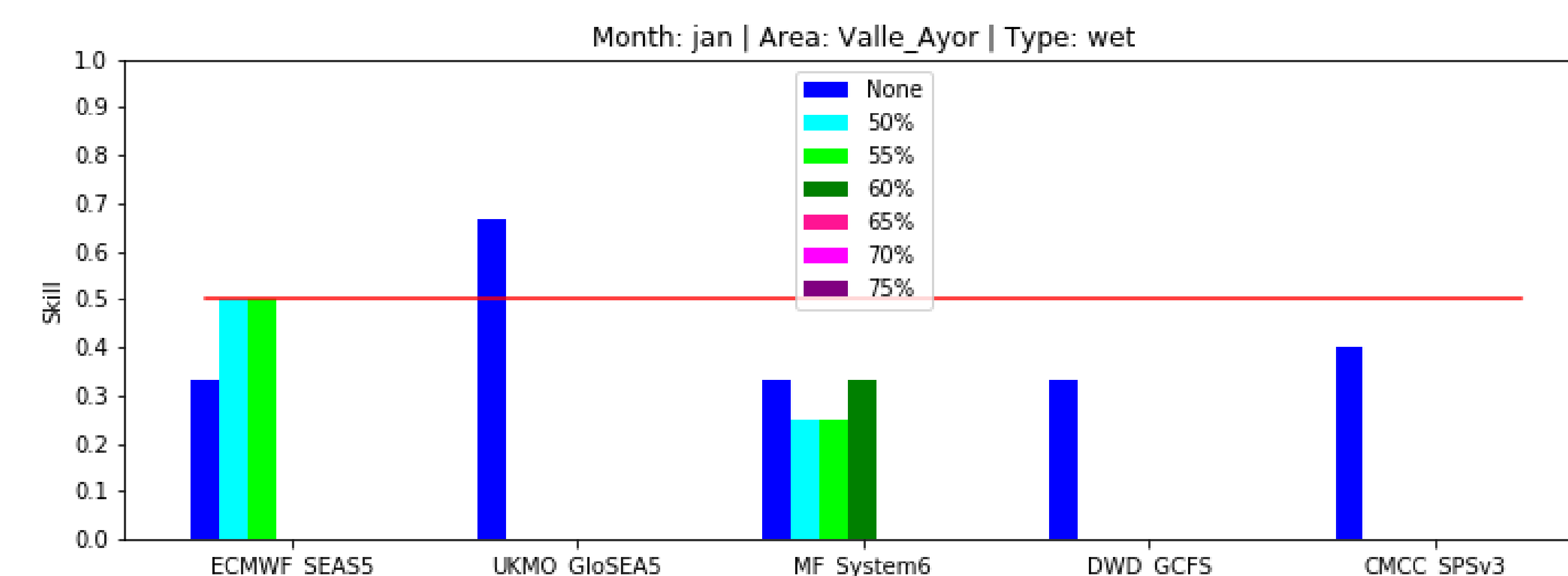


TYPE OF YEAR SKILL RESULTS: WET YEAR FORECASTING IN VALLE DE AYORA DEMAND

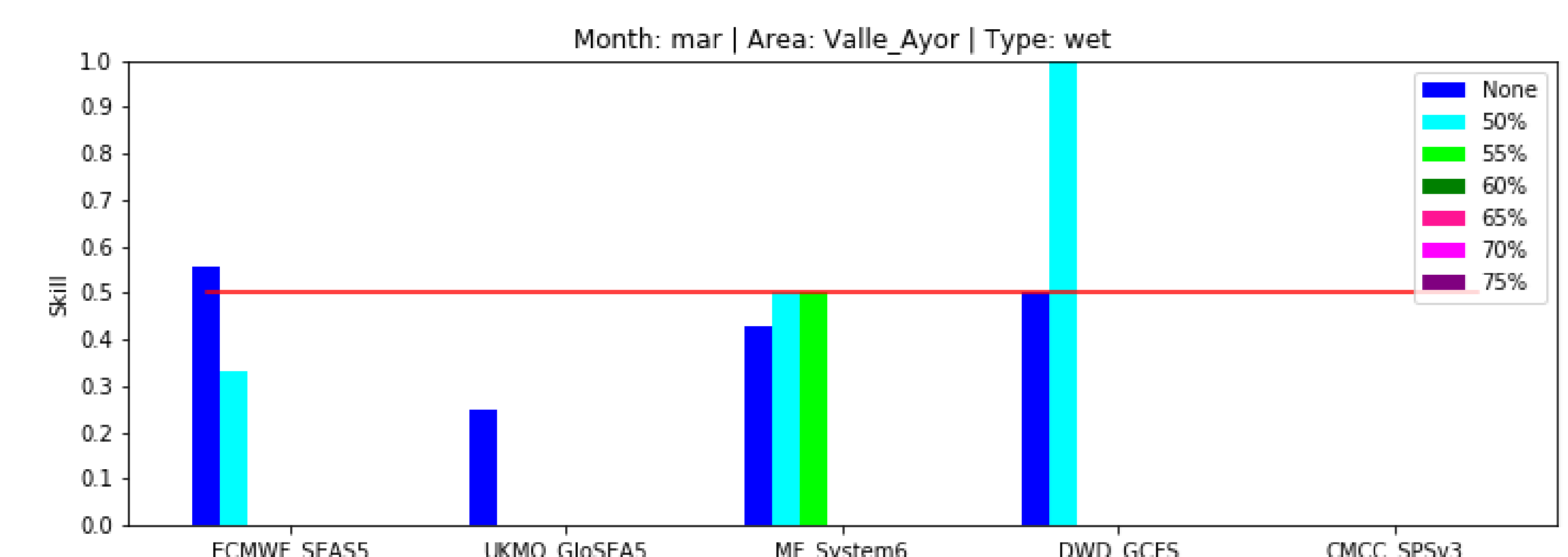
NOVEMBER



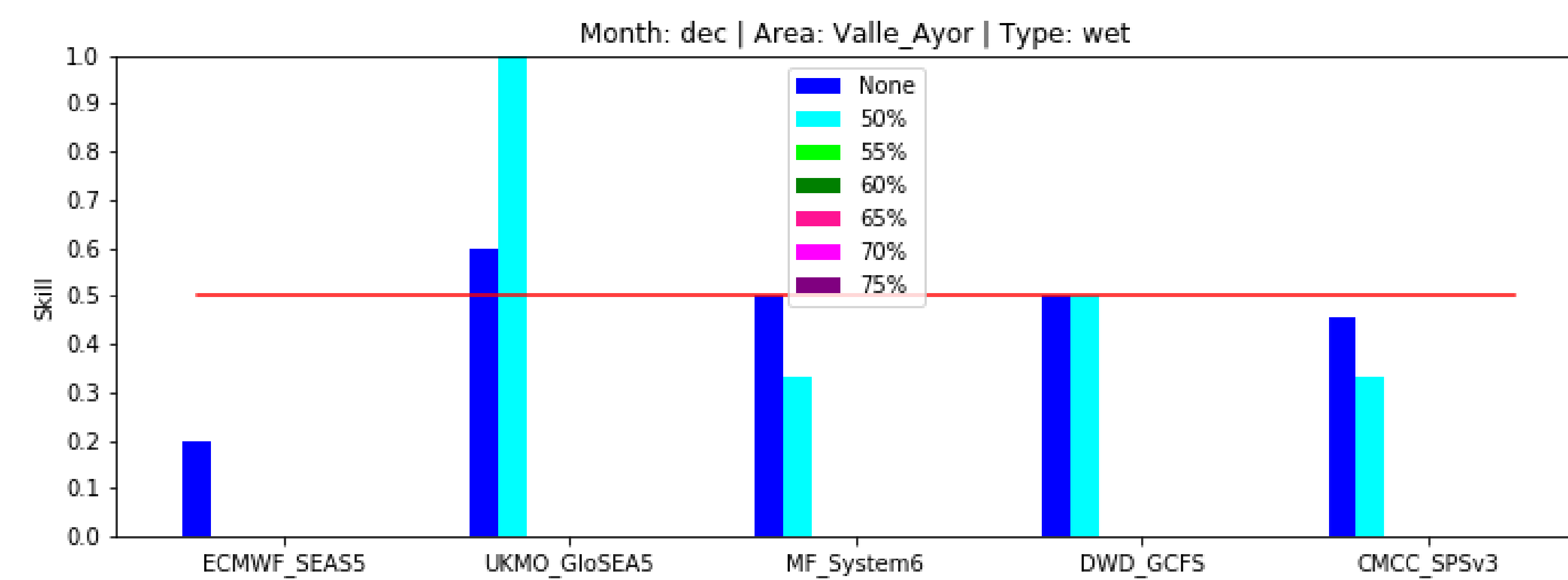
JANUARY



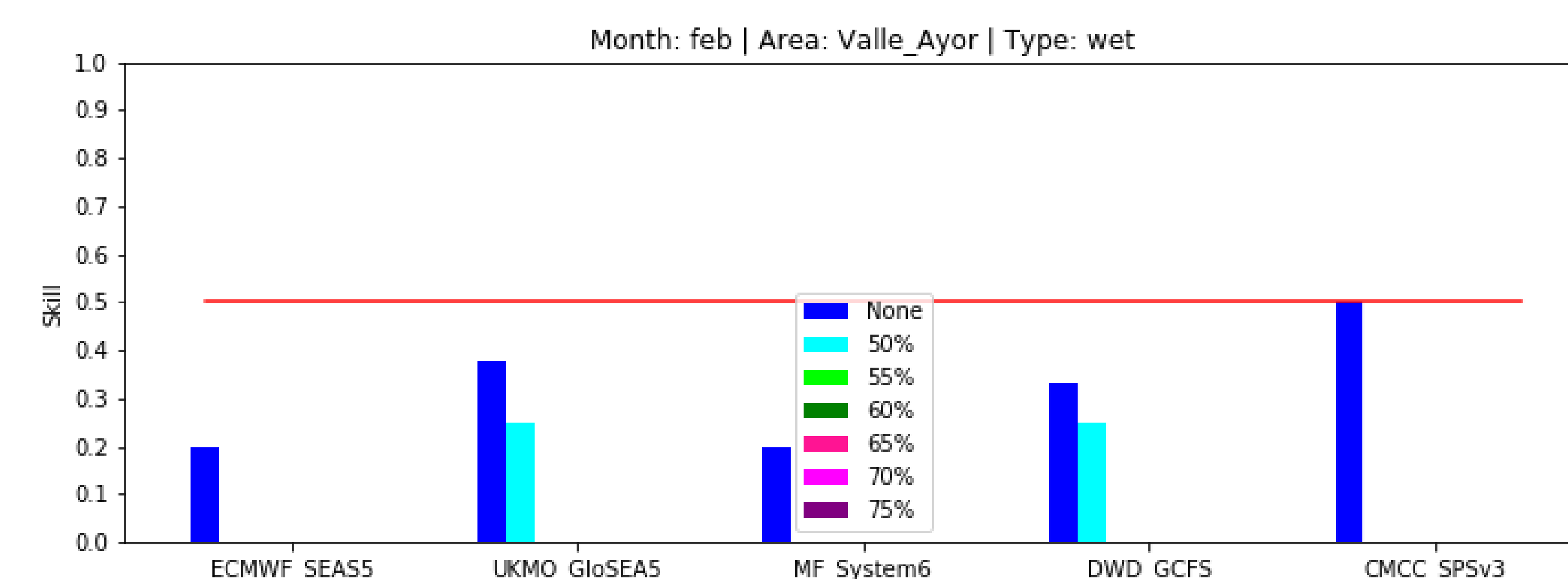
MARCH



DECEMBER



FEBRUARY



APRIL

