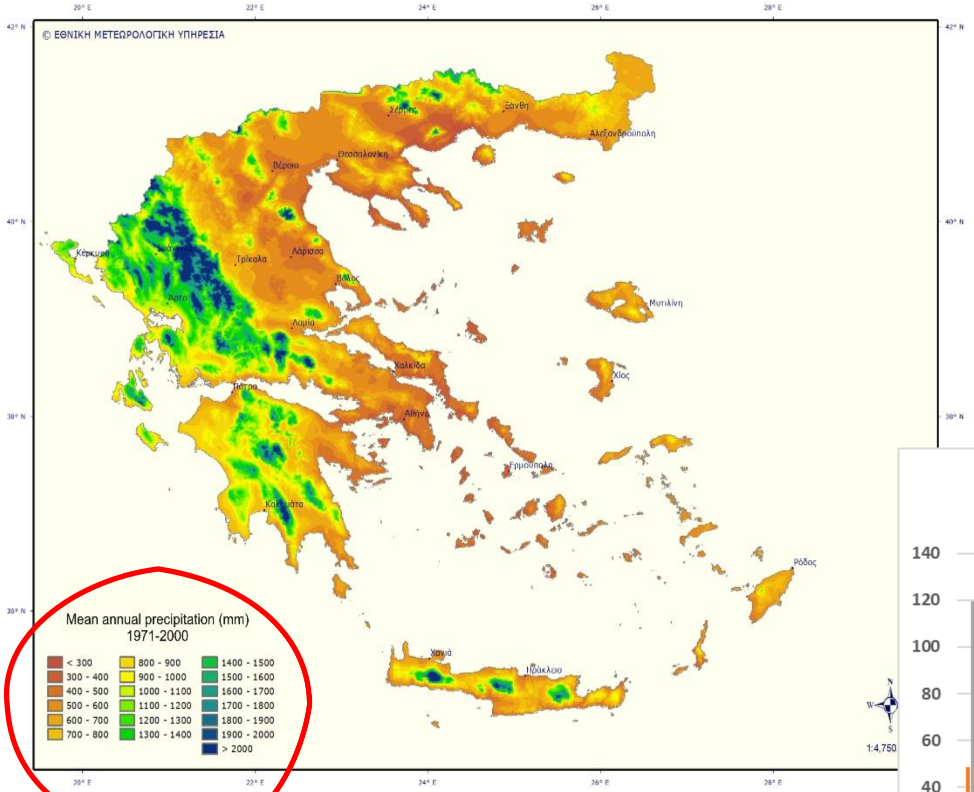
Project AWARE

Task 2.2: Role of SEEPS and EDI-SEDI for the evaluation of extreme precipitation forecasts

Motivation-Plan

- Combining data from a larger number of stations during the evaluation process of NWP forecasts can produce false skill if climatologically diverse regions are combined
- Implications of heavy precipitation events have to be analysed by focusing in regions of similar climatology. Precipitation thresholds can constitute an ‘extreme’ event in a specific area and not in another.
- Study commonly used measures for extreme precipitation events like SEEPS and SEDI
- Analyse their relative strengths and weaknesses and also to highlight the importance of threshold choice especially during the aggregation of results of stations with different climatological characteristics.

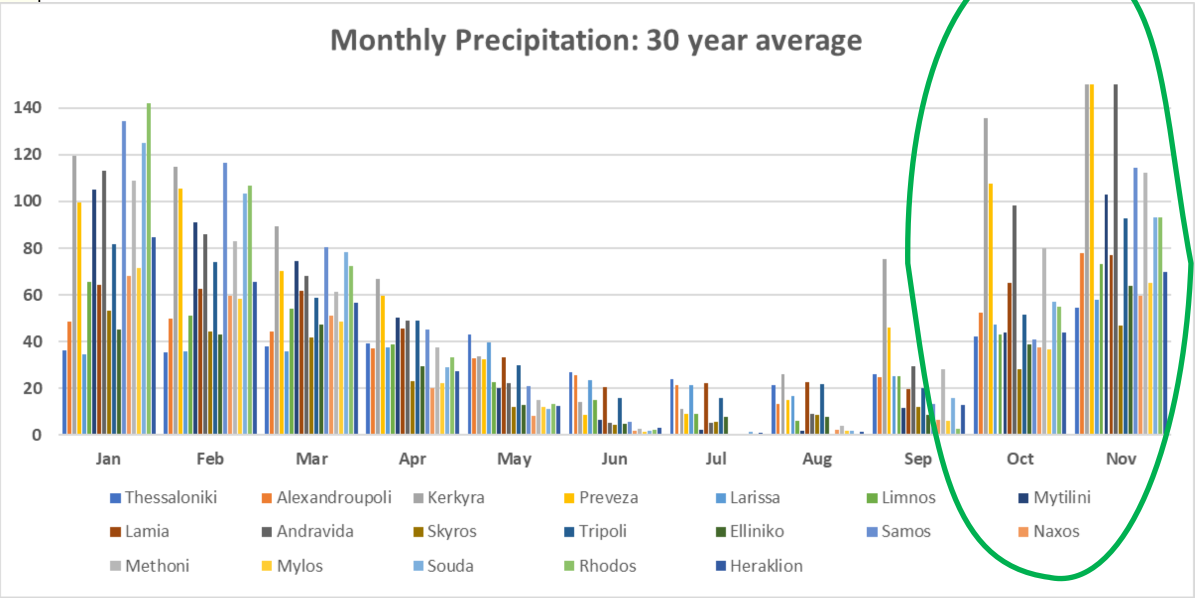
Climatology of Greece



Values of mean monthly and annual precipitation amounts retrieved from Climate Atlas: http://climatlas.hnms.gr/

Analysis of mean monthly values of SYNOP stations revealed high variability among stations

Importance to analyse separate regions with diverse climate in terms of precipitation



Stable Equitable Error in Probability Space (SEEPS)

- Measures the ability of a forecast to discriminate between ‘dry’, ‘light’, and ‘heavy’ precipitation’. Thresholds for each category are defined.
- The threshold (Th1) between dry and light category is constant.
- The threshold defining the boundary between the ‘light’ and ‘heavy’ categories (Th2) varies systematically and is defined by local climatology for each station and month.
- Climatological probabilities are: dry p_1, light p_2, heavy p_3
- A 3x3 scoring matrix Rodwell et al. (2010) with the assumptions $p_3=p_2/2$ and $p_1+p_2+p_3=1$ is written as a function of p_1 only.

SEEPS score calculation

$$S = \frac{1}{2}\begin{Bmatrix} 0 & \frac{1}{1-p_1} & \frac{4}{1-p_1} \\ \frac{1}{p_1} & 0 & \frac{3}{1-p_1} \\ \frac{1}{p_1}+\frac{3}{2+p_1} & \frac{3}{2+p_1} & 0 \end{Bmatrix}. \quad \mathbf{x} \quad \begin{bmatrix} \text{Ij11} & \text{ij12} & \textbf{ij13} \\ \text{Ij21} & \text{ij22} & \text{ij23} \\ \text{Ij31} & \text{ij31} & \text{ij33} \end{bmatrix}$$

- SEEPS score is the scalar product of the scoring matrix- function of p1 which is a penalty matrix) multiplied by a matrix of contigency table
- (e.g. **ij13** represents how many cases of **Heavy OBS-light FCS** are found in one month for each station)
- SEEPS is also a 3x3 matrix. values (0 to 1) measure the error in each category. The best score is **0**.
- SEEPS can be applied as a measure of extreme events, as Heavy Precipitation can be validated separately.

Methodology

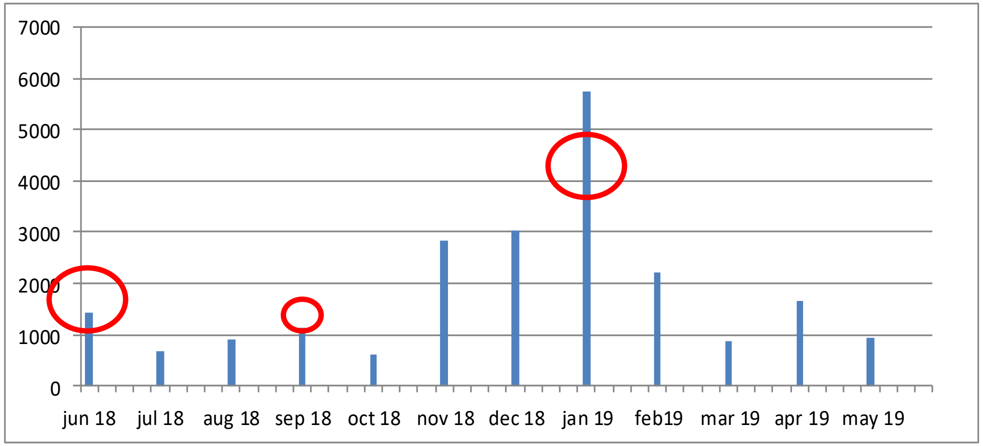
6- hourly Precipitation forecasts from **COSMOGR 4** and **COSMOGR-1** are verified against synop observations over Greece using the SEEPS score for the period: June 18 - May 19 (one year).

The thresholds (light to heavy) and probabilities for the score calculation are taken from a 30-year Europe database with climatological data for each individual station and each month **(provided by ECMWF)**.

Software-adapted for 6-hourly forecasts.

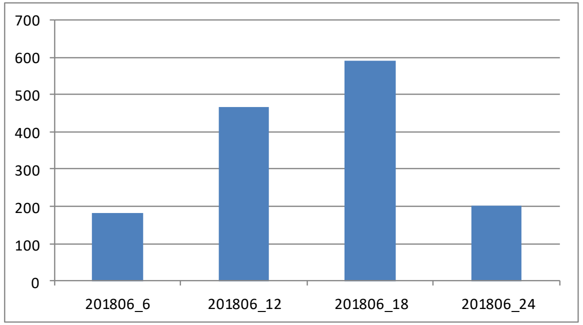
In order to calculate the area score over Greece, a weighting distance factor for each station is applied (to avoid over-emphasis of regions with high station density).

Then the monthly score was averaged by season (for seasonal scores).

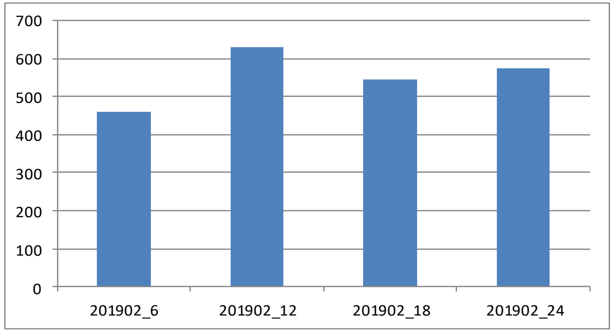


Data : June 18 to May 19

Total precipitation (mm) for each month
Extreme months are June and January.
Locally extreme events also in September
(precip from all stations are added together)



June 18

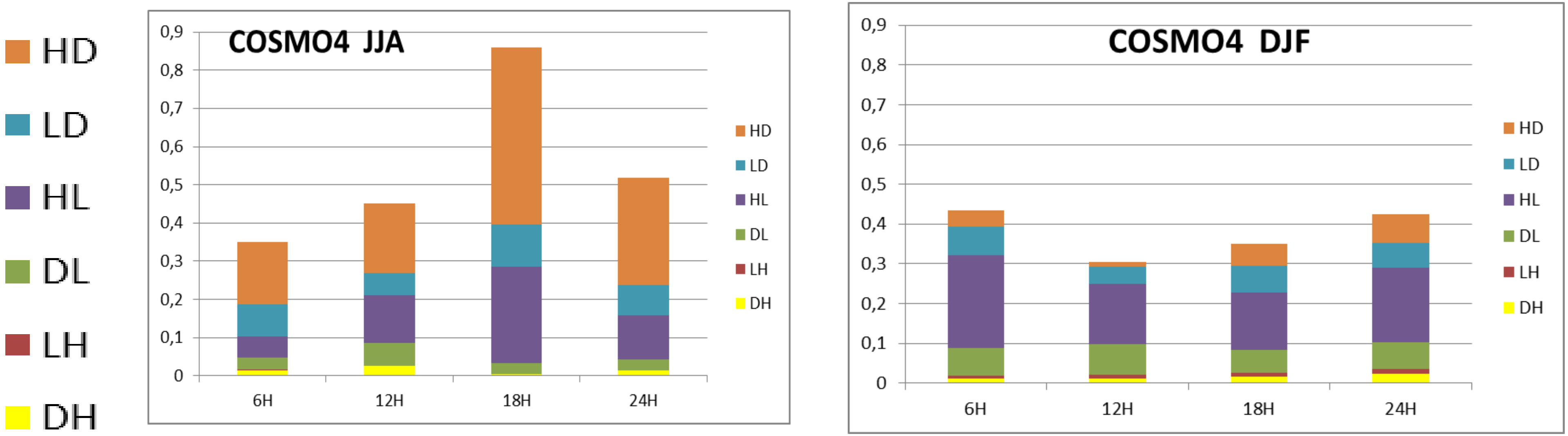


Feb 19

Different daily distribution of 6h preci
In different months/seasons.
Max values in the afternoon in summe
while equally distributed in winter

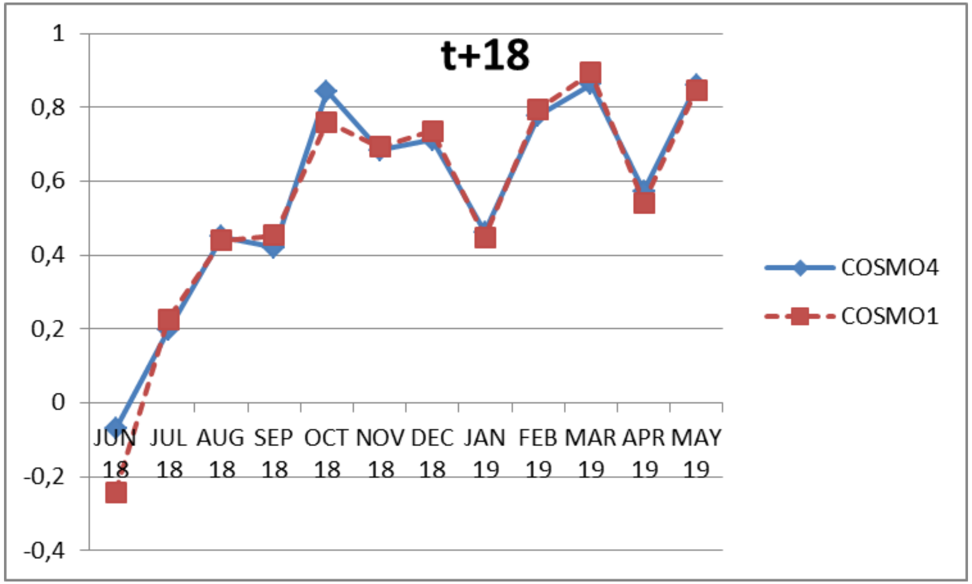
Important to analyze SEEPS for 6h precipitation accumulations

SEEPS 6h precipitation seasonal results (for all stations). The colors show different score contributions from each seeps matrix element: (HD means Heavy obs/ Dry forecast)



The contribution of HD is higher in JJA especially in the afternoon, where HEAVY rain is Predicted as DRY more often. In DJF the contribution of HL (HEAVY obs, LIGHT fcs) is more significant

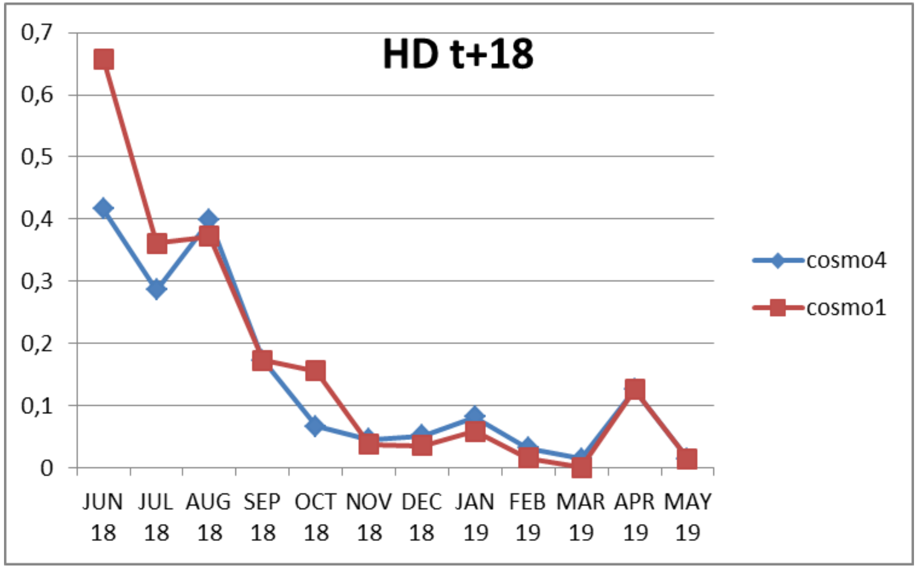
1-SEEPS (Monthly)

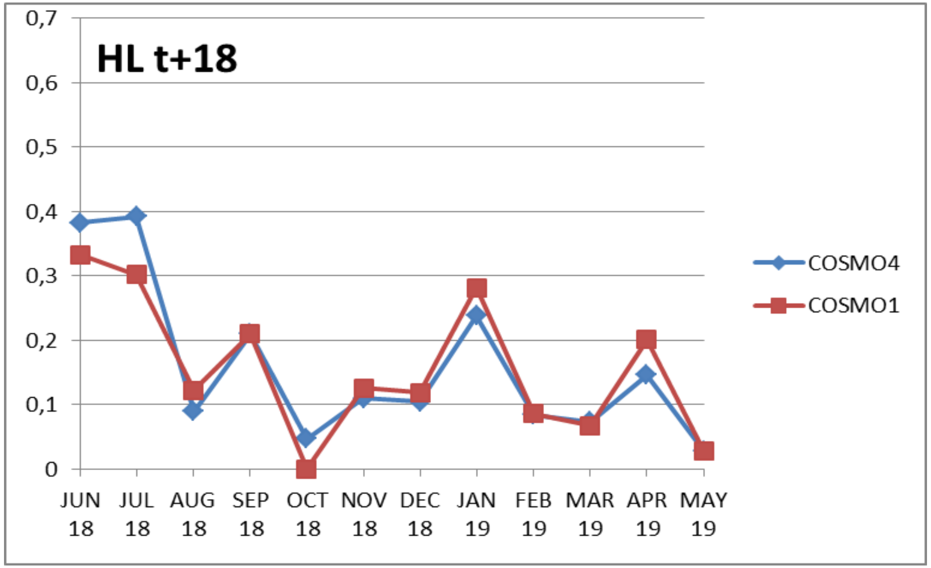


SEEPS totals is the sum of all matrix elements (plotted as 1-SEEPS, best is 1):

- Worse values in JJA and secondary min in January.
- Differences between the COSMO4-COSMO1 not significant

Components of SEEPS (Monthly)





SEEPS HD (Heavy OBS, Dry FCS) component (best is 0). Higher values in the summer-> SEEPS JJA main component is HD. COSMO1 worse in JJA.

SEEPS HL (Heavy OBS, Light FCS) component (best is 0). January high values -> SEEPS January main component is HL.

Symmetric extremal dependence index (SEDI) score

$$SEDI = \frac{\ln F - \ln H + \ln(1-H) - \ln(1-F)}{\ln F + \ln H + \ln(1-H) + \ln(1-F)}$$

-1 to 1
Best is 1
0 is unskilled forecast

H= Hit rate, F= False Alarm rate

<u>Suitable for extreme events</u>
Independent of base-rate
Symmetric
Equitable
It is a function of H and F

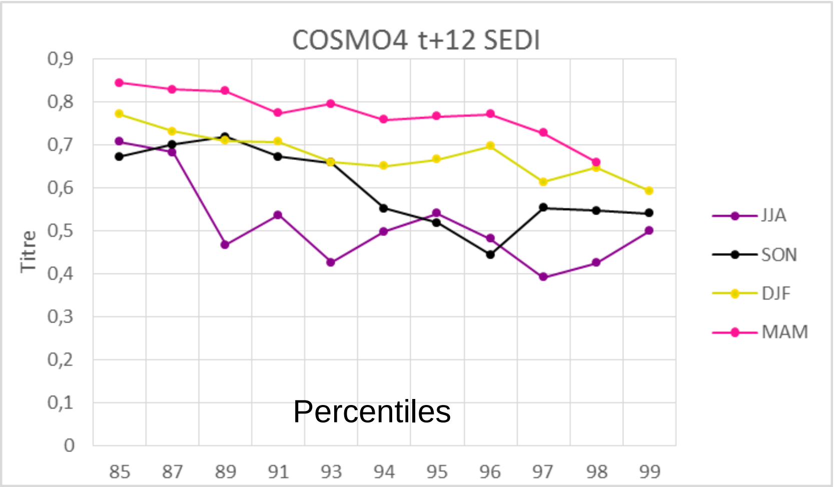
SEDI Methodology

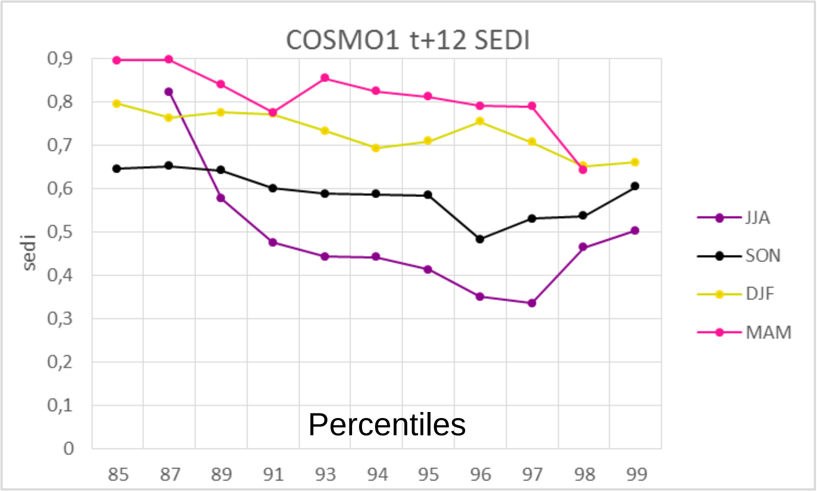
- ✓ Instead of constant thresholds, SEDI score for each season is calculated for climatologically different precipitation thresholds for each station and month based on extreme percentile values .

- ✓ Percentile value of 90% (eg. 20mm) means that there is 90% climatological probability that precipitation is lower than this value, which means that is quite extreme.

- ✓ Percentile values for each station and each month are taken from a 30-year database (ECMWF).

- ✓ Contingency tables for SEDI for the season are based on the sum of hits, false alarms etc. of all stations and months (for each station a different threshold is applied)





SEDI for all seasons. The first results show tendency to decrease with higher percentiles. Lower values (worse) in JJA. Better in MAM (it was a season with no extremes). COSMO1 lower values for JJA

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On going work :

Scores for individual stations for SEDI-SEEPS
Comparison of EDI-SEDI scores
Interpretation of results combining all scores by analyzing their strengths and weakness

Thank you !!