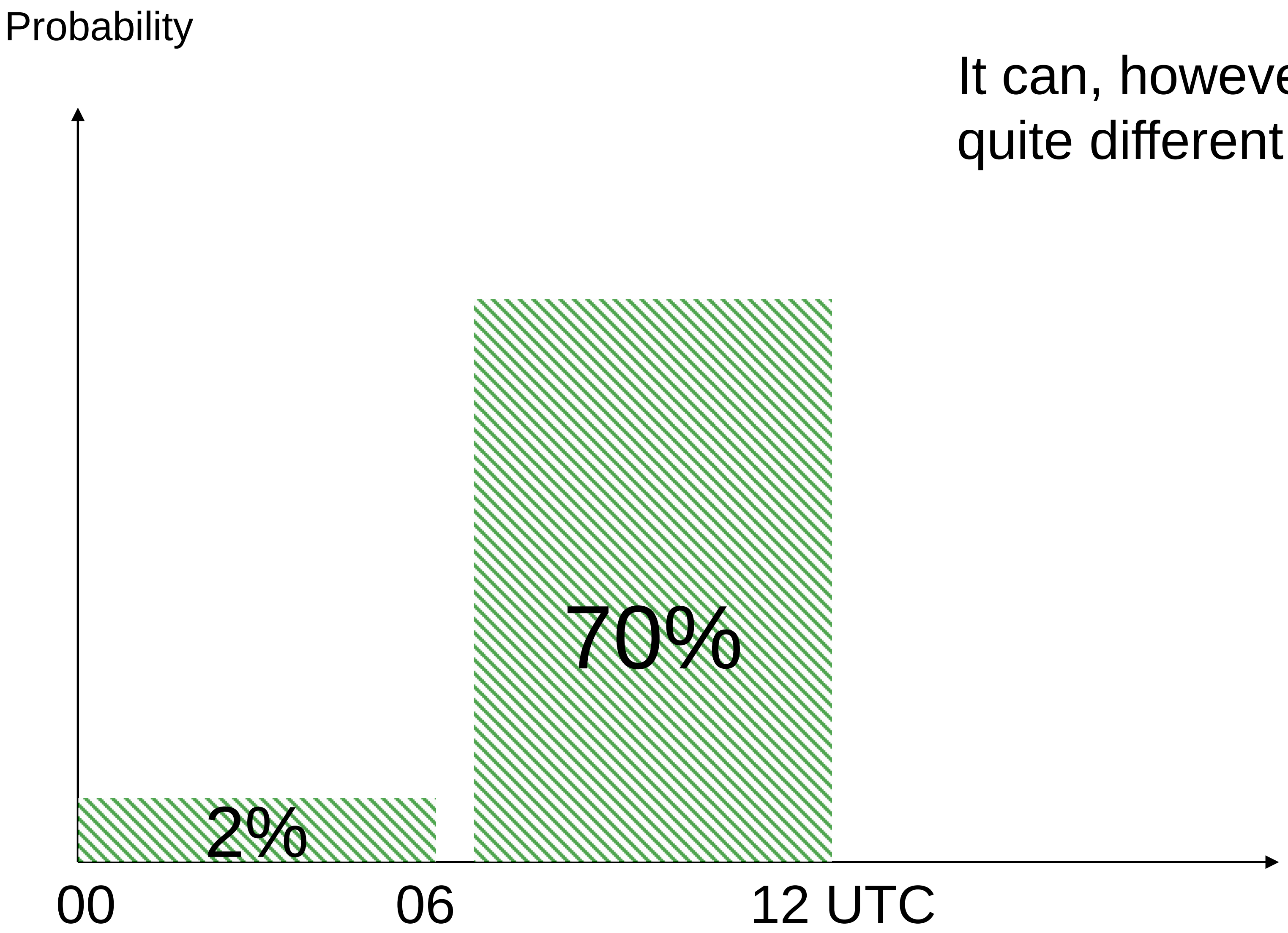
III Subjective probabilities

3. How to draw conclusions from small probabilities (extension from I.1.3)

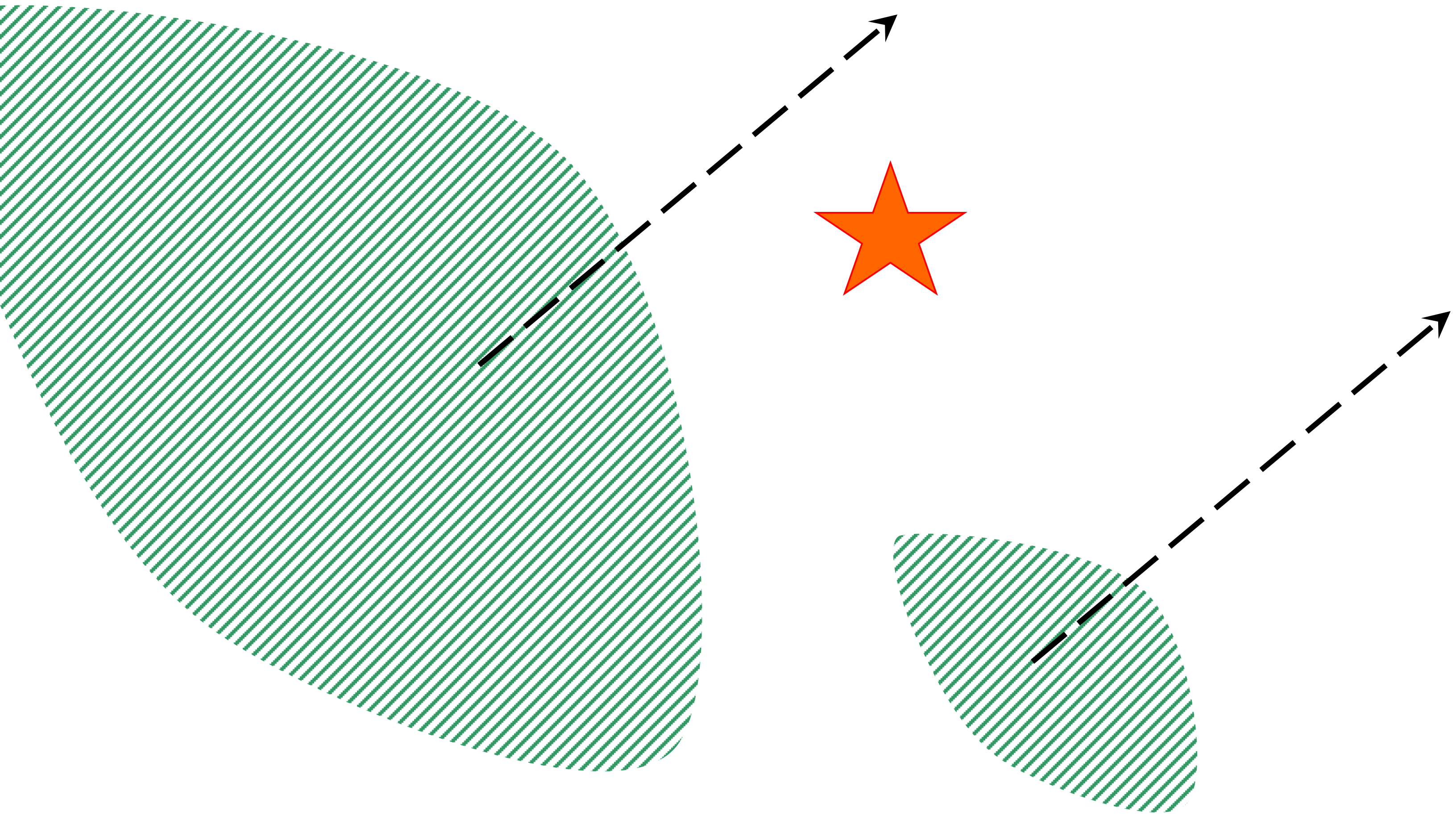
III.3.1 The risk of over-confident probabilities

Probabilities of rain according to some reliable system

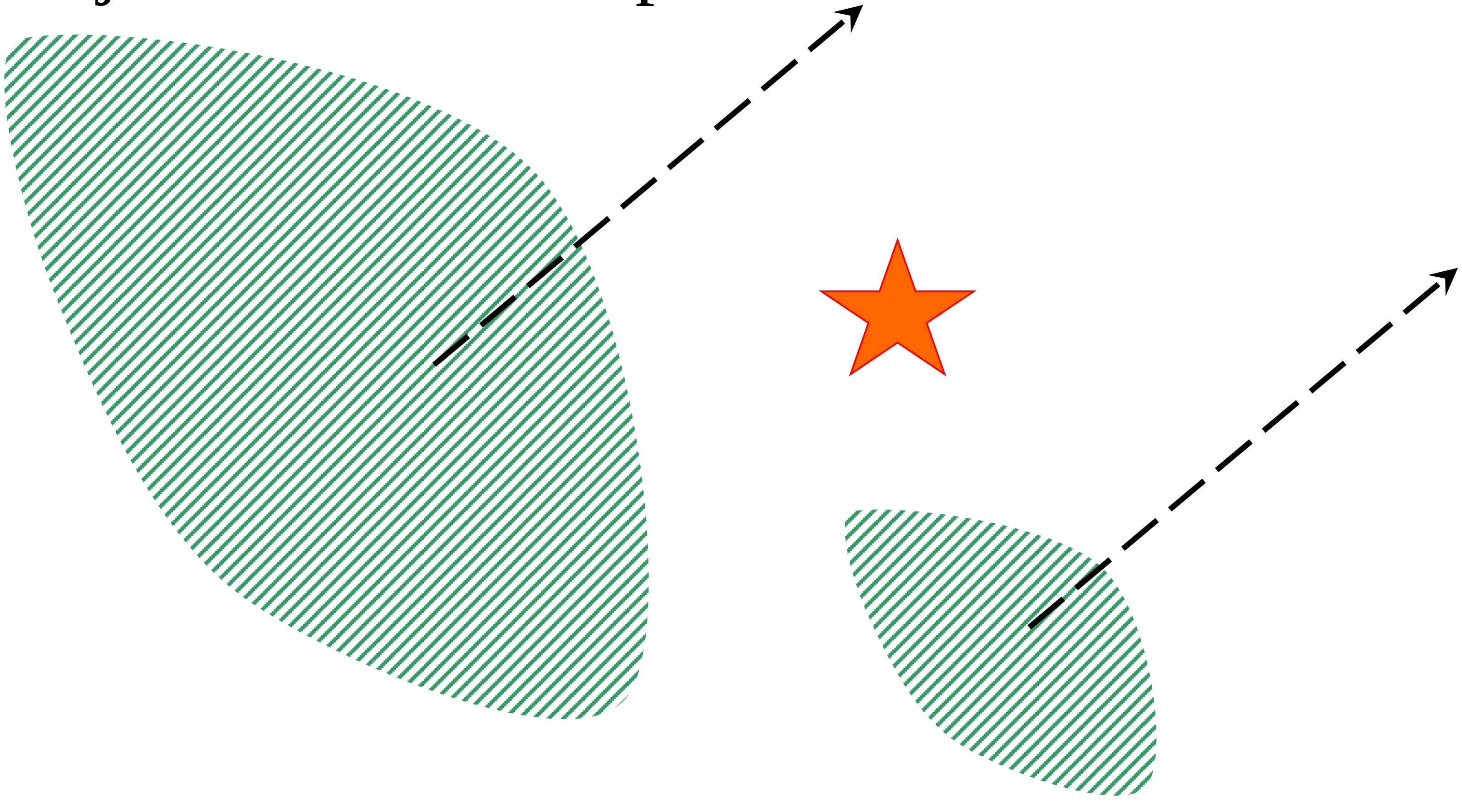
It can, however, mean quite different things



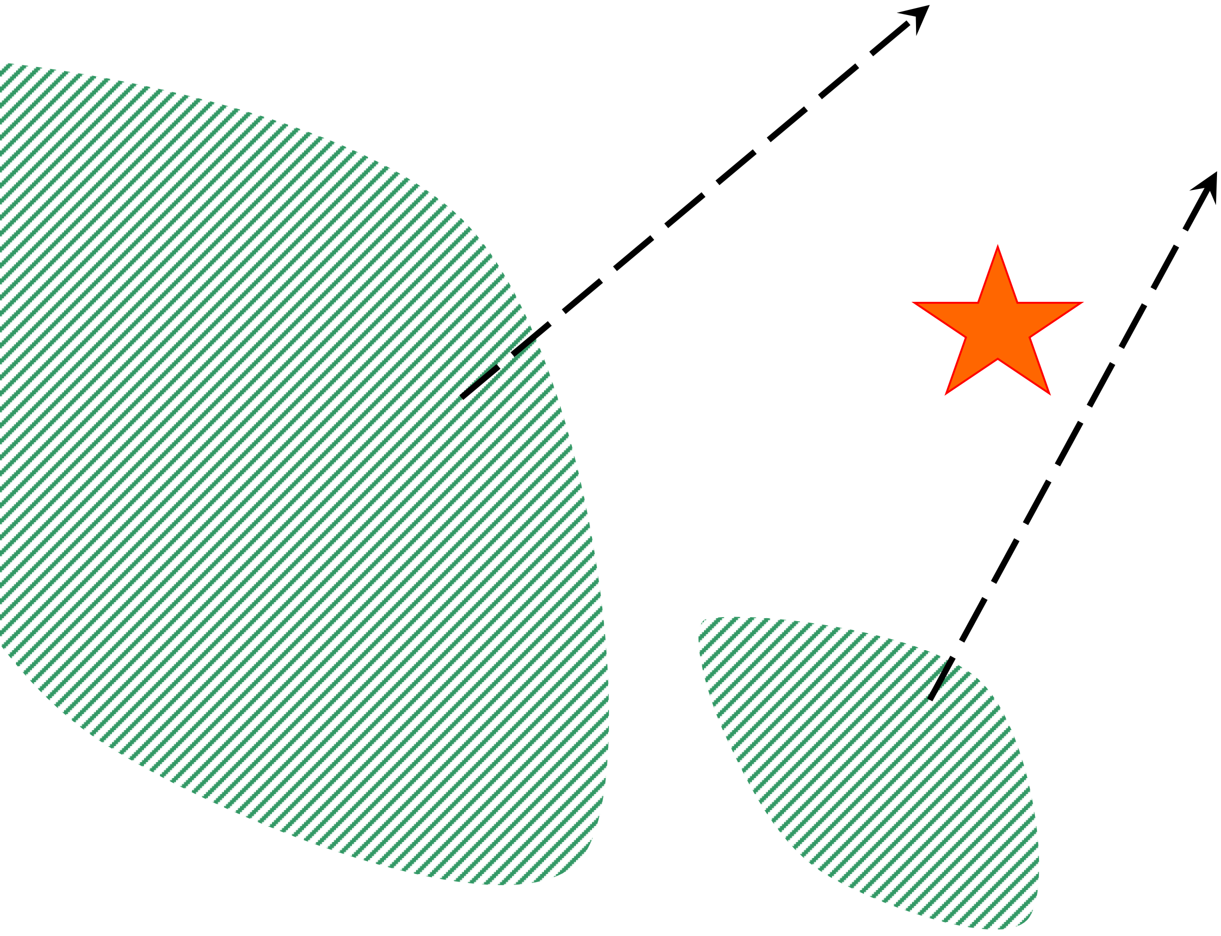
Most likely: First dry, later a major rain area will most likely pass.

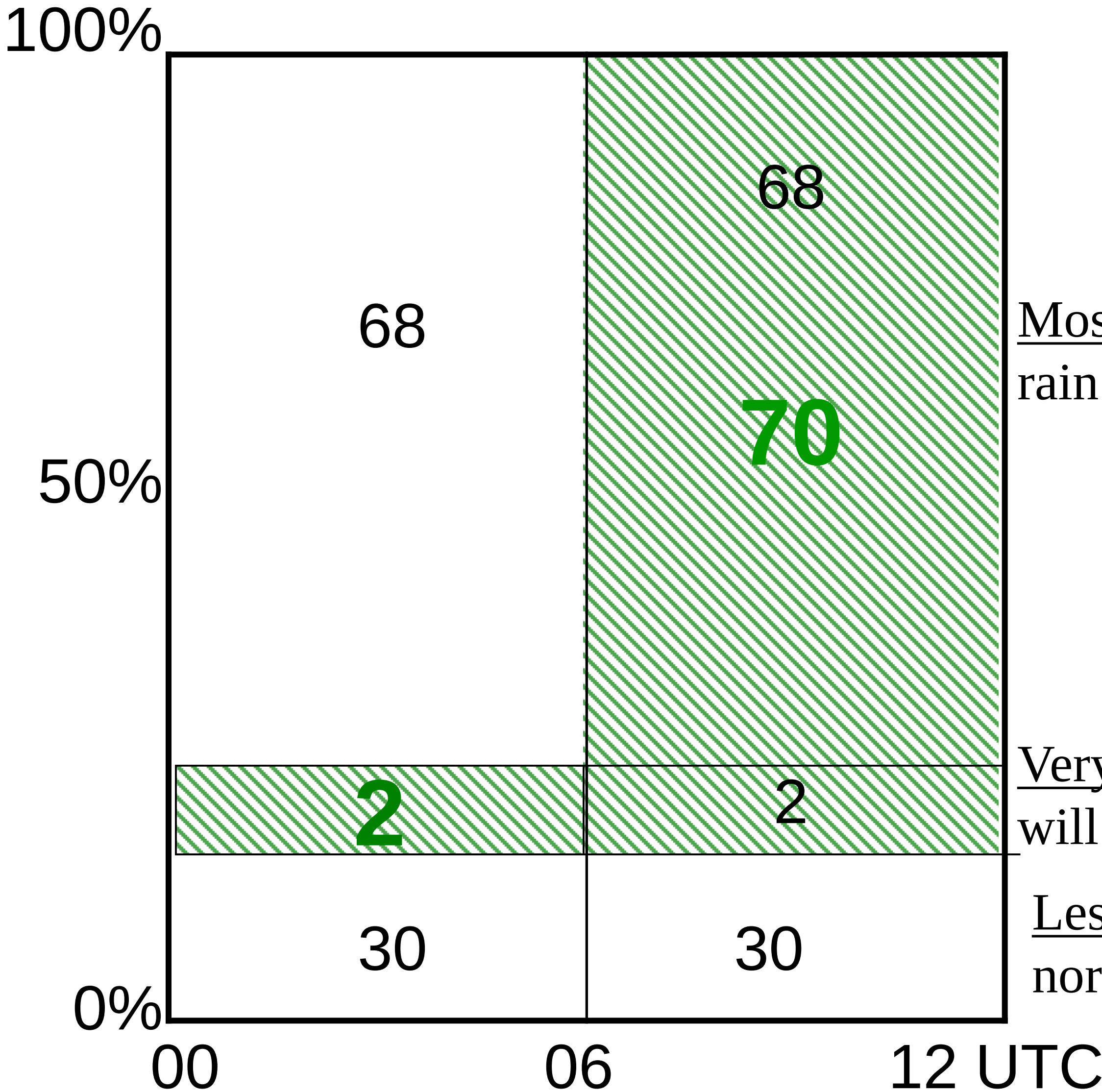


Less likely: Neither the scattered rain showers nor the major rain area will pass



Very unlikely: Scattered rain showers will pass before the major rain area approaches.

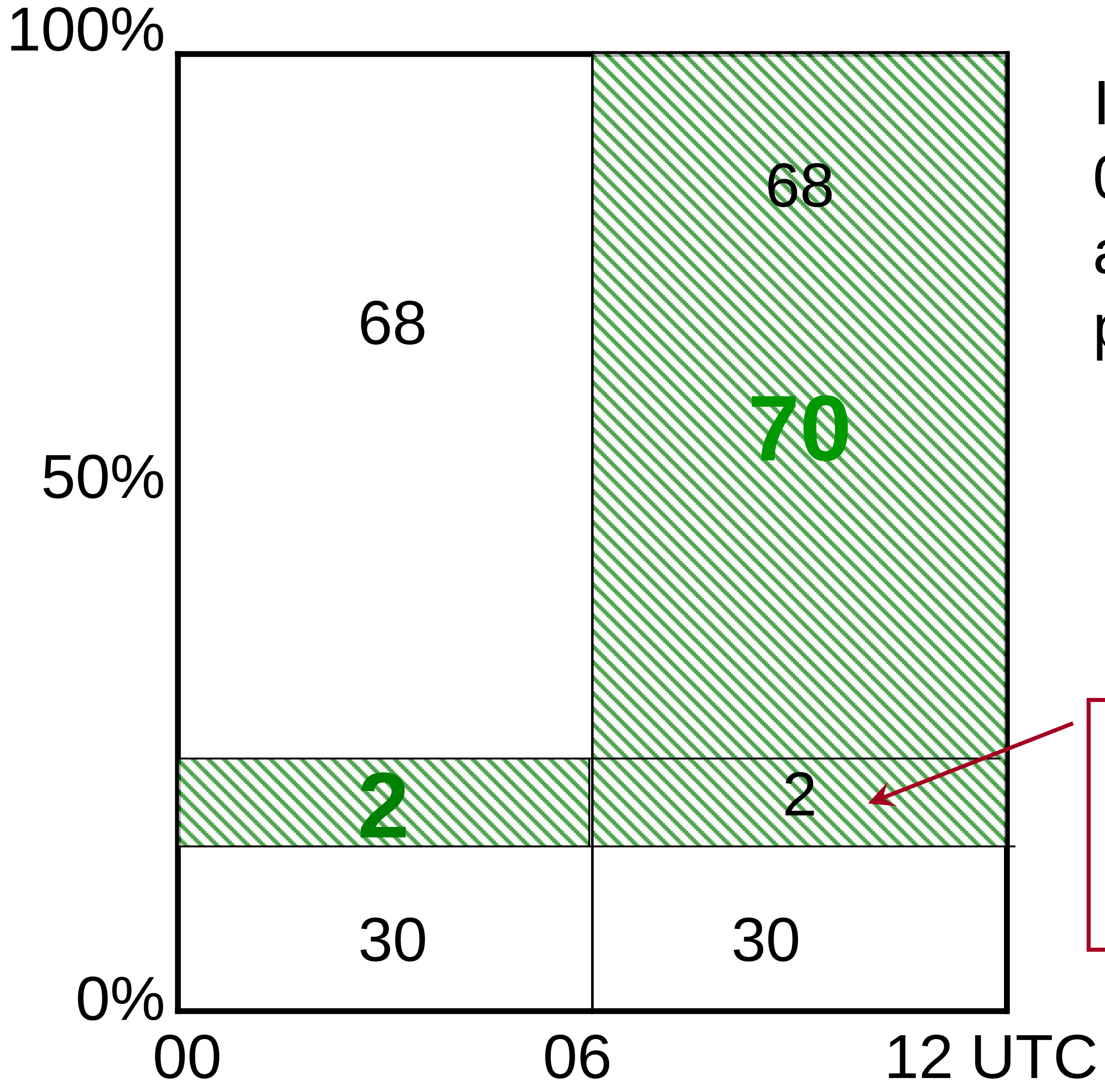




Most likely: At first dry, later a major rain area will most likely pass.

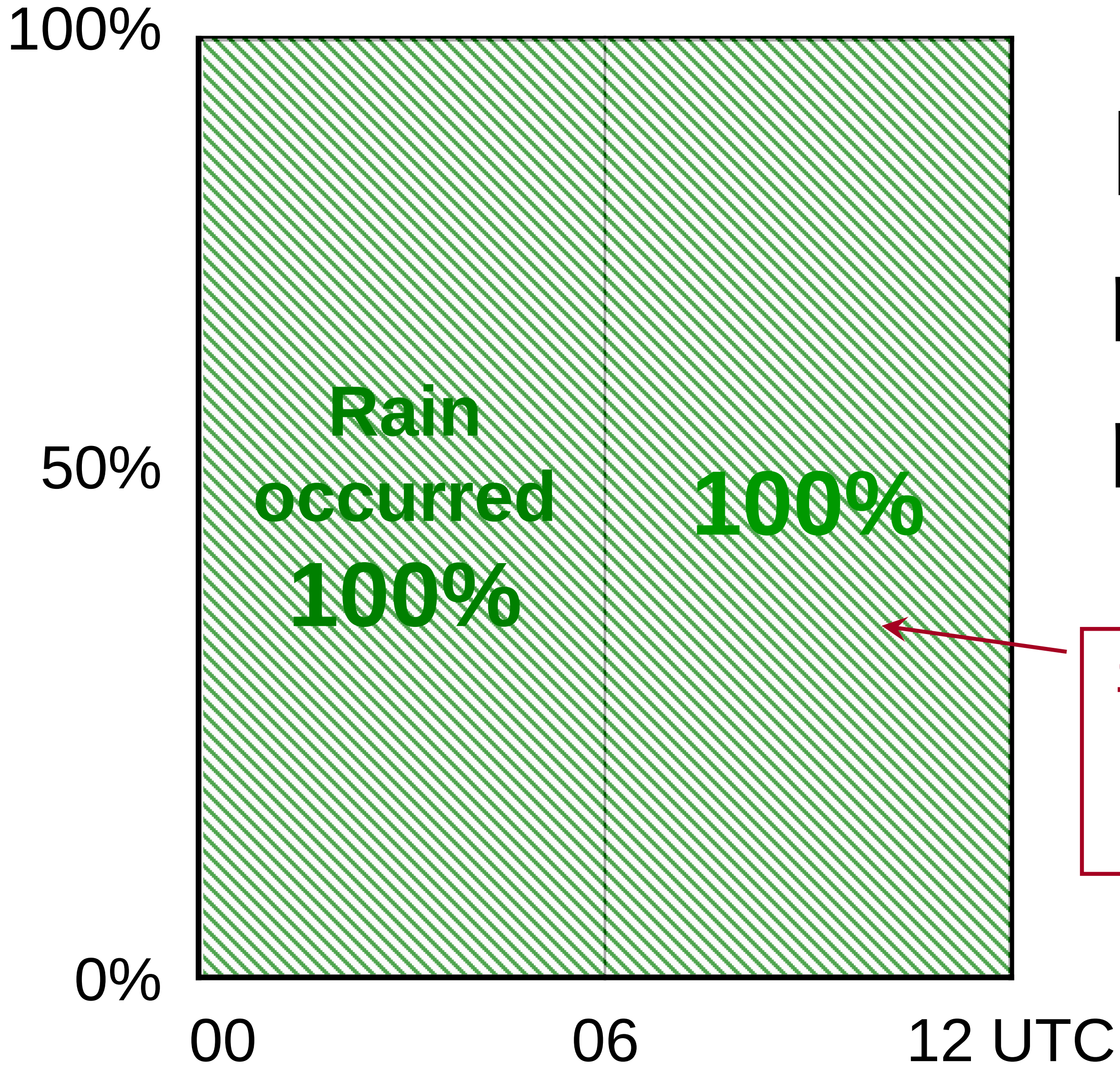
Very unlikely: Scattered rain showers will pass before the major rain area.

Less likely: Neither the rain showers nor the major rain area will pass



If it actually rains 00-06? How will that affect the probabilities 06-12?

There seems to be a 100% probability of rain in the 2nd period if it rains in the 1st period



Is this really realistic?

<u>Correlation:</u> There seems to be a 100% probability of rain in the 2nd period if it rains in the 1st period

Frequentist view: For 00 – 06 UTC one (1) member has rain (i.e.2 % probability) and it has rain also for 06 – 12 UTC

If it really rains at 00 – 06 UTC this implies that the probability of rain 06 – 12 UTC is 100%. **But we feel it counter-intuitive to base a 100% forecast on just *one* member.**

Bayesian view: We apply "Laplace Law of Succession".

We add two members to the 50, one with **rain** and one with **dry** weather.

III.3.2 Application of “Laplace’s Rule”

The ECMWF has for long times applied **“Laplace Rule of Succession”** without be aware of it

$$p = \frac{1 + Nrain}{2 + N}$$

Because of the limited number of members (50) it is not realistic to assume the probability = 0% when no member has the event, nor that it is 100% when all have the event

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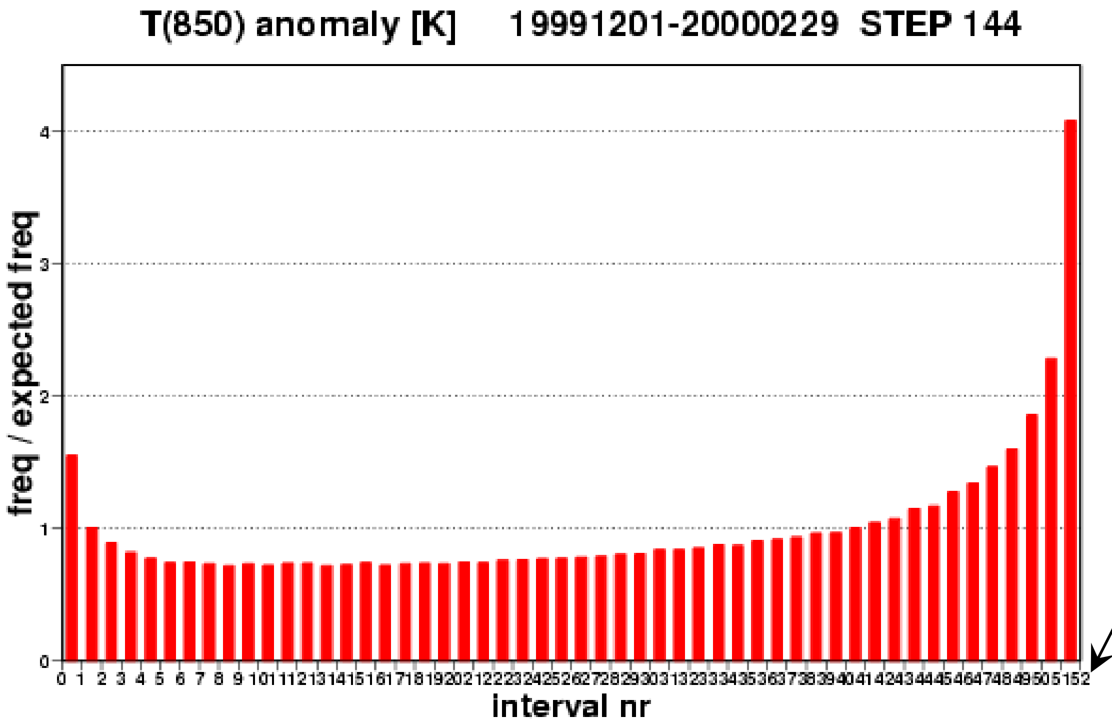
1. It has been assumed that 4% (2%+2%) of the verifying observations are outside the spread



Range 0-52 not 0-50

2. If no member has rain the risk is assumed to be 2%

3. If all members have rain the risk is assumed to be 98%

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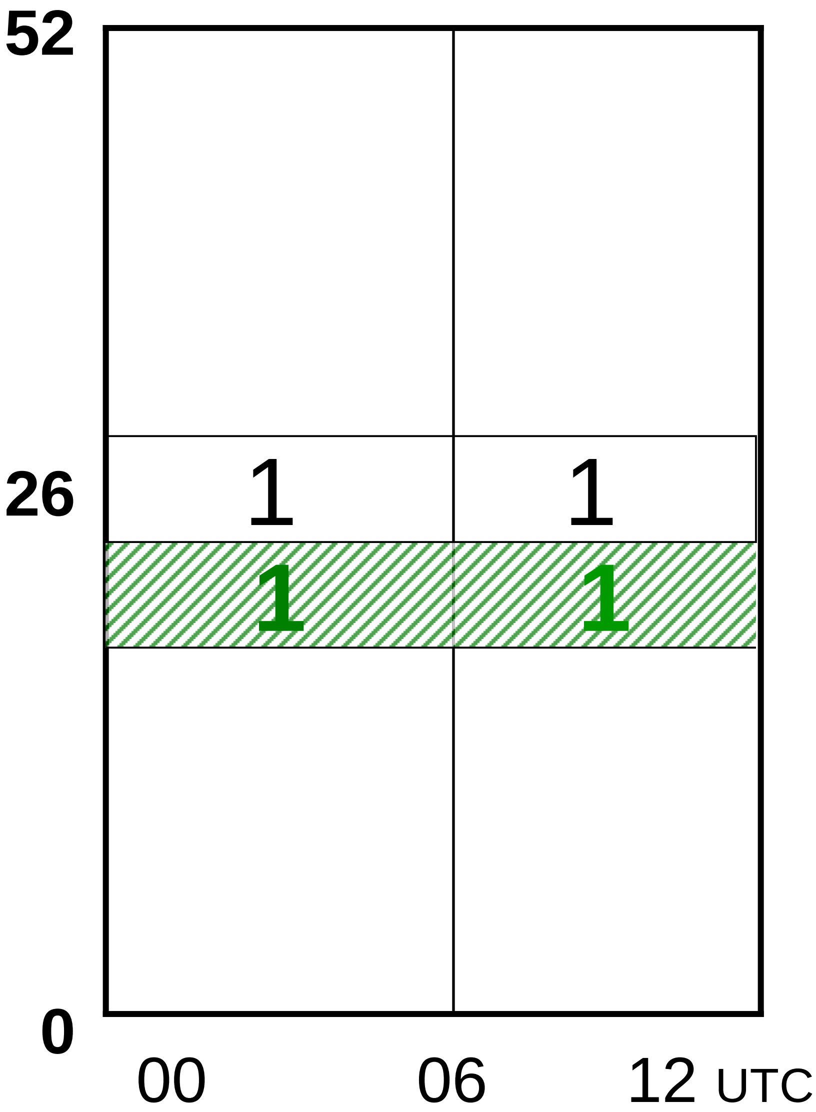
We will add two new members, **one dry** and **one rainy** and thus increase the total number to 52 members

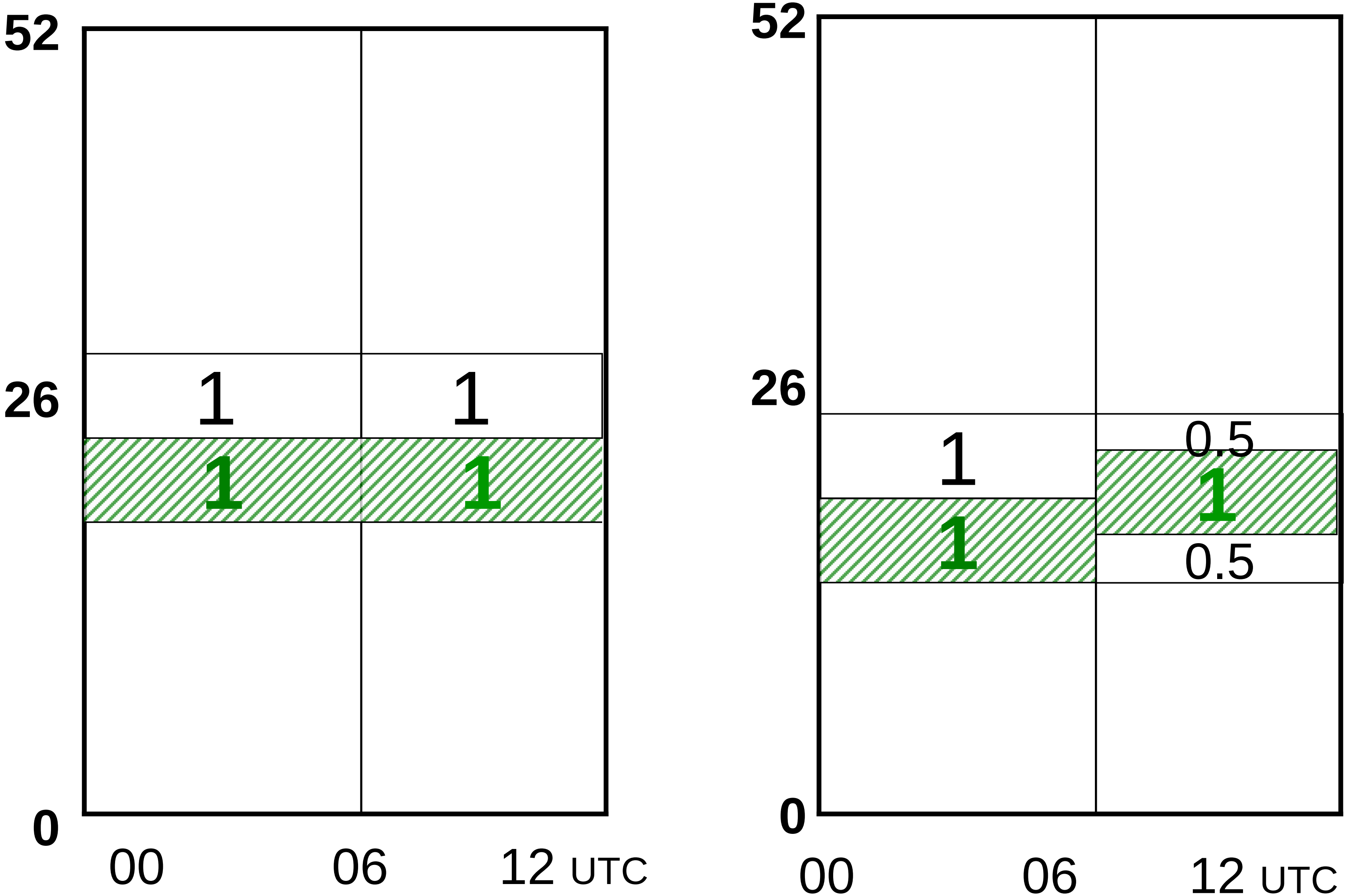


We can chose to have **rain** follow **rain** and **dry** follow **dry**.

But we will subjectively chose to mix the time consistency with **dry** following **rain** and vice verse

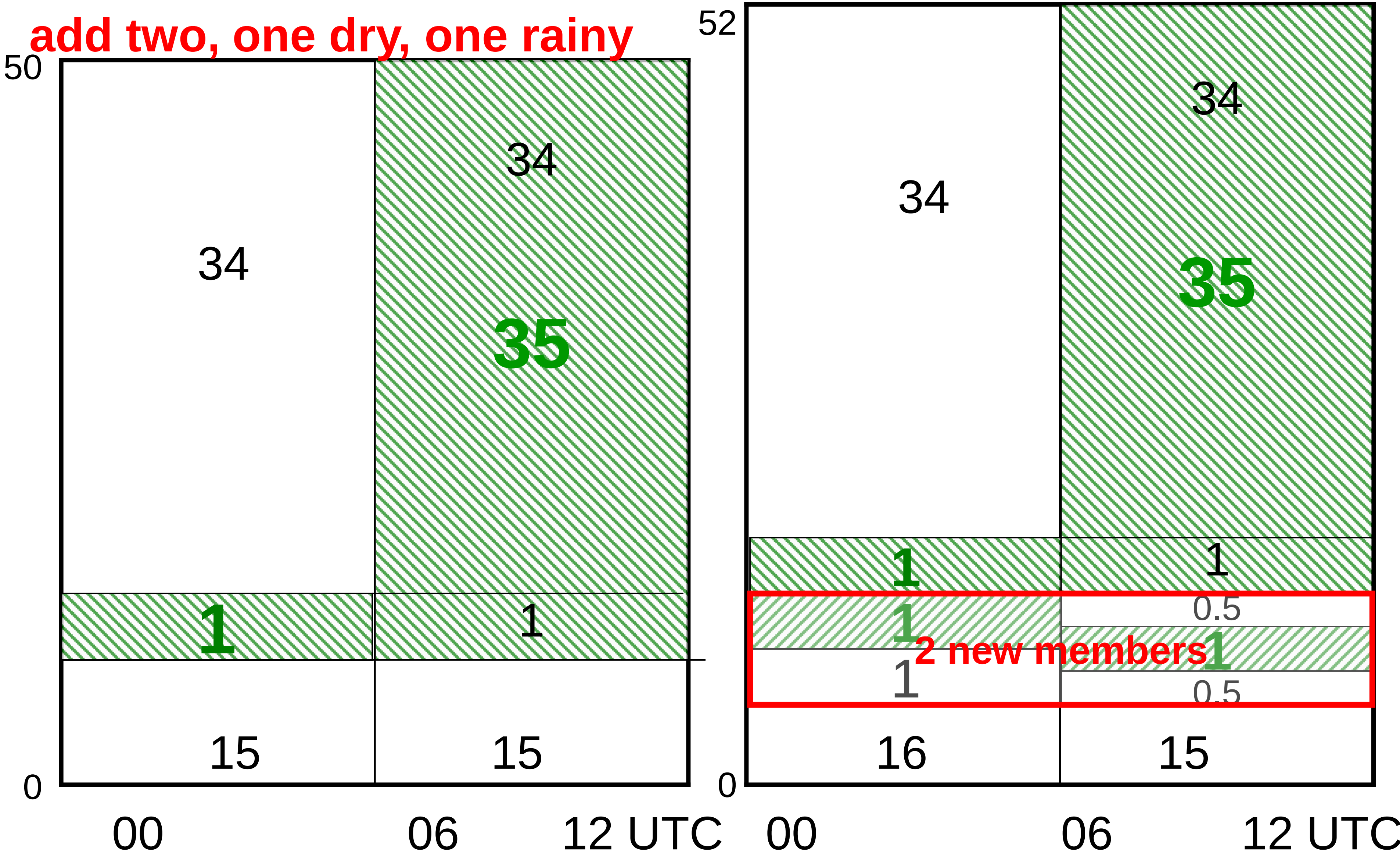
00 06 12 UTC

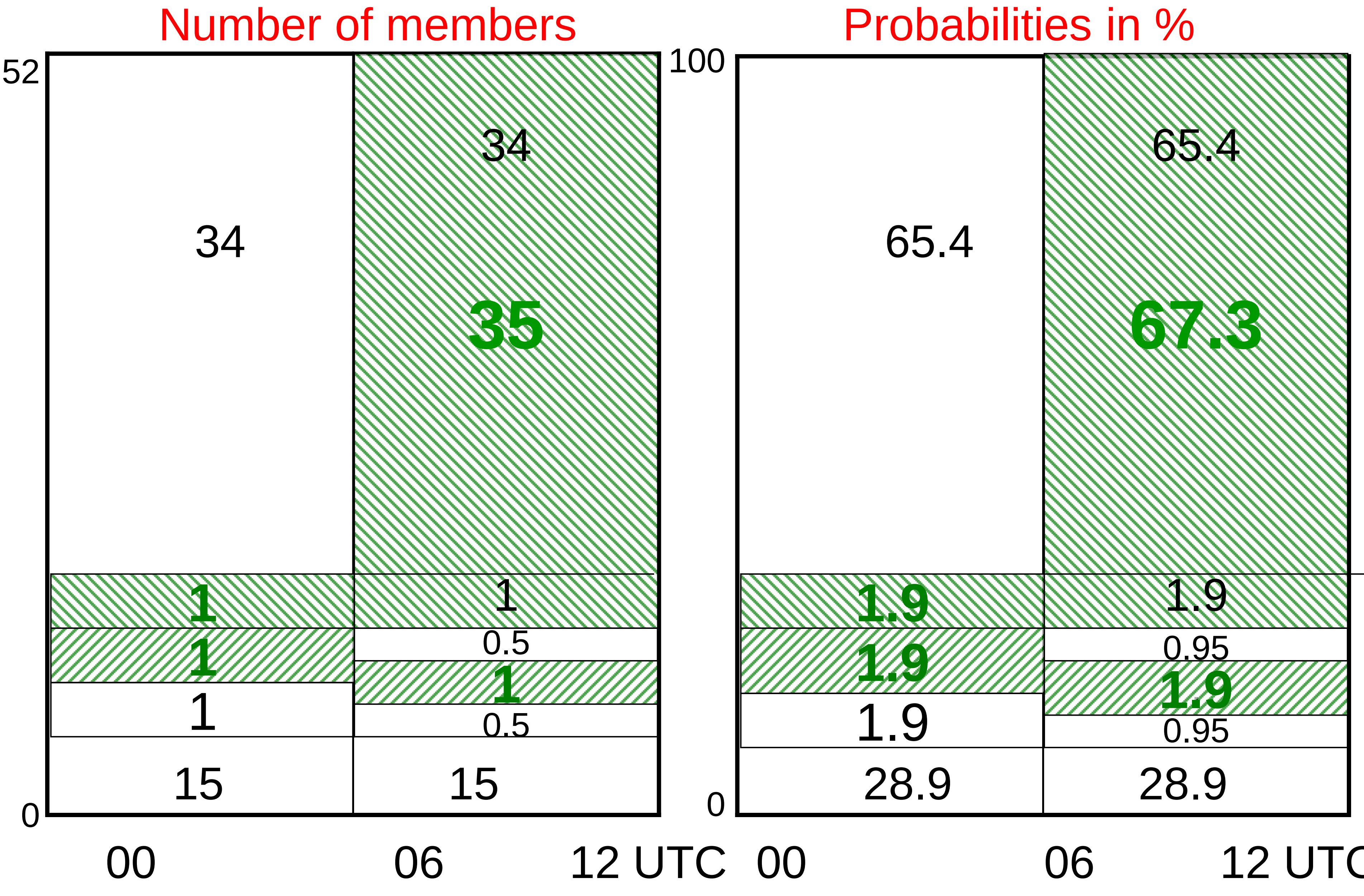
We will add two new members, **one dry** and **one rainy** and thus increase the total number to 52 members



III.3.3 Case 1: rain followed by rain

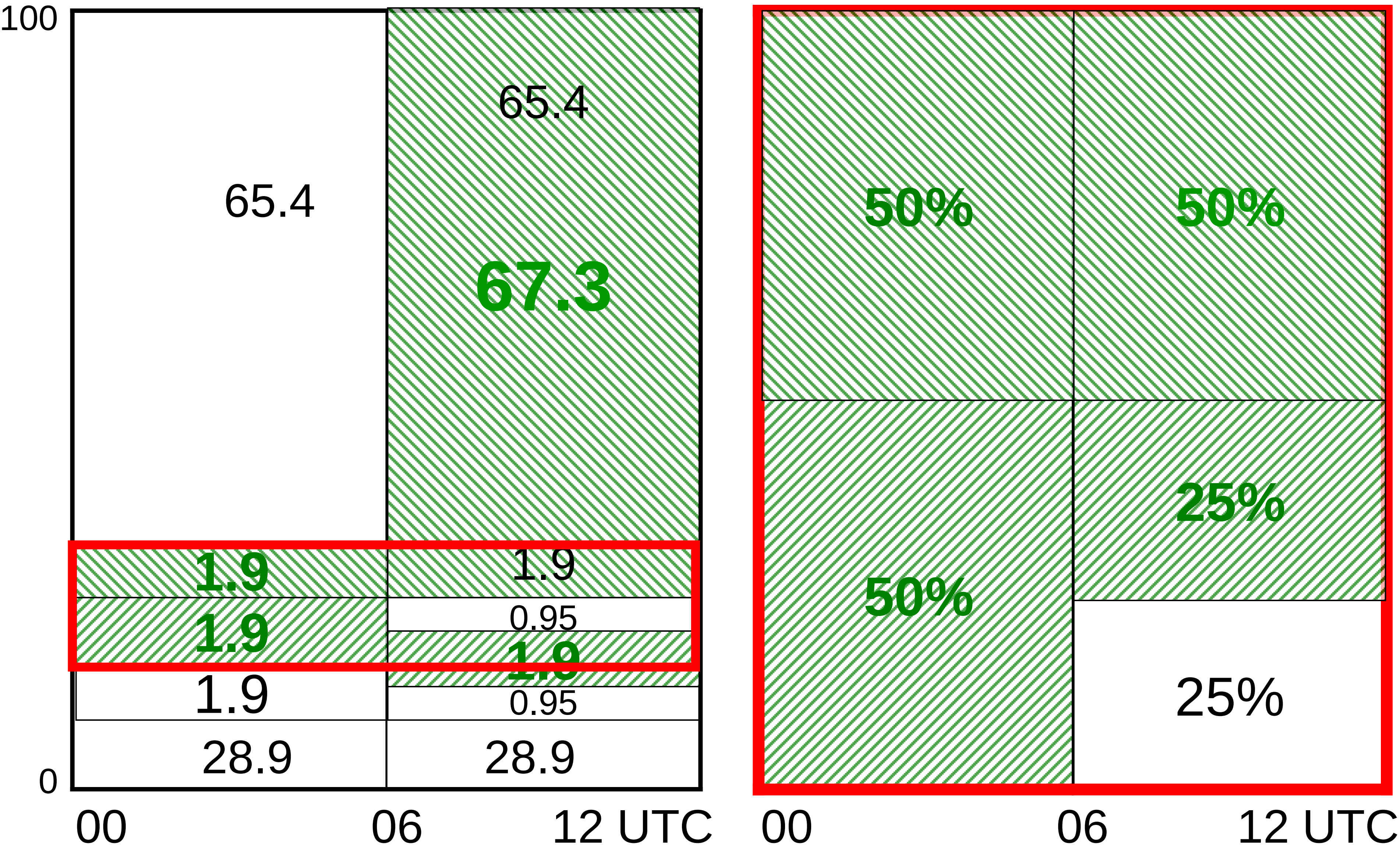
We count in members and will add two, one dry, one rainy



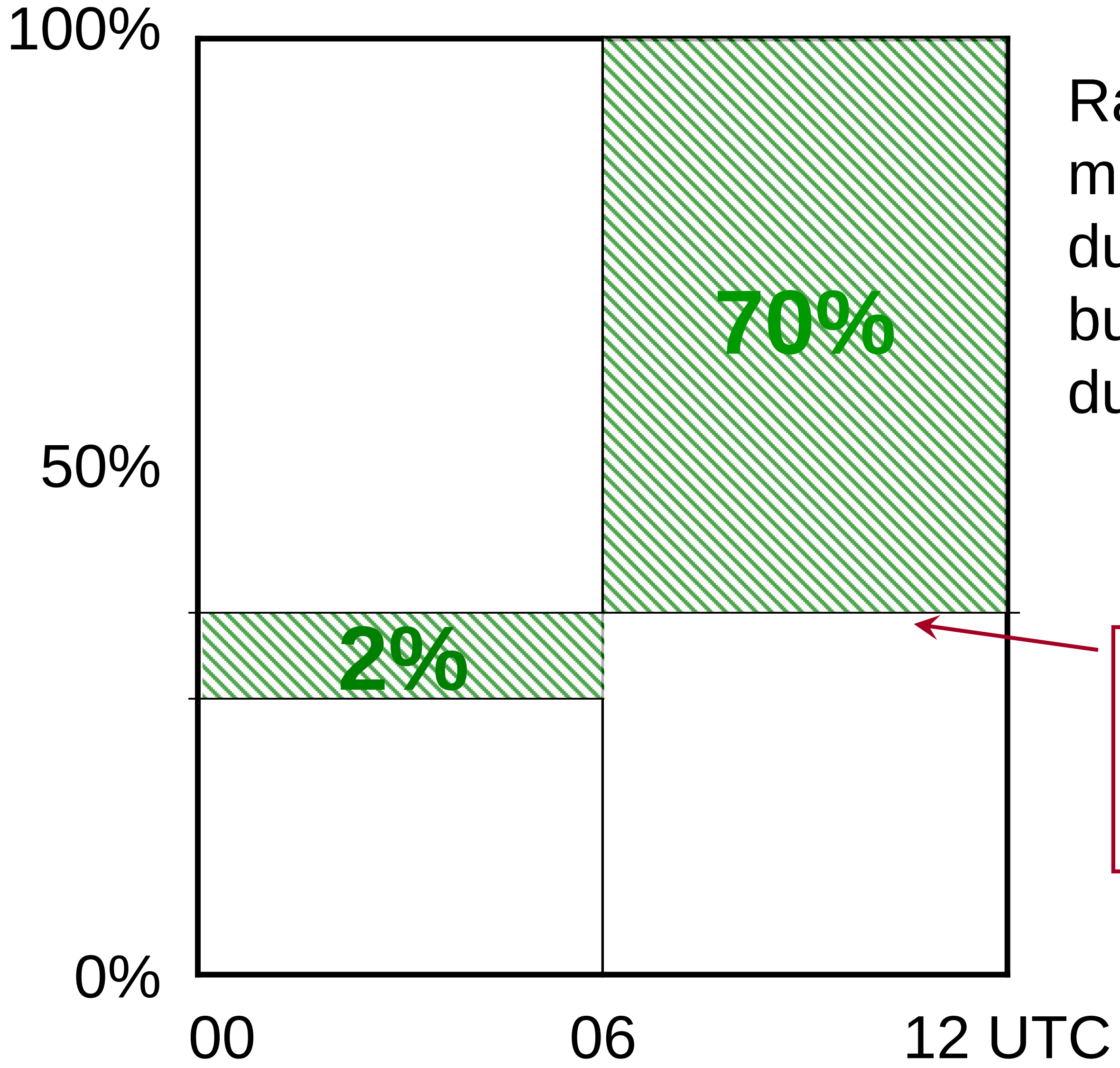


Number of members
Probabilities in %
52
0
34
34
35
1
1
1
1
0.5
1
0.5
15
15
00
06
12 UTC
100
0
65.4
65.4
67.3
1.9
1.9
1.9
1.9
0.95
1.9
0.95
28.9
28.9
00
06
12 UTC

Probabilities in %

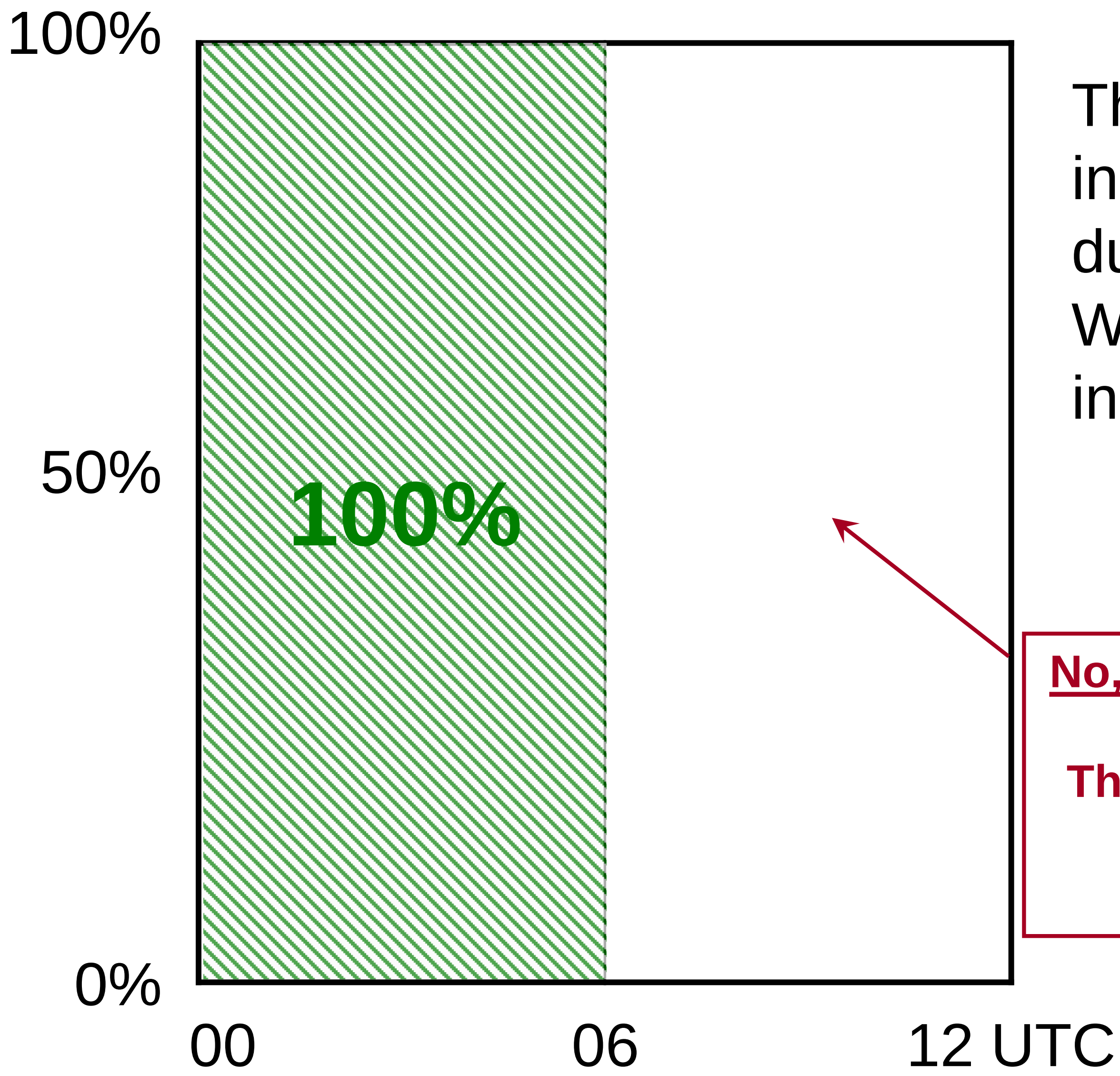


III.3.4 Case 2: rain followed by dry weather



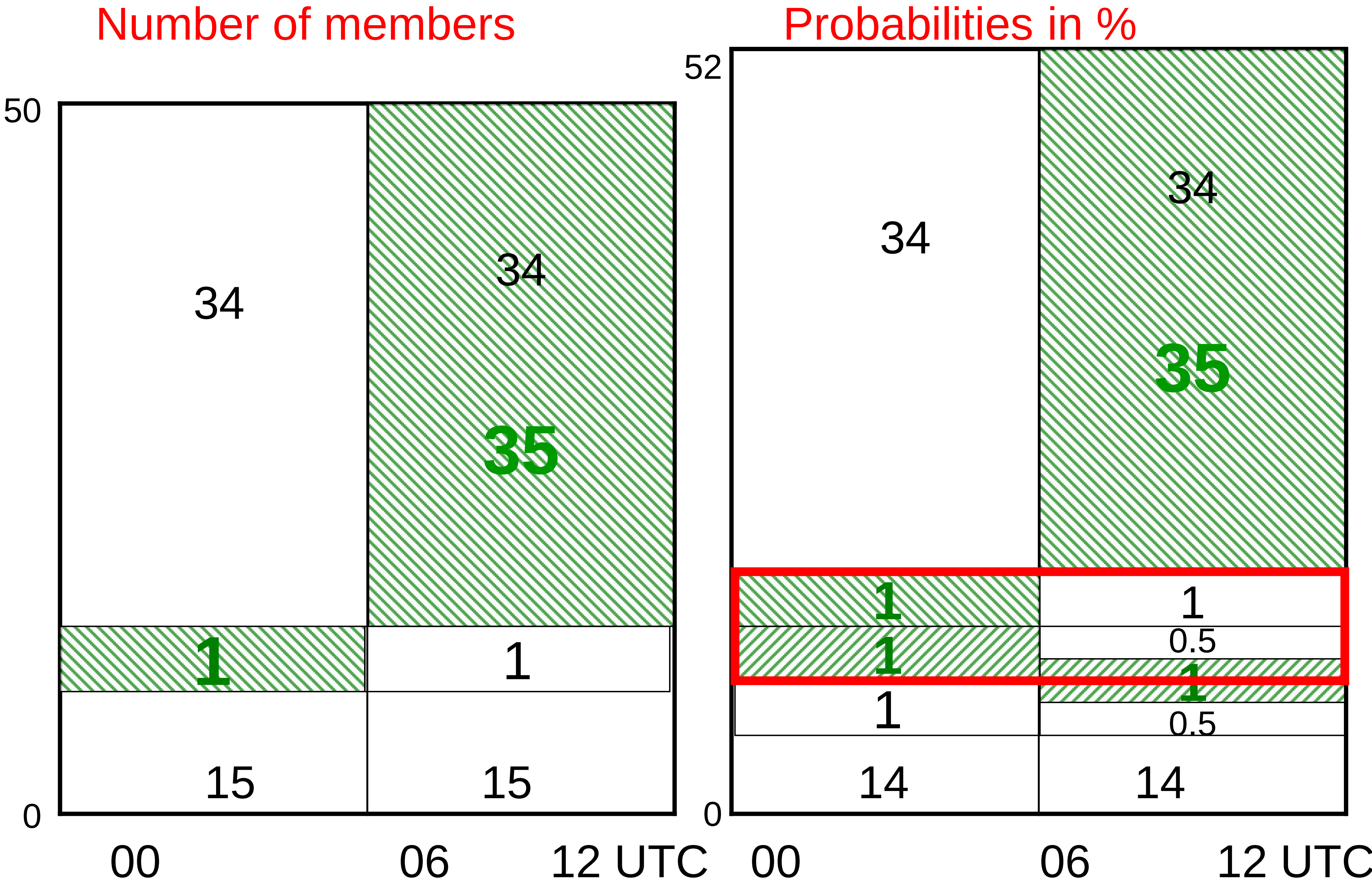
Random showers will most likely strike during the 2nd period but not if there is one during the 1st

Anti-correlation: There is a no (0%) probability of rain in the 2nd period if it rains in the 1st period



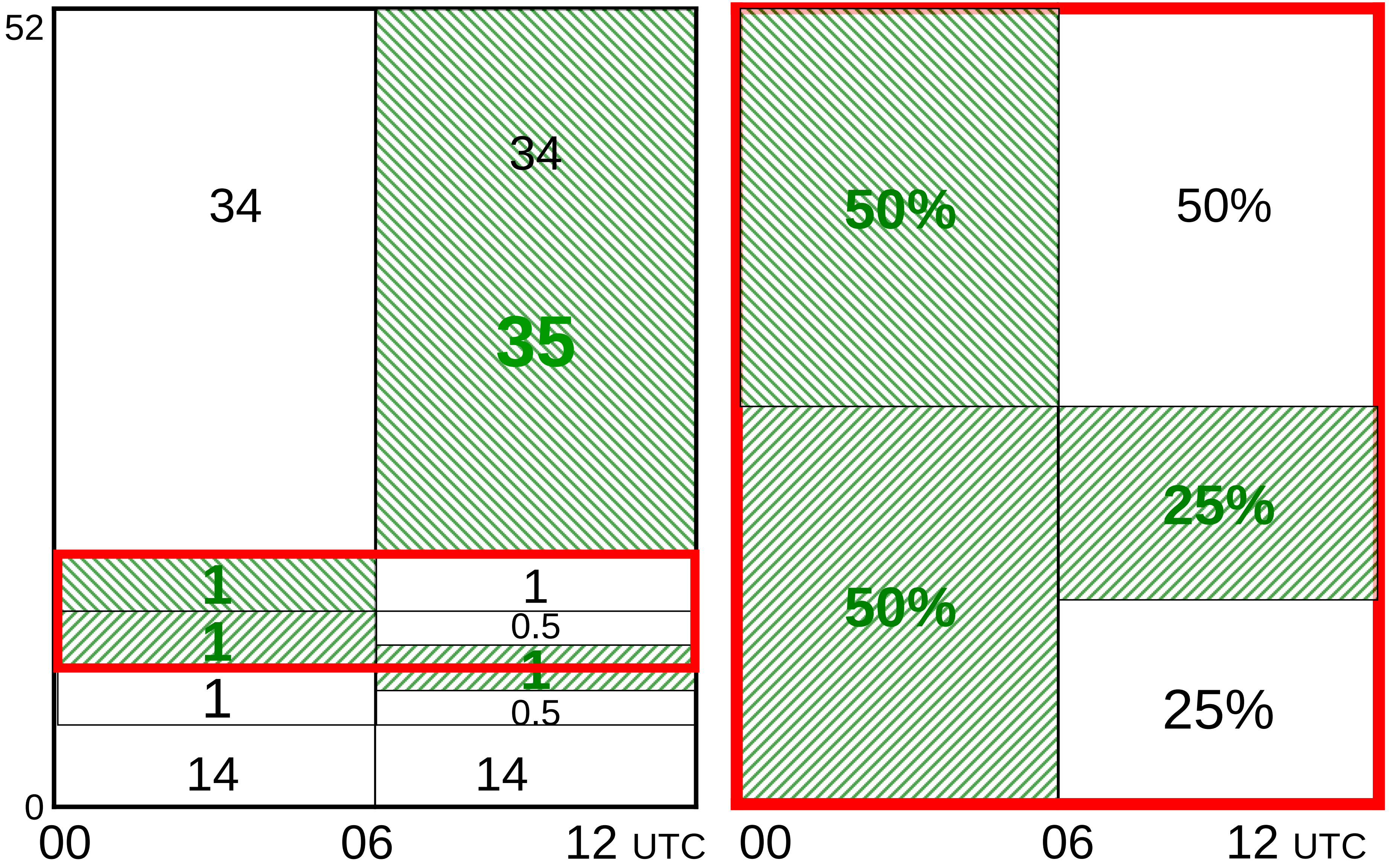
The random shower indeed occurred during the 1st period. Will there be no risk in the 2nd period?

No, the anti-correlation seems to make this most likely:
There is a no (0%) probability of rain in the 2nd period if it rains in the 1st period

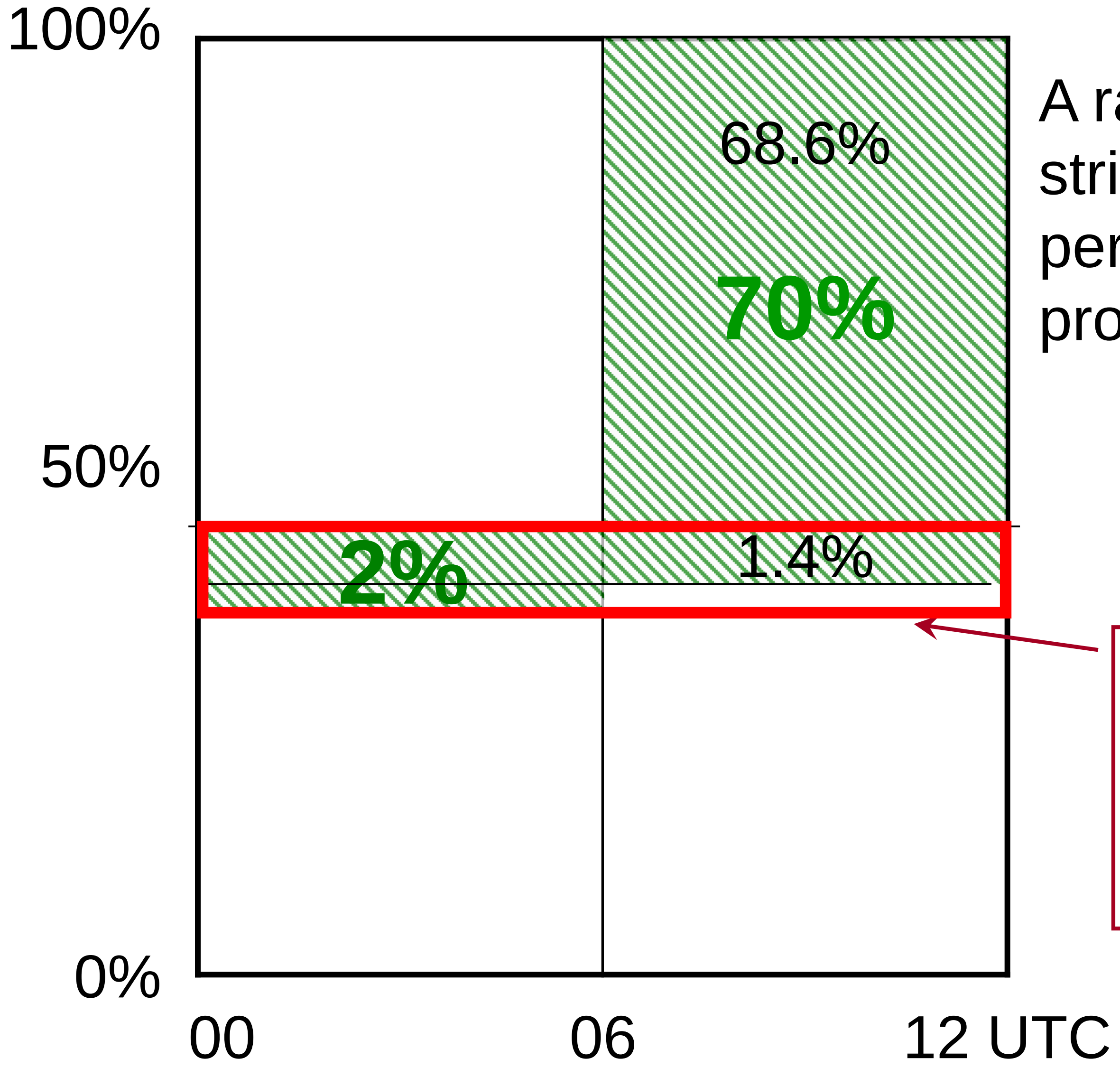


Number of members
Probabilities in %
50
34
34
35
1
1
15
15
0
00
06
12 UTC
52
34
34
35
1
1
1
0.5
1
1
0.5
14
14
0
00
06
12 UTC

Probabilities in %



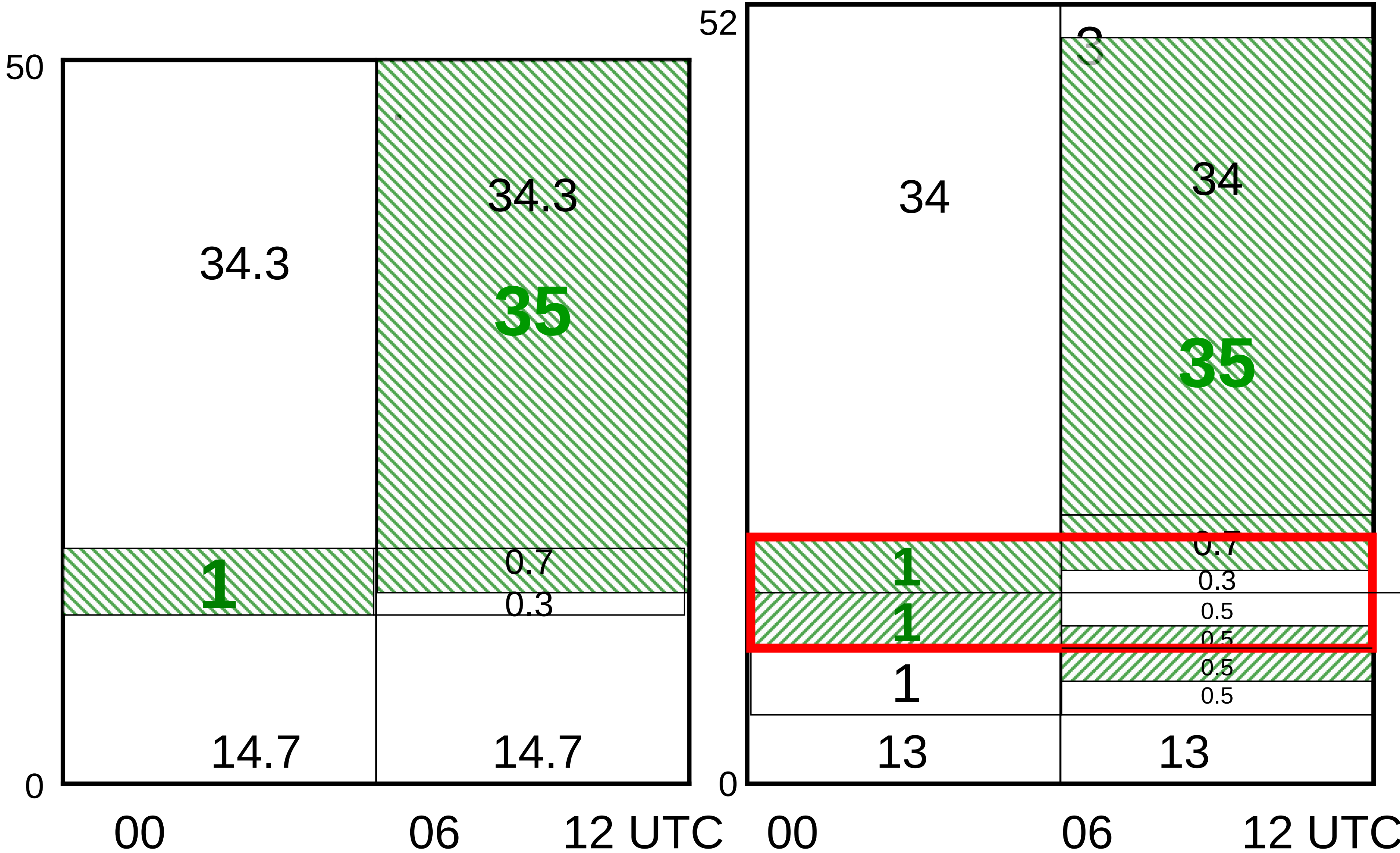
III.3.5 Case 3: rain followed by probability of rain

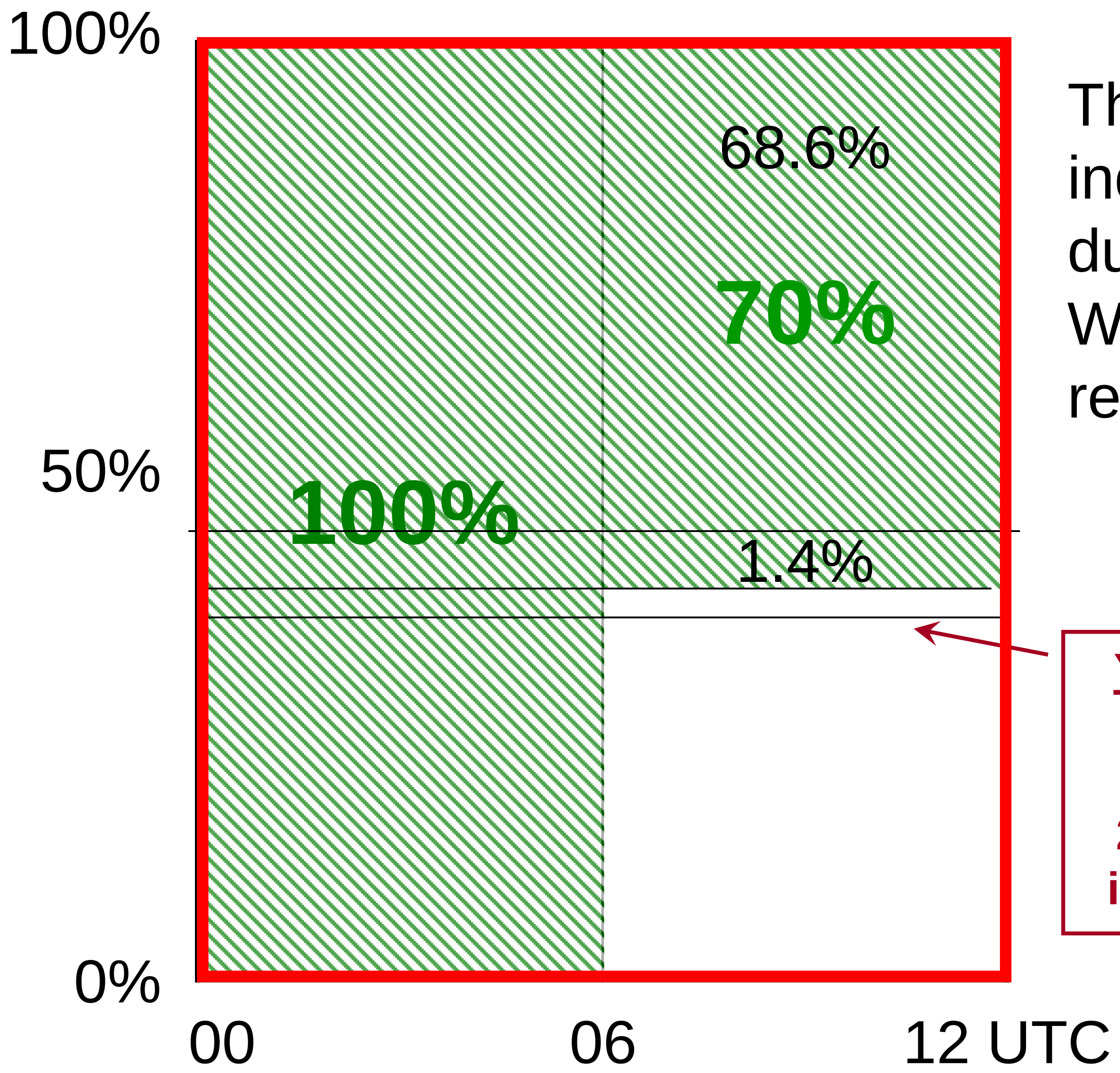


A random shower will strike during the 1st period but most probably during the 2nd

<u>Non-correlation:</u> There is a 70% probability of rain in the 2nd period irrespective if it rains in the 1st period

Number of members



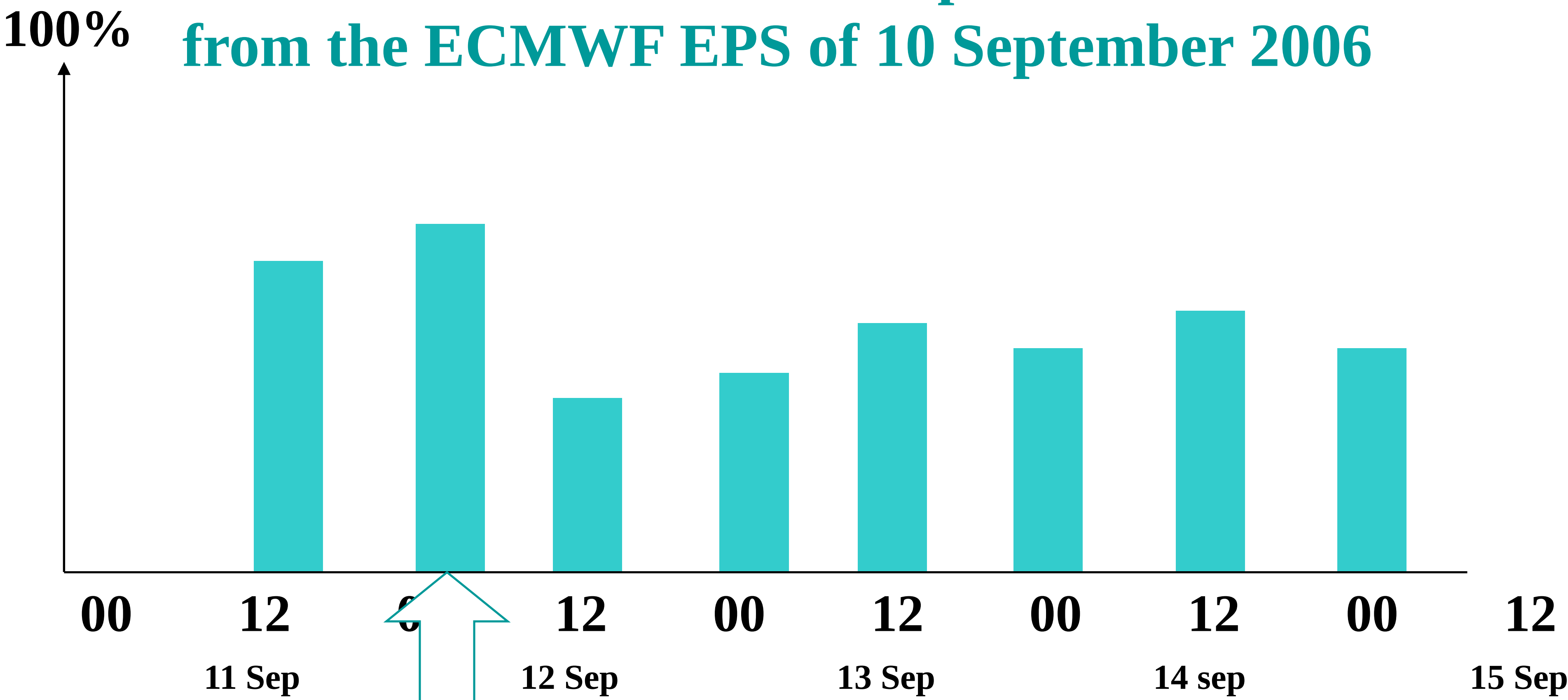


The random shower indeed occurred during the 1st period. Will the risk in the 2nd remain 70%?

Yes, because of the non-correlation: The 70% probability of rain in the 2nd period is irrespective if it rains in the 1st period

III.3.6. Updating of the EPS probabilities in light of later observations?

Probabilities of > 1 mm rain per 12 hours in London from the ECMWF EPS of 10 September 2006



Assume that we know for <u>certain</u> that it will rain in this period

Probabilities of > 1 mm rain per 12 hours in London according to the ECMWF EPS of 10 September 2006

1.00

.00	.58	.66	.32	.36	.44
00-12z 11 Sep	12-24 z 11 Sep	00-12 z 12 Sep	12-24 z 12 Sep	00-12 z 13 Sep	12-24 z 13 Sep

Assume that we are <u>certain</u> it will rain in this period

How will this affect the probability in the next period??

Number of EPS-members forecasting persistent or changing conditions 00-12z to 12-24z 11 Sep.

		12-24z R	12-24z ⊗
00-12z	R	13	20
	⊗	3	14

$\otimes = dry \quad \mathbf{R} = \mathbf{rain}$

From which a transition matrix can be formed

12-00z

Previous period 00-12z

$$\begin{array}{cc} & \begin{array}{cc} \mathbf{R} & \otimes \end{array} \\ \begin{array}{c} R \\ \otimes \end{array} & \begin{pmatrix} .39 & .61 \\ .18 & .82 \end{pmatrix} \end{array}$$

$$\otimes = dry \quad \mathbf{R} = \mathbf{rain}$$

Depending on if rainy or dry conditions proceed the 12-h period the original probability 32% can be updated to 39% or 18%

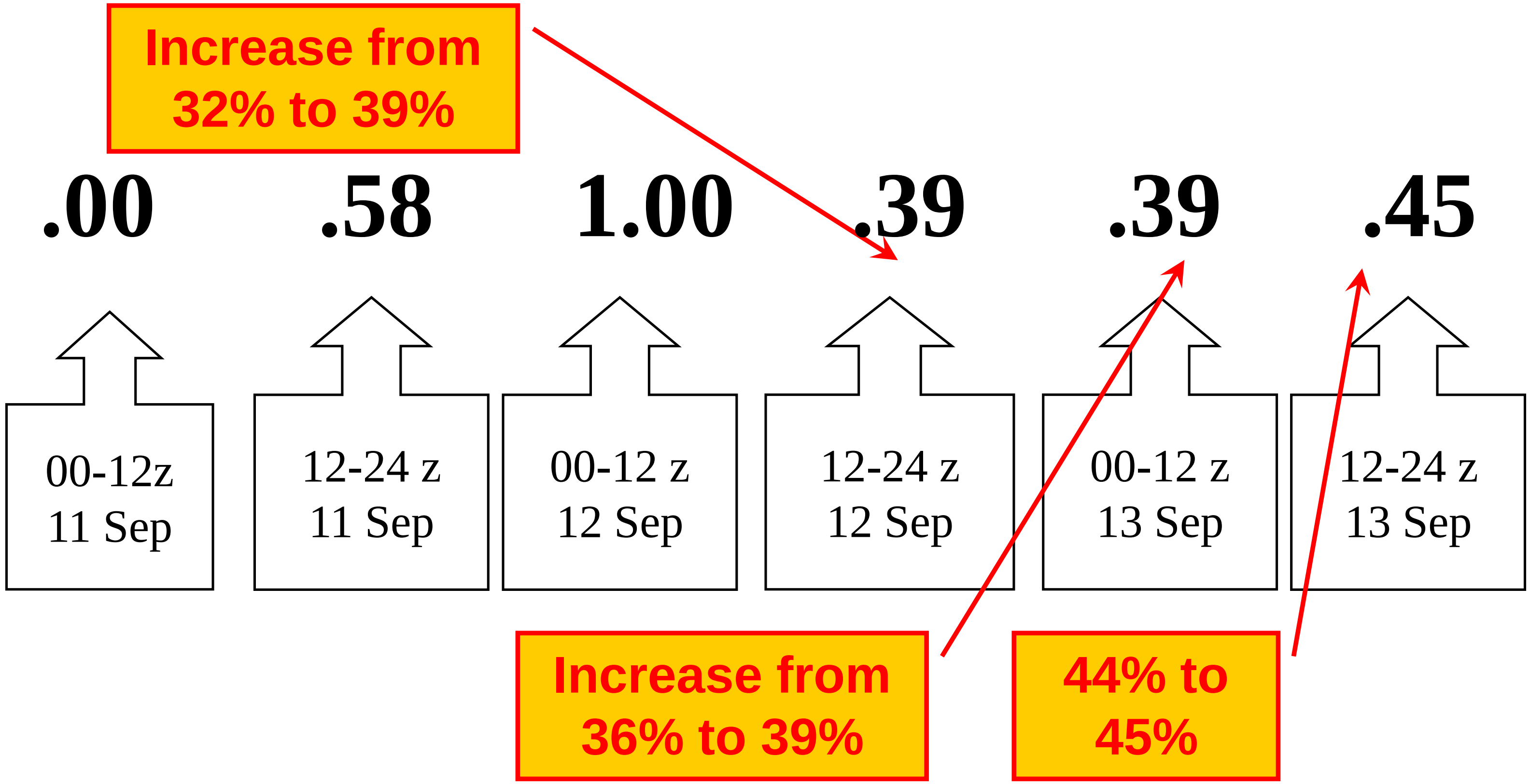
12-00 z

Previous period 00-12 z

$$\begin{array}{c|cc} & \mathbf{R} & \otimes \\ \hline R & .39 & .61 \\ \otimes & .18 & .82 \end{array}$$

$$\otimes = dry \quad \mathbf{R} = \mathbf{rain}$$

Probabilities of > 1 mm rain per 12 hours in London according to the ECMWF EPS of 10 September 2006



Updated probabilities from knowledge of occurred weather 12 hours earlier

old	.00	.58	.66	.32	.36	.44	.42	.48	.38	.38
	⊗	⊗	●	●	●	●	⊗	⊗	⊗	⊗

$$\begin{pmatrix}1.0 & .00\\ .57 & .43\end{pmatrix}\begin{pmatrix}.72 & .28\\ .57 & .43\end{pmatrix}\begin{pmatrix}.39 & .61\\ .18 & .82\end{pmatrix}\begin{pmatrix}.62 & .38\\ .24 & .76\end{pmatrix}\begin{pmatrix}.72 & .28\\ .28 & .72\end{pmatrix}\begin{pmatrix}.55 & .45\\ .32 & .68\end{pmatrix}\begin{pmatrix}.62 & .38\\ .38 & .62\end{pmatrix}\begin{pmatrix}.58 & .42\\ .19 & .81\end{pmatrix}\begin{pmatrix}.47 & .53\\ .19 & .81\end{pmatrix}\begin{pmatrix}.73 & .27\\ .23 & .77\end{pmatrix}$$

new	00	.57	.57	.39	.62	.72	.55	.38	.19	.19
change	0%	−1%	−9%	+7%	+26%	+28%	+13%	−10%	−19%	−19%

END