Effect of shallow convection parametrization on the forecast of convective precipitation

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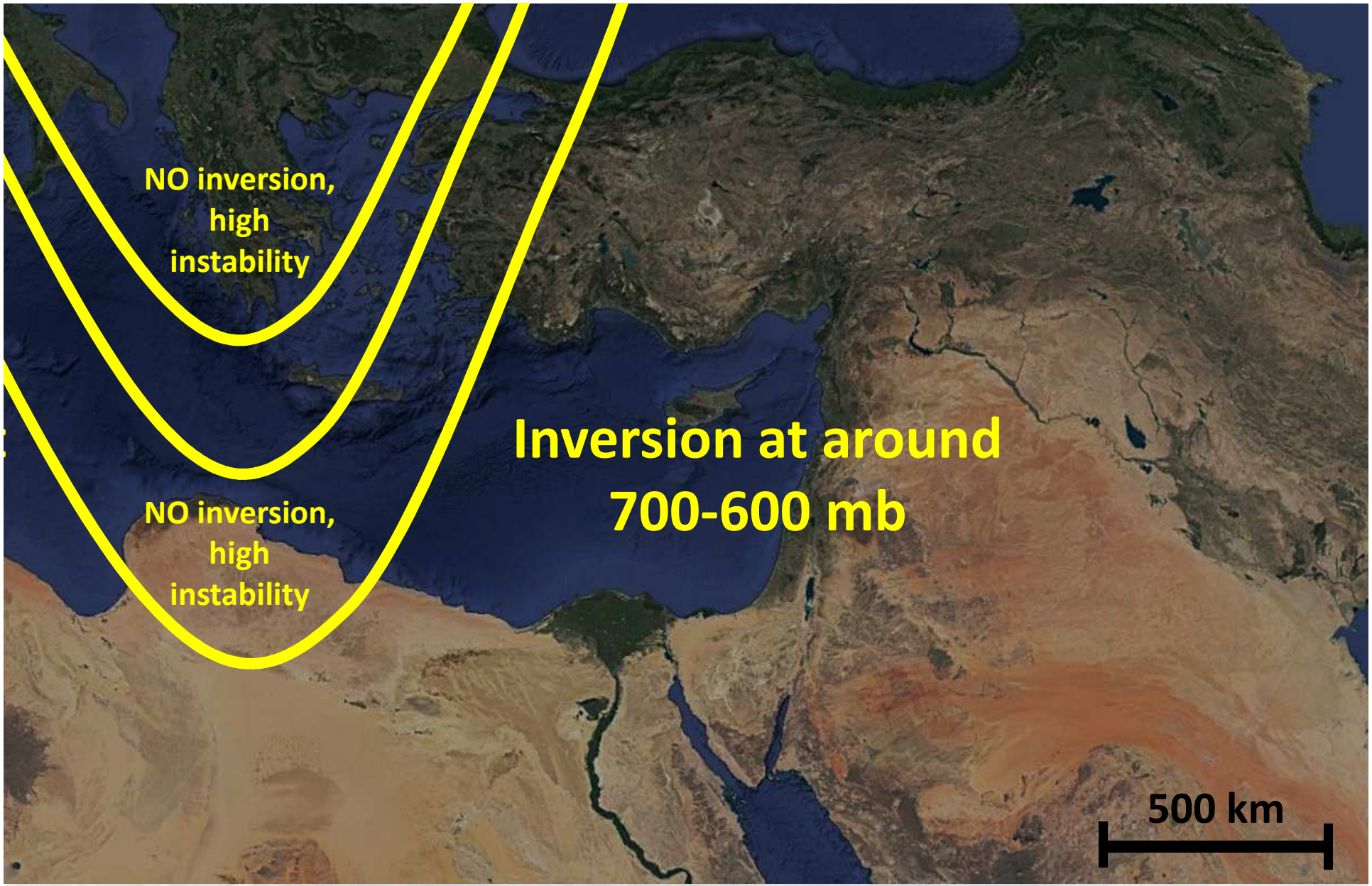
COSMO User Seminar, Offenbach, March 2017

Typical synoptics for rain at the Eastern Mediterranean



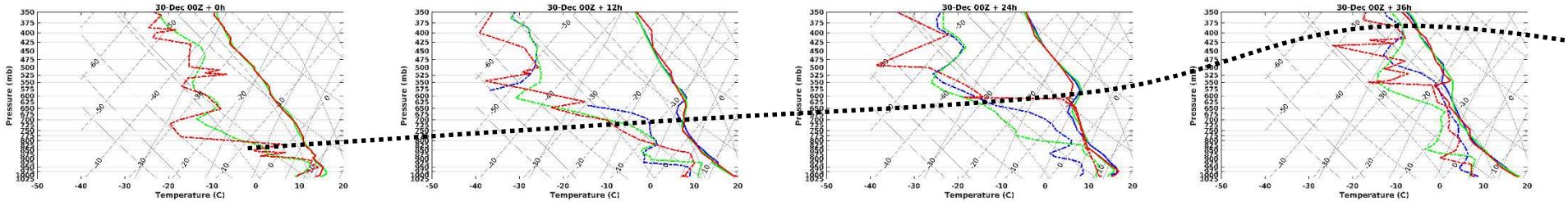
After the trough passage, the rain continues several days (warm sea)

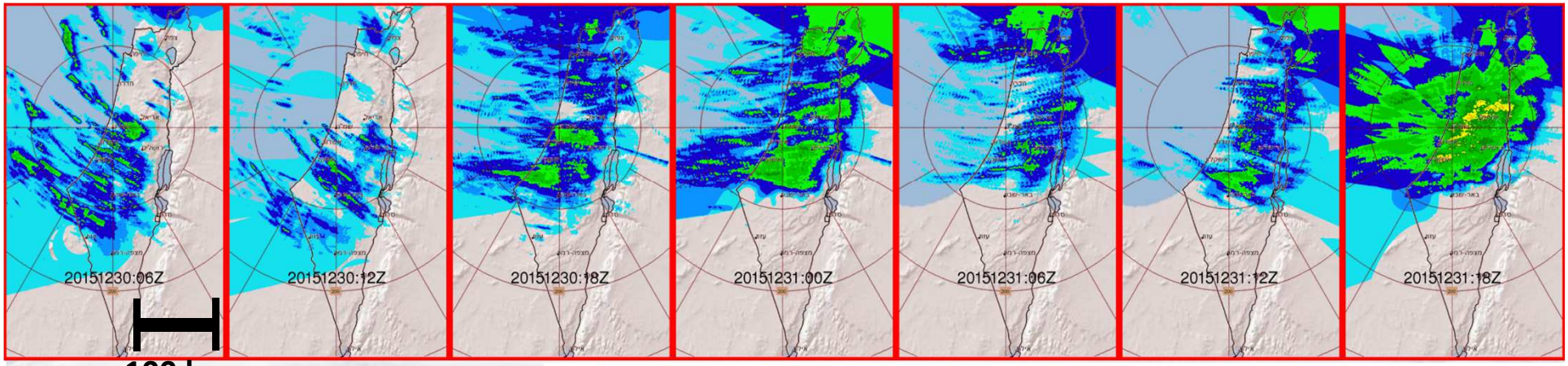
Typical example for trough passage:

30/12/2015 - 02/01/2016

Before upper air trough

Peak of upper ai



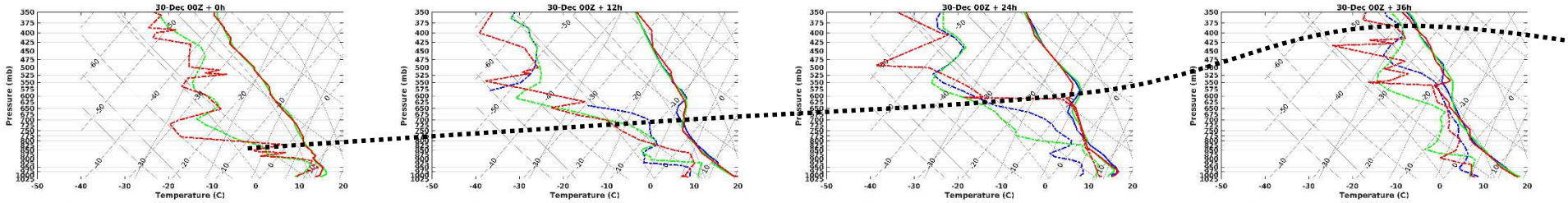


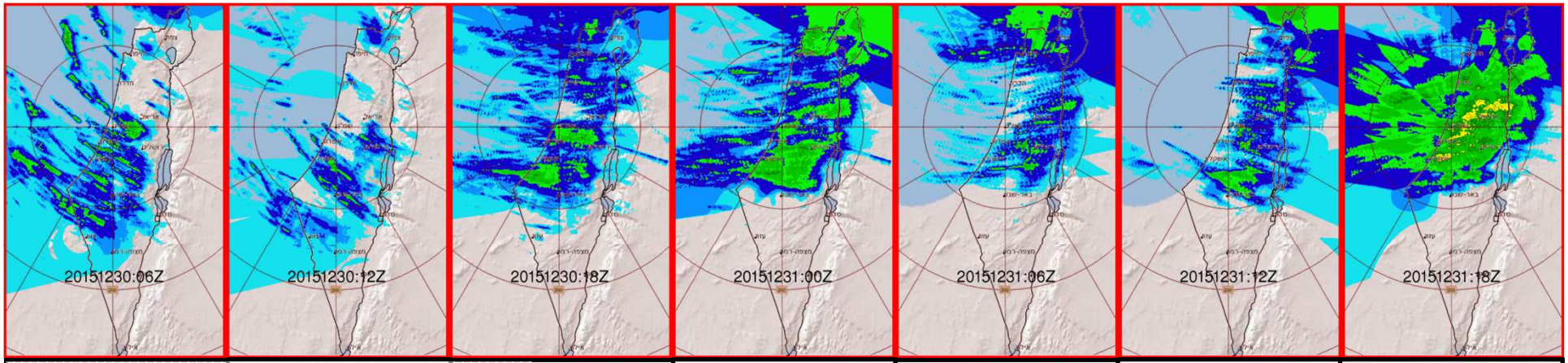
- **Obs profiles:** the inversion goes up, disappears, and then goes down
- **Radar:** the rain is maximal during trough peak, but continues all the time, also with inversions at ~600 mb
- **Most of the time:** moderate rain – before/after the trough peak

What was the COSMO forecast (default configuration) ?

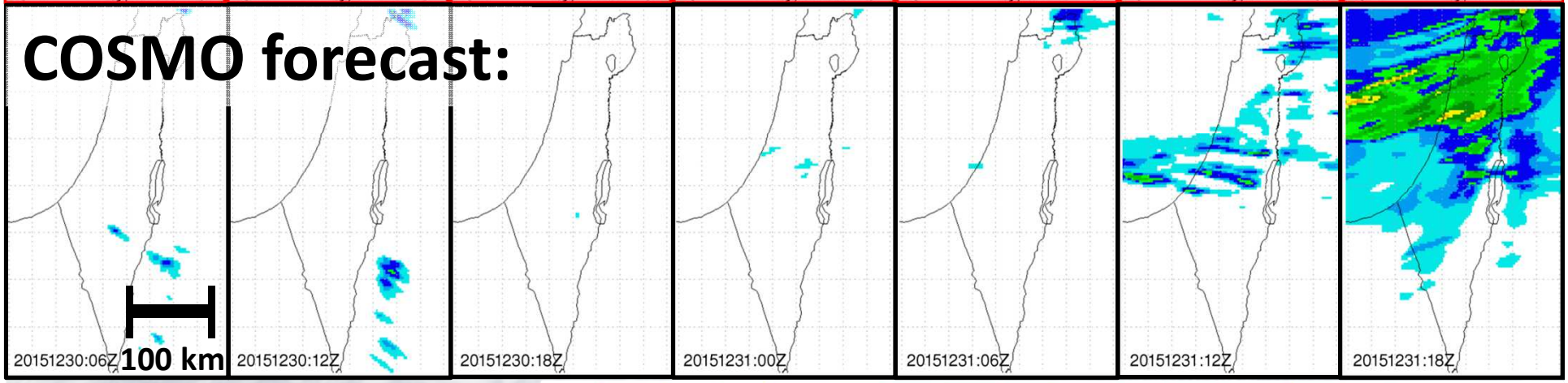
Before upper air trough

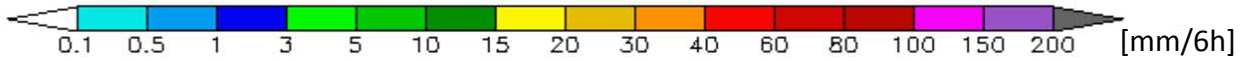
Peak of upper ai





COSMO forecast:





Before/after trough peak – strong underestimation of rain. Why?

It is shallow convection parametrization that makes the problem

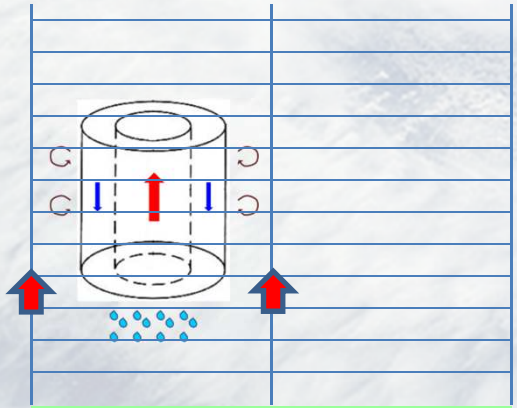
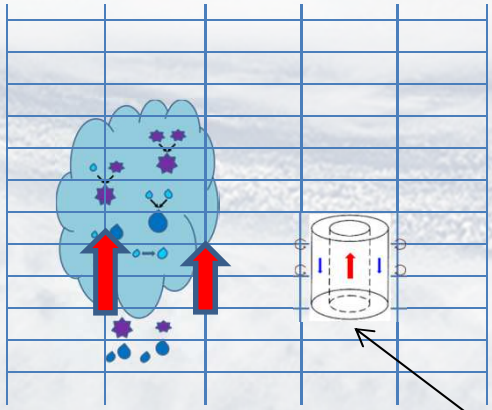
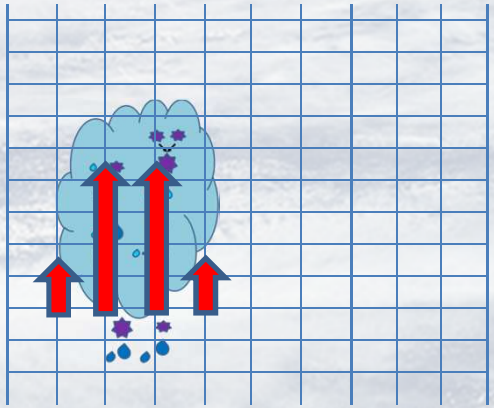

Few minutes to the
Ice Breaker…

Shallow convection parametrization

- **Cumulus convection has a major impact on the vertical structure of the temperature and moisture fields of the atmosphere**

- **In coarse-grid models the vertical velocities in grid cells are small, so the cumulus convection does not develop → convection parametrization**

- **In COSMO 2.8km the deep convection is resolved but shallow – not! → shallow convection parametrization**

Not cloud resolving > ~4 km	Cloud "resolving" COSMO 2.8 km	Cloud resolving ≤ ~1 km
		
"Simple" bulk cloud model which represents ensemble of clouds	**Responsible for vertical mixing of heat, moisture and momentum in the lower atmosphere. Important in fair weather !**	

Shallow convection parametrization in COSMO 2.8km

2 parameters:

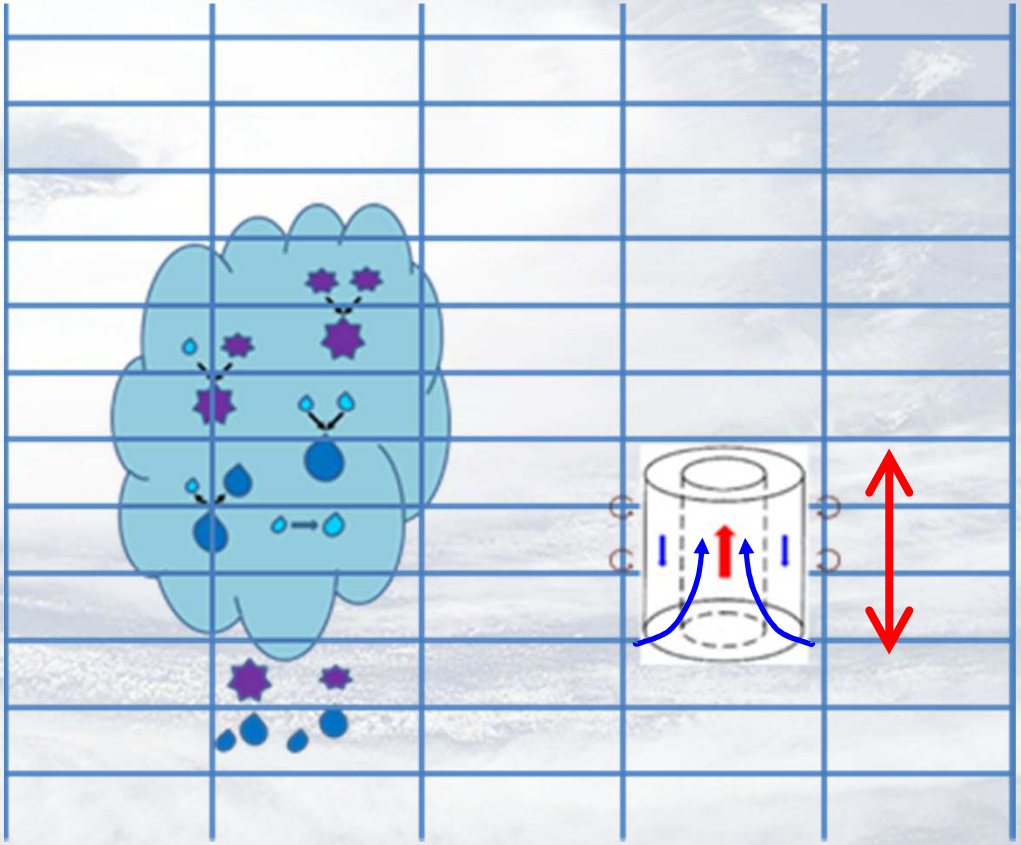
- **thick_sc – (maximal allowed) thickness of mixing layer**

  If the "test" parcel rises above thick_sc, shallow convection is switched off

  range: **100 hPa** (small mixing layer) till **250 hPa** (large mixing layer)

- **entr_sc – entrainment rate: determines the humidity transport upwards by shallow clouds**

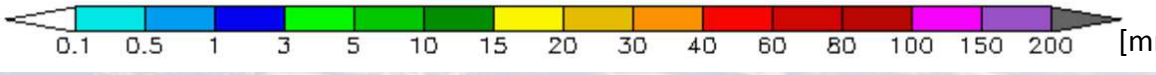
  range: **0.00005 m^{-1}** (small transport) till **0.002 m^{-1}** (large transport)

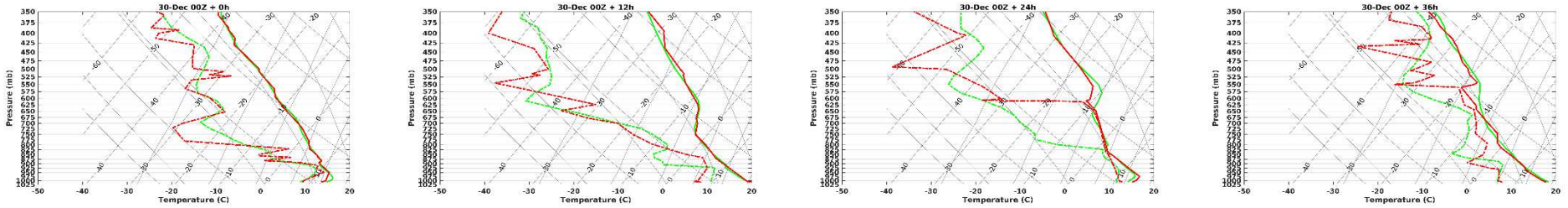


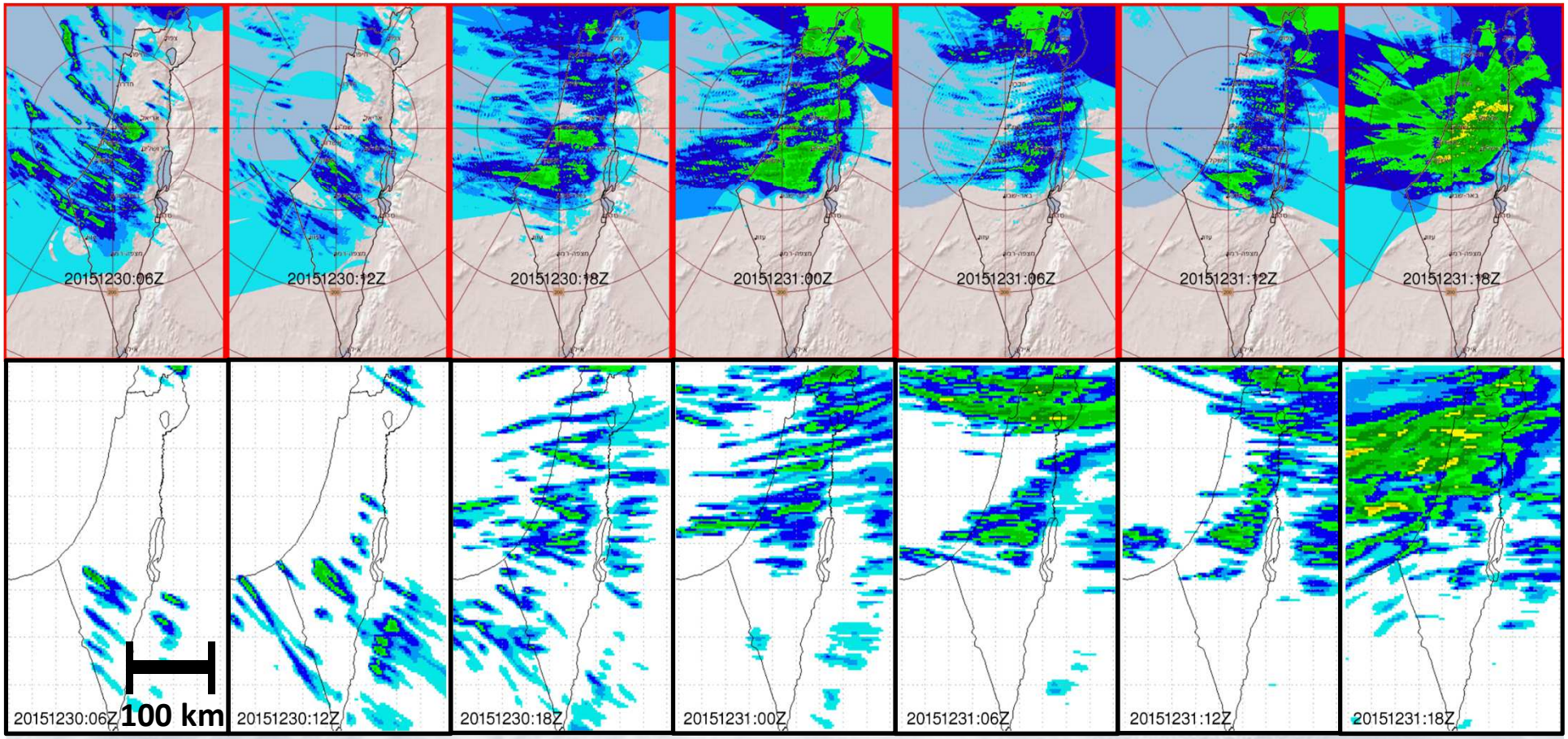
Back to the example:

30/12/2015 - 02/01/2016

30/12/2015 00 UTC + …

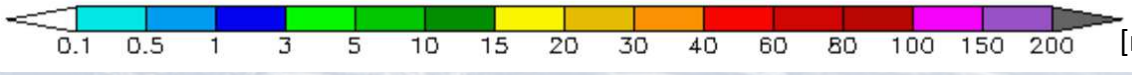


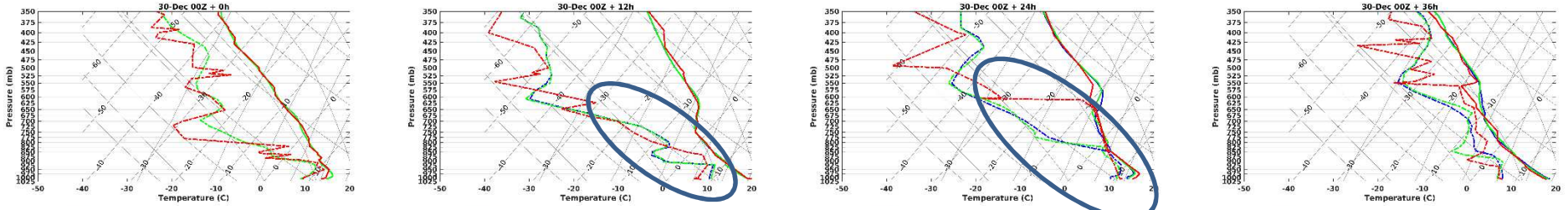


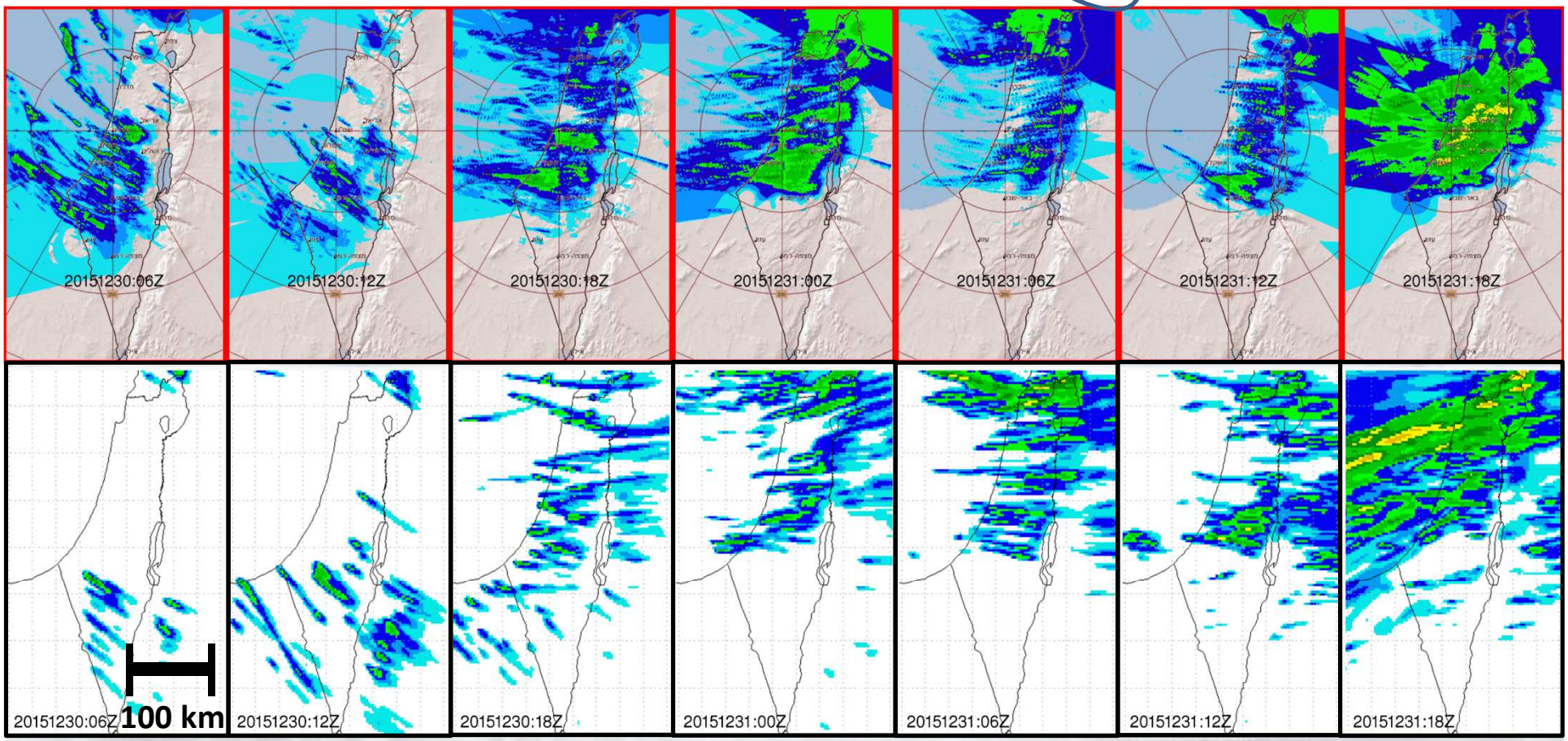


Shallow convection OFF

30/12/2015 00 UTC + …

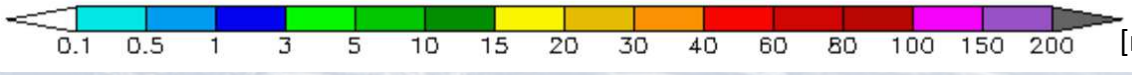


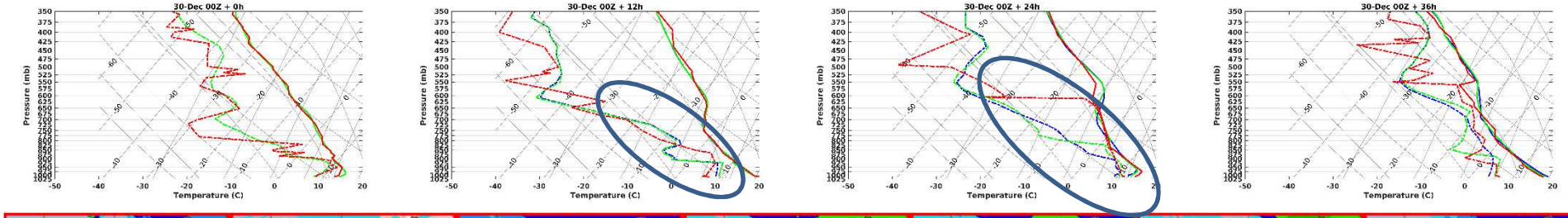


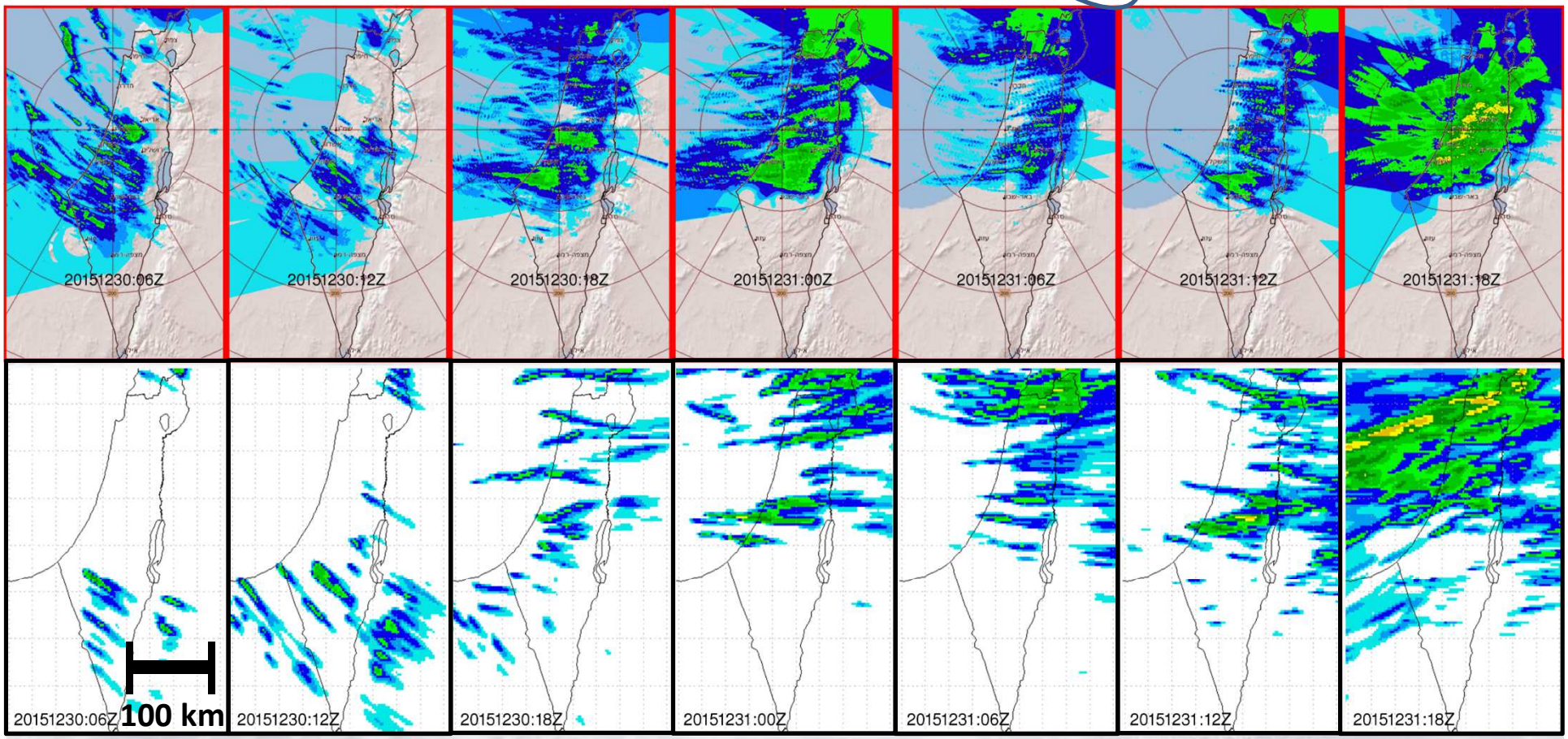


100 hPa thickness ; weak humidity transport

30/12/2015 00 UTC + …

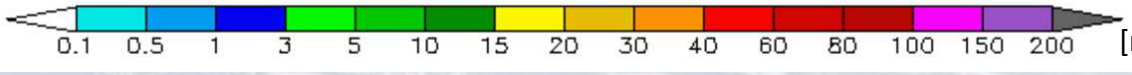


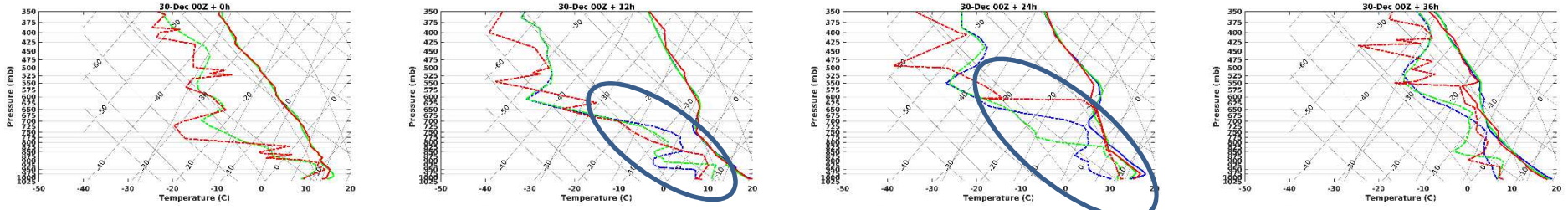


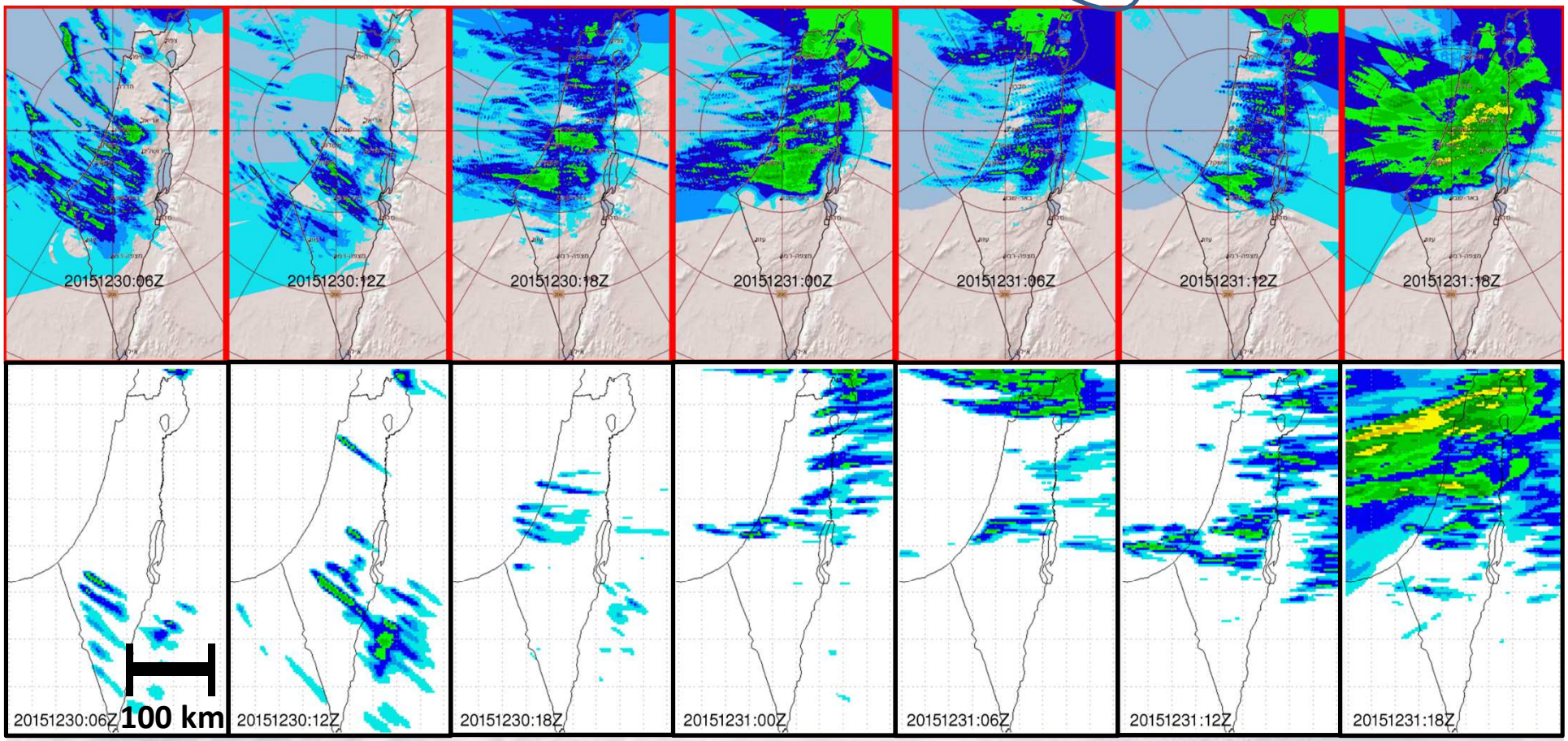


100 hPa thickness ; moderate humidity transport

30/12/2015 00 UTC + …

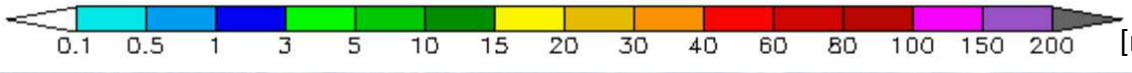


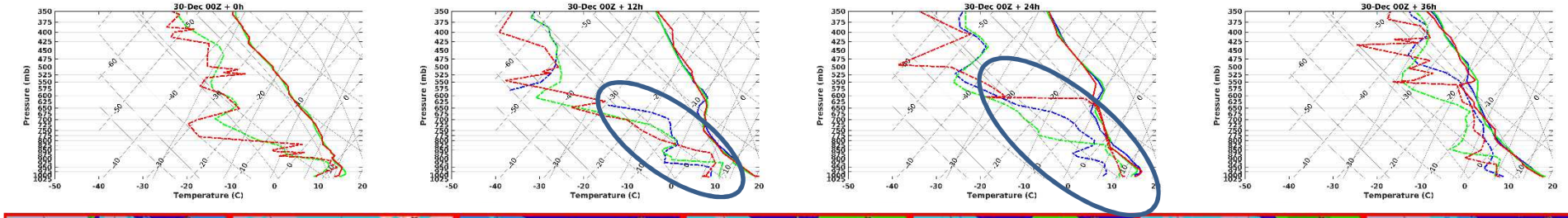


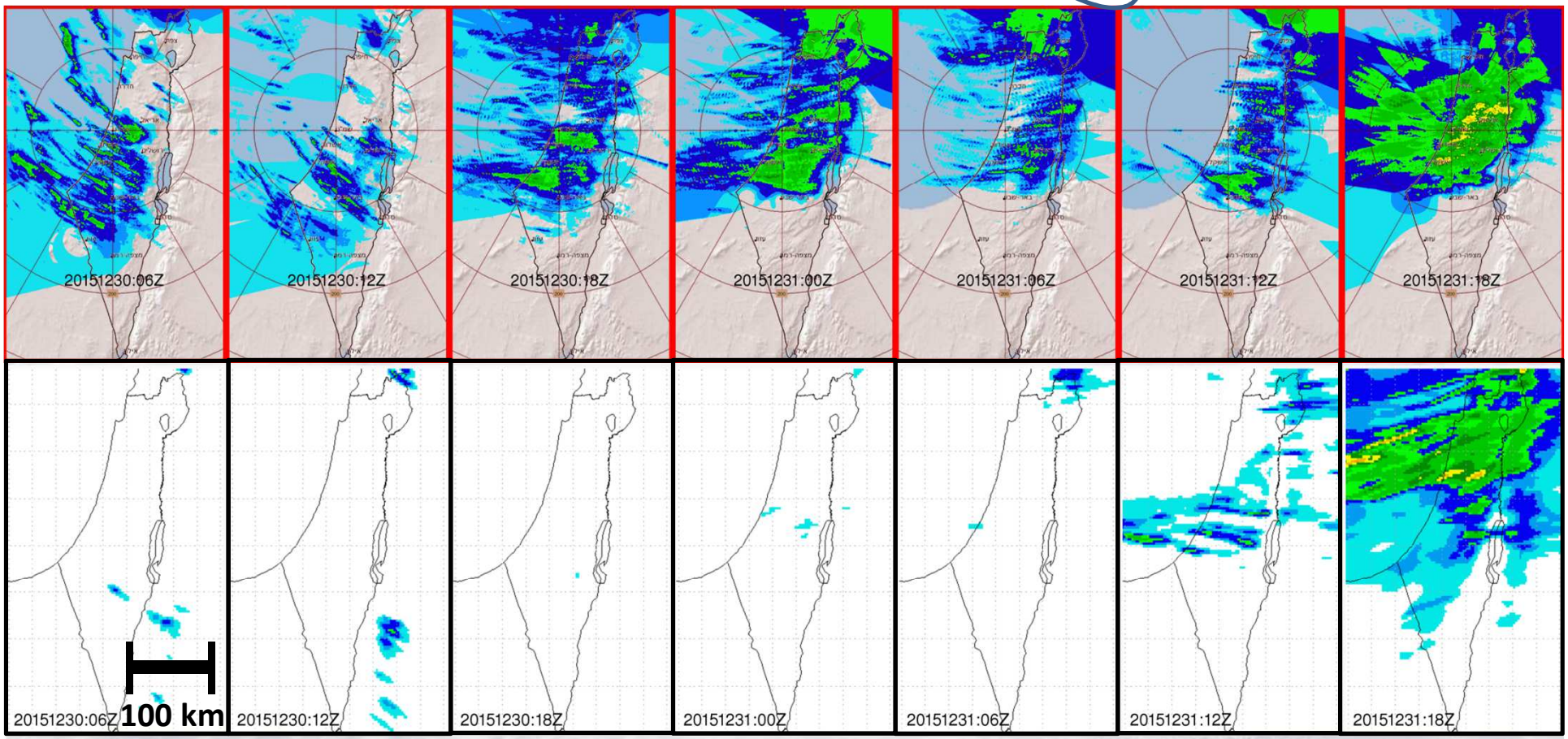


100 hPa thickness ; strong humidity transport

30/12/2015 00 UTC + …



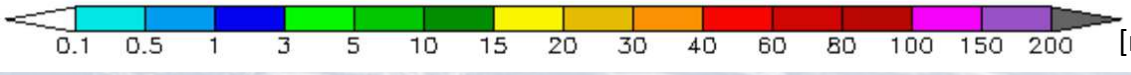


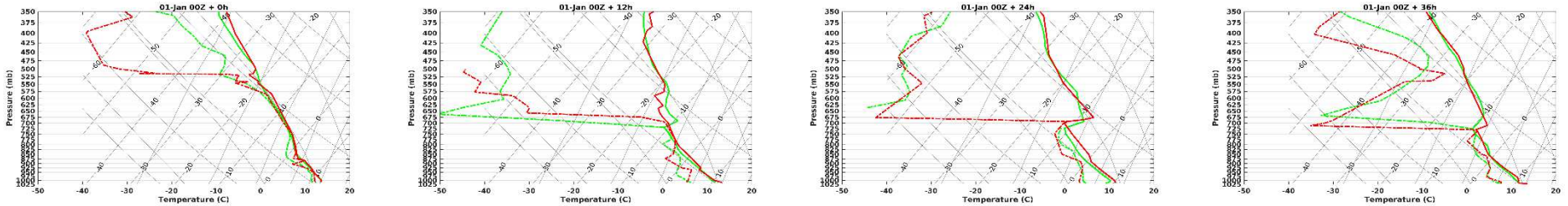


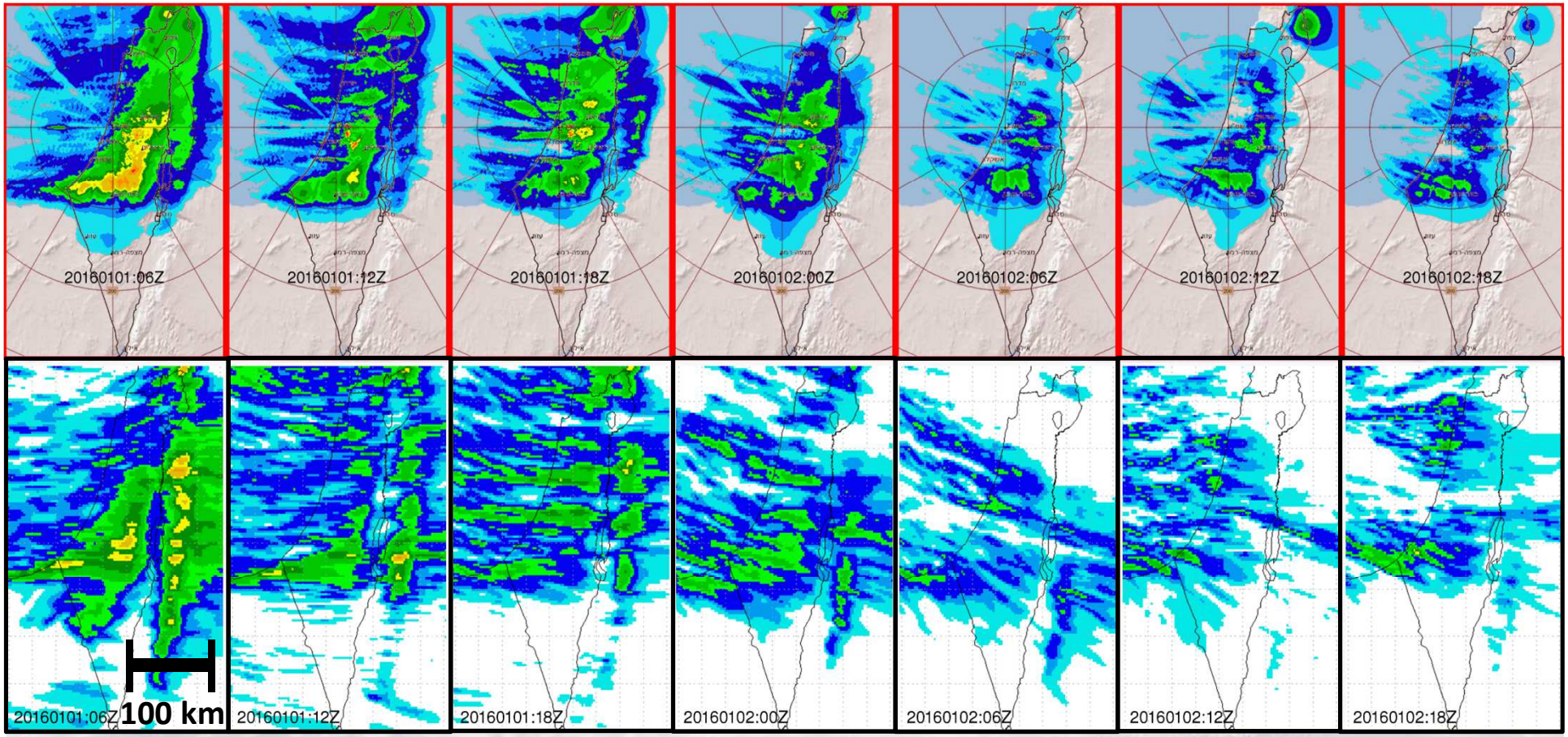
250 hPa thickness ; moderate humidity transport

***default**

01/01/2016 00 UTC + …

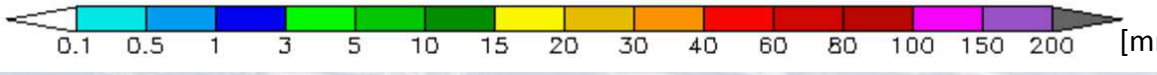


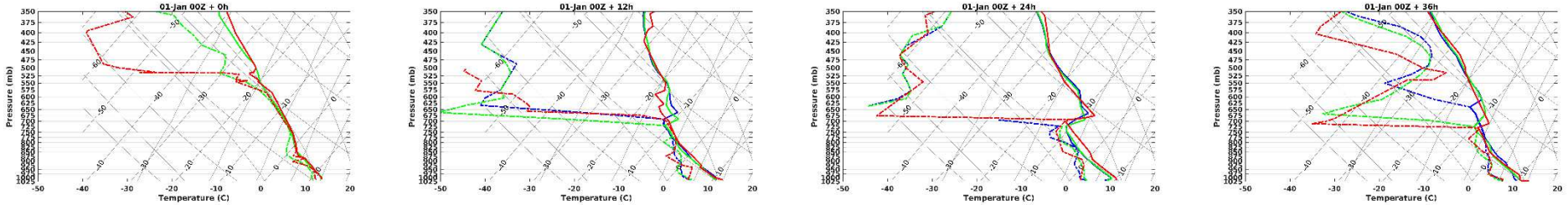


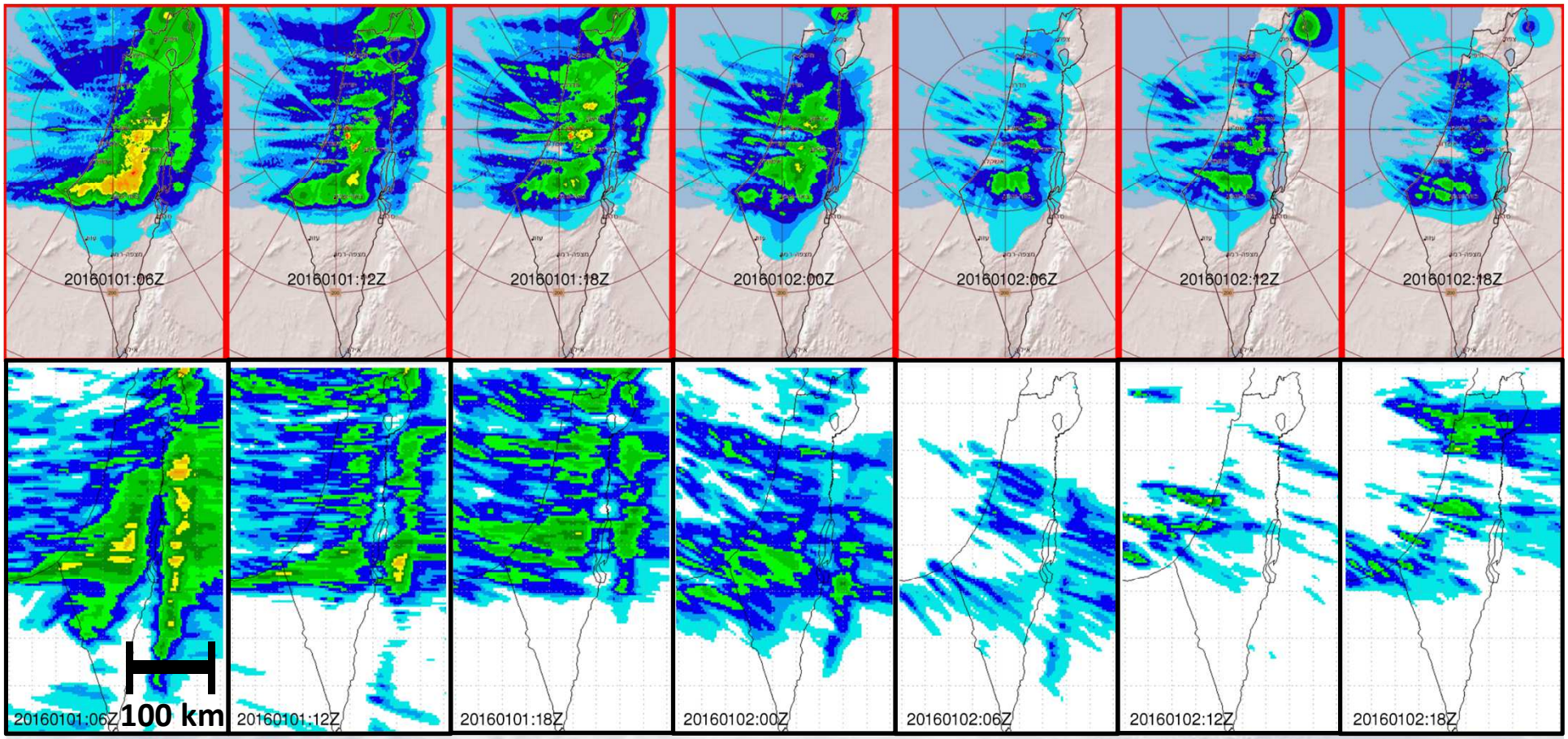


Shallow convection OFF

01/01/2016 00 UTC + …

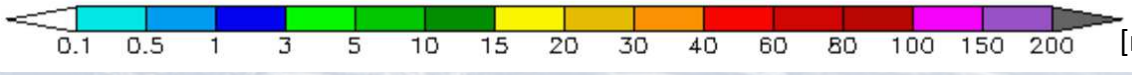


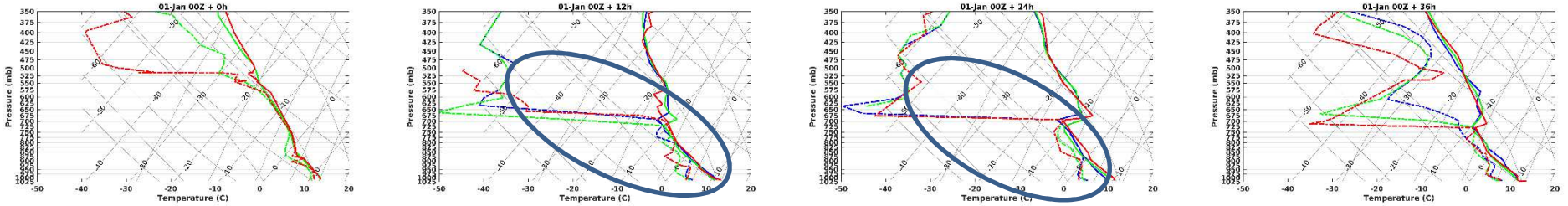


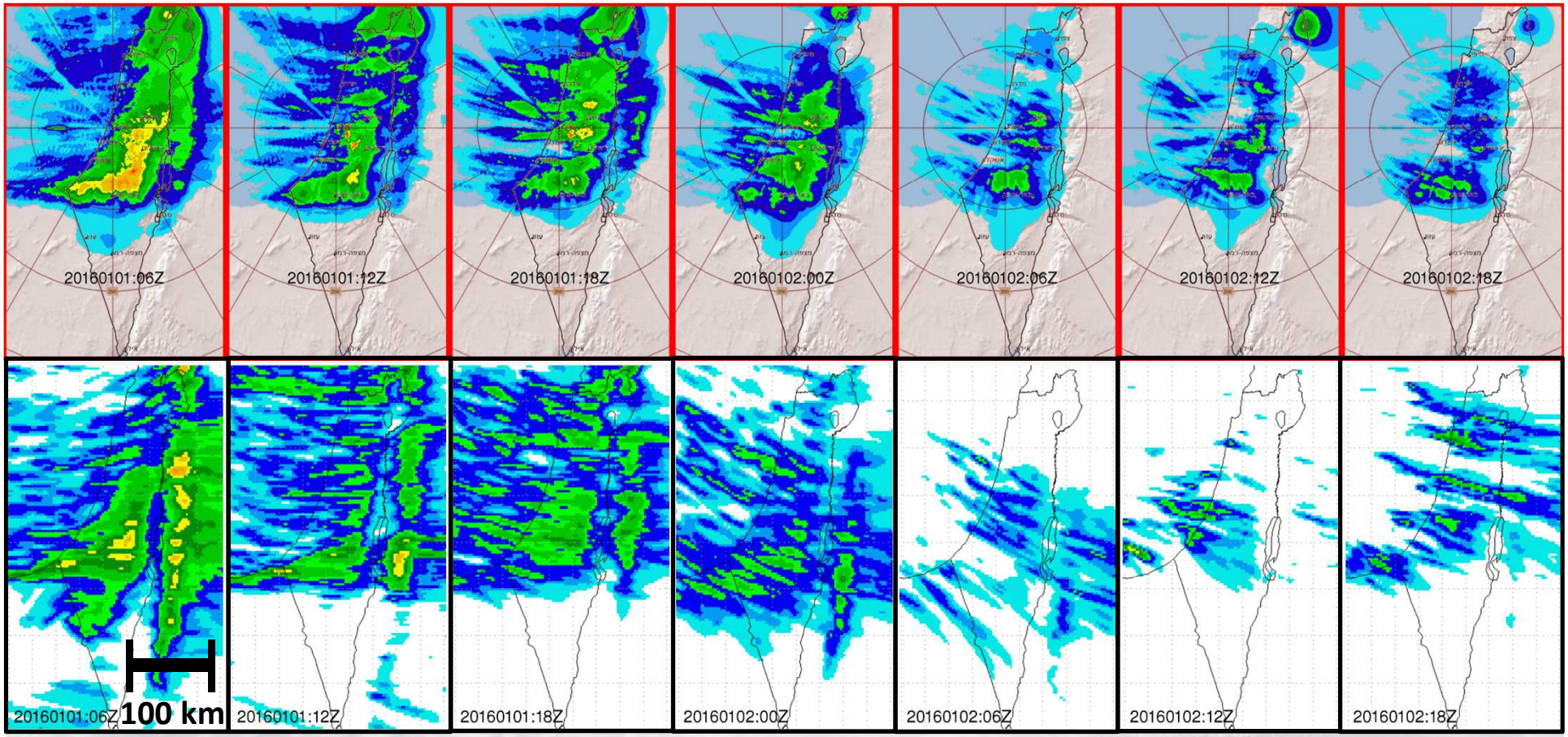


100 hPa thickness ; weak humidity transport

01/01/2016 00 UTC + …

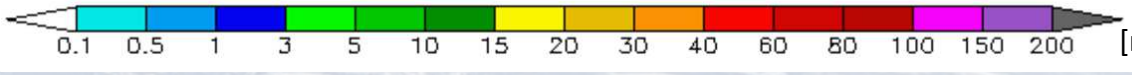


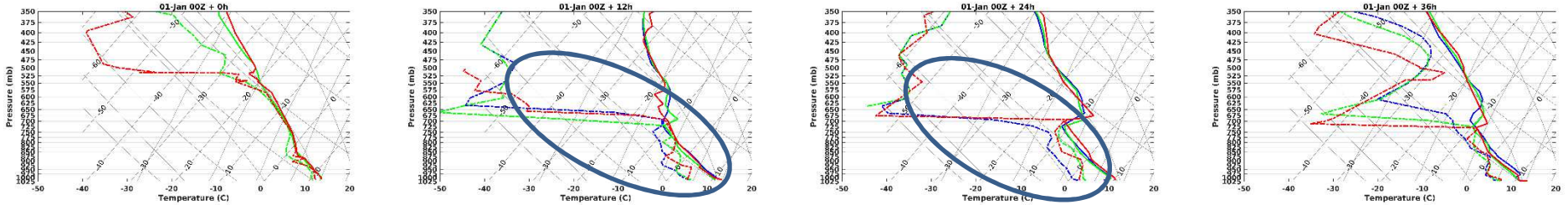


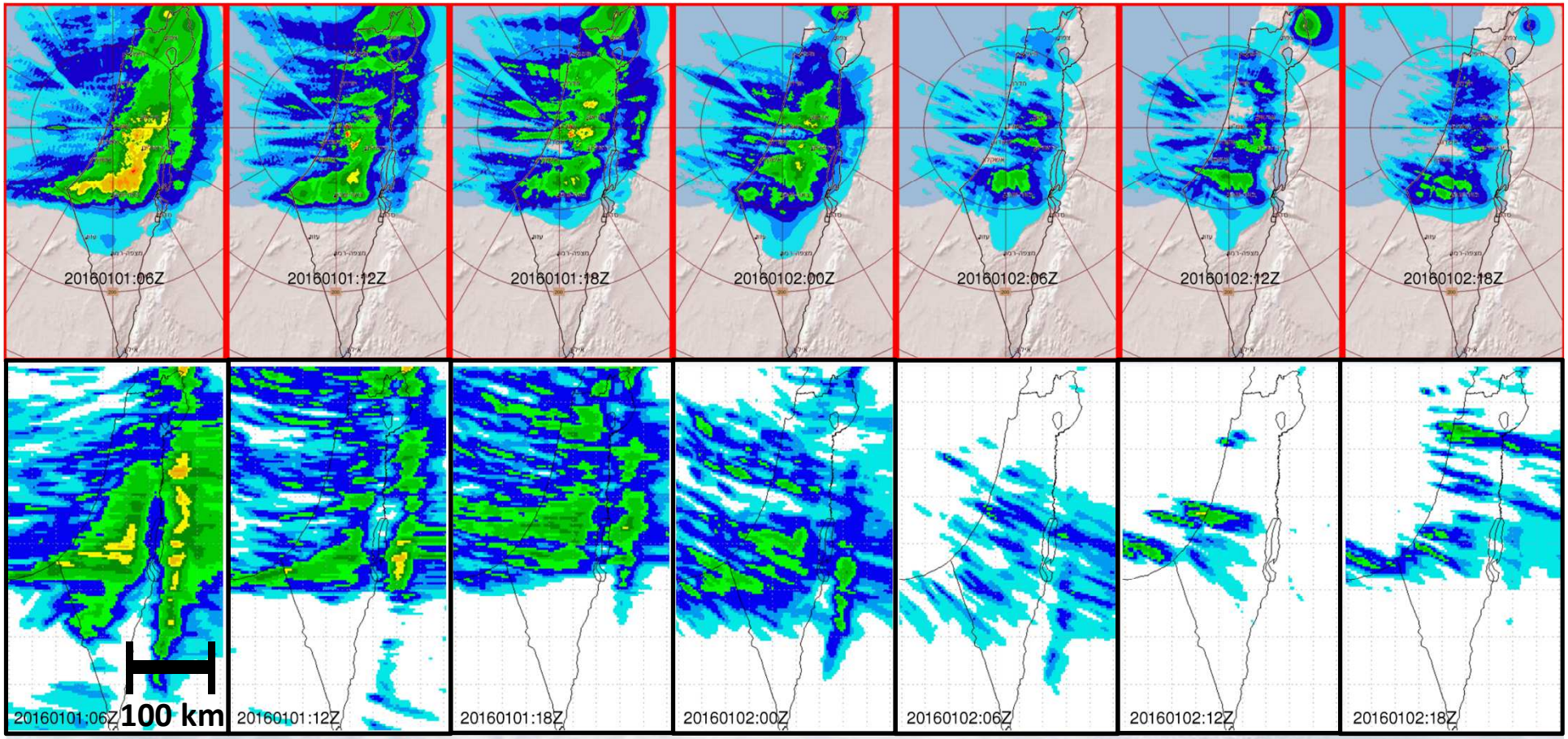


100 hPa thickness ; moderate humidity transport

01/01/2016 00 UTC + …

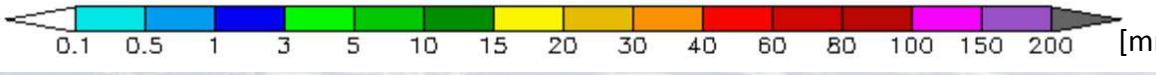


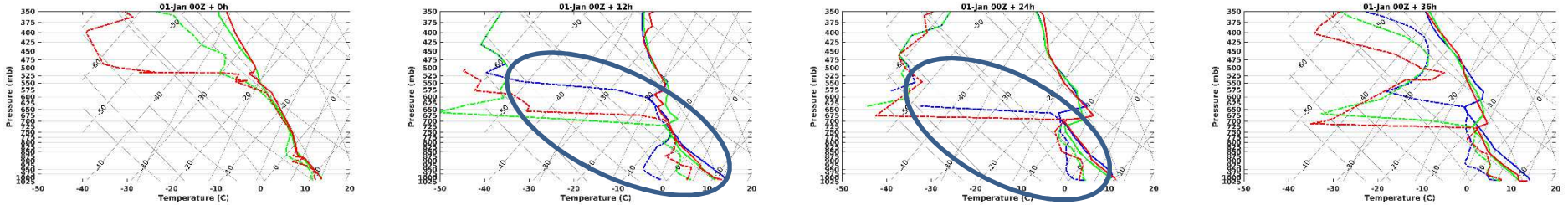


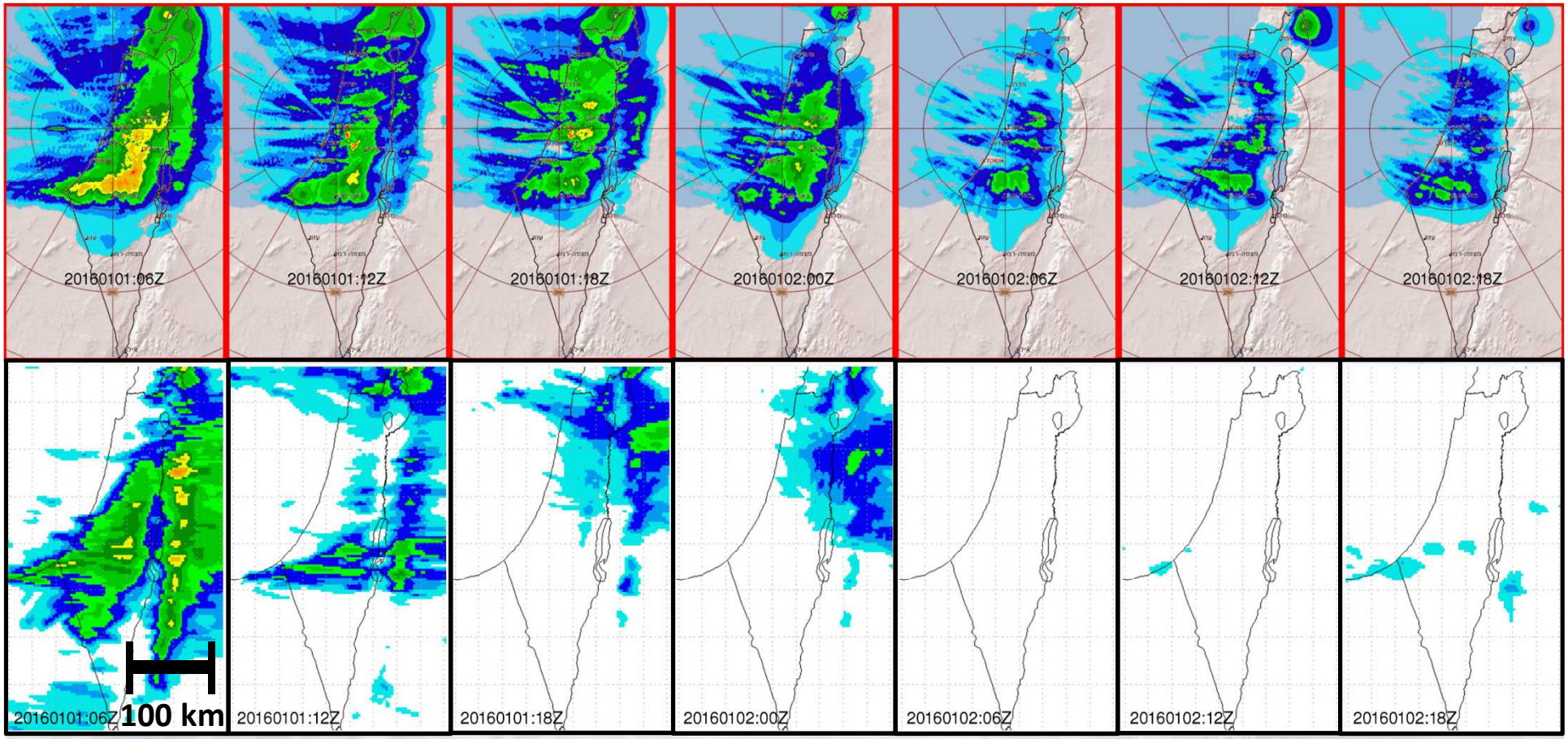


100 hPa thickness ; strong humidity transport

01/01/2016 00 UTC + …







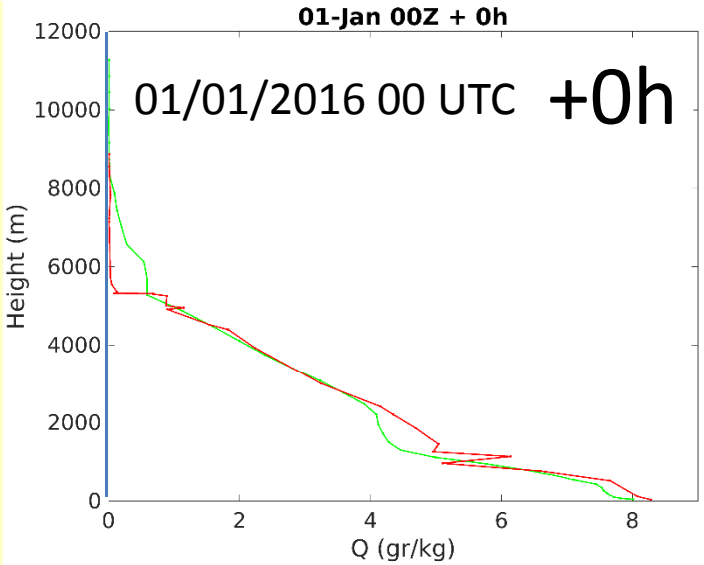
250 hPa thickness ; moderate humidity transport

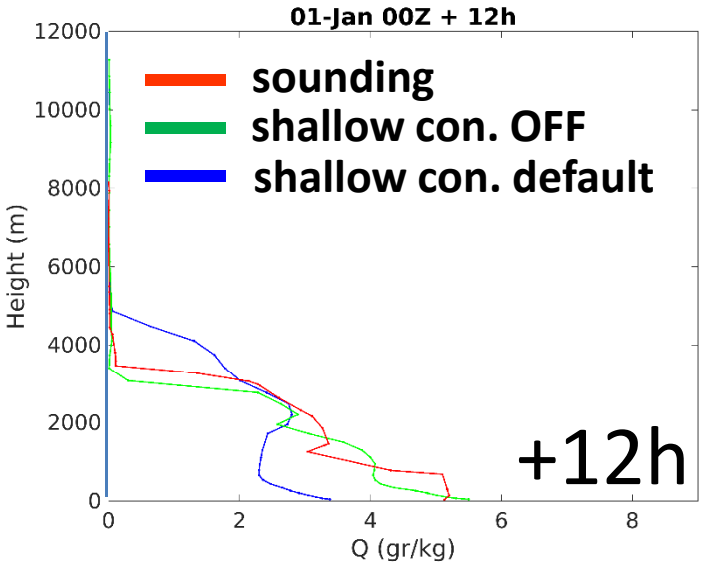
***default**

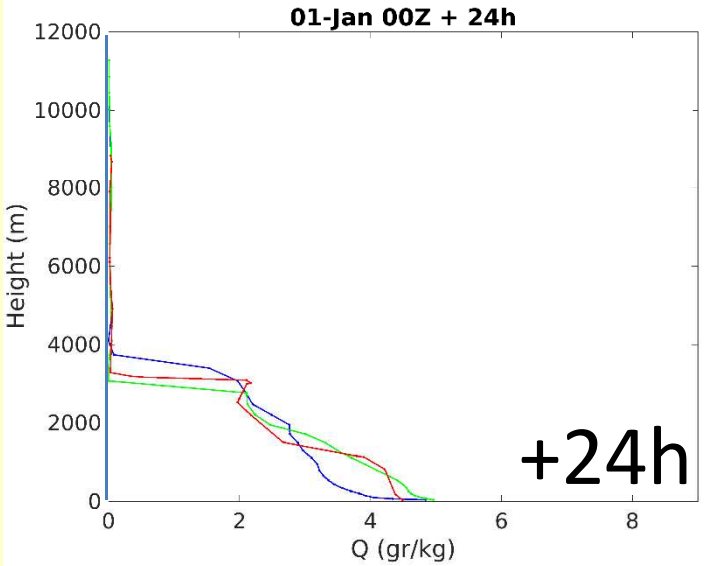
Effect of Shallow convection parametrization on the water vapor

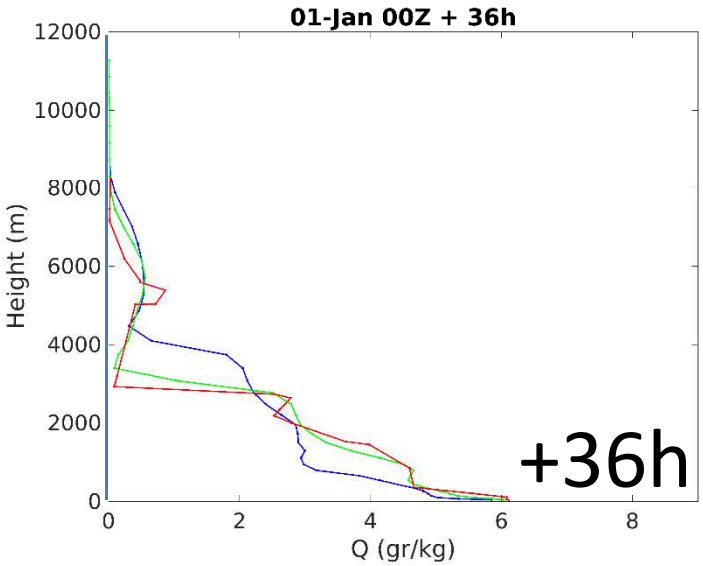
Shallow convection parametrization blows upwards the humidity from the lower atmosphere destroying grid scale weak and moderate precipitation

(At deep convection it usually turns it self off automatically)





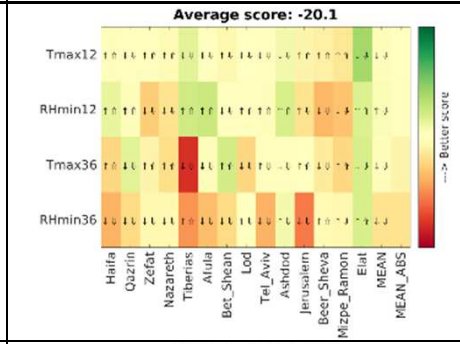
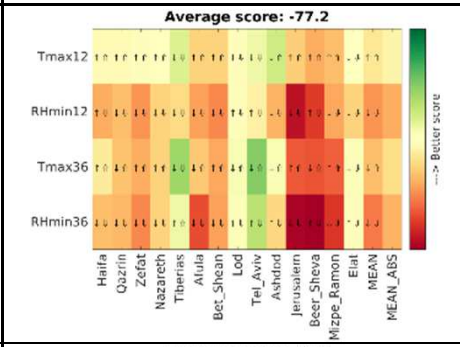
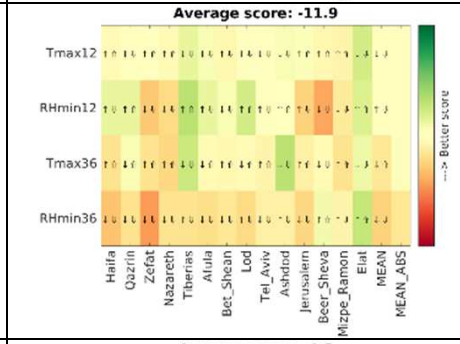
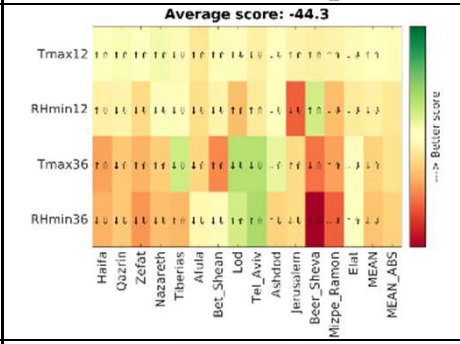
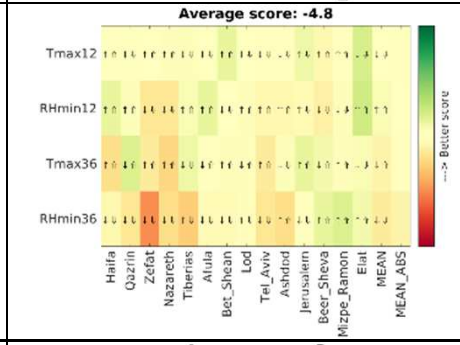
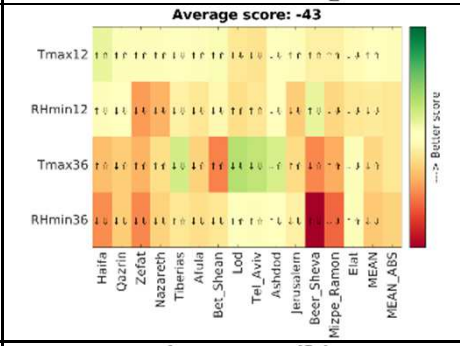
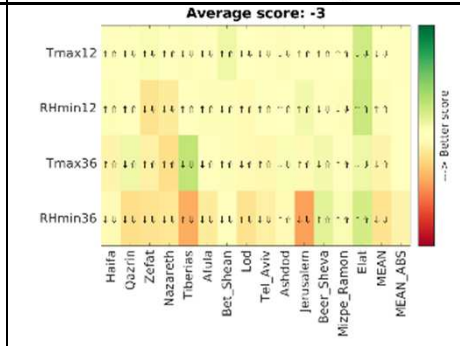
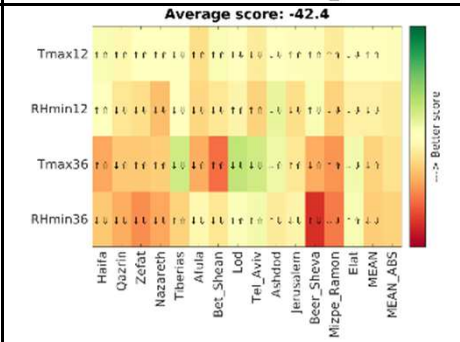




2m-temperature and humidity verification

Better then
"Shallow convection OFF"

Worse then
"Shallow convection OFF"

	30/12/2015 00 UTC + …	01/01/2016 00 UTC + …
250 hPa thickness ; moderate humidity transport ***default**		
100 hPa thickness ; strong humidity transport		
100 hPa thickness ; moderate humidity transport		
100 hPa thickness ; weak humidity transport		

How to improve Shallow Convection parametrization ?

The updraft in shallow cumulus clouds should be low!

Possible idea: Gradually switch off the Shallow Convection parametrization (BL mass convergence) if the updraft speed increases above ~1m/s

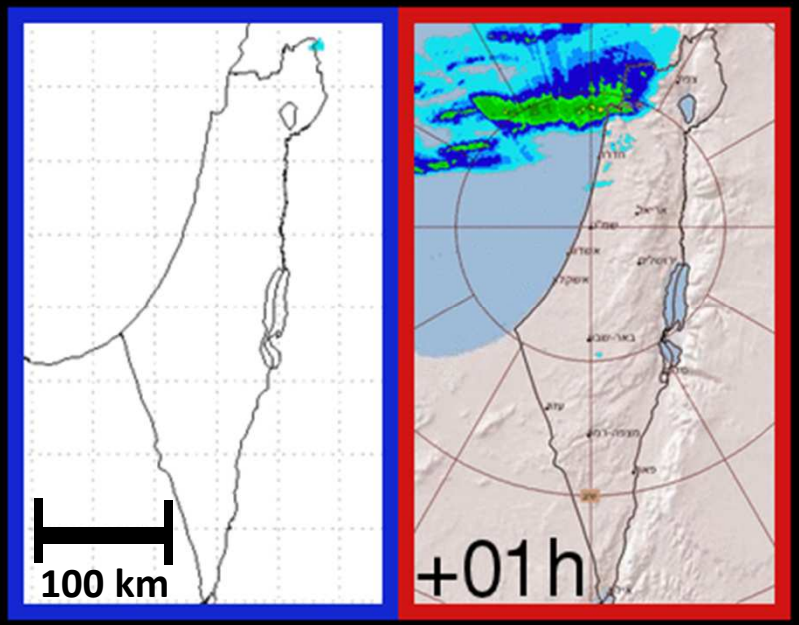
Alternatively: Steef Boing et al. 2017 (submitted)

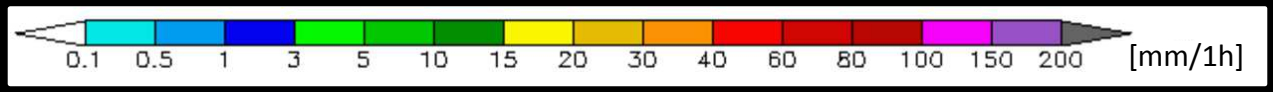
Meanwhile at IMS: switching OFF Shallow Convection parametrization on rainy days

Rain forecast improved dramatically!

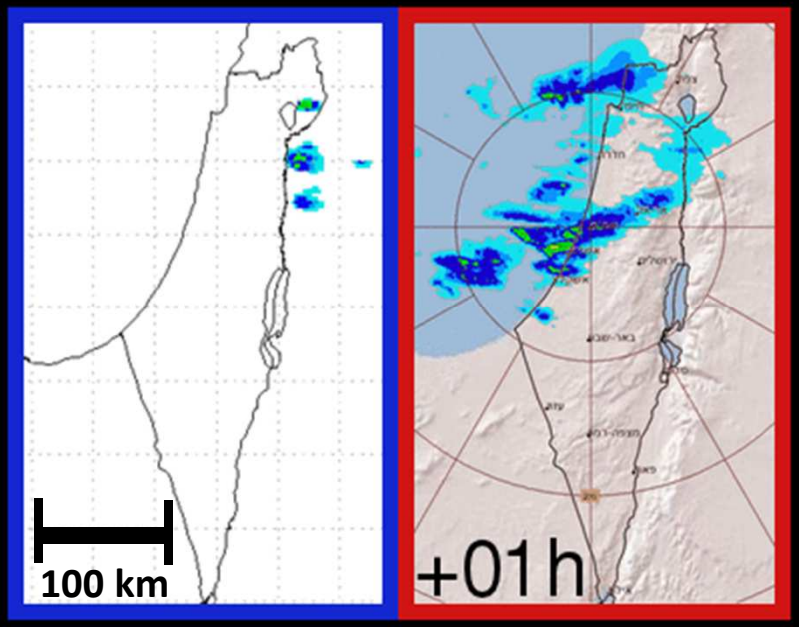
Quantitative verification not yet ready… Let's see several examples…

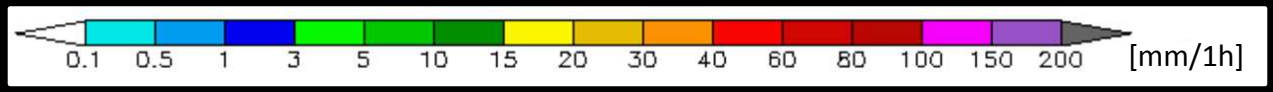
Example: forecast from 13/12/2016 00 UTC



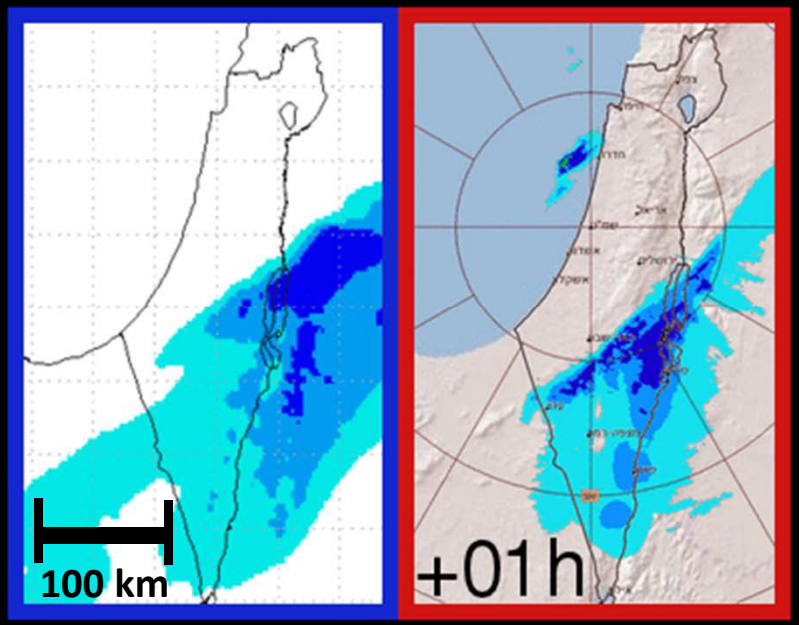


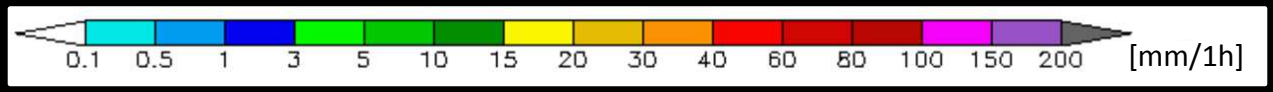
Example: forecast from 17/12/2016 00 UTC



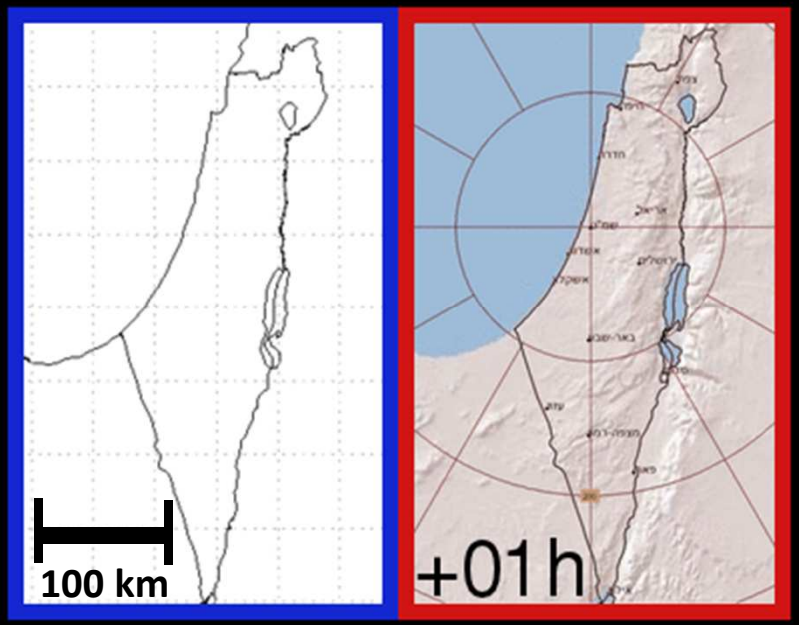


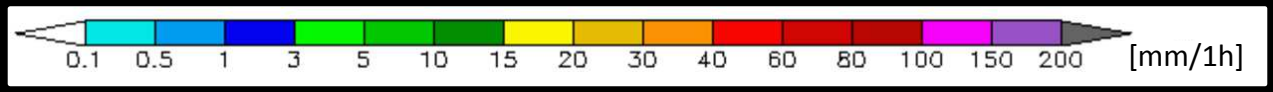
Example: forecast from 24/12/2016 00 UTC





Example: forecast from 07/01/2017 00 UTC



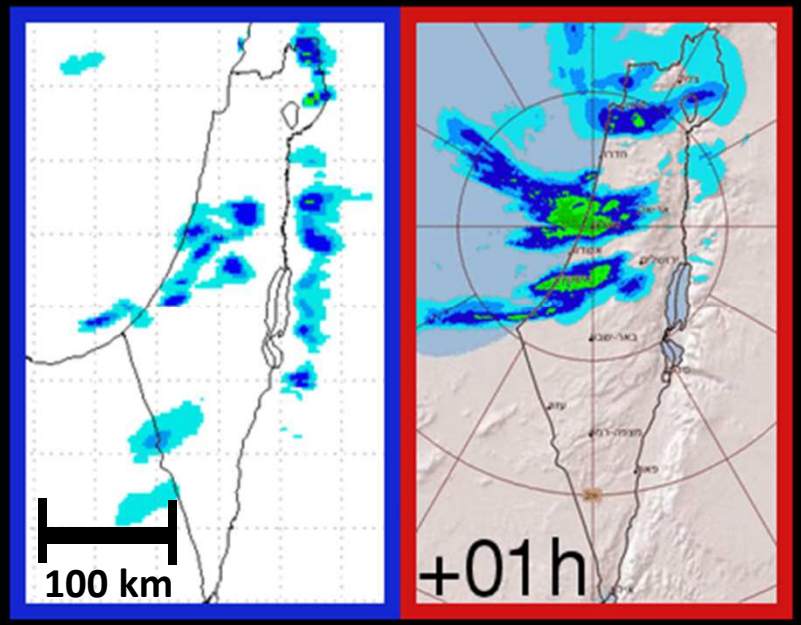


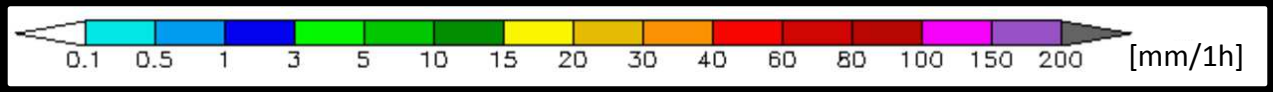
This is the end of Pavel's talk, thank you dear colleagues!


מזג האוויר
This is the end of
Pavel's talk, thank you
dear colleagues!

Additional slides …

First TV forecast: from 15/02/2017 00 UTC





Effect of Shallow convection parametrization on the temperature

Shallow convection parametrization rises the inversion and blows upwards the humidity from the lower atmosphere destroying grid scale weak and moderate precipitation

(At deep convection it usually turns it self off automatically)

01/01/2016 00 UTC +…