



Effect of **shallow convection parametrization** on the forecast of **convective precipitation**

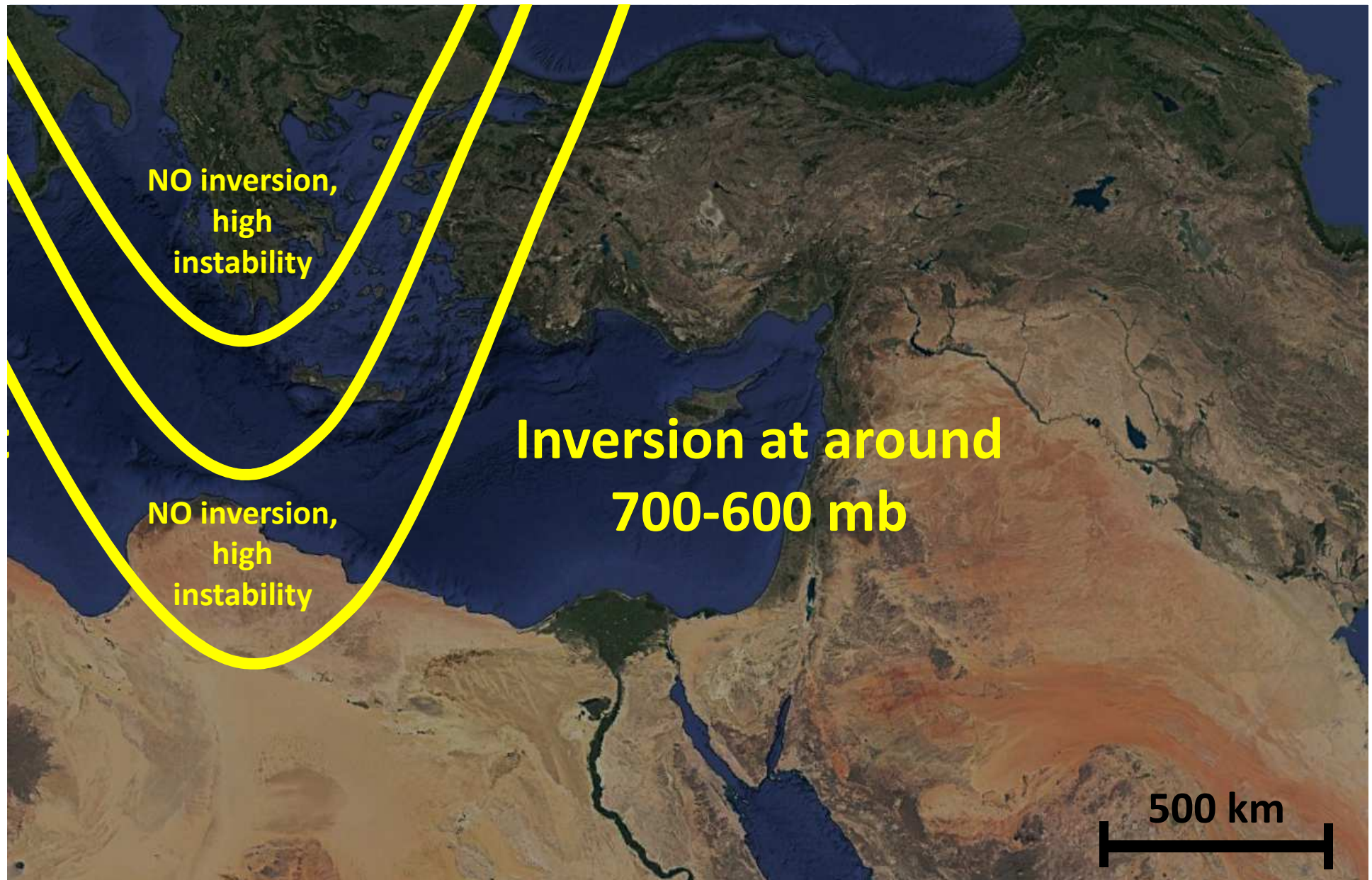
P. Khain¹, A. Shtivelman¹, E. Vadislavsky¹, Y. Levi¹, N. Stav¹, U. Blahak² and D. Mironov²

¹Israel Meteorological Service

²Deutscher Wetterdienst

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)

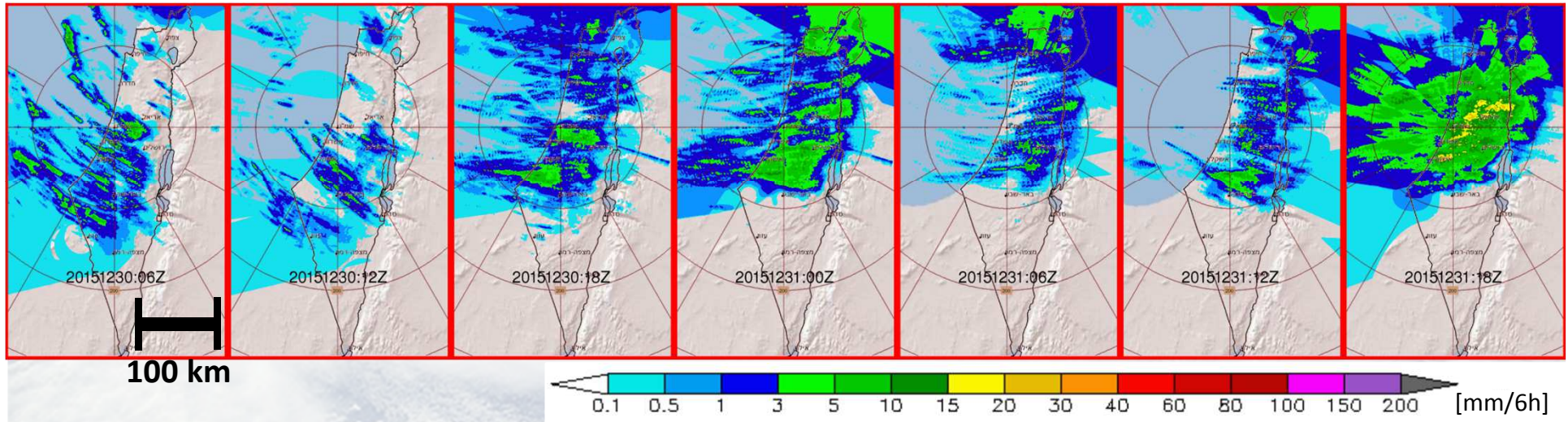
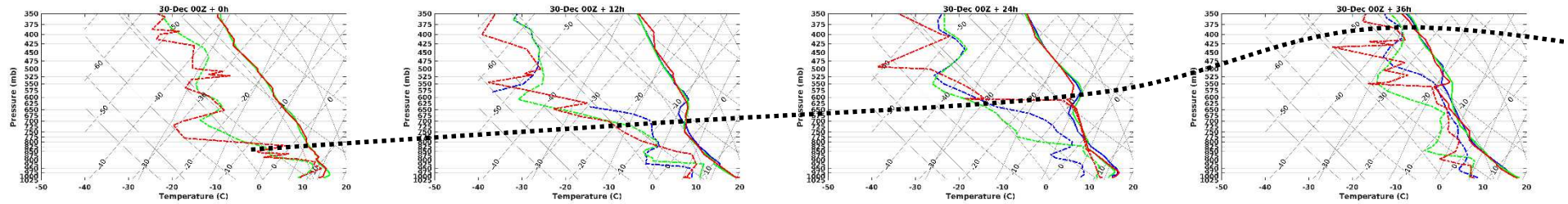
A satellite image showing a large-scale atmospheric feature over the ocean, likely a trough passage. The image displays a prominent, elongated, and somewhat curved cloud pattern with a distinct trough or dip in the center, characteristic of a low-pressure system. The surrounding cloud cover is more diffuse and less organized. The text is overlaid on the central part of the image.

Typical example for trough passage:

30/12/2015 - 02/01/2016

Before upper air trough

Peak of upper air

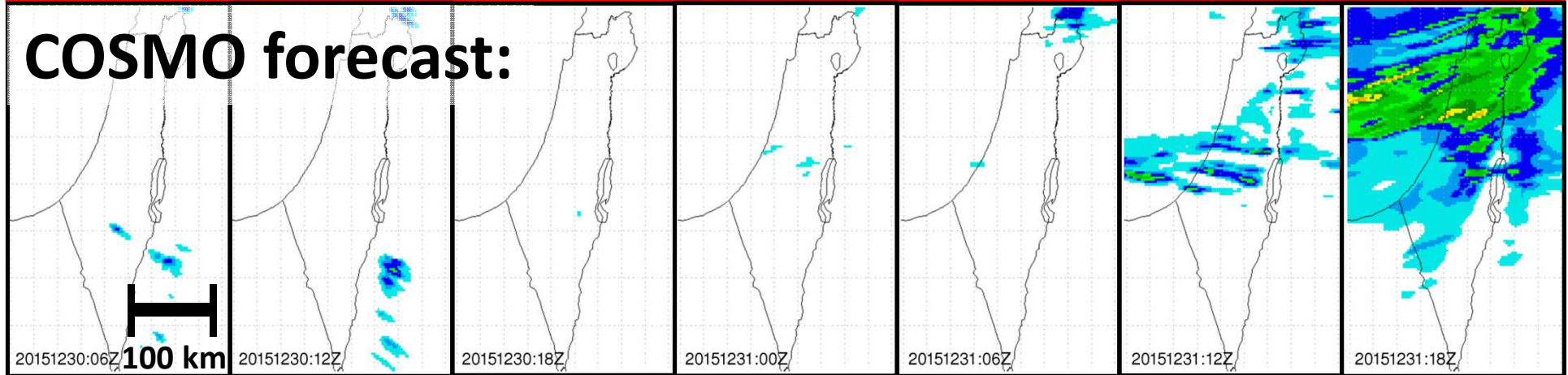
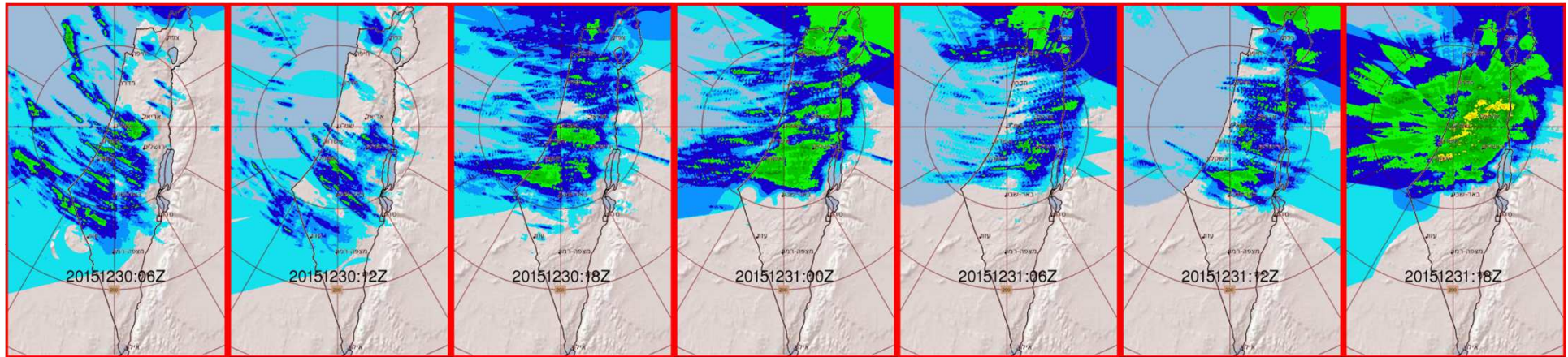
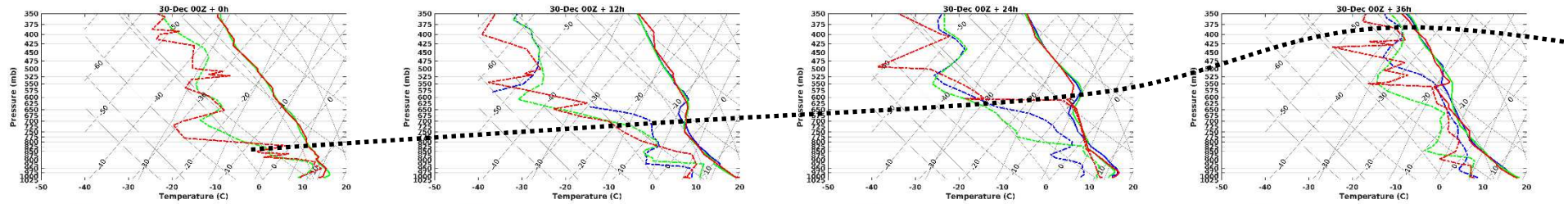


- **Obs profiles:** the inversion goes up, disappears, and then goes down
- **Radar:** the rain is maximal during trough peak, but continues all the time, also with inversions at ~600 mb
- **Most of the time:** moderate rain – before/after the trough peak

What was the COSMO forecast (default configuration) ?

Before upper air trough

Peak of upper air



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

An aerial photograph of a tropical cyclone, showing a distinct eye in the center surrounded by dense, swirling cloud bands. The image is used as a background for the text.

**It is shallow convection parametrization
that makes the problem**

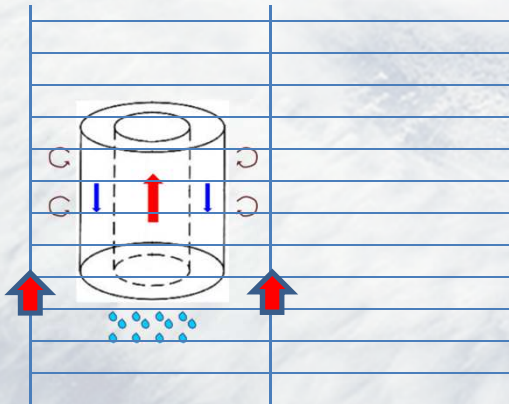
Few minutes to the Ice Breaker...



Shallow convection parametrization

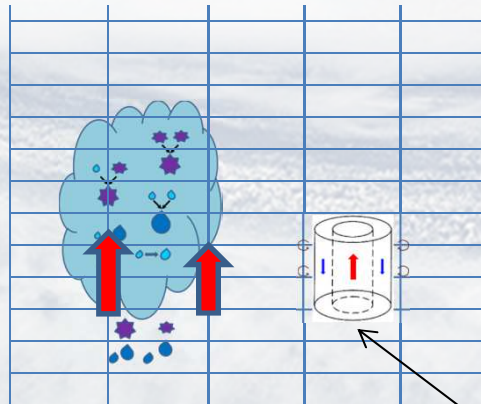
- Cumulus convection has a major impact on the vertical structure of the temperature and moisture fields of the atmosphere
- In coarse-grid models the vertical velocities in grid cells are small, so the cumulus convection does not develop → convection parametrization
- In COSMO 2.8km the deep convection is resolved but shallow – not! → shallow convection parametrization

Not cloud resolving
> ~4 km



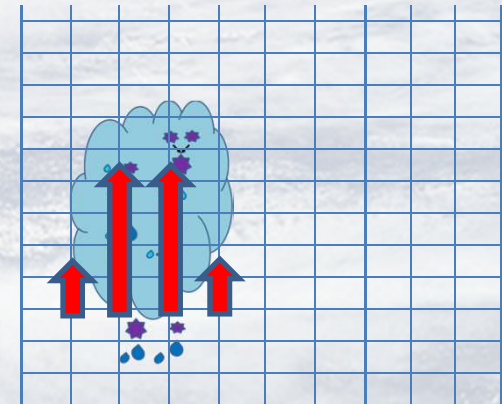
“Simple” bulk cloud model which represents ensemble of clouds

Cloud “resolving”
COSMO 2.8 km



Responsible for vertical mixing of heat, moisture and momentum in the lower atmosphere. **Important in fair weather !**

Cloud resolving
≤ ~1 km



Shallow convection parametrization in COSMO 2.8km

2 parameters:

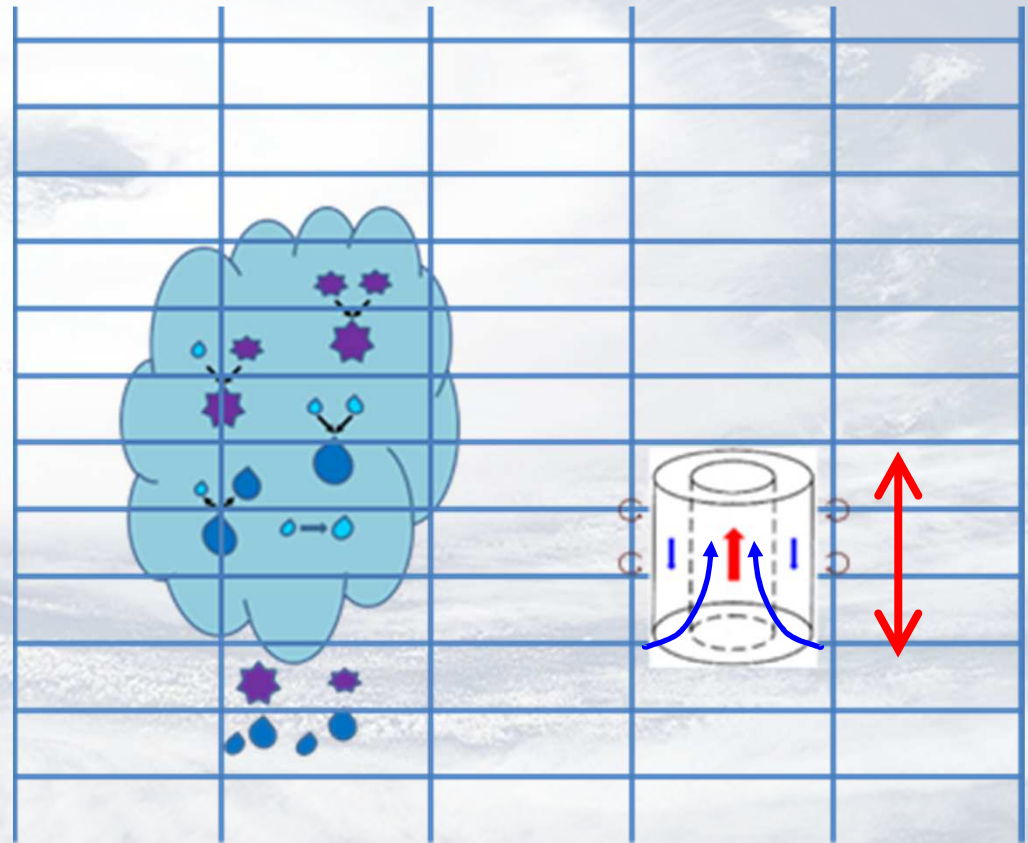
- **thick_sc** – (maximal allowed) thickness of mixing layer

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)

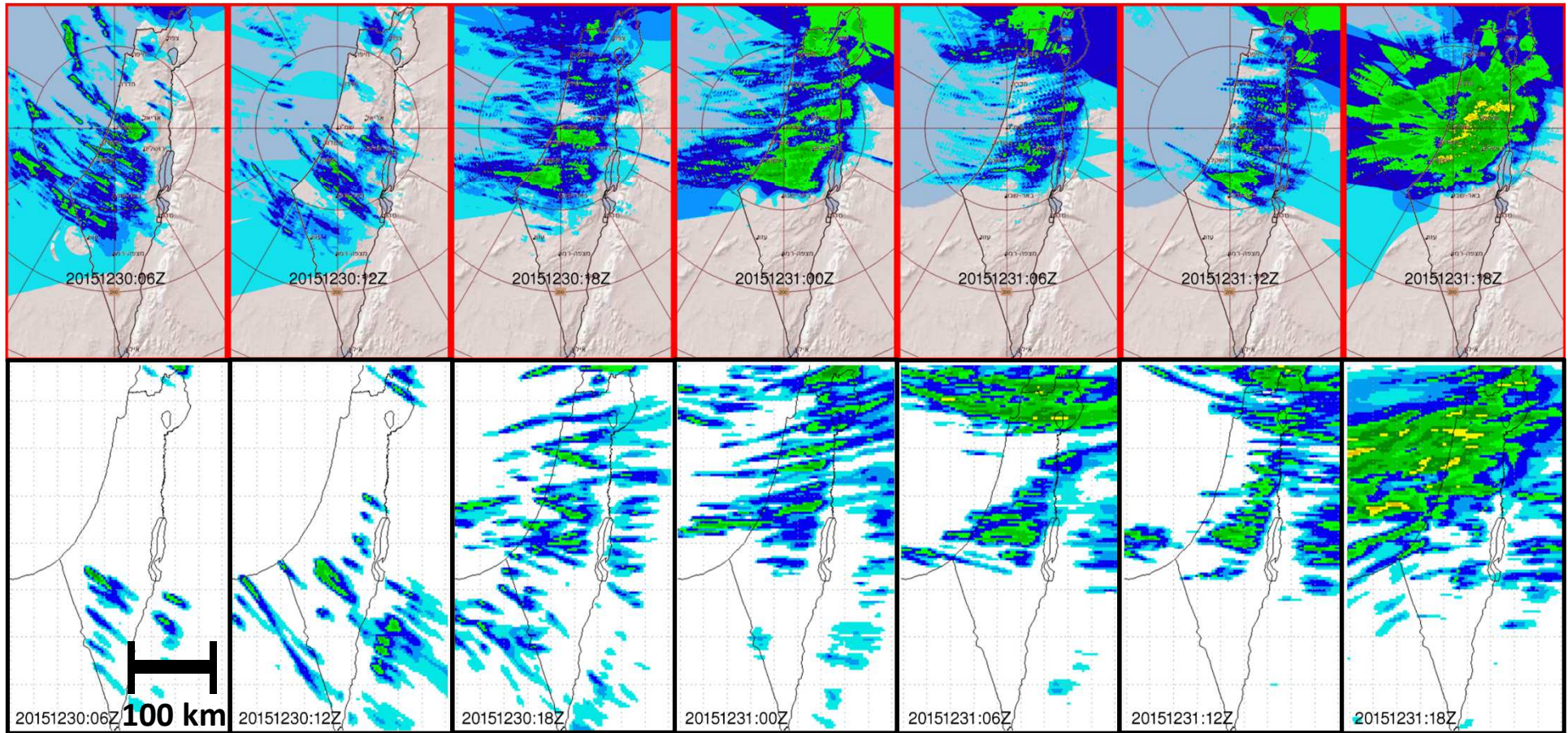
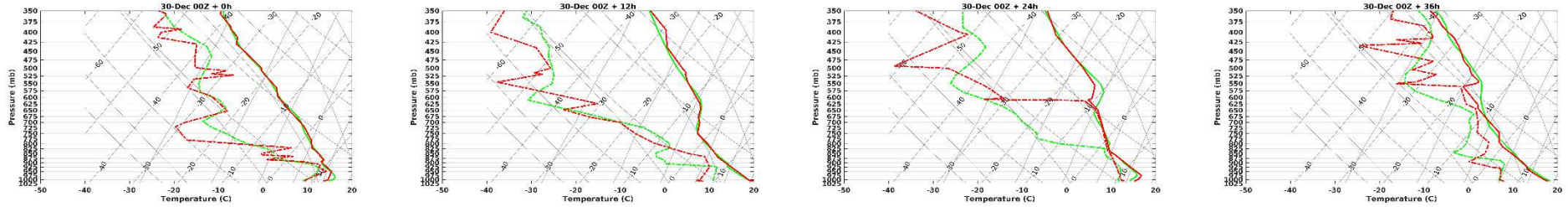
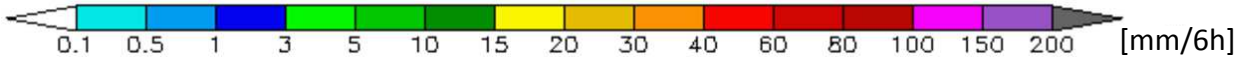




Back to the example:

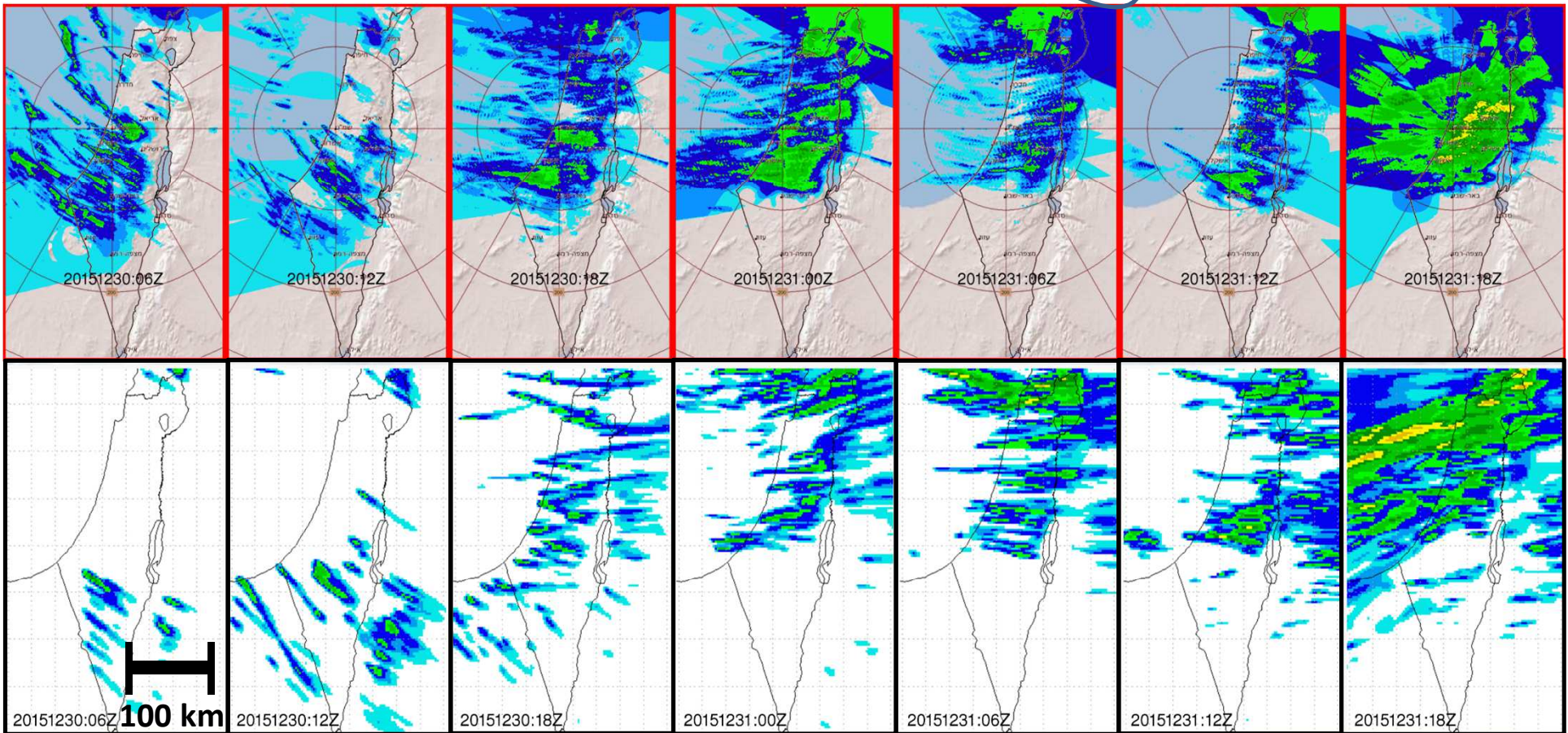
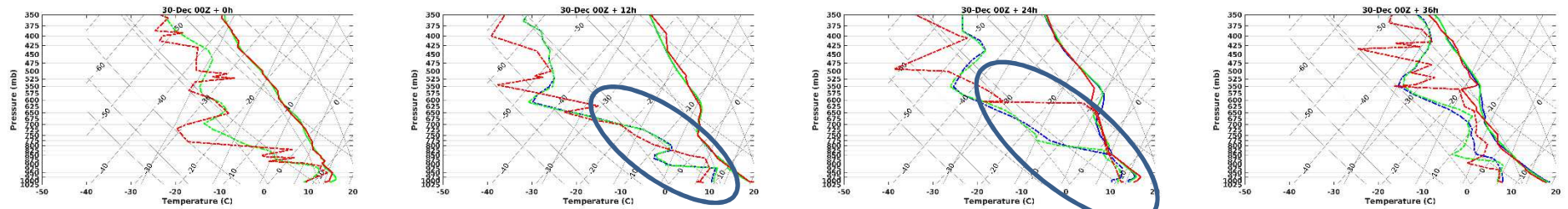
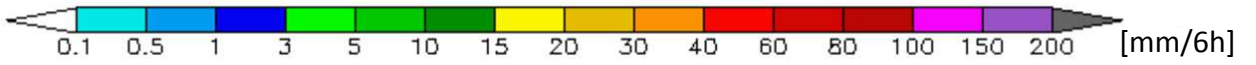
30/12/2015 - 02/01/2016

30/12/2015 00 UTC + ...



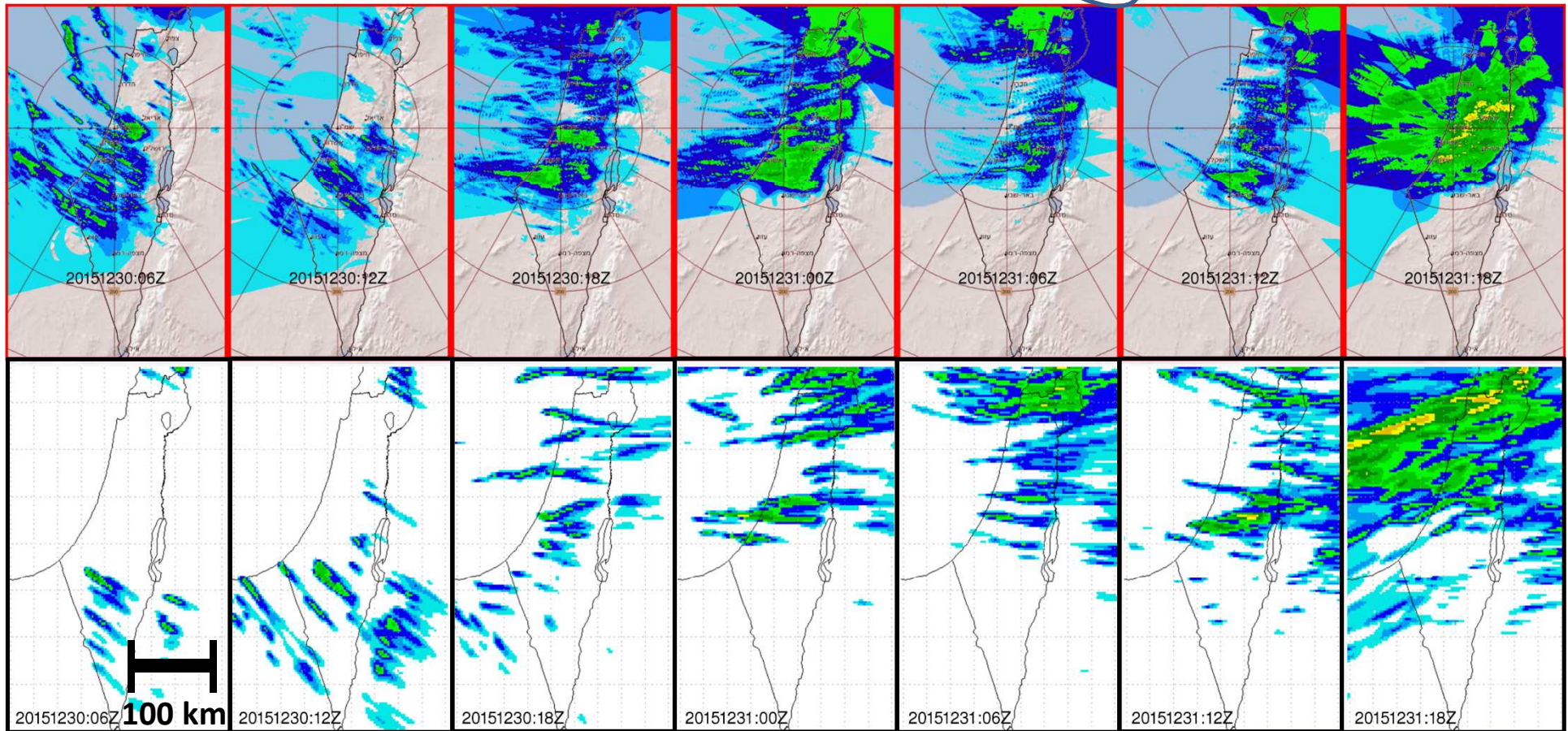
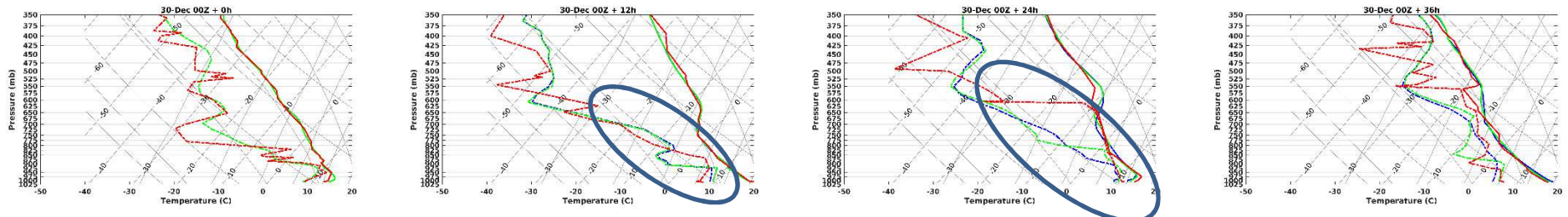
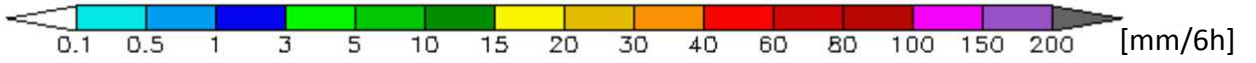
Shallow convection OFF

30/12/2015 00 UTC + ...



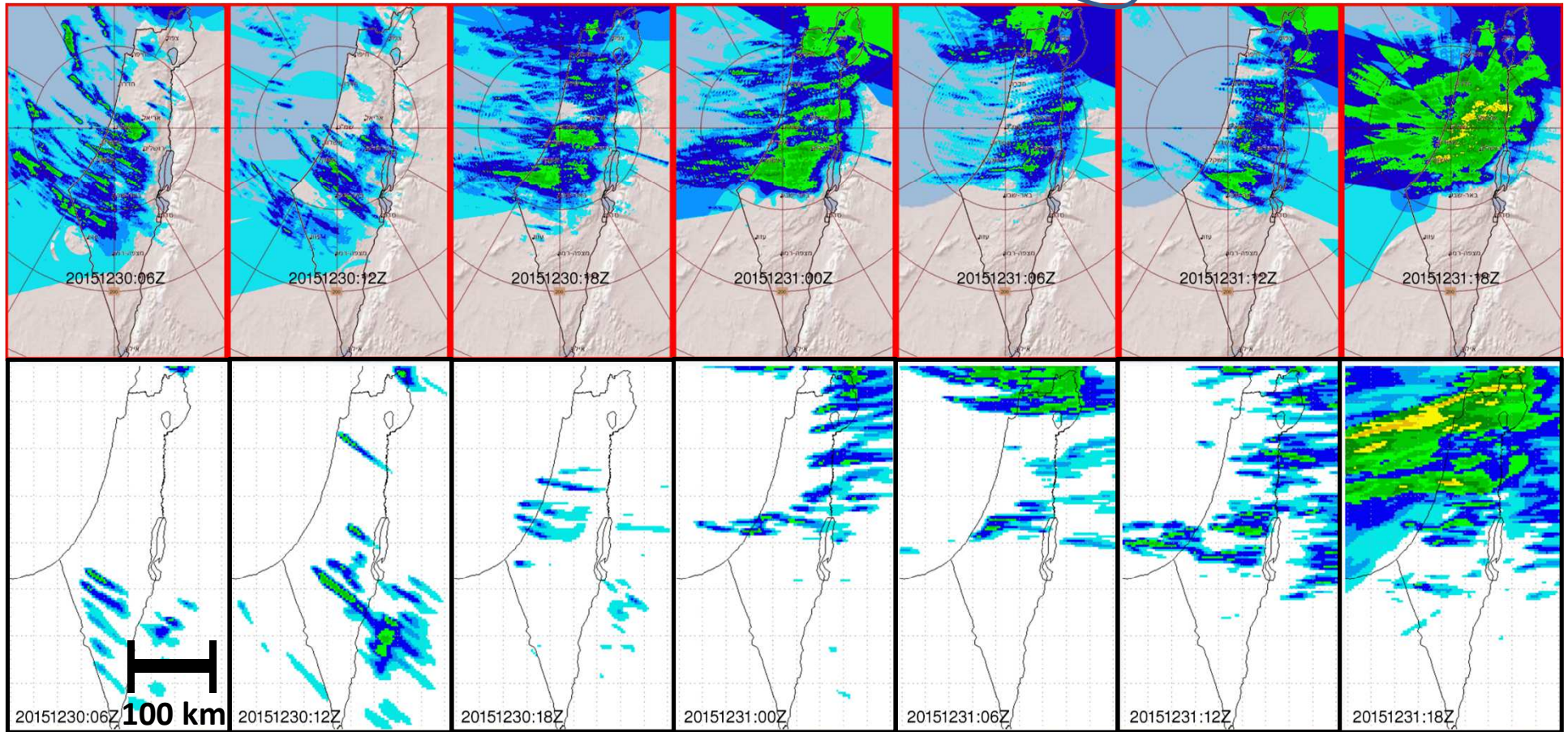
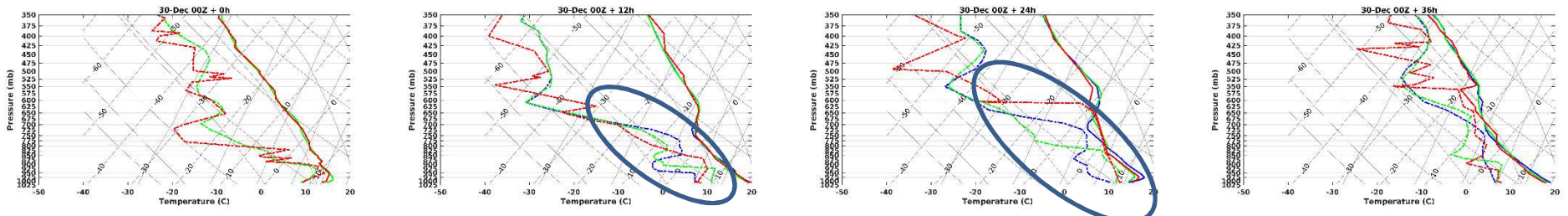
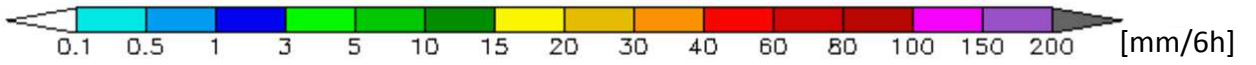
100 hPa thickness ; weak humidity transport

30/12/2015 00 UTC + ...



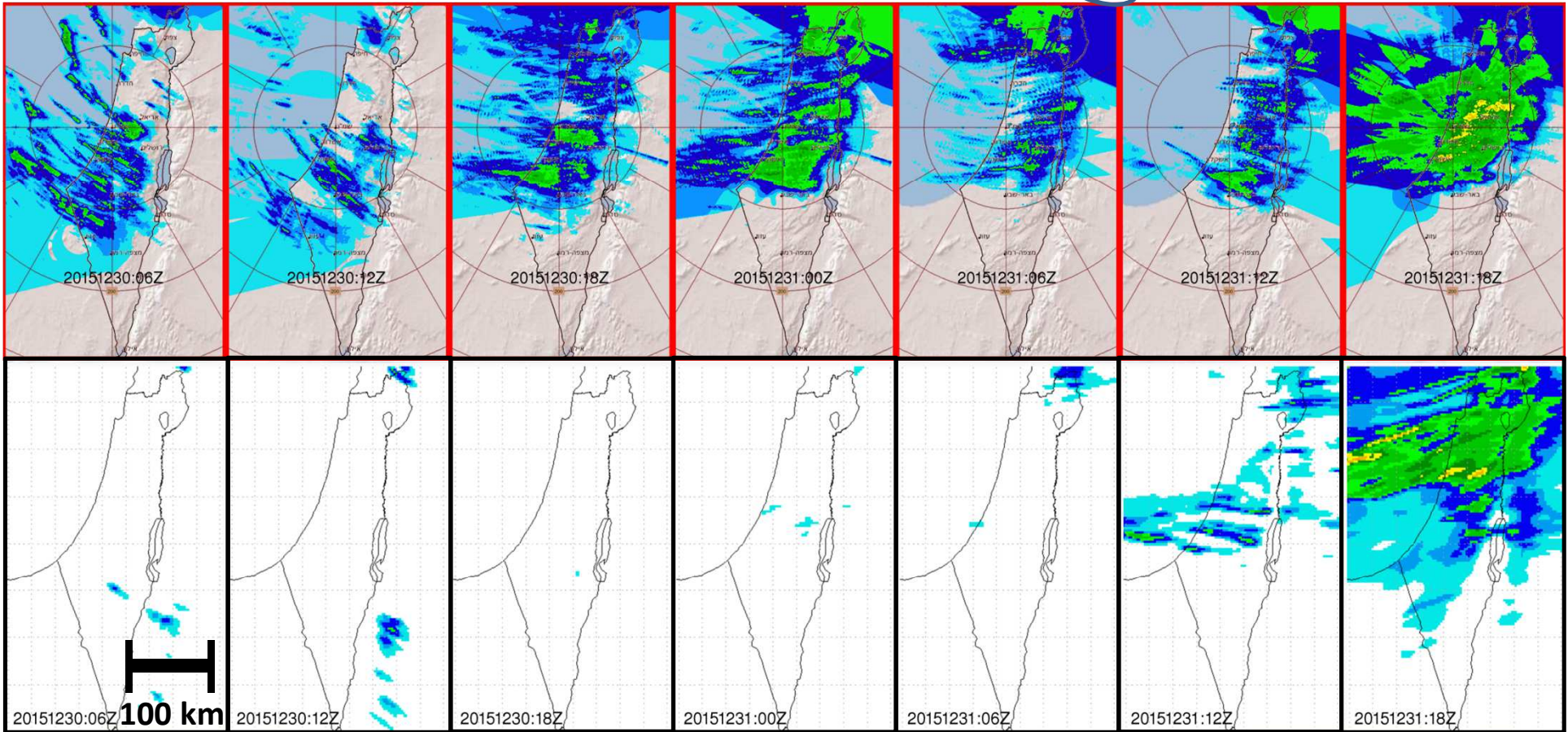
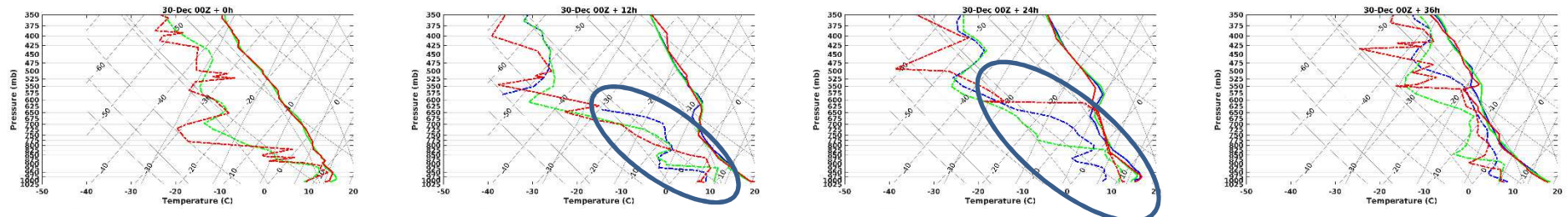
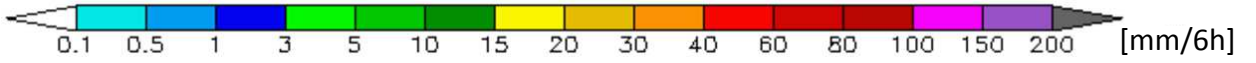
100 hPa thickness ; moderate humidity transport

30/12/2015 00 UTC + ...



100 hPa thickness ; strong humidity transport

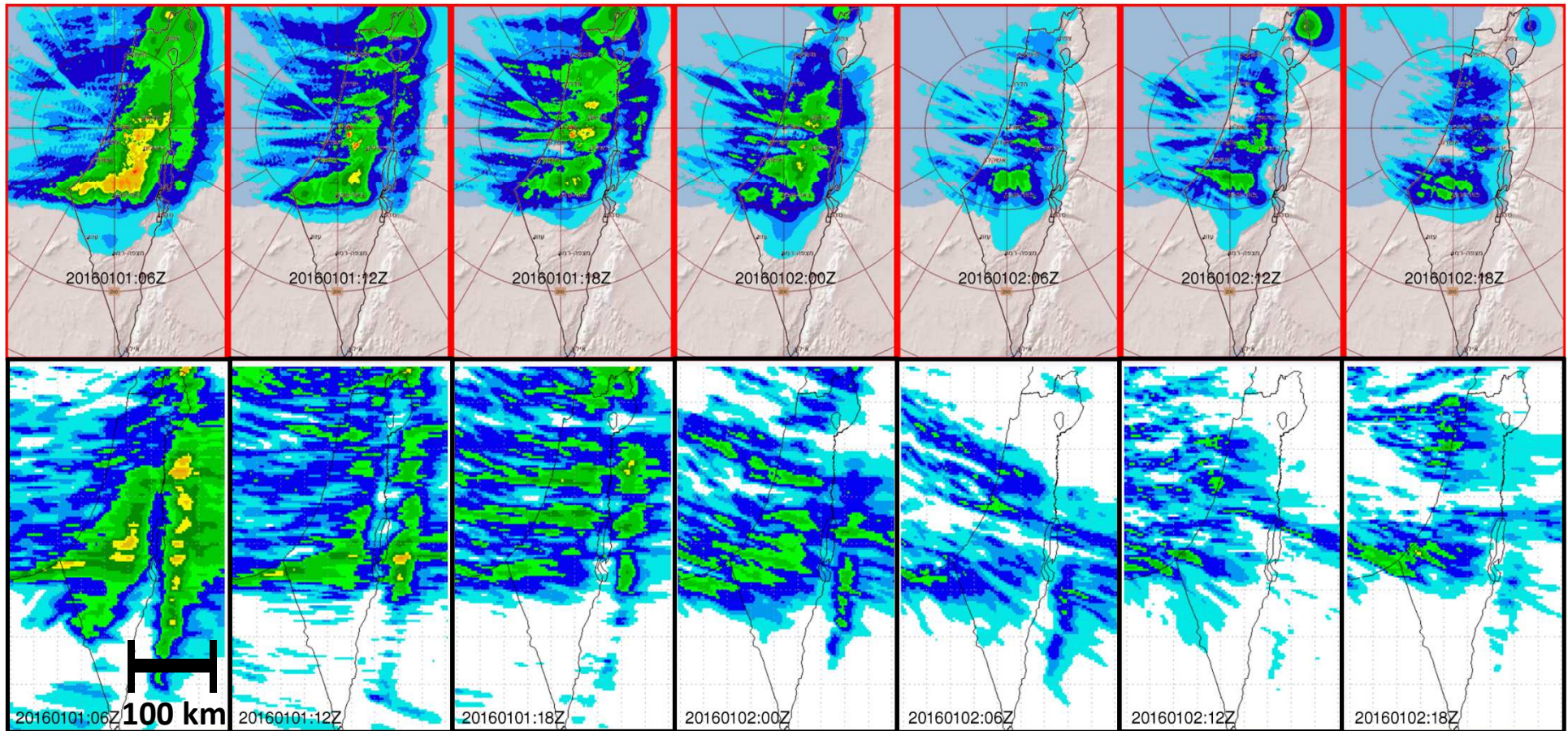
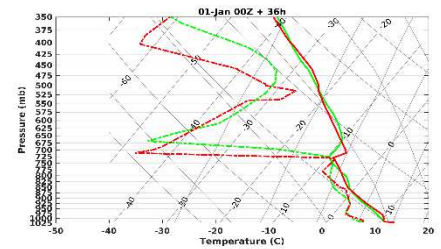
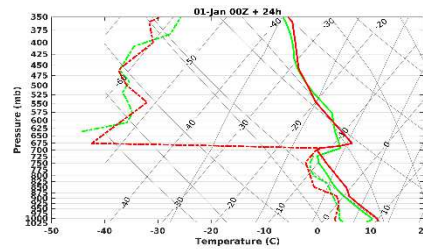
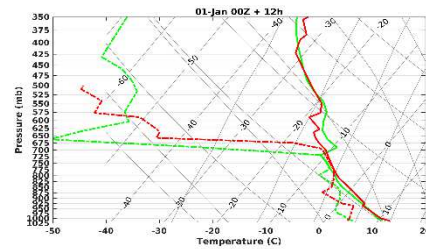
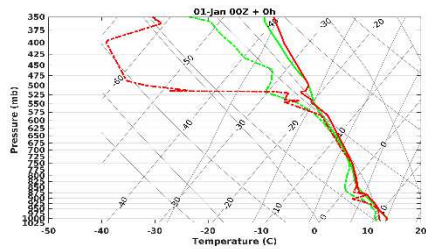
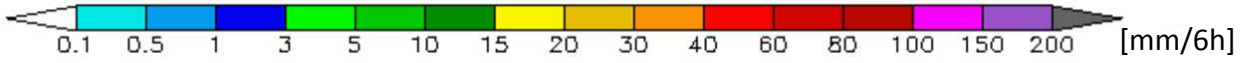
30/12/2015 00 UTC + ...



250 hPa thickness ; moderate humidity transport

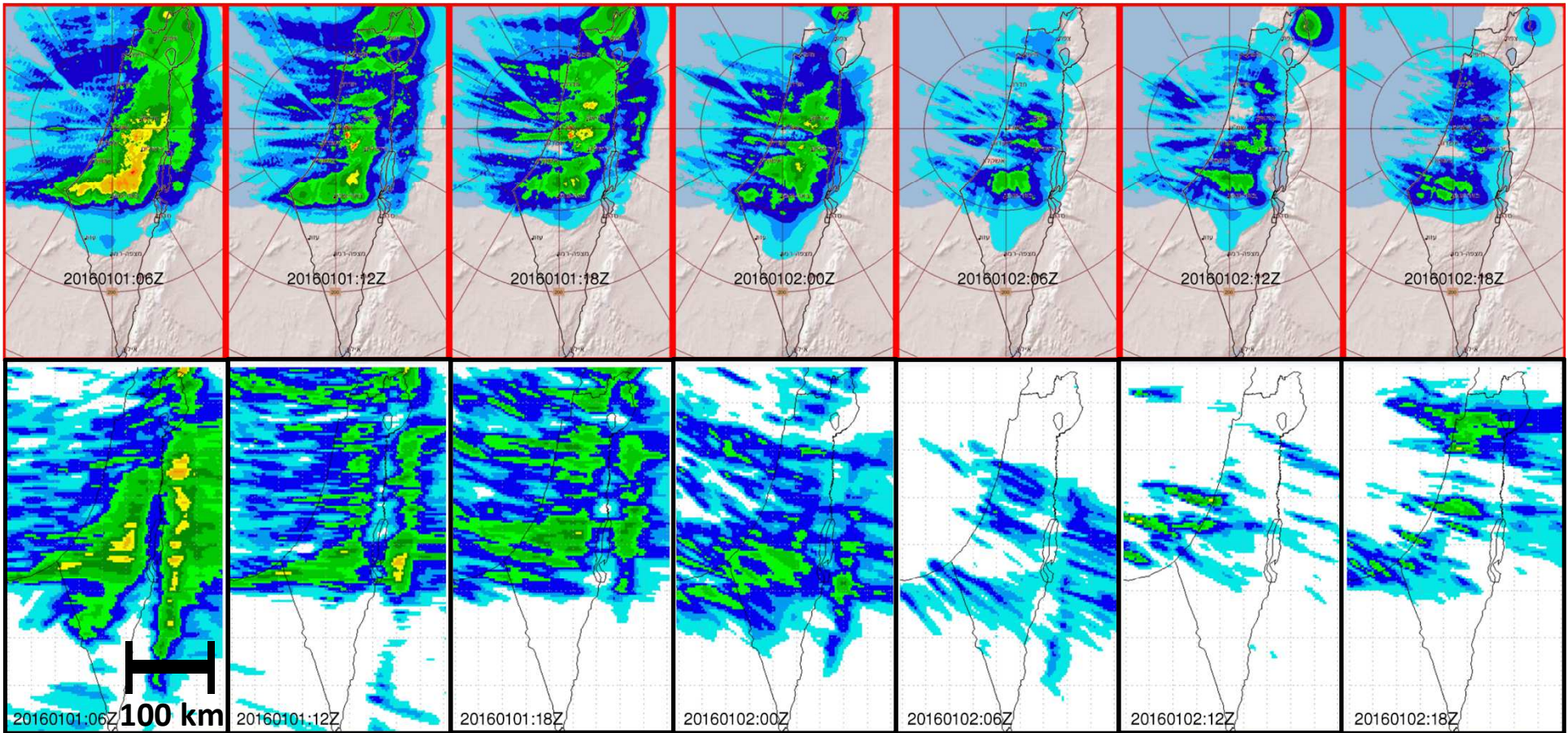
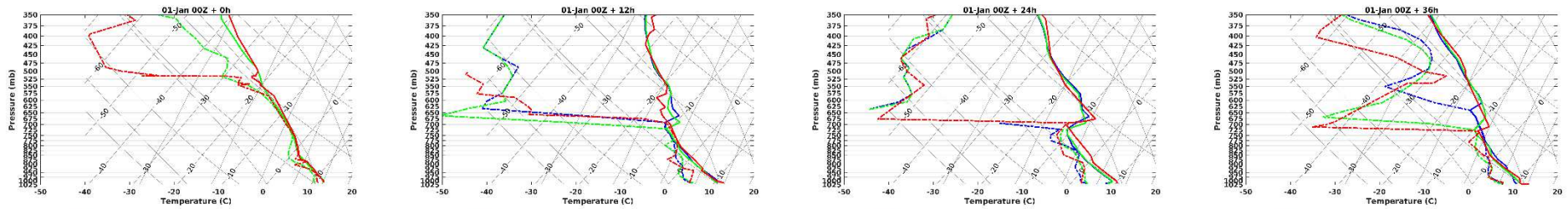
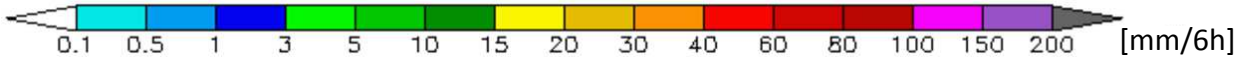
***default**

01/01/2016 00 UTC + ...



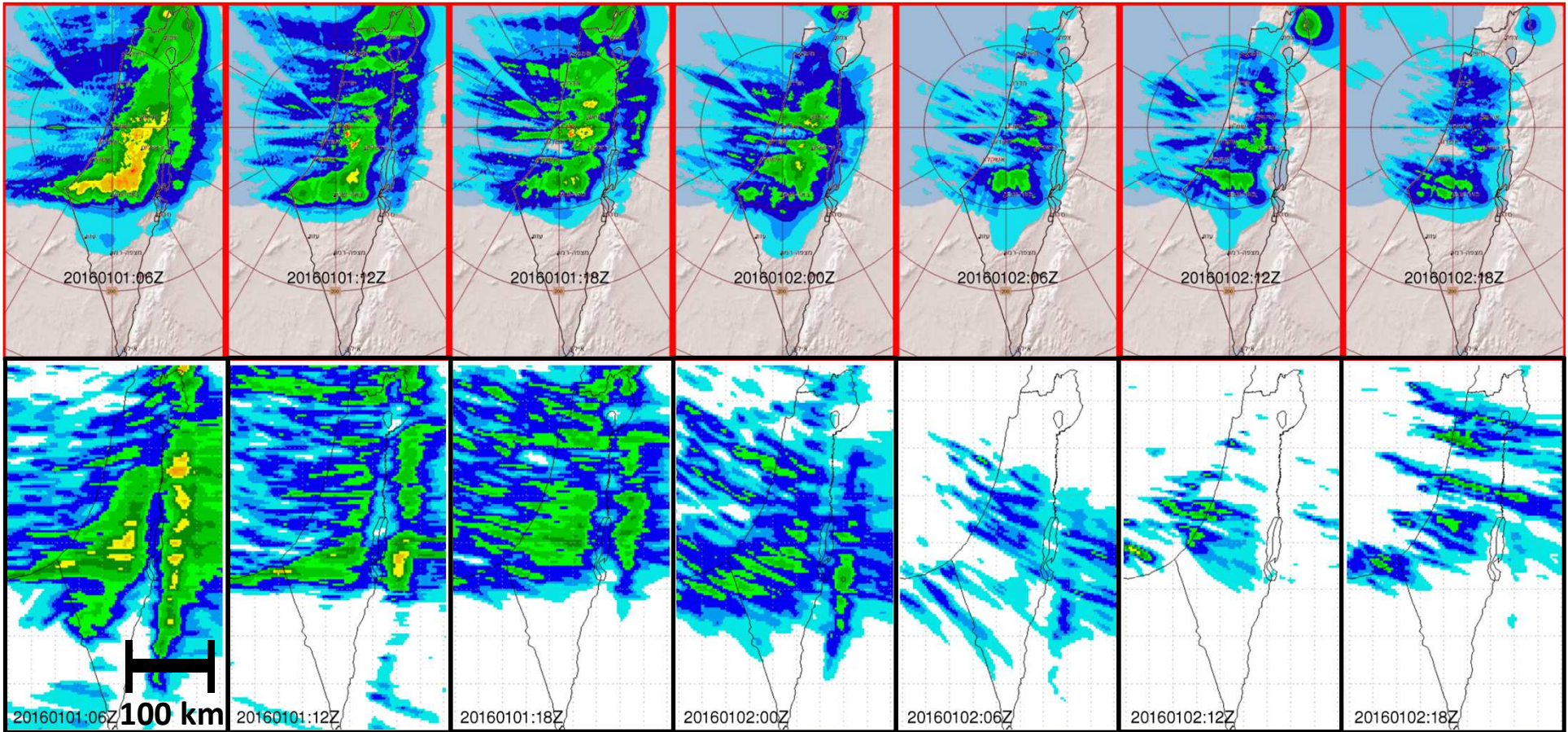
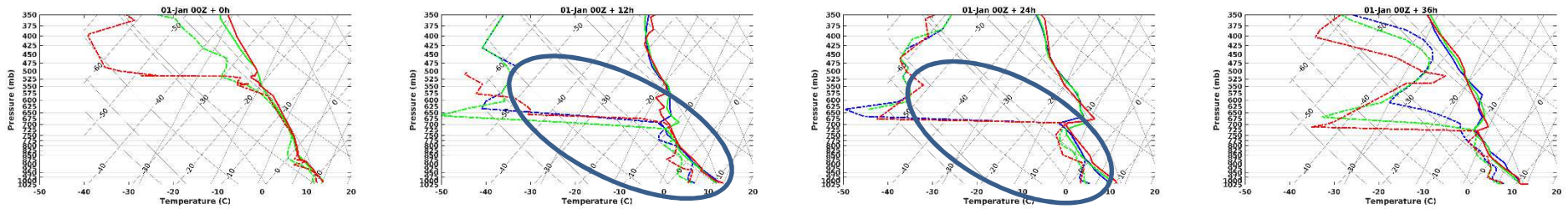
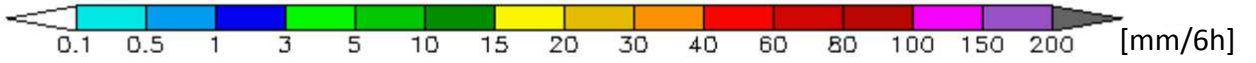
Shallow convection OFF

01/01/2016 00 UTC + ...



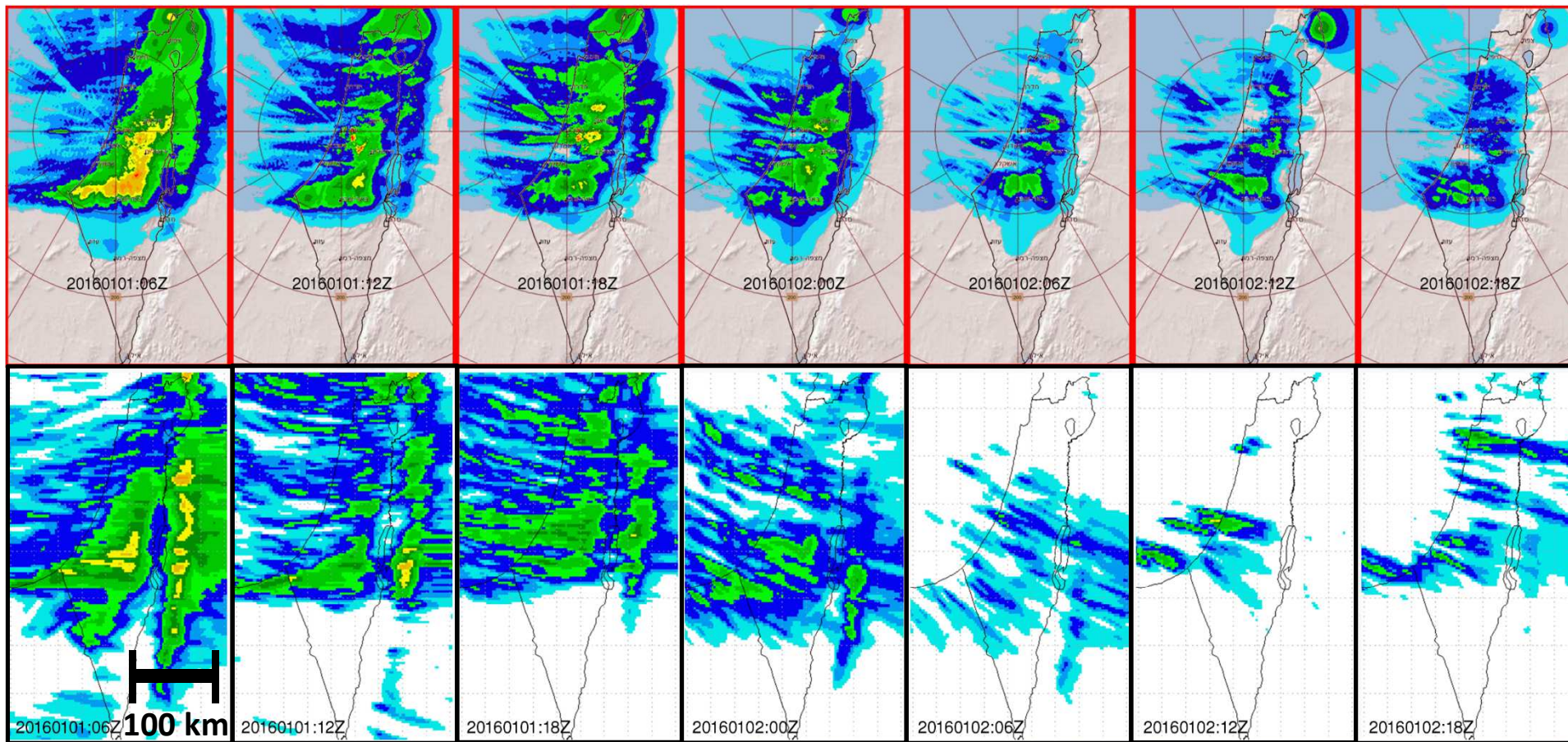
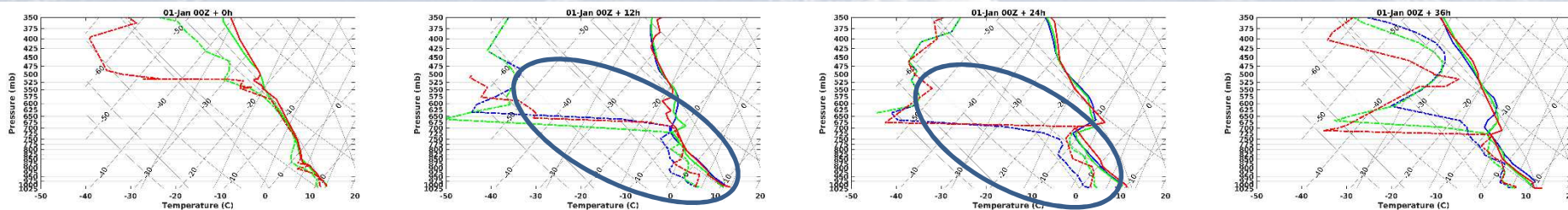
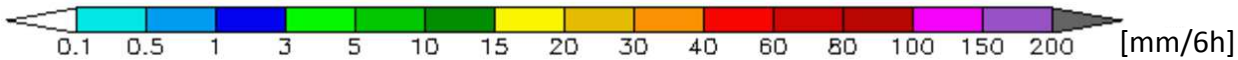
100 hPa thickness ; weak humidity transport

01/01/2016 00 UTC + ...



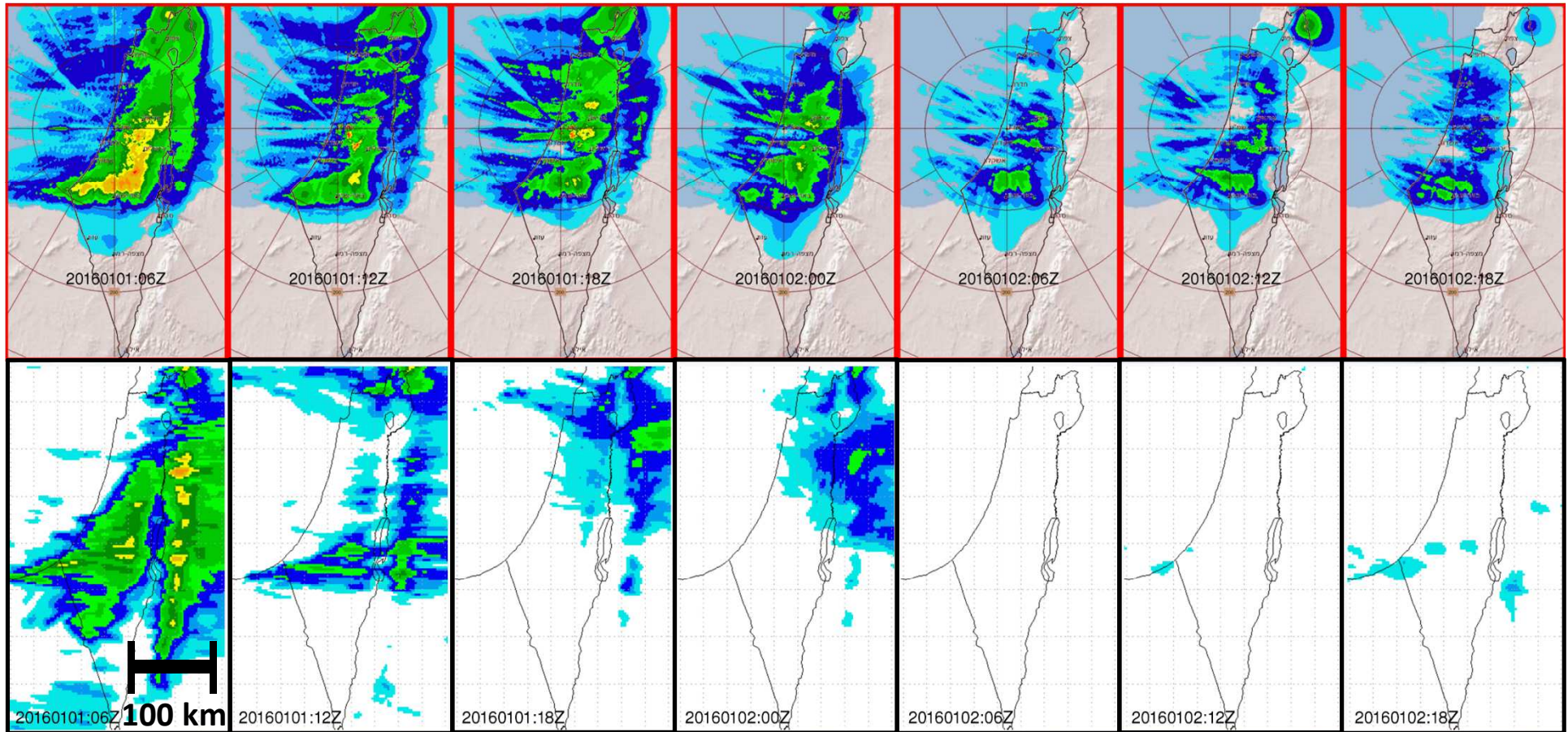
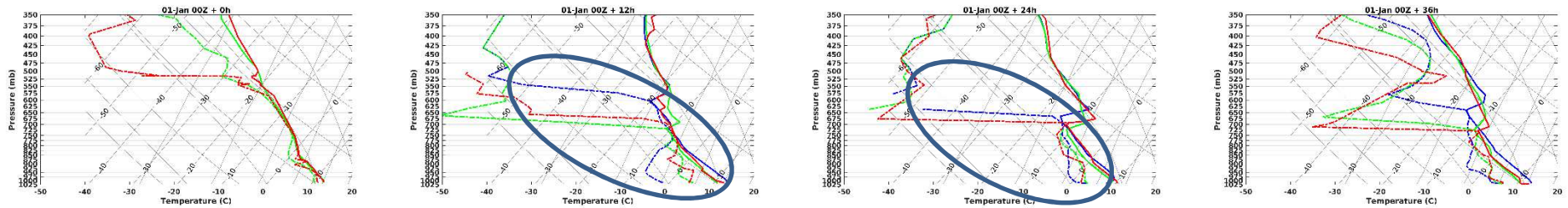
100 hPa thickness ; moderate humidity transport

01/01/2016 00 UTC + ...



100 hPa thickness ; **strong** humidity transport

01/01/2016 00 UTC + ...



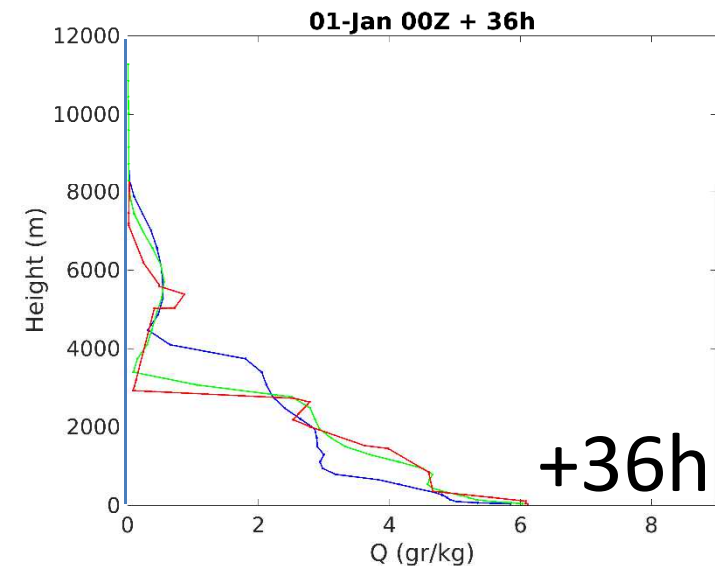
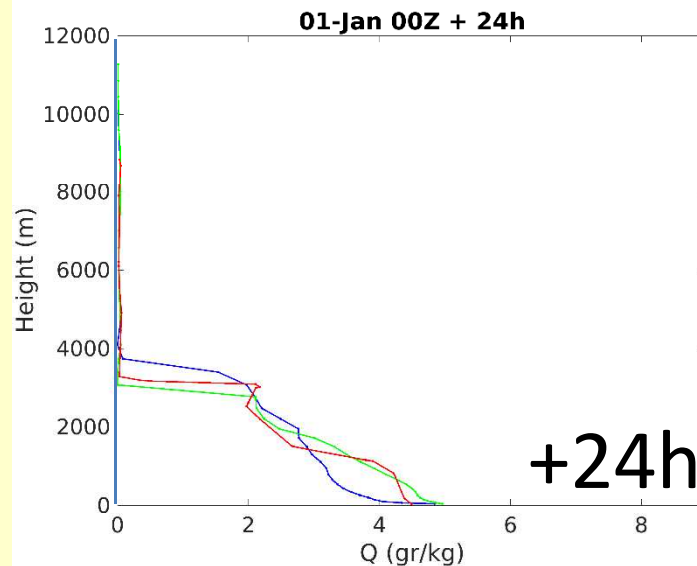
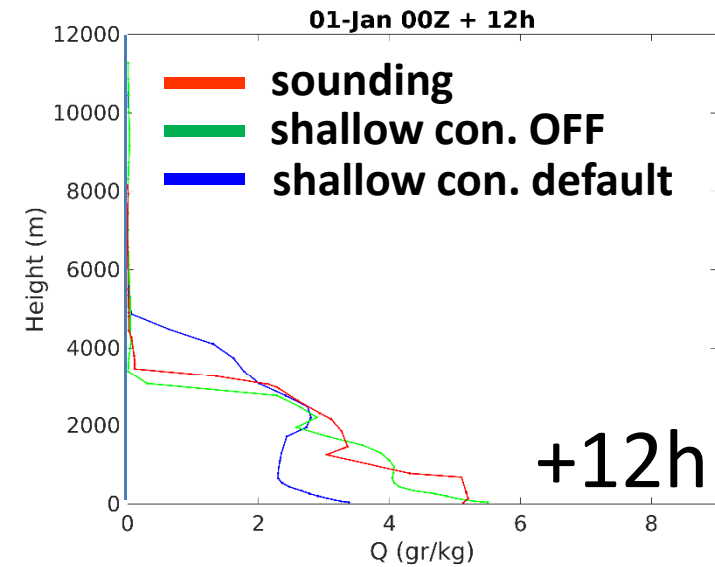
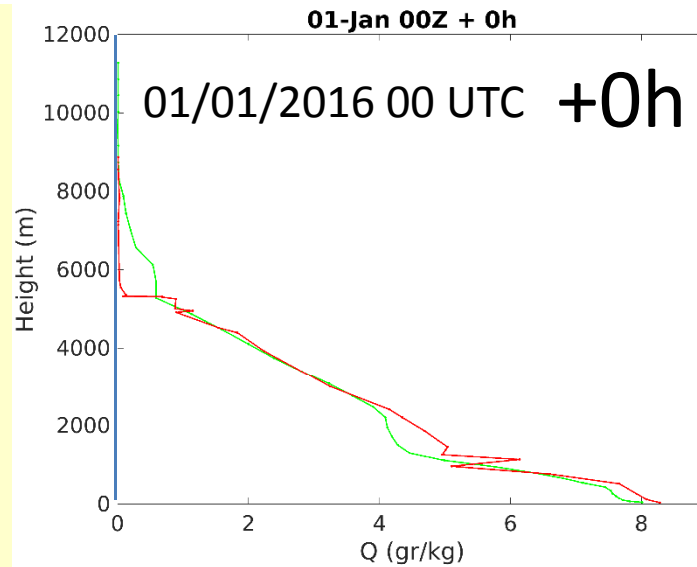
250 hPa thickness ; moderate humidity transport

***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 than
"Shallow
convection OFF"

Worse than
"Shallow
convection OFF"



	30/12/2015 00 UTC + ...	01/01/2016 00 UTC + ...
<p>250 hPa thickness ; moderate humidity transport *default</p>	<p>Average score: -20.1</p>	<p>Average score: -77.2</p>
<p>100 hPa thickness ; strong humidity transport</p>	<p>Average score: -11.9</p>	<p>Average score: -44.3</p>
<p>100 hPa thickness ; moderate humidity transport</p>	<p>Average score: -4.8</p>	<p>Average score: -43</p>
<p>100 hPa thickness ; weak humidity transport</p>	<p>Average score: -3</p>	<p>Average score: -42.4</p>

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 $\sim 1\text{m/s}$

Alternatively: Steef Boing et al. 2017 (submitted)

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

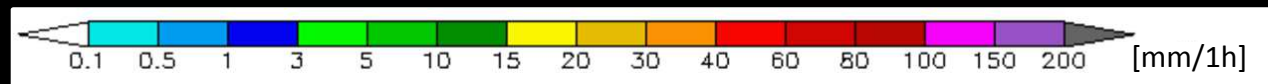
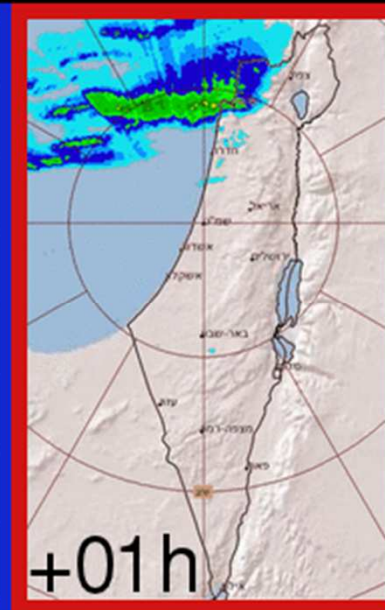
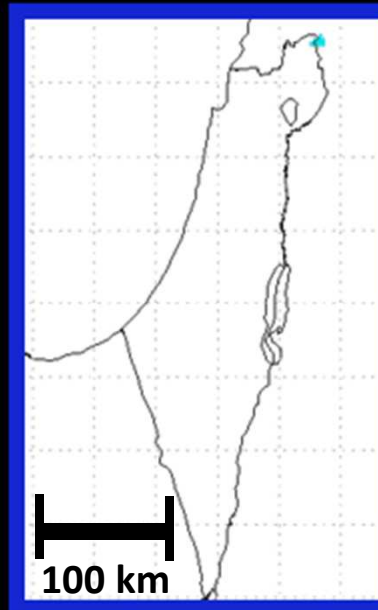
Rain forecast improved dramatically!

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

Example: forecast from 13/12/2016 00 UTC

COSMO

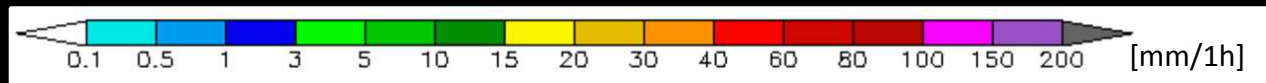
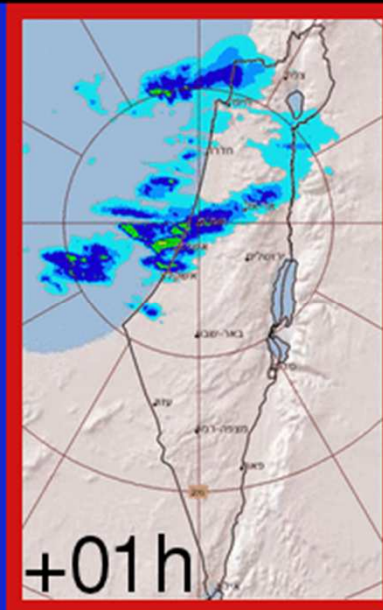
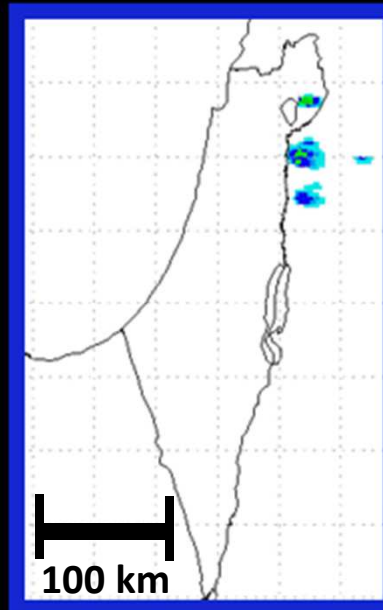
RADAR



Example: forecast from 17/12/2016 00 UTC

COSMO

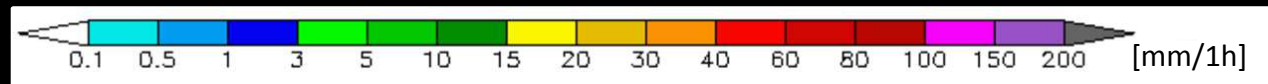
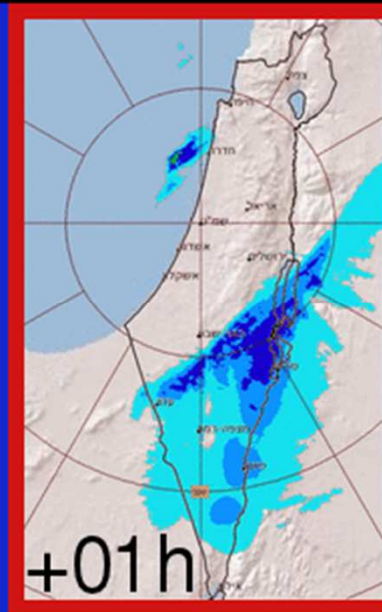
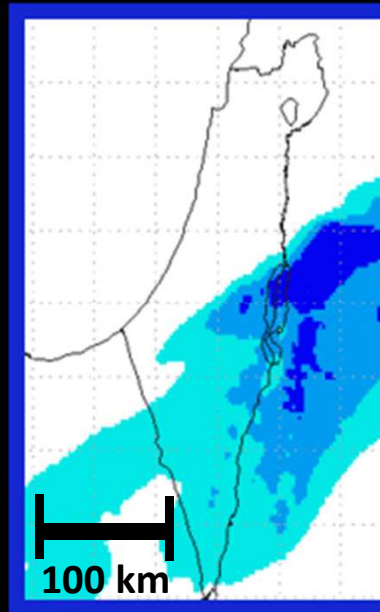
RADAR



Example: forecast from 24/12/2016 00 UTC

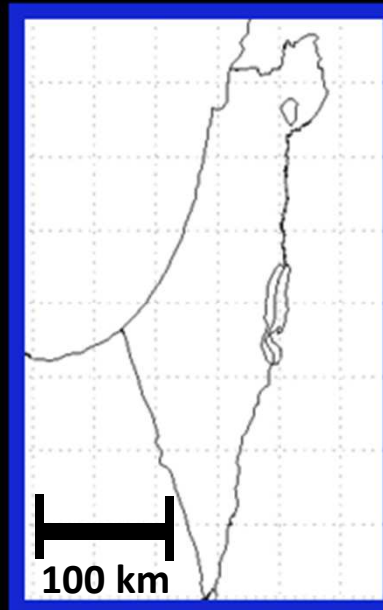
COSMO

RADAR

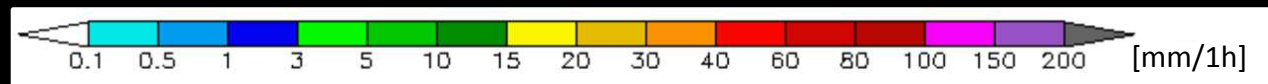


Example: forecast from 07/01/2017 00 UTC

COSMO



RADAR





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



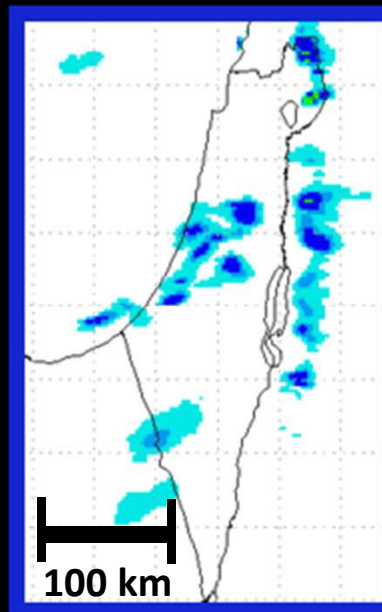
**This is the end of
Pavel's talk, thank you
dear colleagues!**

An aerial photograph showing a large, circular, light-colored area, possibly a crater or a large body of water, surrounded by darker, textured terrain. The central area is bright and somewhat hazy, while the surrounding terrain is darker and more detailed, showing various textures and patterns. The overall scene is captured from a high angle, looking down on the landscape.

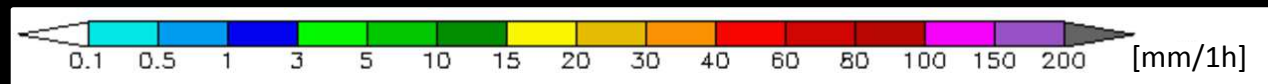
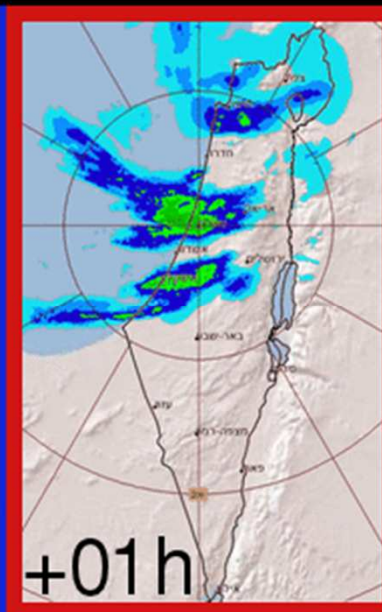
Additional slides ...

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

COSMO



RADAR



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)

