Storm Environment Studies with IASI L2 Data

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Introduction and motivation

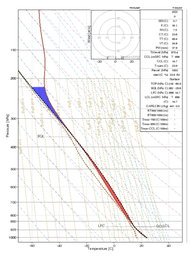
Since the end of 2017 temperature and water vapour profiles are available 30 minutes after sensing time from IASI (Infrared Atmospheric Sounding Interferometer) measurements onboard Metop satellites.

The Meteosat Third Generation Sounder (MTG-S) satellite will have a IASI like instrument onboard, IRS (Infrared Sounder) providing temperature and humidity profiles every half an hour over Europe in cloud free conditions. IASI L2 data can be tested to get prepared for IRS applications. It allows us to study the nature of the profiles and the possibilities.

IASI L2 EARS data

IASI
AMSU
MHS
AVHRR
L1

→ PWLR^3
Statistical retrieval
ALL SKY



T, Td profiles
Quality indicators

✓Small vertical structures of the profile have no effect on the radiances at the top of atmosphere.
✓Sensitivity and vertical resolution is lower near the surface.

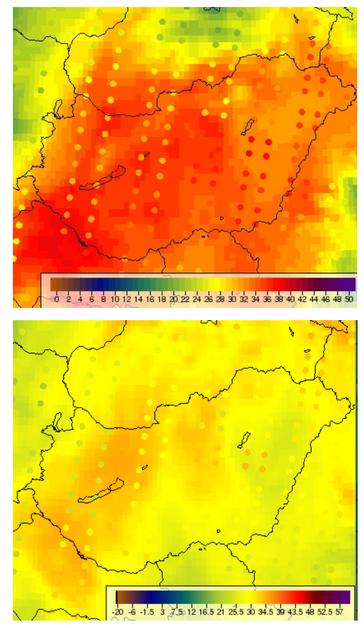
↓

Smoother profiles

IASI instability indices

✓TPW
✓K-Index
✓Best lifted index
✓MLCAPE/MUCAPE
✓Lapse rate
- ➢400-700 hPa
- ➢600-925 hPa

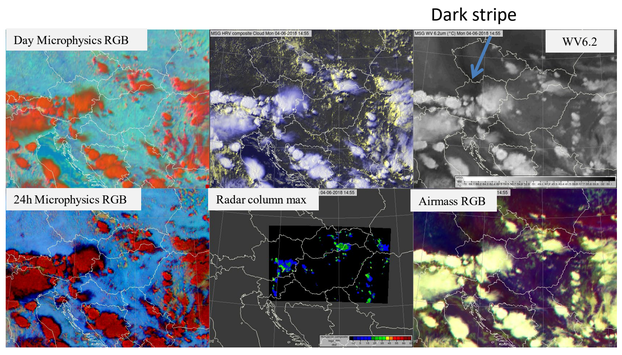
✓Maximum Buoyancy



Examples for TPW (upper) and K-Index (lower)

Case study – 04.06.2018

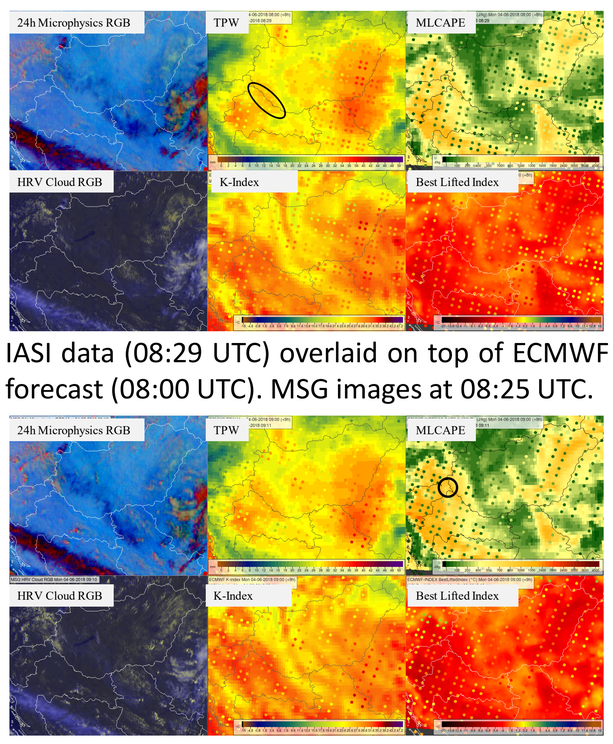
Thunderstorm were expected over Hungary – warm, moist airmass was present with no fronts.
In south-western Hungary less thunderstorms formed than expected.



The weather situation at 14:55 UTC

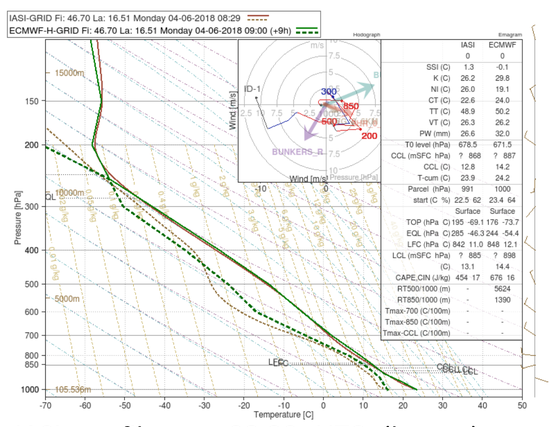
IASI and ECMWF instability indices

Over South west Hungary IASI indicates less moister and less instable environment.
IASI TPW (26.6mm) is lower than ECMWF TPW (~32mm).
The ECMWF Td is much higher in the mixing layer. That is why the ECMWF MLCAPE is significantly higher.



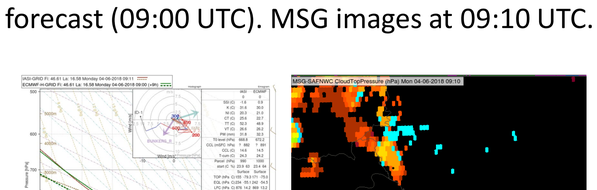
IASI data (08:29 UTC) overlaid on top of ECMWF forecast (08:00 UTC). MSG images at 08:25 UTC.

IASI data (09:11 UTC) overlaid on top of ECMWF forecast (09:00 UTC). MSG images at 09:10 UTC.



IASI profiles at 08:29 UTC (brown) over southwest Hungary, ECMWF forecast at 08:00 UTC (green).

IASI MLCAPE has high values at 09:11 UTC where a storm developed (marked with circle) while in the east it was low but storms developed there anyway. NWCSAF Cloud Top Pressure product support the IASI profile. Both indicate the cloud around 800 hPa.

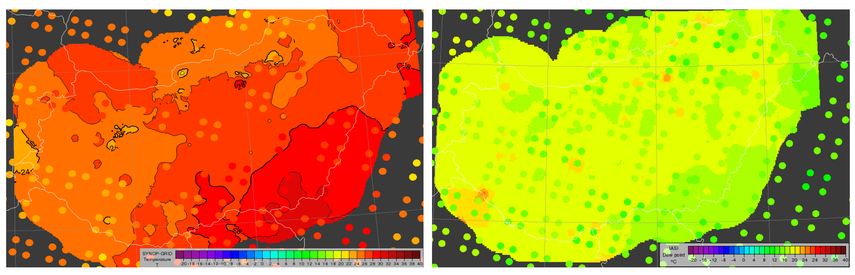


The IASI (brown) profiles at 09:11 UTC over southwest Hungary, ECMWF (green) forecast at 09:00 UTC (left), the NWCSAF Cloud Top Pressure at 09:10 UTC (right).

Merging with synop

The IASI profiles have larger uncertainties at low levels, they are often drier below than indicated by the model profiles or synop measurements at the surface.

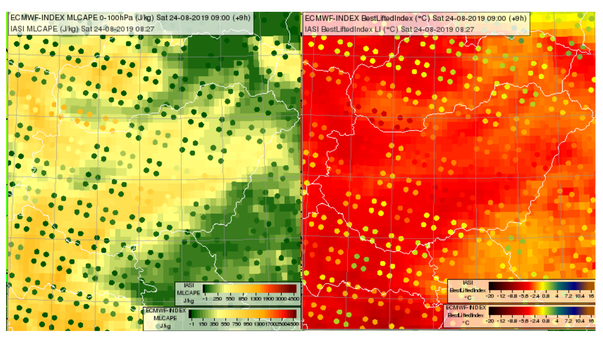
→ Would merging with synop help?



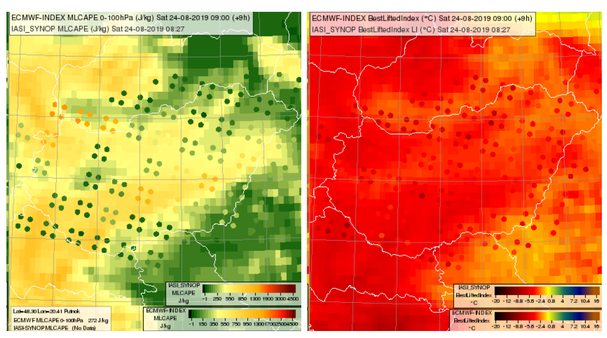
Differences between the synop measurements and retrieved IASI temperatures at 2m are up to 3 °C (for Td).

IASI temperature (left) and dew point (right) at 2m (24.08.2019 08:27 UTC) overlaid on top of interpolated synop data(08:30 UTC).

The IASI instability indices show very often smaller values than models. These indices depends very much on the low level temperature and moisture.

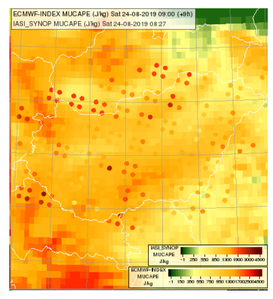


IASI MLCAPE (left) and Best Lifted Index (right) at 24.08.2019. 08:27UTC overlaid on top of ECMWF forecast at 09:00.



IASI+Synop MLCAPE (left) and Best Lifted Index (right) at 24.08.2019. 08:27UTC overlaid on top of ECMWF forecast at 09:00.

Combining the IASI profiles with synop measurements can improve indices which more dependent on the 2 m values. MLCAPE is dependent in the lowest 100 hPa layer which is still often dryer than the models. Using MUCAPE might be a better choice.



IASI+Synop MUCAPE at 24.08.2019. 08:27UTC overlaid on top of ECMWF forecast at 09:00.

Conclusion

IASI L2 EARS data is shown to be valuable proxy data for MTG IRS. The profiles are available 30 minutes after sensing which makes them possible to be used in nowcasting/forecasting.
Very often IASI profiles indicate less moisture in the low layers than ECMWF, which results in the instability indices showing more stable conditions than the model. Merging the IASI data with synop measurements seems to have a rather positive effect on the indices, especially on the ones more dependent on the 2 meter values.

Acknowledgement

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