



Practical use of NWC SAF Products in high impact weather in CIS countries

**Training event on satellite monitoring and nowcasting
of high impact weather events for
National Hydrometeorological Services of CIS countries
Moscow & Balashikha, Russia - June 2019**

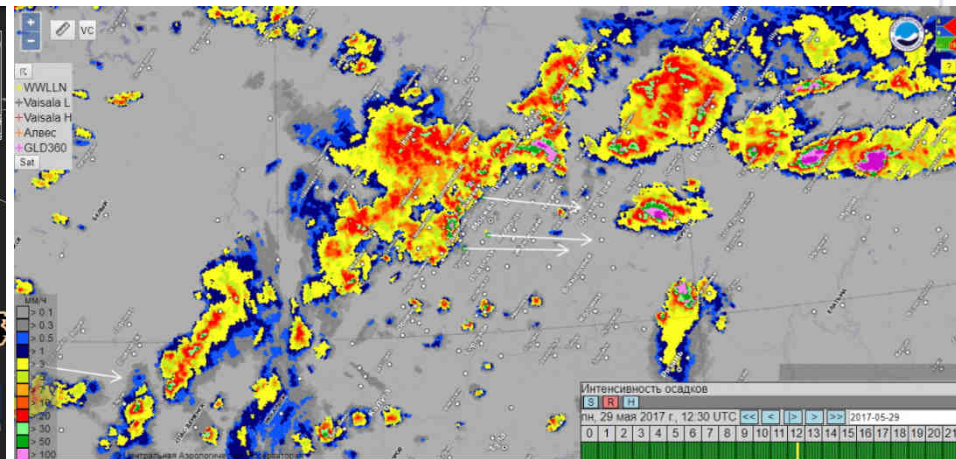
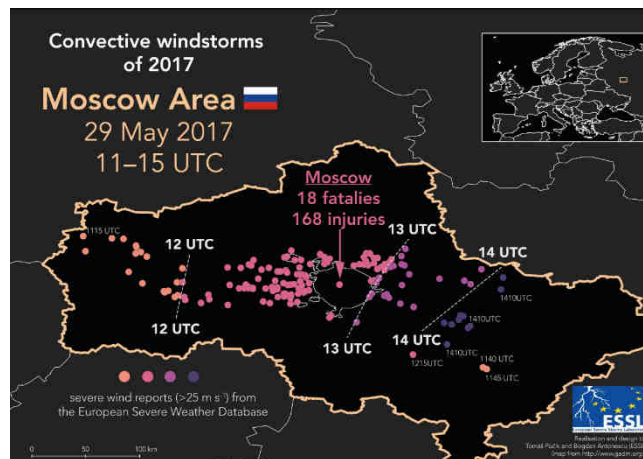
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with contributions by
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Case studies

- **Six case studies** are going to be considered in this session:
 - **Convection in Moscow, 29 May 2017.**
 - **Convection in Barnaul, 23 June 2018.**
 - **Large size hail case in Glazov, 3 July 2018.**
 - **Strong wind in Izhevsk (24 m/s), 4 July 2018.**
 - **Heavy rainfall in Volgograd, 15 July 2018.**
 - **Meteorological Analysis for flight accident in Moscow, 5 May 2019.**
- For all these case studies,
we will check **how “NWC SAF products” can help us
in the weather monitoring and nowcasting.**

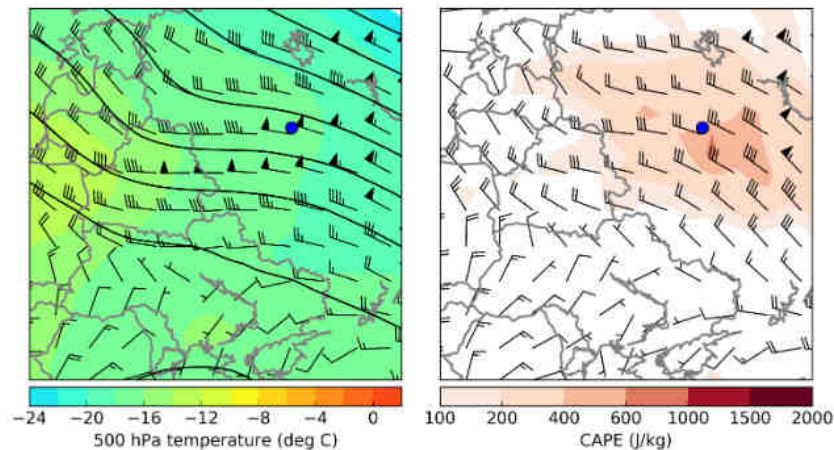
Case 1: Convection in Moscow 29/05/17

- The “European Severe Storm Laboratory (ESSL)” made a summary analysis of this first case:
(<https://www.essl.org/cms/convective-windstorms-in-2017-episode-1-29-may>):
 - **Largest impact for a convective event in Europe in 2017**
(18 fatalities, 168 injuries, economic loss of 25 M rubles).
 - **Wind damage** start at 11Z, maturity at 12-13Z, decay after 14Z.
 - **A linearly oriented convective system, not particularly large, without very high reflectivity values, without “bow-echo” structure, without lightning activity in the southern part of the system**
(➔ phenomena normally related to damaging wind gusts/strong updrafts).



Case 1: Convection in Moscow 29/05/17

- Conditions generally unfavourable for a severe weather event:
 - Convective storm formed ahead of an advancing trough.
 - Low buoyancy with CAPE values around 400 J/kg (ERA-Interim).
 - Moderate vertical wind shear (15 m/s for 0-6 km layer).

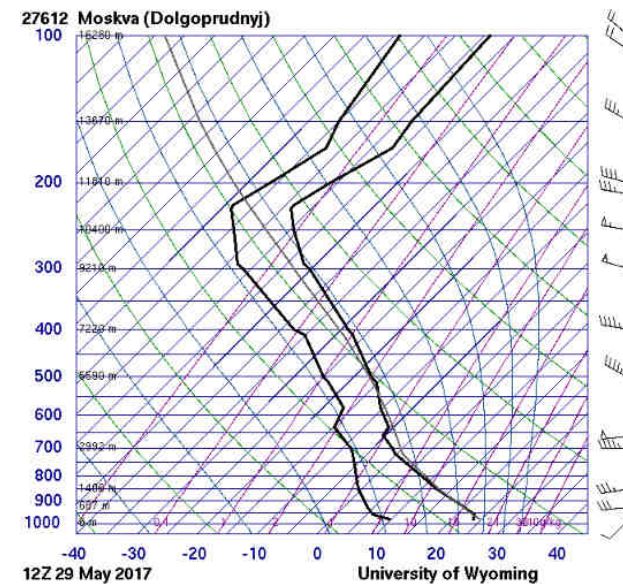


But a combination of:

- Strong flow in low troposphere
- Dry boundary layer

defines conditions for **powerful downdrafts!**

High impact convective wind storms possible in a wide variety of conditions !!



Case 1: Convection in Moscow 29/05/17

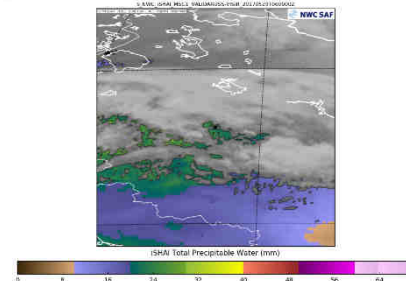


- Are NWC SAF Products able to see these phenomena?
The most useful products can be:
 - iSHAI (for humidity in several layers and stability indices)
 - HRW (for winds)
 - CT/CTTH/CMIC (for cloud evolution)
 - PC/PCPh & CRR/CRPh (for precipitation) ...

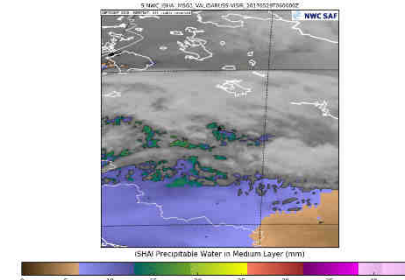
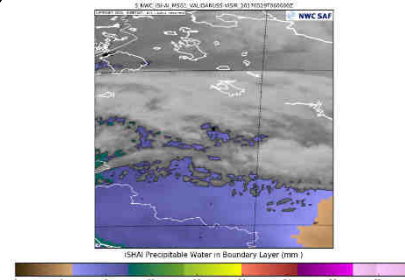
(5-7 minutes for personal analysis of NWC SAF products now...)

Case 1: Convection in Moscow 29/05/17

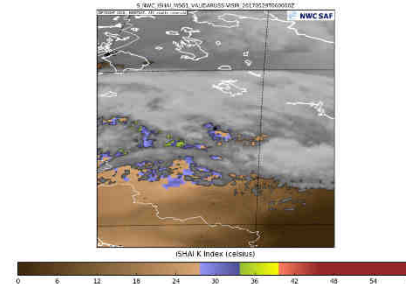
- “NWC SAF iSHAI product” shows moisture in the area with “Total Precipitable Water (tpw)” = 24 mm in the early morning (06Z, 09H local)



- But moisture more significant in the “Middle layer (ml)” (> 12 mm) than in “Boundary layer (bl)” (< 10 mm) → Some signal of “Dry boundary layer”

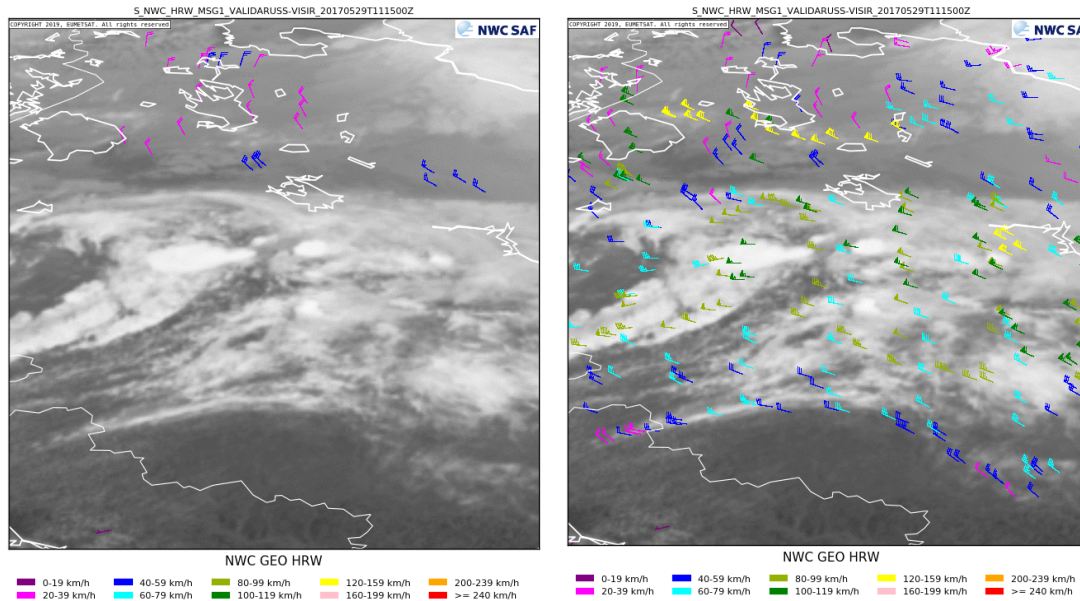


- Instability with “K index (ki)” > 36” in the early morning (06Z, 09H local)



Case 1: Convection in Moscow 29/05/17

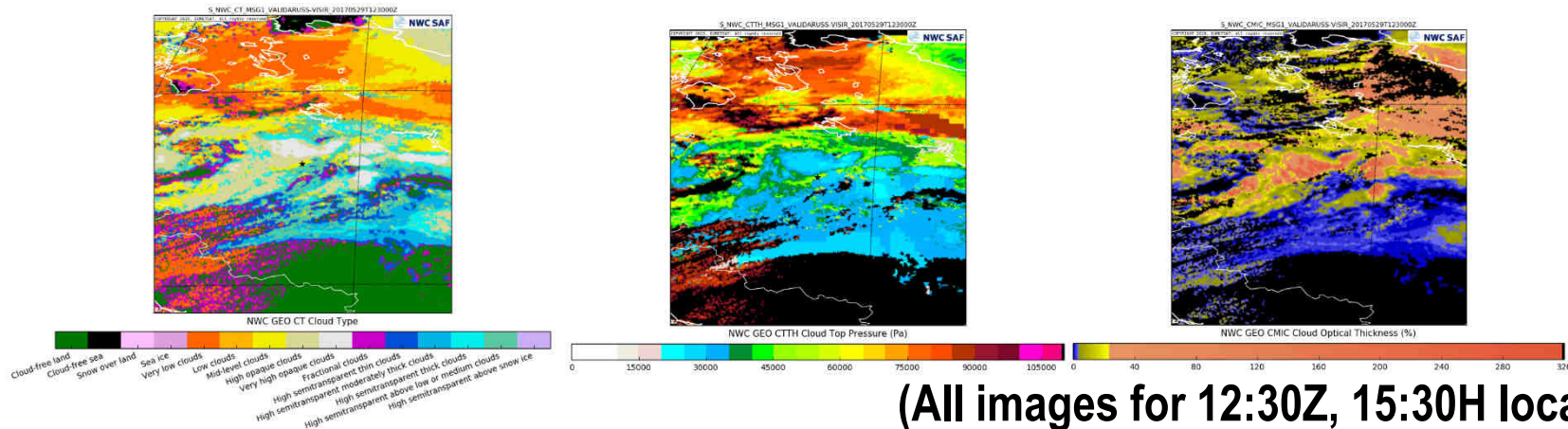
- Observation showed **wind gusts of up to 108 km/h.**
- Considering “HRW product” for winds, **N/NW mean winds up to 55 km/h in 800-100 hPa layer occur (coherent with those gusts) related to low clouds in areas North of Moscow.**
- **Lack of low clouds inhibit low layer wind observations in other areas.**
- **Wind shear is clearly shown comparing winds at all levels.**



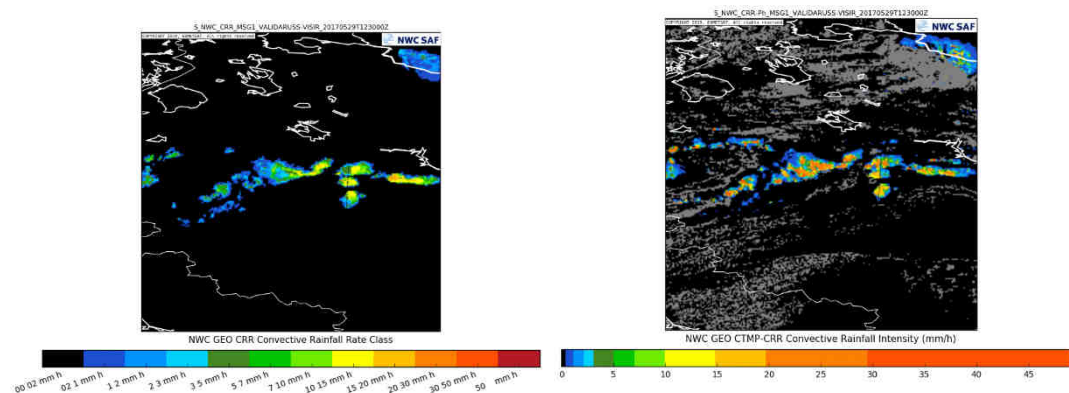
(HRW winds for low levels and all levels for 11:15Z, 14:15H local).

Case 1: Convection in Moscow 29/05/17

- Evolution of cloudiness seen with “Cloud Type (ct)”, “CTTH Cloud top pressure (ctth_pres)” and “CMIC Cloud optical thickness (cot)” products.



- “CRR Precipitation intensity products (crr & crrph)” shows values > 30 mm/h.



Case 2: Convection in Barnaul 23/06/18

- **Big storm in Barnaul/Altai with hail (00-15Z, 07-22H local).
Strong wind with power cuts & many trees fallen; one victim with a crane fall.**



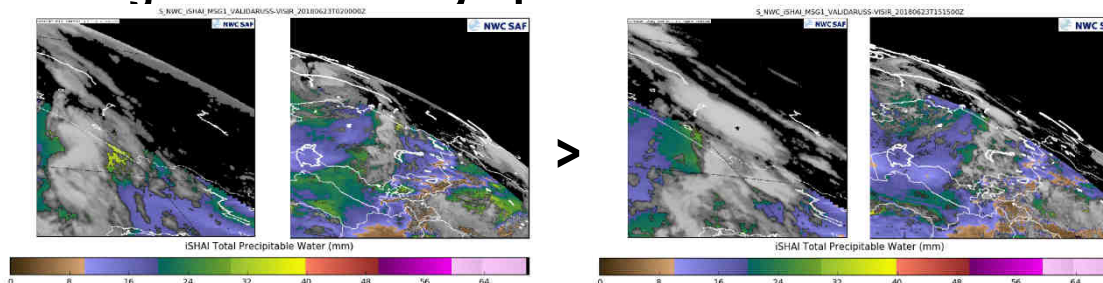
(photos by
“The Siberian Times”)

5-7 minutes for personal analysis of situation with NWC SAF products now:

- **iSHAI (for humidity in several layers and stability indices)**
- **HRW (for winds)**
- **CT/CTTH/CMIC (for cloud evolution)**
- **PC/PCPh & CRR/CRPh (for precipitation)**
- **RDT (for convection evolution) ...**

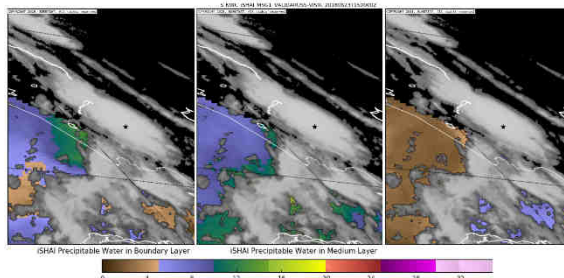
Case 2: Convection in Barnaul 23/06/18

- “NWC SAF iSHAI product” shows very important moisture in the area with “Total Precipitable Water (tpw) ~ 40 mm” from early morning (02Z, 09H local) throughout all the day up to the moment of the storm (15Z, 22H local)



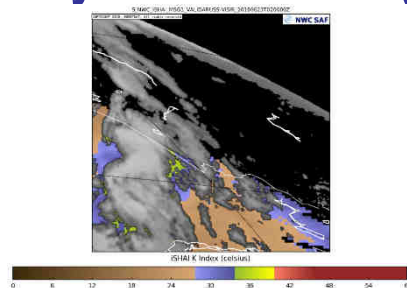
> Moisture flow coming from the SW.

Moisture in “Boundary layer 0-1500 m (bl)” and “Middle layer 1500-5500 m (ml)”



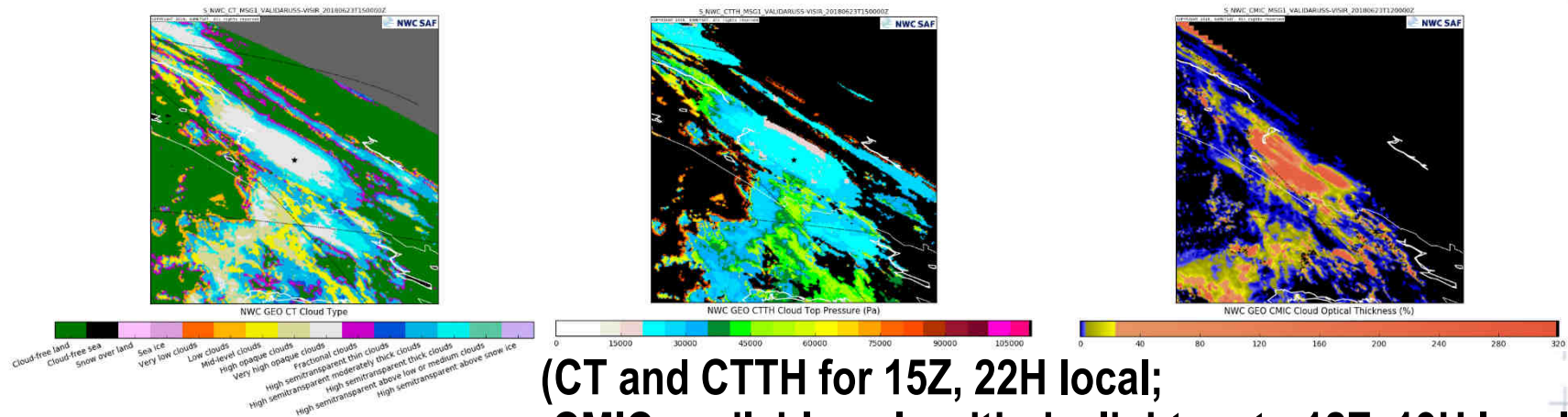
- > “VIL density” $\sim 40 \text{ kg/m}^2 / 11000 \text{ m} = 3.6 \text{ g/m}^3$ (with “Severe hail threshold” = 3.5 g/m^3 !).
- > SW moisture flow kept this throughout all day.

Instability with “K index (ki) > 36”, related to the SW flow all the day.



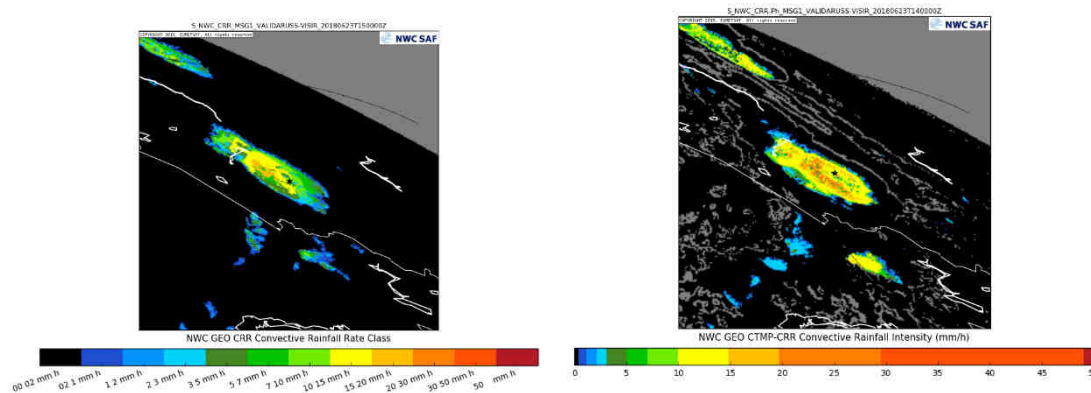
Case 2: Convection in Barnaul 23/06/18

- Evolution of cloudiness seen with “Cloud Type (ct)”, “CTTH Cloud top pressure (ctth_pres)” and “CMIC Cloud optical thickness (cot)” products during the storm



(CT and CTTH for 15Z, 22H local;
CMIC available only with daylight up to 12Z, 19H local)

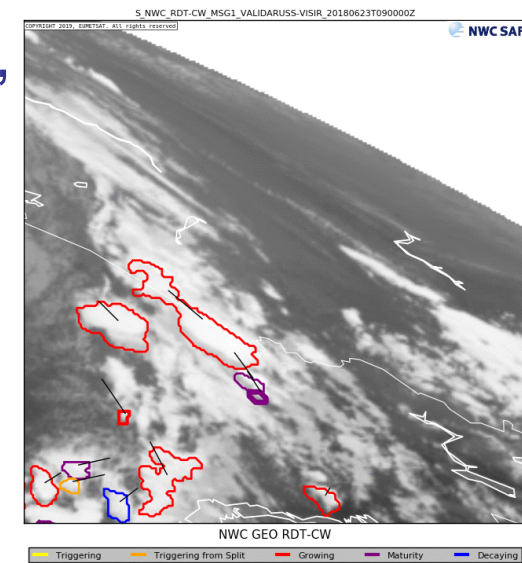
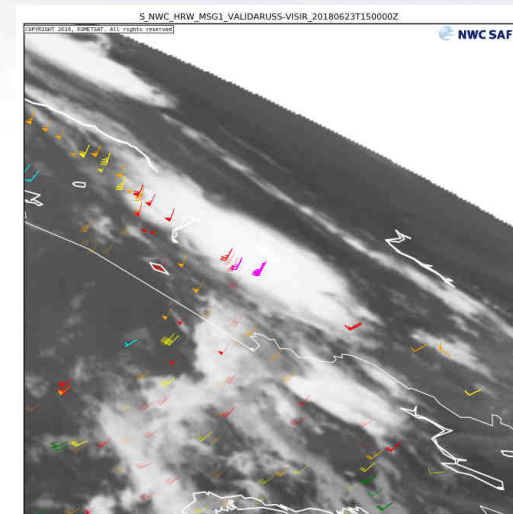
- “CRR Precipitation intensity products (crr & crrph)” shows values > 30 mm/h.



> With important
precipitation extended
to the whole storm!

Case 2: Convection in Barnaul 23/06/18

- **"HRW product" winds do not provide much information in this case, due to the lack of winds at low levels, and small wind shear in the different levels.**
- **"Rapid Developing Thunderstorms (rdt) product" clearly identifies the Barnaul storm in its early stages of development in the SW (at 09Z, 16H local) although its situation near the "RDT product working edge" avoids any analysis when it reaches the city of Barnaul.**



Case 3: Large hail in Glazov 03/07/18



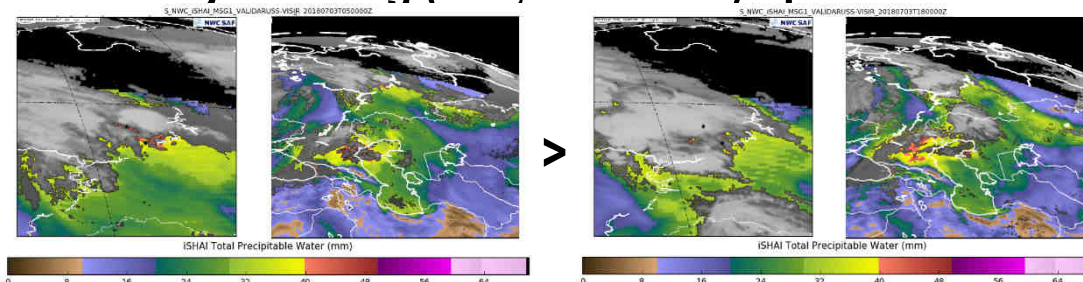
- **Convection in Glazov/Udmurtia**
Convection throughout the whole day,
with large hail in the late evening (18:30-20Z, 22:30-00H local).

5-7 minutes for personal analysis of situation with NWC SAF products now:

- iSHAI (for humidity in several layers and stability indices)
- HRW (for winds)
- CT/CTTH/CMIC (for cloud evolution)
- PC/PCPh & CRR/CRPh (for precipitation)
- RDT (for convection evolution) ...

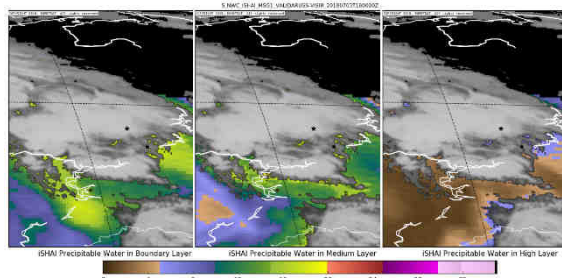
Case 3: Large hail in Glazov 03/07/18

- “NWC SAF iSHAI product” shows very important moisture in the area with “Total Precipitable Water (tpw) up to 45 mm” from early morning (05Z, 09H local) up to the late evening (18Z, 22H local)



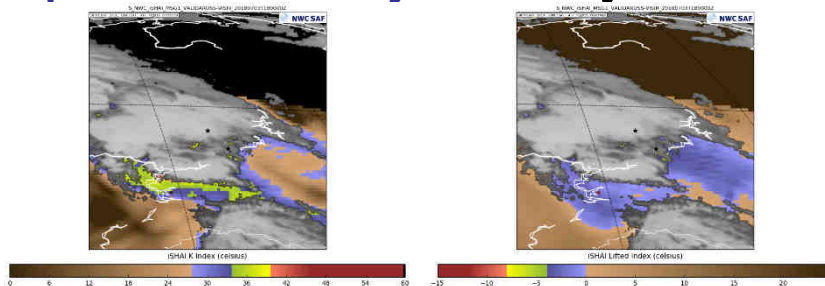
> Important moisture in all Russia West of Urals.

Moisture in “Boundary layer 0-1500 m (bl)” and “Middle layer 1500-5500 m (ml)”



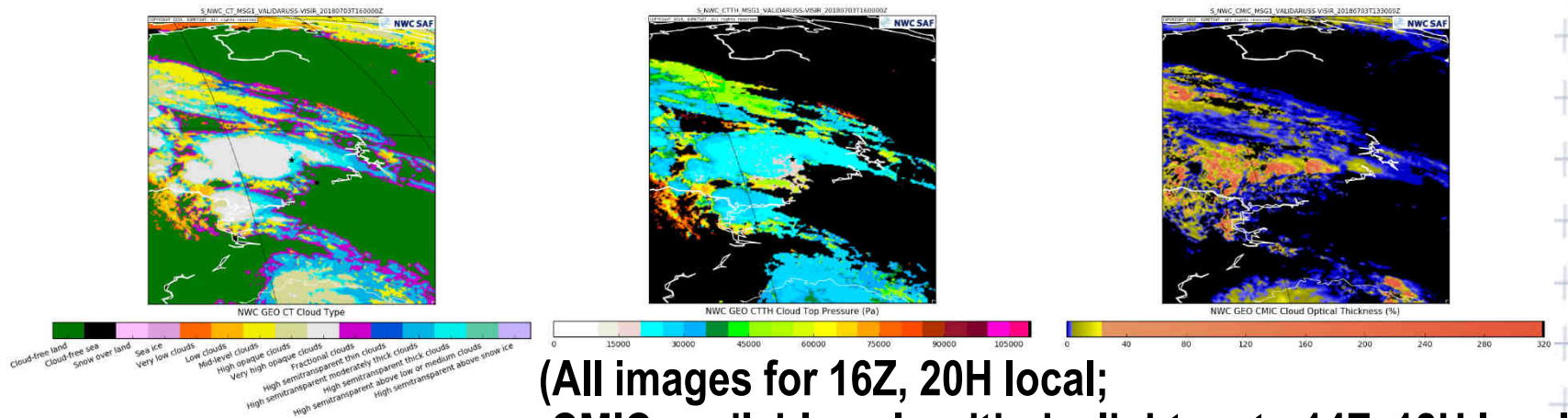
- > “VIL density” $\sim 45 \text{ kg/m}^2 / 11000 \text{ m} = 4.1 \text{ g/m}^3$ (with “Severe hail threshold” = 3.5 g/m^3 !).
- > The places where convection starts relates very well with the Moisture at “middle layer”.

Important instability shown by “K index (ki) > 40” and “Lifted Index (li) < -6”

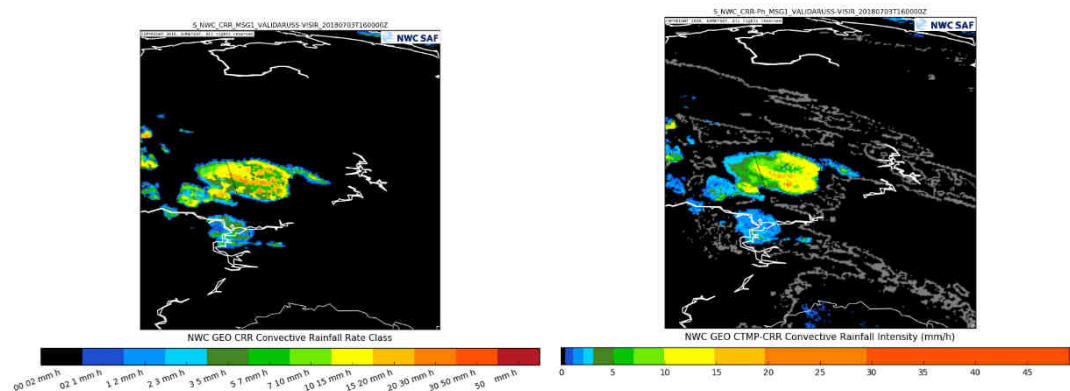


Case 3: Large hail in Glazov 03/07/18

- Evolution of cloudiness with “Cloud Type (ct)”, “CTTH Cloud top pressure (ctth_pres)” and “CMIC Cloud optical thickness (cot)” → Smaller “cot” than in previous case.



- “CRR Precipitation intensity products (crr & crrph)” again with values >30 mm/h.

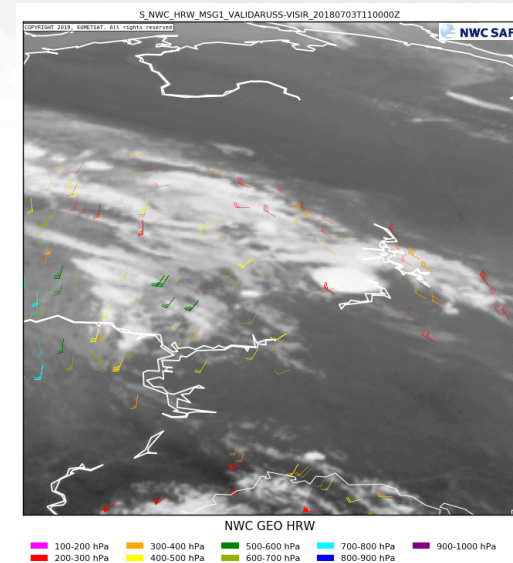


> Convection seen
with both products
for all storms throughout
the whole day.

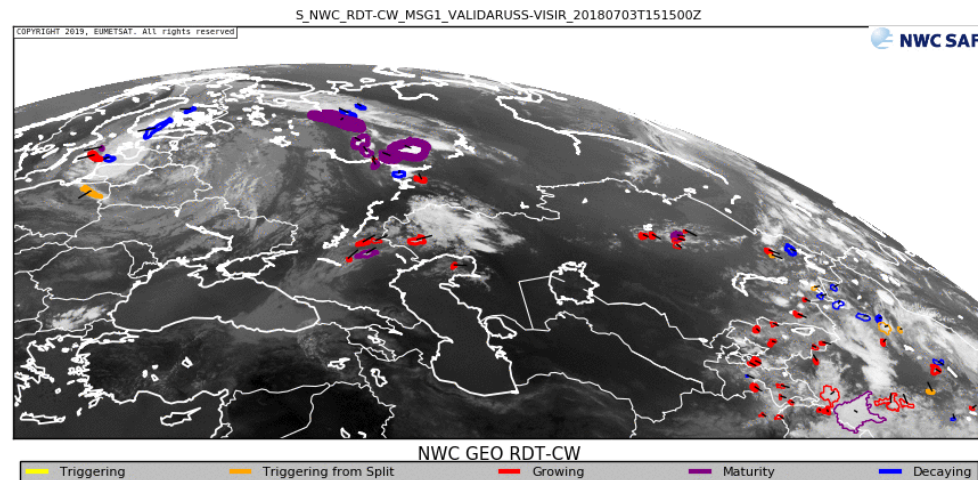
Case 3: Large hail in Glazov 03/07/18

- **"HRW product" shows wind shear** with **"W/NW high winds"** and **"S/SW low/medium winds"** contributing to the convection near Glazov, throughout the morning (11:15Z, 15:15H local).

However, there are few "low level winds" to check, due to the lack of clouds at low levels.



- **"RDT product" identifies the convective cells in the area around Glazov for this episode.**
 - Example of many cells for 15:15Z, 19:15H local, reaching status of **"maturity"**.



Case 4: Strong wind in Izhevsk 04/07/18



- **Convection in Izhevsk/Udmurtia**

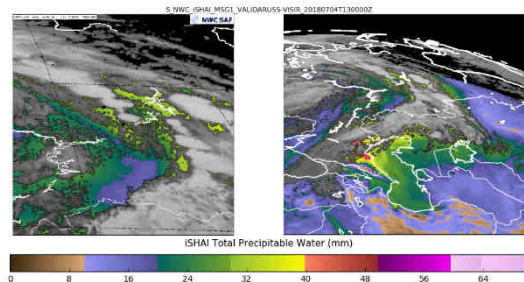
Convection related to the previous case (the same meteorological system), with rain, hail and wind gusts of up to 86 km/h measured in the evening (13-14:30Z, 17-18:30H local).

5-7 minutes for personal analysis of situation with NWC SAF products now:

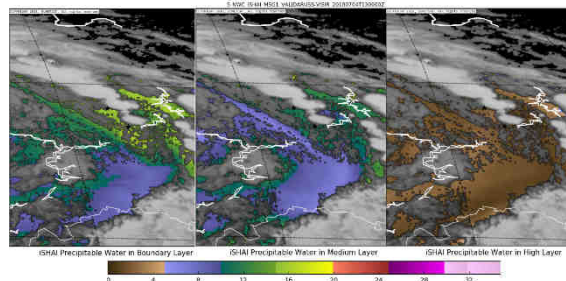
- iSHAI (for humidity in several layers and stability indices)
- HRW (for winds)
- CT/CTTH/CMIC (for cloud evolution)
- PC/PCPh & CRR/CRPh (for precipitation)
- RDT (for convection evolution) ...

Case 4: Strong wind in Izhevsk 04/07/18

- “NWC SAF iSHAI product” shows the moisture from the previous day (with “Total Precipitable Water (tpw) up to 30 mm”) is still there but smaller when convection starts in Izhevsk at 13Z, 17H local.

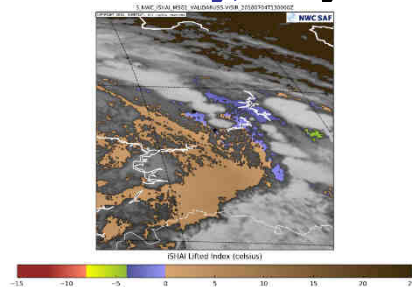


Moisture smaller in both “Boundary layer (bl) and “Middle layer (ml)”



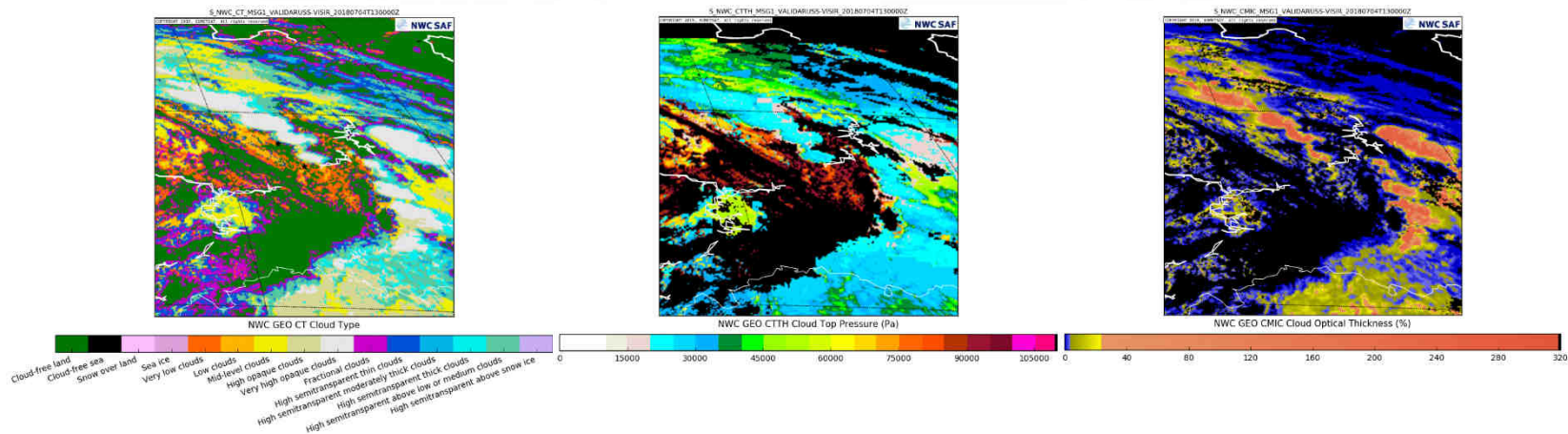
> “VIL density” $\sim 30 \text{ kg/m}^2 / 10000 \text{ m} = 3 \text{ g/m}^3$
with smaller danger of severe hail.

Smaller instability, only shown now by “Lifted Index (li) ~ 0 ”

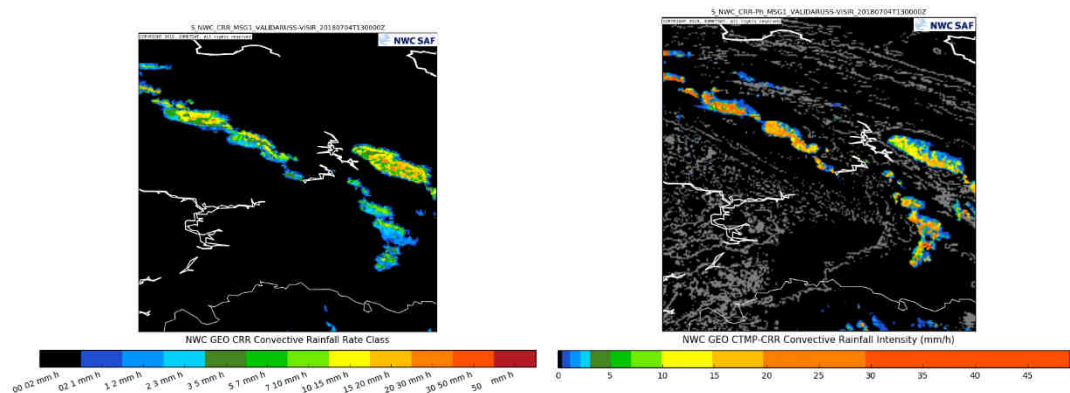


Case 4: Strong wind in Izhevsk 04/07/18

- Cloud products show a “line of convective cells” starting to grow at Izhevsk at 13Z, 17H local.

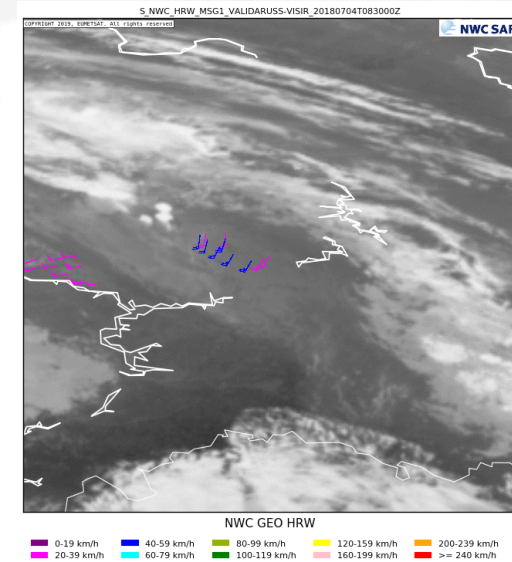


- “CRR Precipitation intensity products (crr & crrph)” also show this linear organization of precipitation.

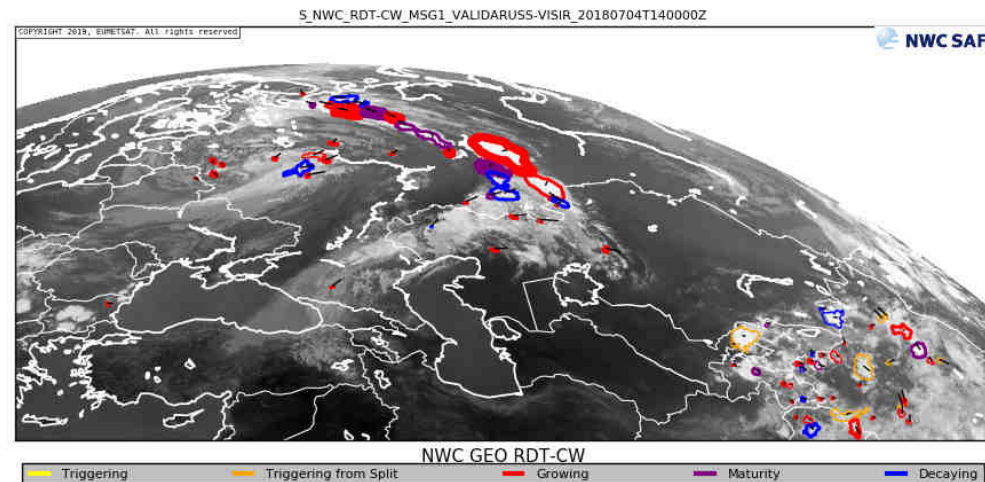


Case 4: Strong wind in Izhevsk 04/07/18

- "HRW product" shows in some moments before the start of convection mean winds at low levels > 50 km/h, coherent with the observed wind gusts of 86 km/h > Wind related to this organized convection !!



- "RDT product" clearly identifies the "line of convective cells" (organized convection) affecting a big region and moving north at 14Z, 18H local.



Case 5: Heavy rainfall Volgograd 15/07/18

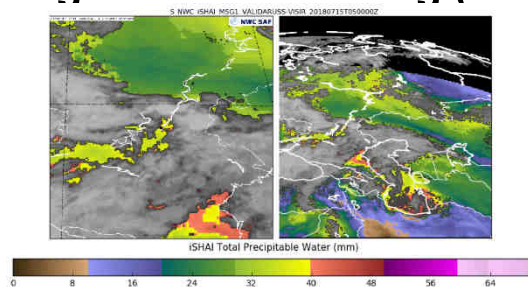
- **Torrential rainfall in Volgograd in the afternoon between 10-13Z, 14-17H local with additional convection in the morning in areas North of the city**
 - > **Main effect: raise of level of Volga river & landslide damaging the World Cup Stadium near the Volga river.**

5-7 minutes for personal analysis of situation with NWC SAF products now:

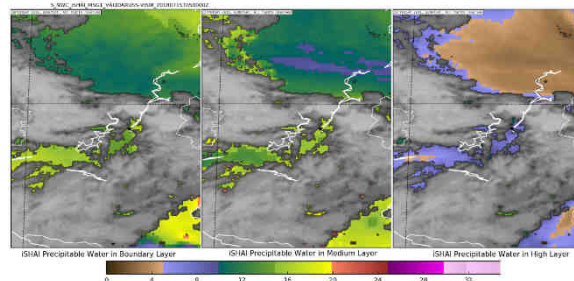
- **iSHAI (for humidity in several layers and stability indices)**
- **HRW (for winds)**
- **CT/CTTH/CMIC (for cloud evolution)**
- **PC/PCPh & CRR/CRPh (for precipitation)**
- **RDT (for convection evolution) ...**

Case 5: Heavy rainfall Volgograd 15/07/18

- “NWC SAF iSHAI product” shows very important moisture in the area (with “Total Precipitable Water (tpw)” up to 40 mm in some locations!) throughout the morning (at 05Z, 09H local).

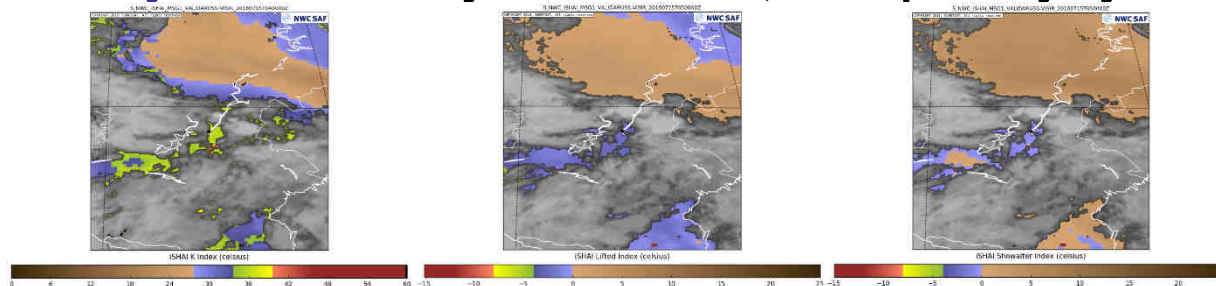


Moisture in both “Boundary layer (bl) and “Middle layer (ml)”



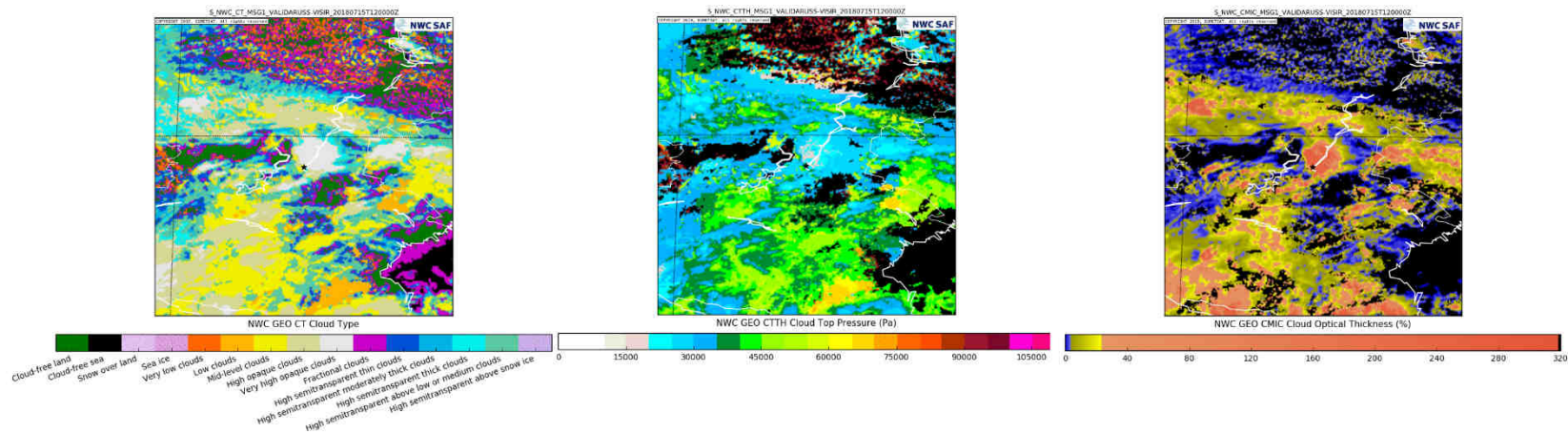
> “VIL density” $\sim 40 \text{ kg/m}^2 / 11000 \text{ m} = 3.6 \text{ g/m}^3$
with moderate danger of severe hail.

Instability shown here by the 3 indices, and specially by “K Index (ki) ~ 40 ”



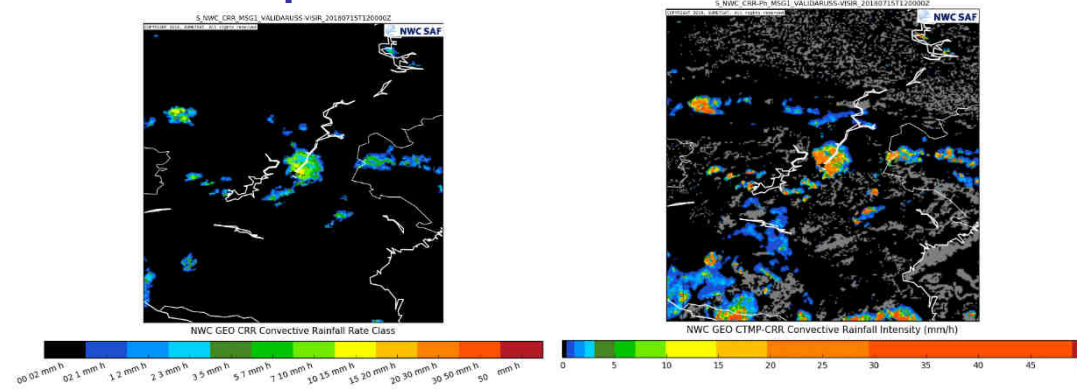
Case 5: Heavy rainfall Volgograd 15/07/18

- Cloud products show the development of a “line of convective cells” starting to grow North of Volgograd at 04Z, 08H local, and an “isolated cell” over the city starting to grow at 10Z, 14H local (images shown for largest development of the isolated cell at 12Z, 16H local).



“CRR Precipitation intensity products (crr & crrph)” clearly identify this cell.

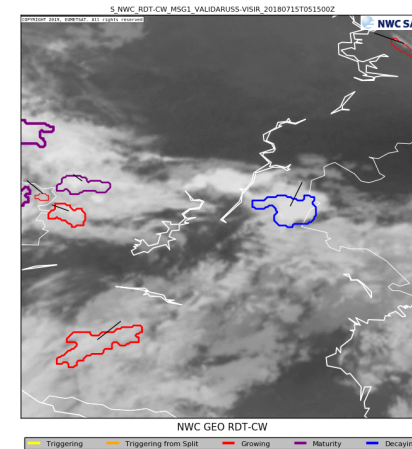
- > “crrph” shows >30 mm/h in an extended area of the cell.
- > The problem in the Stadium could be related to both the precipitation over it and the increased flow in the Volga from the North.



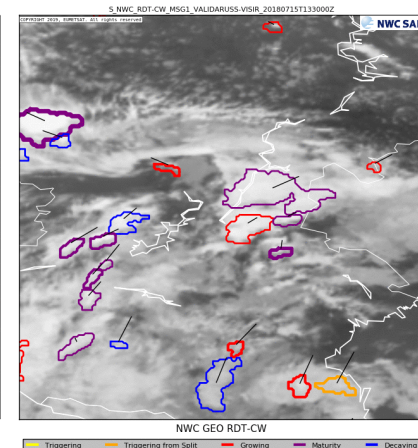
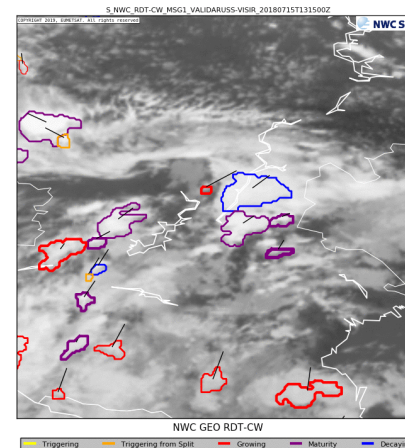
Case 5: Heavy rainfall Volgograd 15/07/18

- Considering “RDT product” the situation is mixed in this case:

- The “line of convective cells” North of Volgograd in the morning is only partially identified (example image for 05:15Z, 0:15H local).



- The “isolated cell” over Volgograd is identified in all slots but changing several times its size & stage of development (example images for 13:15Z, 17:15H local and 13:30Z, 17:30H local)



NWC/GEO products sometimes do not provide the expected information!

Case 6: Flight accident Moscow 05/05/19

- A flight from Moscow to Murmansk had an accident with 41 fatalities on 05 May 2019 at 15Z, 18H local in Moscow/Sheremetyevo Airport due to:
 - > Lightning strike while climbing after take-off.
 - > Failure of radio and other equipment.
 - > Bounced emergency landing and hard touch-down, with collapse of the undercarriage, and a fire in the rear of the aircraft.

Cause of the accident related to:

- > Poor weather: convection with lightning, 54 km/h S wind (50° crosswind) during landing. wind shear during landing.
- > Human errors during flight and rescue.
- > Mechanical problems.

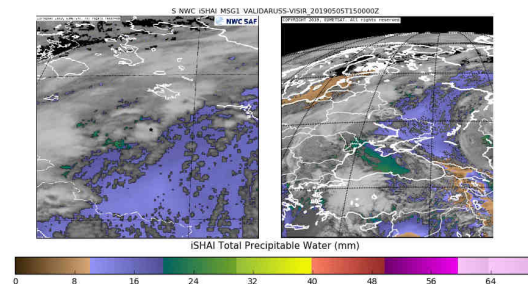
Could NWCSAF products have helped to diagnose better the meteorological situation, to avoid the accident?

Analysis here based on:

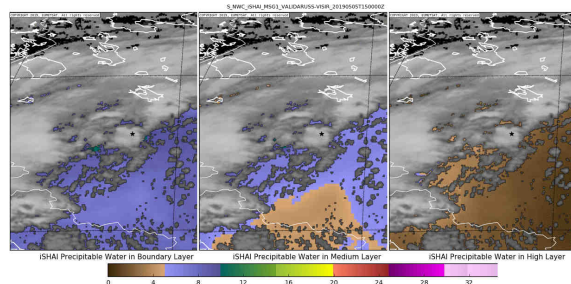
- > CT/CTTH/CMIC (for cloud evolution).
- > PC/PCPh, CRR/CRPh, CI, RDT (for convection evolution).
- > HRW (for winds). > ASII-TF, ASII-GW (for turbulence).

Case 6: Flight accident Moscow 05/05/19

- “NWC SAF iSHAI” shows moisture less significant than in all previous cases (with “Total Precipitable Water (tpw)” over 20 mm North of the airport only!)

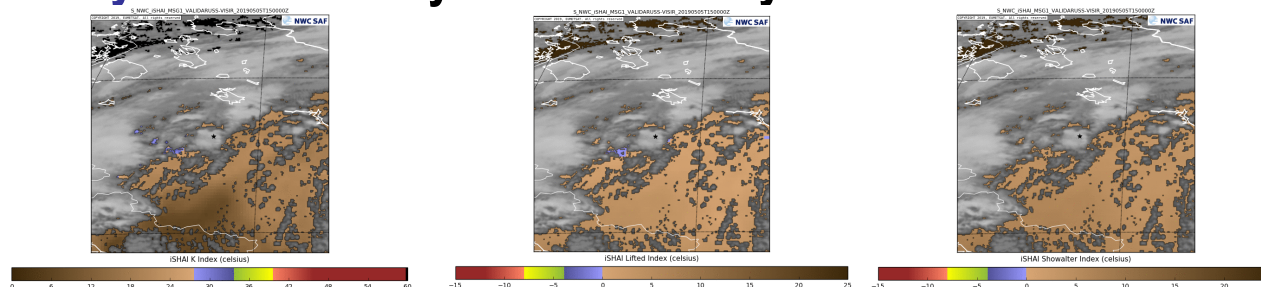


Vertical distribution of moisture also smaller than in previous cases



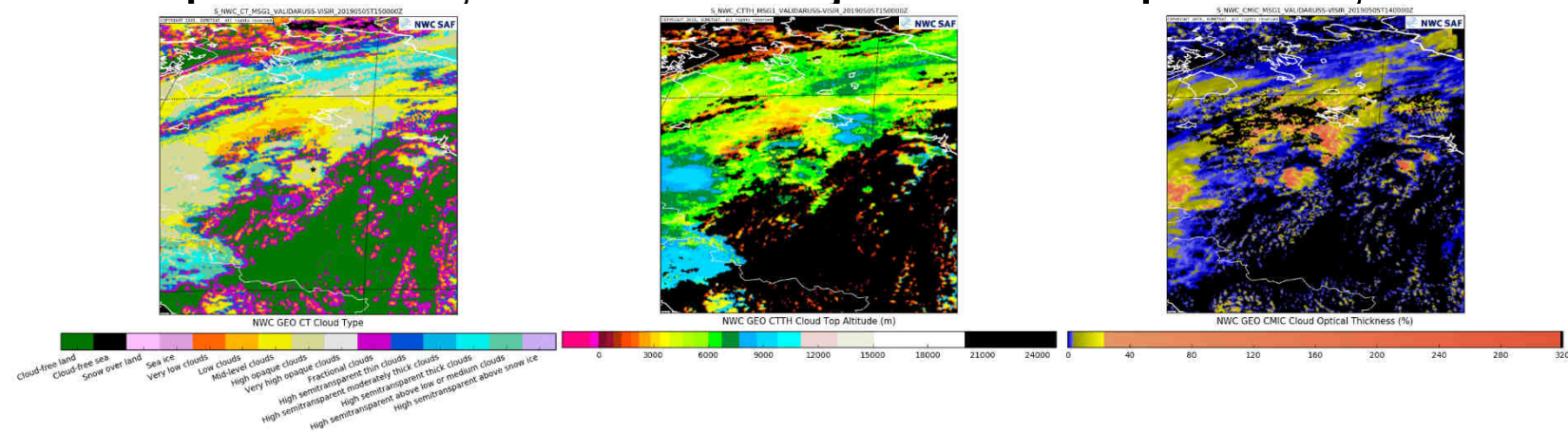
> “VIL density” < $20 \text{ kg/m}^2 / 8000 \text{ m} = 2.5 \text{ g/m}^3$
with small danger of severe hail.

Stability shown here by the 3 instability indices!

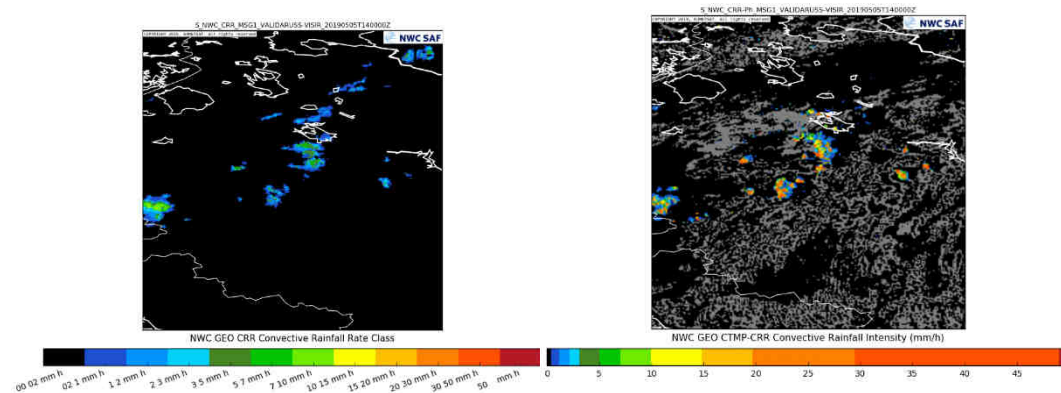


Case 6: Flight accident Moscow 05/05/19

- Cloud prods. show small “convective cell”, not especially dense/high
 - > CTTH Cloud top height (ctth_alti) coherent with METAR (8800 m high).
 - > In spite of its size, “convective cell” just over the airport at 15Z, 18 H local !!



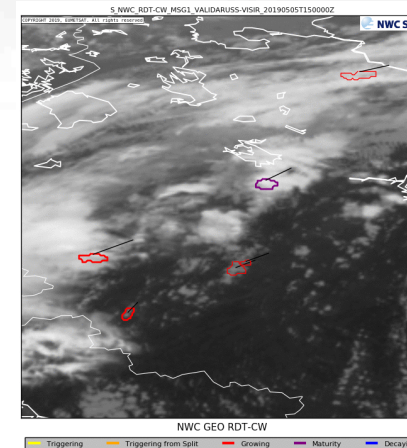
With “CRR Precipitation intensity products (crr & crrph)”



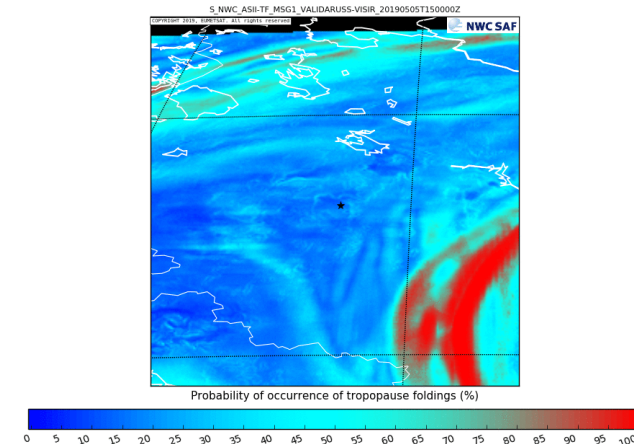
- > Precipitation not very widespread/significant.
- > There is besides an issue:
 - Accident near sunset, with change of day/night Precipitation algorithms.
 - Precipitation unavailable in some moments.

Case 6: Flight accident Moscow 05/05/19

- Considering “RDT product”, due to its size, the “convective cell” related to this situation is not even identified in any moment!

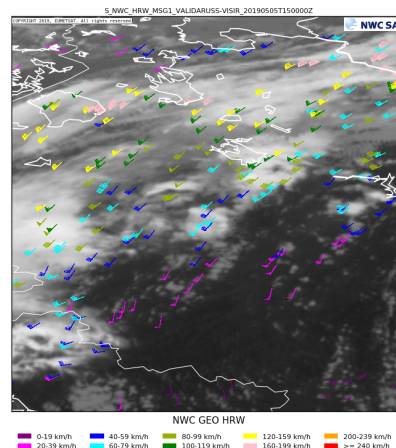


Considering
“ASII-TF – Tropopause folding”
“ASII-WG – Gravity wave”
Clear air turbulence products:
there is no signal of turbulence
for any of the products.



Case 6: Flight accident Moscow 05/05/19

- Considering "HRW product"
 - > General SW flow at all pressure levels,
with normal higher speeds at higher levels.
 - > Crosswind during airport operations (06/24 runways)
but no signal of wind shear shown by HRW.



Conclusions

NWC/GEO products have shown to be very useful for the Monitoring and Nowcasting of meteorological situations.

However, they have some limitations:

- Some products work **only during daytime** (CMIC).
or **change its output at twilight** (All cloud & precipitation products).
- Some products **change its output for different slots** (RDT).
- Some products **cannot provide some outputs for all slots**.
 - HRW winds, dependent on the presence of clouds/humidity gradients.
- Some products are **providing partial outputs for the moment**.
 - CI/Convection initiation.
 - Clear air turbulence, for the moment only
 - ASII-TF/Tropopause foldings & ASII-GW/Gravity waves.

Conclusions

As already said yesterday,
registering as NWC SAF users and downloading the software is so suggested.

For any additional doubt/question on

- NWC SAF and NWC/GEO software package
- How to get it and install it
- How to run and visualize its products

do please contact me today afterwards.

More information and feedback is also welcome at:

- Through the NWC SAF website:
- Through the email address:

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