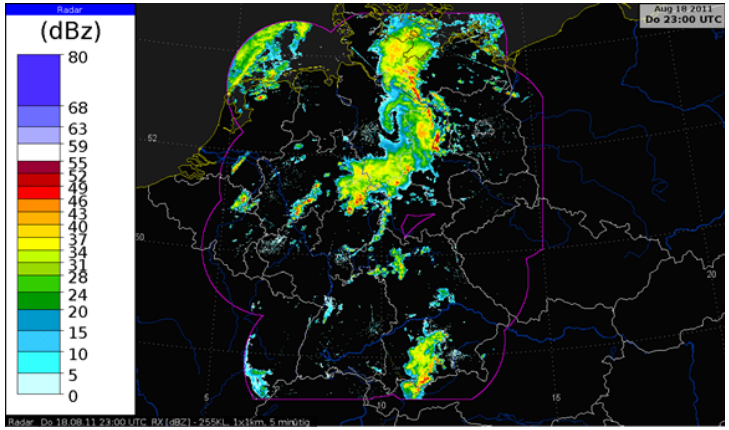
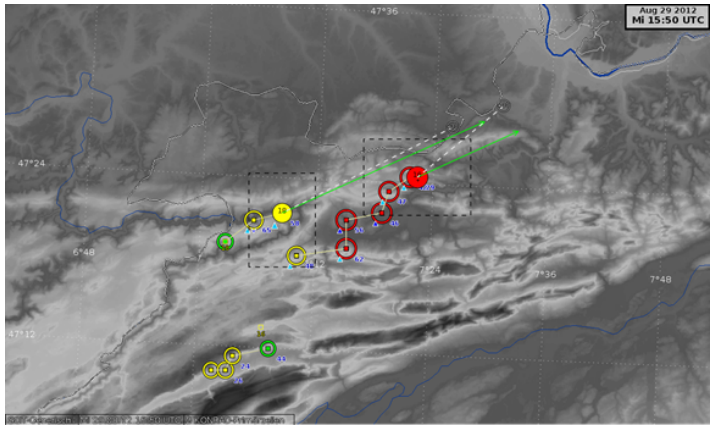
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Nowcasting of severe weather at Deutscher Wetterdienst (DWD) using remote sensing and nowcast products - Actual status and developments

Tim Böhme

Weather Forecasting department





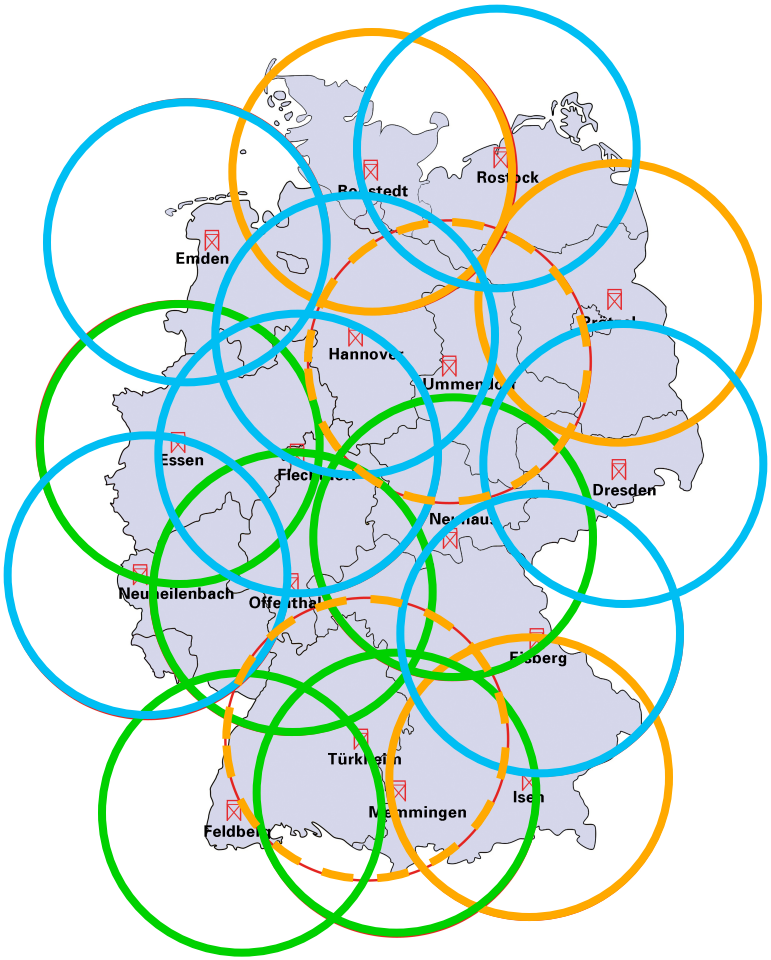
7 European Conference on Severe Storm (ECSS) – 2013 – Helsinki

Outlook

- **Remote sensing data at DWD**
  - **Radar** data
    - Extension of radar network
    - Upgrade with new dual-pol Doppler radars
    - New radar scan strategy
  - **Satellite** data
    - images, composits
    - derived products
  - **Lightning** data
- **Nowcast products at DWD**
  - Monitoring of objects for storm warning
  - Gridded data for storm warning → consistent warning procedures

Remote sensing data at DWD - Radar

➔ **Extension / replacement of radar network** (RadSys-E project → until 2015/16):



- network consists of

  17 operational radars + 1 research radar:

  currently:

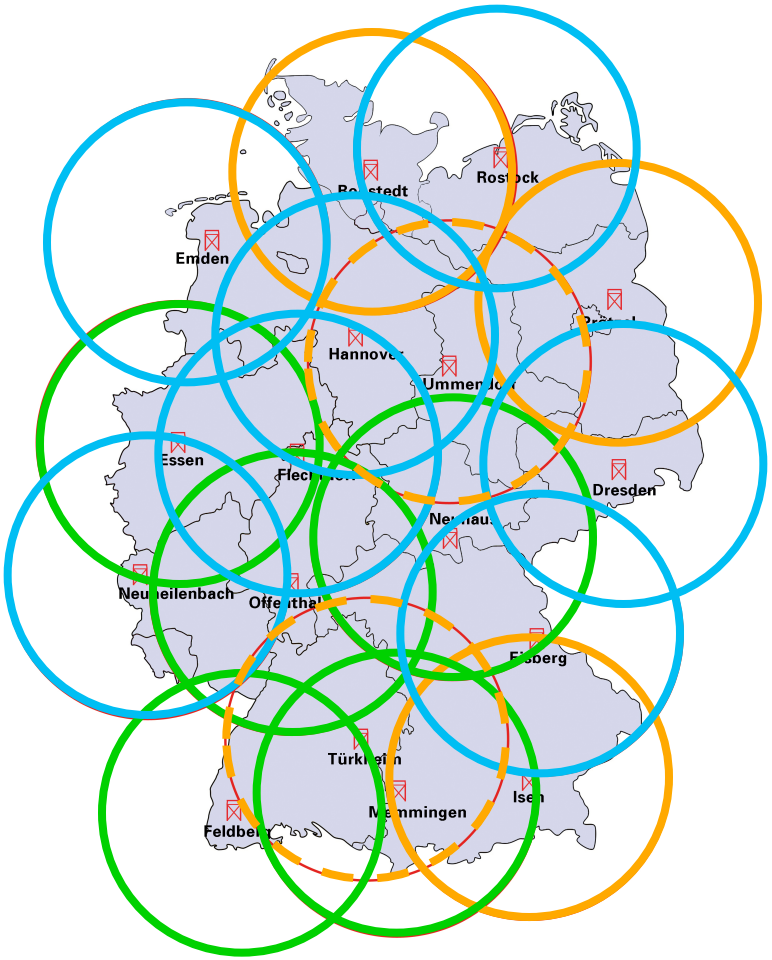
  5 radars polarimetric

  5 radars replacement

  7 radars waiting
- network covers 100% of Germany (radius of 150 km)
- denser coverage near the Alps (South)

Remote sensing data at DWD - Radar

➔ **Extension / replacement of radar network** (RadSys-E project → until 2015/16):



- network consists of

  17 operational radars + 1 research radar
- network covers 100% of Germany (radius of 150 km)
- denser coverage near the Alps (South)
- displacement from large cities towards countryside:

  Berlin → Prötzel
  Hamburg → Boostedt
  München → Isen
  Frankfurt → Offenthal

Remote sensing data at DWD - Radar

Radar data interpretation:

Natural and artificial effects on the radar scanning which have to be taken into account:

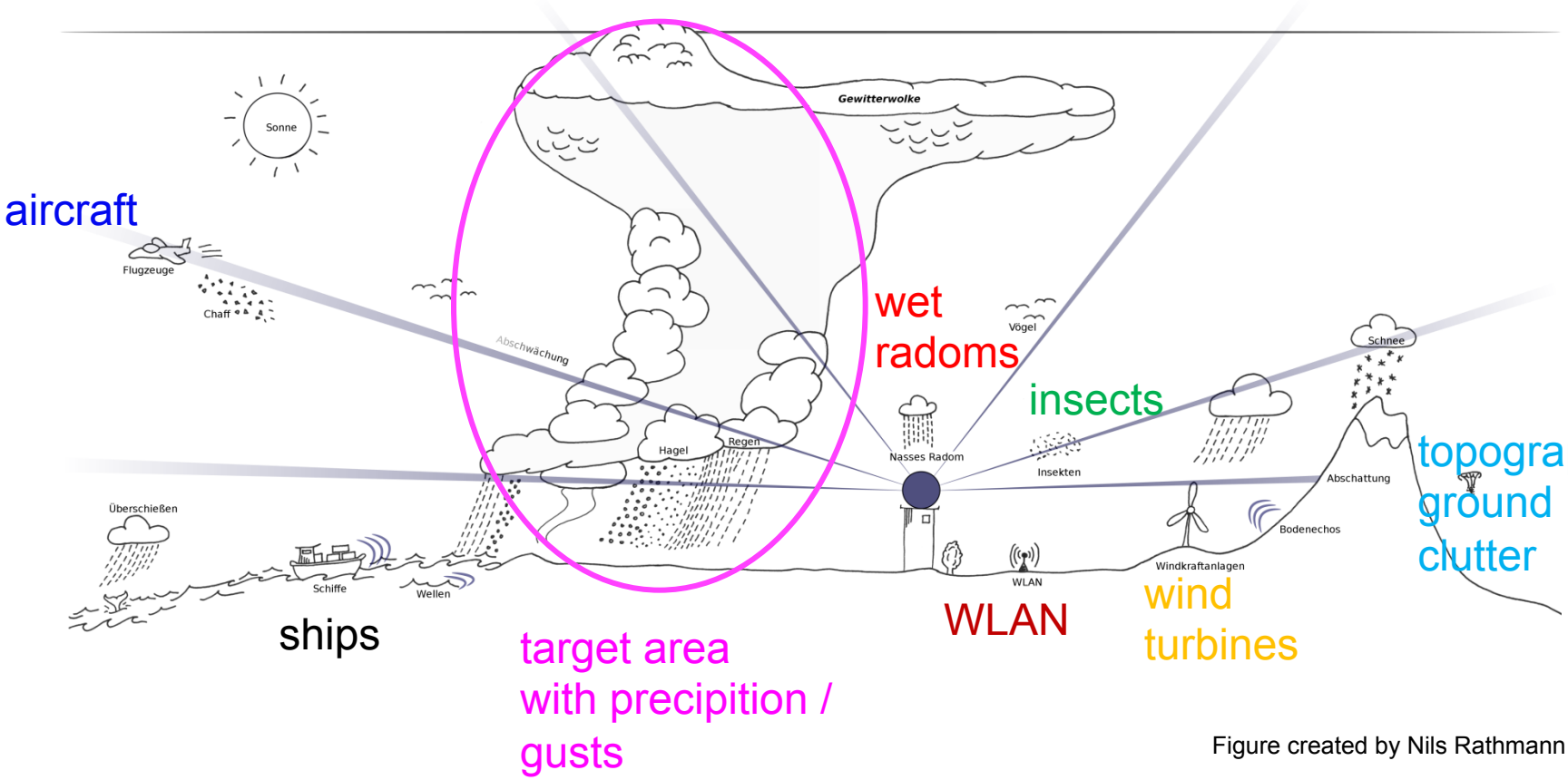


Figure created by Nils Rathmann

Remote sensing data at DWD - Radar

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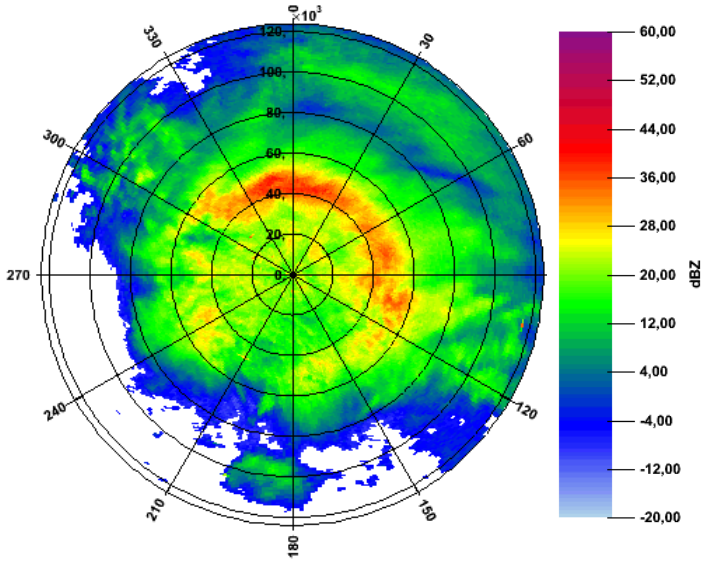
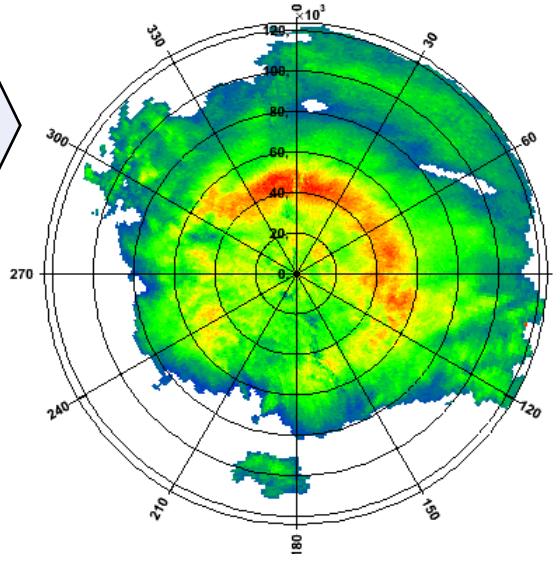
➔ **Quality control:** polarimetric radar in Essen - elevation: 2.5° - PPI plot

uncorrected reflectivity

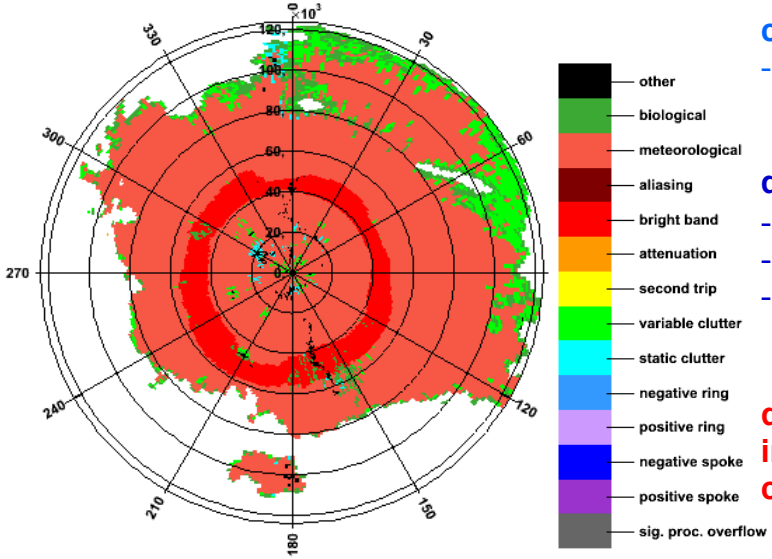


quality control
at radar site



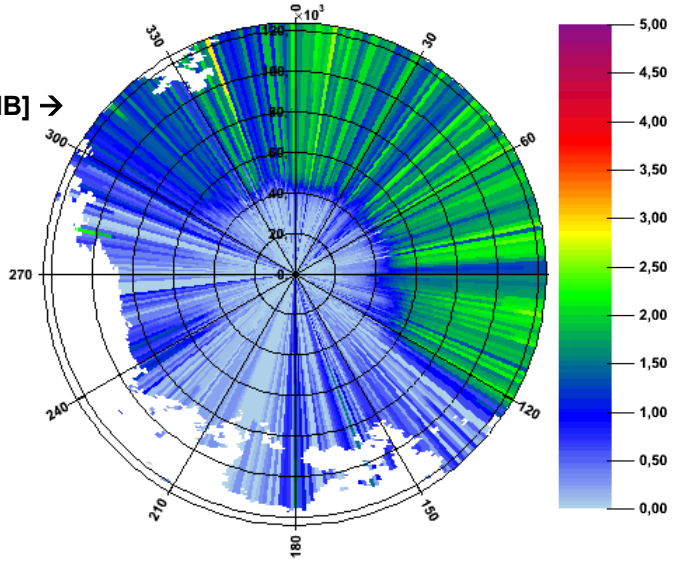
filter at radar site:
- control of radar system
- spectral clutter filter
- „second trip“ filter
- „noise“ threshold filter

Quality product „QS- bits“



correction algorithms:
- absorption

absorption correction [dB] →



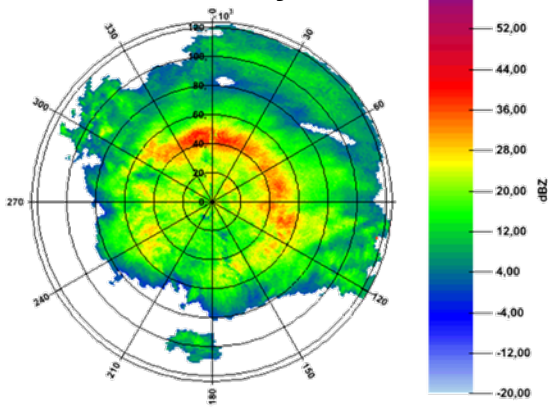
detection of:
- positive/negative spokes
- positive/negative rings
- clutter, …

quality product includes information of the complete quality control

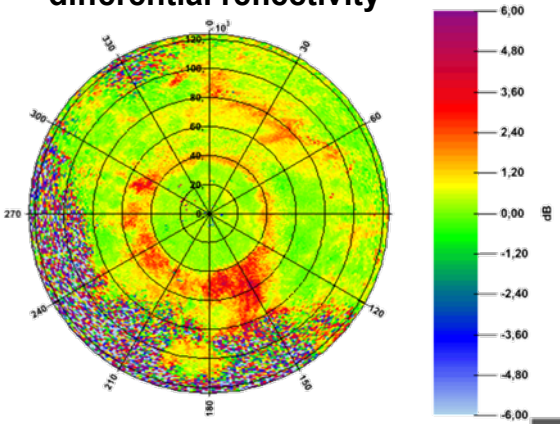
Remote sensing data at DWD - Radar

➔ **Hydrometeor classification:**

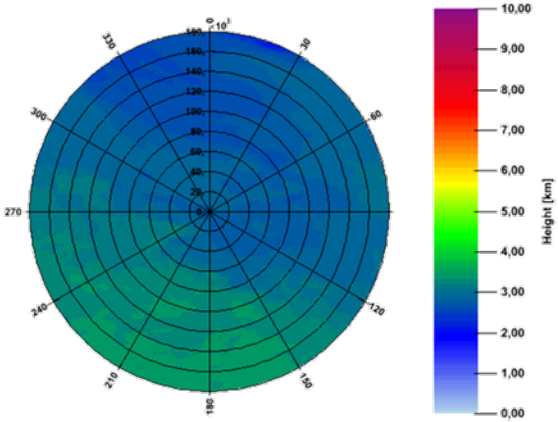
reflectivity



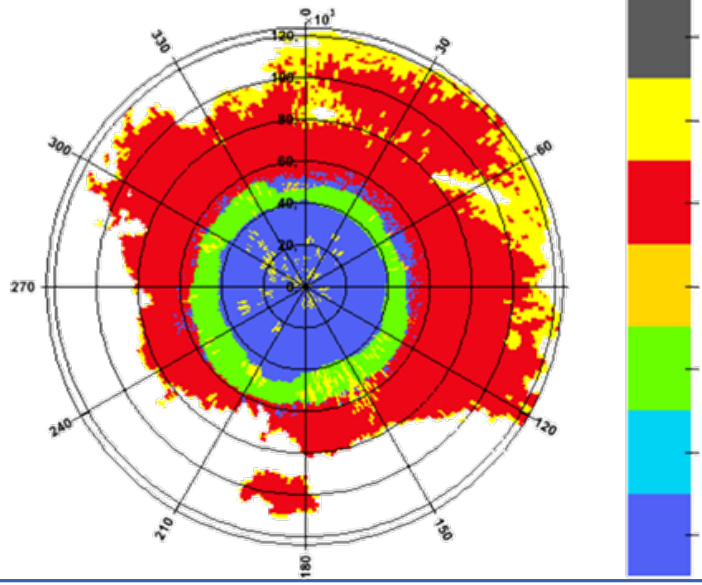
differential reflectivity



external parameter:
height of 0°C level (e.g., COSMO-DE)



resulting hydrometeor classification



- unclassified
- non-meteorological
- snow
- graupel
- bright band
- hail
- rain

Remote sensing data at DWD - Radar

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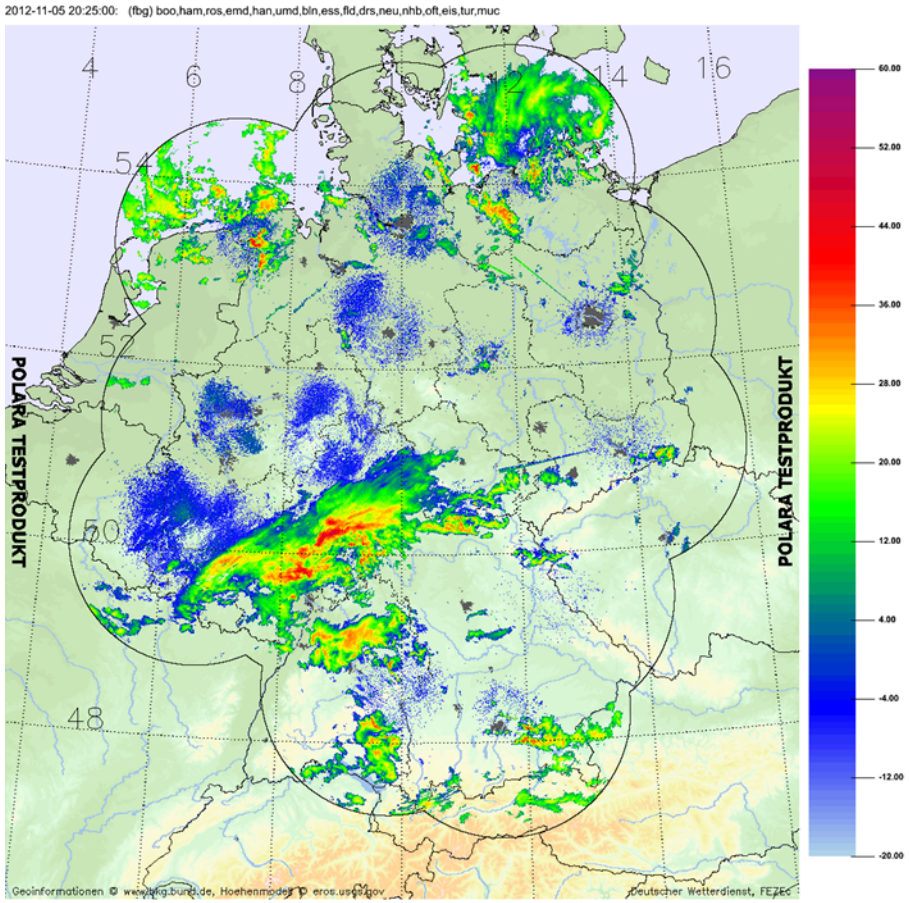
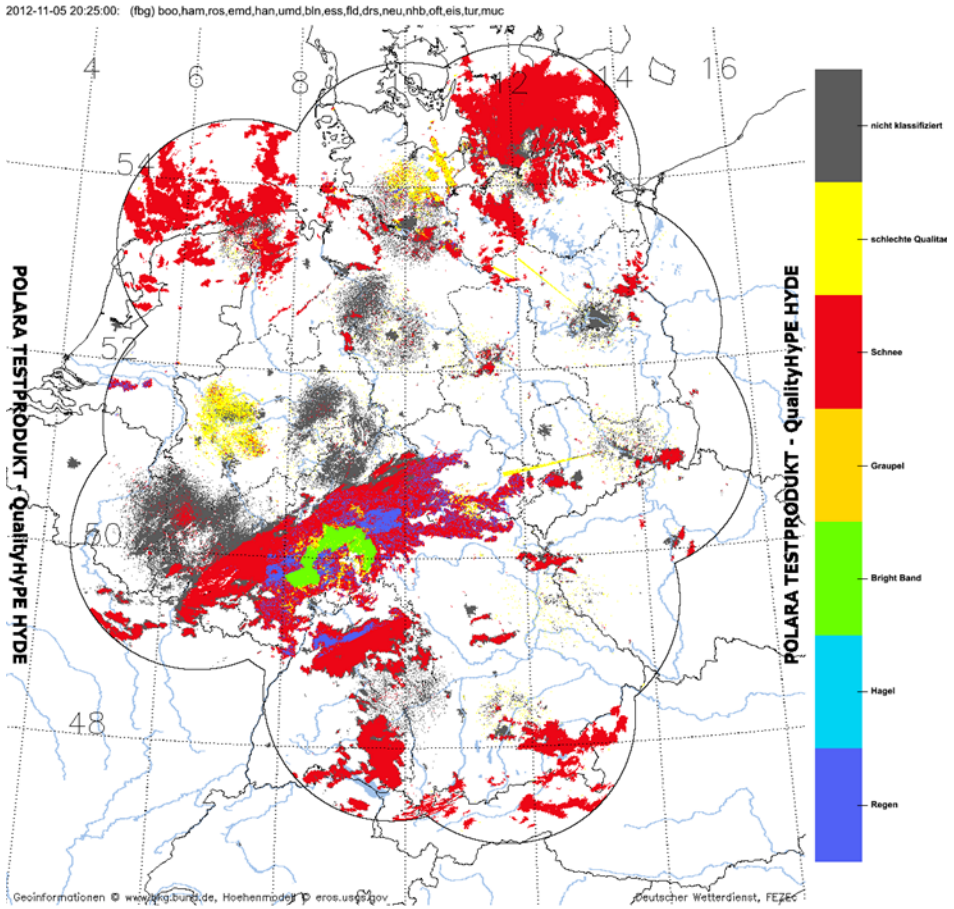
Example: 05.11.2012, 20.25 UTC

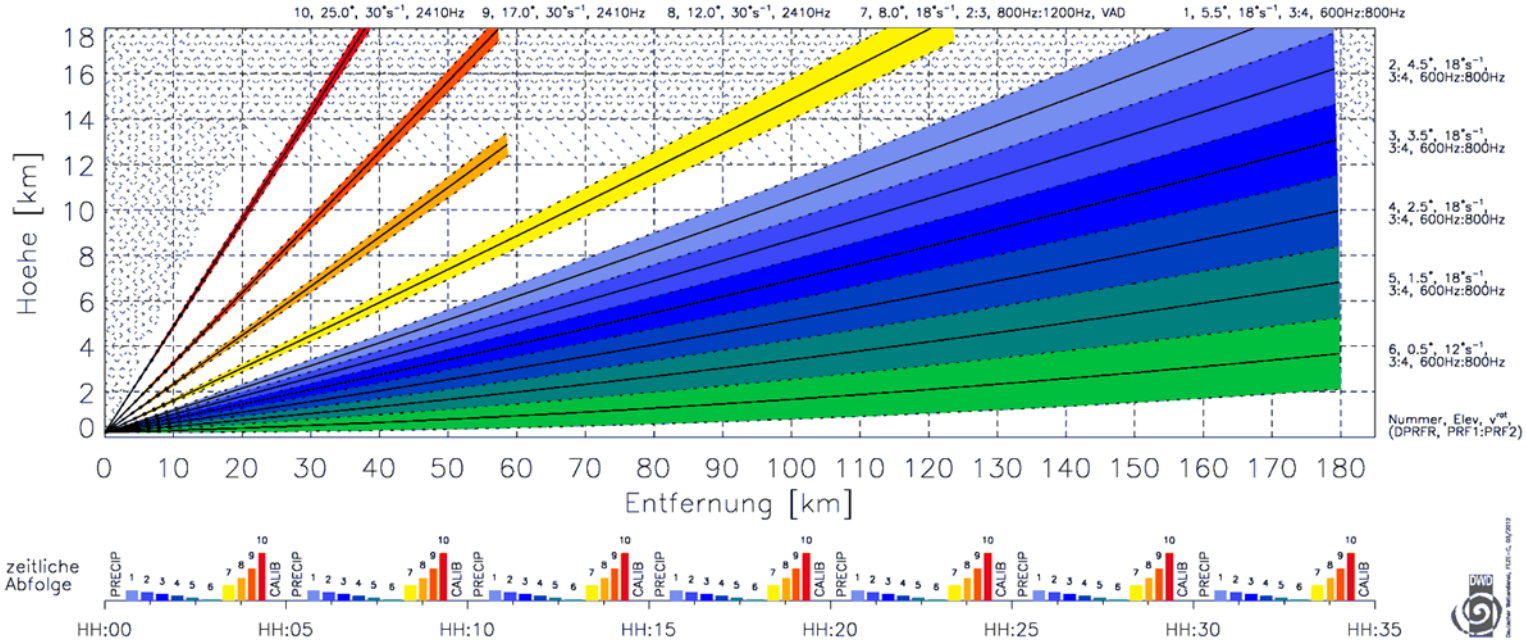




Remote sensing data at DWD - Radar

➔ **New radar scan strategy:**

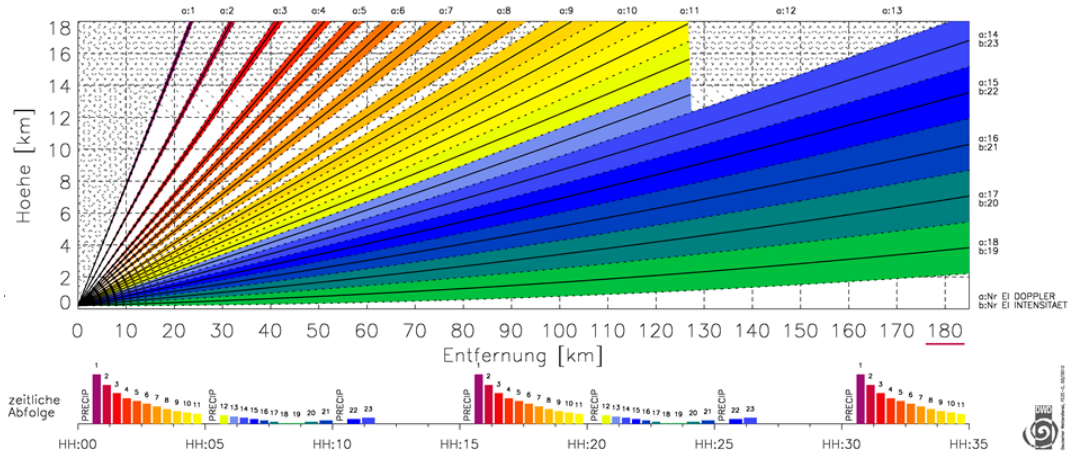
- **10 scans** (sweeps) between 0,5° and 25° **every 5 minutes + 1 precip-scan**
- Sweeps 1-6 (5,5°-0,5°) up to a horizontal distance of **180 km**
- 3-4 additional elevations after complete radar upgrading (due to faster rotation)

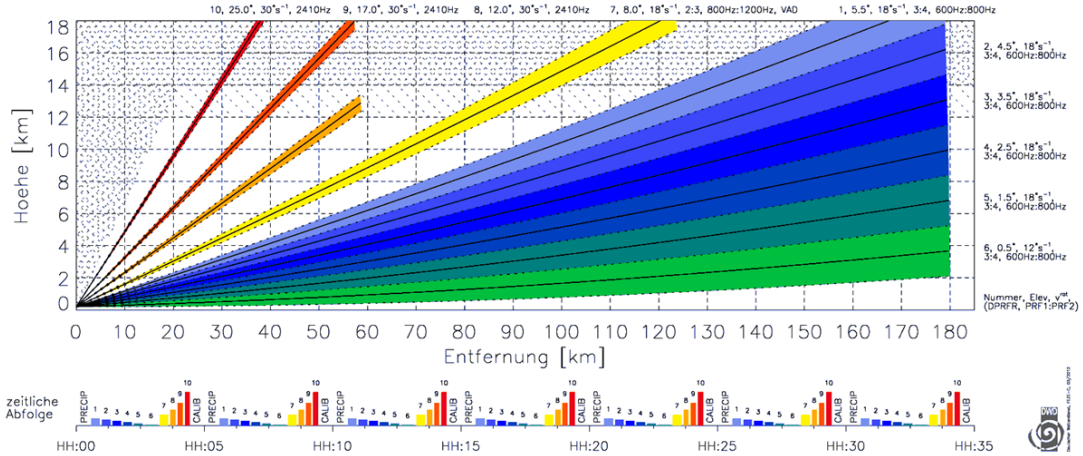


Remote sensing data at DWD - Radar

➔ New radar scan strategy:

- ➢ Comparison of previous and new scan strategy:





previous strategy:
- 18 elevations
- 120–240 km distance
- every 15 minutes

actual strategy:
- 10 elevations

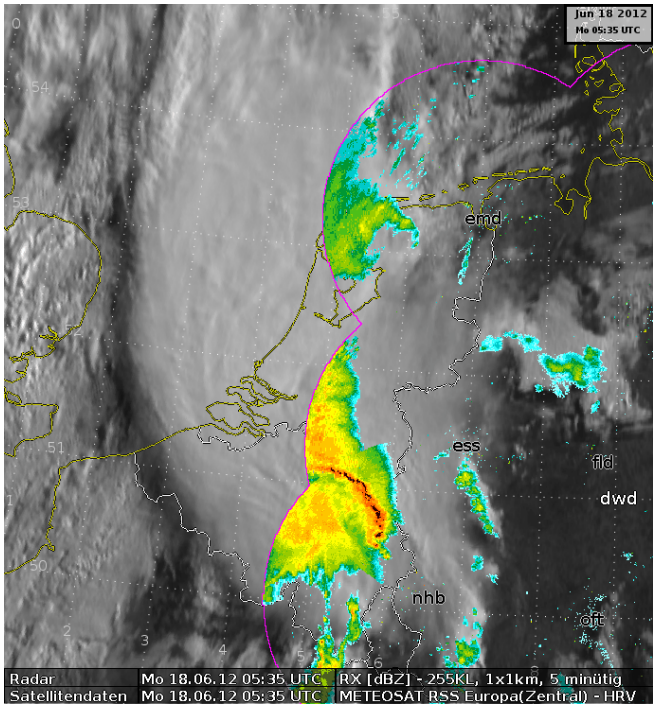
→ reducing top elevations
- 180 km distance
- every 5 minutes

Remote sensing data at DWD - Radar

➔ **New radar scan strategy:**

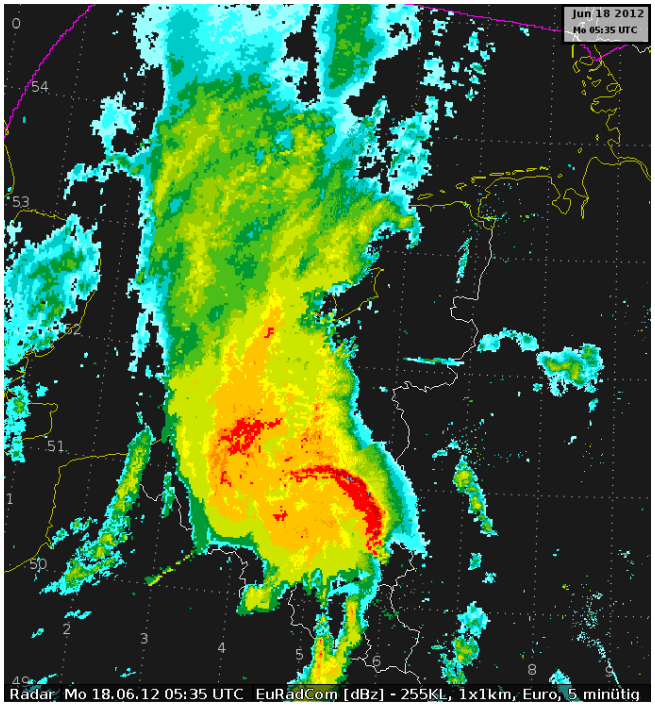
- the reduction of number of sweeps
- the enlargement of cone of silence
- long distance (absorption effects)

enforce the use of **composite** products !



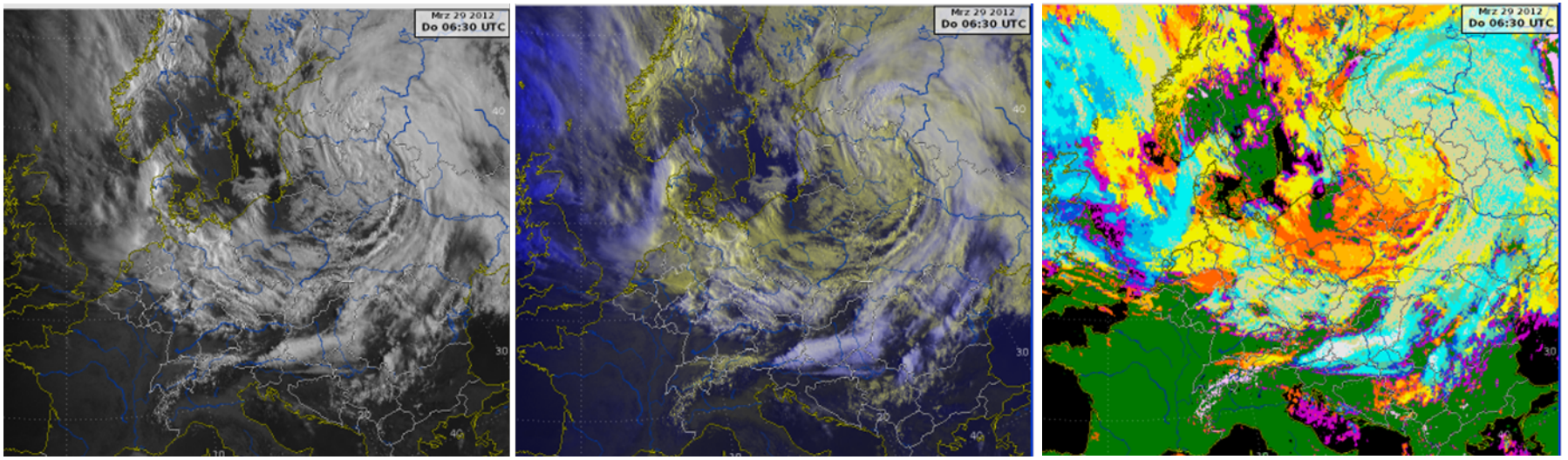
Absorption effects
behind strong
convective cells

example:
18 June 2012 morning



Remote sensing data at DWD - Satellite

- ➔ satellite images (geostationary: **MSG**, polar: **METOP**, **TERRA / AQUA**, etc.)
- ➔ satellite composits (multi spectral images of MSG, e.g. different cloud heights / types)
- ➔ derived satellite products, e.g.:
  - NWC SAF *(**S**atellite **A**pplication **F**acility on support to **Nowc**asting):*
    → precipitable water, stability analyses, …
  - MPEF *(**M**eteorological **P**roducts **E**xtraction **F**acility)*
    → vegetation, cloud classification, sea surface, …
  - volcano ash
  - ice surface coverage

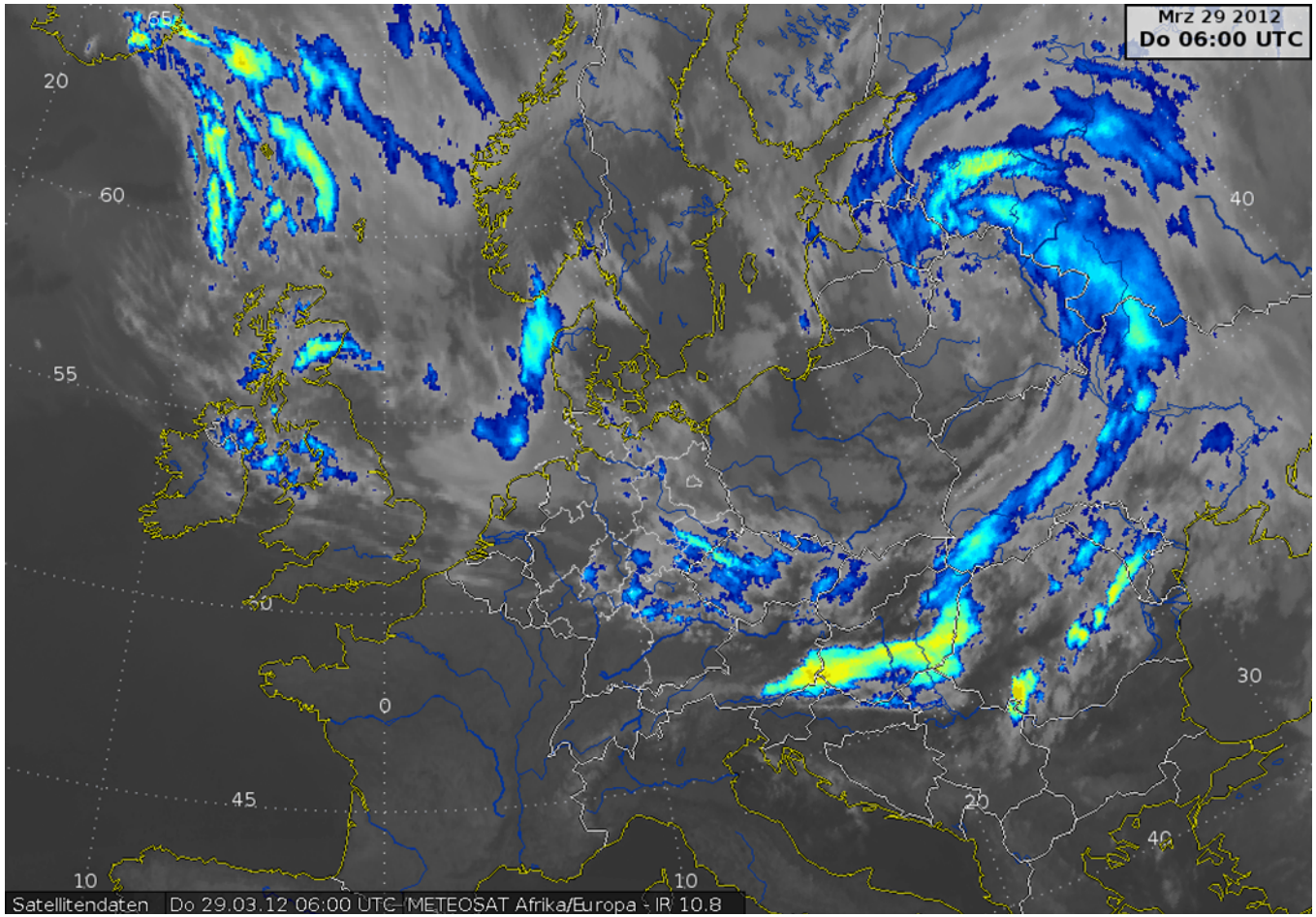


Remote sensing data at DWD - Satellite

MSG - IR 10.8 µm image

case: 29 March 2012

identification of „Cold Pools“ - regions marked by instability and cold air



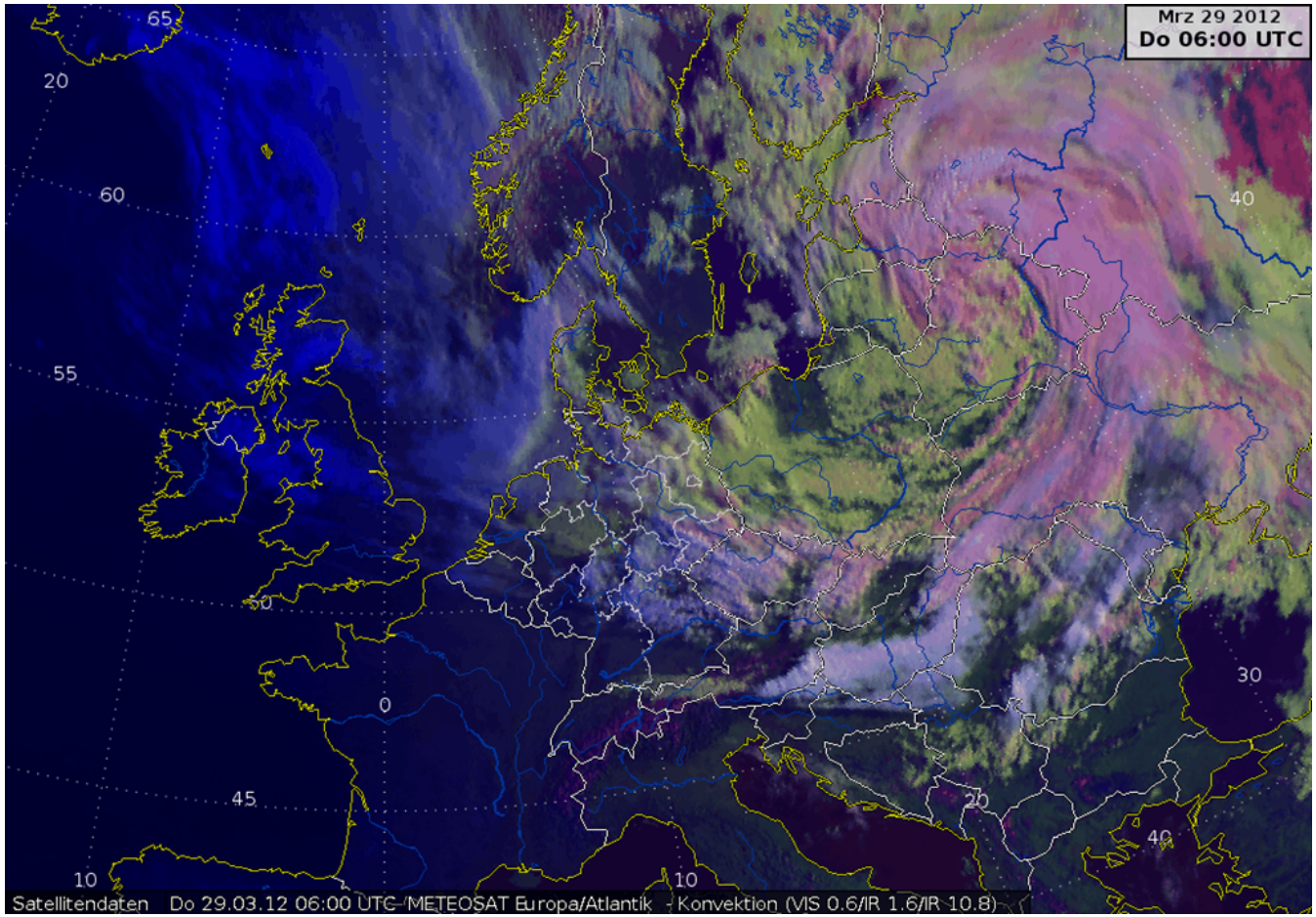
Remote sensing data at DWD - Satellite

Combination of different MSG channels into composits

case: 29 March 2012

visual 0.6µm
infrared 1.6µm & 10.8µm

- ➔ convection
- ➔ heavy convection
- ➔ air mass
- ➔ dust



Remote sensing data at DWD - Lightning

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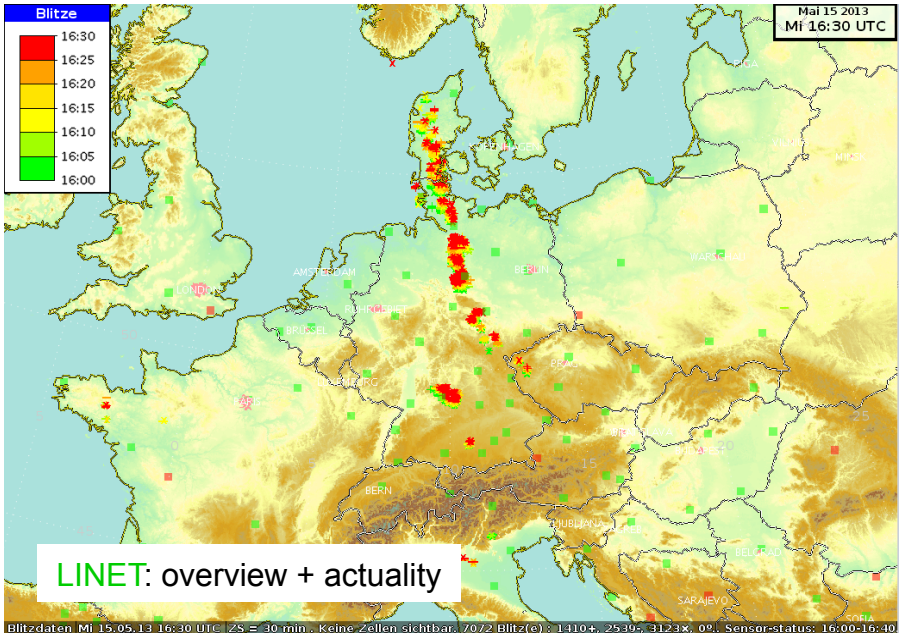
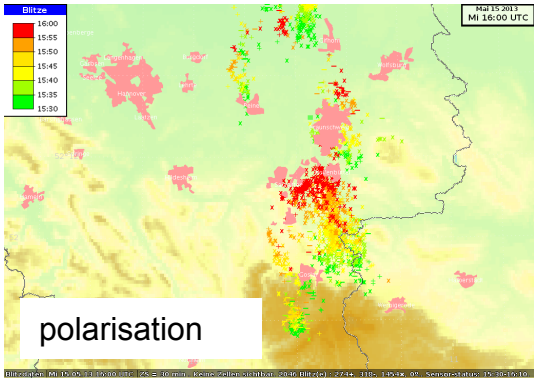
Lightning network data:

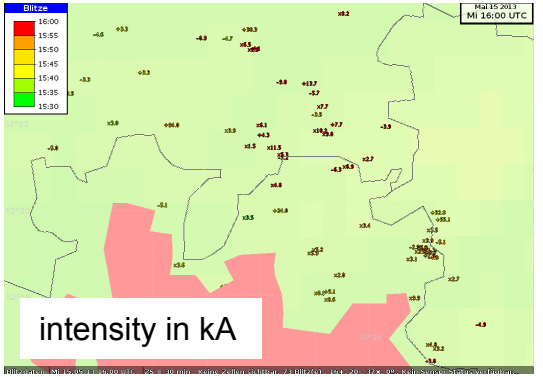
- LINET network of company Nowcast



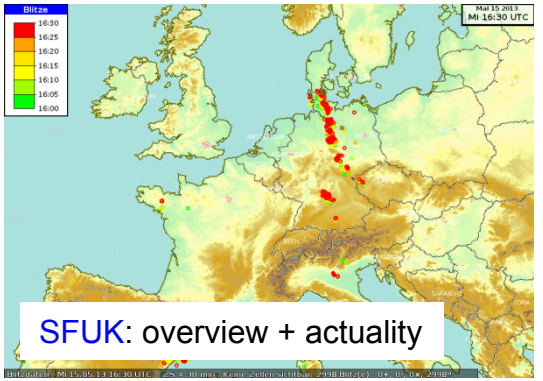
LINET: overview + actuality



polarisation



intensity in kA



SFUK: overview + actuality

- Network SFUK of UK MetOffice
  (currently restrictions due to new data format)

- see poster of Kathrin Wapler & Christopher Frank (92)
  on Thursday afternoon (14.30 h)

Remote sensing data at DWD – Nowcasting

- **Nowcast data at DWD:**
  - **Remote sensing data** (radar, satellite, lightning data)
  - **Nowcast data** for up to 2 hours basing mainly on remote sensing data
    - Gridded data:
      - ***quantitative forecasts*** of precipitation events (RADVOR-OP)
        - see poster of Tanja Winterrath & Wolfgang Rosenow (102) on Thursday afternoon (14.30 h)
      - ***warning products*** including a multitude of meteorological information

        e. g. hazardous sites → point + area (NowCastMIX, ITWS)
        - see poster of Paul James et al. (65) on Thursday afternoon (14.30 h)
    - Object data:
      - ***storm cell*** tracking (CI, KONRAD, CellMOS, RDT)
      - ***gust*** / *wind shear* areas (mesocyclone detection)
      - in planning: **winterly phenomena**

        e. g. heavy snowfall areas / icing areas

Remote sensing data at DWD – Nowcasting

- **Nowcast** data at DWD:
  - examples for **convective events:**
    - **convective initiation** example of 28 May 2013
    - **mesocyclone detection** **example of 02 May 2013**

    in comparisons to:
      - **radar + satellite**
      - **KONRAD**
      - **CellMOS**
      - **NowcastMIX**

Remote sensing data at DWD – Nowcasting

CI (Convective Initiation)

- **development:** *John Mecikalski (UAH) and Kristopher Bedka (CIMSS/NASA)*
- **aim:** **Early detection of development of heavy convection / thunderstorms**
- **advantage:** satellite based identification ahead of precipitation signals in radar
- **basis:** concept bases on **IR temperatures and their trends**
  - see presentation of Pierre Fritzsche (49) on Friday morning (11.30 h)

Remote sensing data at DWD – Nowcasting

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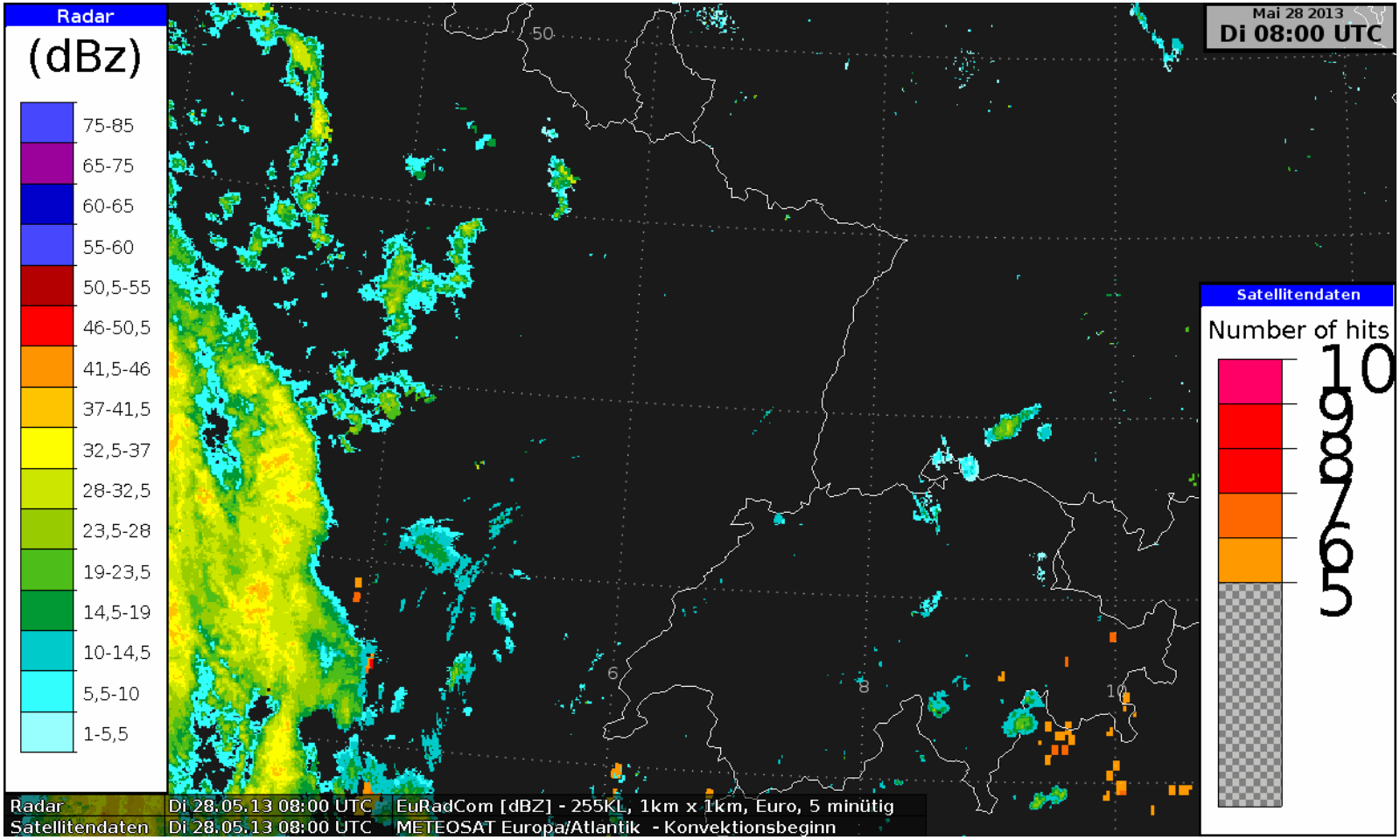
Wetter und Klima aus einer Hand

CI (Convective Initiation)

example: 28 May 2013, 08.00 – 14.00 UTC



Remote sensing data at DWD – Nowcasting

Mesocyclone detection

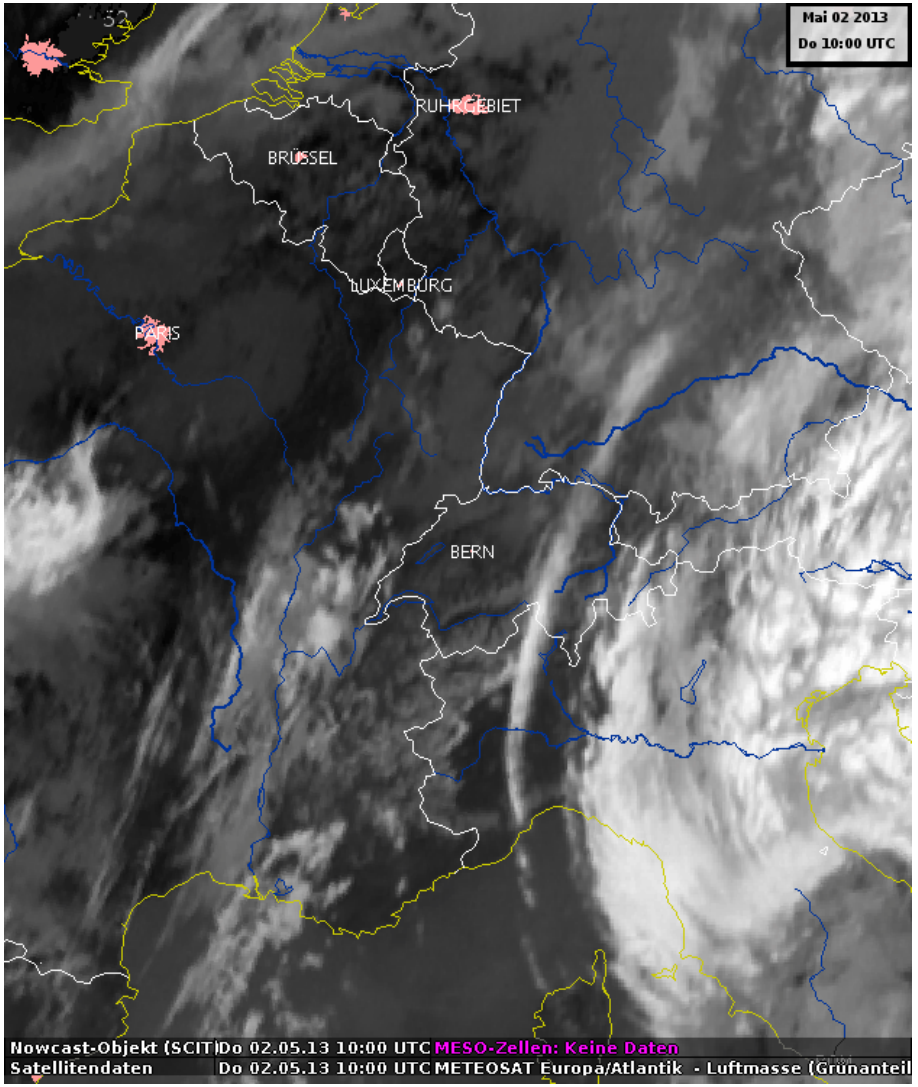
- **development:** Thomas Hengstebeck, Paul Joe, Peter Lang
- **aim:** **detection of areas of heavy wind shear → tornadoes**
- **basis:** concept bases on **wind data of radar network**
  - see poster of Thomas Hengstebeck et al. (135) on Thursday afternoon (14.30 h)

Remote sensing data at DWD – Nowcasting

Mesocyclone detection

Mesocyclone detection

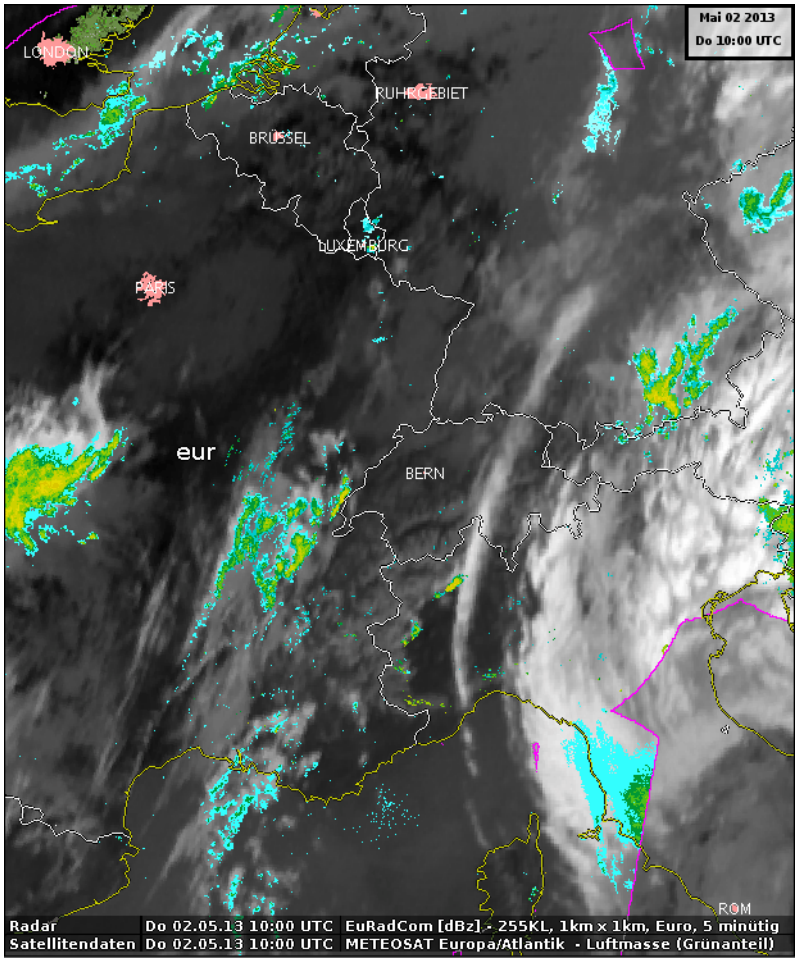
example: 2 May 2013, 10.00 – 22.00 UTC



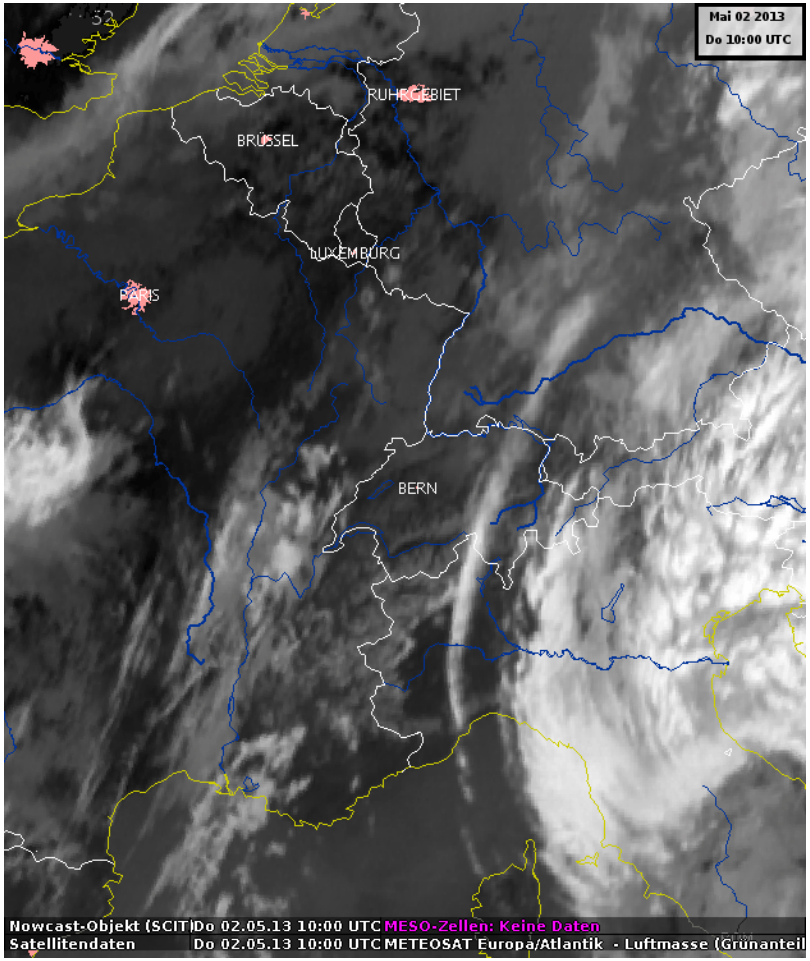
Remote sensing data at DWD – Nowcasting

Mesocyclone detection

EuRadCom



Mesocyclone detection



Remote sensing data at DWD – Nowcasting

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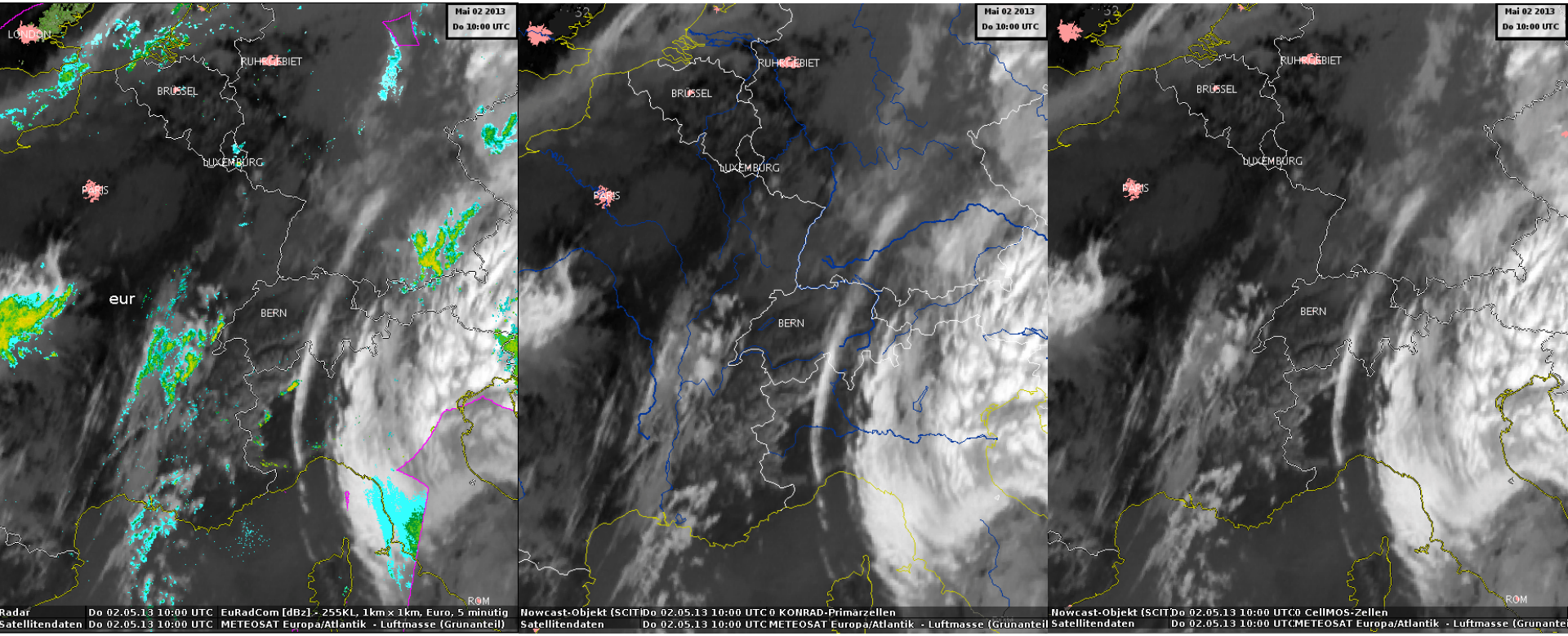
Storm cell warning + hazardous zones warning

EuRadCom | **KONRAD (radar)** | **CellMOS (radar/lightning/model)**



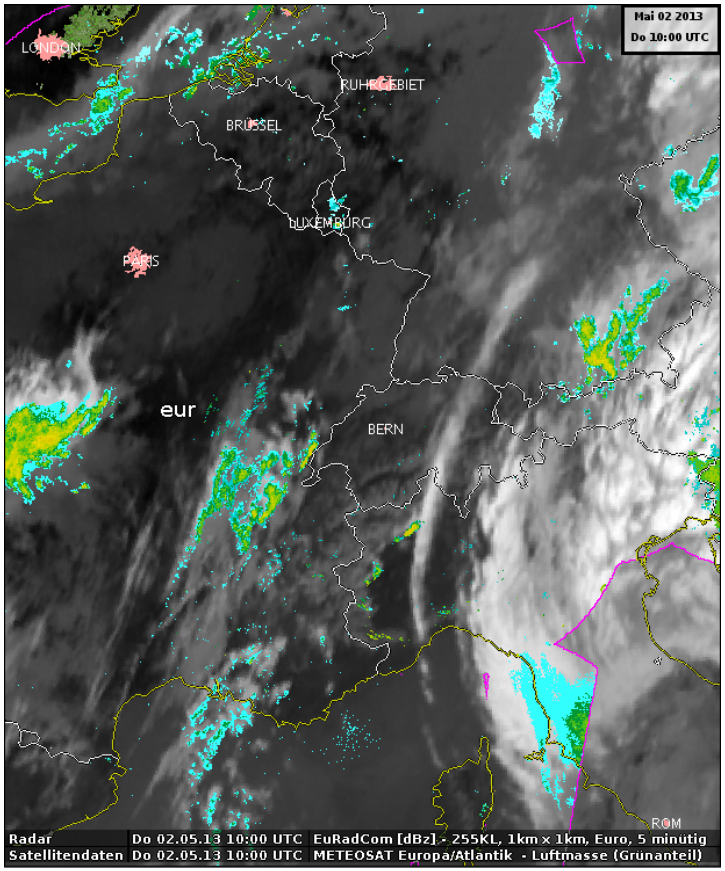
example: 2 May 2013, 10.00 – 22.00 UTC

Remote sensing data at DWD – Nowcasting

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

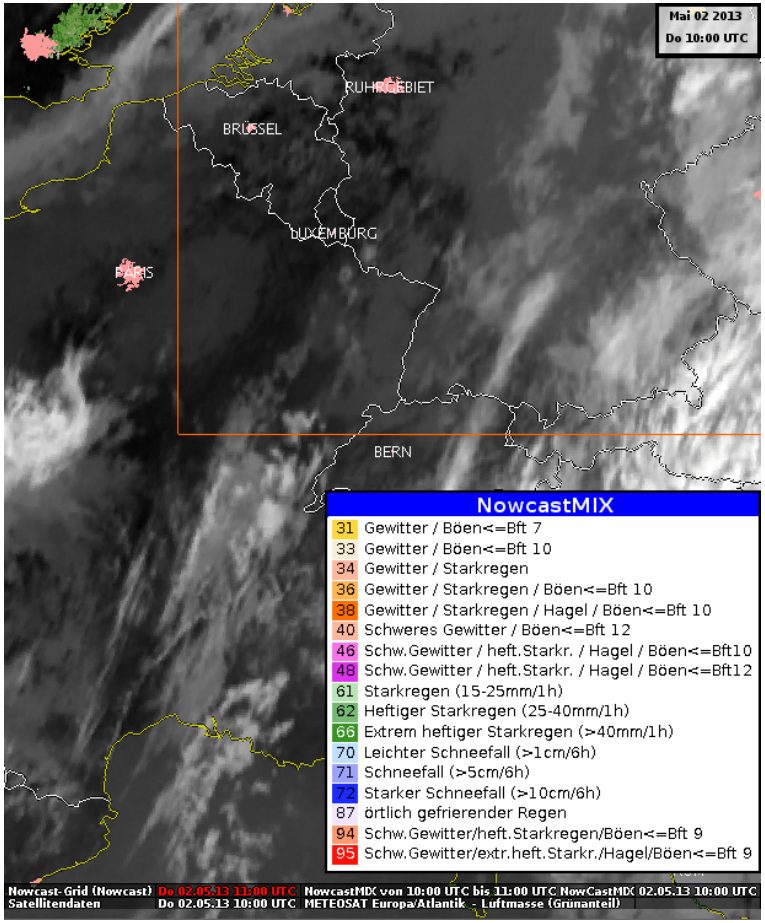
Storm cell warning + hazardous zones warning

EuRadCom



example: 2 May 2013, 10.00 – 22.00 UTC

NowCastMIX (observations/model) +1h forecast



Summary

- **Remote sensing data at DWD**
  - Developments in radar gives increasing quantity of weather information
    - extension of radar network and shortening of time interval
    - upgrade with new dual-pol Doppler radars (quality, hydrometeor identification)
  - **Satellite** data
    - strong impact in pre-precipitation period
  - Lightning data
- **Nowcast products at DWD**
  - Monitoring of precipitation structures and warning products
  - Comprehensive use of single and integrated products in operational weather forecast

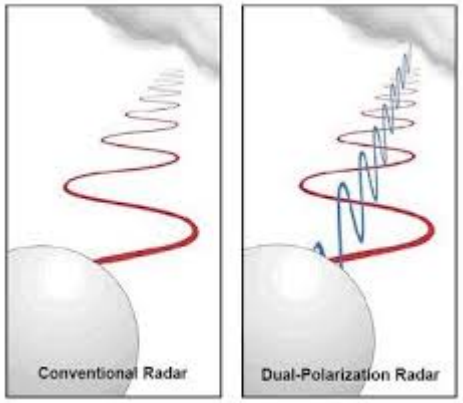
Thank you

for your attention !!

Bavaria, 02 June 2013

Remote sensing data at DWD - Radar

➔ **Upgrade with new dual-pol Doppler radars:**



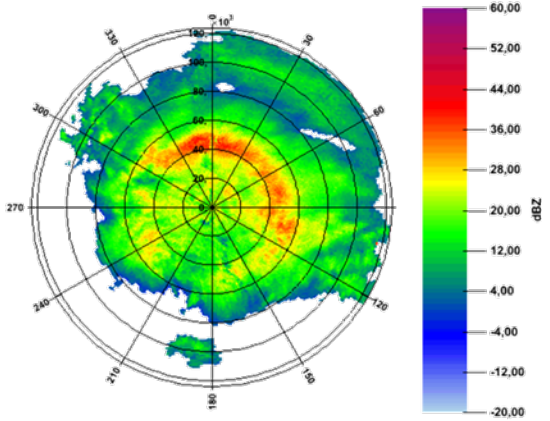
- **improved quantification** of precipitation amount
- Identification and **classification of hydrometeors**

↓

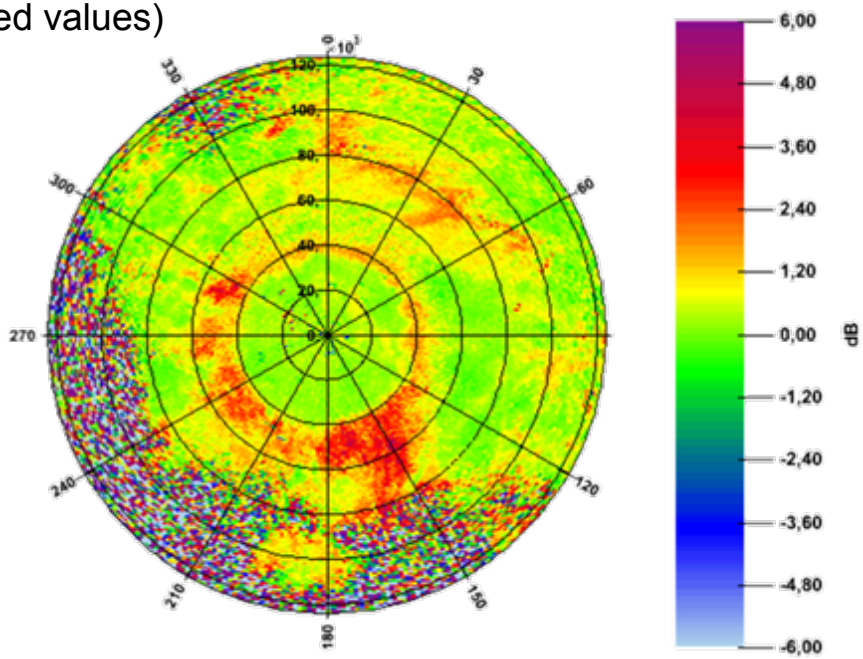
reflectivity of sweeps of 2 different polarisation directions

- roughly equal for small drops
  - ZDR near zero (green values)
- different for ice cristals
  - |ZDR| large (red values)

standard reflectivity Z



differential reflectivity ZDR



Remote sensing data at DWD - Radar

➔ **New radar scan strategy:**

- the reduction of number of sweeps
- the enlargement of cone of silence
- long distance (absorption effects)

enforce the use of **composite** products !

Cone of silence at radar München