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

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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, composites
    - 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)
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:

- aircraft
- ships
- target area with precipitation / gusts
- wet radoms
- insects
- topography/ground clutter
- WLAN
- wind turbines

Figure created by Nils Rathmann
Remote sensing data at DWD - Radar

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

quality control at radar site

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

correction algorithms:
- absorption
  absorption correction [dB] →

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

quality product includes information of the complete quality control
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

Example: 05.11.2012, 20.25 UTC
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)
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 composites (multi spectral images of MSG, e.g. different cloud heights / types)
- Derived satellite products, e.g.:
  - NWC SAF (*Satellite Application Facility on support to Nowcasting*):
    - Precipitable water, stability analyses, ...
  - MPEF (*Meteorological Products Extraction Facility*)
    - Vegetation, cloud classification, sea surface, ...
  - Volcano ash
  - Ice surface coverage
MSG - IR 10.8 μm image

case: 29 March 2012

identification of „Cold Pools“ - regions marked by instability and cold air
Combination of different MSG channels into composites

case: 29 March 2012
visual  0.6µm
infrared  1.6µm & 10.8µm

⇒ convection
⇒ heavy convection
⇒ air mass
⇒ dust
Remote sensing data at DWD - Lightning

Lightning network data:
- LINET network of company Nowcast
- 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
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
Cl (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)
CI (Convective Initiation) example: 28 May 2013, 08.00 – 14.00 UTC
**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)
Mesocyclone detection

example: 2 May 2013, 10.00 – 22.00 UTC
Remote sensing data at DWD – Nowcasting

Mesocyclone detection

EuRadCom

Mesocyclone detection
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

Storm cell warning + hazardous zones warning

EuRadCom

NowCastMIX (observations/model) +1h forecast

example: 2 May 2013, 10.00 – 22.00 UTC
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!!
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 crystals
  - $|\text{ZDR}|$ large (red values)
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!