Schweizerische Eidgenossenschaft
Confédération suisse
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Confederaziun svizra

Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

Analysing Convective Events in Switzerland using MSG, Radar and Lightning observations (COALITION second generation)

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What is available … and what is missing

TRT (Thunderstorms Radar Tracking)

540 km

Legend:

Solid: present position
Hatched: 1 hour forecast
Blue vector: cell velocity
White line: past trajectory

Cell severity ranking:

WEAK (L1)

MODERATE (L2)

SEVERE (L3)
based on vertically integrated liquid water **(VIL)**, 45 [dBZ] echo top and max echo [dBZ]

"Flash Orage": severe thunderstorm cell → warning (MeteoSwiss)

Hering, A. M., Morel, C., Galli, G., Sénési, S., Ambrosetti, P., and Boscacci, M. (2004), *Nowcasting thunderstorms in the alpine region using a radar based adaptive thresholding scheme*. Proceedings, Third ERAD Conference, Visby, Sweden, 206-211.

Goals of COALITION

The goal of COALITION is to make an optical forecast for thunderstorms and their risk potential for the next 60min.

Validation criteria are: high probability of detection, a small false alarm ration and a long warning lead time.

Therefore, COALITION makes use of different data sources
a) satellite observation
b) radar observation
c) lightning observation
d) numerical weather forecast

COALITION 1st generation

- **Goals**
  Forecast of Severity
  Early detection
  High POD, low FAR
- **Input**
  Satellite, Radar, NWP, lightning, topography
- **8 modules for VIL or CTT**
- **Forecasting method**
  Pseudo kinetic energy approach

Pseudo kinetic energy approach

Nisi, L., Ambrosetti, P. and Clementi, L. (2014), *Nowcasting severe convection in the Alpine region: the COALITION approach*. Q.J.R. Meteorol. Soc., 140: 1684–1699. doi: 10.1002/qj.2249

COALITION 2nd generation

- **Goals**
  Forecast of Severeness
  Early detection
  High POD, low FAR
- **Input**
  Satellite, Radar, NWP, lightning, topography
- **Methods**
  Logistic and Linear Regressions
  Neural Networks

Hamann, U., L. Nisi, L. Clementi, J. Figueras i Ventura, M. Gabella, A. M. Hering, I. Sideris, S. Trefalt, U. Germann, 2015, *Observing convection with satellite, radar, and lightning measurements*, Symposium EGU General Assembly 2015, Vienna, Austria

Hamann, U., L. Nisi, A. Hering, L. Clementi, M. Gabella, U. Germann, 2014 *Investigating the typical development of thunderstorms using satellite, radar and lightning observations* Eumetsat Conference 2014, Geneva, Switzerland

Regression models

Neural Networks

COALITION-2 data flow chart

Thunderstorm detection from MSG

COALITION-2 uses brightness temperature, their spectral and temporal differences of SEVIRI channels (onboard of Meteosat Second Generation MSG)

Four categories of threshold tests detect
a) optical thick clouds
b) ice clouds
c) updraft
d) small ice crystals

COALITION-2 make use of IR channels only to provide results day and night.

Threshold test for «Convective Initiation»	Cathegory
WV6.2µm – IR10.8µm	cloud depth
WV6.2µm – IR7.3µm	cloud depth
IR10.8µm	cloud depth
IR7.3µm – IR13.4µm	cloud depth
WV6.2µm – IR9.7µm	cloud depth
IR8.7µm – IR12.0µm	cloud depth
15min trend (IR8.7µm + IR12.0µm – 2xIR10.8µm)	glaciation indicator
IR8.7µm + IR12.0µm – 2xIR10.8µm	glaciation indicator
15min trend (IR8.7µm – IR10.8µm)	glaciation indicator
IR8.7µm – IR10.8µm	glaciation indicator
IR12.0µm – IR10.8µm	glaciation indicator
30min trend (WV6.2µm – IR7.3µm)	updraft strength
30min trend (IR10.8µm)	updraft strength
15min trend (WV6.2µm – IR7.3µm)	updraft strength
30min trend (IR9.7µm – IR13.4µm)	updraft strength
30min trend (WV6.2µm – IR10.8µm)	updraft strength
IR3.9µm – IR10.8µm (day only)	small ice crystals

Inspired by Mecikalski et al, 2010, *Cloud-Top Properties of Growing Cumulus prior to Convective Initiation as Measured by Meteosat Second Generation. Part I: Infrared Fields*

05:55

Comparsion of wind fields

Multi-level advection scheme
for nowcasting of brightness temperatures

real observation

Multi-level advection scheme

real observation

CTP<400hPa

400<CTP<700hPa

CTP>700hPa

Multi-level advection scheme

real observation

CTP<400hPa

400<CTP<700hPa

CTP>700hPa

Multi-level advection scheme

real observation

CTP<400hPa

400<CTP<700hPa

CTP>700hPa

Challenges for multi-level advection

HRoverview:
→low clouds

CloudTopTemperature:
→ fractional clouds, high and low

Challenges for multi-level advection

Challenges for multi-level advection

Challenges for multi-level advection

U. Hamann et al., MeteoSwiss

Challenges for multi-level advection

U. Hamann et al., MeteoSwiss

Threshold Tests for Convective Initiation

COALITION-2 RGB product

COALITION-2 uses the number of passed indicator tests as
a) optical thick clouds (red)
b) updraft (green)
c) ice clouds (blue)
to create a false colour composite (RGB)

Due to the construction the colours have following meaning

- thick ice cloud
- developing cloud
- developing ice cloud
- ice cloud with medium optical thick.

COALITION-2 RGB

optical thickness (red)

updraft (green)

glaciation (blue)

COALITION-2 product suit

07.07.2015

Beside the satellite COALITION-2 makes use of radar and lightning information.

The four panels show a typical example of developing thunderstorms (07.07.2015 11:20 – 18:30 UTC).

Satellite, radar and lightning information show a very good correspondence. Each sensor reveals more details of the thunderstorm and its risk potential.

All data are available each 5min. Spatial resolution is 1km for radar, 3km for satellite, 100m for lightning.

COALITION-2 RGB

High Resolution Visible

Radar Rain Rate

Lightning Rate

COALITION-2 products 12:00 UTC *07.07.2015*

COALITION-2 products 14:30 UTC *07.07.2015*

COALITION-2 product suit

08.08.2015

Combined satellite, radar, and lightning observations for 23rd July 2014

Radar

Radar

Lightning

MSG SEVIRI

MSG SEVIRI

06UTC 09UTC 12UTC 15UTC 18UTC 21UTC 24UTC

Take home messages

- Nowcasting Algorithms at MeteoSwiss
  Thunderstorm Radar Tracking
  COALITION First Generation
  COALITION Second Generation (in preparation)

- Goals of COALITION
  Input datasets: Radar, satellite, lightning, NWP forecasts
  Increase lead-time for thunderstorm warnings
  Forecast of intensification of thunderstorms

- COALITION as multi-sensor (Expert) System
  Satellite: Brightness temperatures, reflectivity, channel differences, temporal tendencies
  Radar: Maximum reflectivity, ECHOTOPS, MESH, POH
  Lightning: lightning density, cloud-ground, intra-cloud, current
  COSMO: CAPE, CIN, wind shear, tropopause height, freezing level

- COALITION Second Generation
  Replacing pseudo-kinetic energy approach with threshold tests
  and later regression and neural network technics
  Making use of long term statistics

COALITION-2 product suit

07.07.2015

COALITION-2 products 11:20 UTC *07.07.2015*

COALITION-2 products 11:30 UTC *07.07.2015*

COALITION-2 products 11:40 UTC *07.07.2015*

COALITION-2 products 11:50 UTC *07.07.2015*

COALITION-2 products 12:00 UTC *07.07.2015*

COALITION-2 products 12:10 UTC *07.07.2015*

COALITION-2 products 12:20 UTC *07.07.2015*

COALITION-2 products 12:30 UTC *07.07.2015*

COALITION-2 products 12:40 UTC *07.07.2015*

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COALITION-2 products 17:50 UTC *07.07.2015*

COALITION-2 products 18:00 UTC *07.07.2015*

Multi-sensor approach

- Monitoring and Nowcasting of intense thunderstorm
- Automatic support for the weather forecaster
- Generating Warning according to specific risks
  Intense precipitation, hail, lightnings, wind gusts
- Synergetic use of satellite, radar, lightning and NWP weather models

Outlook: COALITION-2.5

- **Goals**
  Forecast of Severeness
  Early detection
  High POD, low FAR
- **Input**
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Regression models

Neural Networks

Convective Initiation Satellite product

COALITION-2 uses the indicators
a) optical thick clouds
b) ice clouds
c) updraft
to create a false colour composite (RGB)

Due to the construction the colours have following meaning

- thick ice cloud
- developing cloud
- strong developing or expanding cloud

COALITION-2 RGB

updraft (red)

glaciation (blue)

optical thickness (green)