

Evaluating the representation of precipitation in the COSMO model for Belgium

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QUEST (*Quantitative Evaluation of Regional Precipitation Forecast Using Multi-Dimensional Remote Sensing Observations*)

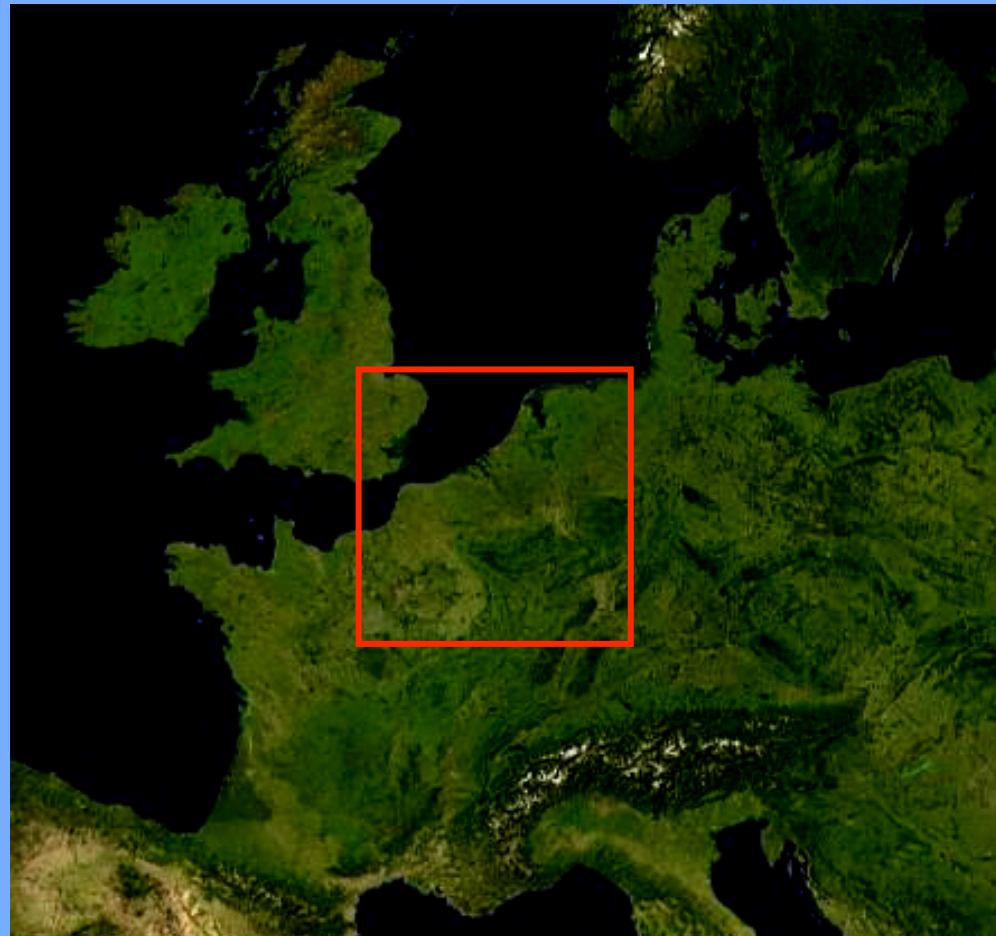
→ QUEST-B: Focus on Belgium

This presentation:

- Can the radar observations help to show a model progress from 3-21 to 4-3?

→ Reflectivity and precipitation studies (frontal & convective situations)

Region of interest:



Atmospheric model - I

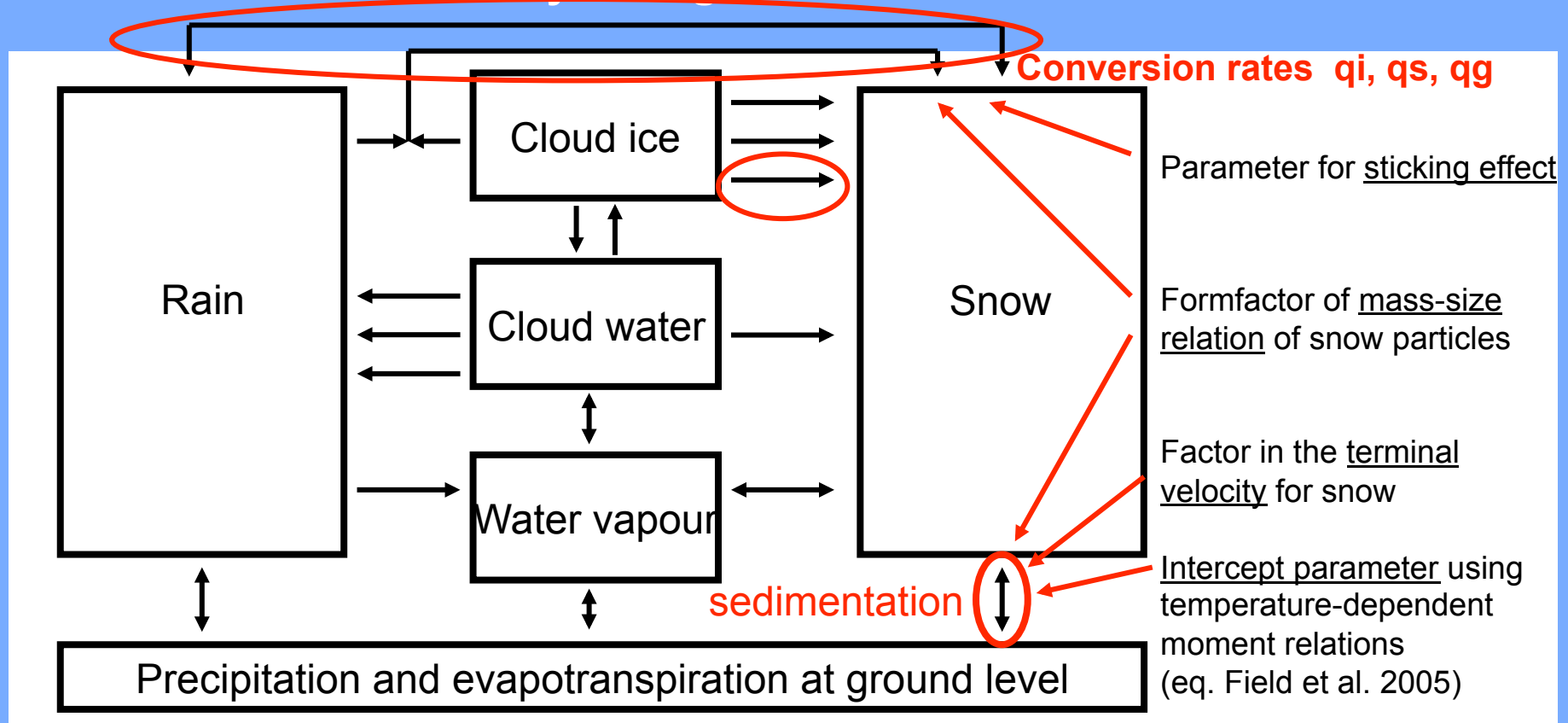
- **COSMO-DE** model ($\Delta x = 2.8$ km), forcing with COSMO-EU
- “4-3” version 4-3 (full version),
“3-22” version 4-3 with 3-21 rain parameterization,
“3-21” version 4-3 with 3-21 rain and snow parameterization
- in case studies → comparison of - reflectivity
- precipitation data
with volume radar data (Wideumont)

Atmospheric model - II

- Major Changes in the **snow** parameterization: (version 3-21 in brackets)
 - Variable intercept parameter for **snow** (equation of Field, 2005):
$$\text{isnow_n0temp} = 2 \quad (0)$$
 - Changes in geometry and fall speed of **snow**
(factor in the terminal velocity for snow):
$$\text{zv0s} = 20.0 \quad (4.90), \quad \text{zv1s} = 0.50 \quad (0.25)$$
 - Formfactor in the mass-size relation of **snow** particles:
$$\text{zams} = 0.069 \quad (0.038)$$
 - Change in parameter for sticking effect $\text{zeff} = \text{max. } 0.2 \quad (0.5)$
- Change in autoconversion rate
 - Kessler (3-21) → Seifert and Beheng (4-3) warm rain scheme with constant droplet number concentration

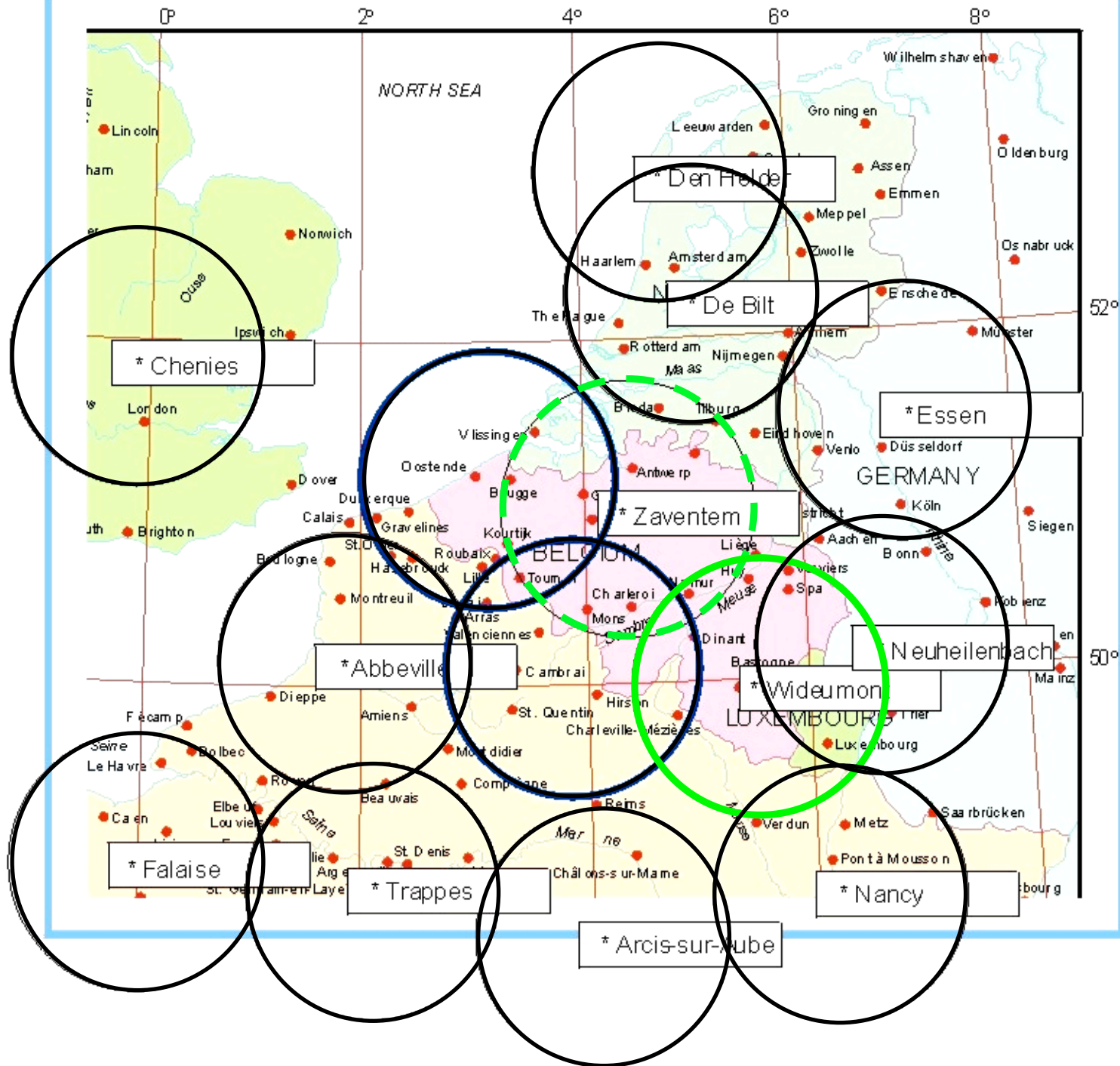
Atmospheric model COSMO 4-3:

Parts of the hydrological cycle in the model,
which are affected by changes:



Comparison to observations_

- C-band Doppler Radar ($f = 5.6 \text{ GHz}$, $\lambda = 5.4 \text{ cm}$)
 - Scans at 10 elevation angles each 15 minutes ($0.5 - 17.5^\circ$)
 - Horizontal resolution is 500 m in range and 1° in azimuth
 - Use of **volume data** (Wideumont)
- Satellite data (MSG, MODIS, CLOUDSAT)
- GPS data
- Synoptical weather stations

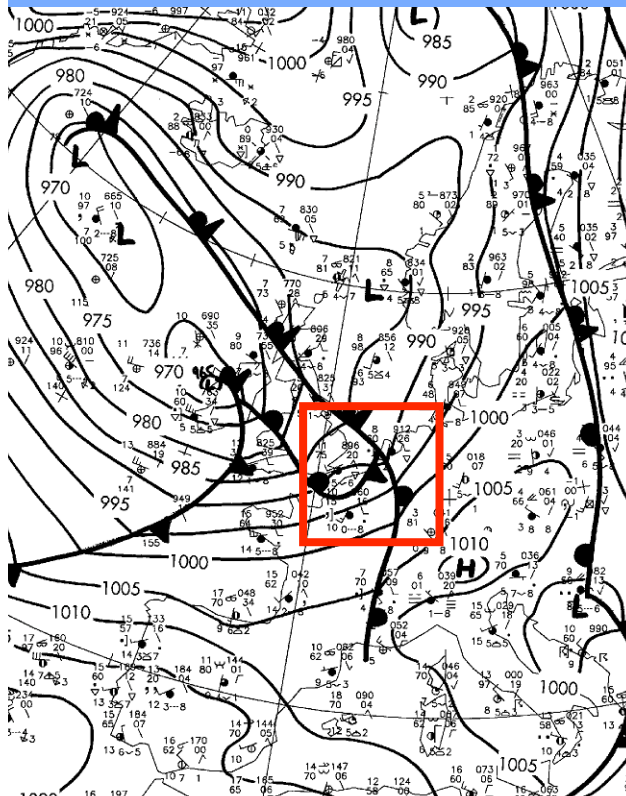


Case studies:

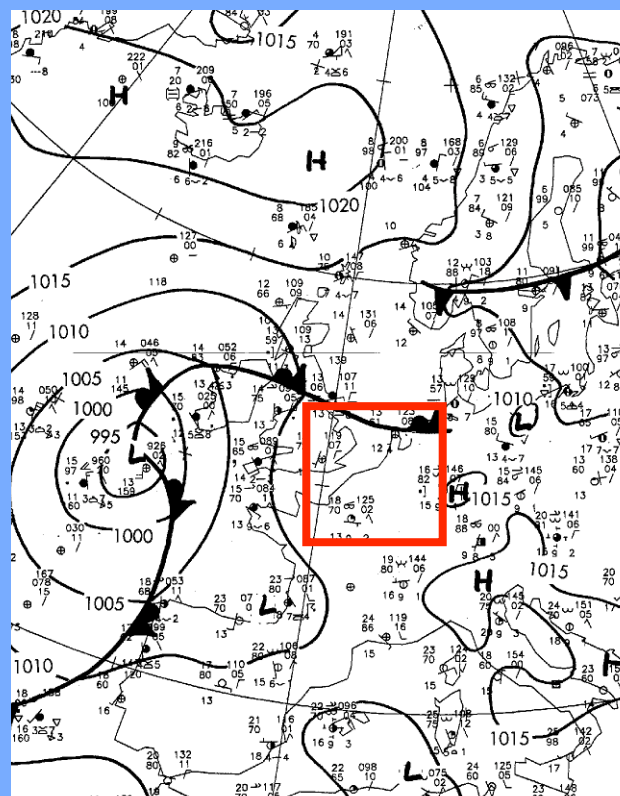
(23/11/06 (F), 19/06/07 (F), 22/06/07 (C), 20/07/07 (C), 12/08/07 (C))

2 stratiform precipitation cases

23/11/2006



19/06/2007



Case studies:

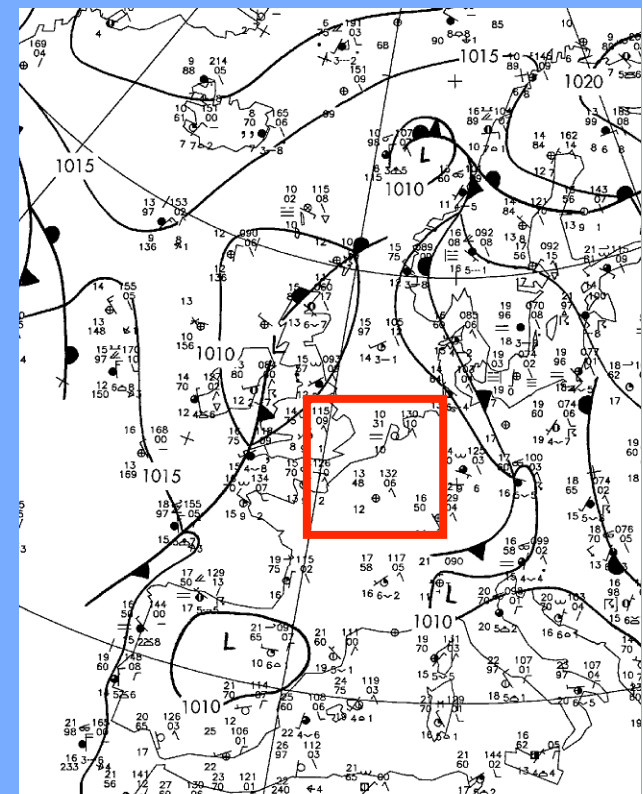
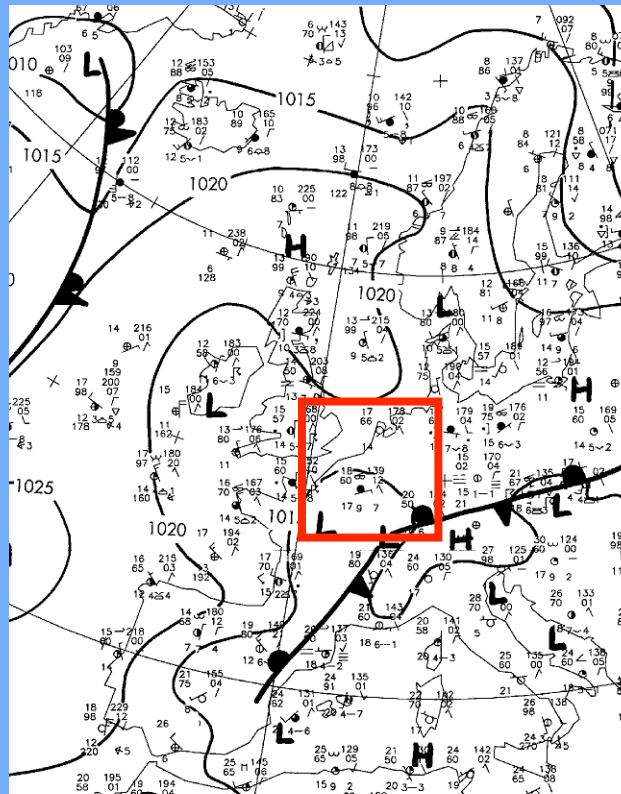
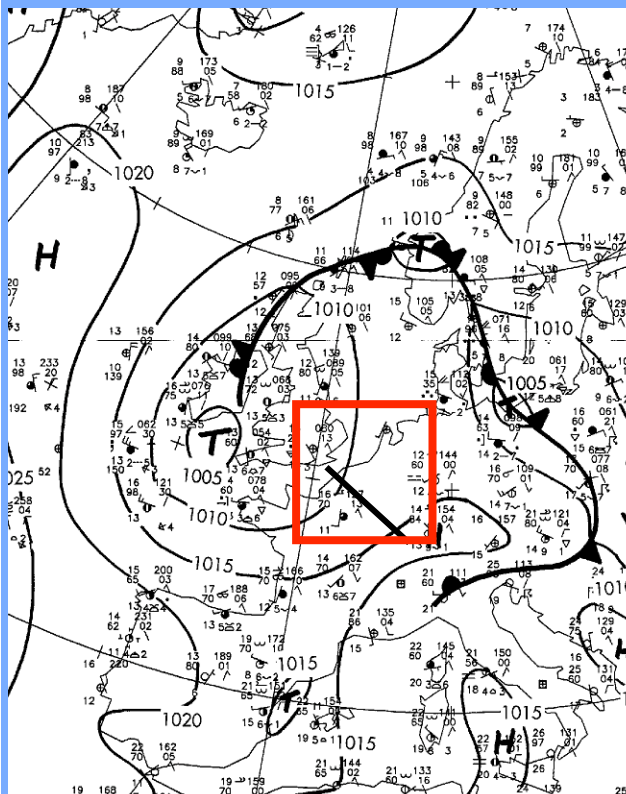
(23/11/06 (F), 19/06/07 (F), 22/06/07 (C), 20/07/07 (C), 12/08/07 (C))

3 Convective cases

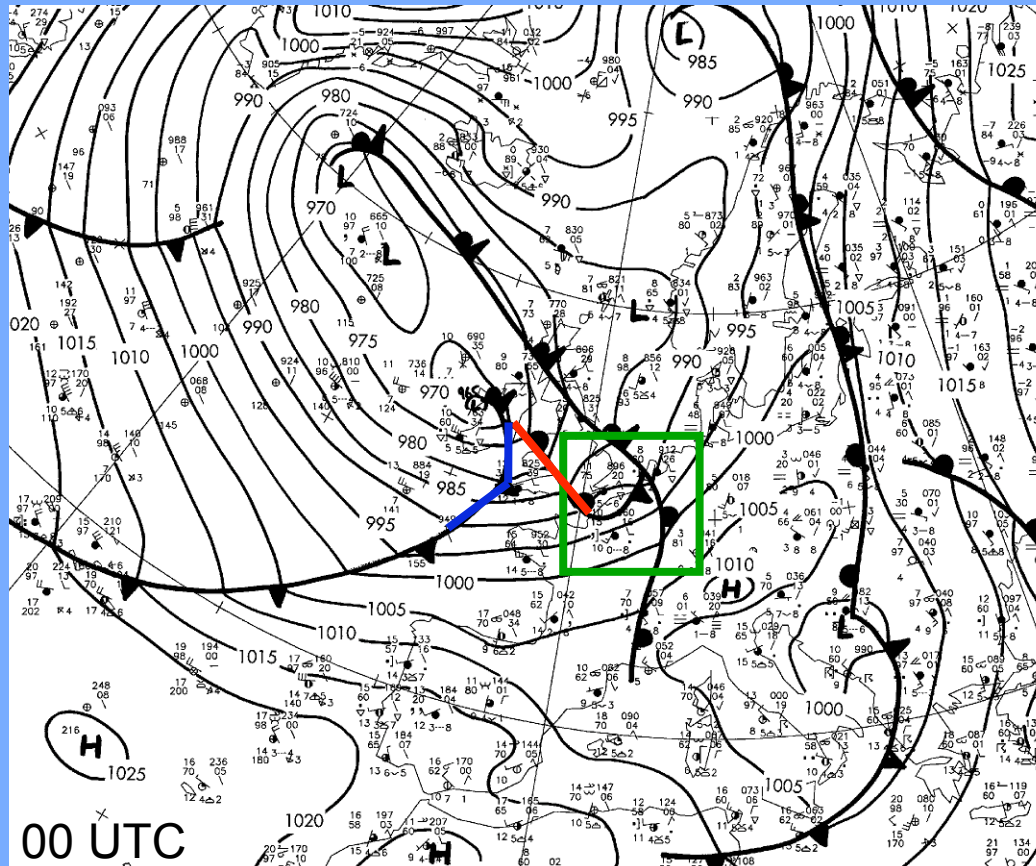
22/06/2007

20/07/2007

12/08/2007

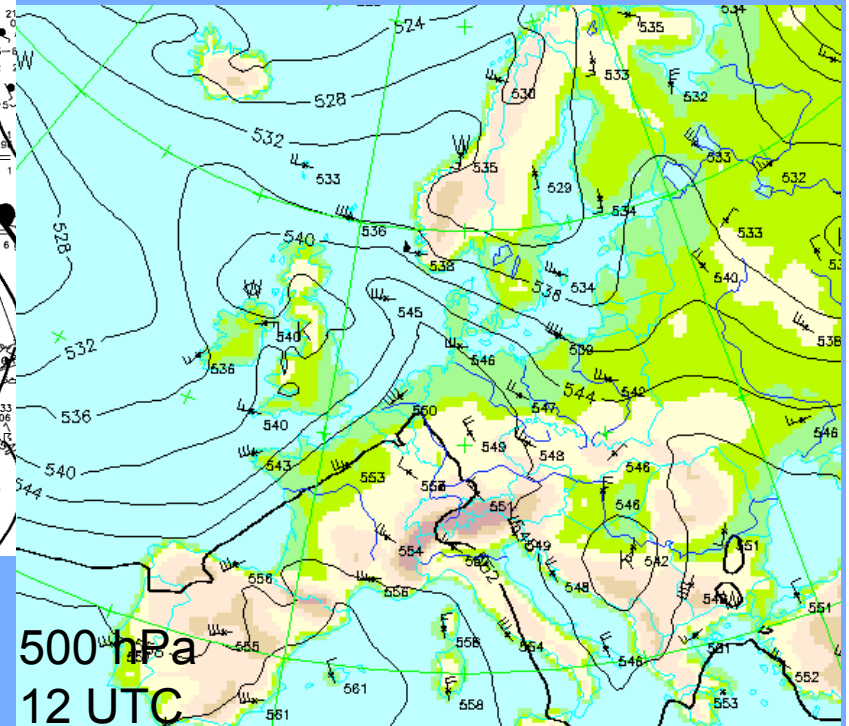


Case studies I: 23/11/2006



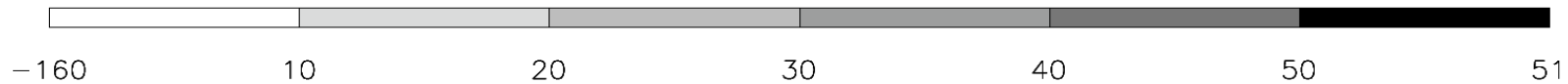
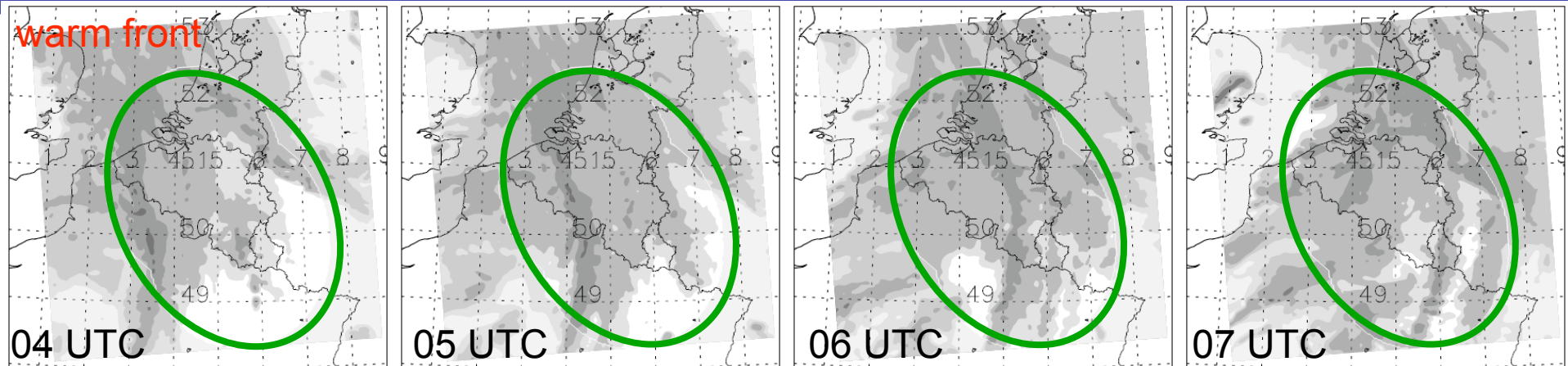
In the morning:
passing of a **warm** front

In the afternoon:
passing of a **cold** front

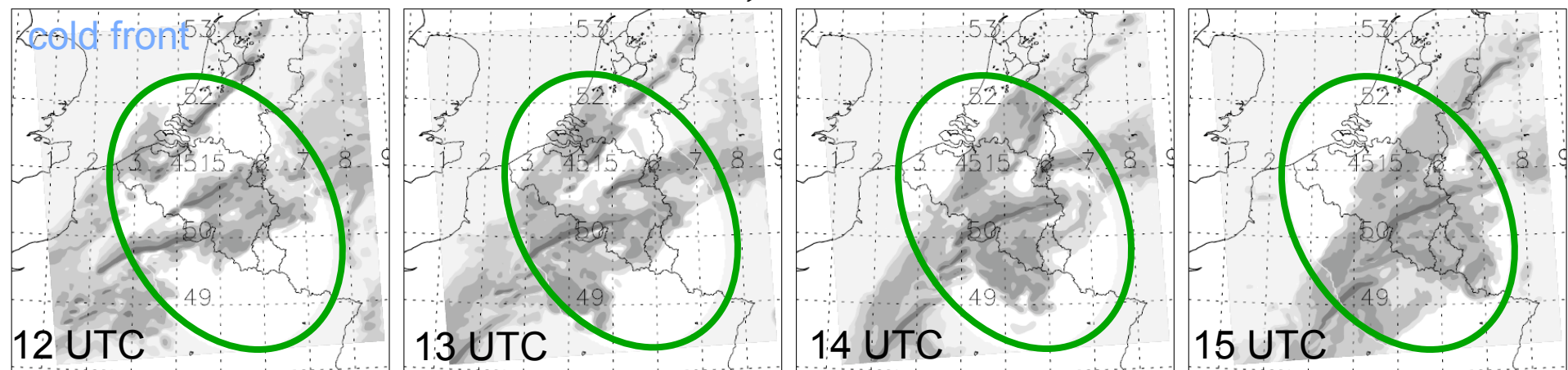


Case studies I - reflectivity: 23/11/2006

Modelled reflectivity of the **warm front** 04-07 UTC and **cold front** 12-15 UTC (4-3):

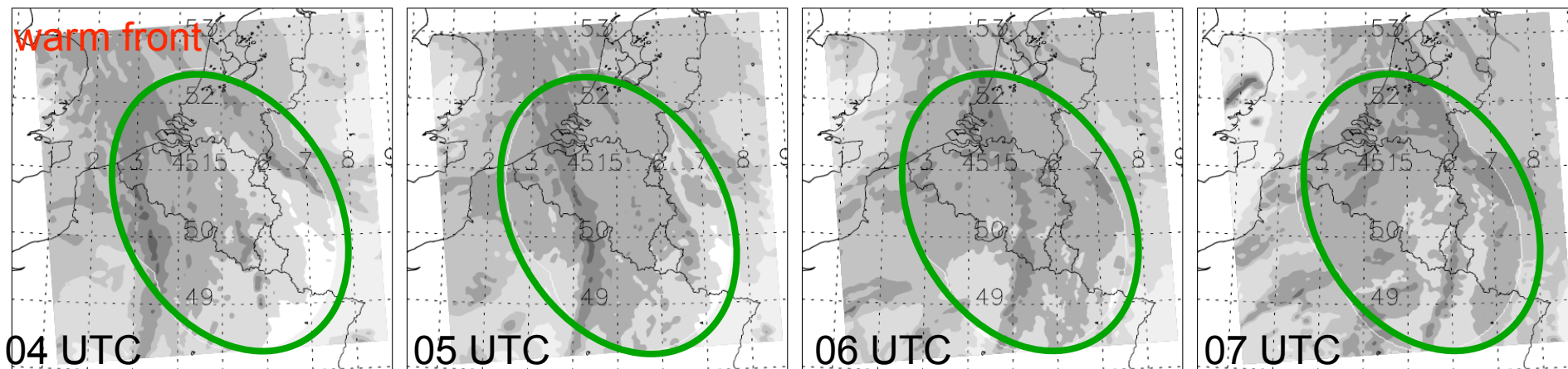


Reflectivity value in dBZ

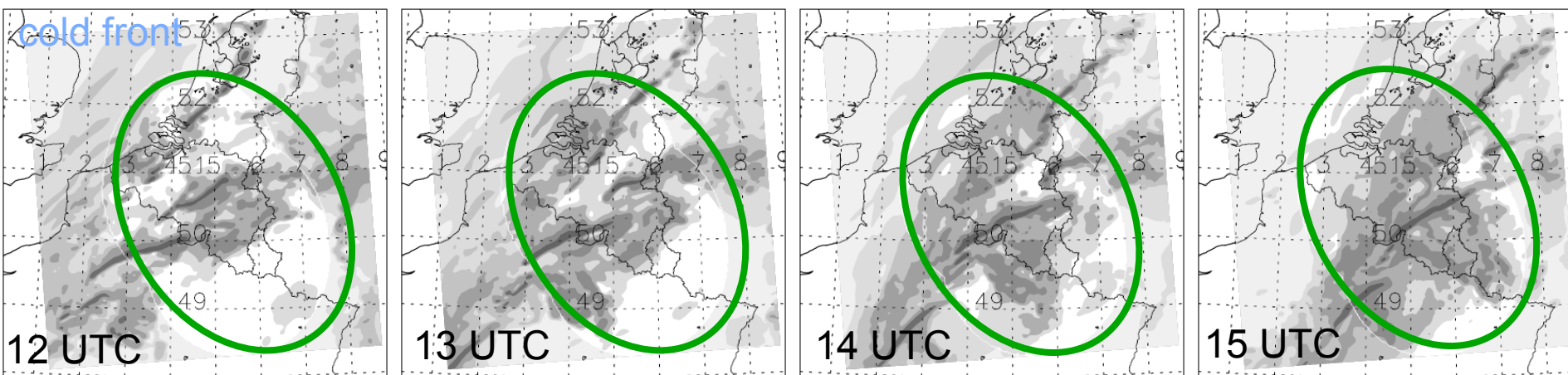


Case studies I - reflectivity: 23/11/2006

Modelled reflectivity of the **warm front** 04-07 UTC and **cold front** 12-15 UTC (3-21):

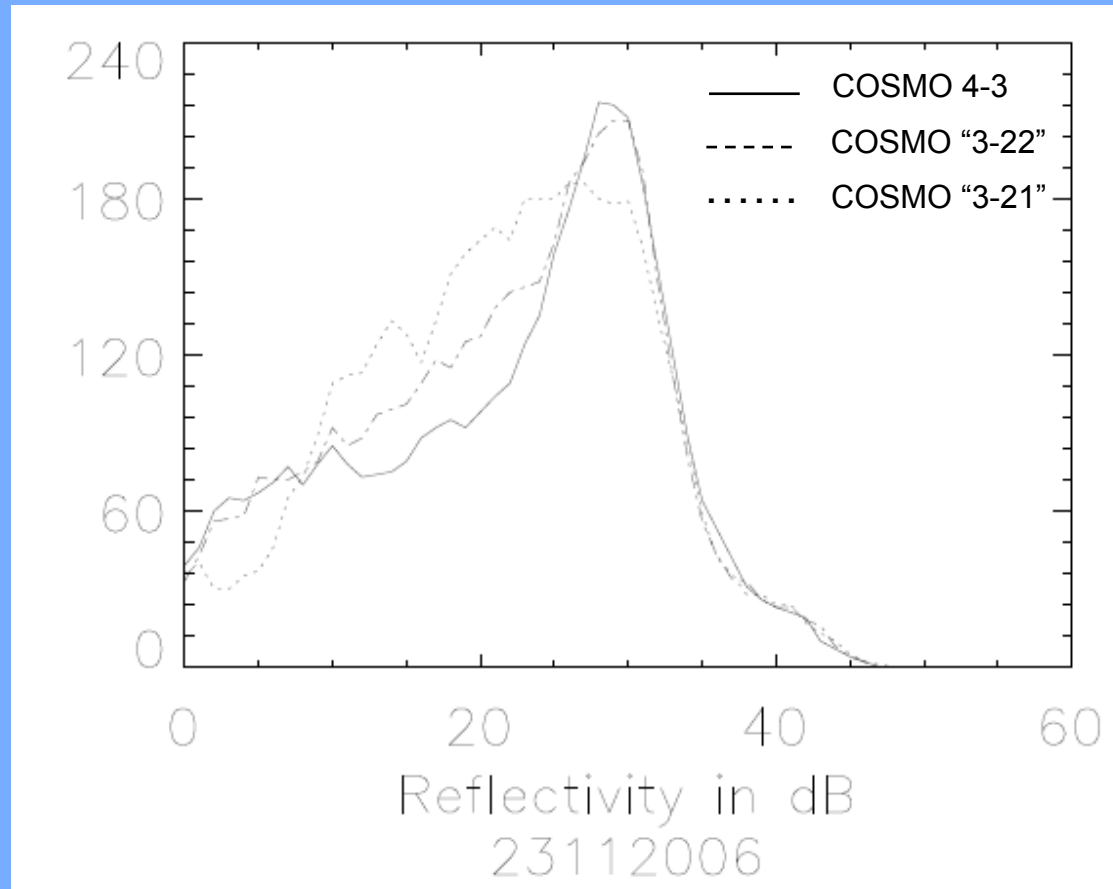


Reflectivity value in dBZ



Case studies I - reflectivity: 23/11/2006

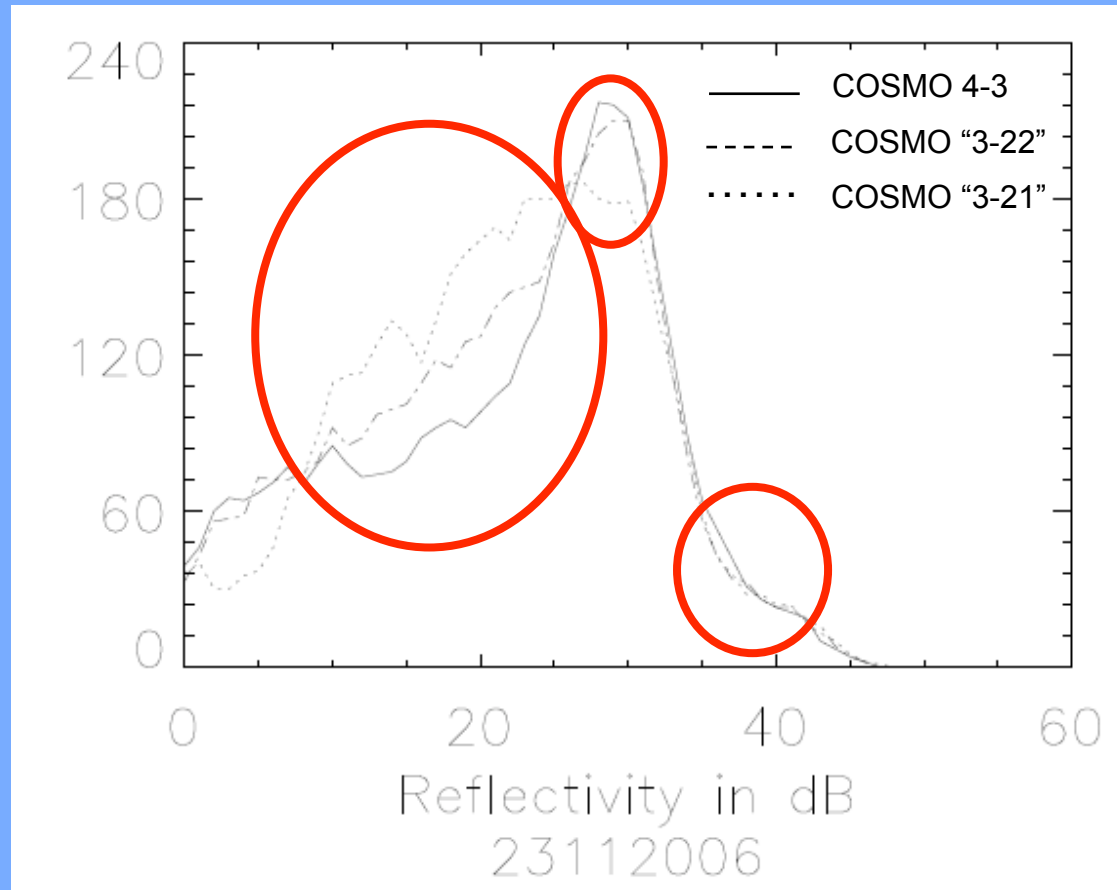
Histograms reflectivity:



Averaged reflectivity over event time
in 120 km from Wideumont radar

Case studies I - reflectivity: 23/11/2006

Histograms reflectivity:



Averaged reflectivity over event time
in 120 km from Wideumont radar

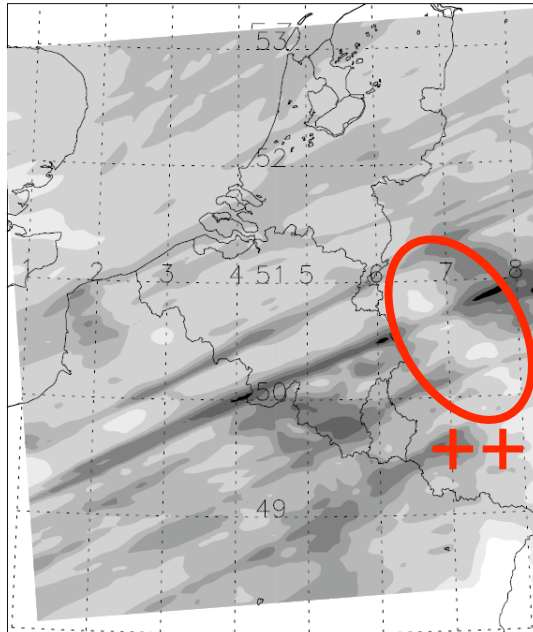
Case studies I - precipitation: 23/11/2006

COSMO „3-21“ (rain+snow)

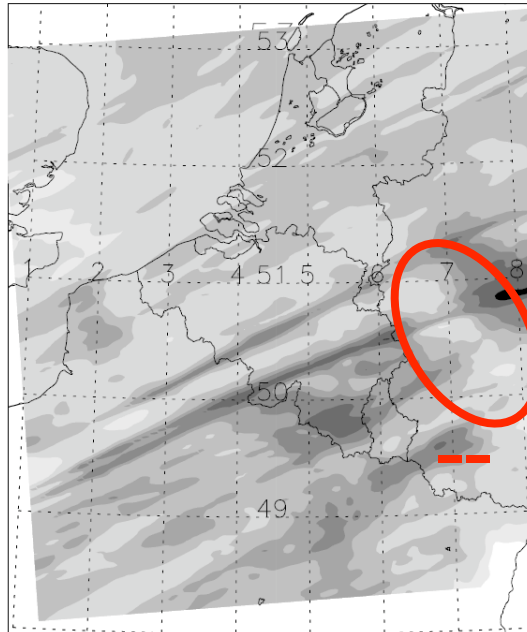
COSMO 4-3

COSMO „3-22“ (rain)

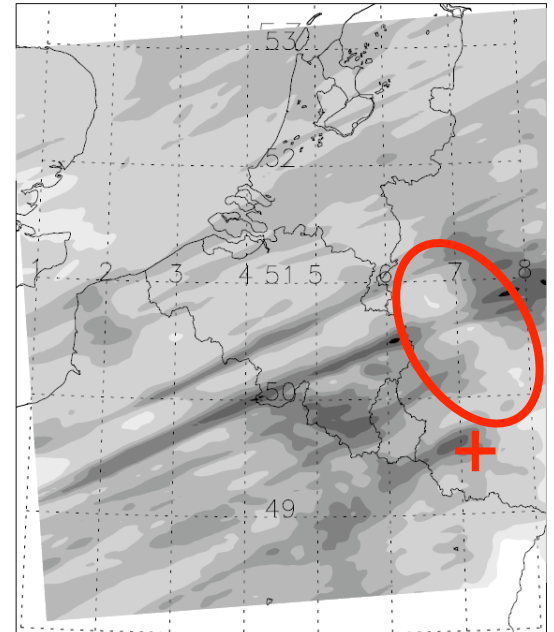
Precipitation (COSMO 3-21) – 20061123



Precipitation (COSMO 4-3) – 20061123



Precipitation (COSMO 3-22) – 20061123



24 hours accumulated precipitation (00-24 UTC)



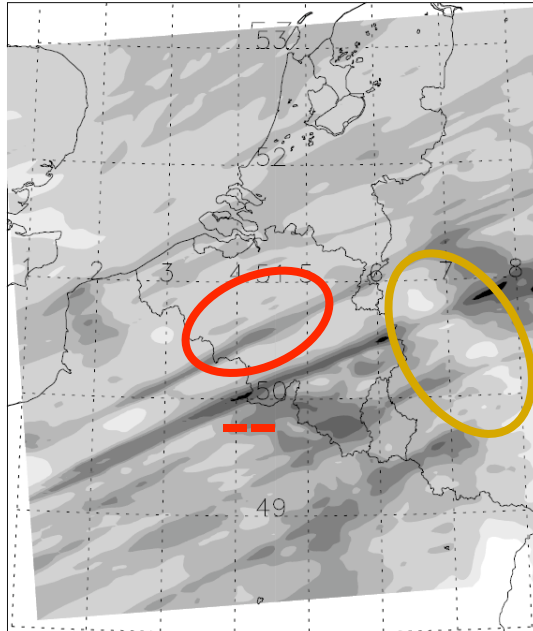
Case studies I - precipitation: 23/11/2006

COSMO „3-21“ (rain+snow)

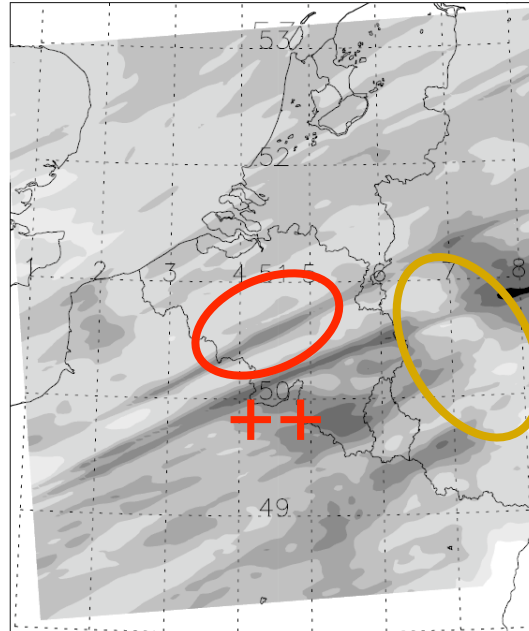
COSMO 4-3

COSMO „3-22“ (rain)

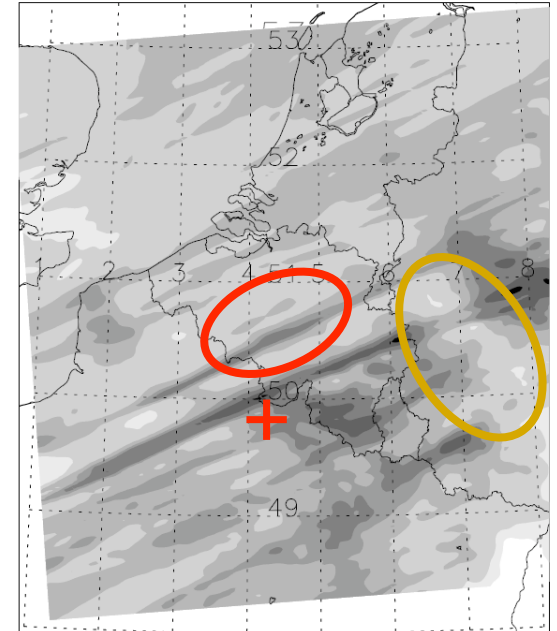
Precipitation (COSMO 3-21) - 20061123



Precipitation (COSMO 4-3) - 20061123



Precipitation (COSMO 3-22) - 20061123



24 hours accumulated precipitation (00-24 UTC)

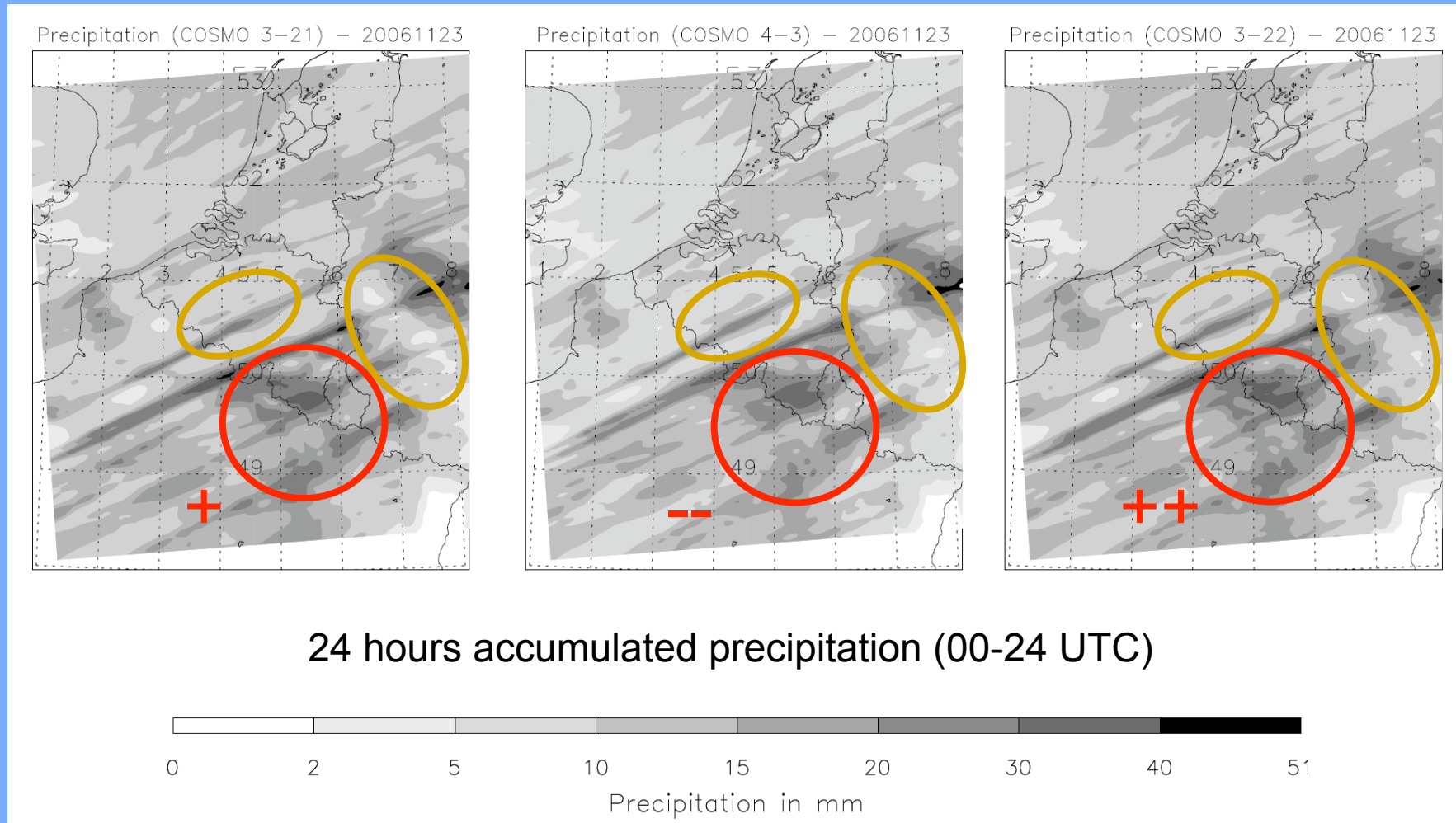


Case studies I - precipitation: 23/11/2006

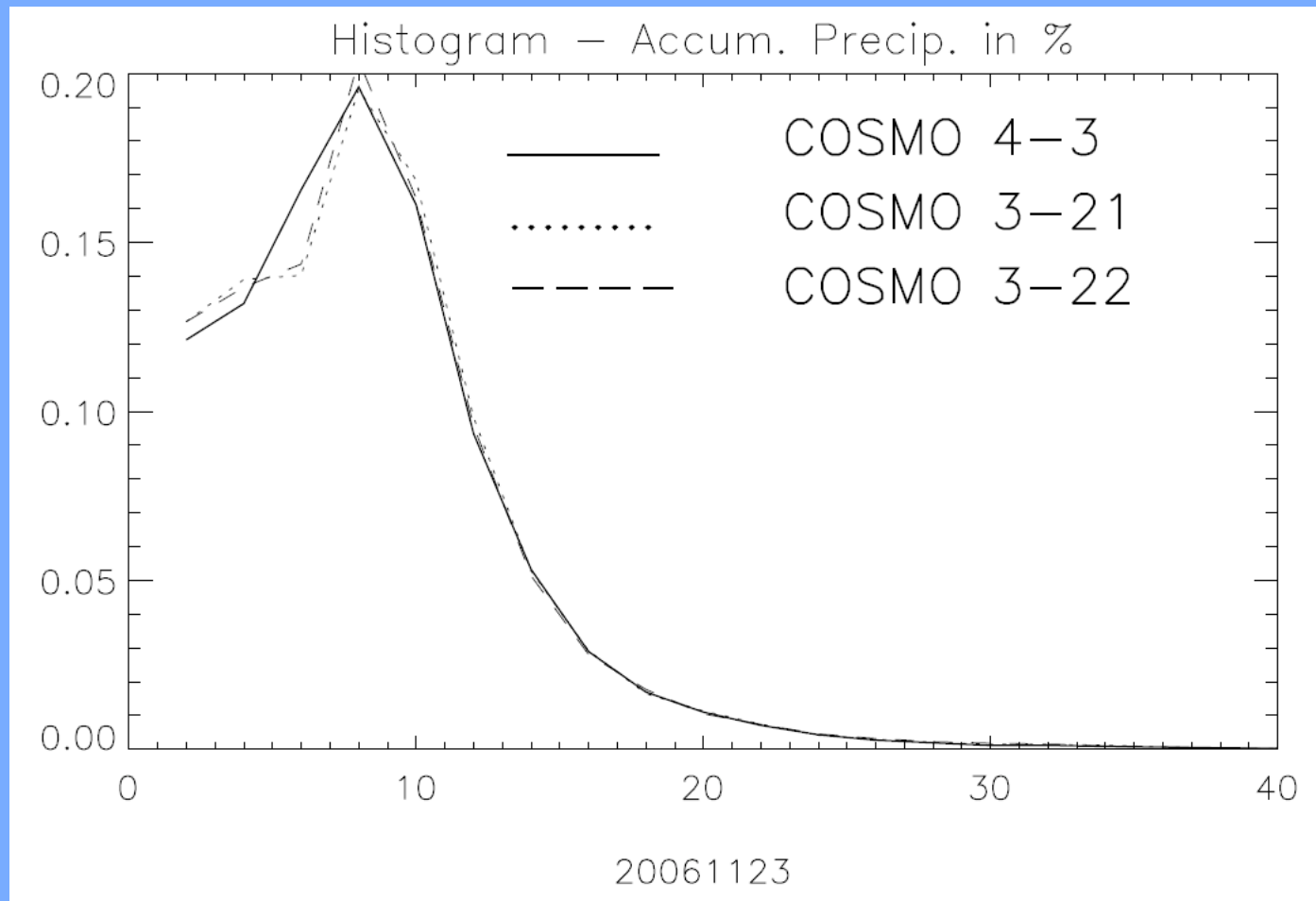
COSMO „3-21“ (rain+snow)

COSMO 4-3

COSMO „3-22“ (rain)



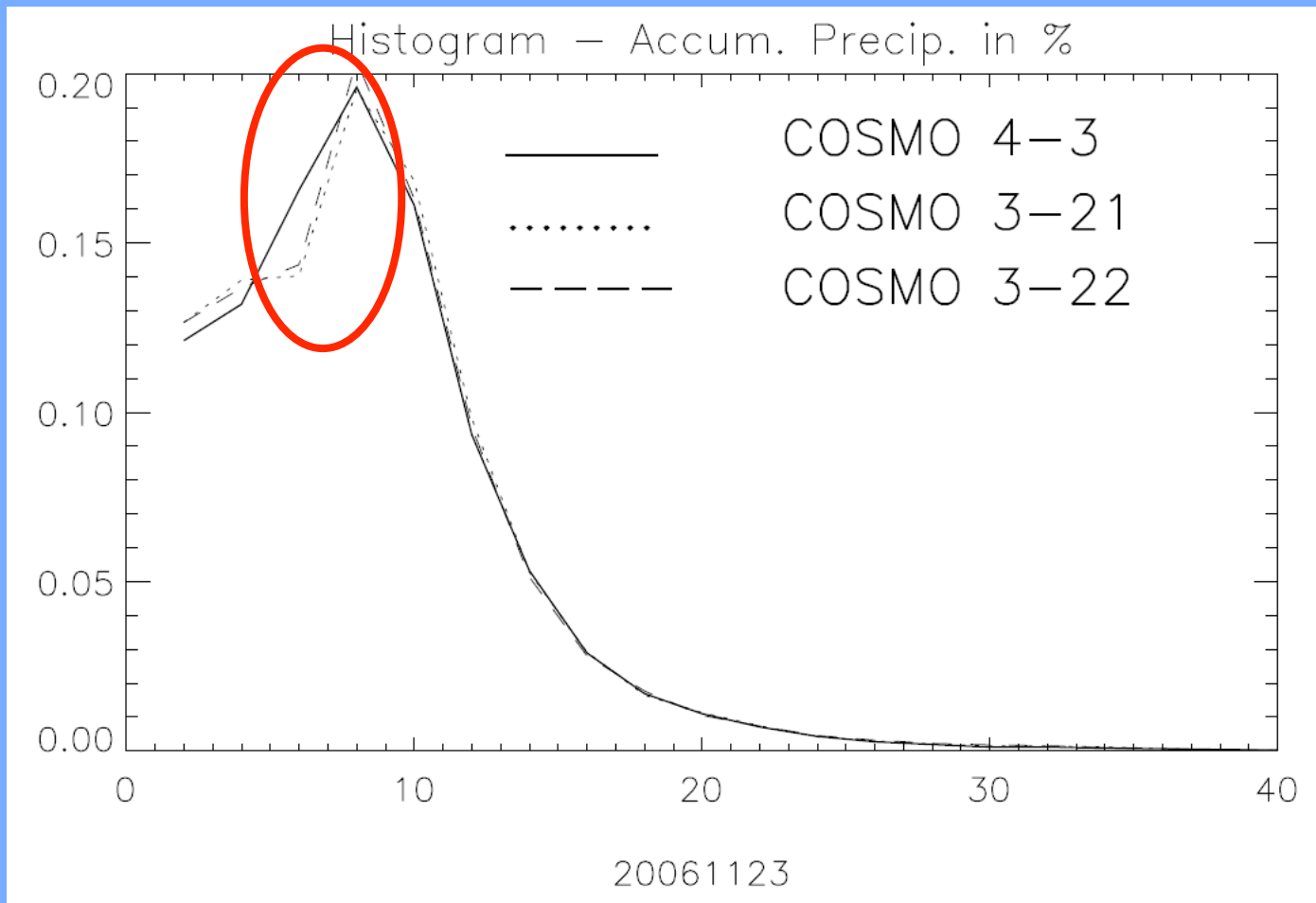
Case studies I - precipitation: 23/11/2006



24 hours accumulated precipitation (00-24 UTC)
of the entire domain

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Case studies I - precipitation: 23/11/2006



24 hours accumulated precipitation (00-24 UTC)
of the entire domain

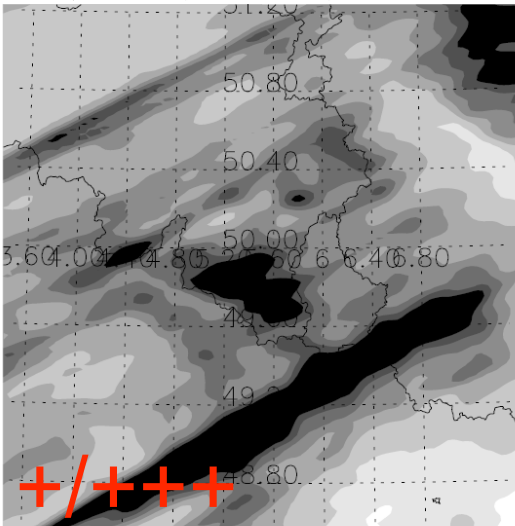
Case studies I - precipitation: 23/11/2006

ECMWF forcing

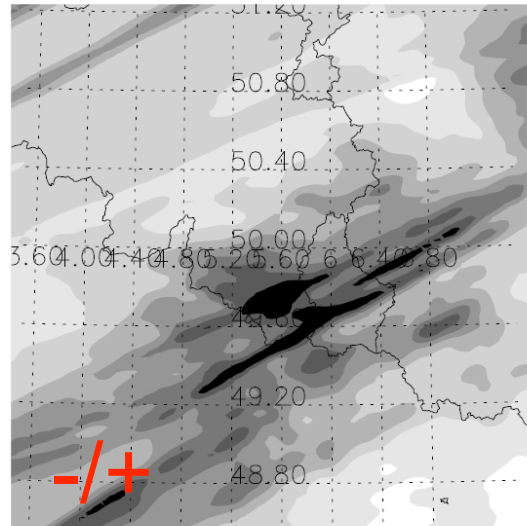
DWD forcing

Volume radar Wideumont
(rain gauge merged data)

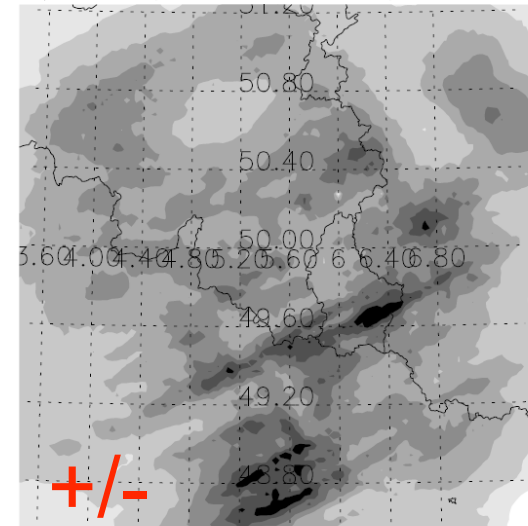
Precipitation (ECMWF-6h) - 20061123



Precipitation (COSMO-6h) - 20061123



Precipitation (RADAR Wideumont) - 20061123

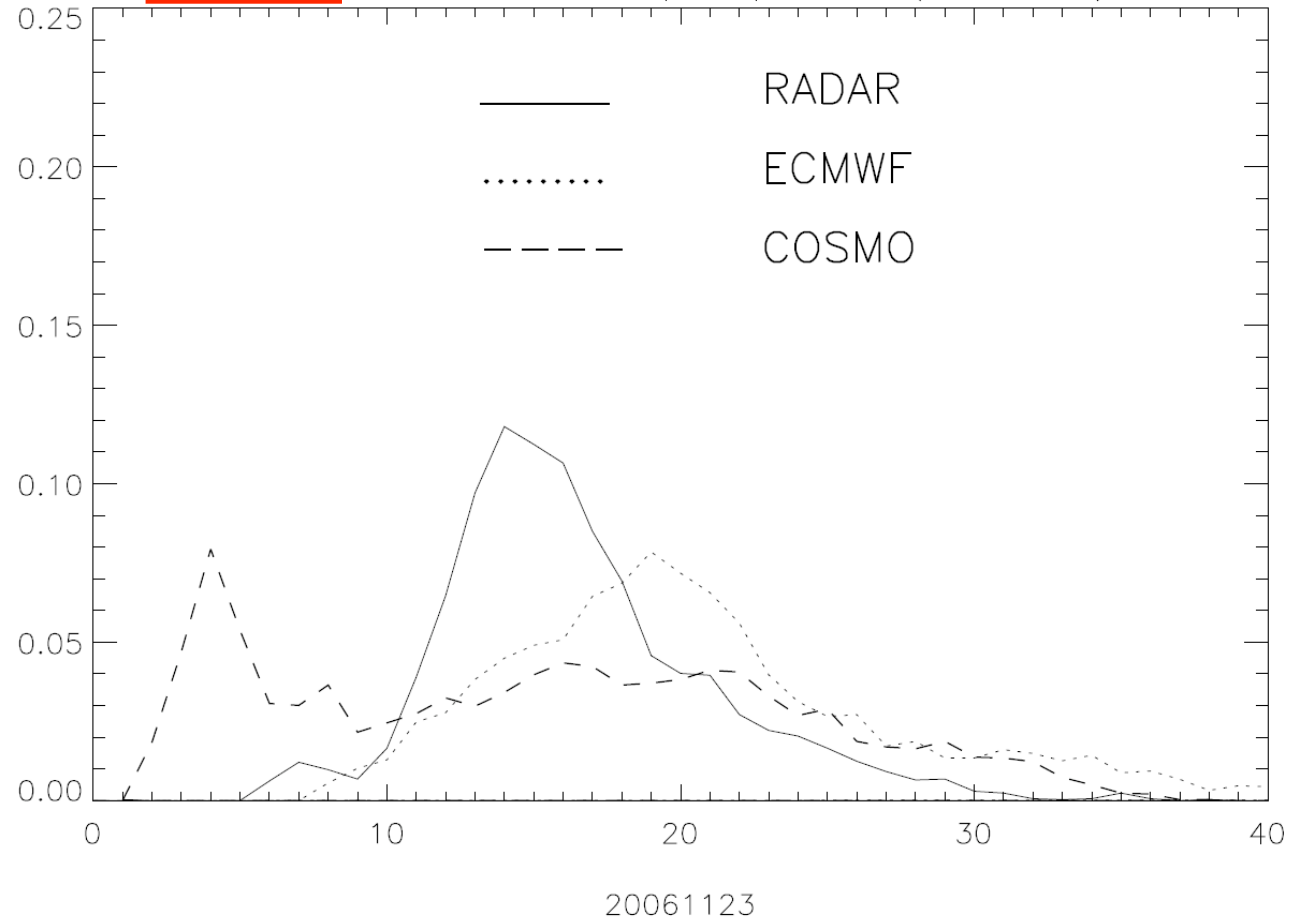


24 hours accumulated precipitation (00-24 UTC)

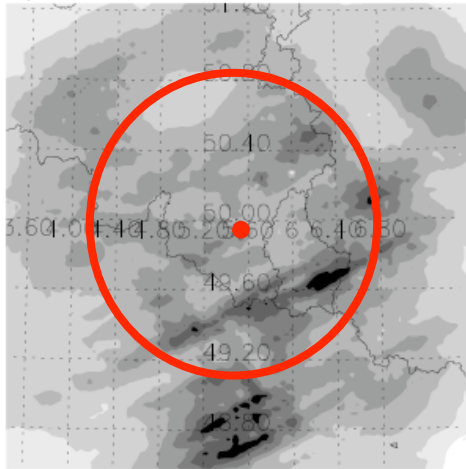


Case studies I - precipitation: 23/11/2006

Histogram – Accumulated precipitation (24 hours) in %



Precipitation (RADAR Wideumont) – 20061123



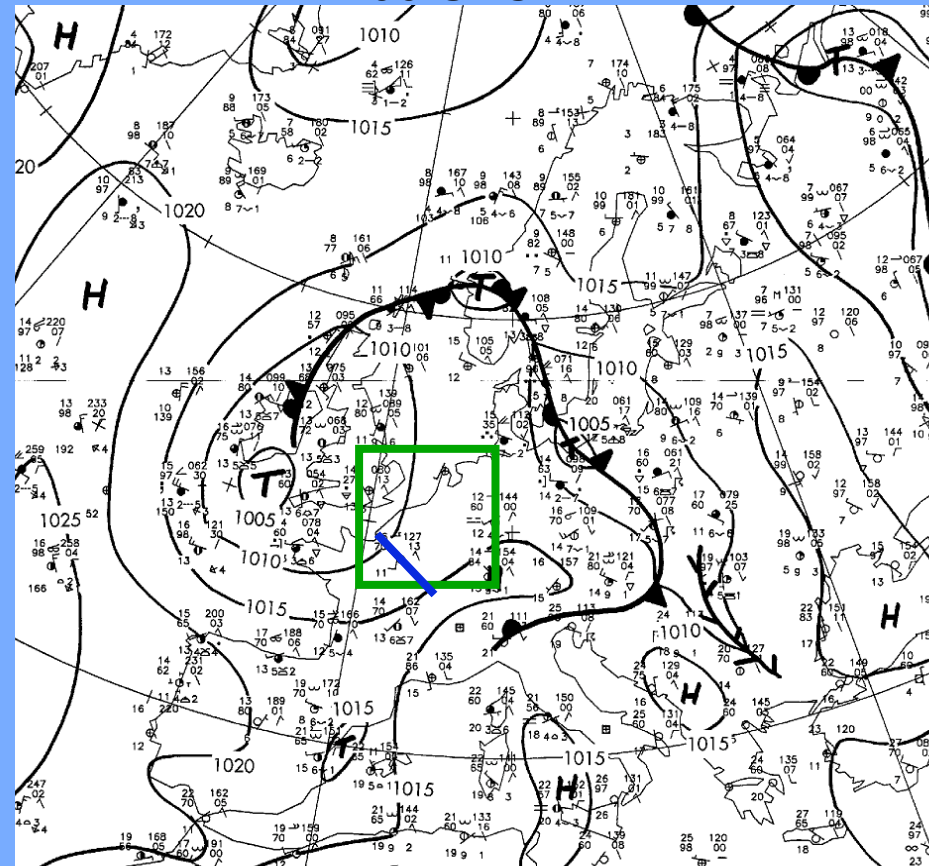
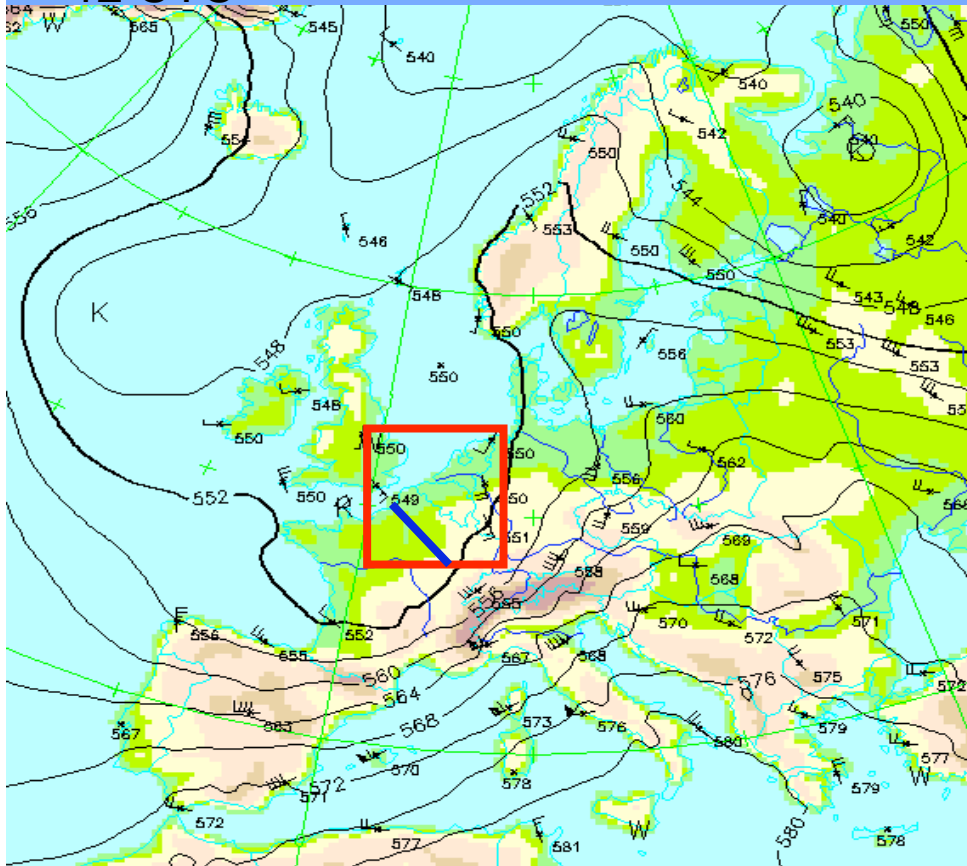
24 hours accumulated precipitation (00-24 UTC)
in 120 km from Wideumont radar

Case studies II: 22/06/2007

500 hPa geopotential
12 UTC

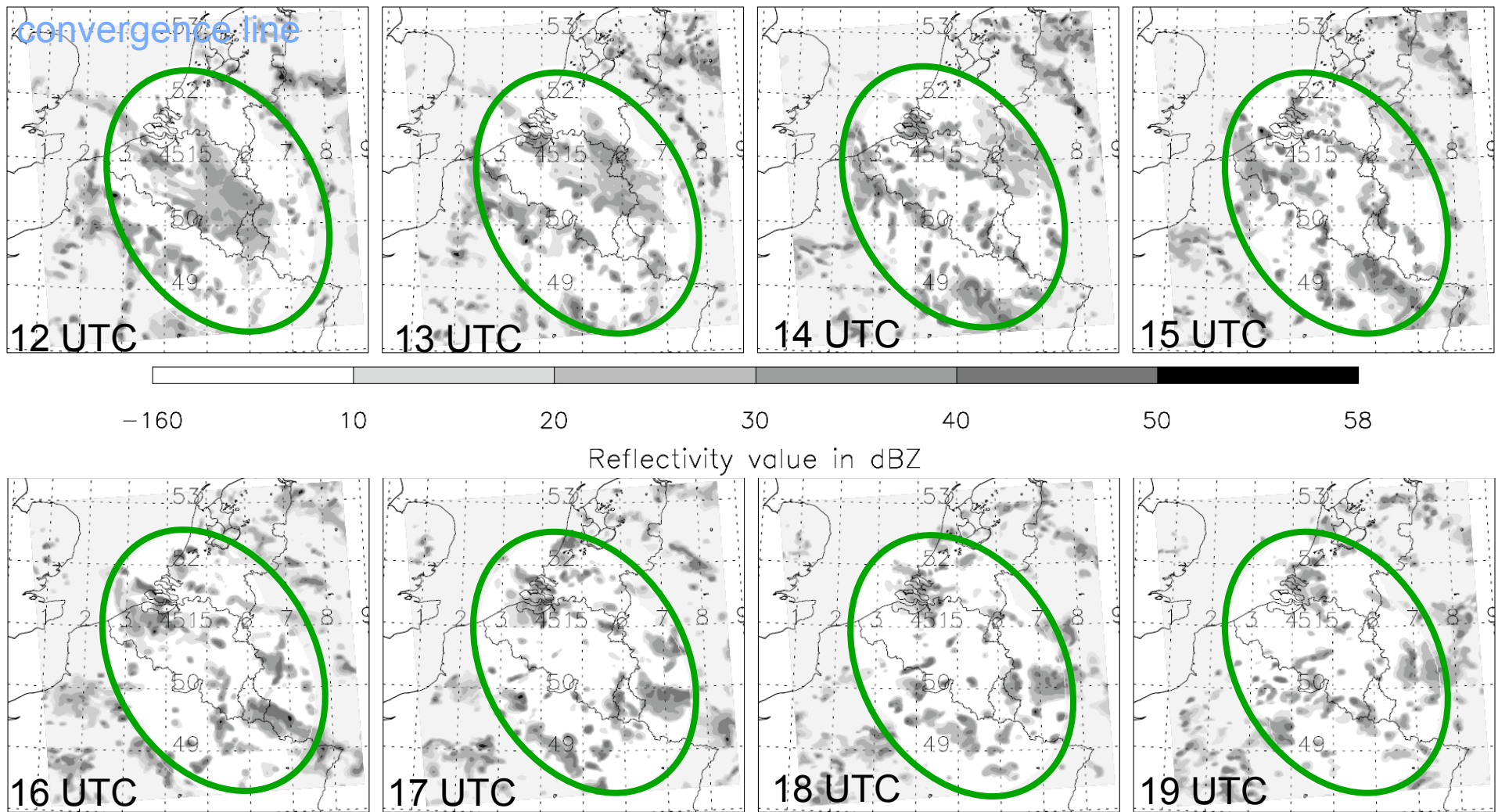
In the morning and afternoon:
passing of a **convergence line**

Fronts + surface pressure
00 UTC



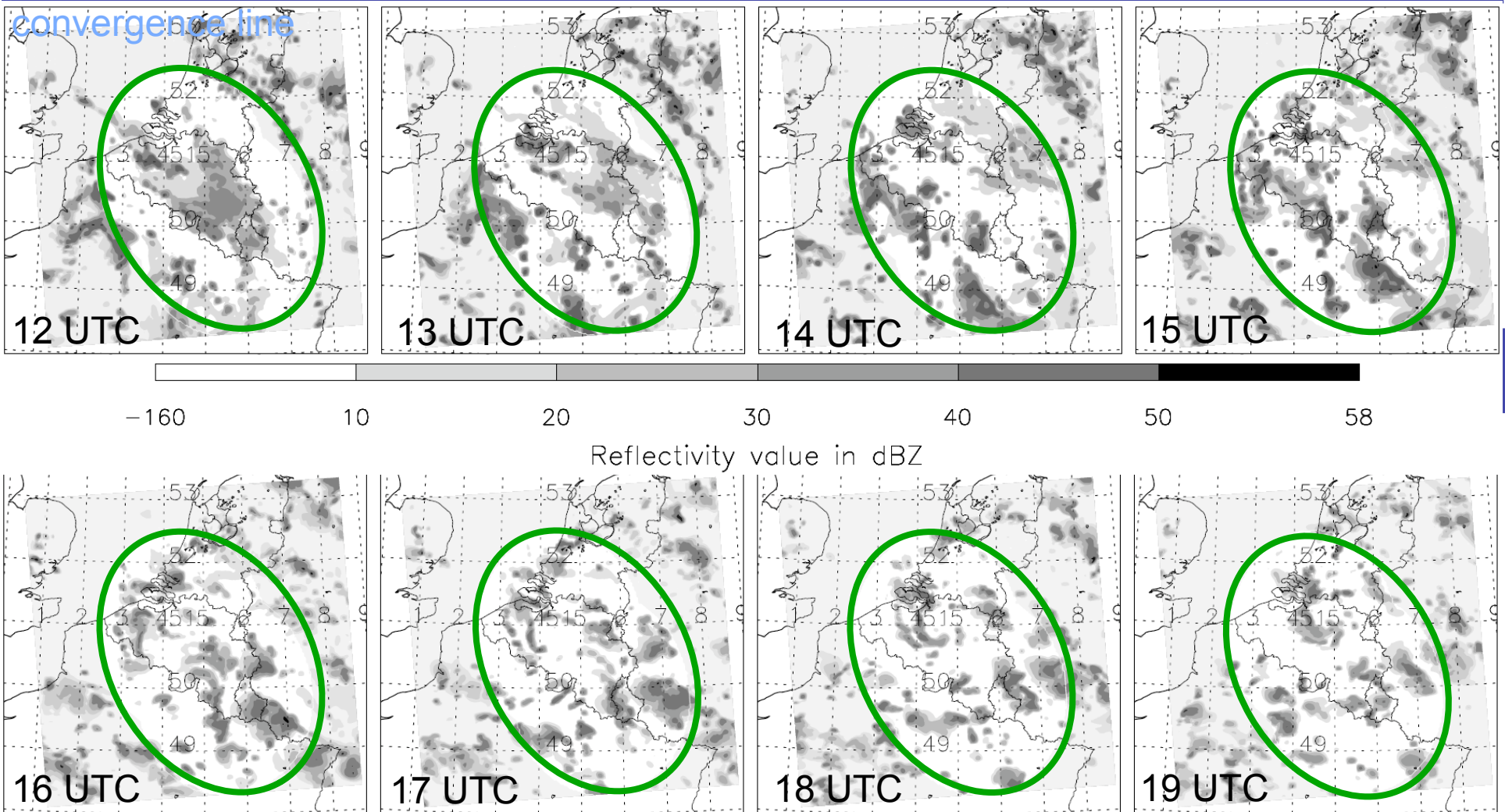
Case studies II - reflectivity: 22/06/2007

Modelled reflectivity of the convergence line 12-19 UTC (4-3):



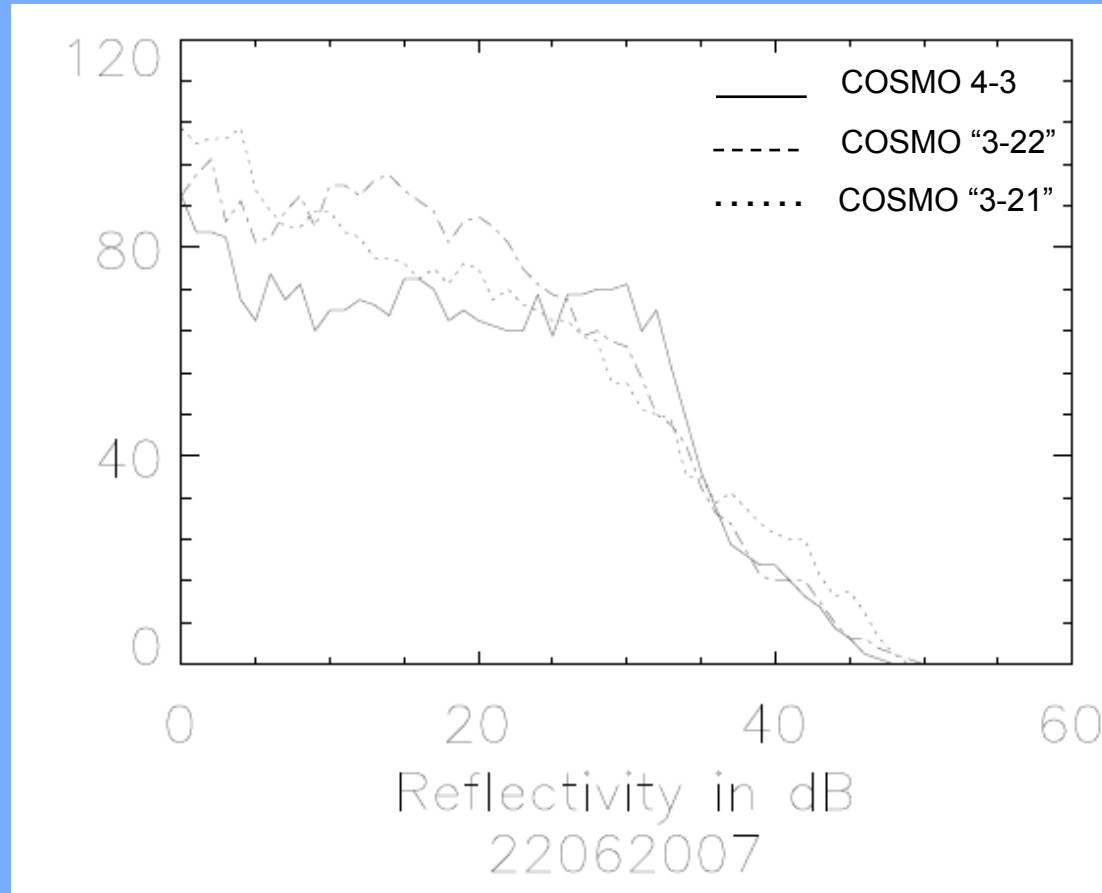
Case studies II - reflectivity: 22/06/2007

Modelled reflectivity of the convergence line 12-19 UTC (3-21):



Case studies II - reflectivity: 22/06/2007

Histograms reflectivity:

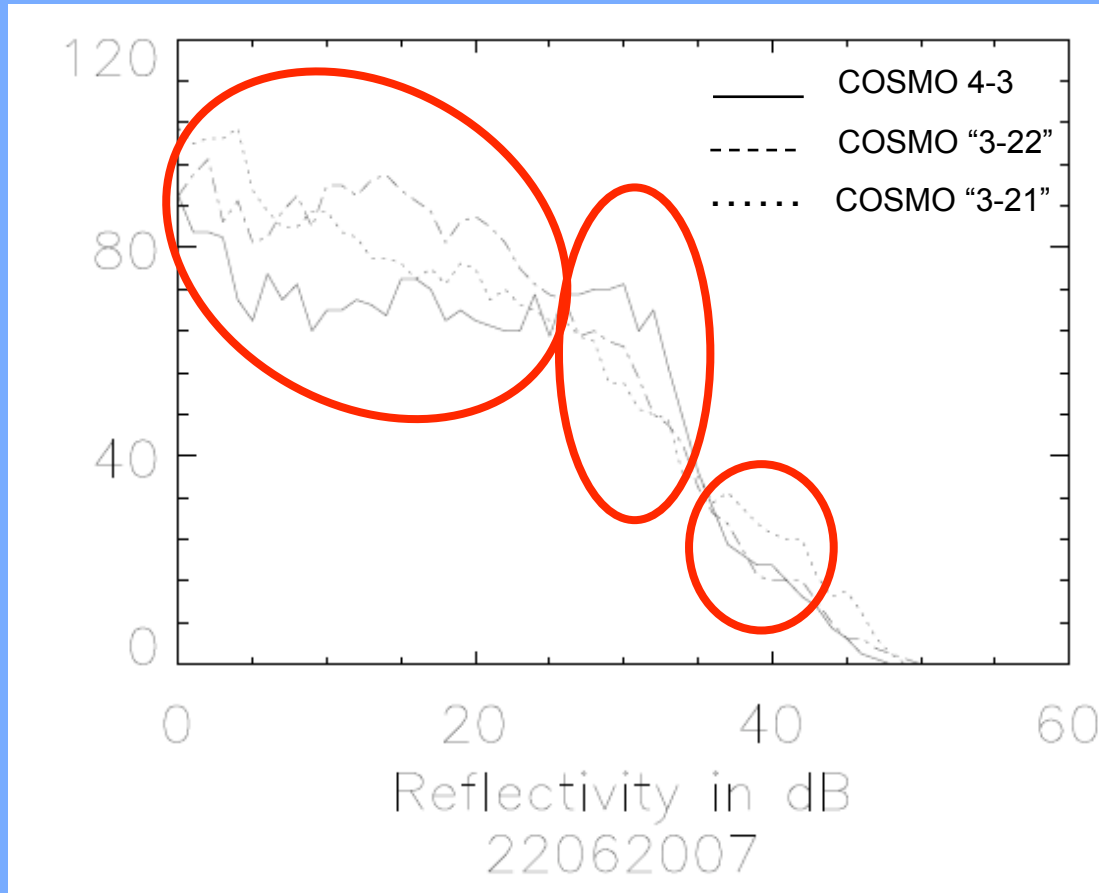


Averaged reflectivity over event time
in 120 km from Wideumont radar

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Case studies II - reflectivity: 22/06/2007

Histograms reflectivity:

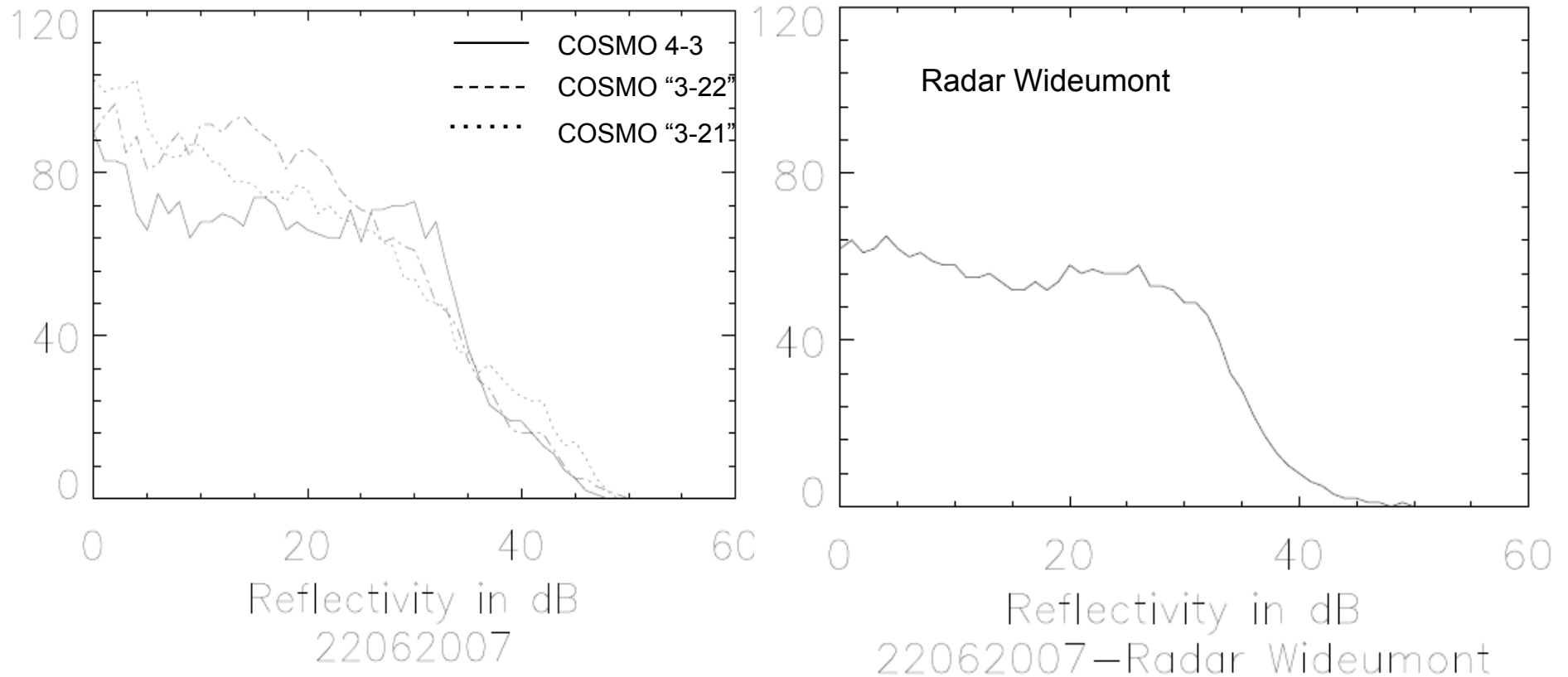


Averaged reflectivity over event time
in 120 km from Wideumont radar

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Case studies II - reflectivity: 22/06/2007

Histograms reflectivity:



Averaged reflectivity over event time
in 120 km from Wideumont radar

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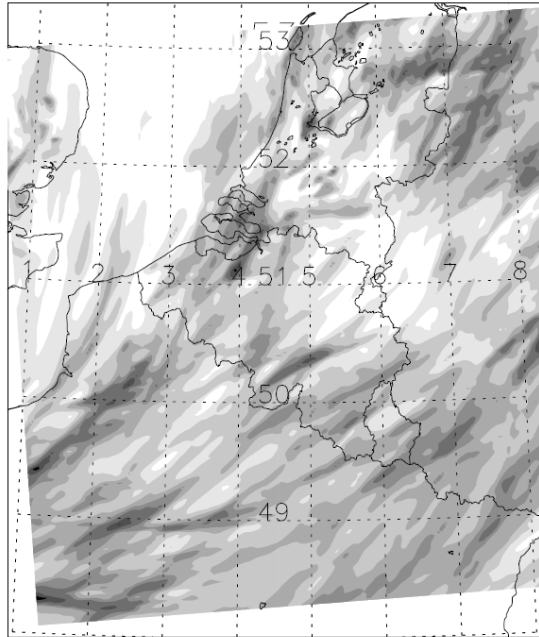
Case studies II - precipitation: 22/06/2007

COSMO „3-21“ (rain+snow)

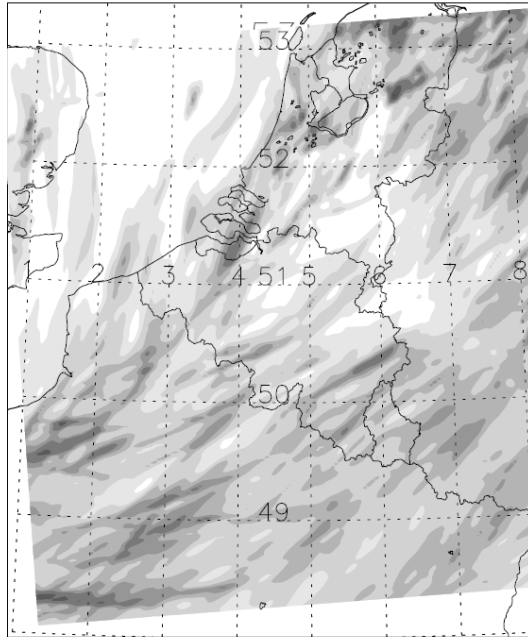
COSMO 4-3

COSMO „3-22“ (rain)

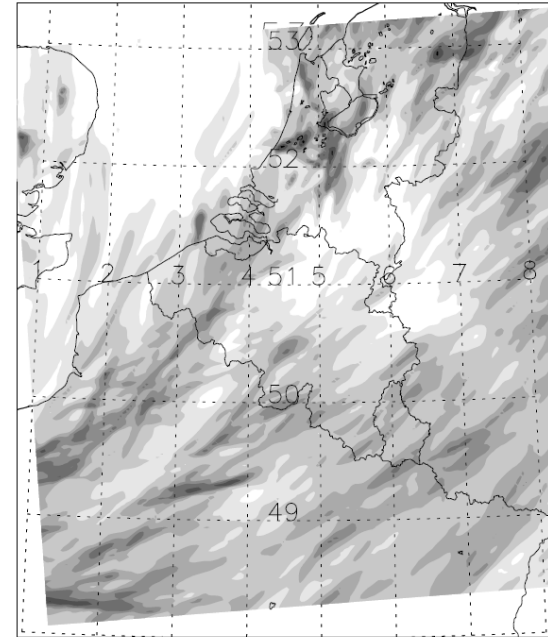
Precipitation (COSMO 3-21) – 20070622



Precipitation (COSMO 4-3) – 20070622



Precipitation (COSMO 3-22) – 20070622



24 hours accumulated precipitation (00-24 UTC)

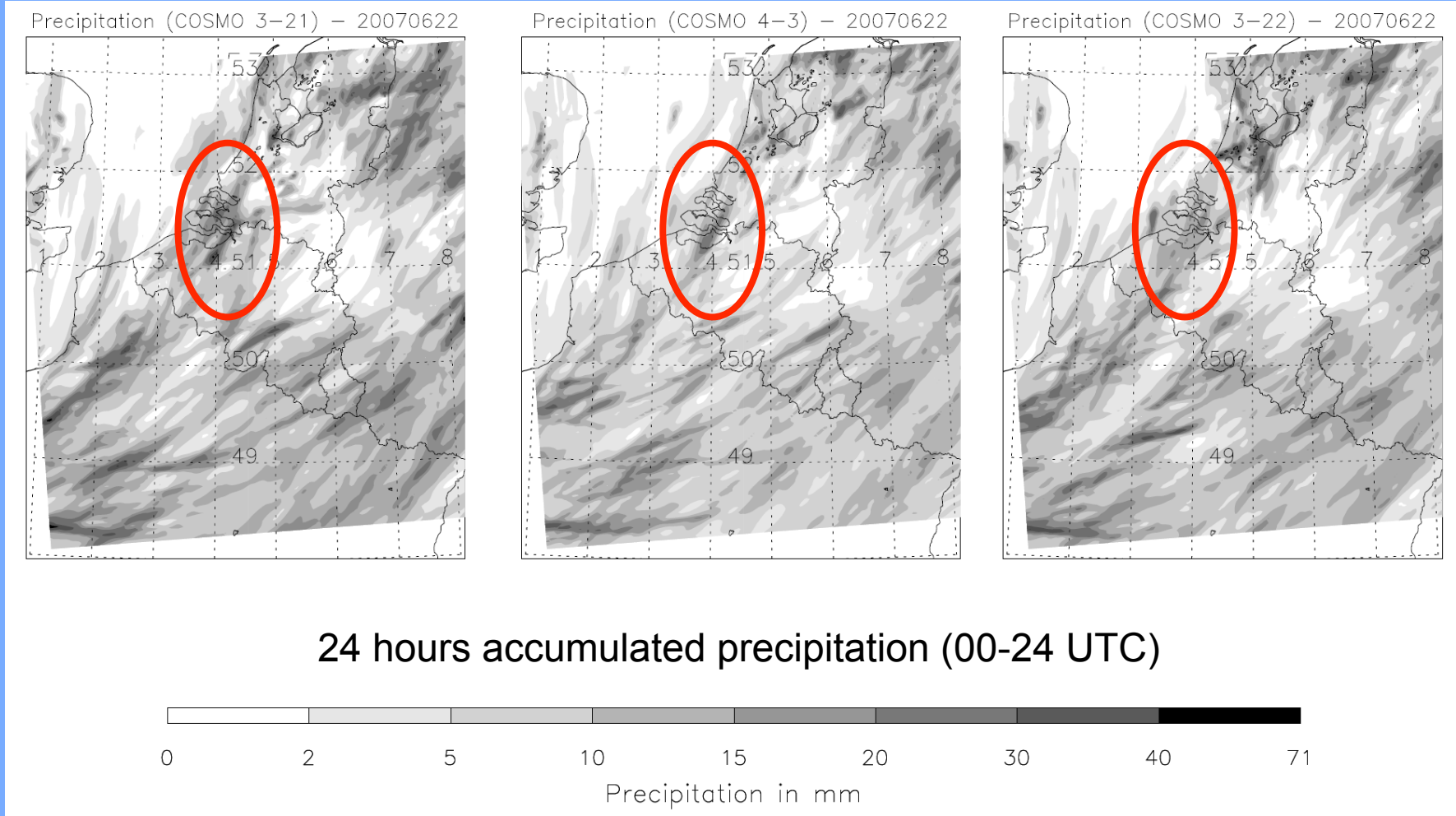


Case studies II - precipitation: 22/06/2007

COSMO „3-21“ (rain+snow)

COSMO 4-3

COSMO „3-22“ (rain)

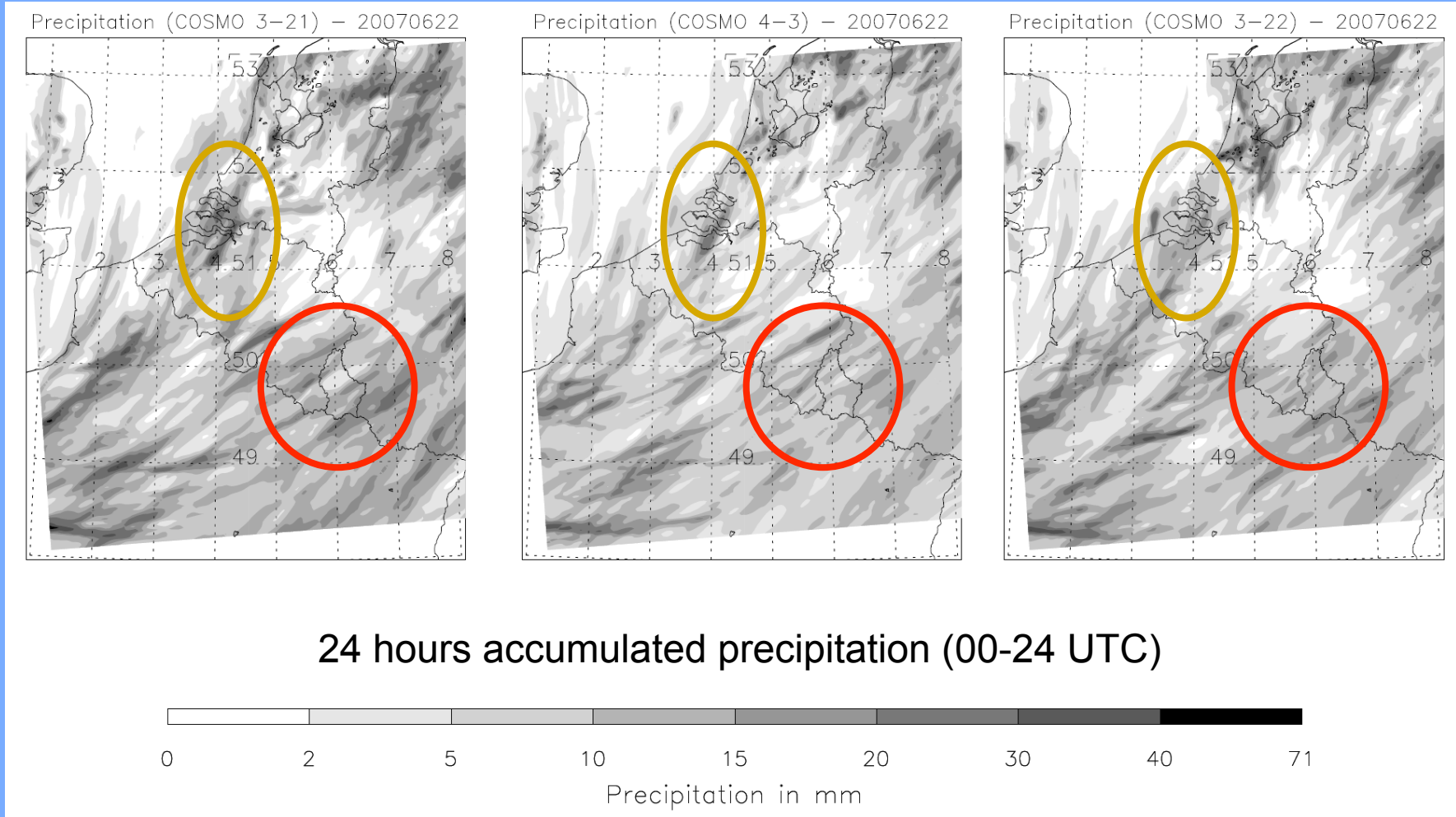


Case studies II - precipitation: 22/06/2007

COSMO „3-21“ (rain+snow)

COSMO 4-3

COSMO „3-22“ (rain)

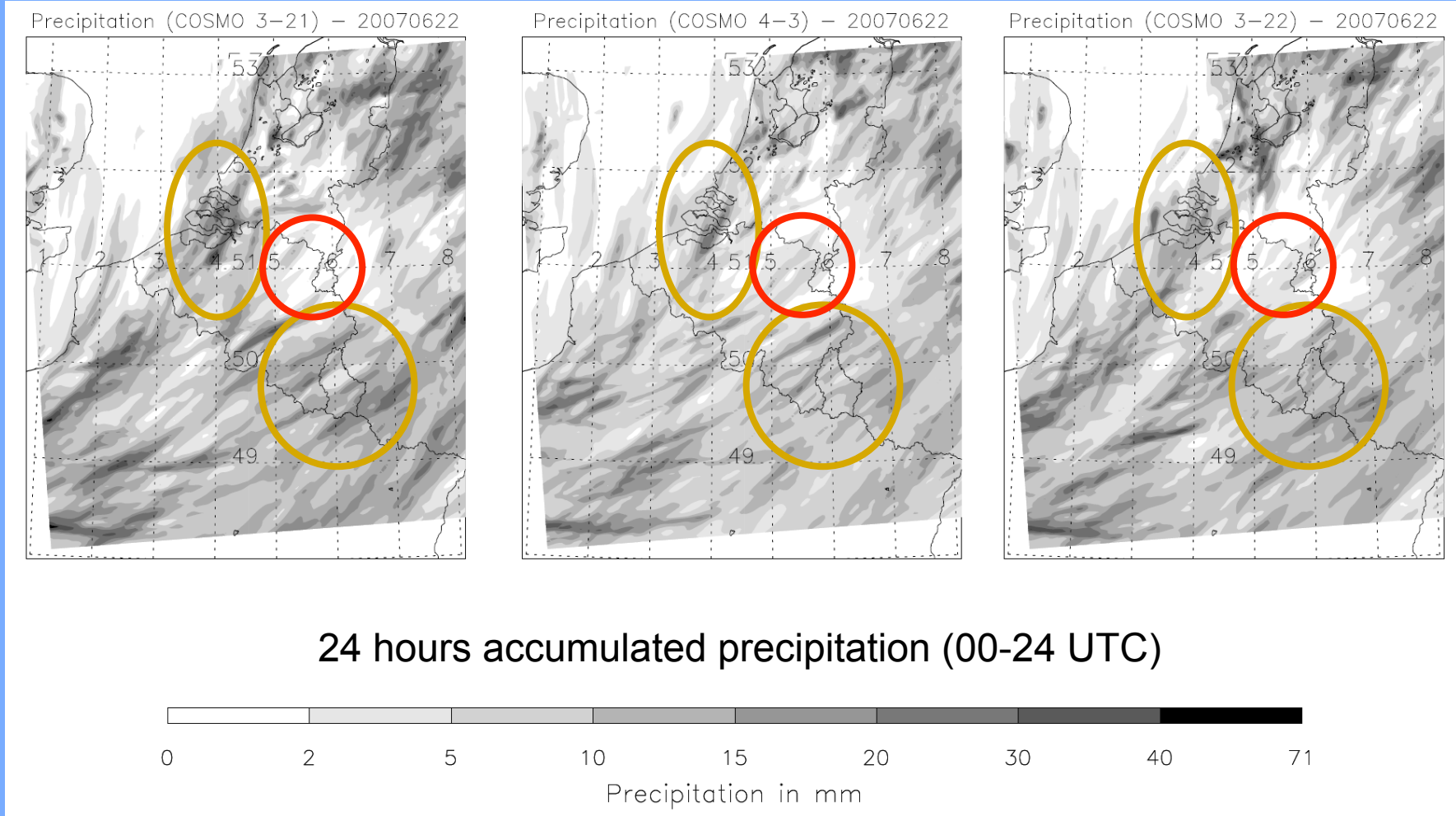


Case studies II - precipitation: 22/06/2007

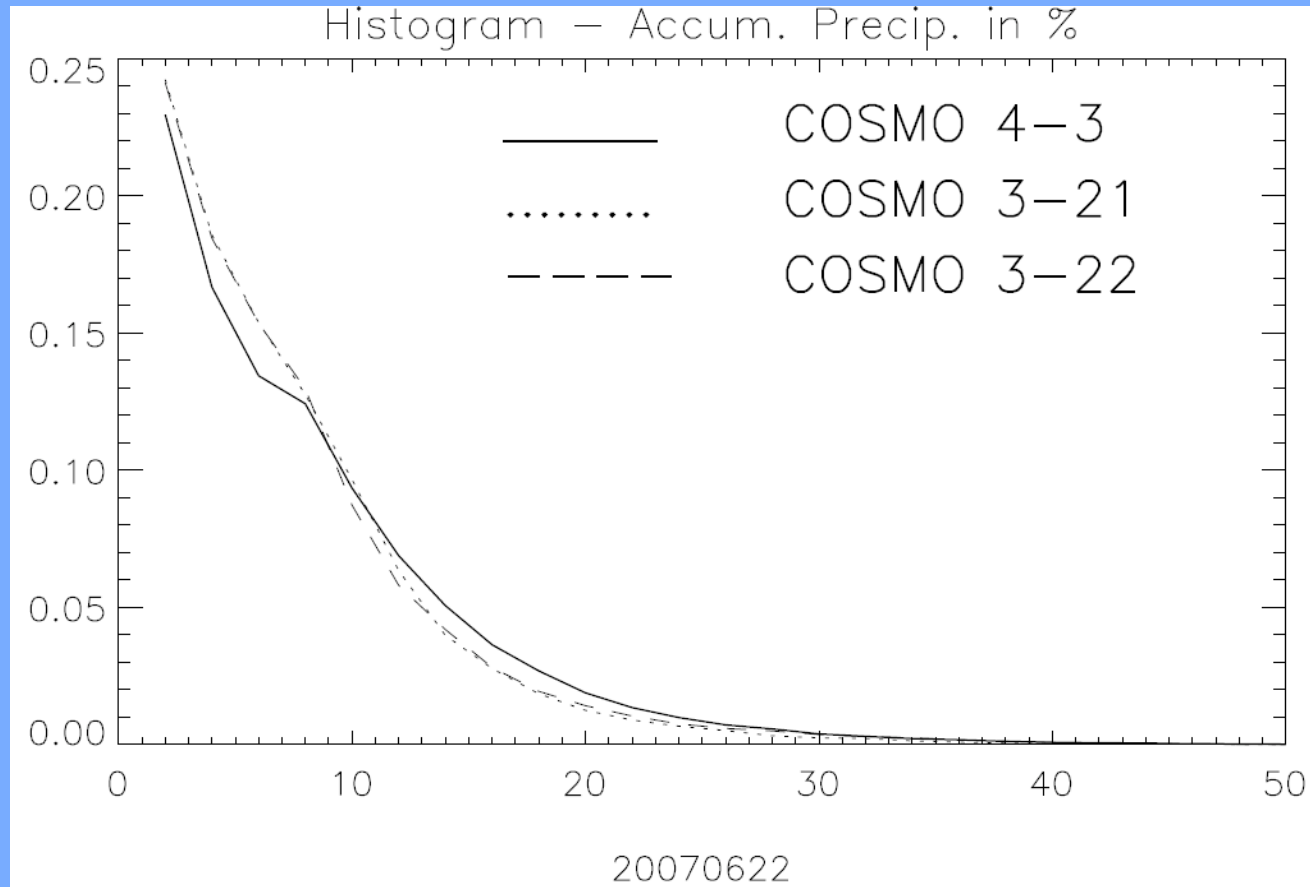
COSMO „3-21“ (rain+snow)

COSMO 4-3

COSMO „3-22“ (rain)



Case studies II - precipitation: 22/06/2007



24 hours accumulated precipitation (00-24 UTC)
of the entire domain

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Summary I:

Characteristics from the comparison of the model reflectivities with the observed reflectivities:

- Model 4-3/"3-21"/"3-22": mostly small differences except for < 20 dB
- There is an improvement from **3-21** to **4-3** towards values of the radar observations, especially for **low reflecties** areas in **stratiform** situations
- **Convection** (e.g. convergence line like on 22/06/2007) is **well modelled** compared to radar observations

Summary II:

Characteristics from the comparison of the model precipitation with the observed precipitation:

- Model 4-3/"3-21"/"3-22": mostly small differences over the **entire domain** but sometimes clear differences in **subregions**
- Larger effects when using **different forcing data**
- Still clear **differences** between **model** and **radar precipitation** especially the spatial variability

Outlook:

- Compilation of precipitation characteristics for two contrasting summer seasons (probably 2006 and 2007)
 - Precipitation patterns / characteristics in Belgium
 - Additional information concerning initialisation process of convective precipitation

- Interdisciplinary research:
e. g. input for soil erosion models

*Thank you for
your attention !!*

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