Micro Squall Line in Belém Region

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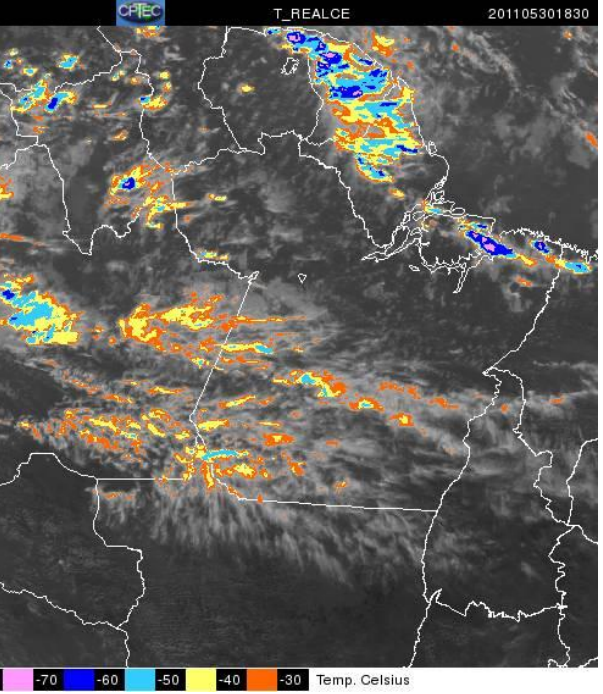
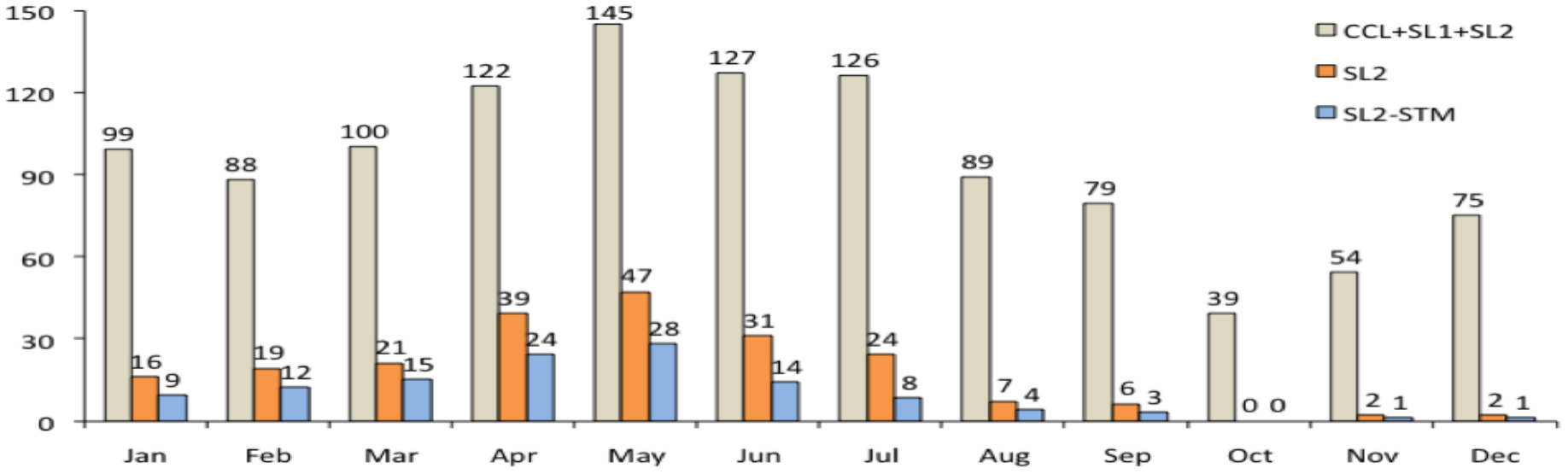


Squall Lines : 2000 to 2006

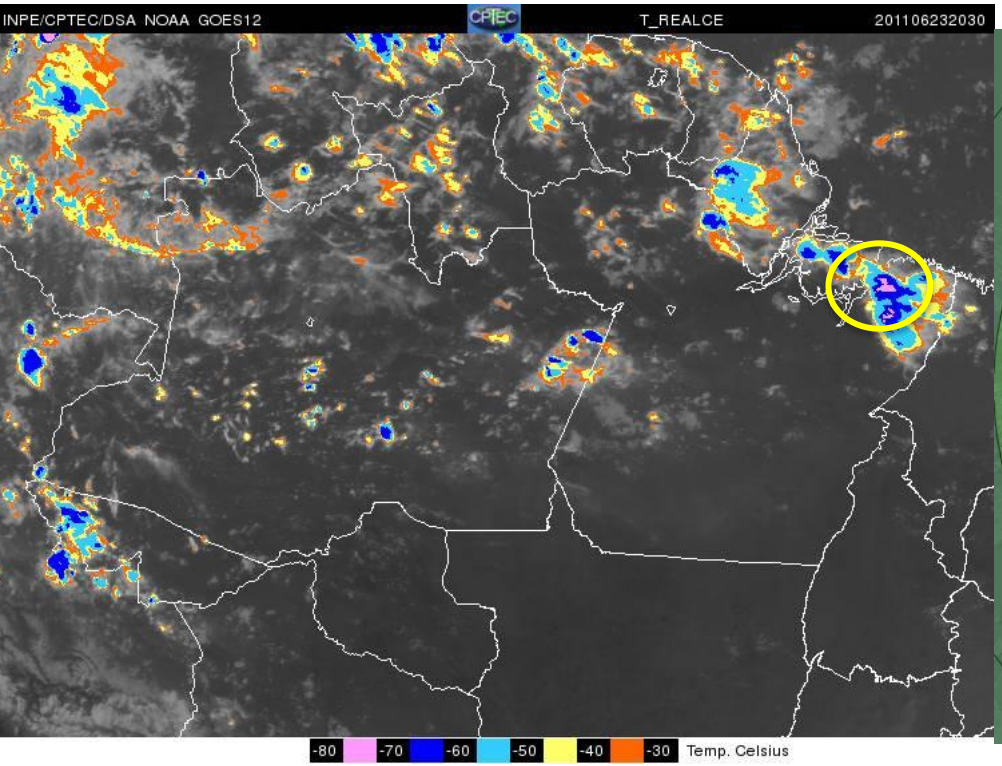
According to Kousky (1980), when the cumulonimbus develops from sea breeze in the coast it organize as a line of convective clouds, it can propagate inside the land as a squall line.

These squall lines have large dimensions of about thousands kilometers and therefore is easily viewed in satellite image and it can be classified having a space scale like a system of the synoptic scale.

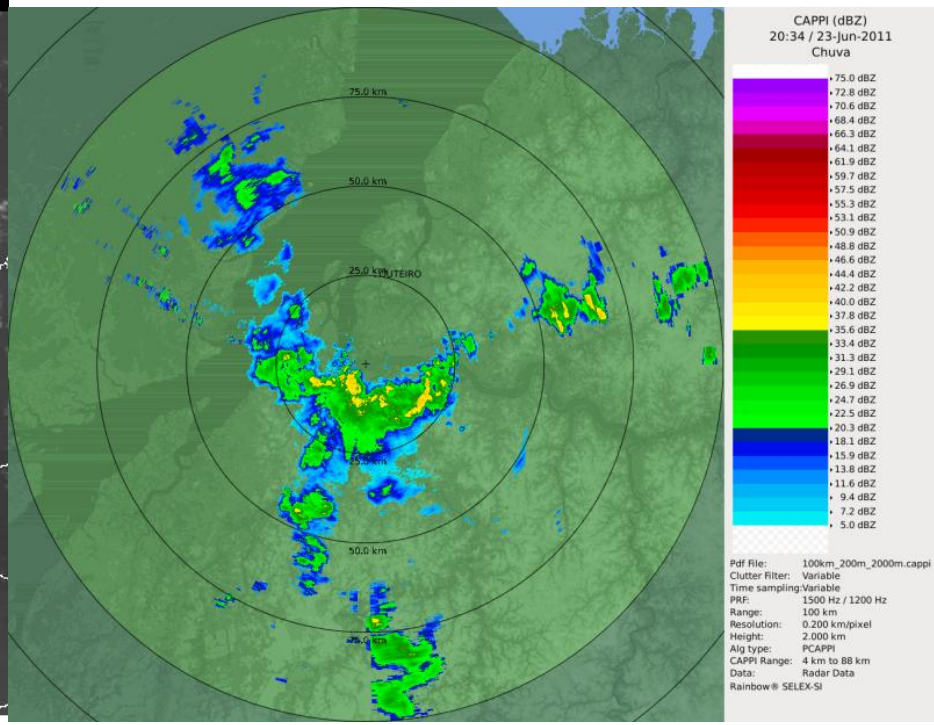


Target in Belem: Squall Lines

June, 23 2011 20:30 UTC



June, 23 2011 20:34 UTC

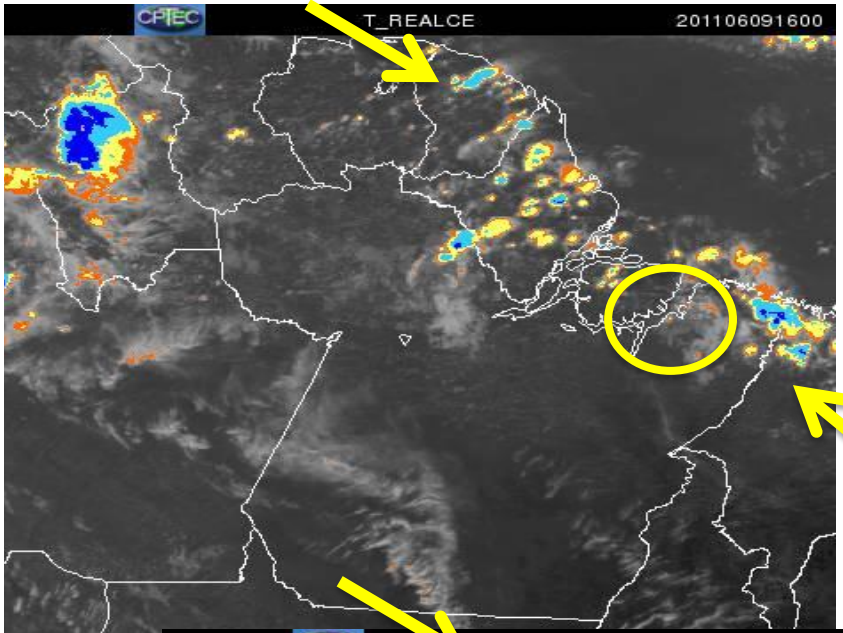


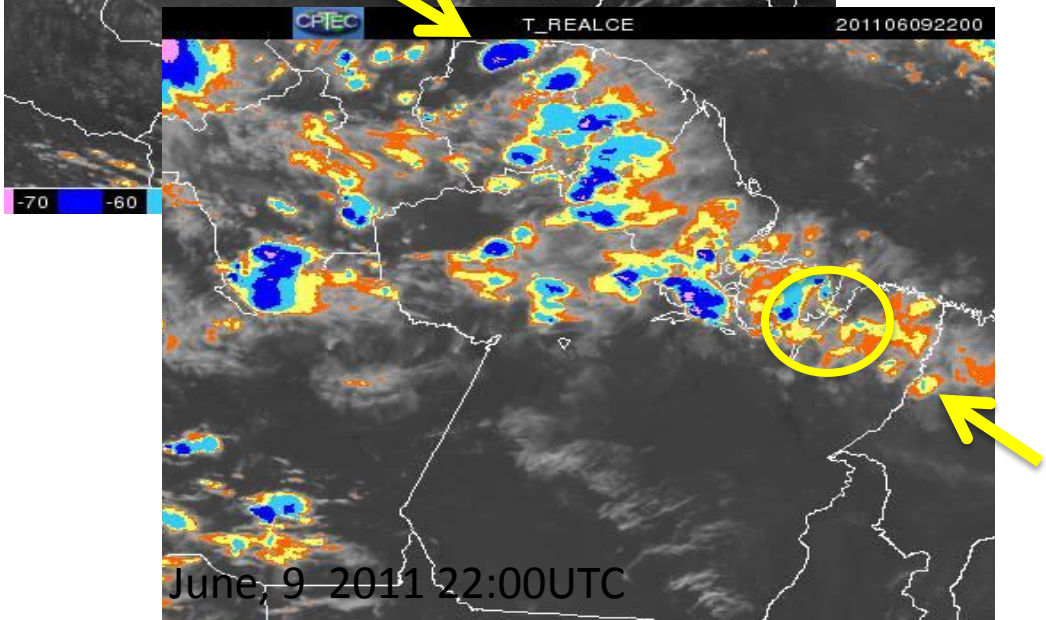
Number of cases observed during the Chuva campaign

20 Squall Lines – June, 7 to 30 2011.

1 Squall Line and 2 Micro Squall Lines

June, 9 2011 16:00UTC

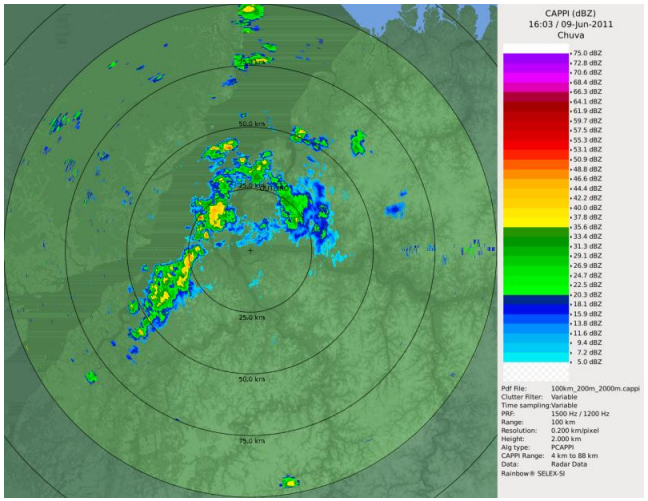




June, 9 2011 22:00UTC

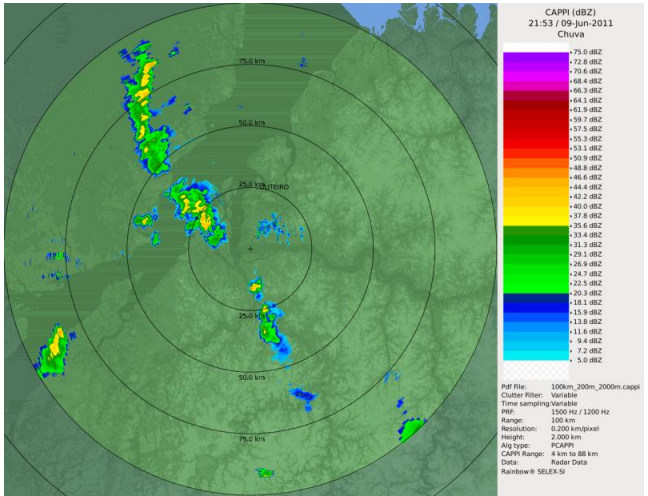
Parallel to Marajo Bay (MSLP)

June, 9 2011 16:03UTC



Transversal to Marajo Bay (MSLT)

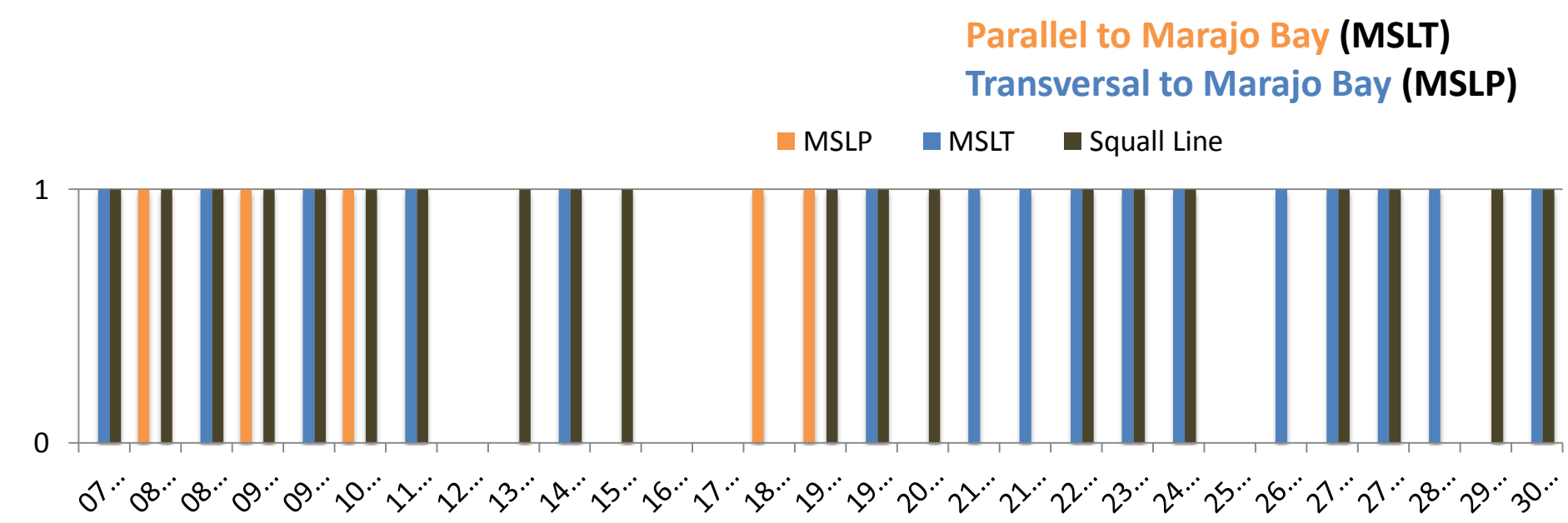
June, 9 2011 21:53UTC



The aim of this paper is to study this new type of squall Line, trying to find its morphology and to understand the relationship of such convective band with the classic Squall Line.

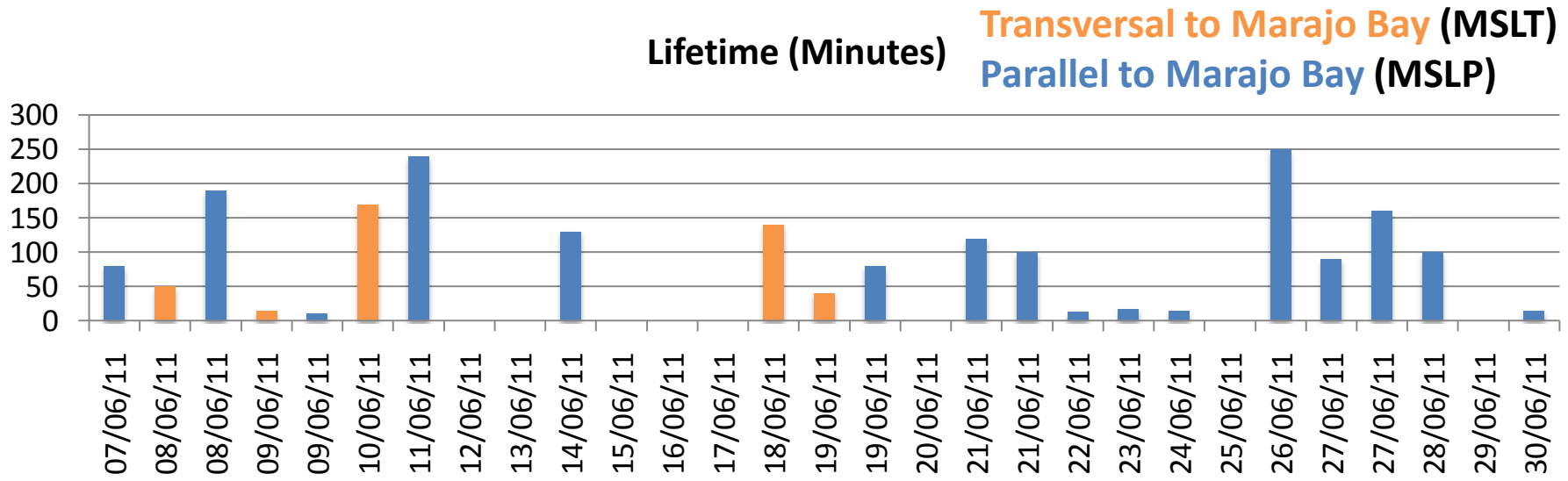
- Average characteristics of the micro lines (FORTRACC).
- Understand the relationship with the classic Squall Line.
- Possible mechanisms of formation (modeling).

Distribution of Micro-Squall Lines in Belem



- **20 Squall Lines (9 CSL, 4 SL1 and 4 SL2)**
- **21 cases of MSL (5 MSLP and 16 MSLT)**
- **16 MSL was observed in day with Squall Line**
- **5 MSL occurred in absence of Squall Line**
- **Two cases MSL same day (June, 8, 9, 19, 21 and 27)**

Lifetime (minutes) of the Micro-Squall Lines

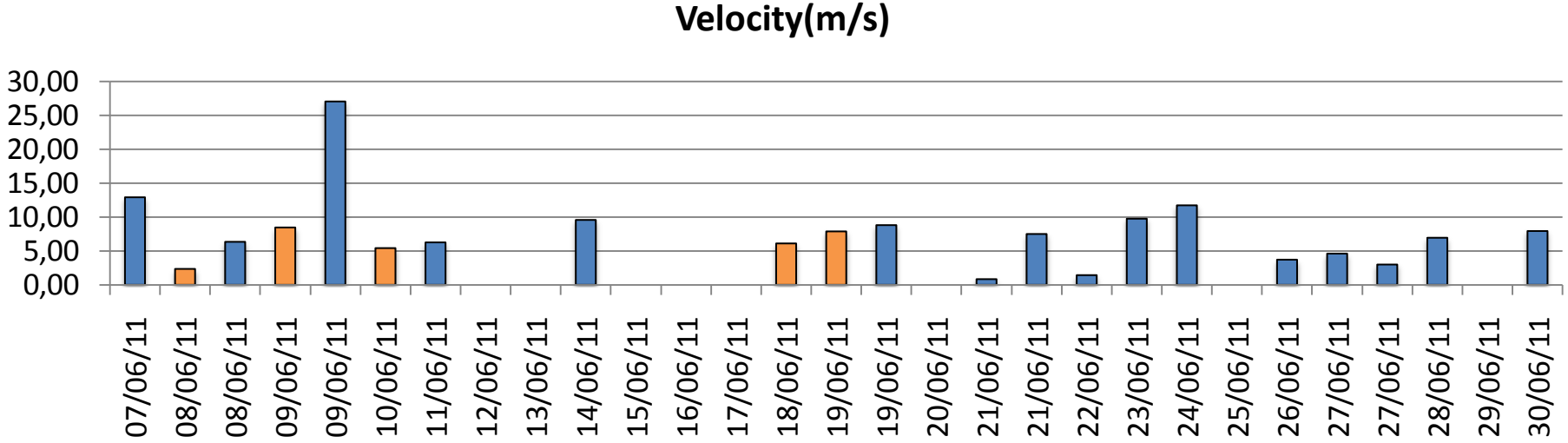


- **Average lifetime for MSL = 1h:50min**
  - **MSLP = 50 min**
  - **MSLT = 2h:20min**
- **MSLP had its formation earlier (from 15 to 19:30 UTC)**
- **MSLT (between 17:30 and 23UTC)**
- **a case of the MSLT overnight (04UTC).**

CSL = 9 hours
SL1 = 12 hours
SL2 = 16 hours

Propagation velocity (m/s) of the Micro-Squall Lines

Transversal to Marajo Bay (MSLT)
Parallel to Marajo Bay (MSLP)

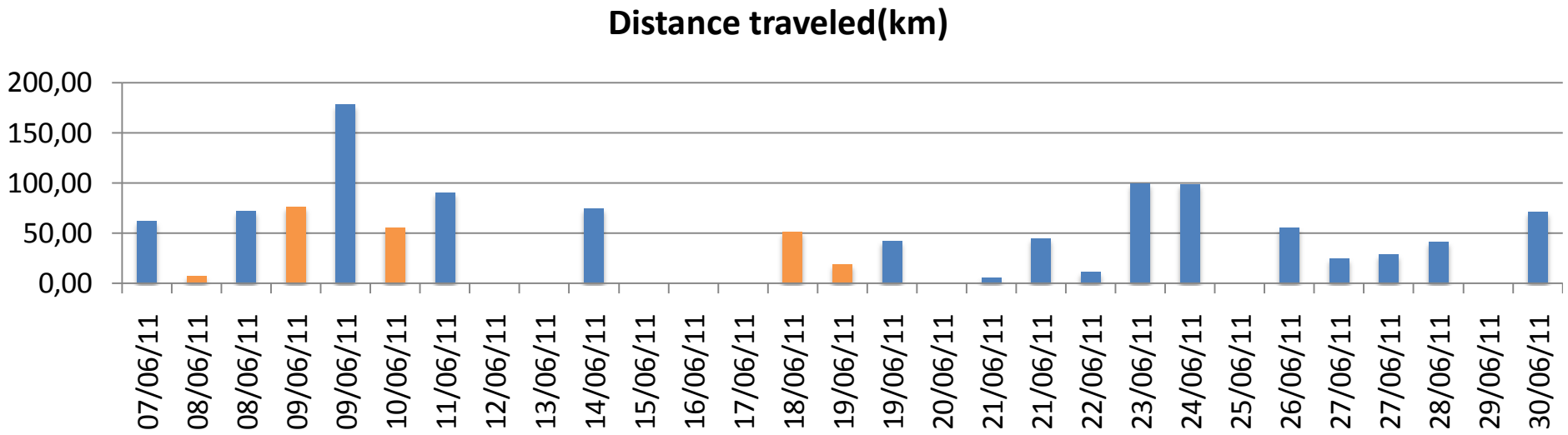


Average speed = 7 m/s

MSLP = 6 m/s
MSLT = 8m/s

SL1 = 12 m/s
SL2 = 16 m/s

Distance (km) traveled by the Micro-Squall Lines



Mean distance traveled = 57.63km

MSLP = 42km

MLST = 62 km

Maximum for SL2 = 2000 km

Some differences

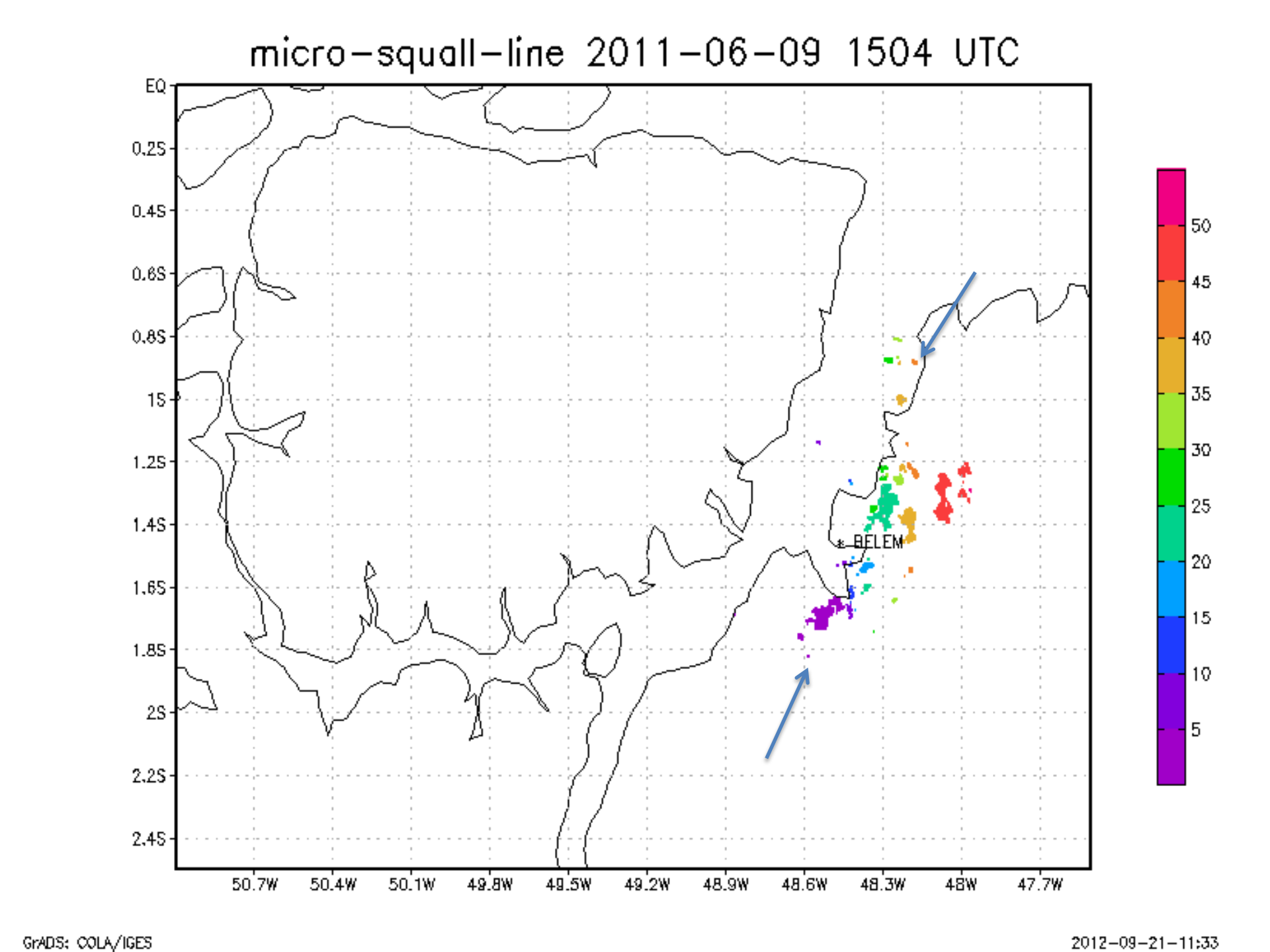
Micro Squall Line (MSL)

- **Length = 150km**
- **Average lifetime = 1h:50min**

Classical Squall Line (SL)

- **Length = 1500km**
- **Average lifetime = 9, 12 e 16 hours for CSL, SL1 and SL2, respectively.**

- **MSL is Meso β scale**
- **SL is meso α scale**


micro-squall-line 2011-06-09 1504 UTC
EQ
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0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
50
45
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15
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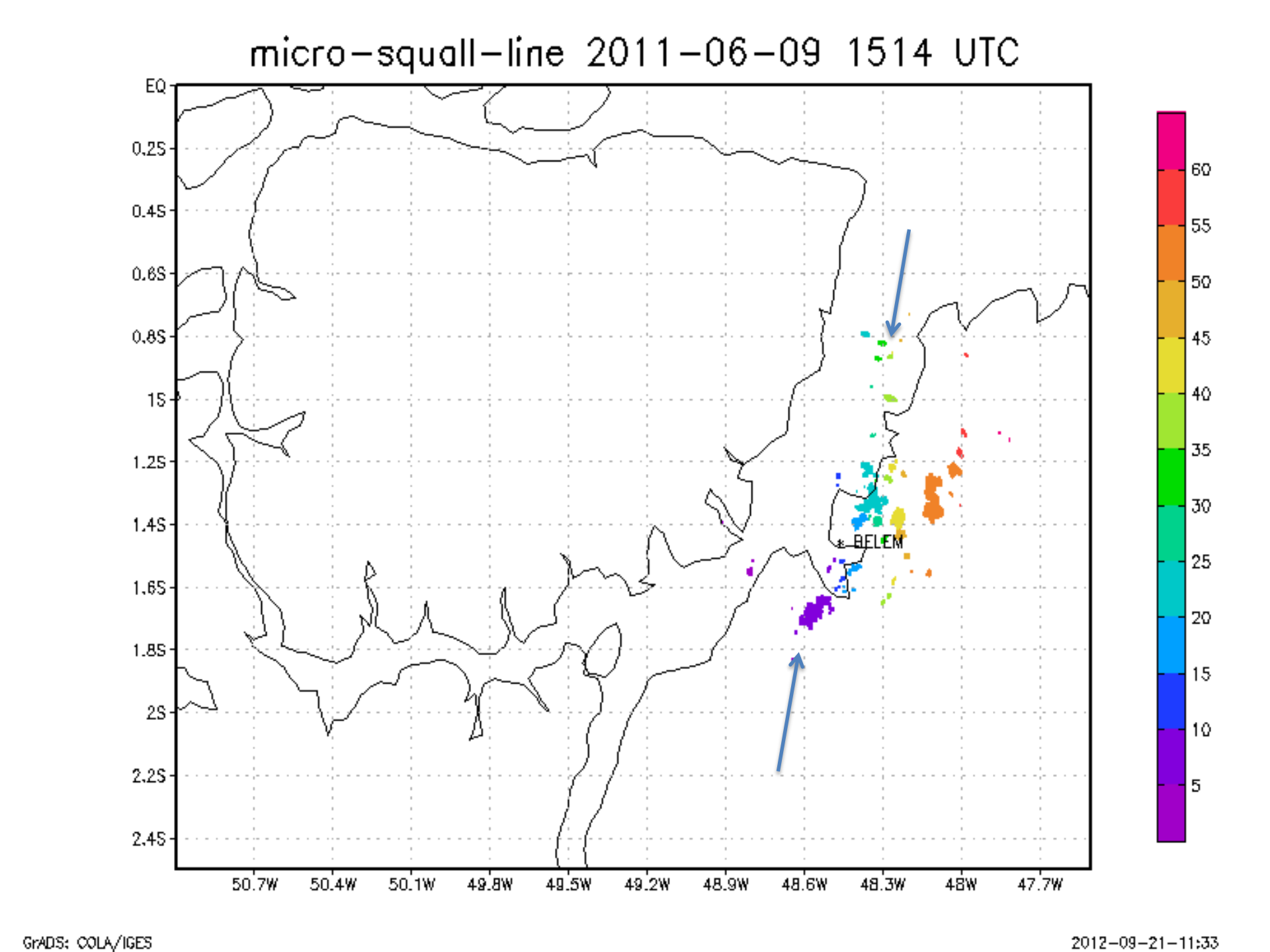
5
GrADS: COLA/IGES
2012-09-21-11:33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EQ
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0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
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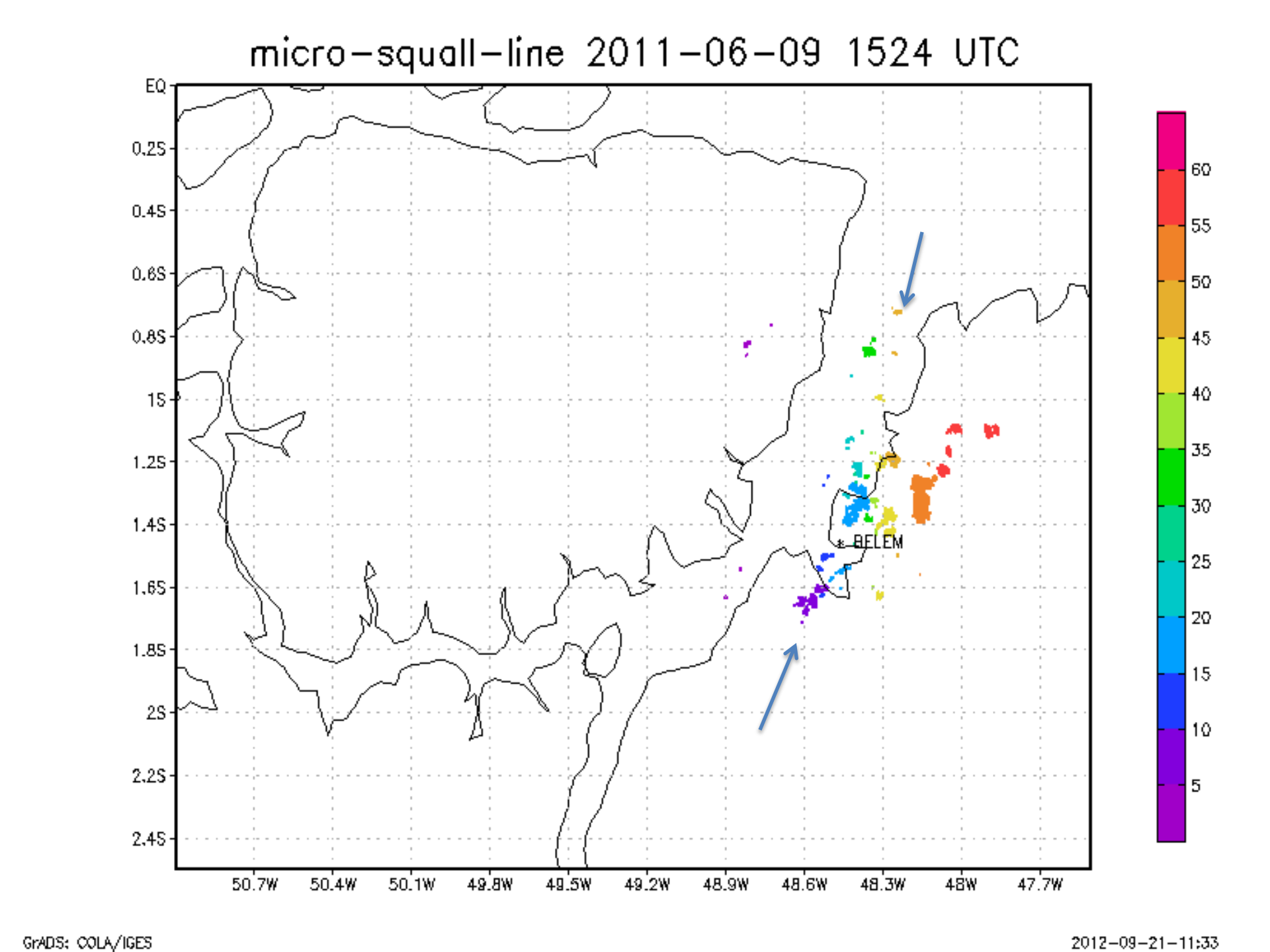
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0.8S
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1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
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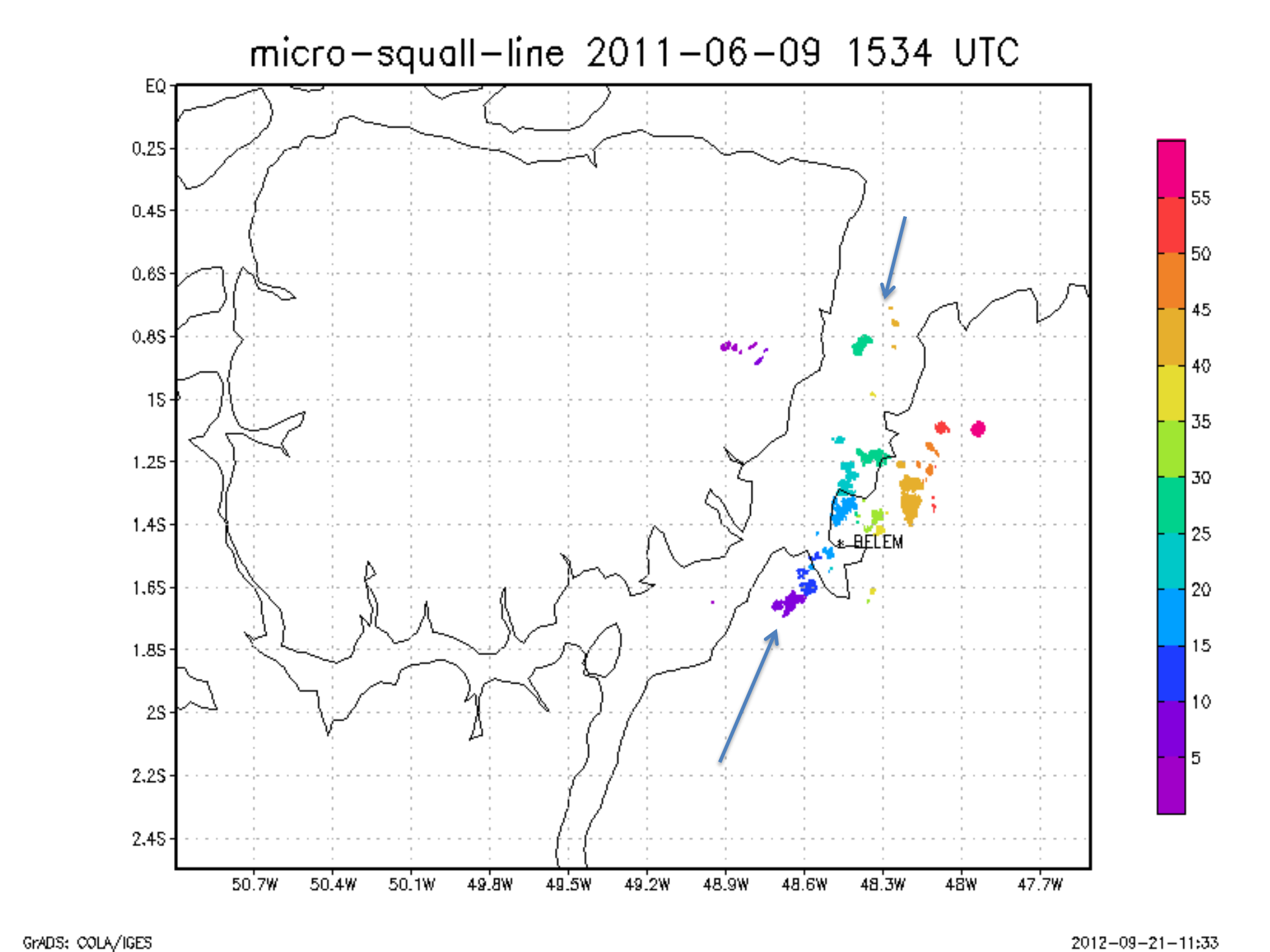
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EQ
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0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
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BELEM
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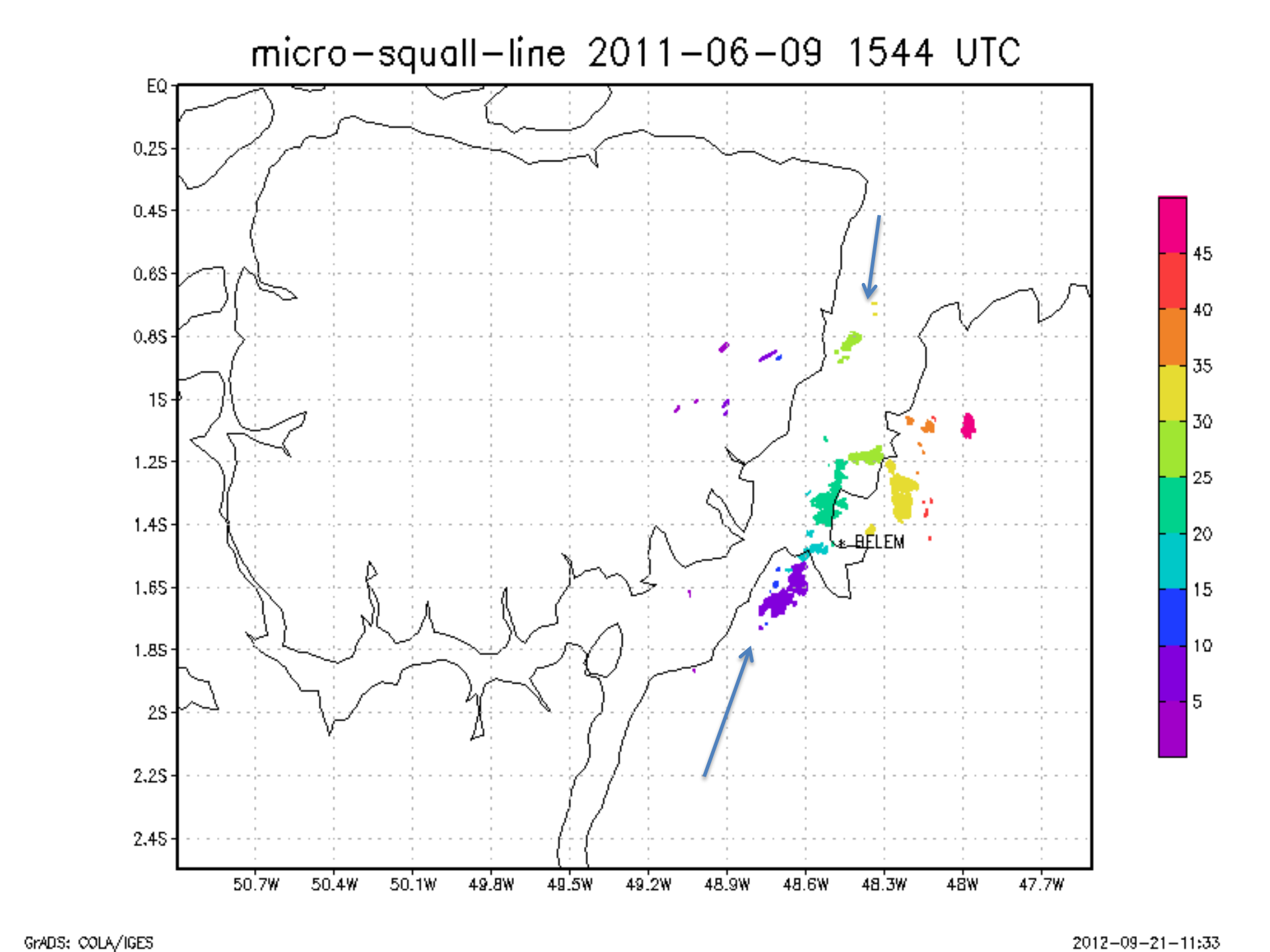
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1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
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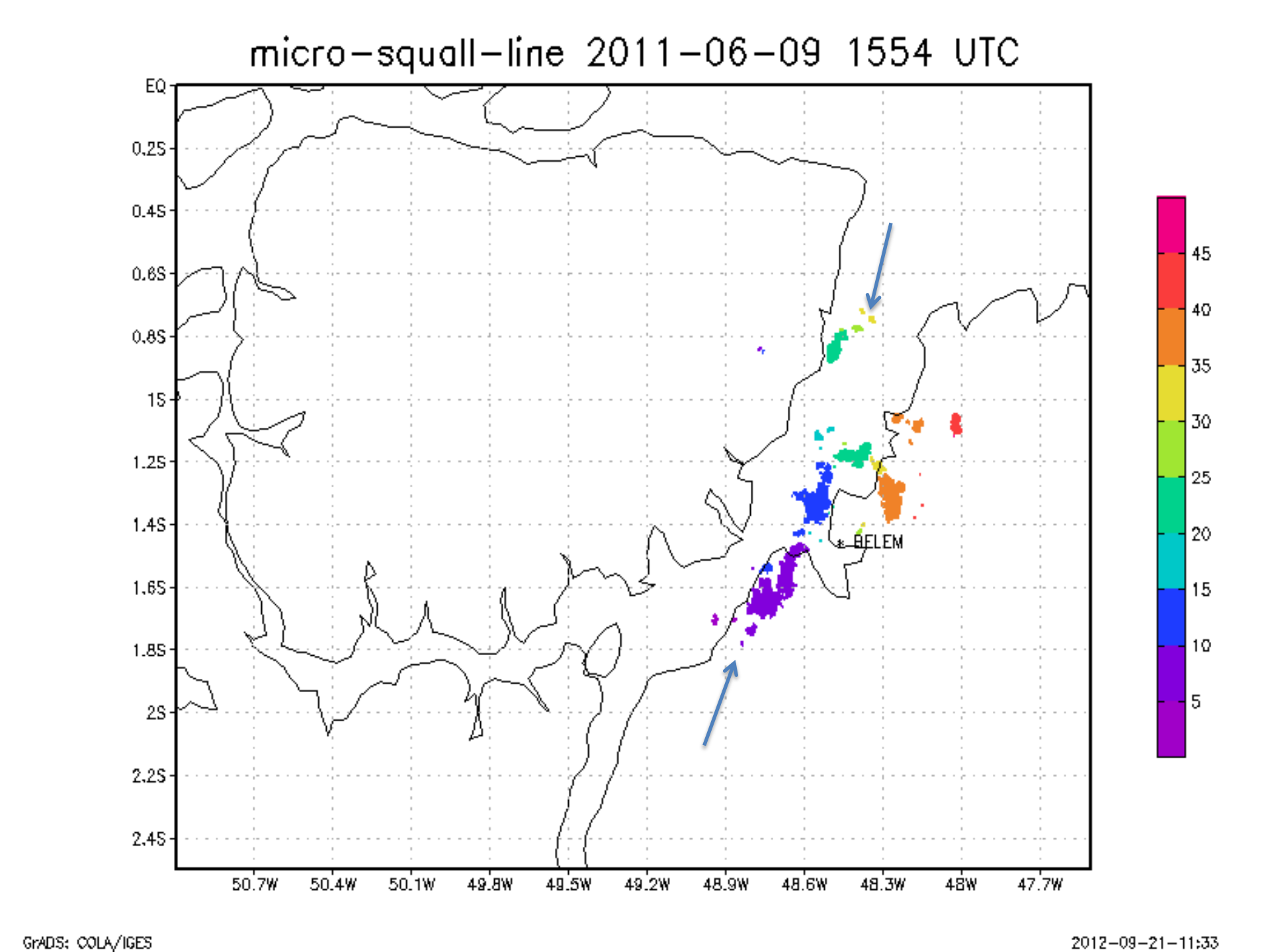
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1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
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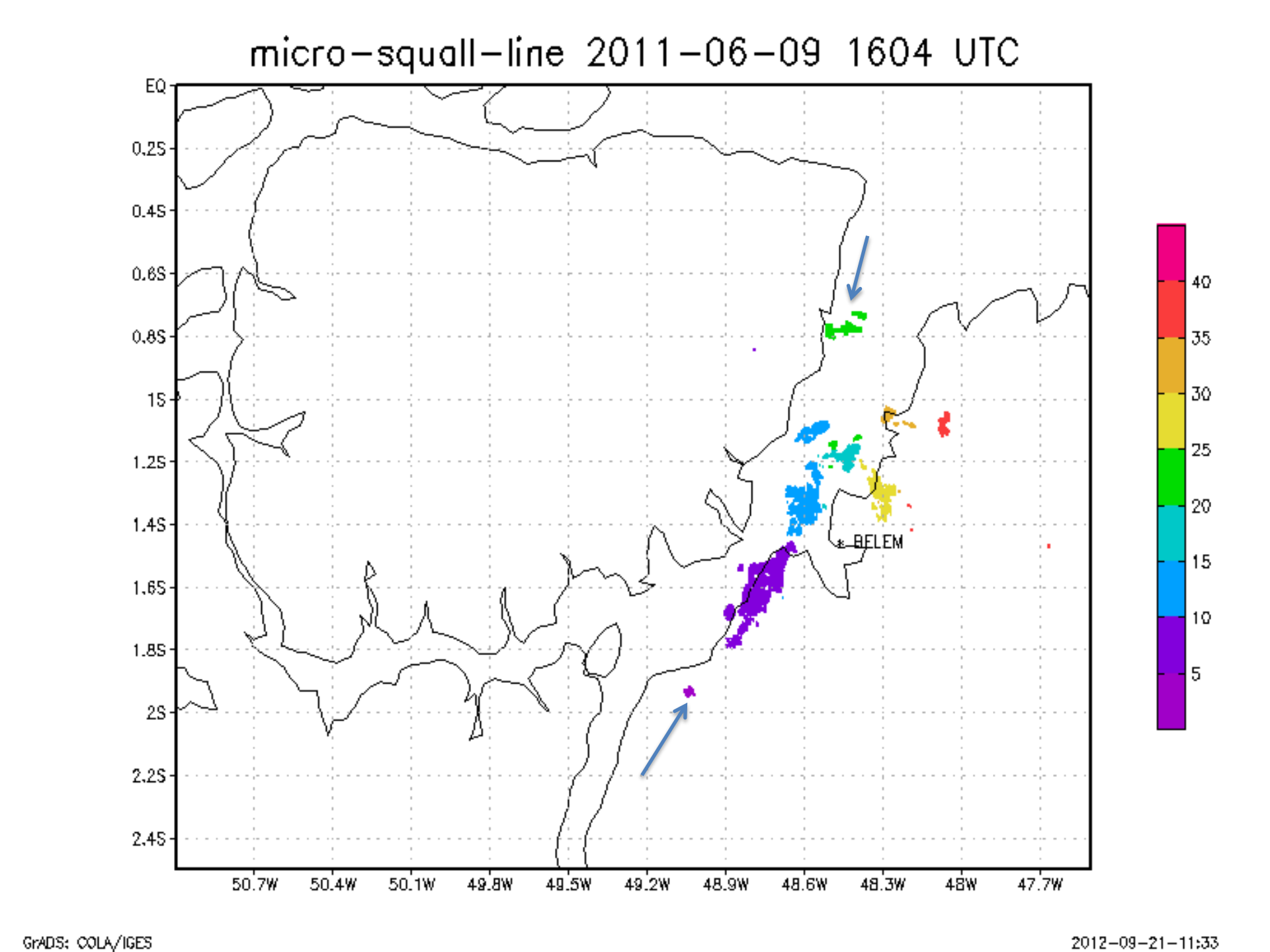
micro-squall-line 2011-06-09 1604 UTC
EQ
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0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
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BELEM
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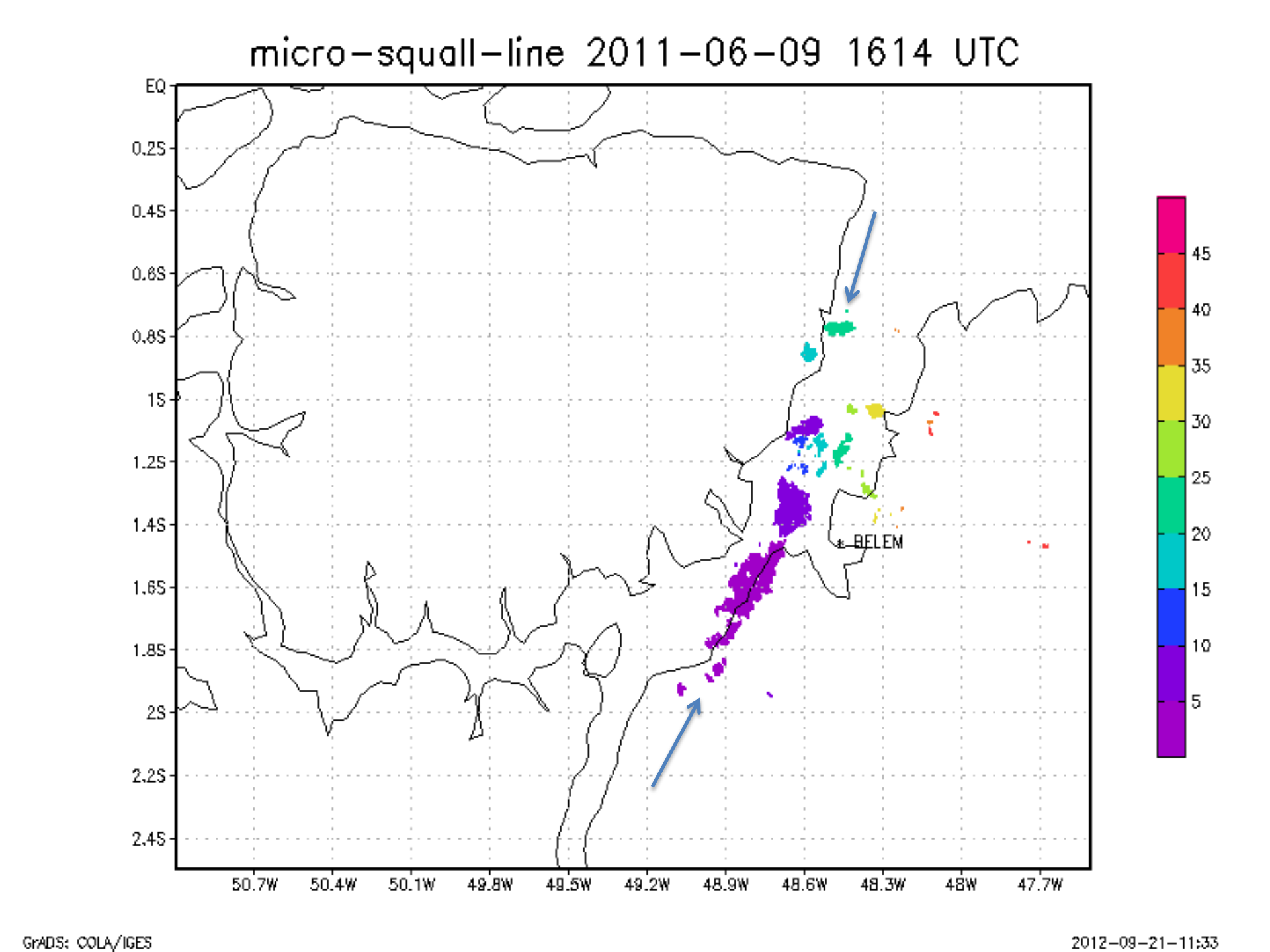
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EQ
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0.6S
0.8S
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1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
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BELEM
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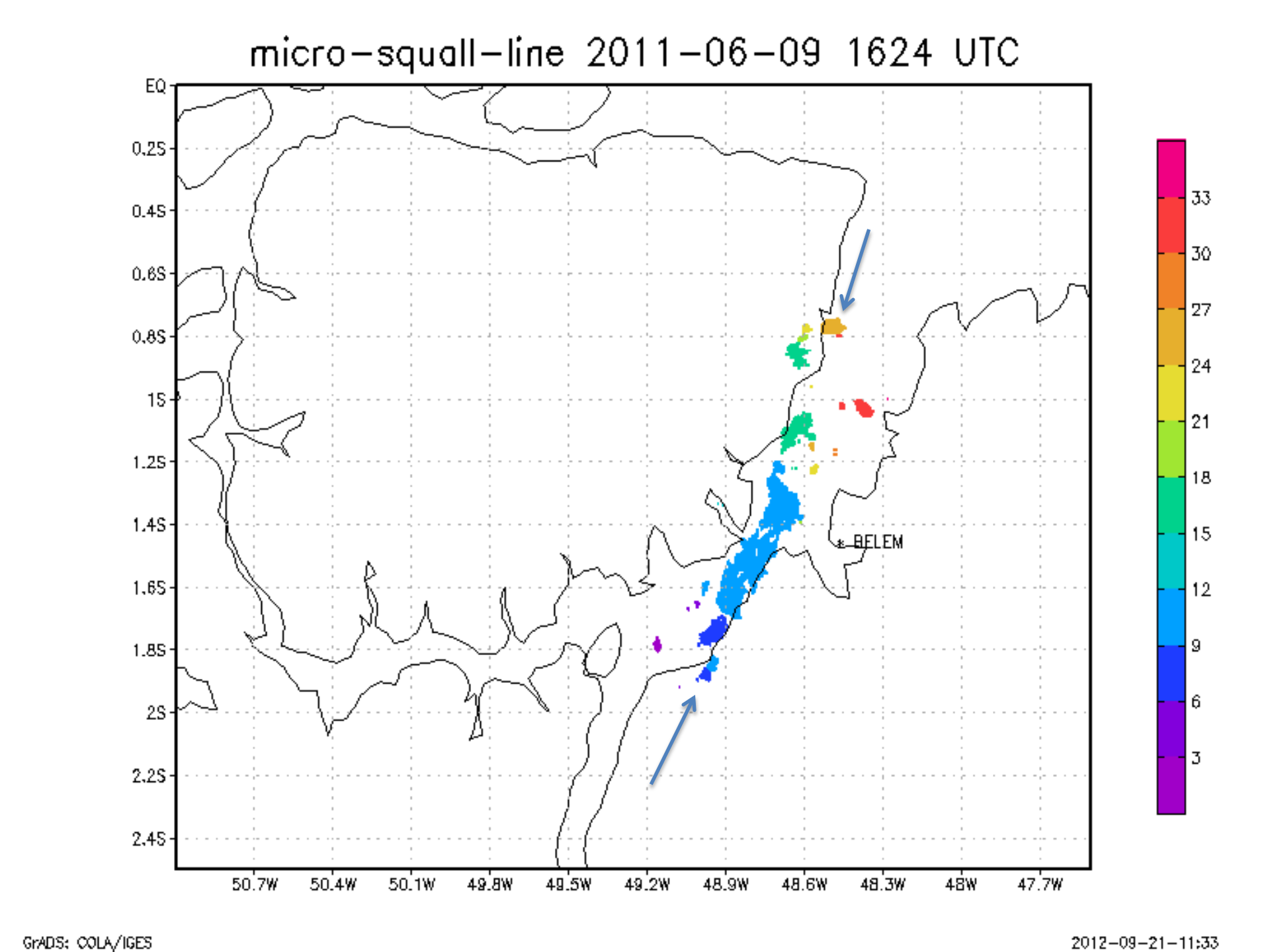
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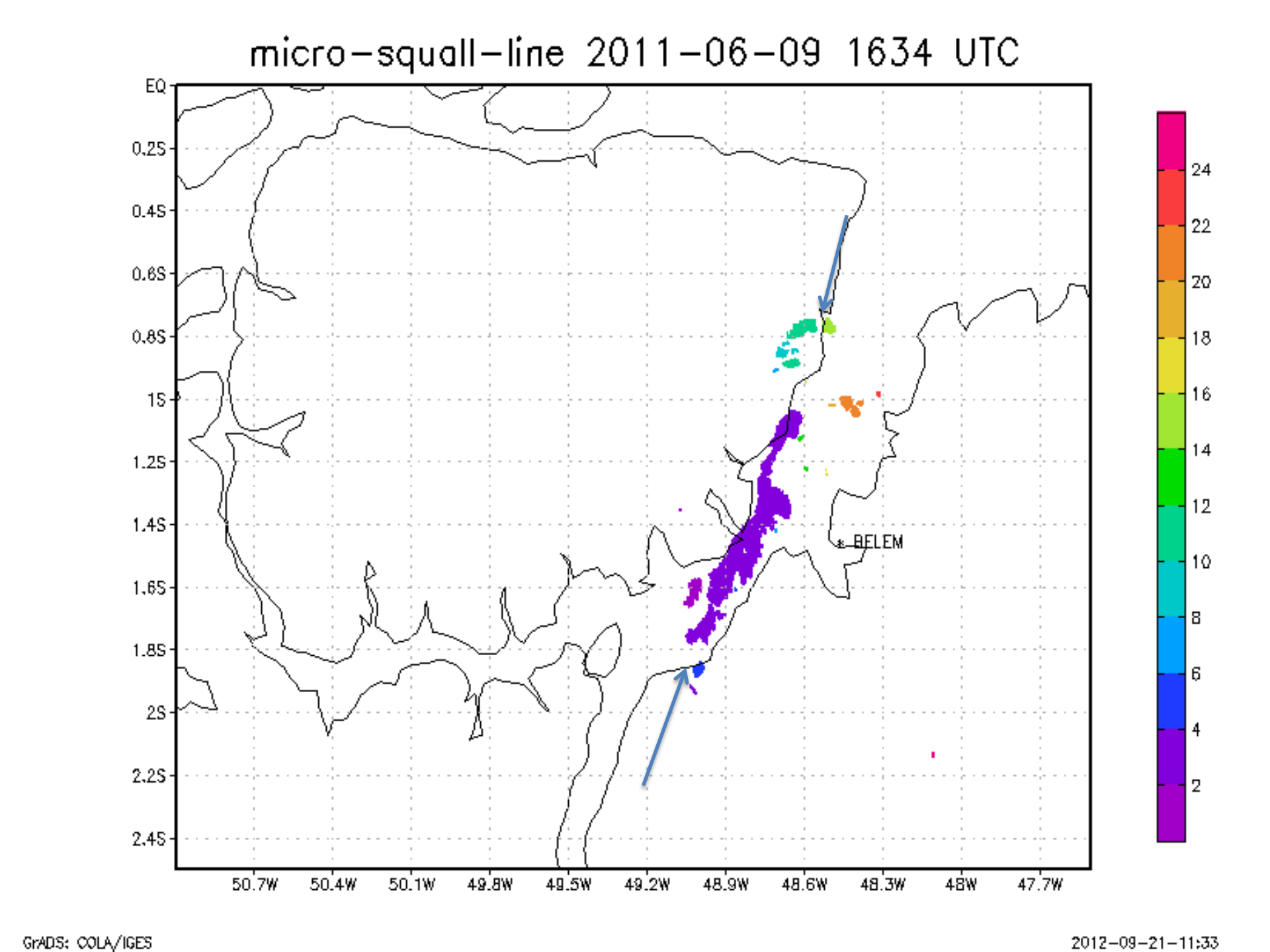
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2.4S
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50.4W
50.1W
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48.6W
48.3W
48W
47.7W
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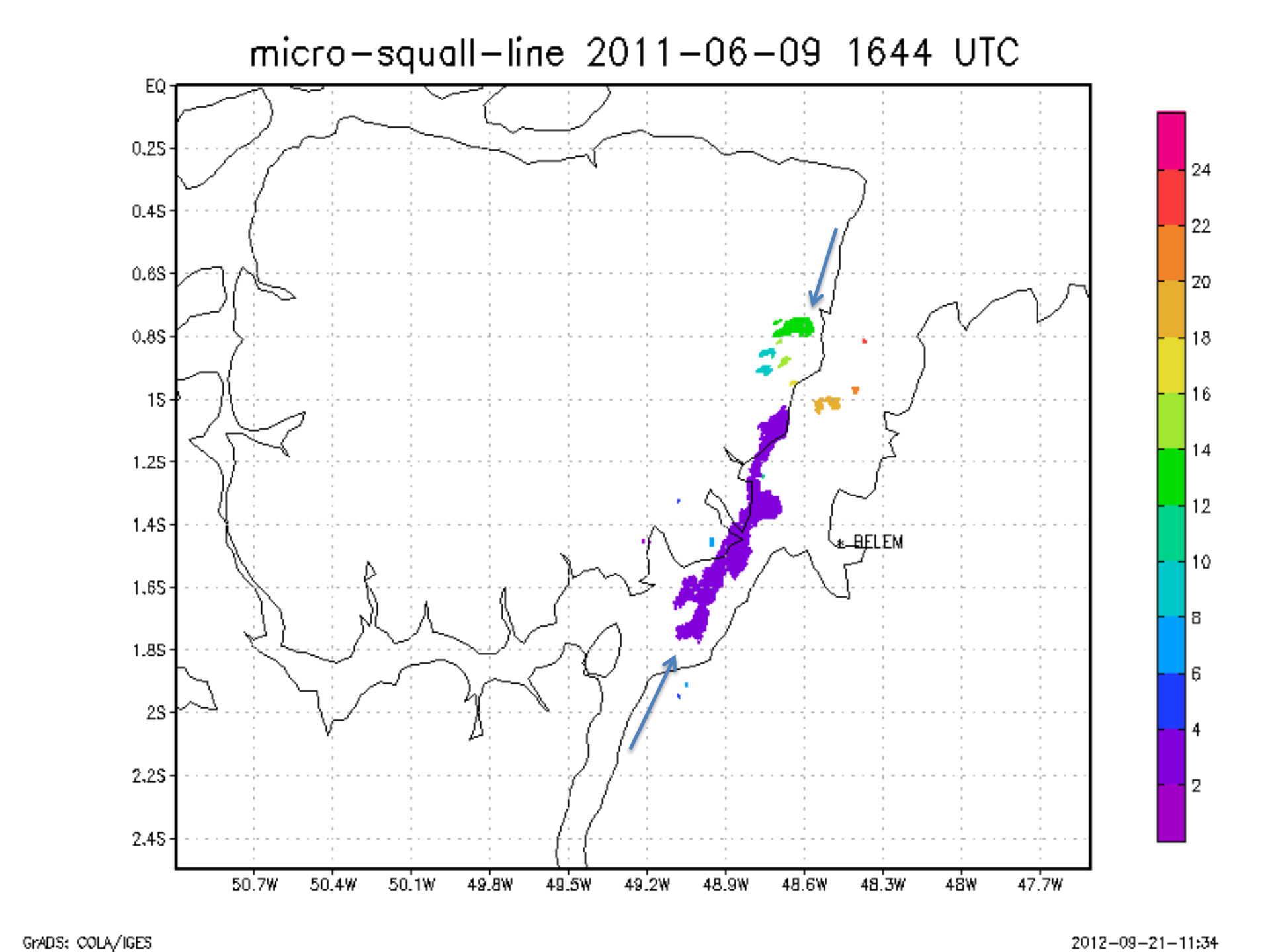
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1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
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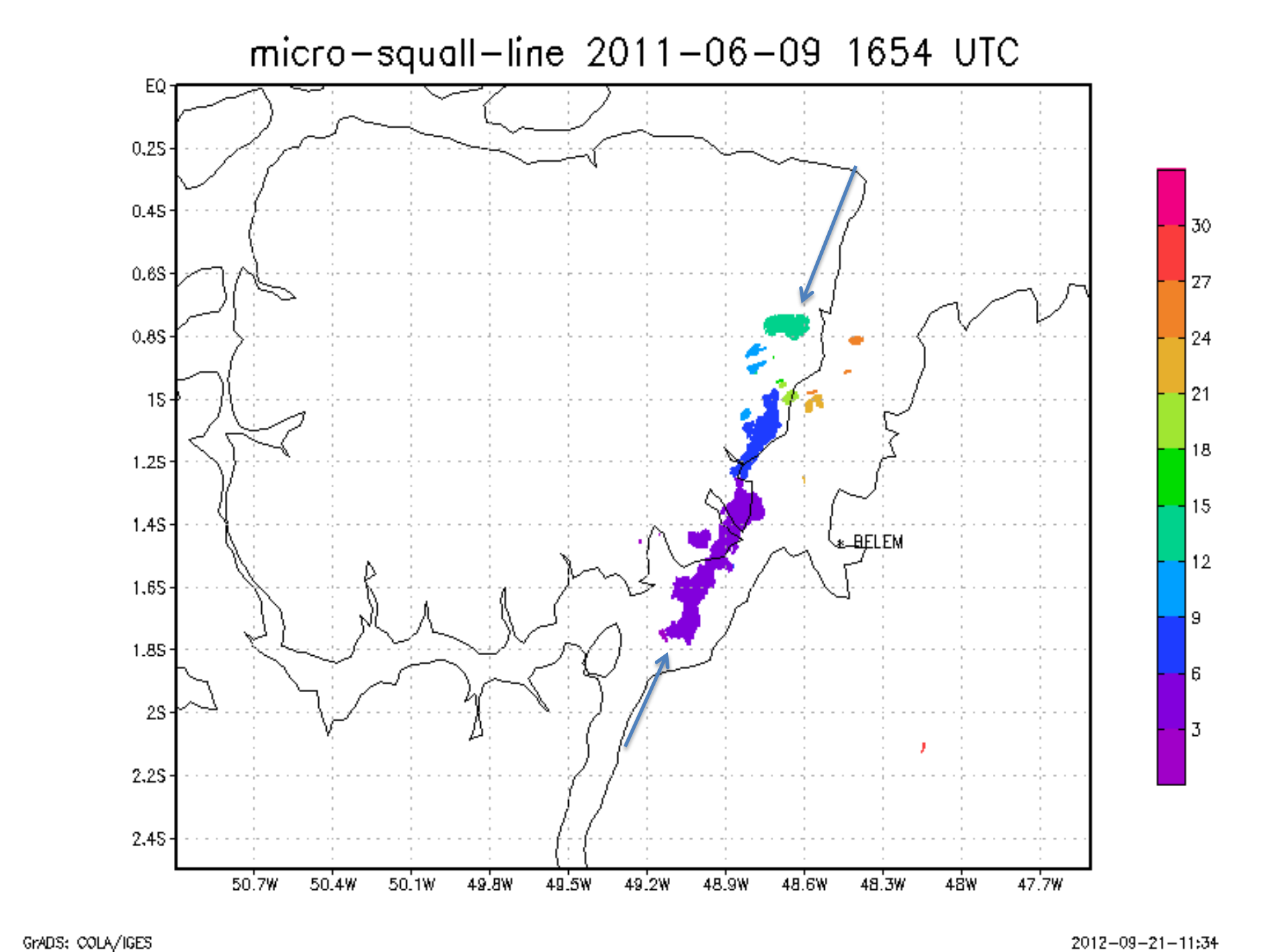
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1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
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49.2W
48.9W
48.6W
48.3W
48W
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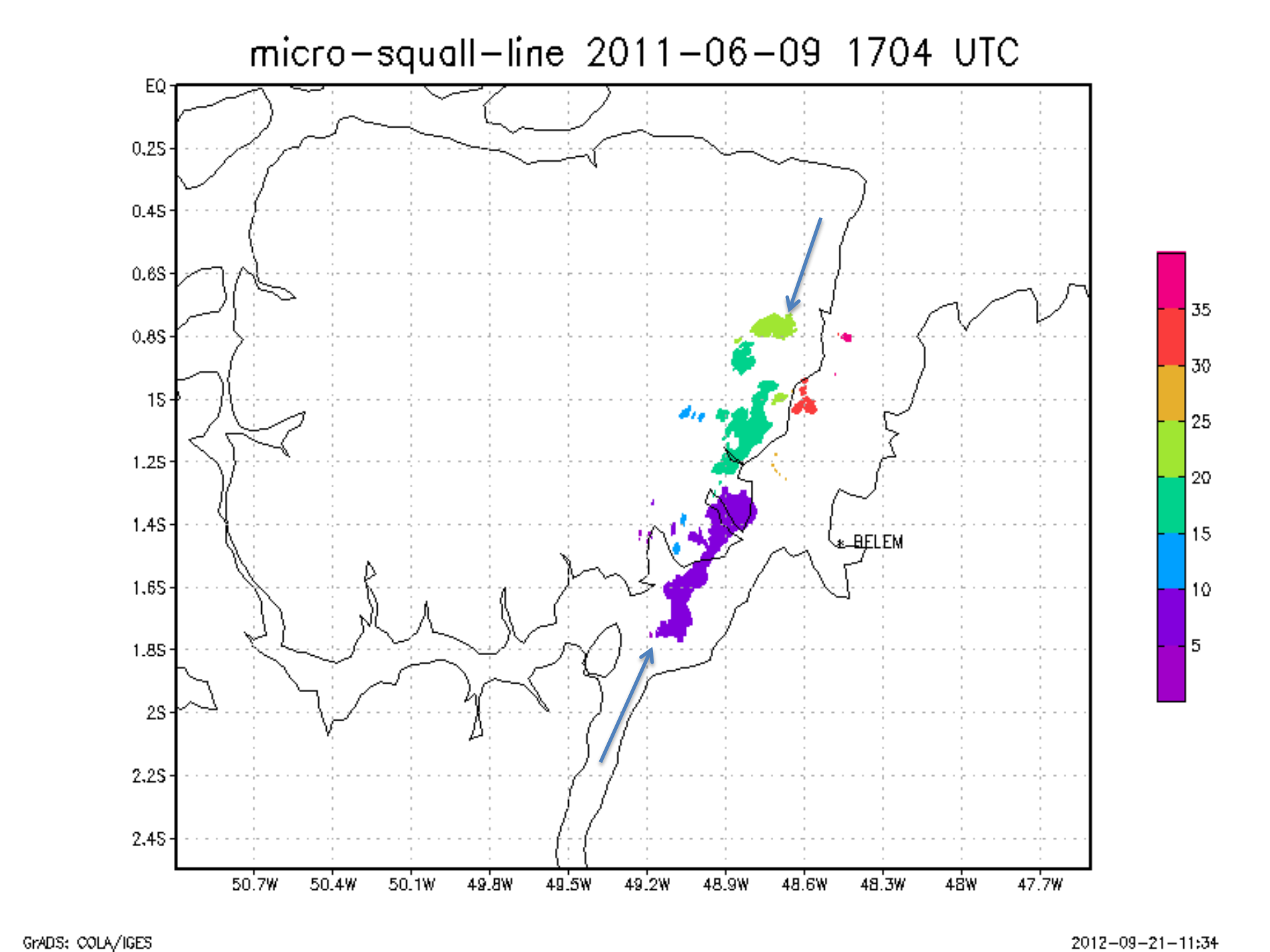
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2.4S
50.7W
50.4W
50.1W
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49.2W
48.9W
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BELEM
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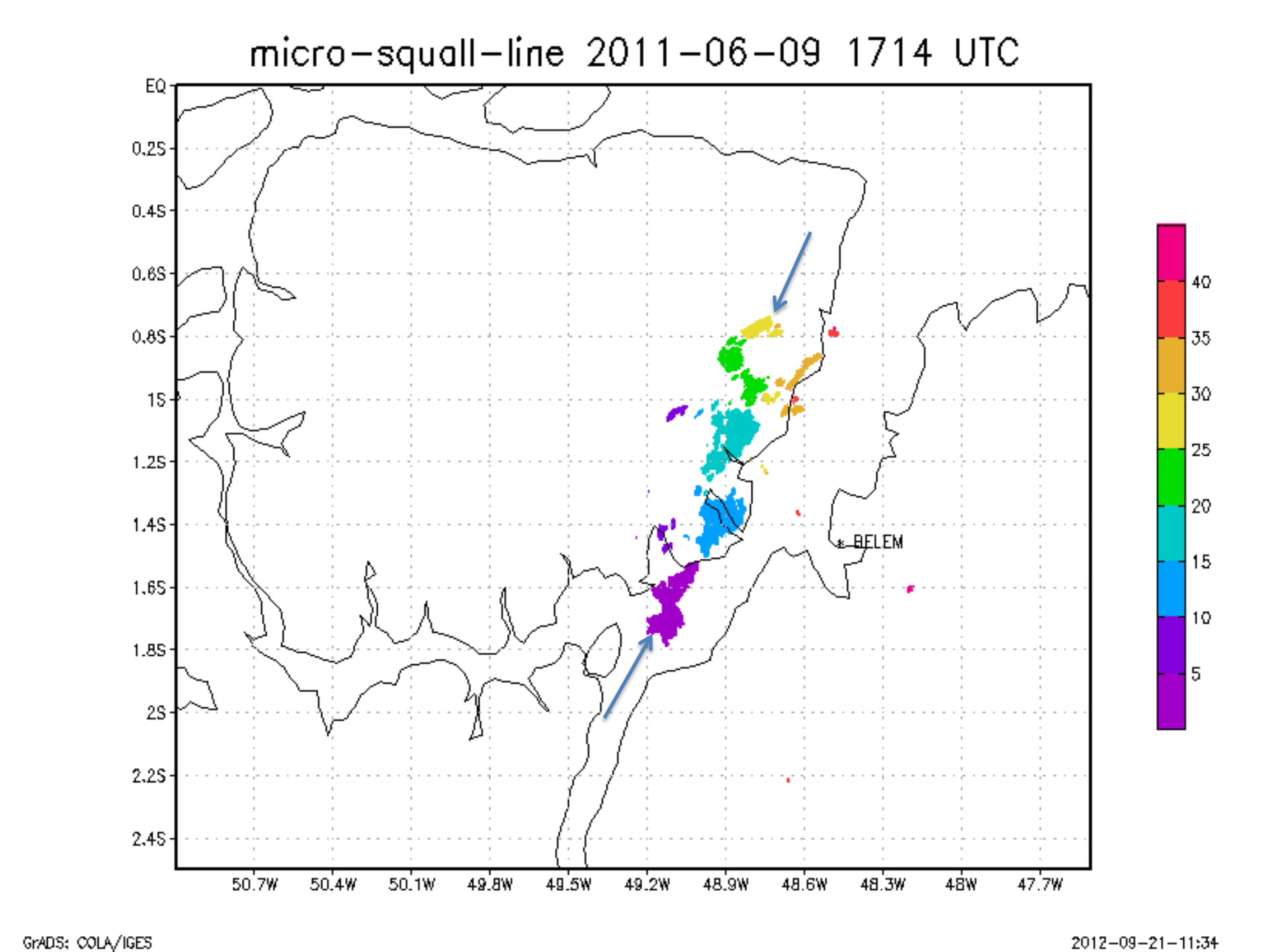
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50.4W
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49.5W
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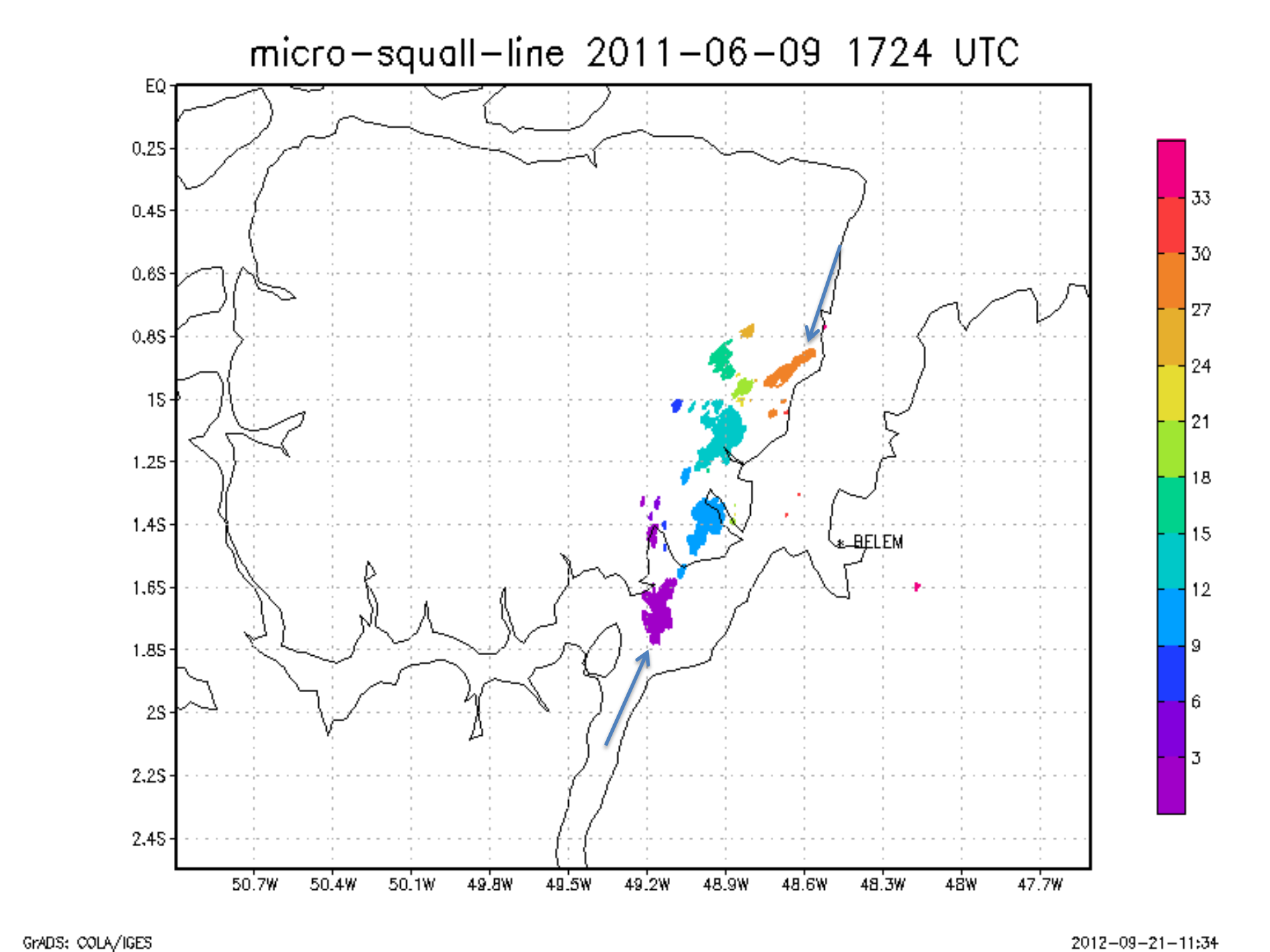
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EQ
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1.8S
2S
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50.7W
50.4W
50.1W
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48W
47.7W
BELEM
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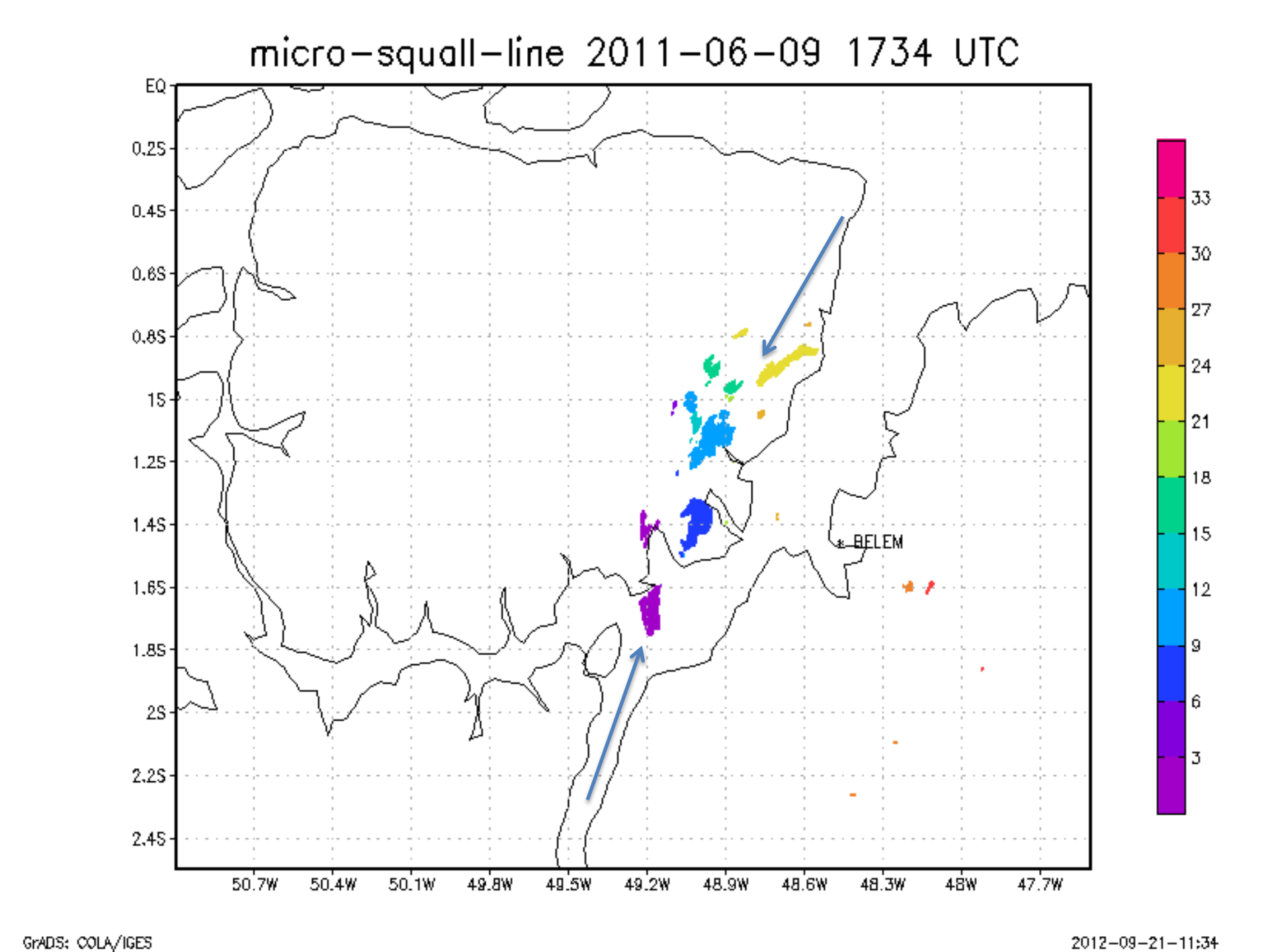
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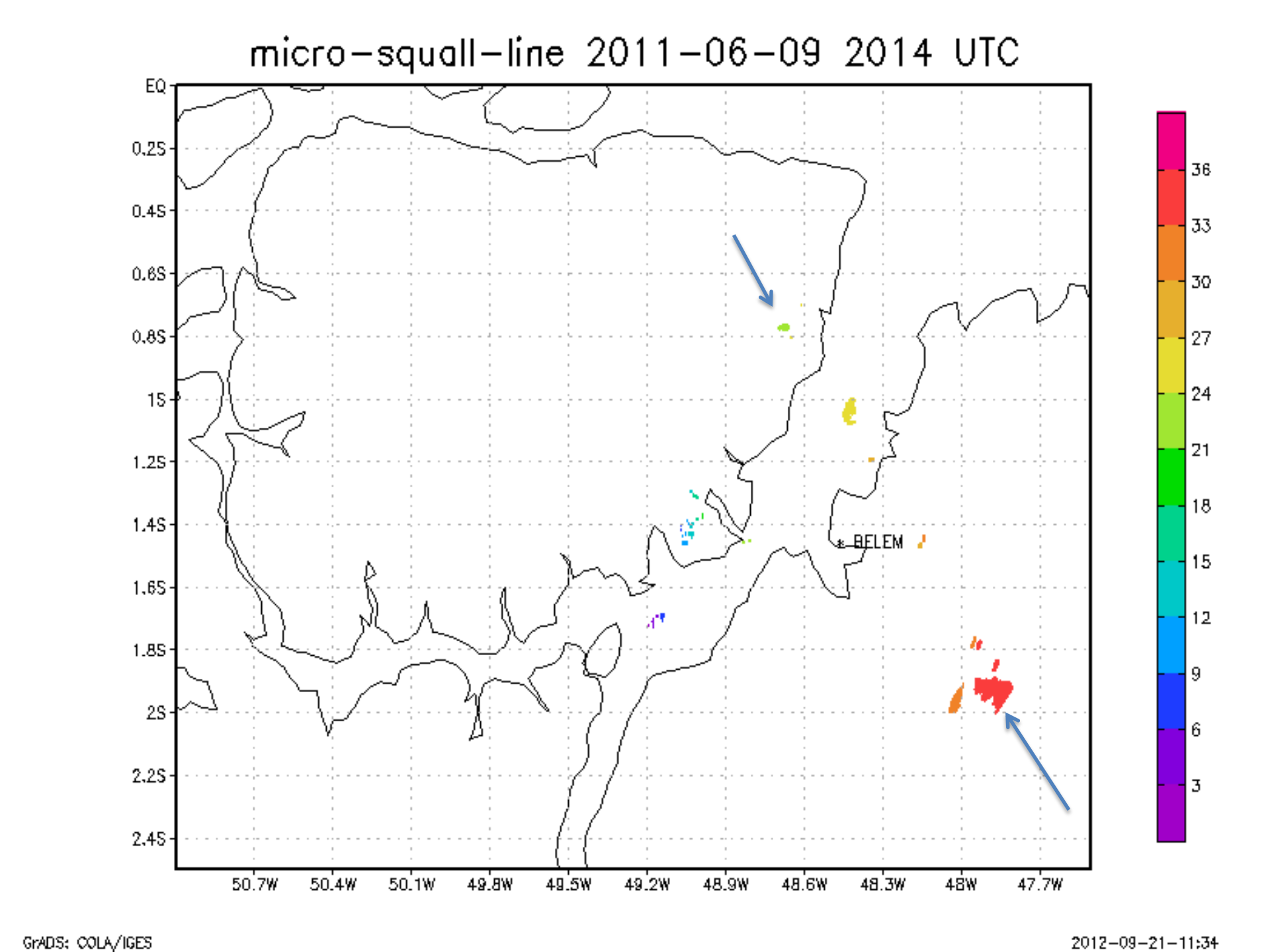
micro-squall-line 2011-06-09 2014 UTC
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2.4S
50.7W
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48W
47.7W
BELEM
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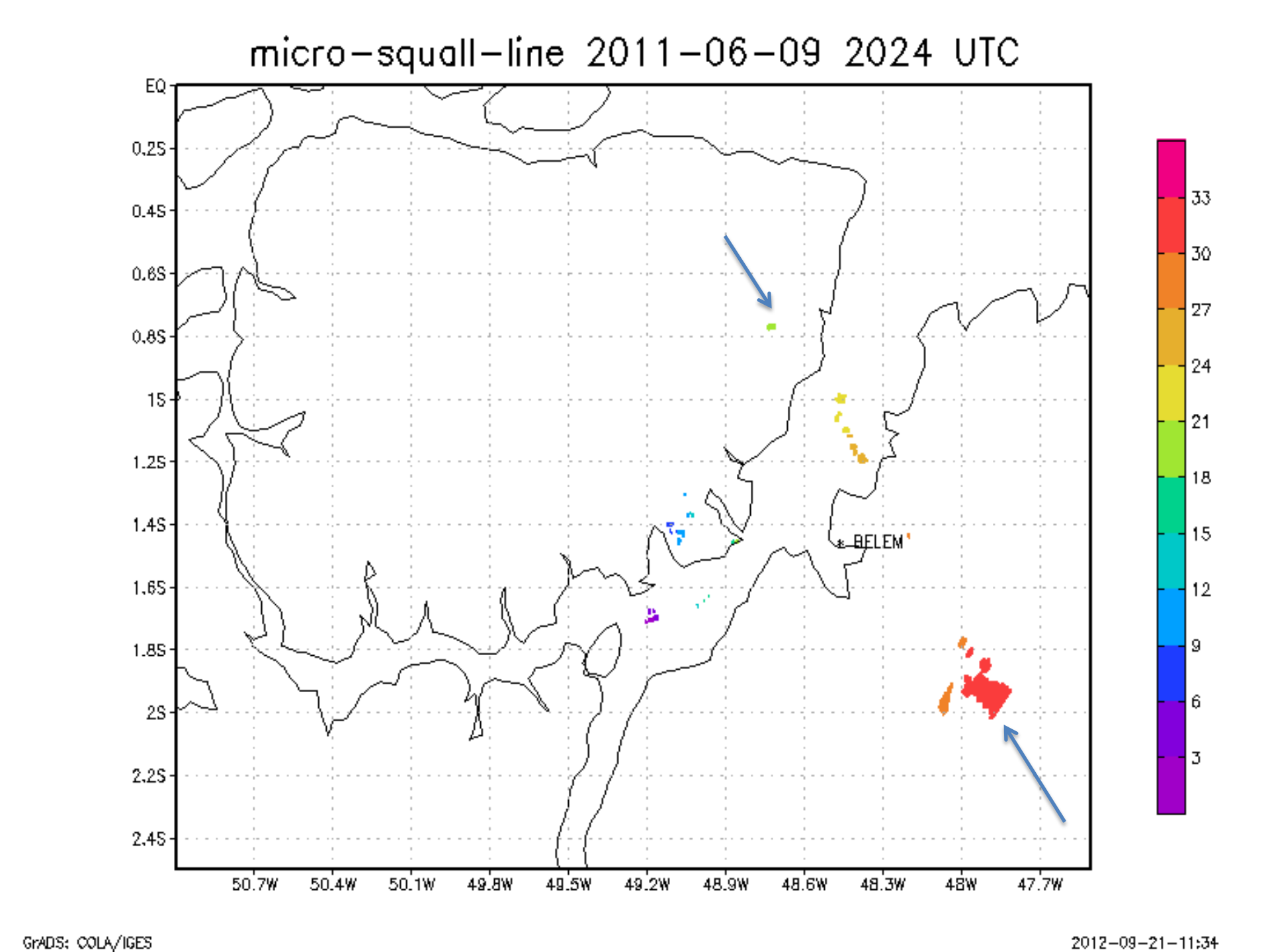
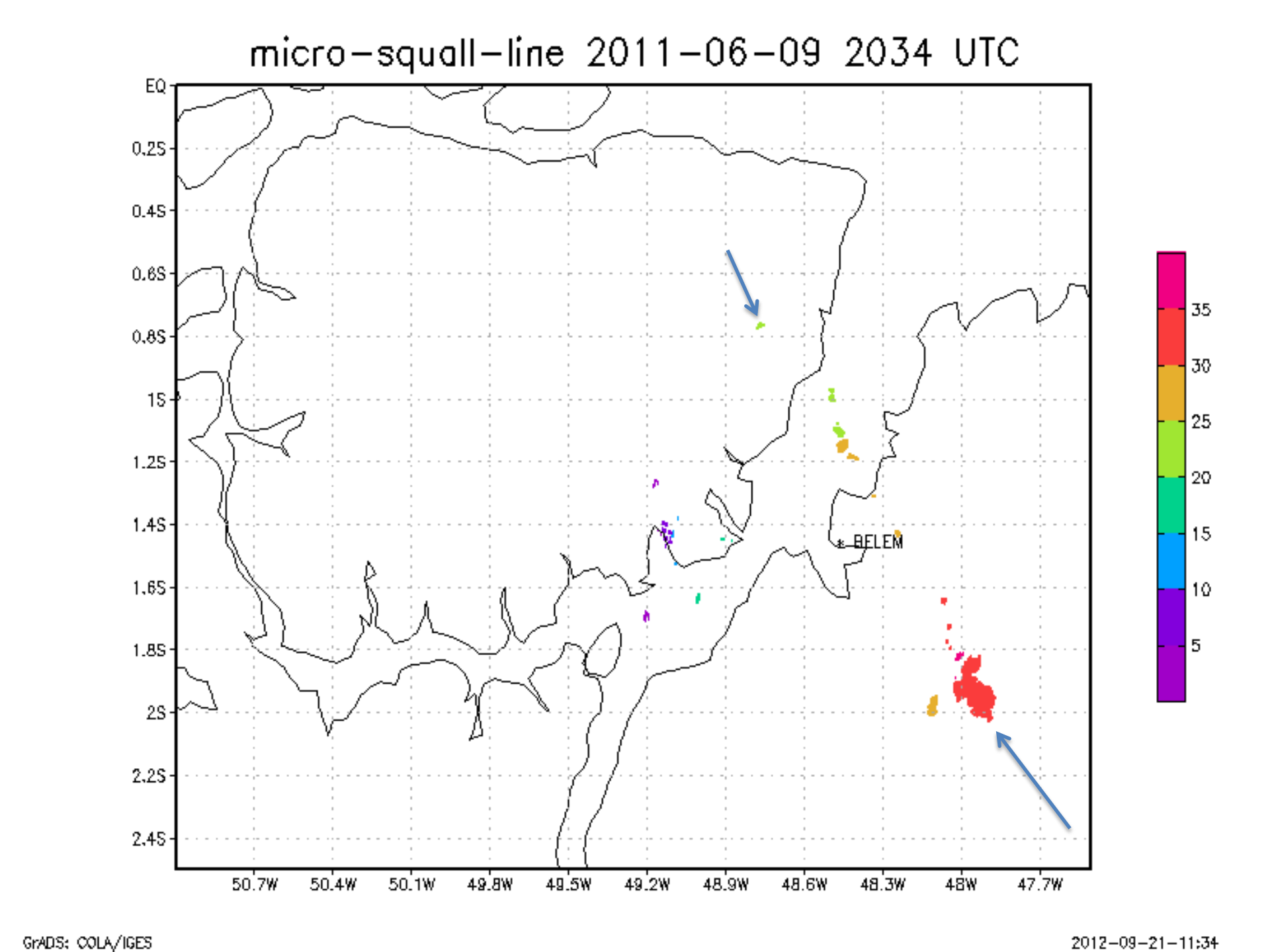
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2024 UTC
EQ
0.2S
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
33
30
27
24
21
18
15
12
9
6
3
GrADS: COLA/IGES
2012-09-21-11:34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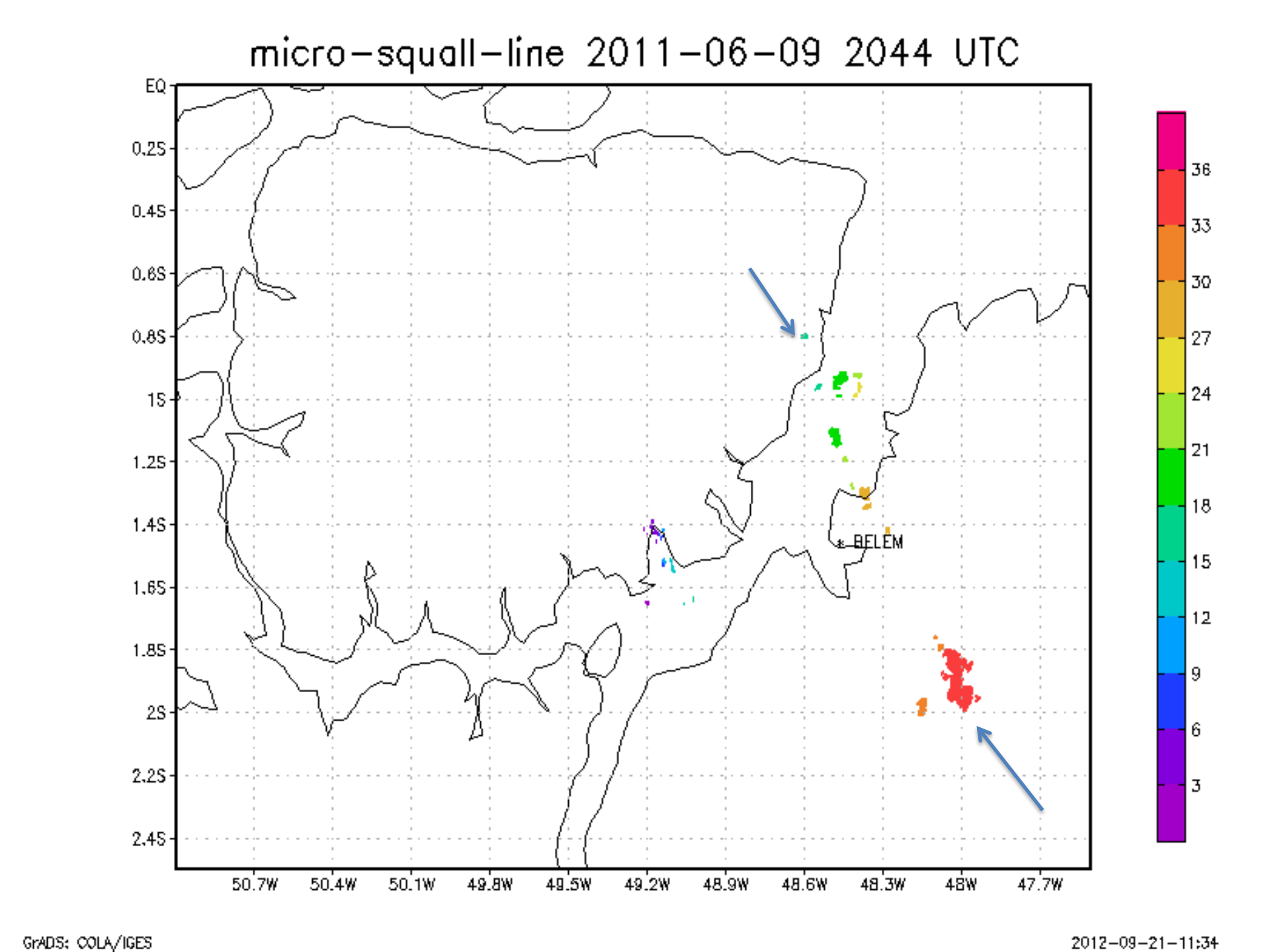
EQ
0.2S
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
35
30
25
20
15
10
5
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2044 UTC
EQ
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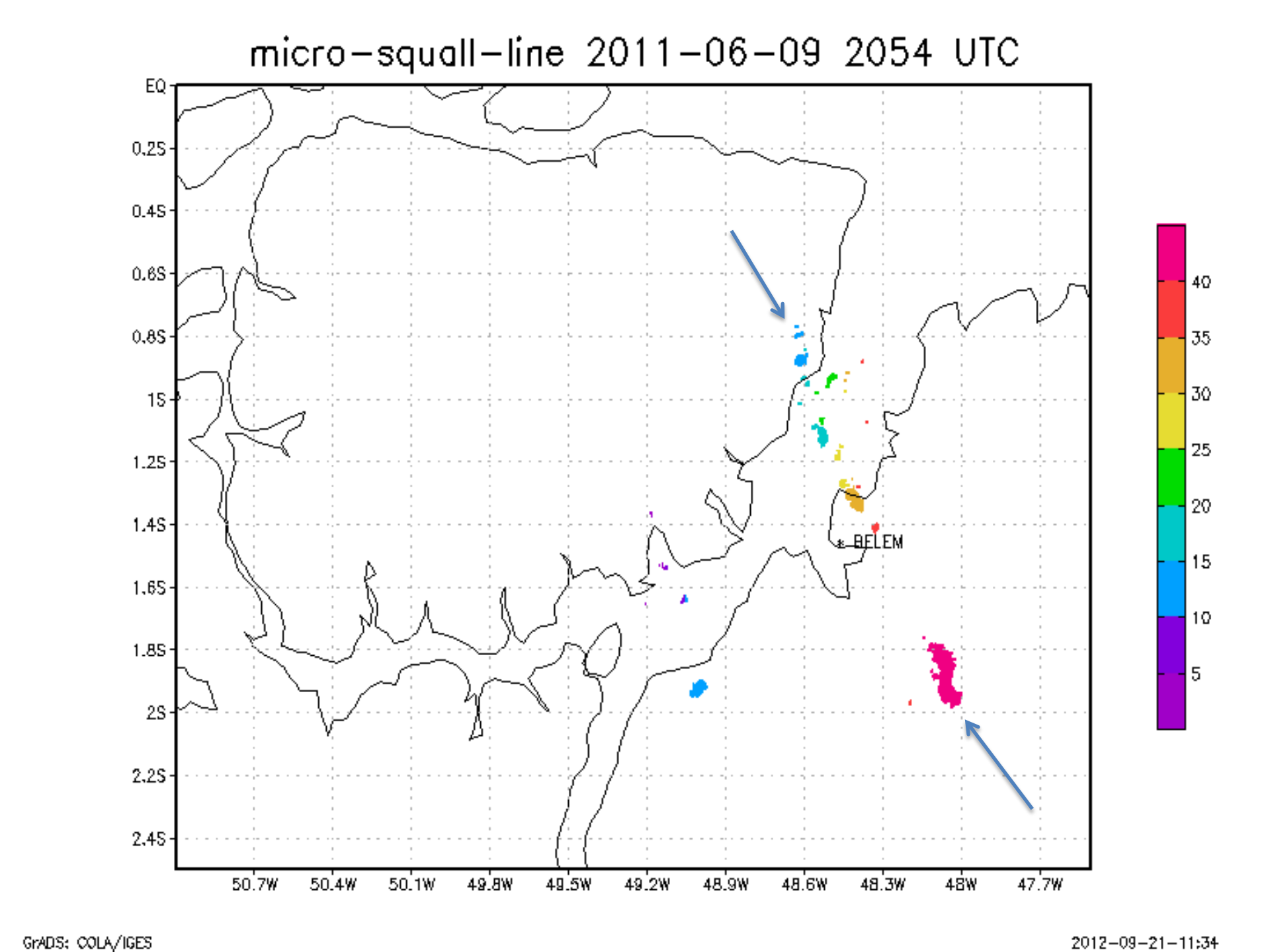
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
36
33
30
27
24
21
18
15
12
9
6
3
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2054 UTC
EQ
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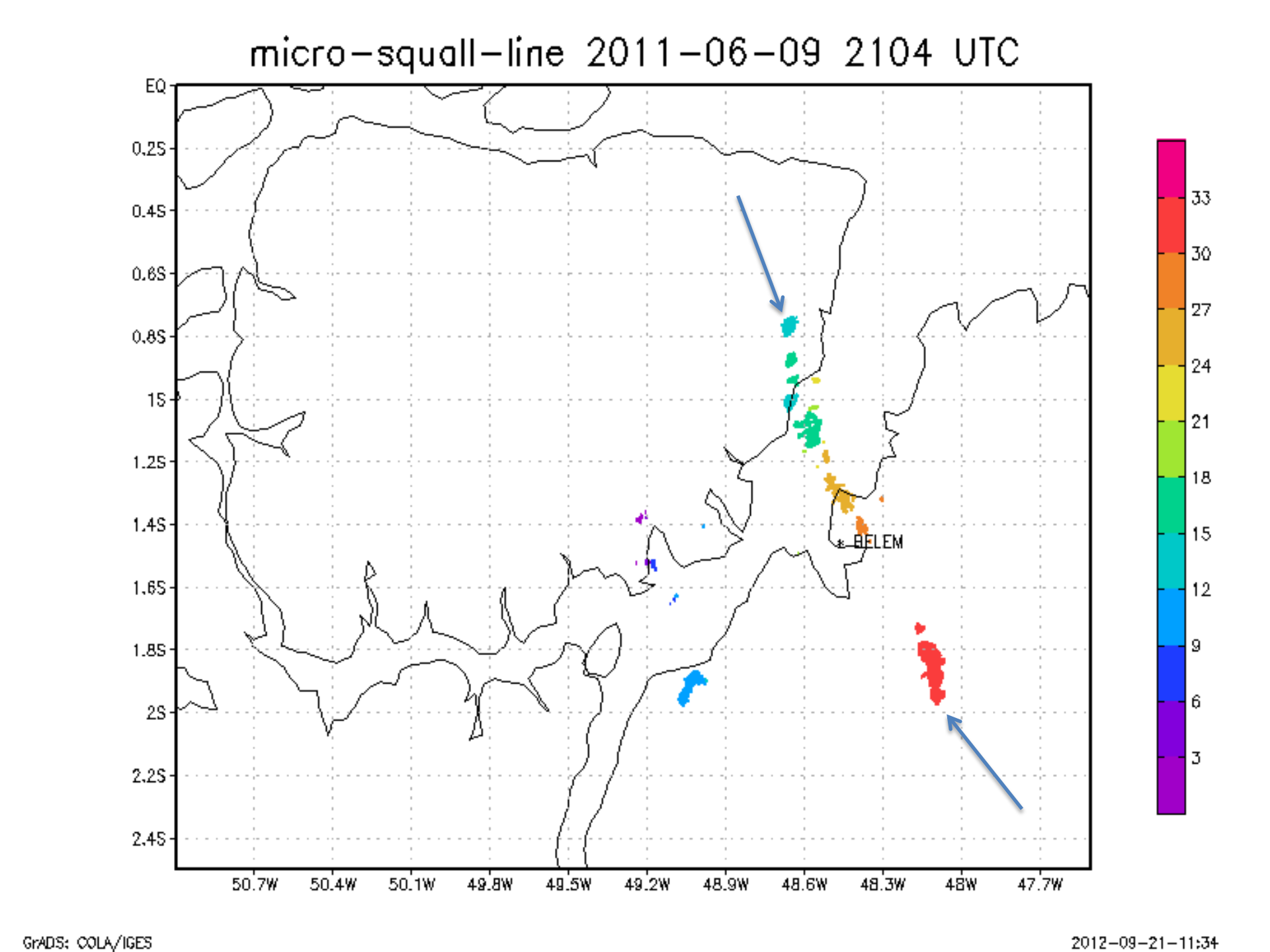
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
40
35
30
25
20
15
10
5
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2104 UTC
EQ
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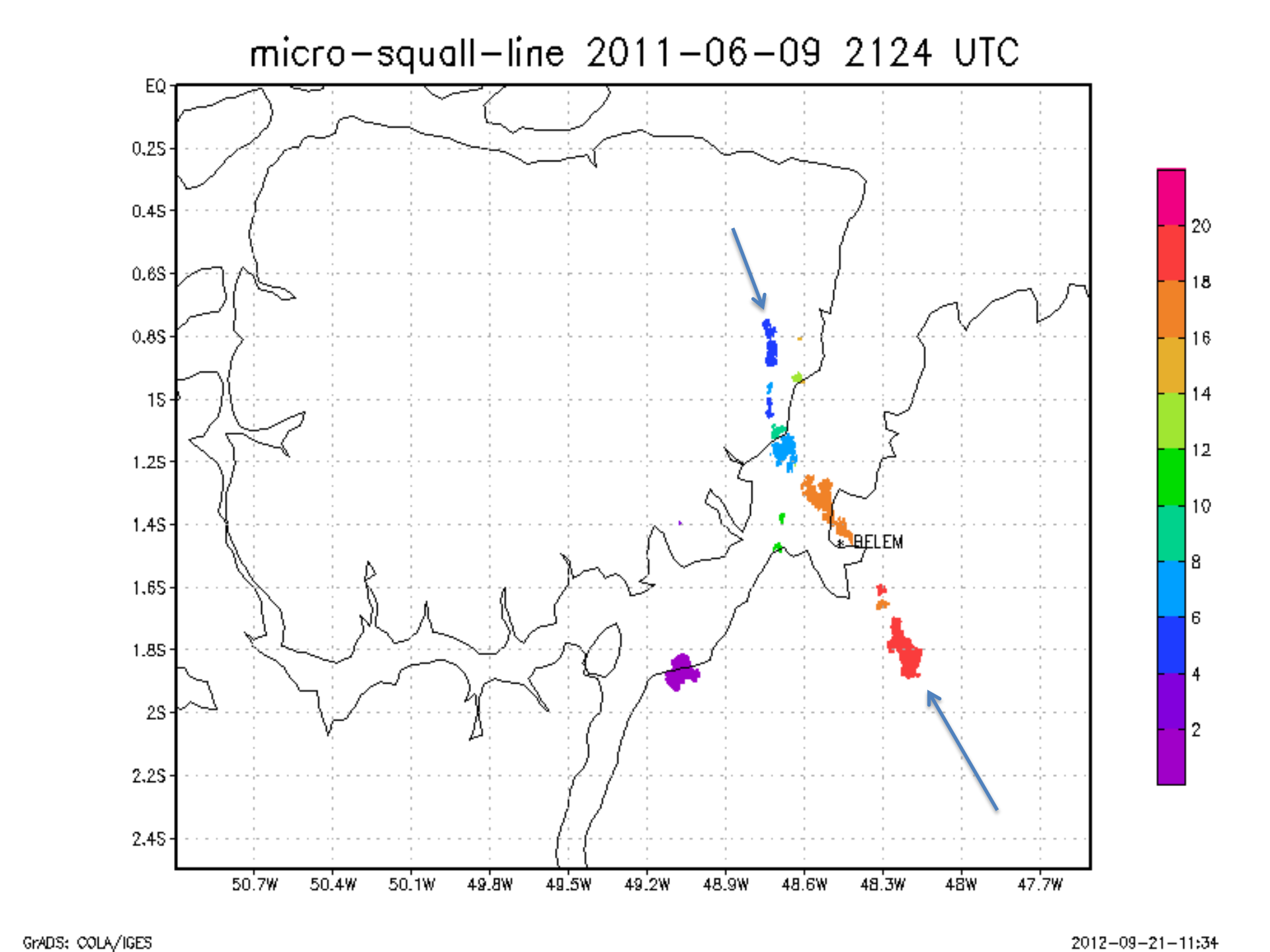
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
33
30
27
24
21
18
15
12
9
6
3
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2124 UTC
EQ
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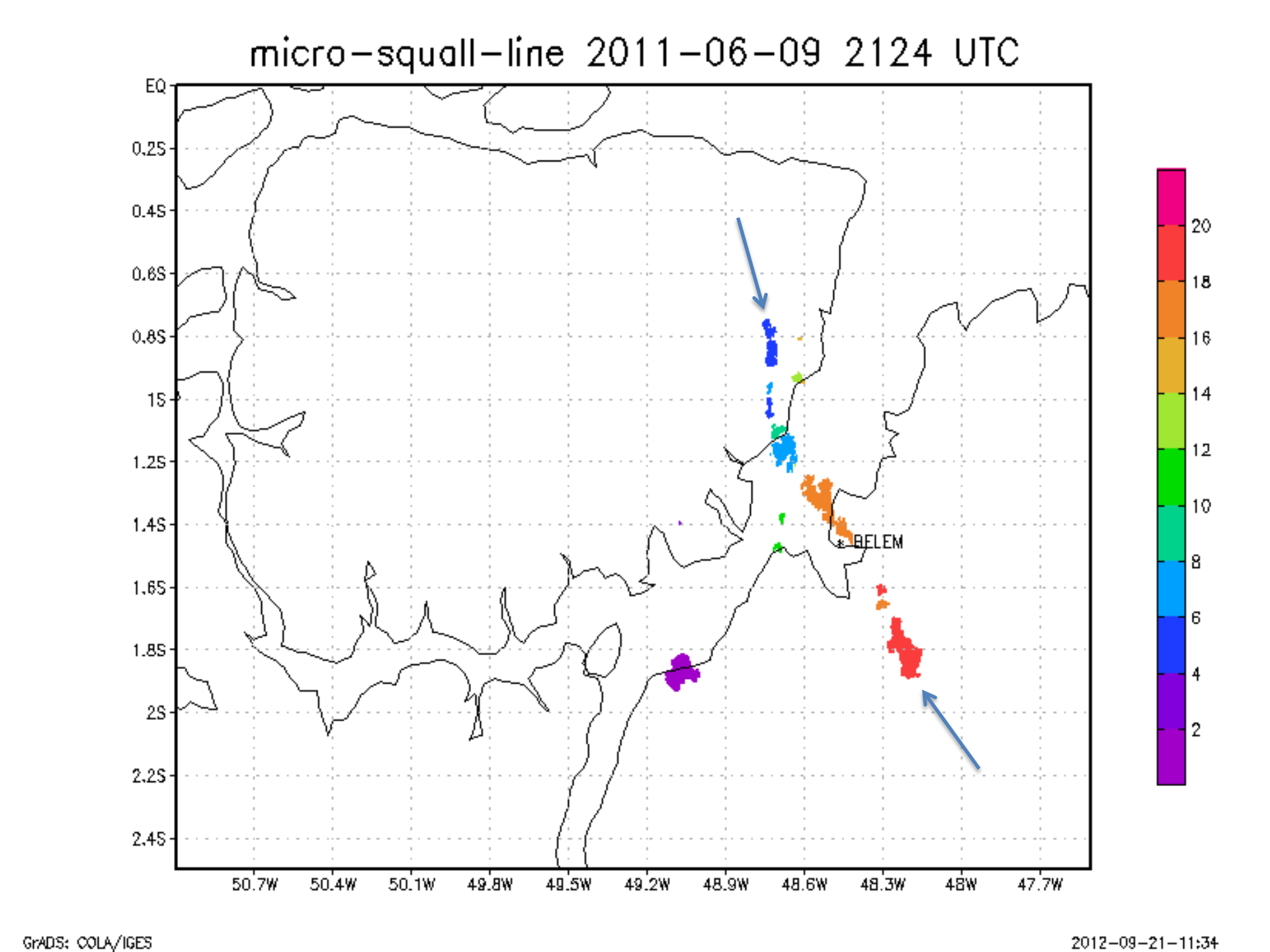
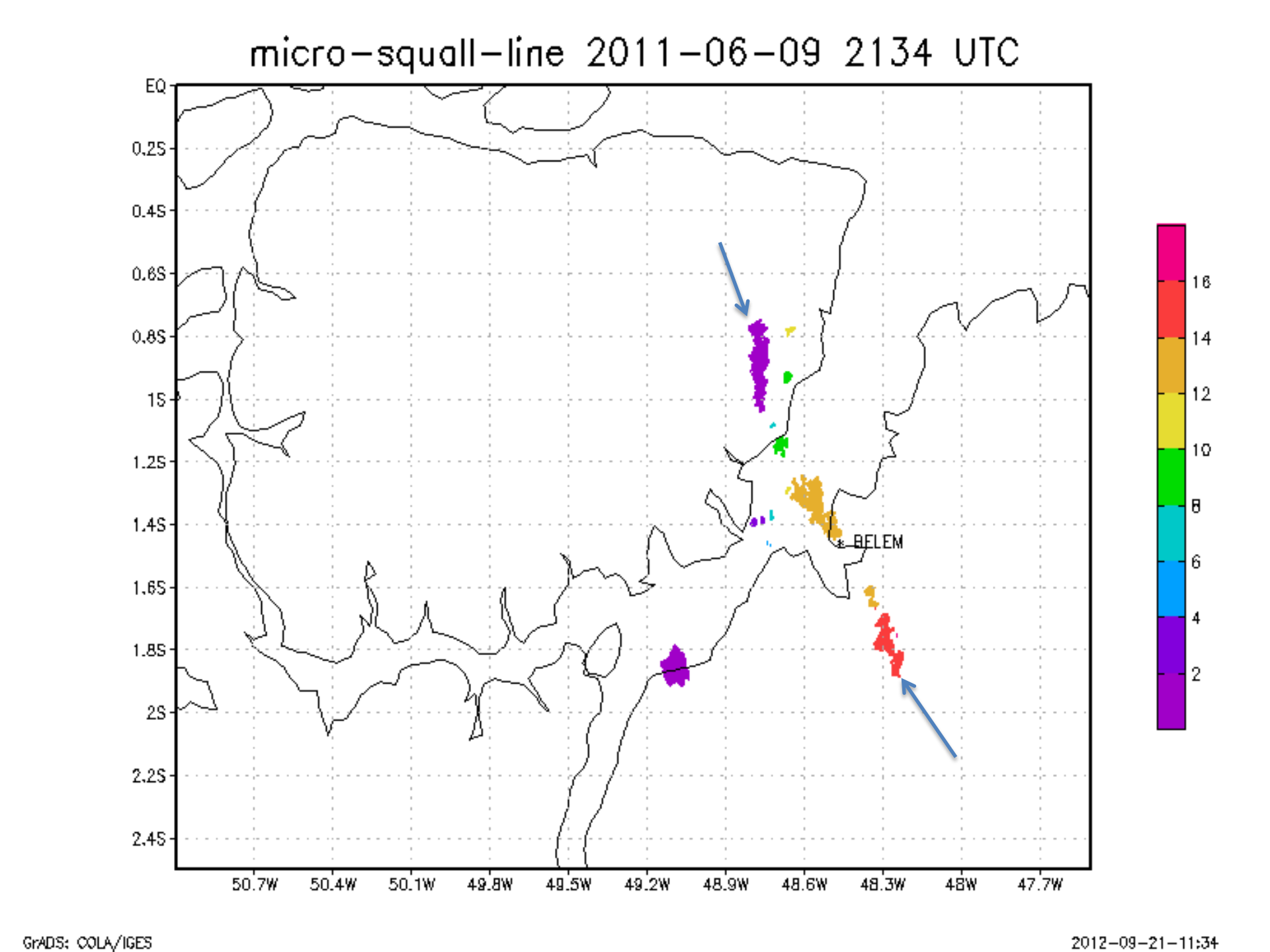
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
20
18
16
14
12
10
8
6
4
2
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2124 UTC
EQ
0.2S
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
20
18
16
14
12
10
8
6
4
2
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2134 UTC
EQ
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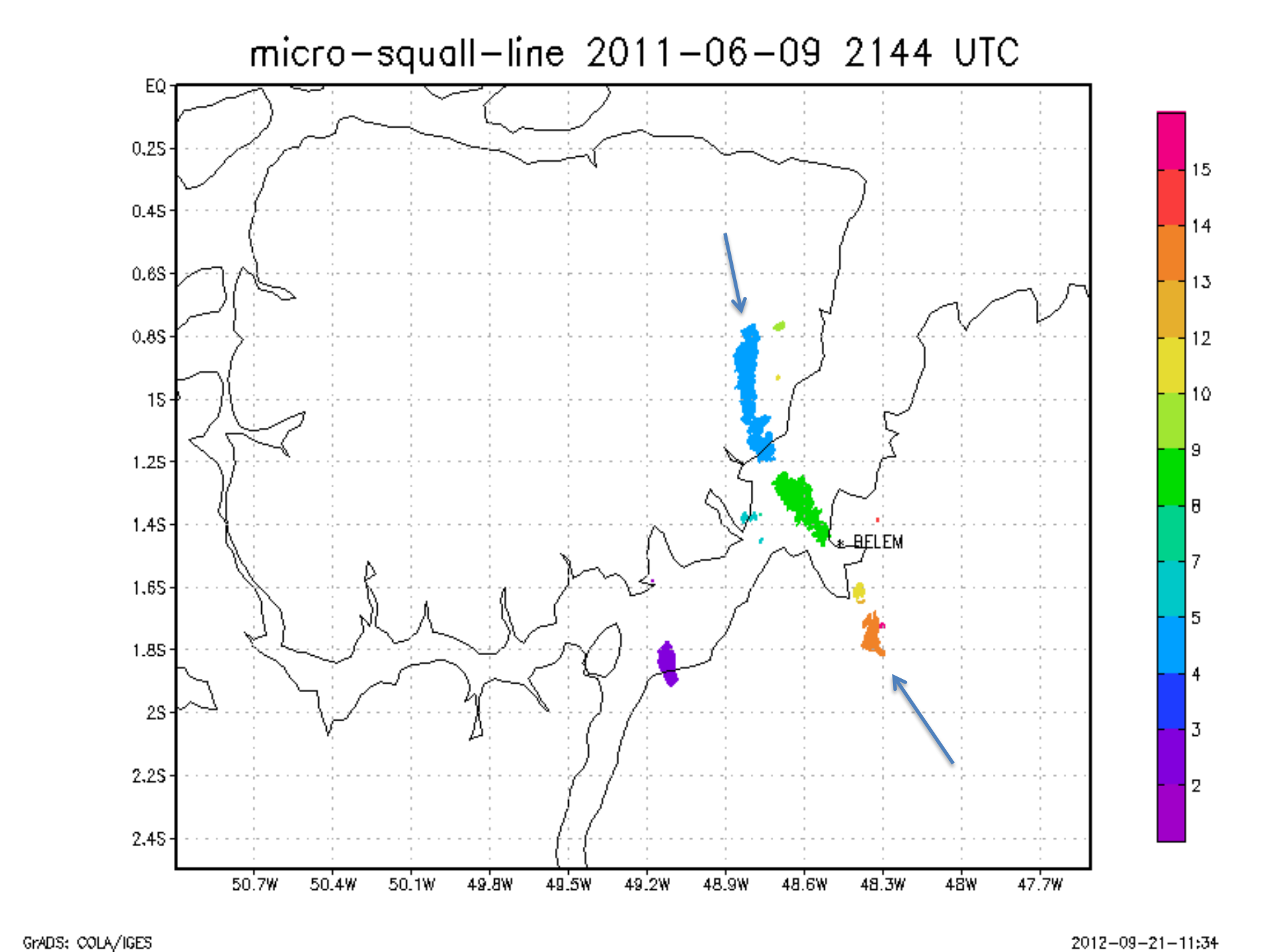
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
16
14
12
10
8
6
4
2
GrADS: COLA/IGES
2012-09-21-11:34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EQ
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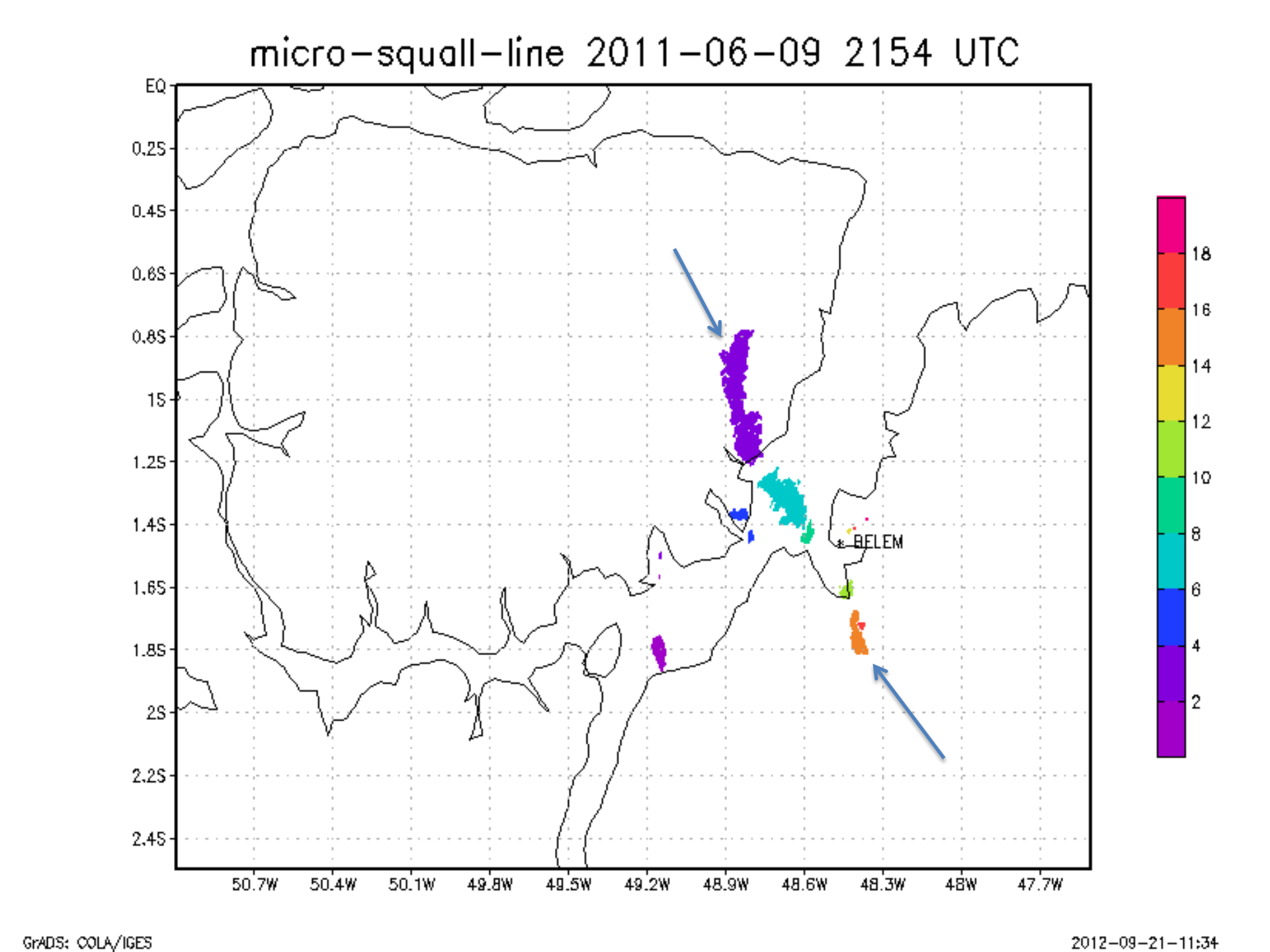
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
15
14
13
12
10
9
8
7
5
4
3
2
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2154 UTC
EQ
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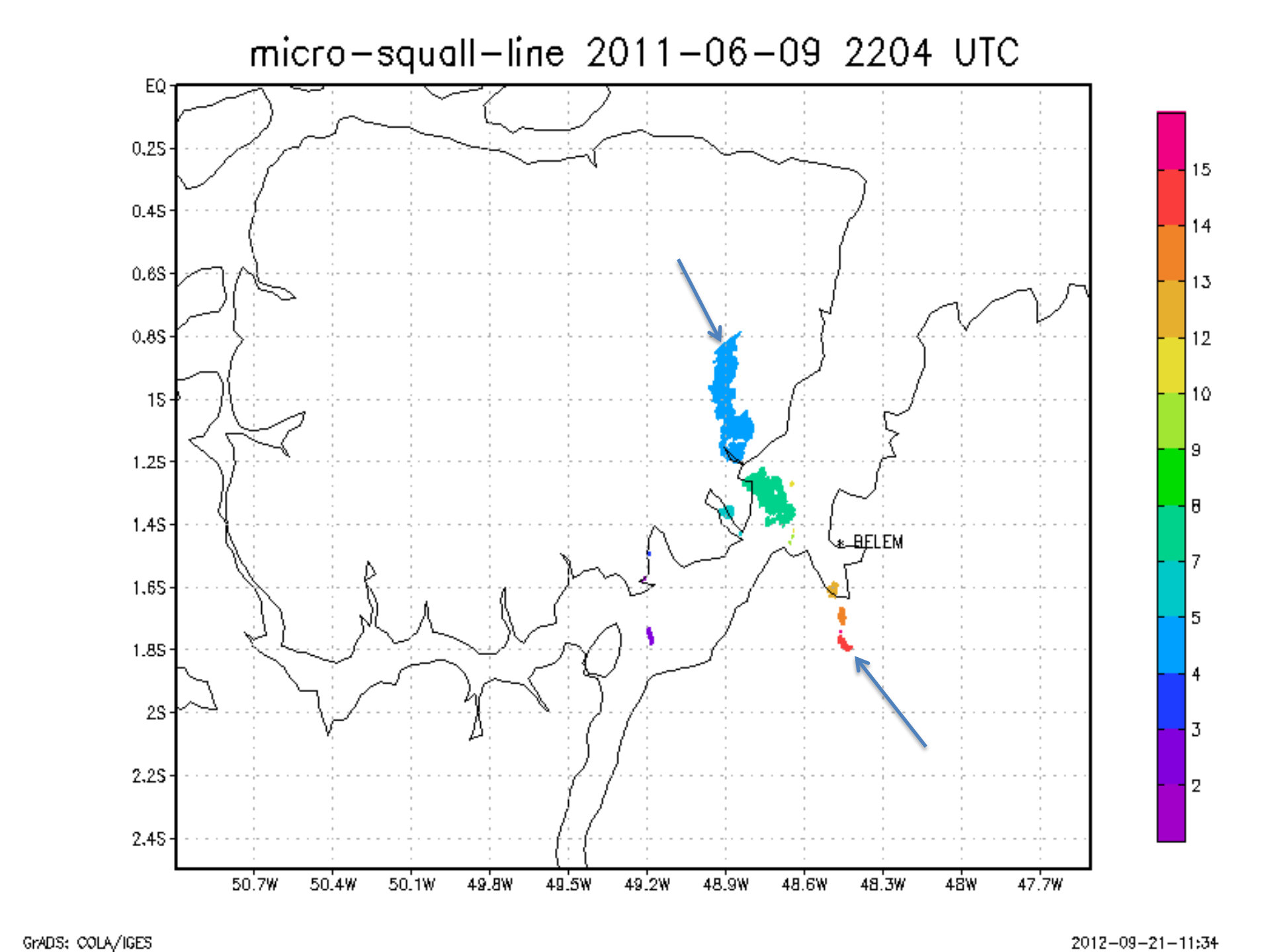
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
18
16
14
12
10
8
6
4
2
GrADS: COLA/IGES
2012-09-21-11:34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0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
15
14
13
12
10
9
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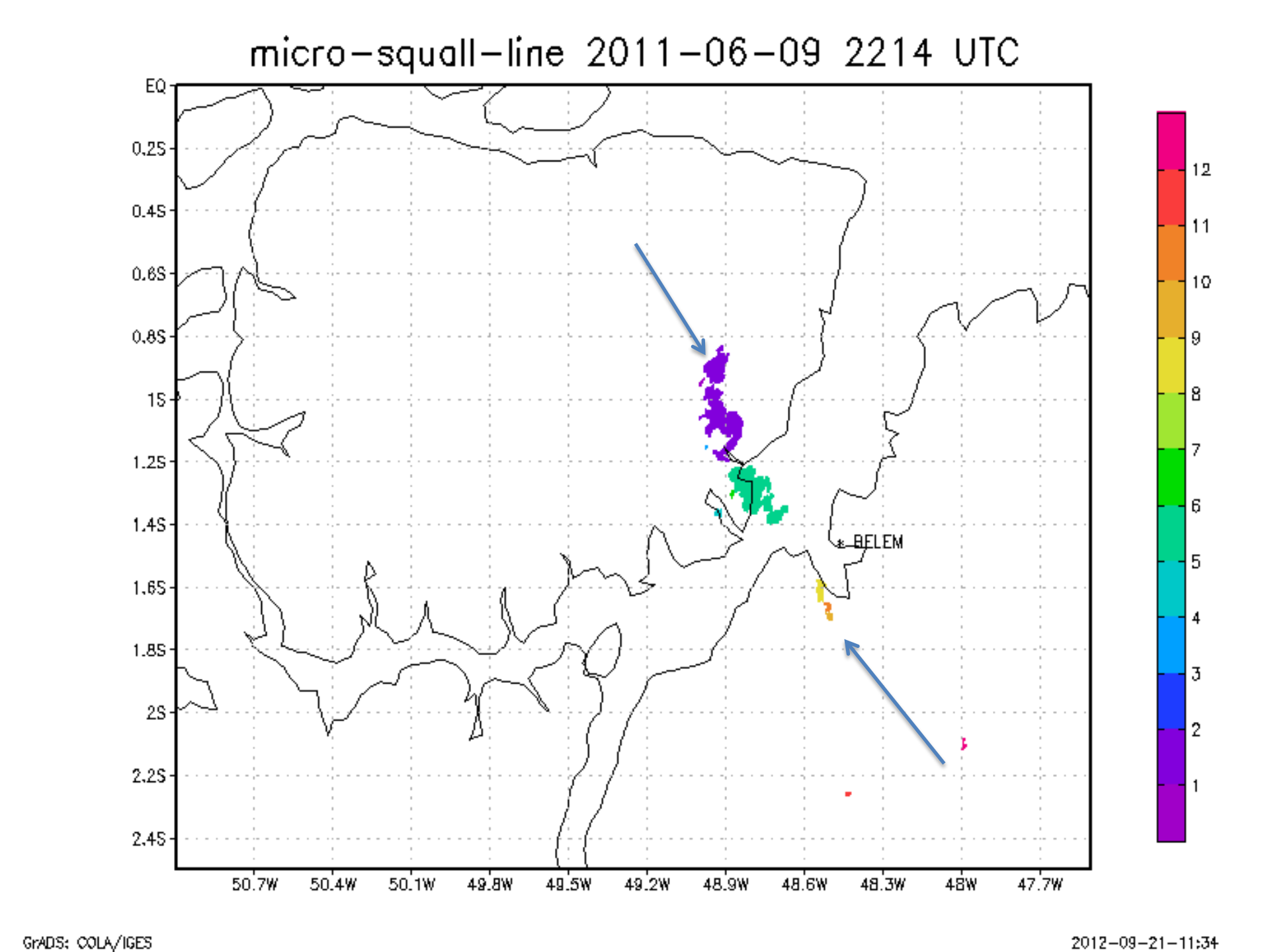
7
5
4
3
2
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2214 UTC
EQ
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0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
12
11
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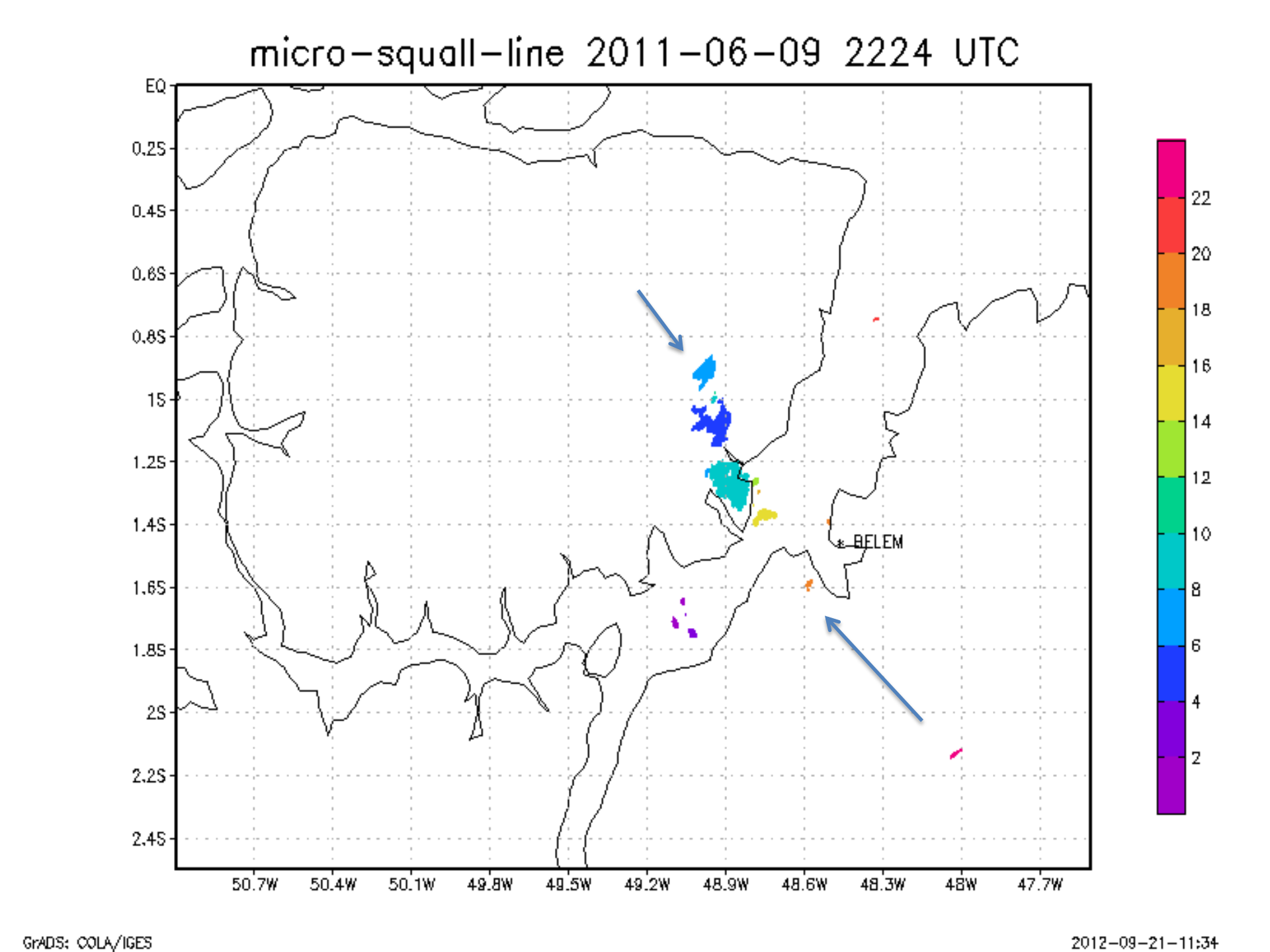
9
8
7
6
5
4
3
2
1
GrADS: COLA/IGES
2012-09-21-11:34


micro-squall-line 2011-06-09 2224 UTC
EQ
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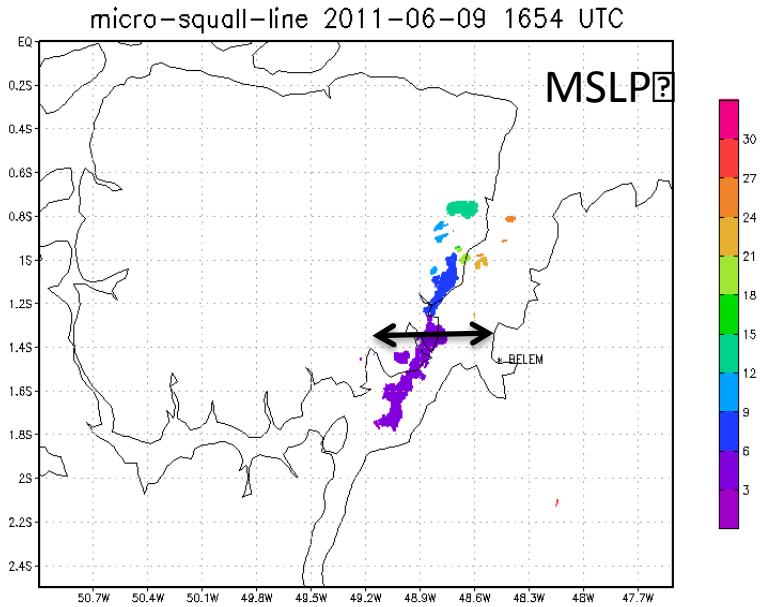
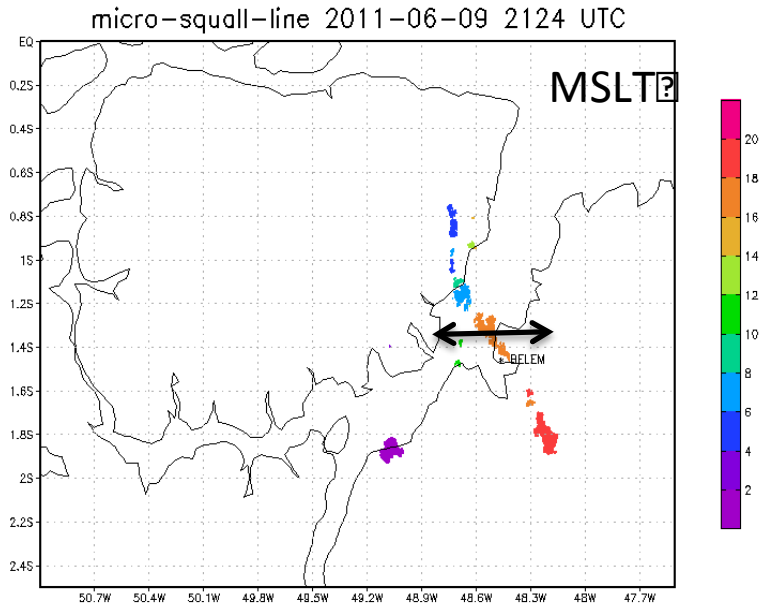
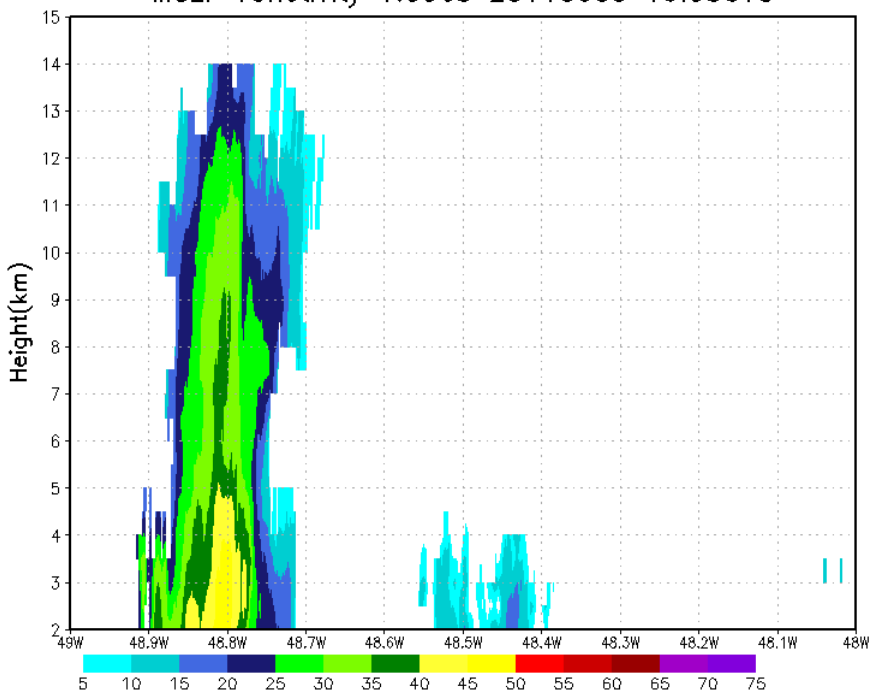
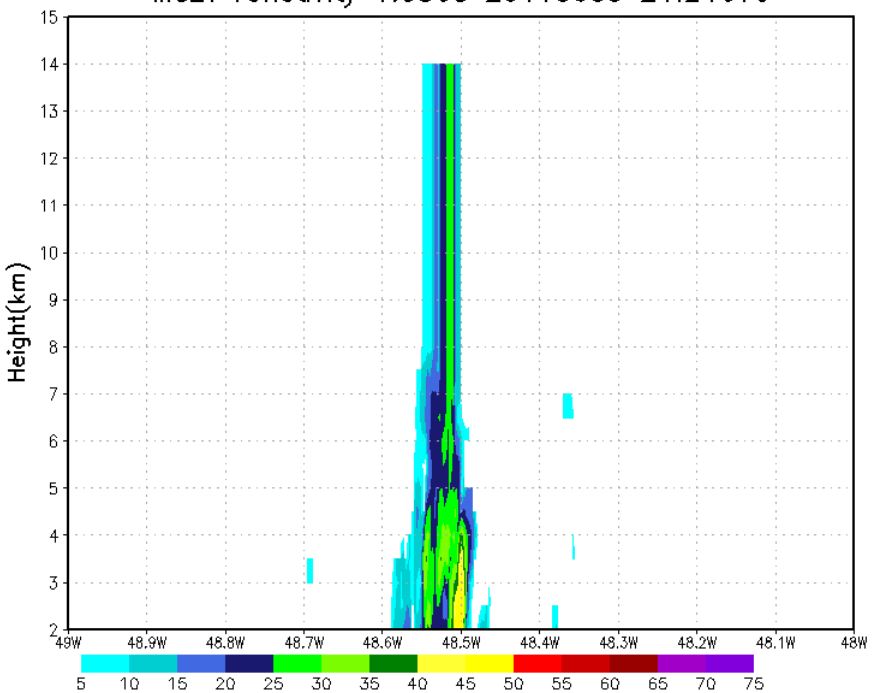
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
50.7W
50.4W
50.1W
49.8W
49.5W
49.2W
48.9W
48.6W
48.3W
48W
47.7W
BELEM
22
20
18
16
14
12
10
8
6
4
2
GrADS: COLA/IGES
2012-09-21-11:34

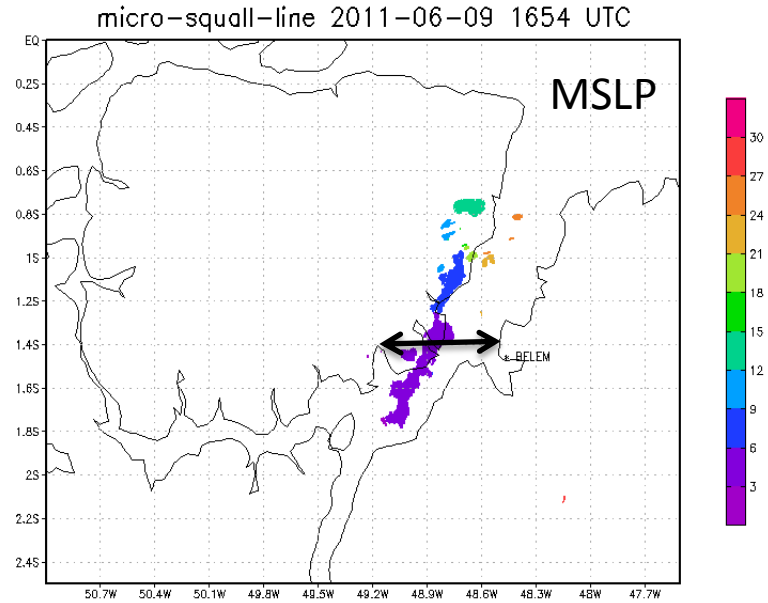
1 Squall Line and 2 Micro Squall Lines

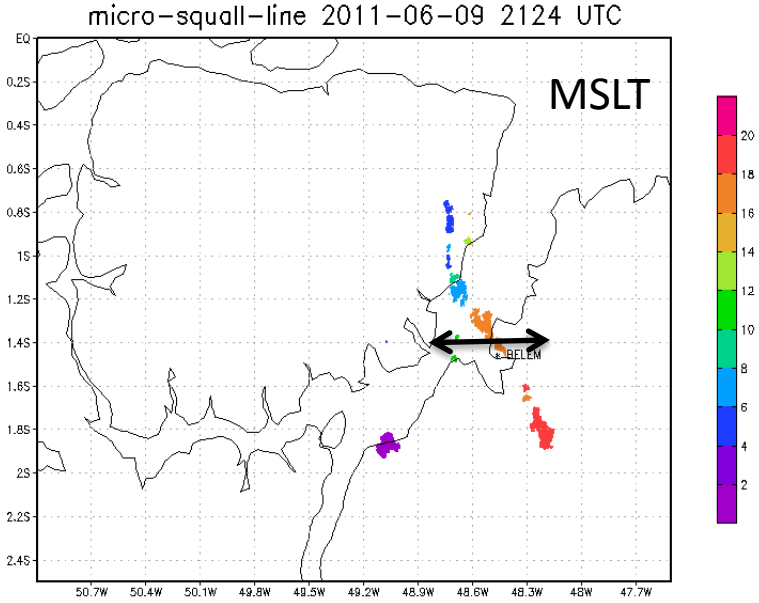


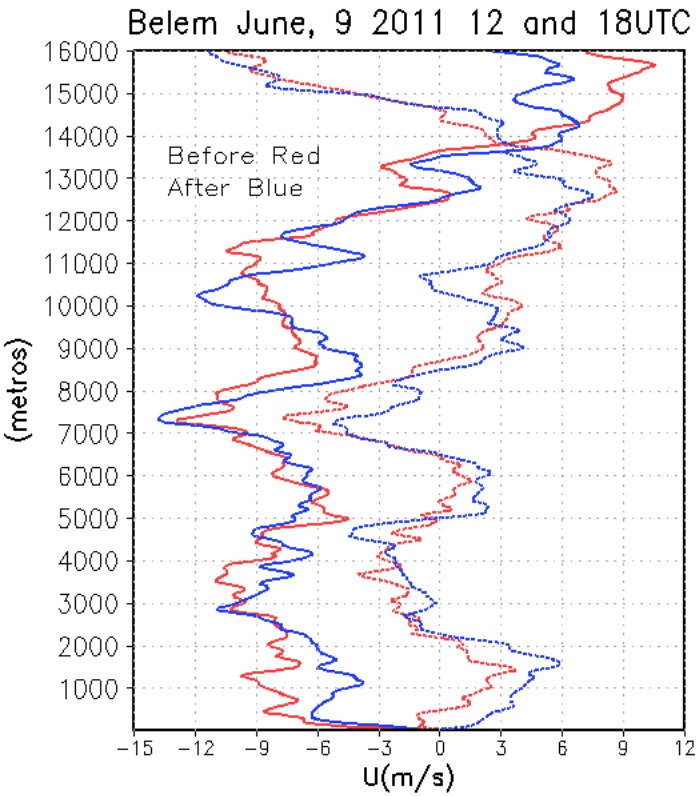


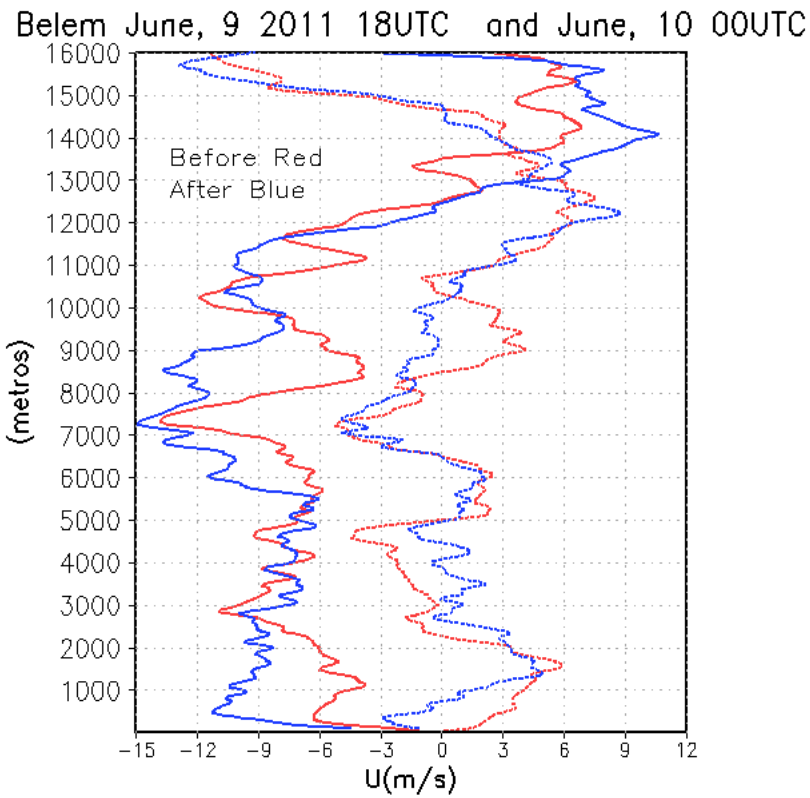




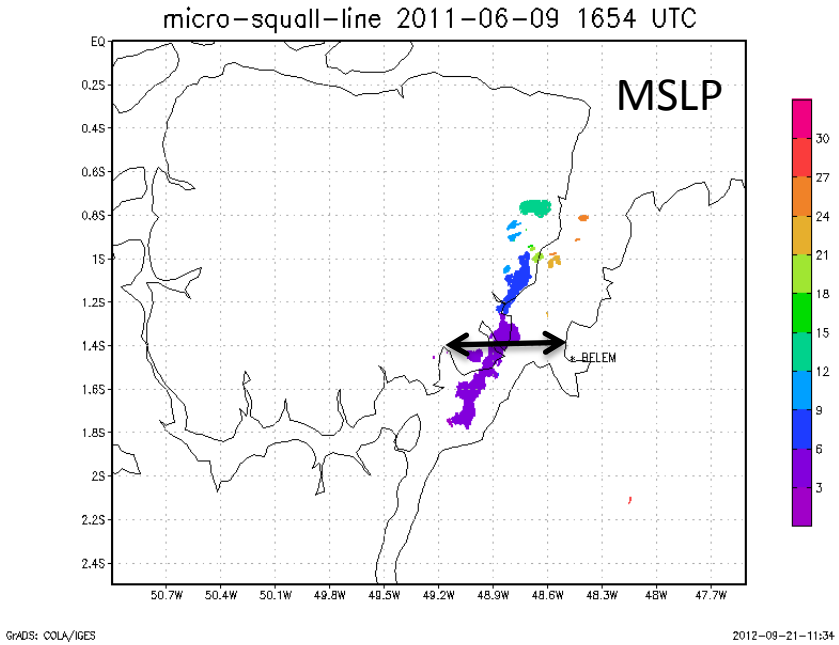


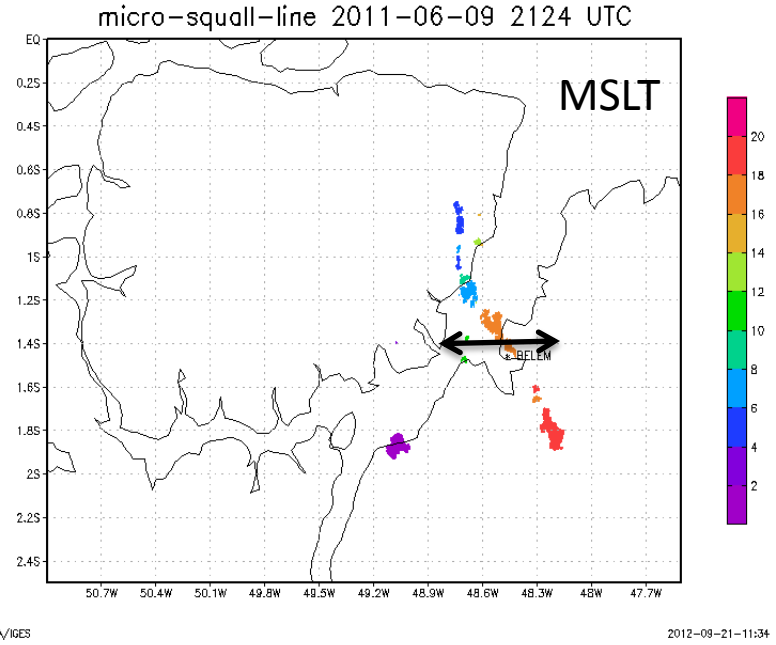






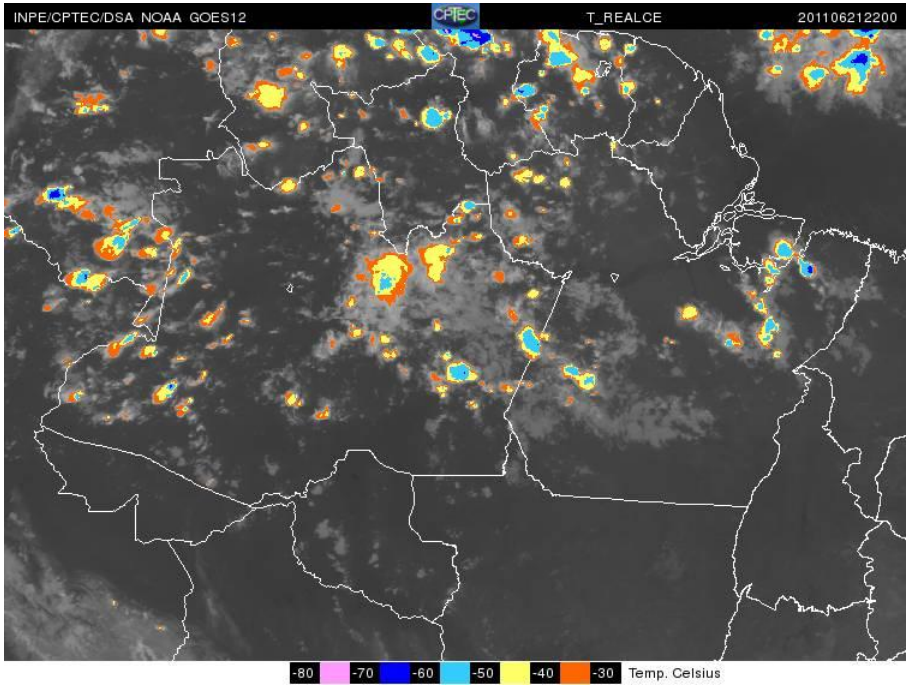
GrADS: COLA/IGES

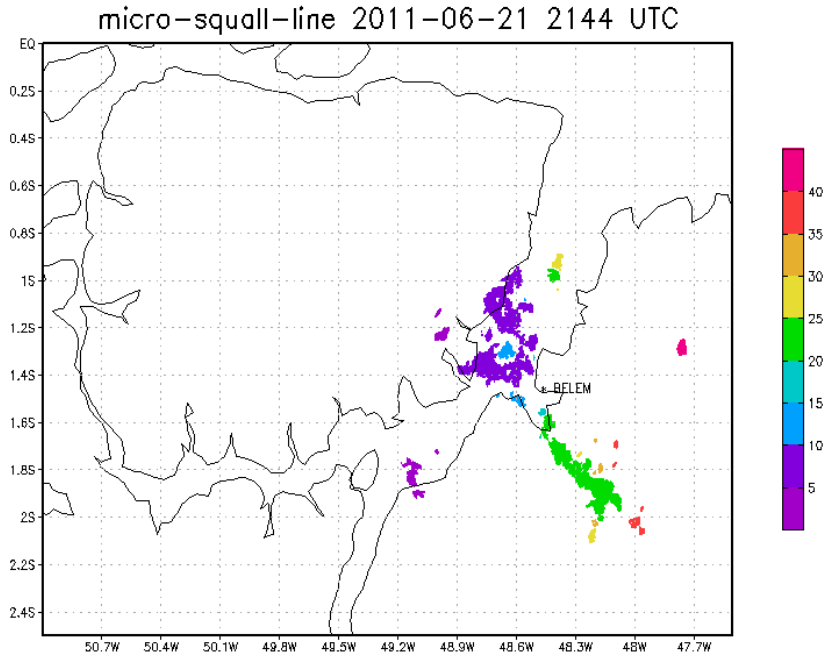


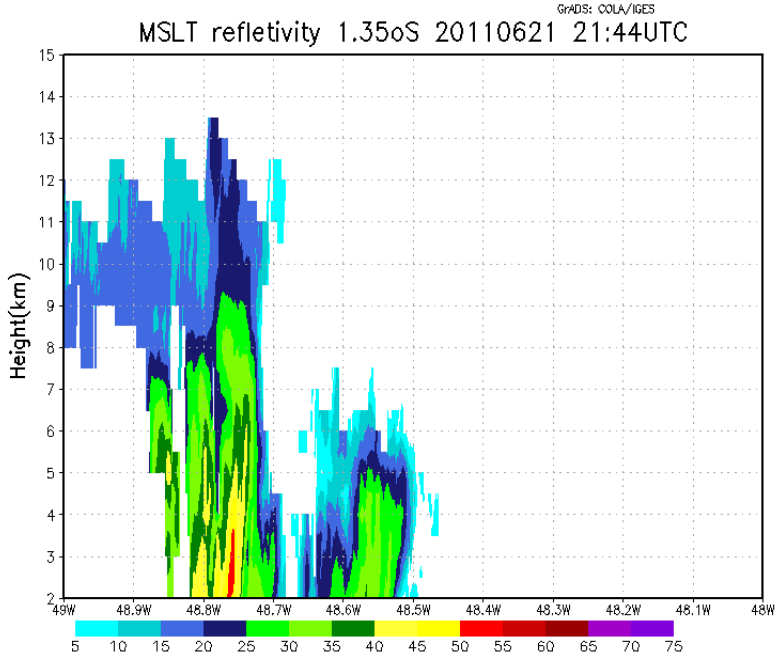


Rainfall(mm)

	Benevides	Outeiro	DTCEA	INMET
MLSP	8.636	1.778	0.762	0
MSLT	0	0	1.524	9.144


INPE/CPTEC/DSA NOAA GOES12
CPTEC
T_REALCE
201106212200
-80 -70 -60 -50 -40 -30 Temp. Celsius


micro-squall-line 2011-06-21 2144 UTC
EQ
0.2S
0.4S
0.6S
0.8S
1S
1.2S
1.4S
1.6S
1.8S
2S
2.2S
2.4S
BELEM
50.7W 50.4W 50.1W 49.8W 49.5W 49.2W 48.9W 48.6W 48.3W 48W 47.7W
40 35 30 25 20 15 10 5


GrADS: COLA/IGES
2012-09-21-11:59
MSLT refletivity 1.35oS 20110621 21:44UTC
Height(km)
15 14 13 12 11 10 9 8 7 6 5 4 3 2
49W 48.9W 48.8W 48.7W 48.6W 48.5W 48.4W 48.3W 48.2W 48.1W 48W
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

Preliminary Conclusions

- Generally, these systems are embedded in clouds that belong to classical Squall Lines which are observed on satellite image as a single convective organization.

- Moreover, it seem to have a series of pulses of precipitation, giving an idea of existence of another scale internal of the organization.