Seasonal and Interannual Variability of Thunderstorms in Iceland and the Origin of Airmasses in the Storms

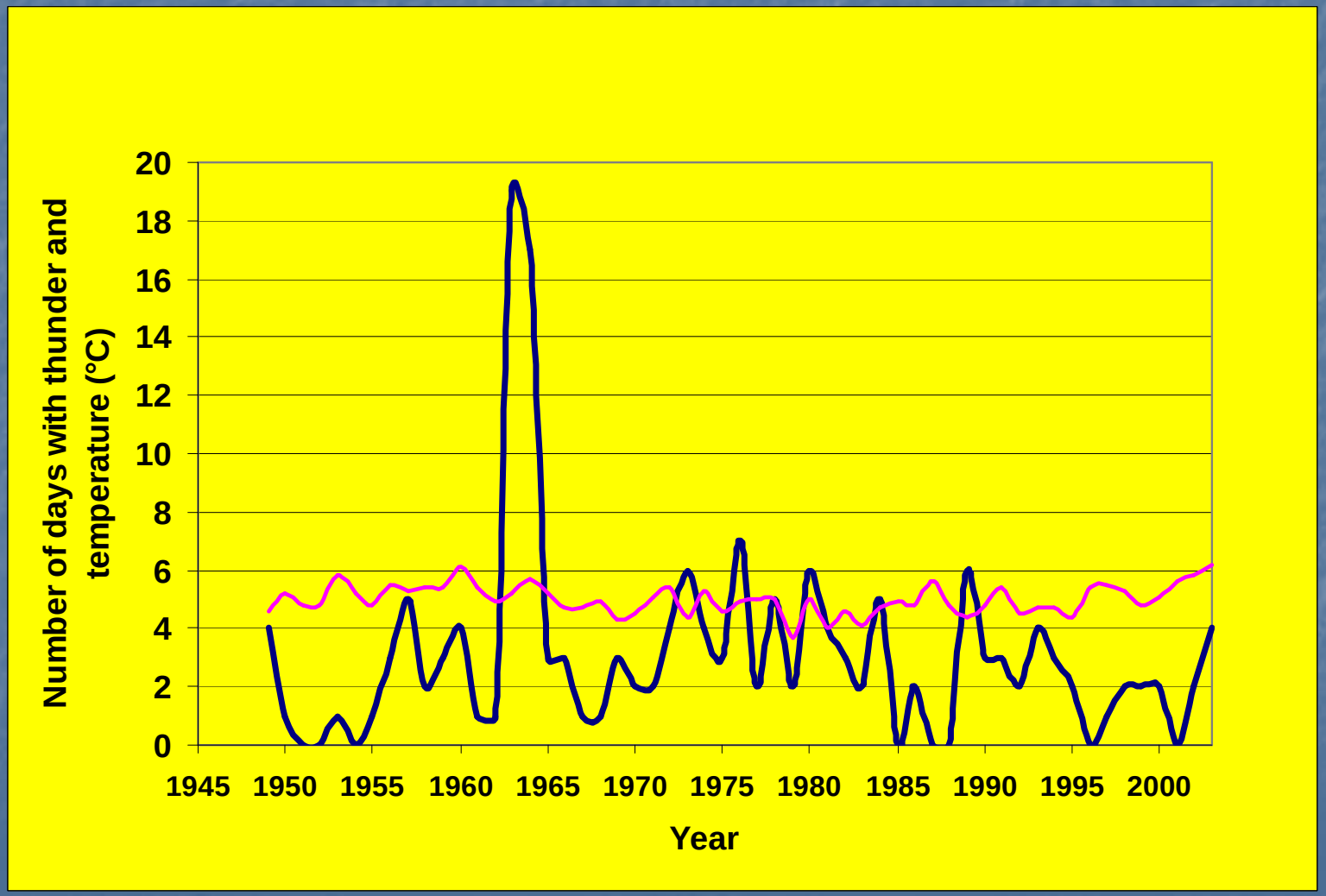
Haraldur Ólafsson
Þórður Arason
Trausti Jónsson

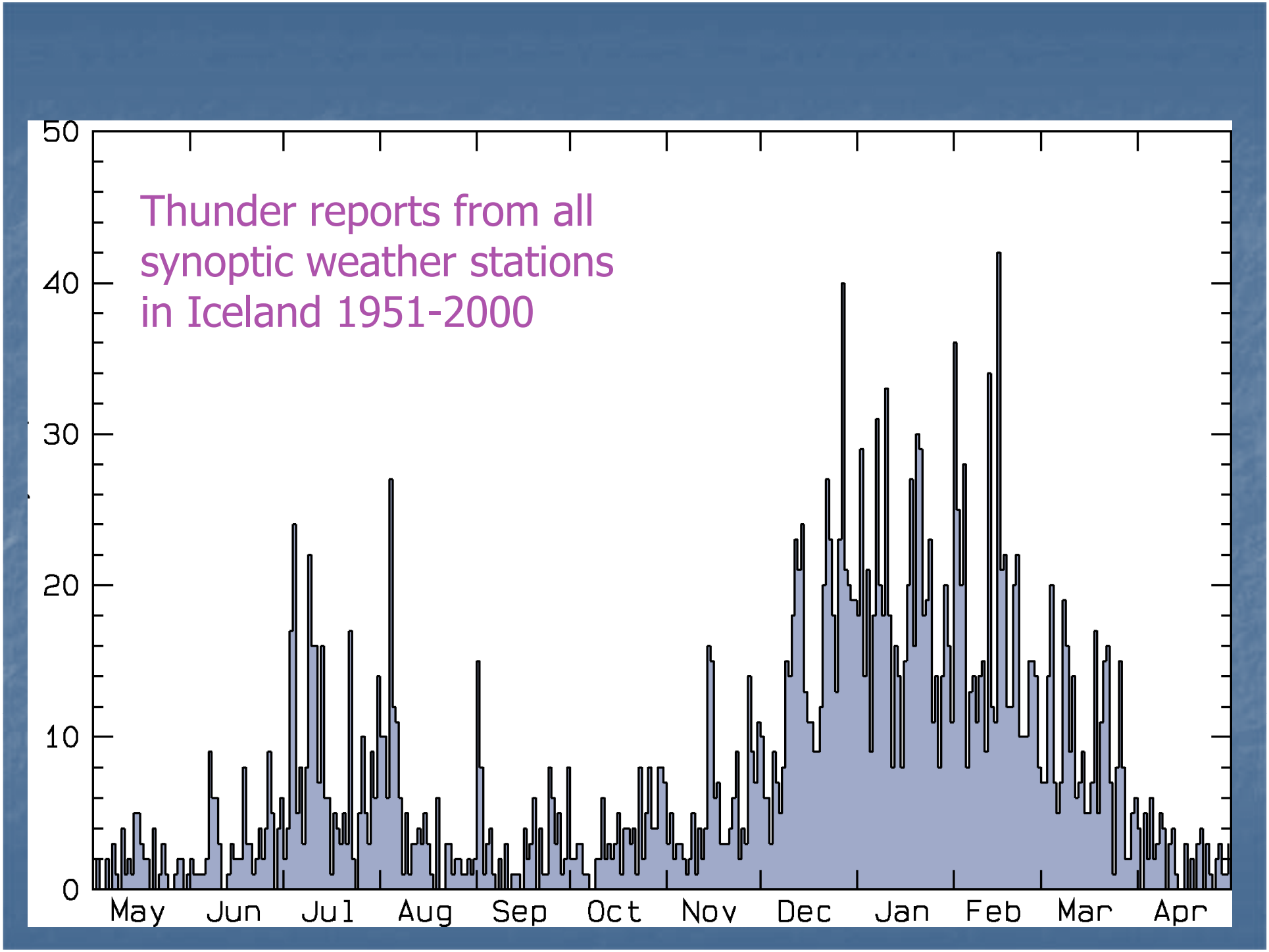
University of Iceland and the Icelandic Meteorological Office

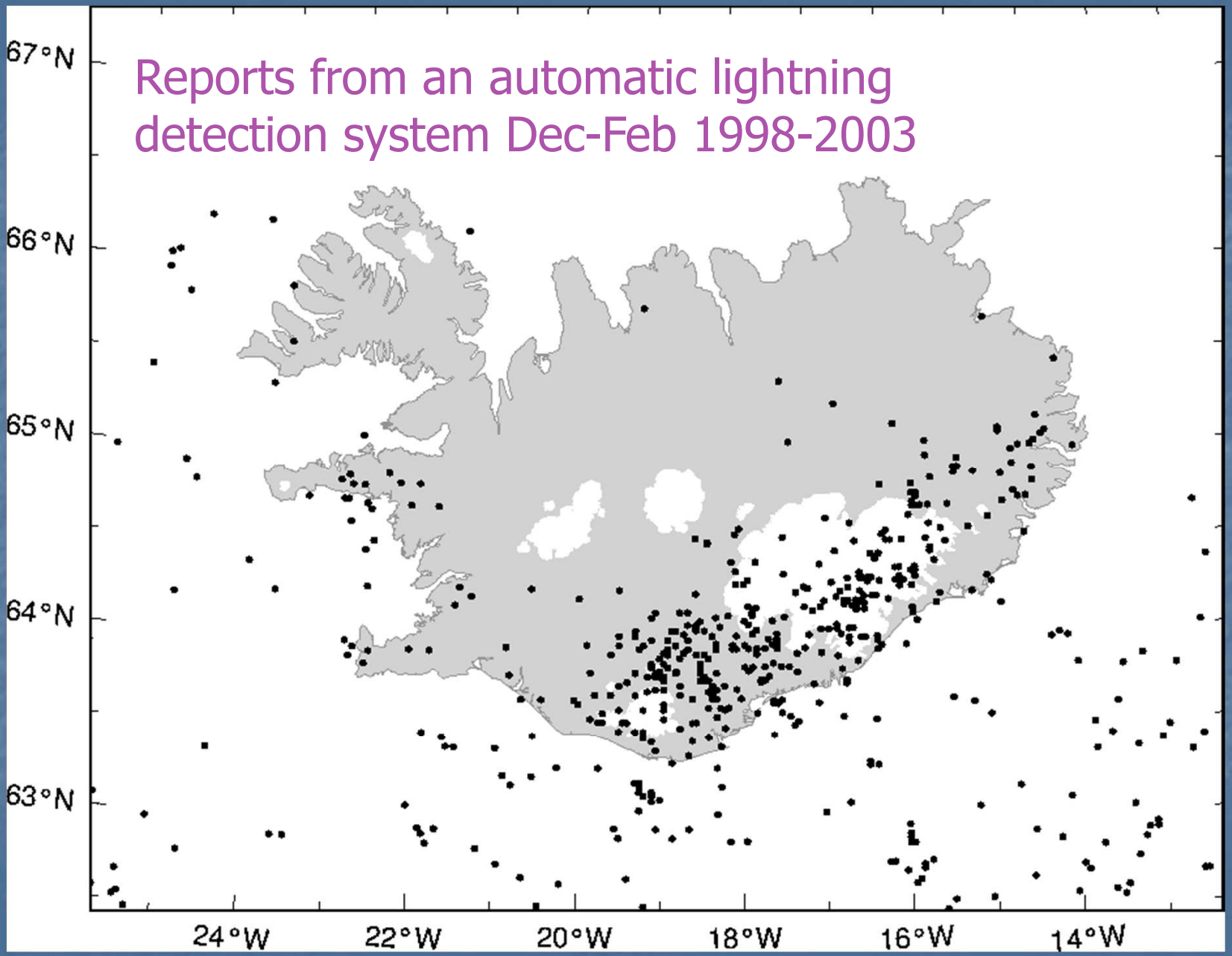
Thunder and Lightning in Iceland

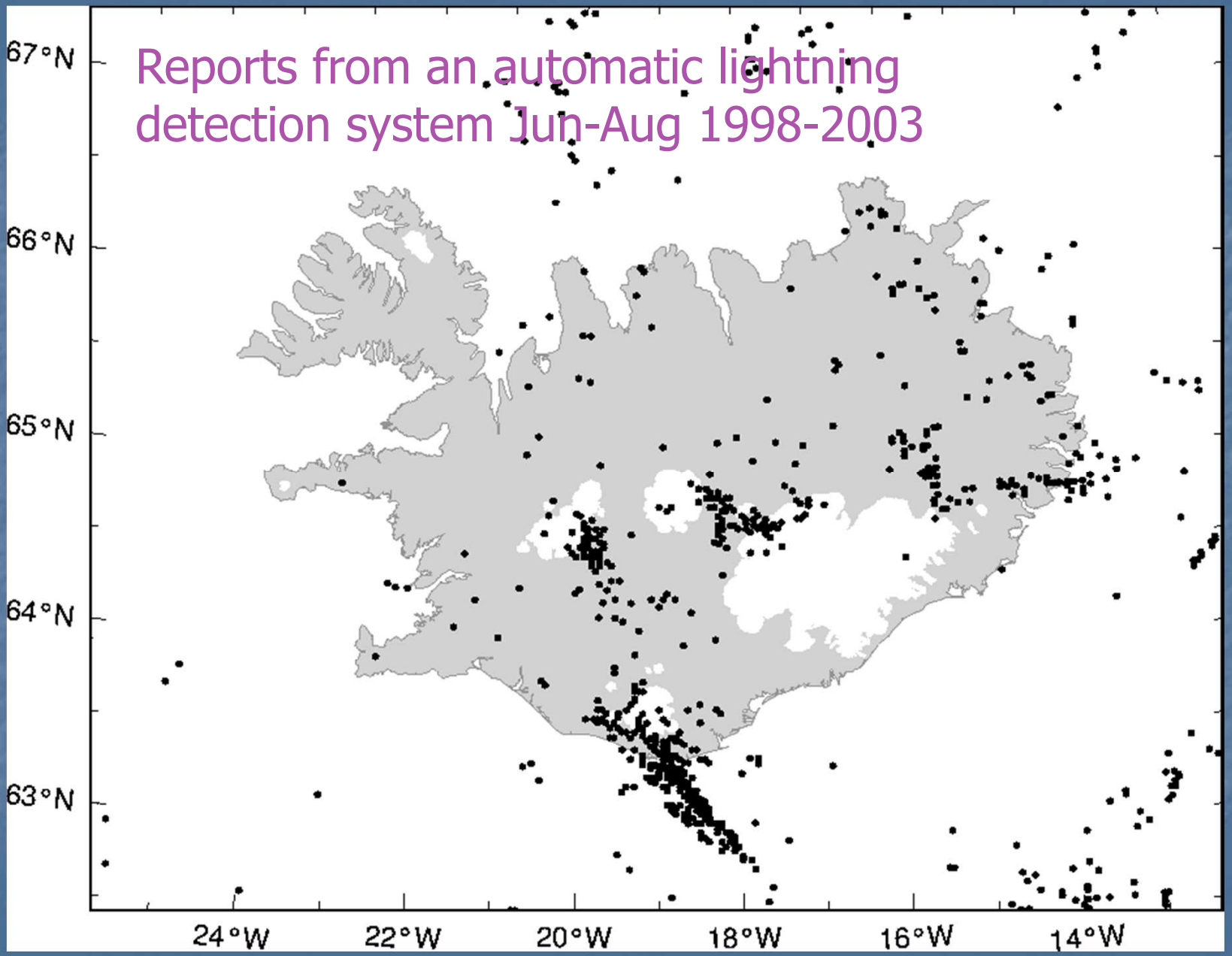
- Climatology
- Synoptic situations and origin of airmasses
- Predictability

Frequency of thunder at Stórhöfði (S-coast of Iceland)



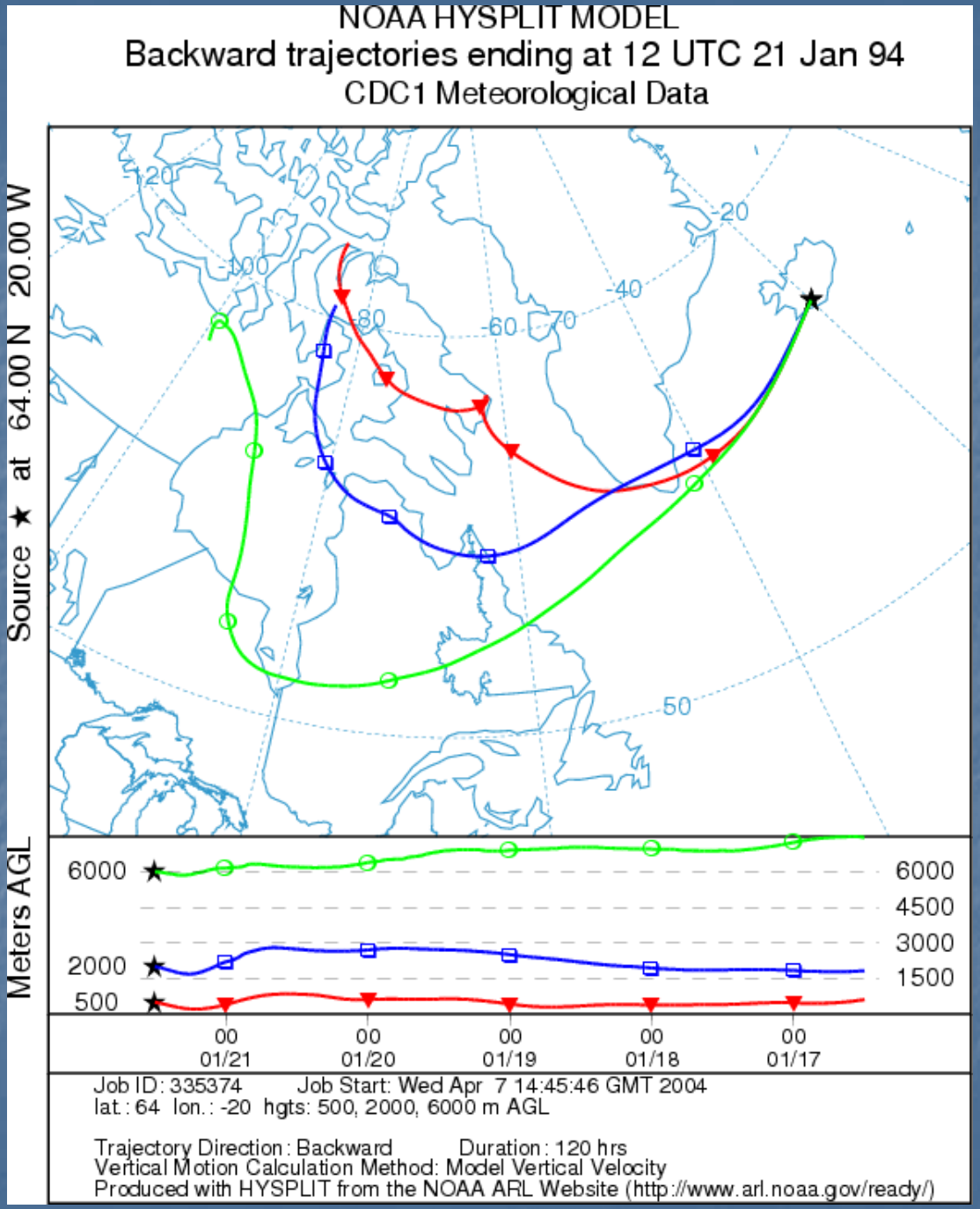

Thunder reports from all
synoptic weather stations
in Iceland 1951-2000
50
40
30
20
10
0
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr

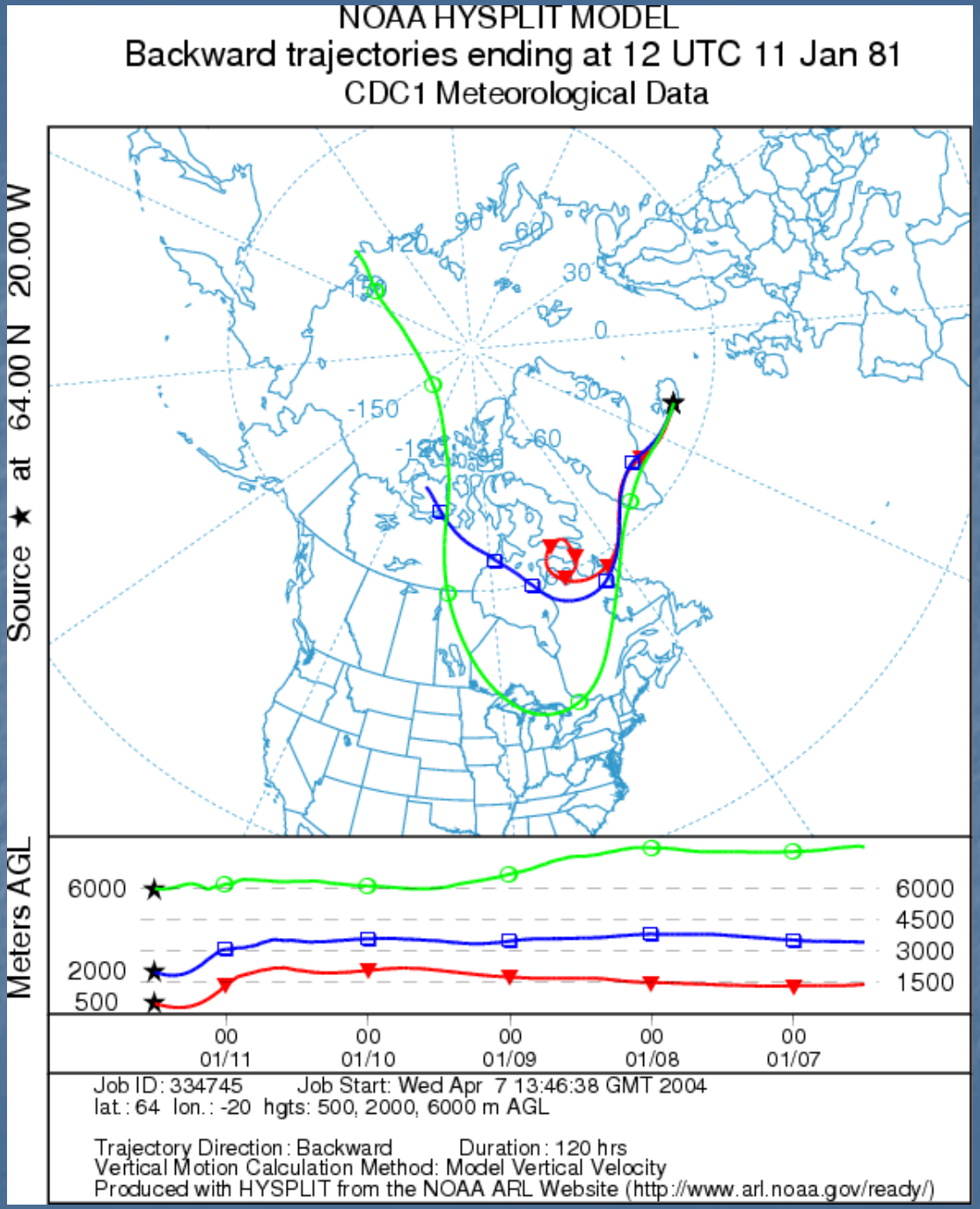

Reports from an automatic lightning detection system Dec-Feb 1998-2003
67°N
66°N
65°N
64°N
63°N
24°W
22°W
20°W
18°W
16°W
14°W

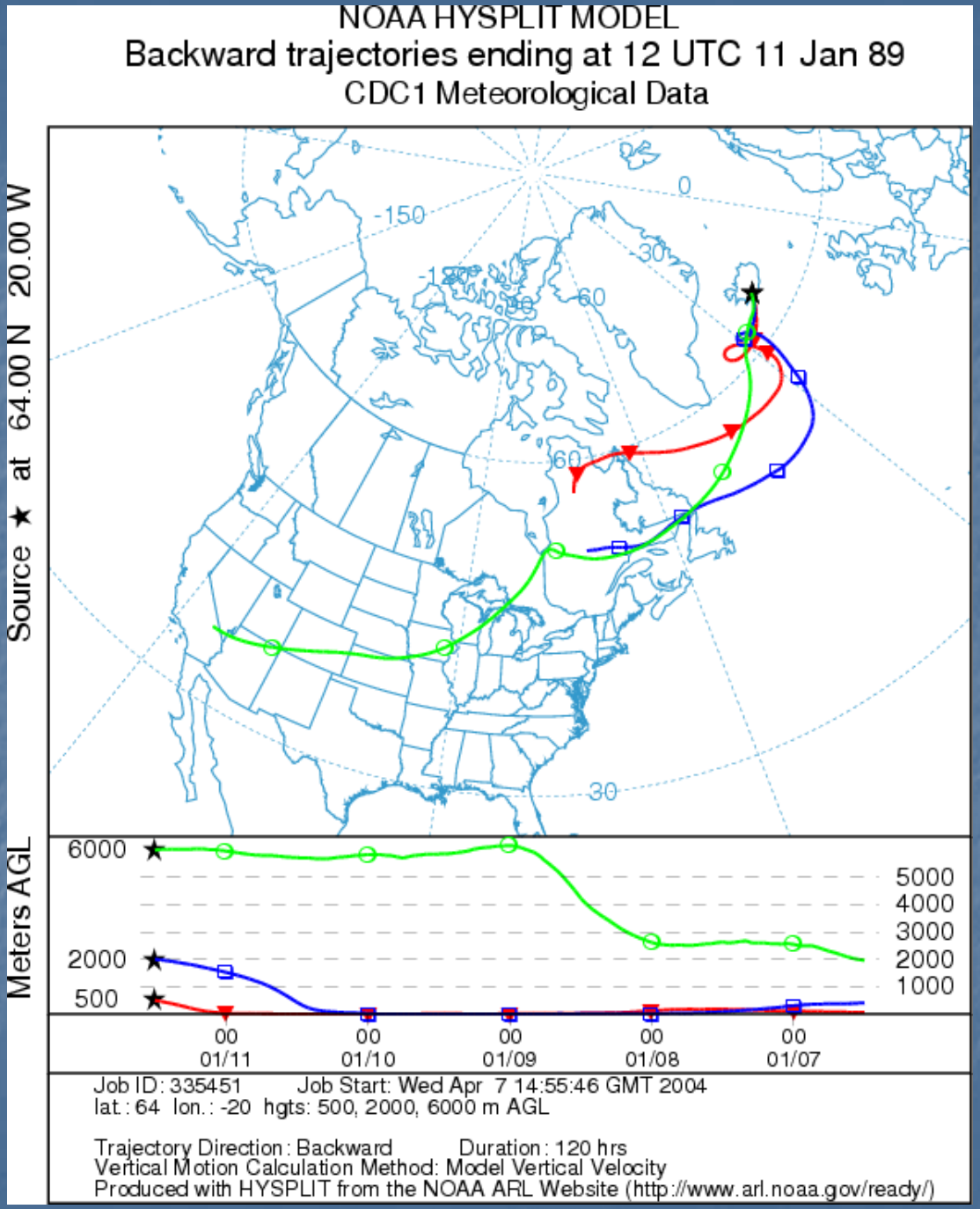

Reports from an automatic lightning detection system Jun-Aug 1998-2003
67°N
66°N
65°N
64°N
63°N
24°W
22°W
20°W
18°W
16°W
14°W

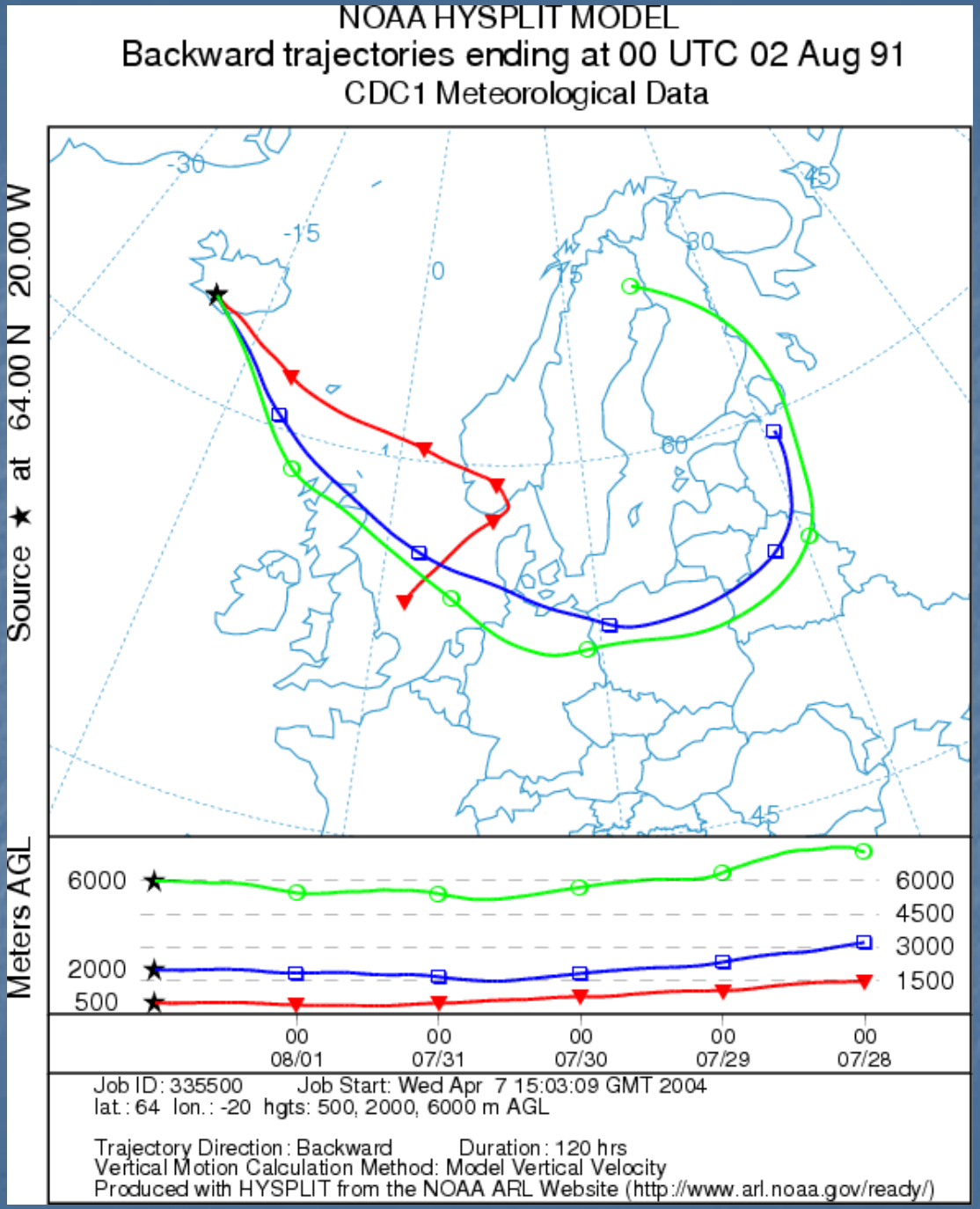
Five most intensive thunderstorms in each season 1981-2000

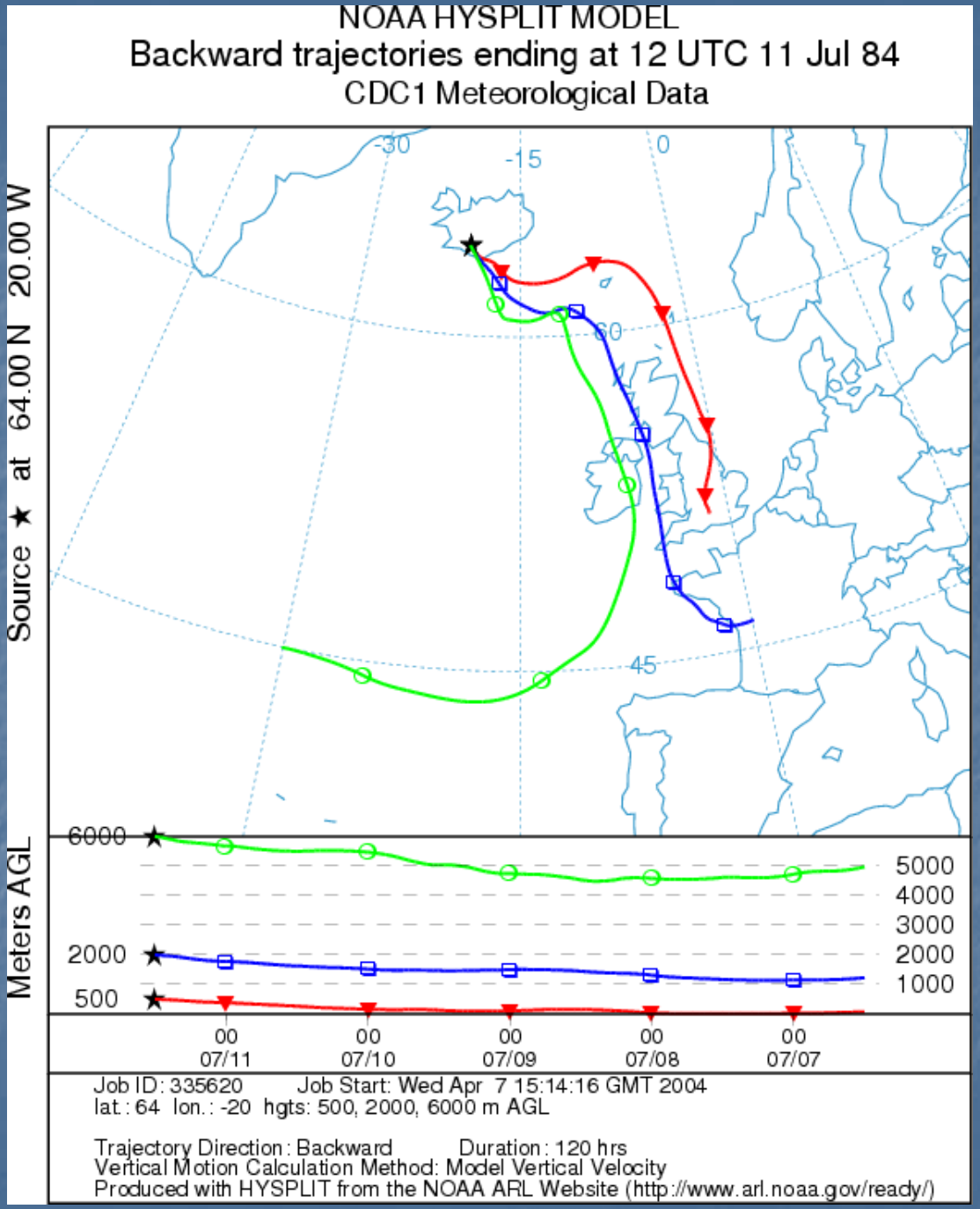
Winter	Origin of low level airmass	Wind veering	Advection
94-01-21	N-America	0°	60 m/s
93-02-12	N-America	20° (warm advection)	40 m/s
91-01-30	N-America	10° (warm advection)	40 m/s
89-01-11	N-America	0°	10 m/s
83-12-27	N-America	0°	20 m/s
Summer			
91-08-02	Britain/Cont.Europe	0°	10 m/s
91-07-08	Britain/Cont.Europe	0°	10 m/s
88-07-10	Britain/Cont.Europe	0°	10 m/s
84-07-11	Britain/Cont.Europe	10° (warm advection)	10 m/s
82-07-03	S-Ocean	80° (cold advection)	10 m/s
Interm. Season			
99-09-05	N-America	50° (cold advection)	10 m/s
97-09-27	N-America	10° (warm advection)	30 m/s
89-10-31	N-America	0°	50 m/s
81-09-01	Britain/SE-Ocean	0°	30 m/s
81-05-14	Britain/Cont. Europe	0°	20 m/s

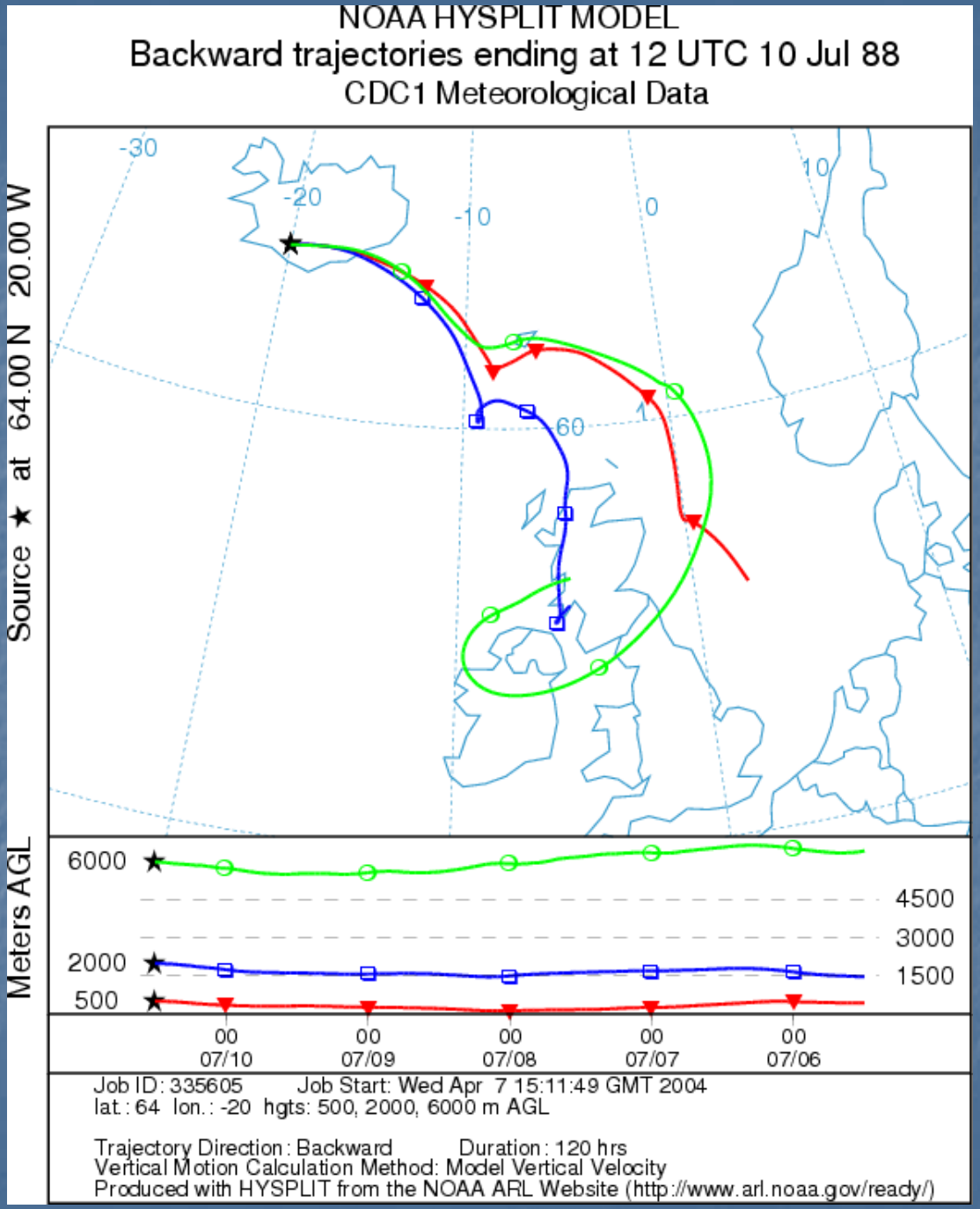

NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 21 Jan 94
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
-120
-100
-80
-60
-70
-40
-20
50
Meters AGL
6000
2000
500
6000
4500
3000
1500
00 01/21
00 01/20
00 01/19
00 01/18
00 01/17
Job ID: 335374 Job Start: Wed Apr 7 14:45:46 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

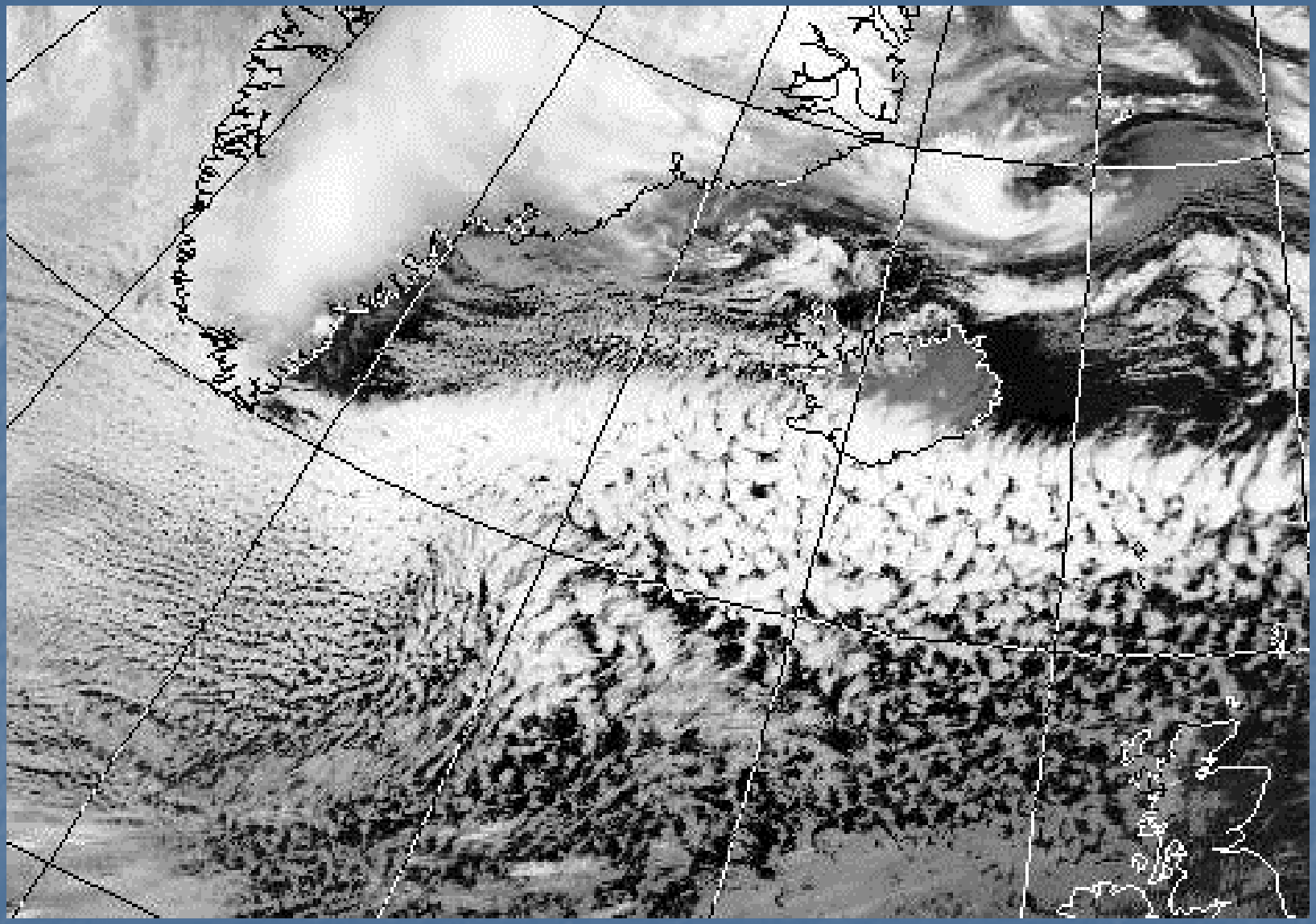

NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 11 Jan 81
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
Meters AGL
6000
2000
500
6000
4500
3000
1500
00 01/11
00 01/10
00 01/09
00 01/08
00 01/07
Job ID: 334745 Job Start: Wed Apr 7 13:46:38 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)


NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 11 Jan 89
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
Meters AGL
6000
2000
500
5000
4000
3000
2000
1000
00 01/11
00 01/10
00 01/09
00 01/08
00 01/07
Job ID: 335451 Job Start: Wed Apr 7 14:55:46 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

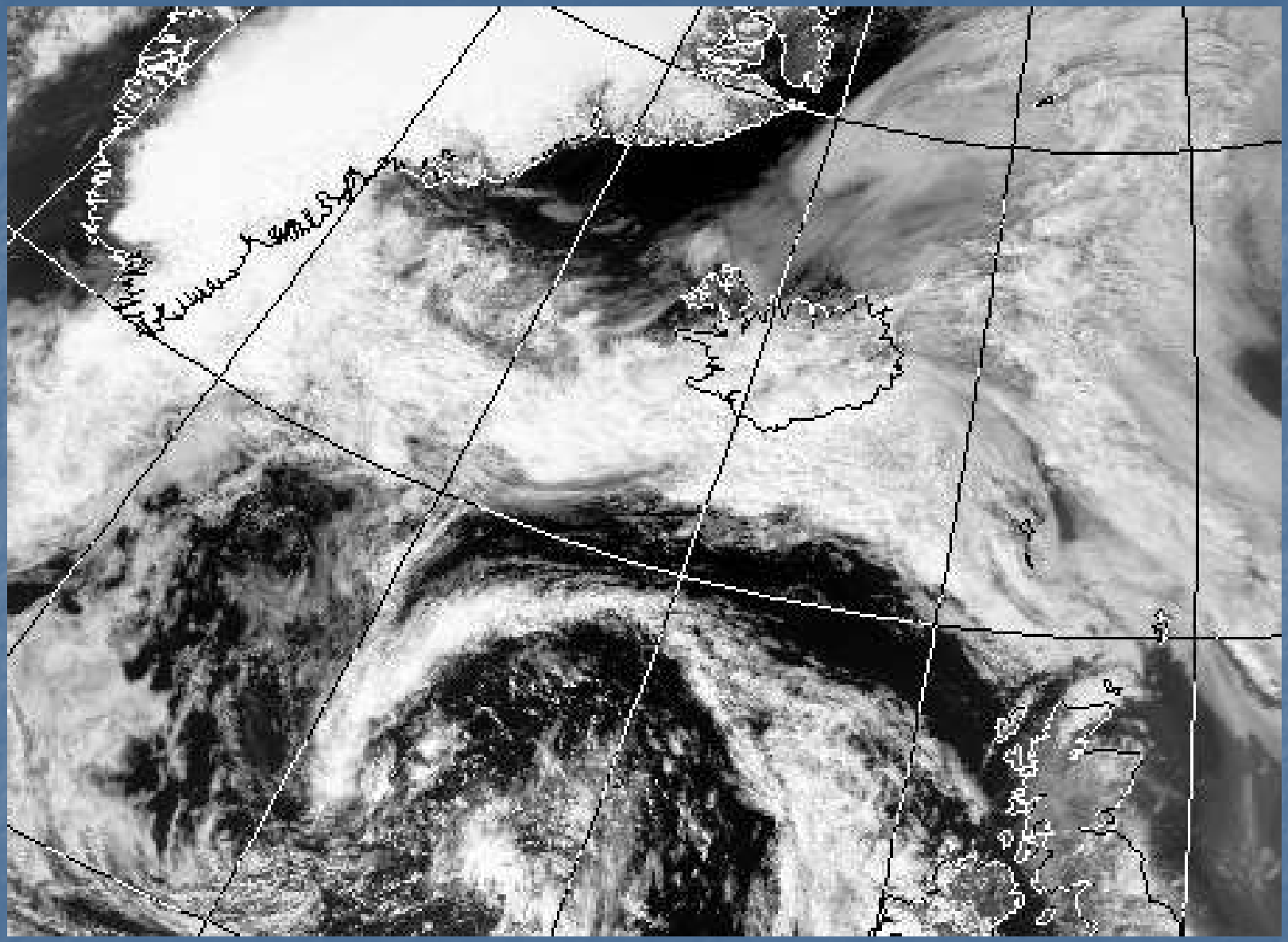

NOAA HYSPLIT MODEL
Backward trajectories ending at 00 UTC 02 Aug 91
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
Meters AGL
-30
-15
0
15
30
45
60
45
6000
2000
500
6000
4500
3000
1500
00 08/01
00 07/31
00 07/30
00 07/29
00 07/28
Job ID: 335500 Job Start: Wed Apr 7 15:03:09 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)


NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 11 Jul 84
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
-30
-15
0
60
45
Meters AGL
6000
2000
500
5000
4000
3000
2000
1000
00 07/11
00 07/10
00 07/09
00 07/08
00 07/07
Job ID: 335620 Job Start: Wed Apr 7 15:14:16 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)


NOAA HYSPLIT MODEL
Backward trajectories ending at 12 UTC 10 Jul 88
CDC1 Meteorological Data
Source ★ at 64.00 N 20.00 W
-30
-20
-10
0
10
60
Meters AGL
6000
4500
3000
2000
1500
500
00 07/10
00 07/09
00 07/08
00 07/07
00 07/06
Job ID: 335605 Job Start: Wed Apr 7 15:11:49 GMT 2004
lat.: 64 lon.: -20 hgts: 500, 2000, 6000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

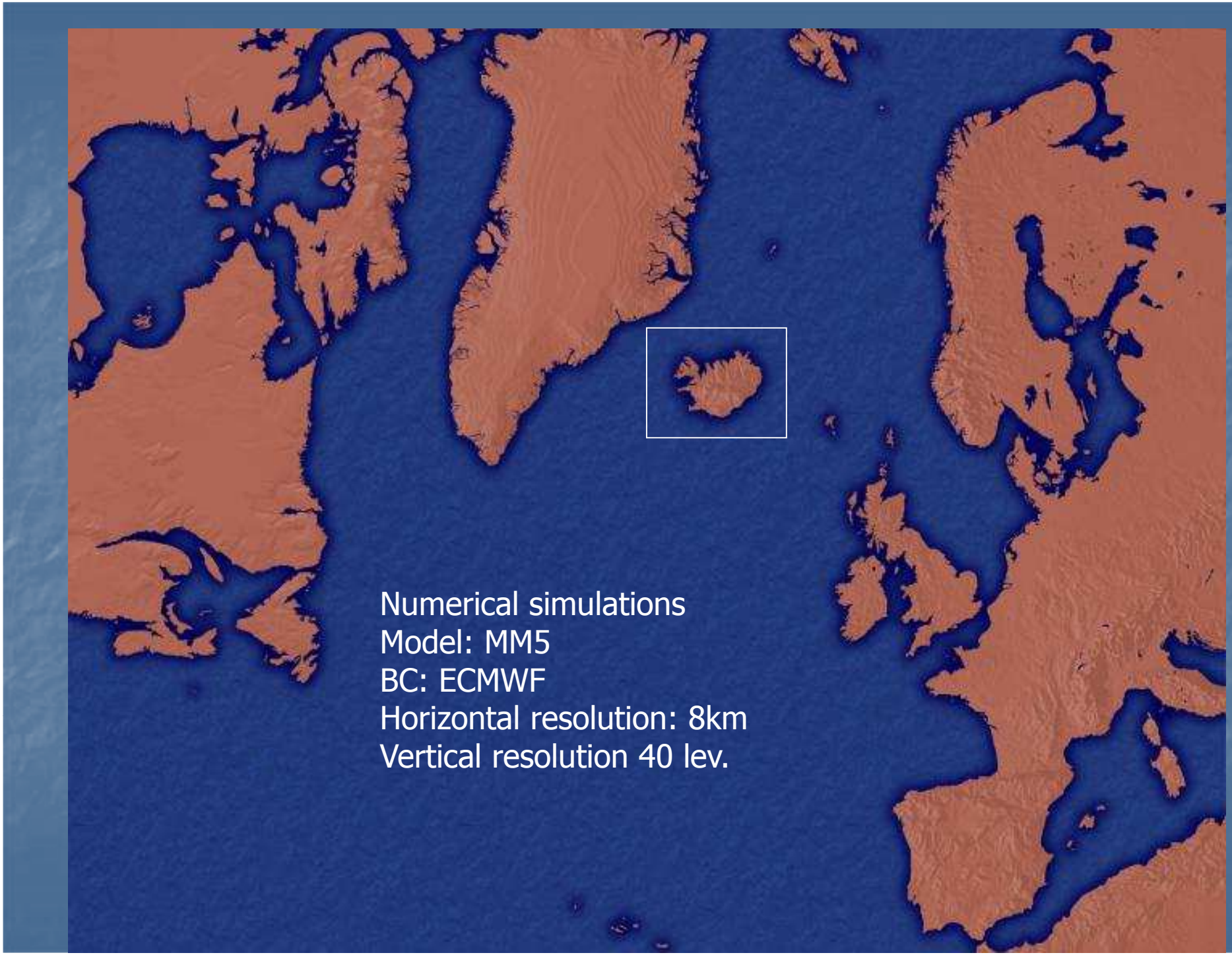


IR-image 21 Jan 1994



VIS-image 2 Aug 1991

Can we predict these storms?


Numerical simulations
Model: MM5
BC: ECMWF
Horizontal resolution: 8km
Vertical resolution 40 lev.

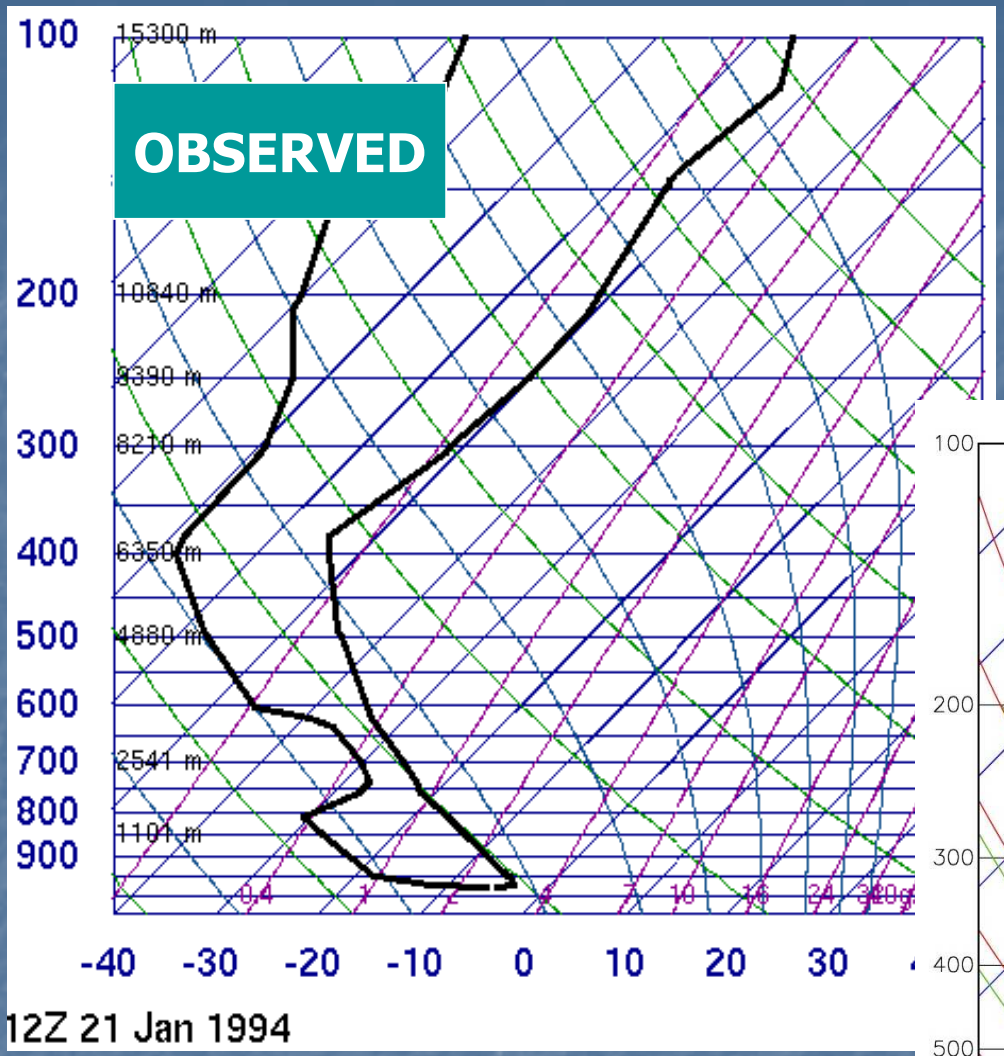
Two winter storms and two summer storms have been simulated

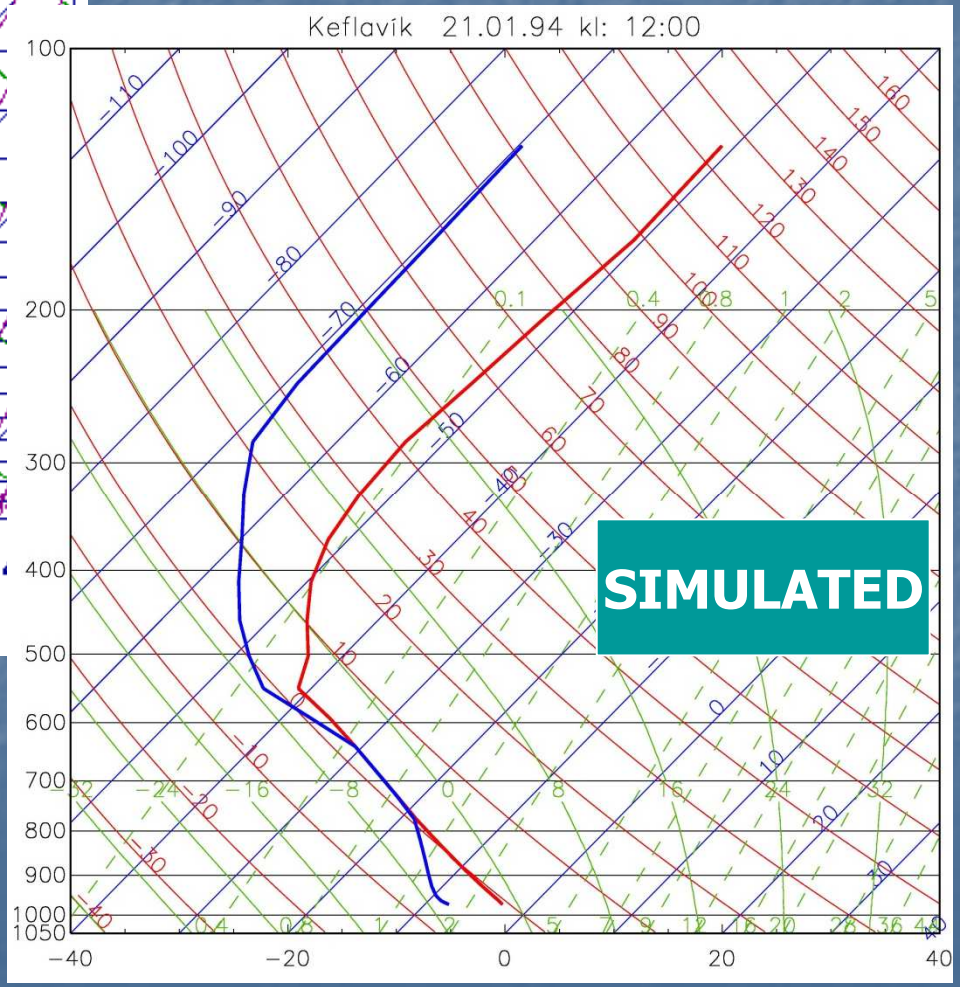
Results:

The winter storms are well reproduced

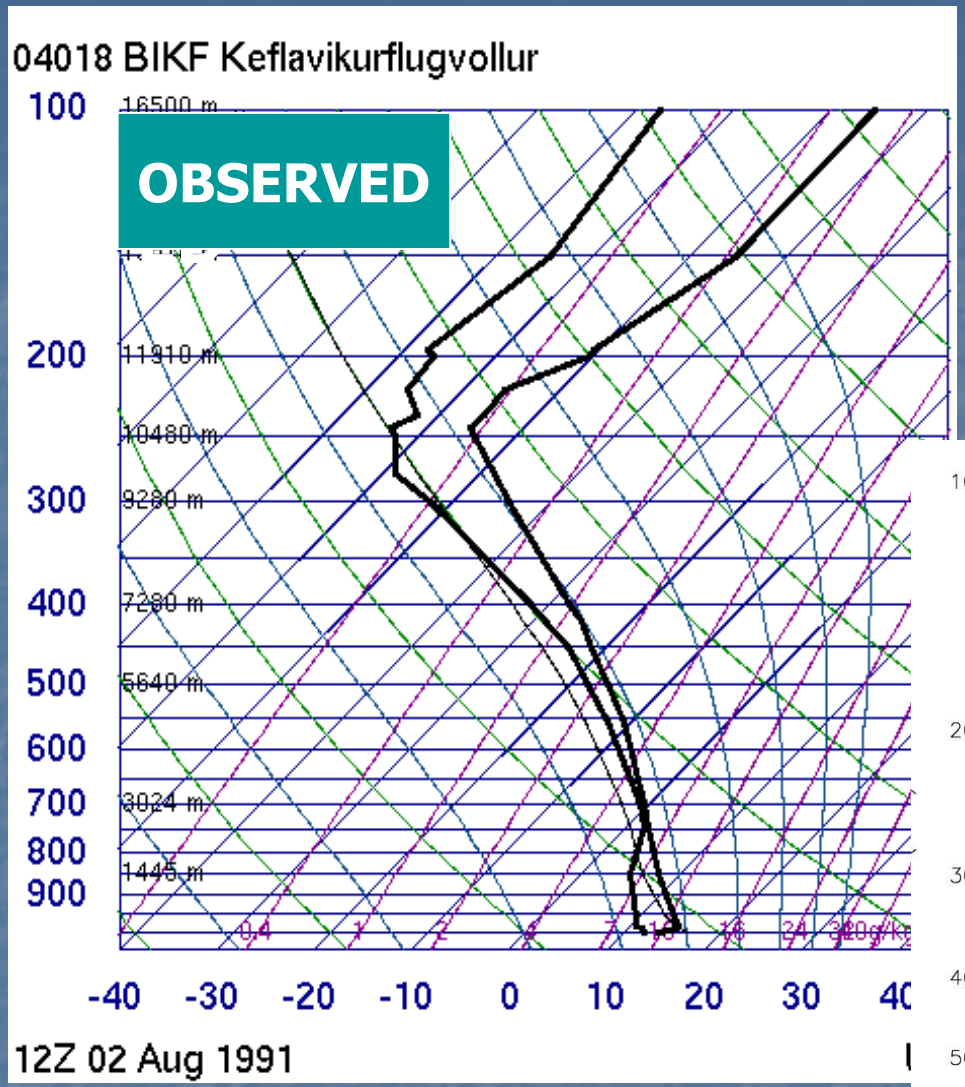
The summer storms are not as well well reproduced

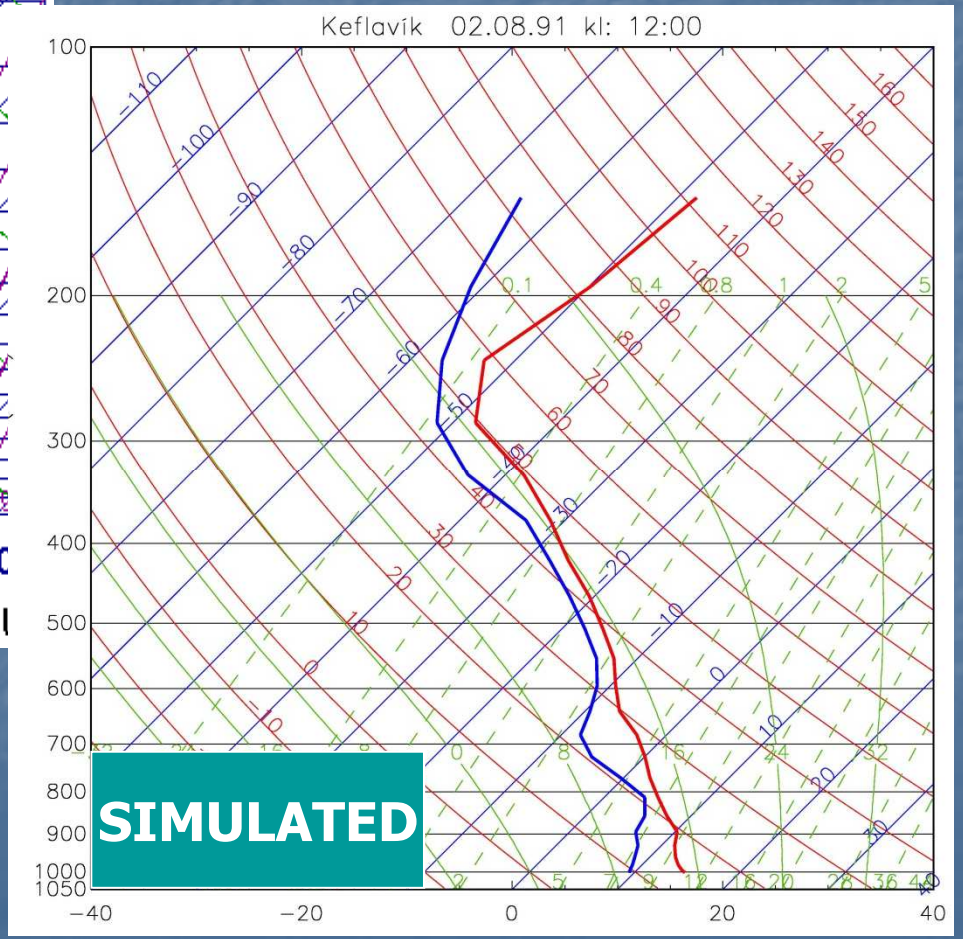
A winter case
- sucessful simulation



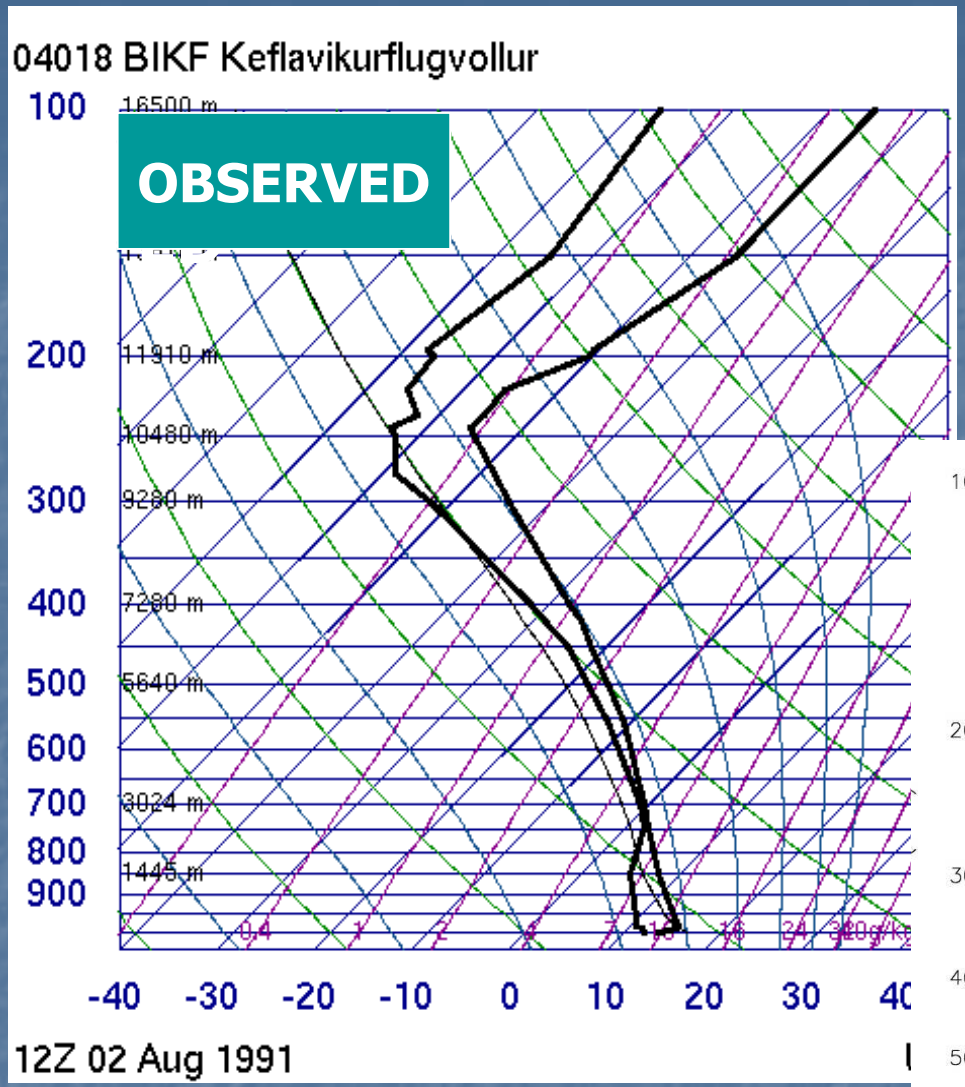


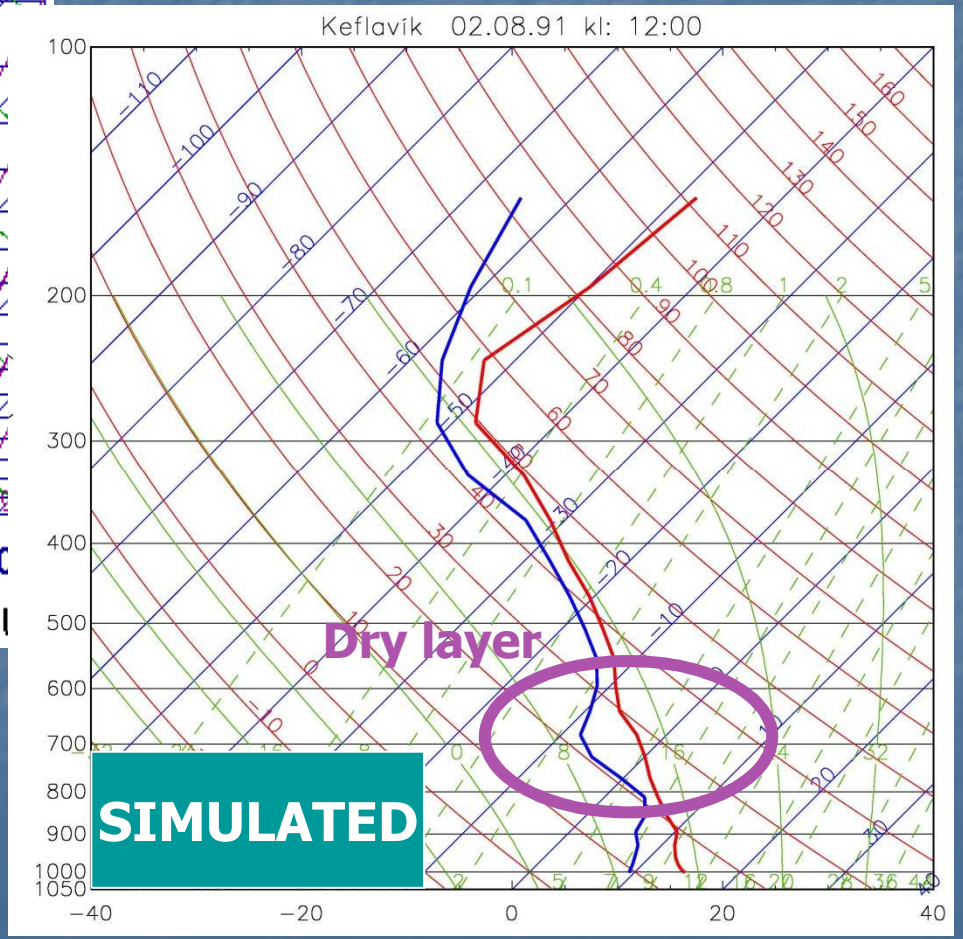
A summer case
- failure of simulation





A summer case
- failure of simulation





Conclusions on thunder in Iceland

- Main activity in mid-winter, a secondary maximum in mid-summer
- Some interannual variability, but no clear trend in long-term frequency
- Winter storms: Arctic air advected rapidly from N-America. Organized convection.
- Summer storms: Advection from SE (Britain/Cont.Europe). Front-like structures.
- Case studies indicate that the meteorological conditions in which the winter storms form may be easier to predict than those of the summer storms