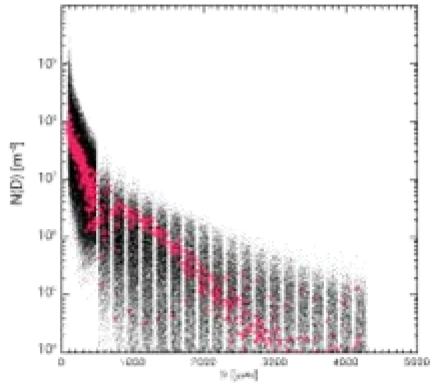
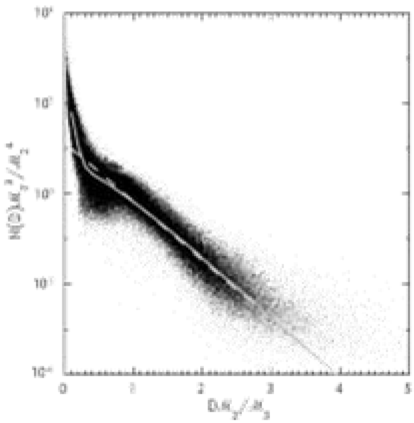
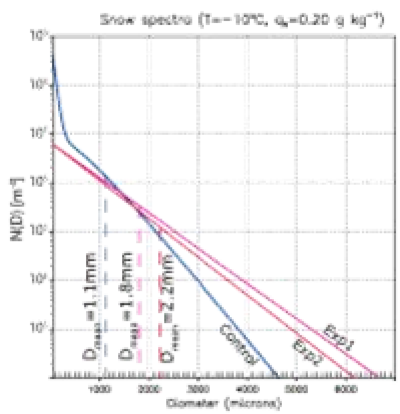
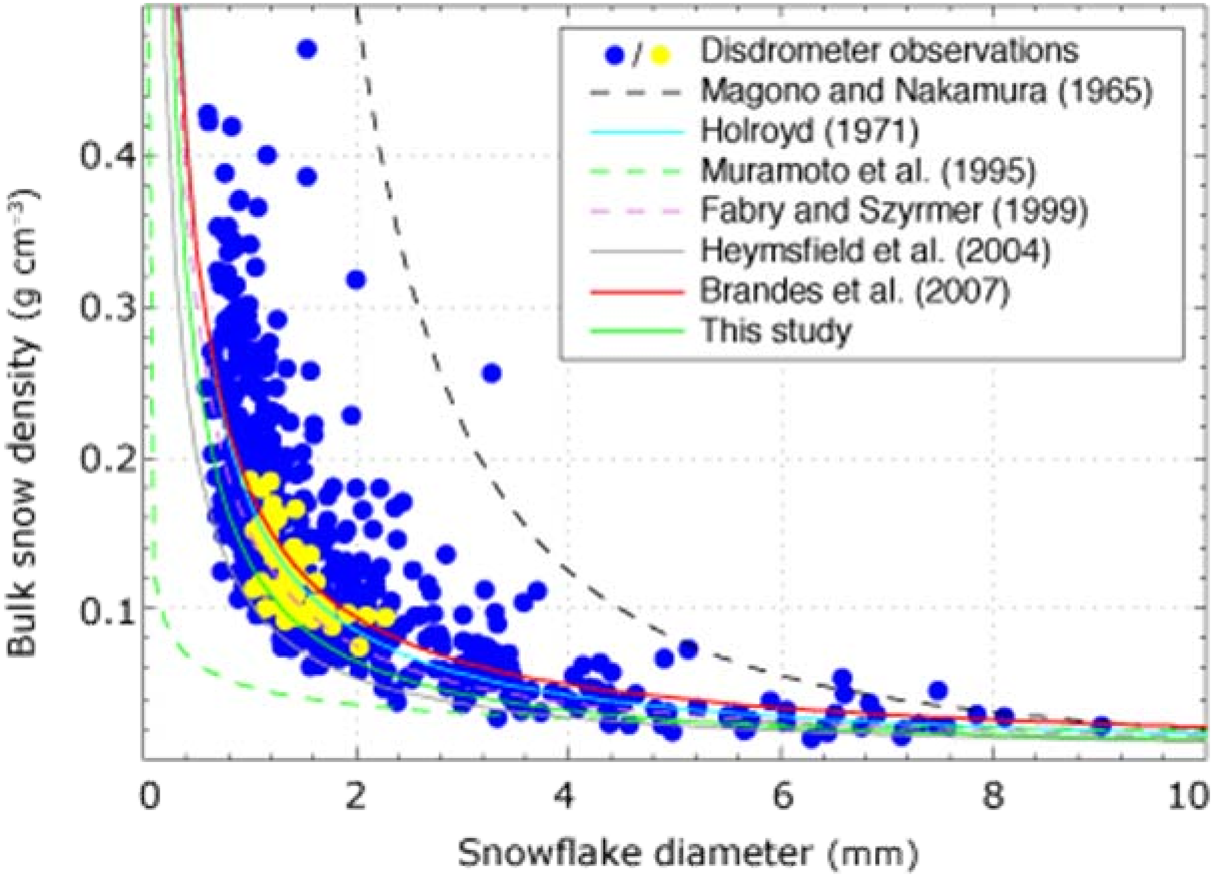






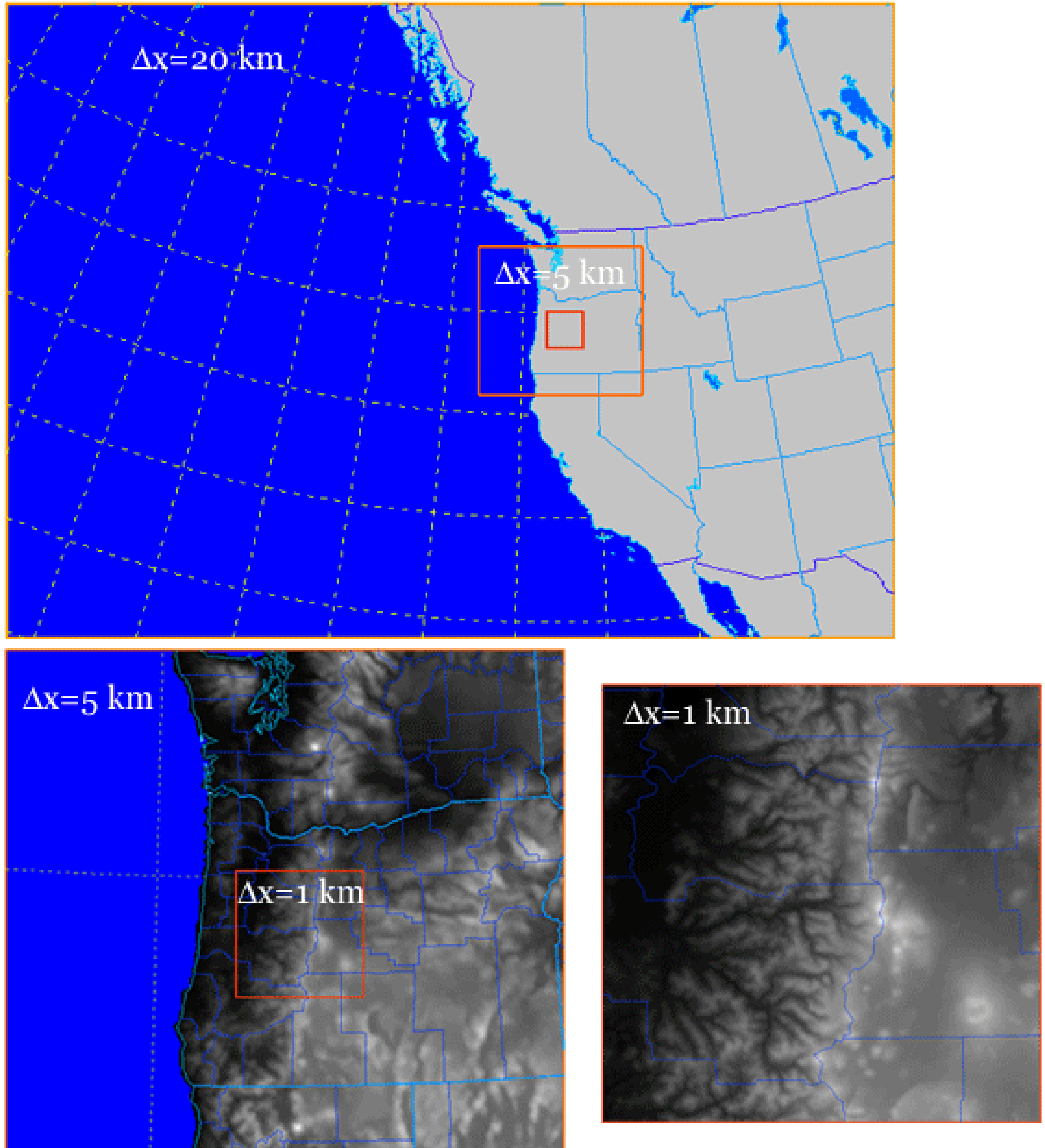
Unique aspect of the new microphysical scheme:

Implementation of the non-dimensional snow size distribution of Paul Field's

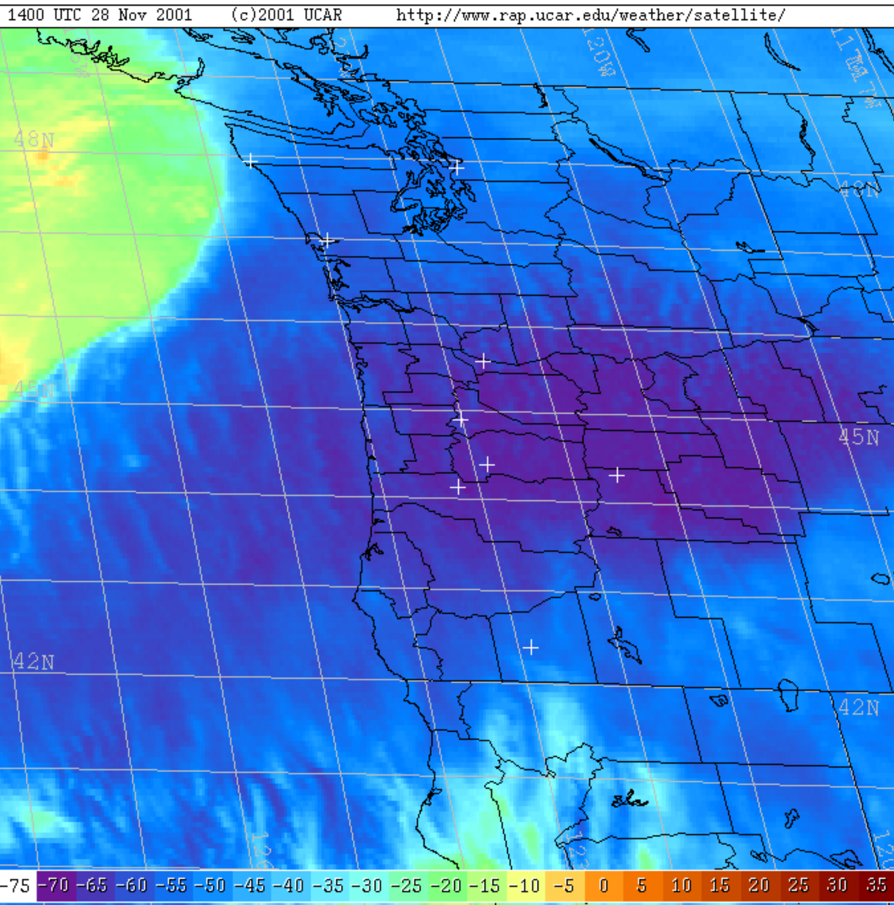


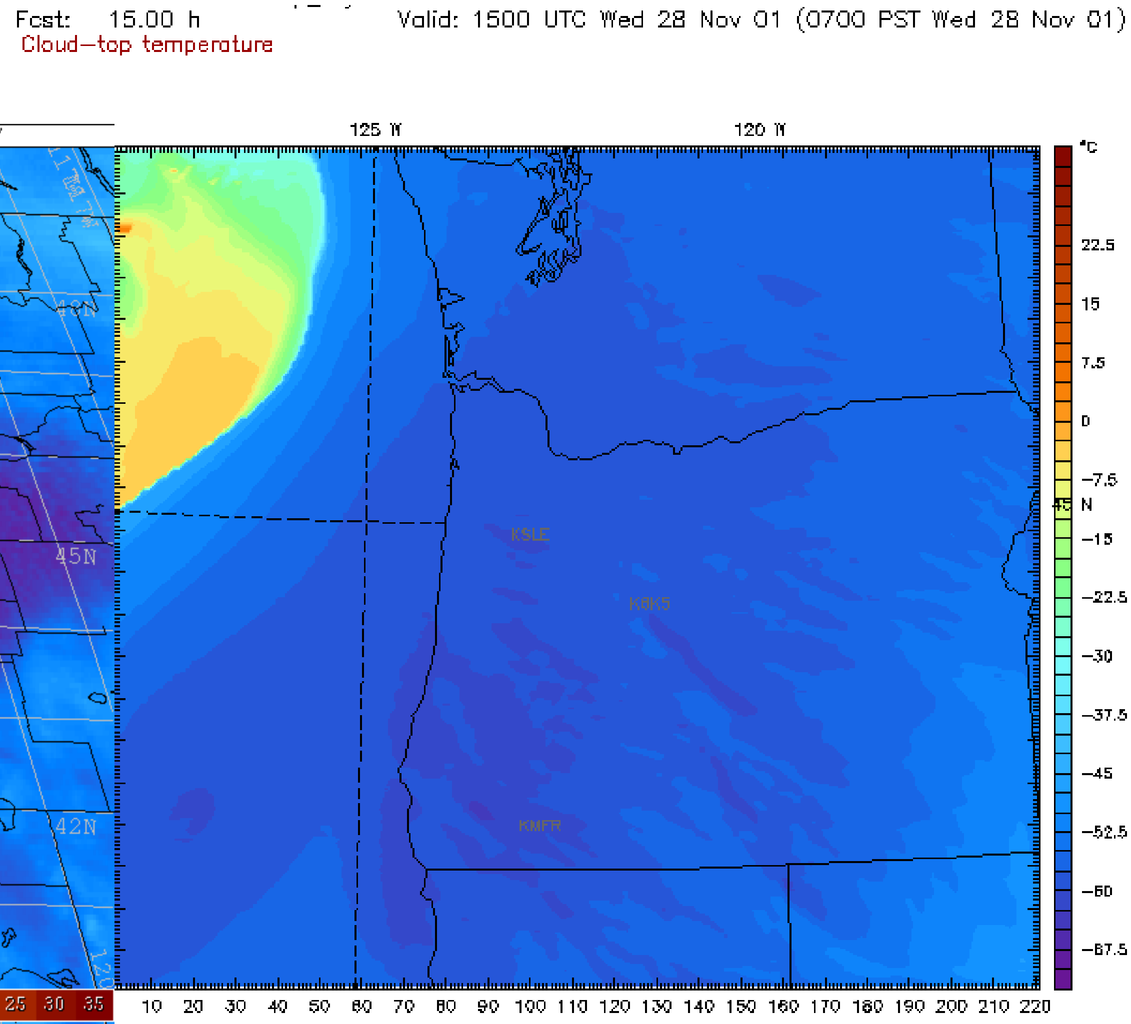
As a result of the new snow size distribution, the scheme is able to appropriately simulate the observed dependence of snow density on snowflake diameter

Cloud droplet concentration assumed to be 25 cm^{-3} based on FSSP and CCN observations.



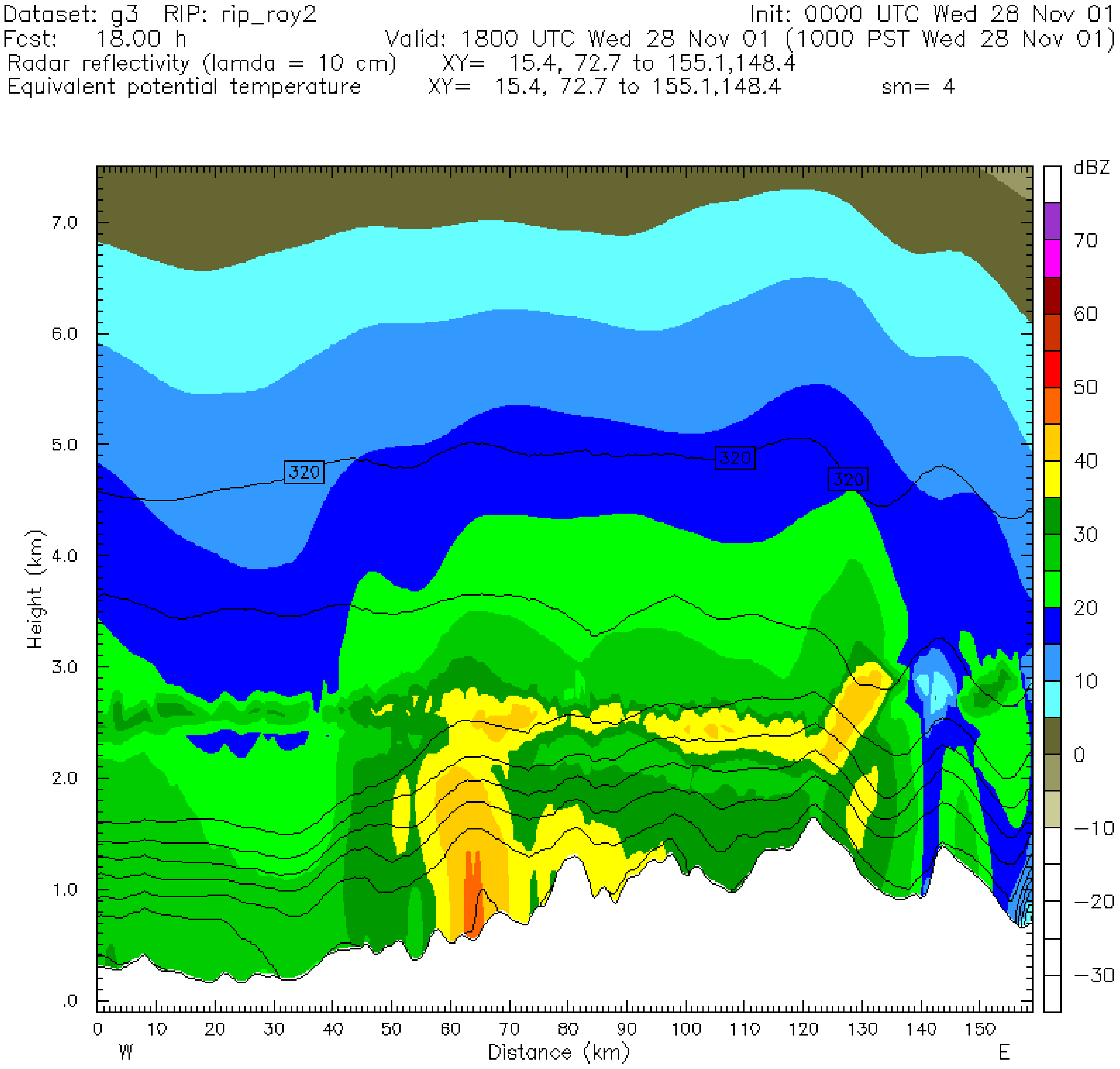
1600 UTC Nov. 28 – 0200 UTC Nov. 29



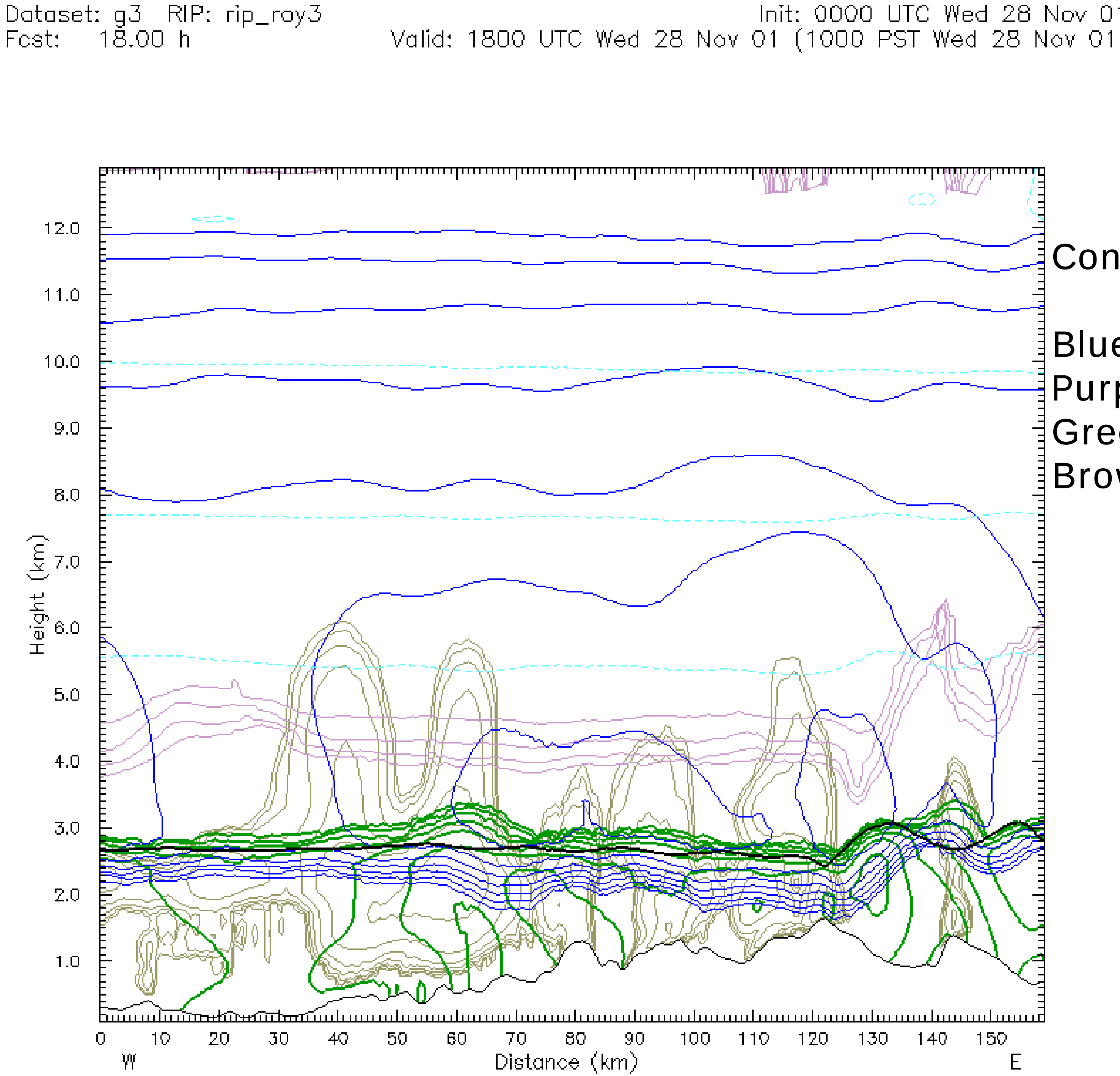


IR Satellite loop from November 28, 2001

Simulated IR cloud top temperature Loop from model output



Dataset: g3 RIP: rip_roy2
Init: 0000 UTC Wed 28 Nov 01
Fcst: 18.00 h
Valid: 1800 UTC Wed 28 Nov 01 (1000 PST Wed 28 Nov 01)
Radar reflectivity (lamda = 10 cm) XY= 15.4, 72.7 to 155.1,148.4
Equivalent potential temperature XY= 15.4, 72.7 to 155.1,148.4 sm= 4
Height (km)
.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
320
320
320
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
W
Distance (km)
E
dBZ
70
60
50
40
30
20
10
0
−10
−20
−30

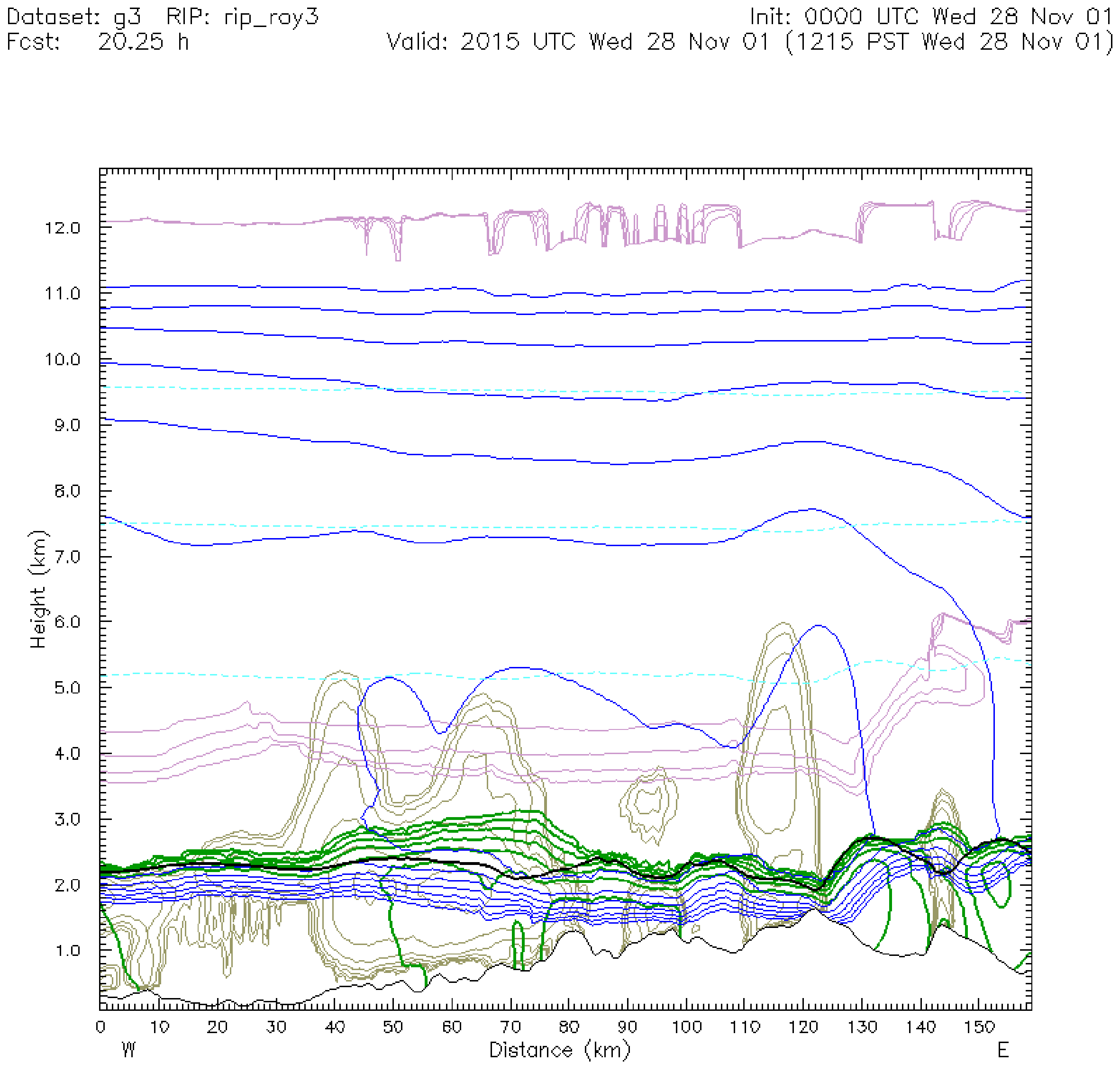


Contours

Blue-snow
Purple-ice
Green-drizzle
Brown-Cloud water

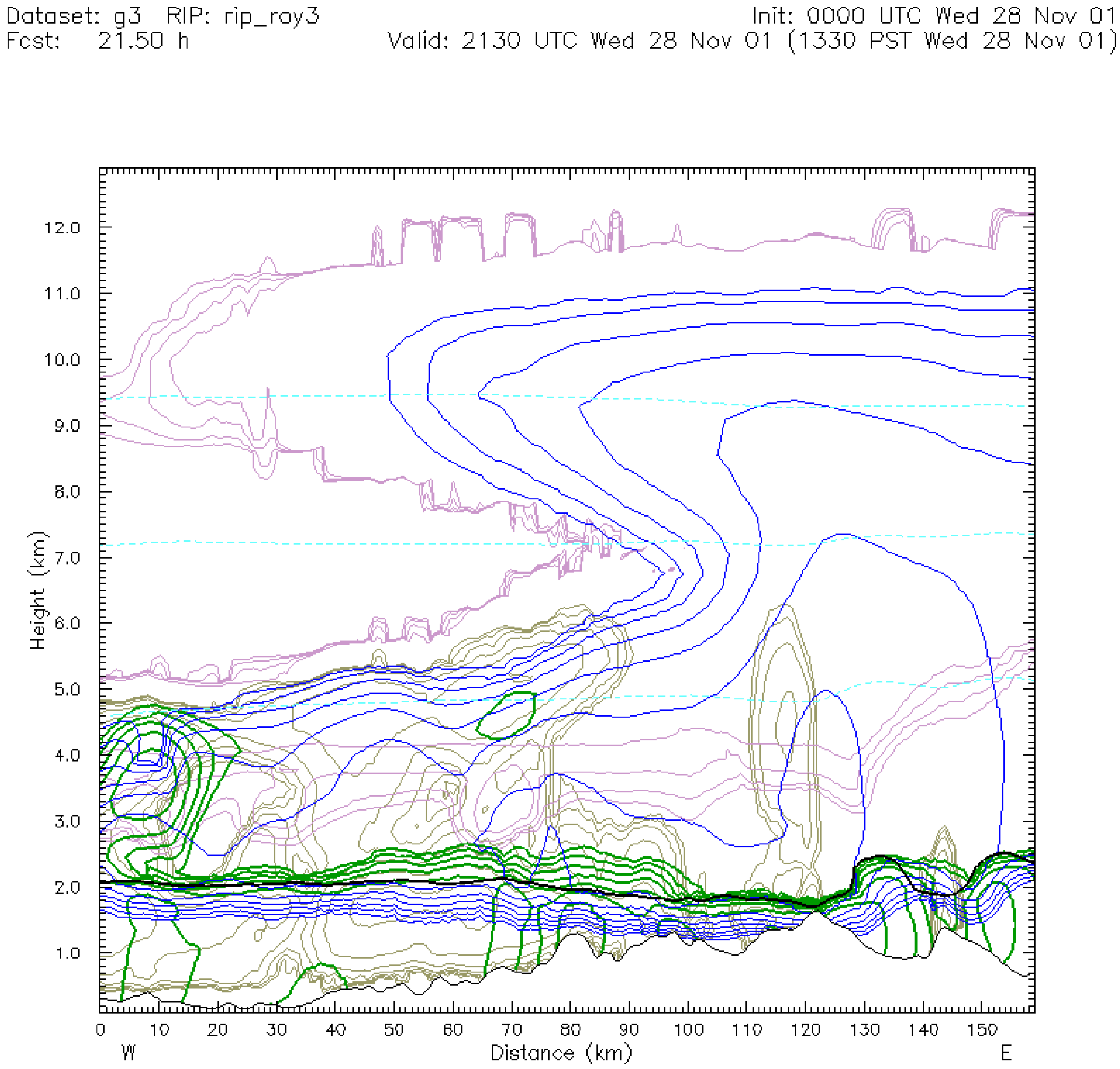
Pre-frontal

Contours: cloud water (tan), drizzle (green), snow blue)



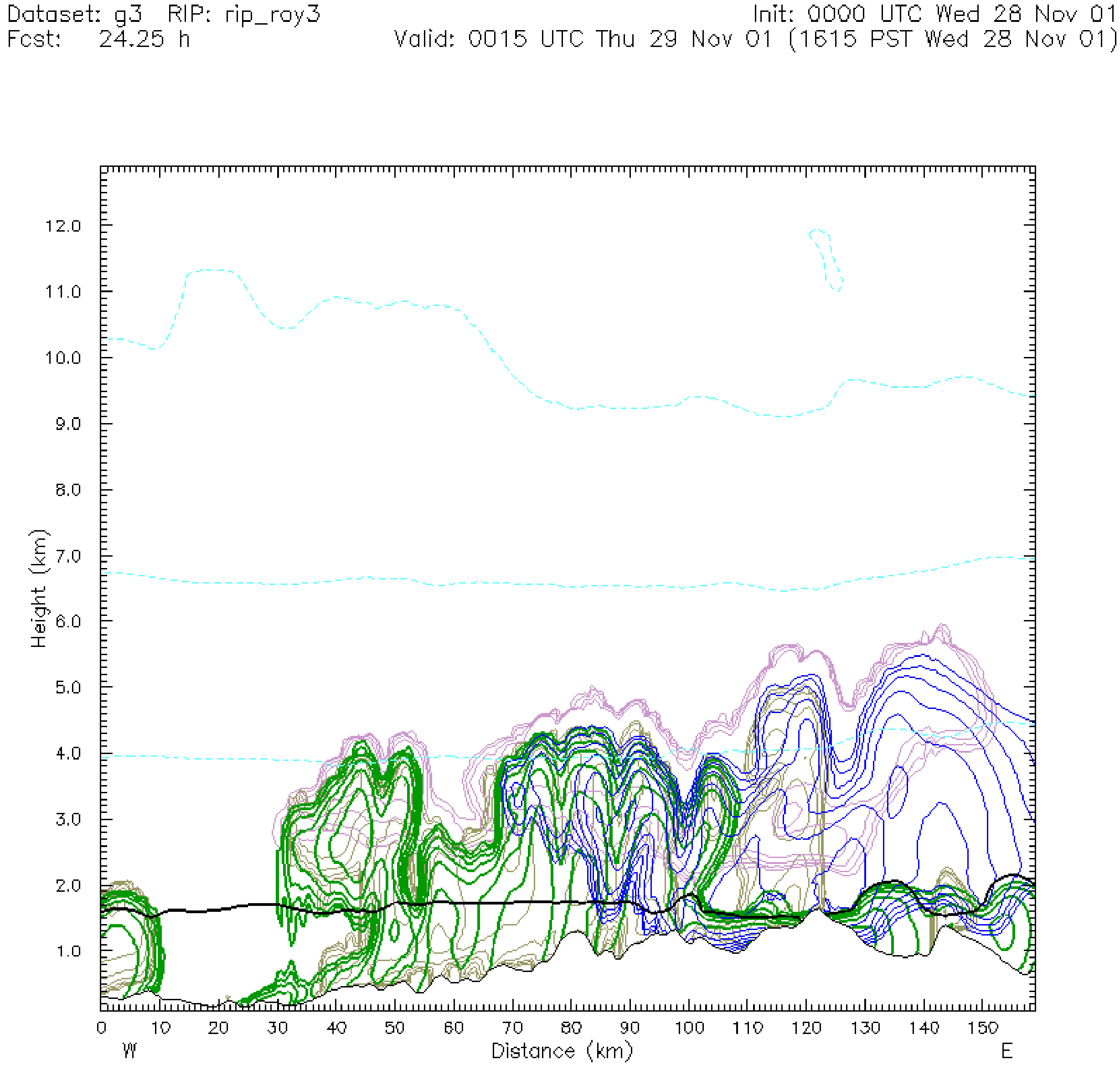
Intra-frontal

Contours: Cloud water (tan), drizzle (green), and blue (snow)



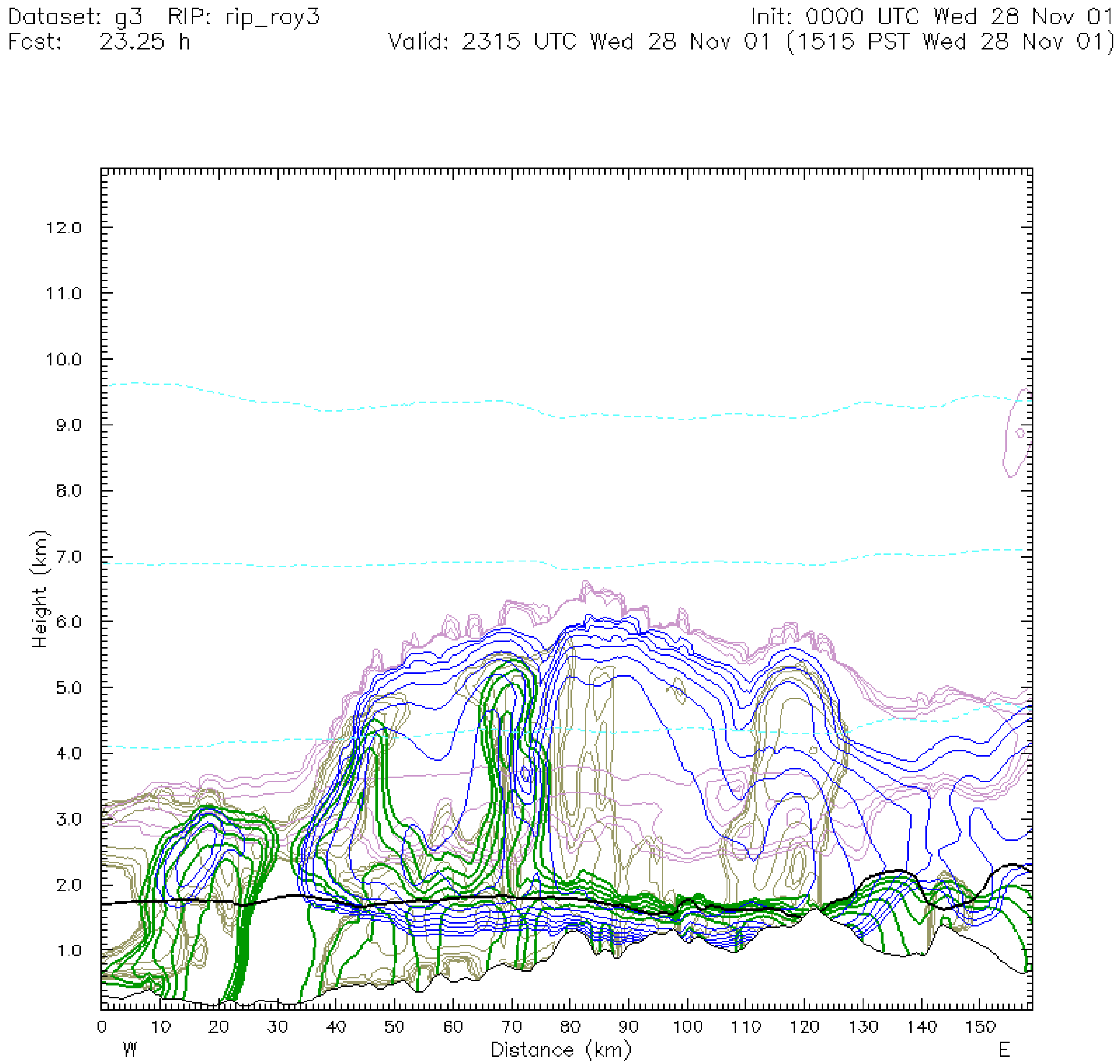
Post-frontal

Contours: cloud water (tan), drizzle (green), snow blue)

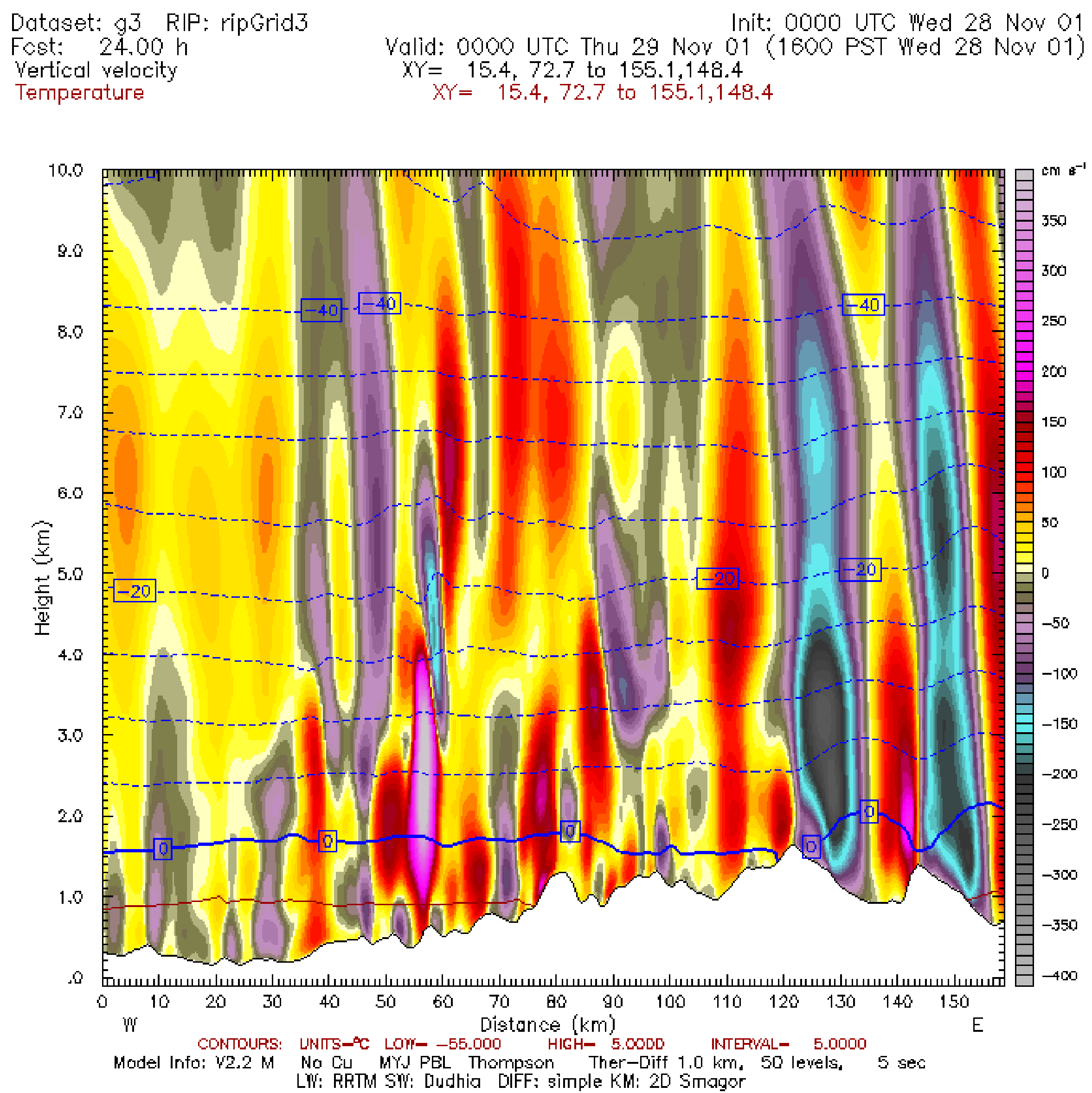


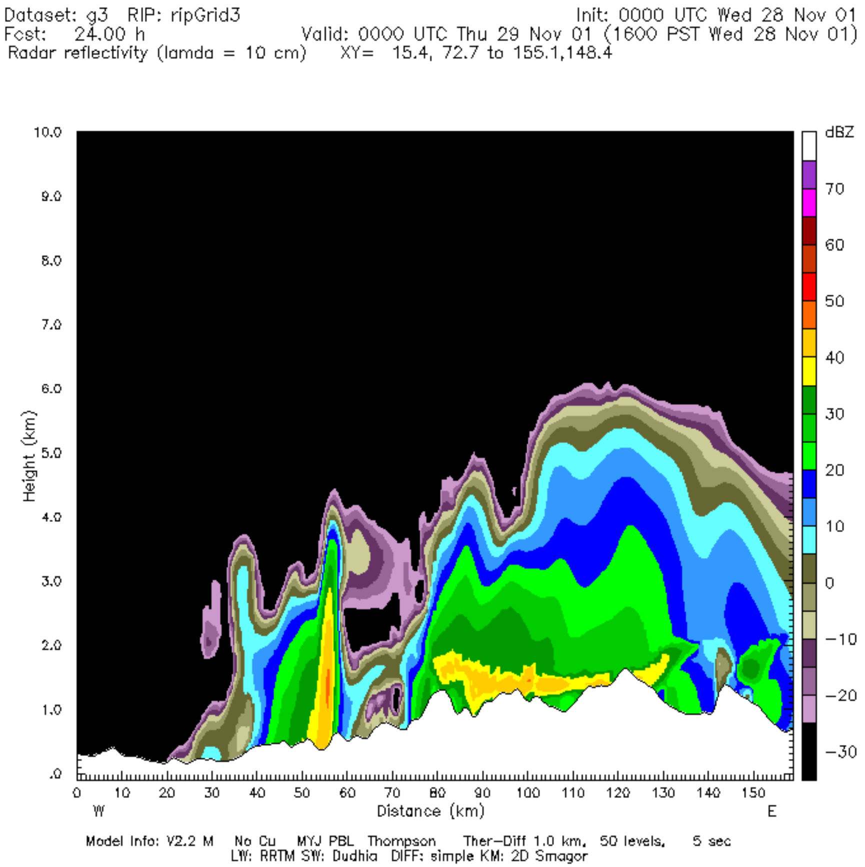
Post-frontal

(Cloud water (tan) and drizzle (green))

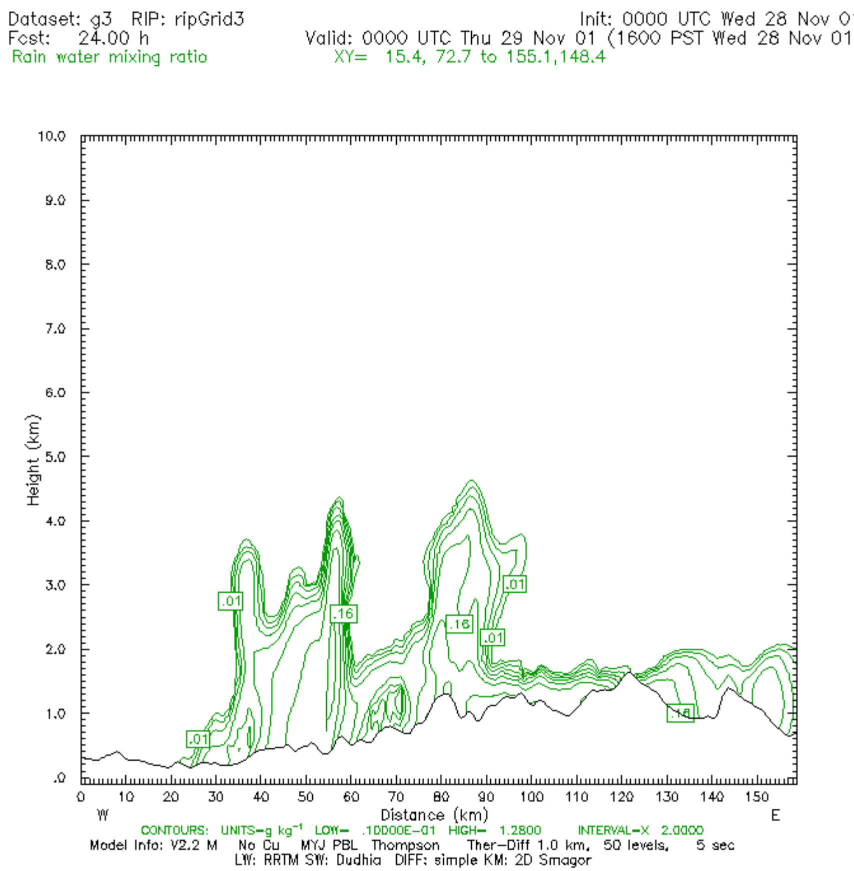


Updraft Velocity (Post frontal)

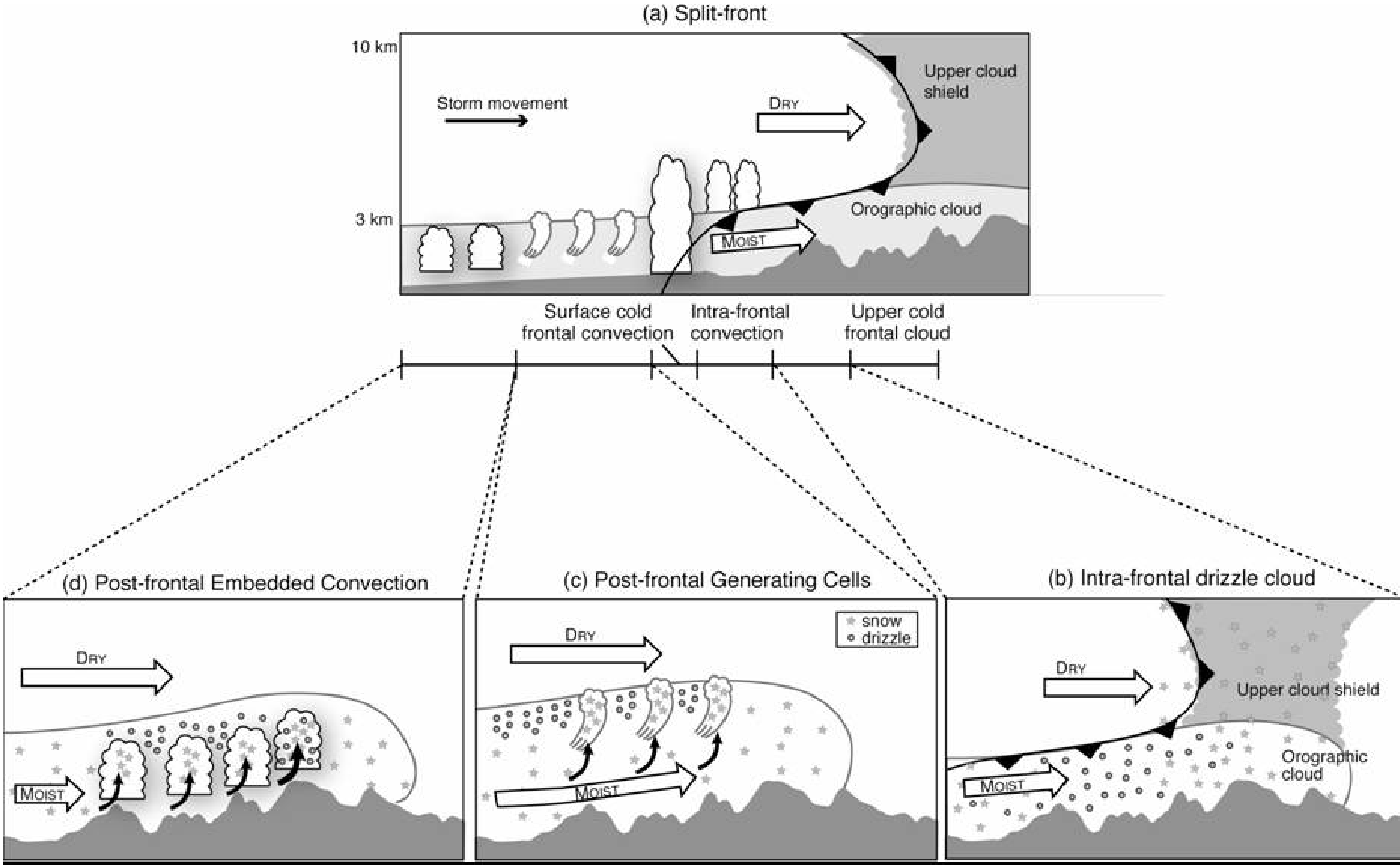




Dataset: g3 RIP: ripGrid3
Init: 0000 UTC Wed 28 Nov 01
Fcst: 24.00 h
Valid: 0000 UTC Thu 29 Nov 01 (1600 PST Wed 28 Nov 01)
Radar reflectivity (lamda = 10 cm) XY= 15.4, 72.7 to 155.1,148.4
Height (km)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
W
Distance (km)
E
dBZ
70
60
50
40
30
20
10
0
−10
−20
−30
Model Info: V2.2 M No Cu MYJ PBL Thompson Ther−Diff 1.0 km, 50 levels, 5 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor


Dataset: g3 RIP: ripGrid3
Init: 0000 UTC Wed 28 Nov 01
Fcst: 24.00 h
Valid: 0000 UTC Thu 29 Nov 01 (1600 PST Wed 28 Nov 01)
Rain water mixing ratio
XY= 15.4, 72.7 to 155.1,148.4
Height (km)
Distance (km)
W
E
.01
.16
CONTOURS: UNITS=g kg-1 LOW= .10000E-01 HIGH= 1.2800 INTERVAL-X 2.0000
Model Info: V2.2 M No Cu MYJ PBL Thompson Ther-Diff 1.0 km, 50 levels, 5 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

Conceptual Model of Split Front Extratropical Cyclone observed during Nov. 28, 2001 and December 13, 2001



Comparison of Model to Observations

1. Observation: Freezing drizzle observed in intra-frontal and post frontal period in cloud water of 0.15 to 0.2 g/kg and low reflectivity.

   Model: Freezing drizzle found during the same storm periods.

1. Observation: During post-frontal convection (either generating cells or embedded convection), drizzle was found in-between the cells, while high ice crystal concentration was found within the cells.

   Model: Drizzle found in the cells, not outside the cells.

3. Freezing drizzle was also observed to occur in the presence of ice and relatively high radar reflectivity (up to 15 dBZ) and cold cloud top temperatures (< 15 C) in association with strong vertical motions associated with large scale topographic uplift greater than 0.5 m/s.

   Model: Did not reproduce the drizzle over the steepest barrier.

4. The strong vertical motions also prevents the sedimentation of snow from aloft to lower levels, allowing cloud liquid water generated at lower levels to build up and form freezing drizzle.

   Model: Yes.

5. Model: forecasts of aircraft icing need high horizontal (< 2 km) and vertical resolution (< 0.25 km) to adequately capture the observed vertical motions.

Final Remarks

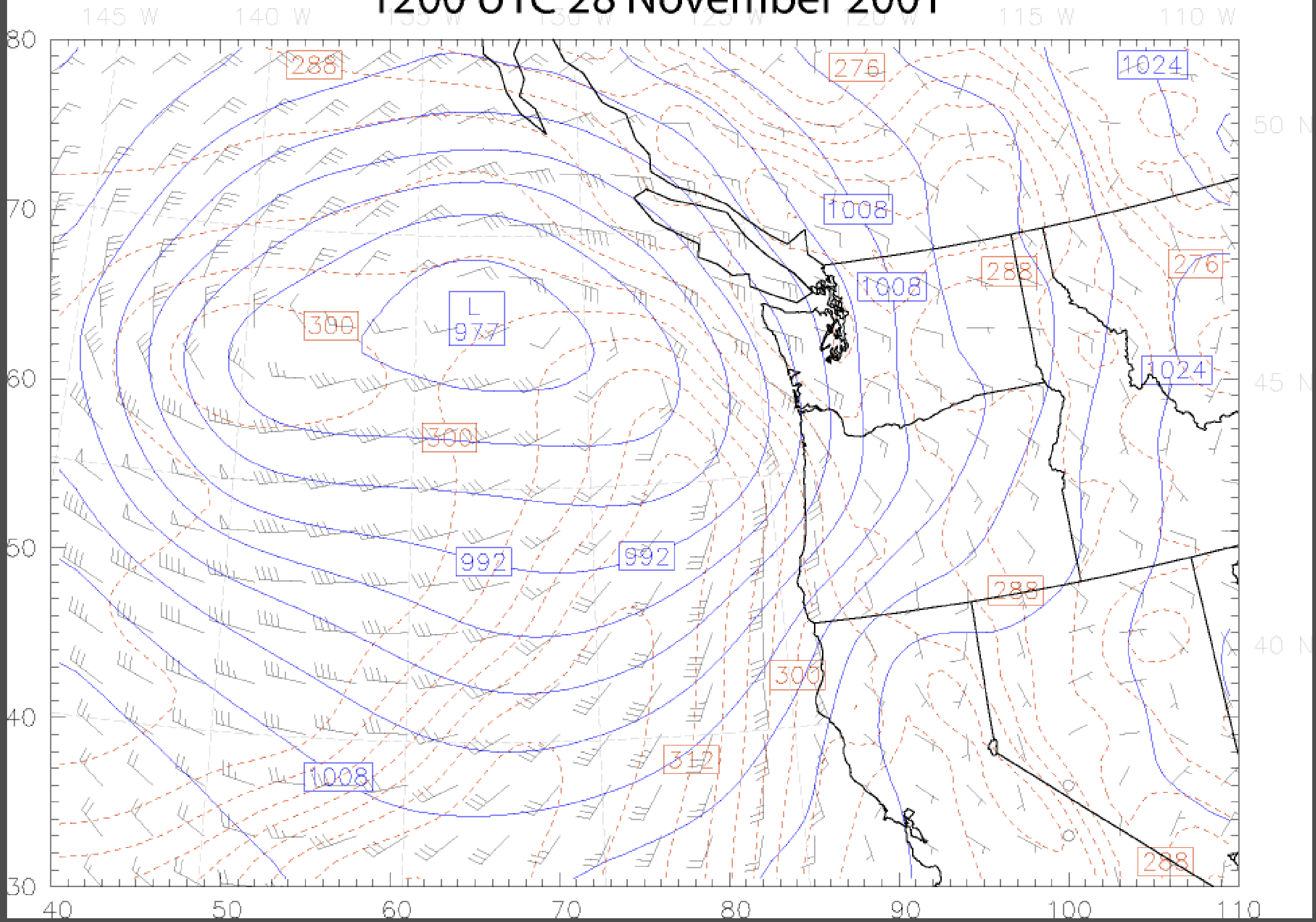
- Model simulation of the formation of freezing drizzle has improved significantly since 1990.
  - Non-dimensionalized snow size distribution has improved the overall simulation significantly
  - High resolution (at least 2 km) needed in complex terrain

- A number of areas still need work:

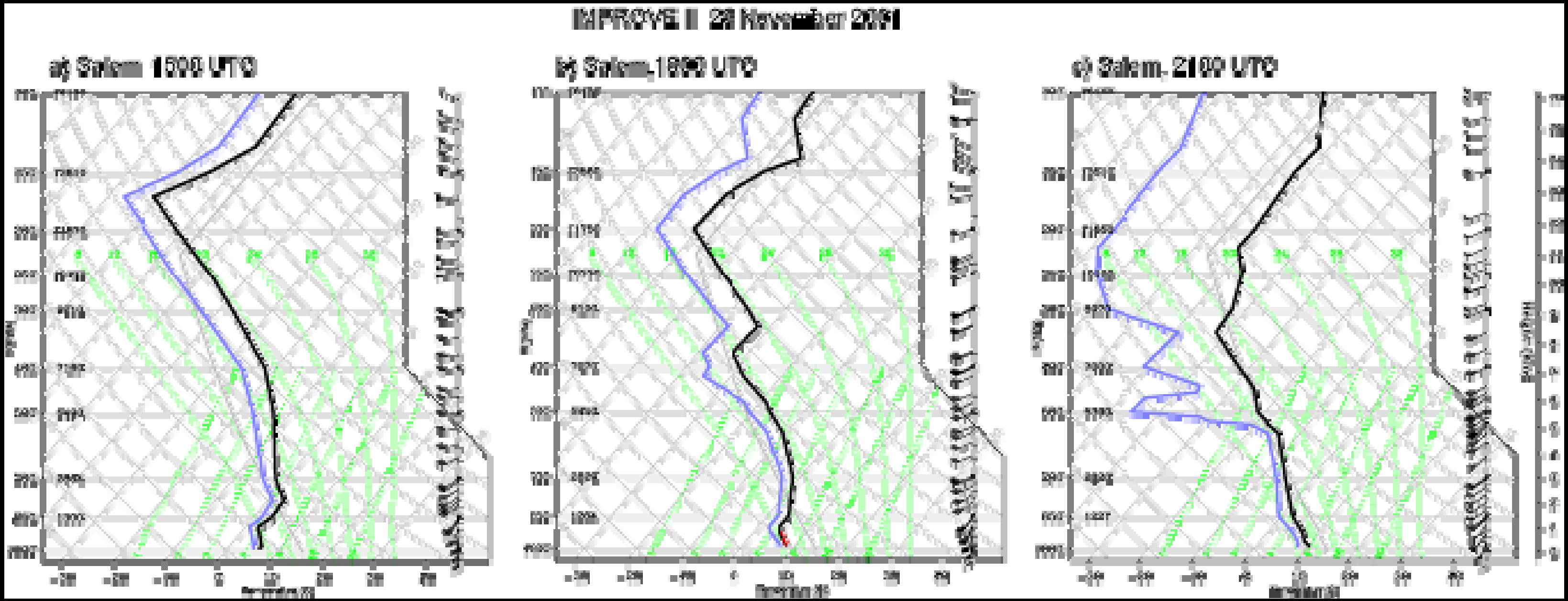
1. Ice initiation
2. Ice nuclei tracking (sources and depletion)
3. Drizzle initiating mechanisms (including the appropriate representation of CCN and auto-conversion)

Thank you!

1200 UTC 28 November 2001

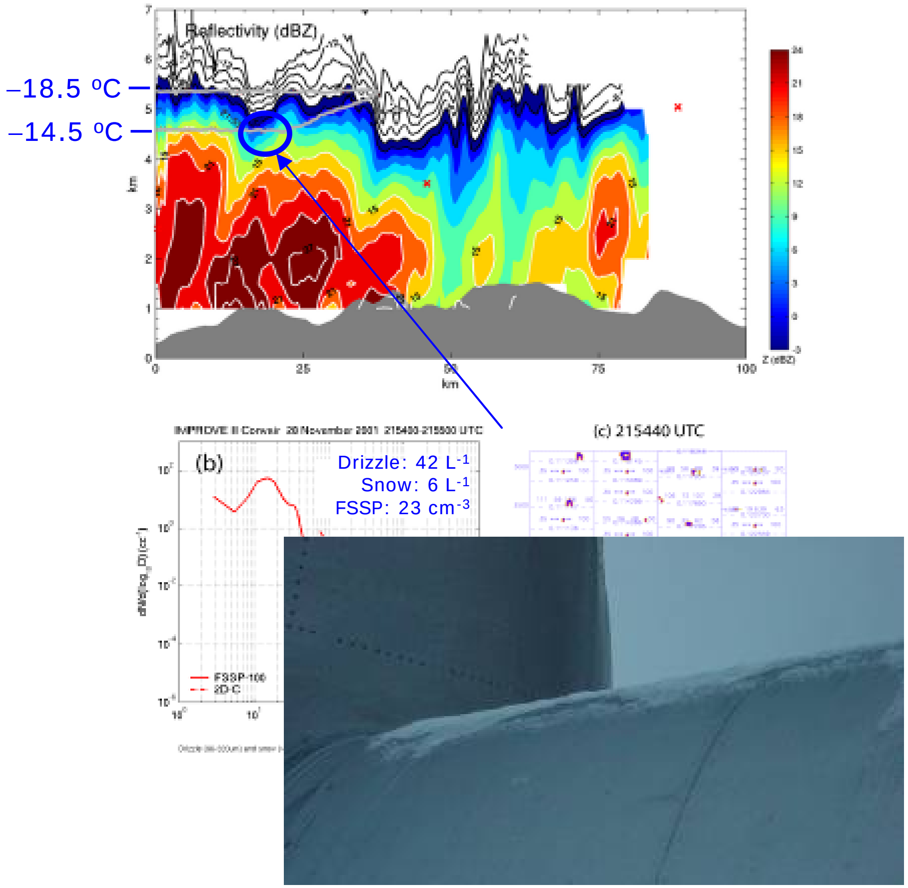


Salem Soundings

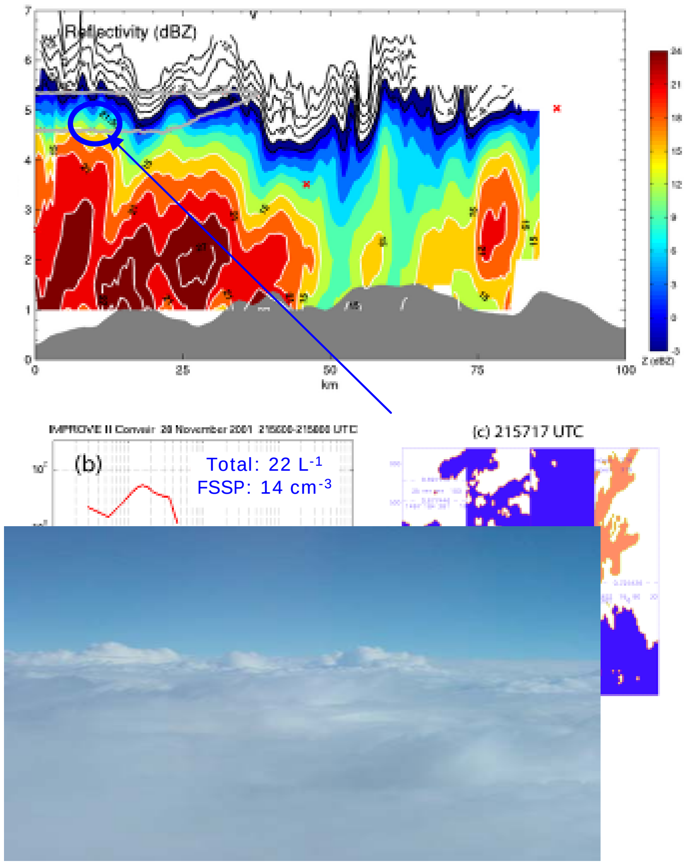


Observations: the Convair’s cross-barrier flight leg

Supercooled drizzle



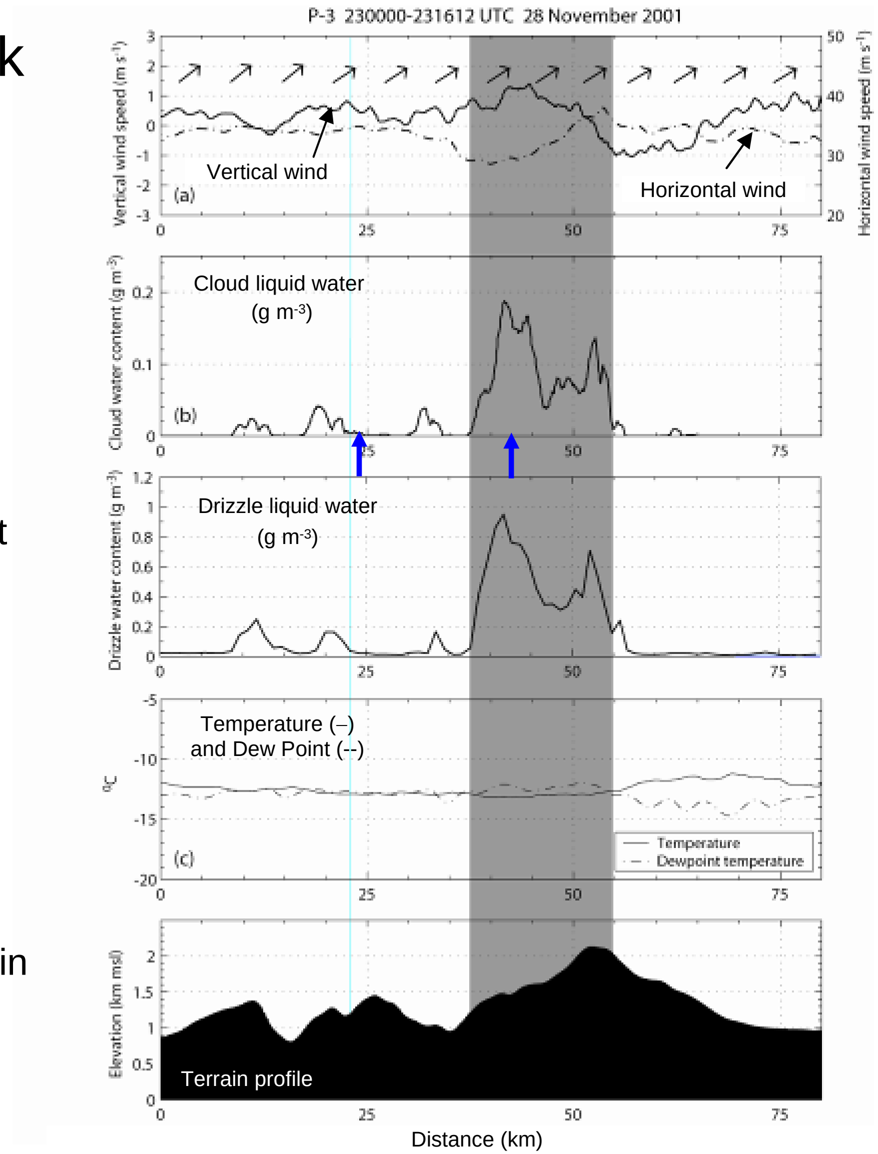
Dendrites



The P-3's cross-barrier flight track between 2300 and 2318 UTC

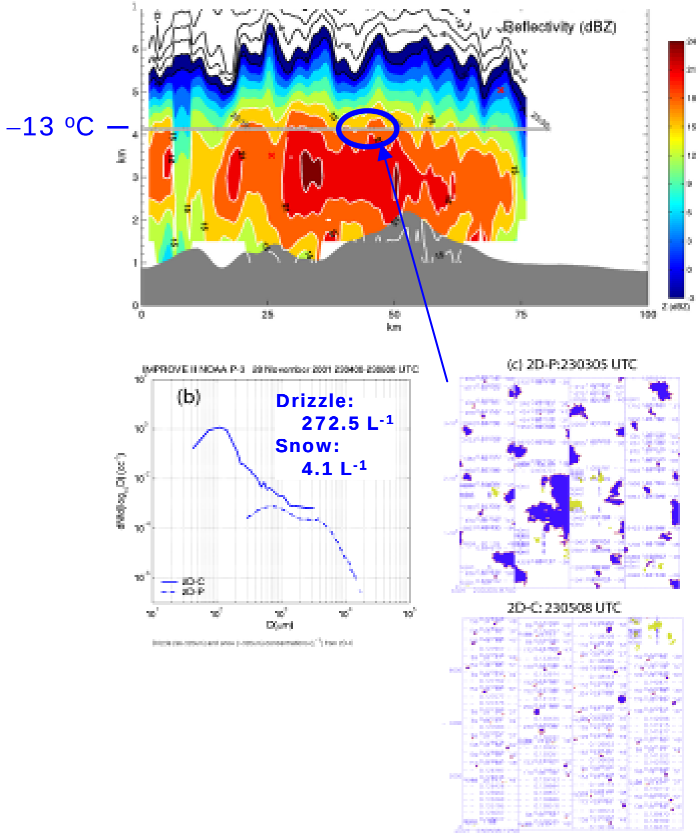
Flight altitude = 4.2 km MSL
Temperature = –13°C

- Variations of liquid water content and vertical velocity generally follow topography (Garvert et al. 2005)
- High LWC is associated with the location of local topographic ridges and strong upward motions
- The maximum LWC (0.19 g m^{-3}) and the maximum vertical velocity (1.3 m s^{-1}) was measured just before the airmass reached the mountain crest
- A strong subsidence (–1 m s^{-1}) and drying occurred immediately downwind of the mountain crest

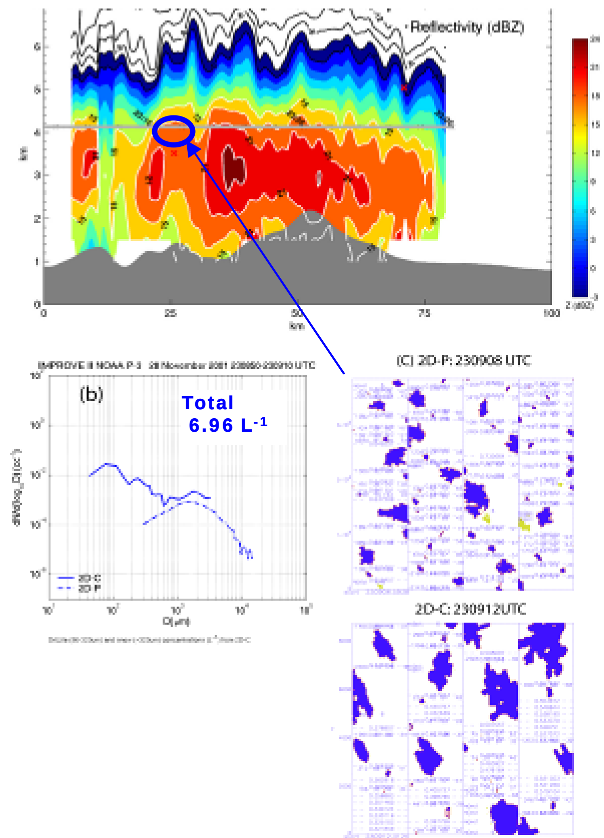


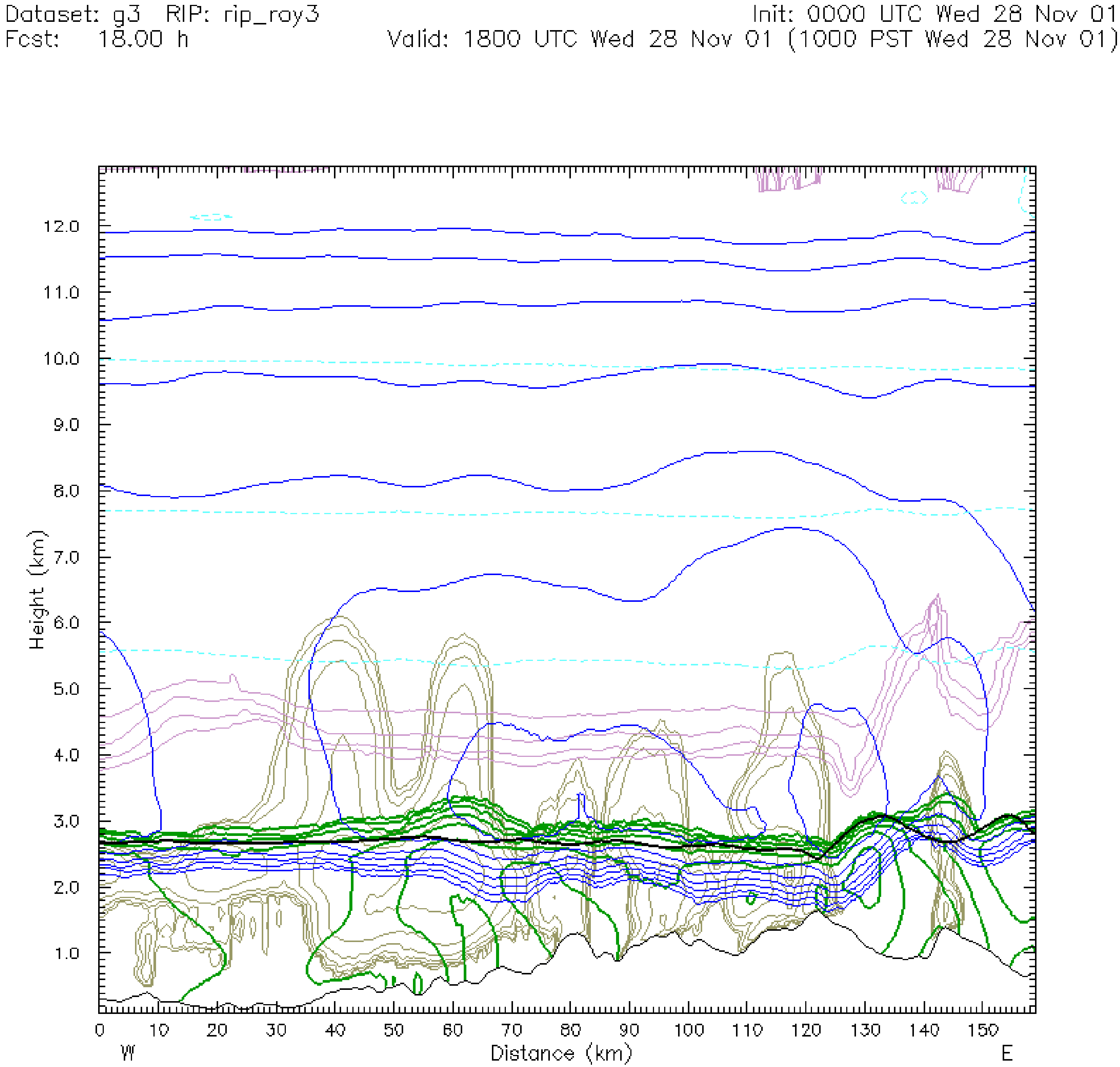
Observations: the P-3's cross-barrier flight leg

Freezing drizzle mixed with snow aggregates



Snow aggregates




Dataset: g3 RIP: rip_roy3
Fcst: 18.00 h
Init: 0000 UTC Wed 28 Nov 01
Valid: 1800 UTC Wed 28 Nov 01 (1000 PST Wed 28 Nov 01)
Height (km)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
W
Distance (km)
E