Supplemental information for

"Optical-chemical relationships for carbonaceous aerosols observed at Jeju Island, Korea with a 3-laser photoacoustic spectrometer"

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Description

The supplemental information for the above titled letter is comprised of a short description of the PASS-3 calibration method and operation, one table showing instrumental detection limits of the PASS-3, and back trajectory calculations for every deployment day during the CAPMEX field campaign. These are all 5-day back trajectories illustrating the path the air masses took to arrive at Cheju Island.
The back trajectories were calculated using the NOAA-HYSPLIT internet application,

Draxler. R. R. and Rolph, G. D. (2003), HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READ (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory

PASS-3 Performance Characteristics

Before the campaign the β_{abs}, β_{sca}, and β_{ext} (β_{abs} + β_{sca}) signals were calibrated using highly absorbing aerosols and non-absorbing (highly scattering) aerosols. The β_{ext} signal was calibrated using non-absorbing aerosols (from smoldering cardboard) and the laser power at 405, 532, and 781 nm and using $\beta_{ext} = \frac{-1}{0.2486} \ln \frac{I}{I_0} \times 10^6$ [Mm^{-1}]. Here, 0.2486 is the pathlength of the cavity in meters, I and I_0 refer to the interpolated laser power over the sampling period using the laser power measured immediately before the aerosols were sampled and immediately after completely flushing the cavity with filtered air. Because β_{ext} for non-absorbing aerosols equals β_{sca}, the slope of the linear regression line for the signal measured by the scattering sensor vs. β_{ext} is used as a calibration factor for the β_{sca} measurement. The absorption coefficient (β_{abs}) is calibrated in a similar manner using kerosene soot. The slope of the linear regression line for a plot of the photoacoustic absorption signal vs. (β_{ext} - β_{sca}) is used as the calibration factor for β_{abs}. Further, absolute calibration of β_{abs} was performed using gaseous NO_2 absorption at 405 and 532 nm. Nitrogen dioxide was measured independently with a commercial NO_x measurement instrument (2B Technologies, Boulder, CO.). Between 200 and 0 ppb NO_2, we measured a linear photoacoustic response at both wavelengths. The relative and absolute β_{abs} calibrations agree within 4% at 405 and 3% at 532 nm. The error introduced to β_{sca} by truncation of the scattering detection angle is found to be minimal. We compared the PASS-3 β_{sca} to nephlometer data from ambient measurements and find linear response in all laser channels (m_{405} = 0.93, R^2= 0.97; m_{532} = 1.01, R^2 = 0.99 ; m_{781} = 1.18 R^2= 0.96). A manuscript describing the calibration of the instrument and its performance characteristics is in preparation (Flowers, B. A., Mazzoleni, C., Dubey, M. K., and Walker, J., *manuscript in preparation*, 2010). In the interim, details about the calibration and performance of the PASS-3instrument can be obtained through contact with the LANL and MTU author(s).

The instrumental noise was determined by measuring β_{abs} and β_{sca} for particle free dry air at three-second intervals over several hours. Because of low NO_2 and O_3 concentrations in the lab and because the background absorption and scattering signals are continuously and automatically subtracted, there should be negligible absorption and scattering signals from gases, so the standard deviation of the β_{abs} and β_{sca} signals for a given signal integration time arise solely from instrumental noise sources.

Table 1. Absorption and Scattering standard deviation and integration time values obtained for particle free and absorber-free air. The values at 600 sec integration time are the instrumental noise for the β_{abs} and β_{sca} discussed in the text.

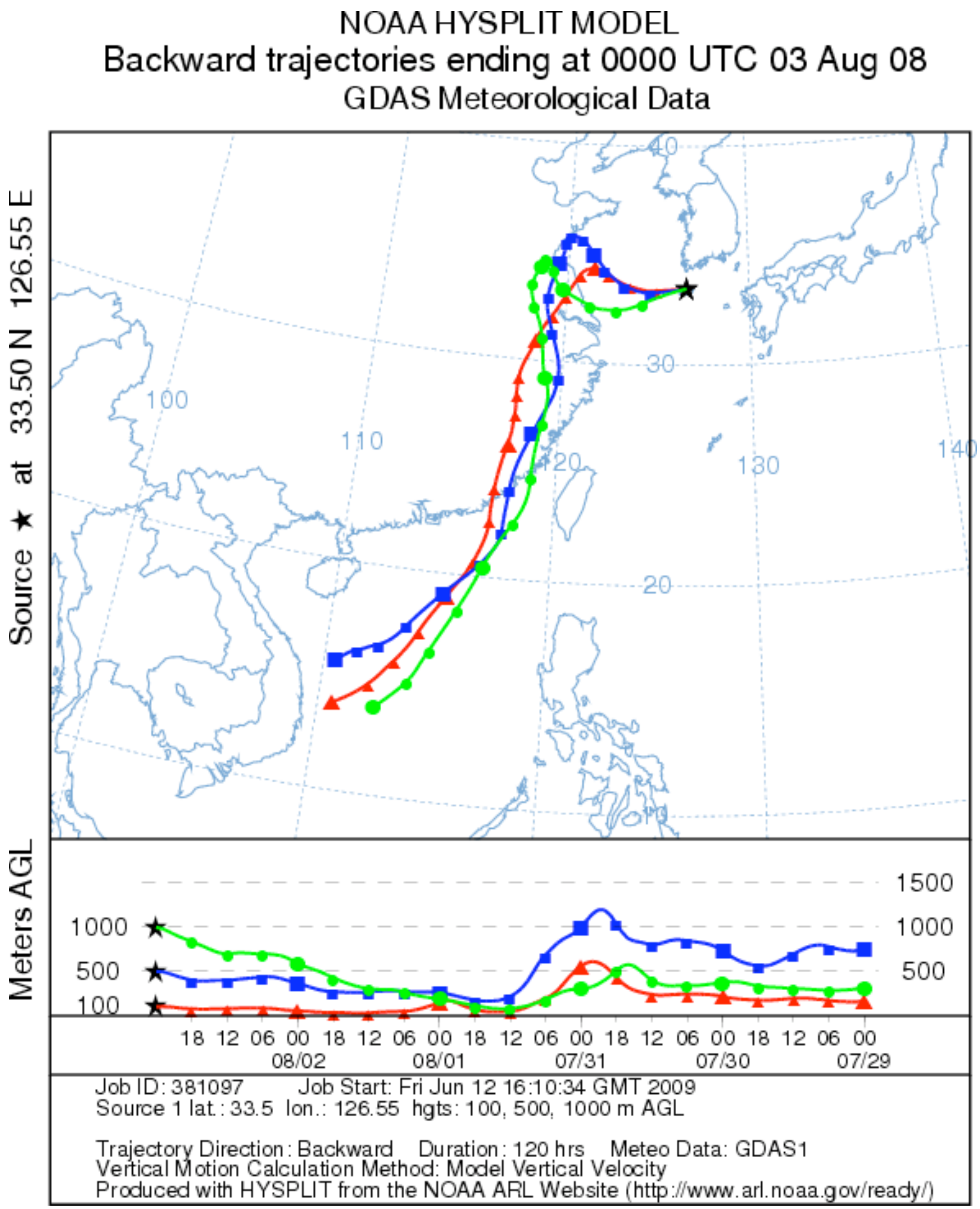
Integration time / sec.	λ / nm	β_{abs} / Mm^{-1}	β_{sca} / Mm^{-1}
	405		
10		4.2	6.1
100		1.8	2.6
600		1.3	1.8
	532		
10		4.5	4.7
100		2.3	3.0
600		1.8	2.7
	781		
10		0.31	2.5
100		0.15	1.4
600		0.13	1.0

PASS-3 Operational Details

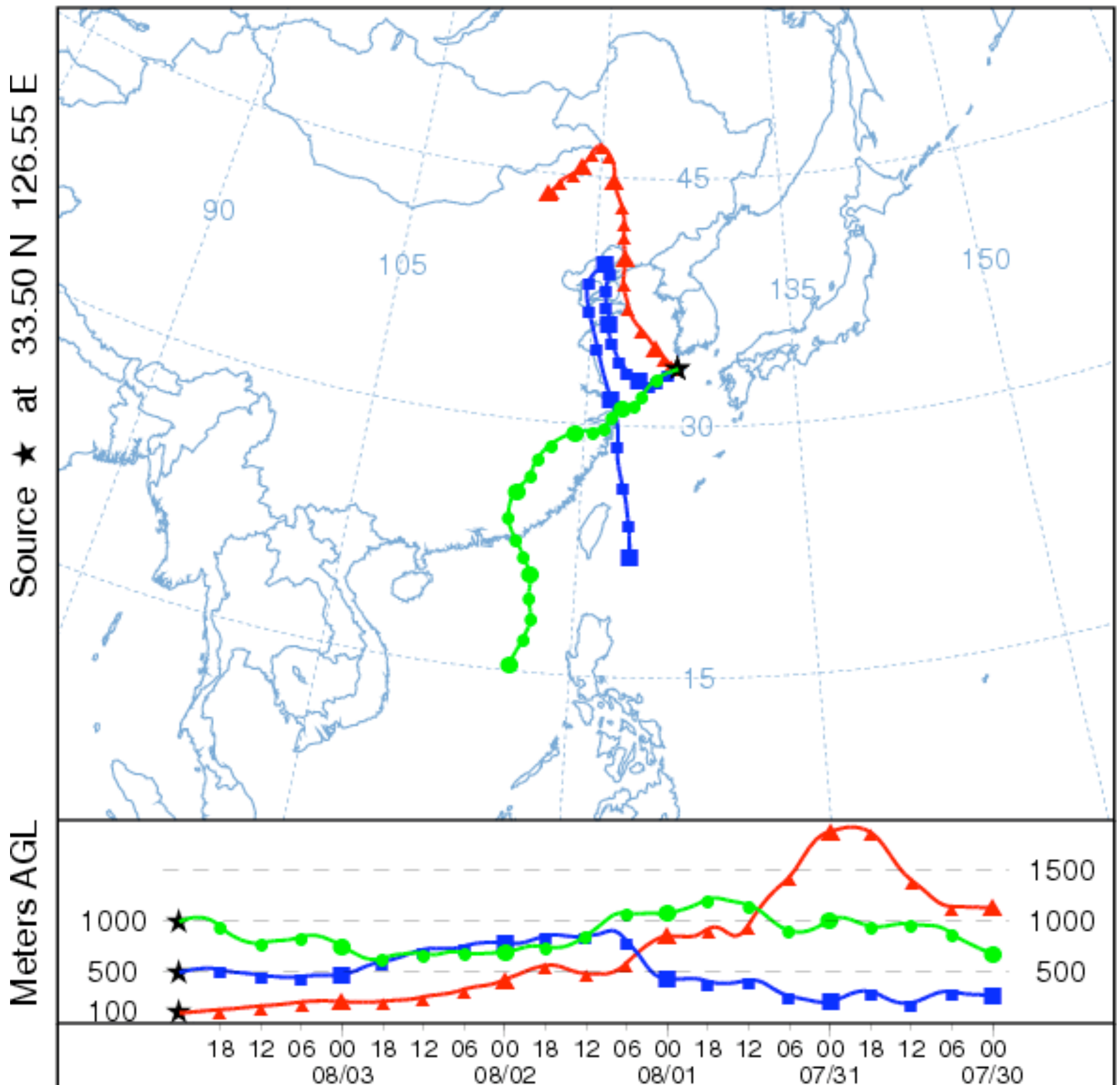
The 3-laser photoacoustic soot spectrometer (PASS-3, Droplet Measurement Technologies, Inc., Boulder, CO) was used to measure aerosol absorption and scattering coefficients (β_{abs} and β_{sca}) at Jeju. The PASS-3 uses 405, 532, and 781 nm diode lasers aligned in an acoustic resonator cavity (l = 2.6 m) and measures β_{abs} using the photoacoustic effect and β_{sca} with a spherical integrating nephlometer. The lasers are modulated at three different frequencies within the acoustic resonance bandwidth and a microphone measures the acoustic signal generated from aerosol light absorption. A Lambertian diffuser mounted at the center of the acoustic resonator is used to measure light scattering integrated from 5°-175° with a cosine square weighting. As mentioned previously, the scattering angle truncation error is negligible.

We measure *dry* aerosols sampled at < 25% relative humidity inside the instrument. Particle-free "zeros" are taken with a duty cycle of 0.72 and interpolation of the acoustic background signal is performed between zero periods to correct for background drifts. In conjunction with "zero" measurements, an acoustic calibration is also routinely performed to lock the laser modulation to the acoustic resonance. Laser powers are continuously monitored to normalize the data. For this ground-based deployment, the background subtracted β_{abs} and β_{sca} signals were averaged into 10-minute segments, to increase the signal to noise ratio.

Episode 1, 3 August 2008.



NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 04 Aug 08
GDAS Meteorological Data



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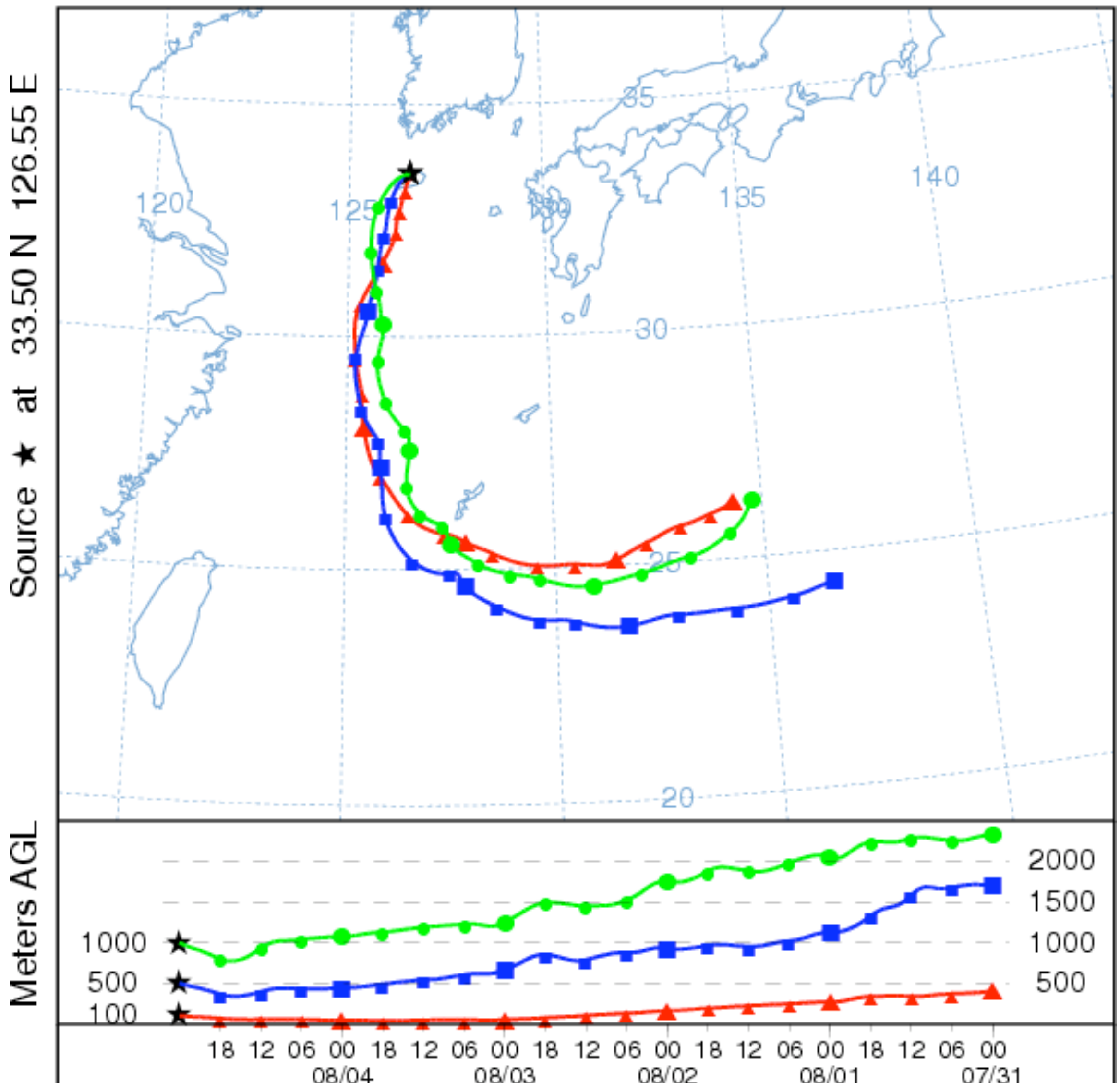
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 01 Aug 2008 - GDAS1

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 05 Aug 08
GDAS Meteorological Data



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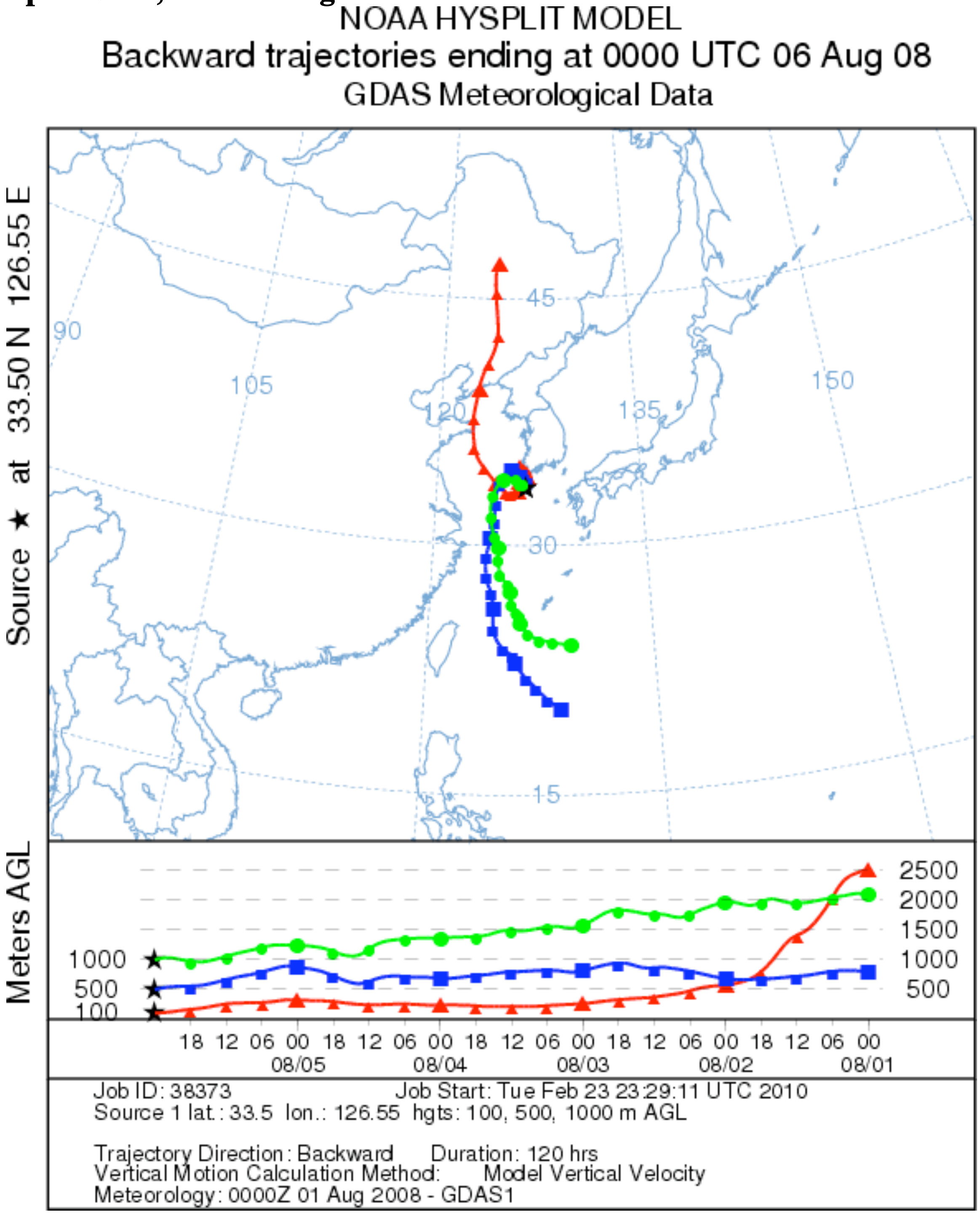
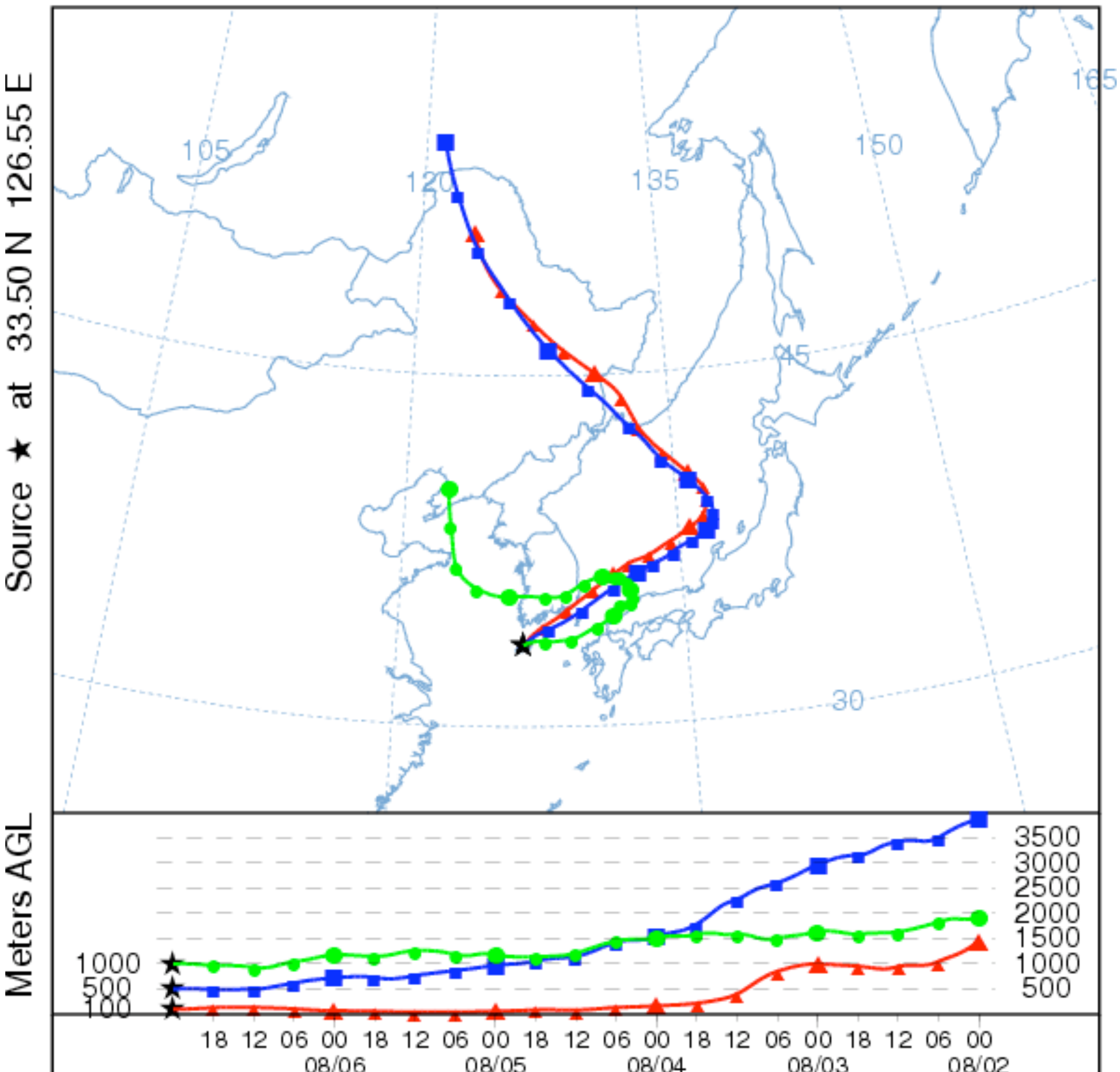
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 01 Aug 2008 - GDAS1

Episode 2, 06-08 August 2008.



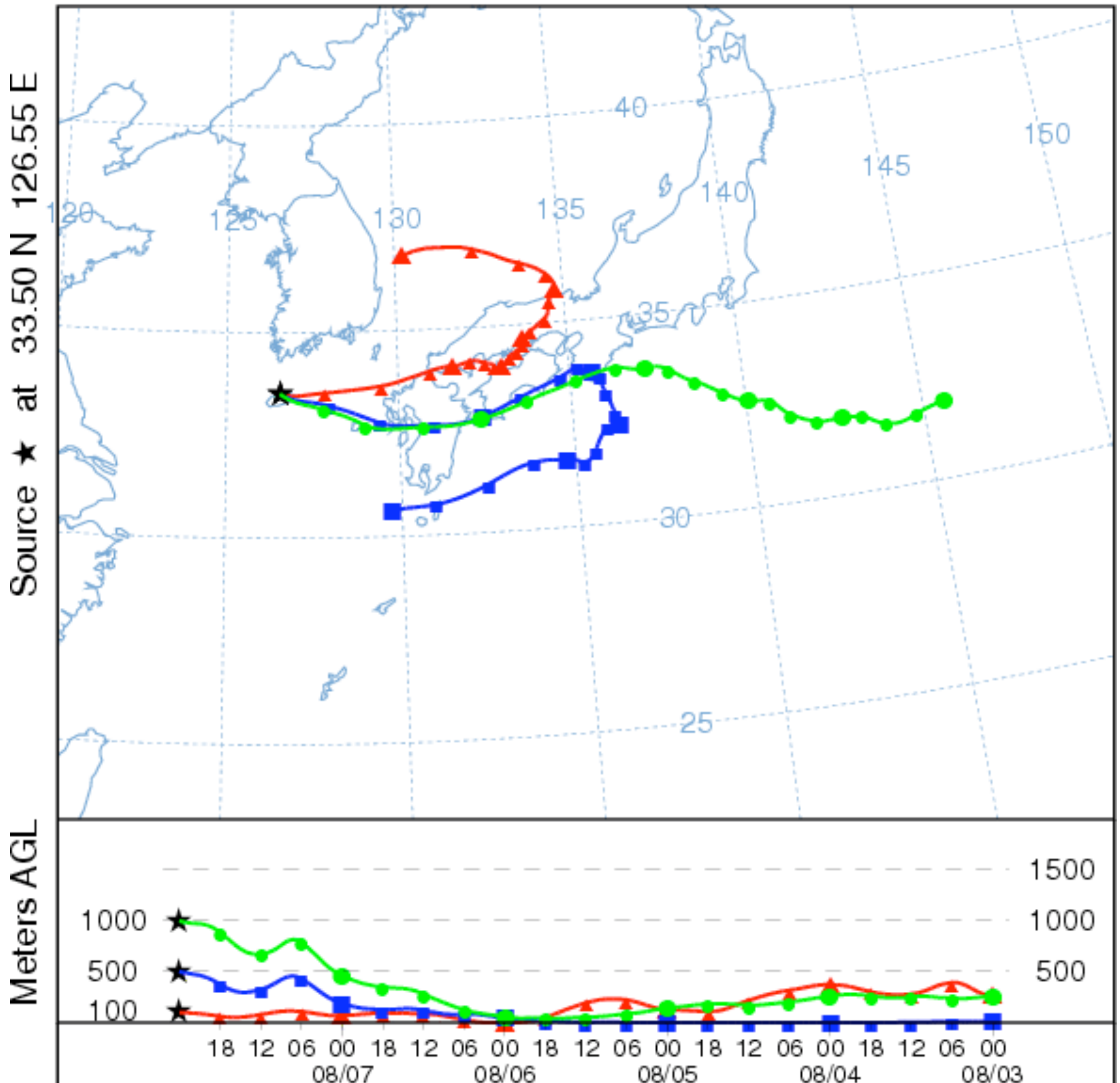
NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 07 Aug 08
GDAS Meteorological Data



Job ID: 38433 Job Start: Tue Feb 23 23:31:08 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

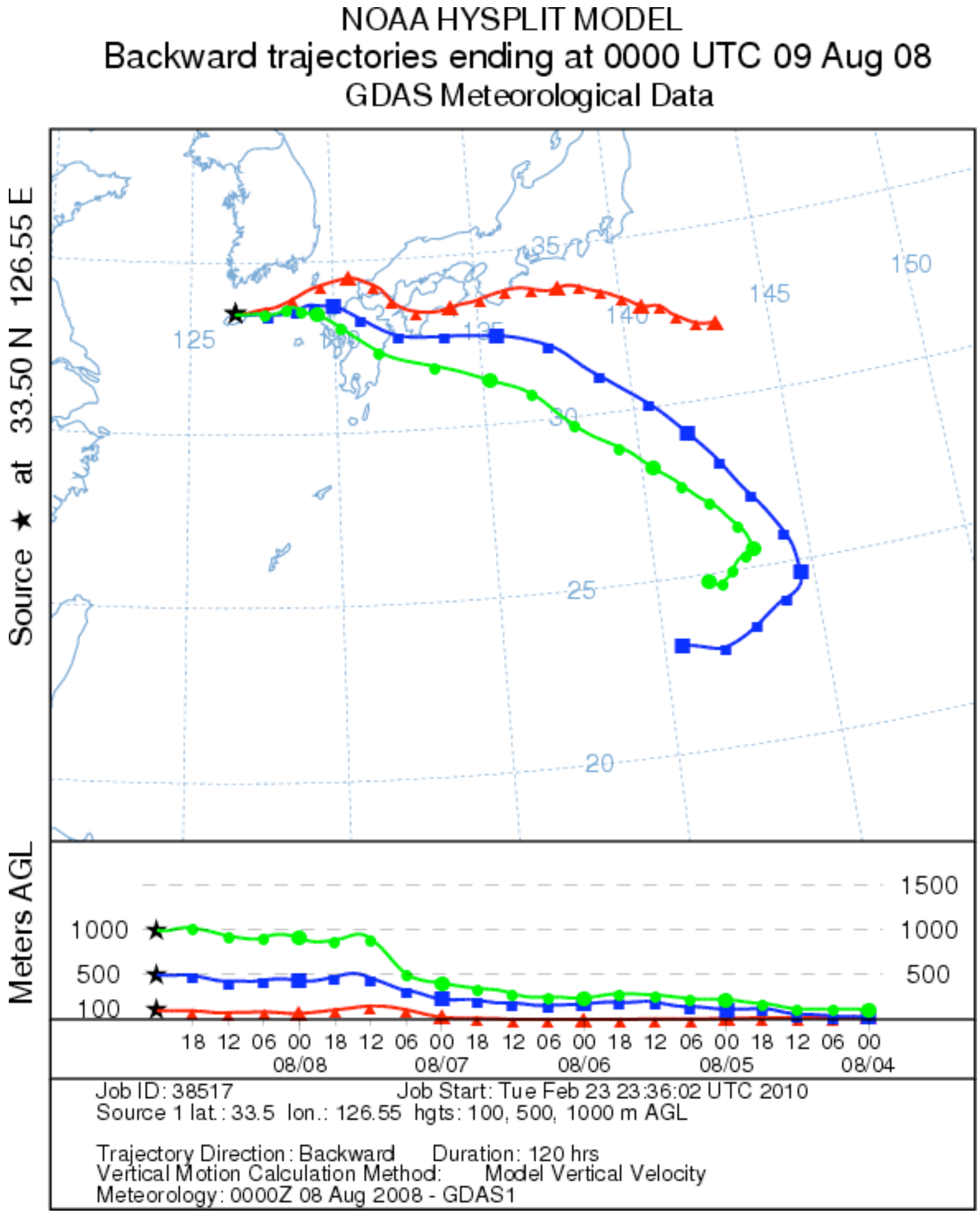
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 01 Aug 2008 - GDAS1

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 08 Aug 08
GDAS Meteorological Data



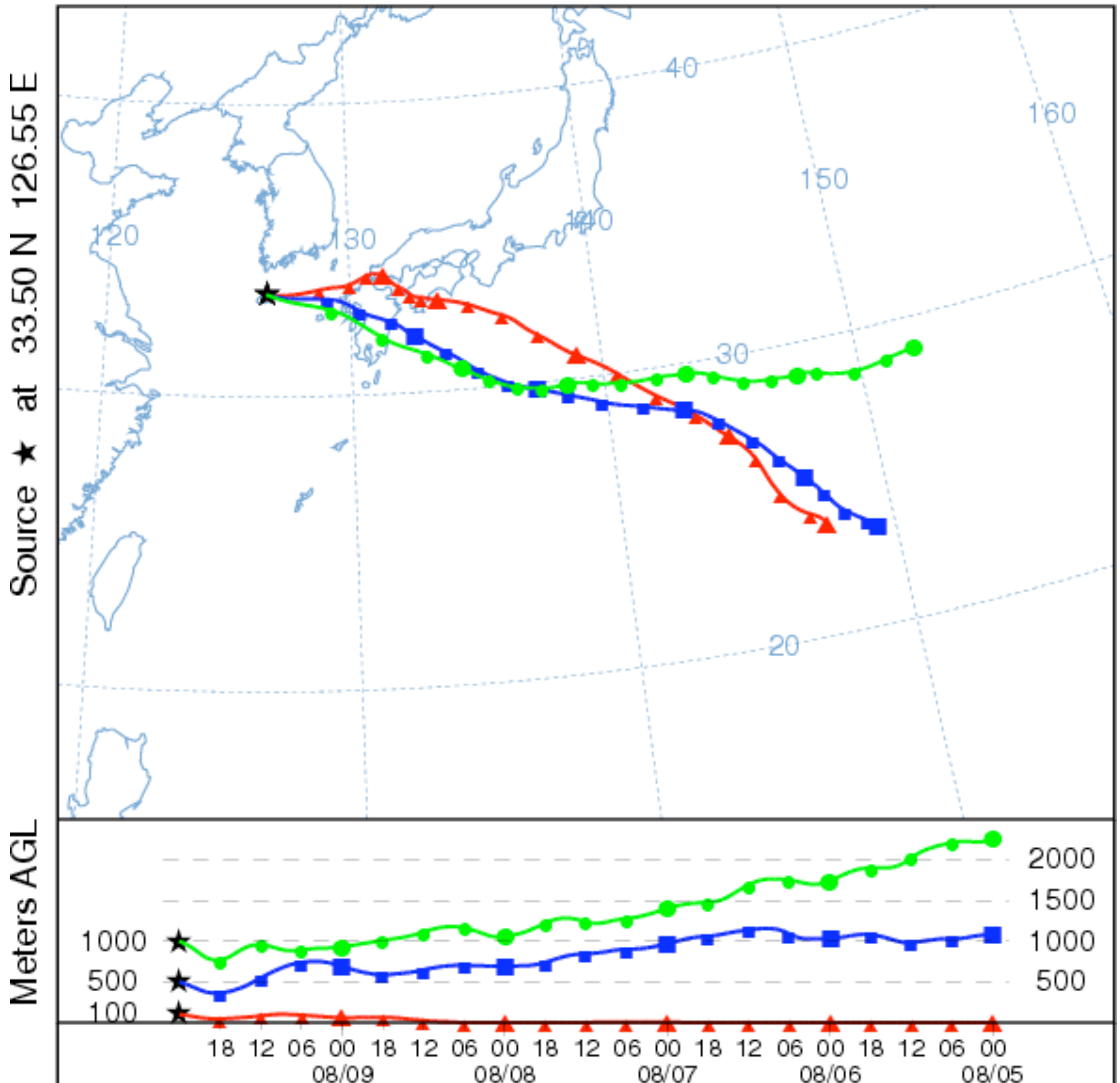
Job ID: 38481 Job Start: Tue Feb 23 23:33:45 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Aug 2008 - GDAS1



NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 09 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
125
130
135
140
145
150
35
30
25
20
Meters AGL
1500
1000
500
100
18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00
08/08
08/07
08/06
08/05
08/04
Job ID: 38517 Job Start: Tue Feb 23 23:36:02 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Aug 2008 - GDAS1

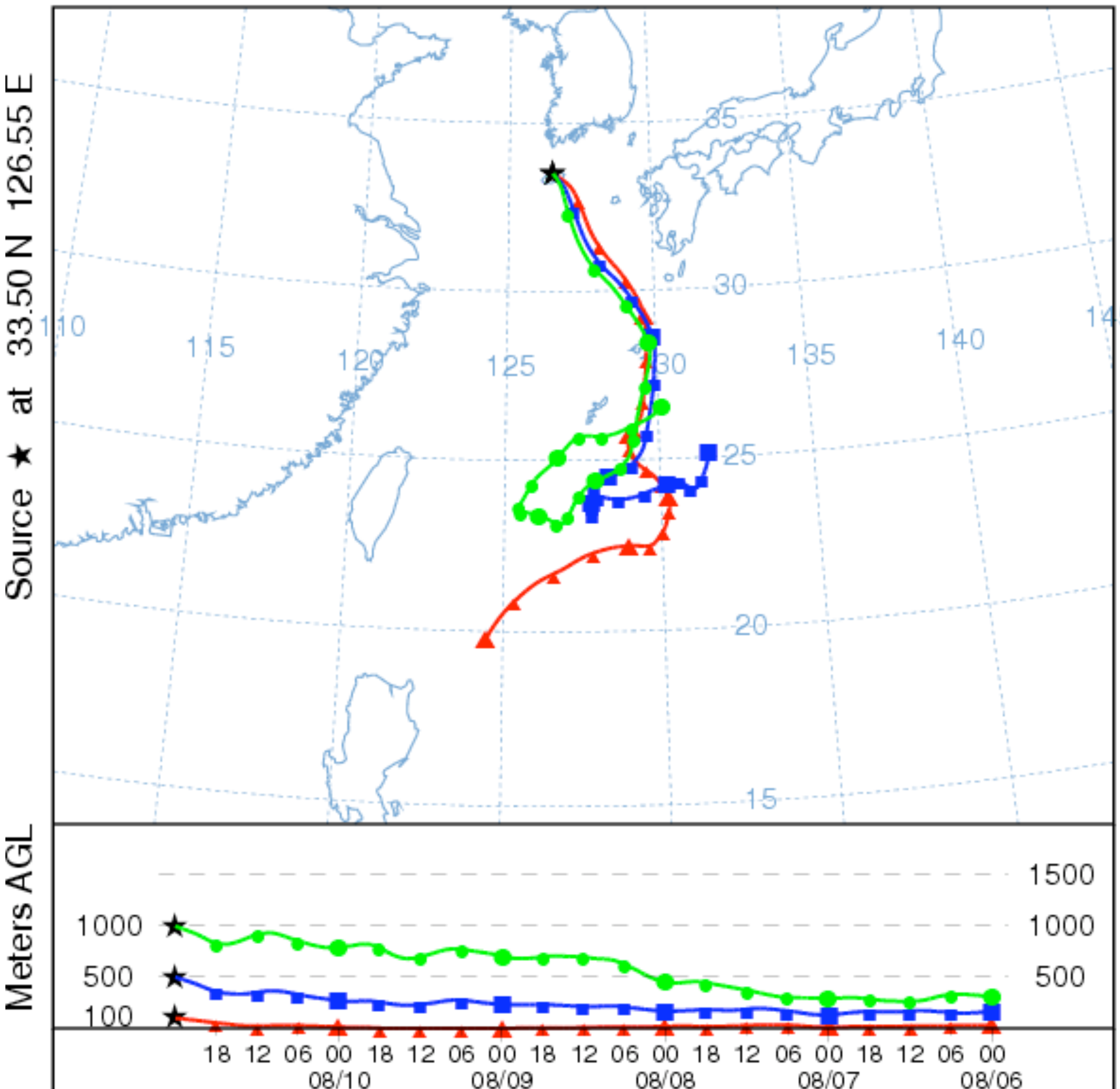
NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 10 Aug 08
GDAS Meteorological Data



Job ID: 38528 Job Start: Tue Feb 23 23:37:56 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Aug 2008 - GDAS1

NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 11 Aug 08
GDAS Meteorological Data



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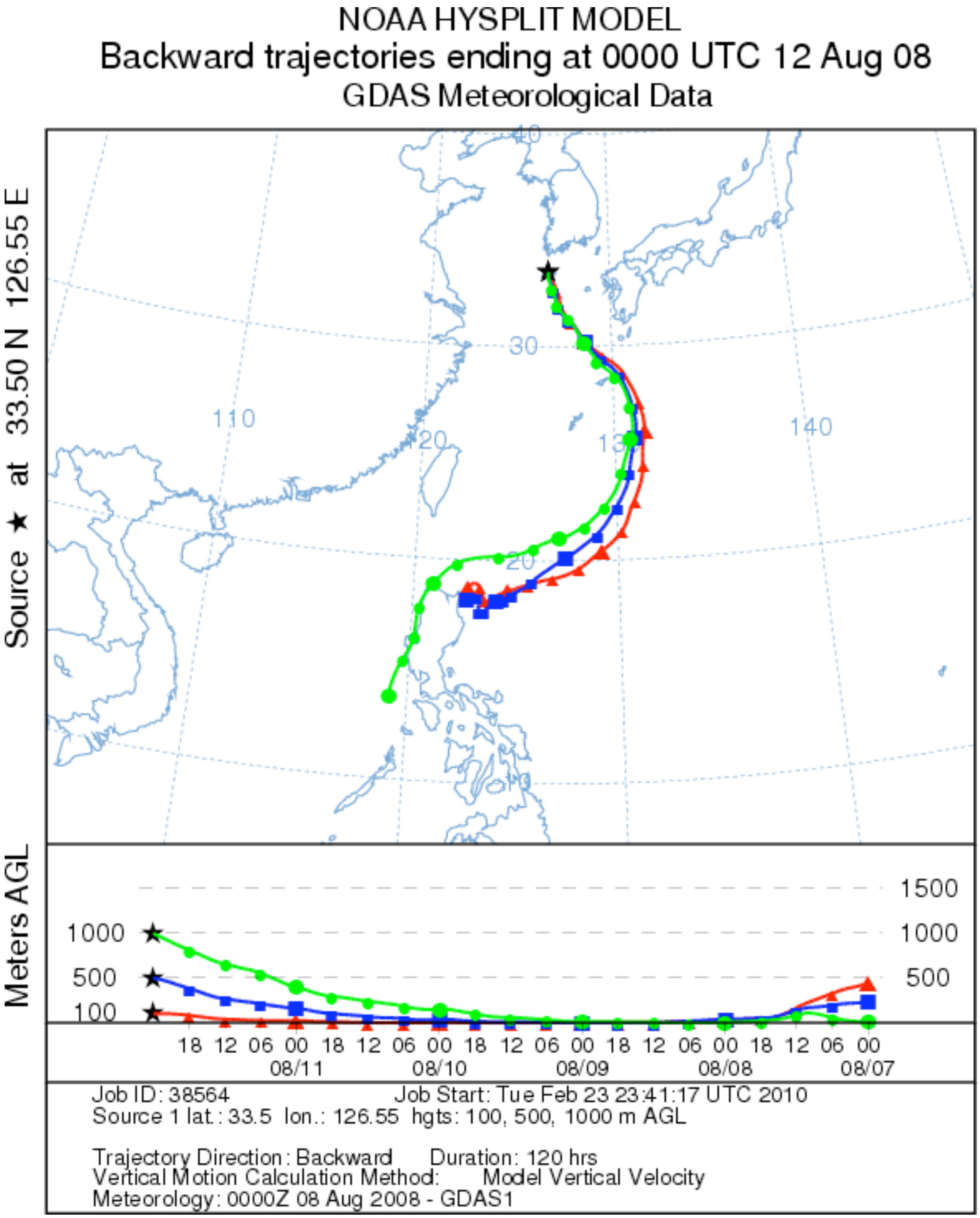
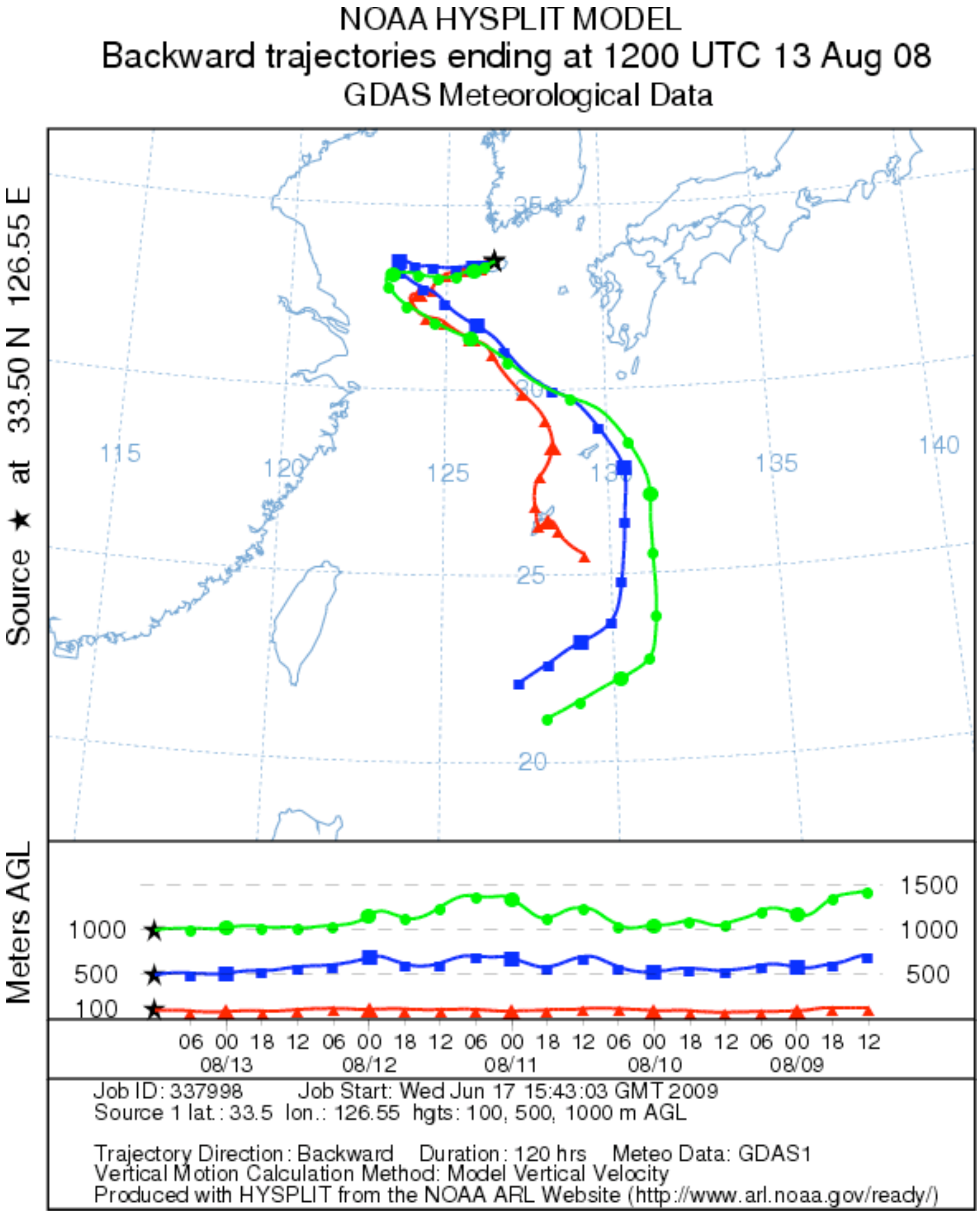
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

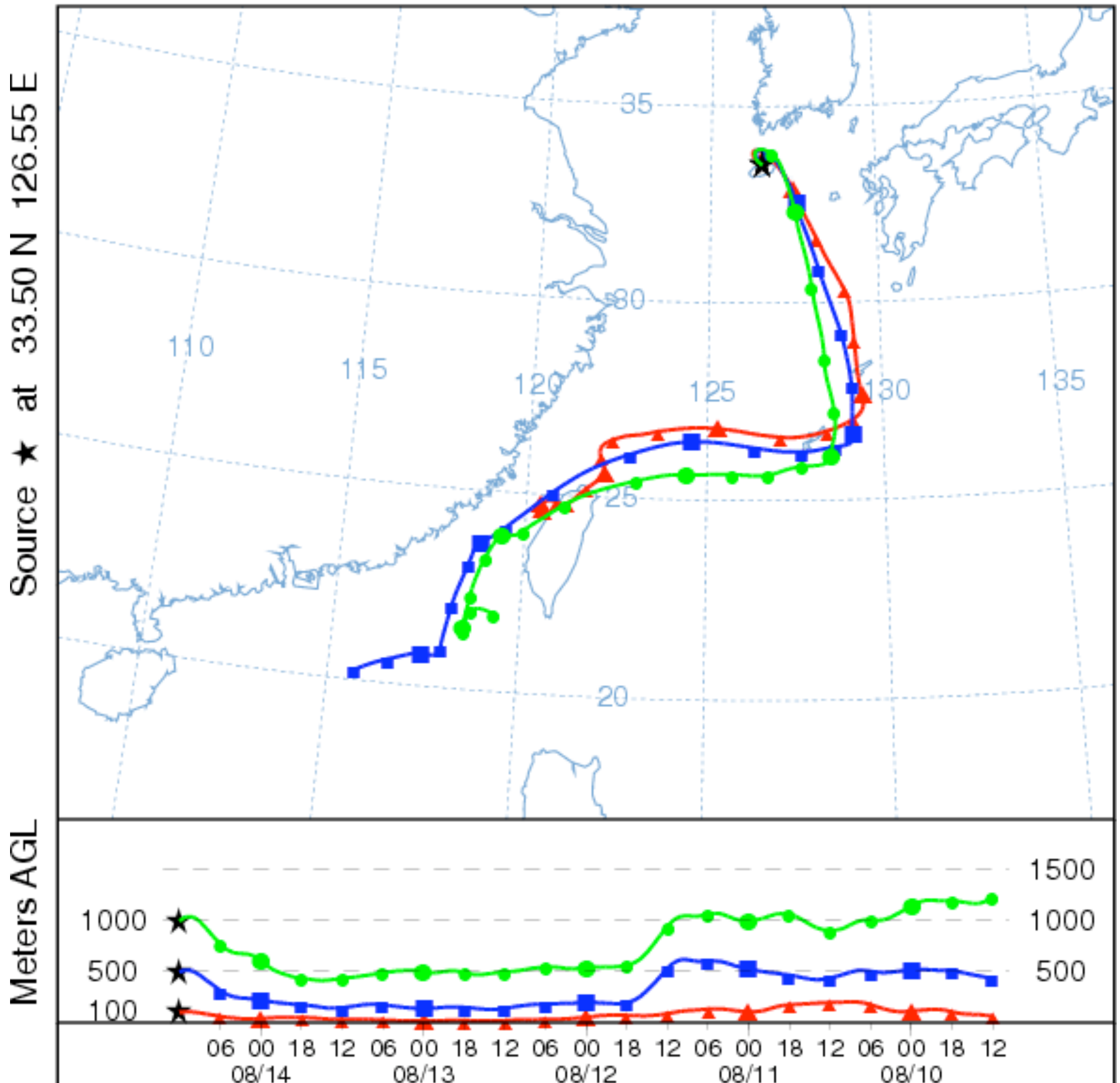
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Aug 2008 - GDAS1


NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 12 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
40
30
20
10
110
120
130
140
Meters AGL
1500
1000
500
100
18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00
08/11
08/10
08/09
08/08
08/07
Job ID: 38564
Job Start: Tue Feb 23 23:41:17 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward
Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Aug 2008 - GDAS1

Episode 3, 13-23 August 2008.



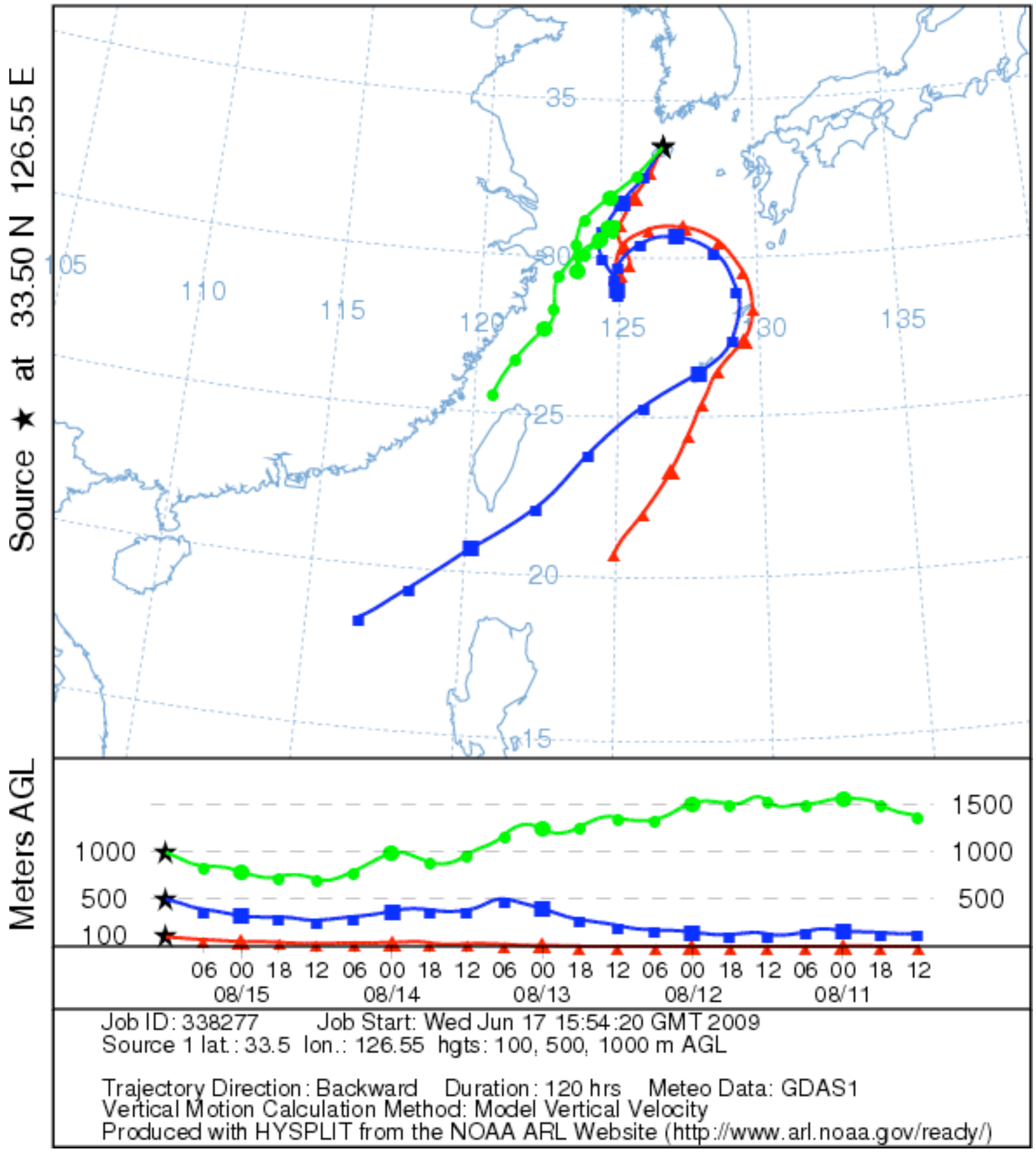
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 14 Aug 08
GDAS Meteorological Data



Job ID: 337677 Job Start: Wed Jun 17 15:30:18 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

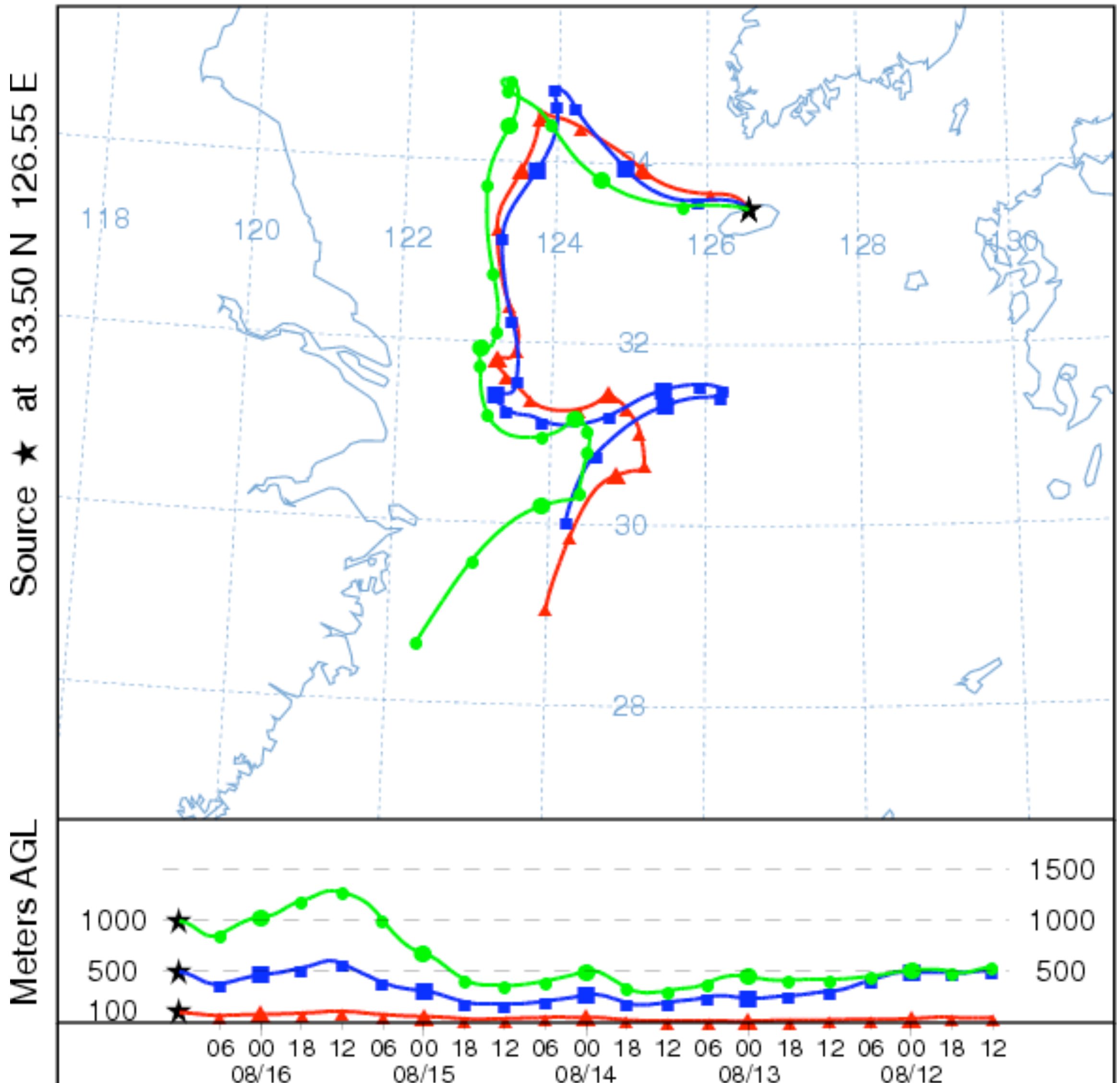
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 15 Aug 08
GDAS Meteorological Data



NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 16 Aug 08

GDAS Meteorological Data



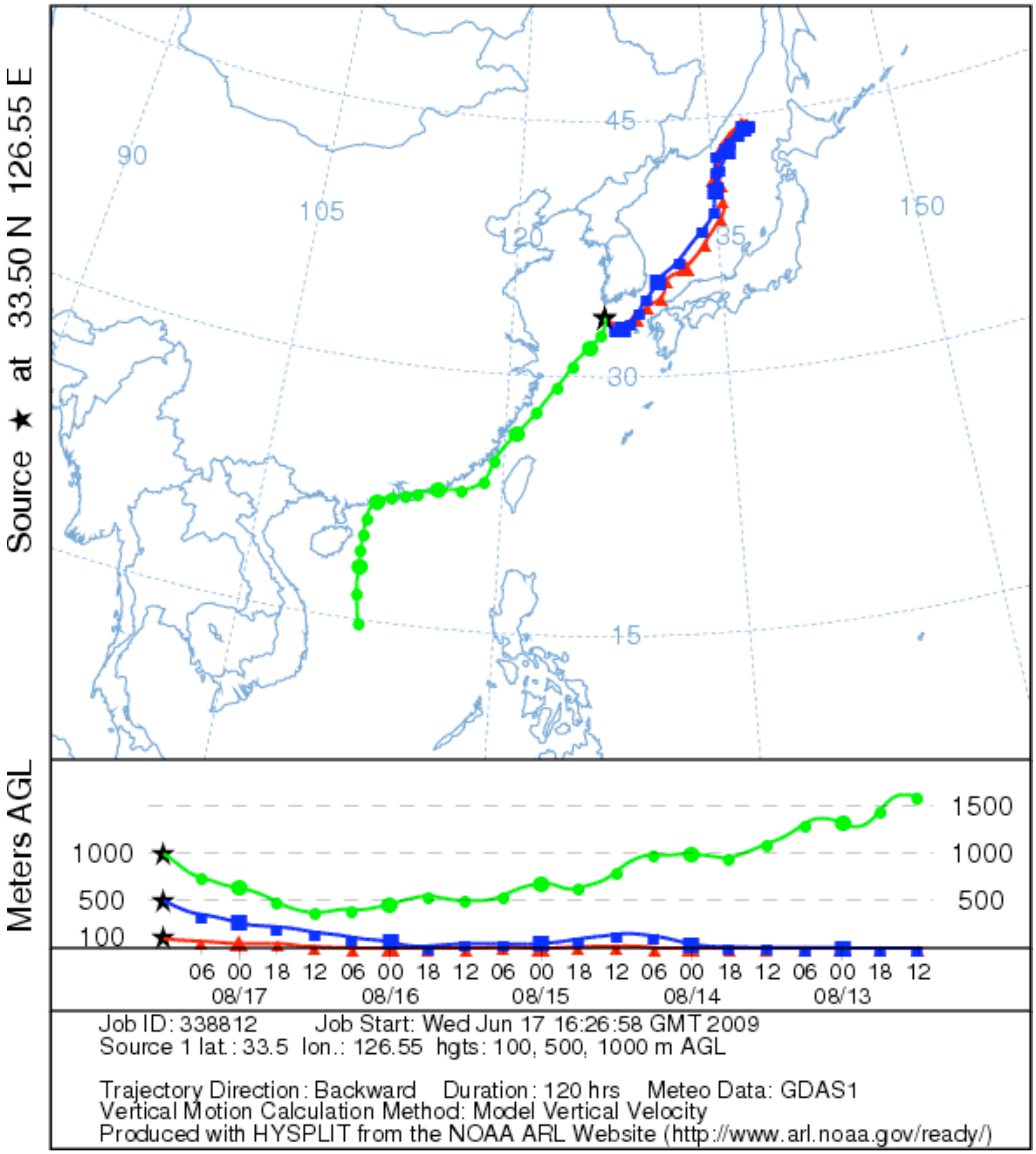
Job ID: 338681 Job Start: Wed Jun 17 16:16:58 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

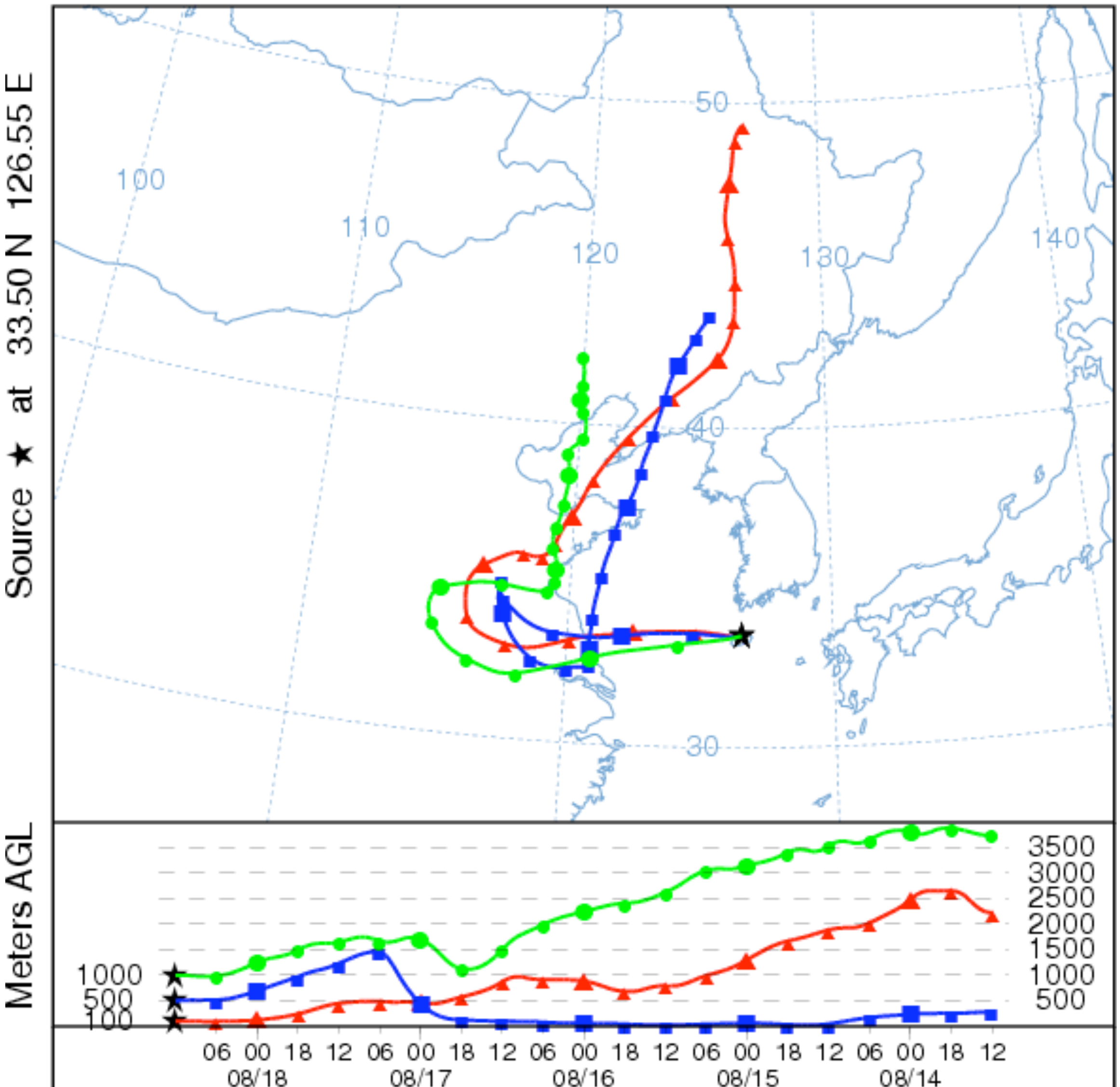
NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 17 Aug 08

GDAS Meteorological Data

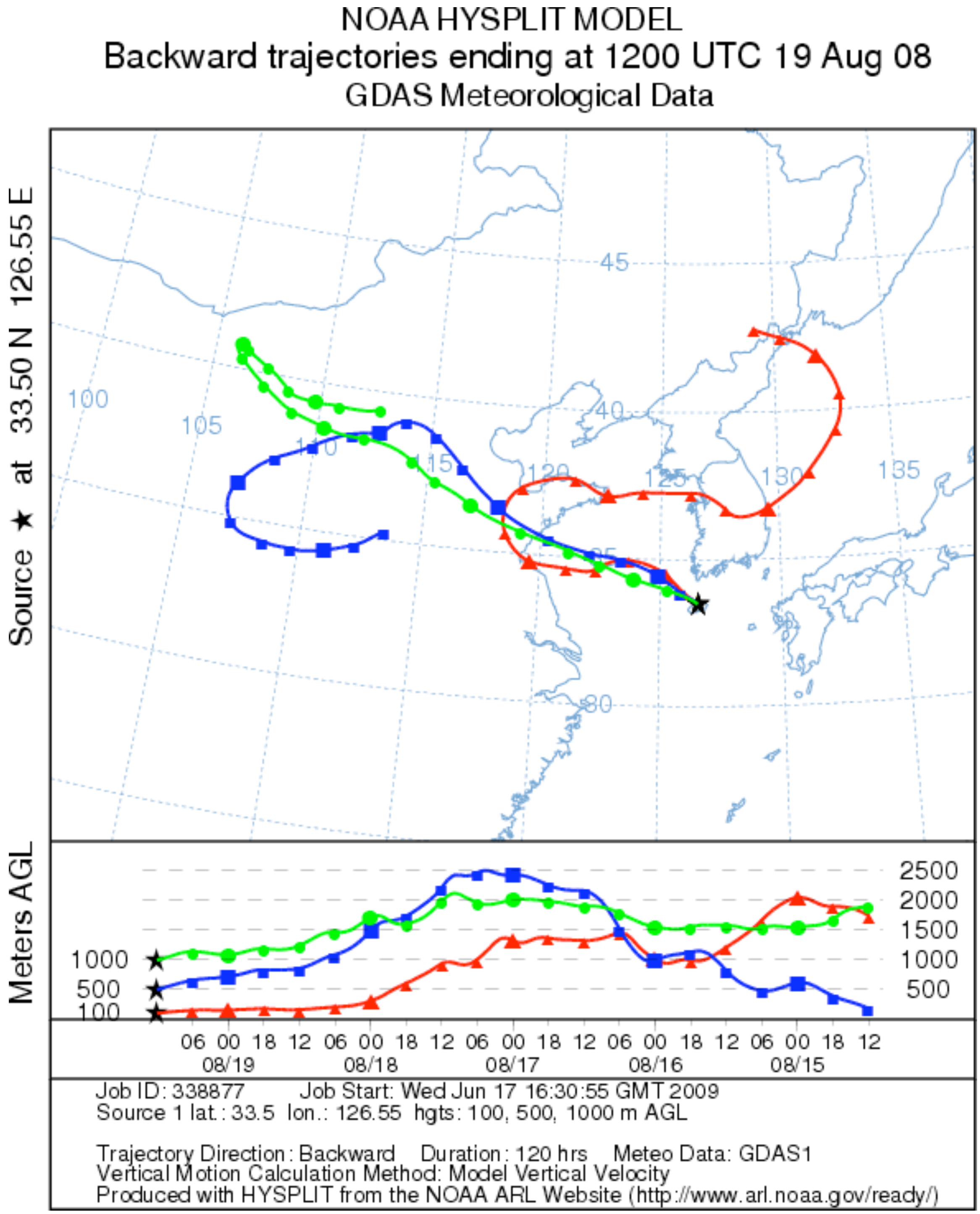


NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 18 Aug 08
GDAS Meteorological Data

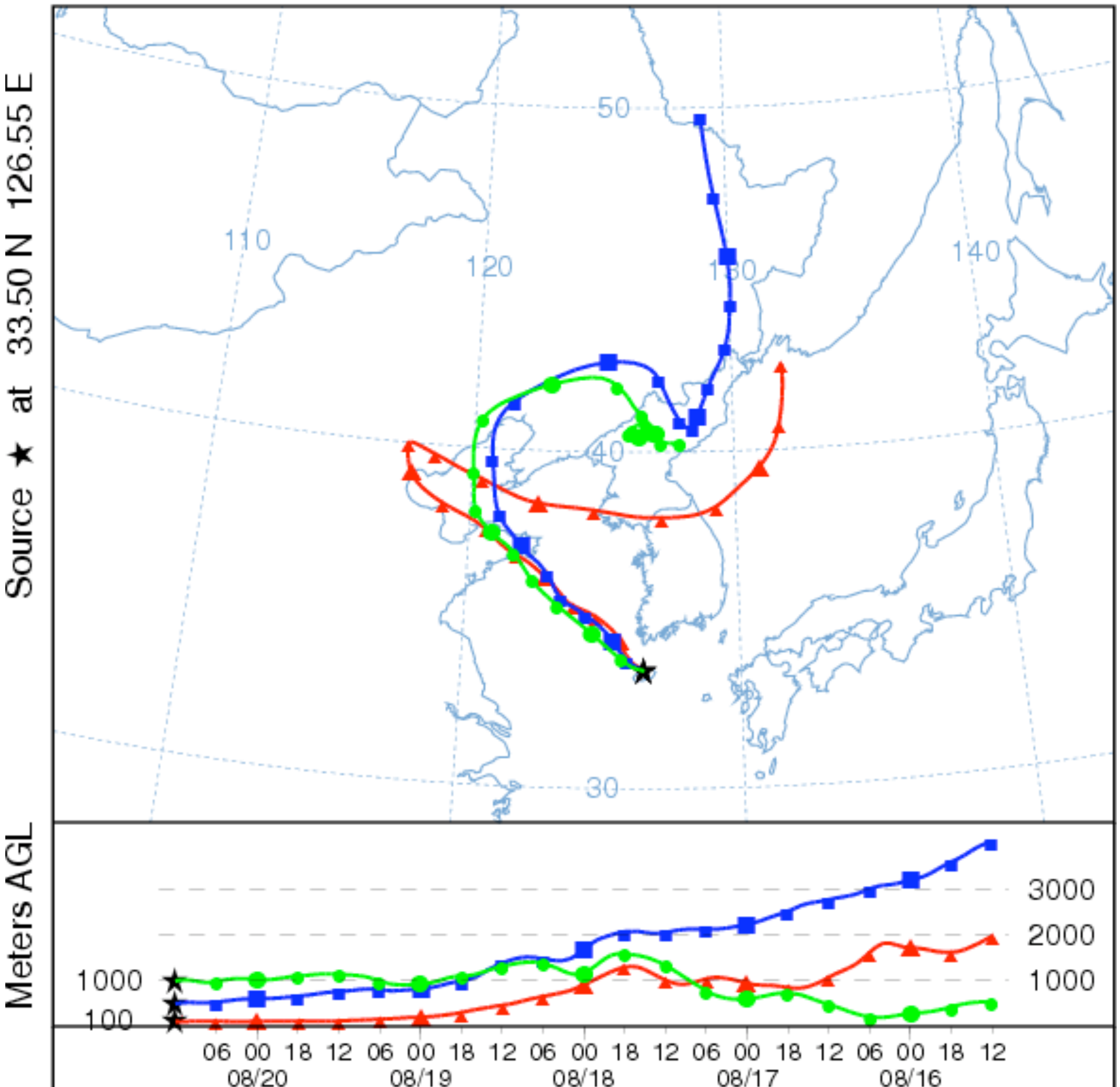


Job ID: 338846 Job Start: Wed Jun 17 16:29:16 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 19 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
Meters AGL
2500
2000
1500
1000
500
100
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
08/19 08/18 08/17 08/16 08/15
Job ID: 338877 Job Start: Wed Jun 17 16:30:55 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

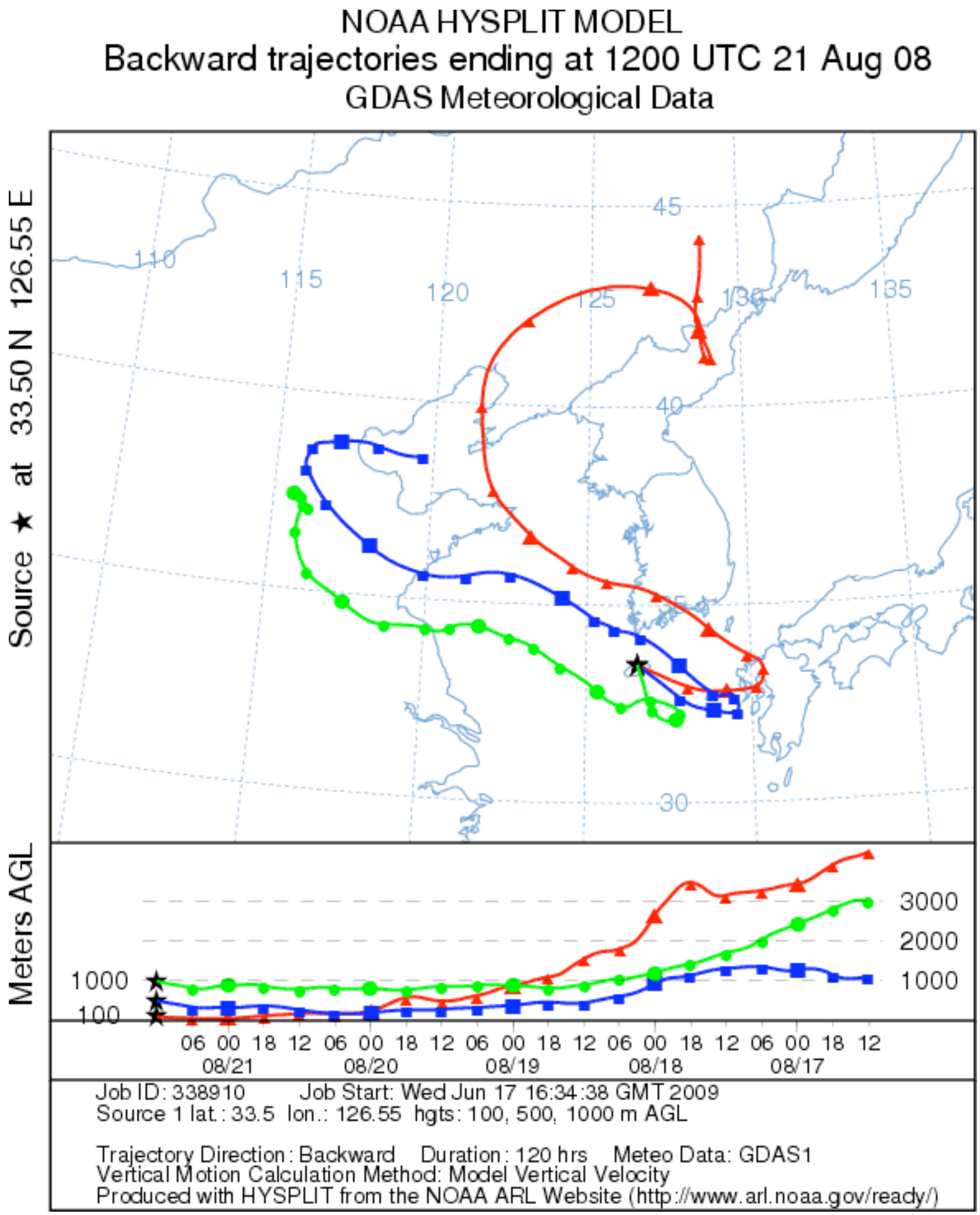
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 20 Aug 08
GDAS Meteorological Data



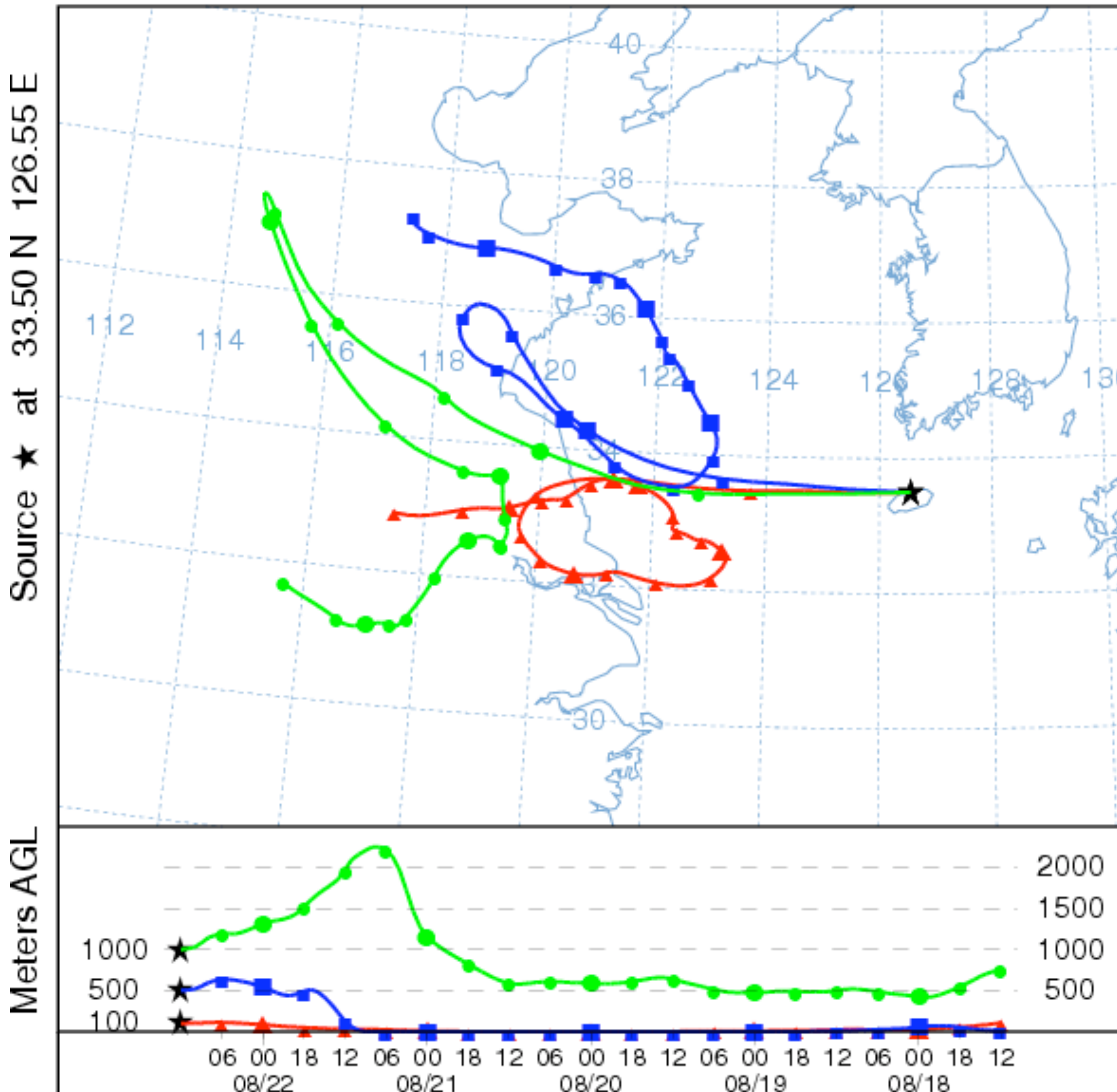
Job ID: 338900 Job Start: Wed Jun 17 16:32:46 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 3 13-23 August 2008.



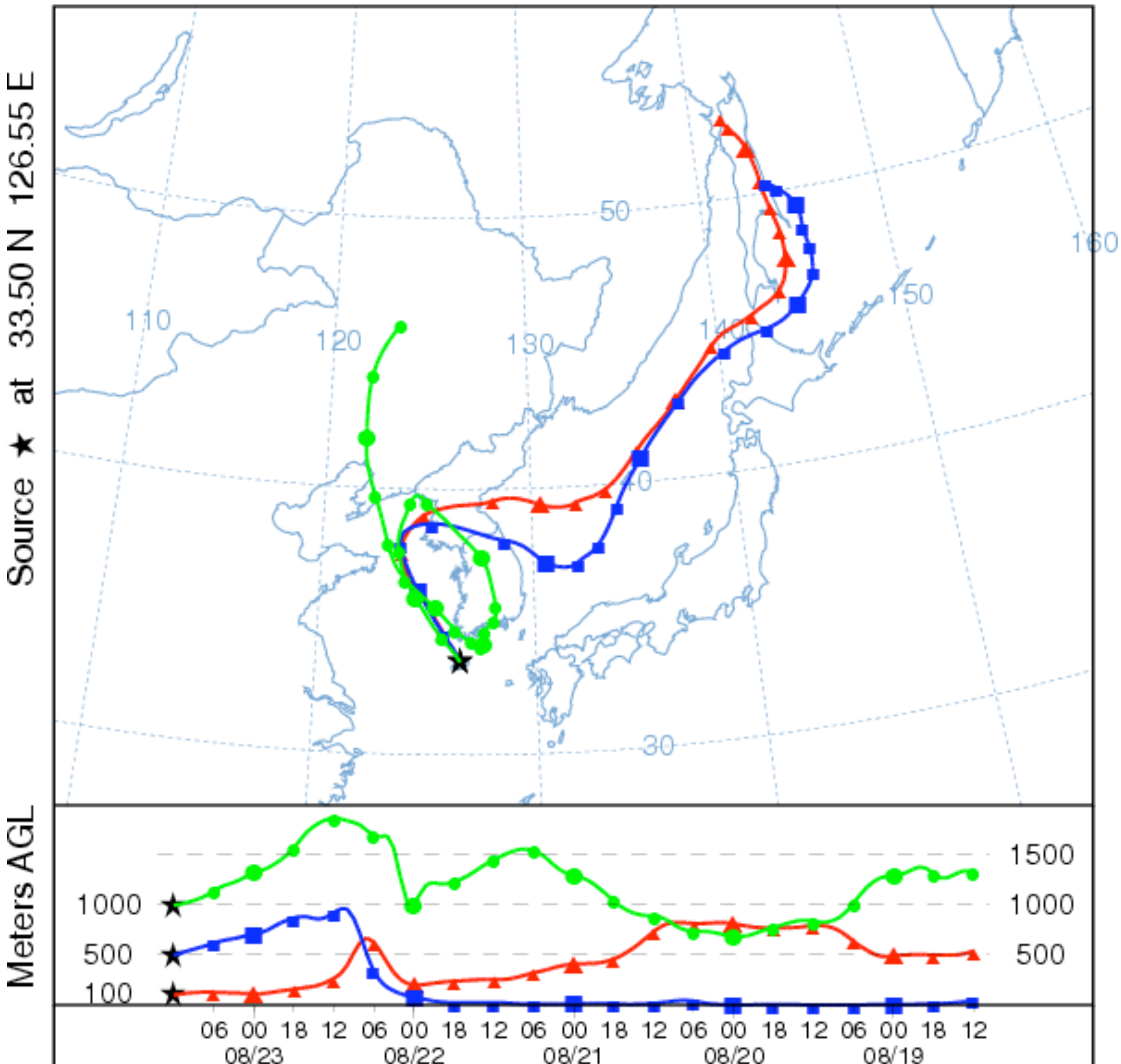
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 22 Aug 08
GDAS Meteorological Data



Job ID: 339782 Job Start: Wed Jun 17 17:30:46 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

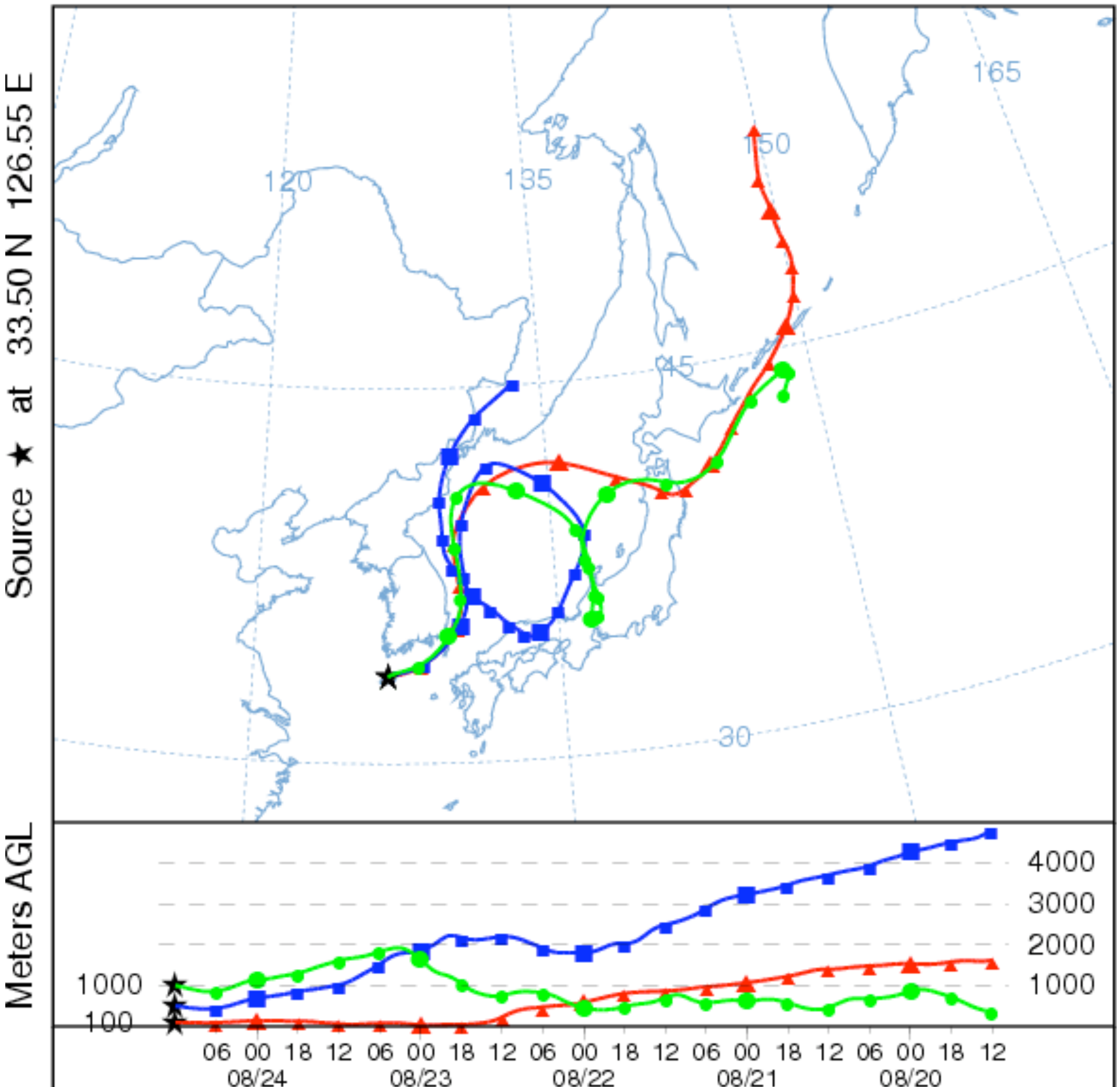
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 23 Aug 08
GDAS Meteorological Data



Job ID: 339732 Job Start: Wed Jun 17 17:28:15 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

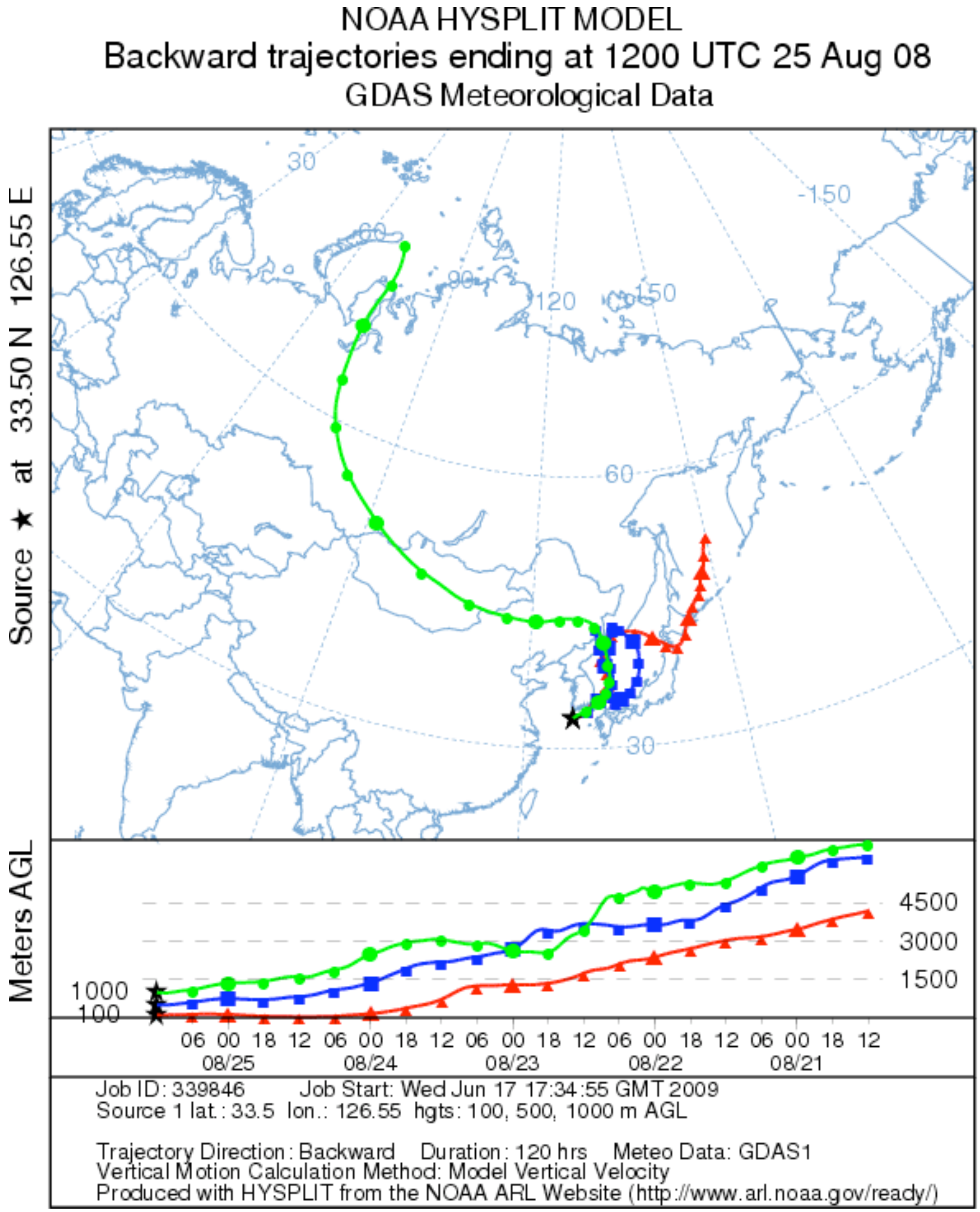
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 24 Aug 08
GDAS Meteorological Data



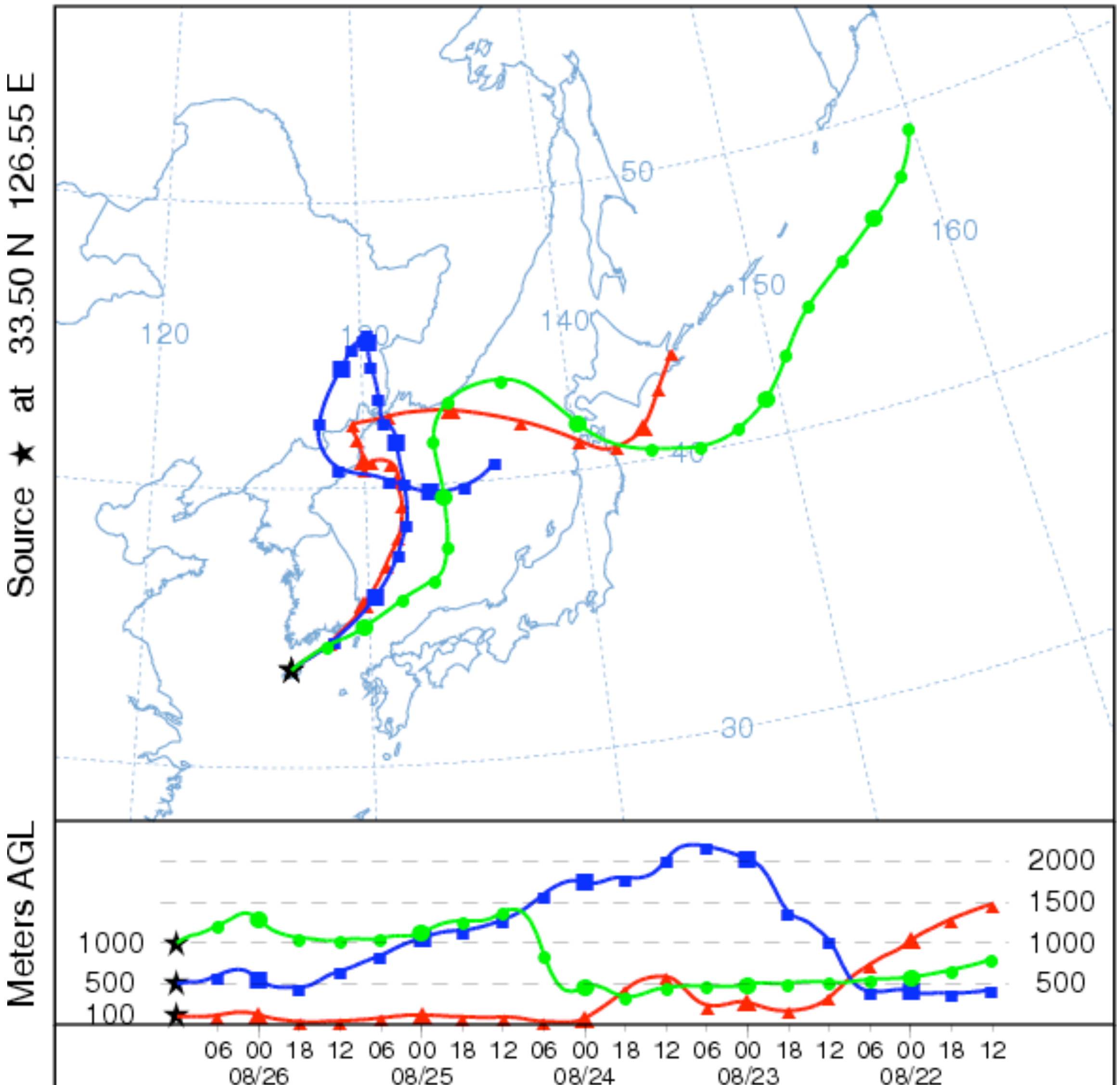
Job ID: 339815 Job Start: Wed Jun 17 17:32:37 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 25 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
30
60
90
120
150
-150
60
30
Meters AGL
4500
3000
1500
1000
100
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
08/25
08/24
08/23
08/22
08/21
Job ID: 339846 Job Start: Wed Jun 17 17:34:55 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 26 Aug 08
GDAS Meteorological Data



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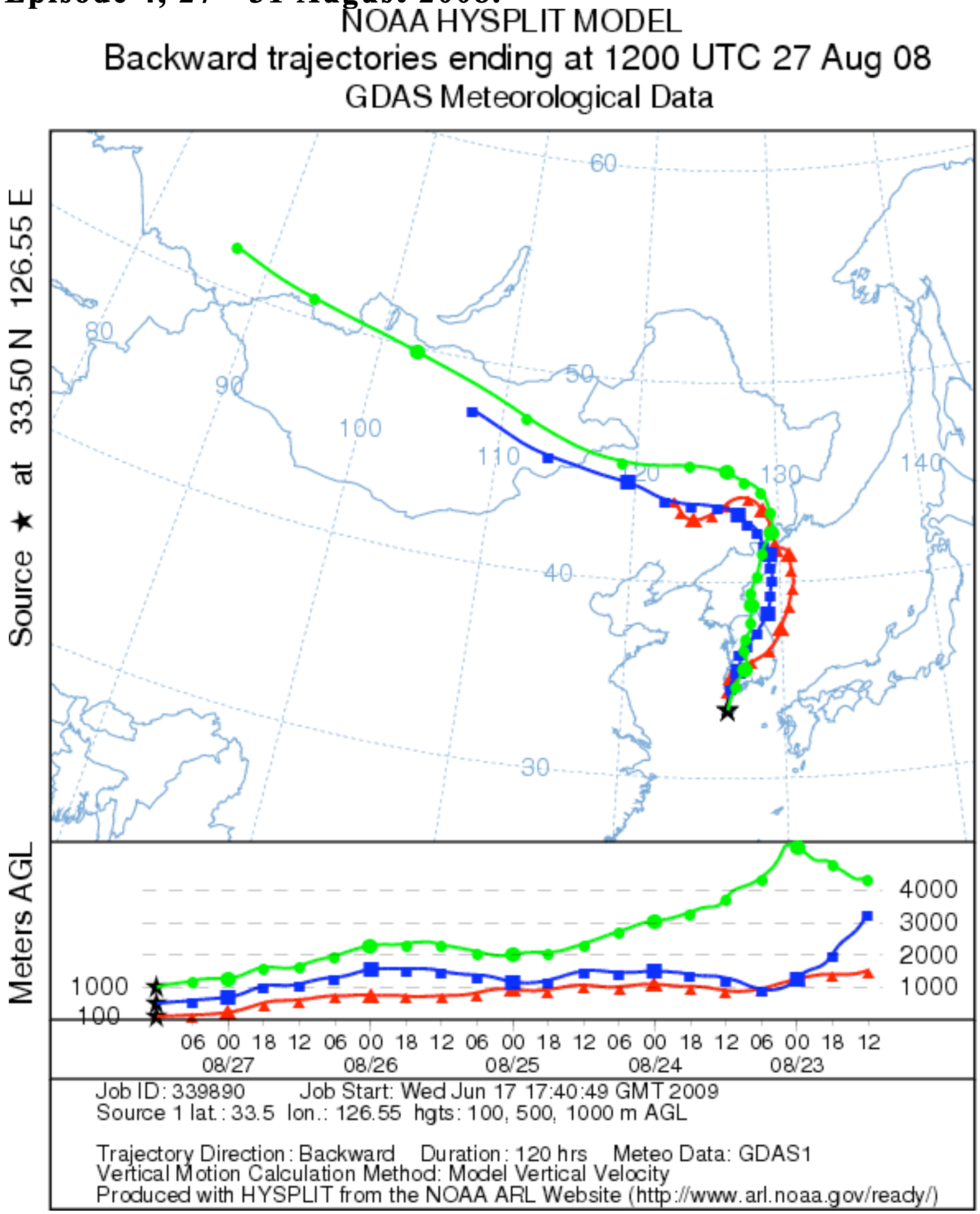
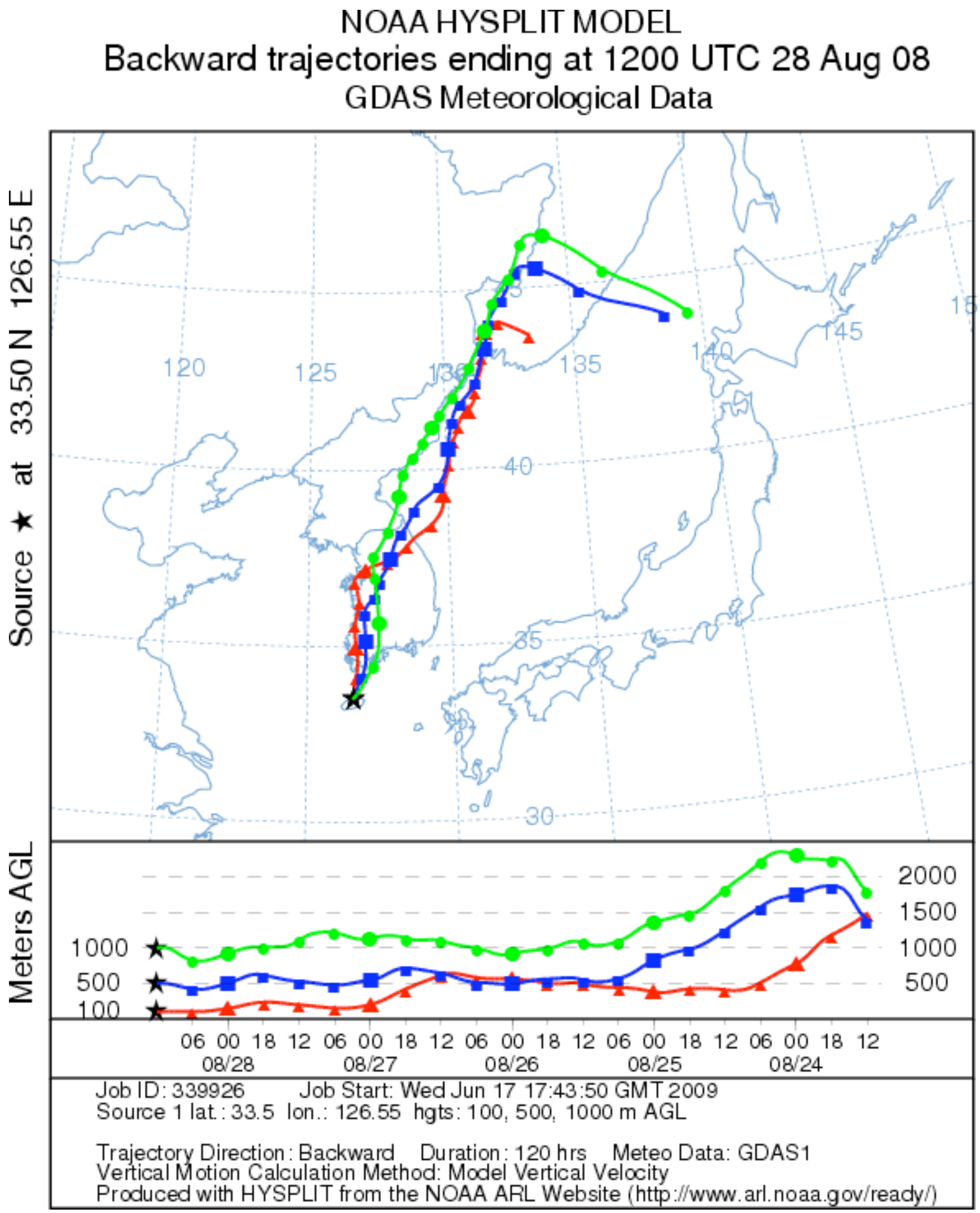
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

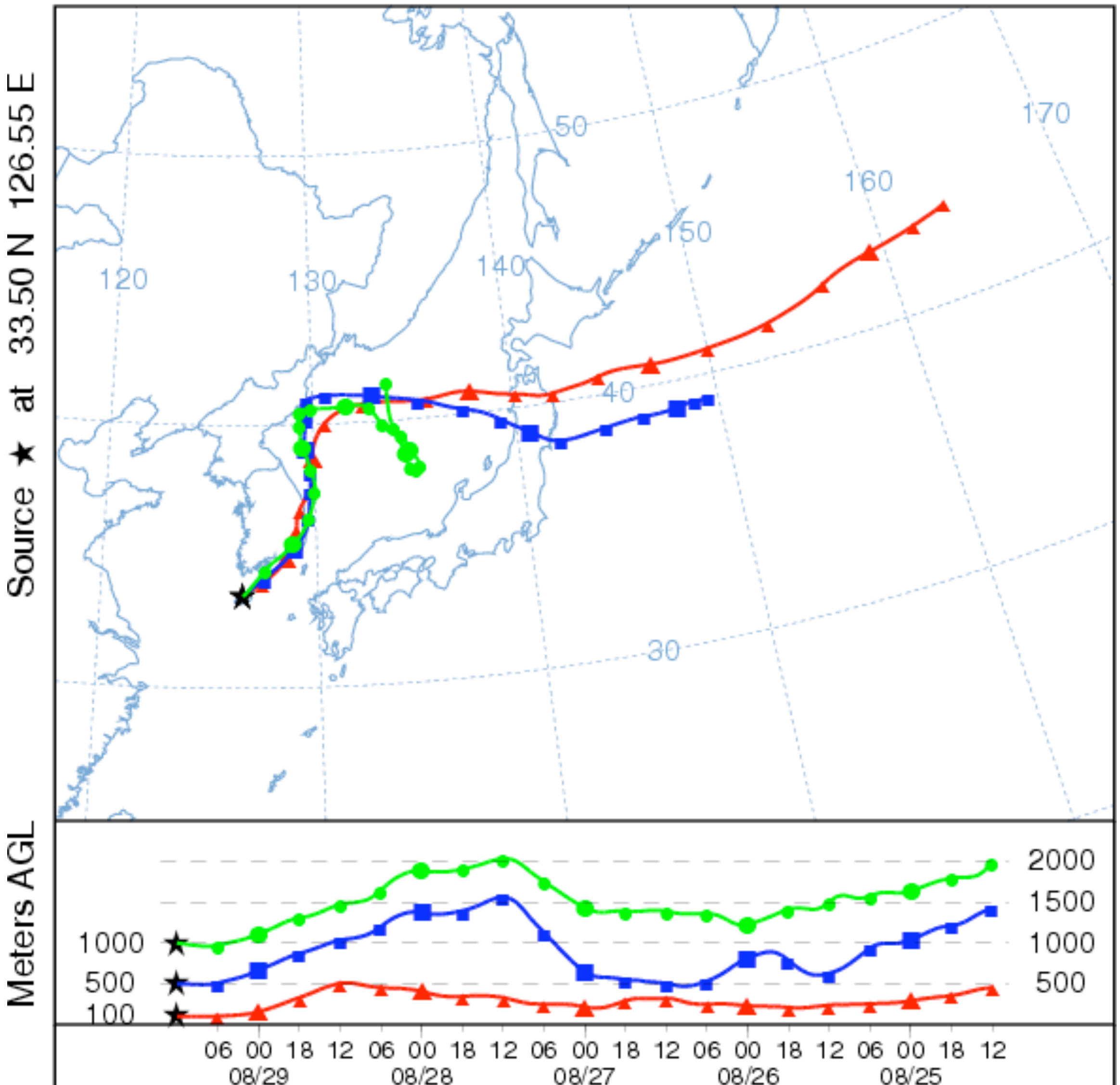
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 4, 27 - 31 August 2008.



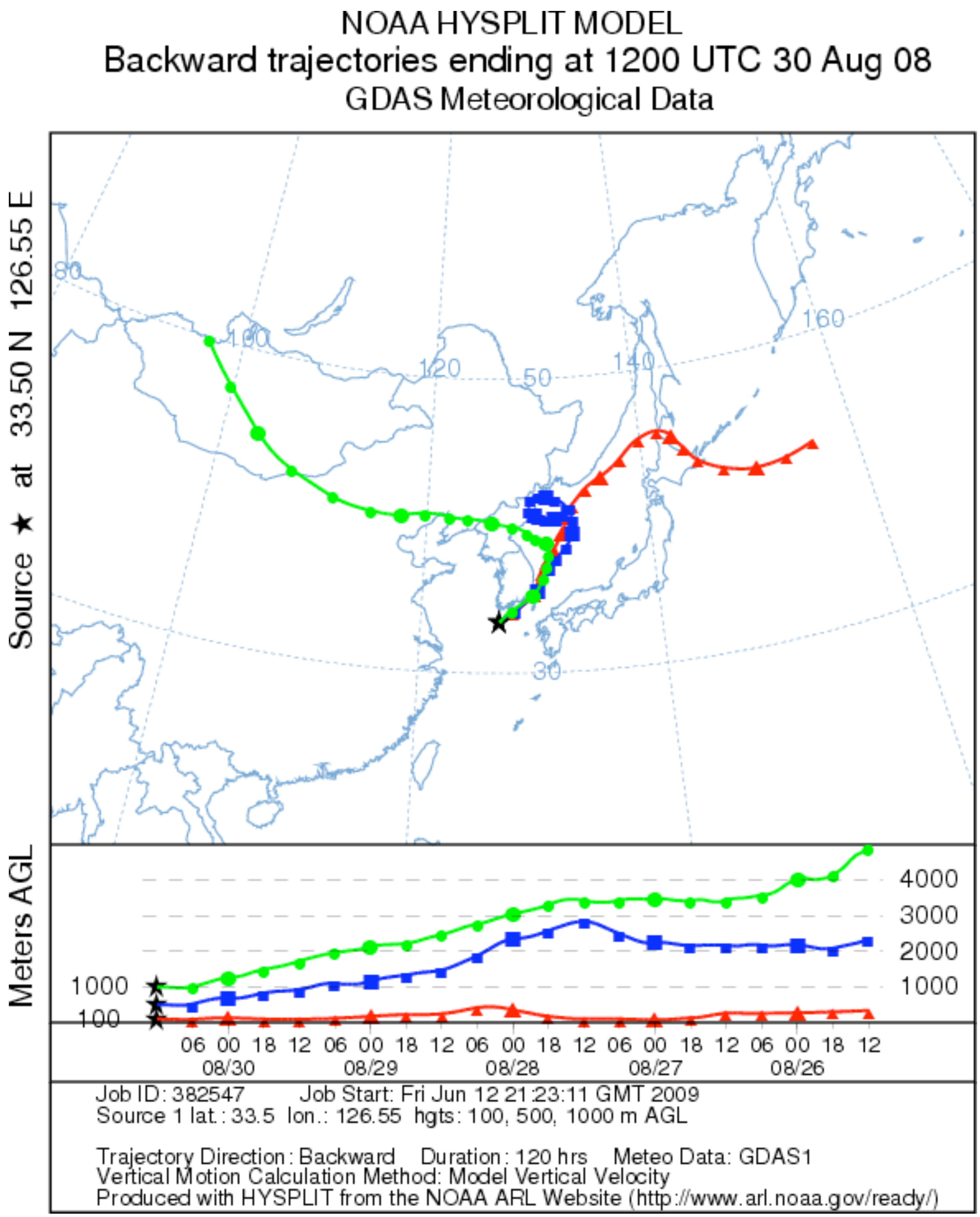

NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 28 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
120
125
130
135
140
145
150
40
35
30
Meters AGL
1000
500
100
2000
1500
1000
500
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
08/28
08/27
08/26
08/25
08/24
Job ID: 339926 Job Start: Wed Jun 17 17:43:50 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 29 Aug 08
GDAS Meteorological Data



Job ID: 382595 Job Start: Fri Jun 12 21:36:16 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

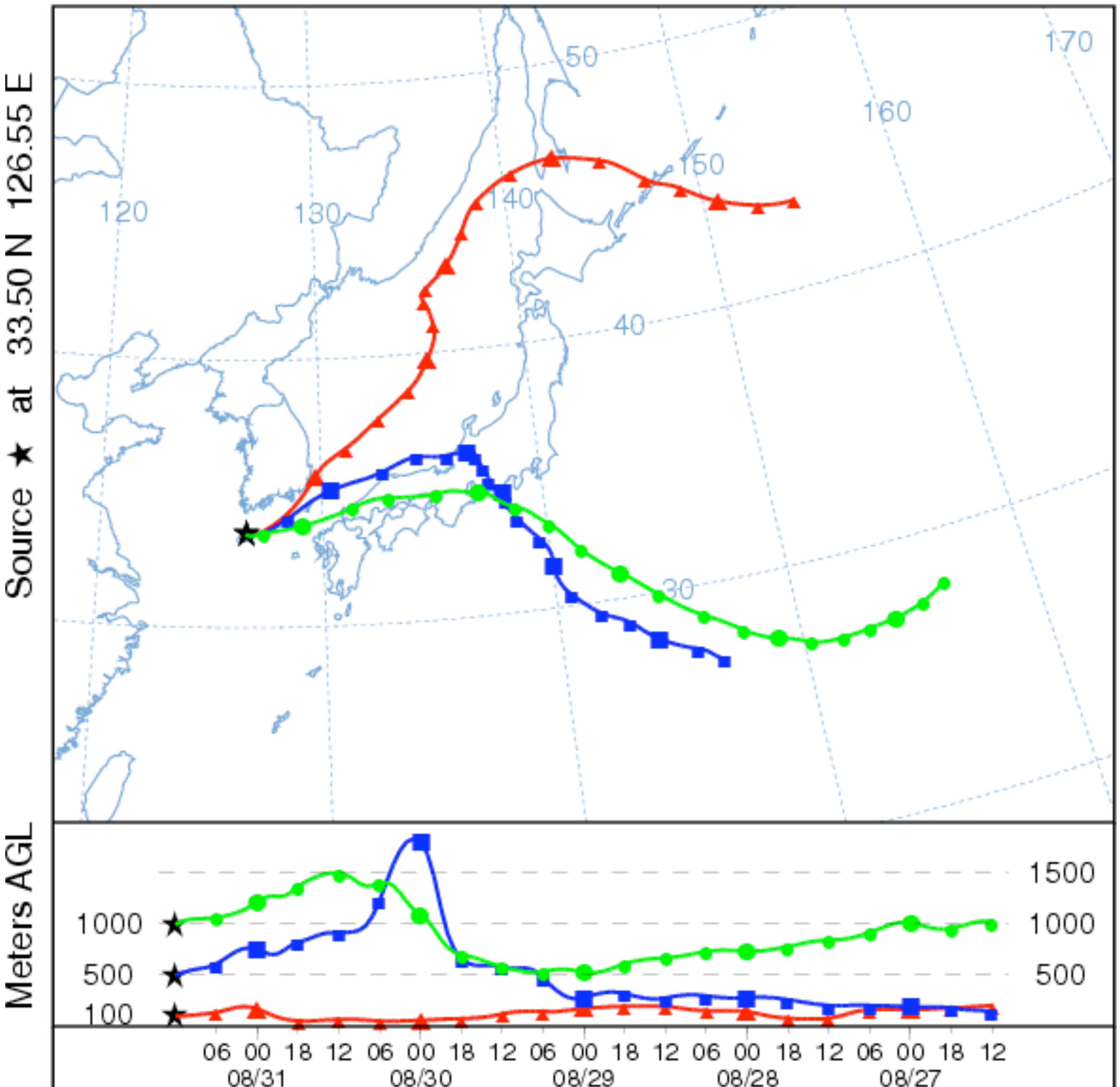
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)


NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 30 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
Meters AGL
1000
100
4000
3000
2000
1000
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
08/30 08/29 08/28 08/27 08/26
Job ID: 382547 Job Start: Fri Jun 12 21:23:11 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 31 Aug 08

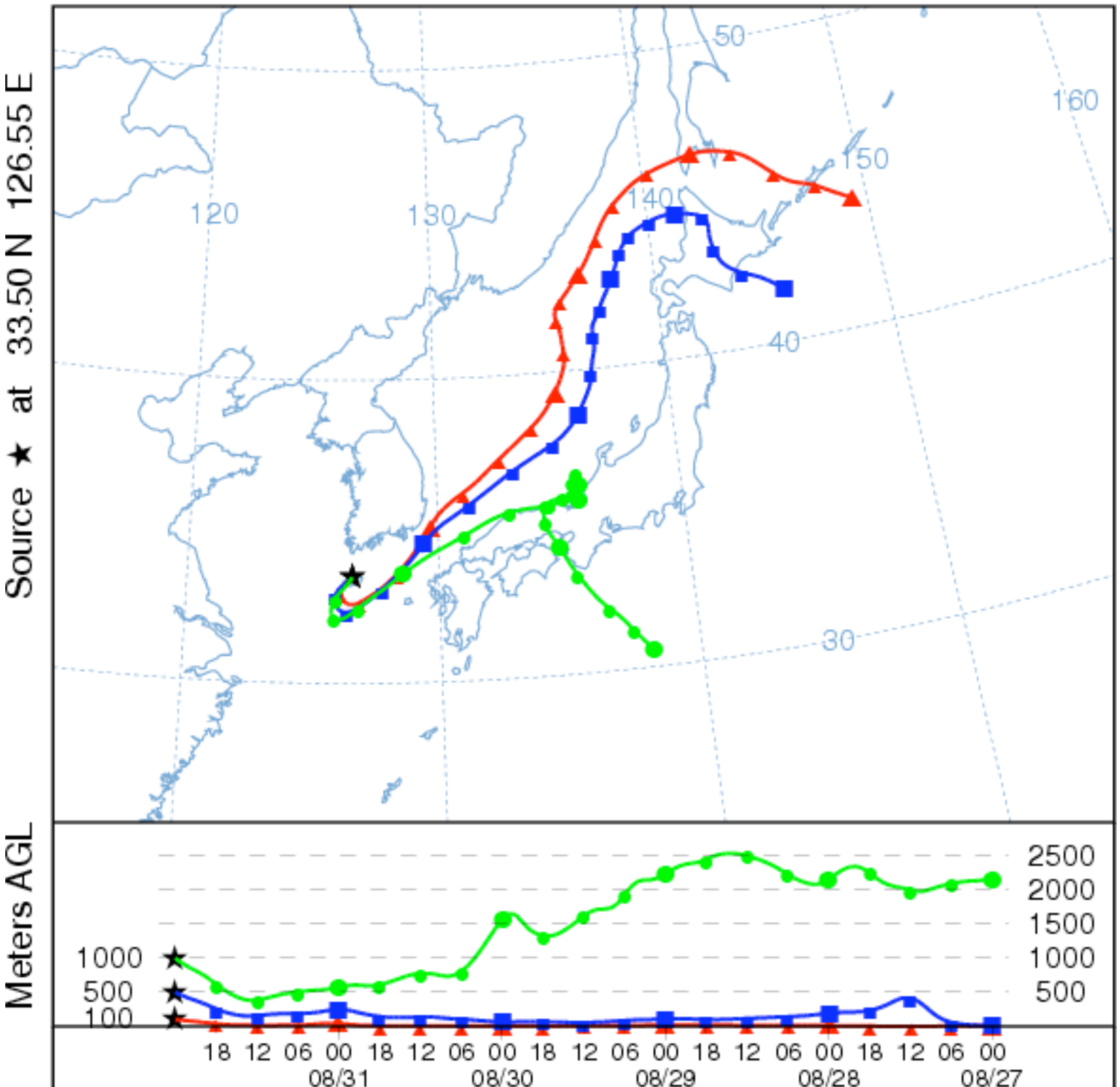
GDAS Meteorological Data



Job ID: 382489 Job Start: Fri Jun 12 21:09:13 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 0000 UTC 01 Sep 08
GDAS Meteorological Data



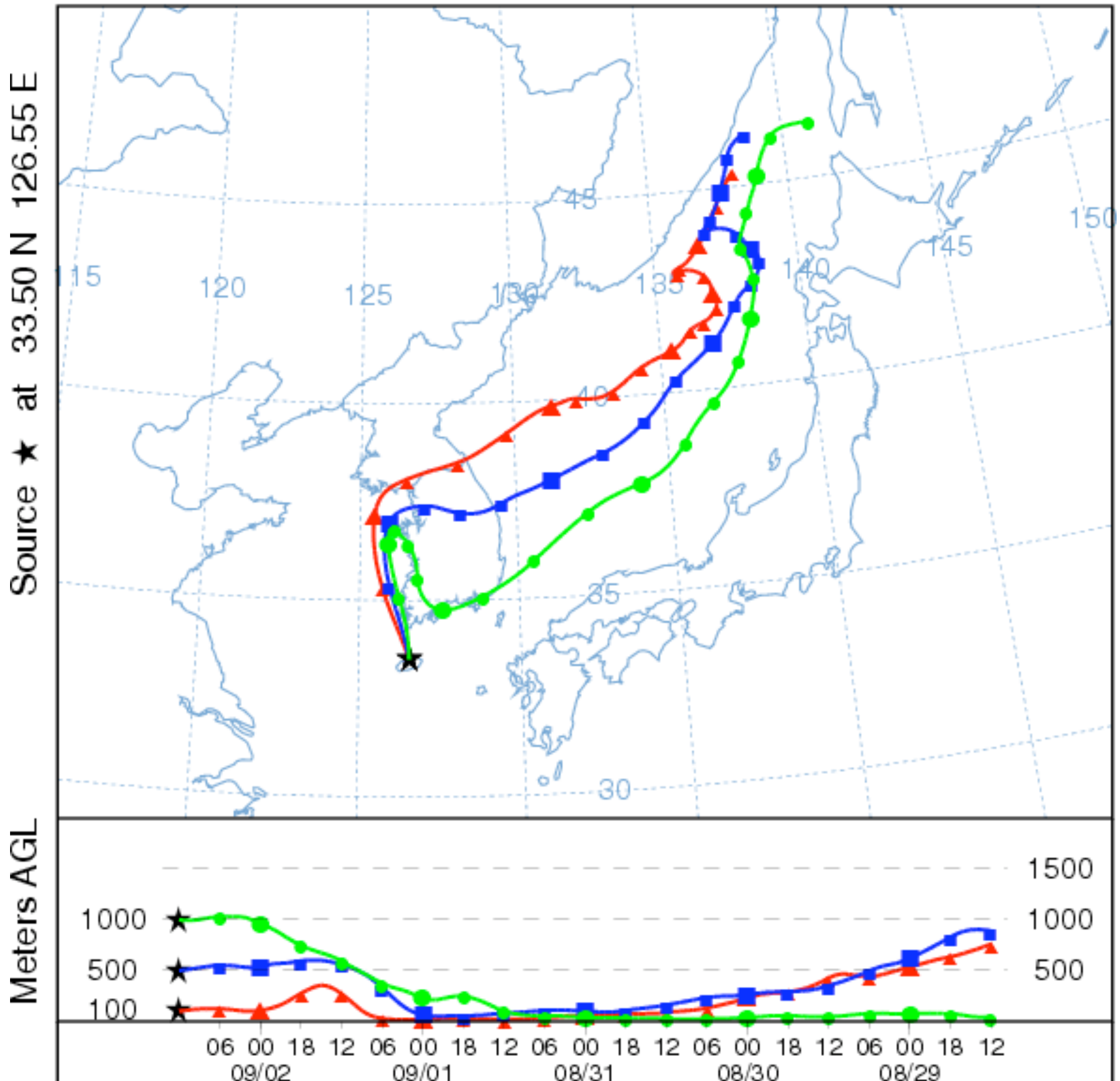
Job ID: 37994 Job Start: Wed Feb 24 20:18:43 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 01 Sep 2008 - GDAS1

NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 02 Sep 08

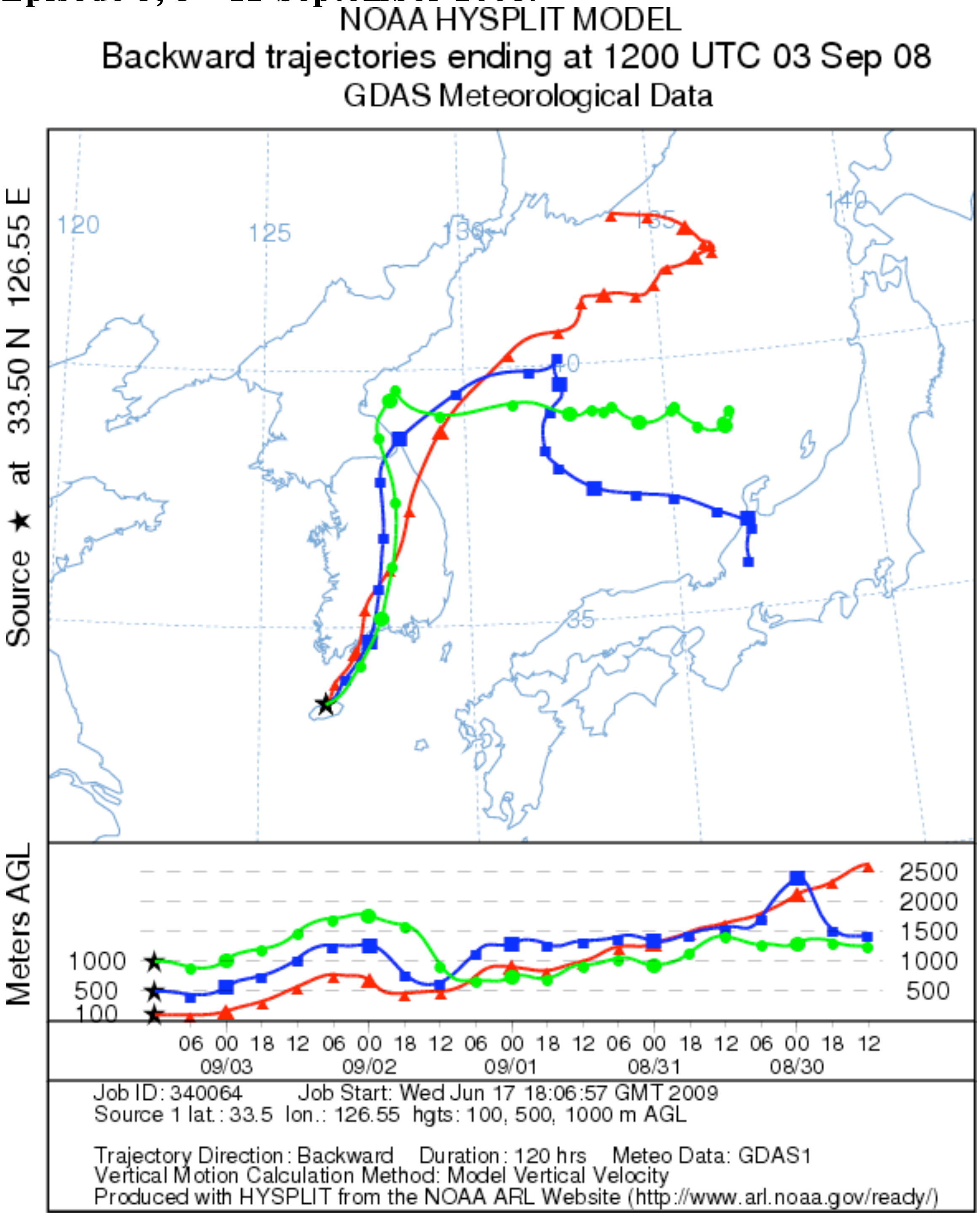
GDAS Meteorological Data



Job ID: 341082 Job Start: Wed Jun 17 20:01:43 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

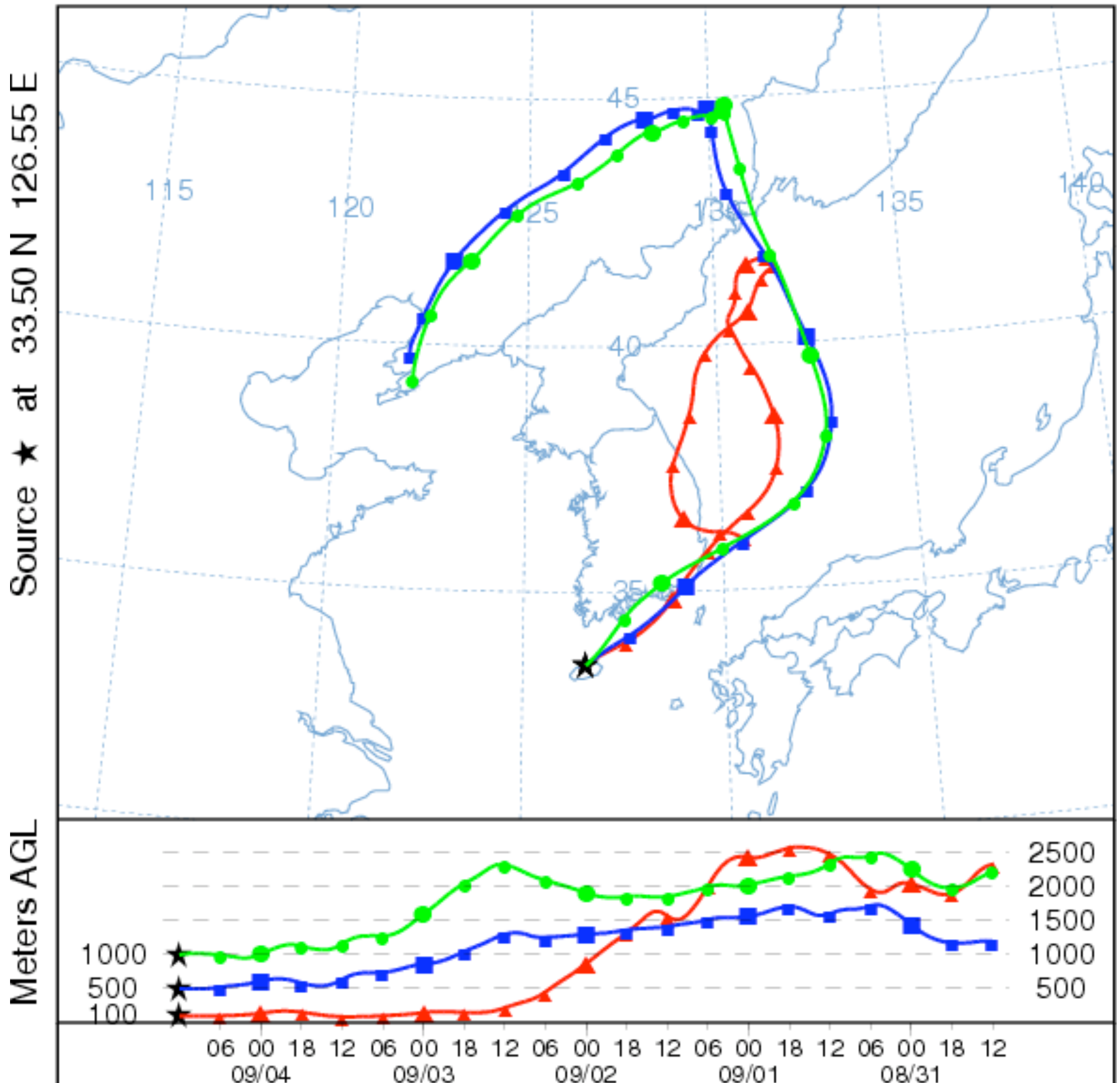
Episode 5, 3 - 12 September 2008.



NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 04 Sep 08

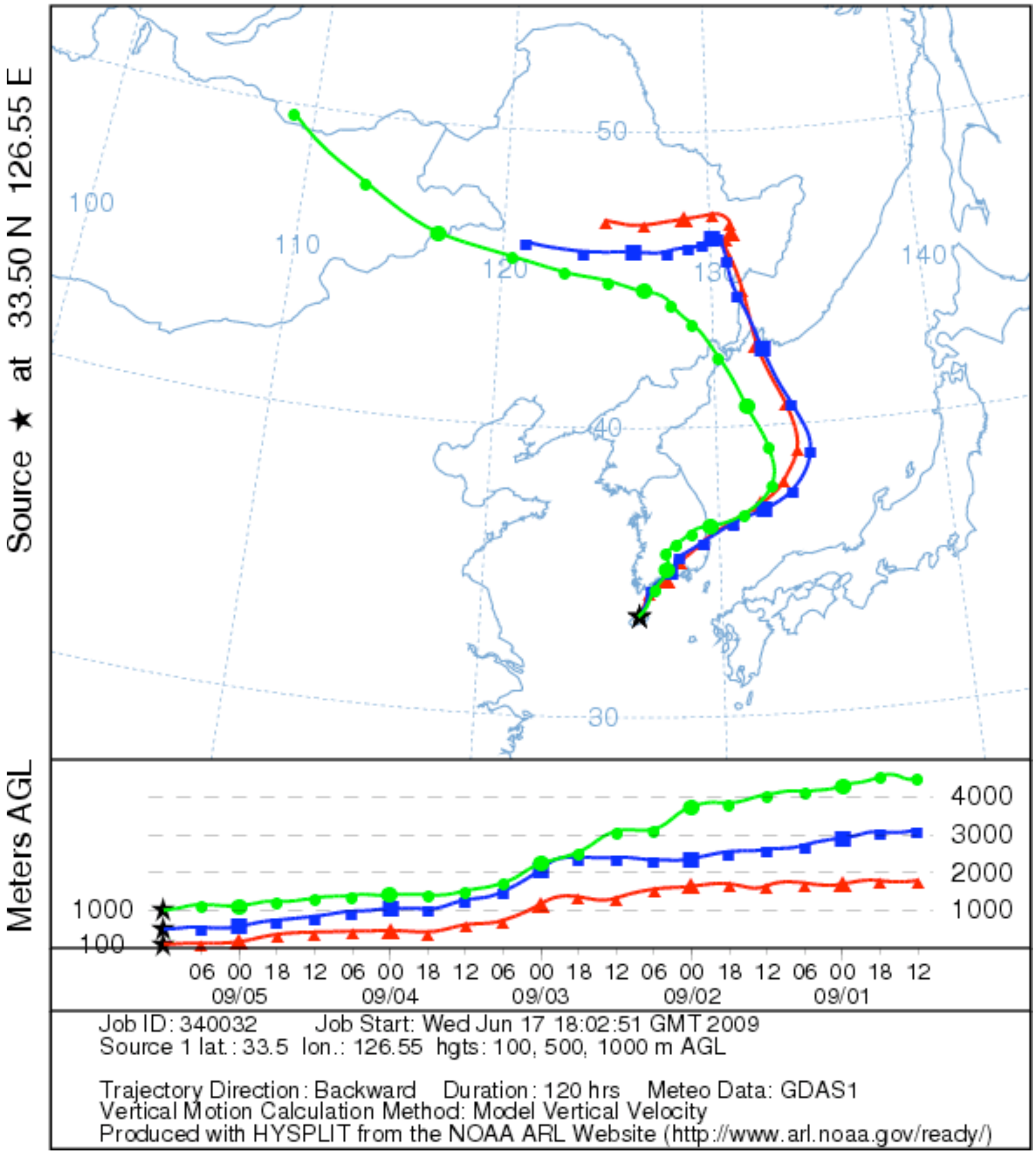
GDAS Meteorological Data



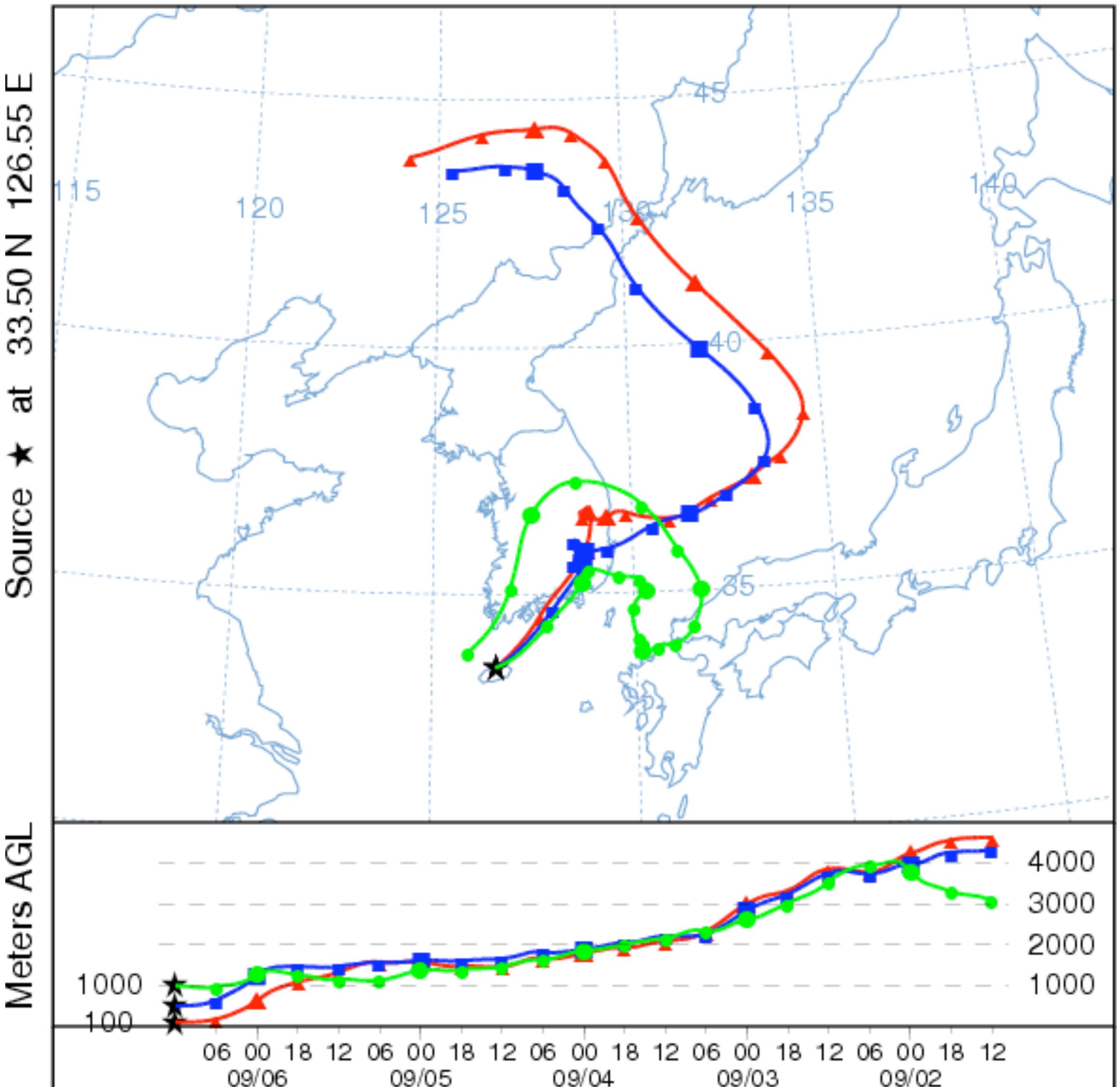
Job ID: 340050 Job Start: Wed Jun 17 18:05:43 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 05 Sep 08
GDAS Meteorological Data



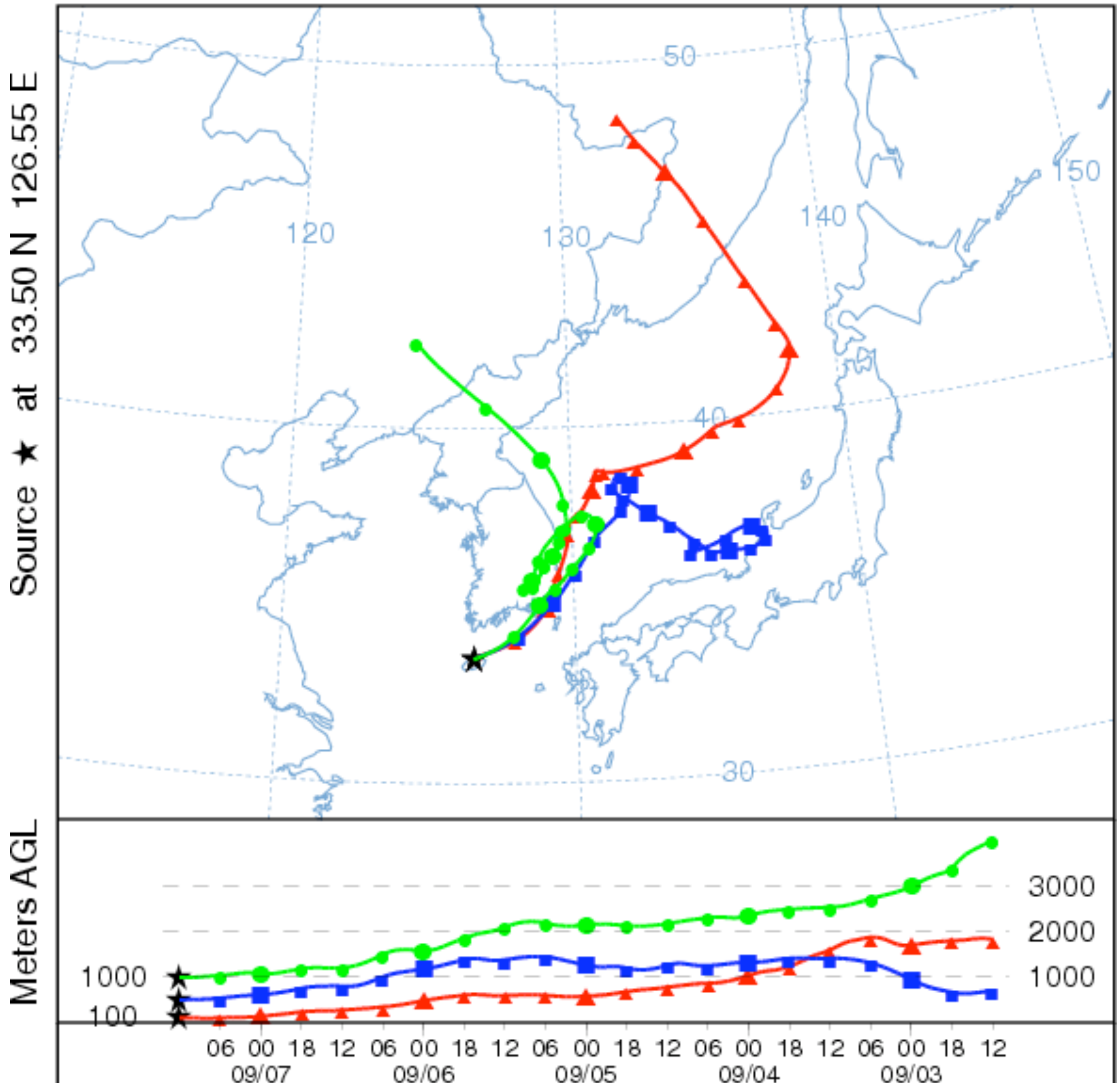
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 06 Sep 08
GDAS Meteorological Data



Job ID: 340081 Job Start: Wed Jun 17 18:08:48 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

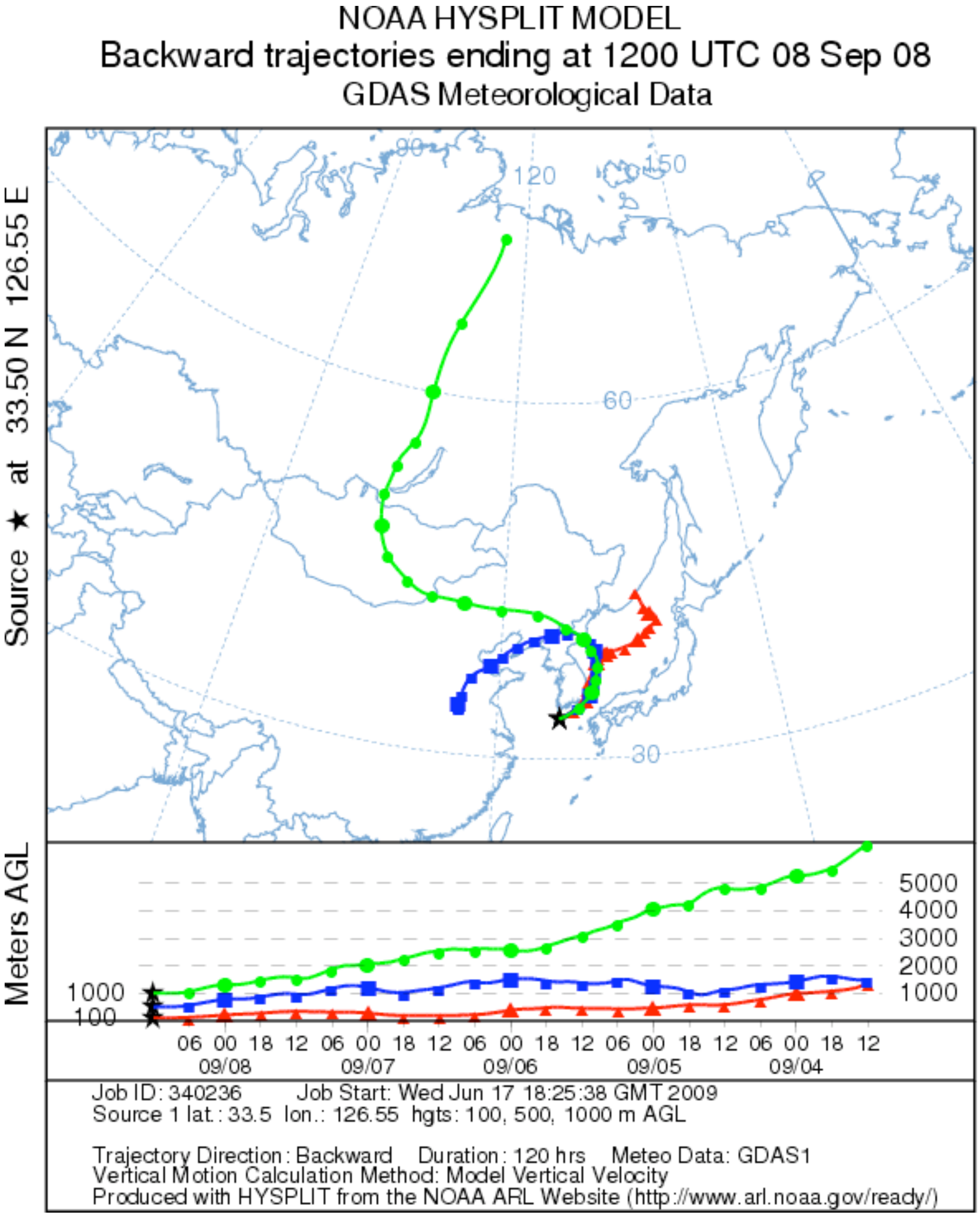
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 07 Sep 08
GDAS Meteorological Data



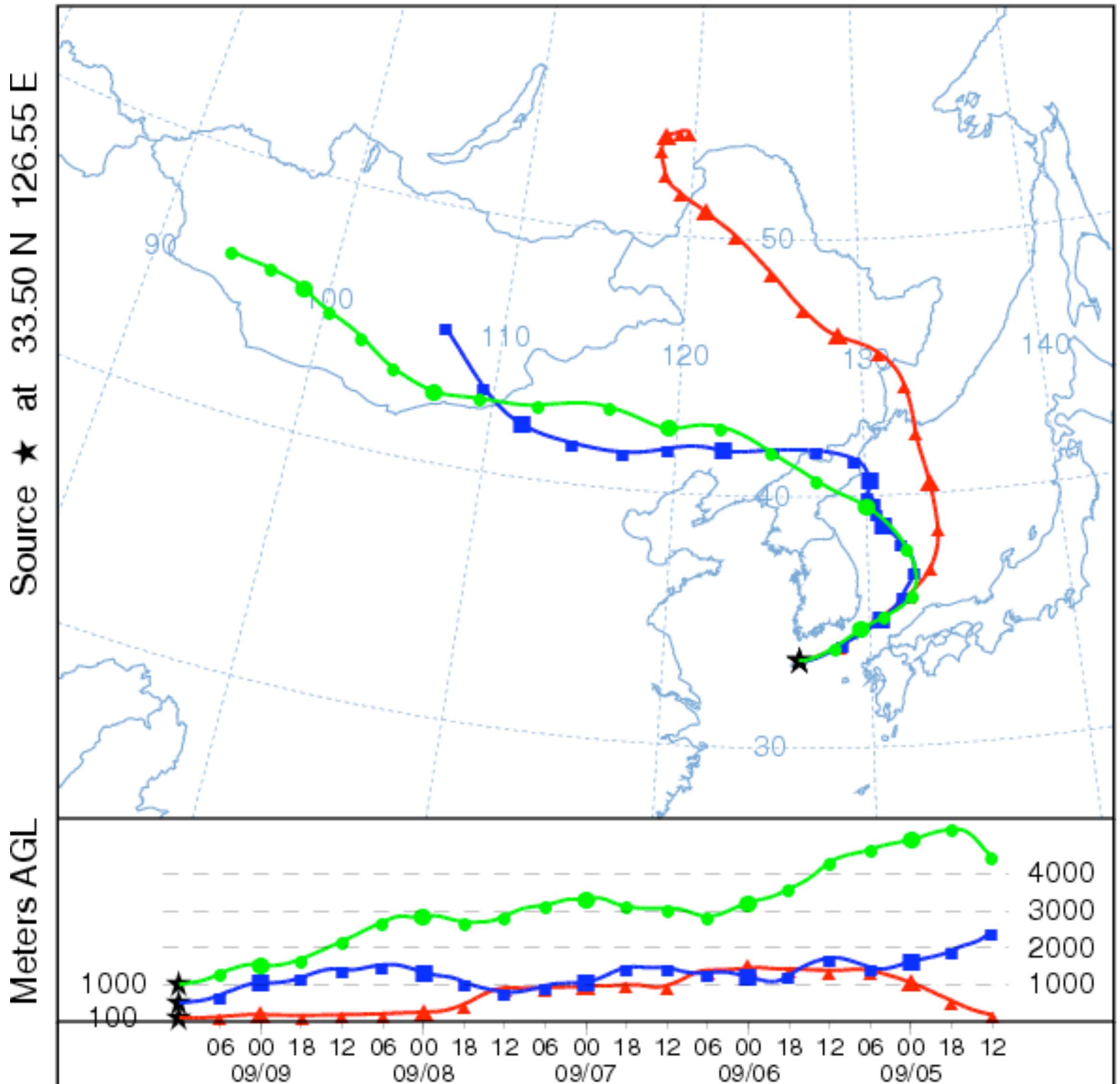
Job ID: 340138 Job Start: Wed Jun 17 18:11:58 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 5, 3-14 September 2008.

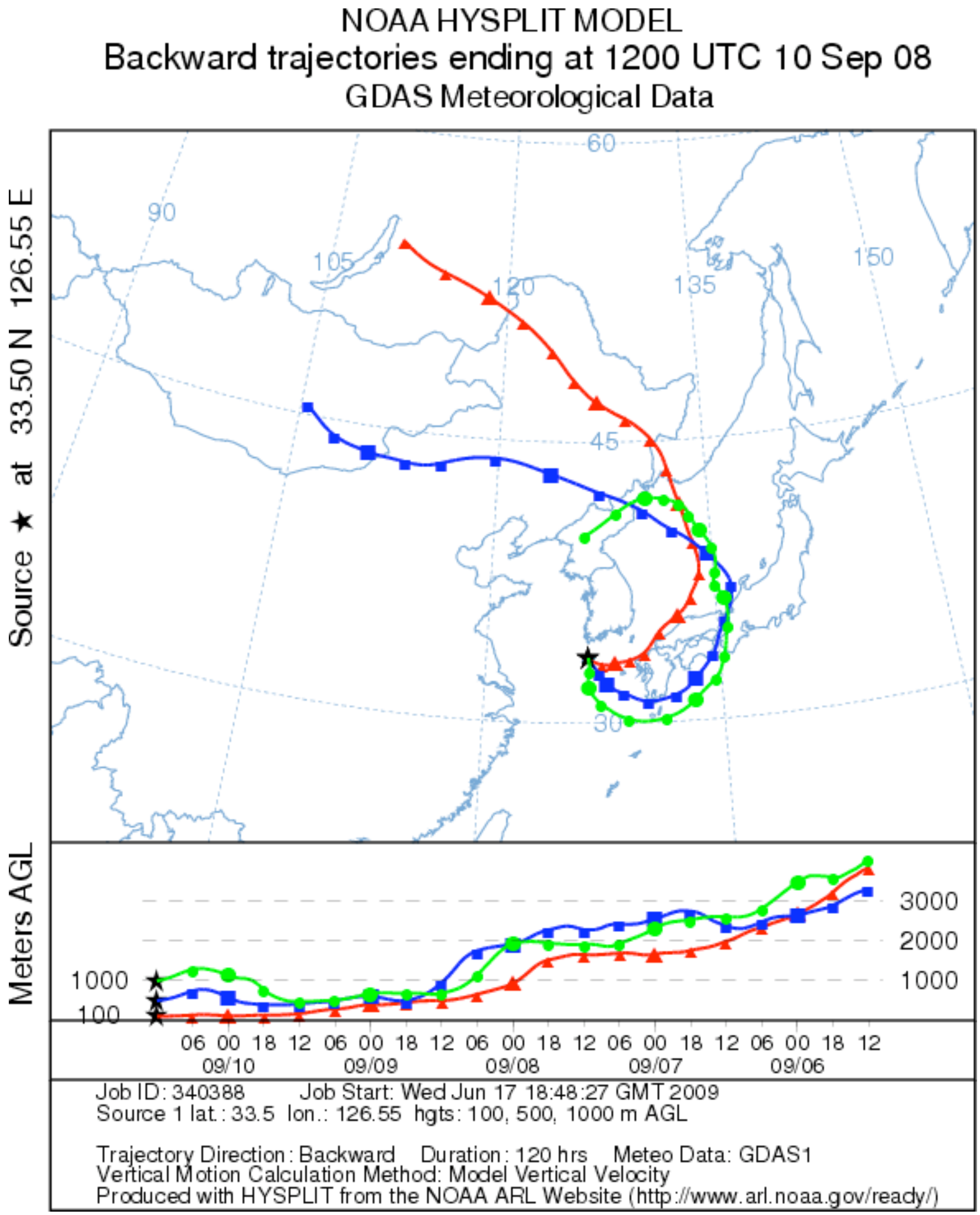


NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 09 Sep 08
GDAS Meteorological Data

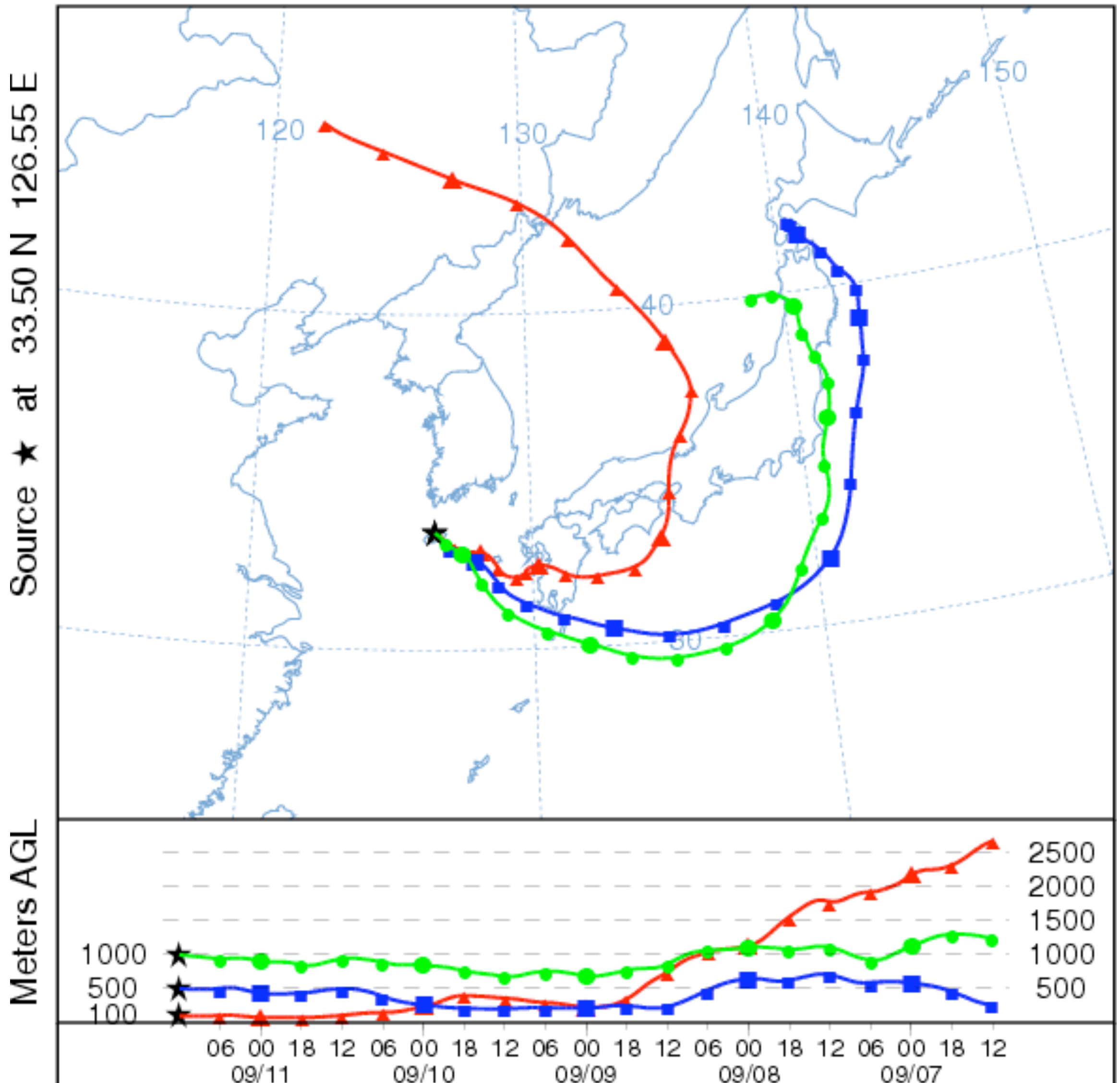


Job ID: 340367 Job Start: Wed Jun 17 18:46:45 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 10 Sep 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
60
90
105
120
135
150
45
30
Meters AGL
1000
100
3000
2000
1000
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
09/10
09/09
09/08
09/07
09/06
Job ID: 340388 Job Start: Wed Jun 17 18:48:27 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

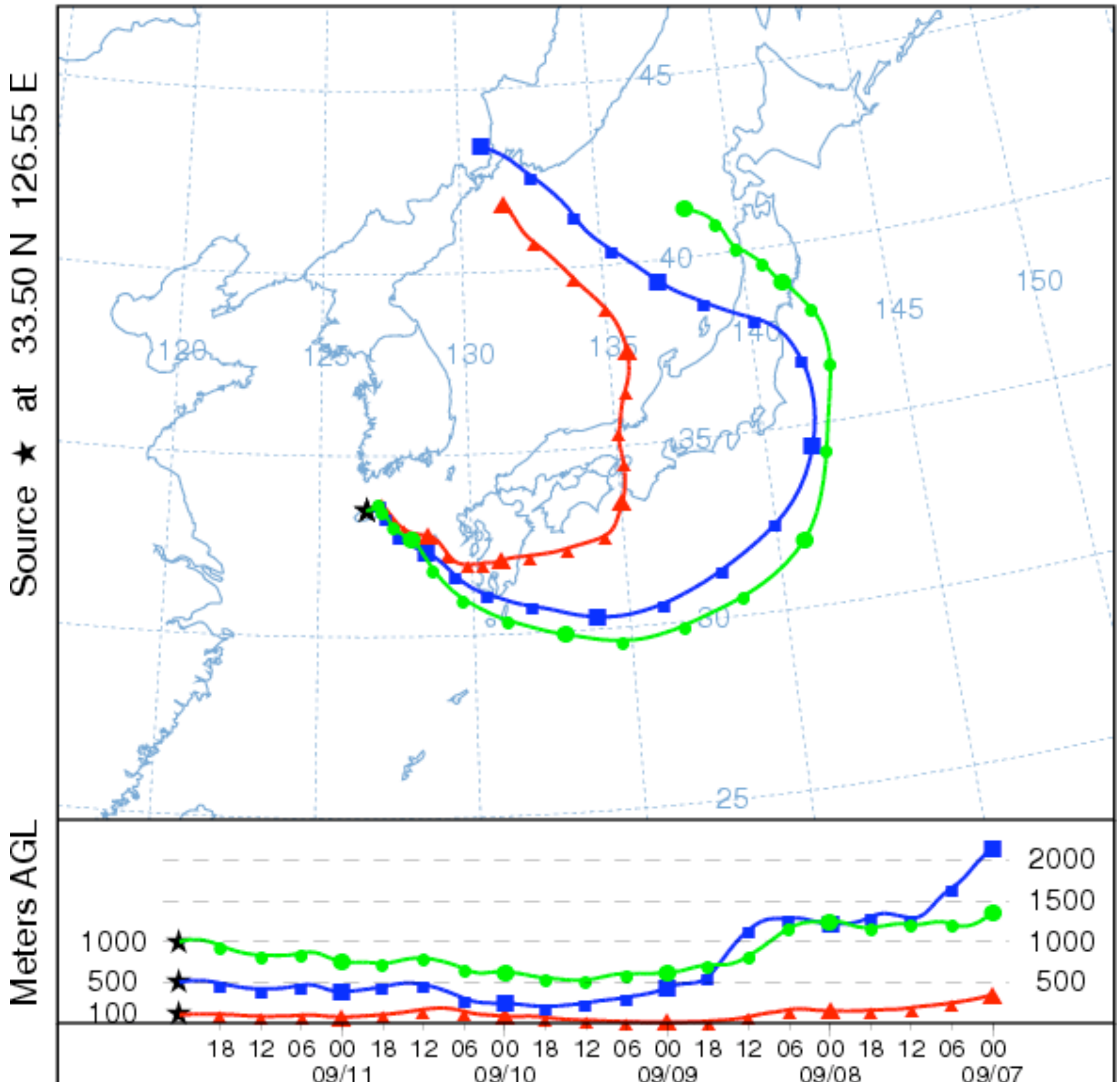
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 11 Sep 08
GDAS Meteorological Data



Job ID: 340407 Job Start: Wed Jun 17 18:51:19 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

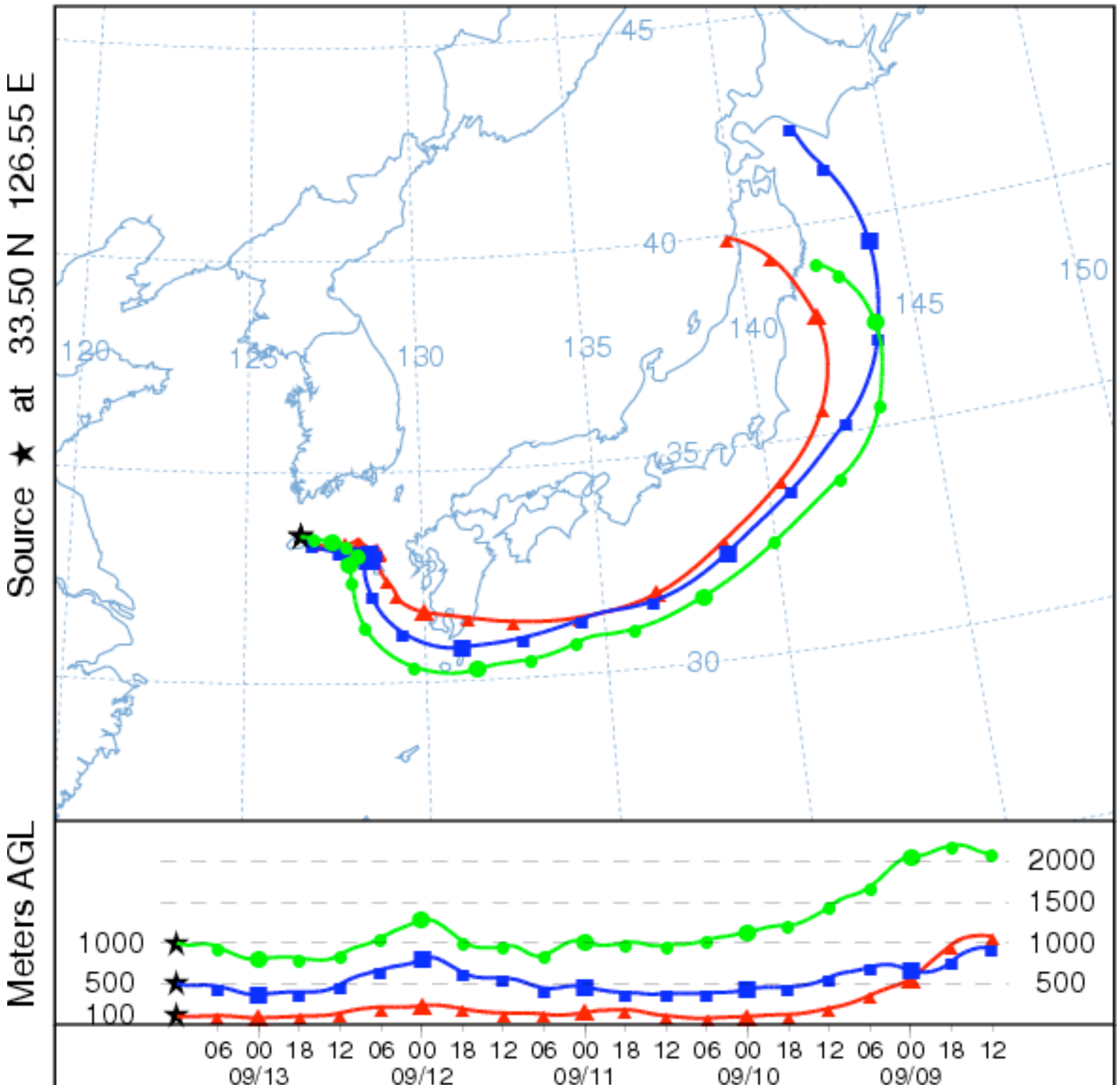
NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 12 Sep 08
GDAS Meteorological Data



Job ID: 38166 Job Start: Wed Feb 24 20:36:32 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 08 Sep 2008 - GDAS1

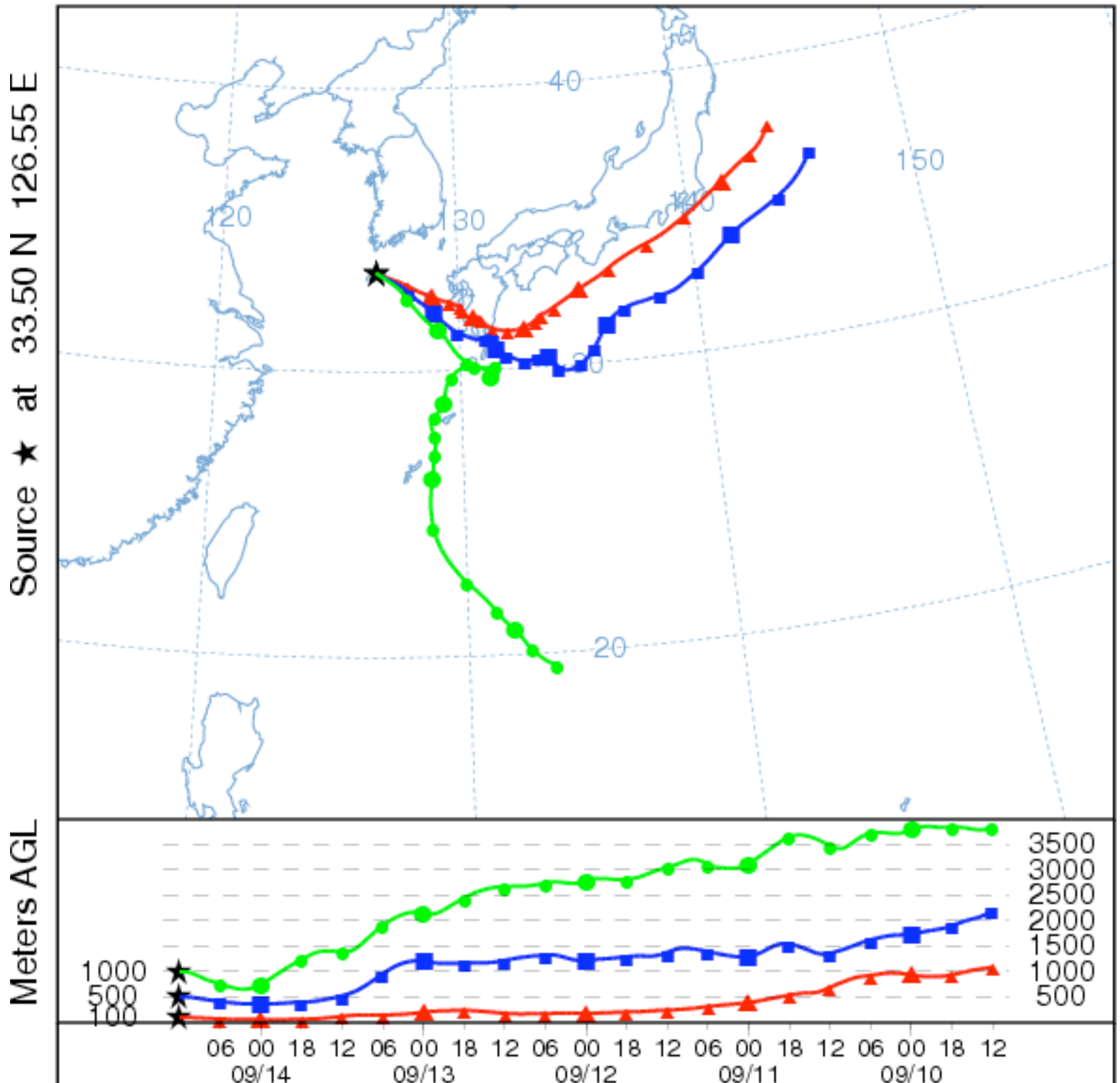
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 13 Sep 08
GDAS Meteorological Data



Job ID: 340432 Job Start: Wed Jun 17 18:55:57 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 14 Sep 08
GDAS Meteorological Data



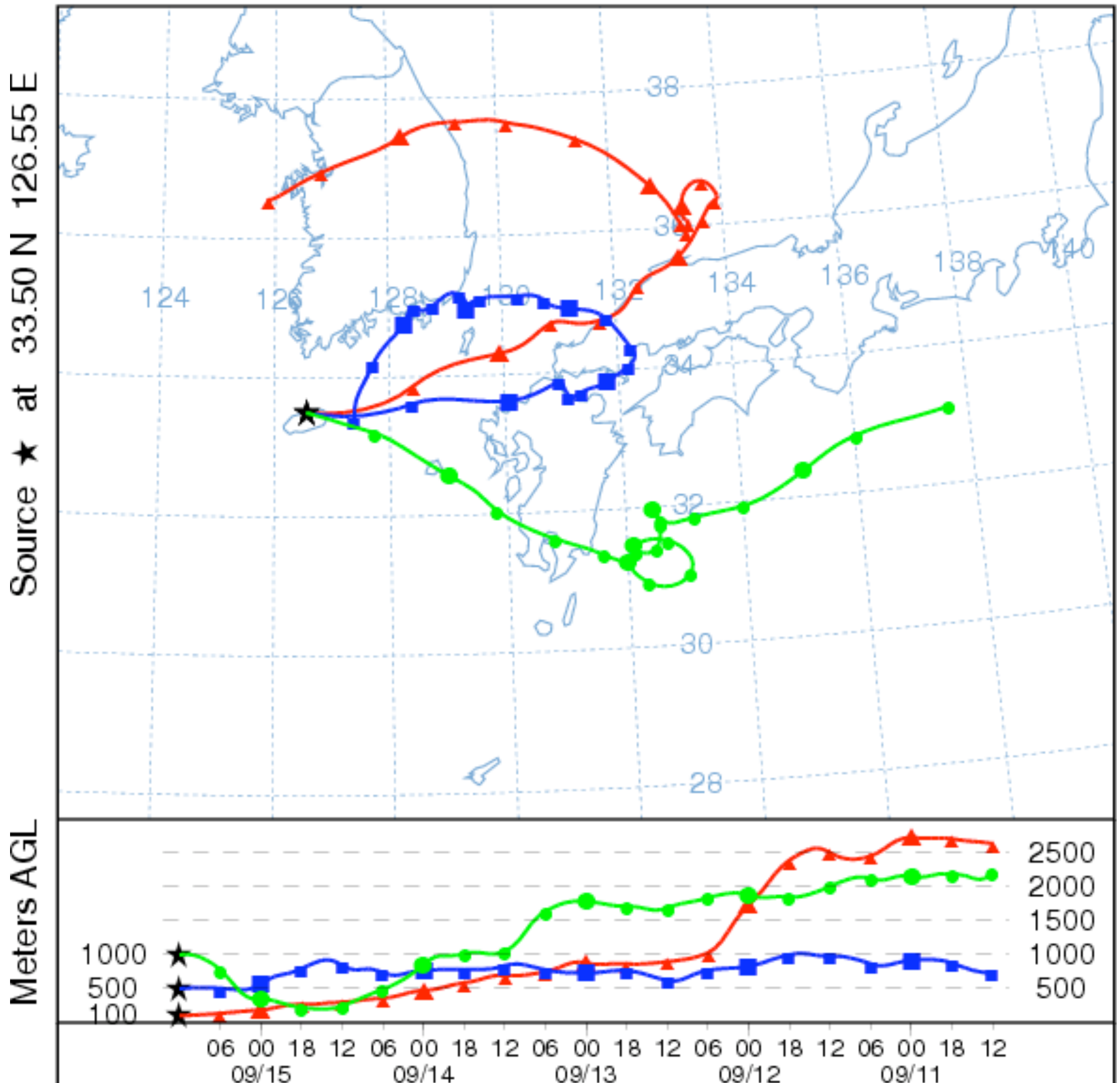
Job ID: 340466 Job Start: Wed Jun 17 18:59:46 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 15 Sep 08

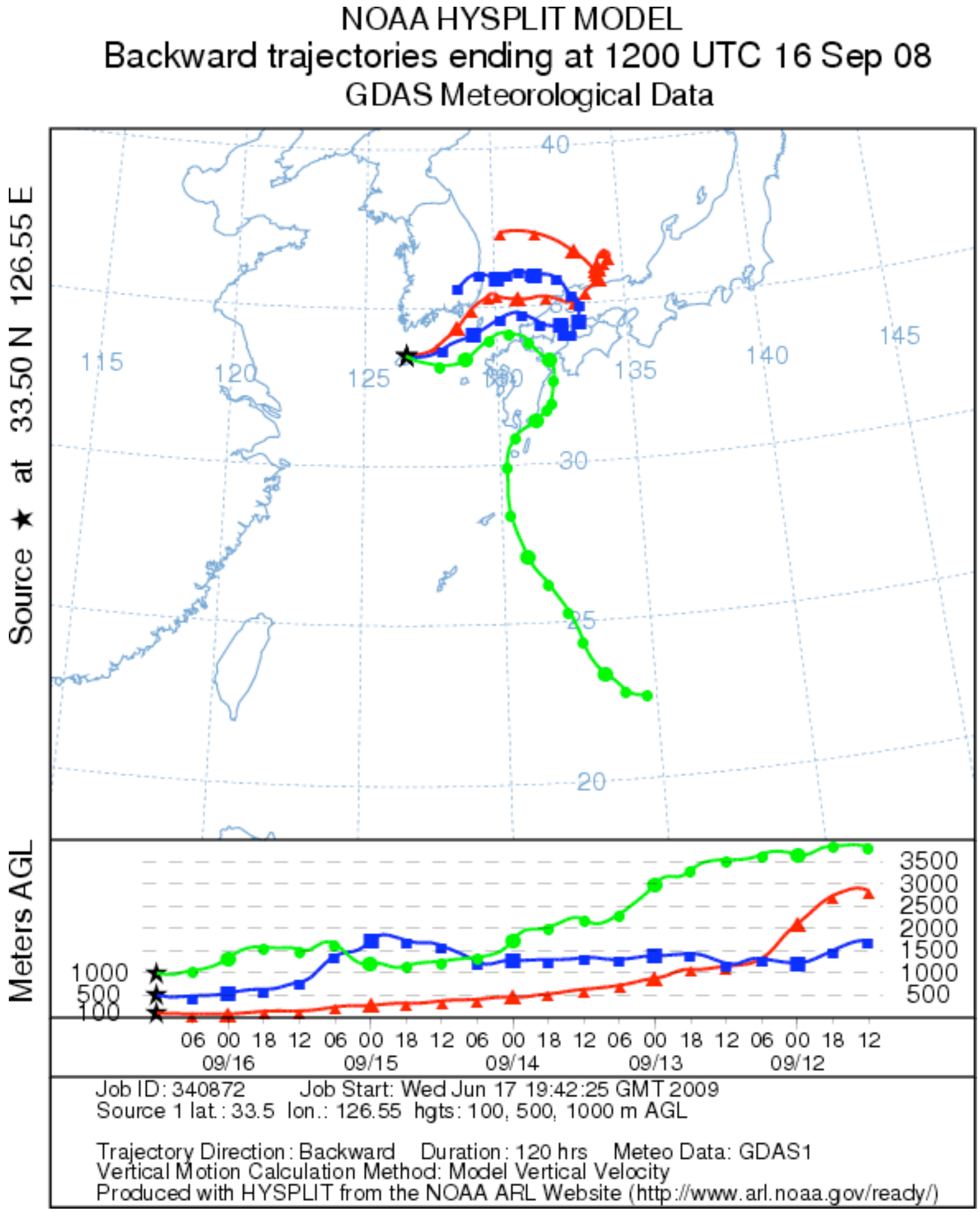
GDAS Meteorological Data



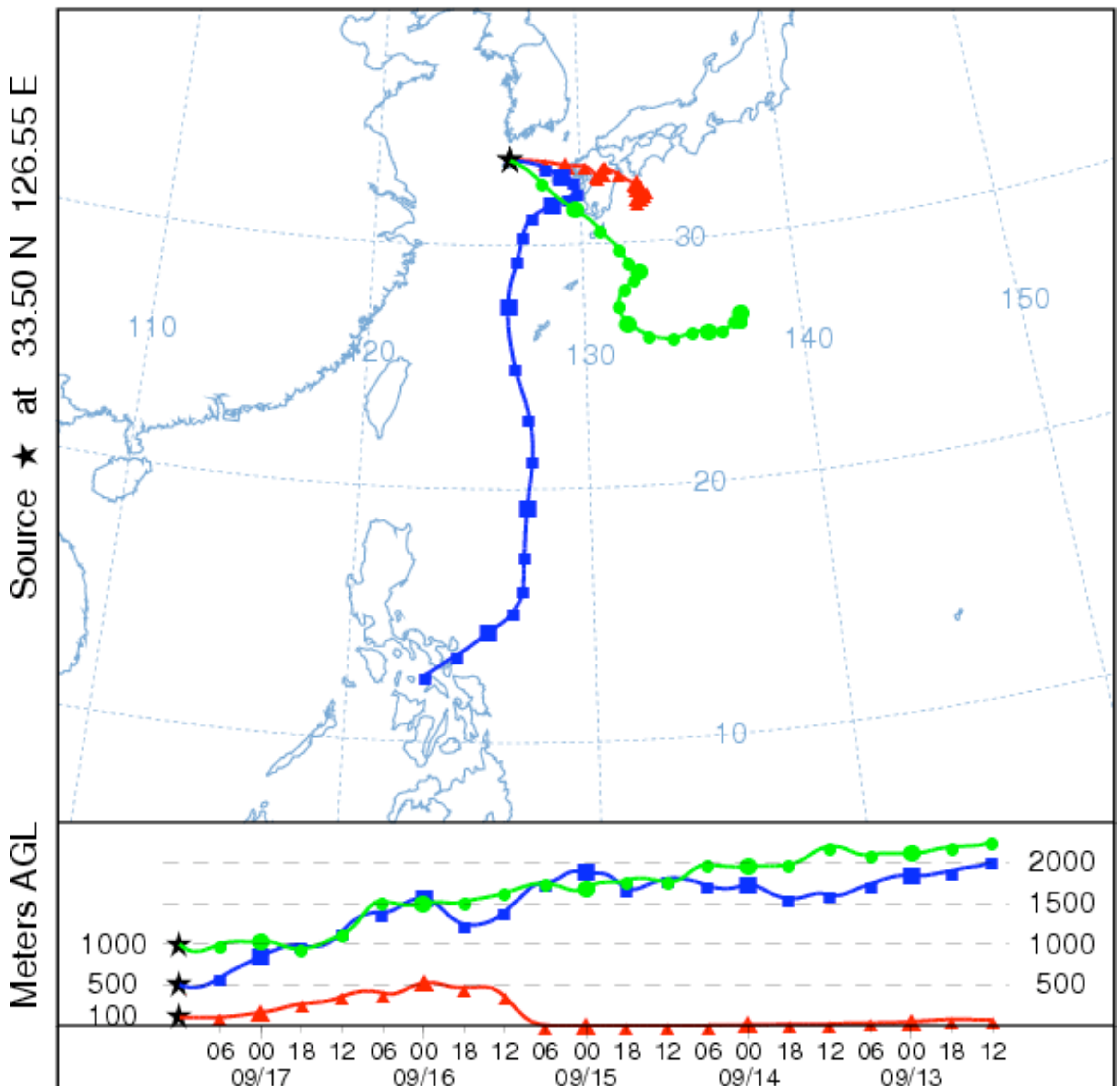
Job ID: 340843 Job Start: Wed Jun 17 19:39:27 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 6, 16 – 20 September 2008.

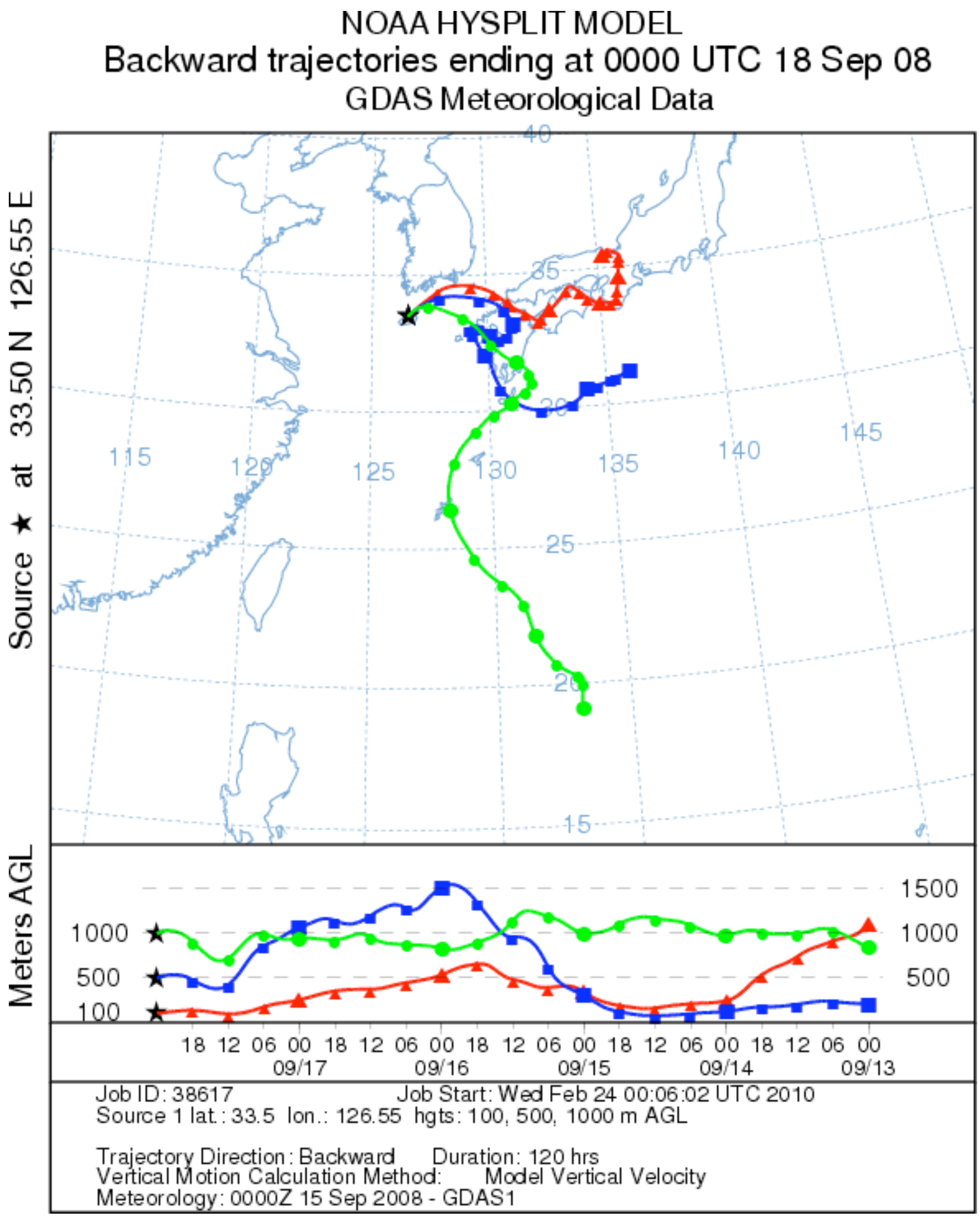


NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 17 Sep 08
GDAS Meteorological Data

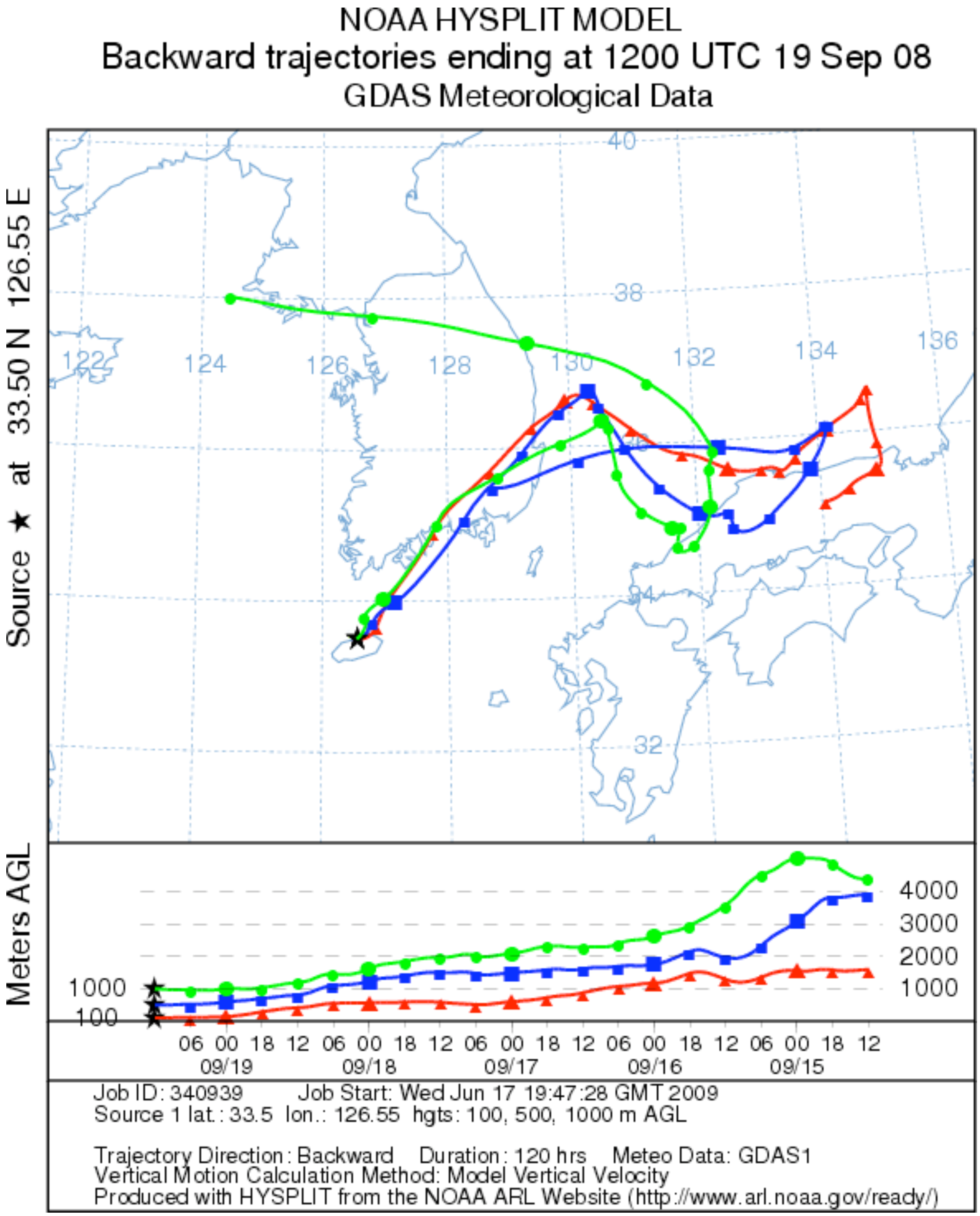


Job ID: 340892 Job Start: Wed Jun 17 19:44:33 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 0000 UTC 18 Sep 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
40
35
30
25
20
15
115
120
125
130
135
140
145
Meters AGL
1500
1000
500
100
18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00
09/17
09/16
09/15
09/14
09/13
Job ID: 38617 Job Start: Wed Feb 24 00:06:02 UTC 2010
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 15 Sep 2008 - GDAS1

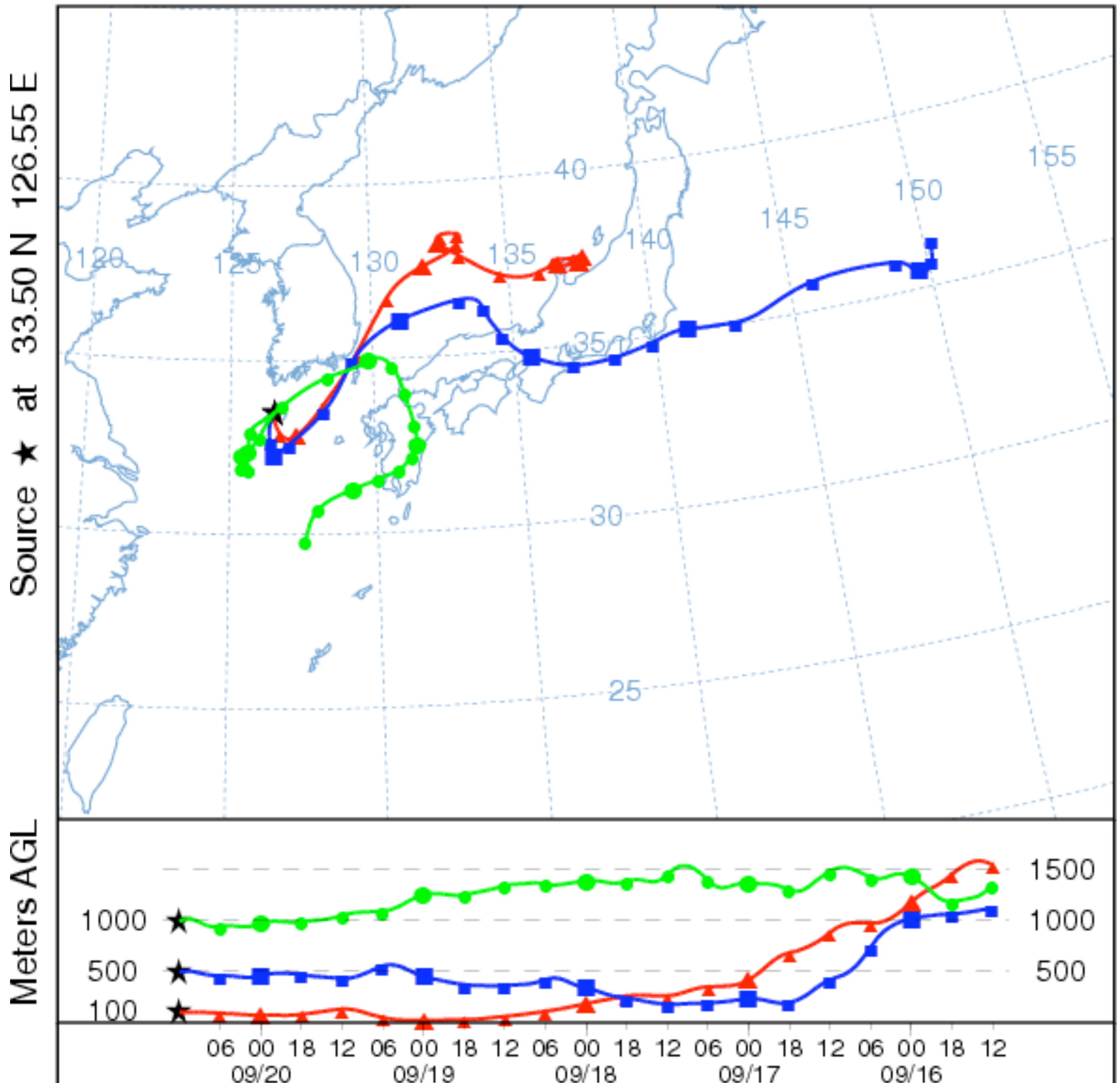
Episode 6, 17-21 September 2008.



NOAA HYSPLIT MODEL

Backward trajectories ending at 1200 UTC 20 Sep 08

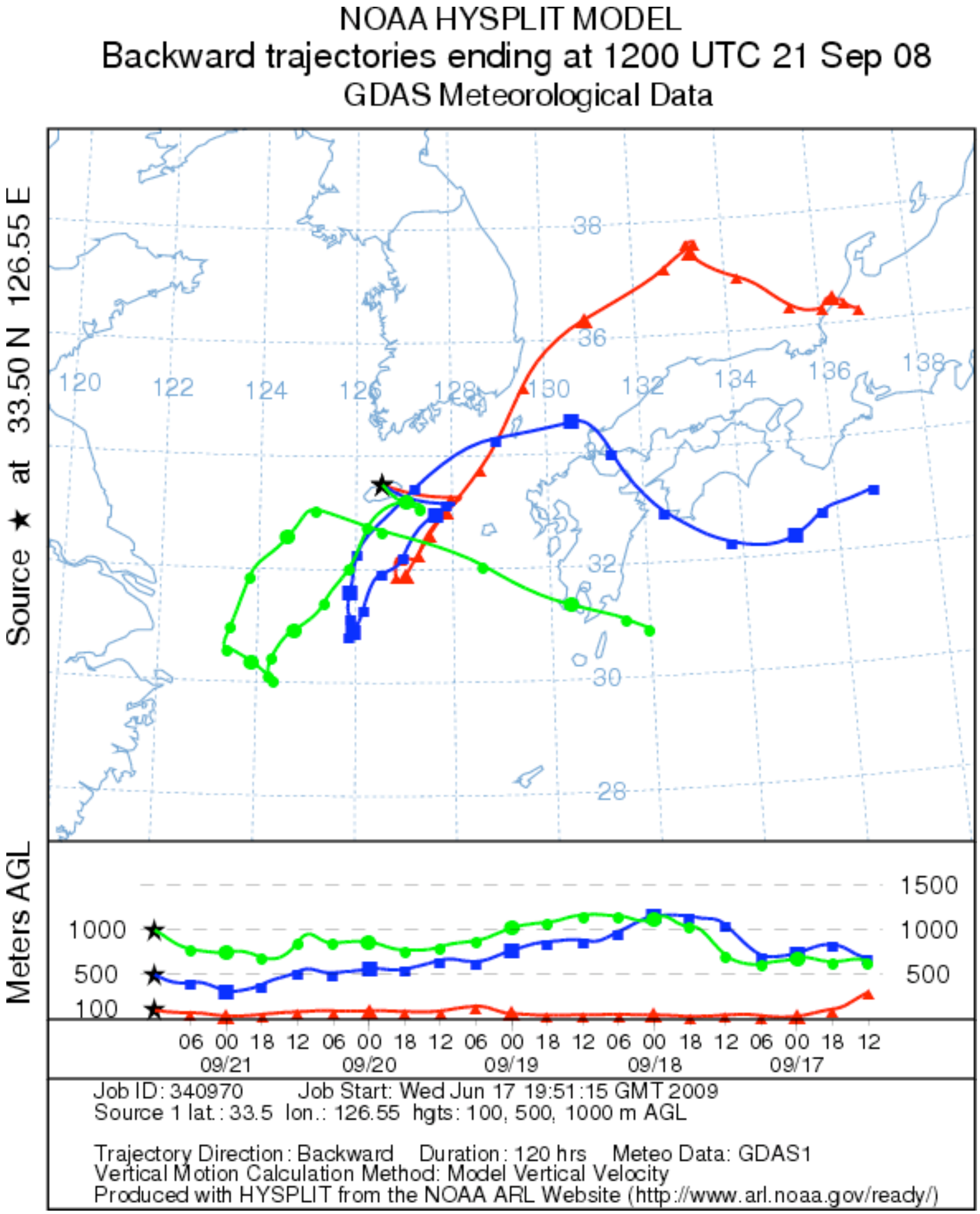
GDAS Meteorological Data



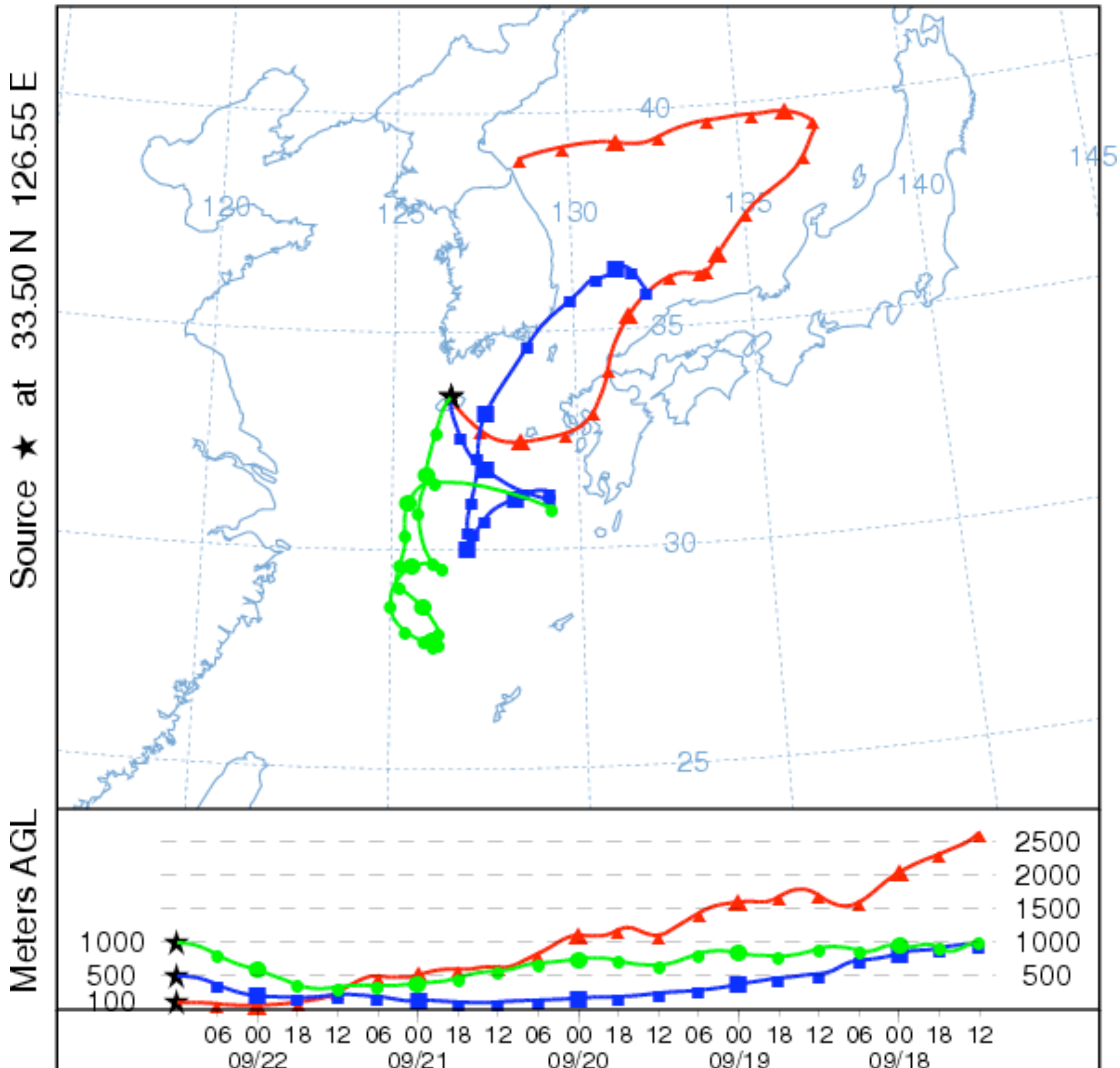
Job ID: 340956 Job Start: Wed Jun 17 19:49:30 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 7, 21 - 25 September 2008.



NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 22 Sep 08
GDAS Meteorological Data



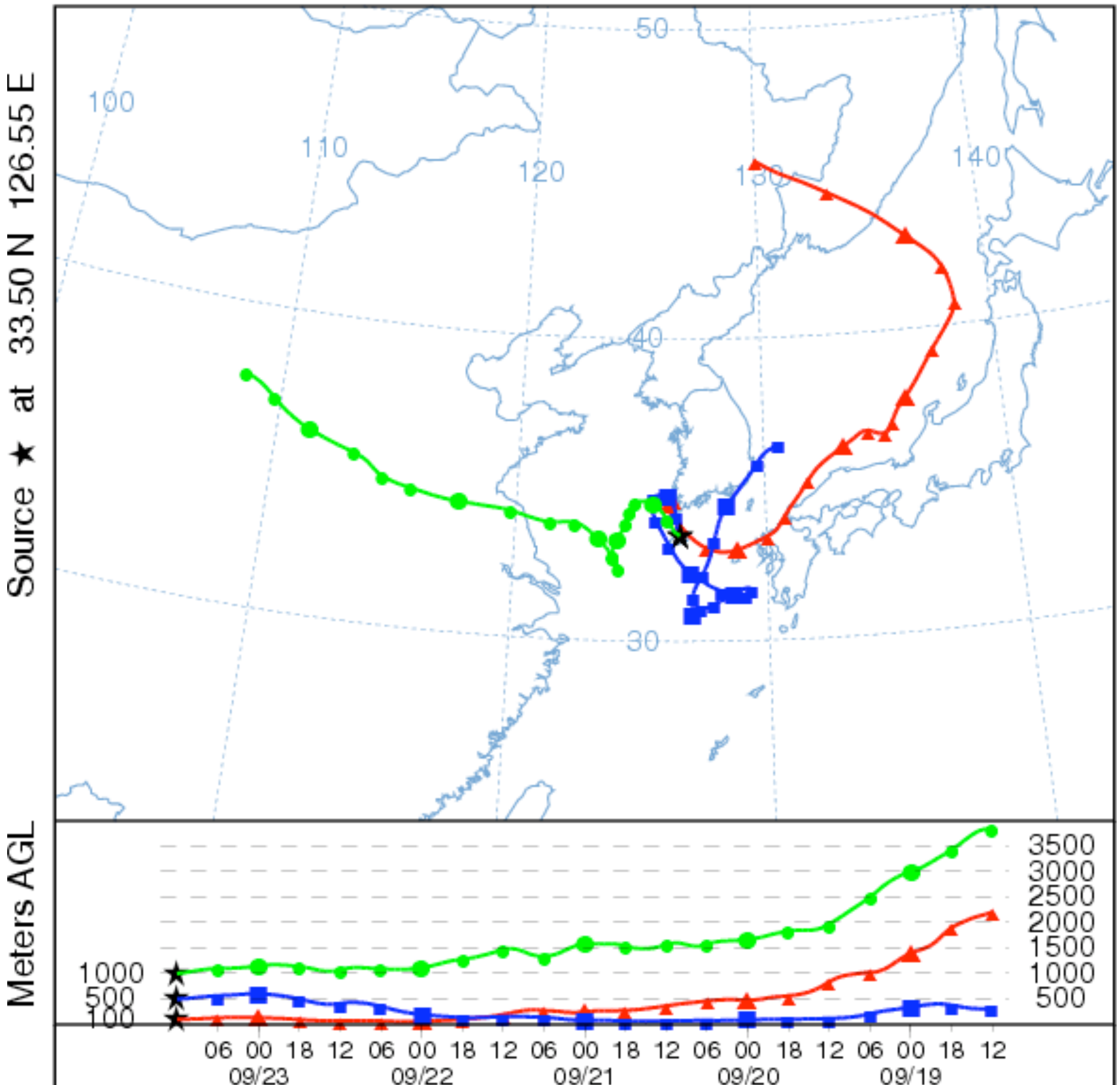
Job ID: 340508 Job Start: Wed Jun 17 19:07:18 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 23 Sep 08

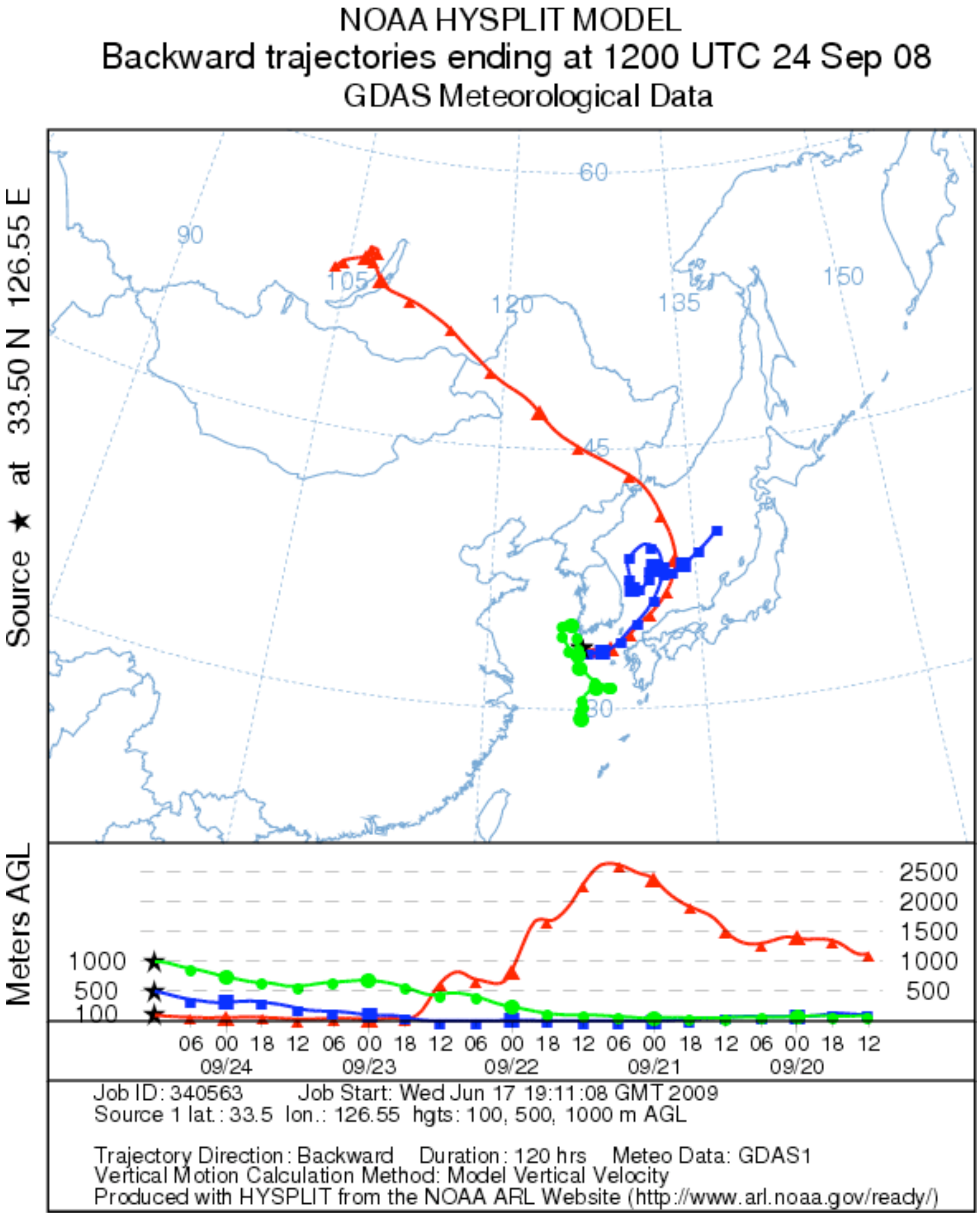
GDAS Meteorological Data



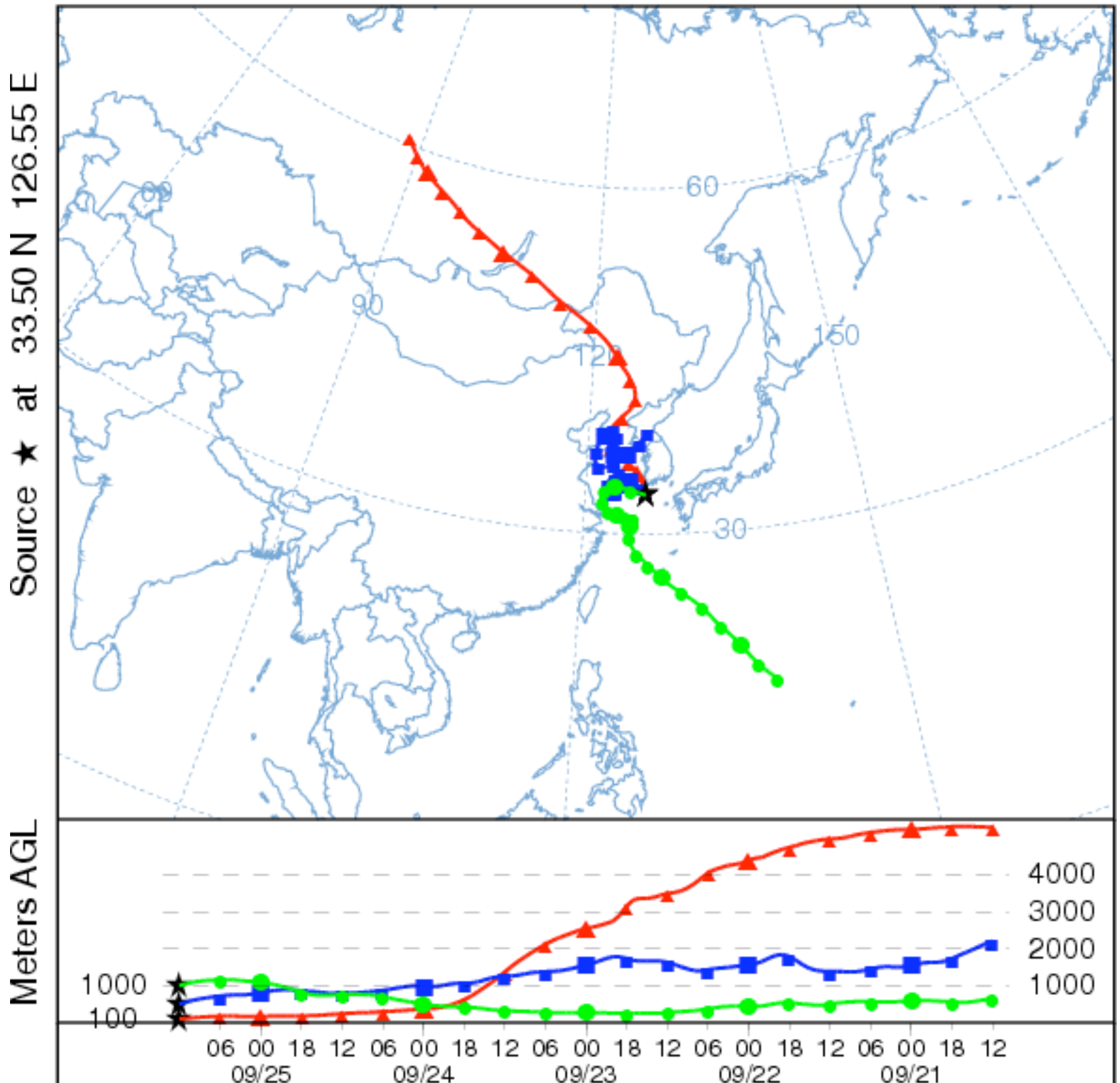
Job ID: 340550 Job Start: Wed Jun 17 19:09:19 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 7, 22-25 September 2008.



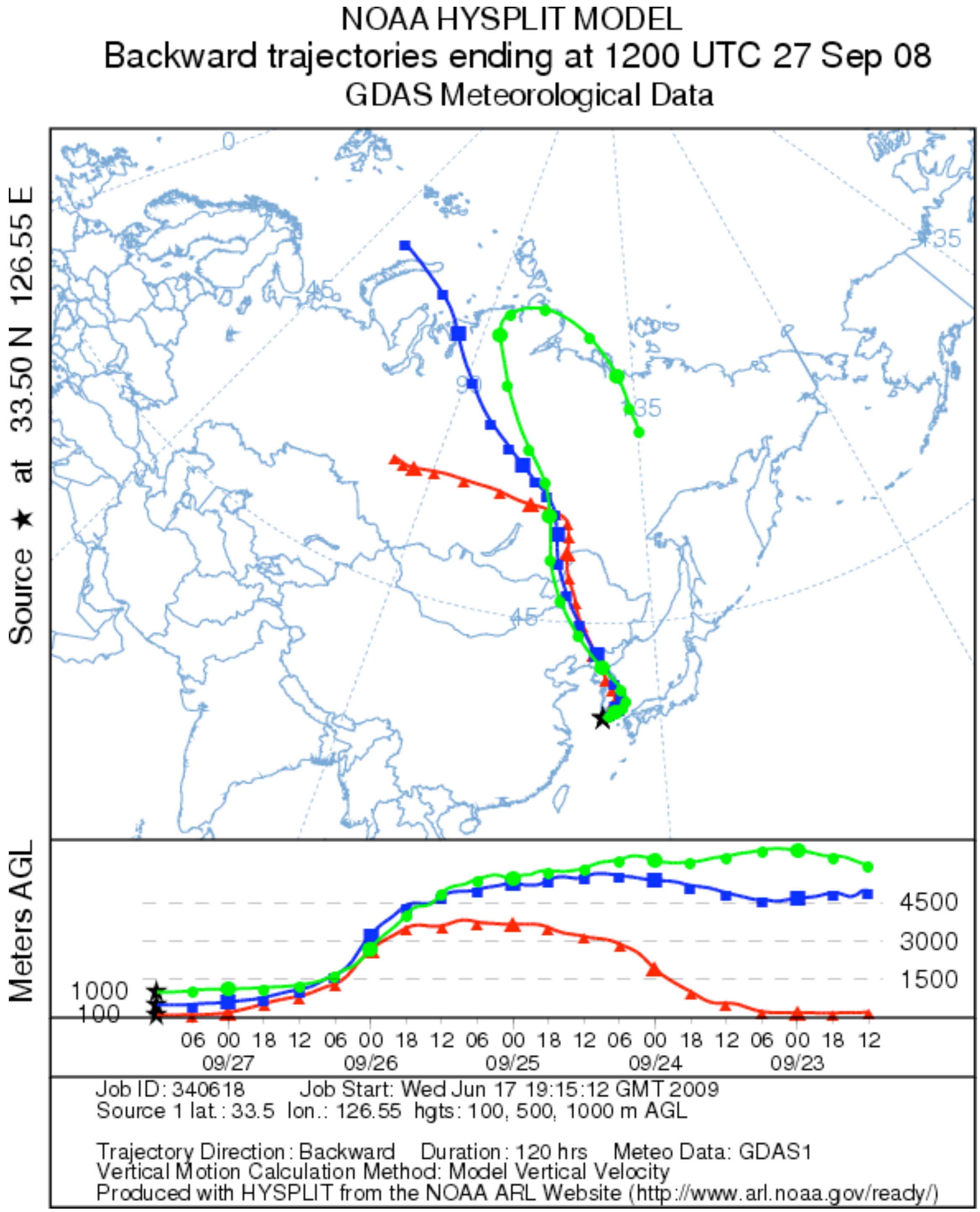
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 25 Sep 08
GDAS Meteorological Data



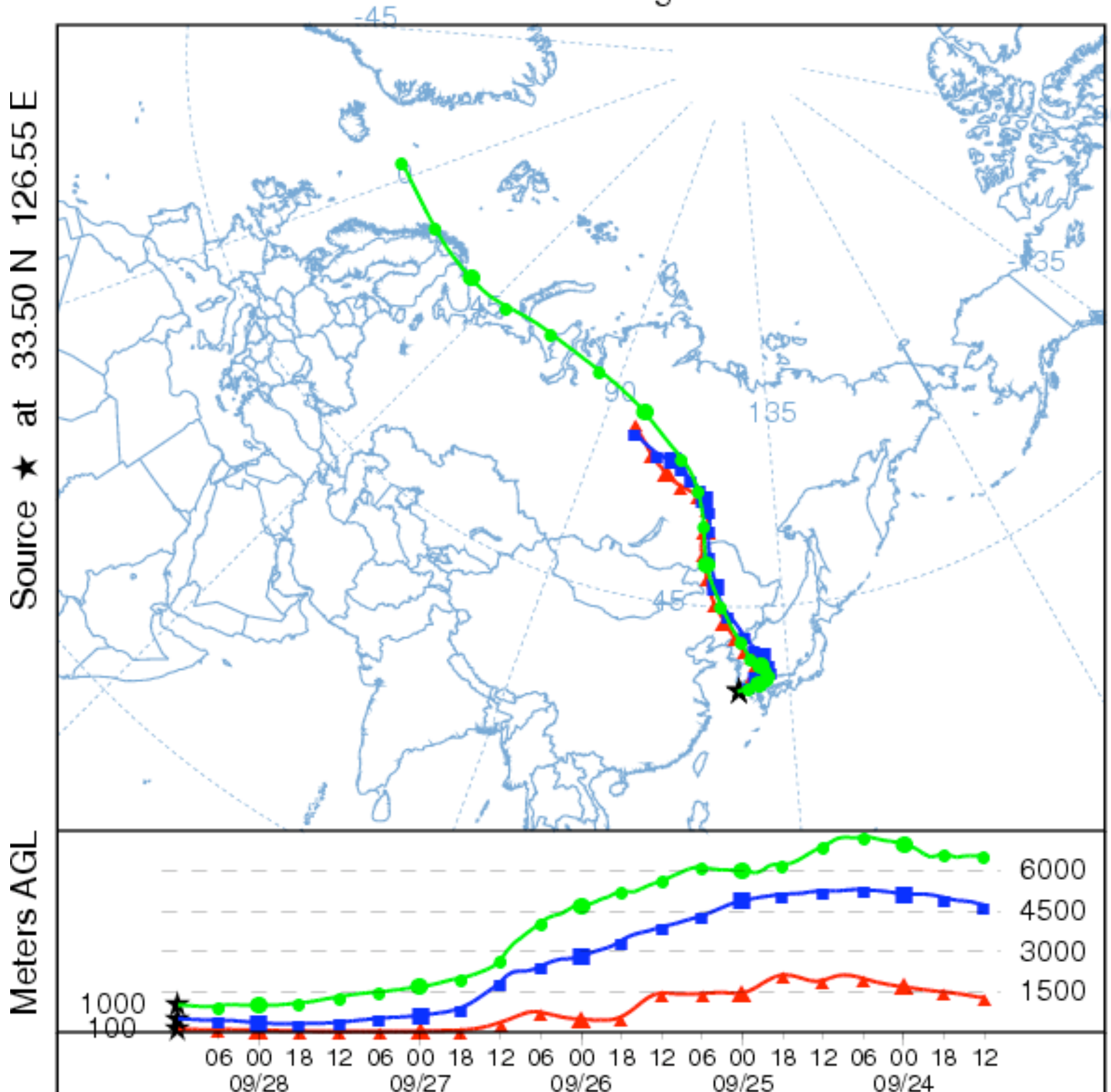
Job ID: 340581 Job Start: Wed Jun 17 19:12:17 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

Episode 8, 27 – 29 September 2008.



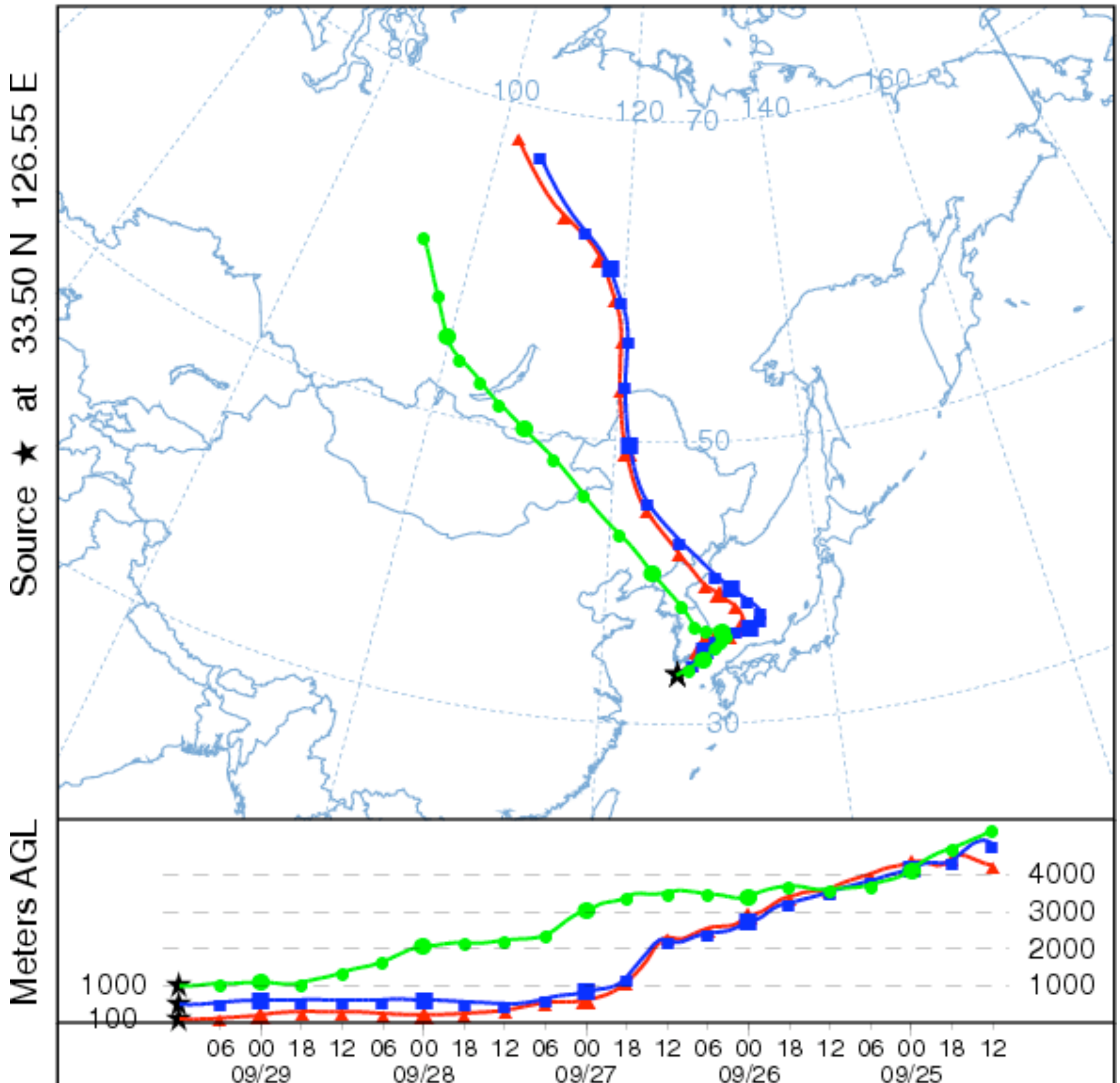
NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 28 Sep 08
GDAS Meteorological Data



Job ID: 340663 Job Start: Wed Jun 17 19:18:17 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

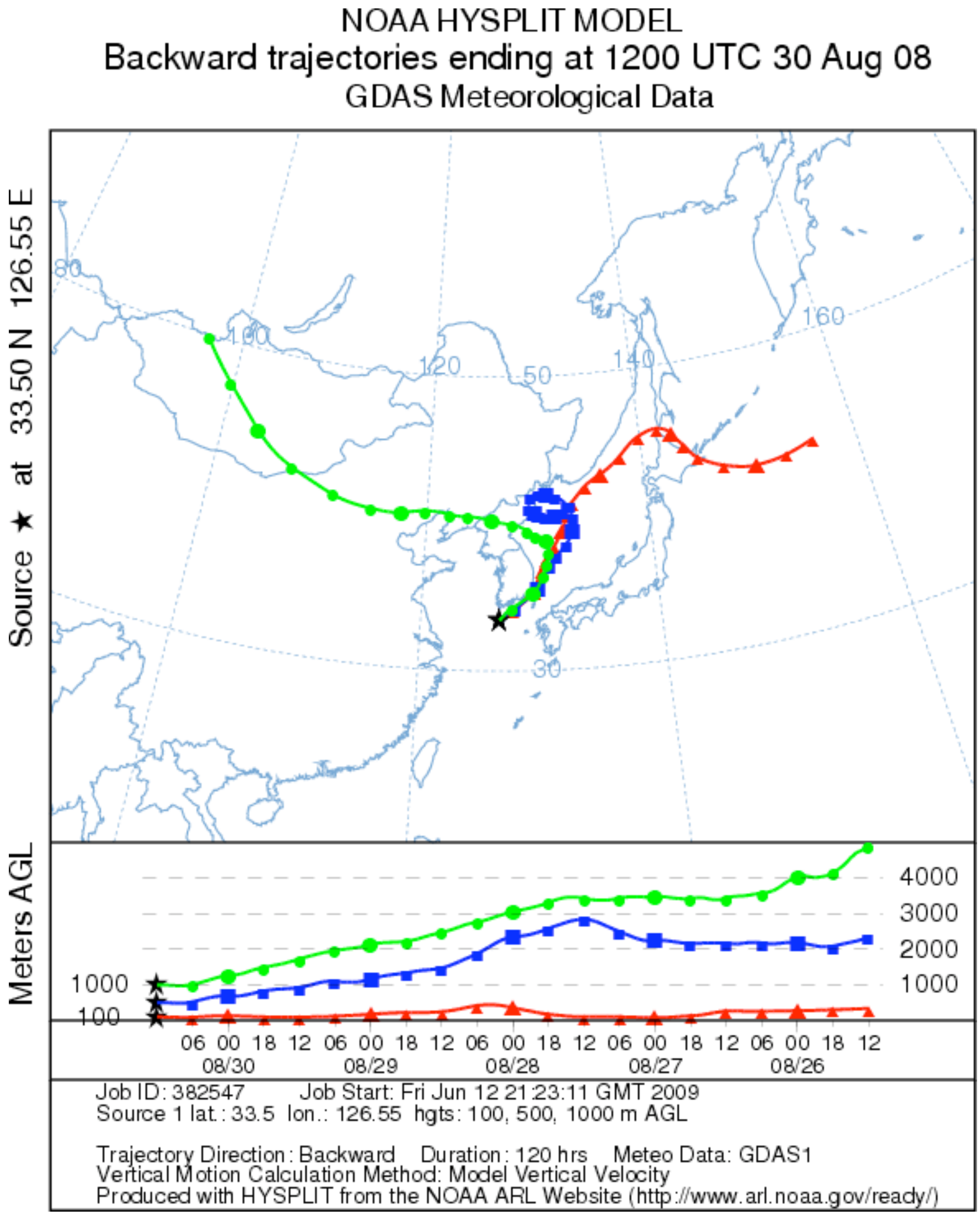
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)

NOAA HYSPLIT MODEL
Backward trajectories ending at 1200 UTC 29 Sep 08
GDAS Meteorological Data



Job ID: 340705 Job Start: Wed Jun 17 19:21:41 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL

Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
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 1200 UTC 30 Aug 08
GDAS Meteorological Data
Source ★ at 33.50 N 126.55 E
80
100
120
140
160
50
30
Meters AGL
1000
100
4000
3000
2000
1000
06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12 06 00 18 12
08/30
08/29
08/28
08/27
08/26
Job ID: 382547 Job Start: Fri Jun 12 21:23:11 GMT 2009
Source 1 lat.: 33.5 lon.: 126.55 hgts: 100, 500, 1000 m AGL
Trajectory Direction: Backward Duration: 120 hrs Meteo Data: GDAS1
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)