Analysis of Atmospheric Stability during Selected Events from SowMEX/TimREX

Rita Roberts[1], Eric Nelson[1],
Juanzhen Sun[1], and Fu-Tien Tsai[2]

[1]National Center for Atmospheric Research
[2]Meteorological Forecast Center, Central Weather Bureau

Special Acknowledgements
Paul Ciesielski, S.-C. Huang, W.-M. Chang, P.-H. Lin and C.-H. Liu
John Braun

Objectives

- Utilize frequent sounding and surface data to analyze the evolution of atmospheric stability over Taiwan for synoptic and non-synoptic events during TiMREX and resulting convection.

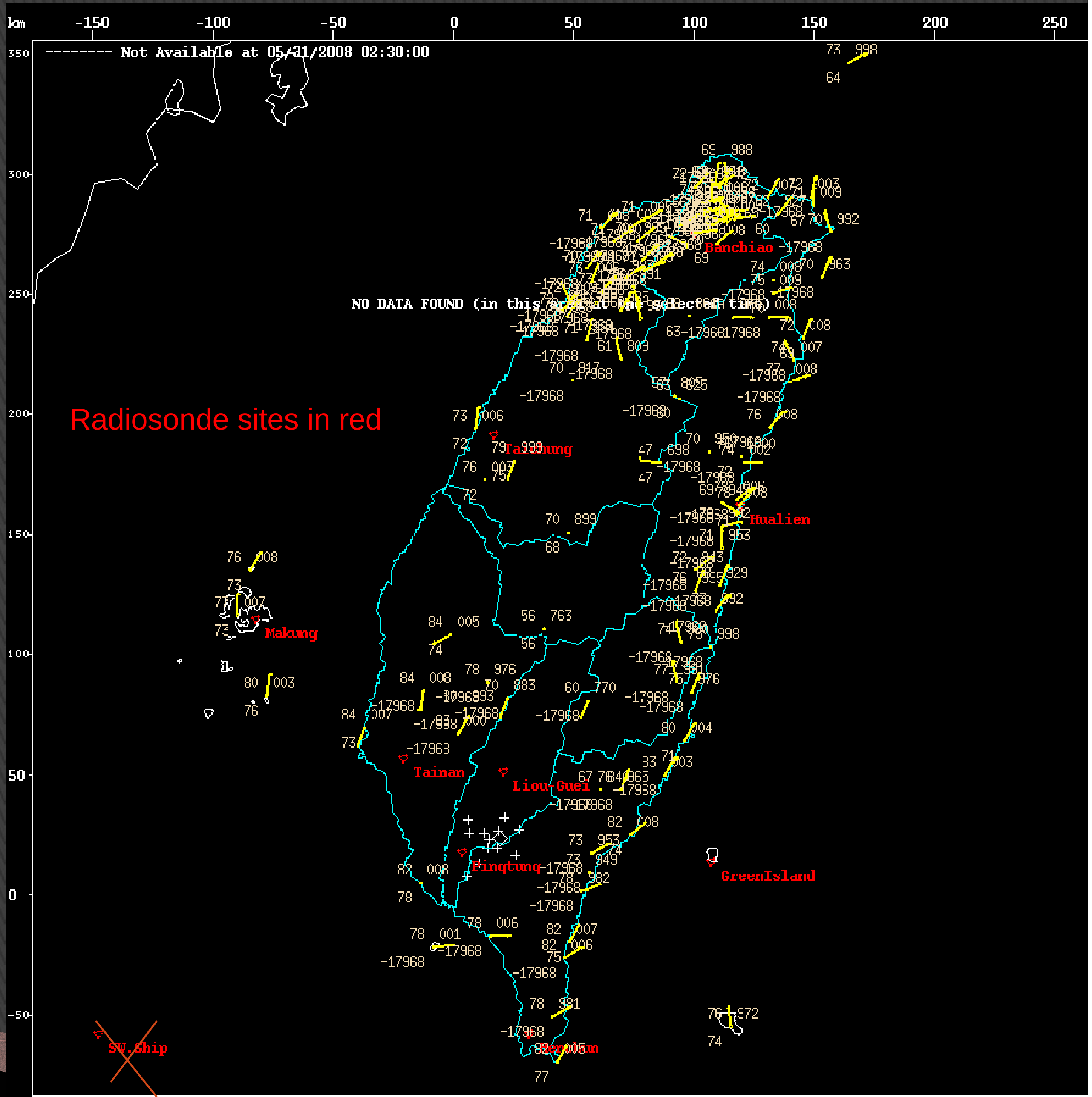
- Compare CAPE/CIN fields derived from observations with NWP models and VDRAS retrieved estimates.

- Evaluate the contribution of the gridded fields to short term nowcasting, particularly in monitoring and automatically tracking with time the changes in stability occurring prior to storm initiation and to storm dissipation.

Surface Station and Sounding Data

100+ Surface Stations
- Temperature QC done by John Braun at UCAR/COSMIC

9 of 12 Sounding locations
- Humidity-corrected, (V3) done by Ciesielski et al.
- launches every 3 to 6 hr depending on sounding site



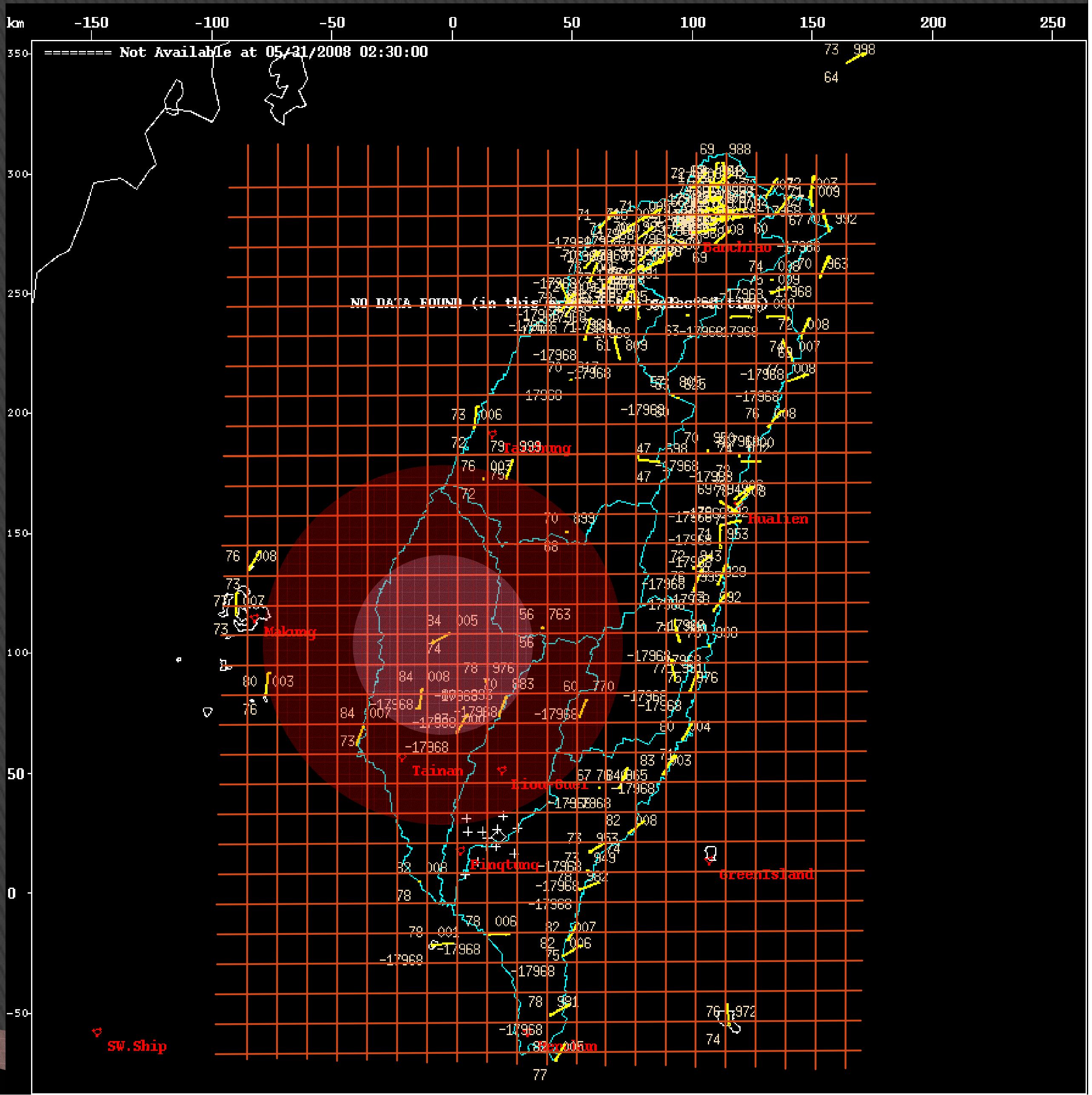
Algorithmic Processing to Retrieve gridded Surface-Based CAPE and CIN fields

MetarCAPECIN algorithm
SurfInterp algorithm

Data is interpolated to a grid using Cressman weighting and Barnes analysis methodologies.

75 km radius specified to grab closest and most recent surface station data

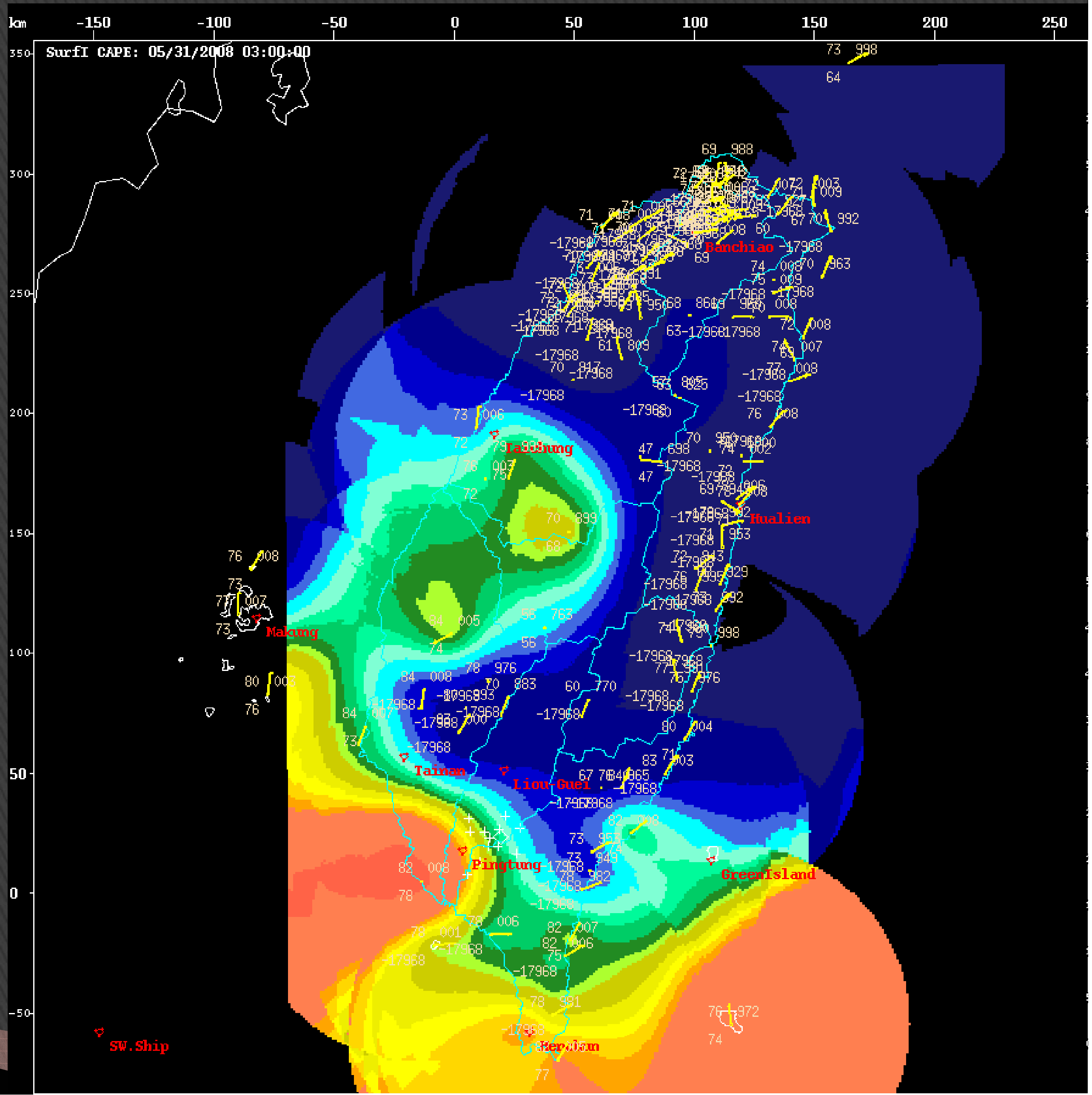
150 km radius specified to grab closest and most recent sounding information



Gridded CAPE field

The CAPE and CIN values are originally calculated from the soundings using the mean T and T_d values in the lowest 100 mb.

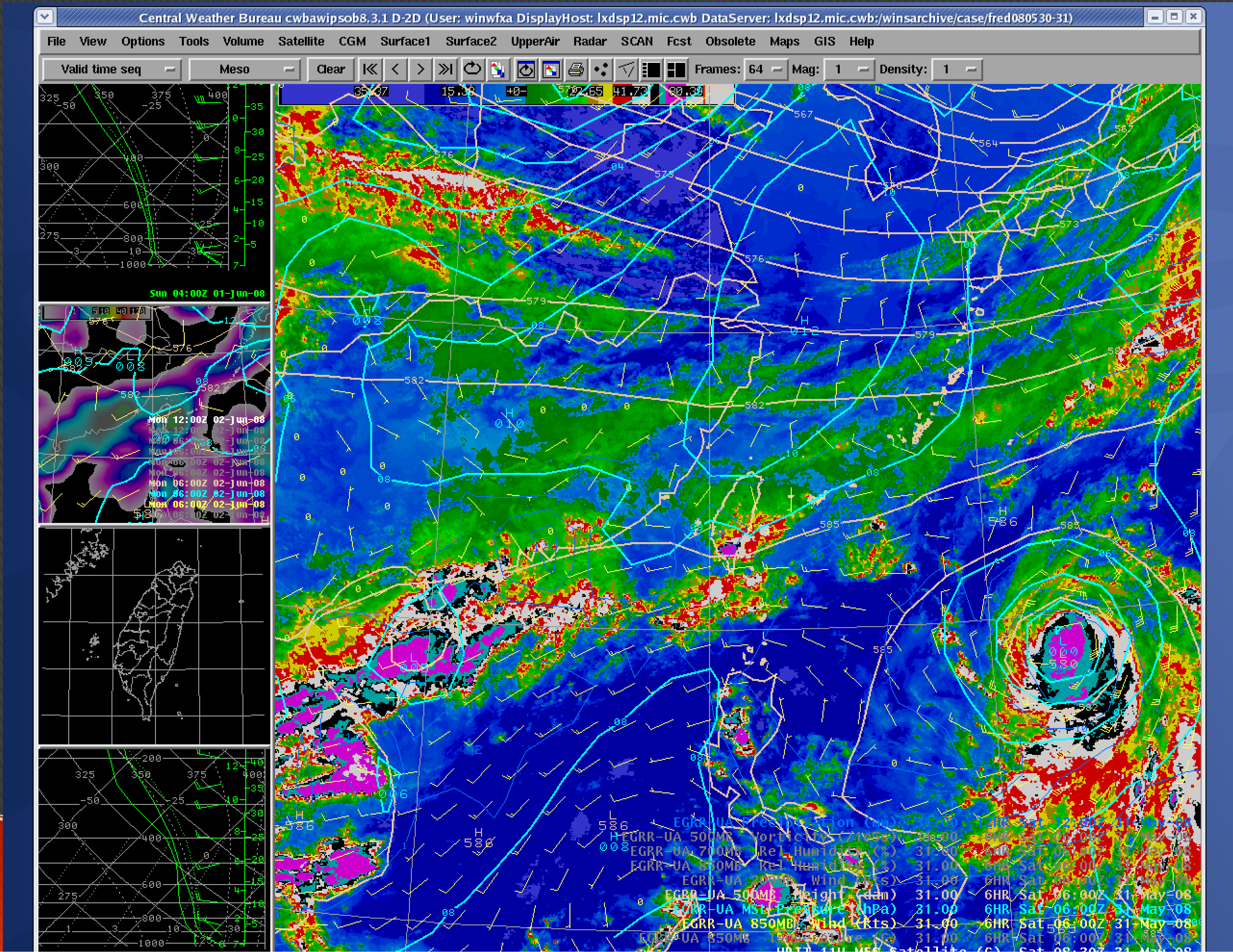
Sounding profiles are then modified using the hourly updated surface station T and T_d values to get a new CAPE and CIN value at each grid point



Cases

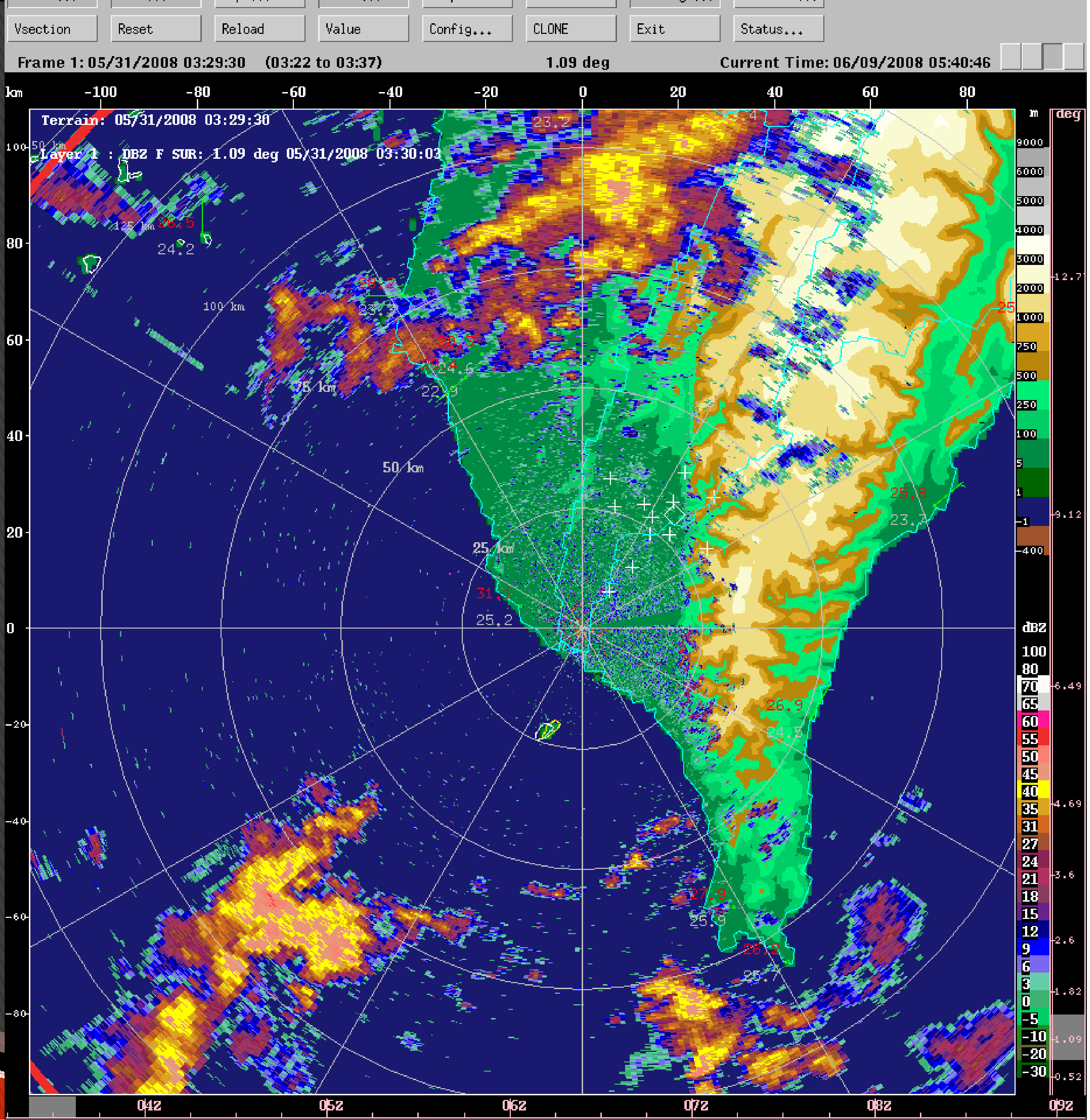
- 31 May – Mei Yu frontal- and locally-driven convection
- 8 June – locally-driven convection
- 9 June – locally-driven convection, but with an approaching upper level, short wave disturbance

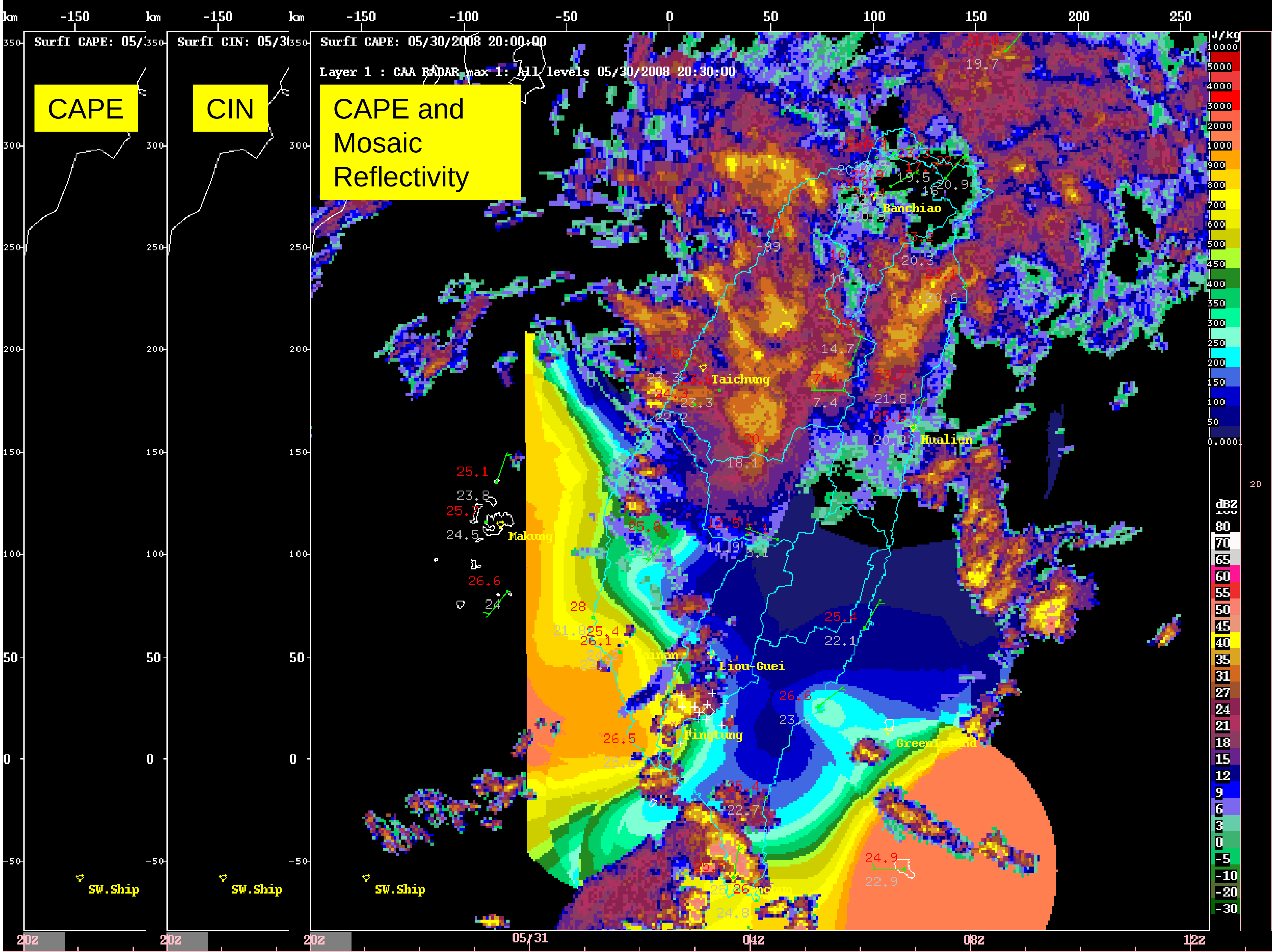
31 May 2008 – Mei Yu Front



May 31, 2008

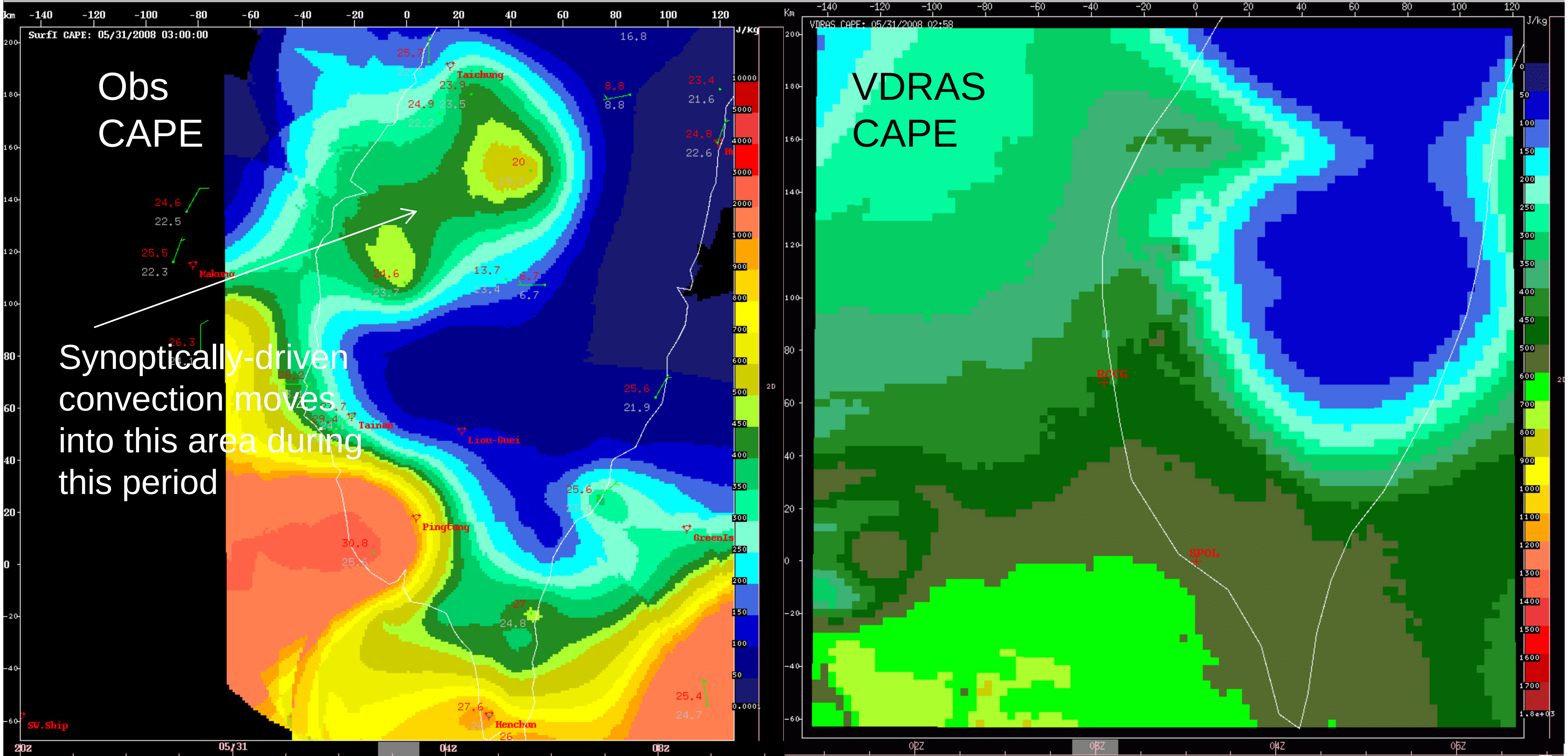
Terrain and
S-Pol Radar
Reflectivity




CAPE
CIN
CAPE and Mosaic Reflectivity
SurfI CAPE: 05/30/2008 20:00:00
Layer 1 : CAA RADAR max 1: All levels 05/30/2008 20:30:00
SurfI CIN: 05/3
Banchiao
Taichung
Hualien
Makung
Liou-Guei
Pingtung
SW.Ship
J/kg
dBZ
05/31
04Z
08Z
12Z

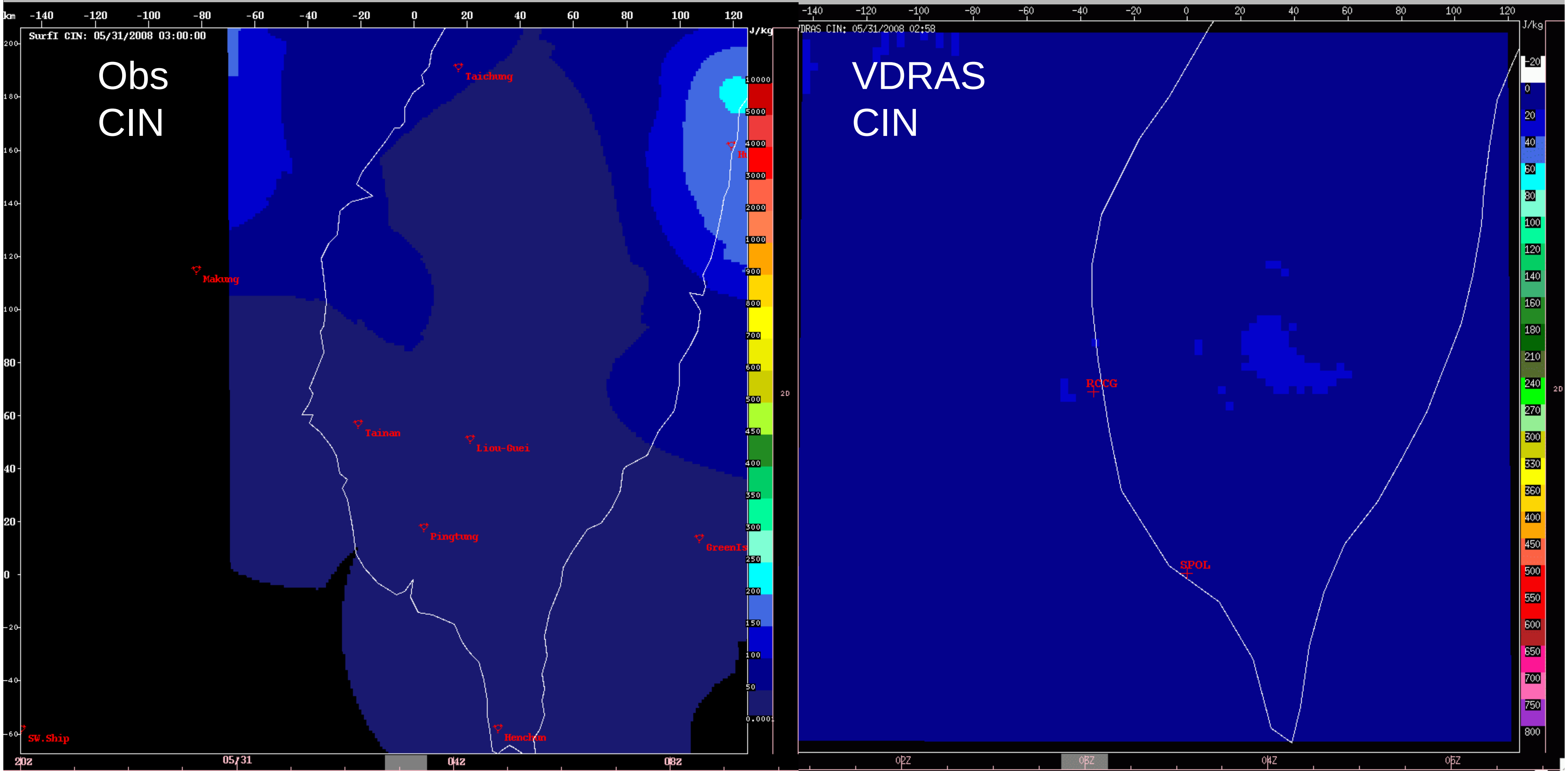
Comparison of Observations with VDRAS

31 May 2008
03:00 UTC



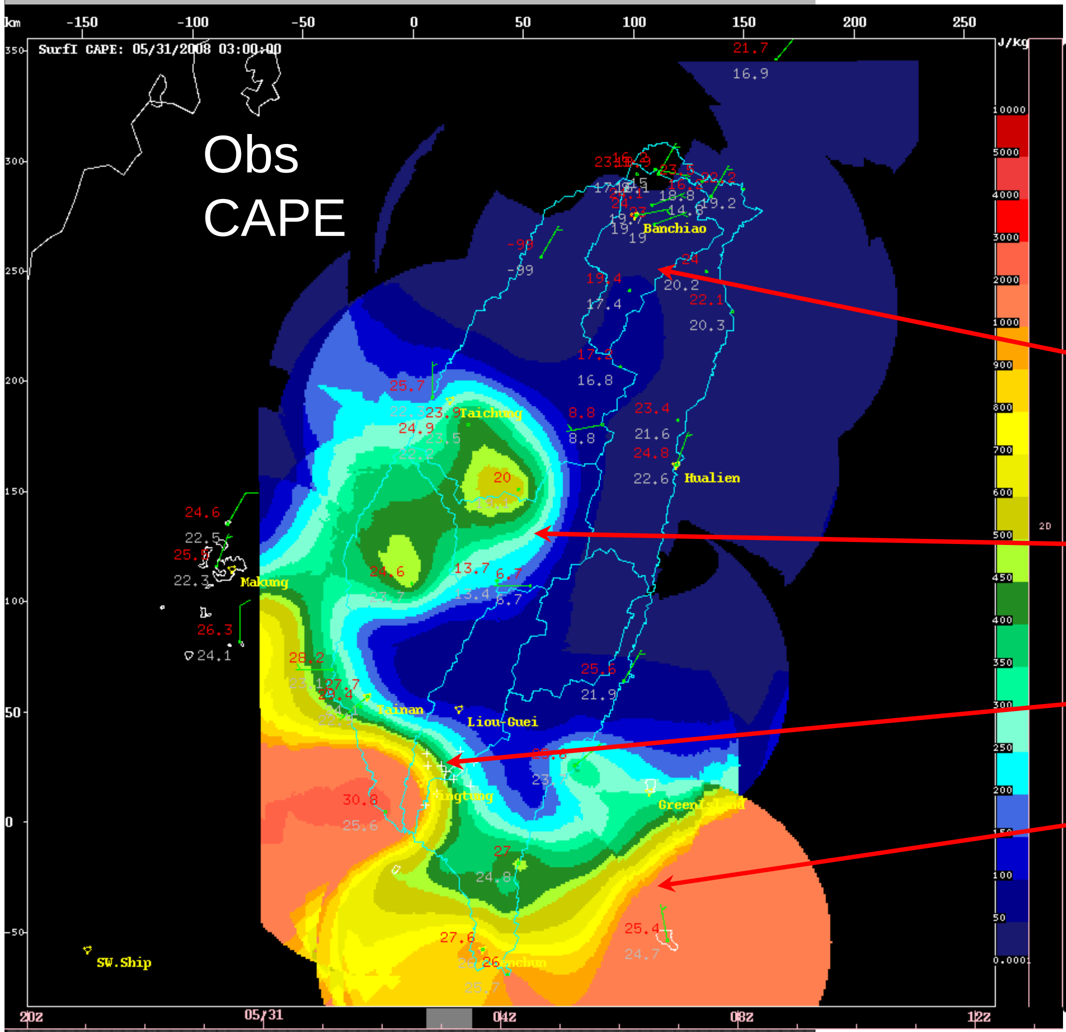
Comparison of Observations with VDRAS

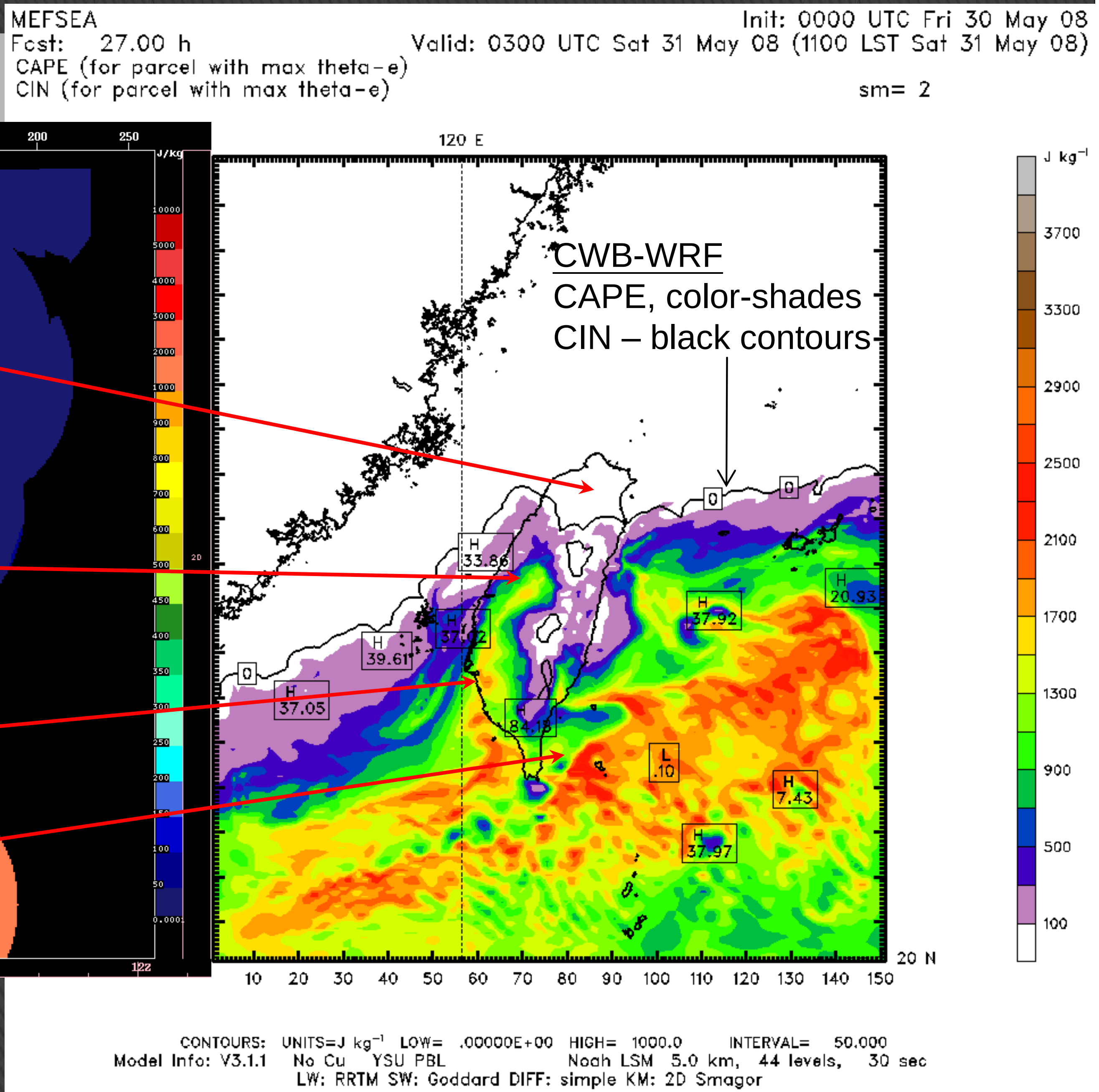
31 May 2008
03:00 UTC



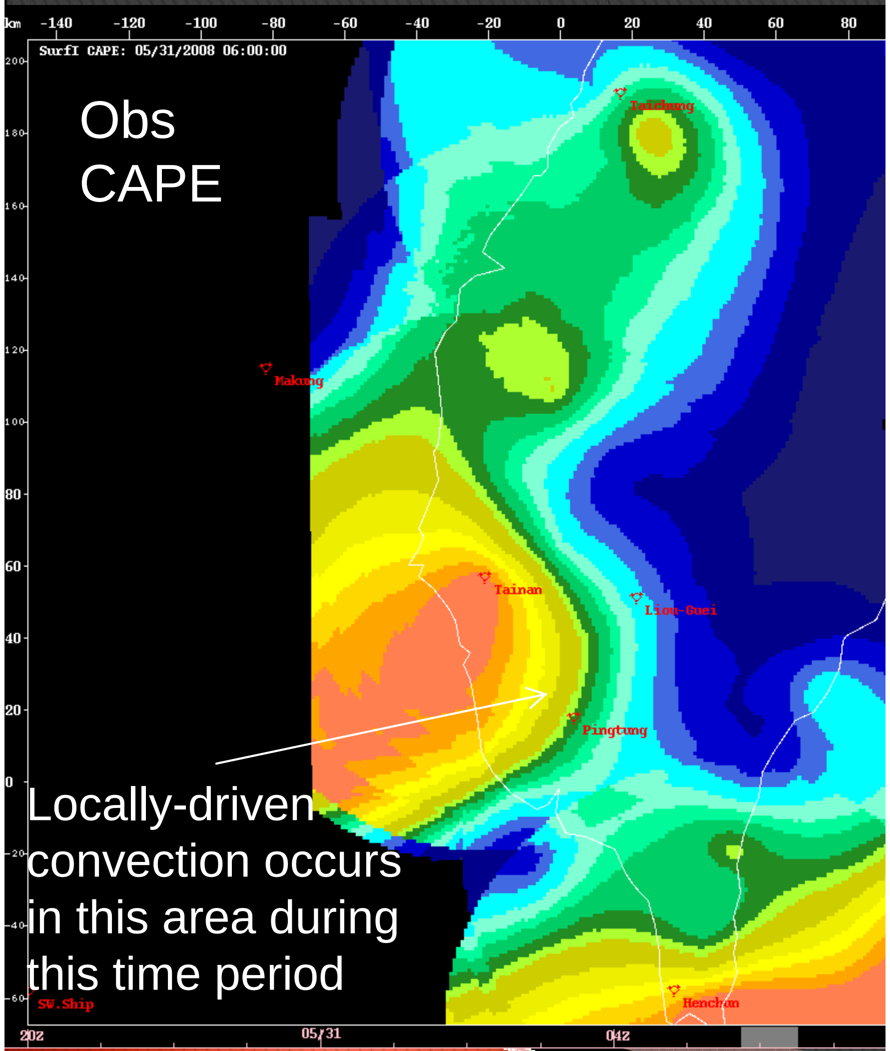
Comparison of Obs with CWB-WRF

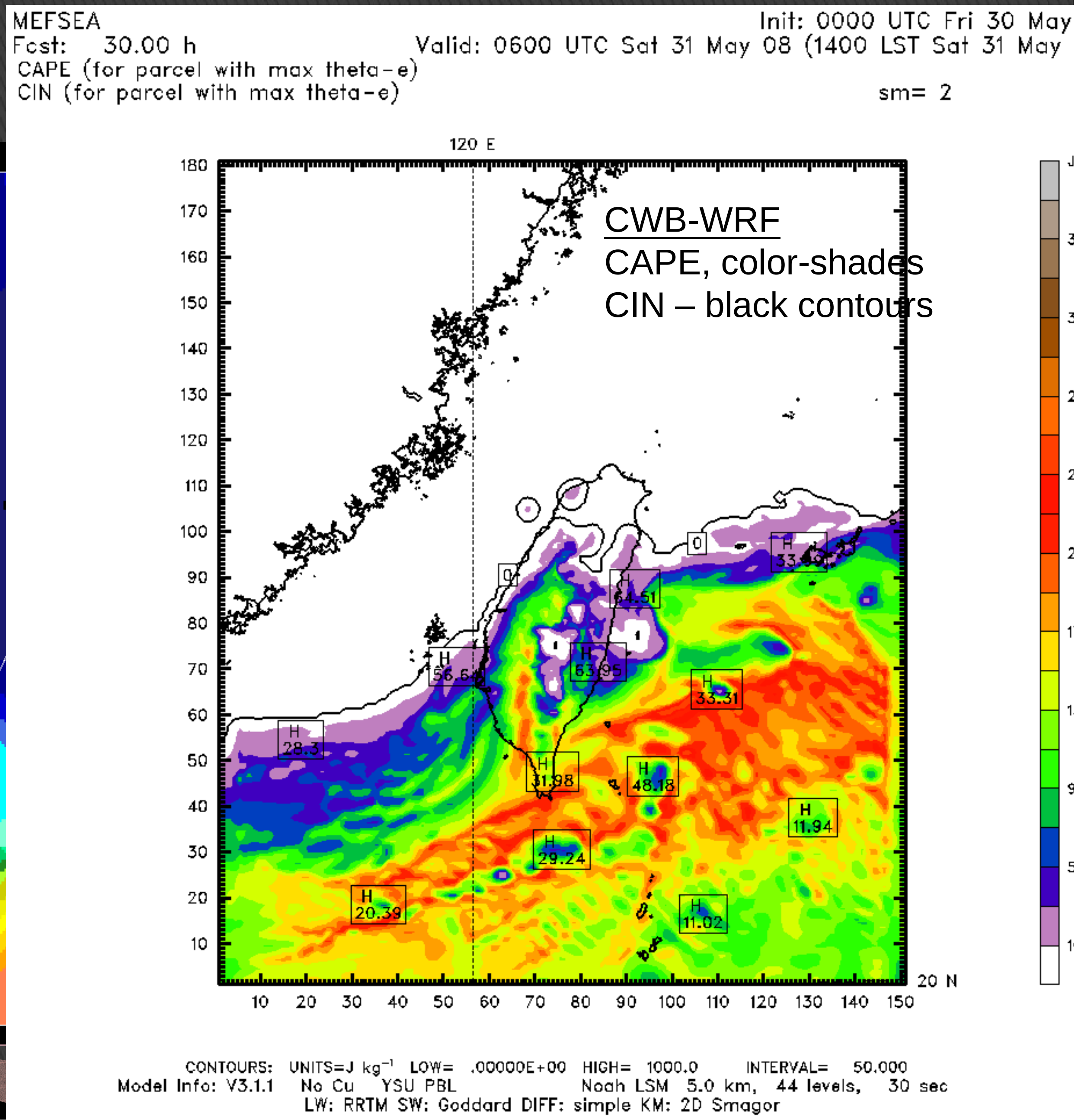
31 May 2008 03:00 UTC

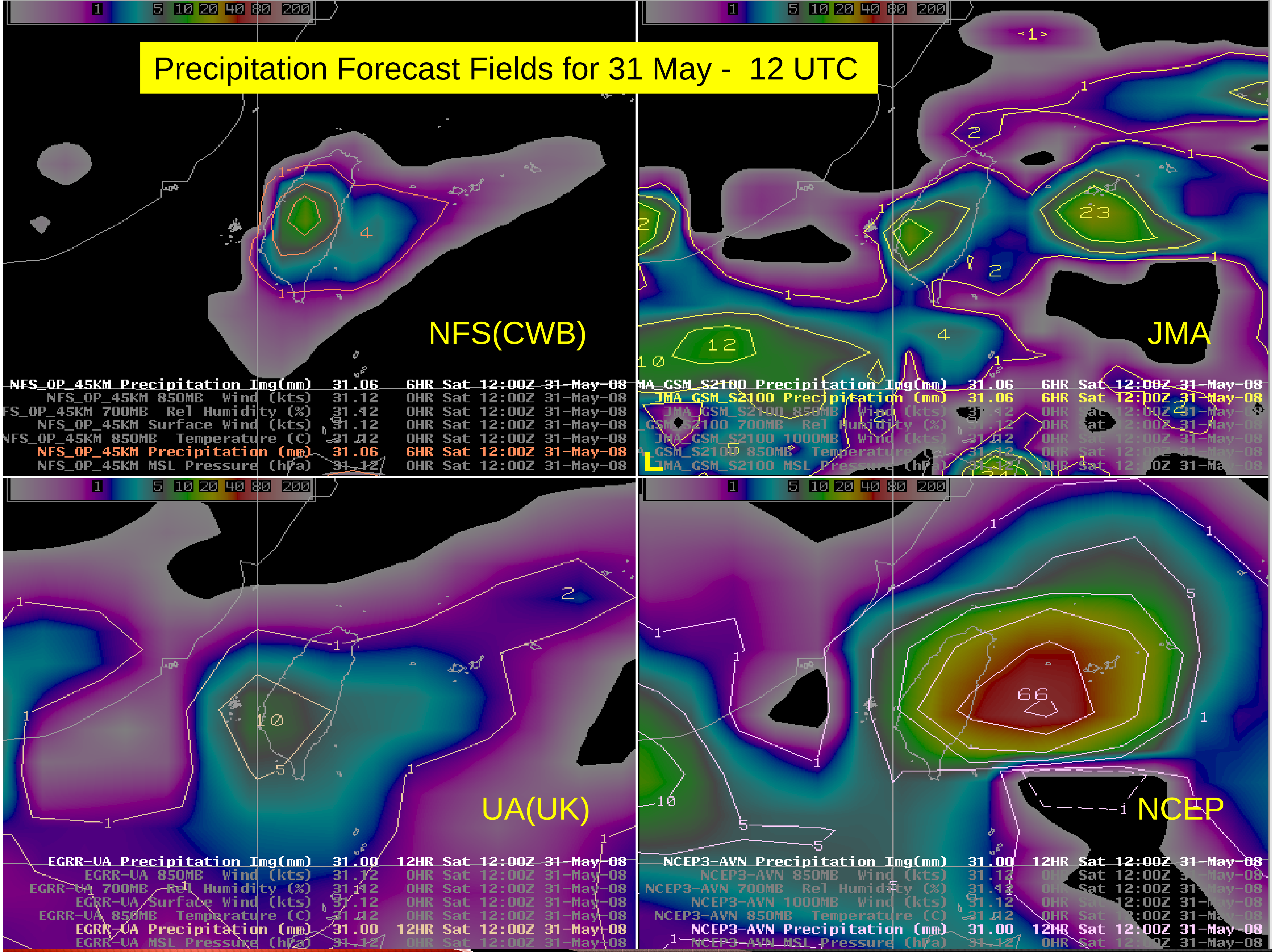


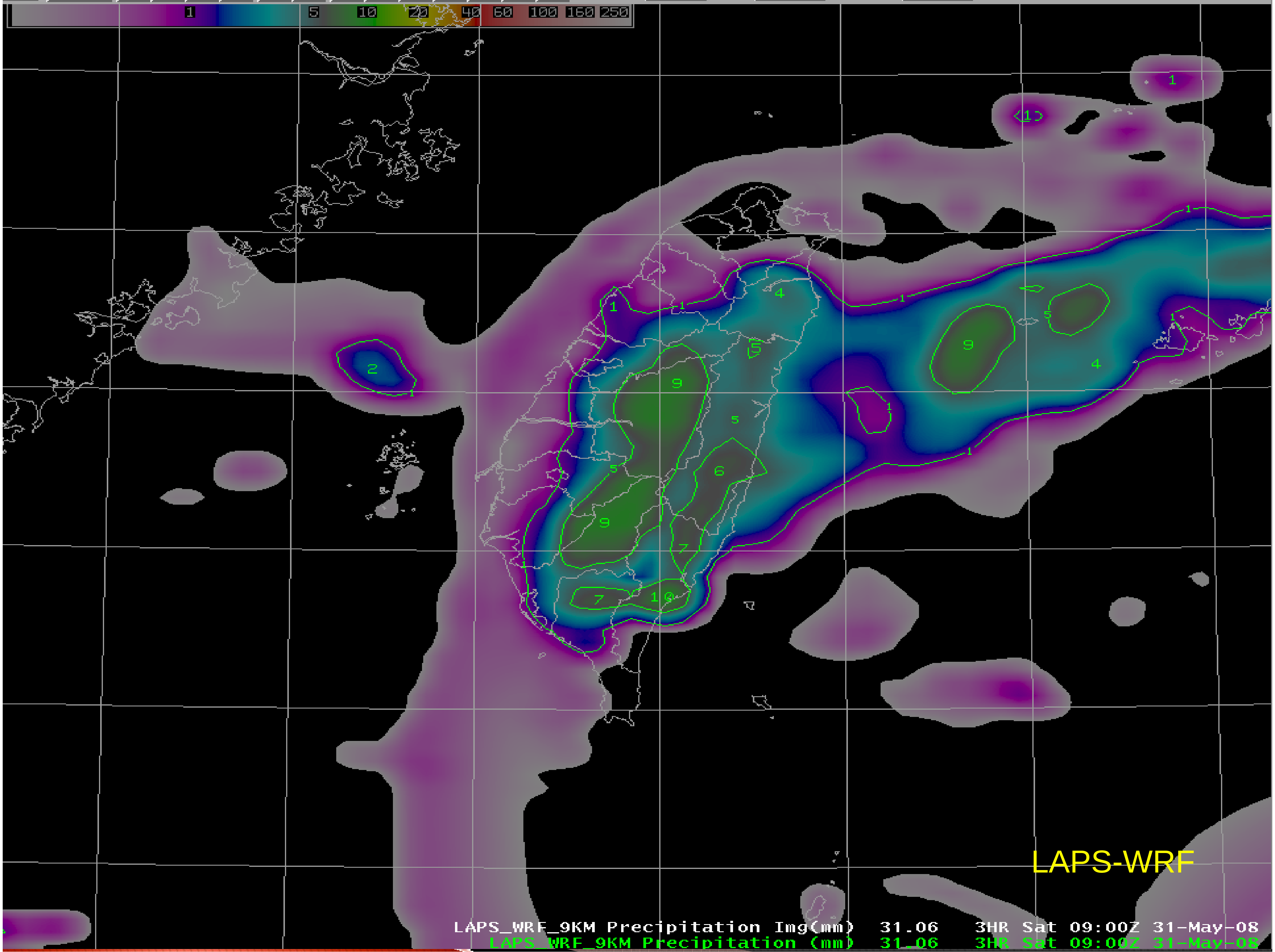


Obs/ VDRAS/ CWB-WRF
31 May, 0600 UTC

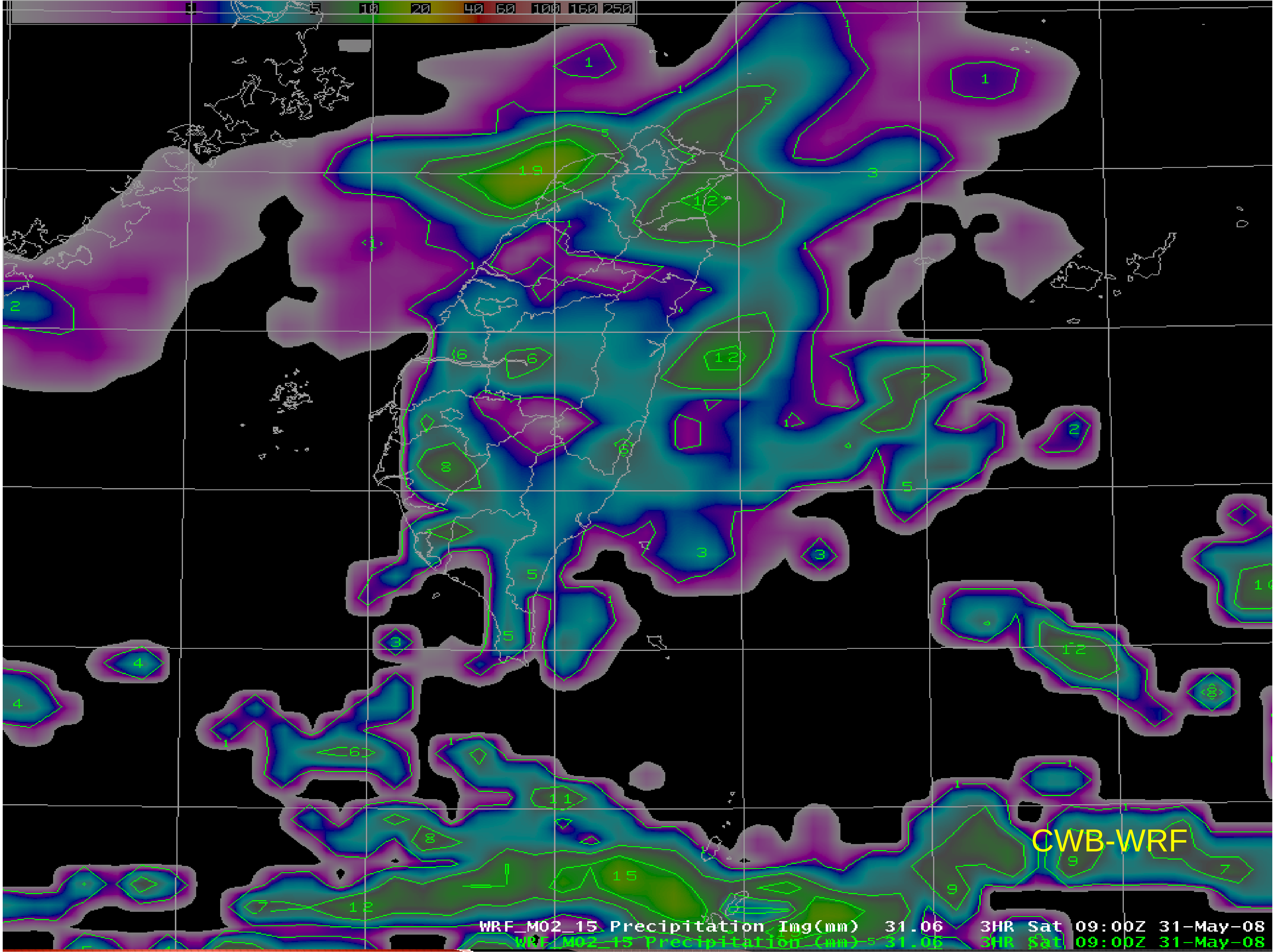




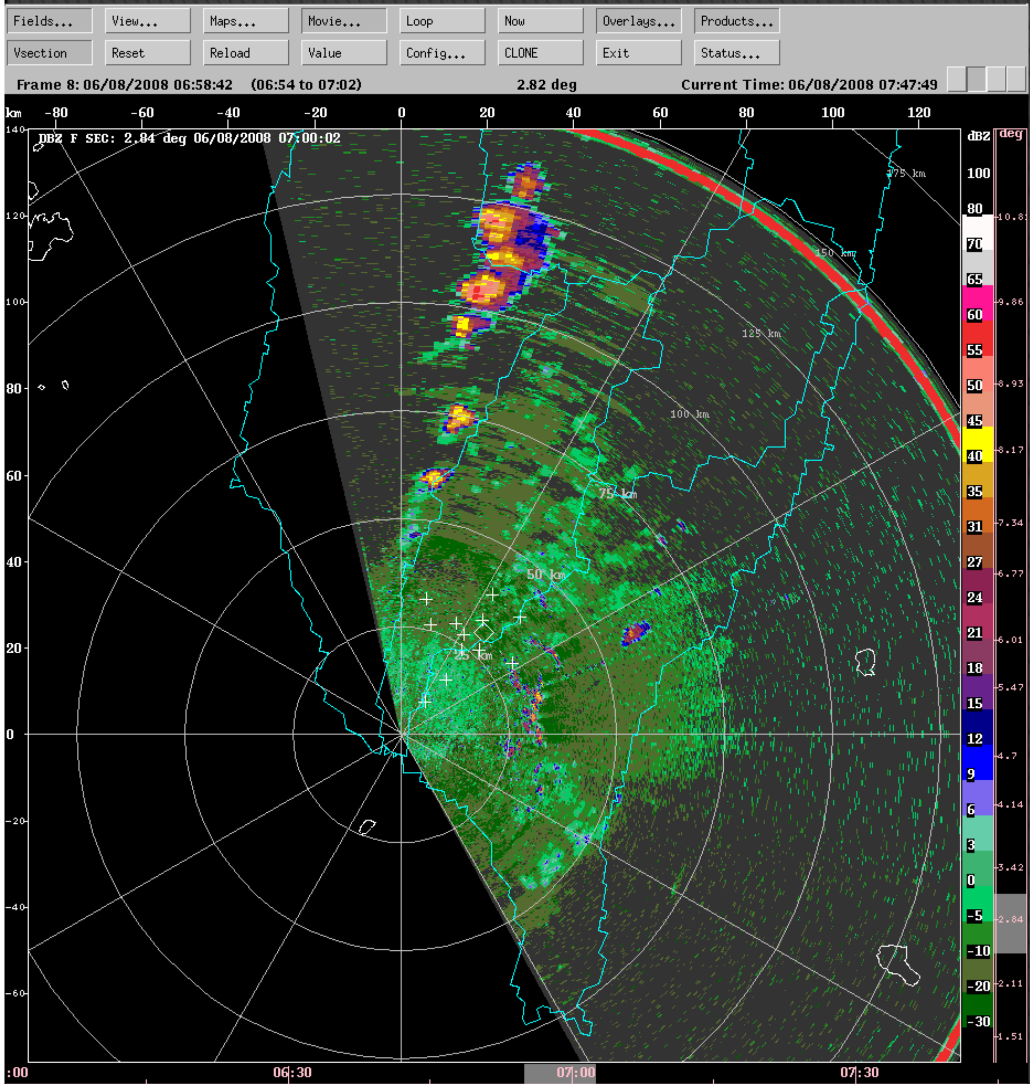

Precipitation Forecast Fields for 31 May - 12 UTC
NFS(CWB)
JMA
UA(UK)
NCEP
NFS_OP_45KM Precipitation Img(mm) 31.06 6HR Sat 12:00Z 31-May-08
NFS_OP_45KM 850MB Wind (kts) 31.12 0HR Sat 12:00Z 31-May-08
NFS_OP_45KM 700MB Rel Humidity (%) 31.12 0HR Sat 12:00Z 31-May-08
NFS_OP_45KM Surface Wind (kts) 31.12 0HR Sat 12:00Z 31-May-08
NFS_OP_45KM 850MB Temperature (C) 31.12 0HR Sat 12:00Z 31-May-08
NFS_OP_45KM Precipitation (mm) 31.06 6HR Sat 12:00Z 31-May-08
NFS_OP_45KM MSL Pressure (hPa) 31.12 0HR Sat 12:00Z 31-May-08
JMA_GSM_S2100 Precipitation Img(mm) 31.06 6HR Sat 12:00Z 31-May-08
JMA_GSM_S2100 Precipitation (mm) 31.06 6HR Sat 12:00Z 31-May-08
EGRR-UA Precipitation Img(mm) 31.00 12HR Sat 12:00Z 31-May-08
EGRR-UA 850MB Wind (kts) 31.12 0HR Sat 12:00Z 31-May-08
EGRR-UA 700MB Rel Humidity (%) 31.12 0HR Sat 12:00Z 31-May-08
EGRR-UA Surface Wind (kts) 31.12 0HR Sat 12:00Z 31-May-08
EGRR-UA 850MB Temperature (C) 31.12 0HR Sat 12:00Z 31-May-08
EGRR-UA Precipitation (mm) 31.00 12HR Sat 12:00Z 31-May-08
EGRR-UA MSL Pressure (hPa) 31.12 0HR Sat 12:00Z 31-May-08
NCEP3-AVN Precipitation Img(mm) 31.00 12HR Sat 12:00Z 31-May-08
NCEP3-AVN 700MB Rel Humidity (%)
NCEP3-AVN 1000MB Wind (kts)
NCEP3-AVN 850MB Temperature (C)
NCEP3-AVN Precipitation (mm) 31.00 12HR Sat 12:00Z 31-May-08
NCEP3-AVN MSL Pressure (hPa) 31.12 0HR Sat 12:00Z 31-May-08

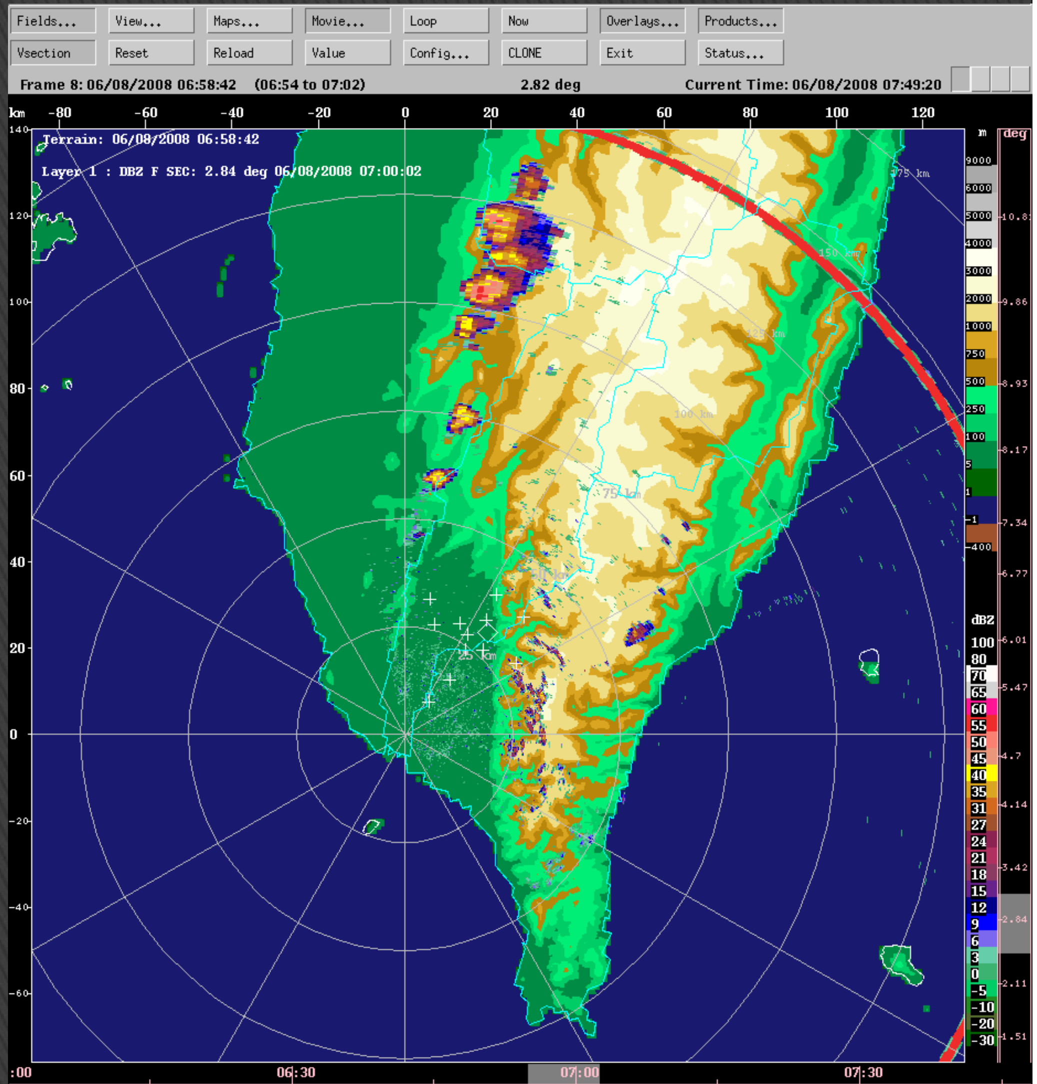


1 5 10 20 40 60 100 160 250
LAPS-WRF
LAPS_WRF_9KM Precipitation Img(mm) 31.06 3HR Sat 09:00Z 31-May-08
LAPS_WRF_9KM Precipitation (mm) 31.06 3HR Sat 09:00Z 31-May-08

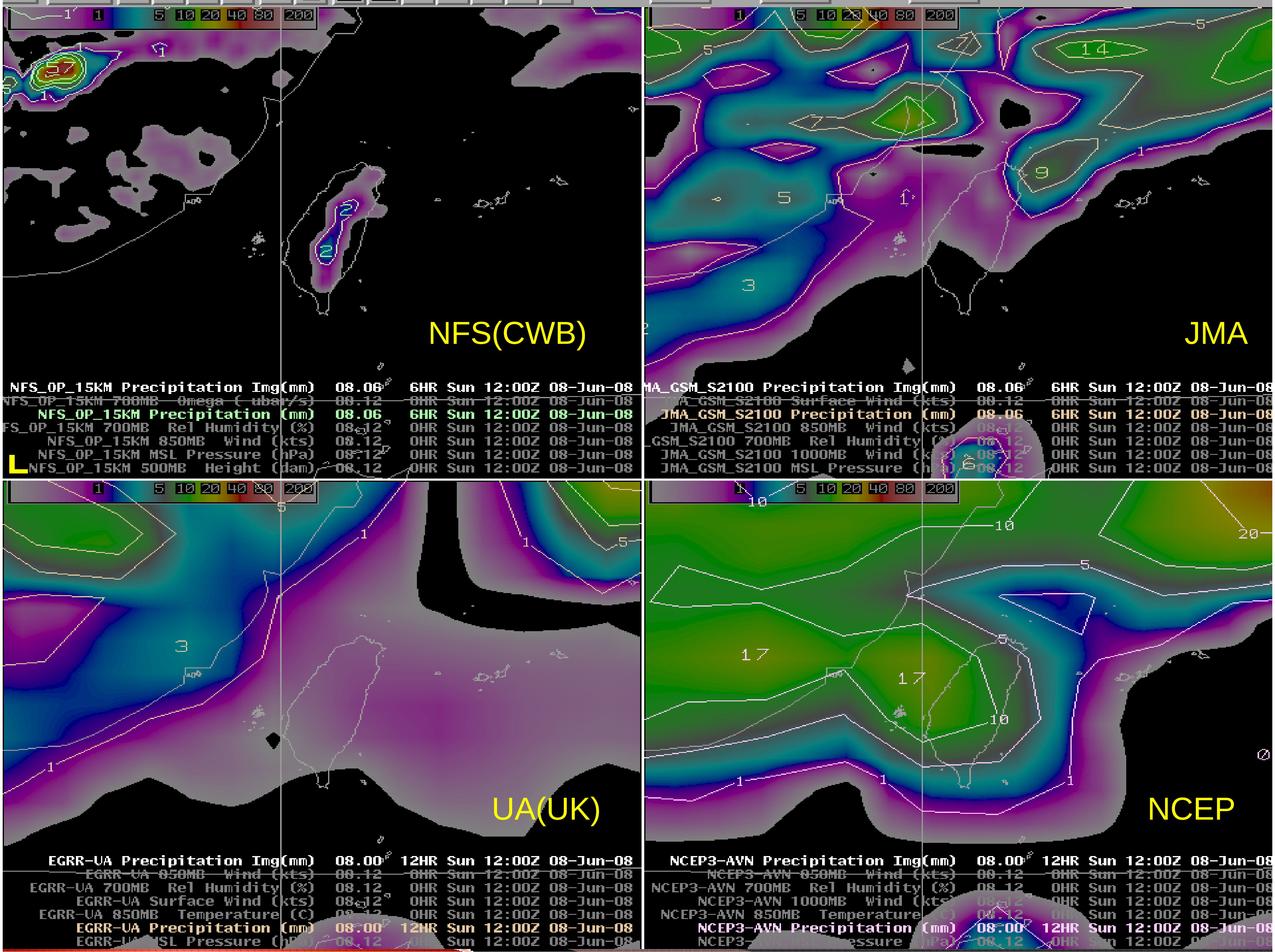

1 5 10 20 40 60 100 160 250
CWB-WRF
WRF_M02_15 Precipitation Img(mm) 31.06 3HR Sat 09:00Z 31-May-08
WRF_M02_15 Precipitation (mm) 31.06 3HR Sat 09:00Z 31-May-08

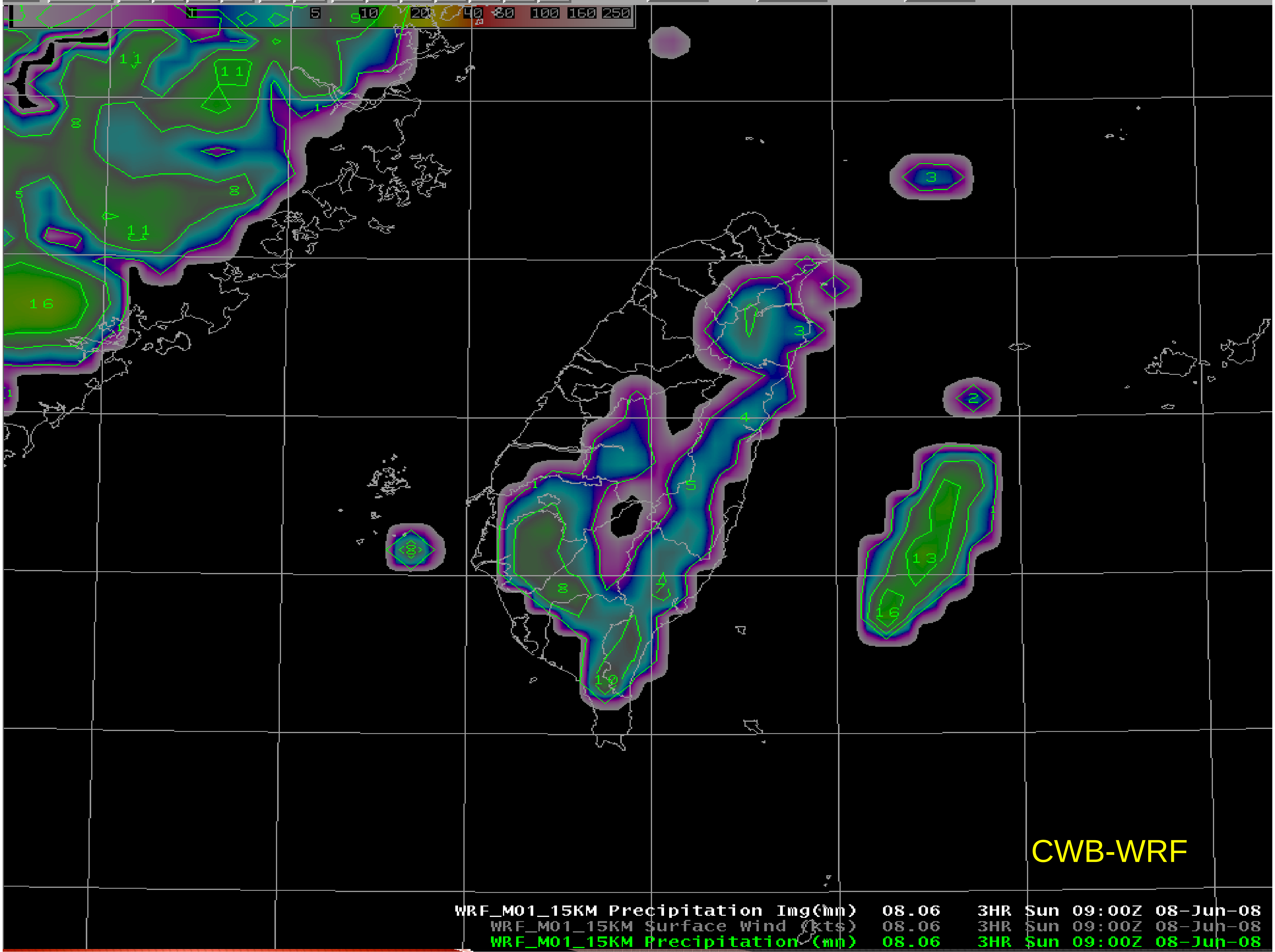
8 June 2008 – Locally-Driven Convection





Low level winds are from the south

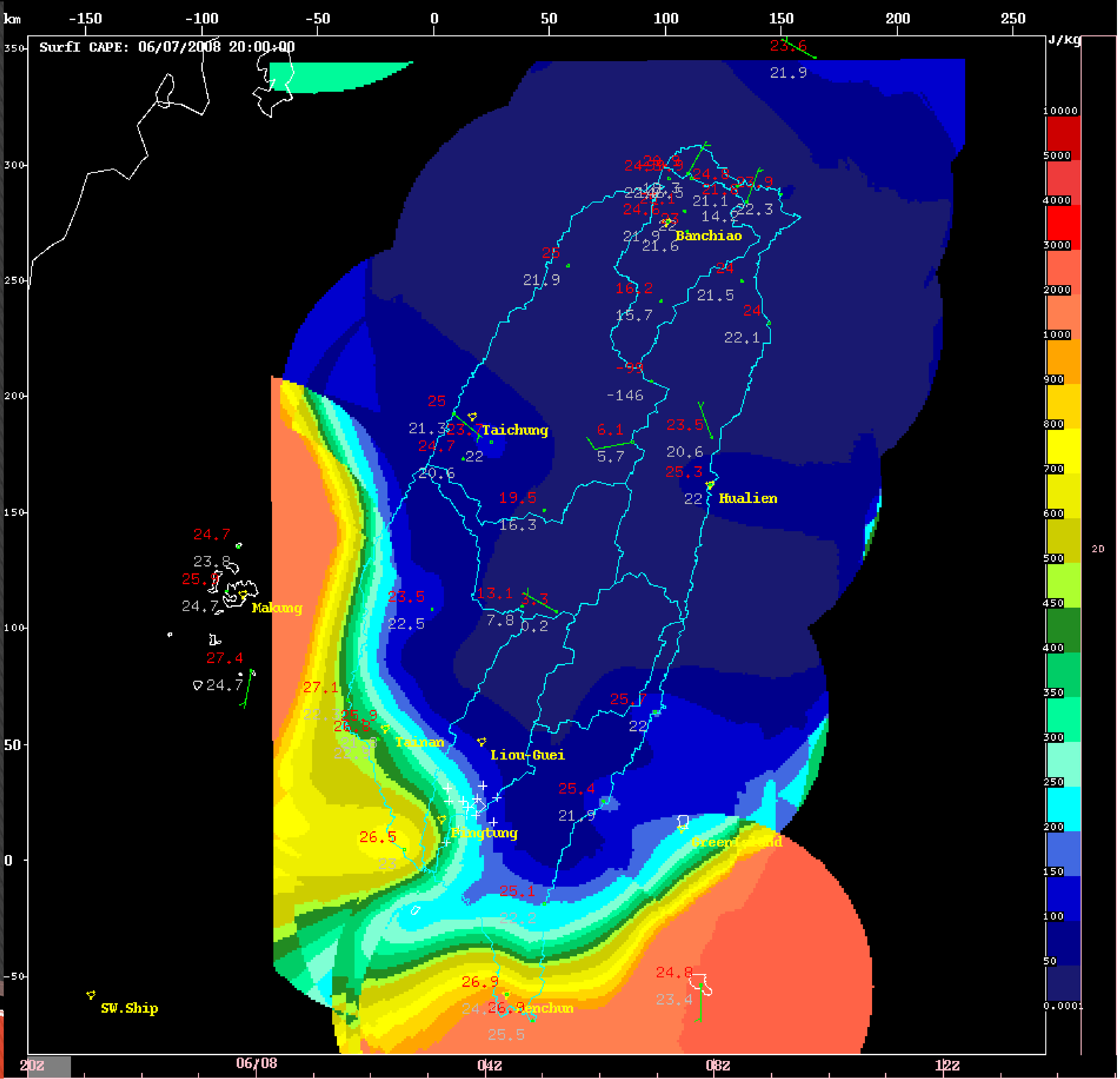

NFS(CWB)
NFS_OP_15KM Precipitation Img(mm) 08.06 6HR Sun 12:00Z 08-Jun-08
NFS_OP_15KM Precipitation (mm) 08.06 6HR Sun 12:00Z 08-Jun-08
NFS_OP_15KM 850MB Wind (kts) 08.12 0HR Sun 12:00Z 08-Jun-08
NFS_OP_15KM MSL Pressure (hPa) 08.12 0HR Sun 12:00Z 08-Jun-08
NFS_OP_15KM 500MB Height (dam) 08.12 0HR Sun 12:00Z 08-Jun-08
JMA
JMA_GSM_S2100 Precipitation Img(mm) 08.06 6HR Sun 12:00Z 08-Jun-08
JMA_GSM_S2100 Precipitation (mm) 08.06 6HR Sun 12:00Z 08-Jun-08
JMA_GSM_S2100 850MB Wind (kts) 08.12 0HR Sun 12:00Z 08-Jun-08
JMA_GSM_S2100 MSL Pressure 0HR Sun 12:00Z 08-Jun-08
UA(UK)
EGRR-UA Precipitation Img(mm) 08.00 12HR Sun 12:00Z 08-Jun-08
EGRR-UA 700MB Rel Humidity (%) 08.12 0HR Sun 12:00Z 08-Jun-08
EGRR-UA Surface Wind (kts) 08.12 0HR Sun 12:00Z 08-Jun-08
EGRR-UA 850MB Temperature (C) 0HR Sun 12:00Z 08-Jun-08
EGRR-UA Precipitation (mm) 08.00 12HR Sun 12:00Z 08-Jun-08
NCEP
NCEP3-AVN Precipitation Img(mm) 08.00 12HR Sun 12:00Z 08-Jun-08
NCEP3-AVN 700MB Rel Humidity (%) 08.12 0HR Sun 12:00Z 08-Jun-08
NCEP3-AVN 850MB Temperature 0HR Sun 12:00Z 08-Jun-08
NCEP3-AVN Precipitation (mm) 08.00 12HR Sun 12:00Z 08-Jun-08



5 10 20 40 80 100 160 250
CWB-WRF
WRF_M01_15KM Precipitation Img(mm) 08.06 3HR Sun 09:00Z 08-Jun-08
WRF_M01_15KM Surface Wind (kts) 08.06 3HR Sun 09:00Z 08-Jun-08
WRF_M01_15KM Precipitation (mm) 08.06 3HR Sun 09:00Z 08-Jun-08

8 June

CAPE



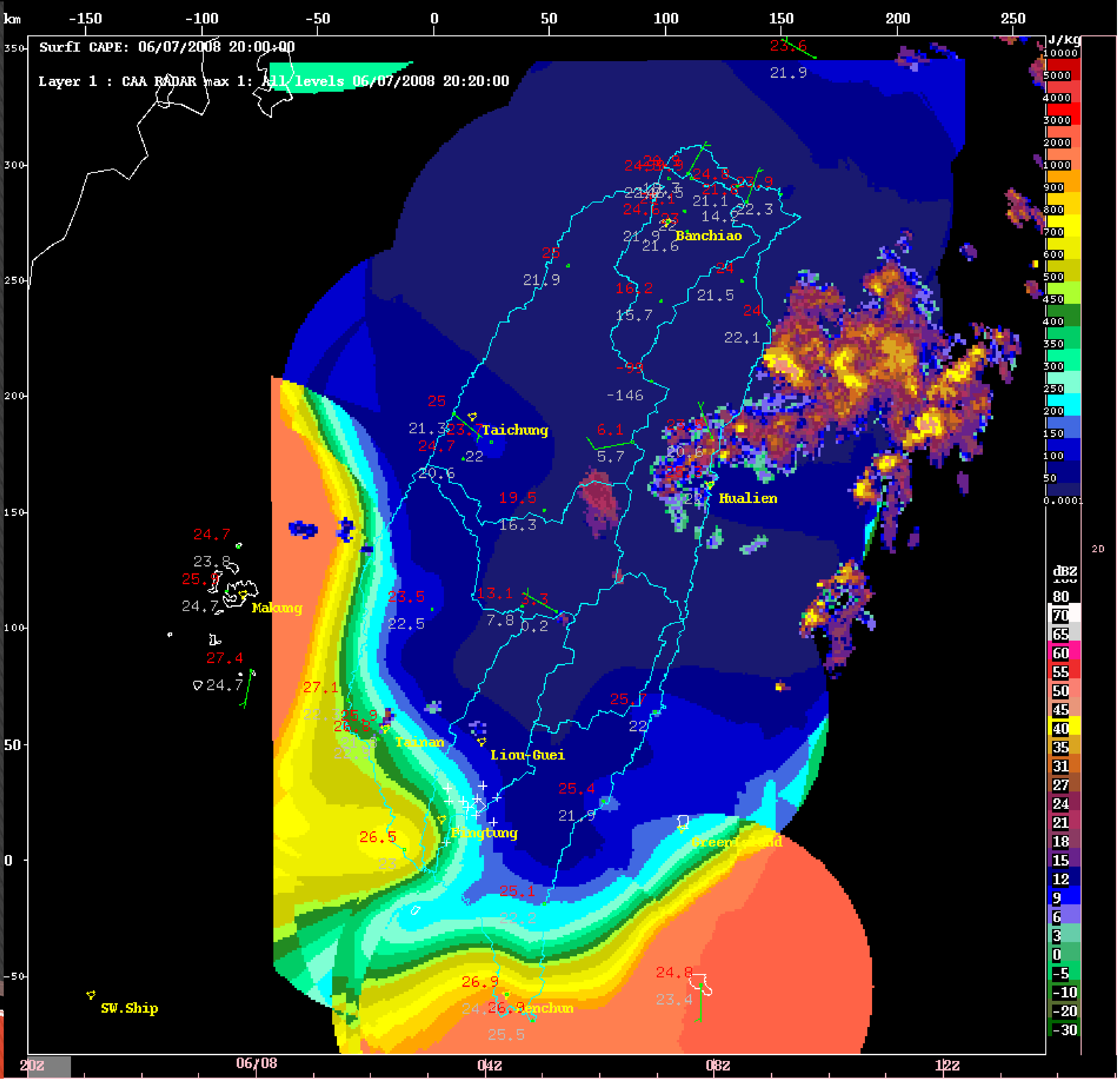
SurfI CAPE: 06/07/2008 20:00:00
km
J/kg
Banchiao
Taichung
Hualien
Makung
Tainan
Liou-Guei
Pingtung
Greenisland
Henchun
SW.Ship
10000
5000
4000
3000
2000
1000
900
800
700
600
500
450
400
350
300
250
200
150
100
50
0.0001
20Z
06/08
04Z
08Z
12Z

8 June

CAPE

Taiwan radar reflectivity mosaic overlaid

Strong convection develops in central Taiwan From 06:00 – 07:00 UTC



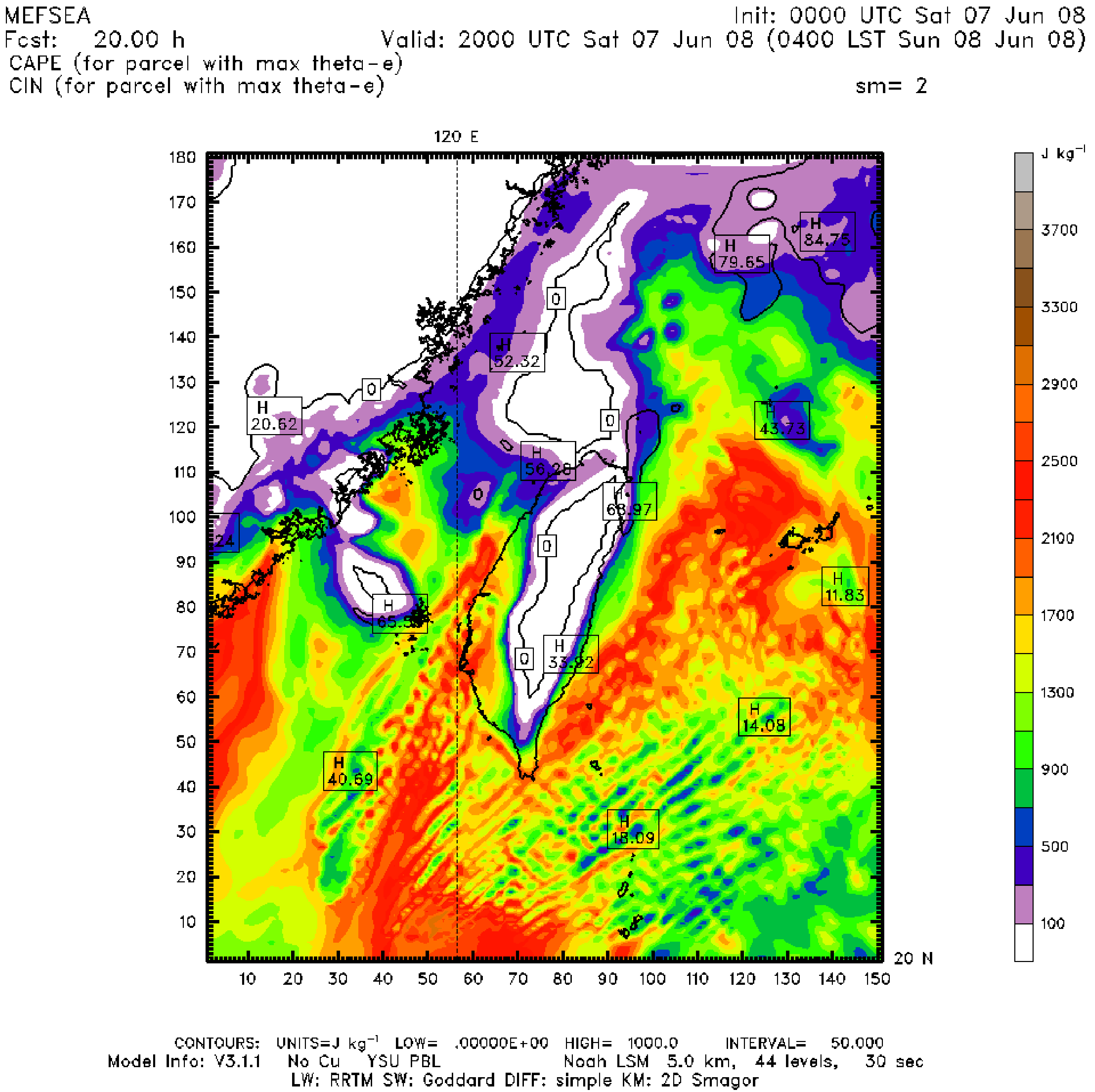
8 June

CWBWRF

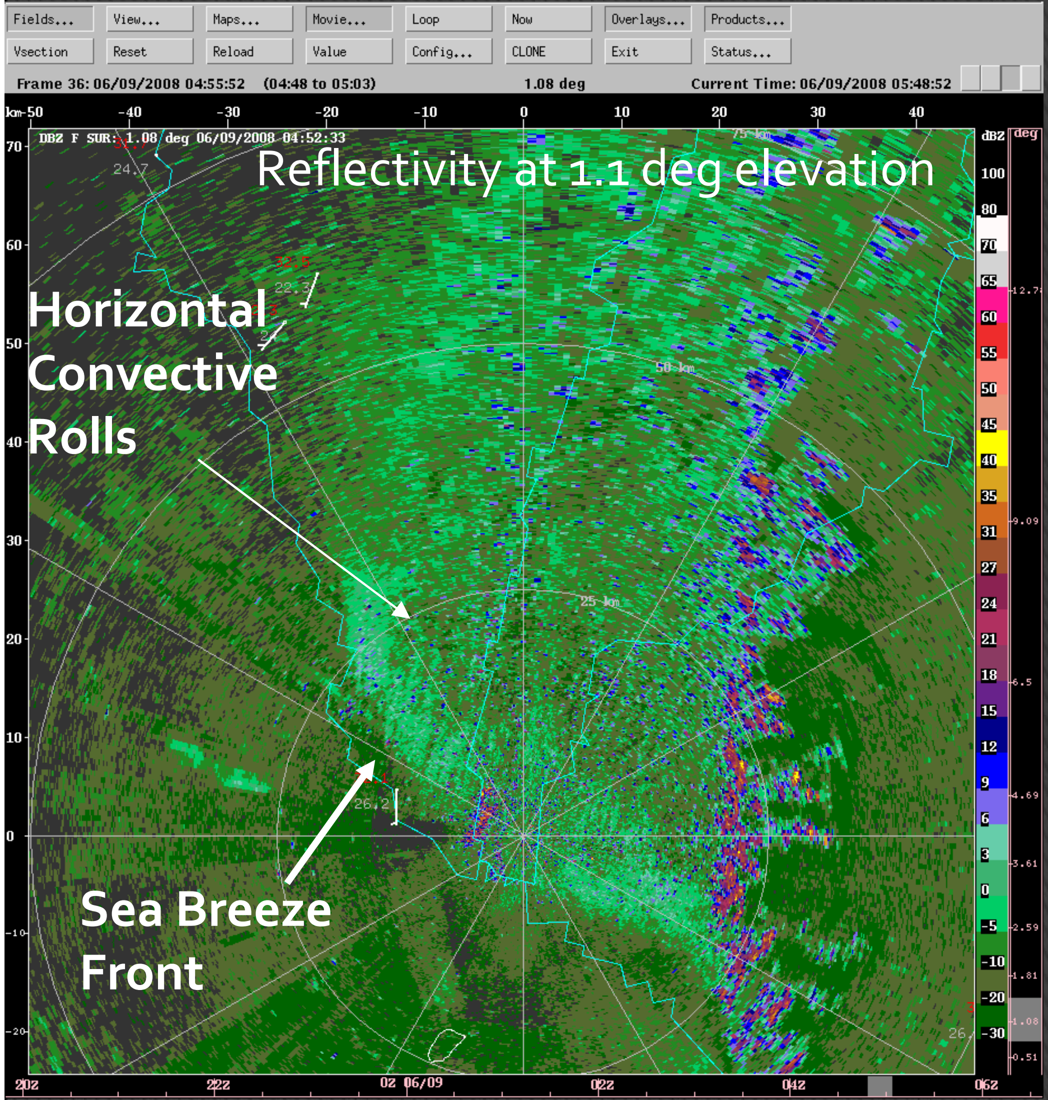
CAPE/CIN loop

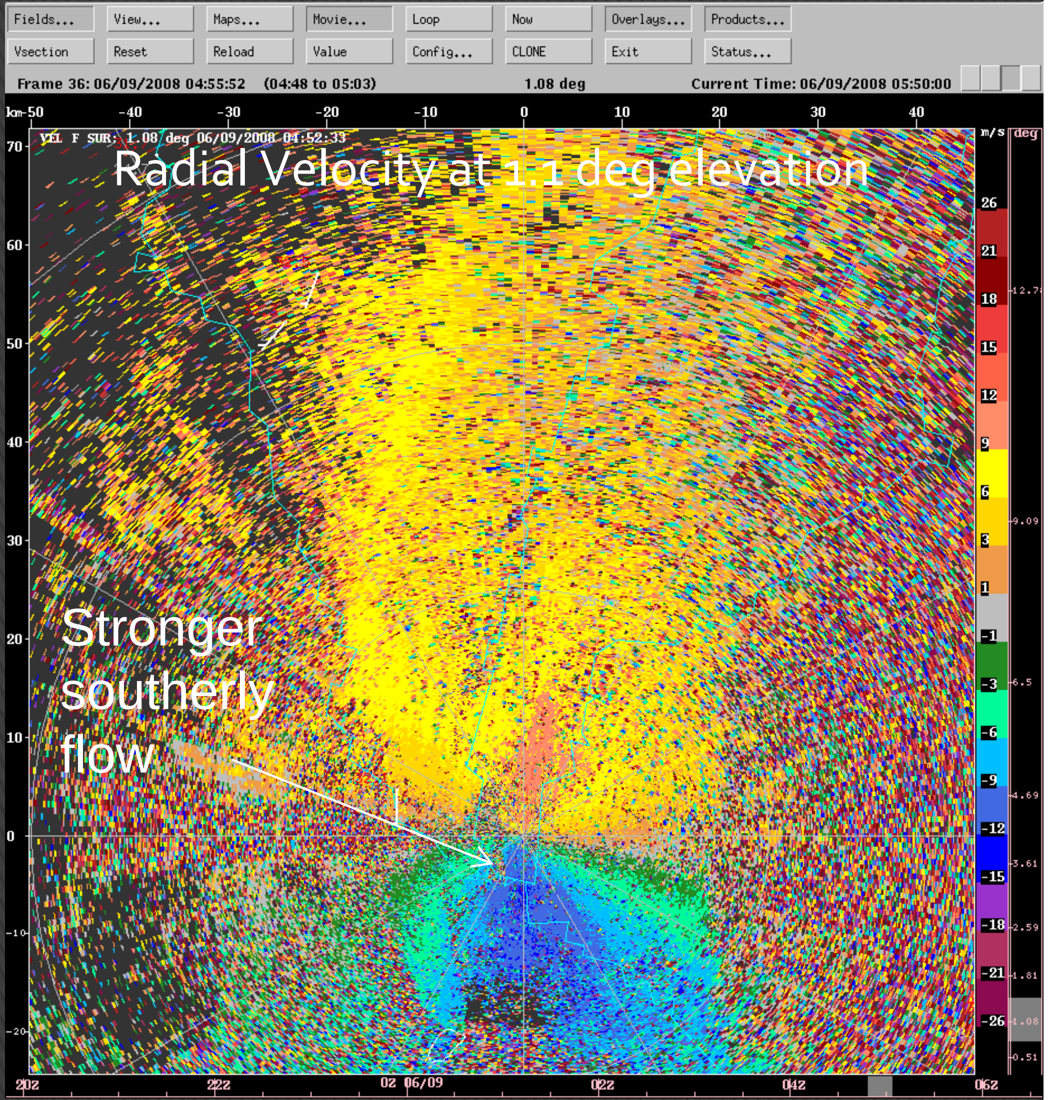
Afternoon convection initiates from 06:00-07:00 UTC

Timing of higher CAPE values along the plains is good, but not specific to where convection actually breaks out

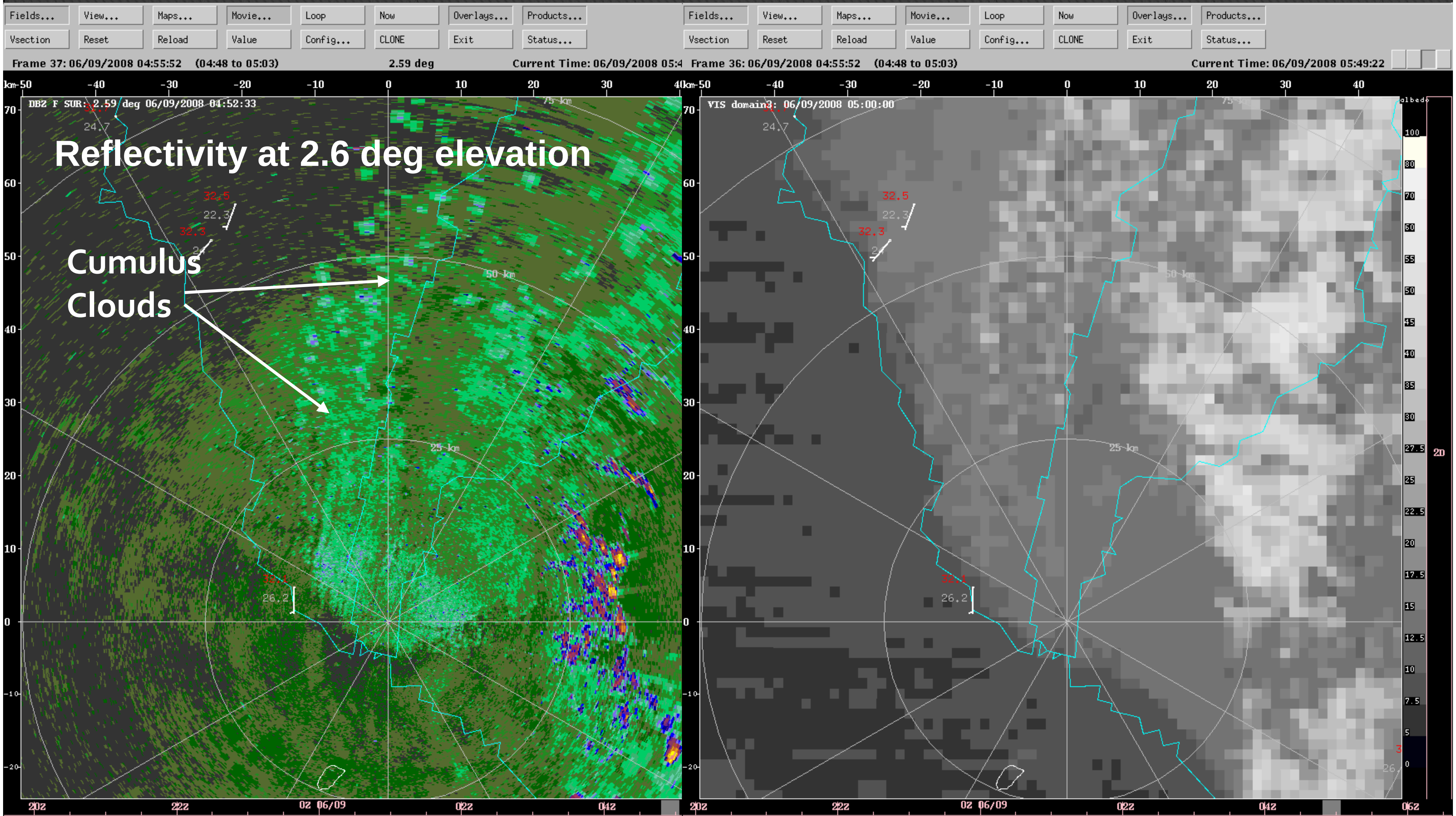


9 June –Locally-Driven Convection with approaching short-wave disturbance



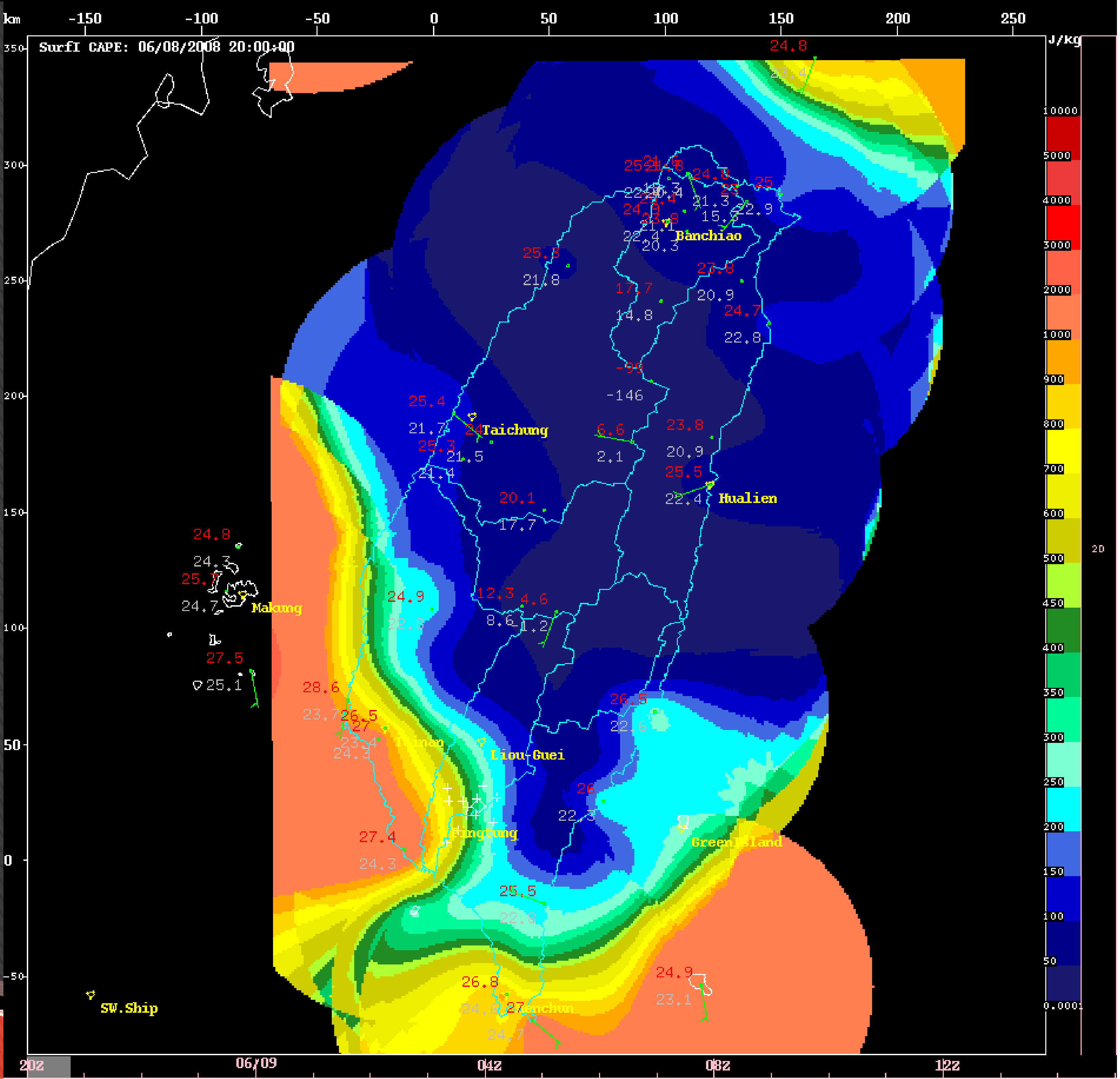


9 June – 05:00 UTC



9 June

CAPE



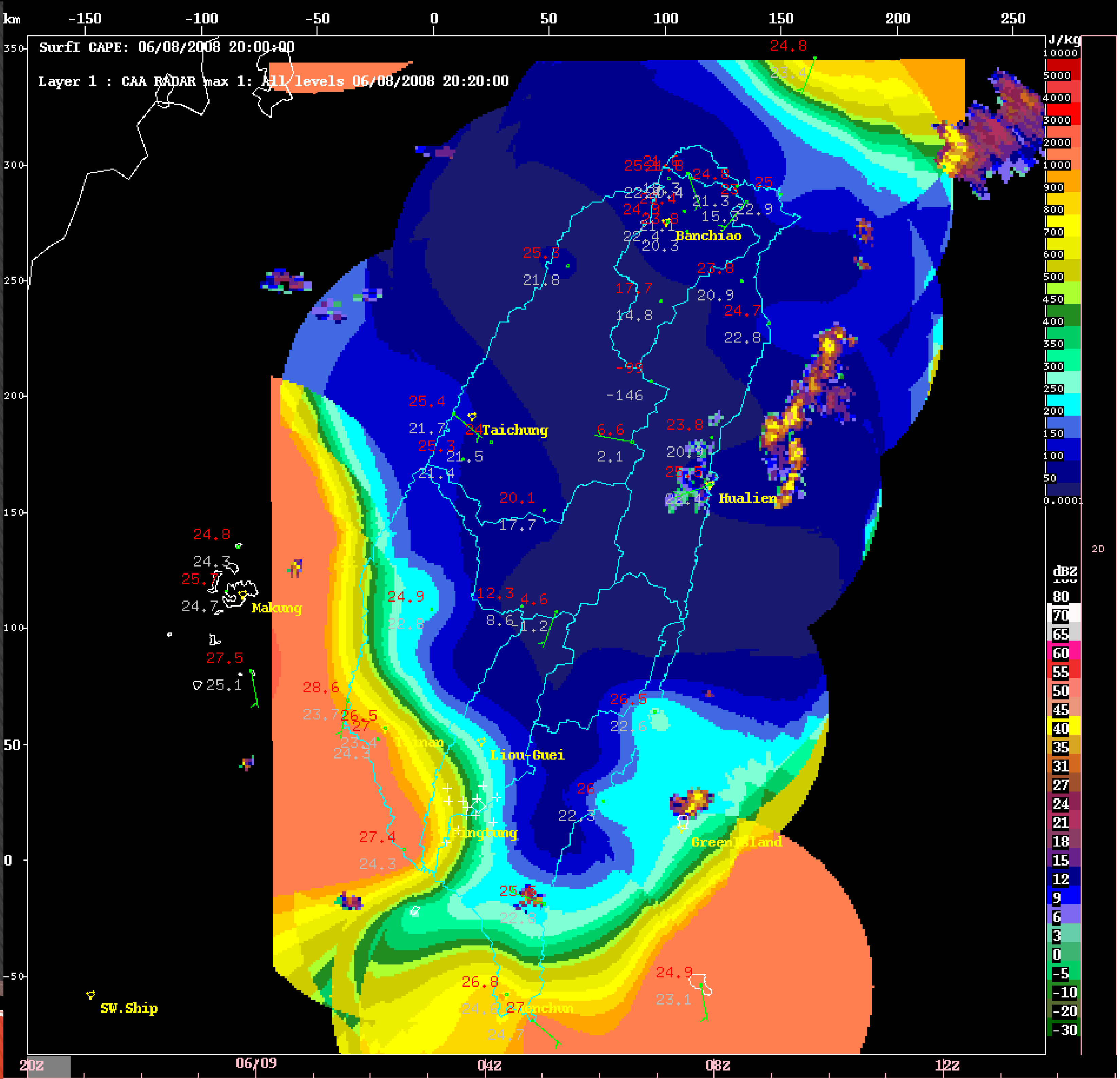
Surfl CAPE: 06/08/2008 20:00:00
km
J/kg
Banchiao
Taichung
Hualien
Makung
Liou-Guei
Green Island
SW.Ship
06/09

9 June

CAPE

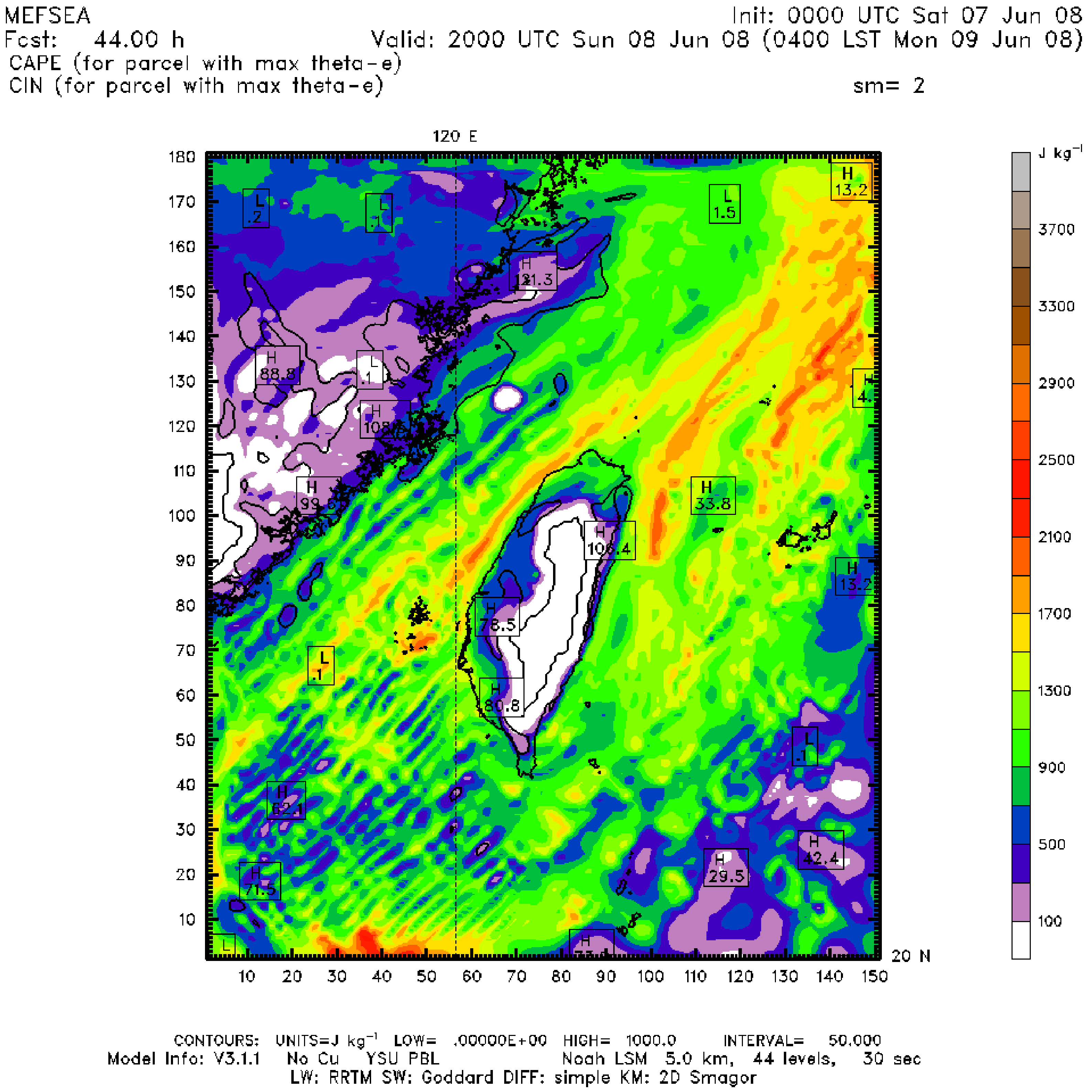
Taiwan radar reflectivity mosaic overlaid

Convection initiates at ~ 06:00 UTC in central and northern Taiwan

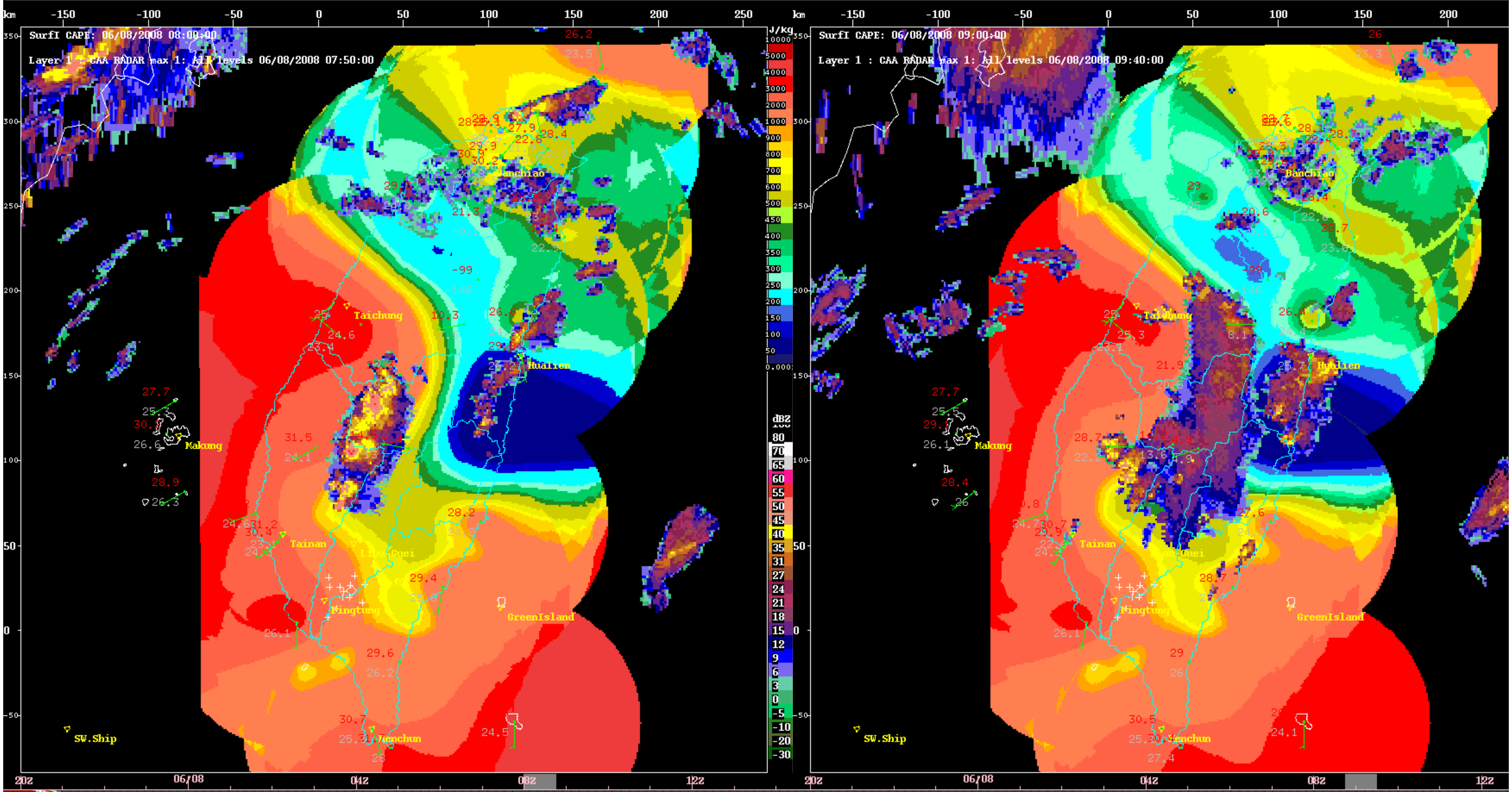


9 June

CWBWRF



Predictability For Dissipation of Convection



IMPRESSIONS

- Plan to use 1 min surface station data posted on SOWMEX/TiMREX web site to evaluate CAPE and CIN fields under rapidly evolving situations.
- Need good QC of the surface data
  - T_d is not recorded at all stations and it is "missing" from stations that do measure this field
  - Braun has noted that there are a large number of temperature "outlier " values that got thrown out in the QC processing
  - Although wind measurements were not used in this study, we noticed that these measurements seem to fluctuate frequently and specific problematic stations need to be flagged
- Highly desirable to have as many surface stations located on the western Plains as possible for short-term nowcasting applications.
- Although we used the V3 sounding data set, there were still a couple of problematic soundings in the data set. We need to modify our algorithm to make better used of the QC flags provided in the data files.

Implications for Nowcasting

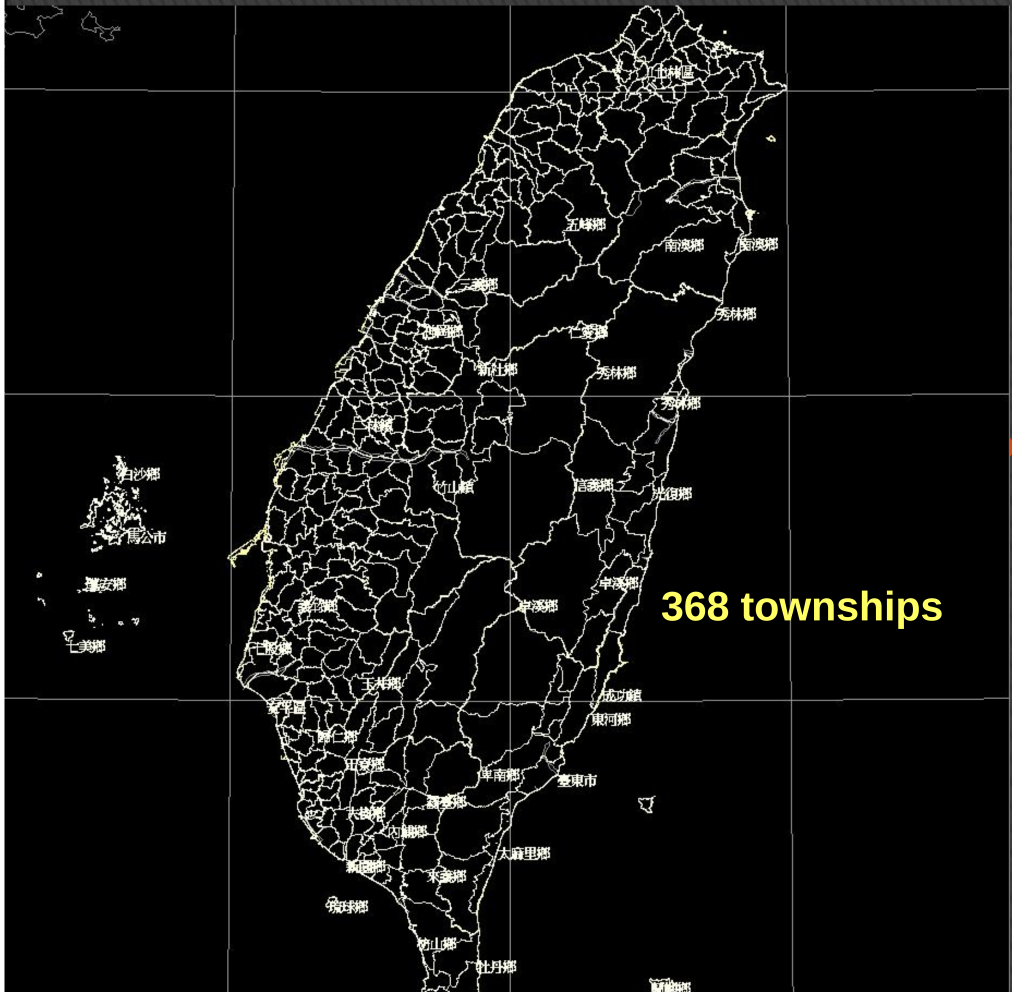
- Taiwan atmosphere generally has high instability as evident from an abundance of CAPE and very little CIN.
- With plenty of available surface moisture, reaching convective temperature (CT) is likely a large contributor to the timing of convection, as evident in the high correlation between maximum CAPE , maximum surface temperature and initiation of storms along the foothills of the terrain, for the two non-synoptic days examined.
- In contrast to the U.S. where tracking the decrease in CIN is a useful field in the prediction storm initiation, in Taiwan the CIN field may not likely be a robust identifier for the onset of new convection (except perhaps on more stable days with capping inversions).

Implications for Nowcasting

- For nowcasting purposes, these CAPE/CIN fields are likely to be most useful in defining more specific areas for the likelihood of new storm development on non-synoptically -driven days, when the NWP models struggle to forecast the exact locations for precipitation (as seen on 8 June).

- Under synoptic situations, these fields may also be useful in predicting whether convection will be sustained or will dissipate as it moves onshore from ocean -to-land or as it moves over the higher terrain.

Ongoing Efforts



- Evaluate several of the TiMREX cases events to assess the utility of the CAPE/CIN fields from NWP, VDRAS and observational datasets for short-term nowcasting applications under synoptic and non-synoptic situations.
- These fields will be evaluated in conjunction with other feature detection “interest” fields in order to produce localized nowcasts of heavy precipitation for the Taiwan townships.