# The Inter-Tropical Convergence Zone

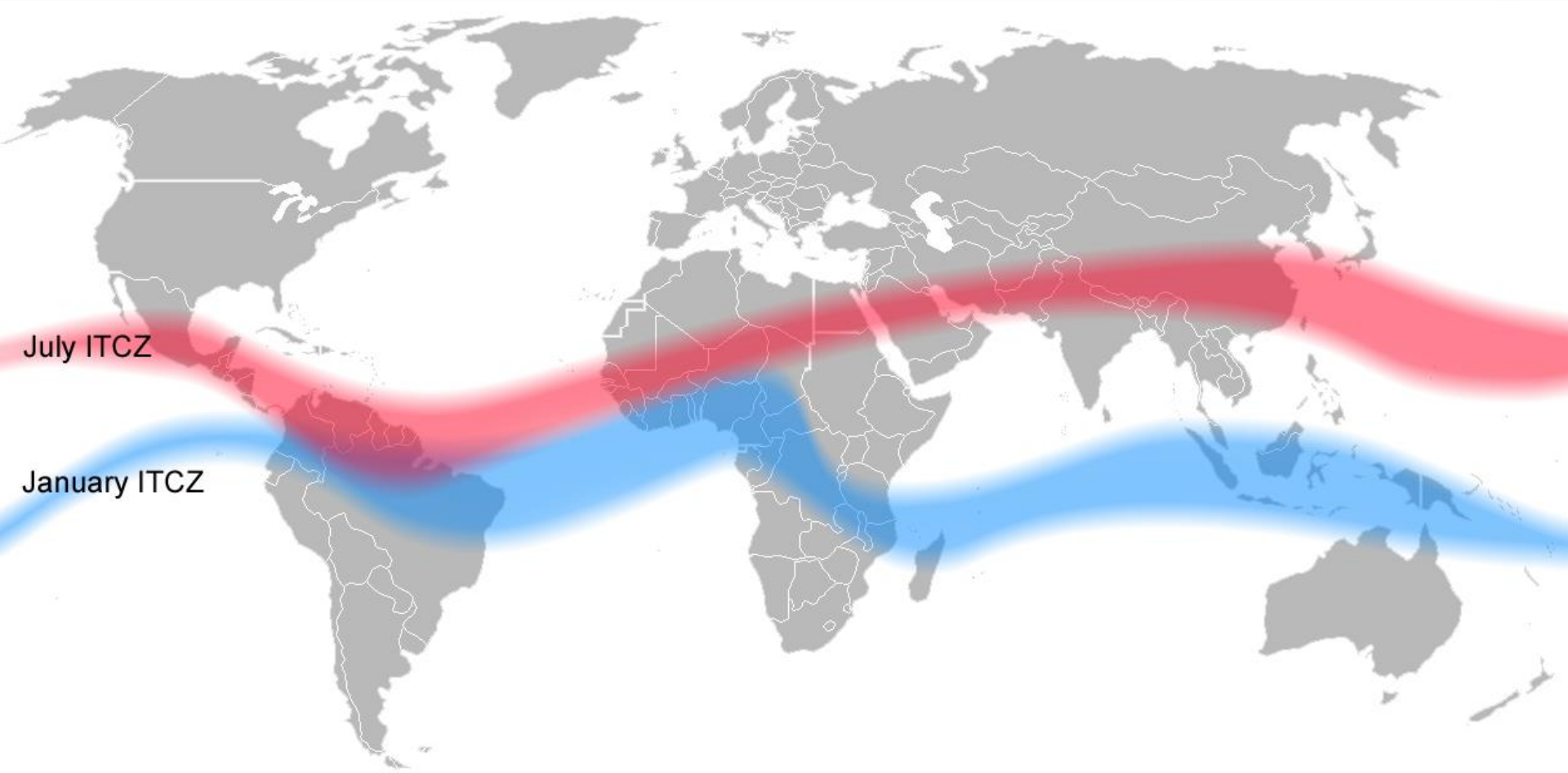
**A Quick Look at the Large-Scale Tropical Circulation**

**Owen Shieh**

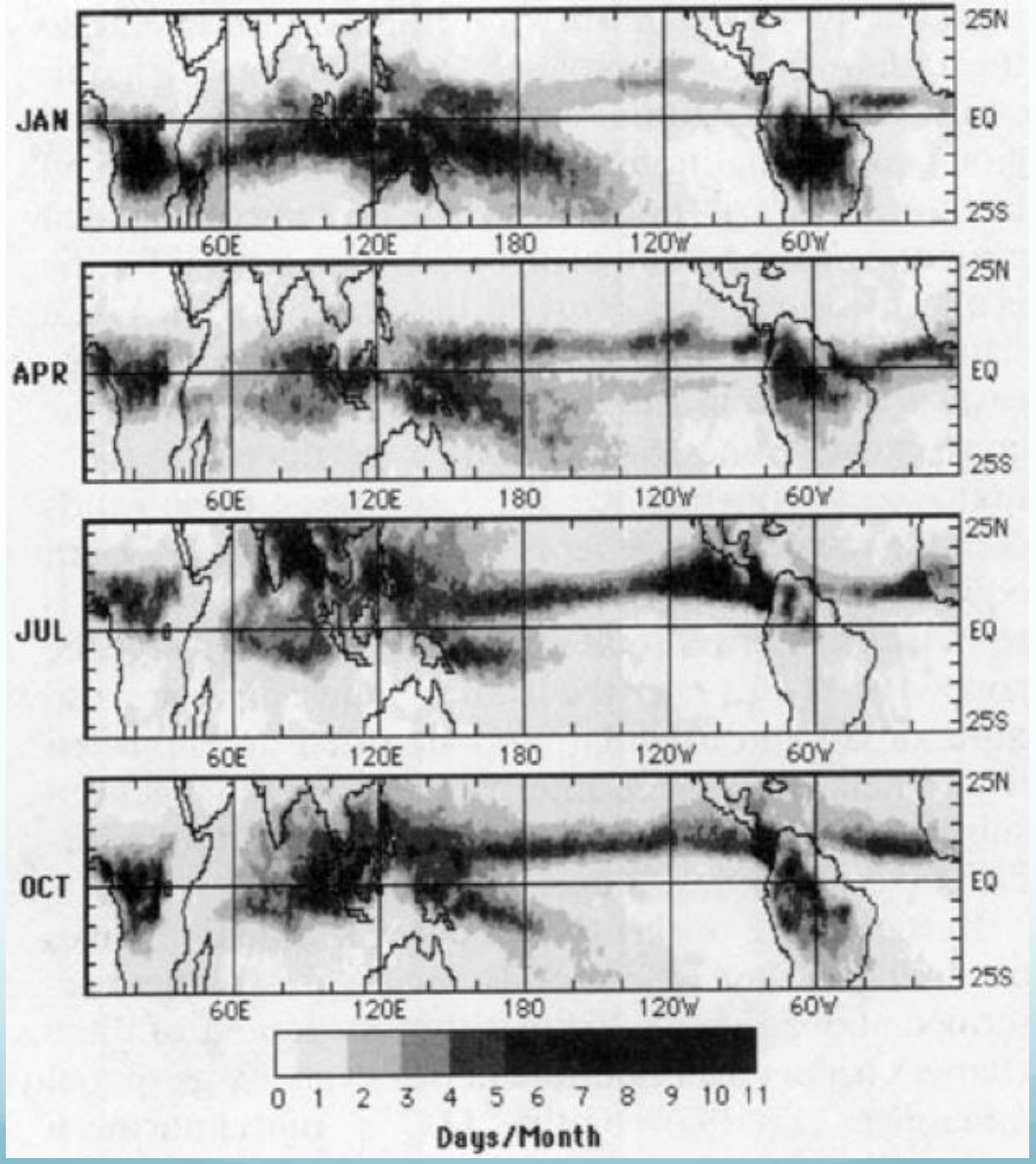
CONRAST Science Meeting

February 12, 2014

# Average ITCZ… is it this simple?



# Actual Seasonal ITCZ Variability



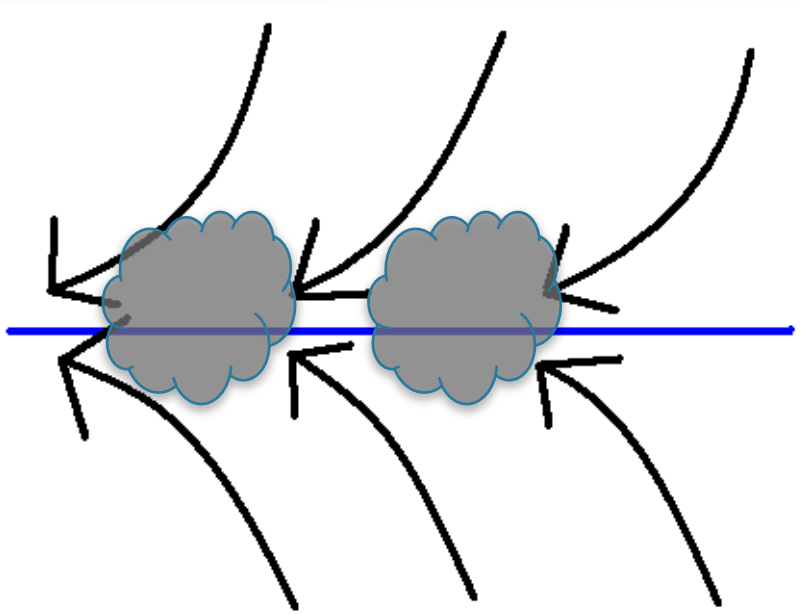

**Waliser and Gautier (1993)**

# Why Streamlines?

- Pressure and geopotential heights are traditionally used to track weather systems… except in the tropics!
- Streamlines are used in the tropics because:
  - Horizontal pressure gradients are low in the tropics (e.g., redistribution by equatorial waves)
  - Semi-diurnal variations in pressure are usually greater than variations due to passing weather (except when there is a tropical cyclone)
  - Geostrophic wind approximations break down due to low Coriolis force

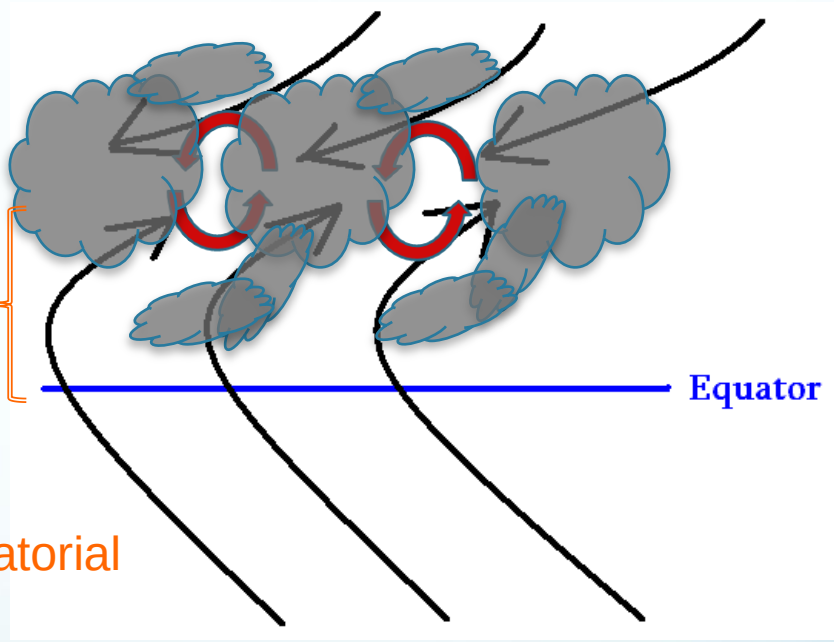
# Two Types of "ITCZ"

**Near-Equatorial Trade Wind Convergence (NETWC)**




Convergence with no cyclonic vorticity!

**Monsoon Trough (MT)**




Cross-equatorial flow results in equatorward westerlies.

Convergence with cyclonic vorticity!

# “ITCZ”

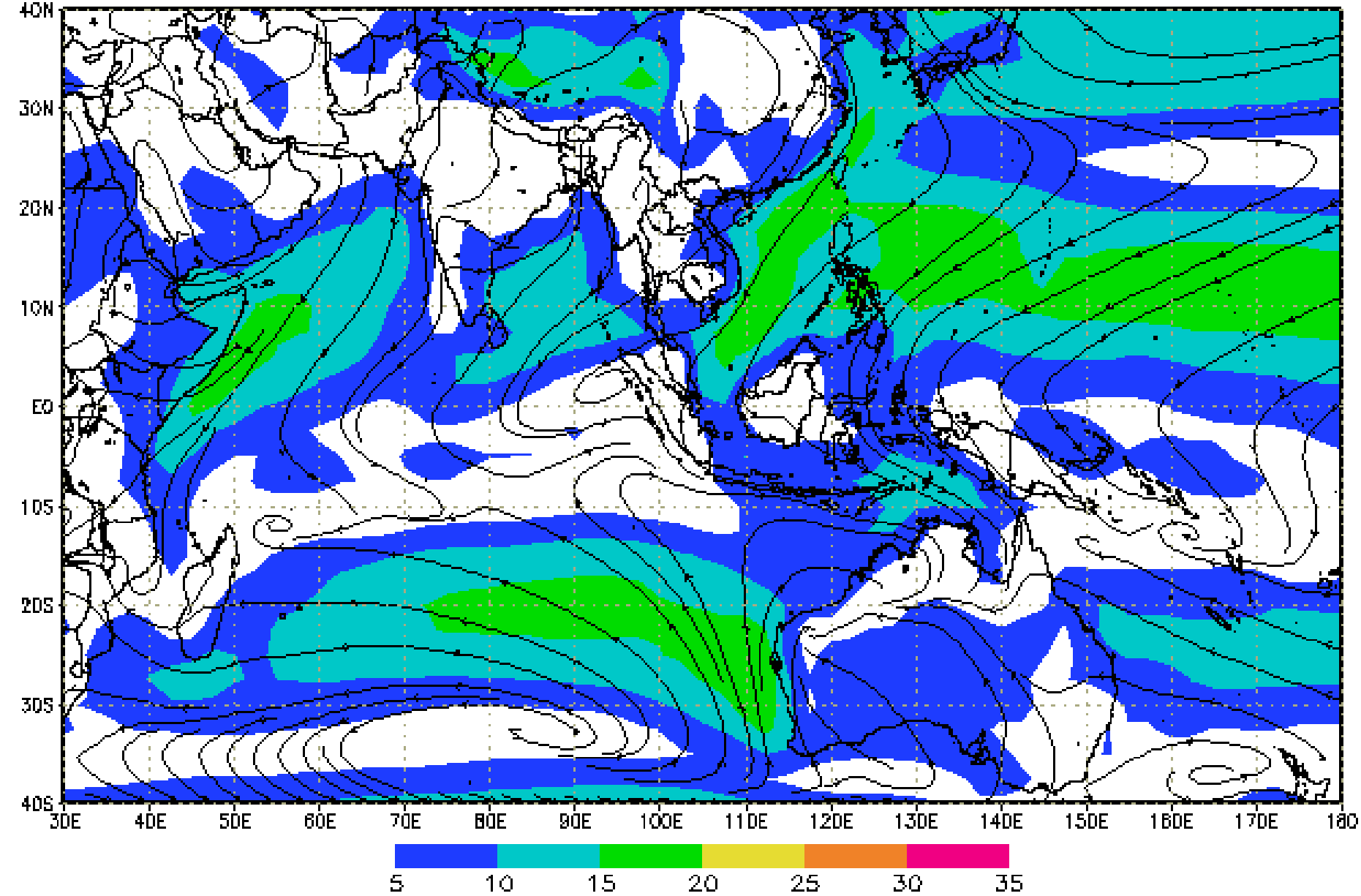
=

Near-Equatorial Trade Wind Convergence

+

Monsoon Trough

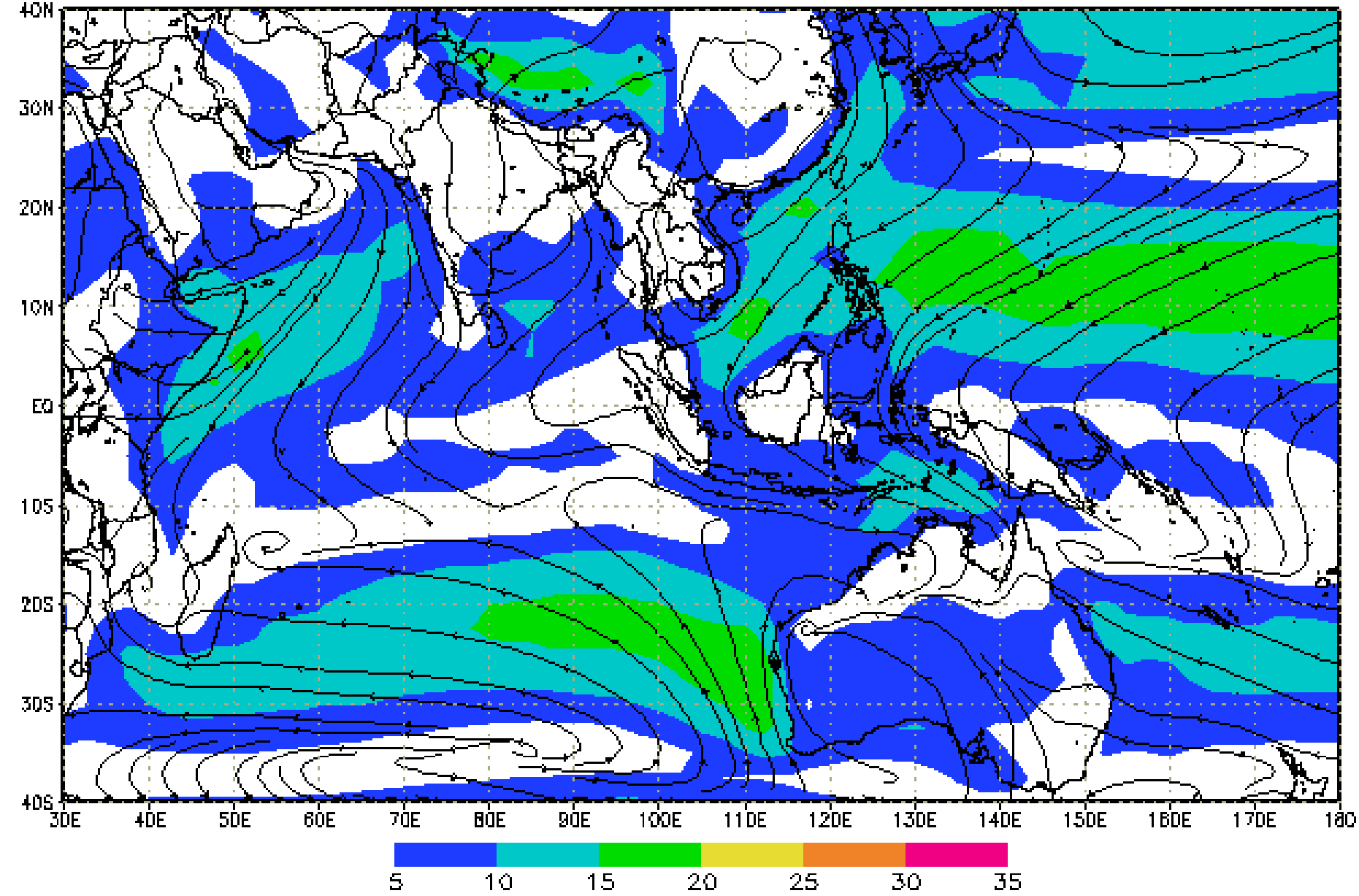
# January
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

Joint Typhoon Warning Center

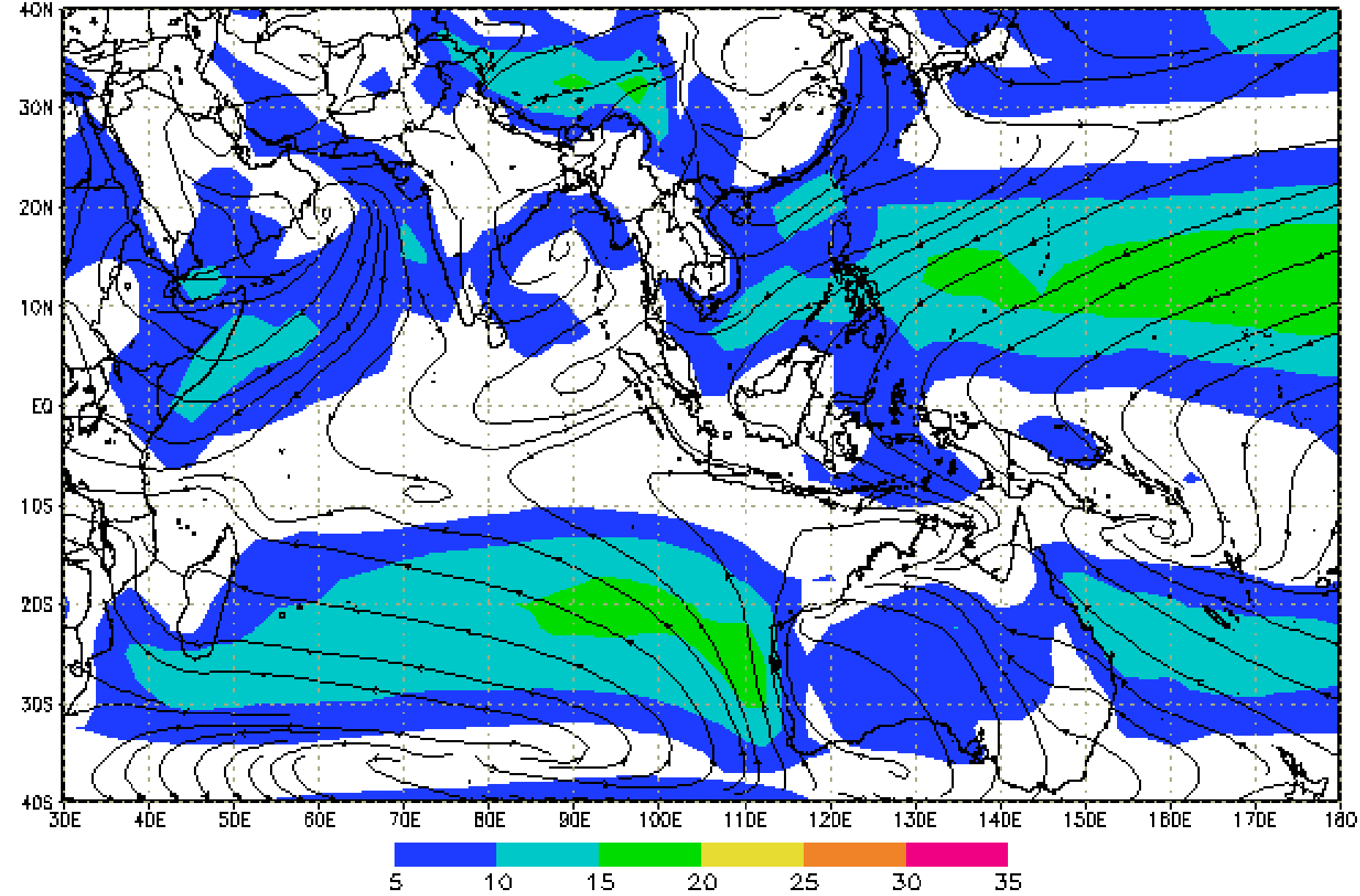
# February
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

Joint Typhoon Warning Center

# March
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

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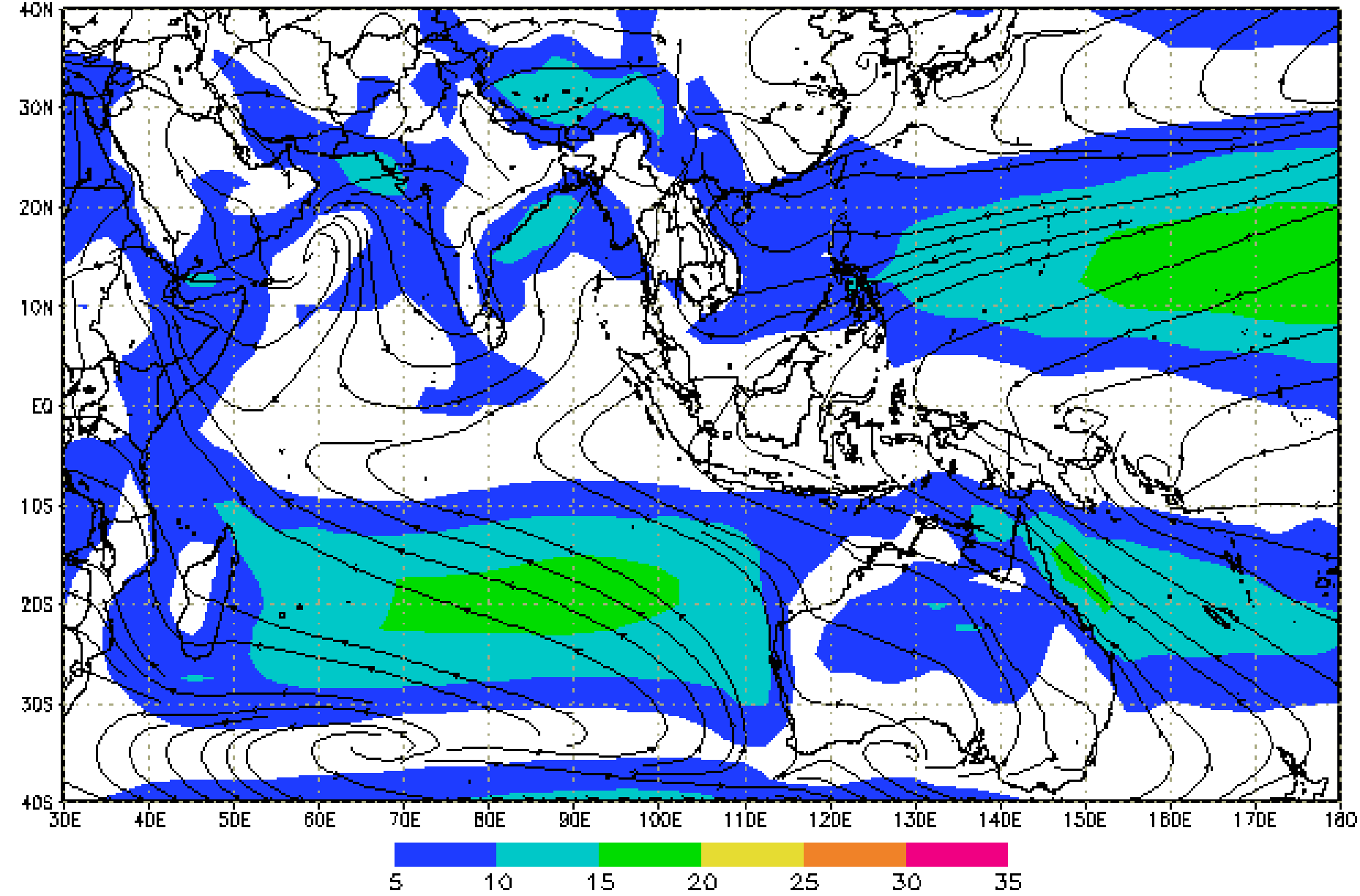
# April
# Resultant Surface Winds [kts]

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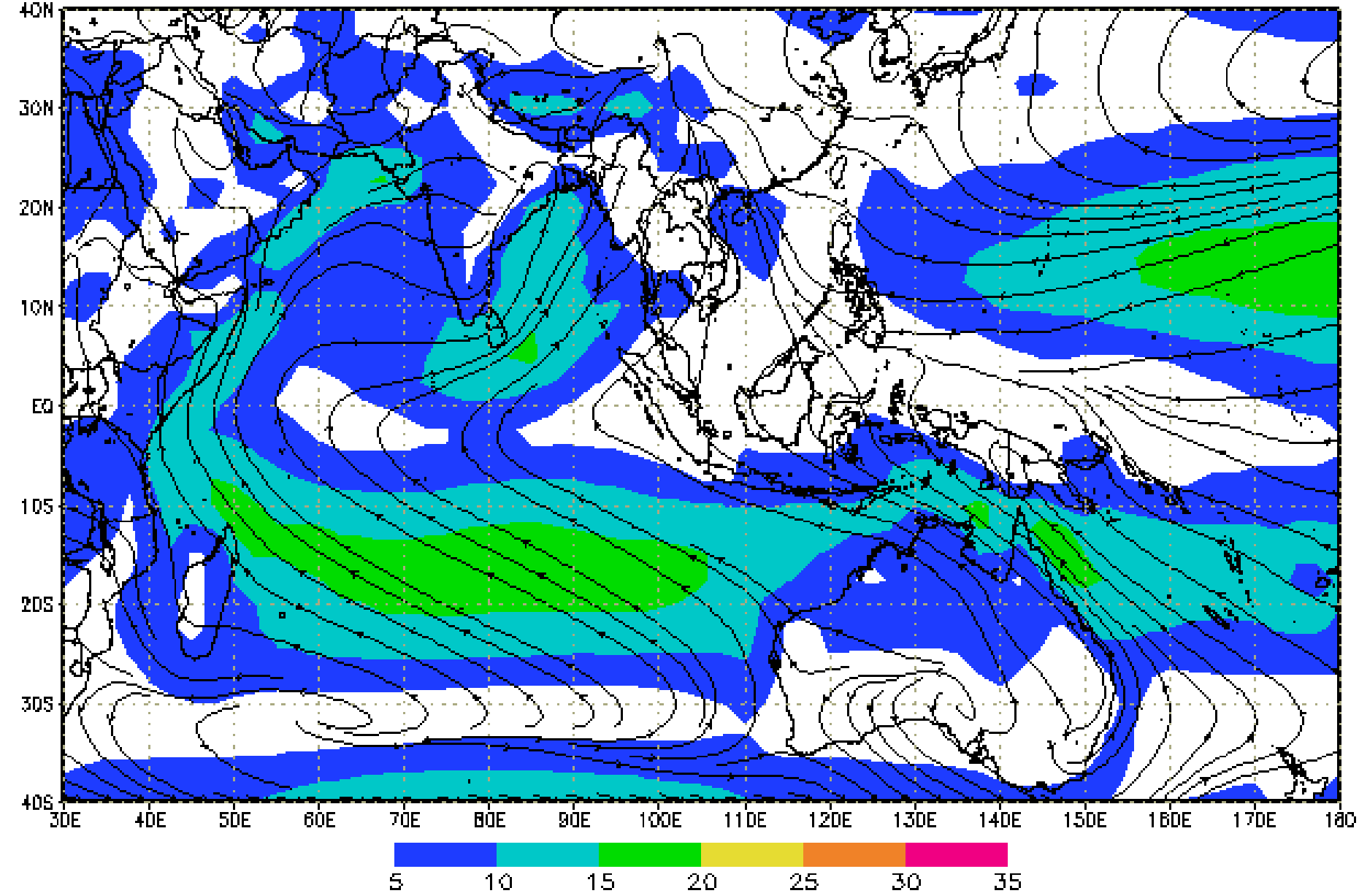
# May
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

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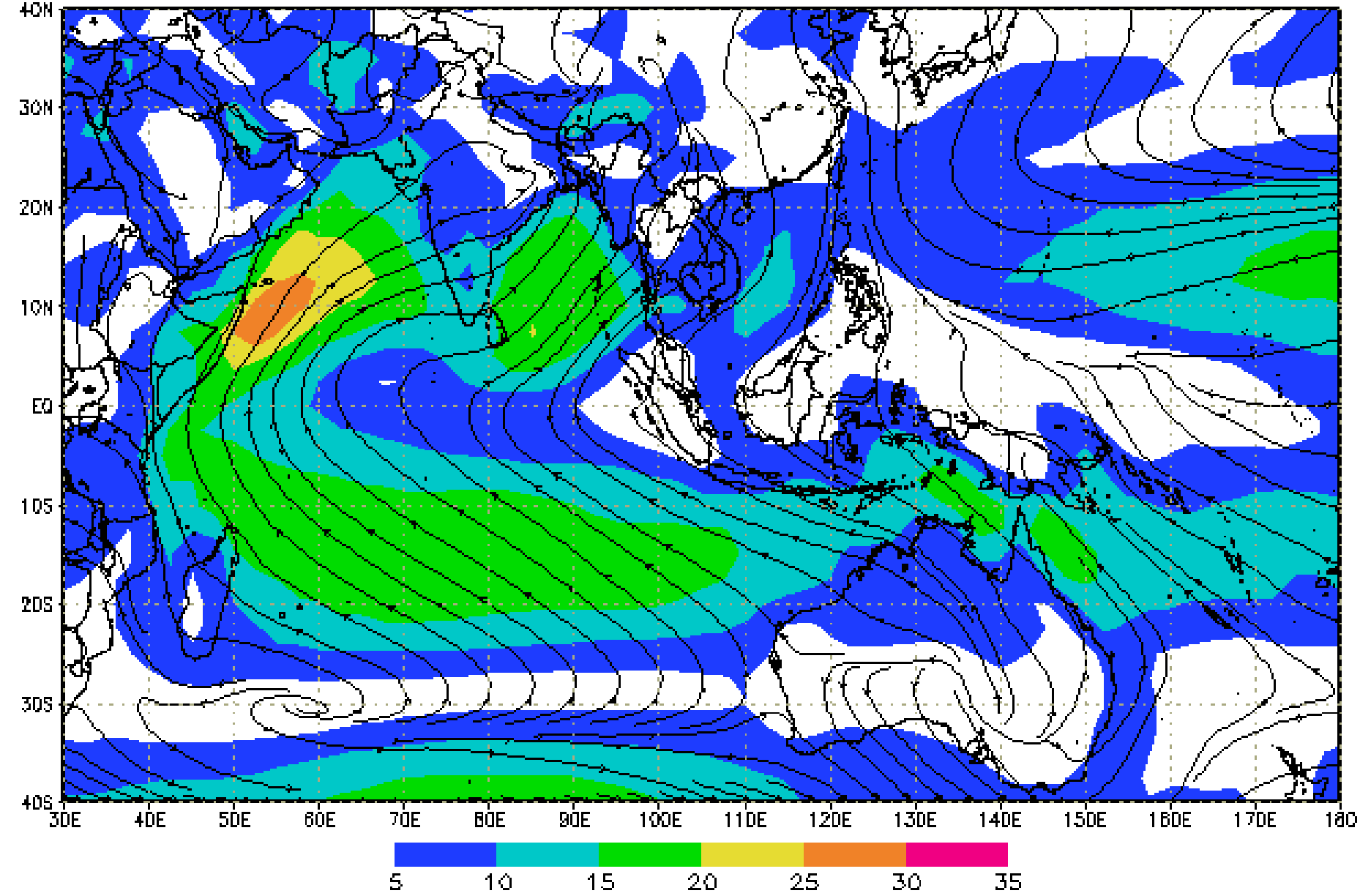
# June
# Resultant Surface Winds [kts]

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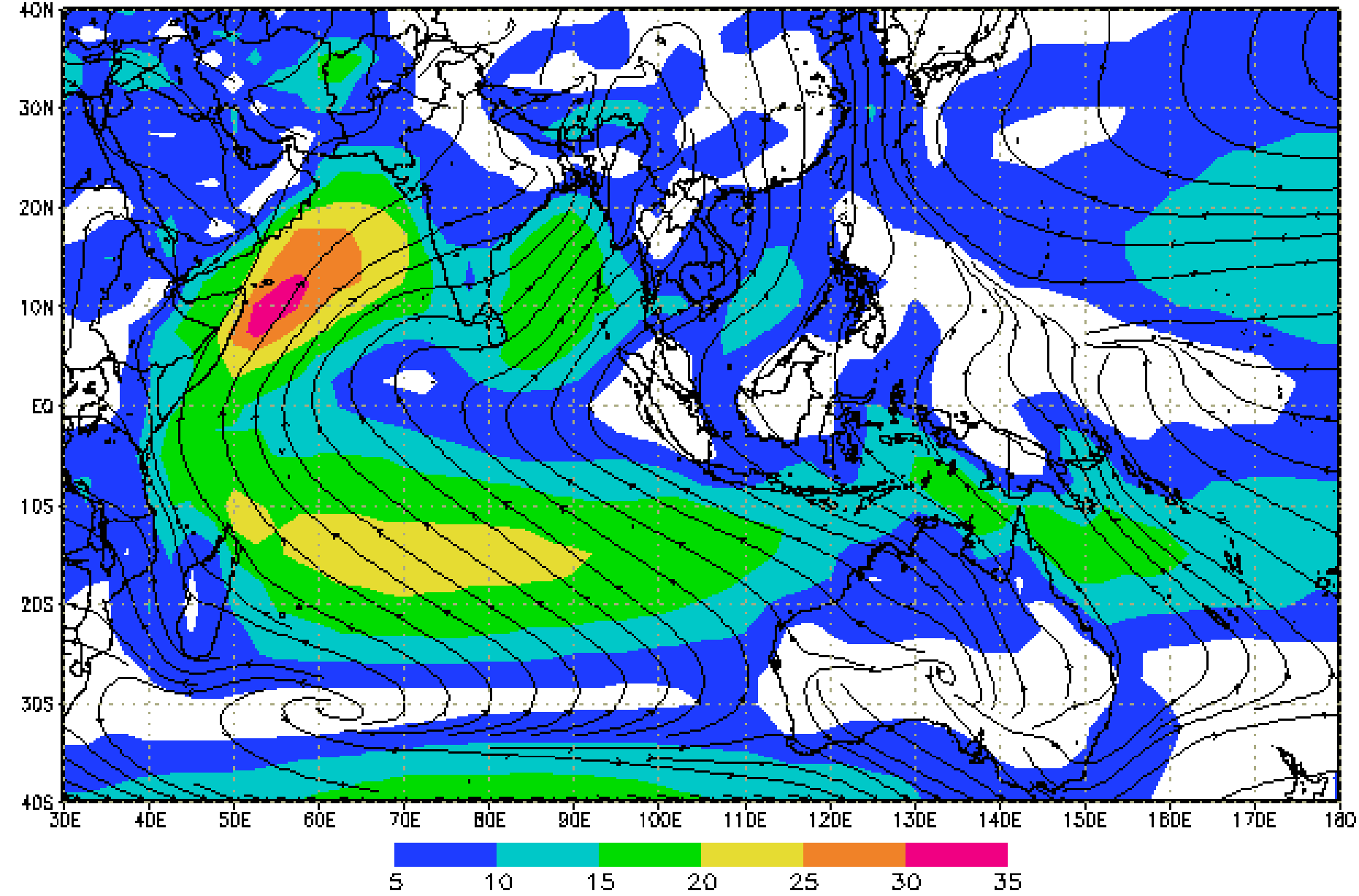
# July
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

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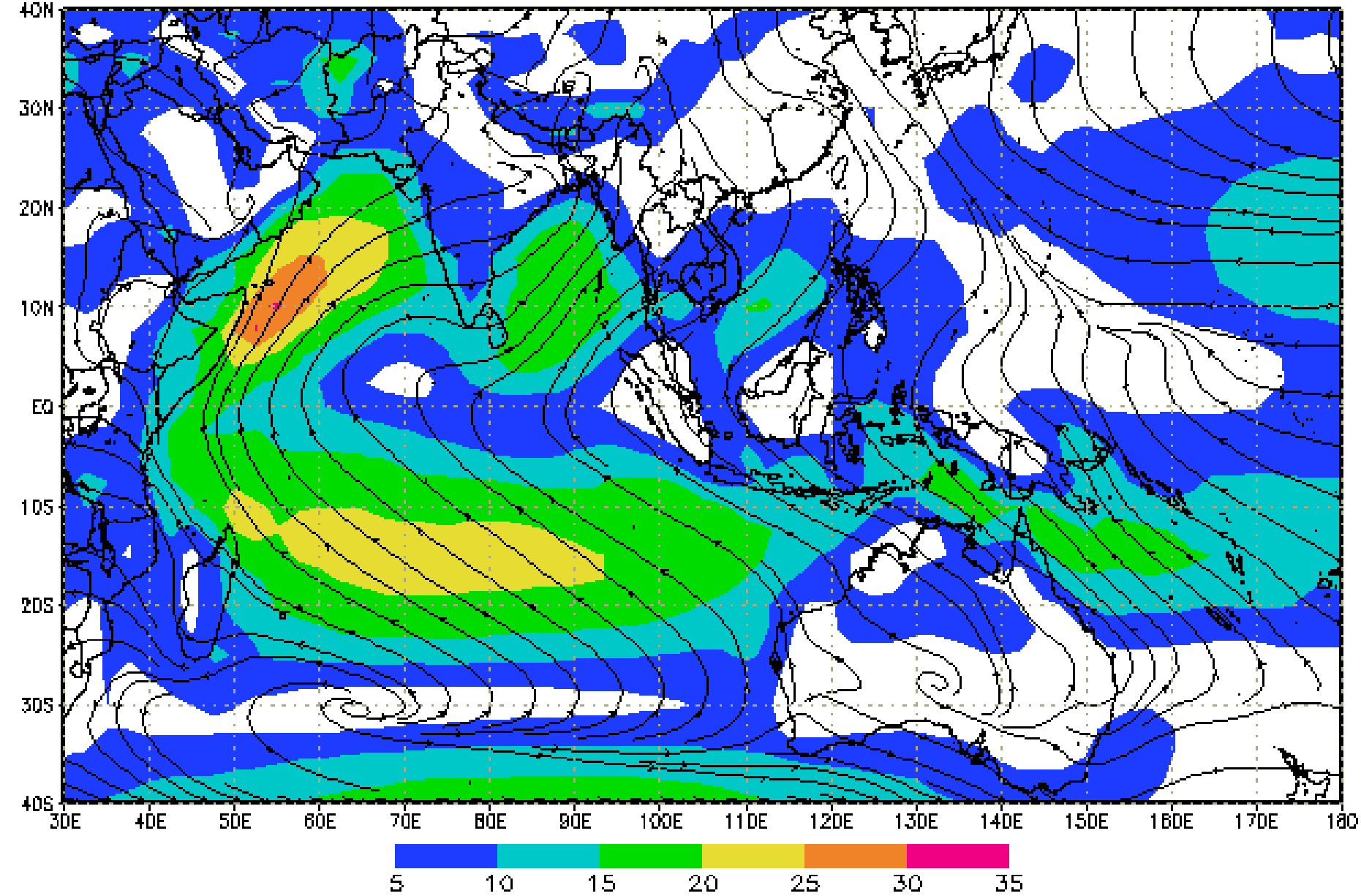
# August
# Resultant Surface Winds [kts]

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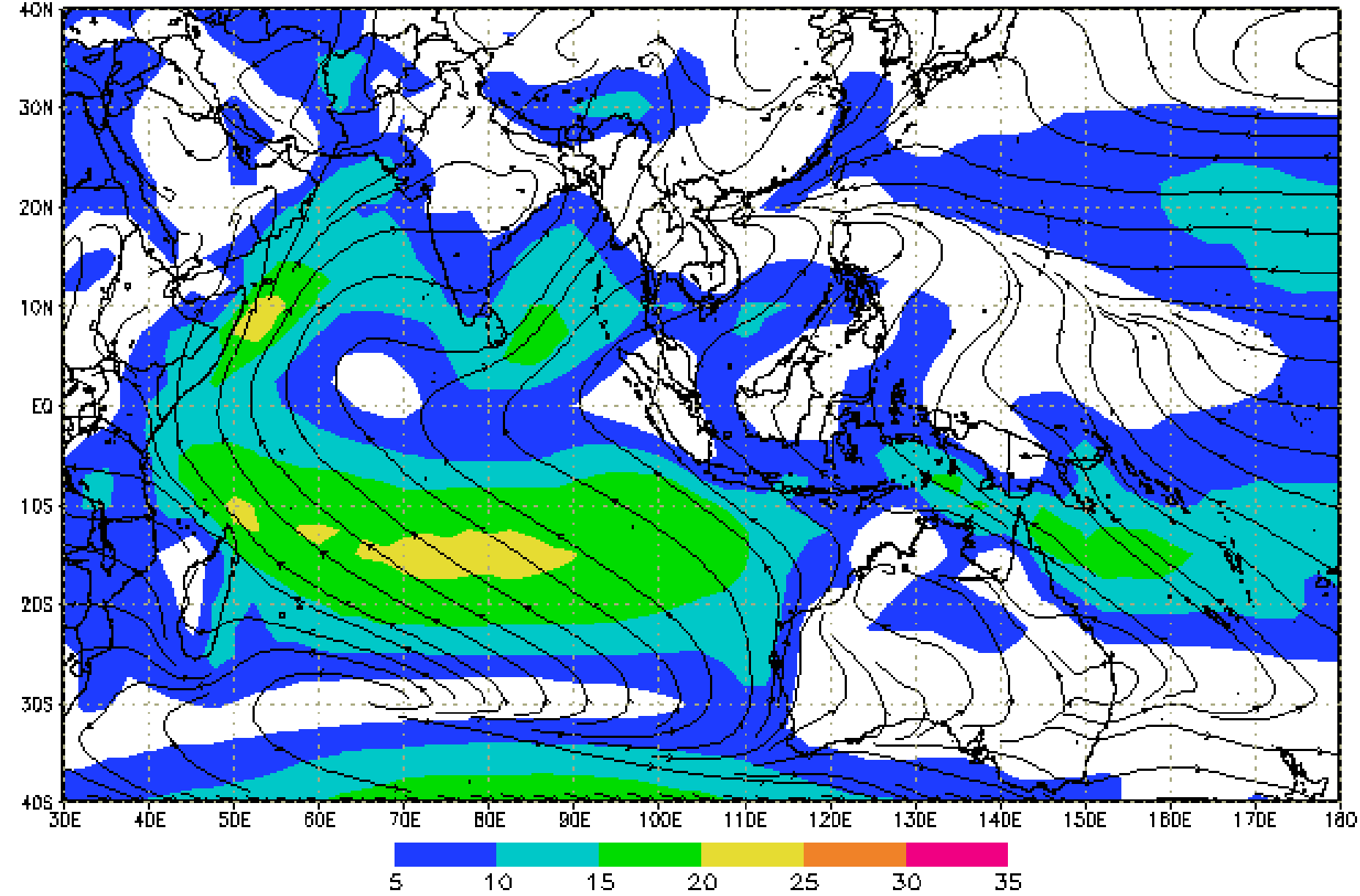
# September
# Resultant Surface Winds [kts]

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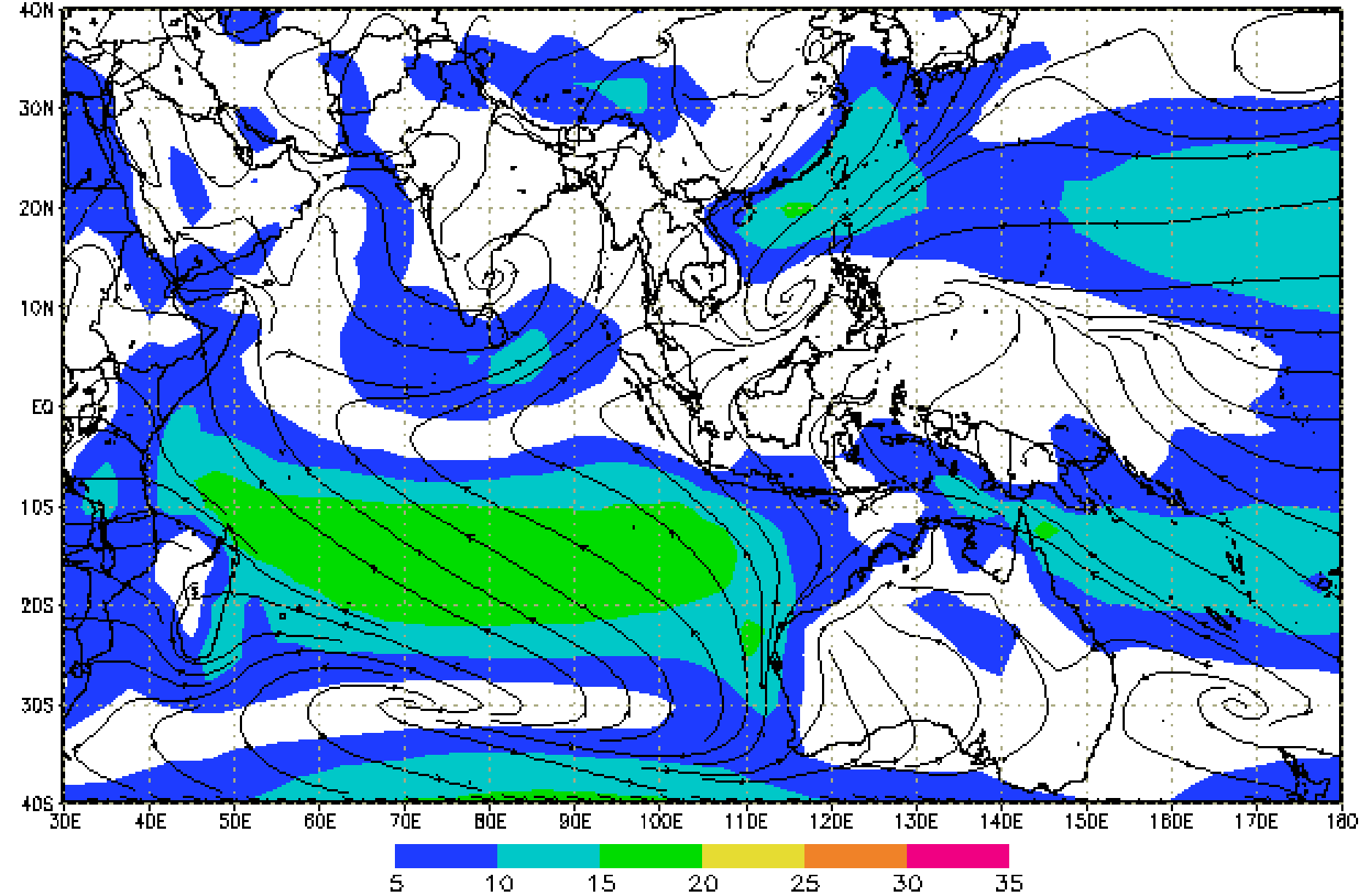
# October
# Resultant Surface Winds [kts]

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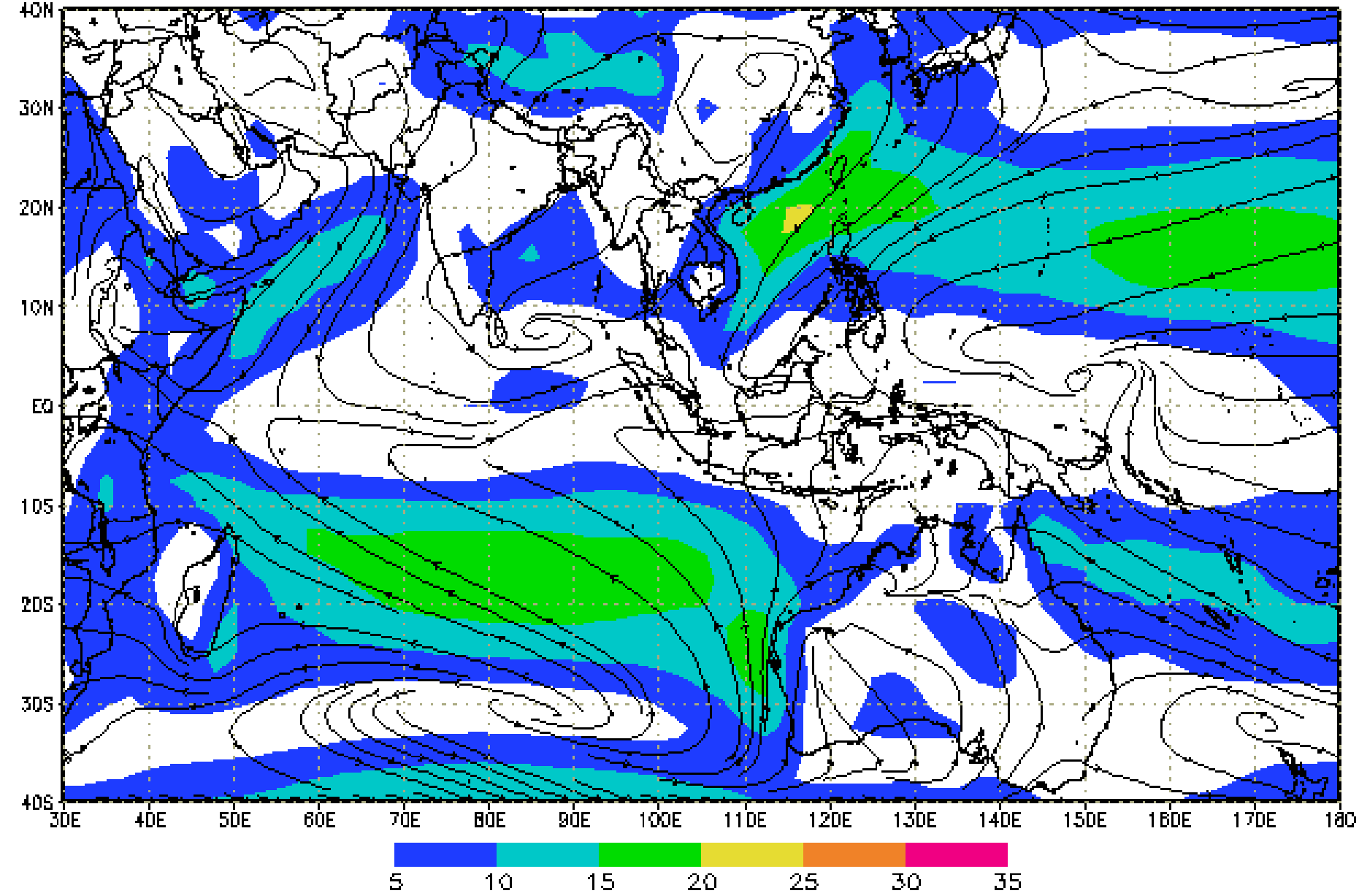
# November
# Resultant Surface Winds [kts]

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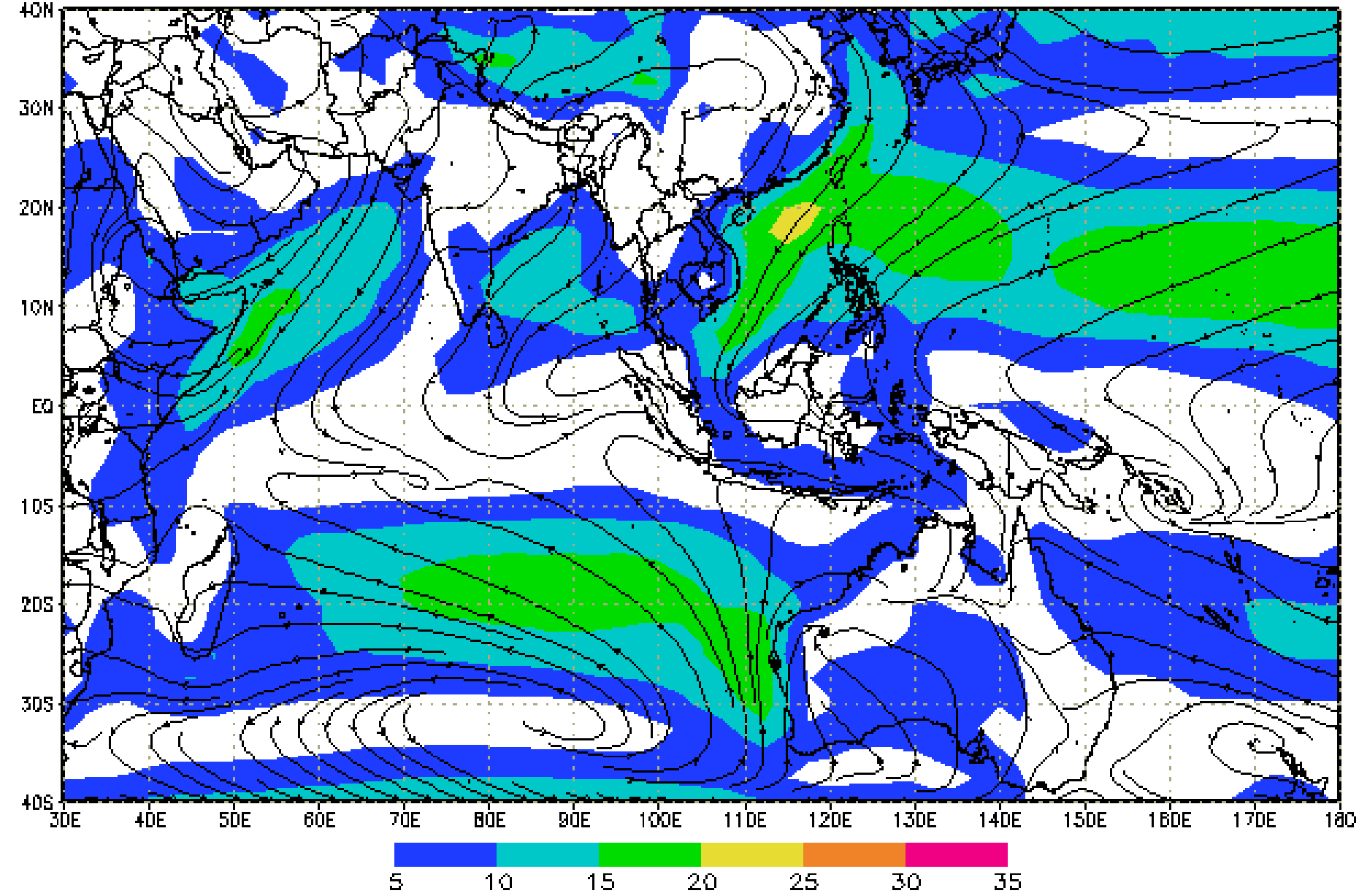
# December
# Resultant Surface Winds [kts]




Maps produced by Chris Cantrell, Capt, USAF

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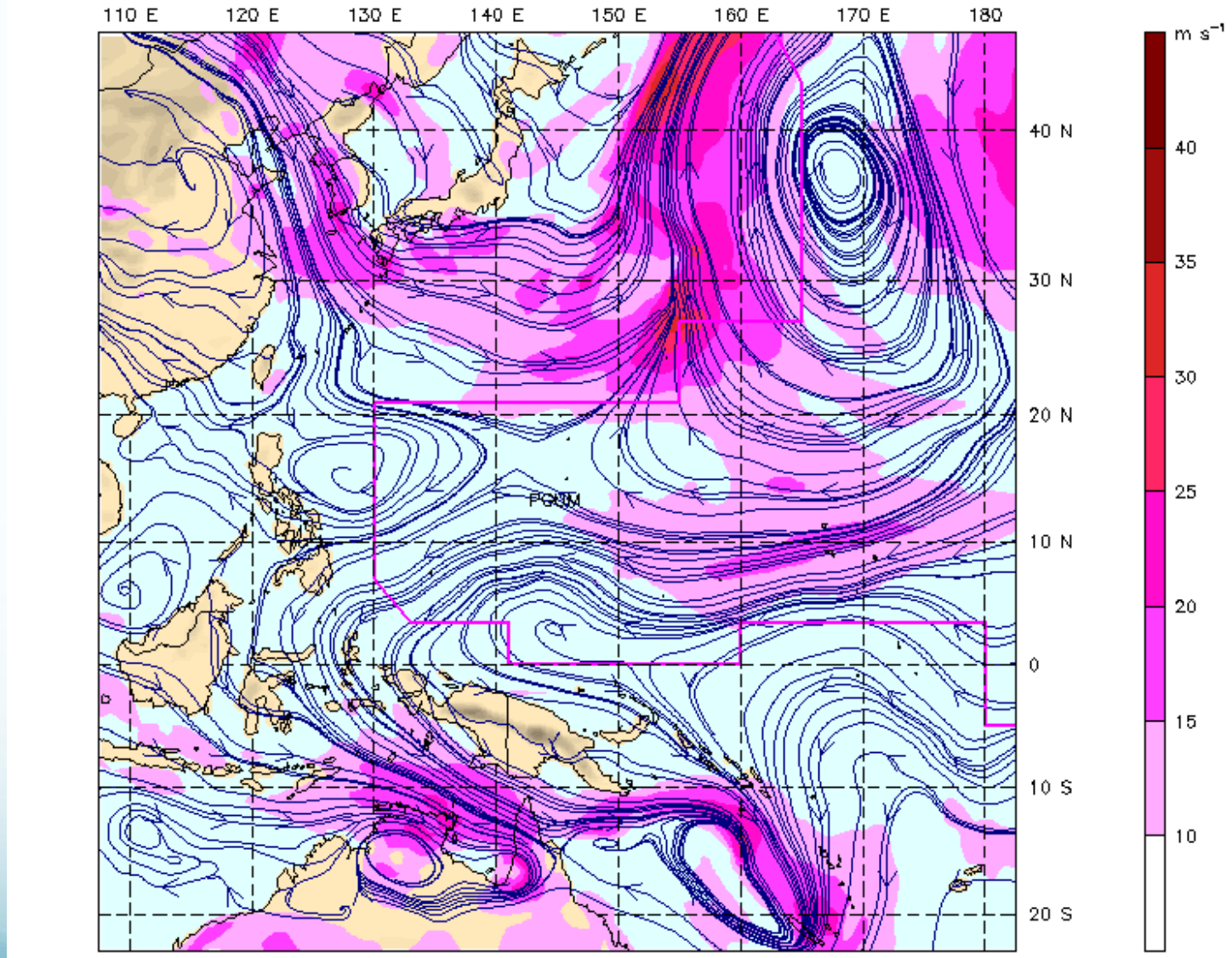
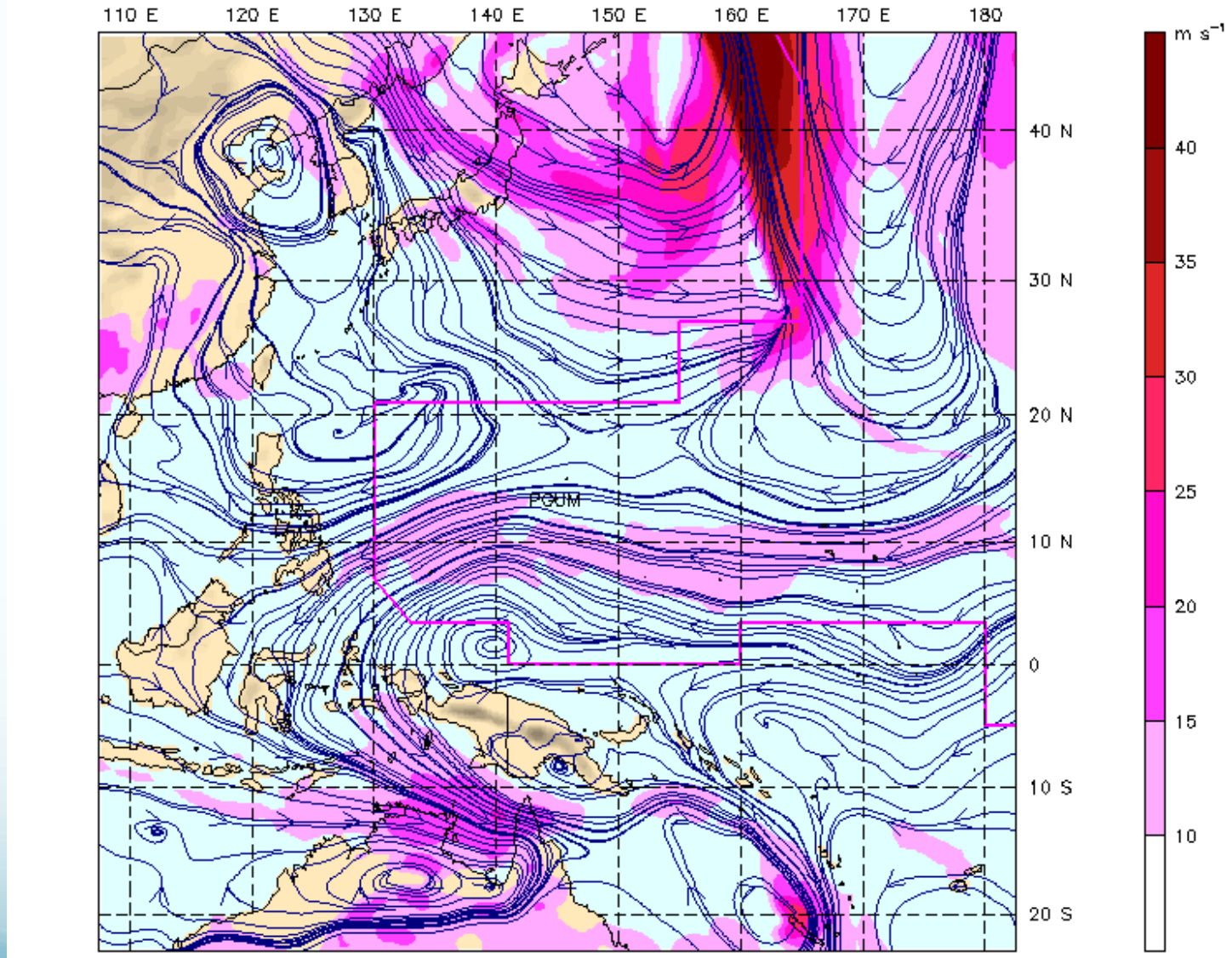
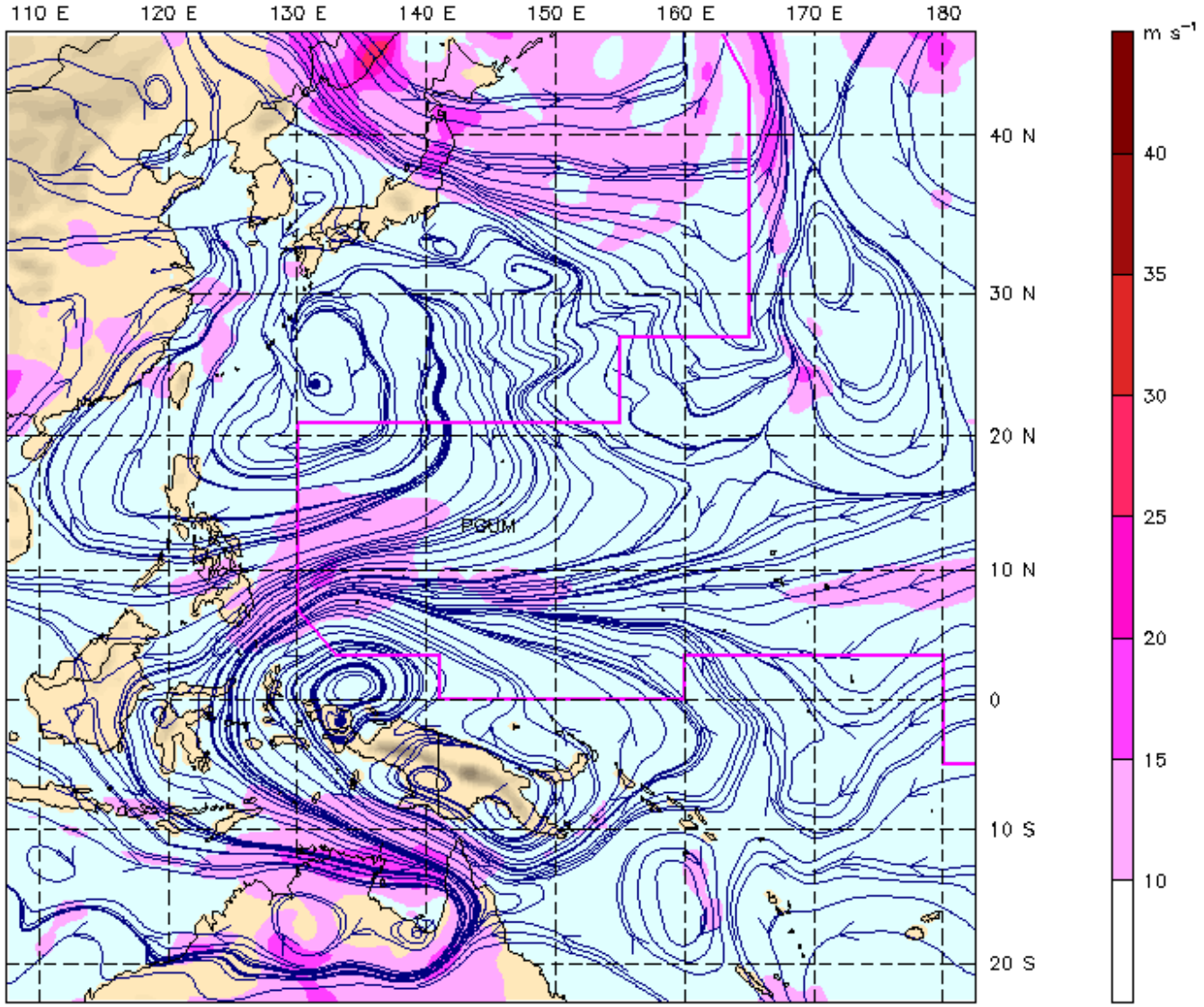

NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Tue 04 Feb 14
Fcst: 0 h Valid: 00 UTC Tue 04 Feb 14 (10 LST Tue 04 Feb 14)
Horizontal wind speed at pressure = 850 hPa sm= 1
Horizontal wind streamlines at pressure = 850 hPa sm= 1
110 E
120 E
130 E
140 E
150 E
160 E
170 E
180
40 N
30 N
20 N
10 N
0
10 S
20 S
PGUM
m s-1
40
35
30
25
20
15
10
OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels

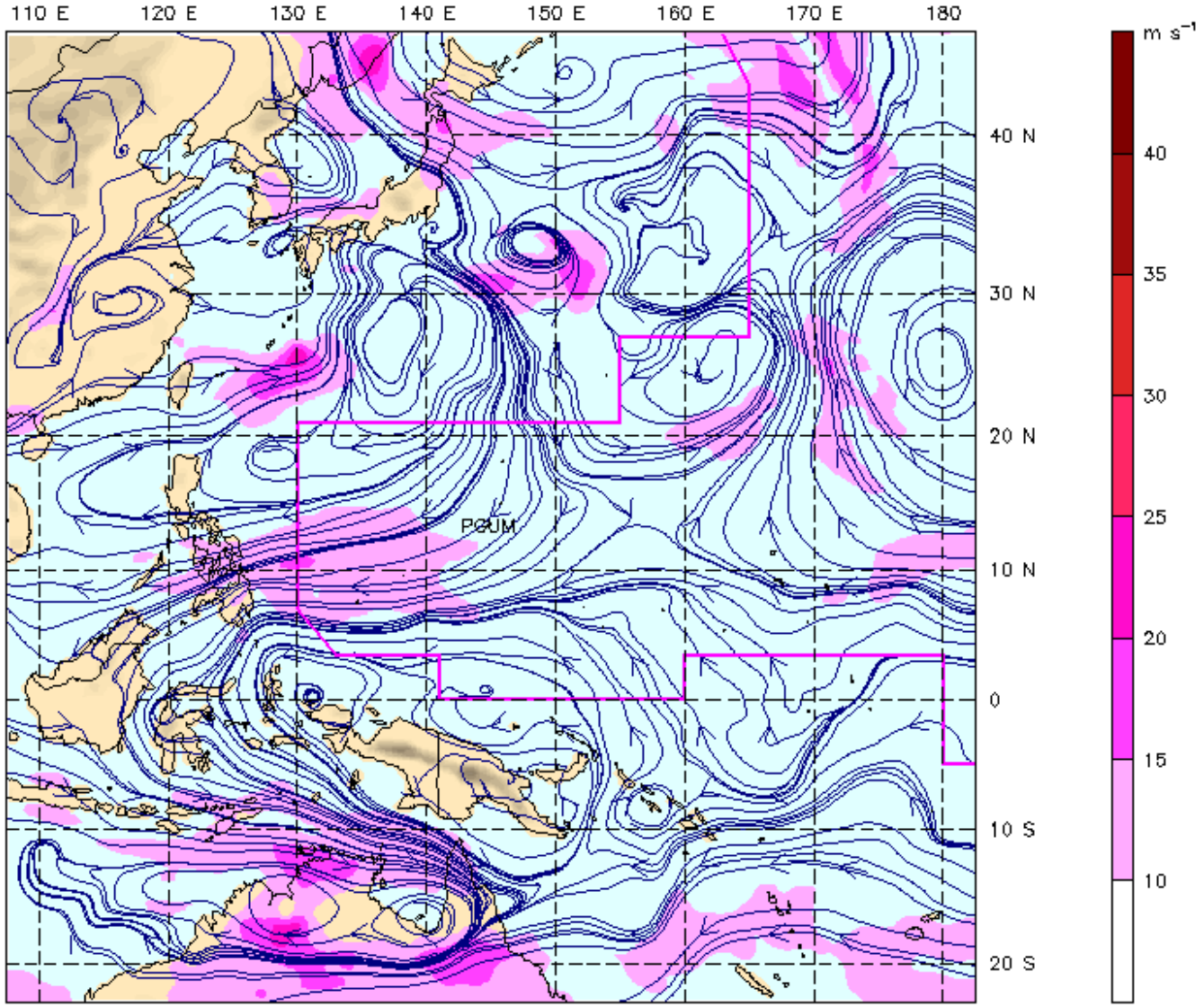

NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Wed 05 Feb 14
Fcst: 0 h Valid: 00 UTC Wed 05 Feb 14 (10 LST Wed 05 Feb 14)
Horizontal wind speed at pressure = 850 hPa sm= 1
Horizontal wind streamlines at pressure = 850 hPa sm= 1
110 E
120 E
130 E
140 E
150 E
160 E
170 E
180
40 N
30 N
20 N
10 N
0
10 S
20 S
PGUM
m s-1
40
35
30
25
20
15
10
OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels

NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Thu 06 Feb 14
Fcst: 0 h Valid: 00 UTC Thu 06 Feb 14 (10 LST Thu 06 Feb 14)
Horizontal wind speed at pressure = 850 hPa sm= 1
Horizontal wind streamlines at pressure = 850 hPa sm= 1

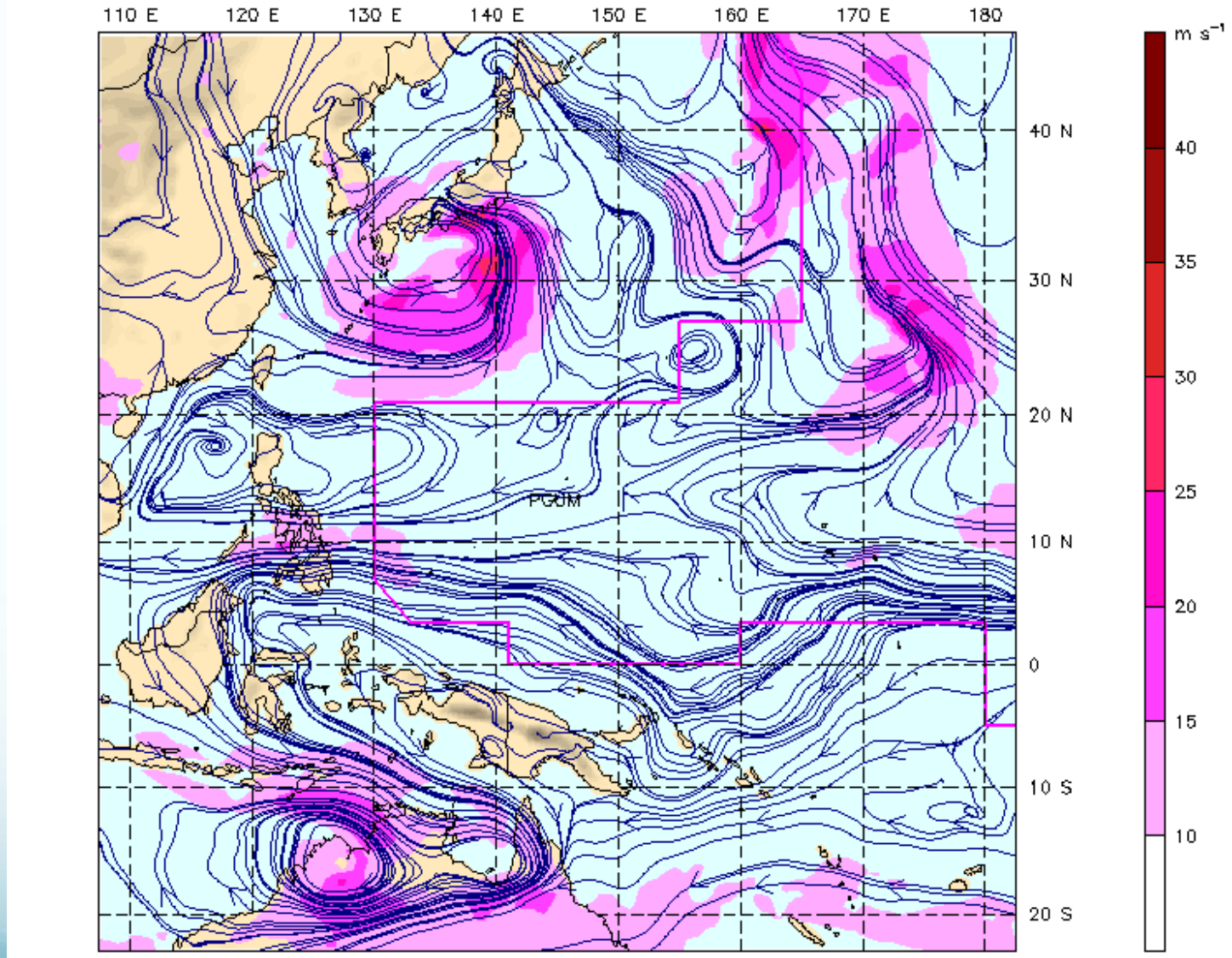


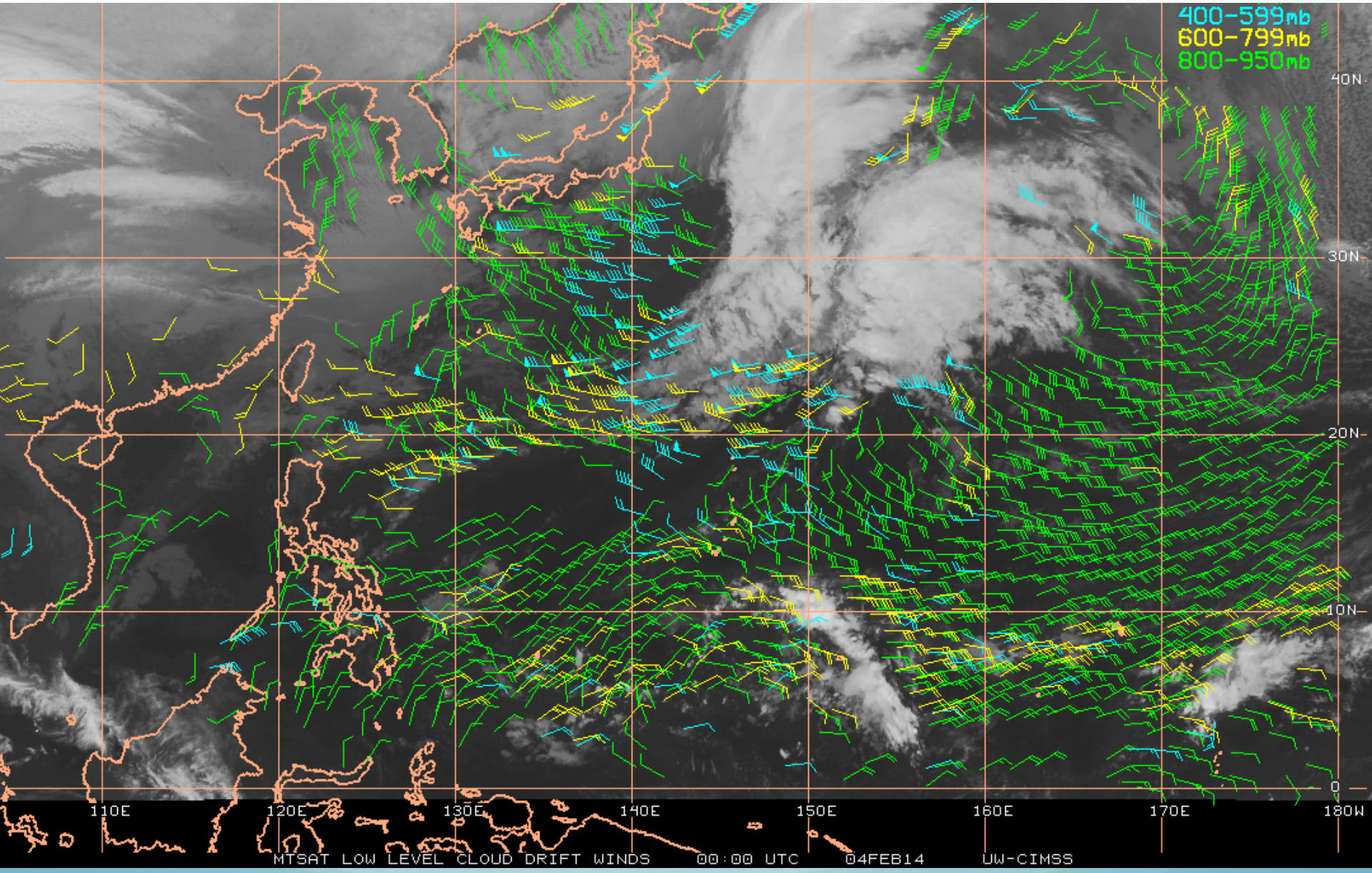

OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels

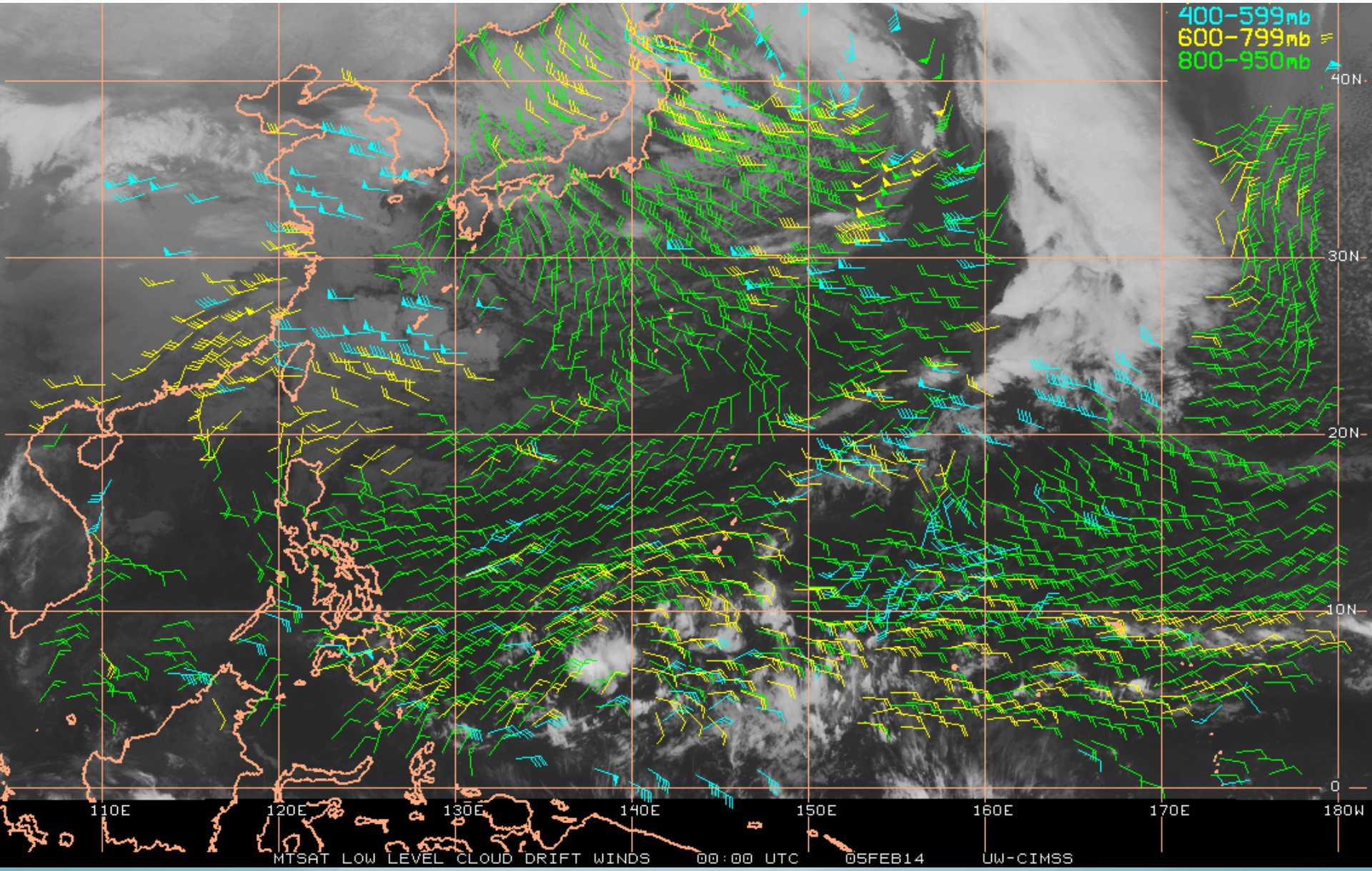
NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Fri 07 Feb 14
Fcst: 0 h Valid: 00 UTC Fri 07 Feb 14 (10 LST Fri 07 Feb 14)
Horizontal wind speed at pressure = 850 hPa sm= 1
Horizontal wind streamlines at pressure = 850 hPa sm= 1

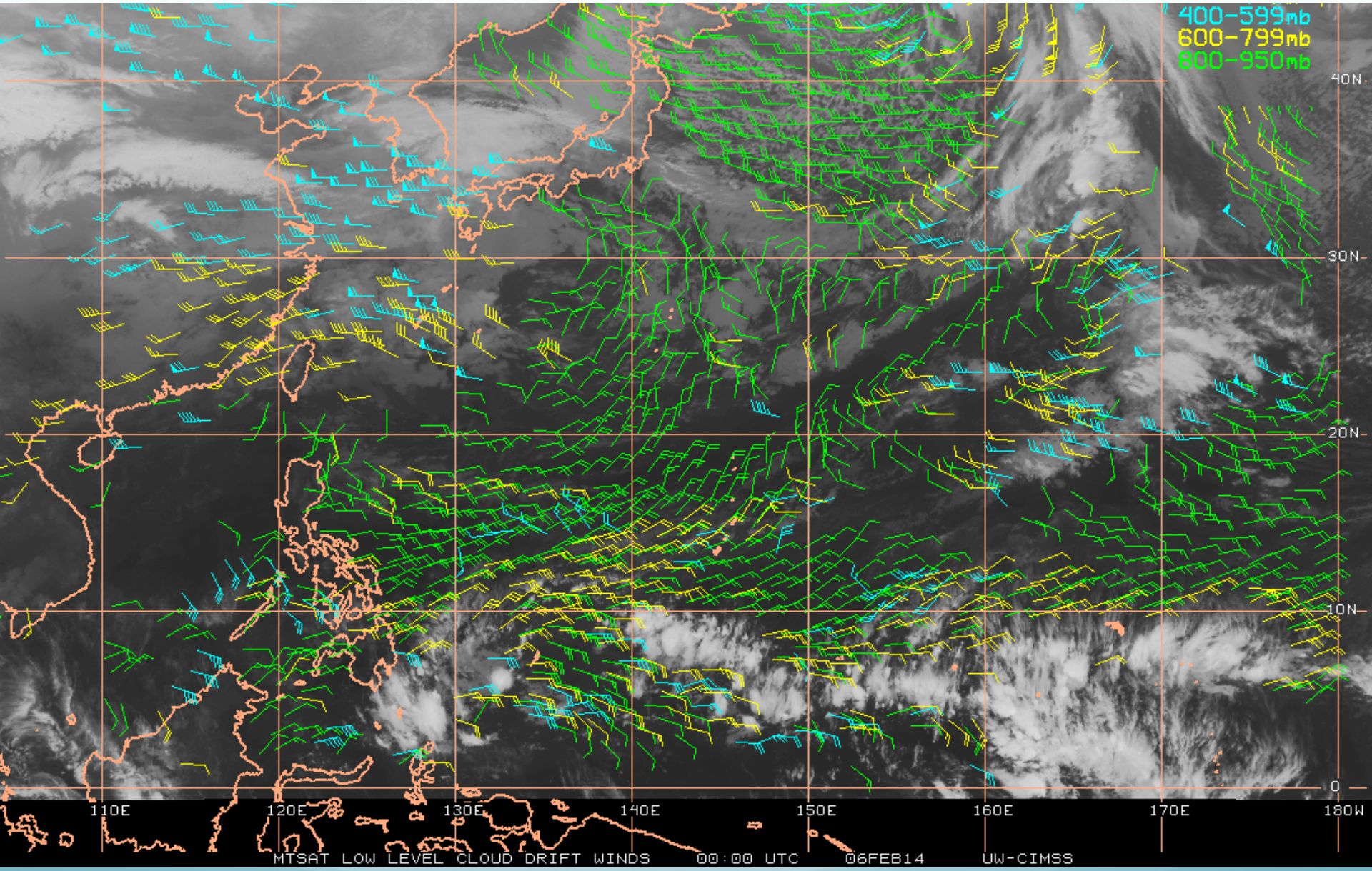


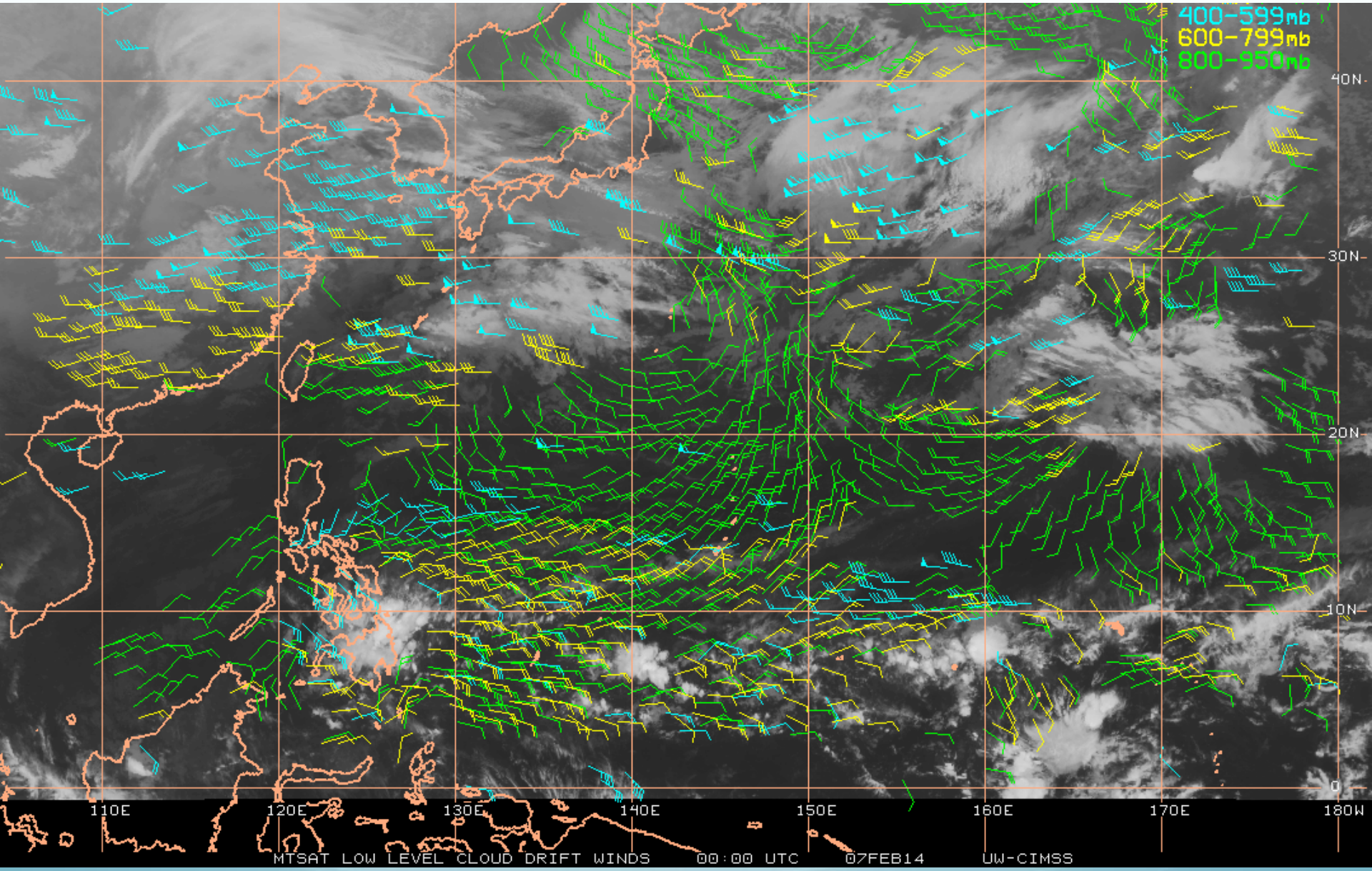

OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels

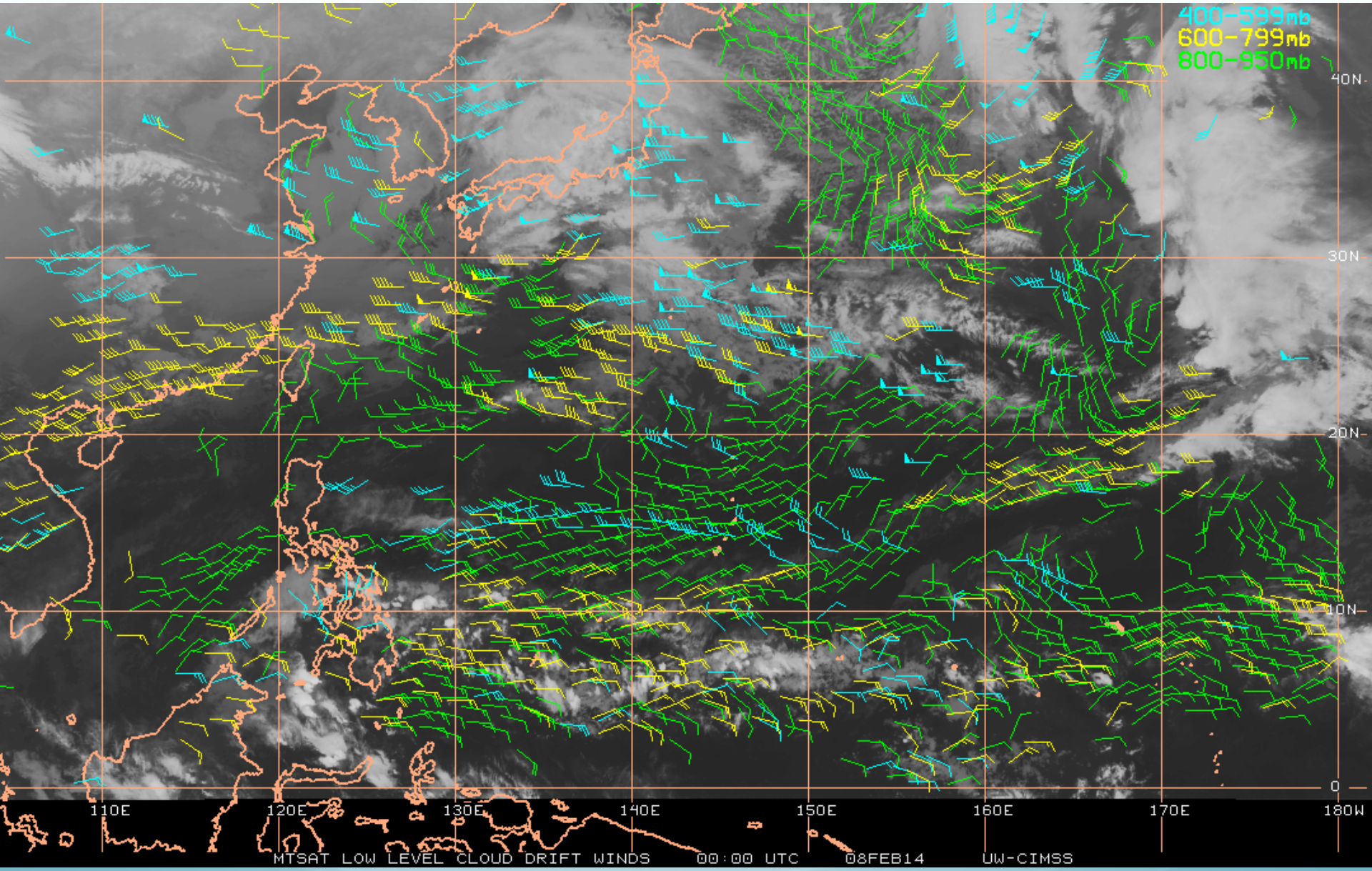

NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Sat 08 Feb 14
Fcst: 0 h Valid: 00 UTC Sat 08 Feb 14 (10 LST Sat 08 Feb 14)
Horizontal wind speed at pressure = 850 hPa sm= 1
Horizontal wind streamlines at pressure = 850 hPa sm= 1
110 E
120 E
130 E
140 E
150 E
160 E
170 E
180
40 N
30 N
20 N
10 N
0
10 S
20 S
PGUM
m s-1
40
35
30
25
20
15
10
OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels


400-599mb
600-799mb
800-950mb
40N
30N
20N
10N
0
110E
120E
130E
140E
150E
160E
170E
180W
MTSAT LOW LEVEL CLOUD DRIFT WINDS 00:00 UTC 04FEB14 UW-CIMSS

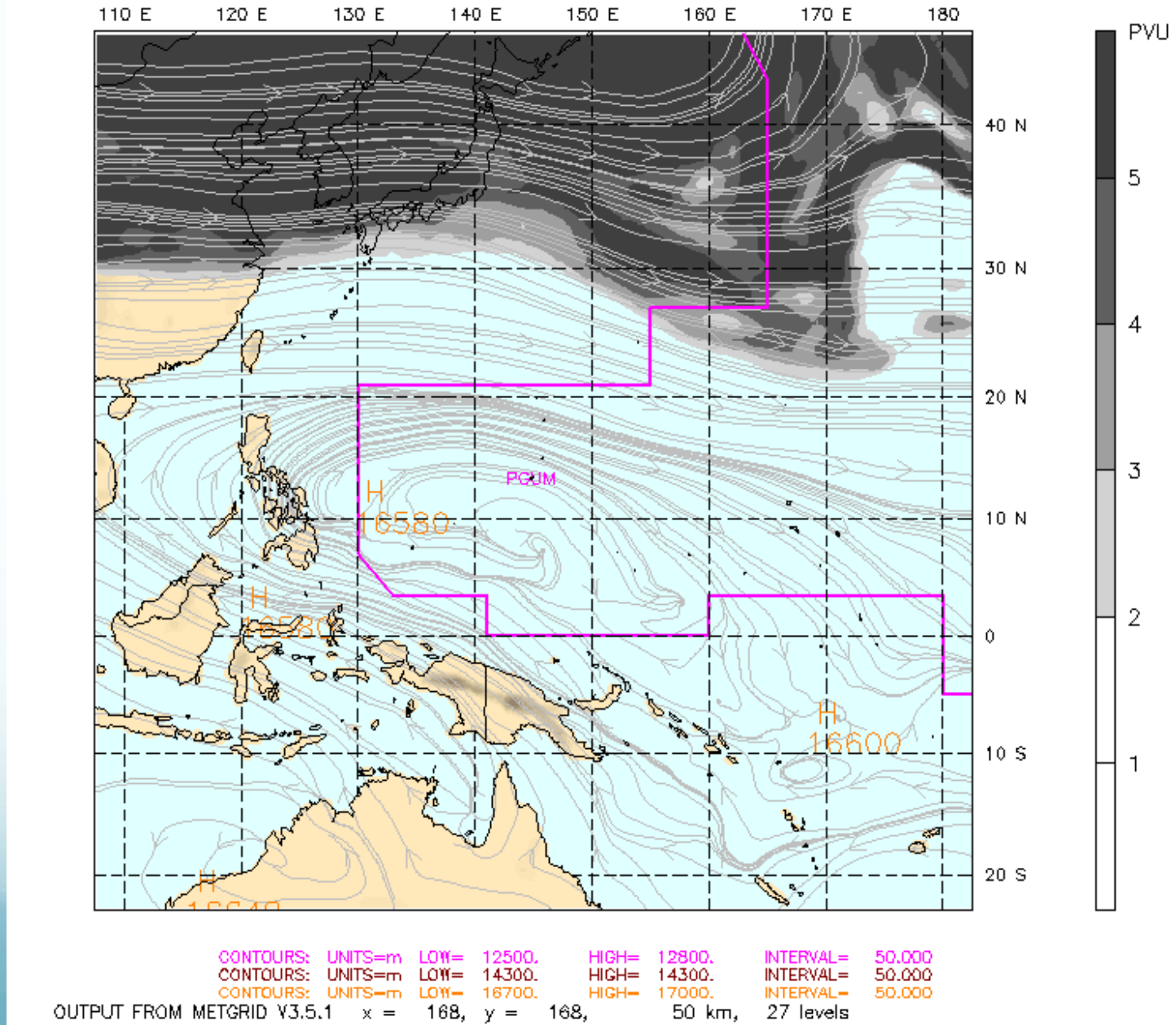

400-599mb
600-799mb
800-950mb
40N
30N
20N
10N
0
110E
120E
130E
140E
150E
160E
170E
180W
MTSAT LOW LEVEL CLOUD DRIFT WINDS 00:00 UTC 05FEB14 UW-CIMSS


400-599mb
600-799mb
800-950mb
40N
30N
20N
10N
0
110E
120E
130E
140E
150E
160E
170E
180W
MTSAT LOW LEVEL CLOUD DRIFT WINDS 00:00 UTC 06FEB14 UW-CIMSS

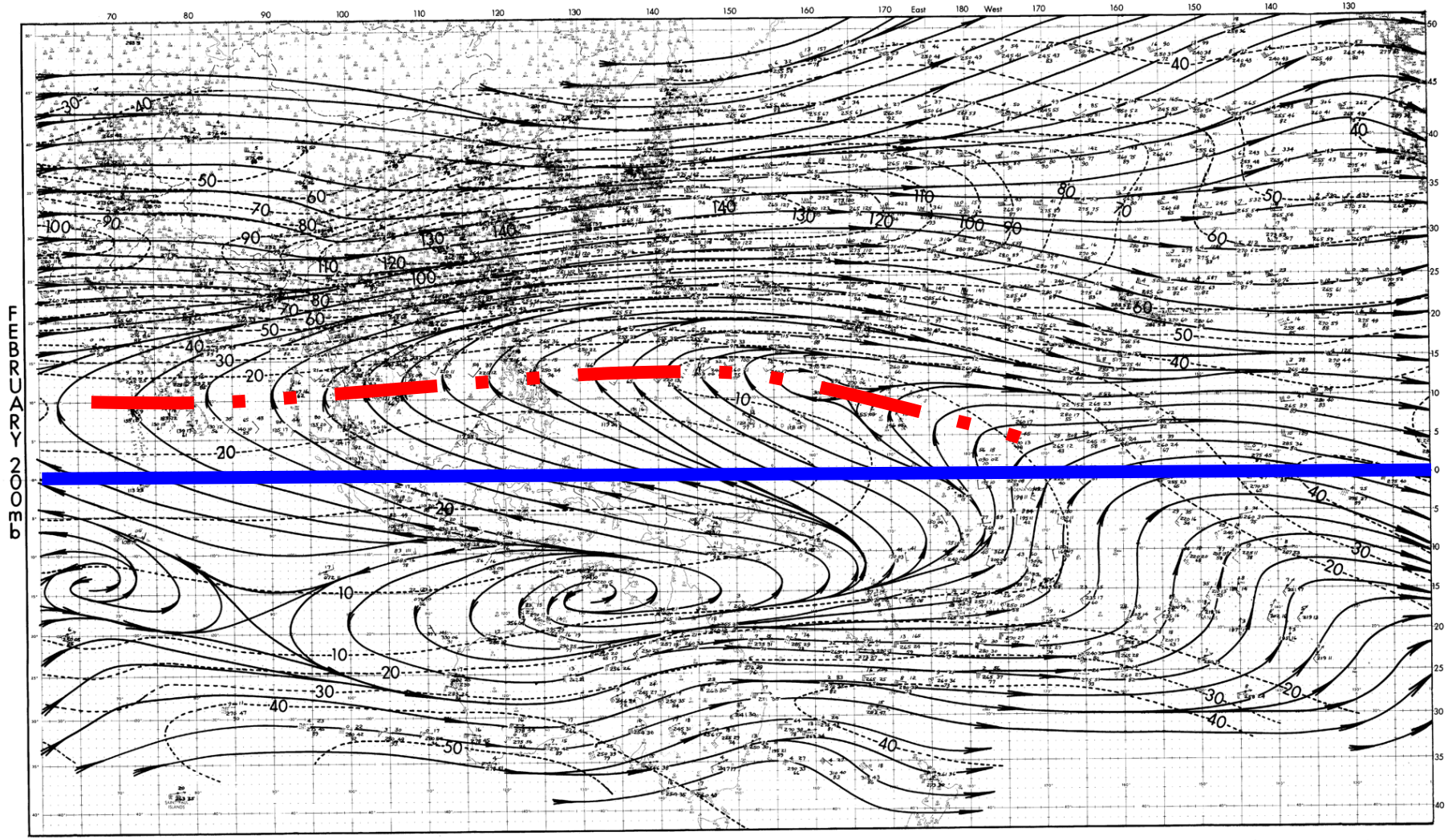

400-599mb
600-799mb
800-950mb
40N
30N
20N
10N
0
110E
120E
130E
140E
150E
160E
170E
180W
MTSAT LOW LEVEL CLOUD DRIFT WINDS 00:00 UTC 07FEB14 UW-CIMSS


400-599mb
600-799mb
800-950mb
40N
30N
20N
10N
0
110E
120E
130E
140E
150E
160E
170E
180W
MTSAT LOW LEVEL CLOUD DRIFT WINDS 00:00 UTC 08FEB14 UW-CIMSS

# What is the relation with upper-tropospheric anticyclones?

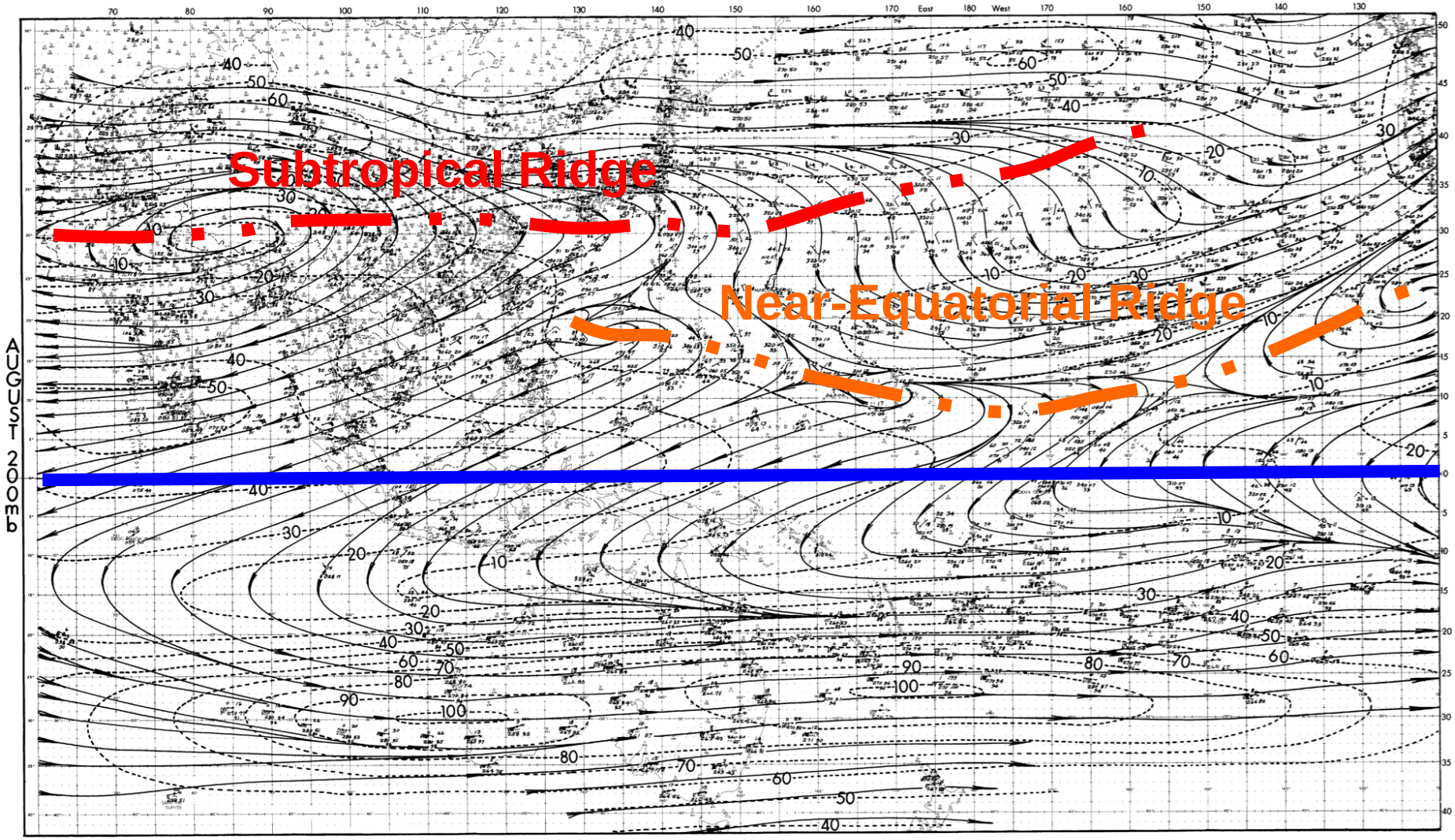

NCEP GFS 0.5 degree NCAR/MMM Init: 00 UTC Sat 08 Feb 14
Fcst: 0 h Valid: 00 UTC Sat 08 Feb 14 (10 LST Sat 08 Feb 14)
Potential vorticity at pressure = 200 hPa
Horizontal wind streamlines at pressure = 150 hPa sm= 1
Geopotential height at pressure = 100 hPa sm= 8
110 E
120 E
130 E
140 E
150 E
160 E
170 E
180
40 N
30 N
20 N
10 N
0
10 S
20 S
PGUM
H
16580
H
16600
PVU
5
4
3
2
1
CONTOURS: UNITS=m LOW= 12500. HIGH= 12800. INTERVAL= 50.000
CONTOURS: UNITS=m LOW= 14300. HIGH= 14300. INTERVAL= 50.000
CONTOURS: UNITS=m LOW= 16700. HIGH= 17000. INTERVAL= 50.000
OUTPUT FROM METGRID V3.5.1 x = 168, y = 168, 50 km, 27 levels

# February 200 mb Climatology




Sadler (1975)

# August 200 mb Climatology




Sadler (1975)

# Concluding Thoughts

- The large-scale tropical circulation strongly adheres to climatology.
- The ITCZ is not necessarily a “clean” seasonal migration between northern and southern hemispheres.
- Forecasting during transition seasons can be tricky; must consider transient phenomena in both hemispheres.
- Not all “anticyclones” are created equal! Some are “subsident,” while others are convectively-driven. Cause-and-effect and vertical structure must be considered.