TROPICAL ANALYSIS

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Why analyzing the tropics is a challenge?

- Poor data coverage
- Lack of understanding of tropical weather systems
- Many tropical weather systems have small amplitude
- Poor pressure/height - wind relationship
- Local effects
  – coastal, topographical, diurnal, semi-diurnal,…and they tend to be more noticeable
- Most textbooks teach mid-latitude systems

Analysis

To know the status of the atmosphere by interpreting the data you have

To make a good analysis one needs to:

- know the general circulation of the atmosphere
- have conceptual model of weather systems
- know the scales of different weather systems
- have the knowledge of how weather systems interact with each other and local environment
- know the history of the systems

In other words, know the Science (dynamics, thermodynamics, kinematics)

If your job is to manage the tropical fruits section

Why is a good analysis important

- Real-time analysis - May lead to better forecast
- Case studies – Can help understand weather systems better
  - A good knowledge is the basis for a better real-time analysis and forecast

(Don’t believe everything you read. Do your own analysis if possible)

The Challenges for me
(This is the most difficult course to teach)

- Should I start with analysis methods
  - Apply to what? Analyzing what?
- Should I start with weather systems we normally deal with in the tropics
  - Sometime you can’t see them without applying some analysis techniques
- Do both the same time using case studies

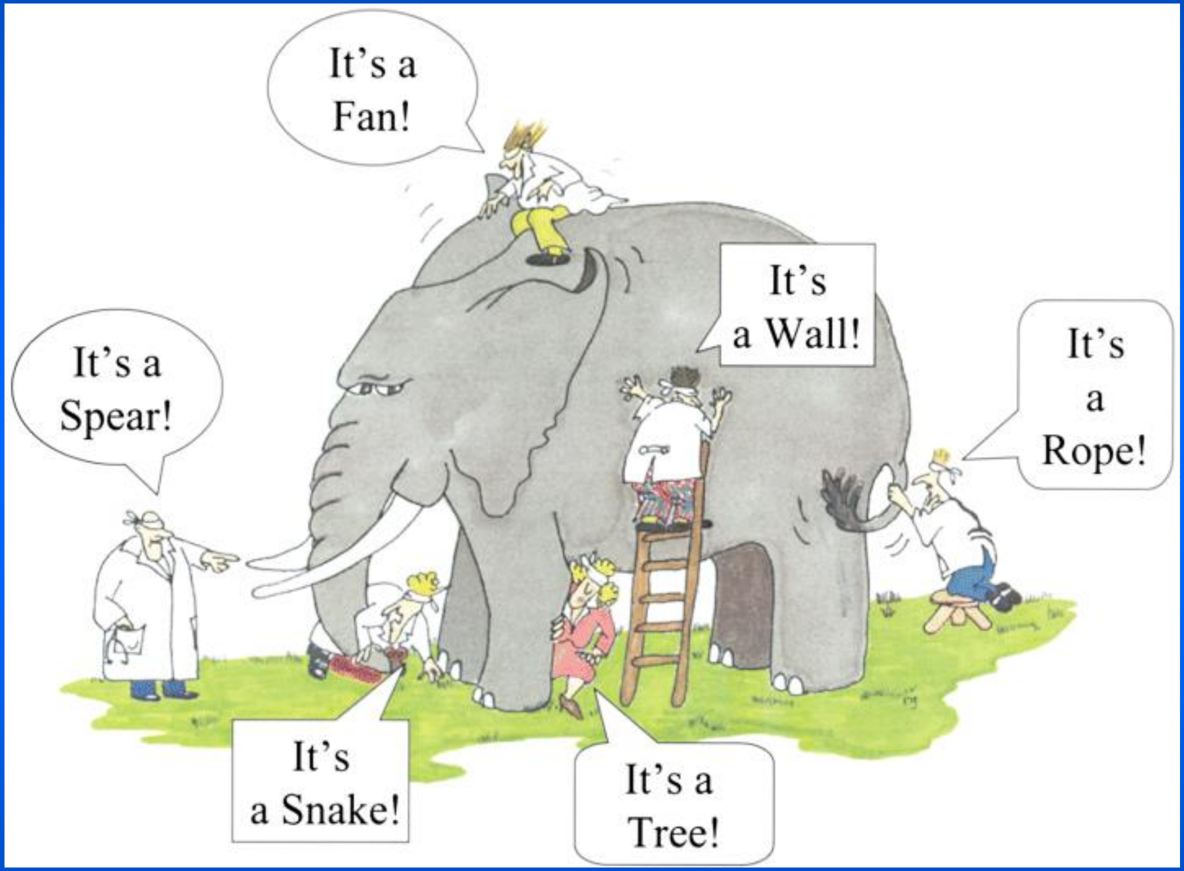
Some Useful Analysis Practices

- Check the data/analysis over a longer period of time – over a period that is greater than the time scale of a synoptic system (and over a larger domain too)
- Time series analysis – use temporal coverage for the lack of spatial coverage
- Check vertical cross sections for structural coherence – Systems don't exist at just one level
- Space-time analysis – time series and structure
- Use wind analysis when possible – both streamlines and isotaches, but don't ignore surface pressure

Some Useful Analysis Practices

- Use all observations you have
- Filtering - separates different systems to allow better depictions of the system you want to identify
- Spectral analysis (1, 2, 3 multi-dimensional)
- If necessary, use continuity – extrapolation (Why are we allowed to do this? What you need to know first?)
- If necessary, use short term forecast from previous global model run
- When nothing else is available, use climatology – just don't do it too often, why?

Blind/blindfolded men and an elephant



When the data is very limited, and the knowledge about the subject is almost none, people sometimes come up with all kind of interpretation based on the limited data they'd collected.

UNDERSTAND THE NATURE OF WEATHER SYSTEMS

Examples of some of the weather systems we have seen (or heard of) in the tropics besides troughs, ridges, fronts, highs, and lows

The weather you are analyzing may be influenced by

- Climatology
- Monsoon (the real monsoon)
- The trade wind
- Easterly waves
- Equatorial waves
  – Rossby waves, Mixed Rossby-Graity waves, gravity waves, Kelvin waves, Madden-Julian Occillation, ….
- Tropical cyclones
- Local effects (topographical, coastal, etc.)
- Extra-tropical systems
- and ……..

THE SCALES

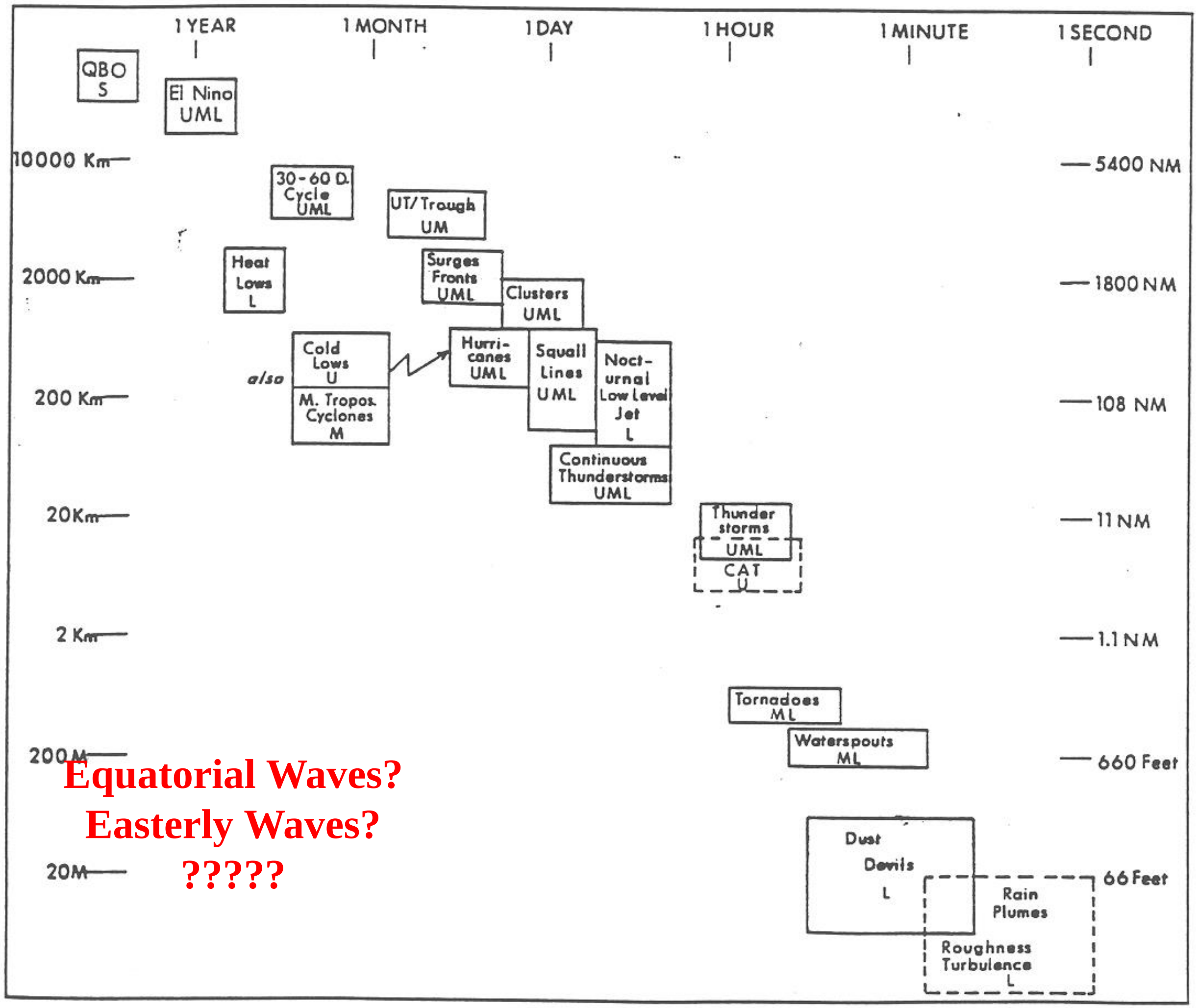
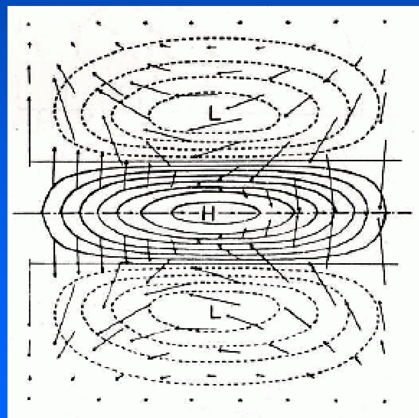
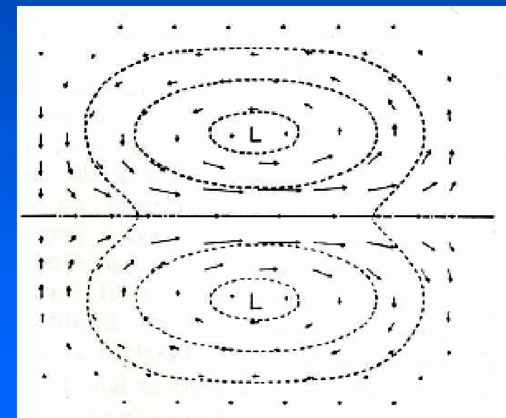


Figure 2-9. Approximate dimension and time scales of tropical systems (after Orlanski, 1975). Key: S -mainly stratosphere; U - mainly upper troposphere; M - mainly middle troposphere; and L - mainly lower troposphere.

PRESSURE AND WIND OF SOME OF THE LOWEST EQUATORIAL NORMAL MODES

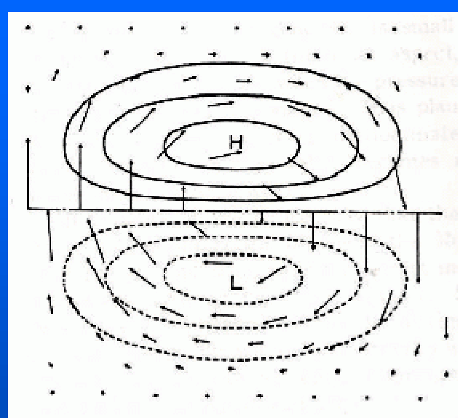


EQ

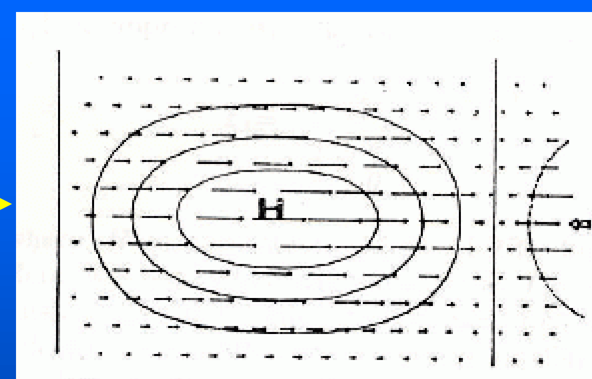


Eastward inertio-gravity wave

Rossby wave



EQ



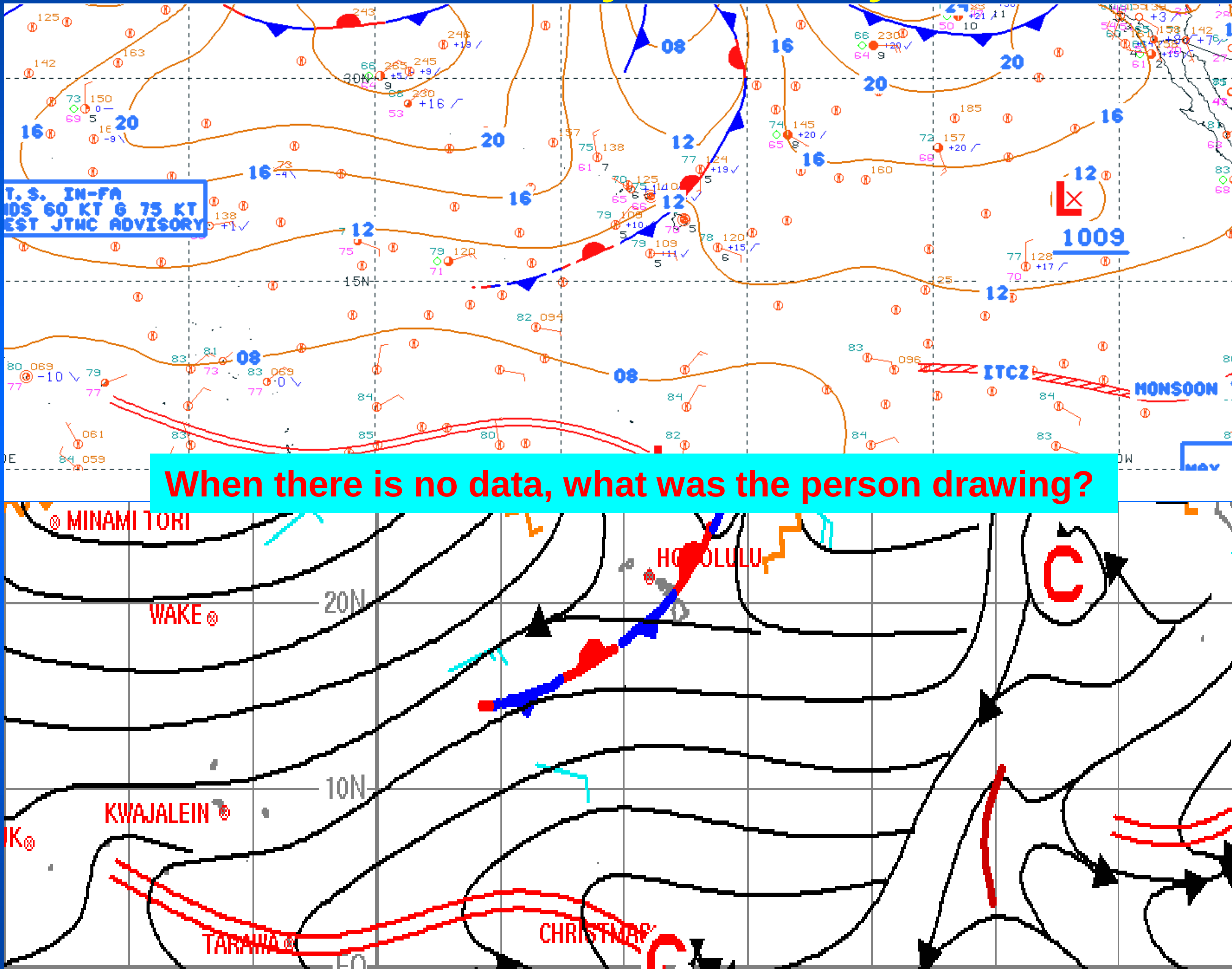
Westward mixed Rossby gravity wave

Kelvin wave

T. Matsuno, JMSJ 1966

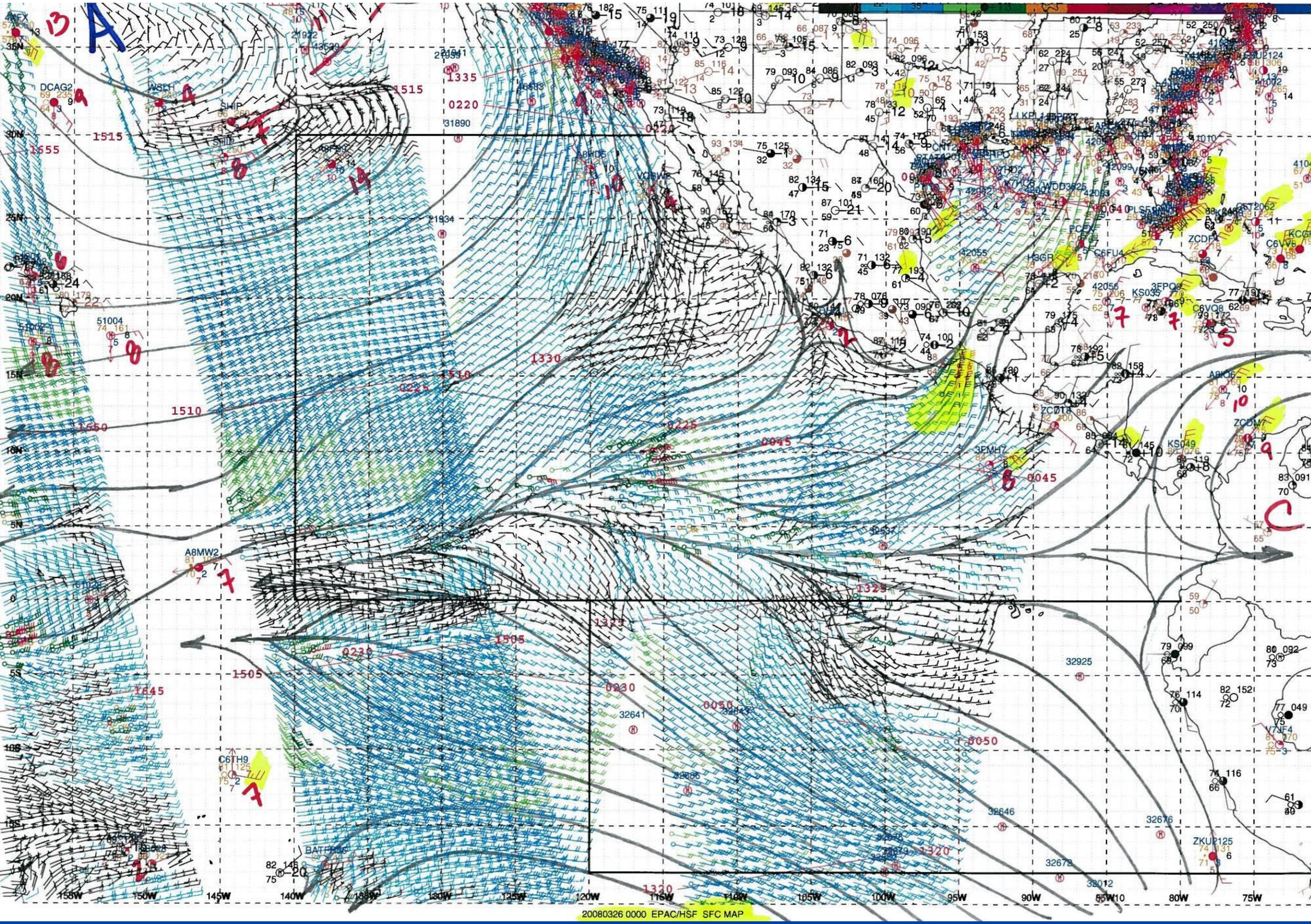
STREAMLINE ANALYSIS
vs
ISOBARIC ANALYSIS

Is Streamline Analysis Always Better?



When there is no data, what was the person drawing?

Maybe With Satellite Derived Winds



Streamline analysis is better in the tropics but experts caution about the way it is used

Weather Analysis and Forecasting
Sverre Petterssen

2.2. Construction of Streamlines. "A mere freehand drawing of streamlines is rarely satisfactory, for on account of the relatively large distance between the observing stations there will be a tendency to carry the streamlines from one station to another and this may introduce systematic distortions." The most satisfactory method of constructing streamlines may be described as follows: (1) Plot the numerical values of the wind direction (in decadegrees) at each station. (2) Draw lines through the stations which have the same wind direction, or interpolate such lines between the stations. These lines are the isogons. It is usually satisfactory to draw isogons at intervals of 30°, except in regions of little variation, where intervals of 15 or 10° should be used. (3) Draw short line segments across each isogon such that the segments indicate the wind direction. (4) Connect the line segments by tangent curves. These curves are the streamlines.

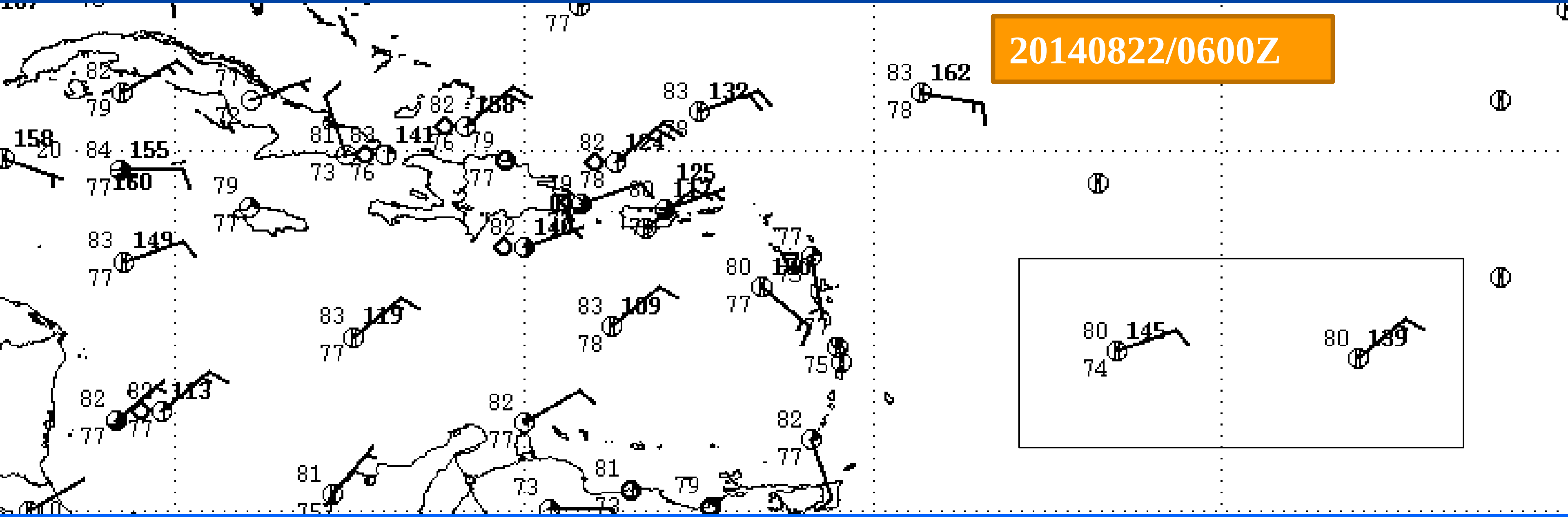
Tropical Meteorology
Herbert Riehl

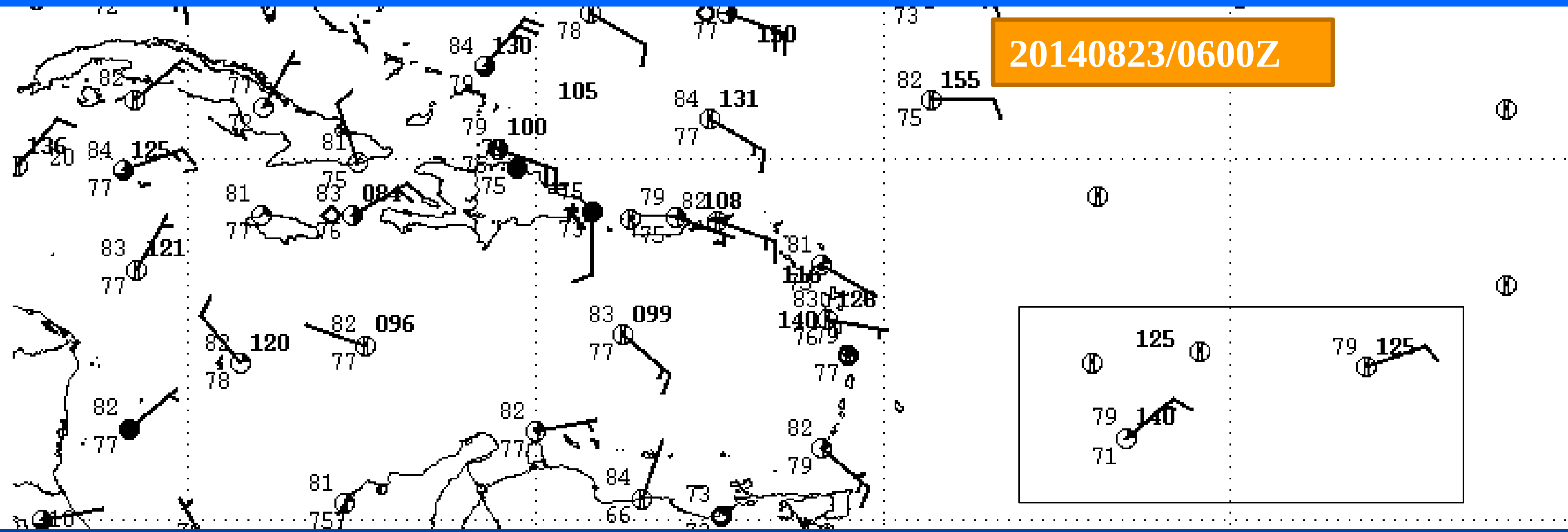
Streamline Analysis. Since the slopes of isobaric surfaces in the tropics are very small, it is never possible to make a reliable analysis from pressure-height data alone. The soundings are subject to the many errors listed above, and the spacing between two stations is often so great that a large disturbance can exist between them without affecting either. Contour analysis should never be attempted without close reference to the time sections, continuity, and the winds. This is no simple task because wind and contour directions can deviate appreciably. Further, upper contour charts must be prepared with aid of the differential analysis (thickness) technique in order to avoid gross errors in drawing contours in open networks; otherwise computations made from such charts are likely to fail. Several basic textbooks give a description of this method.

Streamline analysis is often more satisfactory. Its object is to represent the fields of wind direction and wind speed, and therefore the fields of vorticity and divergence, which are so important in all synoptic work. The degree to which these objectives are attainable depends entirely on quantity and quality of the observations. "When stations are widely spaced and located mainly along a line, usually an air route, and when confidence in any existing pilot reports is low, many analysts extrapolate trough lines, shear lines, and centers from the time sections and past maps and then sketch streamlines that approximately outline the field of wind direction." It is the property of streamlines to parallel the wind direction everywhere. Figure 7.2 illustrates this type of analysis. Beyond depicting wind directions, very little is attempted. This is entirely proper considering the data situation. The author must warn against attempting too much with poor and sparse data. A reasonable balance should always exist between the observations that make up a chart and what the analyst tries to deduce from these observations. Otherwise, serious errors in the form of fantastic map constructions inevitably result.

Exercise #1

- Compare the following 2 surface plots for two minutes (focus on reports inside the box)


20140822/0600Z


20140823/0600Z

Exercise #1

- Turn the maps over
- Group 1 report your impression on the mean sea level pressure
- Group 2 report your impression on the winds

- The first thing you should check is the date/time group (why I chose these two plots at 24 hours apart?)

What have you noticed?

What you may remember 24 hours later

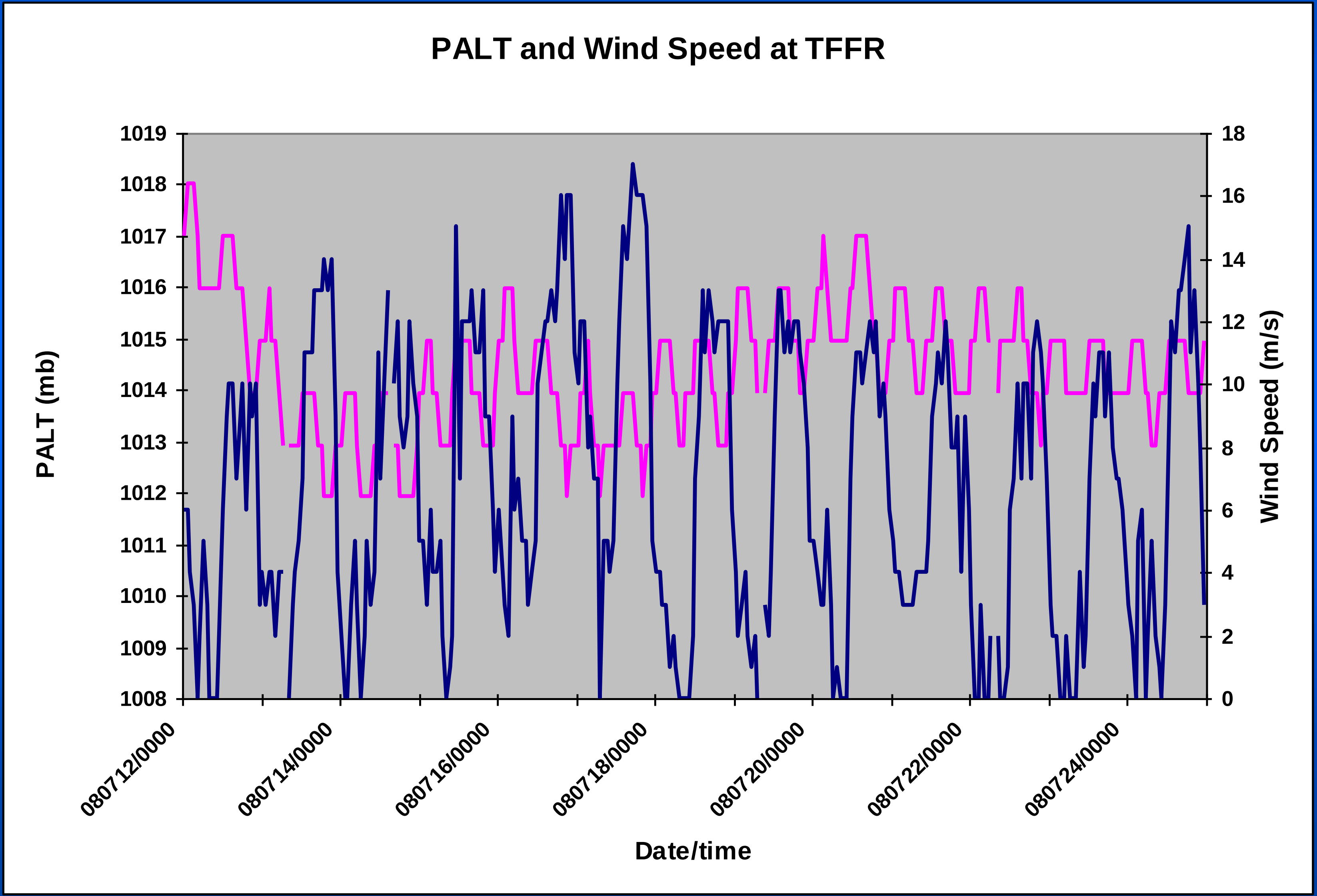
Time-series analysis

- When there are not enough station reports to help you identify weather systems on a map

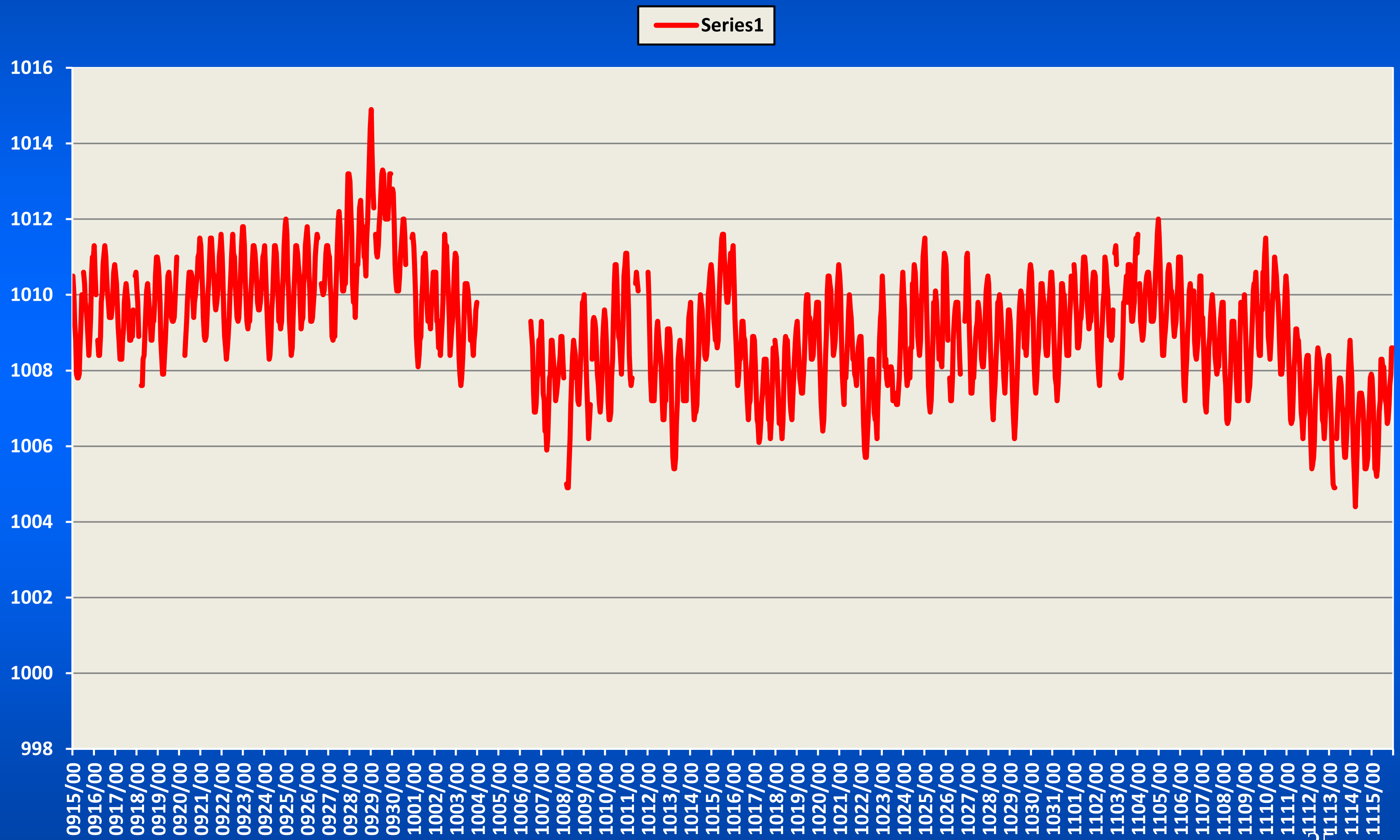
  Time series of observations at fixed stations can be useful to identify weather systems that have passed those stations

PALT and Wind Speed at TFFR

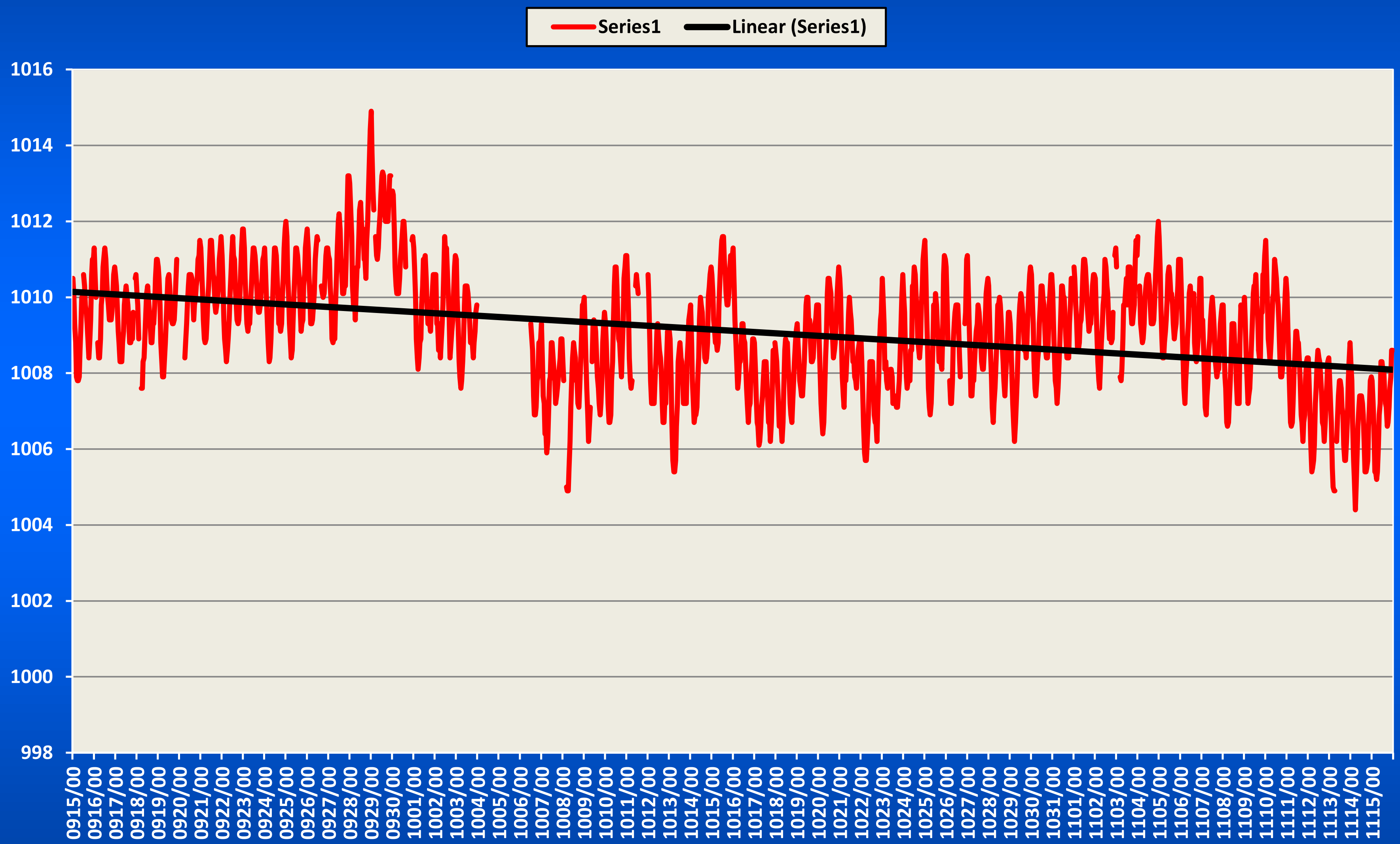
July 07-July 24, 2008



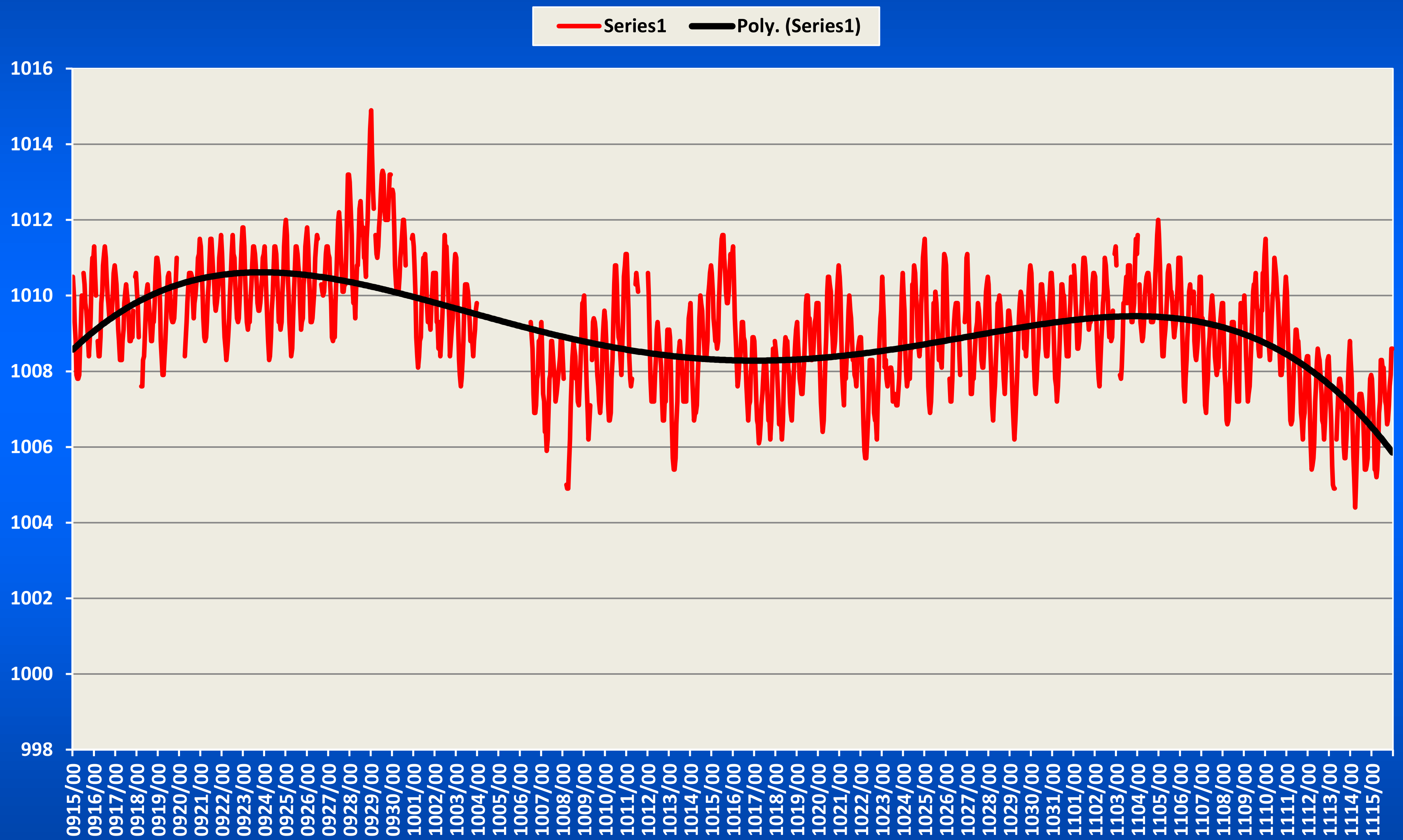
Time series of surface pressure at Truk(Truuk) from Sep. 15 – Nov. 15, 2000



A linear trend during this period



Polynomial fit (period?)



Power Spectra for the vertically averaged zonal and Meridional wind at selected west Pacific stations

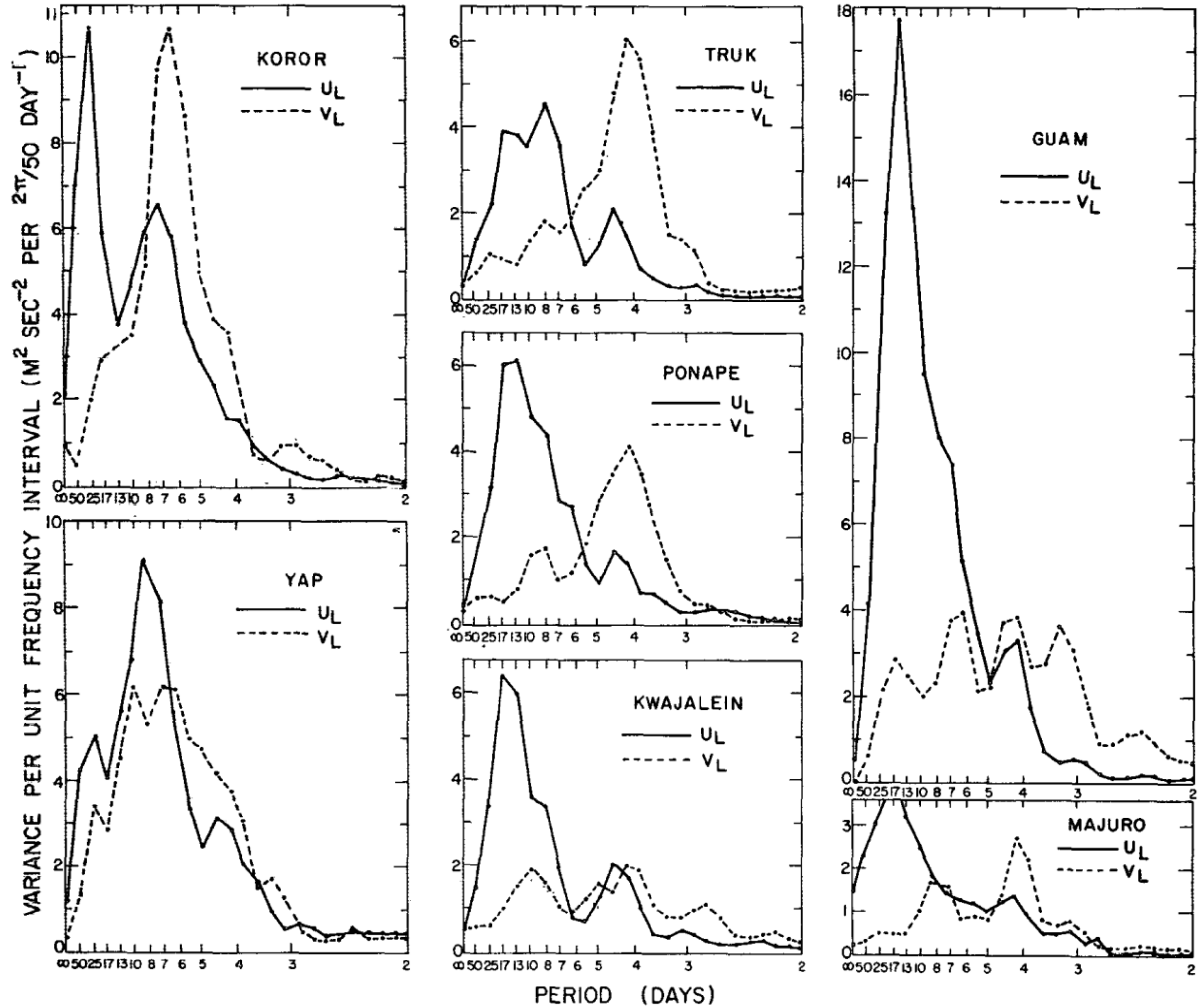


FIG. 1. Power spectra for the vertically averaged (surface–400 mb) zonal and meridional wind components at selected stations.

A statistical Study of Easterly Waves in the Western Pacific: July-December 1964, C.-P Chang, V. Morris, J. M. Wallacek, Journal of the Atmospheric Science, 1970, Vol 27, pp195-201

Using statistical methods to construct the structure of a weather system

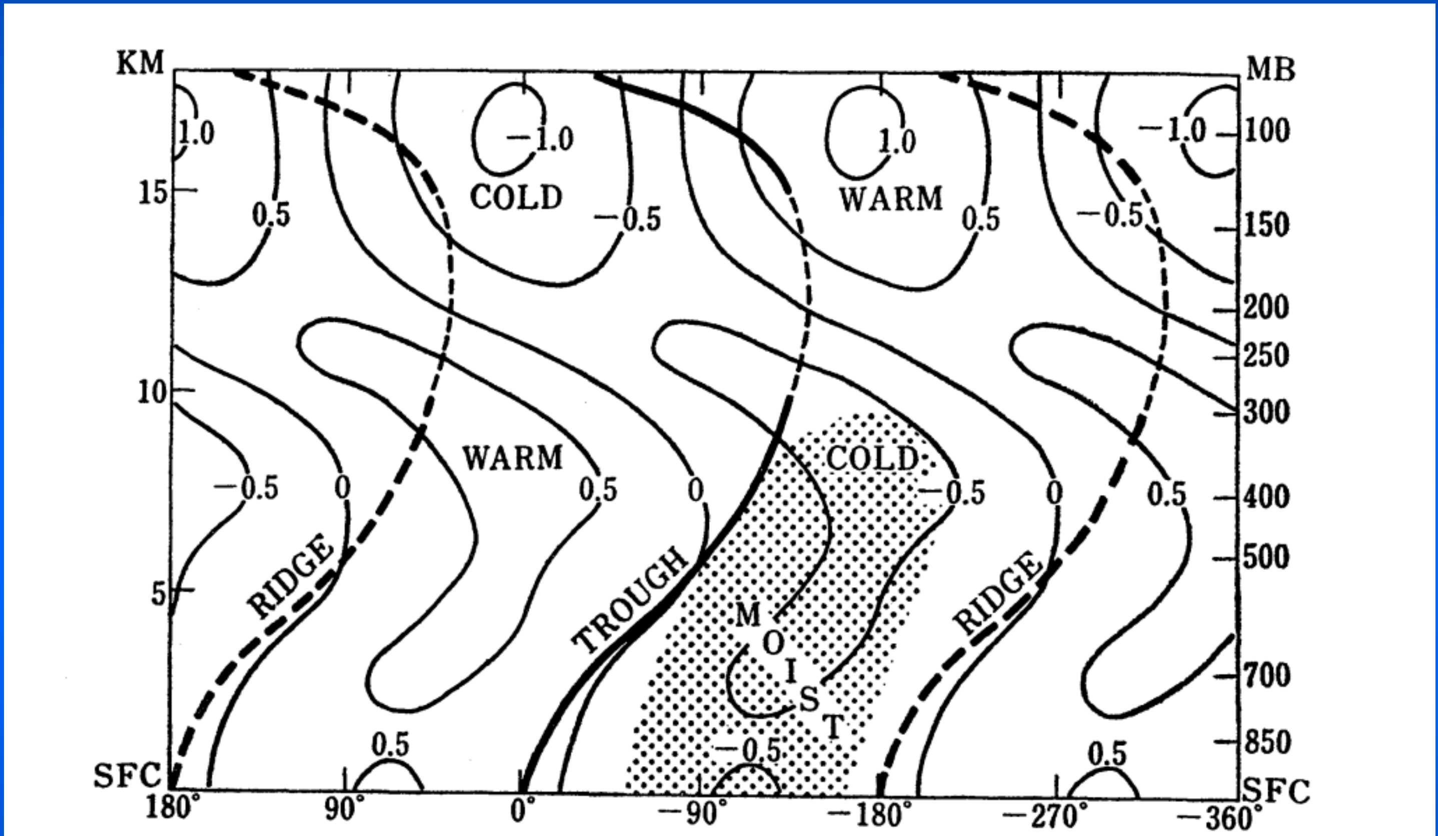


Fig. 14 Schematic structure of the disturbance in the western Pacific (see text).

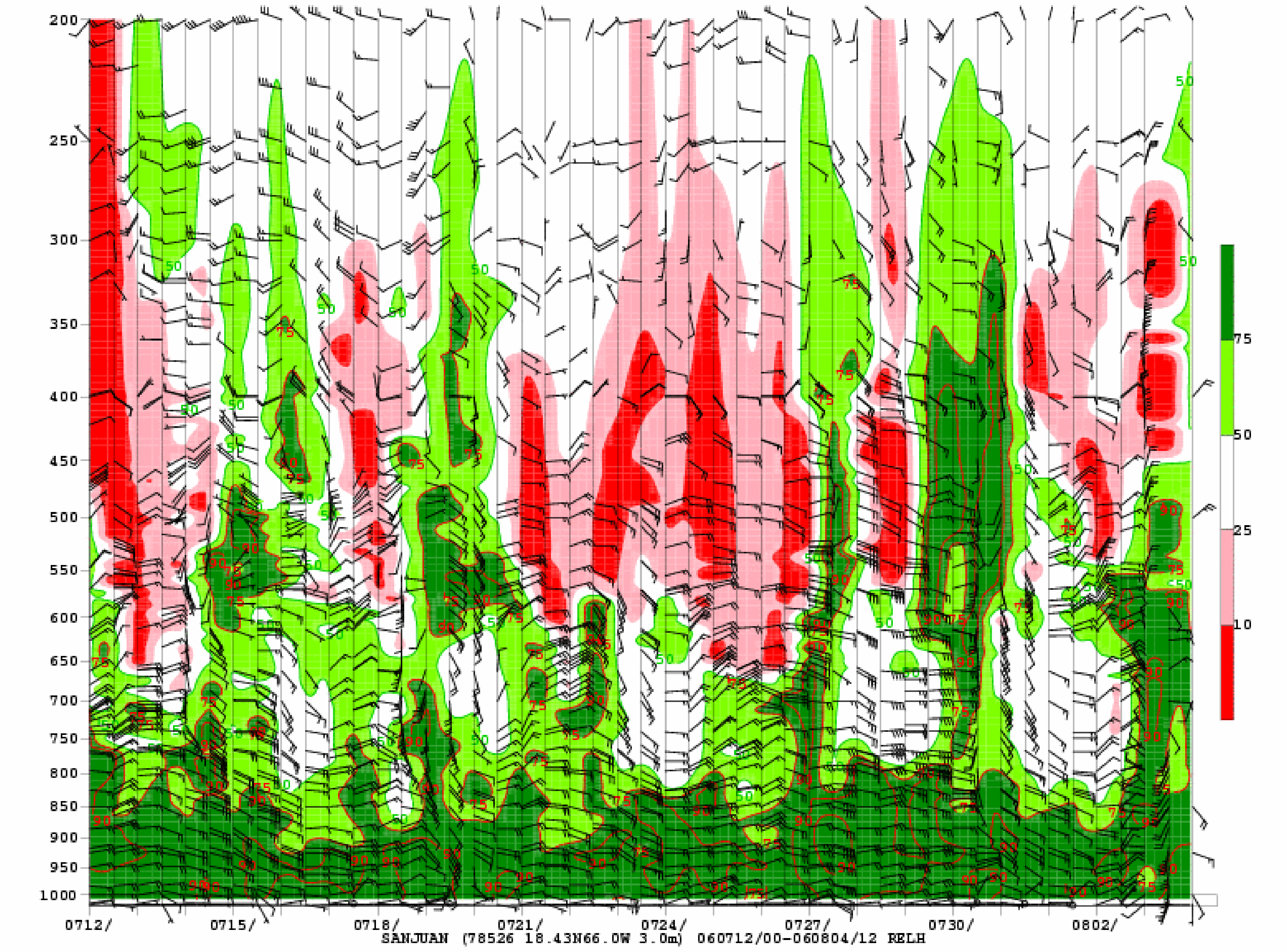
Statistical Study of Tropospheric wave disturbances in the tropical Pacific region. Nitta T.; Journal of the Meteorological Society of Japan, 1965, 48

Space-time composites

- Not just time series of observations at a given location at a given level
- Spatial coverage allows one to check for spatial coherence (structure)
- Time series for temporal structure

Time-Height Analysis

Relative humidity – San Juan July 12 – Aug 04, 2006



Hovmöller charts

Spatial (lat/lon) features and time series in one picture

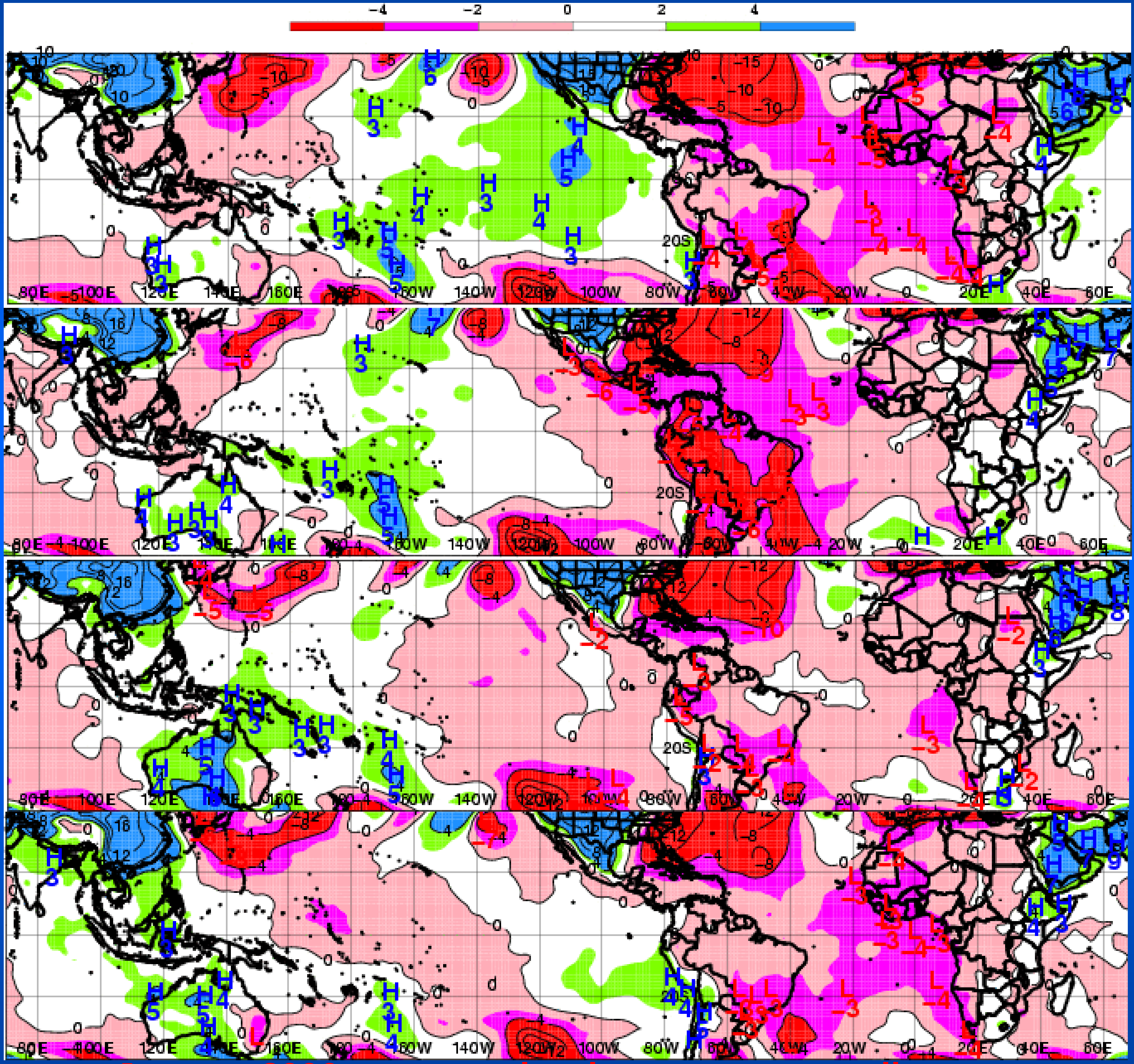
Constructing a Hovmuller Chart (MSLP anomalies)

18Z Jan 5, 2006

21Z Jan 5, 2006

00Z Jan 6, 2006

03Z Jan 6, 2006



January 2006 mean sea level pressure anomalies

PMSL Anomalies From Monthly Mean

00Z 01/06/06
03Z 01/06/06
06Z 01/06/06
09Z 01/06/06
12Z 01/06/06
15Z 01/06/06
18Z 01/06/06
21Z 01/06/06
00Z 01/07/06
03Z 01/07/06
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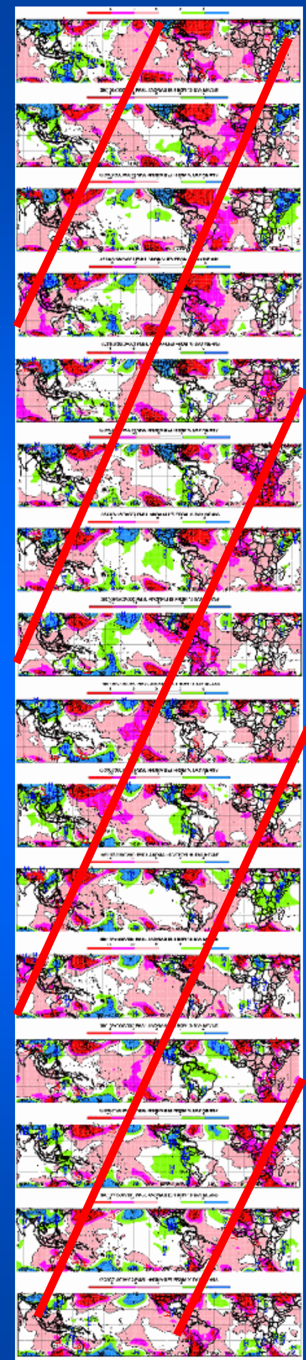
18Z 01/07/06
21Z 01/07/06



How many frames between any two lines?

How fast does the tide travel?

Interannual variability of easterly wave activities

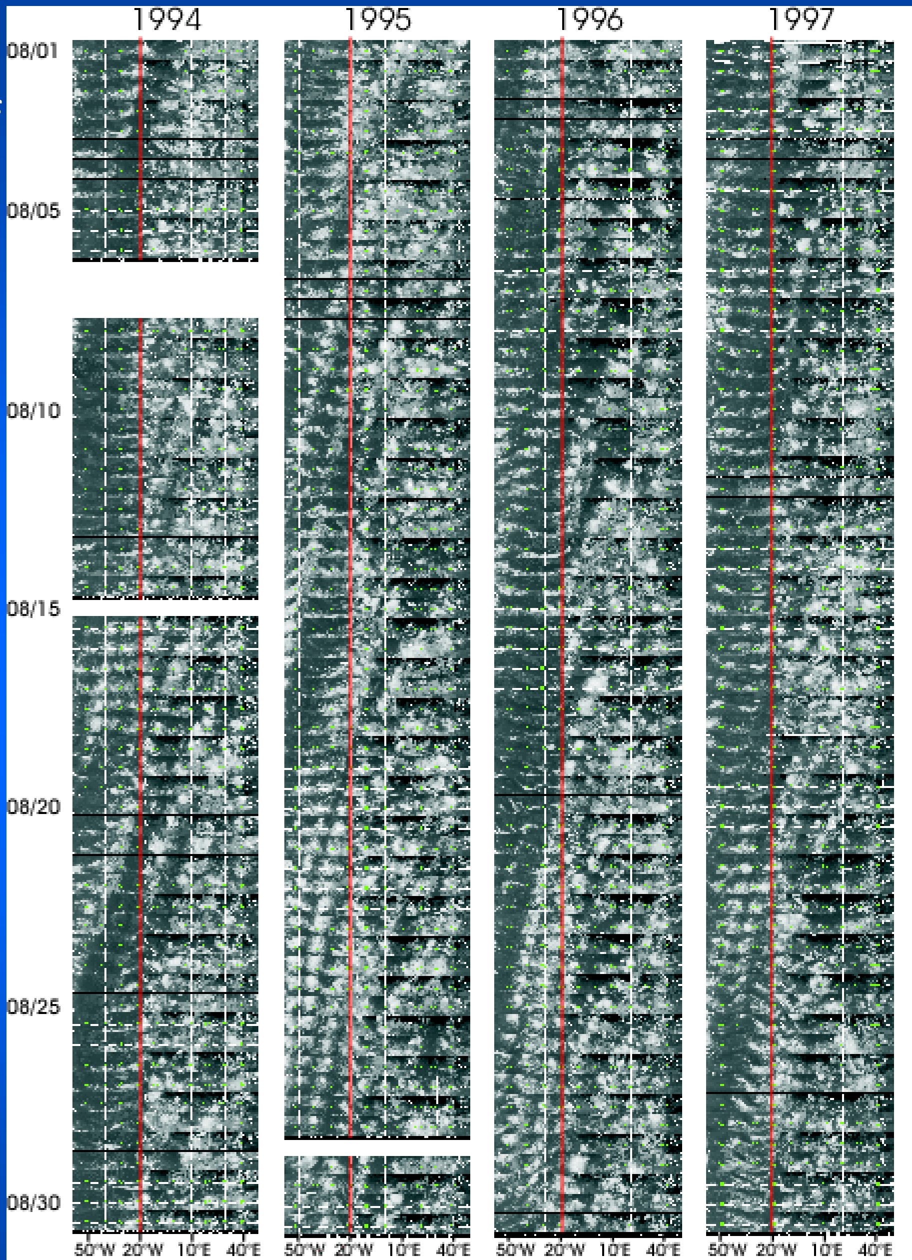
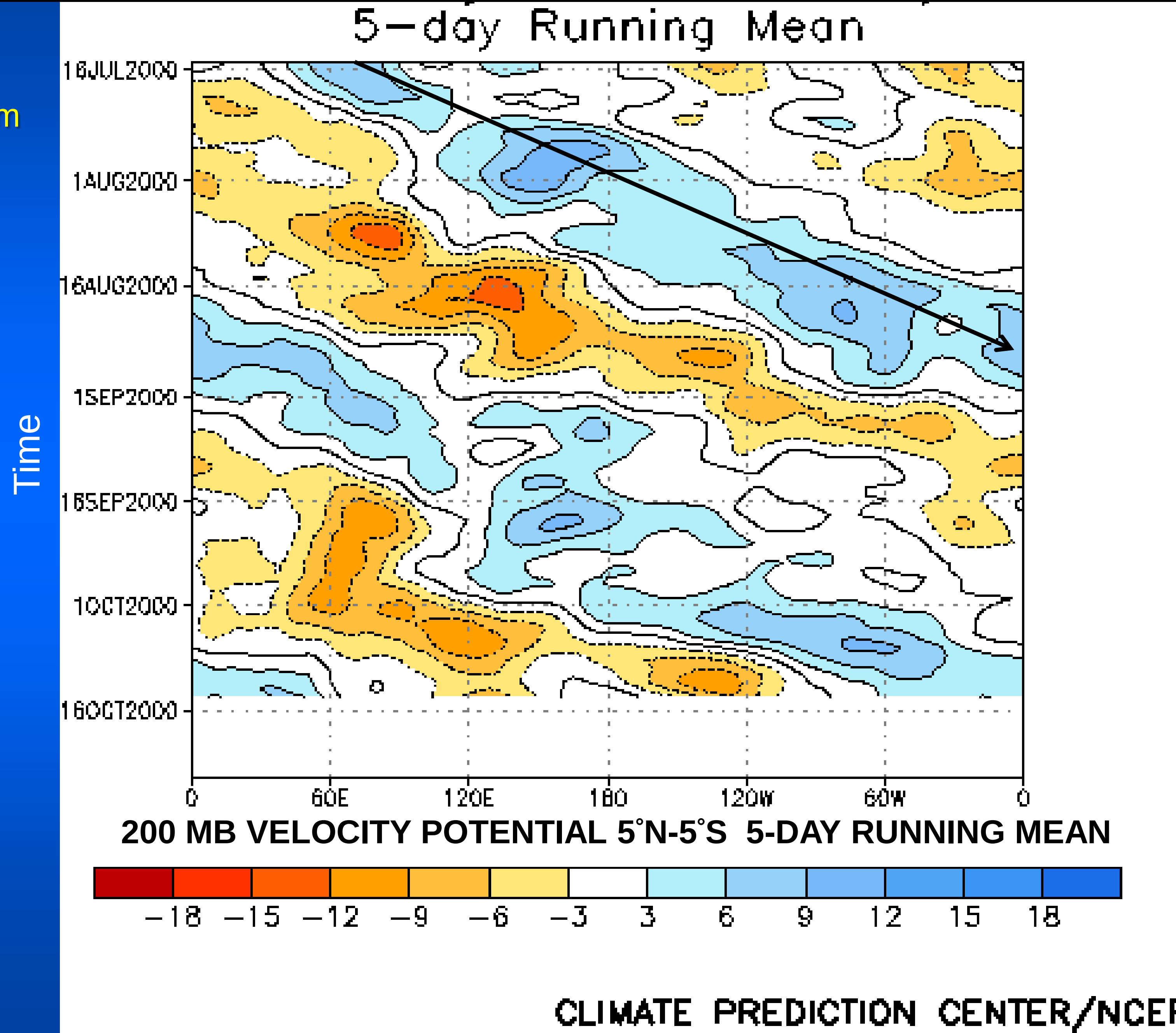


Figure 1: Hovmöller diagrams of 00Z and 12Z Meteosat images. Each strip covers an area between 5°N to 15°N and from 60°W to 60°E.

Using 200 mb velocity potential to track the MJO

What can we get from this picture?

1.
2.
3.
4.



Composite study

- Cut each wave into several categories (trough, ridges, inflation points, etc.)
- Average wave properties (u, v, vertical speed, temperature, moisture, etc.) at each category
- The result is an averaged wave structure

Amplitude of waves along one wavelength

T: 700mb trough

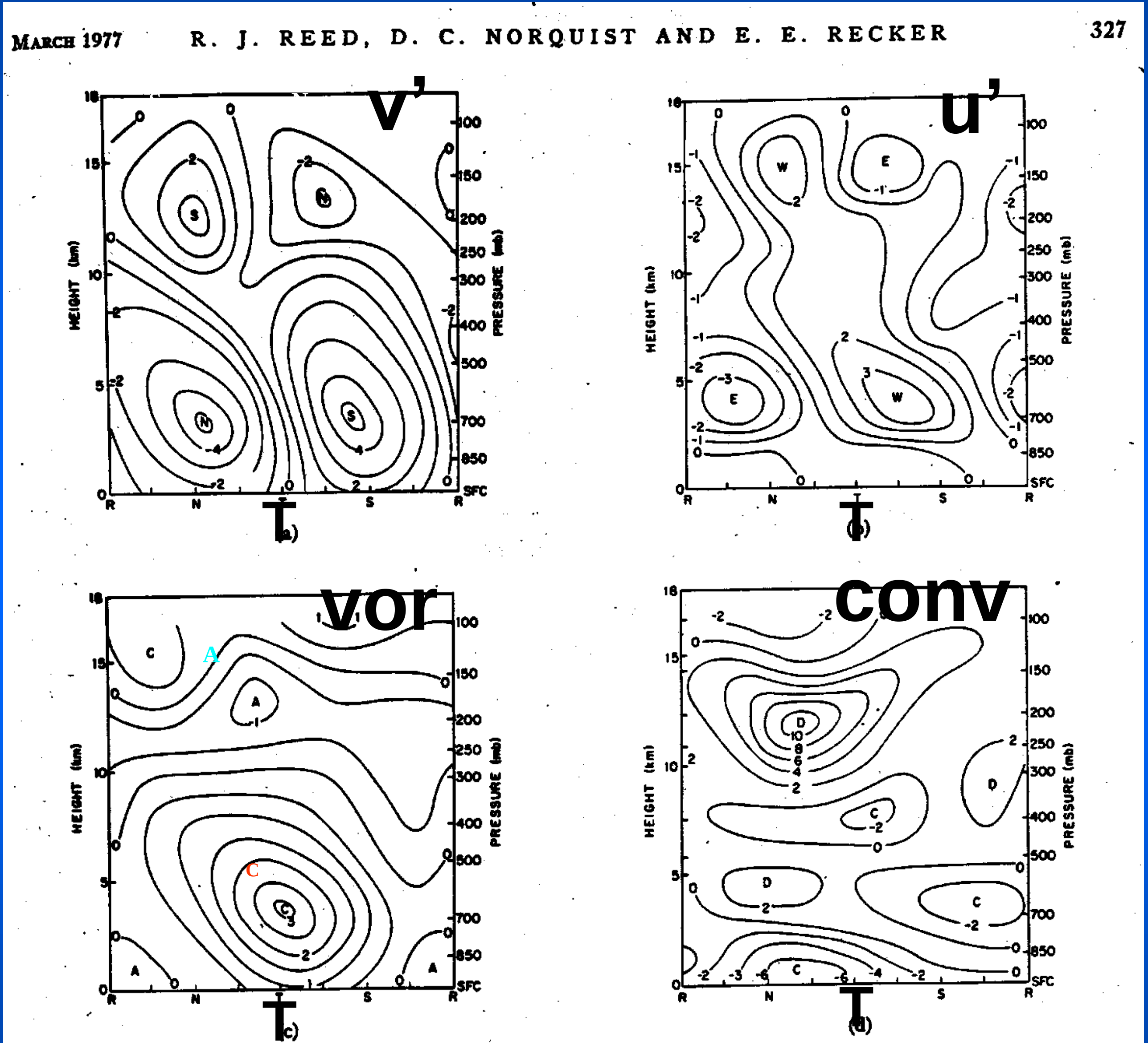


FIG. 8. Vertical cross sections along reference latitude. (a) Meridional wind deviation (m s^{-1}); (b) zonal wind deviation (m s^{-1}); (c) vorticity (10^{-5} s^{-1}); (d) divergence (10^{-6} s^{-1}). R, N, T, S refer to ridge, north wind, trough, south wind sectors of the wave, respectively.

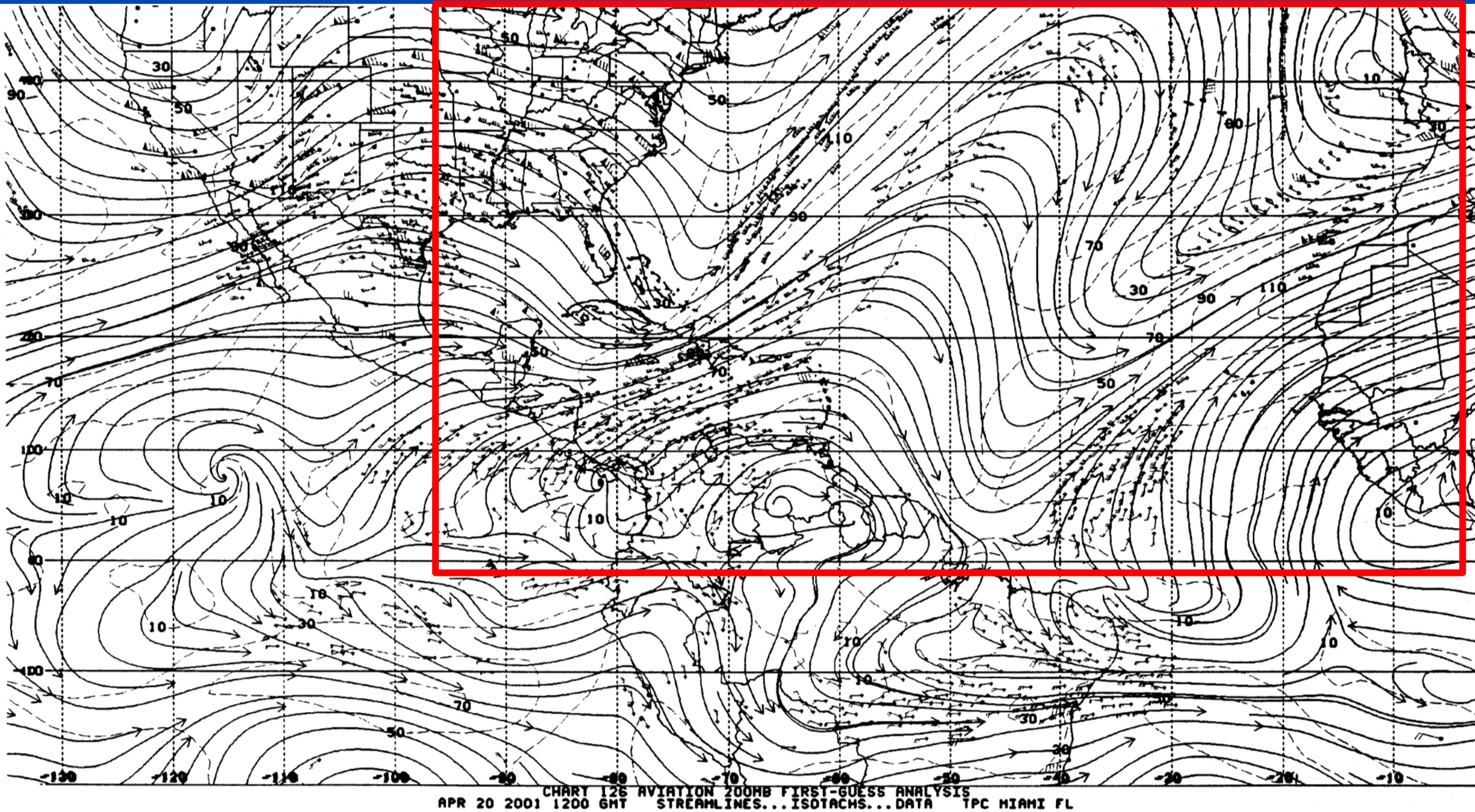
How is the trough defined?

Exercise #2

Explain what you see in the following 200 mb stramline chart

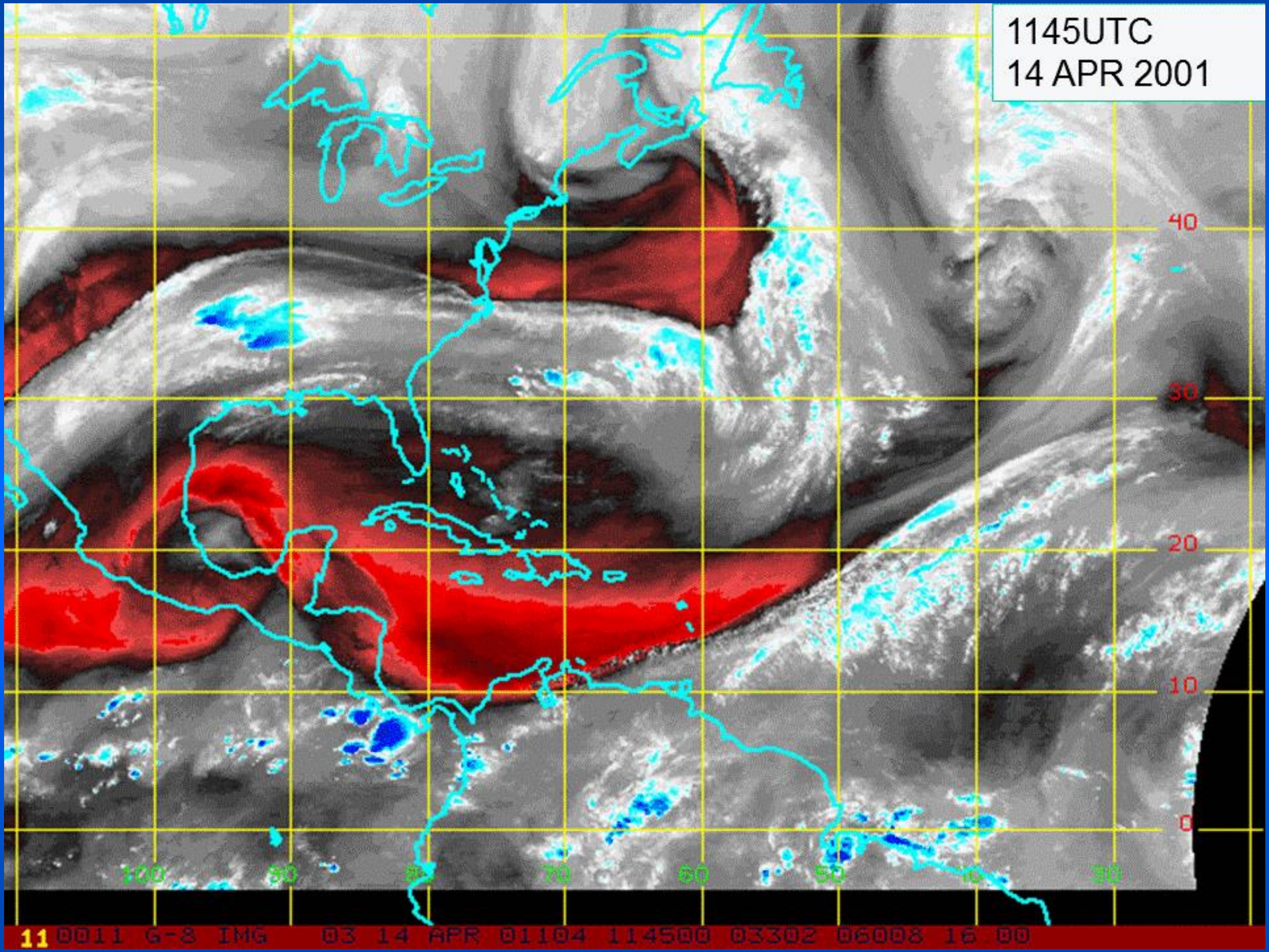
200 mb streamlines

How many large-scale features can you identify?

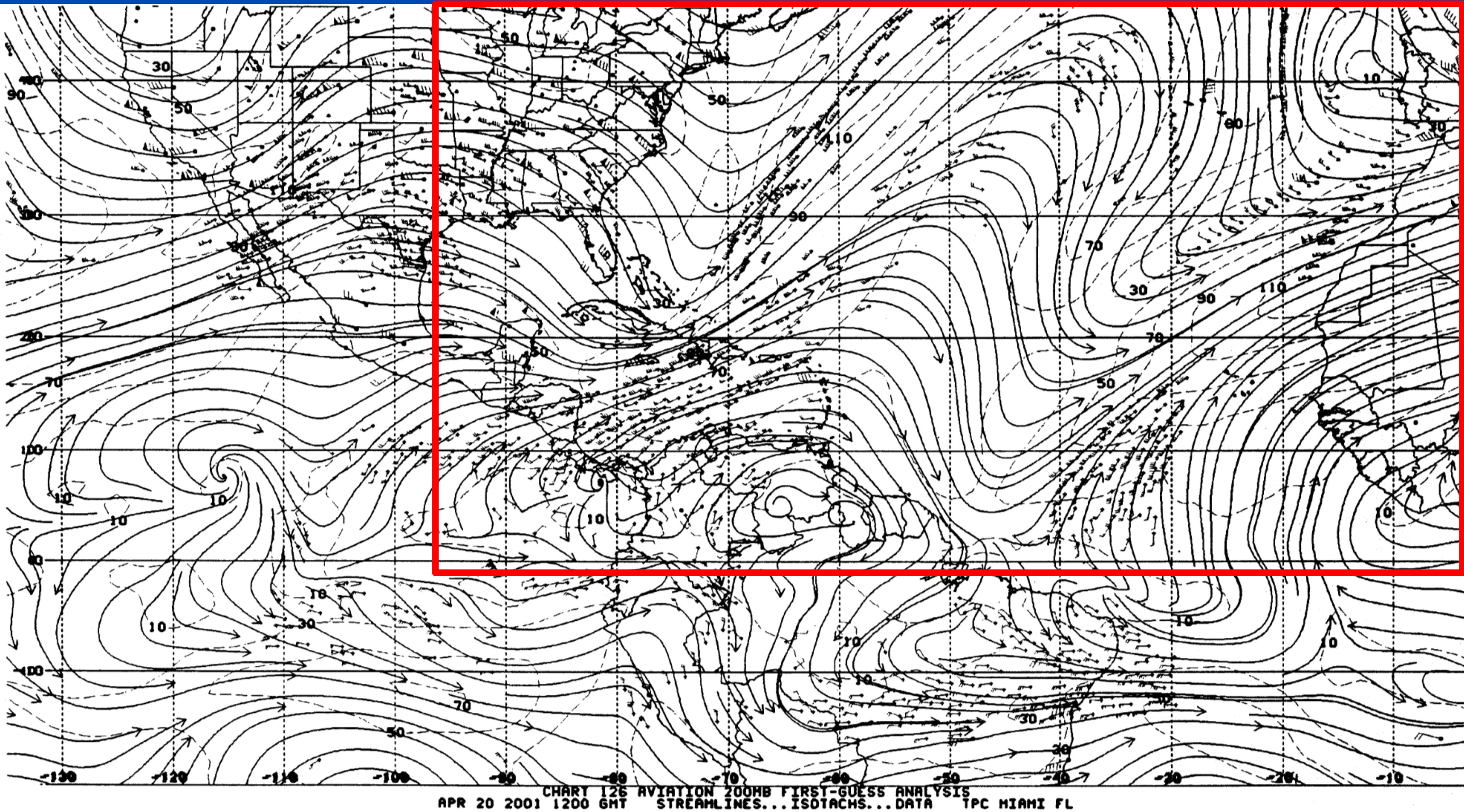


1200 UTC Apr. 20, 2001

April 14-20 2001

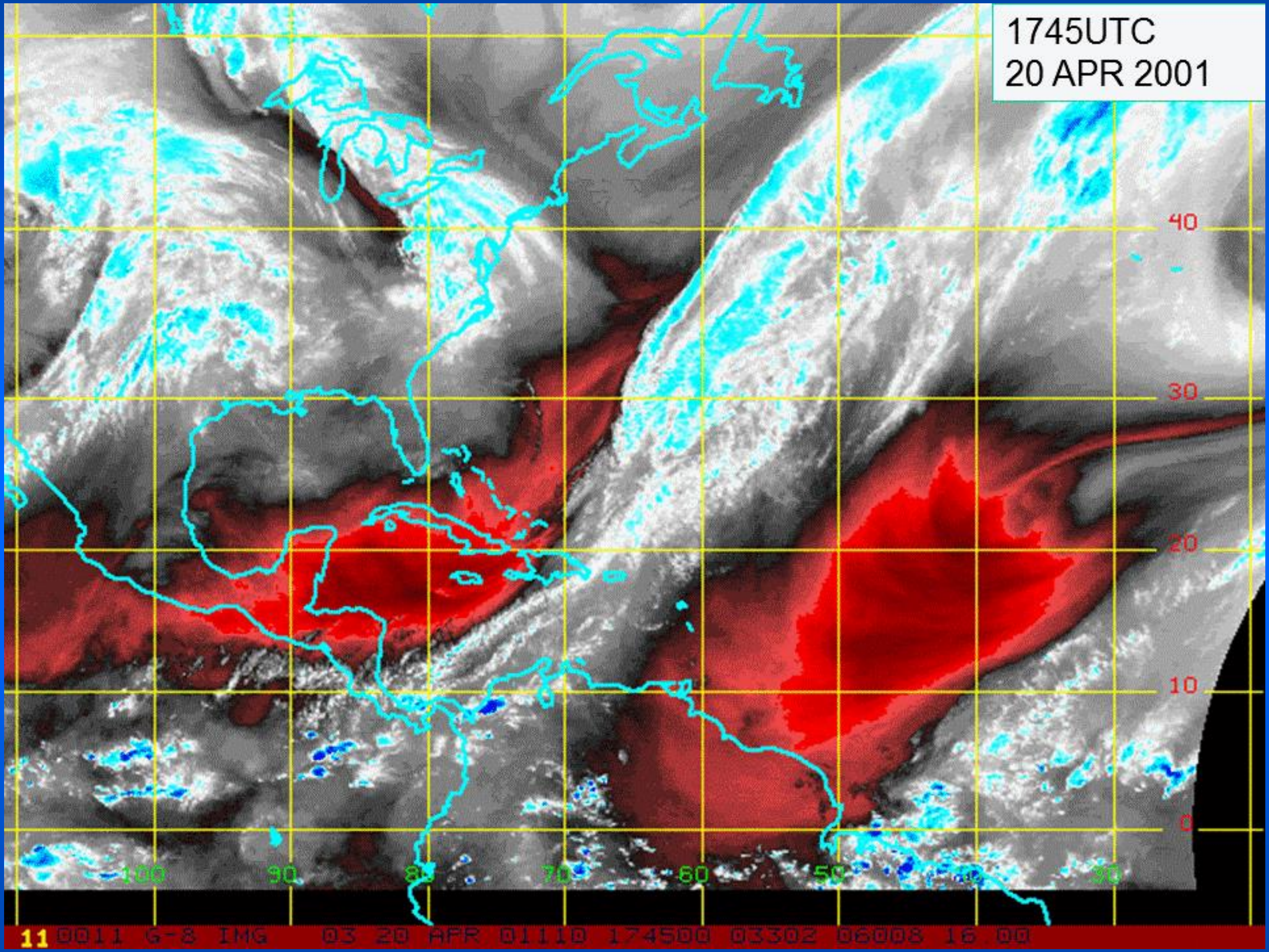


200 mb streamlines
How many large-scale features can you identify?

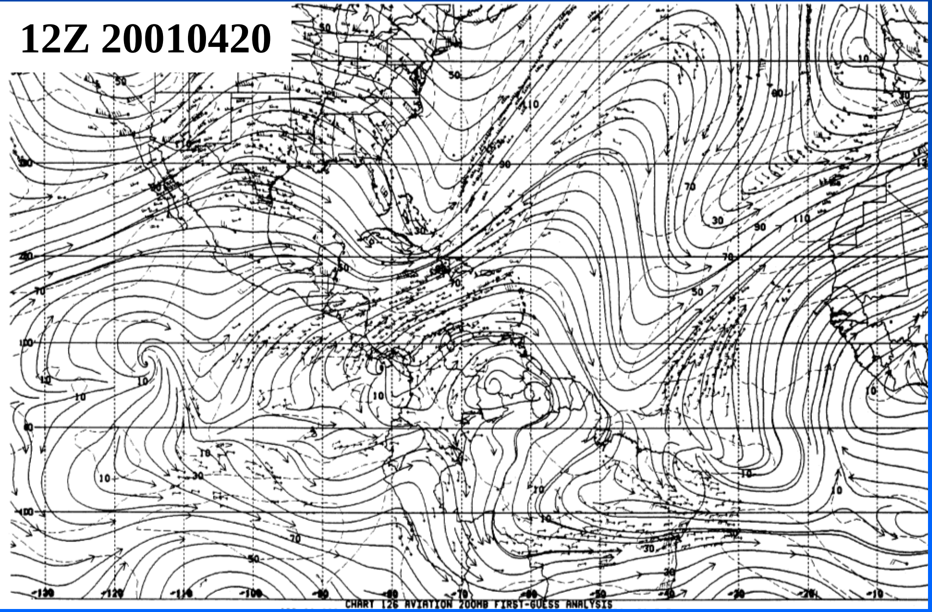


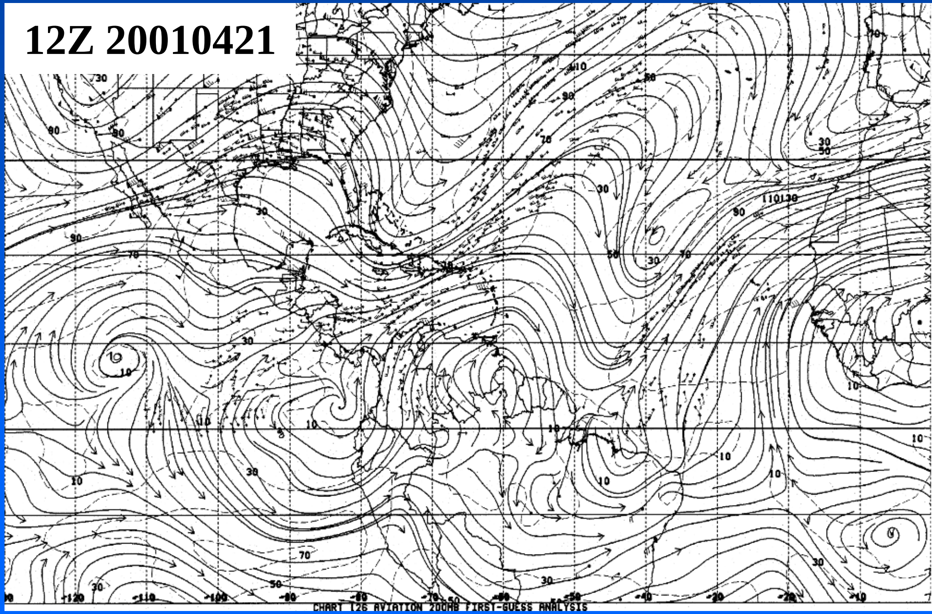
1200 UTC Apr. 20, 2001

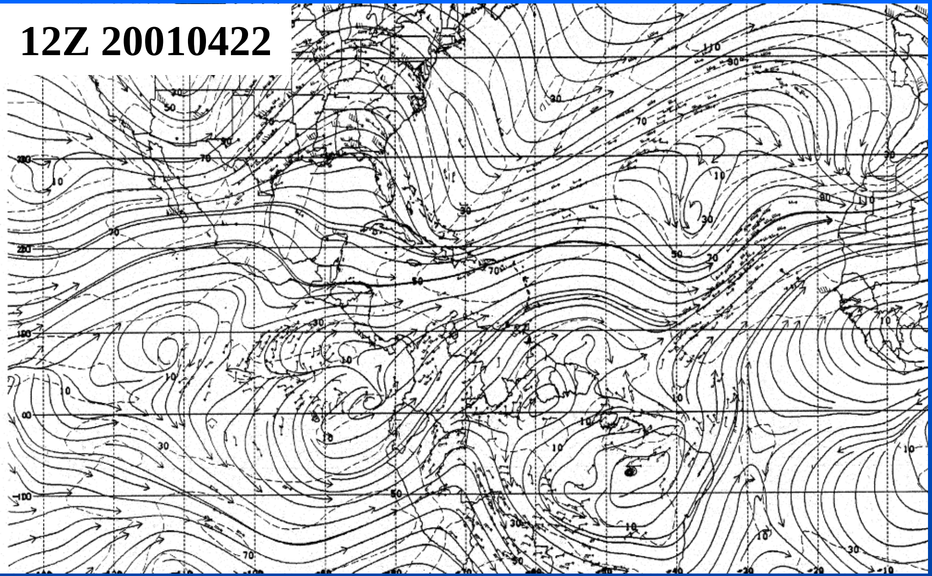
April 20-23 2001

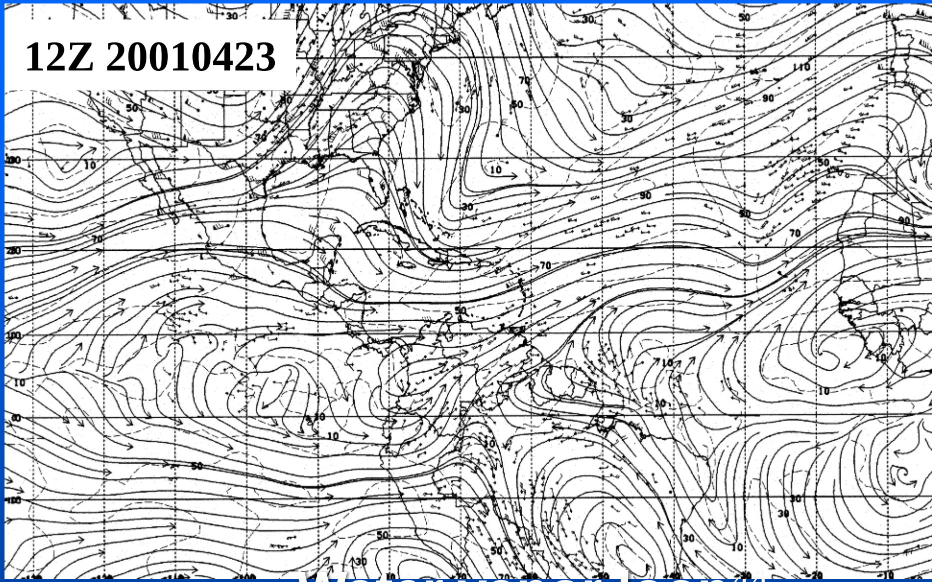


Days later



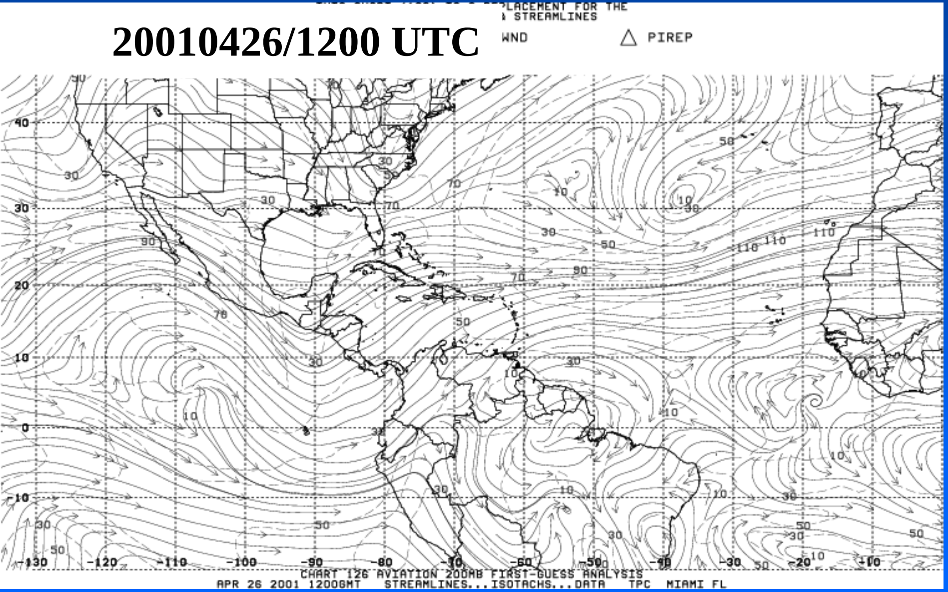






Water vapor loop

and later


20010426/1200 UTC
PIREP
CHART 126 AVIATION 200MB FIRST-GUESS ANALYSIS
APR 26 2001 1200GMT STREAMLINES...ISOTACHS...DATA TPC MIAMI FL

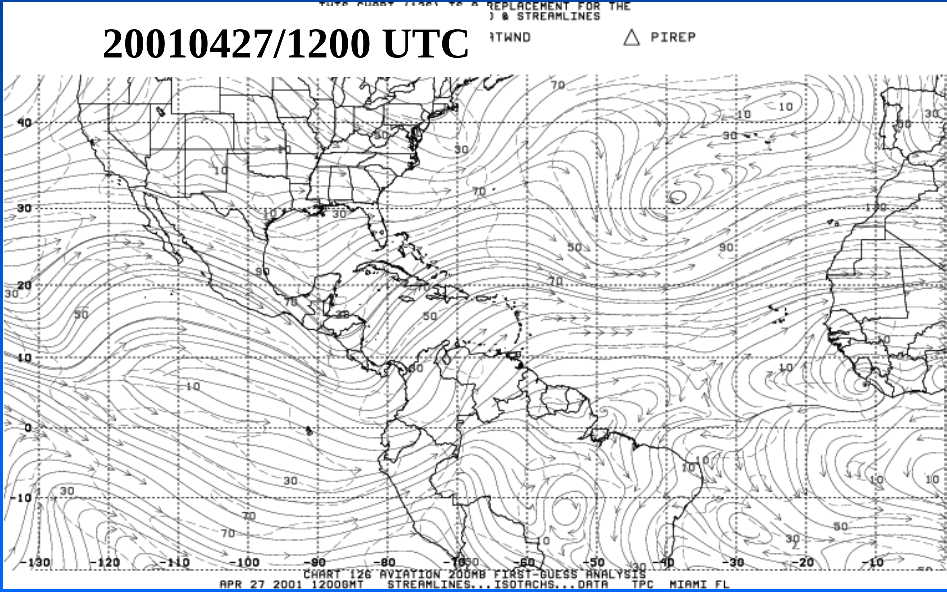

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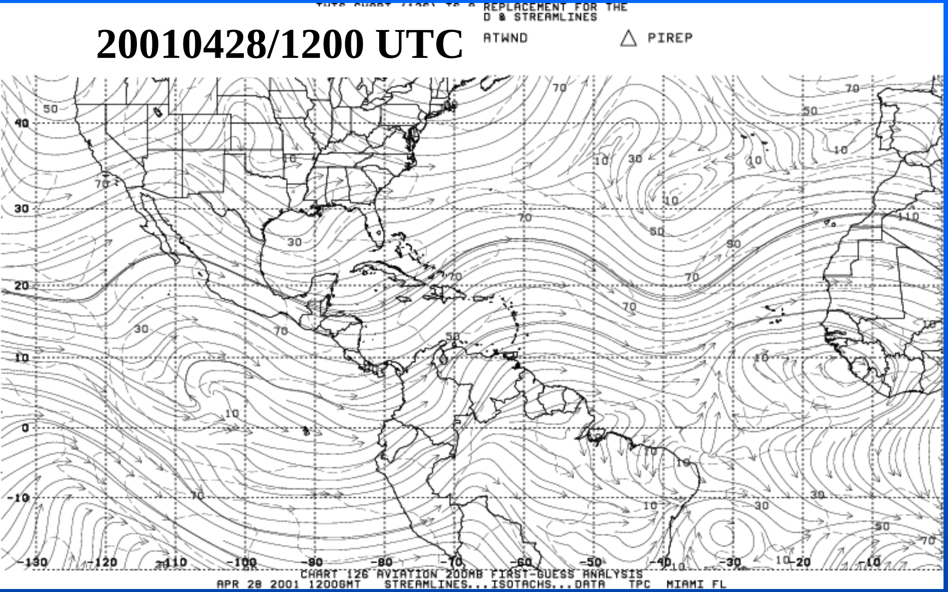
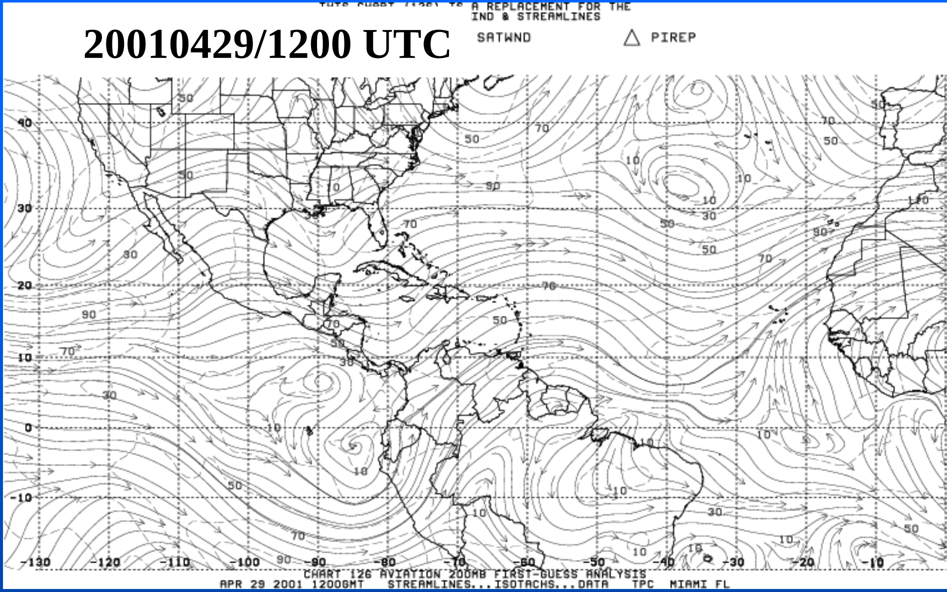
CHART 126 AVIATION 200MB FIRST-GUESS ANALYSIS
APR 27 2001 1200GMT STREAMLINES...ISOTACHS...DATA TPC MIAMI FL


20010428/1200 UTC
PIREP
CHART 126 AVIATION 200MB FIRST-GUESS ANALYSIS
APR 28 2001 1200GMT STREAMLINES...ISOTACHS...DATA TPC MIAMI FL


20010429/1200 UTC
SATWND
PIREP
CHART 126 AVIATION 200MB FIRST-GUESS ANALYSIS
APR 29 2001 1200GMT STREAMLINES...ISOTACHS...DATA TPC MIAMI FL

What we see on a chart maybe the combination of many different systems, sometimes from different latitudinal regimes

It is critical that a forecaster is able to identify and separate these different systems

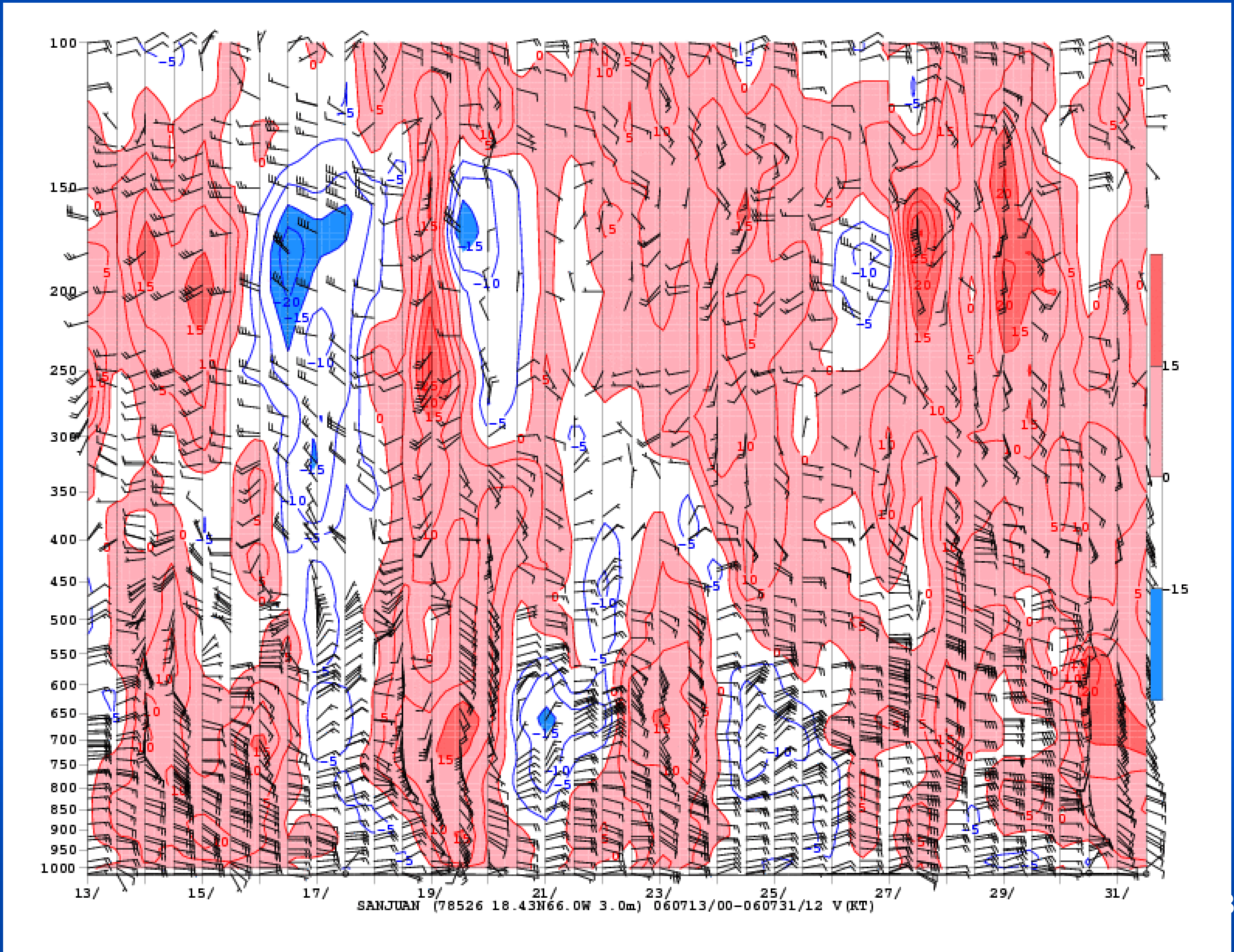
Filtering

High pass, low pass, band pass, …

Perturbation analysis (easiest one)

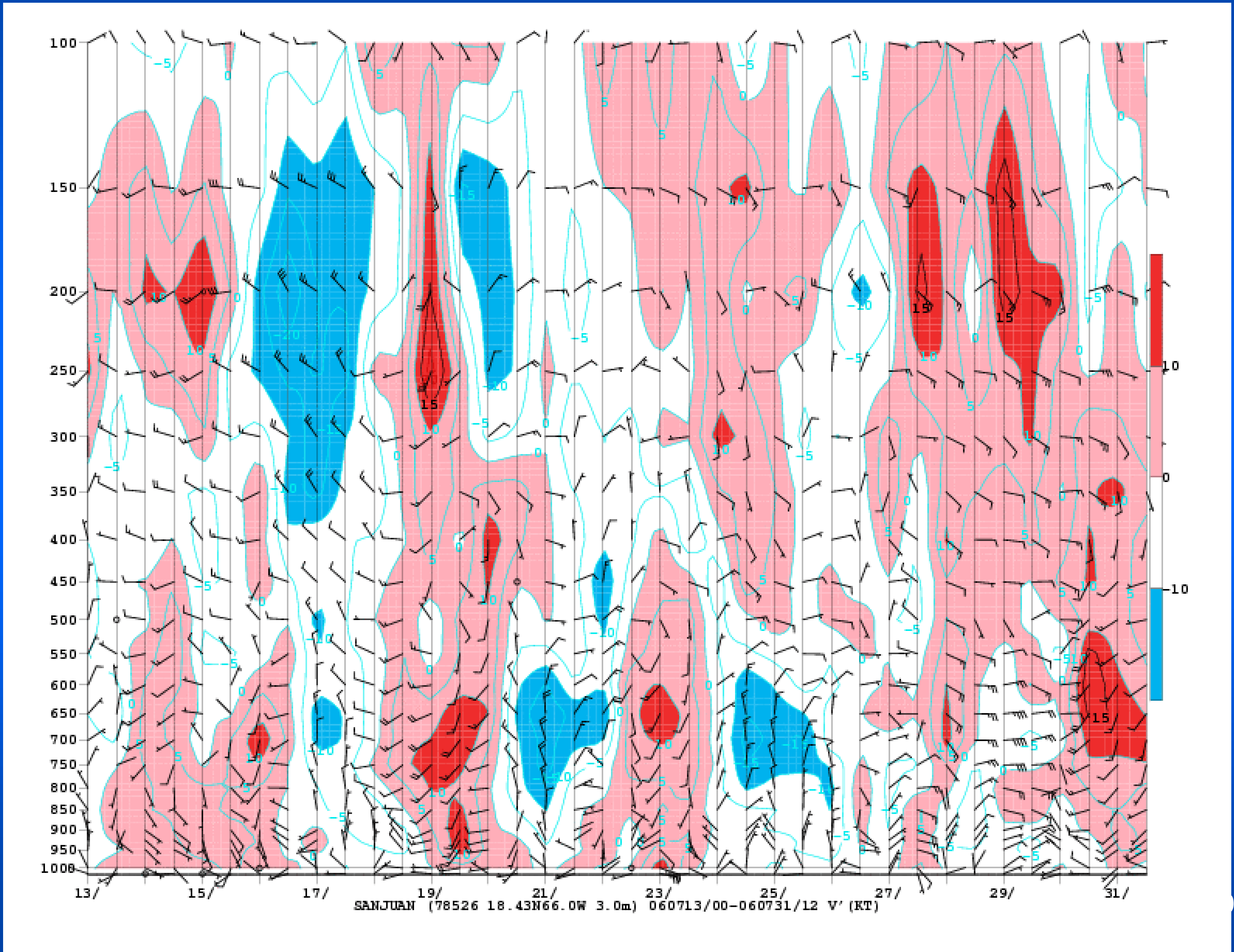
- Remove the area-mean or time-mean to show the anomalies
- It shows the presence of weather systems better
- Very useful in the tropics when the amplitude of many systems are small

Meridional Wind – San Juan
July 13-July 31, 2006

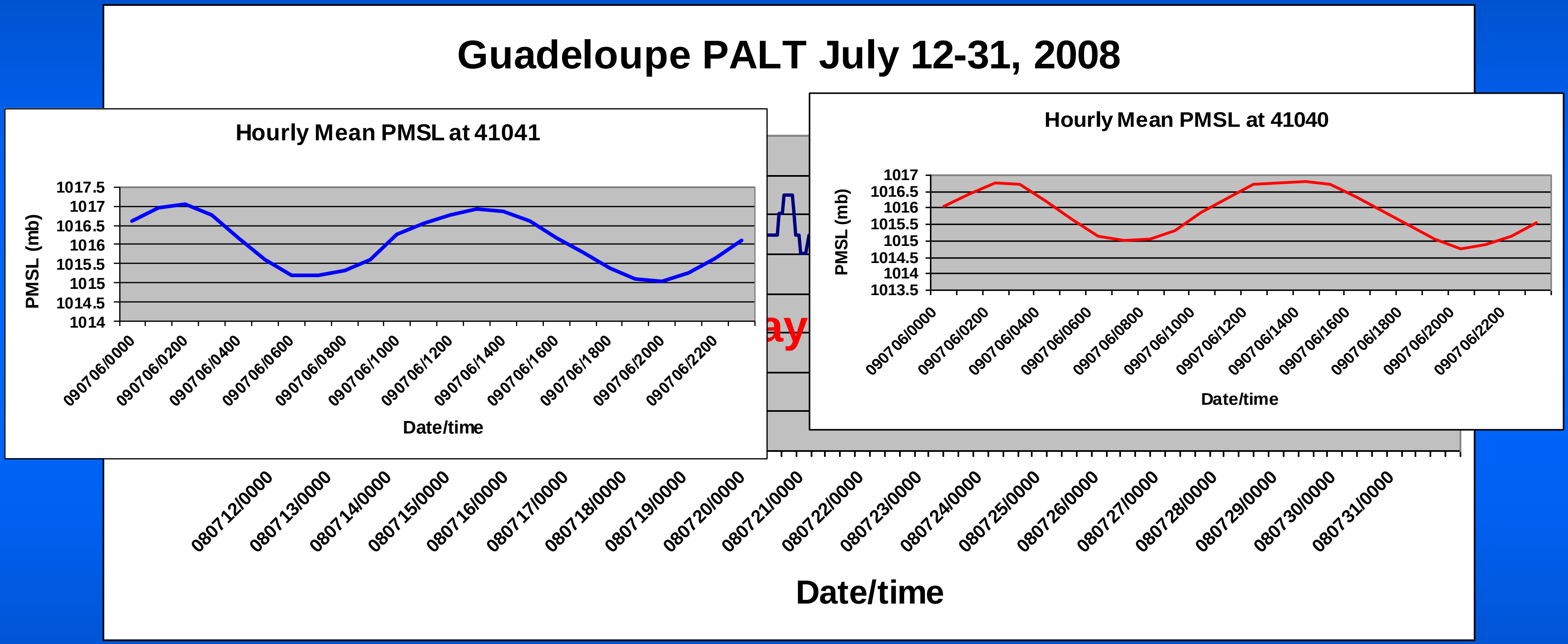


Meridiornal Wind Anomalies – San Juan

July 13-July 31, 2006 time-means at each level removed



The mean hourly pressures also hold information semidiurnal pressure tides



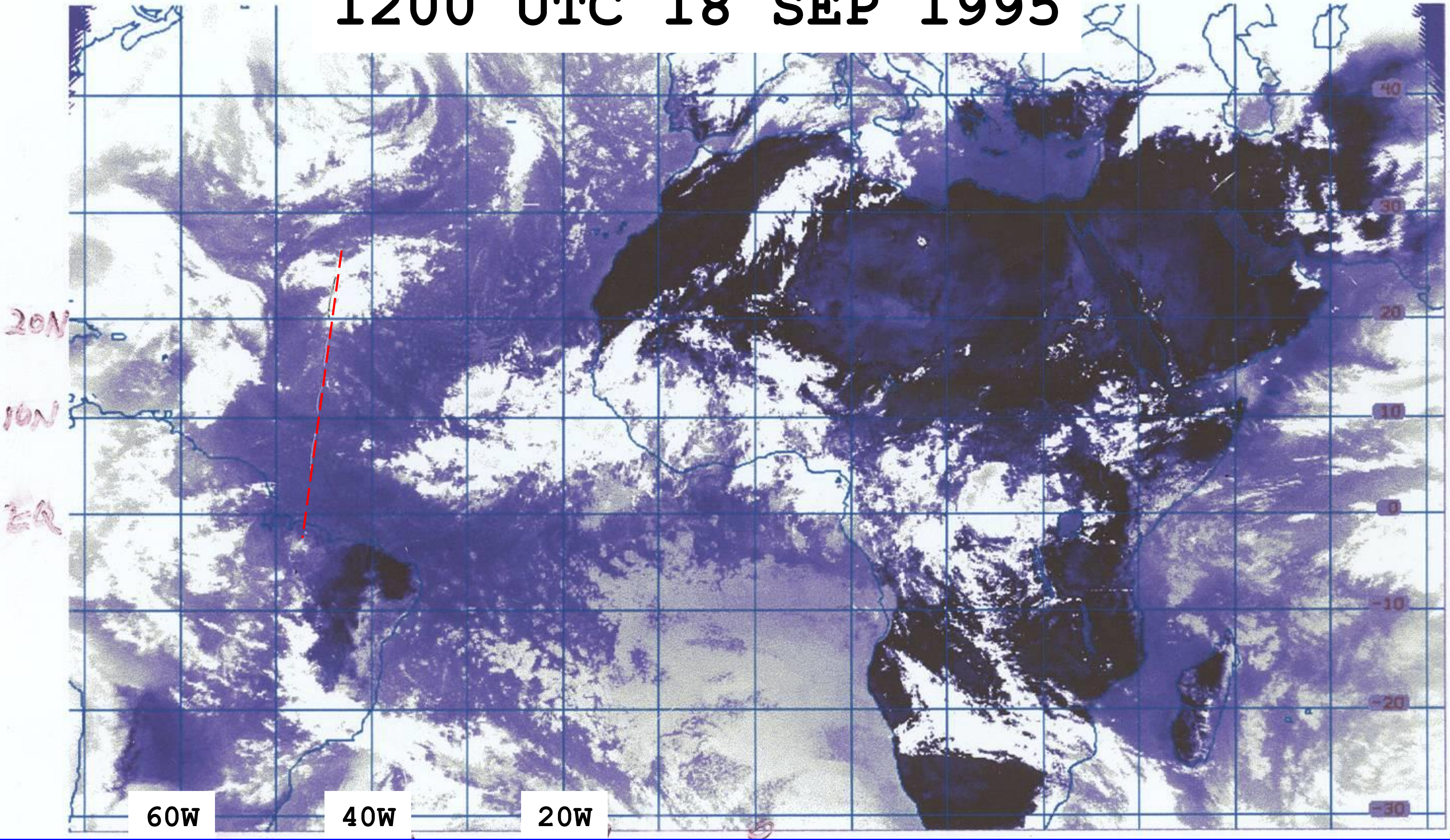
- By averaging MSLP for each hour, 00Z, 01Z, 02Z, … the resulting series show the Diurnal and semidiurnal surface pressure tide, and the long term mean (~1016 mb)

- By removing the long term man and the diurnal/semidiurnal tides from the observed data, we can see the effects of weather related surface pressure changes better.

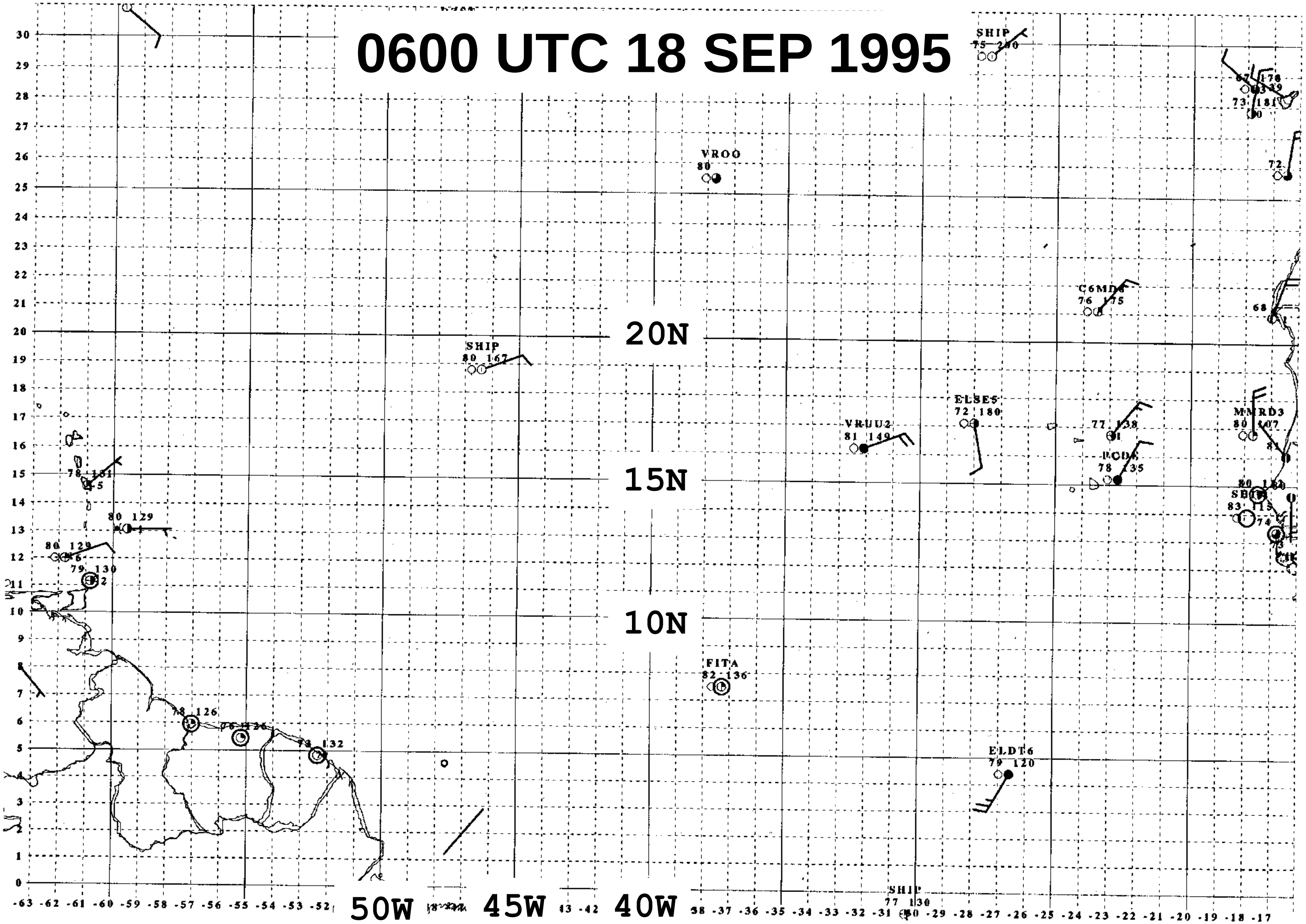
COMPOSITE ANALYSIS

Looking beyond just one reporting time

1200 UTC 18 SEP 1995

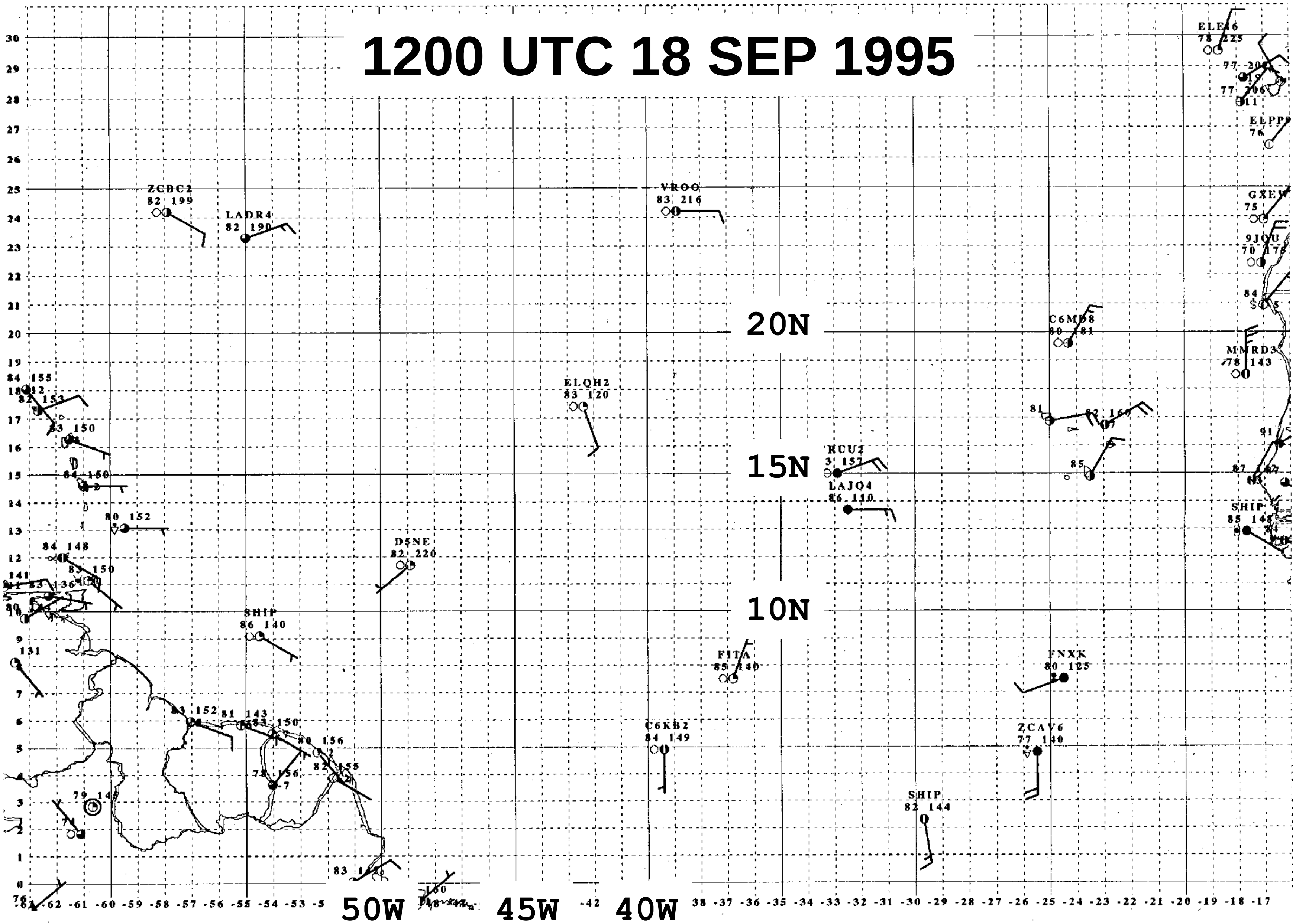


0600 UTC 18 SEP 1995



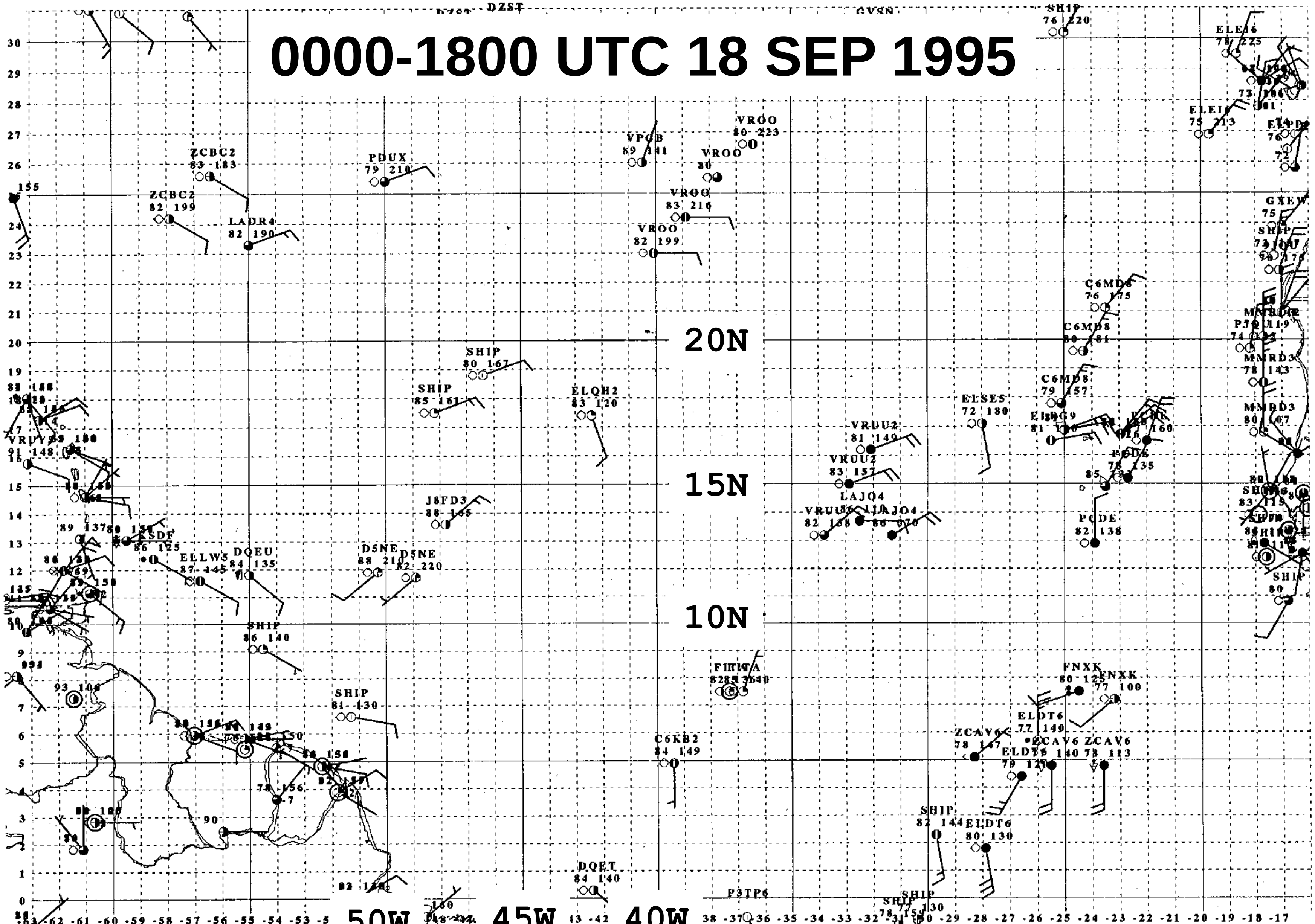
950918/06Z MEAN SEA LEVEL CHART

1200 UTC 18 SEP 1995



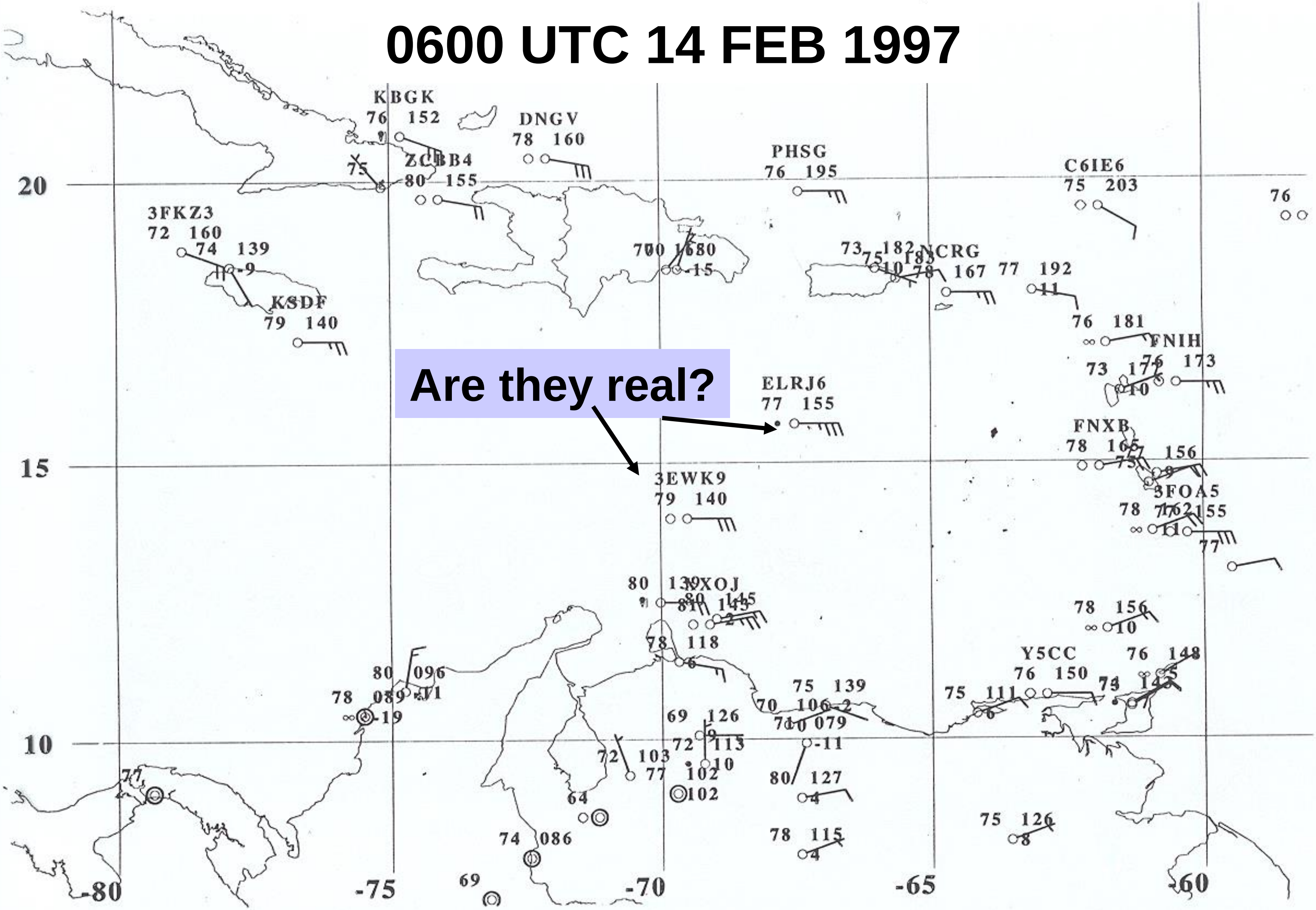
950918/12Z MEAN SEA LEVEL CHART

0000-1800 UTC 18 SEP 1995

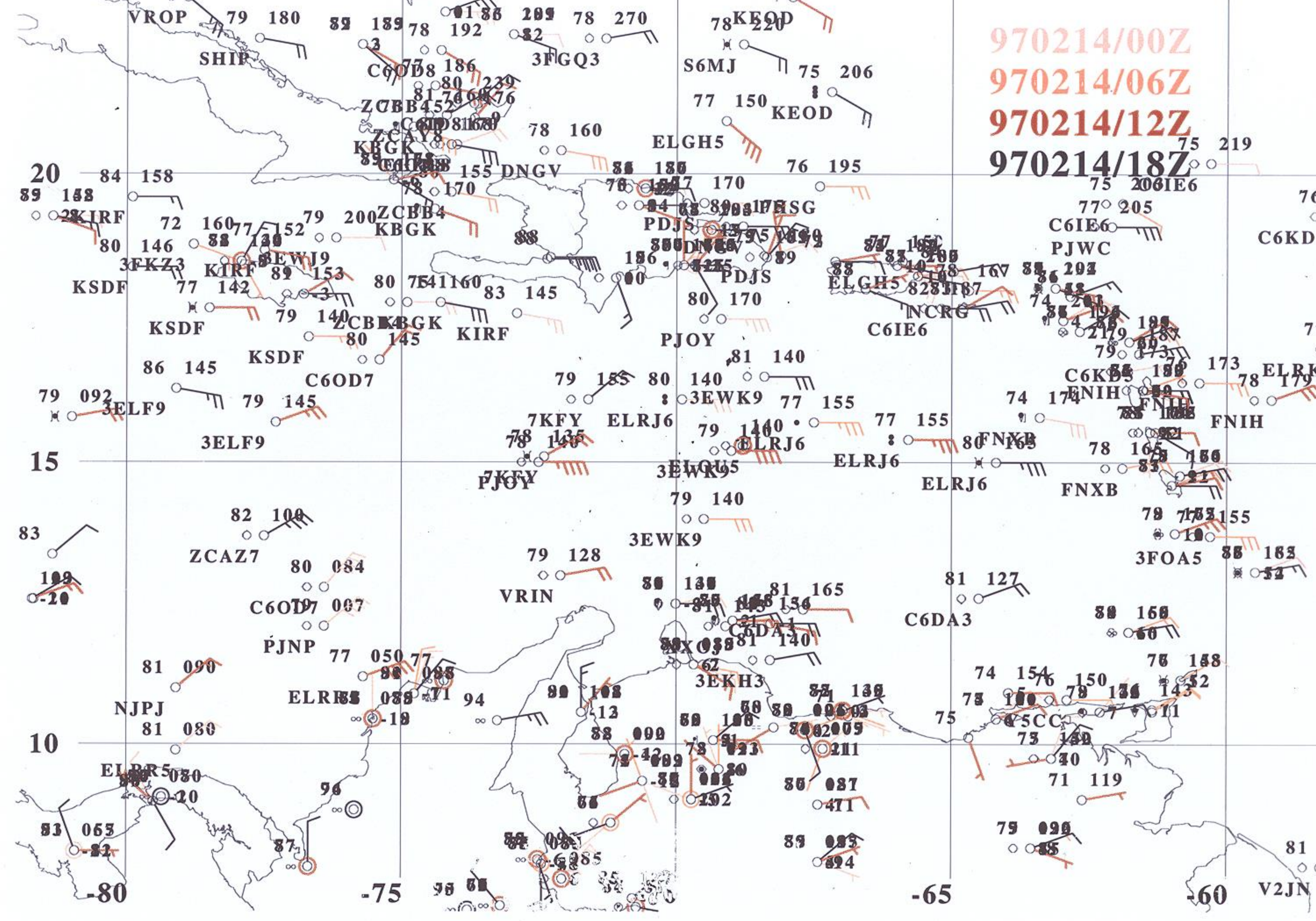


950918/00-18Z MEAN SEA LEVEL CHART

0600 UTC 14 FEB 1997



970214/06Z MEAN SEA LEVEL CHART

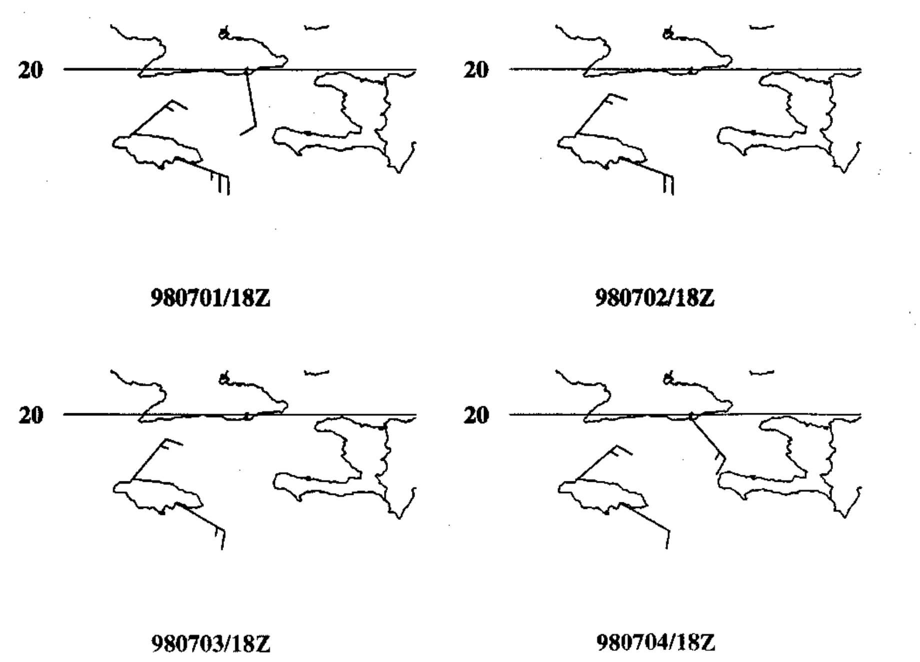


970214/00Z-970214/18Z COMPOSITE MSL CHART

LOCAL EFFECTS

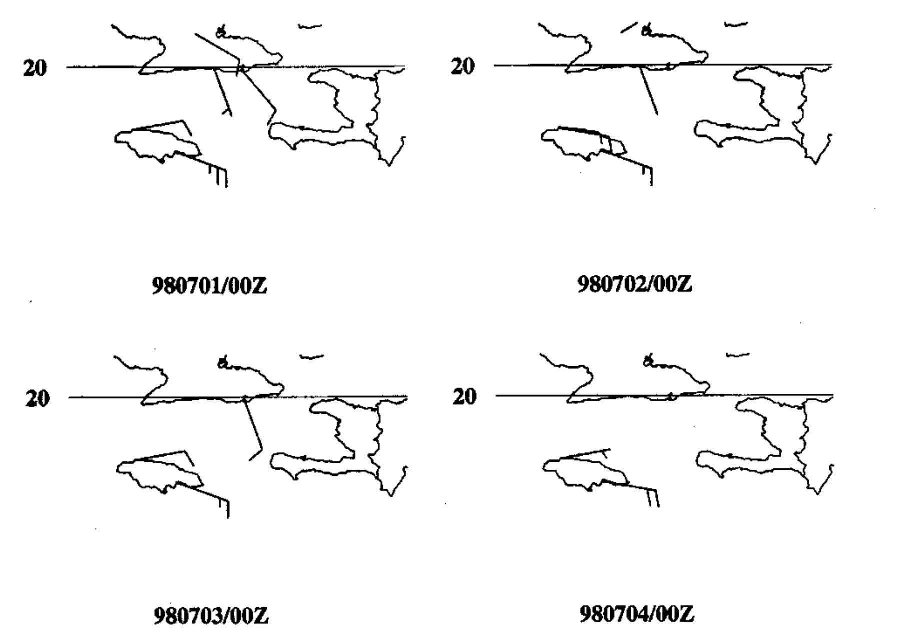
They can make synoptic analysis a very difficult task if not removed from the dataset
(either physically/mathematically or mentally)

Wind shift between Kingston and Montego Bay at 18Z on those days, suggesting a trough over the island



Heated island

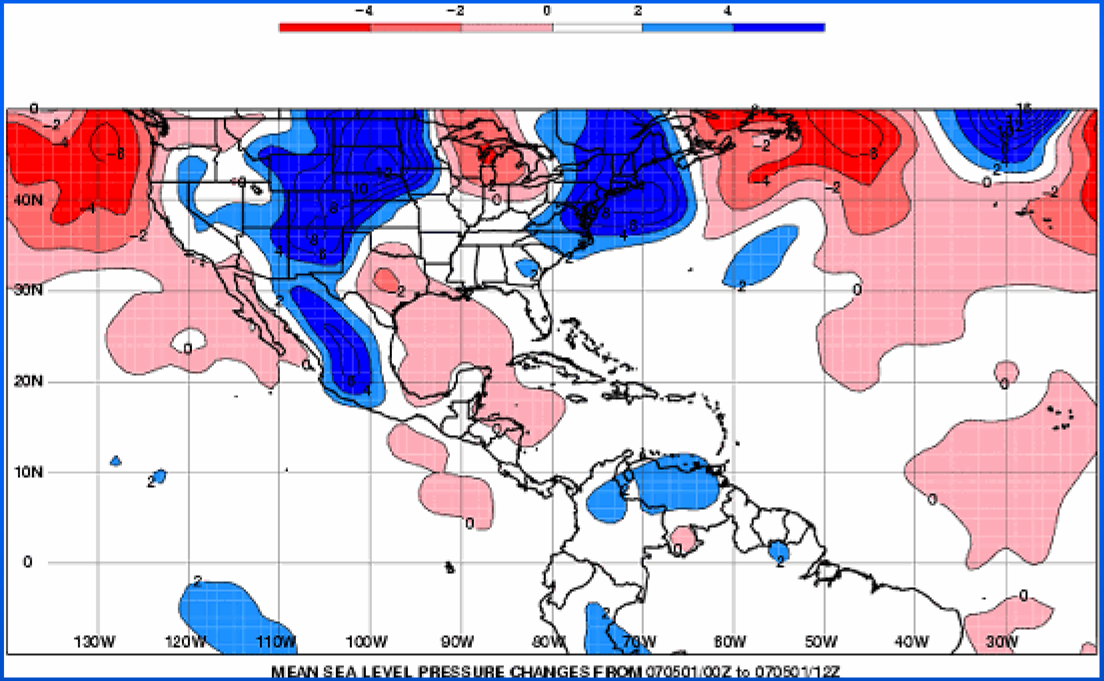
But the wind shift was mostly gone by 00Z



Topographical + Diurnal effects can mislead you

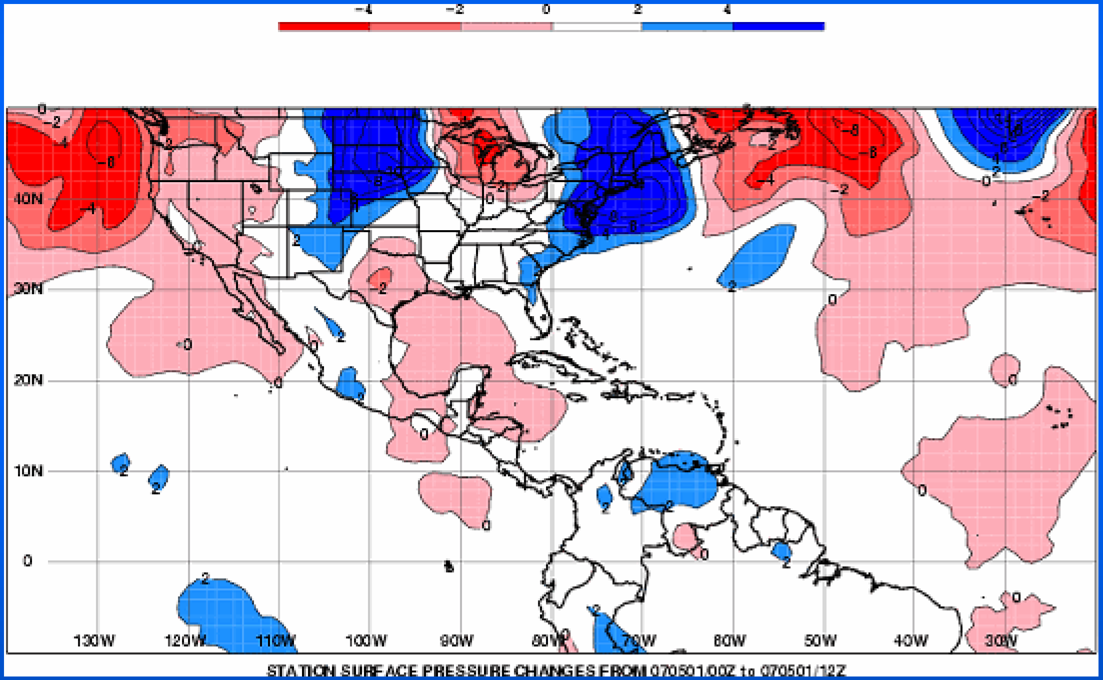
Example: Mean Sea Level Pressure Changes (12Z – 00Z)

20070501-20070515



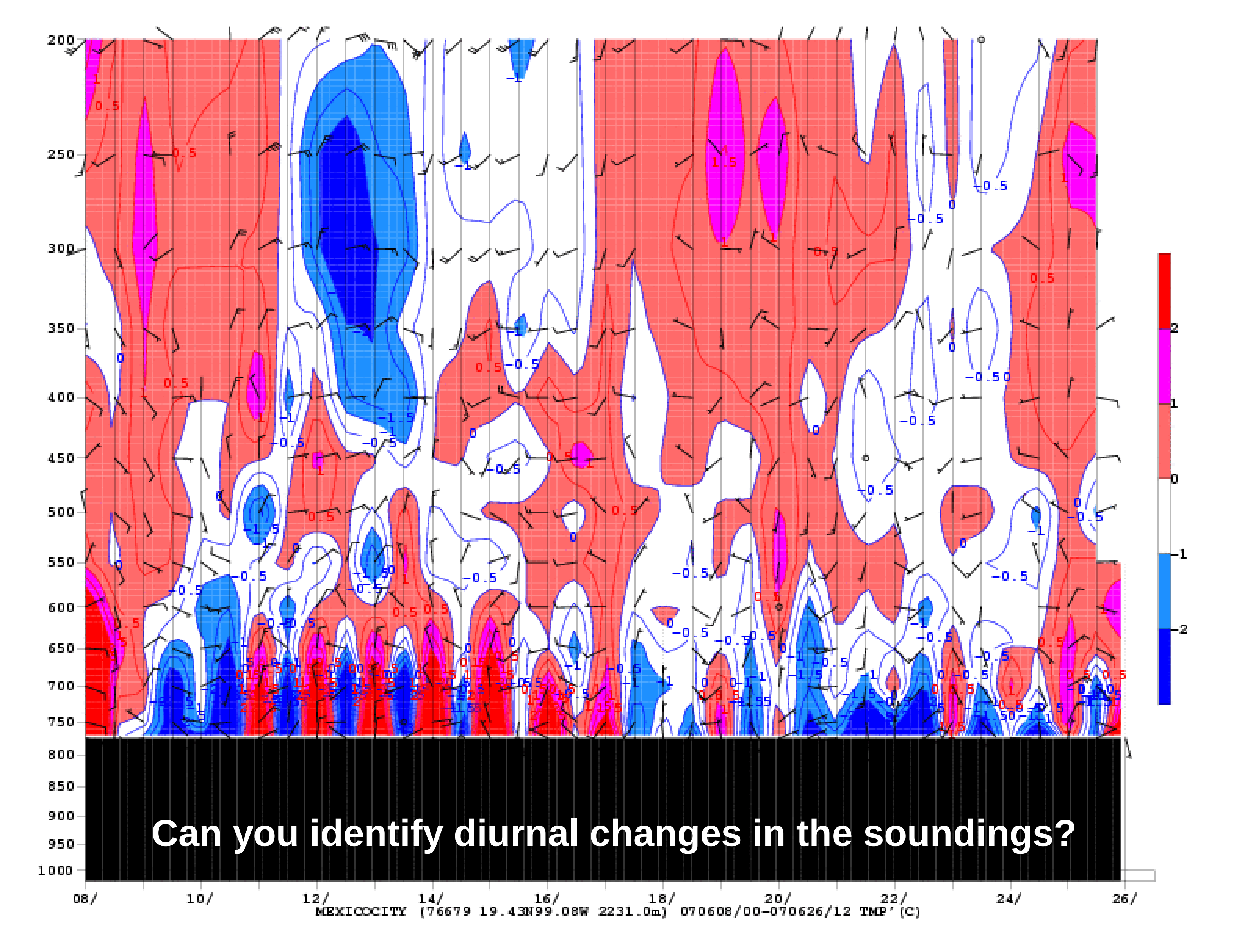
Topographical+Diurnal

Surface Pressure Changes 12Z – 00Z



Morning high pressure persisted over Mexico in PMSL is not as strong
Low pressure can appear in the morning over the Rocky Mountains

Temperature (sounding) anomalies at Mexico City June 8 – June 26, 2007



Case Study
Example of a thorough analysis

- Identify the characteristics of African easterly waves (AEW) over the Atlantic ocean during this period
  - With the knowledge gained, you can do a better analysis tracking the waves
- Are AEW on the surface?

A good analysis can be useful in helping us understand the atmosphere

NHC analysis has been challenged:

Do tropical (easterly) waves really propagate from west Africa into the Caribbean Ocean?

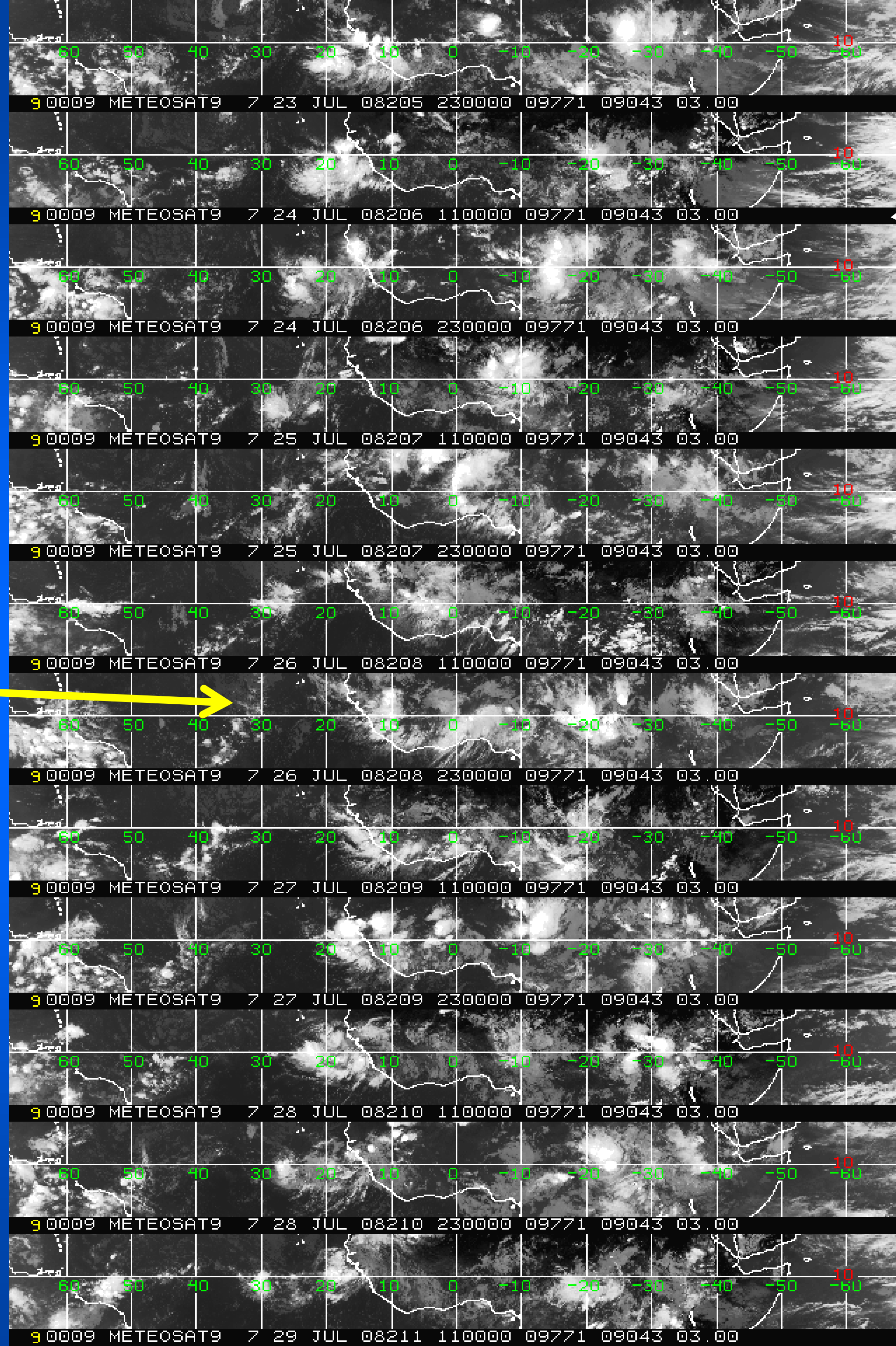
Are tropical (easterly) waves really on the surface?

The following case study uses several different techniques discussed earlier

Some Upper-Air Stations Referenced in This Presentation

This hovmöller chart shows the foot print of a weather system propagating from west Africa to eastern Caribbean

Let's call it **wave X**



2300 UTC Jul 23, 2008

1100 UTC Jul 24, 2008

2300 UTC Jul 24, 2008

1100 UTC Jul 25, 2008

2300 UTC Jul 25, 2008

1100 UTC Jul 26, 2008

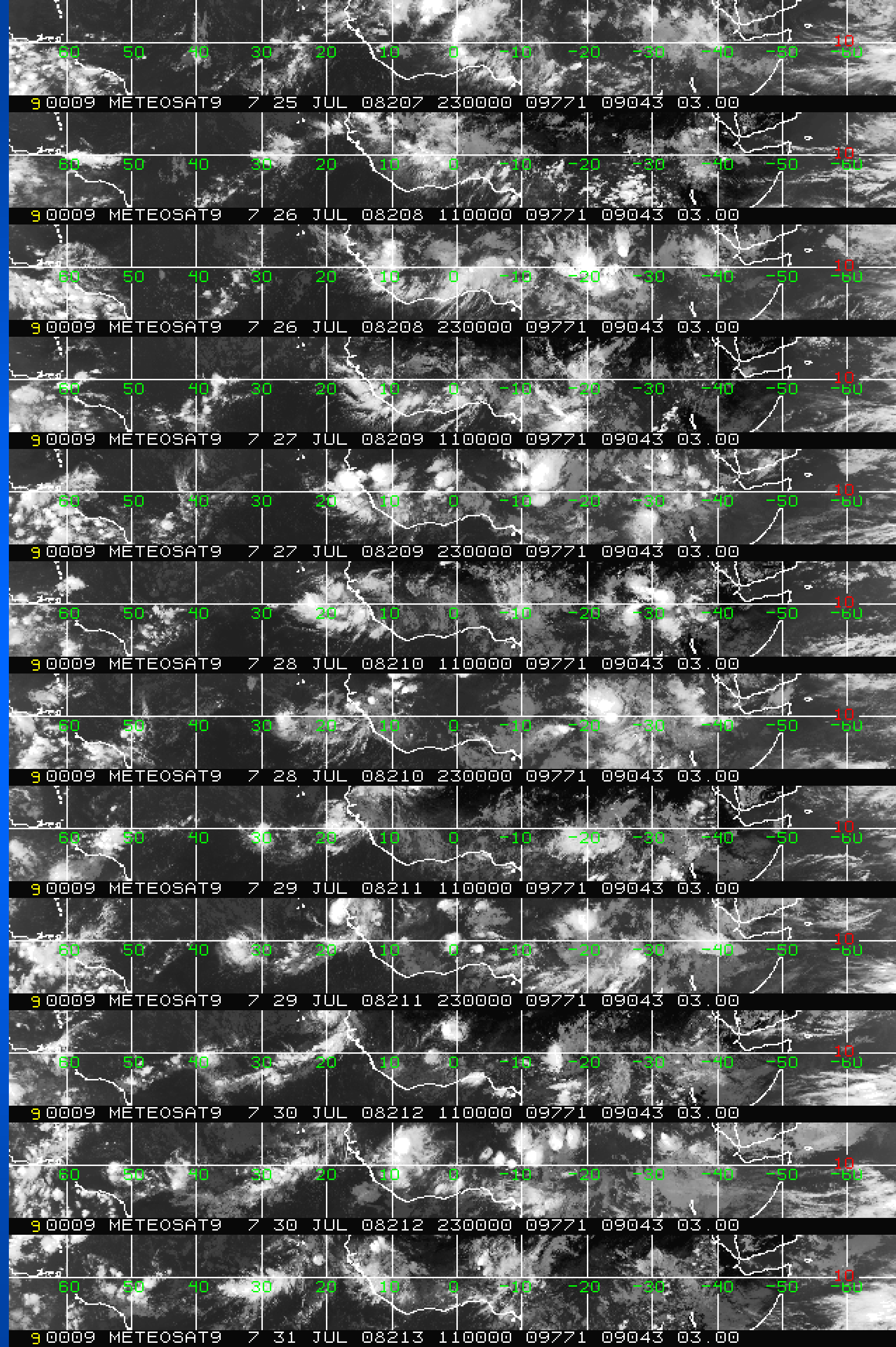
2300 UTC Jul 26, 2008

1100 UTC Jul 27, 2008

Q: When did this wave pass Dakar?

2300 UTC July 25

Q: When did Wave X enter eastern Caribbean



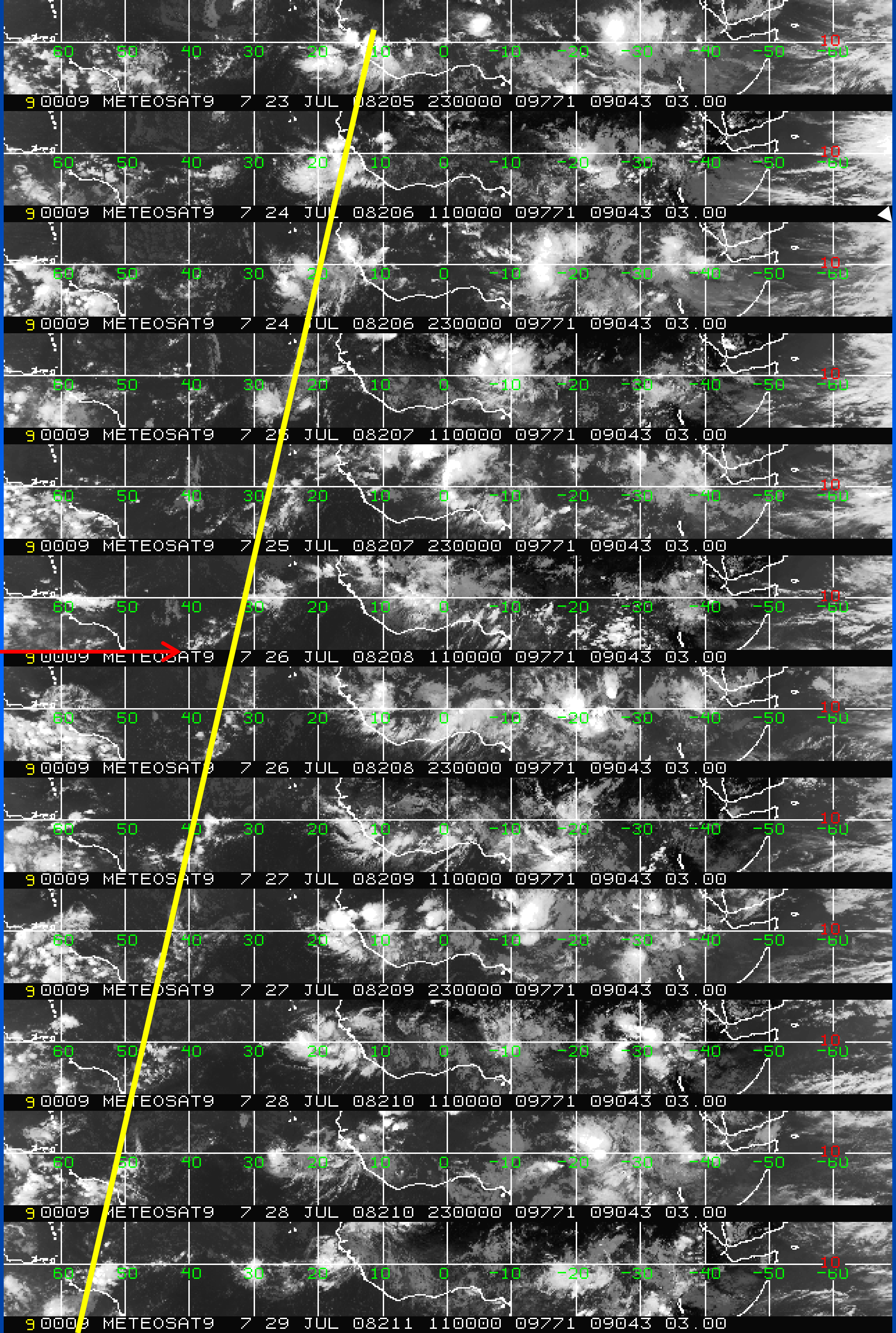
1100 UTC Jul 30

1100 UTC Jul 31

Questions

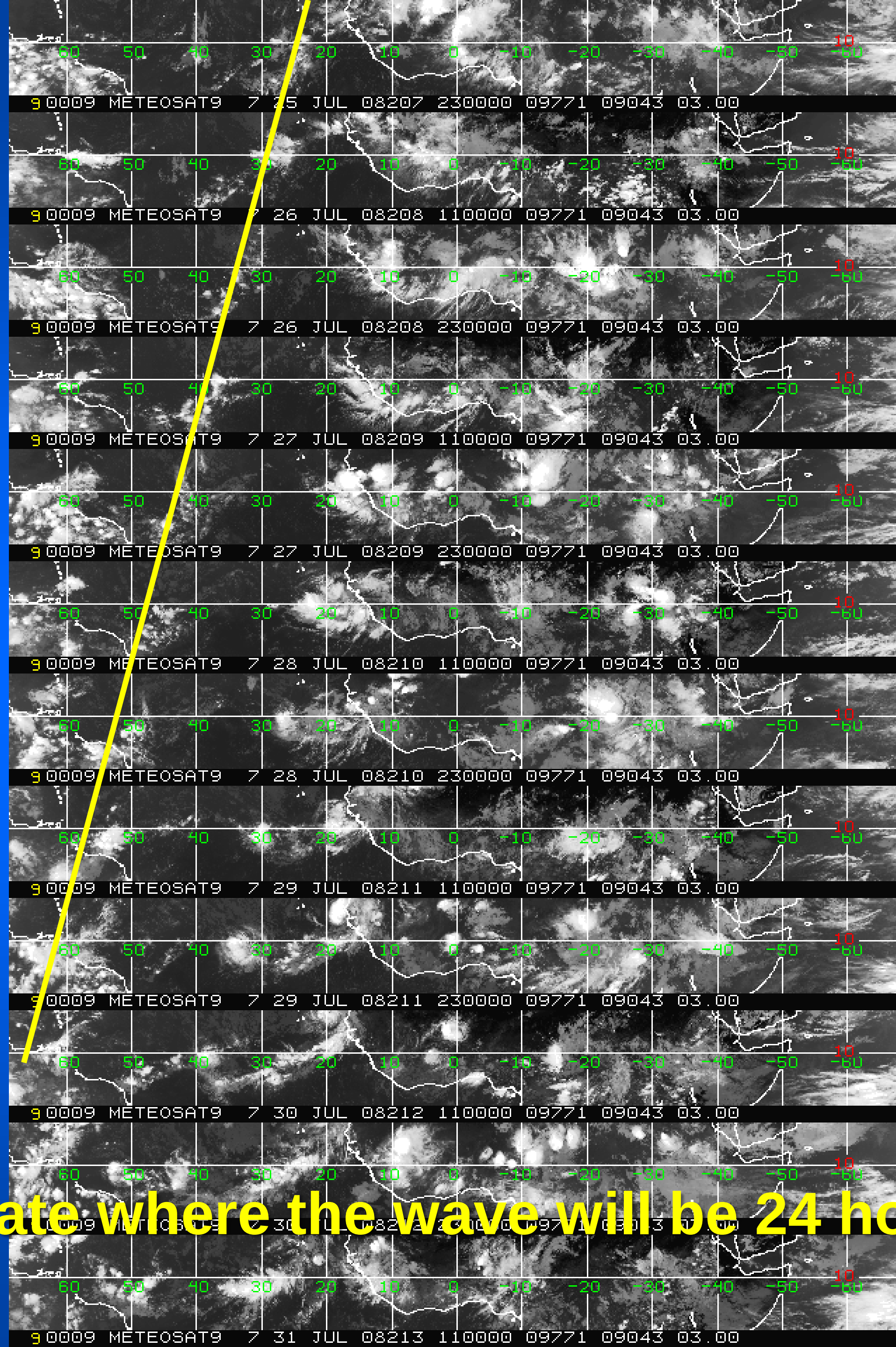
- How long did it take for wave X to propagate from the coast of west Africa to the eastern Caribbean?
- What is the approximate speed of propagation?
- Are these waves on surface?
  - Should you put them on a MSLP chart?

1. Identify the presence of a weather system based on the cloudiness pattern as it propagating from west Africa to eastern Caribbean **wave X**



It passed west Africa around Jul 24, 2008 – an estimate

Wave X entered eastern Caribbean around, Jul 30, 2008 –
Almost 6 days later



Average speed of Propagation:
~42 degrees of long. over ~6 days

You can estimate where the wave will be 24 hours later. Why?

To prove these waves did travel across the Atlantic

Put timesections from Dakar and Guadeloupe together with a 6-day lag

We know from satellite image the approximate time of passage,
we then fine tune it using sounding data

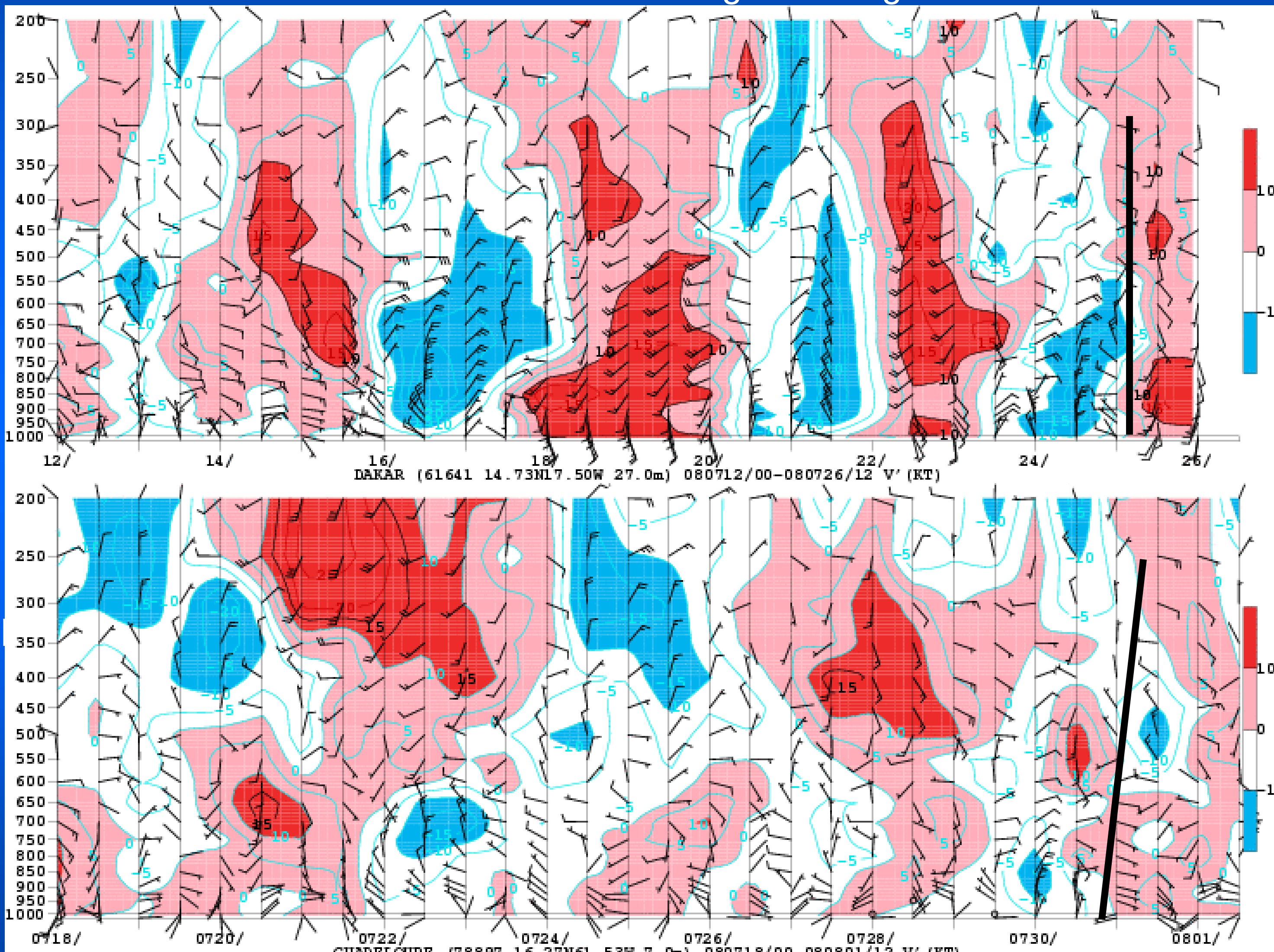
Dakar

July 12

Guadelou

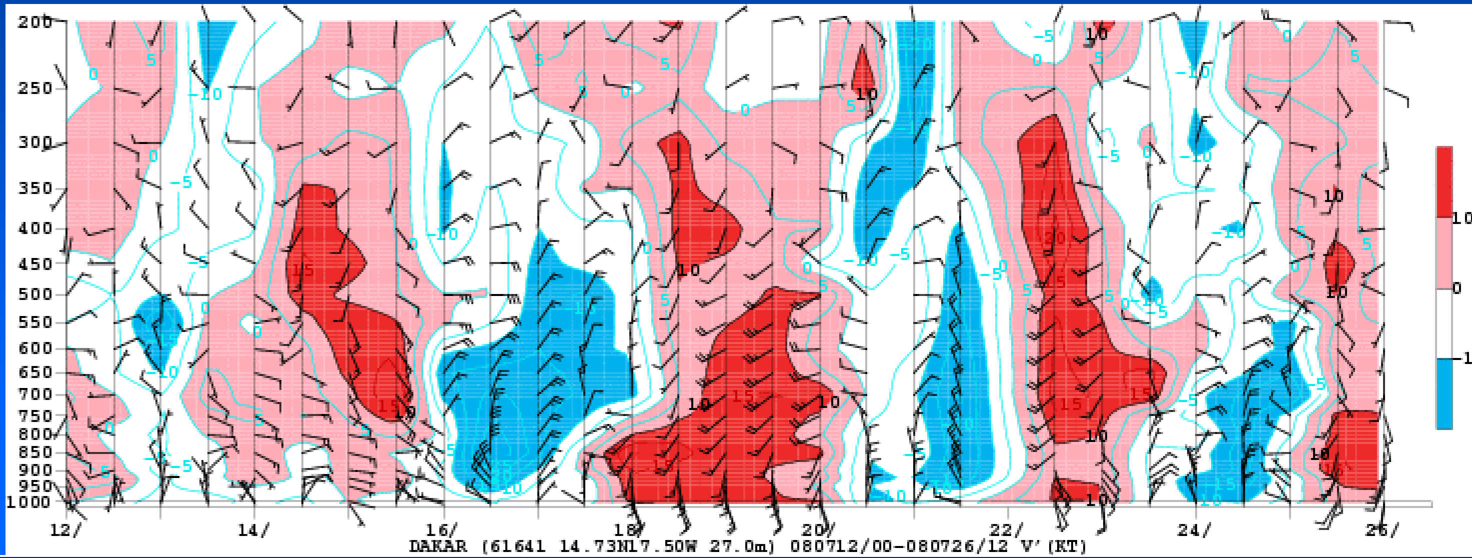
6 day lag

July 18



Sequence of Timesections of v' from Dakar

Dakar

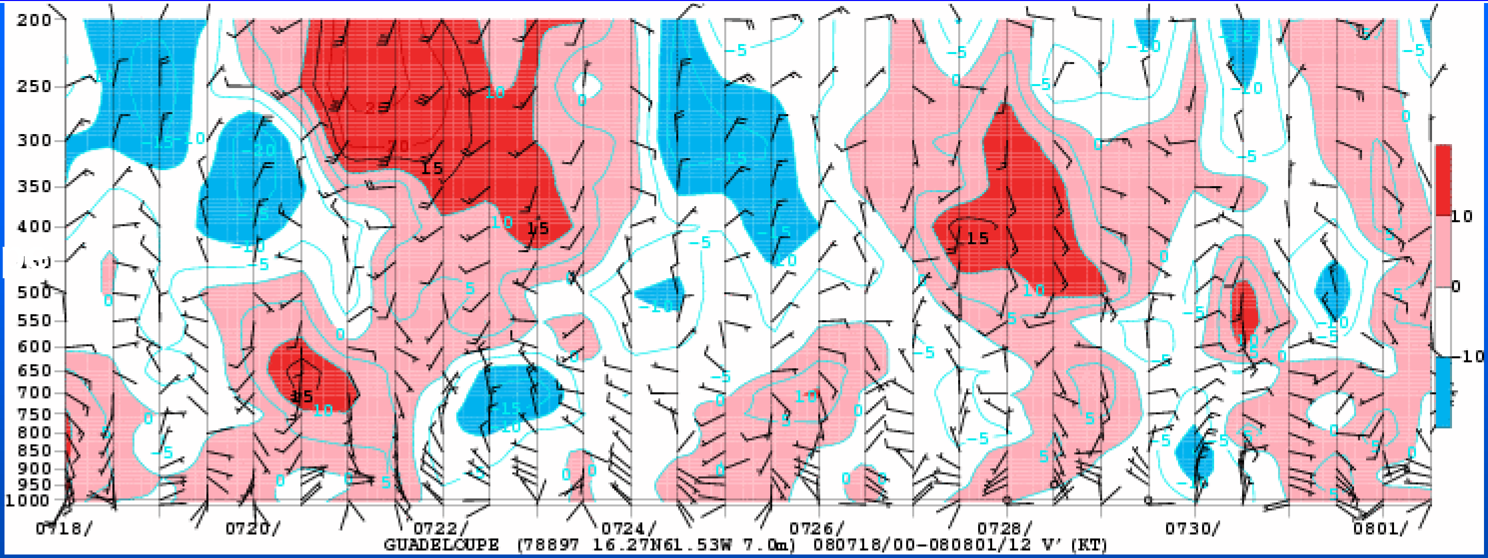


We see waves passed through Dakar one after another

Sequence of Timesections of v’ from Guadeloupe

We also see waves passed through Guadeloupe one after another

Guadelou

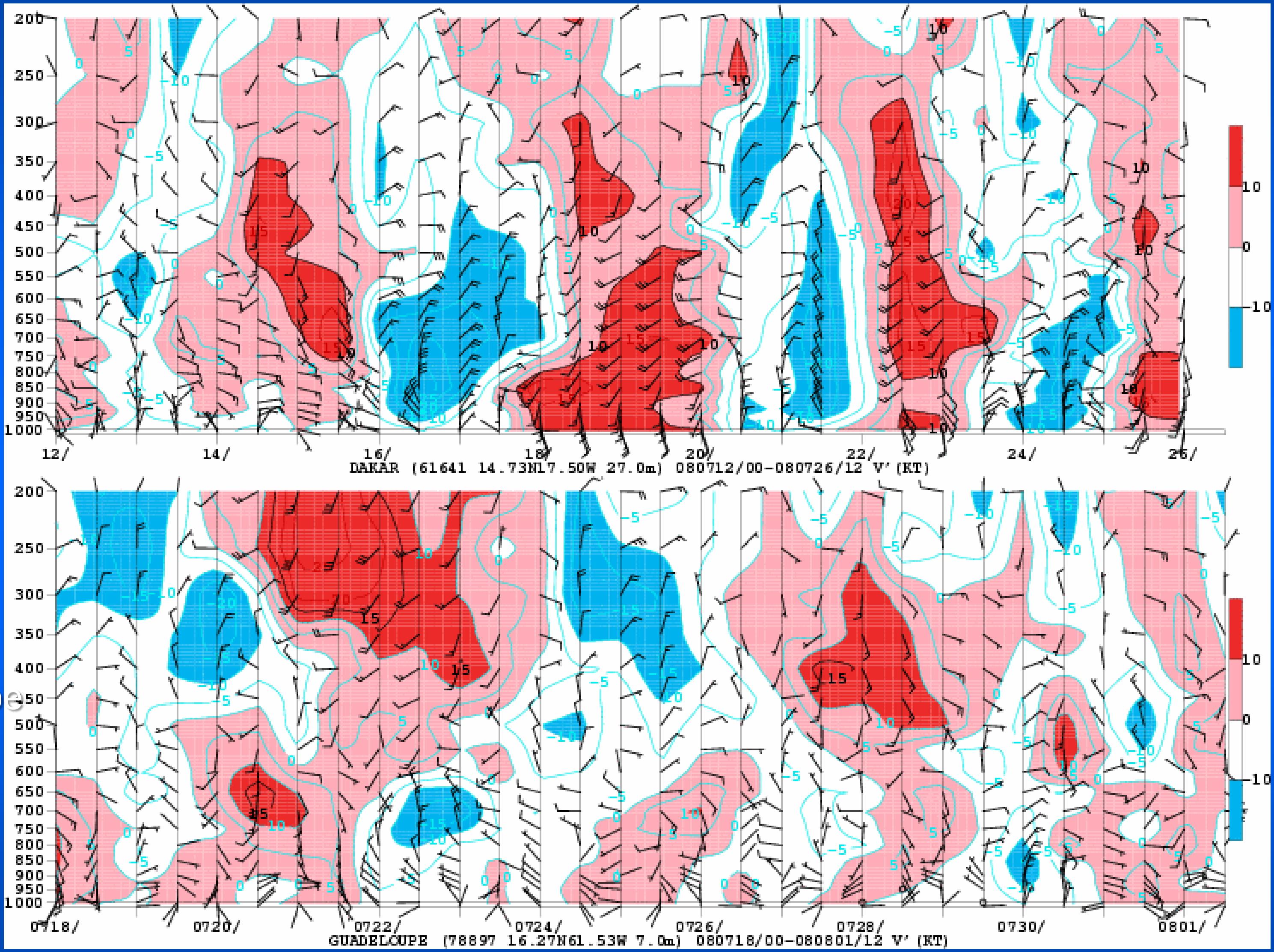


Sequence of Timesections of v’ with 6-day lag

Dakar

Guadeloupe

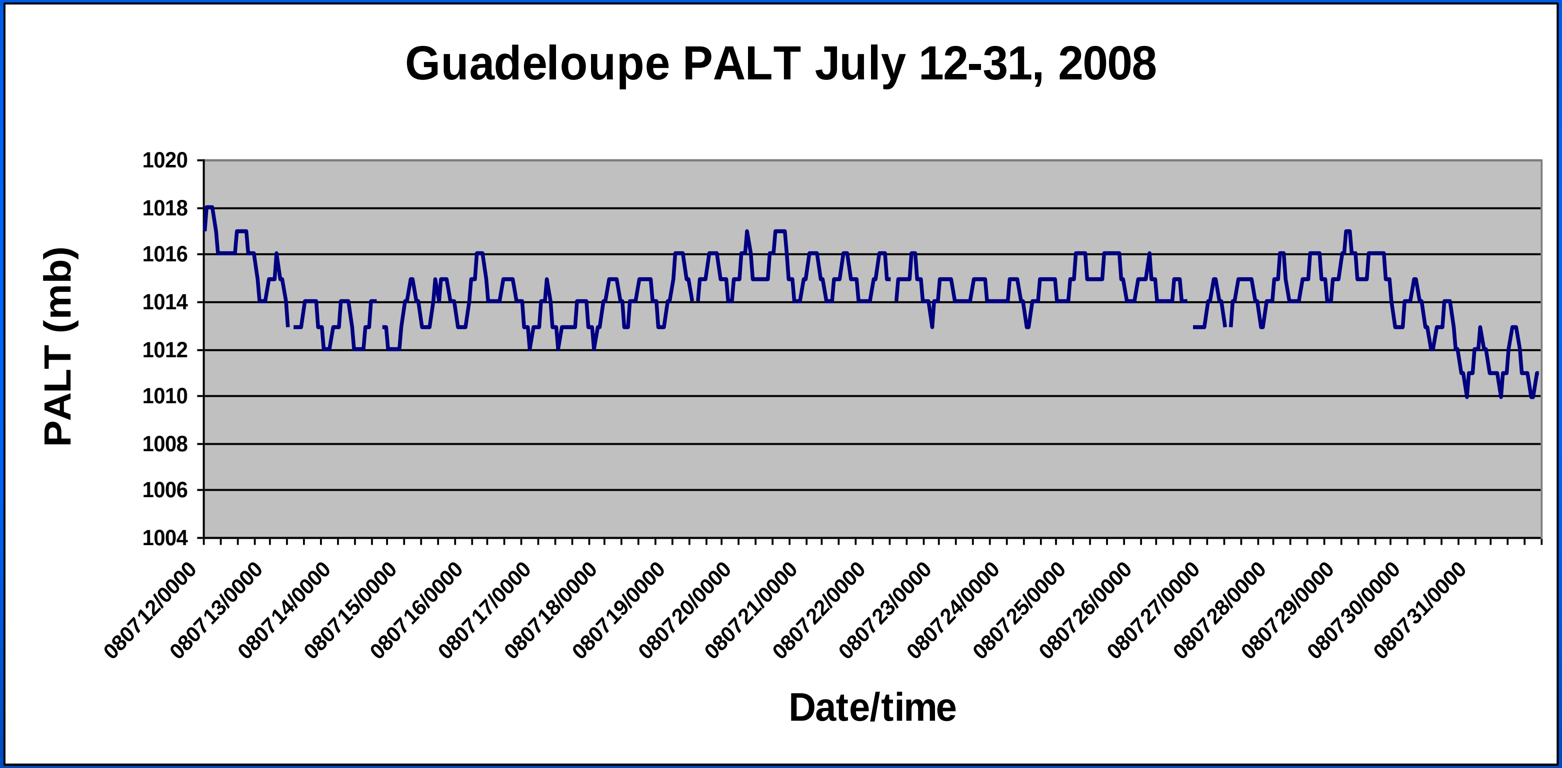
6-day lag



Every wave passed Dakar showed up at Guadeloupe 6-7 days later

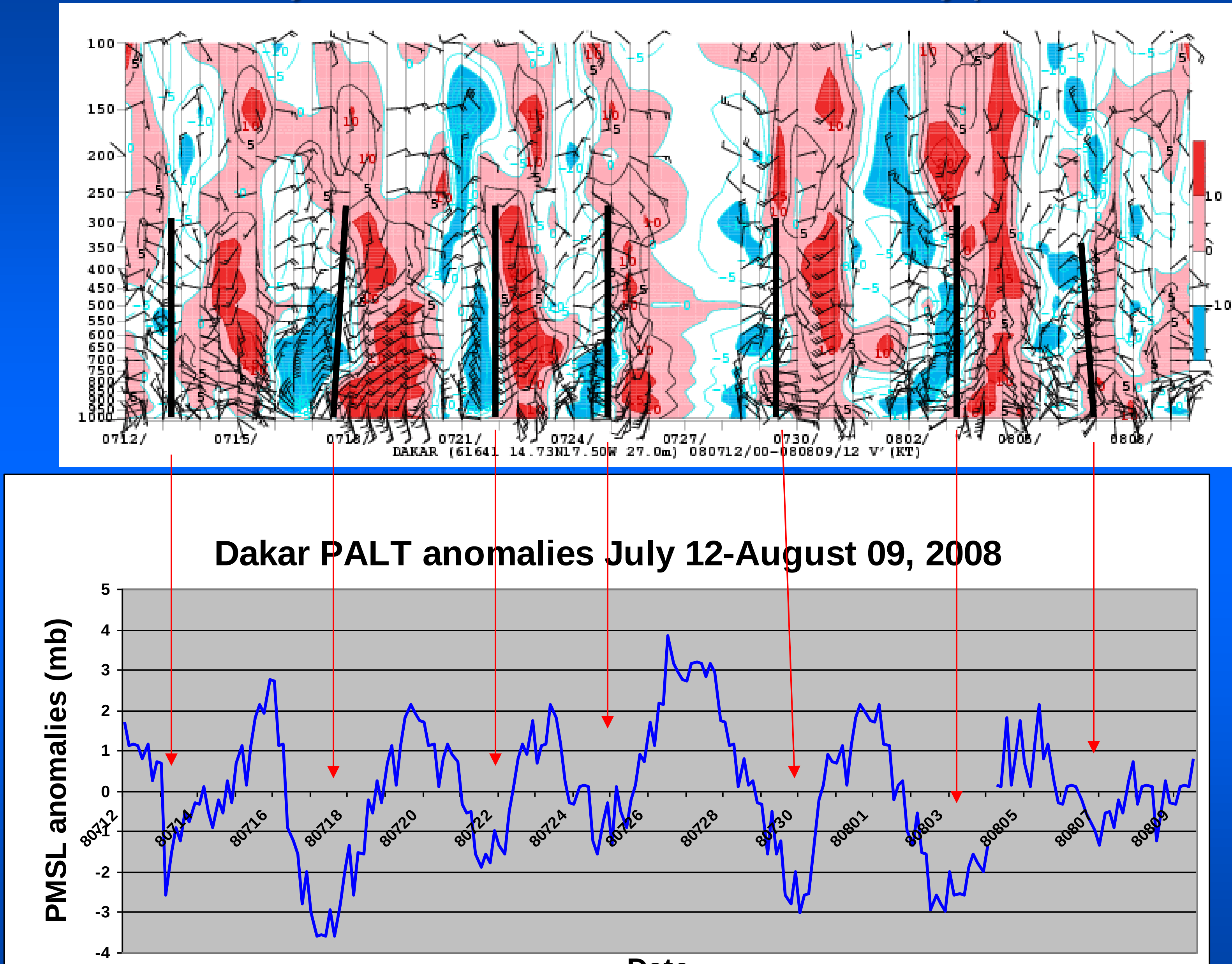
What does it prove?

Surface pressure from Guadeloupe did not strongly indicate passages of waves – but…



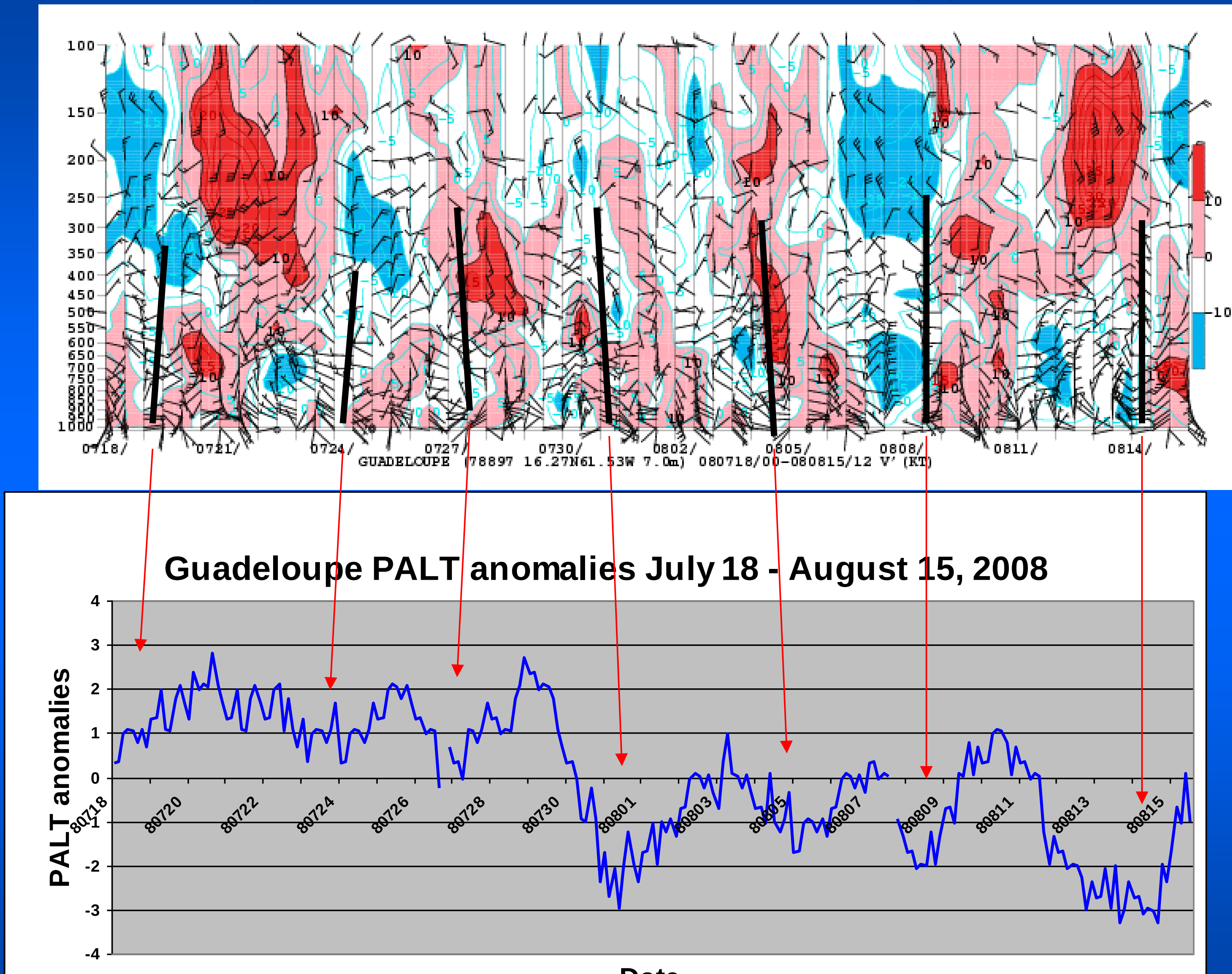
Most noticeable are semidiurnal tide. Some hint of longer period variations

Can we identify these waves at the surface as they passed Dakar?



Surface pressure with mean and diurnal and semi-diurnal tide removed

Can we identify these waves at the surface as they passed Guadeloupe?



Surface pressure with mean and diurnal and semi-diurnal tide removed

We have seen

- AEW do propagate from west Africa to the Caribbean in sequence
- And they on the surface
- How do you define if something is on the surface or not?
  - My answer is
    - If you can measure it (with any meteorological parameter), it is there.
    - If there is no observation at the surface, you need to use science, if not common sense.

Some earlier studies of AEW using surface or mean sea level pressure

- Earlier studies in the late 1930's
  - *Regula (1936 in German), surface pressure variations, moving east to west, 4 day period, extends over 2000 Km in latitudes…
  - *Piersig (1936 in Germaan/English version 1944)
  - *Hubert (1939) Hovmoeller charts of isallobars of 24-hour pressure tendency, 3.5-4 day periodicity, longitudinal width 1000-4000km, move westward 6-14m/s,
- Gordon Dunn 1940 using surface data from the Caribbean
- Toby Carlson, 1969, tracked MSLP amplitude of a series AEW as they moved across the tropical Atlantic.

* "To the 75th anniversary of the discovery of African Easterly Waves" presented by Andreas Fink at the 2011 AMS conference

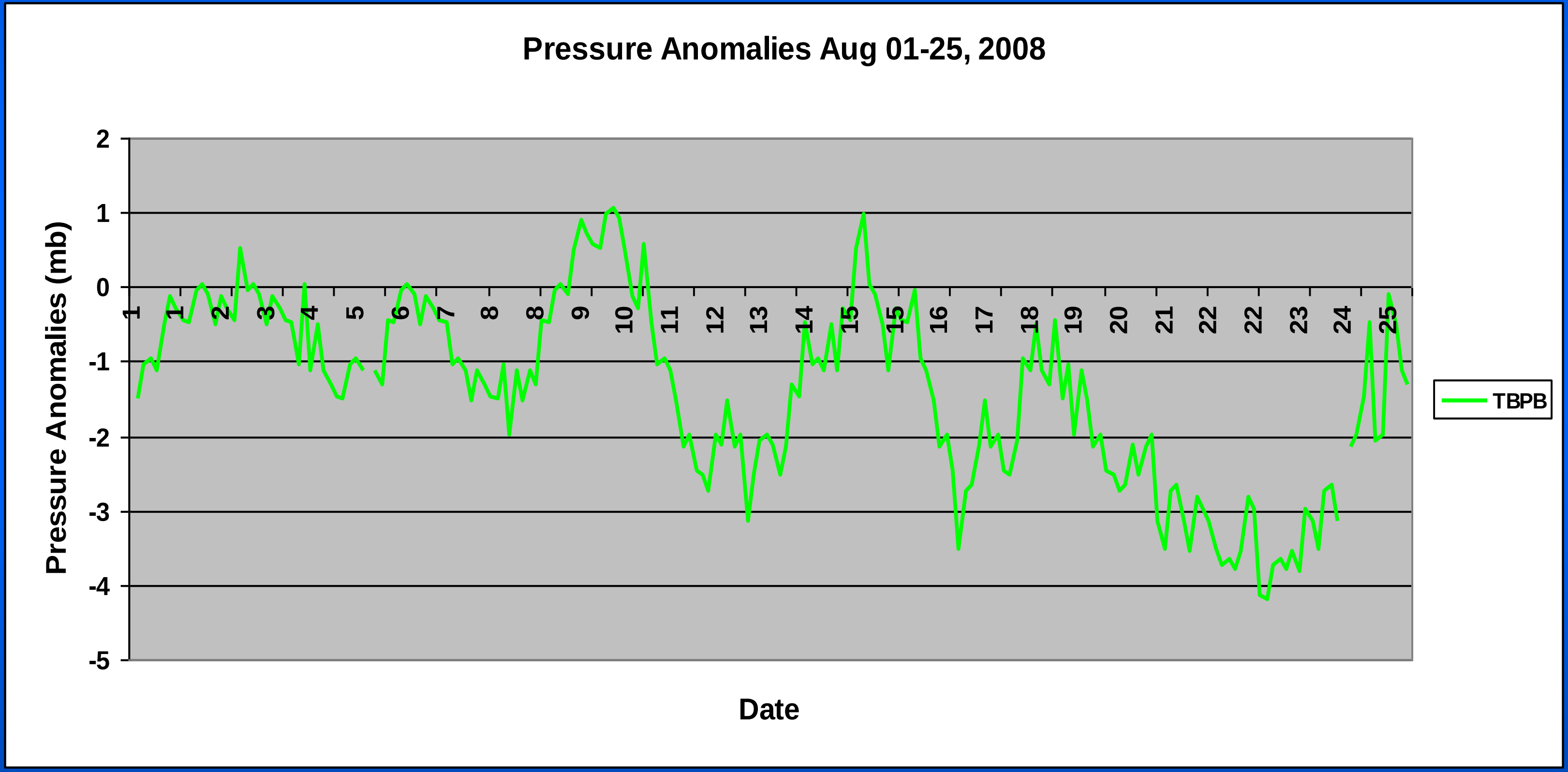
If those that passed Guadeloupe were easterly waves, they should also appear on the soundings and/or surface reports at other stations – Why?

Get a better idea on how far out (N/S) the waves extend

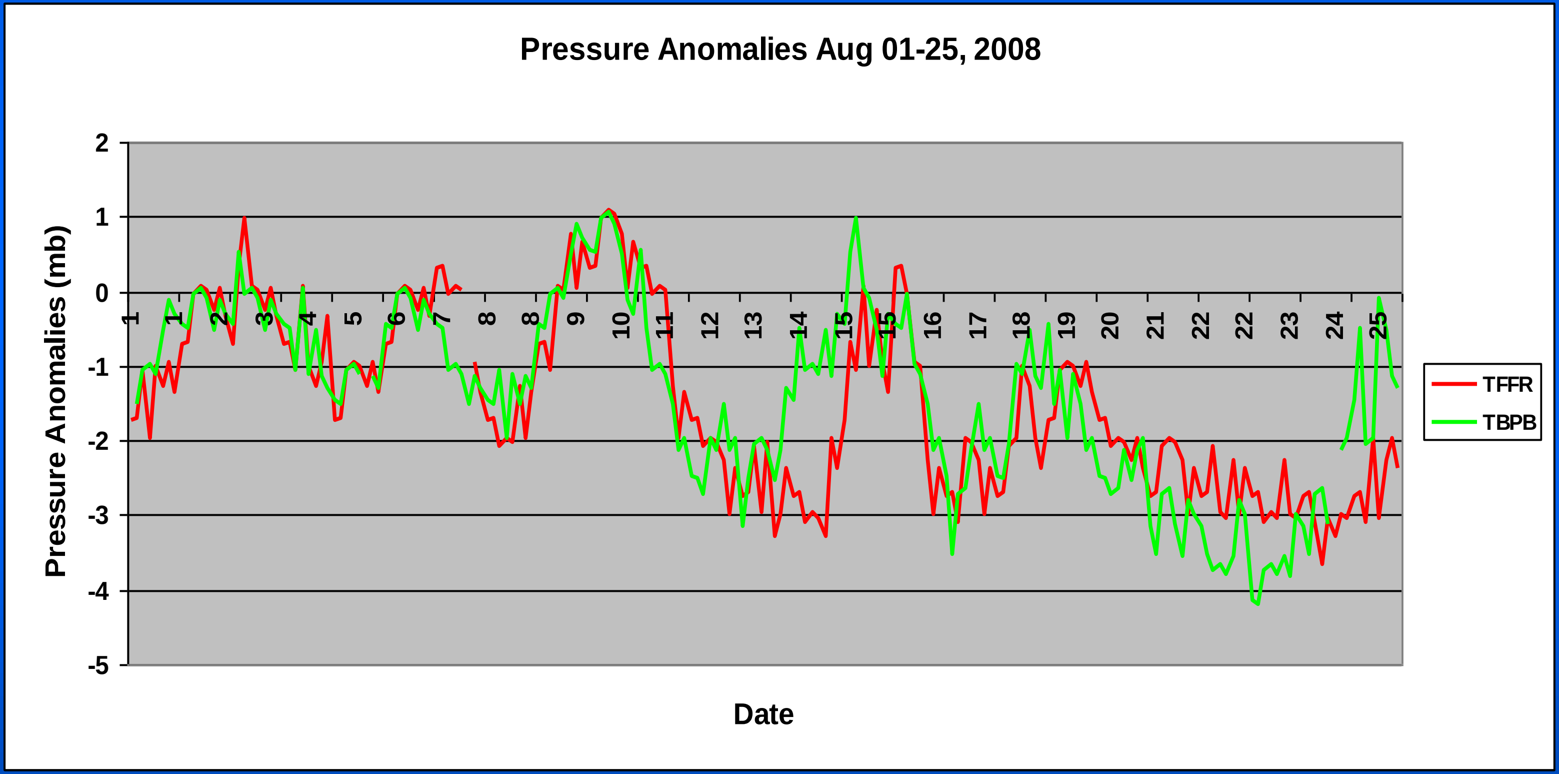
Again, we are trying to build a better knowledge of these waves so we can do a better analysis - building a conceptual model

Let's checks surface pressure anomalies from four eastern Caribbean RAOB stations

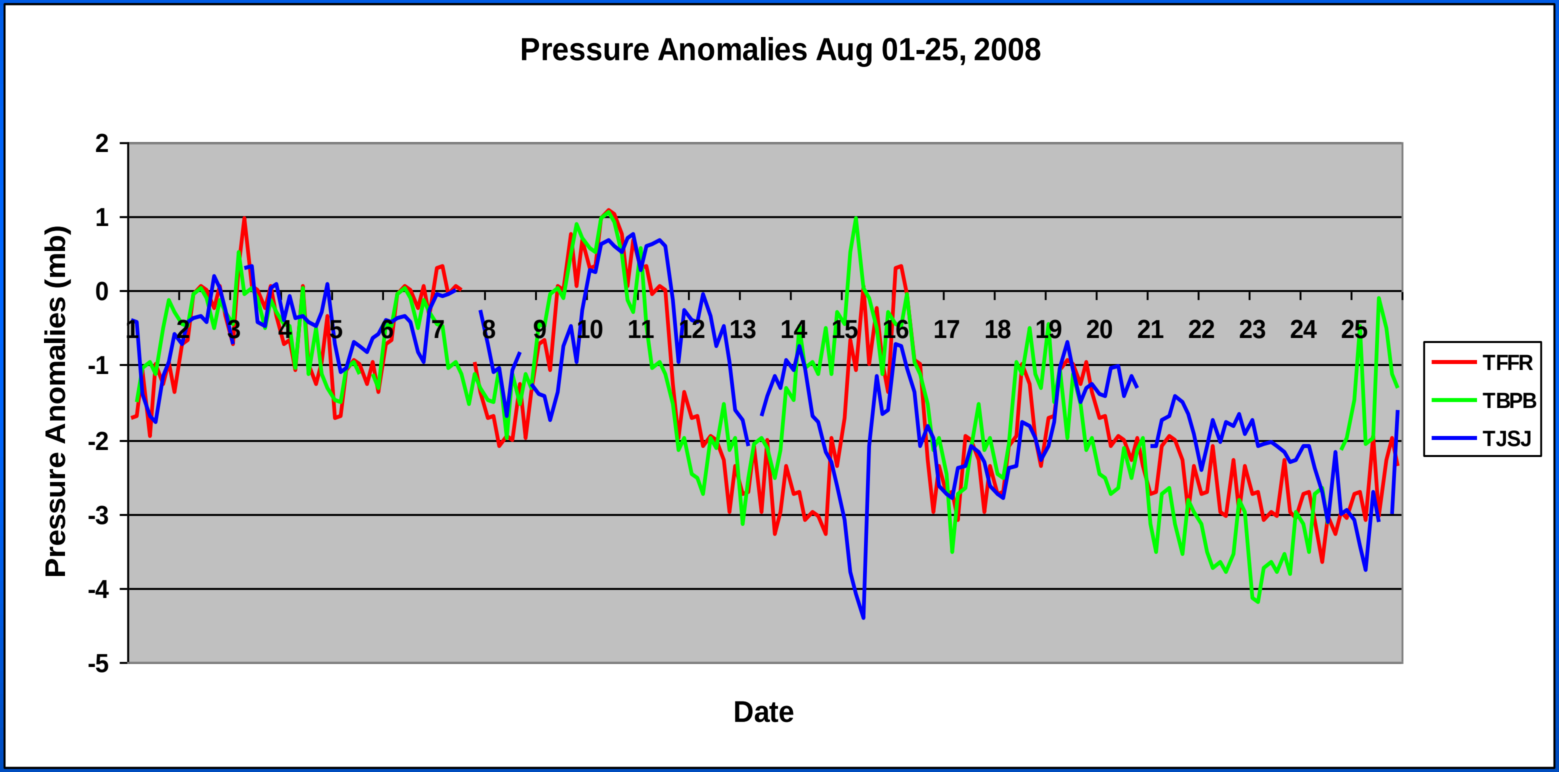
Barbados



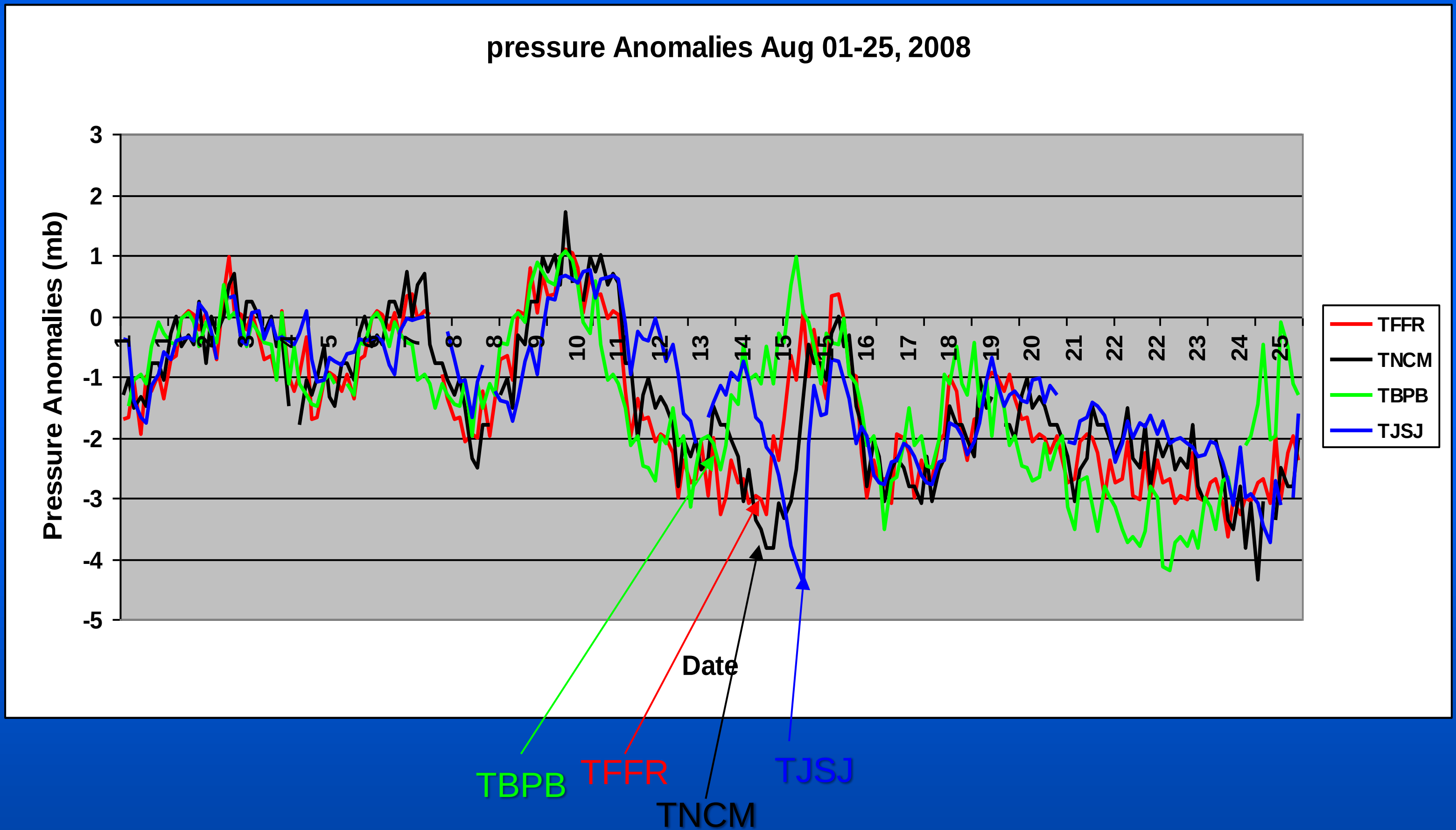
Surface pressure anomalies from Barbados and Guadeloupe



Surface pressure anomalies from
Barbados, Guadeloupe, and San Juan

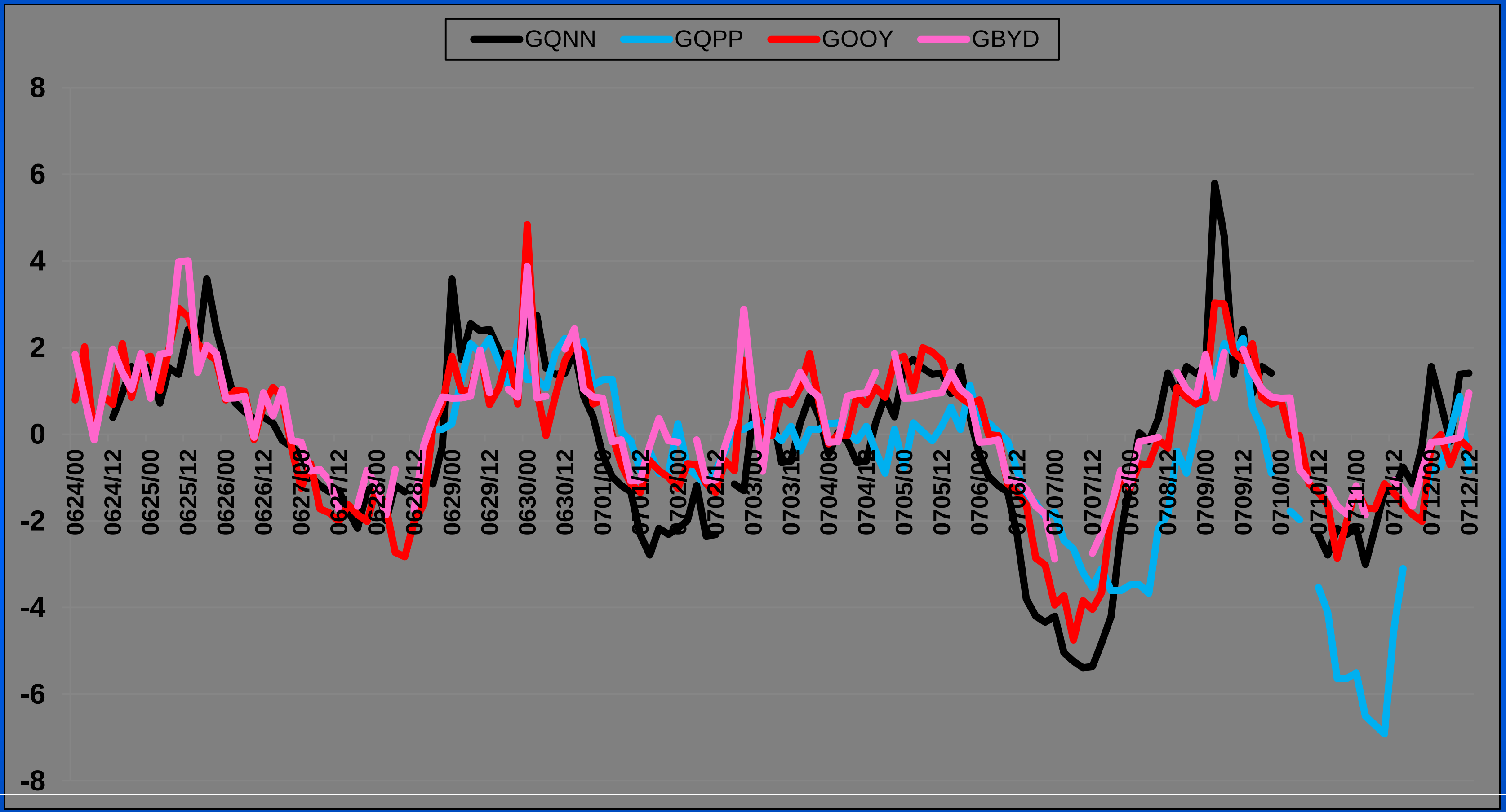


Surface pressure anomalies from
Barbados, Guadeloupe, St. Marteen, and San Juan



Most of the August the pressure anomalies were below 0

Surface Pressure Anomalies at Four West African Stations

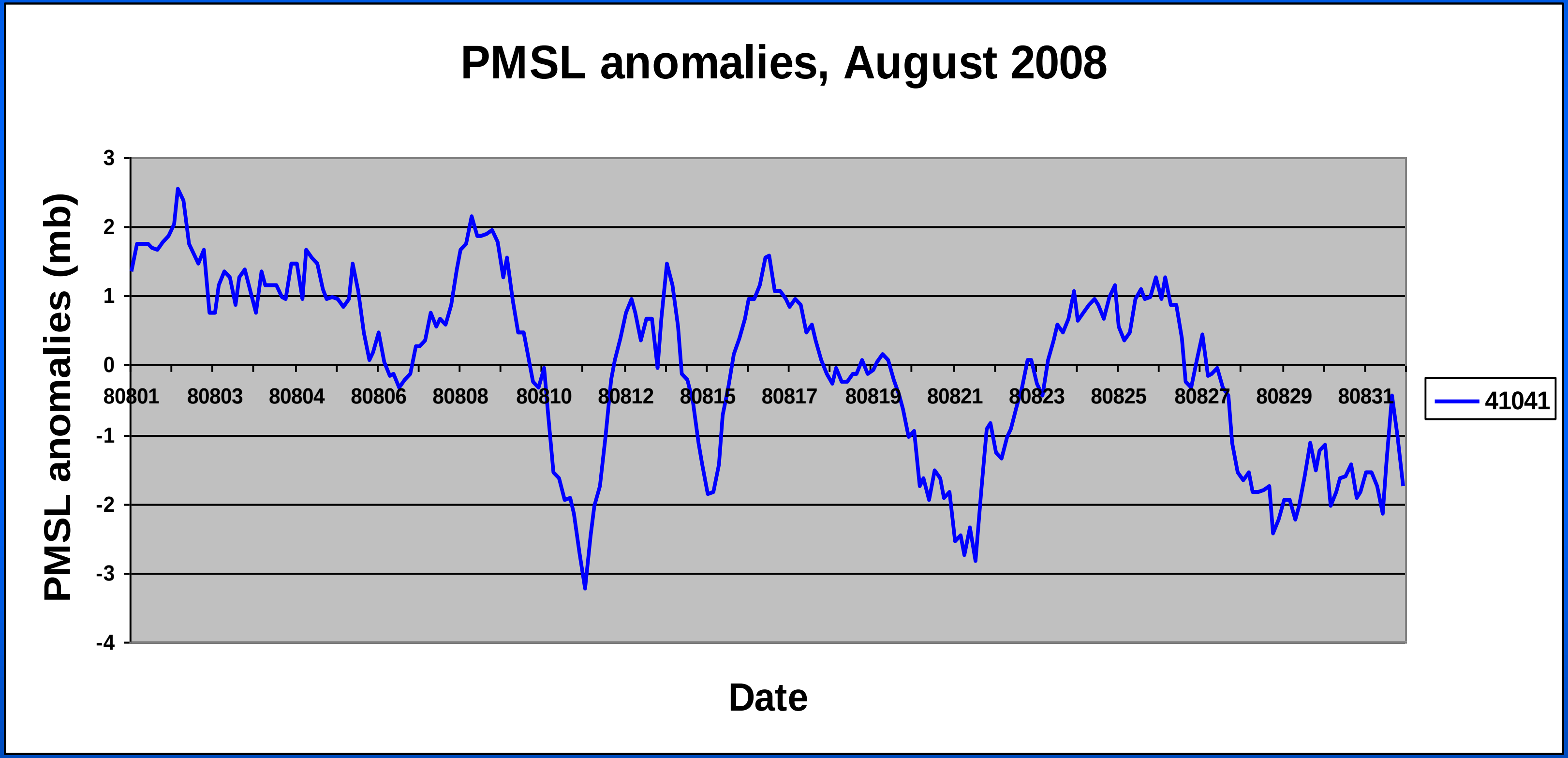


GQPP: 61415 Nouadhibou 20.93N 17.03W   GQNN: 61442 Nouakchott 18.10N 15.95W
GOOY: 61641 Dakar 14.73N 17.50W   GBYD: 61701 Banjul 13.20N 16.63W

Can we find these waves over the water – at the surface?

- Why not? What's there to prevent the wave amplitude from reaching the surface?
- Let's look at some buoy data.

Buoy 41041

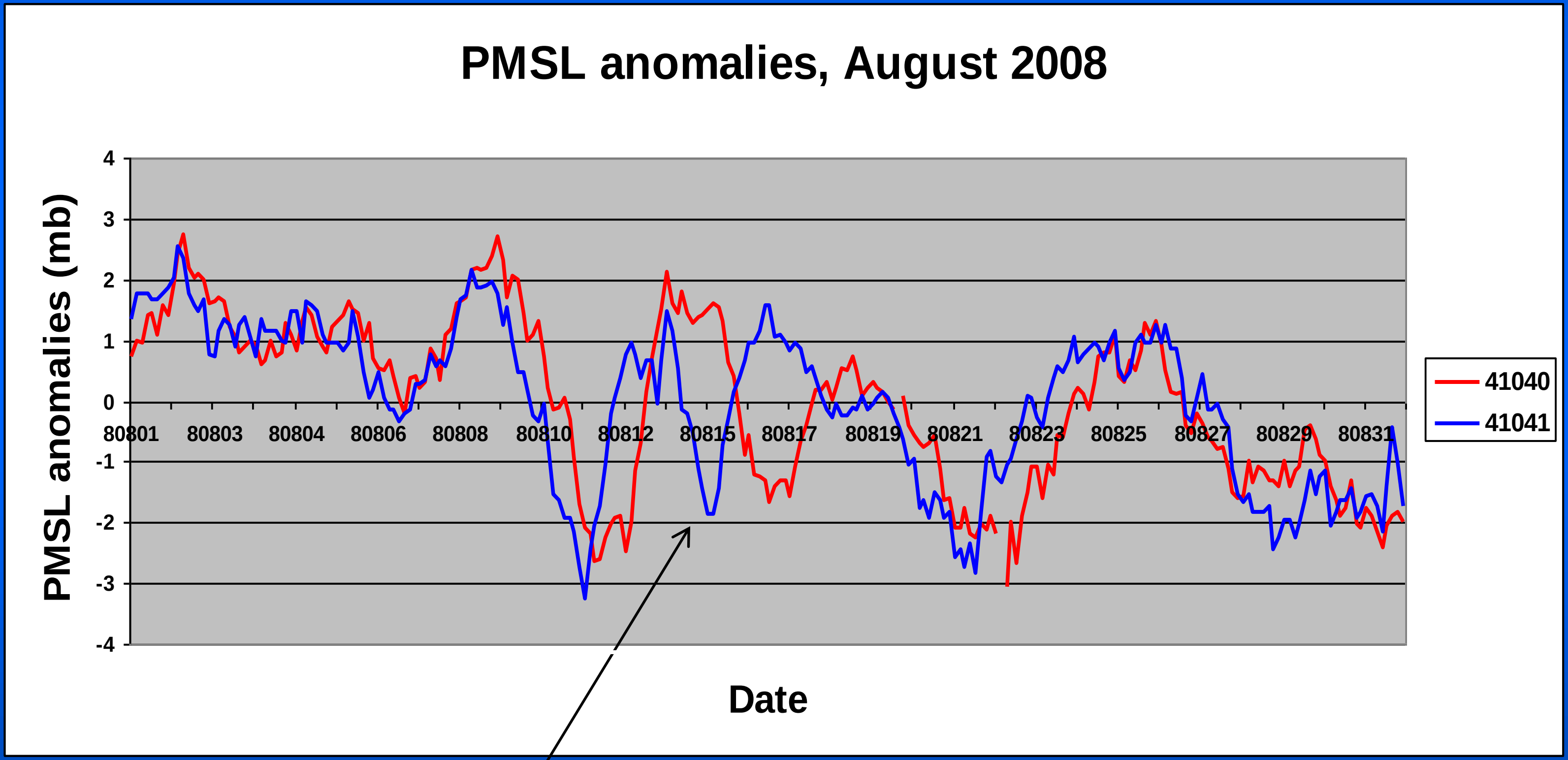


Again, time mean, diurnal and semi-diurnal tides were removed

Buoys 41041 and 41040

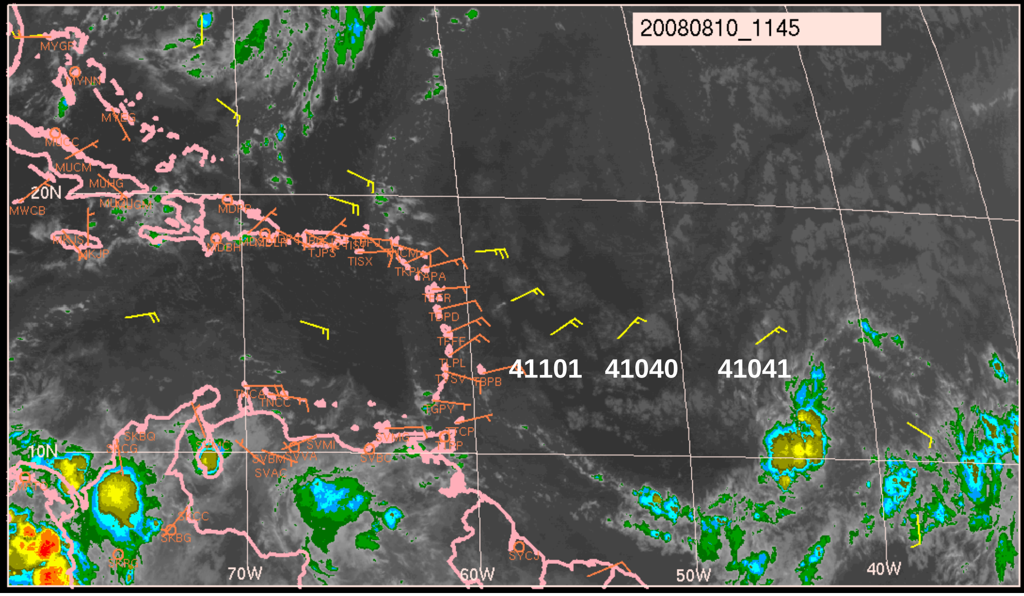
Noticed the coherent pattern between these two buoys?

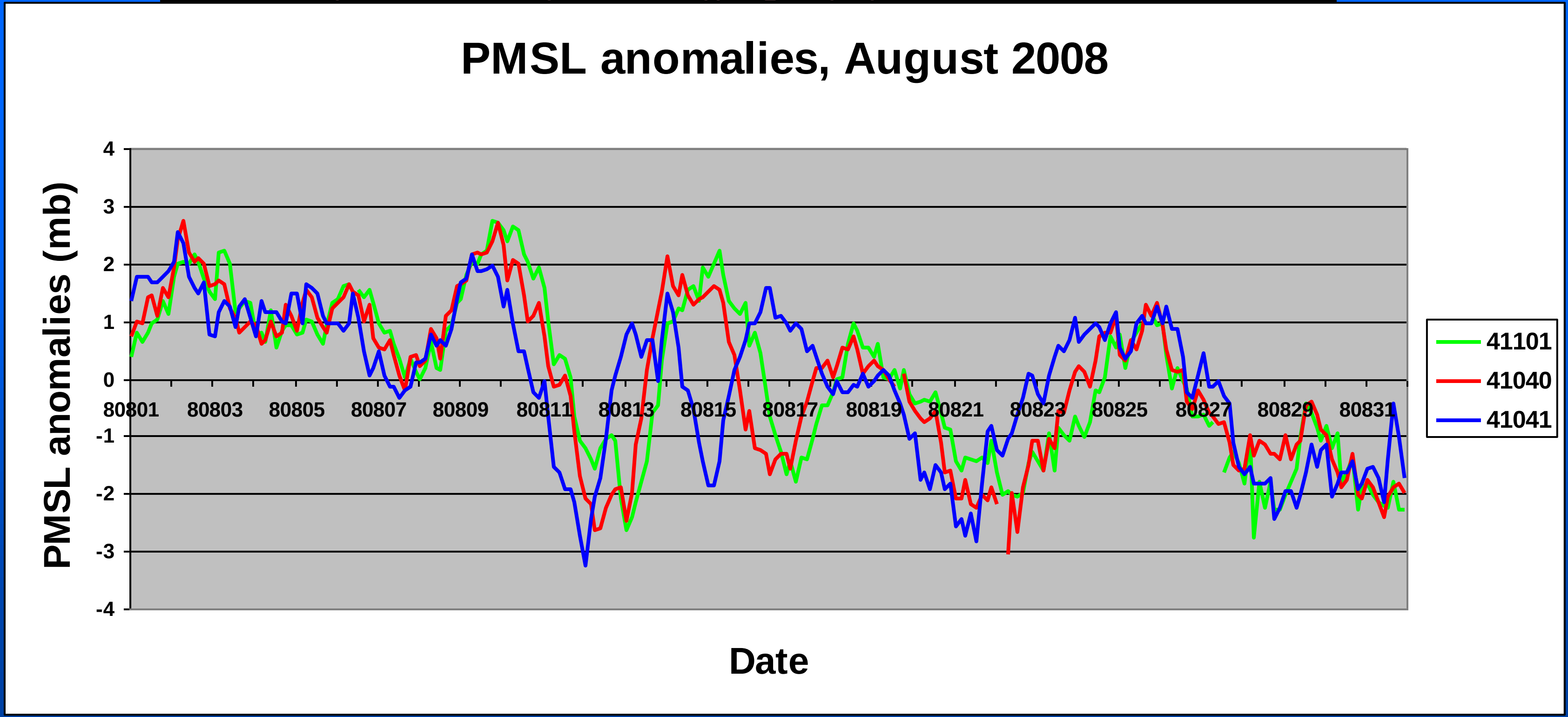
Can you tell which buoy is located to the east?

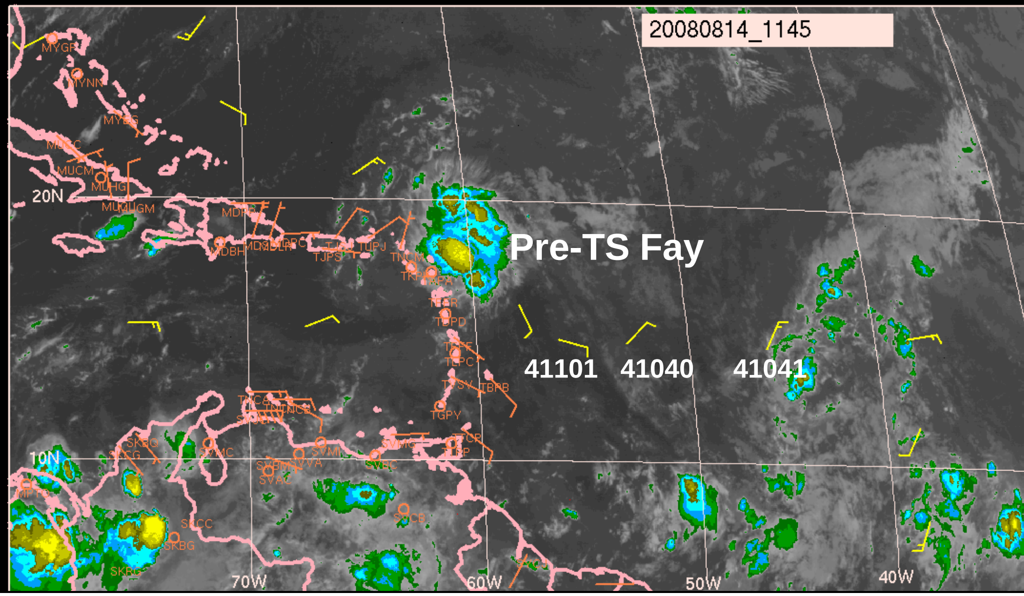


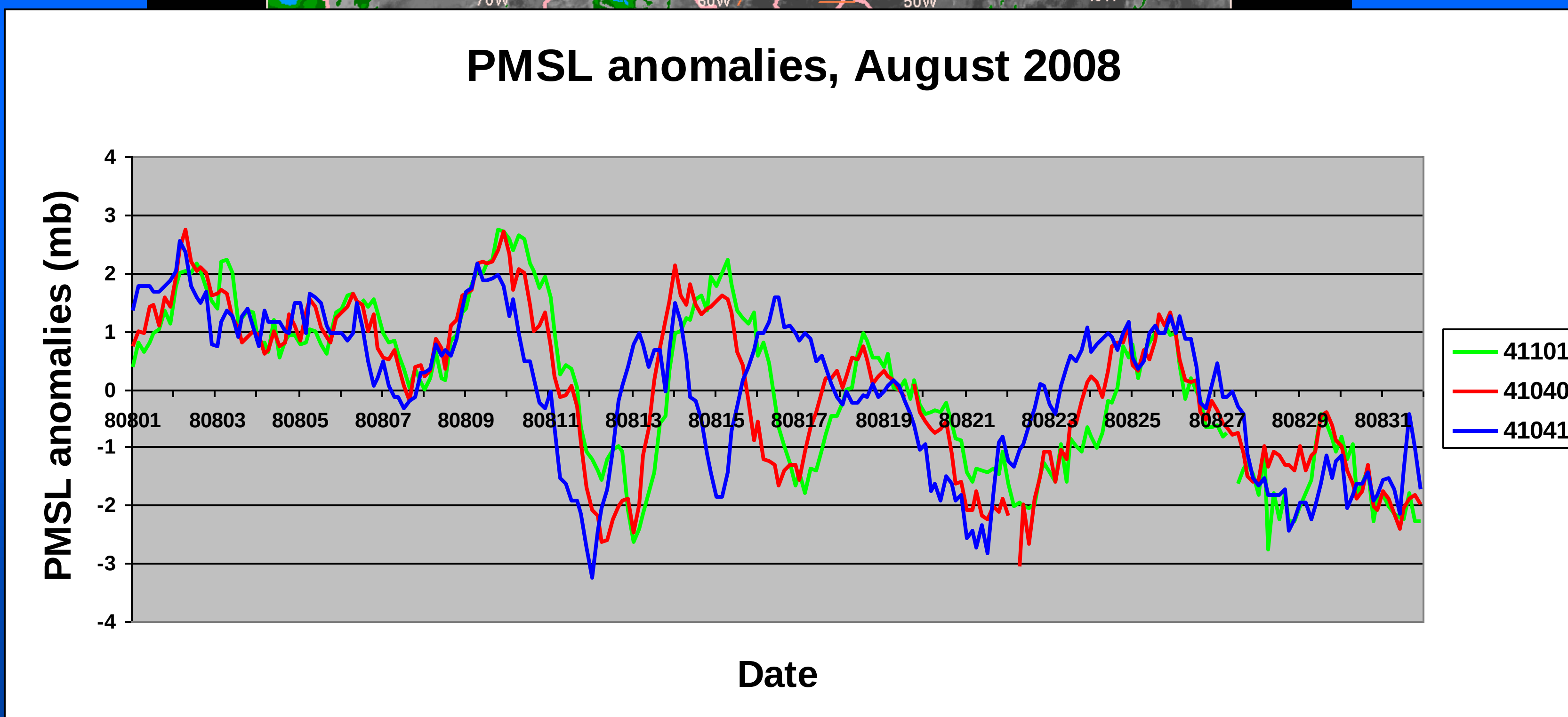
1. The gap between the two lines is wider during this period. What does it mean?

2. The speed of propagation of easterly waves does change from time to time, place to place.


20080810_1145
20N
10N
70W
60W
50W
40W
41101
41040
41041


PMSL anomalies, August 2008
PMSL anomalies (mb)
Date
4
3
2
1
0
-1
-2
-3
-4
80801
80803
80805
80807
80809
80811
80813
80815
80817
80819
80821
80823
80825
80827
80829
80831
41101
41040
41041


20080814_1145
Pre-TS Fay
41101
41040
41041
20N
10N
70W
60W
50W
40W


PMSL anomalies, August 2008
PMSL anomalies (mb)
4
3
2
1
0
-1
-2
-3
-4
80801
80803
80805
80807
80809
80811
80813
80815
80817
80819
80821
80823
80825
80827
80829
80831
Date
41101
41040
41041

Identifying and tracking easterly waves

- Identify them over west Africa using satellite imagery – looking for rotations in low/mid clouds
- Verify their passage over western Africa rawindsonde stations – check for wind shifts using timesections
- Follow the rotating low/mid level clouds across the Atlantic
- Recognize the characteristics of the waves during that period – wavelength, period, speed of propagation
- With the above, use continuity – extrapolation
- Verify and adjust the locations using timesections from eastern Caribbean rawindsonde stations
- Use continuity/extrapolation again if you don't have timesections from east pacific

Identifying and tracking easterly waves

Cloudiness tend to be associated with waves but they do not define the waves

The N-S extension of a wave IS not defined by the area of convection

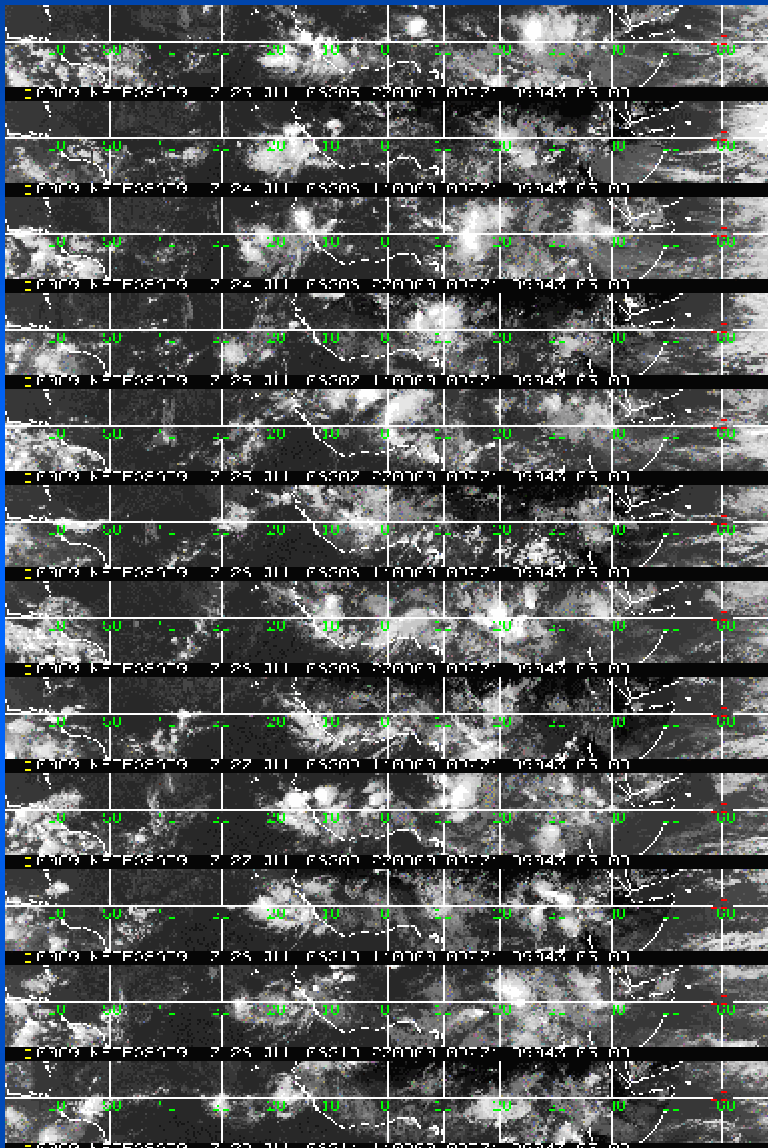
Convection is a meso-scale phenomena, while easterly waves are synoptic-scale systems

- With the knowledge and proper analysis methods, we can identify systems that are otherwise difficult to be identified
- We also learn more about those systems which will help us perform better analysis
- Don’t just take what I said, or what Simon said, unless you strongly agree with my analysis.

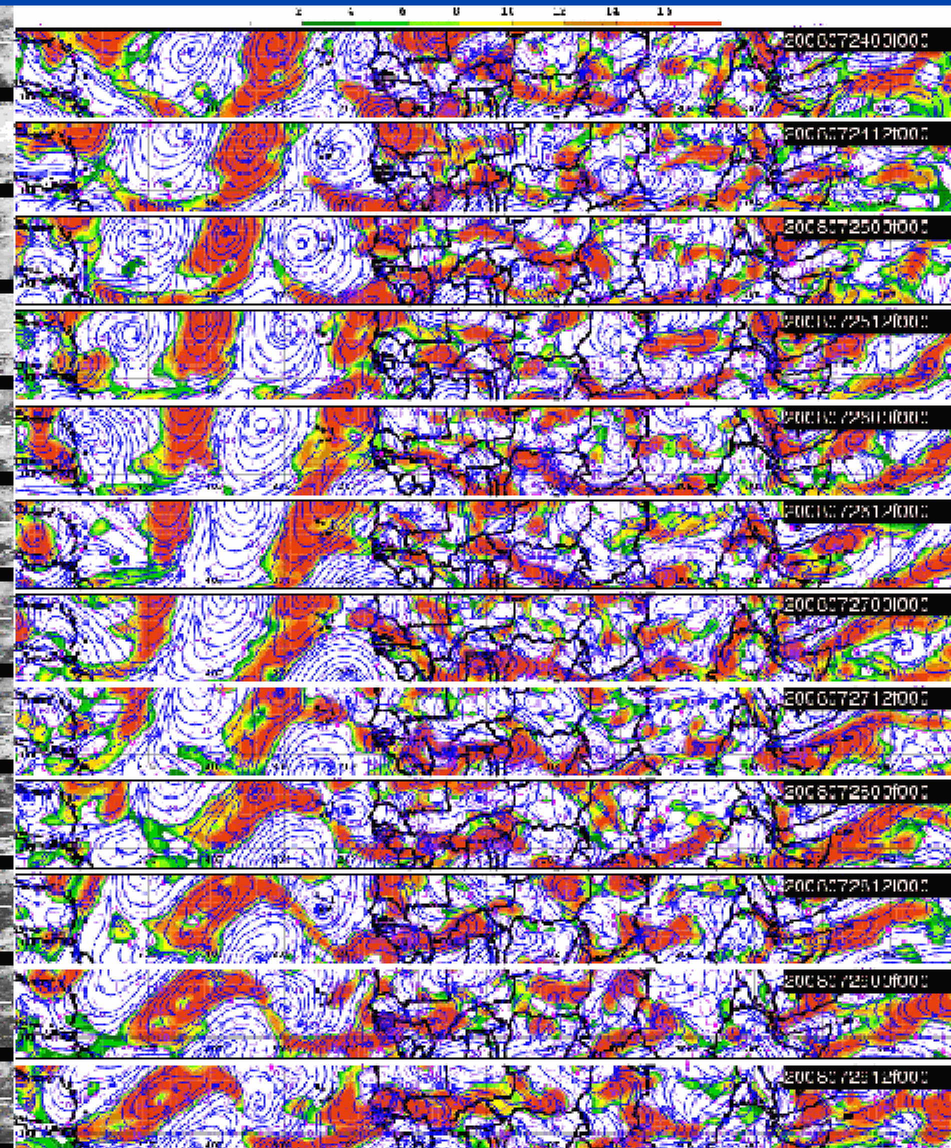
Can we find easterly waves in numerical models?

- Global models are known to be able to carry AEW
- Global models may also carry signals from other sources, some computational (no physical meanings)
- Same as analyzing observed data, filtering of model data makes the weather systems much better defined

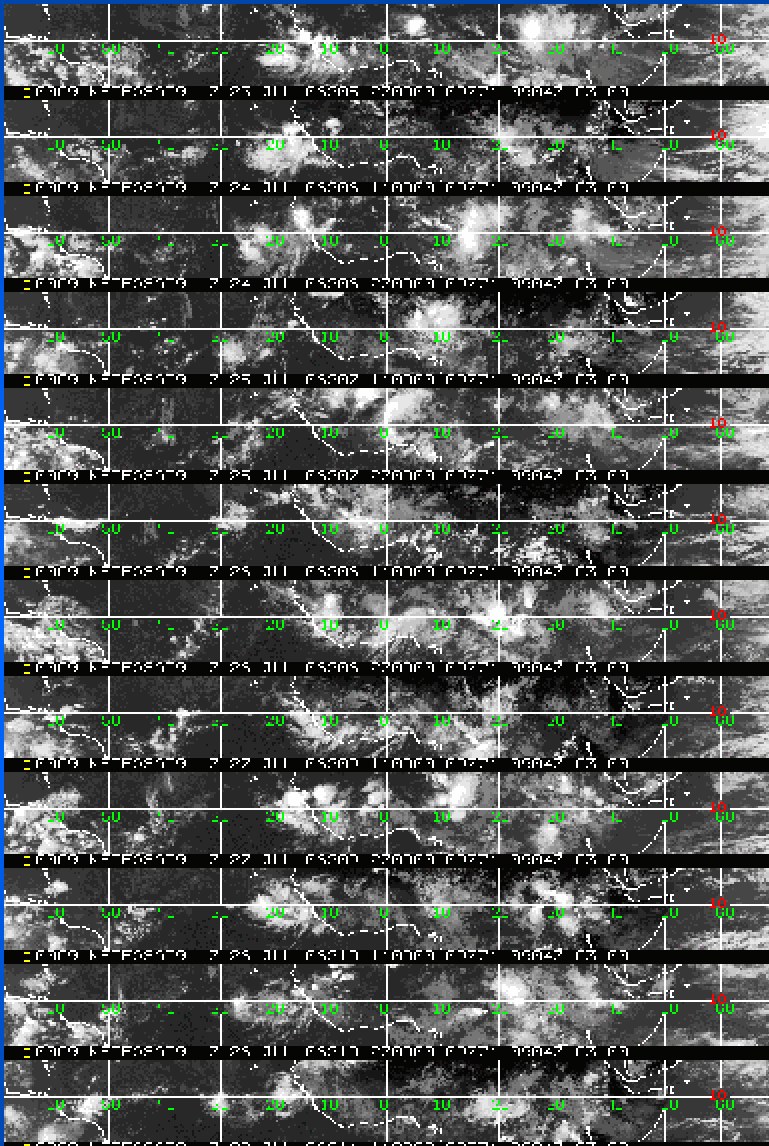
Satellite Hovmöller Charts



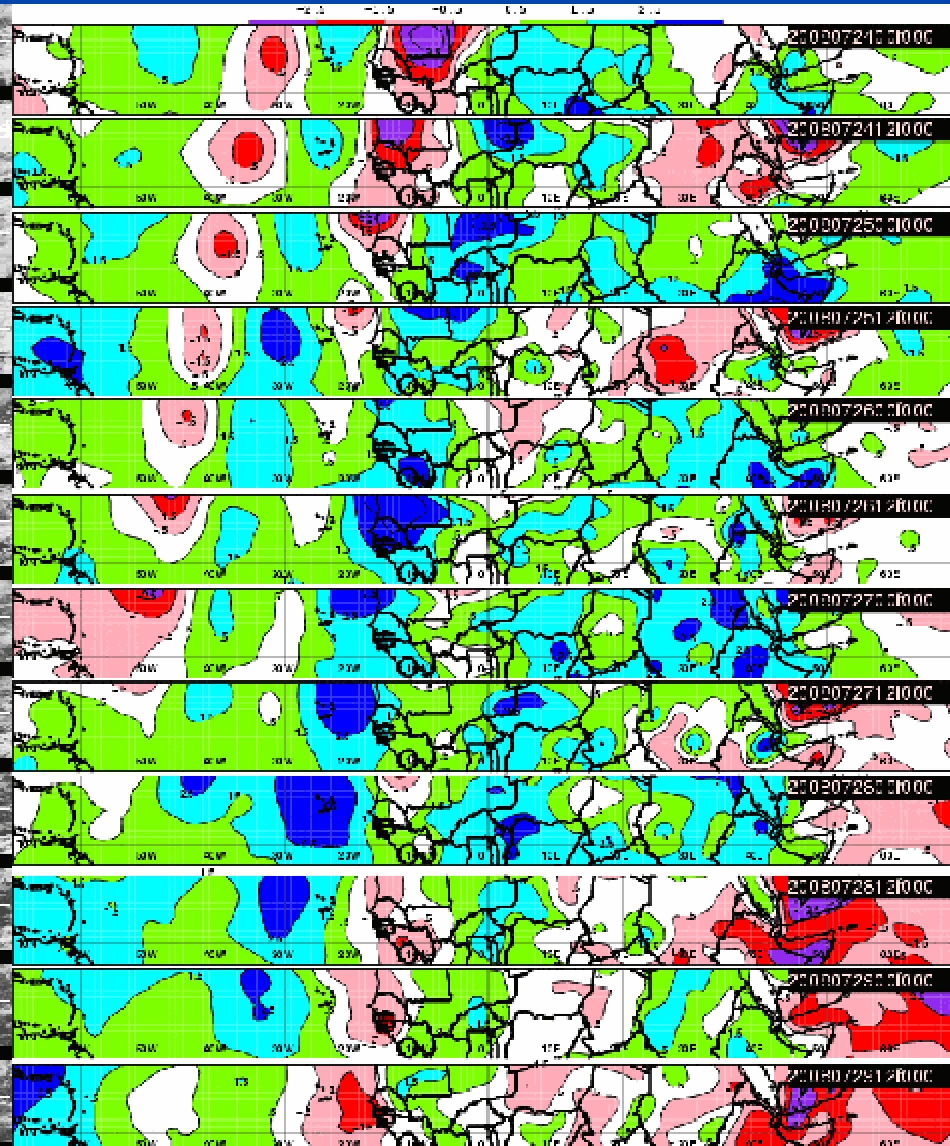
700 mb Rel Vort Anomalies



Satellite Hovmölluer Charts

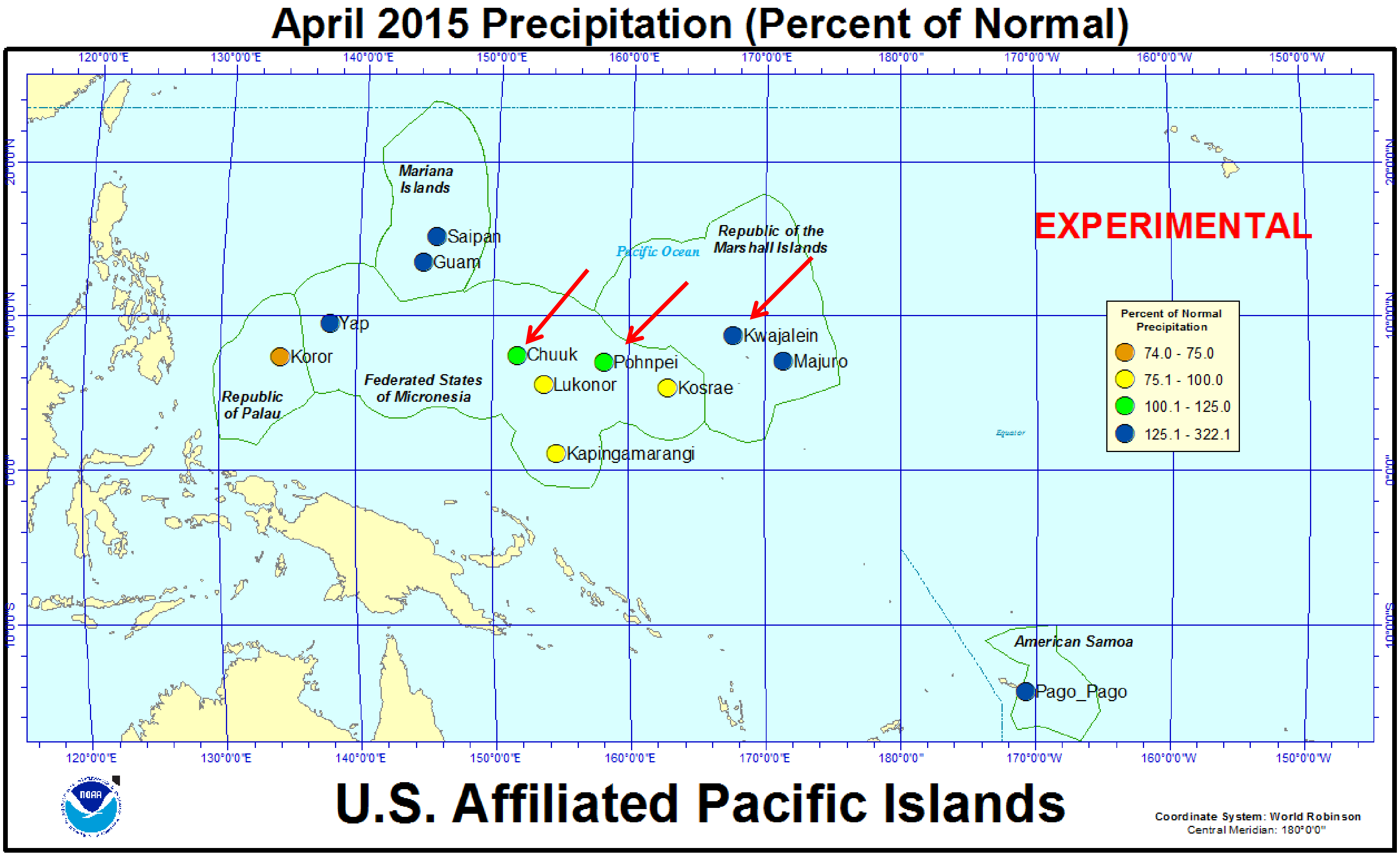


PMSL Anomalies



July 24-August 07, 2008

Identifying Easterly Waves in the W Pacific

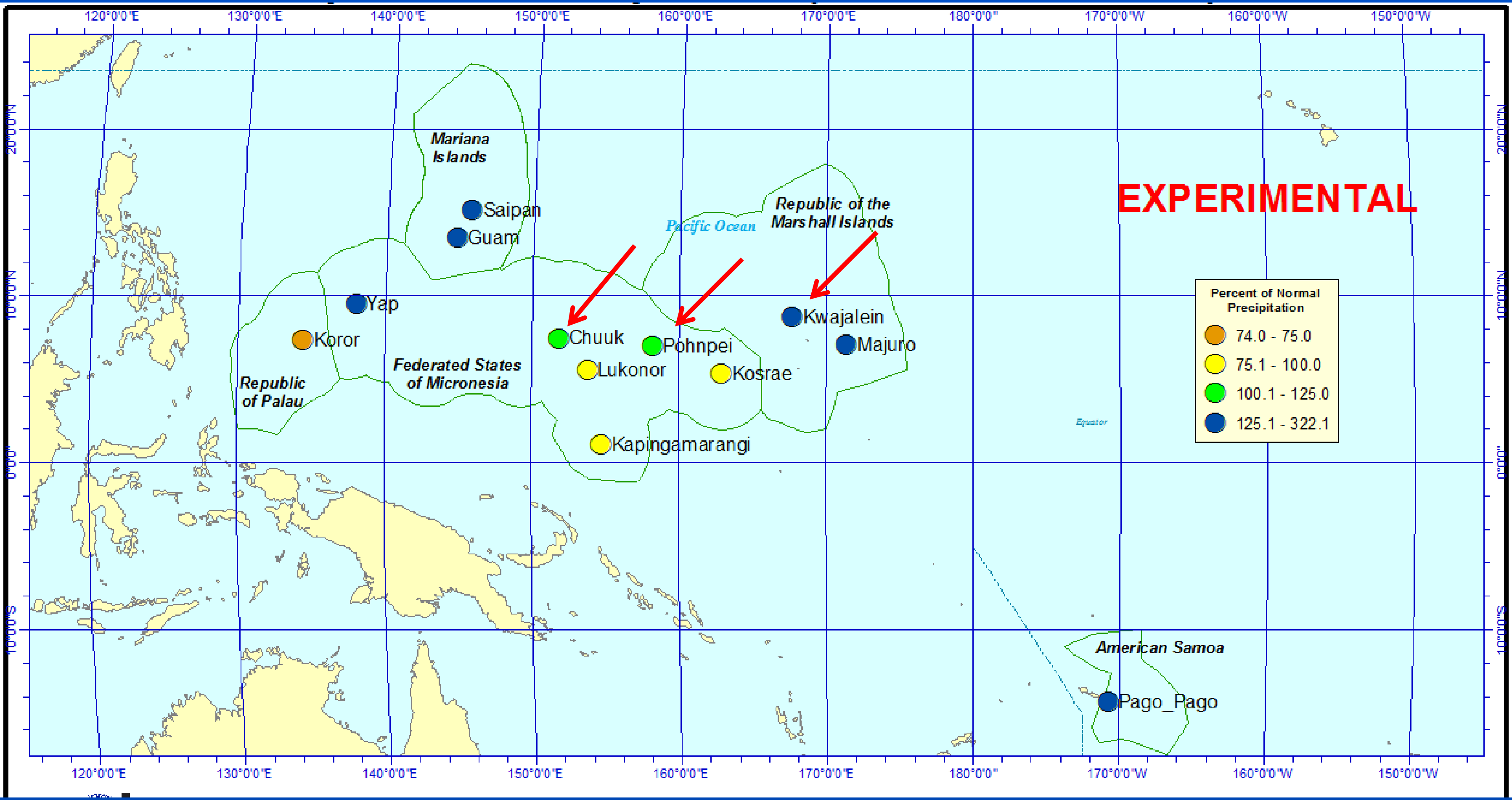


Satellite Hovmoller chart for 1 July-14 August 1967
5N-10N, 150E-100W

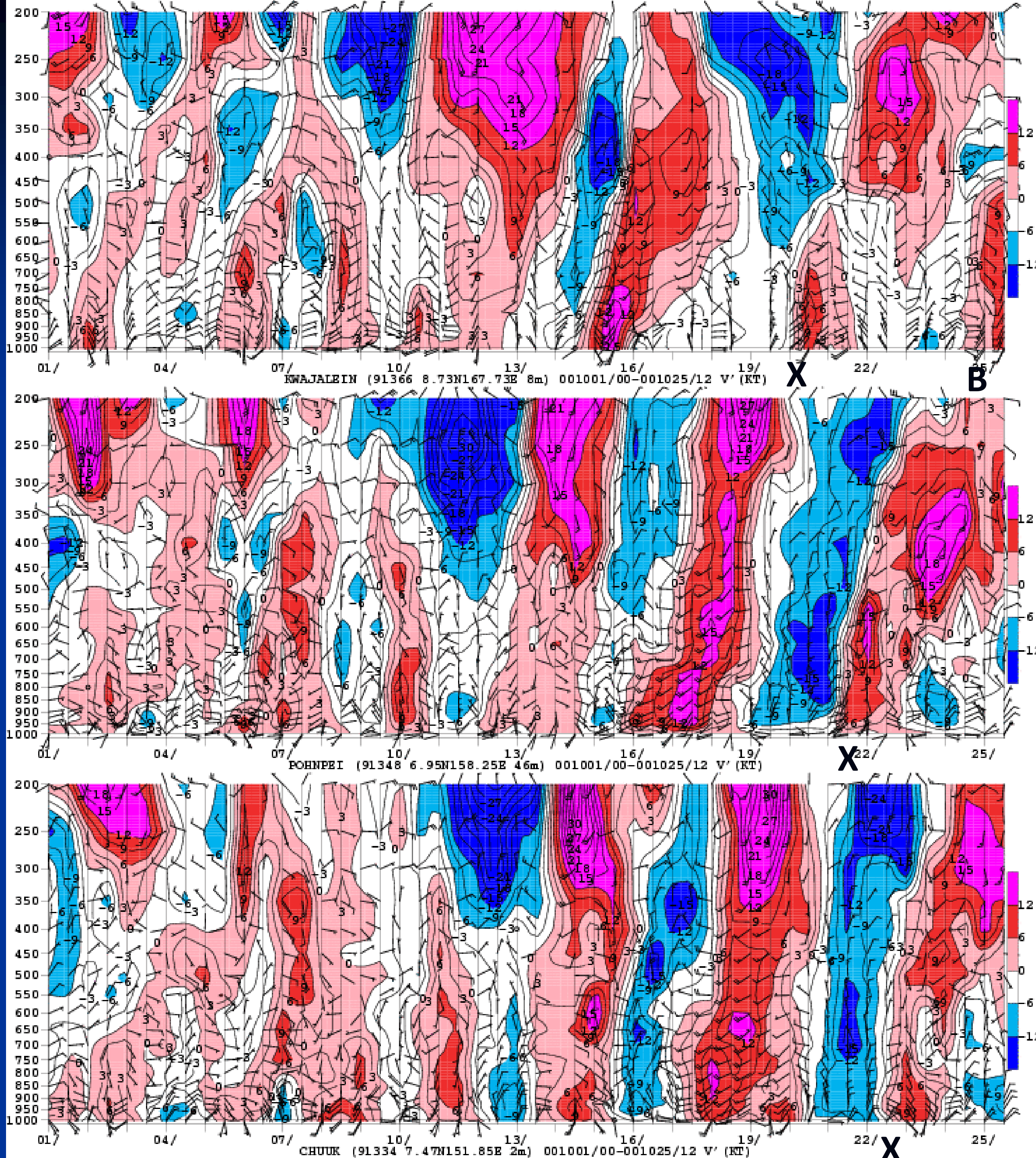
FIG. 1. Time-longitude section of satellite photographs of the period 1 July–14 August 1967 for the 5–10N latitude band in the Pacific. The following data are missing: 4 July (150E–155W), 17 July (150E–150W, 130W-100W), 29 July (130W–100W), 11 August (150E–150W).

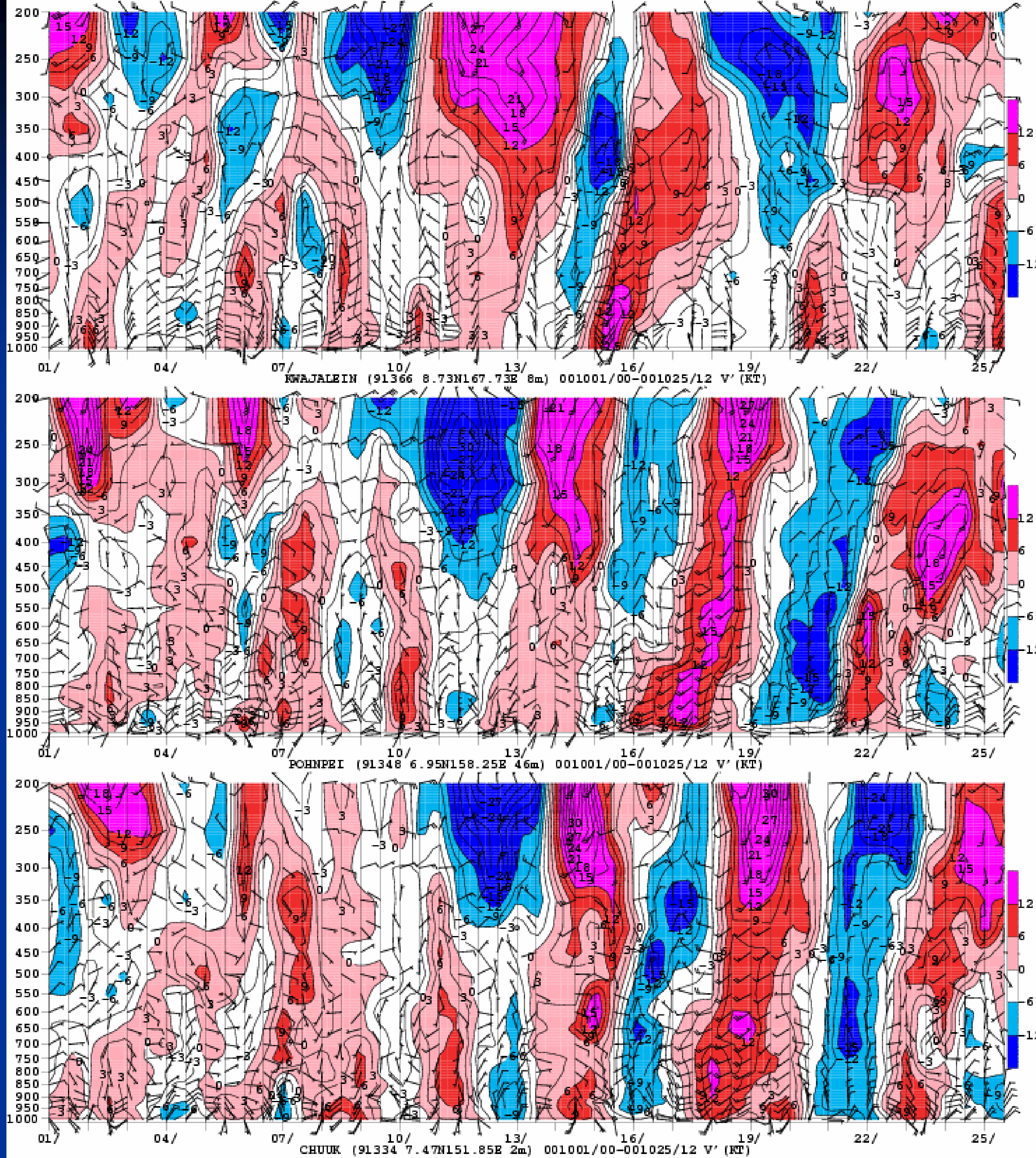
C.-P. Chang: Westward Propagating Cloud Patterns in the Tropical Pacific as seen from Time-Composite Satellite Photographs, Journal of the Atmospheric Science, 1970, vol. 27, pp 133-138

Identifying Easterly Waves in the W Pacific

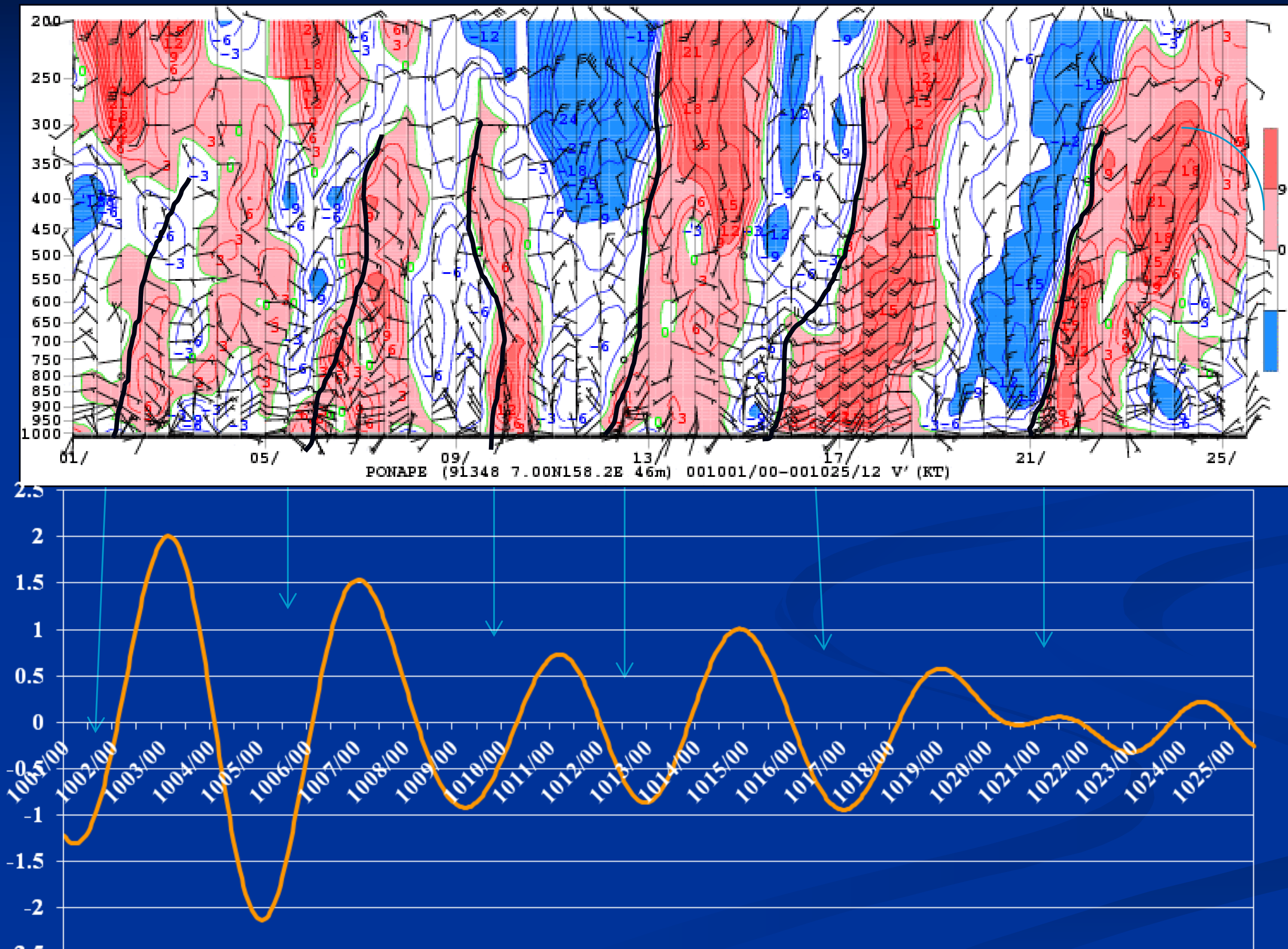


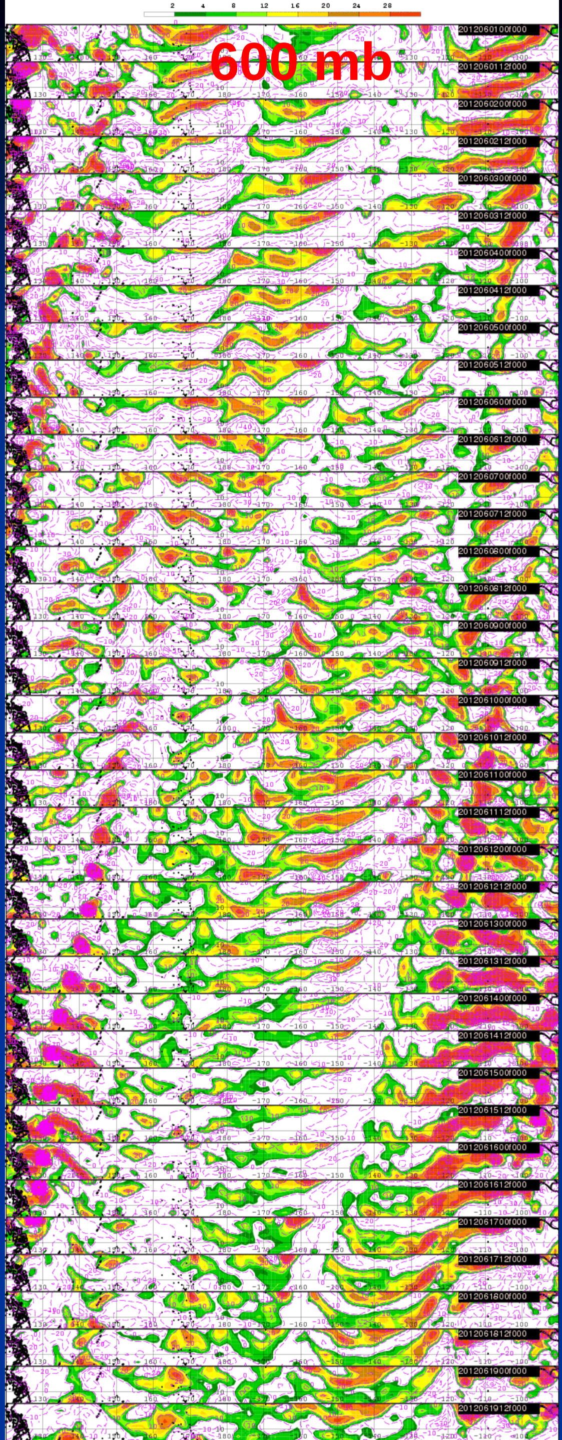
Easterly waves over western north Pacific



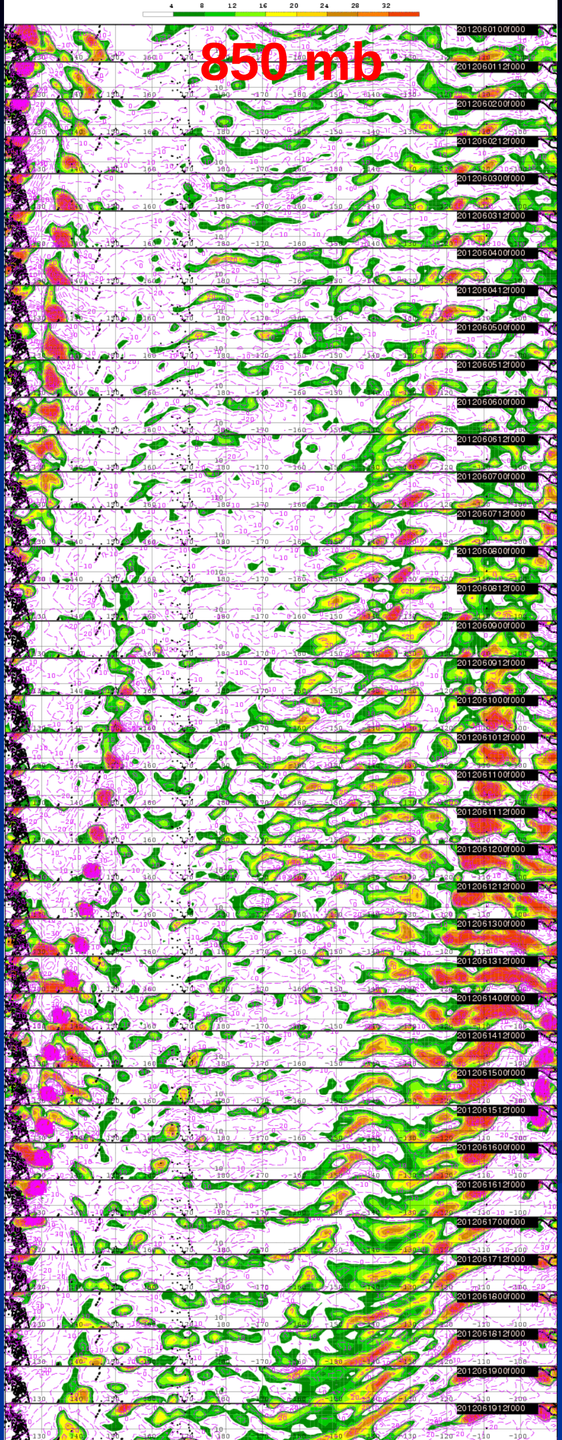

KWAJALEIN (91366 8.73N167.73E 8m) 001001/00-001025/12 V' (KT)
POHNPEI (91348 6.95N158.25E 46m) 001001/00-001025/12 V' (KT)
CHUUK (91334 7.47N151.85E 2m) 001001/00-001025/12 V' (KT)

Time series of upper air data and surface pressure Pohnpei 20000901-20000925



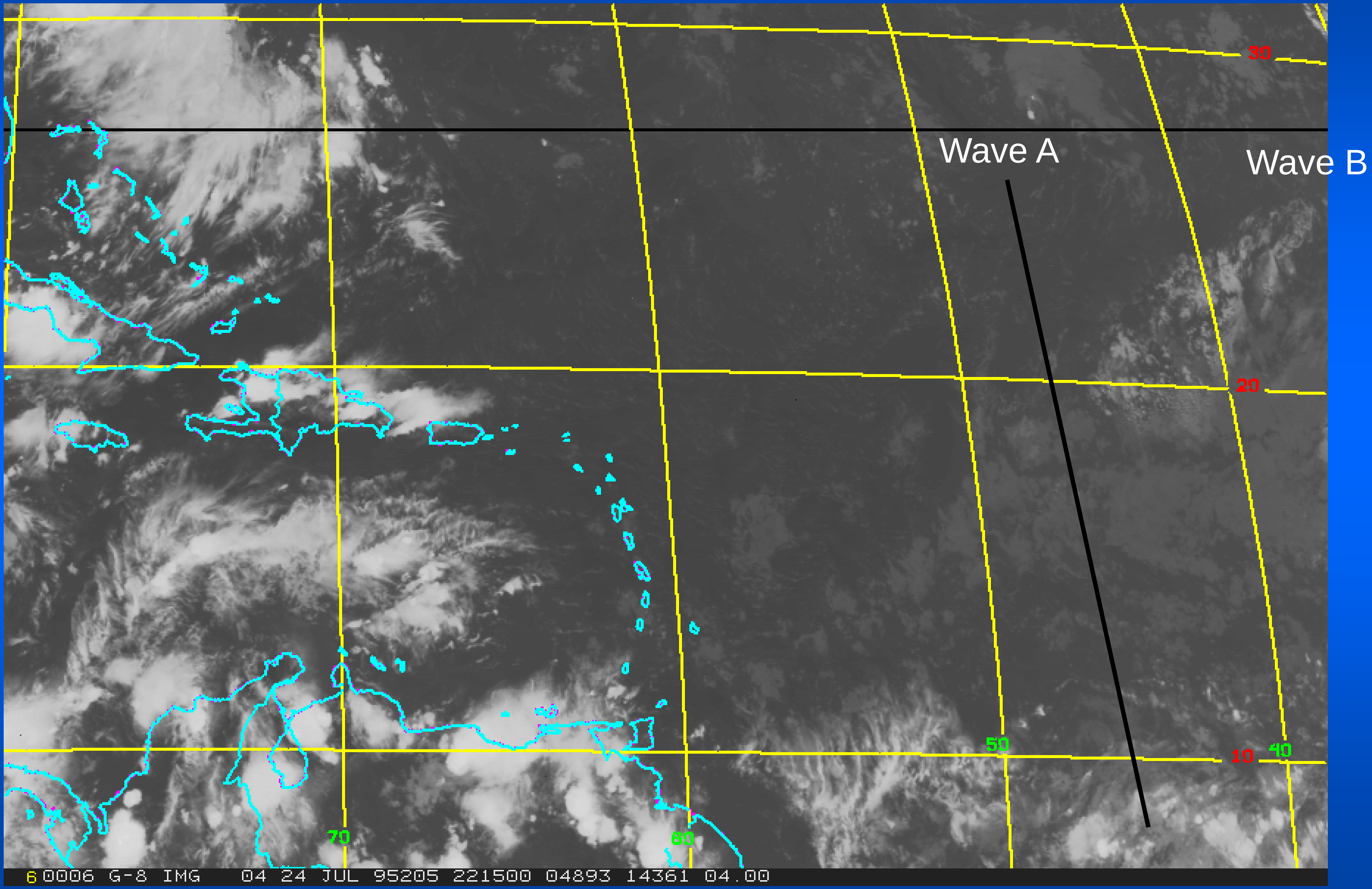

600 mb


700 mb

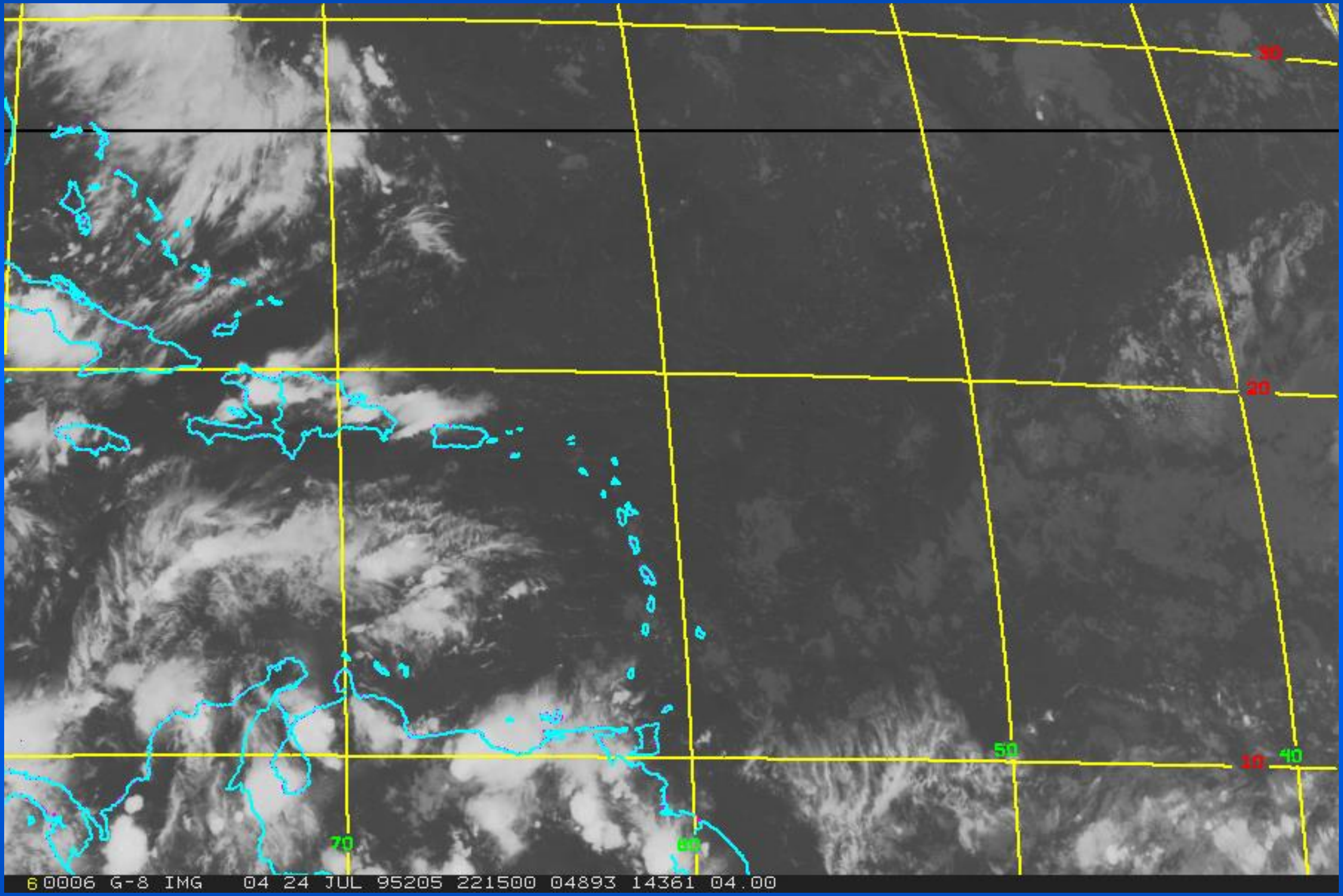

850 mb

Interactions between different systems of different scales – very often causes for heavy rainfall

Example of systems interacting with each other



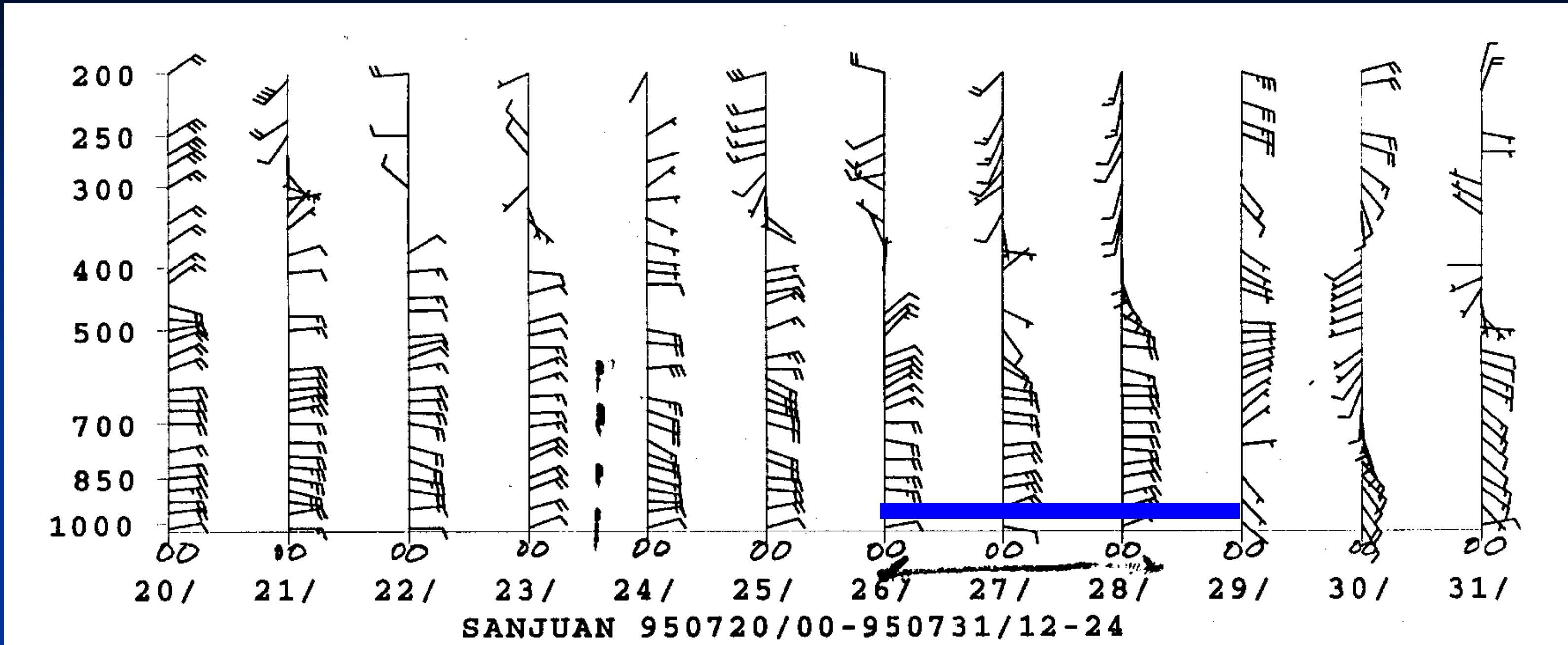
July 24 – 27, 1995

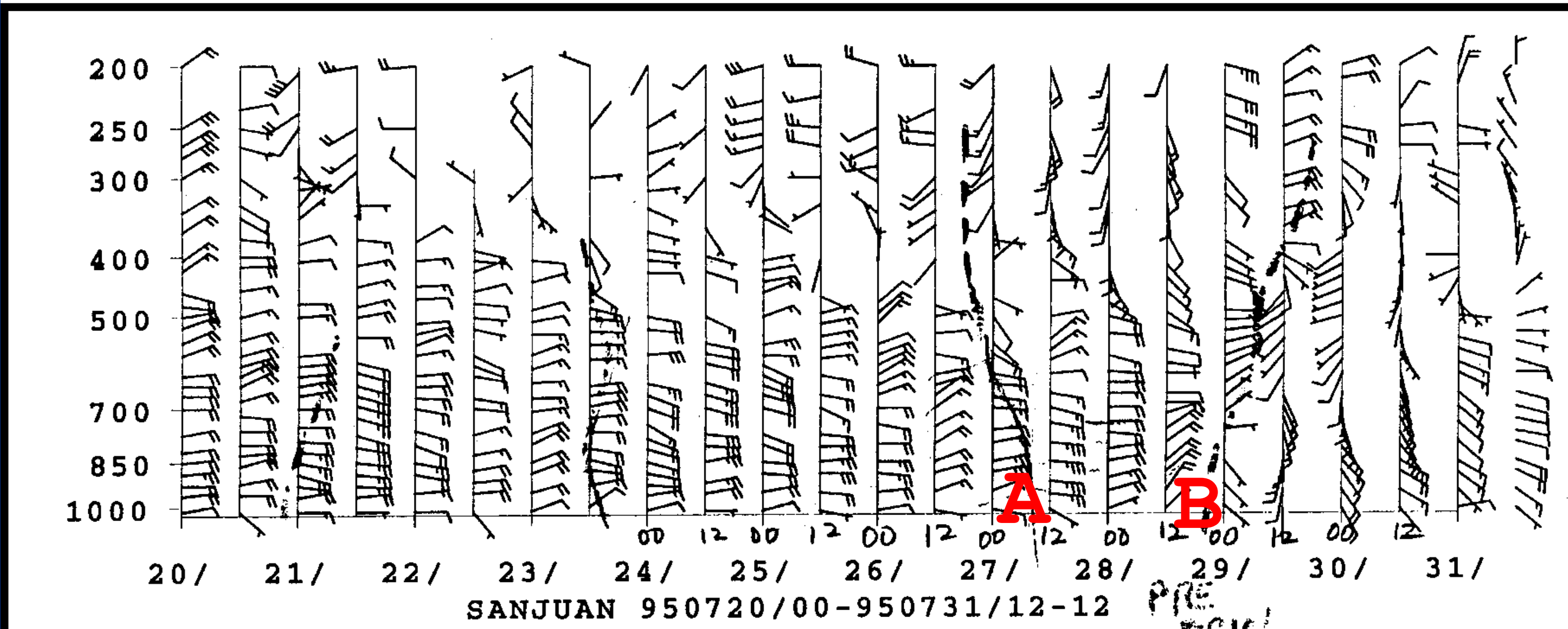


IS
ONCE-A-DAY RAWINSONDE
ENOUGH?

The wave in the above example passed TJSJ between 00Z and 12Z of 27 July 1995

Can you locate the wave Between 00-12Z 27 July?





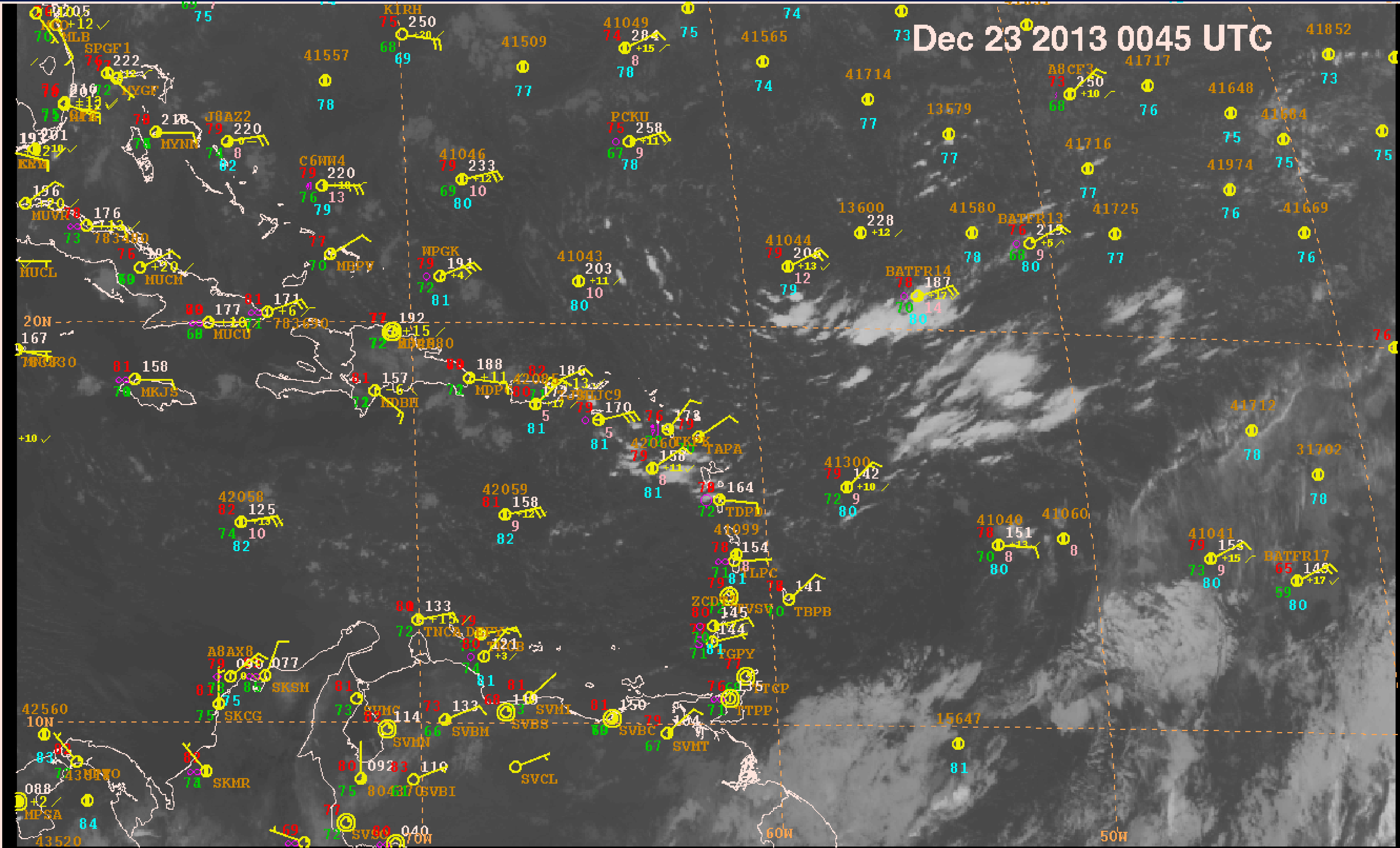
Heavy rainfall over the eastern Caribbean Islands December 24-26, 2013

A quick look

Eastern Caribbean: Floods and Landslides - Dec 2013

- Severe rains and high winds **due to a low level trough system** caused floods and landslides in St. Vincent and the Grenadines, Saint Lucia and Dominica from 23-25 Dec 2013 – *reliefweb.int*
- Torrential rains on Christmas Eve, with **15 in falling in 24** hours, led to dramatic floods and landslides that washed through St Vincent and the Grenadines, St Lucia and Dominica *–theguardian.com*
- From 6 to 10 inches of rain has fallen on part of the Leeward and Windward islands during the early and middle part of this past week - *AccuWeather.com*
- This is the third wettest December on record for St. Thomas and at least the fifth wettest on record for St. Croix, according to the National Weather Service in Puerto Rico

A quick view using GOES-E imagery



Dec 23 2013 0045 UTC GOES-E IR and Surface Obs

GOES-E

2345 UTC Dec 23

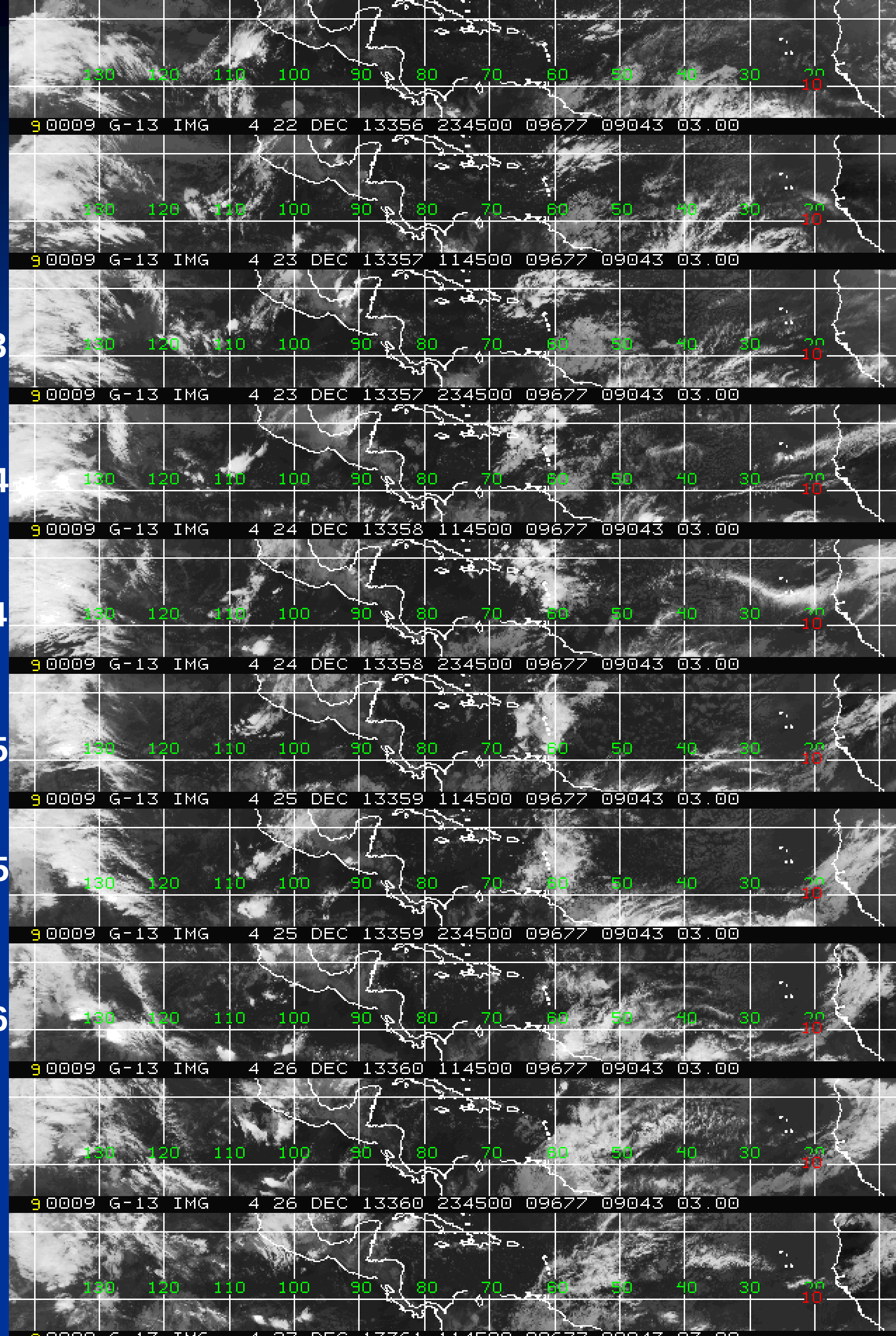
1145 UTC Dec 24

2345 UTC Dec 24

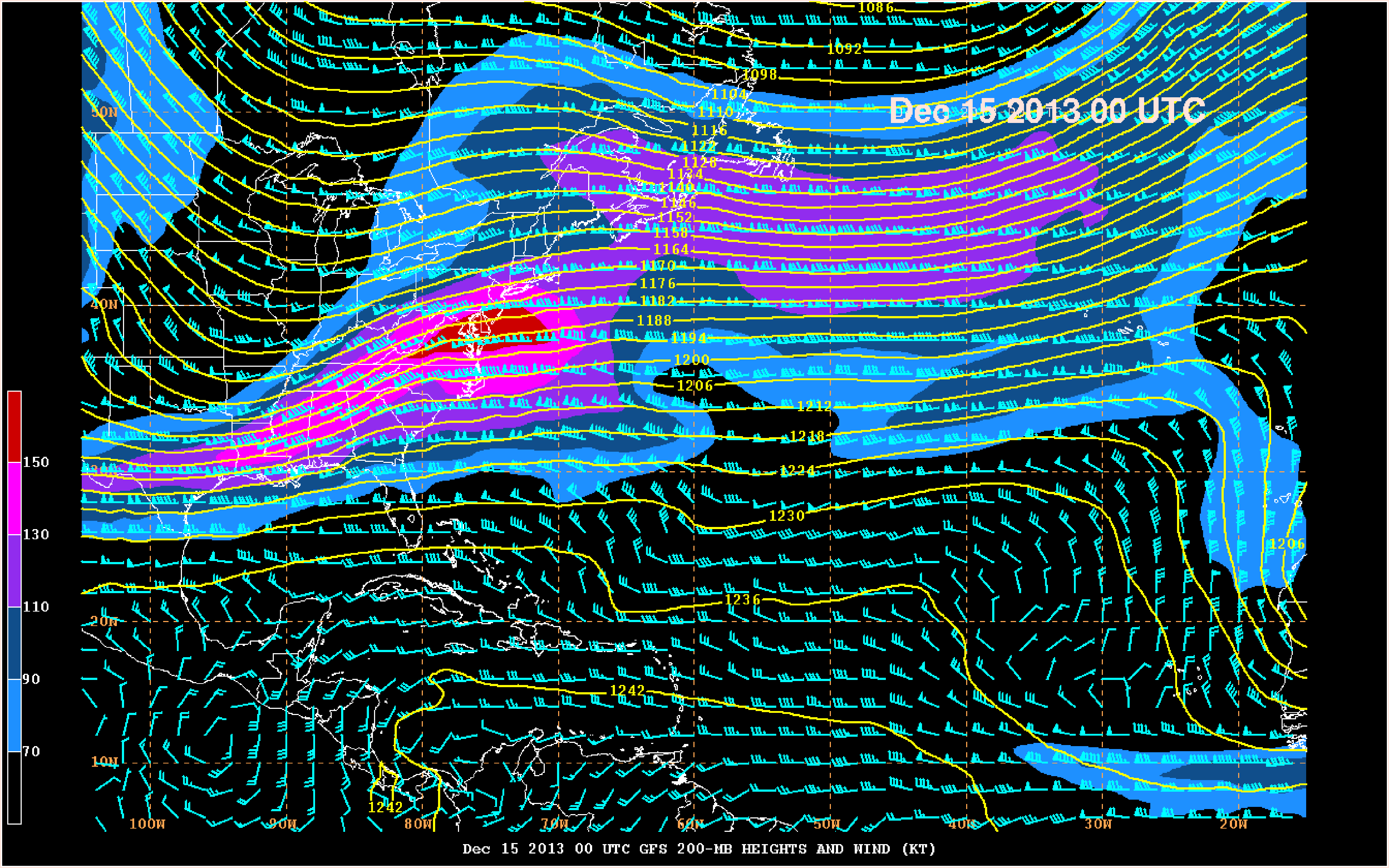
1145 UTC Dec 25

2345 UTC Dec 25

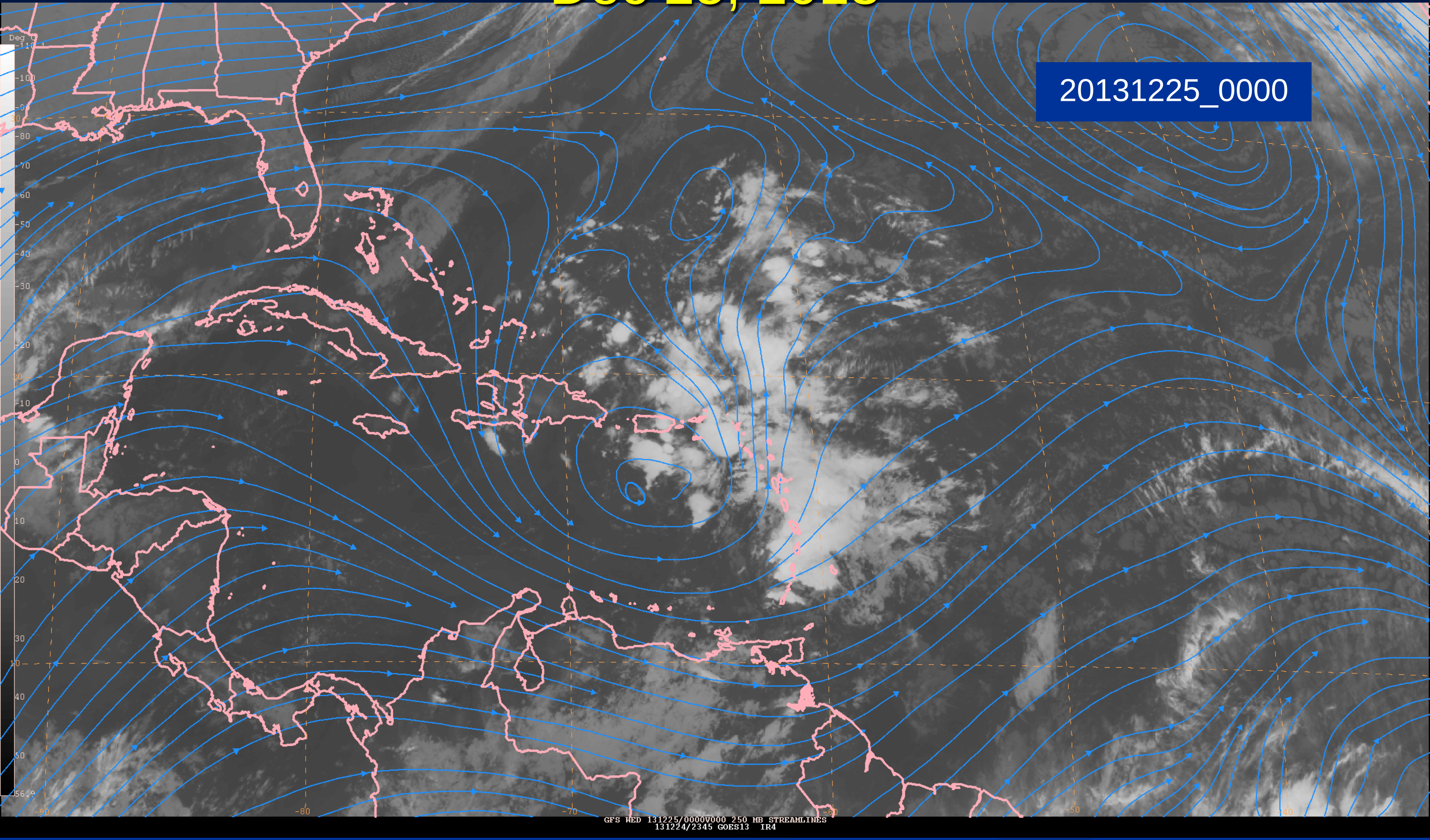
1145 UTC Dec 26



200 mb heights and wind
00Z Dec 15 – 18Z Dec 27

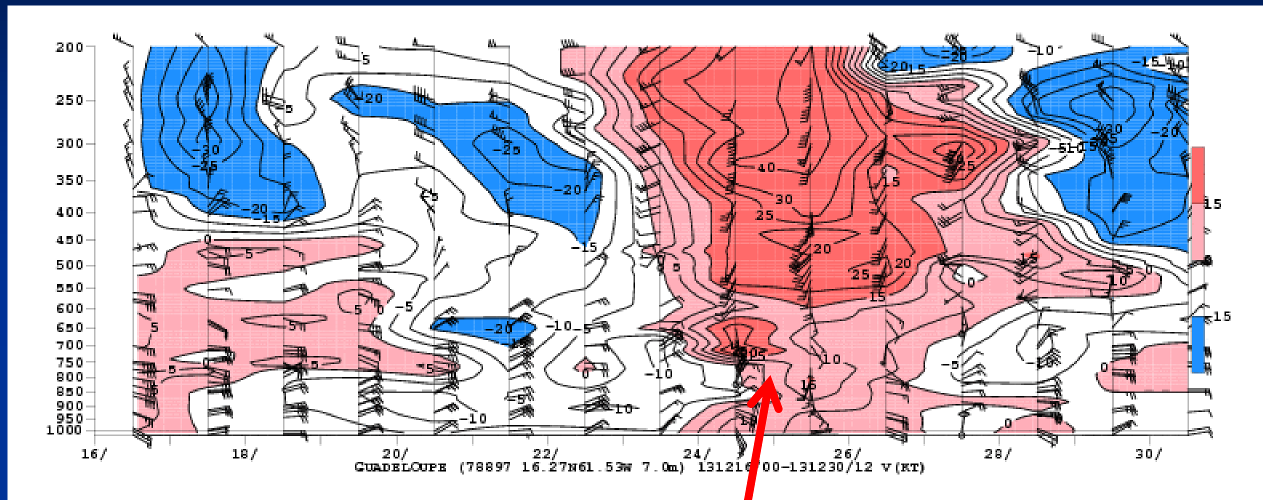


IR image and 250 mb streamlines at 0000 UTC Dec 25, 2013

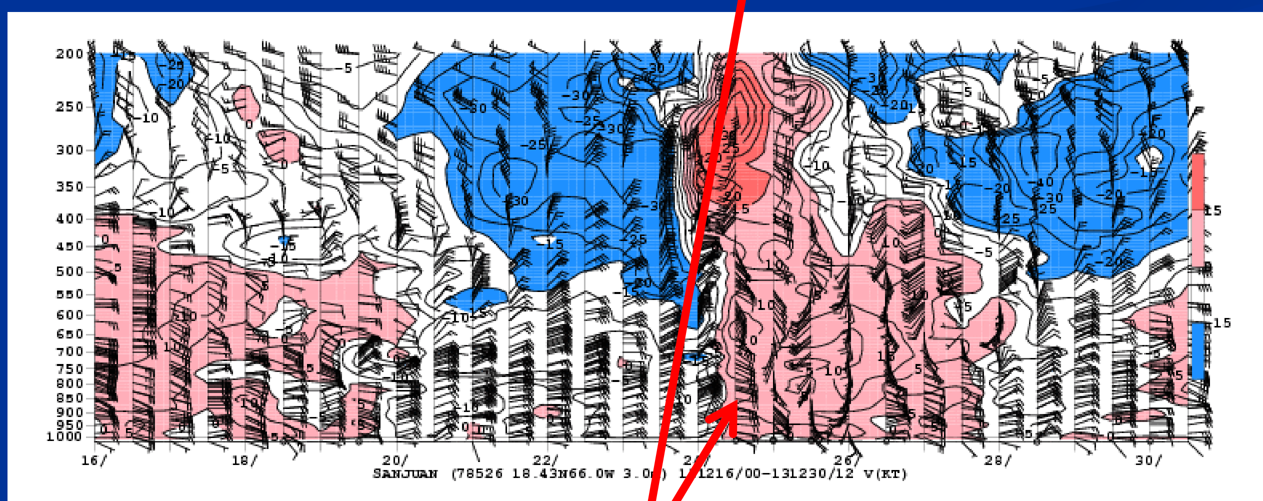


Sounding winds Dec 16 – Dec 30

Guadeloupe



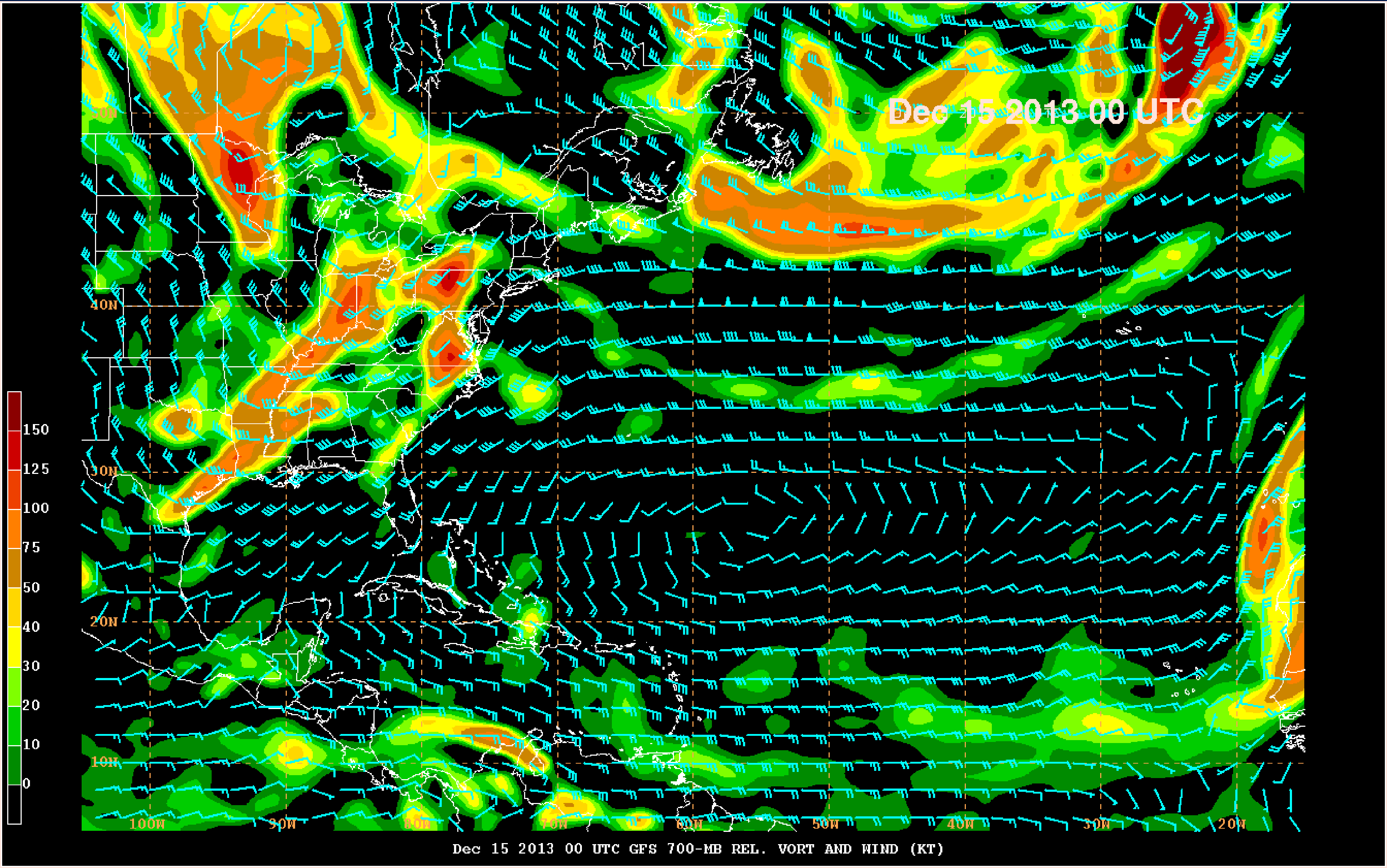
San Juan



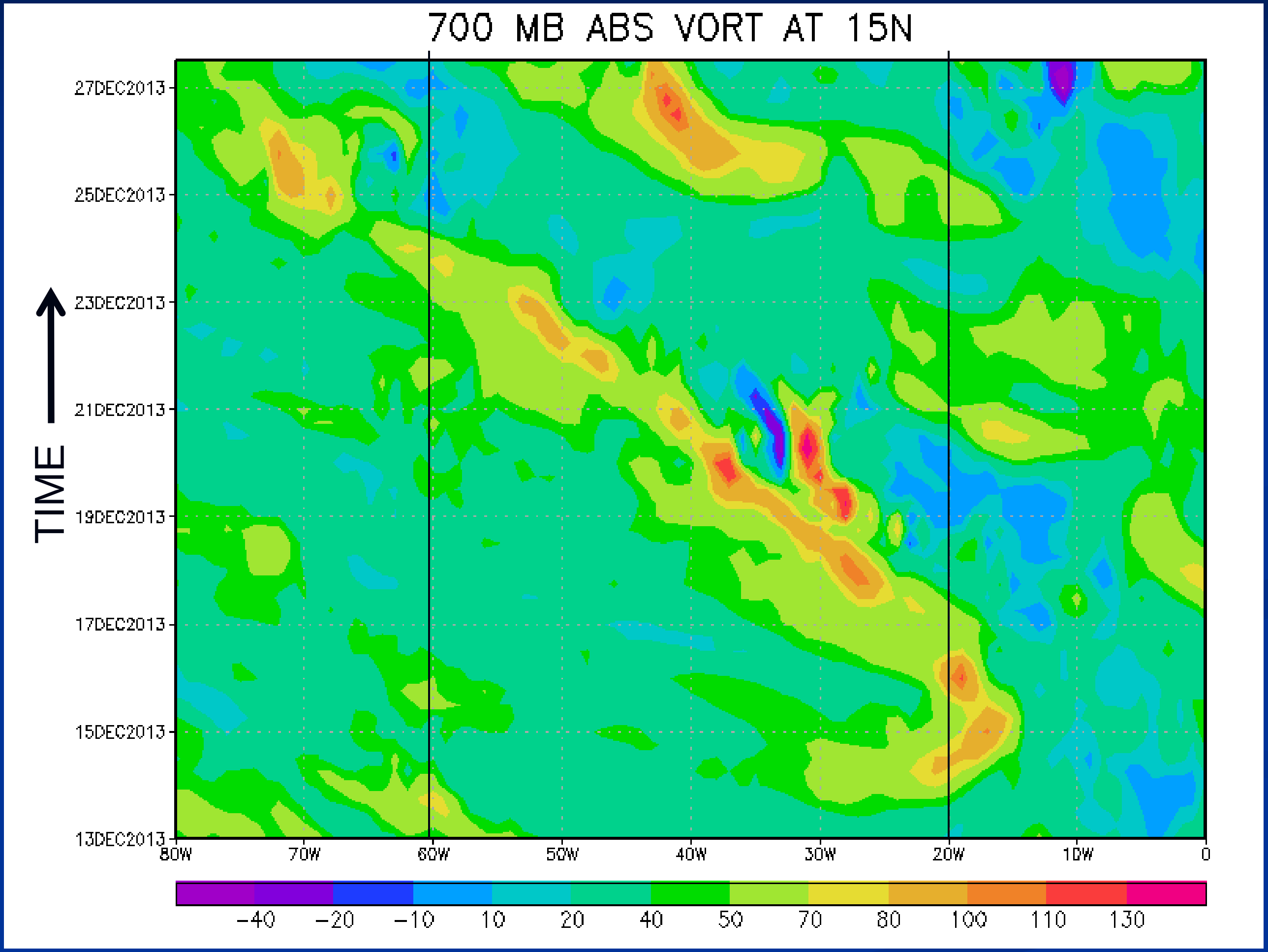
Was the low level southerly winds related to the upper level low only?

Was the heavy rainfall over the Windward Islands caused by the upper level low and a shortwave, or by the low level trough, or both?

700 mb relative vorticity and wind
00 Z Dec 15 – 18Z Dec 27

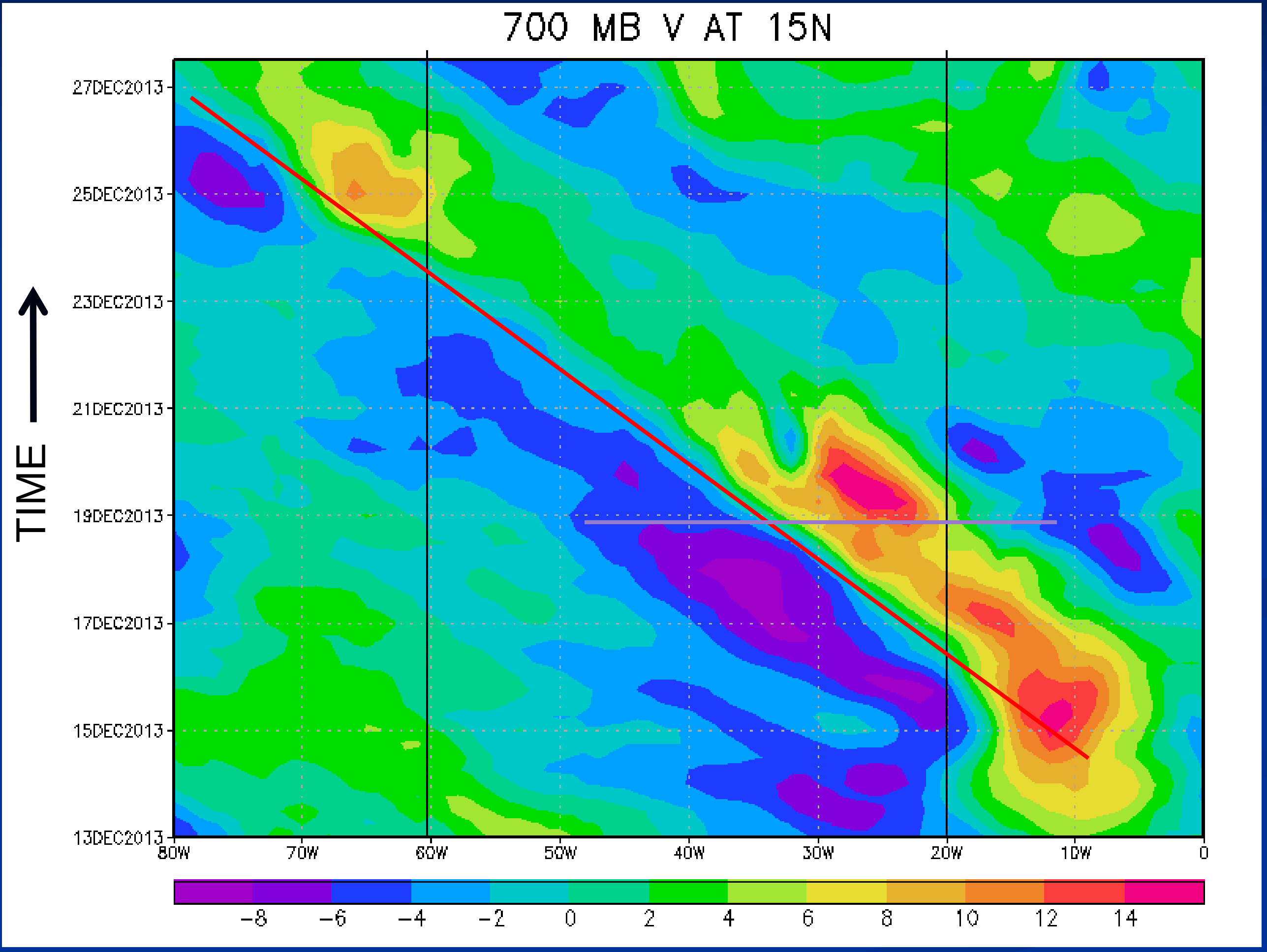


GFS analysis



LONGITUDE

GFS analysis



LONGITUDE

This case is very similar to the earlier example of July 24-27, 1995

- Unusual/unexpected heavy rainfalls in the tropics tend to be the results of interaction of various systems in favorable environments
- Good analysis, close monitoring/tracking of all systems, upper-level and low-level, gives forecasters confidence in making heavy rainfall forecasts
- Frequent update of rainfall amount and forecast is helpful

Now someone says there is an elephant outside
and
you have been asked to make a good analysis

What's the best approach?

- Do some quick research on elephants
- Step back and see the whole thing
- Then approach it and take a detailed look
- . . .
-

(Don't do cross section analysis)

Some Advises on Performing Analysis

- On satellite animations (loops)
  - Always start your day by watching a long loop that covers 2-3 days of images and over a large domain. One frame per hour is more than enough.
  - Identify large-scale features, their motions, and intensity changes, if any.
  - Then watch a shorter loop on systems you are interested in (with higher imagery frequency).
  - Apply this approach even if you are doing Dvorak classification.

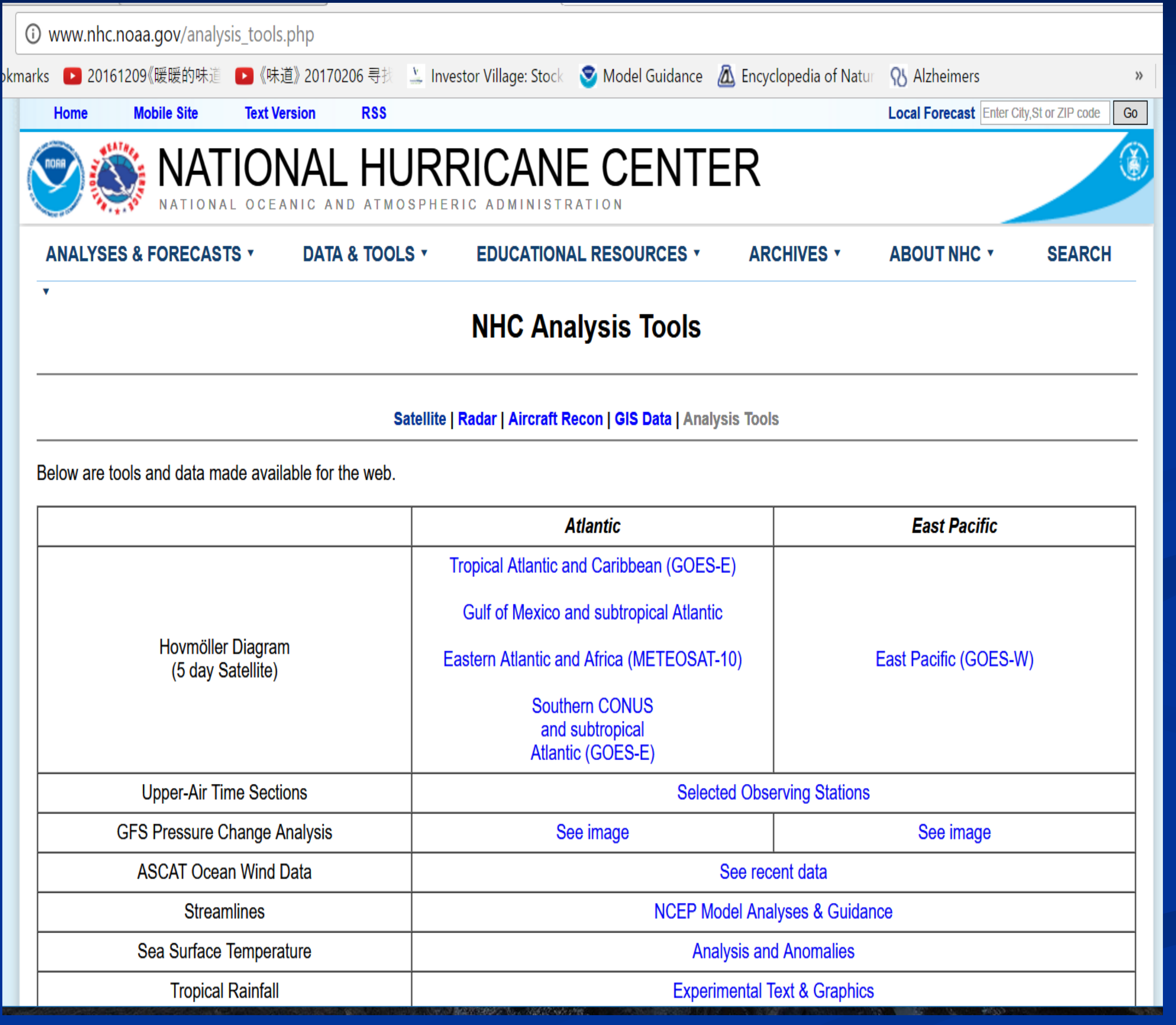
Some Advises on Performing Analysis

- On Analyzing maps, surface analysis or upper level charts
  - Step back and look at the large picture (whole domain).
  - Take a look at previous maps and gain some ideas of the features there and the history of them.
  - Then look at the current map and check the area where these systems should be.
  - Cloudiness may suggest locations of synoptic features, but synoptic features do not always have convection accompany them.

Some Advises on Performing Analysis

- If your office do not use paper charts, and all the lines are drawn by computer automatically
  - If you have doubt, print a page and analyze that section by hand.
  - Ask supporting staff to program the computers to generate some of the analysis tools you've seen earlier like timesections, timeseries, HovmÖller charts (of satellite image or model fields).

Analysis tools on NHC web site



www.nhc.noaa.gov/analysis_tools.php

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NHC Analysis Tools

Satellite | Radar | Aircraft Recon | GIS Data | Analysis Tools

Below are tools and data made available for the web.

	Atlantic	*East Pacific*
Hovmöller Diagram (5 day Satellite)	Tropical Atlantic and Caribbean (GOES-E) Gulf of Mexico and subtropical Atlantic Eastern Atlantic and Africa (METEOSAT-10) Southern CONUS and subtropical Atlantic (GOES-E)	East Pacific (GOES-W)
Upper-Air Time Sections	Selected Observing Stations	
GFS Pressure Change Analysis	See image	See image
ASCAT Ocean Wind Data	See recent data	
Streamlines	NCEP Model Analyses & Guidance	
Sea Surface Temperature	Analysis and Anomalies	
Tropical Rainfall	Experimental Text & Graphics	

Anything else that can help?

Spectral analysis-on demand???

Thank you