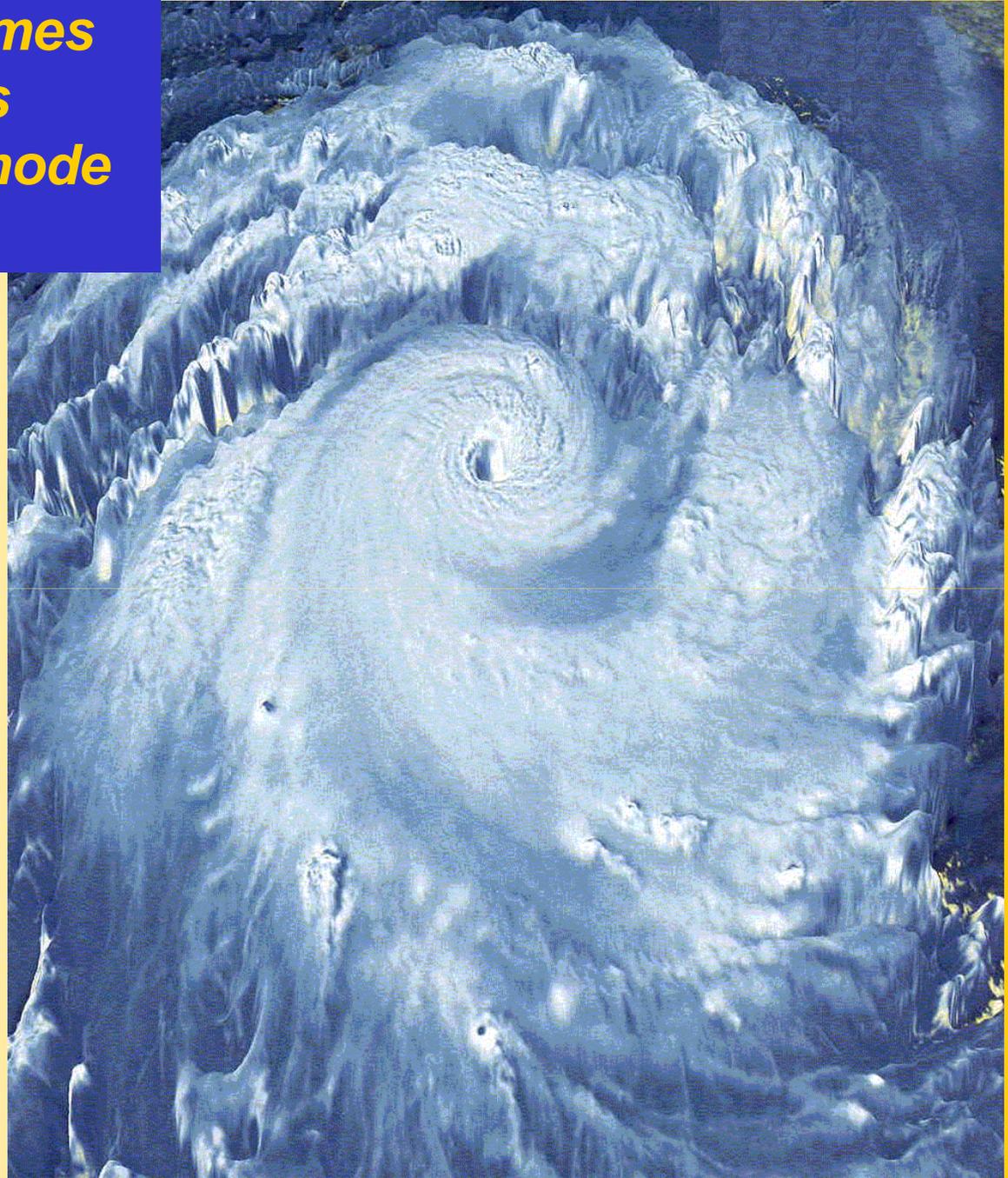
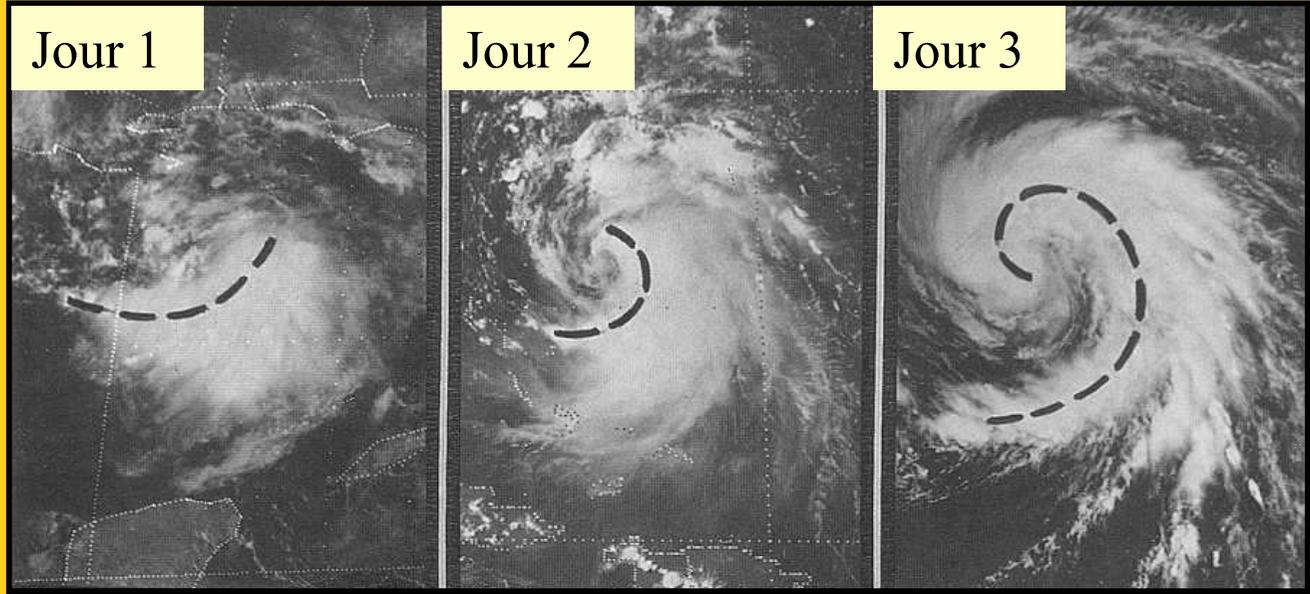


*L'analyse des systèmes
dépressionnaires
tropicaux par la méthode
de Dvorak*

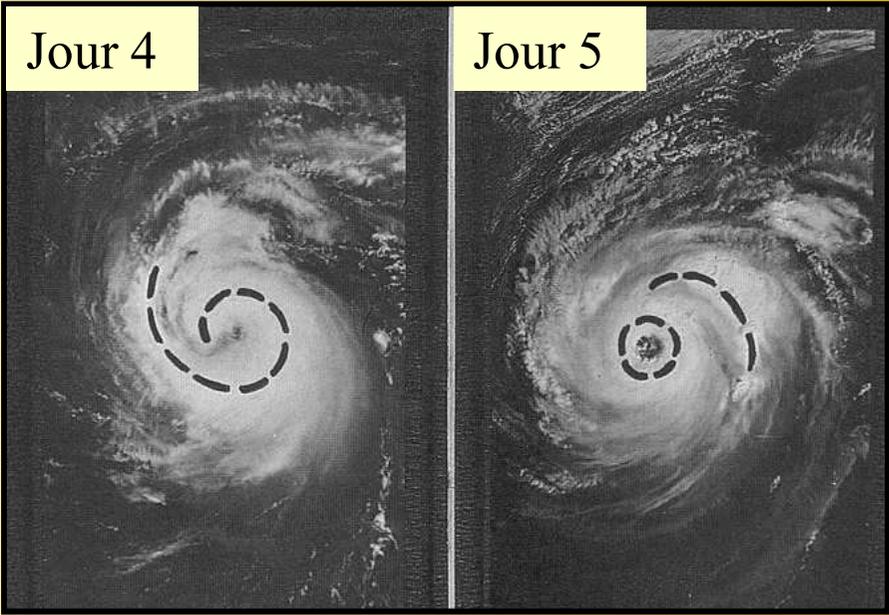
**Tropical Cyclone Analysis
using the Dvorak
Intensity Analysis
Technique**

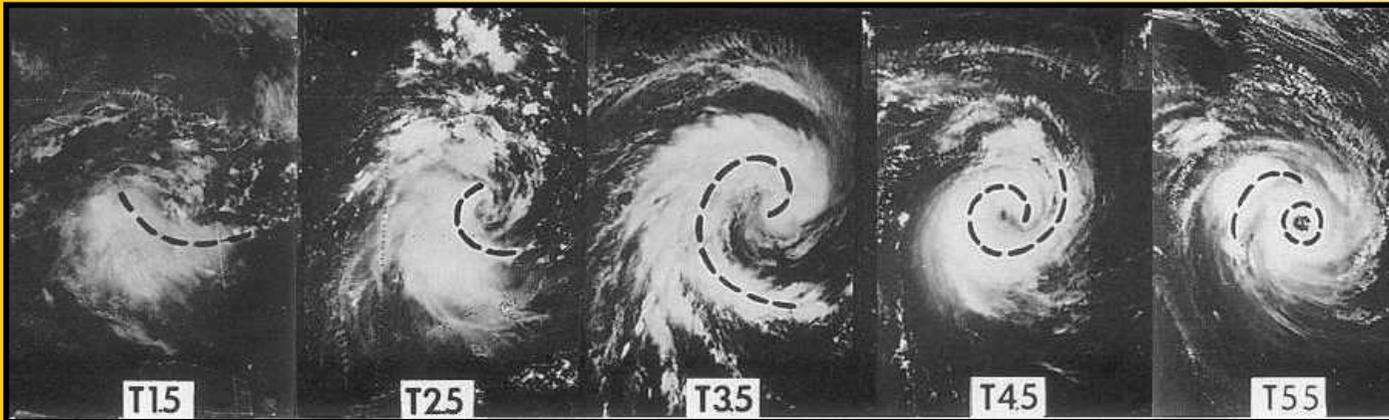




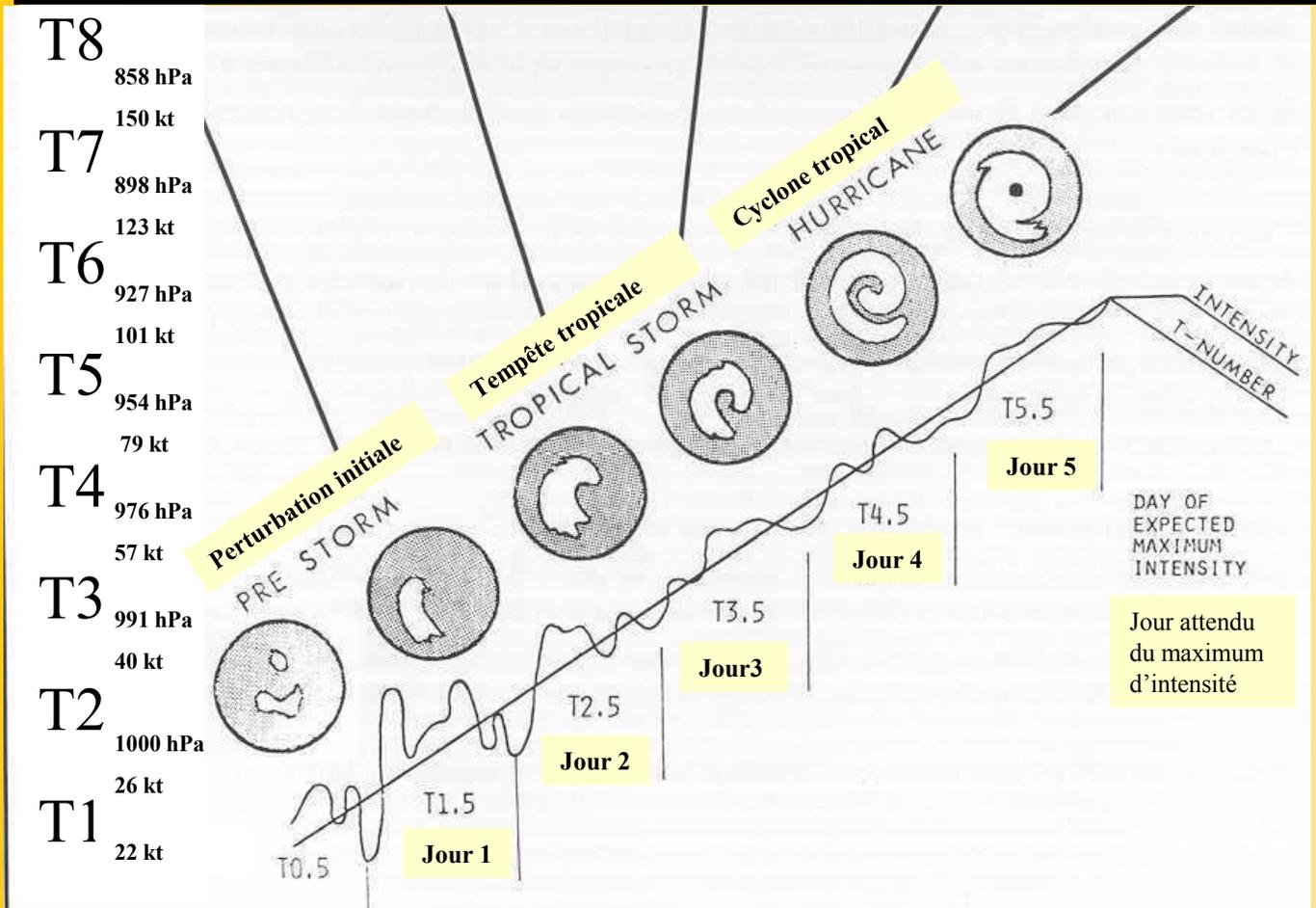
Imagerie en canal visible montrant l'évolution typique sur 5 jours (à raison d'une image par jour) d'une configuration en bande incurvée.

Visible imagery showing typical 5 days tropical cyclone evolution of the curved band pattern (day by day).

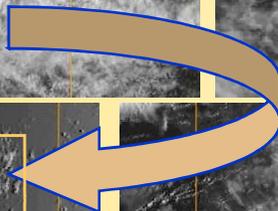
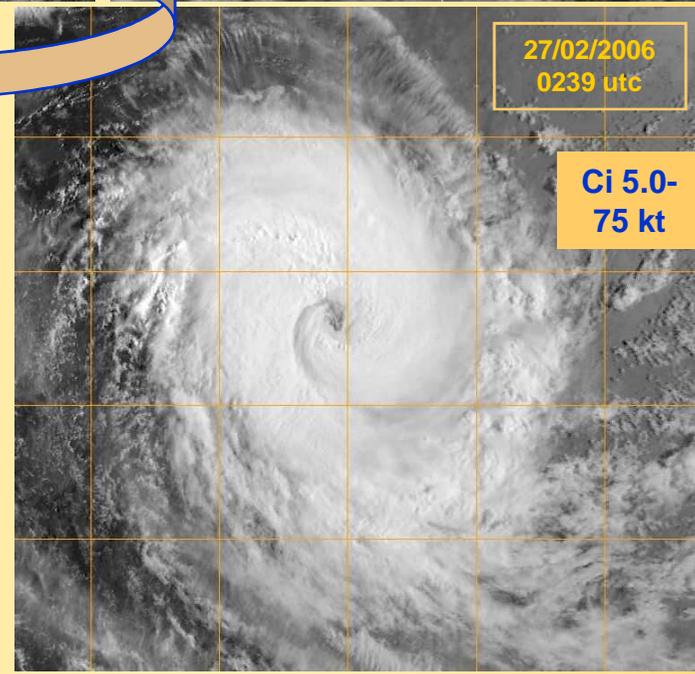
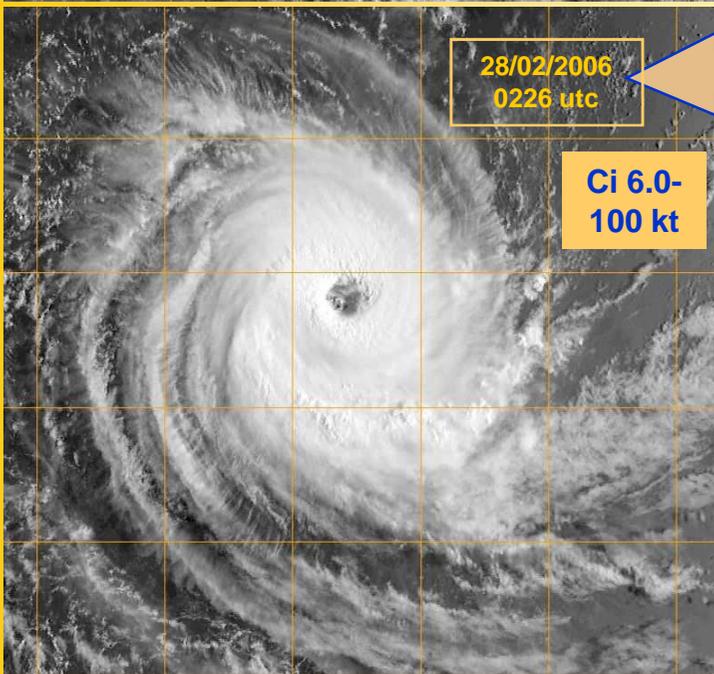
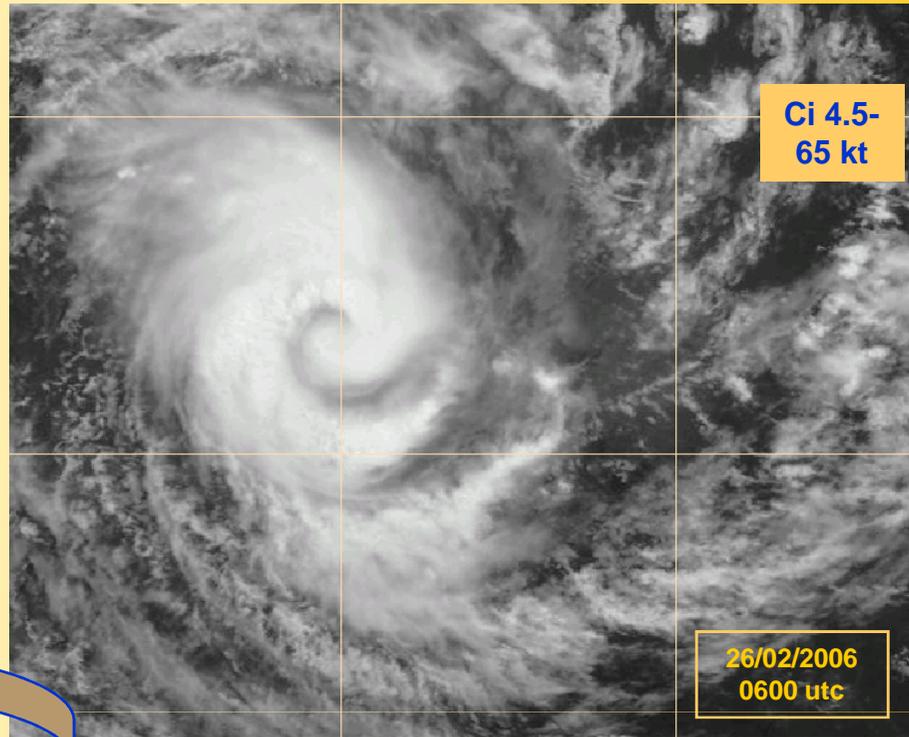
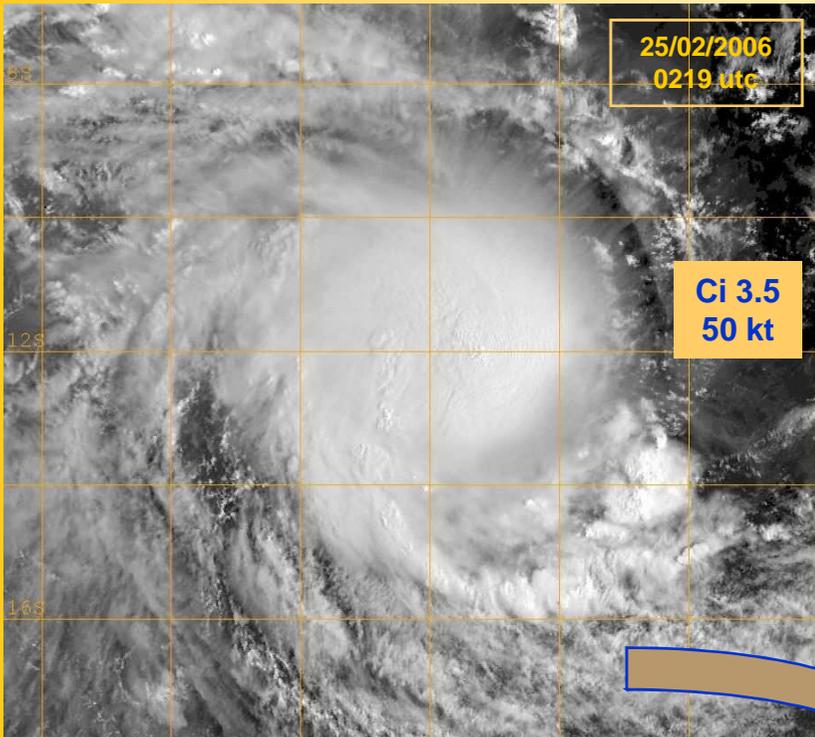




Développement d'un cyclone tropical modèle (suivant un taux d'intensification d'un nombre T par jour).



A modeled depiction of tropical cyclone development (at the average rate of one T-number per day).

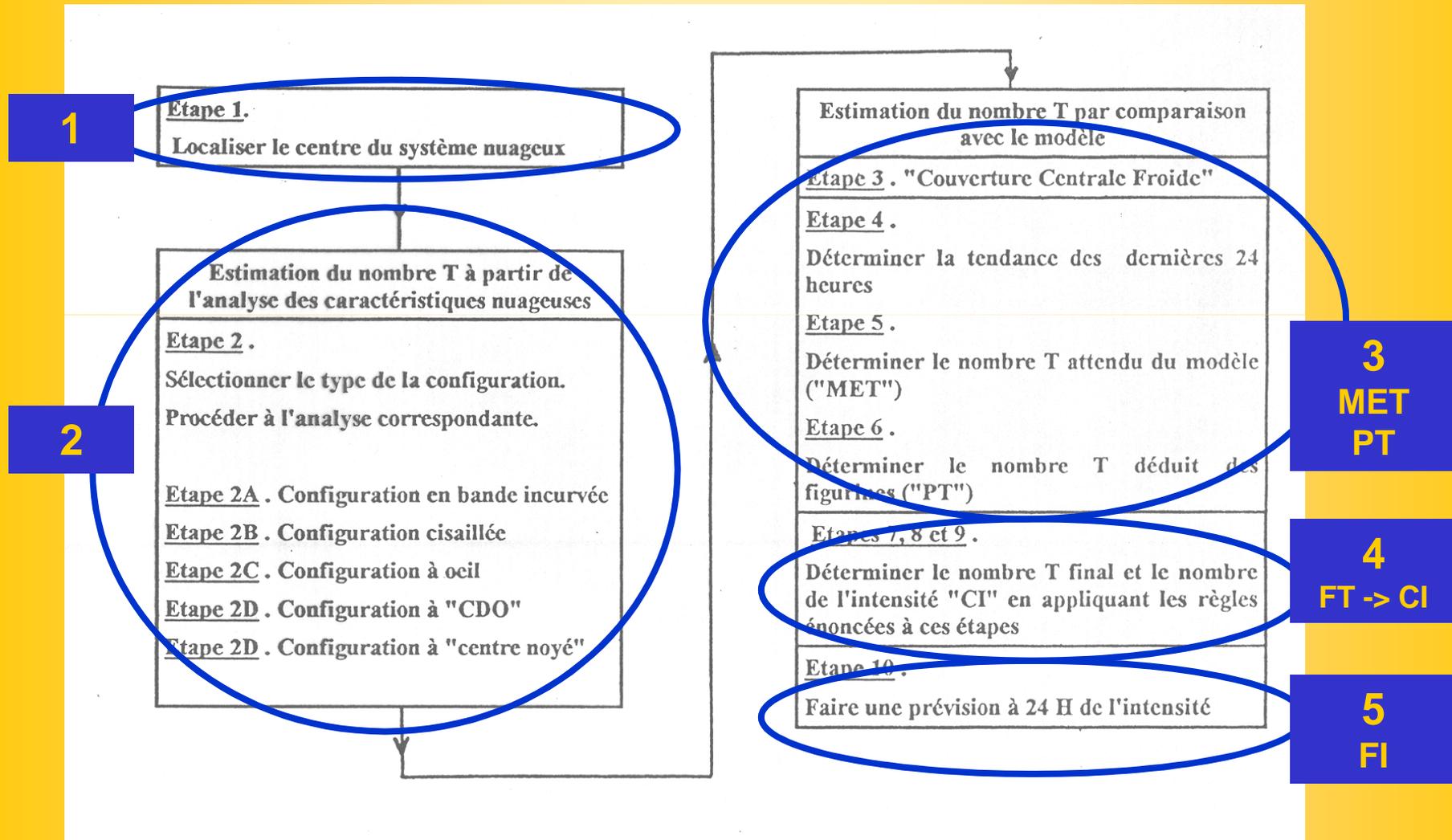


Cyclone CARINA :
une intensification
d'école.

*Cyclone CARINA a
text-book
intensification*

Une procédure en cinq parties principales et en dix étapes.

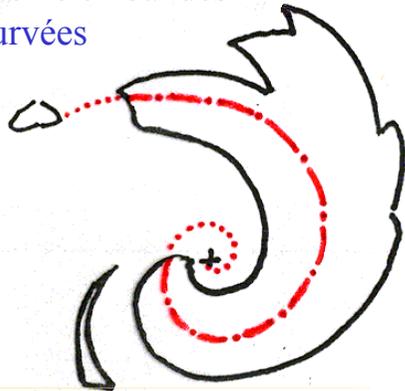
The five major parts and the ten steps of the analysis procedure.



Quatre configurations nuageuses principales.

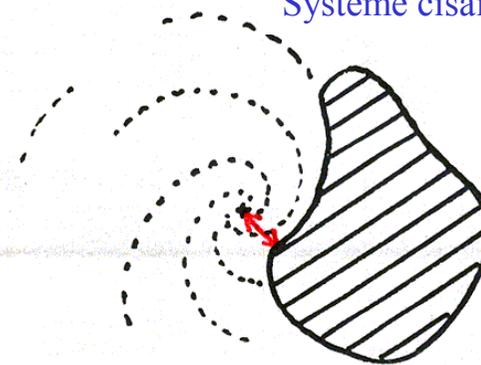
The four major cloud patterns.

Système en bandes incurvées



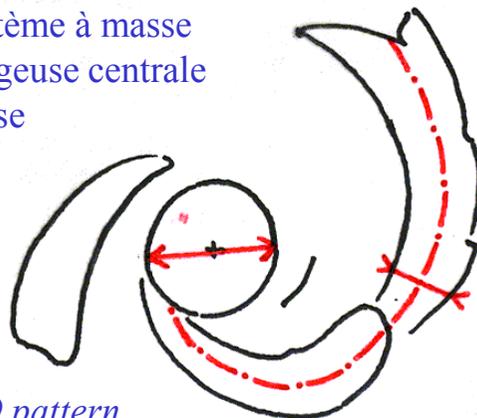
*Curved
band pattern*

Système cisailé



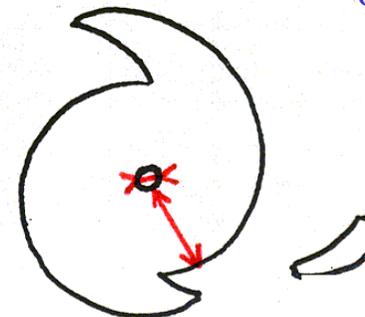
Sheared pattern

Système à masse nuageuse centrale dense



CDO pattern

Système à oeil



Eye pattern

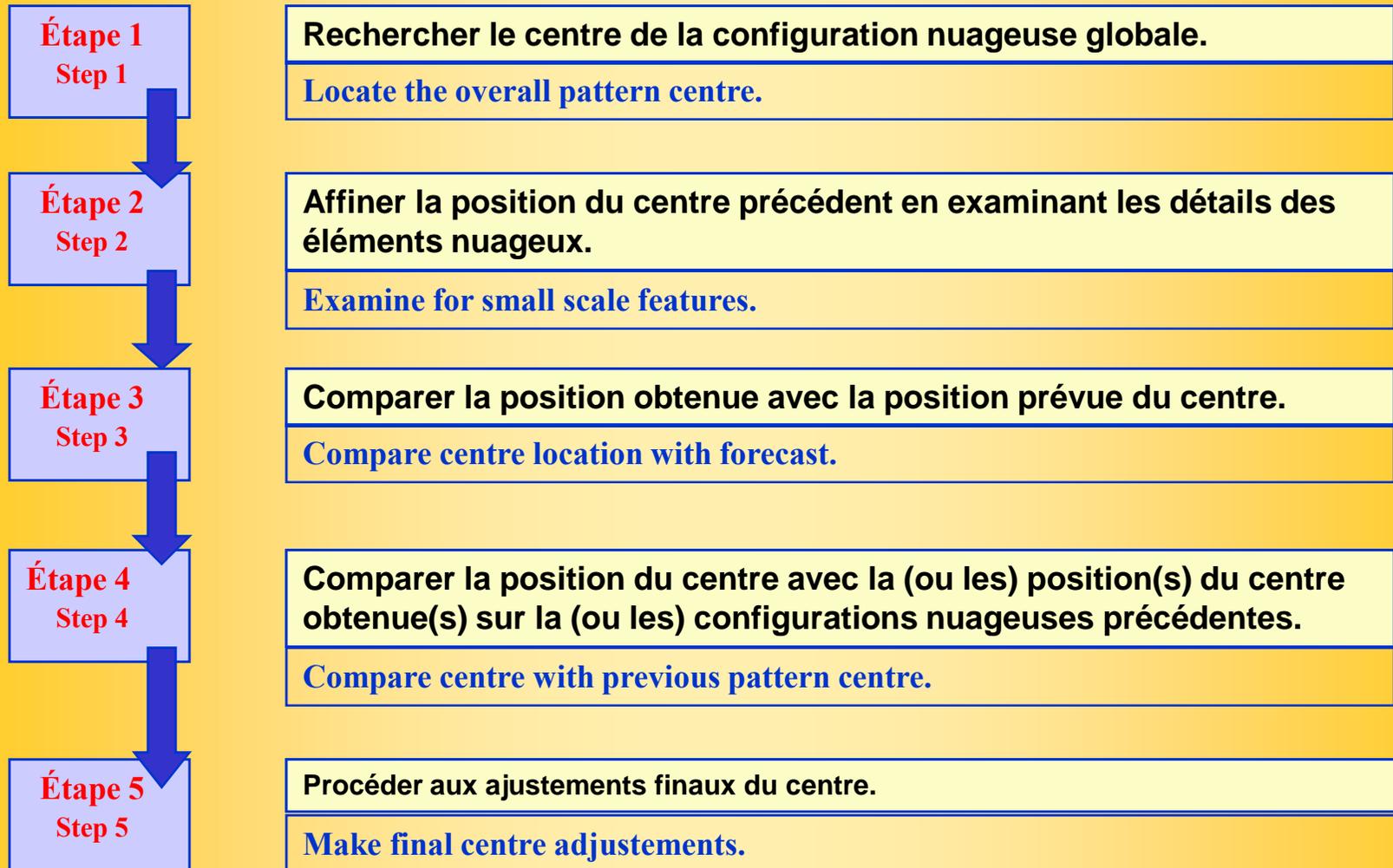


***La localisation du centre d'un système
dépressionnaire tropical***

Locating Tropical Cyclone Centres

Cinq étapes pour positionner le centre d'un système dépressionnaire tropical à partir de l'imagerie satellitaire

Five steps for locating Tropical cyclone centres using satellite imagery



Étape 1 : Rechercher le centre de la configuration nuageuse globale.
Step 1 : Determine the centre of the overall cloud pattern.



Pour estimer, en première approche, la position du centre :

The first guess estimate of the centre is determined by :

Rechercher le point focal de courbure des lignes nuageuses et bandes nuageuses de grande échelle.

Locating the focal point of the broadscale cloud line and curvature of the system



Rechercher le modèle de configuration nuageuse directement comparable à celle de l'image à analyser, et positionner le centre conformément à la manière dont il est défini sur ce modèle.

Comparing the cloud pattern with those of tropical cyclone development models, and locating the centre as defined on the corresponding model.



Étape 2 : Affiner la position du centre précédent en examinant les détails des éléments nuageux.

Step 2 : Examine for small scale features.



Les éléments à prendre en compte à ce niveau sont :

The cloud features used in this step include :

Présence d'un œil ou indication de la présence d'un œil (point chaud).

Presence of an eye or indication of the presence of an eye (warm spot).



Courbure des enroulements nuageux de basses couches, zones de présence nuageuses faibles (« trous »), ou zone vers laquelle convergent des alignements nuageux.

Low level cloud line curvature, cloud minimum areas (holes), or area of cloud line mergence.



Éléments concernant les couches nuageuses moyennes ou supérieures, tels que courbure d'alignements ou de bandes nuageuses, zones de nuages plus froids, « trous » dans le couche nuageuse, sommets de cumulonimbus plus élevés.

Middle or upper level cloud features such as line or band curvature, cold cloud areas, holes in cloud cover, or protruding cumulonimbus tops.



Étape 3 : Comparer la position obtenue avec la position prévue du centre.

Step 3 : Compare centre location with forecast.



Cette étape est fondamentale pour faire apparaître un éventuel problème d'analyse et nécessite :

This step is crucial to discovering problems with the analysis, that may not have been previously recognized, and requires :

Comparer le centre obtenu après les étapes 1 et 2 avec la position prévue pour l'heure de l'image satellite, position obtenue par extrapolation de la trajectoire antérieure.

To compare the centre arrived at after the first two steps, with the expected position for the time of the satellite image (position extrapolated from the previous track).

On pourra ainsi mettre en évidence une erreur de positionnement du centre pour cause de mauvais choix de ce centre, ou une erreur pour cause de déplacement du centre lié par exemple à un cisaillement vertical du vent.

This step highlights possible errors due to wrong cloud centre selection or displacements caused by vertical wind shear.



Étape 4 : Comparer la position du centre avec la (ou les) position(s) du centre obtenue(s) sur la (ou les) configurations nuageuses précédentes.

Step 4 : Compare centre with previous pattern centre.



Cette technique, souvent très utile pour les systèmes complexes présentant des centres mal définis ou bien plusieurs centres nuageux, consiste à :

This technique, that often helps in complex cloud patterns having poorly defined centres, or having multiple cloud centres, consists in :

Comparer la position du centre de la configuration nuageuses avec la position du centre nuageux d'une (ou plusieurs) image(s) précédente(s) présentant une configuration nuageuse semblable.

Compare pattern centre to cloud features of previous image(s) to current image with similar cloud features.

NB1 : *Cette étape peut se révéler un moyen efficace, quand l'étape 3 fait apparaître une possible erreur de positionnement.*

This step may be efficient when step 3 reveals a possible location error.

NB2 : *Cette technique peut également fonctionner en sens inverse, pour revenir sur une position antérieure incertaine et la corriger, quand un centre fiable est désormais visible sur l'imagerie.*

This technic may also work in reverse, to improve a previous centre, when a good centre is now apparent in the current image.



Étape 5 : Procéder aux ajustements finaux du centre.

Step 5 : Make final centre adjustments.

Cette étape permet de procéder aux éventuelles corrections finales de la position du centre et tiennent essentiellement en des ajustements pour tenir compte des éléments suivants :

This step is to make final corrections in the centre placement when indicated, and mainly consist in making adjustments to take into account the following factors :

Correction de la grille.

Gridding errors (check accuracy against land features).



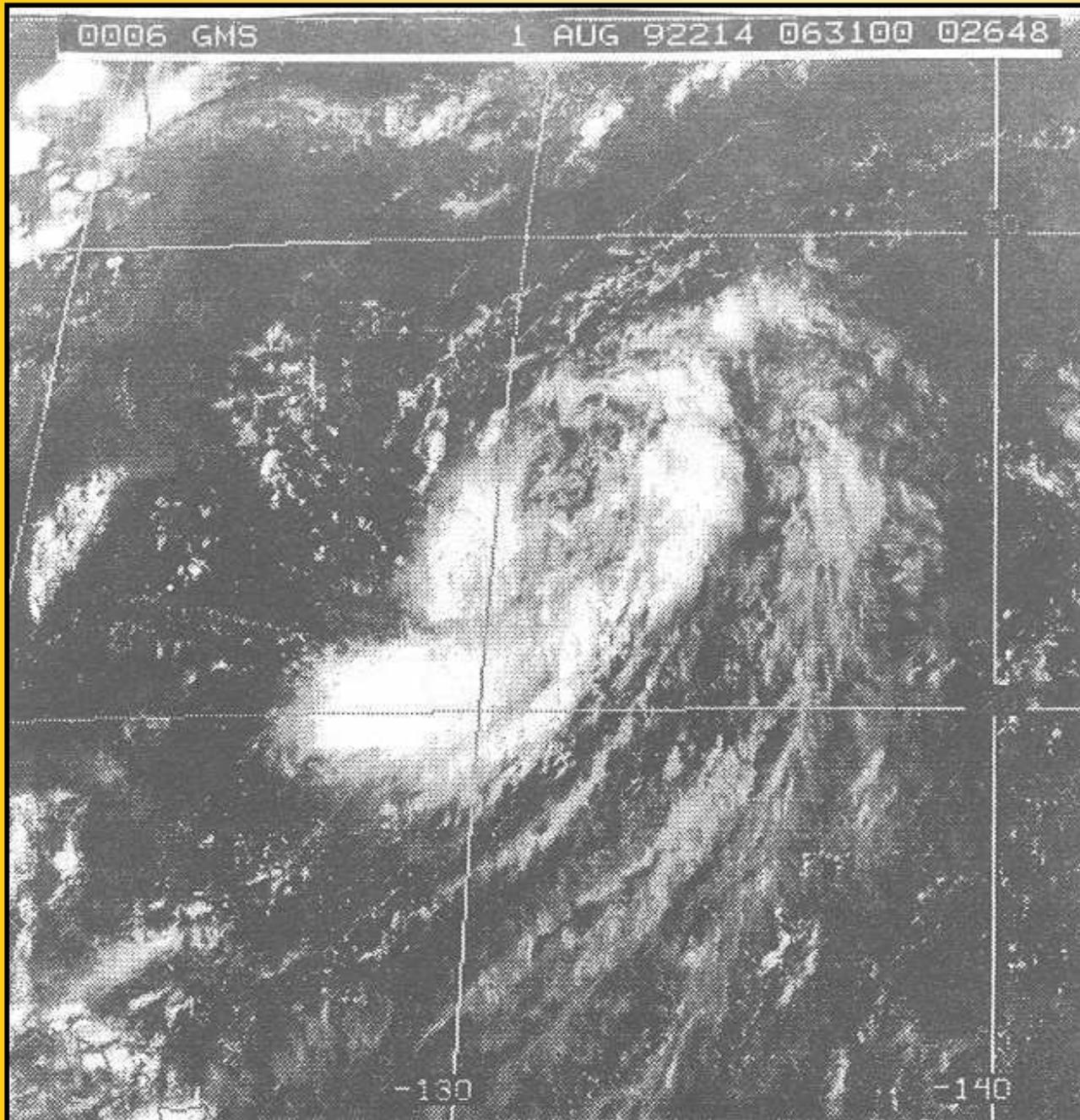
Erreurs de parallaxe.

Parallax errors (high satellite viewing angles).



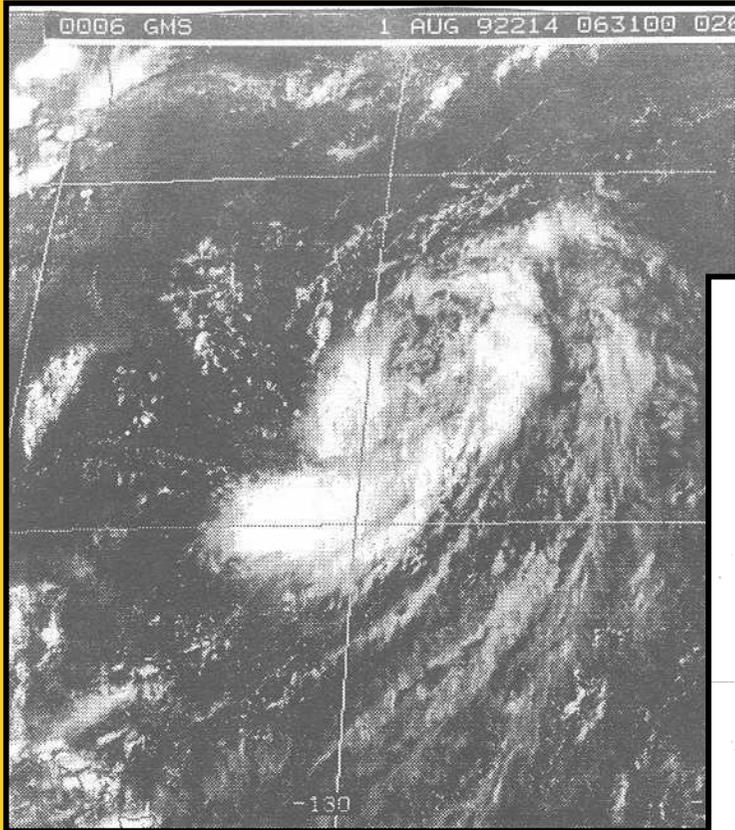
**Décalage entre le centre nuageux et le centre de la circulation
dépressionnaire de surface.**

Displacement of the cloud system away from the surface wind centre of the system.



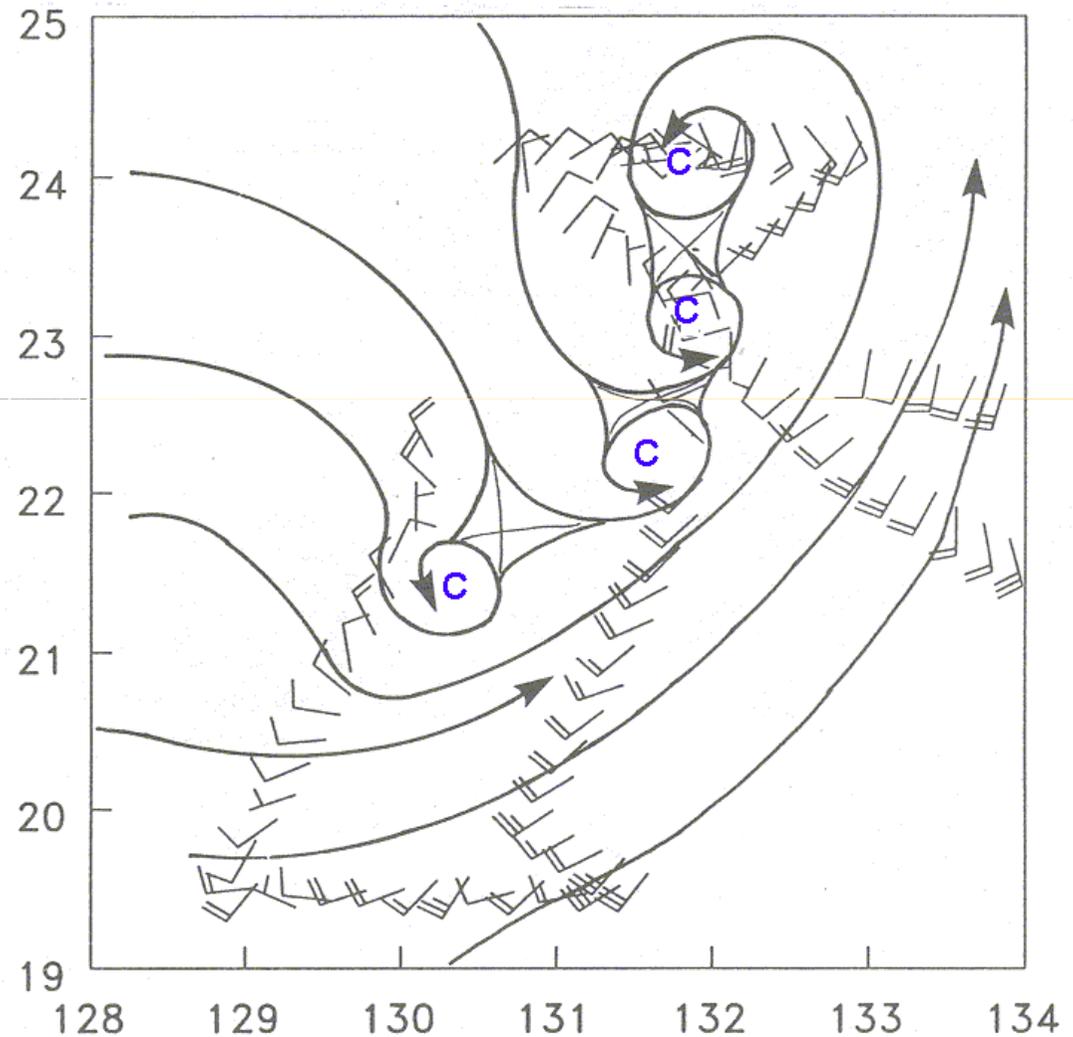
Comparaison des données de vents observées lors d'une reconnaissance aérienne avec l'imagerie satellitaire correspondante, lors de la phase de genèse du futur cyclone tropical Irving (données collectées lors de la campagne de mesures TCM-92 dans le Pacifique Nord-Ouest).

Aircraft reconnaissance observations, compared to the related satellite imagery for the developing tropical cyclone Irving (data obtained during the TCM-92 experiment in the western North Pacific).



Comparaison des données de vents observées lors d'une reconnaissance aérienne avec l'imagerie satellitaire correspondante, montrant une situation à centres multiples lors de la phase de genèse du futur cyclone tropical Irving (données collectées lors de la campagne de mesures TCM-92 dans le Pacifique Nord-Ouest).

Aircraft reconnaissance observations showing a multiple centres situation, compared to the related satellite imagery for the developing tropical cyclone Irving (data obtained during the TCM-92 experiment in the western North Pacific).



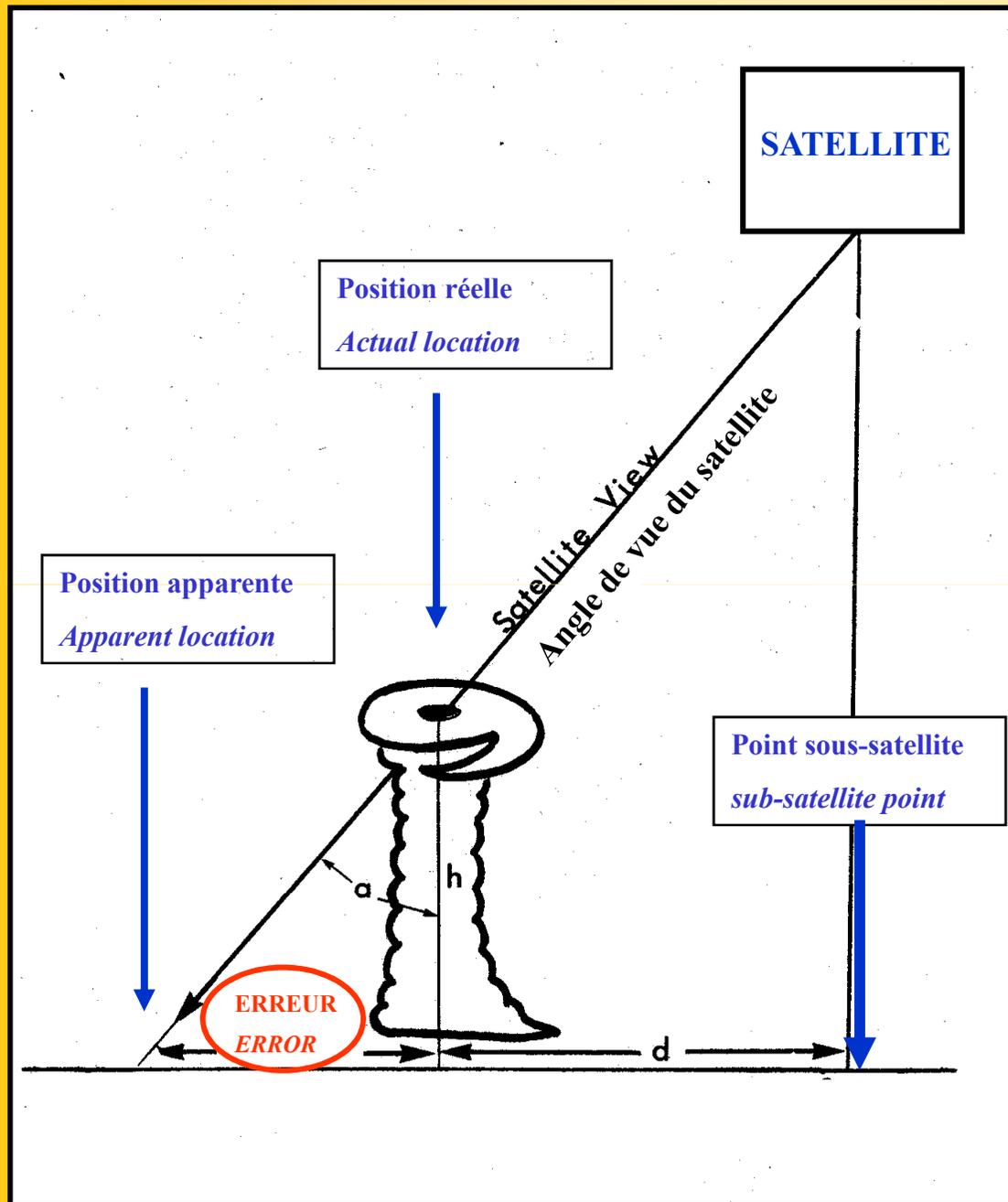
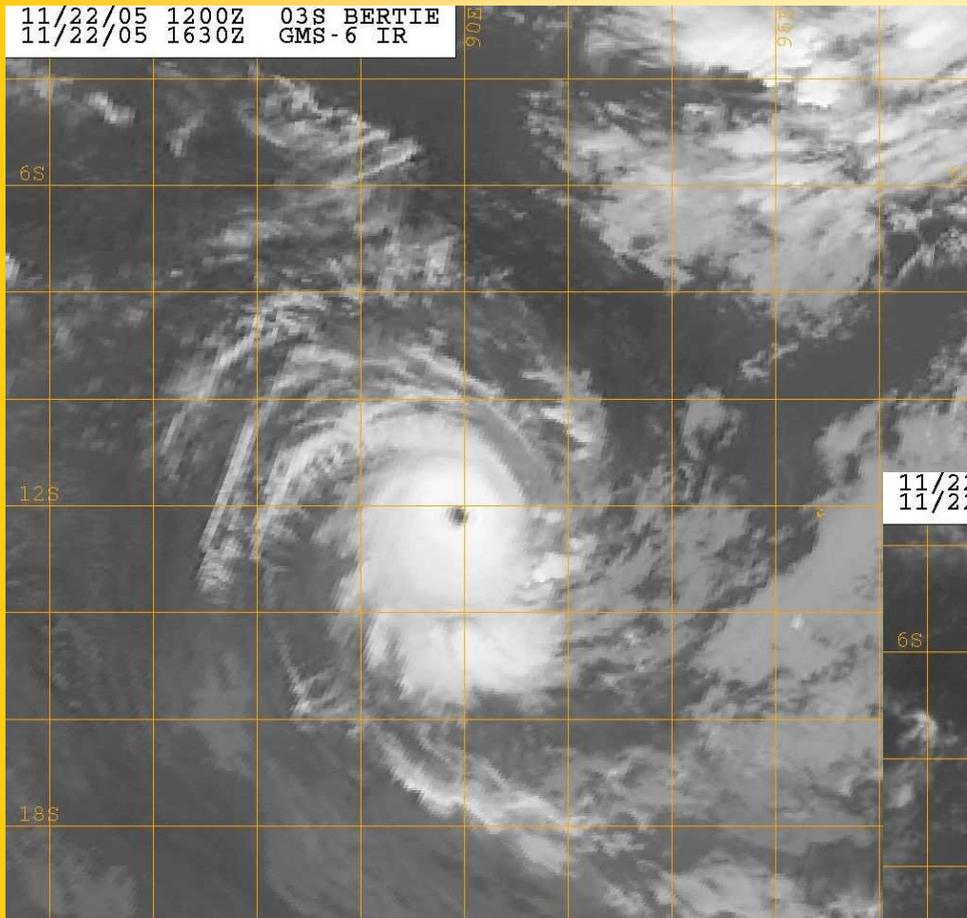


Schéma illustrant l'erreur de parallaxe associée à l'observation satellitaire d'un cyclone tropical depuis l'espace (échelle réelle modifiée).

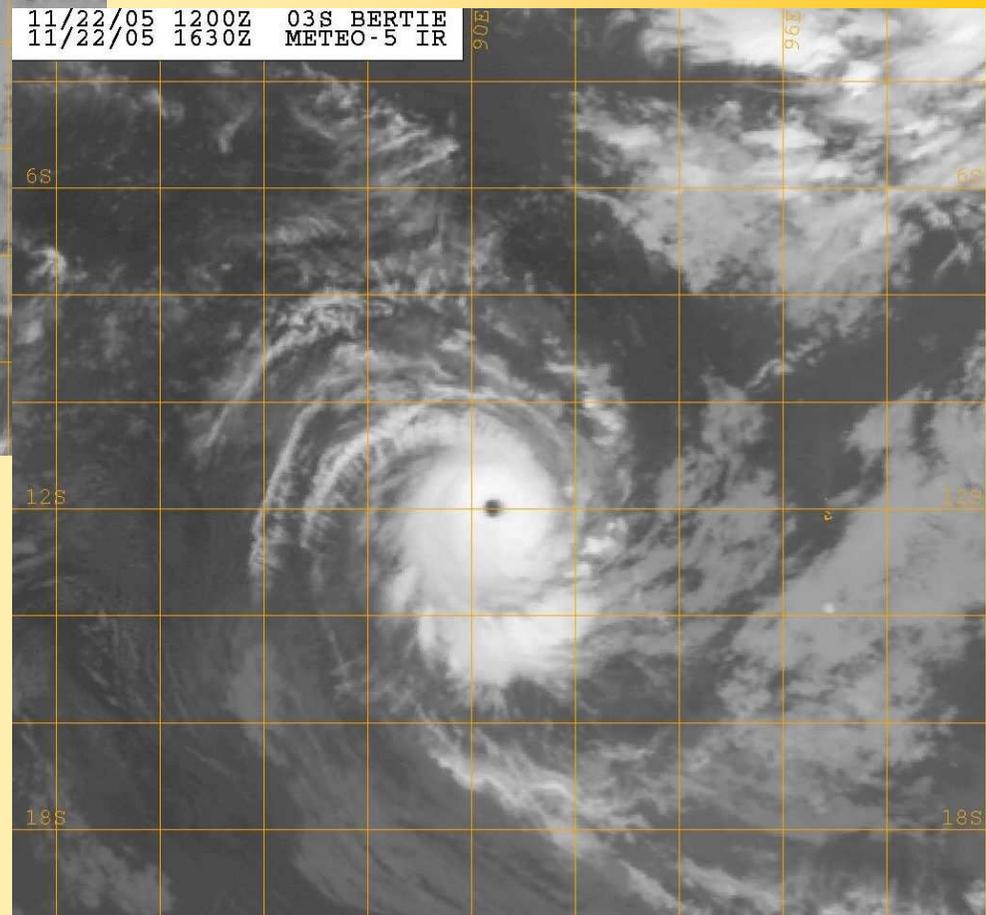
Schematic (not drawn to scale) illustrating the parallax error induced when viewing a tropical cyclone from space (satellite observation).

11/22/05 1200Z 03S BERTIE
11/22/05 1630Z GMS-6 IR



Erreur de parallaxe :
images illustrant le décalage qu'il peut
y avoir entre les localisations du centre
d'un même cyclone (ALVIN/BERTIE)
par deux satellites géostationnaires
différents.

11/22/05 1200Z 03S BERTIE
11/22/05 1630Z METEO-5 IR



Parallax error :
concomitant images showing the
spatial difference that can exist
between the locations of a
cyclone's centre as seen by two
different geostationary satellites.

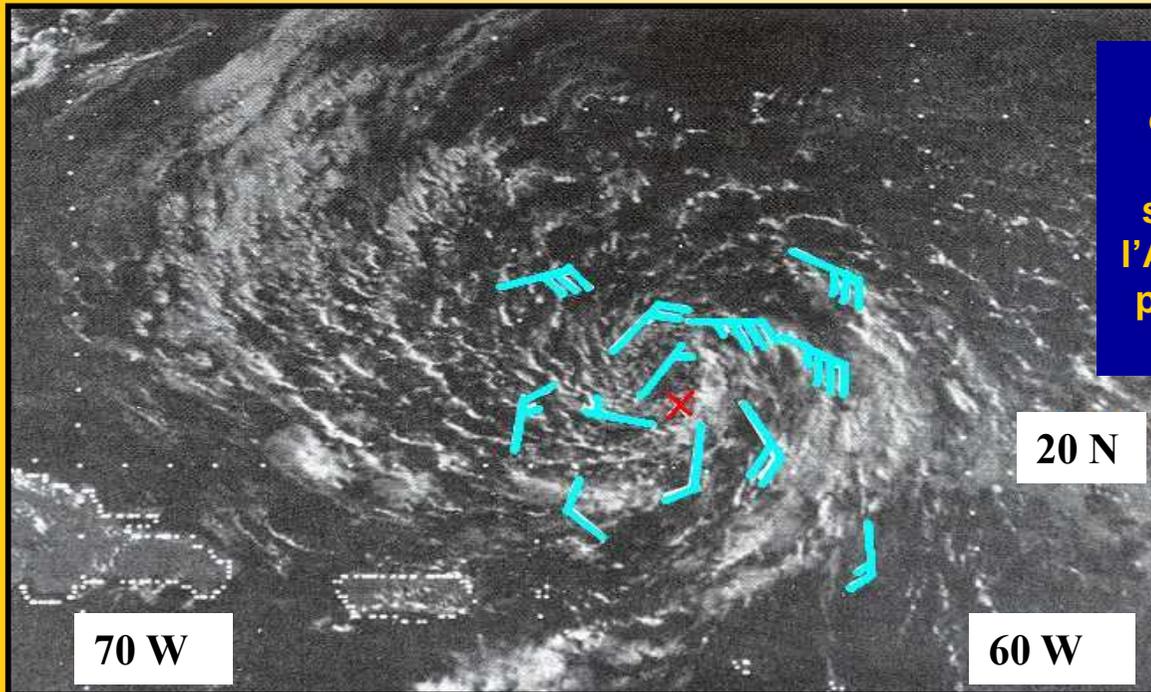
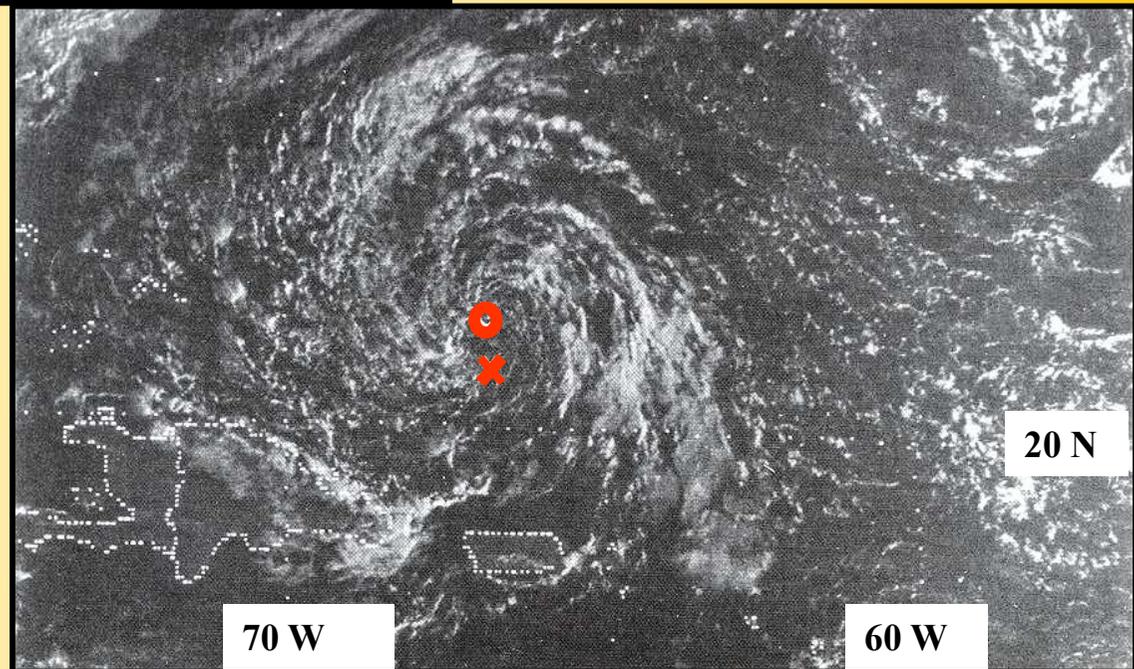


Image visible montrant le décalage existant entre le centre de courbure des enroulements nuageux d'un système dépressionnaire tropical de l'Atlantique (O), avec le centre observé par reconnaissance aérienne (X) et la circulation de vents autour.

Visible image showing the difference between the cloud line curvature centre (O) and the reconnaissance aircraft centre (X), for a weak tropical low in the northern Atlantic basin.





***Analyse de l'intensité d'un système
dépressionnaire tropical***

Tropical Cyclone intensity

EVOLUTION TYPIQUE DE LA CONFIGURATION NUAGEUSE

TYPICAL CLOUD PATTERN EVOLUTION

Jour 1 (T1.5)	Jour 2 (T2.5)	Jour 3 (T3.5)	Jour 4 (T4.5)	Jour 5 (T5.5)
Configuration en bande incurvée <i>Basic curved band pattern type</i>				
Configuration à couverture nuageuse dense <i>Central dense overcast (CDO) pattern type</i>				
Configuration de type cisailée « shear » pattern type				

Modèles d'évolution de la configuration nuageuse utilisés pour estimer le nombre de Dvorak DT.

Modeled cloud patterns to be used in estimating DT-numbers

Diagramme d'analyse dans le canal visible, 1^{ère} partie Vernon f. Dvorak (sept. 1984).

Visible (VIS) Analysis Diagram, part I Vernon f. Dvorak (sept. 1984)

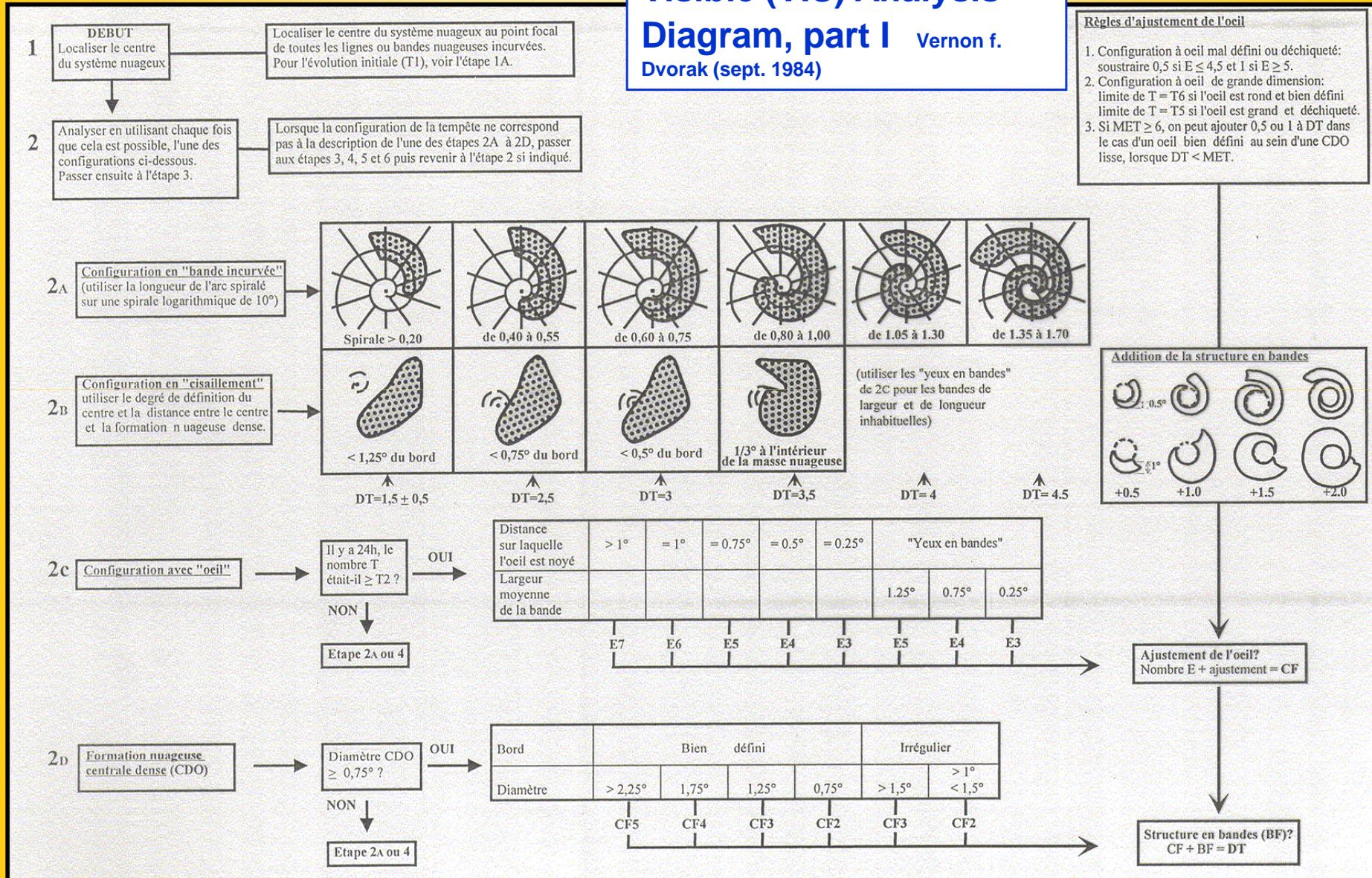


Diagramme d'analyse dans le canal visible, 2^{ème} partie

Vernon f. Dvorak (sept. 1984)

Visible (VIS) Analysis Diagram, part II Vernon f. Dvorak (sept. 1984)

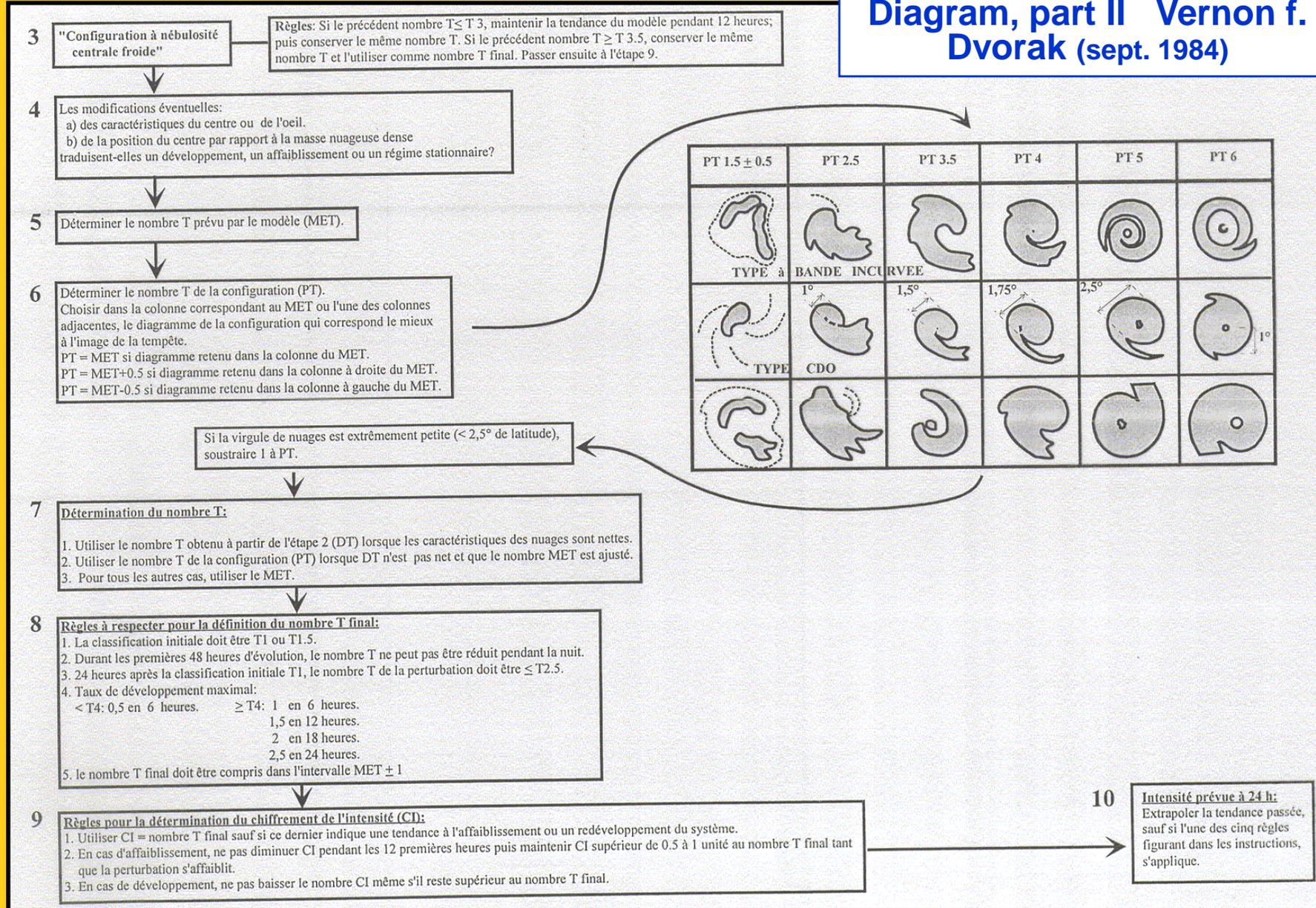


Diagramme d'analyse dans le canal infrarouge renforcé, 1^{ère} partie

Vernon f. Dvorak (sept. 1984).

Enhanced infra-Red (EIR) Analysis Diagram, part I Vernon f. Dvorak (sept. 1984)

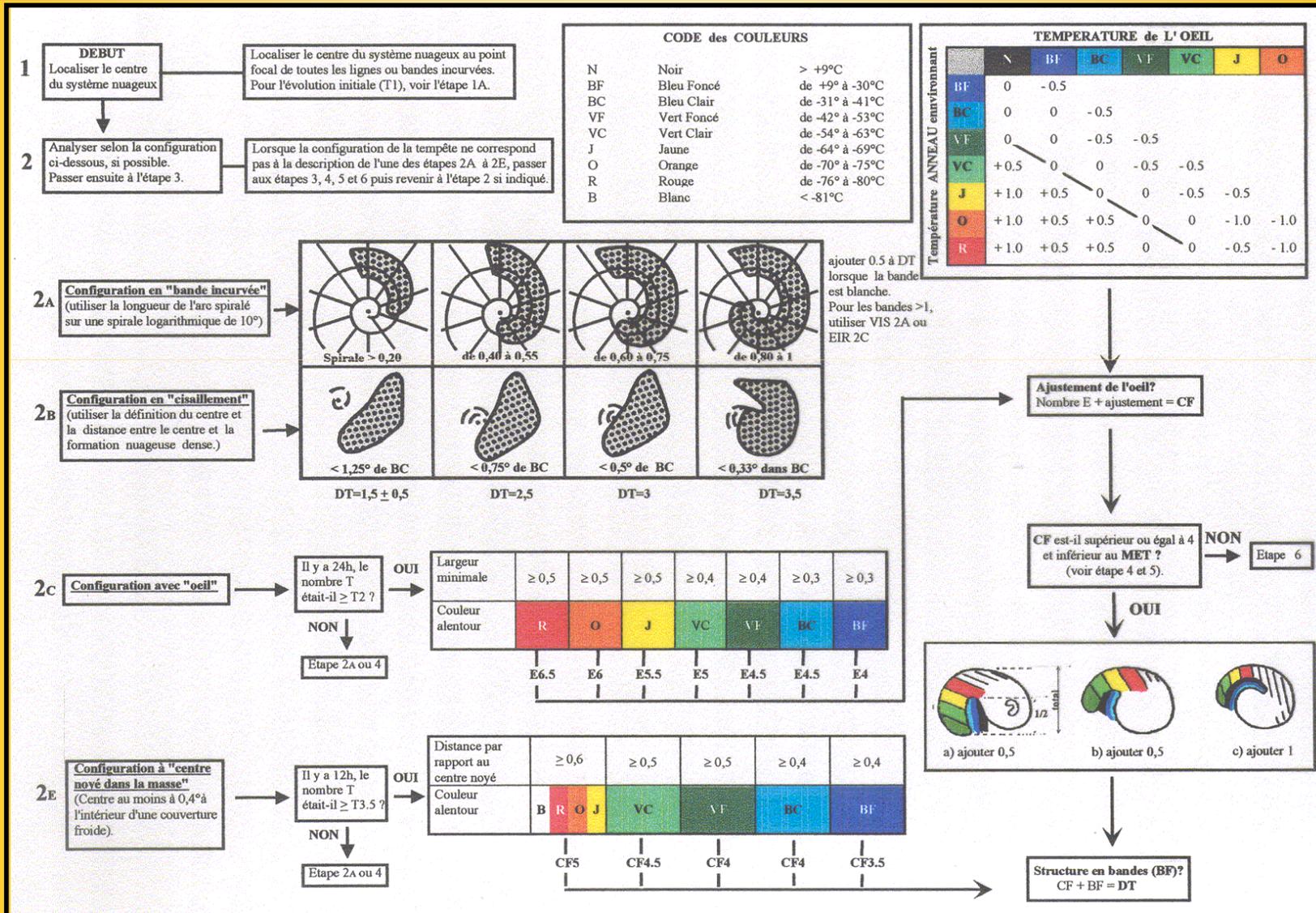
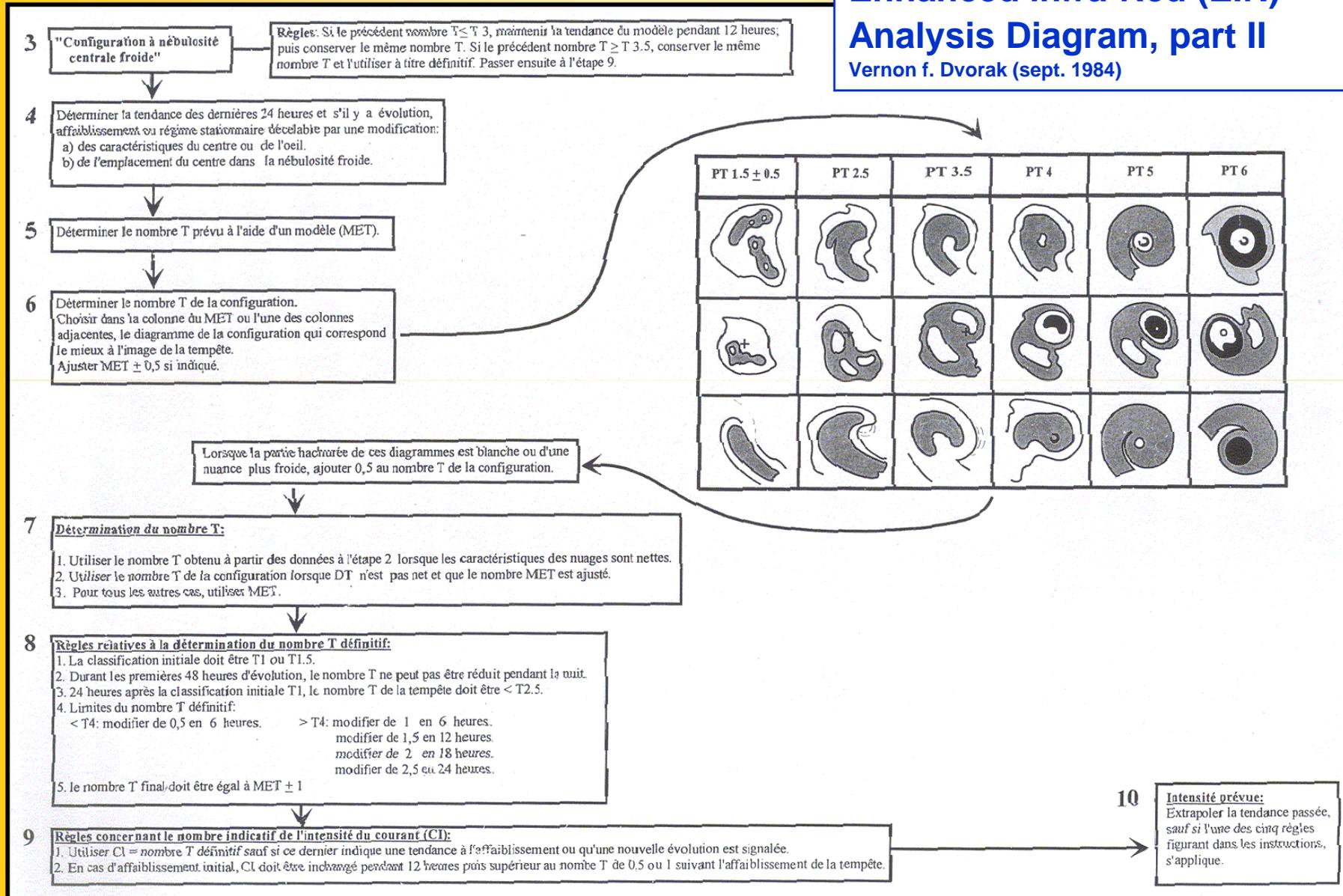


Diagramme d'analyse dans le canal infrarouge renforcé, 2^{ème} partie

Vernon f. Dvorak (sept. 1984).

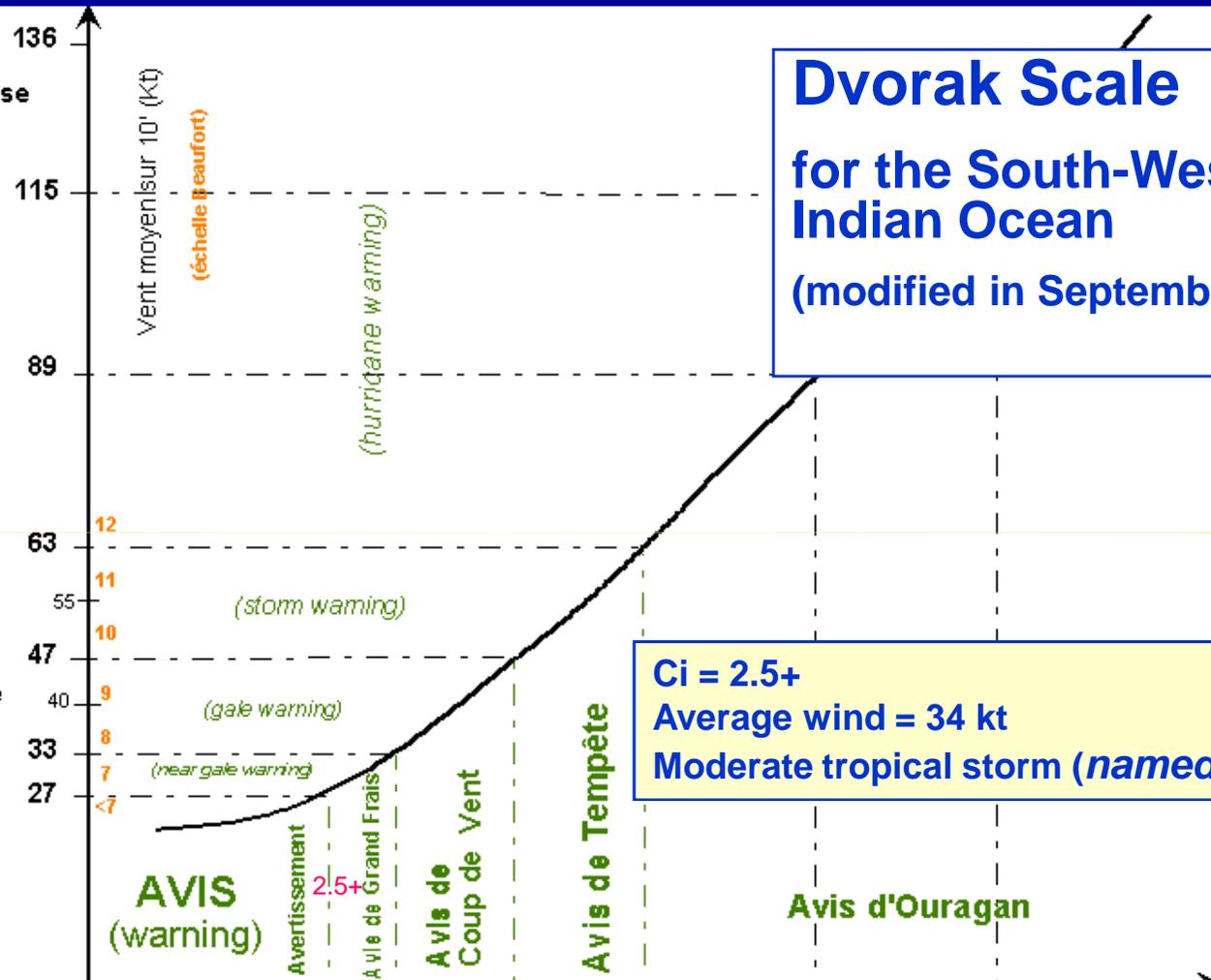
Enhanced infra-Red (EIR) Analysis Diagram, part II Vernon f. Dvorak (sept. 1984)





Echelle Dvorak pour le Sud-Ouest de l'océan Indien (modifiée en septembre 1999).

**Dvorak Scale
for the South-West
Indian Ocean
(modified in September 1999)**

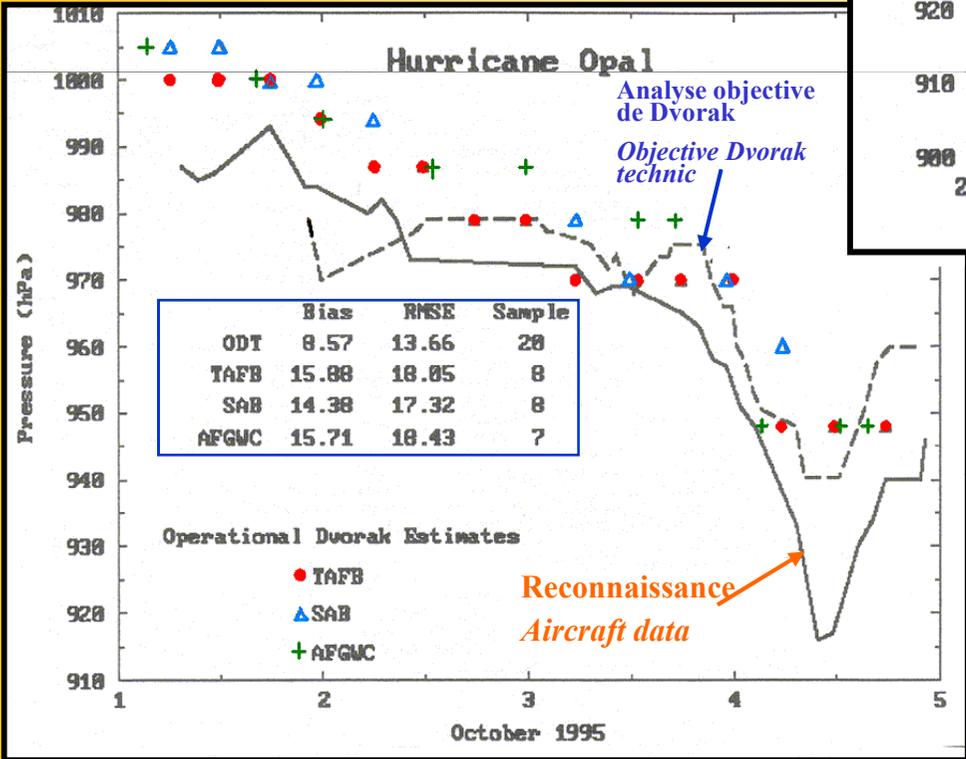
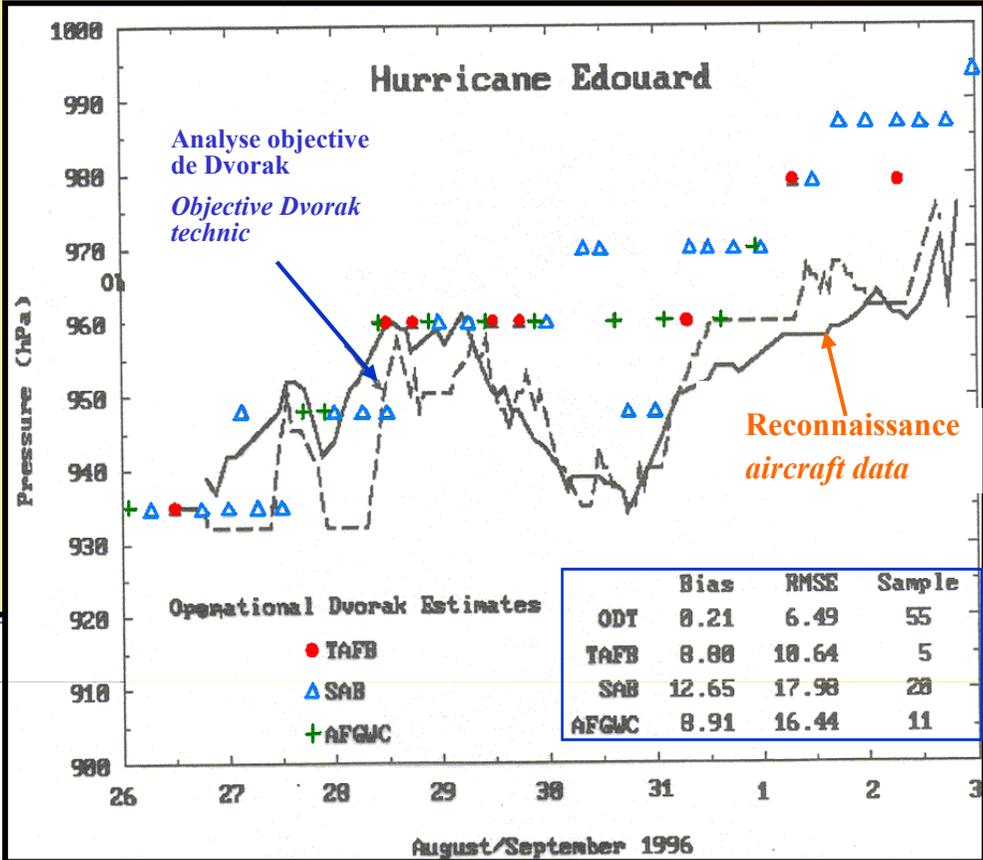


**Ci = 2.5+
Average wind = 34 kt
Moderate tropical storm (named storm)**

Nombre Ci (échelle Dvorak)
Vent moyen (10') en Kt
Vent soutenu (1') en Kt
Rafales en Kt
Pression au centre (hPa)

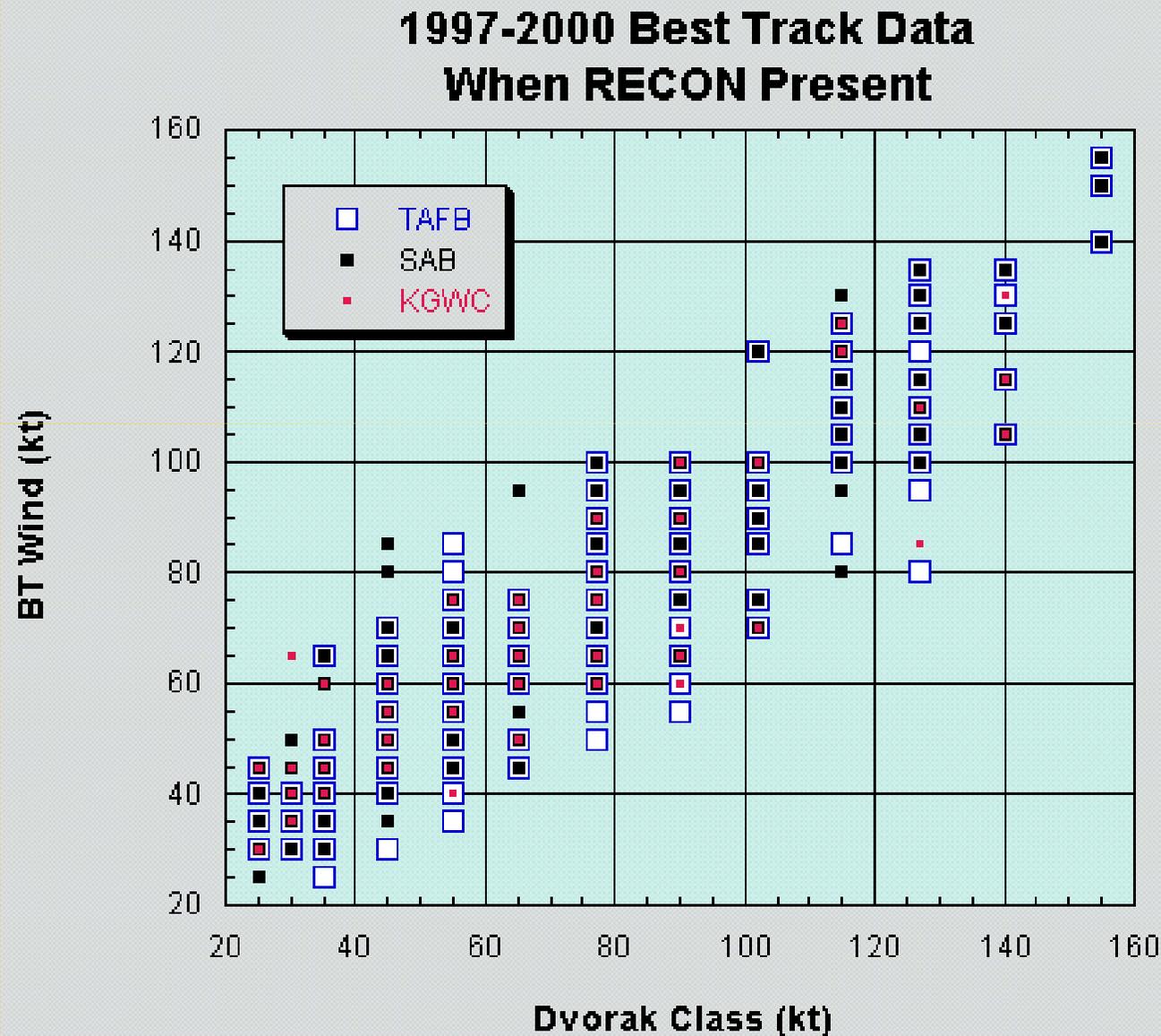
1	2	3	4	5	6	7	8
22	26	31	40	49	57	68	79
25	30	35	45	55	65	77	90
31	37	43	56	68	80	96	112
	1000	997	991	984	976	968	954
						941	927
						914	898
						879	858

La technique objective de Dvorak (ODT).



The Objective Dvorak Technique (ODT).

Les analyses d'intensité de Dvorak comparées aux données des reconnaissances aériennes



Dvorak
analysis
intensity
estimates
compared to
air recon data

Les analyses sont
issues de trois
centres différents
et concernent la
période 1997-2000
sur l'Atlantique.

Les correspondances pressions-vents dans les systèmes dépressionnaires tropicaux

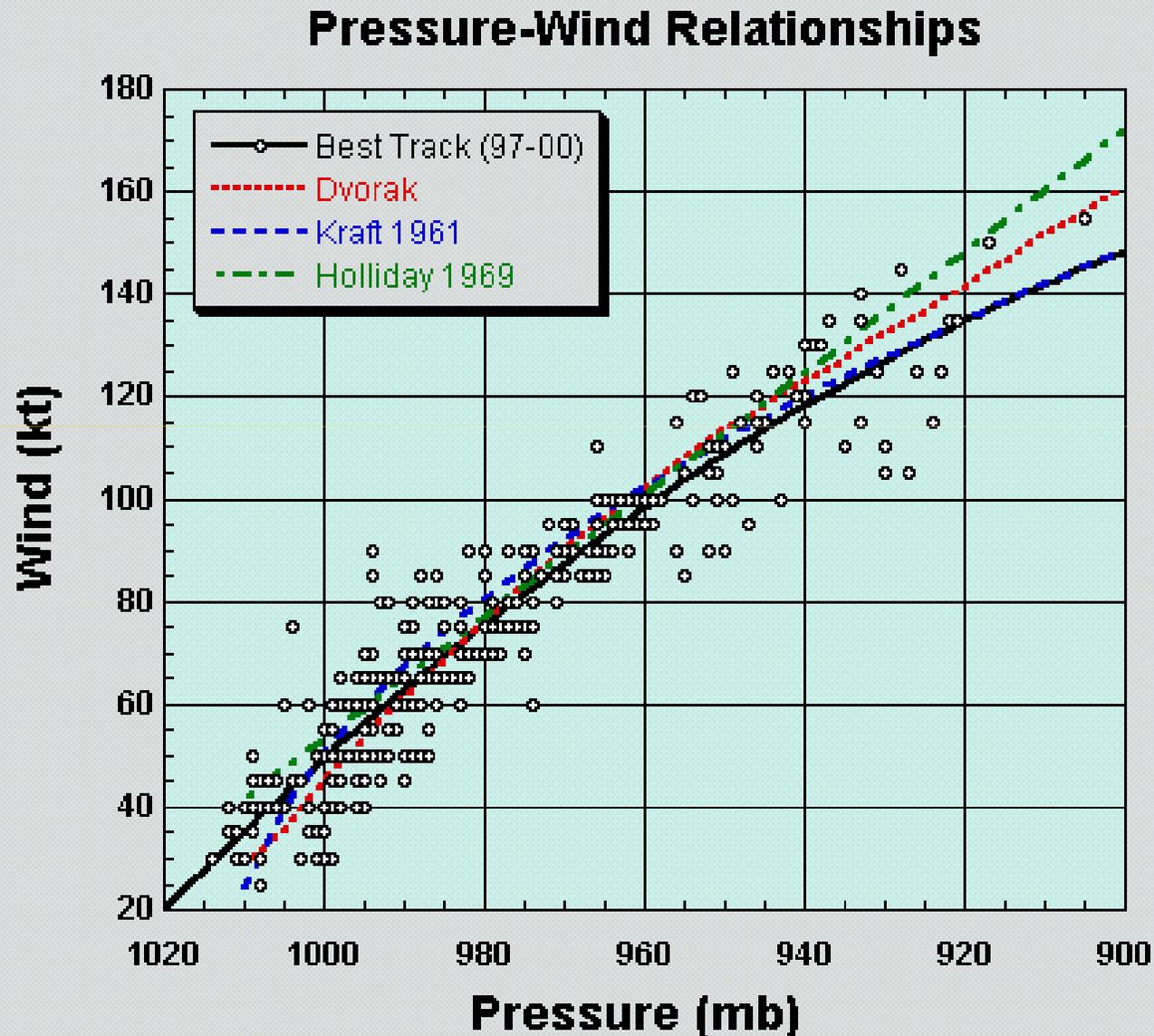
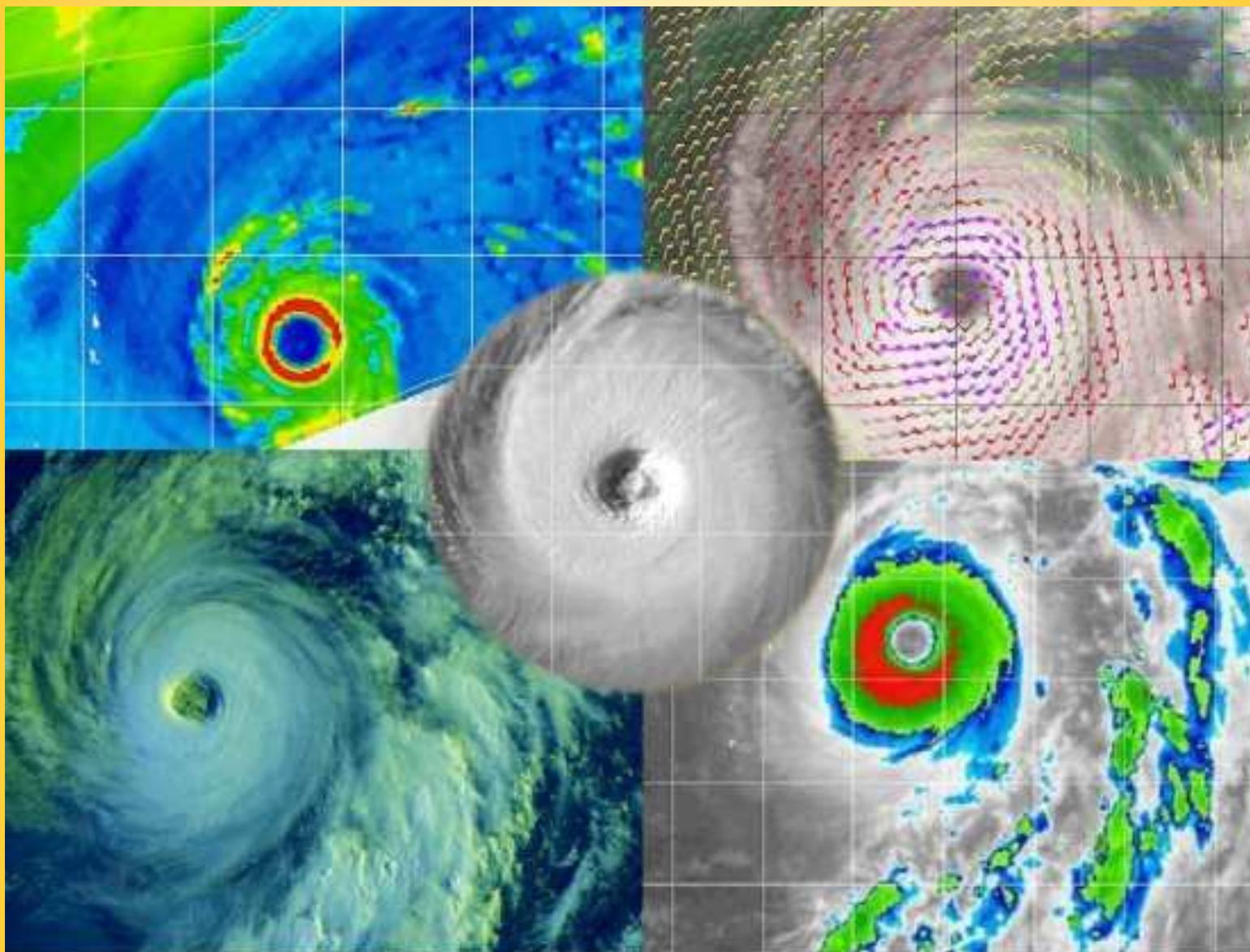


Diagram showing as a scatter plot all the pressure wind points from the NHC best track, over the years 1997-2000, only for those best track times when recon was present. Also included P-W curves from Dvorak, Kraft, and Holliday, as well as the best fit curve derived from the NHC data.

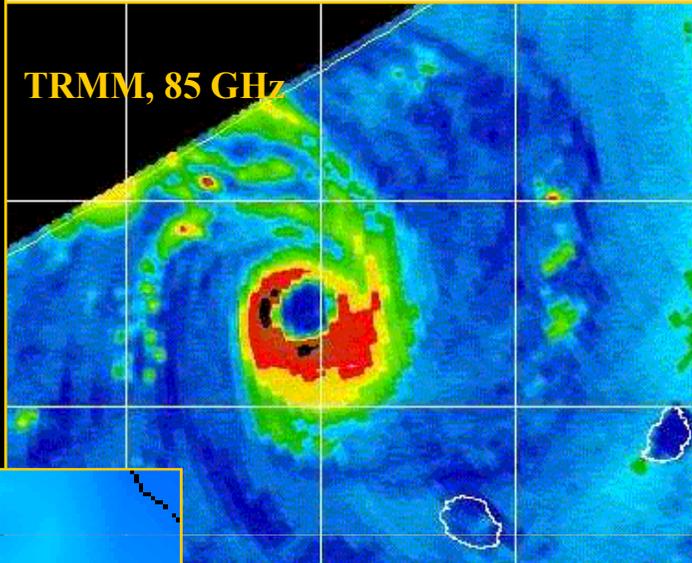
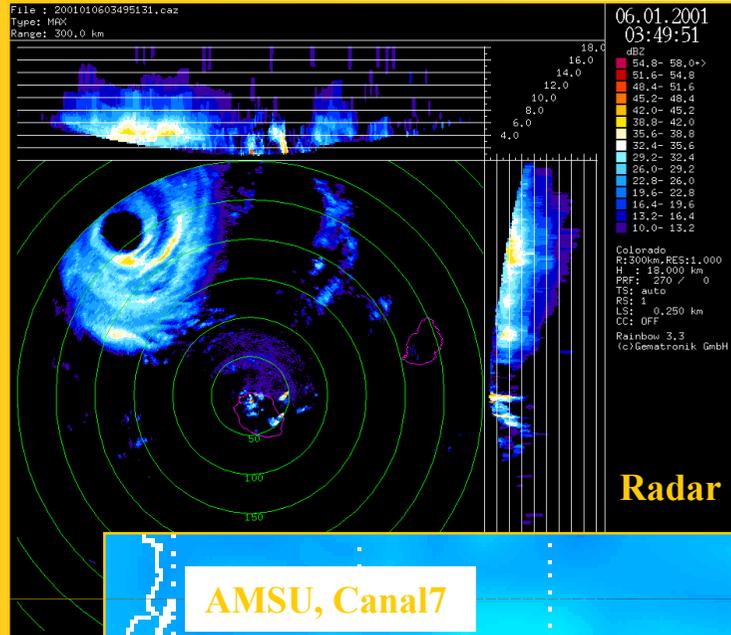
Les données Best-Tracks issues de reconnaissances aériennes sur la période 1997-2000 sur l'Atlantique, sont comparées avec les correspondances pressions-vents de Dvorak ou issues de diverses formules empiriques pressions-vents.

Les nouvelles données issues de l'imagerie micro-onde

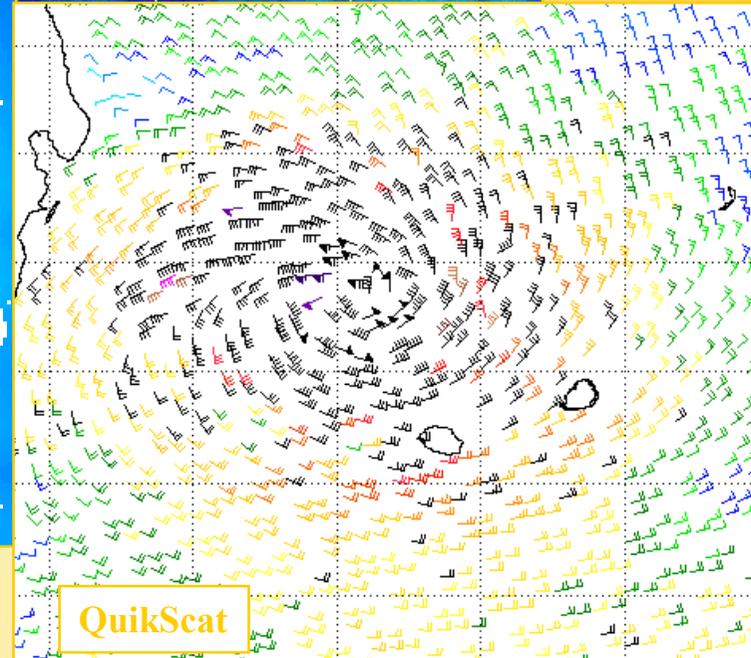
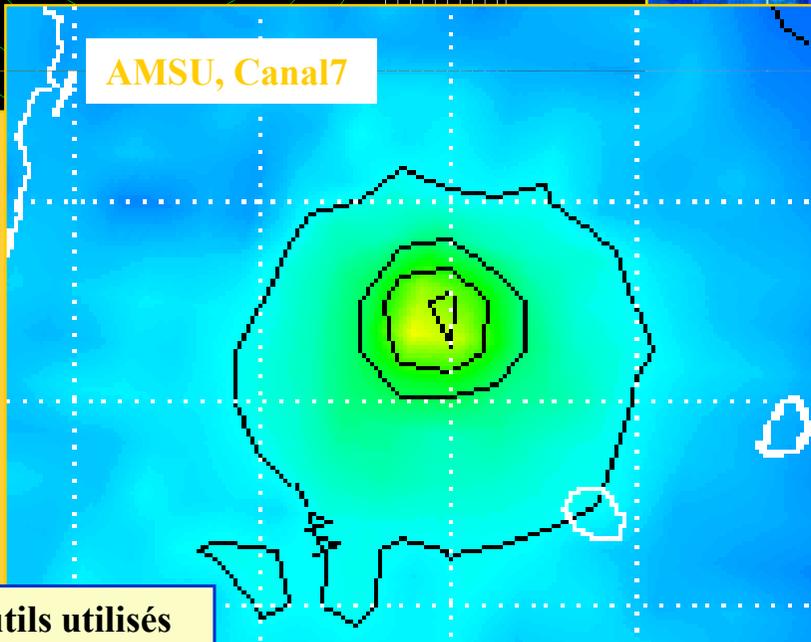
New data for TC analysis : the micro-wave data



ANDO, vu par 4 moyens d'observations différents (matin du 6 janvier 2001)



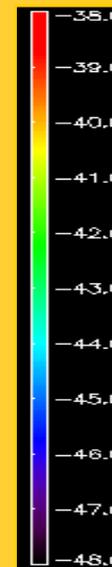
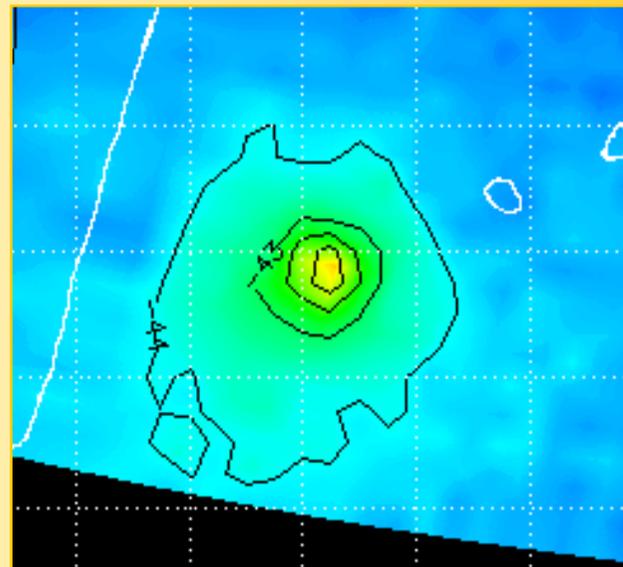
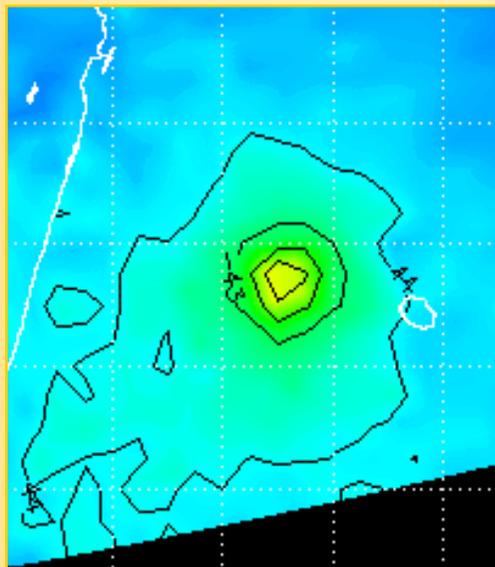
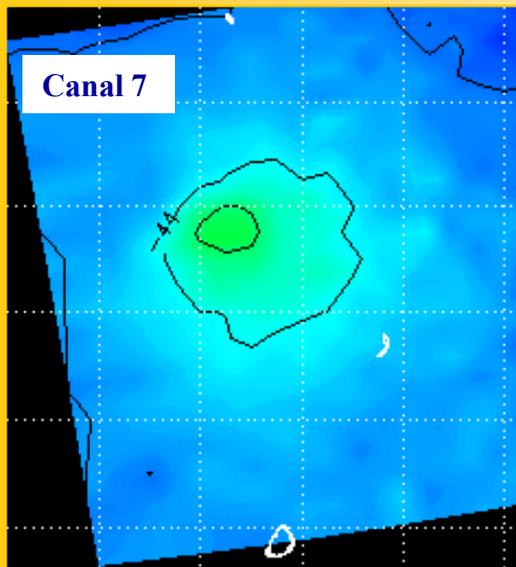
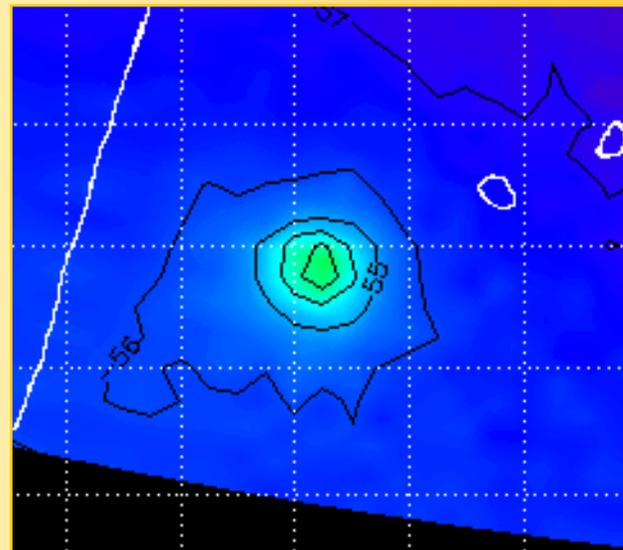
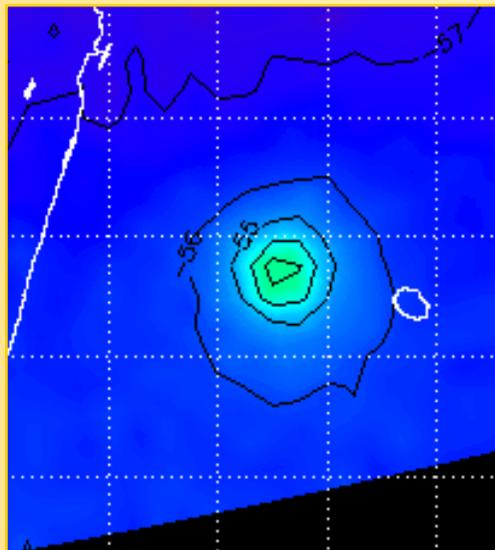
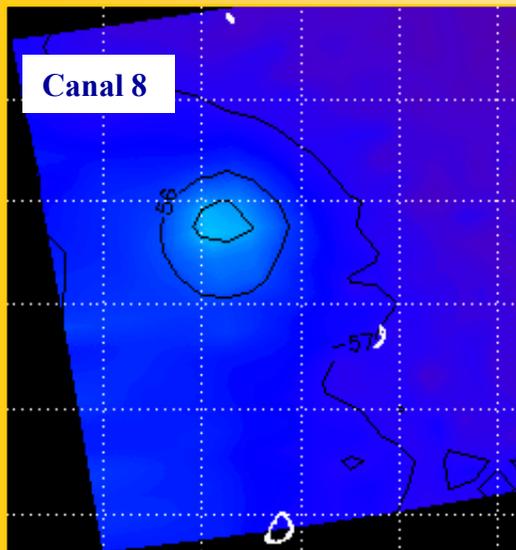
ANDO :
as viewed by 4
different tools
(06/01/2001,
morning).



**4 outils utilisés
pour l'analyse
des systèmes.**

ANDO, analysé par AMSU, canaux 7 et 8.

Température de brillance (°C)
Brightness temperature (°C)



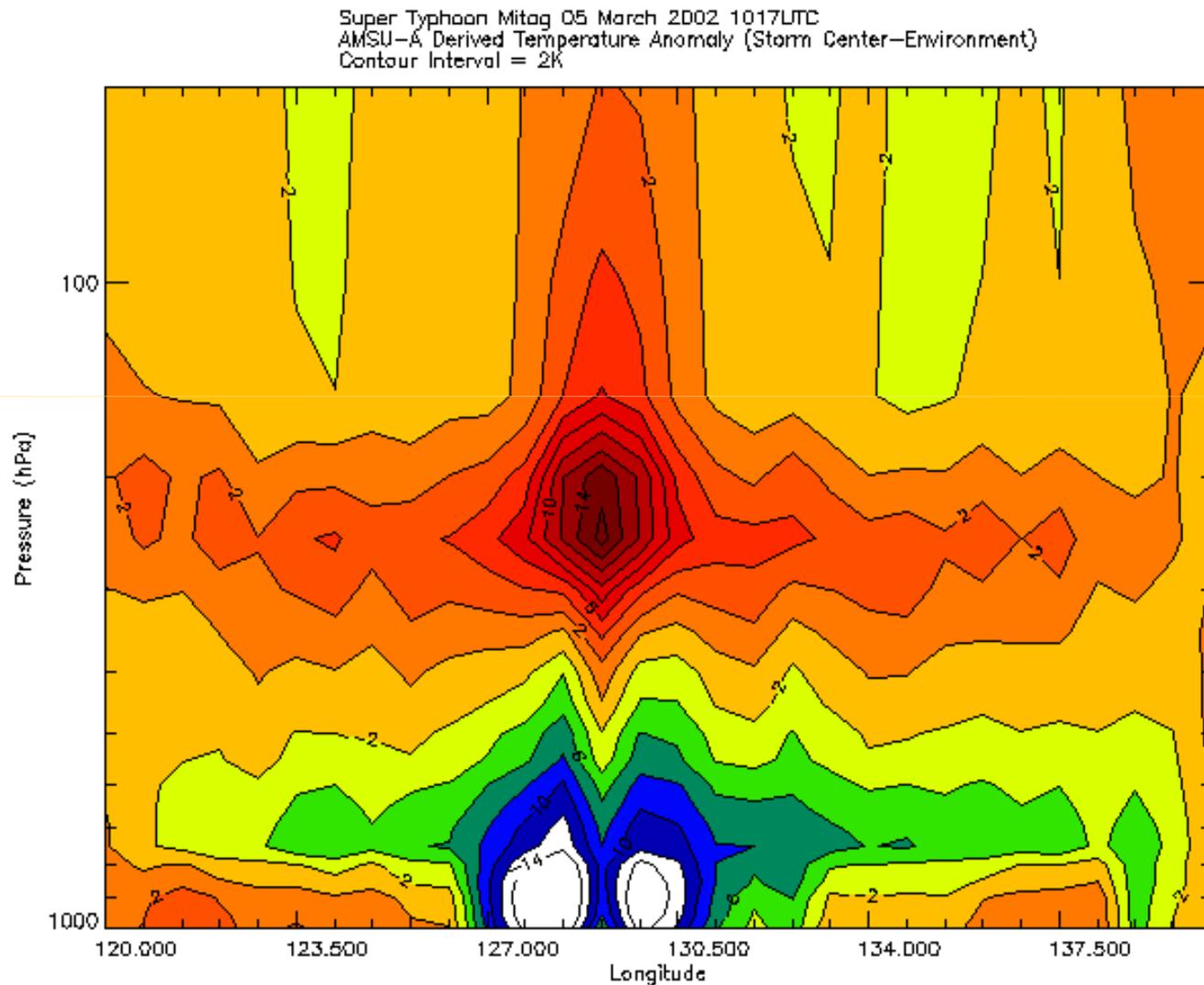
4 janvier 2001, 1521 UTC

6 janvier 2001, 1615 UTC

7 janvier 2001, 0325 UTC

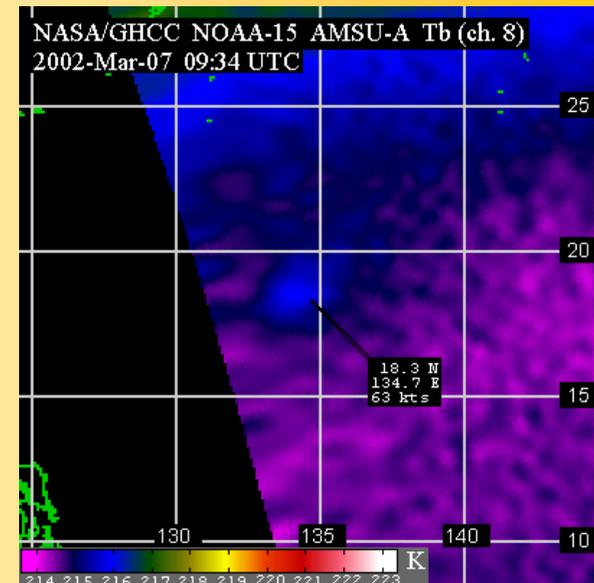
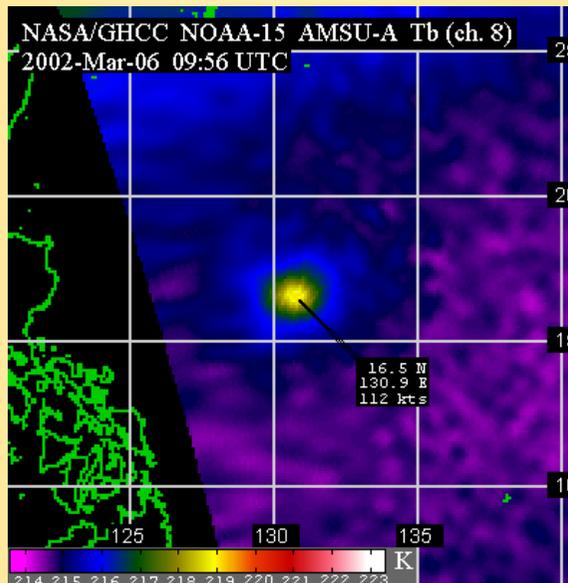
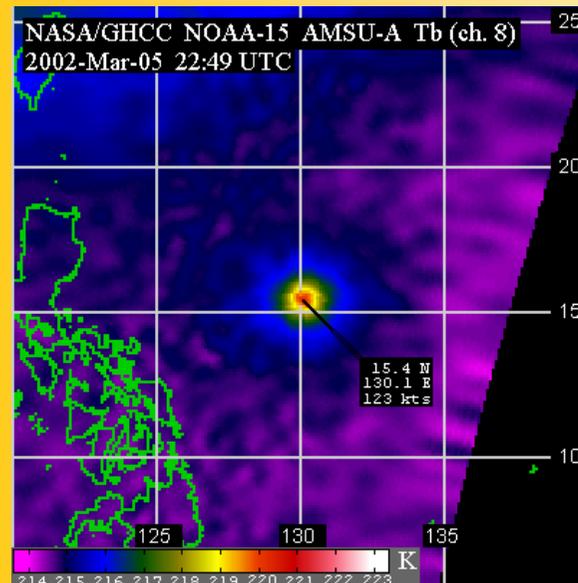
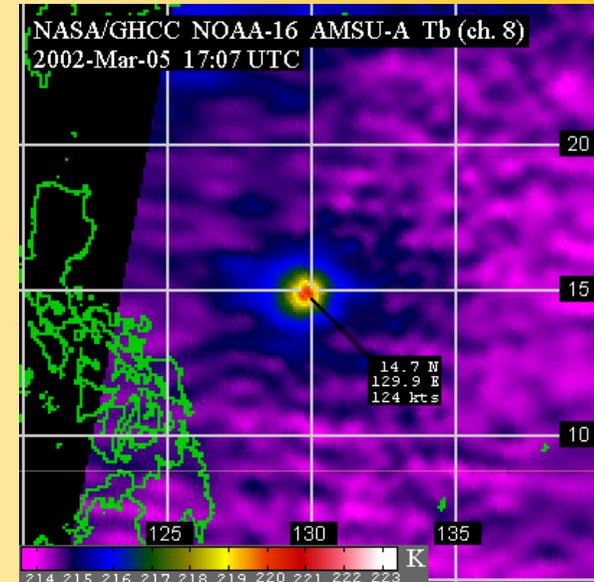
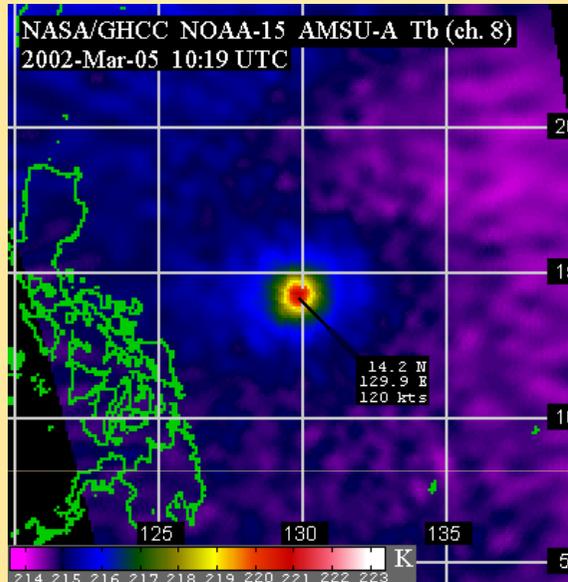
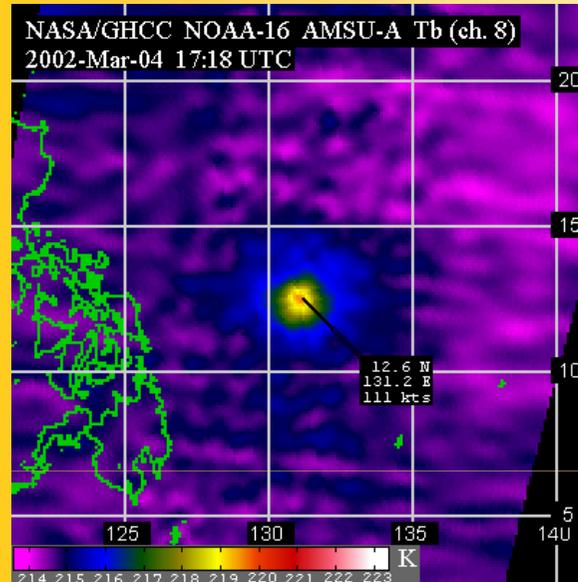
Les nouvelles donnée issues de l'imagerie micro-onde

New data for TC analysis : the AMSU micro-wave data

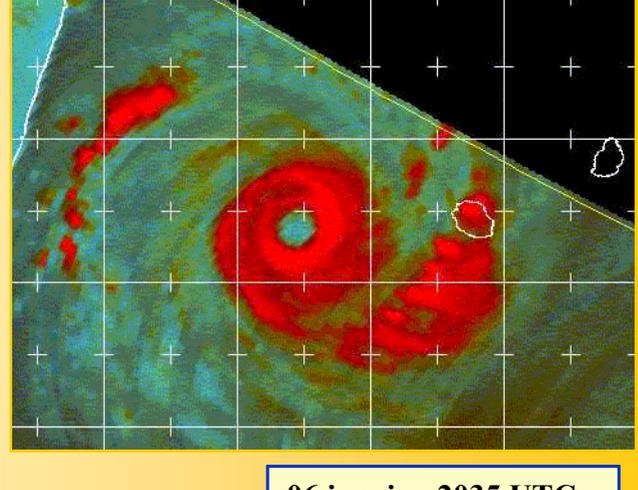
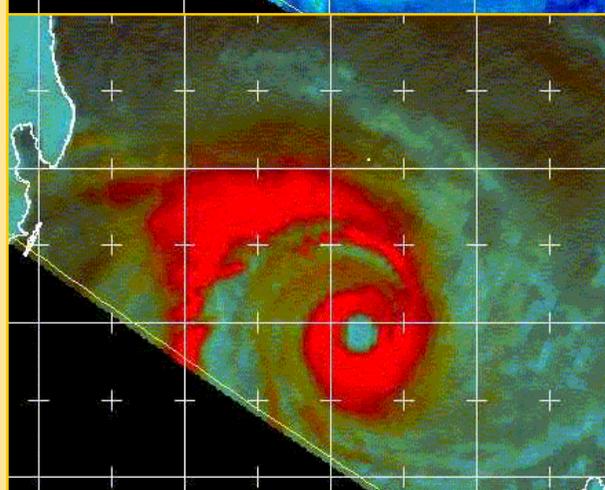
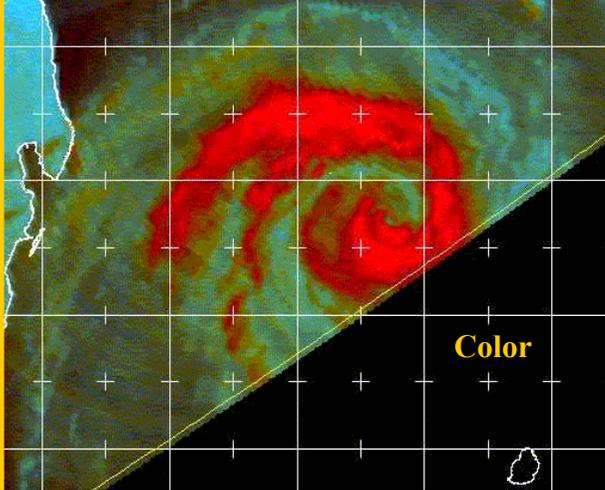
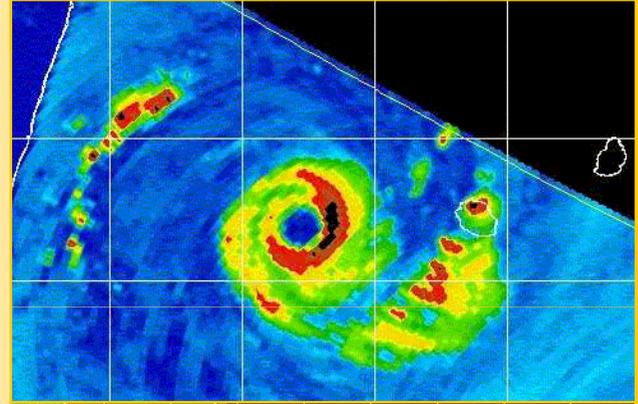
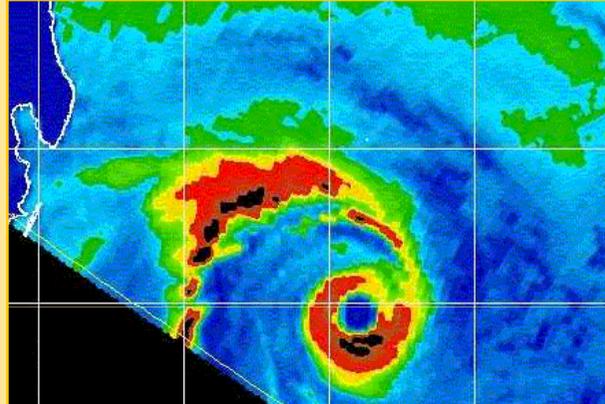
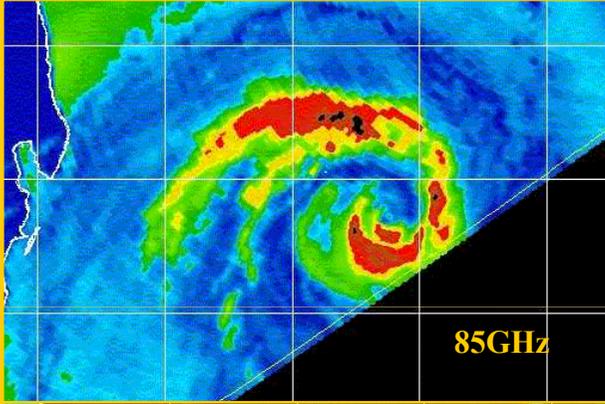
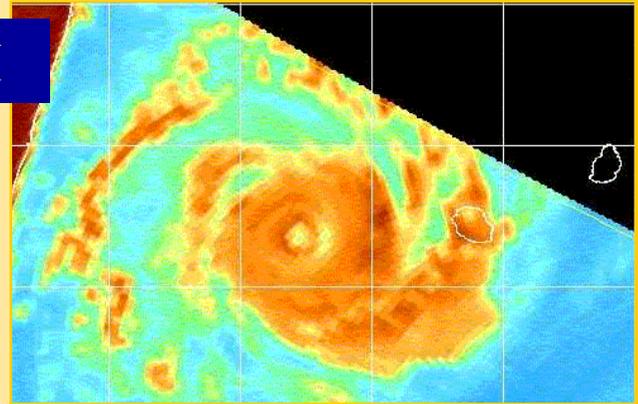
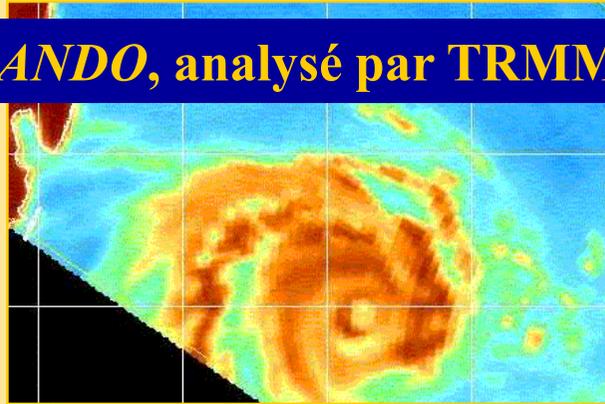
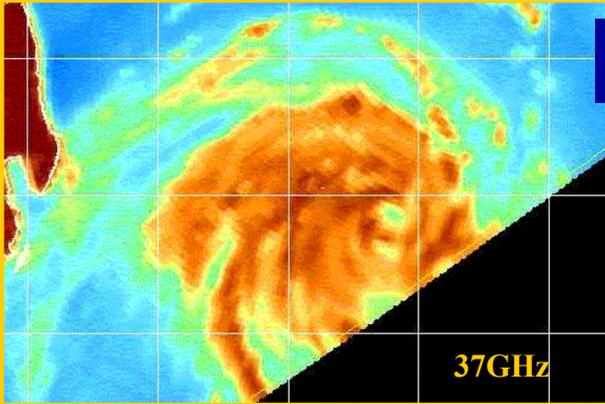


Les nouvelles donnée issues de l'imagerie micro-onde

New data for TC analysis : the AMSU micro-wave data



ANDO, analysé par TRMM

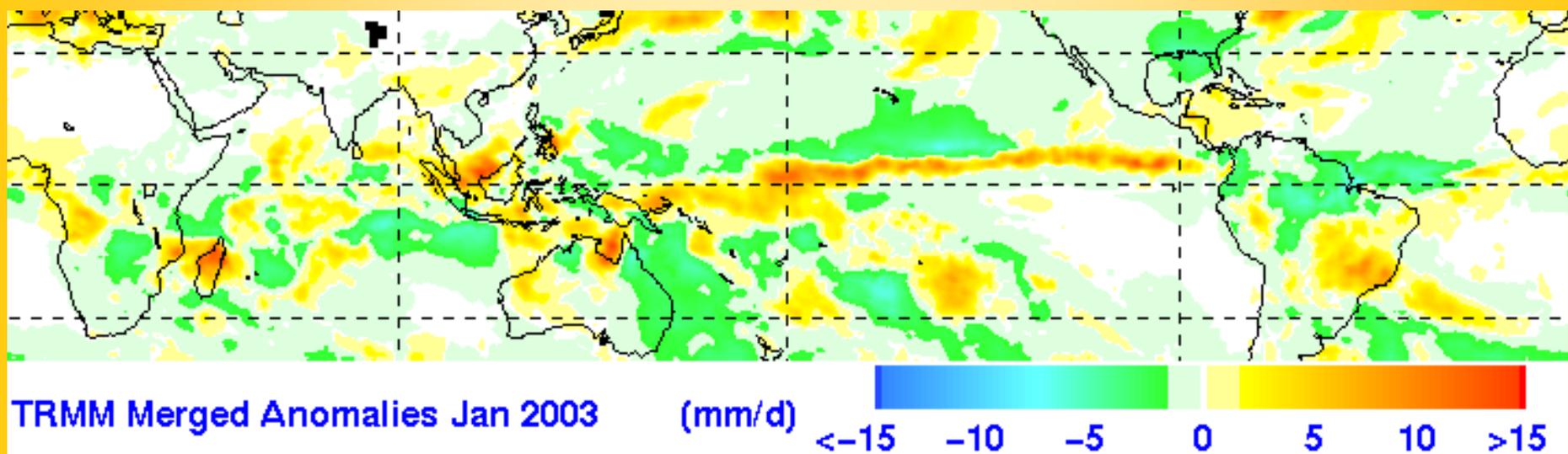
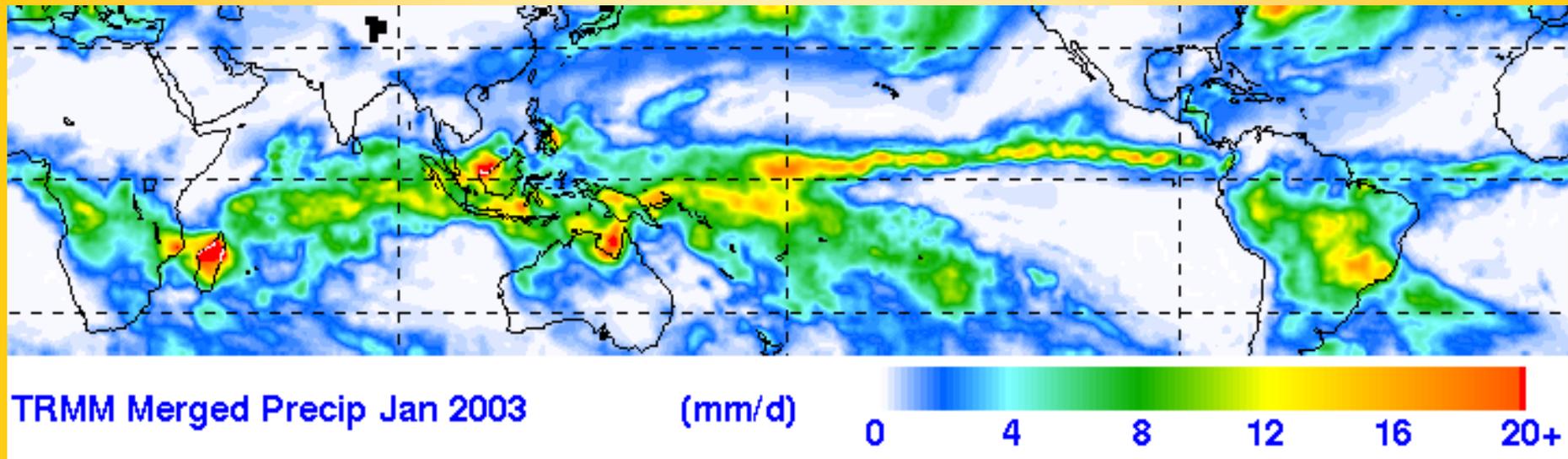


05 janvier, 0530 UTC

05 janvier, 2011 UTC

06 janvier, 2035 UTC

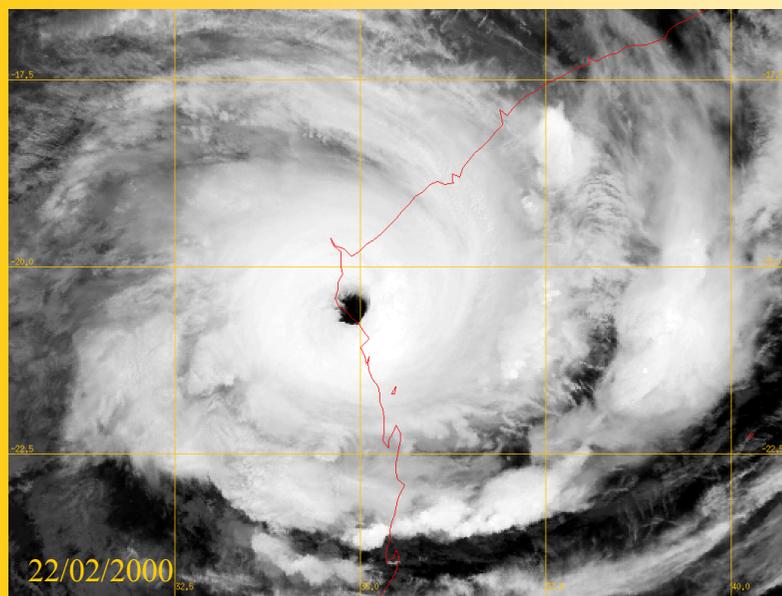
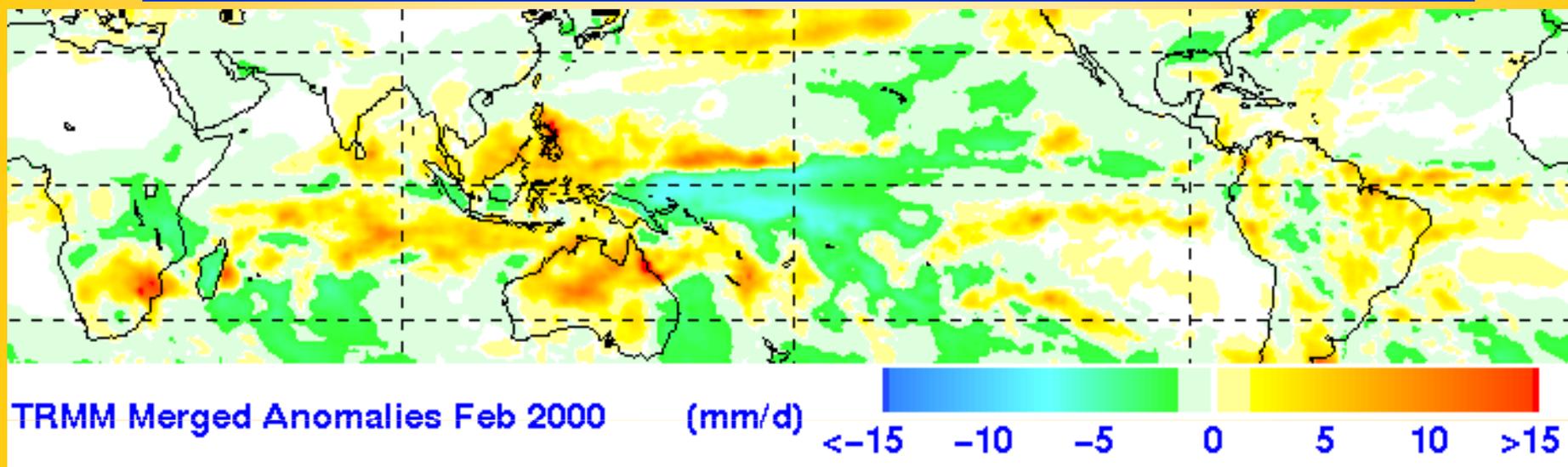
La quantification des précipitations grâce au satellite TRMM



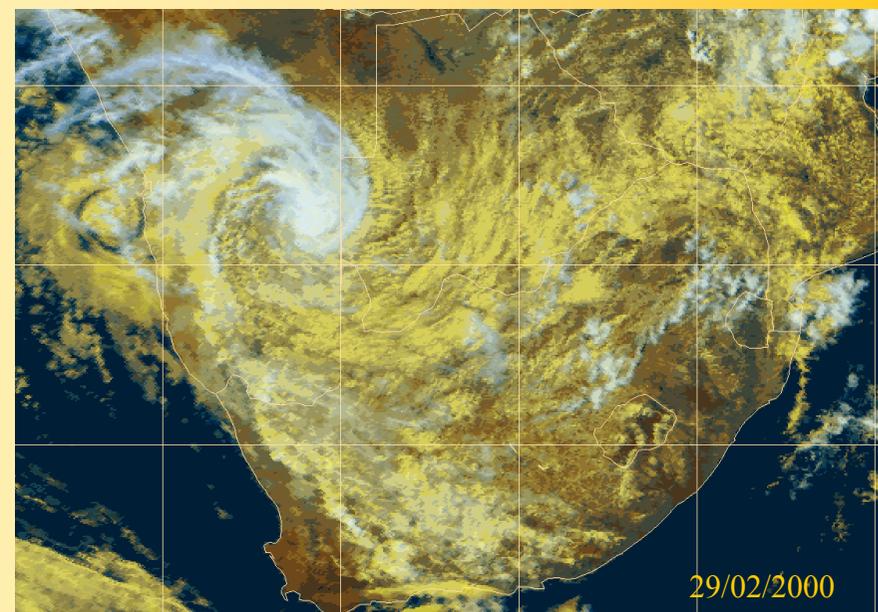
Précipitations et anomalies de précipitations sur les zones tropicales en janvier 2003 (données combinant les mesures de différents satellites calibrées grâce aux données TRMM et aux observations de surface).

La quantification des précipitations grâce au satellite TRMM

L'impact du cyclone tropical intense ELINE sur l'Afrique australe

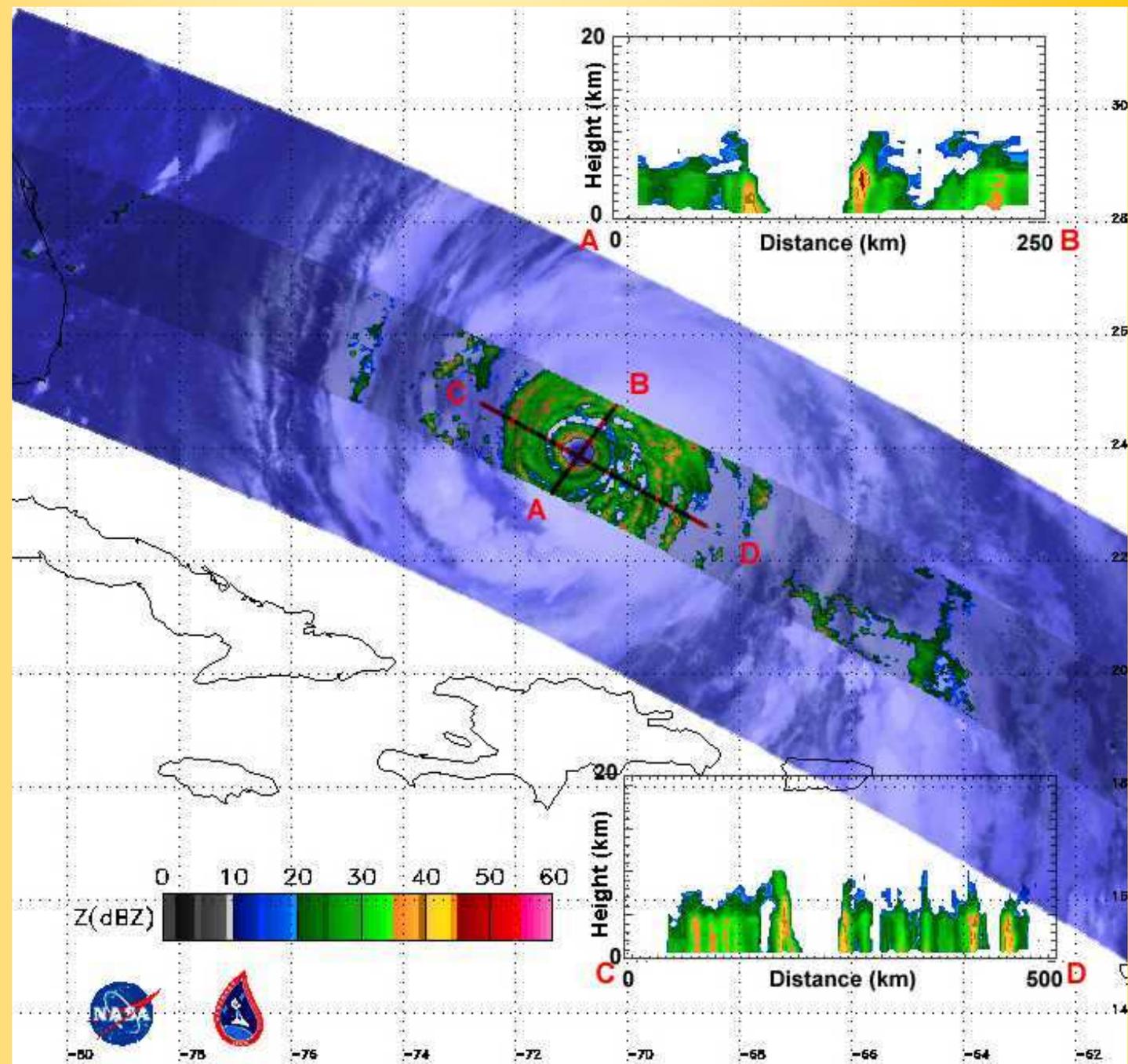


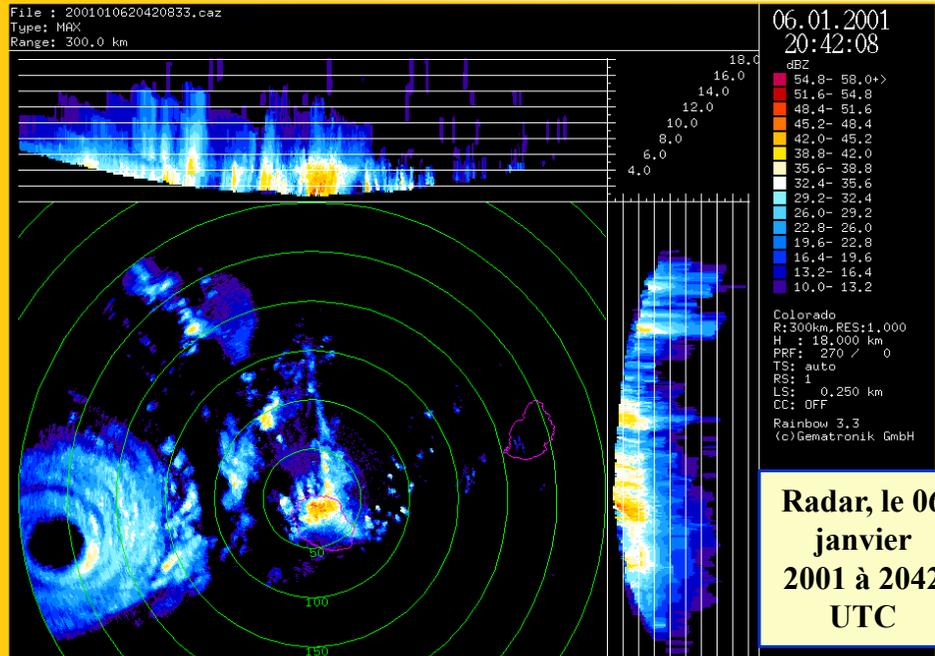
CHSZ



Quantification des précipitations grâce au radar TRMM

Coupes de réflectivité radar à travers l'ouragan Floyd (13/09/1999)

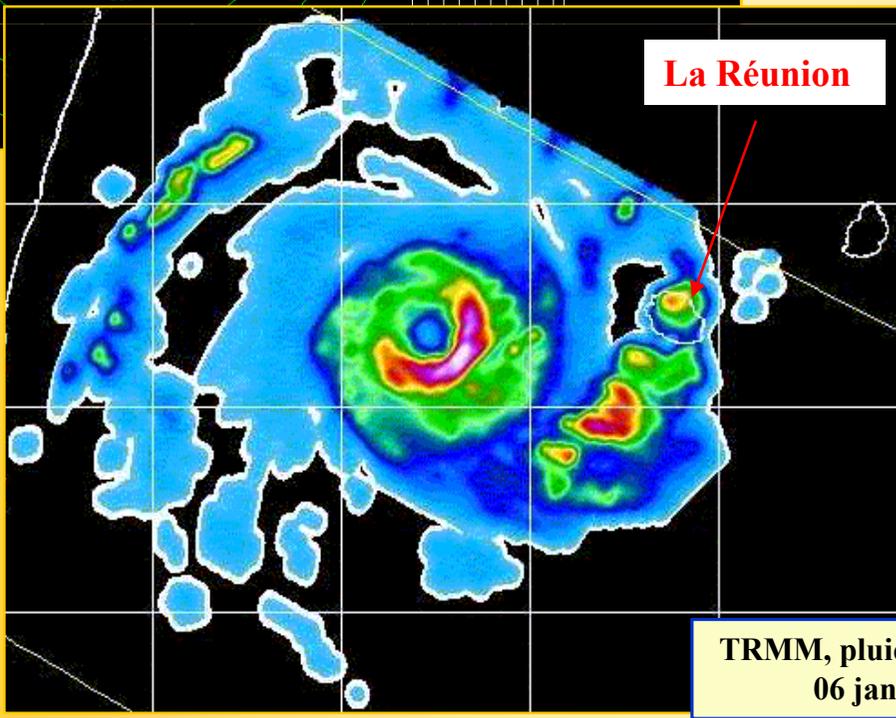




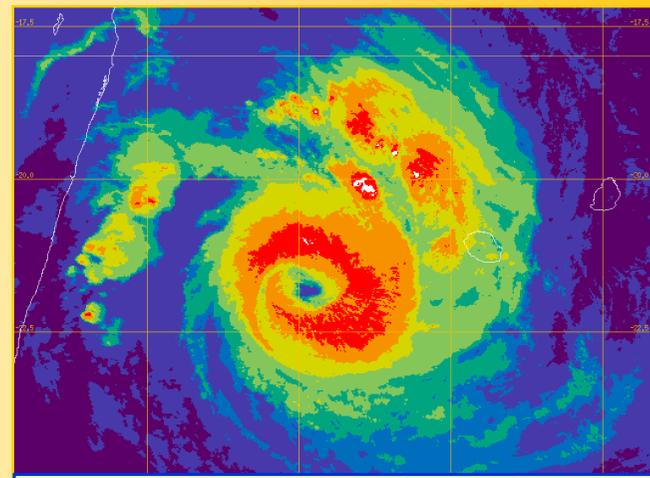
Radar, le 06
janvier
2001 à 2042
UTC

ANDO :
Utilisation du radar et du TRMM
pour quantifier les lames d'eau
sur LA REUNION

Use of the radar and TRMM surface
rain to quantify precipitations at
LA REUNION Island



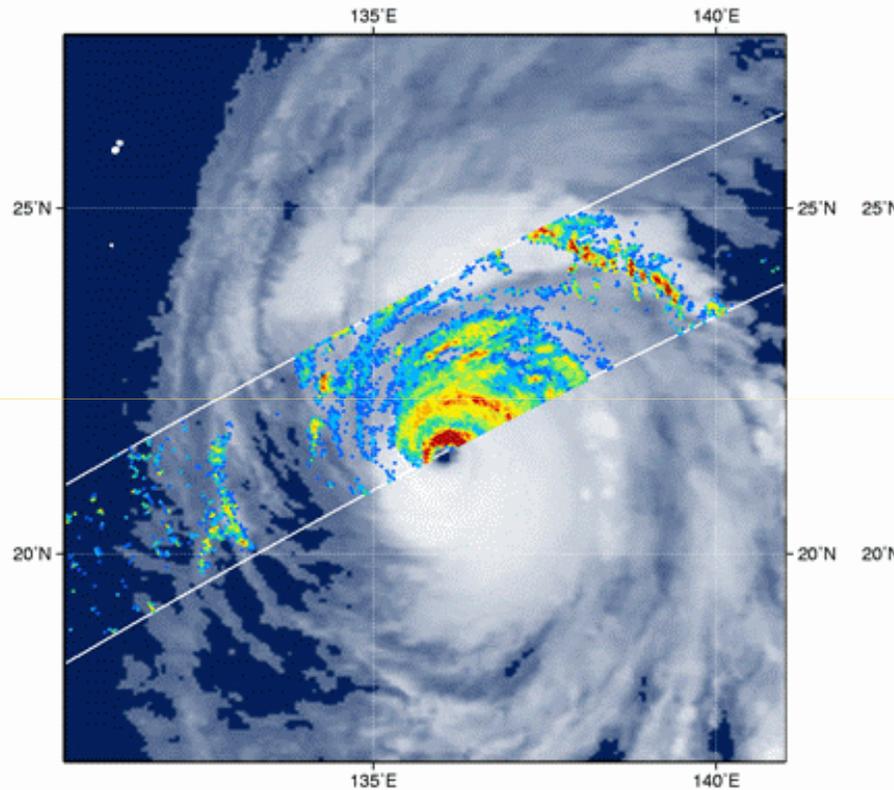
TRMM, pluie en surface (surface rain), le
06 janvier 2001 à 2035 UTC



NOAA14, le 7 janvier 2001 à 0015 UTC

La quantification des précipitations grâce au satellite TRMM

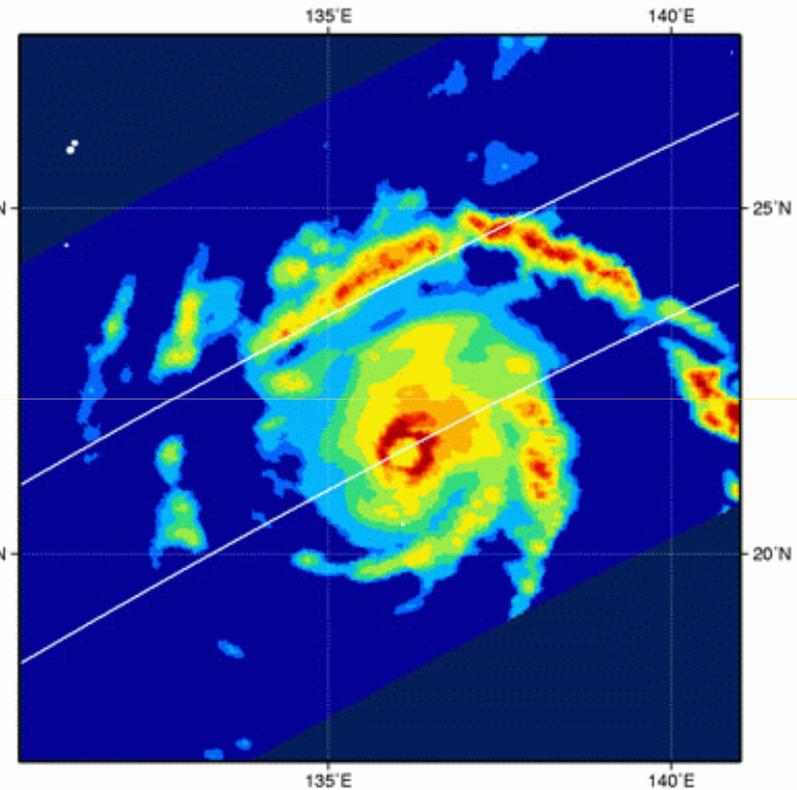
Comparaison entre le radar précipitations et les données imageur



HIGOS T0221 - Rainrate by PR -
2002-09-29 16:45:37 to 2002-09-29 16:50:12 (UTC)
PR: 2A25.020929.27786.5A.25W.HIGOS.HDF

PR rainrate :  [mm/hr]

Cloud Image : GMS-5 (17:00 UTC) by JWA

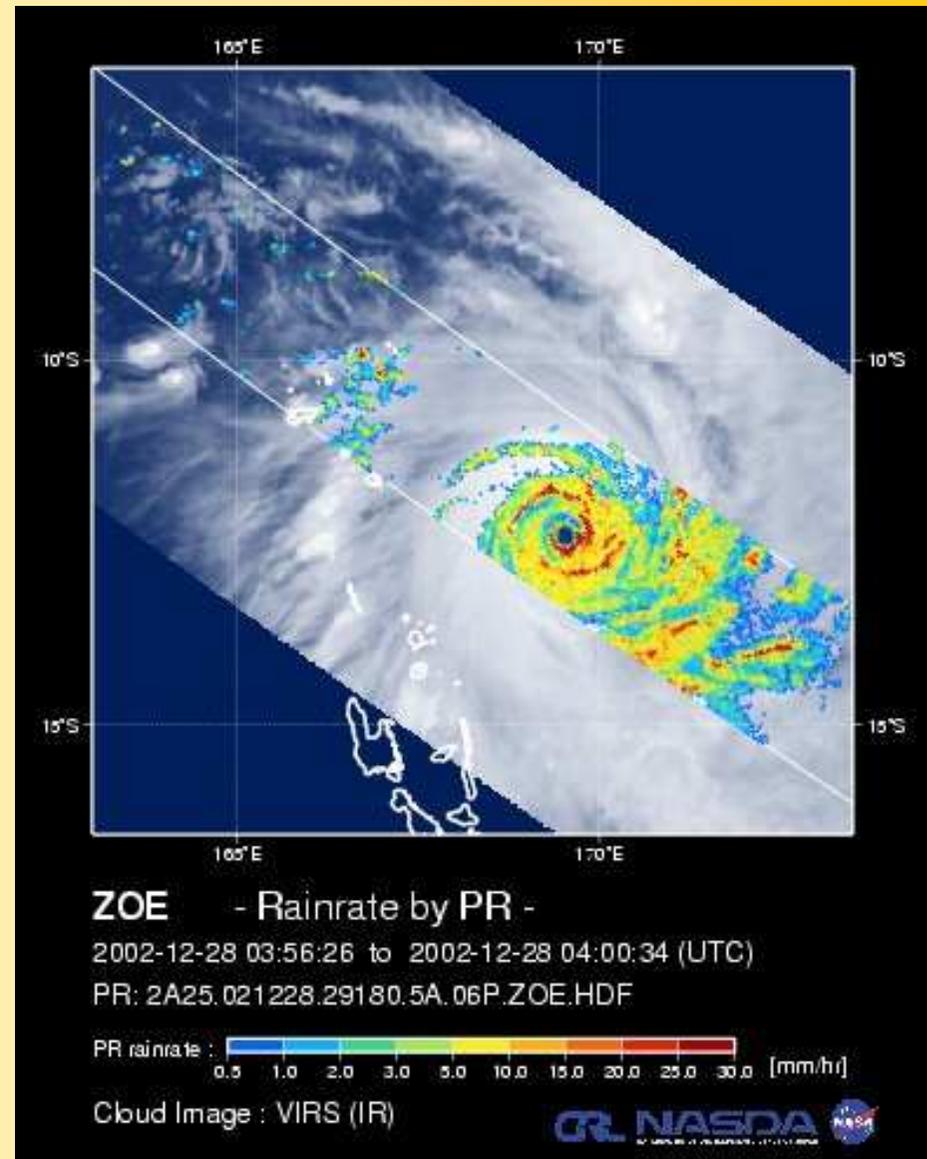
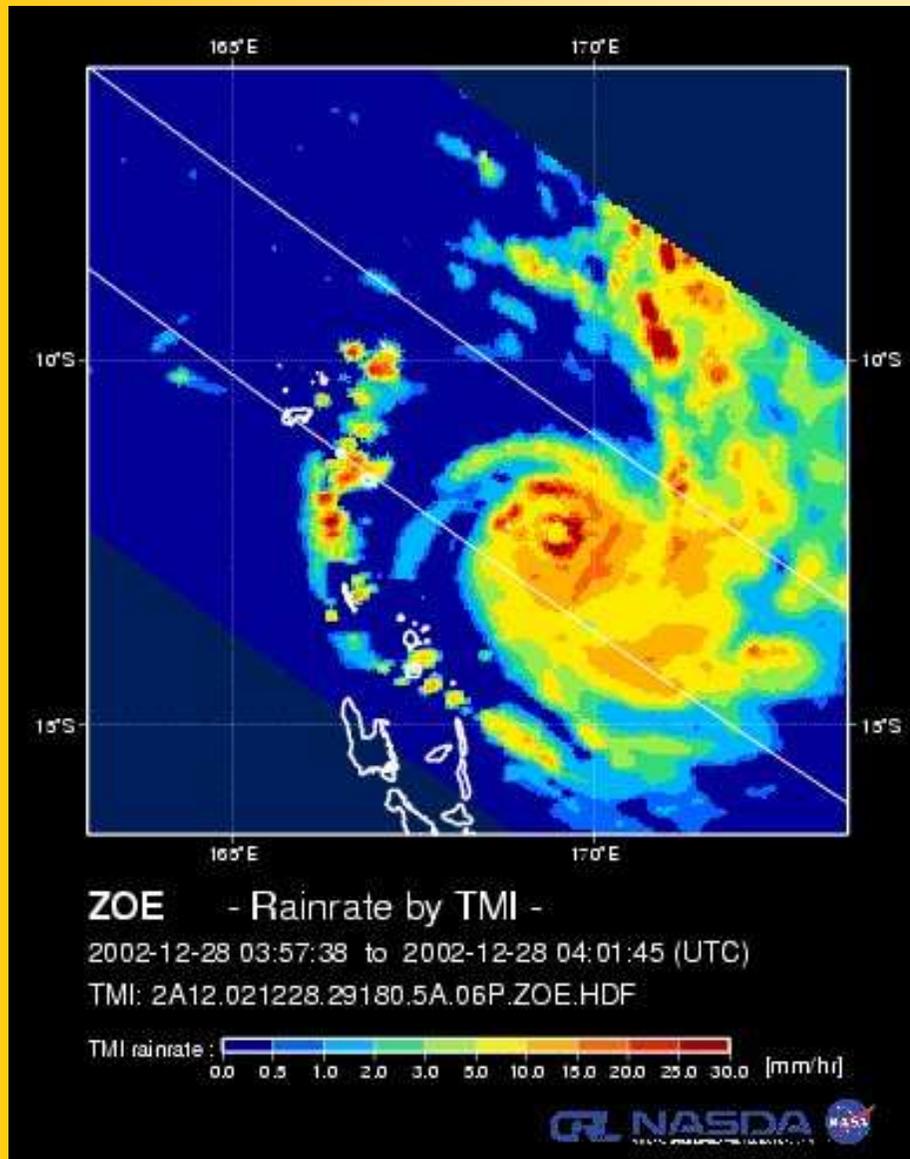


HIGOS T0221 - Rainrate by TMI -
2002-09-29 16:44:27 to 2002-09-29 16:49:00 (UTC)
TMI: 2A12.020929.27786.5A.25W.HIGOS.HDF

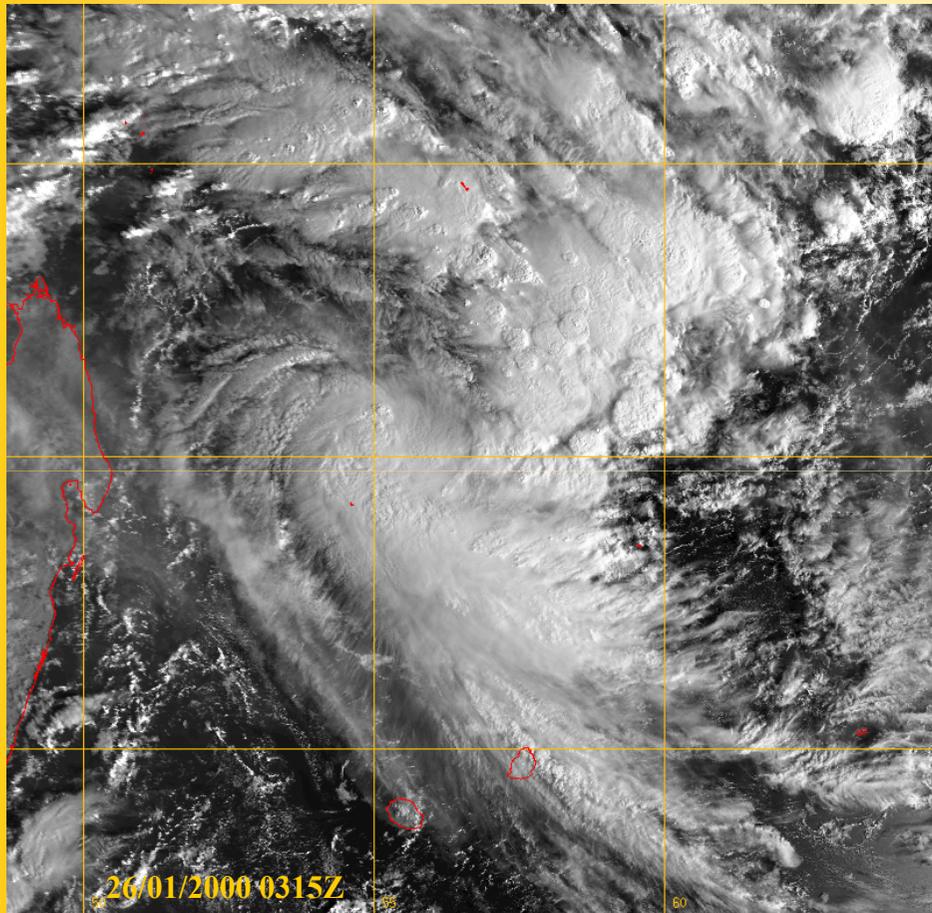
TMI rainrate :  [mm/hr]

La quantification des précipitations grâce au satellite TRMM

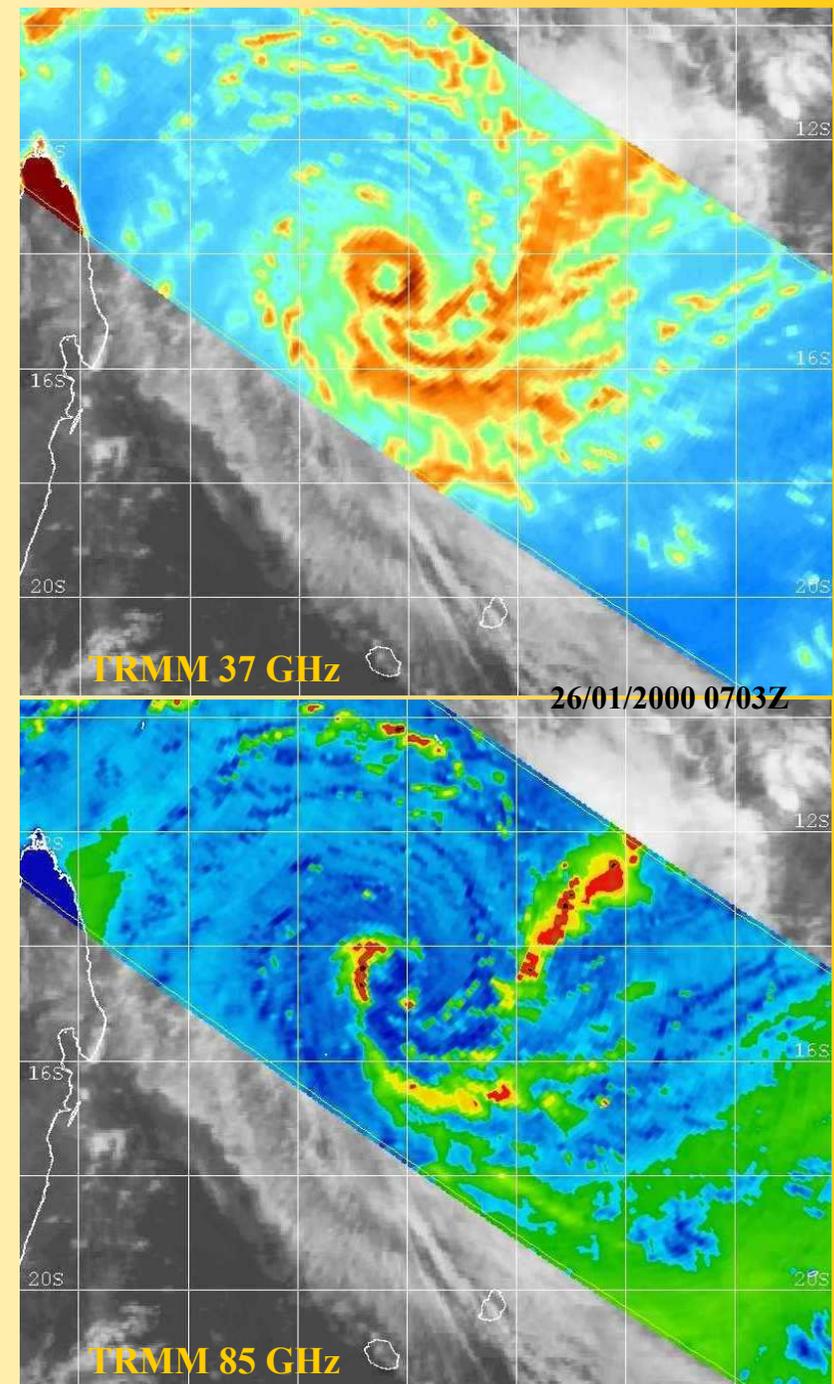
Comparaison entre le radar précipitations et les données imageur



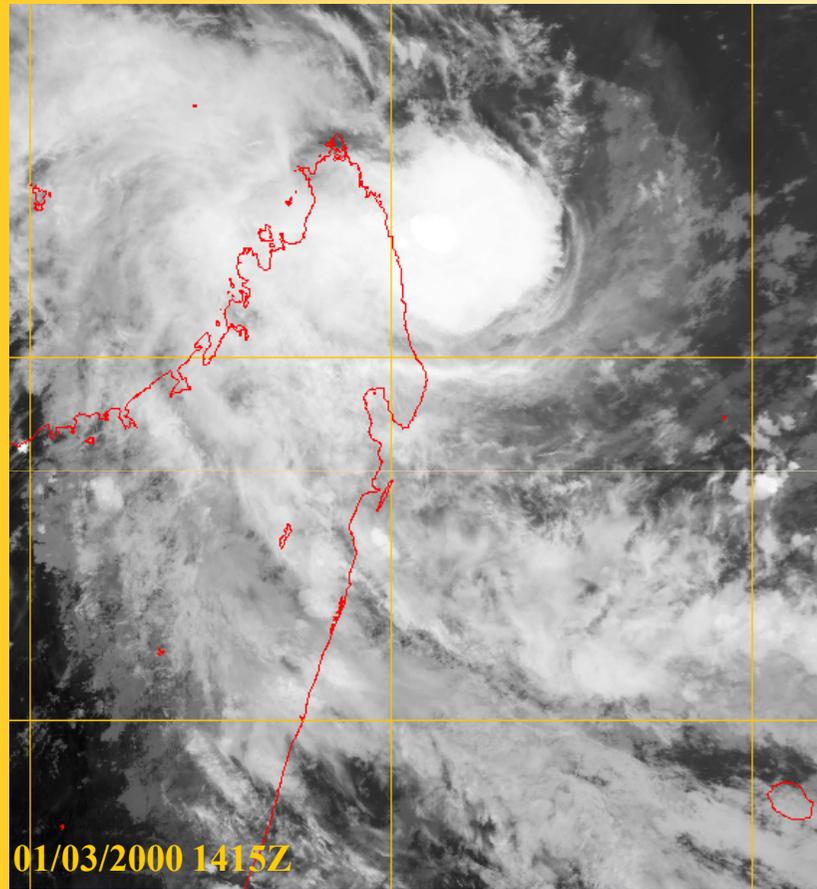
**L'apport de l'imagerie micro-onde :
meilleure localisation du centre,
détection précoce des yeux en formation**



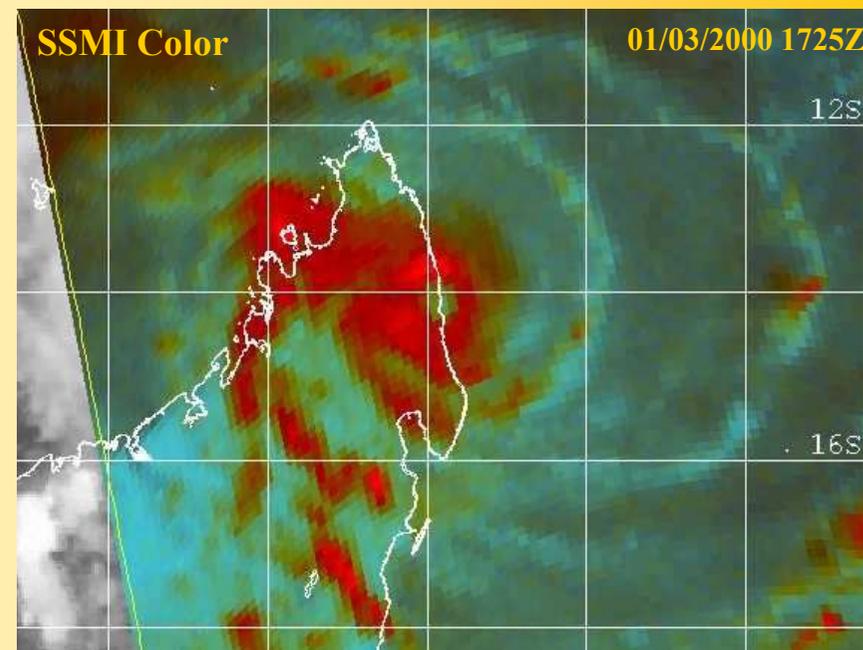
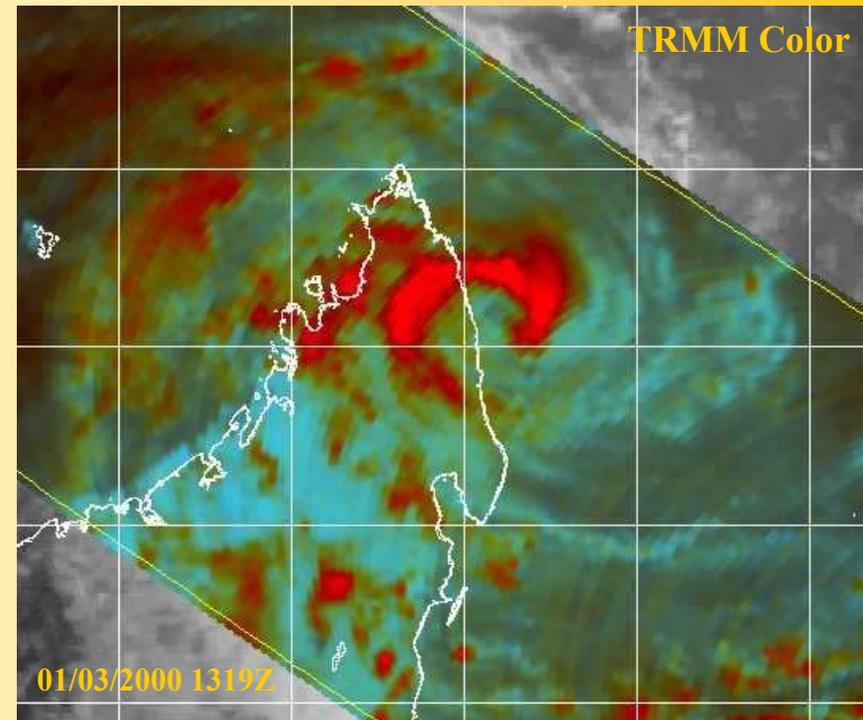
The invaluable power of microwave
imagery for TC monitoring :
**better location of the LLCC, early detection of
pre-eyewall formation (TC CONNIE jan 2000).**



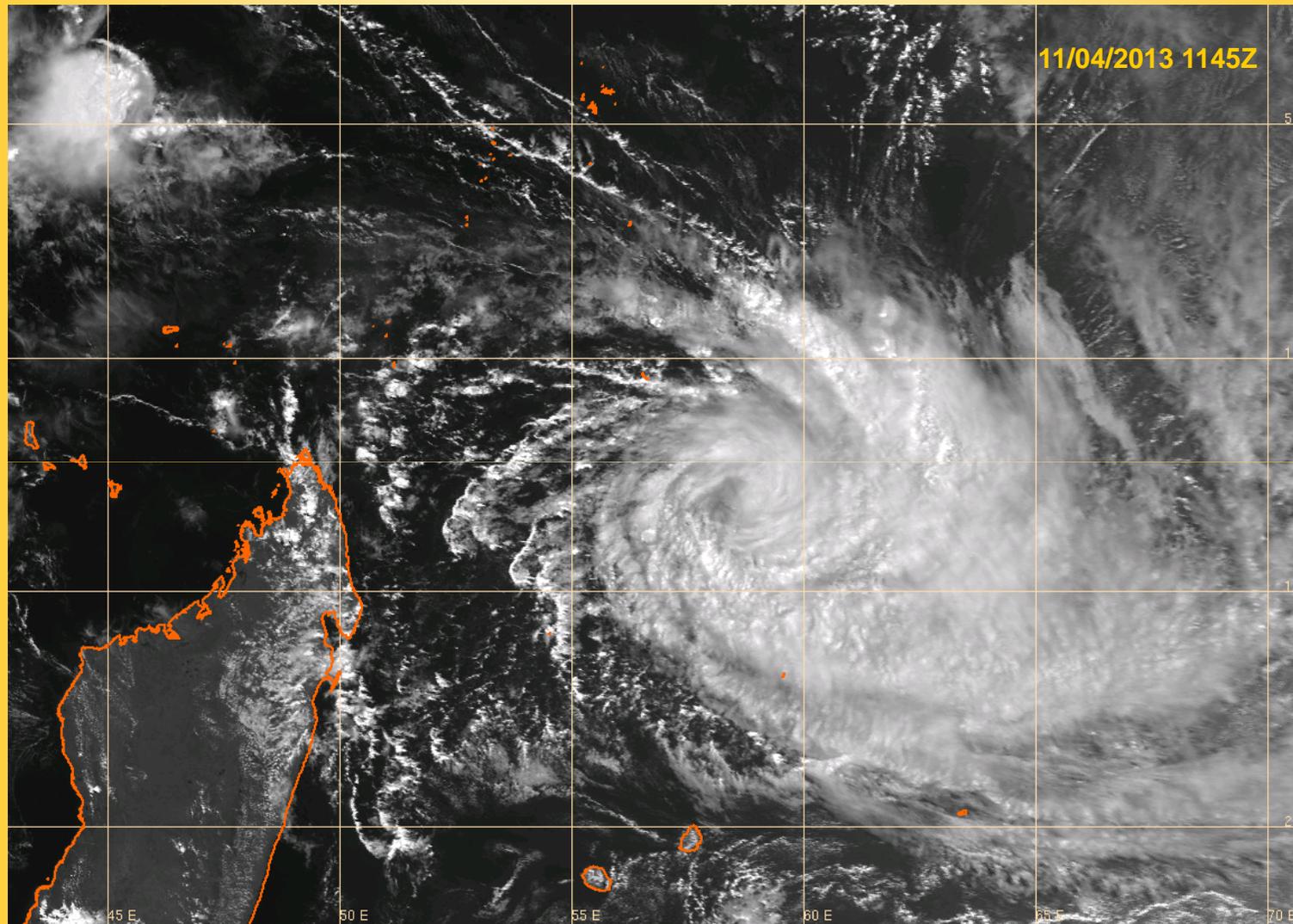
**L'apport de l'imagerie micro-onde :
meilleure localisation du centre,
détection précoce des yeux en formation**



The invaluable power of microwave imagery
for TC monitoring :
**better location of the LLCC, early detection of
pre-eyewall formation (TS GLORIA March 2000).**

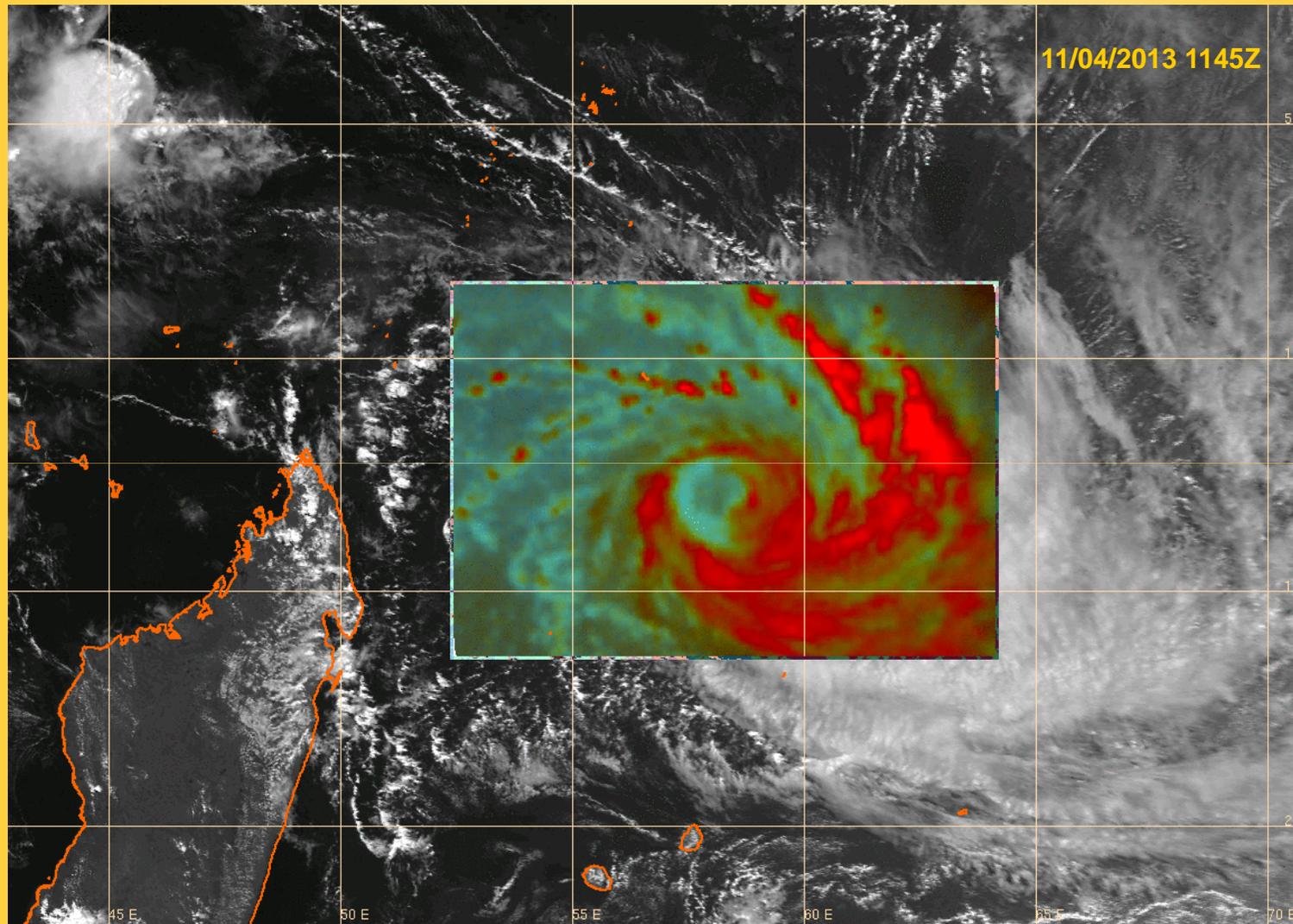


L'apport de l'imagerie micro-onde : meilleure vision de la structure interne



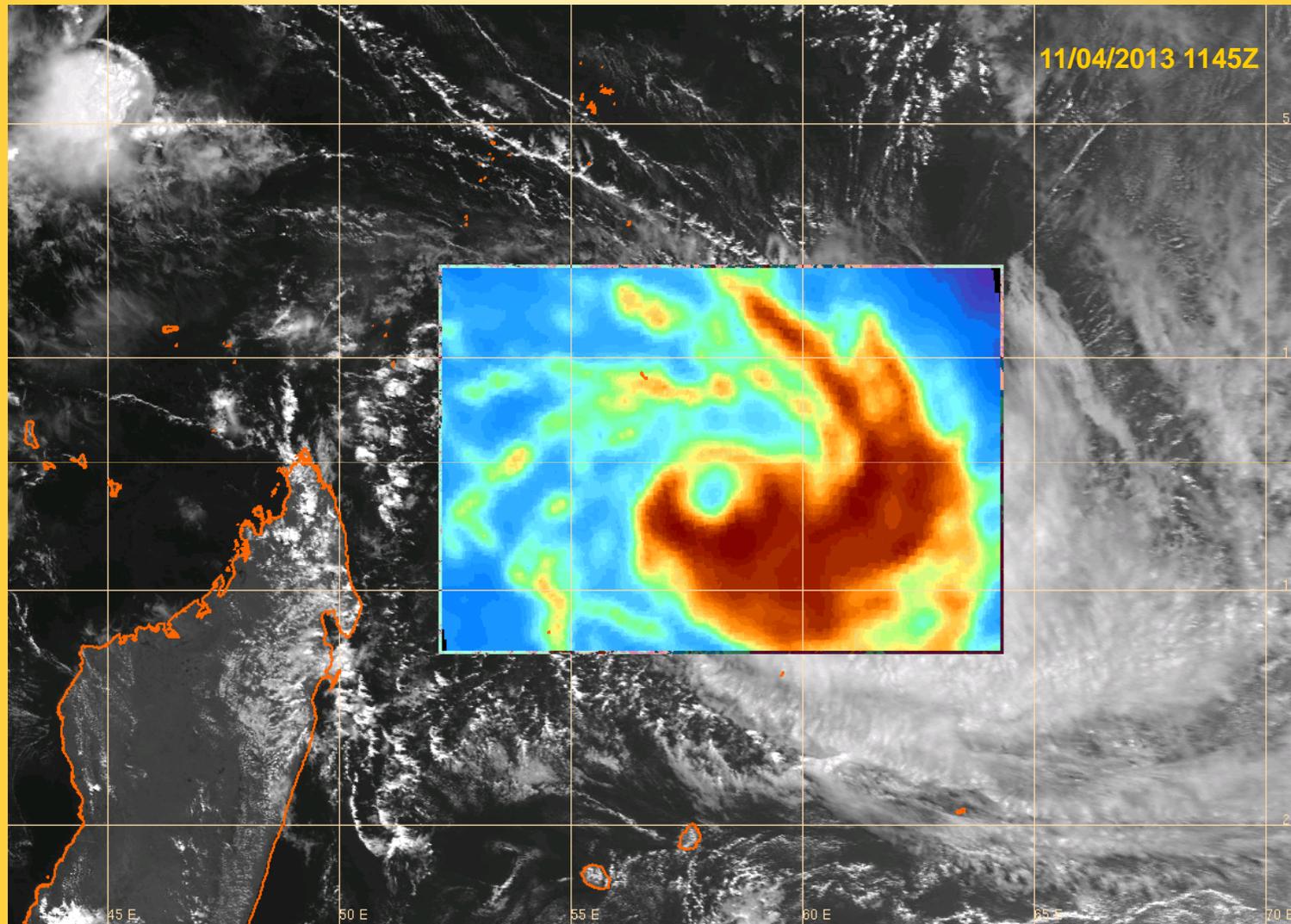
The invaluable power of microwave imagery for TC monitoring :
Better depiction of inner structure (TC IMELDA).

L'apport de l'imagerie micro-onde : meilleure vision de la structure interne



The invaluable power of microwave imagery for TC monitoring :
Better depiction of inner structure (TC IMELDA).

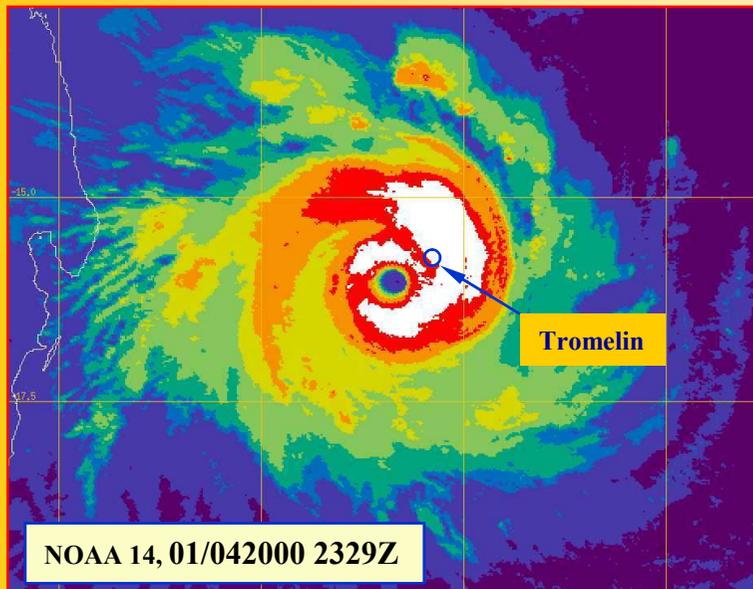
L'apport de l'imagerie micro-onde : meilleure vision de la structure interne



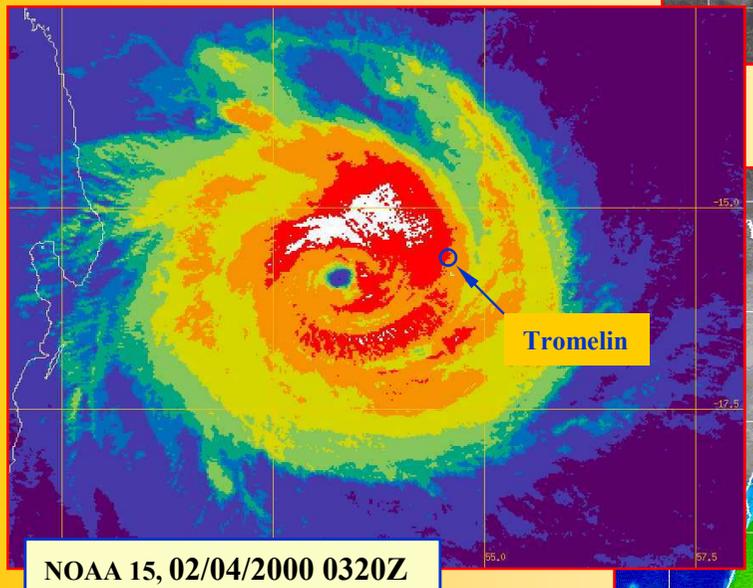
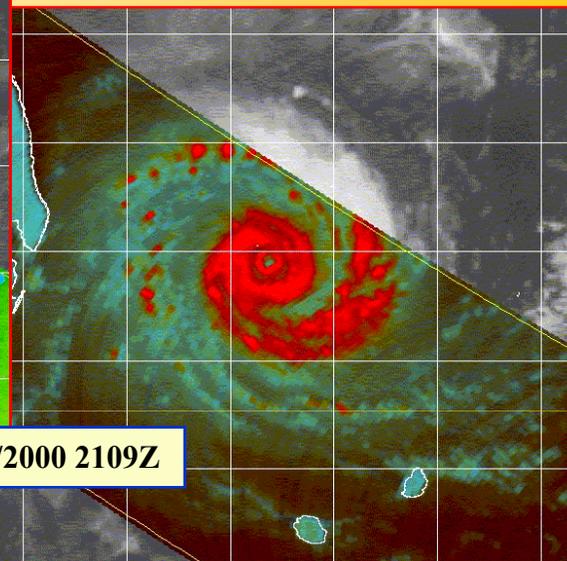
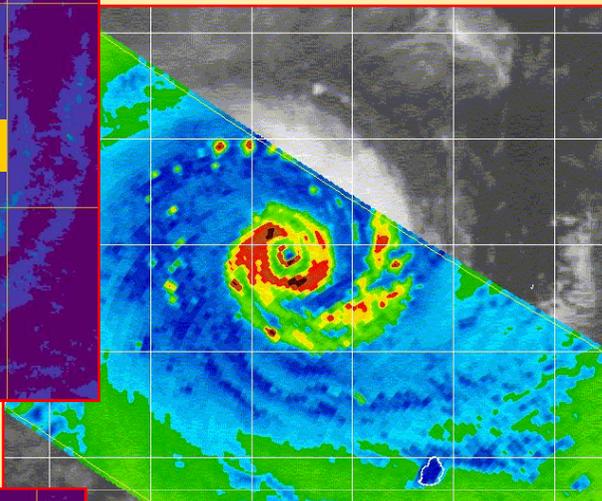
The invaluable power of microwave imagery for TC monitoring :
Better depiction of inner structure (TC IMELDA).

**CYCLE de L'ŒIL
d'HUDAH**

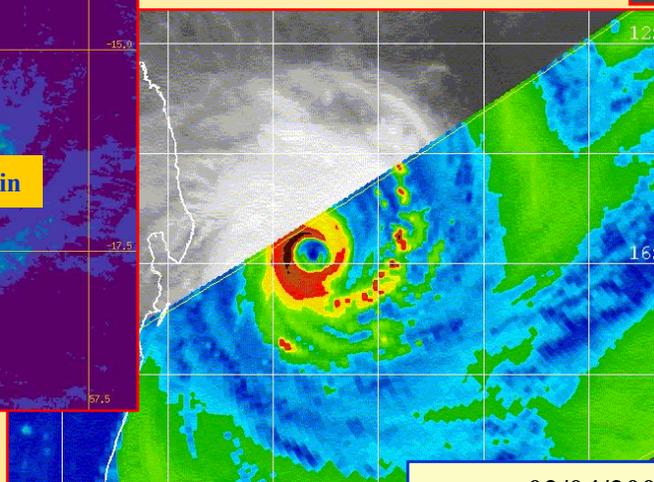
- Better vision of :
 - specific features



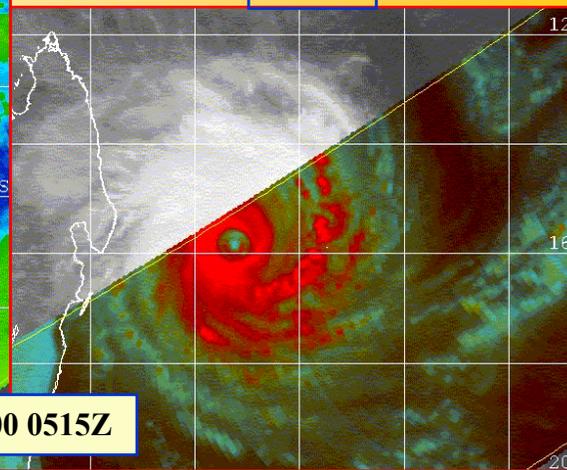
EIR

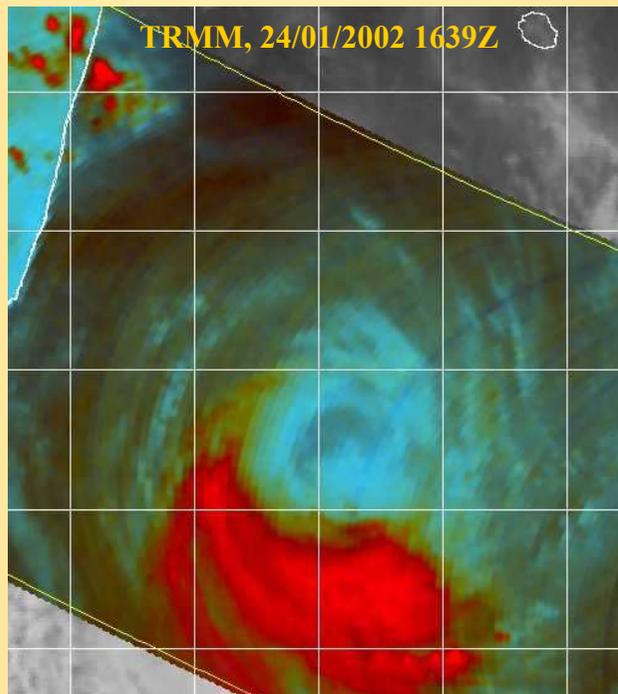
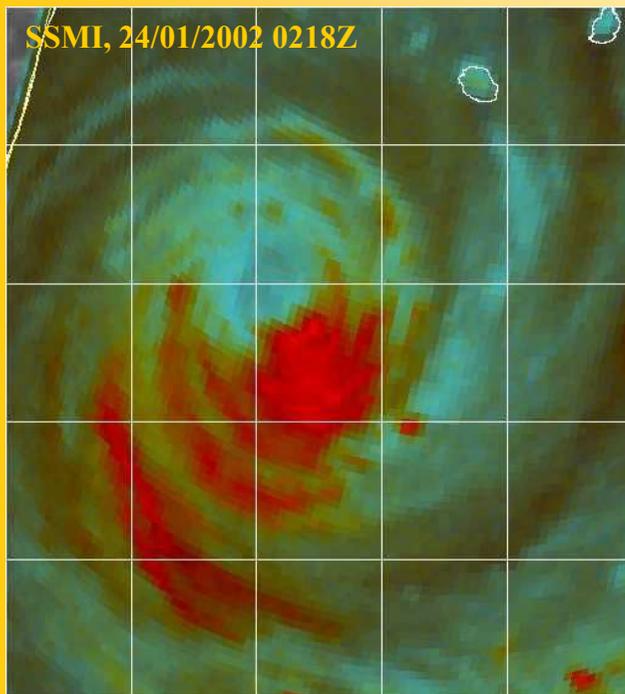
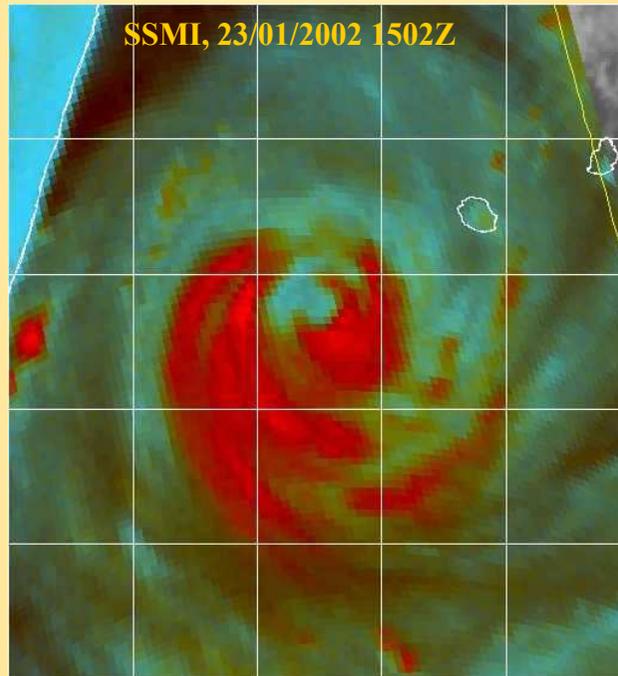
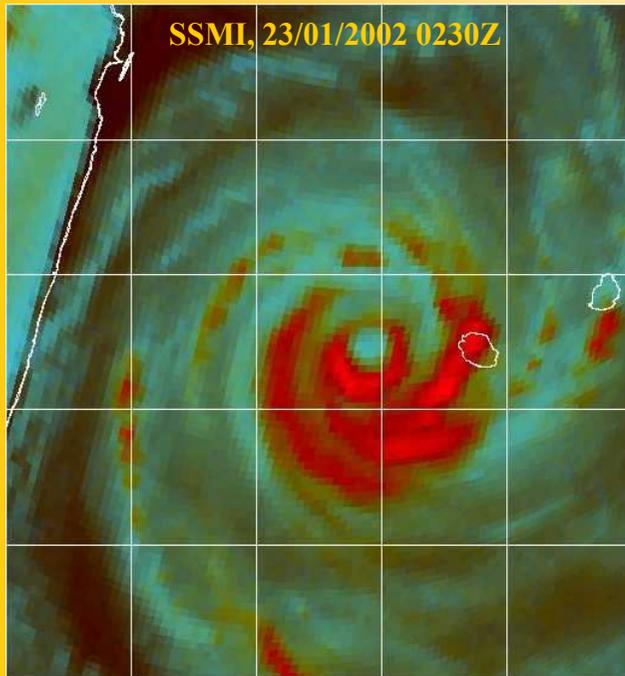


**Eyewall cycles are well depicted on
micro-wave imagery (TC HUDAH)**



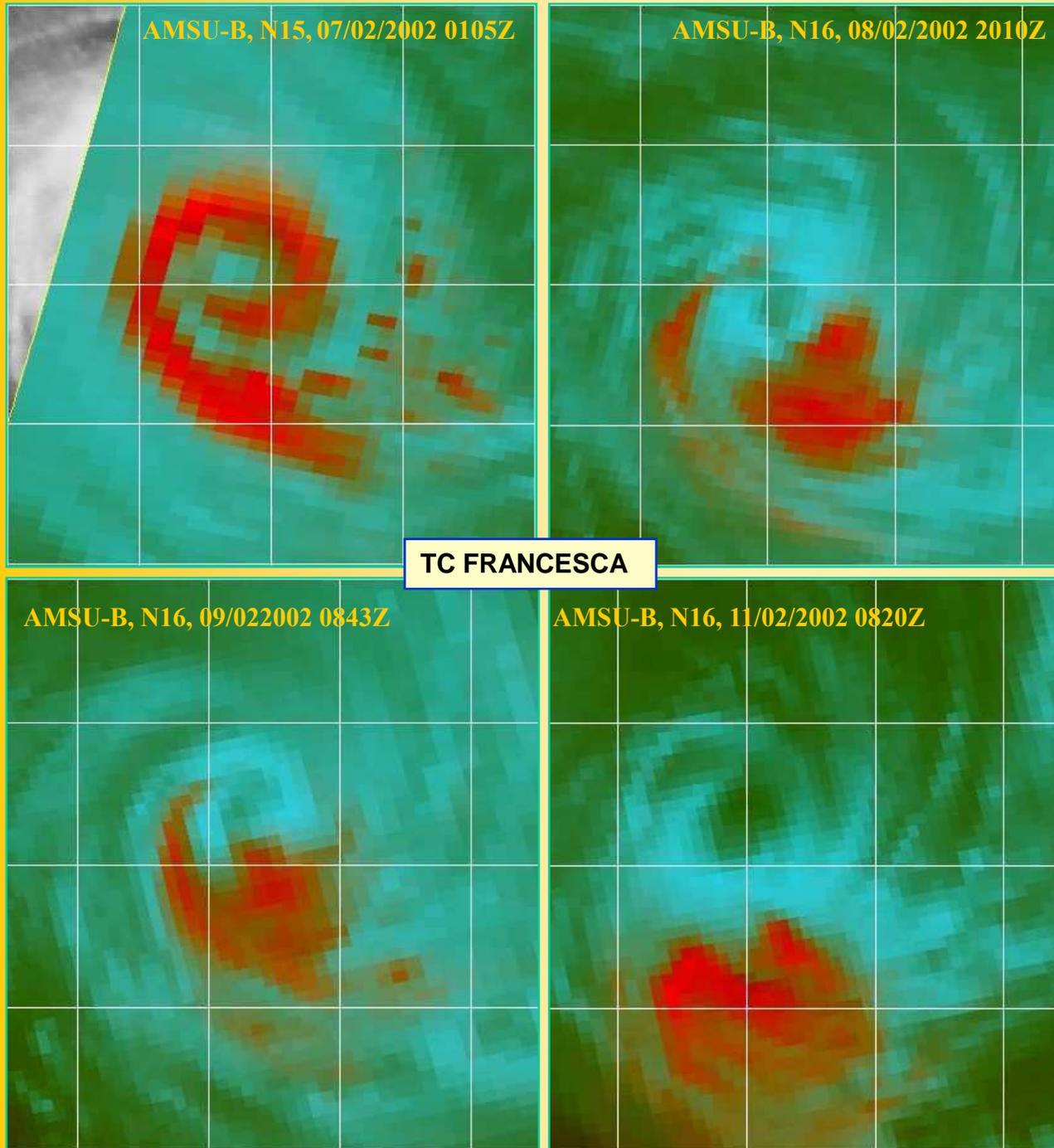
TRMM, 02/04/2000 0515Z





Affaiblissement du cyclone DINA par cisaillement de vent

- Better location of LLCC for systems during initial shearing stage
- Better vision of : structure changes

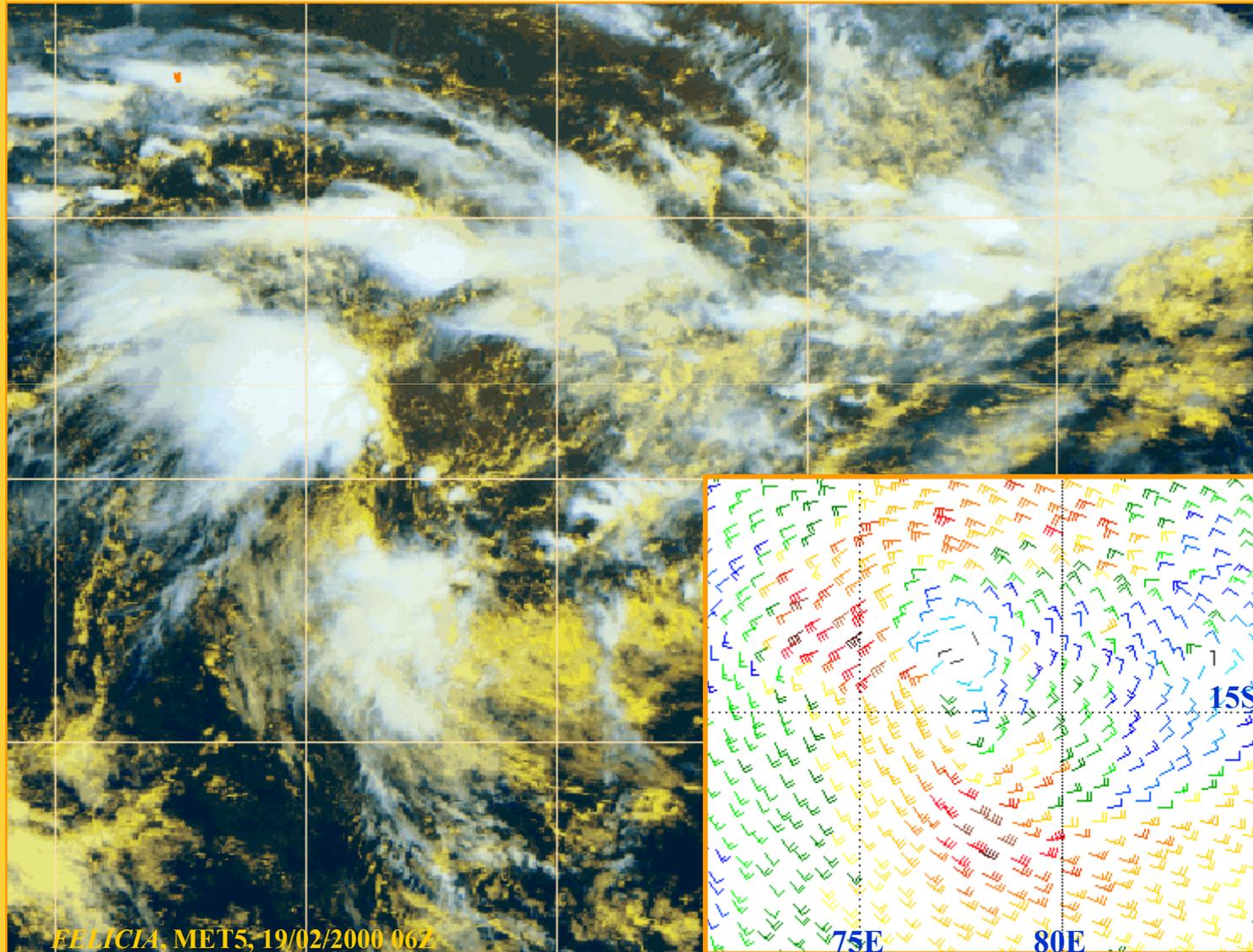


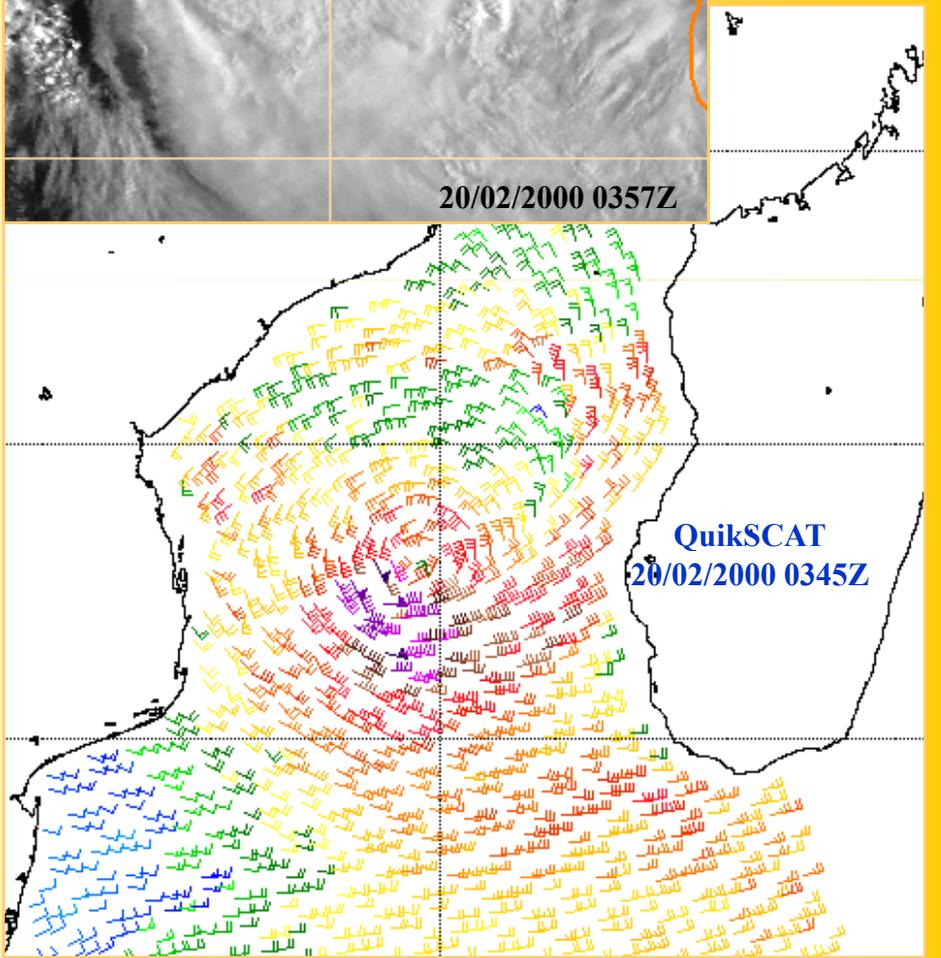
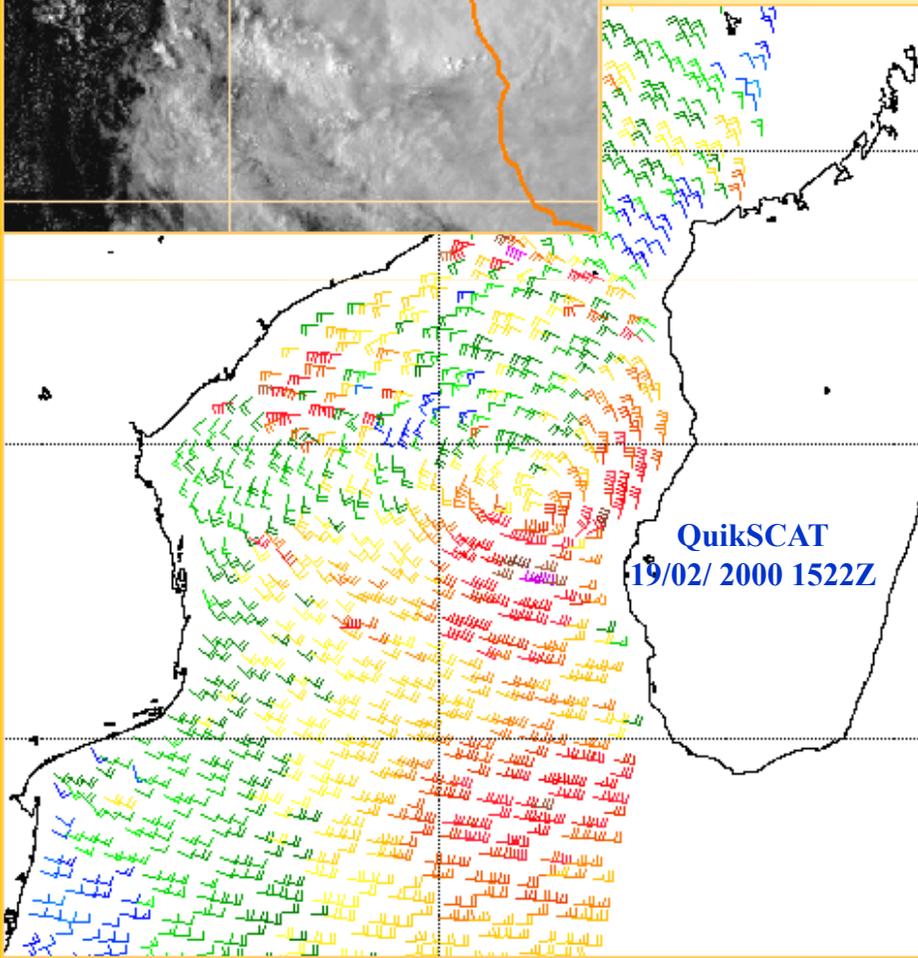
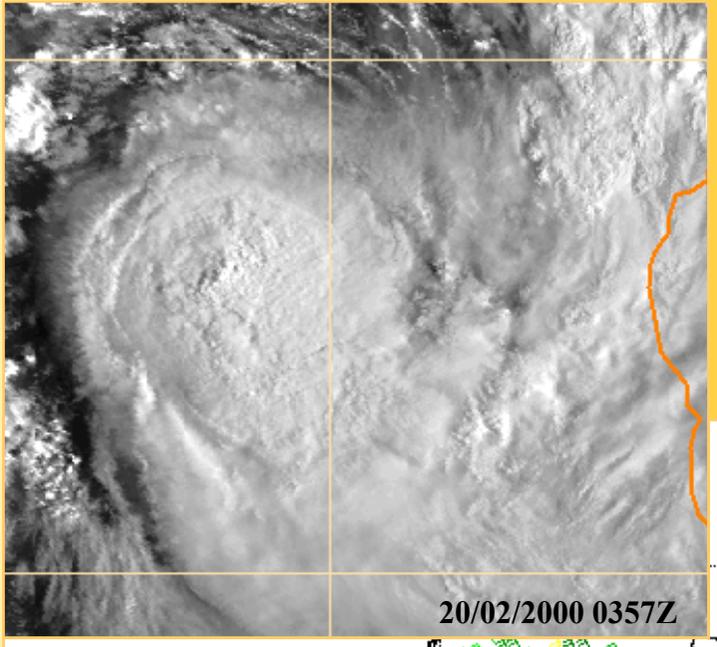
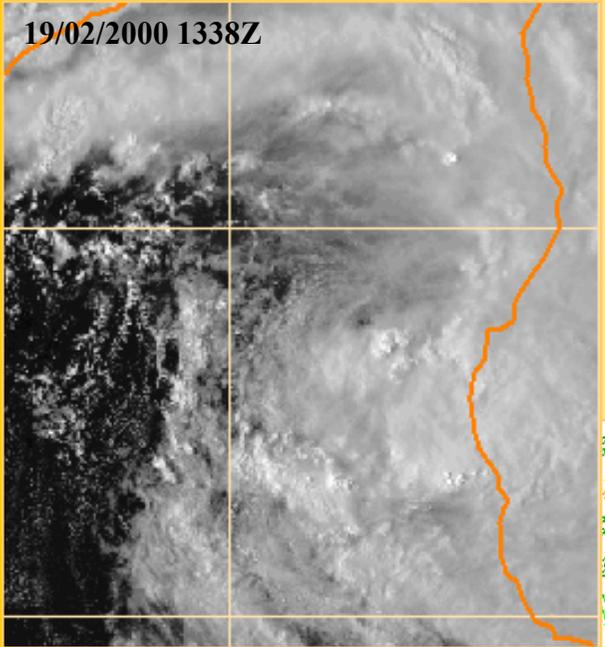
AMSU-B

- 89 GHz, Composite
- Available with the classical NOAA imagery
- Useages
 - Like an imager
 - Qualitative evolution of intensity
 - Better vision of specific structures or structure modifications
 - Location of centre in shear patterns
- Limitations
 - Poor resolution especially on the edge of the swath.

LES DONNEES DIFFUSIOMETRIQUES

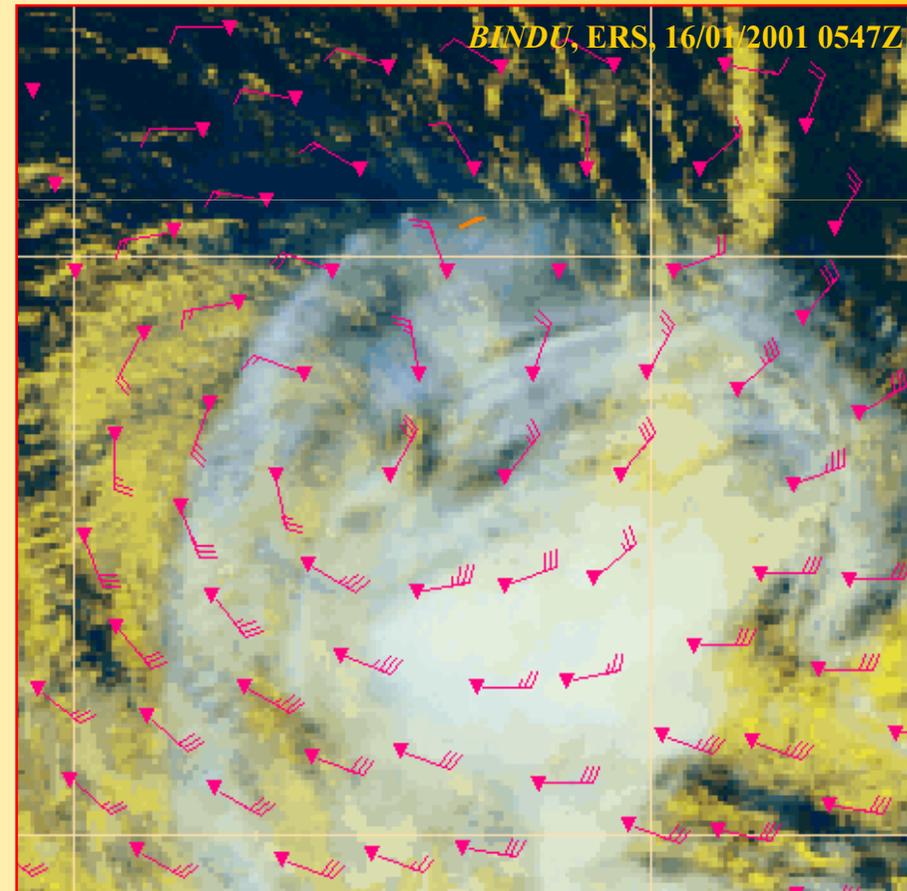
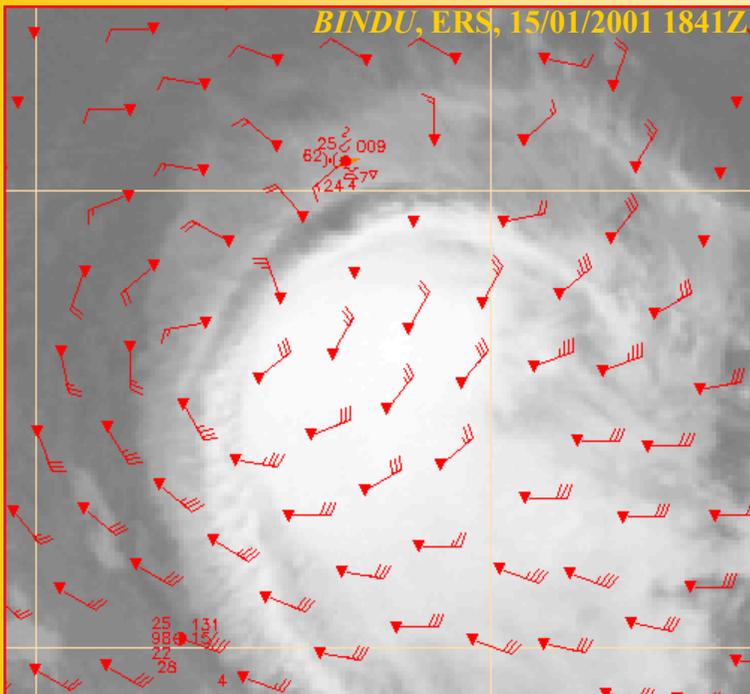
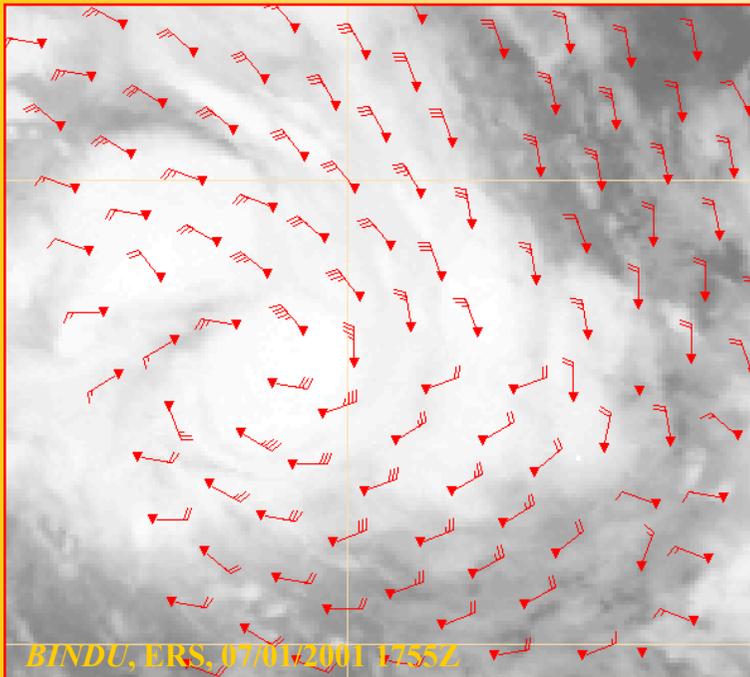
- Location of TC centres
 - Especially for weak systems
 - Sheared systems
 - pre-genesis





LES DONNEES DIFFUSIOMETRIQUES

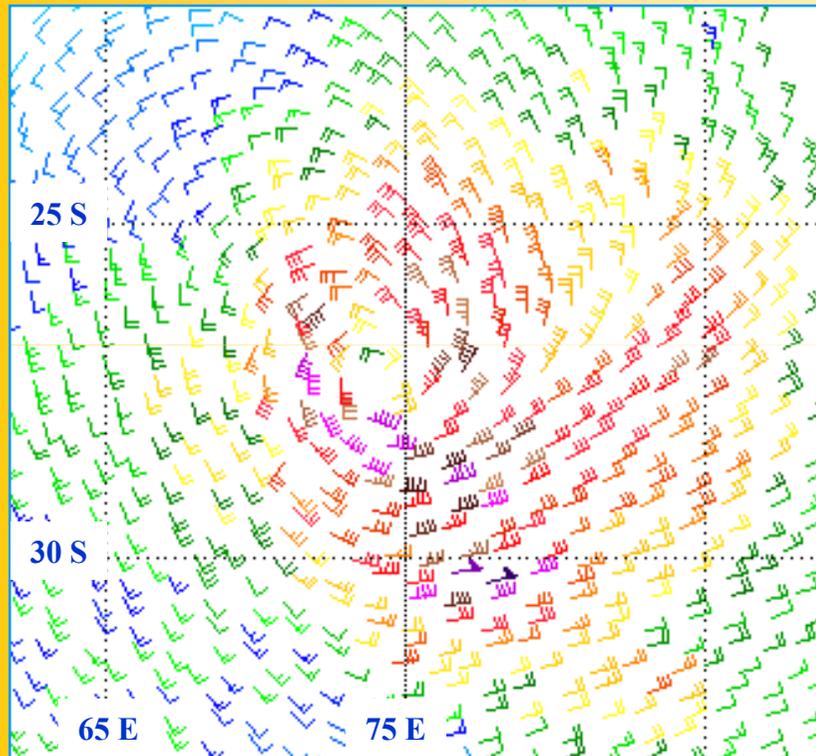
- Location of TC centres
 - Sheared systems
 - Systems with CDO



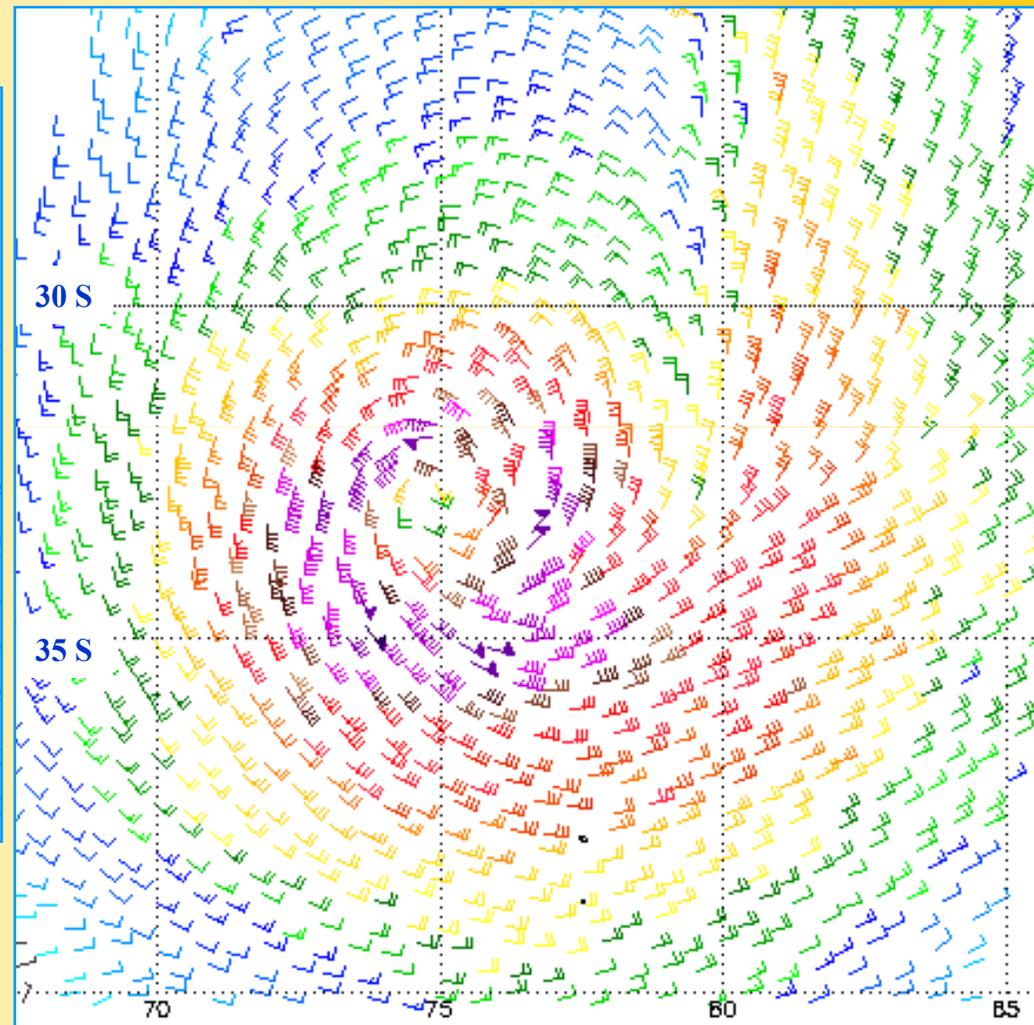
LES DONNEES DIFFUSIOMETRIQUES

- Structures changes
 - Size changes
 - Extratropical transition

12/01/2000 07 UTC

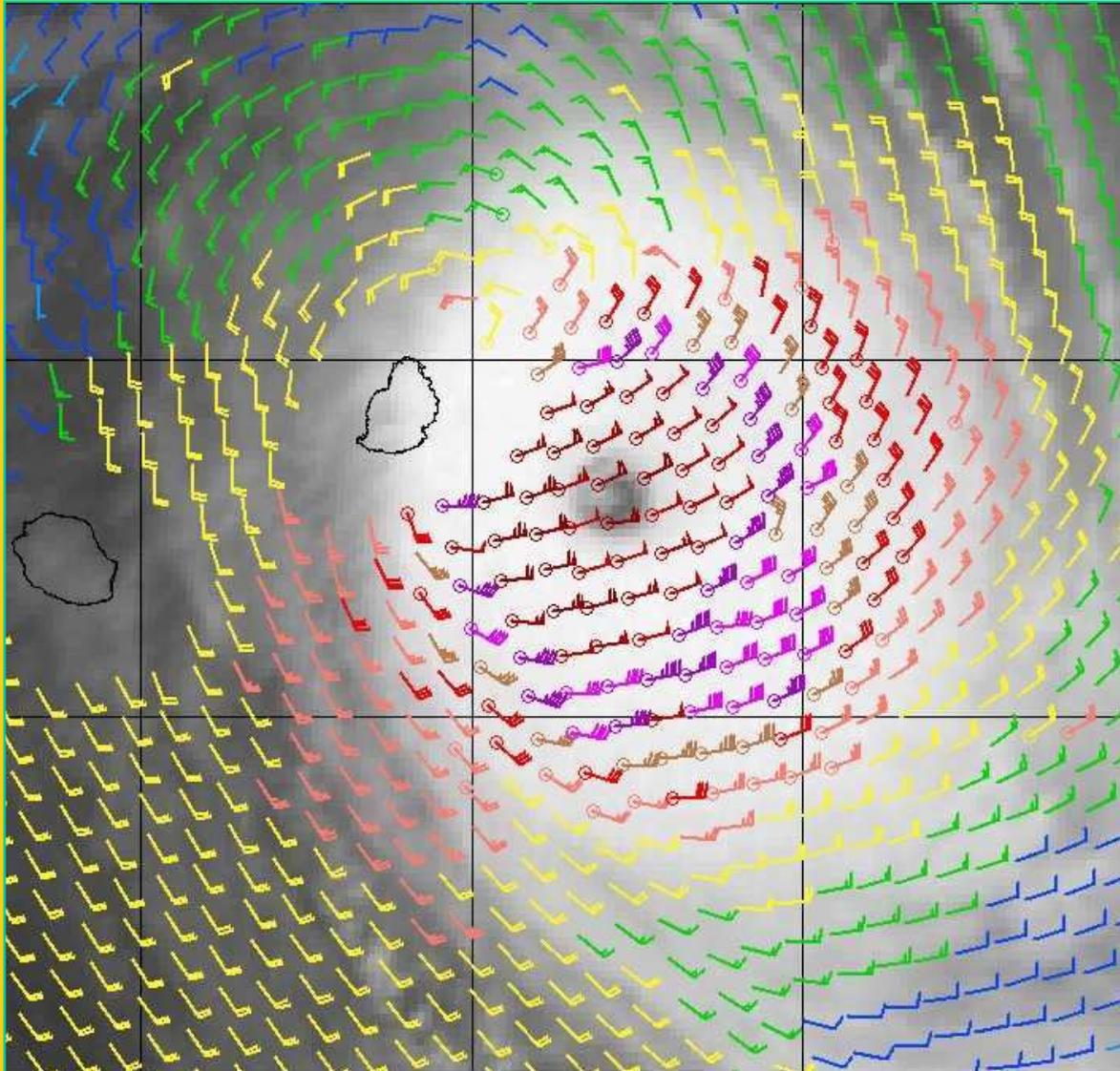


BABIOLA, QuikSCAT, 12/01/2000 1308Z



BABIOLA, QuikSCAT, 13/01/2000 1227Z

LES LIMITATIONS DES DONNEES DIFFUSIOMETRIQUES

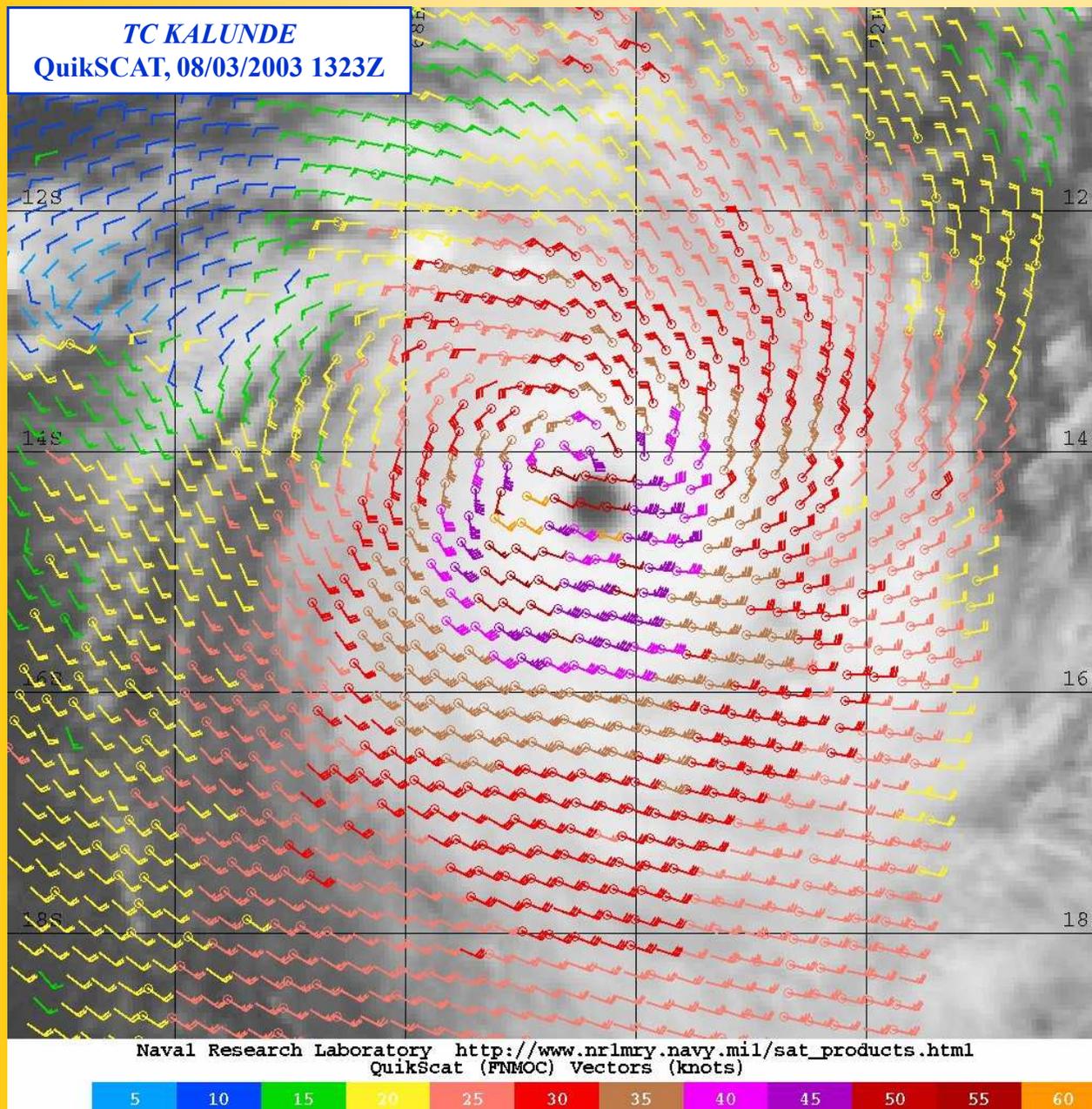


- **Limitations**

- False position
- wrong solution for the ambiguity selection

GUILLAUME, QuikSCAT, 20/02/2002 0207Z

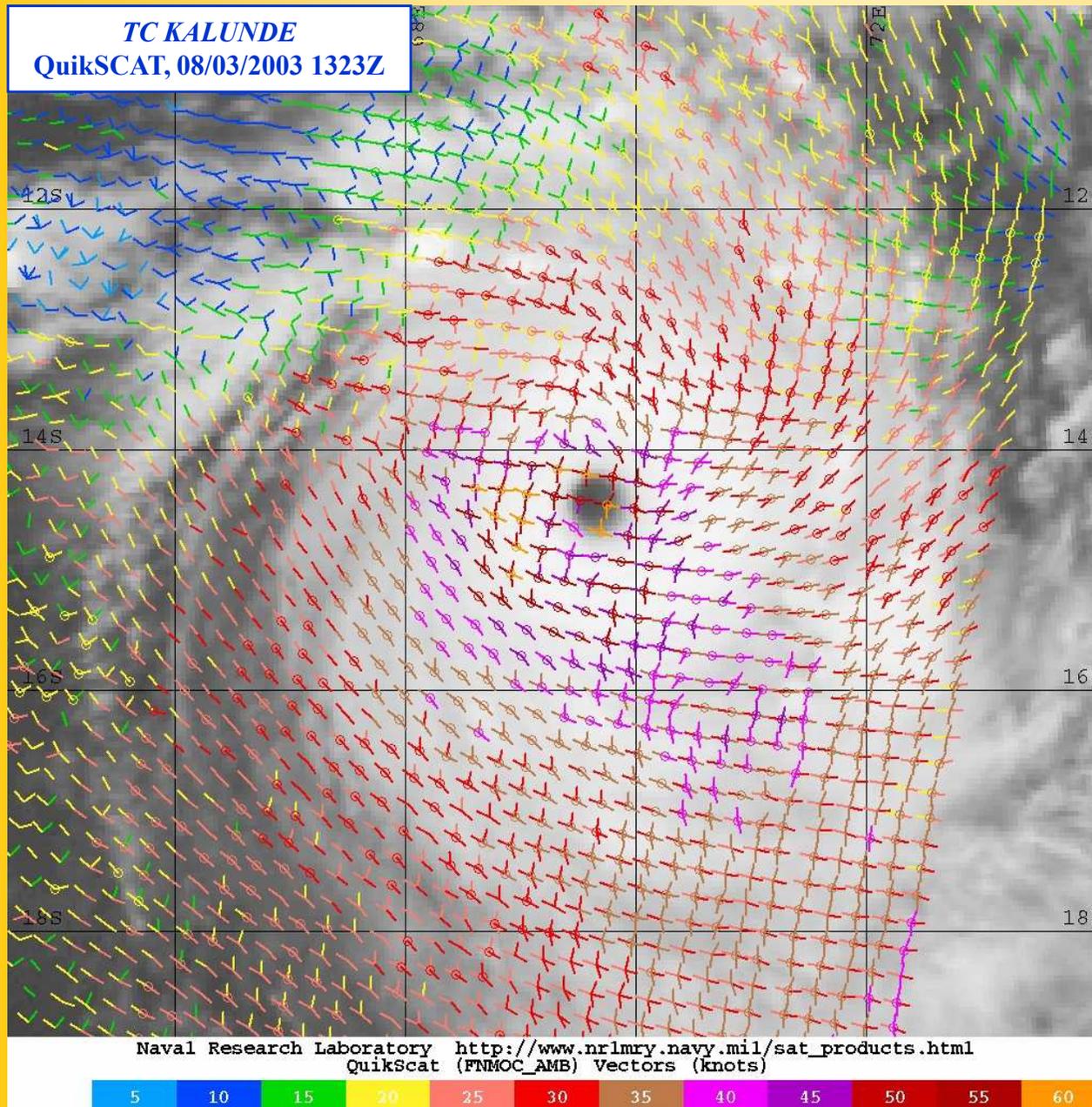
LES LIMITATIONS DES DONNEES DIFFUSIOMETRIQUES



● Limitations

- False position
- wrong solution for the ambiguity selection

LES LIMITATIONS DES DONNEES DIFFUSIOMETRIQUES



● Limitations

- False position
- wrong solution for the ambiguity selection

LES LIMITATIONS DES DONNEES DIFFUSIOMETRIQUES

TC KALUNDE
QuikSCAT, NRCS
12/03/2003 0215Z

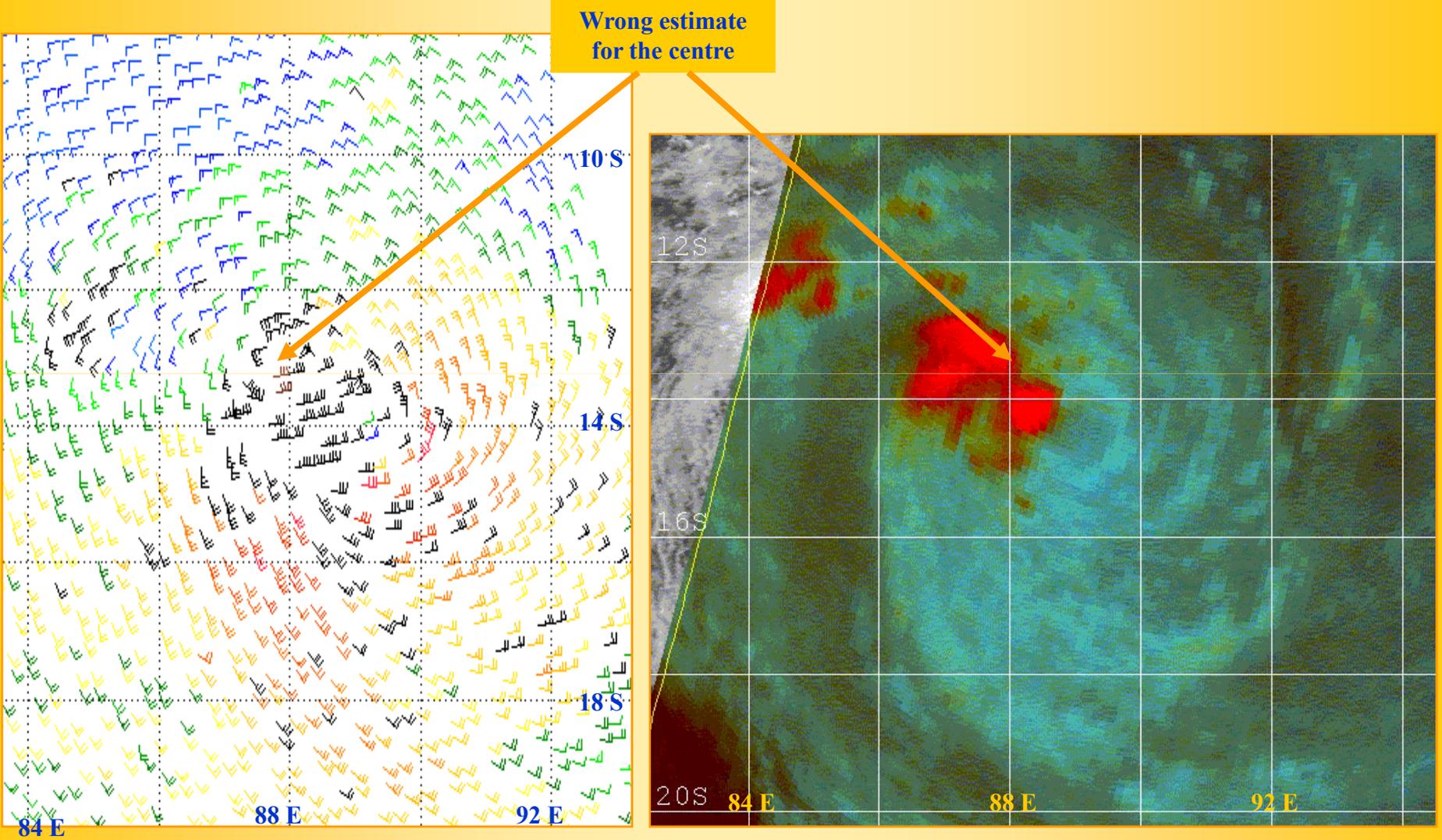
L'utilisation des données NRCS
(pour Normalized Radar Cross-
Section) peut souvent
permettre de localiser le centre.

NRCS data may
be very powerful
to help more
accurate location
of the LLCC.

TC KALUNDE
QuikSCAT, NRCS 12/03/2003 1323Z

QuikSCAT

- Limitations
 - Wrong estimate for the centre

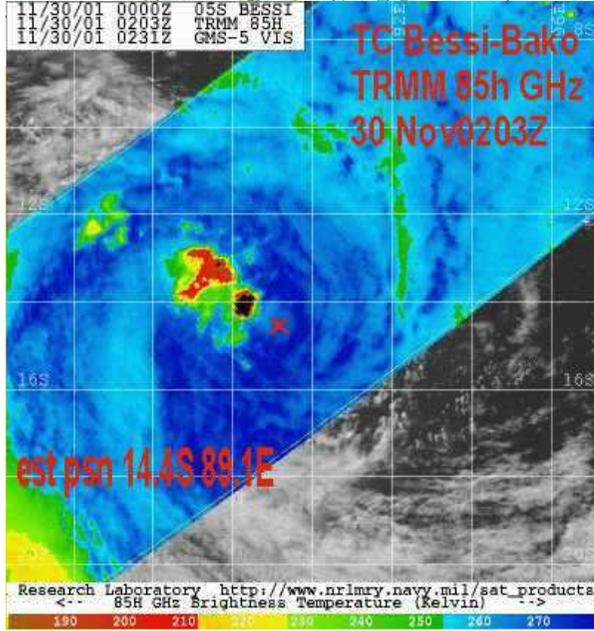
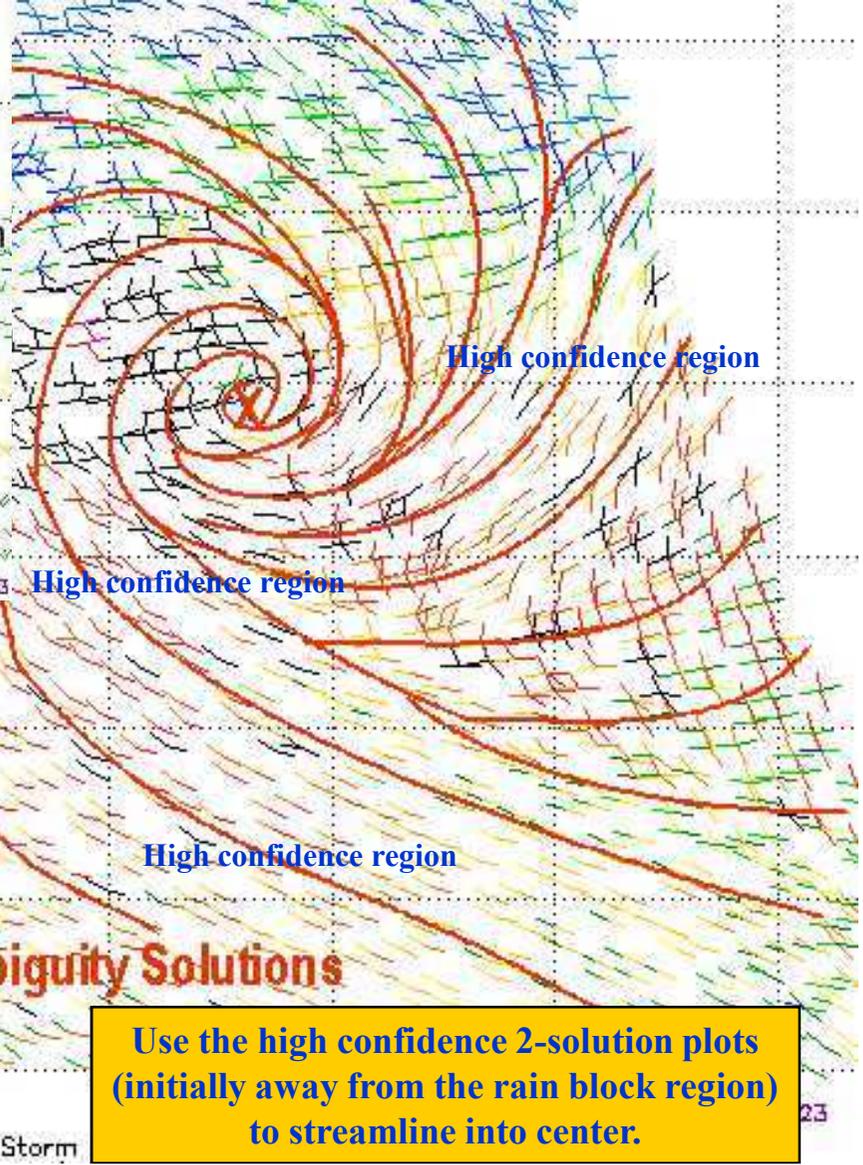
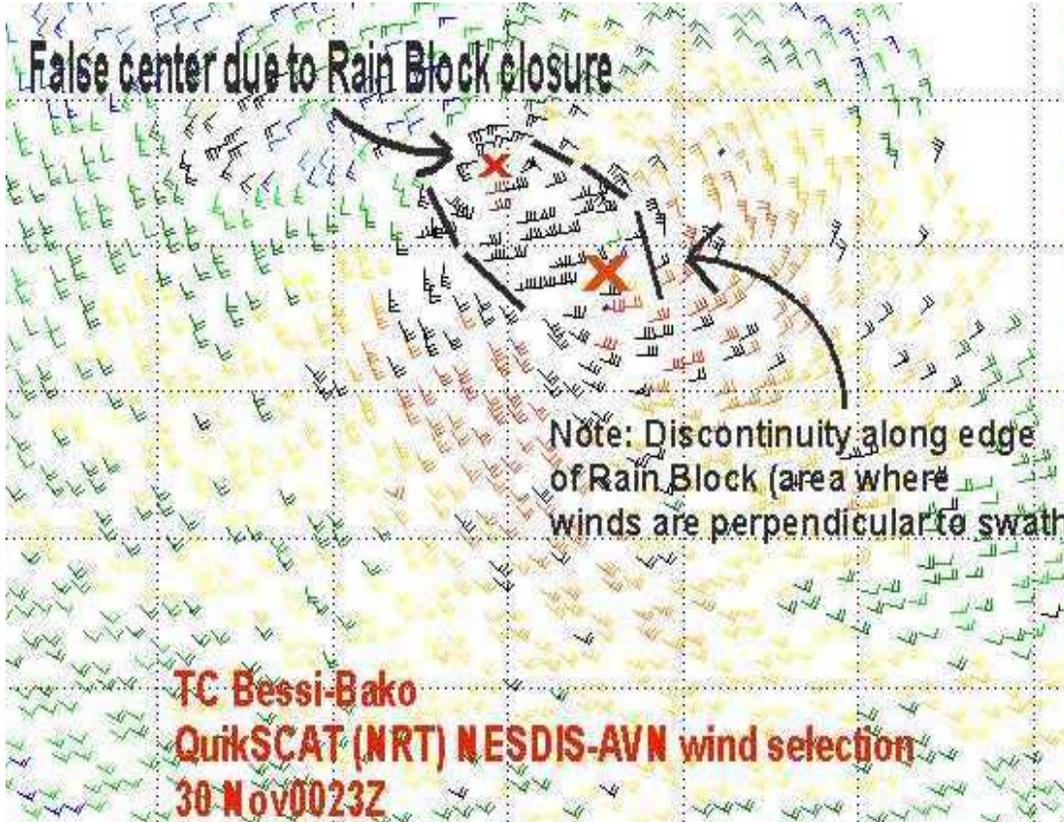


QuikSCAT solution from NESDIS, 30/11/2001 0023Z

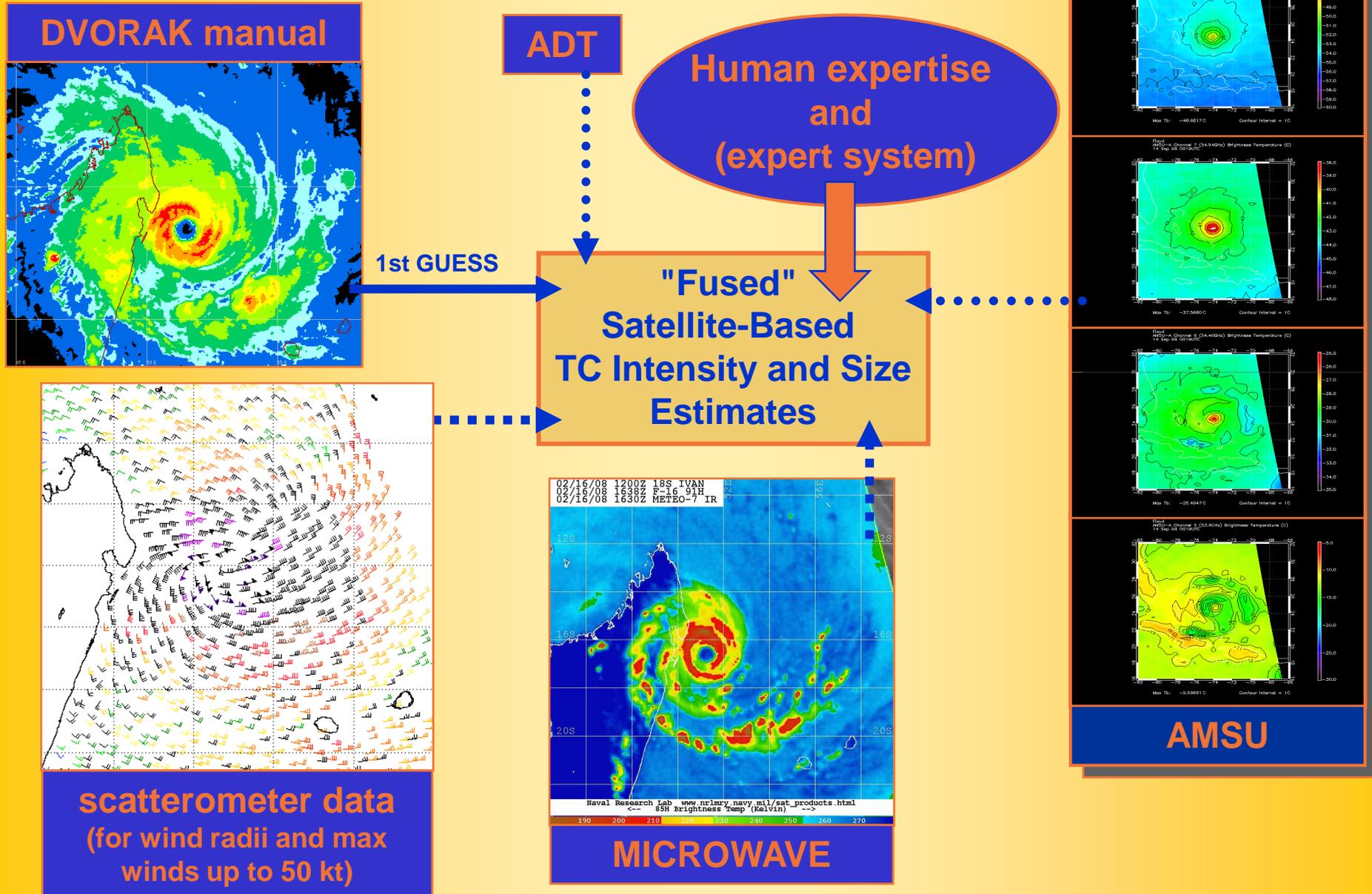
SSMI, 30/11/2001 0218Z, LLCC = 14.4S/89.1E

QuikSCAT

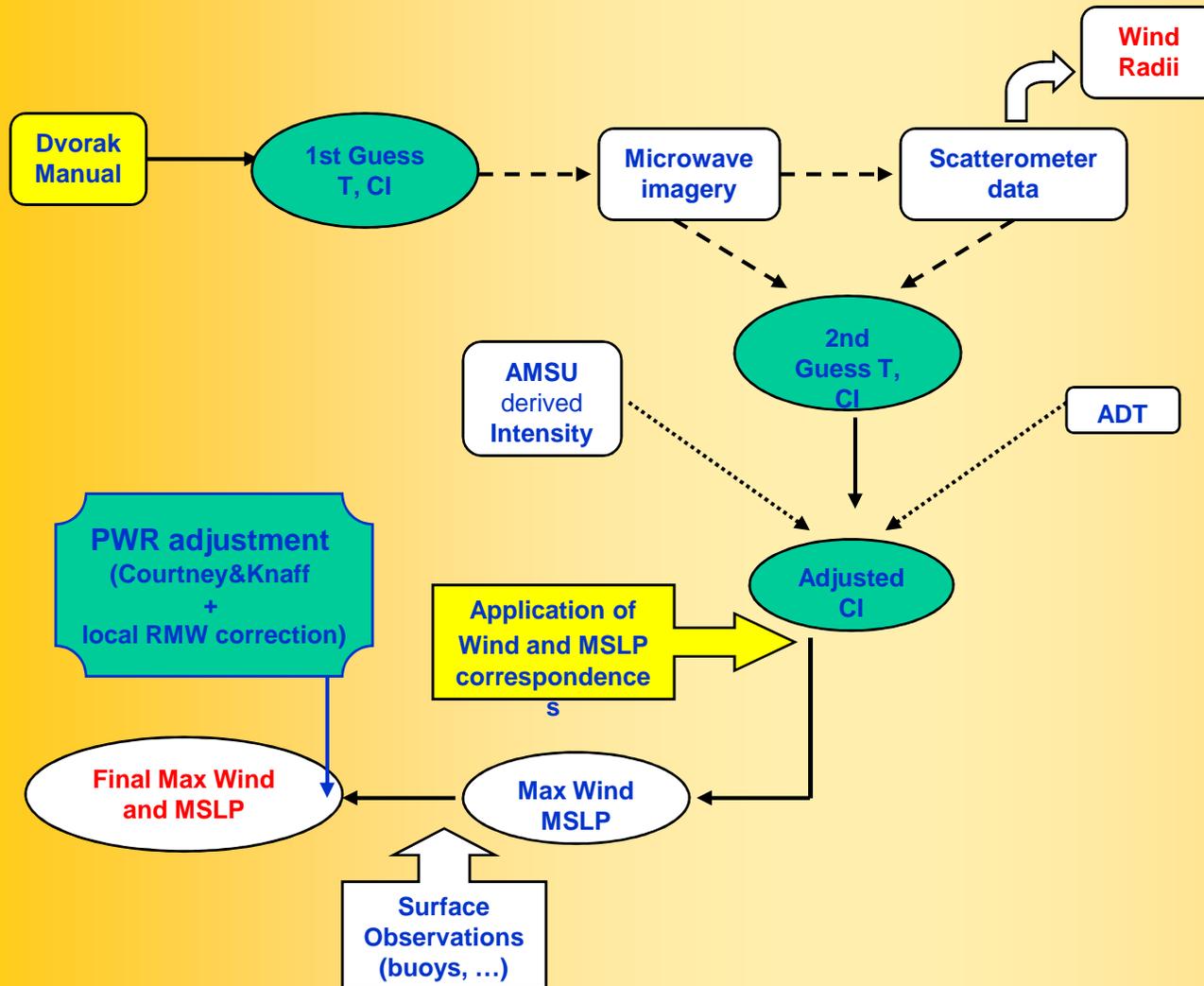
- Ambiguity selection



TC analysis : an integrated process



TC analysis : an integrated process



Schematic diagram of the TC analysis process at RSMC La Réunion.

TC analysis : an integrated process

