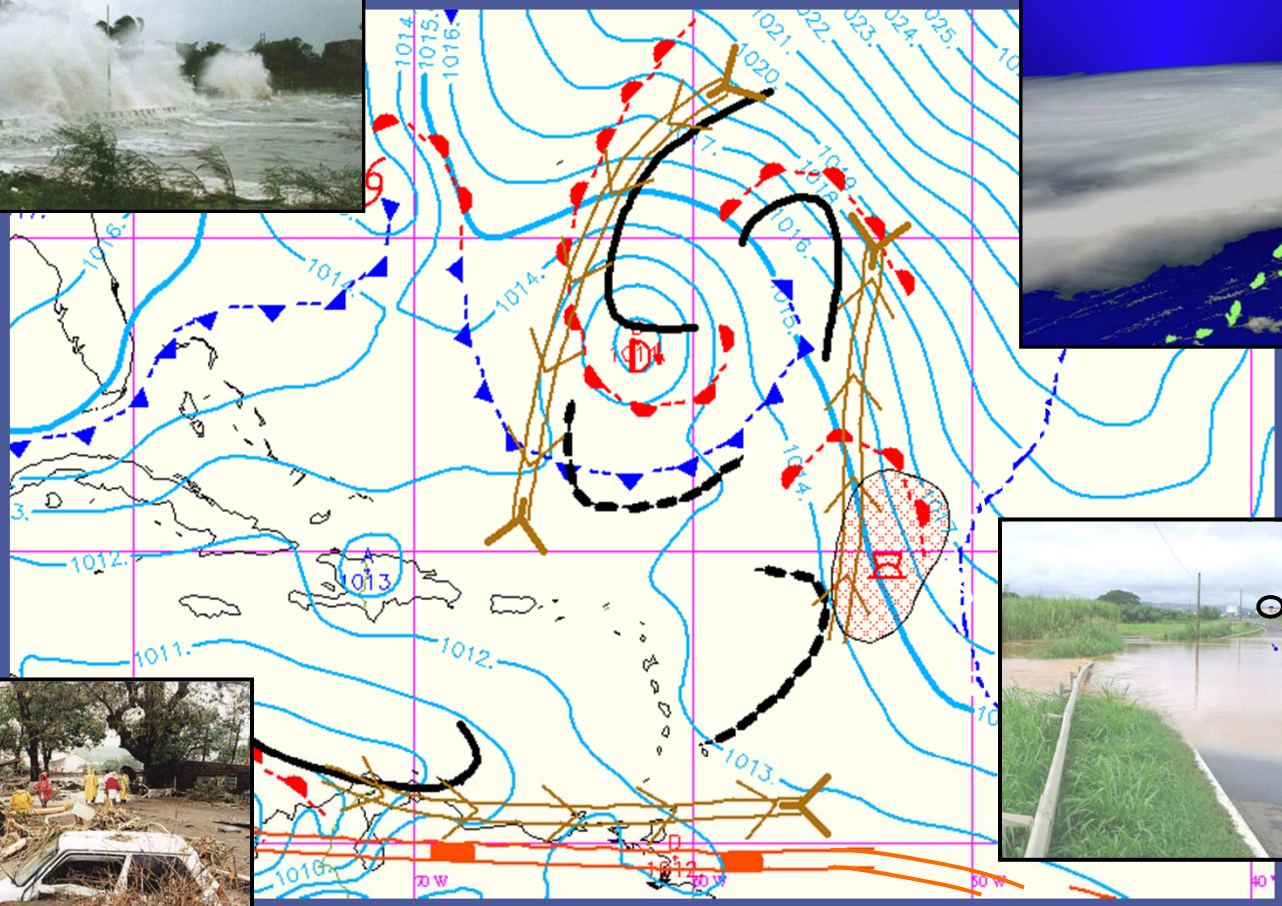
Forecasting methodologies for severe weather at MétéoFrance – FWI

Jean-Noel DEGRACE (MétoFrance Antilles-Guyane)



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Executive Summary

- The scale story
- Seasonal and monthly approach
- Methodology, tools and data for synoptic scale
- Downscaling
- Consequences approach and nowcasting

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A story of scales …

Geographical scales

- Global
- Regional (North Tropical Atlantic)
- Sub-regional (Antilles)
- Country/territory/Island
- Part of the country/island
- Community, River basin, …

Time scales

- Seasonal forecast
- Monthly forecast
- Medium range forecast (5-7 days)
- Short range forecast (1-3 days)
- Day forecast (12 – 24 hours)
- Nowcast (1 – 12 hours)

Contents

- ENSO, NAO, MJO, Monsoon

→ **Level 1: eg. drought**

- Probabilities of anomalies (rainfall, temperatures, SST, …)
- Guidance for general circulation, favorable conditions, potential of genesis, tracks, probabilities (thresholds) of severe weather…

→ **Level 2: eg. tropical wave**

- Disturbances and potential for associated severe weather (time frame, activity,…)

→ **Level 3: eg. heavy rain**

- Fine tuning for parameters (rainfall, wind force, waves characteristics, …); Consequences approach

→ **Level 4: eg. flooding**

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Organisation and methodologies related to the different scales

Seasonal and monthly forecast (level 1)

- Seasonal forecast based and compilation of several seasonal outputs for 2 essential parameters : rainfall and temperature
- Monthly forecast based on ECMWF products (dynamic model)
- + human expertise on anomalies, recent past conditions, known correlations, climatological references, …

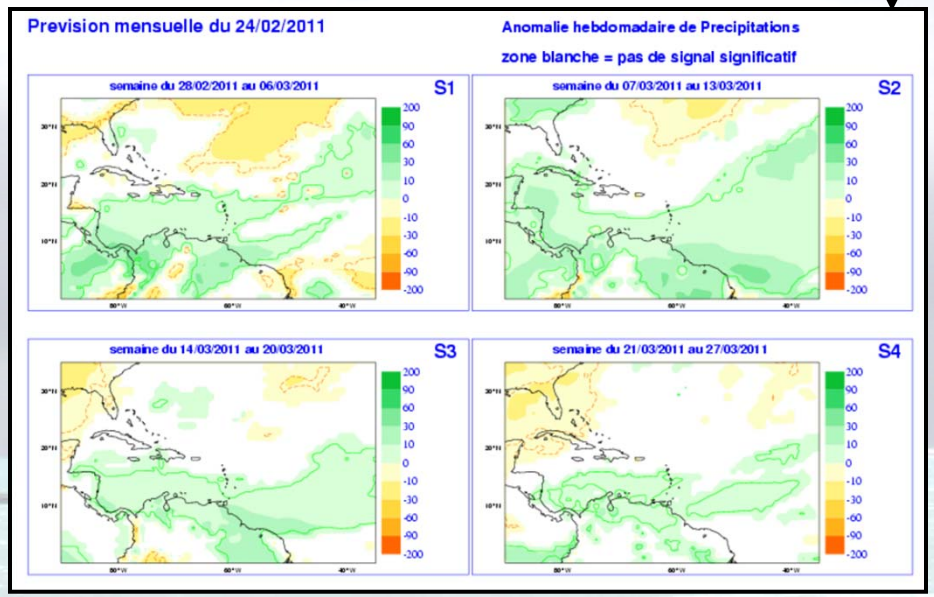
MODELES	France Métropole	Antilles	Guyane
CEP			
IRI			
MF			
Met Office			
JMA			
Synthèse	(3/5)	(4/5)	(4/5)
Scénario privilégié par Météo-France	Sec	Humide	Humide

P inférieures à la normale (sec)

P proches de la normale

P supérieure à la normale (pluvieux)

Pas de scénario privilégié



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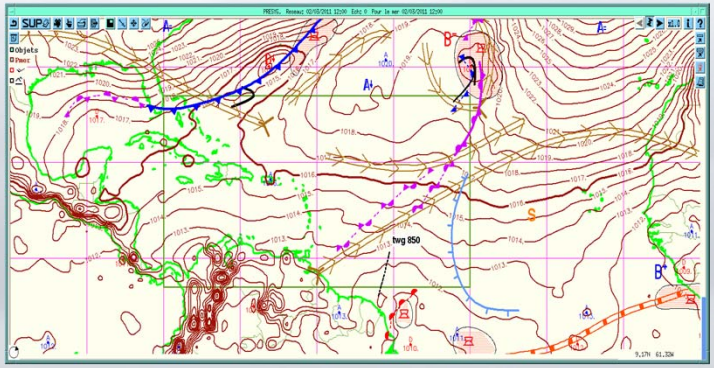
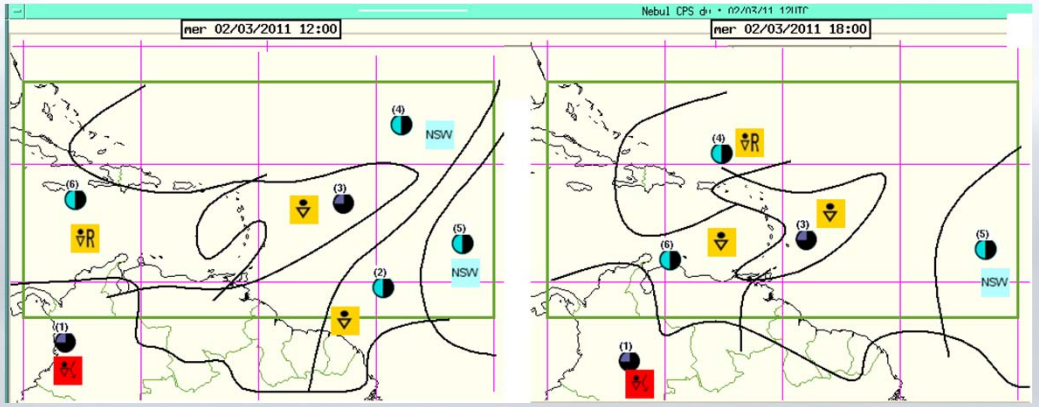
Organisation and methodologies related to the different scales

Synoptic and regional forecast and guidance (dealing with level 2 features)

- Specific « synoptic tropical desk » in Martinique (called « CPS » for Centre de Prévision Synoptique »
  - guidance and harmonisation (coherency) for day to day forecasting and for severe weather forecasting (vigilance system)
  - « expertise » products + conferences with the 3 « proximity forecast centers » (called « CPP » for Centres de Prévision de Proximité)



ANASYG (T00) and PRESYG (currently T+36, T+72)



Regional charts (type of weather), till Day+5 (step 6 or 12 hours)

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ANASYG/PRESYG methodology

- **Set of graphic documents for a 4D representation of the atmosphere, with all the meteorological features involved**

  a synthetic, concrete and efficient way to

  - ☞ analyse, understand and describe the dynamics of the atmosphere using state of the art of science
    - ☞ Choose the "best" scenario based on the alignment of several models with regards to the analysis and the recent hours
  - ☞ follow up the meteorological situation ("all in one") and all the features of interest (specifically for potential severe weather)
  - ☞ build guidance on the scenario (not on one model) for a better coordination and communication between forecasters

- **Completed by regional significant weather charts for downscaling purpose**

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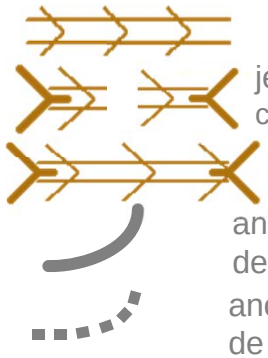
High trop. dynamic



courant jet

jet avec forte confluence/diffluence

rapide du Jet

anomalie dynamique de tropopause

anomalie latente de tropopause

High-Mid trop.

Axe talweg (250 à 500 hPa, quand **non associé à anomalie de tropo**

Sea Level Features

A= anticyclone stationnaire

A anticyclone en baisse

A anticyclone en hausse

D= dépression stationnaire

D↓ dépression se creusant

D↑ dépression se comblant

δ dépression orographique

d dépression thermique

D_{Hugo} dépression provenant d'un ex-cyclone

D_p polar low

cyclone tropical

tempête tropicale

dépression tropicale

Frontal systems

anafront froid front chaud occlusion

front quasi stationnaire

front froid en frontolyse

front chaud en frontolyse

front quasi-stationnaire en frontolyse

occlusion se dissipant

trace en surface

trace en altitude

Pseudo frontal systems (baroclinic areas)

pseudo-front froid

pseudo front chaud

pseudo-quasi-stationnaire

Limite air très sec et subsident

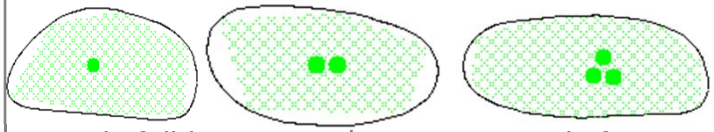
Advection sable

Large scale features

Trace, sans activité

Activité convective

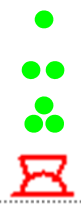
Areas of precipitation



zone de faibles précipitations

zone de précipitations modérées

zone de fortes précipitations



frontogenèse faible

frontogenèse modérée

frontogenèse forte

activité convective orageuse

Low level features

ligne de convergence en surface

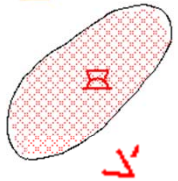
jet de basses couches

Modérée Intense

Tropical waves

Areas of strong convection

Forte convection en ligne, ou en virgule



Amas de forte convection en air chaud (pas d'organisation claire)

ligne de grains (en air chaud)

Tools and data

Comprehensive workstation for expertise and production of guidance

- All kinds of satellite products (IR, VIS, WV,…) including
  - Composite coloured imagery from Africa to Central America, High resolution (1km)Visible regional images, Scatterometers information,
- All kinds of observations (surface, altitude – from RS, planes, satellite derived, sea surface, lightning – from long range UK system, …)
- Global models from different NWP centres, with deterministic and probabilistic (from Ensemble) products for atmosphere and waves
  - ECMWF : 2 runs per day, till H+180; 0.25° and 0.5° resolution for deterministic charts
    - specific products from EPS (Meteogrammes), probabilities of exceeding thresholds, tropical cyclone management (spaghettis, track probabilities, …), Extreme Forecast Index (EFI)
  - ARPEGE : 4 runs per day, till H+84, 0.5° resolution for charts; Ensemble products being tested presently
  - GFS (from GTS only) : 4 runs per day, till H+168; 2.5° resolution

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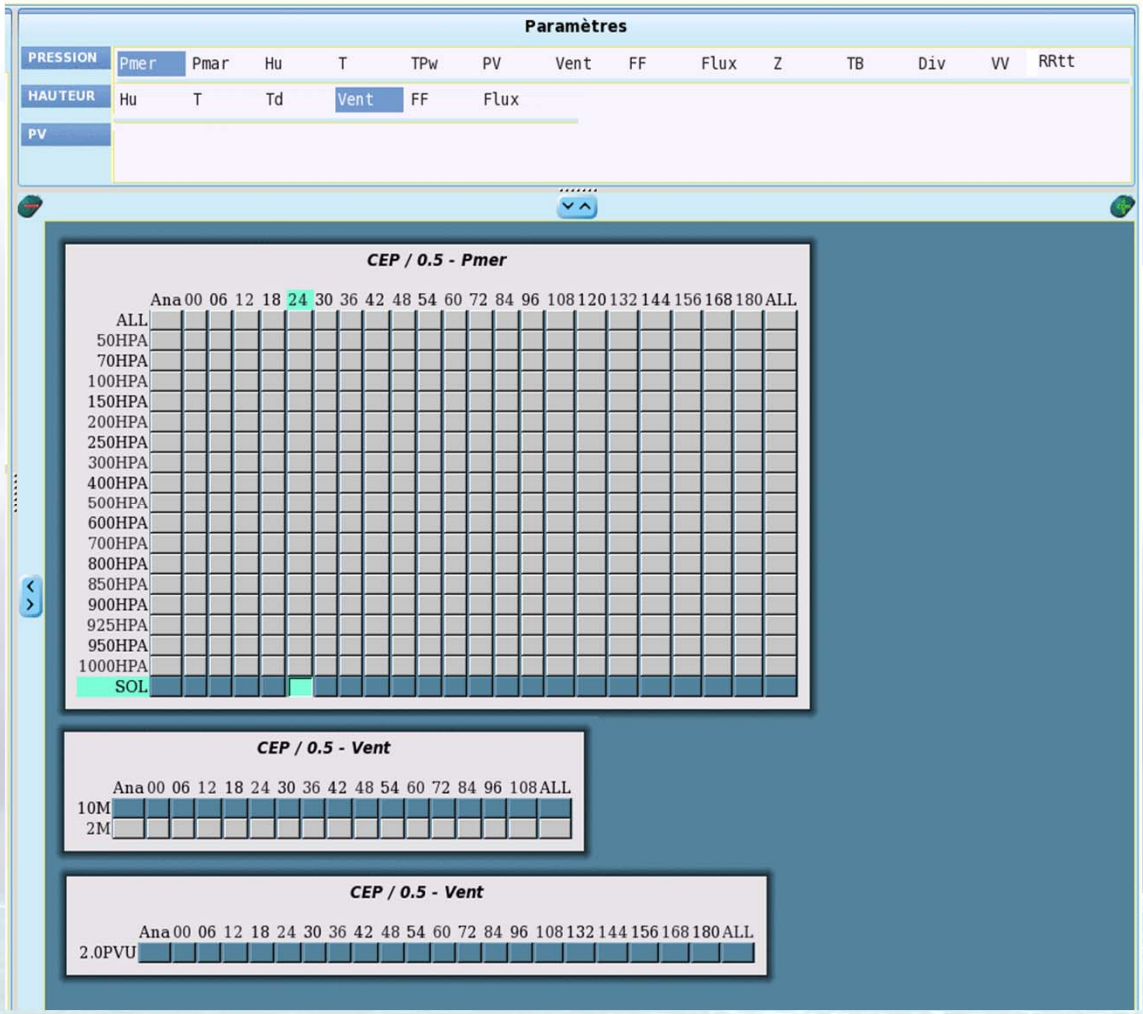
NWP on « Synergie » workstation



Example of parameters and levels available from ECMWF deterministic model

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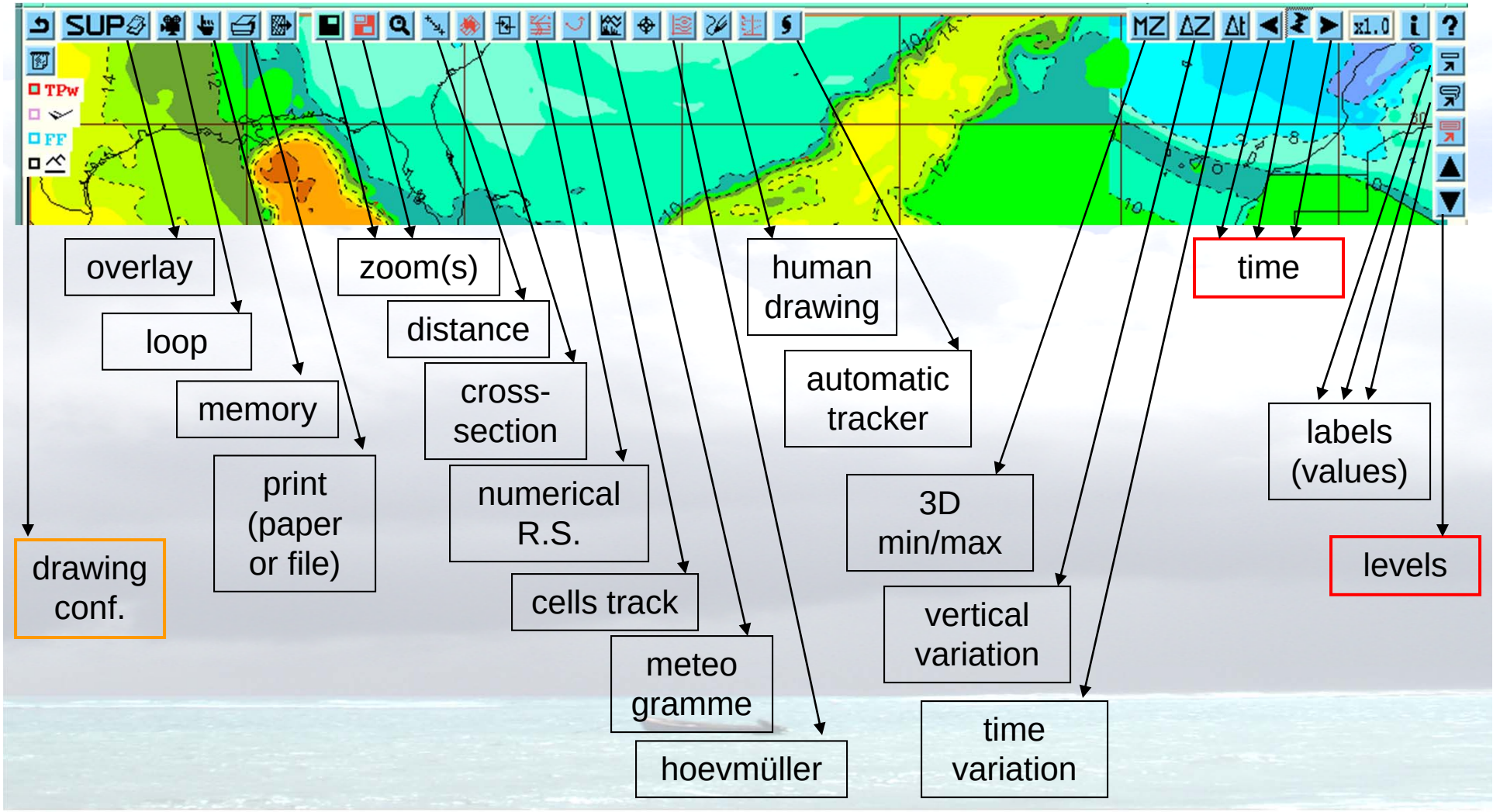
NWP on « Synergie » workstation



Example of functions avalaible for NWP expertise

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Organisation and methodologies related to the different scales

Downscaled short range forecast for each island/territory

From regional guidance to local forecast, dealing with danger of level 3, using :

- **Guidance products (consensus scenario)**

- **Local observations**
  - **Radar : up to 256km, 5 minutes frequency, 250 to 1km resolution; intensity and rainfall accumulation (15' to 24 hours)**
  - **AWS : rainfall, wind, temperatures, … (more than 40 sites in Martinique thanks to local institutional partners, less in Guadeloupe, too few in French Guyana)**
  - **Waveriders : 3 around Martinique, 2 around Guadeloupe; spectral information on waves (height, direction, period, energy, spectrum, temperature**

- **Regional numerical models, in 0.1° resolution**
  - **Aladin « Antilles-Guyane » for atmosphere**
  - **Antilles Wave model (Vag-Antilles)**

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Organisation and methodologies related to the different scales

From significant weather to "consequences approach" through an integrated methodology (danger of level 4), with a vision open to…

- **Recent past and vulnerability**
  - Recent climatology (eg. accumulated rainfall in the previous week) available to the forecaster in real time
  - Status/level of the rivers thanks to cooperation with local institutional partners through « limnimeters » networks; Status of soil
  - Knowledge of (up to date) risk assessment, report of recent severe events
- **Fine mesh monitoring capacities (cf. observations)**
  - + non conventional monitoring tools (webcam, limnimeters, …)
- **Nowcasting**
  - Regional NWP from T+00 to T+12 step 3h
  - Specific tools for radar « advection » (2 Π R methodology currently being tested)
  - Rainfall/flow models for flash flood forecasting (being discussed between partners; need for hydrologists input)

➢ **Example of tool and application : the Flash Flood Guidance System**

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Limnimeters network on main sensitive rivers (example during Tomas,

Pont Spitz.

Caractéristiques :
Nom de la rivière : la Lézarde
Nom de la commune : Lamentin

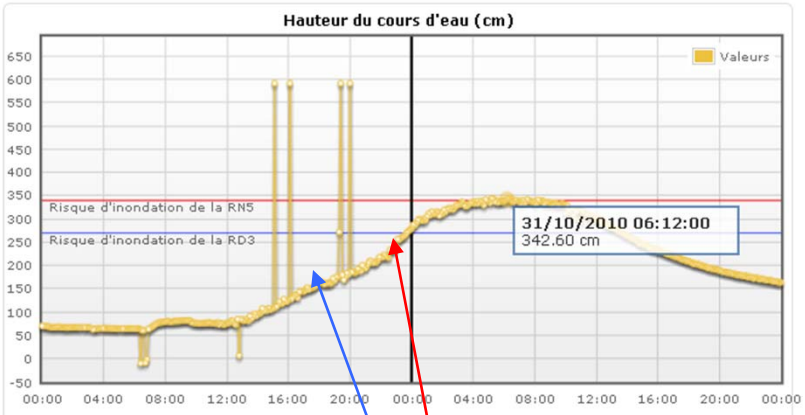
Valeur des seuils d'alerte :
Risque d'inondation de la RN5 : 340 cm
Risque d'inondation de la RD3 : 270 cm

31/10/2010

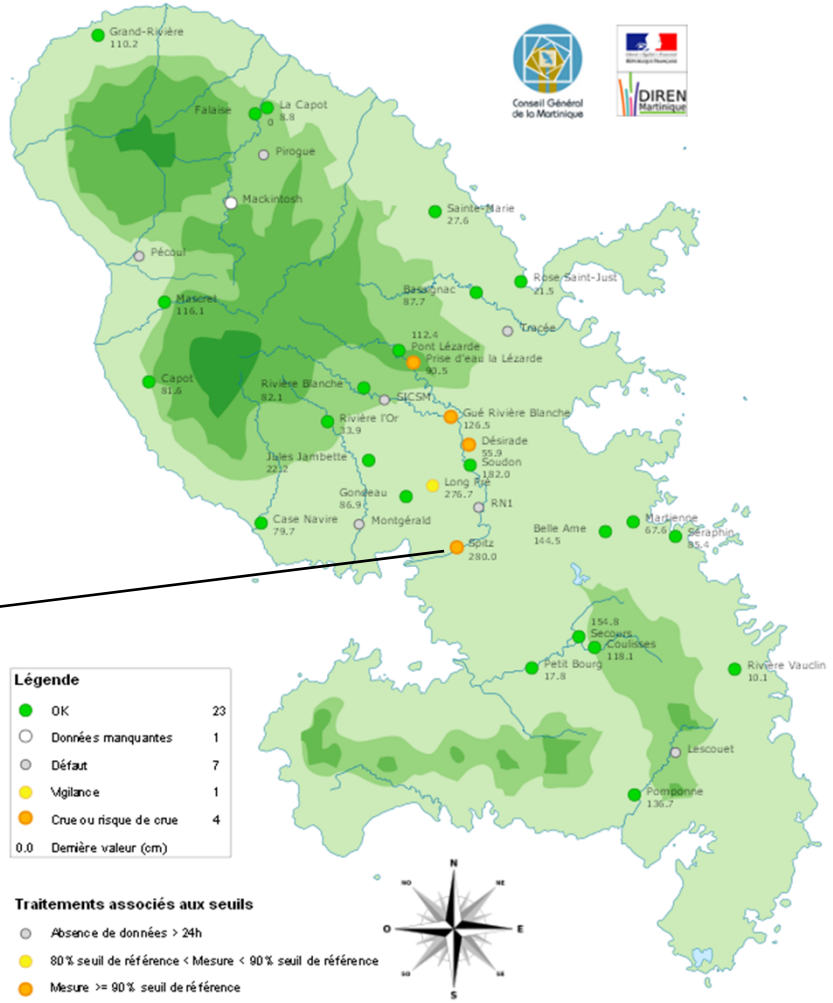
Graphe | Tableau | Graphe & Tableau

Relevé Limnimétrique du 30/10/2010 au 31/10/2010.

GRAPHE DE DONNÉES LIMNIMÉTRIQUES



Relevé limnimétrique du 31/10/2010 00:00:00.



Thresholds for flooding

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WEBCAM network, at sensitive sites (rivers, heavy traffic area, shore, …)

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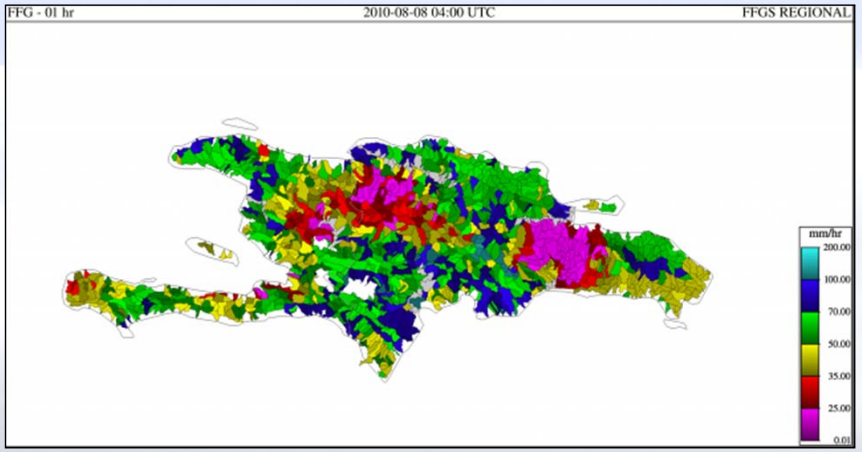
Example of integrated tool: Flash Flood Guidance System used for Haiti and Dom. Rep.

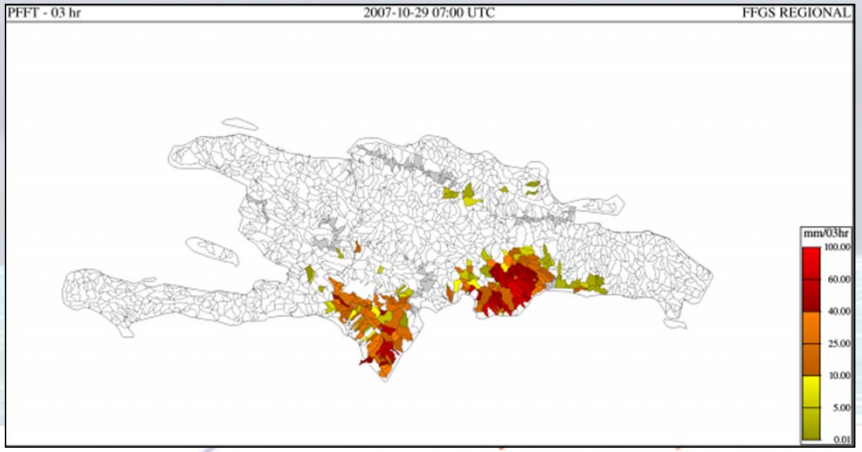
- **A tool providing INDICES of FLASH FLOOD POTENTIAL**

- **Basic Features of FFG Technology**

  - Flash Flood Guidance
    → volume of rainfall of a given duration (1-6 hours) over a given small catchment that is just enough to cause bank full flow at the outlet

  - Flash Flood Threat
  - → rainfall of a given duration in excess of the corresponding Flash Flood Guidance value (past or "forecast" rainfall; measure of uncertainty)

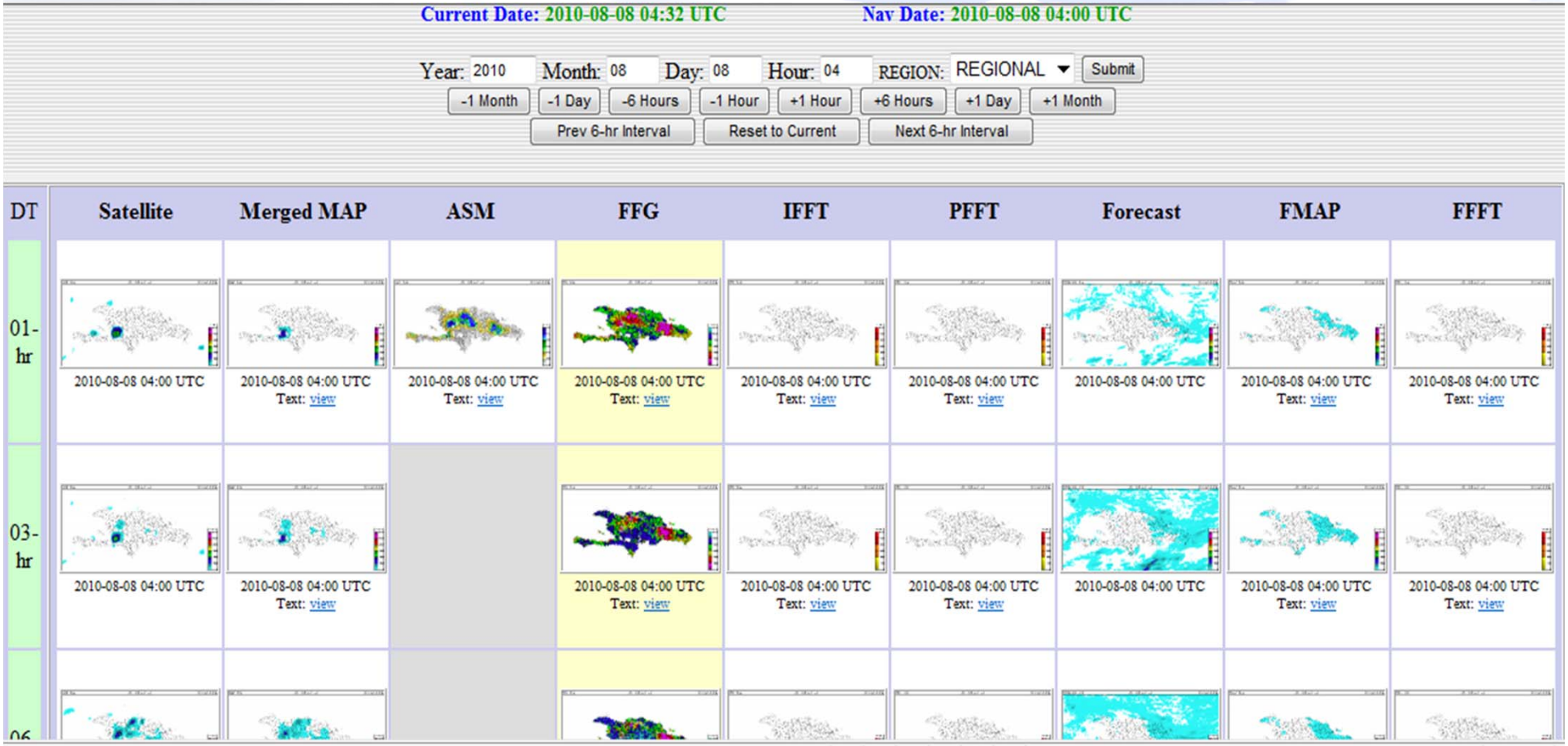




Example of integrated tool: Flash Flood Guidance System used for Haiti and Dom.Rep

- **WEBpage based interface for forecaster**

https://70.168.54.238/HDRFFG/



END

And then, will come the time of other big challenges :

-How to share the information and to build coordinated expertise with other « neighboring » forecast offices

-How to convey the information with the best efficiency to DRM agencies, multi-sectorial stakeholders, media, general public , . . .

This will be the next story . . .

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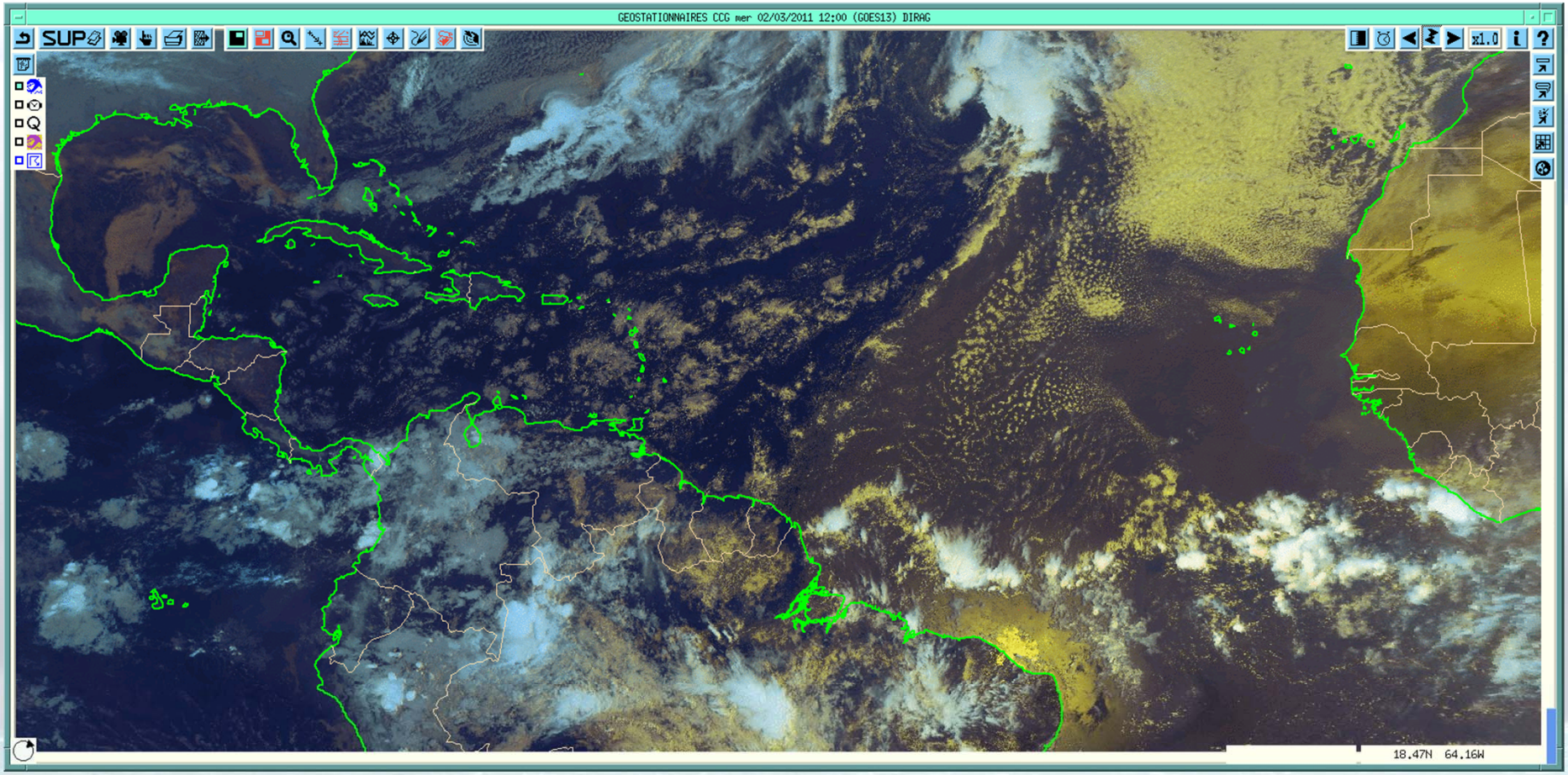
Example of composite (IR + Vis) bi-satellite (GOES+MSG) image



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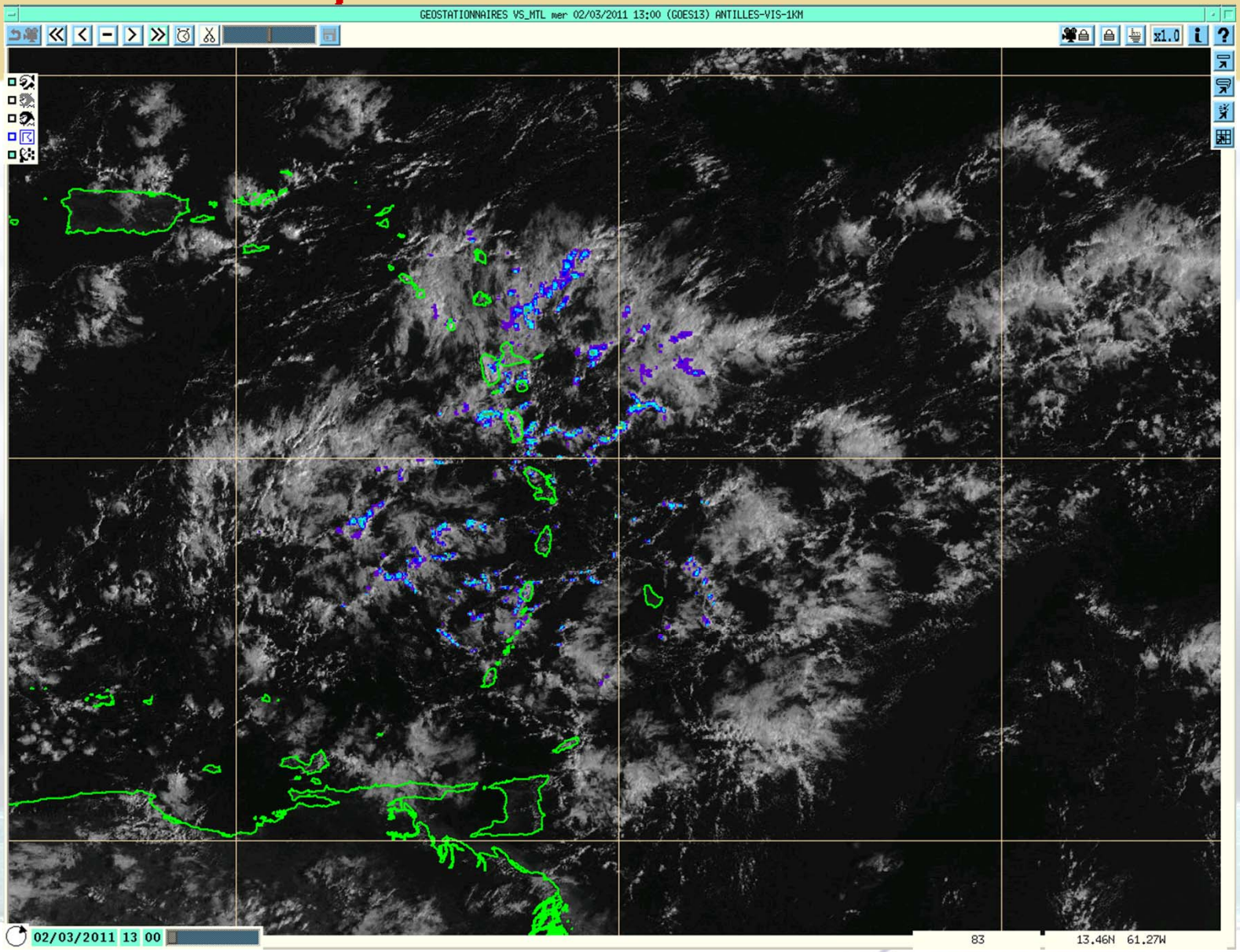
Example Vis HR 1 km + Radar 400km



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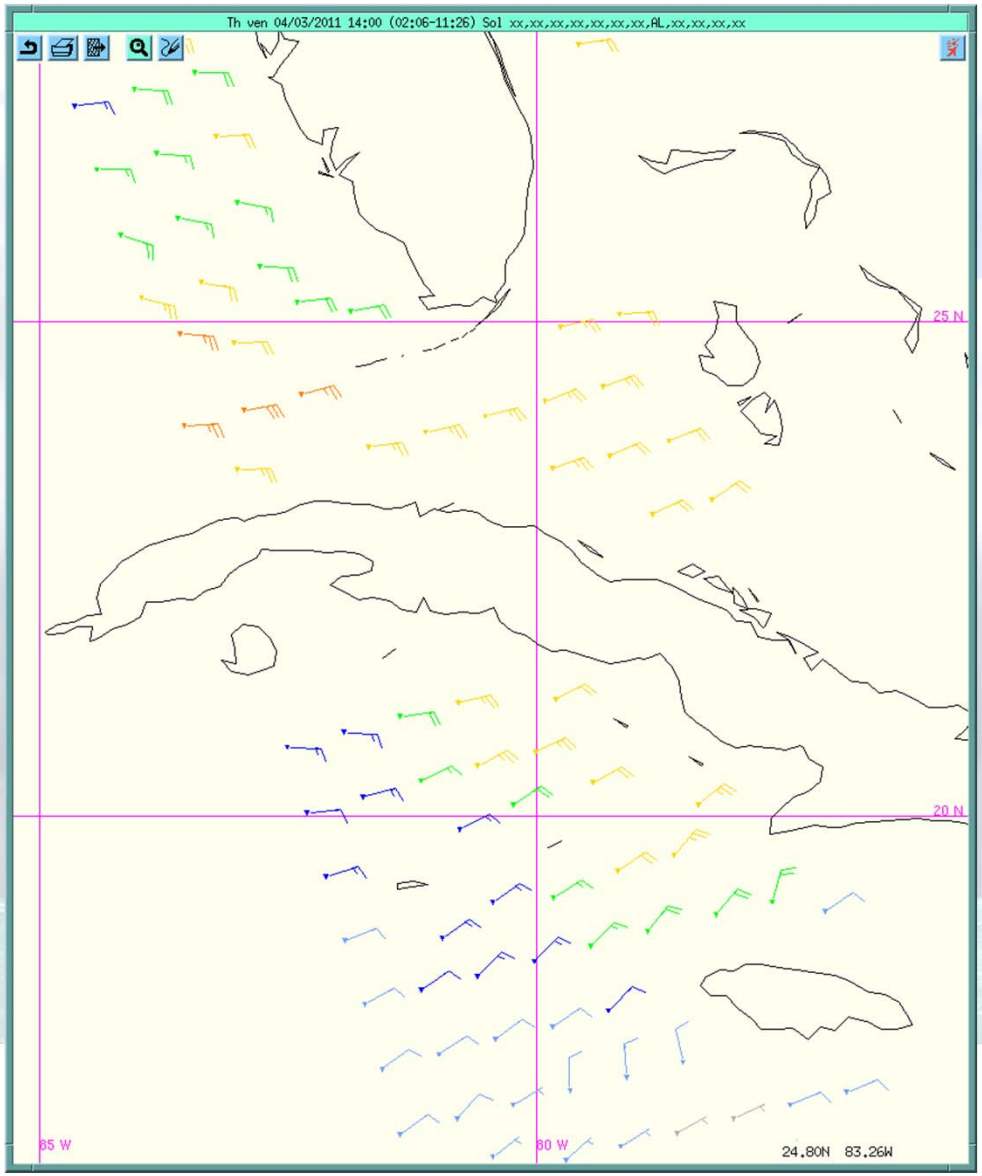
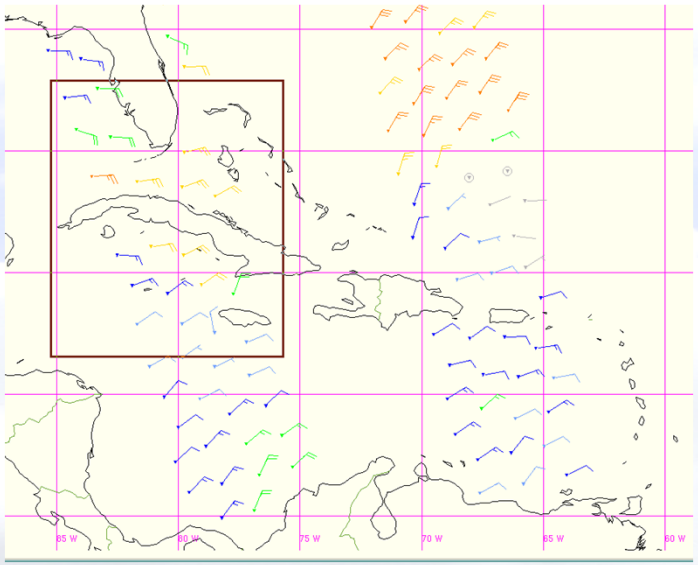
Example : Wind from scatterometer (Windsat)





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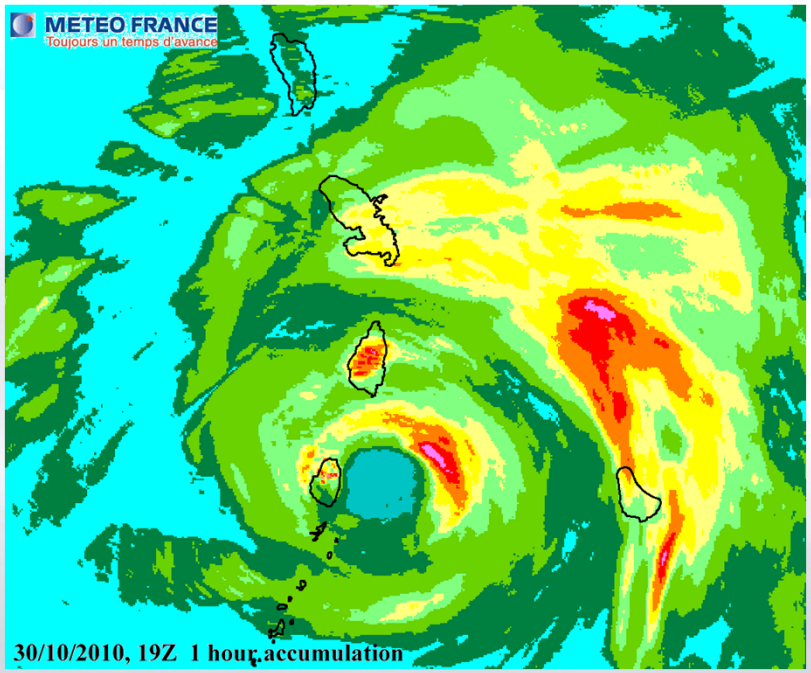
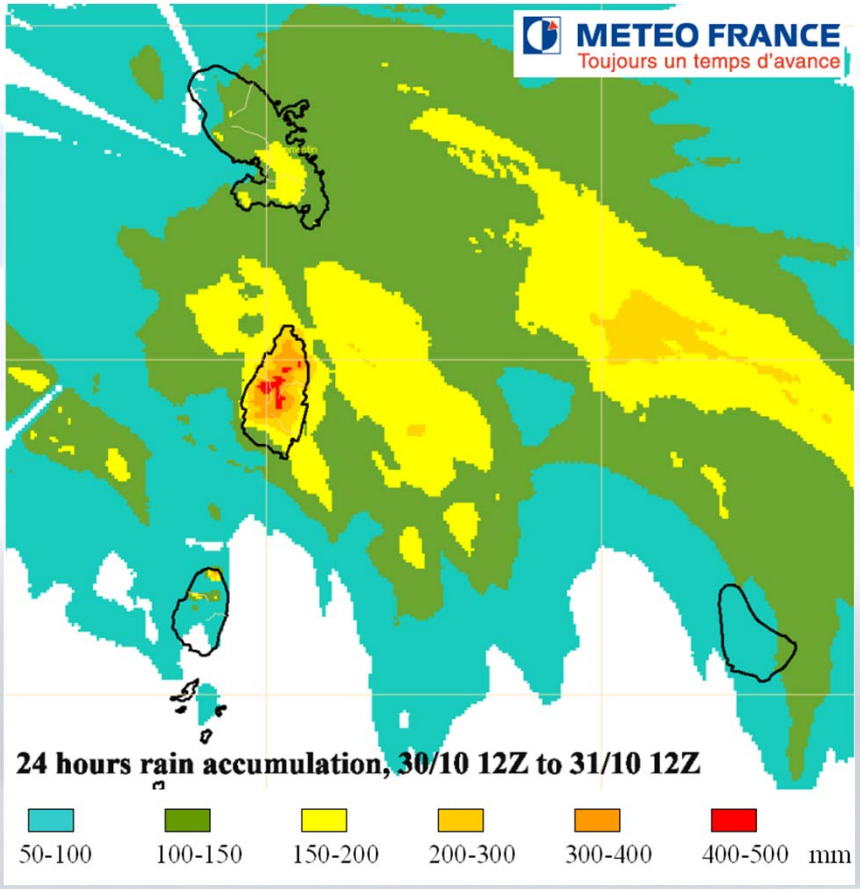
Example of rainfall accumulation from the radar



1 hour accumulation, during the passage of Tomas

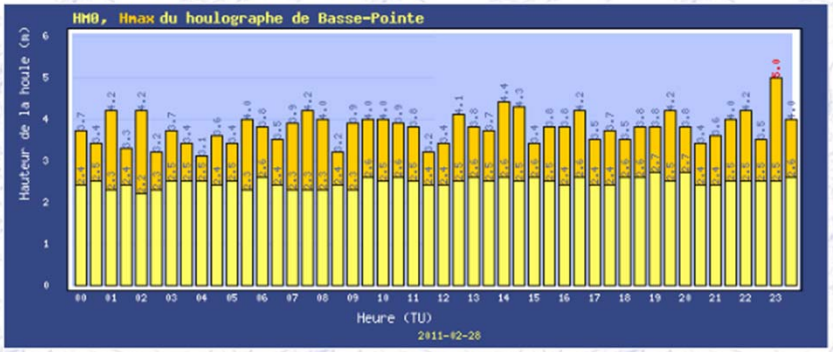


24 hours accumulation, during the passage of Tomas

Example of spectral information from waveriders

Houlographe de Basse-Pointe: données horaires et spectrales

le - 2011-02-28 + Houlographe de Basse-Pointe Visualiser

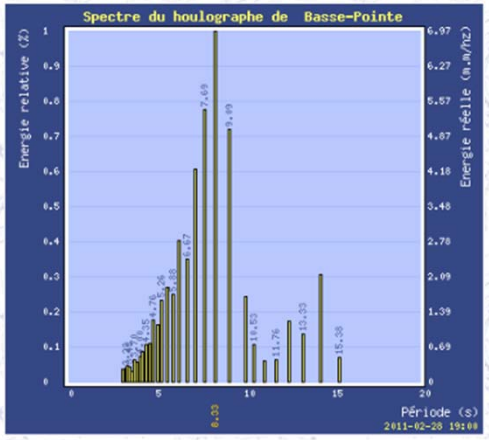


latitude 14°53.429'N longitude 61°06.877'W prof 51.00

Date Heure TU	HM0	Hmax	T(0,2)	Tpic	Epic	Dpic	t(°C)	pile
2011-02-28 23:30	2.6	4.0	6.0	8.3	10.720880	048	26.5	7
2011-02-28 23:00	2.5	5.0	5.7	9.0	5.709853	038	26.5	7
2011-02-28 22:30	2.5	3.5	5.9	7.6	5.767238	045	26.5	7
2011-02-28 22:00	2.5	4.2	5.9	8.3	5.681375	047	26.5	7
2011-02-28 21:30	2.5	4.0	6.0	8.3	6.633902	045	26.5	7
2011-02-28 21:00	2.4	3.6	5.7	8.3	6.667155	042	26.5	7
2011-02-28 20:30	2.4	3.4	5.7	8.3	6.767916	044	26.5	7
2011-02-28 20:00	2.7	3.8	5.9	8.3	7.008987	041	26.5	7
2011-02-28 19:30	2.5	4.2	5.7	7.6	5.825199	054	26.5	7
2011-02-28 19:00	2.7	3.8	5.7	8.3	6.974030	042	26.5	7
2011-02-28 18:30	2.6	3.8	5.7	8.3	7.008987	044	26.5	7
2011-02-28 18:00	2.6	3.5	5.7	8.3	7.008987	049	26.5	7
2011-02-28 17:30	2.4	3.7	5.7	8.3	6.216414	052	26.5	7
2011-02-28 17:00	2.4	3.5	5.7	7.6	4.963907	058	26.5	7
2011-02-28 16:30	2.6	4.2	5.8	7.6	7.079429	061	26.5	7
2011-02-28 16:00	2.4	3.8	5.6	7.6	5.624844	069	26.5	7
2011-02-28 15:30	2.5	3.8	5.8	8.3	7.079429	066	26.5	7
2011-02-28 15:00	2.6	3.4	6.0	8.3	8.954831	058	26.5	7
2011-02-28 14:30	2.5	4.3	6.0	8.3	7.186420	065	26.5	7
2011-02-28 14:00	2.6	4.4	5.7	7.6	7.114914	055	26.5	7

Données spectrales du houlographe de Basse-Pointe

le - 2011-02-28 + - 19:00 + à Basse-Pointe



Période (s)	En. réelle (m²/hz)	Direction (°)
15.38	0.471039	016
14.29	2.121646	021
13.33	0.939122	017
12.50	1.205858	020
11.76	0.439196	026
11.11	0.417779	023
10.53	0.735055	017
10.00	1.677310	028
9.09	5.013797	040
8.33	6.97403	042
7.69	5.404287	051
7.14	4.229965	055
6.67	2.440478	055
6.25	2.807214	058
5.88	1.728394	065
5.56	1.881732	054
5.26	1.619620	063

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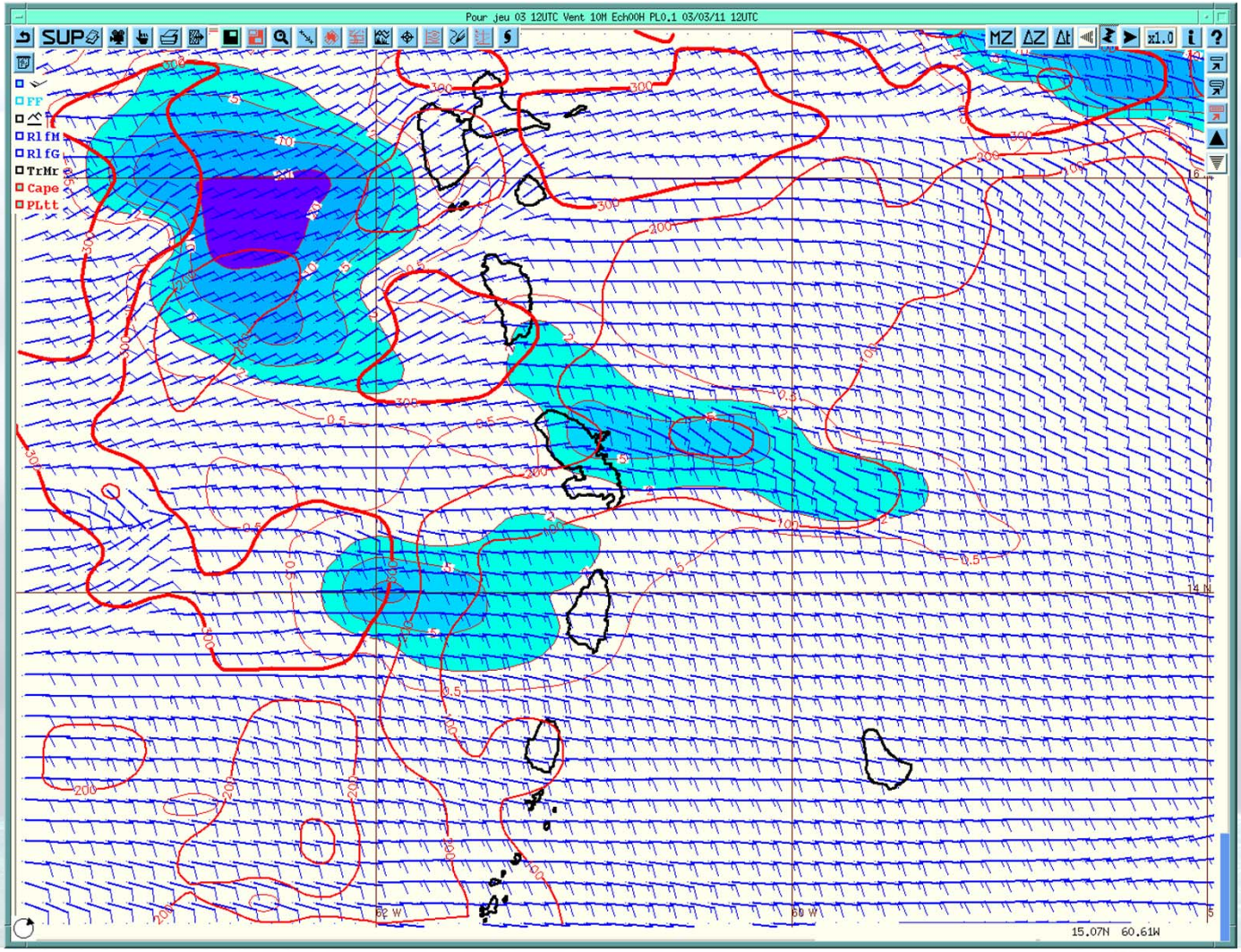
Example from « Aladin »



10m wind

+

06hours rainfall

+

CAPE

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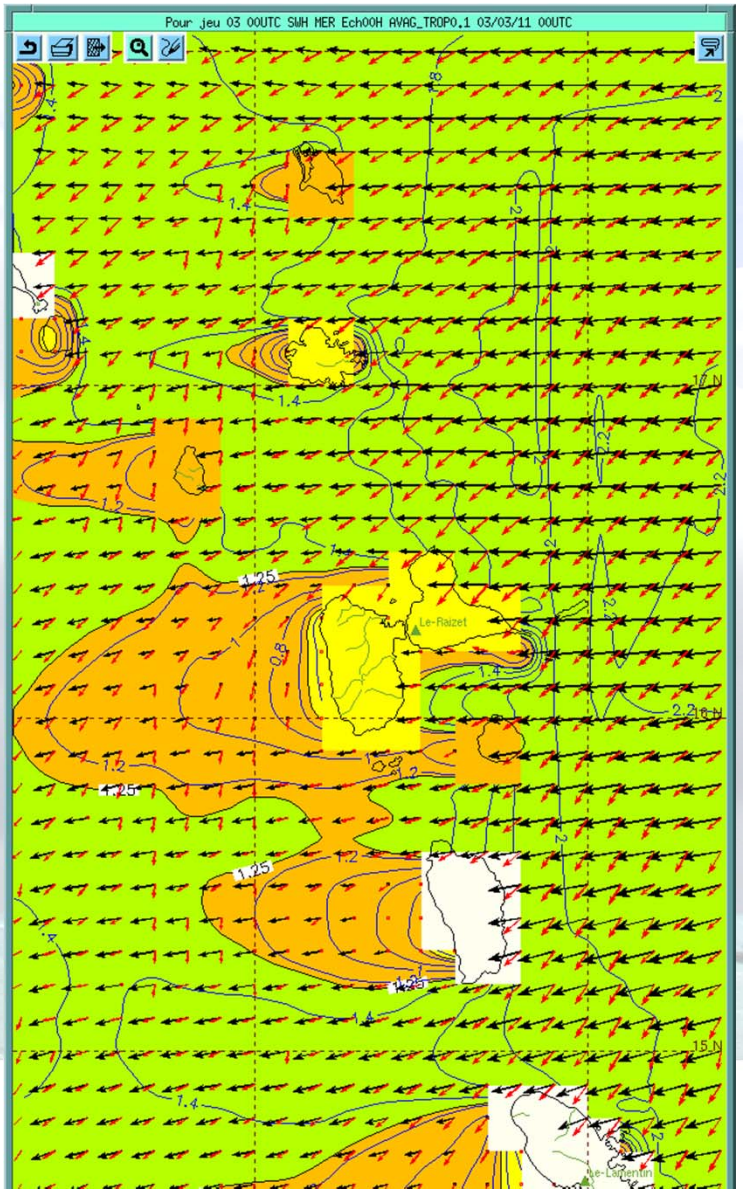
Example from « Vag-Antilles



Total height

+

Swell (height and direction)

+

Windwaves (height and direction)

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