Deducing the Future from Models: Other Model variables.

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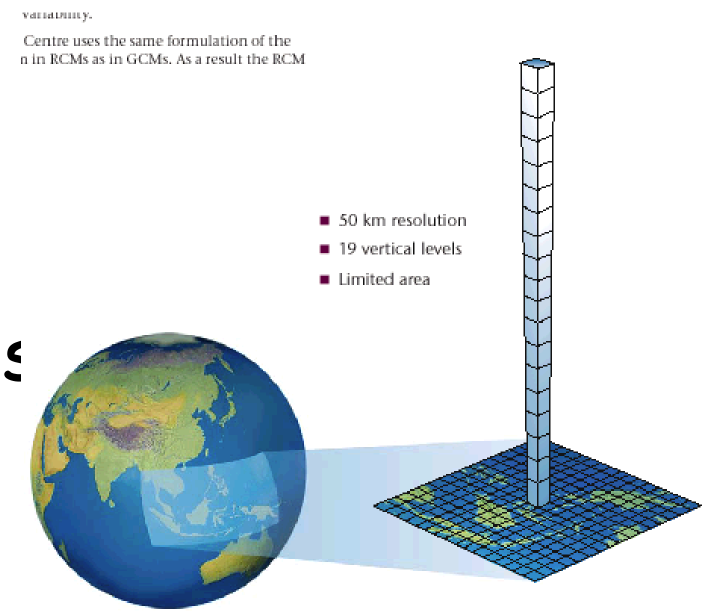

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OUTLINE OF PRESENTATION

- Recap
- Regionalization techniques, Models, Output from models and List of Variables
- Examples of analysis and uses in some cases.
- Tropical Cyclones
- Cold fronts.
- Heavy rainfalls
- Other examples. (dust, radiation, drought, renewable energy)
- Summary.

Recap 1 Equations of a climate model

The equations of a climate model (atmosphere)

$$\frac{\partial \overline{V}}{\partial t} + \overline{V} \cdot \nabla \overline{V} = -\frac{\nabla p}{\rho} - 2\overline{\Omega} \times \overline{V} + \overline{g} + \overline{F}_{\overline{V}}$$

Conservation of momentum

$$C_p\left(\frac{\partial T}{\partial t} + \overline{V} \cdot \nabla T\right) = \frac{1}{\rho}\frac{dp}{dt} + Q + F_T$$

Conservation of energy

$$\frac{\partial \rho}{\partial t} + \overline{V} \cdot \nabla \rho = -\rho \nabla \cdot \overline{V}$$

Conservation of mass

$$\frac{\partial q}{\partial t} + \overline{V} \cdot \nabla q = \frac{S_q}{\rho} + F_q$$

Conservation of water (or chemical tracer)

$$p = \rho R T$$

Equation of state

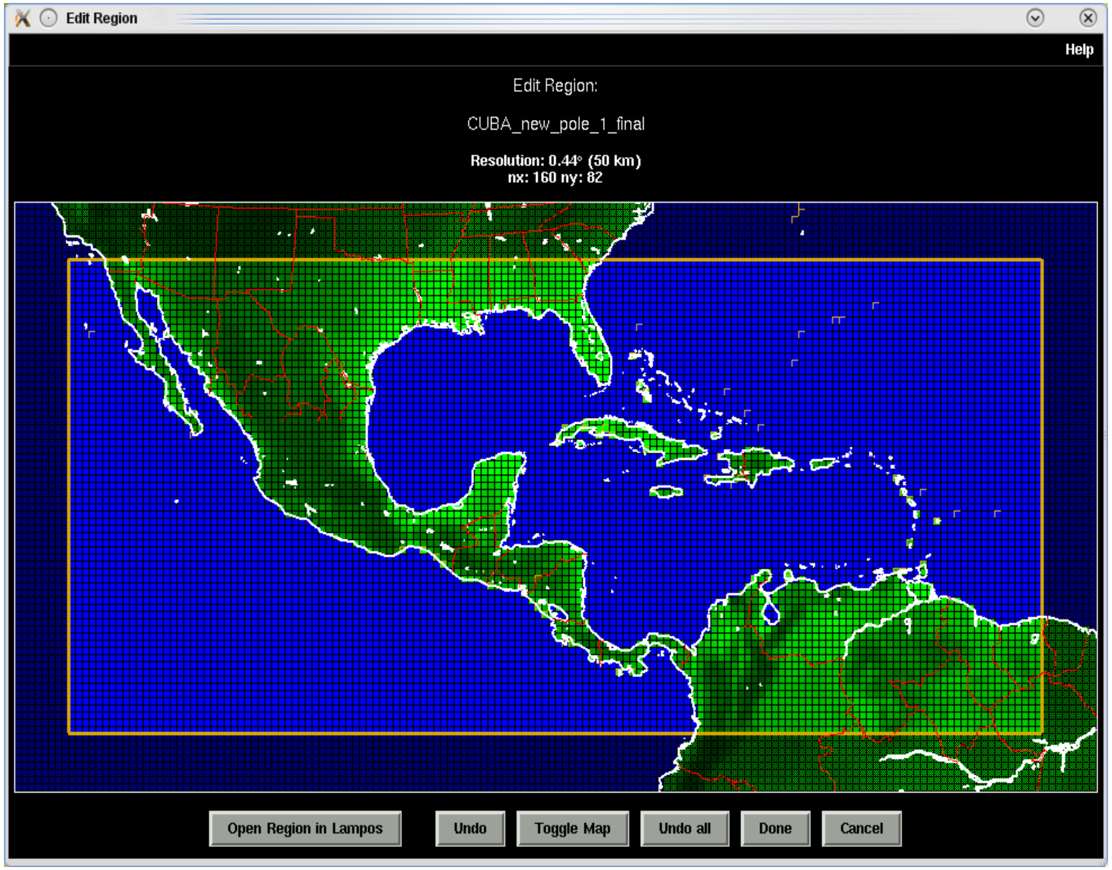
Recap 2 - What is a Numerical modeling ?

Numerical modeling is simply taking the equations that govern a system and using them to simulate the changes in a system with math.

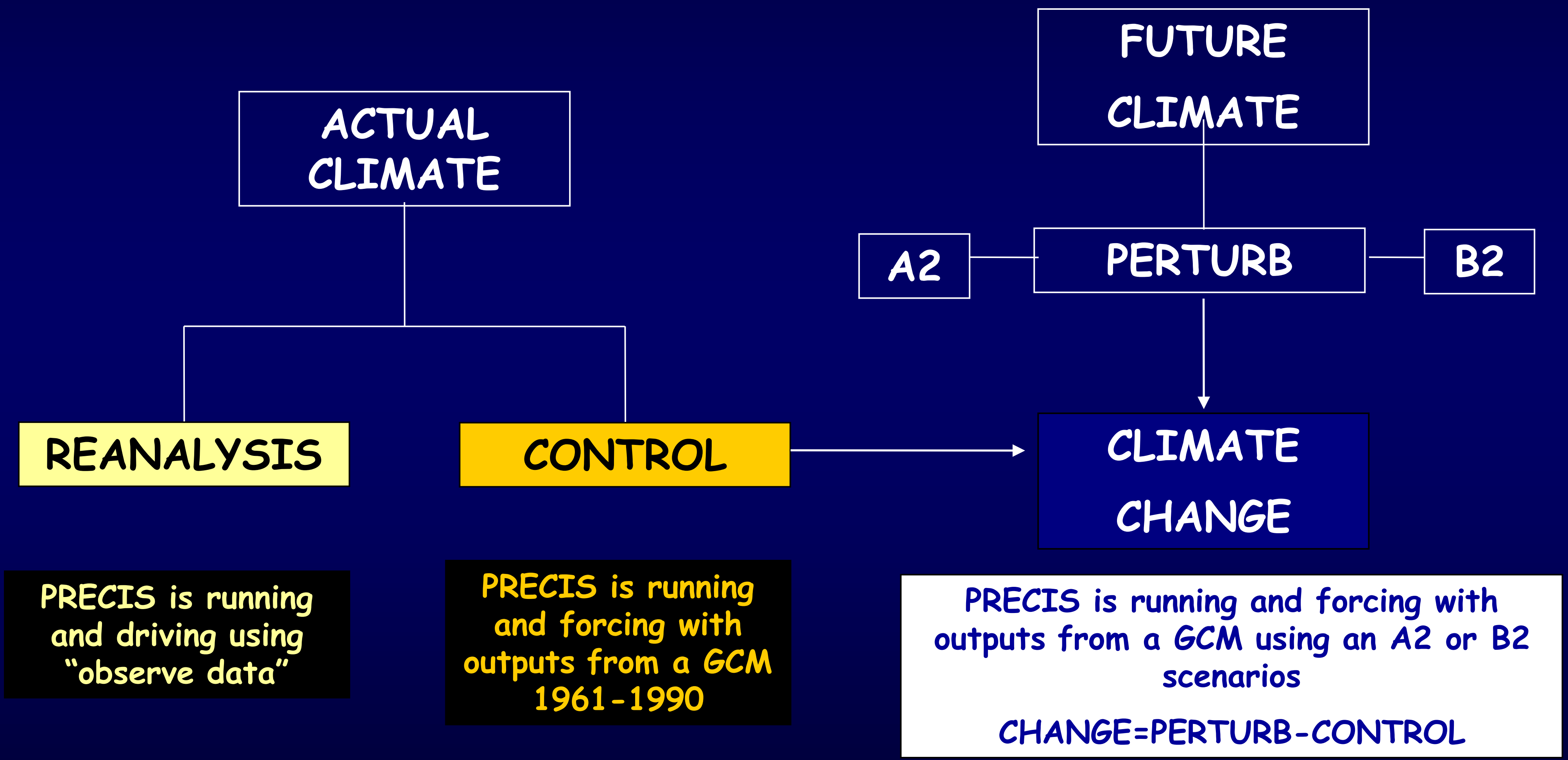
With the right equations and the proper math techniques, scientists can use numbers and variables to create a rather accurate portrayal of atmospheric processes.

The equations are solved for specific variables which can be used in visualizations so that we can see how the atmosphere changes with time.

RECAP 3 How RCM's work from a GCM's output



Recap Work Scheme



Recap 5 – Models are the best !!!

Most agree that GCMs are currently the best way to predict climate change and they are constantly being improved. However, there are two complications for decision makers to consider when using GCMs. First, irreducible uncertainties are an inherent element of climate change, regardless of the sophistication of modelling techniques.

The second challenge concerns the resolution of these models. GCMs are built by creating a grid that covers the entire globe. Predictions are made by resolving the model equations for each square and then linking this to the surrounding squares. The complexity of the models limits the resolution at which predictions can be generated. Currently, most GCMs generate information for grid squares that are about 2° square.

Regionalization techniques.

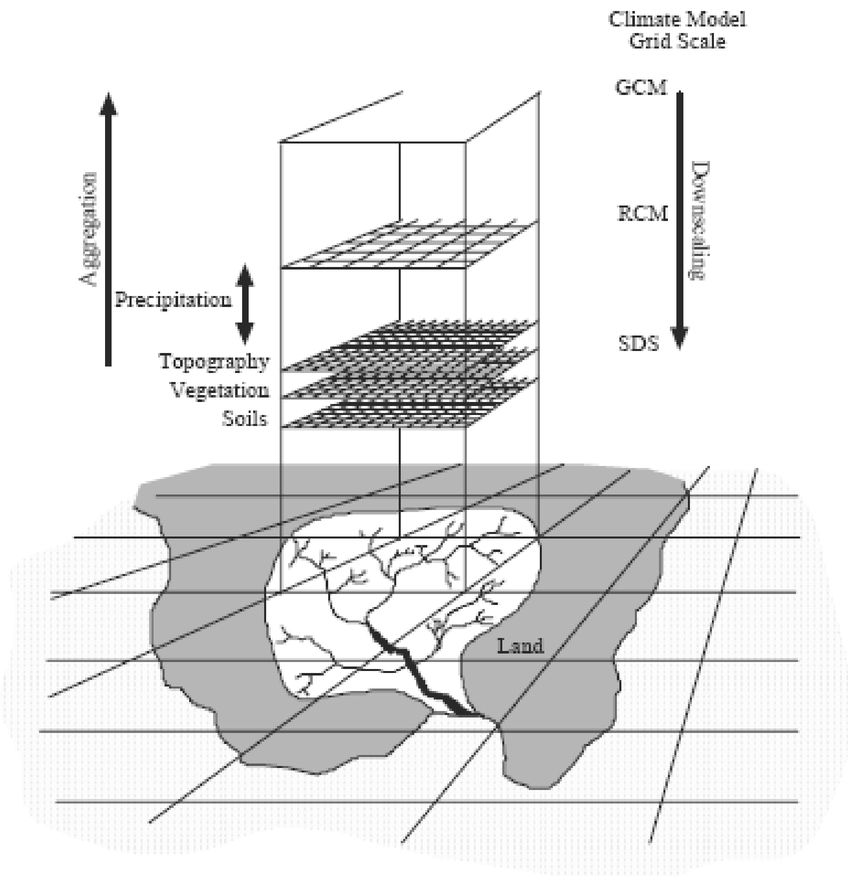
- Downscaling Estadístico (SDSM)

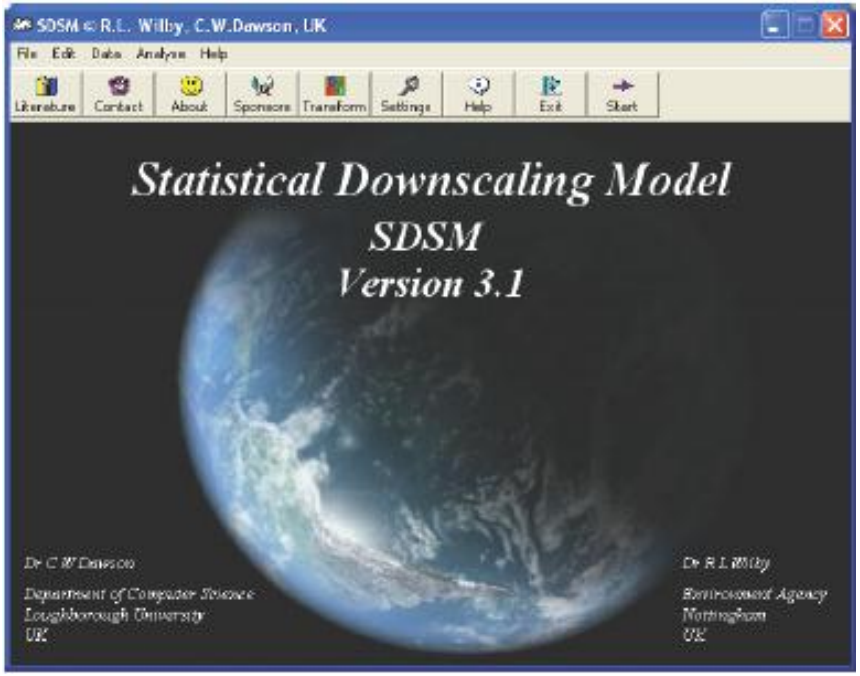
- Regional Climate Models.
  (RegCM, PRECIS, ETA componente climática)

- Statistical-Dynamical downscaling

- Time slices simulations

SDSM (Statistical DownScaling Model)





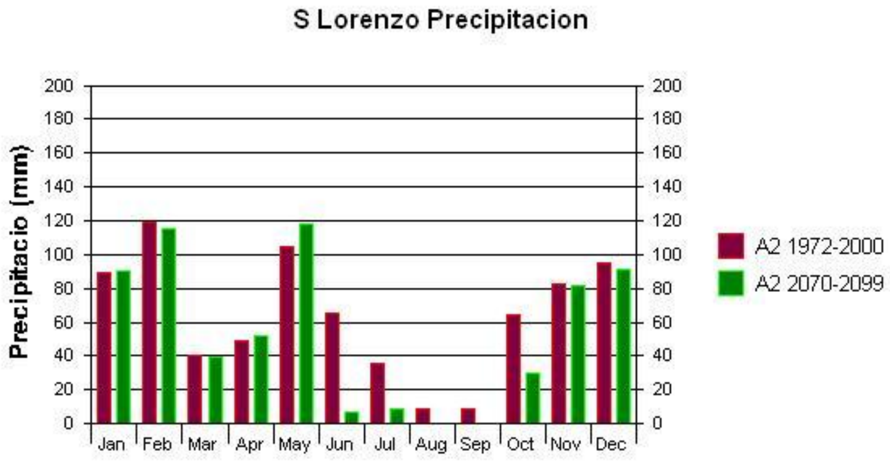
Predictand (local-scale) = function (predictor (GCM))

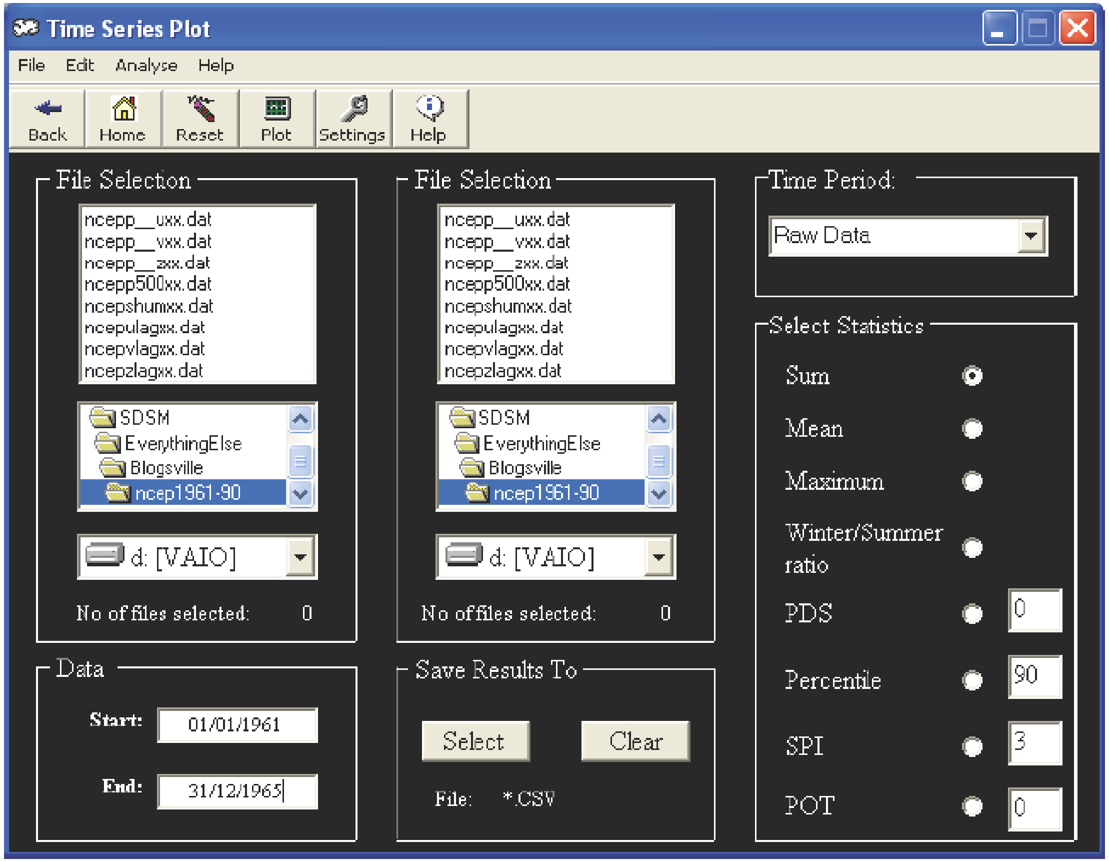
Statistical downscaling is analogous to the "model output statistics" (MOS) and "perfect prog" approaches used for short-range numerical weather prediction.

SDSM (Statistical DownScaling Model)

Key functions of SDSM

Quality control and data transformation
Selection of downscaling predictor variables
Model calibration
Weather generator
Data analysis
Graphical analysis
Scenario generation

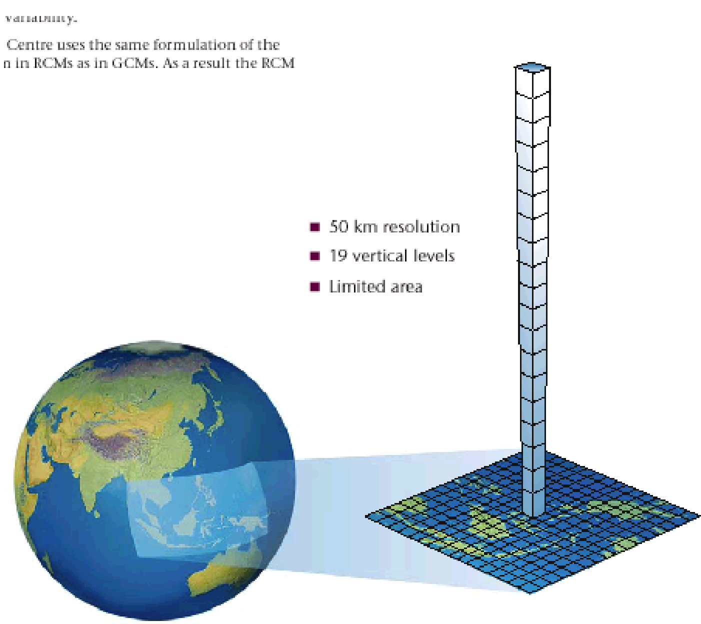




What is a Regional Climate Model ?

A HiRes Limited Area Model (LAM) (for atmosphere and earth surface) that includes representations of the key processes inside the climate system (e.g., clouds, radiation, precipitation, hydrology, etc).

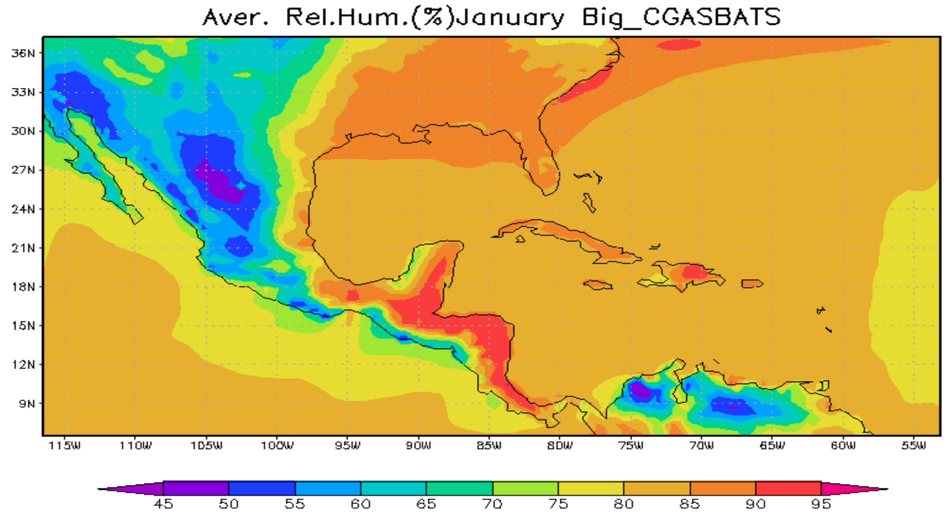
Examp. REMO, EC2, CWRF,
ReGCM, PRECIS

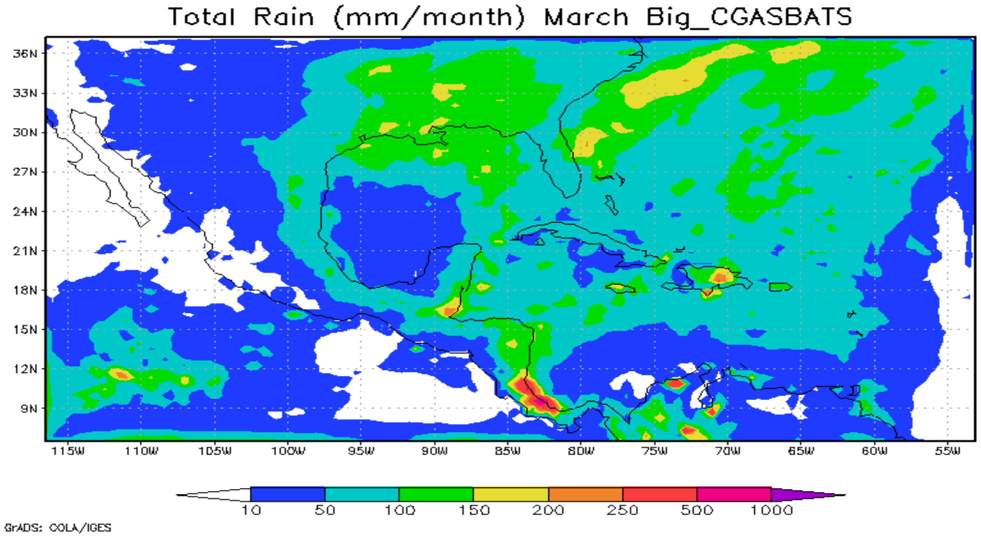


RegCM (Regional Climate Model)

- Group of Physics for Water and Climate (PWC Group)
  International Centre of Theoretic Physics (ICTP) Trieste, Italia.

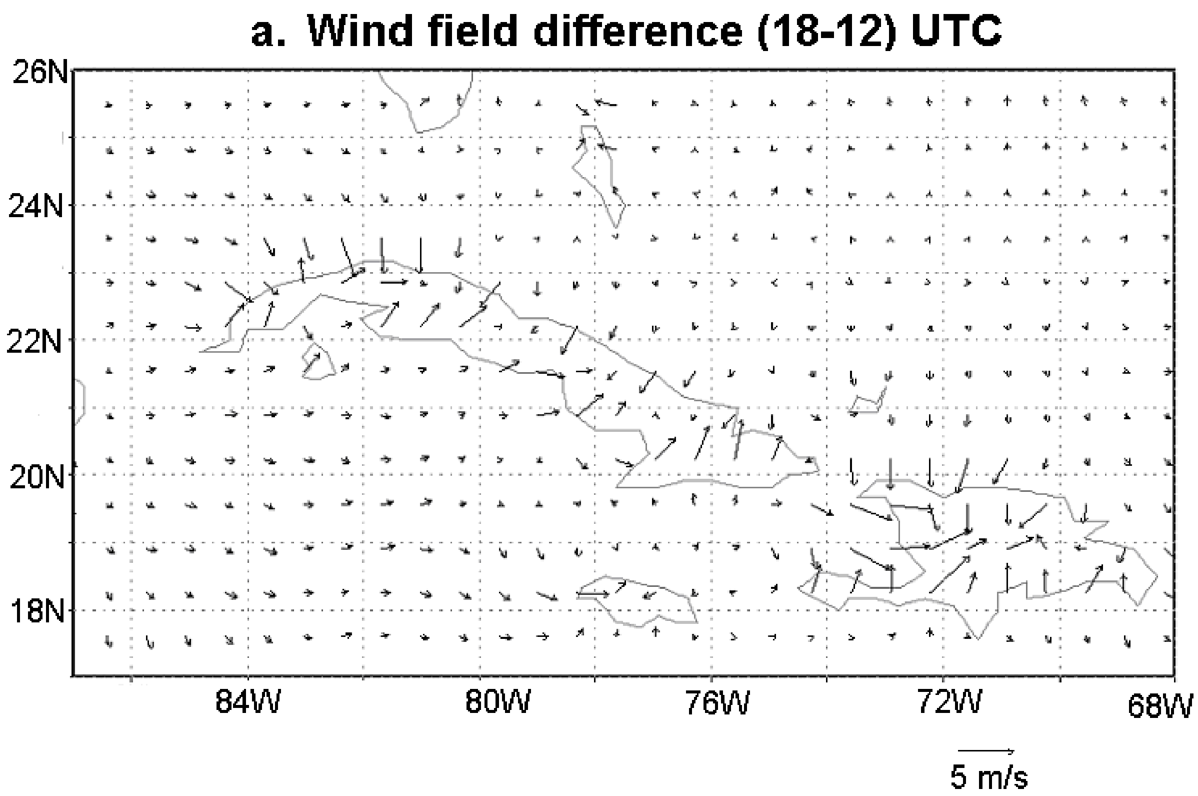
- RegCM3 was developed from the NCAR mesoscale model MM4, but in the present its dynamical component is more similar to that of the hydrostatic version of MM5. Essentially, it is a compressible, grid point model with hydrostatic balance and sigma vertical coordinates

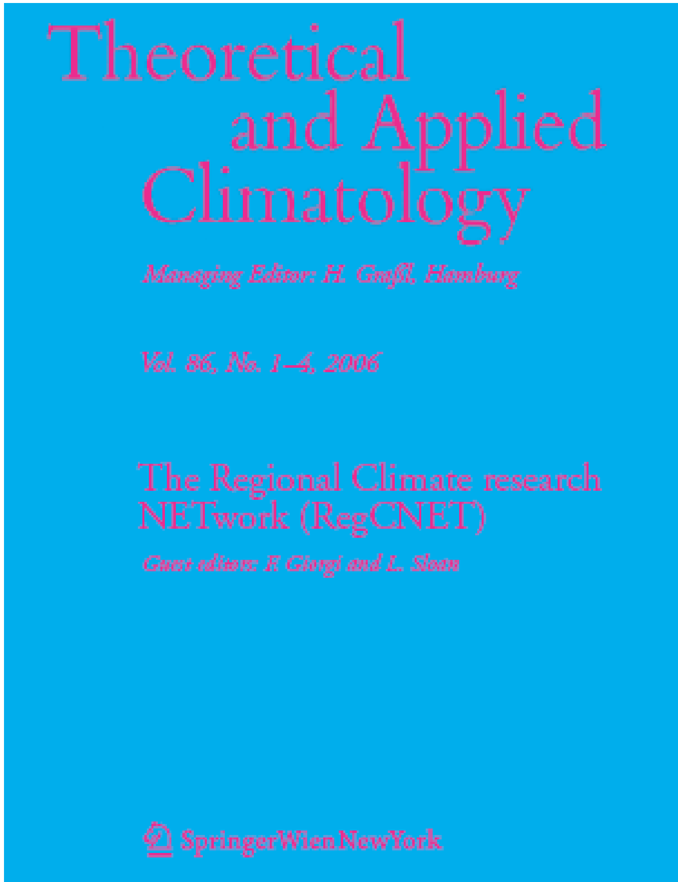




RegCM4 (Regional Climate Model)

Model improvements currently under way include the development of a tropical band version, coupling with a regional ocean model, inclusion of full gas-phase chemistry, upgrades of some physics schemes (convection, PBL, cloud microphysics) and development of a non-hydrostatic dynamical core.





RegCM (Variables)

Table 8: List of output variables from atmosphere

Variables	Description
u	Eastward wind (m s^{-1})
v	Northward wind (m s^{-1})
w	Omega (hPa) p-velocity
t	Temperature (K)
qv	Water vaporMixing ratio (g kg^{-1})
qc	Cloud water mixing ratio (g kg^{-1})
psa	Surface pressure (Pa)
tpr	Total precipitation (mm)
tgb	Lower soil layer temp (K)
smt	Total soil water (mm)
rno	Base flow (mm day^{-1})

Table 9: List of output variables from surface model

Variables	Description
u10m	Anemometer eastward wind (m s^{-1})
v10m	Anemometer northward wind (m s^{-1})
uvdrag	Surface drag stress
tgb	Ground temperature (K)
tlef	Foliage temperature (K)
t2m	Anemometer temperature (K)
q2m	Anemometer specific humidity kg kg^{-1}
ssw	Top layer soil moisture (mm)
rsw	Root layer soil moisture (mm)
tpr	Total precipitation (mm day^{-1})
evp	Evapotranspiration (mm day^{-1})
runoff	Surface runoff (mm day^{-1})
scv	Snow water equivalent (mm)
sena	Sensible heat (W m^{-2})
flw	Net longwave (W m^{-2})
fsw	Net solar absorbed (W m^{-2})
flwd	Downward longwave (W m^{-2})
sina	Solar incident (W m^{-2})
prcv	Convective precipitation (mm day^{-1})
psb	Surface pressure (Pa)
zpbl	PBL height (m)
tgmax	maximum ground temperature (K)
tgmin	minimum ground temperature (K)
t2max	maximum 2m temperature (K)
t2min	minimum 2m temperature (K)
w10max	maximum 10m wind speed ($m\ s^{-1}$)
psmin	minimum surface pressure (hPa)

RegCM (Variables)

Table 10: List of output variables from radiation model

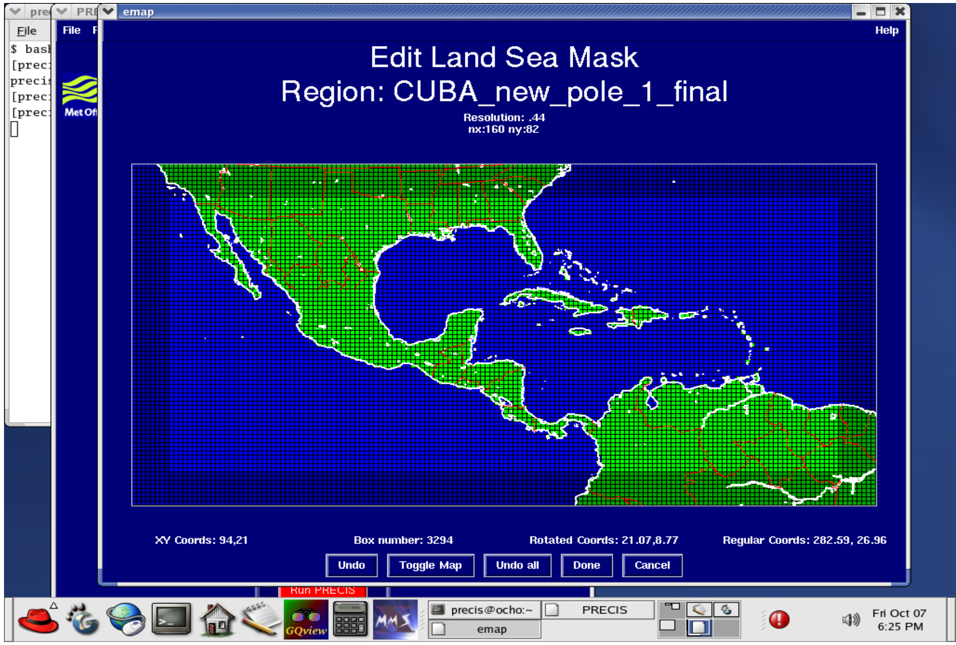
Variables	Description
fc	Cloud fraction (fraction)
clwp	Cld liquid H_2O path (g m^{-2})
qrs	Solar heating rate (K s^{-1})
qrl	LW cooling rate (K s^{-1})
fsw	Surface abs solar (W m^{-2})
flw	LW cooling of surface (W m^{-2})
clrst	Clear sky col abs sol (W m^{-2})
clrss	Clear sky surf abs sol (W m^{-2})
clrlt	Clear sky net up flux (W m^{-2})
clrls	Clear sky LW surf cool (W m^{-2})
solin	Instant incid solar (W m^{-2})
sabtp	Column abs solar (W m^{-2})
firtp	Net up LW flux at TOA (W m^{-2})

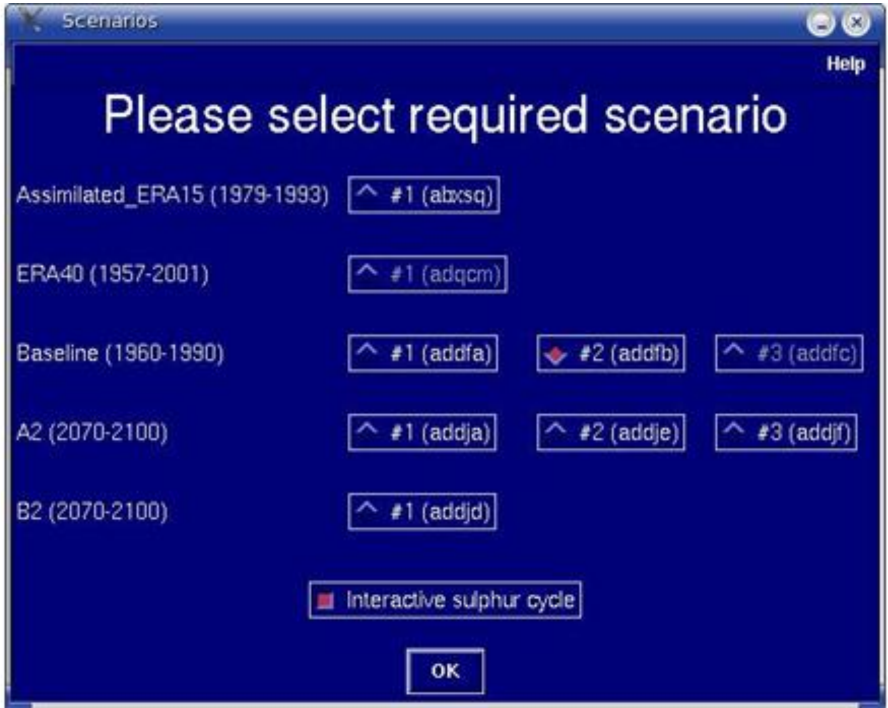
Table 11: List of output variables from tracer model

Variables	Description
trac	Tracer mixing ratio (kg kg^{-1})
aext8	aer mix. ext. coef
assa8	aer mix. sin. scat. alb
agfu88	aer mix. ass. par
colb_tr	Column burden (kg m^{-2})
wdlsc_tr	Wet deposition large-scale (kg m^{-2})
wdcvc_tr	Wet deposition convective (kg m^{-2})
sdrdp_tr	Surface dry deposition (kg m^{-2})
xgasc_tr	chem gas conv. (mg/m2/d)
xaquc_tr	chem aqu conv. (mg/m2/d)
emiss_tr	Surface emission (kg m^{-2})
acstoarf	TOArad forcing av.(W m^{-2})
agfu88	SRFrad forcing av. (W m^{-2})

PRECIS (Providing REgional Climates for Impact Studies)

PRECIS (Providing REgional Climates for Impacts Studies) is a PC-based regional climate model developed by the Hadley Centre of the Meteorological Office of the United Kingdom for use by non-Annex I Parties to the United Nations Framework Convention on Climate Change.





PRECIS (Possibilities)

Obtain and Use our own scenarios for climate change

To share the obtained results with all the scientific community, and stakeholders.

The improvement of the South-South Collaboration

Using the outputs to feed other numeric models (Hydrological, Crops models, etc)

The investigation of the extreme events in the future (strength, duration, frequency, season shiftings, etc.)

Precis (Variables)

Table C.1: **Standard diagnostics: Climate means**

STASH code	Description	Units	Time	Domain
1	SURFACE PRESSURE	Pa	Mean	Single
2	WIND U-COMPONENT (=U) (WIND GRID)	ms^{-1}	Mean	MLC 19
3	WIND V-COMPONENT (=V) (WIND GRID)	ms^{-1}	Mean	MLC 19
4	POTENTIAL TEMPERATURE (THETA)	K	Mean	MLC 19
10	SPECIFIC HUMIDITY	$kg\ kg^{-1}$	Mean	MLC 19
10	SPECIFIC HUMIDITY	$kg\ kg^{-1}$	Mean	Vert mean
24	SURFACE (SKIN) TEMPERATURE	K	Mean	Single
24	SURFACE (SKIN) TEMPERATURE	K	MDmax	Single
25	BOUNDARY LAYER (=BL) DEPTH	m	Mean	Single
31	SEA ICE FRACTION ($0 \leq x \leq 1$)	—	Mean	Single
58	SULPHUR DIOXIDE EMISSIONS	$kg\ m^{-2}s^{-1}$	Mean	Single
59	DIMETHYL SULPHIDE EMISSIONS	$kg\ m^{-2}s^{-1}$	Mean	Single
101	SO_2 MASS MIXING RATIO	$kg\ kg^{-1}$	Mean	MLC 19
102	DIMETHYL SULPHIDE MIXING RATIO	$kg\ kg^{-1}$	Mean	MLC 19
103	SO_4 AITKEN MODE AEROSOL	$kg\ kg^{-1}$	Mean	MLC 19
104	SO_4 ACCUM. MODE AEROSOL	$kg\ kg^{-1}$	Mean	MLC 19
105	SO_4 DISSOLVED AEROSOL	$kg\ kg^{-1}$	Mean	MLC 19
106	H_2O_2 MASS MIXING RATIO	$kg\ kg^{-1}$	Mean	MLC 19
121	NATURAL SO_2 EMISSIONS	$kg\ m^{-2}s^{-1}$	Mean	MLC 19
122	OH CONCENTRATIONS	molecules cm^{-3}	Mean	MLC 19
123	HO_2 CONCENTRATIONS	molecules cm^{-3}	Mean	MLC 19
124	H_2O_2 CONCENTRATIONS	$kg\ kg^{-1}$	Mean	MLC 19
125	OZONE FOR SULPHUR CYCLE	$kg\ kg^{-1}$	Mean	MLC 19
126	HIGH LEVEL SO_2 EMISSIONS	$kg\ m^{-2}s^{-1}$	Mean	Single
1201	NET DOWN SURFACE SW FLUX	Wm^{-2}	Mean	Single
1203	NET DOWN SW RAD FLUX: OPEN SEA	Wm^{-2}	Mean	Single
1204	NET DOWN SURFACE SW FLUX BELOW 690NM	Wm^{-2}	Mean	Single
1207	INCOMING SW FLUX AT TOA	Wm^{-2}	Mean	Single
1208	OUTGOING SW FLUX AT TOA	Wm^{-2}	Mean	Single
1209	CLEAR-SKY UPWARD SW FLUX AT TOA	Wm^{-2}	Mean	Single
1210	CLEAR-SKY DOWN SURFACE SW FLUX	Wm^{-2}	Mean	Single
1211	CLEAR-SKY UP SURFACE SW FLUX	Wm^{-2}	Mean	Single
1221	LAYER CLD LIQ RE × LAYER CLD AMOUNT		Mean	MLC 18
1223	LAYER CLD AMT IN SWRAD (MICROPHYSICS)	—	Mean	MLC 18
1235	TOTAL DOWNWARD SURFACE SW FLUX	Wm^{-2}	Mean	Single
1241	DROPLET NUMBER CONC × CLOUD AMOUNT		Mean	MLC 18
1242	LAYER CLOUD LWC × CLOUD AMOUNT		Mean	MLC 18
1243	SO_4 CCN MASS CONC × COND SAMP WEIGHT		Mean	MLC 18
1244	CONDITIONAL SAMPLING WEIGHT	—	Mean	MLC 18
1245	2-D EFFECTIVE RADIUS × 2-D RE WEIGHT		Mean	Single
1246	WEIGHT FOR 2-D EFFECTIVE RADIUS	—	Mean	Single

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Precis (Variables)

Table C.2: **Standard diagnostics: Daily**

STASH code	Description	Units	Time	Domain
1	SURFACE PRESSURE	Pa	Mean	Single
24	SURFACE TEMPERATURE	K	Mean	Single
24	SURFACE TEMPERATURE	K	Max	Single
24	SURFACE TEMPERATURE	K	Min	Single
25	BOUNDARY LAYER DEPTH	m	Mean	Single
1201	NET DOWN SURFACE SW FLUX	Wm^{-2}	Mean	Single
1204	NET DOWN SURFACE SW FLUX BELOW 690NM	Wm^{-2}	Mean	Single
1207	INCOMING SW FLUX (TOA)	Wm^{-2}	Mean	Single
1208	OUTGOING SW FLUX (TOA)	Wm^{-2}	Mean	Single
1235	TOTAL DOWNWARD SURFACE SW FLUX	Wm^{-2}	Mean	Single
2201	NET DOWN SURFACE LW FLUX	Wm^{-2}	Mean	Single
2204	TOTAL CLOUD AMOUNT ($0 \leq x \leq 1$)	—	Mean	Single
2205	OUTGOING LW FLUX (TOA)	Wm^{-2}	Mean	Single
3217	SURFACE & BL HEAT FLUXES	Wm^{-2}	Mean	MLB 1
3223	SURFACE & BL MOISTURE FLUXES	$kg\ m^{-2}s^{-1}$	Mean	MLB 5
3224	WIND MIXING ENERGY FLUX INTO SEA	Wm^{-2}	Mean	Single
3225	WIND U-COMPONENT AT 10 METRES (WIND GRID)	ms^{-1}	Mean	Single
3226	WIND V-COMPONENT AT 10 METRES (WIND GRID)	ms^{-1}	Mean	Single
3228	SURFACE SENSIBLE HEAT FLUX FROM SEA	Wm^{-2}	Mean	Single
3234	SURFACE LATENT HEAT FLUX	Wm^{-2}	Mean	Single
3236	TEMPERATURE AT 1.5 METRES	K	Mean	Single
3236	TEMPERATURE AT 1.5 METRES	K	Max	Single
3236	TEMPERATURE AT 1.5 METRES	K	Min	Single
3237	SPECIFIC HUMIDITY AT 1.5 METRES	$kg\ kg^{-1}$	Mean	Single
3245	RELATIVE HUMIDITY AT 1.5 METRES	%	Mean	Single
3249	WIND SPEED AT 10 METRES (WIND GRID)	ms^{-1}	Mean	Single
3249	WIND SPEED AT 10 METRES (WIND GRID)	ms^{-1}	Max	Single
3254	THETA$_L$ AT 1.5 METRES	K	Mean	Single
3255	Q_T AT 1.5 METRES	$kg\ kg^{-1}$	Mean	Single
3259	CANOPY CONDUCTANCE		Mean	Single
3296	EVAPORATION RATE FROM SOIL SURFACE	$kg\ m^{-2}s^{-1}$	Mean	Single
3297	EVAPORATION RATE FROM CANOPY	$kg\ m^{-2}s^{-1}$	Mean	Single
3298	SUBLIMATION RATE AT SURFACE	$kg\ m^{-2}s^{-1}$	Mean	Single
3299	TRANSPIRATION	$kg\ m^{-2}s^{-1}$	Mean	Single
4203	LARGE SCALE RAINFALL RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
4204	LARGE SCALE SNOWFALL RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
5205	CONVECTIVE RAINFALL RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
5206	CONVECTIVE SNOWFALL RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
5216	TOTAL PRECIPITATION RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
8023	SNOW MASS	$kg\ m^{-2}$	Mean	Single
8208	SOIL MOISTURE CONTENT (TOTAL)	$kg\ m^{-2}$	Mean	Column mean

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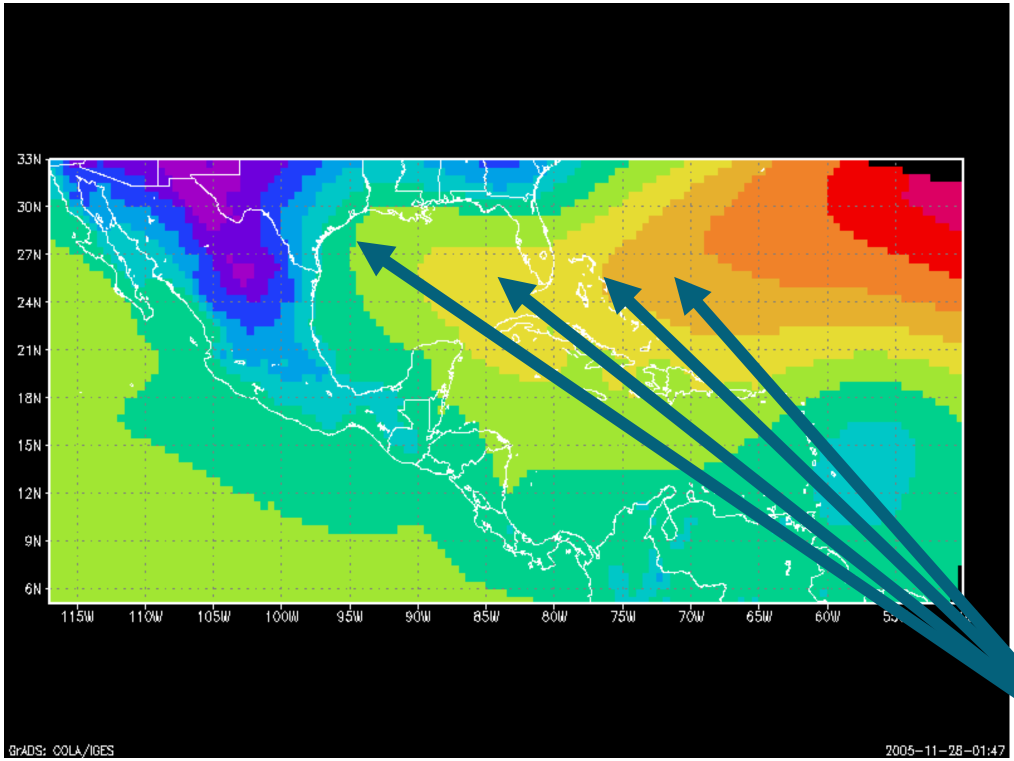
Table C.2: *Daily diagnostics continued*

STASH code	Description	Units	Time	Domain
8209	CANOPY WATER CONTENT	$kg\ m^{-2}$	Mean	Single
8223	SOIL MOISTURE CONTENT	$kg\ m^{-2}$	Mean	SL 4
8225	DEEP SOIL TEMPERATURE	K	Mean	SL 4
8231	LAND SNOW MELT RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
8233	CANOPY THROUGHFALL RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
8234	SURFACE RUNOFF RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
8235	SUB-SURFACE RUNOFF RATE	$kg\ m^{-2}s^{-1}$	Mean	Single
9206	CLOUD LIQUID WATER CONTENT	$kg\ kg^{-1}$	Mean	Column mean
9207	CLOUD ICE CONTENT	$kg\ kg^{-1}$	Mean	Column mean
15201	WIND U-COMPONENT	ms^{-1}	Mean4	PL
15202	WIND V-COMPONENT	ms^{-1}	Mean4	PL
15216	TEMPERATURE (=T) (WIND GRID)	K	Mean4	PL
15222	OMEGA (=W) (WIND GRID)	ms^{-1}	Mean4	PL
15226	SPECIFIC HUMIDITY (=Q) (WIND GRID)	$kg\ kg^{-1}$	Mean4	PL
15227	Q*U ON (WIND GRID)	$kg\ kg^{-1}ms^{-1}$	Mean4	PL
15228	Q*V ON (WIND GRID)	$kg\ kg^{-1}ms^{-1}$	Mean4	PL
15235	Q*W ON (WIND GRID)	$kg\ kg^{-1}ms^{-1}$	Mean4	PL
15242	W*W (WIND GRID)	m^2s^{-2}	Mean4	PL
16202	GEOPOTENTIAL HEIGHT (=Z)	m	Mean4	PL
16203	TEMPERATURE (=T)	K	Mean4	PL
16204	RELATIVE HUMIDITY	%	Mean4	PL
16222	PRESSURE AT MEAN SEA LEVEL	Pa	Mean4	Single

The Frequency of tropical cyclones in the Caribbean and Mexico as show in Regional Climate Model simulations



Cyclone representation is a potential tool to:

- Investigate and assess the Model ability to represent this type of event
- Investigate or project future TC behaviour in the area

TCLVs detection methodology

- It is designed to work with daily mean fields.

- On a grid of 0.44° (50 km), a point of minimum in surface pressure is sought so that the averaged pressure over a circumference of 6° (700 km) centred in the point is at least 5.5 hPa greater than in the point.

- The difference between the maximum and minimum values of the wind speed in a neighbourhood of 3 grid points radius (1.3° or 150 km) centred in the point of minimum pressure must be at least 40 km/h (11 m/s).

- The end of the track of each individual vortex occurs when in two consecutive days, the points of two consecutive TCLV position are located at a mutual distance of more than 7° (800 km).

- The above criteria were adjusted in practice by trial and error based on a detailed visual analysis of selected animated image sequences in the output of the model.

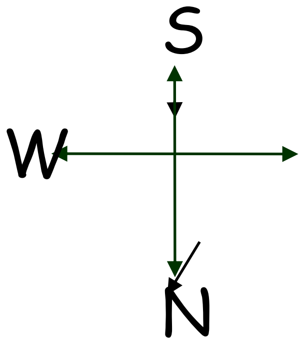
Application of the wind speed criterion to appoint the center of TCLV

7.46	7.10	6.82	7.11	7.90	8.67	9.06	9.06	8.92	8.94
9.17	9.07	8.92	9.03	9.68	10.50	11.02	11.07	10.81	10.53
10.80	11.02	11.16	11.35	11.86	12.63	13.20	13.33	13.01	12.46
12.49	12.97	13.44	13.85	14.32	15.00	15.61	15.83	15.49	14.72
14.44	15.09	15.76	16.39	16.99	17.63	18.23	18.54	18.28	17.44
17.06	17.82	18.58	19.34	20.07	20.70	21.19	21.47	21.24	20.39
20.55	21.60	22.51	23.32	24.04	24.58	24.88	24.89	24.45	23.37
24.82	26.30	27.48	28.33	28.83	29.15	29.25	28.95	28.07	26.47
29.81	31.49	32.24	32.15	31.88	32.20	32.94	33.13	32.00	29.66
34.31	34.02	31.69	29.42	29.06	30.93	33.86	36.00	35.56	32.60
34.50	29.62	21.31	16.84	20.95	27.79	33.94	37.90	38.06	34.70
31.92	23.09	8.90	7.66	20.18	30.02	37.17	40.69	39.75	35.43
32.68	26.81	23.75	27.93	33.93	39.19	42.69	42.86	39.37	34.42
38.20	38.05	39.90	42.71	44.31	44.84	43.87	40.87	36.71	32.29
40.79	42.49	43.83	44.19	43.41	41.78	39.49	36.44	33.02	29.59
37.25	38.67	39.05	38.41	37.25	35.83	33.96	31.68	29.23	26.72
31.91	32.87	33.11	32.72	31.93	30.85	29.43	27.77	25.94	23.99
27.11	27.89	28.18	28.07	27.61	26.82	25.74	24.42	22.90	21.25
22.94	23.64	23.94	23.93	23.62	23.04	22.19	21.10	19.82	18.42
19.32	19.99	20.25	20.22	19.94	19.41	18.66	17.73	16.65	15.53
16.10	16.68	16.91	16.87	16.56	16.05	15.37	14.61	13.73	12.81
13.40	13.78	13.95	13.96	13.73	13.30	12.78	12.19	11.47	10.68
11.59	11.81	11.90	11.96	11.89	11.66	11.26	10.71	10.06	9.34
10.50	10.64	10.72	10.80	10.84	10.75	10.48	9.99	9.36	8.64
9.70	9.78	9.85	9.96	10.05	10.04	9.87	9.44	8.76	8.00

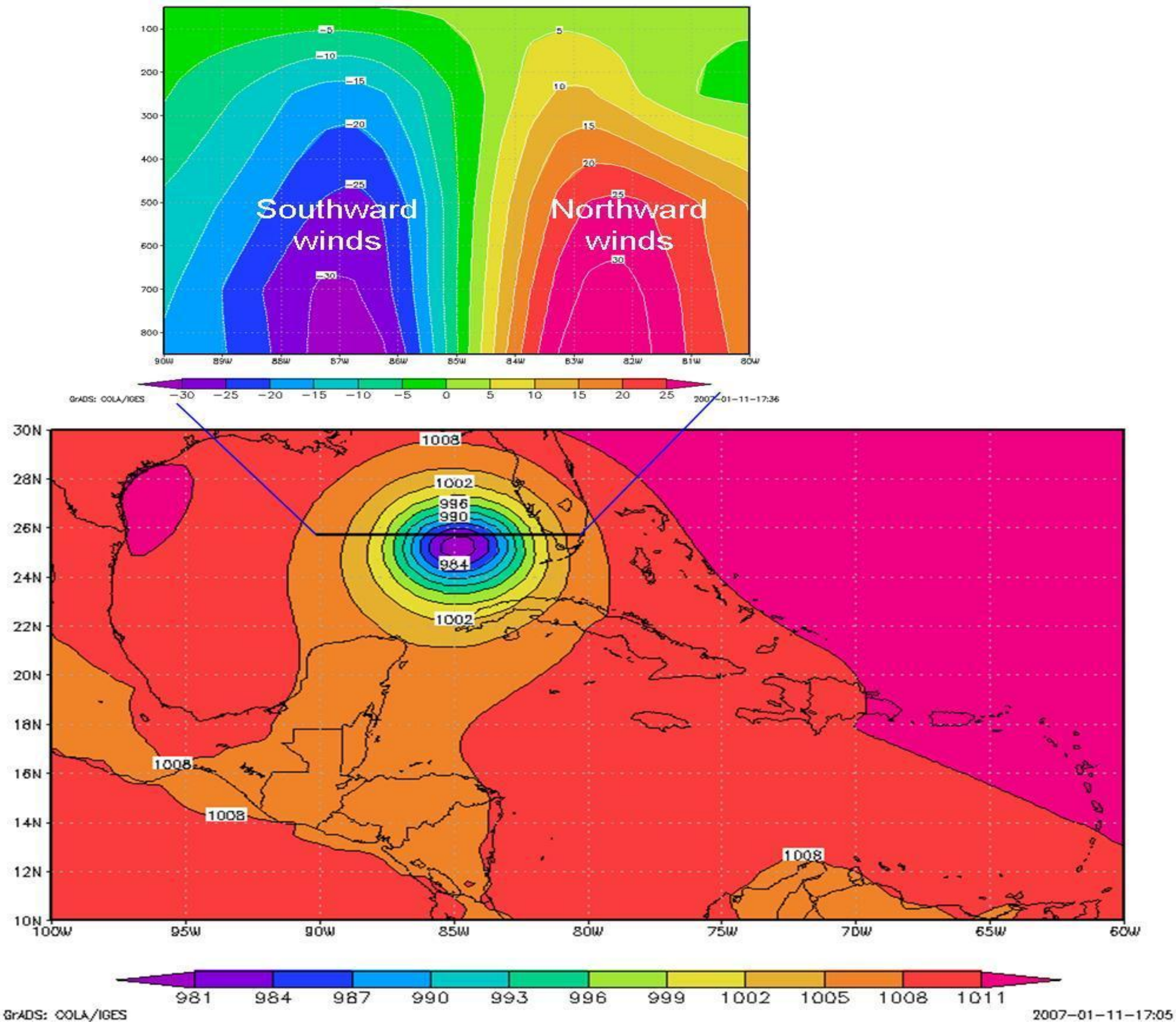
Minimum pressure point

Minimum wind speed

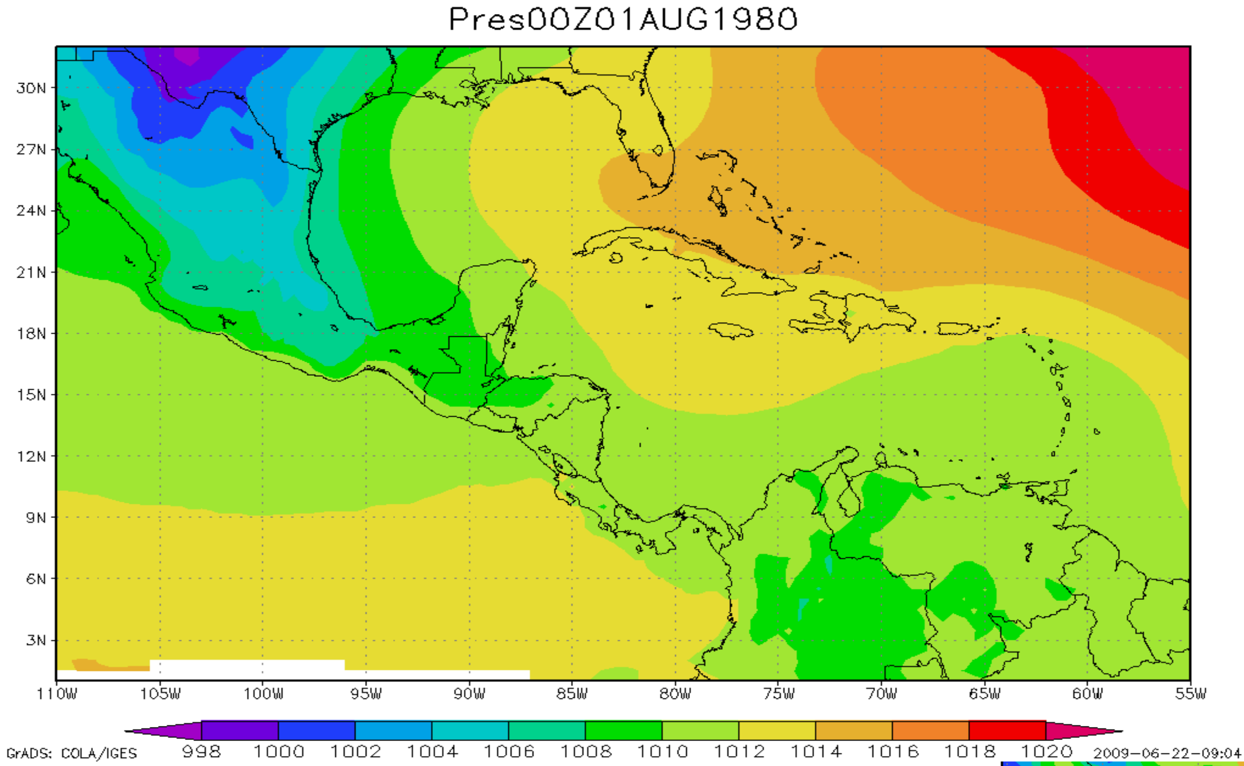
Maximum wind speed

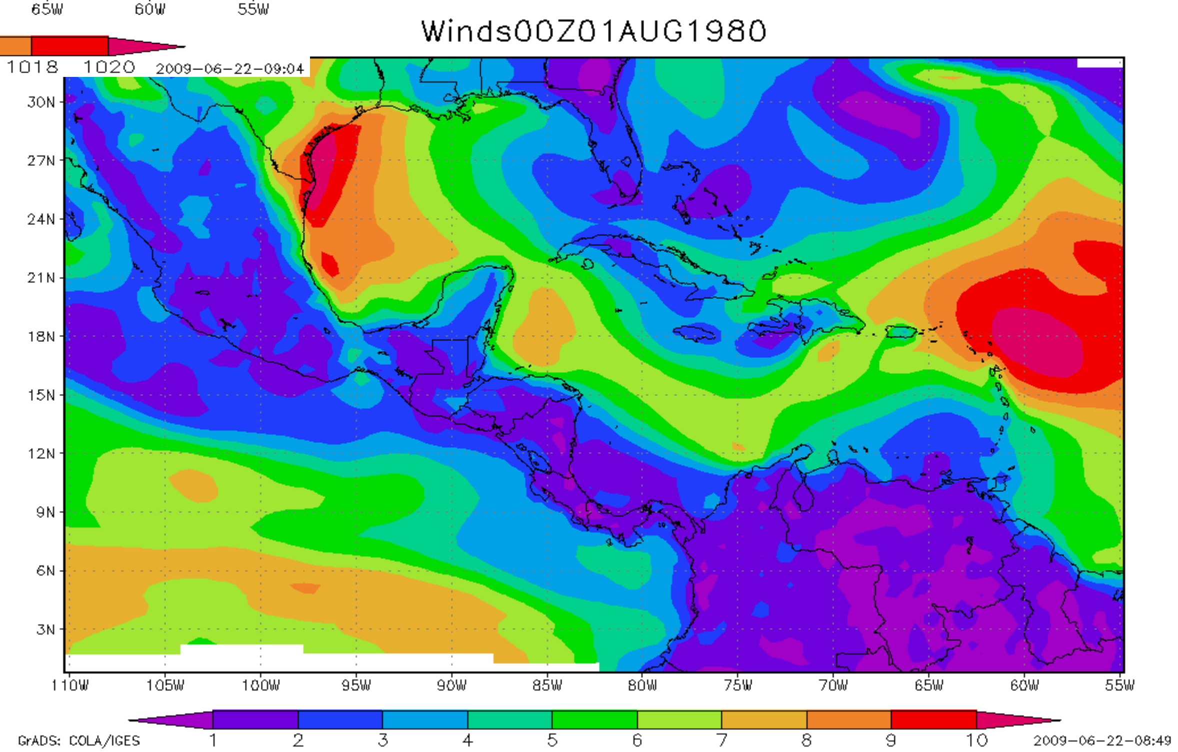


TCLV's Detection



Huracán Allen(I)





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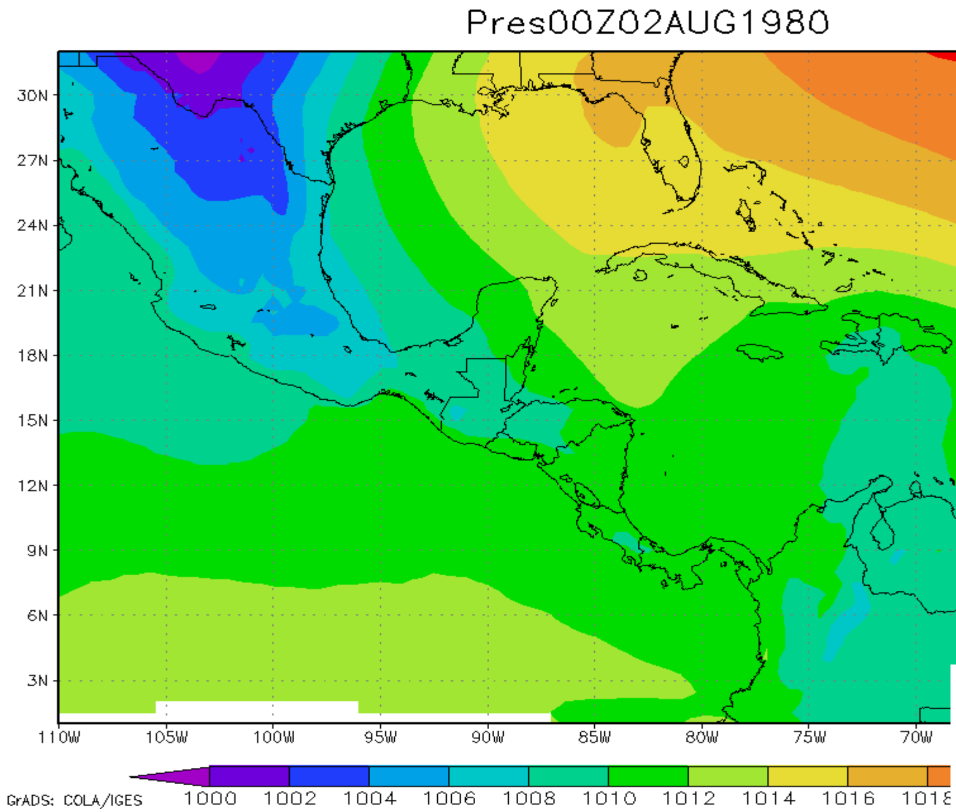

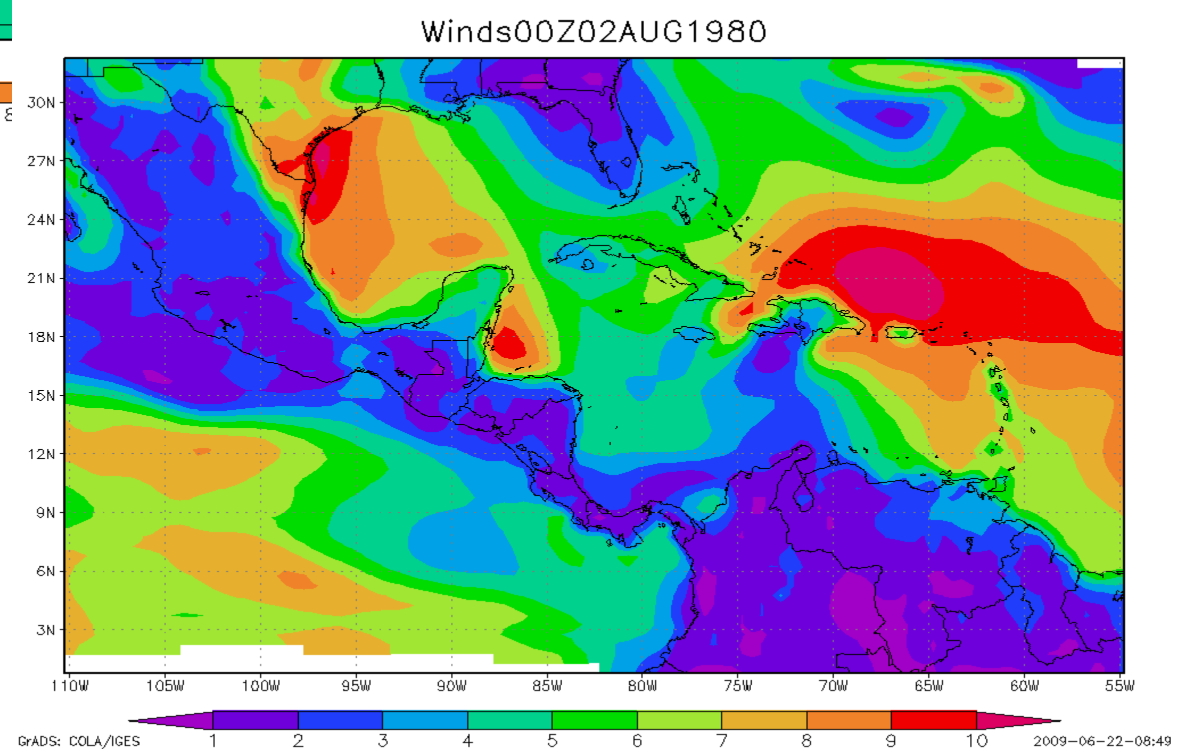

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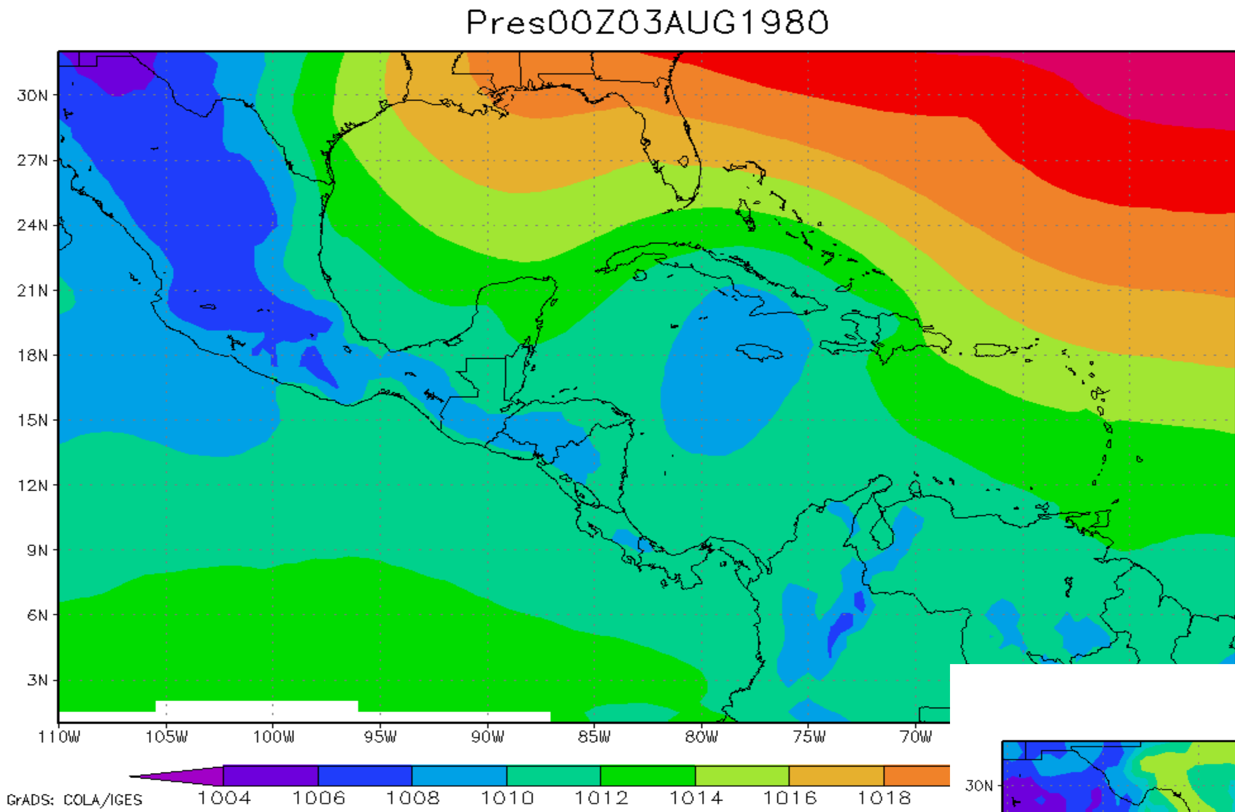

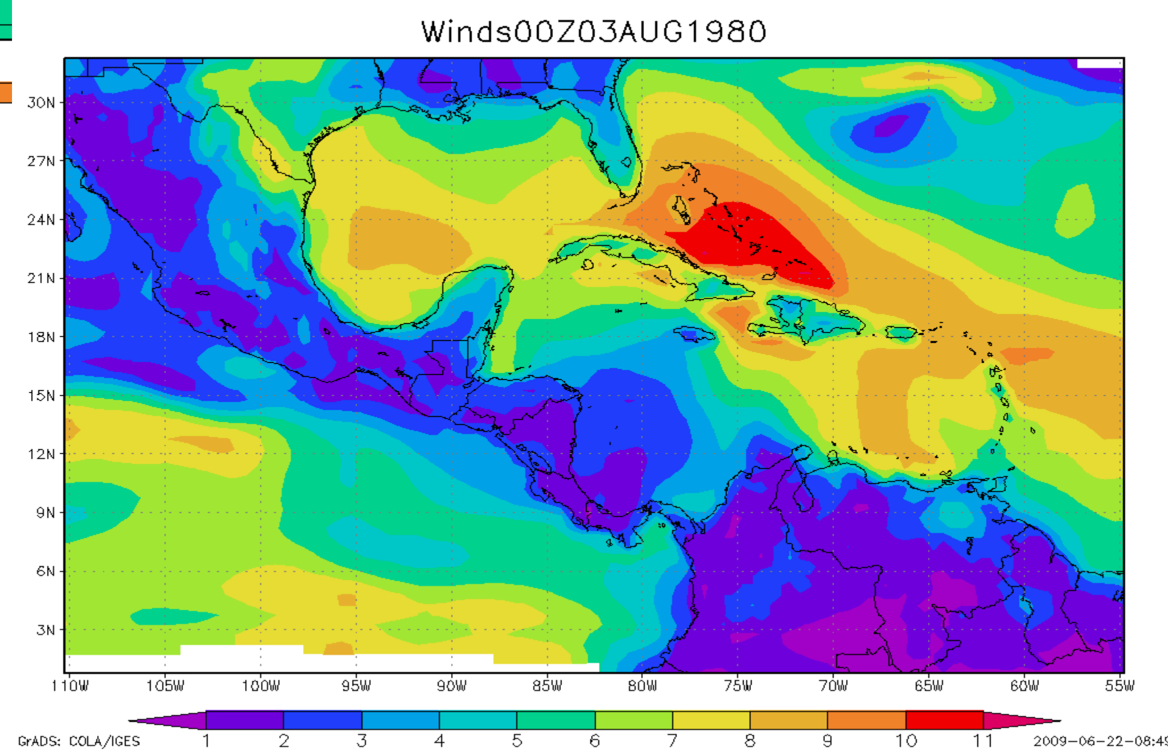

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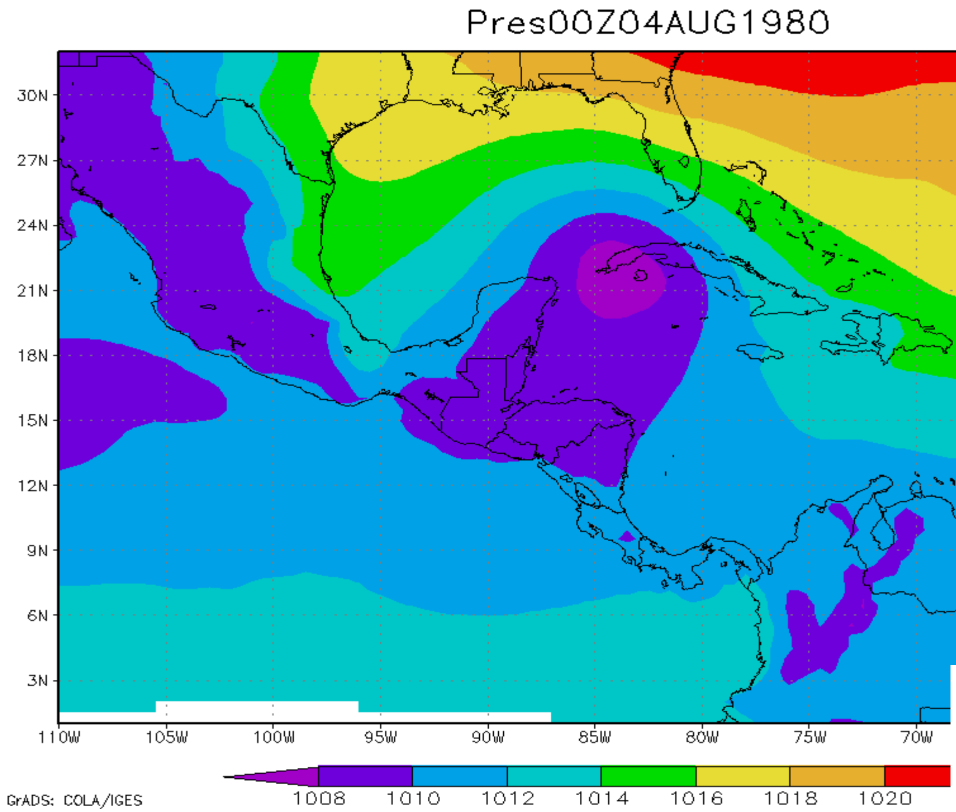

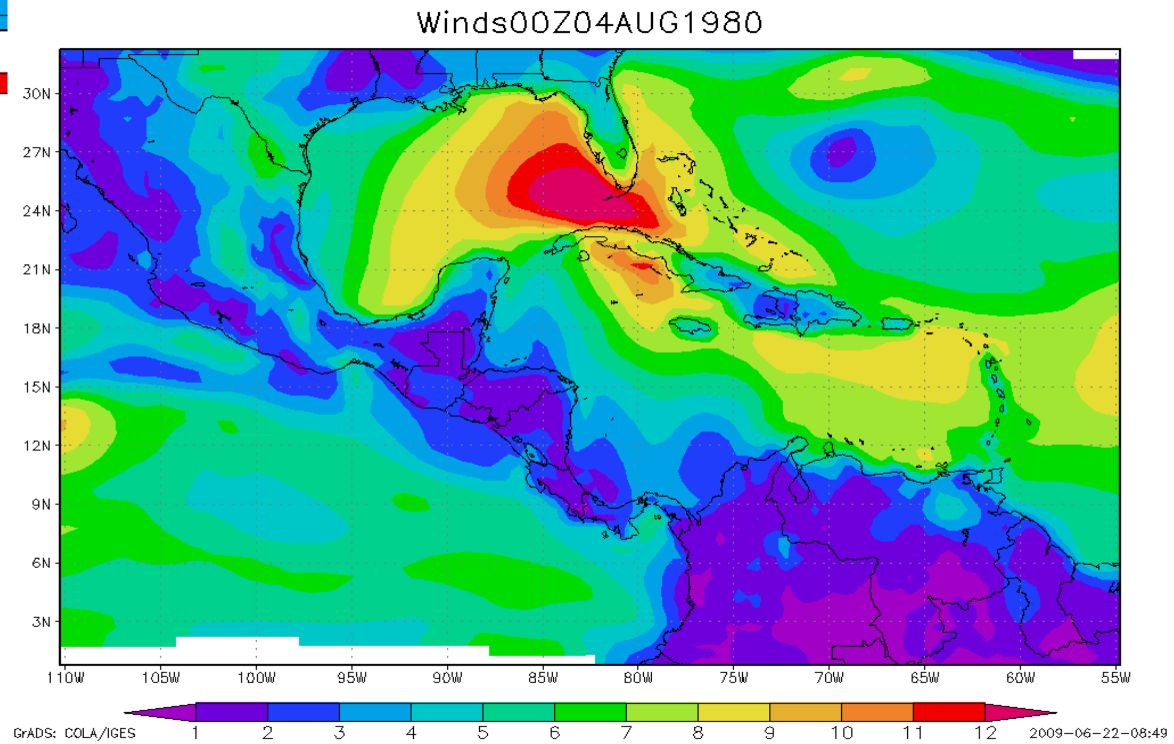

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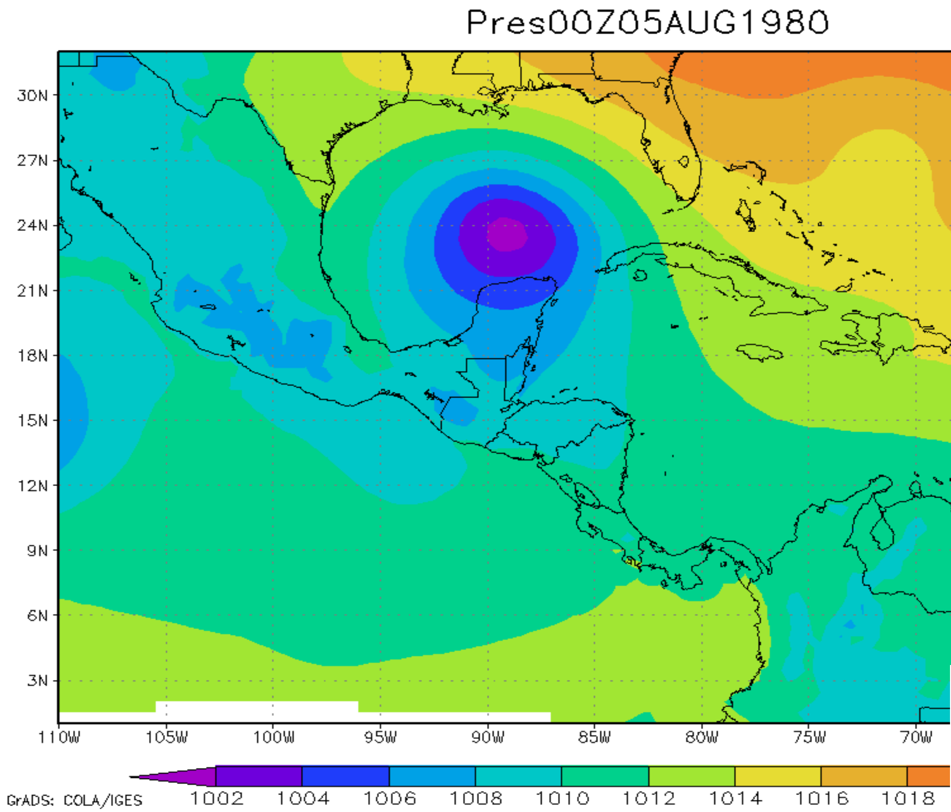

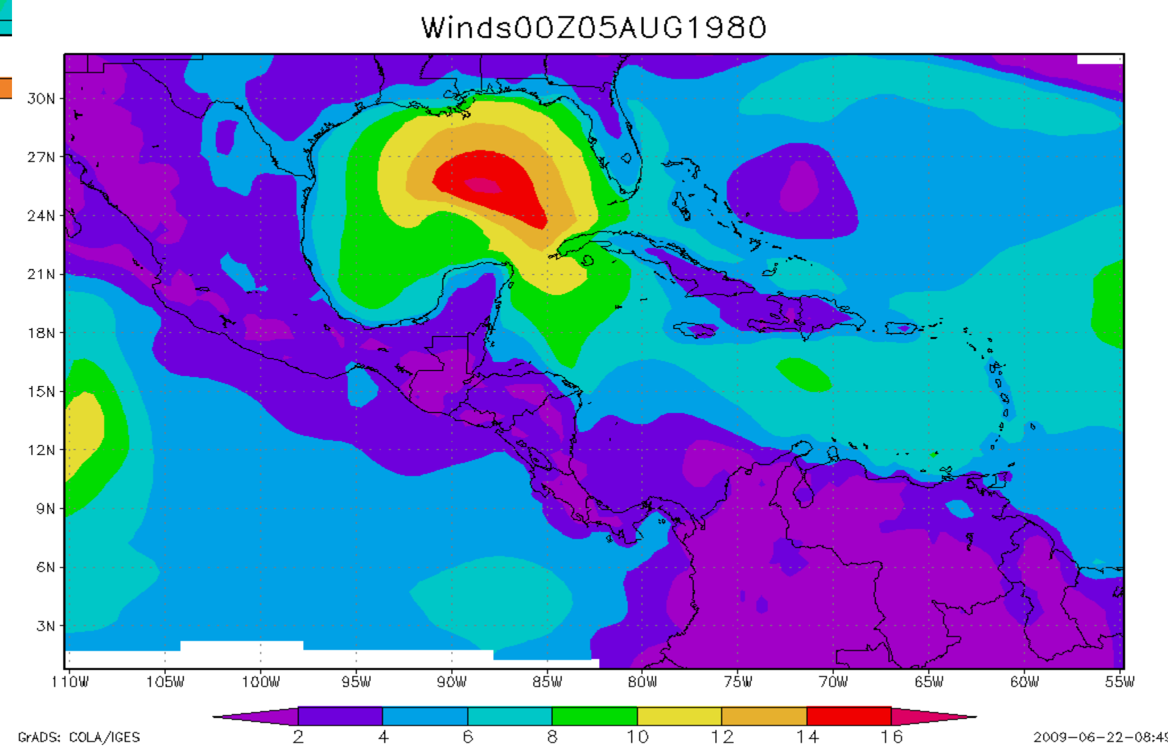

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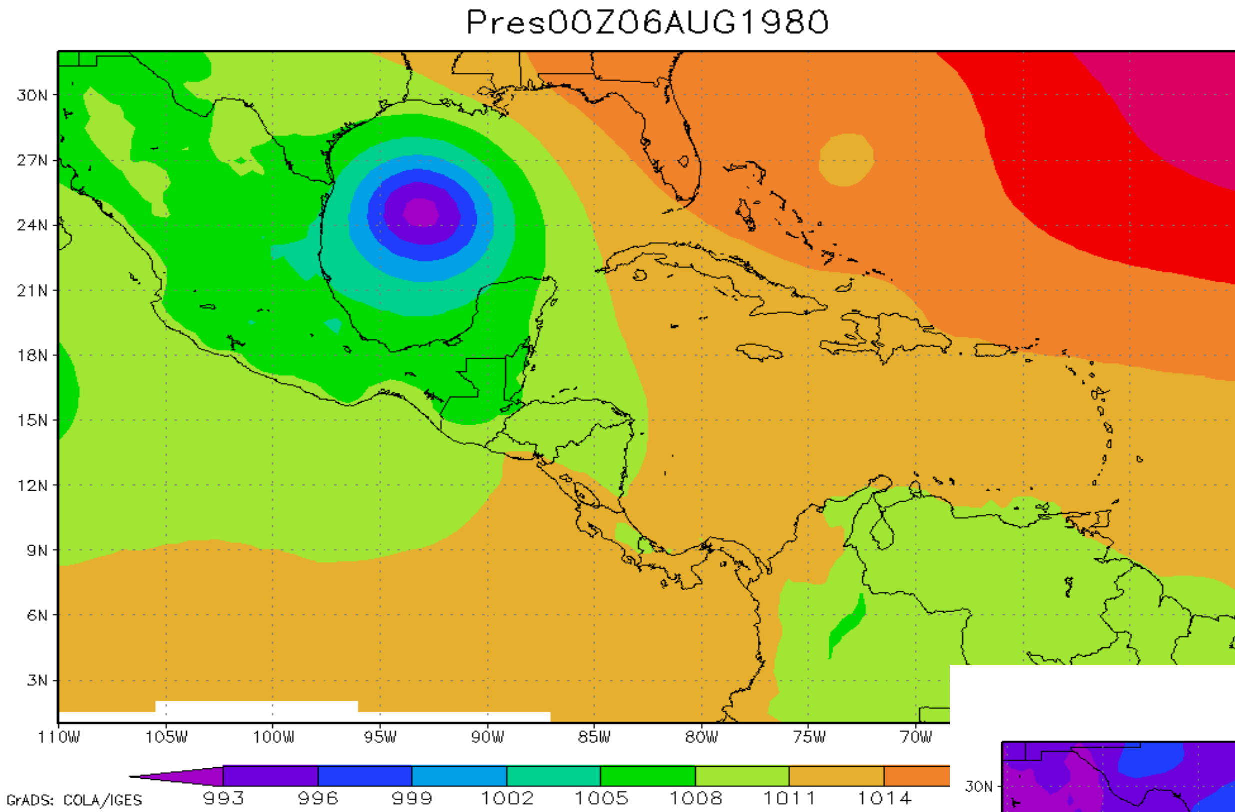
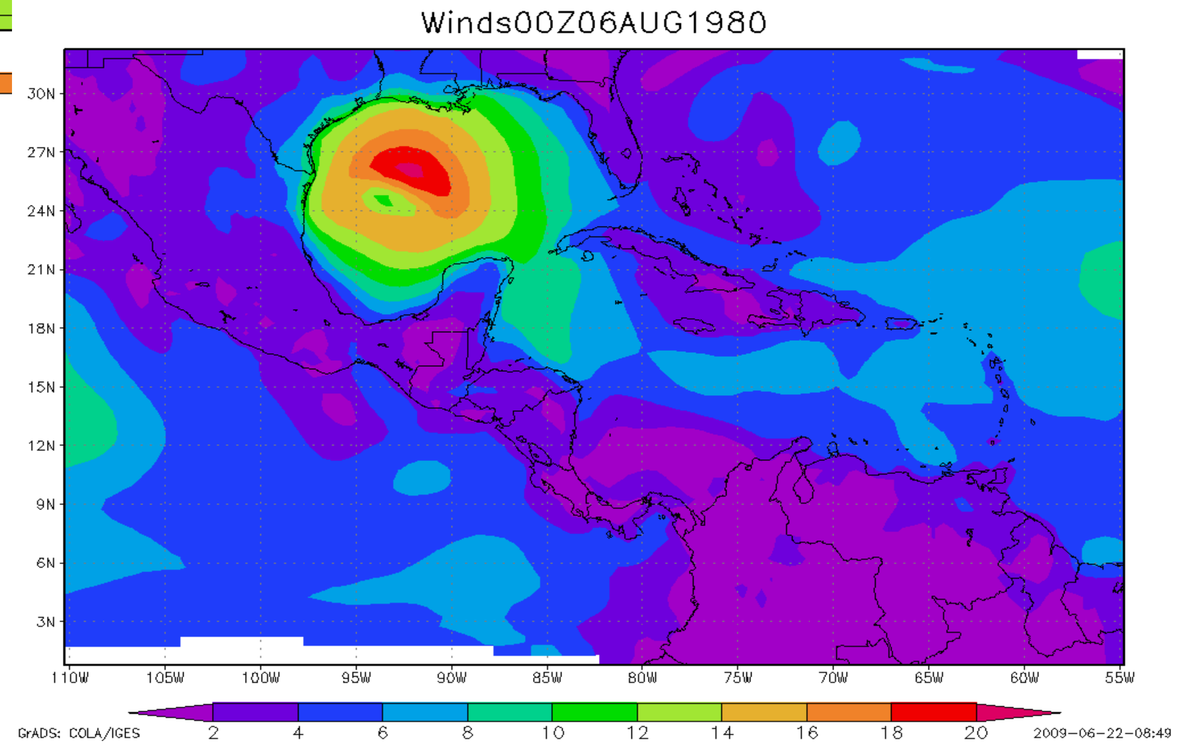
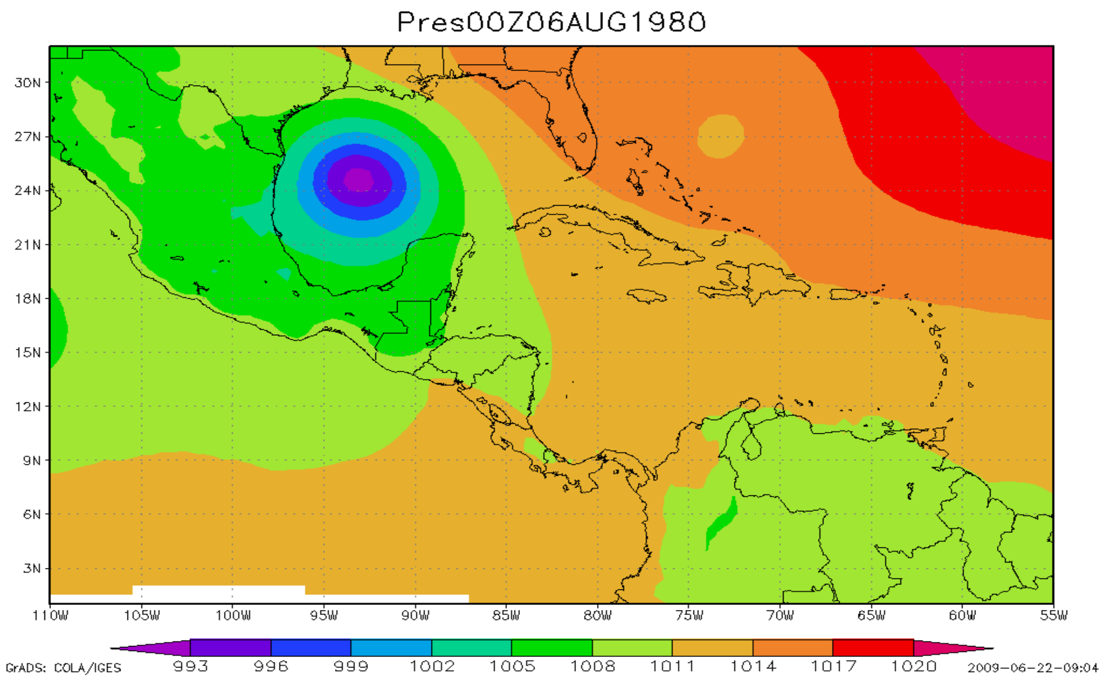
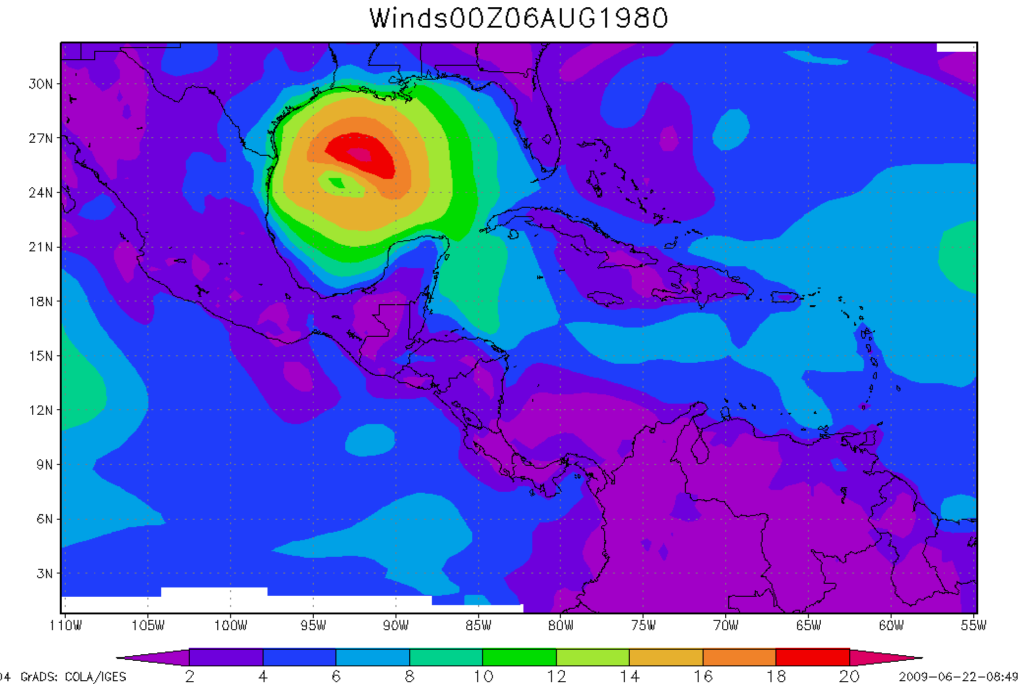
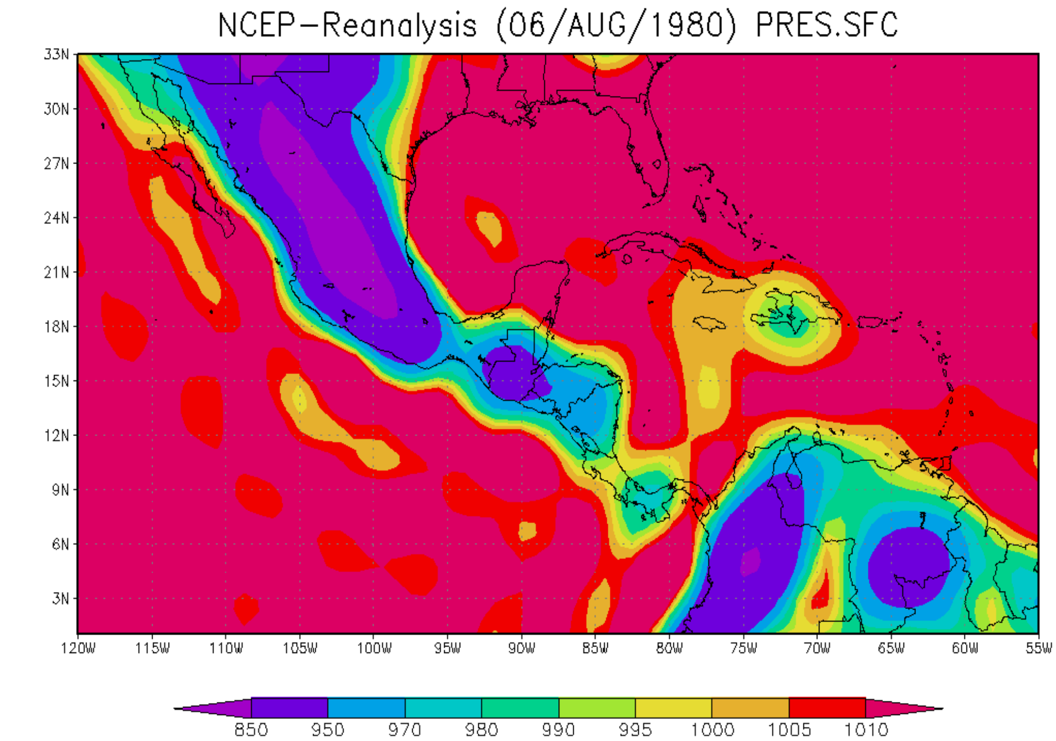


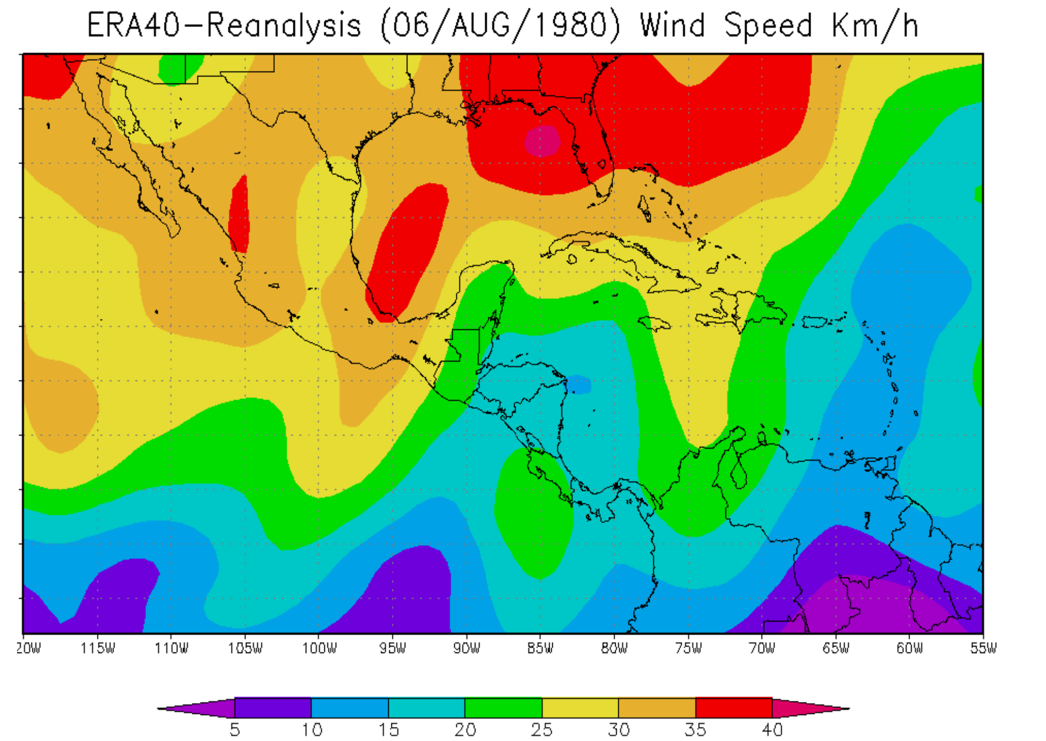


Reanálisis Precis Vs Reanalisis 2.5x2.5º

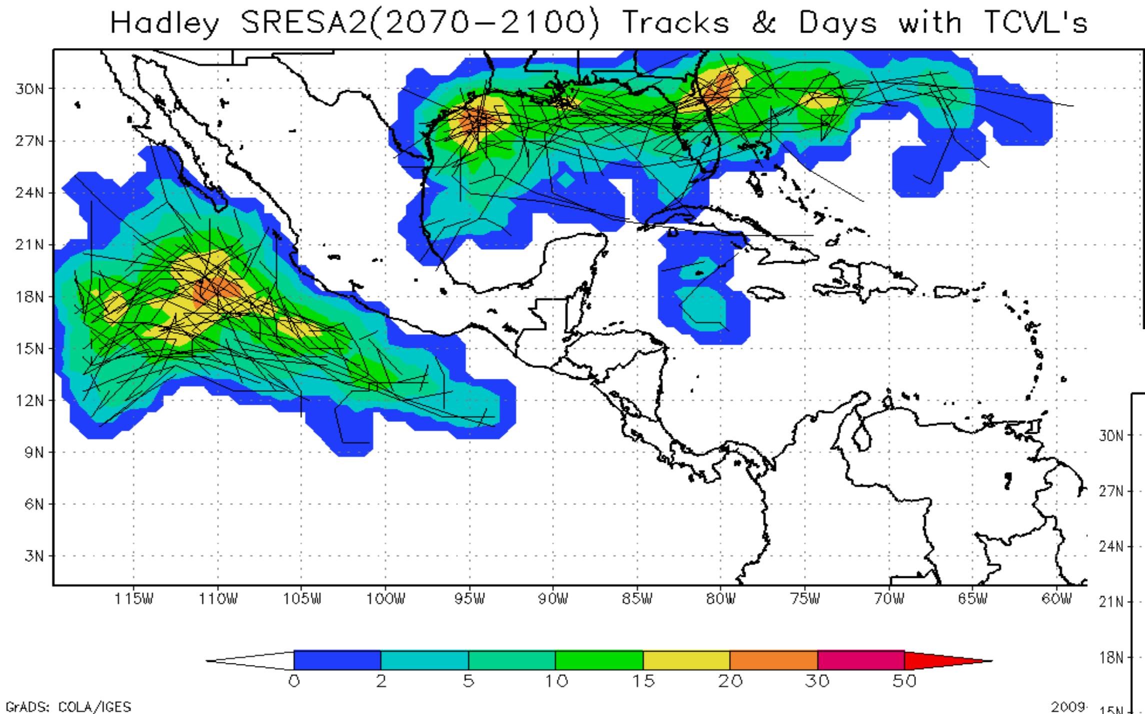


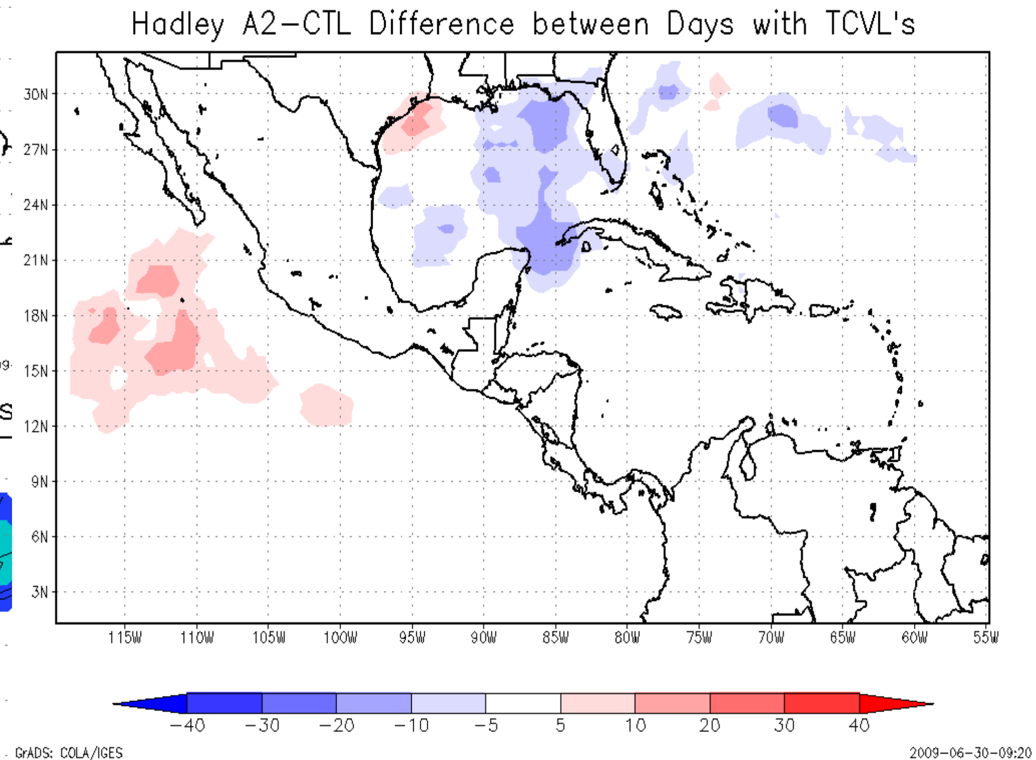


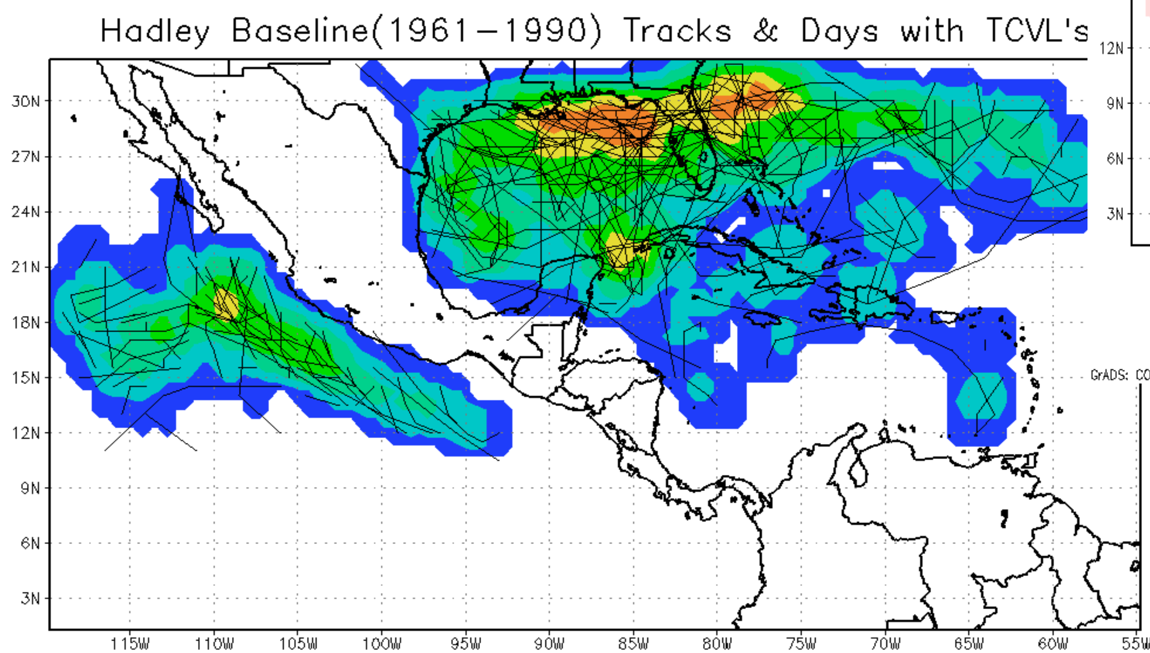




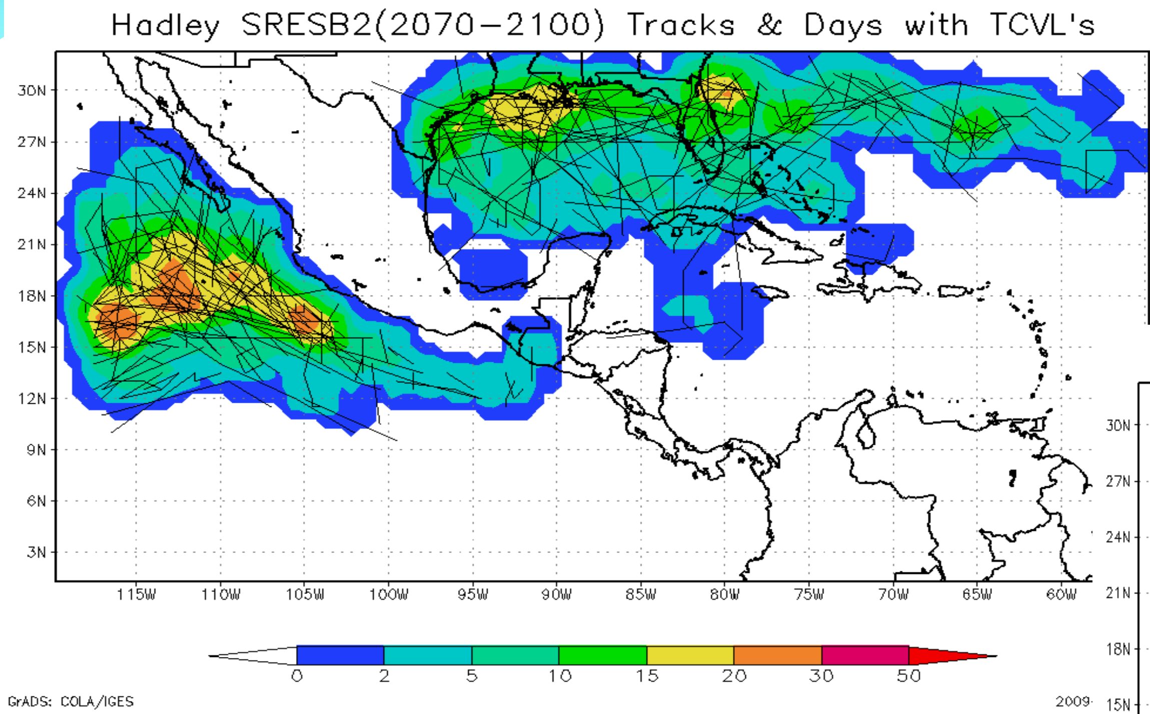
Hadley A2

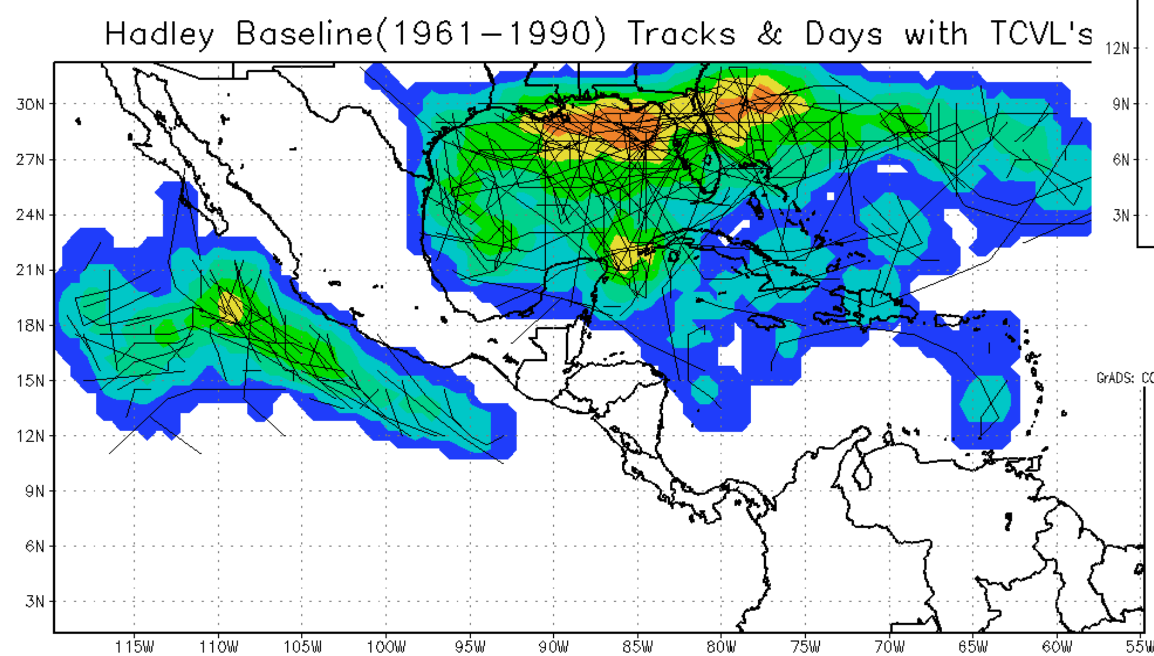

Hadley SRESA2(2070−2100) Tracks & Days with TCVL's
30N
27N
24N
21N
18N
15N
12N
9N
6N
3N
115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W 60W
0 2 5 10 15 20 30 50
GrADS: COLA/IGES
2009

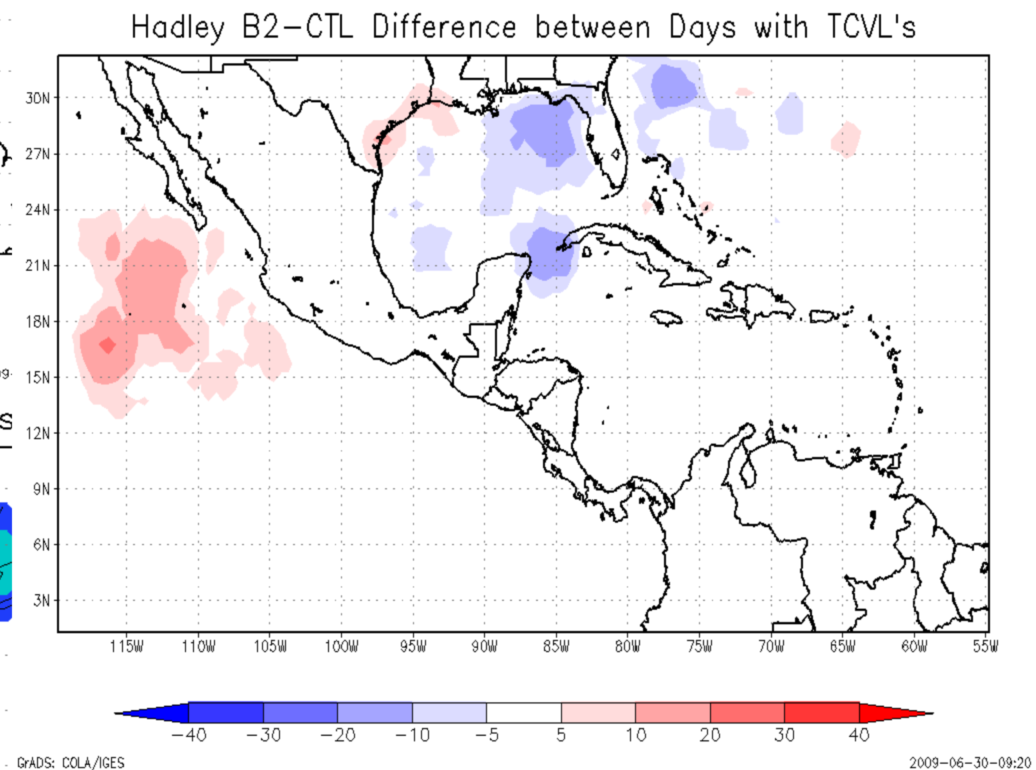

Hadley A2−CTL Difference between Days with TCVL's
30N
27N
24N
21N
18N
15N
12N
9N
6N
3N
115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W 60W 55W
−40 −30 −20 −10 −5 5 10 20 30 40
GrADS: COLA/IGES
2009−06−30−09:20


Hadley Baseline(1961−1990) Tracks & Days with TCVL's
30N
27N
24N
21N
18N
15N
12N
9N
6N
3N
115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W 60W 55W

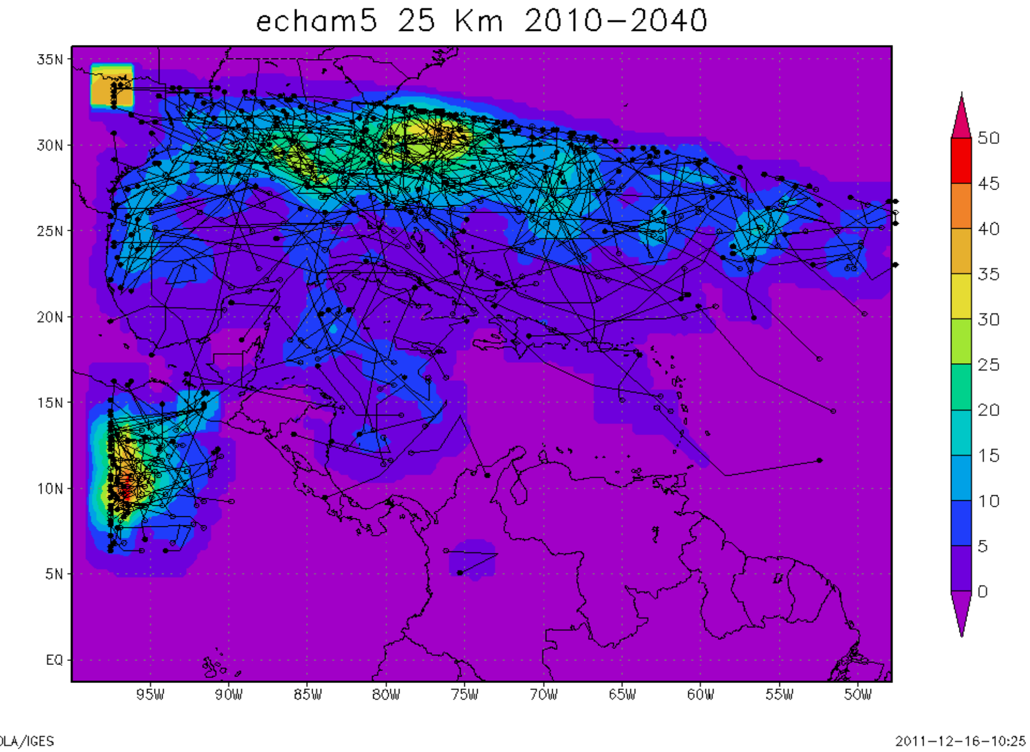
Hadley B2

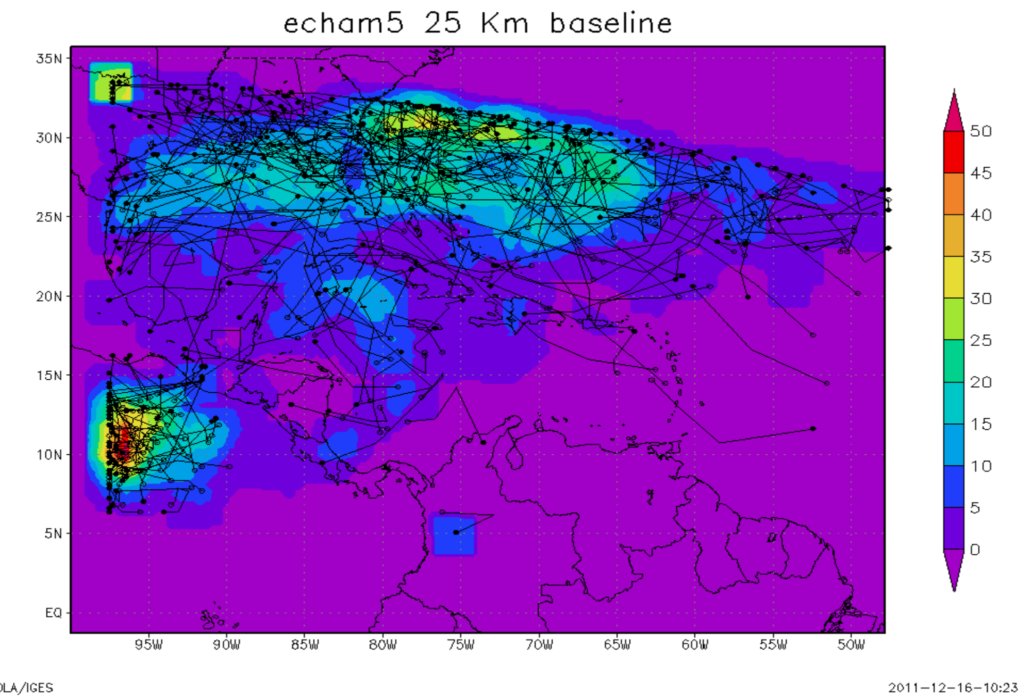

Hadley SRESB2(2070–2100) Tracks & Days with TCVL's
0 2 5 10 15 20 30 50
GrADS: COLA/IGES
2009

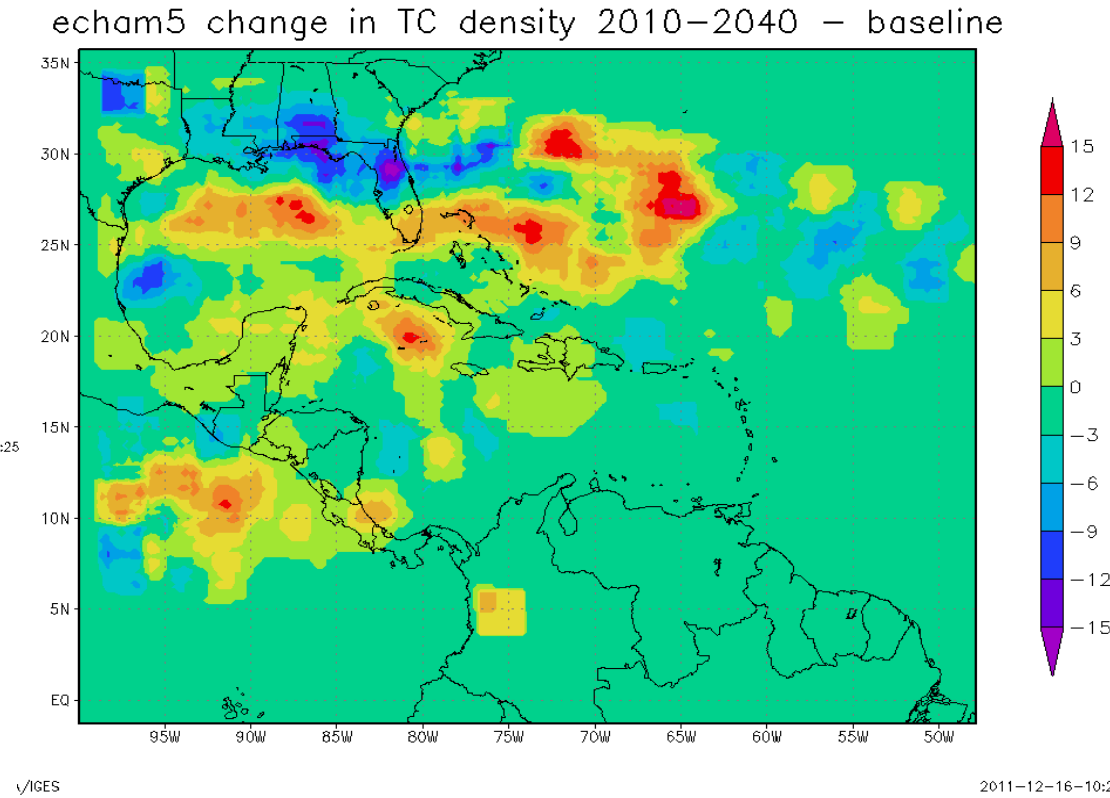

Hadley Baseline(1961–1990) Tracks & Days with TCVL's


Hadley B2–CTL Difference between Days with TCVL's
–40 –30 –20 –10 –5 5 10 20 30 40
GrADS: COLA/IGES
2009–06–30–09:20

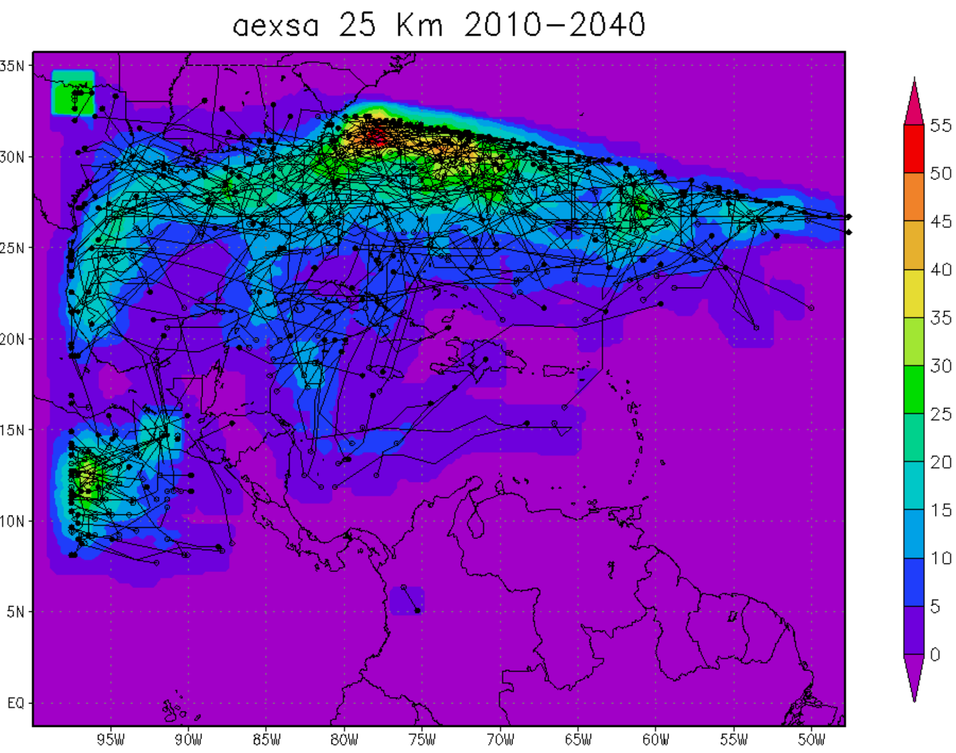
TCLV's future-baseline

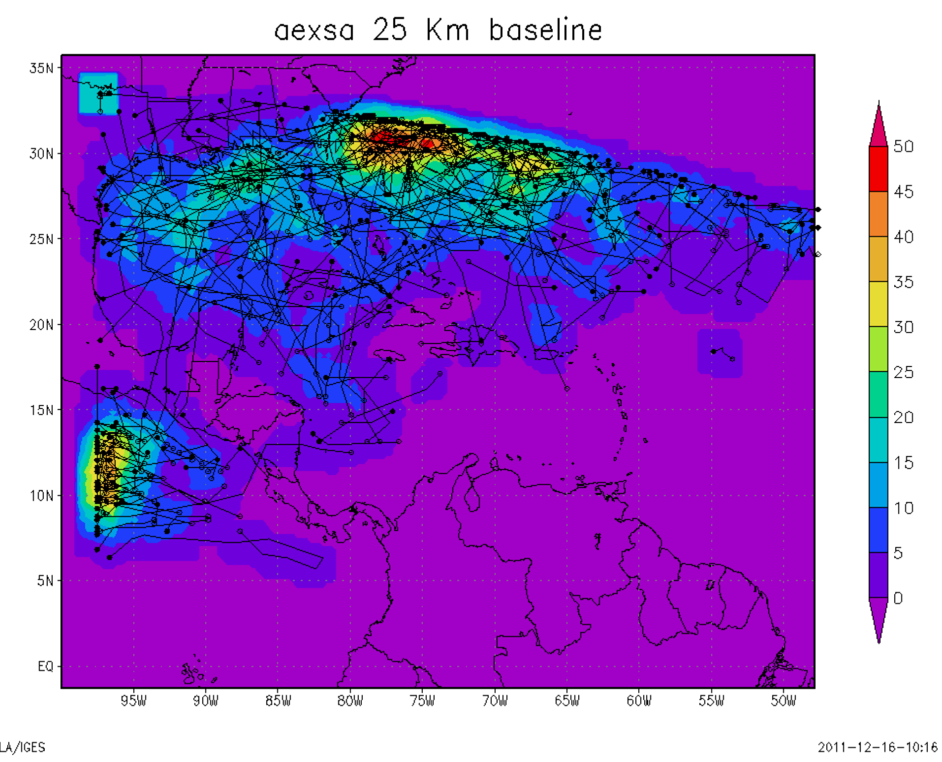


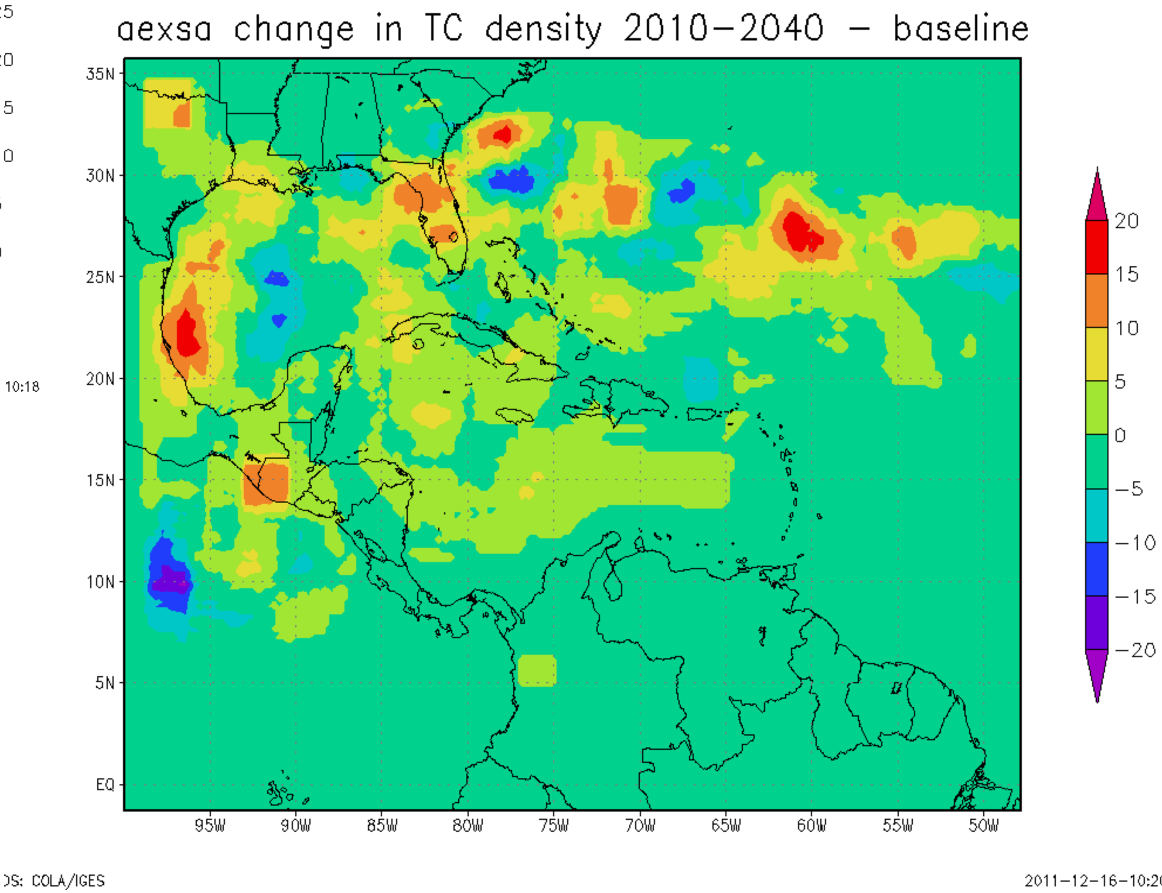




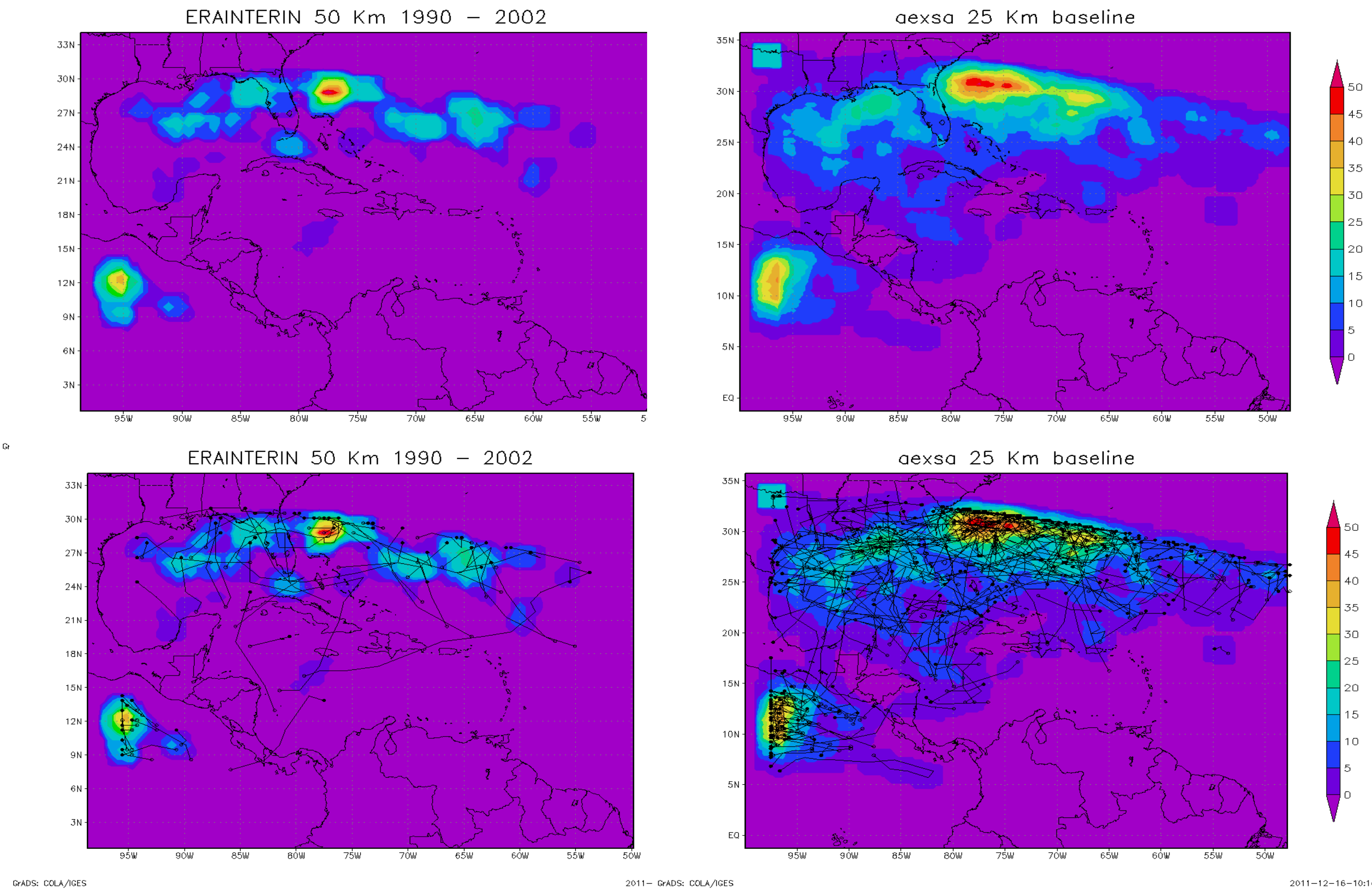
TCLV's future-baseline







ERA INTERIM 50 Vs 25 Km



Partial Conclusions

- PRECIS model has shown a remarkable skill to recreate cyclonic vortices from information given by GCMs.
- Despite big differences between A2 and B2 SRES results do not show a notable difference in the number of days with TCLV.
- Both GCMs show a big difference in the distribution of number of days with TC.
- 25 Km resolution performed better than 50 km resolution.

Debate

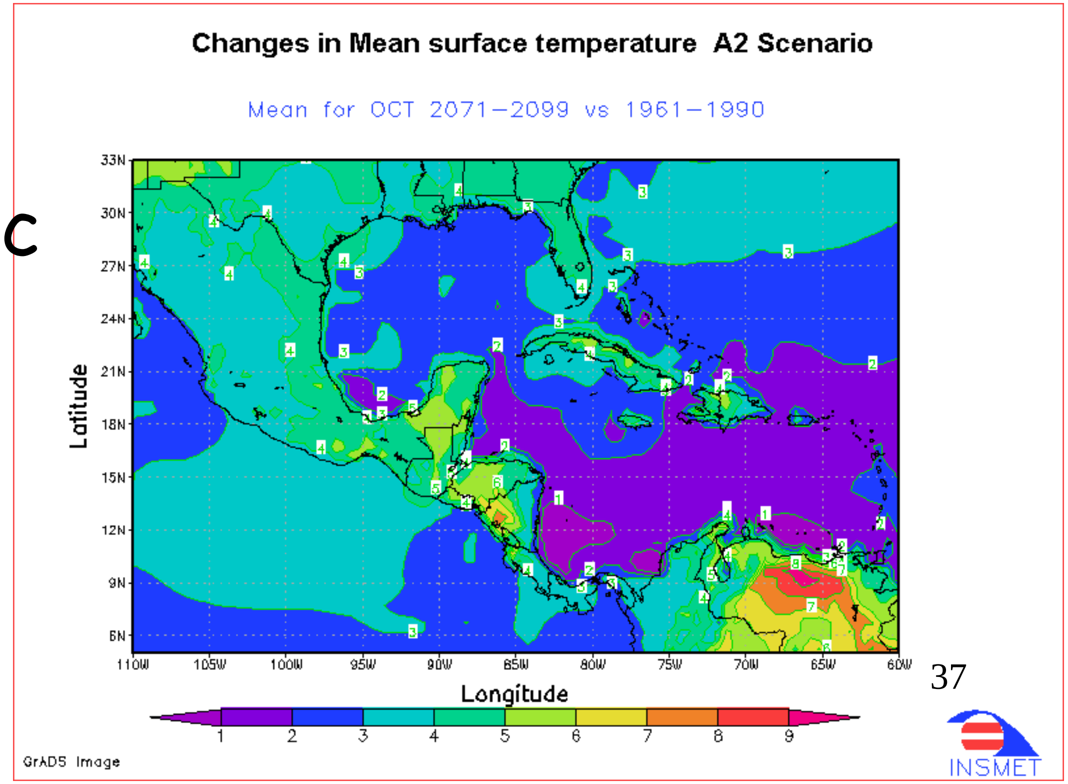
The projected increase in temperature in Eastern Pacific near the coast of Mexico and the smaller increase projected for

Western Tropical Atlantic

seem to be consistent with

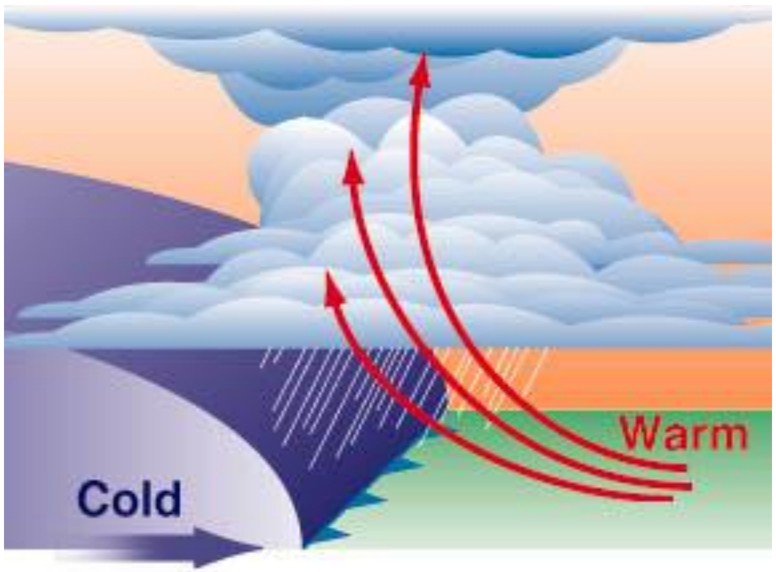
greater projected increase

of TCLVs for Eastern Pacific



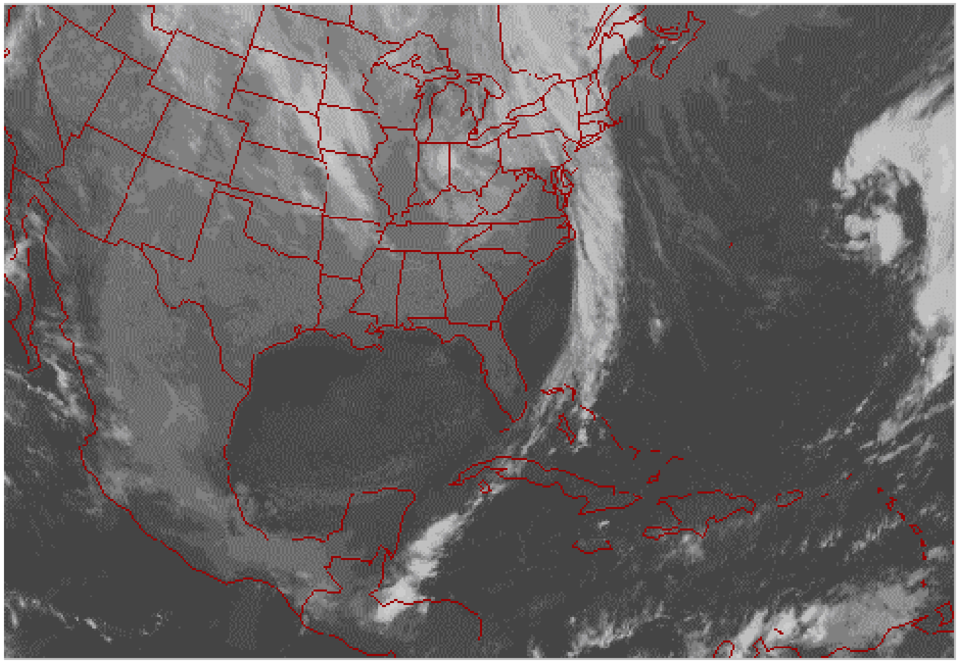
INSMET

Cold Fronts



A cold front is defined as the leading edge of a cooler mass of air, replacing (at ground level) a warmer mass of air.

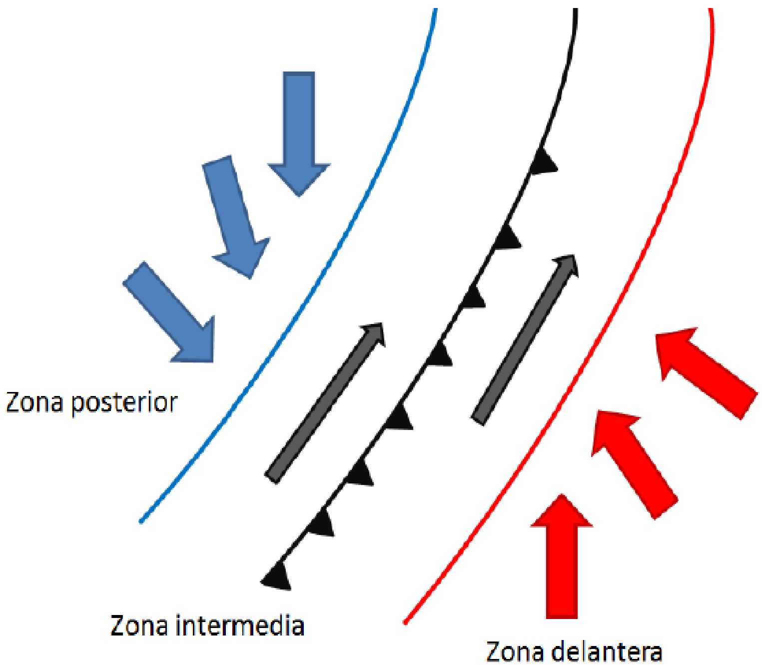
In our region it is the main contributor to rain in the non-rainy season.

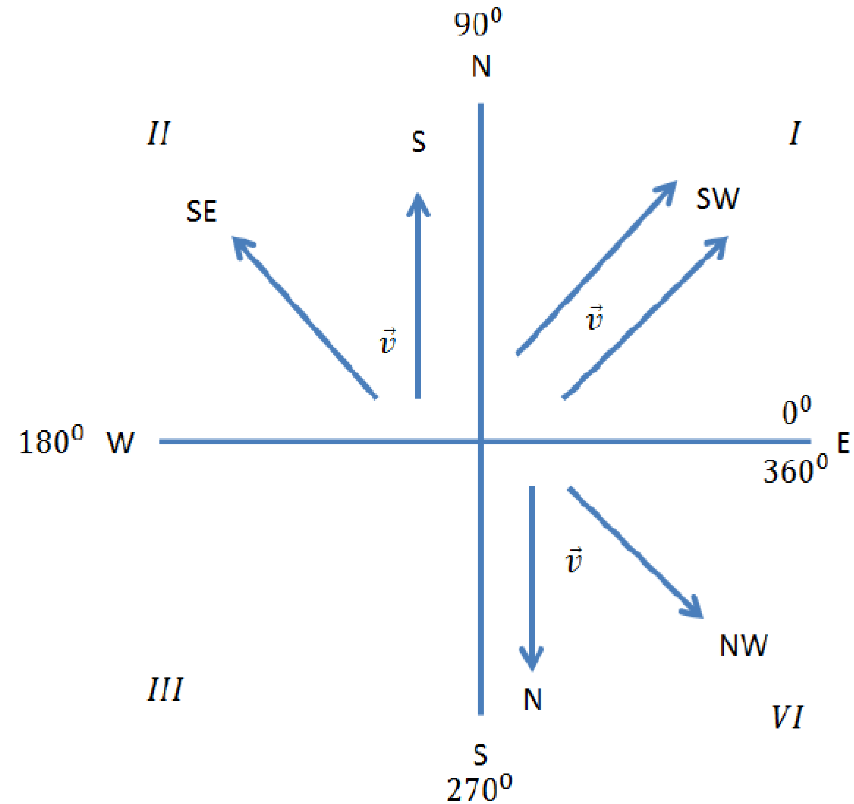


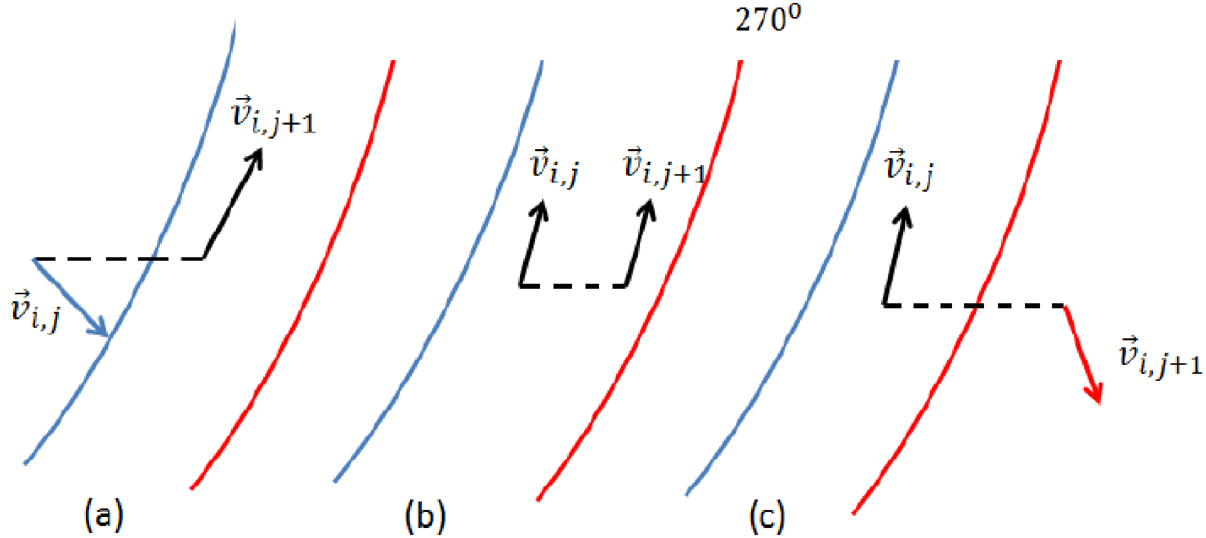
Cold Fronts how variables behave

Weather phenomenon	Prior to the Passing of the Front	While the Front is Passing	After the Passing of the Front
Temperature	Warm	Cooling suddenly	Steadily cooling
Atmospheric pressure	Decreasing steadily	Lowest, then sudden increase	Increasing steadily
Winds	▪ Southwest to southeast (northern hemisphere) ▪ Northwest to northeast (southern hemisphere)	Gusty; shifting	▪ North to west, usually northwest (northern hemisphere) ▪ South to west, usually southwest (southern hemisphere)
Precipitation/conditions*	Light patchy rain can be produced by stratocumulus or stratus in the warm sector.	Prolonged rain (nimbostratus) or thunderstorms (cumulonimbus): depends on conditions.	Showers, then clearing

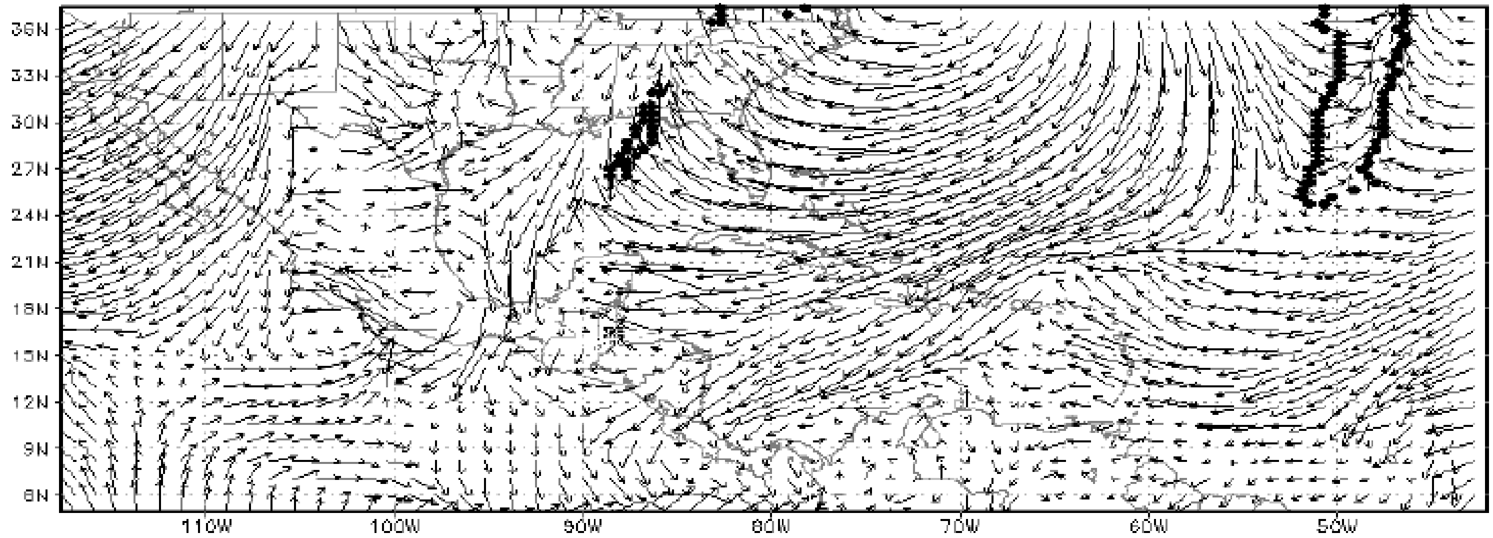
Cold Fronts Searching scheme

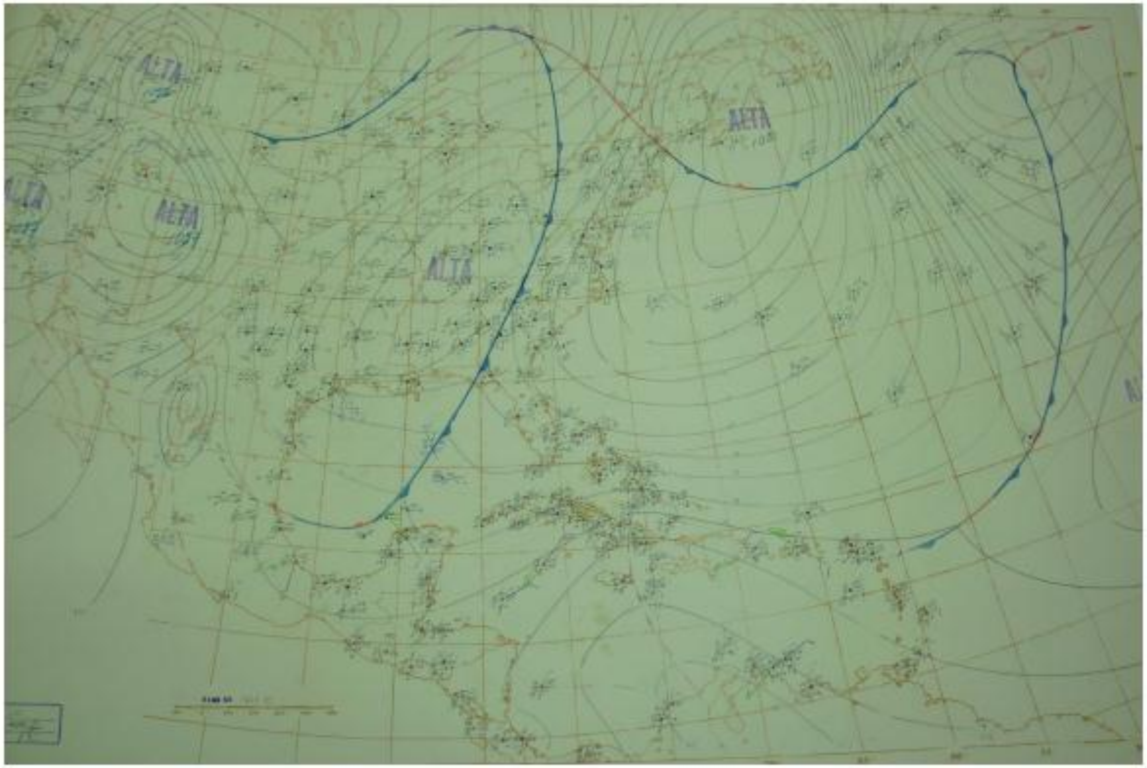




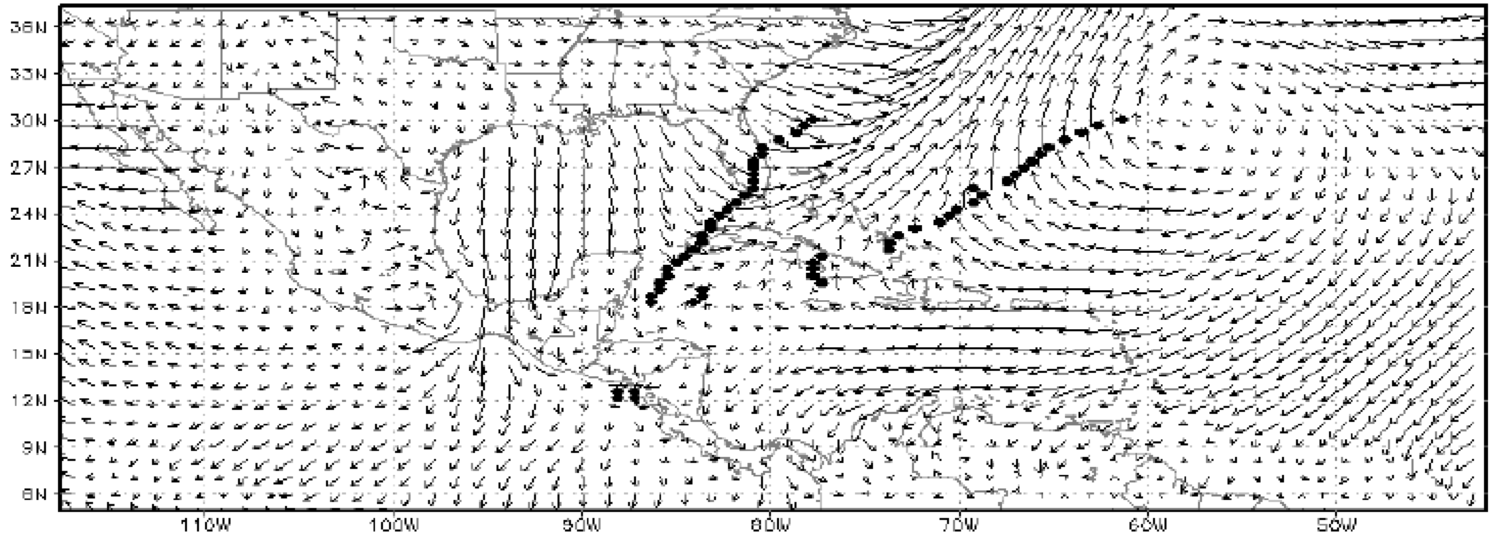


Cold Fronts Comparison





Cold Fronts Comparison



Cold Fronts

1- The algorithm has the ability to identify cold fronts using inputs like the output of a RCM RegCM

2- The method was effective in 92% of the cases. Compare with the synoptic maps from INSMET.

3- At this moment an improved algorithm is being tested at Center for Atmospheric Physics to apply to daily forecast .

PRECIS and extreme precipitation: a case study

Experimental Purpose

Extreme Precipitation can have a severe impact on human life and livelihood

Policy makers and planners have an interest in determining how the frequency and intensity of extreme precipitation could change in the coming century

PRECIS can be used to generate detailed climate projections which will include extreme precipitation

It is thus important to establish whether PRECIS can realistically simulate detailed extreme precipitation

Experimental Set-up

The PRECIS RCM (HadRM3P) was run over four different areas of the world, each featuring differing characteristics and influences on climate. Output data from the RCM was then compared to historical records of rainfall amount (also called "observations").

The model was run between December 1958 and December 1999 over each region.

The input data was from the European Centre for Medium Range Weather Forecasting "ERA-40" quasi-observational data set (i.e. reanalysis data)

Experimental Set-up

Precipitation varies in quantity (some days it rains more than other days)

Precipitation varies in time (it's not always raining)

Precipitation varies in space (rain is a localised weather phenomenon)

Extreme precipitation is, by definition, a relatively rare occurrence

These factors must be taken into consideration when comparing PRECIS output data against historical observations of precipitation

Indices for Comparison

Index 1: Multi-annual seasonal mean precipitation

Provides a "big picture" of how well PRECIS simulates precipitation vs. historical observations (i.e. what actually occurred)

Seasons are abbreviated via the first day of the month: DJF, MAM, JJA, SON.

Indices for Comparison

Index 2: Wet day intensity

- Wet day intensity is defined as the multi-annual seasonal mean of precipitation on "rainy days". A "rainy day" (also called "wet day") is a day which there is more than 0.1mm of rain.

- Allows for comparison of the total amount of rain which PRECIS produces in comparison to how much rain actually occurred (on "rainy days")

Indices for Comparison

Index 3: Wet day frequency

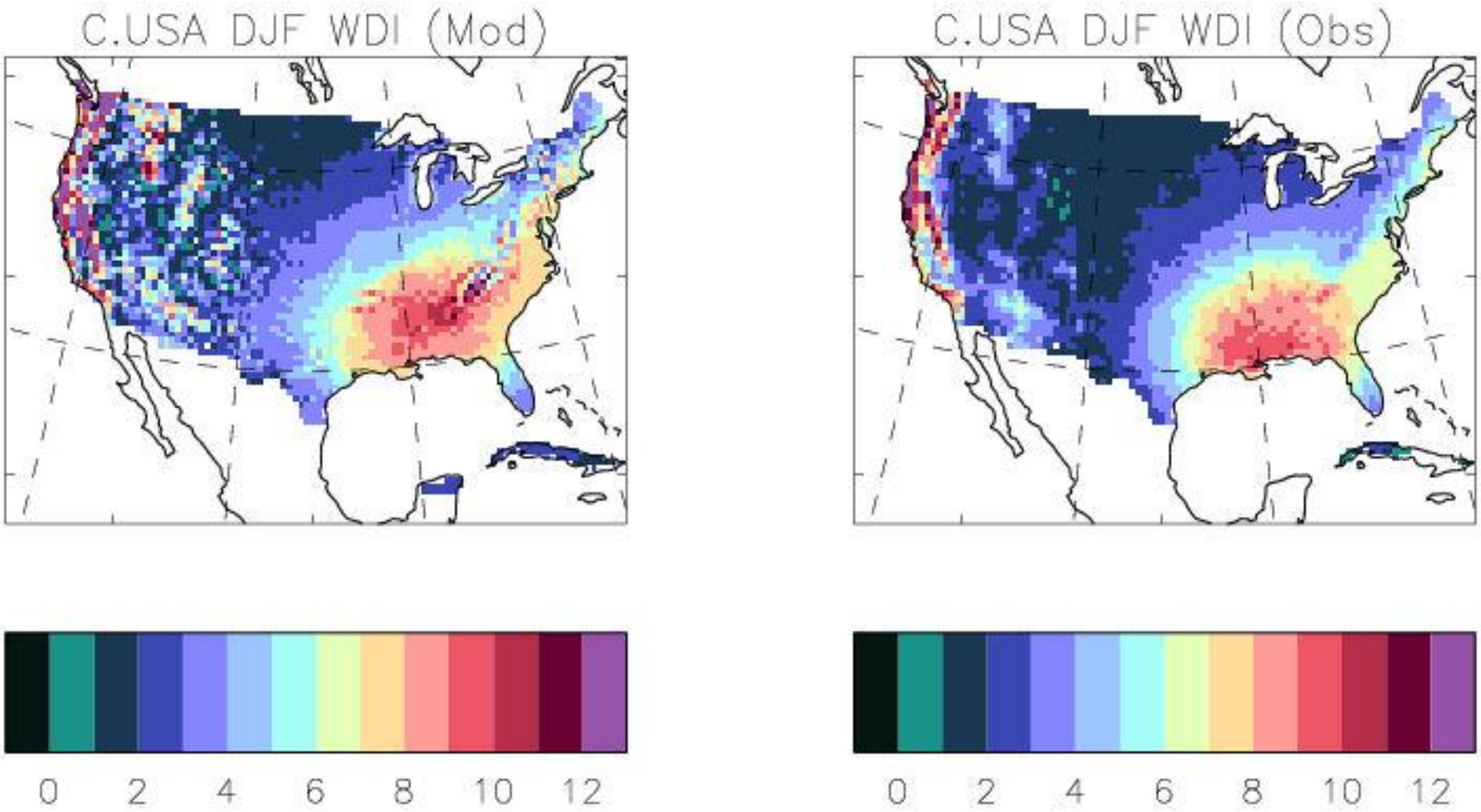
- Wet day frequency is a percentage of the total days in which precipitation occurs
- Allows for comparison between how often PRECIS produces precipitation vs. how often precipitation occurred in historical records

Indices for Comparison

Index 4: Extreme Precipitation

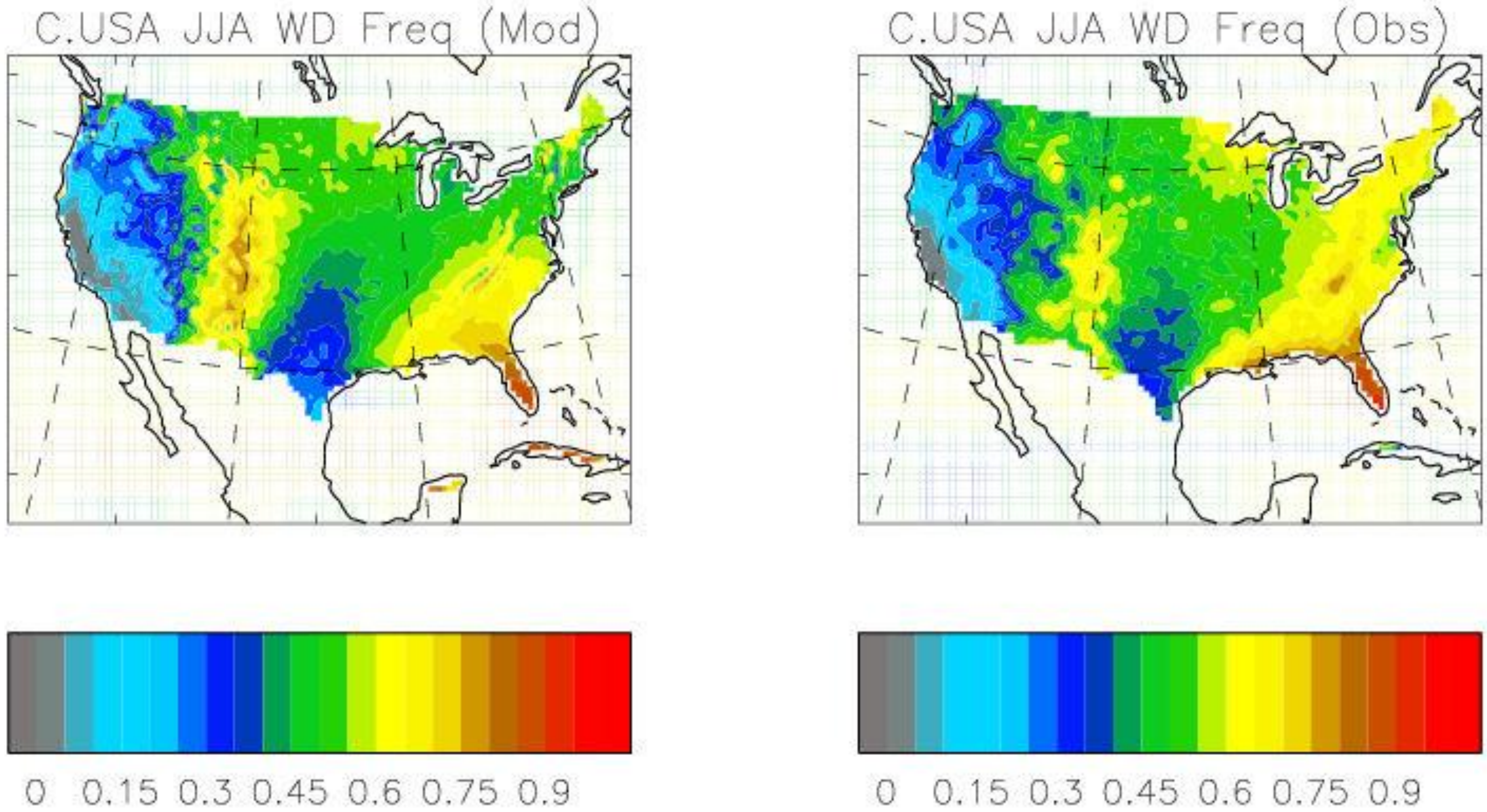
- Allows for comparison of the times when PRECIS produces rainfall in the upper 5% vs. the upper 5% of historical observations.
- Useful to gauge how well that PRECIS simulates extreme precipitation

Wet day intensity



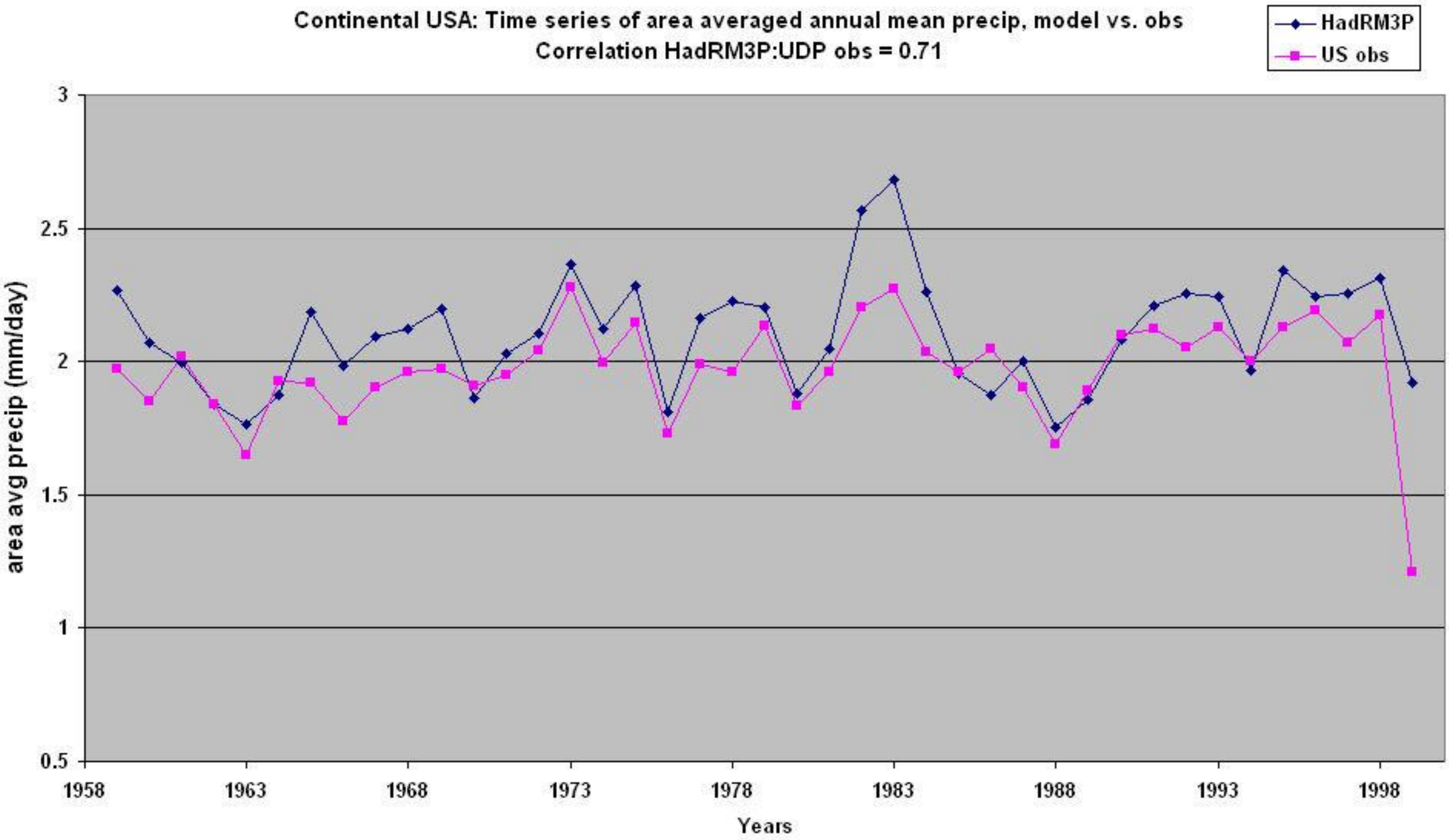
PRECIS produces too much precipitation in the mountainous west, but overall does well in capturing the spatial patterns of wet day intensity

Wet Day Frequency

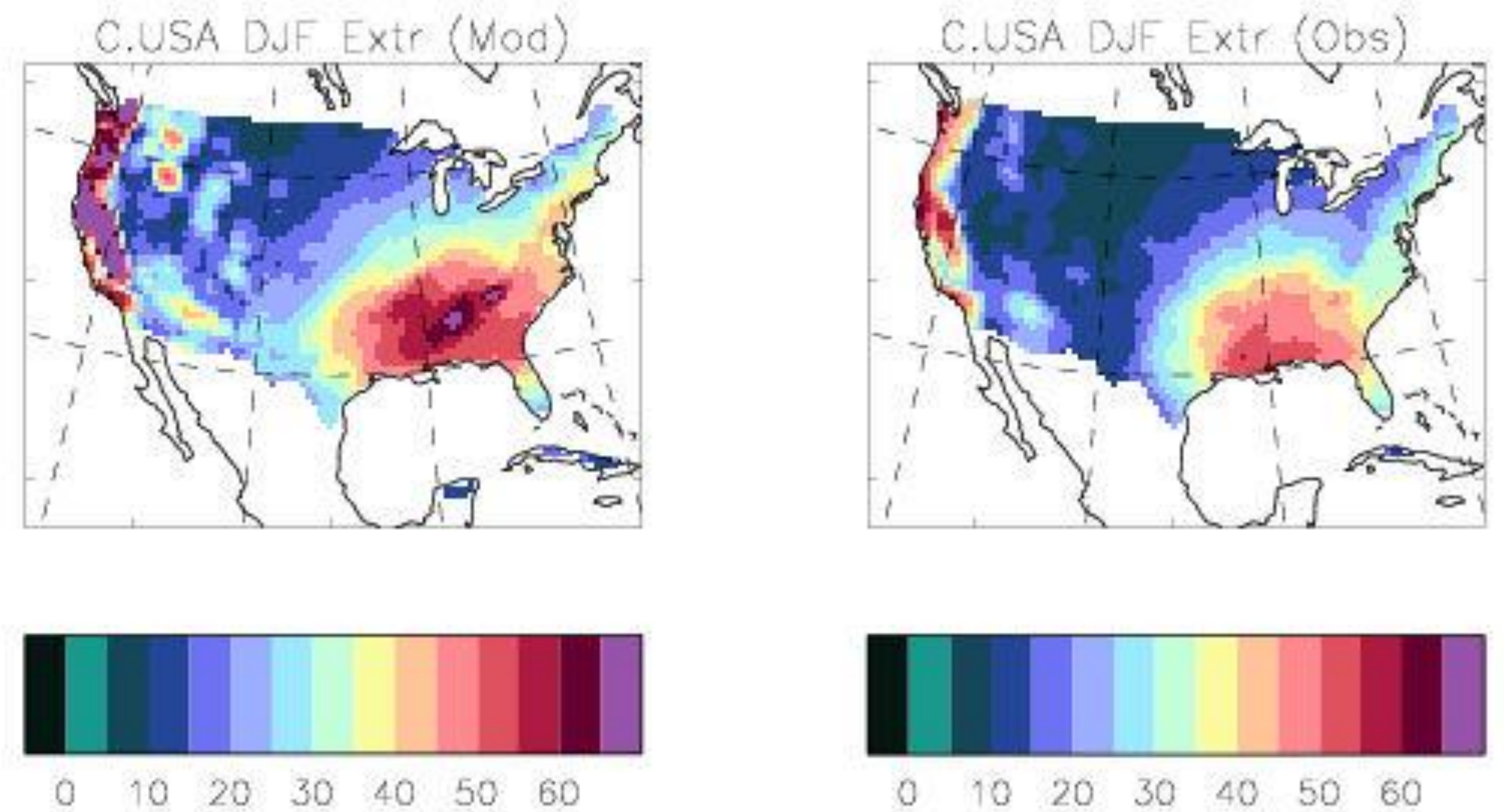


PRECIS performs very well in capturing the spatial distribution of wet day frequency for JJA. Example: the observations show it rains almost everyday in Florida, and rarely in California. PRECIS reproduces this feature.

Mean Precipitation



Extreme Precipitation



For DJF the pattern correlation is extremely good -- PRECIS is producing extreme precipitation in all the right places. However, it produces too much extreme precipitation in the southeast and mountain west

Conclusions

Overall, PRECIS showed better performance in time and location in the regions in which large-scale (i.e. frontal) precipitation dominates (the USA and Europe) than in the regions in which convective rainfall dominates (South Africa and India)

Mountainous areas were problematic for PRECIS in that it tended to overestimate rainfall in these areas

Some Examples (dust)

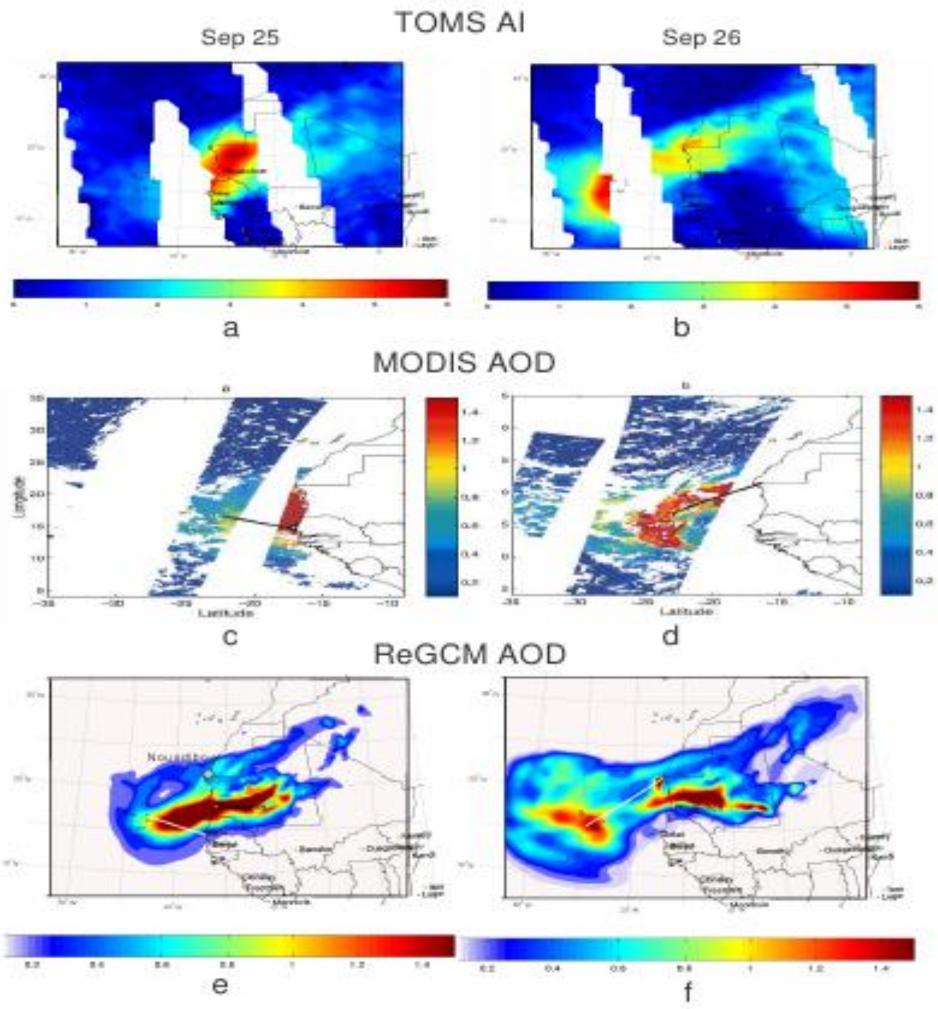
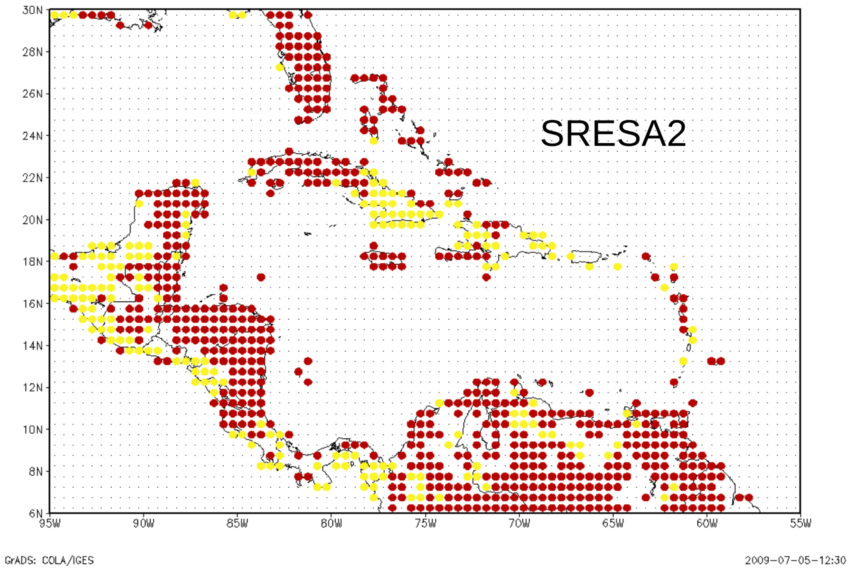
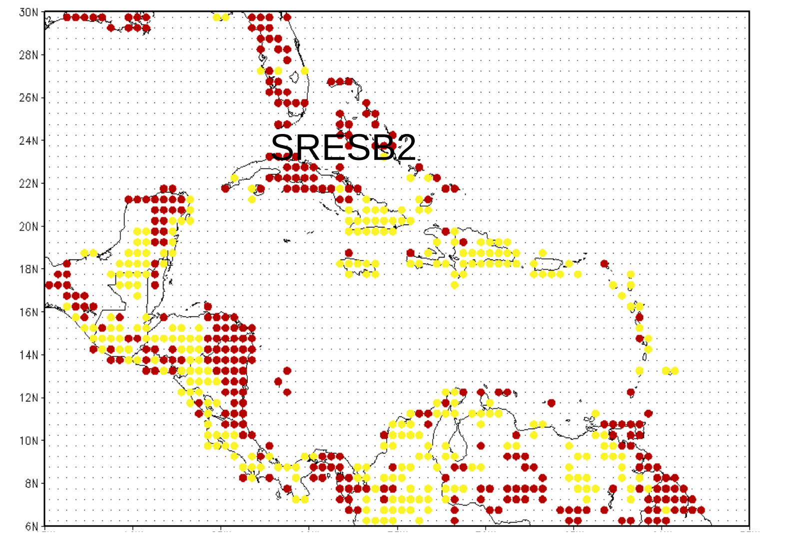


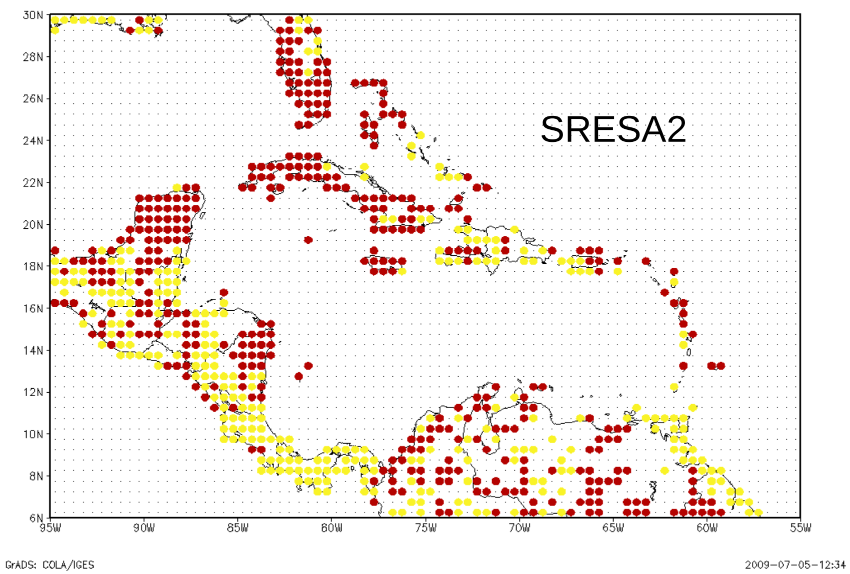
Fig. 6. TOMS aerosol index, MODIS Aerosol optical depth at 550 nm (after Léon et al., 2003) and RegCM simulated Aerosol optical depth on 25 and 26 September 2000. Flight track during the shade experiment are materialized on panels **(c)** and **(d)**. Model vertical cross sections presented in Fig. 9 are materialized on panels **(e)** and **(f)**.

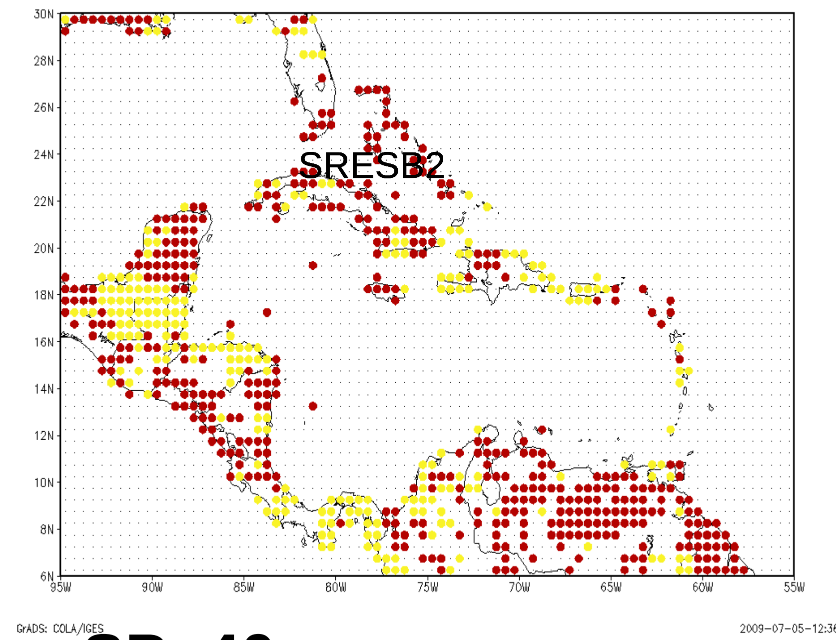
Some Examples (drought)





Precis ECH





Precis Had

Zones of Increasing SCPe y SPe40c

Some Examples

(Wind power & Renewable energy)

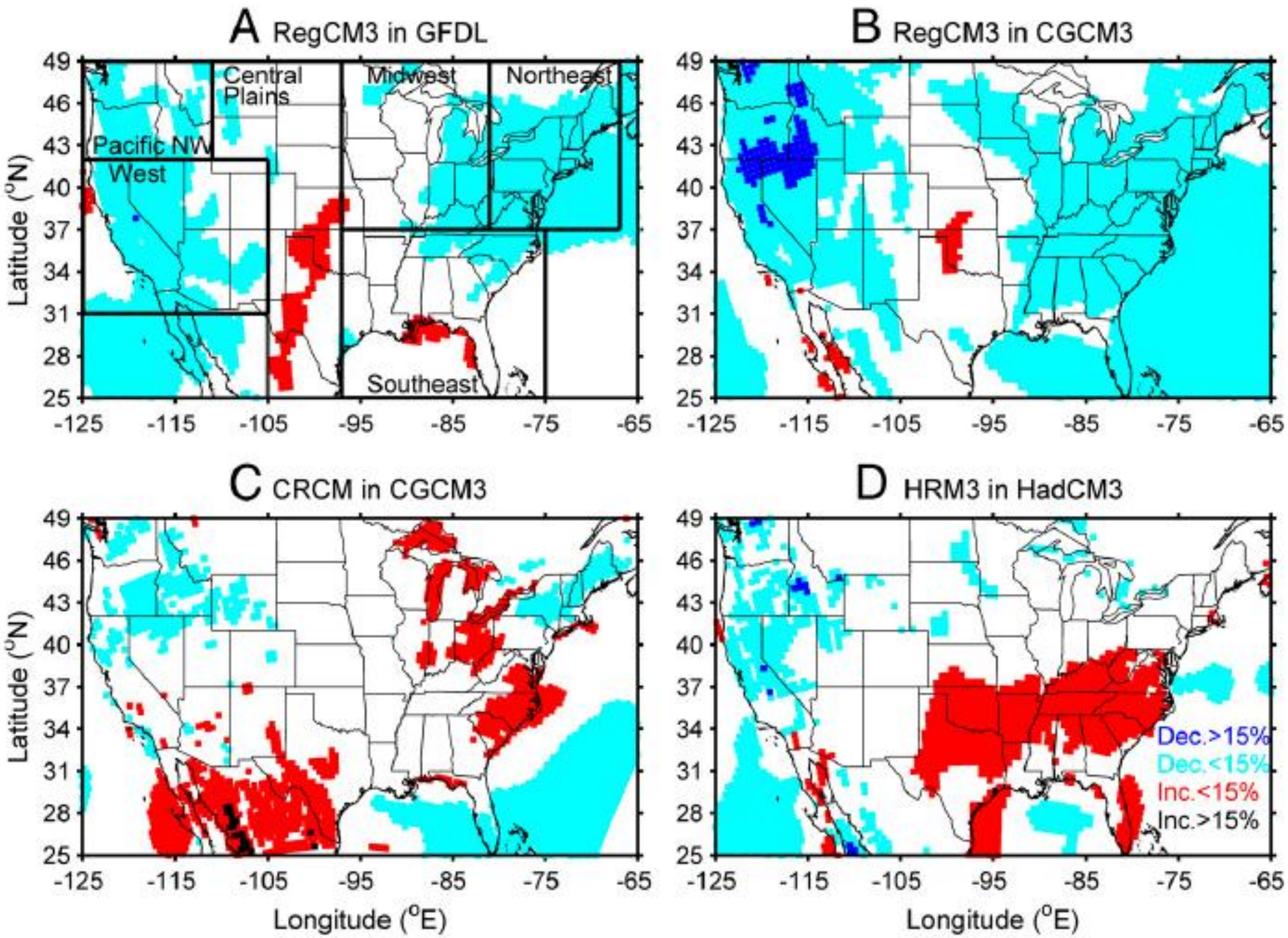


Fig. 3. Difference in the mean wind energy density (in %) for 2041–2062 vs. 1979–2000. *A–D* show the different AOGCM–RCM combinations. The sign and magnitude of change is only shown for grid cells where the value for the future period beyond the 95% confidence intervals on the mean value during 1979–2000. The colors depict both the sign and magnitude of the difference using the legend in *D*. The climate regions as derived from the National Assessment and used in Fig. 4 are denoted in *A*.

Other model Variables (Summary)

- RCMs provide a lot of output variables.
- Many of these variables can be used directly to generate future climate change scenarios.
- A large number of products and analyses can be made from the output variables or combinations of these.
- For the postprocessing process it is crucial to know from the users the number of variables and the time resolutions.

Thanks !!!!

PRECIS Online Access

http://precis.insmet.cu/Precis-Caribe.htm

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