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FLUX DE CHALEUR
SUR L'ATLANTIQUE TROPICAL
EN 1989

Claudio Solano Pereira
Jacques Servain
Alain Morlière

Este trabalho se integra dentro da cooperação
internacional entre INPE(Brasil) e ORSTOM/BREST(França)

INPE
São José dos Campos
Janeiro de 1991

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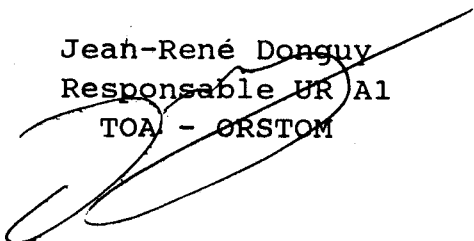
PREFACE

Dans ce document sont rassemblés sous forme de champs mensuels, une partie d'une étude entreprise au Centre ORSTOM de Brest par Claudio Solano Pereira entre début mars et fin août 1990. Ce chercheur en océanographie physique est de nationalité brésilienne; il est fonctionnaire de l'Instituto Nacional de Pesquisas Espaciais (INPE) de São José dos Campos São Paulo, Brésil. Il occupa durant cette période de 6 mois un poste de d'accueil de courte durée au sein de l'ORSTOM.

Le travail présenté ici s'intègre dans le cadre du programme OPERA qui est une action de TOGA-France soutenue par le PNEDC. Il fut originellement proposé au Département T.O.A. de l'ORSTOM par Jacques Servain (ORSTOM/Brest). Ce dernier, ainsi que Alain Morlière (ORSTOM/Brest) collaborèrent à sa réalisation.

Cette étude est un exemple de la coopération internationale entre l'ORSTOM (France) et l'INPE (Brésil) dans le cadre du programme TOGA.

Jean-René Donguy
Responsable UR A1
TOA - ORSTOM



OPERA

Observatoire PERmanent de l'Atlantique tropical

FLUX DE CHALEUR
SUR L'ATLANTIQUE TROPICAL
EN 1989

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PRESENTATION DE L'ETUDE

1. INTRODUCTION

Cette étude est une expérience pilote entrant dans le développement du projet OPERA (Observatoire PERmanent de l'Atlantique tropical). Rappelons que le projet OPERA (Morlière et al., 1990) a pour but de simuler numériquement en temps quasi-réel l'état thermodynamique de l'océan Atlantique tropical. Le modèle numérique utilisé fut originellement développé par l'équipe de Pascale Delécluse au LODYC (Andrich, 1989). Il s'agit d'un OGCM tridimensionnel aux équations primitives forcé à la fois par un champ de tension de vent et un champ de flux de chaleur. Une adaptation pour une utilisation en temps opérationnel fut entreprise au LODYC (Morlière et al., 1989b).

Notre objectif principal dans cette présente étude est de mesurer la sensibilité du modèle lorsque le forçage thermique de celui-ci provient d'un champ mensuel de flux de chaleur calculé à partir de variables physiques réellement observées. Dans la version actuelle du modèle, le forçage thermique résulte simplement d'un calcul utilisant des variables climatiques et simulées (Morlière et al., 1989a). Les observations des variables physiques utilisées dans cette expérience proviennent d'un réseau de navires marchands sélectionnés. Elles servent déjà à l'établissement depuis janvier 1964 des champs mensuels de la température de surface de la mer (SST) et de la tension du vent sur l'Atlantique tropical (Servain, 1990). Le traitement en temps quasi-réel de ces champs - notamment celui de la tension du vent qui est utilisée comme forçage dynamique du modèle océanique - a permis la mise en place du projet OPERA.

2. TRAITEMENT DES OBSERVATIONS

Les données brutes utilisées furent observées durant l'année 1989, dernière année complète disponible au départ de notre expérience. Les variables physiques servant au calcul des flux de chaleur latente et sensible sont:

- SST : température de surface de la mer ($^{\circ}\text{C}$)
- TAR : température de l'air ($^{\circ}\text{C}$)
- PRE : pression atmosphérique au niveau de la mer (mb)
- VEN : vitesse du vent (m/s)
- HUM : humidité relative (%)

Pour chacune de ces variables nous avons préparé les 12 champs mensuels de l'année 1989 sur une grille régulière, et sans trou, de 2° de longitude par 2° de latitude. Les champs de SST étaient déjà disponibles (Servain et Lukas 1990). Pour les autres champs nous avons utilisés une technique de traitement similaire à celle de la SST. HUM a été calculé à partir de l'information originale disponible qui est la dépression de température, c'est-à-dire la différence entre TAR et la température du point de rosée ("dew-point").

La principale difficulté dans l'établissement des champs moyens mensuels provint du fait que le nombre d'observations disponibles n'était pas uniforme pour l'ensemble des variables. La densité des données de dépression de température ne représente par exemple que 55 à 60 % de la densité des données de température de l'air (Table I). Il s'ensuit certainement une certaine différence qualitative, difficile à mesurer, dans la représentation des diverses variables.

Une seconde difficulté découla de la méthode de traitement utilisée. Cette méthode (Picaüt et al., 1985; Servain et al., 1985; Servain et al., 1987), utilise un schéma d'analyse objective (Cressman, 1959) faisant appel à une climatologie mensuelle pour chaque variable. Pour cette étude nous avons utilisé une climatologie provenant des COADS (Anonyme, 1985) et reformatée par Oberhuber (1988).

TABLE I

Nombre d'Observations Disponibles (Année 1989)

MOIS	SST	TAR	PRE	VEN	HUM
01	7464	7305	7375	7471	3966
02	6572	7294	7145	7215	3795
03	7030	7783	7829	7624	4277
04	6445	7395	7321	7230	4286
05	6671	8157	8146	7087	4700
06	5474	6414	6368	6207	3704
07	6410	7229	7177	6971	4111
08	6424	7422	7352	7186	4422
09	6336	7120	7095	6847	4651
10	6452	7179	7256	7042	4135
11	6770	6896	6994	6768	3939
12	6768	7458	8386	7225	4050
MOYENNE	6568	7304	7370	7073	4170

3. CALCUL DES FLUX DE CHALEUR

Les champs mensuels de la chaleur latente (QL) et de la chaleur sensible (QS) sont calculés en utilisant les "bulk formulas":

$$QL = \rho L_v C_E U_{10} (q_w - q)$$

$$QS = \rho c_p C_H U_{10} (\theta_w - \theta)$$

où

- * ρ : densité de l'air à proximité de l'interface air-mer (Kg/m^3)
- * L_v : chaleur latente de vaporisation = $2455 \cdot 10^3$ (J/Kg)
- * c_p : chaleur spécifique de l'air humide à pression constante = 1004.6 (J/Kg/K)
- * C_E : terme d'échange de la chaleur latente
- * C_H : terme d'échange de la chaleur sensible
- * U_{10} : vitesse du vent à une altitude de 10m (m/s)
- * q_w : humidité spécifique saturante à la SST (g/g)
- * q : humidité spécifique atmosphérique (g/g)
- * θ_w : température de l'air au niveau de la mer (K)
- * θ : température potentielle de l'air à 10 m d'altitude (K)

Les coefficients C_E et C_H dépendent de la vitesse du vent et la stabilité de la couche atmosphérique au voisinage de la surface de la mer (Liu et al., 1979). La densité de l'air est fonction de la température de l'air, de la pression atmosphérique et de l'humidité spécifique.

4. PRESENTATION GRAPHIQUE DES RESULTATS

L'ensemble des résultats graphiques que nous reproduisons dans ce mémoire se décompose en quatre parties. Pour chacune de ces parties - et chacune des variables à l'intérieur de chaque partie - nous fournissons la moyenne annuelle, les quatre moyennes saisonnières et les douze moyennes mensuelles de l'année 1989.

La première partie (pages 11 à 55) est relative aux cinq variables primaires observées; à savoir SST, TAR, PRE, VEN et HUM.

Dans la seconde partie (pages 57 à 74) nous reproduisons les champs de QL et QS calculés à partir des variables primaires observées.

La troisième partie (pages 76 à 93) est composée des champs de QL et QS tels qu'ils sont calculés par la version actuelle du modèle océanique, c'est-à-dire à partir de données climatiques et simulées.

La quatrième partie (pages 95 à 112) représente la différence arithmétique entre les champs de chaleur "observés" (partie 2) et les champs de chaleur "climatiques" (partie 3).

5. CONCLUSION

Ce document de travail est un recueil des principaux résultats graphiques obtenus lors de la première étape de notre étude, à savoir le calcul des termes du flux de chaleur sur l'Atlantique tropical au cours de l'année 1989. Il sera suivi d'un second fascicule où seront publiés les champs mensuels, saisonniers et annuel de la SST simulée par le modèle océanique pour l'année 1989, et ceci pour trois "runs" différents:

- un premier "run" où le modèle est forcé par les flux calculés à partir des variables primaires "climatiques" (version actuelle du modèle).

- un second "run" où le modèle est forcé par les flux calculés à partir de TAR et HUM "observées".

- un troisième "run" où le modèle est forcé par les flux calculés à partir de l'ensemble des variables primaires "observées" (SST, TAR, PRE, VEN, HUM).

Une synthèse de l'ensemble de ce travail, ainsi qu'une discussion des résultats obtenus, sera ensuite proposée pour publication dans une revue internationale.

REMERCIEMENTS

C.S.P. tient à remercier Monsieur Winter, directeur de l'ORSTOM, Monsieur Jarrige, chef du Département T.O.A., Monsieur Donguy, responsable de l'UR A1, Monsieur Conand, directeur du Centre ORSTOM de Brest, Monsieur Gylvan, directeur de la Météorologie du INPE, ainsi que l'ensemble du personnel ORSTOM de Brest, pour avoir permis et facilité son accueil de mars à août 1990 au Centre ORSTOM de Brest.

Josef Oberhuber nous a fourni gracieusement ses fichiers de climatologie par l'intermédiaire de Pascale Delécluse. Les calculs à Brest ont bénéficiés des supports informatiques de l'ORSTOM et de l'IFREMER. Le Bureau Informatique du Centre ORSTOM de Brest, en les personnes de Jean-Jacques Lechauve et Daniel Corre, est particulièrement remercié pour son aide, notamment en ce qui concerne la mise au point du traitement graphique des données. Les simulations numériques ont pu être réalisées grâce aux allocations de calcul sur CRAY 2 accordées par le Conseil Scientifique du CCVR.

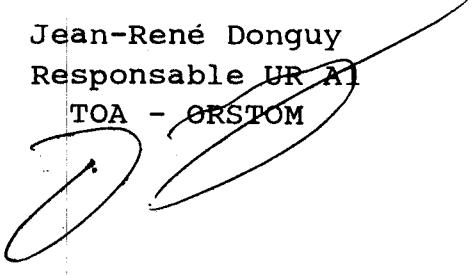
PREFÁCIO

Neste documento serão reunidos sob a forma de campos mensais, uma parte de um estudo realizado no Centro ORSTOM de Brest por Claudio Solano Pereira entre início de março e fim de agosto de 1990. Este pesquisador em oceanografia física é de nacionalidade brasileira, funcionário do Instituto Nacional de Pesquisas Espaciais em São José dos Campos, SP, Brasil. Ele ocupou durante este período de 6 meses um "poste d'accueil" de curta duração no Centro ORSTOM.

O trabalho apresentado aqui se integra dentro do projeto OPERA que é uma atividade do programa TOGA-França promovido pelo PNEDC. Ele foi originalmente proposto ao Departamento Terra-Oceano-Atmosfera do ORSTOM por Jacques Servain (ORSTOM-Brest). Este último, e também Alain Morlière (ORSTOM-LODYC) colaboraram nesta realização.

Este estudo é um exemplo da cooperação internacional entre ORSTOM (França) e INPE (Brasil) dentro de um projeto do programa TOGA.

Jean-René Donguy
Responsable UR A1
TOA - ORSTOM



APRESENTAÇÃO DO ESTUDO

1. INTRODUÇÃO

Este estudo é uma experiência piloto dentro do desenvolvimento do projeto OPERA (Observatoire PERmanent de l'Atlantique tropical). Lembramos que o projeto OPERA (Morlière *et al.*, 1990) tem por objetivo simular numericamente em tempo quasi-real o estado termodinâmico do oceano Atlântico tropical. O modelo numérico utilizado foi originalmente desenvolvido pela equipe de Pascale Delécluse no LODYC (Andrich, 1989). Trata-se de um OGCM tridimensional de equações primitivas, sendo forçado na superfície por um campo de tensão do vento e um campo de fluxo de calor. Uma adaptação para utilização em tempo operacional foi levada a efeito no LODYC (Morlière *et al.*, 1989b).

Nosso objetivo principal neste presente estudo é medir a sensibilidade do modelo quando submetido a ação de uma forçante térmica, proveniente de um campo mensal de fluxo de calor calculado à partir de variáveis físicas observadas. Na versão atual do modelo a forçante térmica resulta simplesmente de um cálculo que utiliza variáveis climáticas e simuladas (Morlière *et al.*, 1989a). As observações das variáveis físicas utilizadas nesta experiência são oriundas de uma rede de navios mercantes selecionados. Desde janeiro de 1964 essas observações já servem ao estabelecimento de campos mensais da temperatura da superfície do mar (SST) e da tensão do vento sobre o Atlântico tropical (Servain, 1990). O tratamento em tempo quasi-real desses campos, notadamente o da tensão do vento que é utilizado como forçante dinâmica do modelo oceânico, tem contribuído para a operacionalidade do projeto OPERA.

2. TRATAMENTO DAS OBSERVAÇÕES

Os dados brutos utilizados foram observações durante o ano 1989, último ano completo disponível no início de nossa experiência. As variáveis físicas utilizadas no cálculo dos fluxos de calor latente e sensível são:

- SST : temperatura da superfície do mar ($^{\circ}\text{C}$)
- TAR : temperatura do ar a 10m de altura ($^{\circ}\text{C}$)
- PRE : pressão atmosférica ao nível do mar (mb)
- VEN : velocidade do vento (m/s)
- HUM : umidade relativa (%)

Para cada uma dessas variáveis nós temos preparado os 12 campos mensais do ano 1989 sobre uma grade regular, contínua, de 2° de longitude por 2° de latitude. Os campos de SST já estavam disponíveis (Servain e Lukas, 1990). Para os outros campos nós temos utilizado uma técnica de tratamento similar àquele da SST. A HUM foi calculada a partir da informação original disponível que é a depressão de temperatura, ou seja, a diferença entre TAR e a temperatura do ponto de orvalho ("dew point").

A principal dificuldade no estabelecimento dos campos médios mensais vem do fato que o número de observações disponíveis não era uniforme para o conjunto das variáveis. Por exemplo, a densidade dos dados de depressão de temperatura não representa mais que 55% a 60% da densidade dos dados de temperatura do ar (tabela I). Isto representa certamente uma diferença qualitativa na representação das diversas variáveis que é difícil de ser estimada.

Uma segunda dificuldade decorre do método de tratamento utilizado. Este método (Picaut et al., 1985 ; Servain et al., 1985 ; Servain et al., 1987) utiliza um esquema de análise objetiva (Cressman, 1959) que referencia uma climatologia mensal para cada variável. Para este estudo nós temos utilizado uma climatologia proveniente do COADS (Anonyme, 1985) reformatada por Oberhuber (1988).

TABELA I

Número de Observações Disponíveis (Ano 1989)

MÊS	SST	TAR	PRE	VEN	HUM
01	7464	7305	7375	7471	3966
02	6572	7294	7145	7215	3795
03	7030	7783	7829	7624	4277
04	6445	7395	7321	7230	4286
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10	6452	7179	7256	7042	4135
11	6770	6896	6994	6768	3939
12	6768	7458	8386	7225	4050
MEDIA	6568	7304	7370	7073	4170

3. CALCULO DOS FLUXOS DE CALOR LATENTE E SENSÍVEL

Os campos mensais de calor latente QL e de calor sensível QS em W/m^2 são calculados utilizando as "bulk formulas":

$$QL = \rho L_v C_E U_{10} (q_w - q)$$

$$QS = \rho c_p C_H U_{10} (\theta_w - \theta)$$

onde

- * ρ : densidade do ar próxima a interface ar-mar (Kg/m^3)
- * L_v : calor latente de vaporização = $2455 \cdot 10^3$ (J/Kg)
- * c_p : calor específico do ar úmido à pressão constante = 1004.6 ($J/Kg/K$)
- * C_E : coeficiente de troca de calor latente
- * C_H : coeficiente de troca de calor sensível
- * U_{10} : velocidade do vento a 10m de altura (m/s)
- * q_w : umidade específica saturada a SST (g/g)
- * q : umidade específica atmosférica (g/g)
- * θ_w : temperatura do ar ao nível da superfície do mar (K)
- * θ : temperatura potencial do ar à 10m de altura (K)

Os coeficientes C_E e C_H são dependentes da intensidade do vento e da estabilidade da parte baixa da atmosfera marinha (Liu *et al.*, 1979). Já a densidade do ar é função da temperatura do ar, da pressão atmosférica e da umidade específica.

4. APRESENTAÇÃO GRÁFICA DOS RESULTADOS

O conjunto de resultados gráficos que nós expomos neste atlas se subdivide em quatro partes. Para cada uma dessas partes, e para cada uma das variáveis, nós apresentamos a média anual, as quatro médias sazonais, e as doze médias mensais do ano 1989.

A primeira parte (pgs. 11 à 55) é relativa às cinco variáveis primárias observadas, à saber SST, TAR, PRE, VEN e HUM.

Na segunda parte (pgs. 57 à 74) nós reproduzimos os campos de QL e QS calculados à partir das variáveis primárias observadas.

A terceira parte (pgs. 76 à 93) é composta dos campos QL e QS tais como eles são calculados para a versão atual do modelo oceânico, isto é, à partir dos dados climáticos e simulados.

A quarta parte (pgs. 95 à 112) representa a diferença aritmética entre os campos de calor "observados" (parte 2) e os campos de calor "climáticos" (parte 3).

5- CONCLUSÕES

Este documento de trabalho é uma compilação dos principais resultados gráficos obtidos na primeira etapa de nosso estudo, a saber, o cálculo dos termos dos fluxos de calor sobre o Atlântico tropical no curso do ano 1989. Ele será seguido de um segundo fascículo onde serão publicados os campos mensais, sazonais e anual da SST simulada, para três diferentes rodadas ("runs") do modelo para o ano 1989:

- um primeiro "run" forçado pelos fluxos calculados à partir de variáveis primárias climáticas (versão atual do modelo).

- um segundo "run" forçado pelos fluxos calculados como na 1ª experiência sendo que as variáveis TAR e HUM são agora valores observados.

- um terceiro "run" forçado pelos fluxos calculados à partir do conjunto de variáveis primárias observadas (SST, TAR, PRE, VEN, HUM).

Uma síntese do conjunto deste trabalho com uma discussão dos resultados obtidos será em seguida proposta para publicação em uma revista internacional especializada.

AGRADECIMENTOS

C.S.P. manifesta seu agradecimento ao senhor Winter, diretor da ORSTOM, senhor Jarrige, chefe do Departamento T.O.A., senhor Donguy, responsável do UR A1, senhor Conand, diretor do Centro ORSTOM de Brest, senhor Gylvan, diretor da área de Meteorologia do INPE, e também ao corpo de profissionais do ORSTOM/Brest, por ter permitido e facilitado seu estágio de março a agosto de 1990 no Centro ORSTOM de Brest.

Josef Oberhuber forneceu graciosamente seus arquivos de climatologia por intermédio de Pascale Delécluse. Os cálculos em Brest foram beneficiados dos suportes da informática do ORSTOM e do IFREMER. O Núcleo de Informática do Centro ORSTOM de Brest, nas pessoas de Jean-Jacques Lechauve e Daniel Corre, é reconhecido por sua ajuda notadamente no que concerne ao processamento gráfico dos dados. As simulações numéricas puderam ser realizadas graças às alocações de cálculos no CRAY 2 concedido pelo Conseil Scientifique du CCVR.

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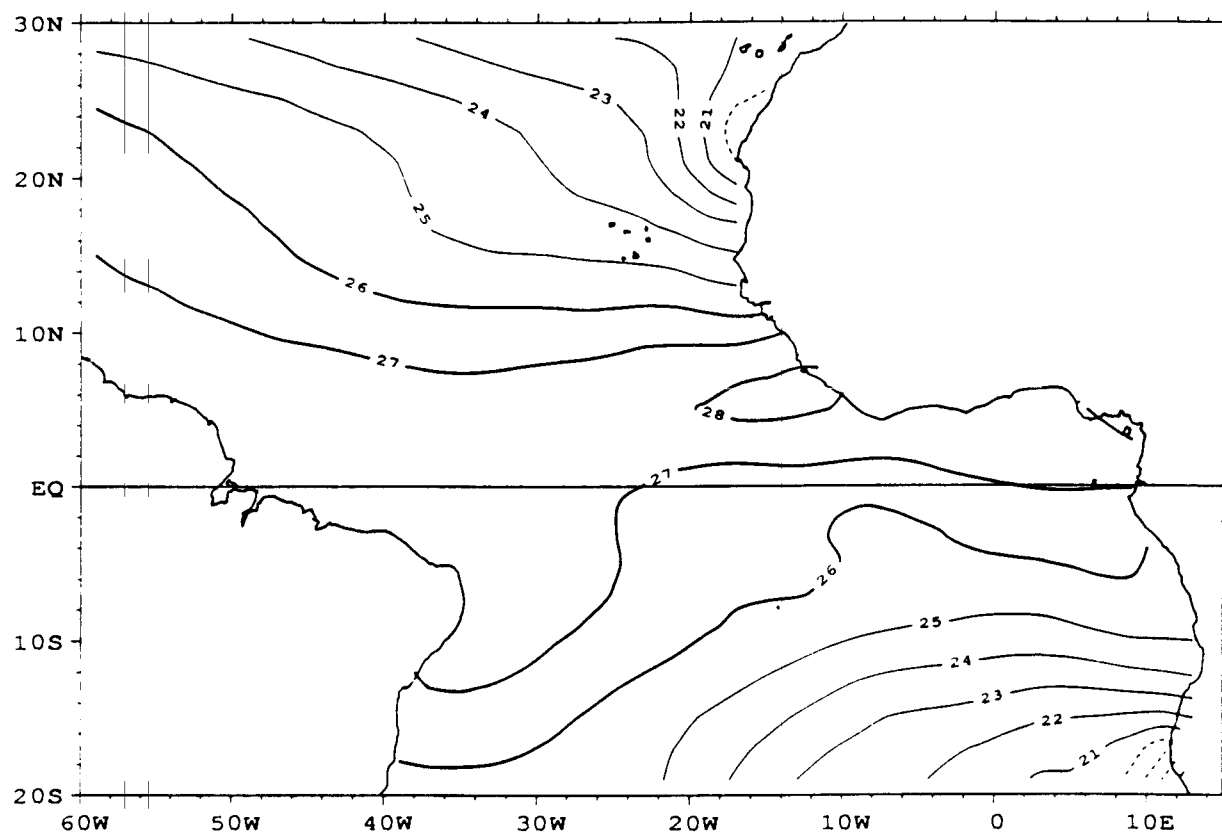
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PREMIERE PARTIE

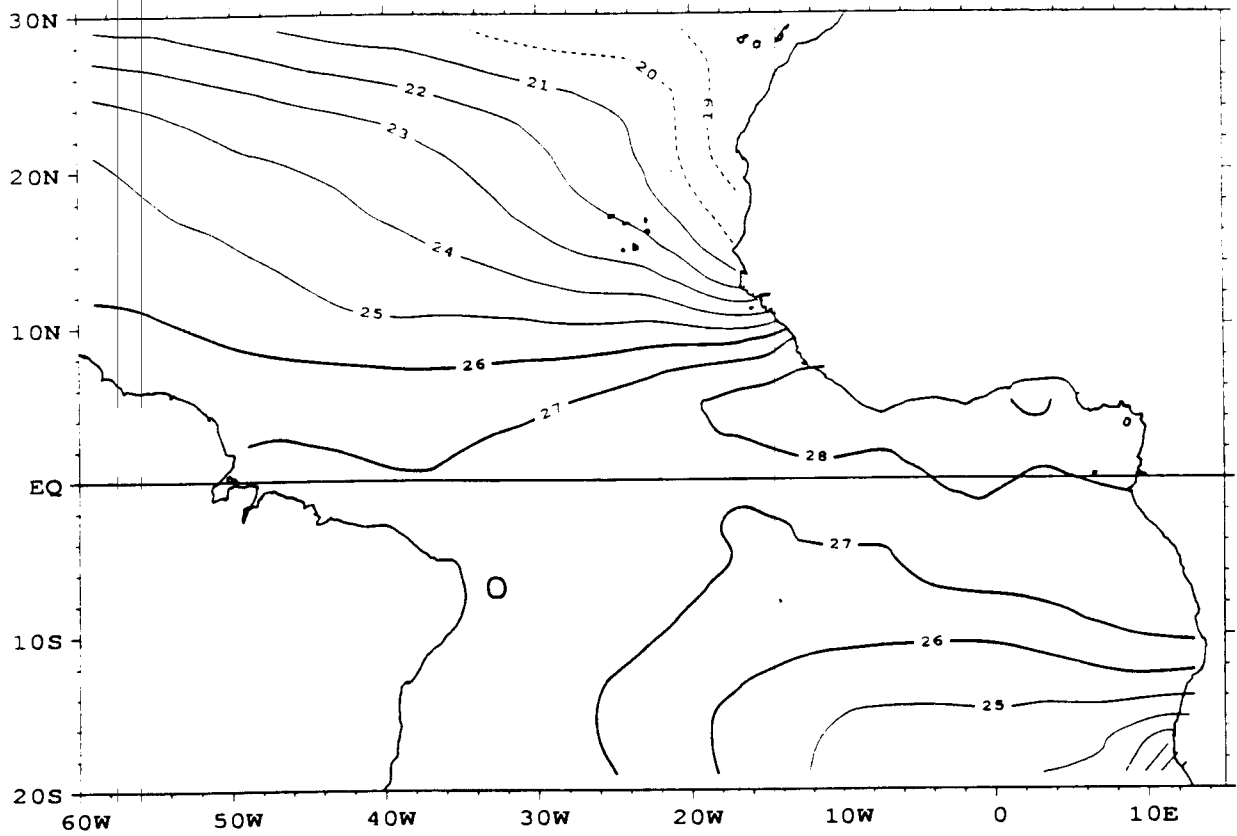
OBSERVATIONS DES VARIABLES PRIMAIRES

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PRE: page	29	à	37
VEN: page	38	à	46
HUM: page	47	à	55

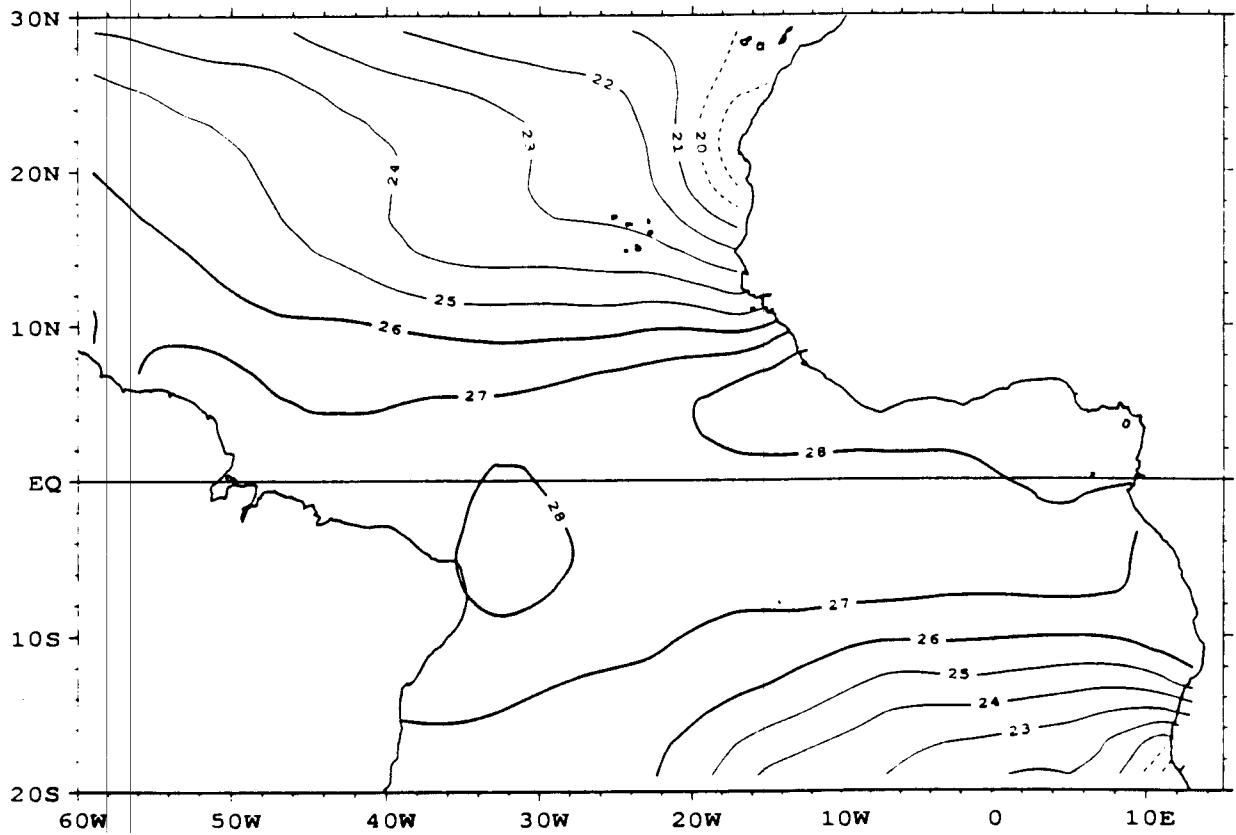
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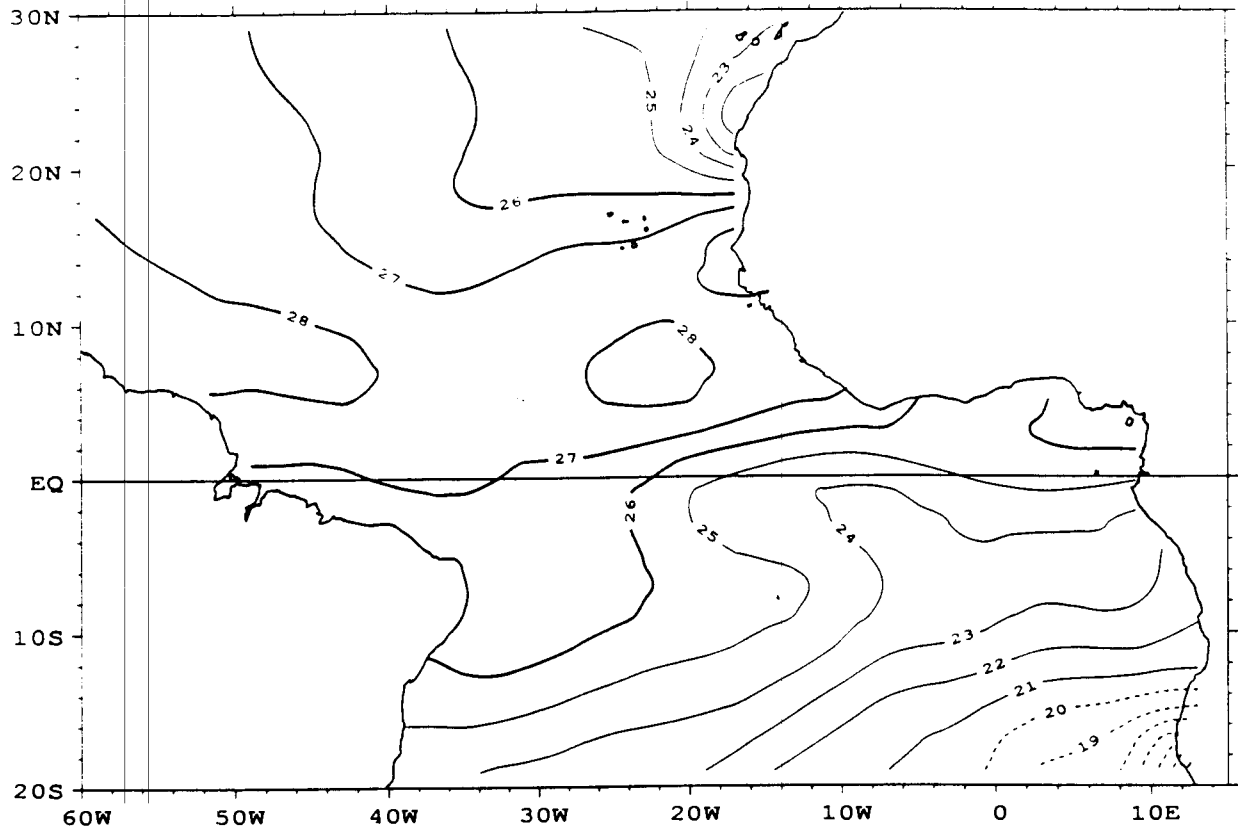
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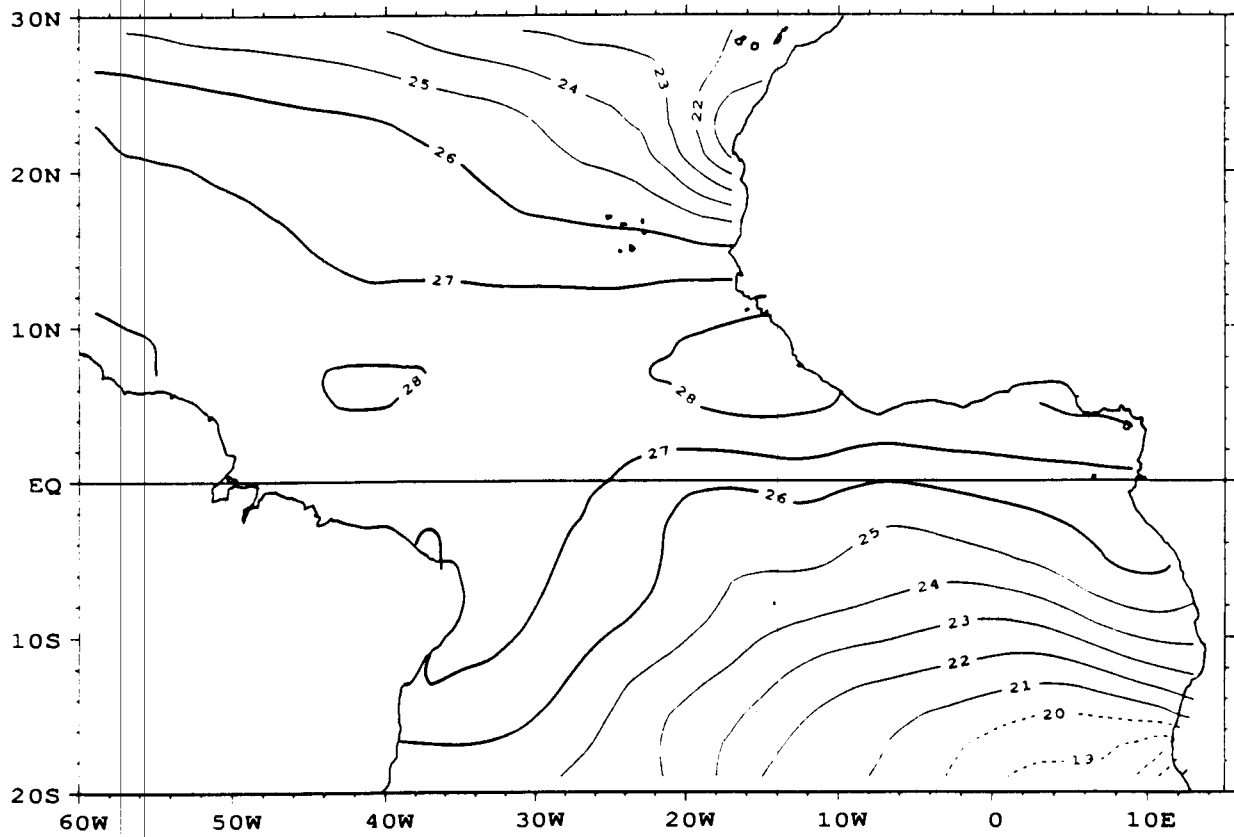
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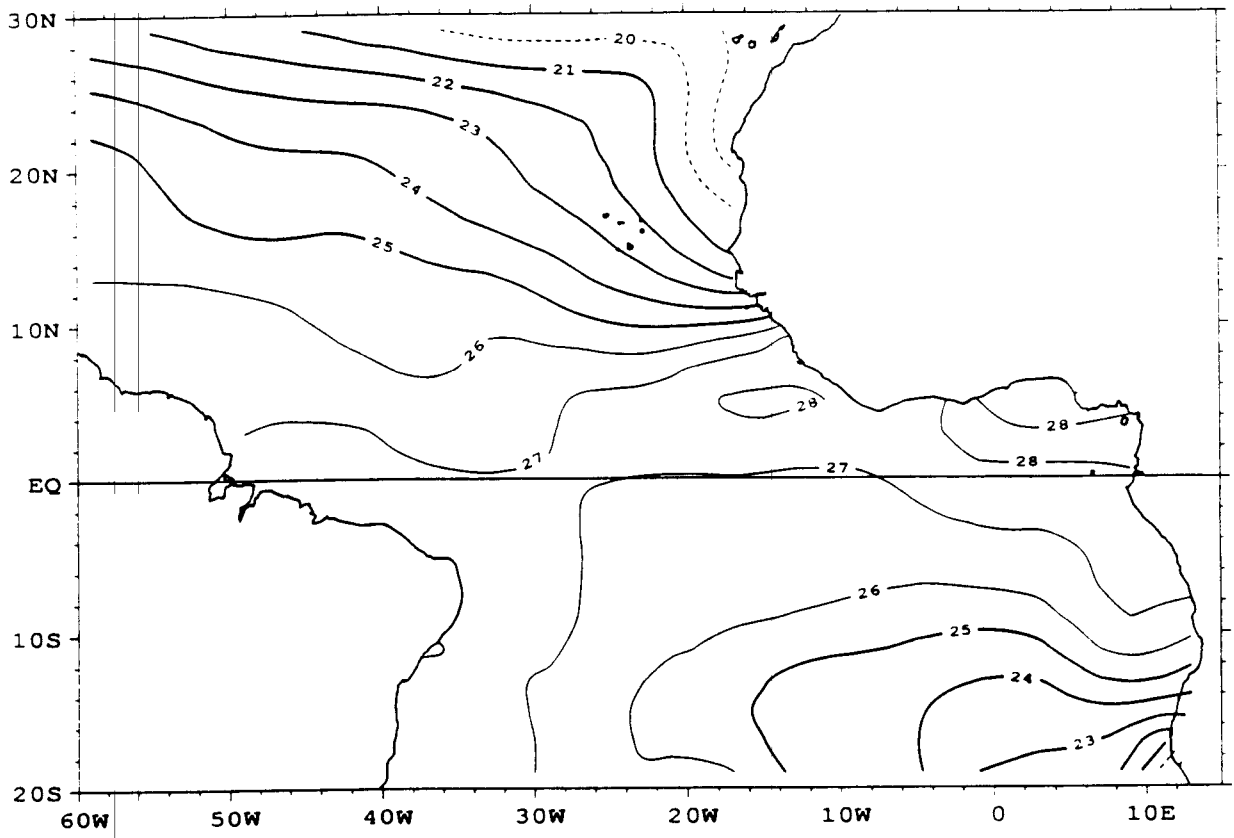
SST (C) *OBSERVATIONS* SEASONAL MEAN (J A S)



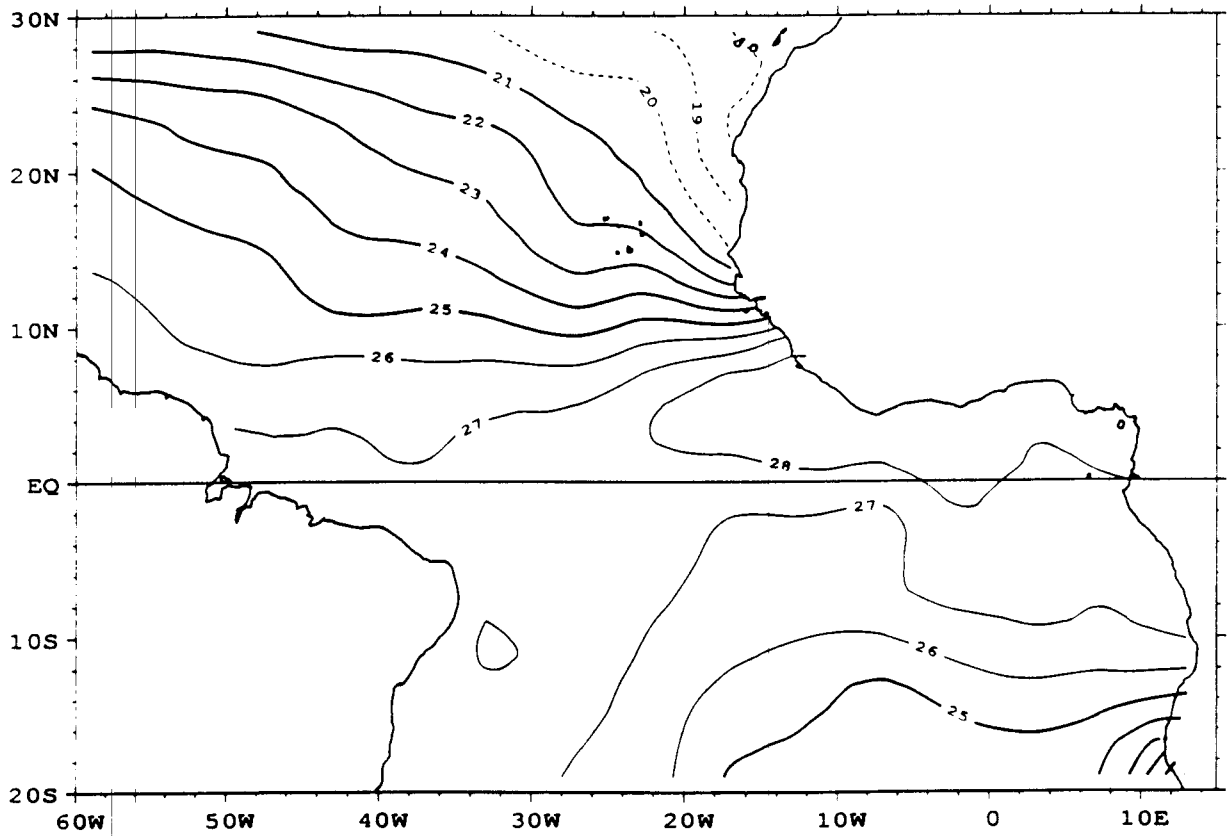
SST (C) *OBSERVATIONS* SEASONAL MEAN (O N D)



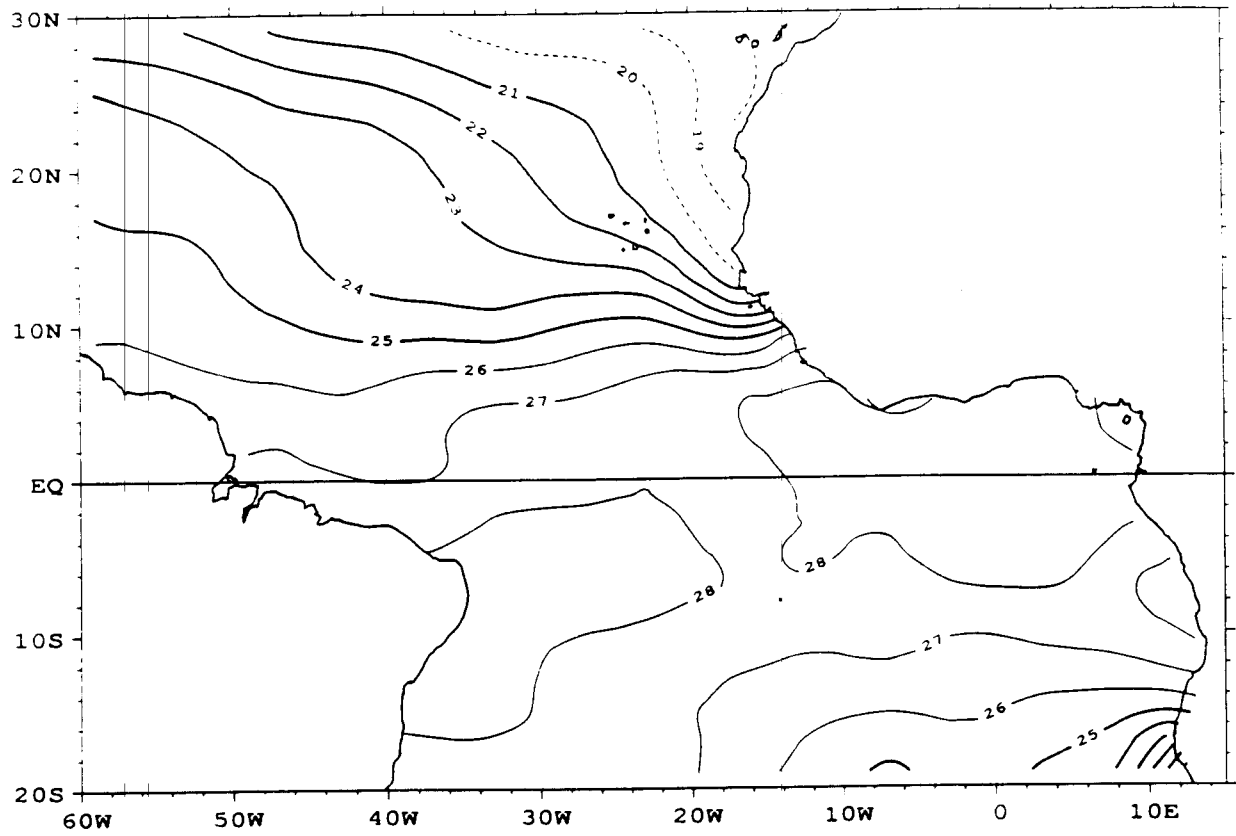
SST - OBSERVATIONS 2x2 - JANVIER 1989



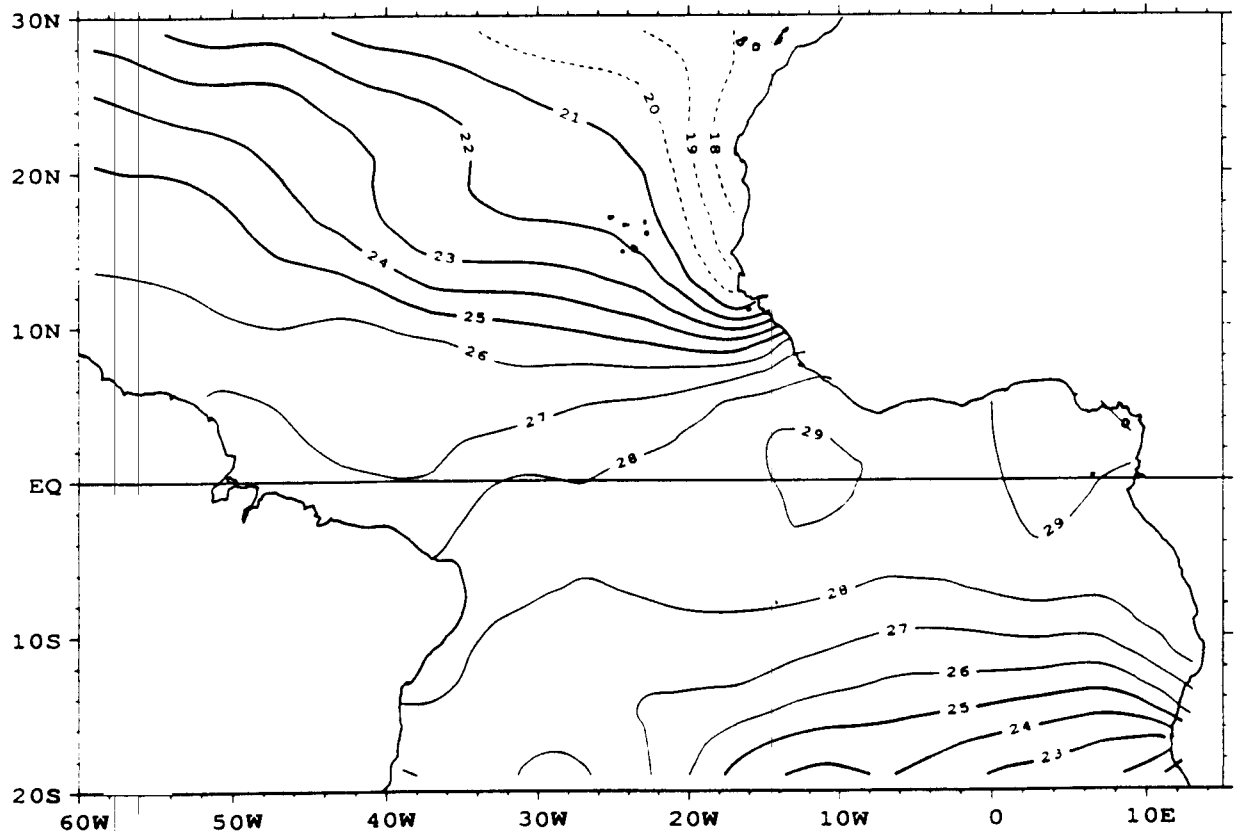
SST - OBSERVATIONS 2x2 - FEVRIER 1989



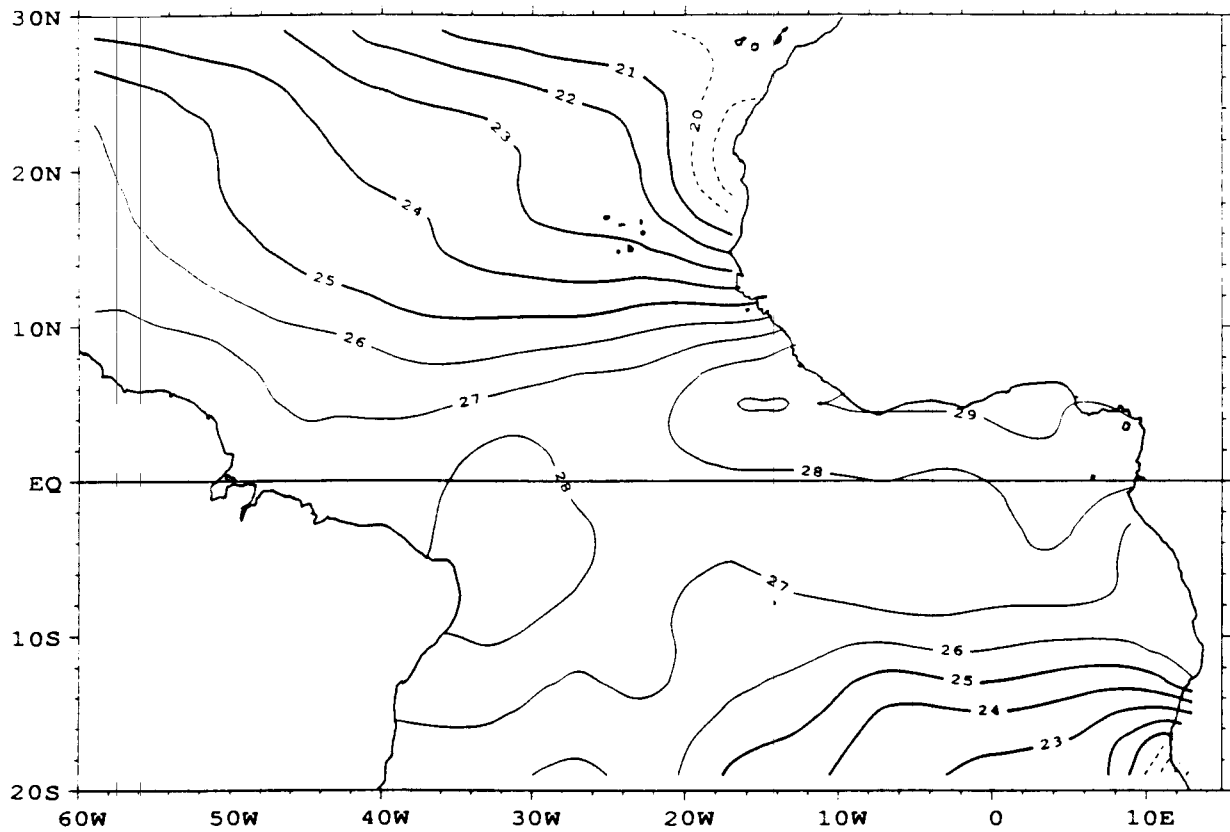
SST - OBSERVATIONS 2x2 - MARS 1989



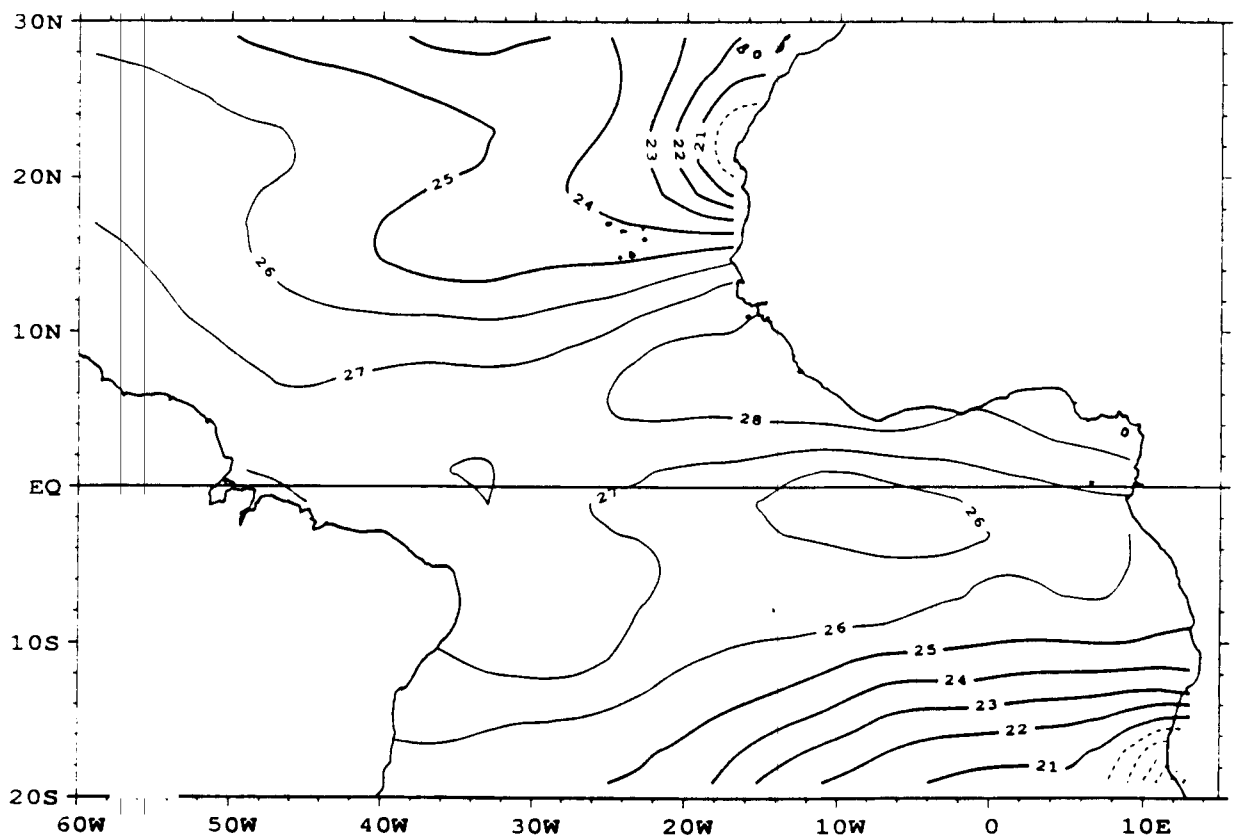
SST - OBSERVATIONS 2x2 - AVRIL 1989



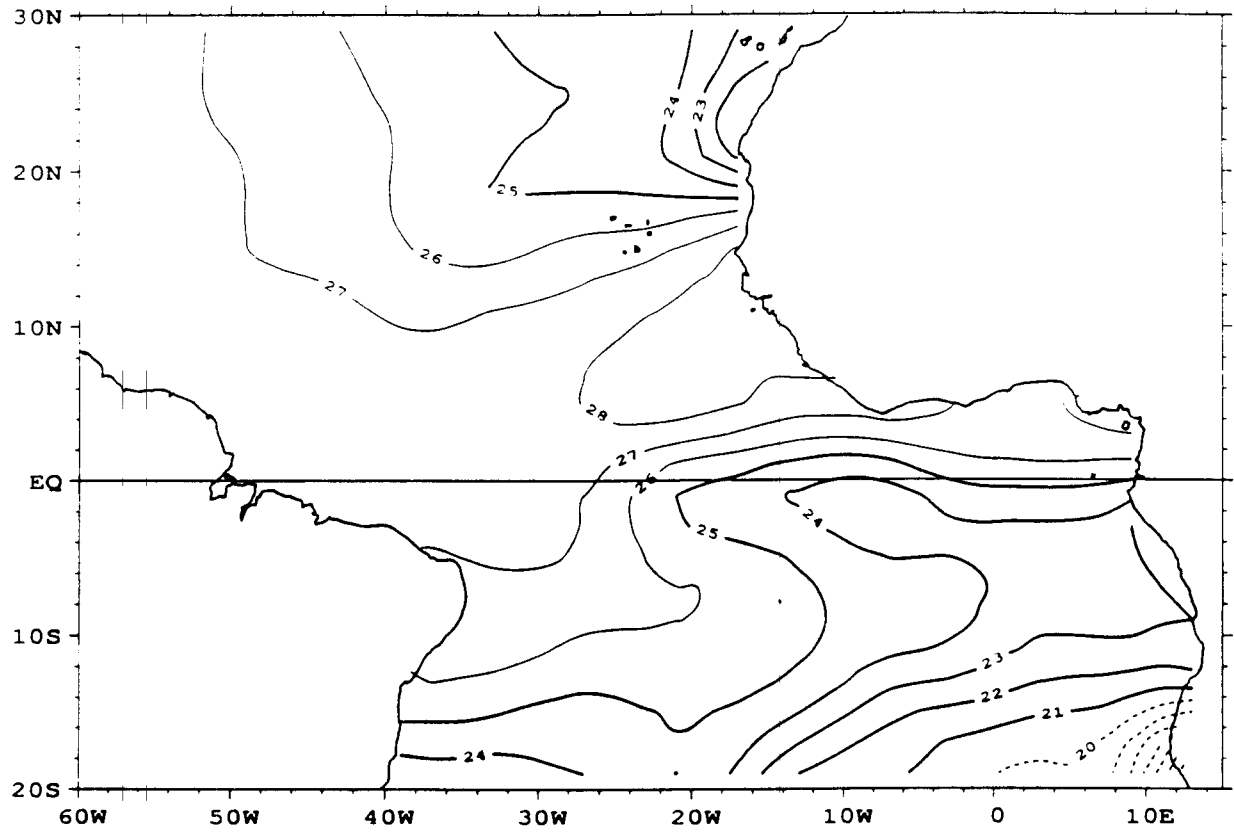
SST - OBSERVATIONS 2x2 - MAI 1989



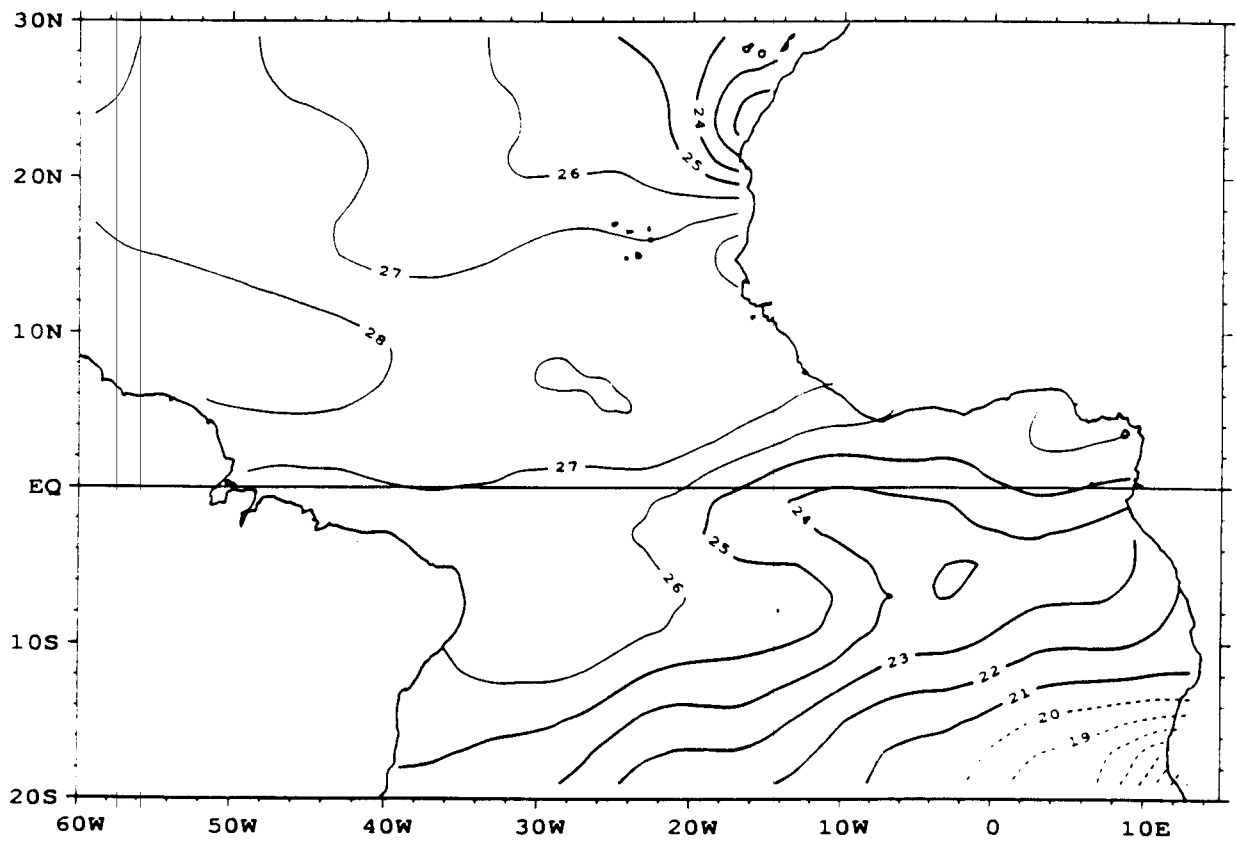
SST - OBSERVATIONS 2x2 - JUIN 1989



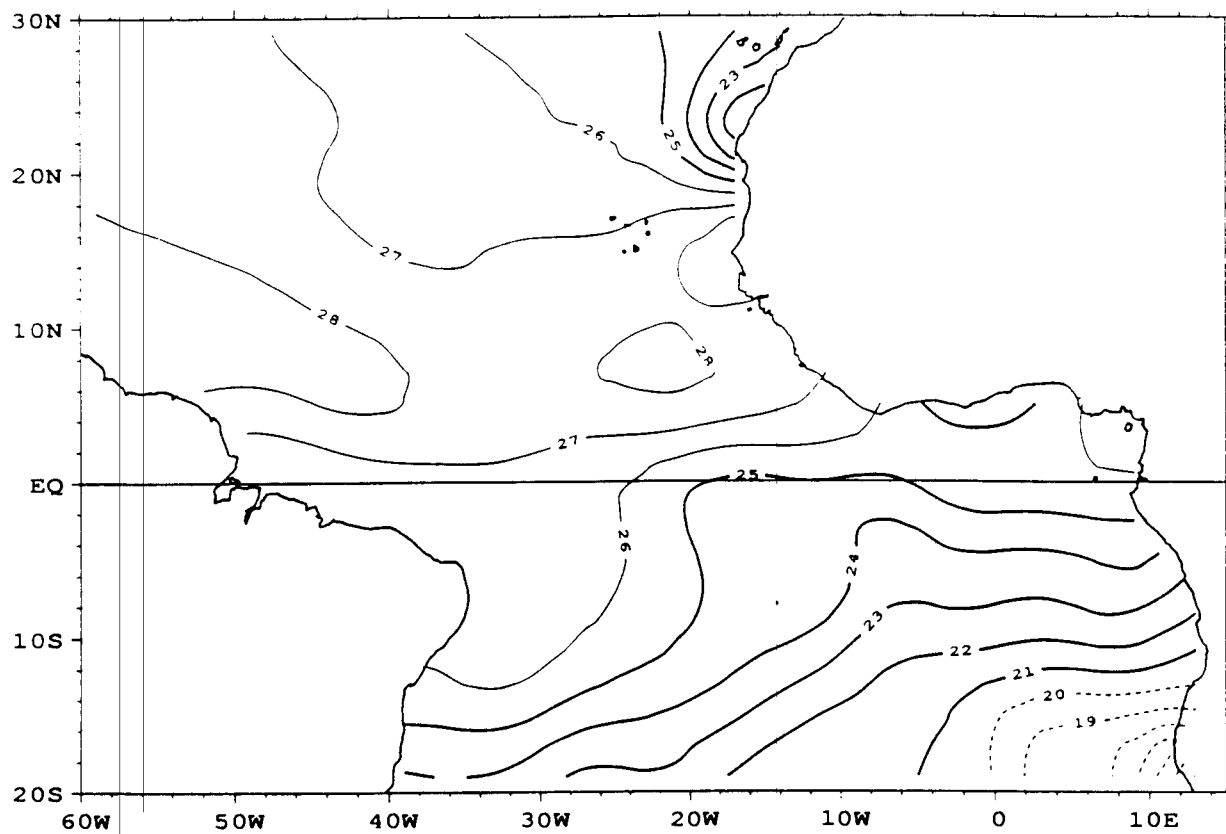
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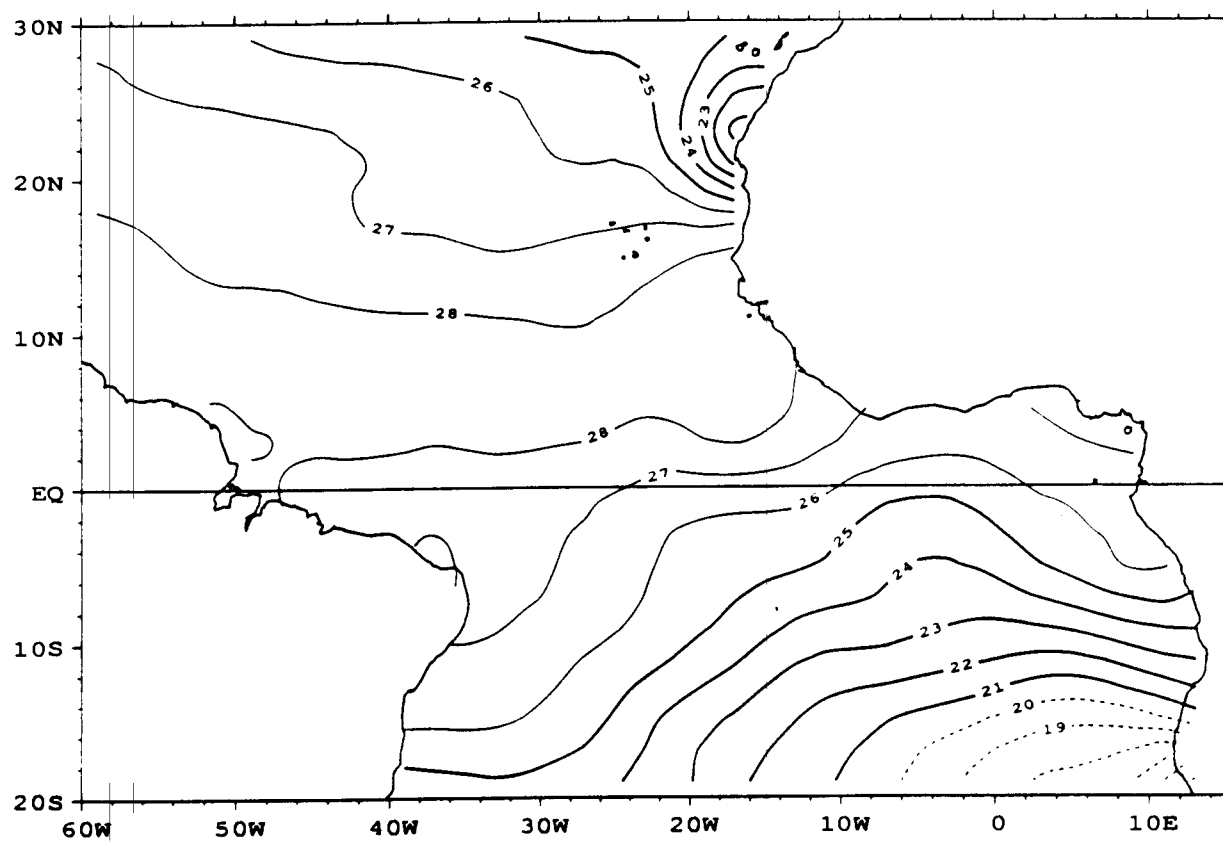
SST - OBSERVATIONS 2x2 - AOUT 1989



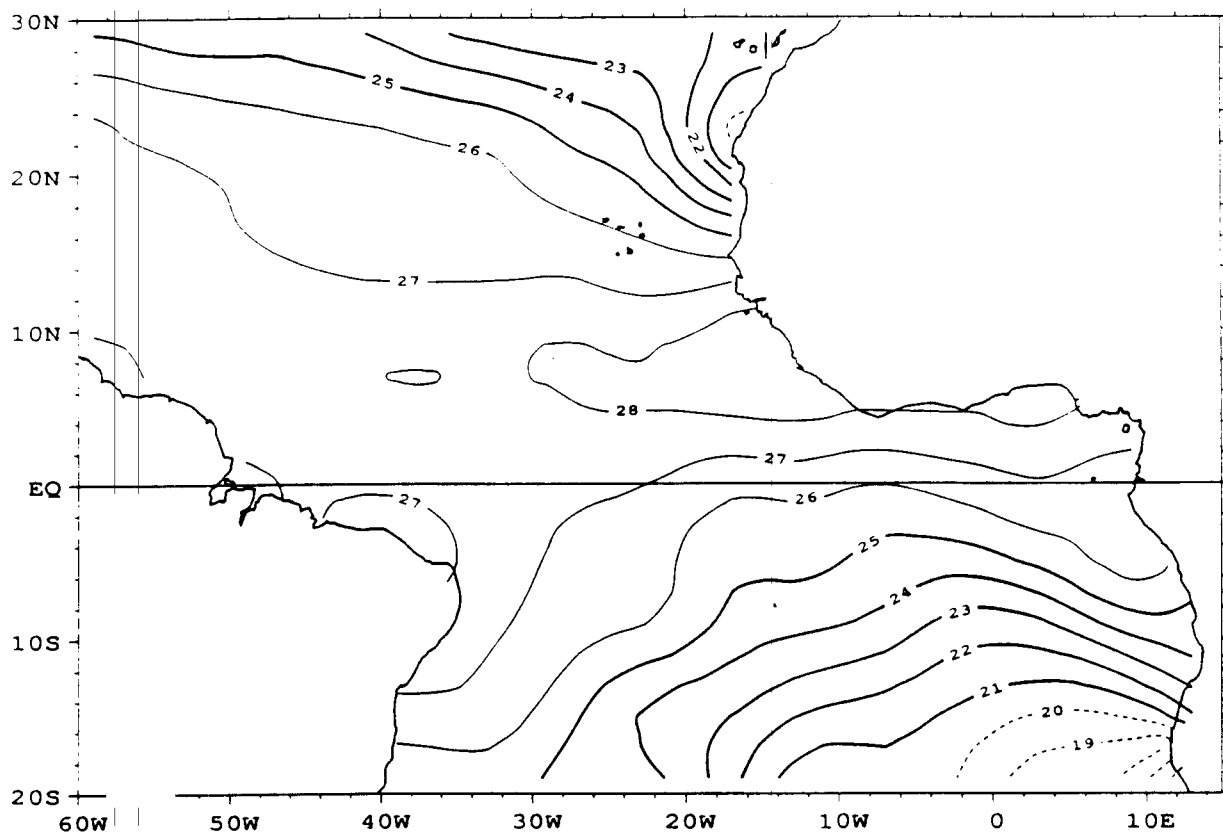
SST - OBSERVATIONS 2x2 - SEPTEMBRE 1989



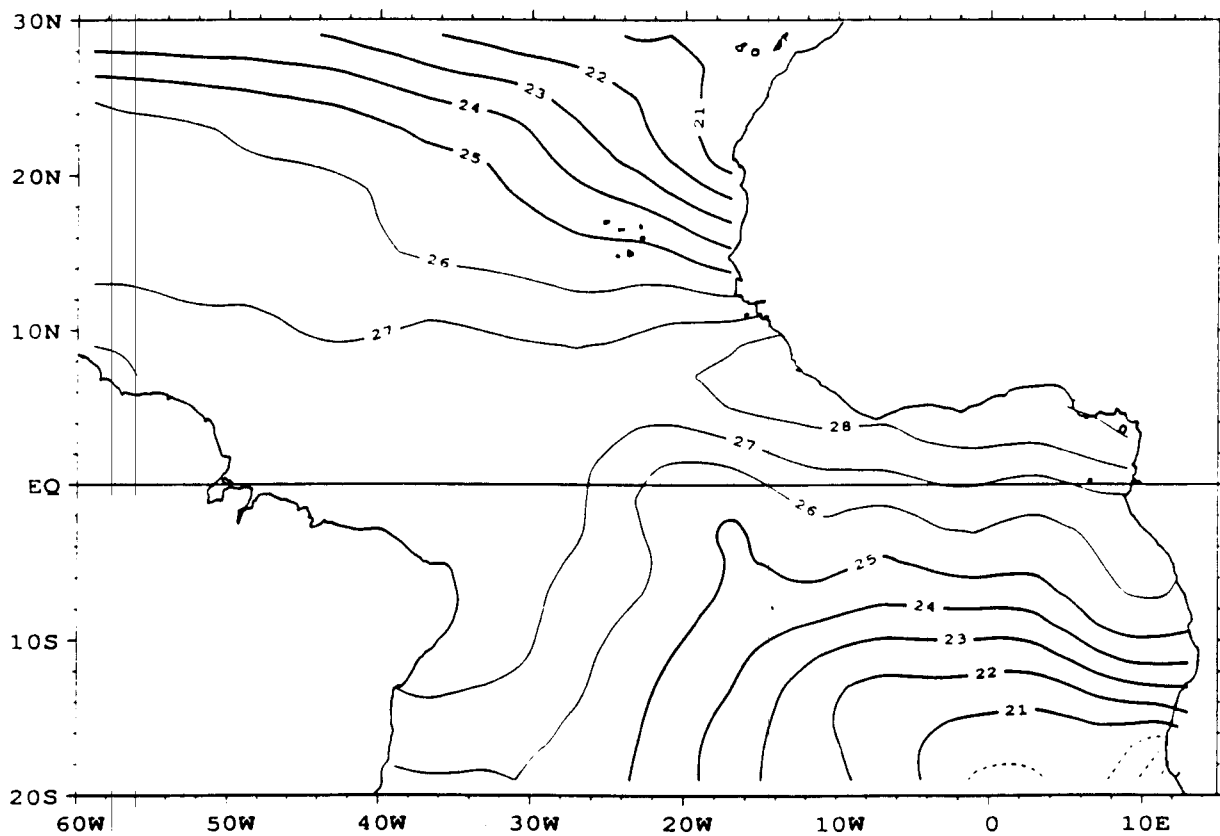
SST - OBSERVATIONS 2x2 - OCTOBRE 1989

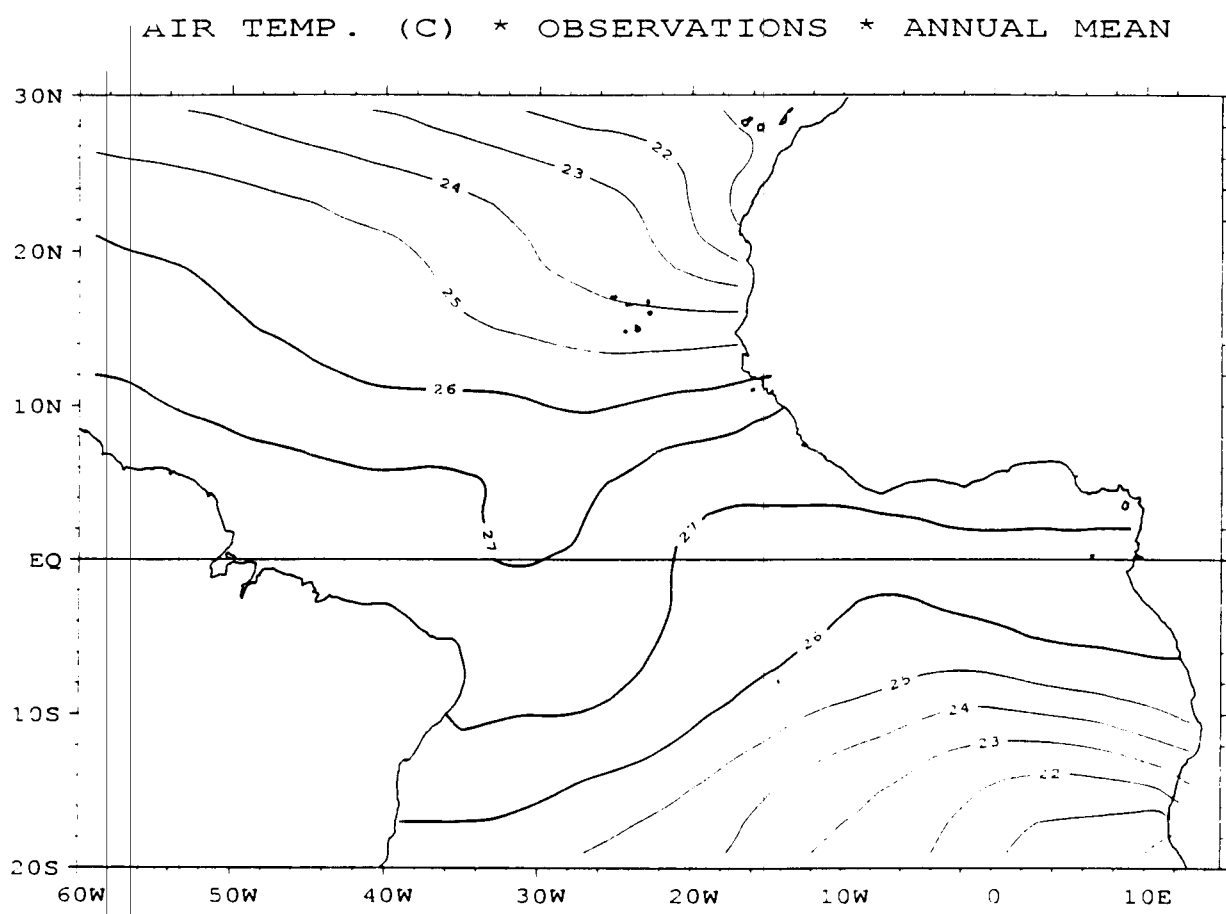


SST - OBSERVATIONS 2x2 - NOVEMBRE 1989

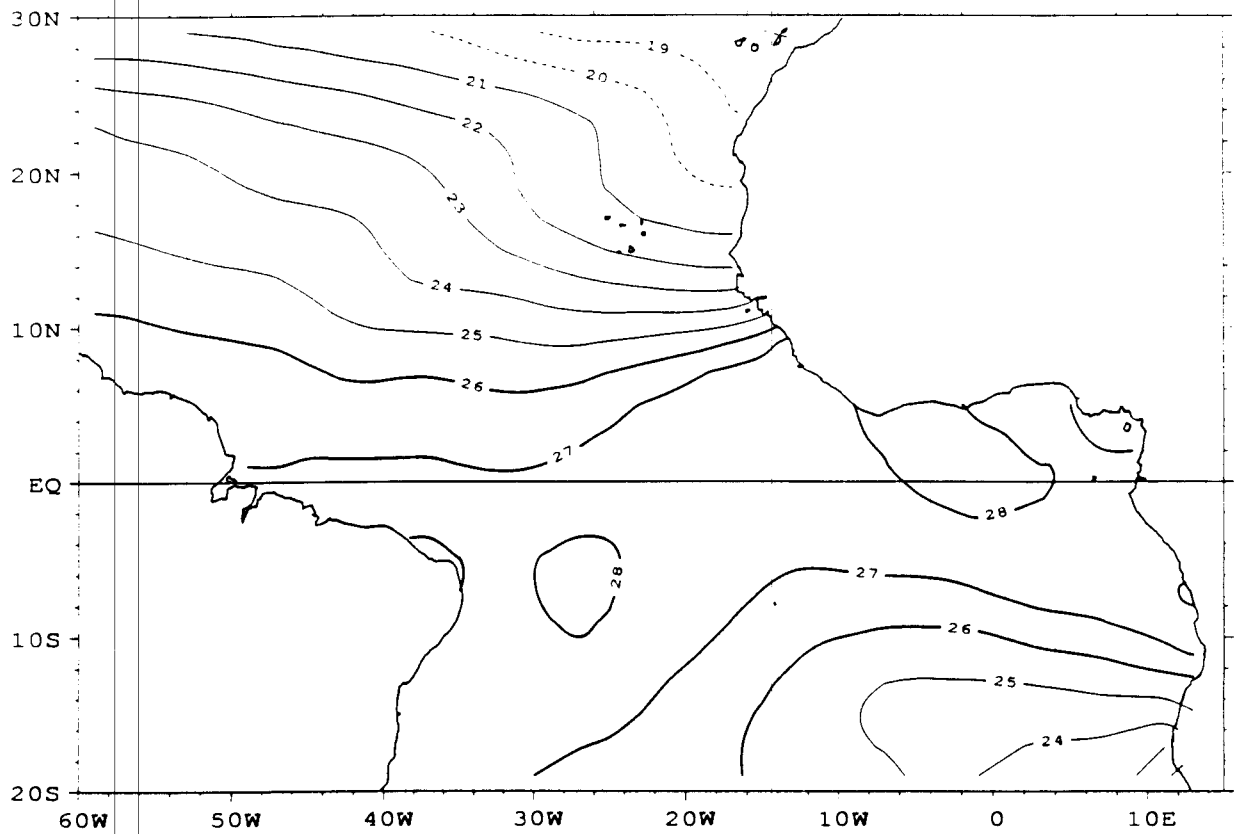


SST - OBSERVATIONS 2x2 - DECEMBRE 1989

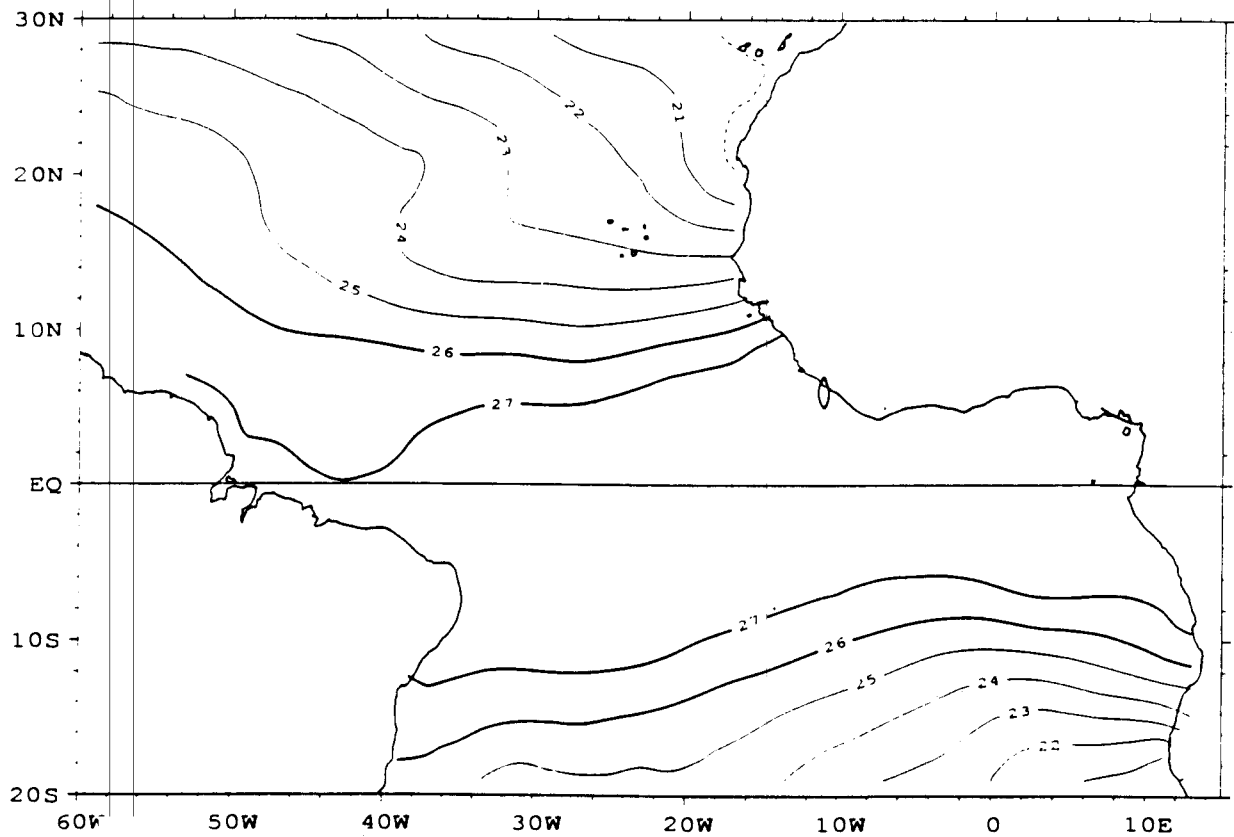




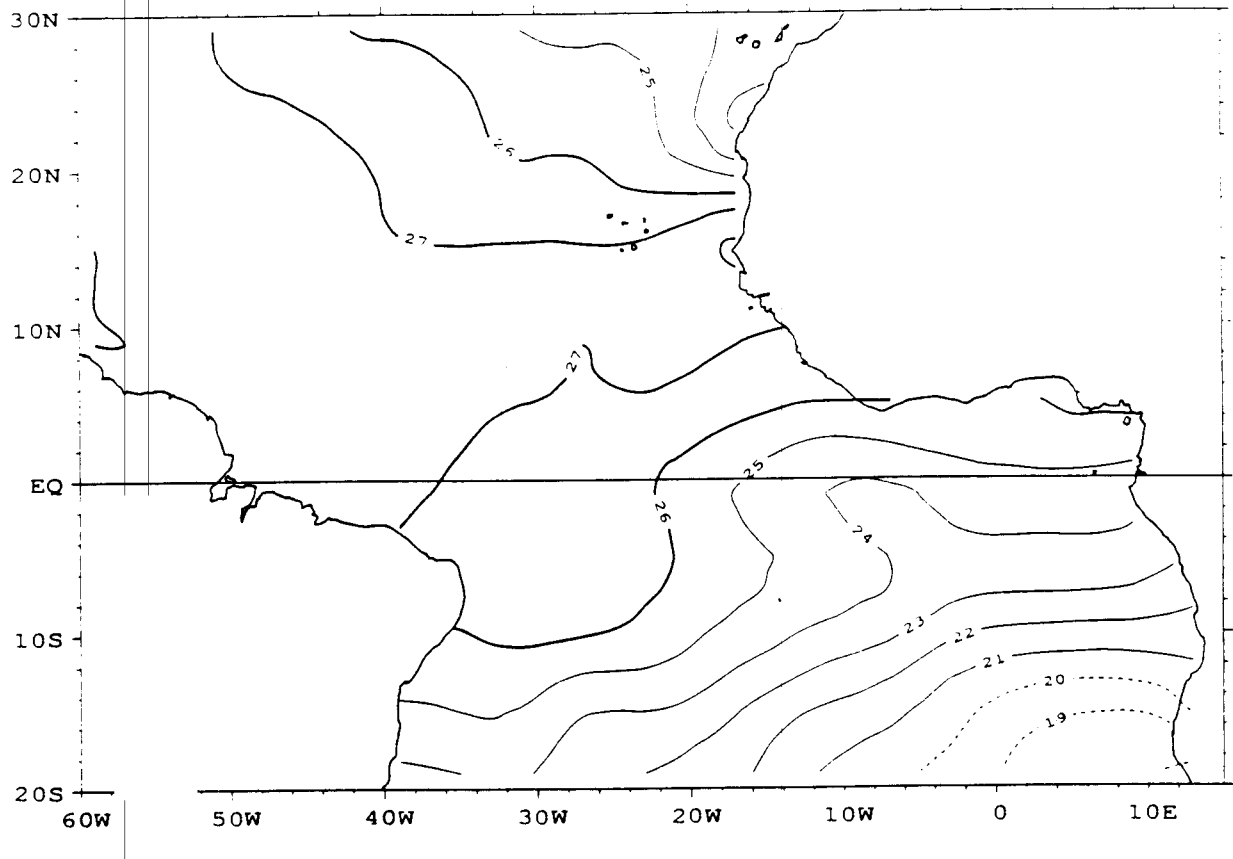
AIR TEMP. (C) *OBSERVATIONS*SEASONAL MEAN (JFM)



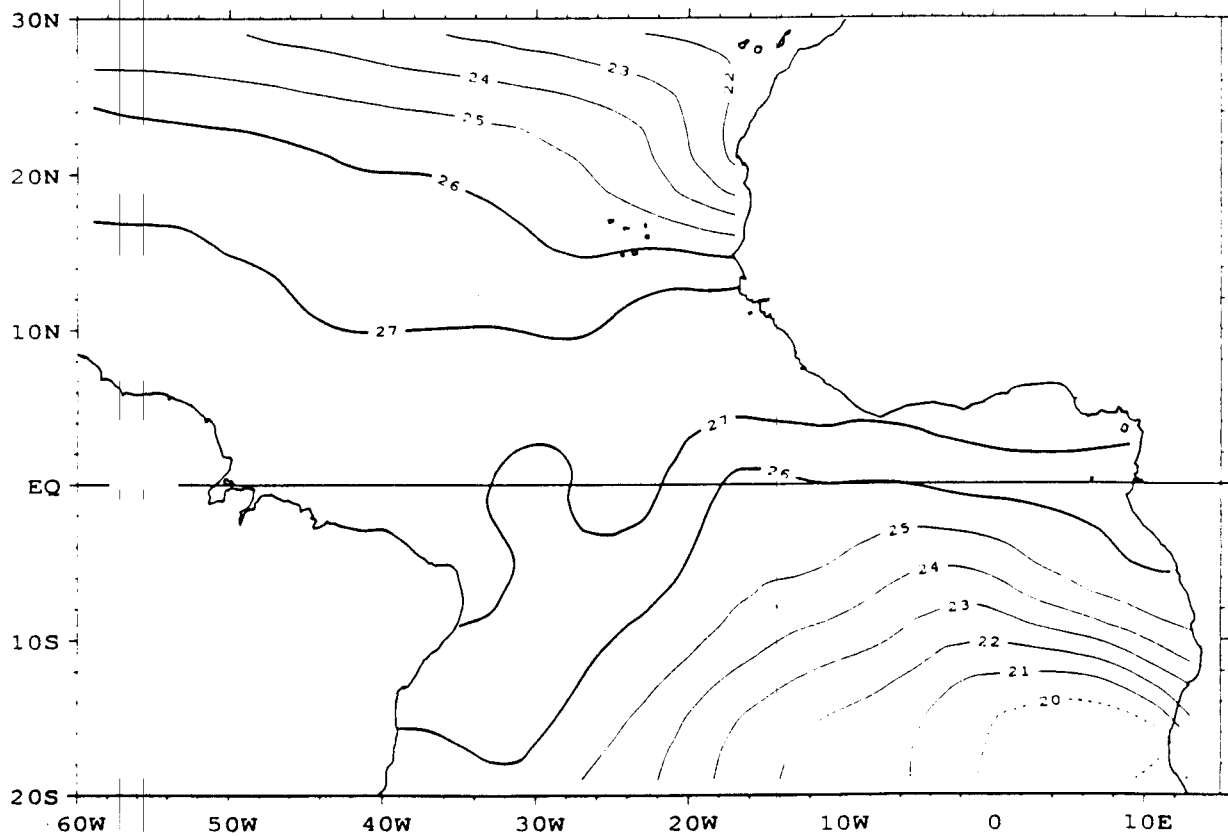
AIR TEMP. (C) *OBSERVATIONS*SEASONAL MEAN (AMJ)



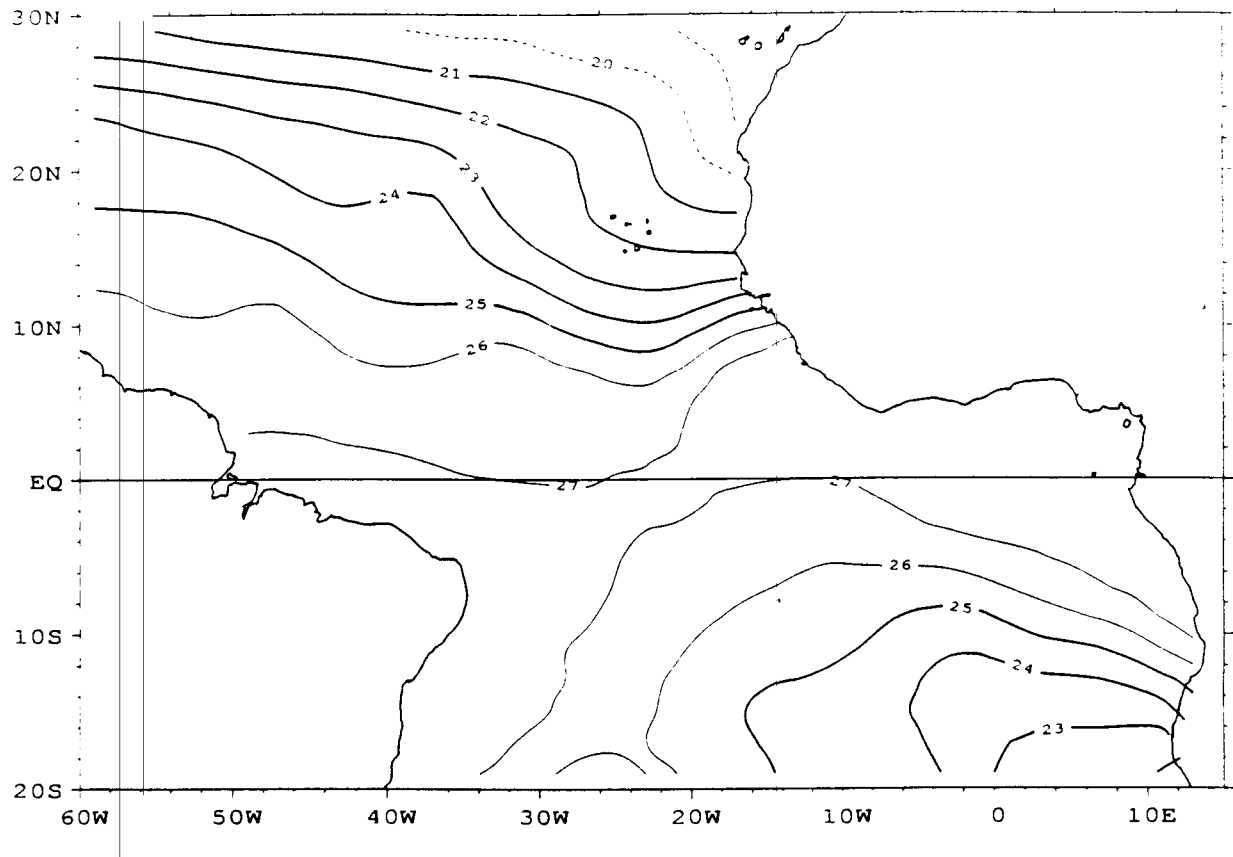
AIR TEMP. (C) *OBSERVATIONS*SEASONAL MEAN (JAS)



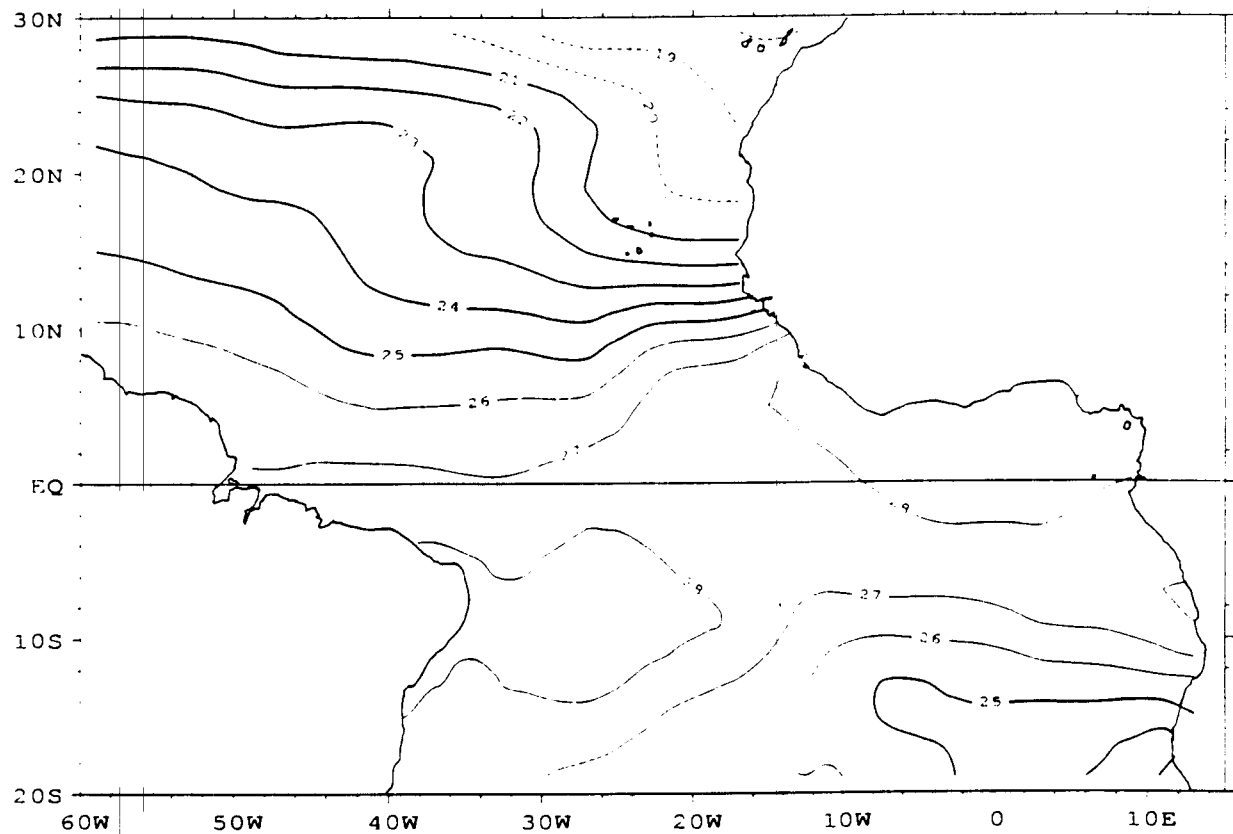
AIR TEMP. (C) *OBSERVATIONS*SEASONAL MEAN (OND)



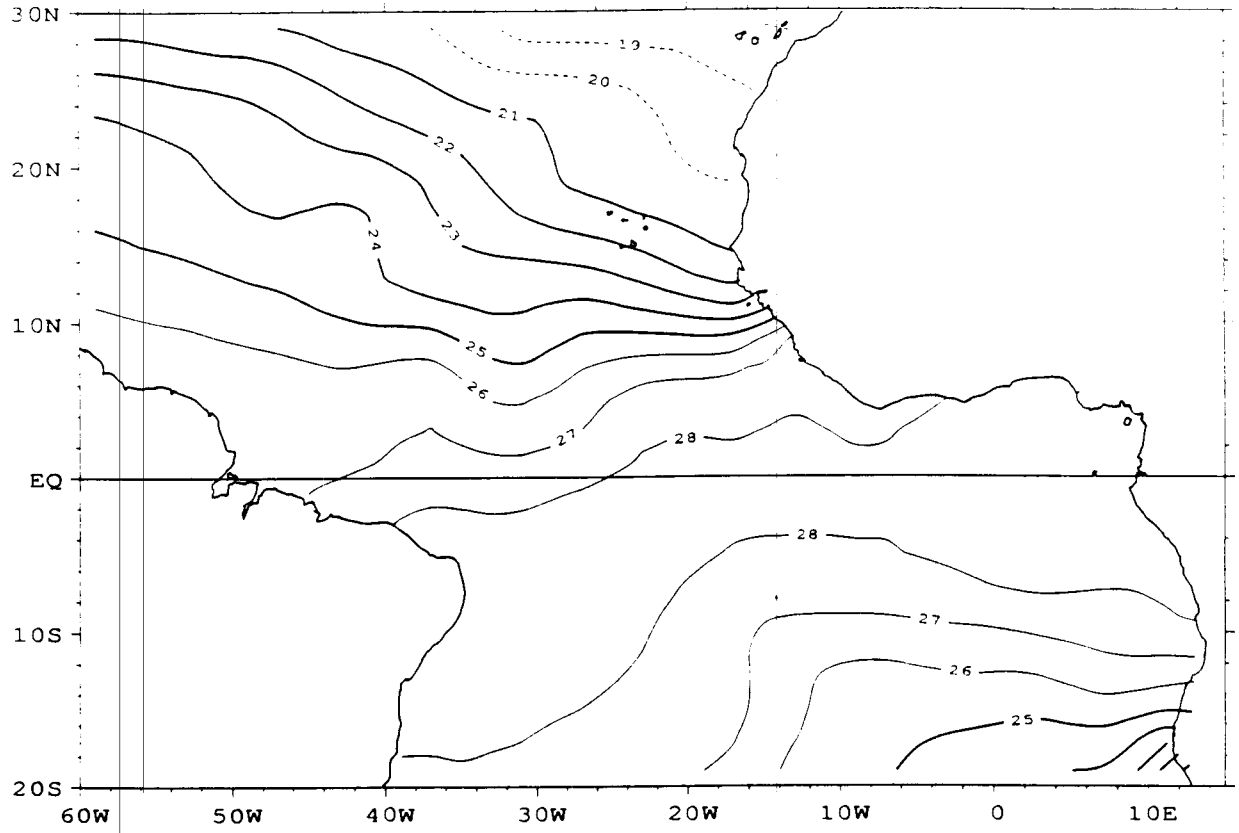
TEMPERATURE AIR - OBS. 2x2 - JANVIER 1989



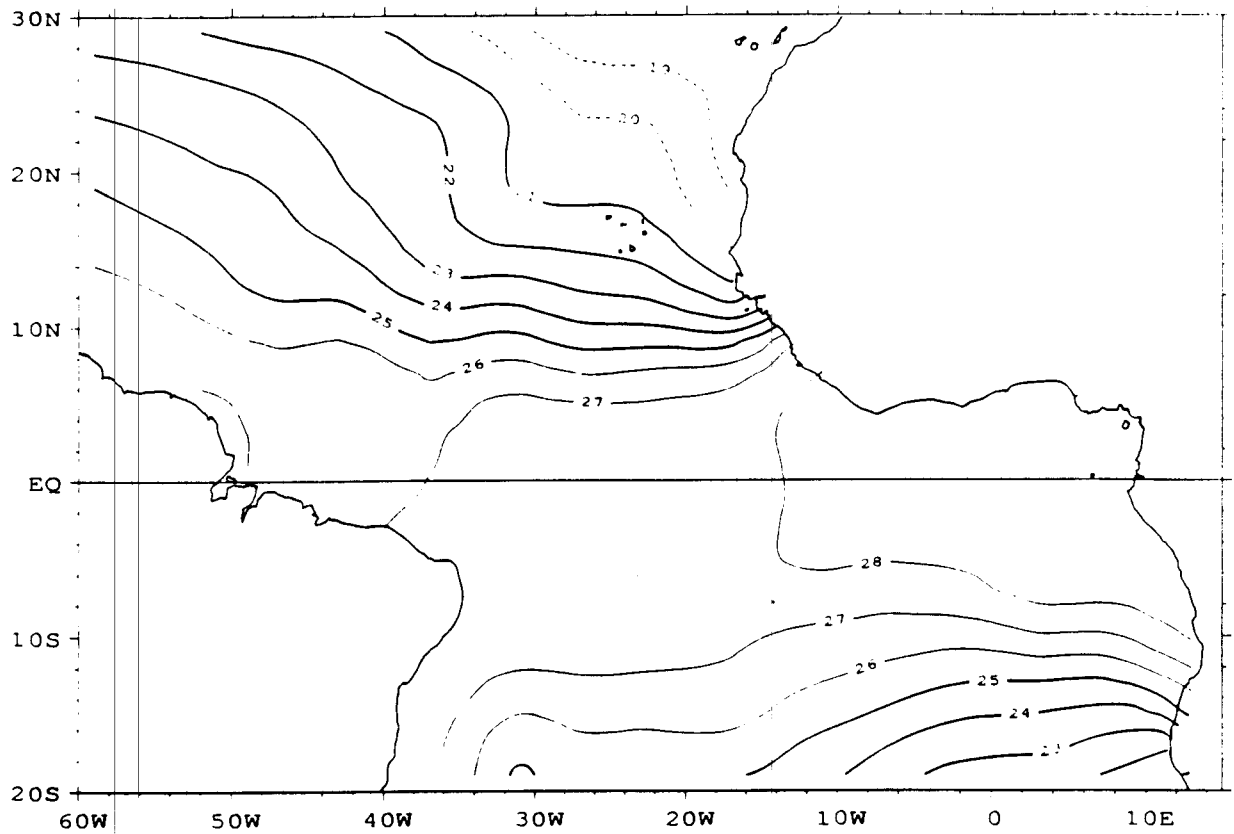
TEMPERATURA AIR - OBS. 2X2 - FEVRIER 1989



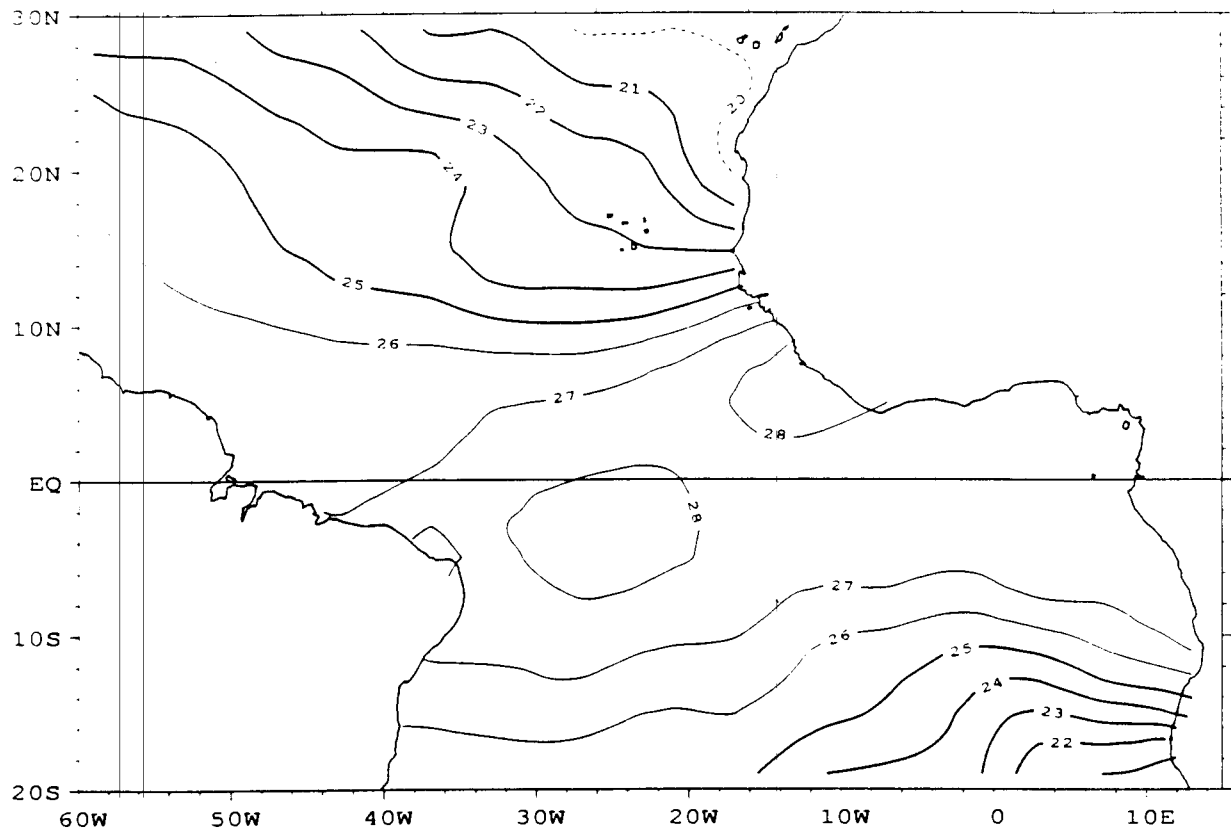
TEMPERATURE AIR - OBS. 2x2 - MARS 1989



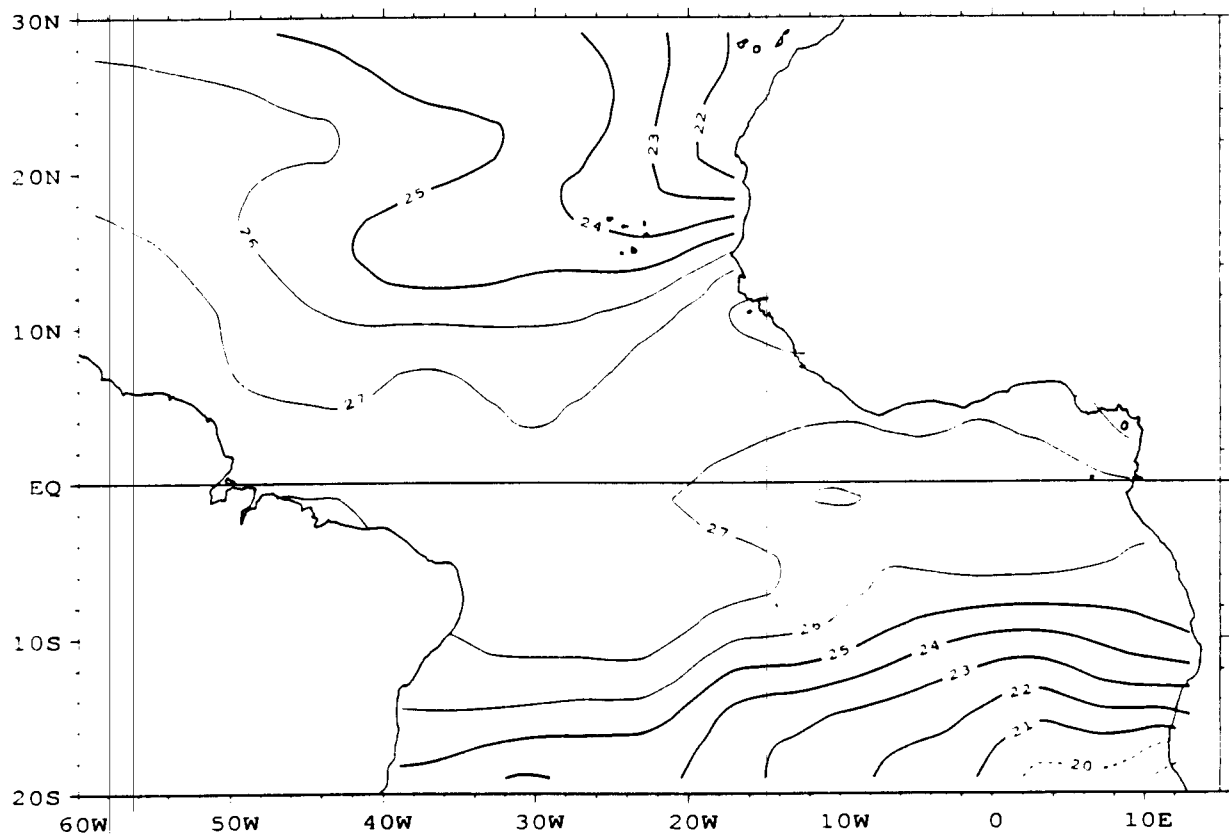
TEMPERATURE AIR - OBS. 2x2 - AVRIL 1989



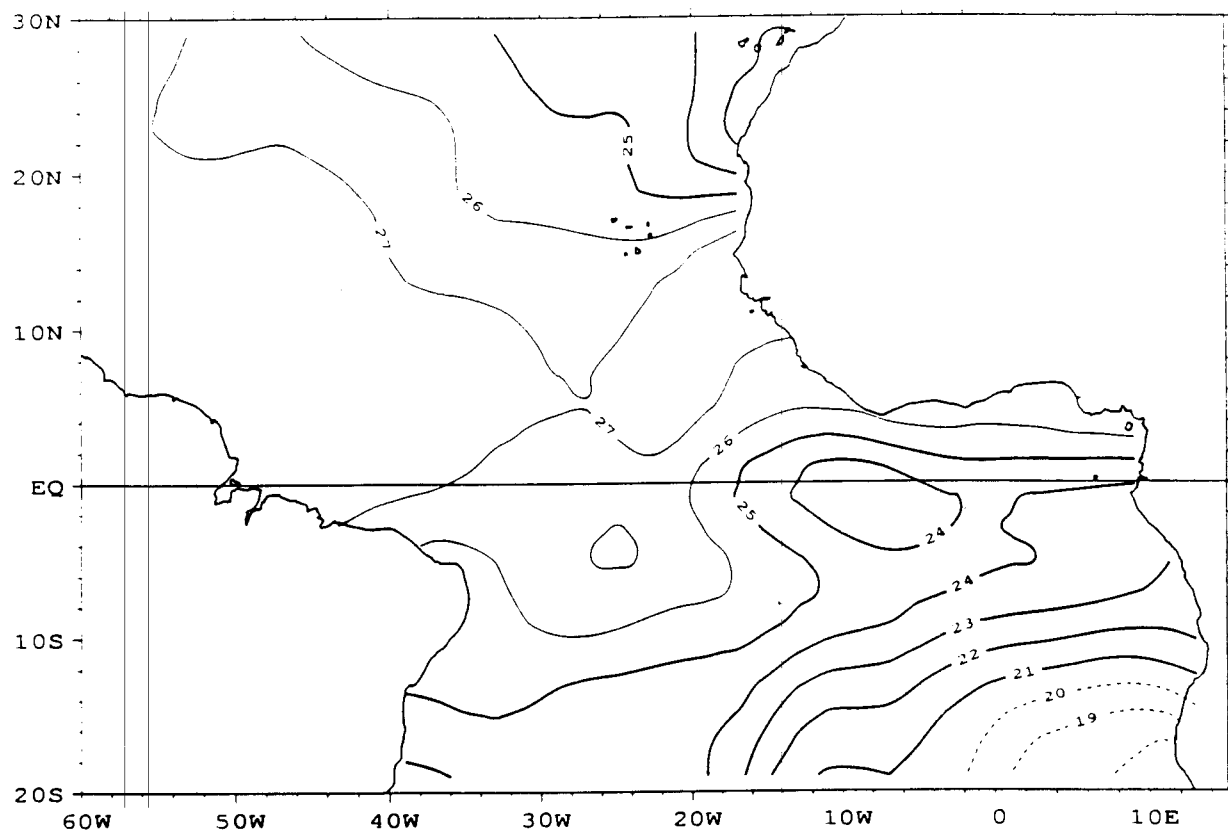
TEMPERATURE AIR - OBS. 2x2 - MAI 1989



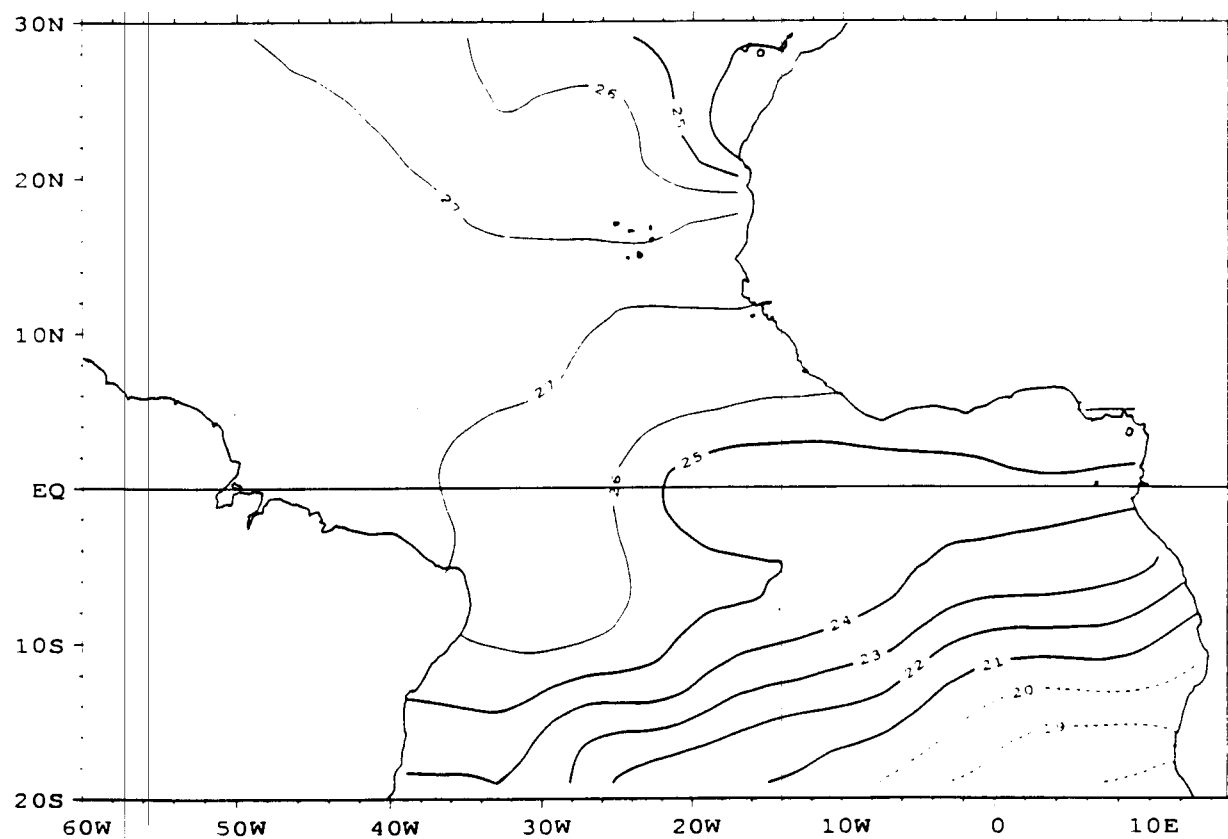
TEMPERATURE AIR - OBS. 2x2 - JUIN 1989



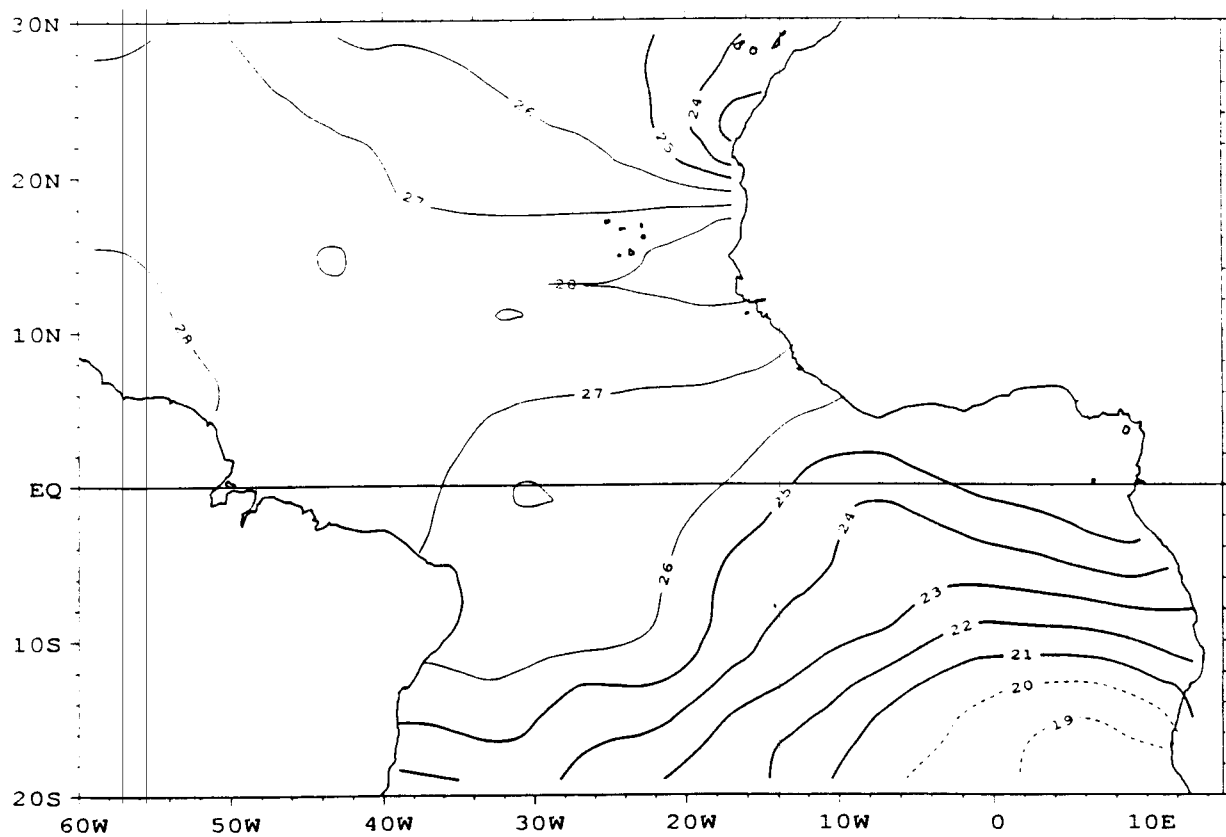
TEMPERATURE AIR - OBS. 2x2 - JUILLET 1989



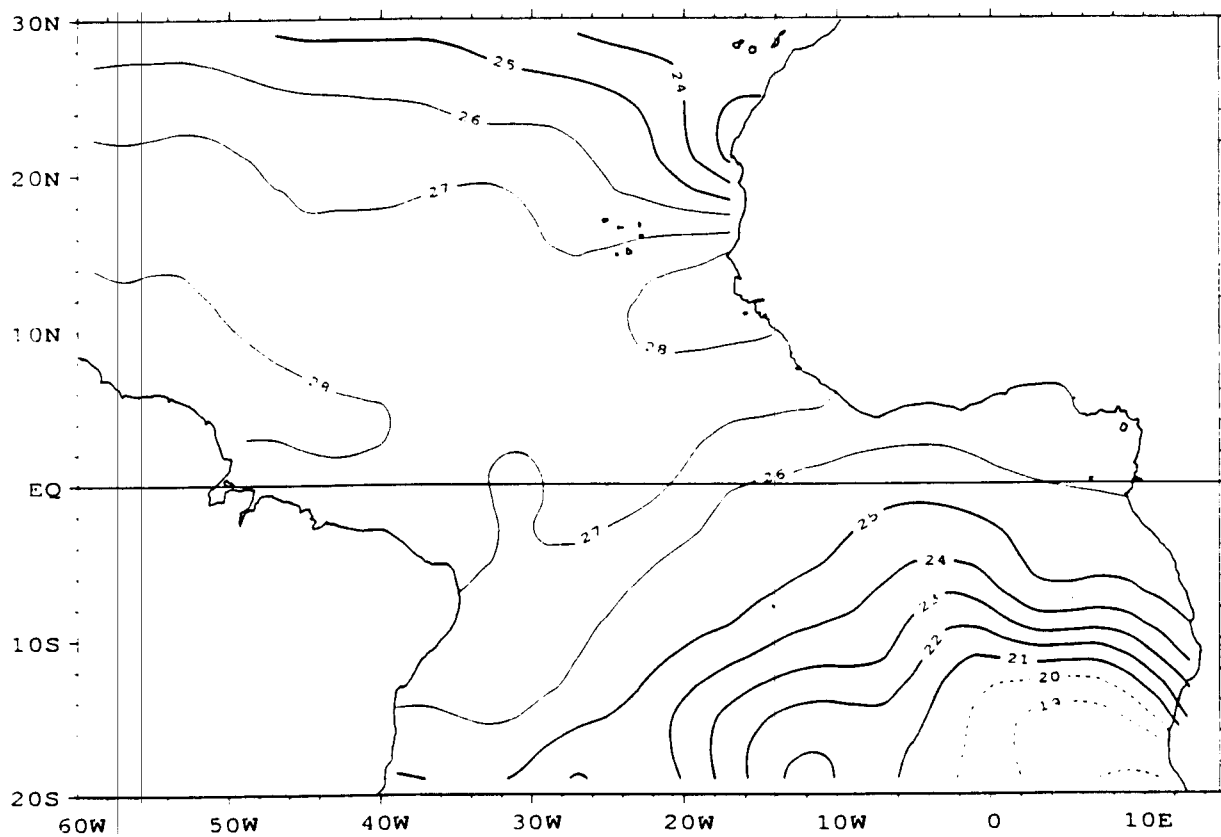
TEMPERATURE AIR - OBS. 2x2 - AOUT 1989



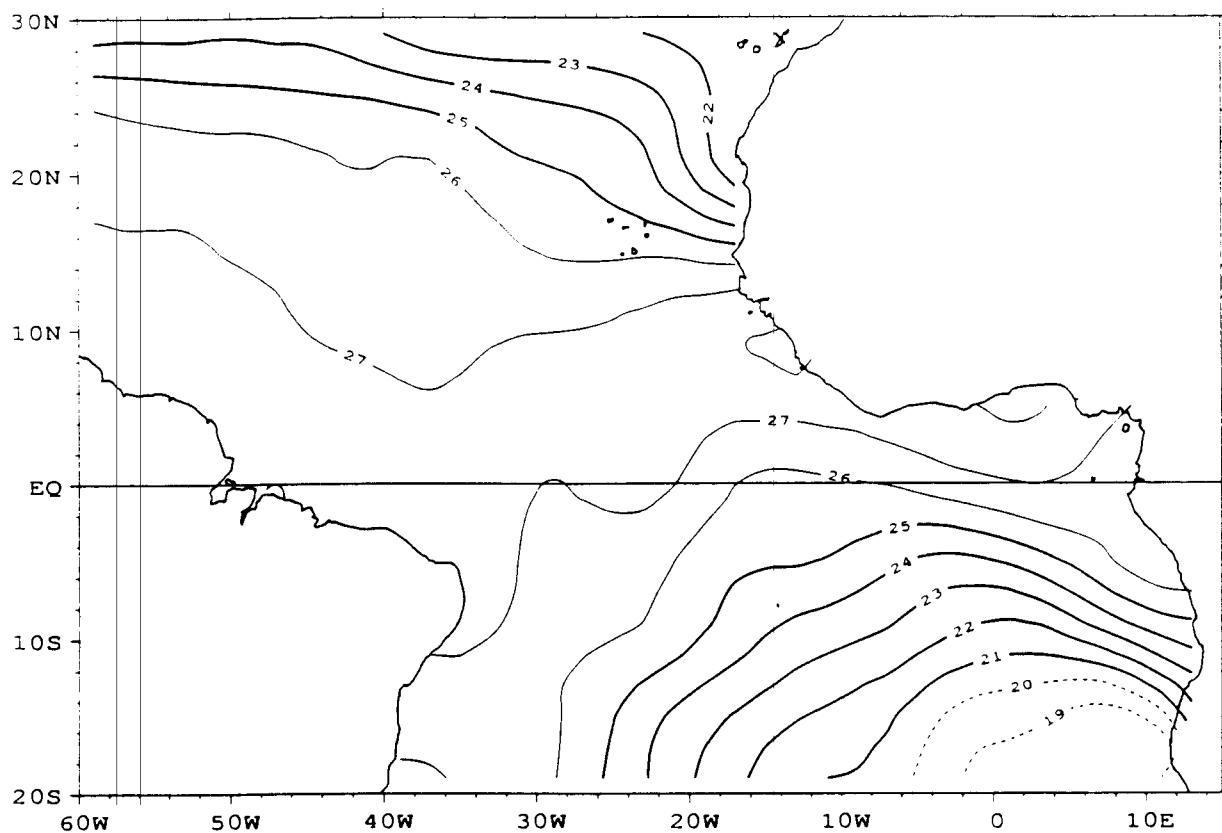
TEMPERATURE AIR - OBS. 2x2 - SEPTEMBRE 1989



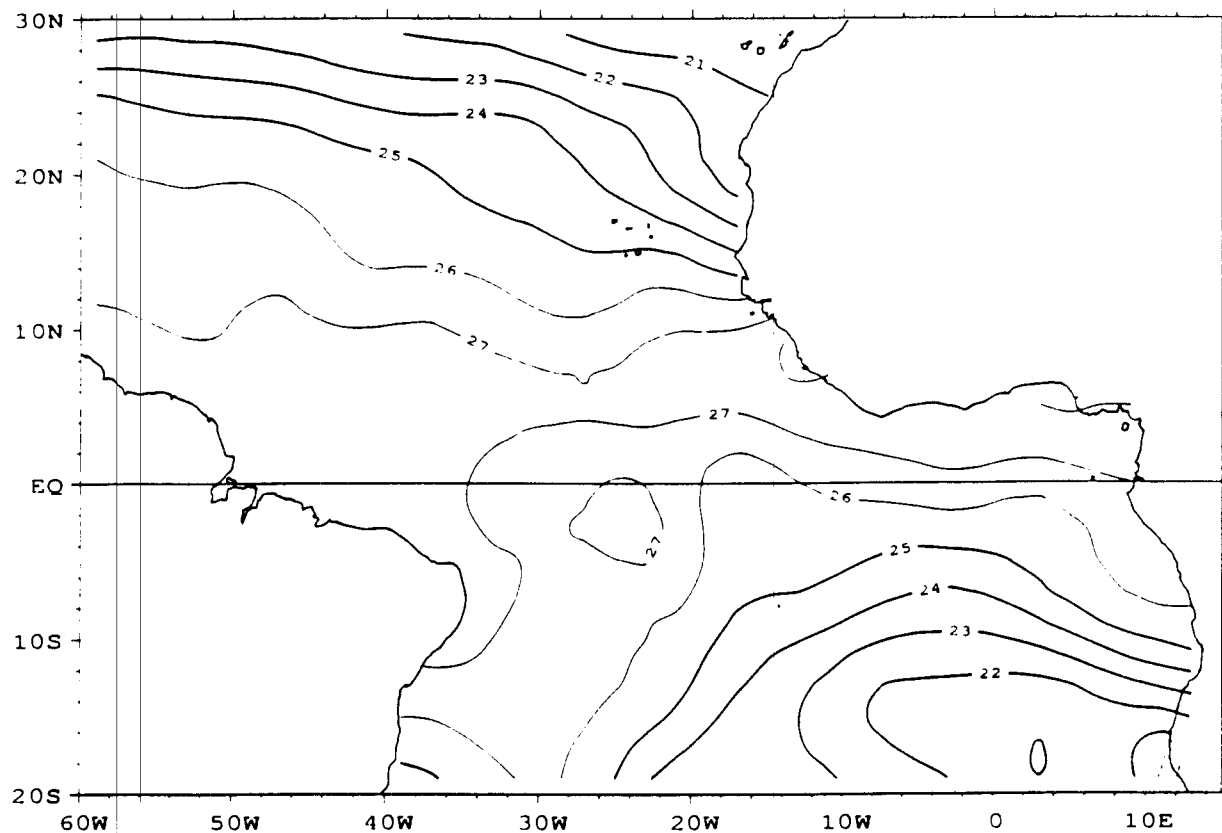
TEMPERATURE AIR - OBS. 2x2 - OCTOBRE 1989



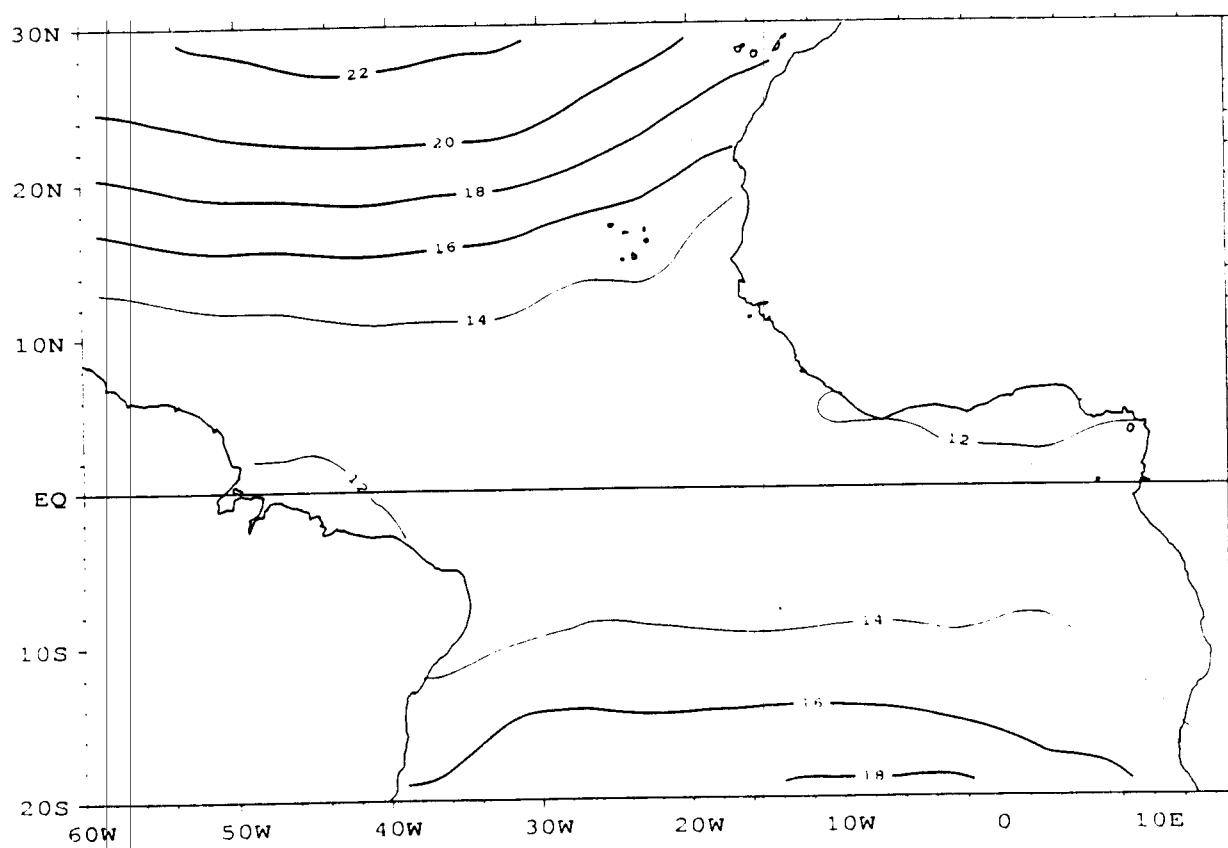
TEMPERATURE AIR - OBS. 2x2 - NOVEMBRE 1989



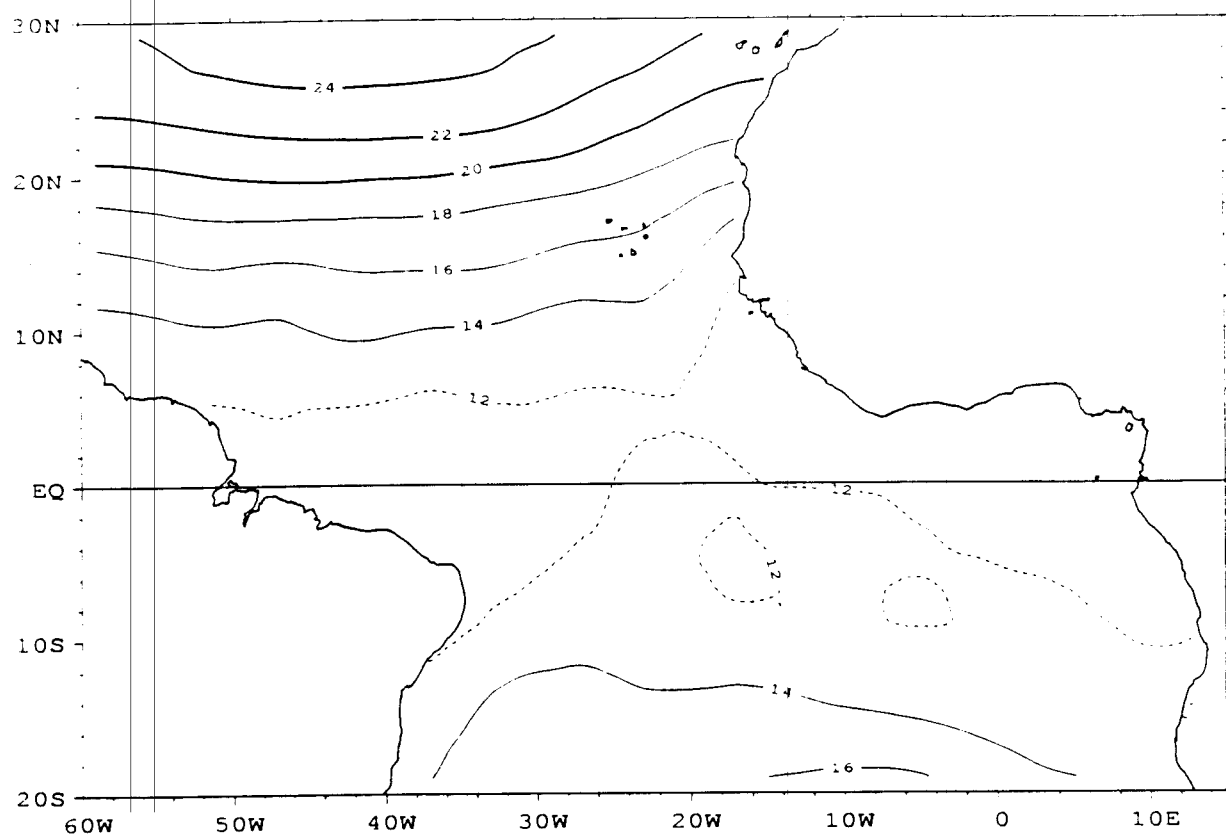
TEMPERATURE AIR - OBS. 2x2 - DECEMBRE 1989



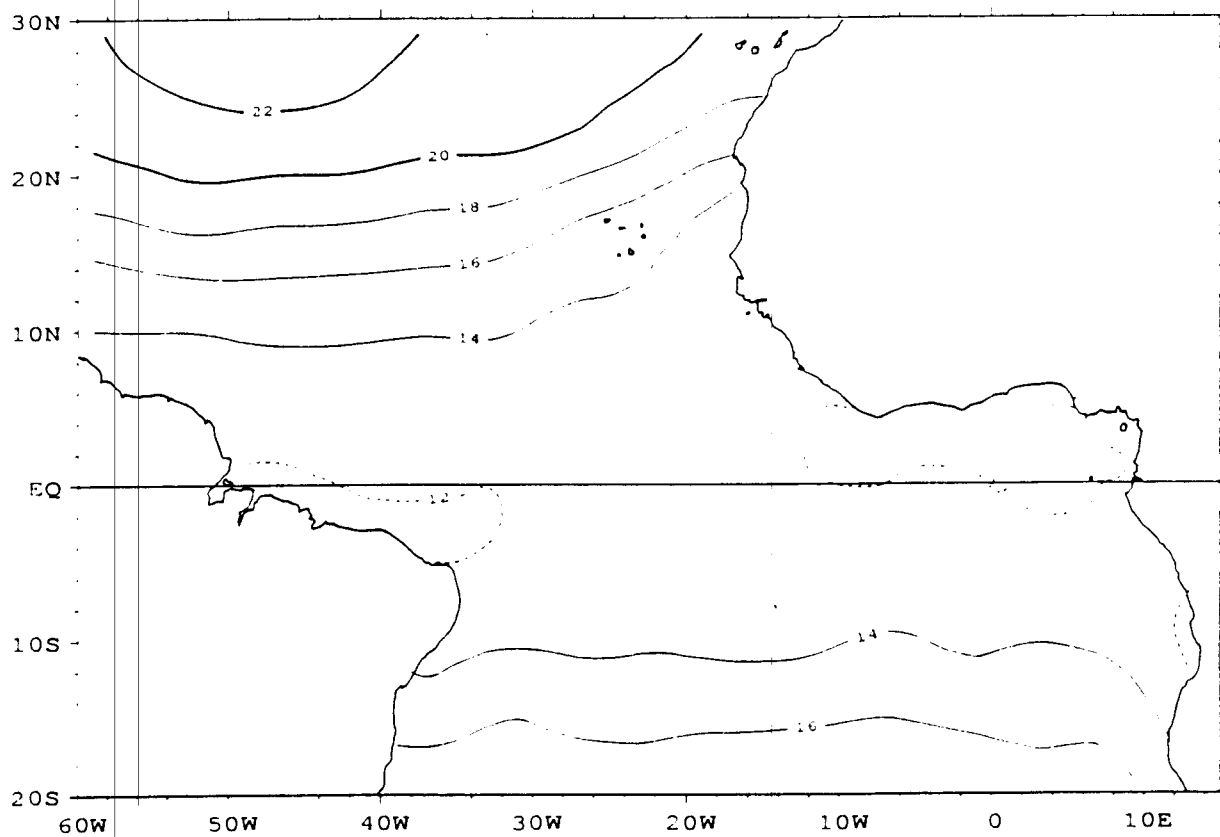
P - 1000 (MB) * OBSERVATIONS * ANNUAL MEAN



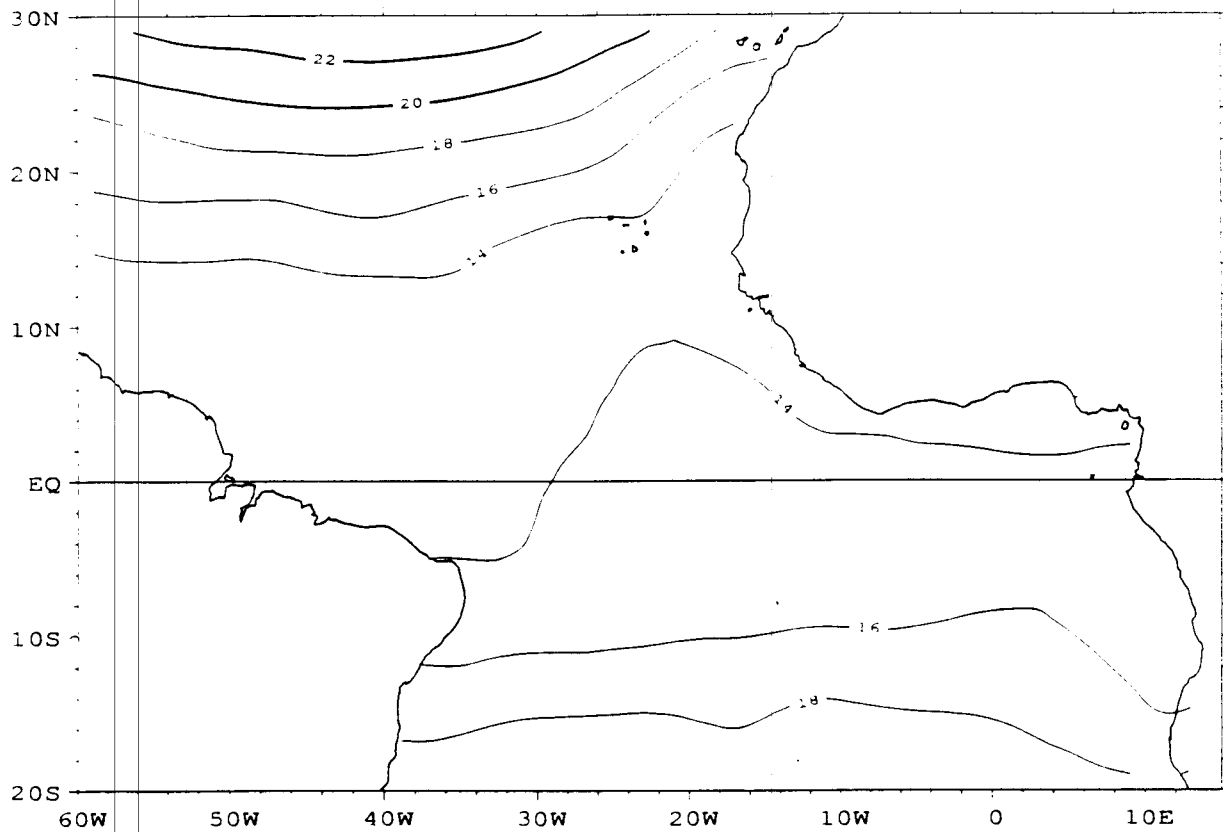
P - 1000 (MB) *OBSERVATIONS*SEASONAL MEAN (JFM)



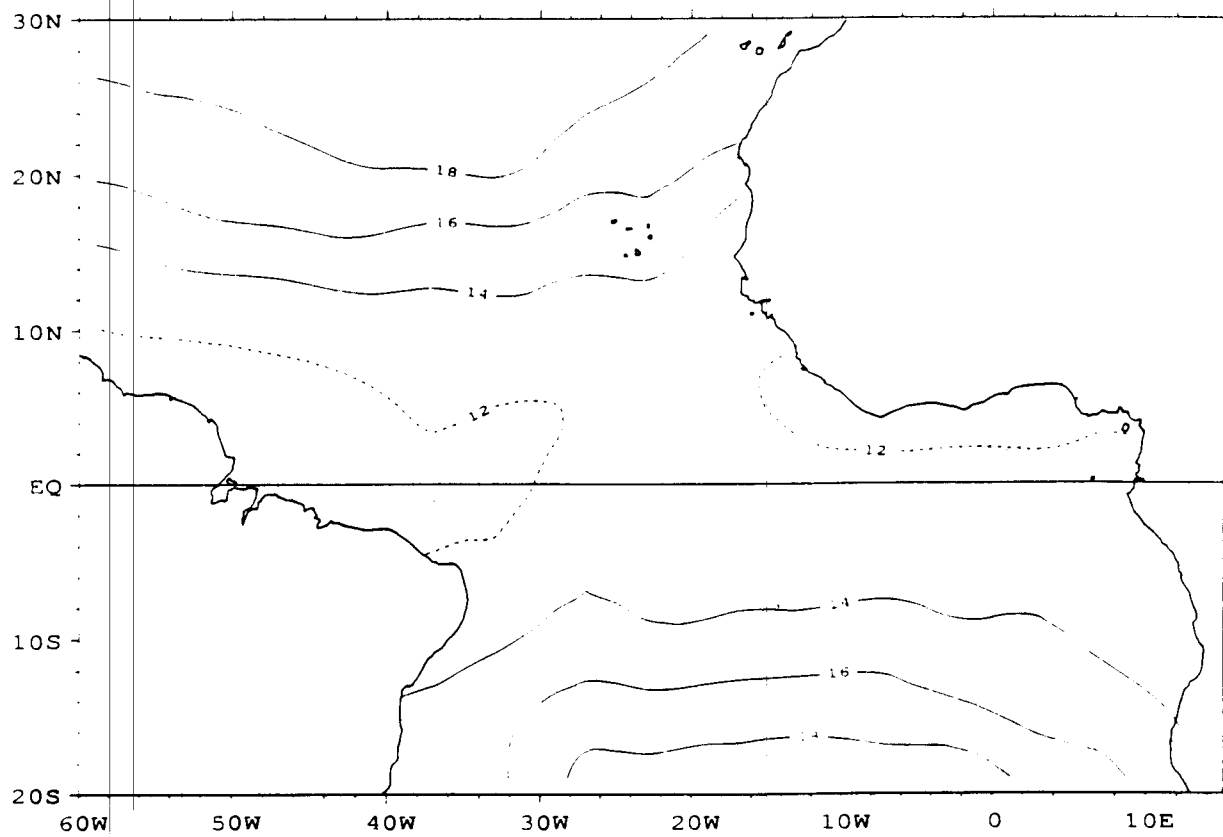
P - 1000 (MB) *OBSERVATIONS*SEASONAL MEAN (AMJ)



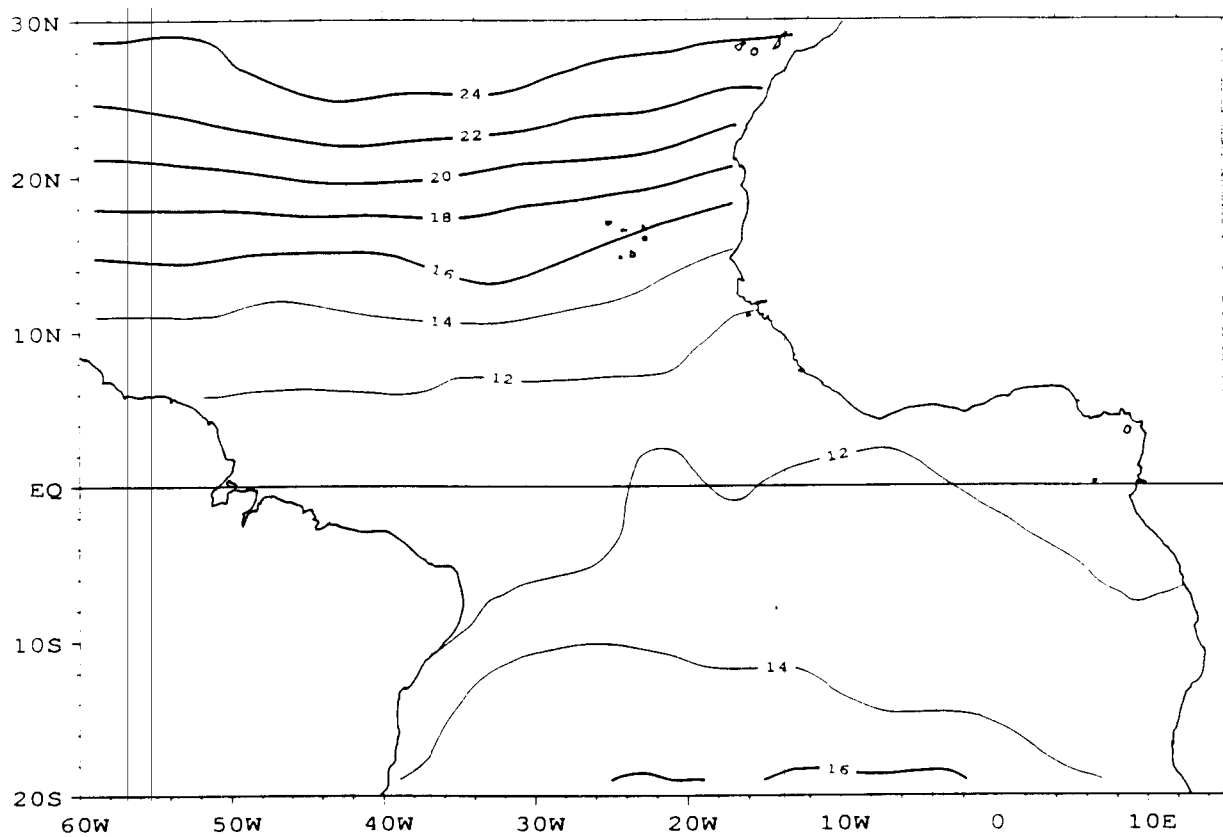
P - 1000 (MB) *OBSERVATIONS*SEASONAL MEAN (JAS)



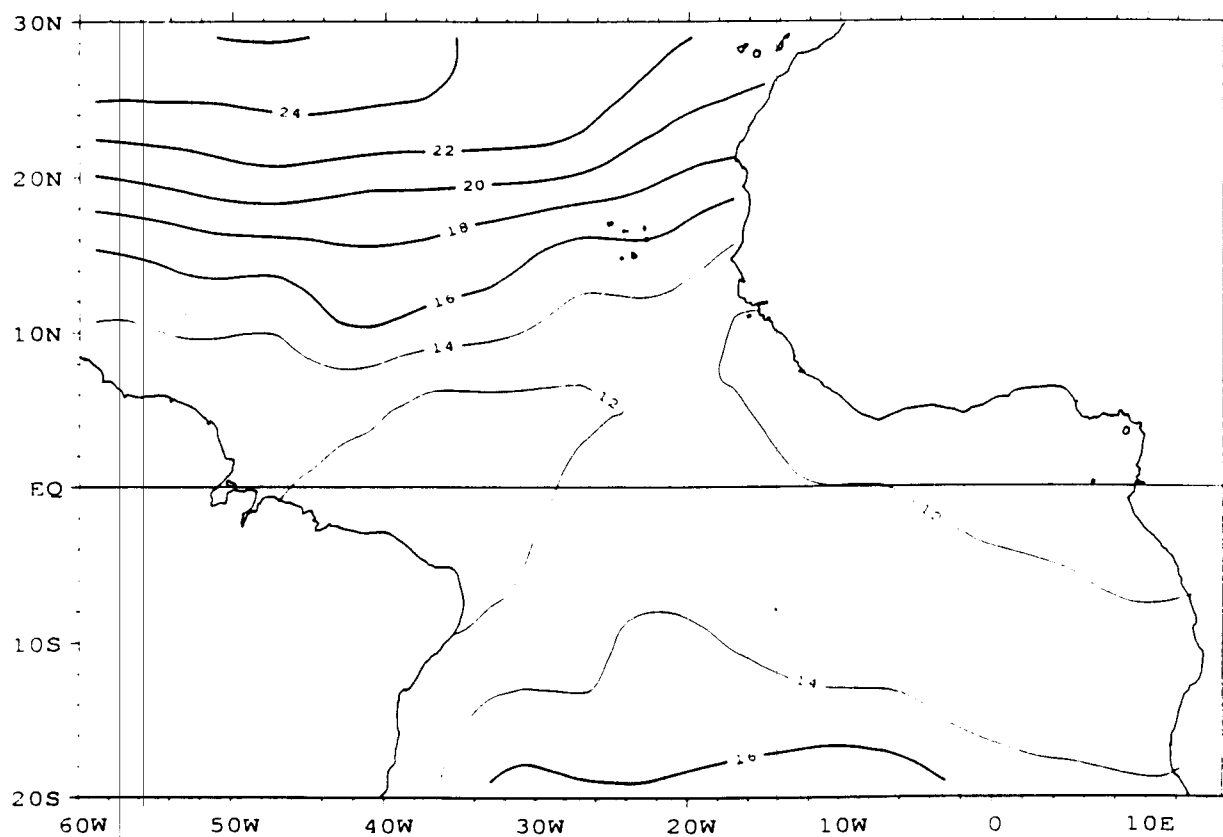
P - 1000 (MB) *OBSERVATIONS*SEASONAL MEAN (OND)



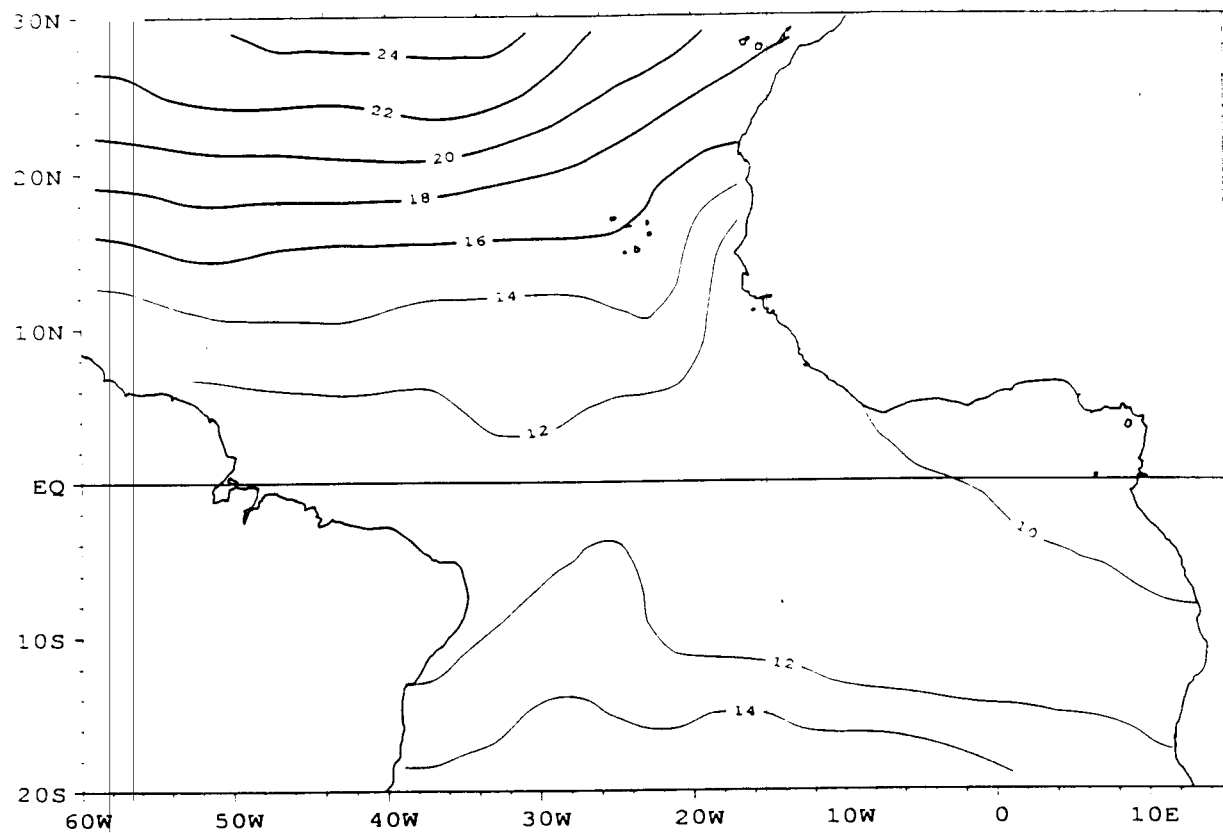
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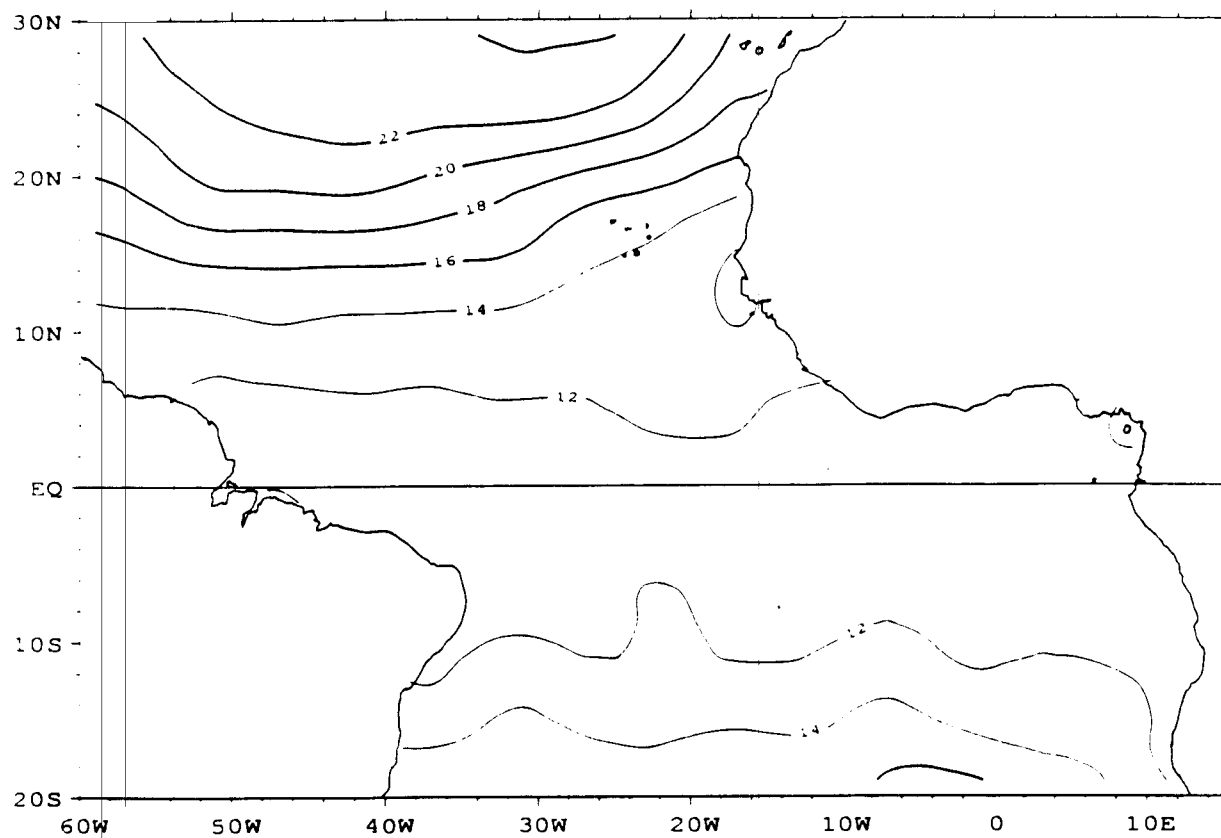
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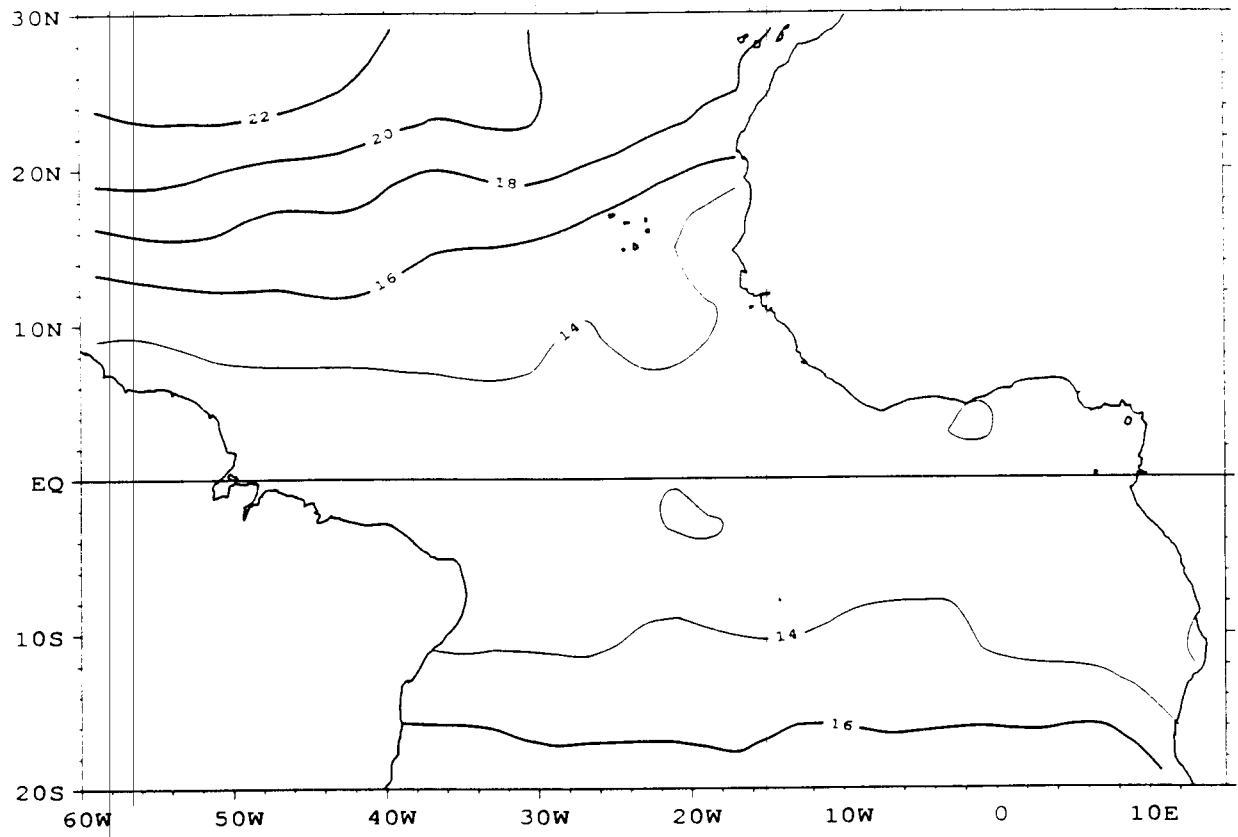
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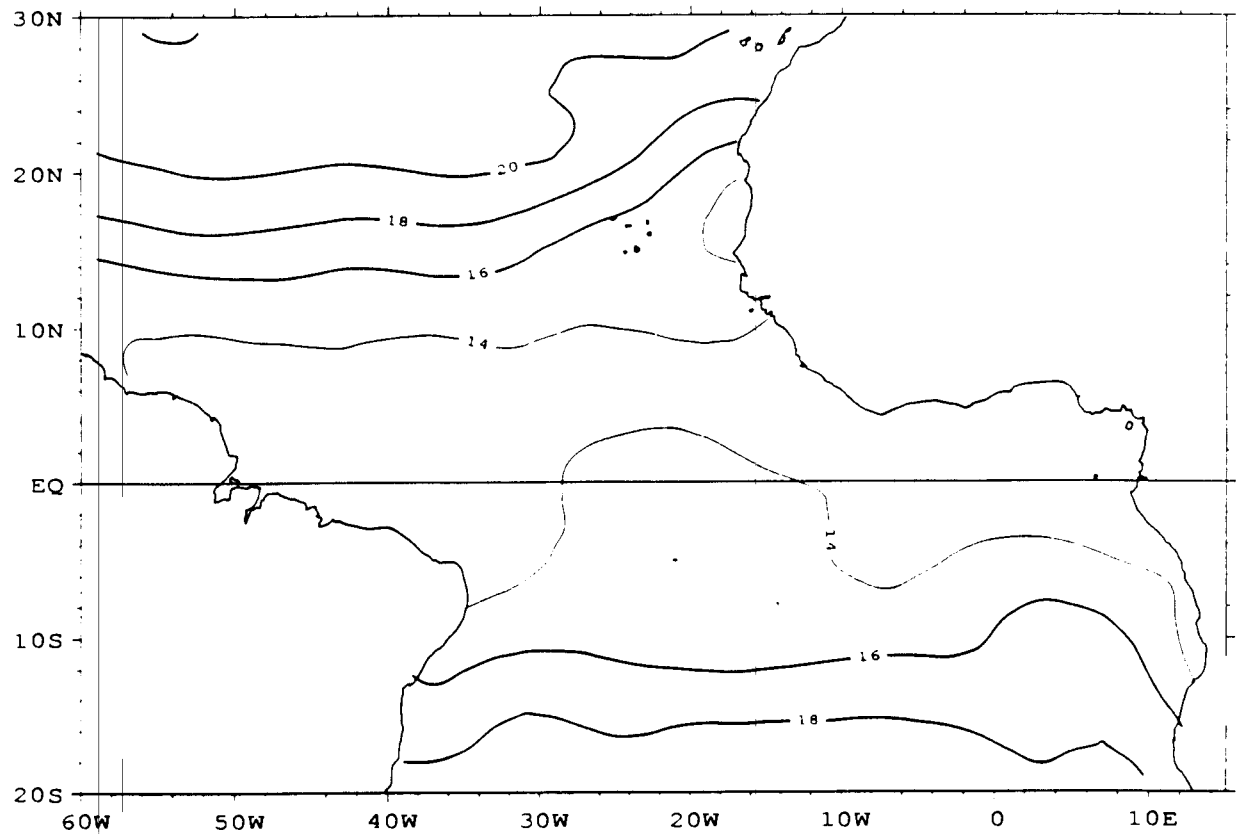
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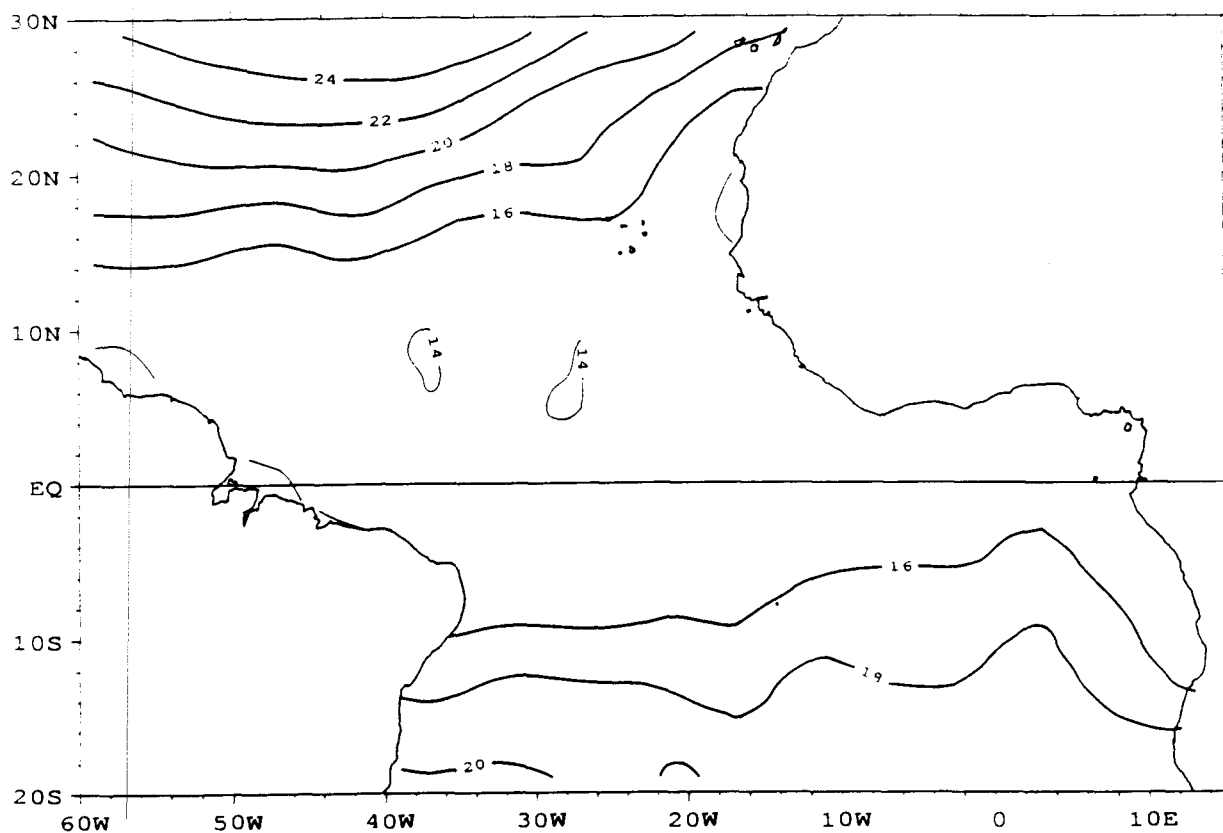
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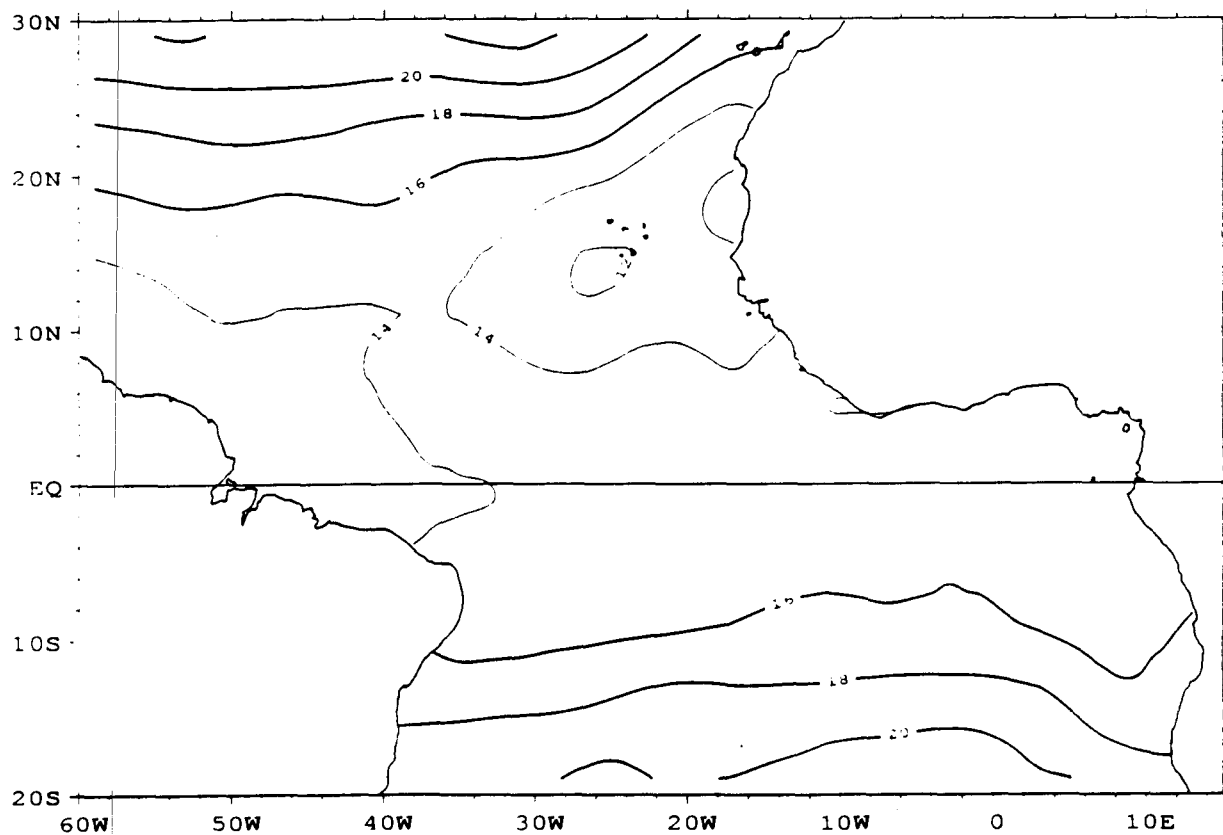
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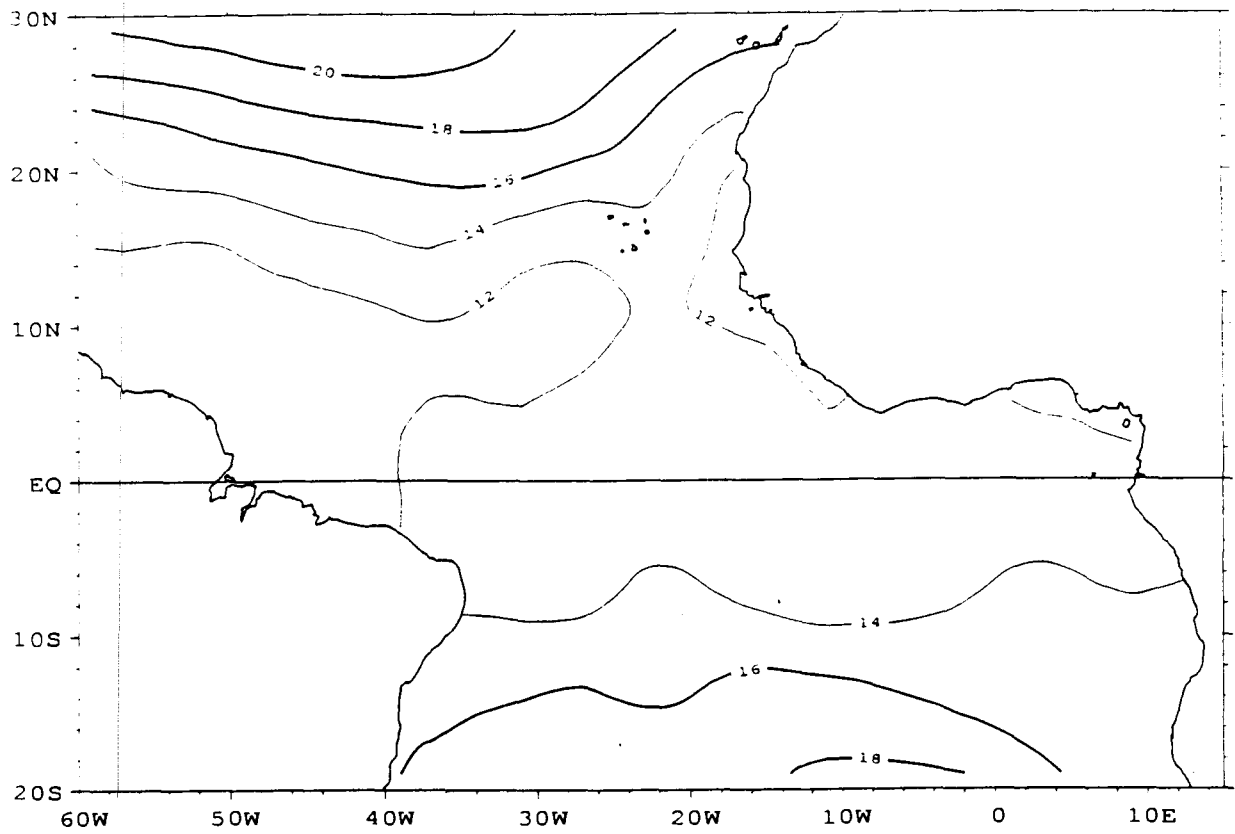
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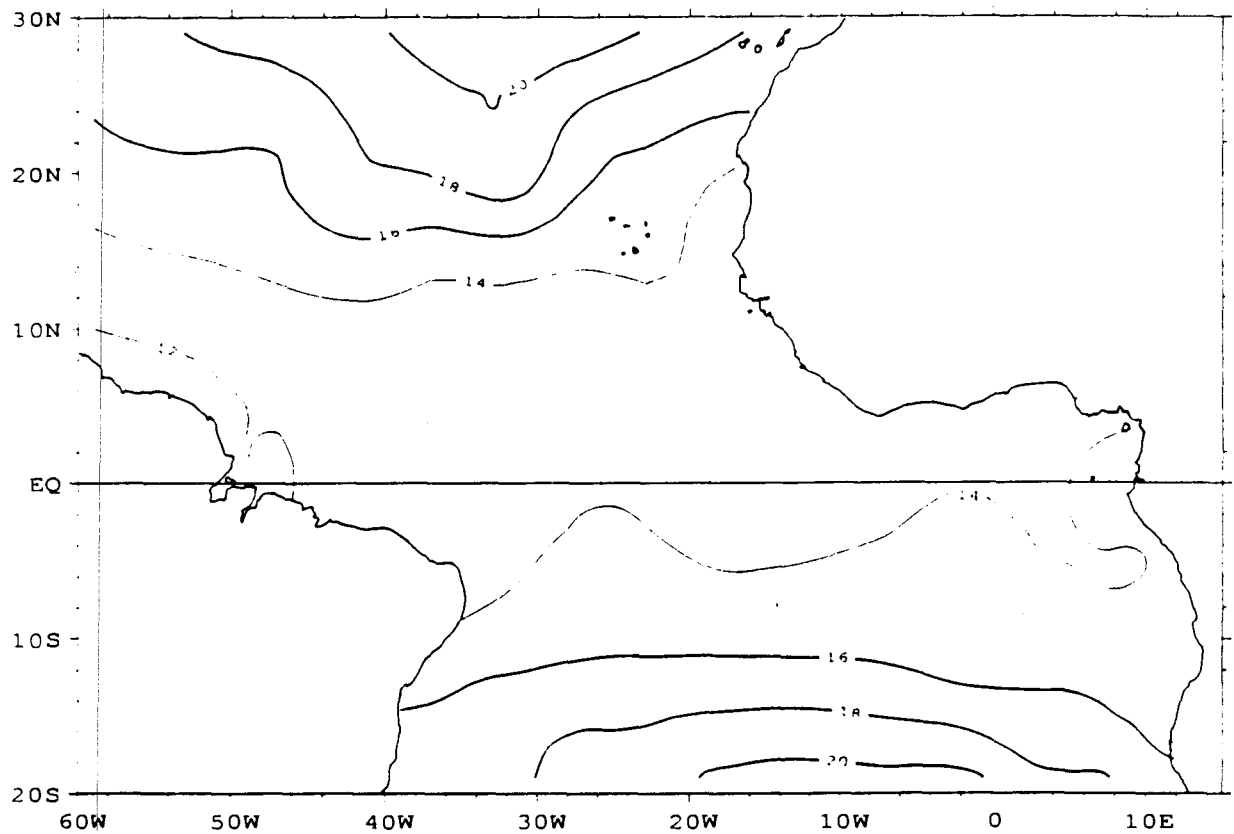
P - 1000 (MB) * OBS. 2x2 * AOUT 1989



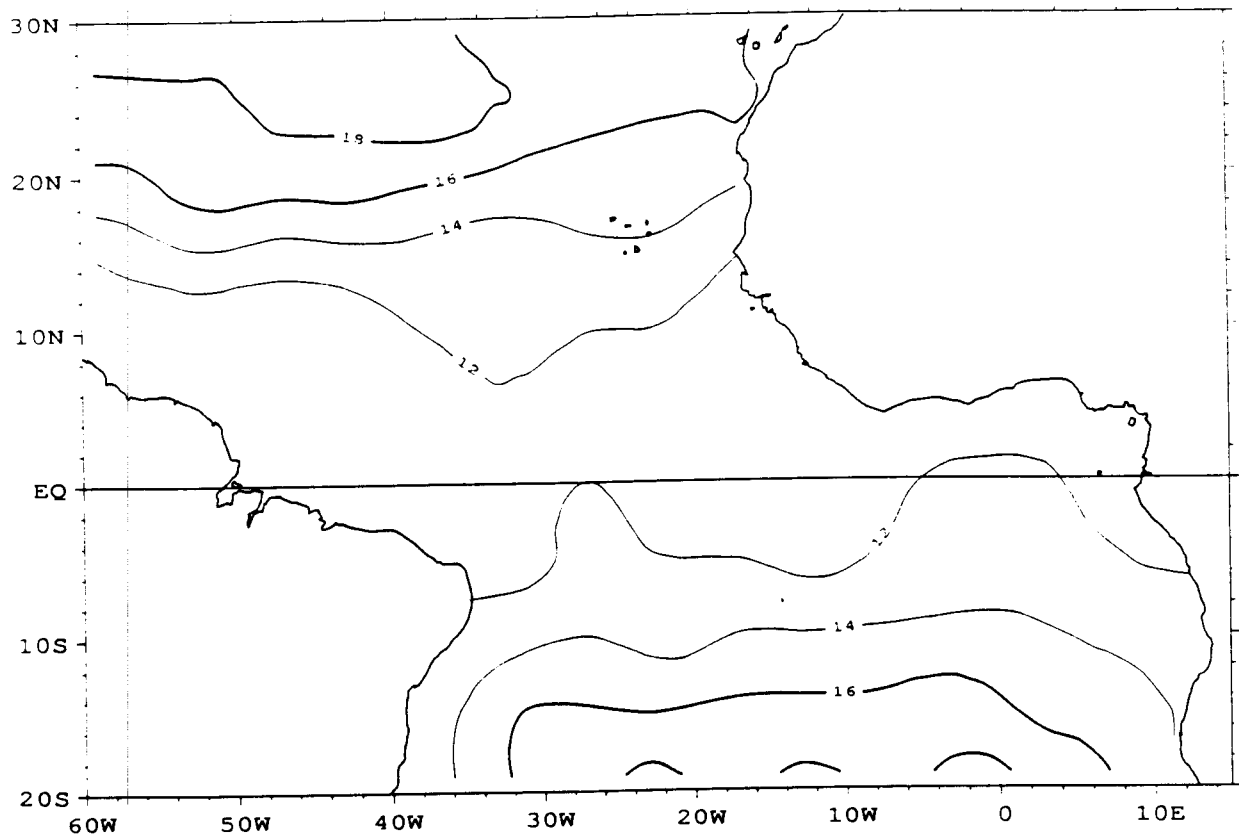
P - 1000 (MB) * OBS. 2x2 * SEPTEMBRE 1989



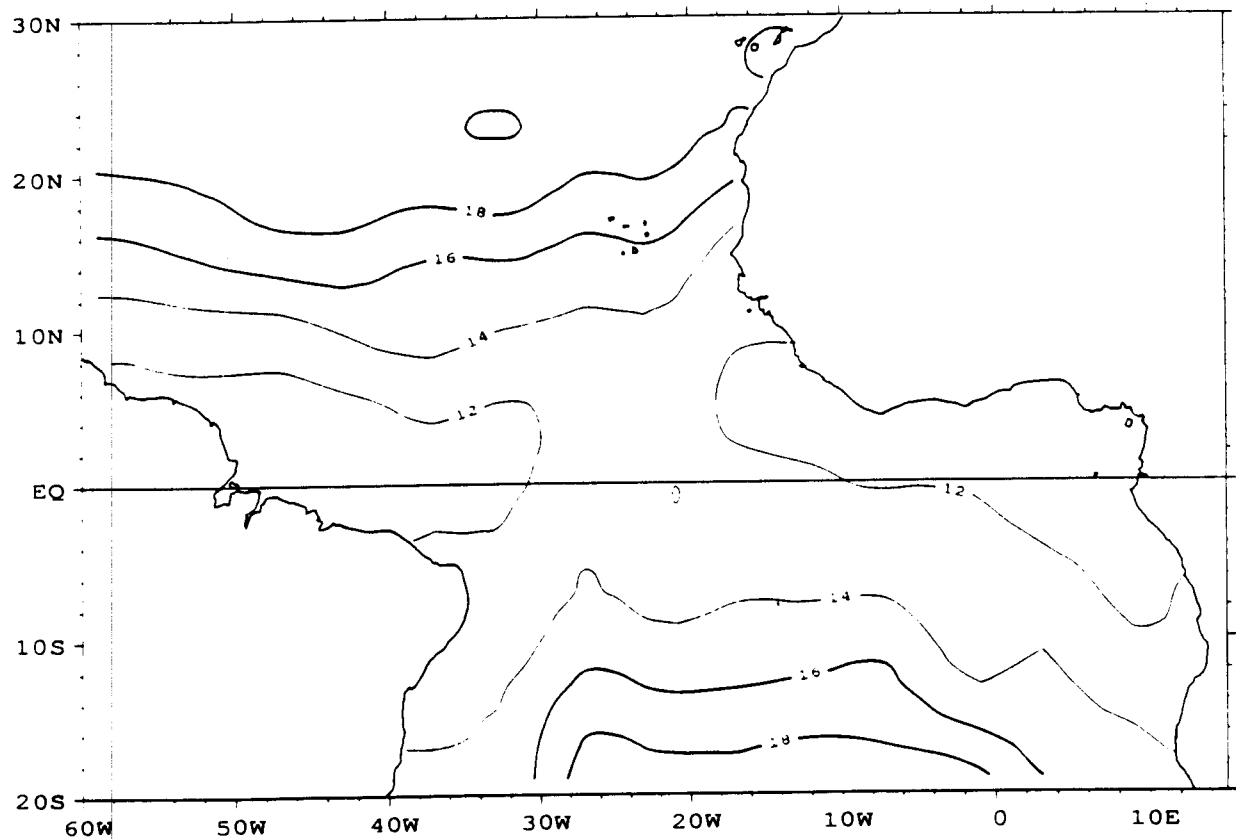
P - 1000 (MB) * OBS. 2x2 * OCTOBRE 1989



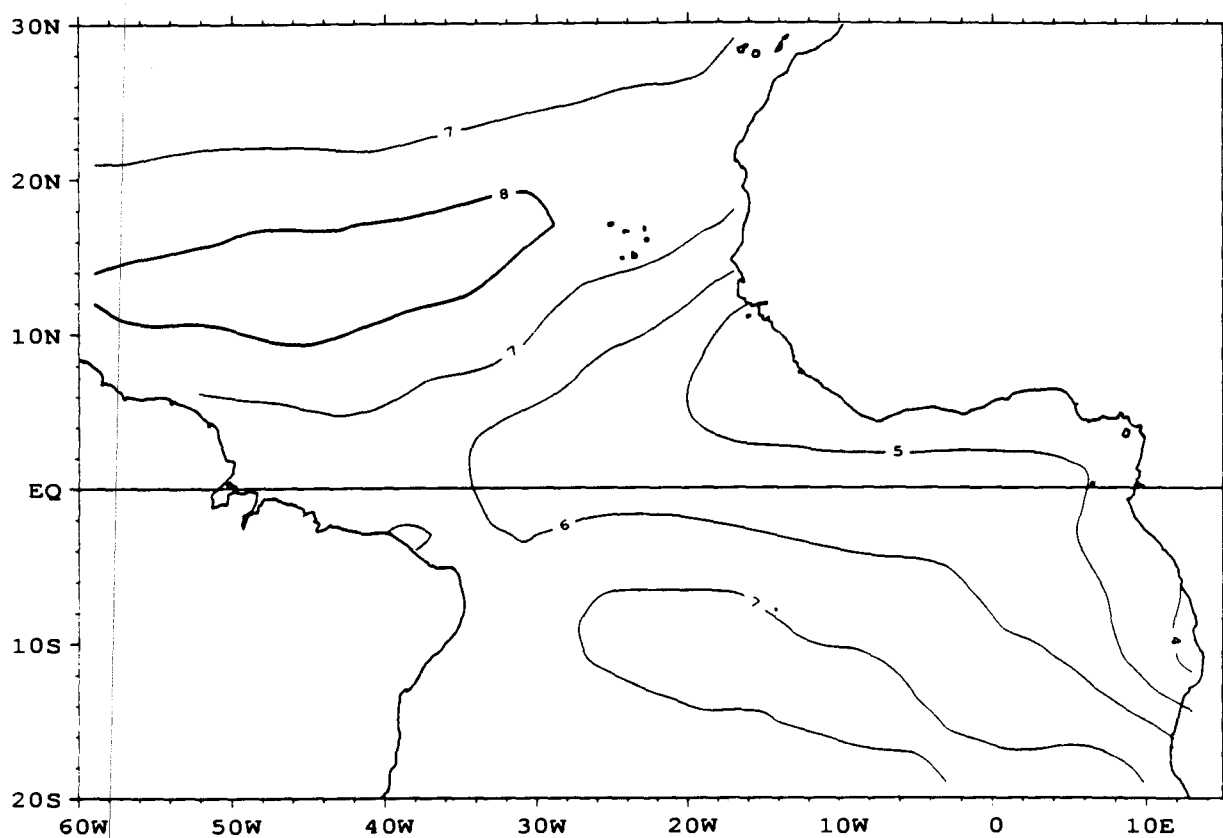
P - 1000 (MB) * OBS. 2x2 * NOVEMBRE 1989



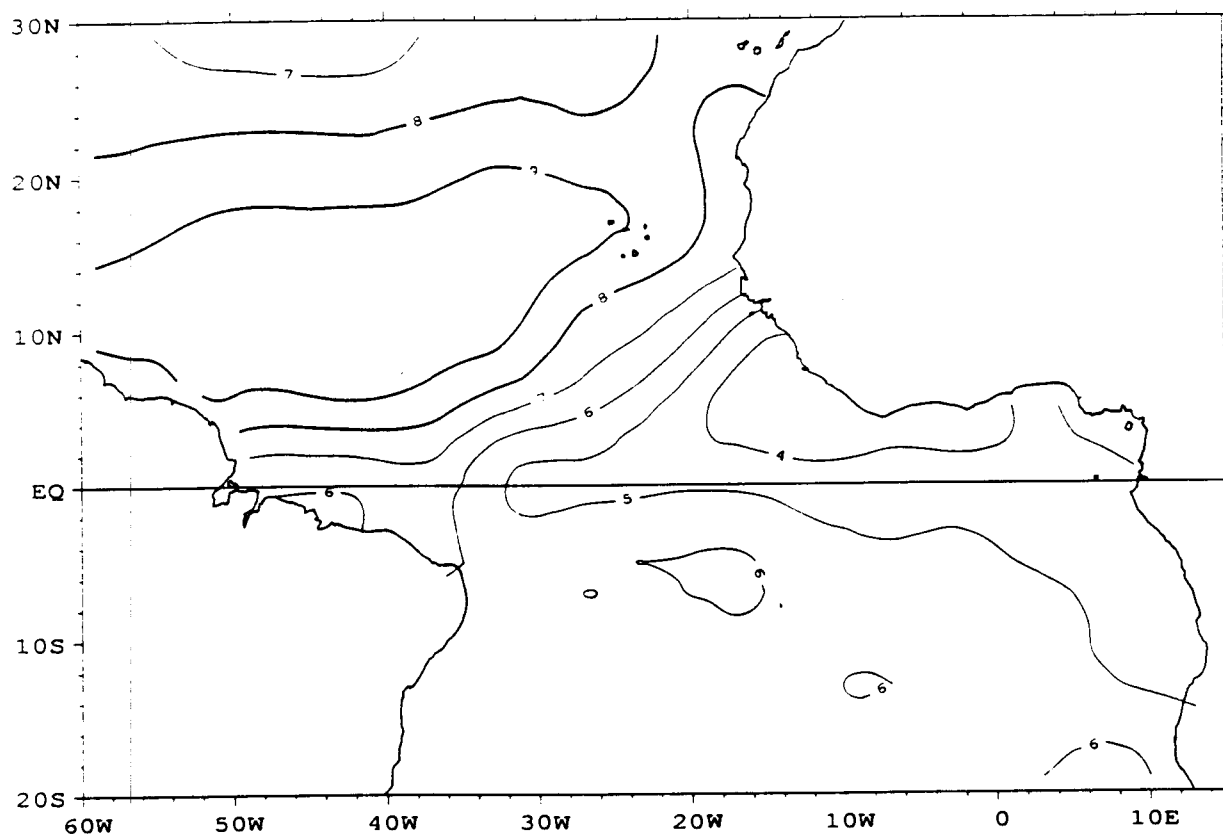
P - 1000 (MB) * OBS. 2x2 * DECEMBRE 1989



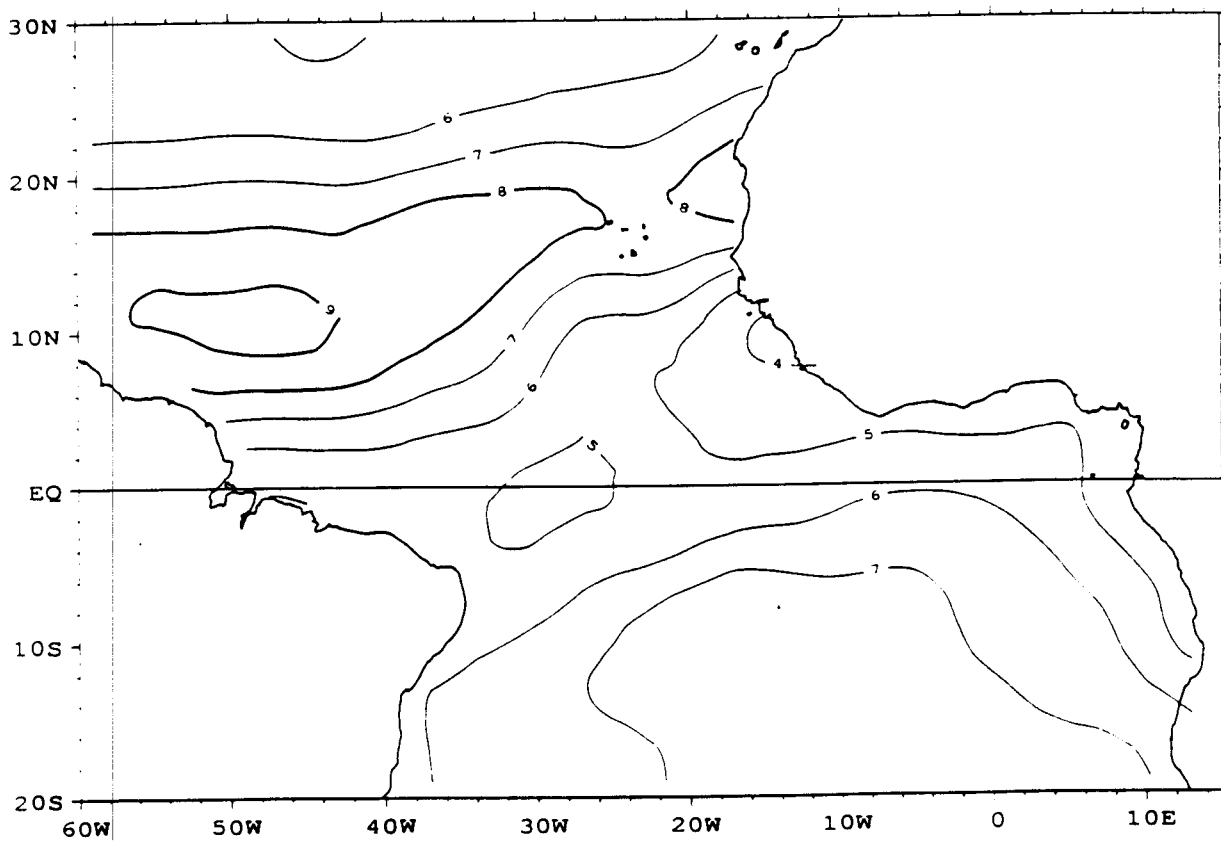
WIND VEL. (M/S) * OBSERVATIONS * ANNUAL MEAN



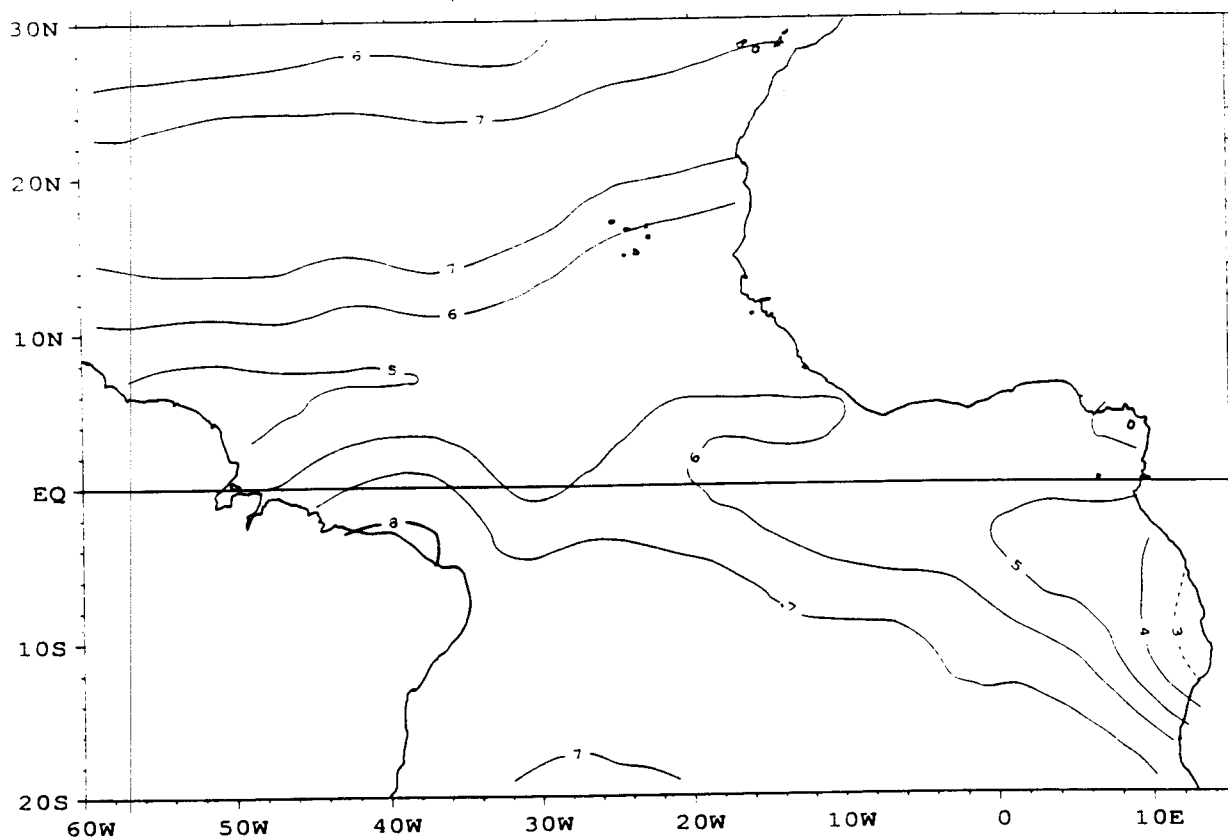
WIND (M/S) *OBSERVATIONS*SEASONAL MEAN (JFM)



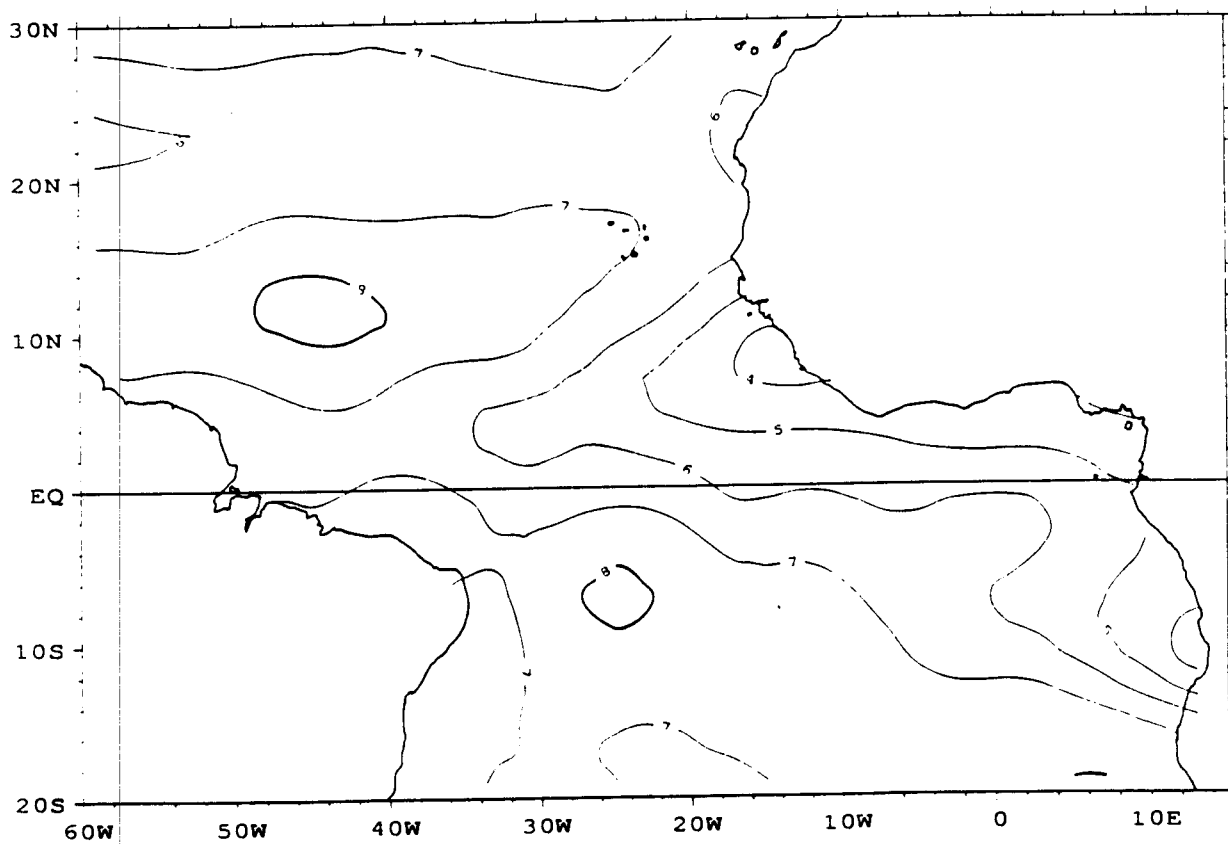
WIND (M/S) *OBSERVATIONS*SEASONAL MEAN (AMJ)



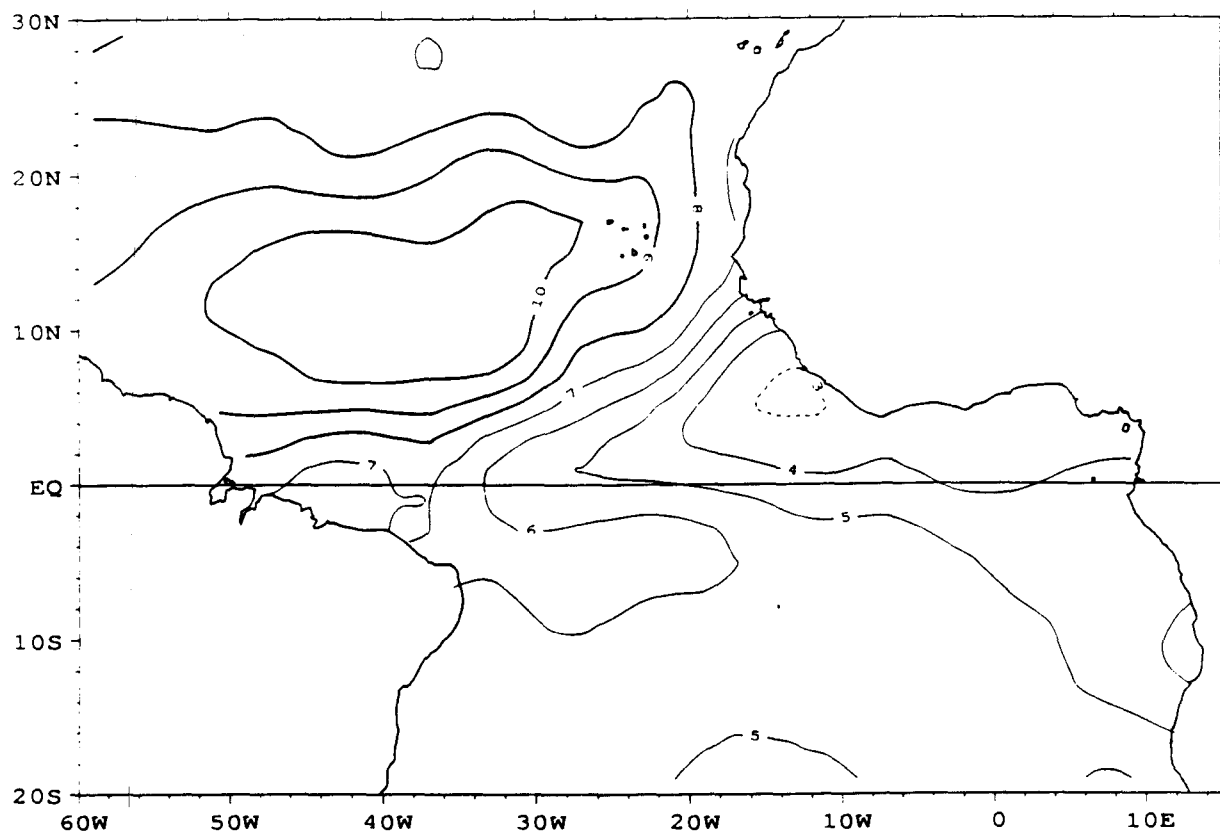
WIND (M/S) *OBSERVATIONS*SEASONAL MEAN (JAS)



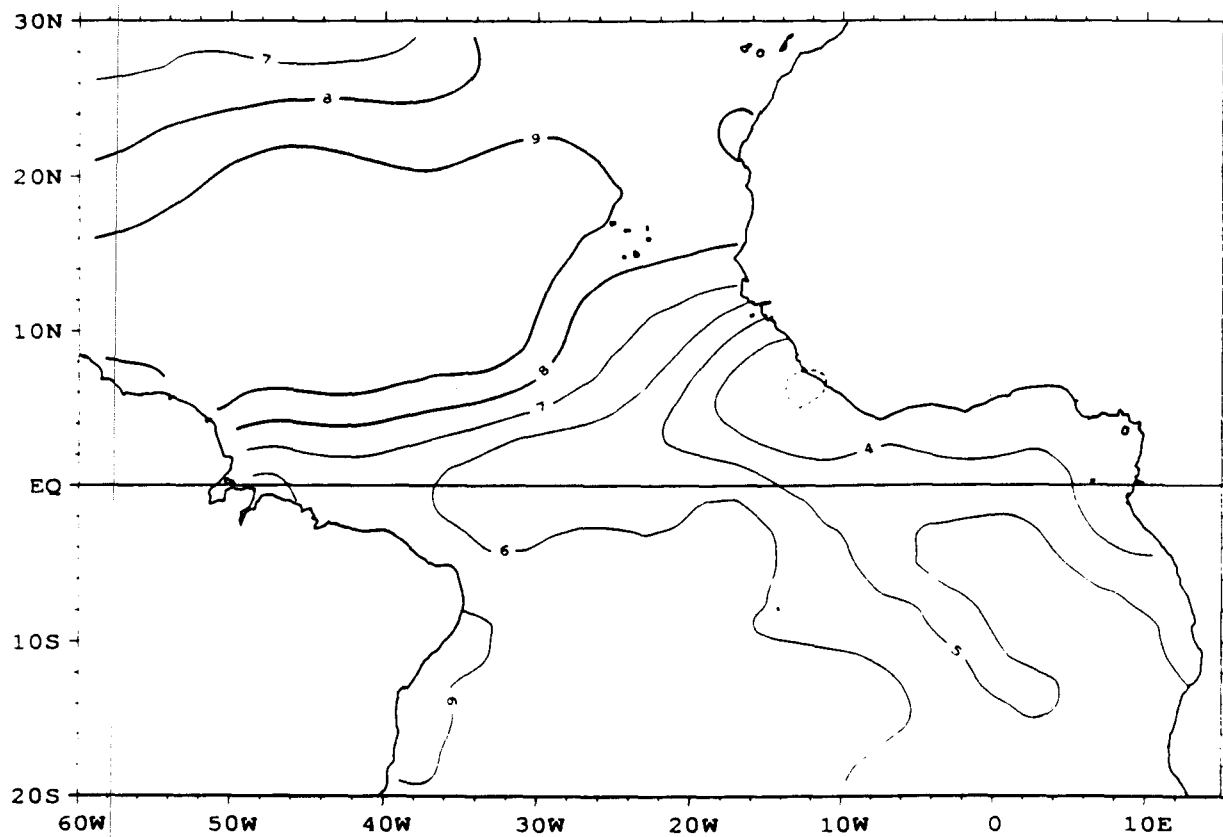
WIND (M/S) *OBSERVATIONS*SEASONAL MEAN (OND)



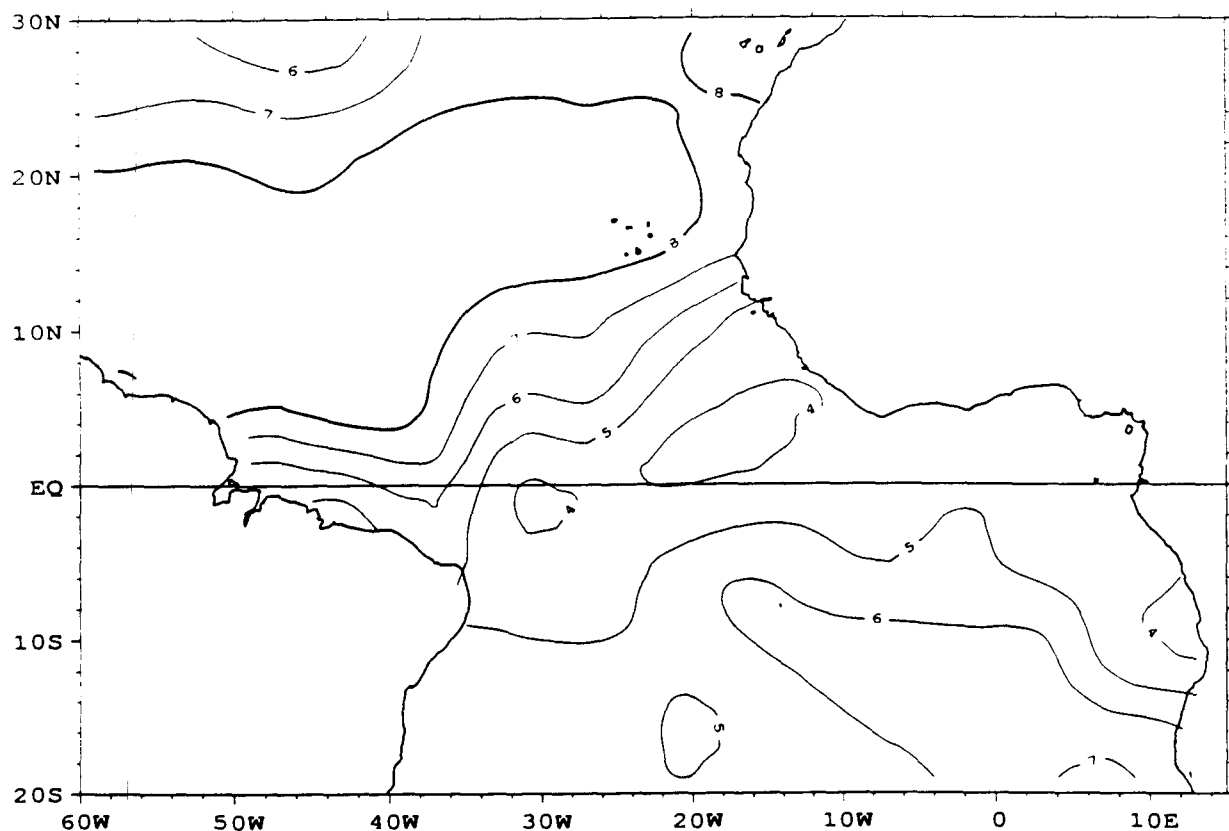
VENT (M/S) - OBSERVATIONS 2x2 - JANVIER 1989



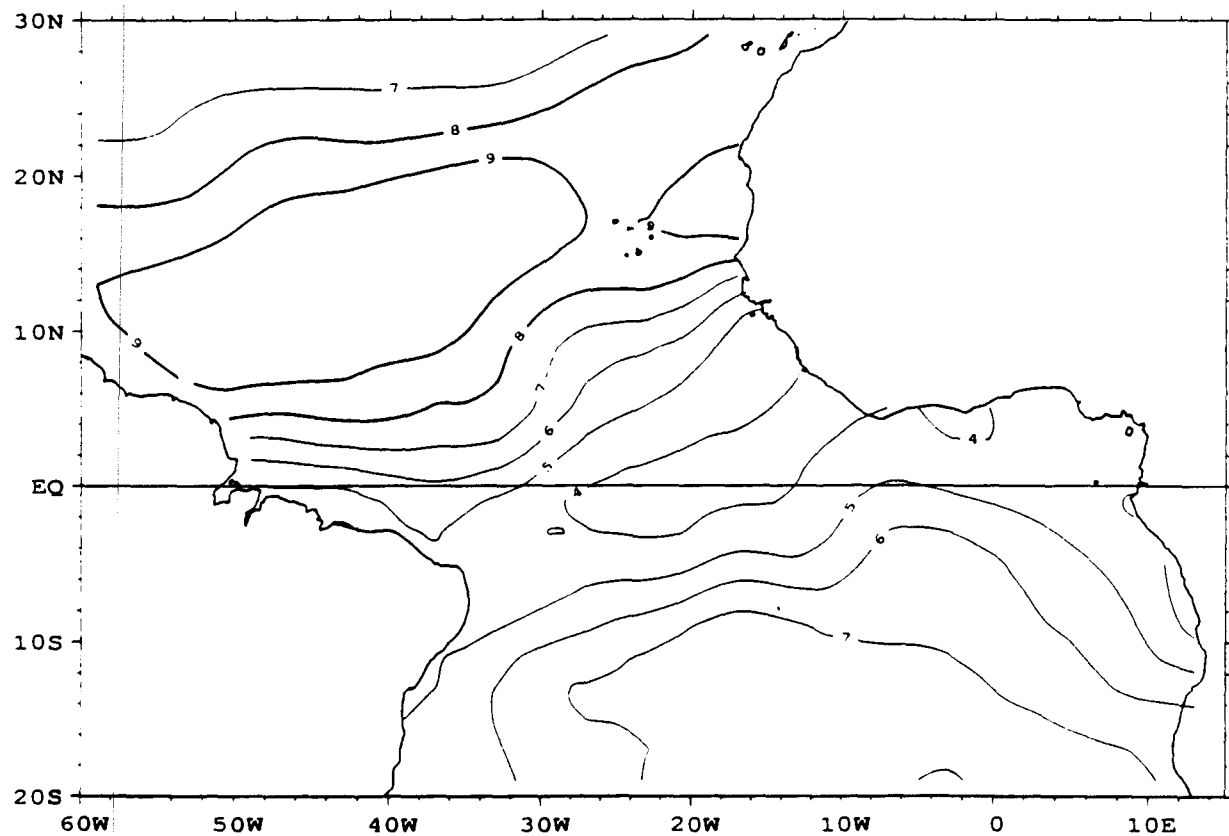
VENT (M/S) - OBSERVATIONS 2x2 - FEVRIER 1989



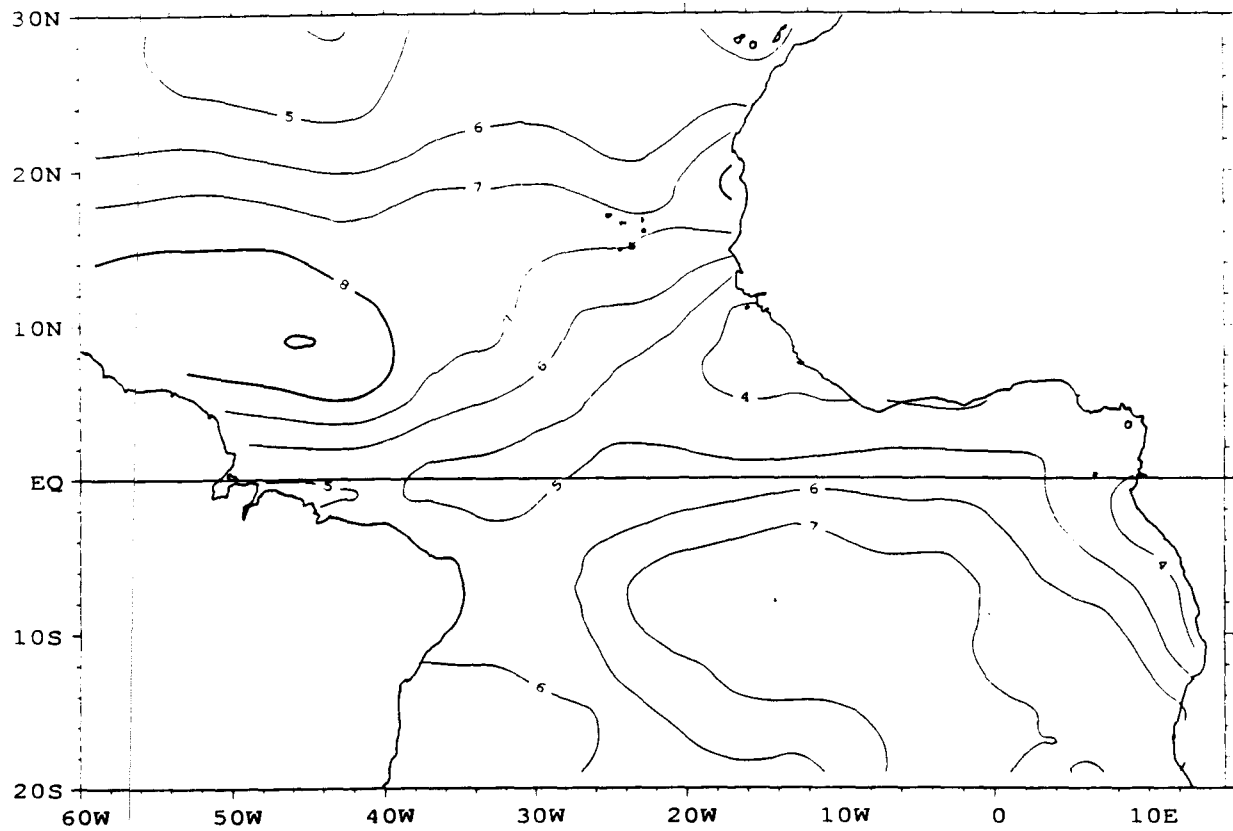
VENT (M/S) -OBSERVATIONS 2x2 - MARS 1989



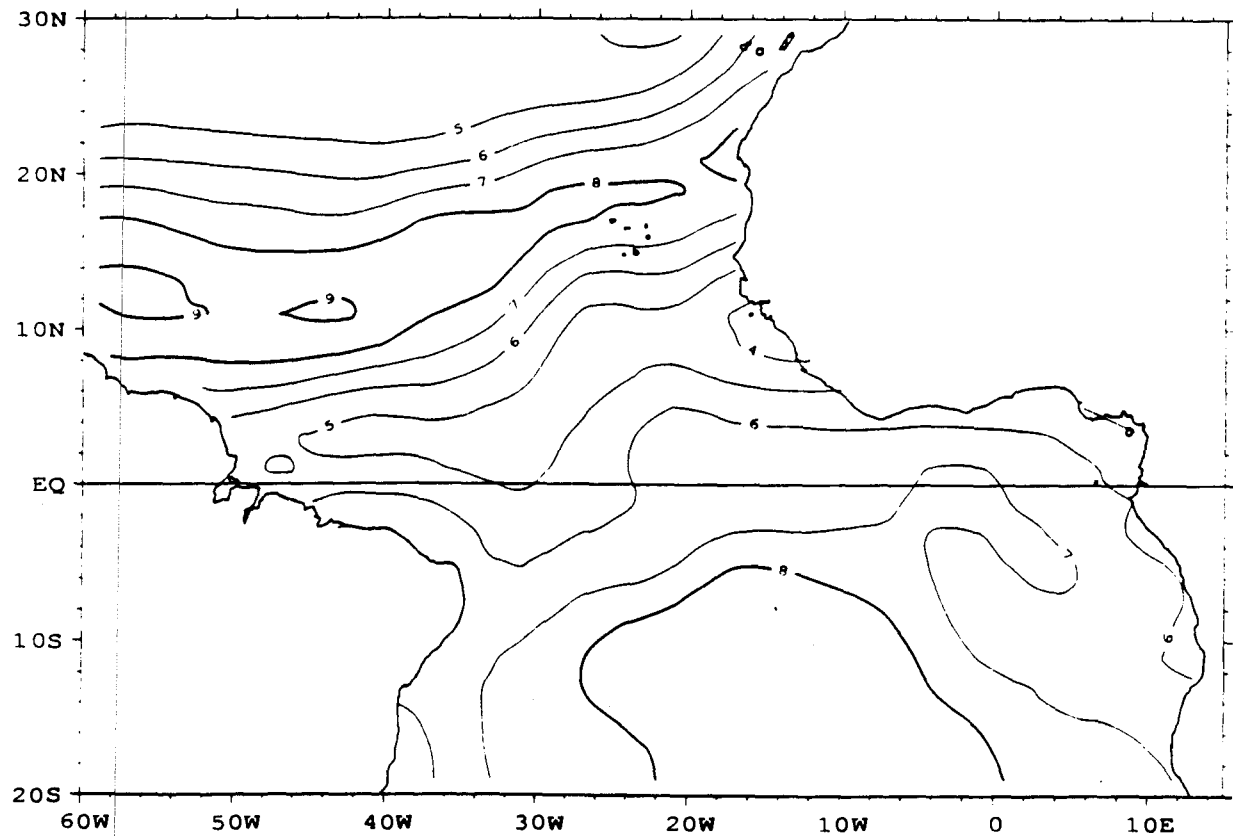
VENT (M/S) - OBSERVATIONS 2x2 - AVRIL 1989



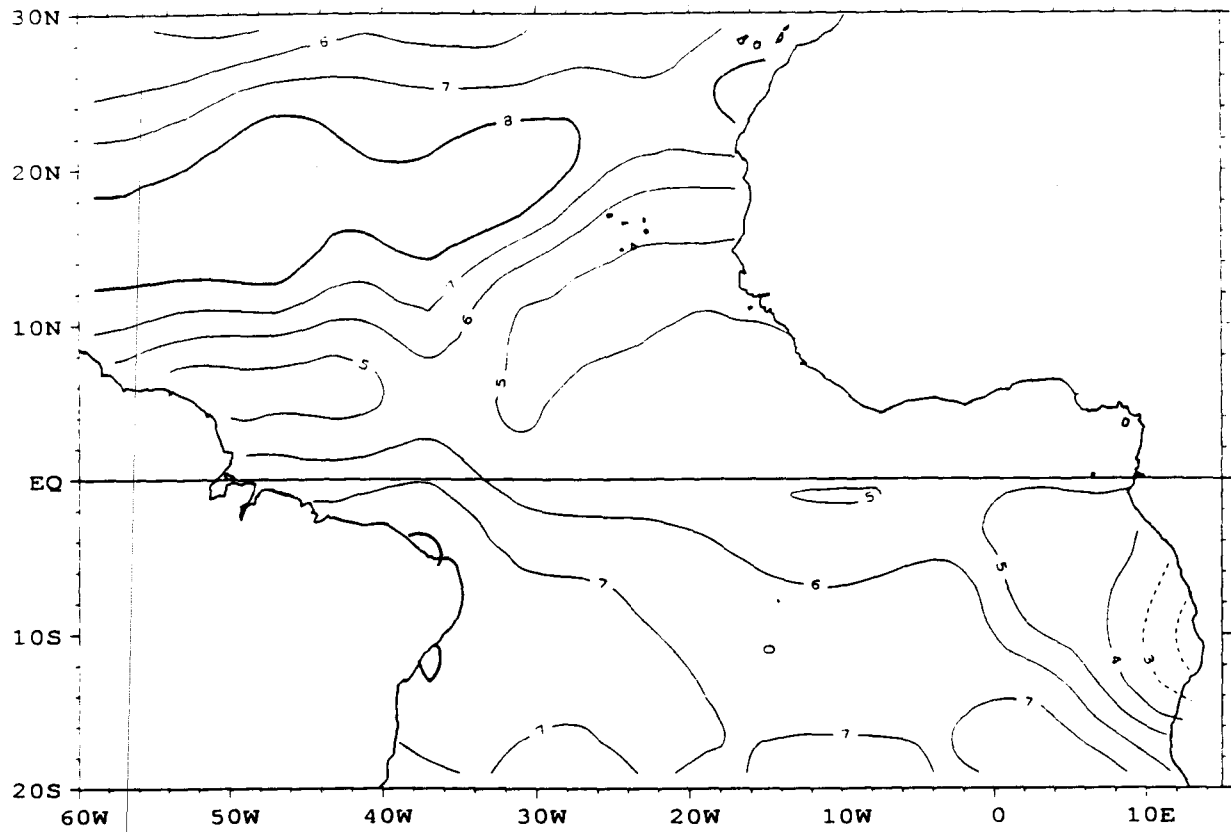
VENT (M/S) - OBSERVATIONS 2x2 - MAI 1989



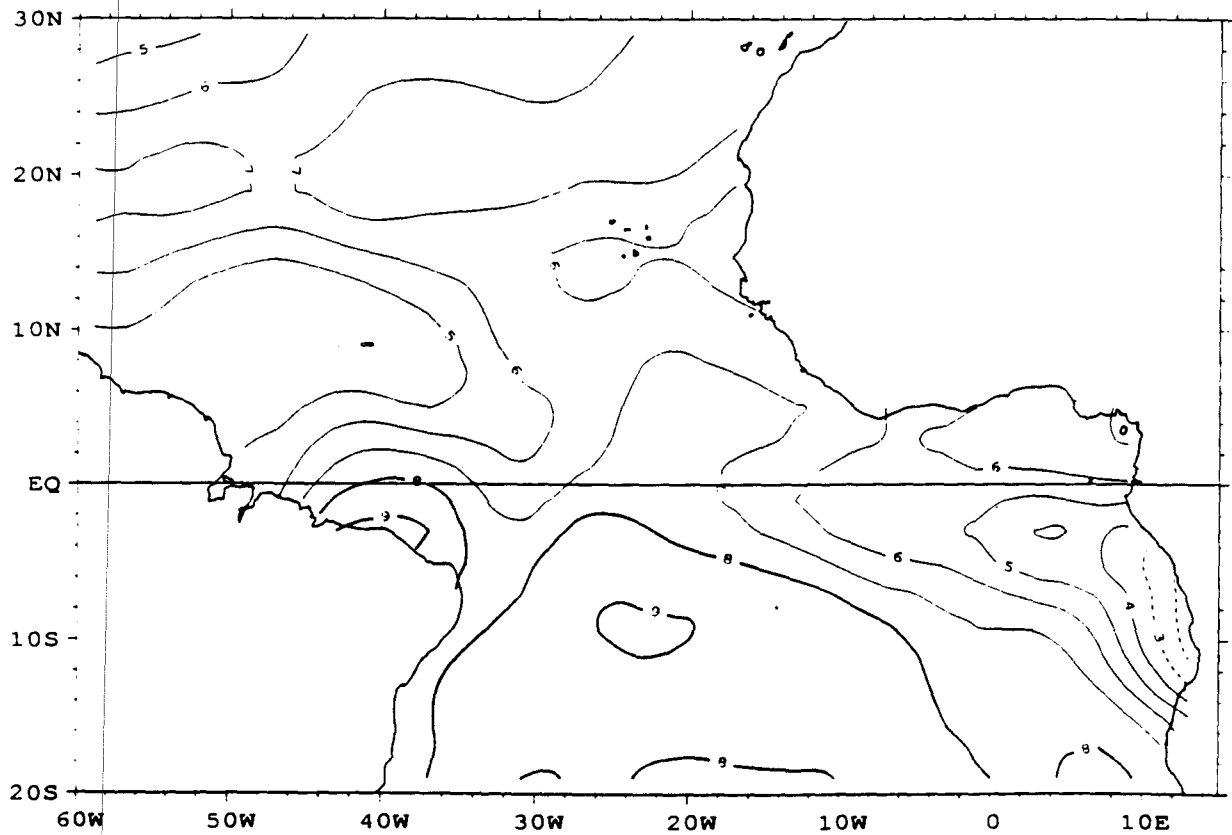
VENT (M/S) - OBSERVATIONS 2x2 - JUIN 1989



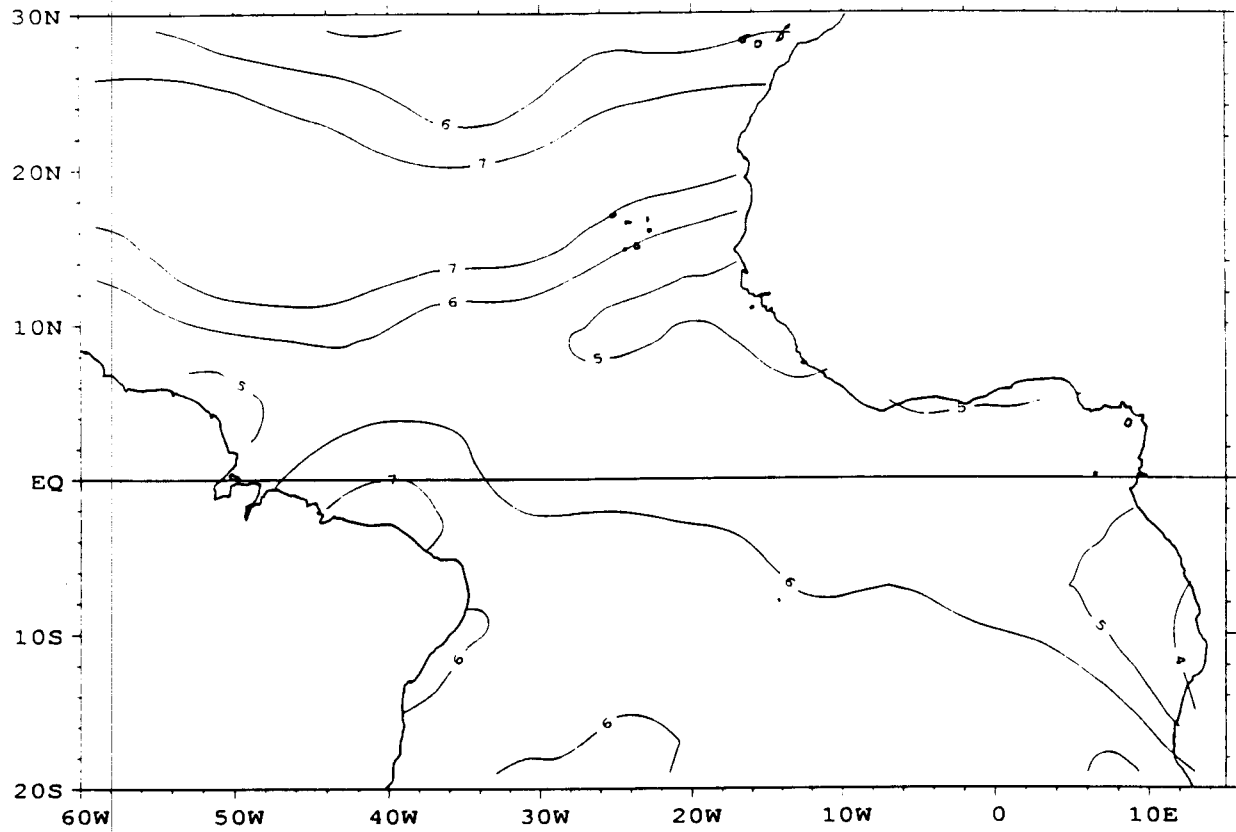
VENT (M/S) - OBSERVATIONS 2x2 - JUILLET 1989



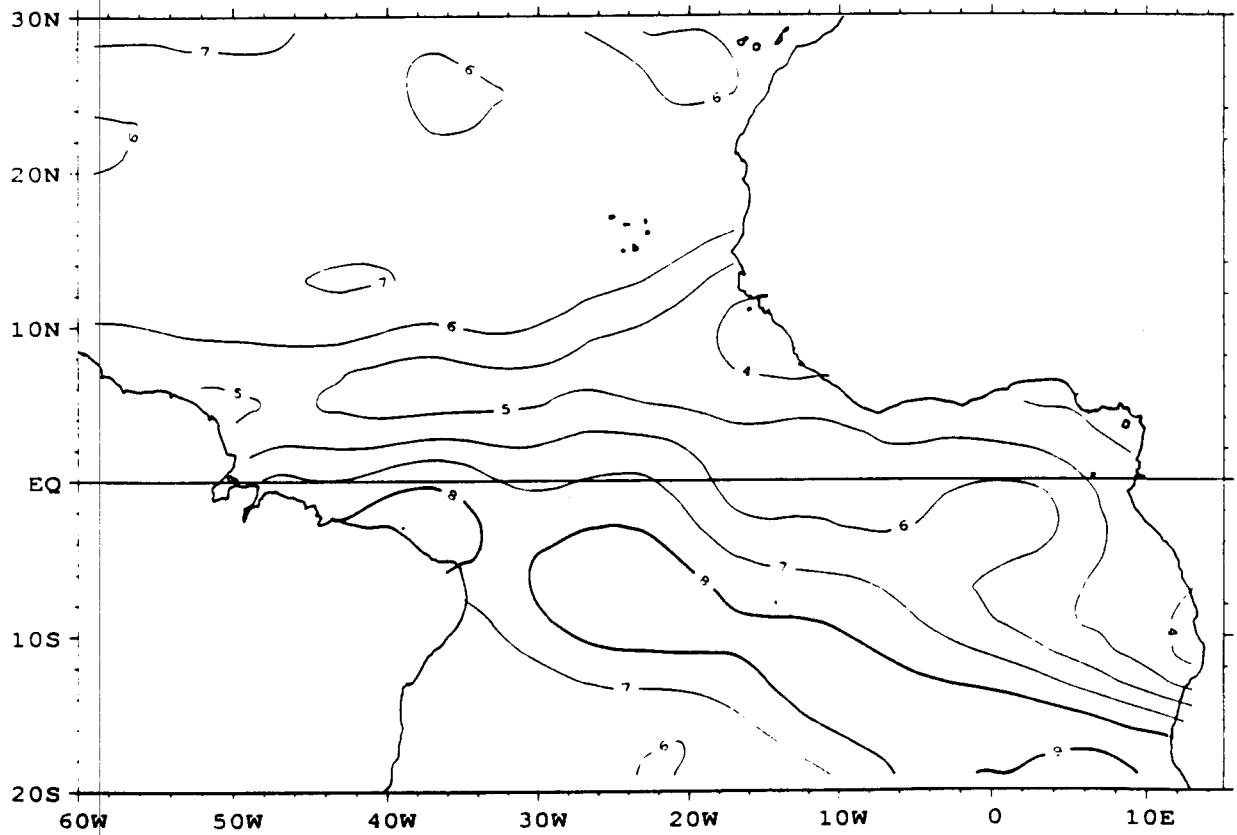
VENT (M/S) - OBSERVATIONS 2x2 - AOUT 1989



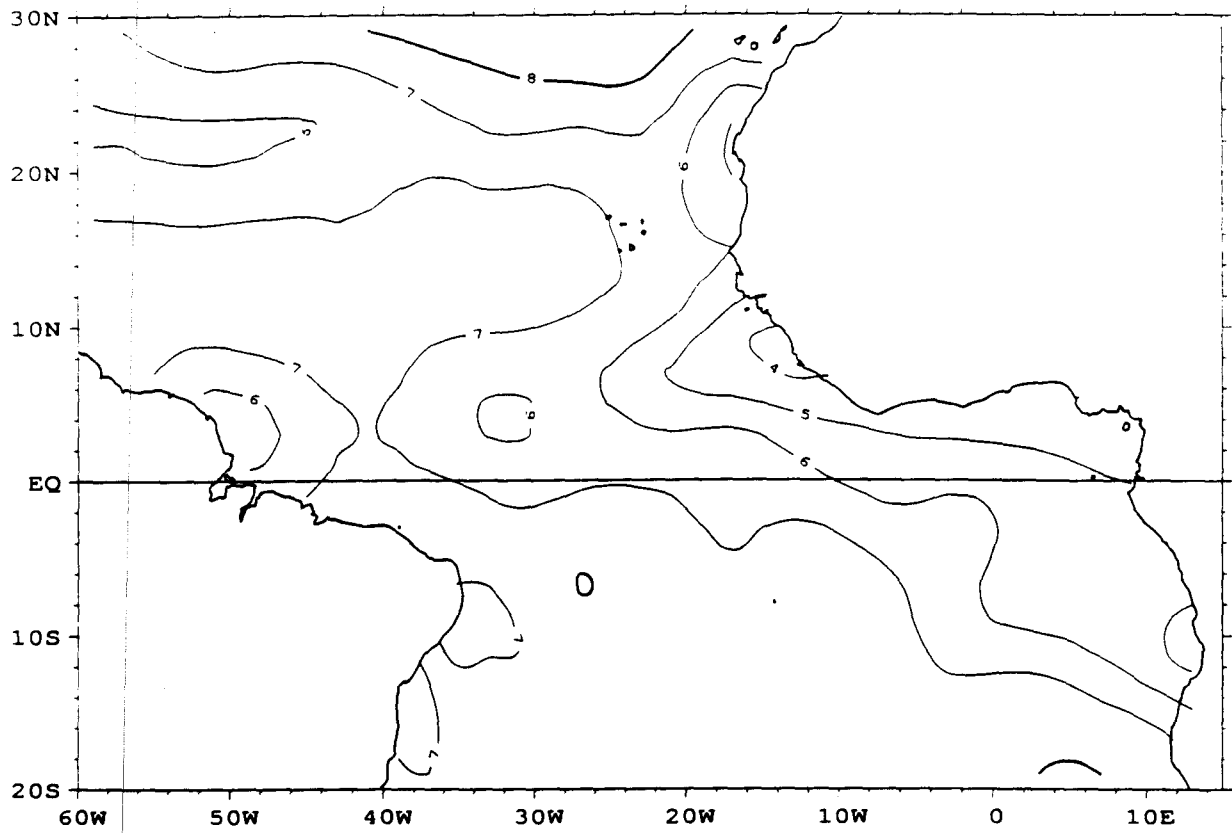
VENT (M/S) - OBSERVATIONS 2x2 - SEPTEMBRE 1989



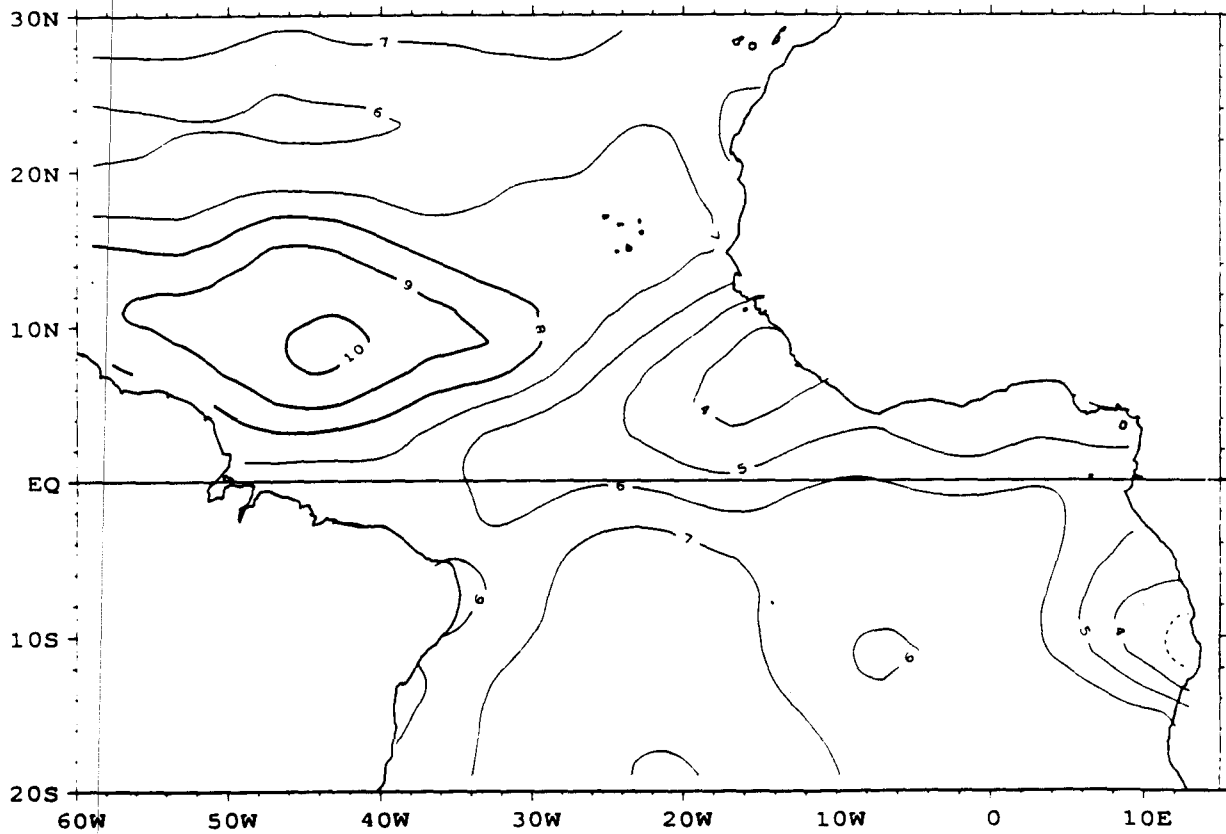
VENT (M/S) - OBSERVATIONS 2x2 - OCTOBRE 1989



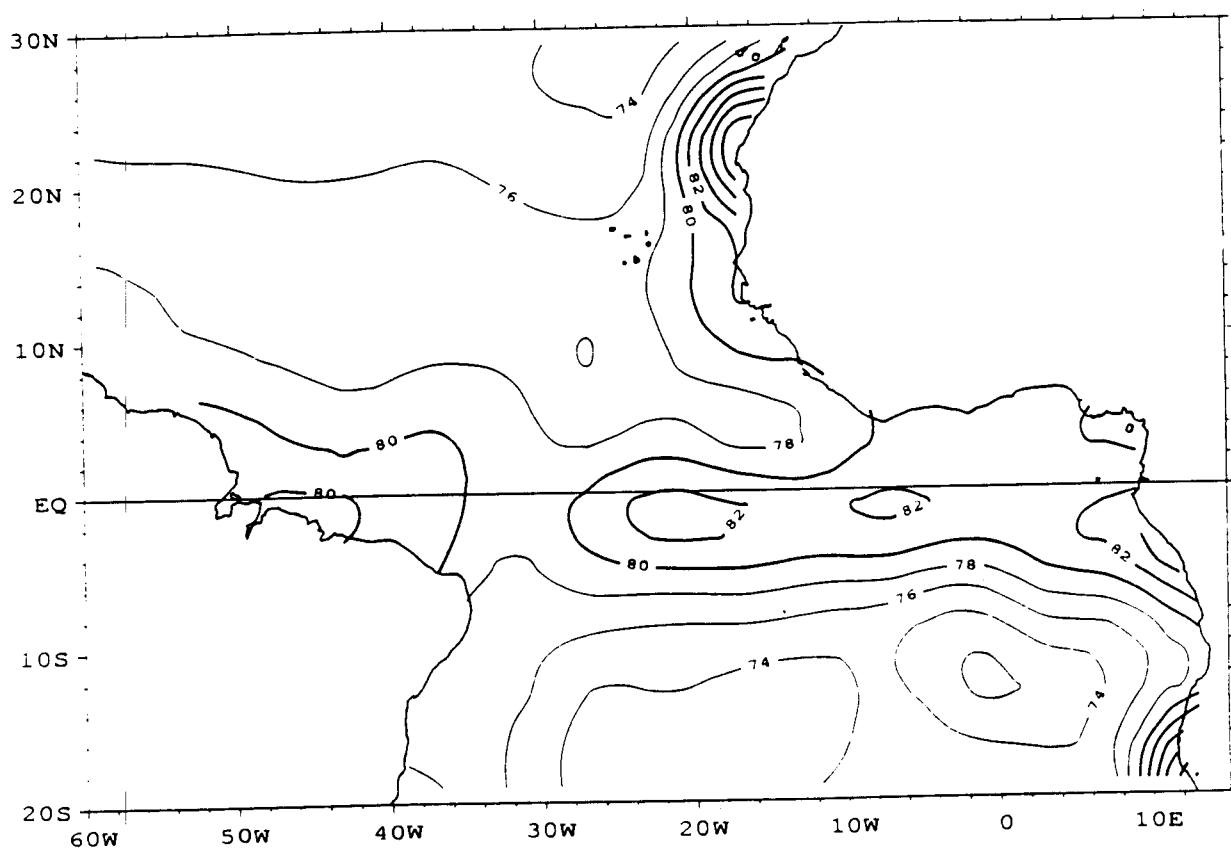
VENT (M/S) - OBSERVATIONS 2x2 - NOVEMBRE 1989



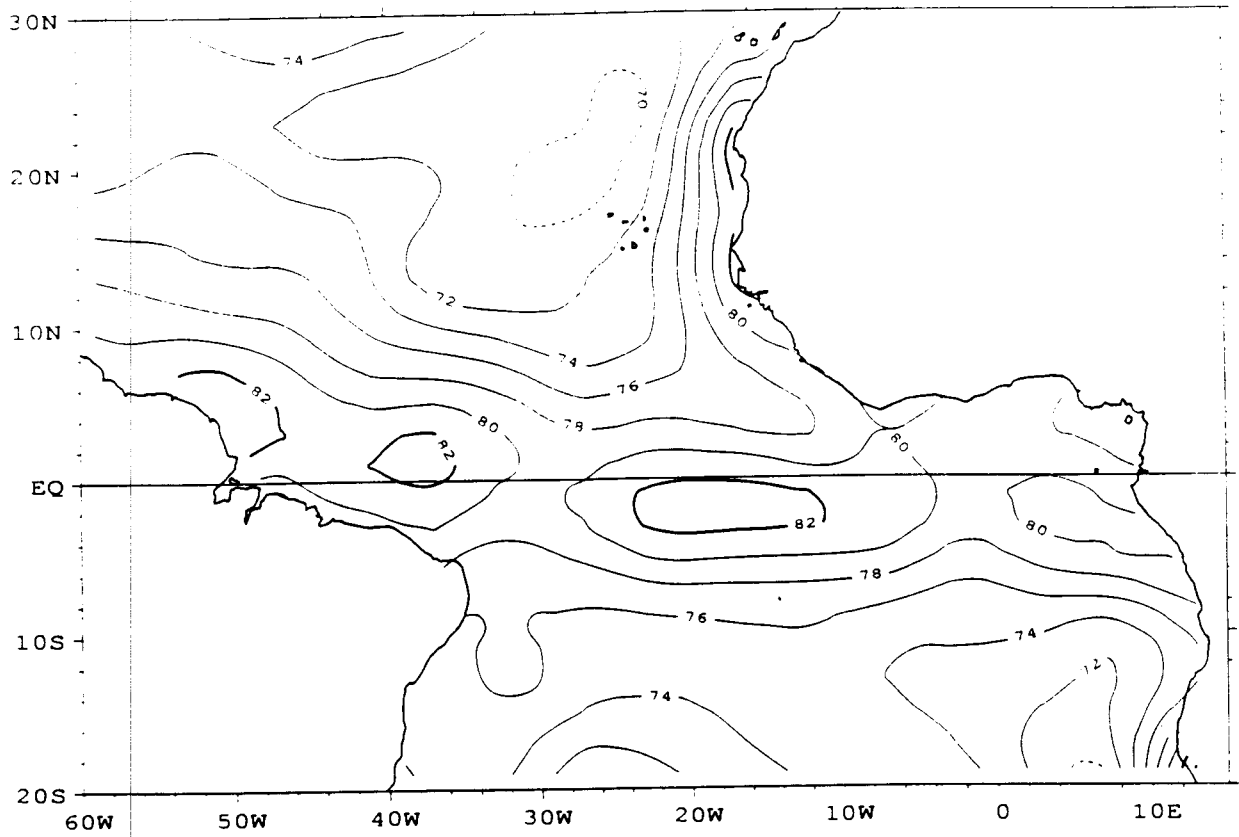
VENT (M/S) - OBSERVATIONS 2x2 - DECEMBRE 1989



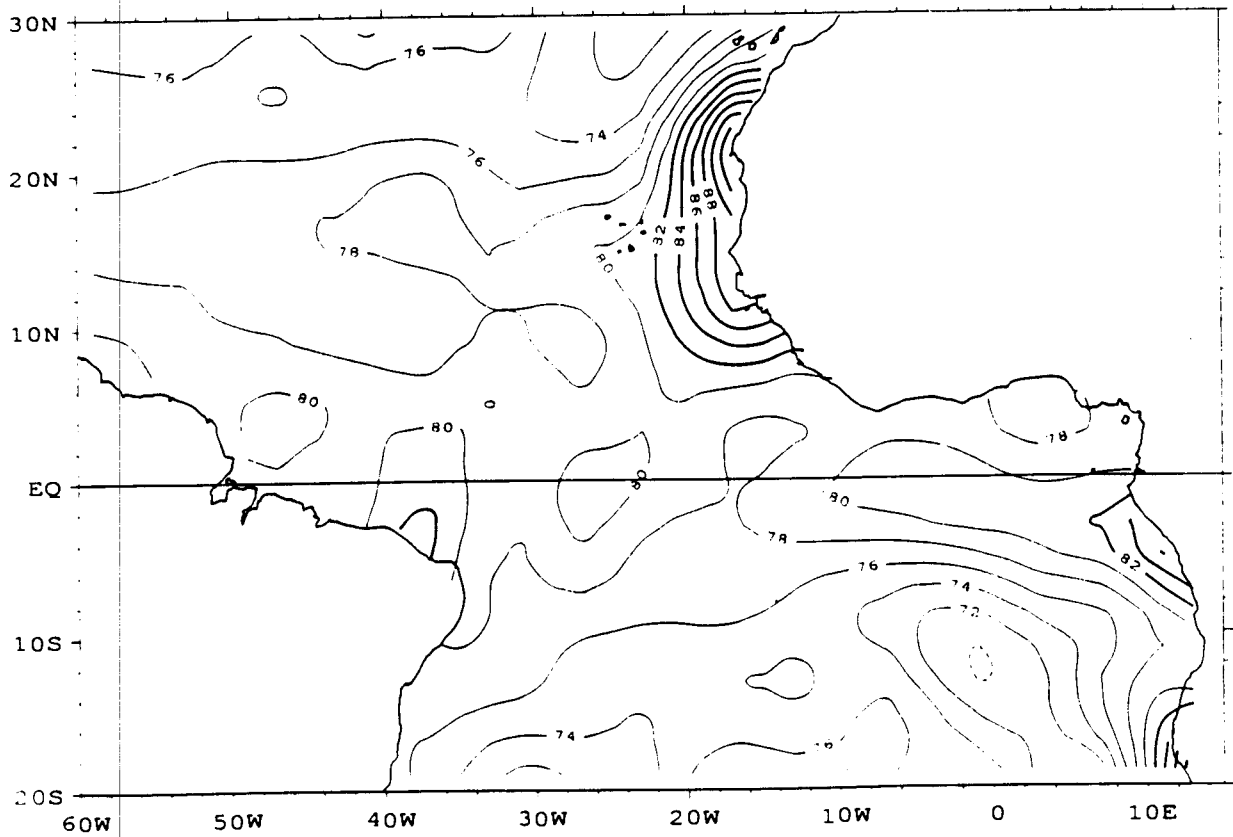
REL. HUM. (%) * OBSERVATIONS * ANNUAL MEAN



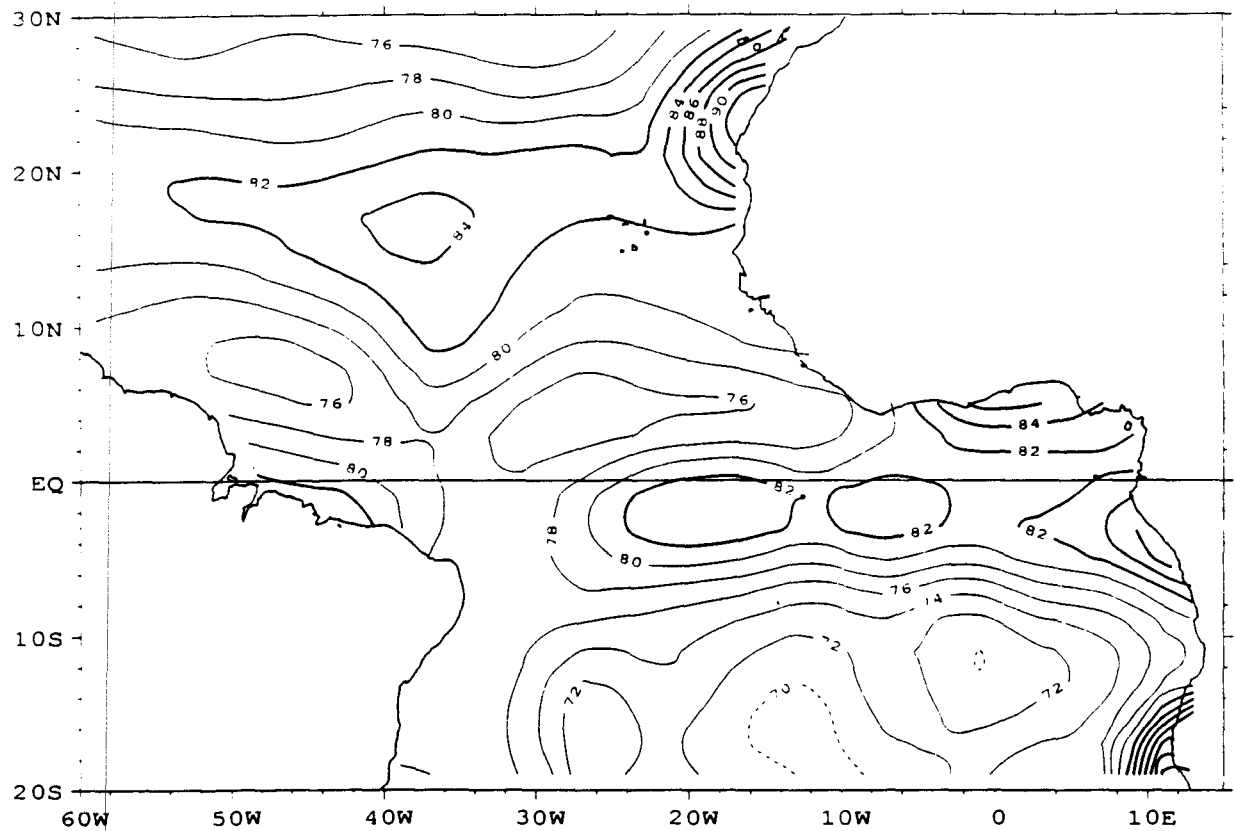
REL. HUM. (%) *OBSERVATIONS*SEASONAL MEAN (JFM)



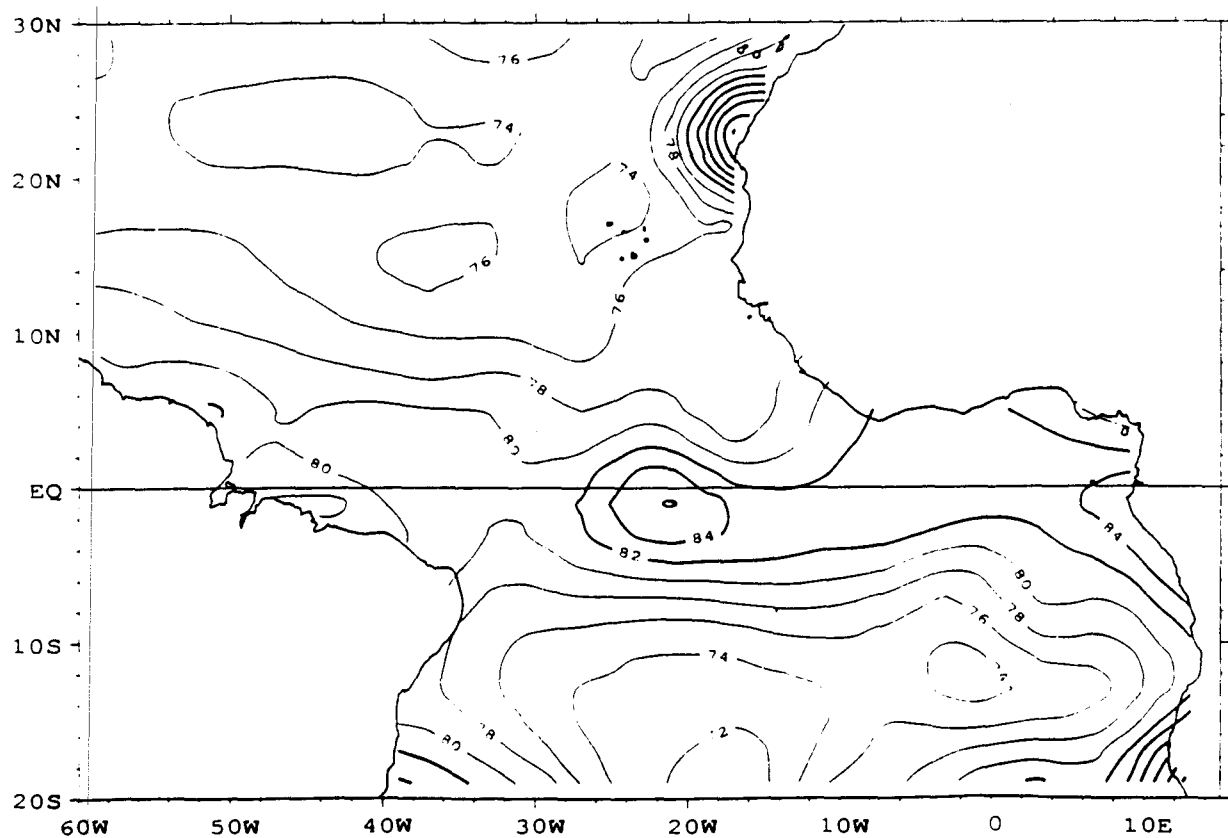
REL. HUM. (%) *OBSERVATIONS*SEASONAL MEAN (AMJ)



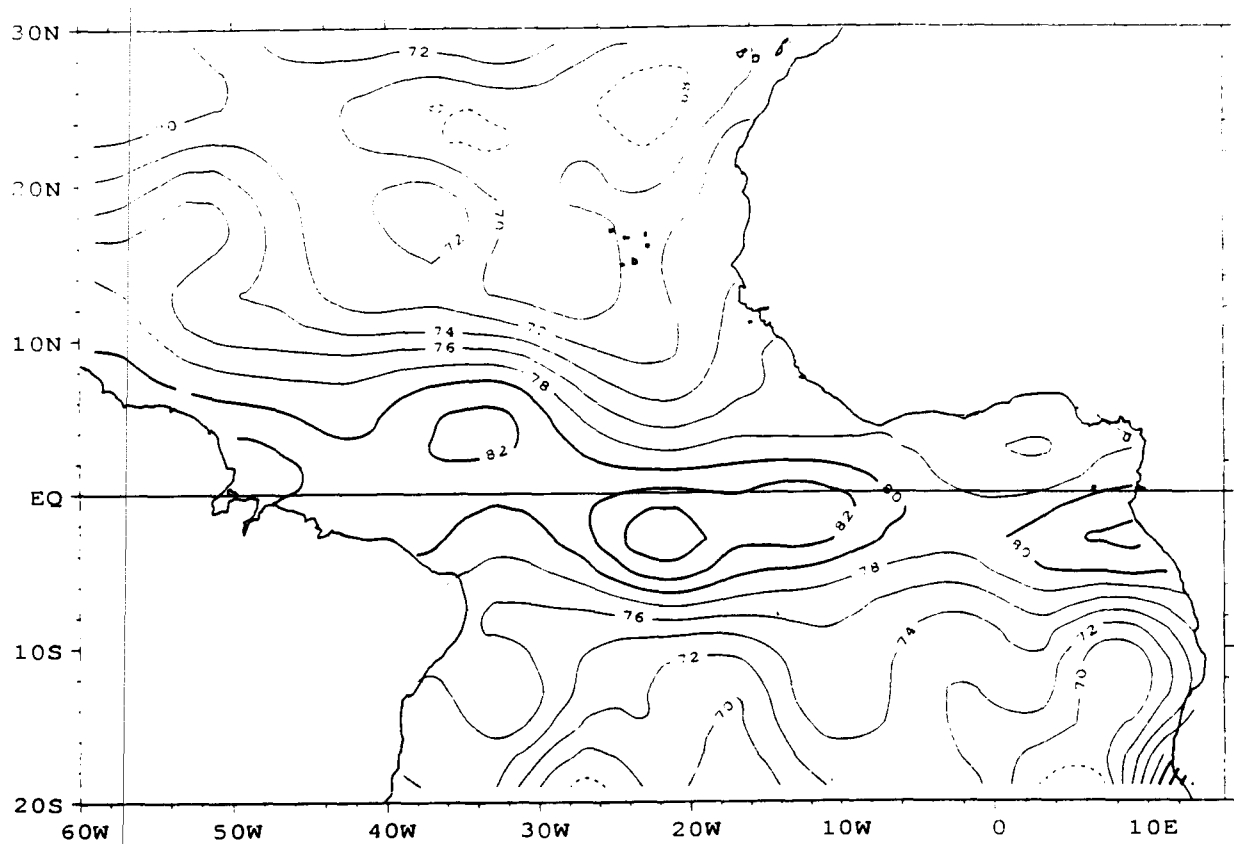
REL. HUM. (%) *OBSERVATIONS*SEASONAL MEAN (JAS)



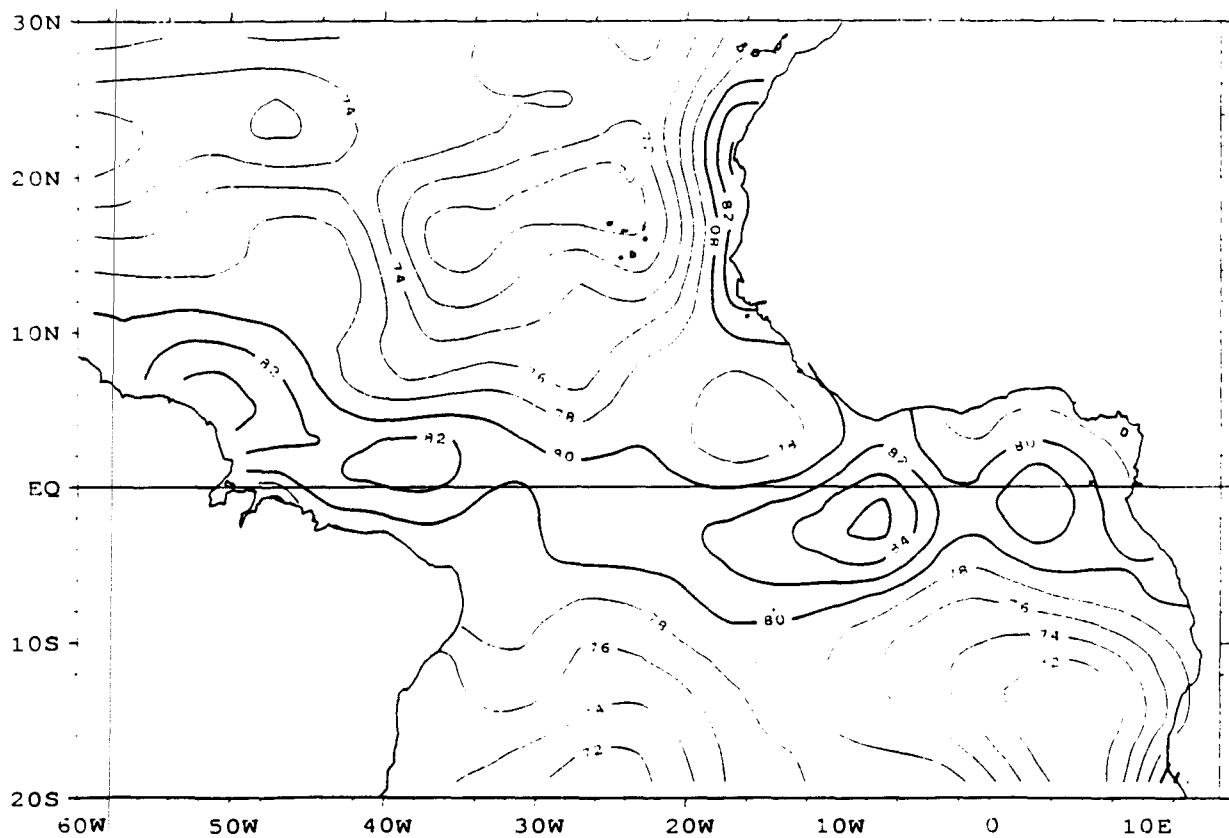
REL. HUM. (%) *OBSERVATIONS*SEASONAL MEAN (OND)



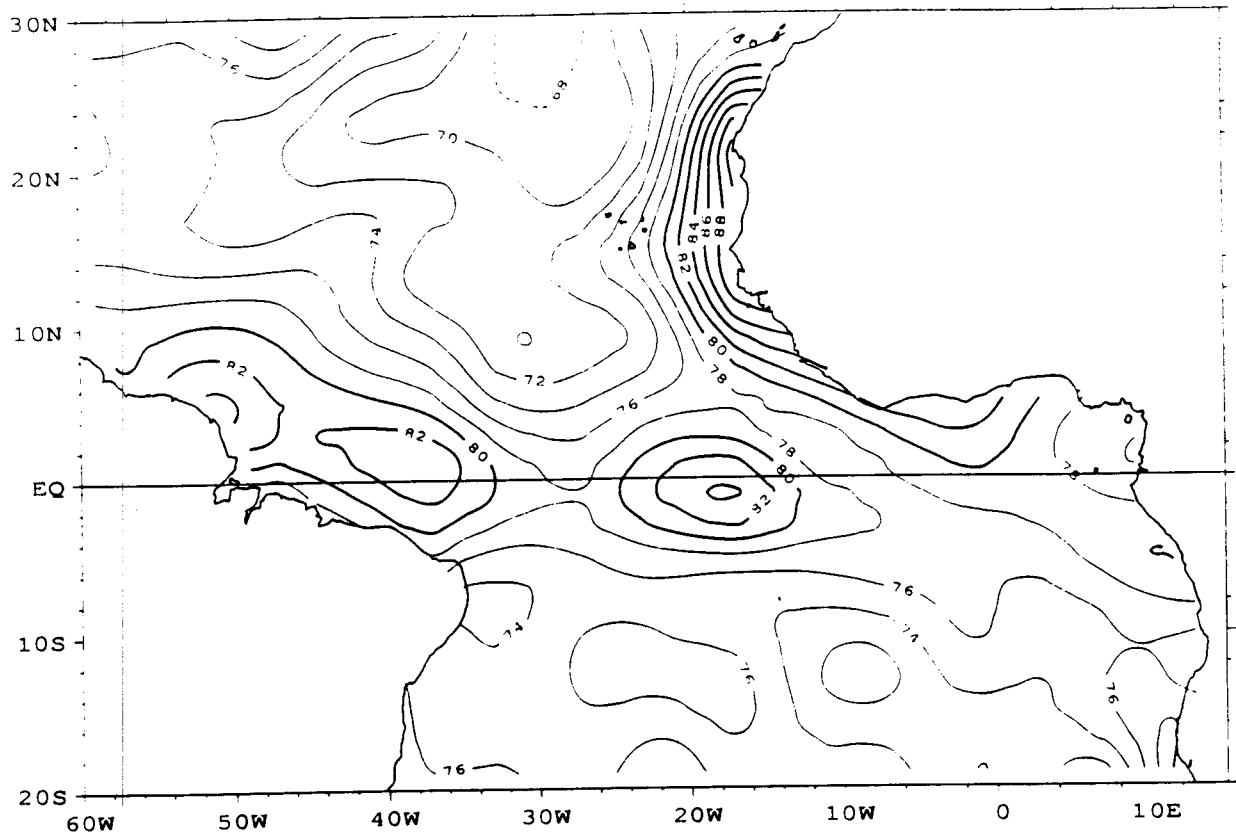
HUM. RELATIVE (%) - OBS. 2x2 - JANVIER 1989



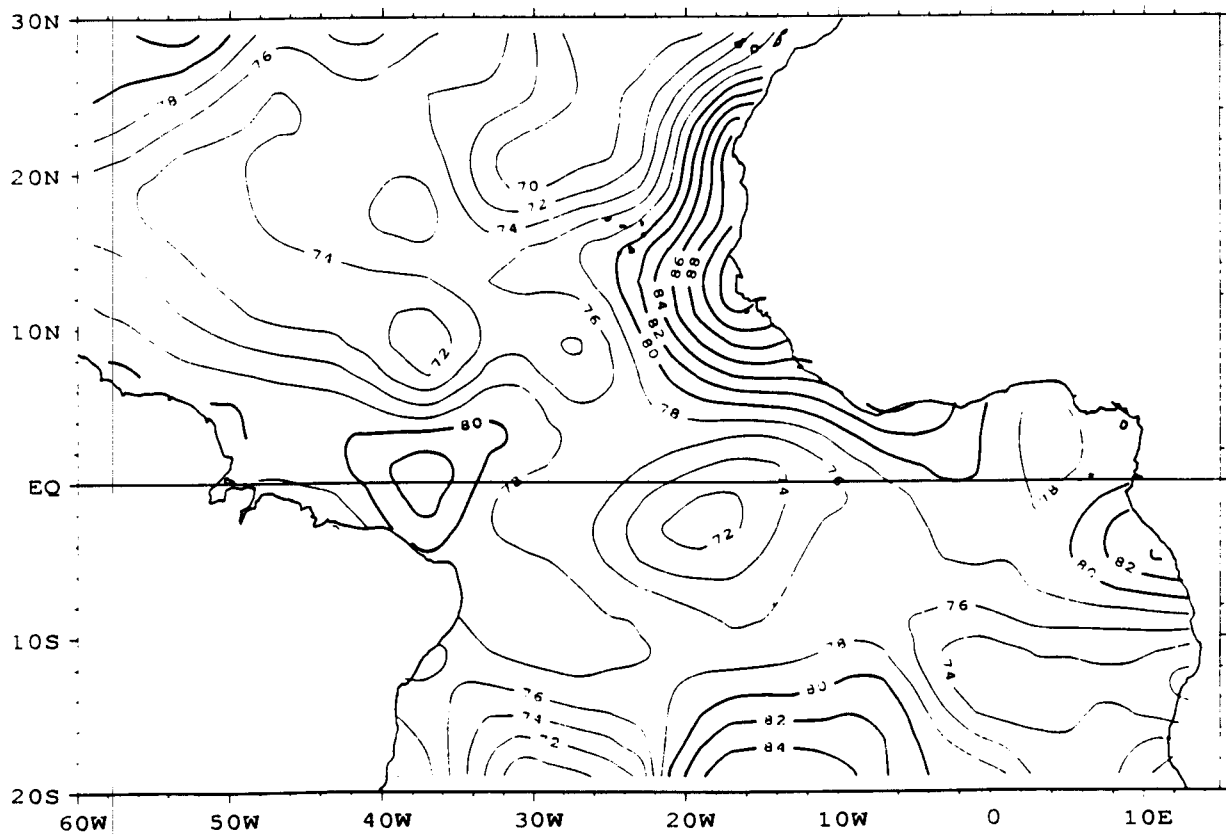
HUM. RELATIVE - OBS. 2x2 - FEVRIER 1989



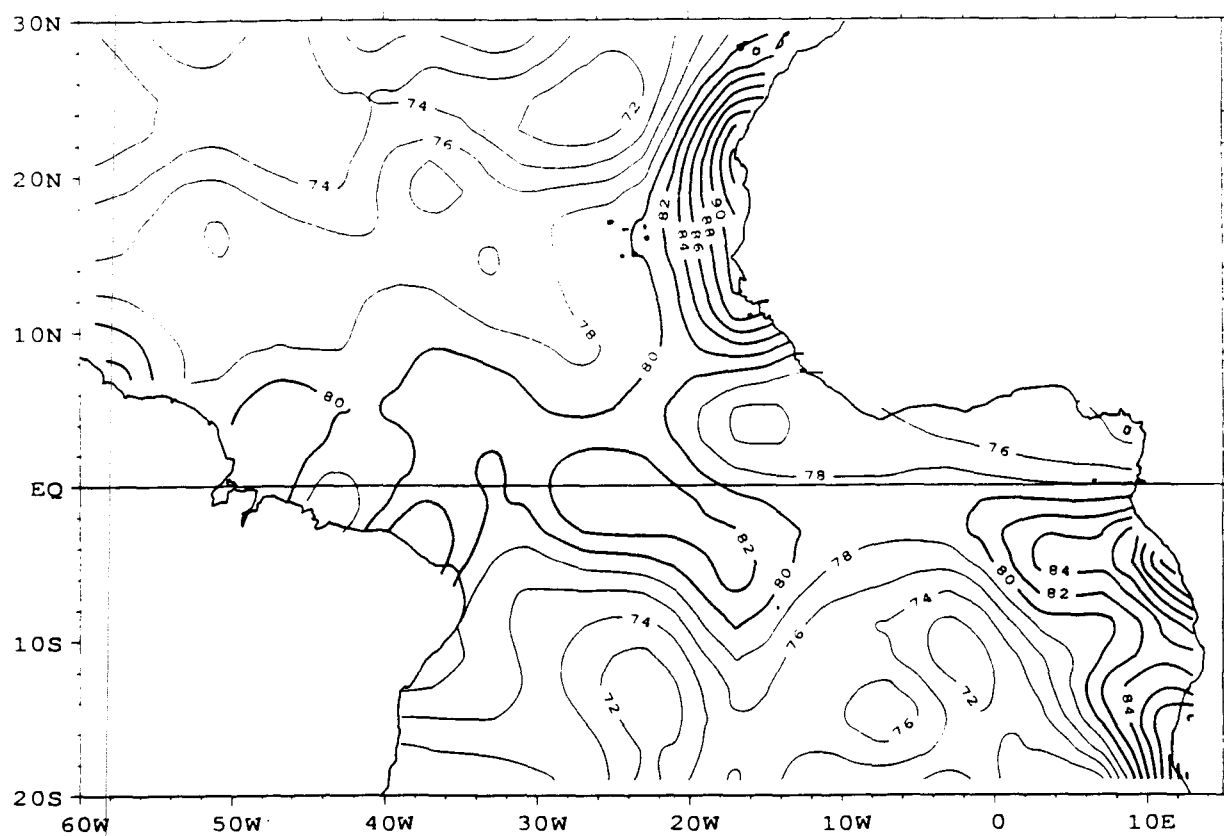
HUM. RELATIVE (%) - OBS. 2x2 - MARS 1989



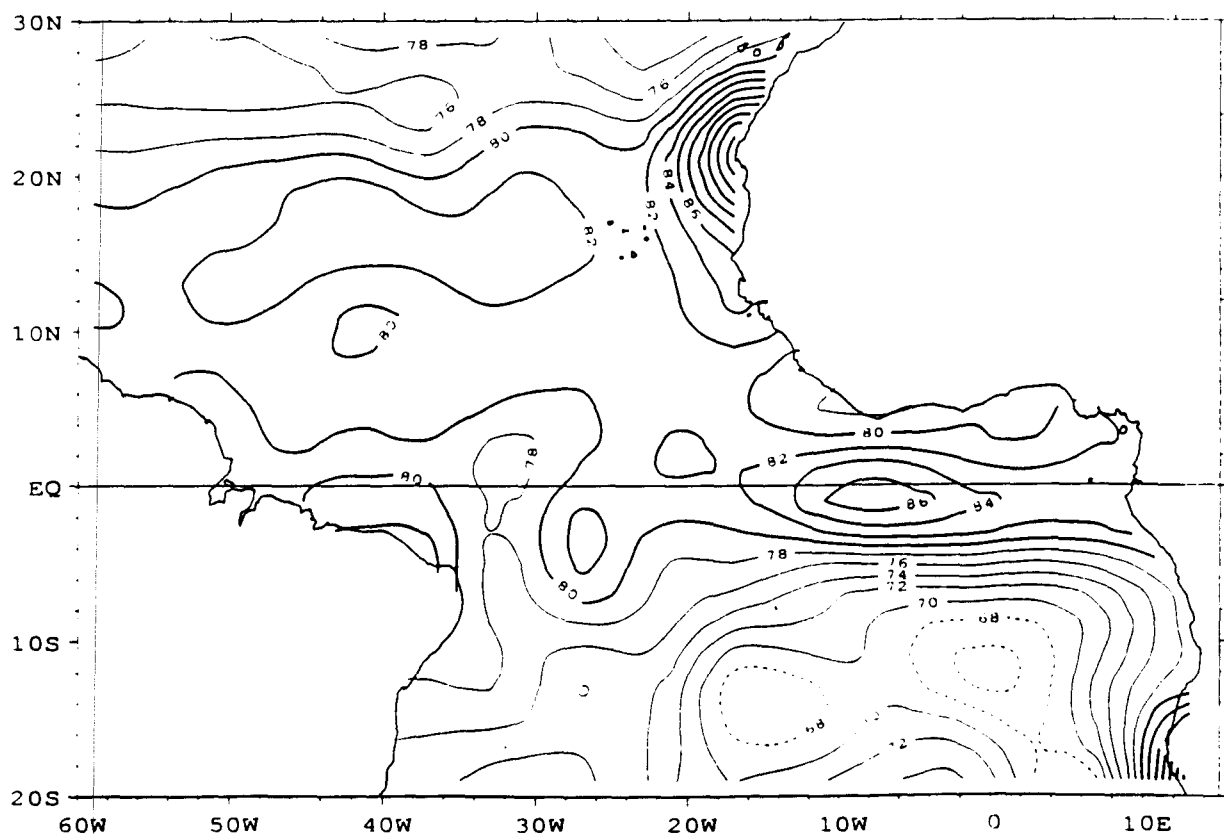
HUM. RELATIVE (%) - OBS. 2x2 - AVRIL 1989



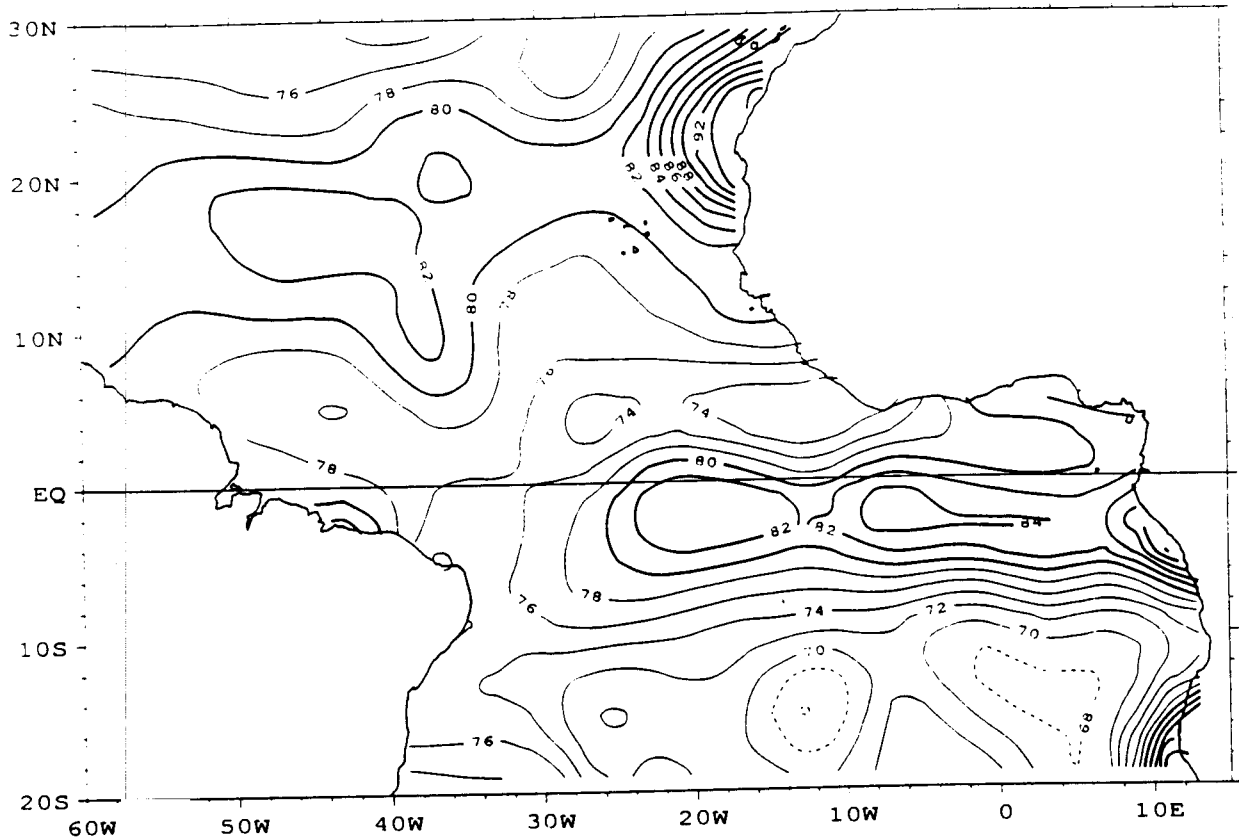
HUM. RELATIVE (%) - OBS. 2x2 - MAI 1989



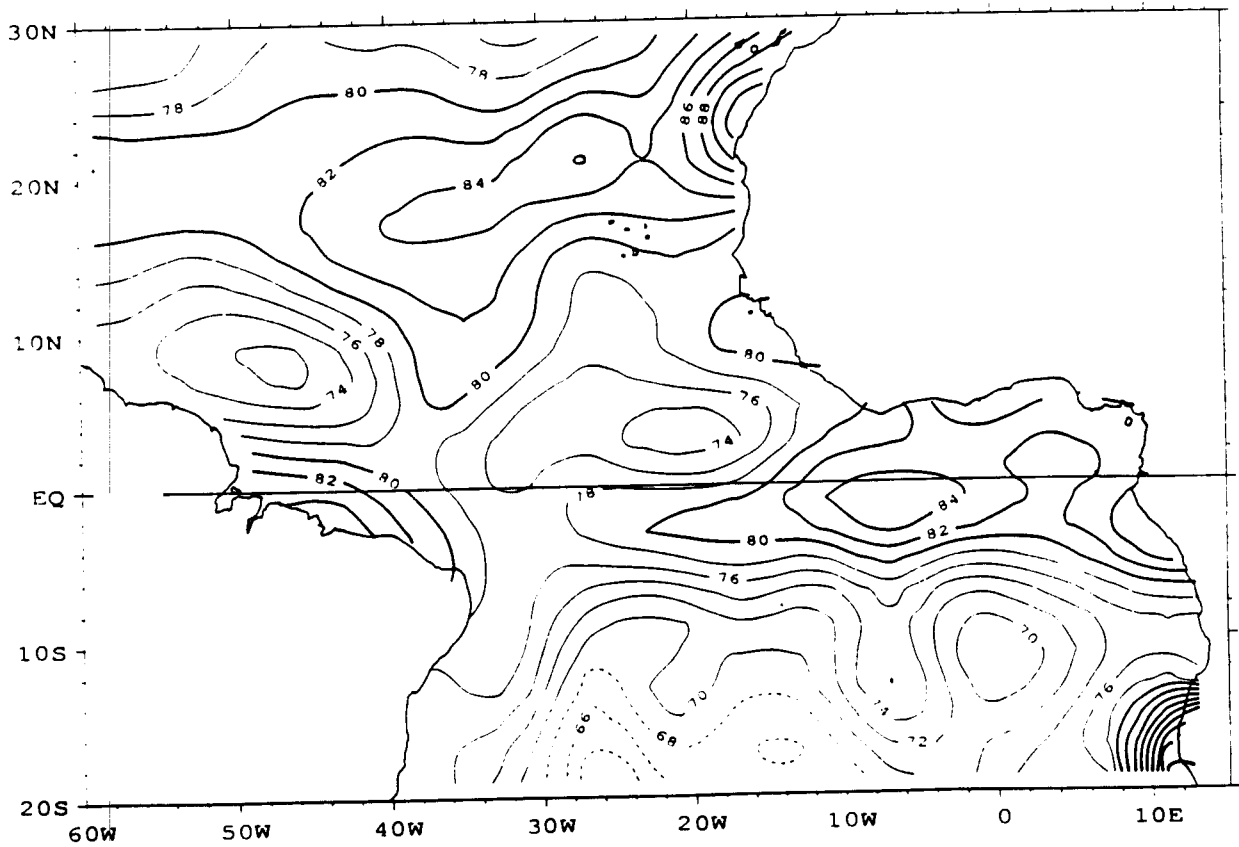
HUM. RELATIVE (%) - OBS. 2x2 - JUIN 1989



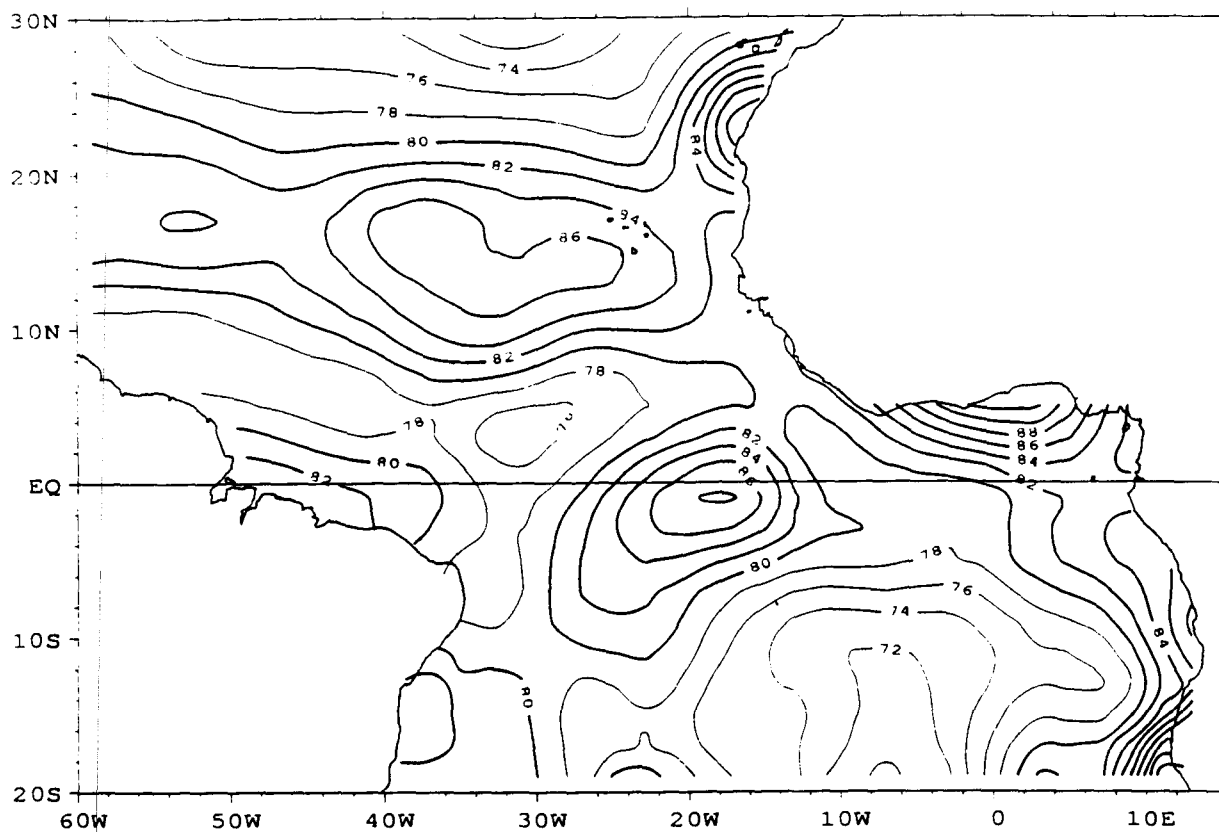
HUM. RELATIVE (%) - OBS. 2x2 - JUILLET 1989



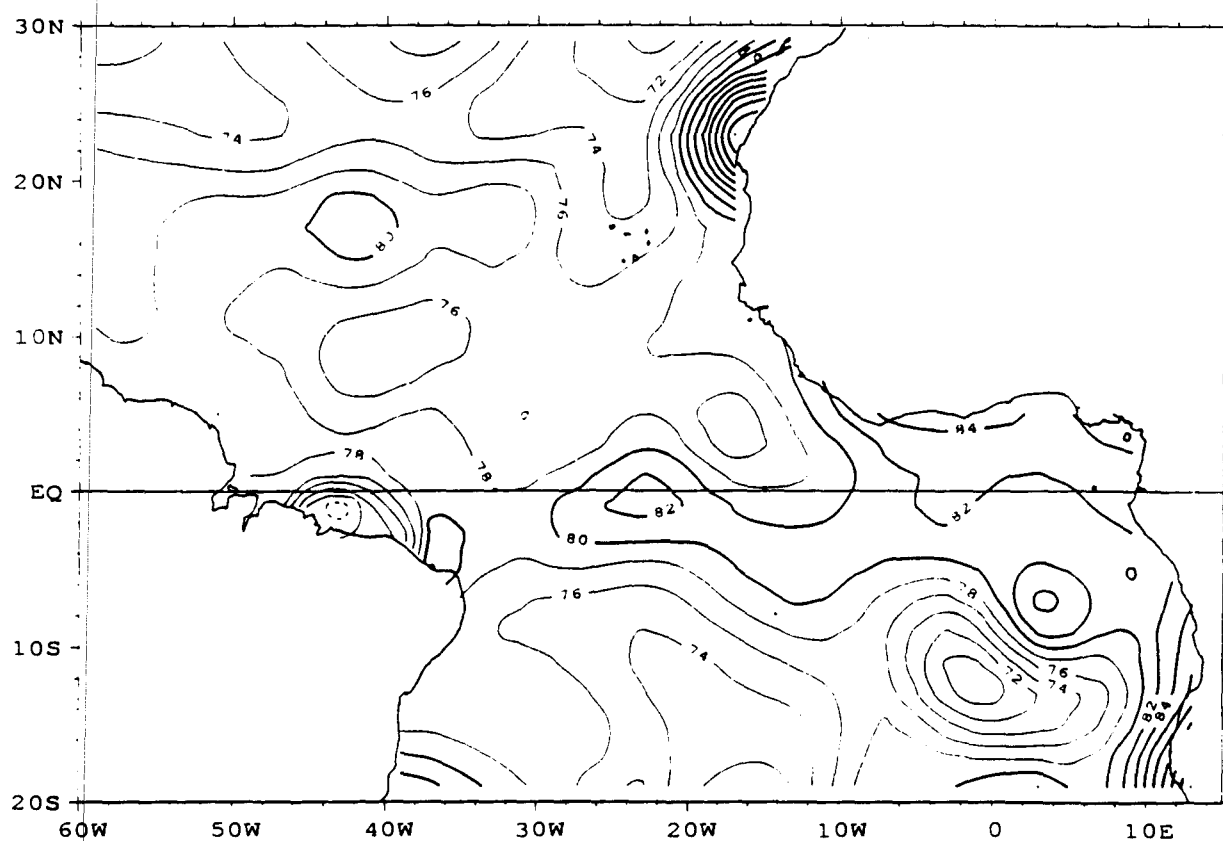
HUM. RELATIVE (%) - OBS. 2x2 - AOÛT 1989



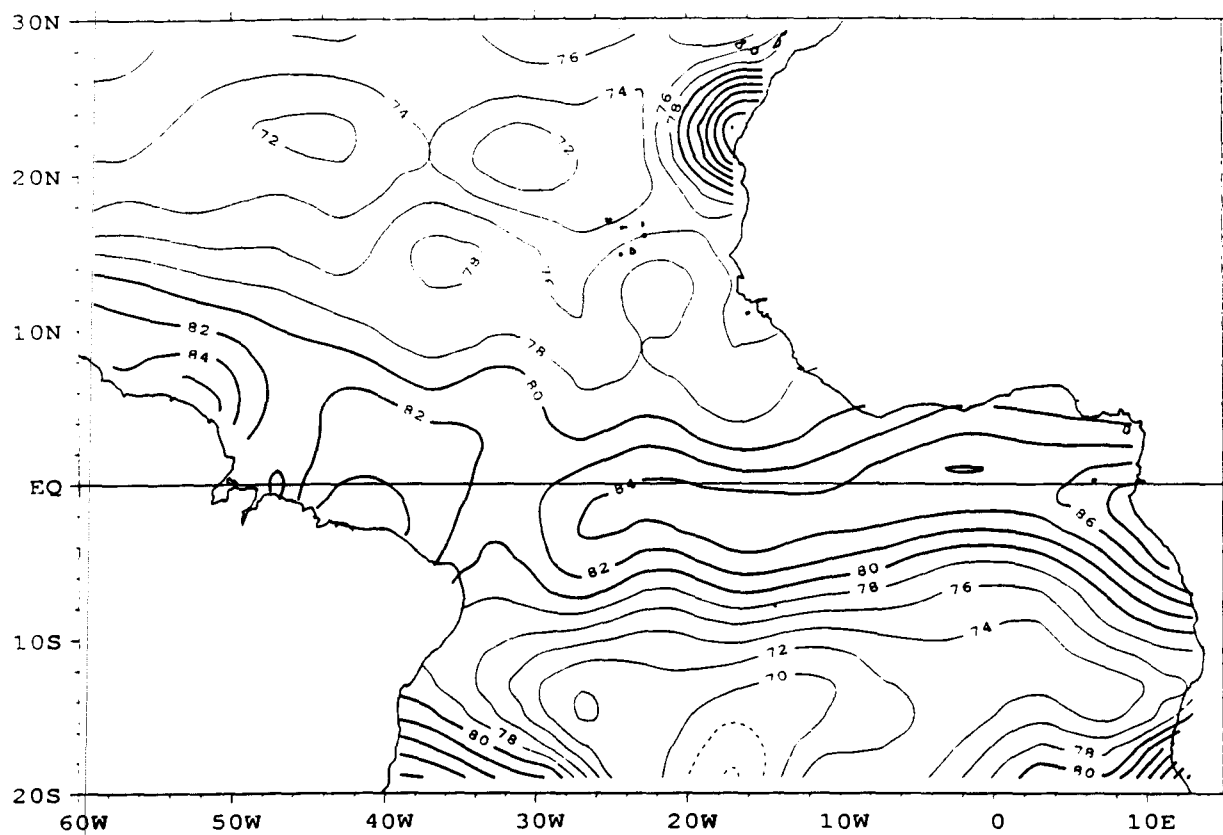
HUM. RELATIVE (%) - OBS. 2x2 - SEPTEMBRE 1989



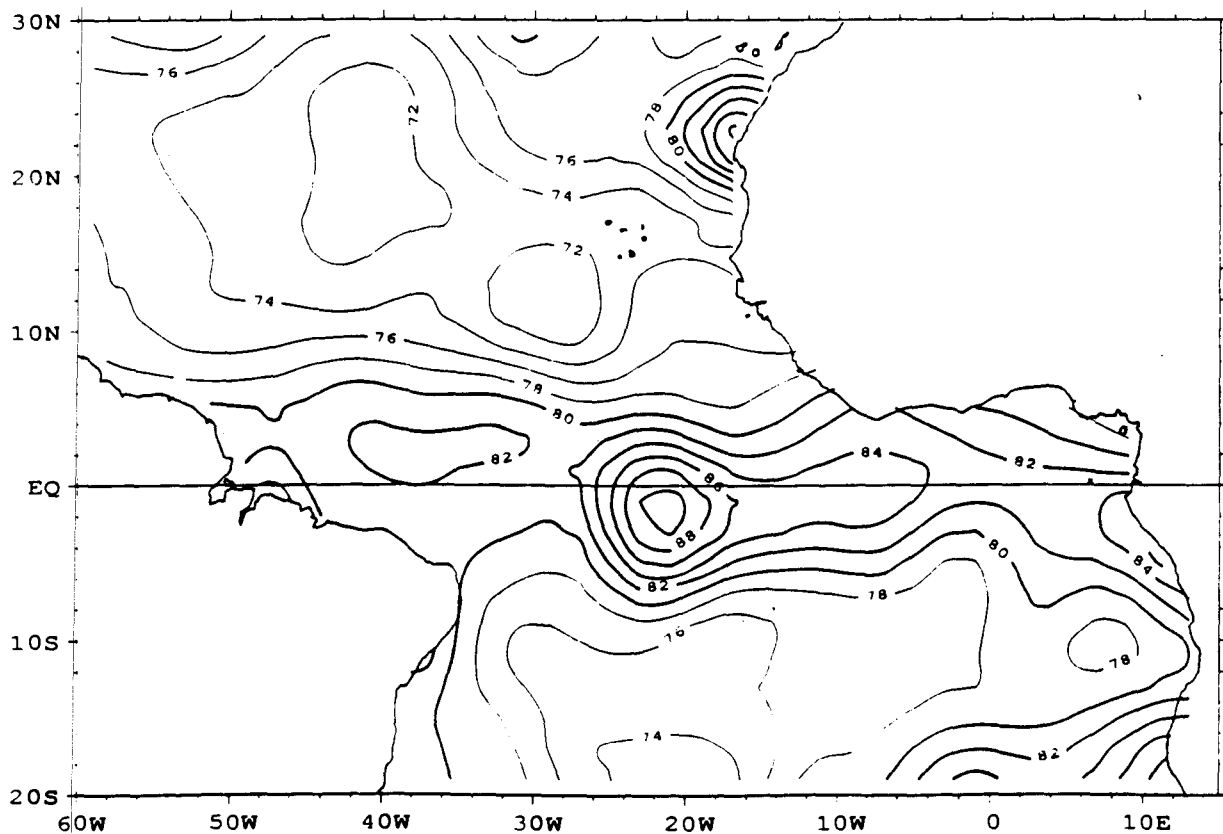
HUM. RELATIVE (%) - OBS. 2x2 - OCTOBRE 1989



HUM. RELATIVE (%) - OBS. 2x2 - NOVEMBRE 1989



HUM. RELATIVE (%) - OBS. 2x2 - DECEMBRE 1989



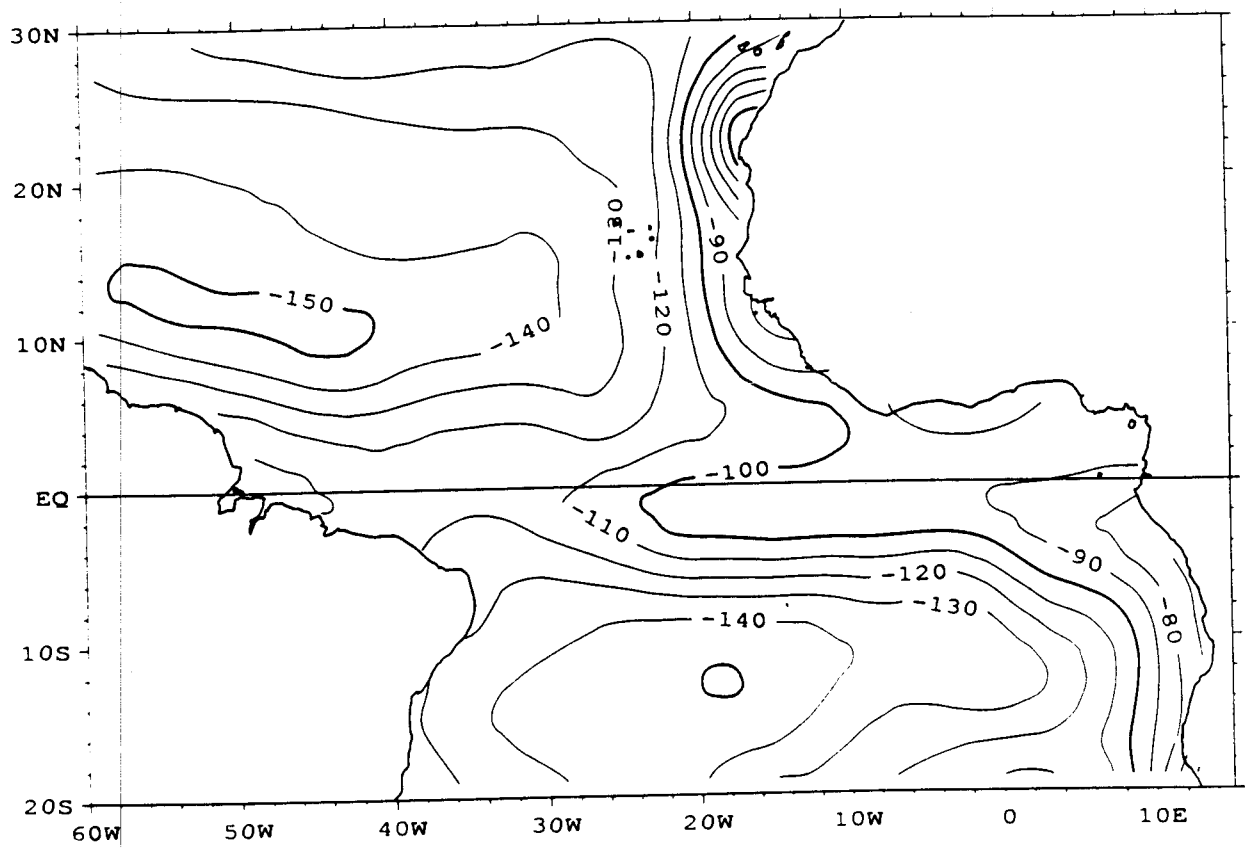
DEUXIEME PARTIE

FLUX DE CHALEUR CALCULES A PARTIR DES OBSERVATIONS PRIMAIRES

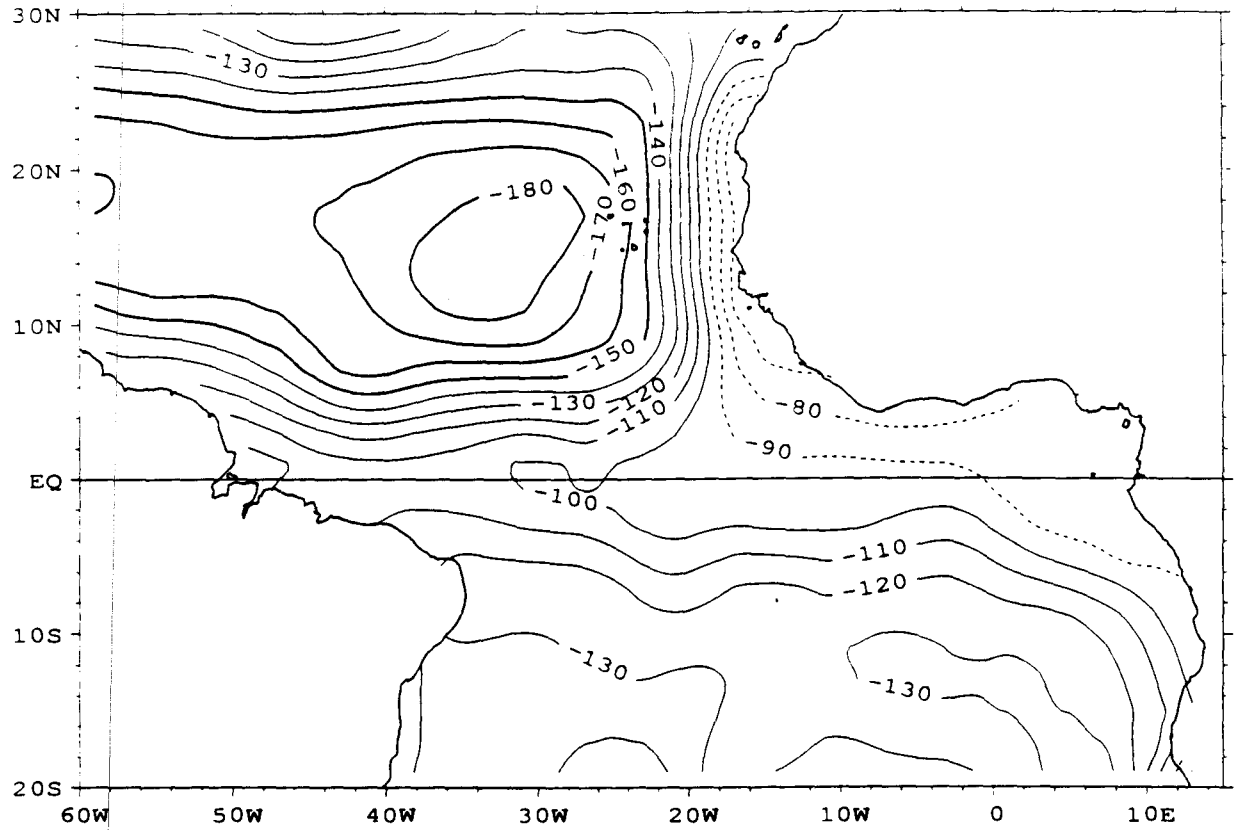
QL: page 57 à 65

QS: page 66 à 74

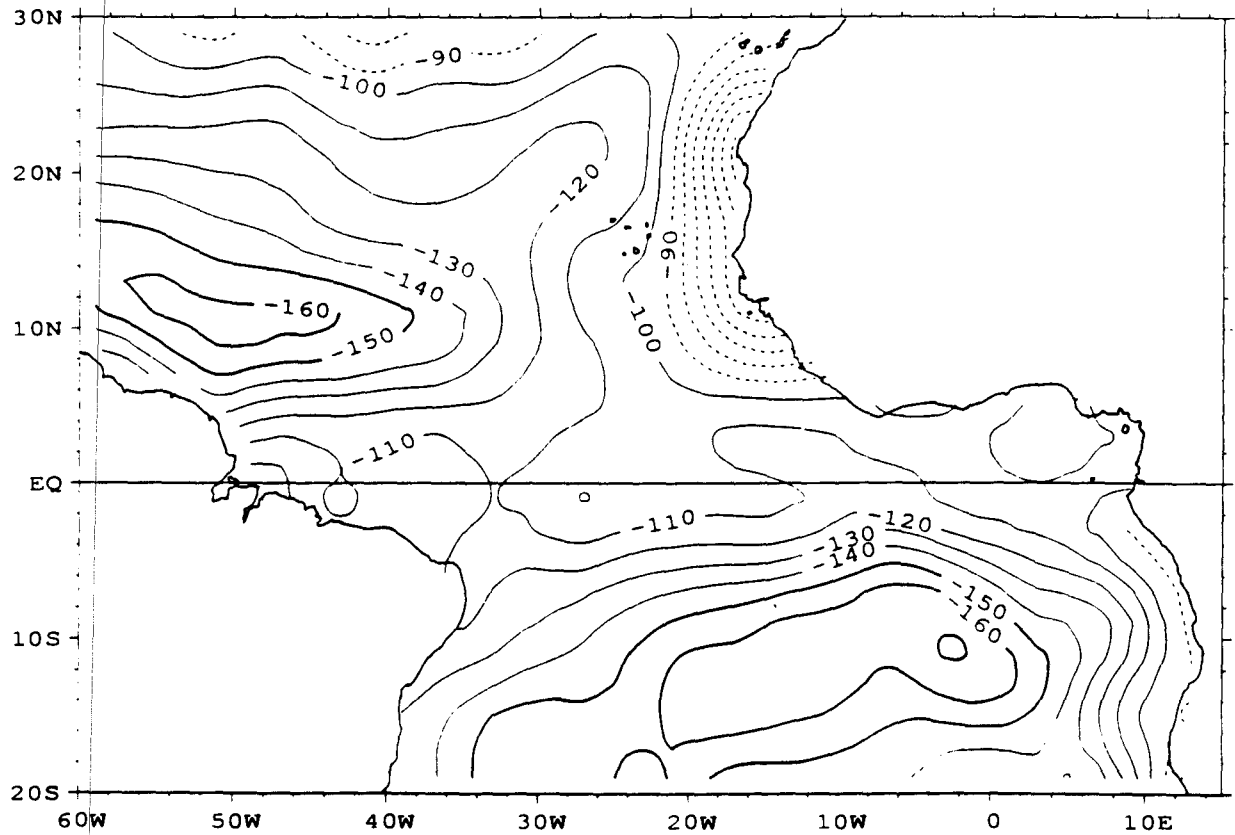
ANNUAL MEAN - QL - OBSERVATIONS 1989



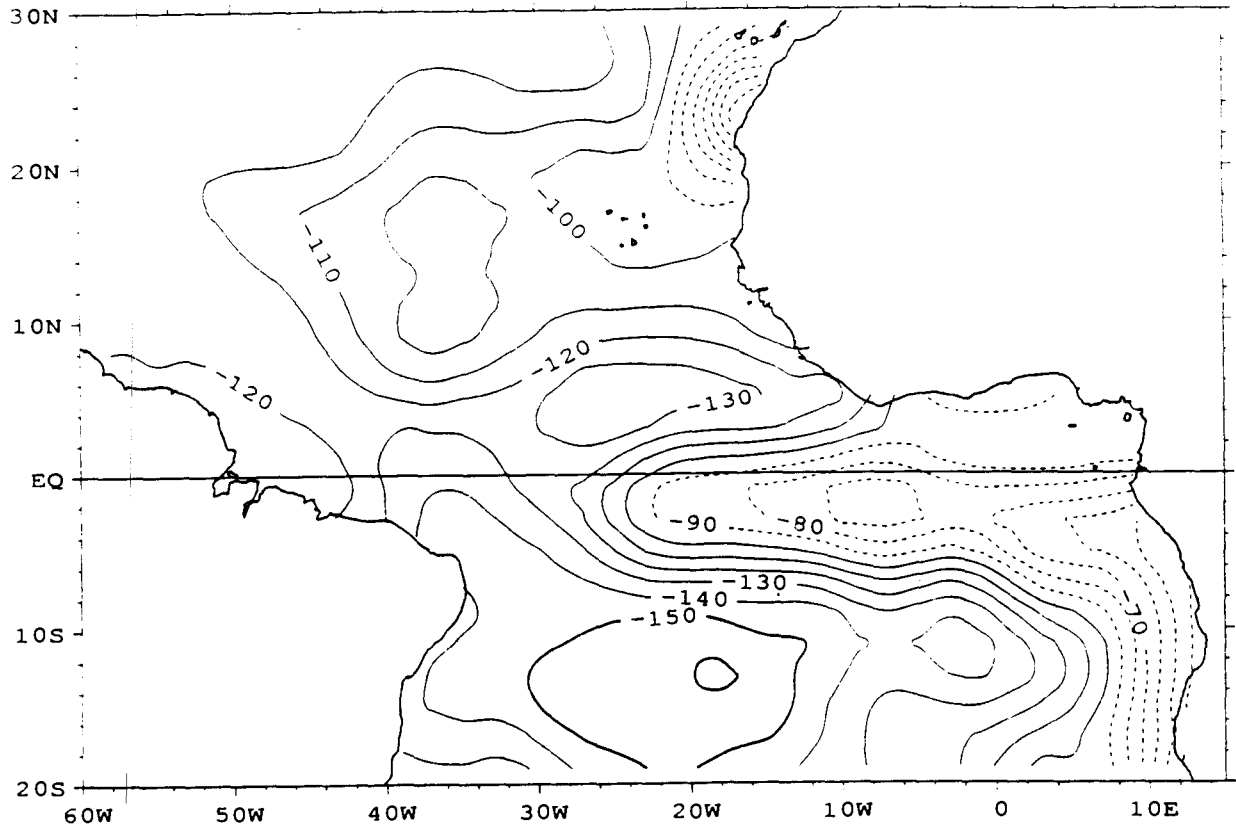
LATENT *OBSERVATIONS* SEASONAL MEAN (J F M)



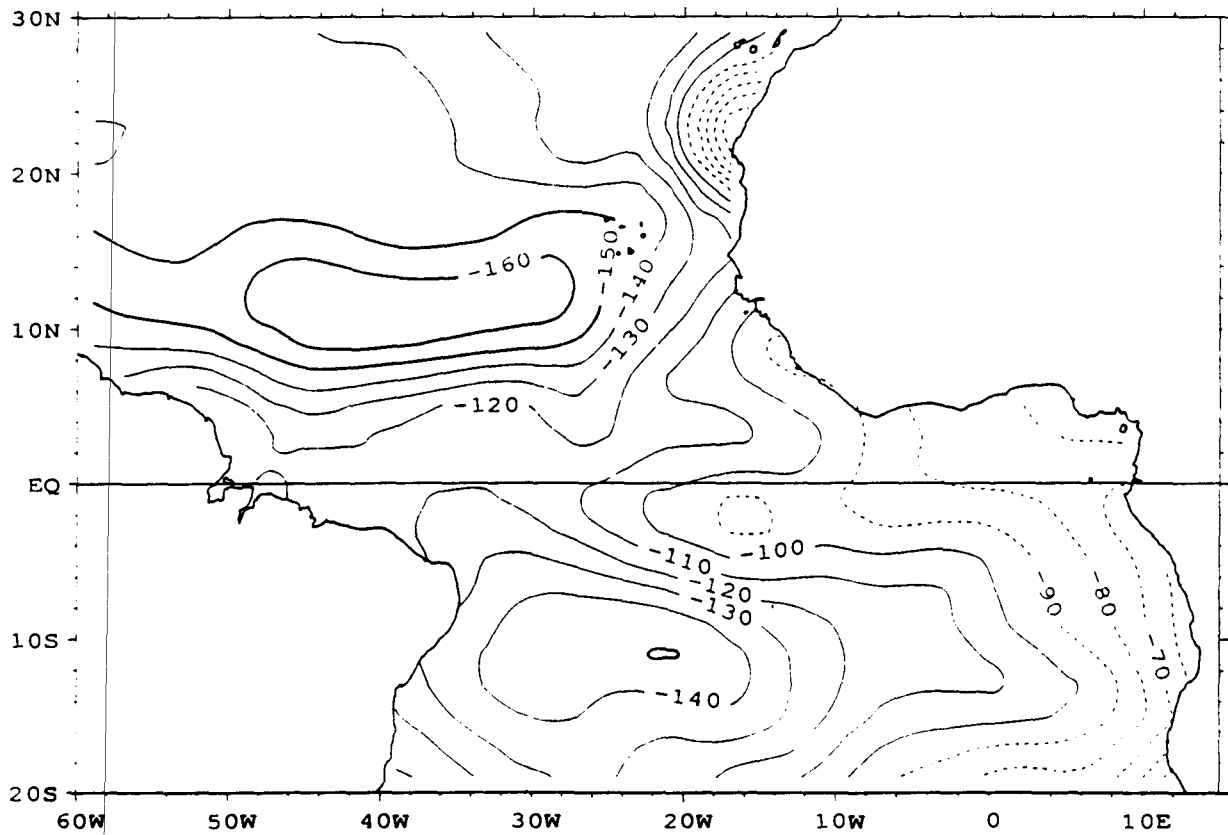
LATENT *OBSERVATIONS* SEASONAL MEAN (A M J)



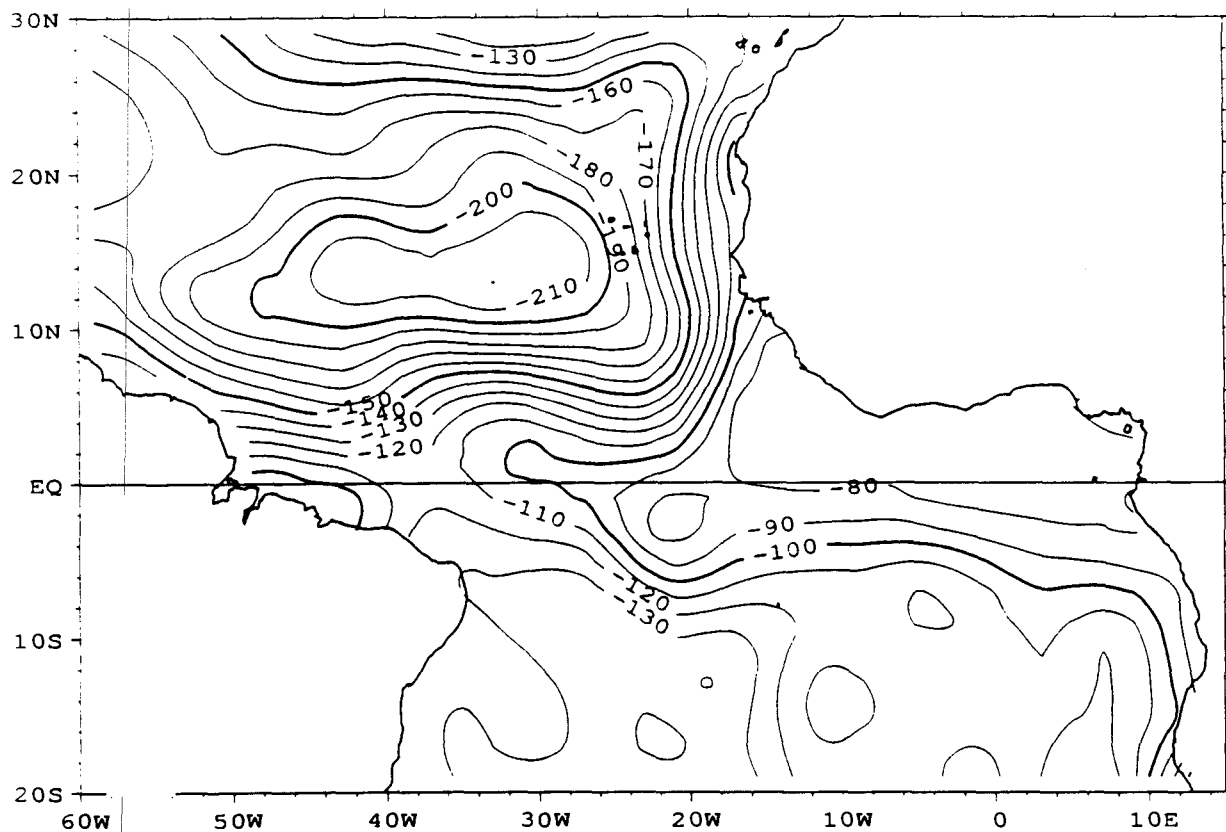
LATENT *OBSERVATIONS* SEASONAL MEAN (J A S)



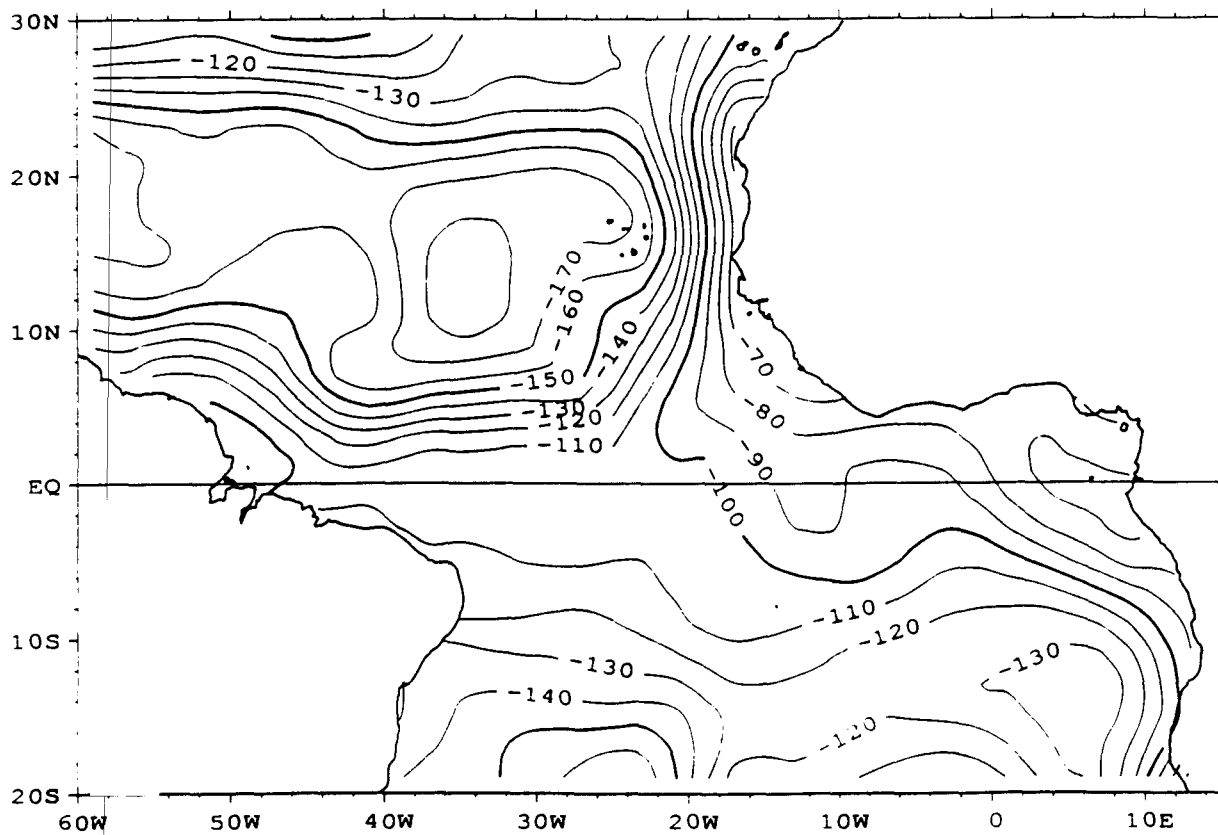
LATENT *OBSERVATIONS* SEASONAL MEAN (O N D)



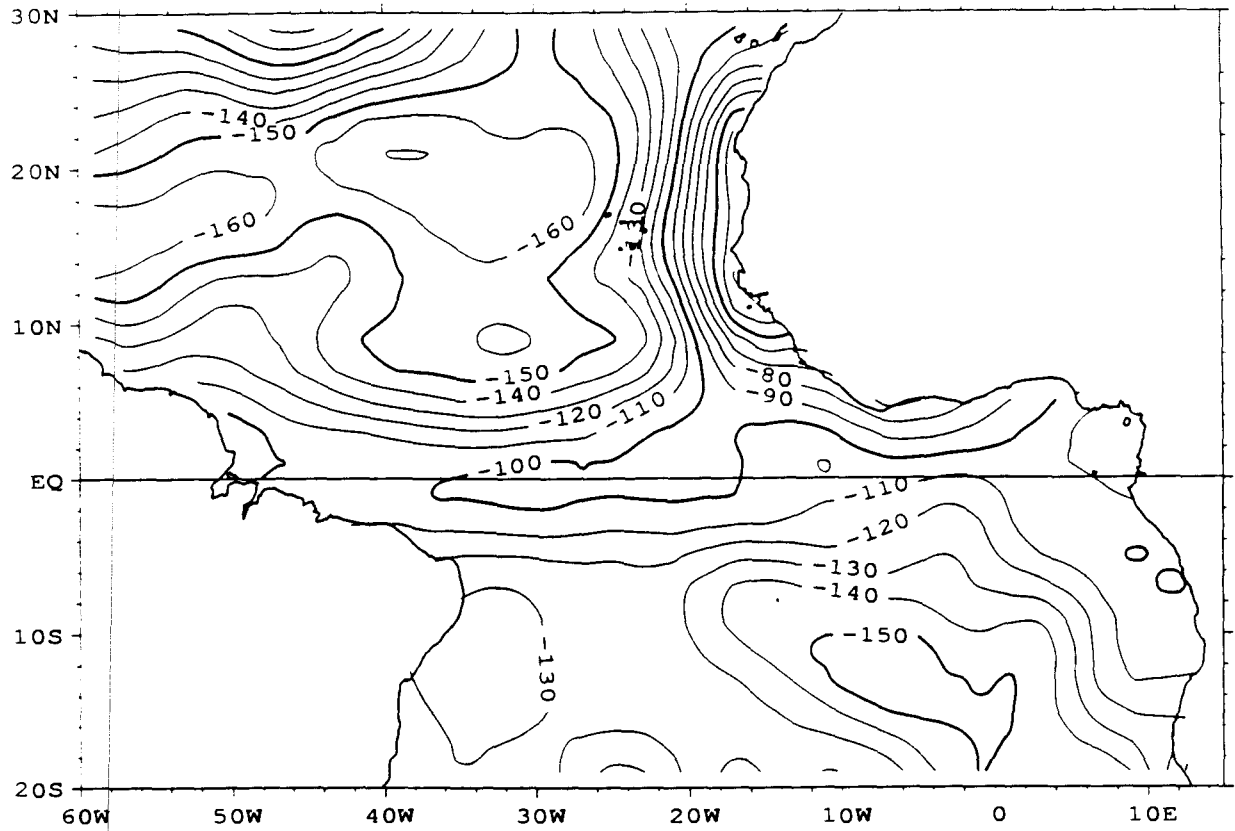
QL OBSERVATIONS - GRID 2X2 - JANVIER



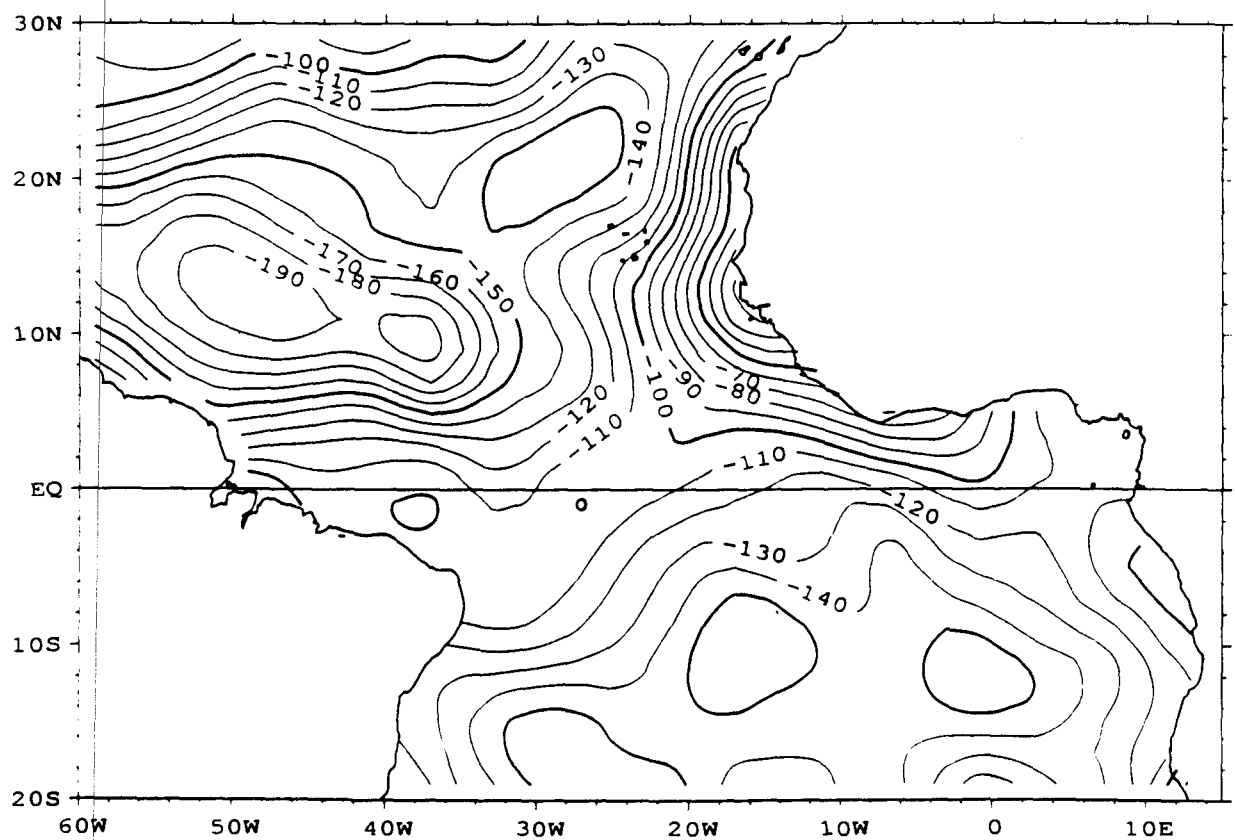
QL OBSERVATIONS - GRID 2X2 - FEVRIER



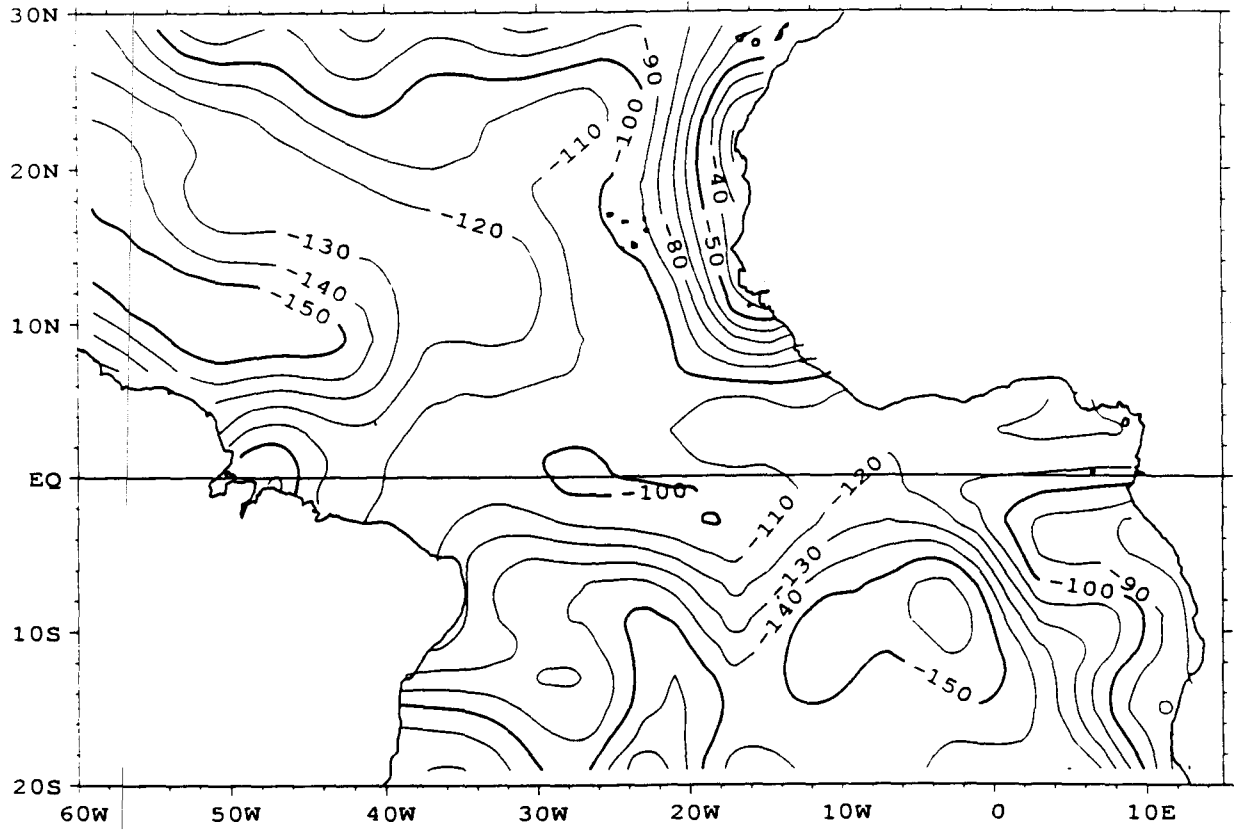
QL OBSERVATIONS - GRID 2X2 - MARS



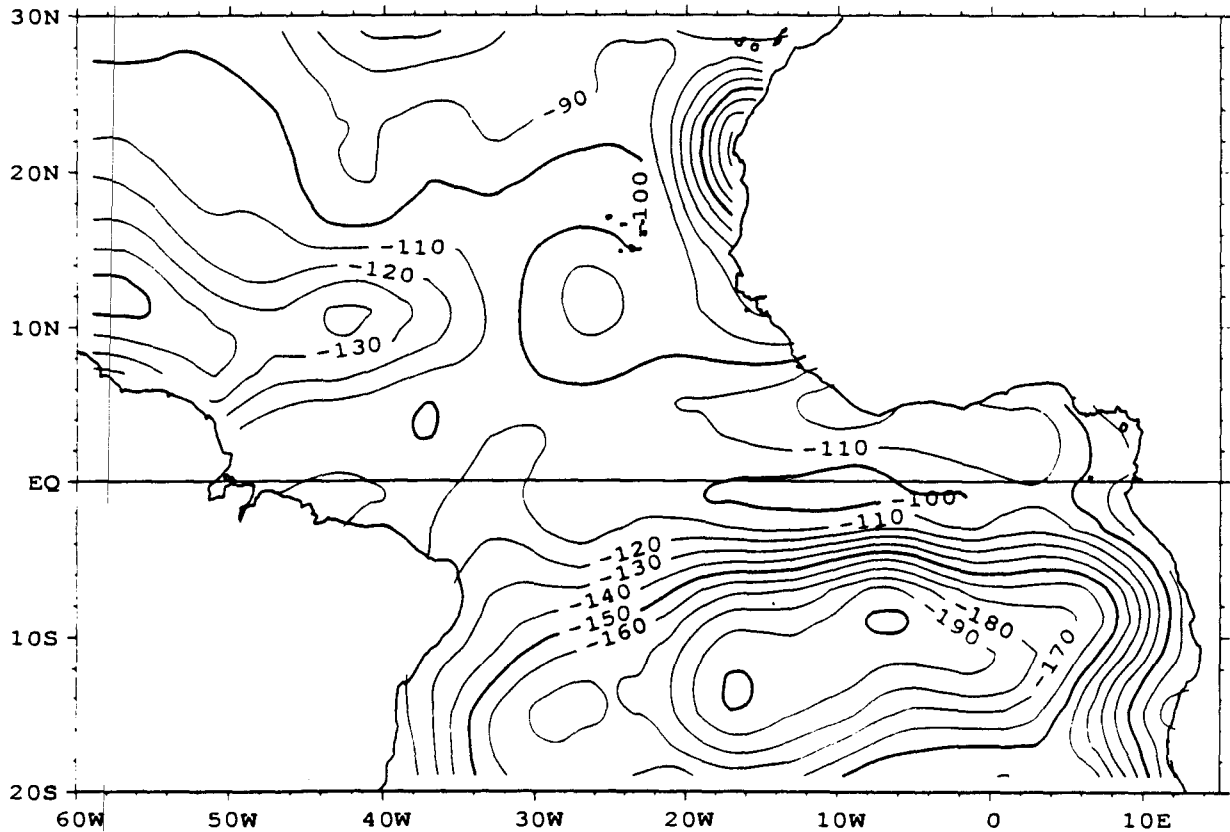
QL OBSERVATIONS - GRID 2X2 - AVRIL



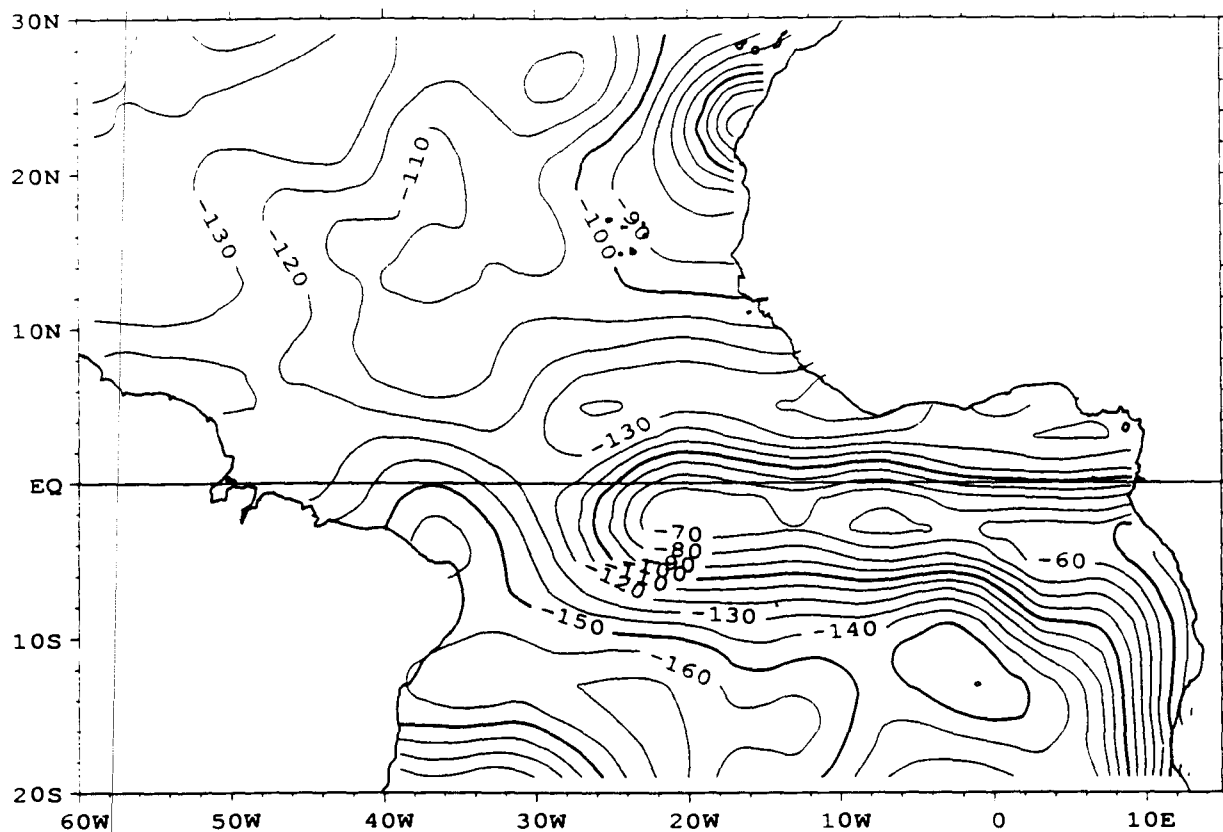
QL OBSERVATIONS - GRID 2X2 - MAI



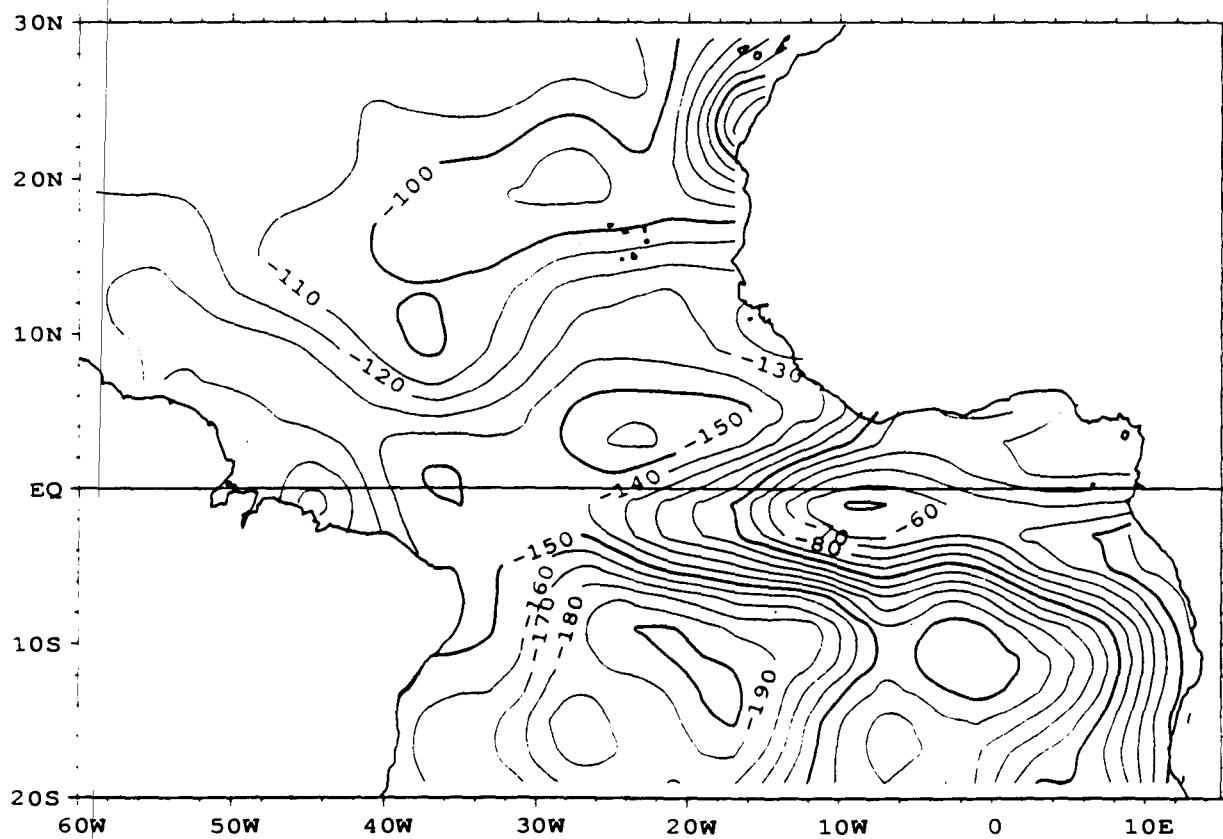
QL OBSERVATIONS - GRID 2X2 - JUIN



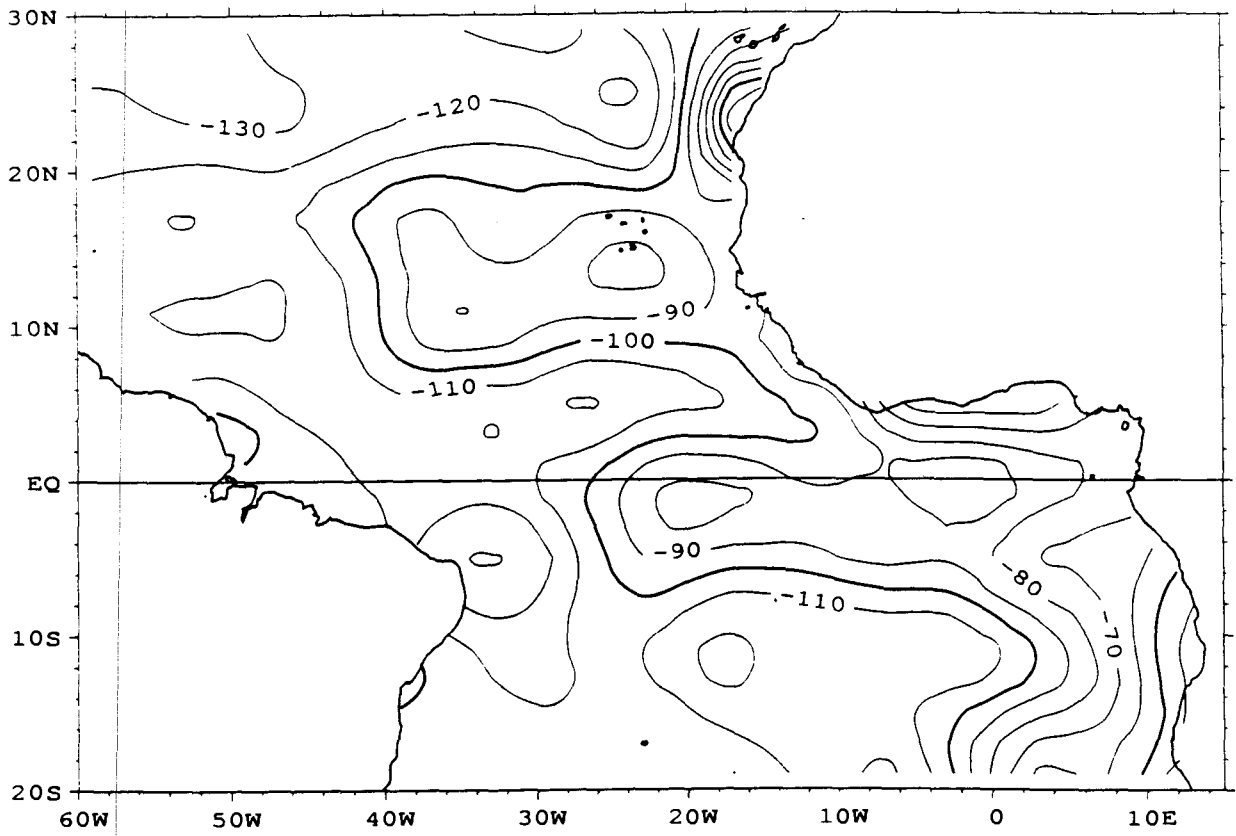
QL OBSERVATIONS - GRID 2X2 - JUILLET



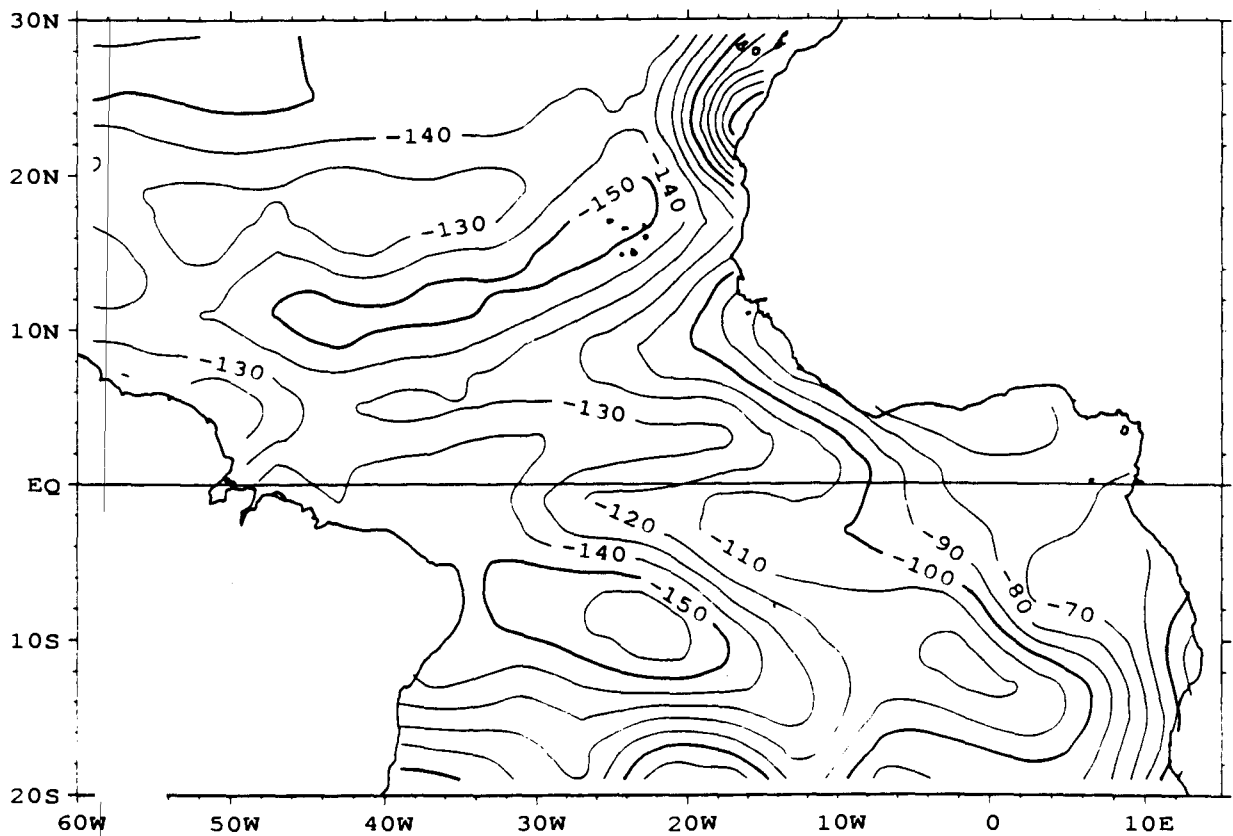
QL OBSERVATIONS - GRID 2X2 - AOUT



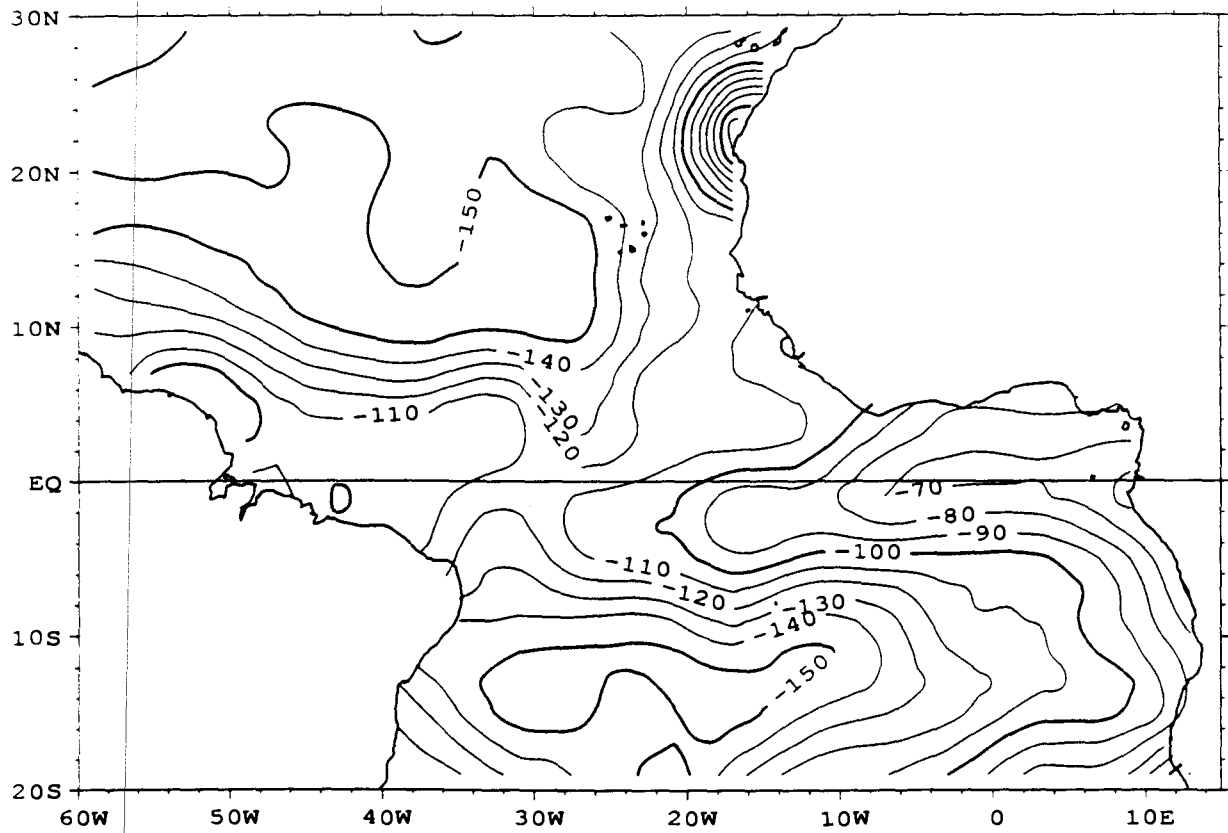
QL OBSERVATIONS - GRID 2X2 - SEPTEMBRE



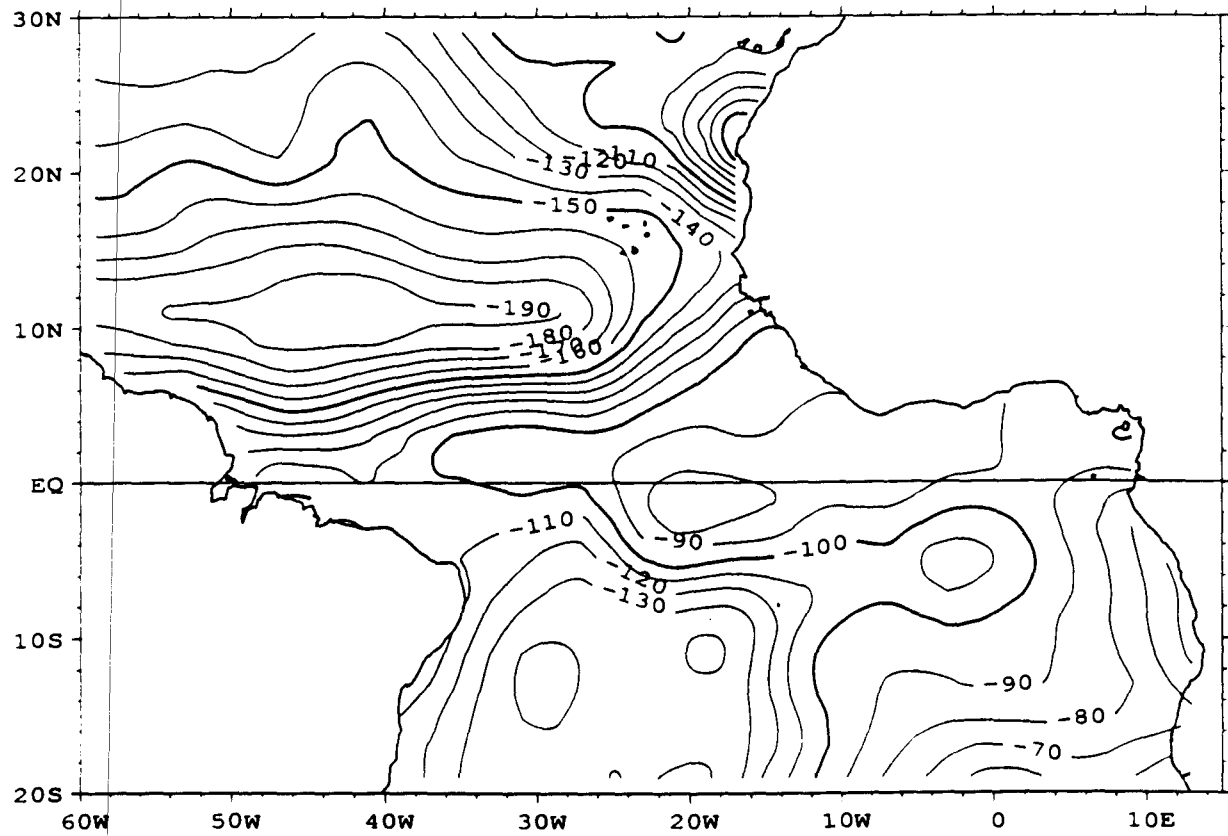
QL OBSERVATIONS - GRID 2X2 - OCTOBRE



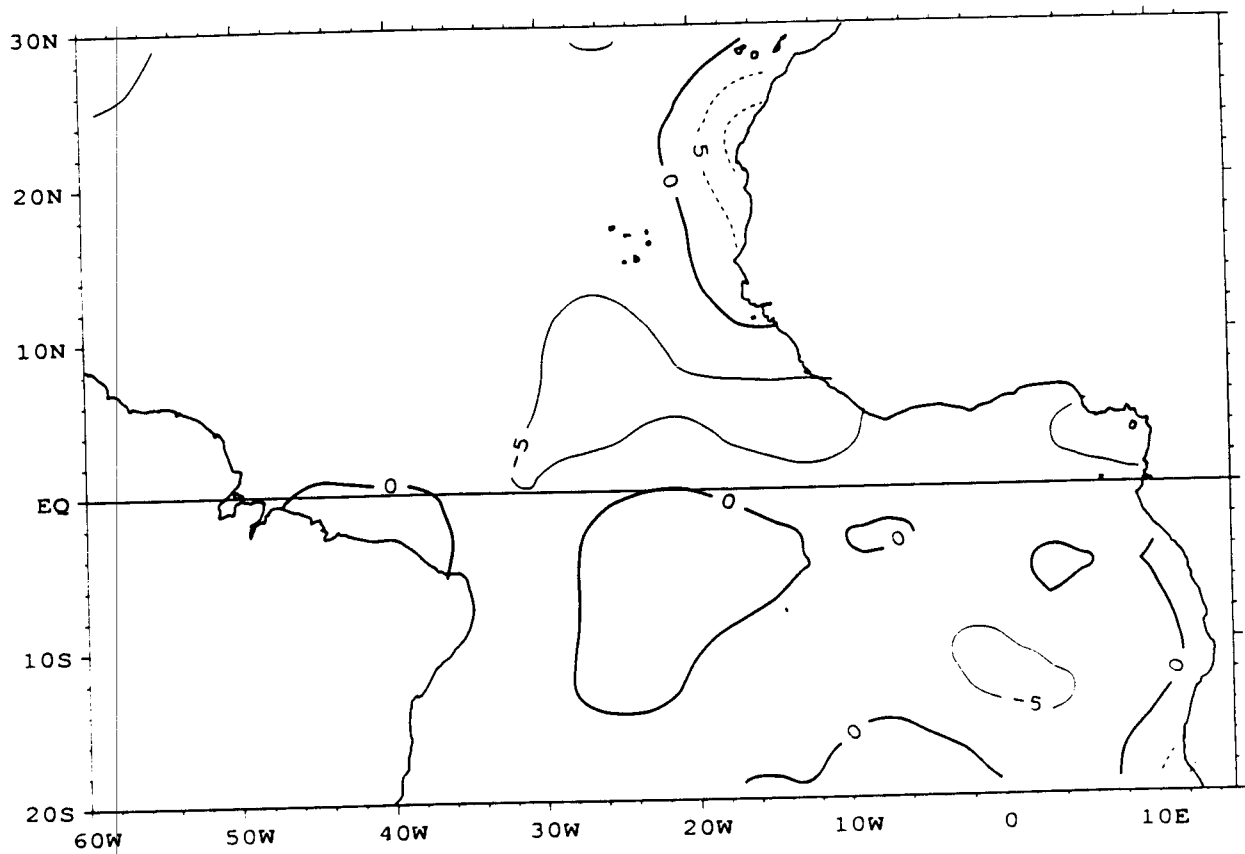
QL OBSERVATIONS - GRID 2X2 - NOVEMBRE



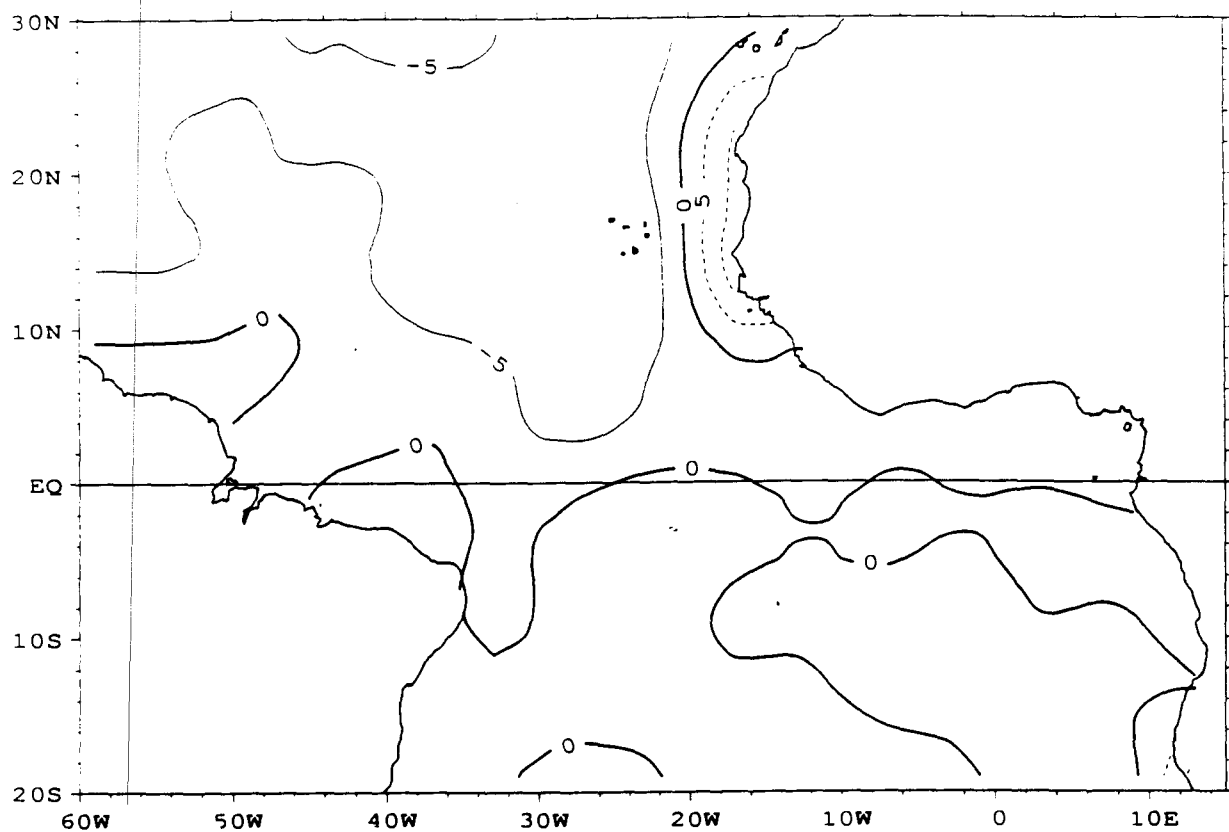
QL OBSERVATIONS - GRID 2X2 - DECEMBRE



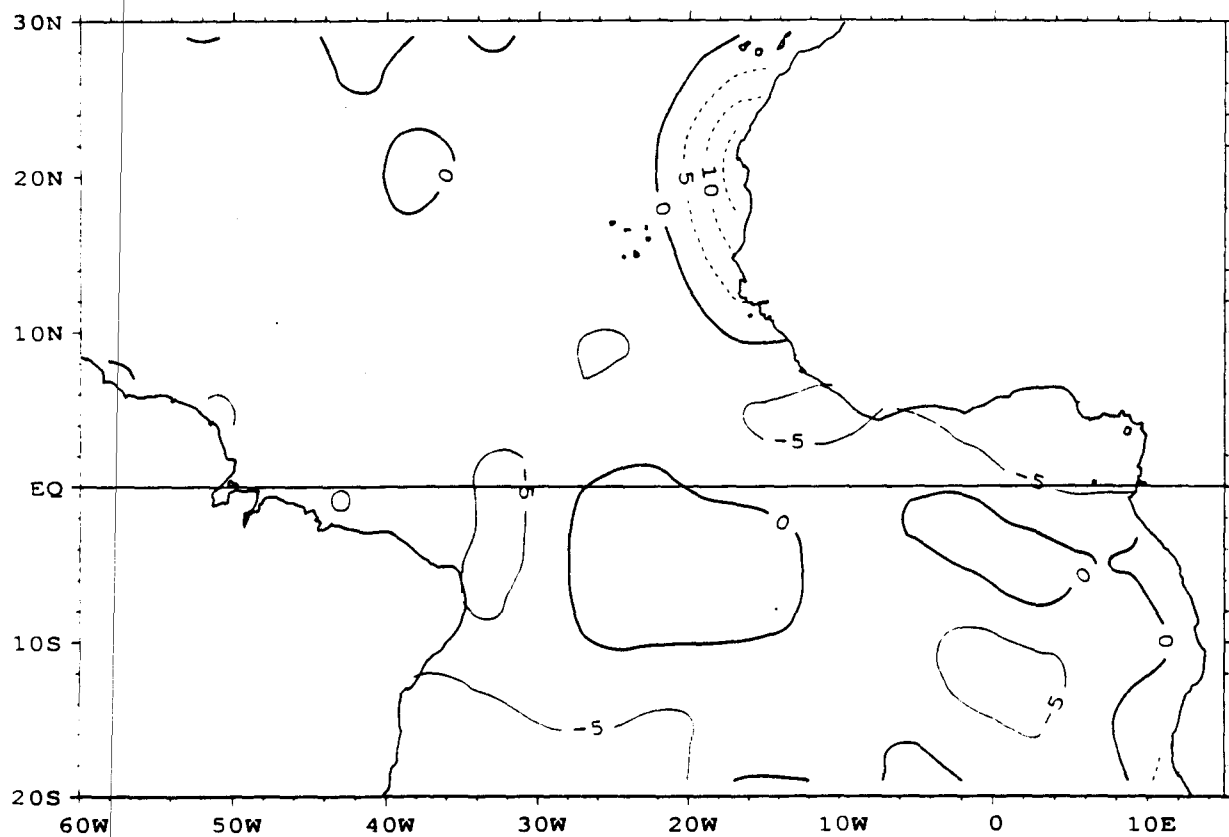
ANNUAL MEAN - QS - OBSERVATIONS 1989



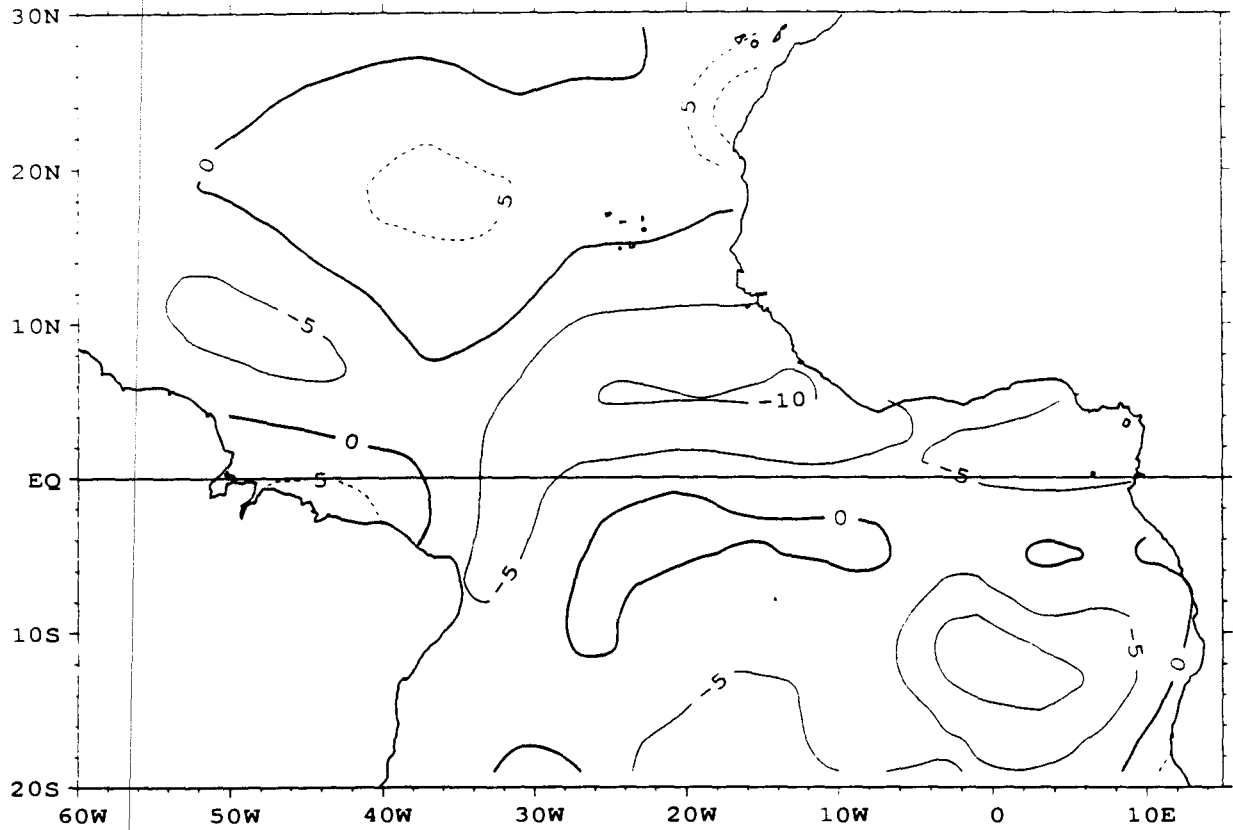
SENSIBLE *OBSERVATIONS* SEASONAL MEAN (J F M)



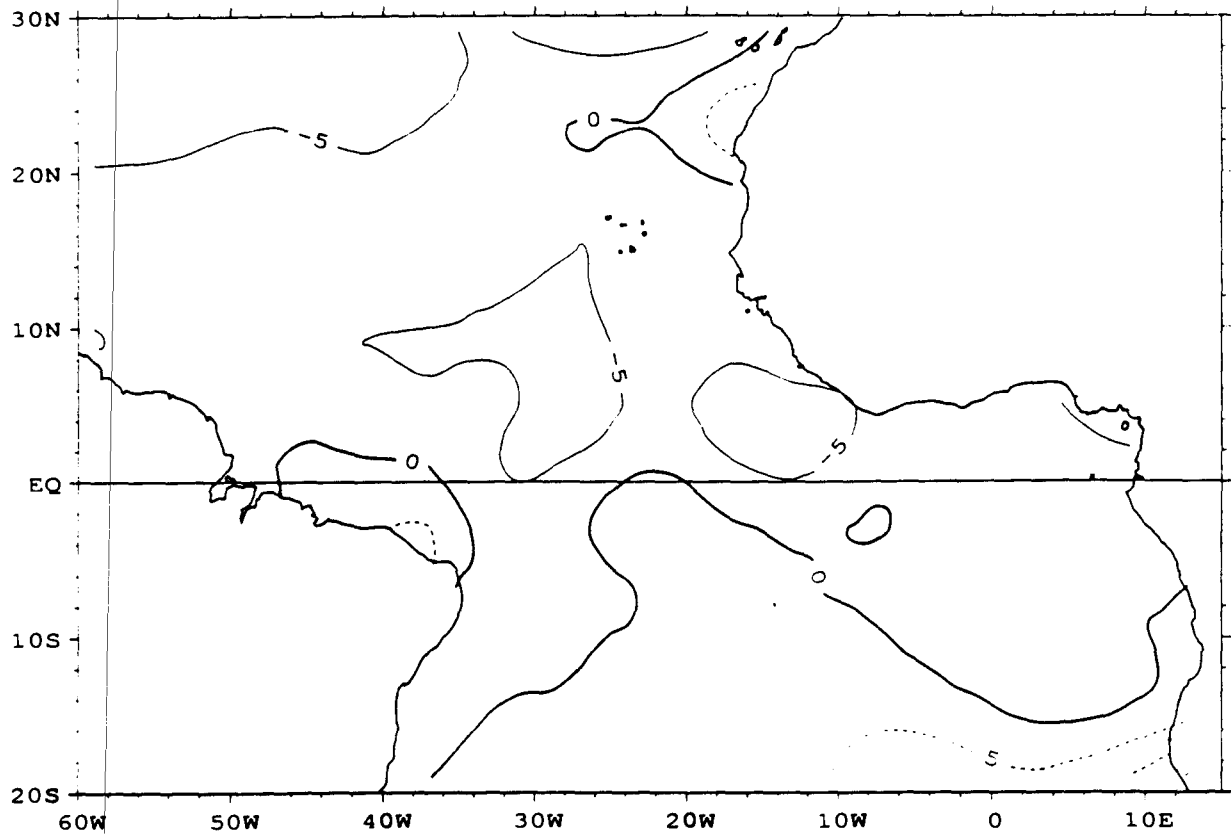
SENSIBLE *OBSERVATIONS* SEASONAL MEAN (A M J)



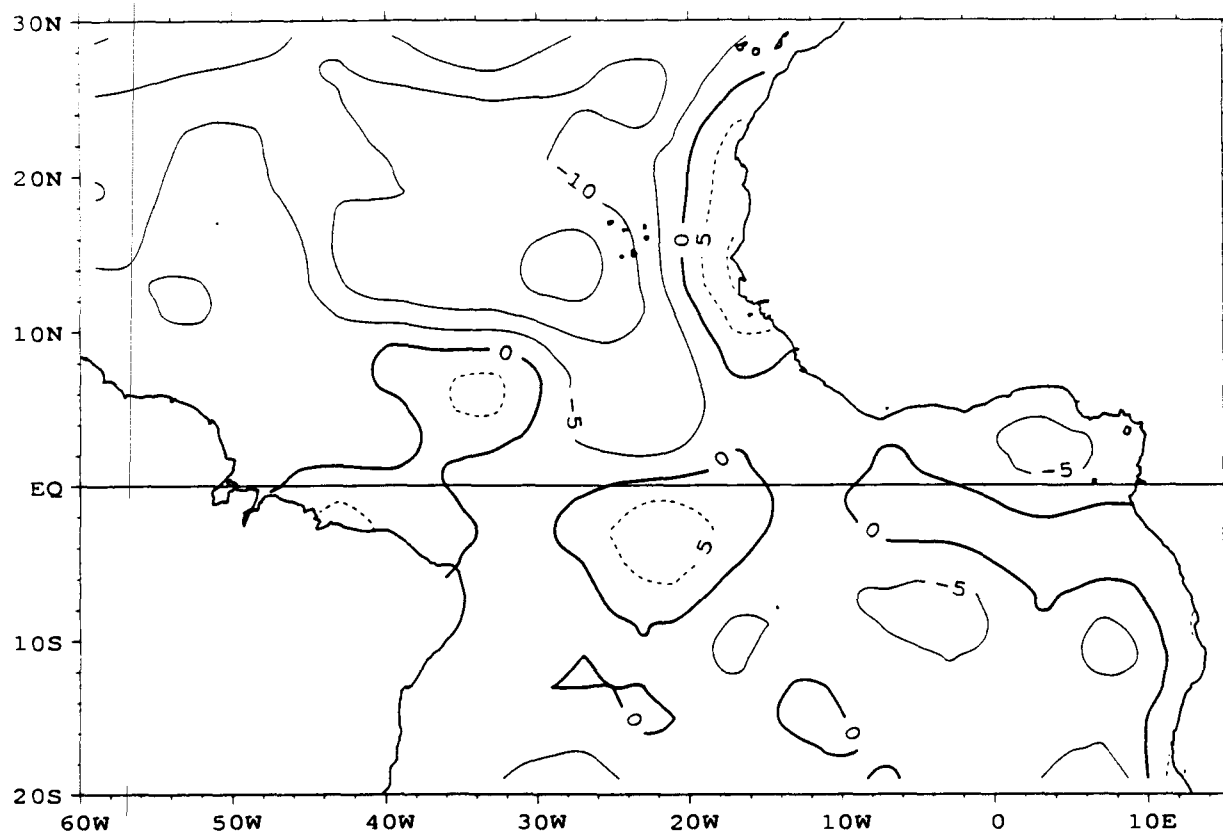
SENSIBLE *OBSERVATIONS* SEASONAL MEAN (J A S)



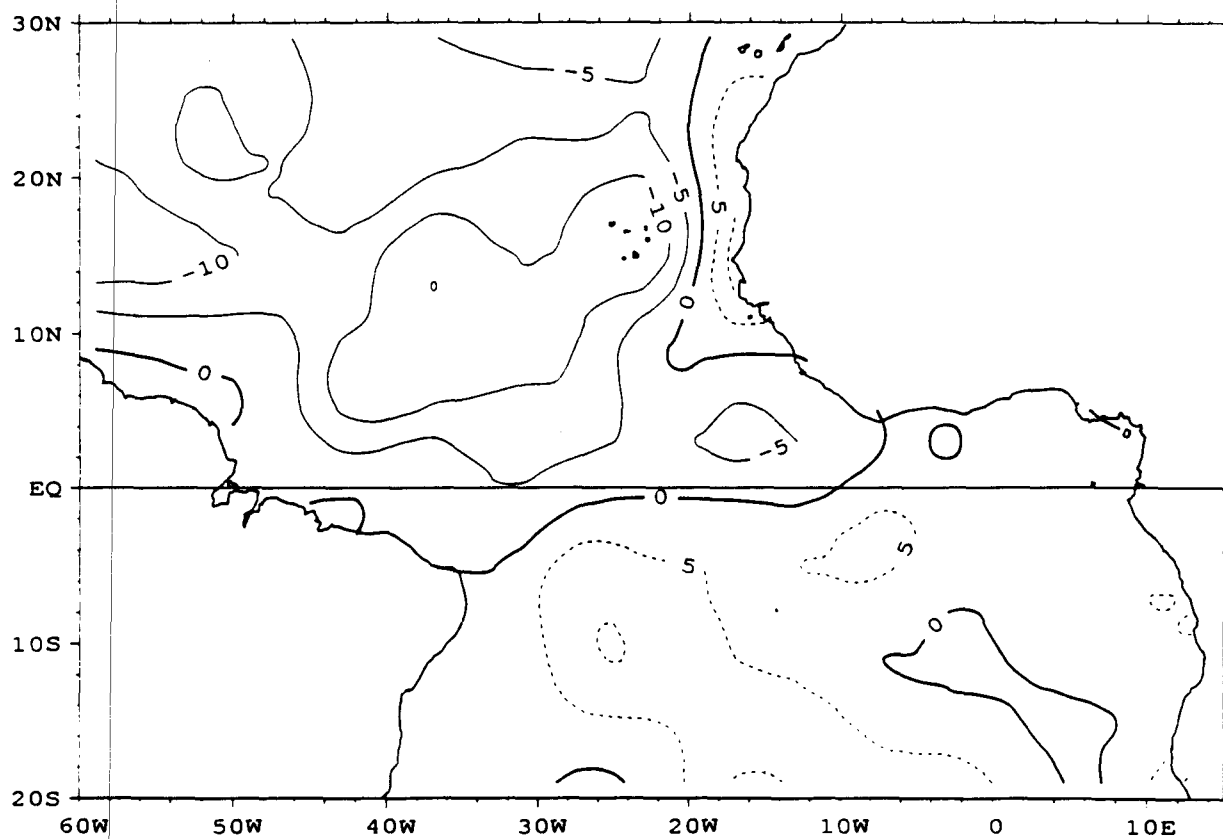
SENSIBLE *OBSERVATIONS* SEASONAL MEAN (O N D)



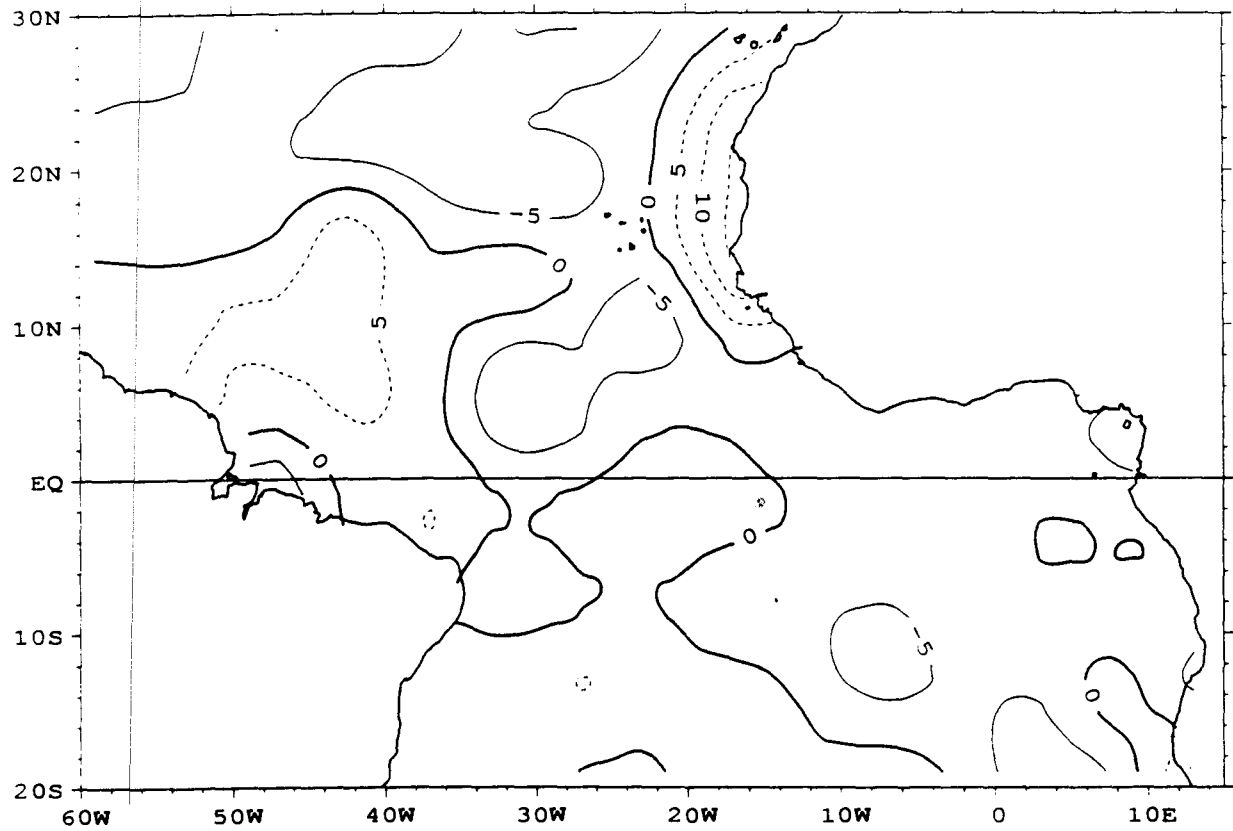
QS OBSERVATIONS - JANVIER 1989



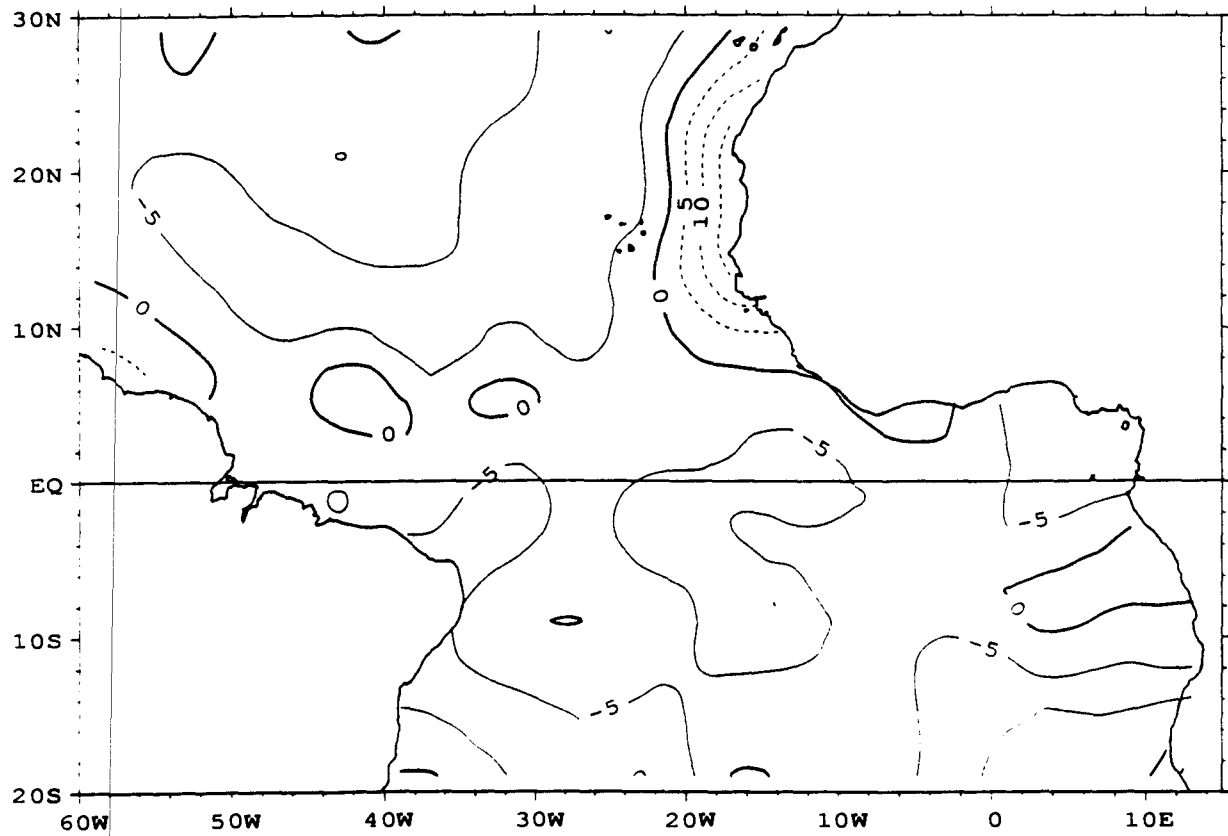
QS OBSERVATIONS - FEVRIER 1989



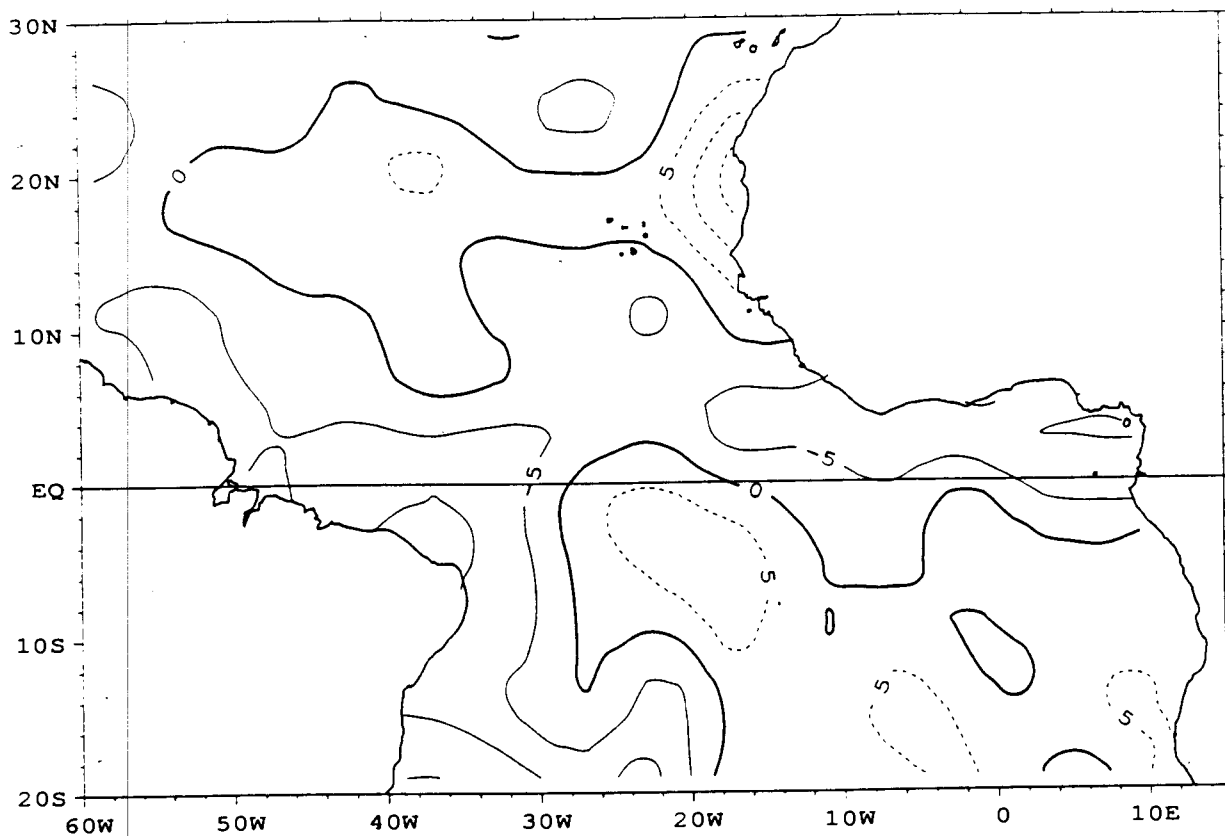
QS OBSERVATIONS - MARS 1989



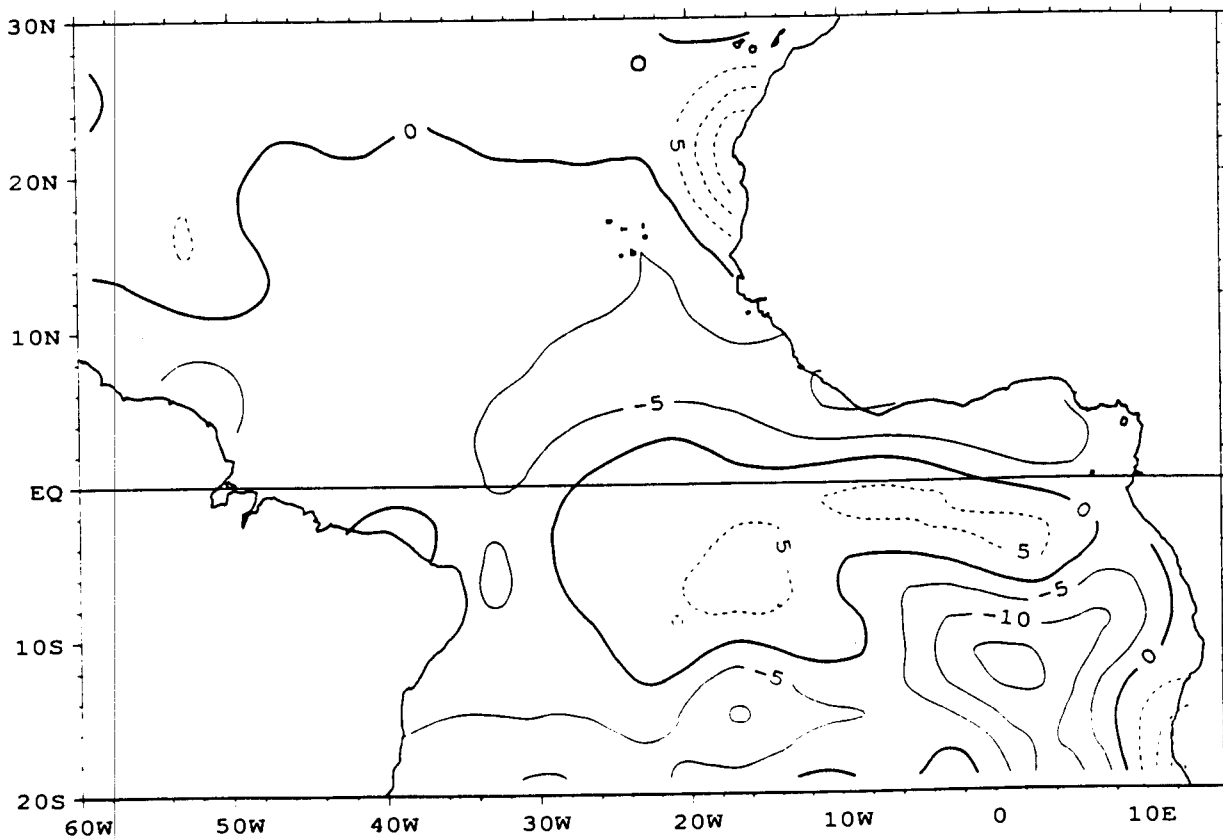
QS OBSERVATIONS - AVRIL 1989



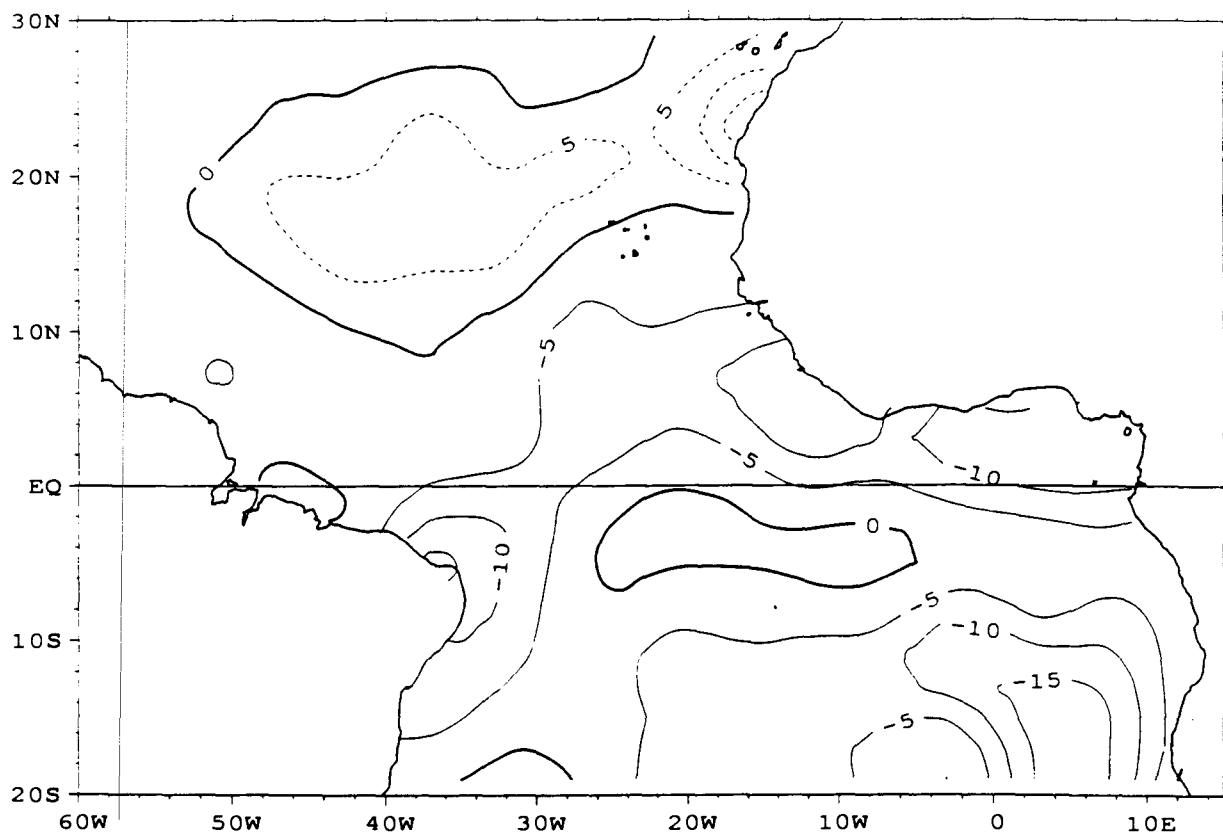
QS OBSERVATIONS - MAI 1989



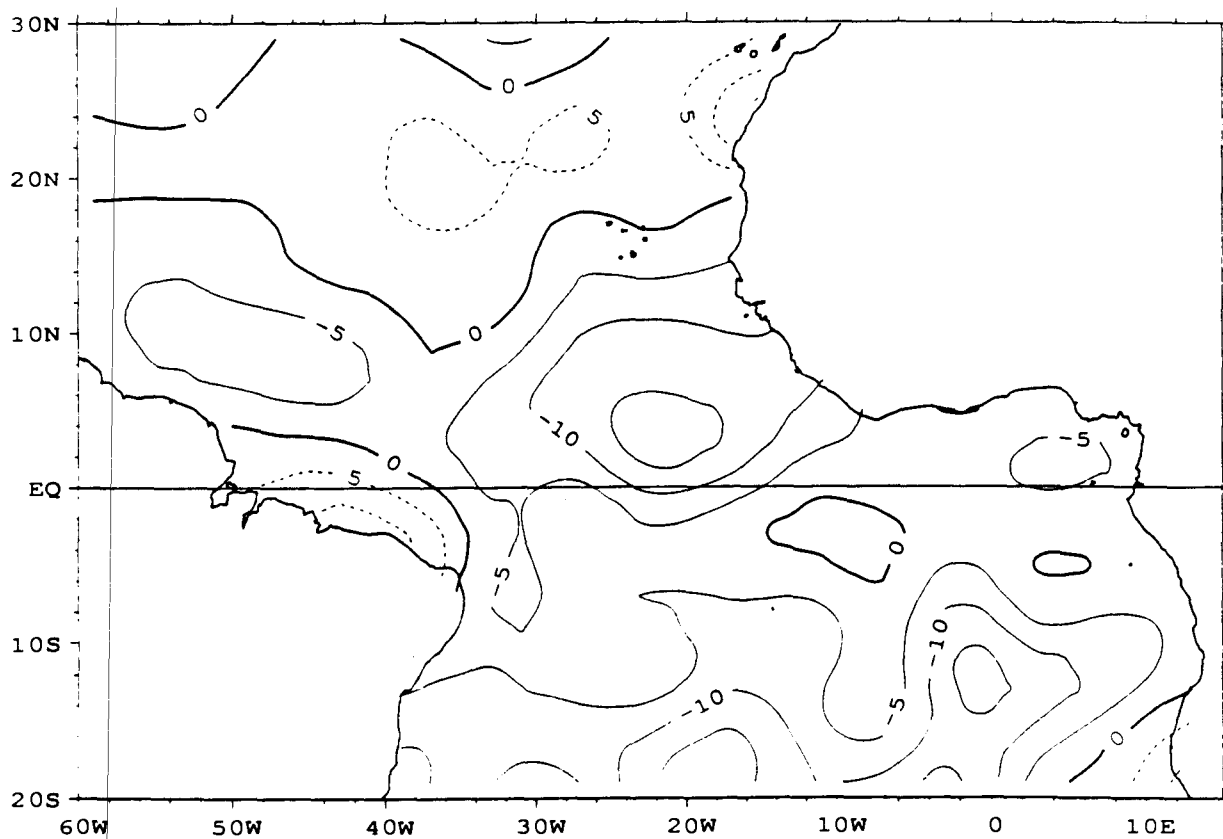
QS OBSERVATIONS - JUIN 1989



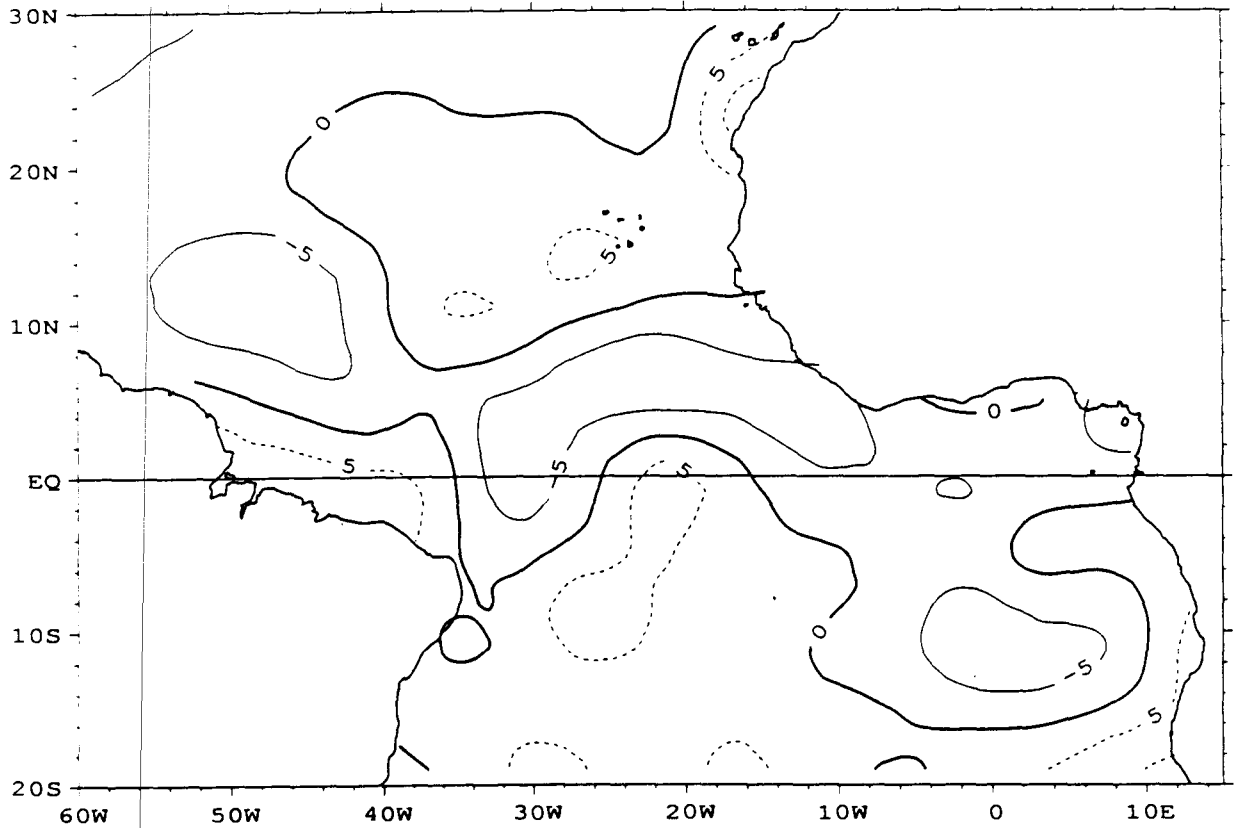
QS OBSERVATIONS - JUILLET 1989



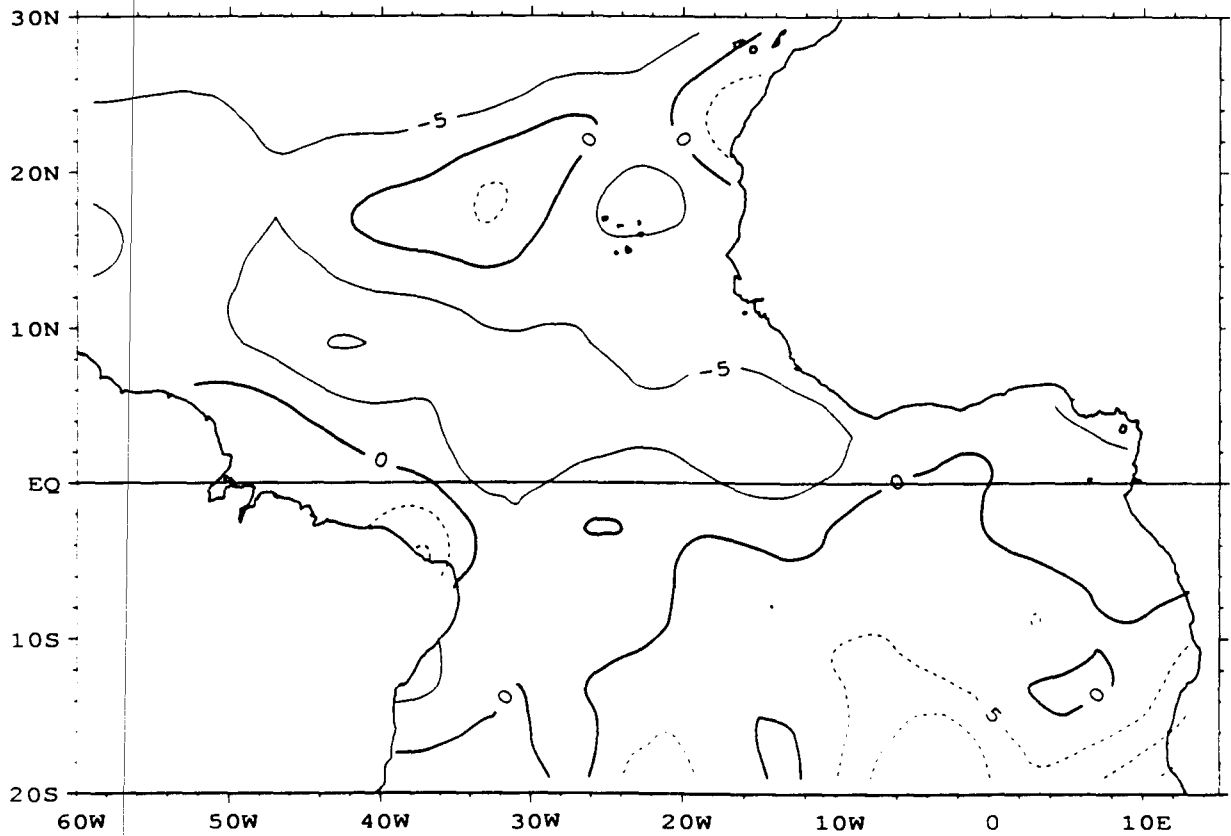
QS OBSERVATIONS - AOUT 1989



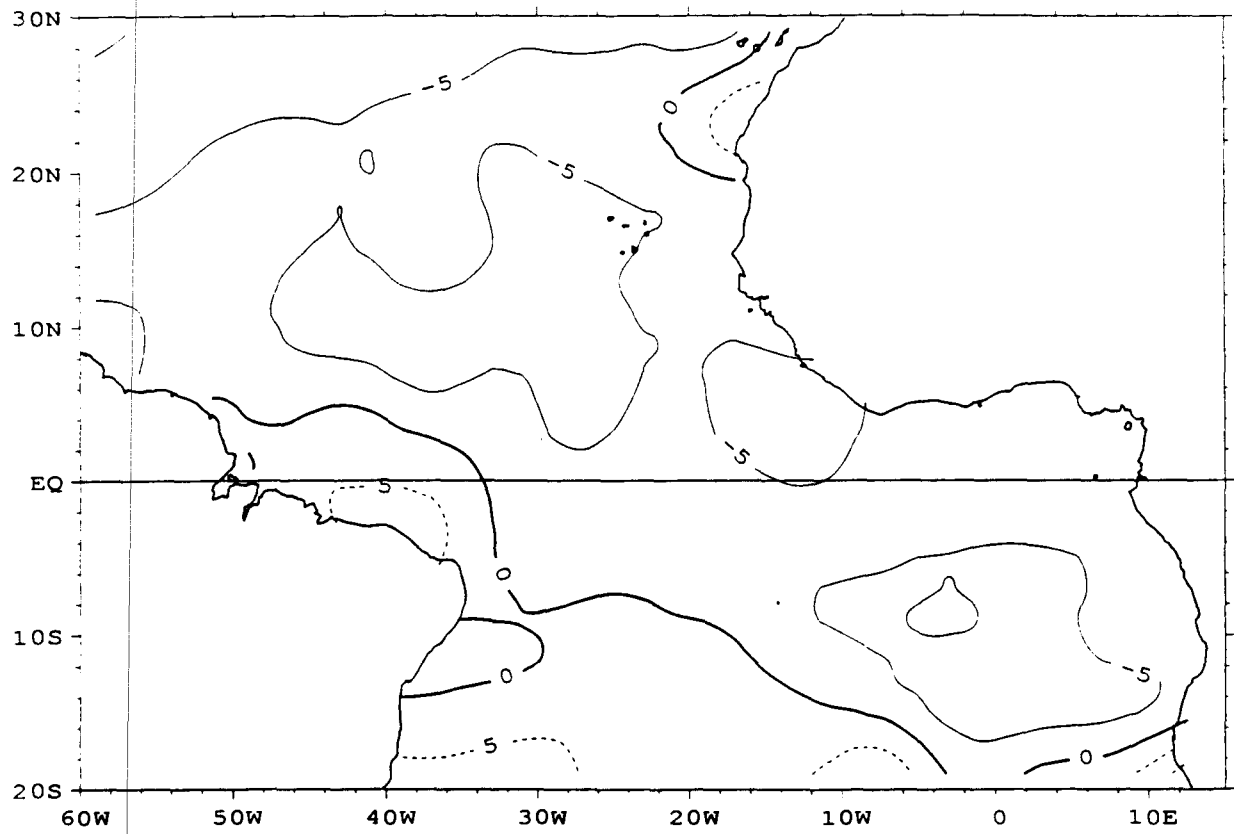
QS OBSERVATIONS - SEPTMBRE 1989



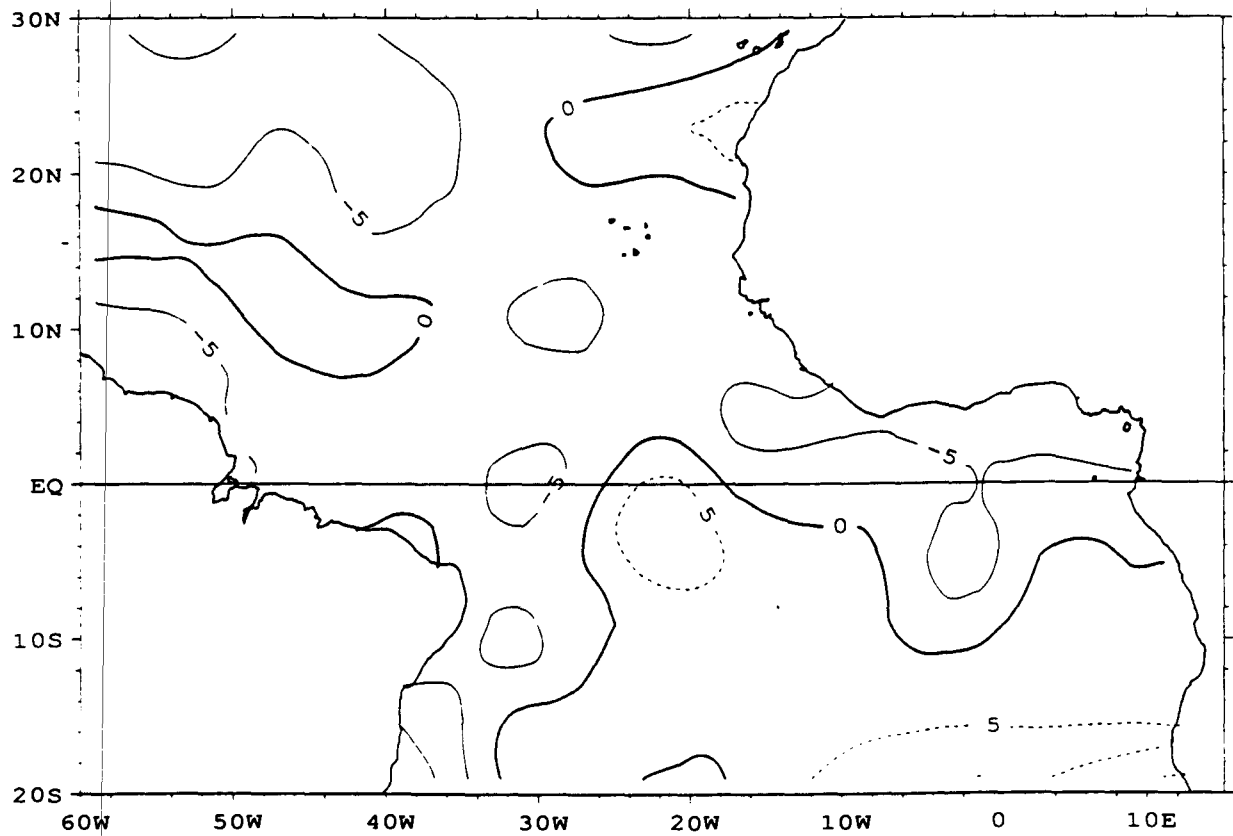
QS OBSERVATIONS - OCTOBRE 1989



QS OBSERVATIONS - NOVEMBRE 1989



QS OBSERVATIONS - DECEMBRE 1989



TROISIEME PARTIE

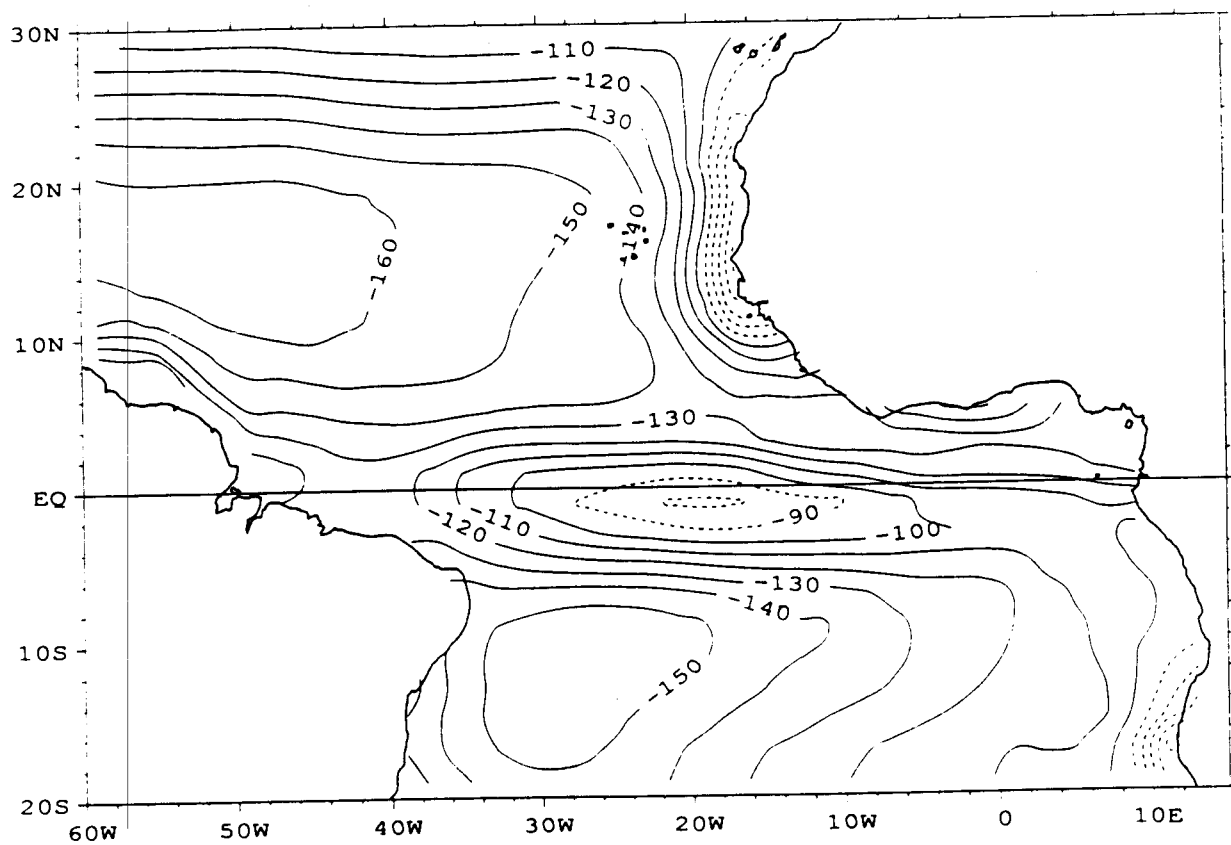
**FLUX DE CHALEUR CALCULES A PARTIR DES CLIMATOLOGIES
DES VARIABLES PRIMAIRES**

(Version Classique du Modèle)

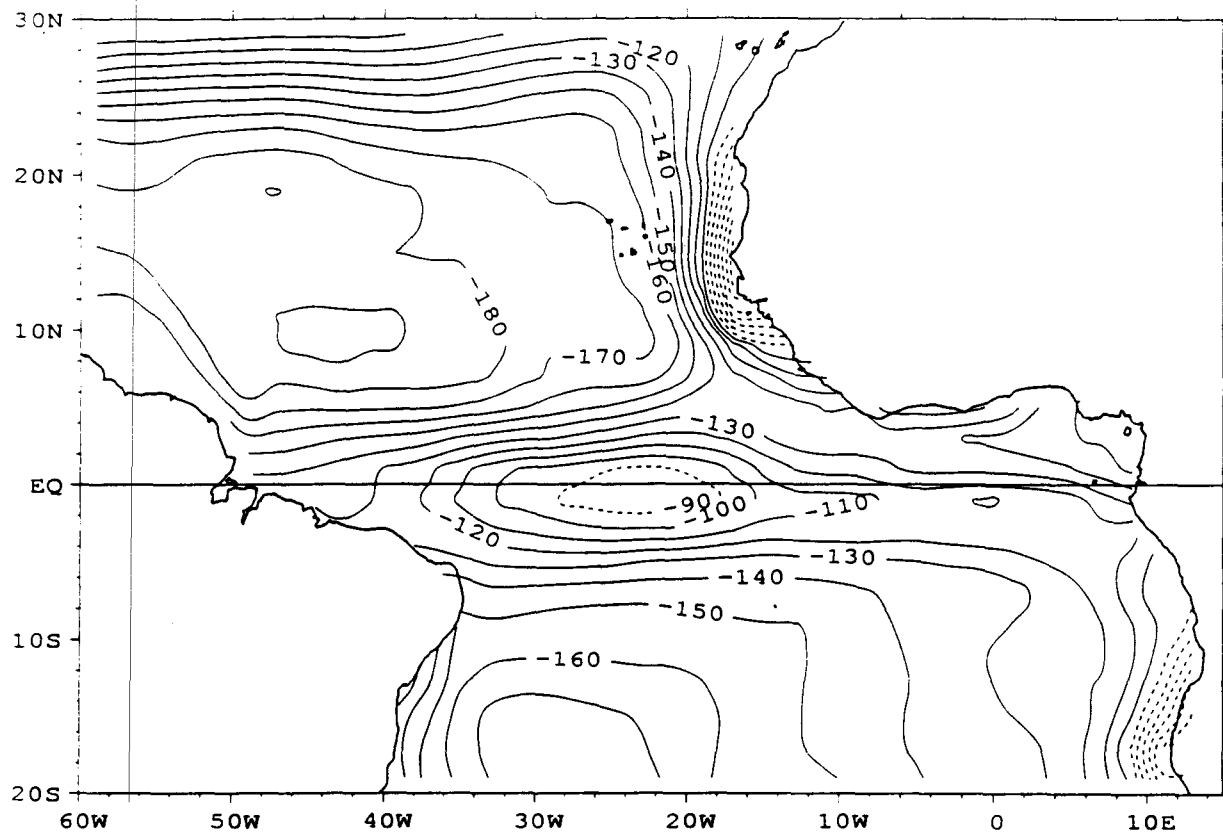
QL: page 76 à 84

QS: page 85 à 93

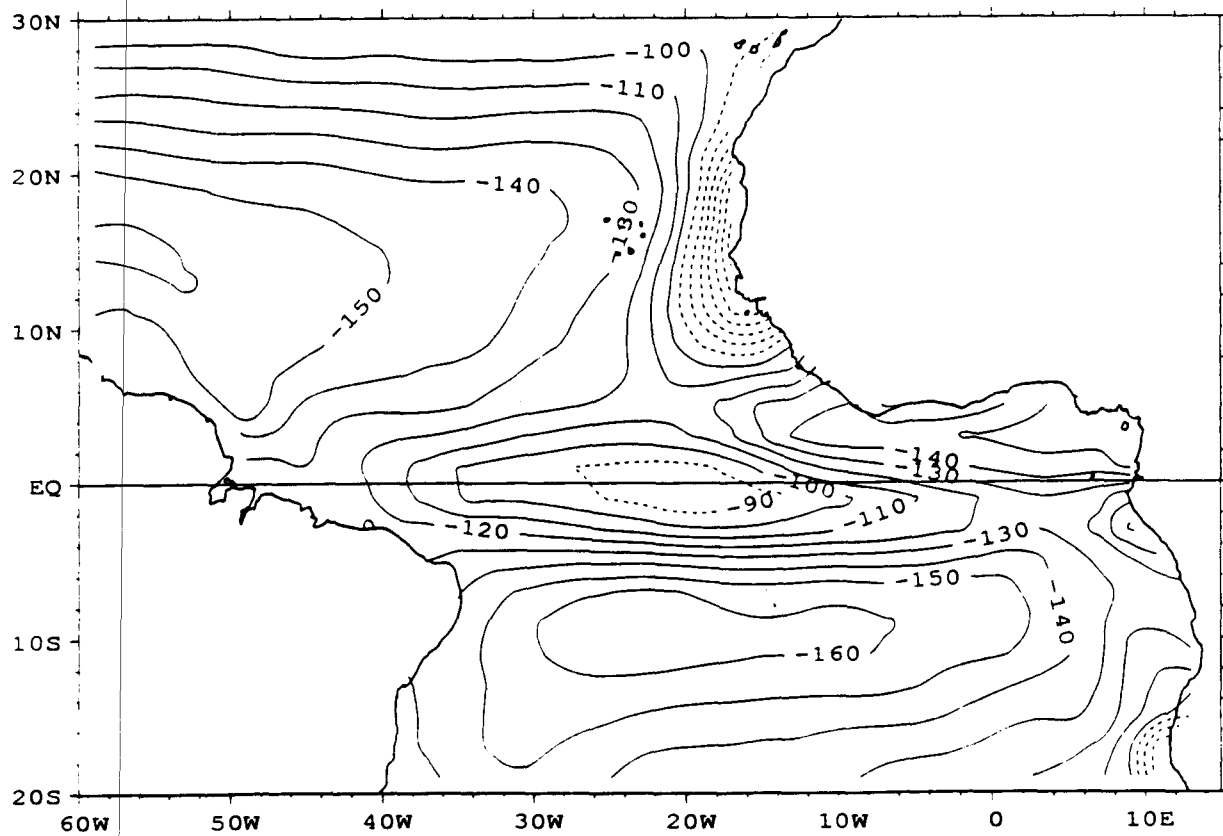
LATENT (W/M**2) *NUMERICAL MODEL*ANNUAL MEAN



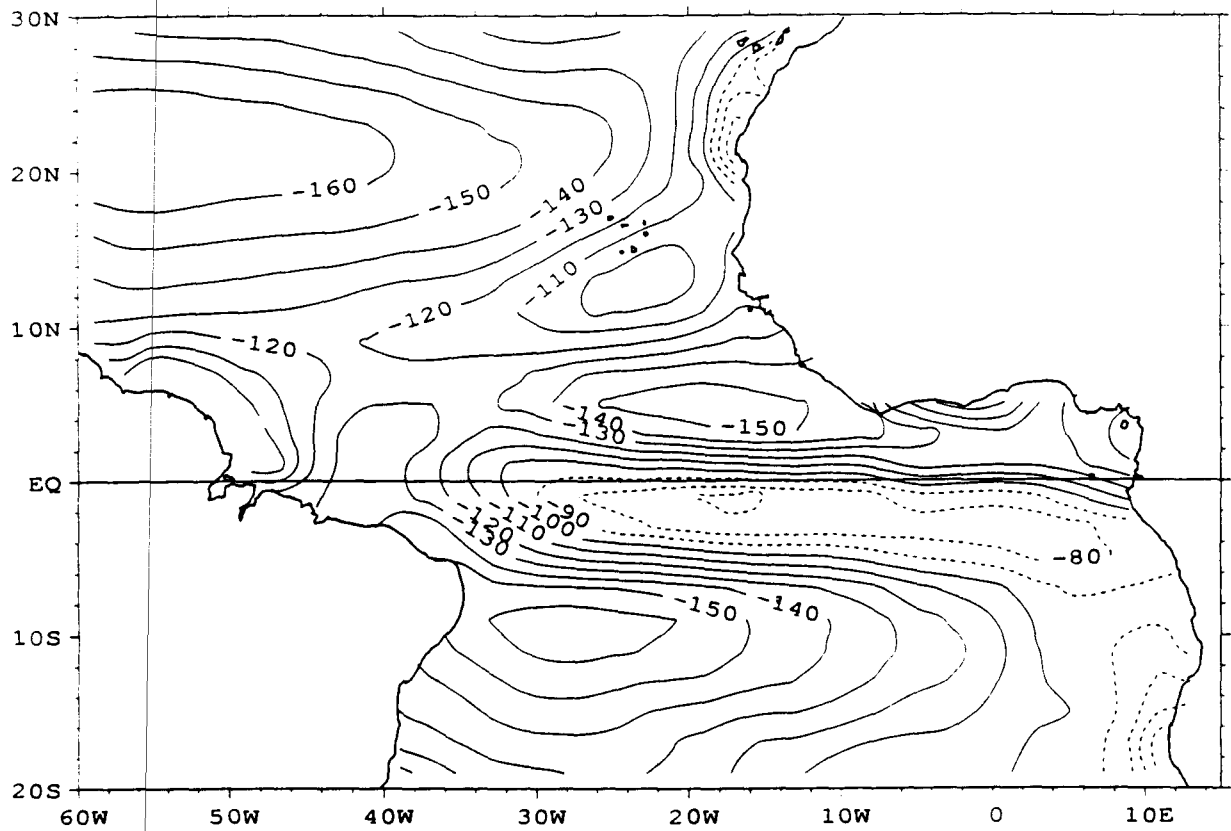
LATENT (W/M**2) *NUM. MOD. *SEASONAL MEAN (J F M)



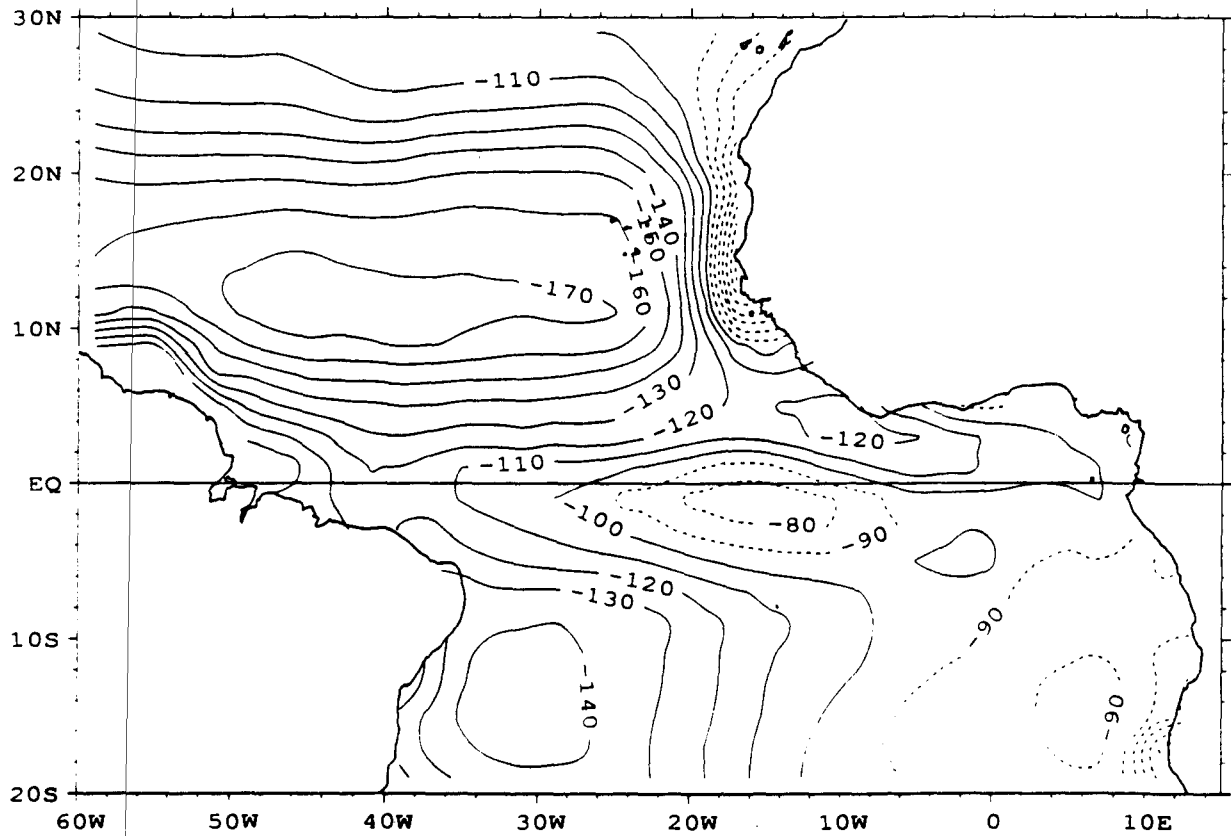
LATENT * (W/M**2) *NUM. MOD. *SEASONAL MEAN (AMJ)



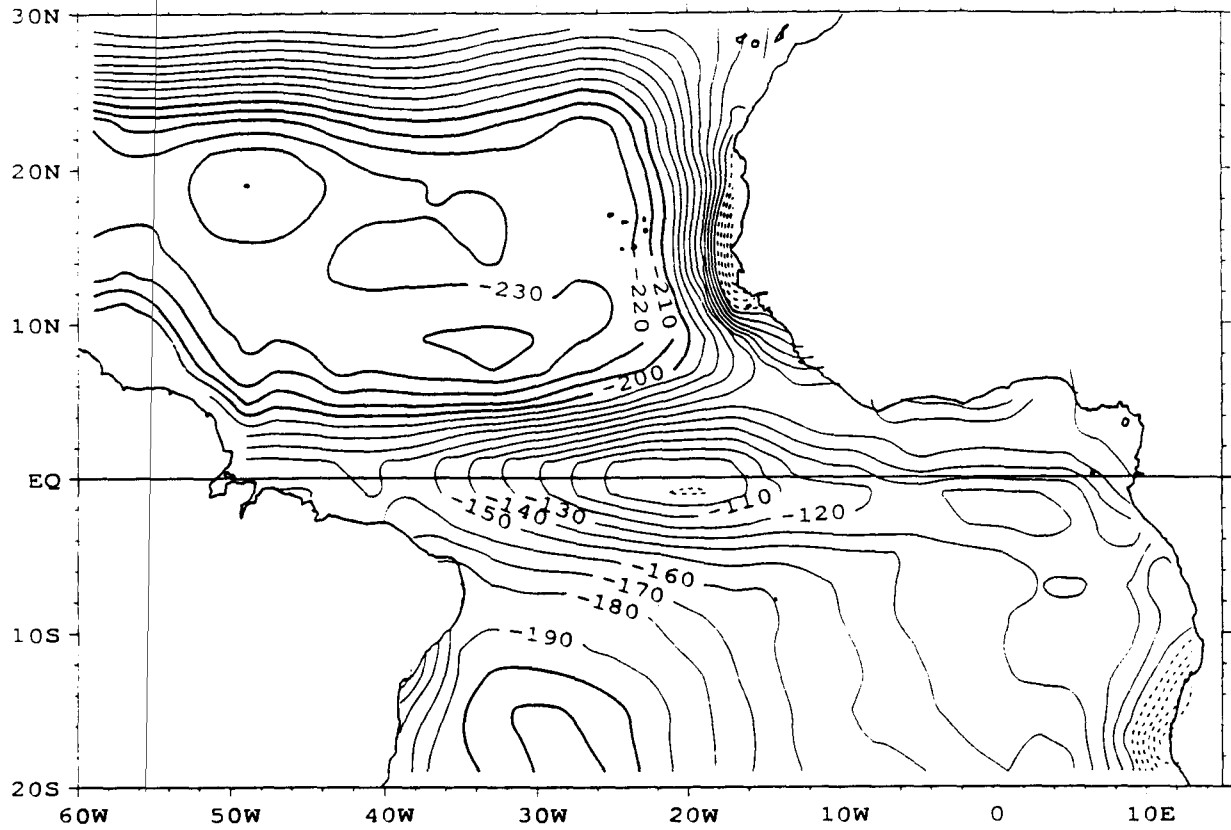
LATENT (W/M**2) *NUM. MOD. *SEASONAL MEAN (JAS)



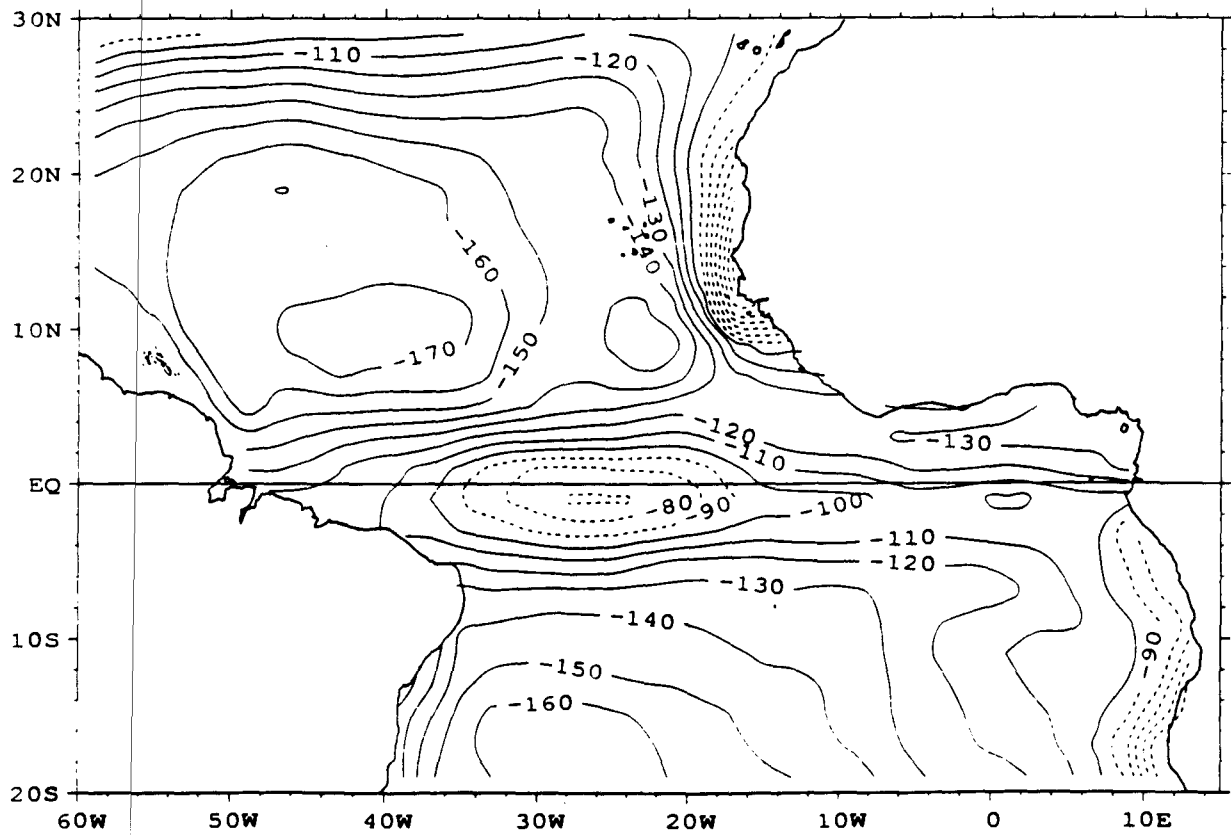
LATENT (W/M**2) *NUM. MOD. *SEASONAL MEAN (OND)



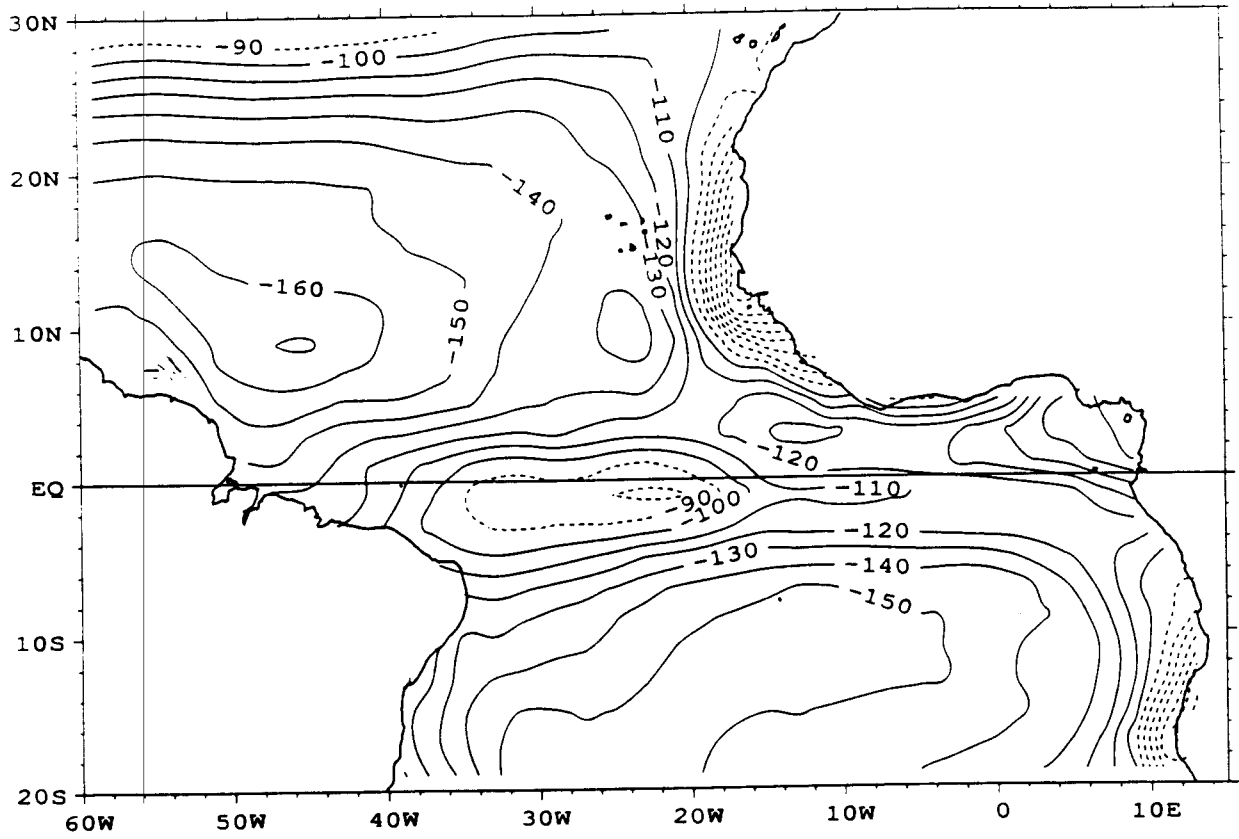
LATENT (W/M**2)*NUMERICAL MODEL*JANVIER 1989



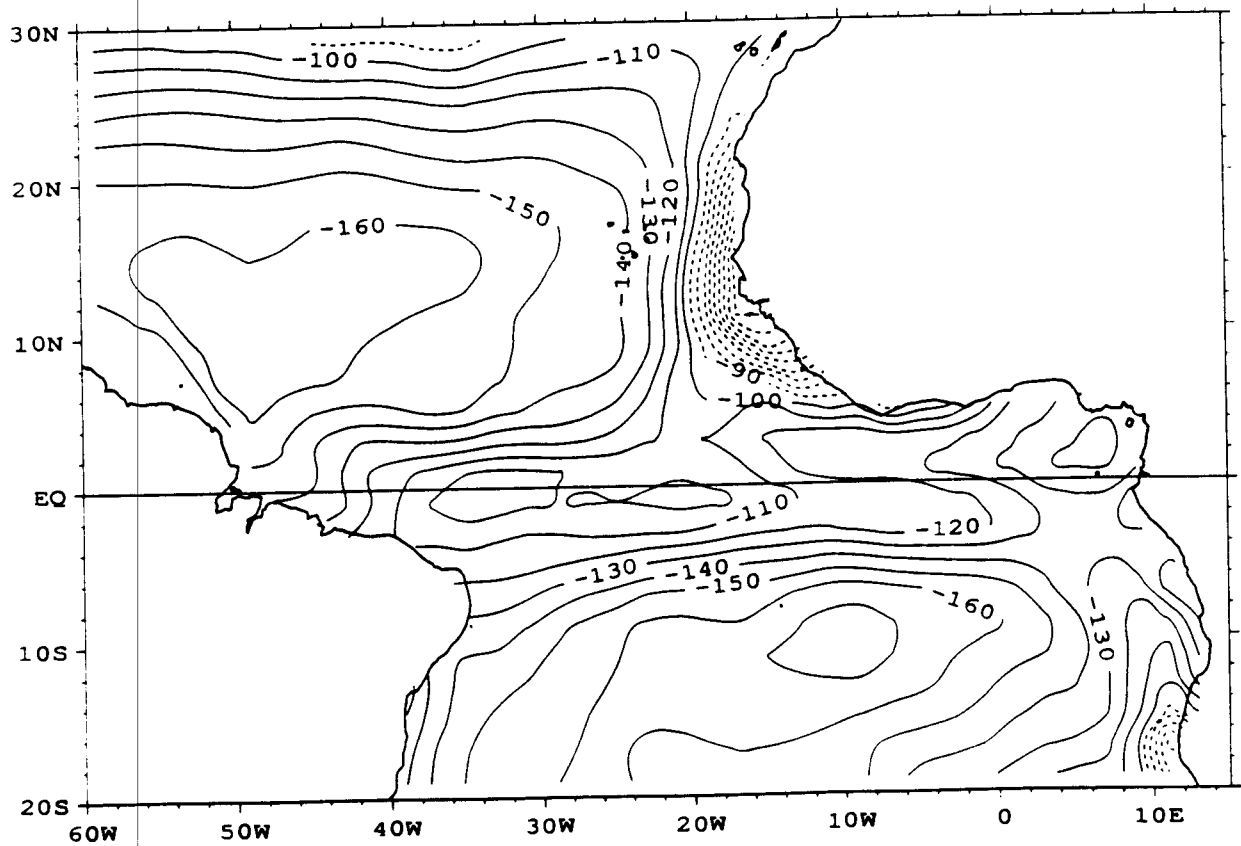
LATENT (W/M**2)*NUMERICAL MODEL*FEVRIER 1989



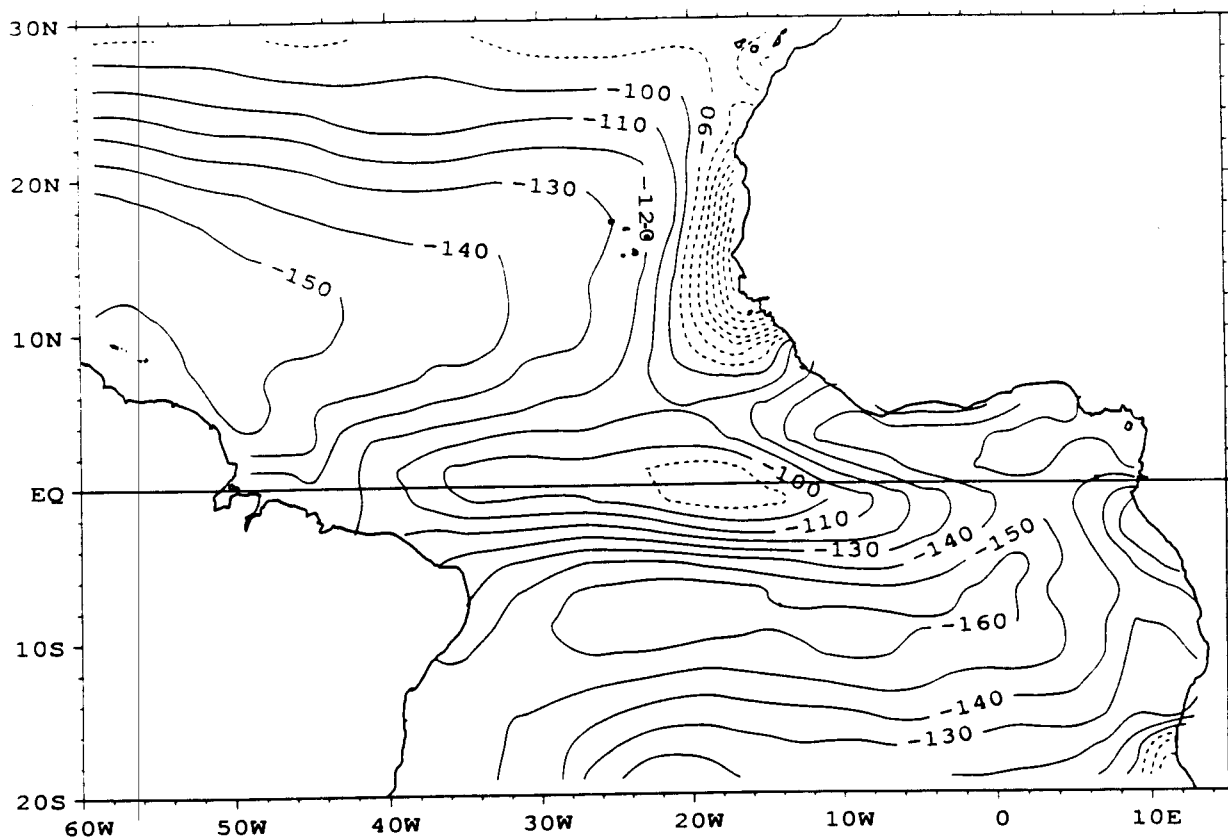
LATENT (W/M**2)*NUMERICAL MODEL*MARS 1989



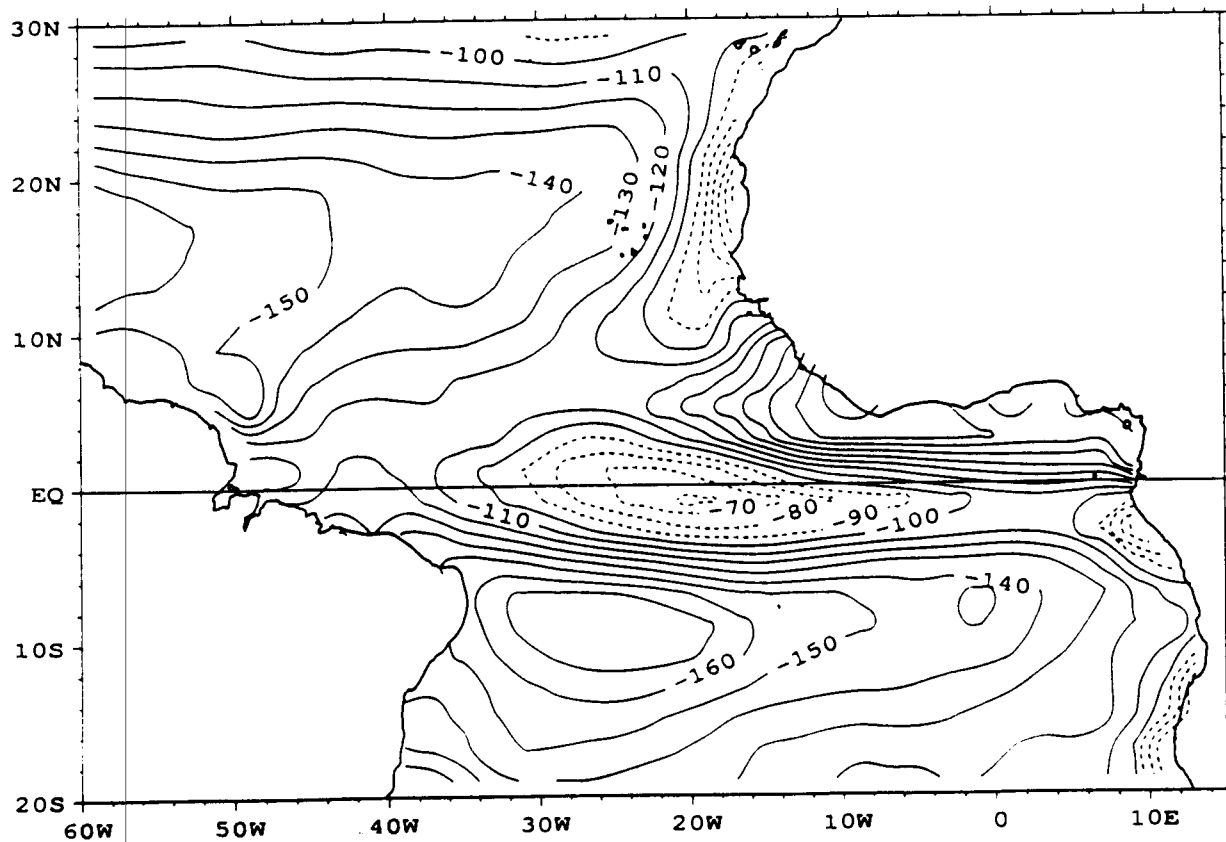
LATENT (W/M**2)*NUMERICAL MODEL*AVRIL 1989



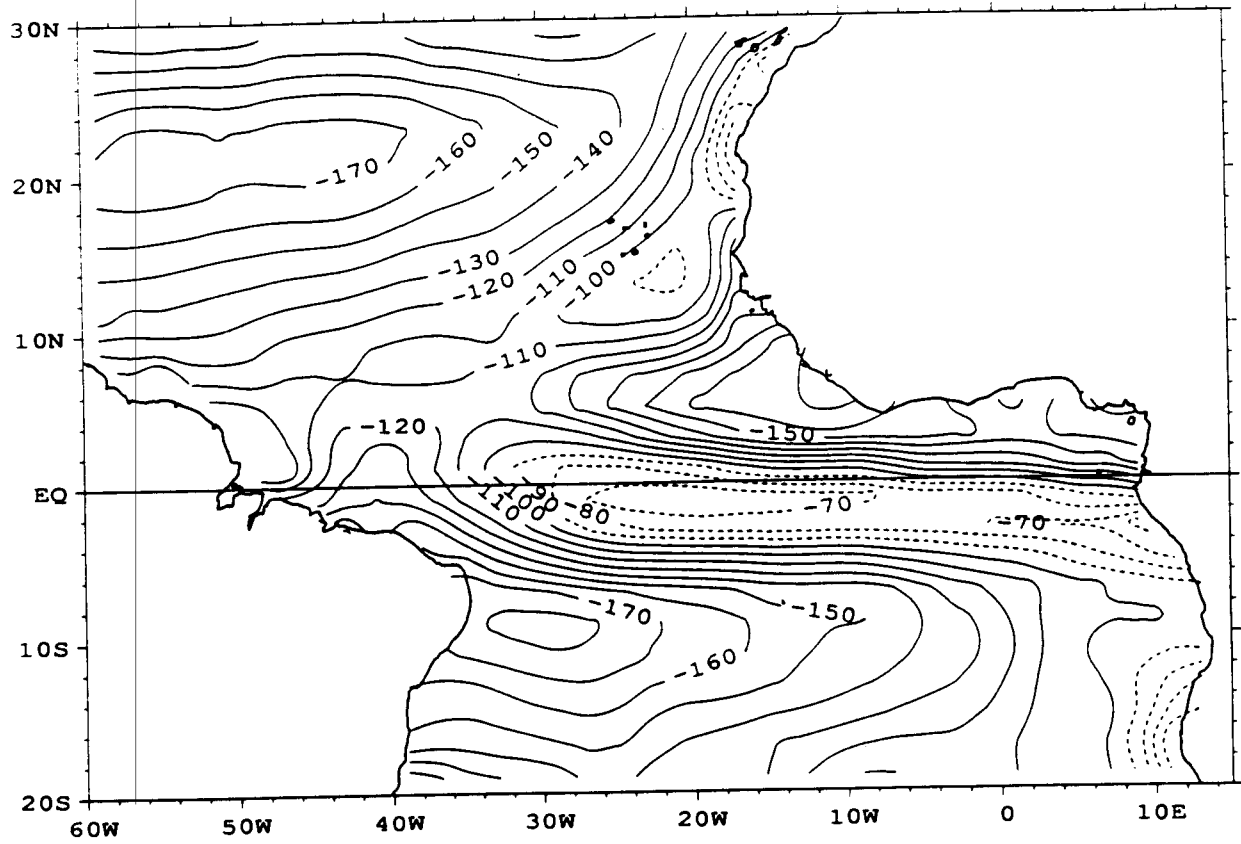
LATENT (W/M**2)*NUMERICAL MODEL*MAI 1989



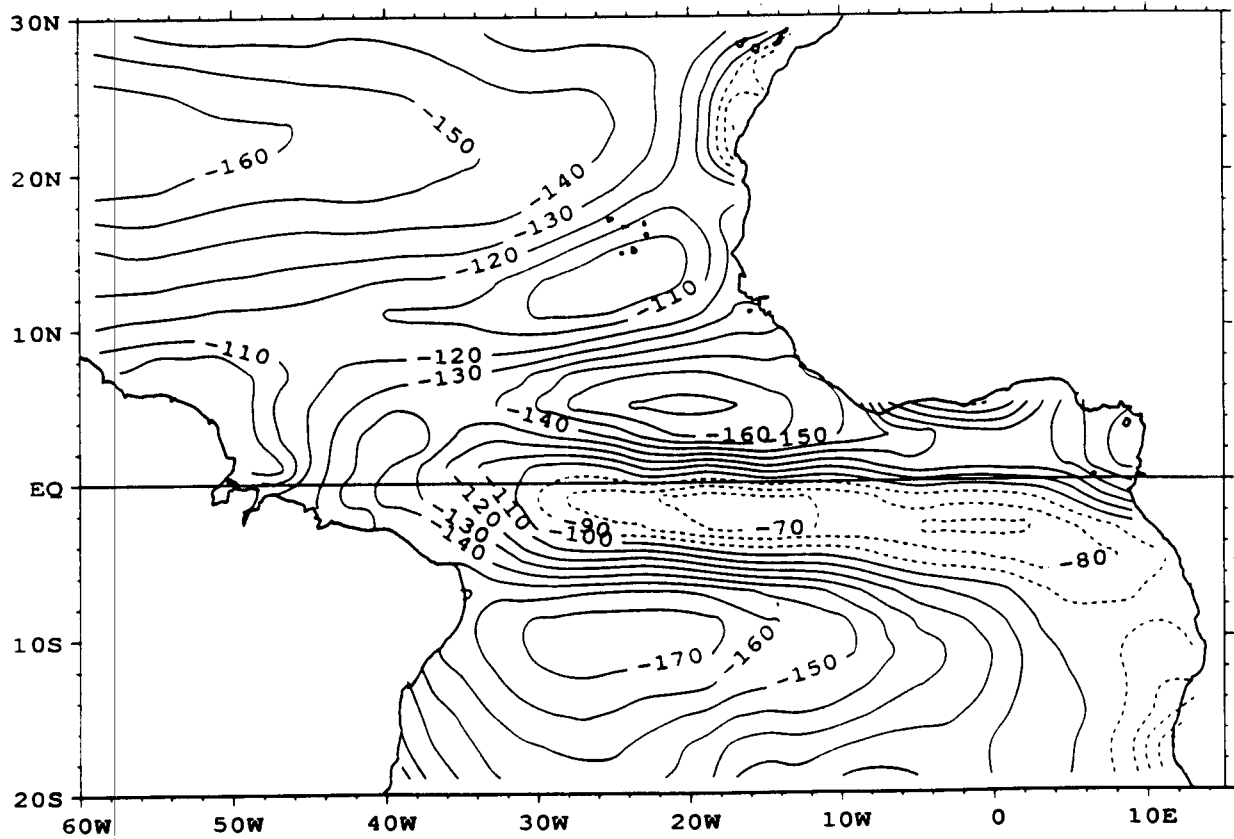
LATENT (W/M**2)*NUMERICAL MODEL*JUIN 1989



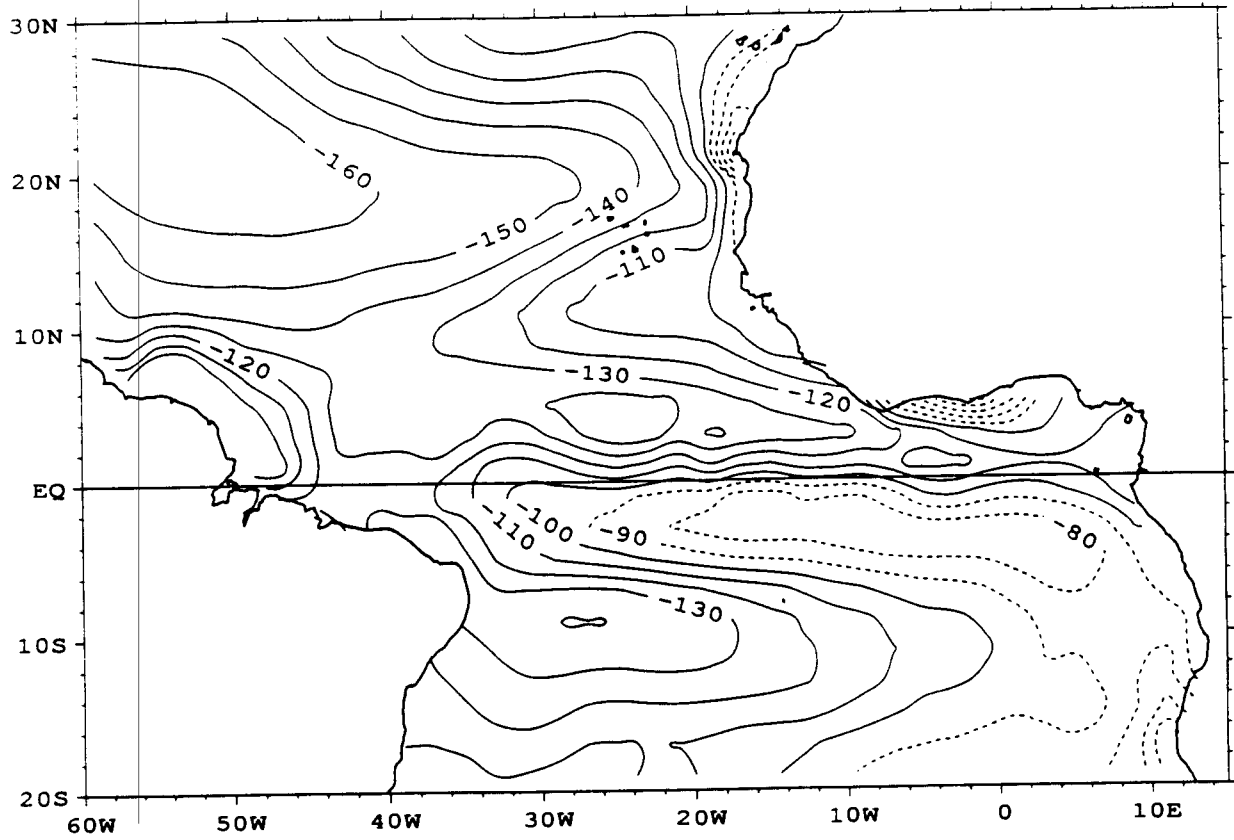
LATENT (W/M**2)*NUMERICAL MODEL*JUILLET 1989



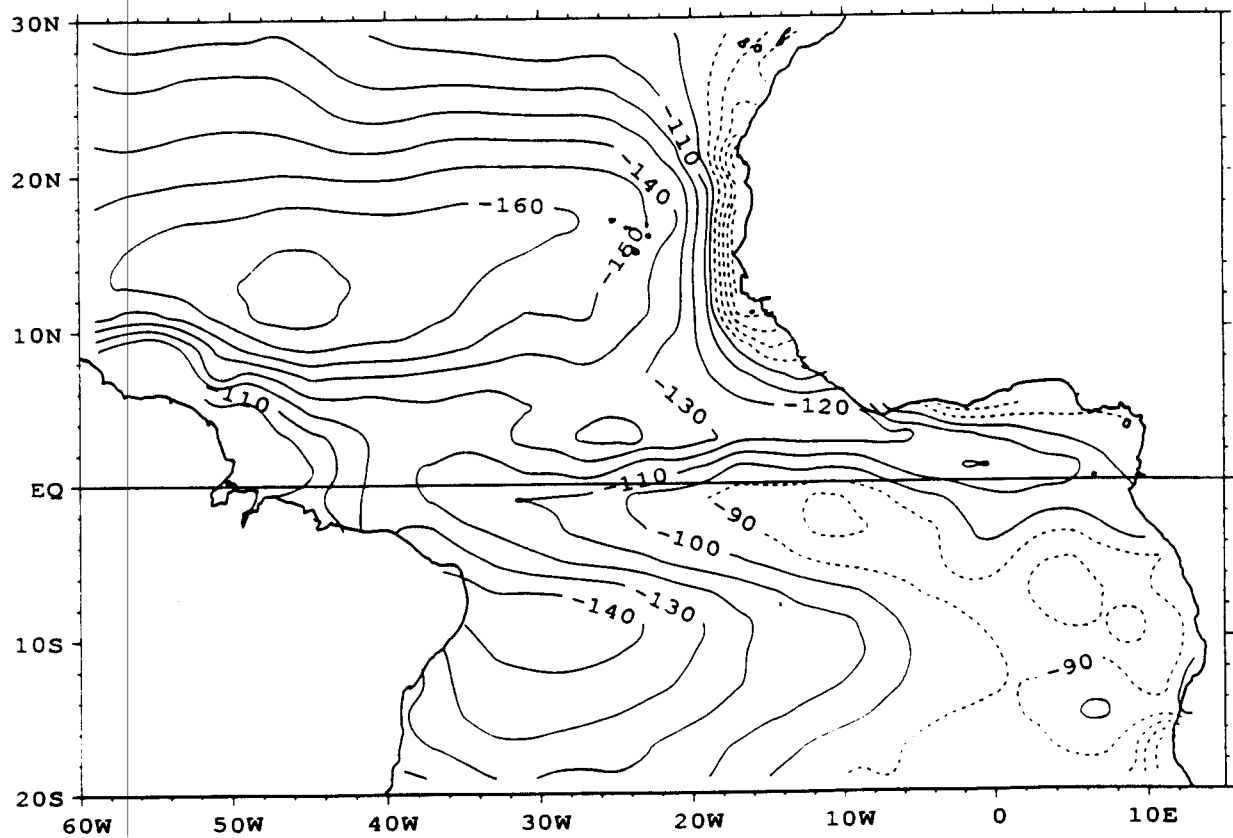
LATENT (W/M**2)*NUMERICAL MODEL*AOUT 1989



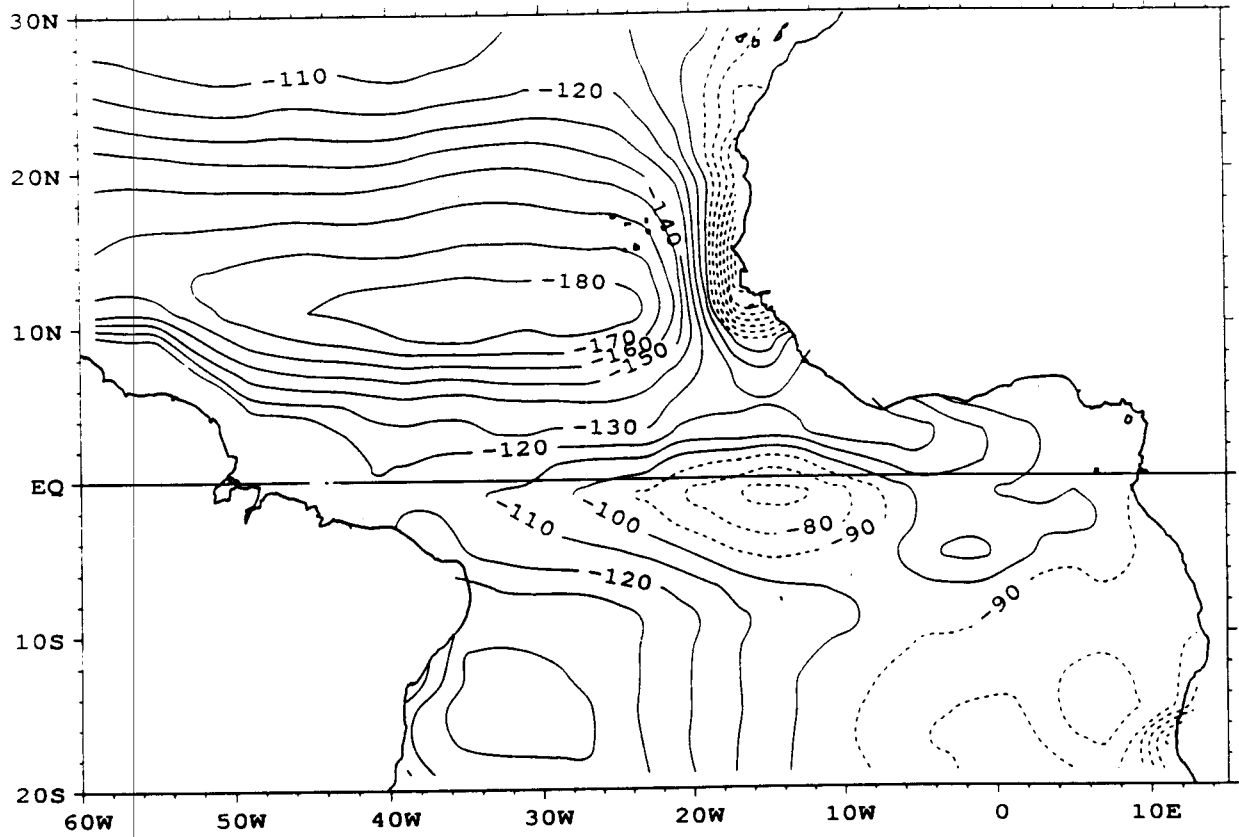
LATENT (W/M**2) *NUMERICAL MODEL*SEPTEMBRE 1989



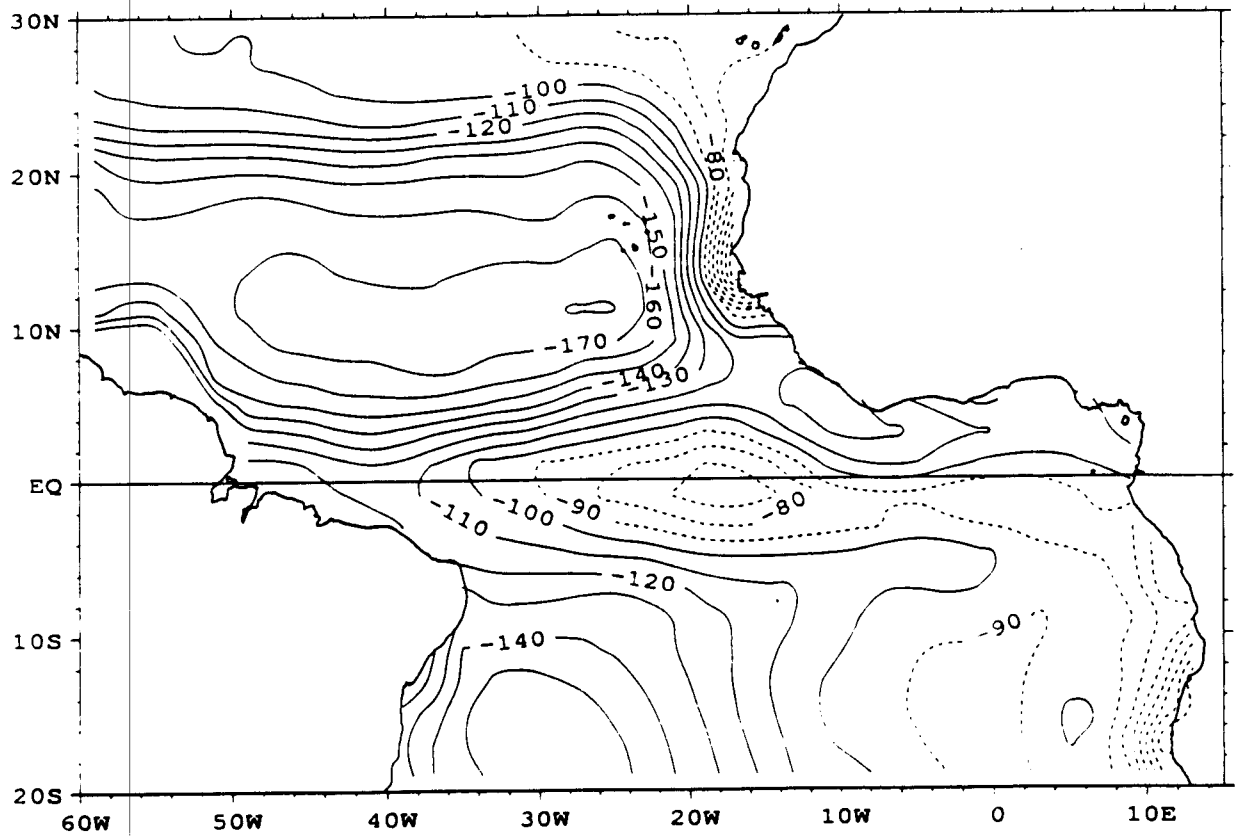
LATENT (W/M**2) *NUMERICAL MODEL*OCTOBRE 1989



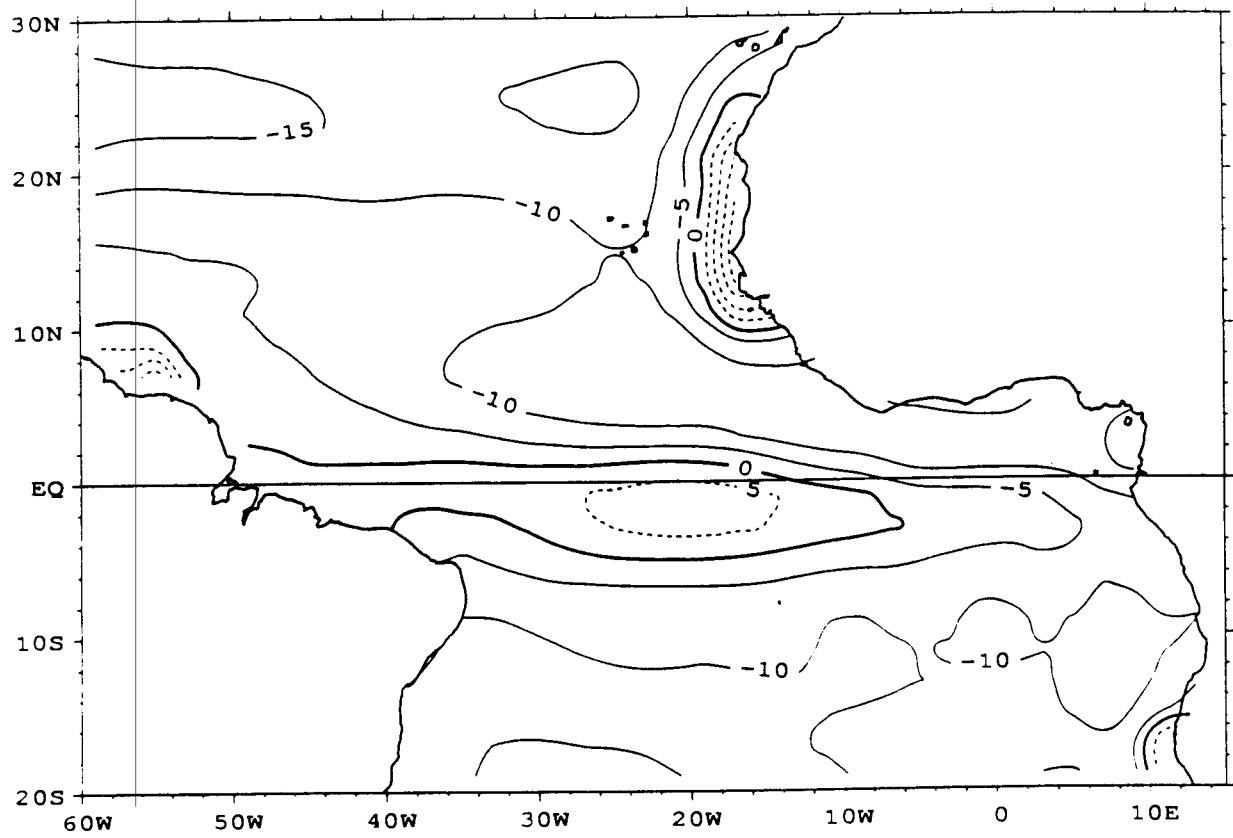
LATENT (W/M**2)*NUMERICAL MODEL*NOVEMBRE 1989



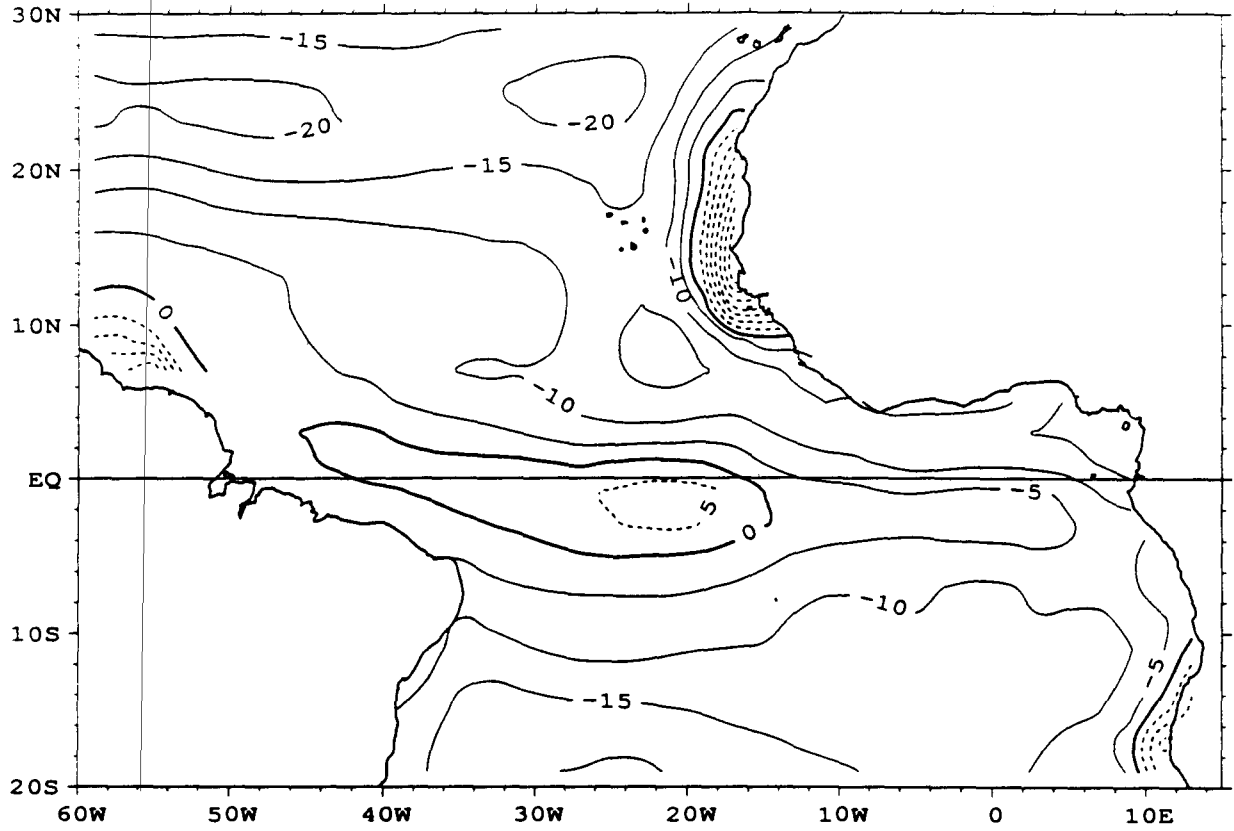
LATENT (W/M**2)*NUMERICAL MODEL*DECEMBRE 1989



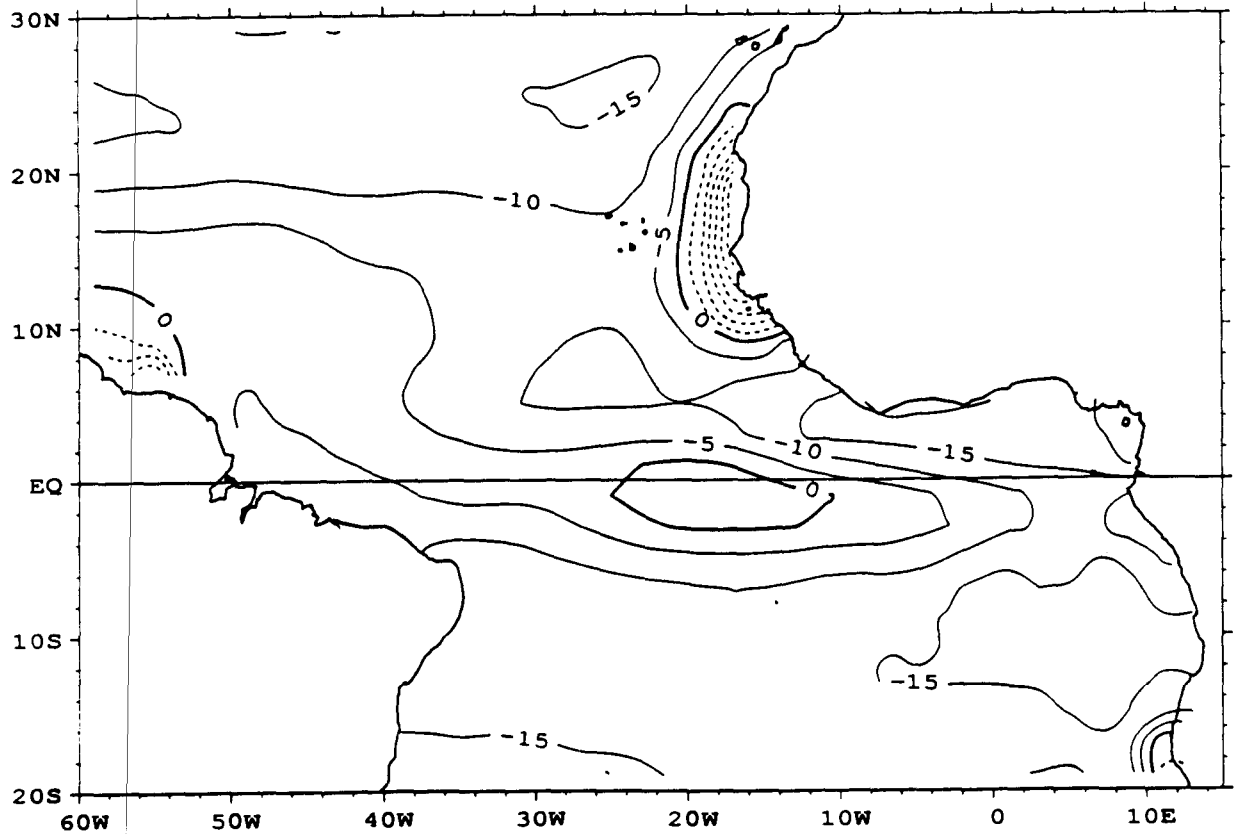
SENSIBLE (W/M**2) *NUMERICAL MODEL*ANNUAL MEAN



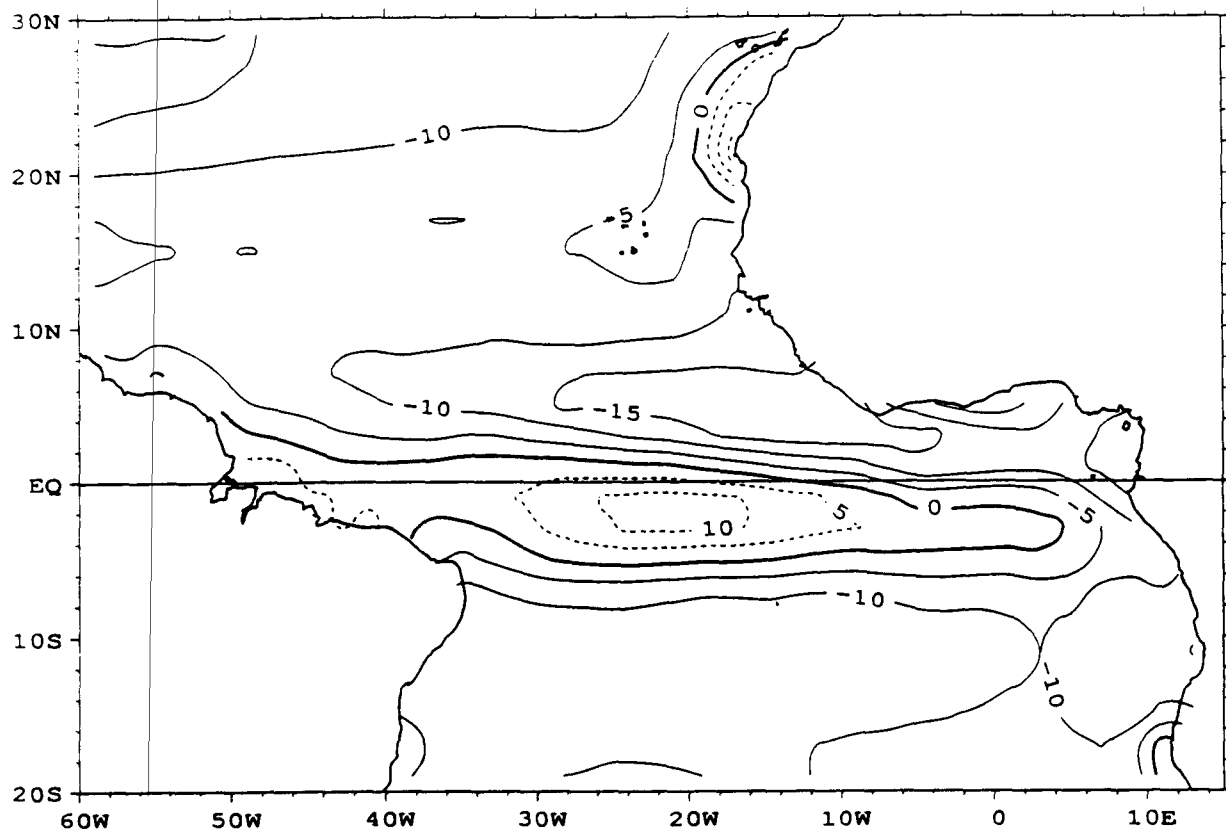
SENSIBLE (W/M**2) *NUM. MOD.*SEASONAL MEAN (JFM)



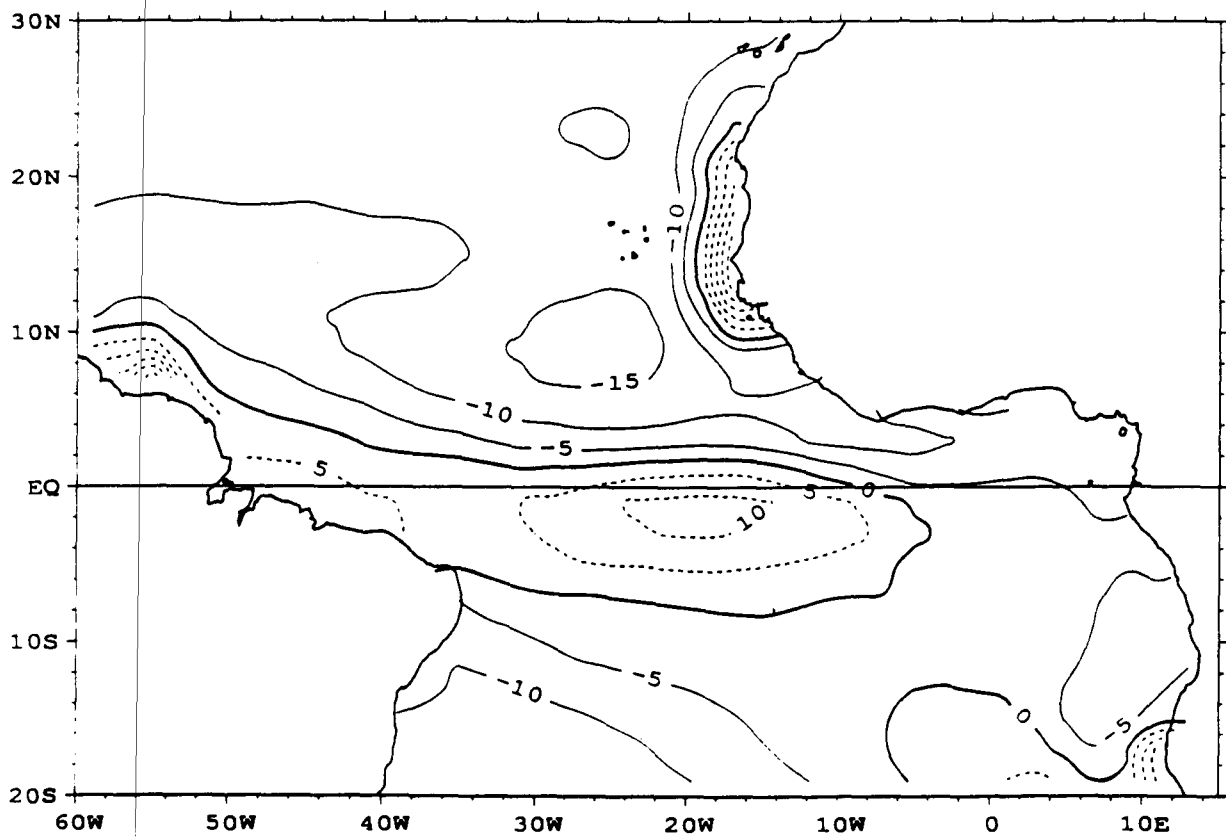
SENSIBLE (W/M**2) *NUM. MOD.*SEASONAL MEAN (AMJ)



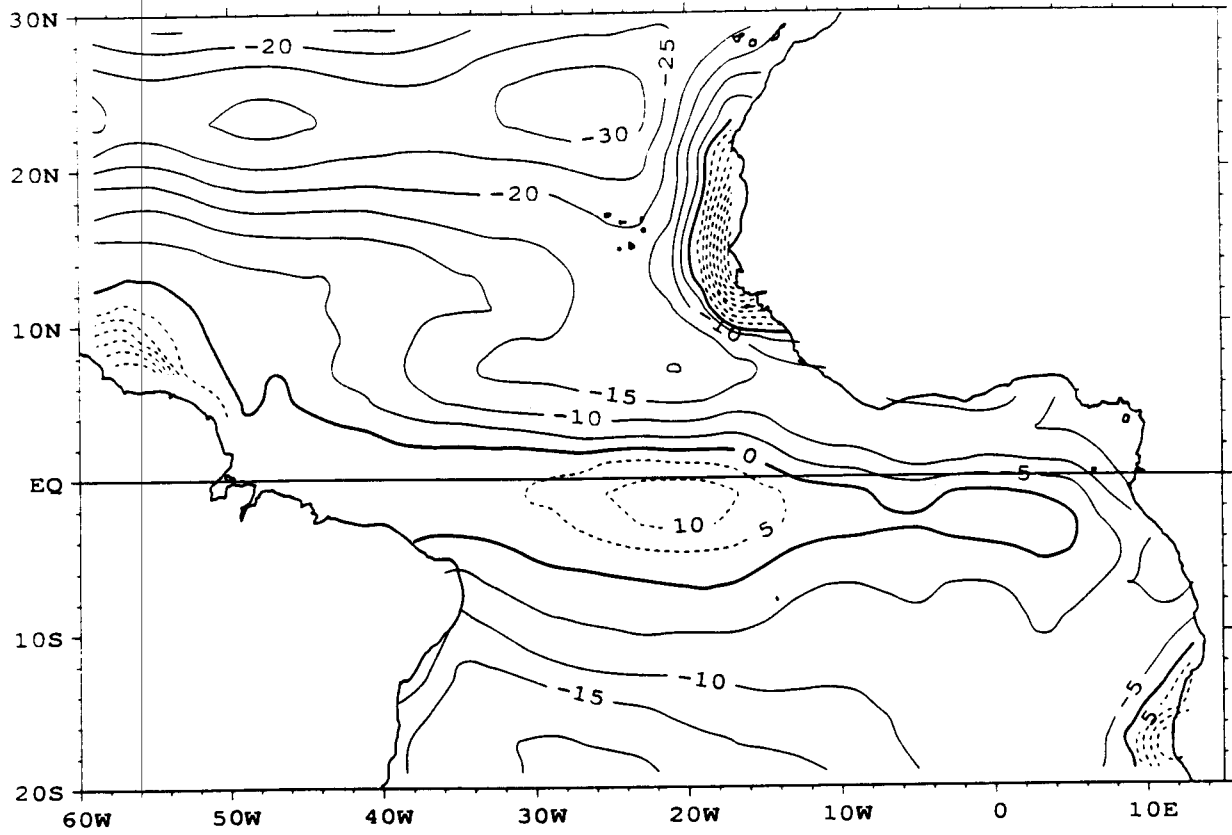
SENSIBLE (W/M**2) *NUM. MOD. *SEASONAL MEAN (JAS)



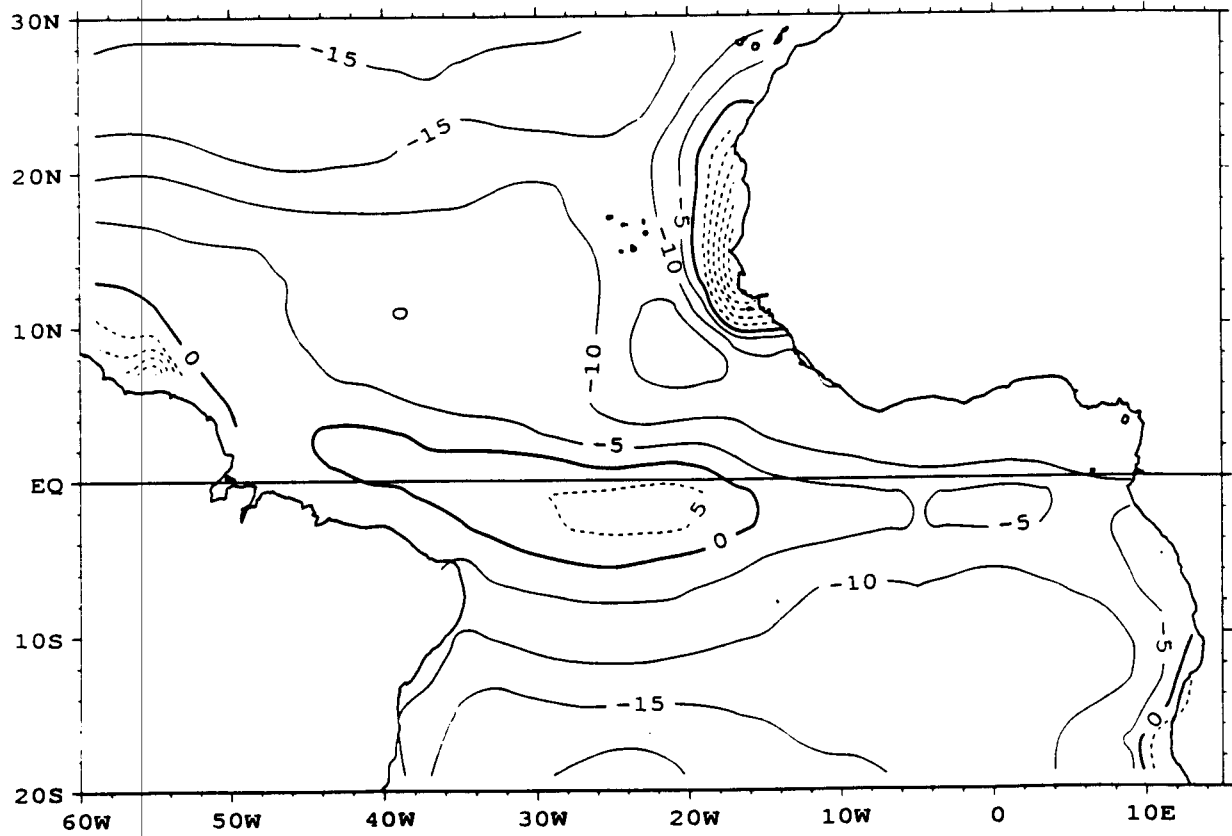
SENSIBLE (W/M**2) *NUM. MOD. *SEASONAL MEAN (OND)



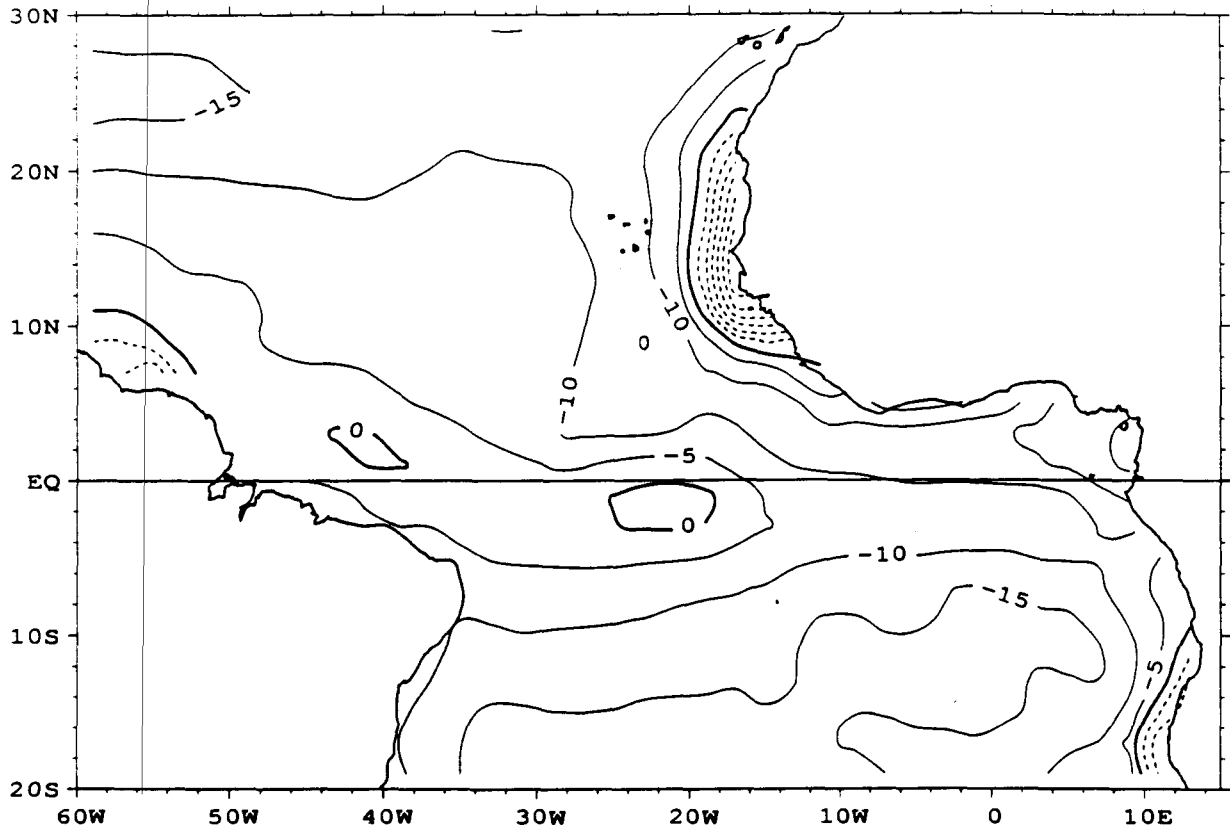
SENSIBLE (W/M**2) *NUMERICAL MODEL*JANVIER 1989



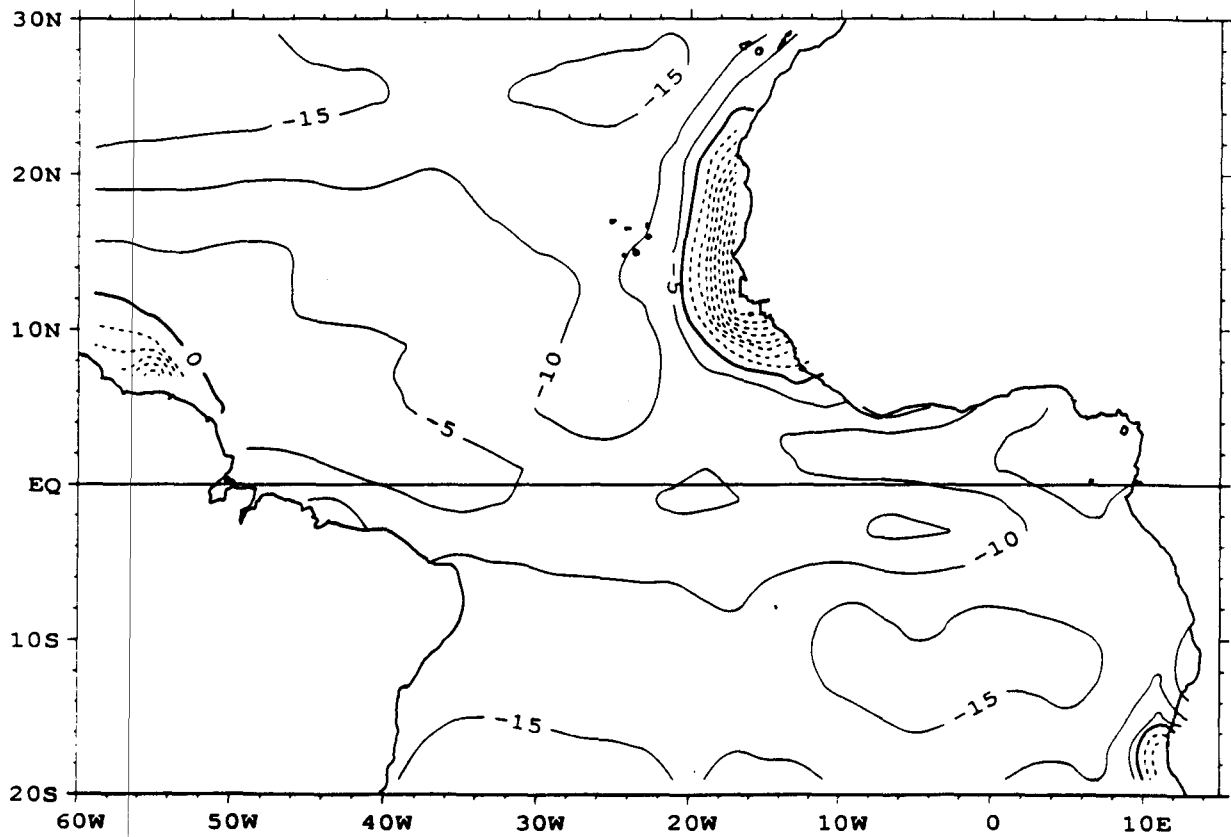
SENSIBLE (W/M**2) *NUMERICAL MODEL*FEVRIER 1989



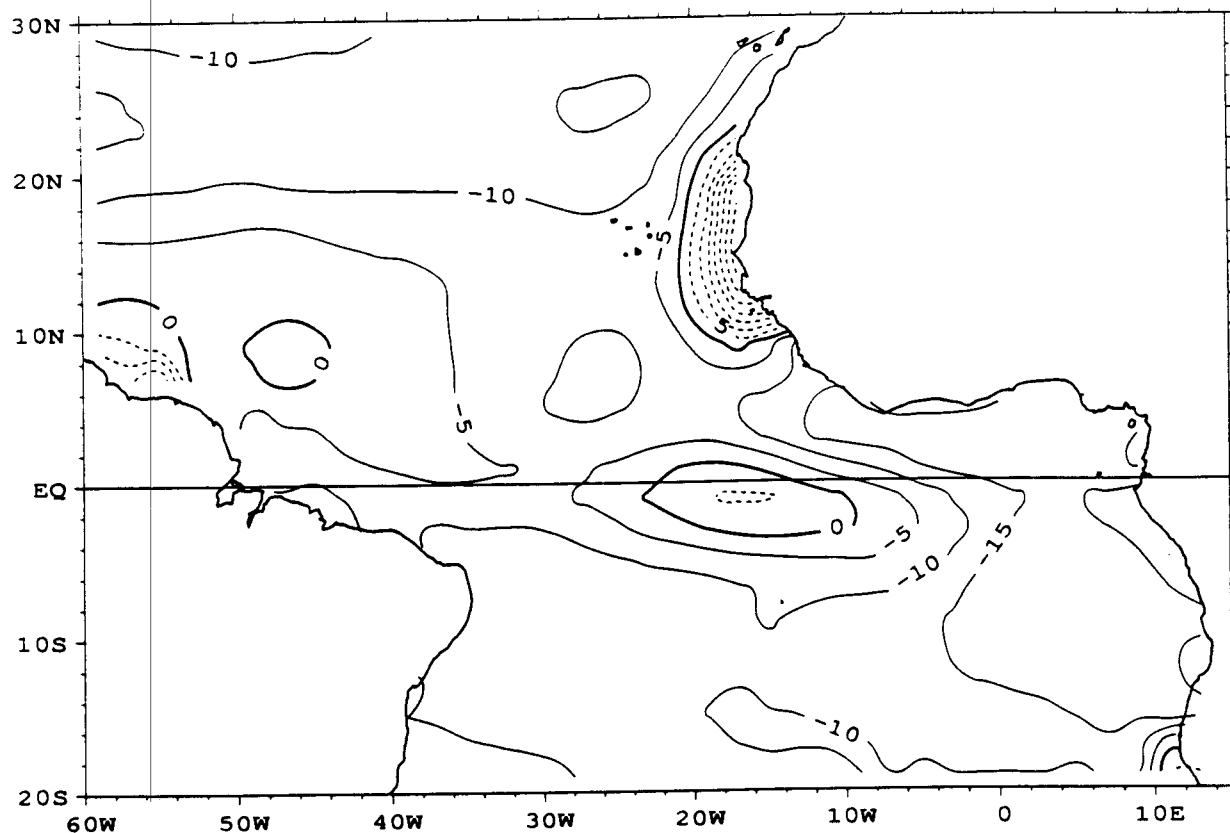
SENSIBLE (W/M**2) *NUMERICAL MODEL*MARS 1989



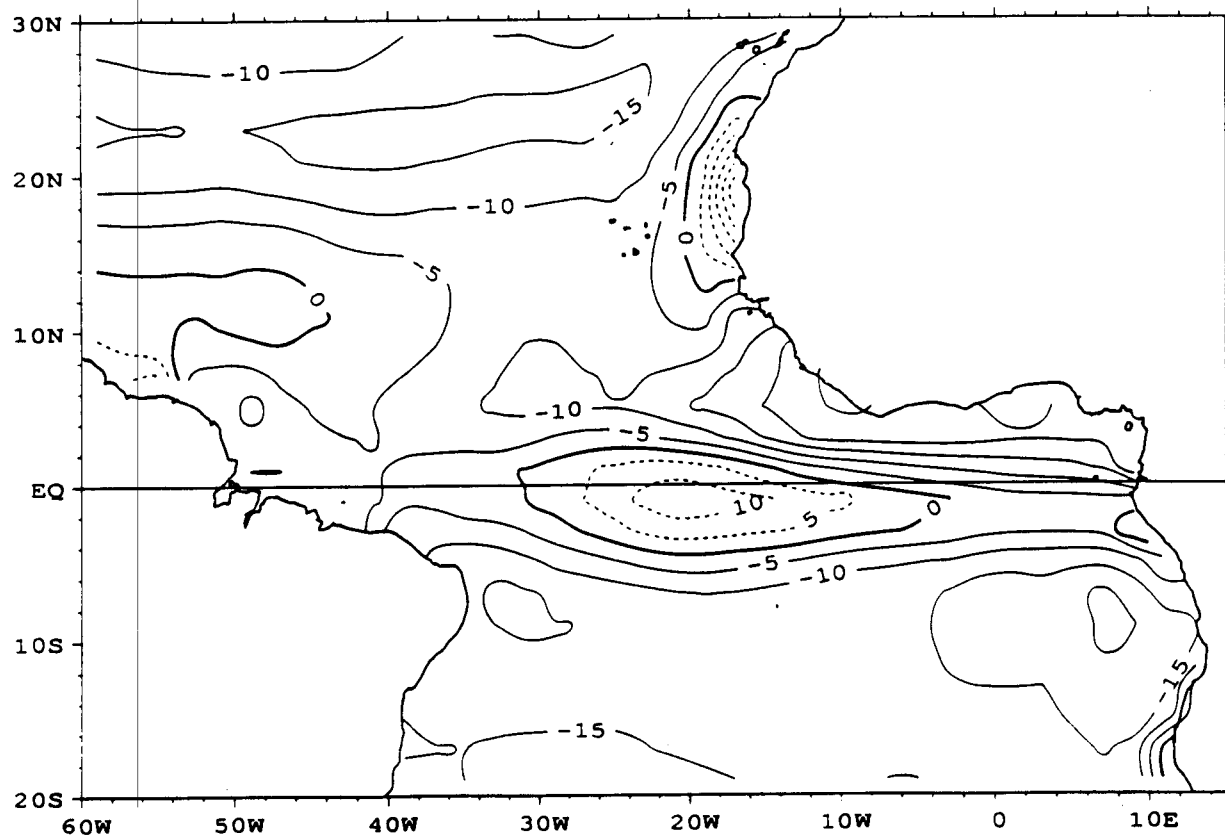
SENSIBLE (W/M**2) *NUMERICAL MODEL*AVRIL 1989



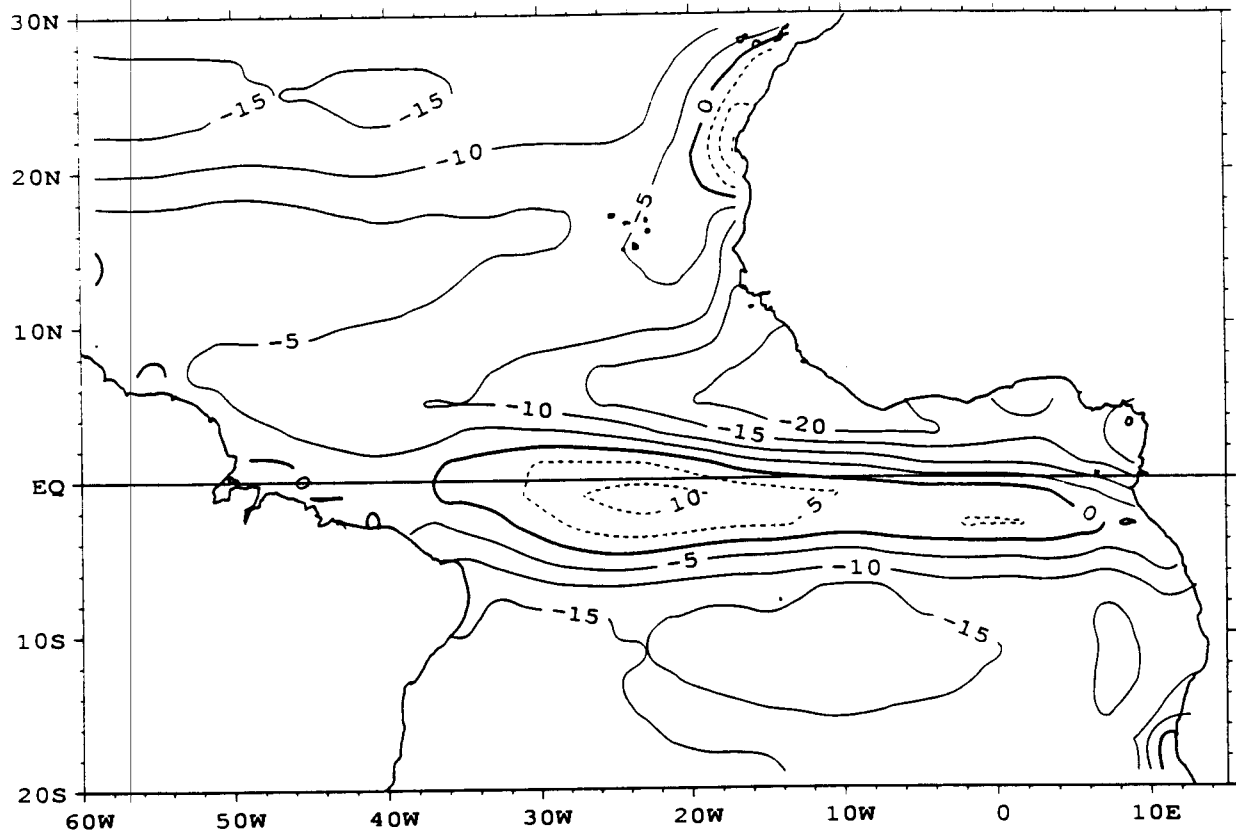
SENSIBLE* (W/M**2) *NUMERICAL MODEL*MAI 1989



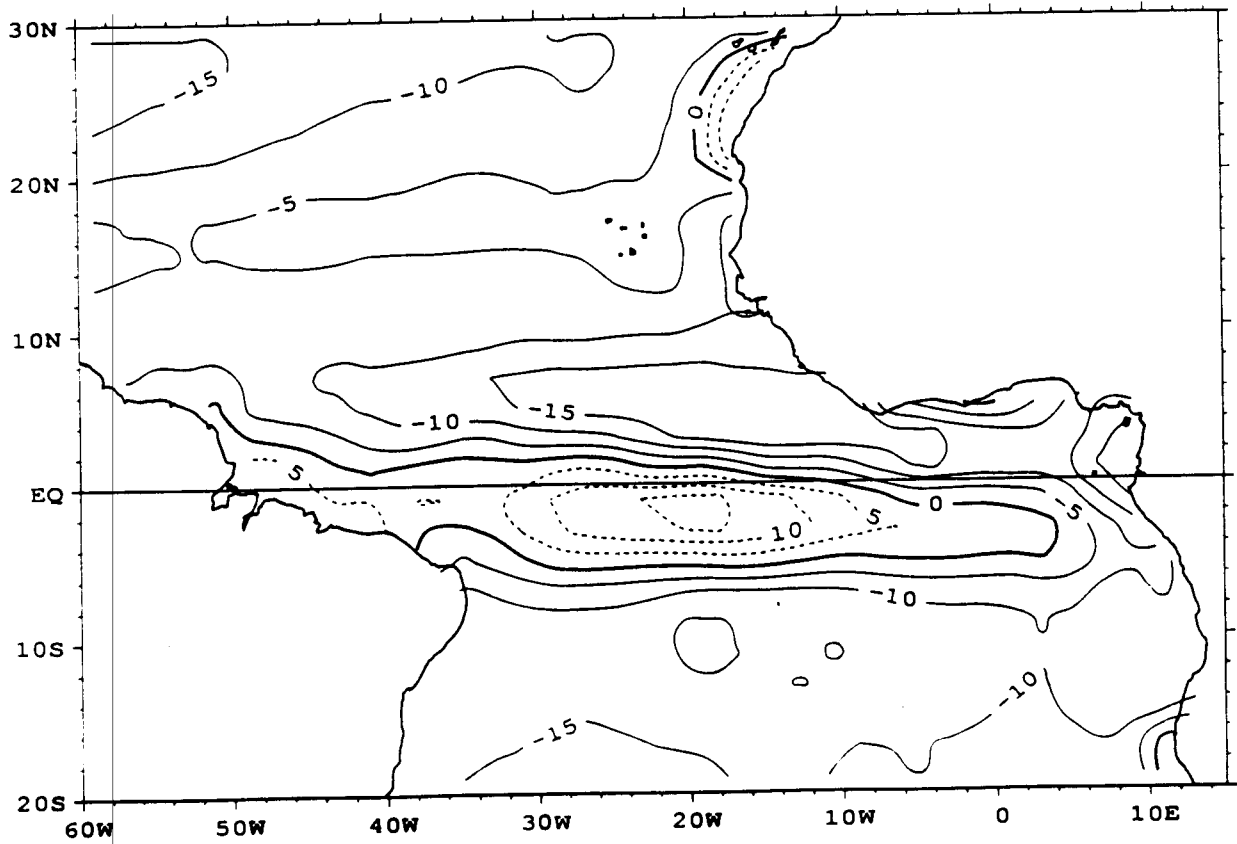
SENSIBLE* (W/M**2) *NUMERICAL MODEL*JUIN 1989



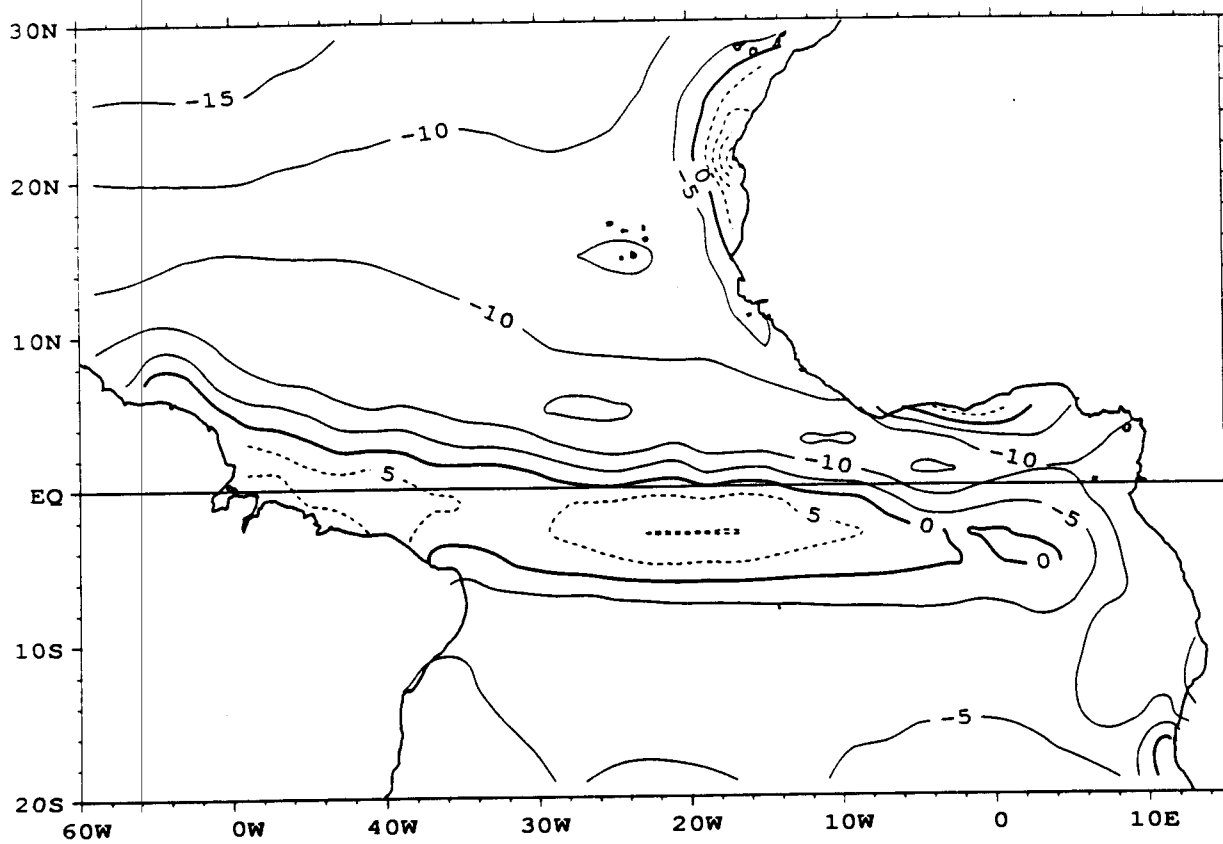
SENSIBLE* (W/M**2) *NUMERICAL MODEL*JUILLET1989



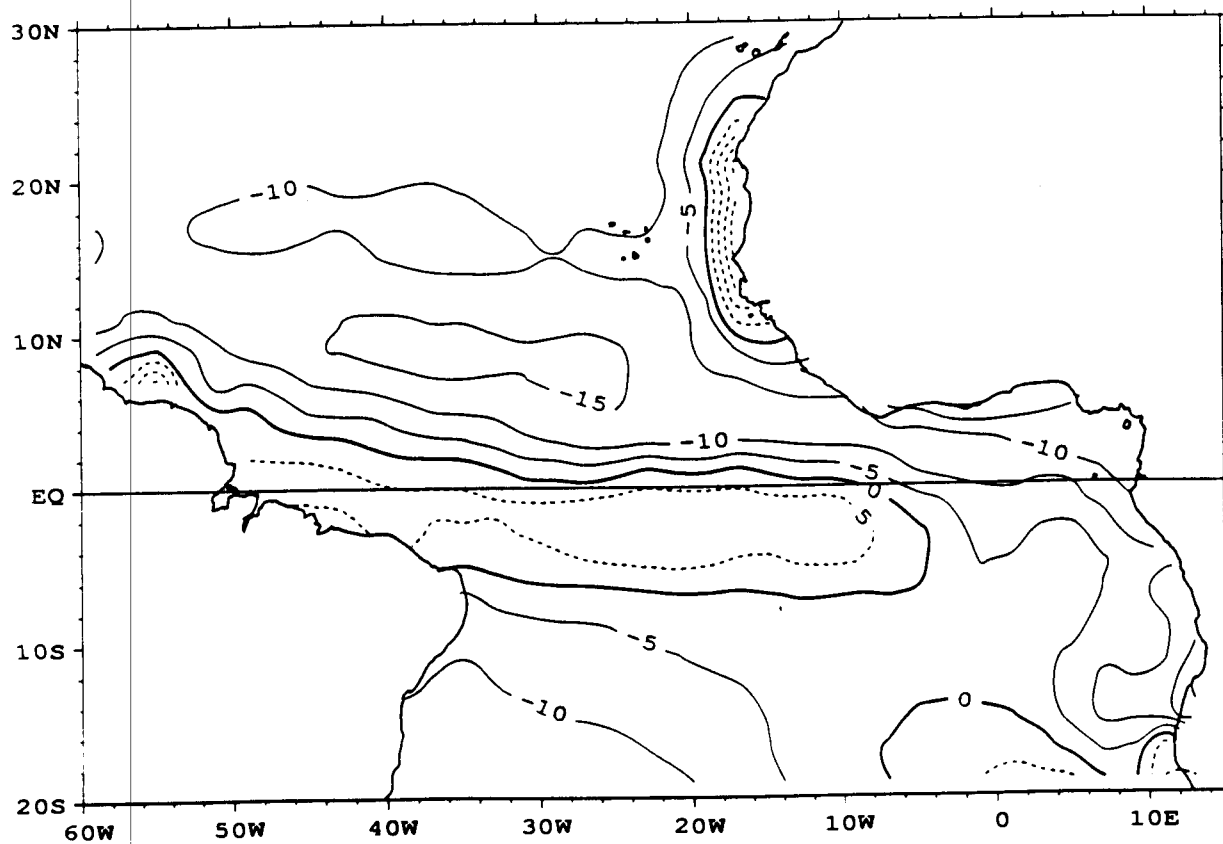
SENSIBLE* (W/M**2) *NUMERICAL MODEL*AOOUT 1989



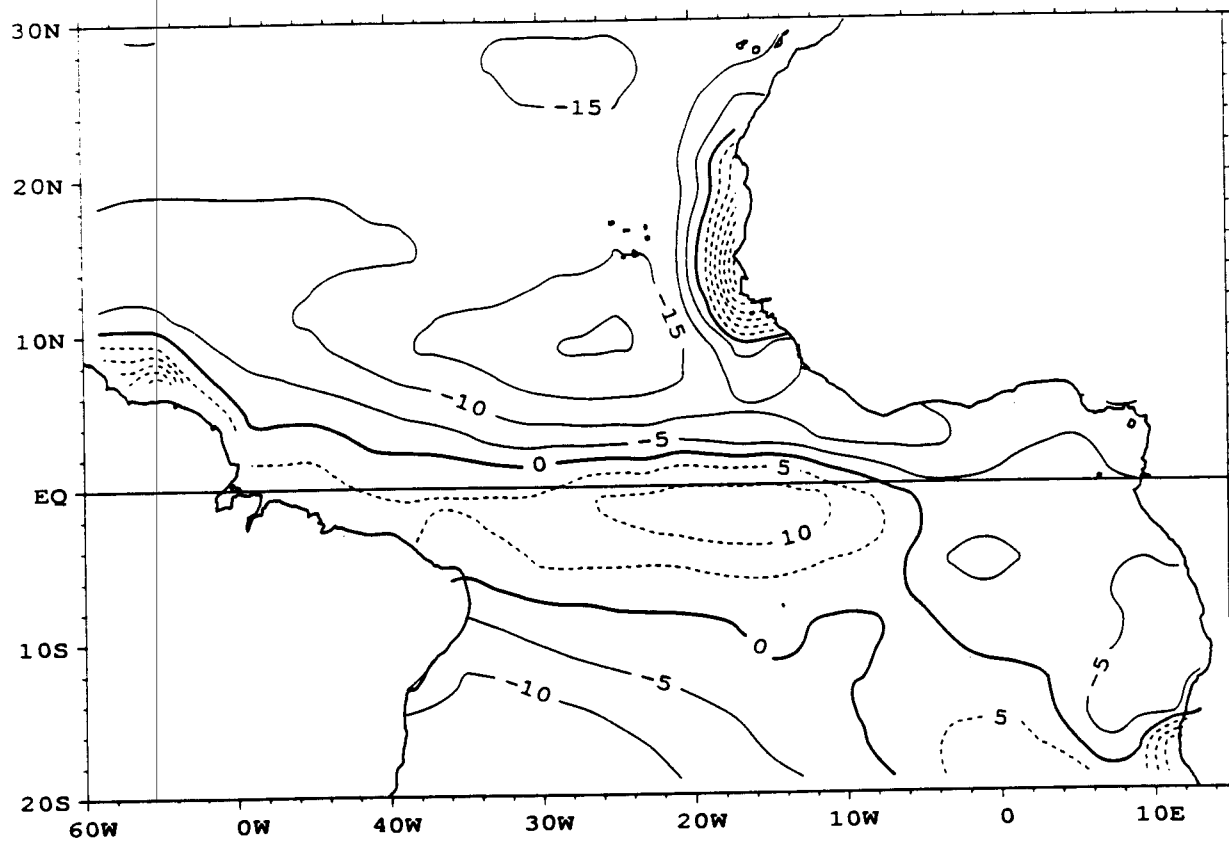
SENSIBLE* (W/M**2) *NUMERICAL MODEL*SEPTEMBRE89



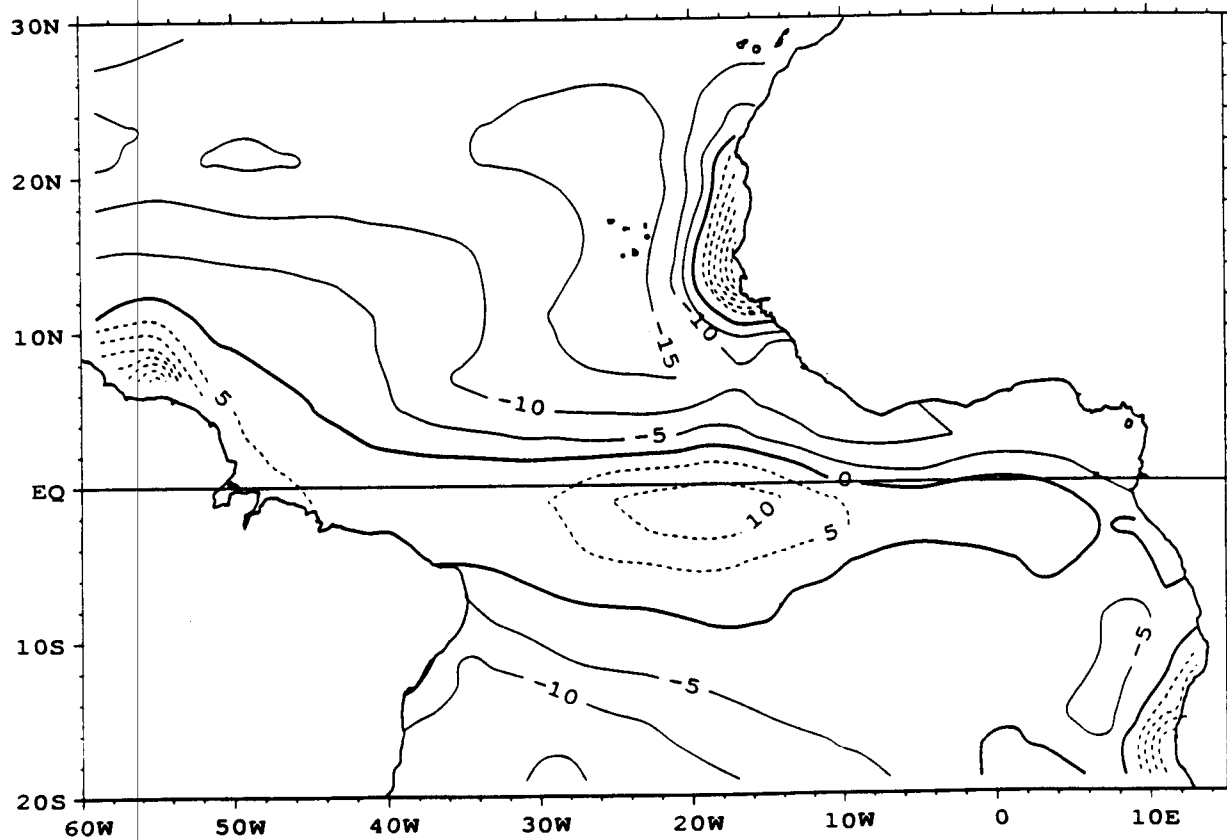
SENSIBLE* (W/M**2) *NUMERICAL MODEL*OCTOBRE 89



SENSIBLE*(W/M**2)*NUMERICAL MODEL*NOVEMBRE 89



SENSIBLE (W/M**2)*NUMERICAL MODEL*DECEMBRE 89



QUATRIEME PARTIE

DIFFERENCE ENTRE FLUX "OBSERVES" ET FLUX "CLIMATIQUES"

QL: page 95 à 103

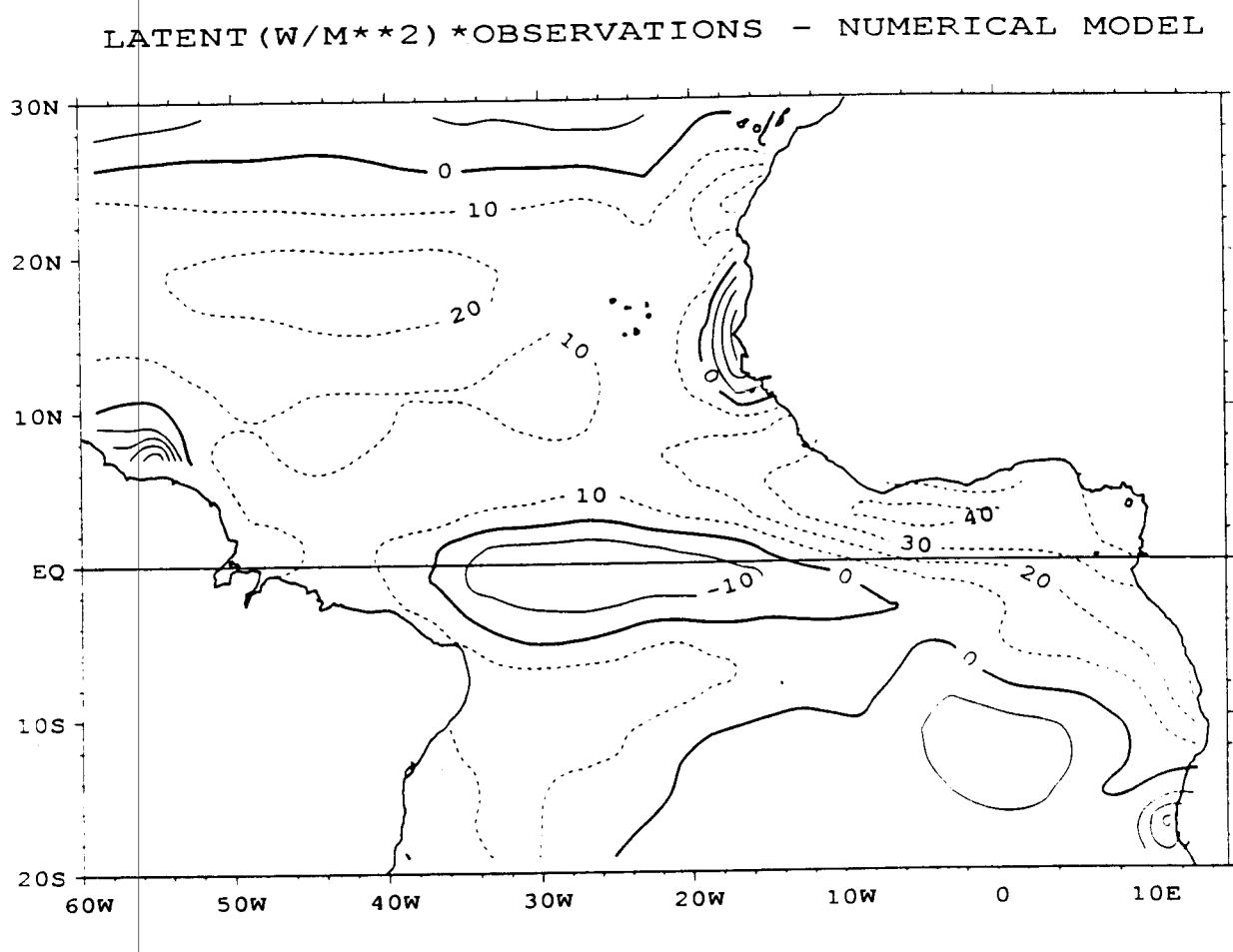
QS: page 104 à 112

QUATRIEME PARTIE

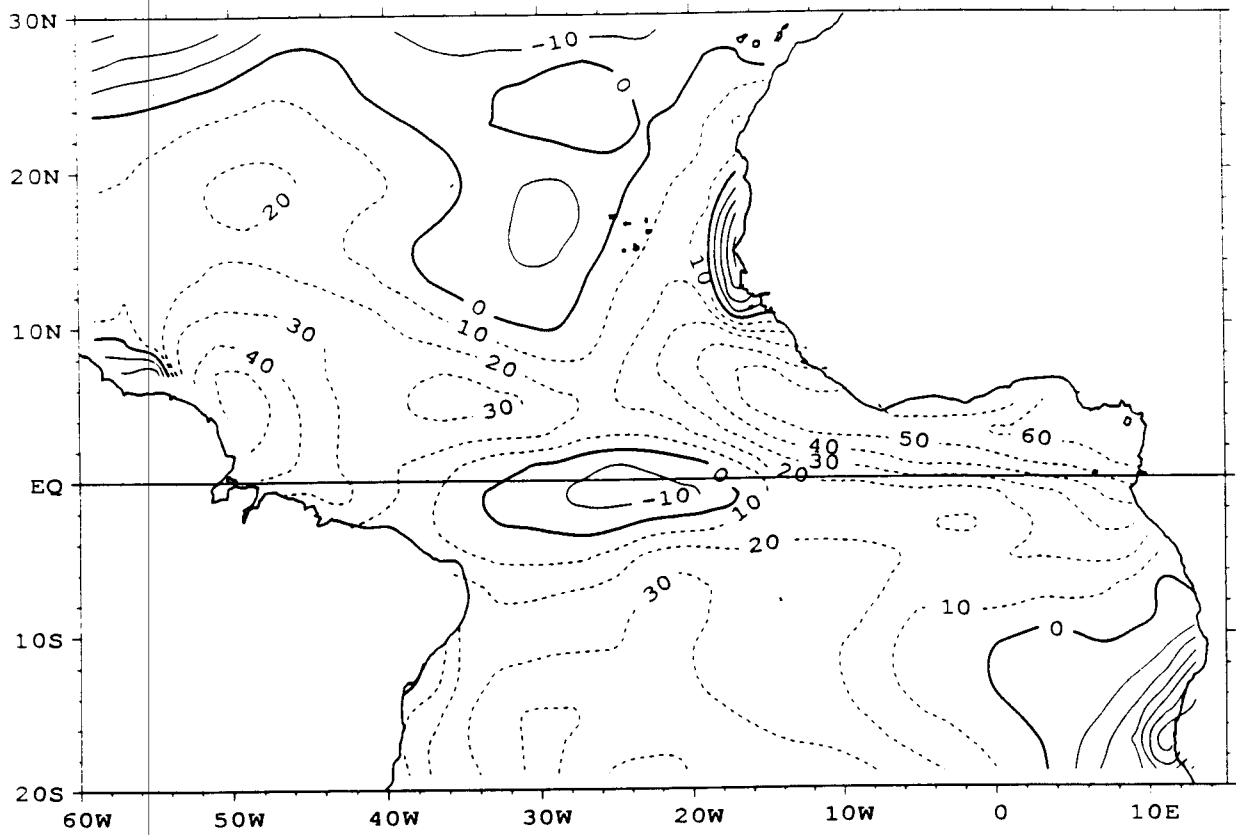
DIFFERENCE ENTRE FLUX "OBSERVES" ET FLUX "CLIMATIQUES"

QL: page 95 à 103

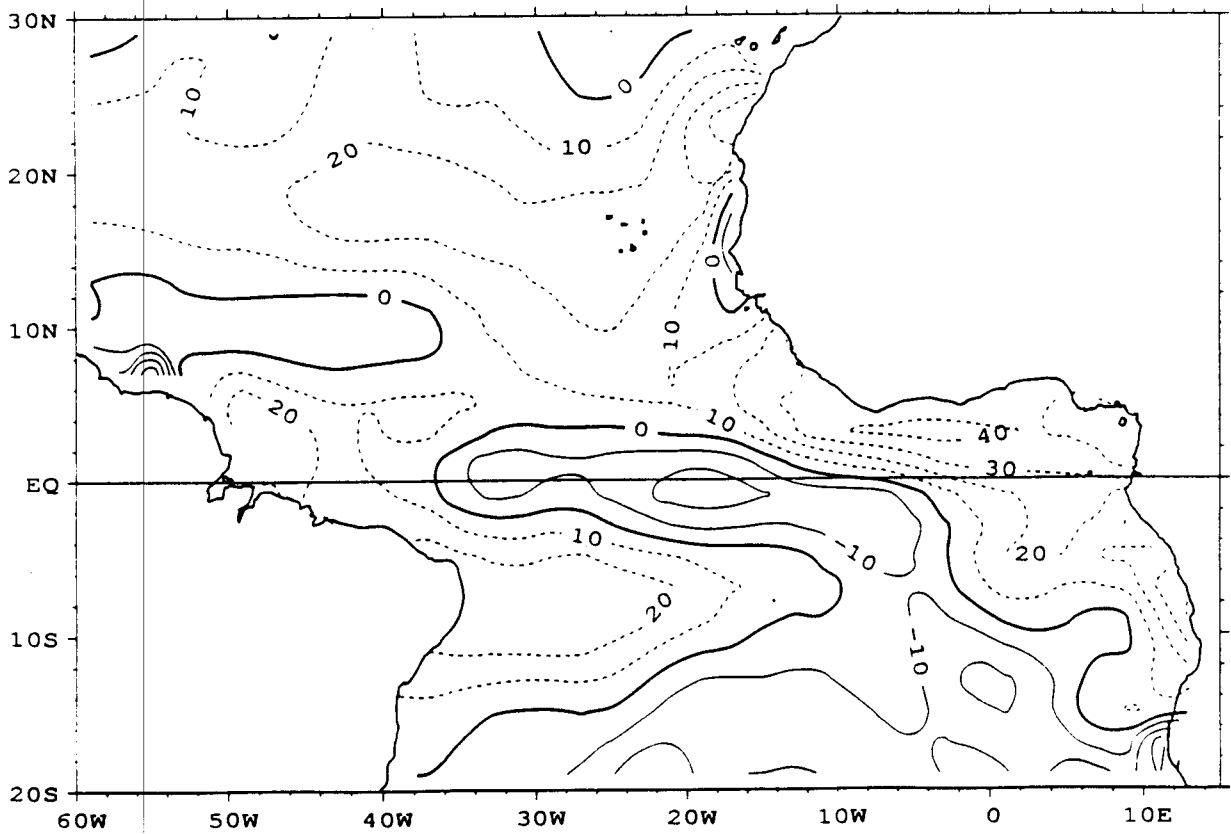
QS: page 104 à 112



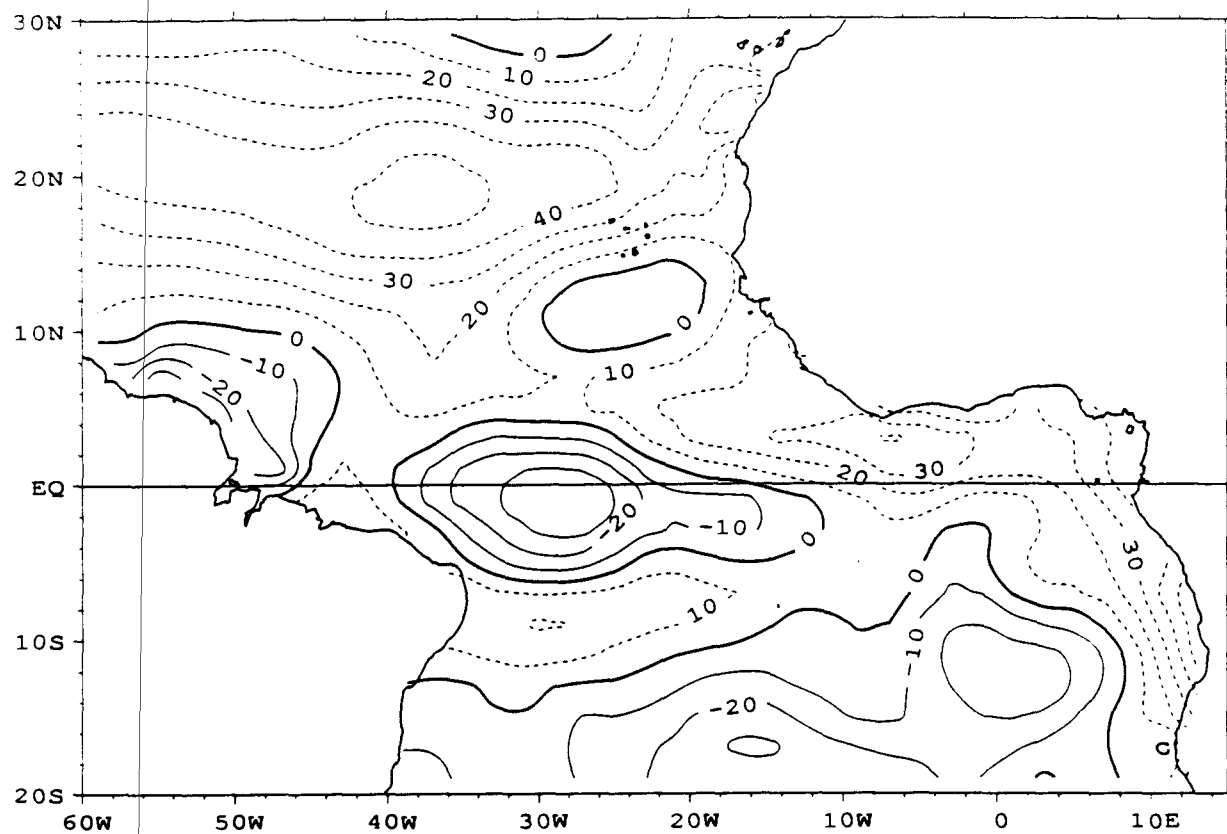
LATENT (W/M**2) *OBS. - NUM. MOD. * SEASON. MEAN (JFM)



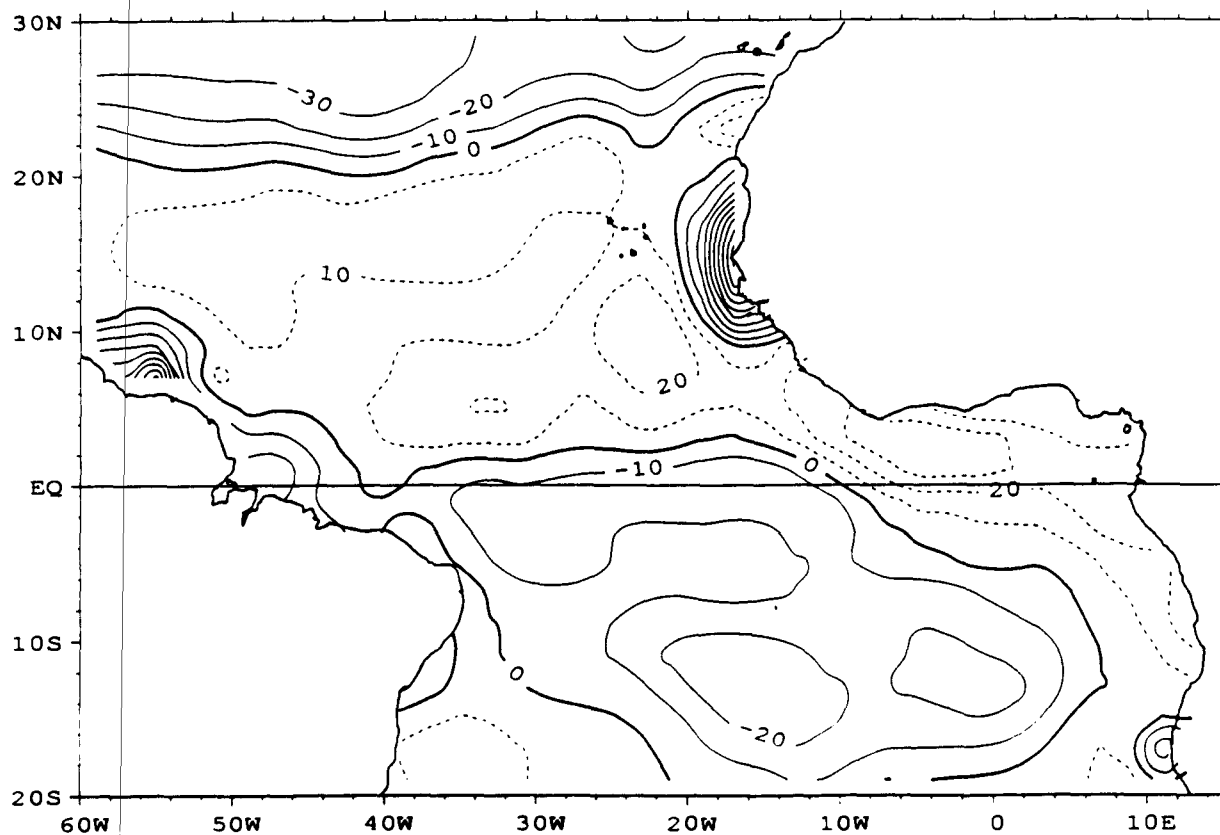
LATENT (W/M**2) *OBS. - NUM. MOD. * SEASON. MEAN (AMJ)



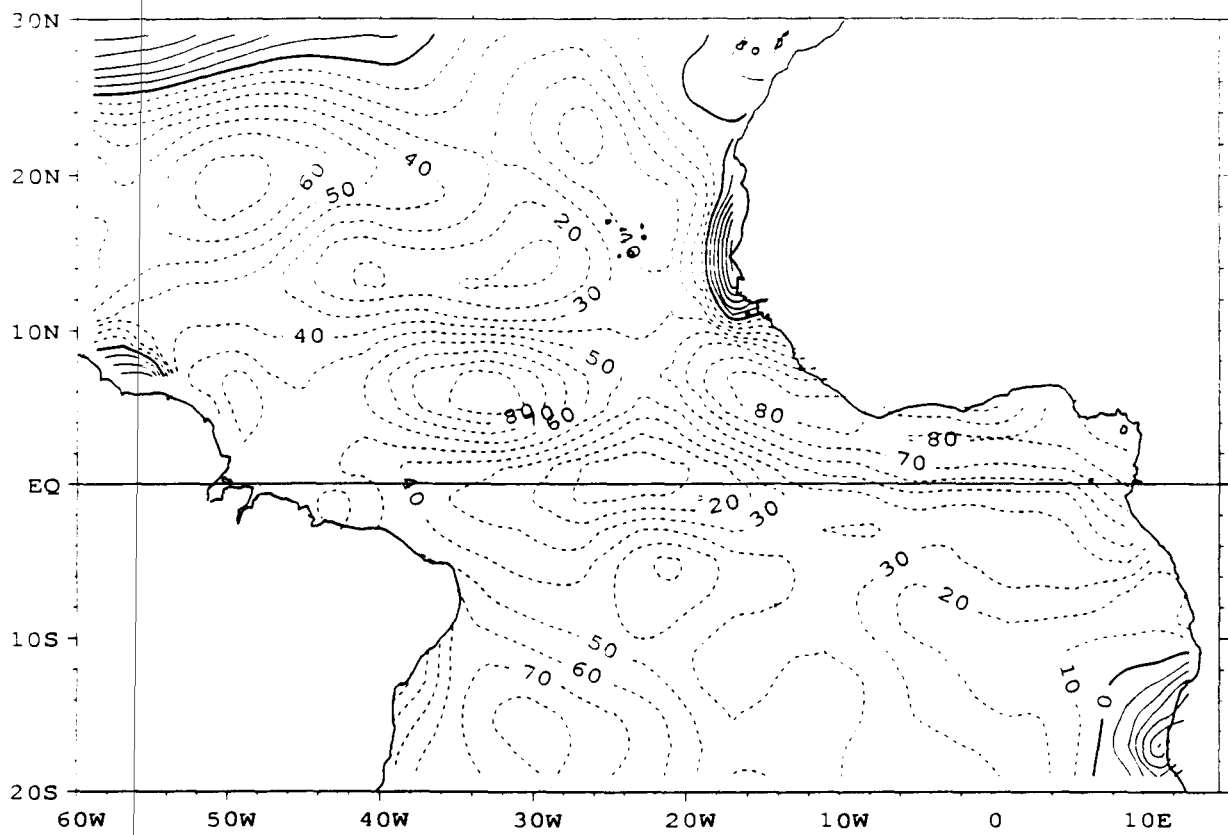
LATENT (W/M**2) *OBS. -NUM.MOD. *SEASON.MEAN (JAS)



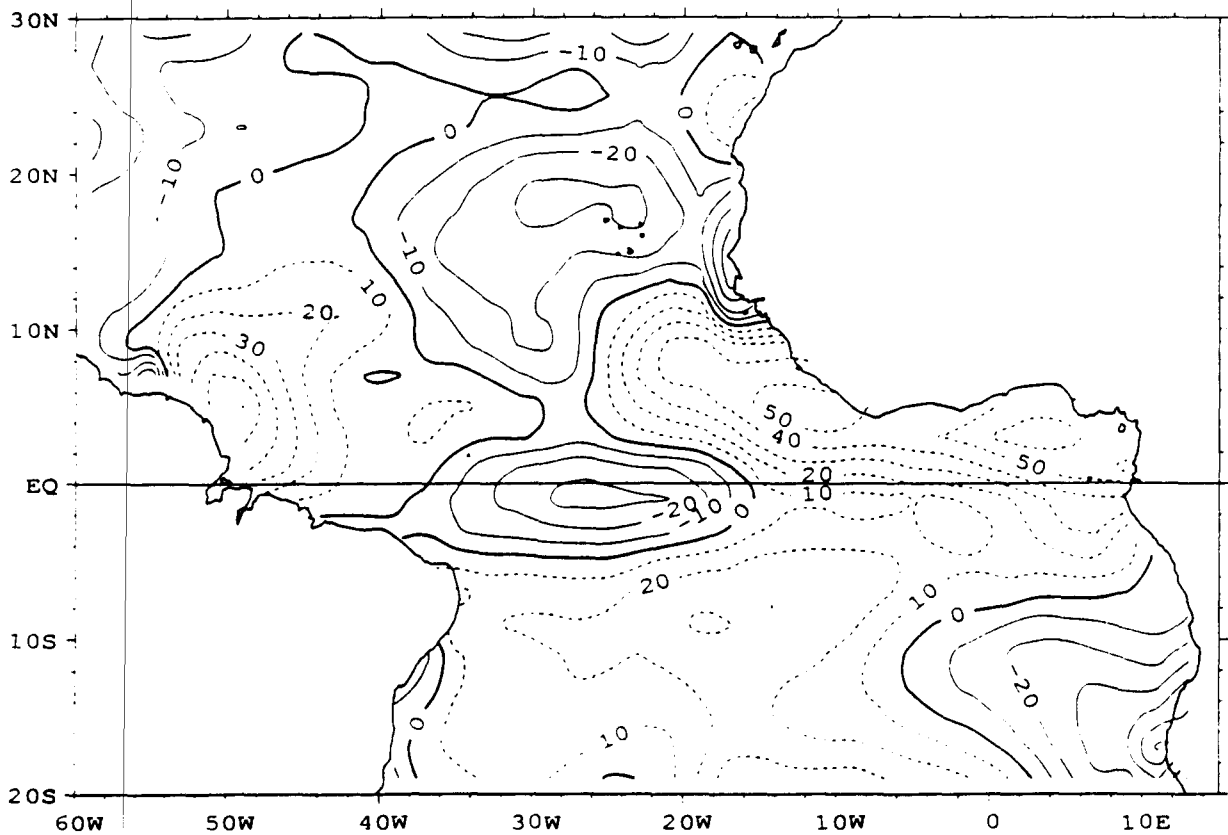
LATENT (W/M**2) *OBS. -NUM.MOD. *SEASON.MEAN (OND)



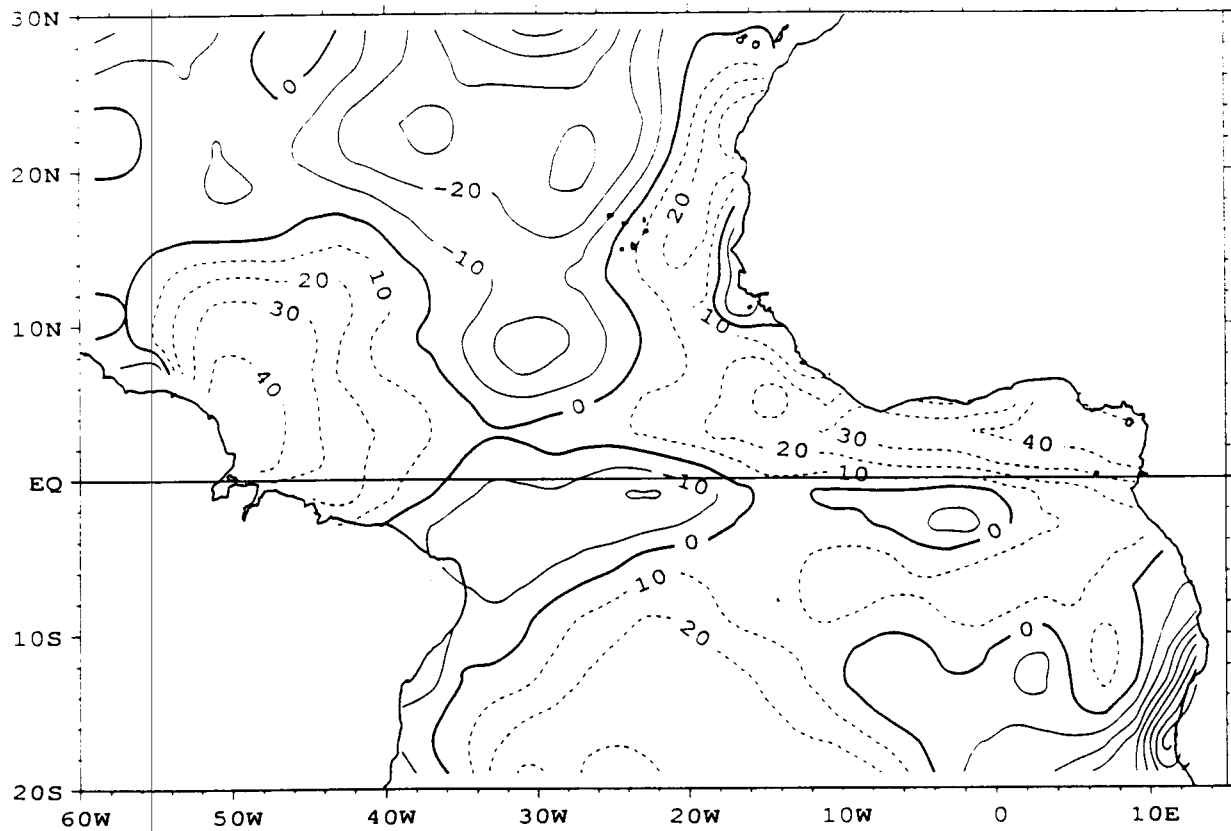
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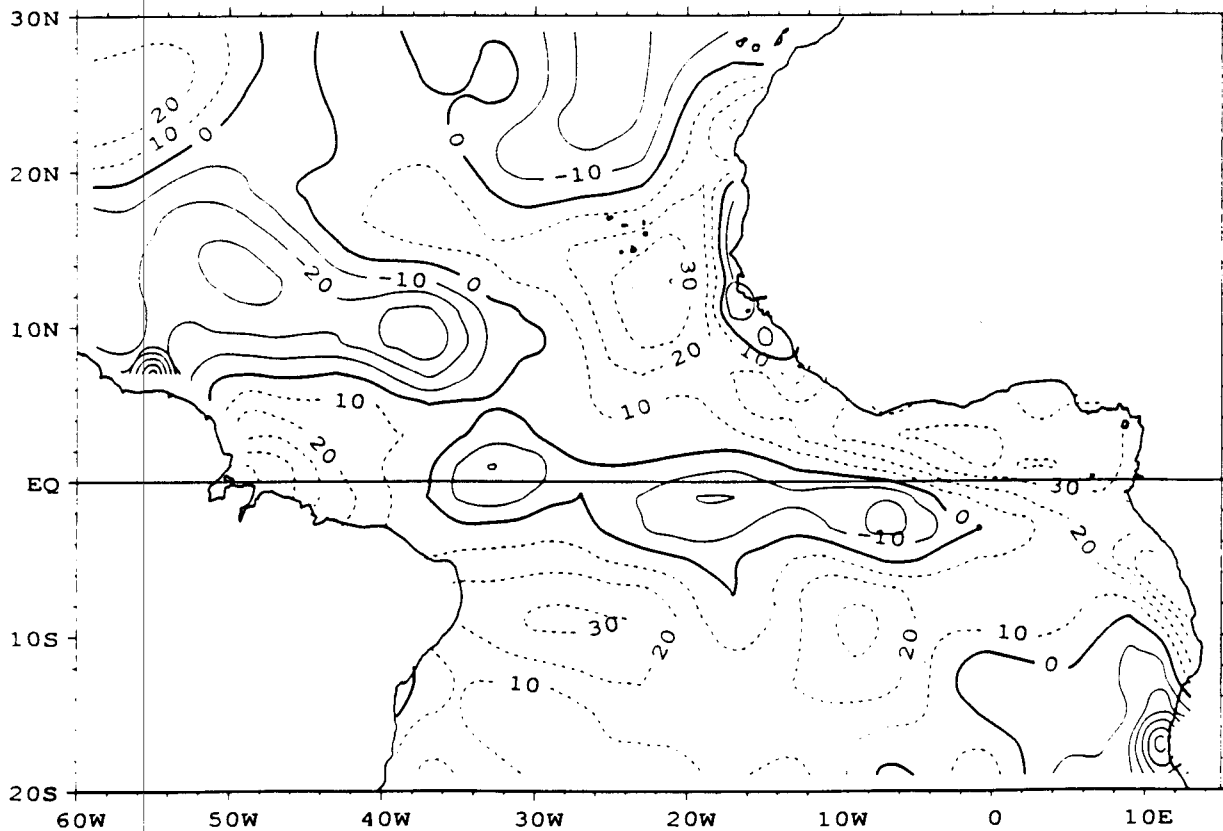
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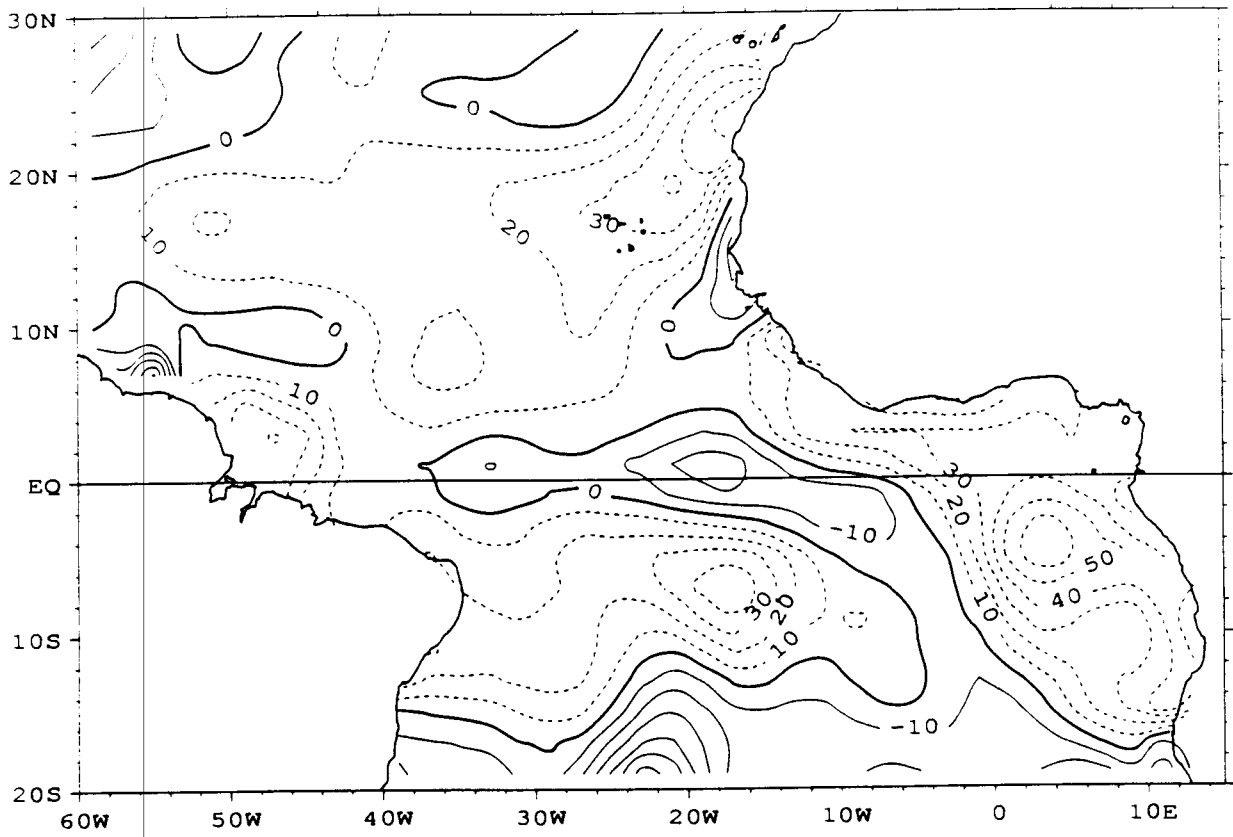
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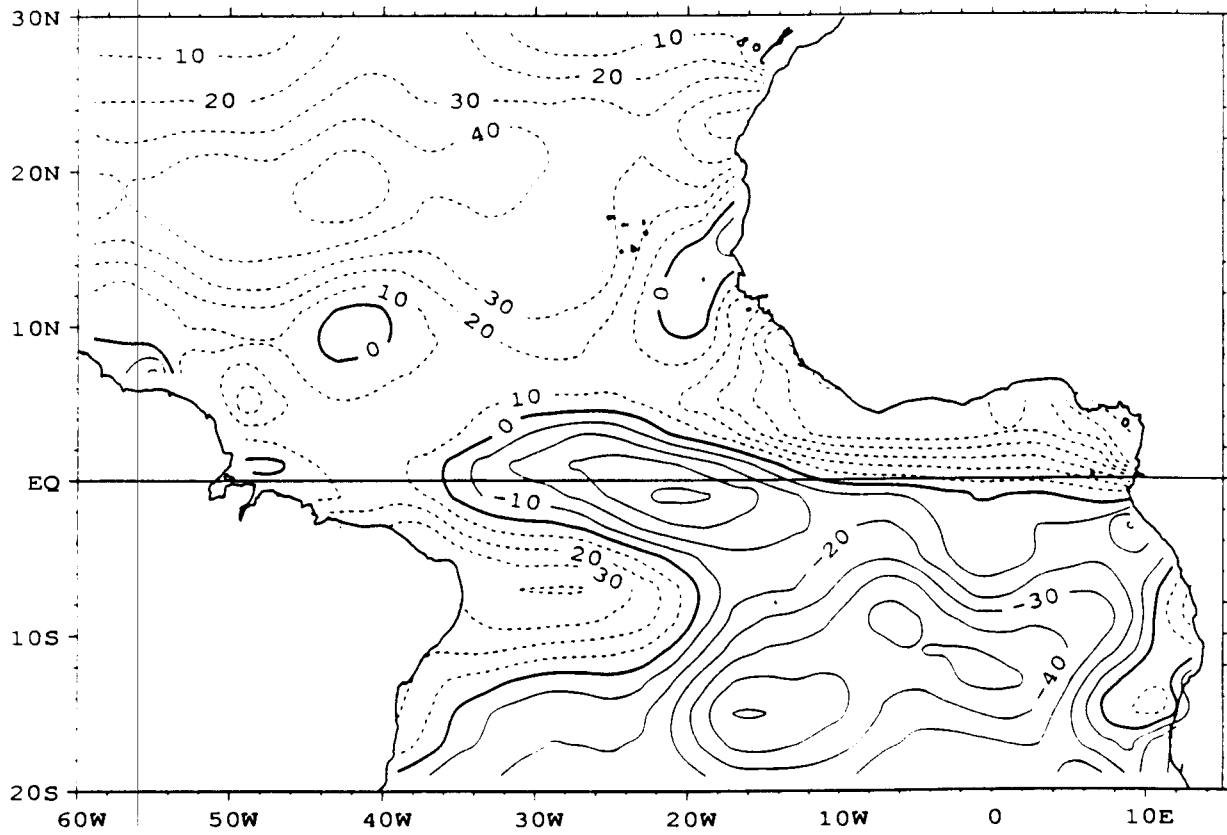
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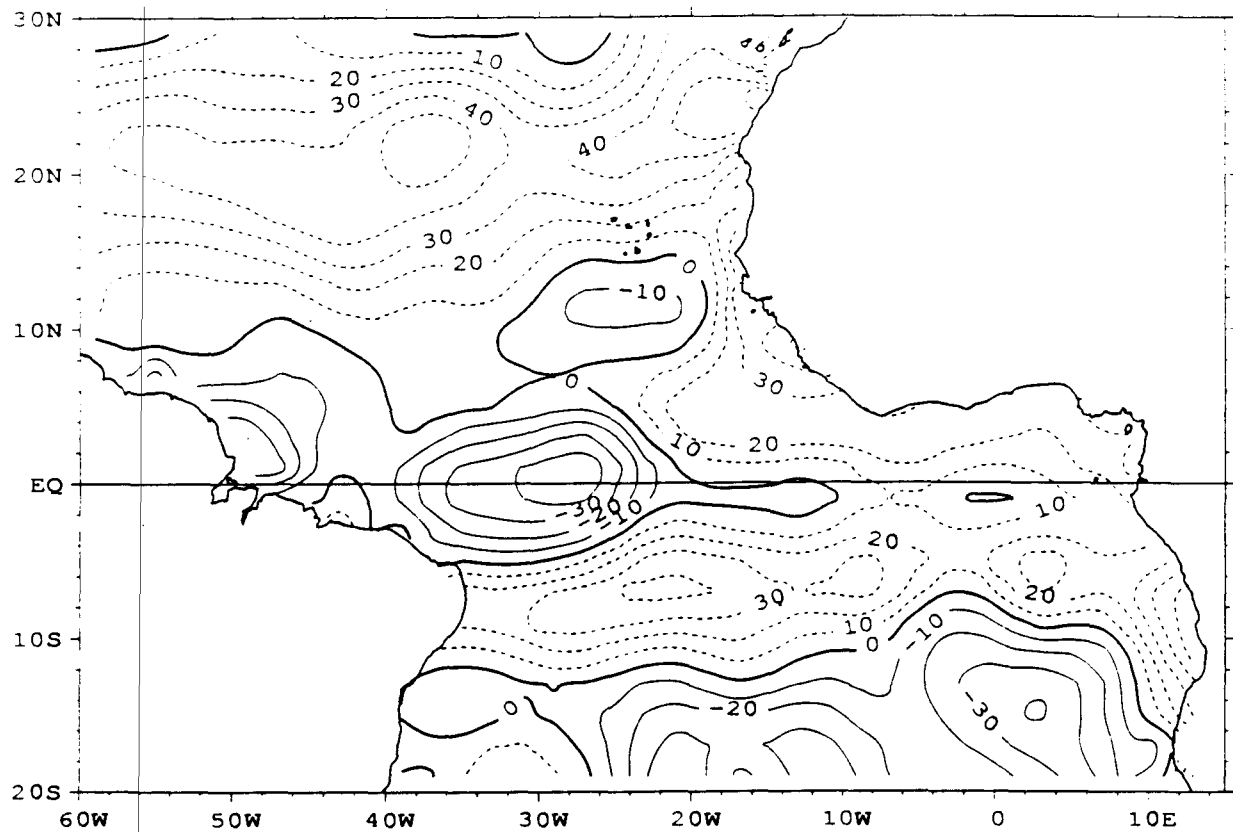
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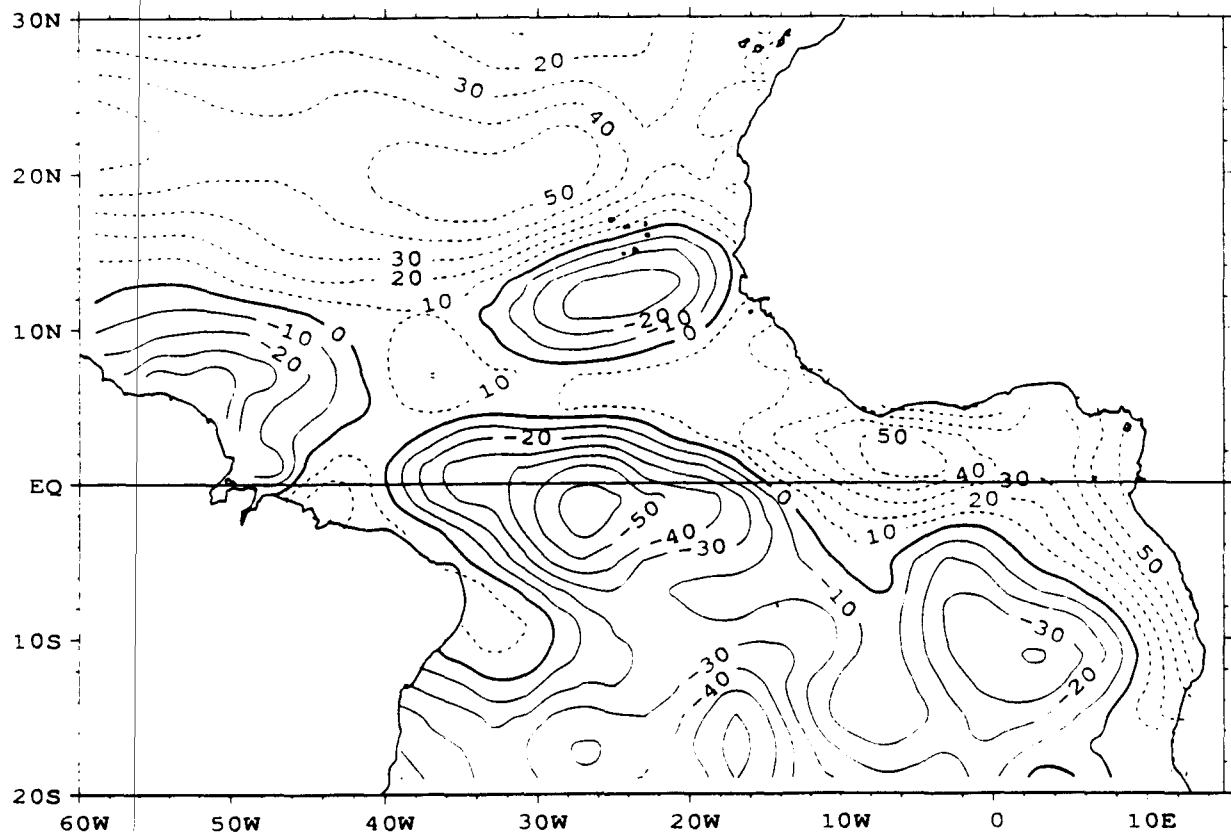
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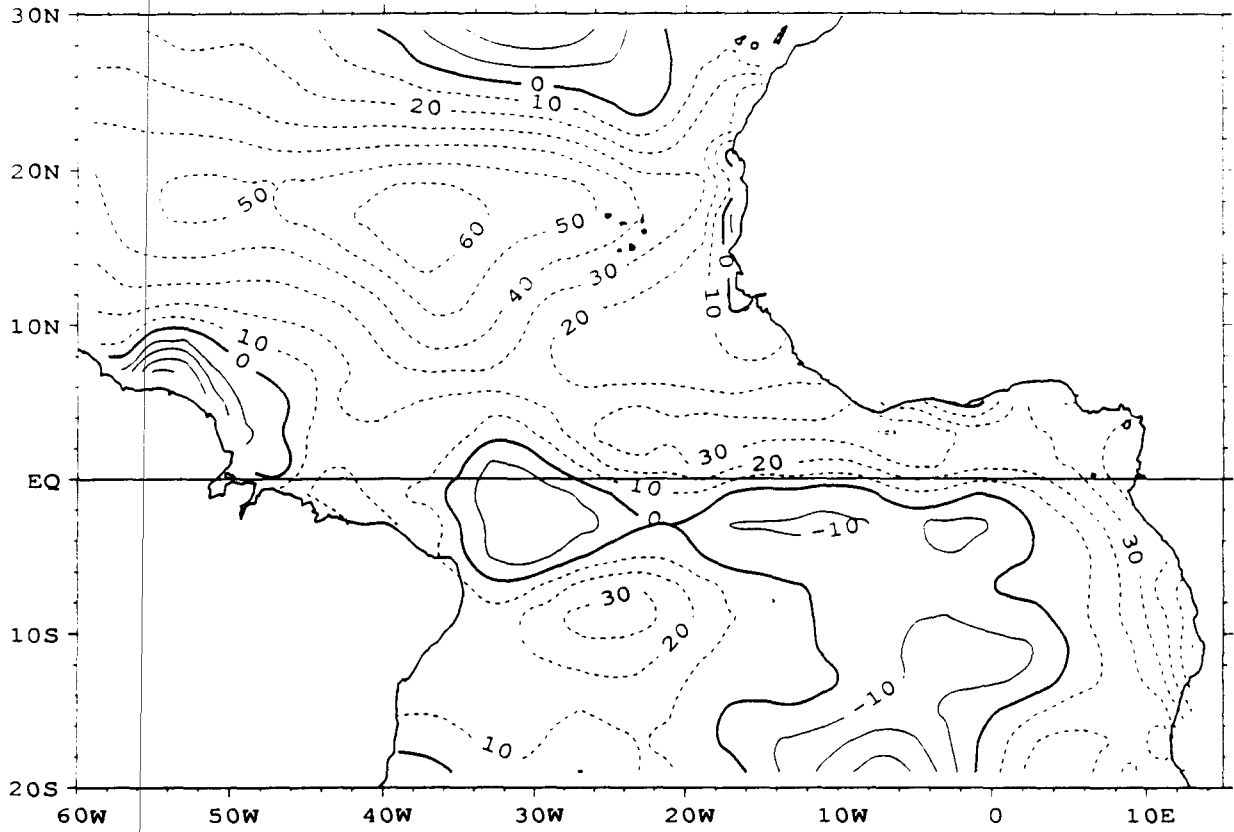
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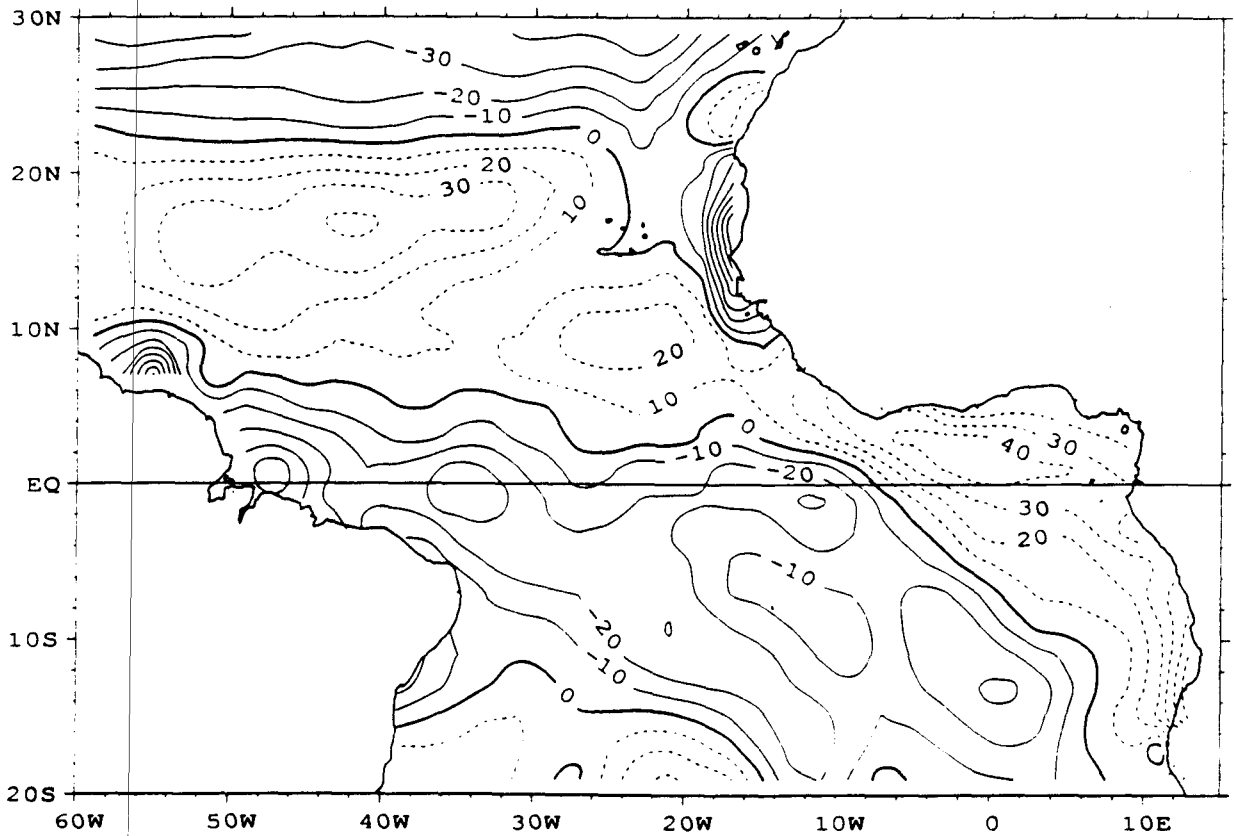
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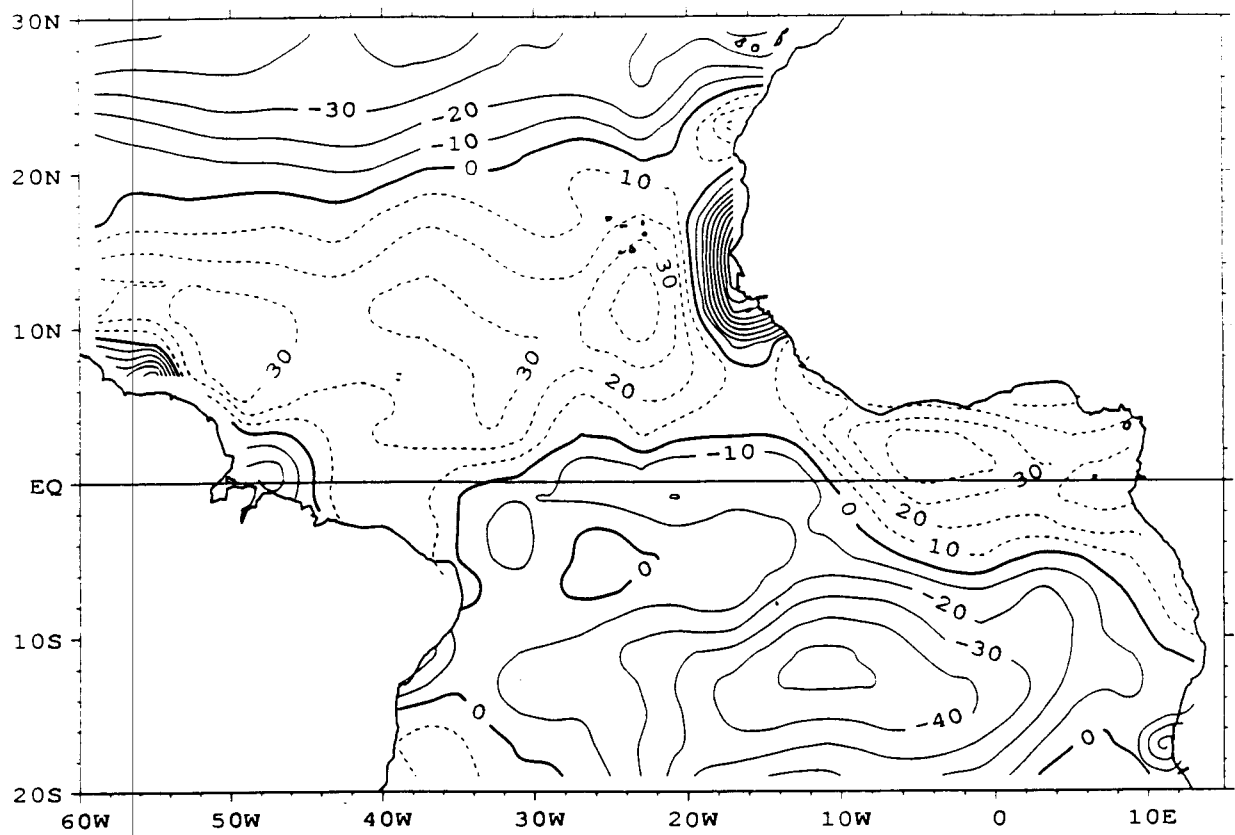
LATENT (W/M**2) *OBS. - NUM.* SEPTEMBRE 1989



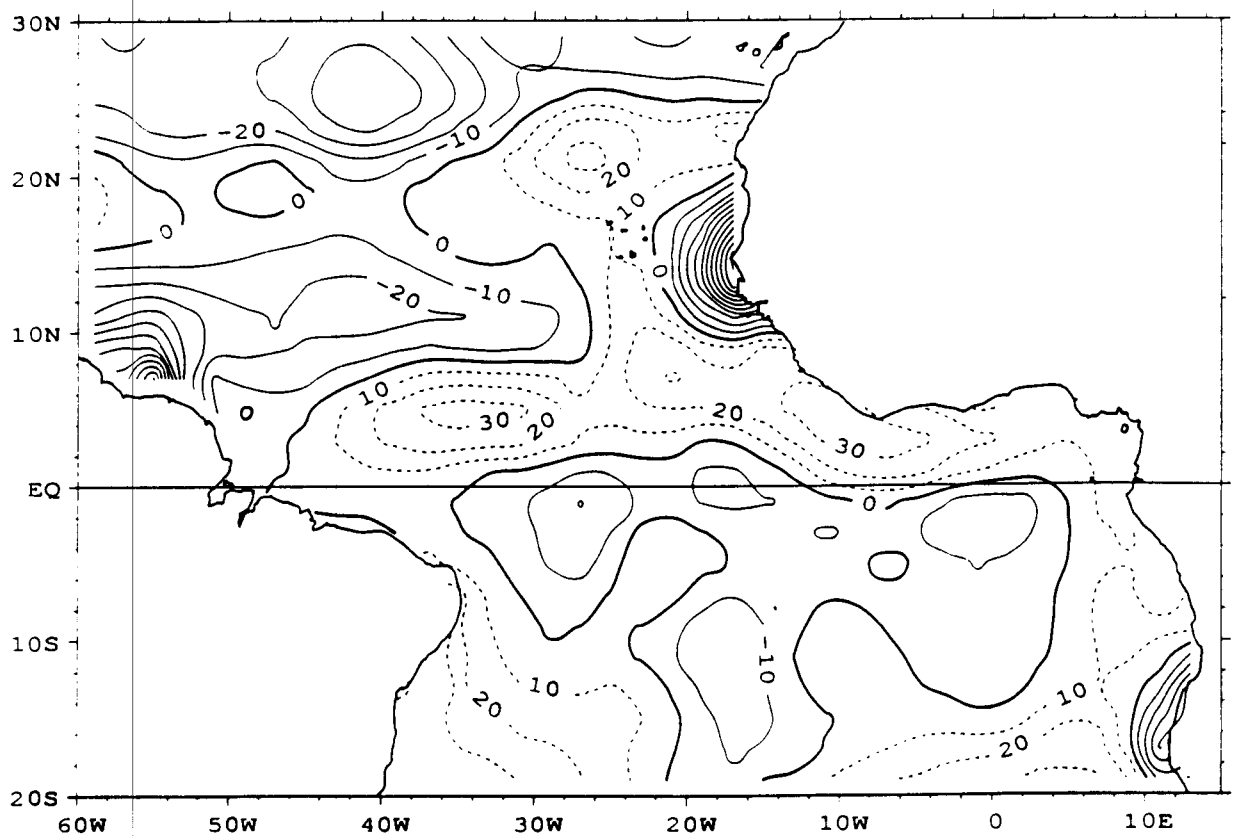
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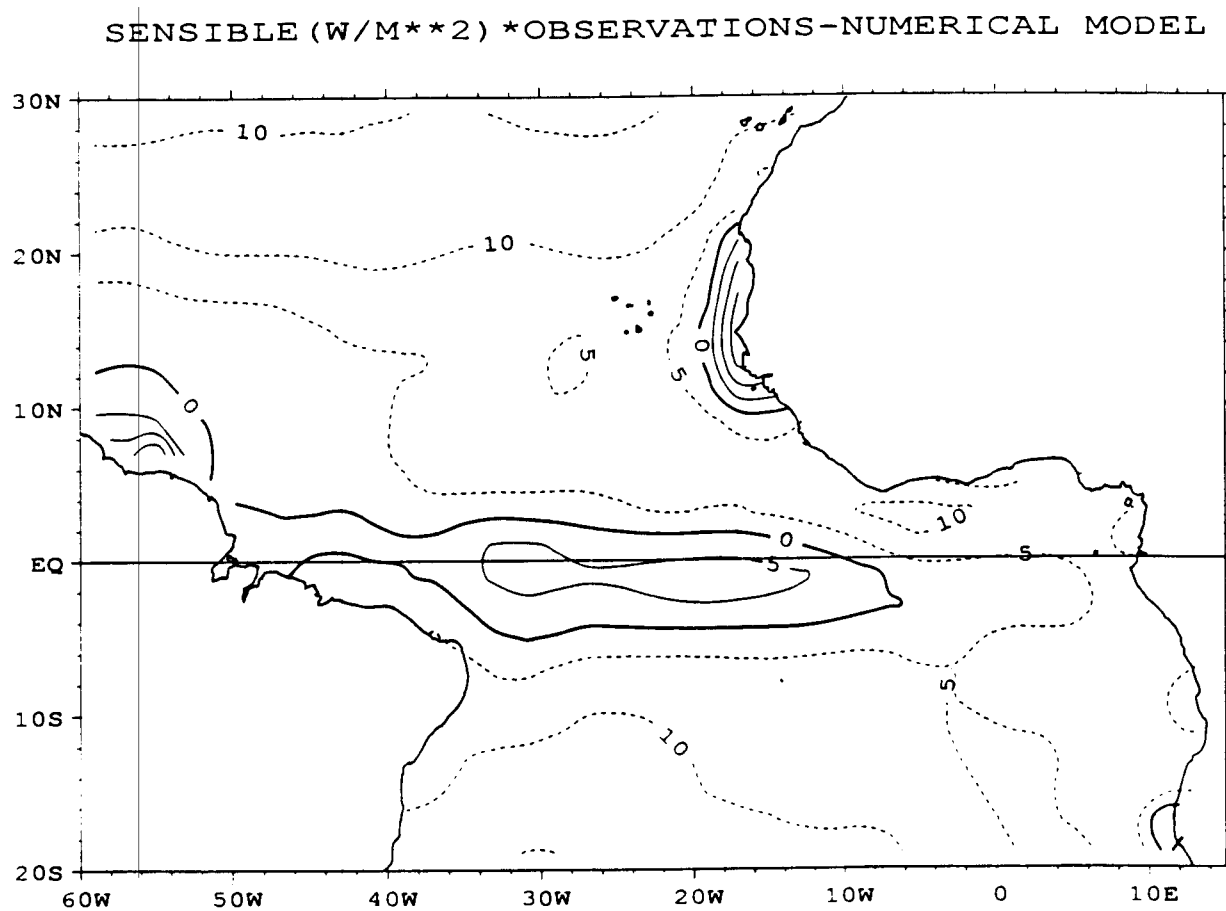


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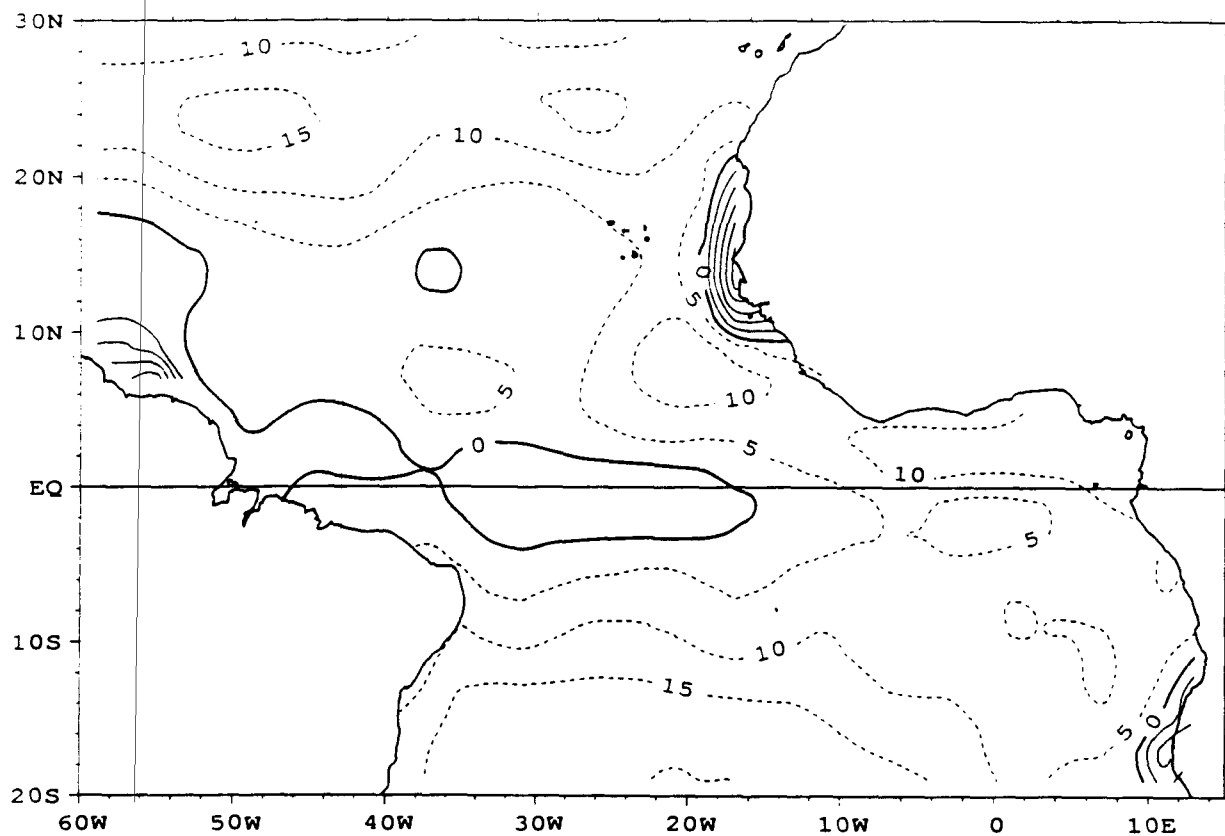


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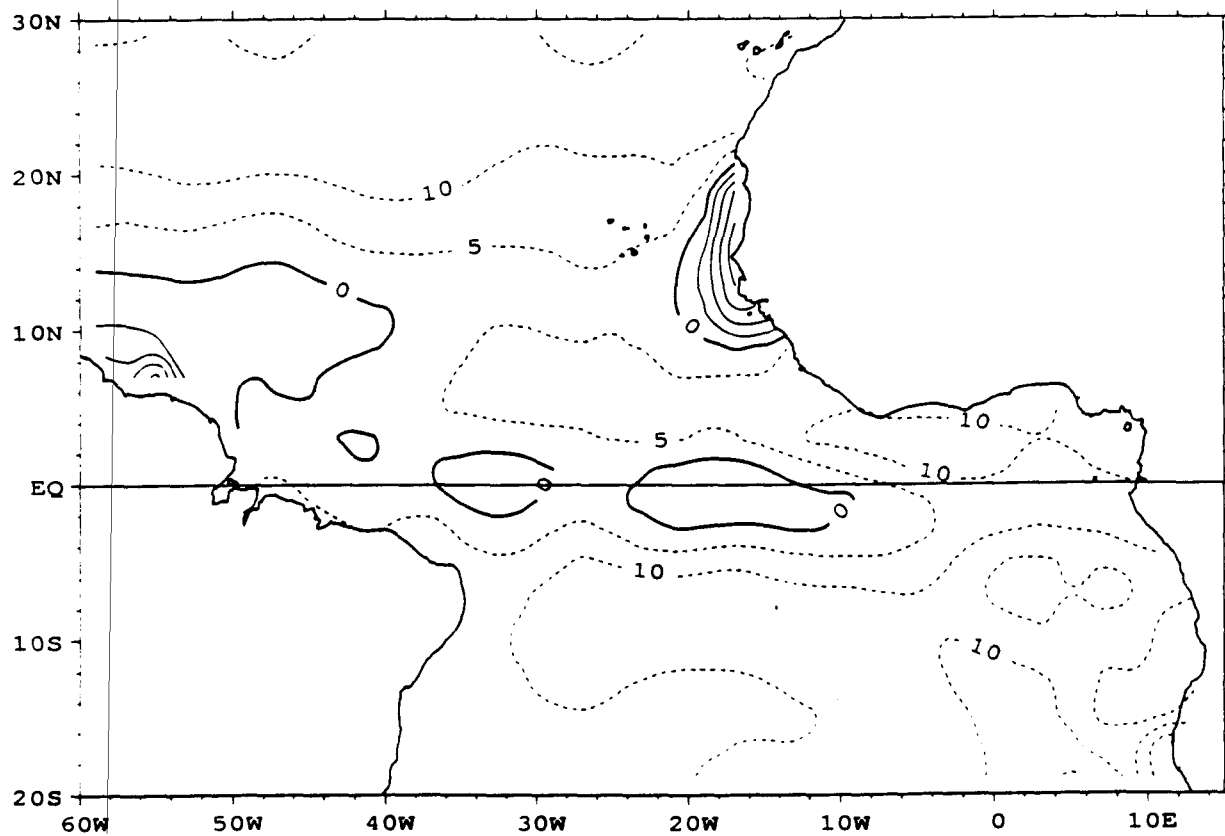




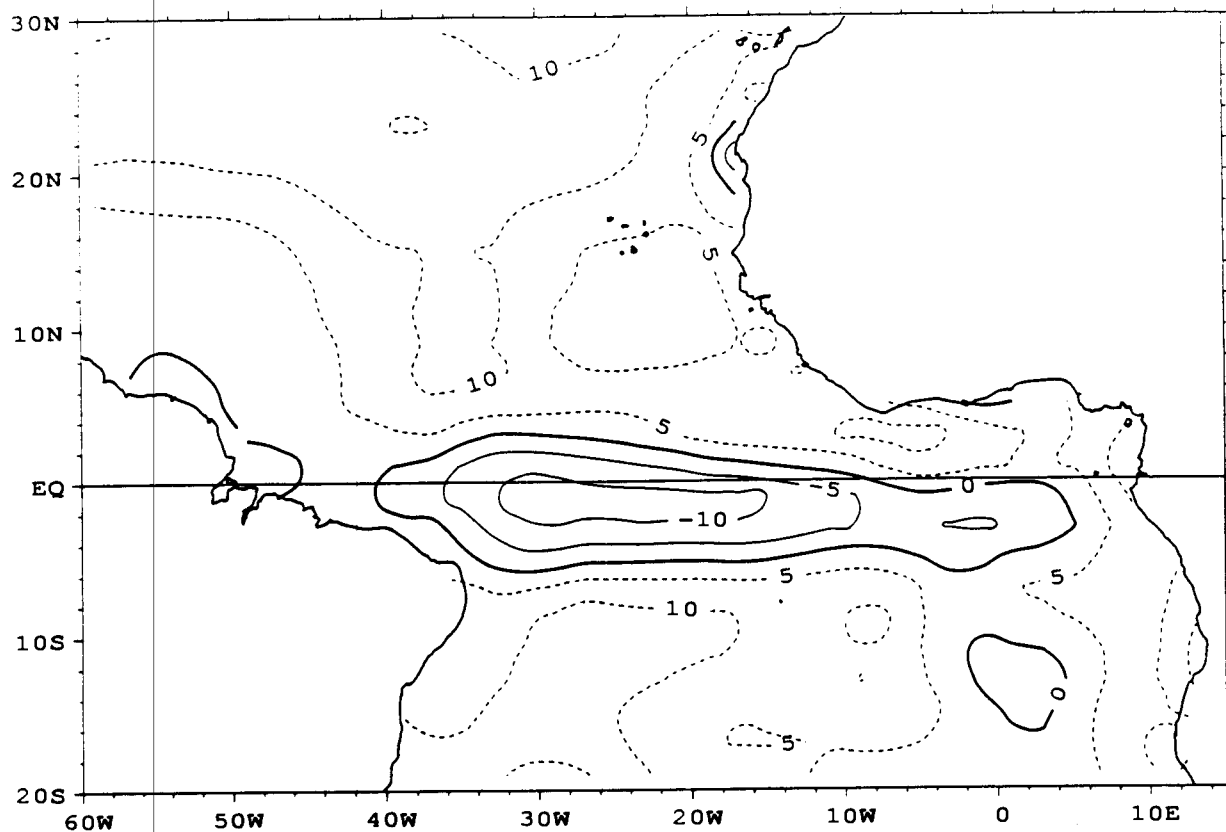
SENSIBLE (W/M**2) *OBS.-NUM.*SEASONAL MEAN (JFM)



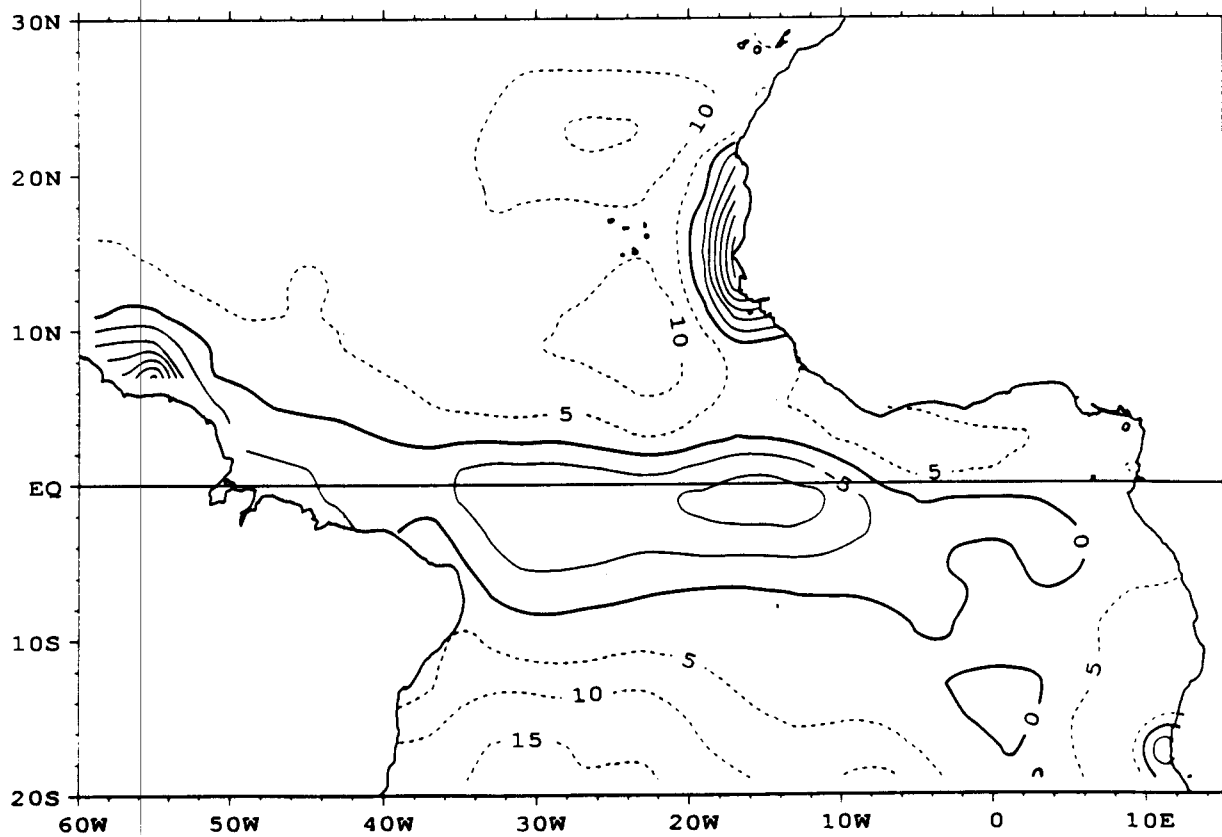
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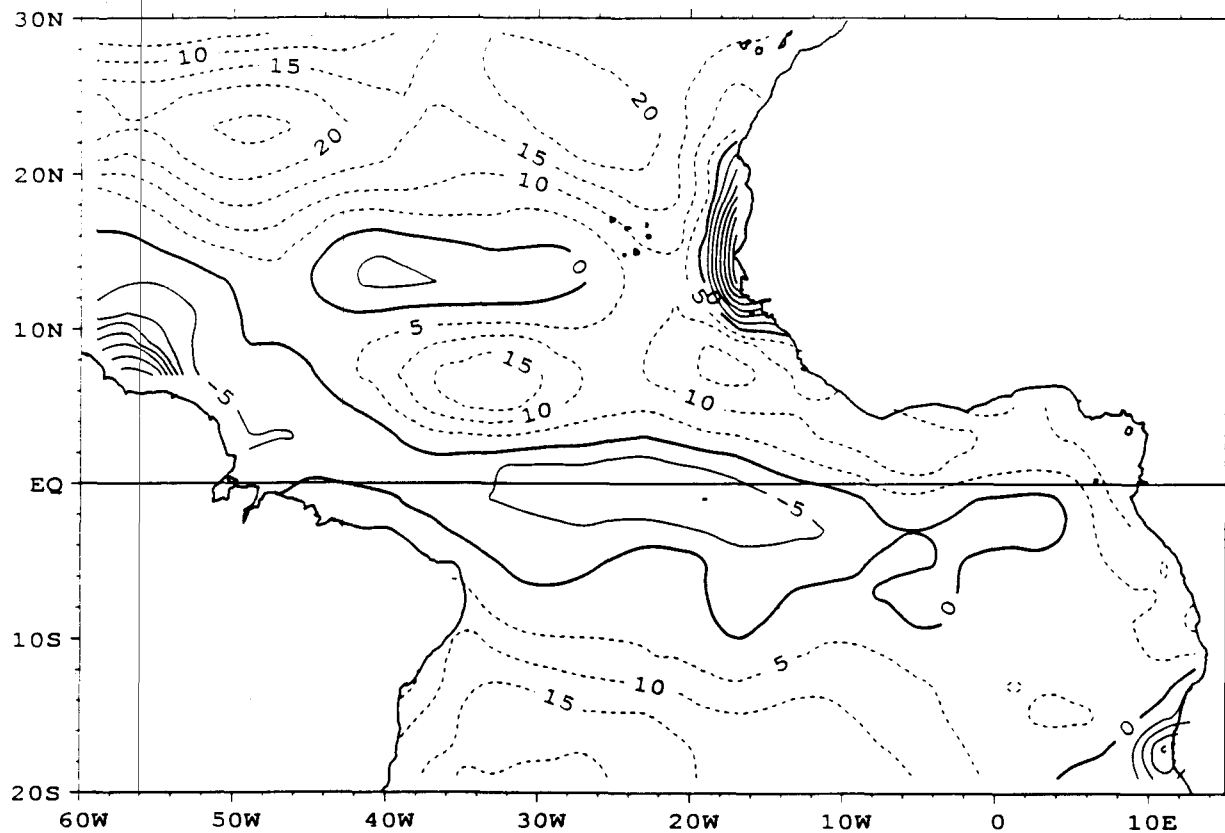


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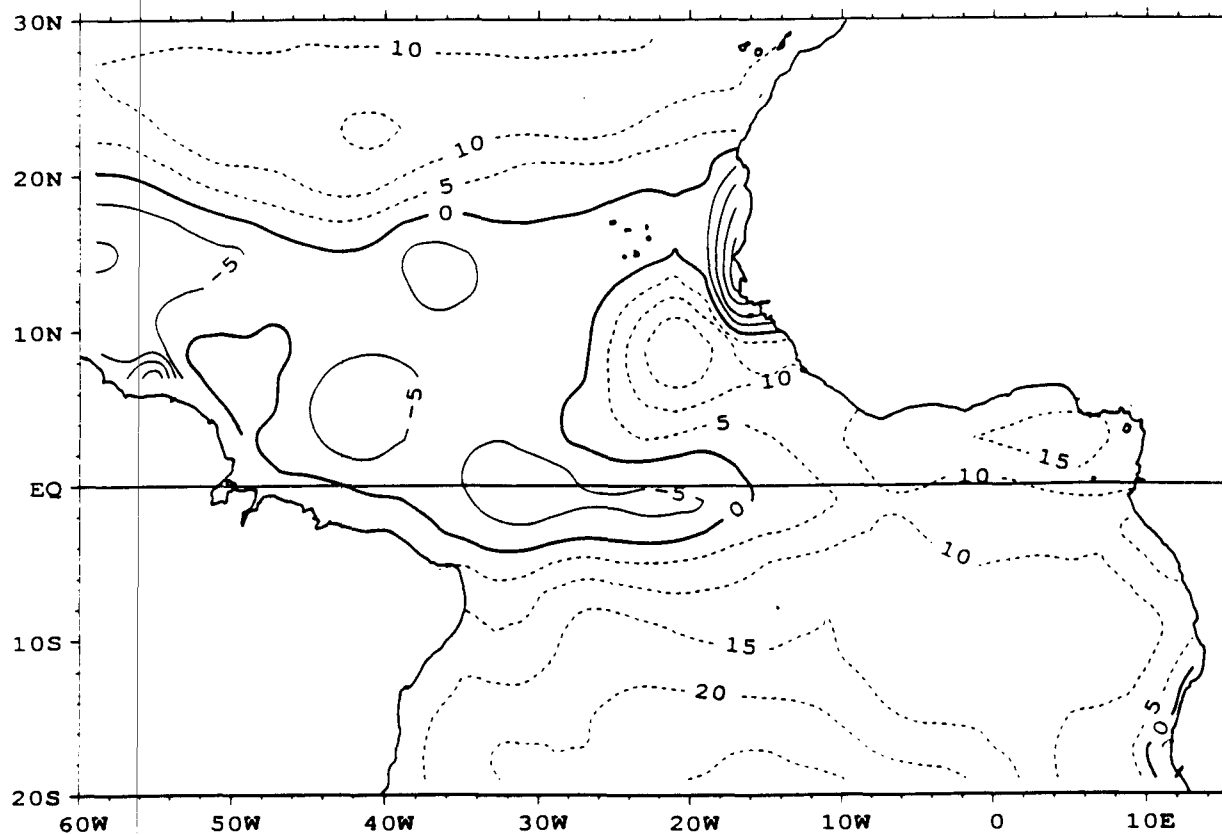


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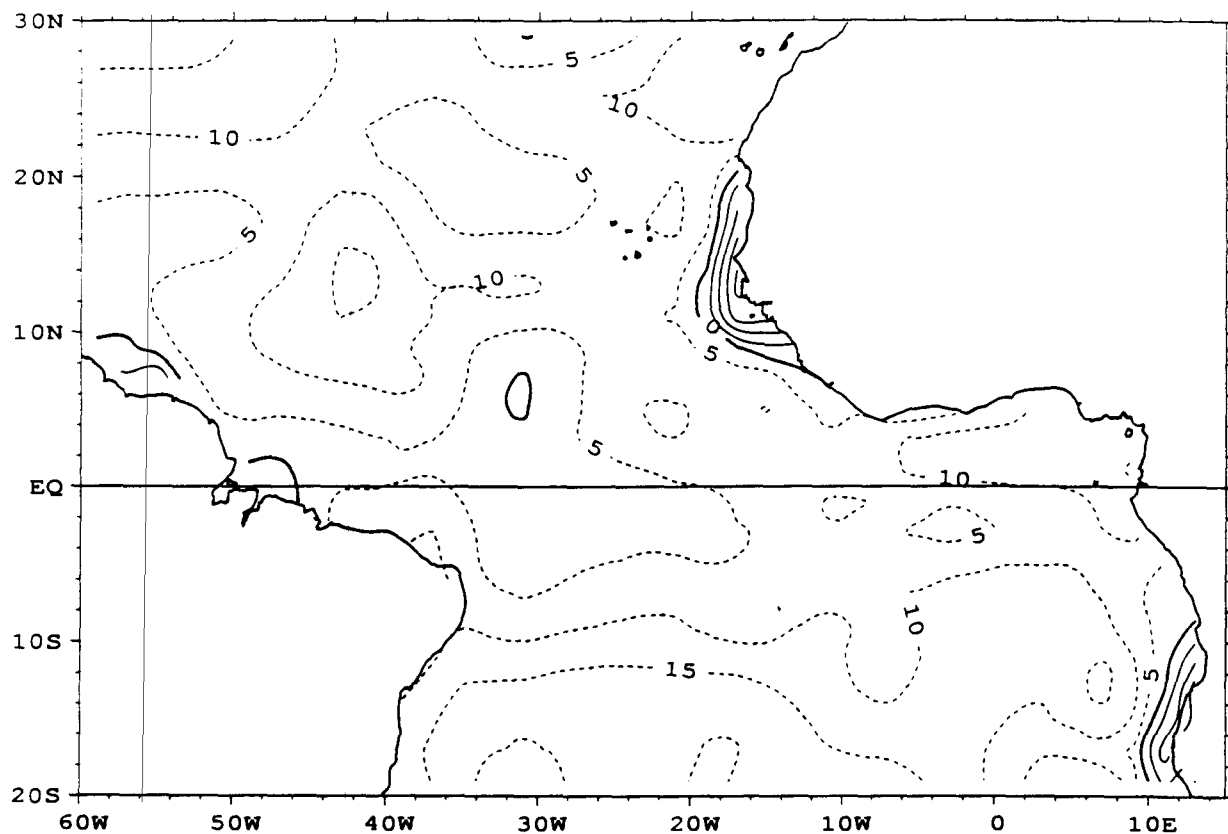




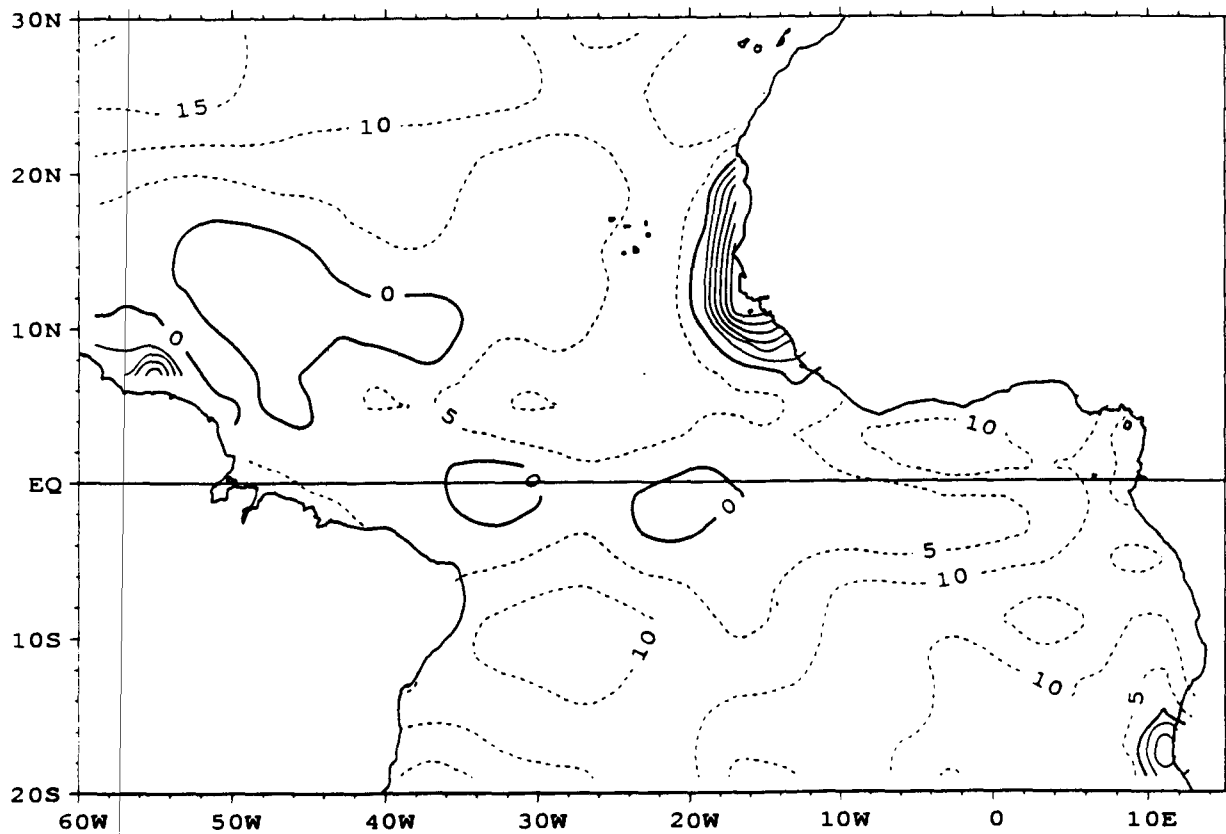
SENSIBLE (W/M**2) *OBS. - NUM. MOD.*FEVRIER 89



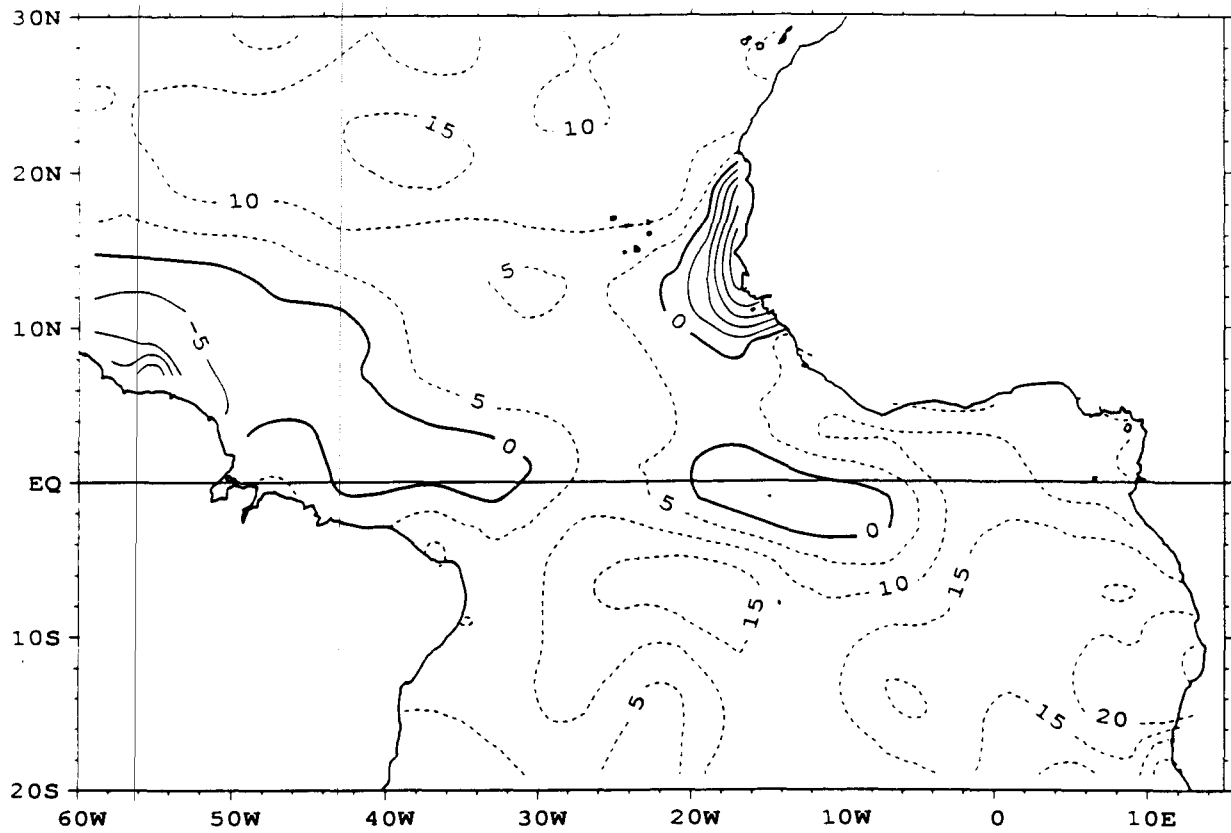
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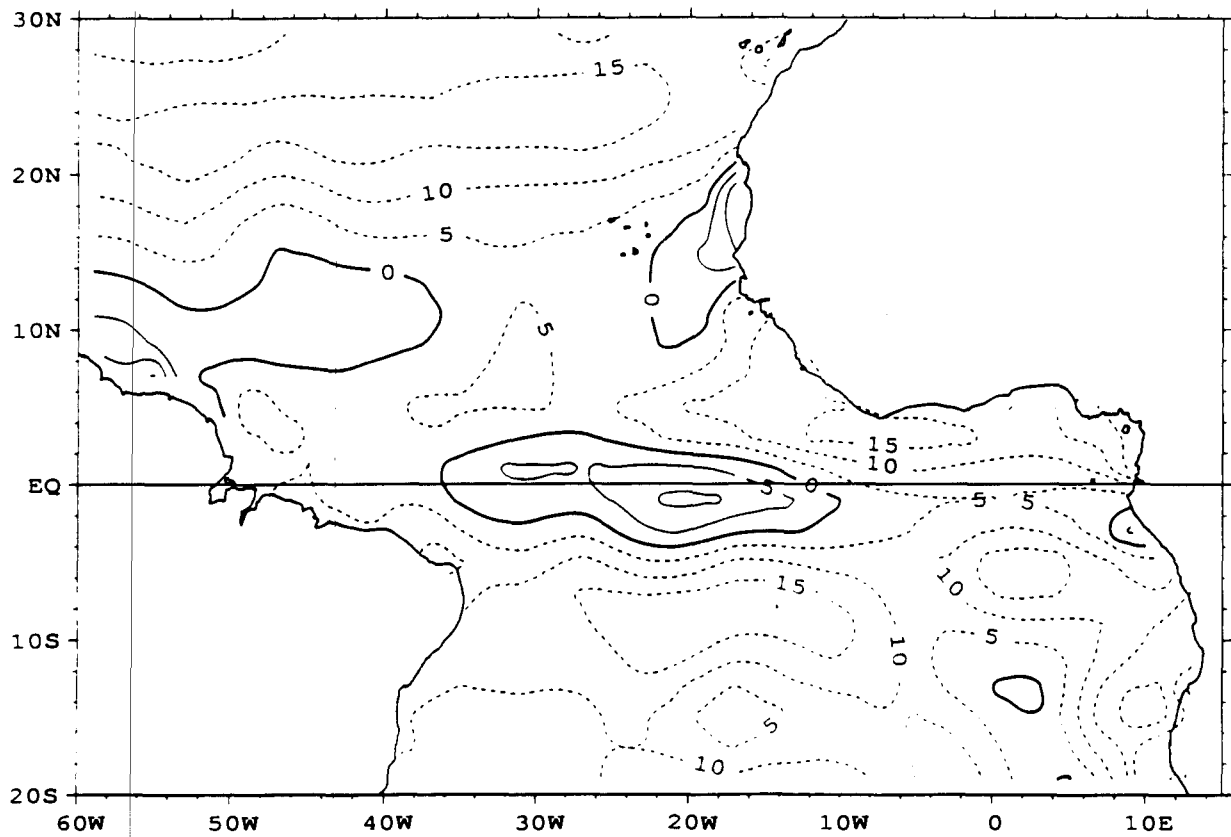
SENSIBLE (W/M**2) *OBS. - NUM. MOD.*AVRIL 89



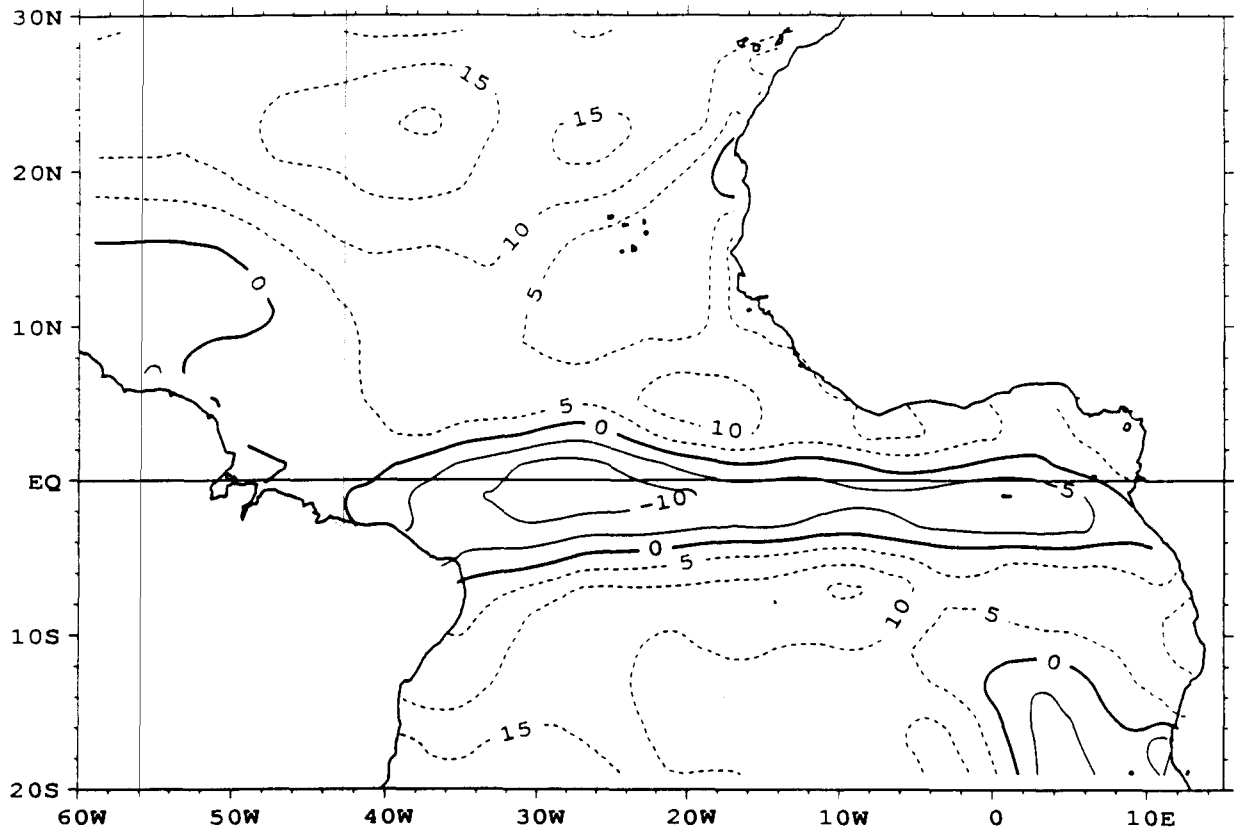
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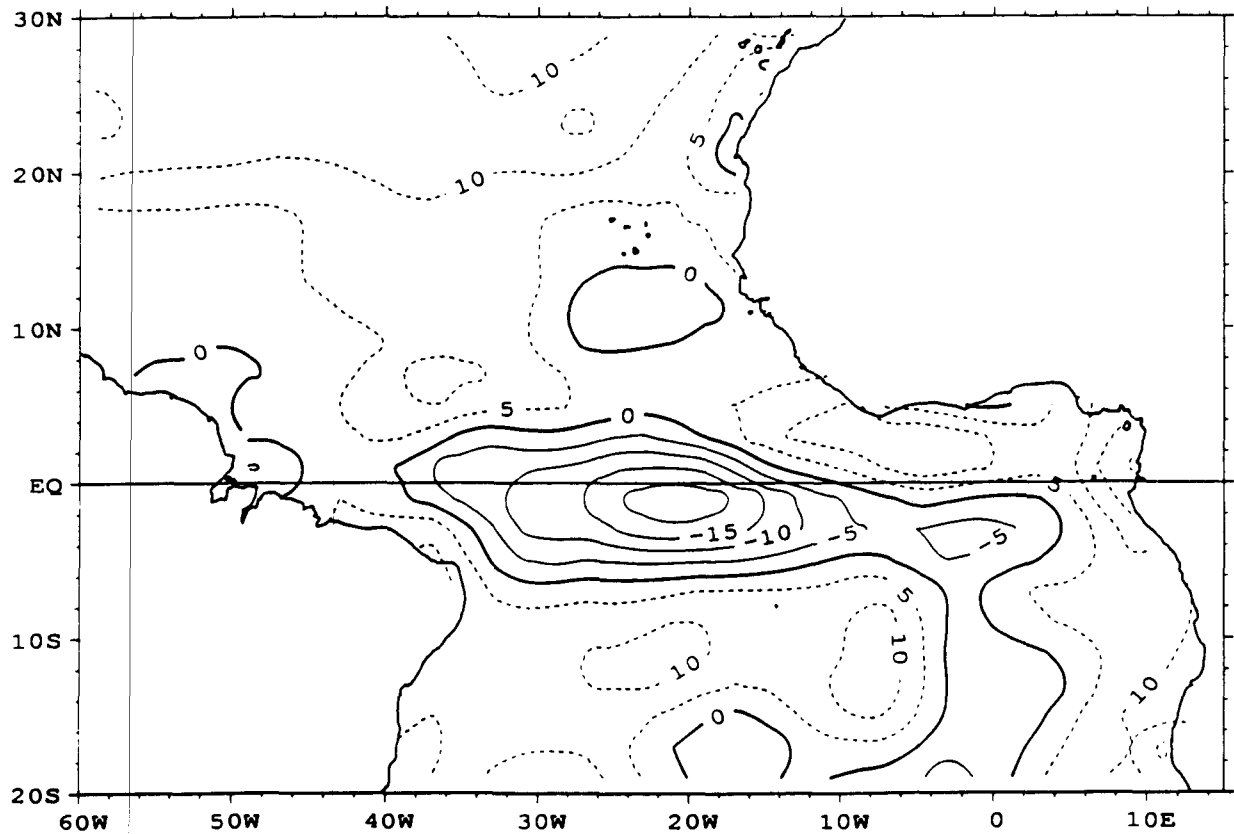
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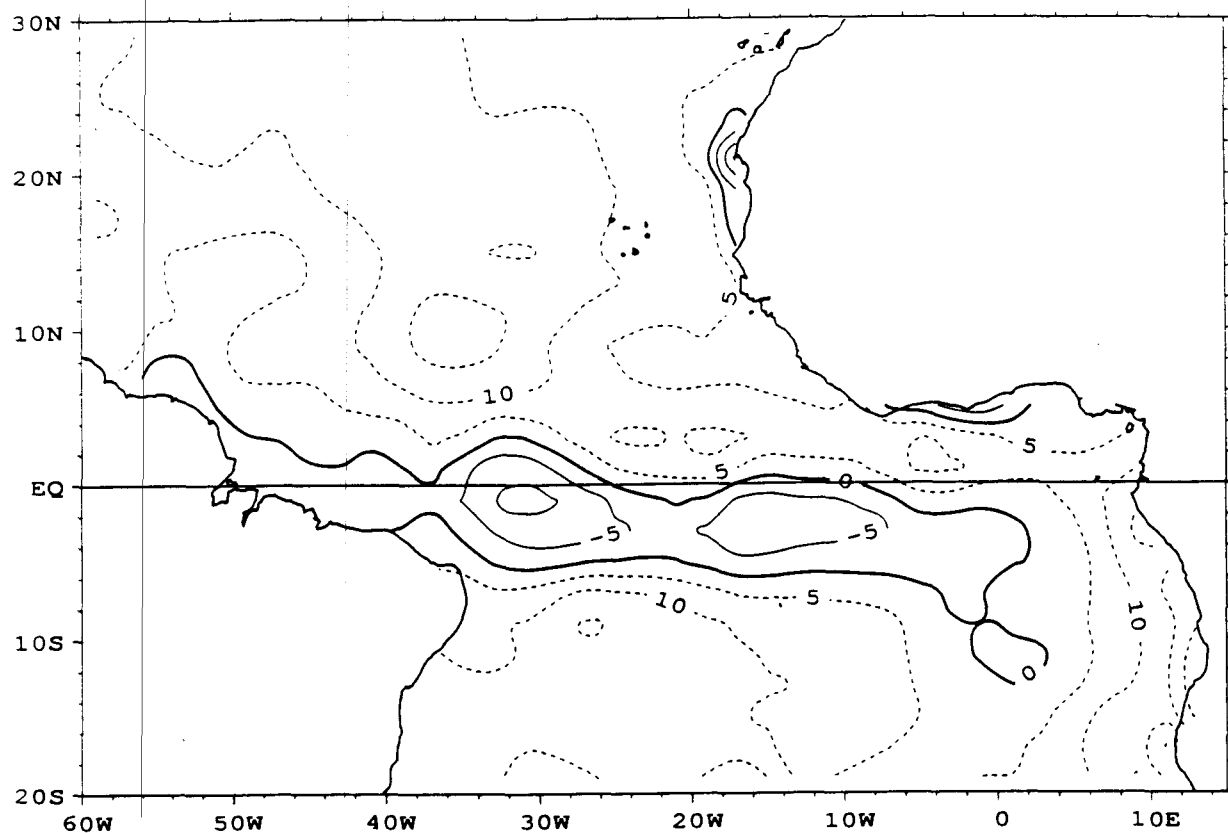
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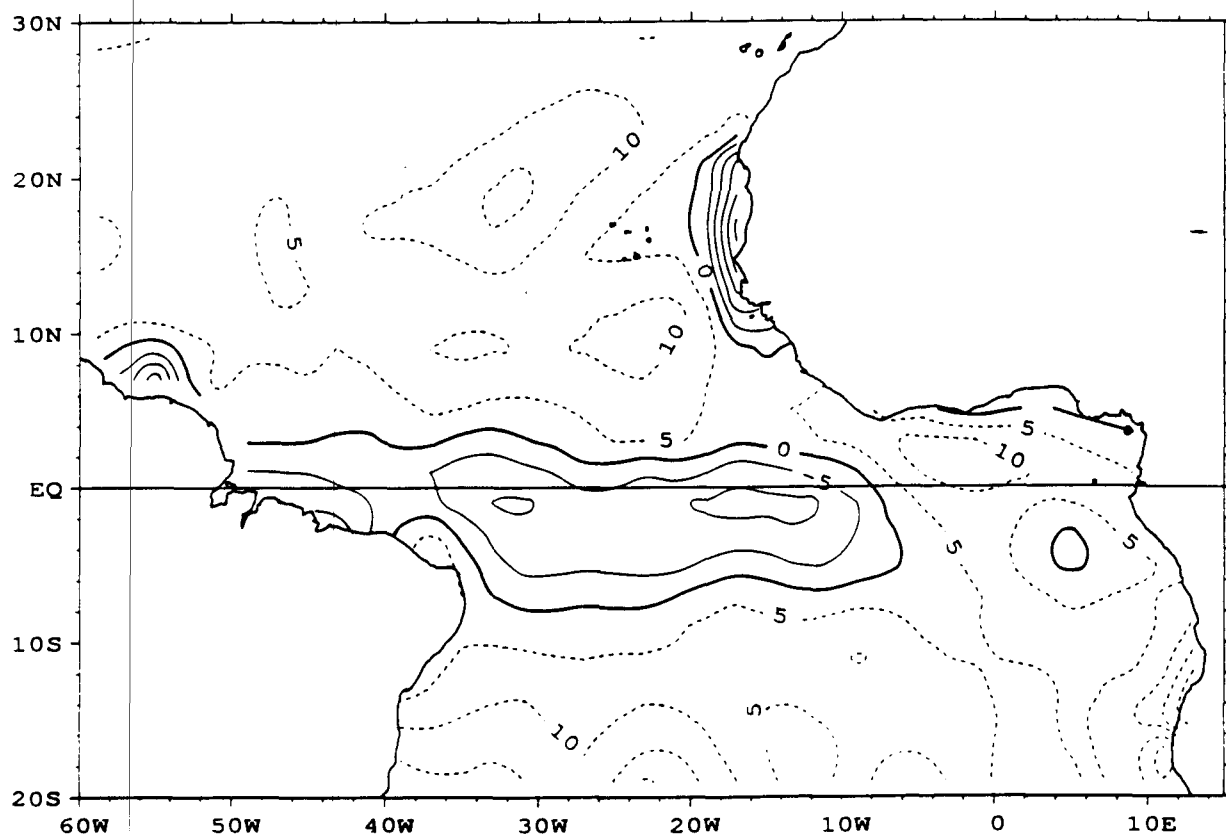
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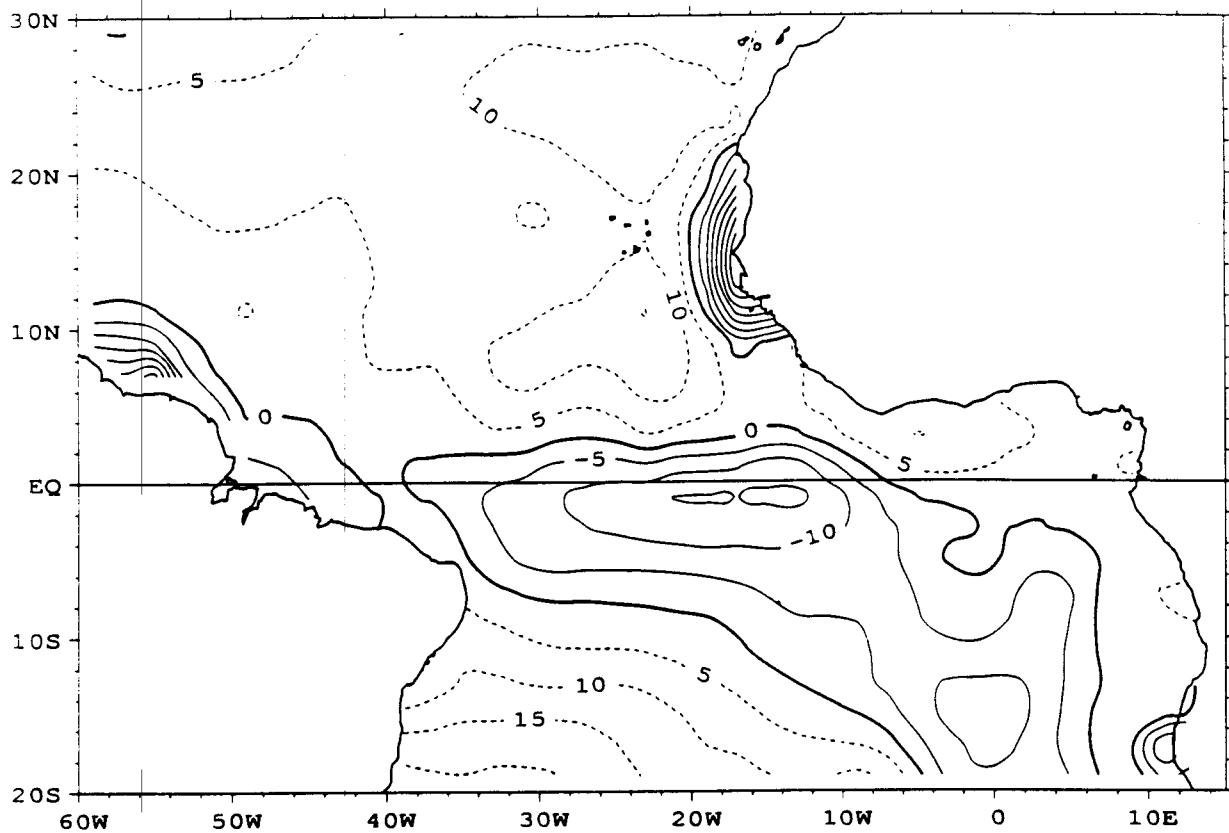
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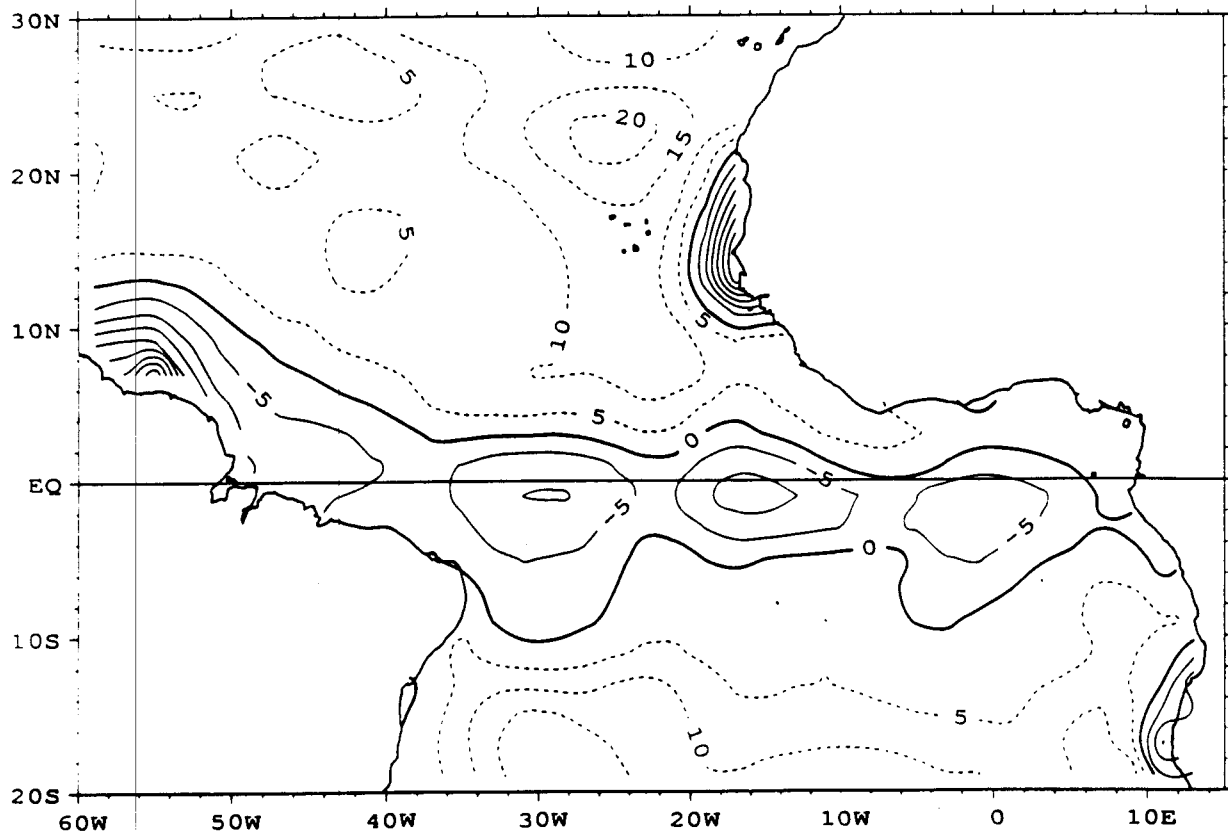
SENSIBLE (W/M**2) *OBS. - NUM.MOD.* OCTOBRE 89



SENSIBLE (W/M**2) *OBS. - NUM.MOD.*NOVEMBRE 89



SENSIBLE (W/M**2) *OBS. - NUM.MOD.*DECEMBRE 89





AUTORIZAÇÃO PARA PUBLICAÇÃO

TÍTULO					
FLUX DE CHALEUR SUR L'ATLANTIQUE TROPICAL EN 1989					
AUTOR					
CLAUDIO SOLANO PEREIRA; JACQUES SERVAIN; ALAIN MORLIÈRE					
TRADUTOR					
EDITOR					
ORIGEM	PROJETO	SÉRIE	Nº DE PÁGINAS	Nº DE FOTOS	Nº DE MAPAS
CPT	MODGEO		112		187
TIPO					
☐ RPQ	☐ PRE	☐ NTC	☐ PRP	☐ MAN	☐ PUD
☒ TAE					
DIVULGAÇÃO					
☒ EXTERNA	☐ INTERNA	☐ RESERVADA	☐ LISTA DE DISTRIBUIÇÃO ANEXA		
PERIÓDICO/EVENTO					
CONVÊNIO					
CENTRE ORSTOM DE BREST					
AUTORIZAÇÃO PRELIMINAR					
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REVISÃO TÉCNICA					
☐ SOLICITADA	☒ DISPENSADA	 ASSINATURA			
RECEBIDA	____/____/____	DEVOLVIDA	____/____/____	ASSINATURA DO REVISOR	
REVISÃO DE LINGUAGEM					
☐ SOLICITADA	☒ DISPENSADA	 ASSINATURA			
Nº	____				
RECEBIDA	____/____/____	DEVOLVIDA	____/____/____	ASSINATURA DO REVISOR	
PROCESSAMENTO/DATILOGRAFIA					
RECEBIDA	____/____/____	DEVOLVIDA	____/____/____	ASSINATURA	
REVISÃO TIPOGRÁFICA					
RECEBIDA	____/____/____	DEVOLVIDA	____/____/____	ASSINATURA	
AUTORIZAÇÃO FINAL					
____/____/____			 ASSINATURA		
PALAVRAS-CHAVE					
ATLANTIQUE TROPICAL; CHAMPS MENSUELS DE CHALEUR					
LATENT ET SENSIBLE					