HIDROMETEOROLOGIA DA BACIA DO RIO TOCANTINS

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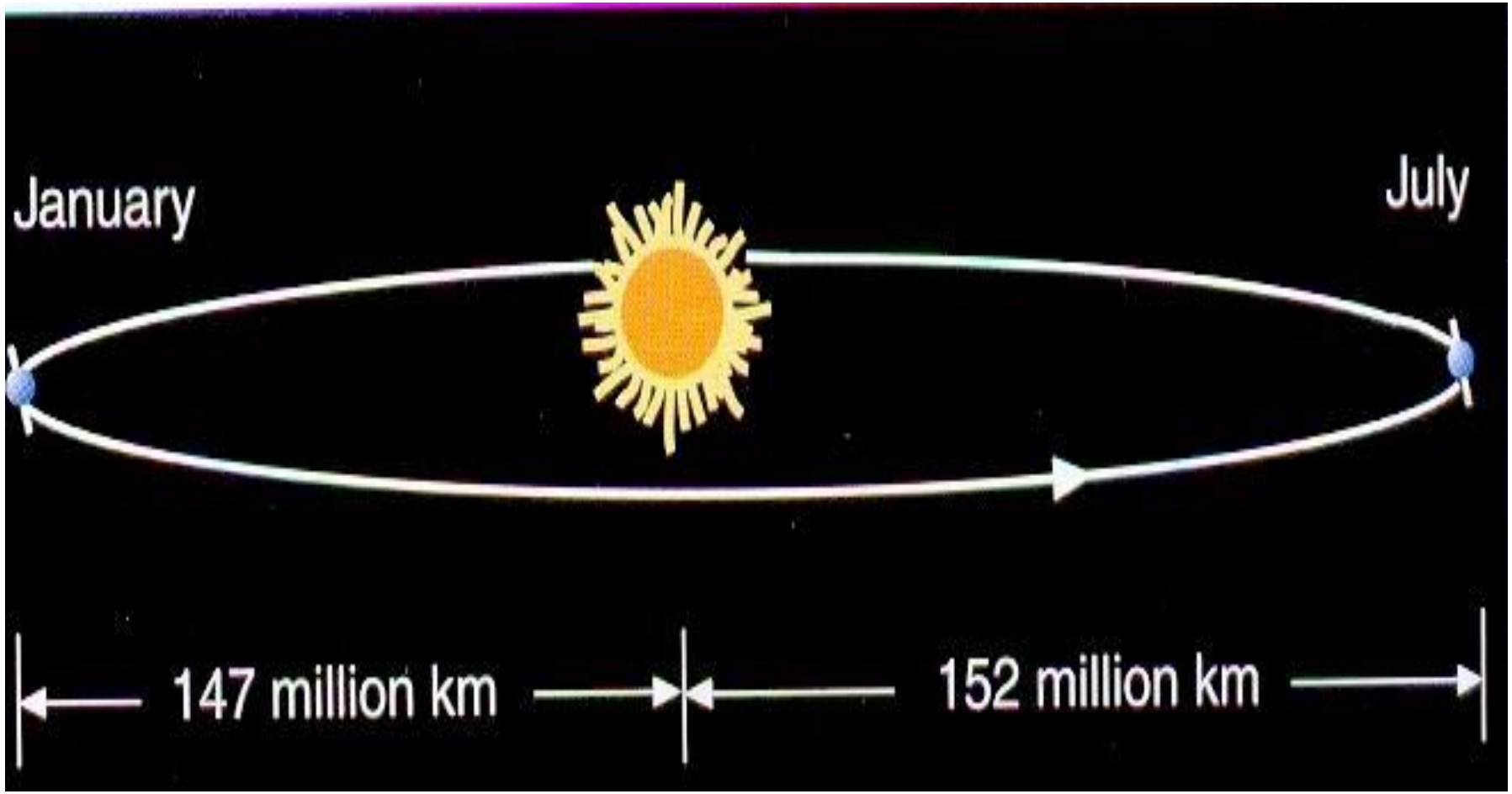
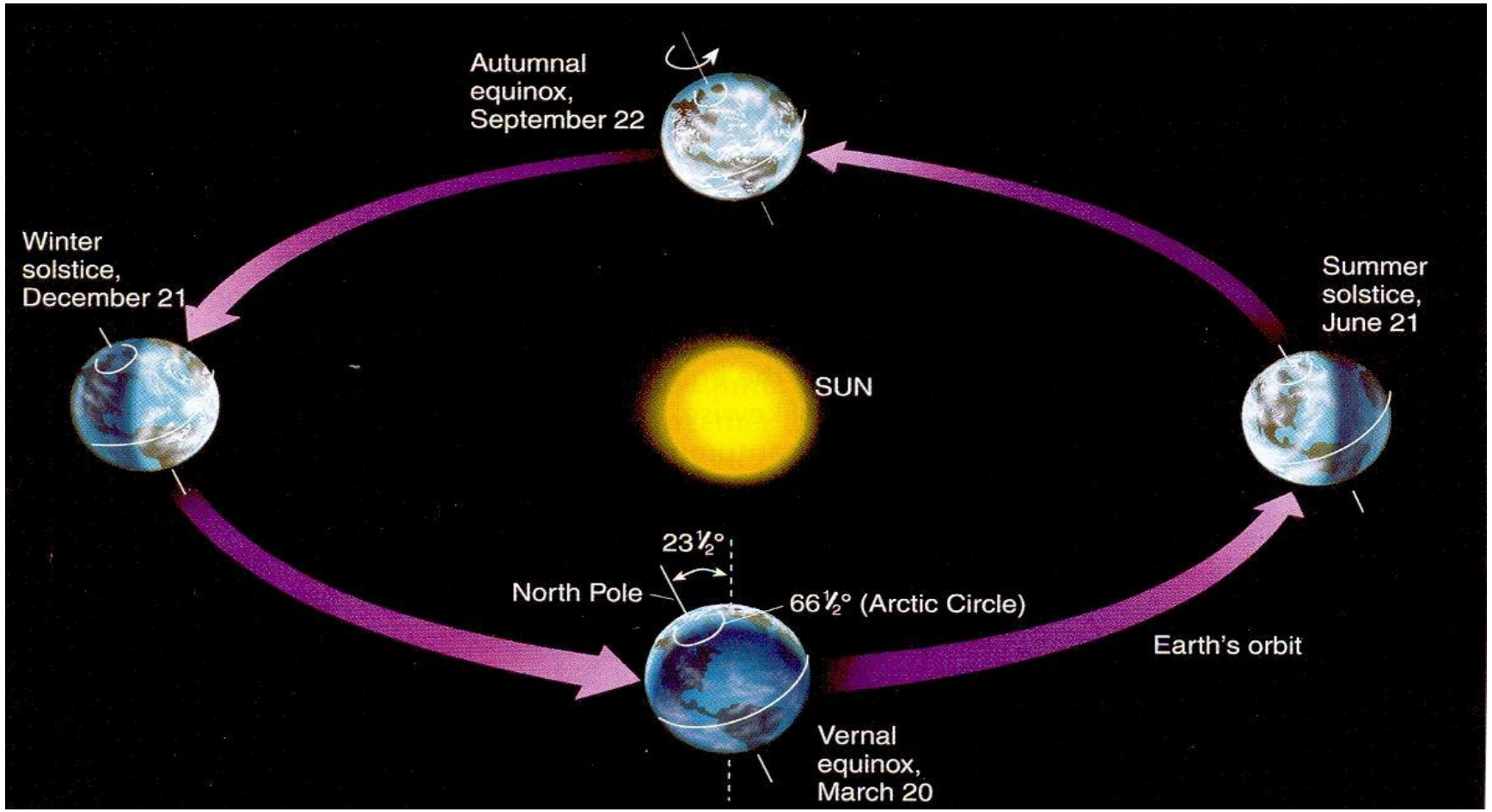
7º Preparatório do CONFEA ao 8º Fórum Mundial da Água CREA-TO
Auditório da Faculdade Católica do Tocantins, Palmas, TO
13 a 14 de Novembro de 2017

CLIMATOLOGIA



(Ahrens, 2005)

Figure 3.1 The elliptical path (highly exaggerated) of the earth about the sun brings the earth slightly closer to the sun in January than in July.



(Ahrens, 2005)

Figure 3.2 **As the earth revolves about the sun, it is tilted on its axis by an angle of $23_{1/2^o}$. The earth´s axis always points to the same area in space (as viewed from a distant star). Thus, in June, when the Northern Hemisphere is tipped toward the sun, more direct sunlight and long hours of daylight cause warmer weather than in December, when the Northern Hemisphere is tipped away from the sun.**

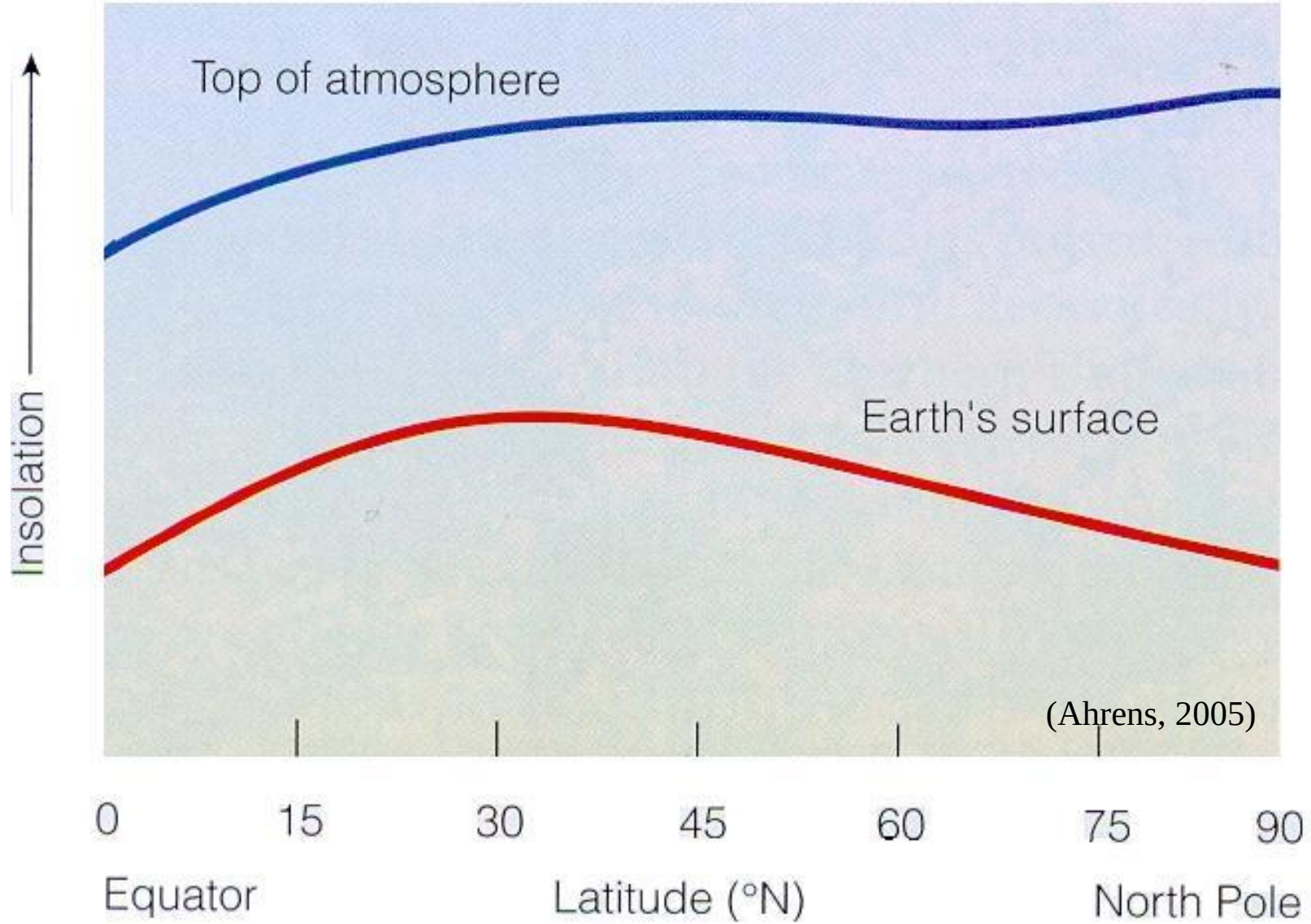


Figure 3.3 **The realtive amount of radiant energy received at the top of the earth's atmosphere and at the earth's surface on June 21 – the summer solstice.**

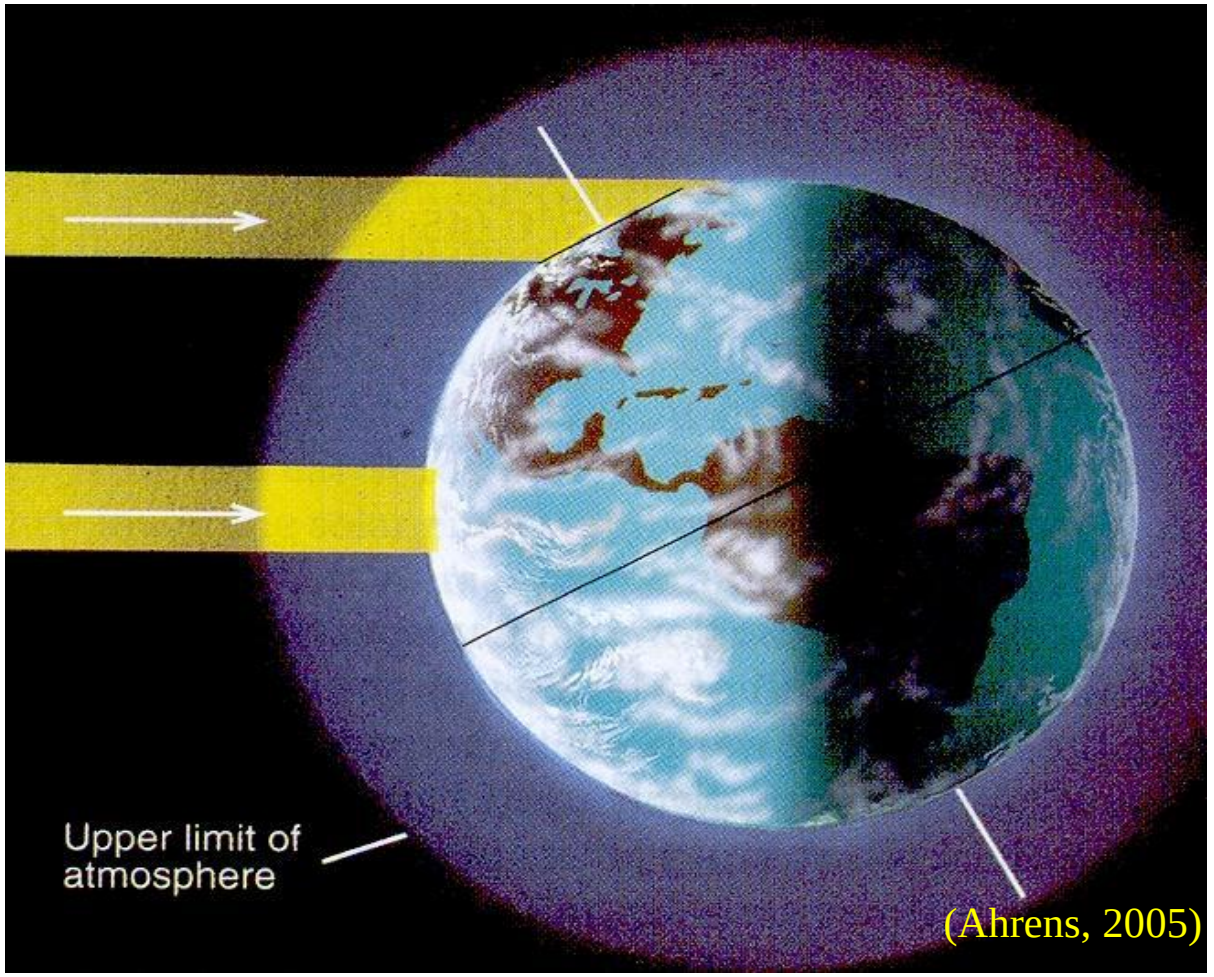
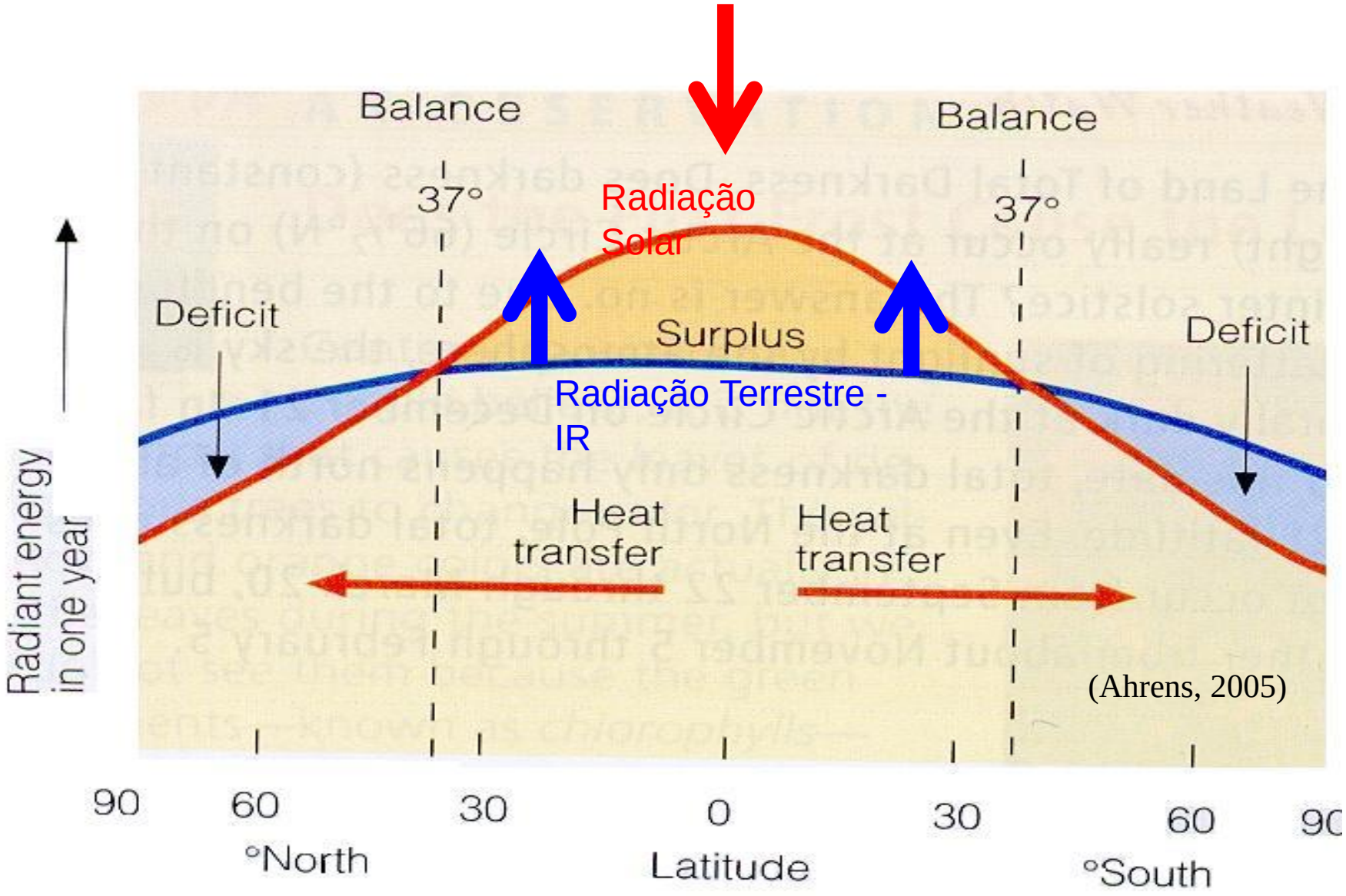
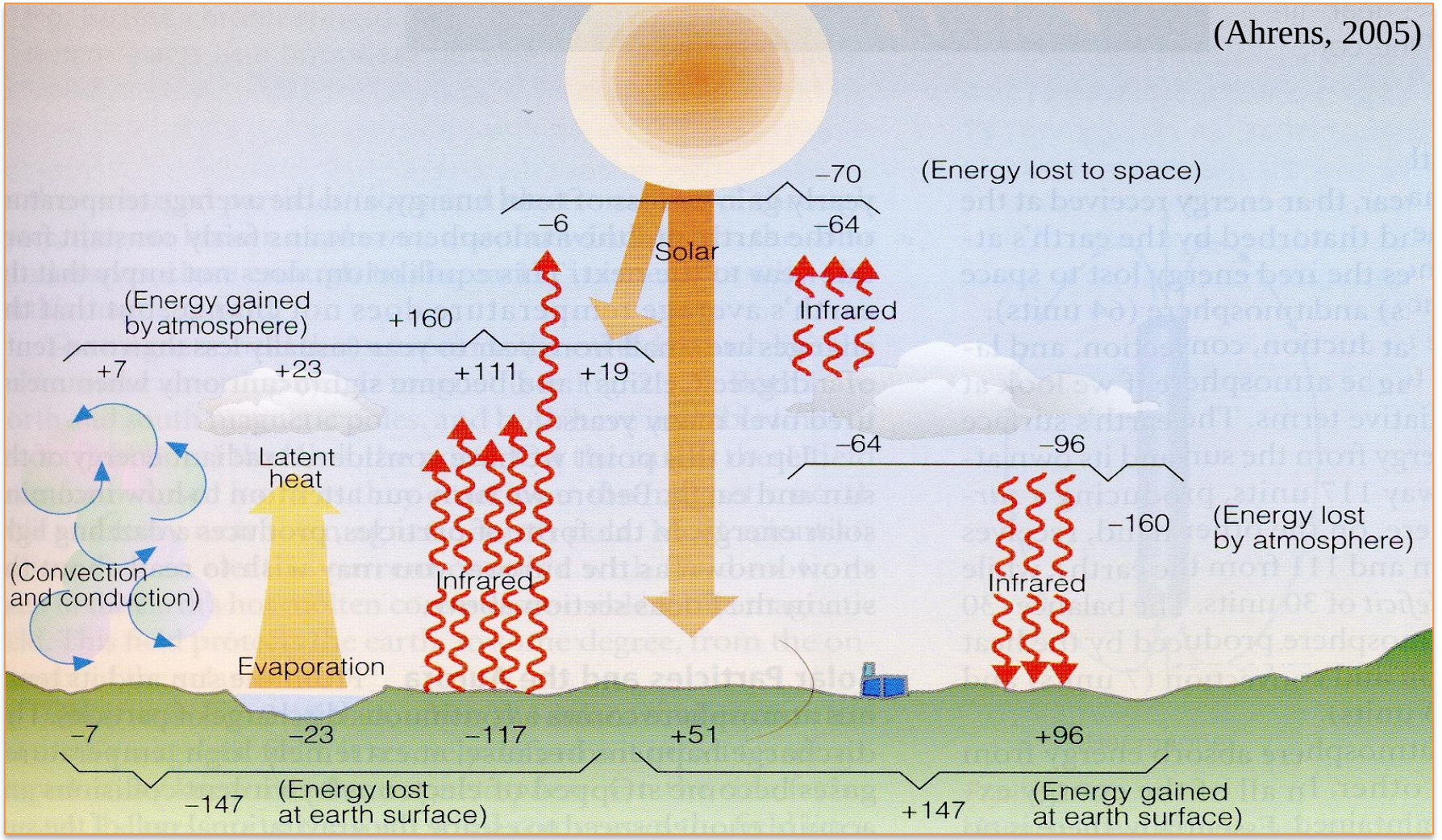


Figure 3.4 **During the Northern Hemisphere summer, sunlight that reaches the earth's surface in far northern latitudes has passed through a thicker layer of absorbing, scattering, and reflecting atmosphere than sunlight that reaches the earth's surface farther south. Sunlight is lost through both the thickness of the pure atmosphere and by impurities in the atmosphere. As the sun's rays become more oblique, these effects become more pronounced.**


Balance
Balance
37°
37°
Radiação Solar
Deficit
Surplus
Deficit
Radiação Terrestre - IR
Heat transfer
Heat transfer
Radiant energy in one year
(Ahrens, 2005)
90
60
30
0
30
60
90
°North
Latitude
°South

Efeito Estufa



CIRCULAÇÃO E PRECIPITAÇÃO GLOBAIS

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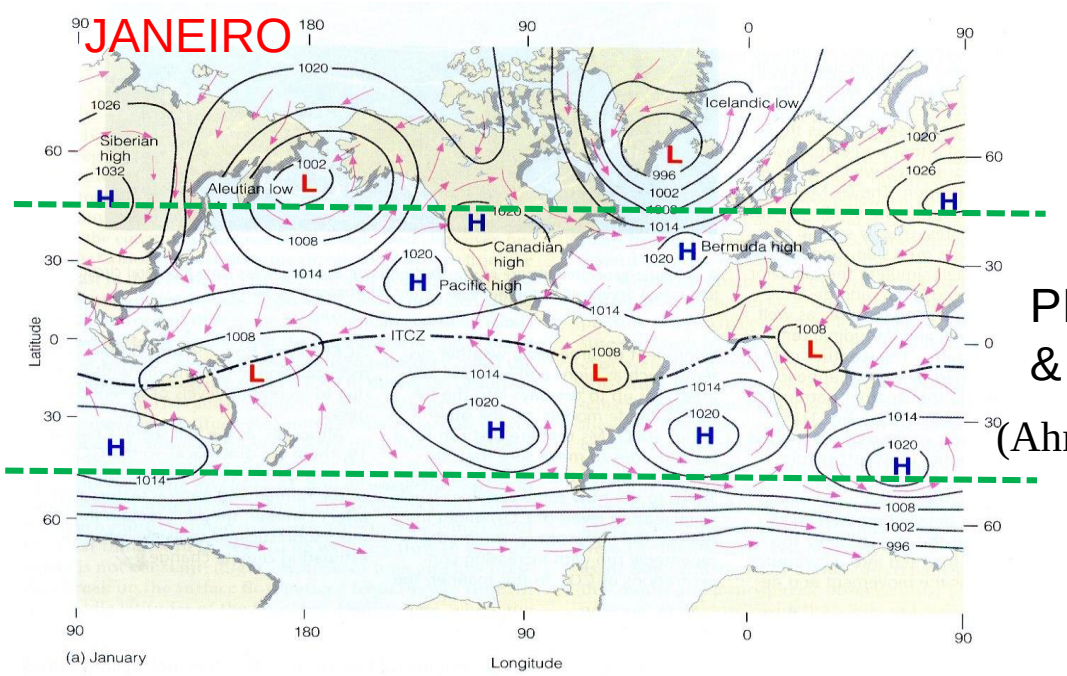
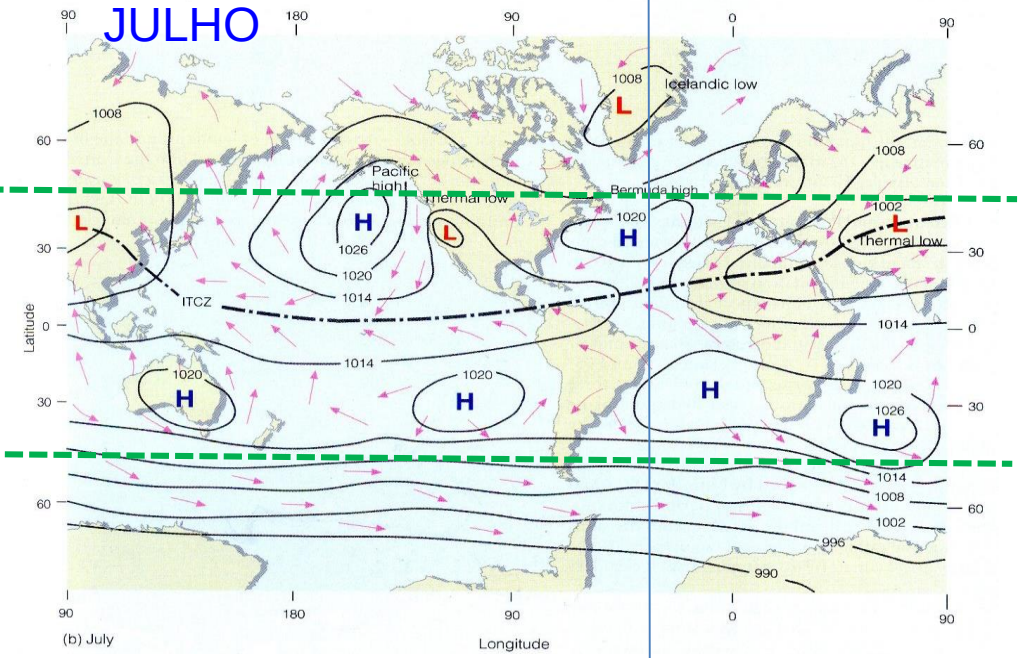
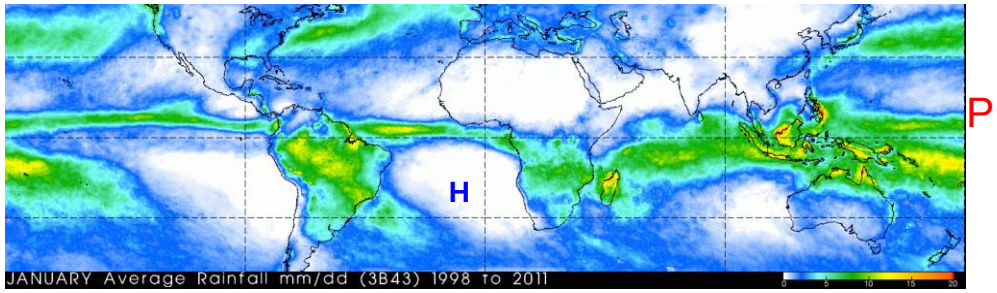


PRESSÃO & VENTO

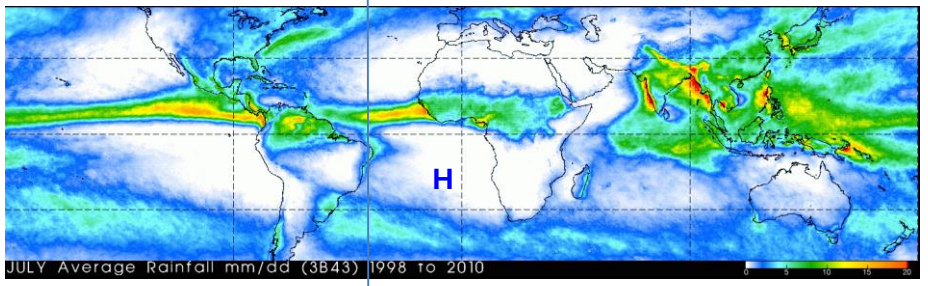
(Ahrens, 2005)

JULHO





PRECIPITAÇÃO TRMM



CICLO DA ÁGUA

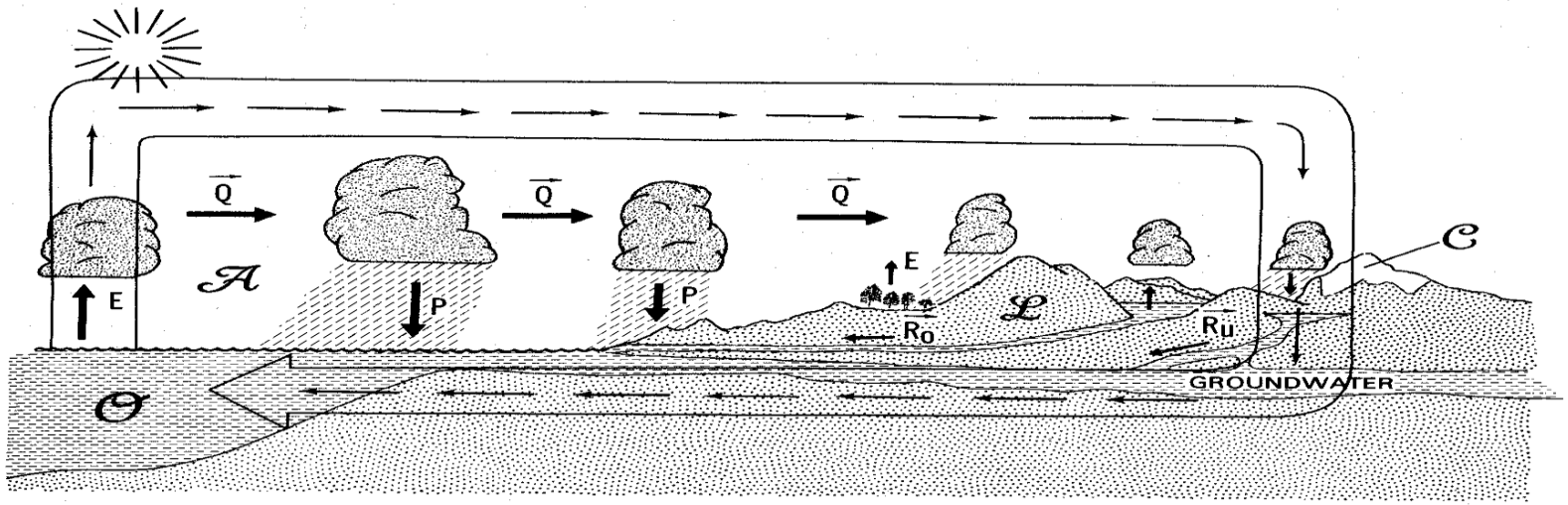


FIGURE 12.1. Schematic diagram of the atmospheric and terrestrial branches of the hydrological cycle showing the importance of evaporation E, advection of water vapor in the atmosphere $\mathbf{Q}$, precipitation P, river runoff $\mathbf{R}_0$, and underground runoff $\mathbf{R}_u$.

(Peixot & Oort, 1992)

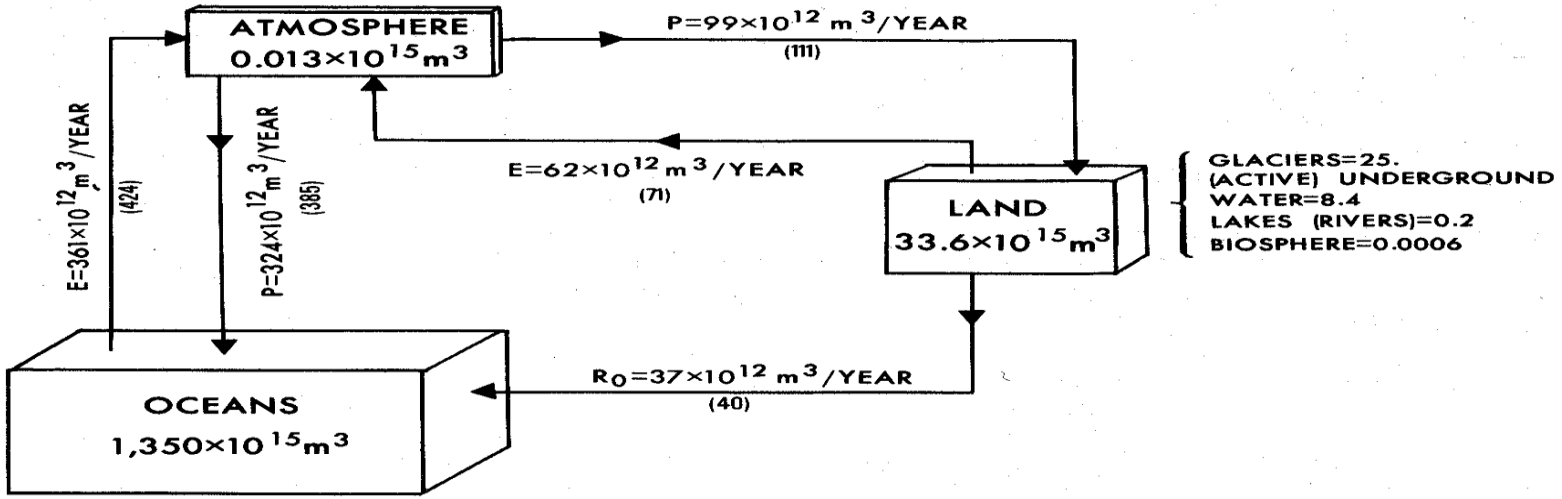


FIGURE 12.2. The amounts of water stored in the oceans, land, and atmosphere, and the amounts exchanged annually between the different reservoirs through evaporation, precipitation, and runoff (estimates are from Peixoto and Kettani, 1973, and, in parentheses, from Baumgartner and Reichel, 1975).

Divergência do vapor d'água – média zonal 0,01 m ano^{-1}

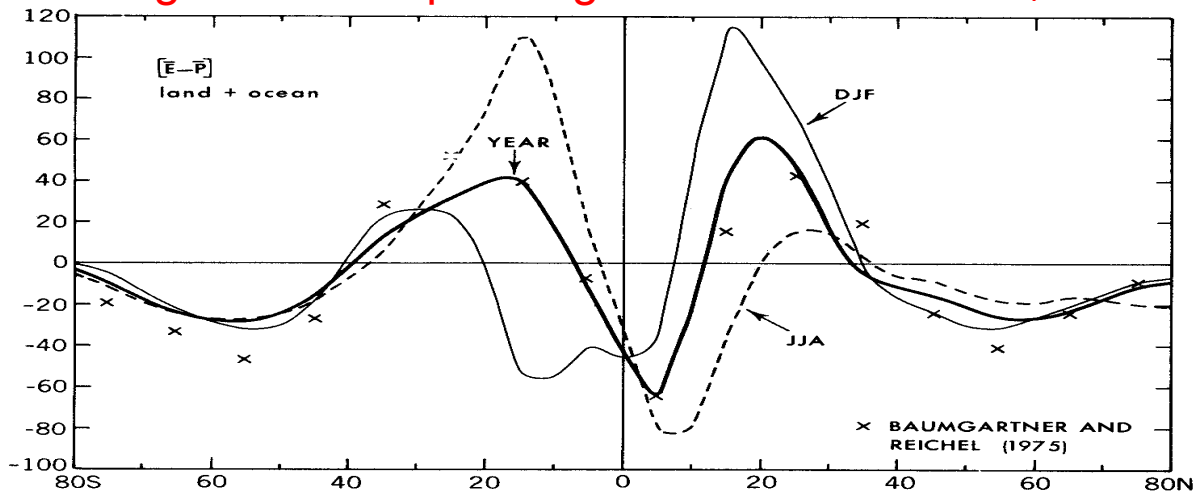


FIGURE 12.16. Meridional profiles of the zonal-mean divergence of the total water vapor transport [div **Q**] $\approx [E - P]$ in 0.01 m yr^{-1} for annual, DJF, and JJA mean conditions. Some annual-mean estimates of $E - P$ by Baumgartner and Reichel (1975) are added for comparison (see also Table 7.1).

(Peixot & Oort, 1992)

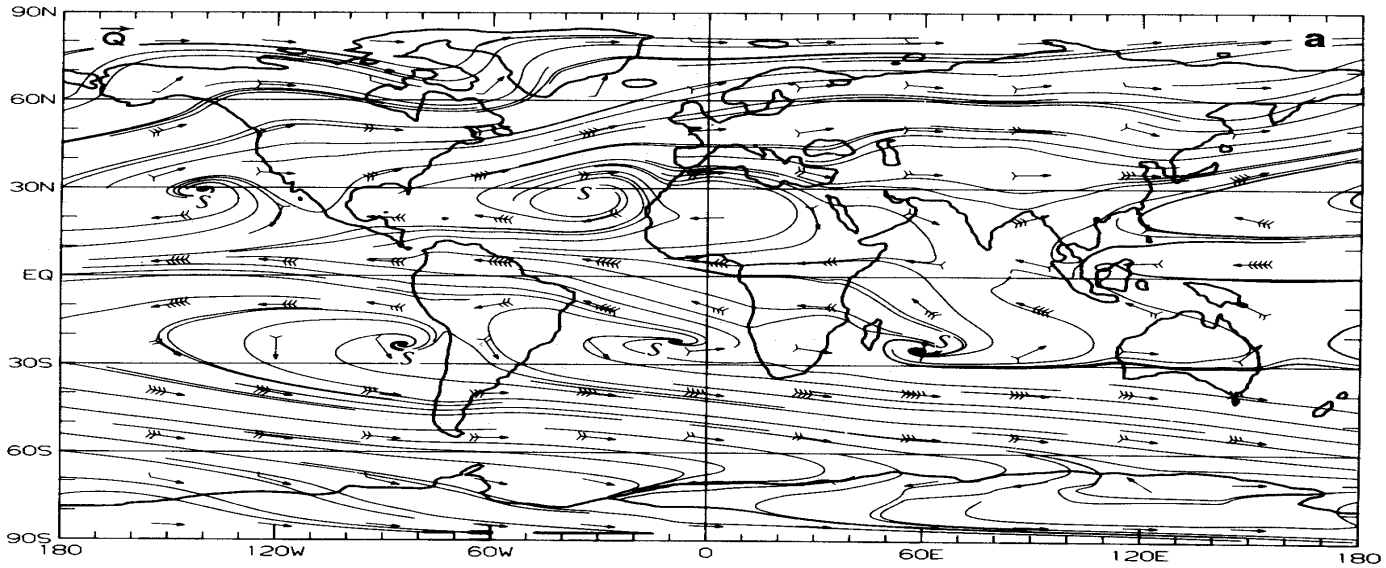


FIGURE 12.17a

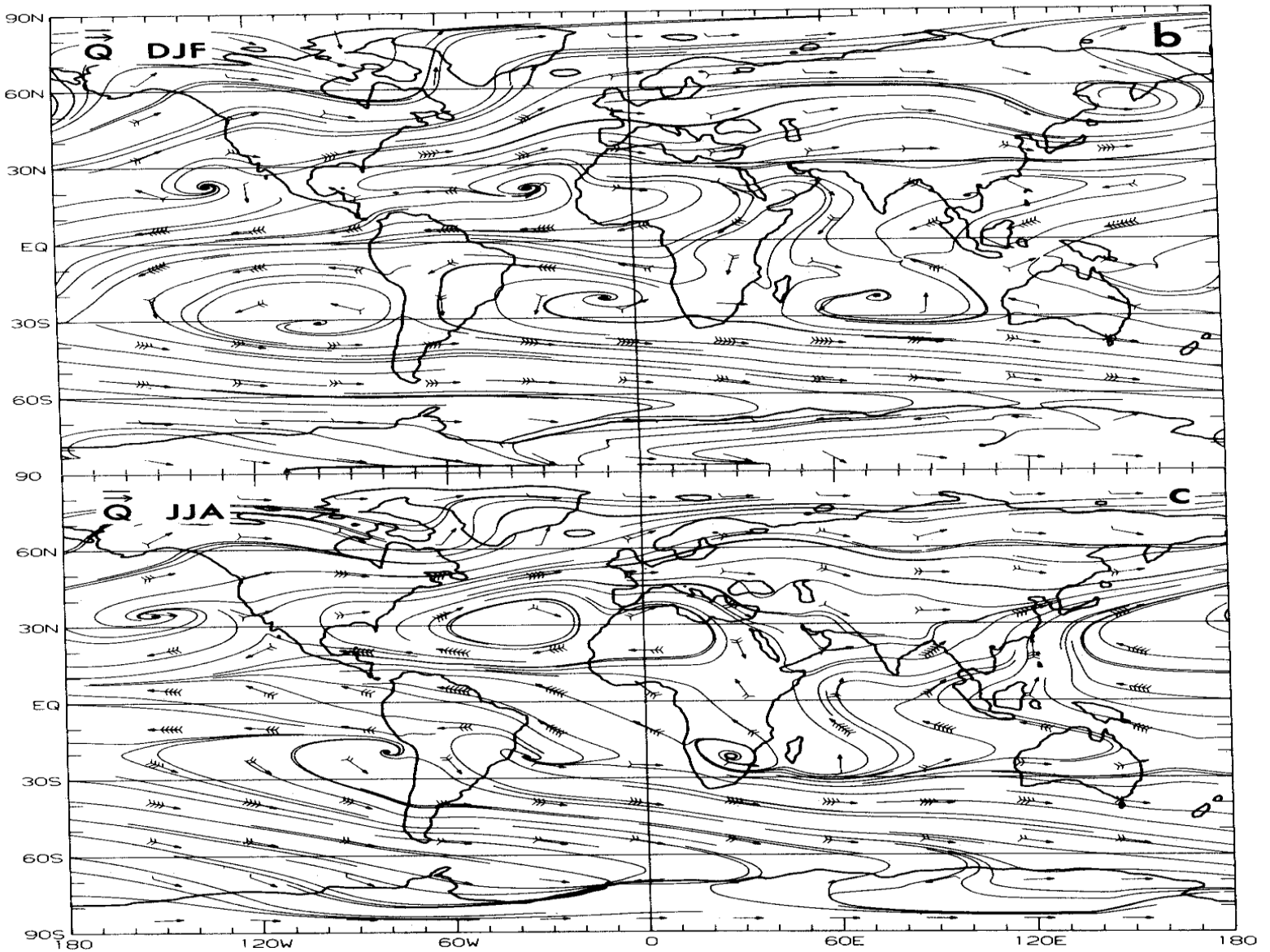
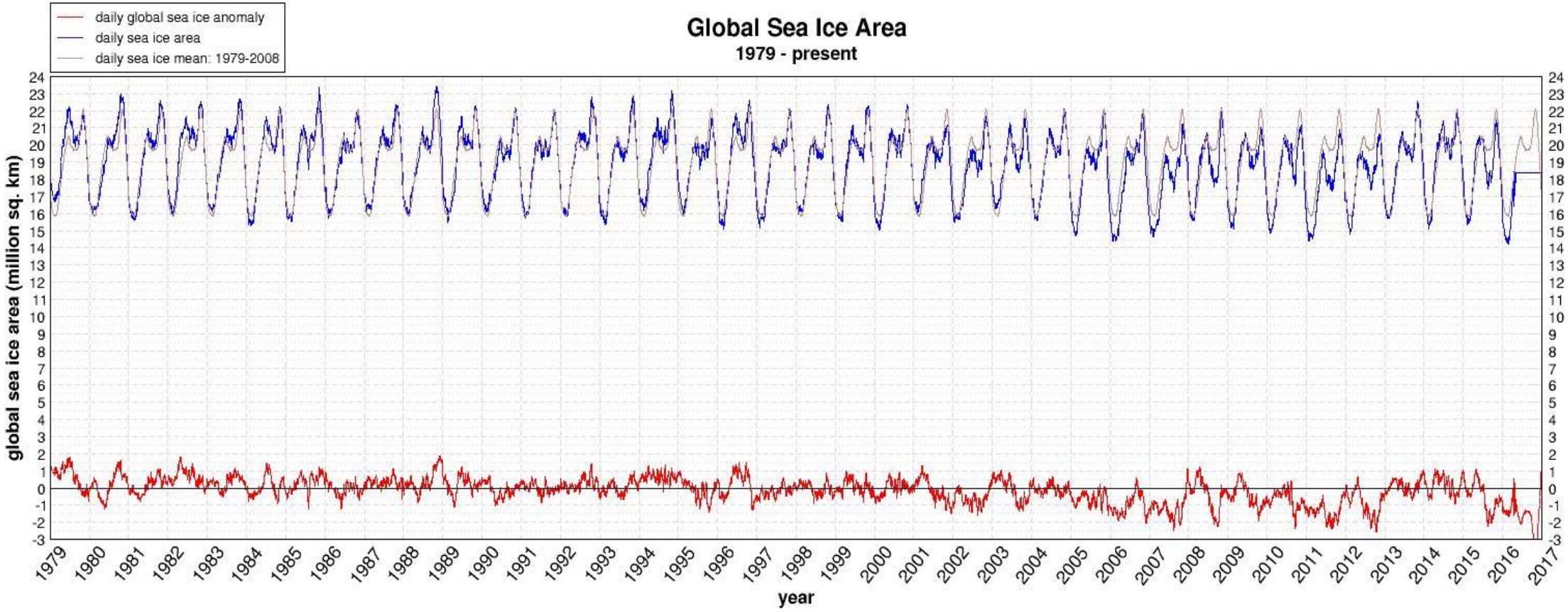


FIGURE 12.17. Global distributions of the total aerial runoff **Q** and some corresponding streamlines for annual (a), DJF (b), and JJA (c) mean conditions. Each barb on the shaft of an arrow indicates a value of 2 m s^{-1} g kg^{-1} (from Peixoto and Oort, 1983).

(Peixot & Oort, 1992)

GELO OCEÂNICO GLOBAL



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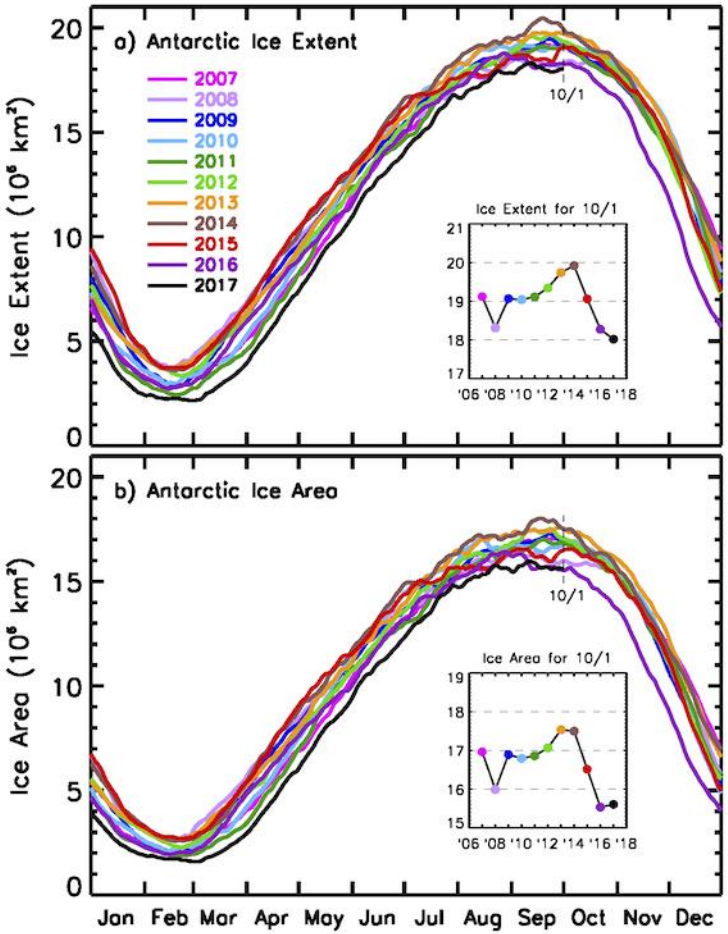

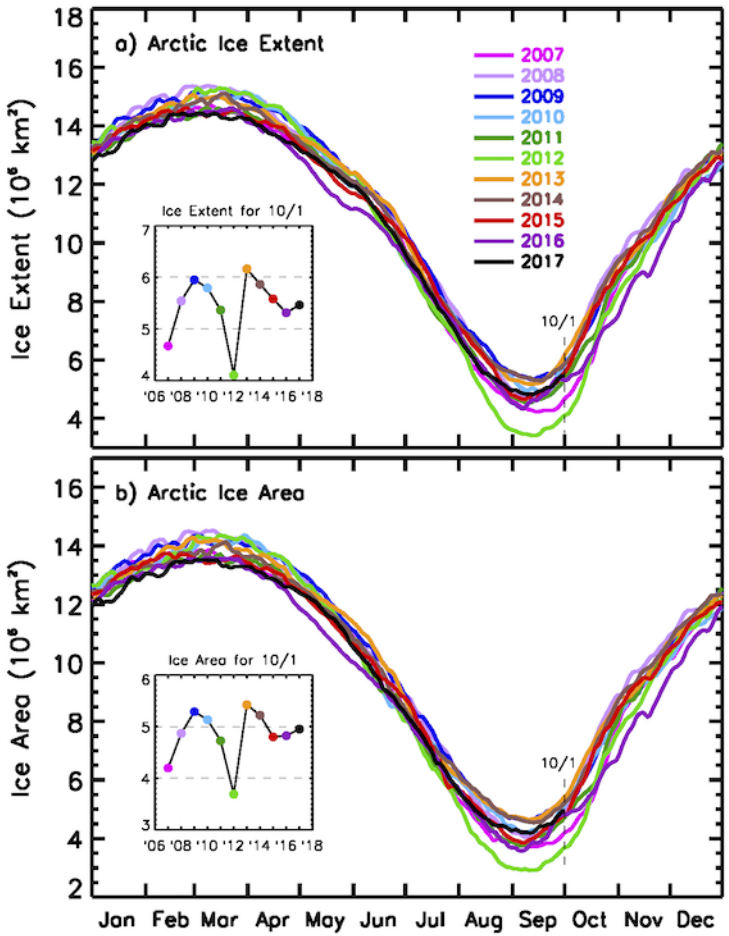

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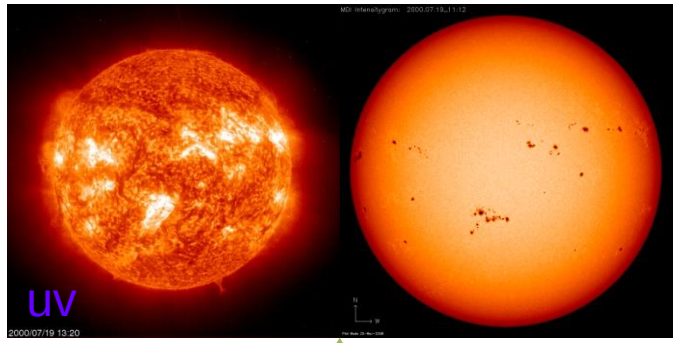

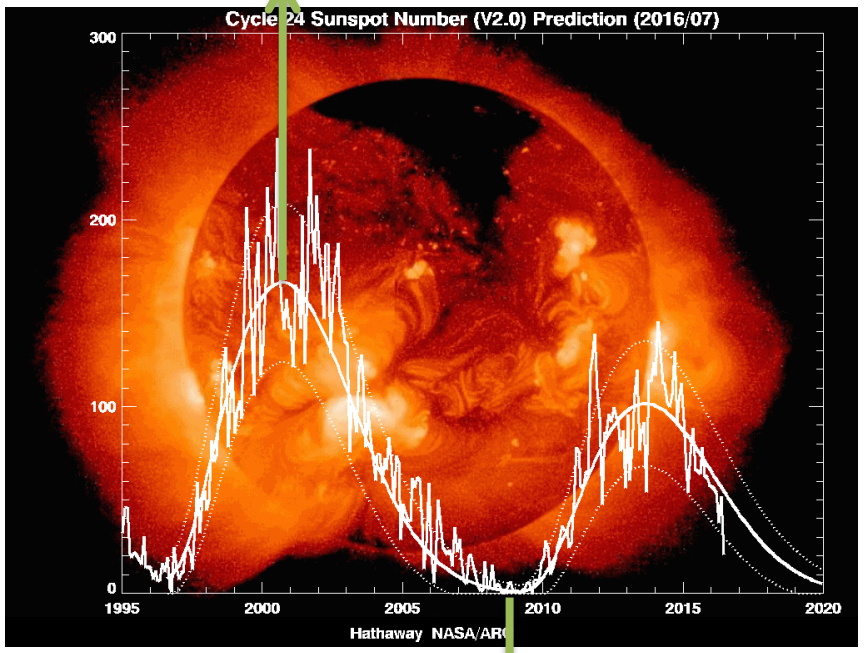

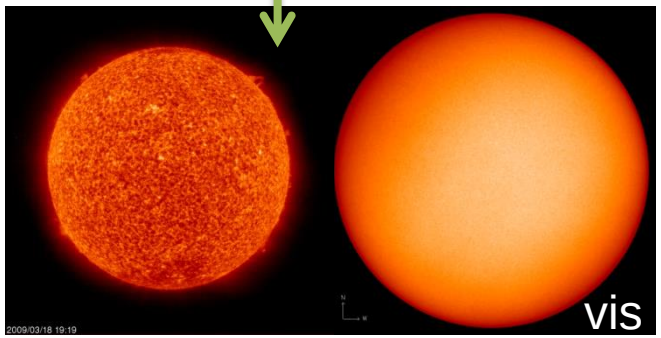

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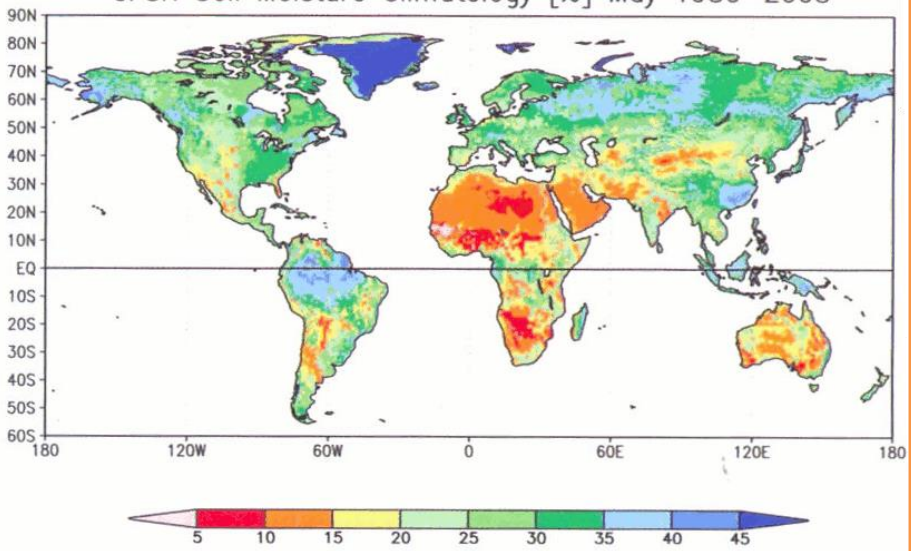


FIG. 17. The 2-m volumetric soil moisture climatology of CFSR for May averaged over 1980–2008.

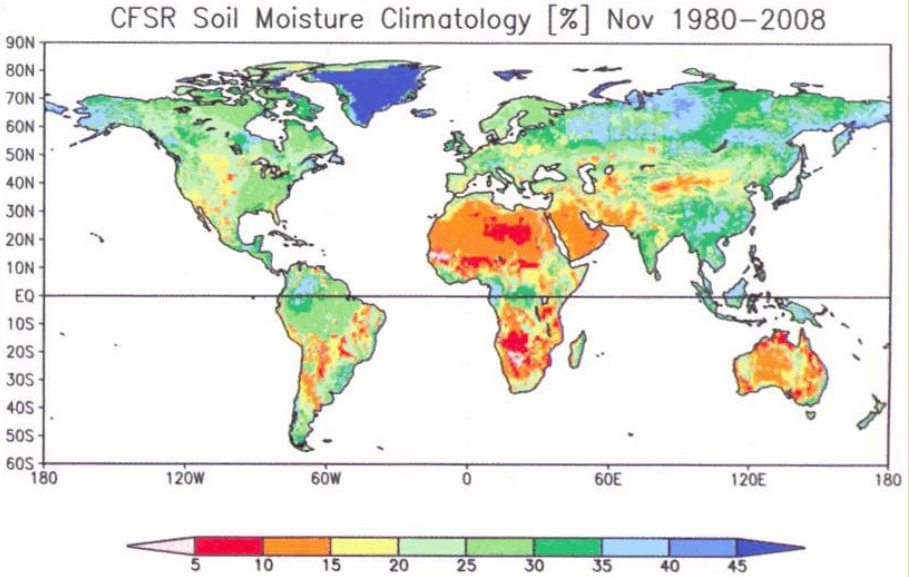
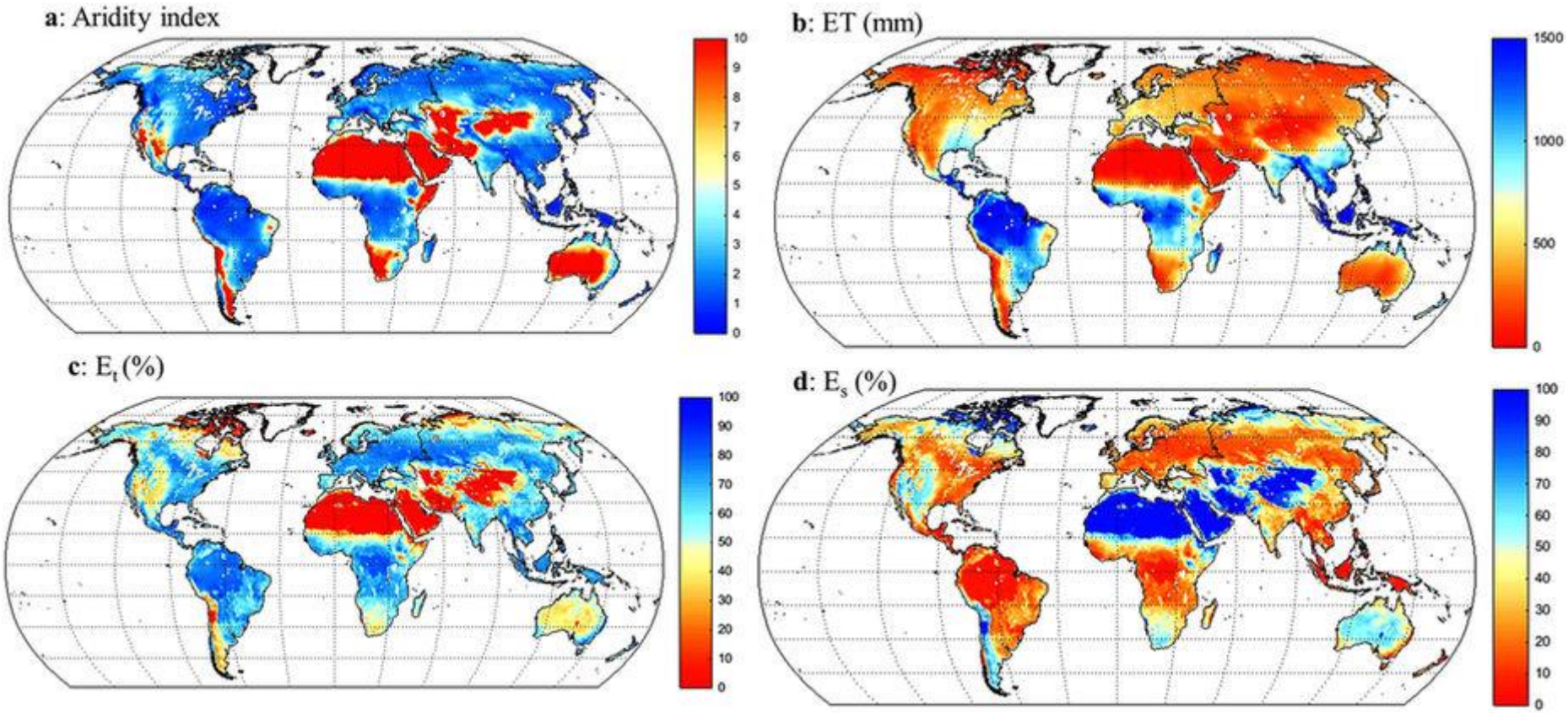


FIG. 18. As in Fig. 17, but for Nov.

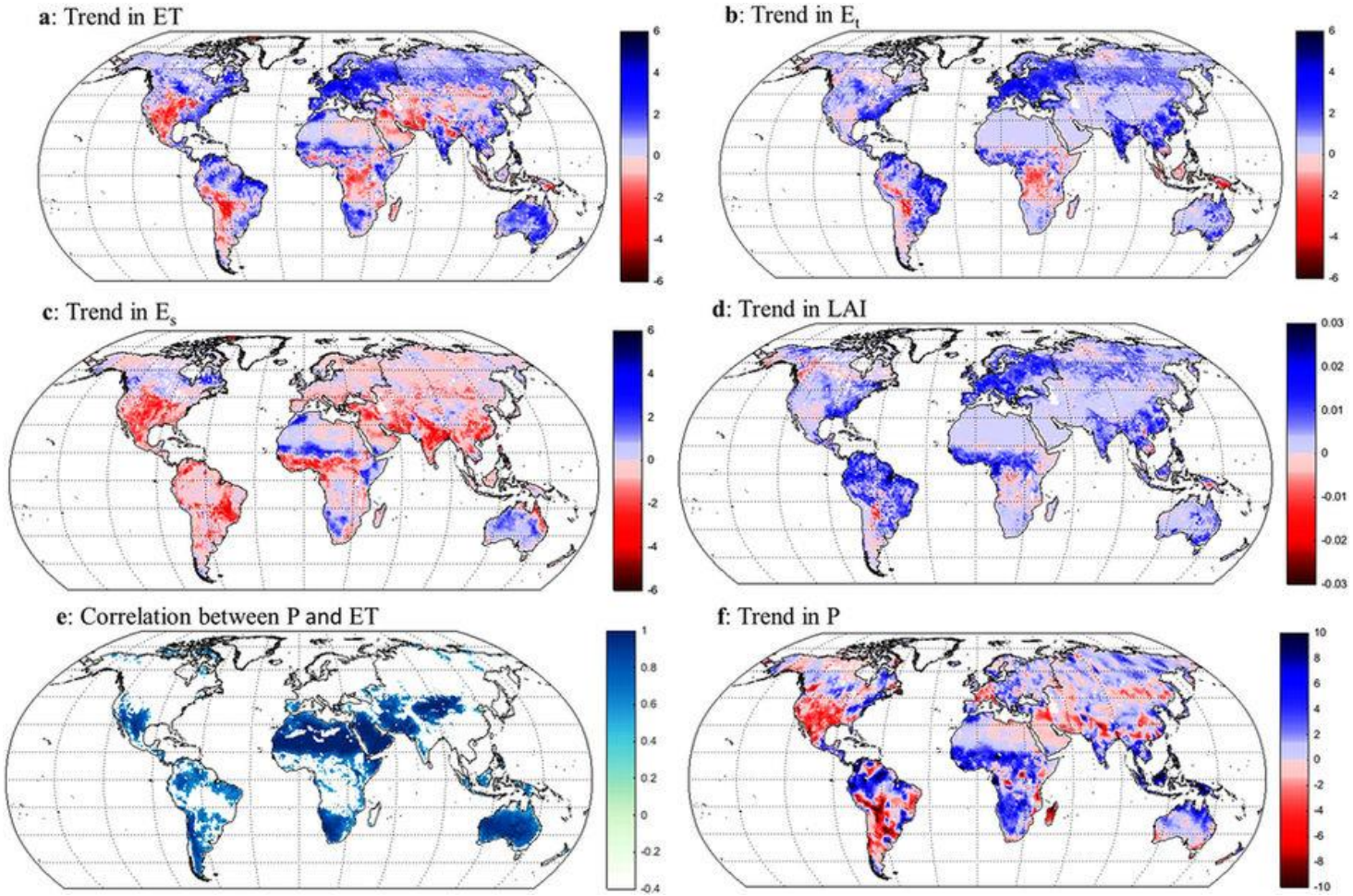
(Saha et al. 2010)

EVAPOTRANSPIRAÇÃO GLOBAL ESTIMADA



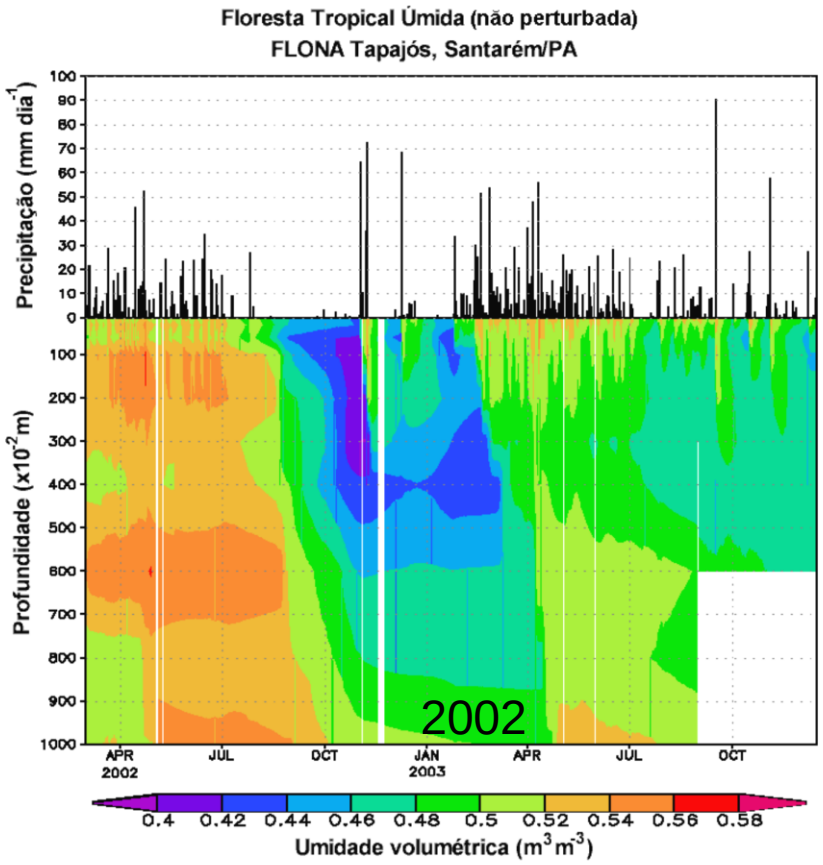
(a) Aridity index (the ratio of mean annual precipitation to mean annual potential evapotranspiration (ET). (**b**) mean annual ET. (**c**) the percentage of transpiration from vegetation (E_t) to ET. (**d**) the percentage of direct evaporation from the soil (E_s) to ET. After: Zhang et al. (2016). Scientific Reports | 6:19124 | DOI: 10.1038/srep19124

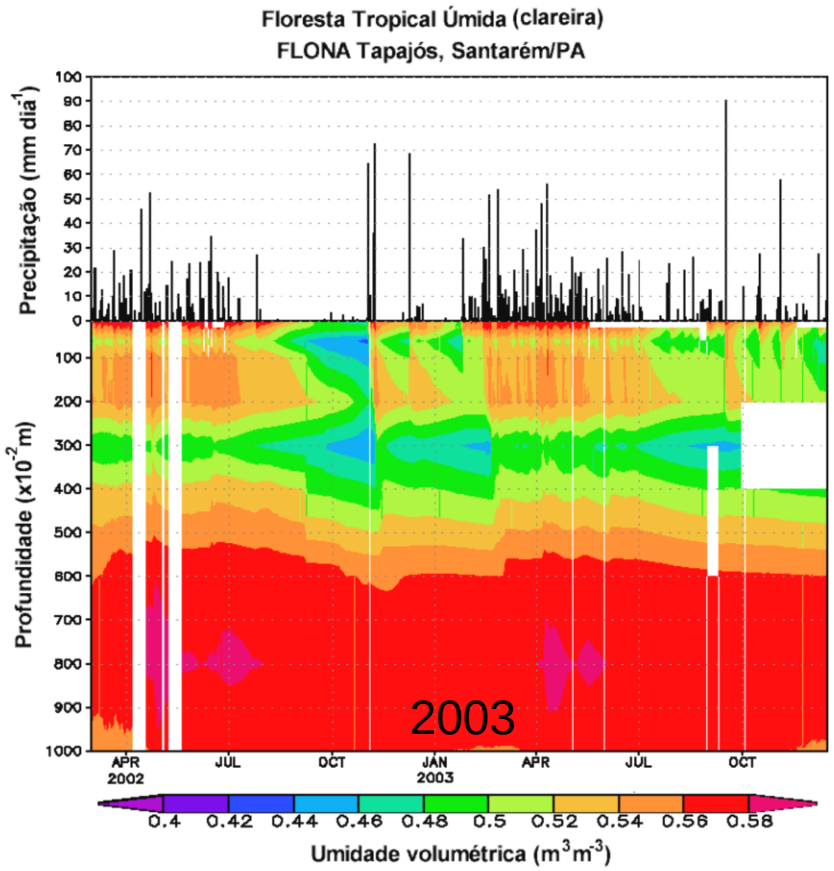
TENDÊNCIAS DA ET



(**a**) ET (Evapotranspiration) trend (mm year^{-2}). (**b**)E_t (transpiration from vegetation) trend (mm year^{-2}). (**c**) E_s (direct evaporation from the soil) trend (mm year^{-2}). (**d**) LAI (leaf are index) trend (m^2 m^{-2} year^{-1}). (**e**) correlation between annual P and annual ET (for land grid cells where $p < 0.01$, else they are white). (**f**) P trend (mm year^{-2}). Trends in ET, E_t, and E_s are obtained from the average of the two PML simulations. Trends in LAI are obtained from the AVHRR based LAI product, and P trends are averaged from the two P products (i.e., PGF and WFDEI). The maps were generated using MATLAB.. After: Zhang et al. (2016). Scientific Reports | 6:19124 | DOI: 10.1038/srep19124

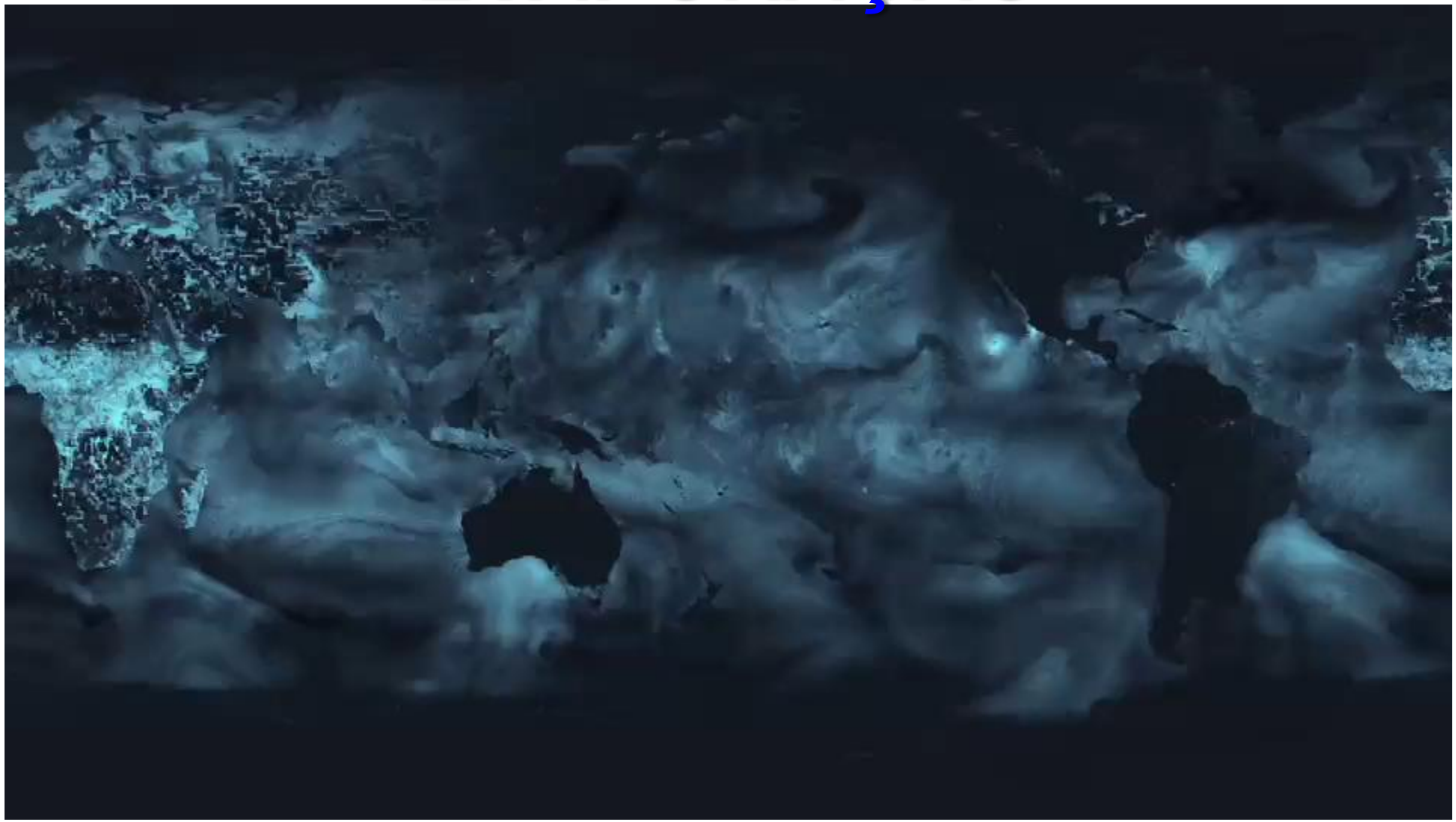
Floresta Amazônica





Bruno e Rocha (2004)

EVAPORAÇÃO



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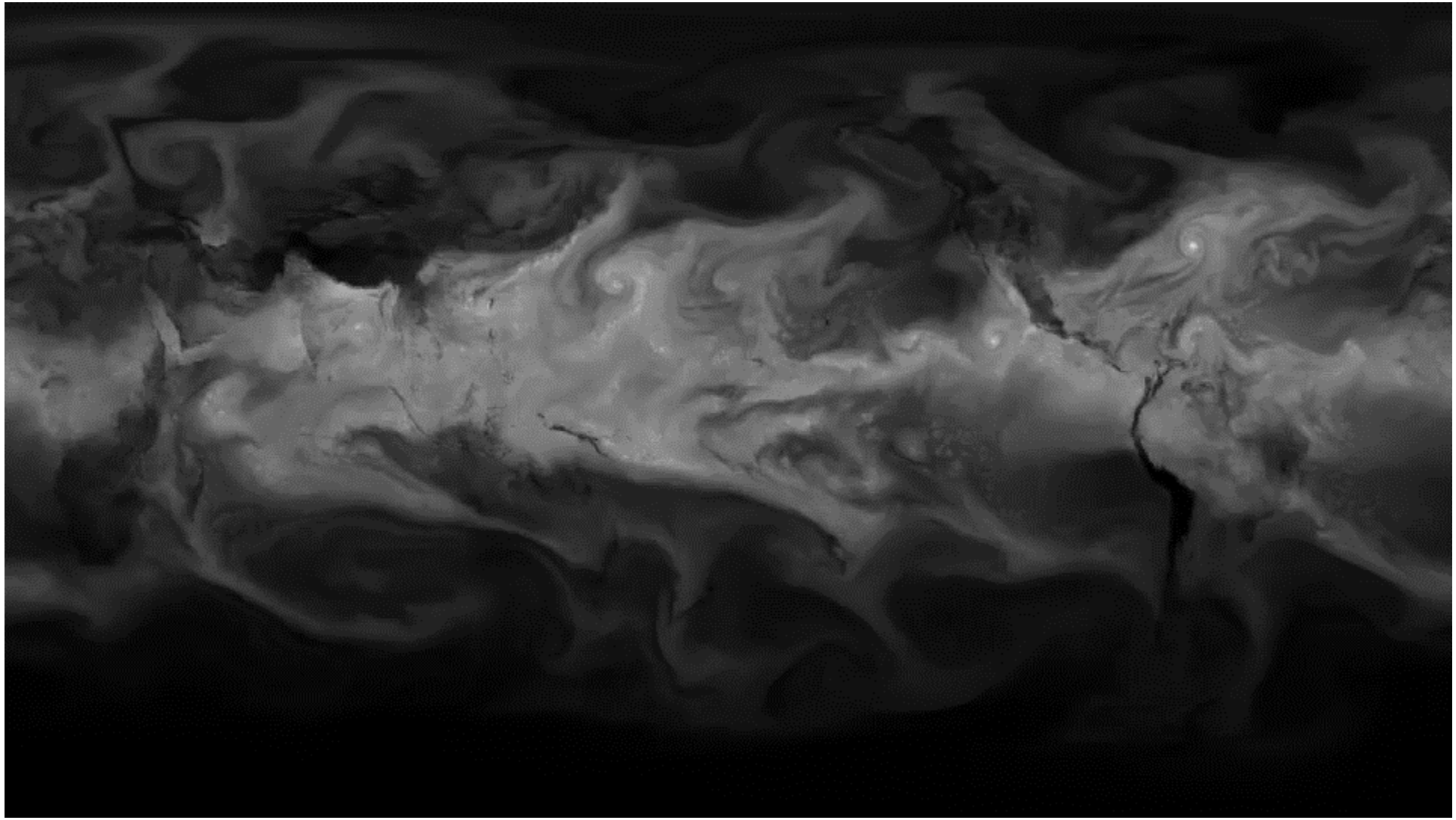
TRANSPORTE DE VAPOR D´ÁGUA



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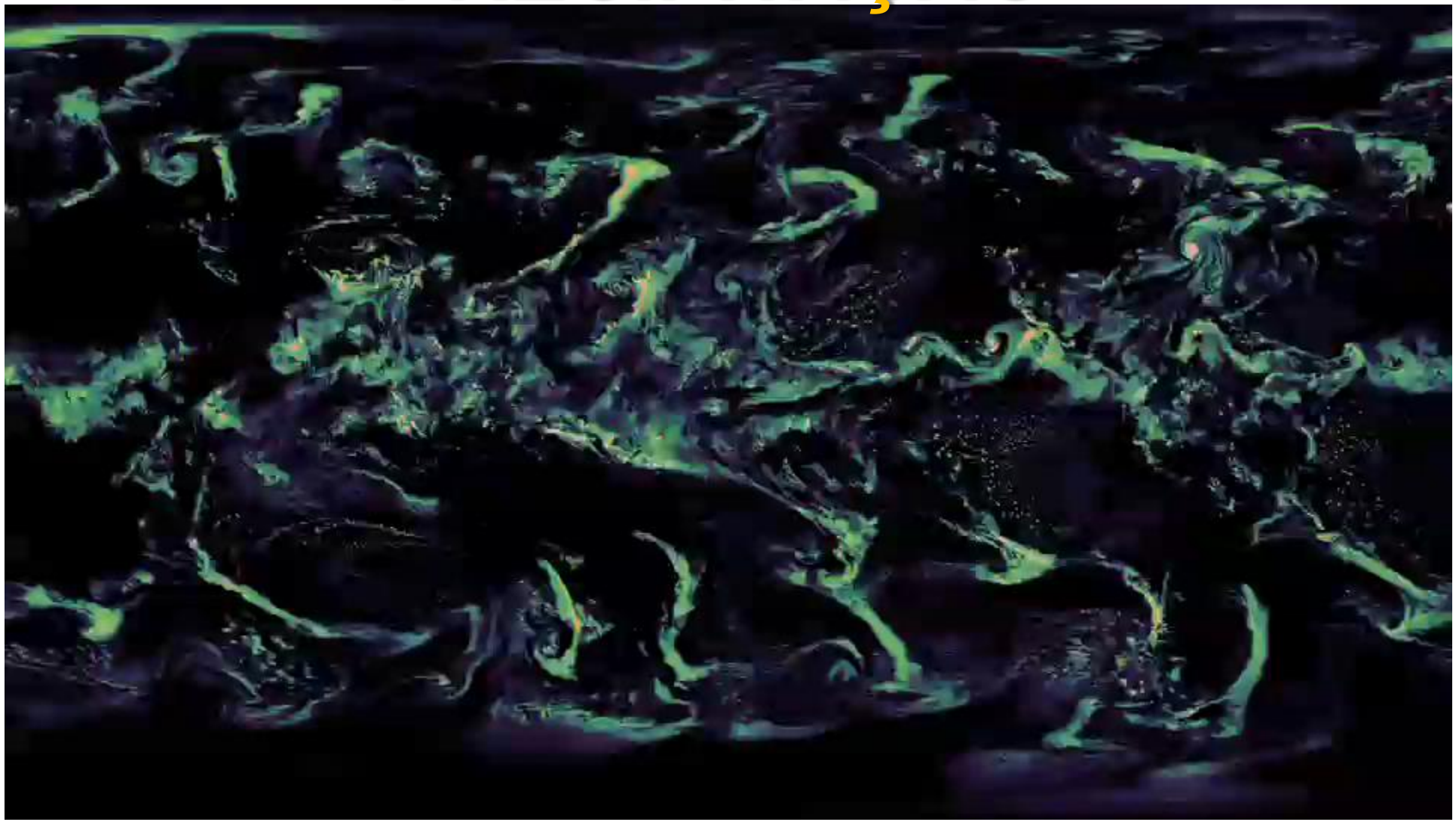
PRECIPITAÇÃO



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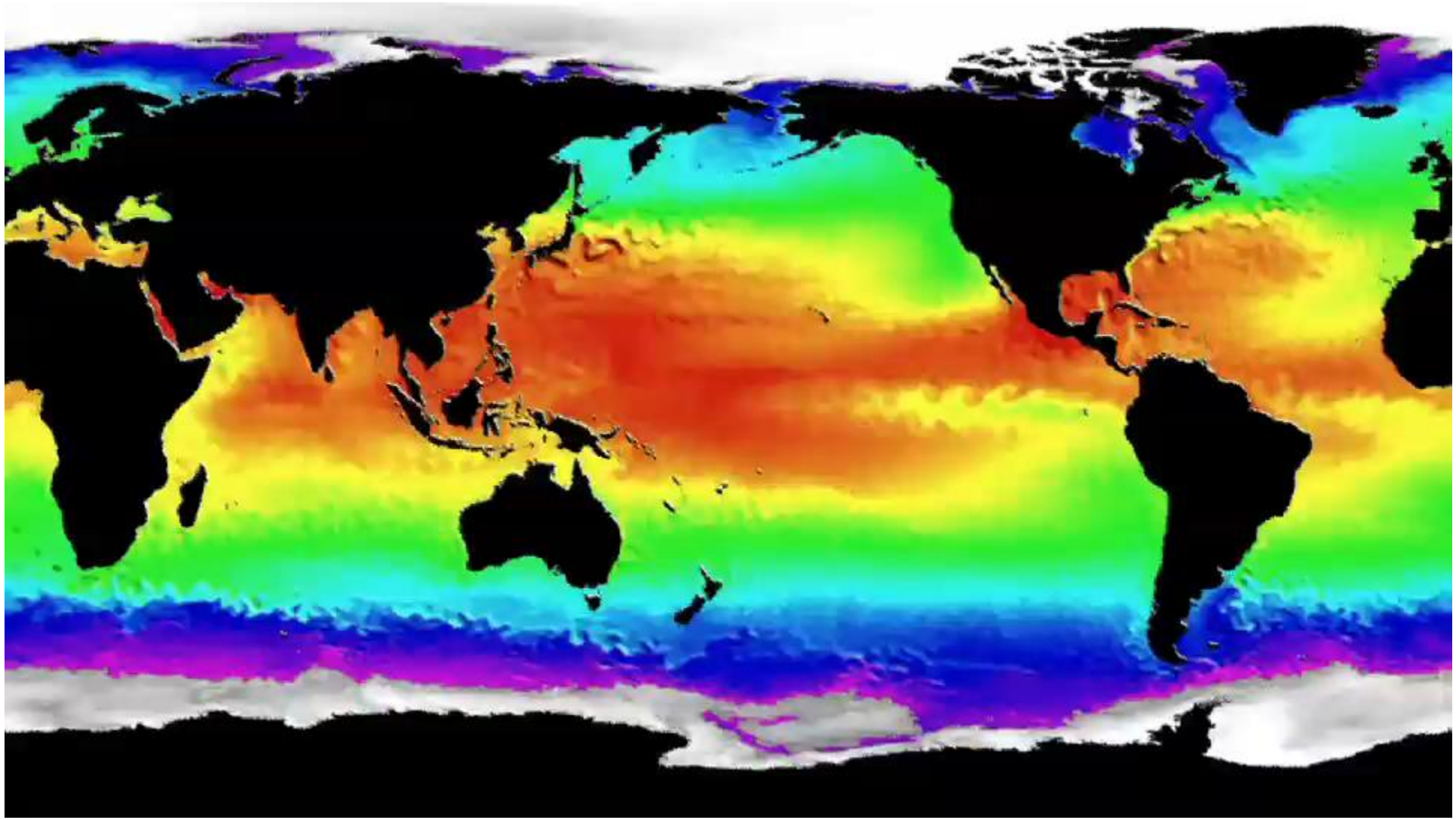
TEMPERATURA DA SUPERFÍCIE DO MAR



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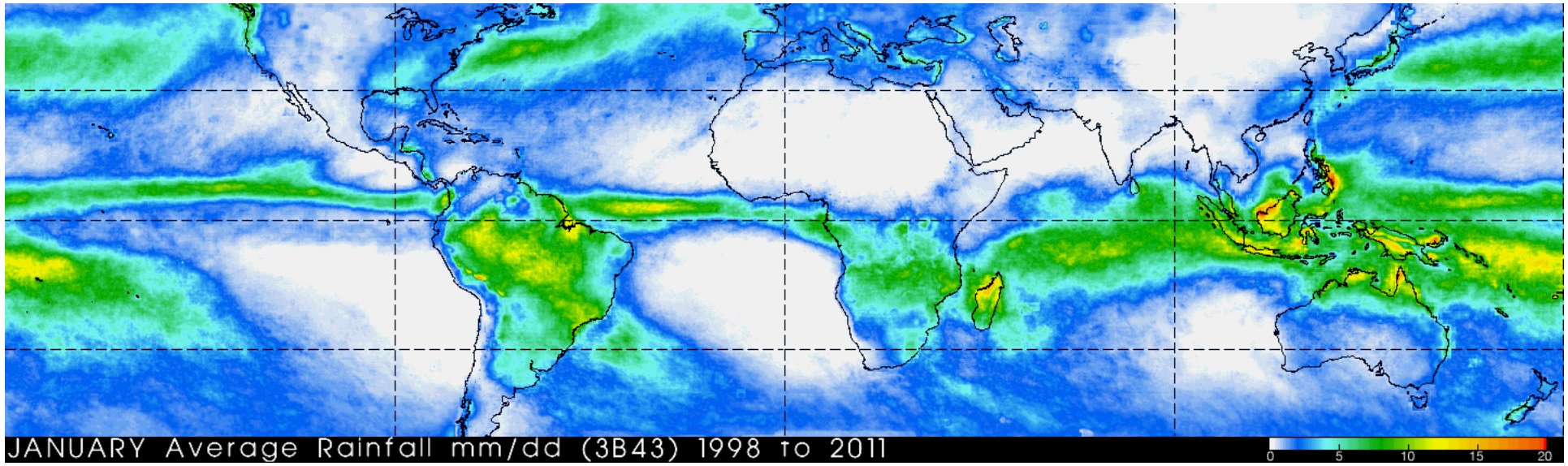
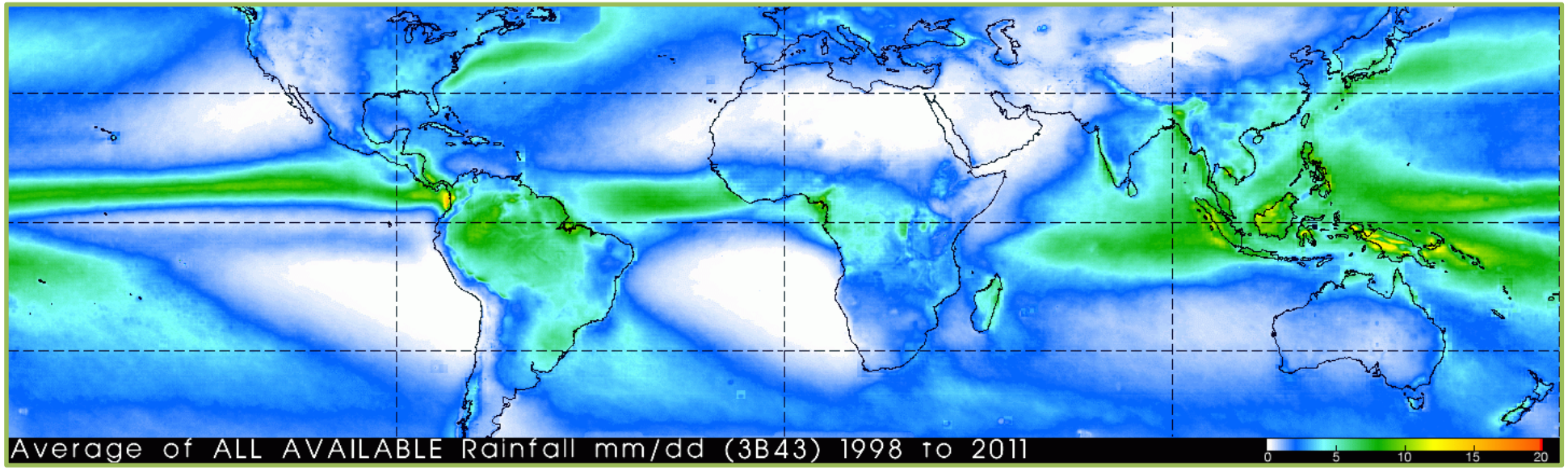
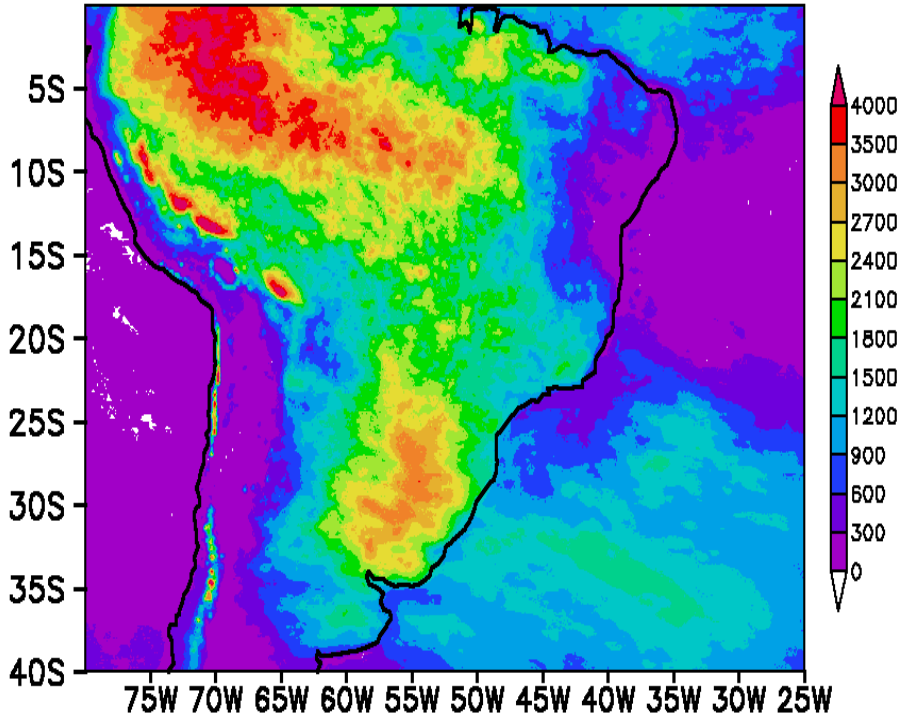
CLIMATOLOGIA TRMM



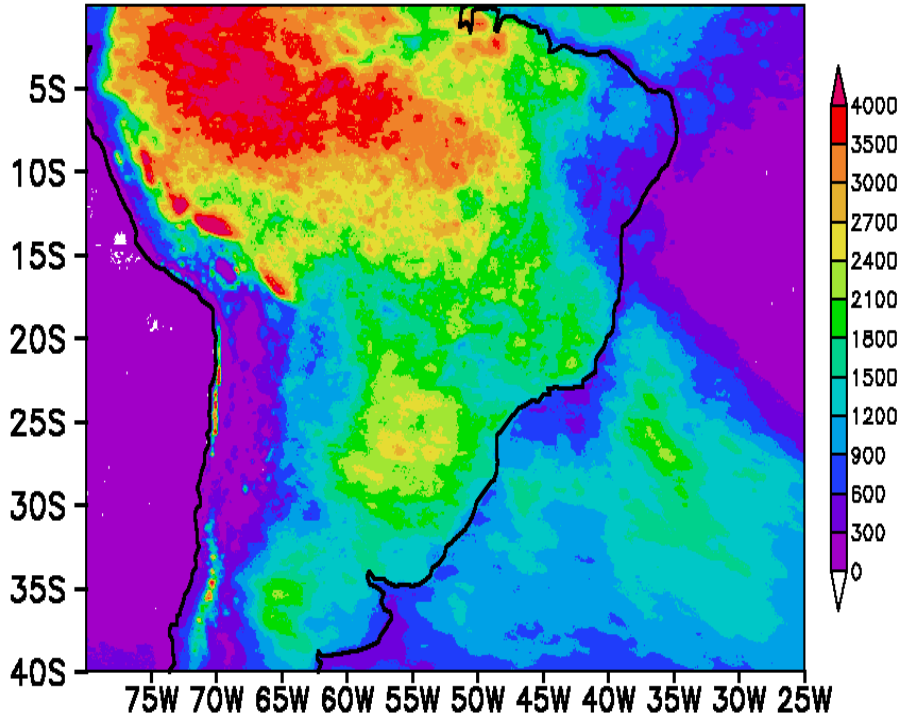


PRECIPITAÇÃO ANNUAL (mm) - CMORPH

2003

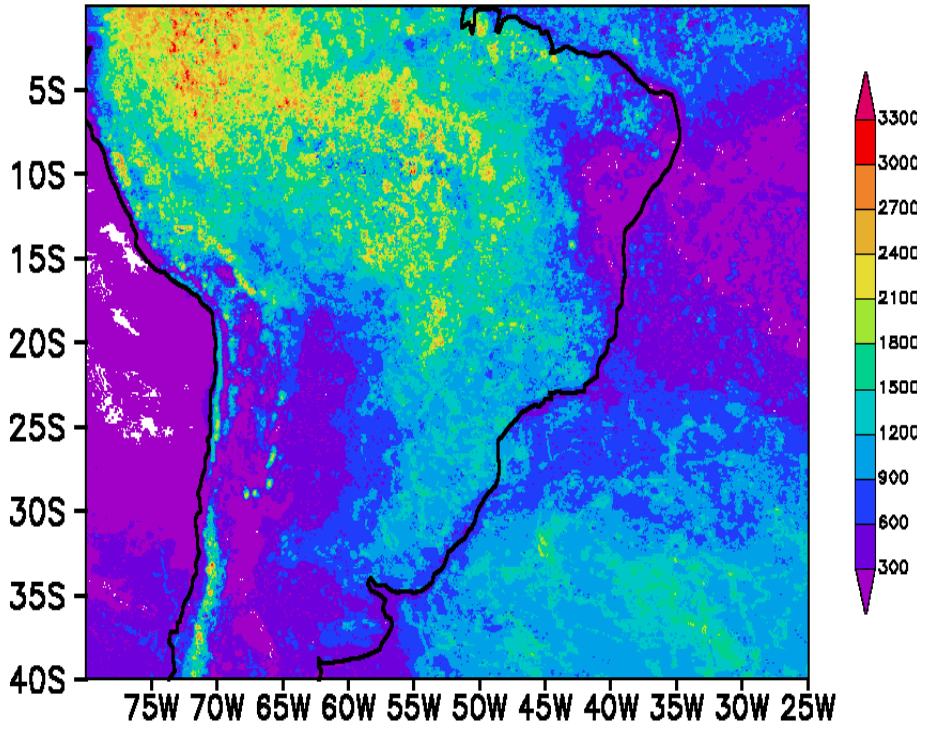


2004

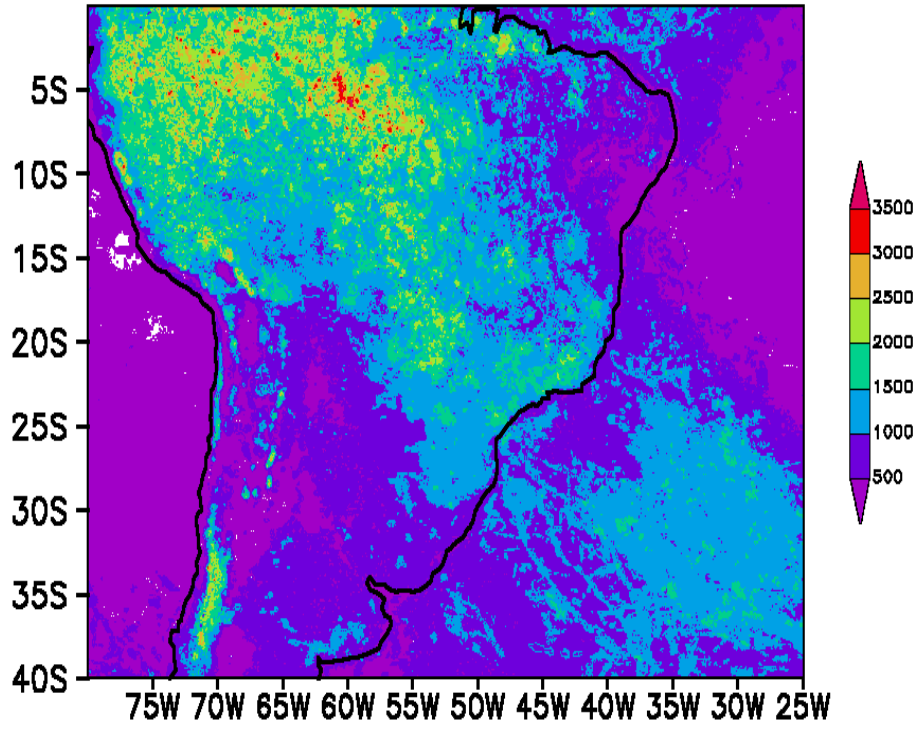


NÚMERO DE HORAS DE CHUVA CMORPH

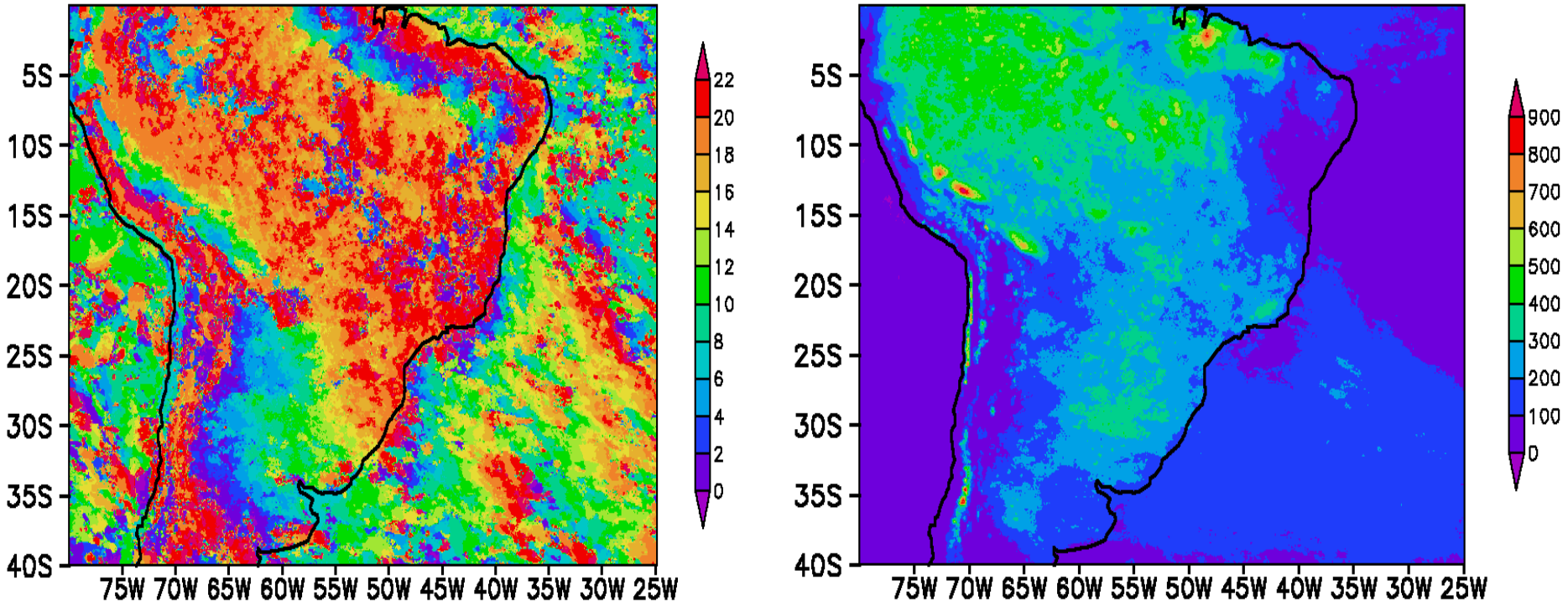
2003



2004

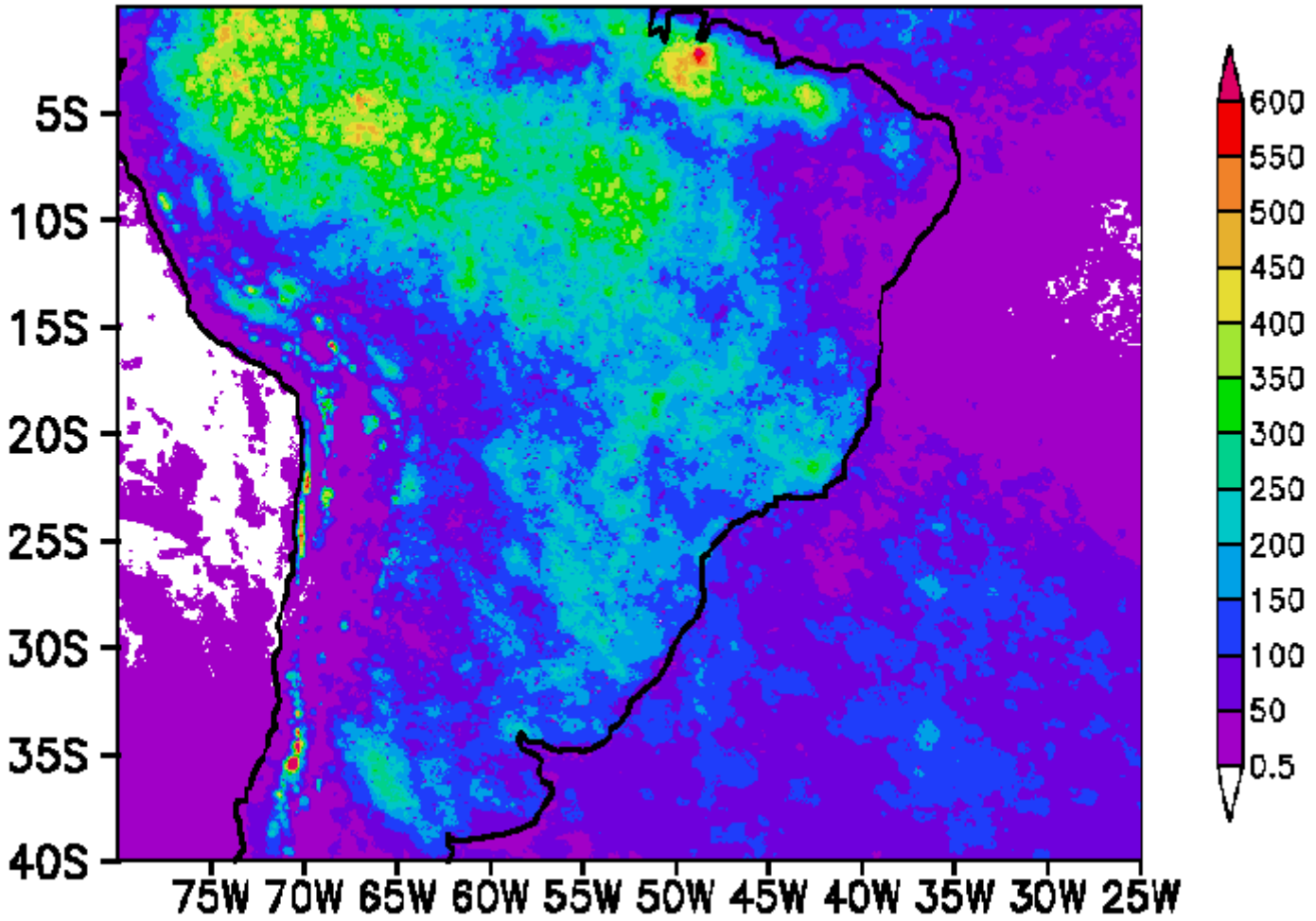


HORÁRIO DE MÁXIMA (UTC) PRECIPITAÇÃO (mm) - CMORPH



2003 e 2004

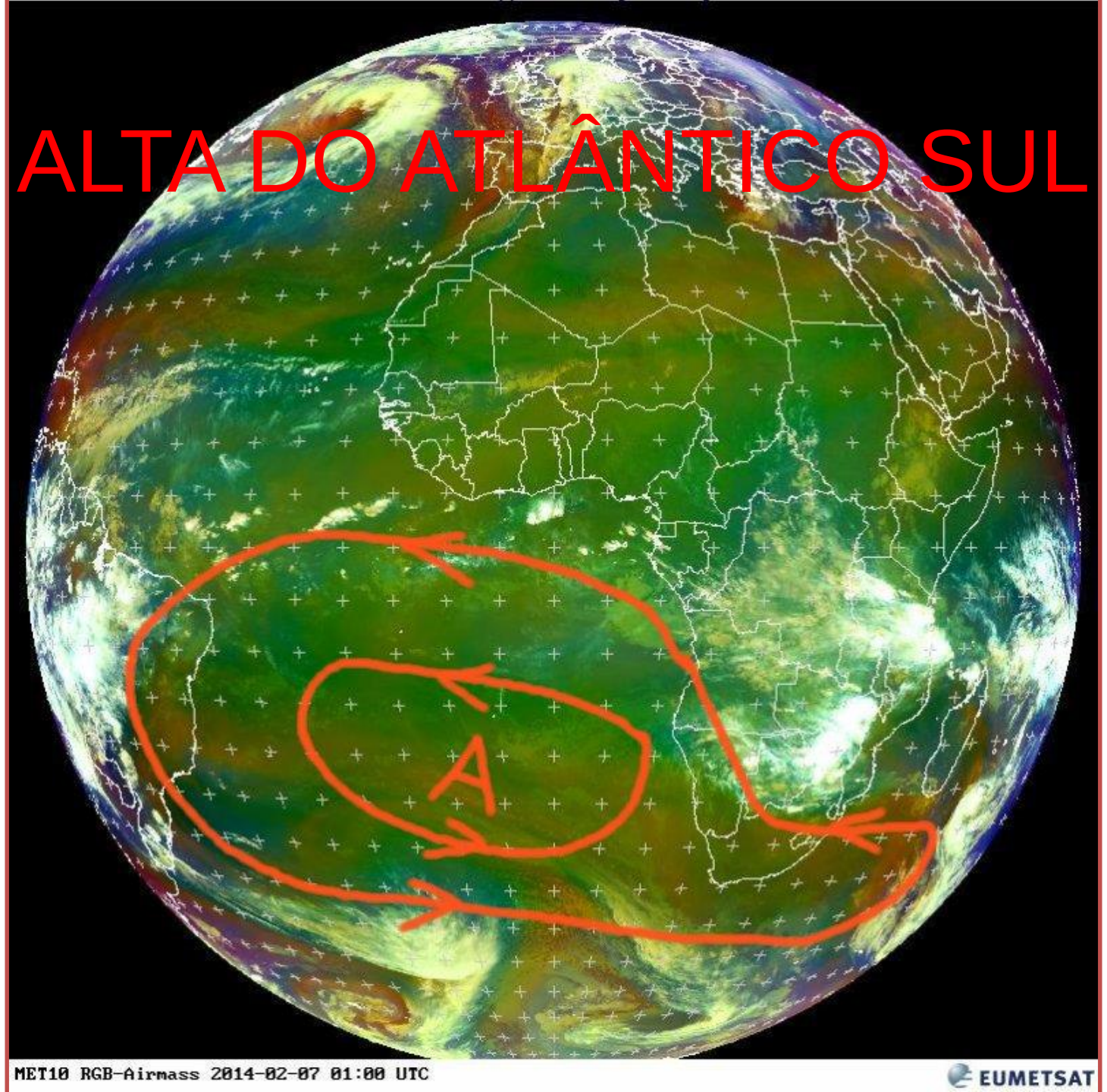
PRECIPITAÇÃO ACUMULADA HORÁRIA (mm) CMORPH



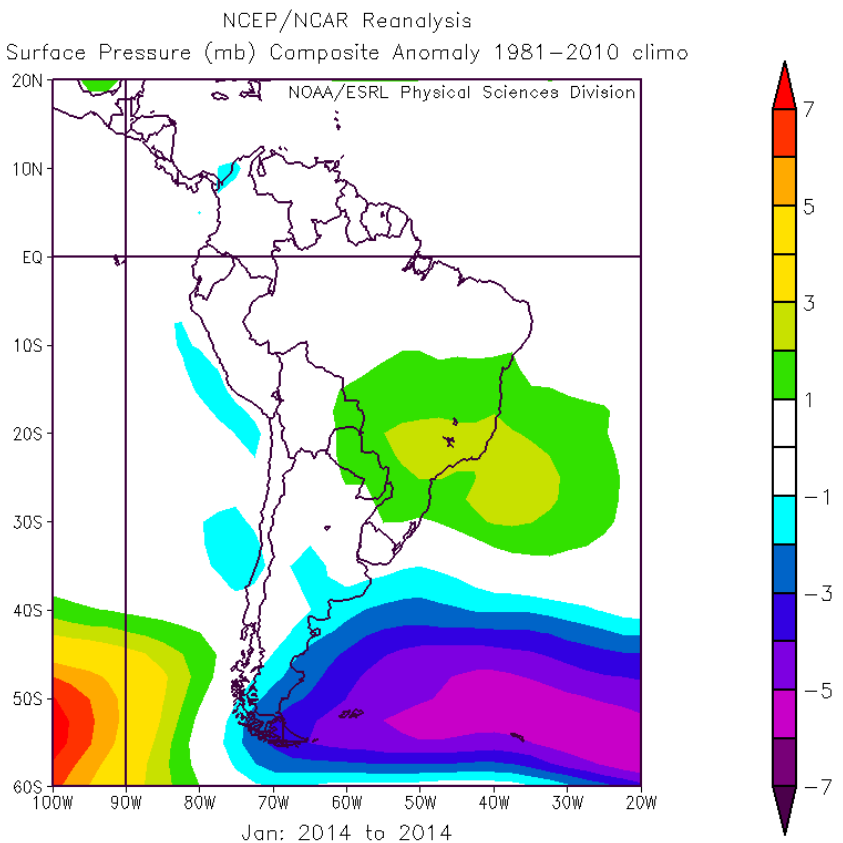
SECA 2014

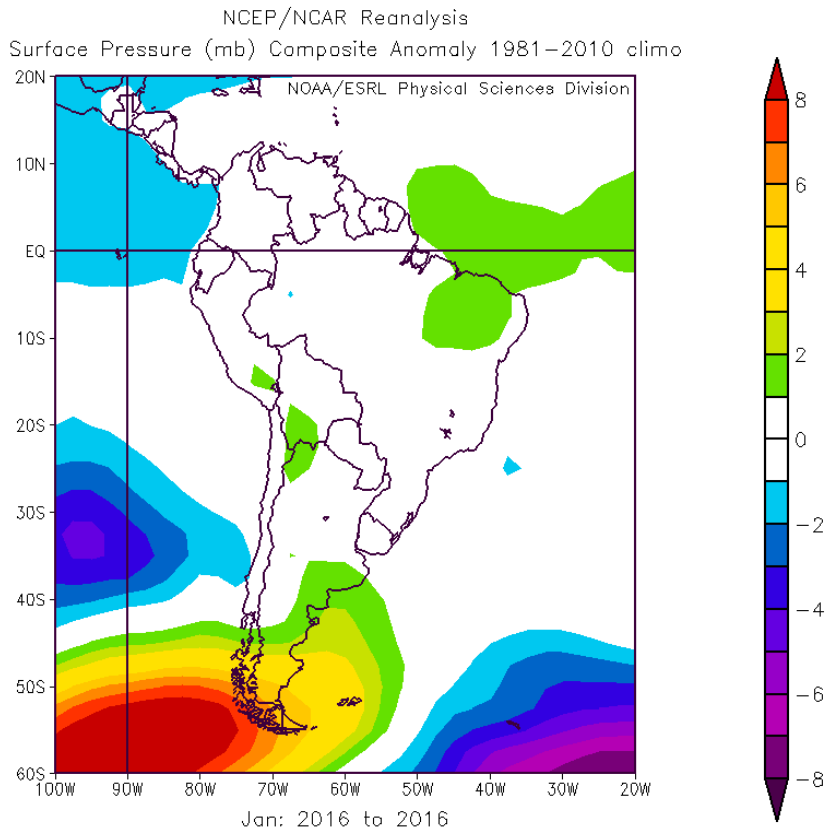
X

CHUVA 2016

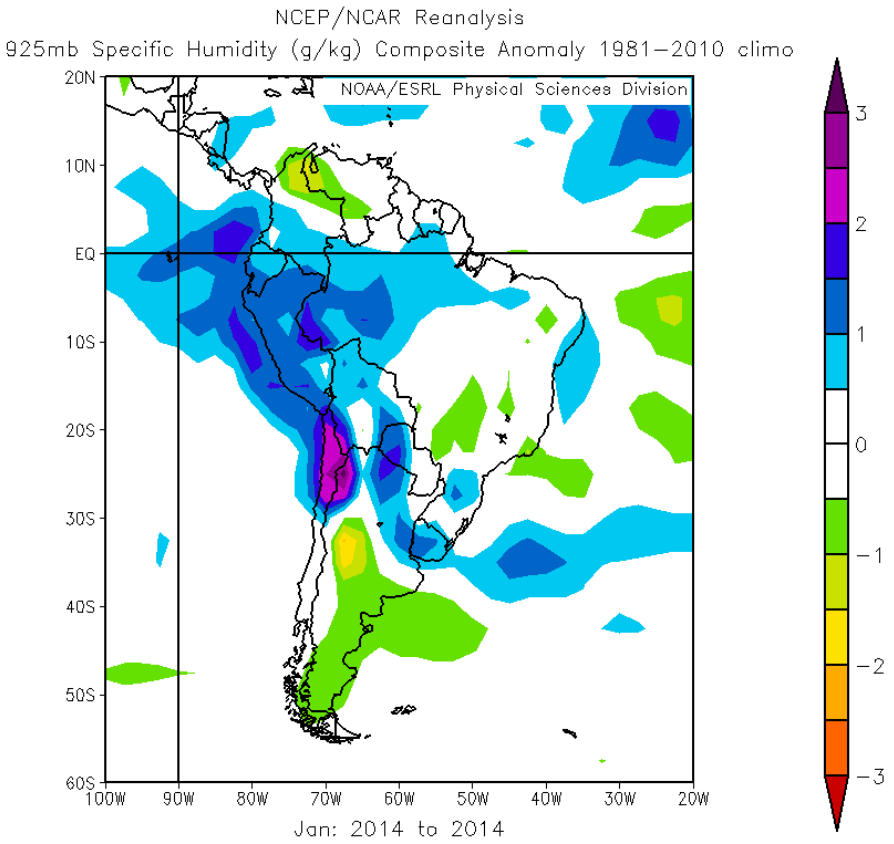

ALTA DO ATLÂNTICO SUL
A
MET10 RGB-Airmass 2014-02-07 01:00 UTC
EUMETSAT

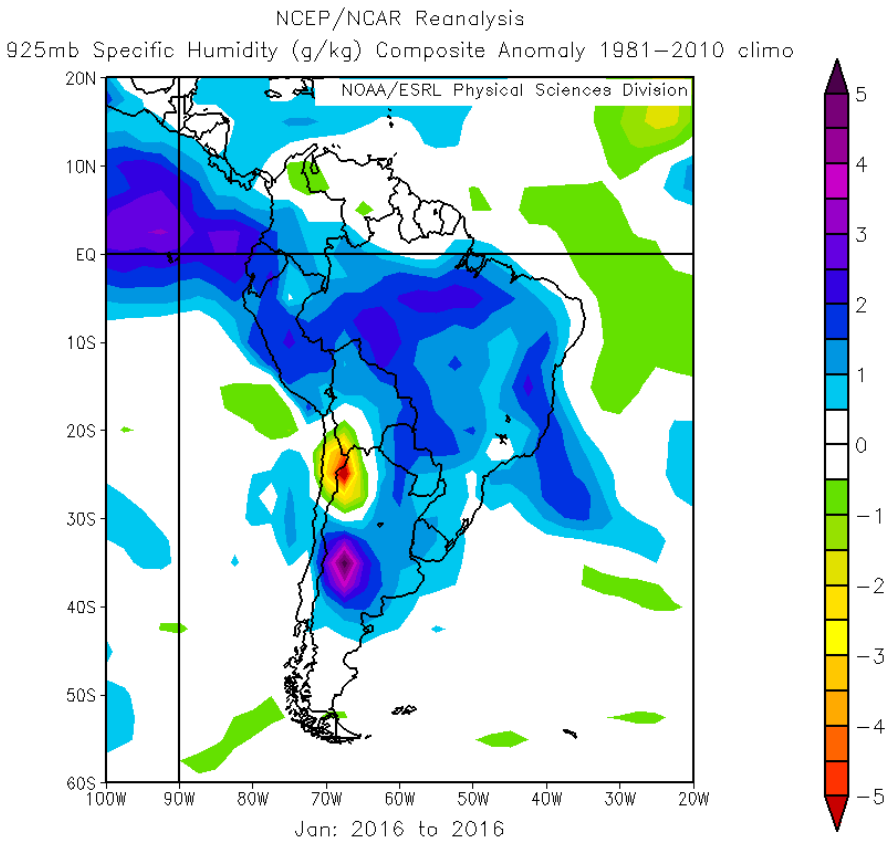
Anomalia de pressão



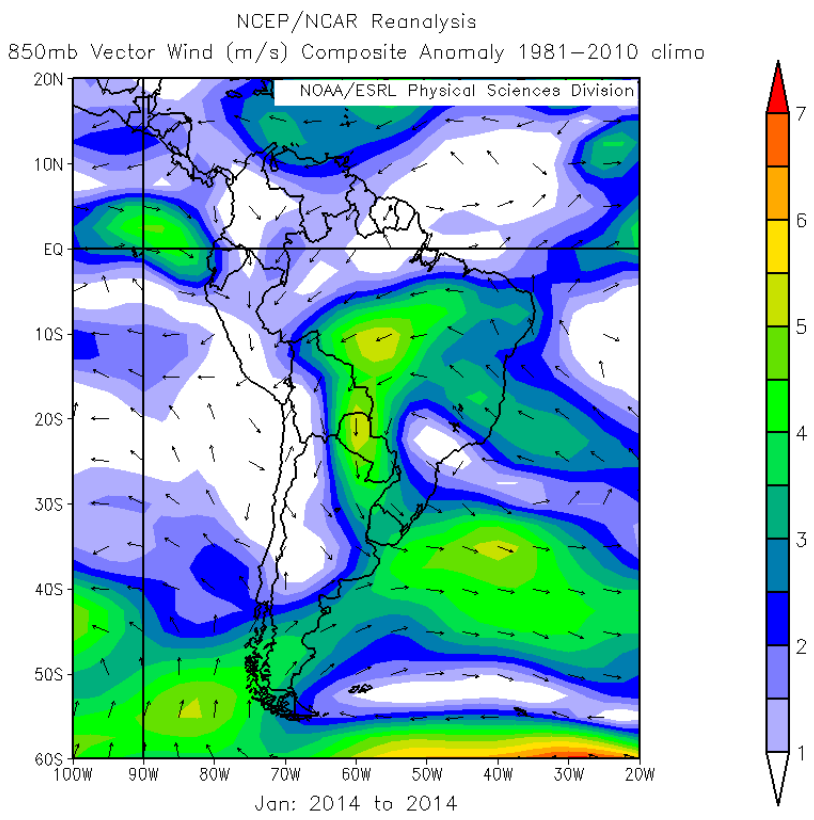


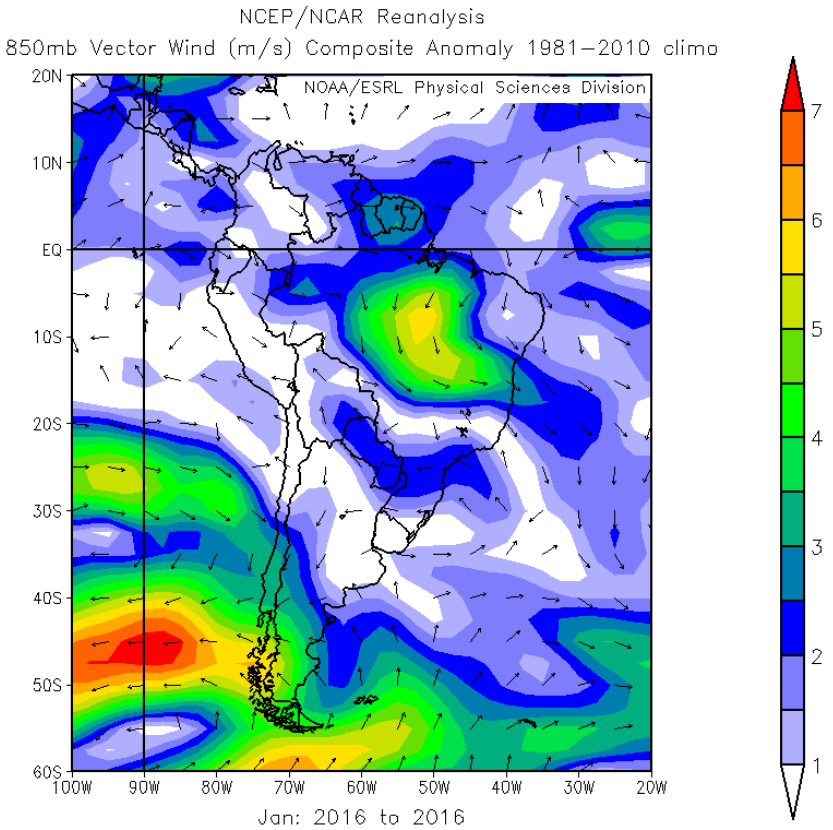
Anomalia de Umidade Específica



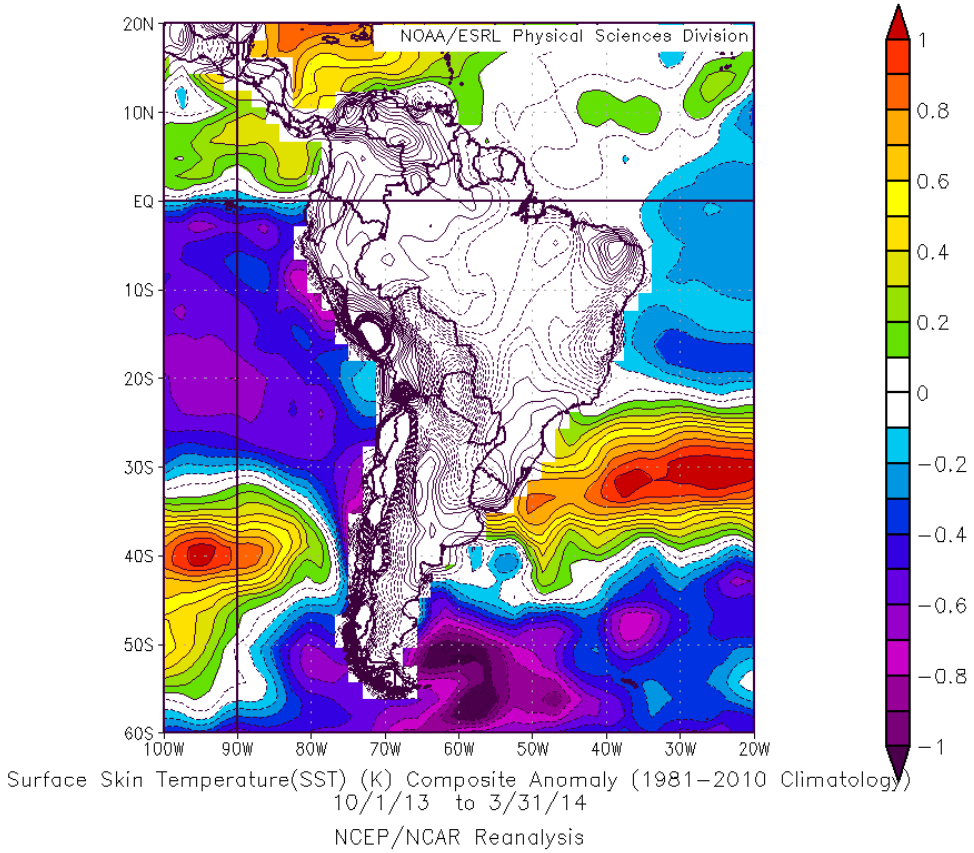


Anomalia de Vento 850 hPa

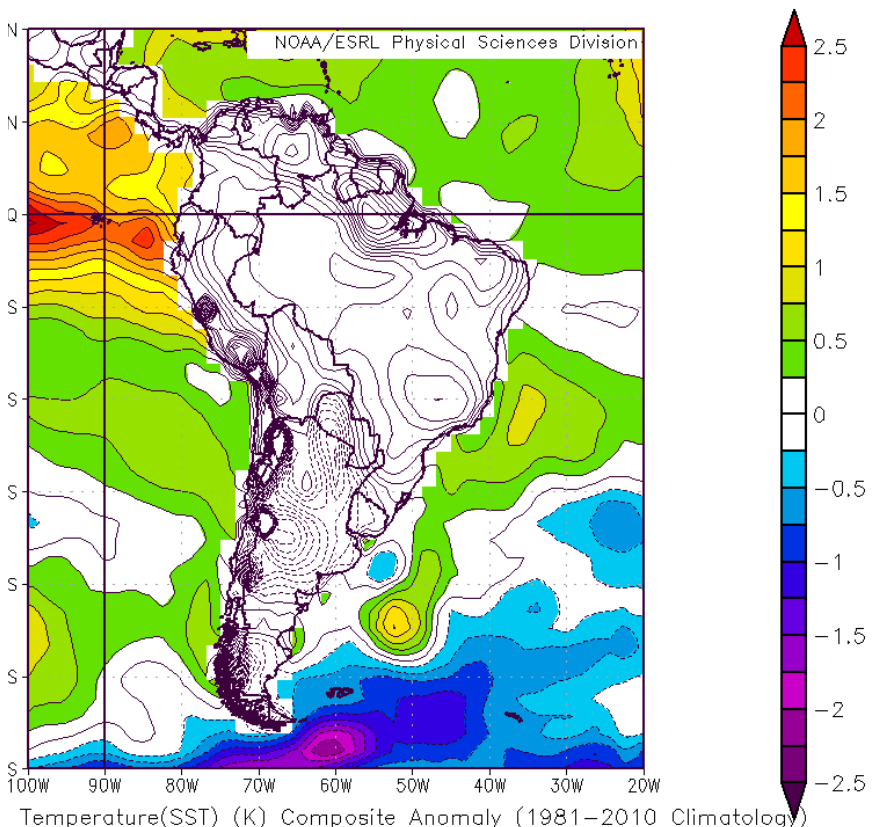




Anomalia de SST

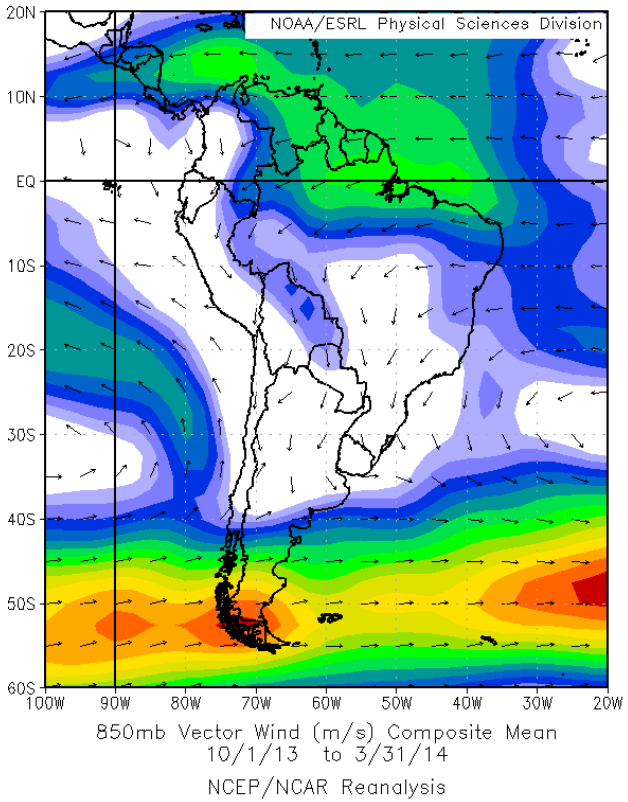


Surface Skin Temperature(SST) (K) Composite Anomaly (1981–2010 Climatology)
10/1/13 to 3/31/14
NCEP/NCAR Reanalysis

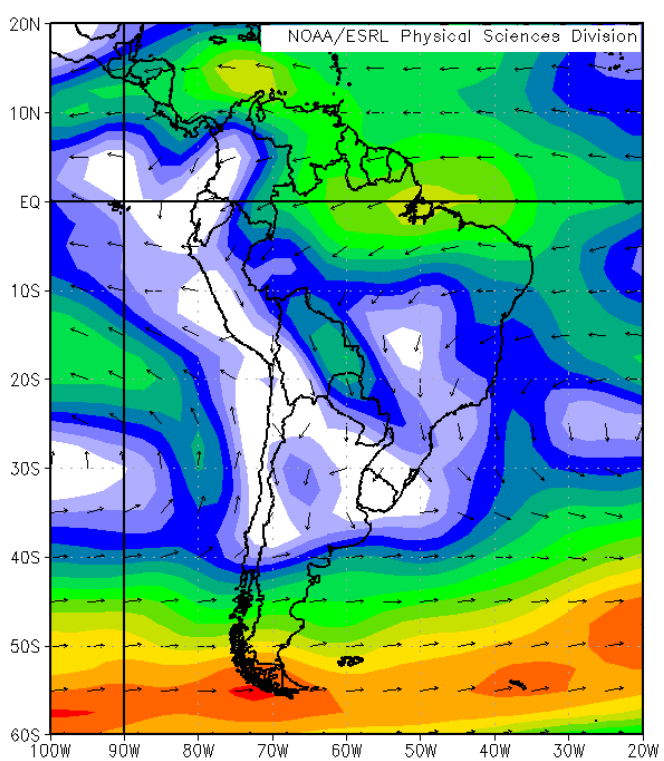


Temperature(SST) (K) Composite Anomaly (1981–2010 Climatology)
10/1/15 to 3/31/16
NCEP/NCAR Reanalysis

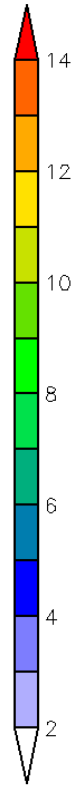
Vento em 850 hPa



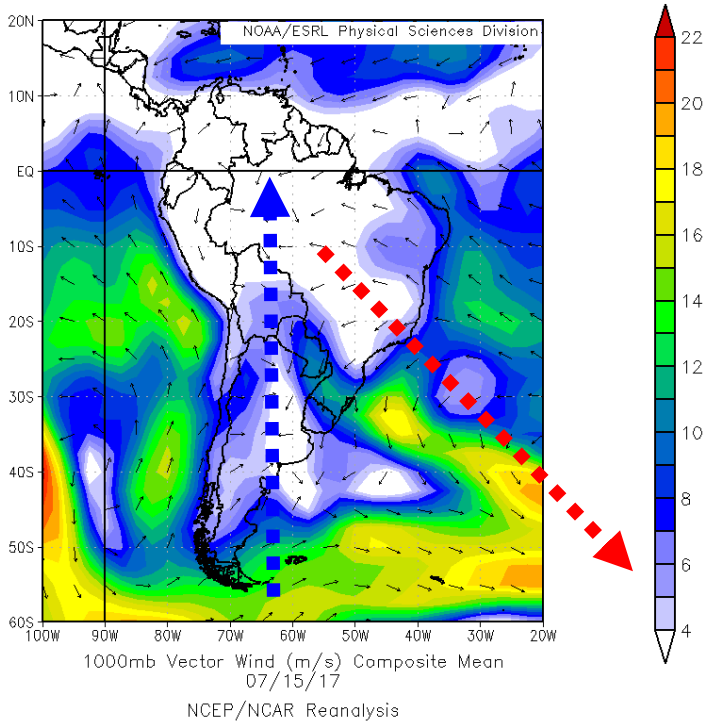
850mb Vector Wind (m/s) Composite Mean
10/1/13 to 3/31/14
NCEP/NCAR Reanalysis

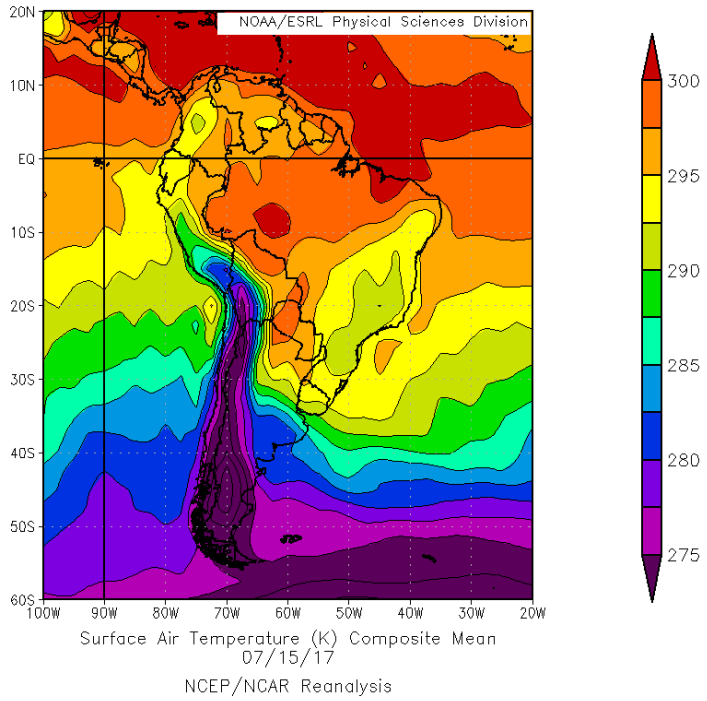


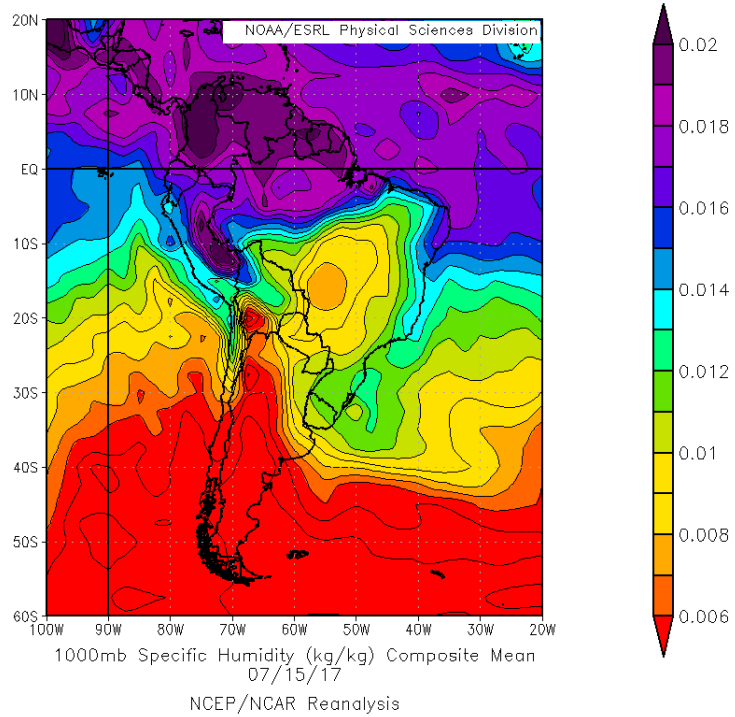
850mb Vector Wind (m/s) Composite Mean
10/1/15 to 3/31/16
NCEP/NCAR Reanalysis



ENTRADA DE AR POLAR SECO

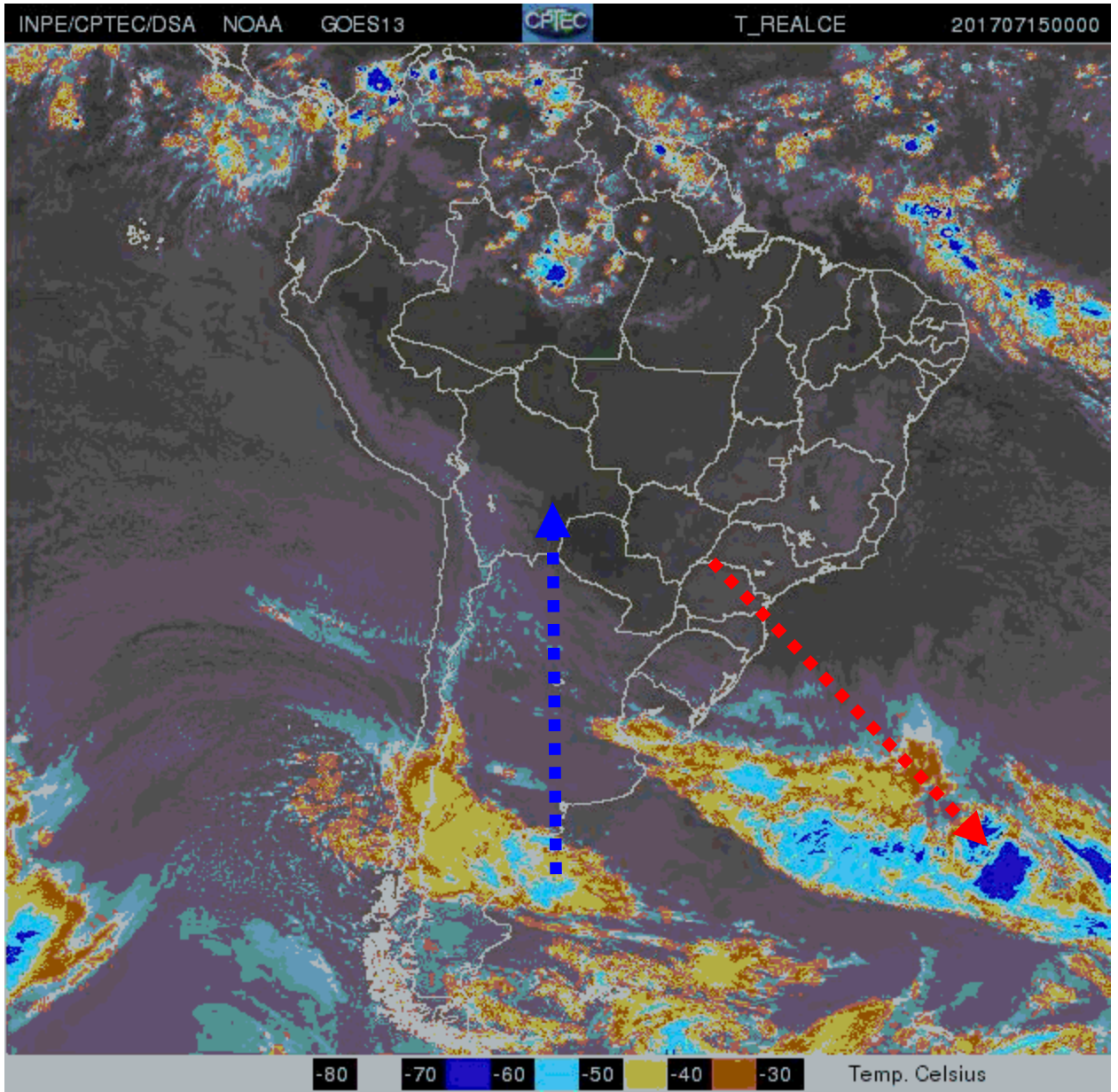




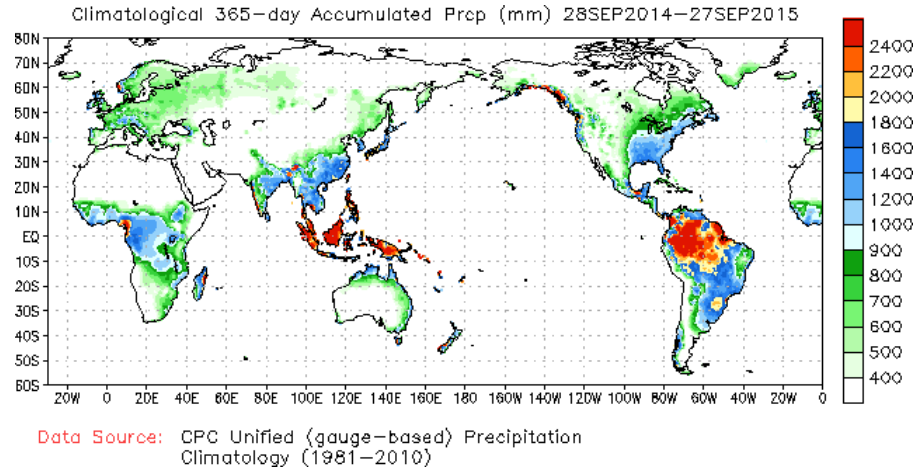


SAIDA DE AR TROPICAL ÚMIDO

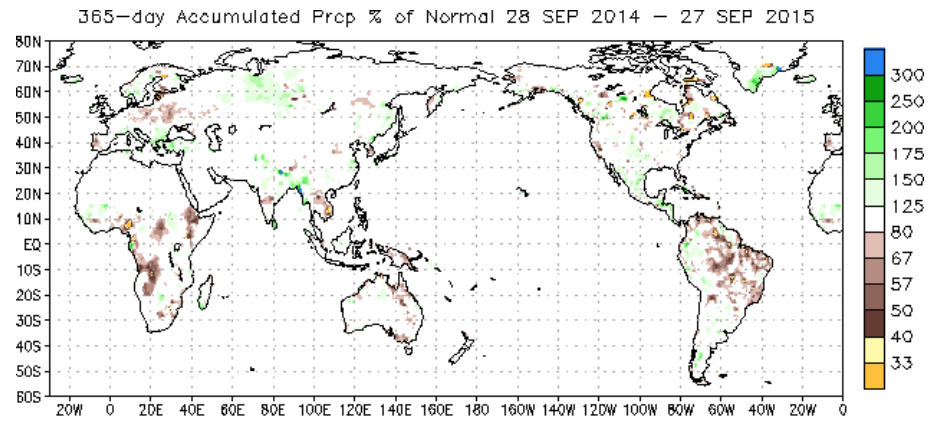
SATÉLITE GOES-13 15-21/07/2017



PRECIPITAÇÃO 365 DIAS 2014/2015

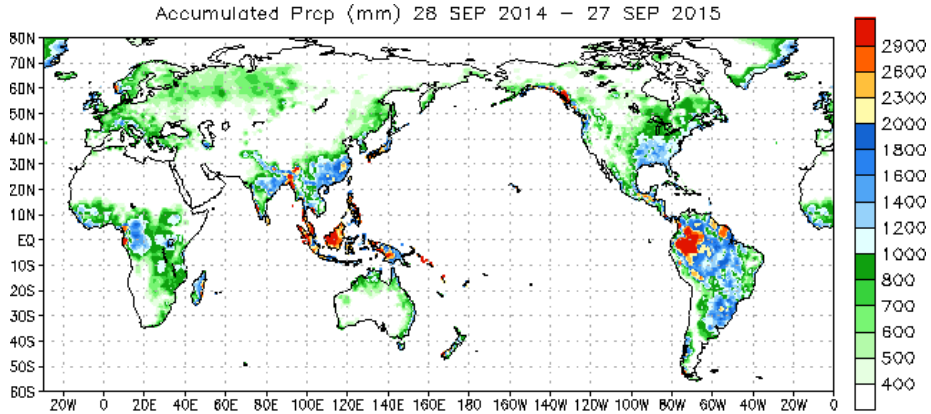


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

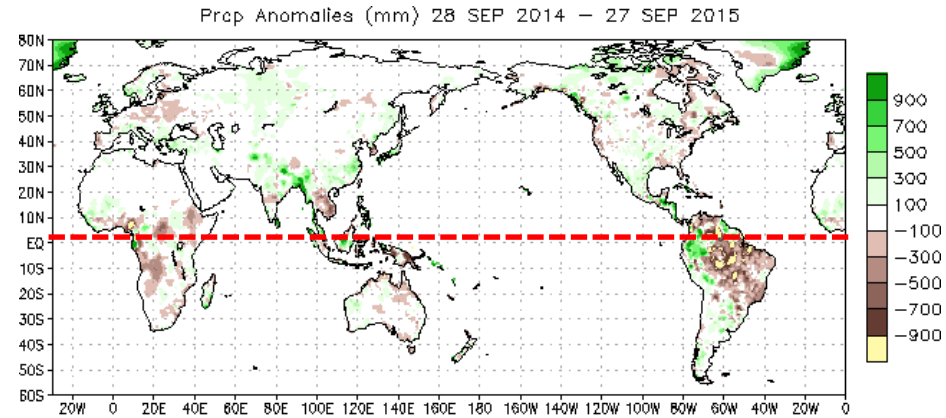


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

Note: Areas which receive on average 1mm/day are masked out.

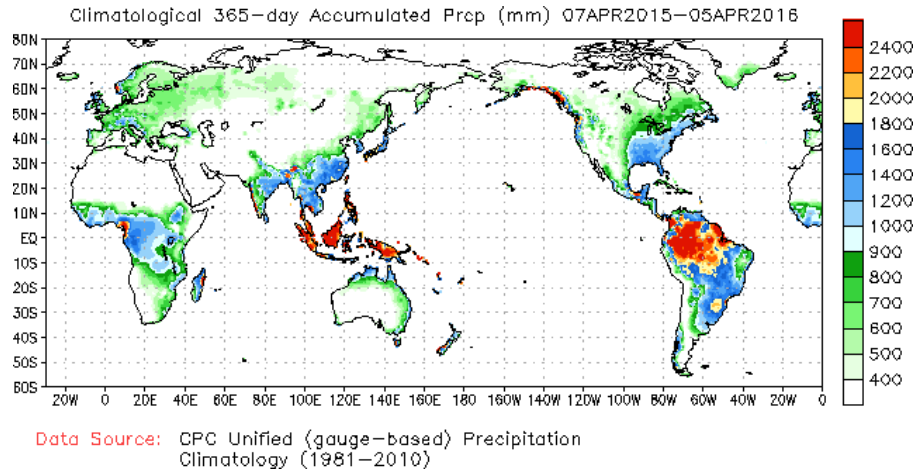


Data Source: CPC Unified (gauge-based) Precipitation

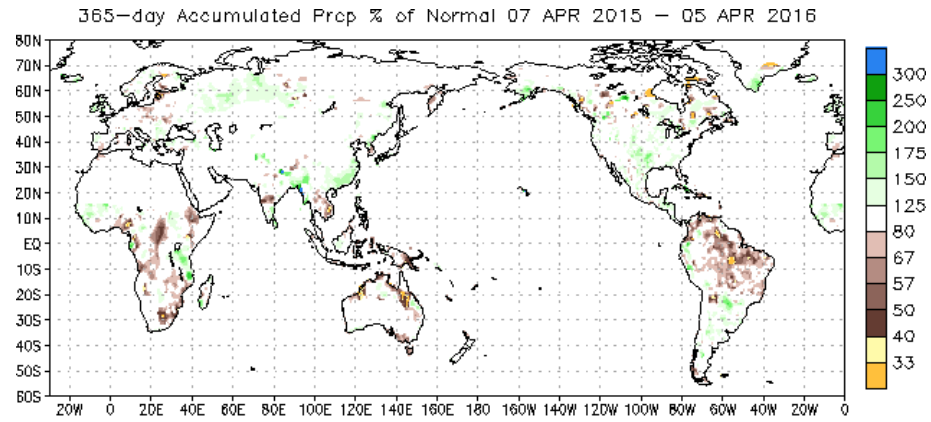


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

PRECIPITAÇÃO 365 DIAS 2015/2016

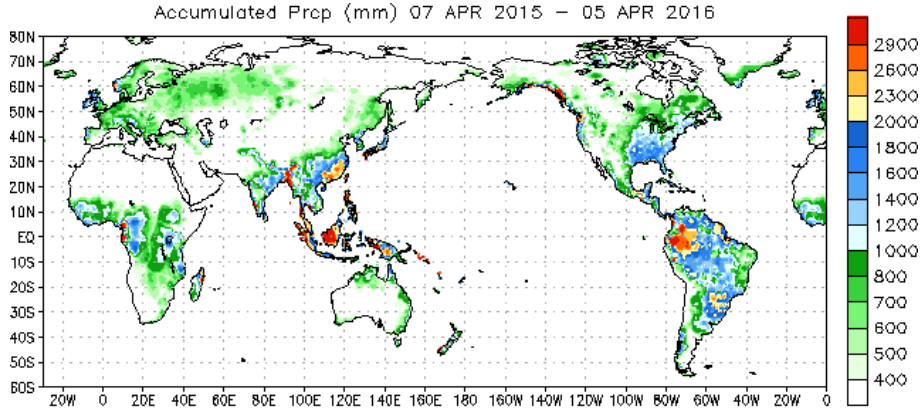


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

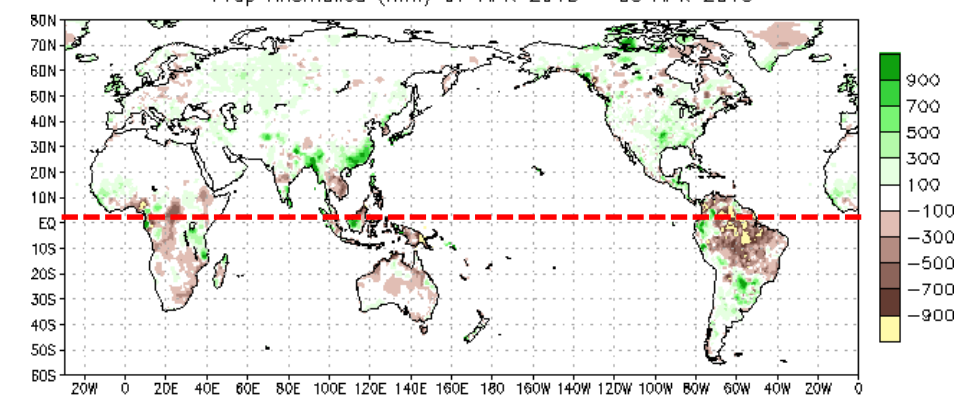


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

Note: Areas which receive on average 1mm/day are masked out.

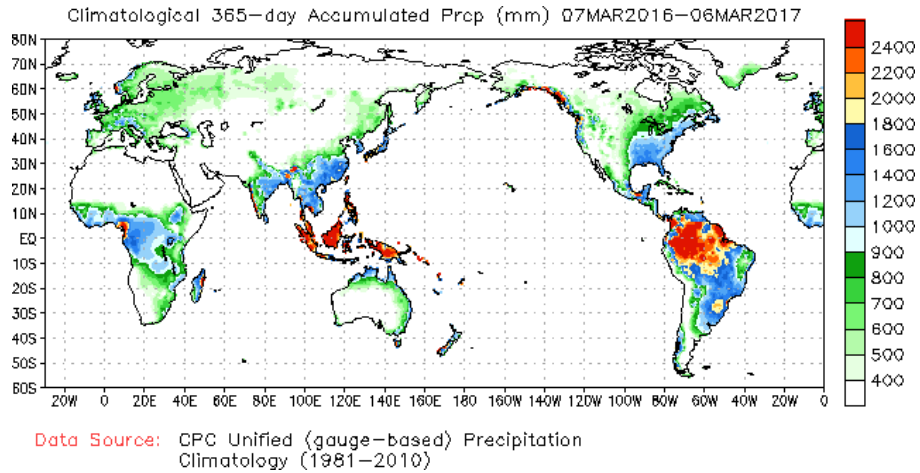


Data Source: CPC Unified (gauge-based) Precipitation

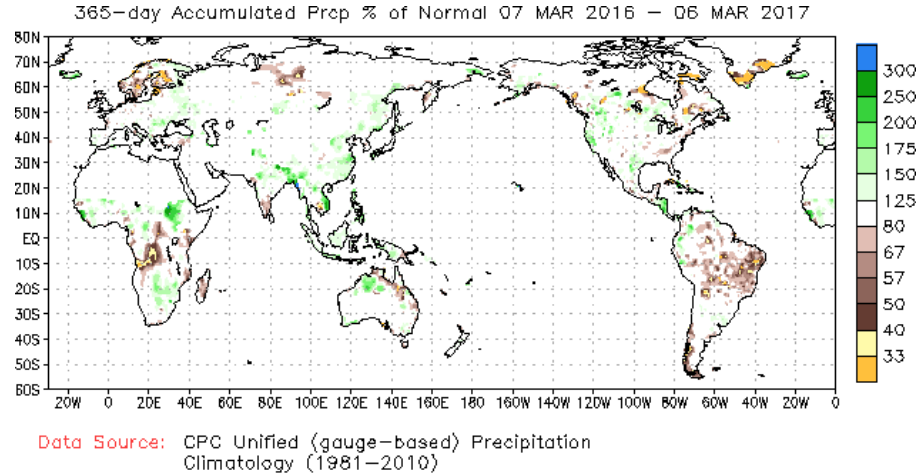


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

PRECIPITAÇÃO 365 DIAS 2016/2017

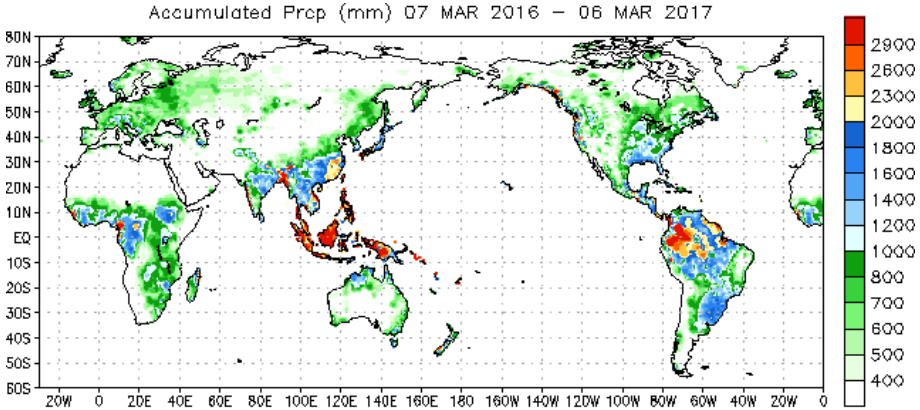


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

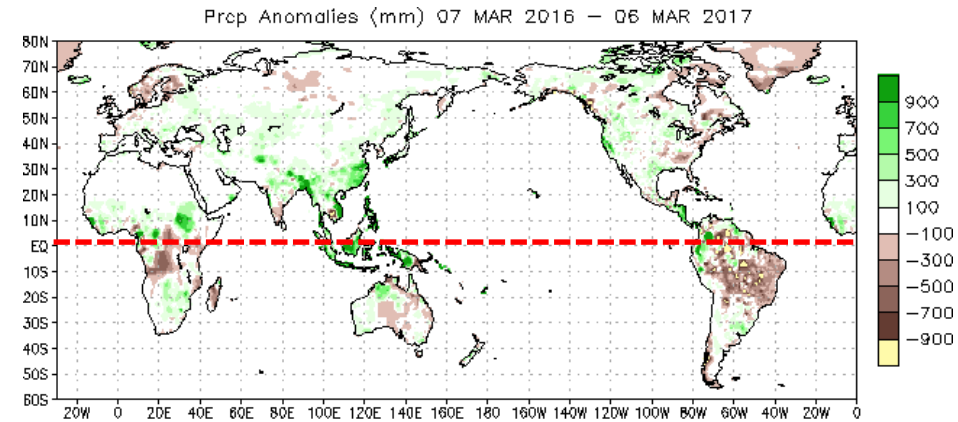


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

Note: Areas which receive on average 1mm/day are masked out.



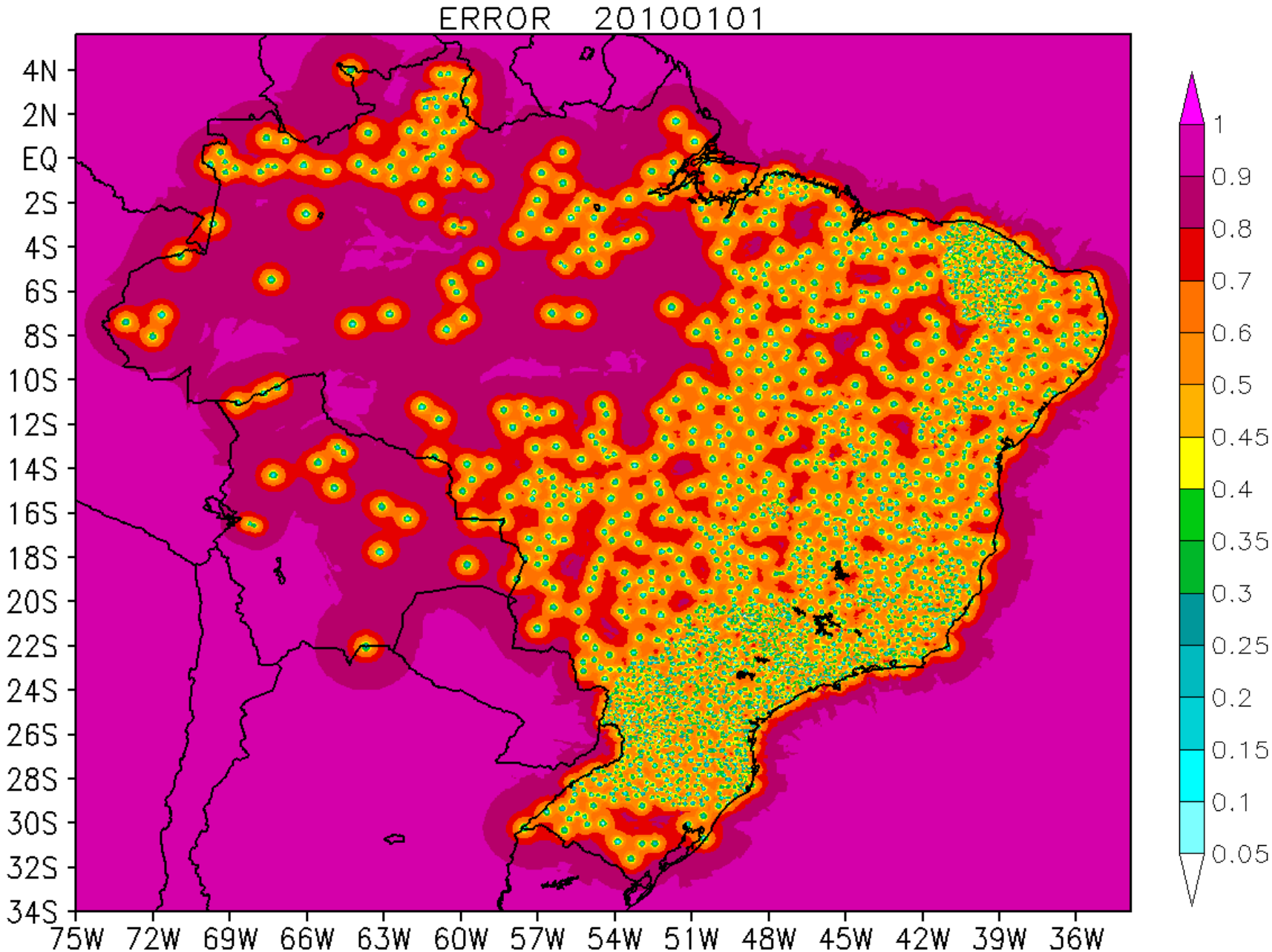
Data Source: CPC Unified (gauge-based) Precipitation

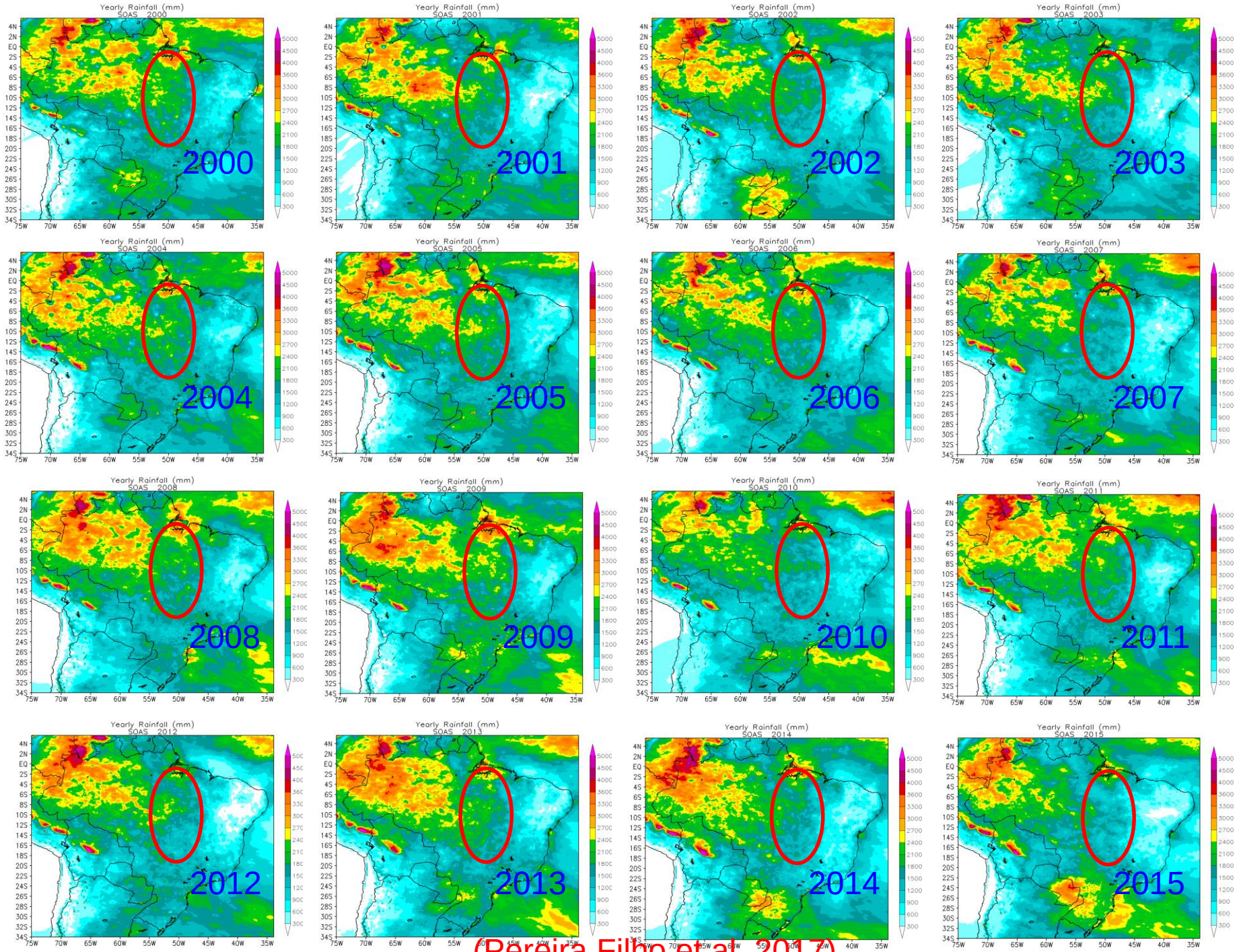


Data Source: CPC Unified (gauge-based) Precipitation
Climatology (1981-2010)

VARIABILIDADE CLIMÁTICA

INTEGRAÇÃO CHUVA DE SATÉLITE E PLUVIÔMETROS

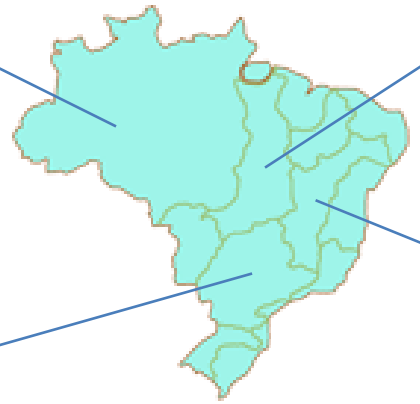




(Pereira Filho et al, 2017)

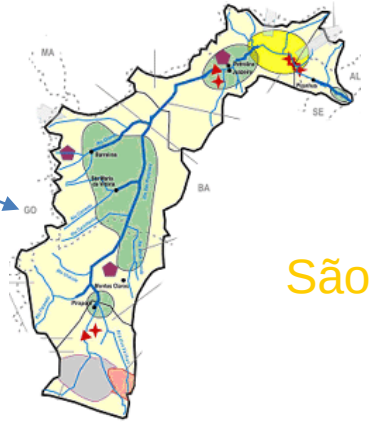
Bacias Brasileiras

Amazonas



Tocantins

Paraná

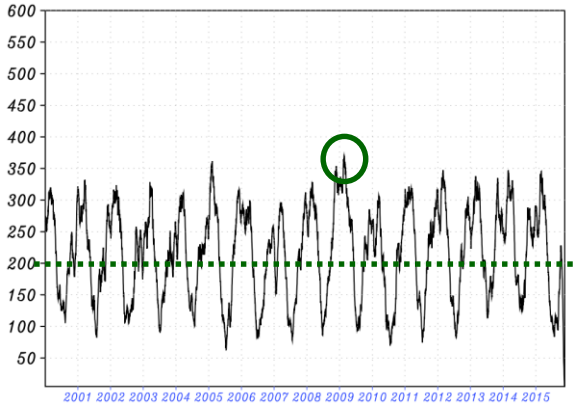


São Francisco

http://www2.ana.gov.br/Paginas/portais/bacias/

PRECIPITAÇÃO MÉDIA 30 DIAS (mm)

Bacia do Amazonas



EN= 0,79

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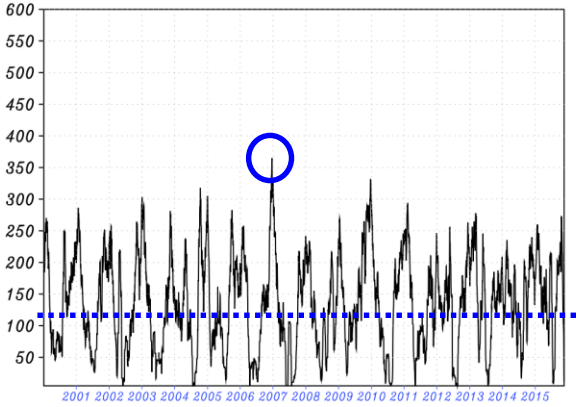

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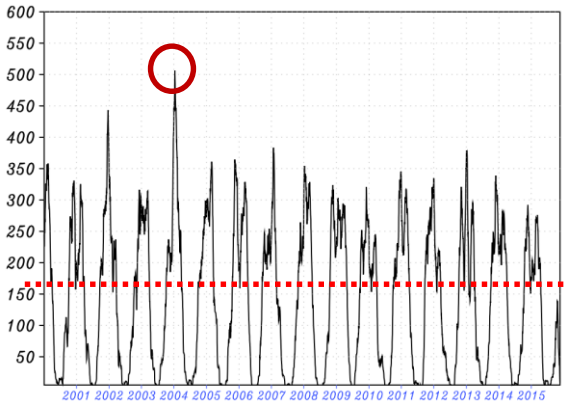
Bacia do Tocantins



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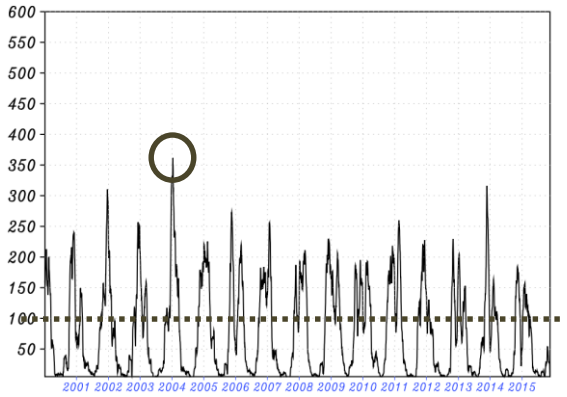
Bacia do São Francisco



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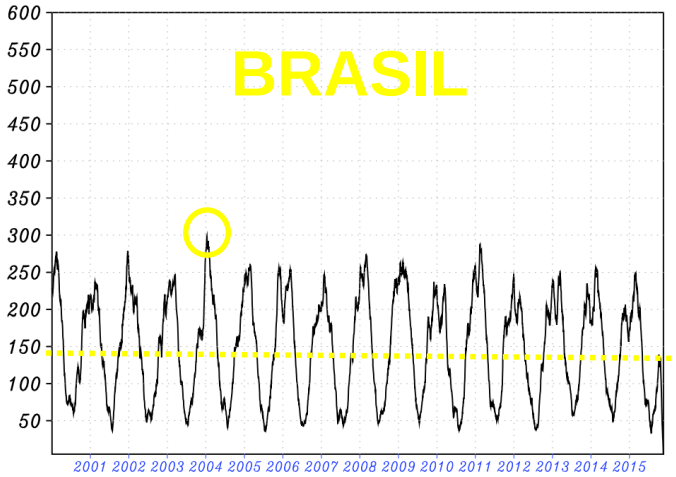


MATRIZ ENERGÉTICA BRASILEIRA

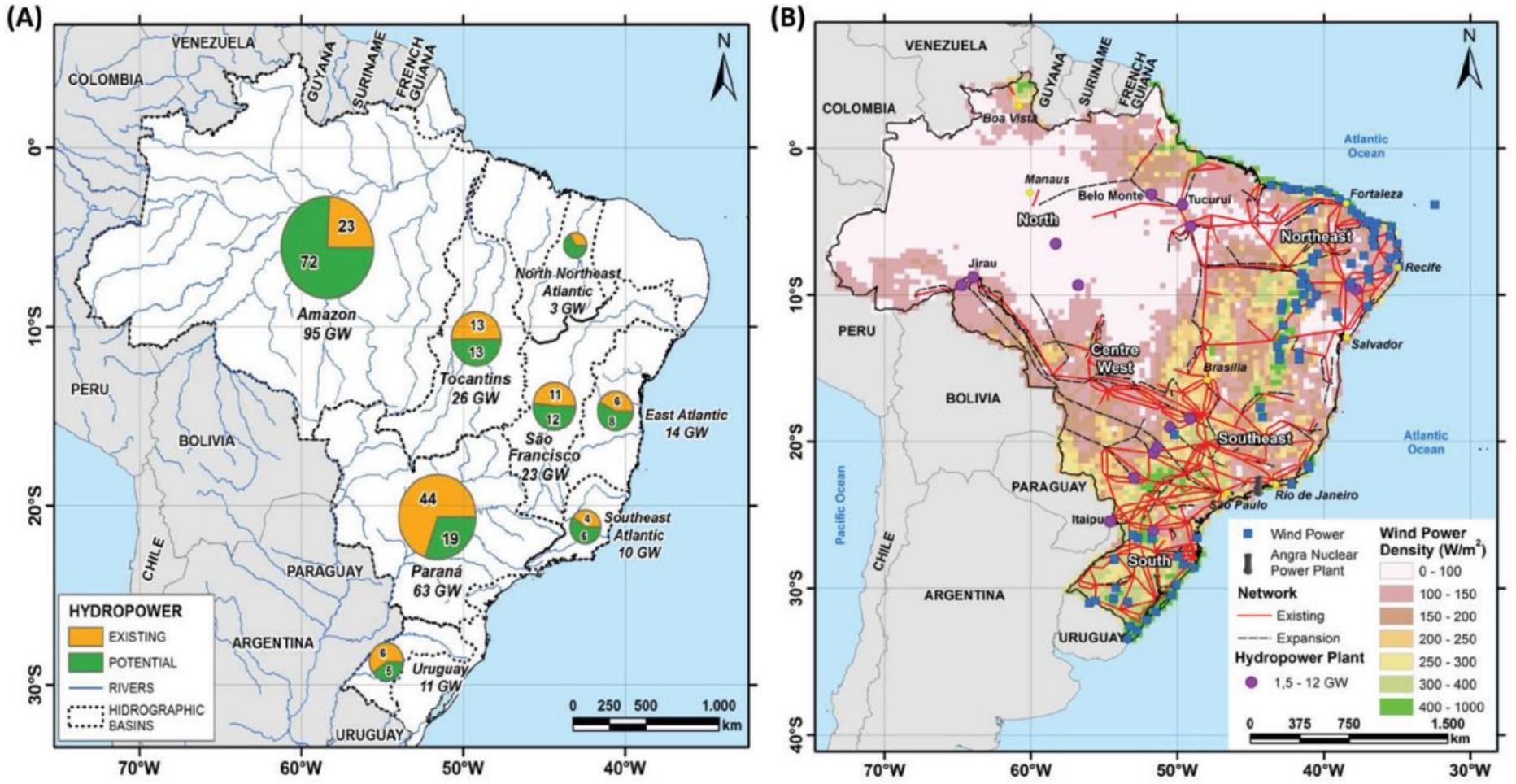
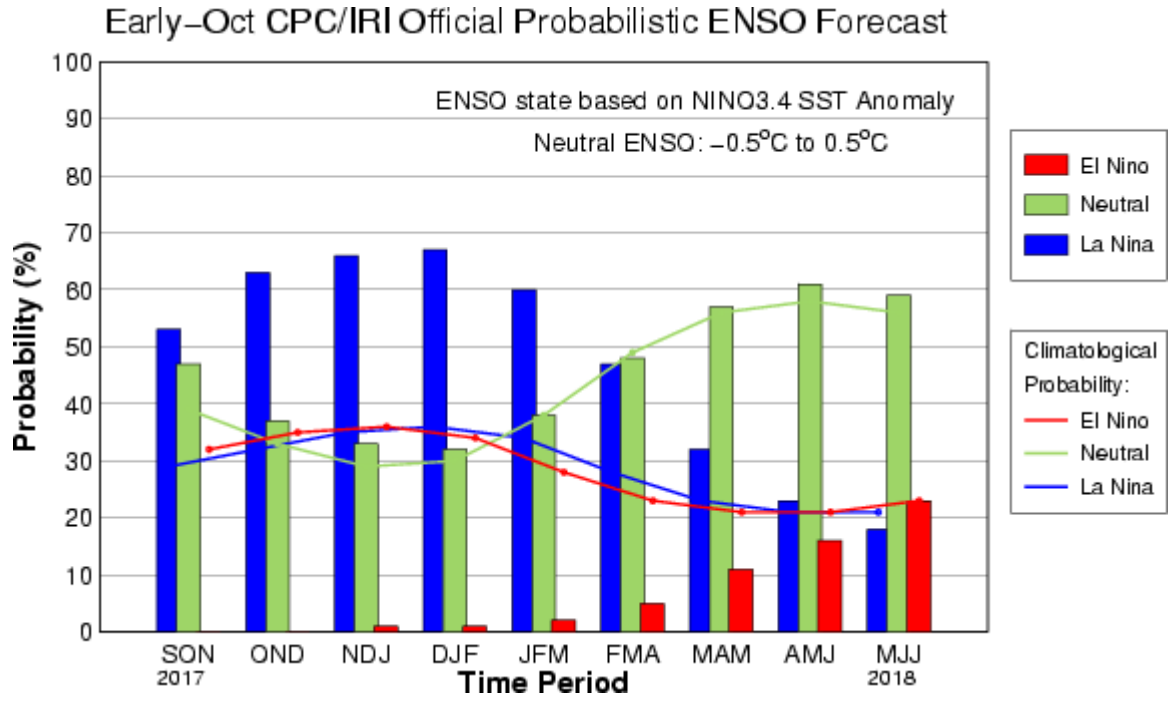
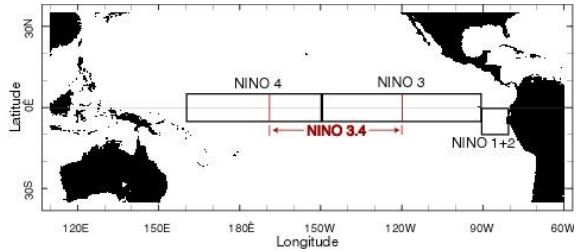


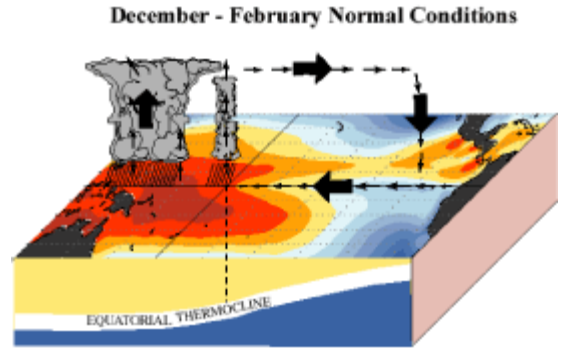
Figure 1 - (A) Current and potential hydropower plants by river basin. (Data source: EIA World Energy Outlook, 2013); **(B)** Map showing the annual wind potential in Brazil. For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.

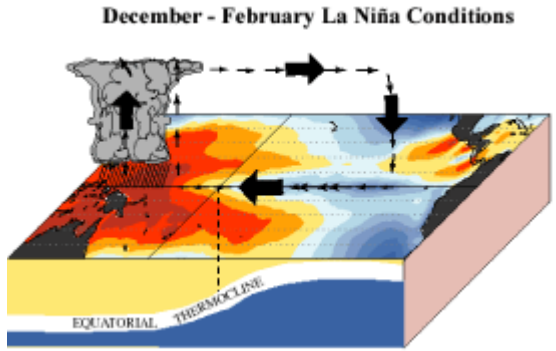
(Rocha et al., 2015)

PROGNÓSTICO CLIMÁTICO PRIMAVERA/VERÃO 2017

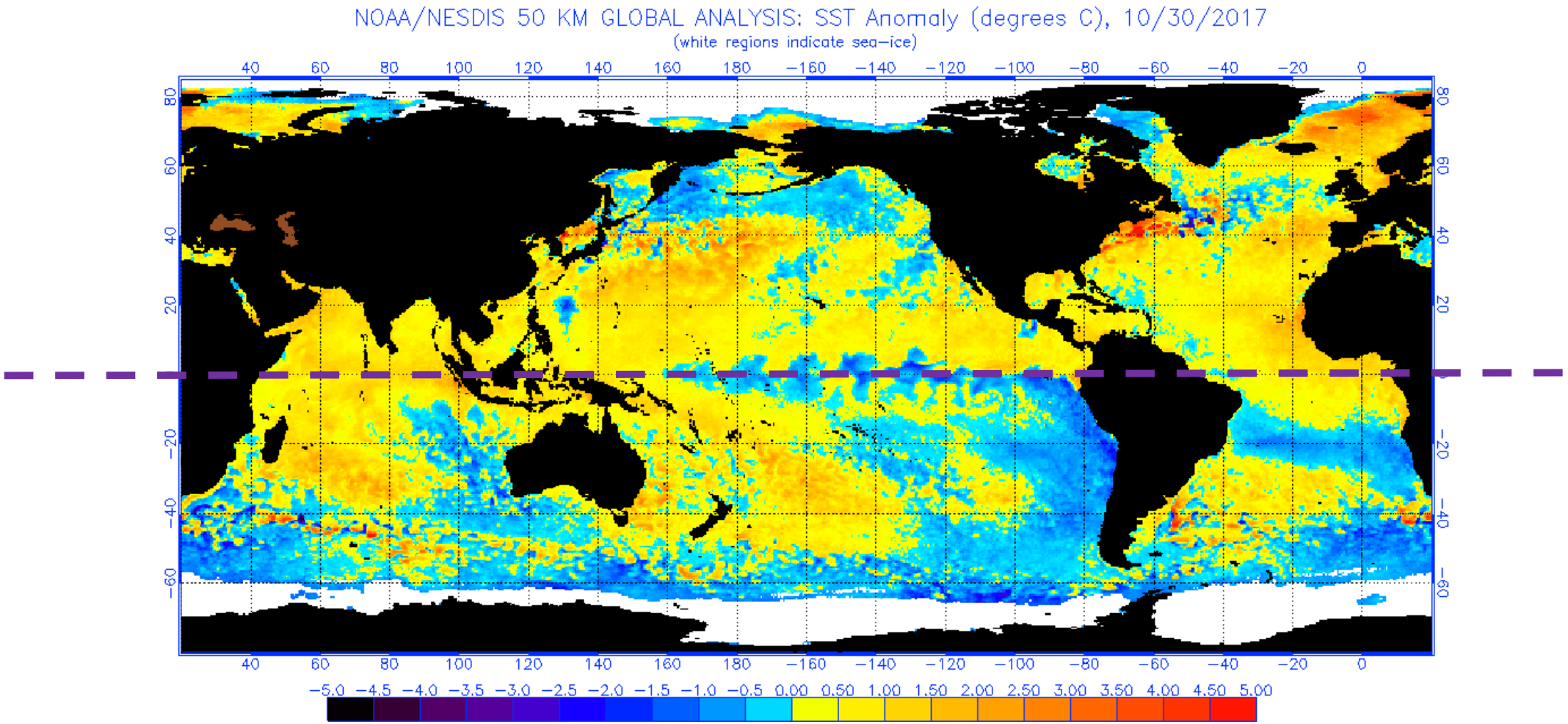

Early–Oct CPC/IRI Official Probabilistic ENSO Forecast
ENSO state based on NINO3.4 SST Anomaly
Neutral ENSO: –0.5°C to 0.5°C
Probability (%)
100
90
80
70
60
50
40
30
20
10
0
SON
2017
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
2018
Time Period
El Nino
Neutral
La Nina
Climatological Probability:
El Nino
Neutral
La Nina


30N
0E
30S
Latitude
NINO 4
NINO 3
NINO 3.4
NINO 1+2
120E
150E
180E
150W
120W
90W
60W
Longitude


December - February Normal Conditions
EQUATORIAL THERMOCLINE

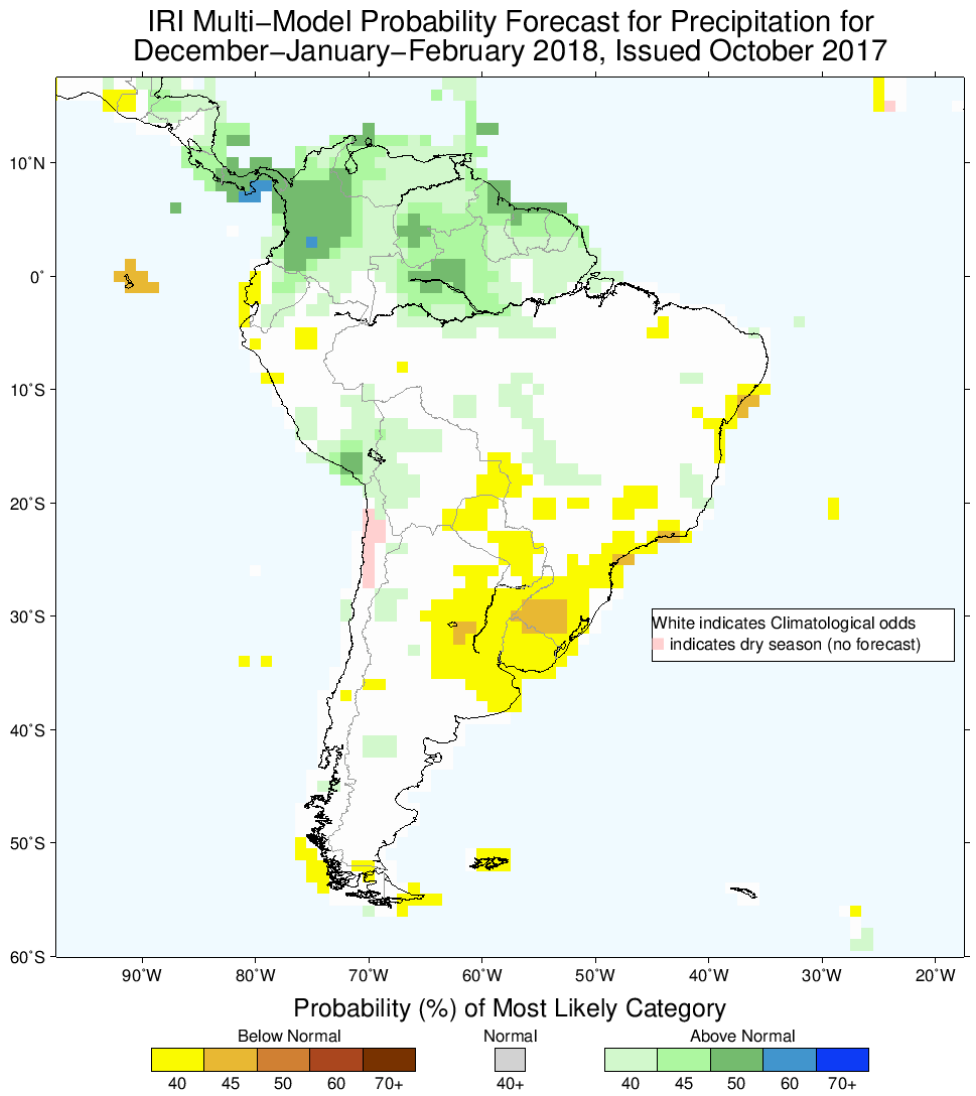

December - February La Niña Conditions
EQUATORIAL THERMOCLINE

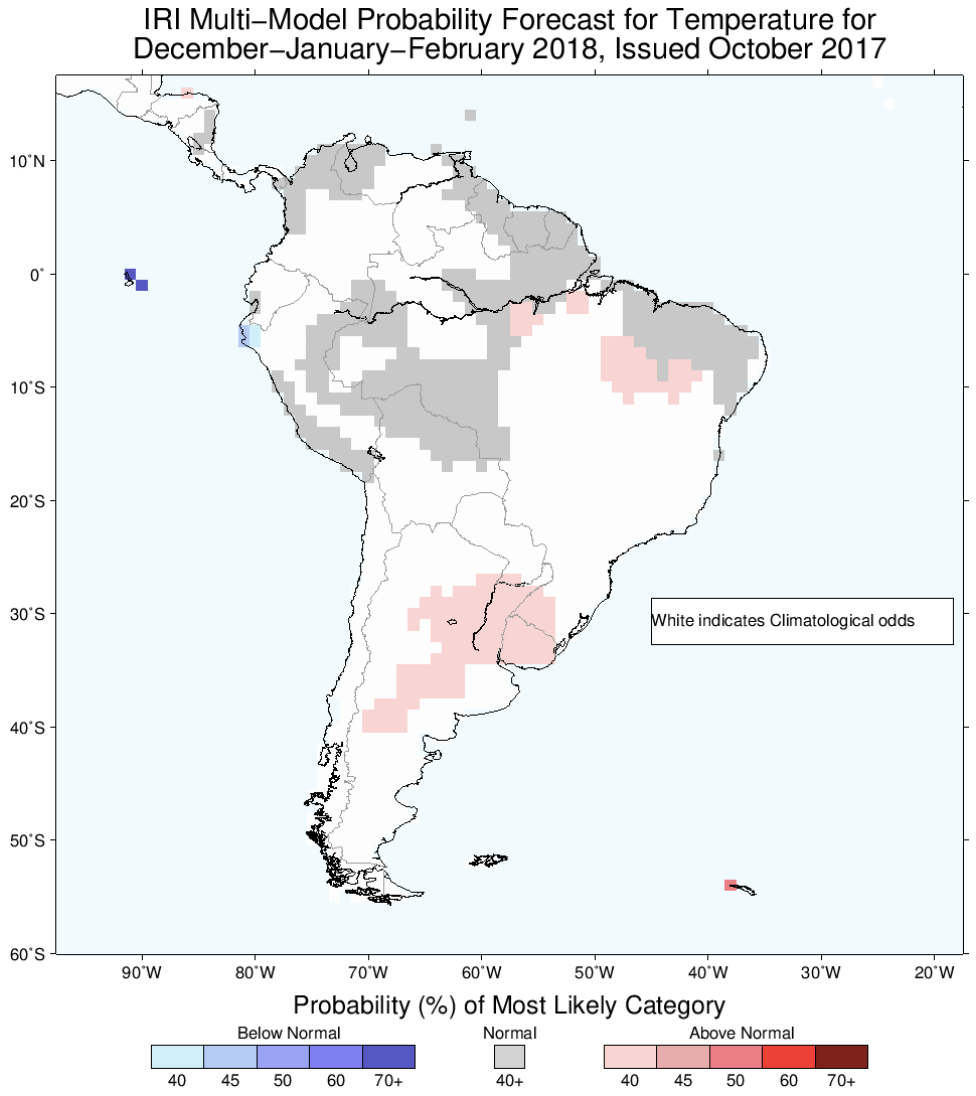
ANOMALIA DE TEMPERATURA DA SUPERFÍCIE DO MAR



http://www.ospo.noaa.gov/Products/ocean/sst/anomaly/

PROGNÓSTICO IRI

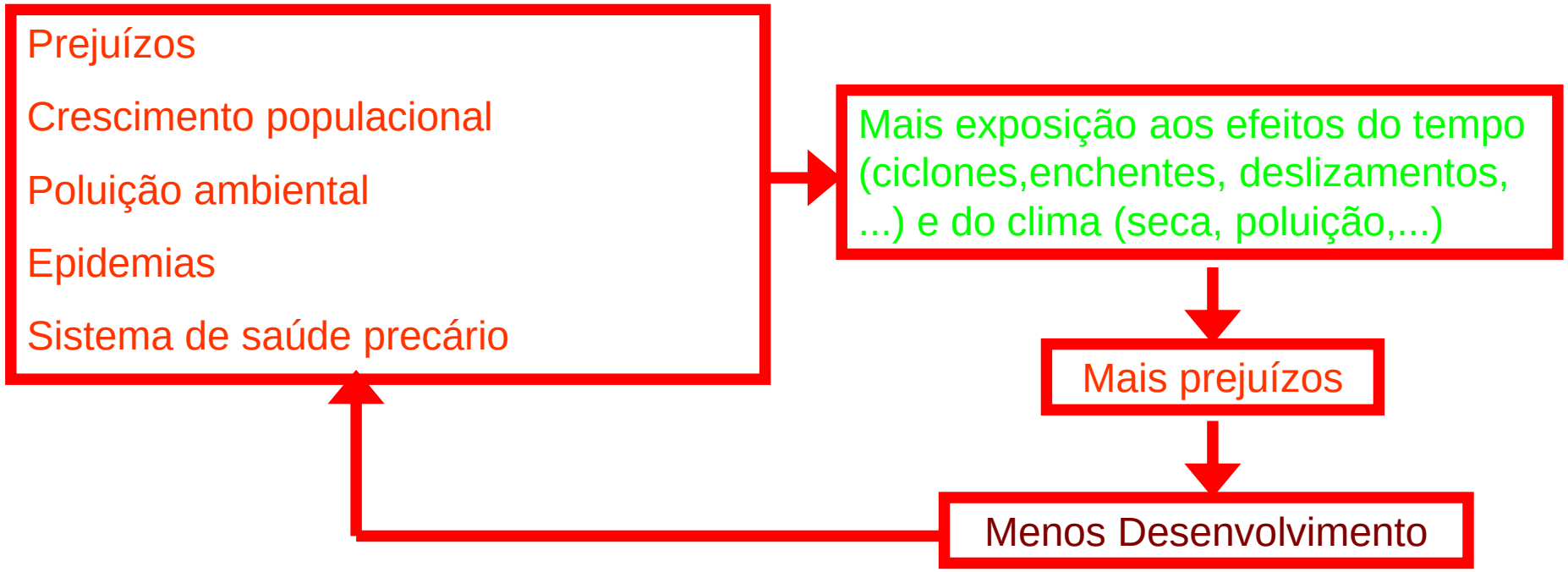




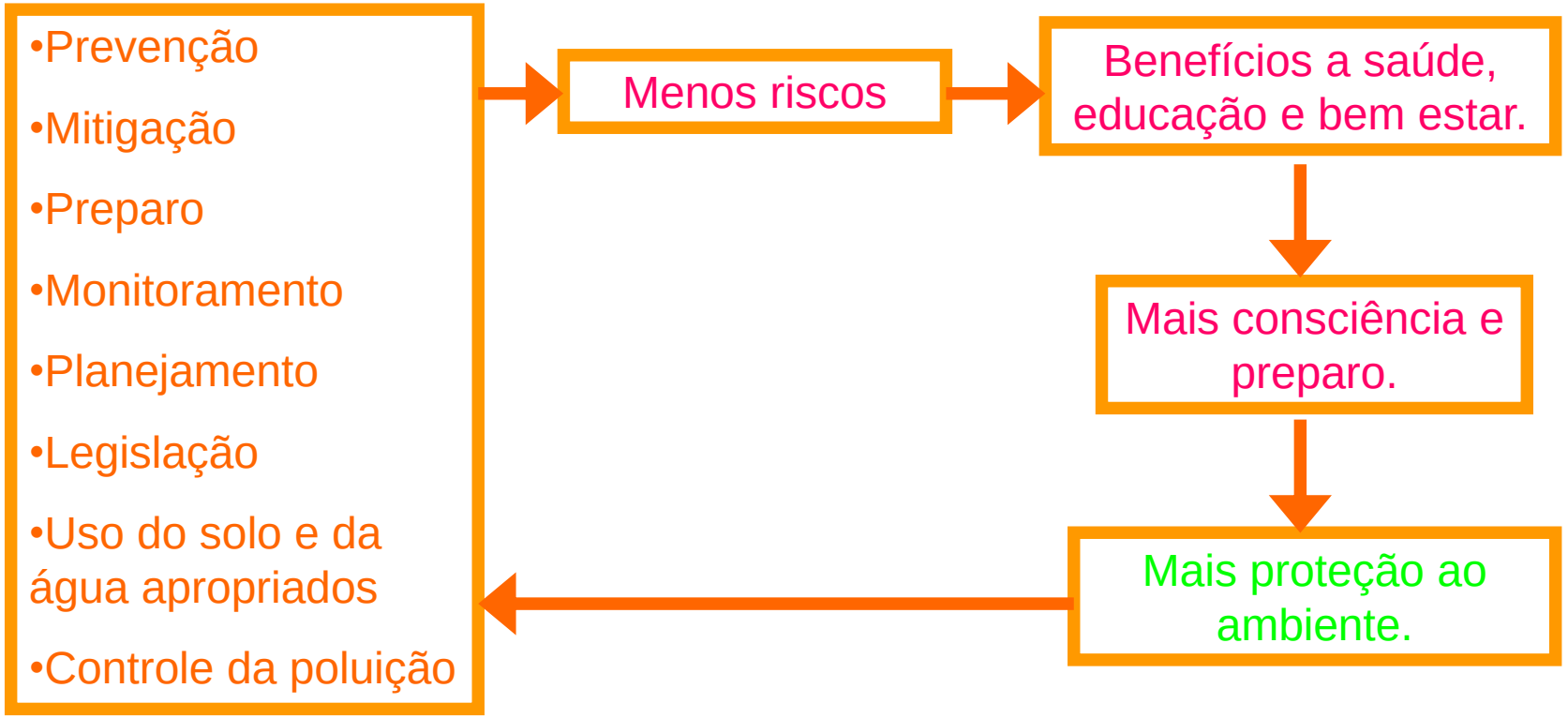
http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/

“As mudanças climáticas devem causar desastres naturais mais freqüentes e mais graves” OMM

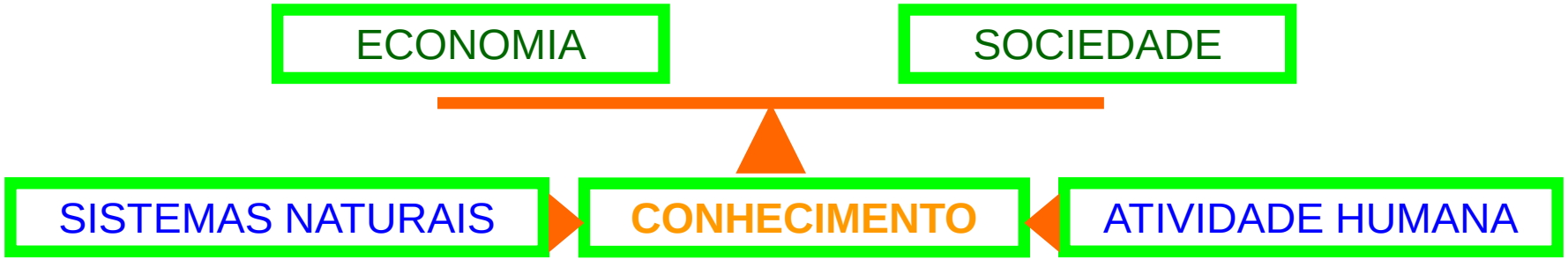
RETRO-ALIMENTAÇÃO POSITIVA DOS PROBLEMAS



GESTÃO AMBIENTAL – FATOR PARA O DESENVOLVIMENTO SUSTENTÁVEL



CIÊNCIA DA SUTENTABILIDADE



OBSERVAÇÃO DA TERRA E DA ATMOSFERA

(Essenciais para a sustentabilidade)

↓

FERRAMENTAS DE PREVISÃO

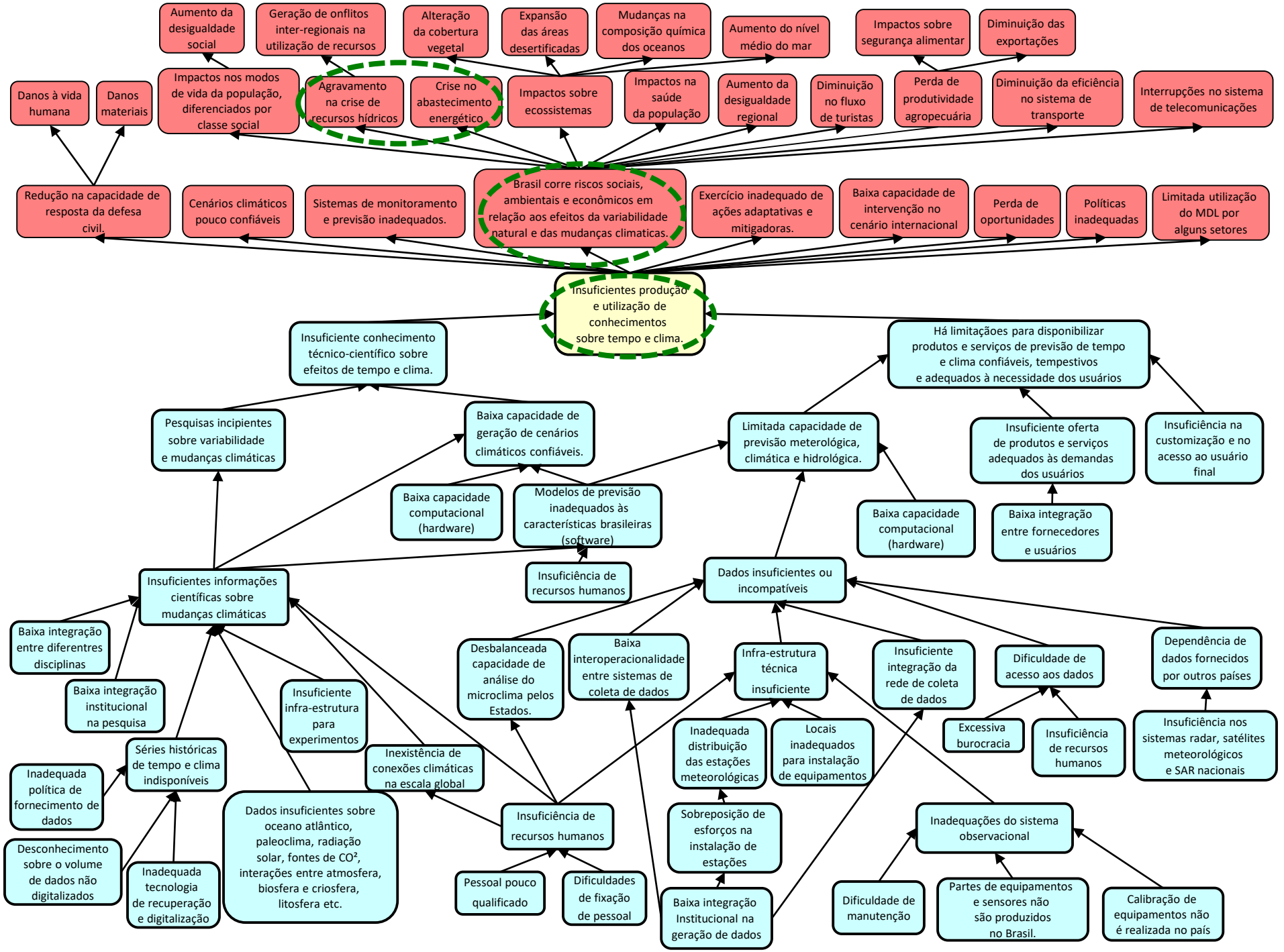
SISTEMAS DE ALERTA

ENTENDIMENTO DO TEMPO E DO CLIMA

INFORMAÇÃO

↓

REDUÇÃO DE RISCOS


Aumento da desigualdade social
Geração de onflitos inter-regionais na utilização de recursos
Alteração da cobertura vegetal
Expansão das áreas desertificadas
Mudanças na composição química dos oceanos
Aumento do nível médio do mar
Impactos sobre segurança alimentar
Diminuição das exportações
Danos à vida humana
Danos materiais
Impactos nos modos de vida da população, diferenciados por classe social
Agravamento na crise de recursos hídricos
Crise no abastecimento energético
Impactos sobre ecossistemas
Impactos na saúde da população
Aumento da desigualdade regional
Diminuição no fluxo de turistas
Perda de produtividade agropecuária
Diminuição da eficiência no sistema de transporte
Interrupções no sistema de telecomunicações
Redução na capacidade de resposta da defesa civil.
Cenários climáticos pouco confiáveis
Sistemas de monitoramento e previsão inadequados.
Brasil corre riscos sociais, ambientais e econômicos em relação aos efeitos da variabilidade natural e das mudanças climaticas.
Exercício inadequado de ações adaptativas e mitigadoras.
Baixa capacidade de intervenção no cenário internacional
Perda de oportunidades
Políticas inadequadas
Limitada utilização do MDL por alguns setores
Insuficientes produção e utilização de conhecimentos sobre tempo e clima.
Insuficiente conhecimento técnico-científico sobre efeitos de tempo e clima.
Há limitaçãoes para disponibilizar produtos e serviços de previsão de tempo e clima confiáveis, tempestivos e adequados à necessidade dos usuários
Pesquisas incipientes sobre variabilidade e mudanças climáticas
Baixa capacidade de geração de cenários climáticos confiáveis.
Limitada capacidade de previsão meterológica, climática e hidrológica.
Insuficiente oferta de produtos e serviços adequados às demandas dos usuários
Insuficiência na customização e no acesso ao usuário final
Baixa capacidade computacional (hardware)
Modelos de previsão inadequados às características brasileiras (software)
Baixa capacidade computacional (hardware)
Baixa integração entre fornecedores e usuários
Insuficientes informações científicas sobre mudanças climáticas
Insuficiência de recursos humanos
Dados insuficientes ou incompatíveis
Baixa integração entre diferentres disciplinas
Baixa integração institucional na pesquisa
Insuficiente infra-estrutura para experimentos
Desbalanceada capacidade de análise do microclima pelos Estados.
Baixa interoperacionalidade entre sistemas de coleta de dados
Infra-estrutura técnica insuficiente
Insuficiente integração da rede de coleta de dados
Dificuldade de acesso aos dados
Dependência de dados fornecidos por outros países
Séries históricas de tempo e clima indisponíveis
Inexistência de conexões climáticas na escala global
Inadequada distribuição das estações meteorológicas
Locais inadequados para instalação de equipamentos
Excessiva burocracia
Insuficiência de recursos humanos
Insuficiência nos sistemas radar, satélites meteorológicos e SAR nacionais
Inadequada política de fornecimento de dados
Desconhecimento sobre o volume de dados não digitalizados
Inadequada tecnologia de recuperação e digitalização
Dados insuficientes sobre oceano atlântico, paleoclima, radiação solar, fontes de CO², interações entre atmosfera, biosfera e criosfera, litosfera etc.
Insuficiência de recursos humanos
Sobreposição de esforços na instalação de estações
Inadequações do sistema observacional
Pessoal pouco qualificado
Dificuldades de fixação de pessoal
Baixa integração Institucional na geração de dados
Dificuldade de manutenção
Partes de equipamentos e sensores não são produzidos no Brasil.
Calibração de equipamentos não é realizada no país

MUITO OBRIGADO!

augusto.pereira@iag.usp.br