PÓS-GRADUAÇÃO Oceanografia
Física Química Geológica

PPGOGQG
TE: Oceanos e Clima

Aula 6 – Monções e o Dipolo do Oceano Índico

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Laboratório de Estudos dos Oceanos e Clima (LEOC)

1º SEM. 2016
Terça-feira – 14:00/16:00h, sala 2119

FURG

O Regime de Monções

- O Regime das Monções é um fenômeno climatológico que influencia cerca de metade da área tropical do planeta (1/4 da superfície da Terra) (da palavra Árabe "mausim" que significa "estações")

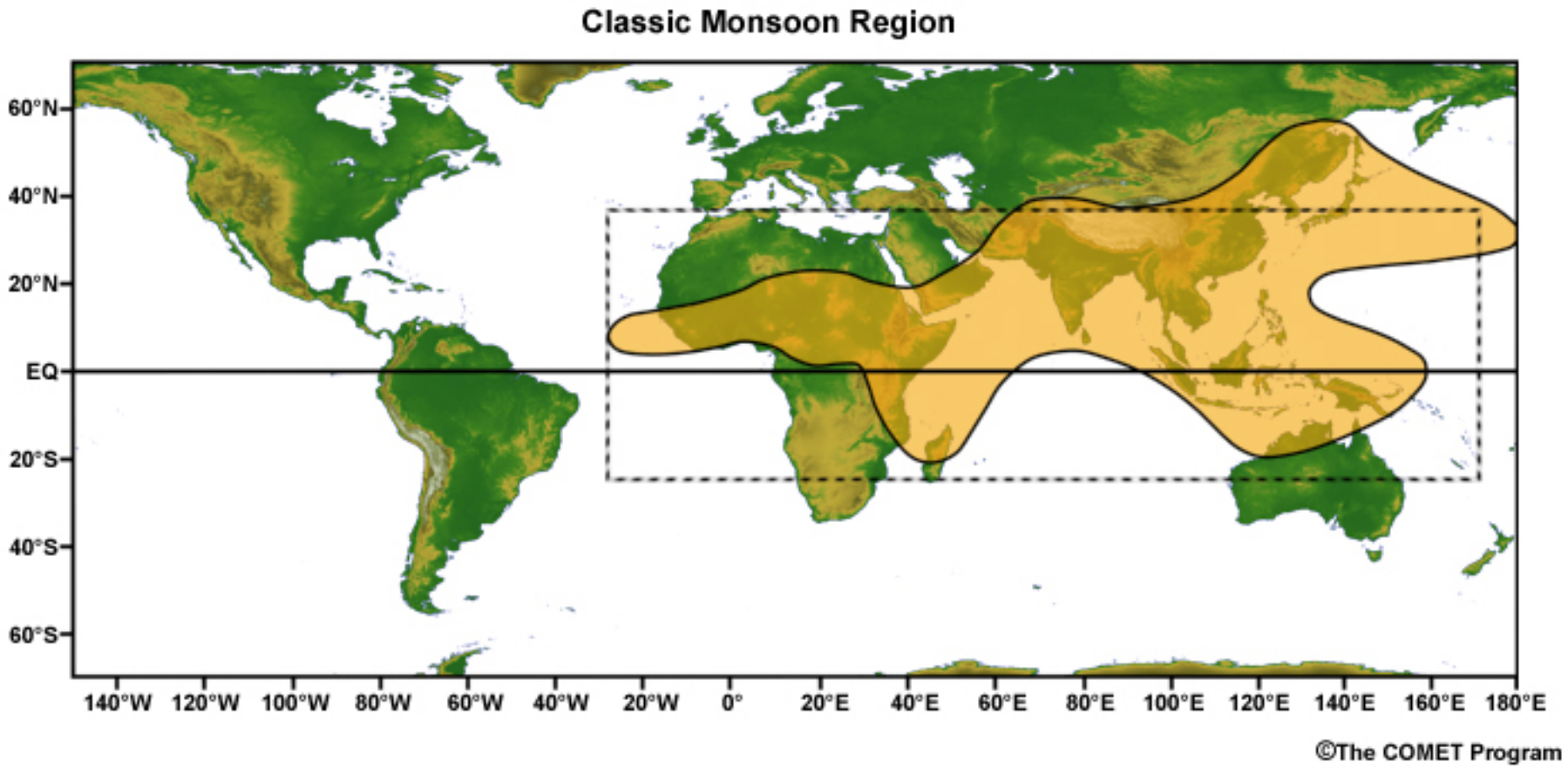
- Essencialmente é um sistema onde os ventos e precipitação revertem de estação para estação (verões chuvosos, invernos secos)

- Estes padrões definidos sustentam a agricultura tropical

- A área sob influência das Monções engloba 65% da população mundial

- Pequenas alterações interanuais no regime podem ser catastróficas.

Caso clássico: Monção Asiática



OUTROS EXEMPLOS

North American
West African
African Winter
(Indian Summer)
East Asian
N.W. Australian

Verão Boreal

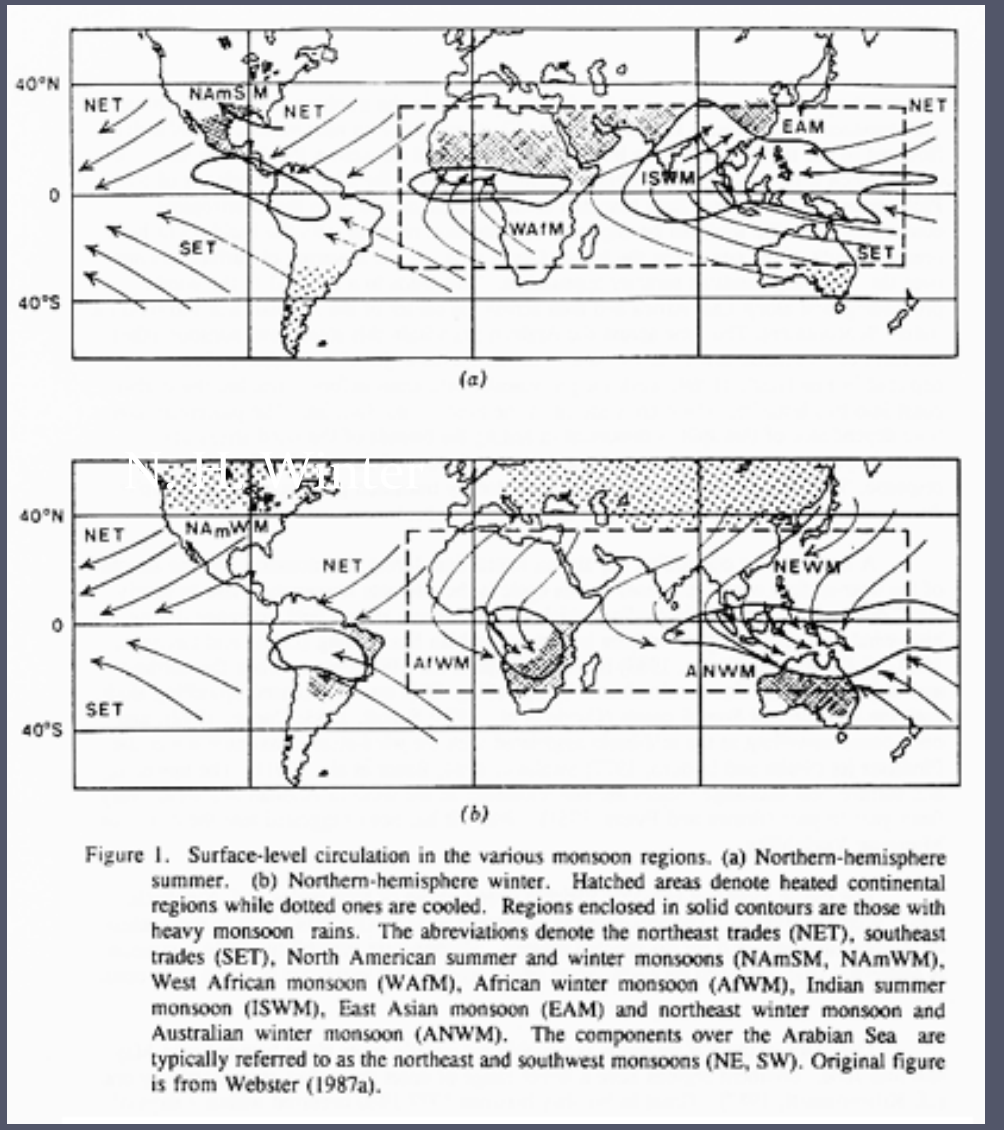
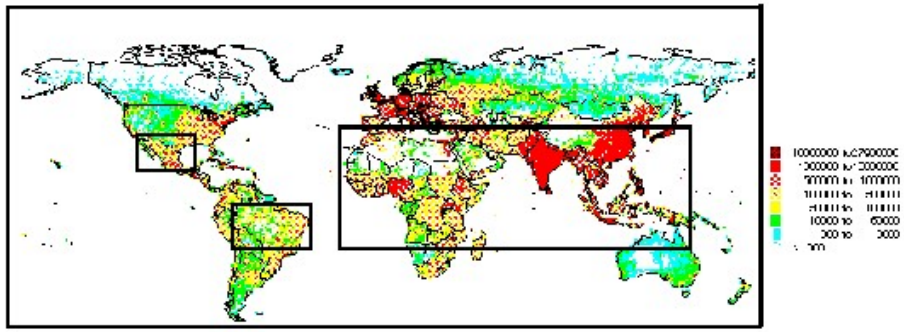


Figure 1. Surface-level circulation in the various monsoon regions. (a) Northern-hemisphere summer. (b) Northern-hemisphere winter. Hatched areas denote heated continental regions while dotted ones are cooled. Regions enclosed in solid contours are those with heavy monsoon rains. The abreviations denote the northeast trades (NET), southeast trades (SET), North American summer and winter monsoons (NAmSM, NAmWM), West African monsoon (WAfM), African winter monsoon (AfWM), Indian summer monsoon (ISWM), East Asian monsoon (EAM) and northeast winter monsoon and Australian winter monsoon (ANWM). The components over the Arabian Sea are typically referred to as the northeast and southwest monsoons (NE, SW). Original figure is from Webster (1987a).

Demografia das Monções

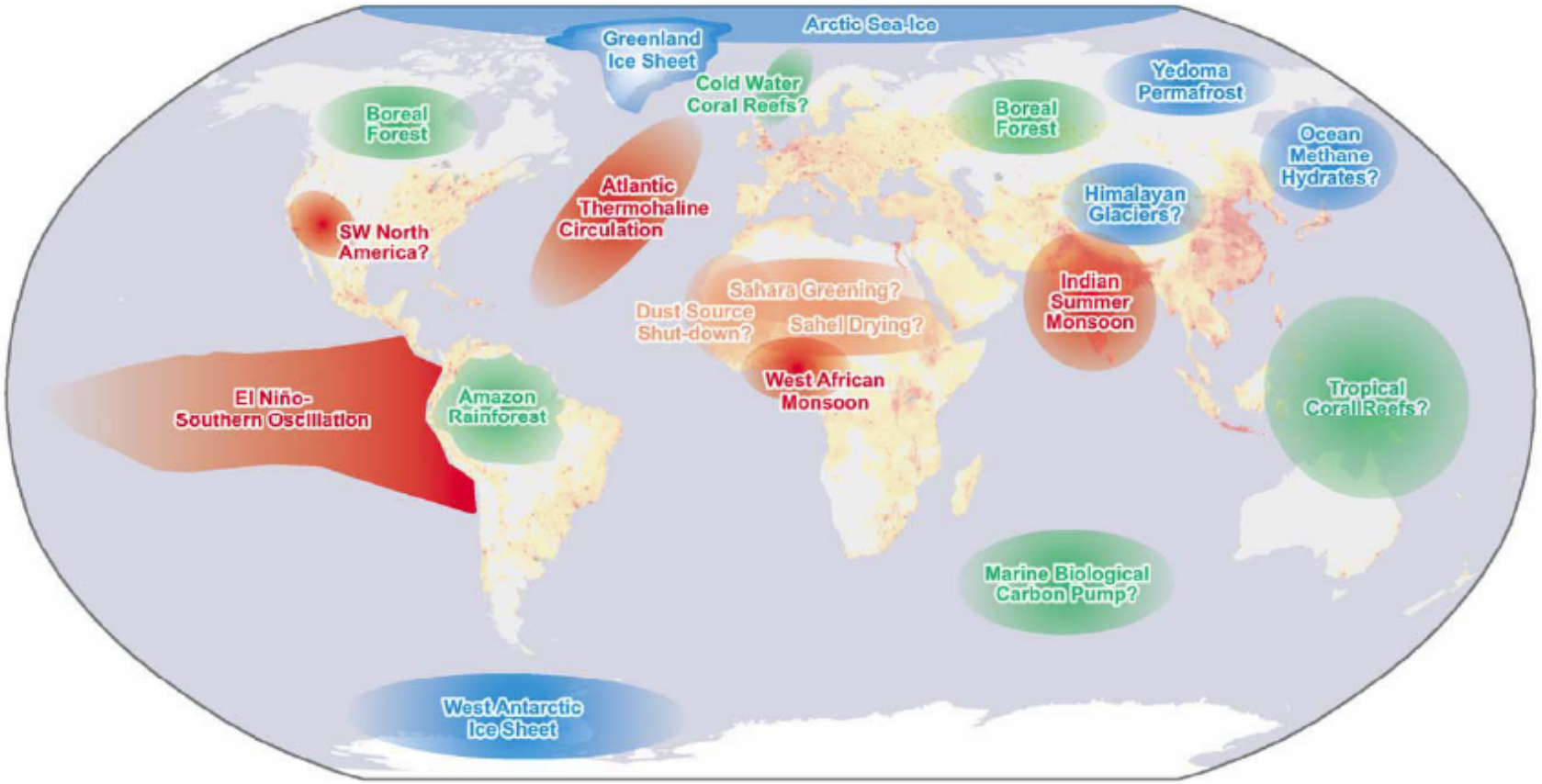
DEMOGRAPHICS OF THE MONSOON REGIONS



Rank	1950 Country	Rank	1995 Country	Rank	2025 Country
1	**China**	1	**China**	1	**India**
2	**India**	2	**India**	2	**China**
3	USA	3	USA	3	**Pakistan**
4	Russia	4	**Indonesia**	4	USA
5	Japan	5	Brazil	5	**Nigeria**
6	**Indonesia**	6	Russia	6	**Indonesia**
7	Germany	7	**Pakistan**	7	Brazil
8	Brazil	8	Japan	8	**Bangladesh**
9	UK	9	**Bangladesh**	9	**Ethopia**
10	Itlay	10	**Nigeria**	10	**Iran**

Data from World Population Estimate (1995).

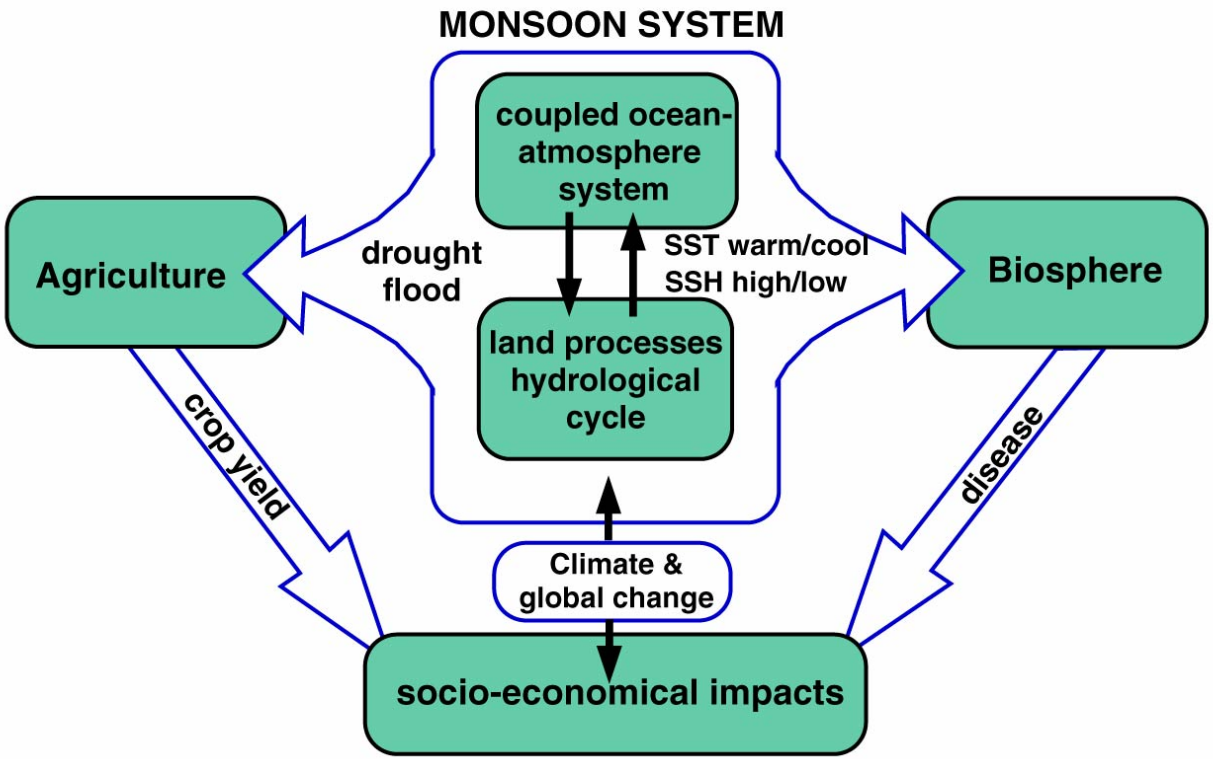
Updated Map of Tipping Elements in the Earth System



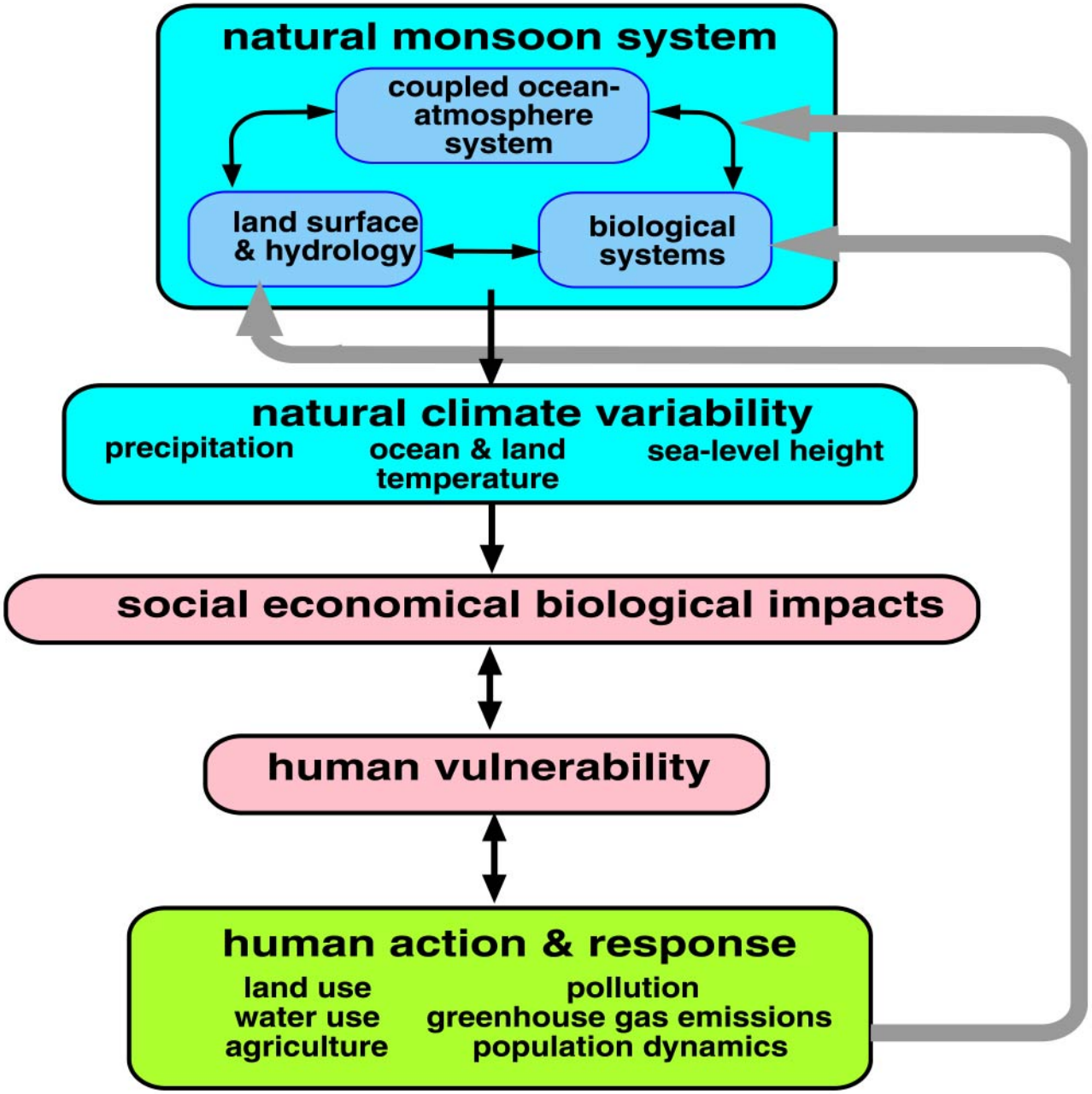
(Source: after Lenton et al. 20(

O Regime de Monções e suas relações com aspectos sócio-econômicos

By understanding the coupled ocean-atmosphere system, there is potential for predicting the **probability** of the occurrence of a number of socially relevant climate related impacts.



Bio-complexity view of the natural and human monsoon system



Fundamentos do Regime de Monções

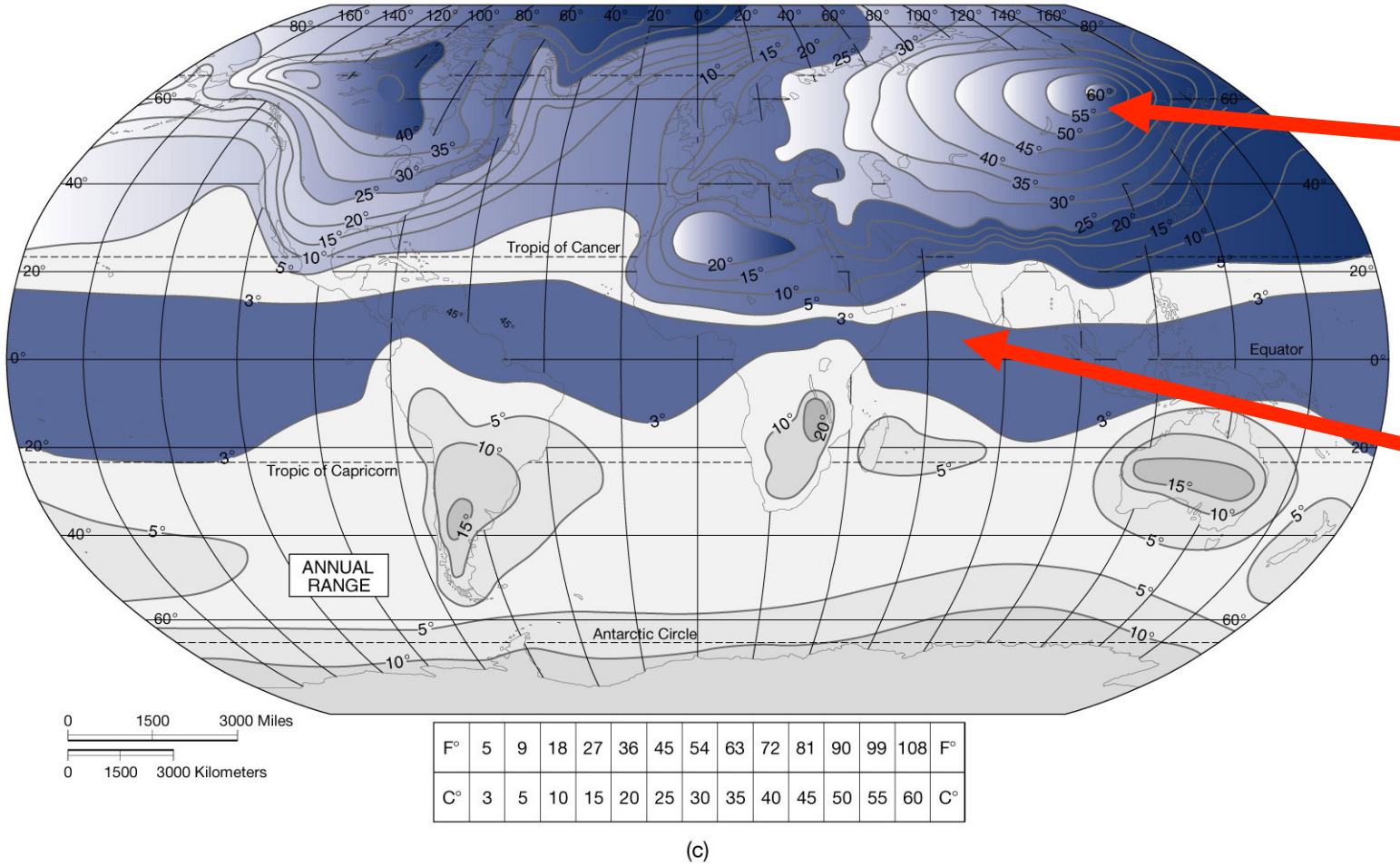
- Essencialmente resulta do aquecimento/ resfriamento diferenciado entre os continentes e o Oceano

- As consequencias são alterações nos regimes de vento e precipitação, principalmente.

- As alterações do regime de ventos afeta a circulação oceânica

Surface temperature range that results in the monsoon

Sea surface temperature variations are much smaller than land surface temperature variations. (Mainly the seasonal cycle)



F°	5	9	18	27	36	45	54	63	72	81	90	99	108	F°
C°	3	5	10	15	20	25	30	35	40	45	50	55	60	C°

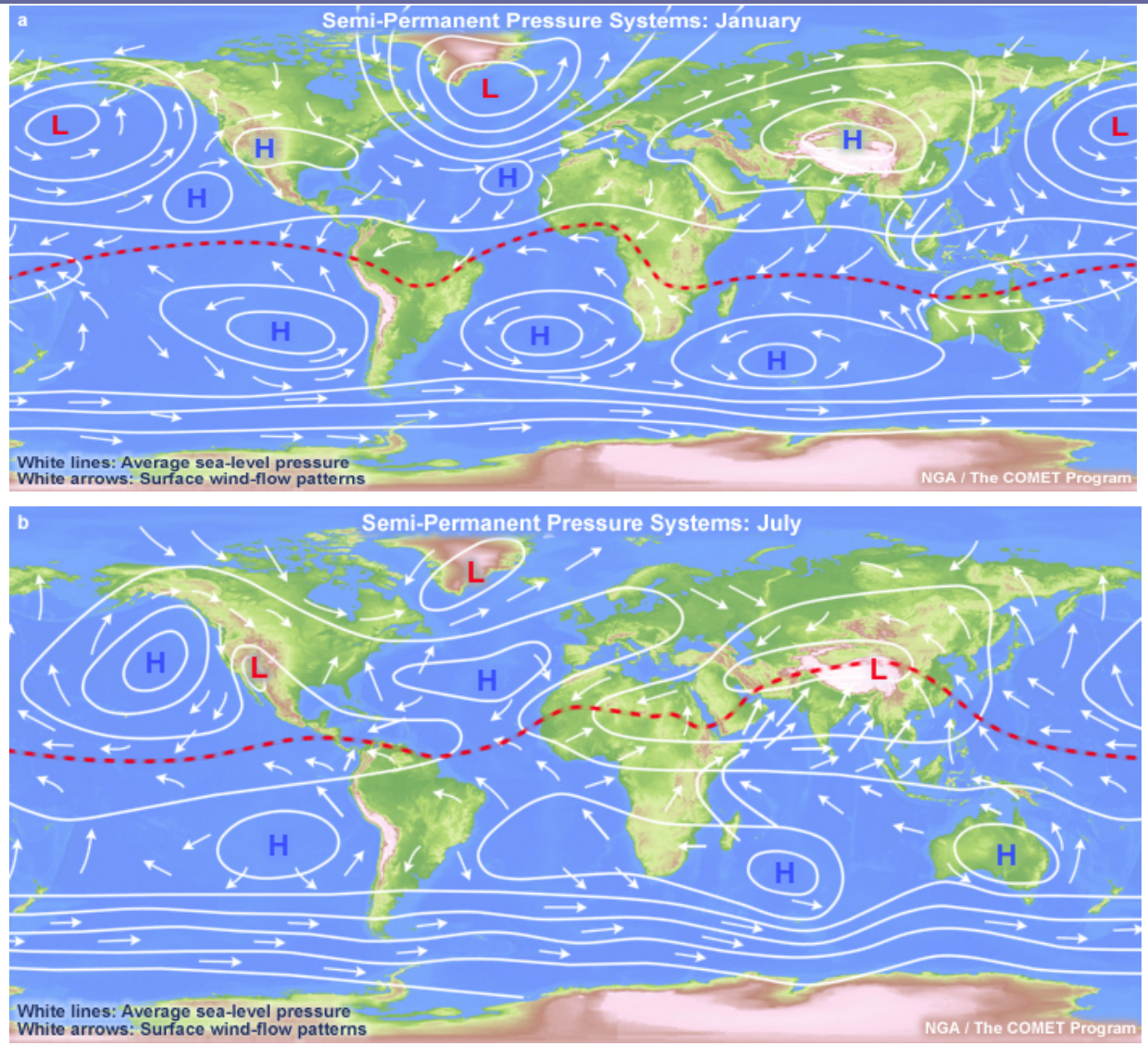
(c)

Tibetan plateau: range of 60°C

Ocean: range of 3 to 5°C

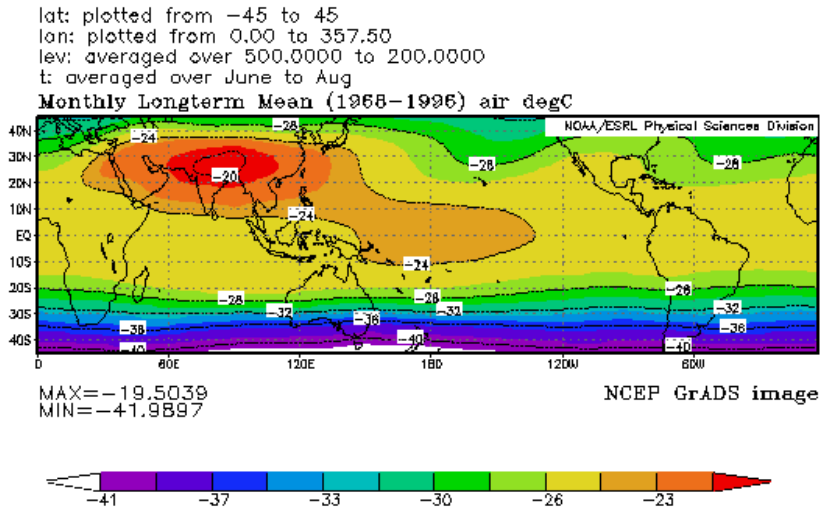
Kump et al. text (2004)

Pressão Atm

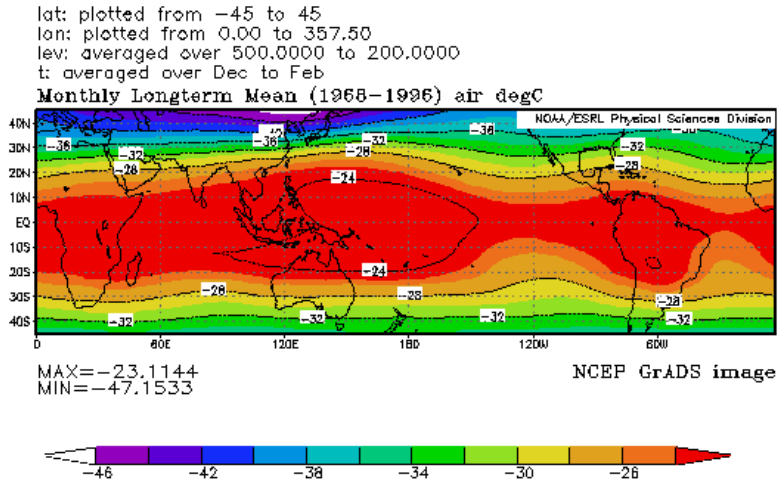

a
Semi-Permanent Pressure Systems: January
L
L
L
H
H
H
H
H
H
White lines: Average sea-level pressure
White arrows: Surface wind-flow patterns
NGA / The COMET Program
b
Semi-Permanent Pressure Systems: July
L
L
L
H
H
H
H
H
White lines: Average sea-level pressure
White arrows: Surface wind-flow patterns
NGA / The COMET Program

Temperatura da Troposfera Superior

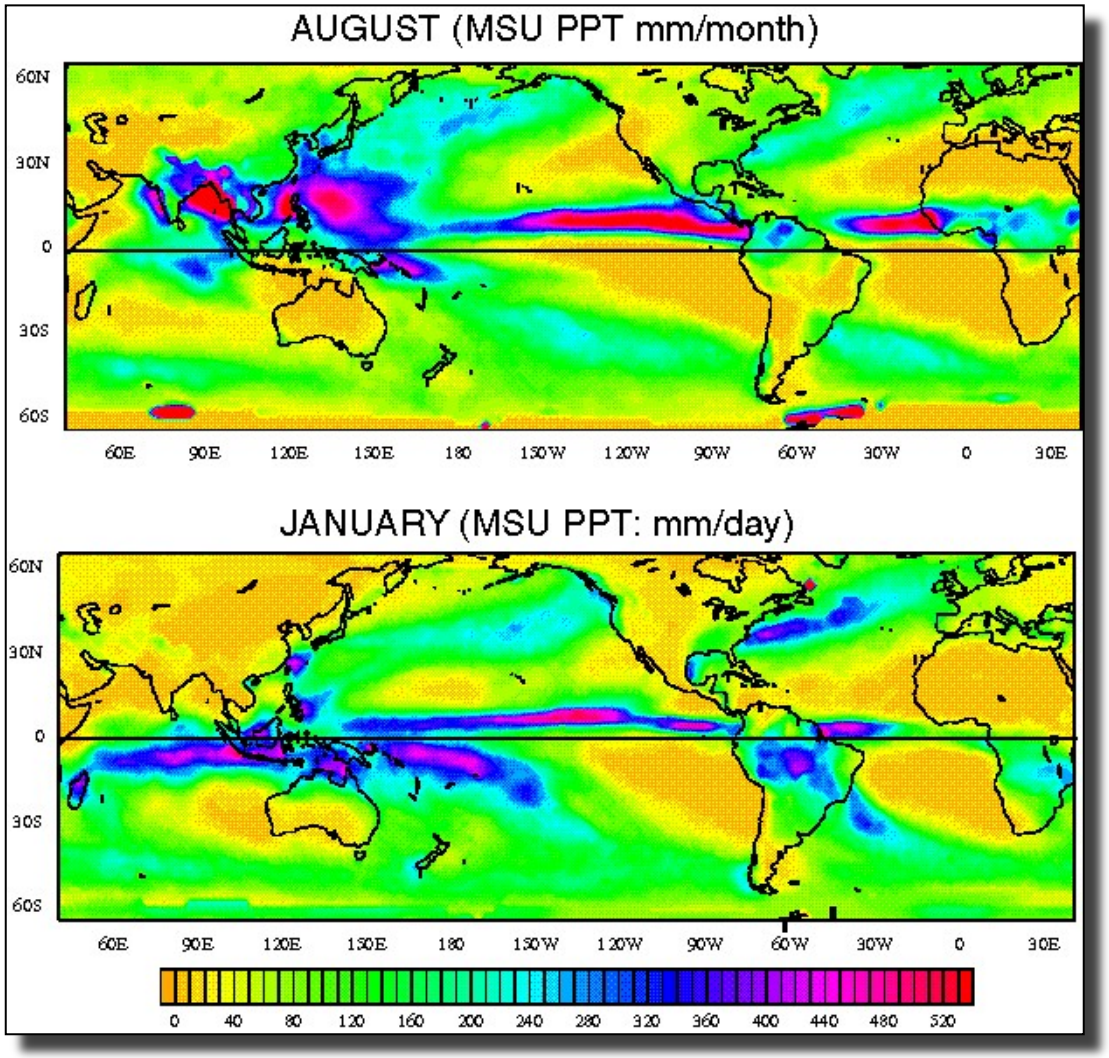
JJA



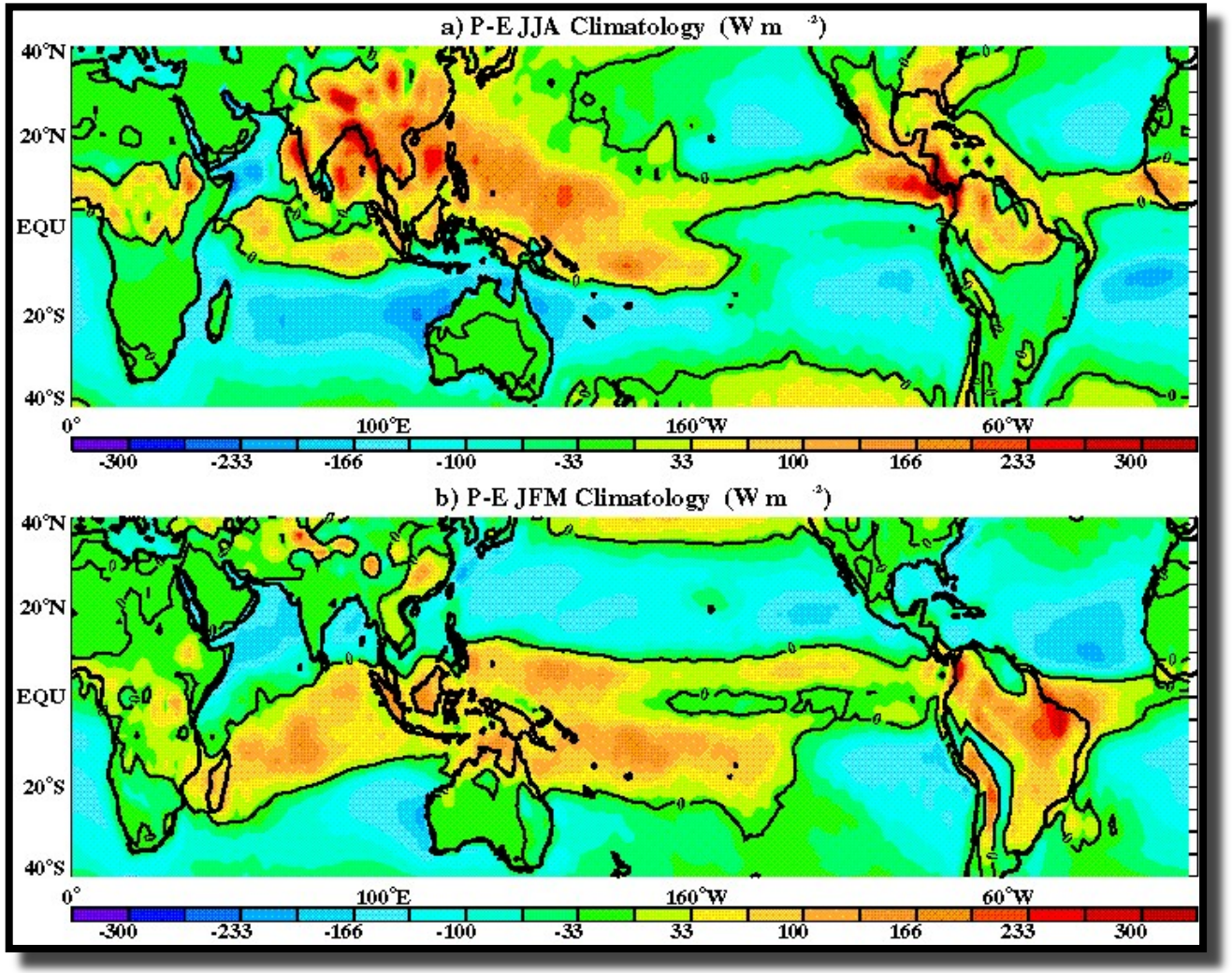
DJF



mean august and january precipitation
from MSU satellite (mm/day)



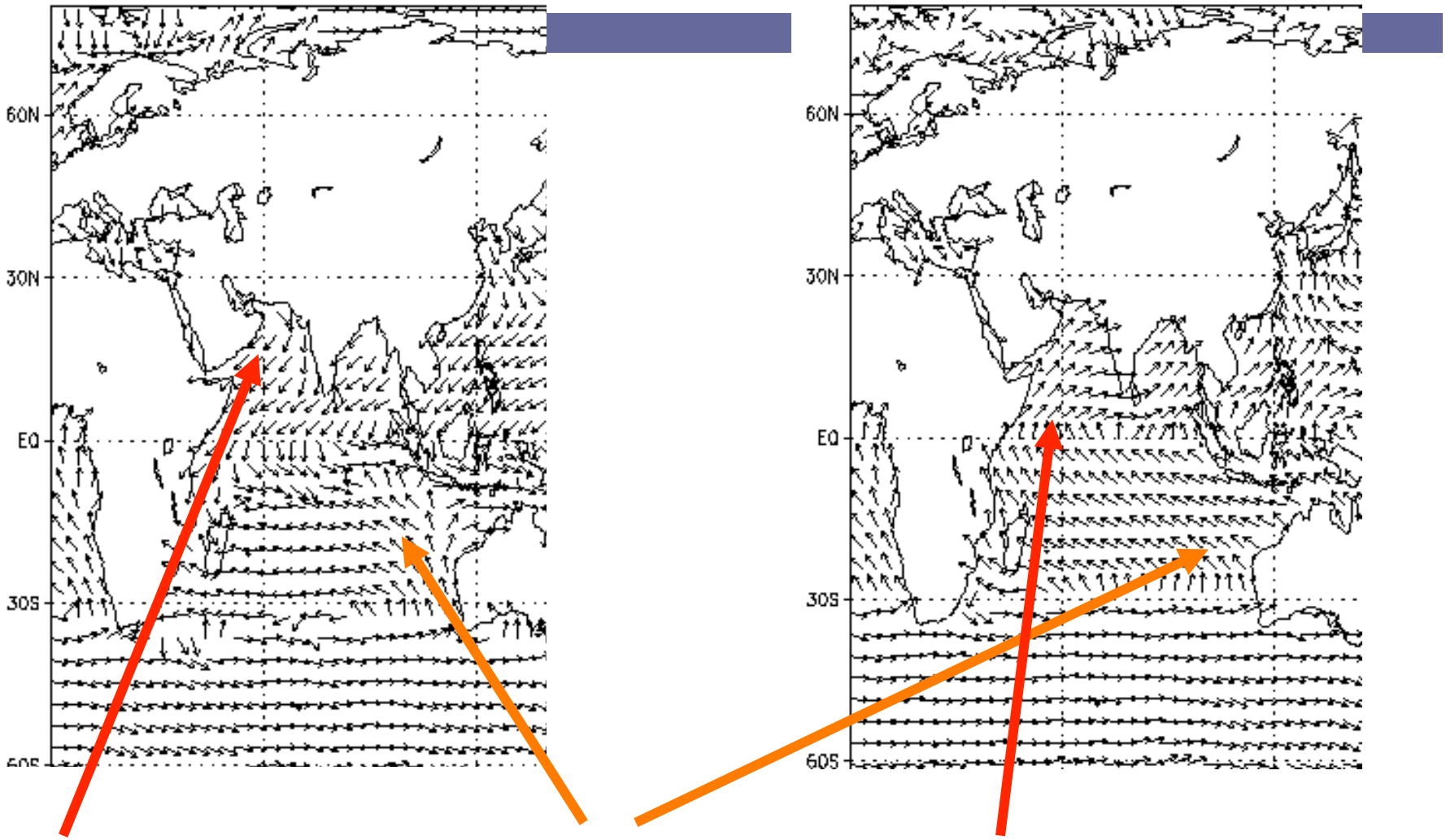
Monsoon regions are the
largest region where precipitation exceeds evaporation.
This excess water must come from somewhere …



Pro quadro ….

Dec-Jan winds
(NE monsoon)

Jul-Aug winds
(SW monsoon)

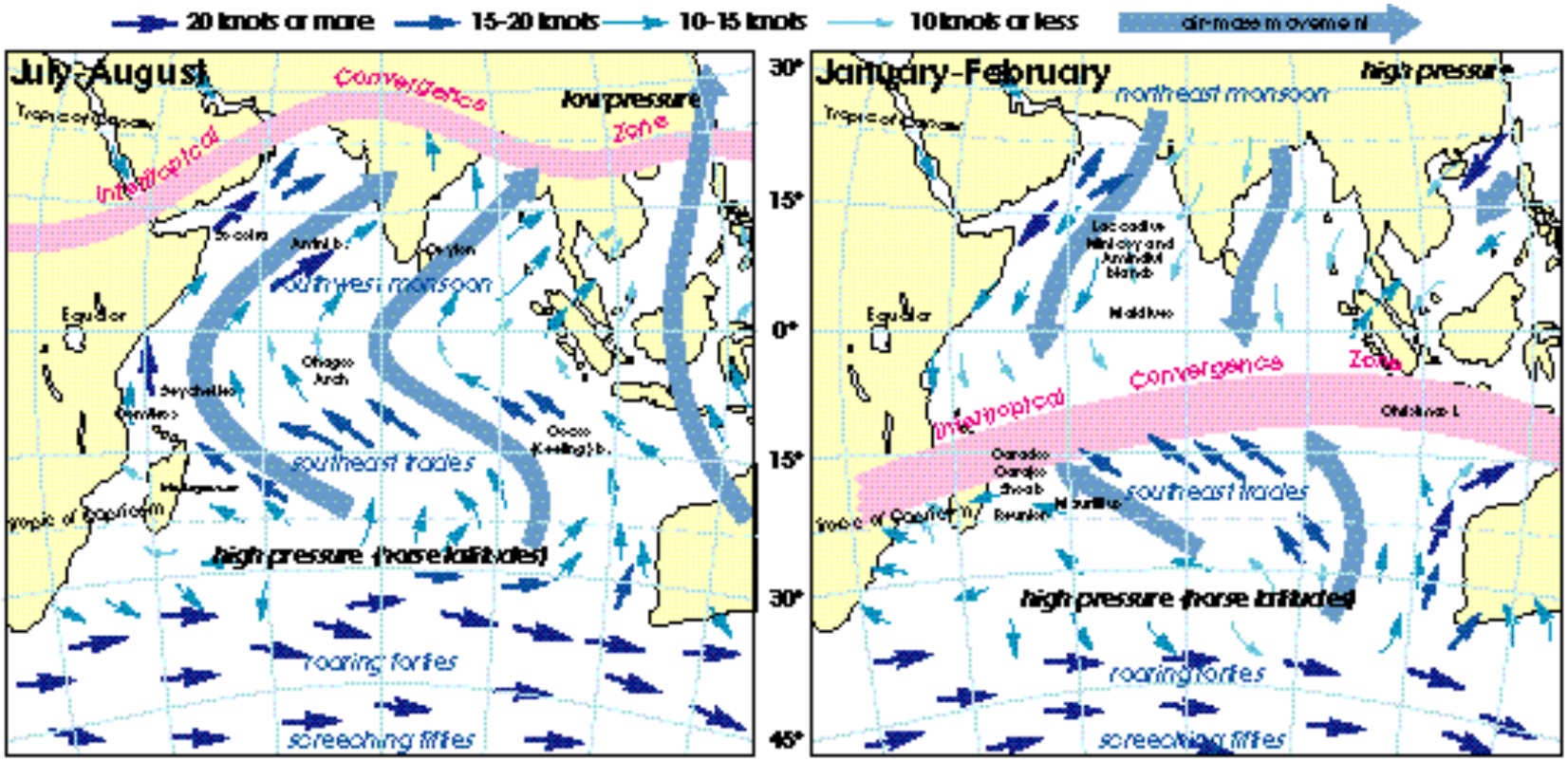


NE monsoon winds

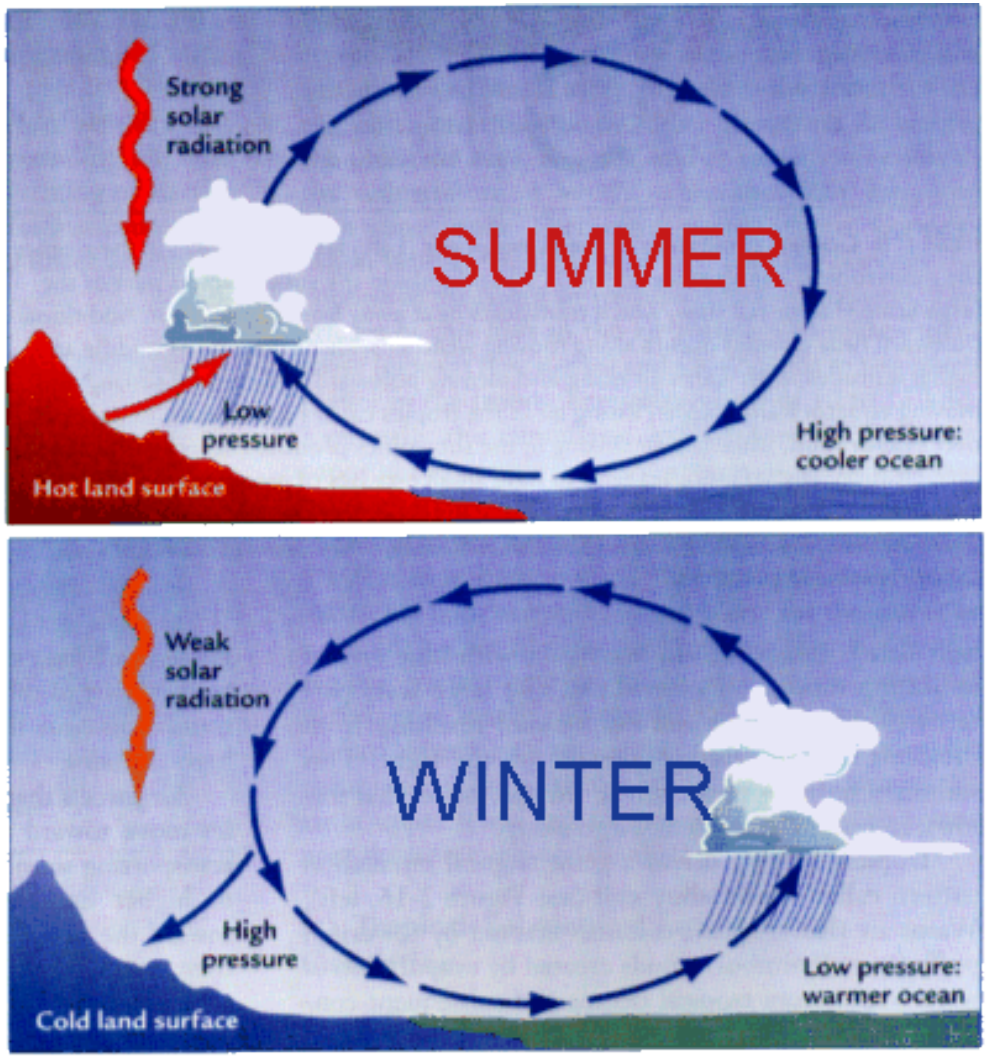
Trade winds

SW monsoon winds

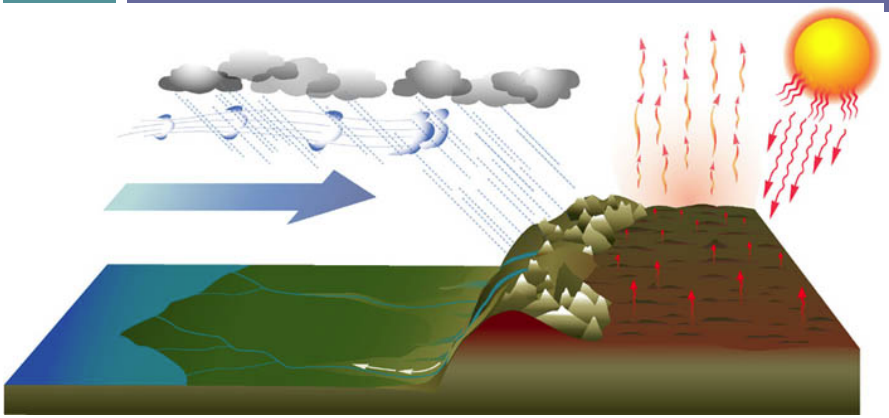
Mudanças sazonais no regime de ventos sobre o Oceano Índico



Monção de Inverno/Verão



Efeito orográfico



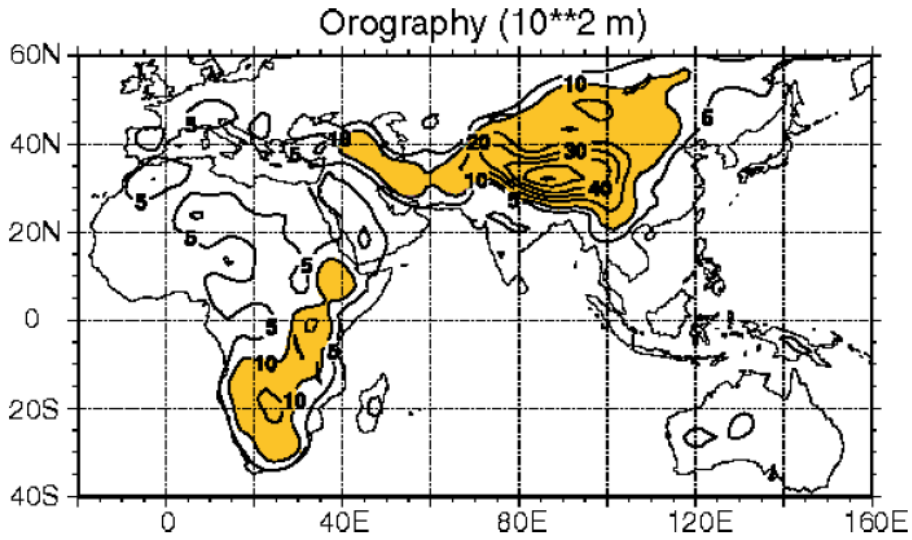
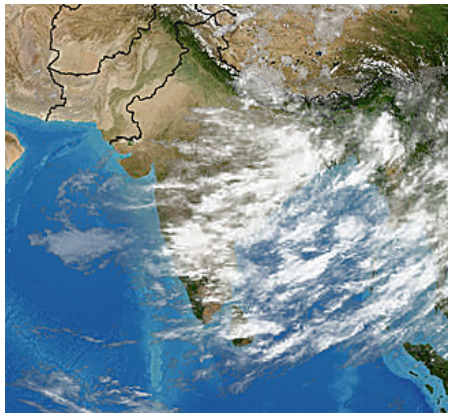


Figure 11a.(a) Orography and the south Asian summer monsoon. Orographic structure of the eastern hemisphere (units are 102 m). The Indian Ocean is surrounded by the East African Highlands to the west and the Himalayan Mountains to the north. Australia, on the other hand, is devoid of major orography. Orography with elevations >1 km are shaded. .

Índia: Monção de NE

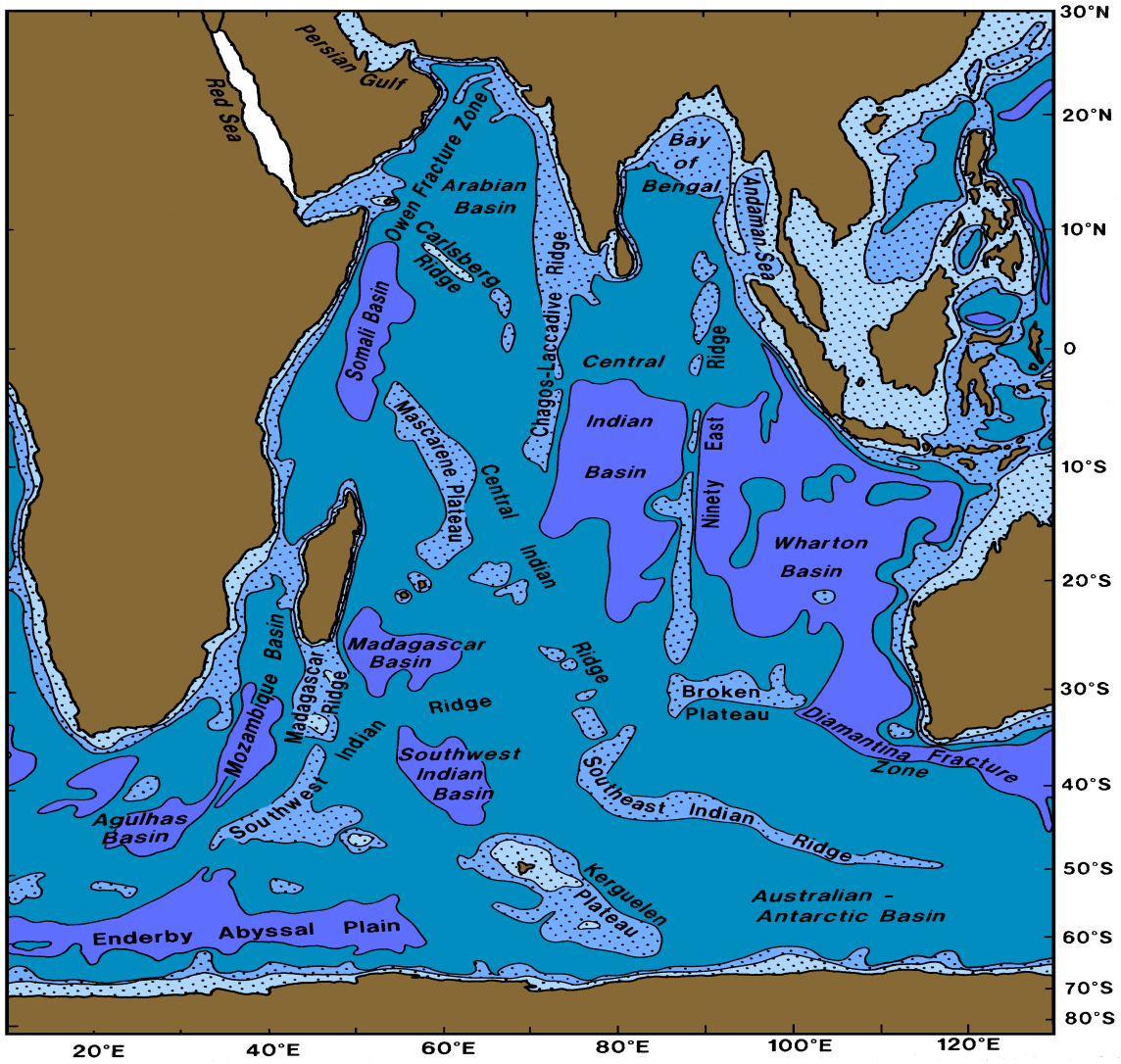



Índia: Monção de SW





Oceano Índico



Oceano Índico

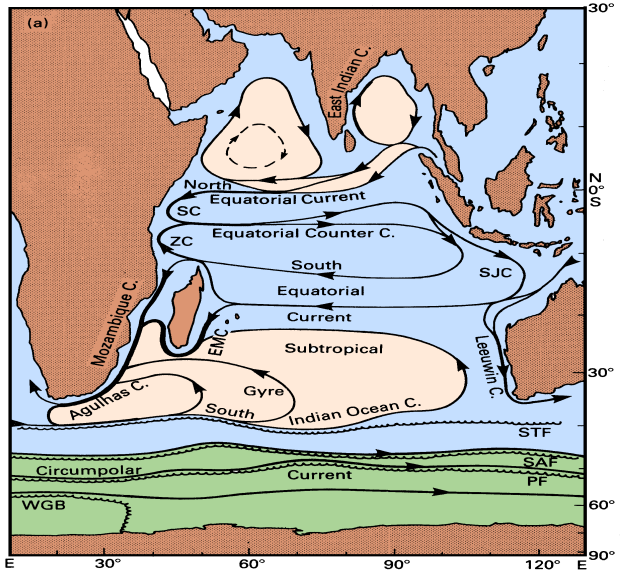
•Ao norte de 10 ^{0}S a extensão zonal se reduz devido ao fechamento das massas de terra continentais. Próximo ao Trópico de Câncer, o oceano já esta completamente fechado.

•A península Índica divide a porção norte do OI em dois grandes Golfos: A baía de Bengala, a leste, e o Mar da Arábia para oeste.

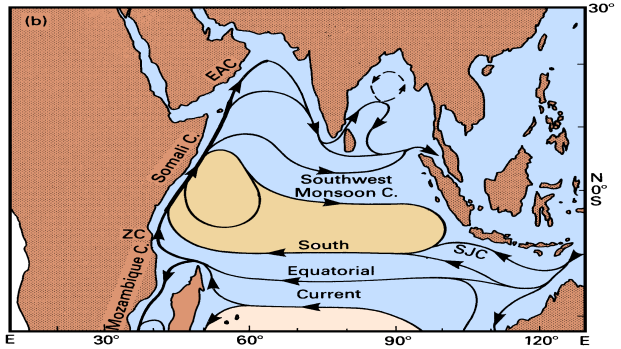
• A área total deste oceano, incluindo os mares adjacentes, é de ~49 milhões de km^{2}, sendo a menor das bacias oceânicas.

• A profundidade média do OI é de ~3800 m com as máximas encontradas na fossa de Java (7700 m).

Circulação do Oceano Índico

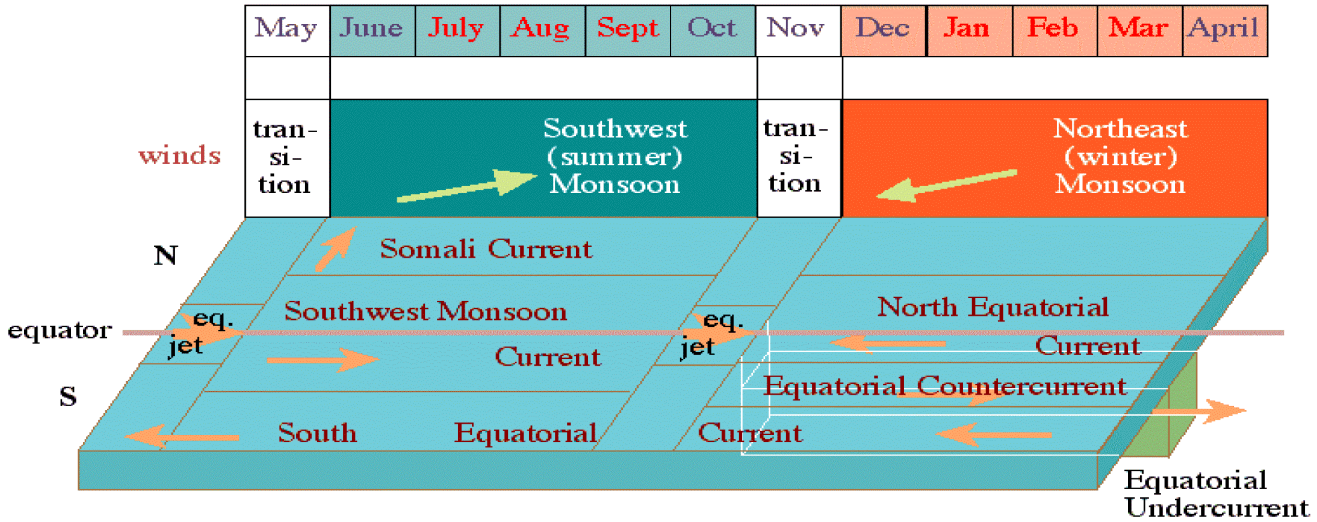


Monção NE



Monção SW

O Regime de Correntes de Monção no Oceano Indico Equatorial



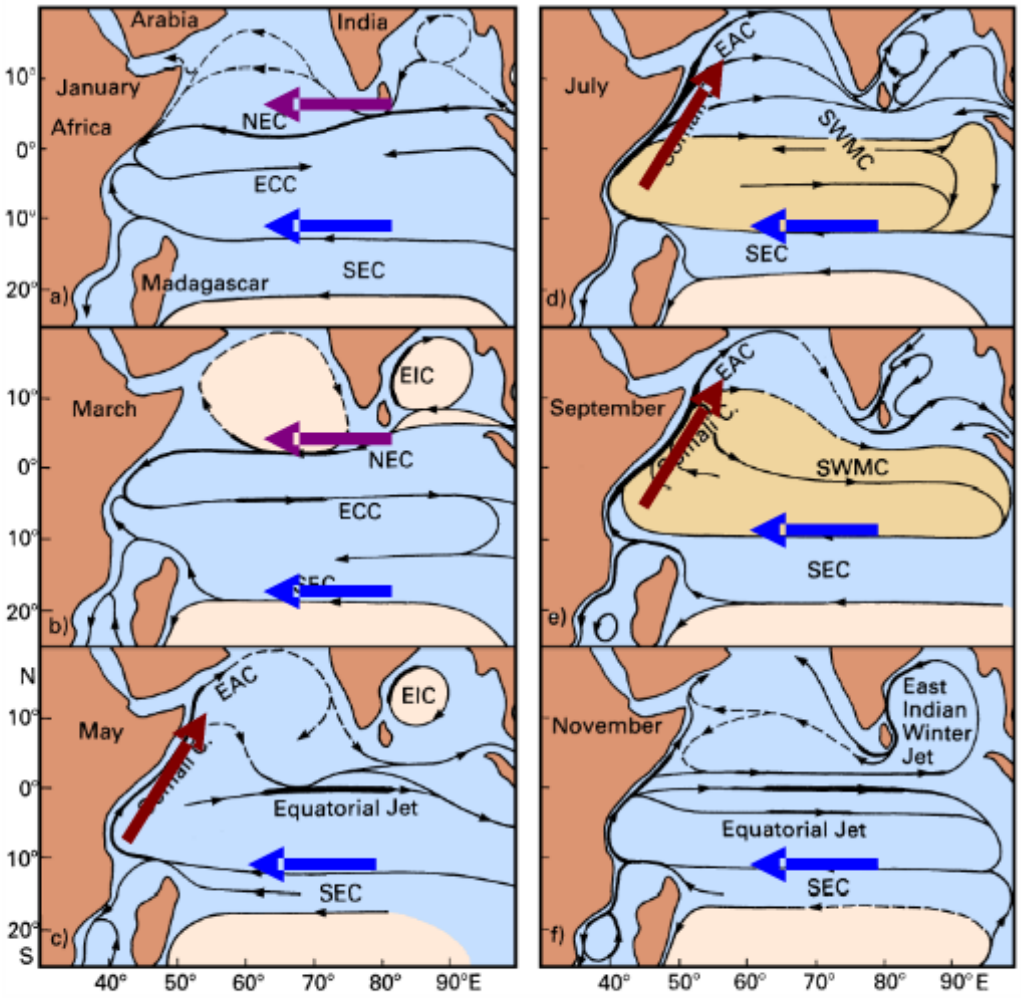
Monção de SW

- **Formação da Corrente da *Monção de verão (SW)*, fluindo pra lete.**
- **Corrente da Somália, a oeste (10S – 8N):**
  - **Sazonal e limitada a *monção de SW;***
  - **Origina-se no H.Sul e cruza o Equador**
  - **Velocidades de até 4 m/s (!!) já foram observadas próximo a 8N.**
  - **Ressurgência no Mar da Arábia.**

Monção de NE

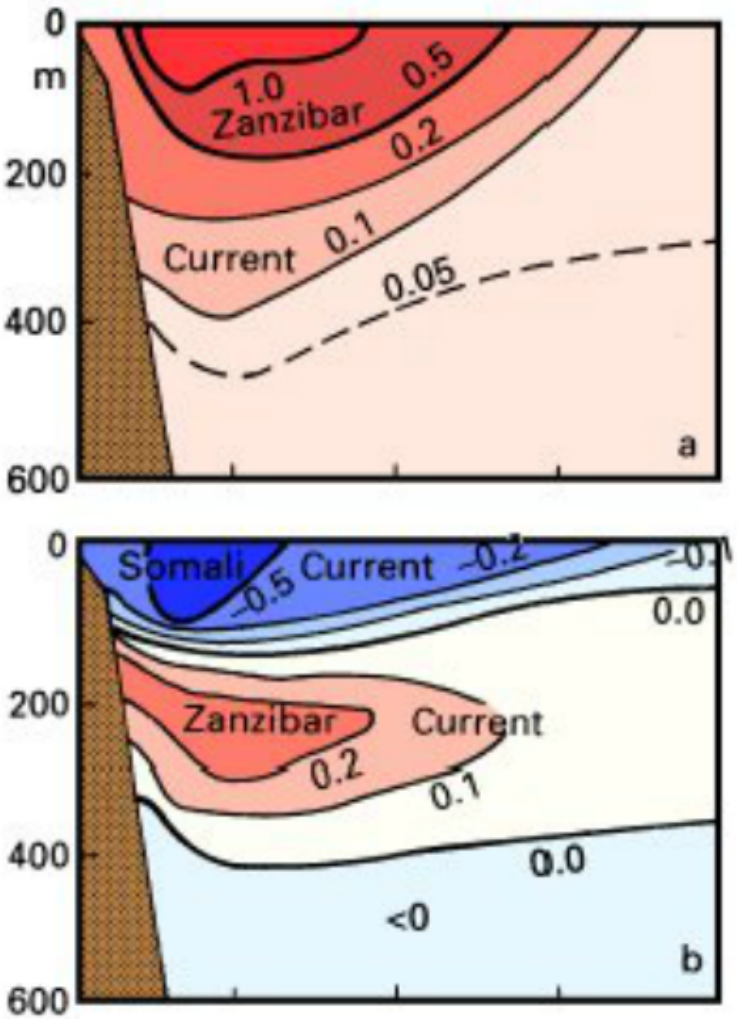
- **Tanto no Mar da Arábia como na Baía de Bengala forma-se uma circulação anti-ciclônica de pequena intensidade.**
- **O limite sul desta circulação é a CNE fluindo para oeste.**
- **Esta corrente acumula água na costa africana gerando um sistema de contra-correntes equatoriais similar ao OA e OP.**

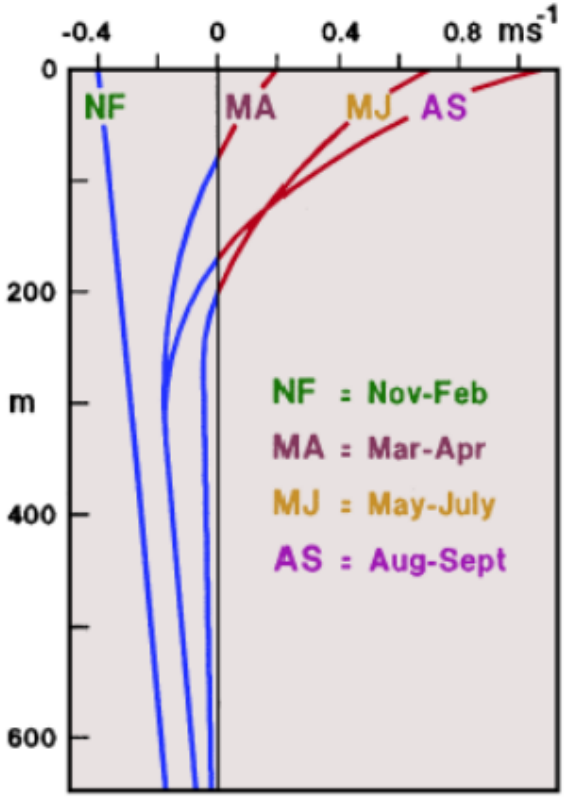
The Equatorial Current System



Surface currents in the northern Indian Ocean as derived from ship drift data. SEC: South Equatorial Current, NEC: North Equatorial Current, ECC: Equatorial Countercurrent, SWMC: Southwest Monsoon Current, EAC: East Arabian Current, EIC: East Indian Current. Adapted from Cutler and Swallow (1984).

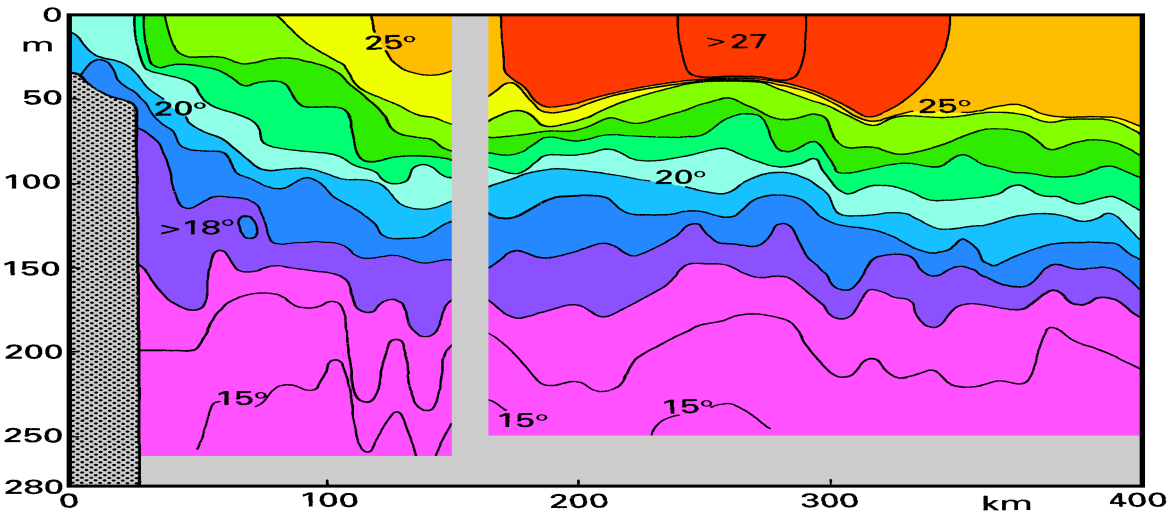
Somali Current

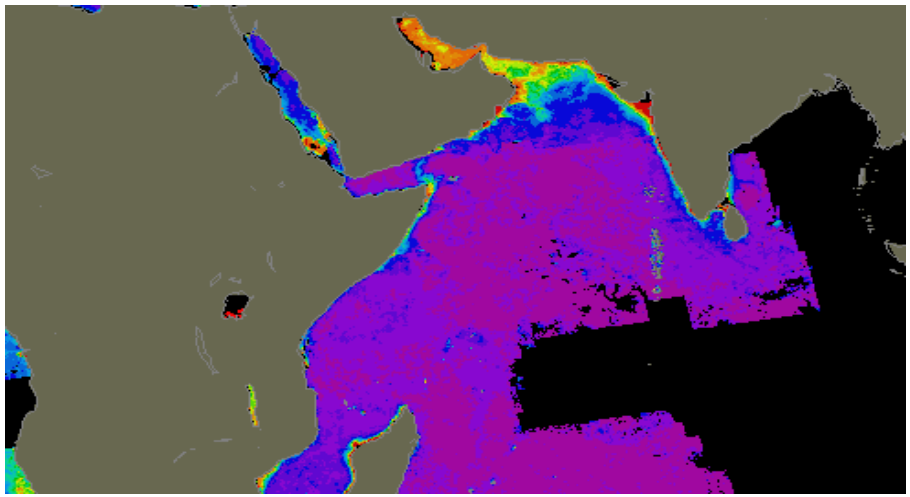




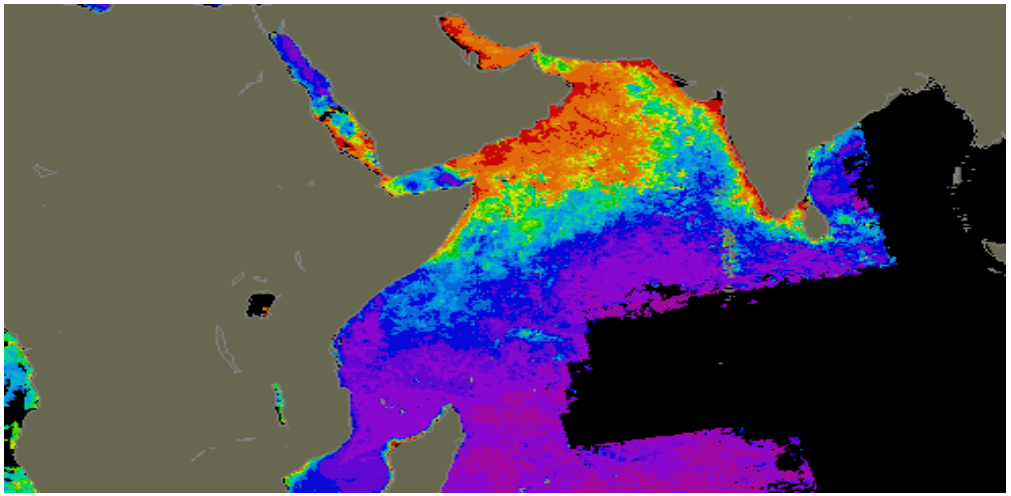
- (Left) Mean meridional current velocity (m/s) in the western boundary currents at the equator, derived from 2 years of observations during 1984 - 1986. (a) June - September, (b) December - February. After Schott *et al*. (1990).
- (Right) Mean alongshore velocity (positive = northeastward) ir the Somali Current at 5°N, from 30 months of current meter records. After Quadfasel and Schott (1983).

Ressurgência no mar da Arábia próximo a 18N em Julho/1983



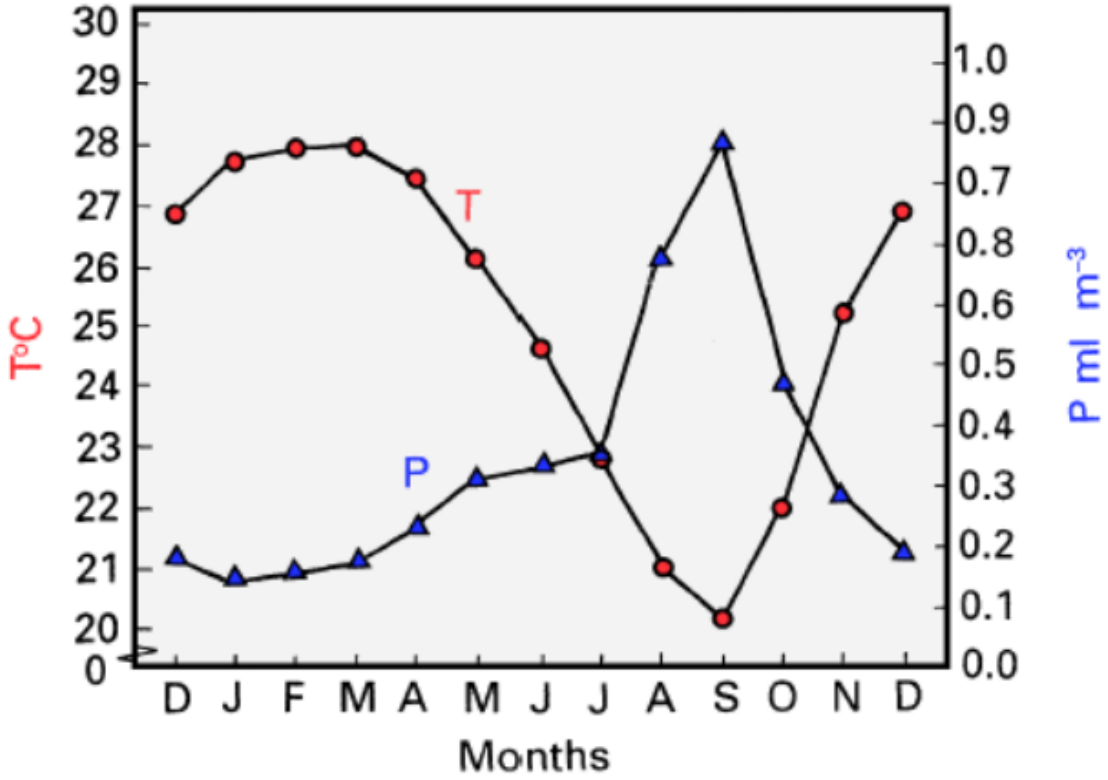


CZCS composite image of the Arabian Sea for April-June 1979, the latter half of the annual period of low productivity preceding the development of the southwest monsoon. Outflow features from the Persian Gulf are also visible.



CZCS composite image of the Arabian Sea for July-September 1979, showing the large area of high productivity waters that develops under the influence of the southwest monsoon.

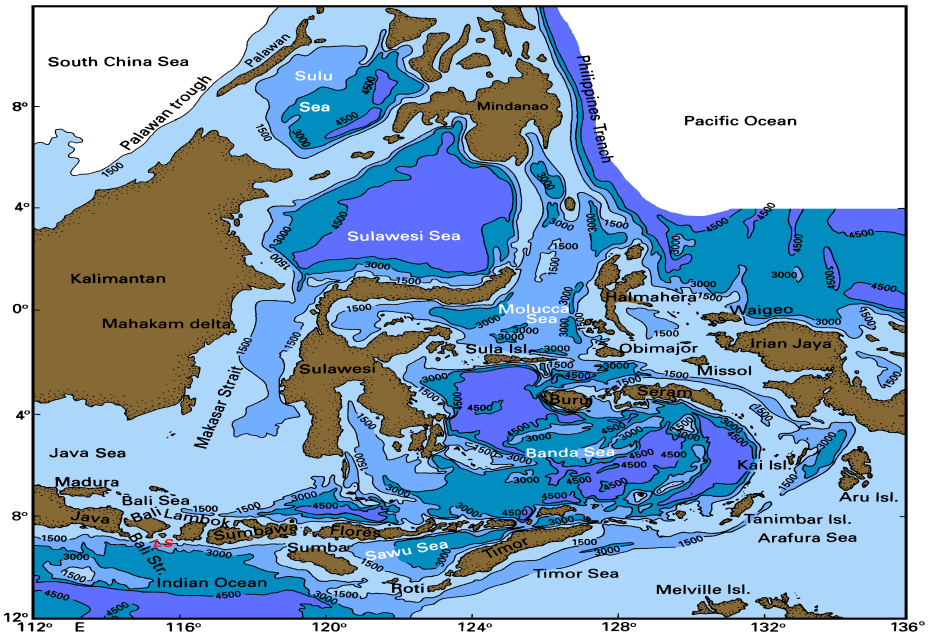
Arabian Sea

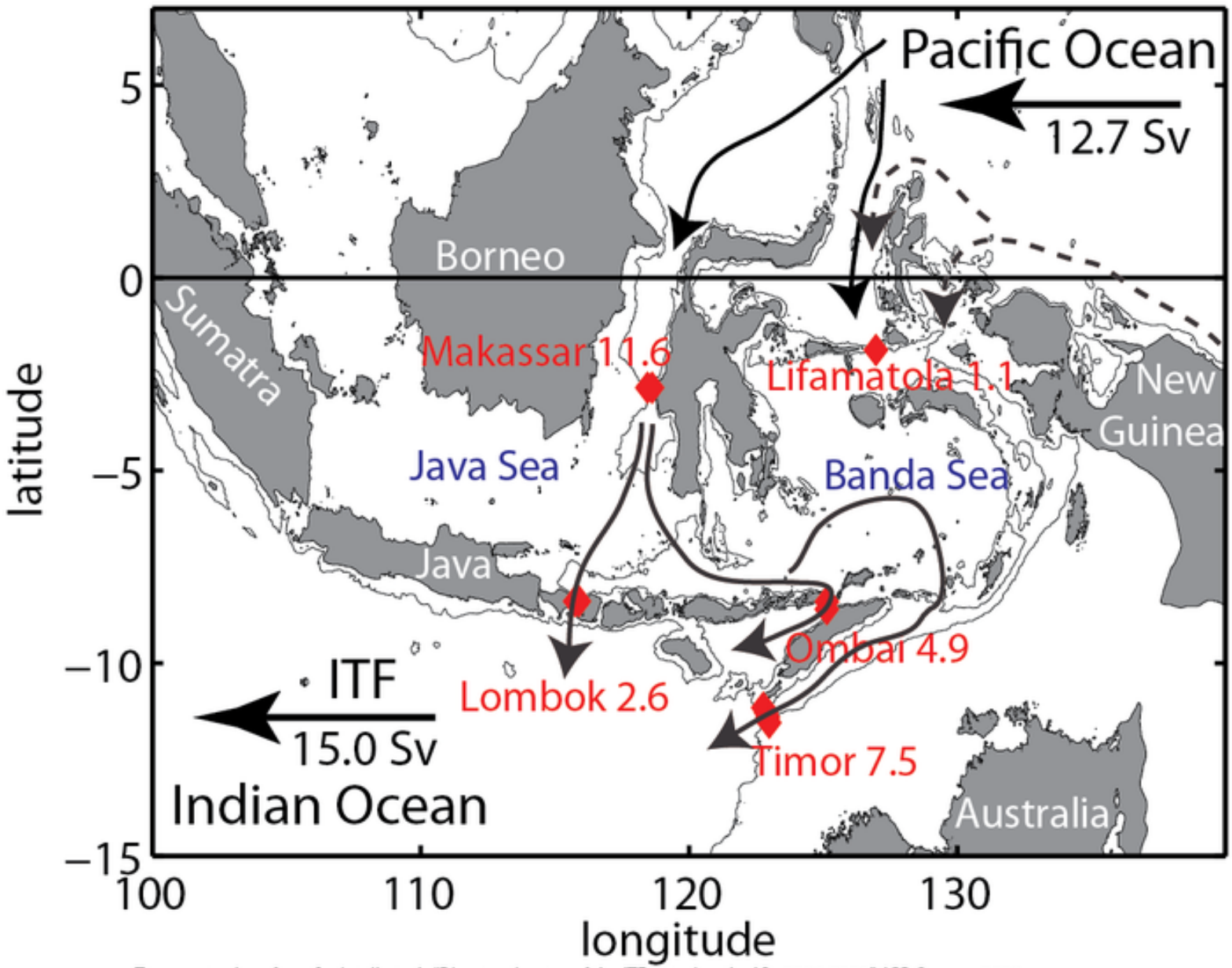


- Monthly mean temperature at 50 m depth (*T*) and zooplankton biomass (*P*) on the western Indian shelf between 8N and 15N. From Murty (1987).

O Fluxo Através-da-Indonésia (*Indonesian Throughflow*)

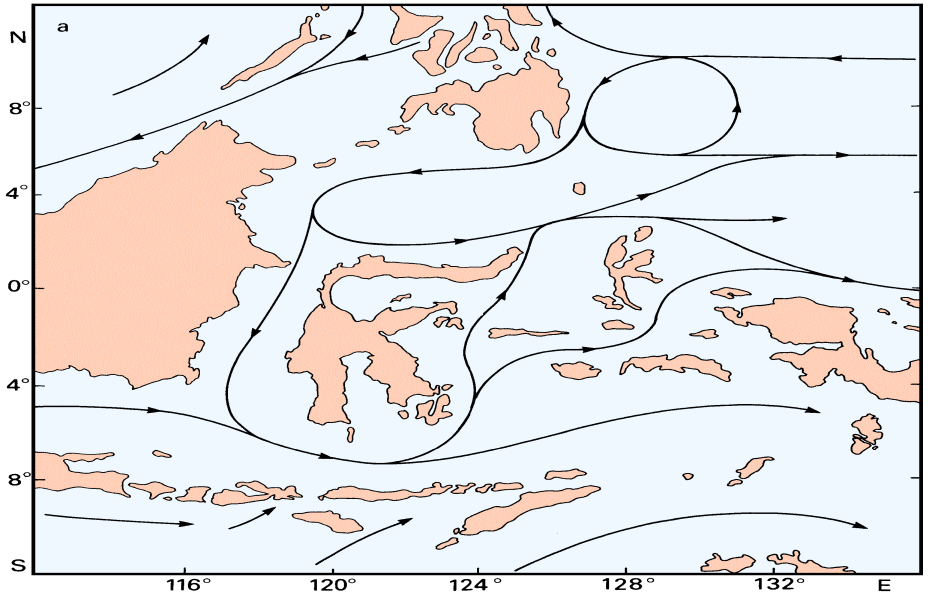
- Batimetria mais complicada do oceano mundial.
- O Mar Mediterrâneo da Indonésia é uma bacia de diluição (P>E).
- *Thorughflow* máximo durante a monção de SW (Agosto) e mínimo durante a monção de NE (Janeiro).
- Transporte de 12-20Sv.



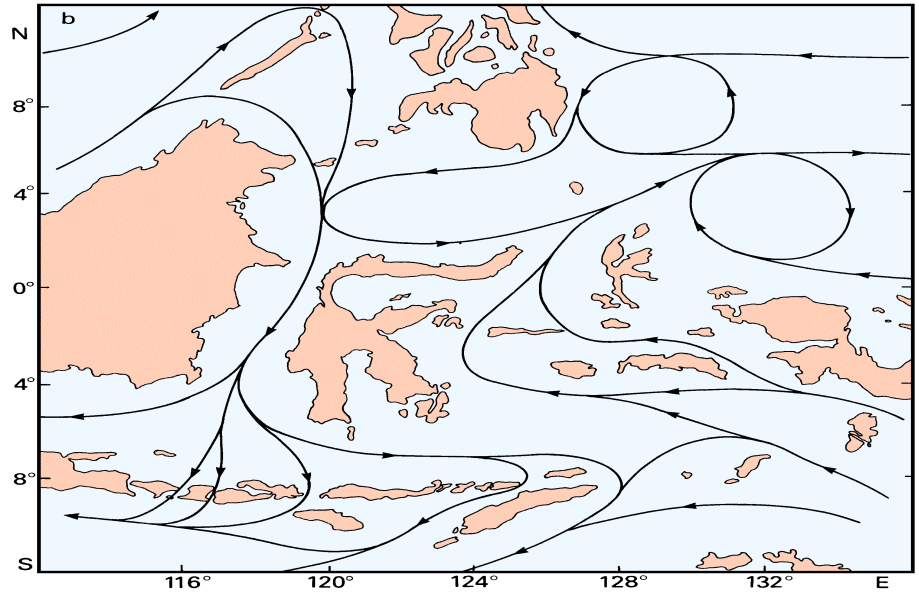


Transport values from Sprintall et. al., "Direct estimates of the ITF entering the IO: 2004-2006", JGR Oceans. 2009

Correntes Superficiais na Indonésia

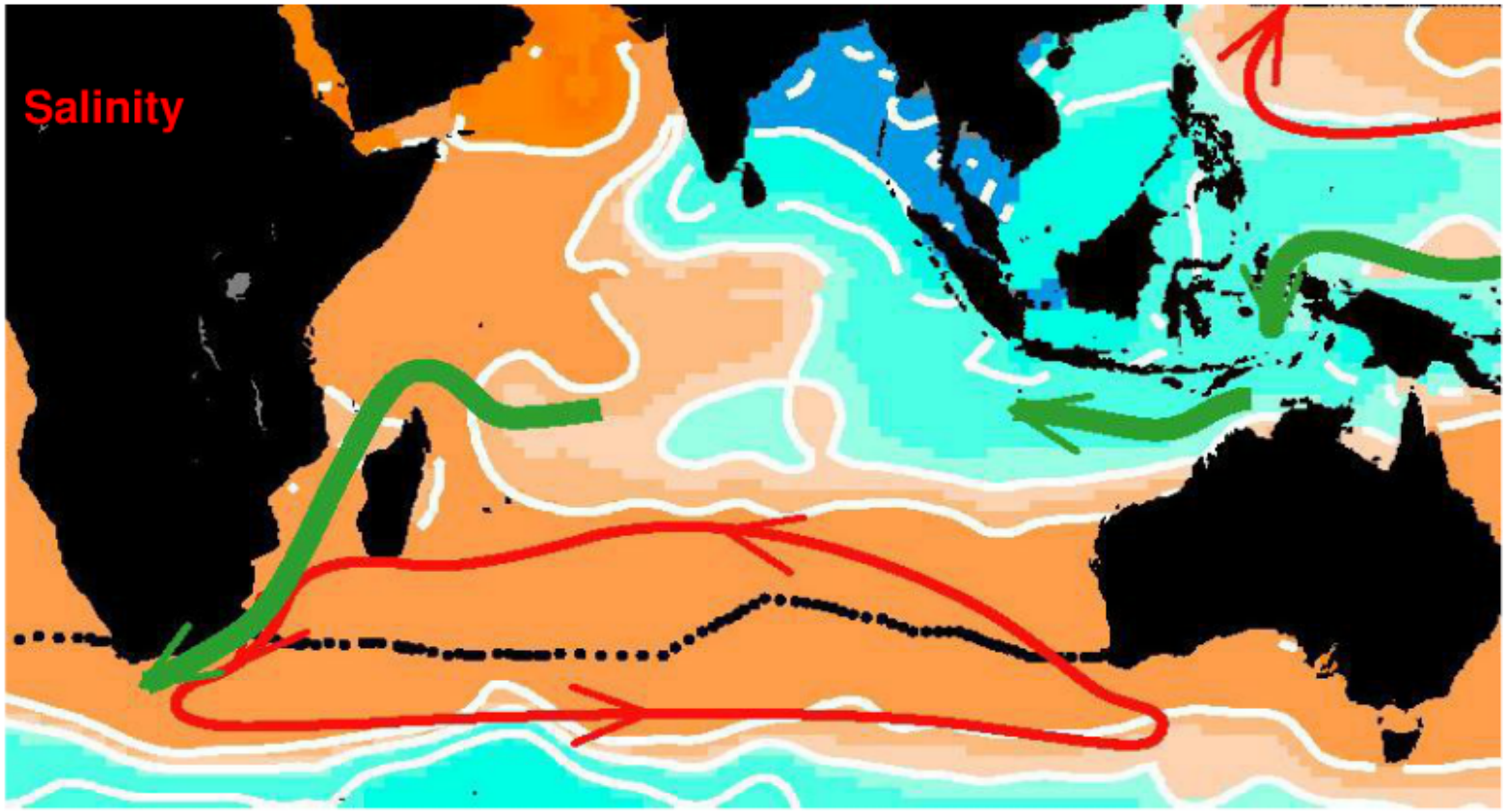


Monção de NE



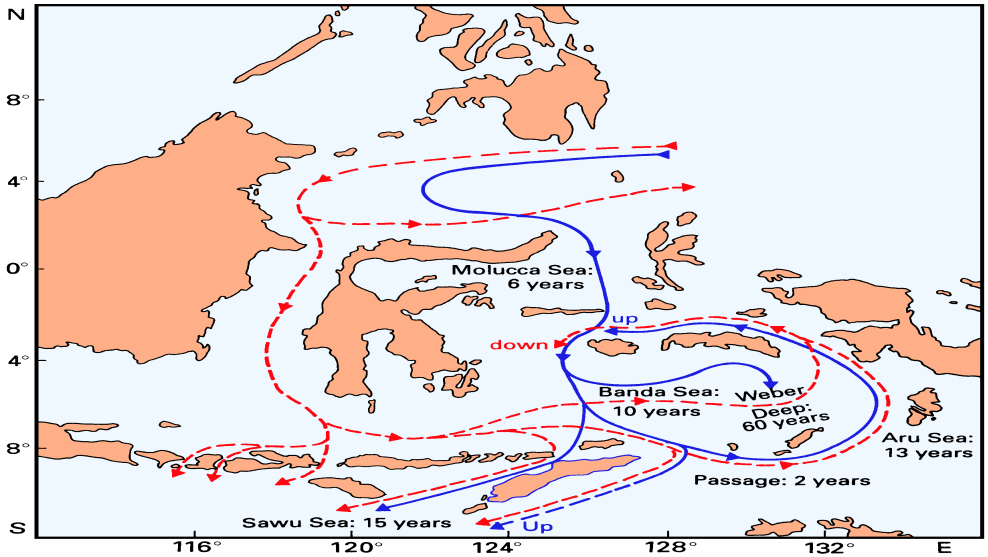
Monção de SW

Indonesian Throughflow

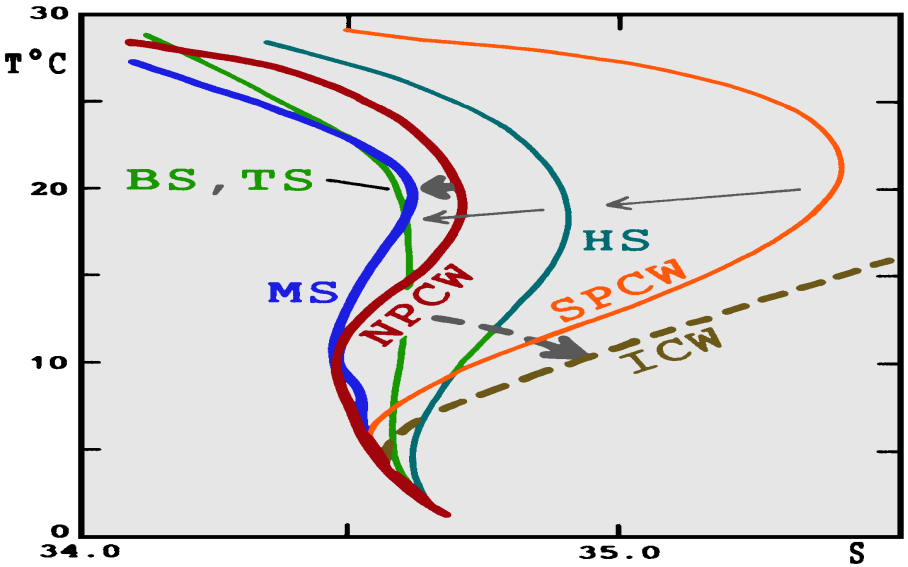


- Connection of upper ocean waters from Pacific to Indian Ocean through complicated set of straits.
- Low salinity Pacific water evident in zonal jet across Indian tropical region.

Correntes Profundas (--) e de Fundo (-) no mar Mediterrâneo da Indonésia

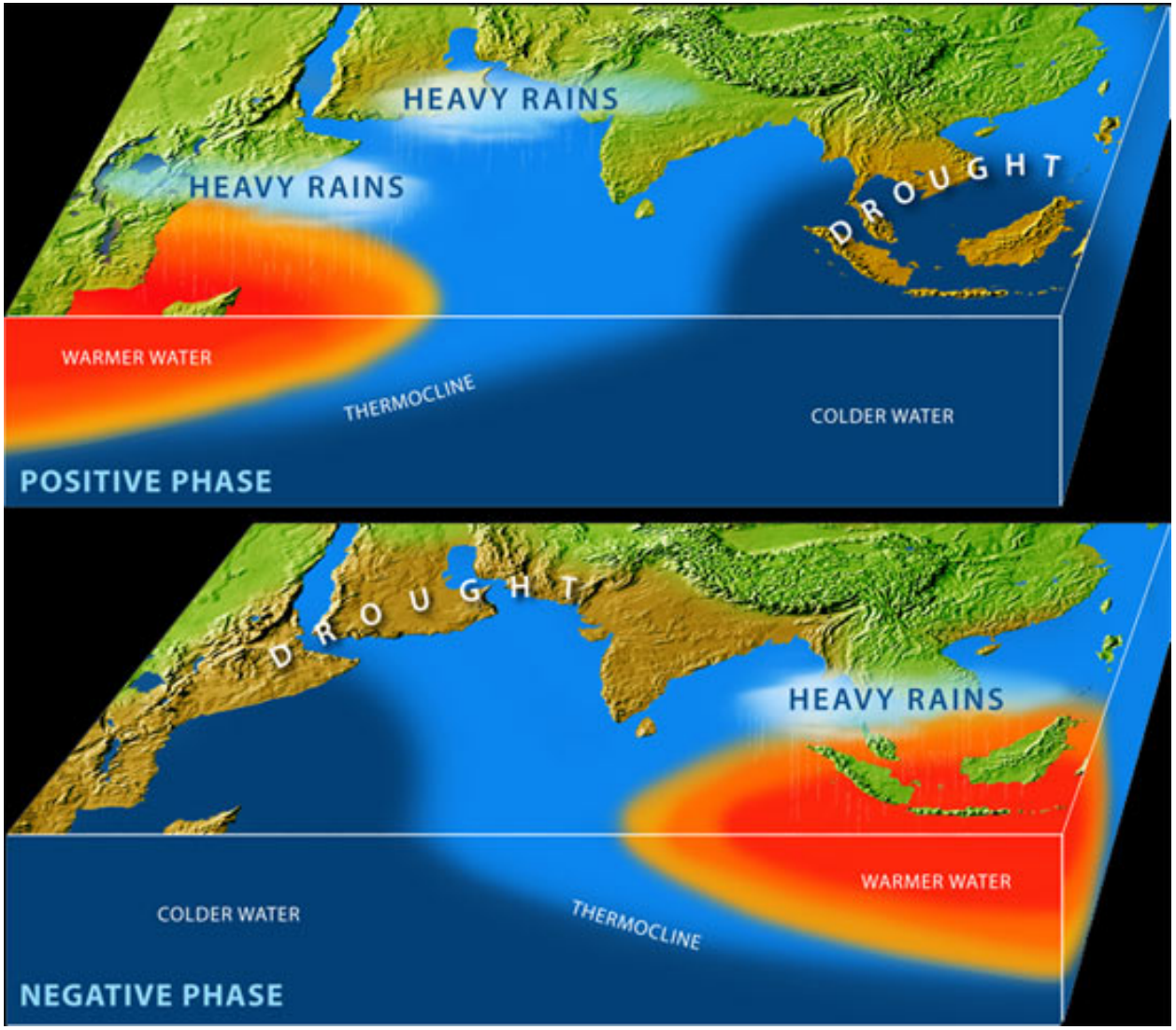


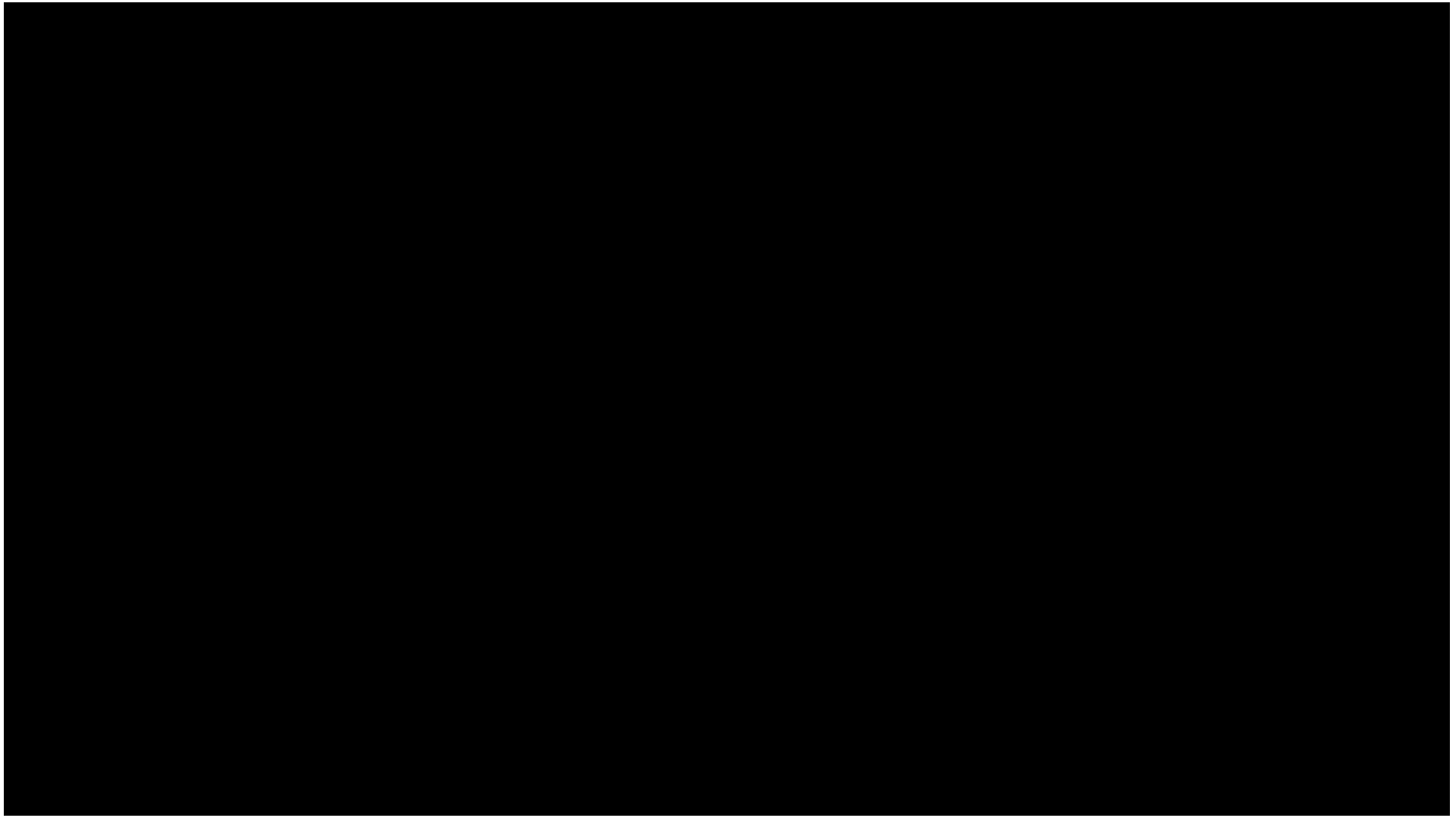
T/S : Caminho do *Throughflow*



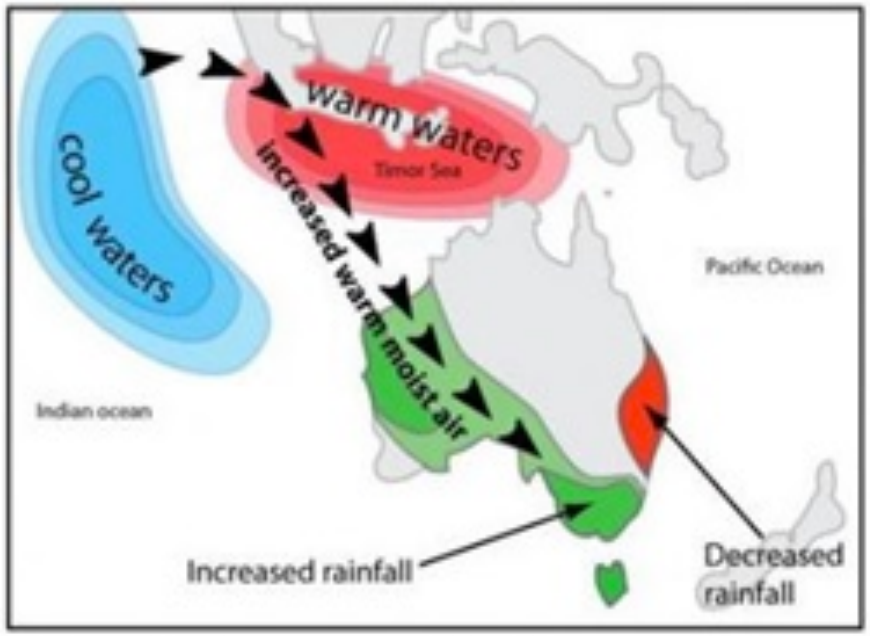
Indonesian through-flow, showing the transformation of Pacific Central Water into Australasian Mediterranean Water (demonstrating the character of the Australasian Mediterranean Sea as a dilution basin) and subsequently into Indian Central Water. South Pacific Central Water (SPCW) passes through the Halmahera Sea (HS) into the South Banda (BS) and Timor Seas (TS). North Pacific Central Water (NPCW) passes through Makassar Strait (MS) to the Timor Sea (TS). Both are then converted into Indian Central Water (ICW).

Dipolo do Oceano Índico

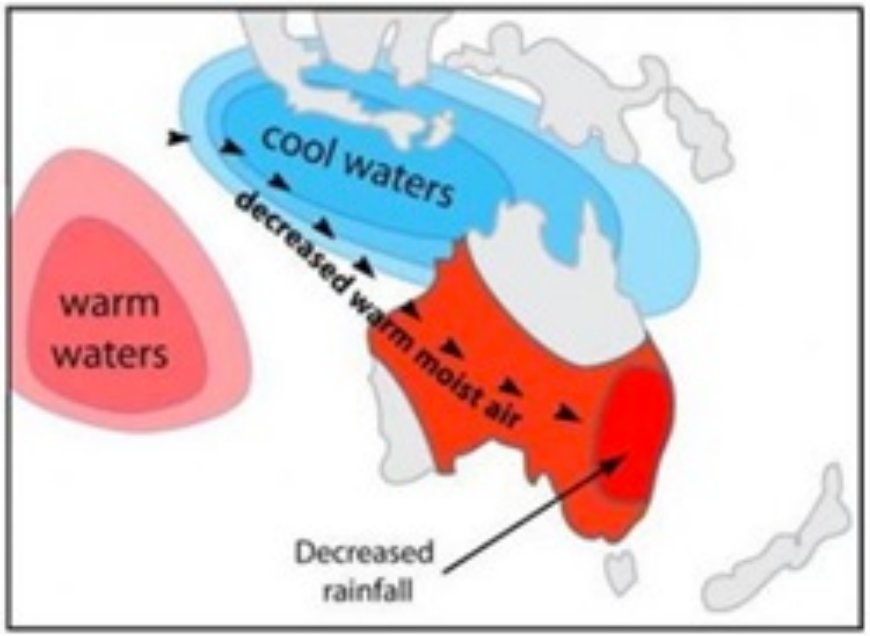




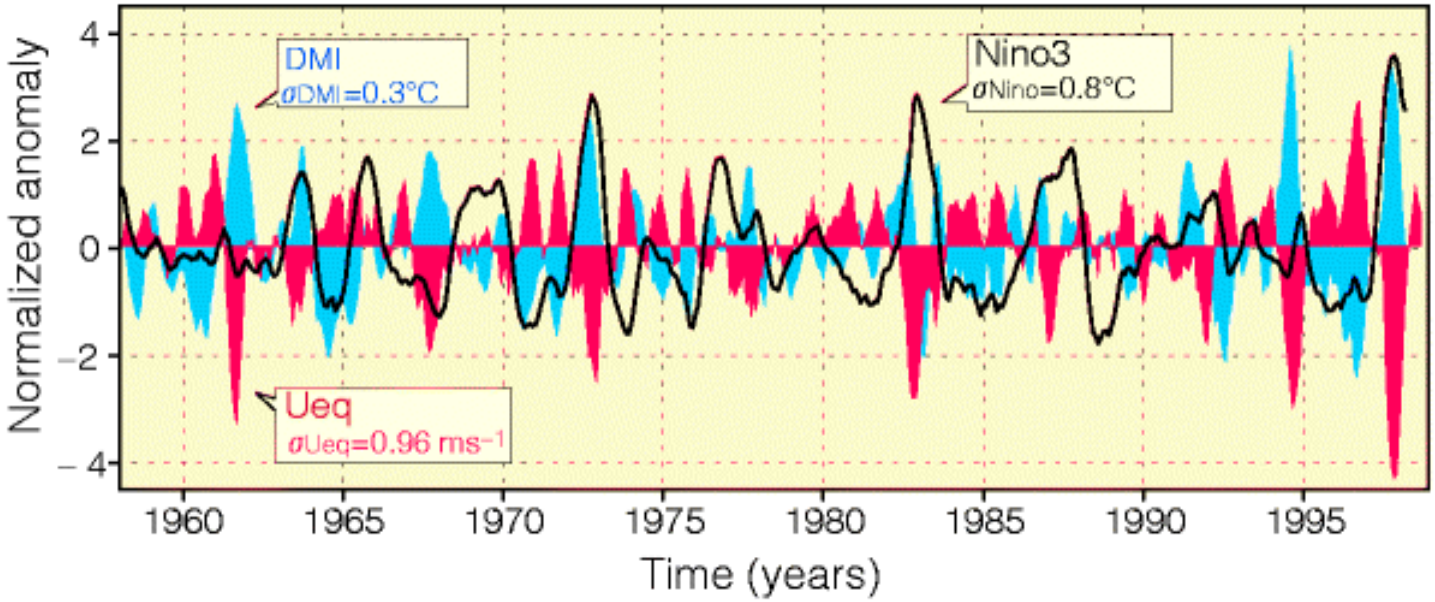
Afeta o regime de precipitação no entorno do Oceano Índico, principalmente da Austrália.



Negative phase: cool Indian Ocean water drives moist warm air and brings normal rainfall.



Positive phase: warm Indian Ocean water leads to weaker, drier winds and less rainfall.



A Dipole Mode in the Tropical Indian Ocean
Nature 401, 360-363 (23 September 1999) |

As Monções realmente influenciam a vida na Índia..