Curso Básico CROCO 2022

Tema: Mareas

Fernando Campos

Centro de Investigación Científica y de Enseñanza Superior de Ensenada
(CICESE)

11-01-2022

Mareas: Parte teórica (referencias)

- Hendershott M, Munk W. Tides. Annual review of fluid mechanics. 1970 Jan;2(1):205-24.
- Hendershott MC. Ocean tides. Eos, Transactions American Geophysical Union. 1973 Feb;54(2):76-86.
- Godin G. Tides. CICESE, ENSENADA(MEXICO), 1988, 290. 1988.
- Egbert GD, Erofeeva SY. Efficient inverse modeling of barotropic ocean tides. Journal of Atmospheric and Oceanic technology. 2002 Feb;19(2):183-204.
- Hendershott M. Lecture 1: Introduction to ocean tides. 2004 Program of Study: Tides. 2005 Jul:1. Pawlowicz R, Beardsley B, Lentz S.
- Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE. Computers & Geosciences. 2002 Oct 1;28(8):929-37.

Mareas: Parte teórica

Figure 1: Interestellar: tides triggered by a black hole gravity (The Science of Interstellar)

Mareas: Qué son y por qué son importantes?

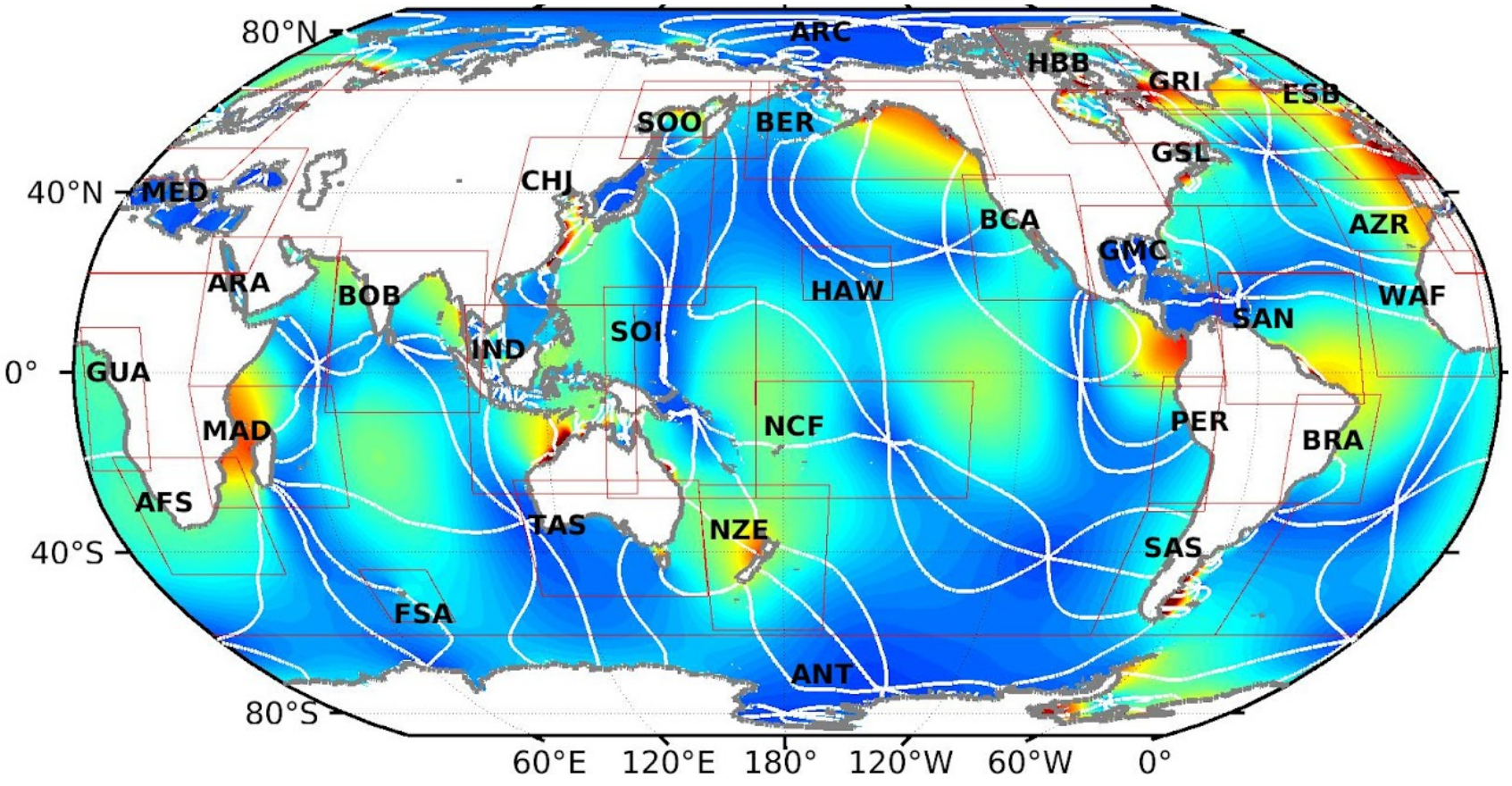


Figure 2: Mapa global TPXO de mareas (link)

Mareas: Qué fuerzas las generan?

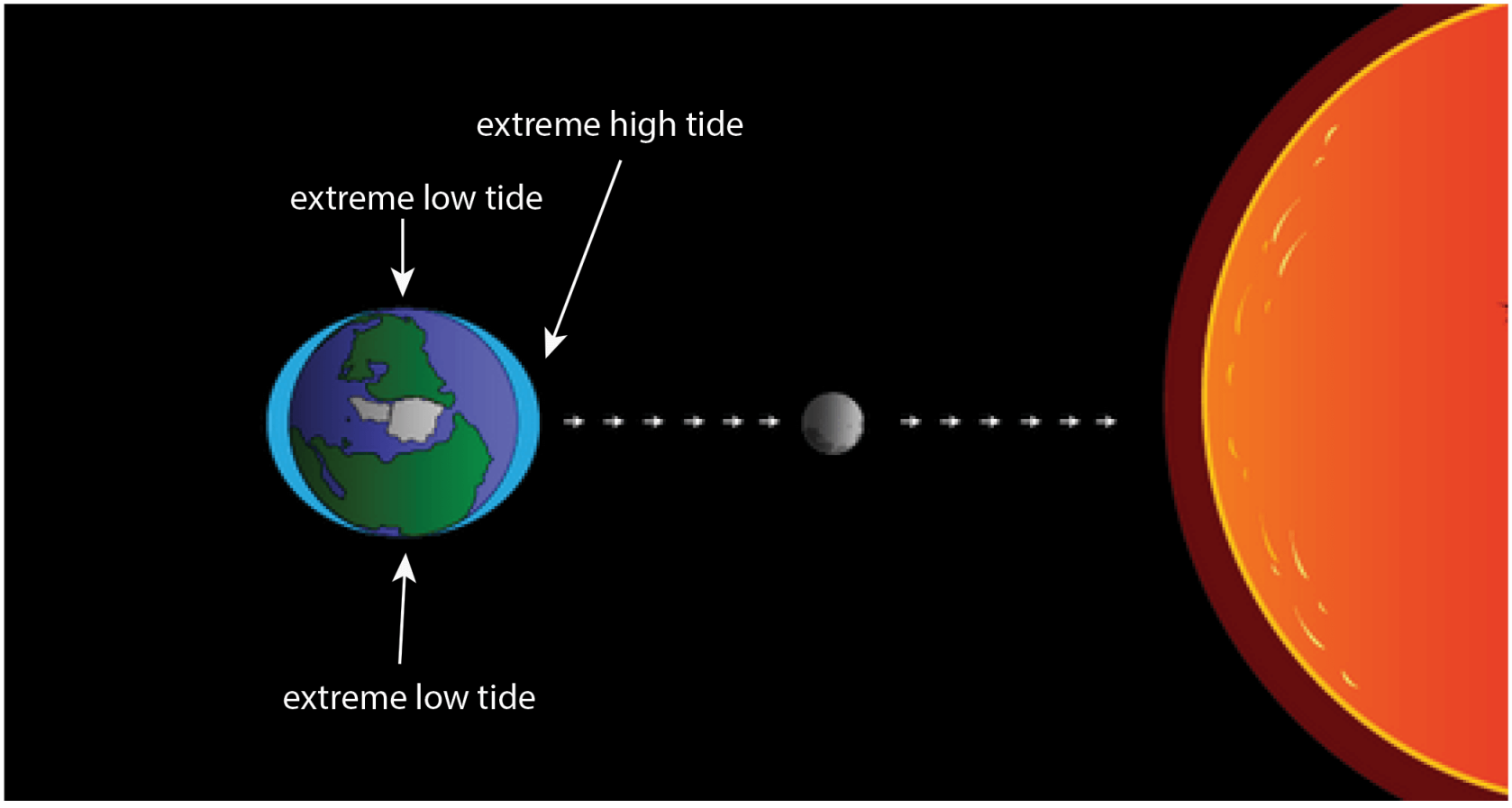


Figure 3: what causes tides?

Mareas: Análisis y predición

$$\eta_{(t)} = trend(\eta_t) + \sum_k A_k cos(\omega_k t + \theta_k)$$

- η_t: elevación del mar
- trend(η_t): tendencia de la elevación del mar
- A_k: Amplitud de la componente "k"
- ω_k: período de la componente "k"
- θ_k: fase de la componente "k"

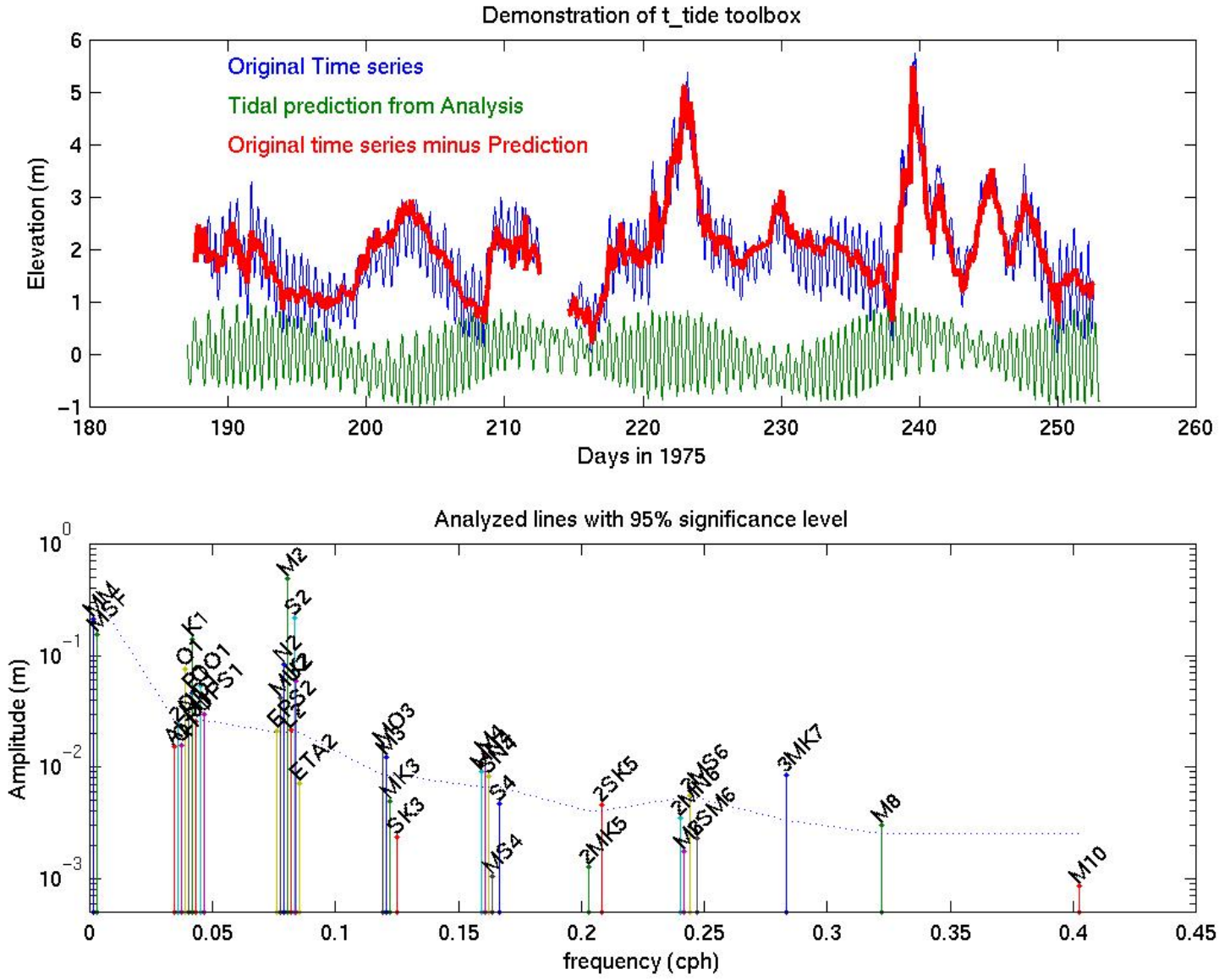
Mareas: Análisis y predicción

Table 1
Principal tidal constituents (Defant 1961)

Name	Symbol	Period, solar hr
Principal lunar	M_2	12.42
Principal solar	S_2	12.00
Larger lunar elliptic	N_2	12.66
Luni-solar semidiurnal	K_2	11.97
Larger solar elliptic	T_2	12.01
Smaller solar elliptic	L_2	12.19
Lunar elliptic second order	$2N_2$	12.91
Larger lunar evectional	ν_2	12.63
Smaller lunar evectional	λ_2	12.22
Variational	μ_2	12.87
Luni-solar diurnal	K_1	23.93
Principal lunar diurnal	O_1	25.82
Principal solar diurnal	P_1	24.07
Larger lunar elliptic	Q_1	26.87
Smaller lunar elliptic	M_1	24.84
Small lunar elliptic	J_1	23.10
Lunar fortnightly	Mf	327.86
Lunar monthly	Mm	661.30
Solar semiannual	Ssa	2191.43

Figure 4: Defant, A. (1961). Physical oceanography (Vol. 1). Pergamon.

Mareas: mediante T_TIDE



Mareas: dentro del modelo CROCO

- El modelo CROCO permite añadir la influencia de las fuerzas generadoras de marea usando el código en matlab **make_tides** la cual se agrega al archivo netcdf **croco_frc.nc**
- Este código emplea la metodología descrita en Flather (1976).
- Previamente se debe haber compilado el código **make_forcing**

Mareas: crocotools_param.m

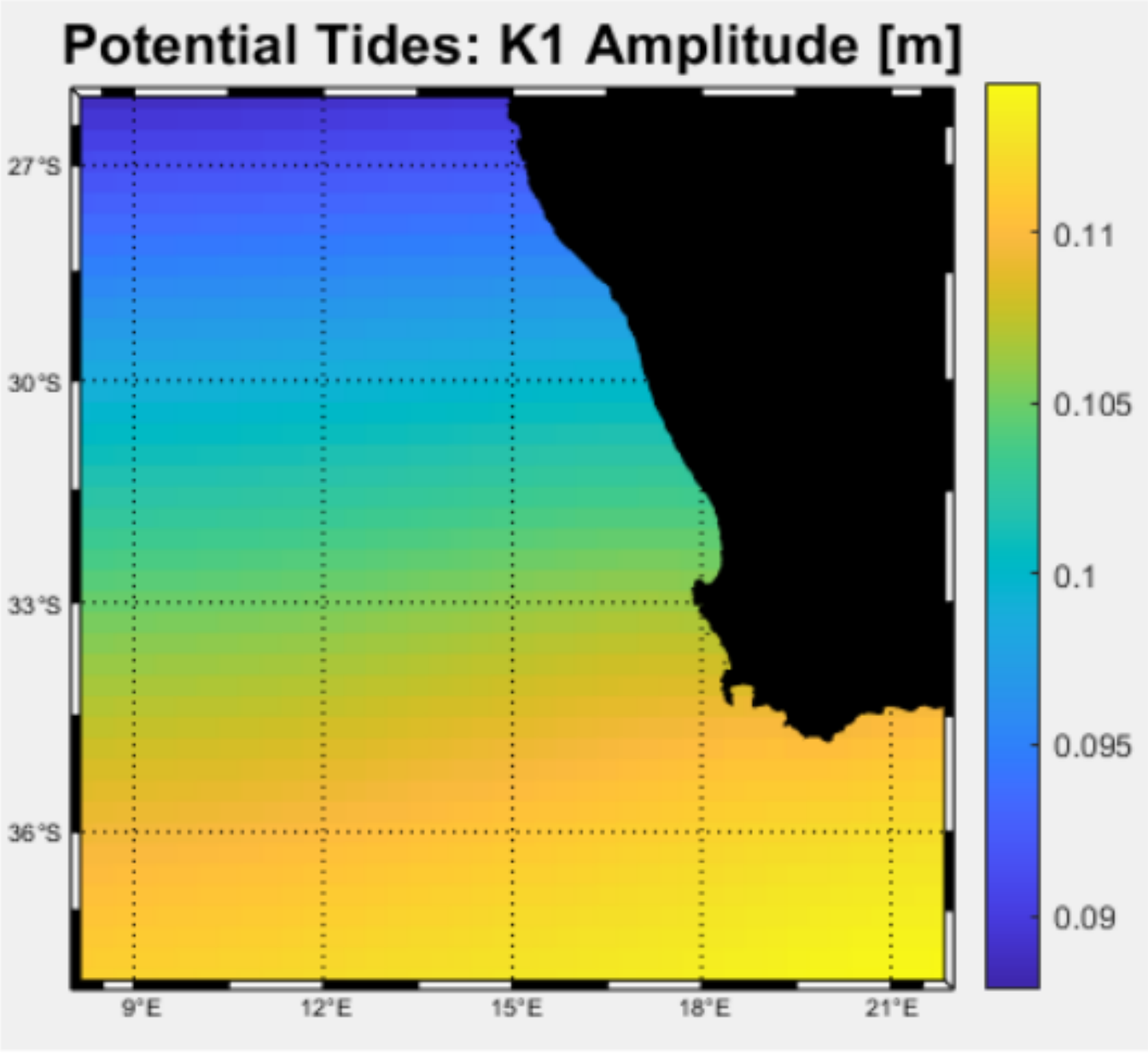
```
%%%%%%%%%%%%%%%%%%%%%%%%%
%
% 5-Parameters for tidal forcing
%
%%%%%%%%%%%%%%%%%%%%%%%%%
%
% TPXO file name (TPXO7)
%
tidename=[CROCOTOOLS_dir,'TPXO7/TPXO7.nc'];
%
% Number of tides component to process
%
Ntides=10;
%
% Chose order from the rank in the TPXO file :
% "M2 S2 N2 K2 K1 O1 P1 Q1 Mf Mm"
% " 1 2 3 4 5 6 7 8 9 10"
%
tidalrank=[1 2 3 4 5 6 7 8 9 10];
%
% Compare with tidegauge observations
%
lon0=18.37;
lat0=-33.91; % Cape Town location
Z0=1; % Mean depth of the tidegauge in Cape Town
```

Mareas: compilando ...

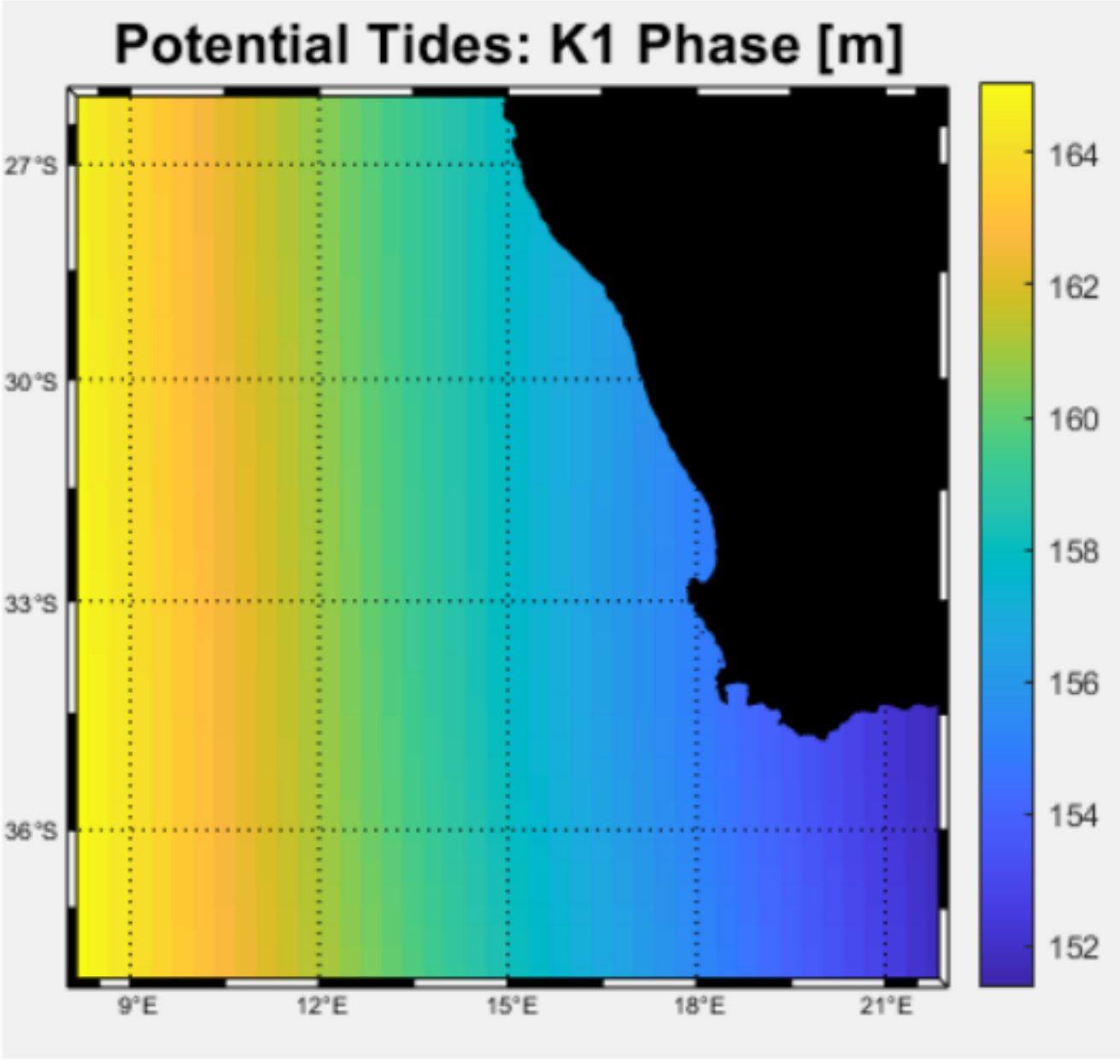
- start.m
- make_tides.m

```
mkdir: cannot create directory ‘/home/courses/instructor01/croco/MAREAS/CROCO_FILES/’:
File exists
Start date for nodal correction : 1-Jan-2005
Reading CROCO grid parameters ...
Tidal components : M2 S2 N2 K2 K1 O1 P1 Q1 Mf Mm
Processing tide : 1 of 10
  ssh...
Getting ssh_r for time index 1
Getting ssh_i for time index 1
  u...
Getting u_r for time index 1
Getting u_i for time index 1
  v...
Getting v_r for time index 1
Getting v_i for time index 1
Convert to tidal ellipse parameters...
Process equilibrium tidal potential...
Process tidal loading and self-attraction potential...
Get total tidal potential...
```

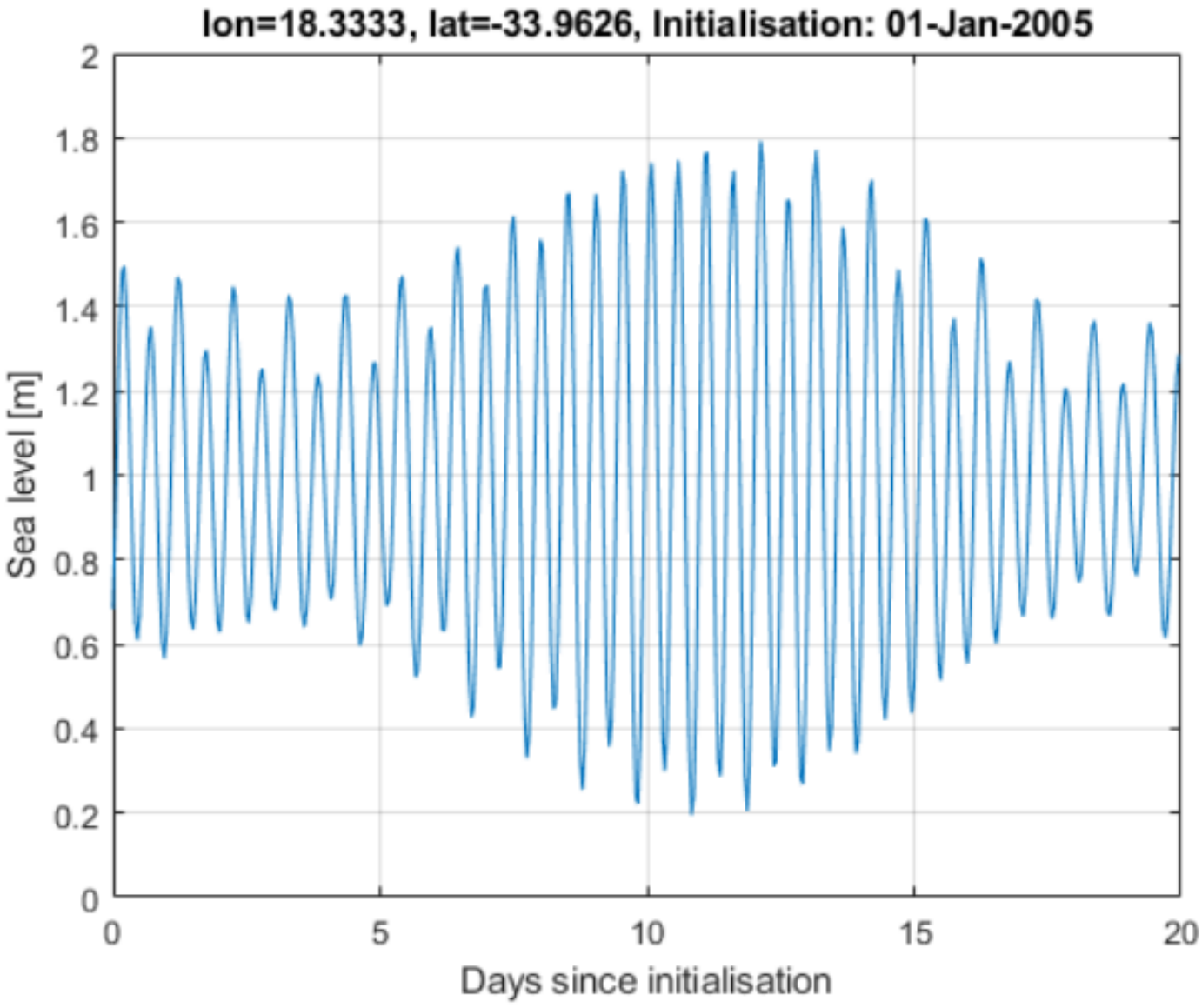
Mareas: graficando ...



Mareas: graficando ...



Mareas: graficando ...



Mareas: cppdef.h

```
/* Open Boundary Conditions */
# define TIDES

/* Open Boundary Conditions */
# ifdef TIDES
#  define SSH_TIDES
#  define UV_TIDES
#  define POT_TIDES
#  undef  TIDES_MAS
#  ifndef UV_TIDES
#   define OBC_REDUCED_PHYSICS
#  endif
#  define TIDERAMP
# endif
# define OBC_M2CHARACT
# undef  OBC_M2ORLANSKI
# define OBC_M3ORLANSKI
# define OBC_TORLANSKI
# undef  OBC_M2SPECIFIED
# undef  OBC_M3SPECIFIED
# undef  OBC_TSPECIFIED
```

Mareas: param.h

```
#if defined SSH_TIDES || defined UV_TIDES
      integer Ntides              ! Number of tides
                                  ! ====== == =====
# if defined IGW || defined S2DV
      parameter (Ntides=1)
# else
      parameter (Ntides=10)
# endif
#endif
```

Nota: el número de componentes de la marea debe ser aquí debe ser consistente con **crocotools_param.m**