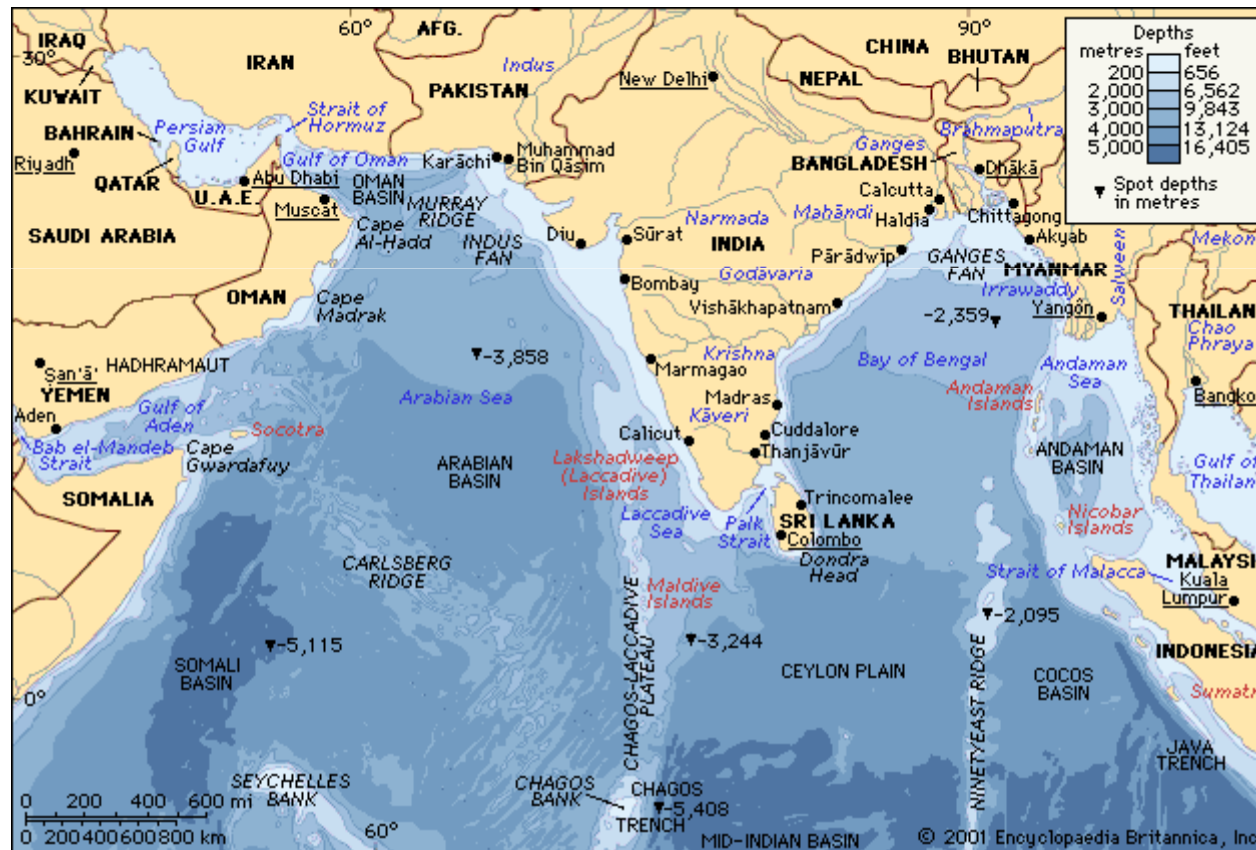


# Tidal Modeling of the Arabian Sea

Unnikrishnan A.S.<sup>(1)</sup>, Testut L.<sup>(2)</sup>, Koch-Larrouy A.<sup>(2)</sup> and Lyard F.<sup>(2)</sup>

(1) NIO, Goa

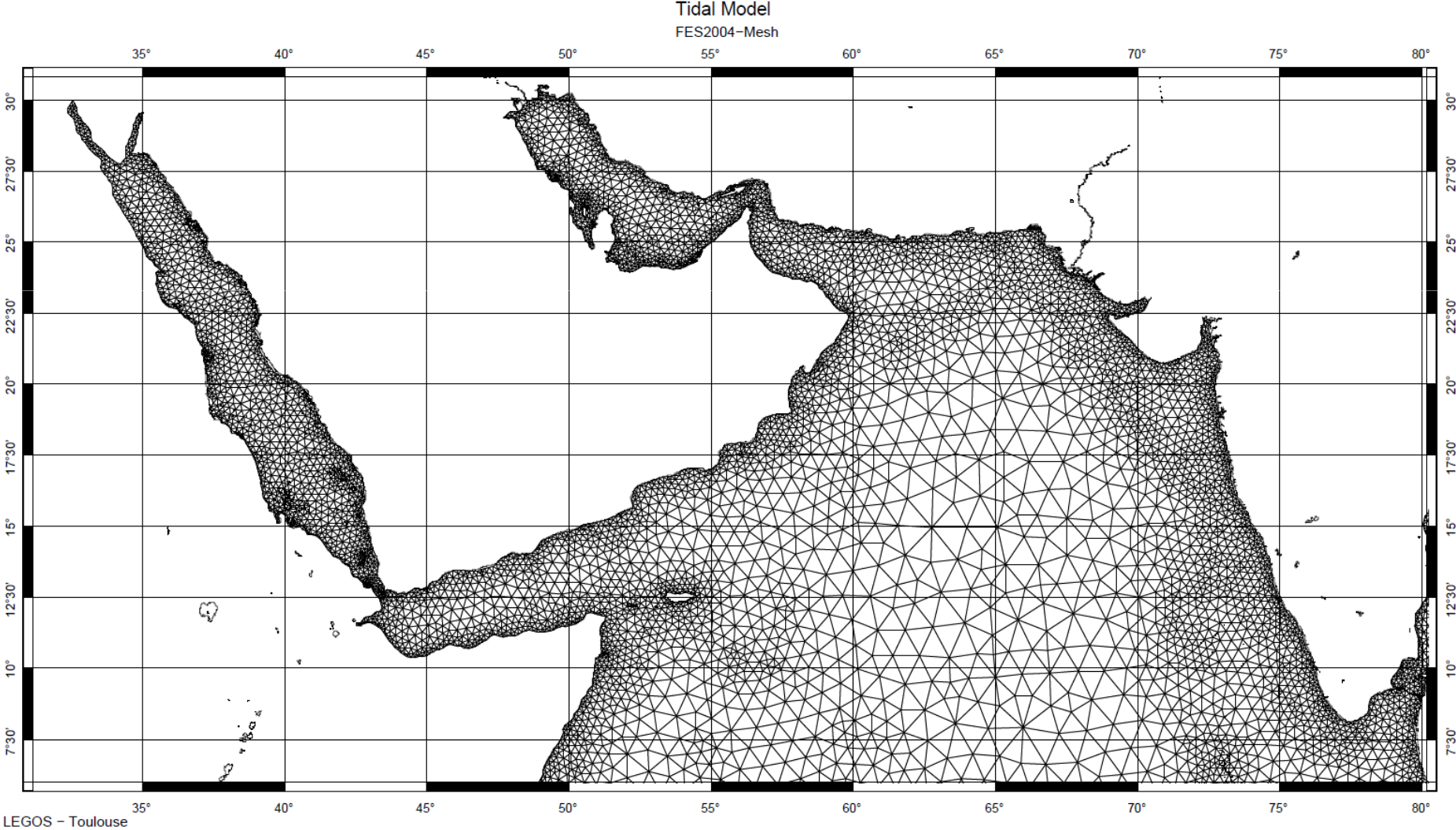
(2) LEGOS, Toulouse



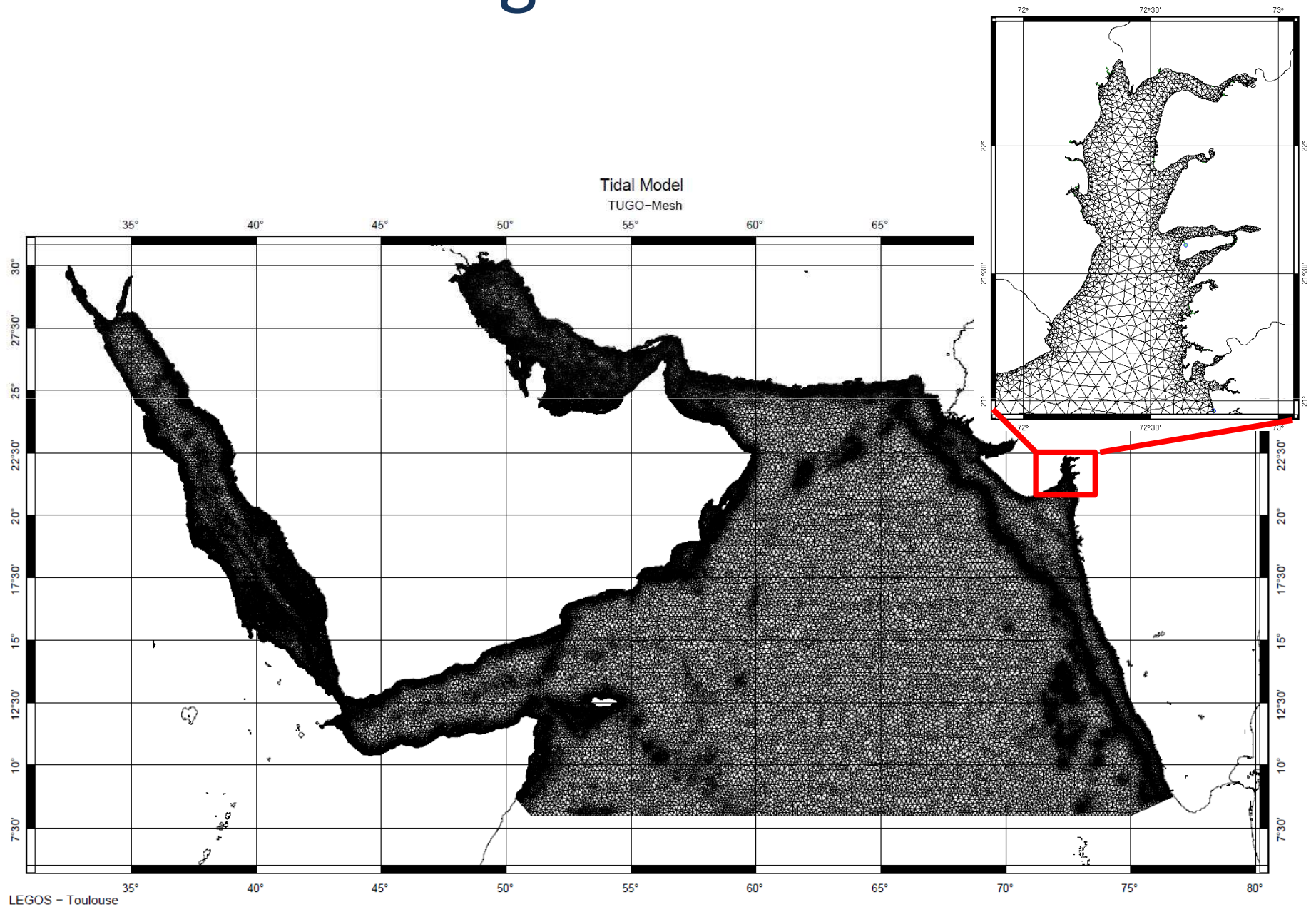
# The tidal model

- **t-UGOm** (*Toulouse Unstructured Grid Ocean model 2D, ex-Mog2D*)
  - 2D barotropic model
  - Using finite element for the spatial discretization of the mesh
  - Based on the non-linear shallow water equations (Lynch and Gray, 1979)
  - Without assimilation
  - We have run the model for 11 of the principal tidal waves (M2,K1,O1,P1,S2,....)
- **Forced at the boundary with FES2004**
- **Used the ETOPO2 modified bathymetry (Sindhu et al., 2007)**

# FES2004 – Global Tidal Model



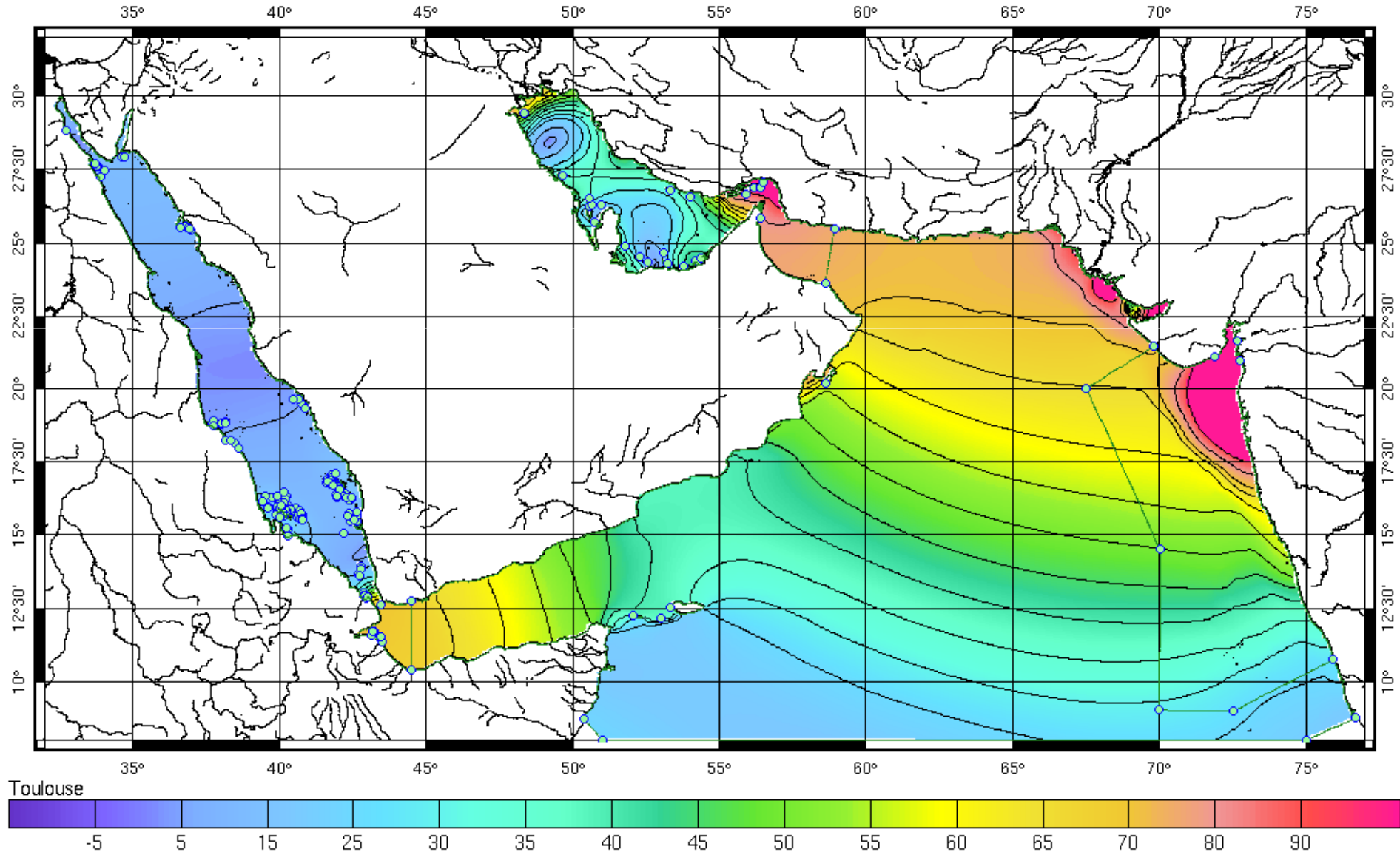
# TUGO – Regional Tidal Model



# TUGO – M2 Solution

Test run for 10 month

Arabian-sea I-ugo model  
barotropic tides no assimilation

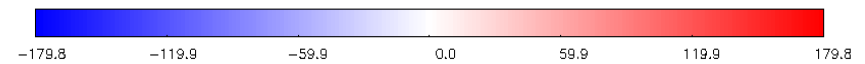
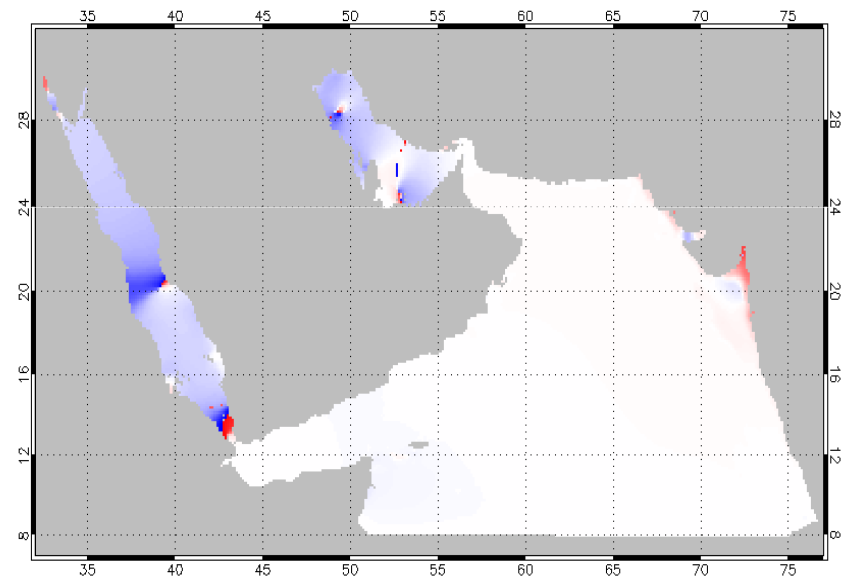
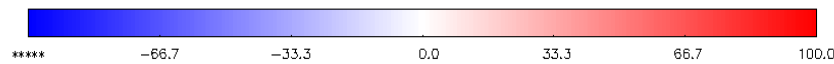
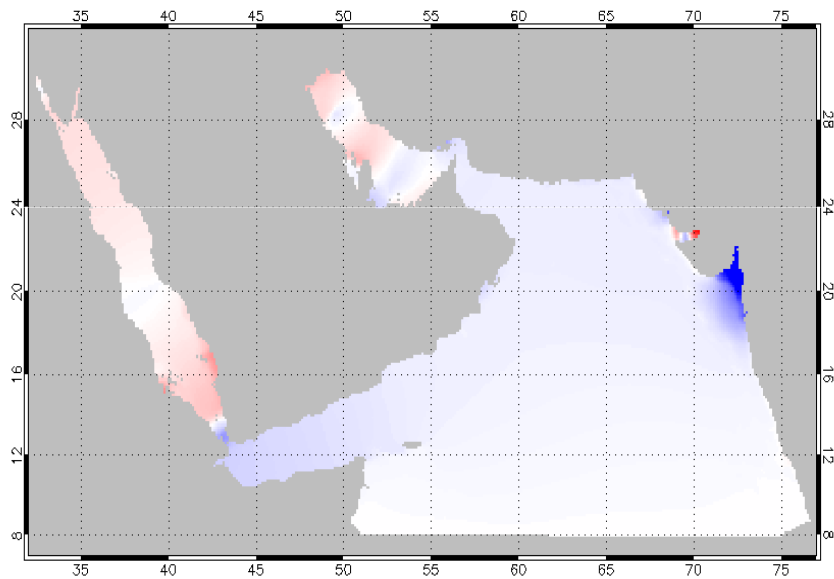


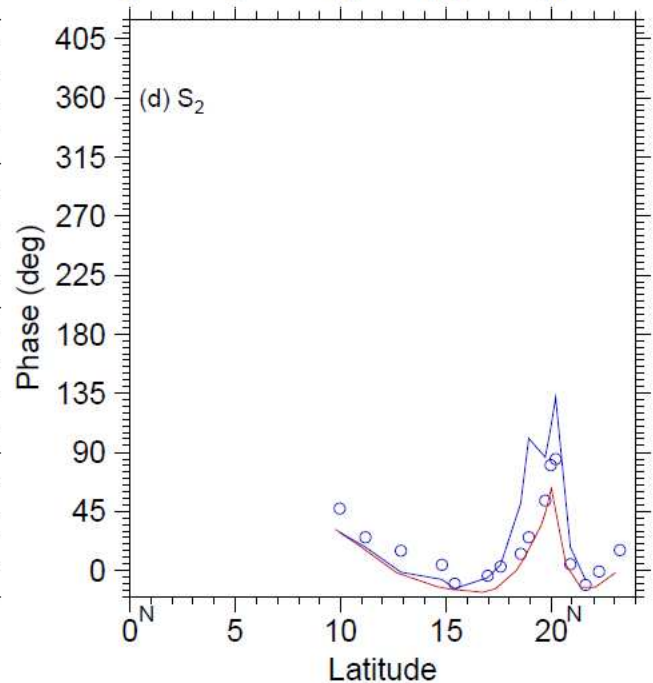
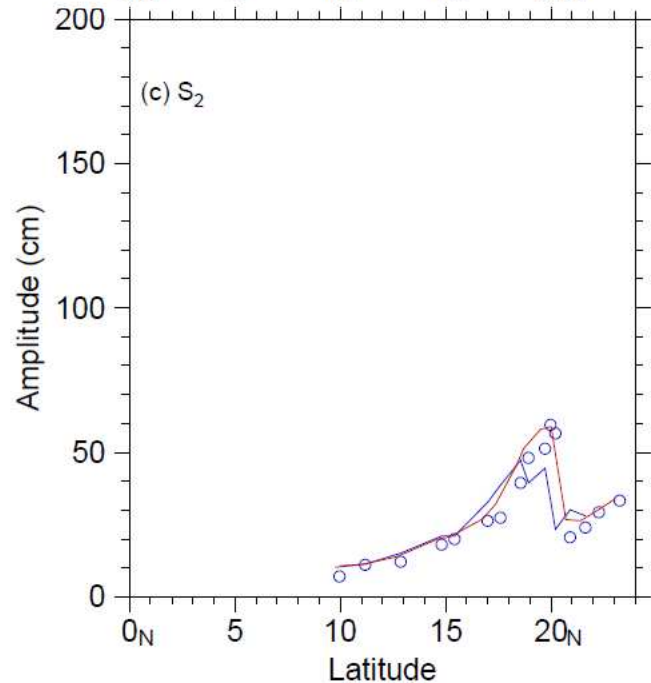
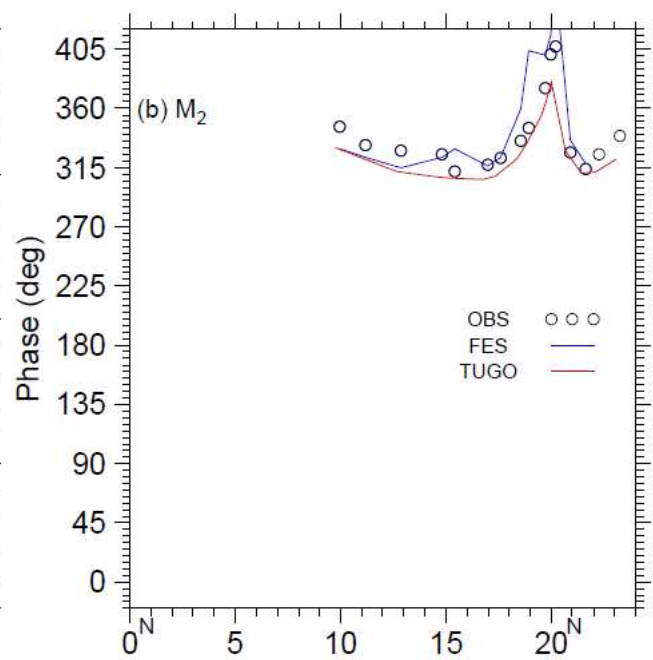
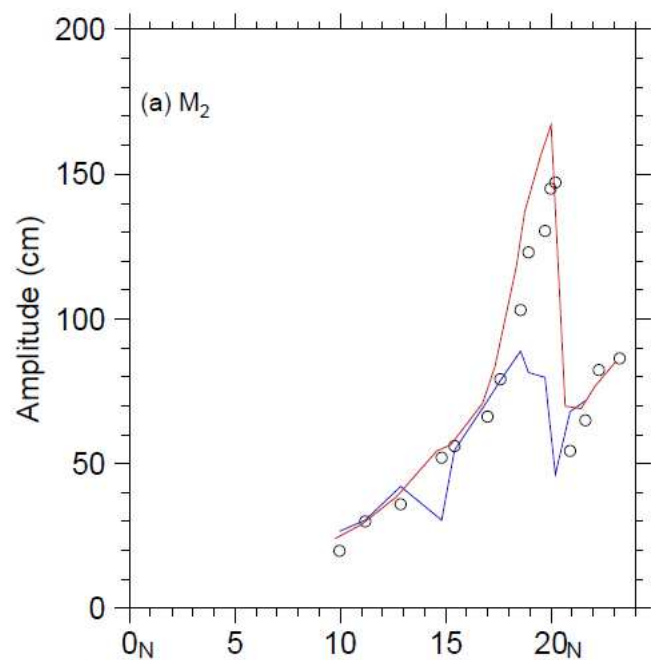
# Comparison FES2004-TUGO

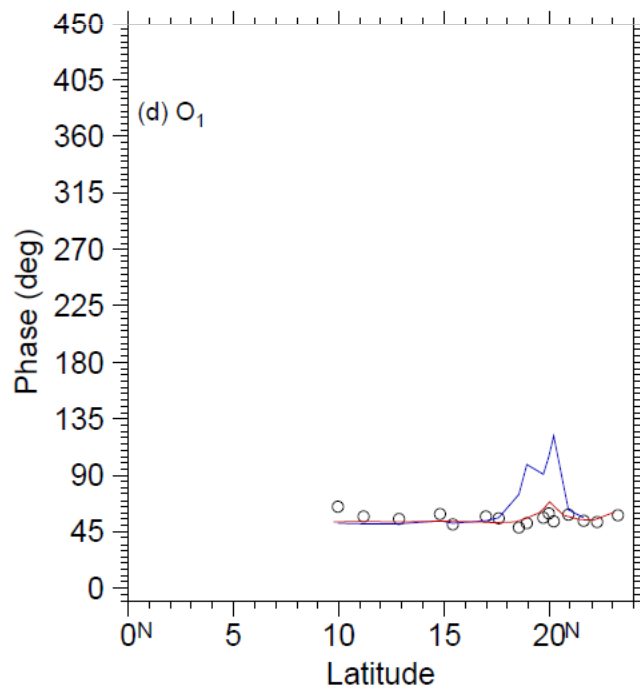
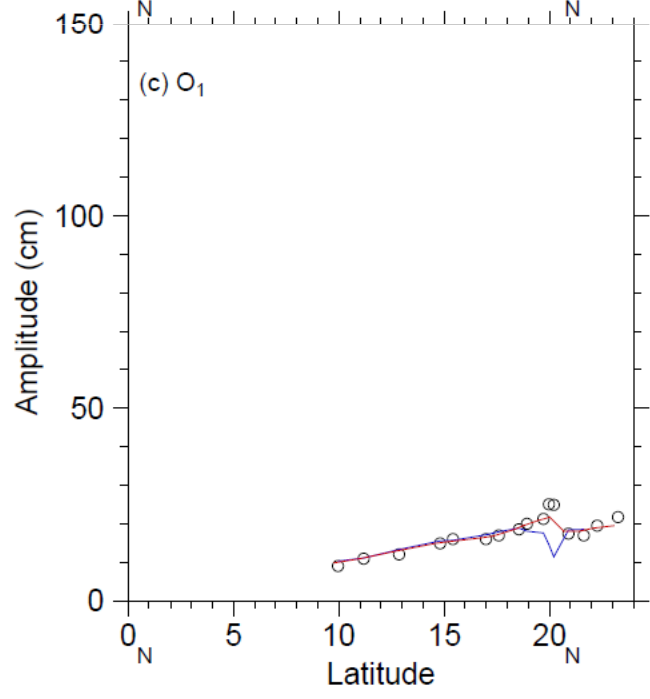
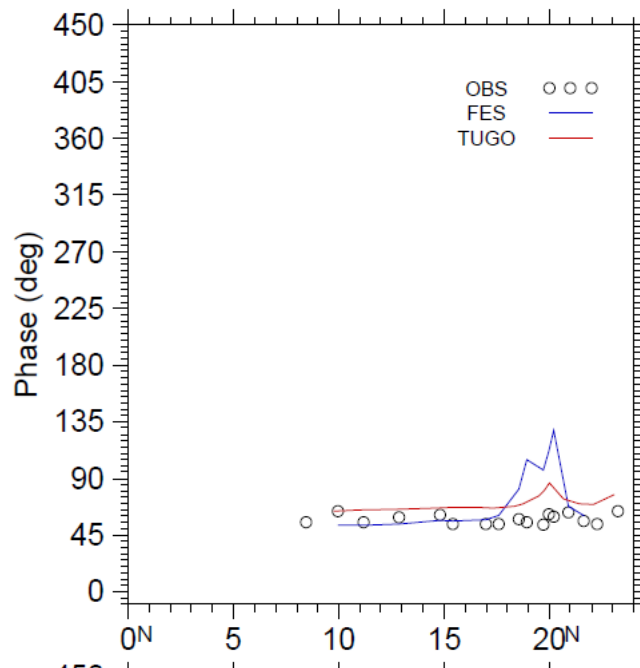
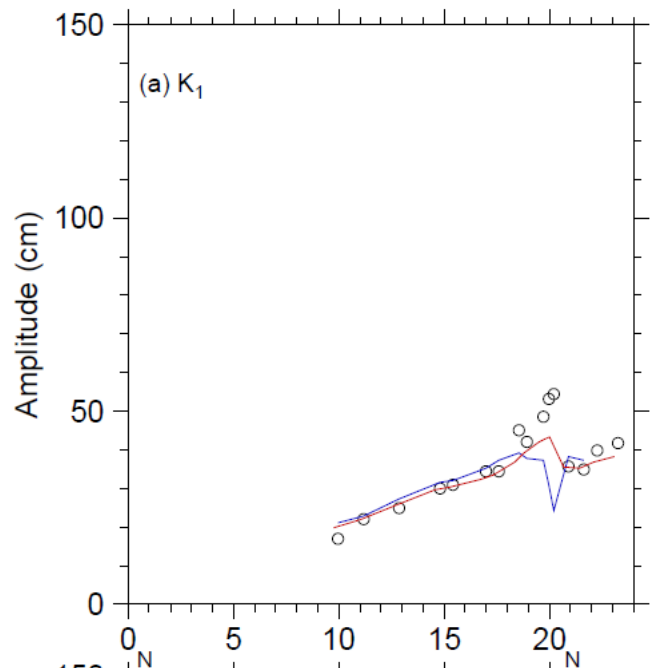
MODEL: fes2004 - tugo\_arabian WAVE: M2

Amplitude (cm) (mean=-3.1)

Phase (deg) (mean=-3.3)







# Validation against tide gauges

The root mean square (rms) misfit between the model results and sixteen tidal stations along Indian coast was calculated as follows (Matsumoto et al., 2000)

$$\text{RMS} = \left[ \frac{1}{N} \sum_{i=1}^N 0.5 ( A_M^2 - 2 A_M A_T \cos(\Phi_M - \Phi_T) + A_T^2 ) \right]^{1/2}$$

where  $A$  and  $\Phi$  are the amplitude and phase of the constituent with the subscripts  $M$  and  $T$  denoting the model and observation respectively.  $N$  is the number of observation points.

# Computed rms misfits

	FES2004	TUGO
	(cm)	(cm)
M2	38.0	28.0
K1	15.0	8.0

# Conclusion

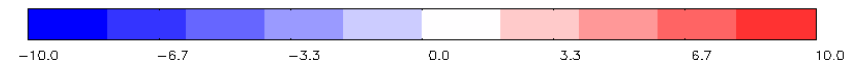
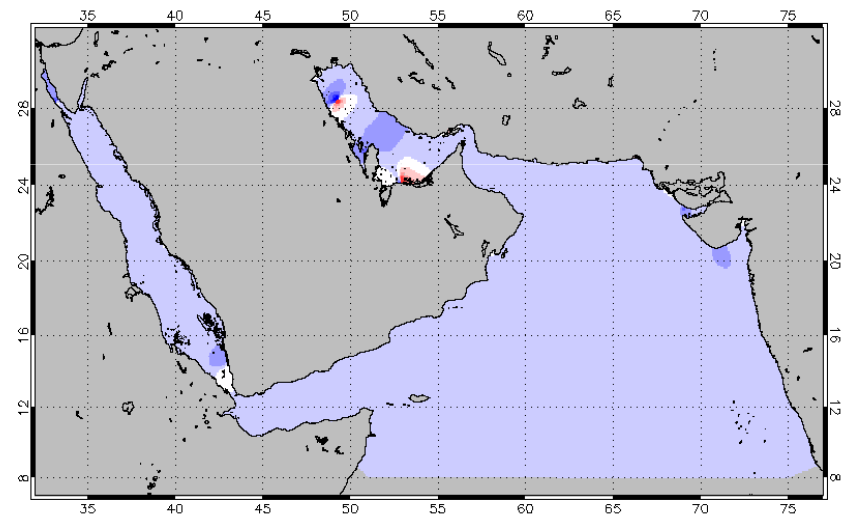
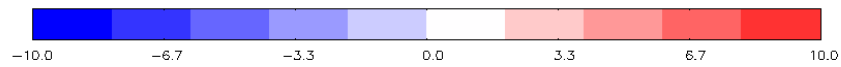
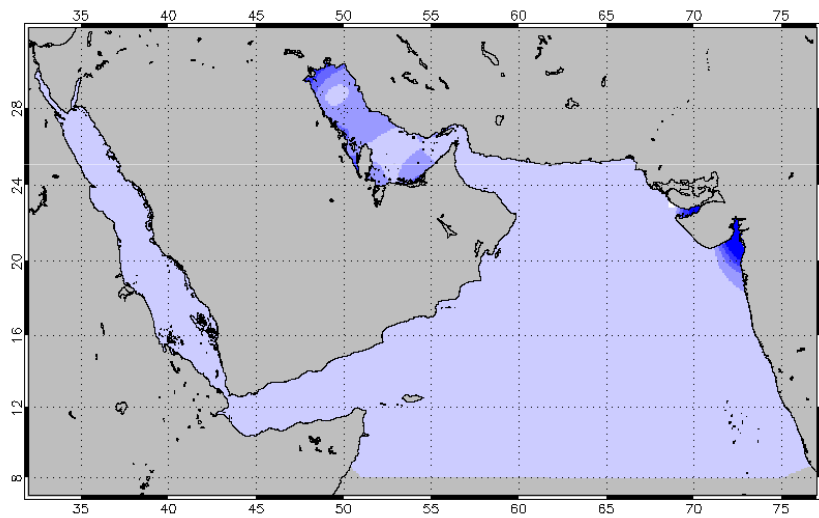
- TUGO model shows encouraging first results but
- We can improve the solution using sensitivity tests of the model against:
  - Bathymetry
  - Bottom friction
  - Boundary conditions
- Make the full validation against:
  - All available tidal dataset for the Arabian Sea (tide gauges & altimetry)

# Influence of bottom friction

MODEL:  $\text{rugo}=2.5\text{e-}3$  -  $\text{rugo}=3\text{e-}3$  WAVE: M2

Amplitude (cm) (mean=-0.1)

Phase (deg) (mean=-0.1)



# Perspectives

- Explain the main features of the tidal dynamics of the Arabian Sea
- Provide the best possible altimetric tidal correction for this zone.
- Run the model with atm. forcing
- Extend the zone to the whole Northern Indian Ocean