



Tide-gauges Network and Altimetric Reference in Algeria

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Abstract: The National Institute of Cartography and Remote Sensing by its main activity is responsible for implementing over the national territory basic geodetic networks: GNSS, gravity and leveling networks. The heights of the Algerian leveling network are related to several origins, level deduced from the indications of the Medimaremeter of la Goulette (Tunisia), height of the landmark of “Porte De France” (Tunisia), or the altitude of the console placed at the Sidi El Hemessi station (Tunisia) in 1914. aware about the importance to provide the national territory with a precise altimetric reference, the INCT has invested in the implementation of automatic acquisition tide gauges along the Algerian coast in collaboration with the Hydrographic Service of the Naval Forces in order to observe the sea level in the Mediterranean sea, first to bring the bathymetric surveys to a stable reference, the hydrographic zero or zero of the nautical charts, then to predict the tide or to define reference levels. Through this poster, we present an overview of the current Algerian tide-gauges network and the exploitation of data from acoustic tide-gauges recently installed at the ports of Algiers, Jijel, Oran, Ghazaouet, Ténès and Annaba, in the perspective to a vertical datum determination.

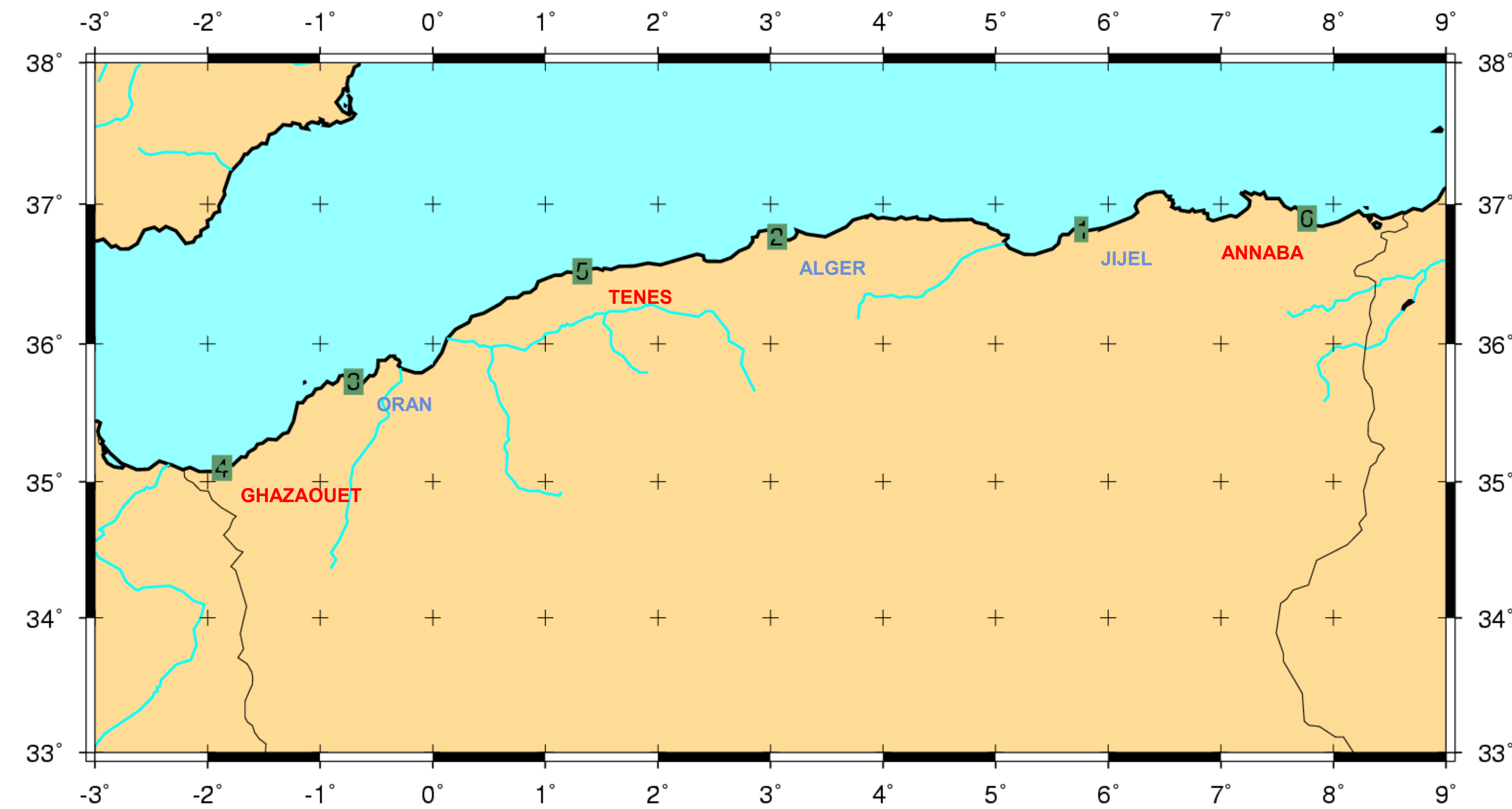


Fig. 1 Location of SHFN tide gauges in red and INCT tide gauges in blue.



Figure 2. Tide gauge of Jijel.



Figure 3. Tide gauge of Oran.

Stability Analysis: Estimation of the Mean Sea Level relative to Hydrographic Zero.

Annaba tide-gauge (LOG_aLevel) :

Period of data sample (15.05.2018 → 05.08.2018)

Number of removed outliers is 88

Power Spectrum Density is fitting to a $S(f) = f^{-1.5}$ low.

The spectrum is close to a : Flicker FM

The Mean Sea Level/Zero hydro (m) = 0.626482

Tenes tide-gauge (LOG_aLevel) :

Period of data sample (30.04.2018 → 01.08.2018)

Number of removed outliers is 74

Power Spectrum Density is fitting to a $S(f) = f^{-1.3}$ low.

The spectrum is close to a : Flicker FM

The Mean Sea Level/Zero hydro (m) = 0.607010

Alger tide-gauge (LOG_aLevel) :

Period of data sample (22.11.2014 → 29.01.2016)

Number of removed outliers is 68

Power Spectrum Density is fitting to a $S(f) = f^{-1.9}$ low.

The spectrum is close to a : Random Walk FM

The Mean Sea Level/Zero hydro (m) = 0.452008

Jijel tide-gauge (LOG_aLevel) :

Period of data sample (22.05.2012 → 27.02.2015)

Number of removed outliers is 203

Power Spectrum Density is fitting to a $S(f) = f^{-1.8}$ low.

The spectrum is close to a : Random Walk FM

The Mean Sea Level/Zero hydro (m) = 0.467692

Ghazaouet tide-gauge (LOG_aLevel) :

Period of data sample (30.04.2018 → 24.07.2018)

Number of removed outliers is 152

Power Spectrum Density is fitting to a $S(f) = f^{-0.99}$ low.

The spectrum is close to a : Flicker FM

The Mean Sea Level/Zero hydro (m) = 0.842384

Oran tide-gauge (LOG_aLevel) :

Period of data sample (10.05.2013 → 10.06.2014)

Number of removed outliers is 119

Power Spectrum Density is fitting to a $S(f) = f^{-1.8}$ low.

The spectrum is close to a : Random Walk FM

The Mean Sea Level/Zero hydro (m) = 0.714594

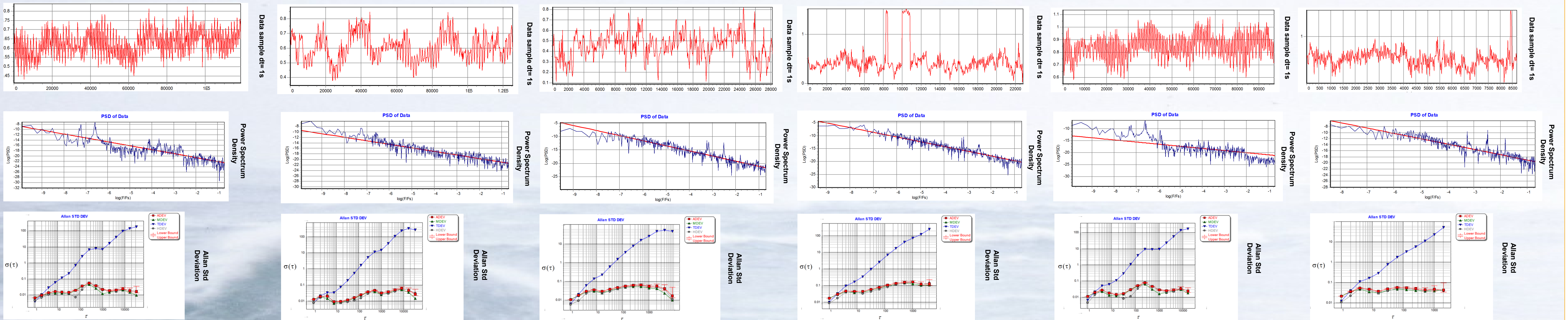


Fig. 4. Noise characterization and Mean Sea Level Estimation relative to Hydrographic Zero: Ghazaouet, Oran, Tenes, Algiers Jijel and Annaba Tide gauges.

Global Levelling Network of Algeria (NGA): National Altimetric Reference.

Development of solution for levelling ajustement

- Leveling line along the East-West highway from Constantine to Oued Tlélat via Berraki (700 km);
- Attachment of the three tide gauges to recent leveling lines (East / West Highway) for a total of 160 km;
- Attachment of the three tide gauge stations to the permanent GNSS network; Leveling line of the axis: Algiers-Ténès-Mers El Kebir on the coast for processing purposes; [398 benchmarks known in GPS coordinates];
- Adjustment of the selected leveling lines (East / West highway and the tidal stations connection) by adjustment constraints by introducing the new values of the altimetric references.

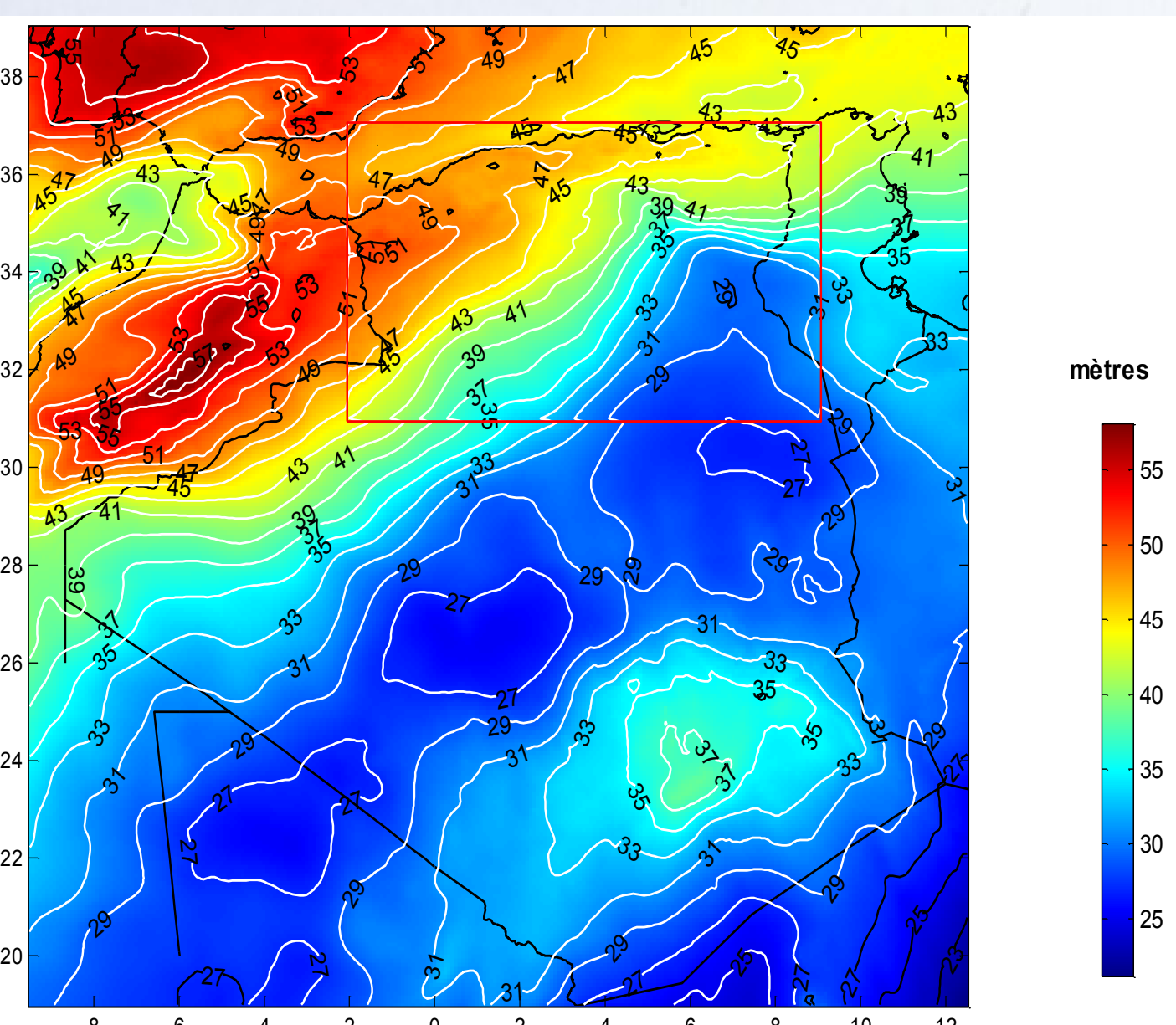


Fig. 6. Gravimetric geoid.

Data used for the local geoid determination:

- Gravity data: BGI, GETECH, SONATRACH, etc.
- Earth Gravitational Model: EGM 2008
- Digital Terrain Model (SRTM)
- Grid of lateral densities
- GPS levelling points

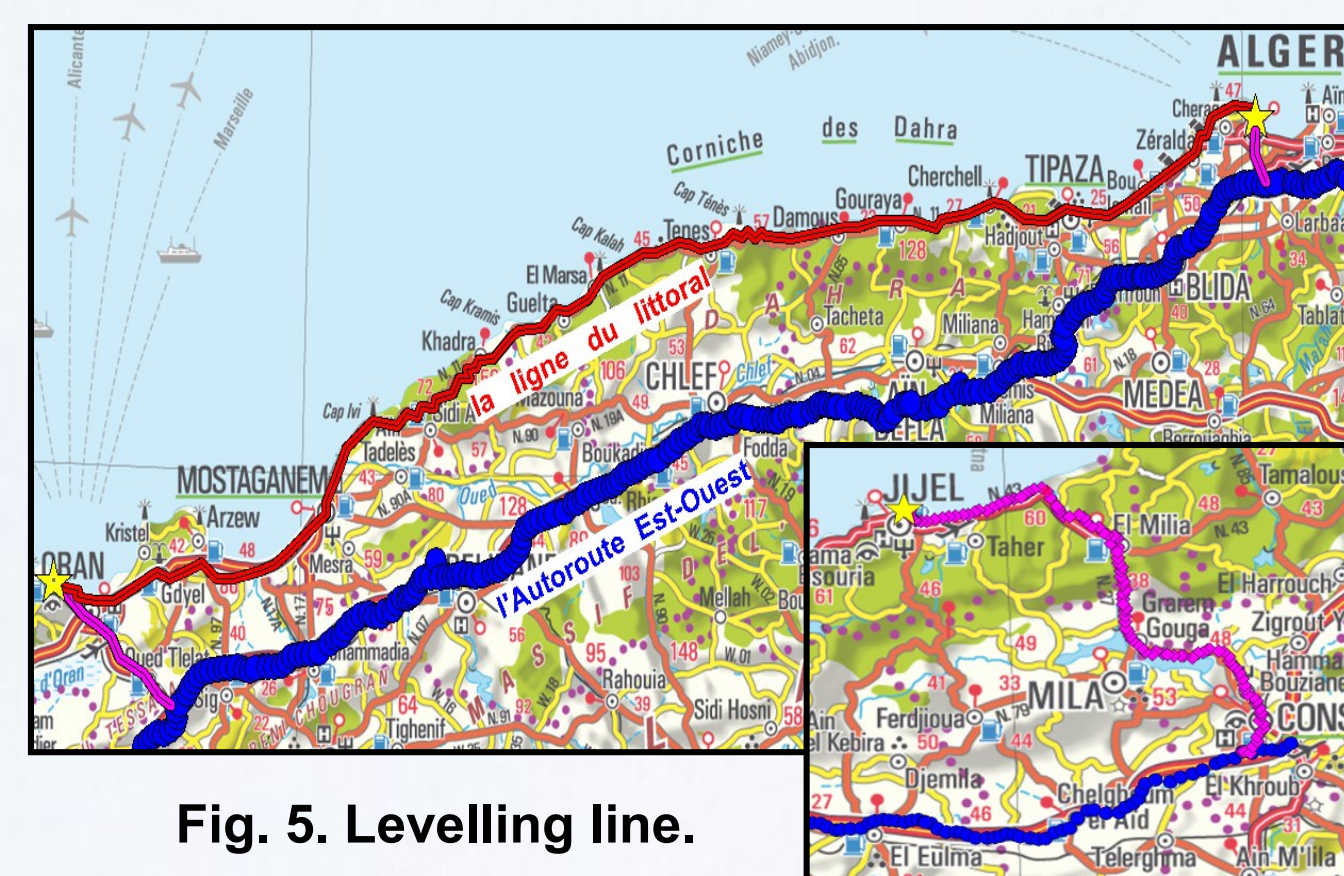


Fig. 5. Levelling line.

Altimetry Conversion Grid

Rep. Niv.	H Elli. (m)	N Gravi. (m)	h ortho. (m)	h ortho. Calc (m)	Ecart (m)
79	47.033	44.542	2.487	2.491	.004
80	46.676	44.543	2.133	2.133	.002
GPS1	47.987	45.831	2.157	2.156	.001
GPS2	52.901	45.831	7.071	7.070	.001
GPS3	46.870	45.831	1.041	1.039	.002
CAP	48.649	45.831	2.819	2.818	.001
ALGER	70.648	45.959	24.720	24.689	.031
1000	196.281	27.827	168.505	168.454	.051
RN25	70.926	45.996	24.948	24.930	.018
R149	63.775	46.256	17.555	17.519	.036
R147	58.260	46.272	12.073	11.988	.085
R153	83.817	46.198	37.682	37.619	.063
NG10	436.007	46.754	389.234	389.253	0.019
RN05	224.871	47.803	177.084	177.068	-0.016
DO38	97.250	47.983	49.250	49.267	0.017
8186	123.767	29.044	94.719	94.723	0.004
RN15	107.943	28.976	79.018	78.967	-0.051
8043	94.527	28.959	65.570	65.568	-0.002
8033	103.656	28.987	74.690	74.669	-0.021
RN26	82.725	29.100	53.636	53.625	-0.011
8062	59.830	29.220	30.624	30.610	-0.014

Harmonic Analysis : Determination of the Mean Sea Level relative to Hydrographic Zero.

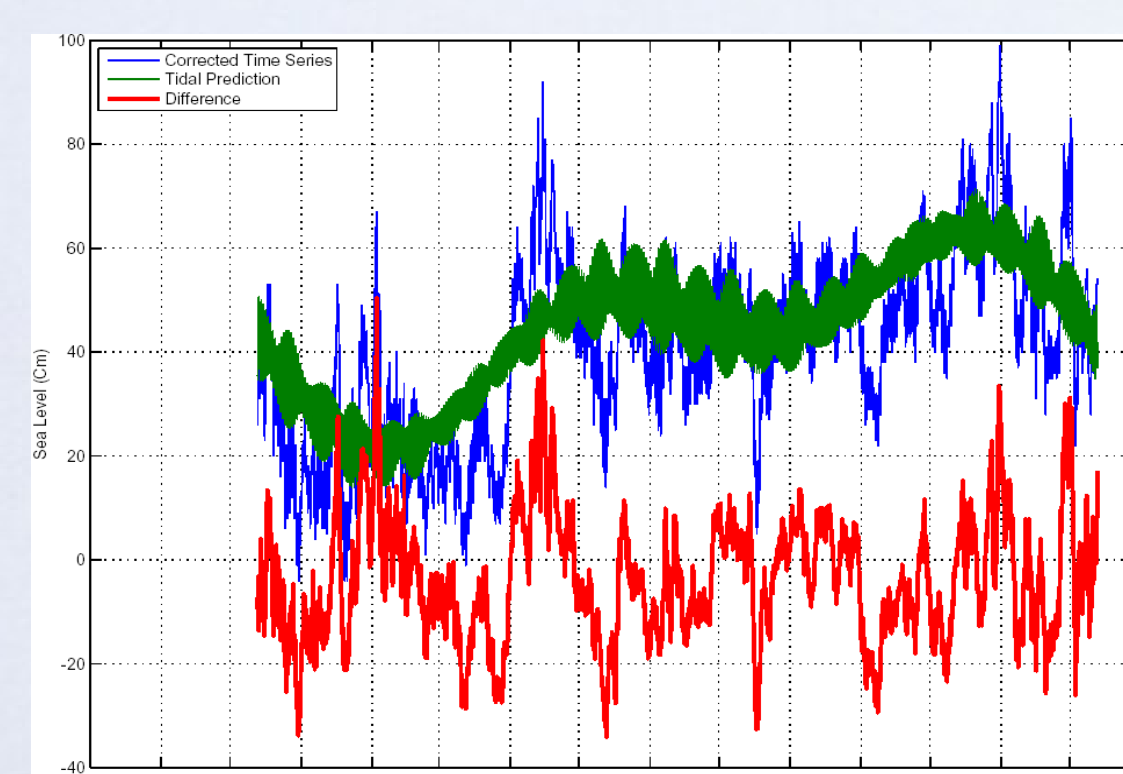


Fig. 7. Algiers Harbour

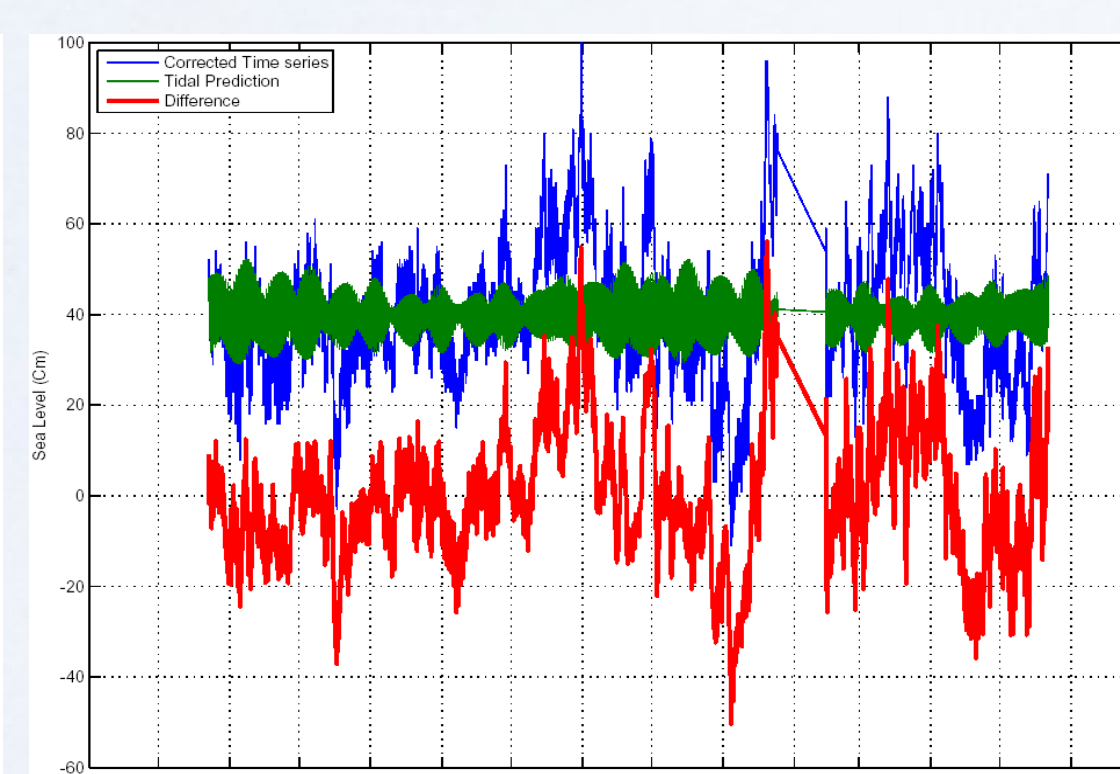


Fig. 8. Jijel Harbour

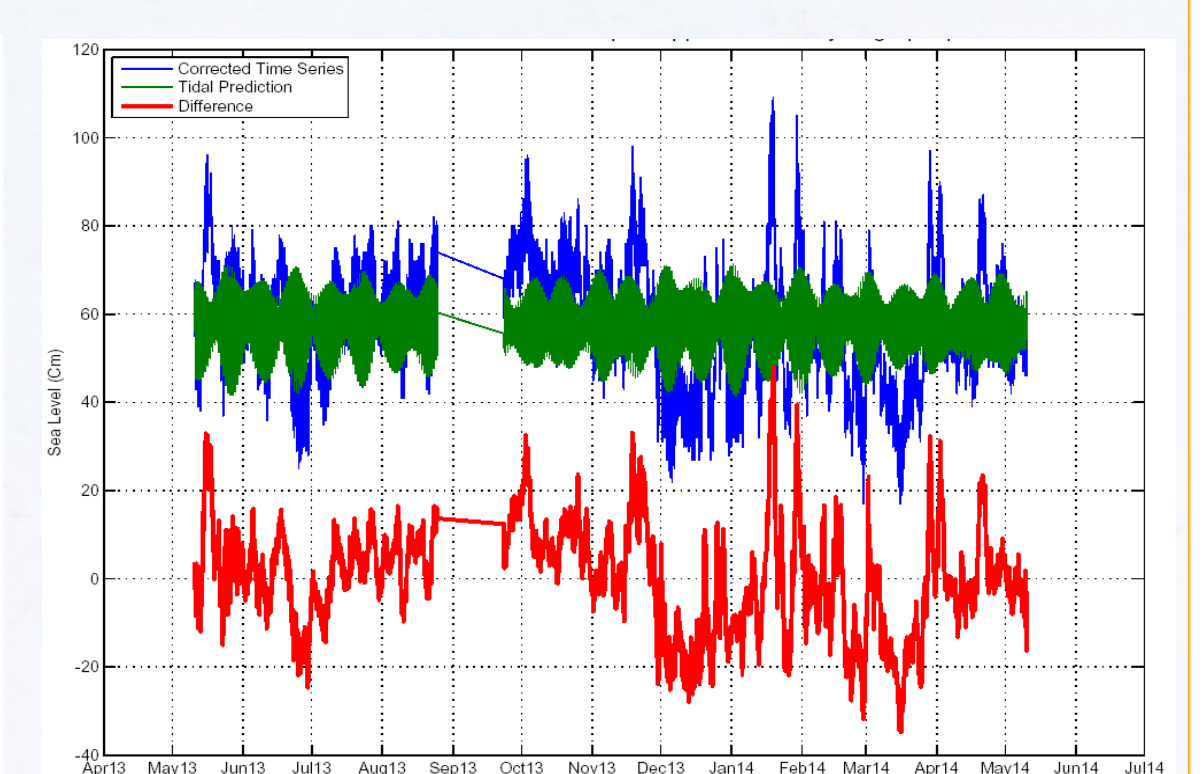


Fig. 9. Oran Harbour

- Preprocessing of the tide gauge data of the three (03) stations of Algiers (more than 04 years), Jijel and Oran (more than 02 years);

- Processing and analysis of the tide gauge data of the three stations for the definition of zero altimetric references (Softwares used: Log-alevel, FileJester and T-Tide [adapted by CTS]).

References	Altitude NGA (m)	New Altitude (m)
GPS4 (Alger)	1.2008	1.1128
Rivet (Jijel)	1.8445	1.8045
GPS1 (Oran)	2.1311	1.8811

Conclusion: The implementation of six automatic tide gauging stations along the Algerian coast (Ghazaouet, Oran, Ténès, Algiers, Jijel and Annaba) is of great interest, particularly for the monitoring of sea level variations and the definition of the national reference. As part of a development project for the definition of the new altimetric reference, a first processing of tide gauge data from the oldest stations by harmonic analysis was carried out in collaboration with scientists from the CTS; leading to determine the mean sea level at the Algiers, Jijel and Oran harbors. The analysis of the results has shown a slight change between the current elevation reference and the one determined at the Algiers (6.6 cm) and Jijel ports (5.8 cm), but relatively important at Oran port (24 cm). Stability analysis of the data from the six tide stations at different times shows that the signals are affected by power law noise processes, Flicker FM and Random Walk FM. The mean sea level along the Algerian coast is not at an equal distance from the surface of the hydrographic datum, because not the same value has been found between the hydrographic datum and the new reference in each station. In perspective, the long-term analysis of tide gauge data will allow the definition of a new altimetric reference that will serve as a zero origin for the Algerian general leveling network.