National Oceanography Centre

Permanent Service for Mean Sea Level

UPDATE: IAPSO BEST PRACTICE STUDY GROUP ON TIDAL ANALYSIS

Andrew Matthews

GLOSS GE XVIII 11-14 March 2025

IAPSO BEST PRACTICE STUDY GROUPS

National Oceanography Centre

Calls issued every two years

Provides funding for a several day meeting

Consensus should be sought regarding the pros and cons of different techniques

Ideally this will result in a short technical guideline that will assist researchers in making the best choices in e.g. analysing data

Recommend https://www.oceanbestpractices.org/

IAPSO BEST PRACTICE STUDY GROUPS

National Oceanography Centre

See https://iapso-ocean.org/activities/best-practice-study-groups.html

- Best Practice Study Group on moored CTD measurements (2020-2021, extended to 2022)
- Best Practice Study Group to identify approaches to be recommended for seawater pH measurement (2020-2021, extended to 2022)
- Best Practice Study group on Tidal Analysis (2022-2023)
- Best Practice Study Group for the systematic evaluation of mapping methods in reconstructing ocean heat content and thermosteric sea level (2022-2023)
- Best Practice Study Group on calibrating measurements of total dissolved inorganic carbon in seawater (2023-2025)
- Best Practice Study Group on ship based CTD/O_2 operations, calibration, and processing procedures (2023-2025)
- Best Practice Study Group on reconciling cross-platform observations of ice-shelf melt (2023-2025)

OVERVIEW

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An attempt to write a best practice document for tidal analysis

Not a comprehensive study of the science

More a practical guide

IAPSO funded meeting at the end of 2023

Will be submitted to www.oceanbestpractices.org

Plans for translations with support of IOC

WHERE ARE WE NOW?

National Oceanography Centre

Google drive with several documents – email antt@noc.ac.uk

Meeting report – IAPSO deliverable

First draft (“Chapter 1”)

Example constituent sets

List of tidal software

EXAMPLE CONSTITUENT SETS

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Duration of data (not inc. gaps)	Number of Constituents	Comments
1 – 10 days	1	M_2 only
15 days	4	M_2, S_2, O_1, K_1 only can potentially generate more however it would involve missing out some of the key constituents (such as N_2 and K_2) and therefore probably of little value. May be of value in quality controlling data but not for future tide table production.
15 days	15 14 if Msf excluded	Msf, $2Q_1$, O_1, K_1, OO_1, Mu_2, M_2, S_2, M_3, M_4, MS_4, S_4, M_6, $2MS_6$, $2SM_6$ Use with caution for tidal prediction as N_2 can't be separated from M_2 with only 15 days of data.
30 days	26 24 if Mm and Msf excluded.	Mm, Msf, Q_1, O_1, M_1, K_1, J_1, OO_1, Mu_2, N_2, M_2, L_2, S_2, $2SM_2$, MO_3, M_3, MK_3, MN_4, M_4, SN_4, MS_4, $2MN_6$, M_6, MSN_6, $2MS_6$, $2SM_6$ Use with caution for tidal predictions as K_2 is not included. It is better to infer K_2 from S_2, than leave it out altogether.

EXAMPLE CONSTITUENT SETS – EXCEL SUMMARY

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	A	B	C	D	E	F	G	H	I	J	K
1	Name	Speed (degrees per hour)	1-10 day	15 days	15 days	30 days	30 days	6 months	12 months	4.5 years	10+ years
2	SA	0.0410686	n	n	n	n	n	n	y	y	y
3	SSA	0.0821373	n	n	n	n	n	y	y	y	y
4	MM	0.5443747	n	n	n	?	?	y	y	y	y
5	MSF	1.0158958	n	n	?	?	?	y	y	y	y
6	MF	1.0980331	n	n	n	n	n	y	y	y	y
7	2Q1	12.8542862	n	n	y	n	n	y	y	y	y
8	SIG1	12.9271398	n	n	n	n	n	y	y	y	y
9	Q1	13.3986609	n	n	n	y	y	y	y	y	y
10	RHO1	13.4715145	n	n	n	n	n	y	y	y	y
11	O1	13.9430356	n	y	y	y	y	y	y	y	y
12	MP1	14.0251729	n	n	n	n	n	y	y	y	y
13	M1	14.4920521	n	n	n	y	y	y	y	y	y
14	CHI1	14.5695476	n	n	n	n	n	y	y	y	y
15	PI1	14.9178647	n	n	n	n	i	n	y	y	y
16	P1	14.9589314	n	n	n	n	i	y	y	y	y
17	S1	15	n	n	n	n	n	n	y	y	y
18	K1	15.0410686	n	y	y	y	y	y	y	y	y
19	PSI1	15.0821353	n	n	n	n	i	n	y	y	y
20	PHI1	15.1232059	n	n	n	n	i	y	y	y	y
21	TH1	15.5125897	n	n	n	n	n	y	y	y	y
22	J1	15.5854433	n	n	n	y	y	y	y	y	y
23	SO1	16.0569644	n	n	n	n	n	y	y	y	y

SOFTWARE LIST

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Harmonic Analysis

Name and link	Language	Notes
IOS Tidal Package (Foreman)	FORTRAN 77	
vtide	FORTRAN	Another implementation of Foreman's improved versatile harmonic tidal analysis, recommended by Luca Repetti (Italian Hydrographic Institute)
t_tide	MATLAB	A reimplementation of the Foreman package using MATLAB
utide (MATLAB)	MATLAB	Builds on the Foreman and t_tide packages - original MATLAB version

EXAMPLES – USING TOO MANY CONSTITUENTS #1

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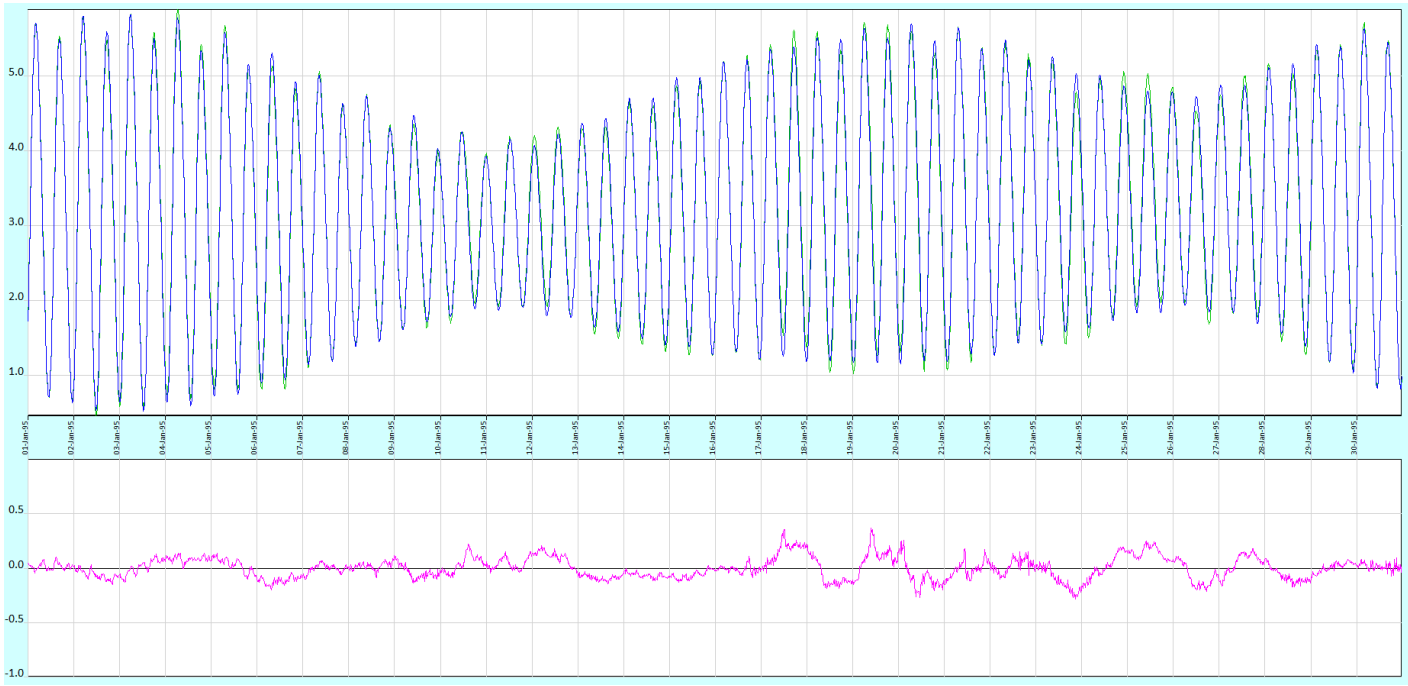
Fitting 54 constituents
to 1 month of data

Rayleigh criteria suggests you
need 6 months



EXAMPLES – USING TOO MANY CONSTITUENTS #2

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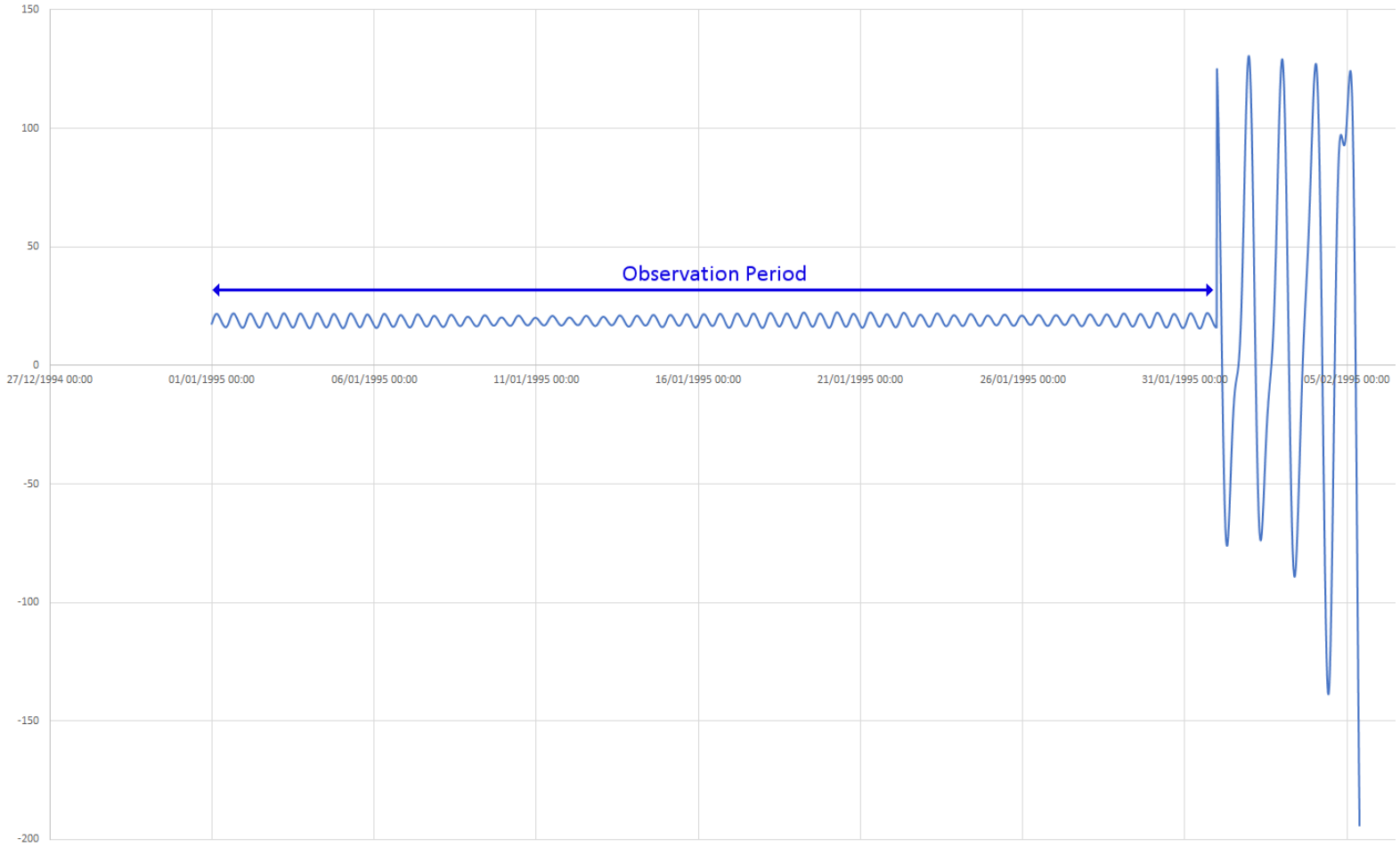
But look at the next month…



DIFFICULT COASTLINES TO MODEL WITH CLASSICAL HARMONICS

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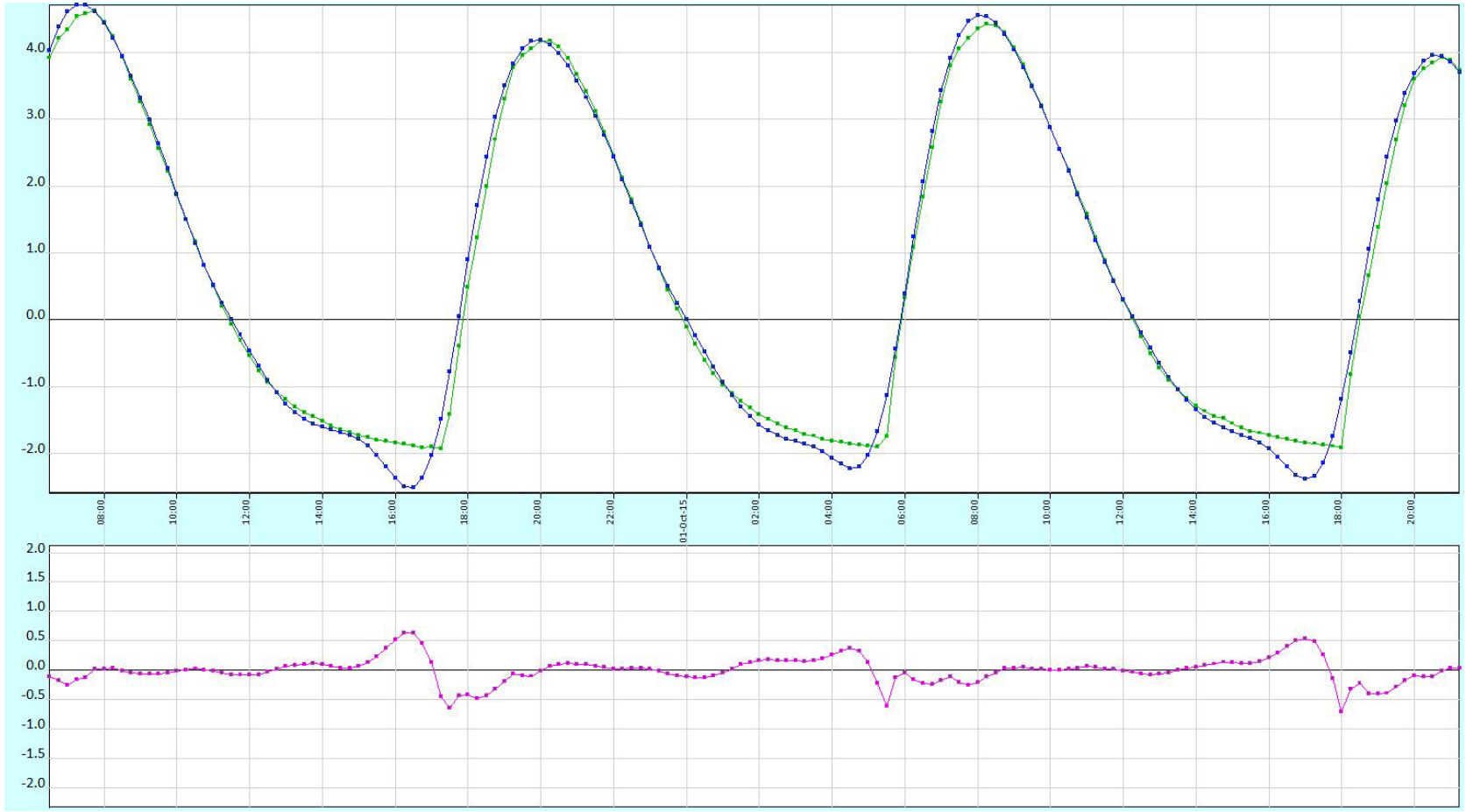
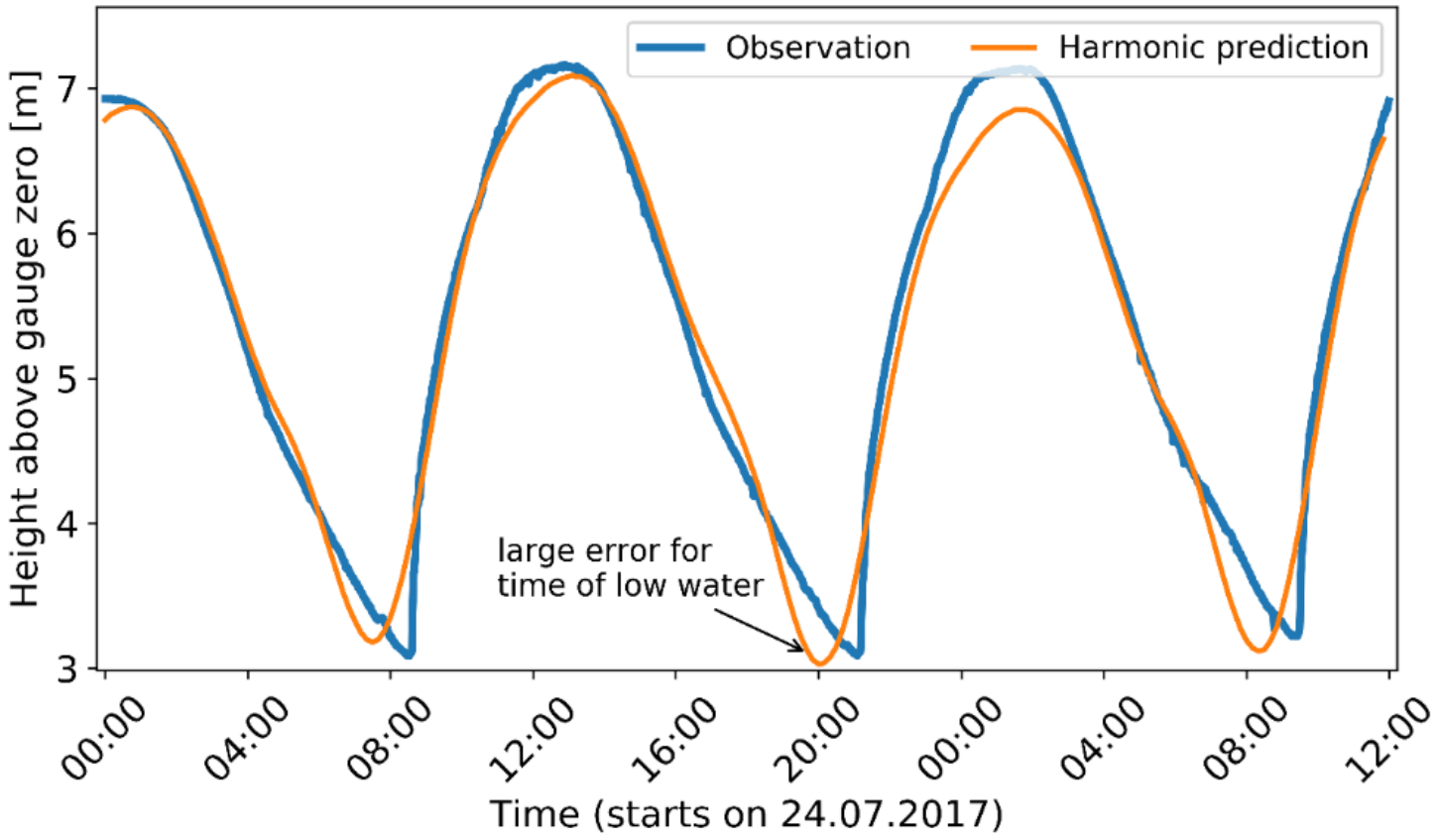


King's Lynn South Quay
Tide Gauge in Green, Predictions in Blue

By Goran_tek-en, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=145917154

DIFFICULT COASTLINES TO MODEL WITH CLASSICAL HARMONICS



Papenburg, Germany

WHY ARE YOU DOING THE TIDAL ANALYSIS?

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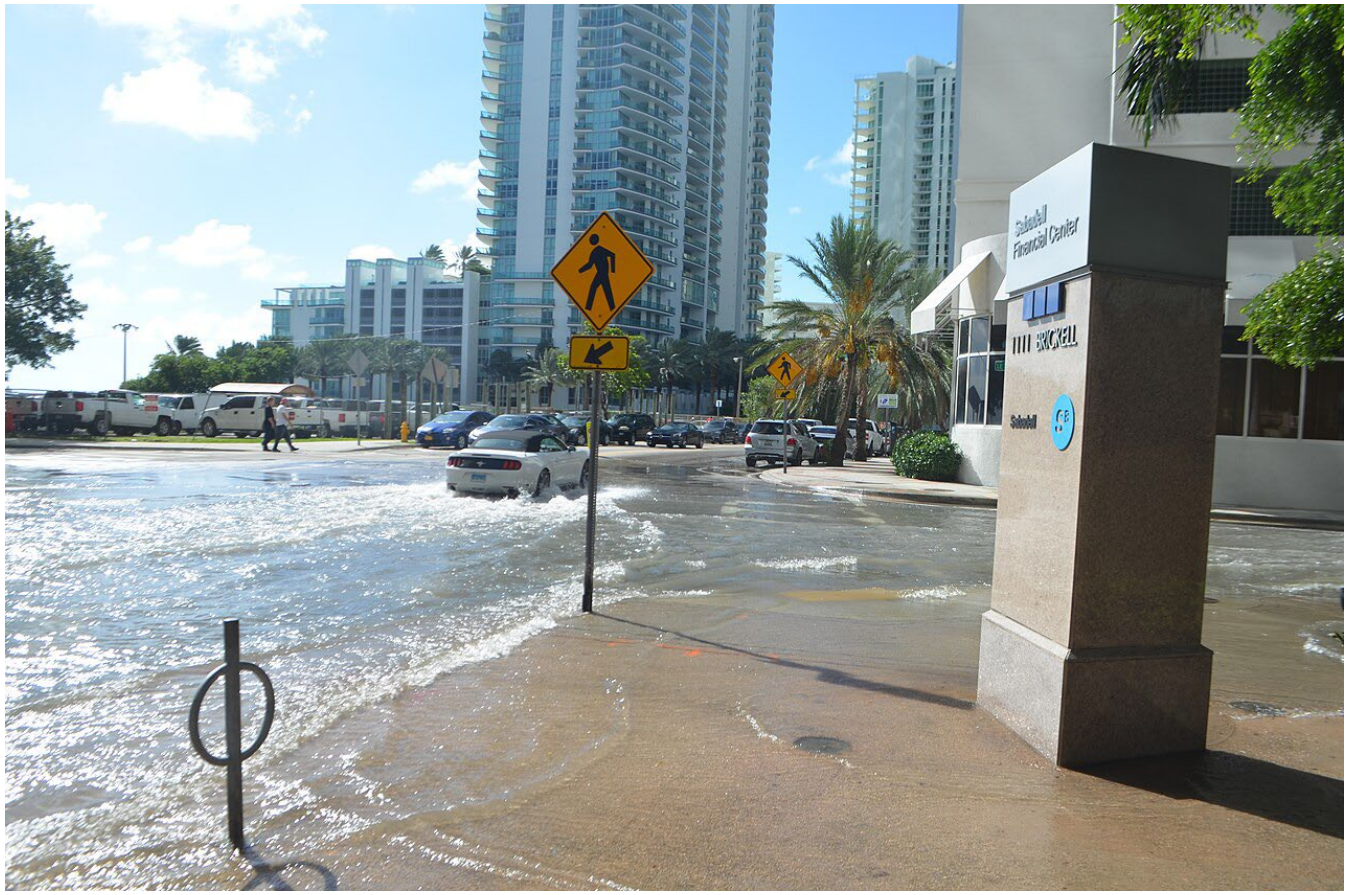
The Disney Treasure at the Meyer Werft shipyard in Papenburg
By HIHIMOINMOIN1 - Own work, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=155118411

October 17, 2016 tidal flooding on a sunny day, during the "king tides" in Brickell, Miami that peaked at 4 ft MLLW
By B137 - Own work, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=52334453



THINGS WE NEED TO ADD

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Needs sections on:

- Satellite data
- Model data
- Analysis of currents
- Techniques other than harmonic analysis
- Third-degree tides
- Tidal analysis metadata

TIDAL ANALYSIS OF SATELLITE DATA IN SUN-SYNCHRONOUS ORBIT

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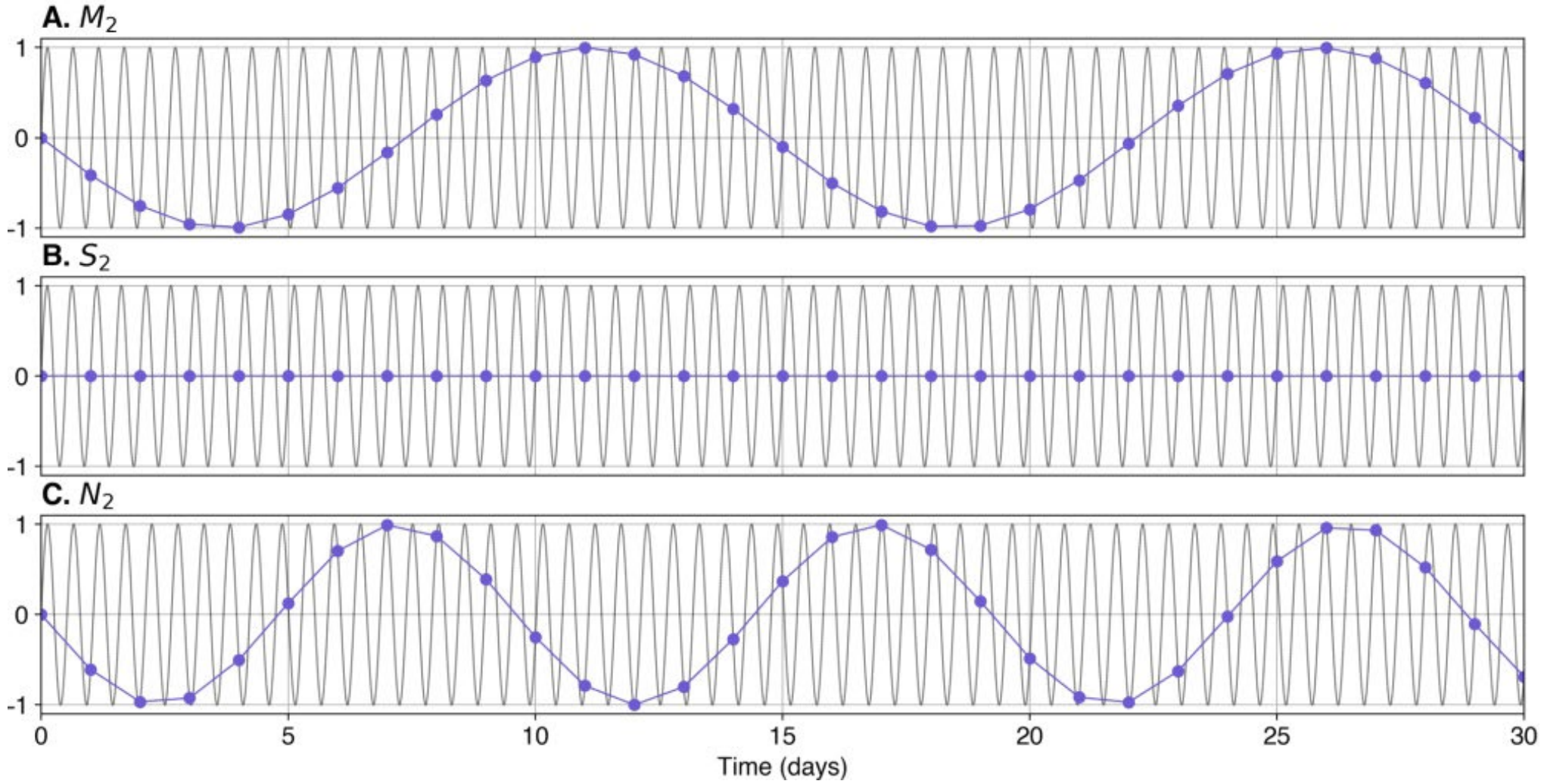

Image courtesy of Michael Hart-Davis, DGFI-TUM

BETTER EXPLANATION OF LONG TERM CYCLES

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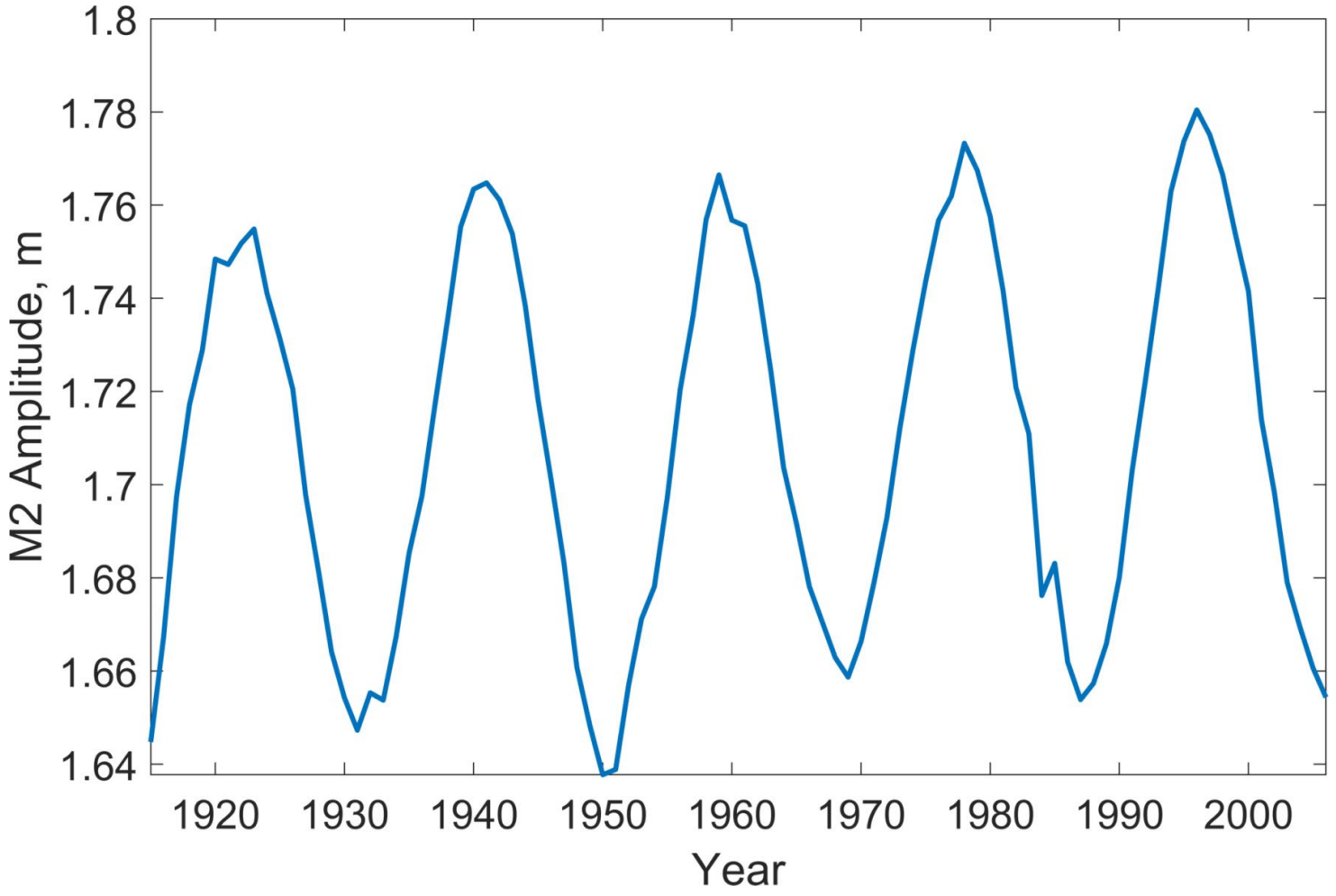
M2 constituent

Annual fits to

Newlyn, UK

without accounting

for nodal cycle



BACKGROUND ON WHERE THE CONSTITUENTS COME FROM

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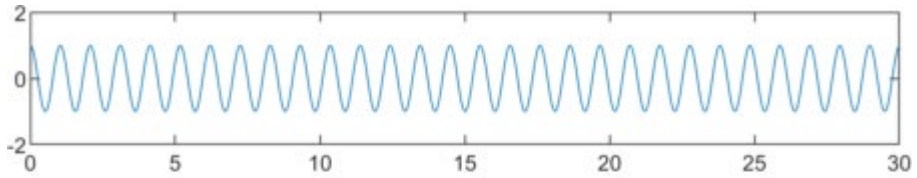
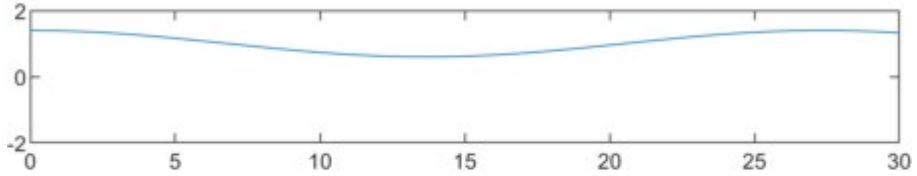
Lunar Day

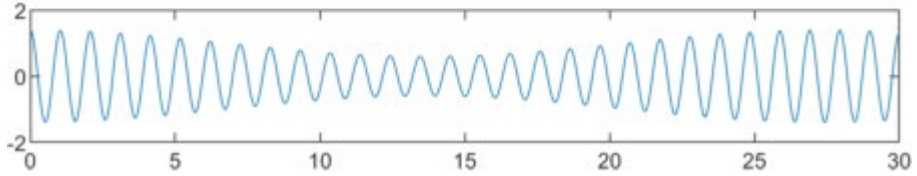
x

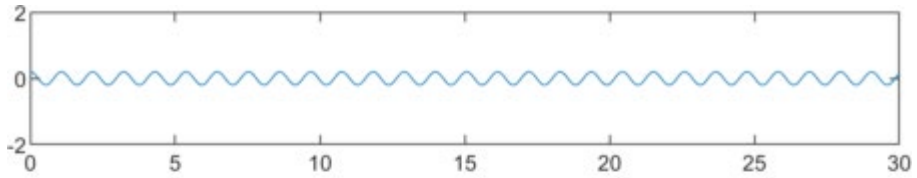
Sidereal Month

=









O1

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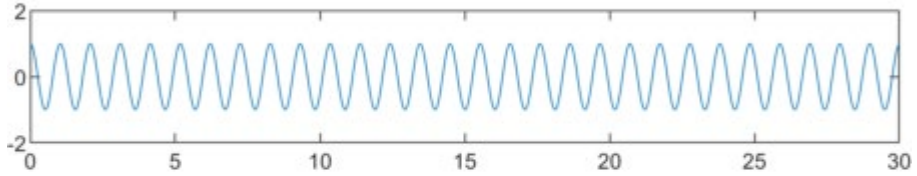

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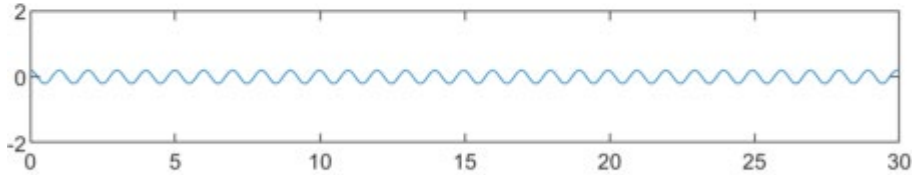

K1

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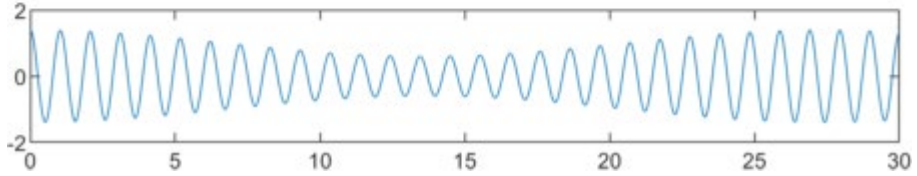

How do we get from 6 astronomical cycles to 115+ constituents?

HOW CAN YOU HELP?

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Examples:

- Different software
- Different difficult scenarios

Any other good ideas you've got!

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THANK YOU

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