Global Storm Surge Data Provision

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Storm Surges

- Storm surges are the rise and fall of the sea surface due to changes in air pressure and winds, instead of the Moon’s and Sun’s gravity as for tides
- The dynamics of surges are otherwise similar to tides

COASTALT Requirement

- ‘Improved IB’ correction
- Distant and lagged air pressures
- Numerical models
- Major European surges (e.g. 1953 North Sea) showed the need to provide a flood forecasting system
- Approx. 16 agencies now have surge forecast schemes

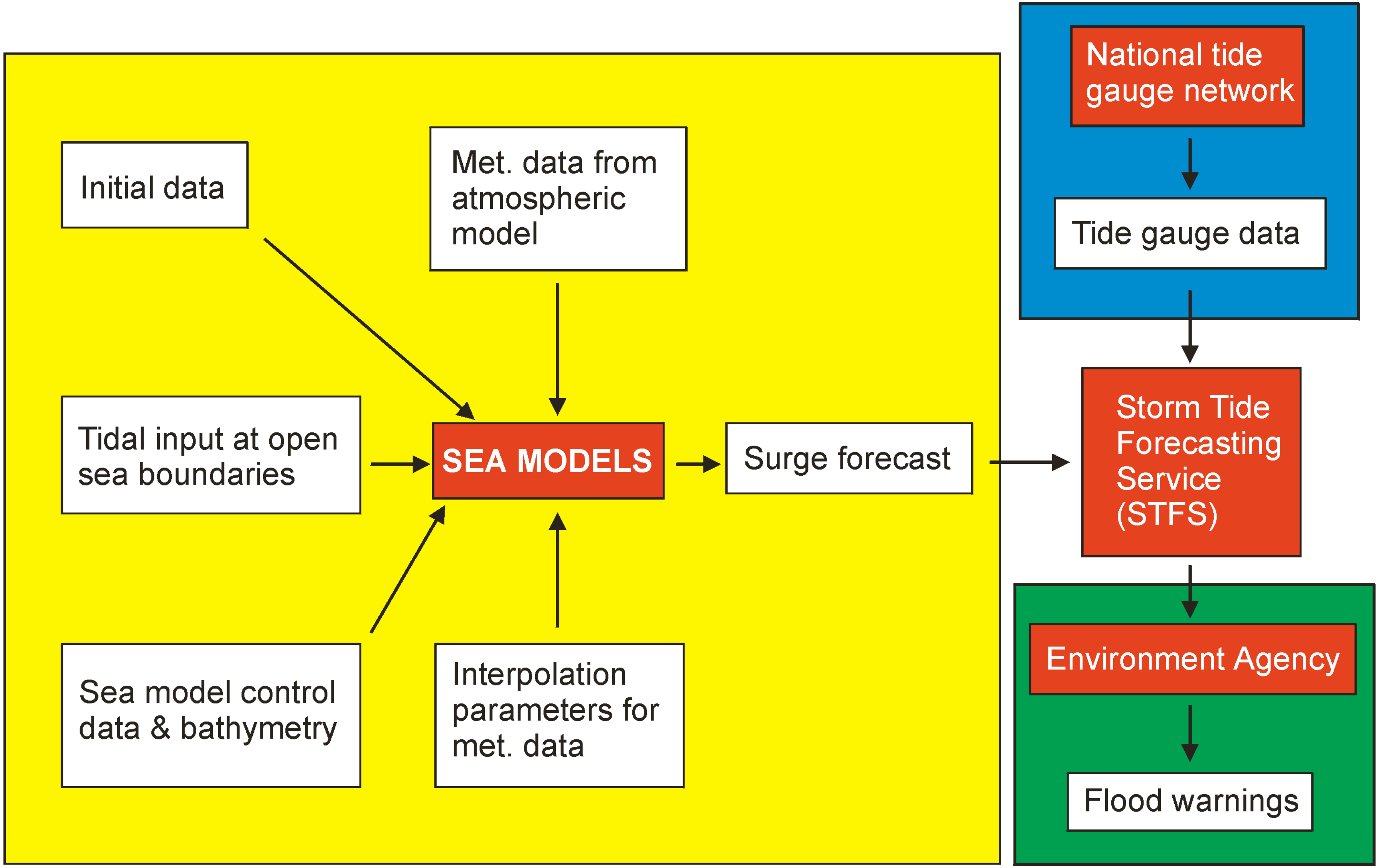
North Sea storm surge of 1953

Sea Palling, Norfolk (1 Feb 1953)

Oosterscheldekering (part of Delta works)

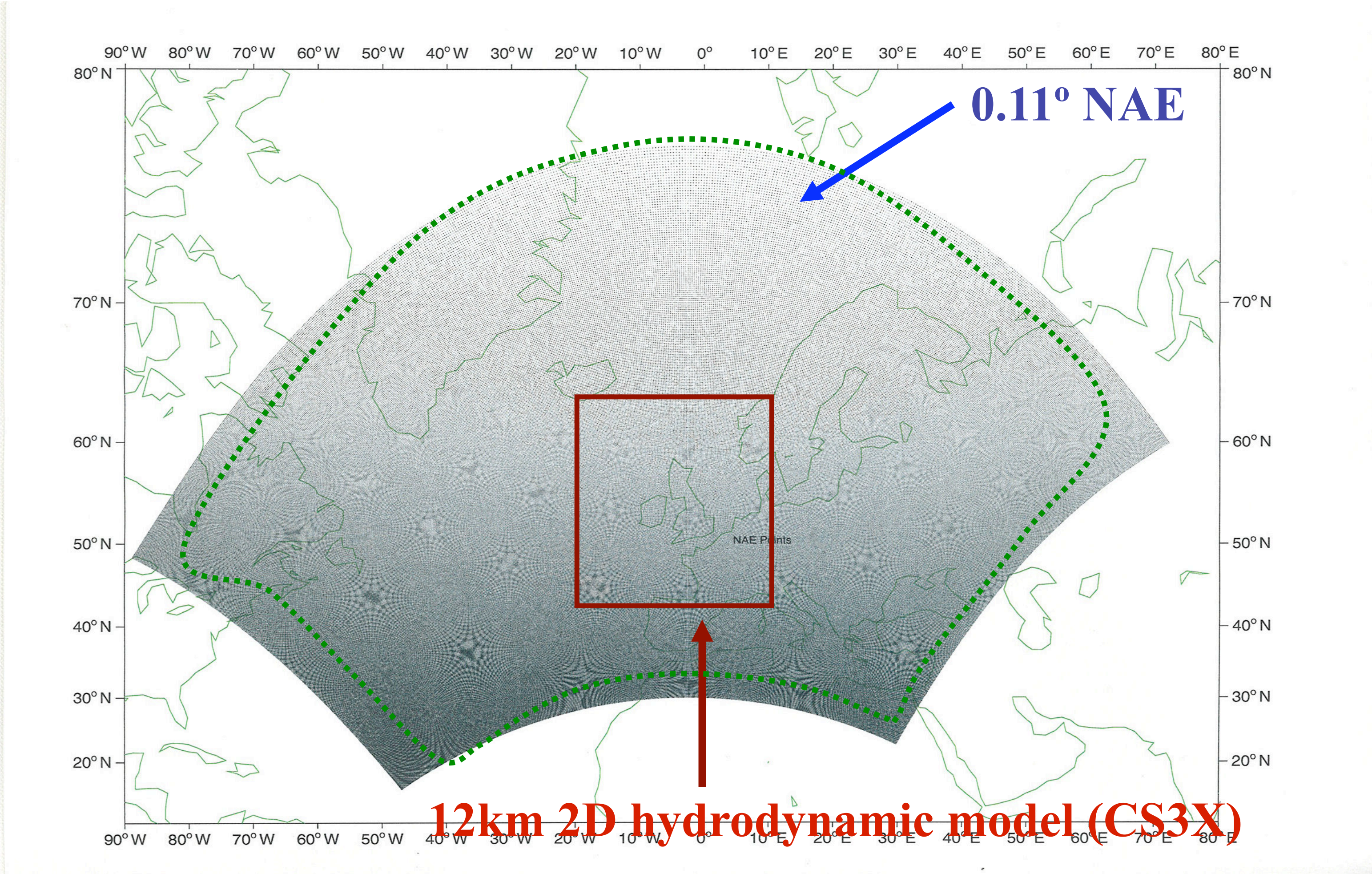
Thames Barrier (1987-)

Norman Heaps and colleagues at POL were the first to use the new high-speed computers becoming available in the 1960s to develop computer models of the development of storm surges

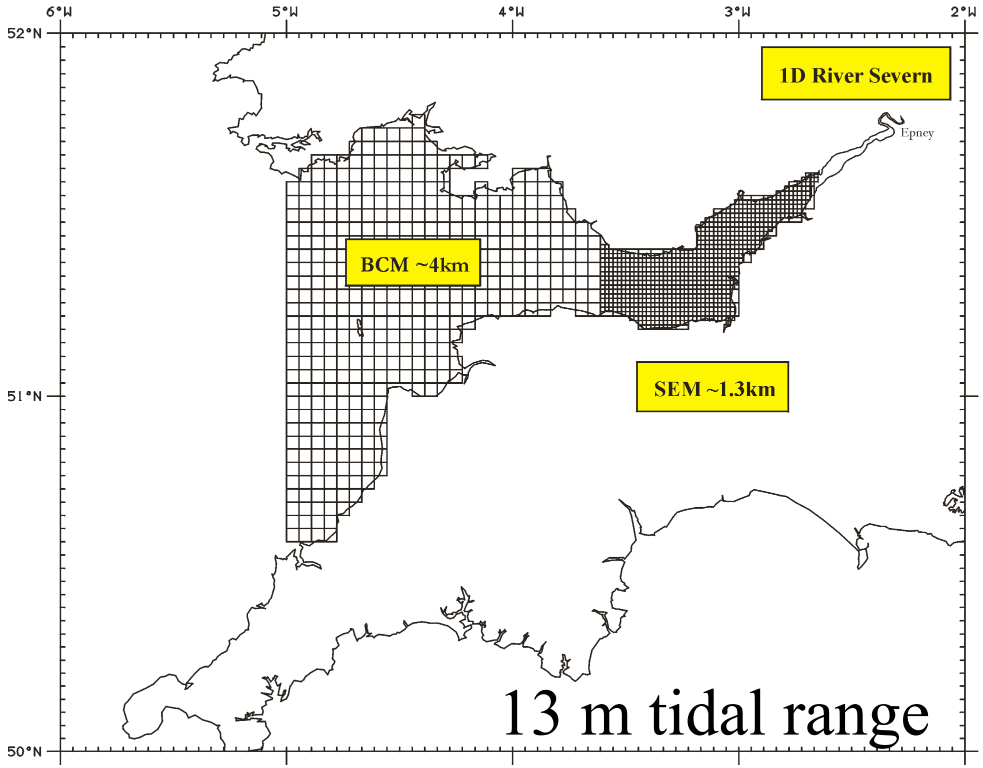


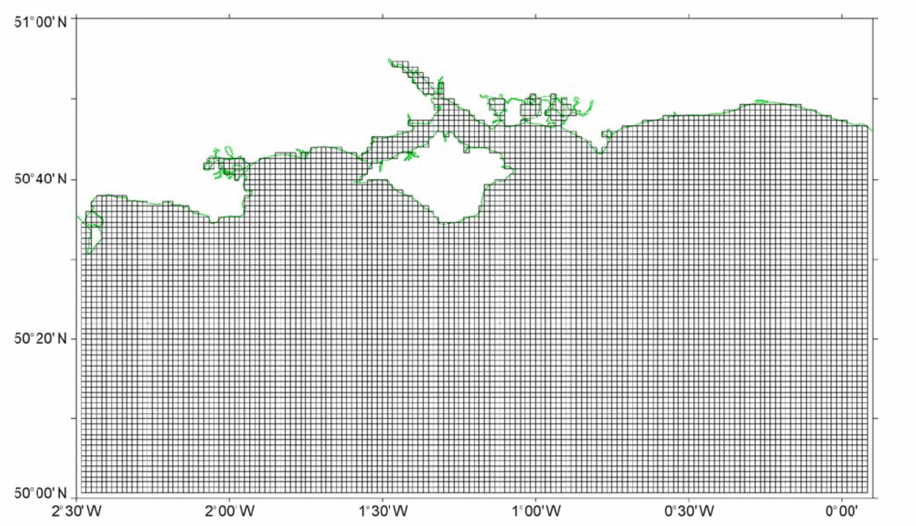
Components of the UK coastal flood warning system

State of the current UK operational modelling system



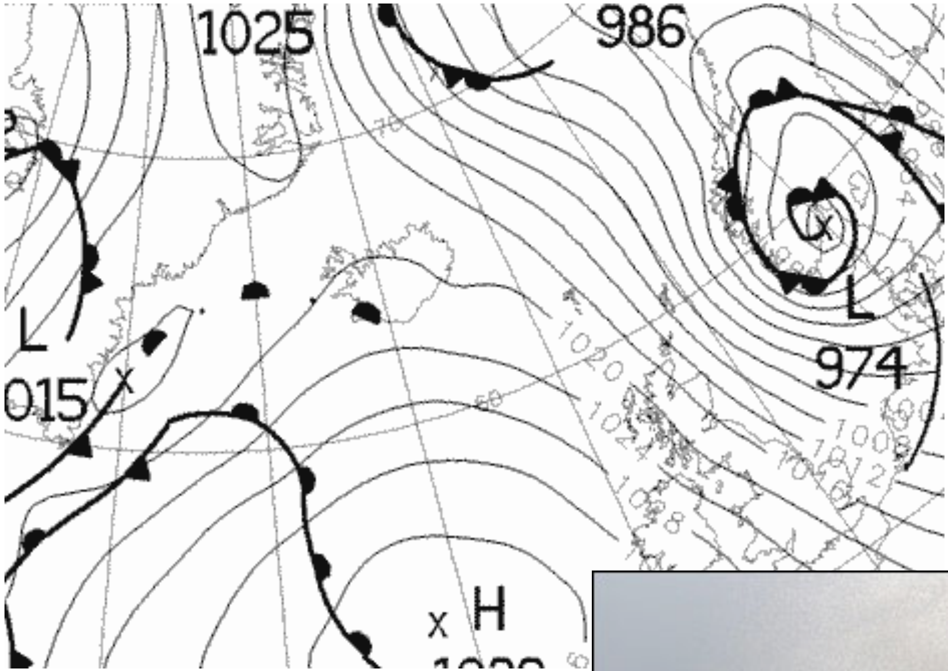
Nested models of Bristol Channel and South Coast. Local model at the Thames Barrier.





9/11/07

Surge raises memories of disaster 50 years ago



4 | News — THE TIMES Friday November 9 2007

Thousands flee to higher ground as stormy sea waters gather momentum

▶ Severe flood warnings along the East Coast

▶ Cobra meets to assess risk to 10,000 homes

Jack Malvern, Ben Quinn

An evacuation was under way last night as thousands of people were told to move their possessions to higher ground before a storm surge today.

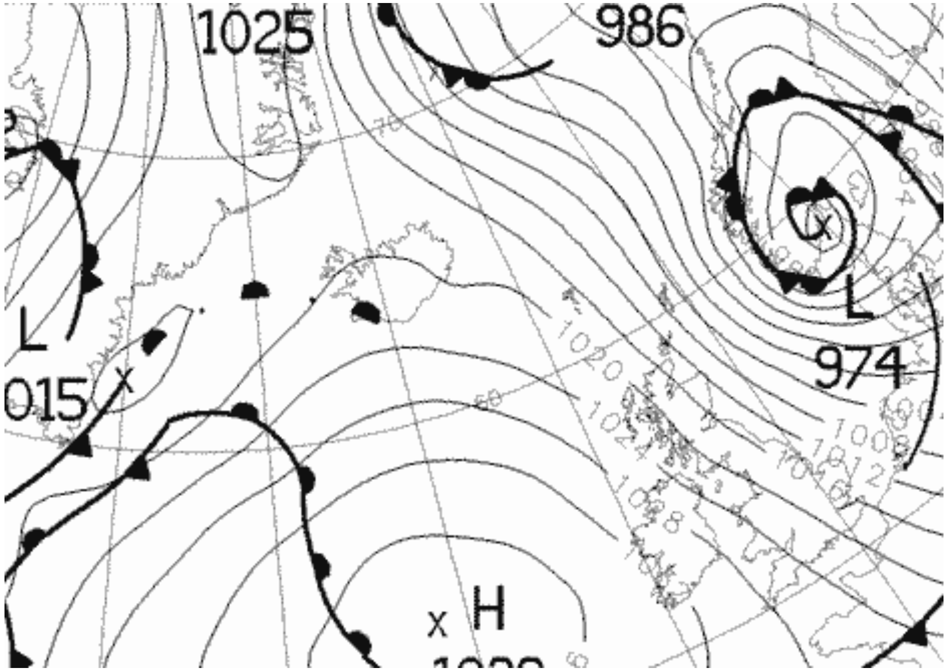
About 10,000 homes and businesses were expected to be affected, according to the Environment Agency, which issued eight severe flood warnings for areas along the northeastern and eastern coasts of England, and as far south as Deal in Kent.

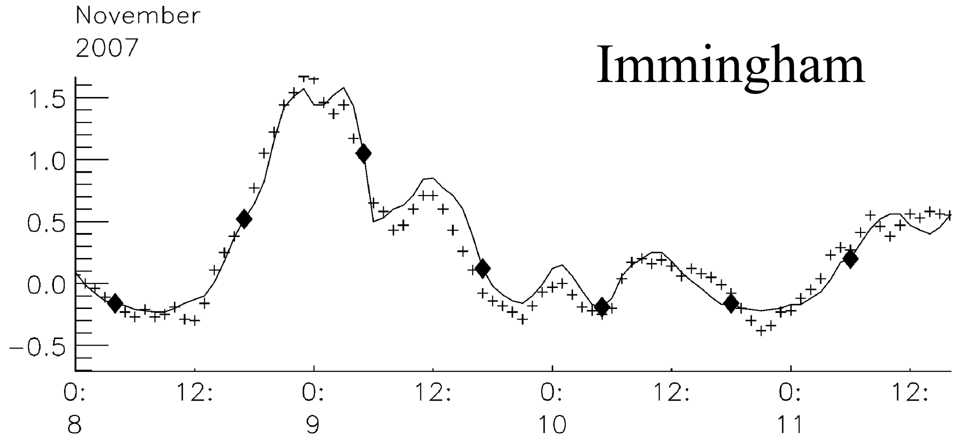
Gordon Brown chaired a meeting of Cobra, the Government's emergency committee, and Hilary Benn, the Environment Secretary, warned the Commons of a serious flooding risk. The Dartford Creek and Thames barriers were closed to protect London.

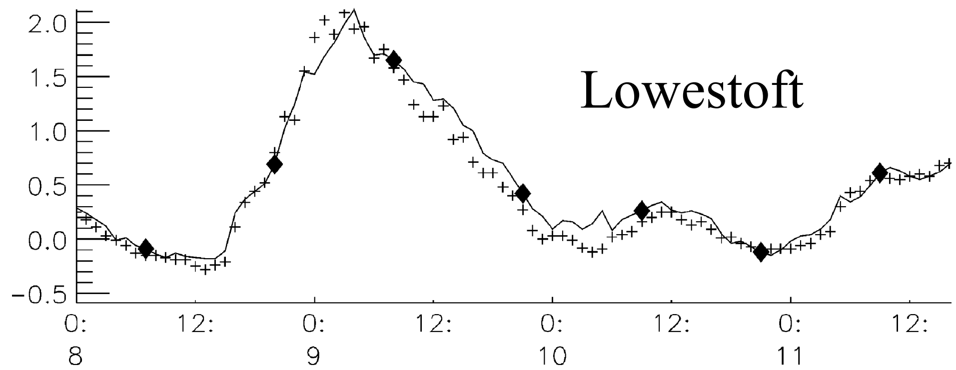
The Met Office predicted that sea levels would rise 3 metres (10ft) above usual as a result of northwesterly winds, a pocket of low pressure and

sea wall in the Scottish village of Pennan, near Peterhead

Operational model performance on 9 Nov 2007



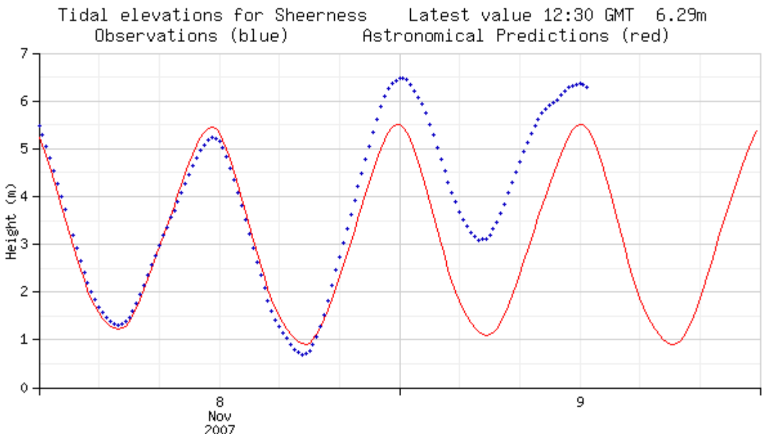


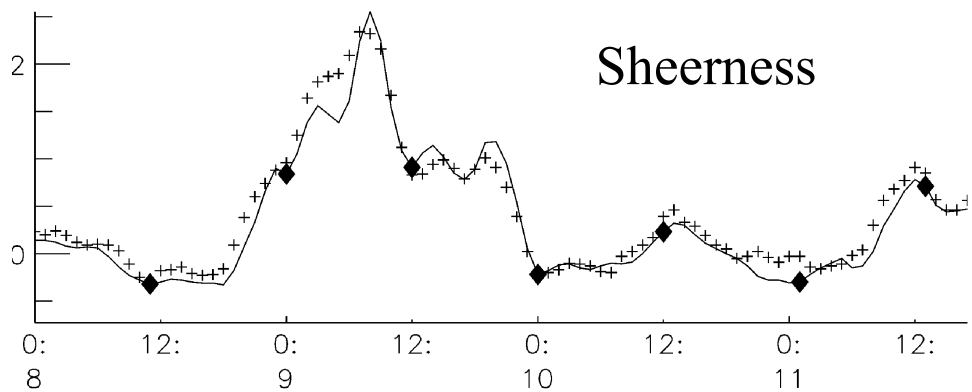


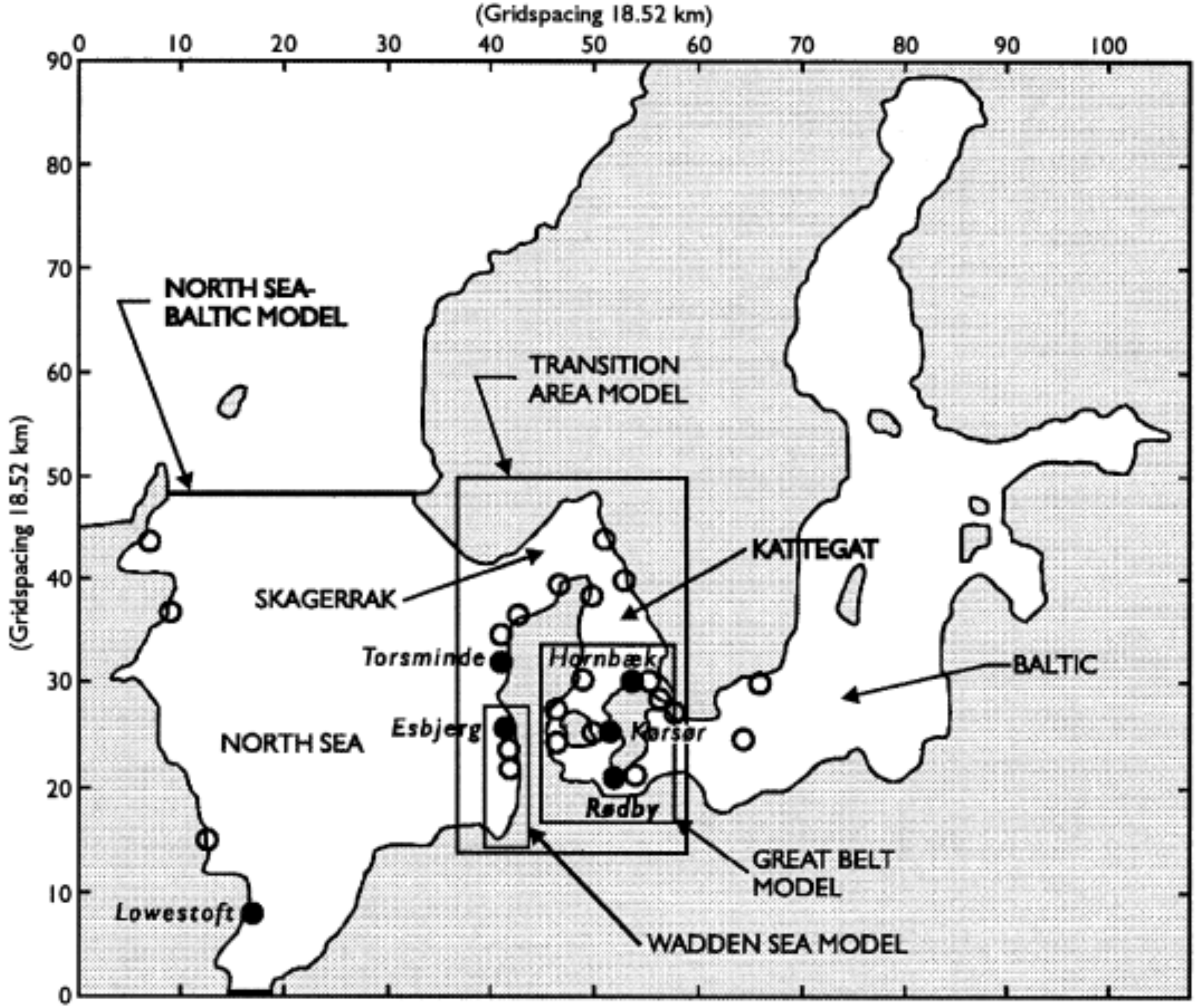
Real/Near-real time data display

Check operational status of tide gauge

Today & Tomorrow | Last Week | Last Month | Custom dates







DMI Nested Models

Model	Area	Type	Grid
HAMSOM/Nivmar	Med.sea and Iberian Peninsula	Vertically integrated barotropic	10 minutes

Model	Area	Type	Grid	Country
derived from MOTHY oil spill drifts model	43°N - 59°N; West Mediterranean basin (from the Gibraltar Strait to Sicily) Restricted area in oversea departments and territories	shallow water equations	5' (5 to 9 km) finer meshes	France
SLOSH (Sea, Lake and Overland Surges from Hurricanes)	sea south of Hong Kong within 130 km	finite difference	Polar, 1km near to 7 km South China Sea	Hong Kong, China
Short-Term Sea Level and Current Forecast	Caspian Sea and near shore low lying zones	3-D Hydrodynamic baroclinic	3 nm horizontal, 19 levels	Russia
IIT Delhi, IIT Chennai, NIOT Chennai	east and west coasts of India and high resolution areas	non-linear finite element explicit finite element	Eg. for inundation model average spacing of 12.8 km offshore direction and 18.42 km along shore	India
CS3 tide-surge	NW European shelf waters	Finite difference, vertically averaged	C grid 12 km nested finer resolution	United Kingdom

Model	Area	Type	Grid	Country
Mike 21 pre-op. 3-D 2-D finite element MOG2D	North Sea, Baltic Sea	2-D hydrodynamic	finite diff. 9nm-3nm-1nm-1/3nm	Denmark
Coupled Ice-Ocean NPAC	Grand Banks, Newfoundland, Labrador NE Pacific 120-160W, 40-62 N	3-D circulation based on Princeton Ocean Model	20 km x 20 km aprox. finite diff. curvilinear c-grid 1/8 deg.	Canada
JMA Storm Surge	23.5 N-46.5 N 122.5 E-146.5 E	2 D linearized shallow water	staggered Arakawa C-grid 1 min. latitude/longitude	Japan
KMA Storm Surge	20 N-50 N 115E-150E	2-D barotropic surge and tidal current based on Princeton Ocean Model	8 km x 8 km aprox. finite diff. curvilinear c-grid 1/12 deg.	Korea
NIVELMAR	Portuguese mainland coastal	Shallow water	1min. latitude/longitude	Portugal
SMARA storm surge	shelf sea 32-55 S 51-70 W Rio de la Plata	2-D depth averaged	geographical Arakawa C 1/3 degree latitude/longitude 1/20 degree, latitude/longitude	Argentina
BSH circulation (BSHcmod) BSH surge (BSHsmod)	NE Atlantic, North Sea, Baltic Sea	3-D hydrostatic circulation 2-D barotropic surge	Reg. spherical North Sea, Baltic 6 nm German Bight, Western Baltic, 1nm Surge North Sea 6nm NE Atlantic 24 nm	Germany
Caspian Storm Surge	Caspian Sea 36-[illegible] 48.5 N, 45[illegible]58 -[illegible] E North Caspian Sea 44.2 48-[illegible]N, 46.5 -55.1 E	2-D hydrodynamic, based on MIKE 21 (DHI Water & Environment)	10km 2 km	Kazakhstan
HIROMB/NOAA	NE Atlantic, Baltic	3-D baroclinic	C-grid, 24nm	Sweden
WAQUA-in-Simona/DCSM98	continental shelf 48N-62N, 12W-13 E	2-D shallow water, ADI method, Kalmanfilter data assimilation	latitude/longitude, 1/8 degree longitude x 1/12 degree latitude	Netherlands
	Near Europe Atlantic (Gulf of Biscay, Channel and North Sea) 8°30' W - 10° E,		Arakawa c grid;	

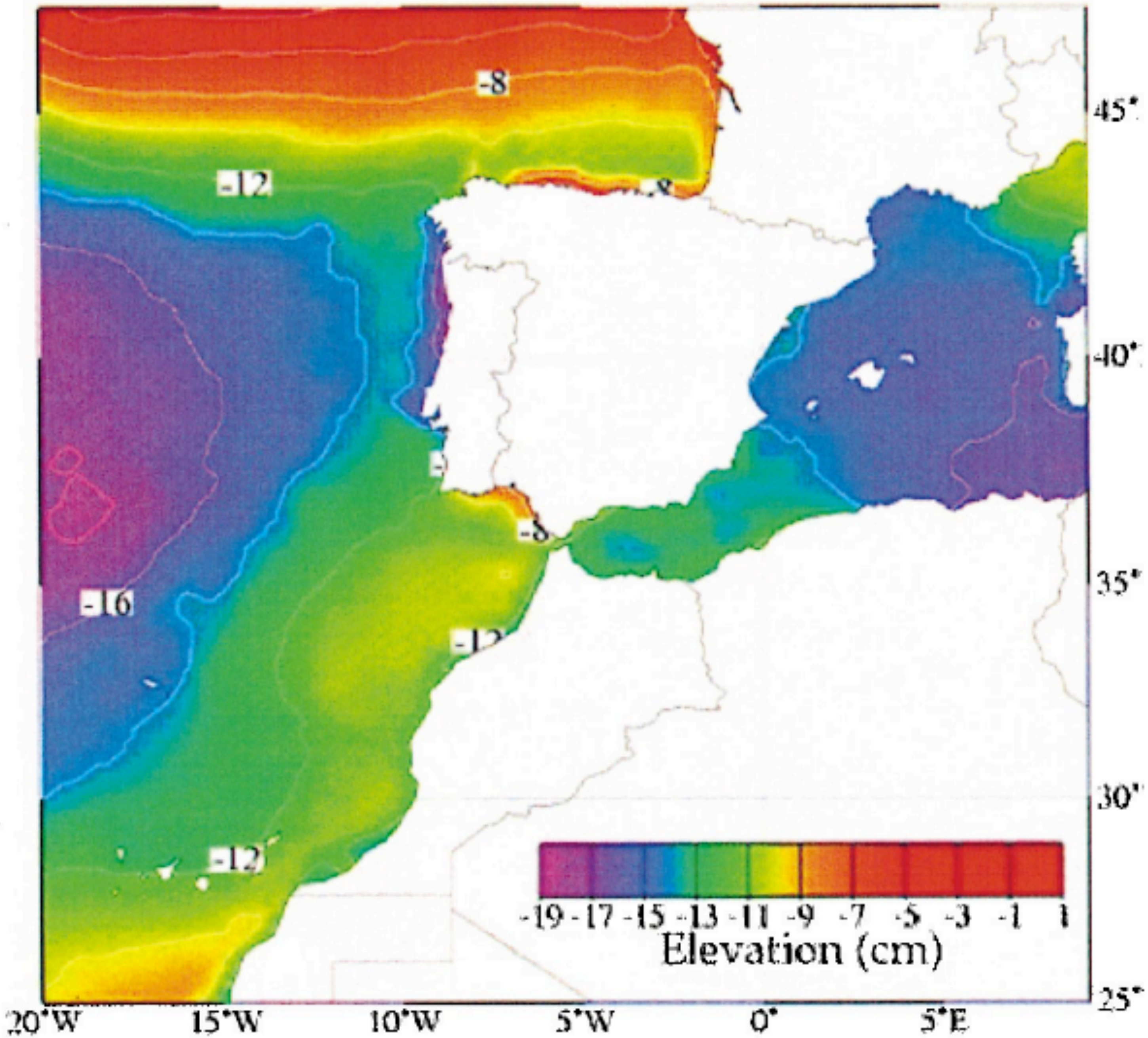
WMO/JCOMM 2008

Regions represented in JCOMM list and some others

- N Sea, Baltic, Med Sea + Iberian Peninsula, Portugal, Black Sea
- Grand Banks, USA (fragmented)
- Japan, Korea, Hong Kong, India, Pakistan, Bangladesh, Russia
- Argentina
- Kazakhstan

Some problems

- All agencies don’t produce a hindcast met product
- Some that do don’t actually archive it e.g. Met Office – POL does the archiving
- If not the best available surge data will be from the last met forecast
- For adequate surge accuracy, ~10 km met regional forcing needed in most places
- Problems of narrow shelves



Nivmar surge forecast

Option 1.

• Use archived regional surge fields based on the most recent forecast met information (typically a few hours old).

• Combine the outputs from operational surge models from different regions.

cf. Proposal by Coastal GOOS but never taken forward.

• Problem is that large regions would not be represented (e.g. the African coastline).

Option 2.

- Use hindcast information several weeks later (or however later is considered acceptable for the altimeter data processing), assuming that the hindcast data are by then of higher quality than the stored forecast information (probably unlikely as meteorological re-analyses are usually performed over a considerable time later).

Option 3.

• Use a global barotropic model forced with global met information. Models presently available include:
• MOG2D (T-UGO) - finite element model with a high spatial resolution at the coastline (Carrère and Lyard, 2003) (e.g. 15 km elements for the global model, 4 km for regional models). The T-UGO incarnation can be used in 2D or 3D mode.
• OCCAM barotropic version from POL, the highest resolution version at present being 0.25 degree.
• The barotropic model of Pacanowski (and Ponte et al.) implemented by Ali, Zlotnicki and others to provide high-frequency (periods shorter than 20 days) corrections to Jason GDRs (Aviso, 2002) with a primary emphasis on the deep ocean.

However, there are disadvantages to the use of a global model over regional ones in that the latter are often based upon considerable local knowledge and experience, especially with regard to the accuracy of the essential bathymetric information, and in the quality of regional meteorology, and tend to be of higher resolution.

What to Do? Personal Opinion

- Choose Option 1 for now and work on developing Option 3.
- But debatable.