Planning for an Uncertain future in the Thames Estuary Haarlem

26th September 2018

Tim Reeder

The 100th Thames Barrier Closure

Environment Agency

What was TE2100?

A Project to provide a plan demonstrating how **flood risk** can be managed in the **Thames Estuary** over this **century** in response to:

- **a changing climate**

- **a changing estuary**

- **ageing flood defences**


Interim Defences during the construction of the Thames Barrier
1928 Flood & subsequent 1930 Flood Act
Late C19 update
to Flood Act
1879 Flood Act

Thames Estuary 2100 Plan Area

- >1.25million people
- £160bn Property
- International Habitats & Species
- Port of London generates £2.7bn/yr.
- 400 Schools, 16 Hospitals
- 30 Mainline Railway Stns
- 68 Underground & DLR Stns
- 8 Power Stations

337kms of Defences

4 Climate Change futures examined

- Defra
- UKCIP Med High
- High +
- High ++

Thames Barrier

- **At Risk**
- **The Current Defences**
- **Future Scenarios**
- **New Barriers**
- **Controlled Inundation**
- **Restoration of the Floodplain**
- **Spatial Planning**

Climate Change & TE2100

- Climate Change critical issue for flood risk
- Main driver of physical flood risk sources in order of uncertainty at project start :-
  - Waves
  - Fluvial Flow
  - Sea Level Rise
  - Surge
  - Joint Probability

Uncertainty

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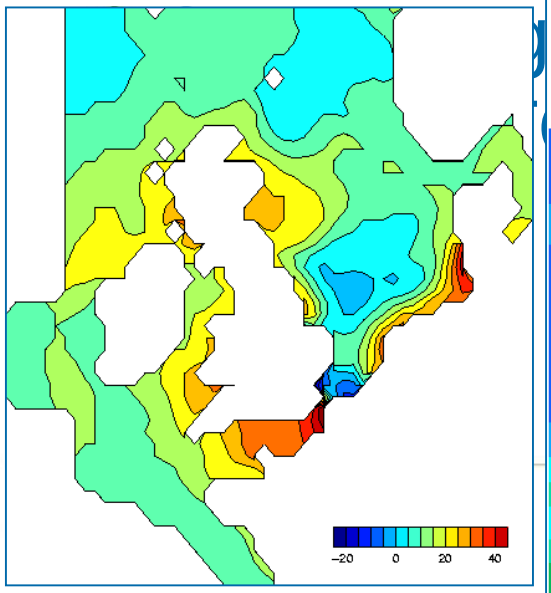
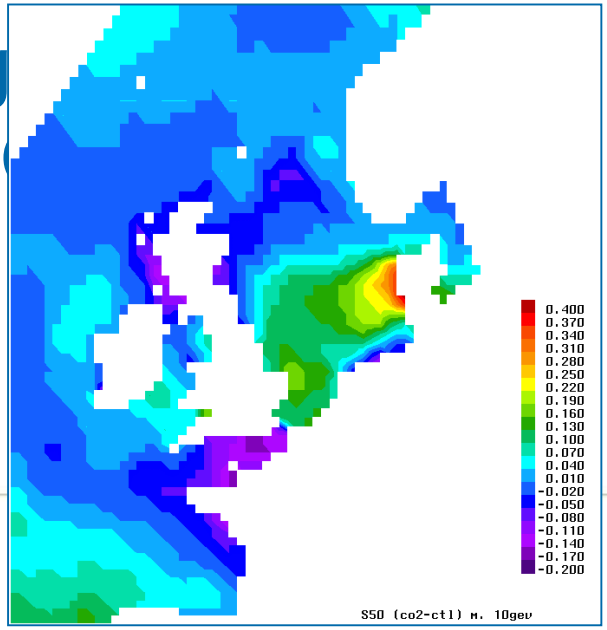
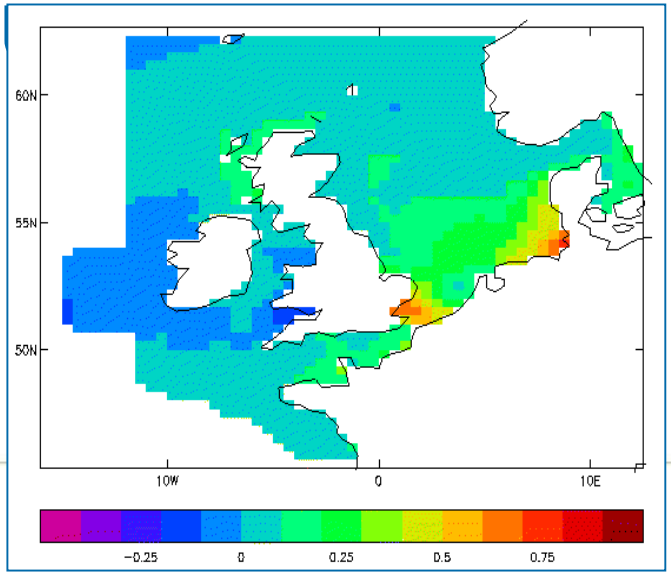
Science before TE2100

- River flow - DEFRA guidance – 20 % increase
- Mean SLR – IPCC 3rd Assessment Report, UKCIP02

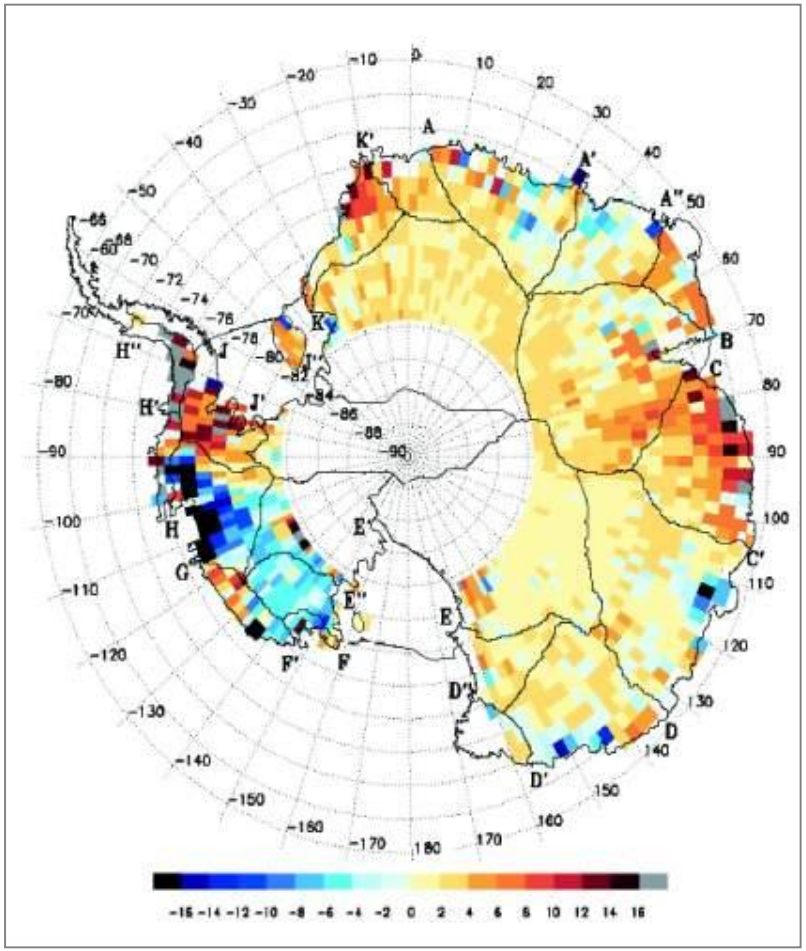






Satellite Altimeter Results 2005

- East Ant : - 0.12mm/y msl
- West Ant : + 0.16mm/y msl
- Marine ice sheet zones
  - major discharges :
    - Pine Island –Thwaites in West Antarctica
    - Totten and Cook in East Antarctica



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TE2100 – Planning for an uncertain future

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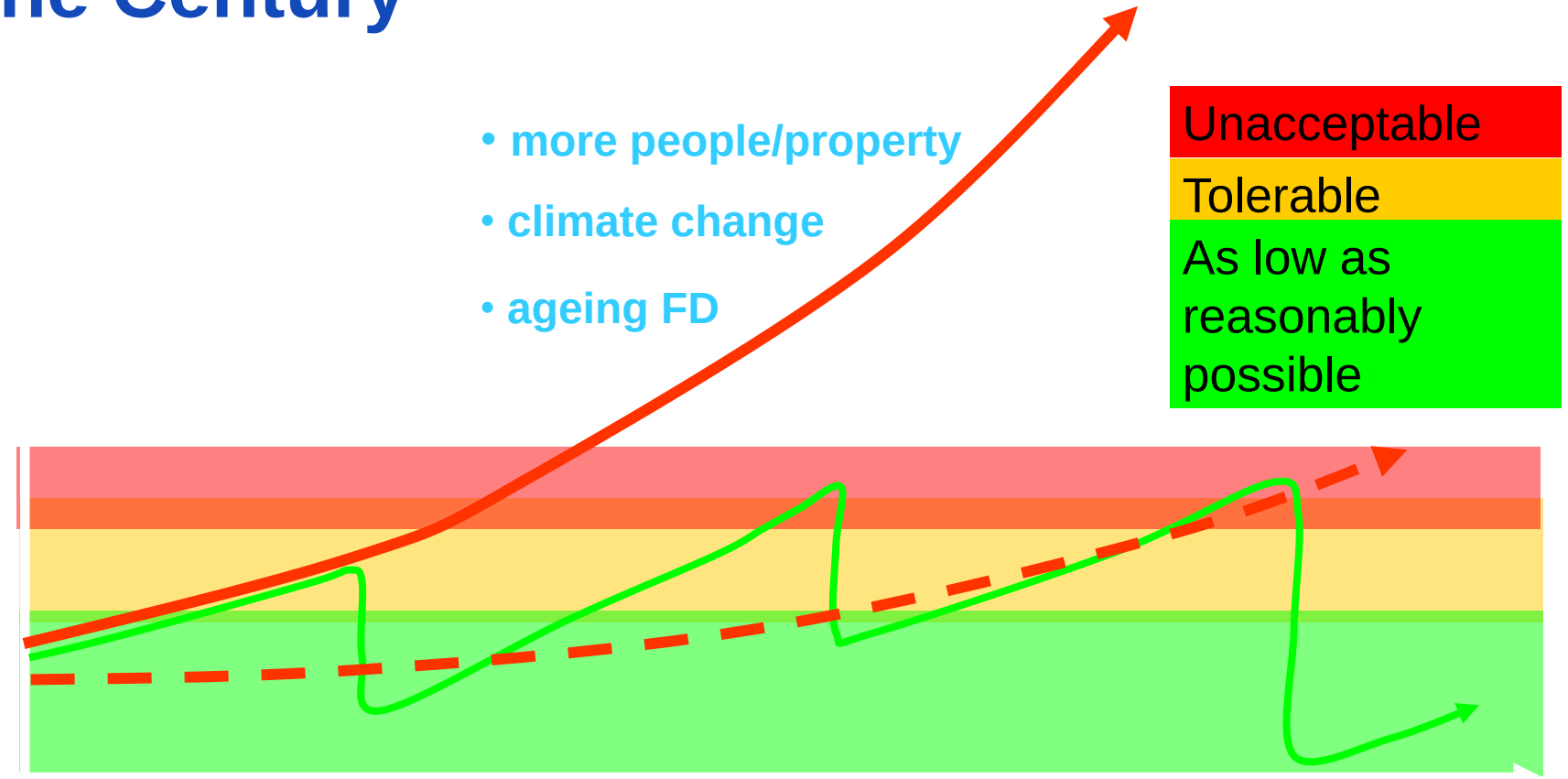
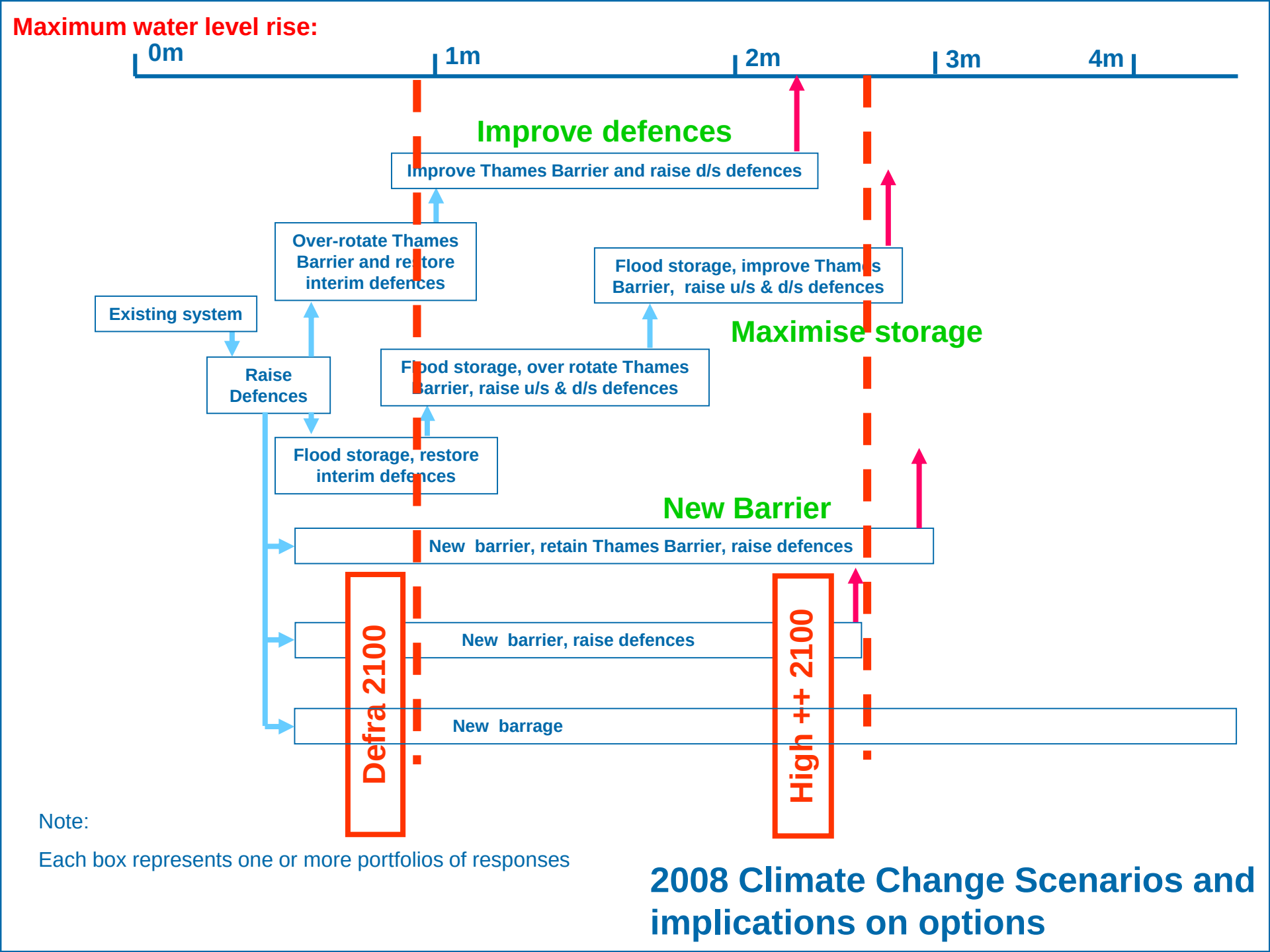
Thames Estuary 2100 Project

- To achieve the project objectives the programme of studies was based around a Decision -Making Framework largely piloted by ESPACE…

Managing Flood Risk through the Century

- more people/property
- climate change
- ageing FD




Maximum water level rise:
0m
1m
2m
3m
4m
Improve defences
Improve Thames Barrier and raise d/s defences
Over-rotate Thames Barrier and restore interim defences
Flood storage, improve Thames Barrier, raise u/s & d/s defences
Existing system
Maximise storage
Raise Defences
Flood storage, over rotate Thames Barrier, raise u/s & d/s defences
Flood storage, restore interim defences
New Barrier
New barrier, retain Thames Barrier, raise defences
New barrier, raise defences
New barrage
Defra 2100
High ++ 2100
Note:
Each box represents one or more portfolios of responses
2008 Climate Change Scenarios and implications on options

TE2100 – Driving the science

Feeding into UKCP09

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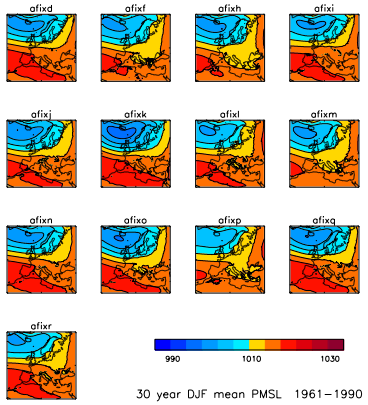
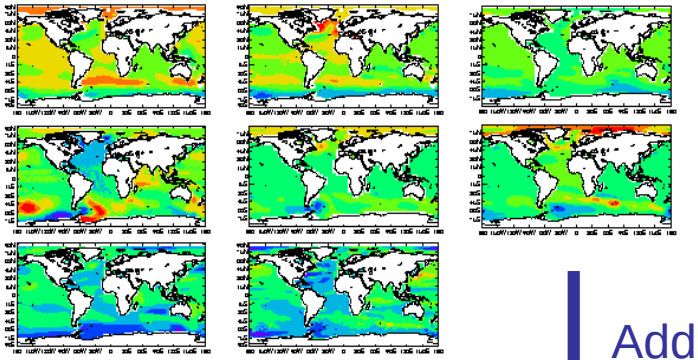
Ensemble climate change projections

Met Office Hadley Centre

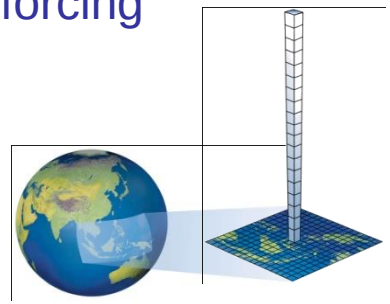
Uncertainty in large scale atmospheric forcing



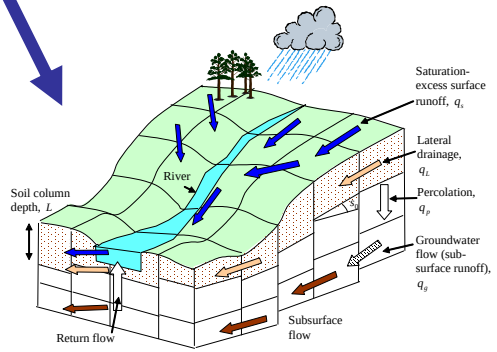


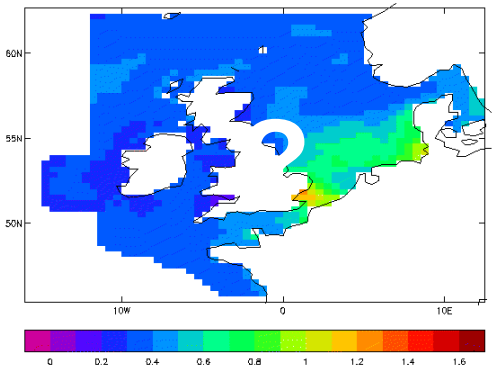
Add in ice melt uncertainty

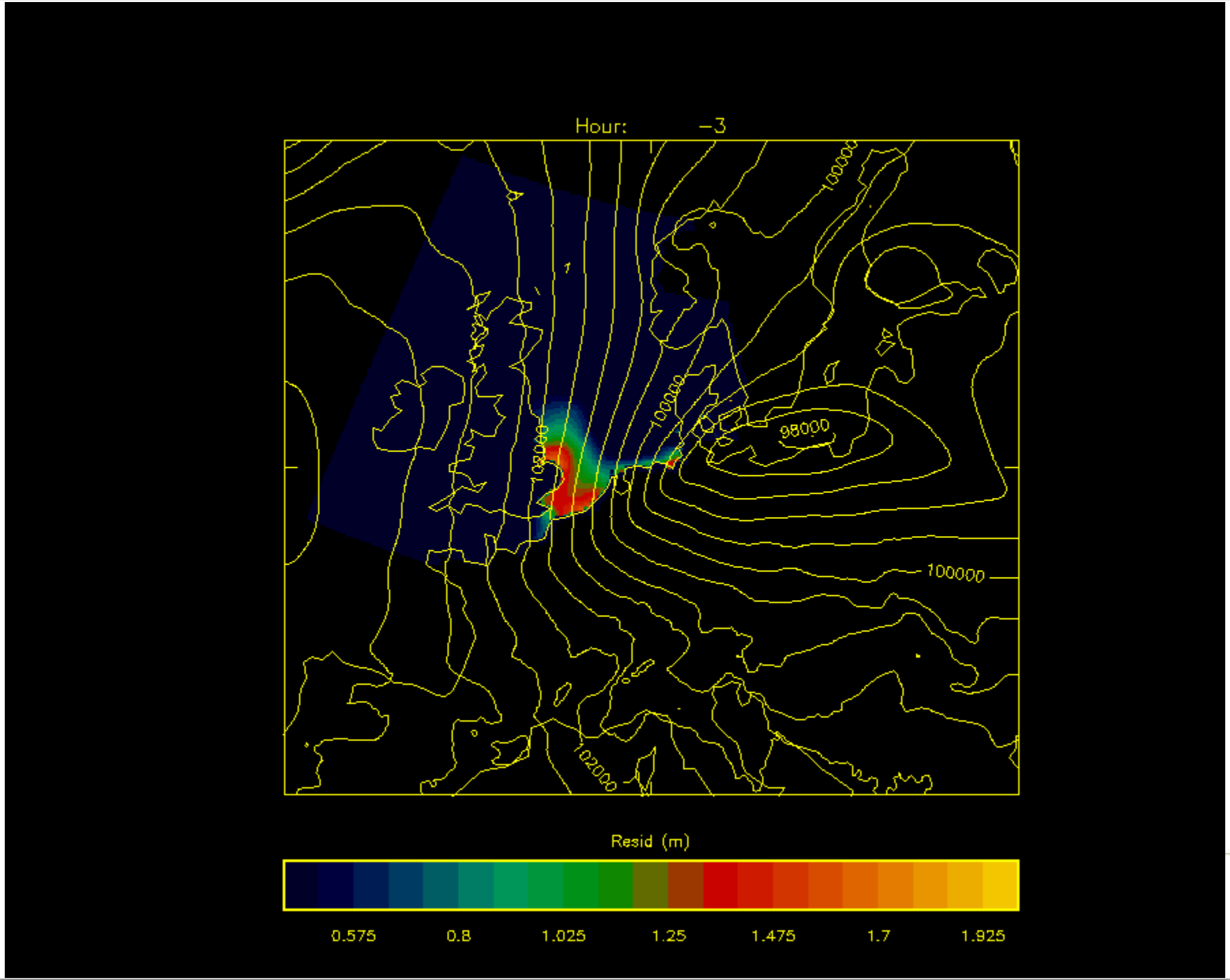
Downscale to get uncertainty in Regional scale atmospheric forcing



Run surge model simulations to estimate uncertainty range in local extreme water levels



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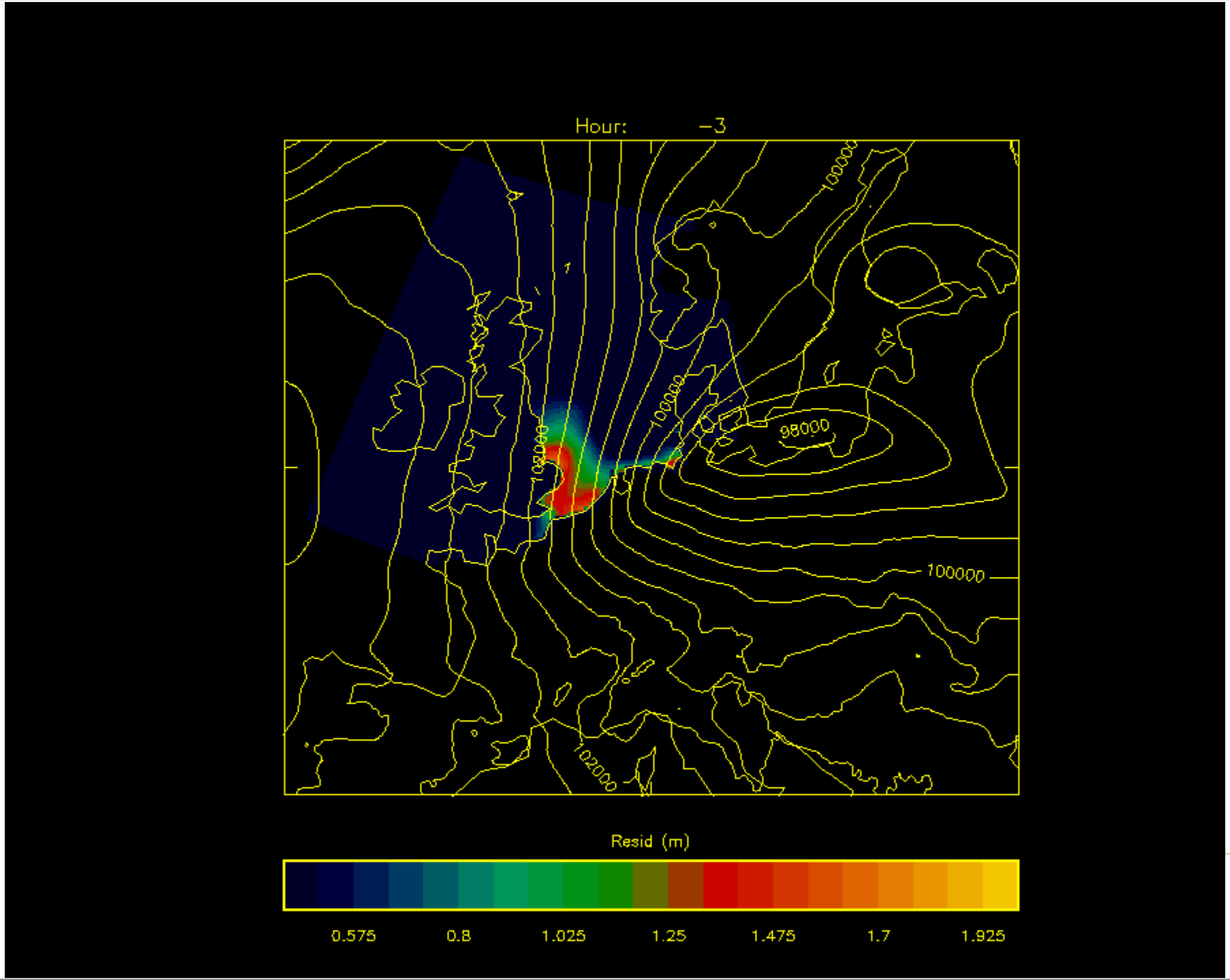
98000
100000
102000
Resid (m)
0.575
0.8
1.025
1.25
1.475
1.7
1.925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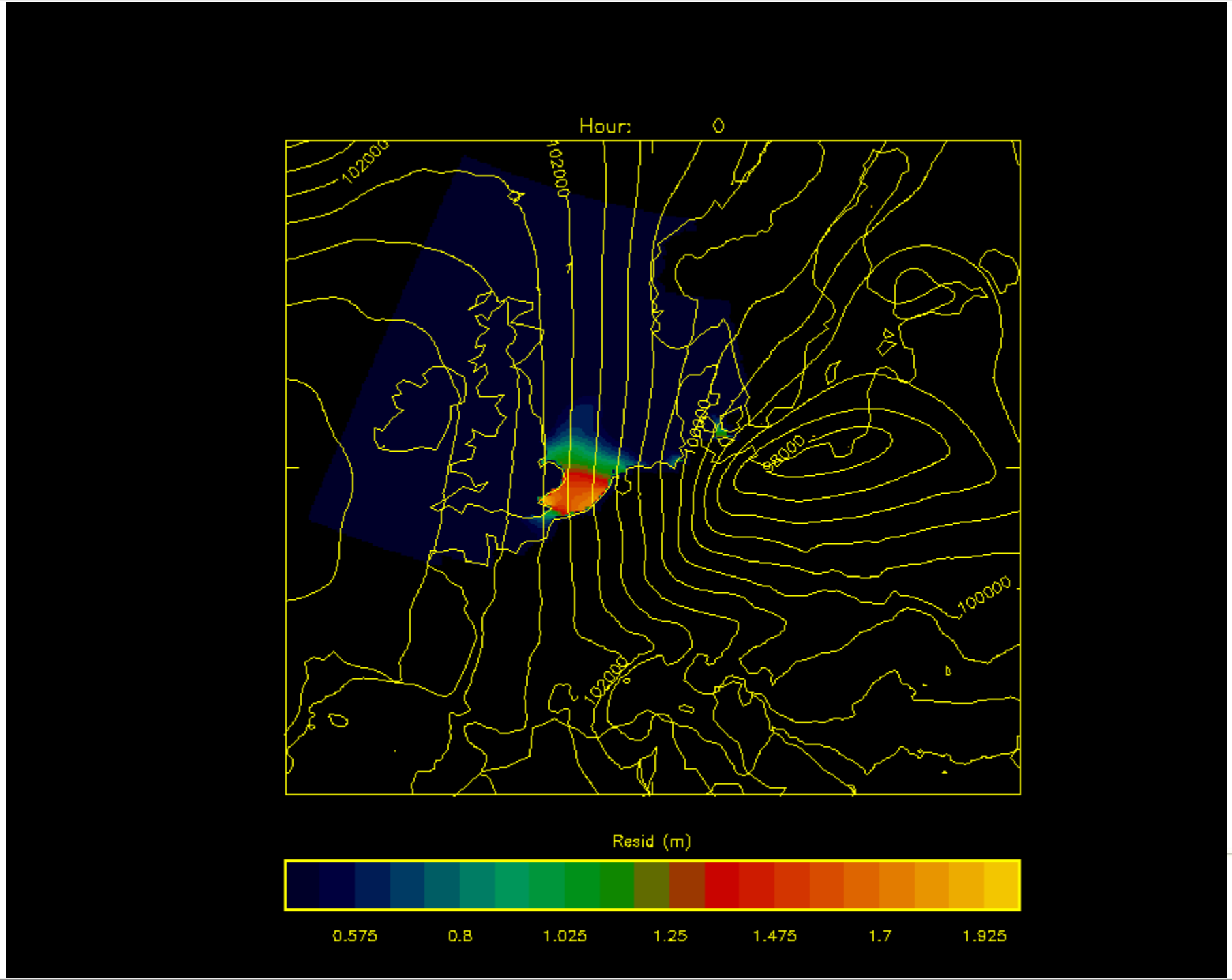
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Resid (m)
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1.025
1.25
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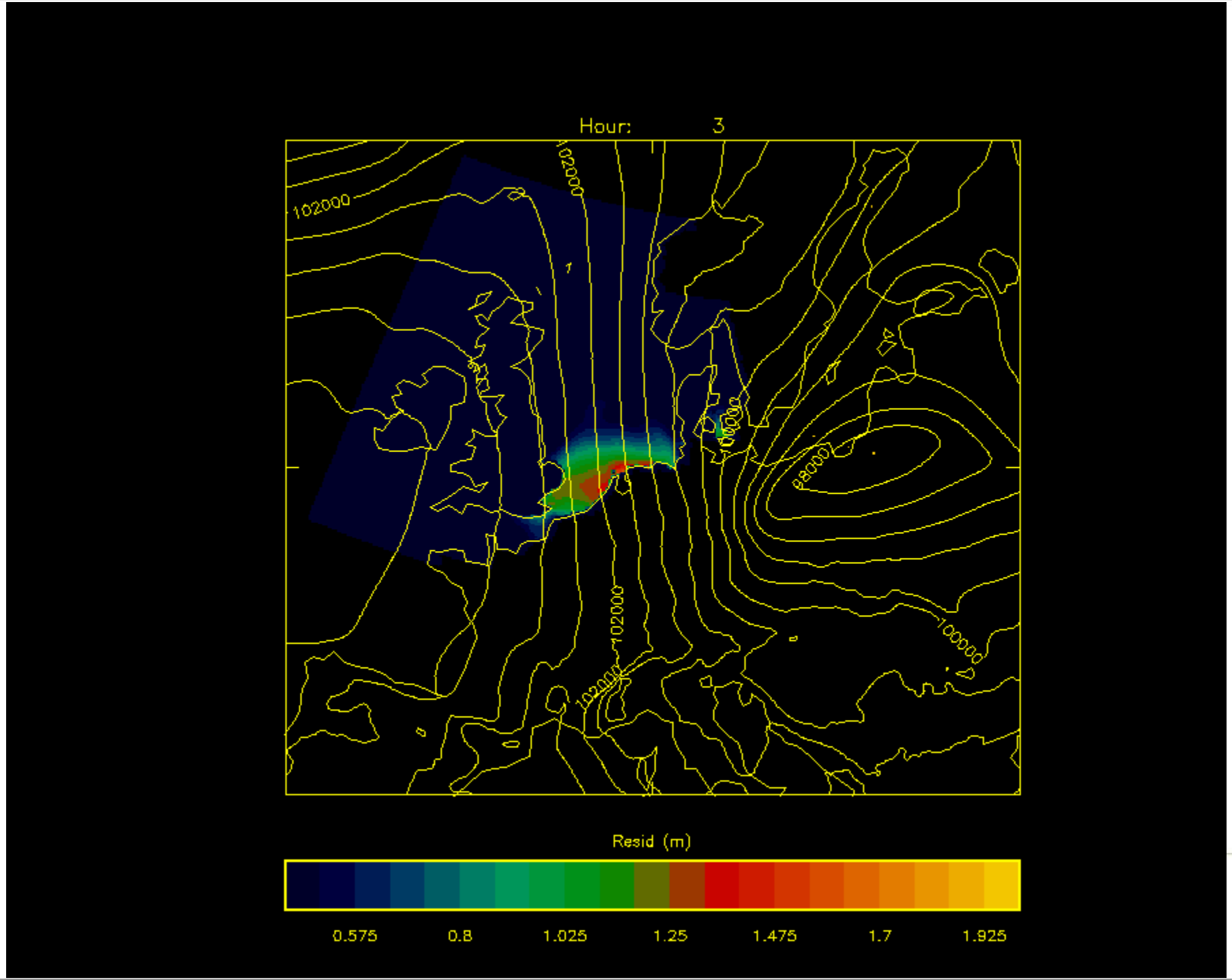
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102000
100000
98000
102000
102000
100000
Resid (m)
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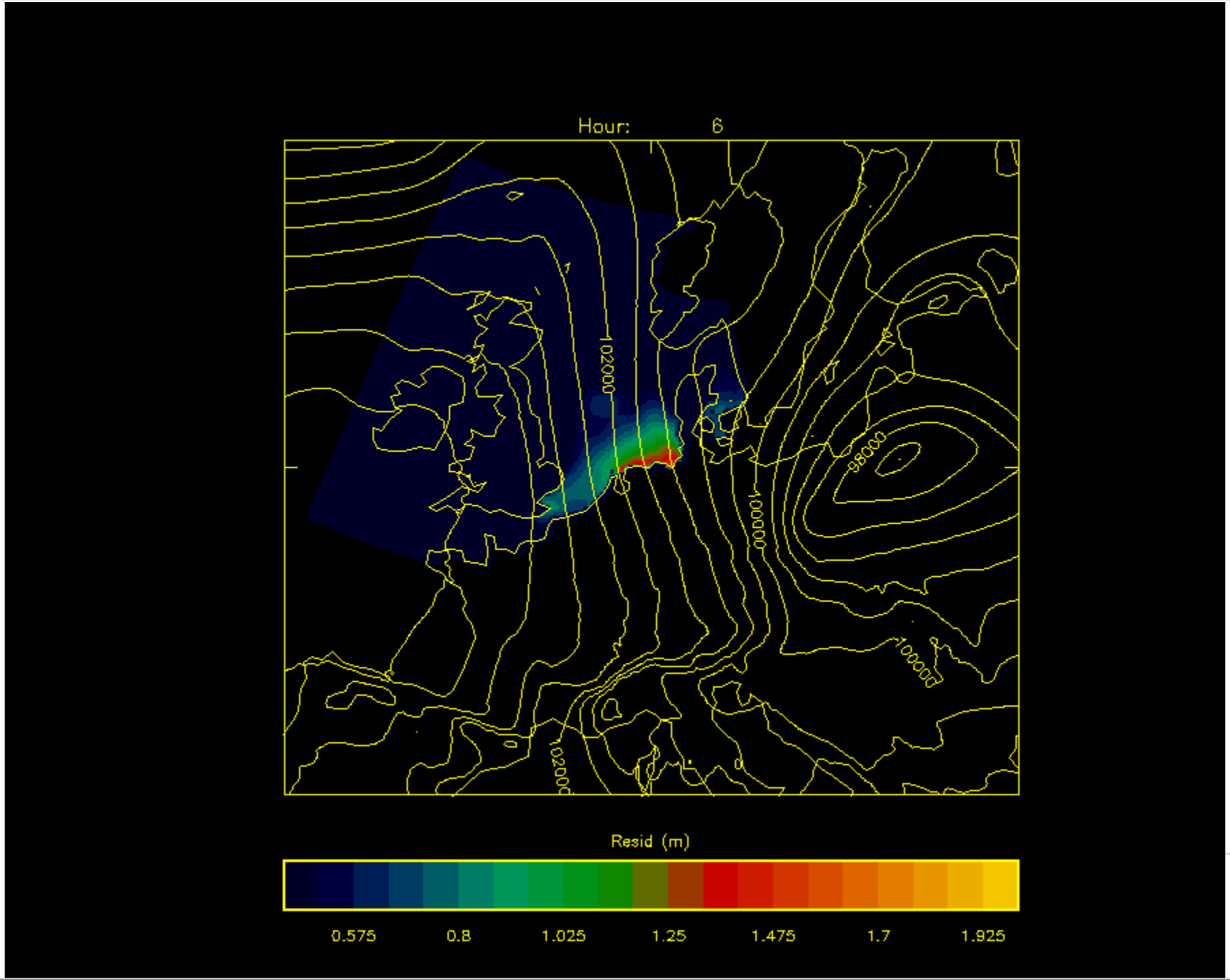
0.8
1.025
1.25
1.475
1.7
1.925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100000
102000
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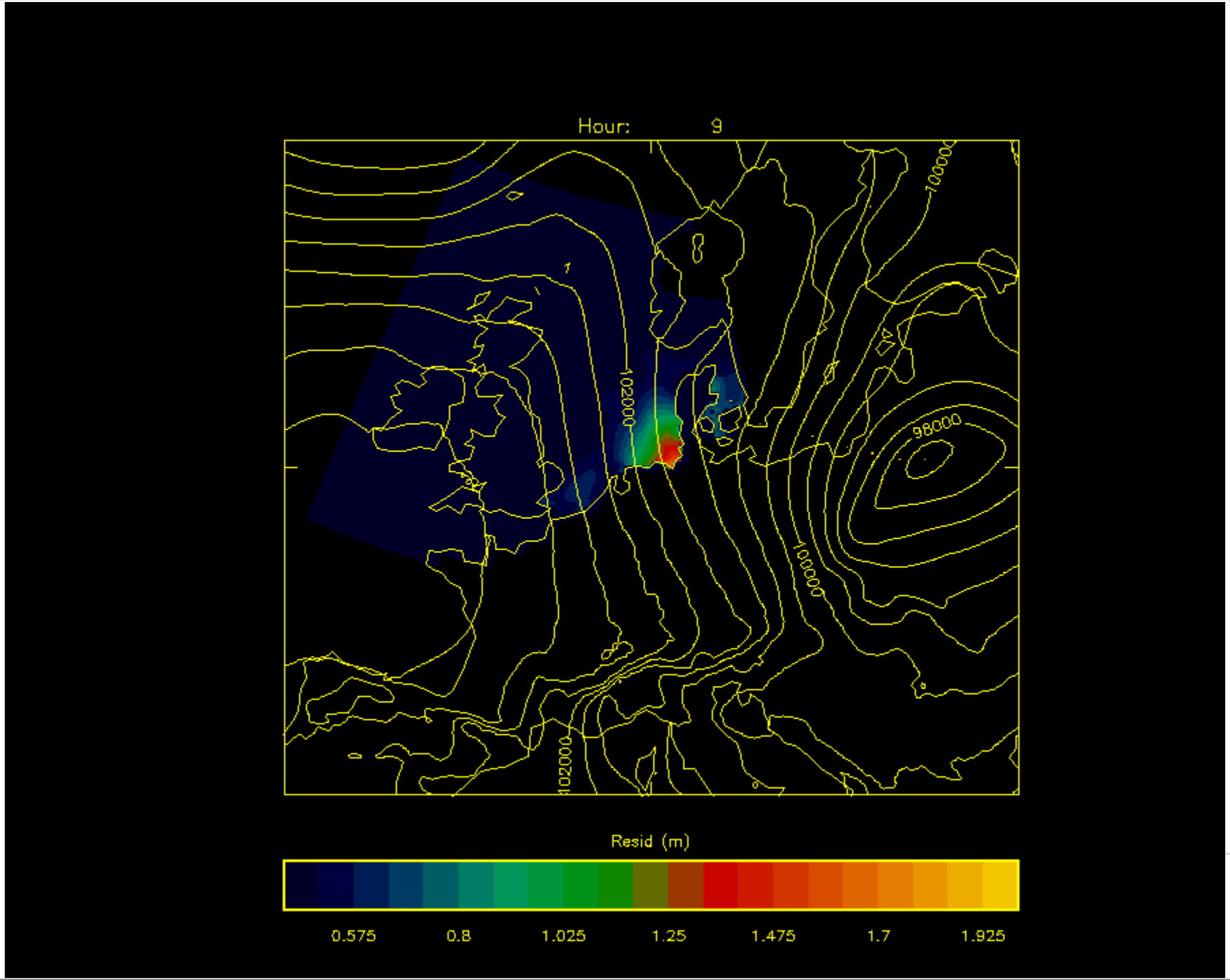
0.8
1.025
1.25
1.475
1.7
1.925


Hour: 9
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100000
98000
100000
102000
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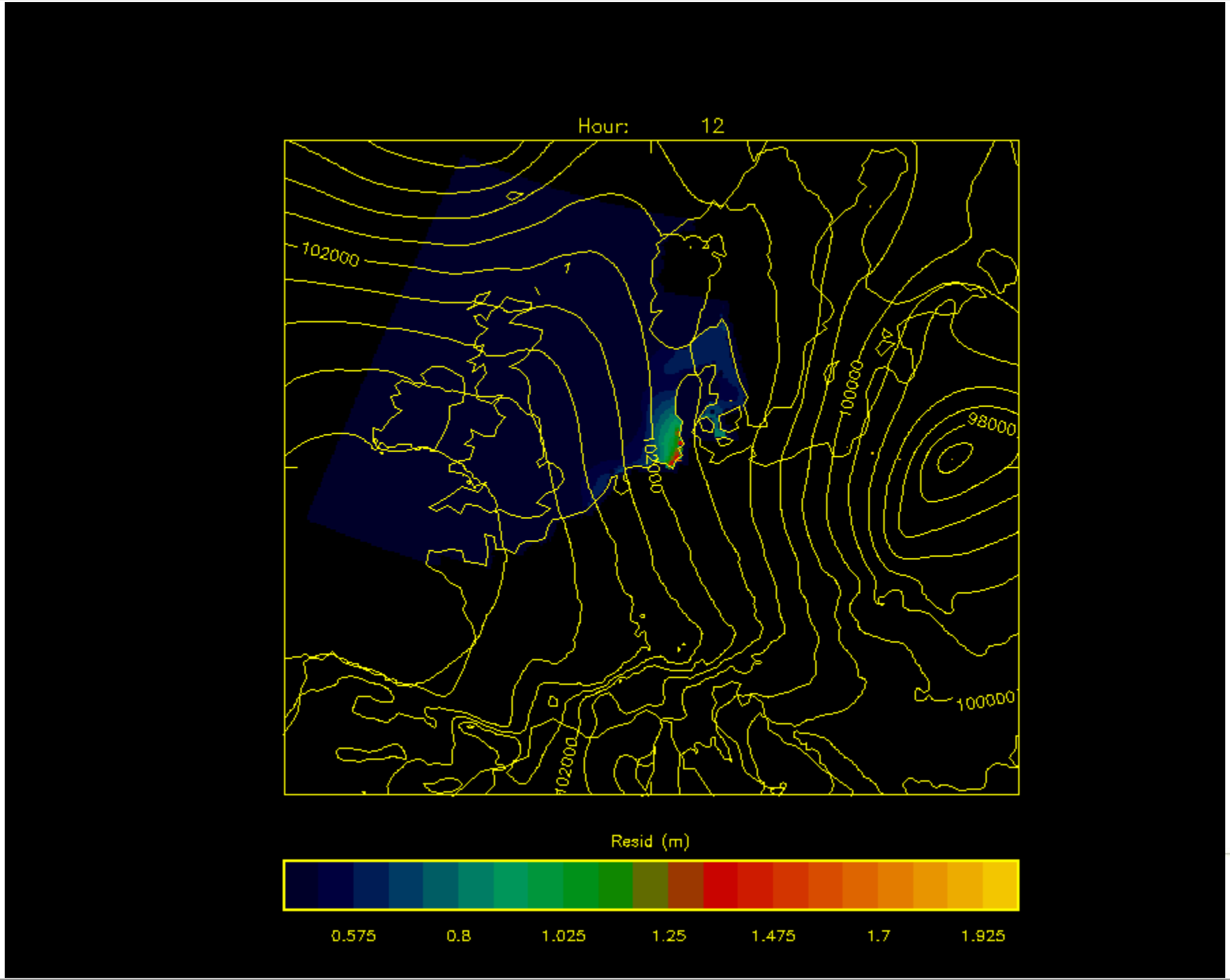
0.8
1.025
1.25
1.475
1.7
1.925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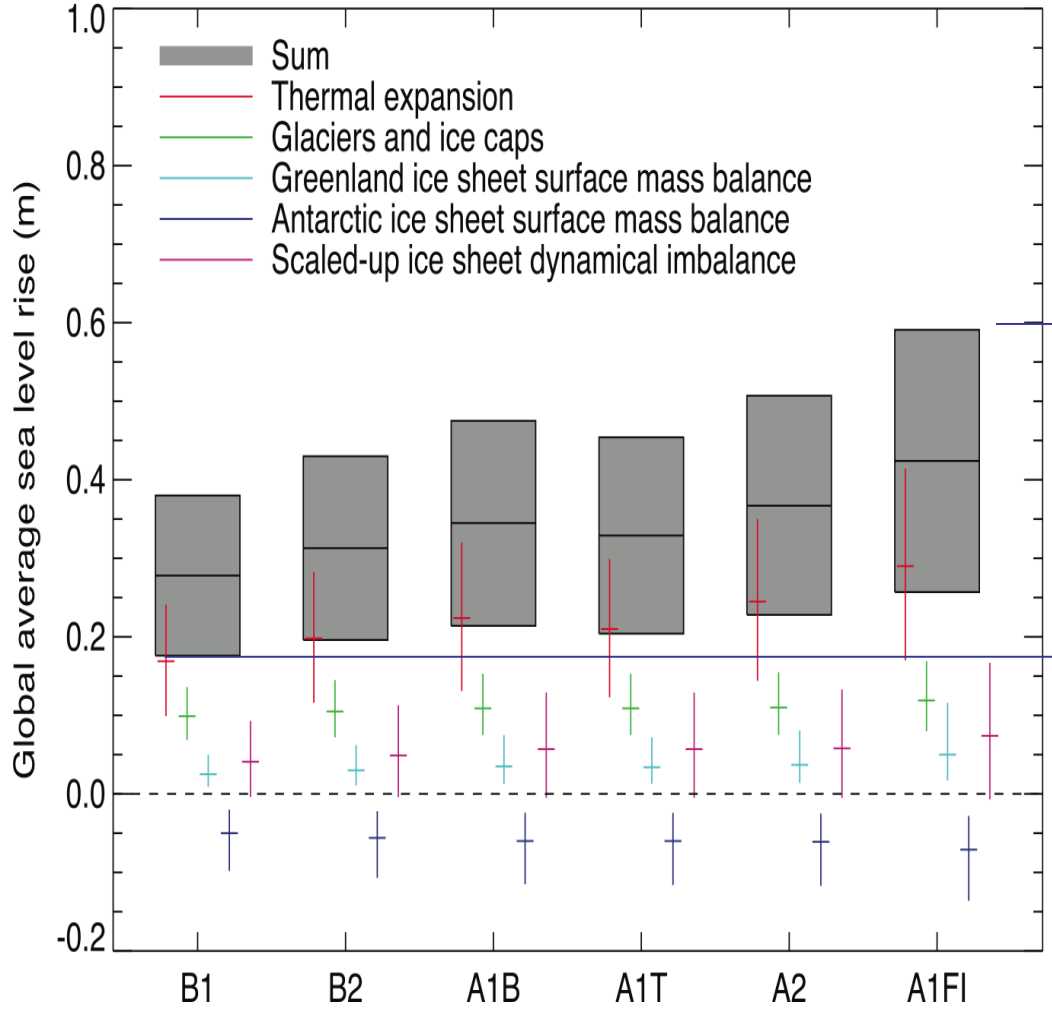
102000
100000
98000
102000
102000
100000
Resid (m)
0.575
0.8
1.025
1.25
1.475
1.7
1.925

IPCC AR4 mean sea level Projections



+additional contribution from ice sheet ???????

AR4 2007

Does the UK experience the global mean?

Is 90cm the upper limit?

- Probably not less than than zero
- Probably not more than 12m
- 4m – based on Lenton et al., 2008 (based on Hansen, 2005)
- 1.6±0.8m – Rohling et al., 2008 (based on Red Sea observations)
- 2m - various personal comms with ice sheet “experts”
- 2m – Pfeffer et al., 2008

- **We present two scenarios to 2100**
  - **The 0.20m to 0.90m as the LIKELY range, with no trend in surges.**
  - **H++ range of 1m to 2m for mean sea level rise for sensitivity testing. With our H++ surge scenario the full H++ range extends to 2.7m for a 5-year period event.**
  - **We think the upper end of this range is VERY UNLIKELY to occur by 2100**

TE2100 Science Key Findings 2008

- Sea level rise in the Thames over the next century due to thermal expansion of the oceans, melting glaciers and polar ice is likely to be between 20cm and 90cm.
- There is still much uncertainty over the contribution of polar ice melt to sea level rise. At the extreme it may further raise sea levels up to 2m (including thermal expansion) - although this is thought highly unlikely.
- Although still uncertain, climate change is less likely to increase storm surge height and frequency in the North Sea than previously thought.
- Future peak freshwater flows for the Thames are also uncertain. At Kingston they could increase by around 40% by 2080.
- To reduce the uncertainty over the potential effect of polar ice melt on sea level rise, further research and monitoring is needed.

TE2100 the first 25 Years

- Continue to maintain the current flood defence system including planned improvements
- Ensuring that floodplain management is in place across the estuary
- Safeguard areas that may be required for future changes to flood defences
- Commencing work to create new habitats

N
W E
S
0 5 10
Kilometres

Environment Agency

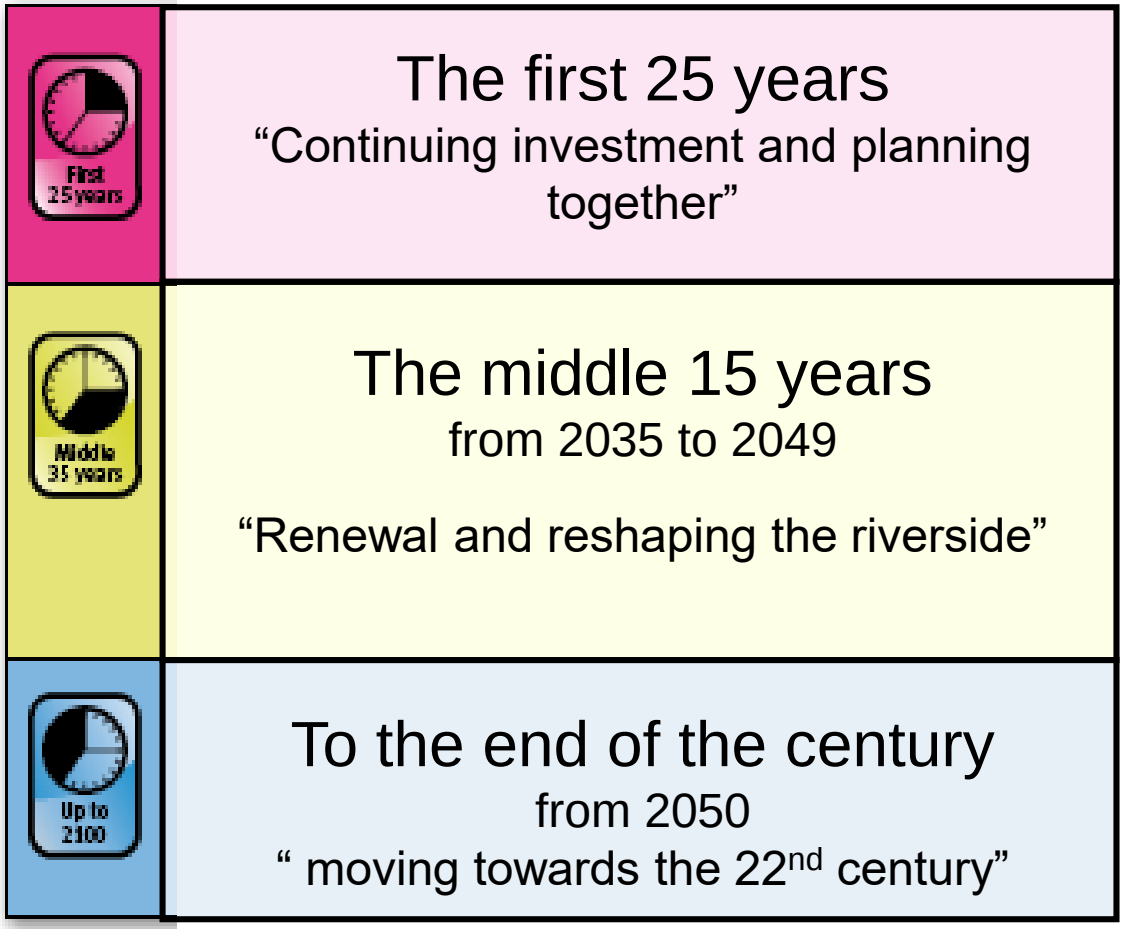
From 2070, moving into the 22nd century

- Replacing and upgrading defences upstream and downstream of the barrier
- Working with regional and local planning authorities
- Take informed decision on building a new barrier at Long Reach or other end of the century option

N
W E
S
0 5 10
Kilometres

Environment Agency

The TE2100 Plan – Three Phases



- ~ £1.5 bn.
- ~ £1.8 bn.
- ~ £6-7* bn.

(* depending on end of century option chosen)

- Current property value protected ~ £200 billion

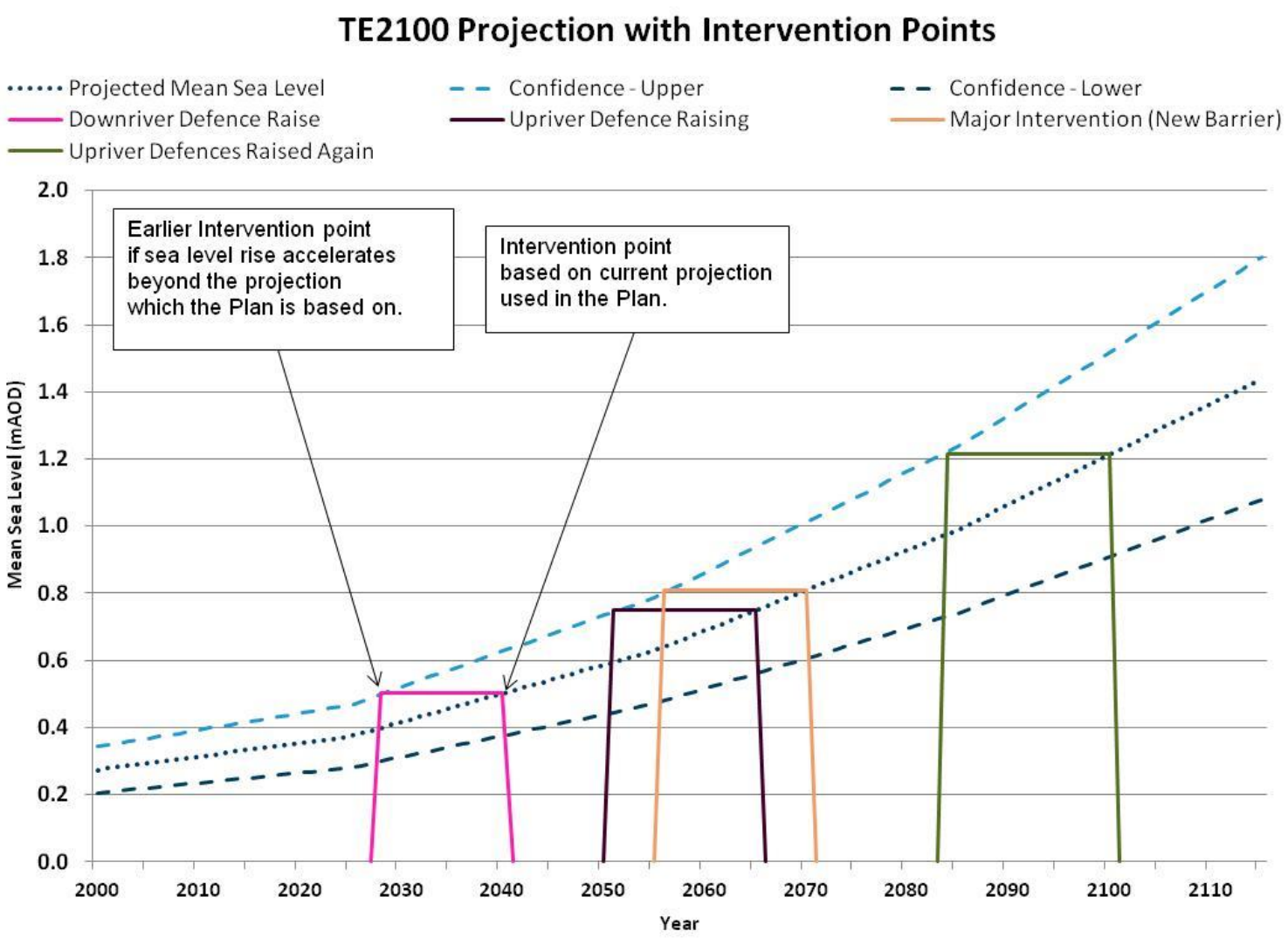
"The TE2100 approach was - no doubt about it with any one involved in the Dutch Deltaprogramme - absolutely of fundamental value in developing our own way (baptized 'adaptive deltamanagement') to somehow deal with uncertainties in the process of preparing the so called Deltadecisions - which together form the basis for the 20 billion proposal which is now in parliament." P Bloemen

Environment Agency

Monitoring is critical

- Plan is adaptable. Regularly reviewed against 10 indicators. Sea level rise and change in storm surge key indicators.
- Expert network to keep at forefront of science - I-STORM. Links to Southampton – E Rise project to tackle links between science and decision lead times.
- Recent review shows plan on track.
- Future peak freshwater flows for the Thames are also uncertain. At Kingston they could increase by around 40% by 2080.

Managing future flood risk



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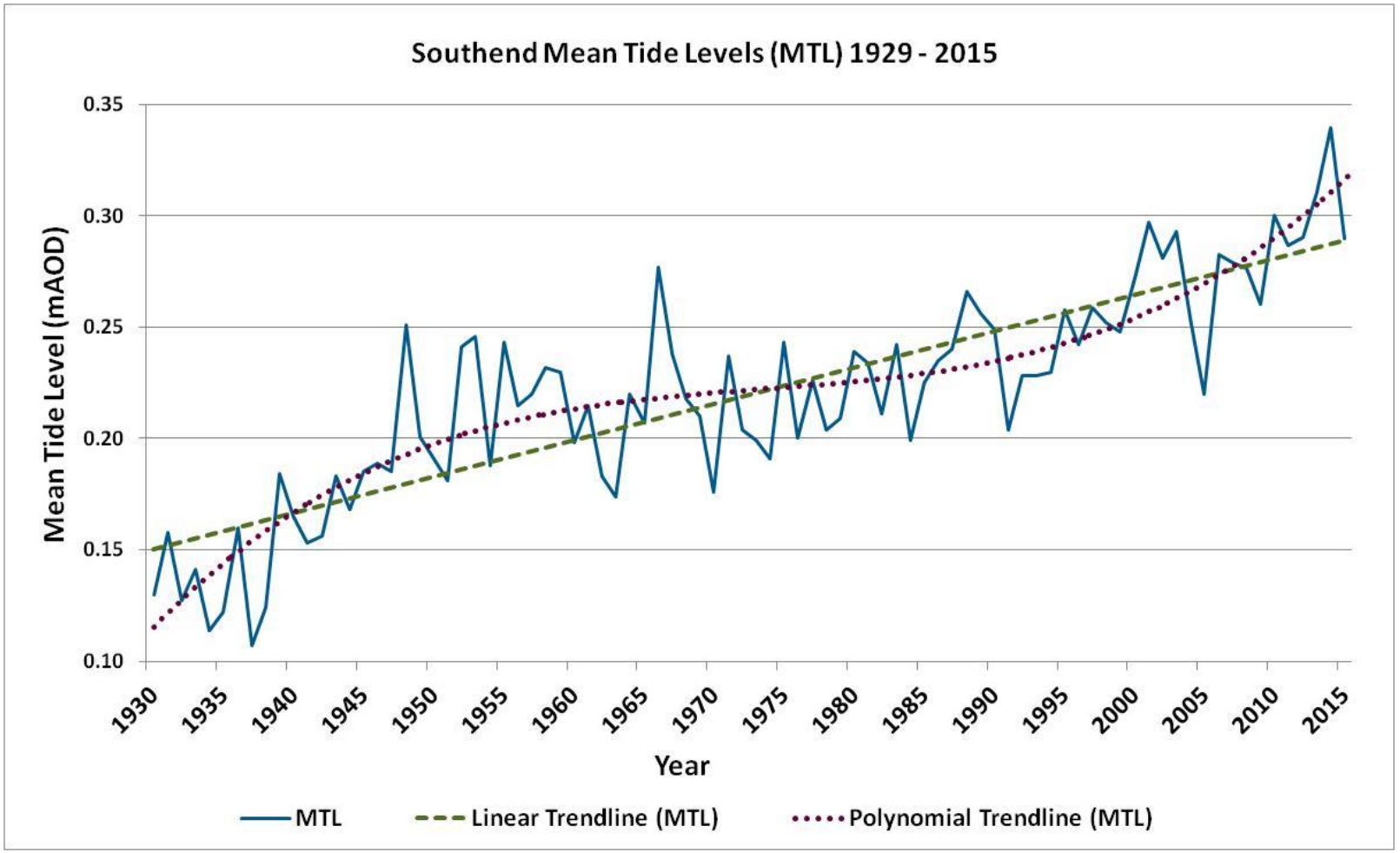
What does our monitoring tell us about sea level rise?



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National Oceanography Centre Southampton
University of Southampton and
Natural Environmental Research Council

UNIVERSITY OF Southampton

E-Rise: Earliest detection of sea-level rise accelerations to inform lead time to upgrade/replace coastal flood defense infrastructure.

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4. Conclusions

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1. Worked closely with the Environment Agency – reflecting on their 5-year Thames Estuary Review – looking to 10 year review;
2. Their current plan is appropriate - sea levels are accelerating – but currently at a rate less than the Defra06 projection.
3. In future reviews of TE2100 we have encouraged the EA to consider:
   a) Using all available records around the UK, rather than just Southend;
   b) Consider UK and global mean sea-level rise rates;
   c) Other proxies – global mean temperature.
4. We have looked at mean-sea level – now working to consider changes in extremes (tides, storm surges)

Summary

- TE2100 was the first major project in the UK to have put climate change adaptation at its core. Working with the Met Office Hadley Centre and other key organisations it pioneered the development and use of new scenarios, adaptation pathways and produced a plan for the Thames Estuary that is adaptable to future climate change.
- The use of adaptation pathways is being taken up by others.