

Niveaux extrêmes et surcotes en Manche : de l'approche historique à l'échelle de l'événement tempétueux

Journées Refmar 2019

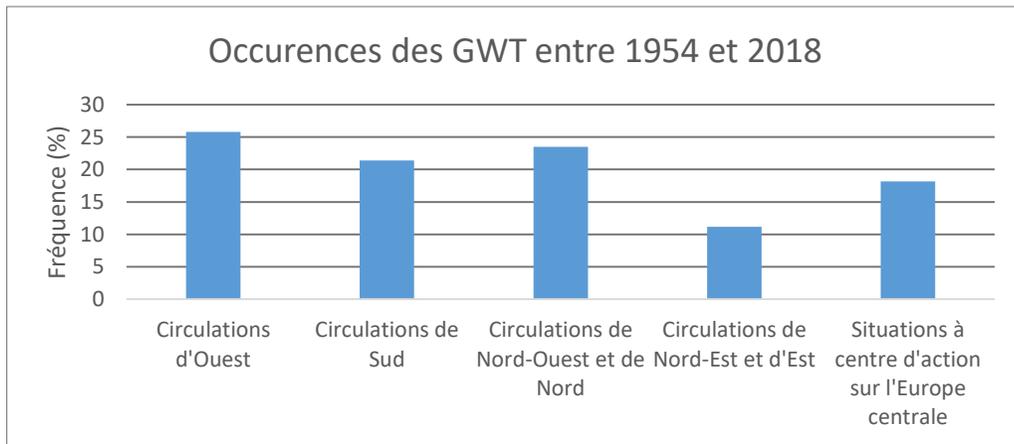
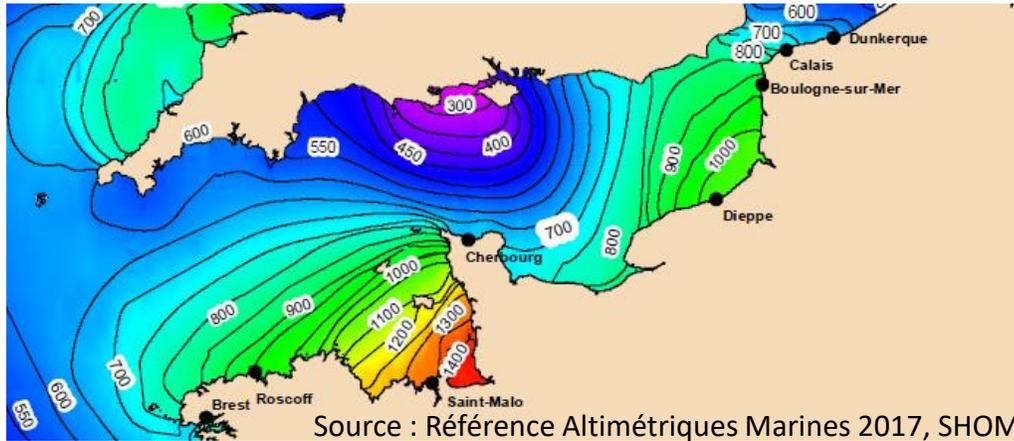
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LETG Caen, UMR 6554 CNRS

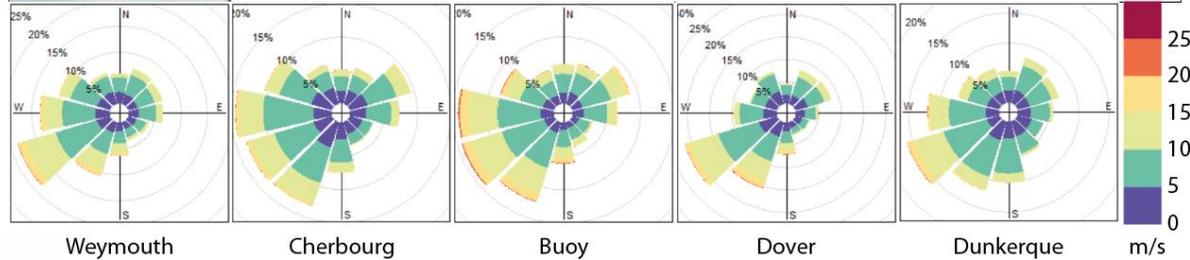
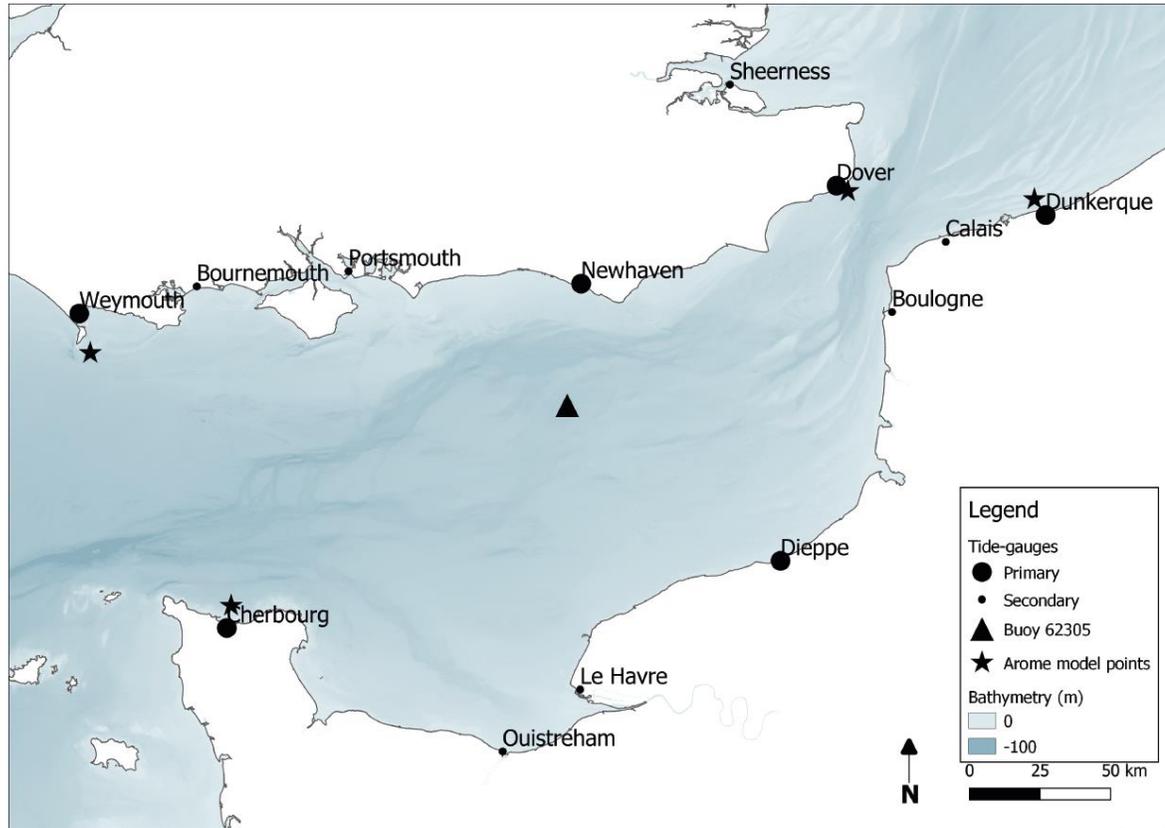
M2C Rouen, UMR 6143 CNRS



- **Projets :**
 - « Risque et Aléa inondation de villes côtières : Approche quantitative et diffusion par la réalité virtuelle » financés par la Fondation de France et la région Normandie portés par LETG-Caen
 - Sites de la façade littorale Normande
- **Etude des niveaux extrêmes en Manche :**
 - Analyse des surcotes et niveaux marins extrêmes en lien avec forçages météo
 - Mise en évidence de différents modes de fonctionnement du bassin lors d'épisodes tempétueux
- **Objectifs :**
 - Mise en forme d'une base de données marégraphiques et météorologiques la plus large possible
 - Analyse statistique des niveaux de surcote et des niveaux marins extrêmes
 - Mise en évidence des phénomènes de réponse du bassin au forçage météo



- Mer épicontinentale, de faible profondeur
- Forme d'entonnoir vers la mer du Nord
- Génère des amplitudes de marées importantes (3 à 10 m) de type semi-diurne
- Ouvert aux flux d'ouest perturbés dominants
- Faible fetch, mer du vent
- Risque submersion important

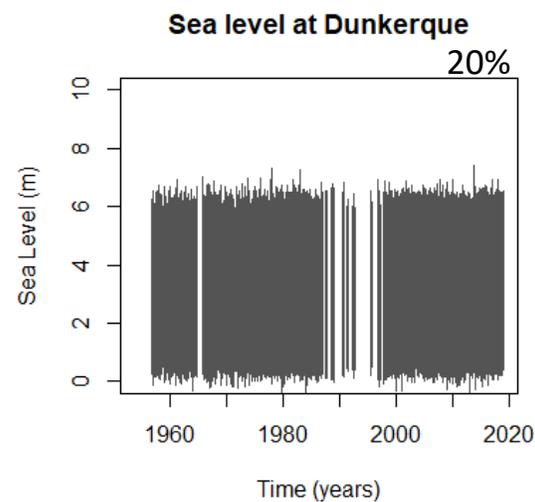
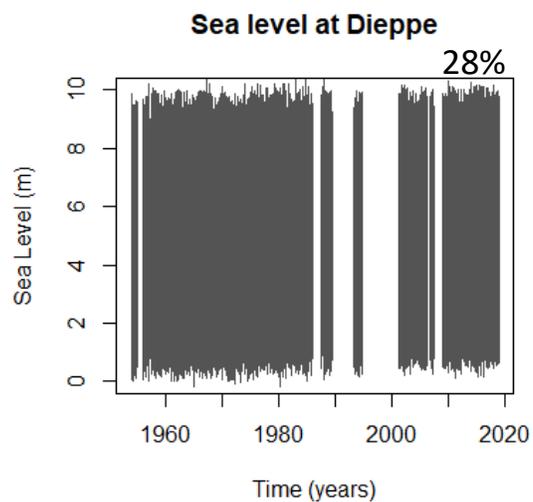
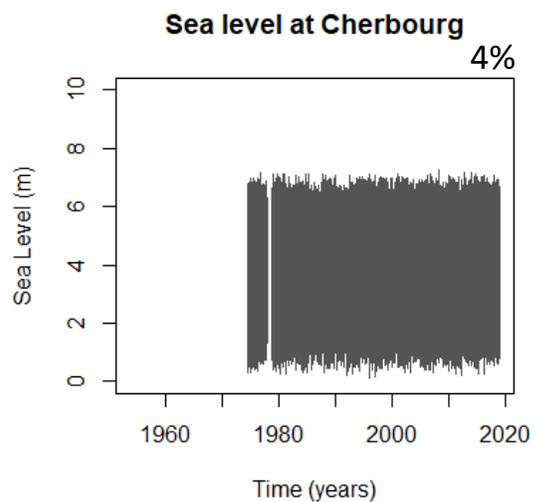
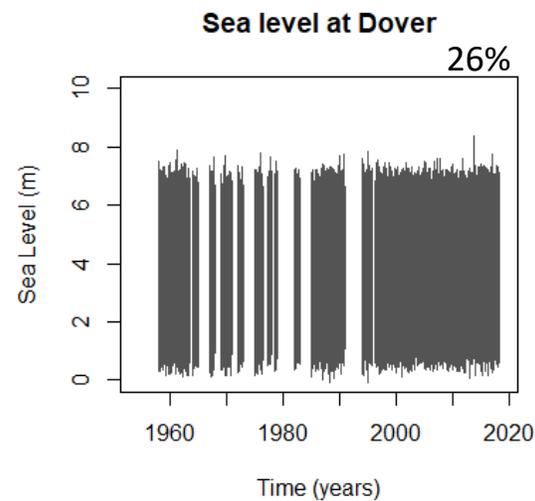
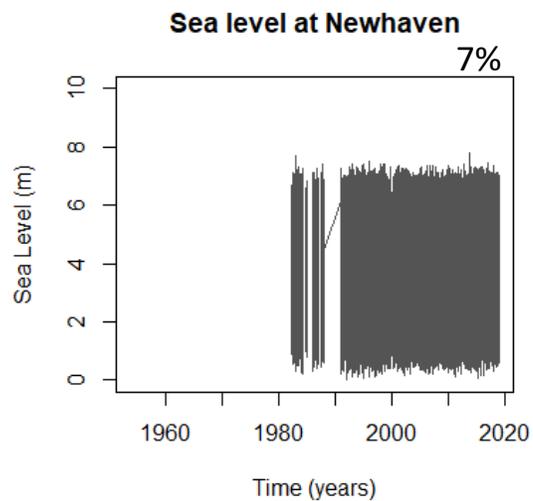
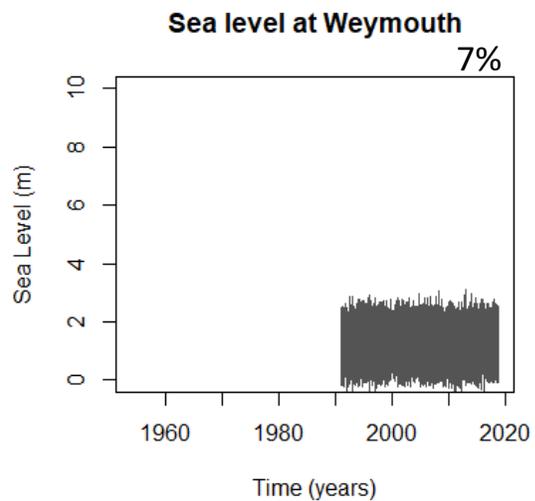


| | Cherbourg | Dieppe | Dunkerque | Weymouth | Newhaven | Dover |
|---------------------|---|--|--|---|--|---|
| Source | Shom, Marine nationale, Port Cherbourg | SHOM / Port de Dieppe | SHOM / GPM Dunkerque | National Oceanography Centre, Liverpool | National Oceanography Centre, Liverpool | National Oceanography Centre, Liverpool |
| Position marégraphe | Latitude : 49.651447 Longitude : -1.635508 | Latitude : 49.92917 Longitude : 1.08449 | Latitude : 51.048091 Longitude : 2.366698 | Latitude: 50.60850 Longitude: -2.44794 | Latitude: 50.78178 Longitude: 0.05703 | Latitude: 51.11694 Longitude: 1.3180 |
| Fuseau horaire | UTC | UTC | UTC | UTC | UTC | UTC |
| Référence verticale | Zéro hydrographique | Zéro hydrographique | Zéro hydrographique | Admiralty Chart Datum (ACD) | Admiralty Chart Datum (ACD) | Admiralty Chart Datum (ACD) |
| Unité | m | m | m | m | m | m |
| Etendue temporelle | 1974 - 2018 | 1954 - 2018 | 1956 - 2018 | 1991 - 2018 | 1982 - 2018 | 1958 - 2018 |
| Lacunes | 4 % | 28 % | 20 % | 7 % | 7 % | 26 % |

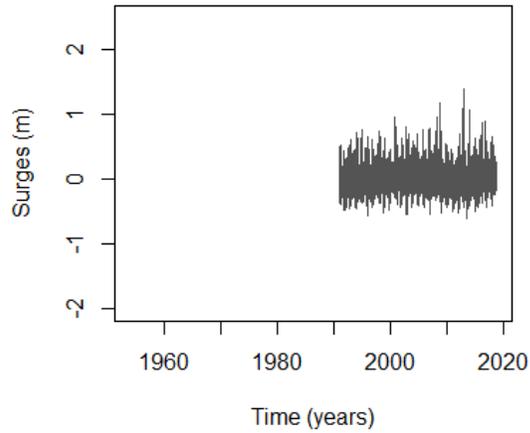
Prédiction de marées

Données météo :

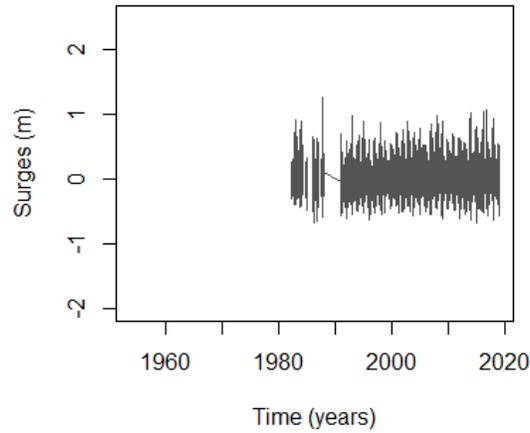
- Modèle Météo France Arome
- Météo sémaphore
- Carte synoptique champs de pression de surface
- Bouée en Manche



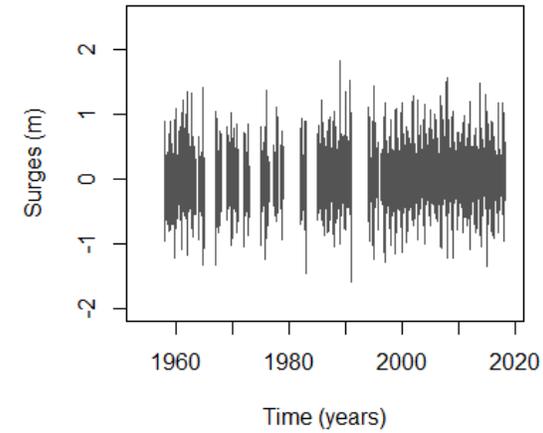
Surges at Weymouth



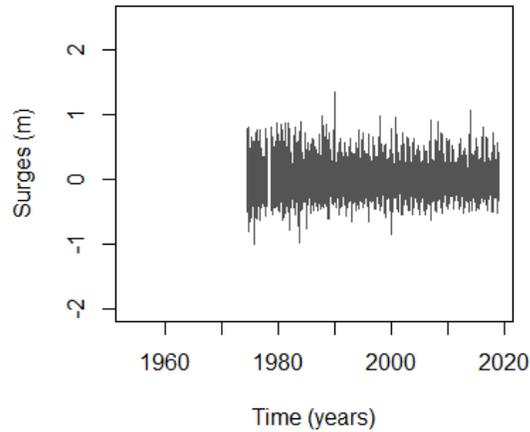
Surges at Newhaven



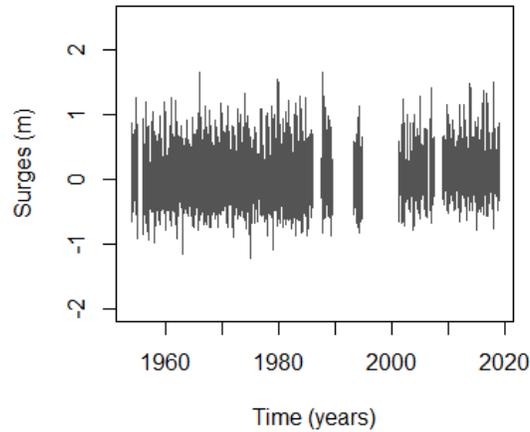
Surges at Dover



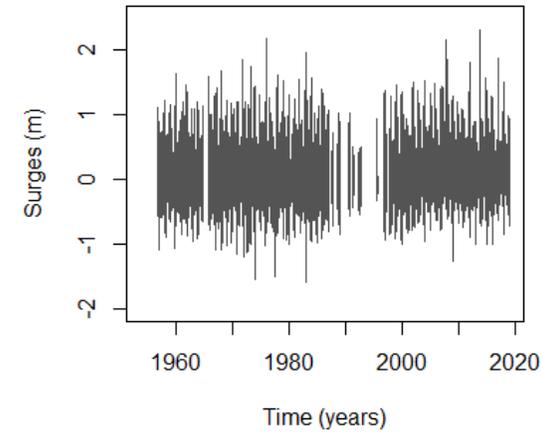
Surges at Cherbourg



Surges at Dieppe



Surges at Dunkerque

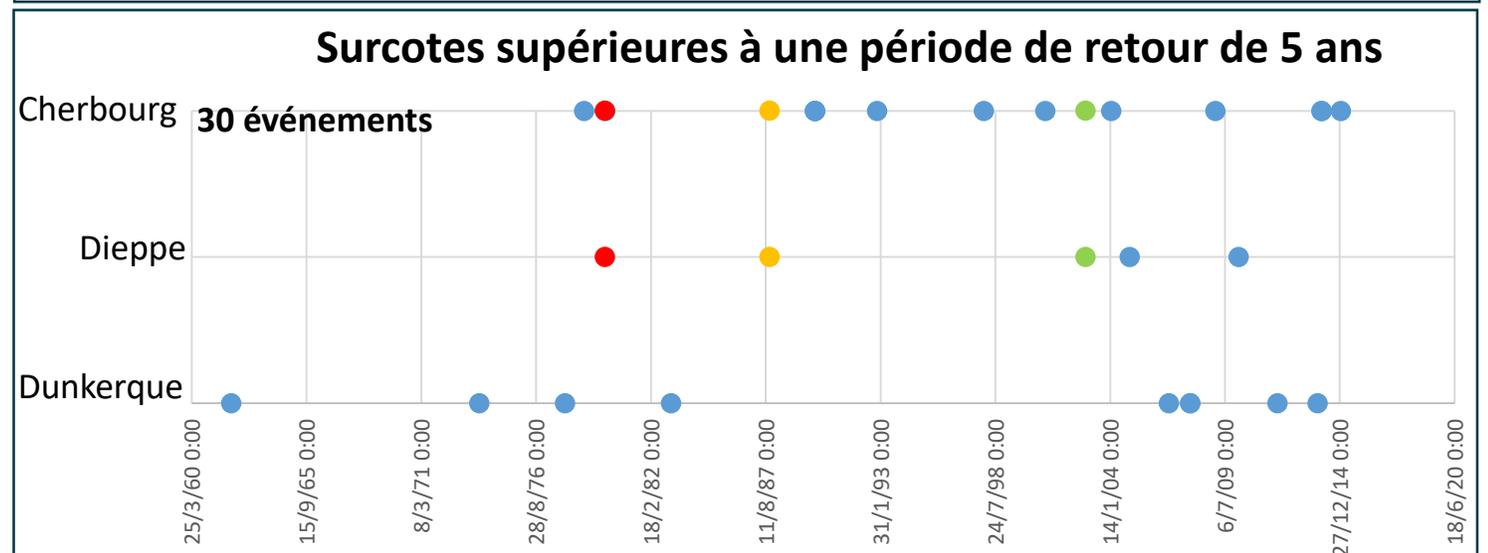
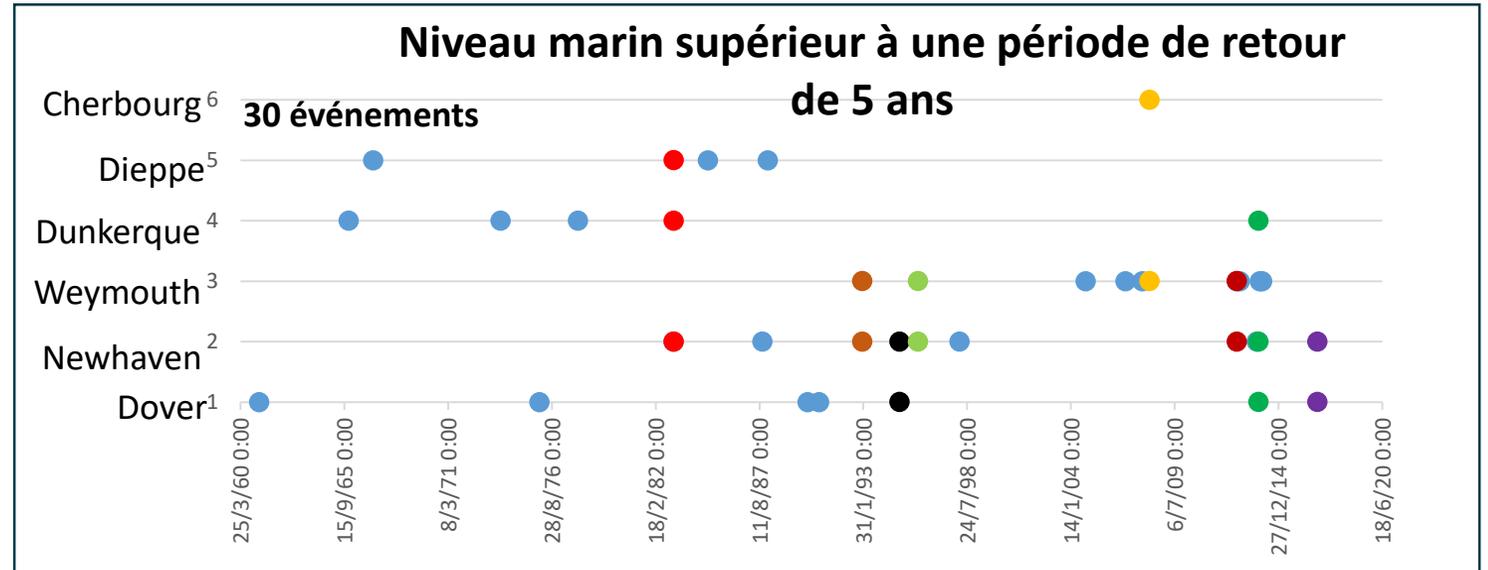


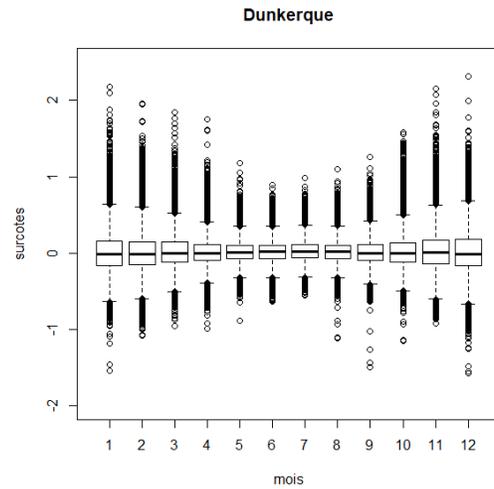
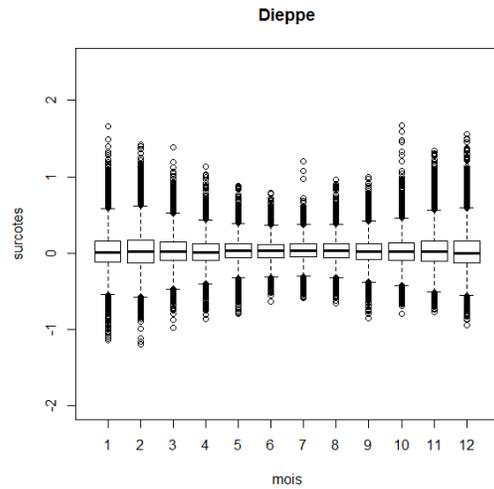
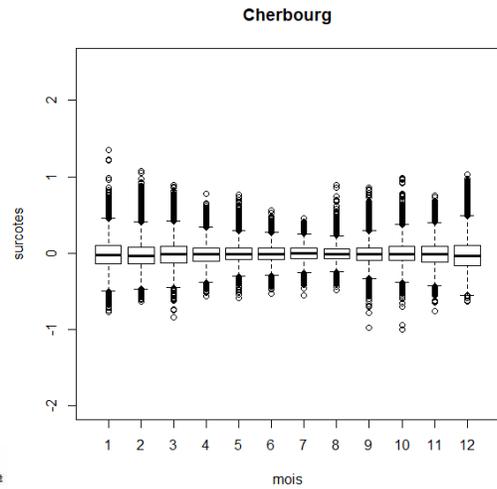
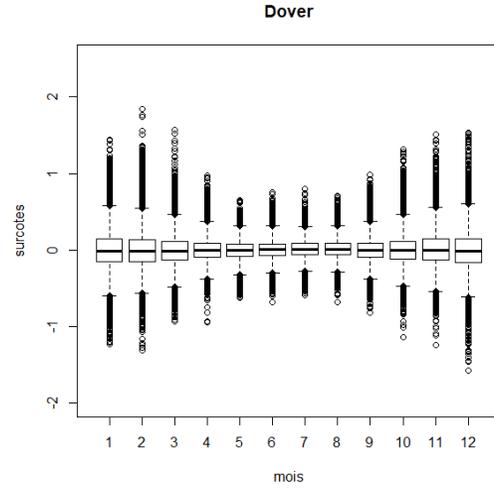
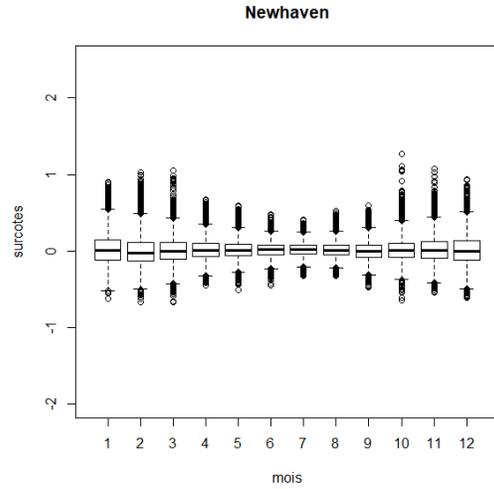
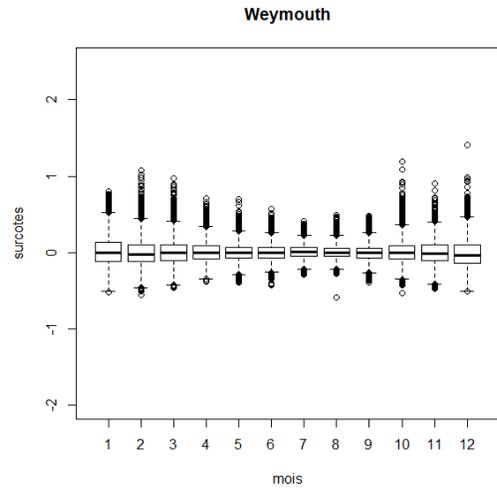
A partir de ces résultats :

- Evolution fréquence et intensité phénomènes extrêmes
- Analyse de chaque événement
- Conditions météo préférentielles de survenue des épisodes
- Submersion marine / quels secteurs impactés

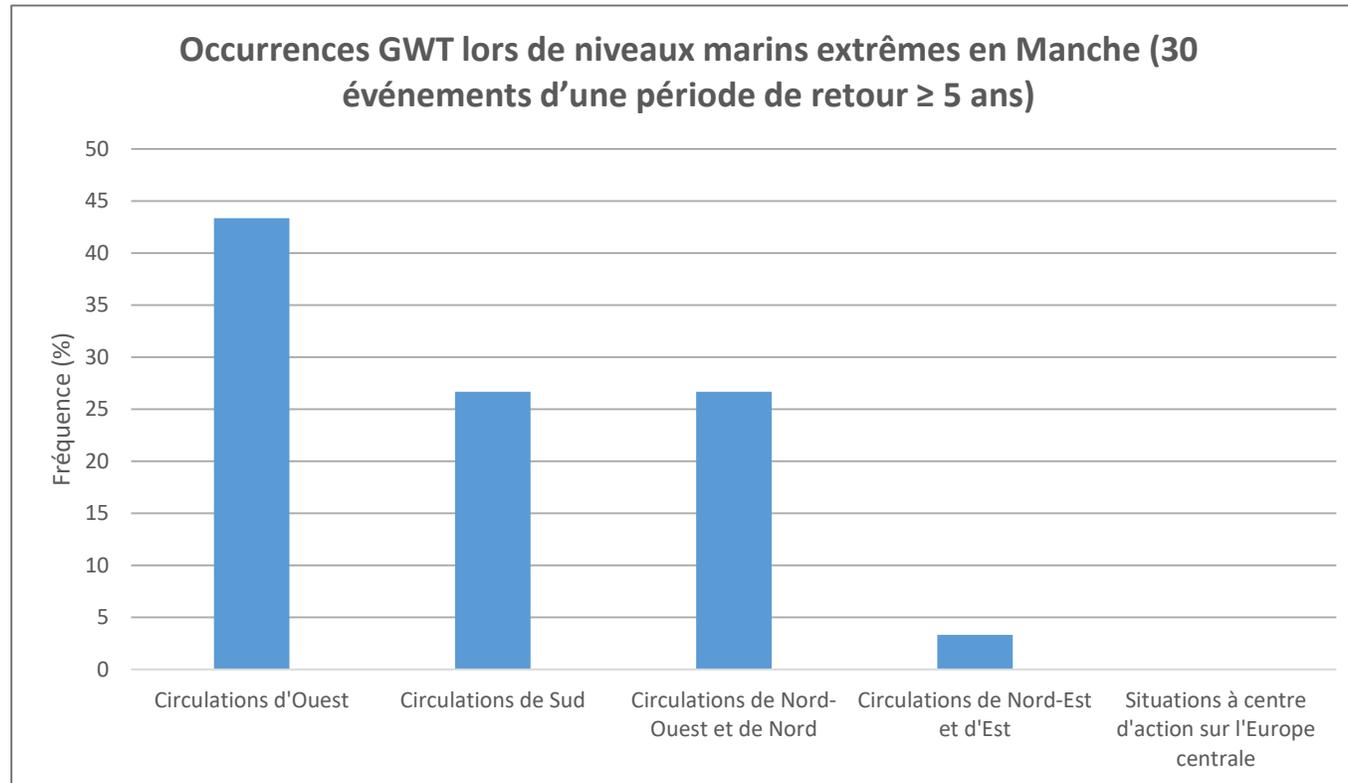
Plus forte surcote à marée haute (surcote max) :

- Cherbourg : 0,93 (1,35)
- Dieppe : 1,67 (1,67)
- Dunkerque : 1,31 (2,31)
- Weymouth : 1,19 (1,4)
- Newhaven : 1,06 (1,27)
- Dover : 1,50 (1,84)

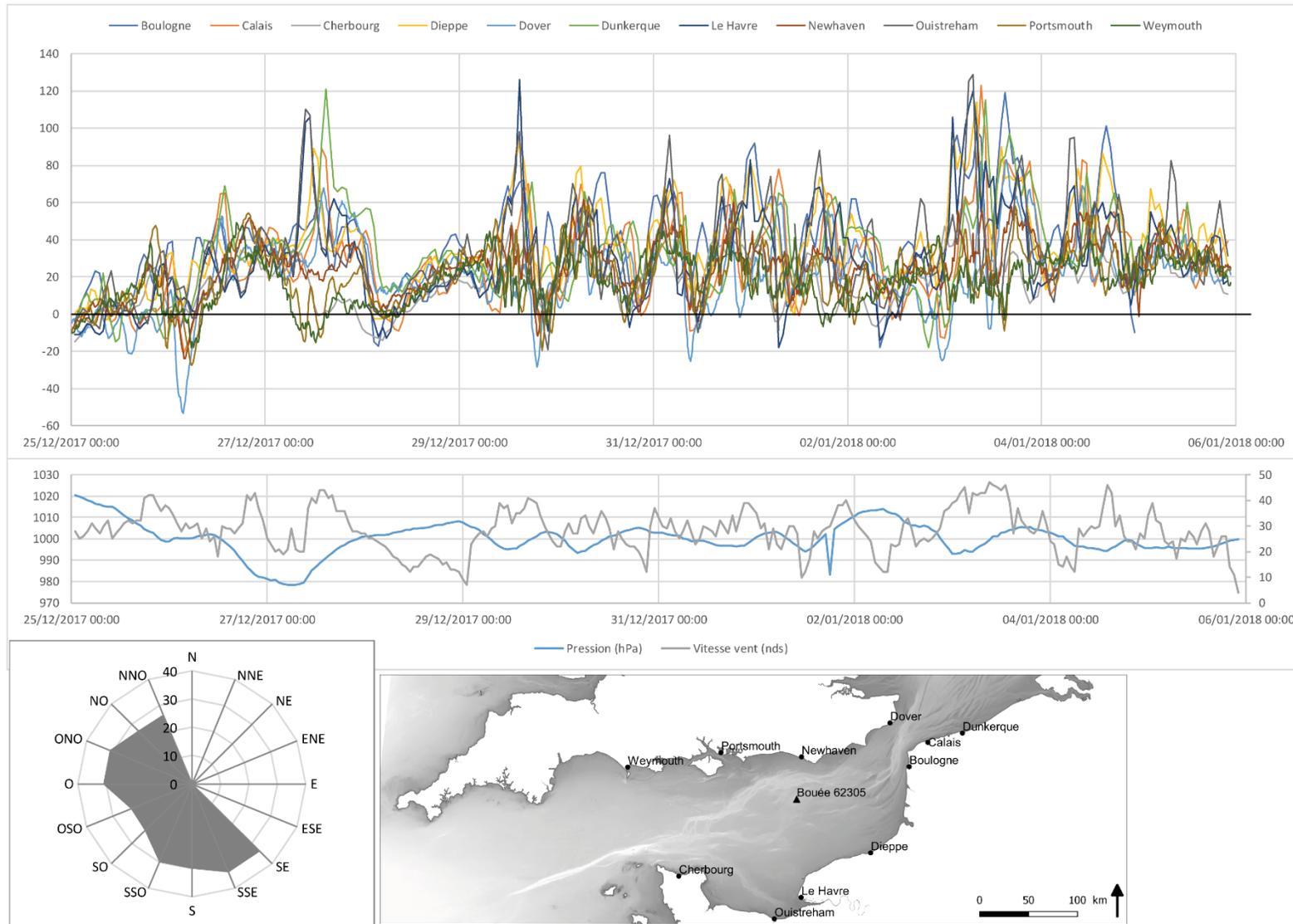


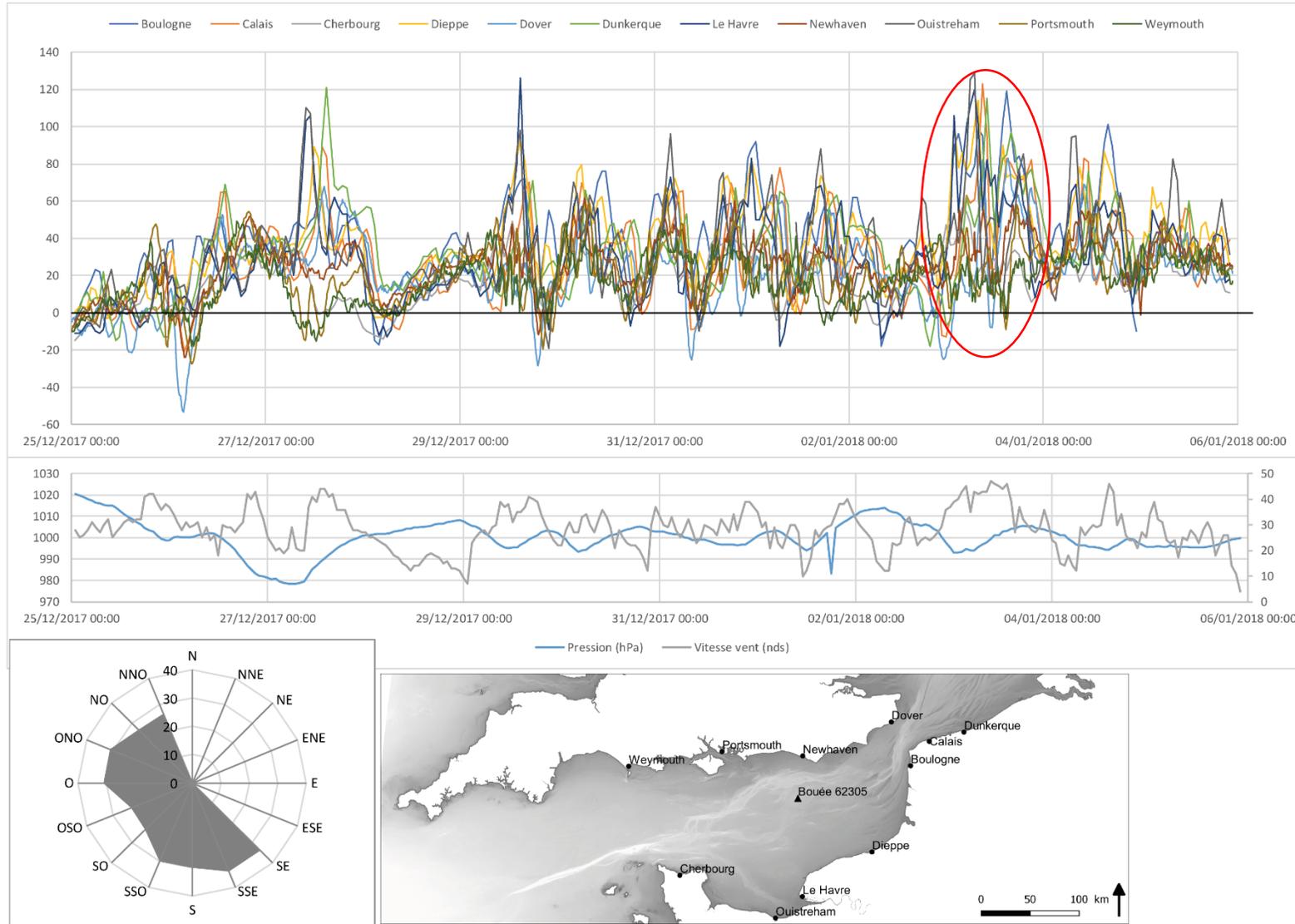


Forte variabilité saisonnière
des surcotes
Gradients ouest-est et nord-
sud



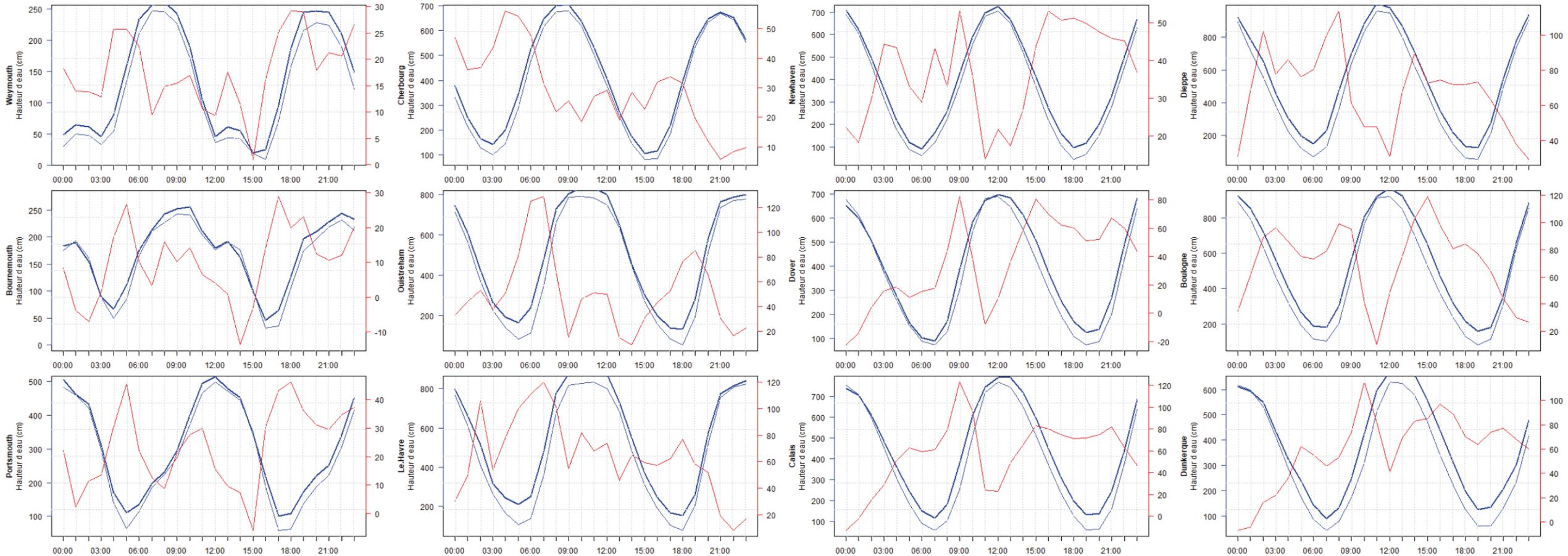
- Classification des grands types de circulation atmosphérique d'échelle synoptique sur l'Europe
- Occurrence de ces circulations lors des niveaux marins extrêmes
- Prédominance des circulations d'Ouest, Nord-ouest et Nord puis Sud





L'exemple du 3 janvier 2018

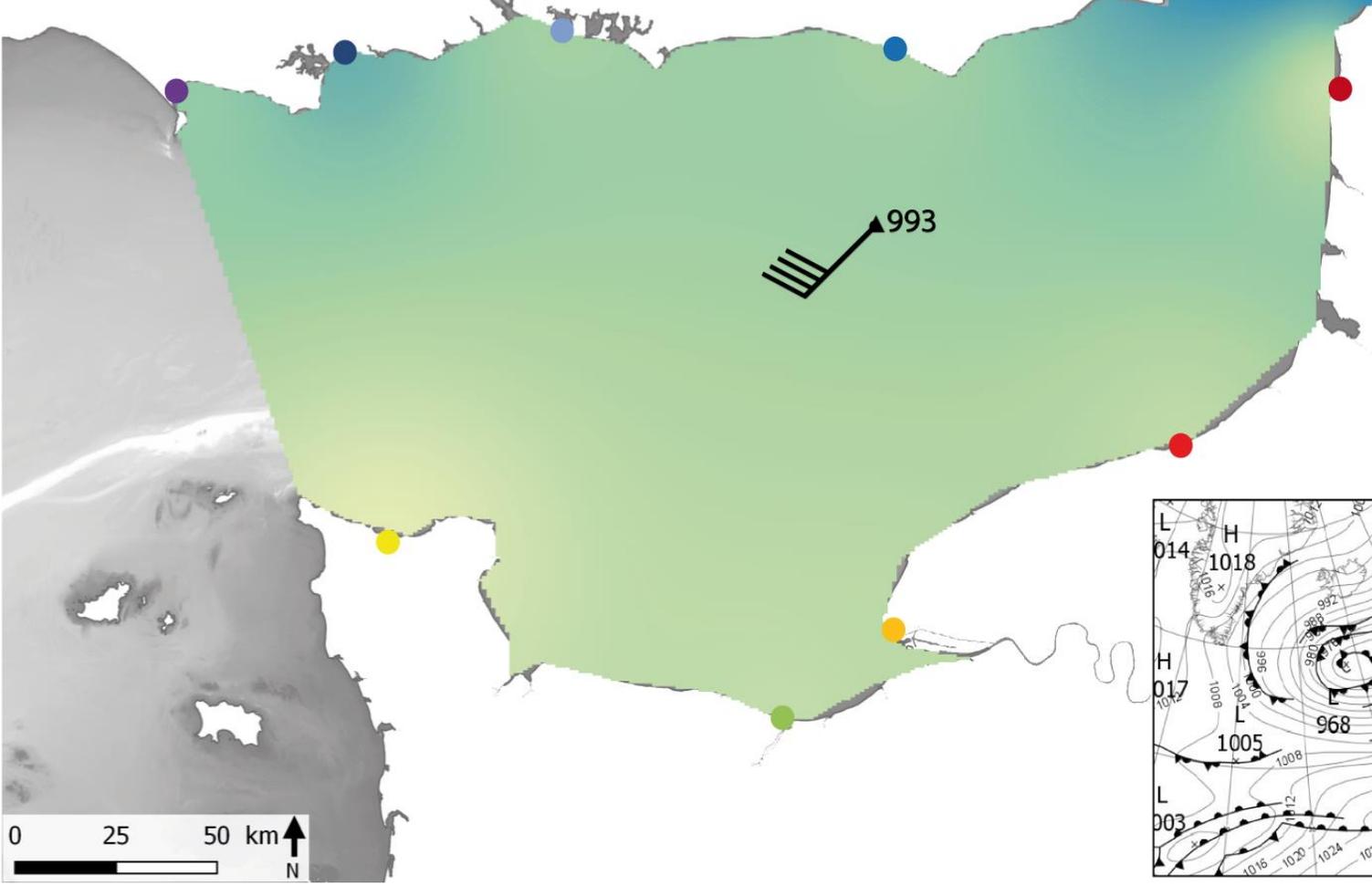
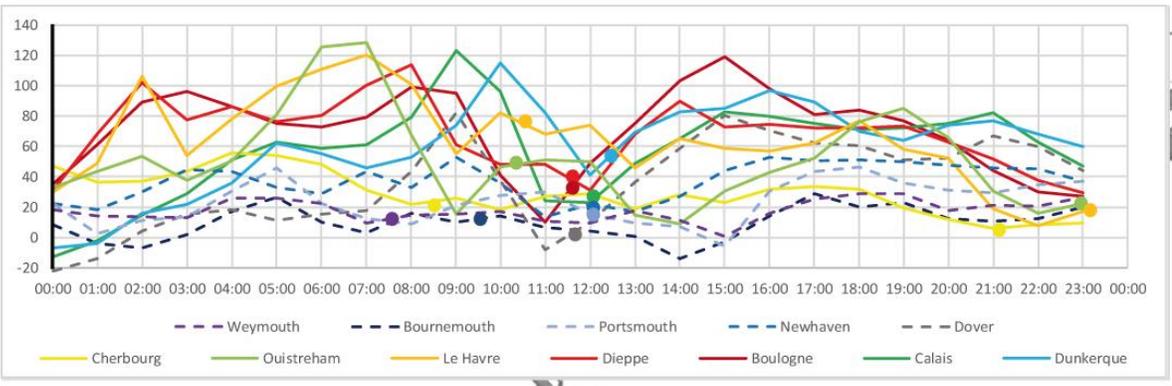
- Pics de surcotes rarement à marée haute
 - Plusieurs pics successifs observés à chaque marégraphe
- besoin de l'approche spatiale pour comprendre



27/03/2019

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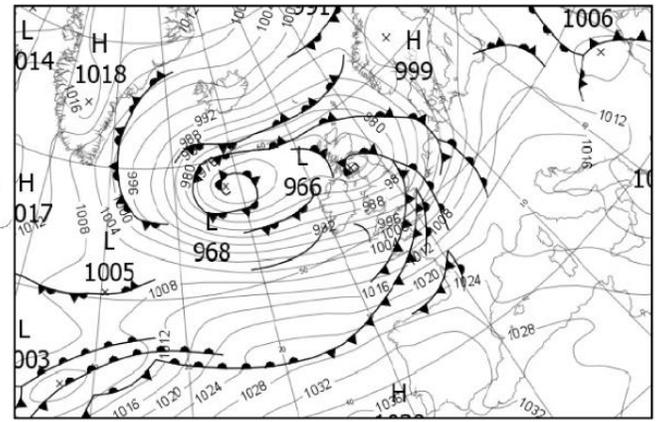


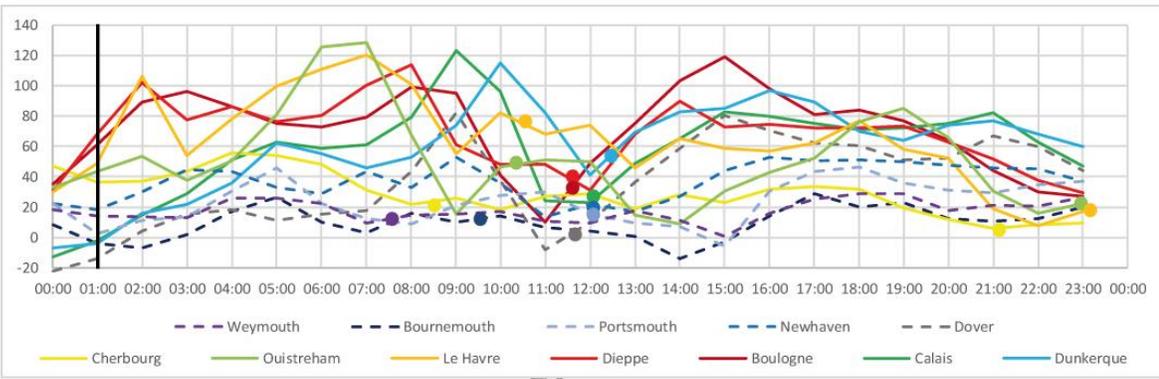
Surcotes (cm)

- 8
- 24
- 56
- 88
- 120

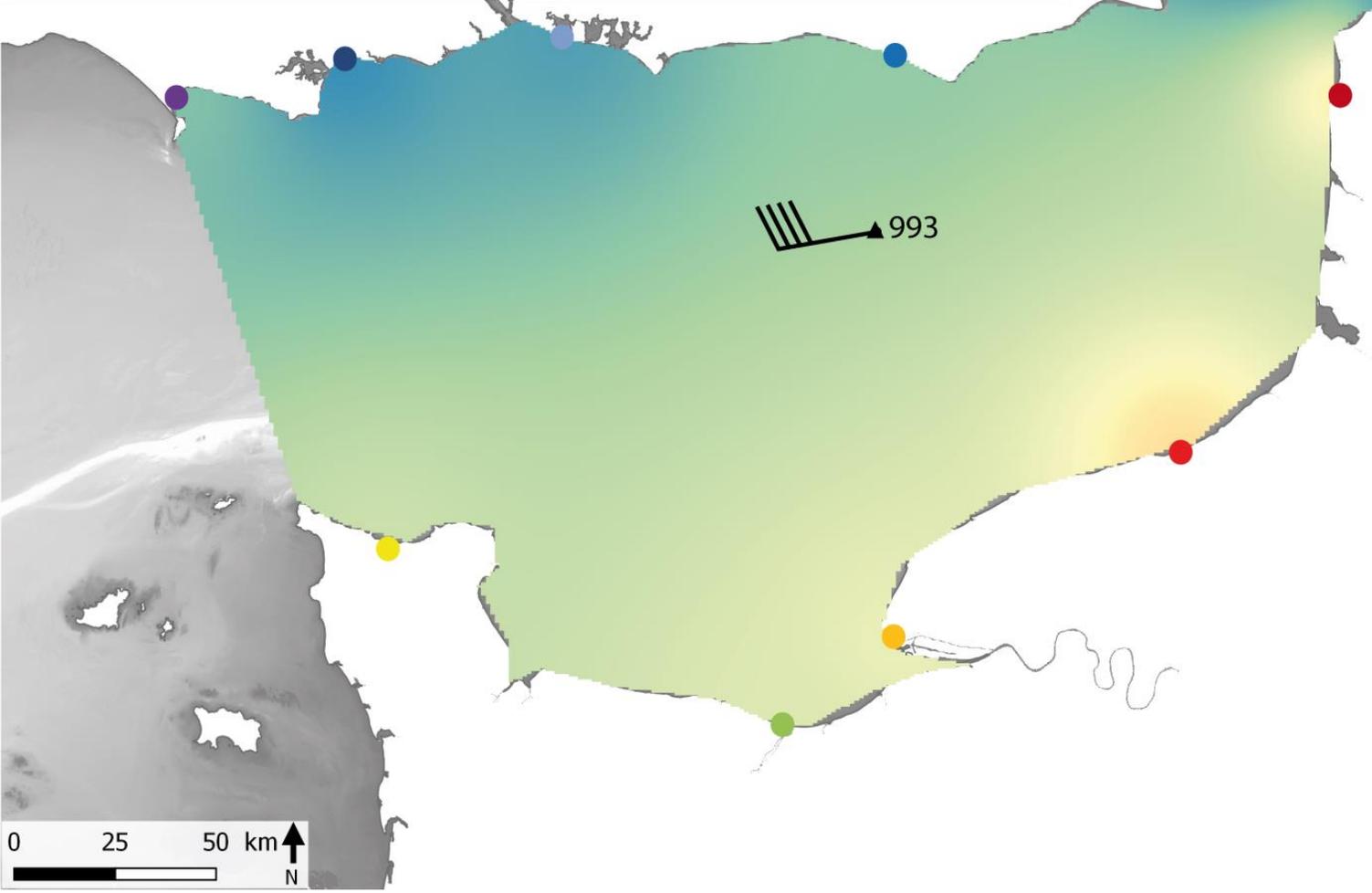
Vent moyen

- 5 kts
- 10 kts
- 50 kts

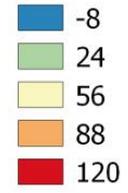




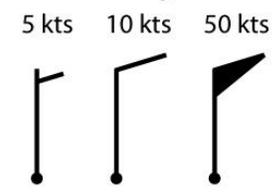
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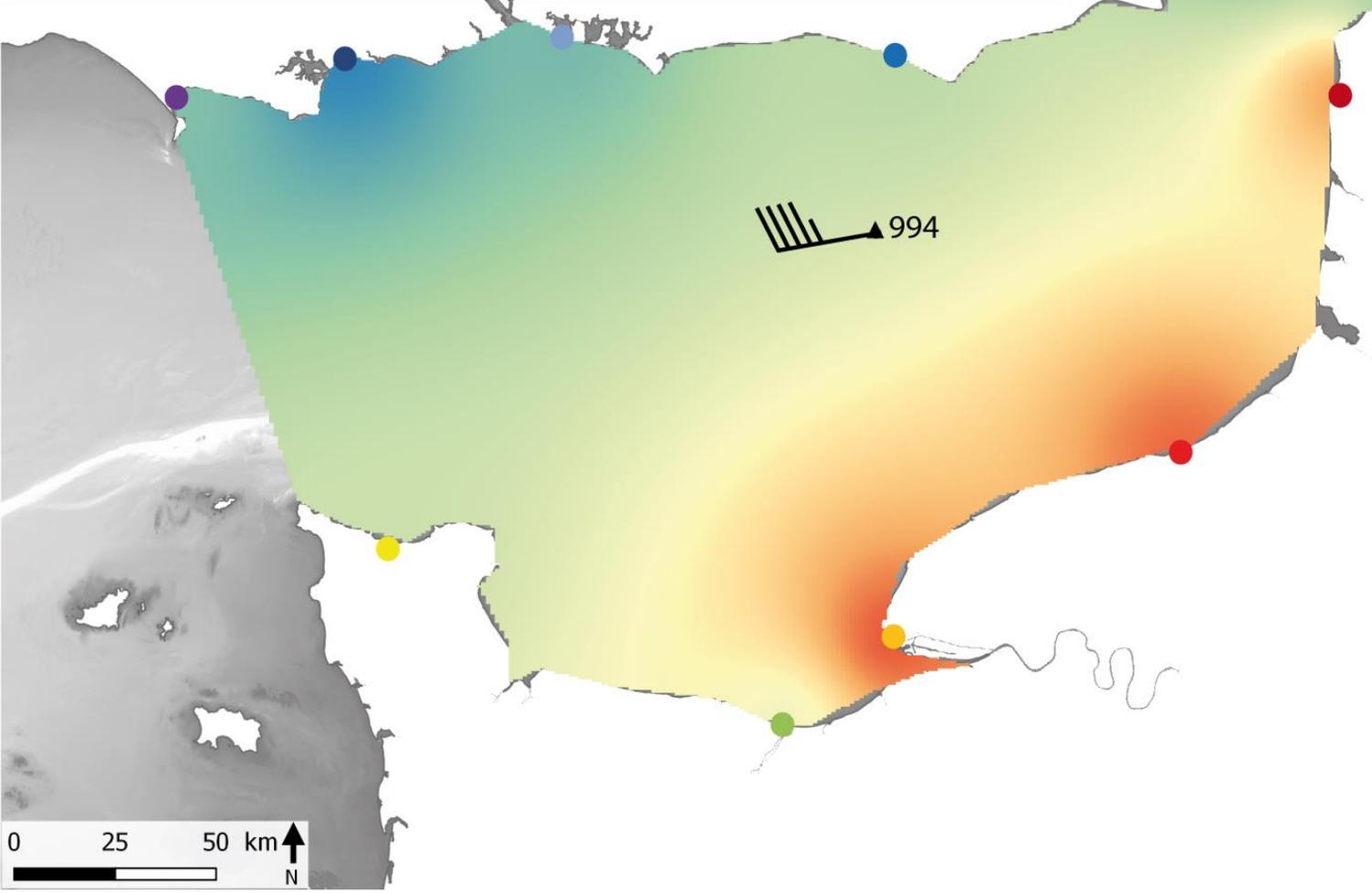
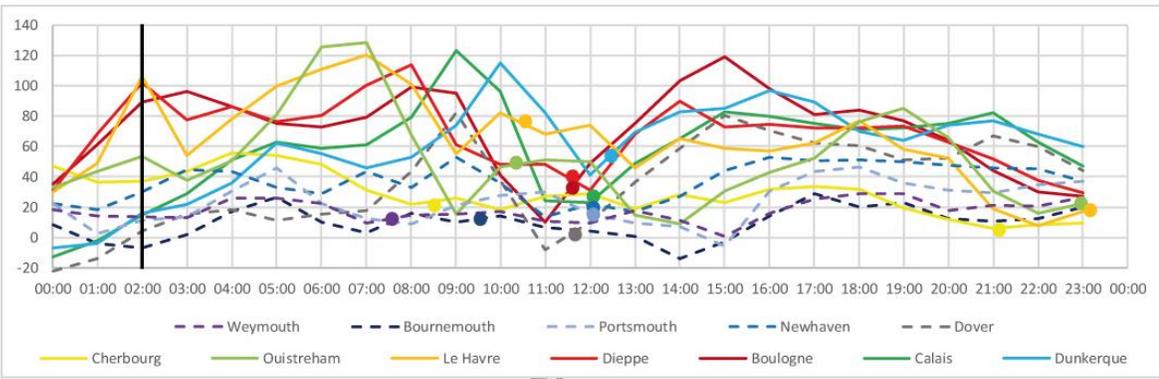


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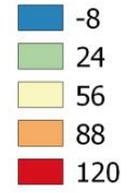


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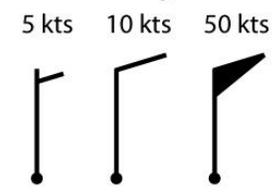


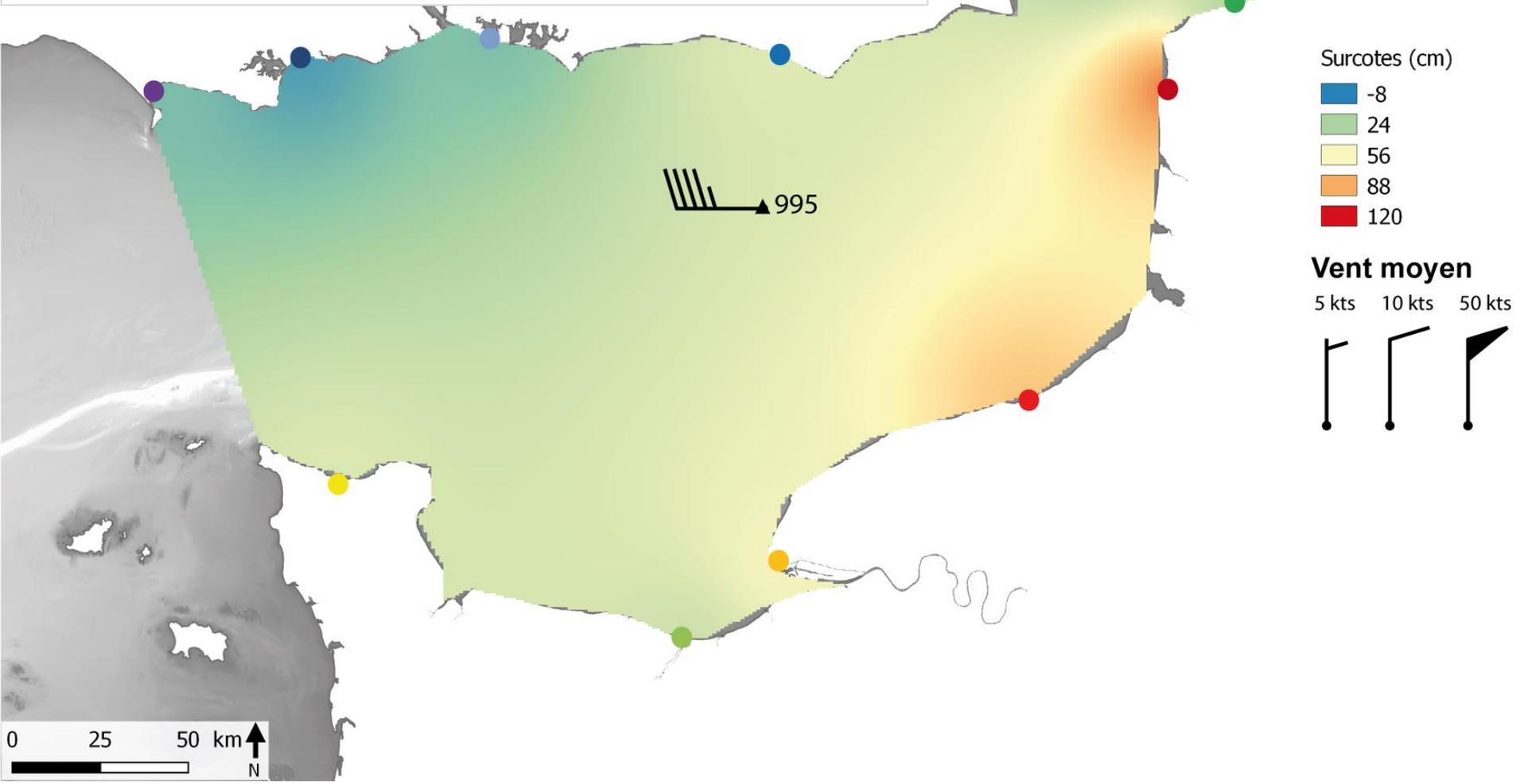
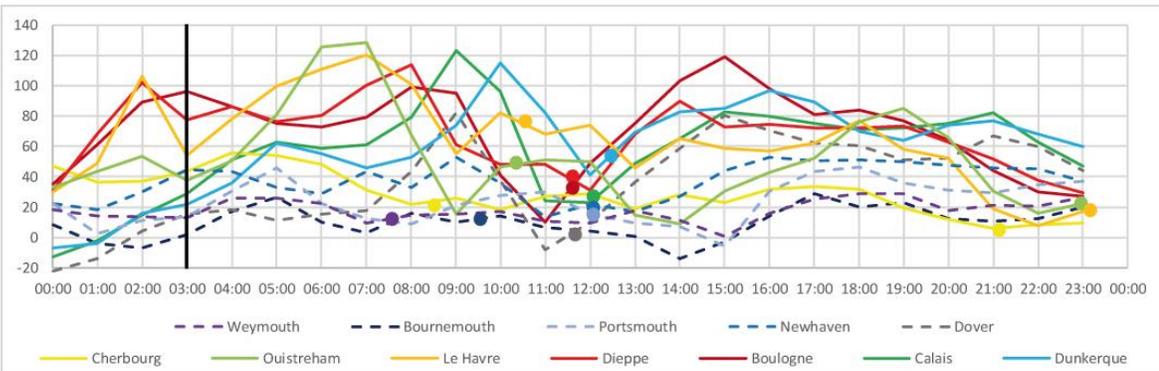


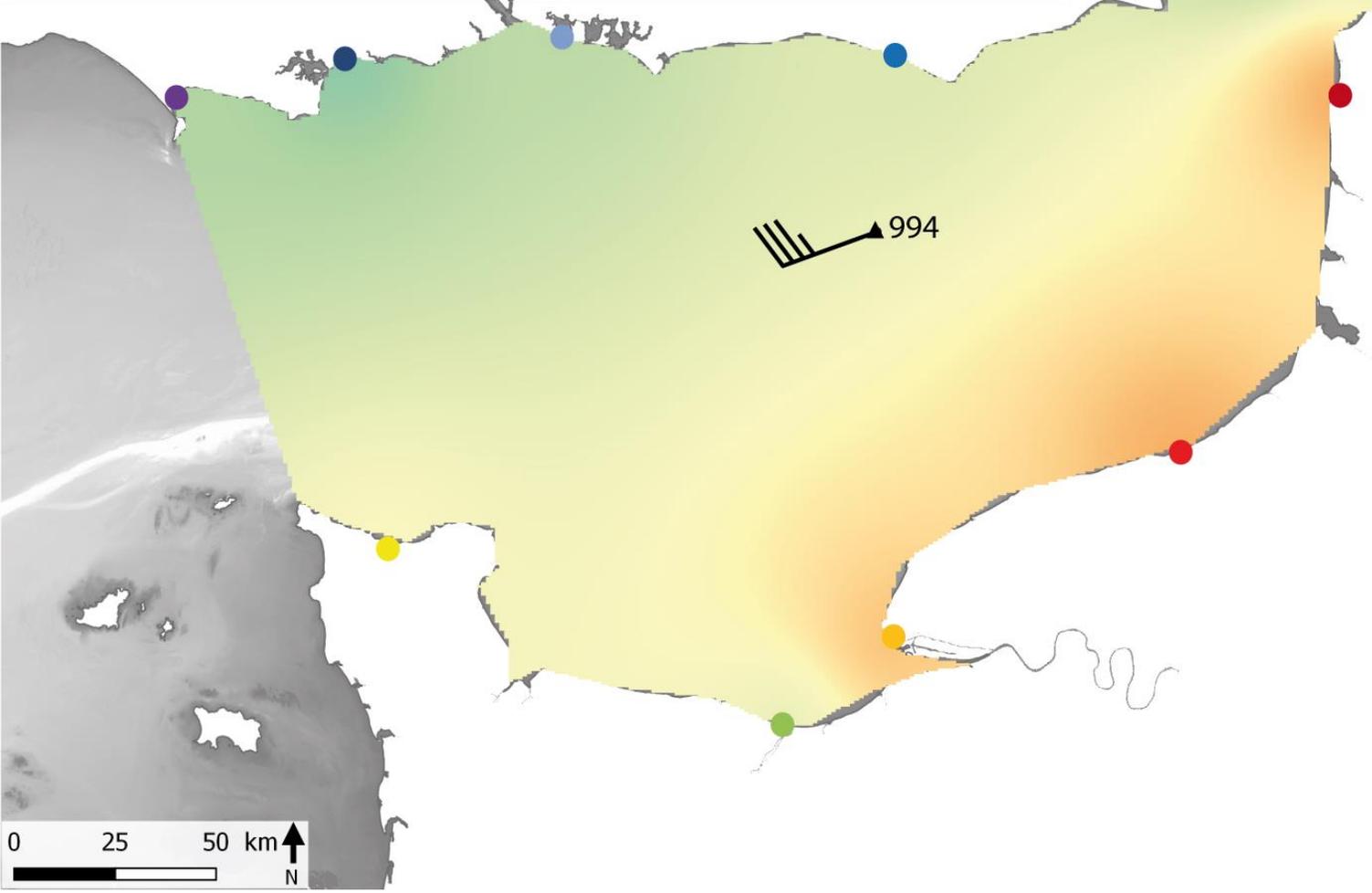
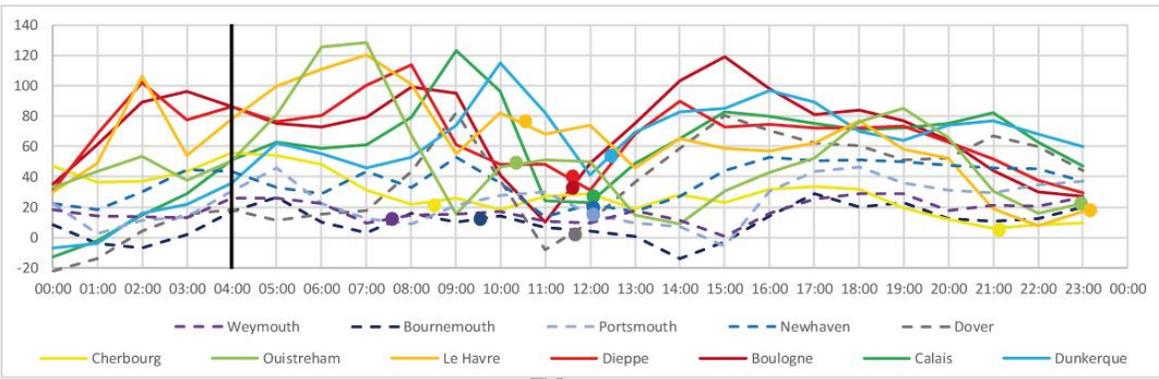
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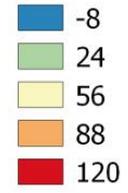
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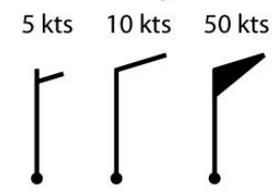


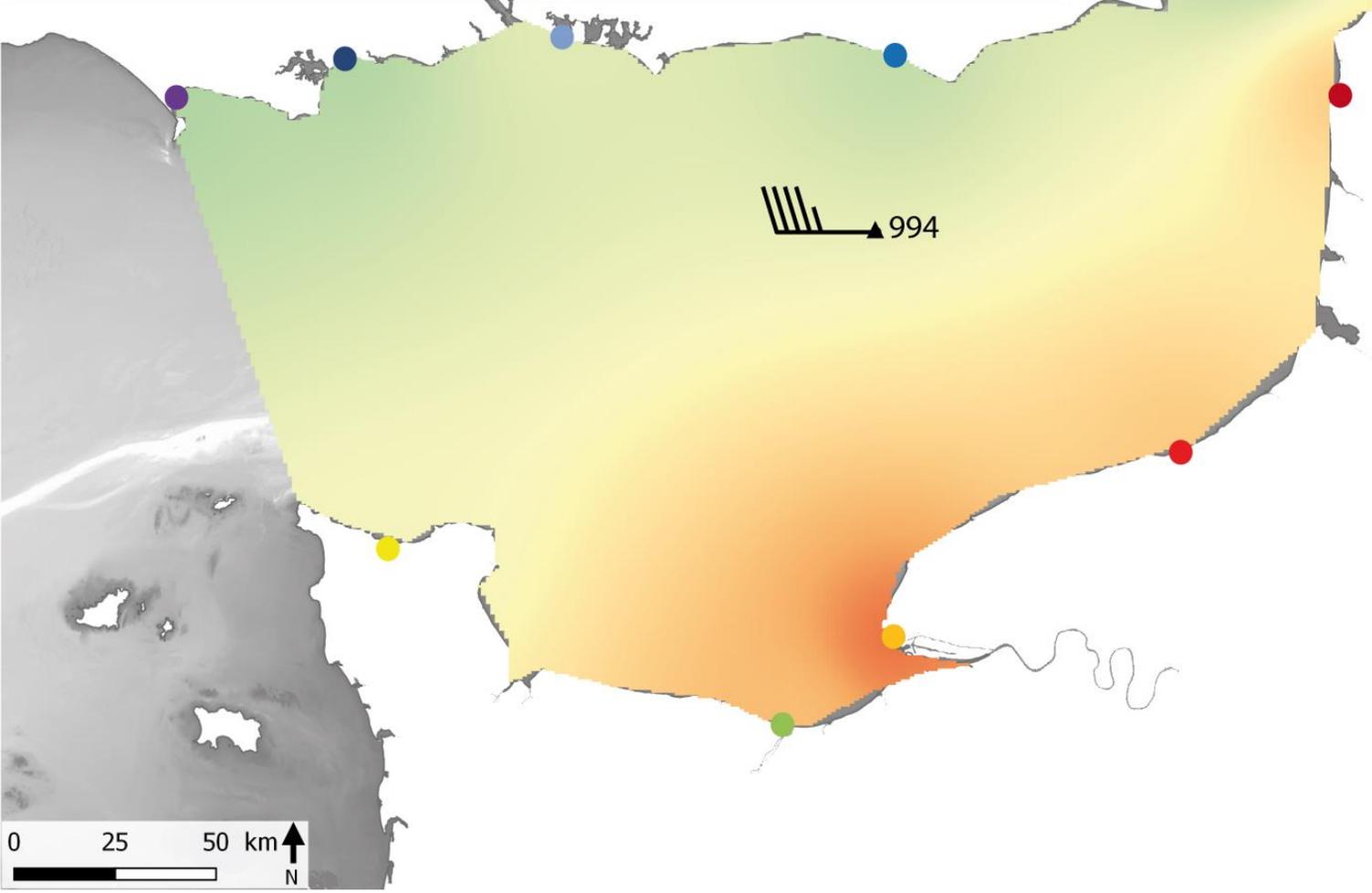
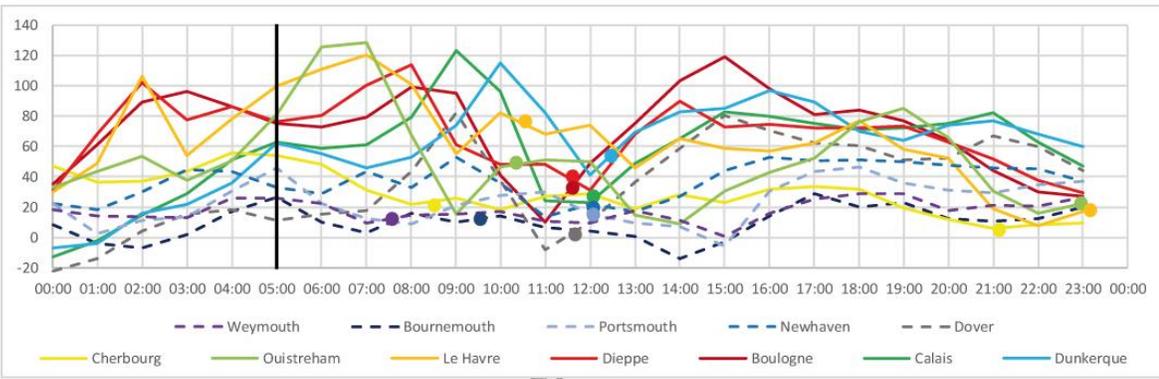


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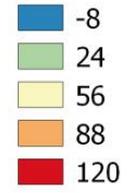


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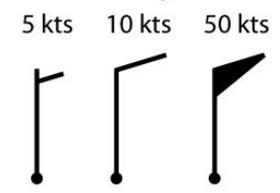


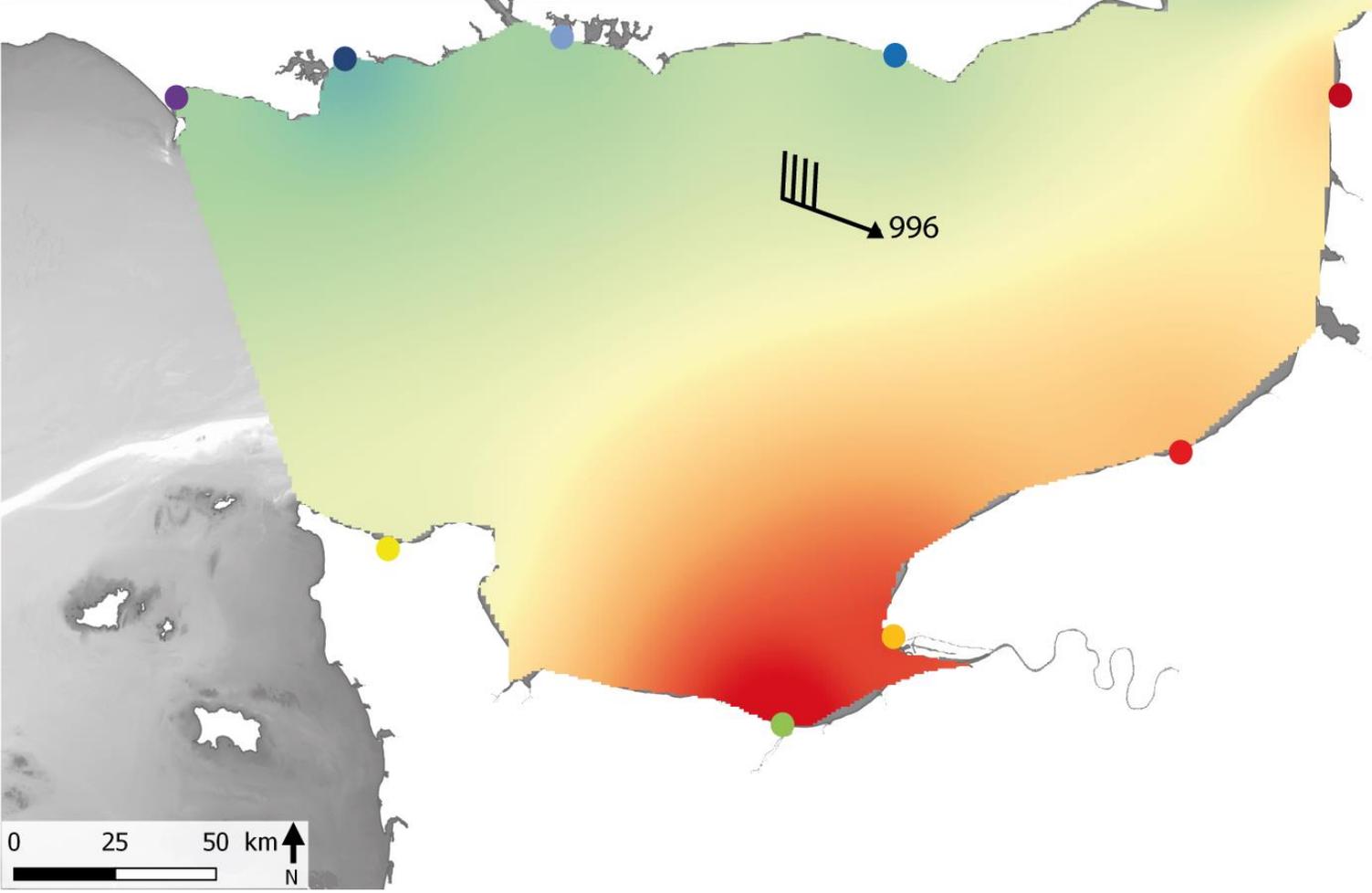
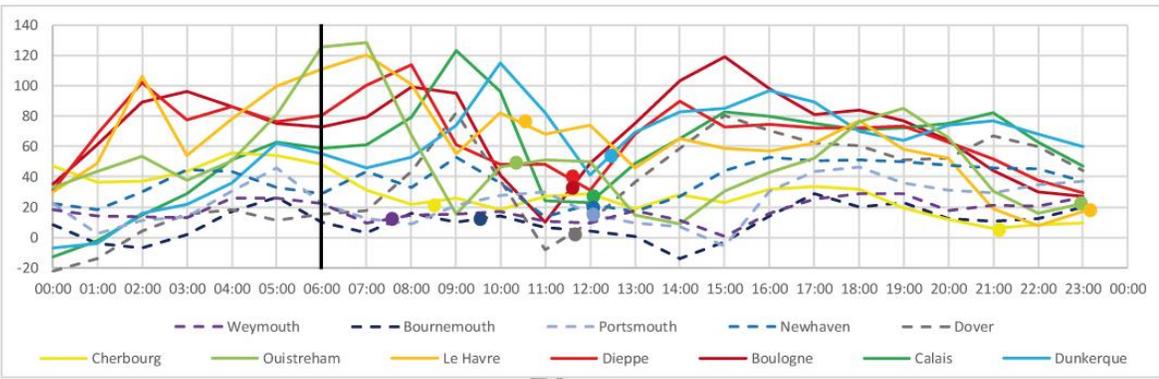


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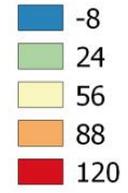


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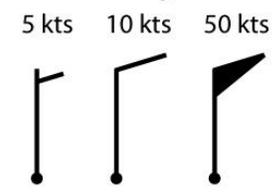


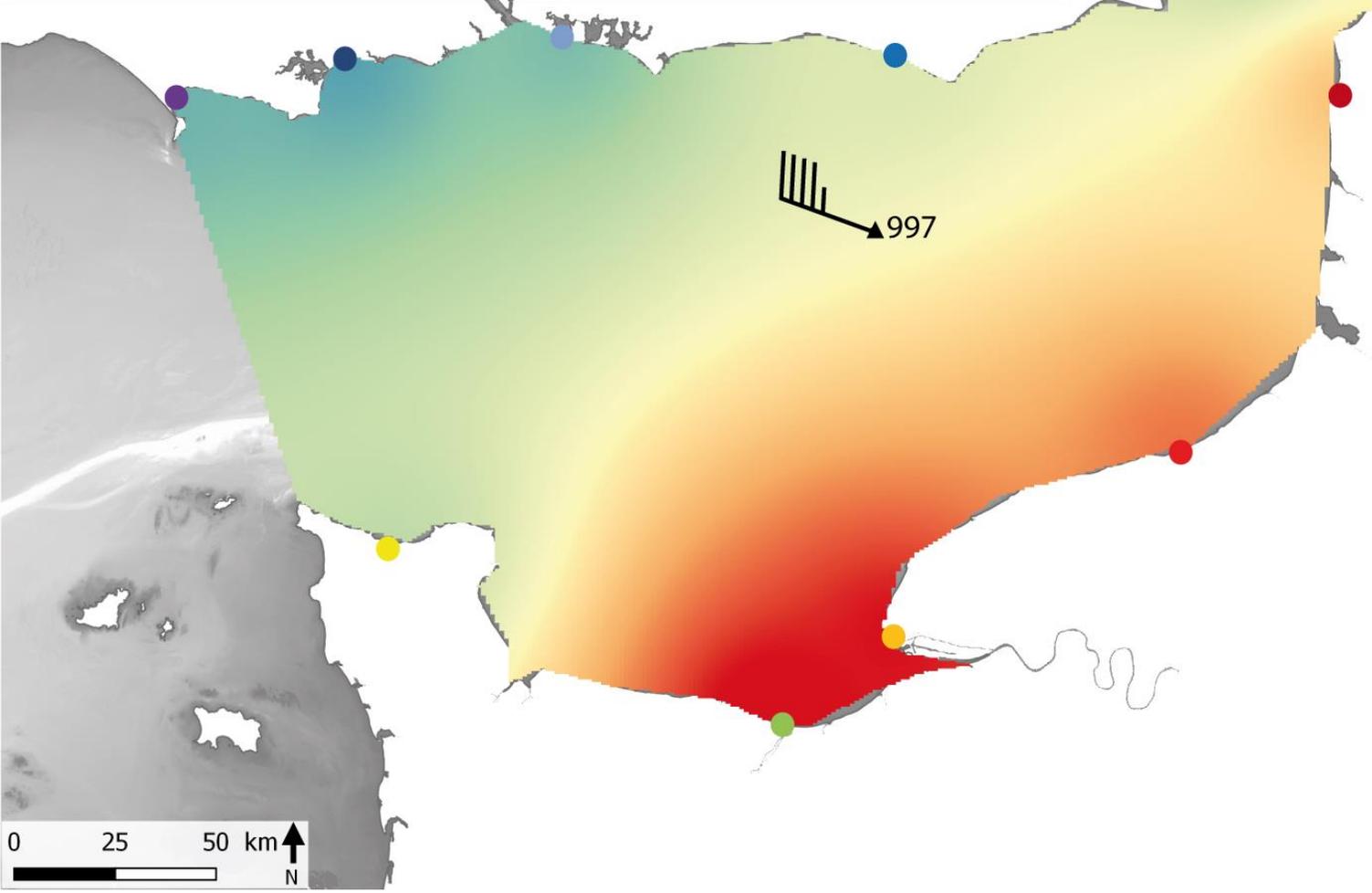
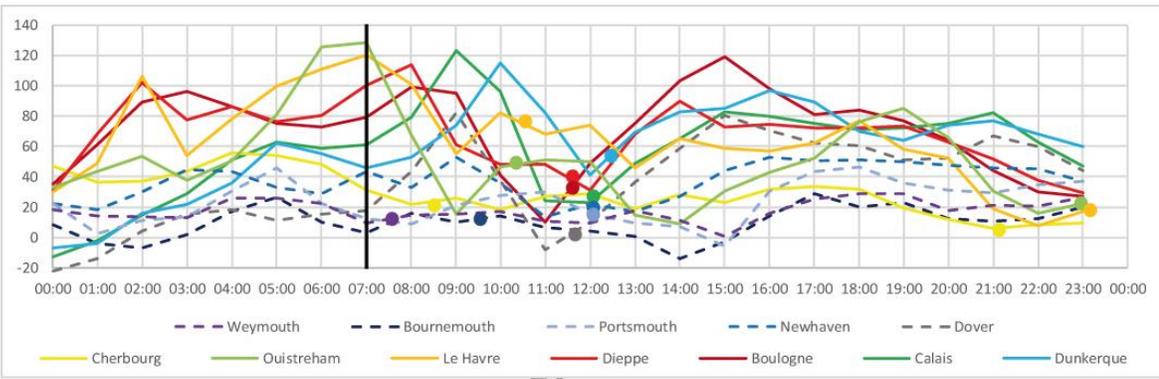


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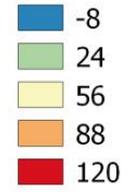


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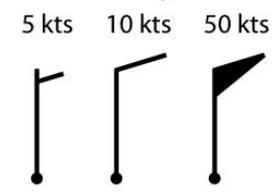


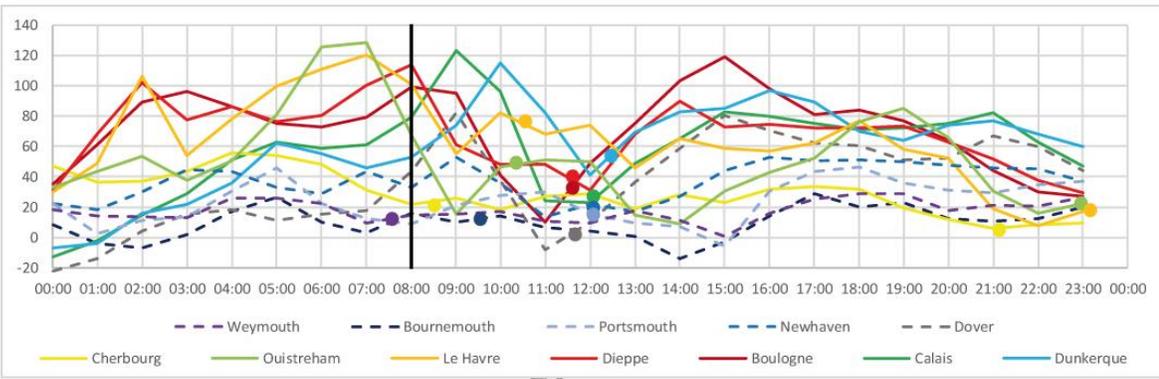


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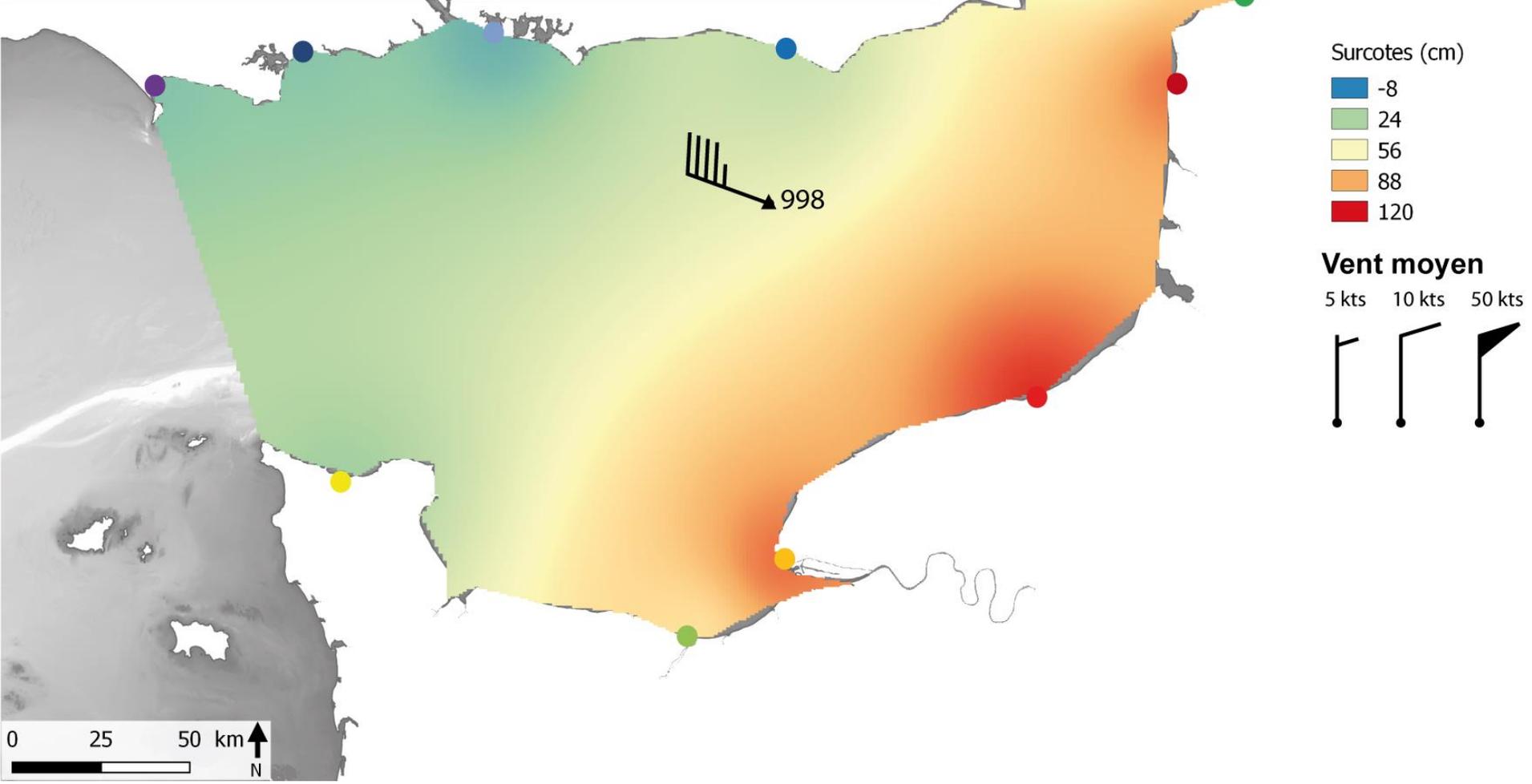


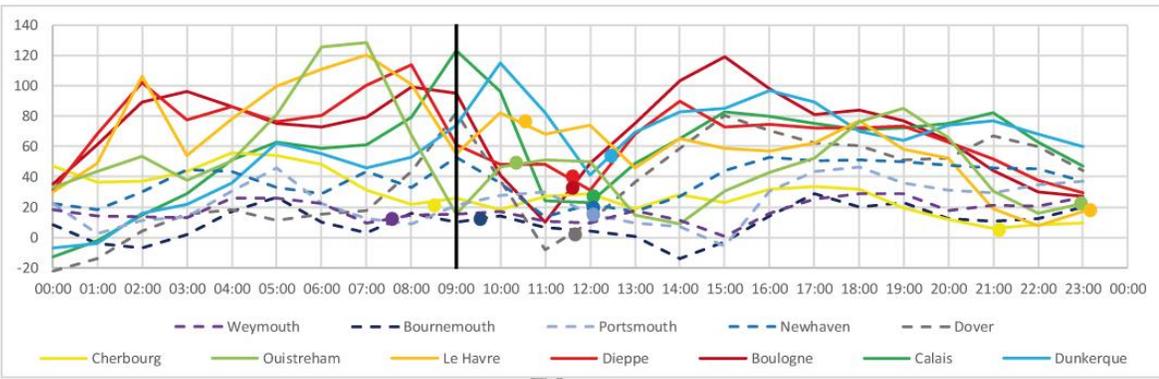
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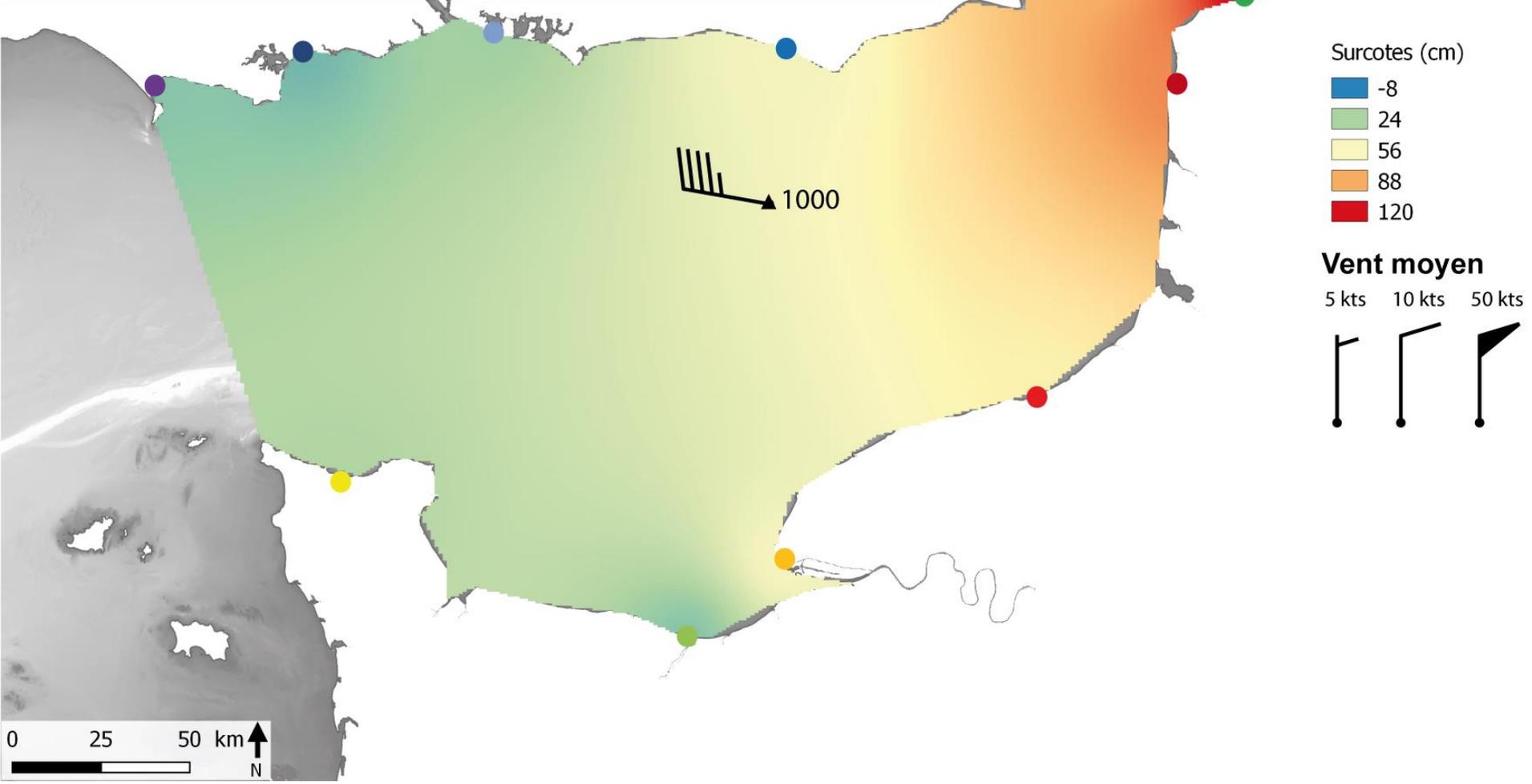


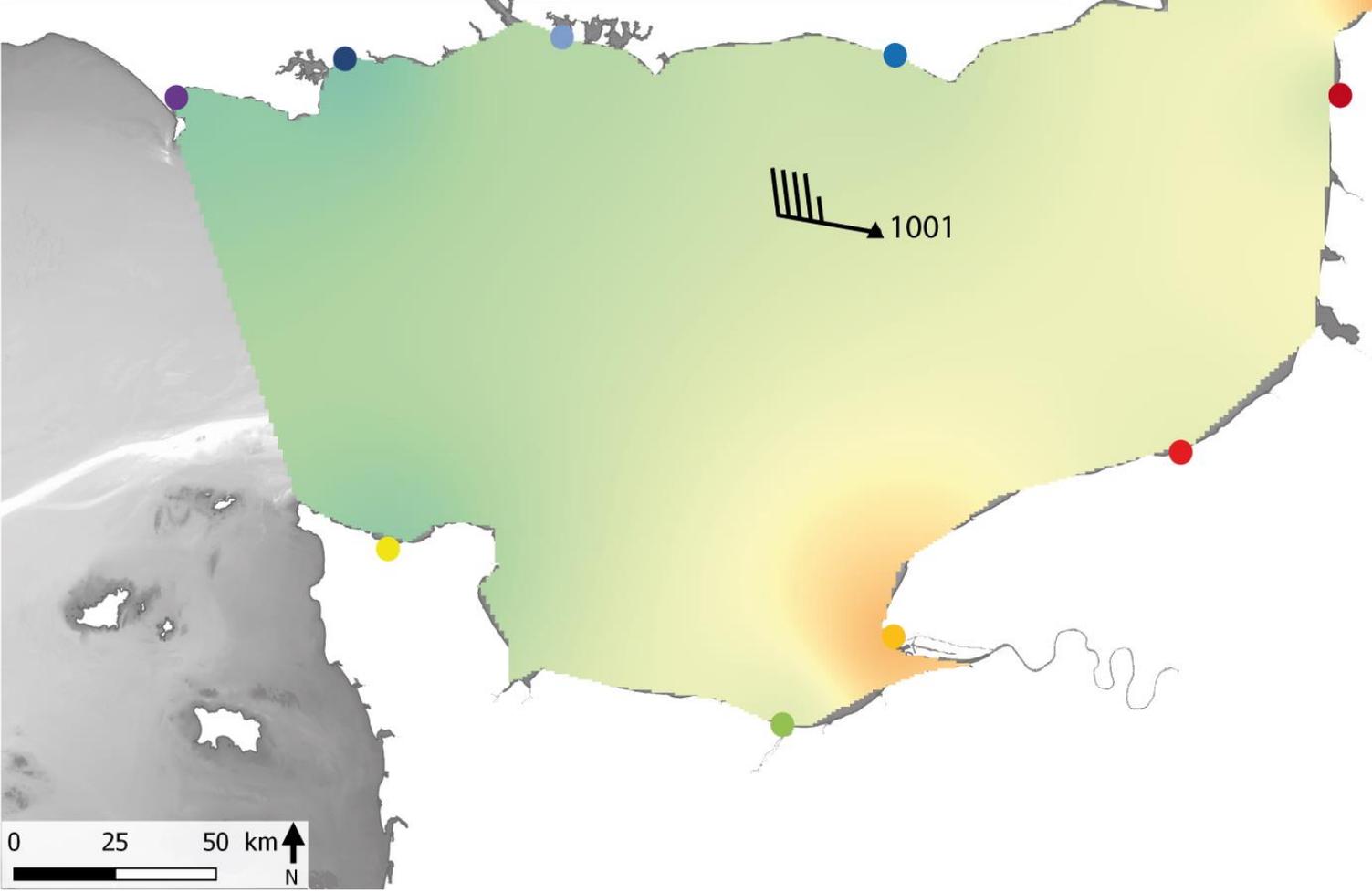
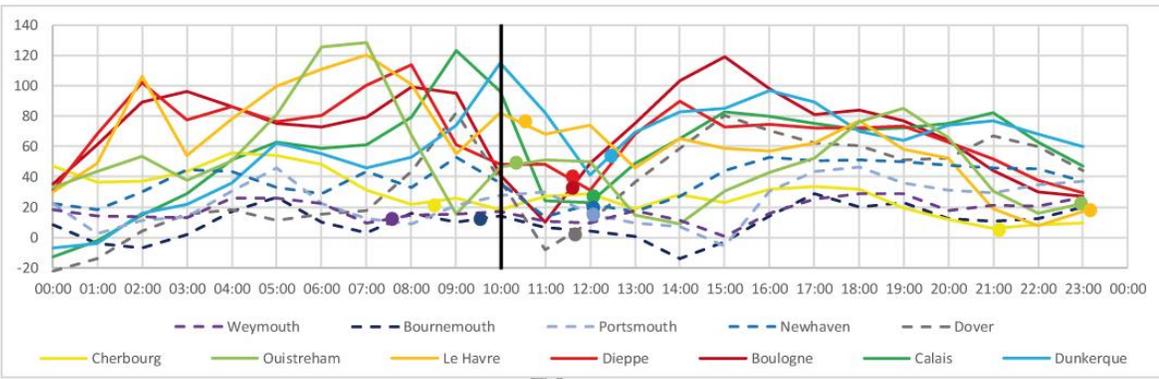
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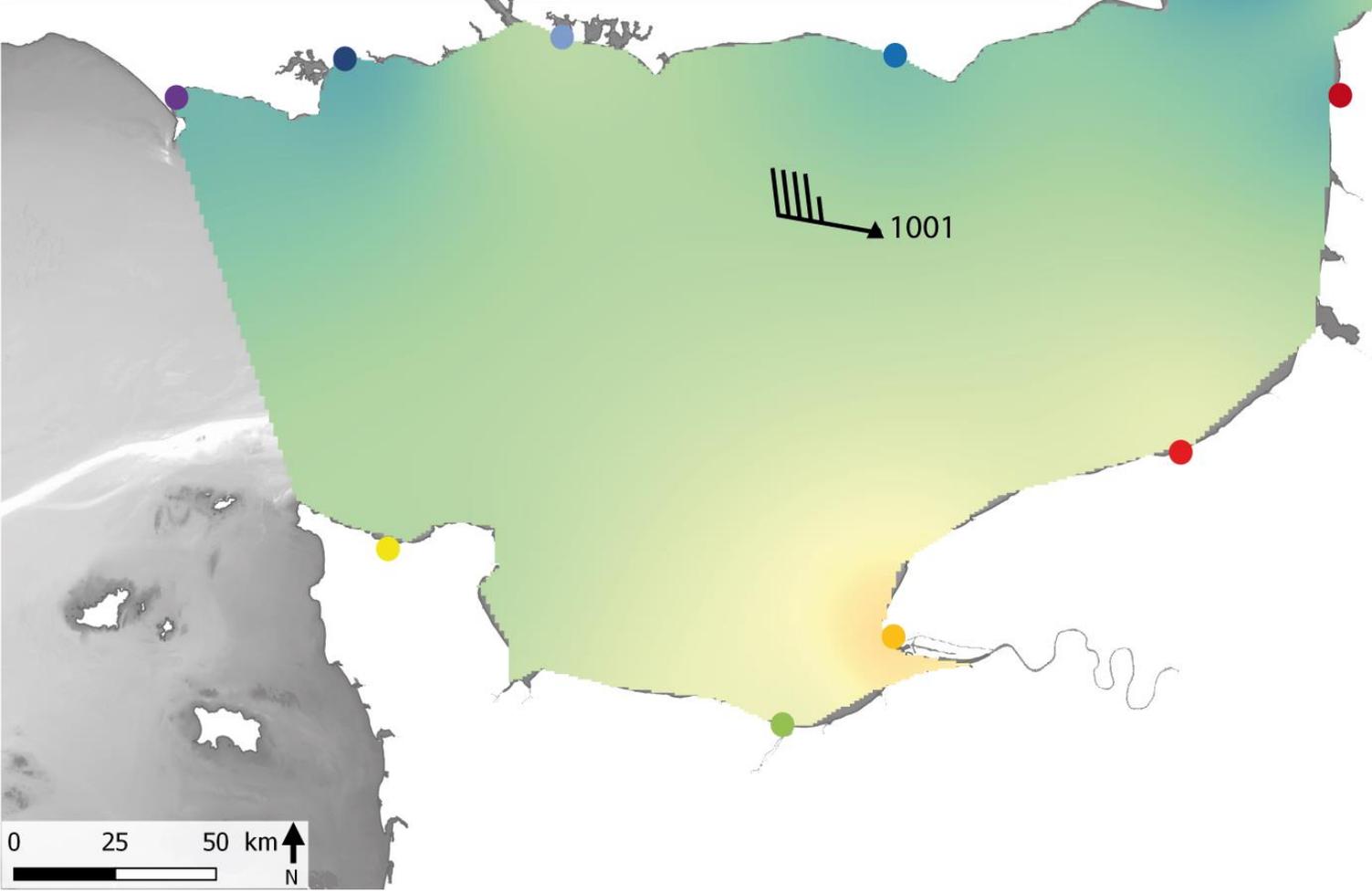
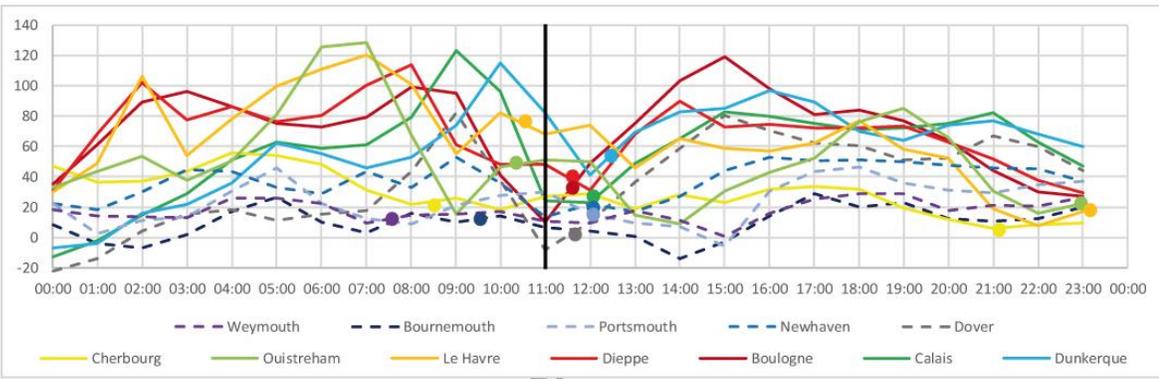
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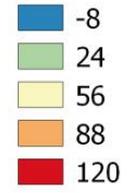
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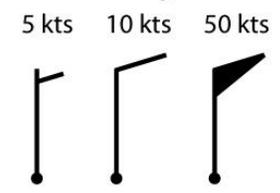


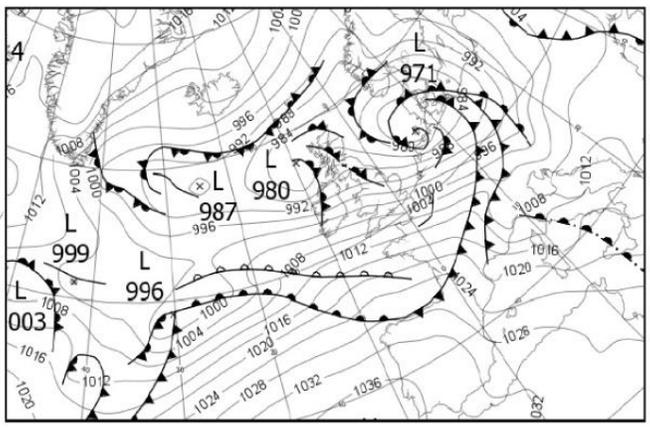
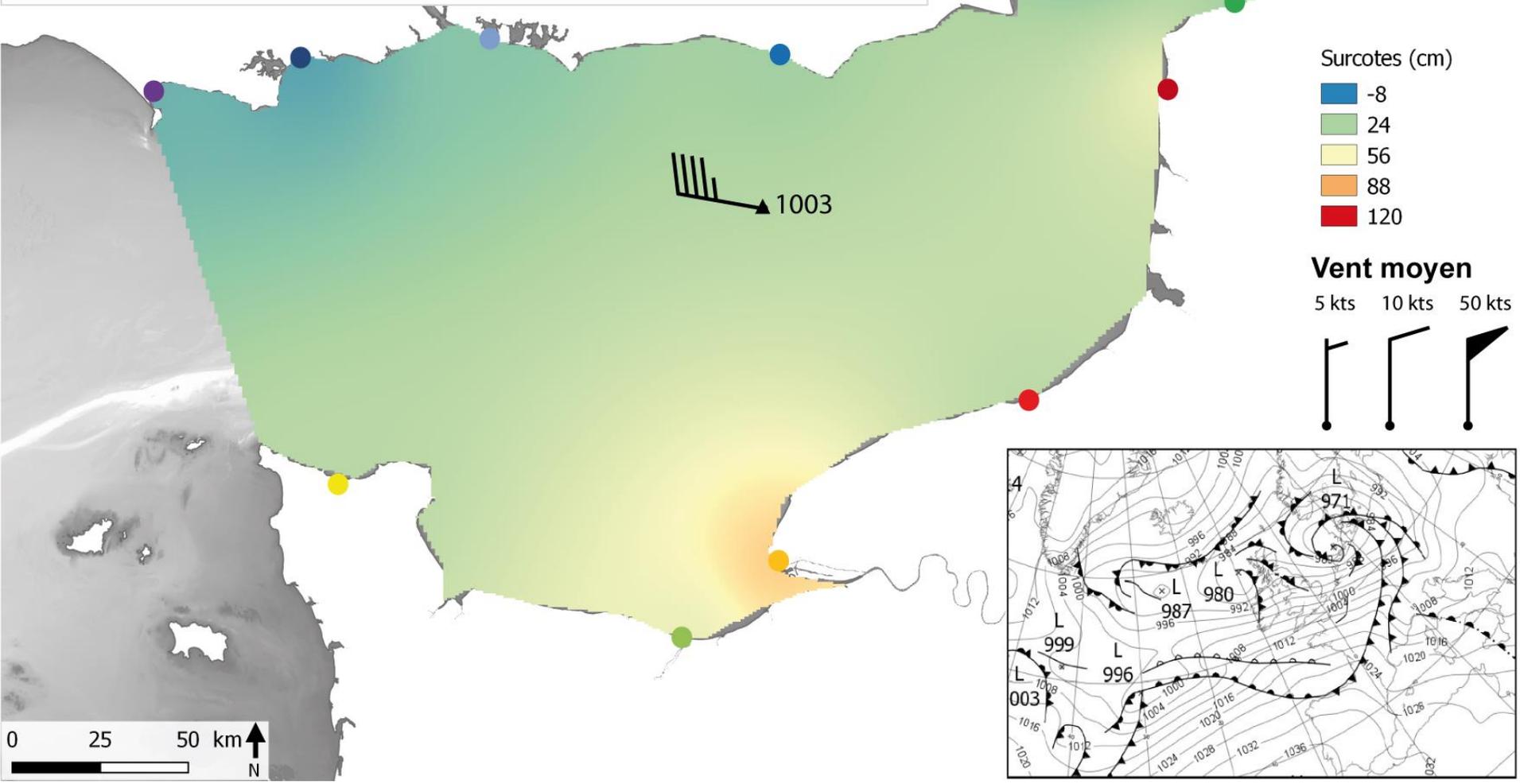
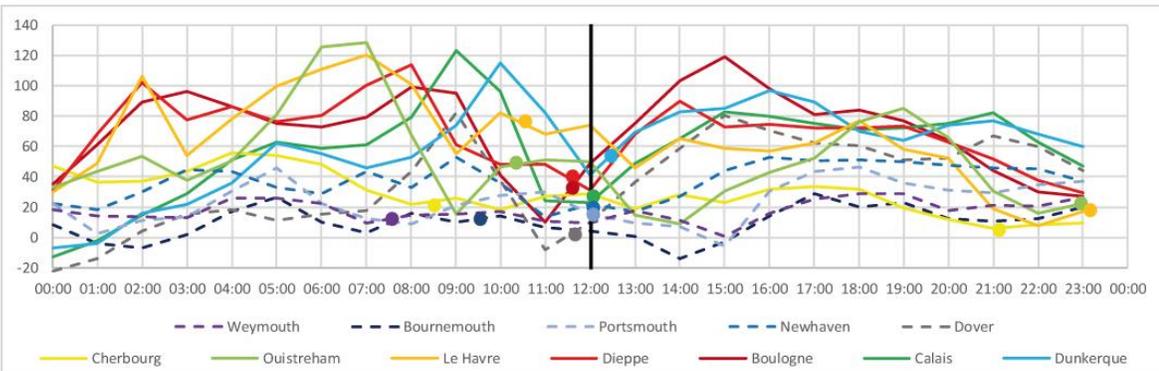


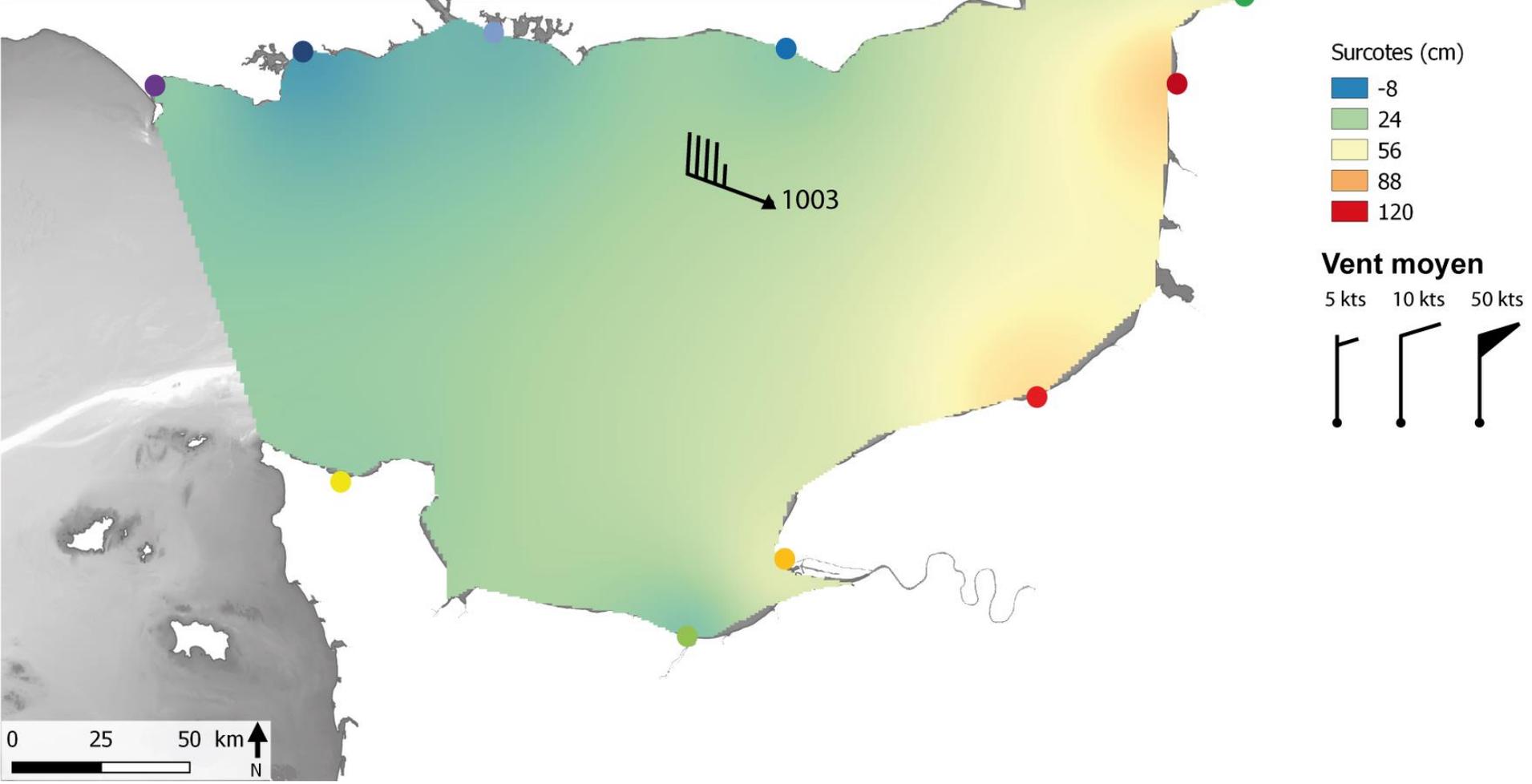
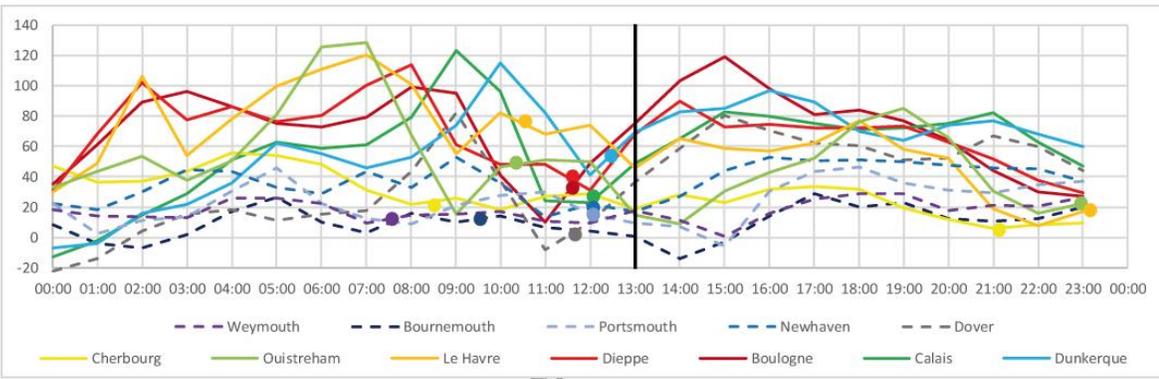
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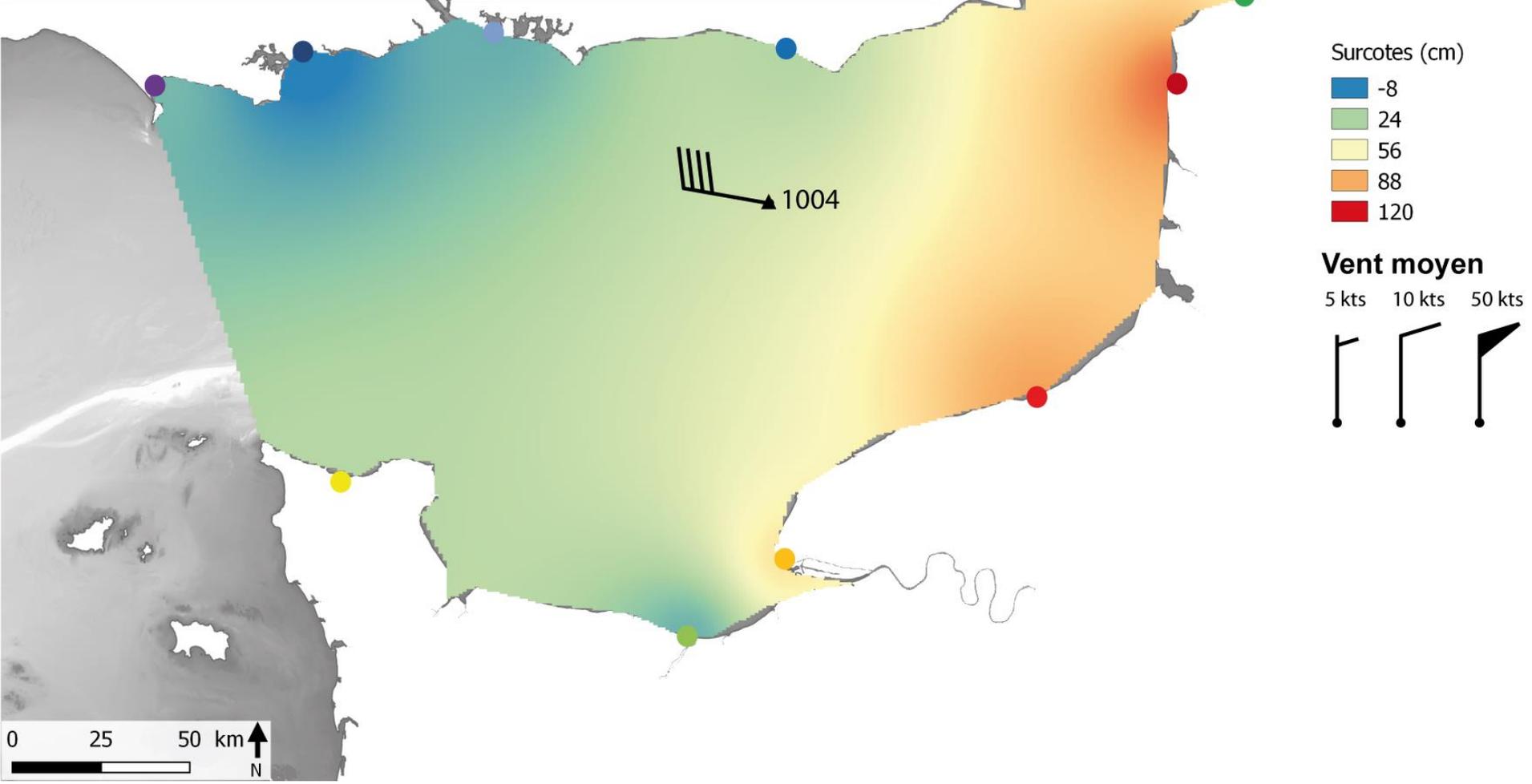
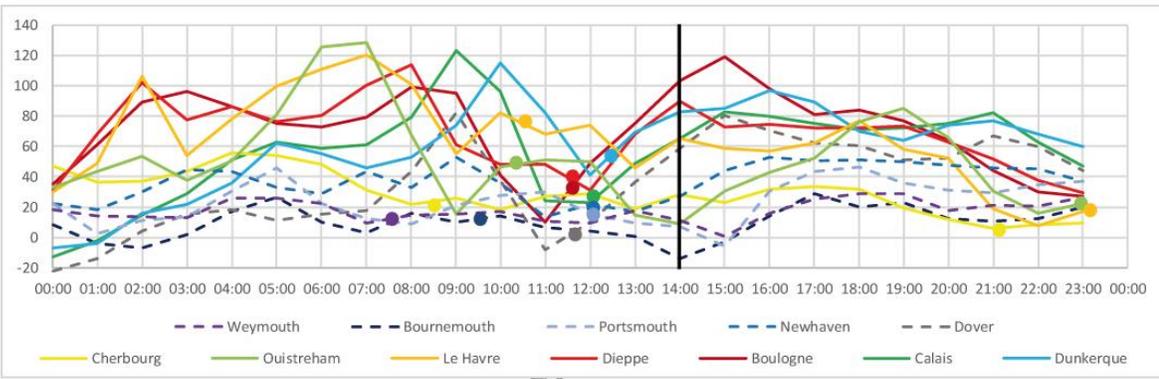


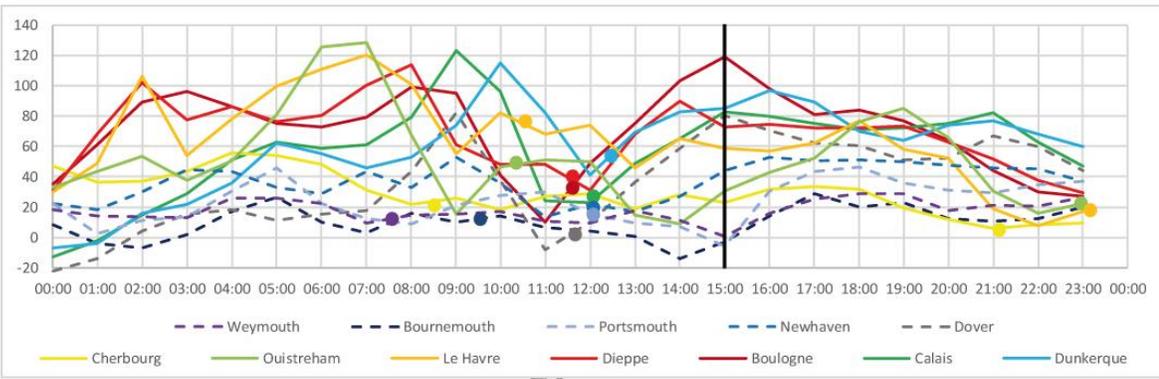
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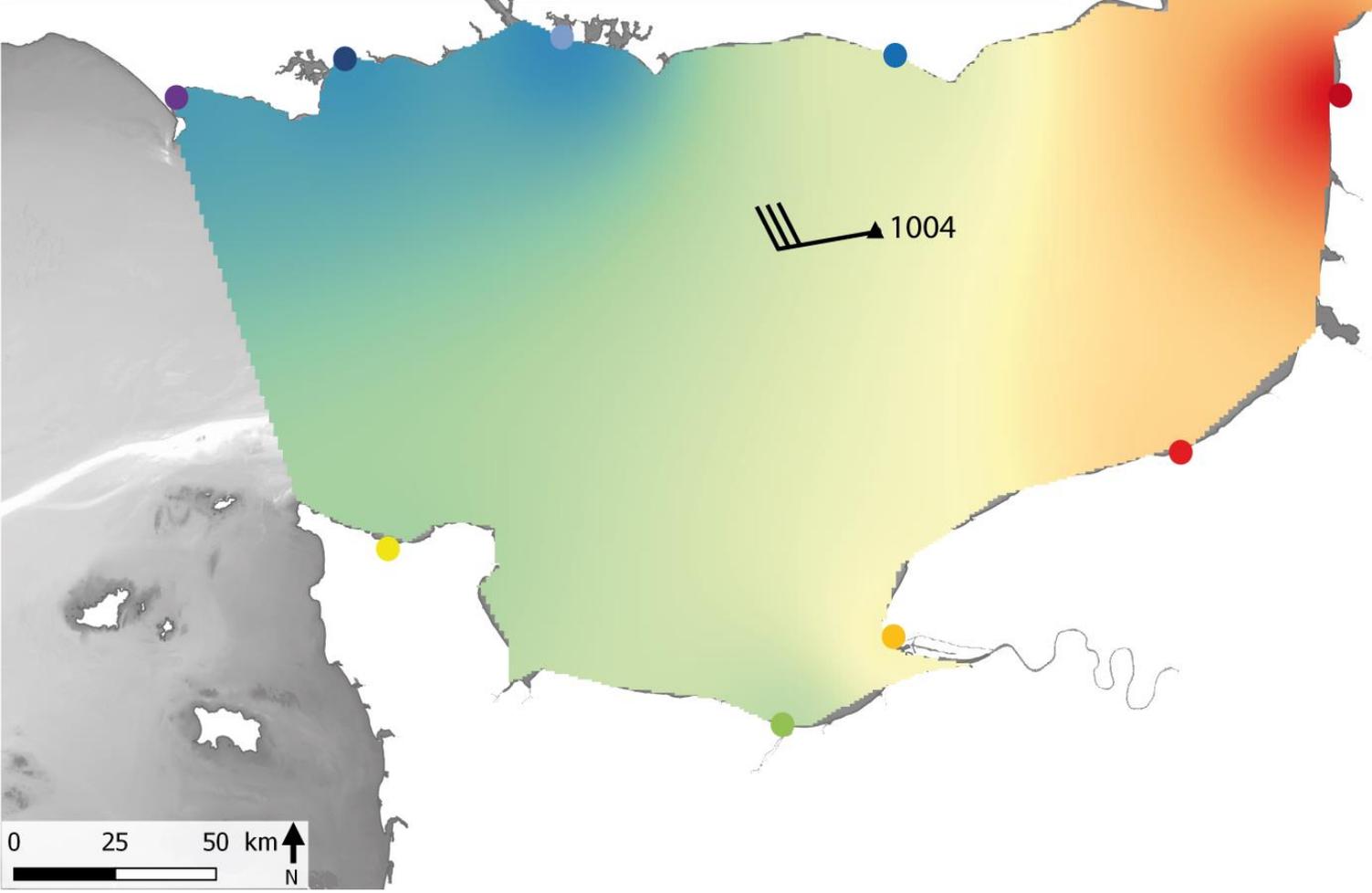








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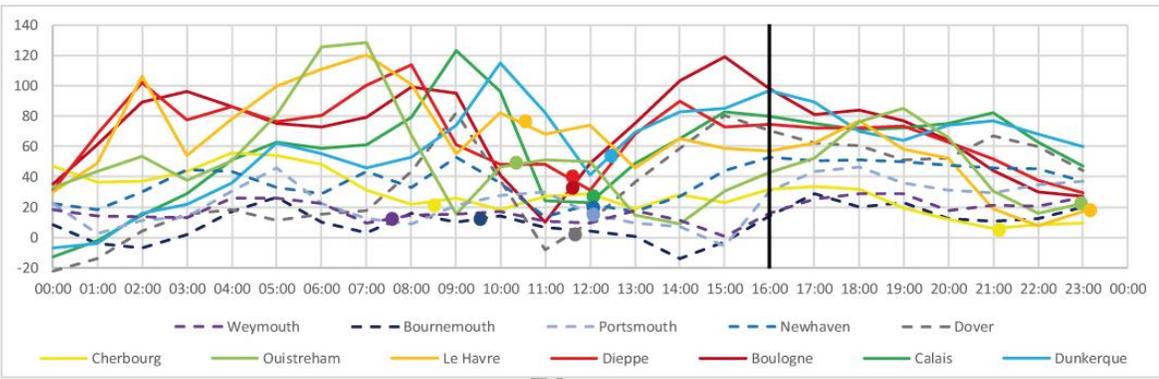


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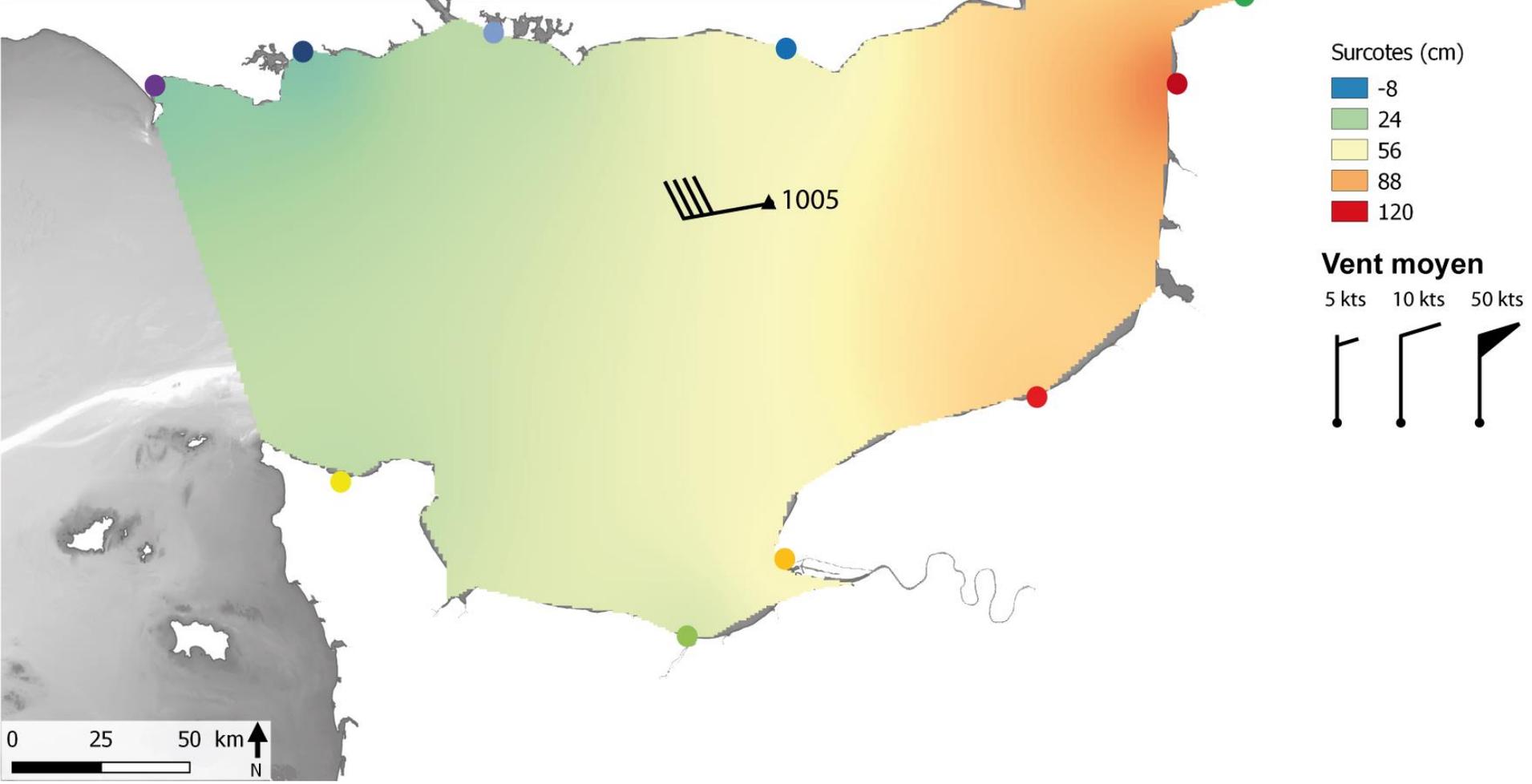
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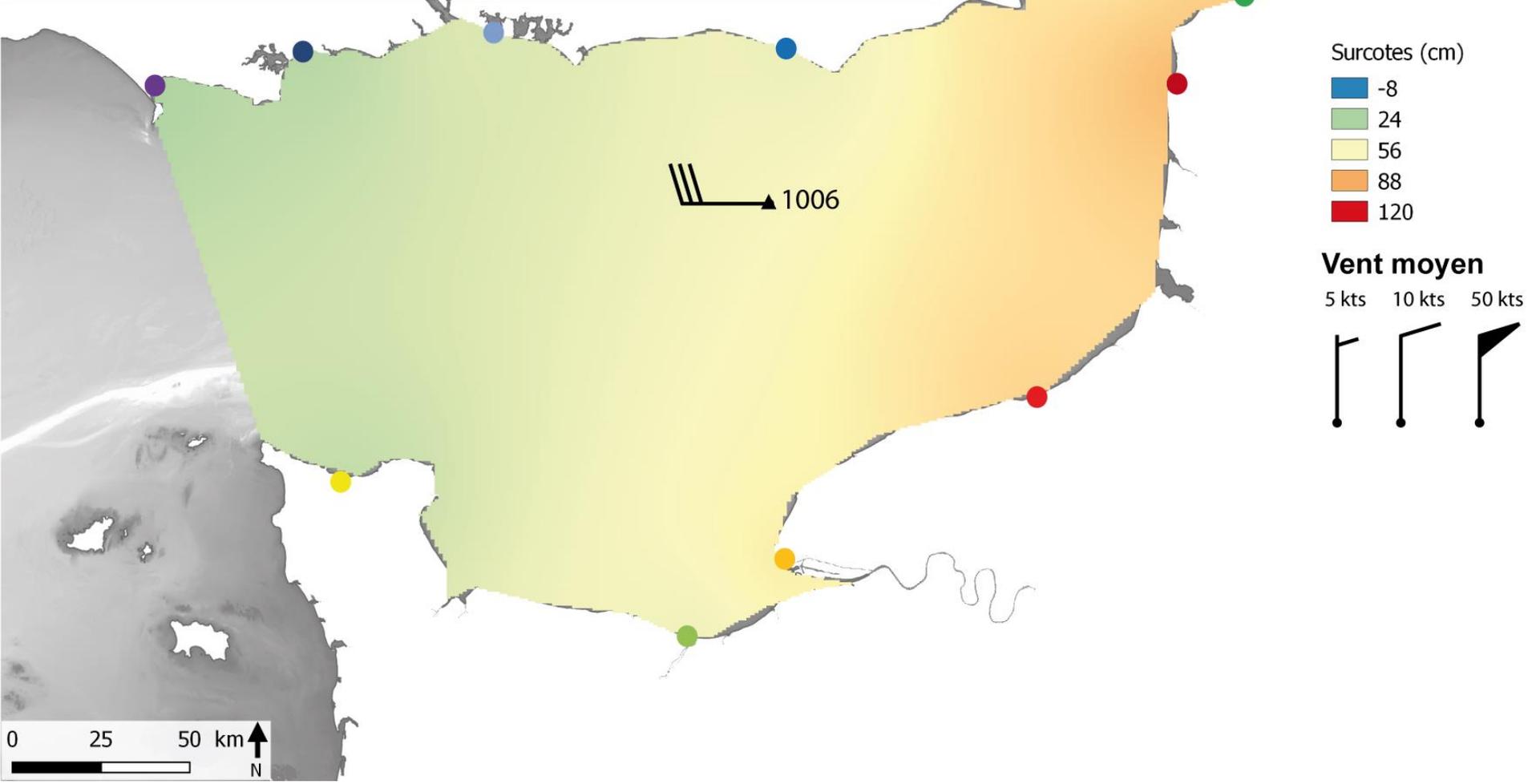
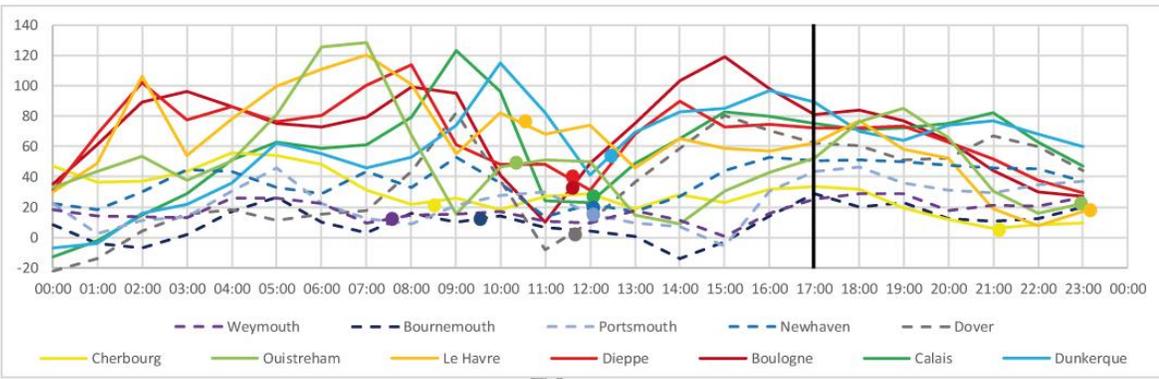
Vent moyen

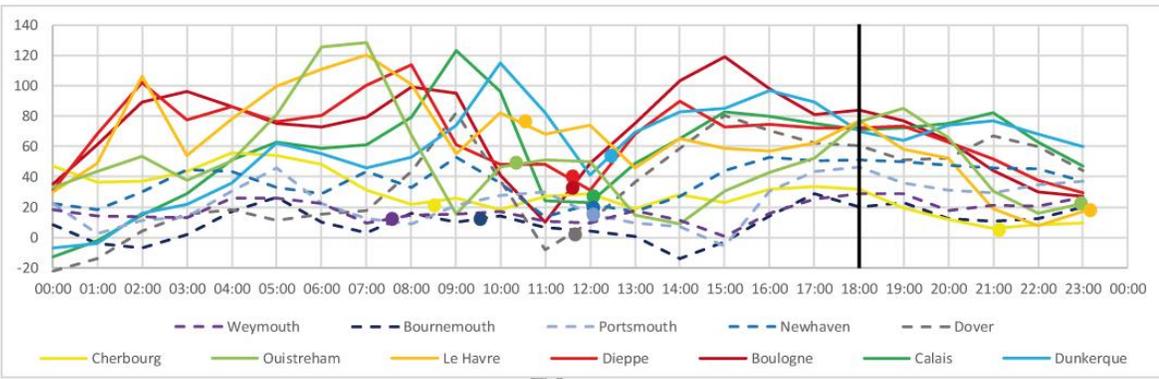
- 5 kts
- 10 kts
- 50 kts



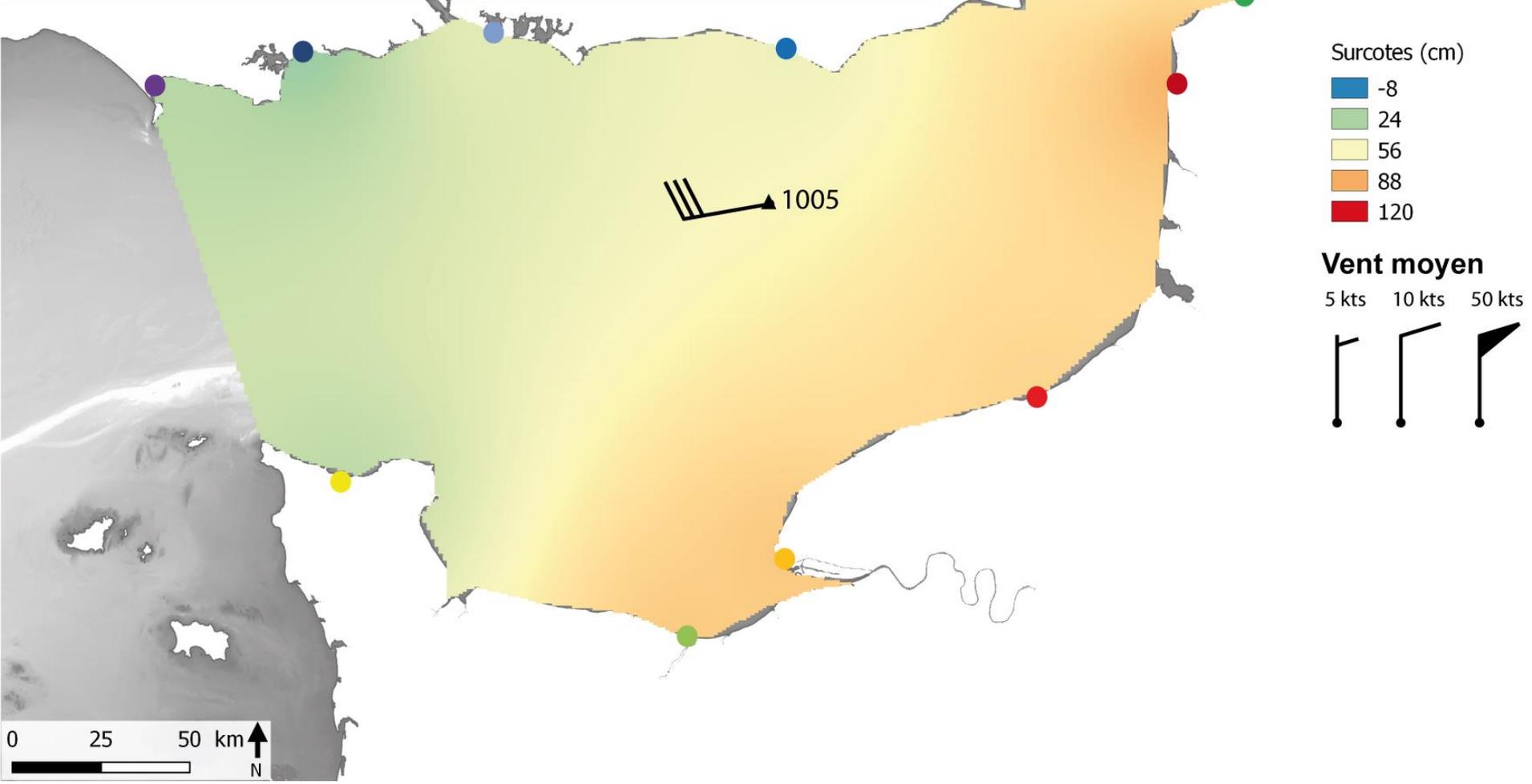
16h

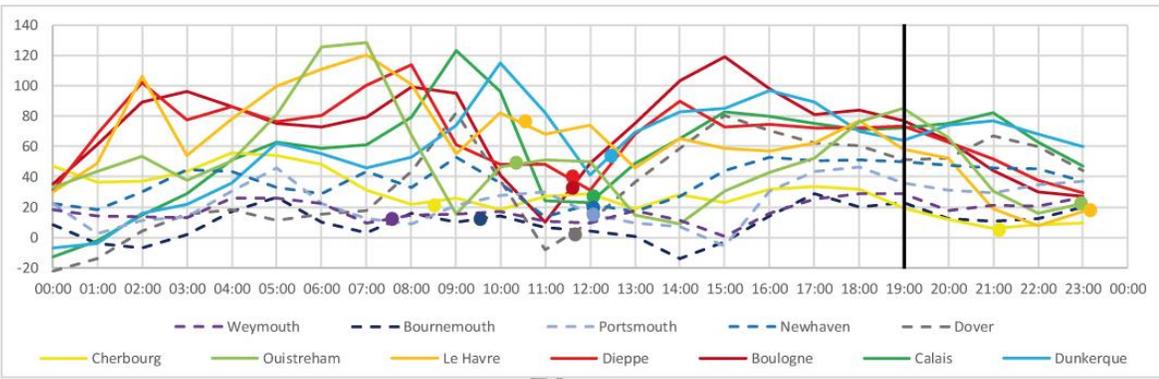




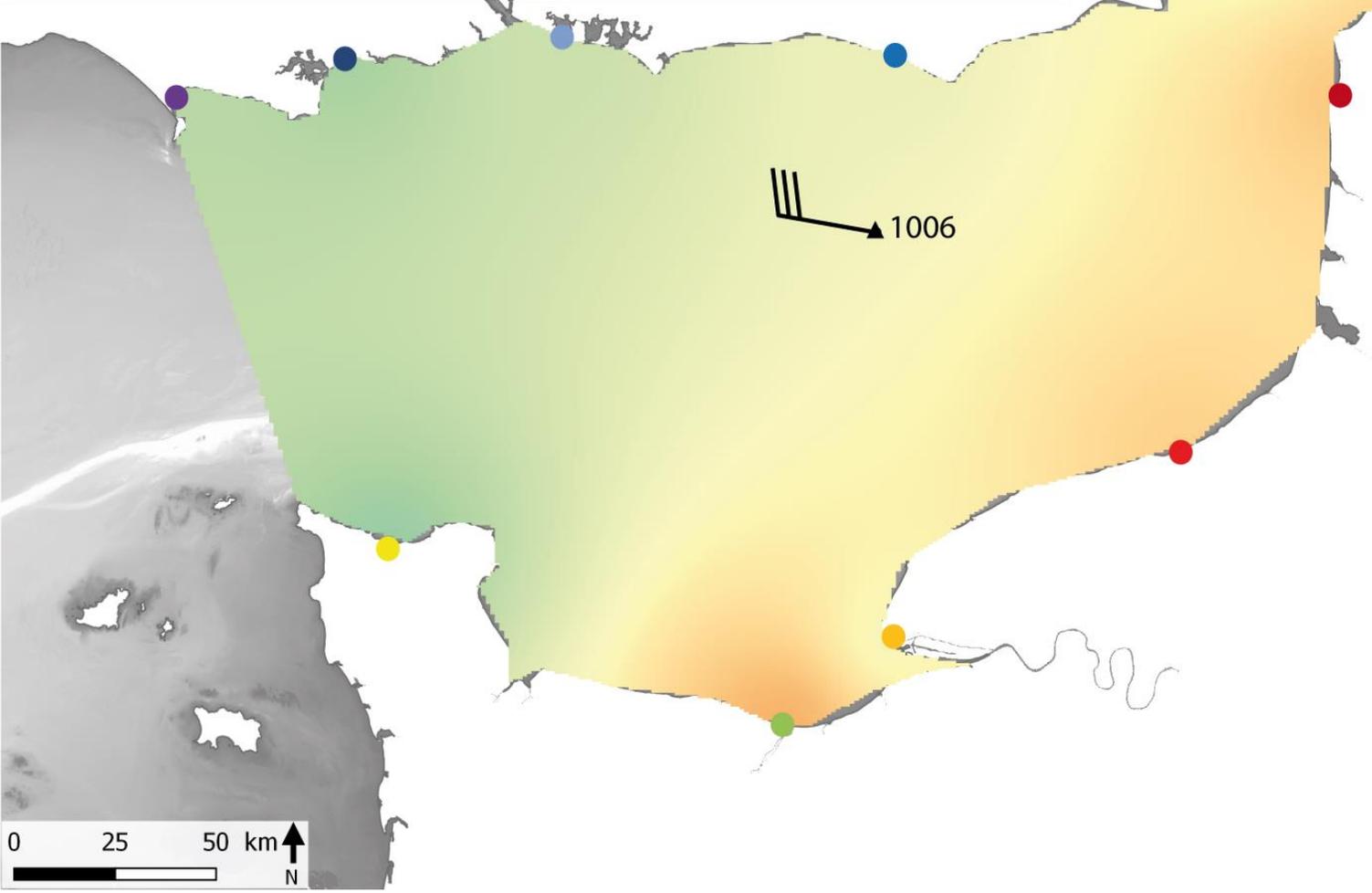


18h





19h



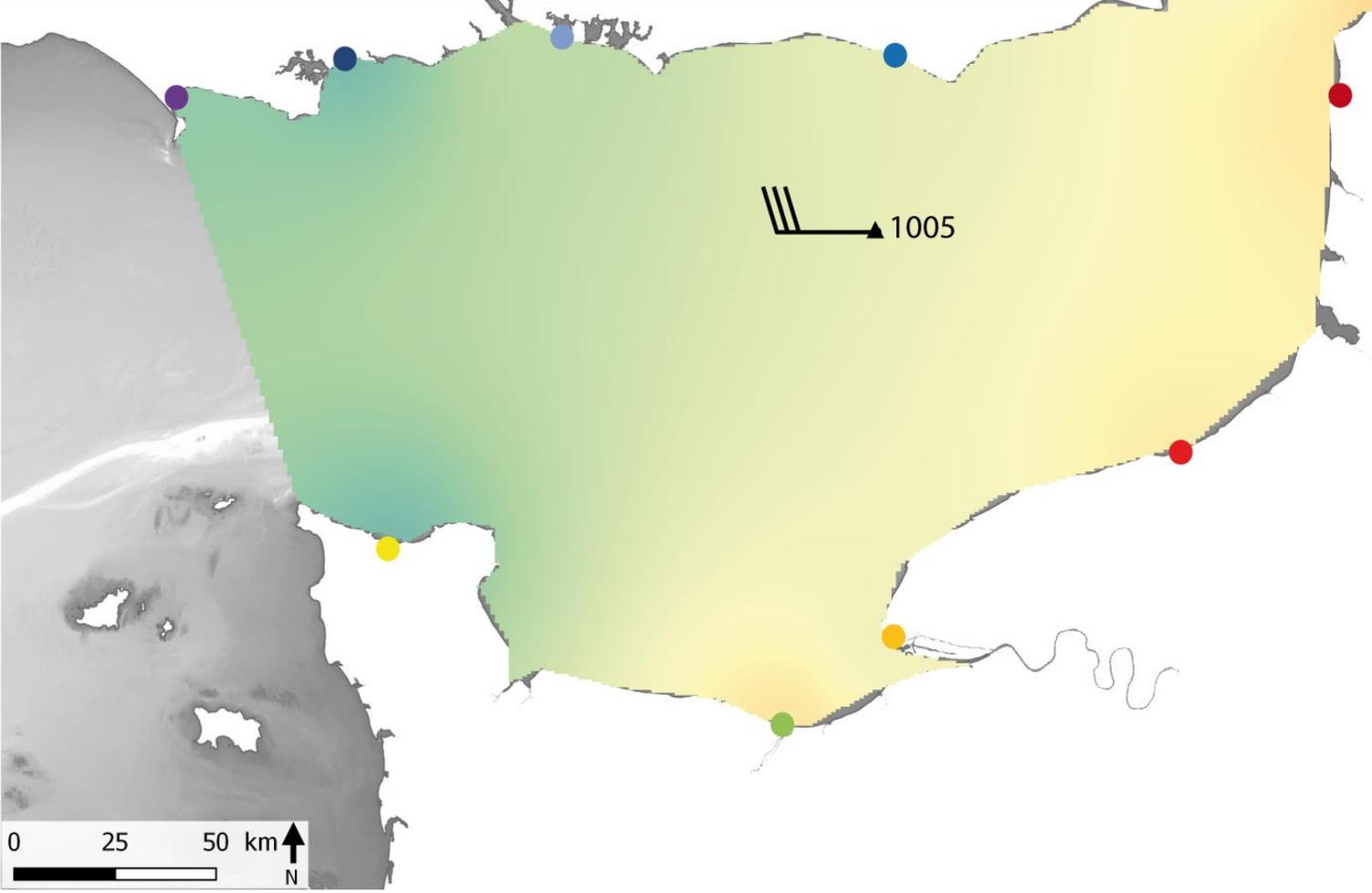
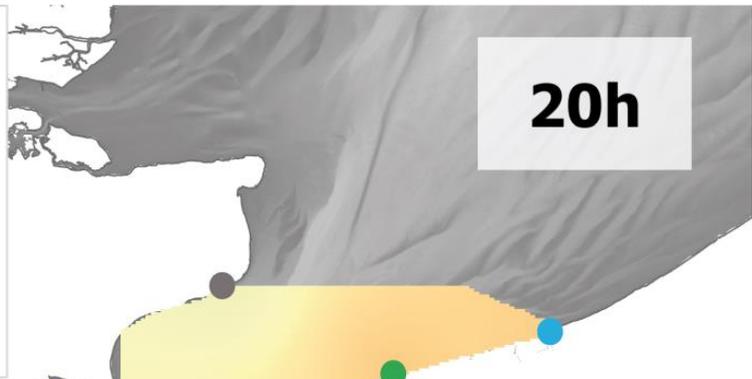
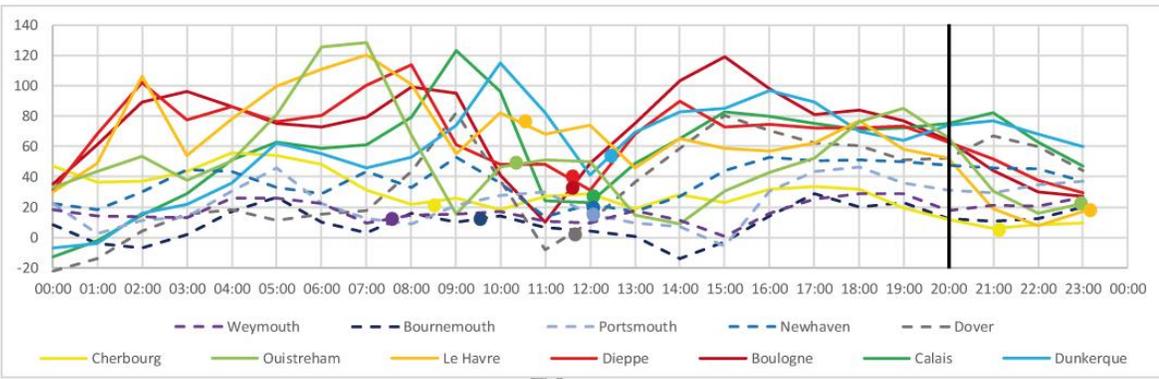
Surcotes (cm)

- 8
- 24
- 56
- 88
- 120

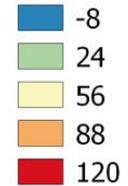
Vent moyen

- 5 kts
- 10 kts
- 50 kts

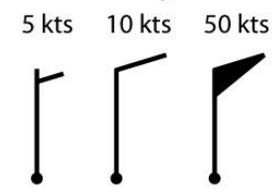


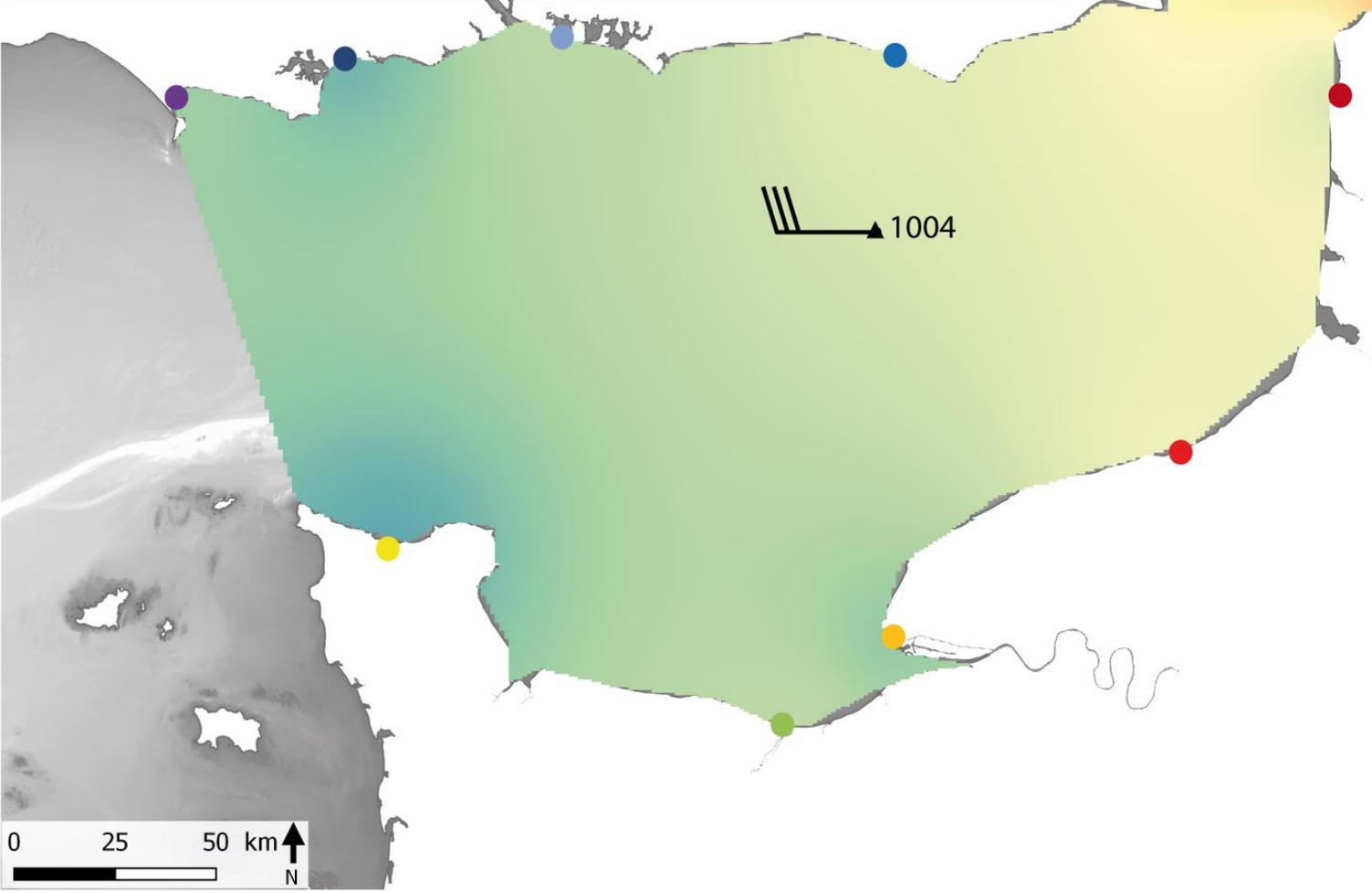
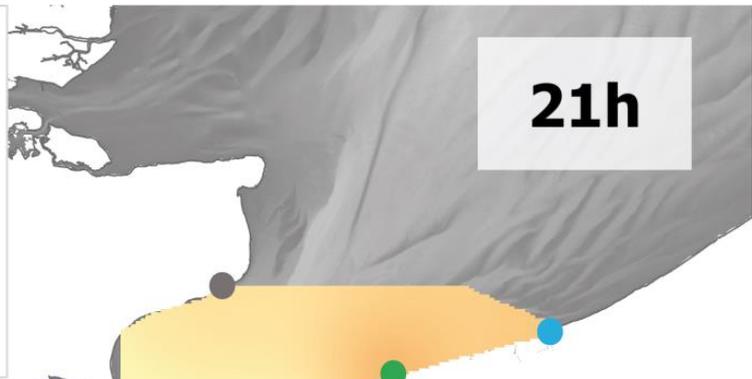
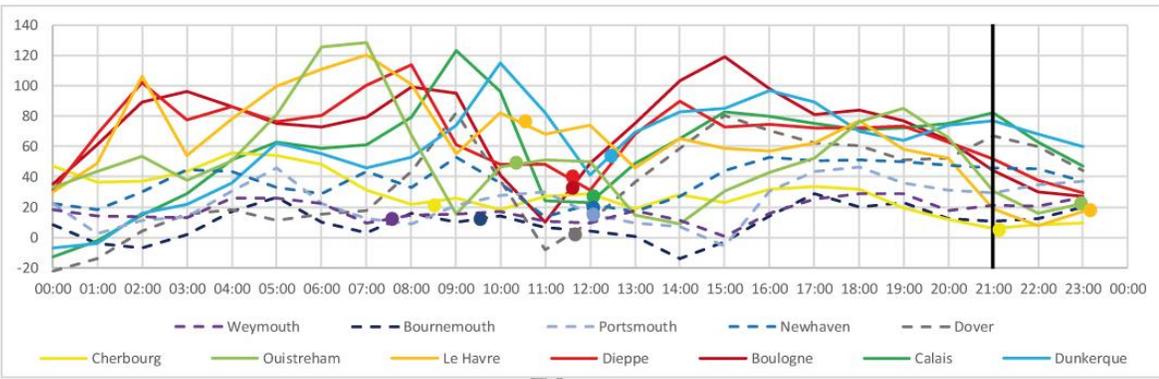


Surcotes (cm)

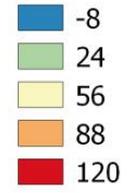


Vent moyen

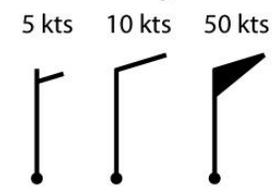


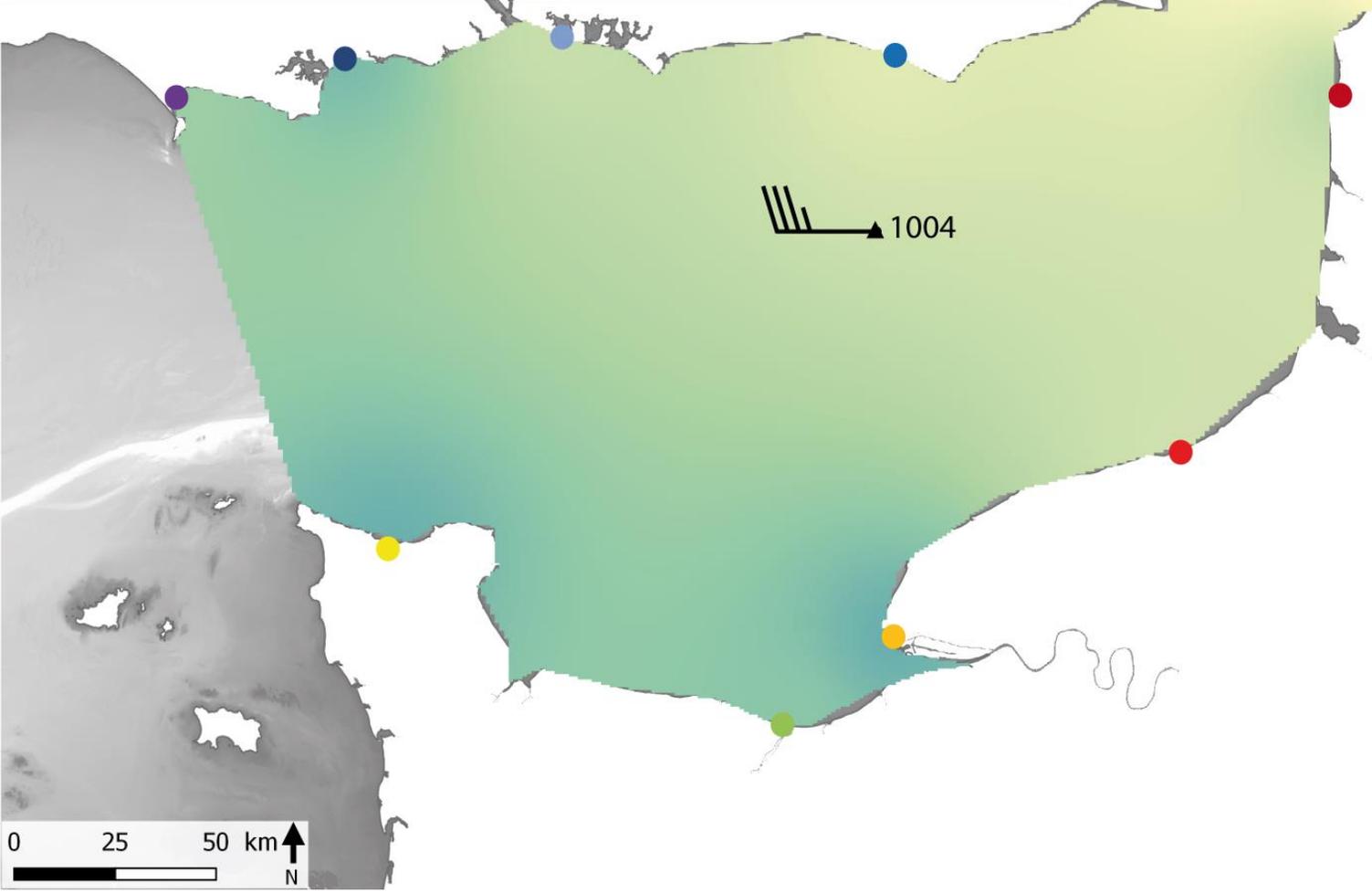
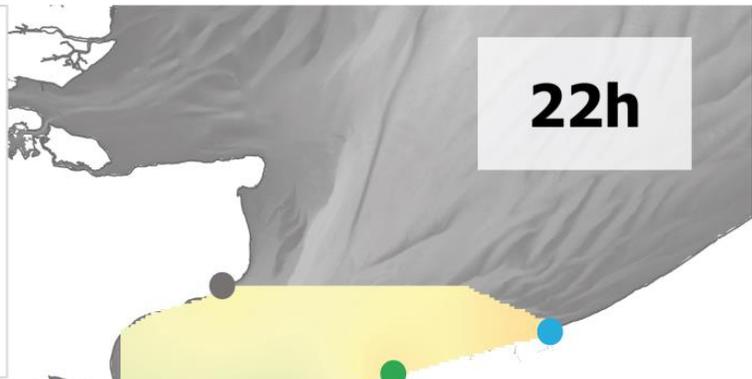
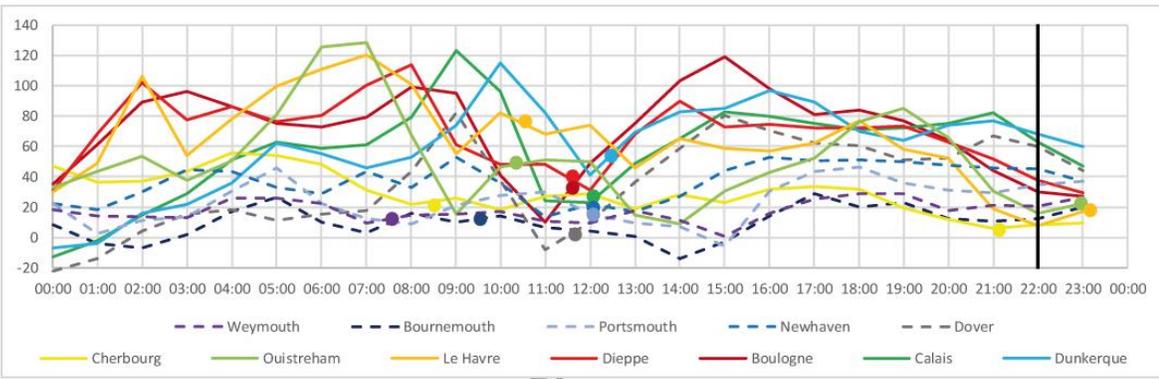


Surcotes (cm)

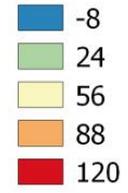


Vent moyen

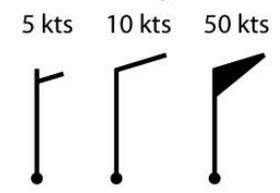


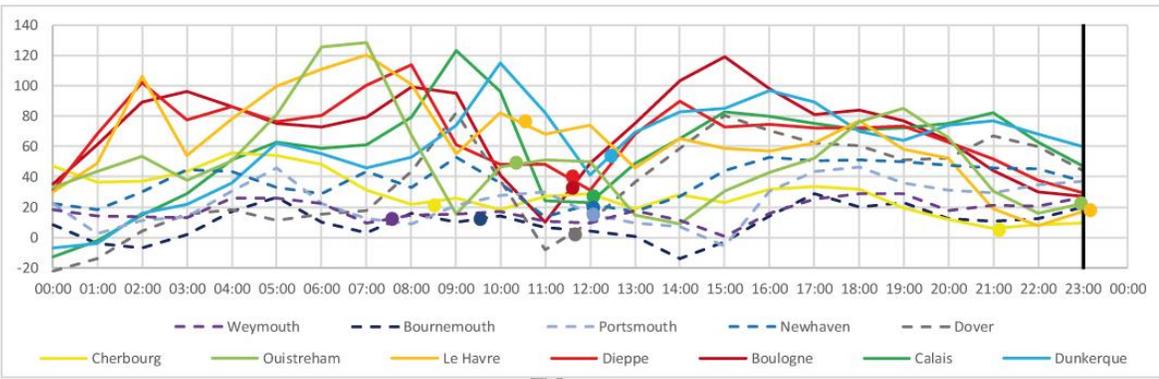


Surcotes (cm)

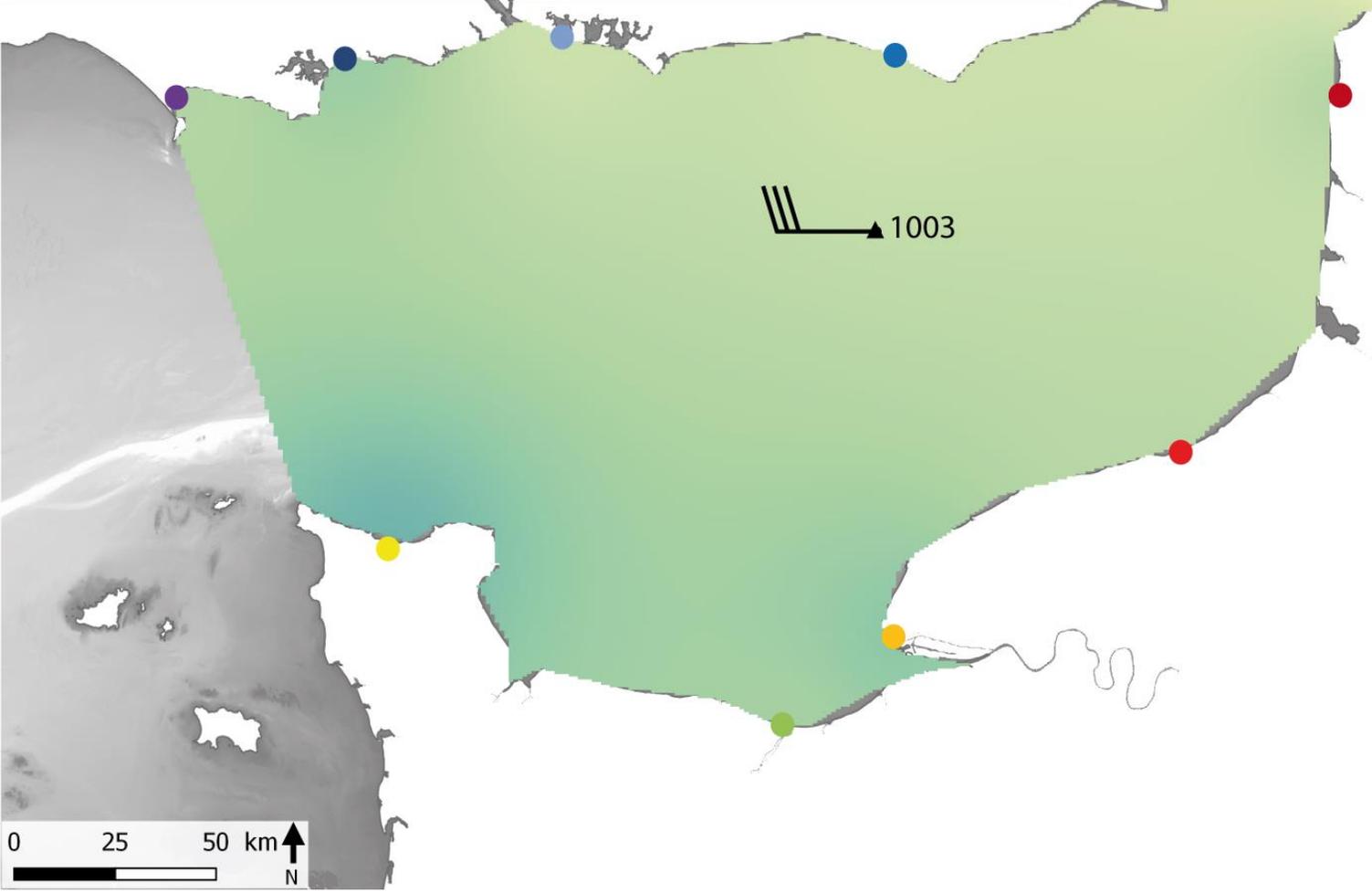


Vent moyen

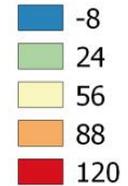




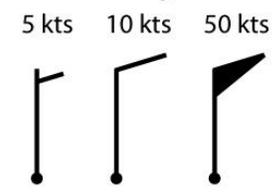
23h



Surcotes (cm)



Vent moyen



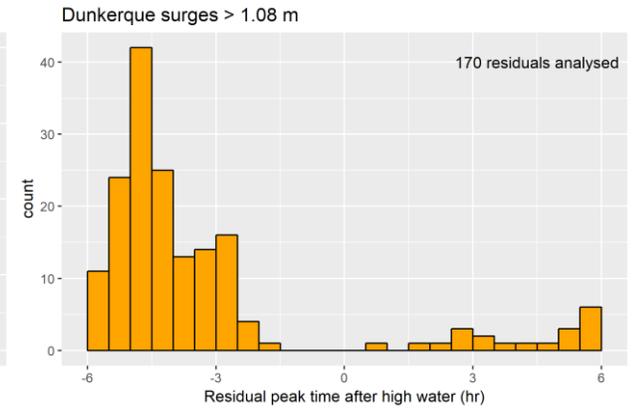
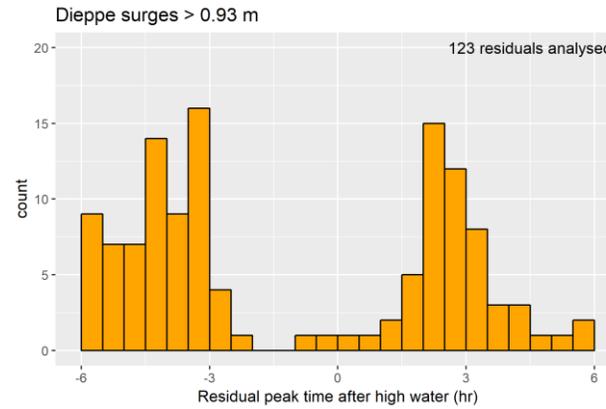
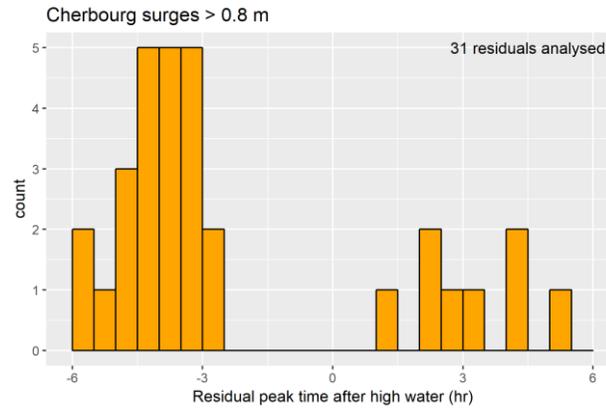
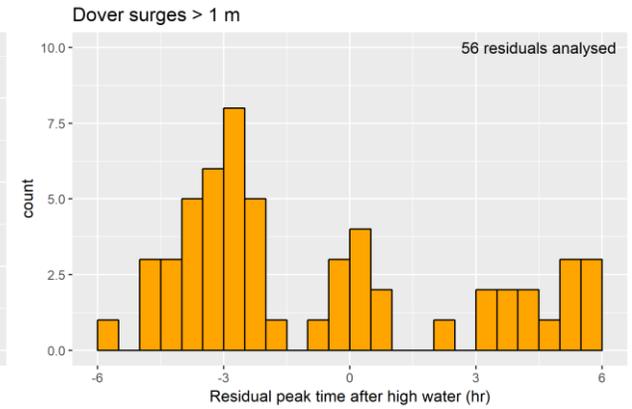
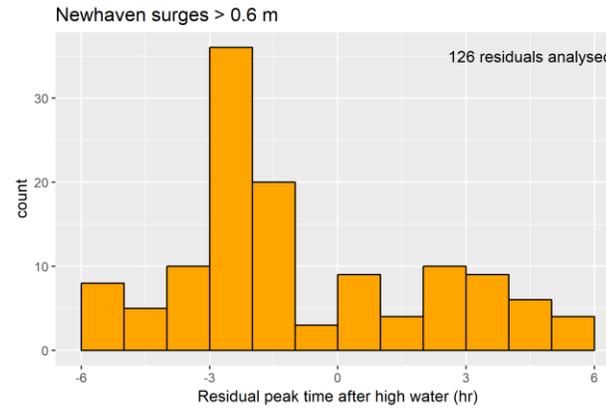
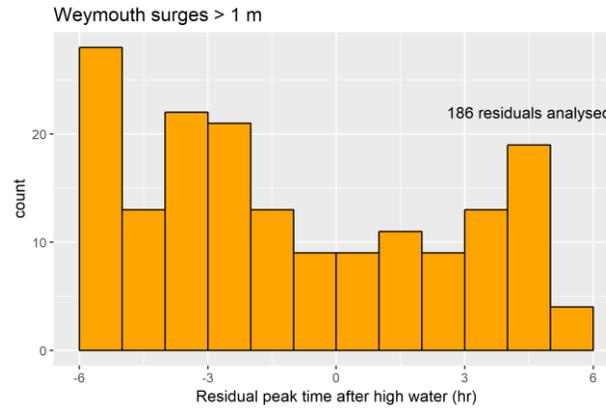
Relation marée/surcotes :

Comparaison pic de surcote sur un cycle de marée avec marée haute

0h : pic à pleine mer

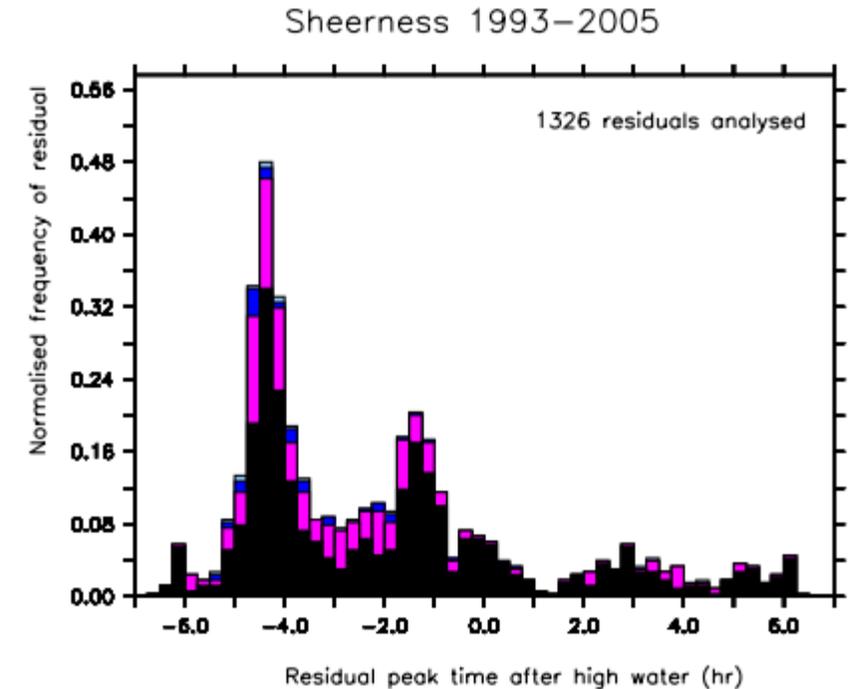
-3h : pic 3h avant la pleine mer

3h : pic 3h après la pleine mer



Relation marée/surcotes

- Le phénomène de surcote est avant tout lié à un phénomène météo extrême, mais ensuite il est également relié au phénomène de marée. Plusieurs pistes d'explication proposées dans la littérature scientifique (Rossiter, 1961, Horsburgh & Wilson, 2007, Tomasin & Pirazzoli, 2008). La principale : l'onde engendrée par le phénomène météo influence la marée en augmentant la hauteur de la colonne d'eau, la marée va alors pouvoir se propager plus vite → surcotes les plus importantes à mi-marée montante.
- De plus, plus le marnage est grand, moins le risque de coincidence entre forte surcote et marée haute est important.
- Tomasin et Pirazzoli (2008) : pas de fortes surcotes à marées hautes par grand coefficient ces dernières décennies.



Source : Horsburgh & Wilson, 2007

Résultats principaux

- Surcotes de pleine mer pour événements extrêmes → risque submersion marine
- Toutes les surcotes pour étude du phénomène lors du passage d'une tempête
- Forte saisonnalité des surcotes
- Gradient d'amplitude ouest-est et nord-sud
- Niveaux extrêmes provoqués en majorité par flux d'ouest, puis nord-ouest nord et sud
- Tempête Eleanor, flux d'ouest, conséquences conformes à ce que l'on connaît mais deux phénomènes particuliers : 1. conjonction pic de surcote et pleine mer rarement observée ; 2. retour des surcotes ensuite alors que vent baisse et pression remonte
- Relation marée/surcote : phénomène très important à prendre en compte en Manche, plus important sur secteur à fort marnage

Perspectives

- Reste encore beaucoup de choses à comprendre sur le fonctionnement hydrodynamique du bassin de la Manche lors de la survenue d'événement tempétueux extrêmes.
- La relation marée-surcote devrait être approfondie et prise en compte dans les études de risque de submersion marine
- Aspects historiques → analyse des phénomènes extrêmes passés → modélisation.