Glider observations of submesoscale features characterised by low salinity in Central New Zealand

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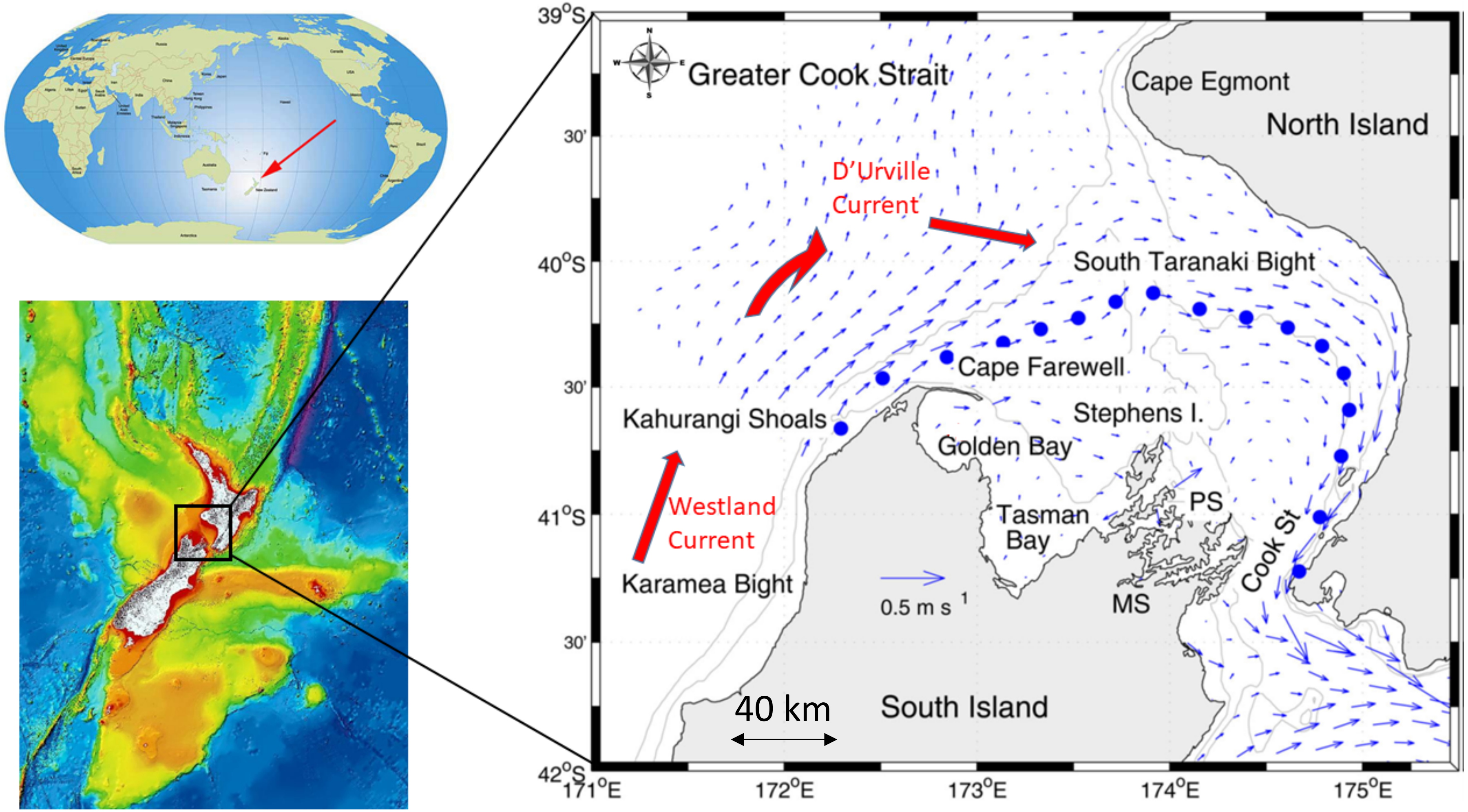
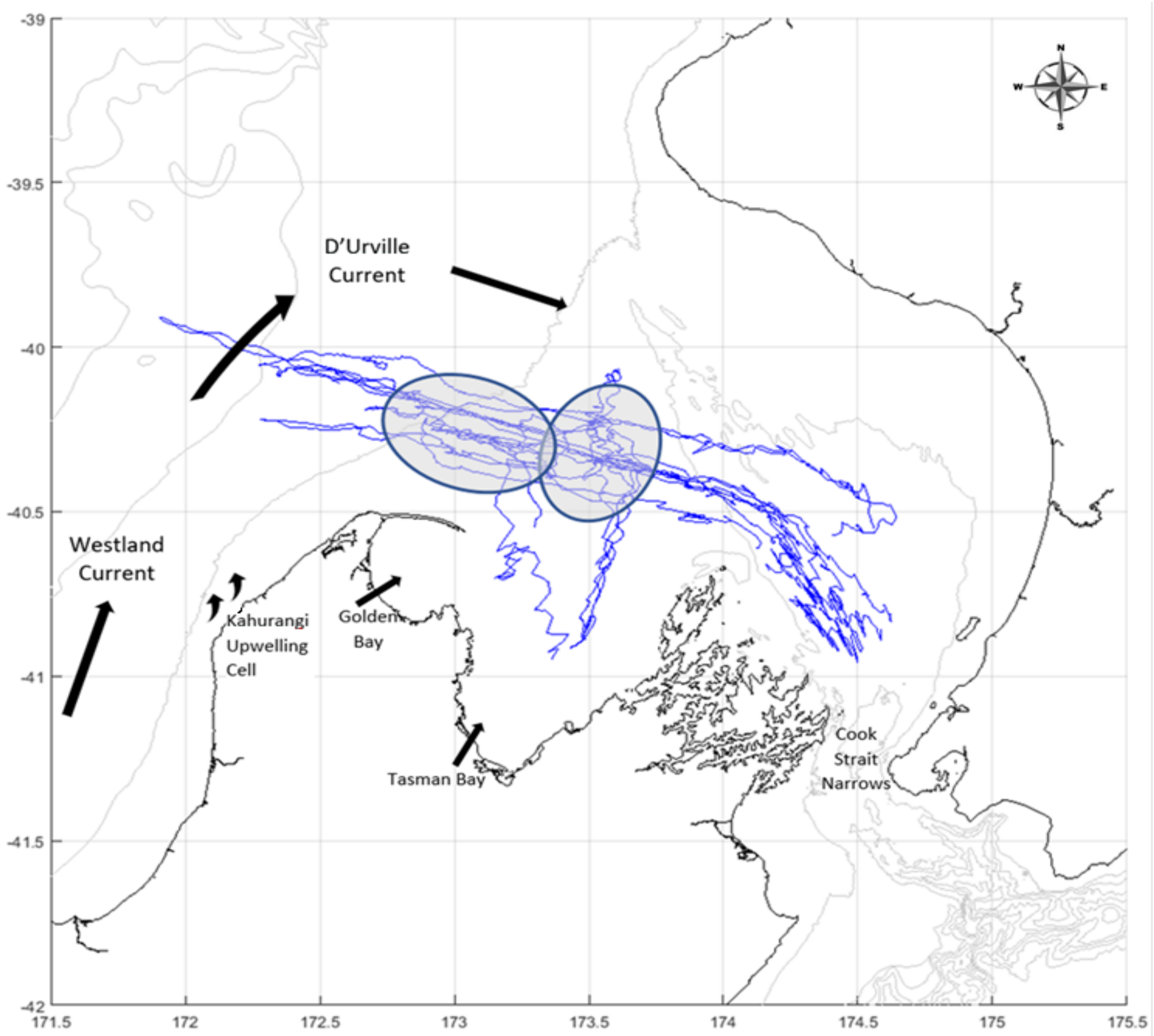
The Central New Zealand shelf region: Greater Cook Strait (GCS)



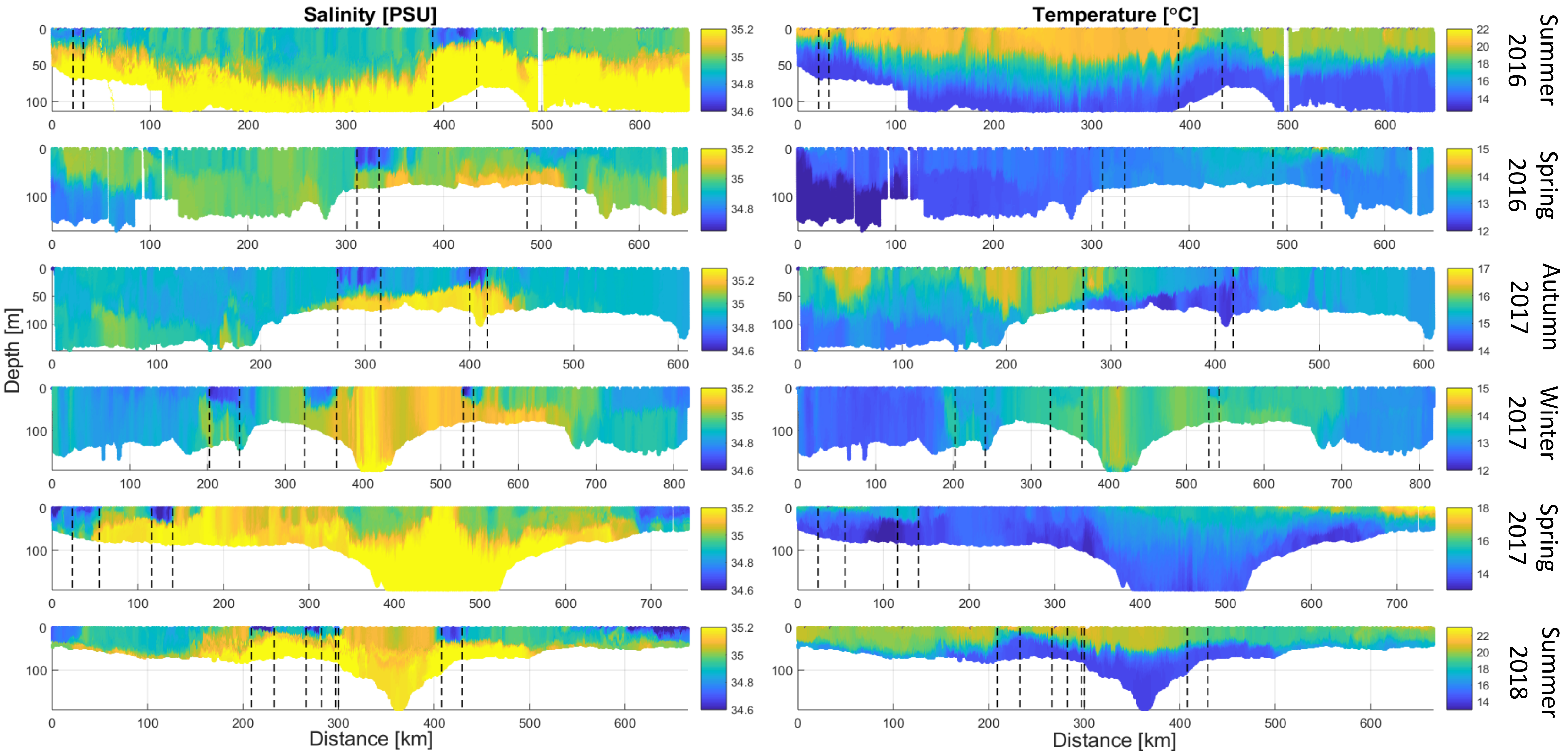
- Wind-driven and tidal currents
- Semi-permanent barotropic current
- Presence of an upwelling region
- Shallow Tasman and Golden Bays

Glider missions in GCS



- Our knowledge in this region is based on limited observations and ocean modelling
- Only 50 subsurface hydrography profiles prior to gliders
- Seven missions within 4 years (2015 -2018) – Blue tracks
- > 26,000 profiles
- Low Salinity Submesoscale Feature (LSMF) hotspot

GCS salinity and temperature transects



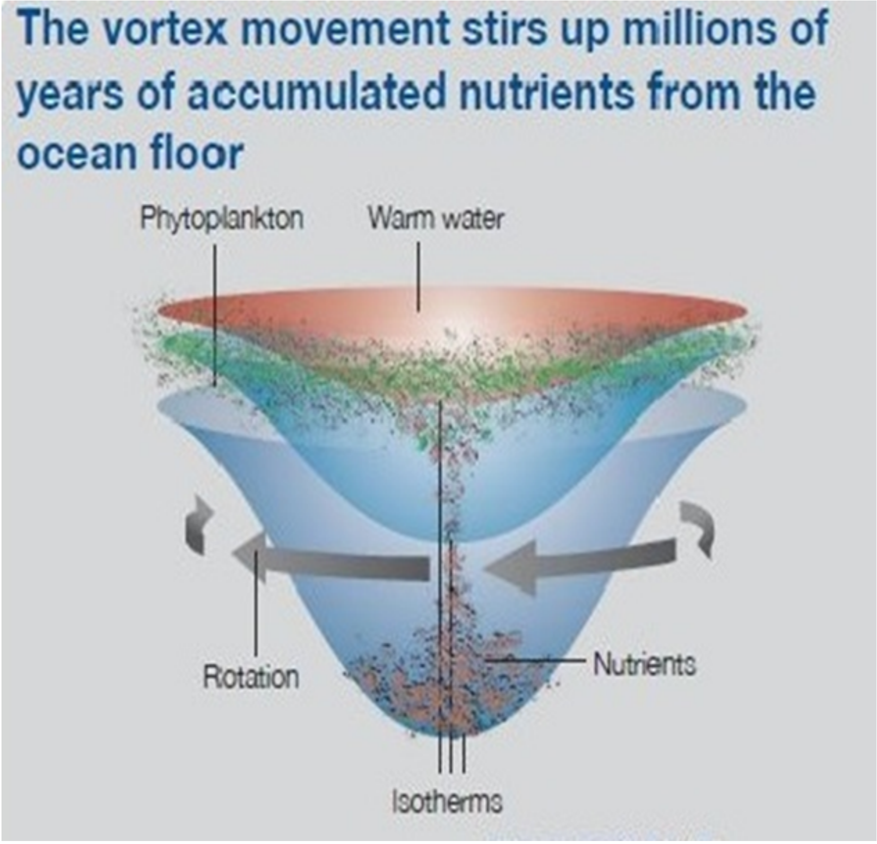
Low salinity submesoscale features (LSMFs):

Temporal scale	Hours - Days
Spatial scale	0.1 – 30 km

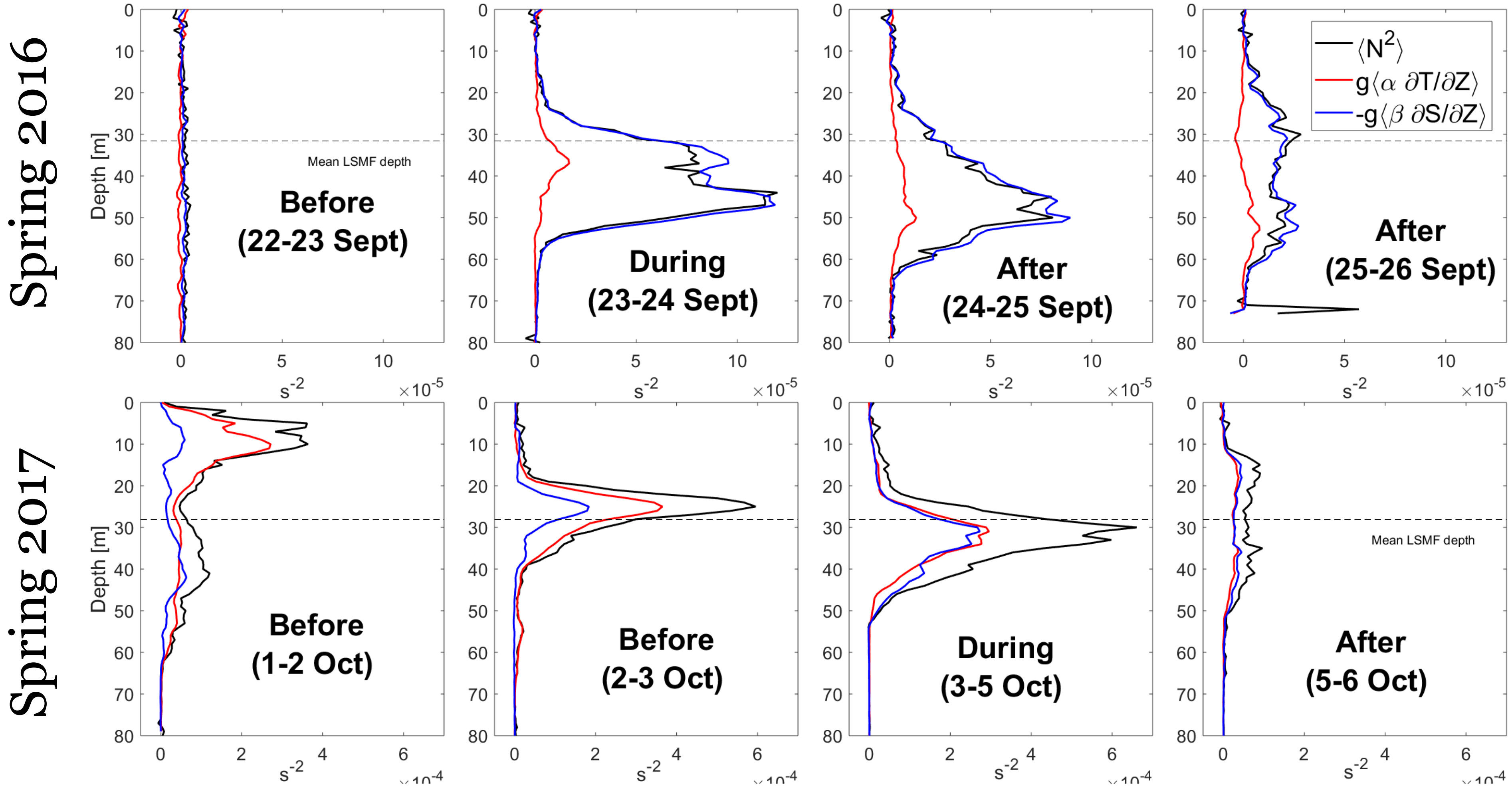
- Can be the result of different types of instabilities (eg. Baroclinic instability, symmetric instability, lateral shear instability, frontogenesis)

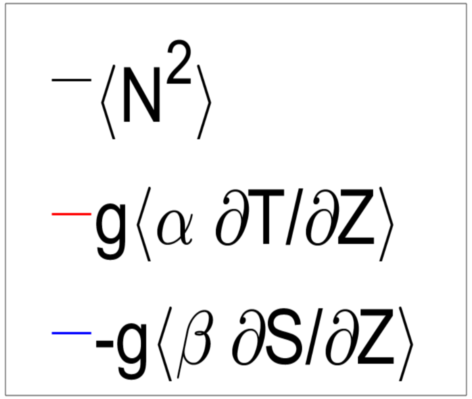
- Have potential ecosystem controls:
  - Occur at same timescale as phytoplankton growth
  - Support large vertical velocities → Transport of nutrients

- **Influence surface layer stratification, and hence, mixing**



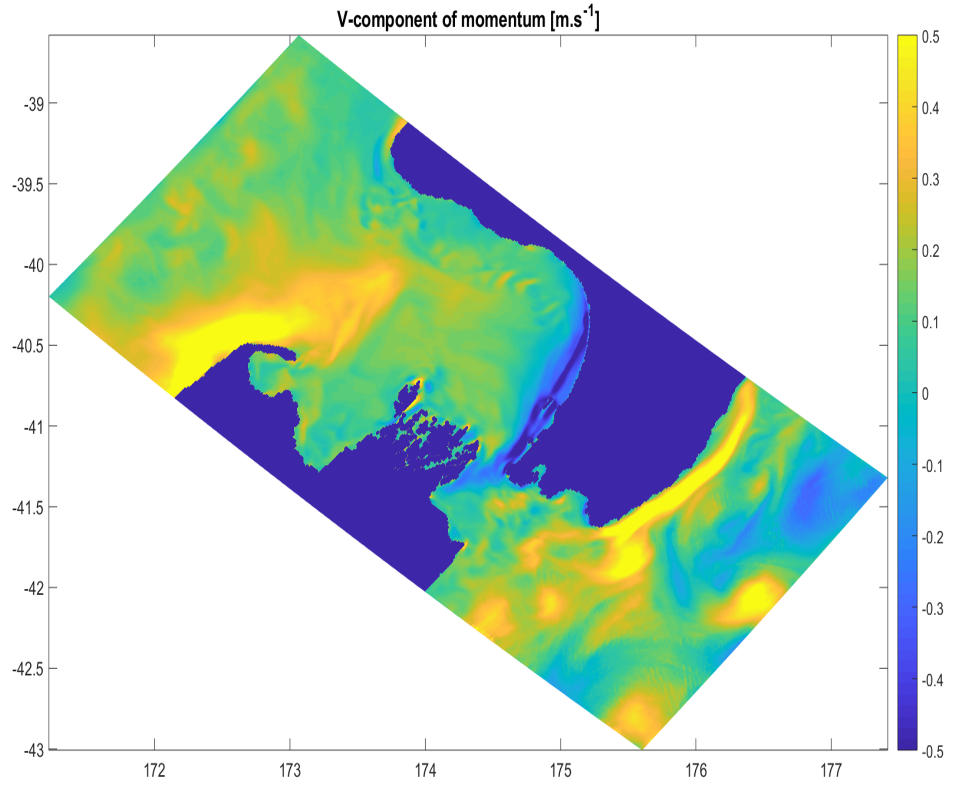
Buoyancy Frequency: Before, during and after LSMF





- Water column stability: stratification
- Mixing

Regional Modelling



ROMS (2009-2012):

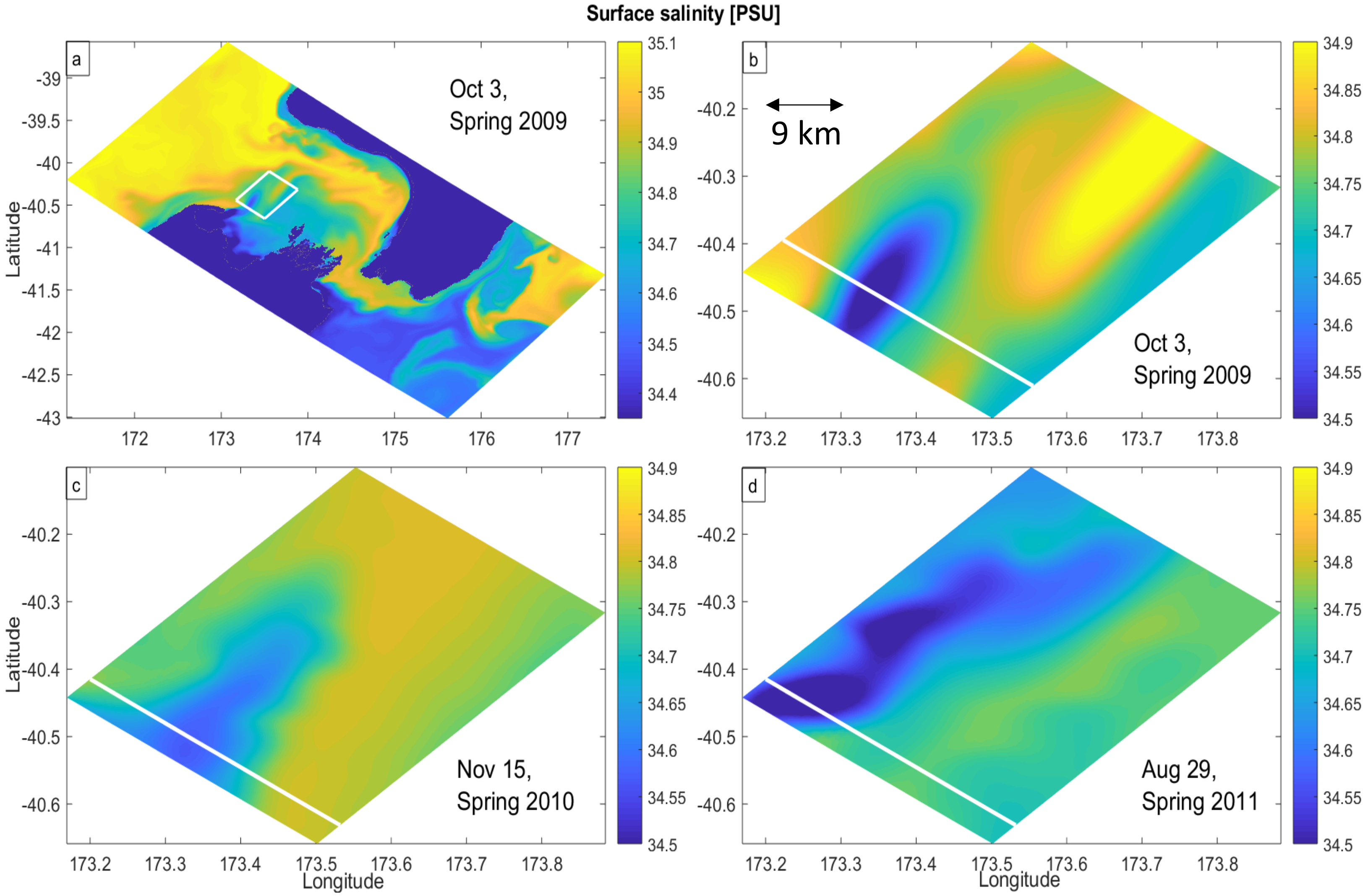
- 1-km horizontal resolution
- 20 vertical layers
- 13 tidal components
- River flow from NIWA rivers model
- Lateral boundary conditions from 5-km ROMS-NZ shelf seas hindcast
- Surface momentum fluxes from WRF-NZ hindcast (Cook Strait subdomain at 4-km resolution)
- Surface stresses from 3-hourly winds from WRF-NZ hindcast

→ Produce currents with realistic magnitudes

- Time-averaged 12-hourly outputs

LSMFs from model

Snapshot of 12-hourly averaged surface salinity for three LSMFs from model

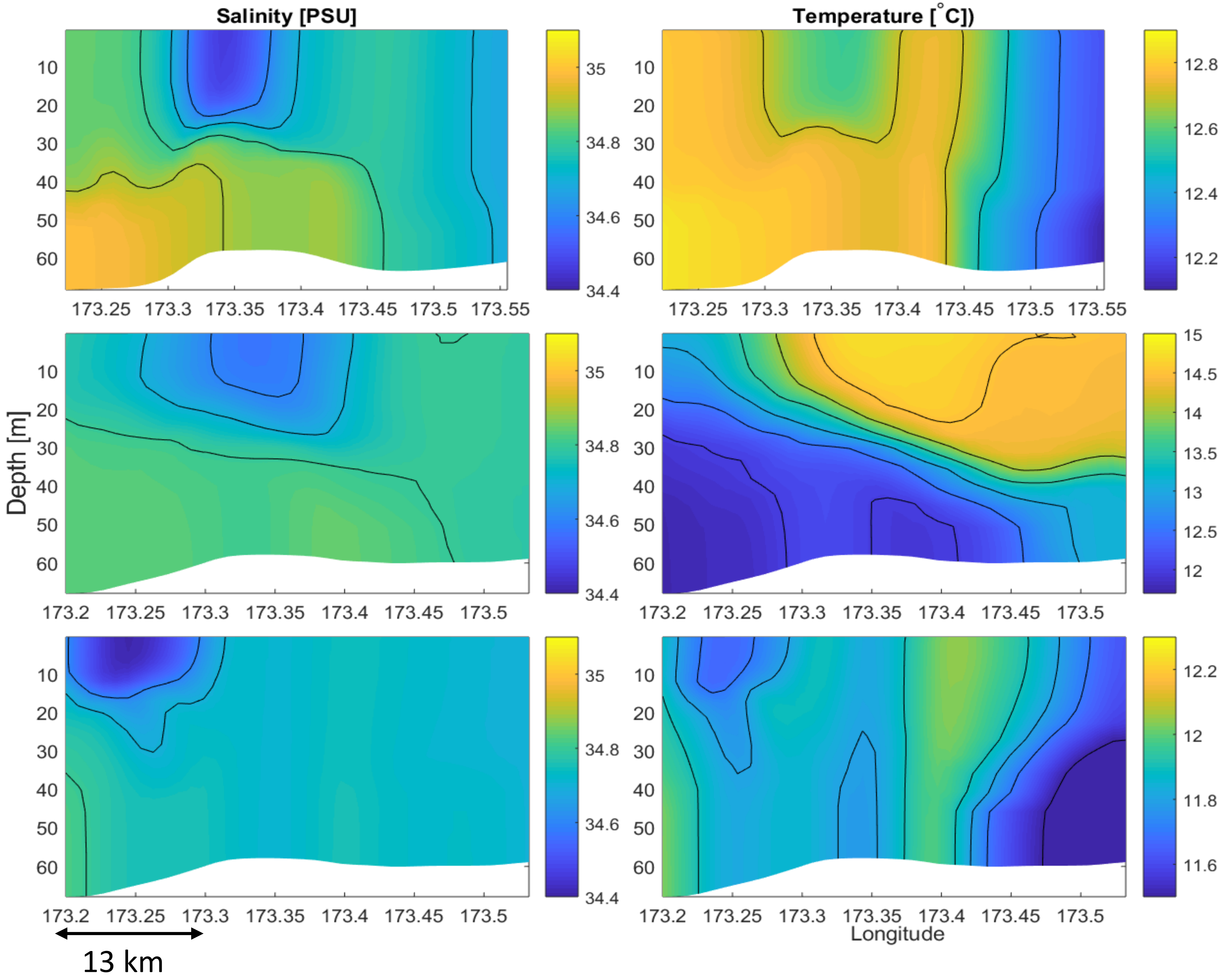


Spring LSMFs from model

Oct, 3
2009

Nov, 15
2010

Aug, 29
2011



*N2 analysis repeated for model outputs, but discretisation between layers exist as there are only 20 vertical layers

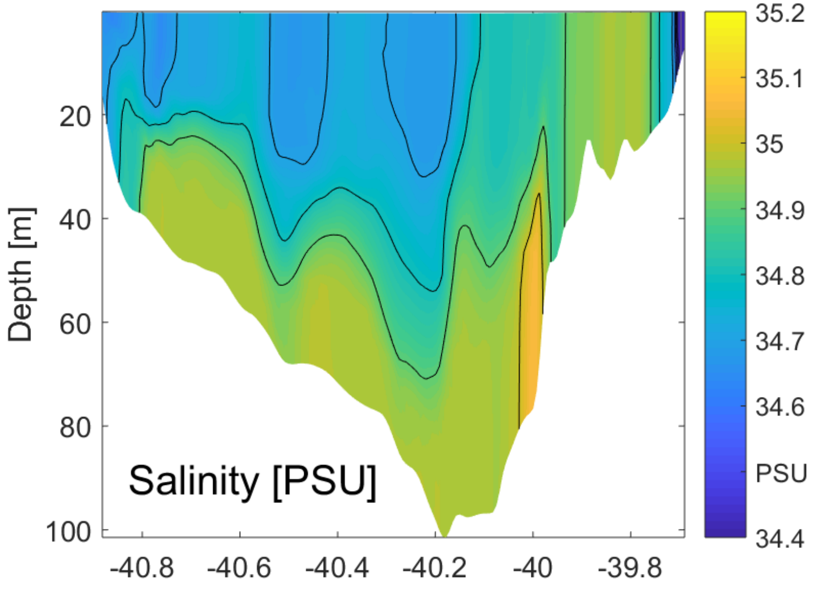
Offshore extension of the LSMF

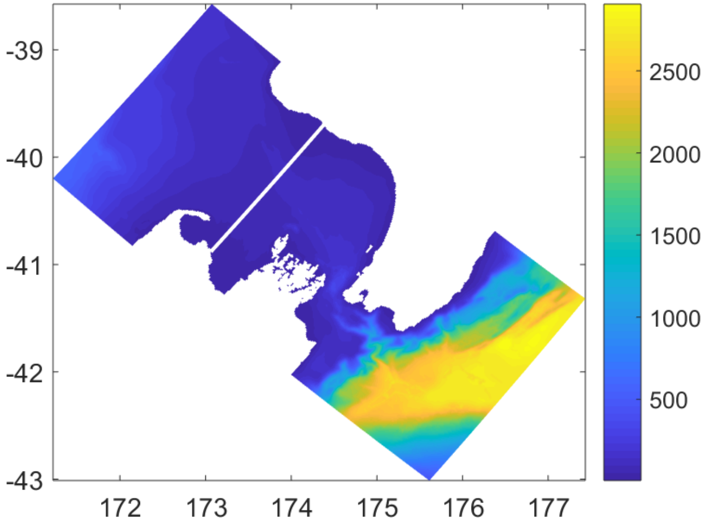
The variability of the dUC:

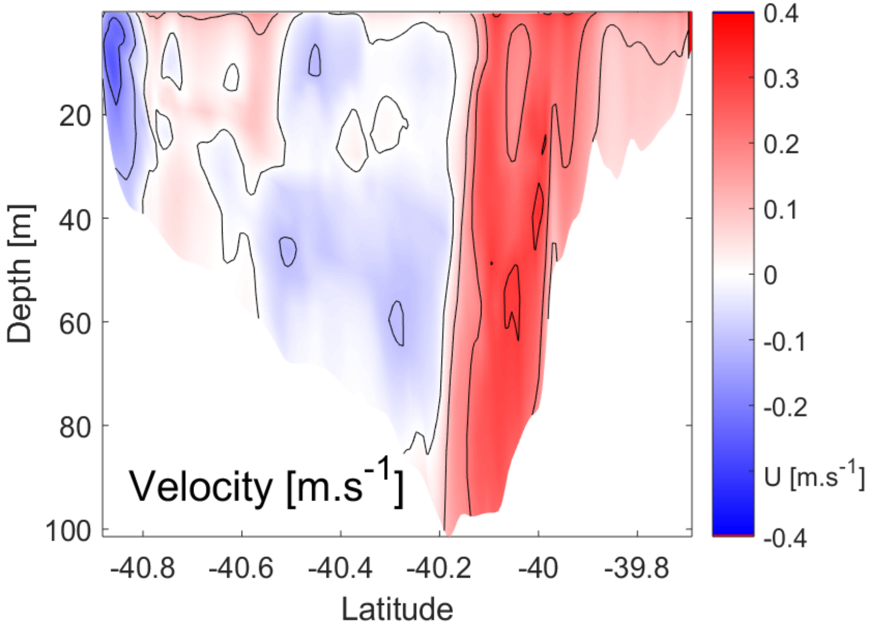
> intensity
> presence (including reversal)
> absence

→ Has a role to play on how far offshore the LSMFs can extend in GCS

LSMF from ROMS
Dec 13, 2009







Summary

Results:

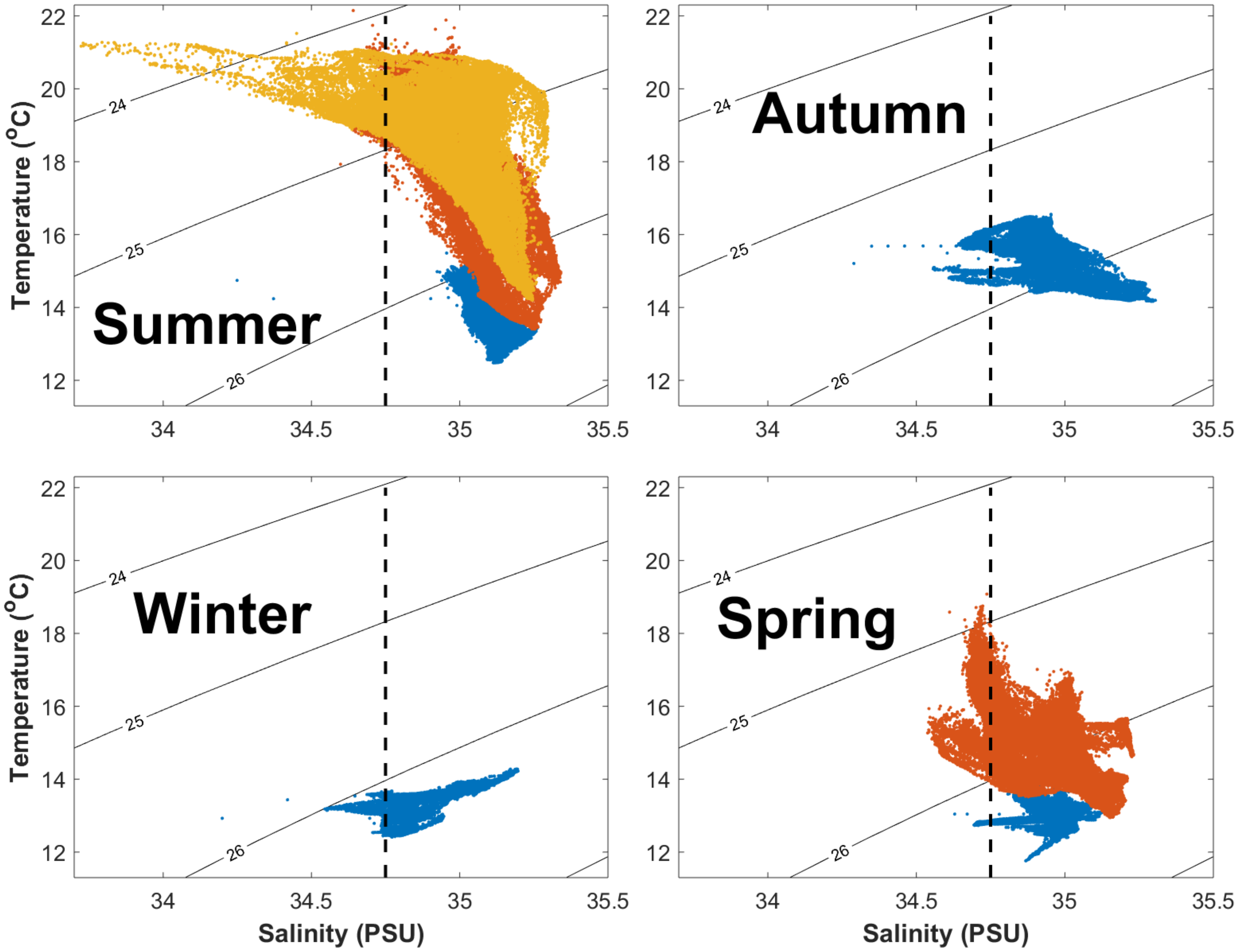
- Signals at the submesoscale observed from gliders in GCS
- These observations of LSMFs only possible since use of gliders
- Persistent throughout seasons, but short lived
- Temporal scale of 1-48 hours, spatial scales of L 1-30 km and H 1-40 m
- The variability of the dUC has a role to play on how far offshore the LSMFs can extend in GCS

Outlook:

- Gliders observations only cannot explain the processes occurring at the frontal region of interaction where the LSMFs meet the dUC.
- Therefore, to have a better mechanistic understanding of the barotropic and baroclinic processes in that energetic hotspot of submesoscale activity:

An integrated approach from observations and model is needed

Seasonal variability



T-S plot for each season, in the 1-50 m layer

	No. of missions	Temp. range [°C]	Sal. range [PSU]
Summer	3	12 - 22	33.7 – 35.5
Autumn	1	14 – 17	33.3 – 35.3
Winter	1	12 – 14	34.2 – 35.2
Spring	2	11 – 19	34.5 – 35.2

Caveats in detecting LSMF from satellite data

- Cloud cover
- Often no temperature signature associated
- Sea Surface Salinity resolution too coarse (25 km)
- Chlorophyll maximums in the subsurface