### Observation of the spatial structures of the SST at sub-mesoscale: data analysis and instrument design

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# SST from a drifting platform (OCARINA with a drogue)



Daily time series from 19 to 23 october 2019, in the northwestern Mediterranean, off the Porquerolles Island (TURBORADAR-TURBIDENT joint experiment, PIs P. Fraunié and J.-L. Devenon).

- On 19 October (blue), rms(SST)=0.006°C (only three times the noise floor)
- On 20 October (orange), rms(SST)=0.04°C (day of maximum variation)



On 20 October: Calm sea and wind conditions, typical of diurnal warming (ajouter hsw)



The daily averaged power spectrum of dSST/dt shows a smooth peak for 20 october



With the Taylor hypothesis (spatial structures do not evolve while sampling), the frequency power spectra are converted into wavelength spectra.

For 20 October, the most energetic part of the signal occurs at  $\lambda$ <200m, and peaks at  $\lambda$ =50 m, which is close to the wave length (~45m according to our data).

In summary, according to data from a drifting platform, and based on a small dataset of five days, we find that in sunny and calm conditions of wind and sea state:

- The SST fluctuations peak to 0.04°C in rms
- The power spectrum shows a smooth peak at 10<sup>-2</sup>-4.10<sup>-1</sup> Hz
- This would correspond to a structure length of 200m or less (Taylor's hypothesis)
- The maximum peak occurs at 50m

What are the shape of these SST structures and the associated physical processes ? Are they two-dimensional? Are they longmuir cells, measurement artifacts, small scale eddies ?

- Our data cannot help to further address this issue : The accuracy of the sensor used is sufficient (+/-0.002°C), but we have no information on the SST gradient perpendicular to the trajectory of the platform.
- Infrared cameras have an accuracy limited to 0.1-0.3°C, or 2-7 times larger than the most energetic signal observed here, thus they cannot be used neither.



A specific instrument and an appropiate measurement strategy have to be set up

Thoughts :

- No single platform can reasonably spans over 100 m
- No remote sensing apparatus has the required accuracy (0.002°C)

Response :

- Use a fleet of identical platforms, with
  - same sensors
  - same depth of measurements
- The platforms would
  - travel at same speed
  - follow parallel trajectories

Question: what can we expect to measure as a function of the magnitude of the SST gradient and of the number of platforms ?

#### 1/5 Simulation of the observed signal with an optimistic configuration :

- Pre-existing steady circular SST structure (φ=100m)
- Ten sensors spaced by 10 m from each other
- Signal to noise ratio of 1000



- A pseudo image is retrieved
- The x and y SST gradients are well defined
- The bottom two panels show comparable envelopes

#### 2/5 With added random noise, for comparison to 20 october 2018 data (rms=0.04°C):

- Ten sensors spaced by 10 m from each other
- Signal to noise ratio = 20



- The pseudo image renders well the spatial variations
- The x and y SST gradients have noise, but their variations are significant

## 2/5 (continued)Application of a 13-points median (low pass) filter to data (modification of the lower right panel of the previous slide)



#### Conclusion :

With a fleet of ten temperature sensors deployed in parallel, we could identify a centered circular SST structure of 0.04°C of magnitude and 100 m of diameter

#### 3/5 With only two sensors available:



Depending on the alignment of the SST structure with respect to the trajectories of the sensors, it may be possible to detect if the structure is two-dimensional or not.

However, this configuration is more risky and needs further investigation.

#### 4/5 Reasonable configuration: four sensors



The pseudo image shows the SST peak, and the envelopes of the x and y gradients [semblent exploitables, à étudier mieux]

#### Minimum acceptable signal to noise ratio = 7, i.e. $max(dSST/dx)=0.014^{\circ}C/50m$



#### 1/2 Toward a new instrument for imaging SST à sub-mesoscale : Timbalès torpedo



The torpedo maintains its heading with PIV+IMU+servo The body of the torpedo is floating (1/3 of the height is outside the water) 2/2 Toward a new instrument for imaging SST à sub-mesoscale : deployment strategy



Four torpedos are deployed from a ship at 20-30 m from each other