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Listen to the ocean

Updates on sensitivity experiments considering the impact of optical variability on ocean heat flux.

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Summary

- Reminder of WP requirements and progress
- PML experimental design
- Results from sensitivity experiments
- Results from satellite data processing
- Outstanding questions
- Next steps

Work package requirements and progress

- Task 3 - Examine the sensitivity of estimated fluxes and the oceanic heat budget to changes in the optical properties of the water, using ocean-colour data and a light transmission model, combined with a General Ocean Turbulence model.
- Deliverable 3.1 – Flux assessment report.

Work package requirements and progress

- Use satellite [Chl] from the OC-CCI project, combined with a spectrally-resolved model of light transmission underwater, to compute the distribution of solar radiation in the surface of the ocean.

- Combine these results with GOTM to study the sensitivity of the oceanic heat budget within the mixed layer and below the mixed layer, and of the air-sea exchange of heat, to the parameterization of light penetration in the ocean and to air-sea exchange of heat.

- Combine satellite [Chl a] with parameterization of vertical structure in chlorophyll, for example as in Longhurst et al. 1995), to study the impact of vertical structure in optical properties on upper-ocean stability and heat budget, using the turbulence model.

- Examine the impact of optical properties of the sea and of optical processes at the air-sea interface on the diurnal variations in SST and hence on the heat budget of upper ocean and lower atmosphere and on air-sea fluxes.

Experimental design

- GOTM sensitivity experiments
- Application of optical model to OC-CCI data

GOTM sensitivity experiments

Calculate irradiance attenuation profiles
Dependence on [Chl a], other constituents
Dependence on sun zenith angle

↓

Fit exponential function to irradiance profile.

↓

Input extinction files to GOTM

↓

Sensitivity of SST/MLD/air-sea flux

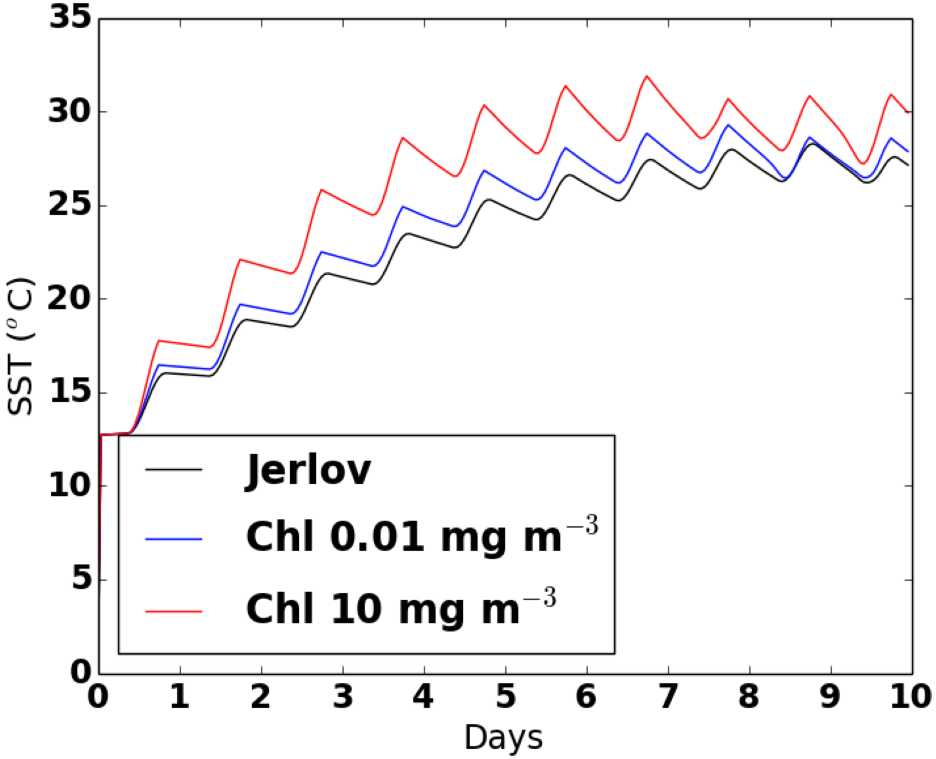
- New development includes:
  - Extension to UV.
  - Updates to optical model including phytoplankton size class model (Brewin)
- Jerlov plus 4 different [Chl a] concentrations (0.01, 0.1, 1, 10)
- 3 different wind speeds
- High latitude and low latitude, winter and summer conditions
- Total of 60 model runs covering all combinations.

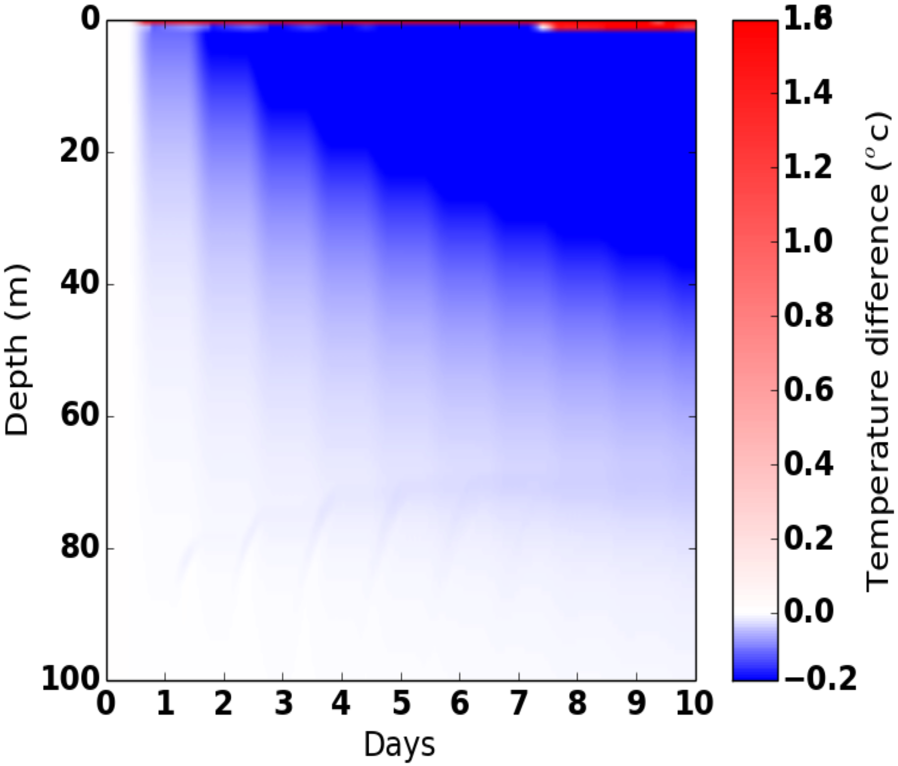
Application of optical model to OC-CCI data

- Using OC-CCI [Chl a] as input.
  - Newly developed version of atmosphere-ocean spectral light transmission model calculates attenuation over depth based on modelled surface PAR.
  - Extracts Irradiance (I) at Mixed Layer Depth (MIMOC)
  - Optimised for computational efficiency:
    - Code in Fortran with Python wrappers
    - Selects I at MLD or 1%, whichever is reached first - not full depth

Results – Sensitivity experiments

- Simplest case: Low wind, low latitude, summer.
  - SST increases with [Chl a]
  - Subsurface cooling.



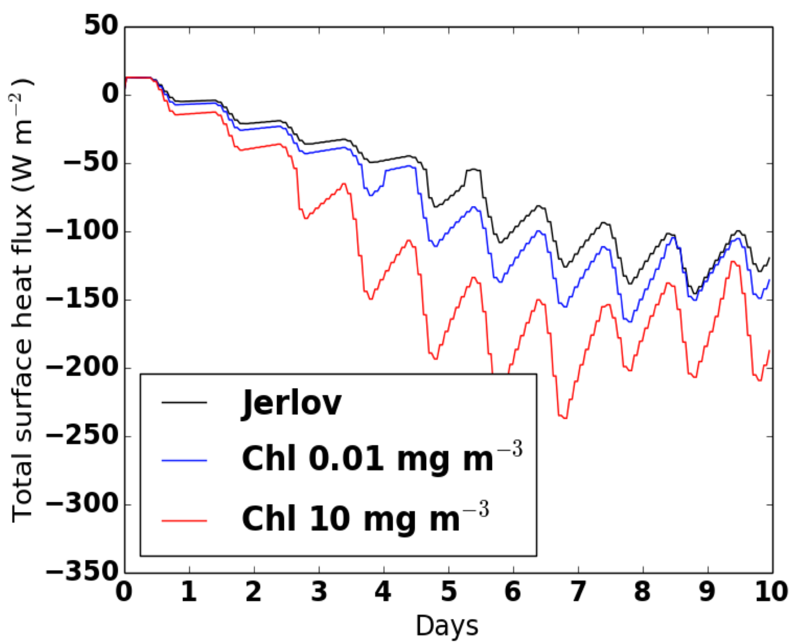


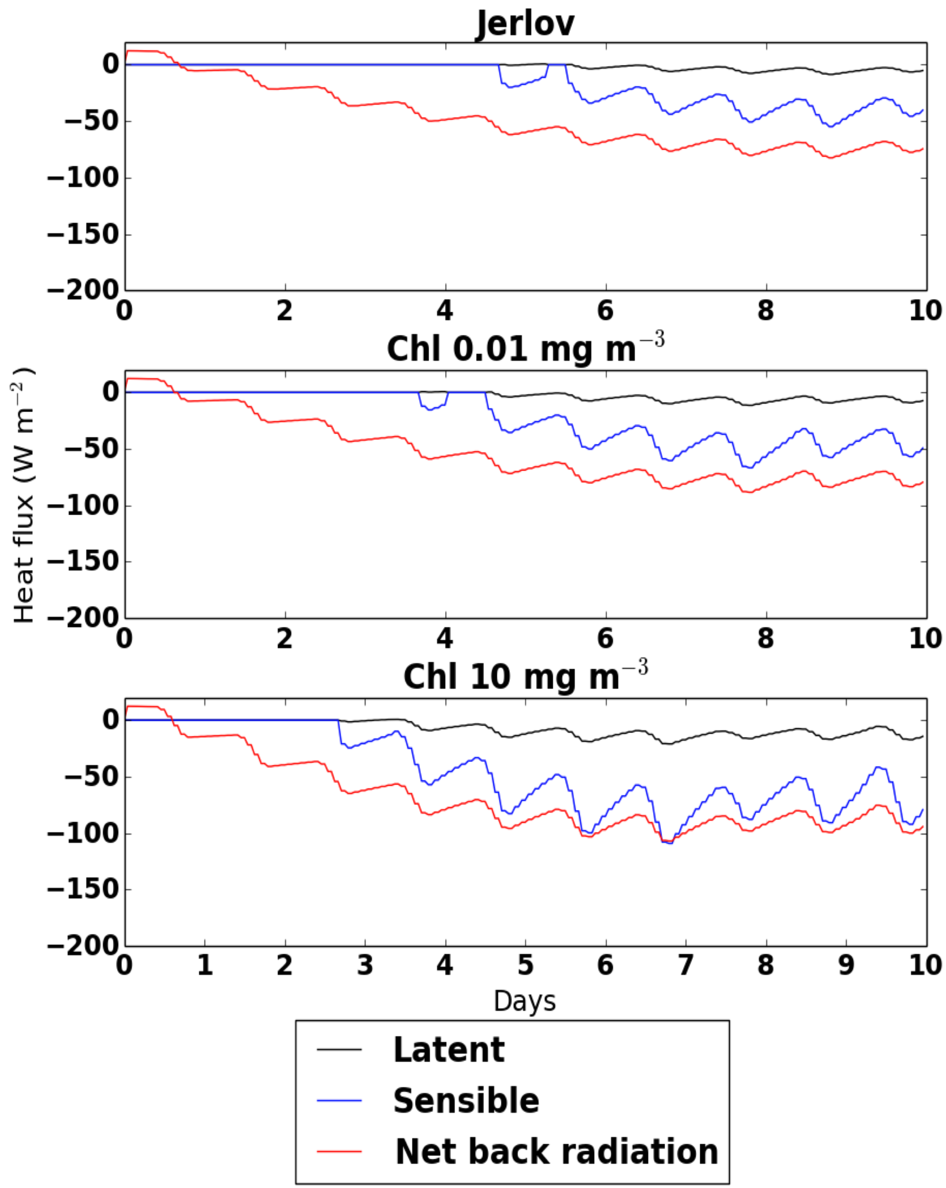
Results – Sensitivity experiments

- Air temp = 25 °C
- Humidity = 70

116.5 Wm^{-2}

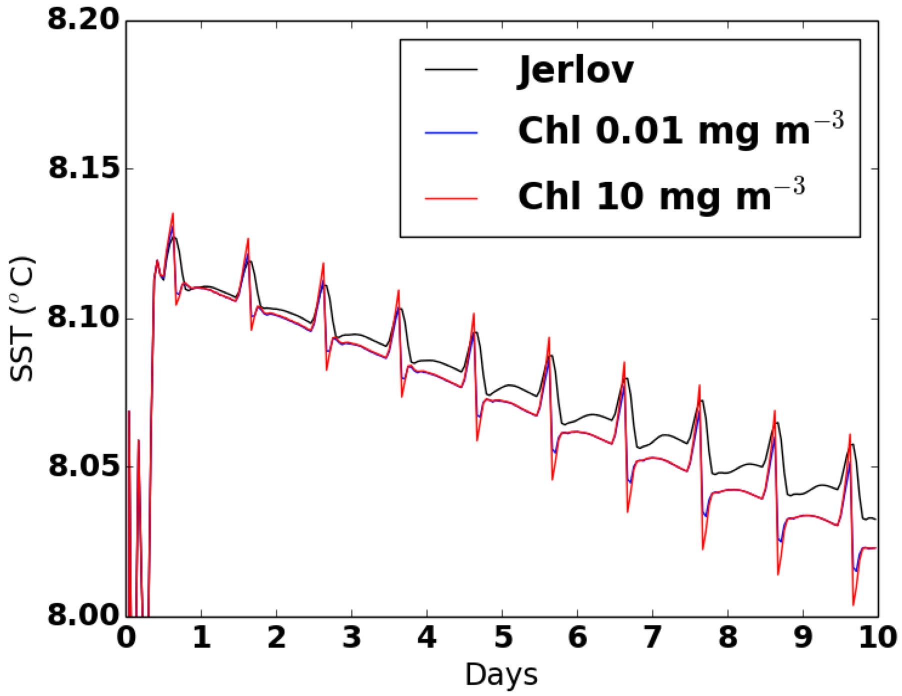
- Max difference = 116.5 Wm^{-2}





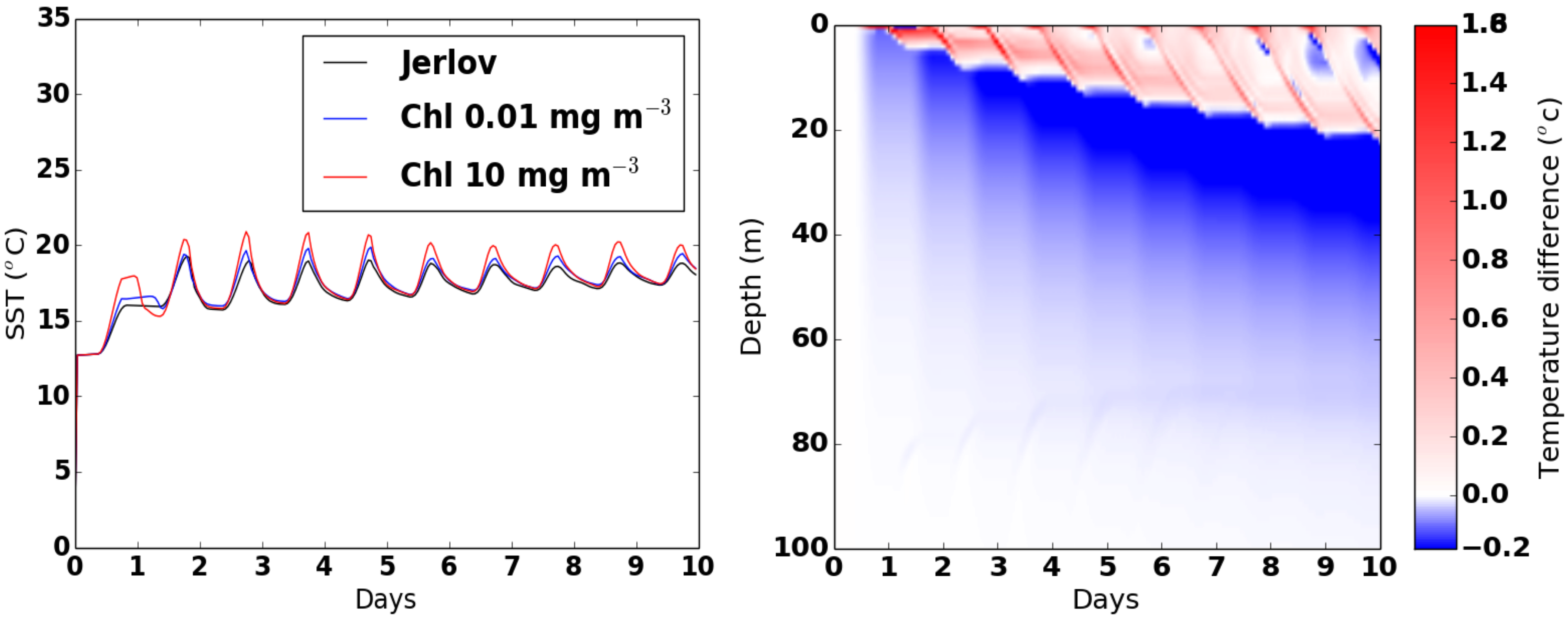
Results – Sensitivity experiments

- Change of season/location: low wind, high latitude, winter (summer similar to previous).
  - Shorter daylength
  - Changes optical sensitivity
  - Only seen at peak.
  - Very small differences in heat flux: -0.6 Wm^{-2}



Results – Sensitivity experiments

- Change of wind conditions (medium wind, low lat, summer):
  - Generally reduces sensitivity to optical variability.
  - Increases mixing, less stratification – surface warming mixed deeper, surface cooling reduced.



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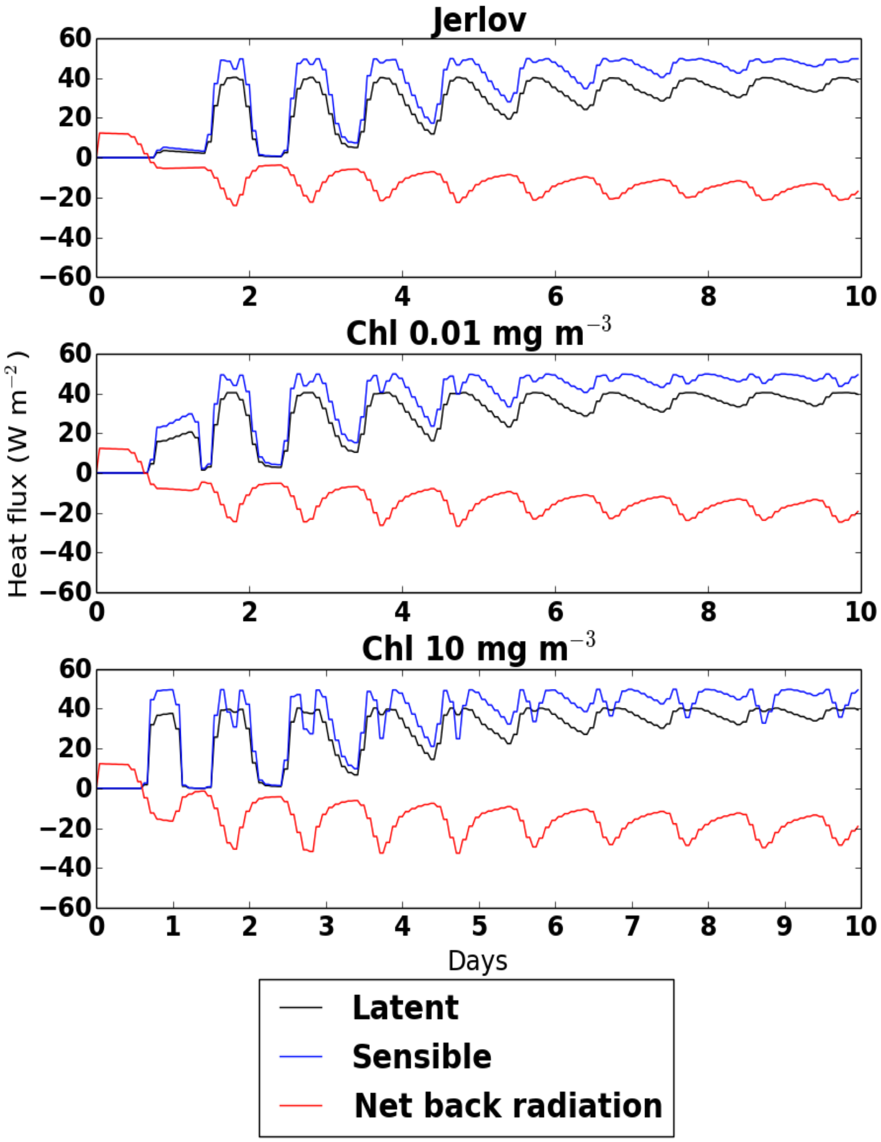
Results – Sensitivity experiments

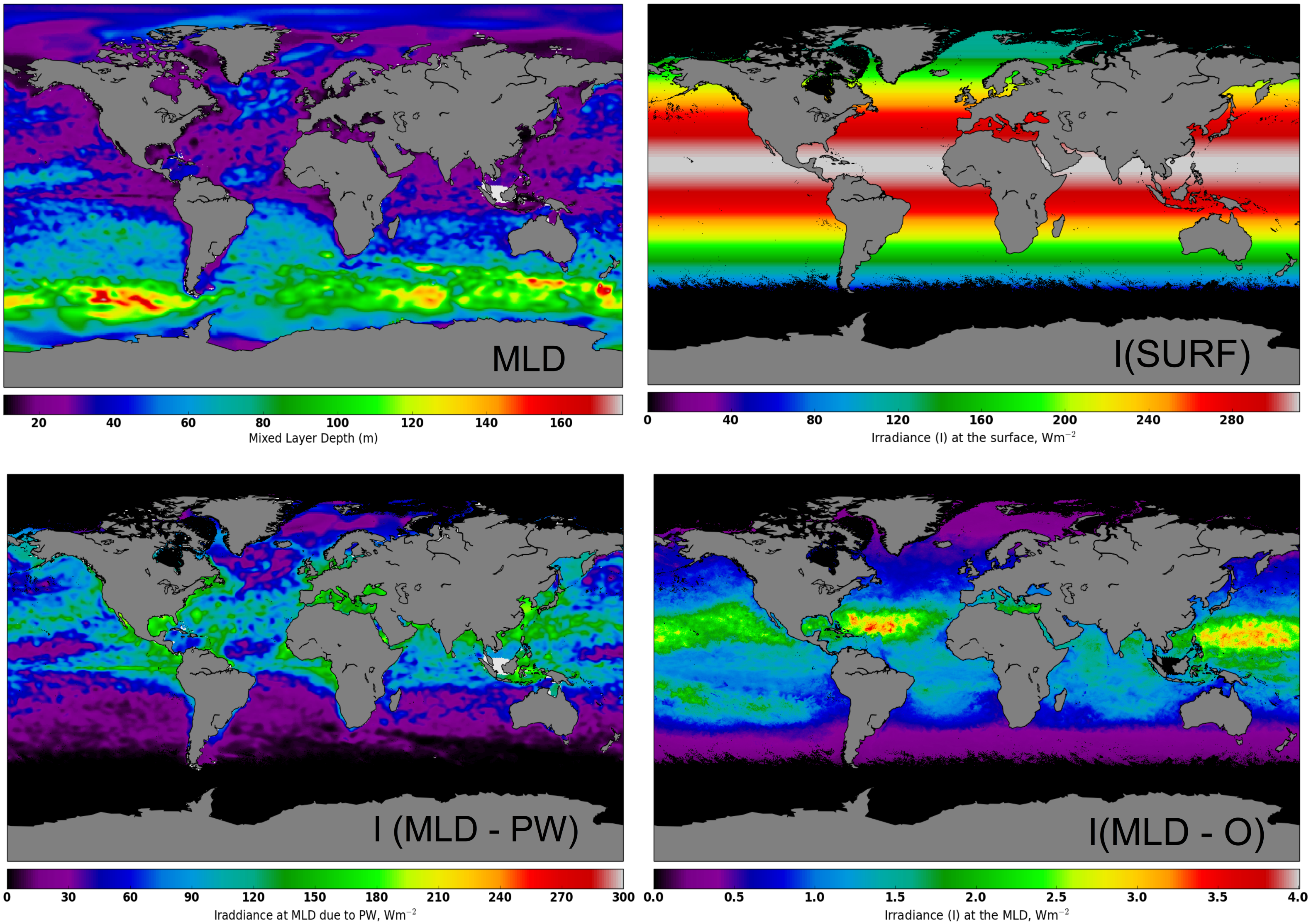
- Change of wind conditions (medium wind, low lat, summer):
    - Changes heat flux (air T>SST)
    - Difference in total HF of around 40 Wm^{-2} in most extreme case.



Results – Sensitivity experiments

- High wind conditions:
  - Low latitude summer: reduced sensitivity, general cooling, air T>SST, highly positive heatflux, sensible = greatest contributor.
  - High latitude summer: as above, air T<SST, negative heat flux.
  - High latitude winter: as above.

Results – example satellite data processing



Further work

- Non-uniform [Chl a] profiles.
- Satellite processing to combine realistic (not clear sky) PAR with in-water optics.
- Continue report on supporting literature, methods, results – someone to check through?

Questions

- Does interpretation of results look coherent/as expected?
- Better ways to summarise?
- Flux product of I at MLD.
  - Is this useful for users i.e. Loic, for mediterranean study.

Questions

- Does interpretation of results look coherent/as expected?
- Better ways to summarise? - Looking at forcing conditions which lead to light penetrating below MLD.
- Flux product of I at MLD.
  - Is this useful for users i.e. Loic, for mediterranean study.