# Discussion topic 1

***Data assimilation of surface velocities: issues, challenges, lessons learnt so far***

Observation operator, observation error, forecast error covariance, DA approach (ensemble,4d/3dVar, ”image”,…), lessons learnt from HF radar and surface drifters, challenges…

# Data assimilation – issues and challenges

- Observation operators:
  - A-TSCV approach used L2C data (provided as eastward/northward currents). We put an observation operator to deal with this type of data into the main NEMO trunk.
  - Could also develop observation operator for the radial velocities.
  - Could include wave model in the main system so it is a coupled wave/ocean/sea-ice and use information from all these to develop an observation operator for lower level data.

- Pros/cons to different approaches?

# Data assimilation – issues and challenges

- Representation errors:
  - Due to mis-matches in horizontal resolution in observations and model:
    - In A-TSCV project we calculated this from the difference with a higher resolution nature run but that isn't the true representation error (when using real data).
    - Other options for estimating it include looking at the sub-grid scale variability in the observations.
  - Due to mis-matches in the depth of observations and model:
    - SKIM data representative of top 1m - same as the depth of the model's top level in our configs - but the model doesn't represent all the processes in the real ocean.

# Data assimilation – issues and challenges

- Dealing with correlated observation errors in DA.
  - Most operational DA systems don't deal with correlated observation errors.
  - Can mitigate their effect by e.g. thinning the data, inflating the specified observation errors.
  - Methods need to be developed to efficiently and effectively represent correlated obs errors in the DA, e.g. the work of O. Goux and A. Weaver on using the implicit diffusion operator on a finite element grid (to allow for the unstructured nature of the observations).

- Control variables used in the DA:
  - correlations between errors in u/v violates the assumptions of the DA. Not a problem in existing schemes which don't assimilate velocity data.
  - other control variables such as streamfunction and velocity potential could allow us to make better use of this type of data.

# Data assimilation – issues and challenges

DA algorithm:

- Ensemble methods
- Variational methods – 3DVar and 4DVar
- Hybrid methods
- Lagrangian DA methods

- Are some better than others at:
  - Initialisation of high frequency processes such as NIOs or tides.
  - Flow-dependence of the forecast error covariances.
  - Representing correlations between variables effectively.

# Data assimilation – issues and challenges

Lessons learnt from work to assimilate HF radar and surface drifter data?