Proposal of CPG for the JPM2023

1. Air-Sea and Air-Land exchanges: see Action B9

CPG for JPM2023.

Many of the actions identified in the JPM21 BOG have not been considered/addressed. There is significant work about air-sea interactions through OASIS, led by Meghan. Thus, we need to avoid redo of work already done.

Proposition:

Set up a small group from panels (Meghan Cronin, Liz Kent, Ghen Darren) to prepare outline for BOG considering the actions from JPM21, the IP B9 Action and the work done within OASIS.

As a starting point, take 1st activity of the IP Action B9:

1. Improve and extend in situ measurements needed to estimate surface fluxes, with the objectives of improving accuracy and better defining the uncertainties of those measurements and calculated fluxes.

Means of assessing progress:

a) A catalogue of the in situ observations providing good quality observations of ECVs relevant for surface fluxes;
b) Number of observations in 1(a) (above) available in data centres;
c) Demonstration reference stations for ECVs needed to calculate surface heat, moisture and momentum fluxes;
d) A plan for the establishment/maintenance/extension of a global network of reference stations for ECVs needed to calculate surface heat, moisture and momentum fluxes.

And ask members of CPG to:

- Produce a list of in-situ observations providing good quality observations of ECVs relevant surface fluxes (starting point is a previous list produced at JPM) and assess availability of observations in data centers. 2 BOG: sea-air and land-air
- Gap analysis: which of these observations need expansion, why? (Geographical gaps, data management (sharing, accessibility etc)
- What is needed to make the case for the extension of the networks (paper, document..): importance of those observations, why actual number/distribution is not sufficient, who will be the community using that (Models, improved parameterization?)

- Results from this group will be outlined in a GCOS report (to be also used as justification for asking extension to NMHS)

<u>Background to this CPG:</u>

GCOS IP Action B9

Action B9: Improve estimates of latent and sensible heat fluxes and wind stress	
Activities	This action focuses on ice-free oceans and the terrestrial land surface 1. Improve and extend in situ measurements needed to estimate surface fluxes, with the objectives of improving accuracy and better defining the uncertainties of those measurements and calculated fluxes. 2. Extend sites with co-located measurements of direct turbulent and radiative fluxes and variables required to estimate turbulent surface fluxes targeted at improving parameterisations of air-sea exchange and air-land exchange. 3. Develop new approaches over land, focusing on improved estimation of transpiration, interception and soil evaporation separately. 4. Develop new approaches and improved methods to better exploit relevant ECV measurements to estimate ocean surface heat, moisture and momentum flux including: a) Better integration of in situ and satellite measurements, data assimilation, fusion techniques, ensuring consistency between different types of measurements and their harmonisation; b) Development and deployment of new satellite missions that are tuned to maximise the sensitivity to the state variables needed to estimate heat flux over the ocean and land; c) Increase and improvements in satellite observations that target both the surface parameters and the near-surface air-parameters; d) Simultaneously use of an approach based on high resolution numerical models (Large Eddy Simulation (LES)) to augment satellite product validations; e) Include in future intercomparison campaigns of latent and sensible heat fluxes measurements inferred from simultaneous observations with a water vapour differential absorption lidar (WVDIAL), a Doppler wind lidar and temperature from rotational Raman lidar.
Issue/Benefits	Understanding and estimating surface fluxes is essential for improving projections of climate change and planning adaptation and response measures. The need for surface, near surface, and boundary layer information, across different temporal and spatial scales for multiple disciplines, has outstripped the capabilities of existing observing networks. Direct observation of surface turbulent (sensible, latent and momentum) fluxes is difficult and costly and globally impractical. For global coverage it is therefore necessary to estimate the

	surface heat and momentum fluxes using empirical parameterisations based on other ECVs (including surface temperature, near surface air temperature and humidity, near surface wind speed and direction). To improve the parameterizations, and quantify uncertainty, high quality in situ measurements of both direct fluxes and collocated ECVs used to calculate the fluxes are needed at key representative locations. Improvement of estimates of ocean surface heat, moisture and momentum flux requires integrating in situ and satellite observations, use of data assimilation and fusion techniques. New and improved methods need to be developed to better achieve this integration.
Implementers	From 1 to 2: **NMHS,** GOOS, Research organizations. 3. **Academia,** Research organizations, NMHS. 4. **Satellite agencies**, NMHS, Academia.
Means of Assessing Progress	1. a) A catalogue of the in situ observations providing good quality observations of ECVs relevant for surface fluxes; b) Number of observations in 1(a) (above) available in data centres; c) Demonstration reference stations for ECVs needed to calculate surface heat, moisture and momentum fluxes; d) A plan for the establishment/maintenance/extension of a global network of reference stations for ECVs needed to calculate surface heat, moisture and momentum fluxes. 2. a) Increased availability of co-located direct flux measurements and flux-relevant ECVs in data centres; b) Published paper(s) demonstrating the reduction in the uncertainty in empirical parameterizations used to calculate turbulent fluxes. 3. Published paper(s) on new approaches for separate estimation of transpiration, interception and soil evaporation. 4. a) Reduced uncertainty in both air-sea and land-atmosphere flux products; b) Scoping and development of satellite missions to better optimise measurements in the Planetary Boundary Layer.

Background

Air-sea: Air-sea exchanges of energy, moisture, and gases drive and modulate the Earth's weather and climate, influencing life, including our own. These air-sea interactions fuel the hydrological cycle and affect precipitation across the globe. Air-sea interactions affect the distribution of carbon dioxide between the atmosphere and ocean, how seawater flows and winds blow, and how pollutants floating on the ocean surface move – information critical to policymakers, industry, and civil society.

Air-land:

JPM 2019:

Actions:

- Caterina Tassone (GCOS) liaison with WCRP to coordinate with existing WCRP ocean & landbase flux groups (WDAC, Surflux Task Team, GEWEX, SOLAS…).
- Liz Kent (AOPC) and Rainer Hollman (AOPC) will discuss with AOPC feasibility of remotely sensed humidity & temperature profiles, optimized for surface boundary layer.
- Bob Weller (OOPC) will work with Christian Lanconelli (BSRN) to set up workshop on a global
- (ocean & land-based) radiation network, and develop best practices for surface radiation.
- Matt Palmer (OOPC) will liaison with WMO/WGNE & WCRP/WGCM
- Meghan Cronin (OOPC) will help coordinate a vision paper for broader community, beyond
  OceanObs19.
- Scoping of a SCOR Working Group Proposal for organizing/implementing near-term goals?

JPM 2021:

The BOG "Surface energy and water fluxes" met with a focus on answering the following questions: How complete is the coverage (spatial and temporal) of Air-sea and Land-Air fluxes (evaporation, sensible heat …)? What can be implemented now and what developments are needed? How consistent are the existing flux ECVs?

Actions:

Satellite fluxes actions

• Evaluate existing space-based observing capability for use in studying fluxes

• Characterize the conditions under which satellite observations meet (or fail to meet) surface flux requirements;

• Improve methods for combining different satellite and in situ observation sources for use in flux studies ;

• Explore methods to improve subdaily resolution using patchwork of observations from geostationary orbits (e.g., every 15 min) or polar orbiting platforms (e.g., twice a day from each platform.

In-situ actions

• Extend the Baseline Surface Radiation Network (BSRN) to the Ocean;

• Continue Ocean Surface Radiation Best Practice efforts within BSRN & Ocean Best Practice Systems (OBPS). Laura Riihimaki and Meghan Cronin will co-lead an OBPS Community Workshop on Surface Radiation Best Practices in September 2021;

• Estimation of global surface fluxes will require interoperable satellite and in situ measurement of multiple ECVs;

• Coordinate intercomparison experiments to test and validate interoperability between (a) different in situ platforms (e.g. shipbased, buoy, uncrewed surface vehicle, fixed

tower) and sensors, (b) in situ and extrapolated satellite retrievals, and (c) observed and modeled variables. A nearshore tower station may provide a useful starting testbed;

• Develop land-based and ocean-based Supersites with direct covariance flux and profiling technology used not only for calibration & validation, but also to understand processes and to test and develop models and parameterizations. Question: Are Supersites = Atmospheric Radiation Measurement (ARM) sites? or Global Atmospheric Watch (GAW) stations? Or some other organized program?

• Leverage technology development to obtain profiler technology suitable for remote applications (i.e. small, low powered, lower cost…).

Modelled Fluxes

• Perform array designs to determine how many supersites are needed within network of reference stations – over land & ocean, where to locate them, initiate through a short-term process study;

• Improve Community practice for FAIR data, latency, continuity;

• Improve communication through SCOR Working Group #162 Observing Air-Sea Interactions Strategy (OASIS), which includes OOPC, AOPC, and BGC & Bio/Ecosystem