Note for group 1:
We collected all the information that we gathered from the discussion. Since this might be too much information, we advise you to focus on the column regarding (dis)similarities between systems for each question.

Question	Marine	Freshwater	Terrestrial	(Dis)similarities
Q1: What is the relative importance of physical drivers (temperature, ocean currents, light, precipitation,...), nutrient availability and biological/ecological drivers (the interaction between species and metabolics) across the three types of ecosystems ?	Nutrients play the important part in the marine system which can be well mixed by ocean currents. Other agents like temperature, light and precipitation can also be important especially in the top layer (critical depth), but are not considered as driving factors. Phytoplanktons have the larger part in primary production.	In freshwater systems (rivers, streams and wetlands) hydrology can be very important. The importance of driving factors is dependent on the scale of the research. It's always a question of time and scale. Spatial and temporal factors can determine the role of other controlling factors.	In terrestrial systems, productivity is not directly controlled by climate and the main point is the availability of biomass. Plants can keep living with water and do the photosynthesis process. Growth in plants is sink limited. Precipitation, water content and temperature can be more important which let cells grow.	Similarities: light and nutrient Dissimilarities: physical constraints: mixing in oceans and freshwater while in terrestrial systems is not the case
Q2: It is known that, in terrestrial environments, the increase in CO2 could lead to an increase in the GPP, by increasing the carboxylation rate. Can we expect an increase of	Not a limiting factor for PP in marine systems. Maybe in eutrophic systems CO2 can be	In inland system, being freshwaters supersaturated with CO_2, it does not limit the productivity.	In terrestrial systems this is a debated matter. It is important to distinguish carbohydrates productivity and cell	CO2 is not a limiting/controlling factor for PP as a substrate. However, its effects on the chemical balance of soils and waters can lead to other issues:

PP in aquatic systems like wetlands etc. with increasing CO_2? What about positive feedback in increasing the CO_2 and PP?	limiting.		growth. The acidification of soils cause damages to foliage and forest in general because trees are not able to handle low pH environment.	- reduced availability of nutrients in acidified soils - direct damage through acid rain - Impact on calcifiers through acidification and carbonate speciation balance.
Q3:What are the main disturbances impacting the PP (fires, floods, eddies, storms) in each ecosystem and what are the challenges to include them in models?	Eddies are an interesting disturbance that could be positive (cause upwelling: more nutrients) and negative (downwelling) for PP. Hurricanes and storms increasing the wind intensification and mix the waters and bring nutrients but greater mixing can also have negative impact	The spatial scales are important, for example larger scale watersheds are buffered and absorb disturbances. There are unprecedented storms and floods at the moment, that hamper predictions for the future.	Terrestrial system space is critical, disturbances are critical because they create space and make a change in biomass. *Remember that the potential of terrestrial ecosystems to remove carbon from the atmosphere depends on the biomass available to perform photosynthesis.	Different timescales of recovery from disturbance. In all three systems the spatial and temporal scale is important to understand the effect of the disturbances but it is difficult to predict whether they will be positive or negative.
Q4:Invasive species impact?	Not significant for planktonic organisms due to high dispersal and connectivity. Benthic(seagrasses and macroalgae) can be	Very high impact in freshwater systems, as distinct streams, lakes and estuaries are not very well connected. Contemporary impacts of	Very high impact on native producers. Mobility is not an option so competition for space is very intense. Impact on PP is not clear, as	Impact of invasive species depends on the connectivity of the system. The less connected the more sensitive.

	highly impacted by alien species, leading in some cases to ecosystem “crash” or extreme reorganization.	invasive species across trophic levels. Although the impact on productivity is difficult to assess on a global scale and depends on individual cases.	individual cases of species replacement can lead to either increases or decreases in PP. However, in the long term the ecosystem resilience decreases and niche partitioning disappears, so competition for resources increases and general efficiency of production goes down.	
Q5:How important are atmospheric sources of nutrients (N2 fixation, dust and aerosols) ? How will this change in the future ?	Because of the important dilution of atmospheric input, only trace metals really have an impact on production (see for instance dust storms, iceberg melting, large fire event plumes).	In comparison, atmospheric input is trivial for most inland waters ecosystems. It can change the N:P ratio though. N2 fixation relevance is still a topic of debate, especially around how relatively limiting phosphate and nitrate are.	A paradox exists for N2 fixation. Because of its high energy cost, N2 fixation is expected in nitrogen limited ecosystems, yet is observed mainly in tropical forests (where phosphate is limitant). It could be explained by stoichiometry, or by the difficulty of extracting phosphate (for which plants need enzymes, and thus nitrate).	The same paradox of N2 fixation has been observed in arctic sea-ice and tropical forests. Atmospheric input is otherwise only really important in marine systems, where trace metals can generate PP.
Q6:Studies (both empirical and modelling) are often limited by temporal and spatial scales. These limitations in turn, affect our capacity to transfer			.	Scale of the study impacts the understanding for all ecosystems. Especially when looking at the effect of climate change on

knowledge from microscales/ short-time scales to whole ecosystems and in the last instance across terrestrial-freshwater-marine systems. Regarding that, how do scales matter in our capacity to understand the effects of climate change on aquatic/terrestrial productivity?				productivity. The implications of studies on small scales may not be applied on the ecosystem as a whole because of the potential feedbacks. In all the ecosystems, small temporal scale studies often fail to include large-scale processes and their impact. Also, small spatial scale studies are not very uniform and may not show reproducibility because of many processes and feedbacks specific to a place or time. So, the scale of study impacts the understanding of all ecosystems on a holistic level.
Q7: How robust is satellite data in terms of production in all systems?	Best tool available at the moment to look at global scales. But is chlorophyll a reliable tool for estimating biomass? There are some big underlying assumptions. Also satellites cannot measure at the deep chlorophyll maximum. This is a problem.	Resolution is the biggest challenge. Most lakes and rivers are small, to the point where resolution is limiting. Resolution is increasing rapidly though.	Quite some complicating factors: f.i. cloud interference. Also it gives information on biomass, but not respiration, therefore no information on NEP. Satellites cannot measure below ground, where lots of important processes happen.	Common issues of limited “depth” penetration of satellite imagery in all systems. Making estimates of biomass difficult as satellites are blinded to either deep Chla maxima in aquatic systems and below ground biomass in terrestrial ones.

Q8:The difference in the scale and complexity of primary producers have made scientists turn to models to assess primary production. Where is the main knowledge gap on assessing and projecting primary production in the anthropocene, as climate change continues to alter our ecosystems: is it the lack of empirical data or do models have to be refocused and “get it right”?				Models are useful supporting hypotheses, testing and to reconstruct future processes but they could be very limited because of lack of data. "All models are wrong" (George EP Box) There are very productive models about photosynthesis,but respiration is really not as evolved. Be careful!
Q9: As society becomes more involved in the "battle" against climate change, how do you think citizen science can help in assessing and monitoring primary production across different ecosystems? Do you think it will become an essential tool or could it lead to more noise and low-quality data in a time when high-quality (i.e., low uncertainty) data is of	Problem of access (except for beach/coast). But some ferries help with monitoring by sensors or sampling.	Mainly obtaining data on phenology.	Long-term (20/30 year) citizen science project with the use of Sechhi-disks. Used for studies on productivity.	

paramount importance?				