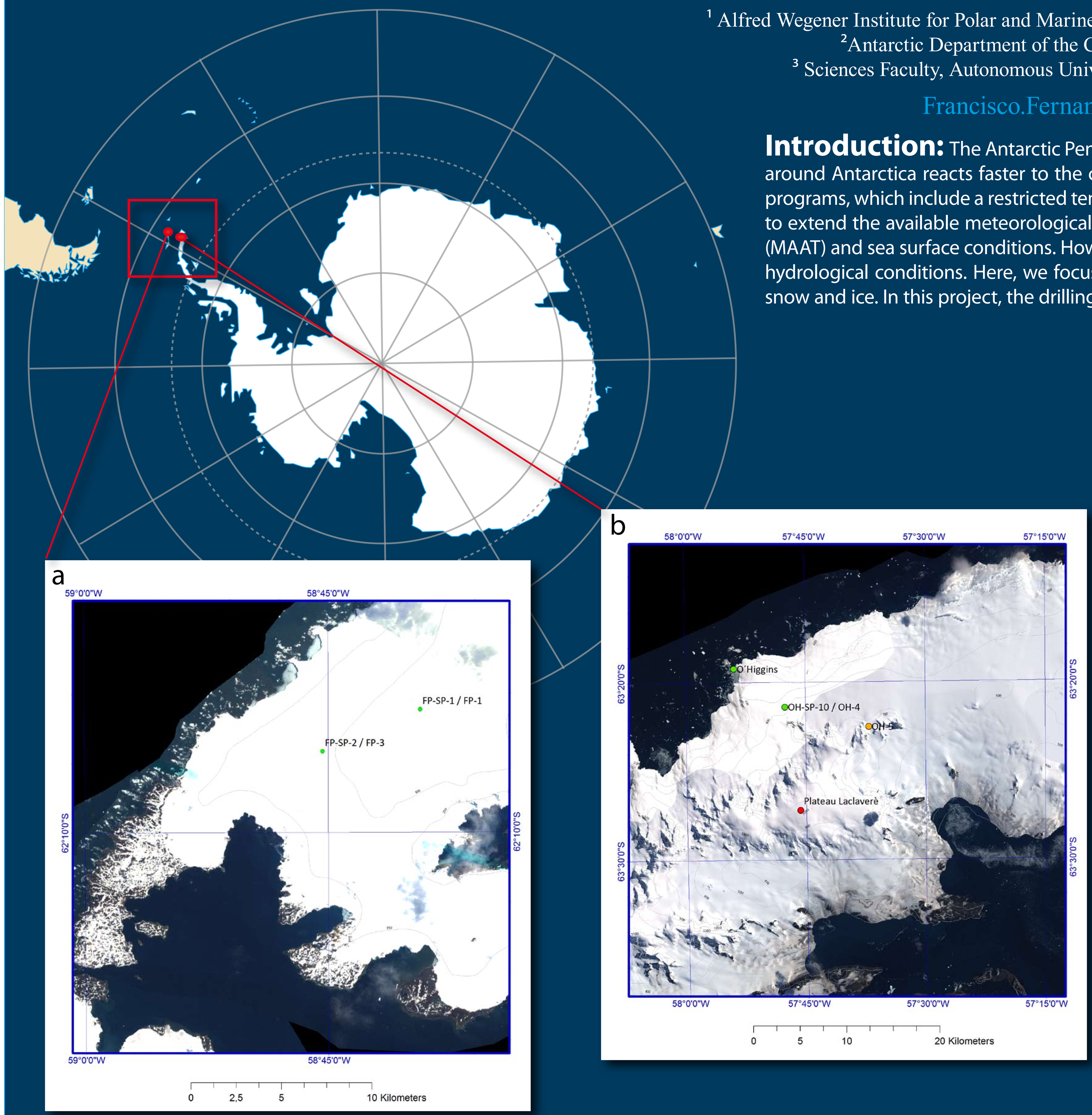
STABLE WATER ISOTOPE CHARACTERISTICS OF THE RECENT HYDROLOGICAL SYSTEM OF THE NORTHERN ANTARCTIC PENINSULA - IMPLICATIONS FOR ICE CORE INTERPRETATION

Francisco Fernandoy[1], Hanno Meyer[1], Cristian Olivares[2] and Mar Cartró[3]

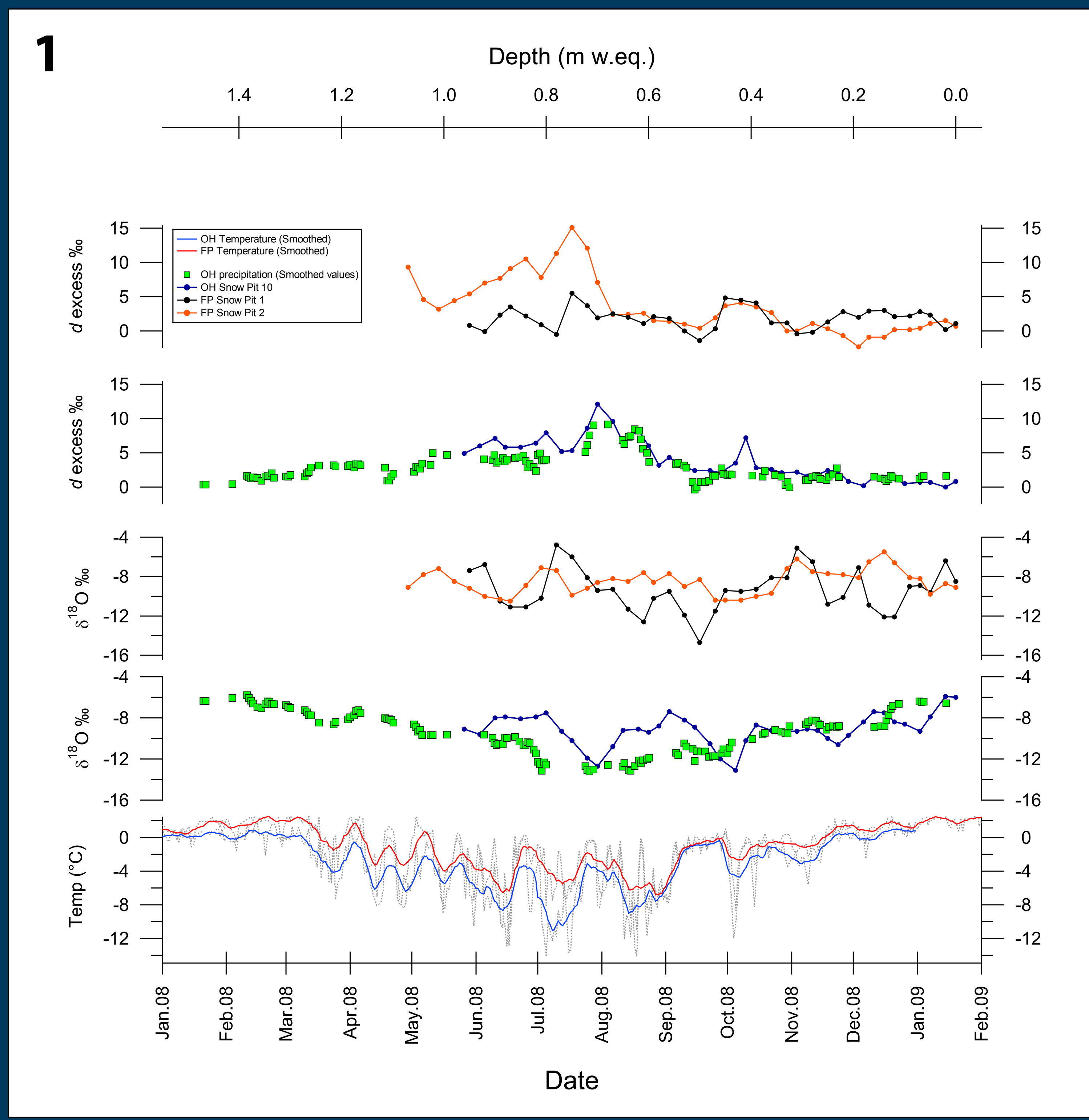
[1] Alfred Wegener Institute for Polar and Marine Research, Potsdam Germany (AWI)
[2] Antarctic Department of the Chilean Army (DAE)
[3] Sciences Faculty, Autonomous University of Barcelona, Spain

Francisco.Fernandoy@awi.de

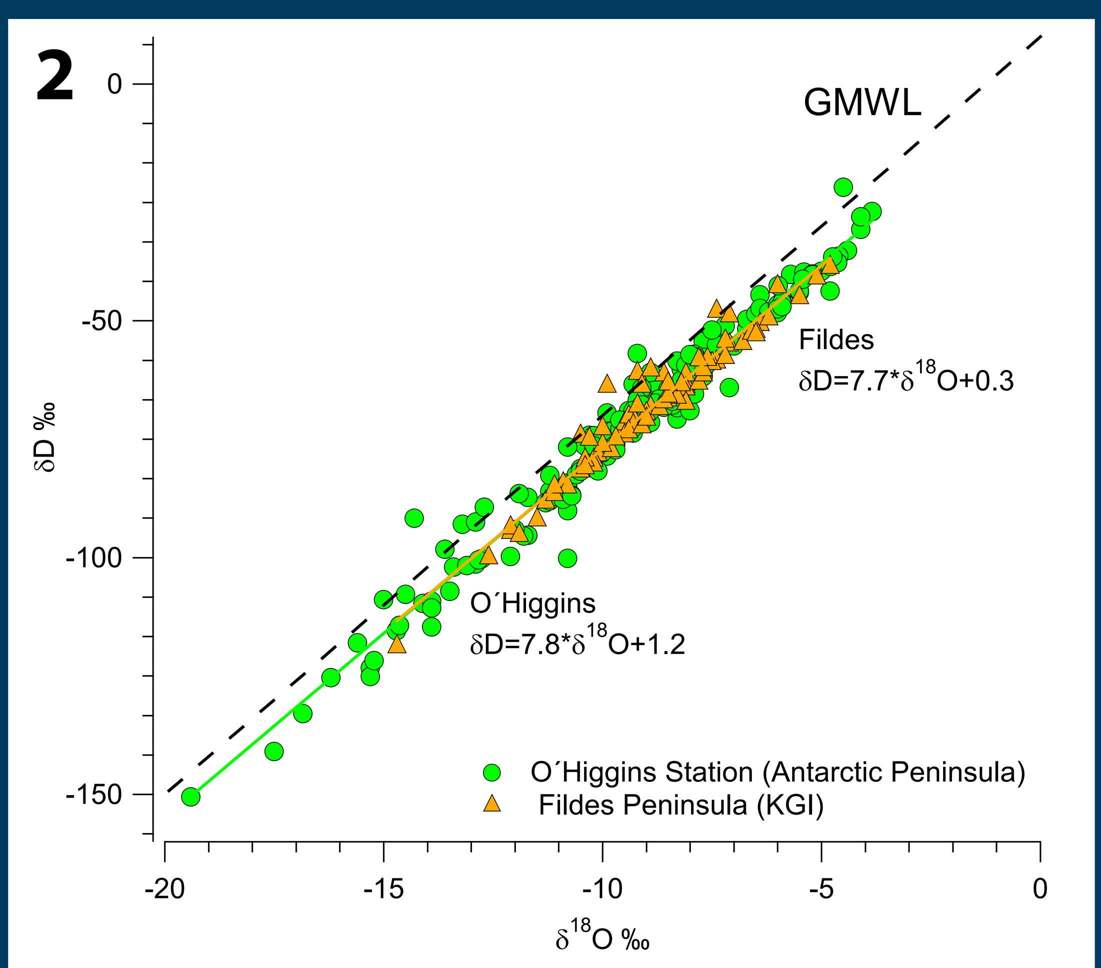
Introduction: The Antarctic Peninsula is one of the world-wide regions with the highest temperatures increase. The stability of ice shelves around Antarctica reacts faster to the climatic change than previously believed. Several nations are presently carrying-out climatic monitoring programs, which include a restricted temporal (50 years) and geographical distribution. Based on geochemical analyses, ice-cores have been used to extend the available meteorological record into the past. Water stable isotope composition is mainly linked to mean annual air temperature (MAAT) and sea surface conditions. However, the interpretation of the isotope variations requires a detailed characterization of local and regional hydrological conditions. Here, we focus on the northern Antarctic Peninsula, a region lacking of glaciological and geochemical information of snow and ice. In this project, the drilling of a medium-depth (100-150 m) ice-core is planned

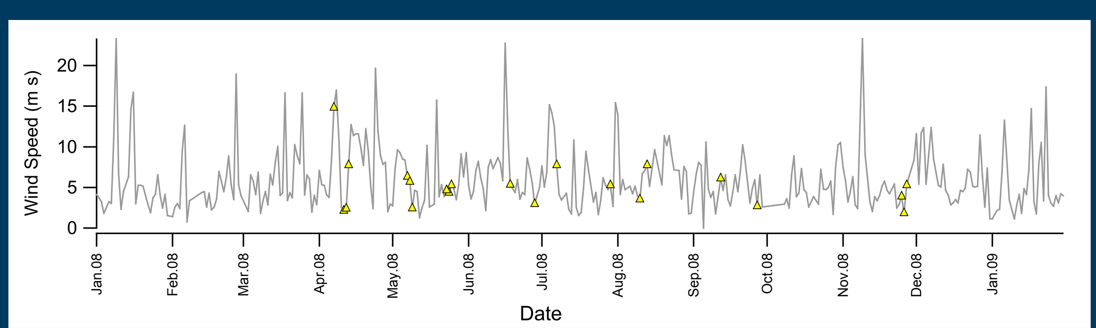


Study area 2008/09: a) Fildes Peninsula, King George Island (Southern Shetlands), Antarctica. During a summer expedition, two firn cores at the positions FP-1 and FP-2 were retrieved (both 16m depth), additionally snow pits (SP) at the same location were excavated (FP-SP-1 and FP-SP-2, respectively). b) North Antarctic Peninsula, at the Chilean Station "O´Higgins", precipitation samples were collected in a daily schedule by the over-wintering crew in 2008. During the summer of 2009 two shallow firn cores were retrieved (OH-4 and OH-5, 16 and 10.5 m depth, respectively). Stable water isotope data of SP and precipitation for all green points in figures a) and b) are presented in this work. In figure b): The red point shows the expected study area (Plateau Laclavère) during the Antarctic summer season 2010.



Results: Isotope and meteorological data of both study areas (Figure 1). Top: Snow Pits from Fildes Peninsula are plotted against depth in meters water equivalent (m w. e., orange and black lines). Snow pits (blue lines) and precipitation samples (green squares and triangles) data of the O´Higgins Station is also displayed. Stable water isotope data of precipitation was smoothed using a 5-points mean running function. At the bottom the daily temperatures are shown for both Fildes (red line) and O´Higgins (blue line). Temperatures were smoothed using a mean running function with an interval of 5 days. A common peak in *d* excess is notable for all data sets, registered in the precipitation samples on 08 August 2008 and at approximately 0.7 m depth for all Snow Pits. The correlation between smoothed air temperature data and stable isotope data for O´Higgins Station (Antarctic Peninsula) is good, with a coefficient of determination 0.31 (r^2) and a relationship of 0.31°C/^{18}O‰.





Local meteoric water lines: LMWL derived from the co-isotope correlation are very similar for the two areas (Figure 2), implying similar evaporation/condensation conditions in this area. Both LMWL deviate slightly from the GMWL ($\delta D= 8*\delta^{18}O+10$‰). For the calculation of the LMWL for OH, some samples were eliminated because of their inconsistent isotope composition for precipitation samples (around 0‰ for both δD and $\delta^{18}O$). These samples represent marine aerosols and are related to strong wind storms, as shown in figure 2 (bottom). From the summary table (a) a latitudinal gradient is observed from the data of Fildes Peninsula and O´Higgins. An altitude effect is observed between snow pit data from Fildes (FP -SP 1 -700 m a.s.l. and FP-SP 2 – 400 m a.s.l.)

a

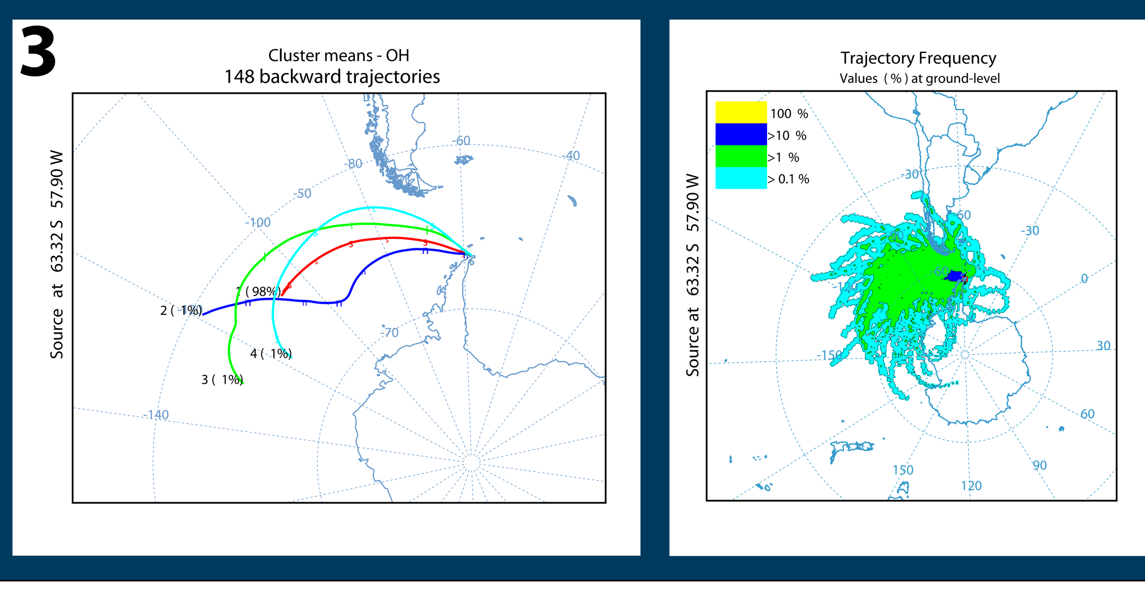
	OH (Precipitation samples)	OH-SP 10 (Snow Pit)	FP-SP 1 (Snow Pit)	FP-SP 2 (Snow Pit)
$\delta^{18}0$ ‰				
Mean	-9.6	-9.1	-9.4	-8.5
Std dev	3.2	1.6	2.2	1.3
Max	-4.6	-5.9	-4.8	-5.5
Min	-19.4	-13.1	-14.7	-10.5
δD ‰				
Mean	-74.1	-69.2	-73.3	-64.3
Std dev	25.5	11.7	17.7	9.2
Max	-36.4	-47.0	-38.7	-45.1
Min	-150.6	-101.7	-118.8	-81.0
***d* excess ‰**				
Mean	2.7	3.9	1.8	3.6
Std dev	4.2	2.9	1.6	4.1
Max	22.3	12.1	5.5	15.1
Min	-6.6	0.0	-1.4	-2.3
n (samples)	148	41	36	40.0

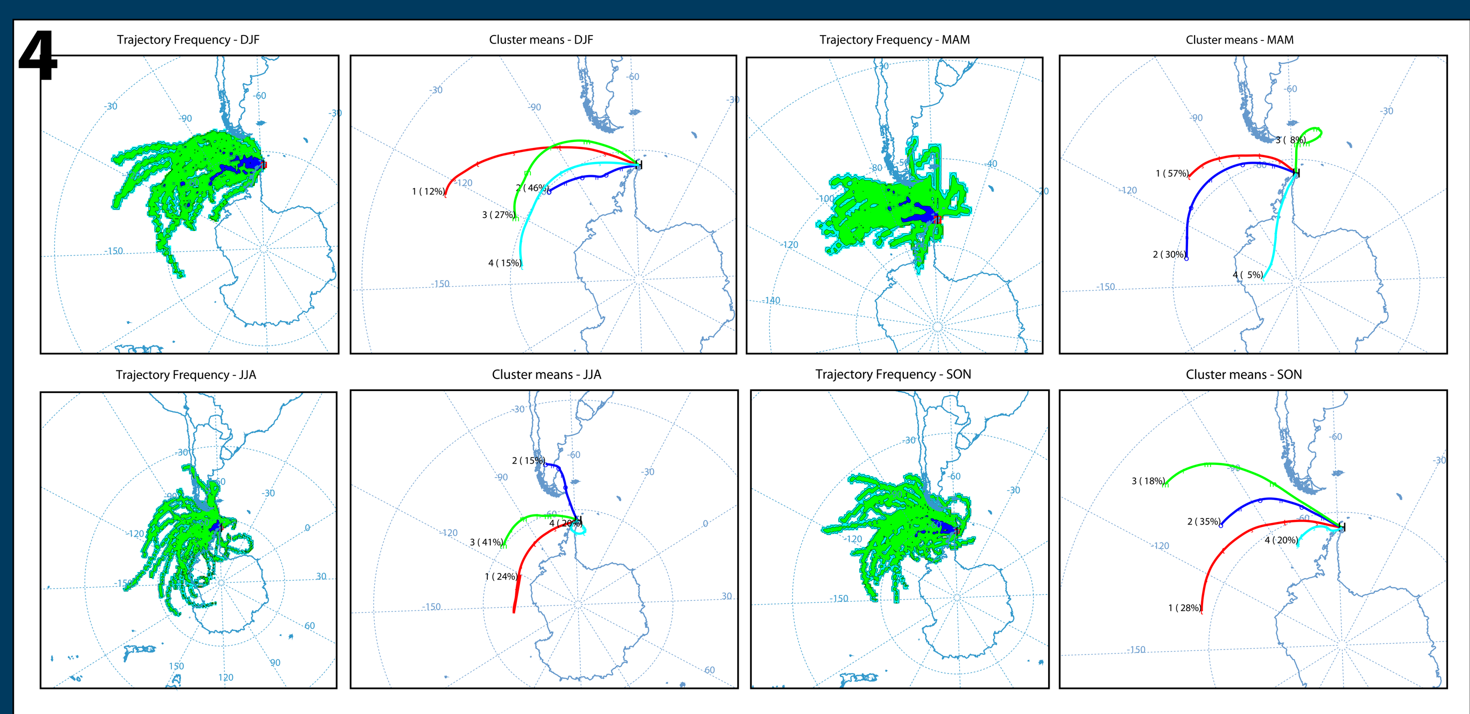
Backward trajectories: In order to investigate the potential moisture sources of precipitation of the study areas, backward trajectories were calculated. For this purpose the NOAA-Hysplit atmospheric circulation model was used (http://www.arl.noaa.gov/ HYSPLIT.php). The model was fed with the GDAS (Global Data Assimilation System) for a 3-days calculation centered on O´Higgins Station (63.32°S/57.90°W). All trajectories were calculated at 1500 m a.s.l. (850 mbar aprox., condensation level). In general, relative stable conditions are observed during the whole year (Figure 4). 98% of the moist air masses follow a similar path, originating between 50° and 70° latitude south. Seasonally some differences can be seen, as reflected in figure 1, $\delta^{18}0$ (*d* excess) of OH precipitation reaching a maximum (minimum) during summer. The secondary parameter *d* excess (d=δD-8*$\delta^{18}O$), reflects the evaporation conditions at the moisture source.

In figure 4, seasonal backward trajectories are displayed (2008/09). In the table (b) mean *d* excess values for calculated seasonal clusters are shown. From the combination of backward trajectories and *d* excess values, similar conditions of evaporation can be interpreted for the summer at ~60°S (DJF). For autumn (MAM), only two important paths were found. Winter (JJA) represents more instable conditions

b

Cluster	DJF (*d* excess ‰)	MAM	JJA	SON
1	-1.2	2.1	4.2	-0.9
2	1.6	4.7	3.8	1.3
3	1.9	-	6.7	1.9
4	1.9	-	6.7	-0.1





Conclusions: In spite of the evidence of melting processes in the firn/ice column and the proximity to the ocean of both regions, annuals isotopic signals from snow pits are relatively well preserved. Moisture originates with few exceptions from a region between 50°S and 70°S at the pacific ocean. OH shows the most suitable conditions to recover a deeper ice core in the future, since meteorological and glaciological conditions, as well as logistical support are most appropriate for this purpose. Until the present, several scientific efforts to model the climate variability are not entirely reliable because of the lack of appropriate glaciological and geochemical antecedents. A new core in this unexplored region would help to improve the actual knowledge of the rapid climatic change of this high sensitive area.

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