A LAGRANGIAN PERSPECTIVE OF THE HYDROLOGICAL CYCLE IN THE CONGO RIVER BASIN

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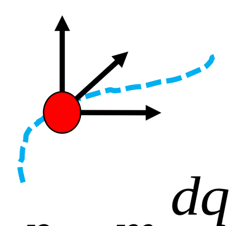
I. INTRODUCTION

The Congo River Basin has been worldwide less studied than other river basins, given the opportunity for hydrological research. In this work the Lagrangian model FLEXPART has been applied to assess the impact of the atmospheric moisture transport on the hydrological cycle at the Congo River Basin (CRB). FLEXPART was utilized to compute the evaporation minus precipitation (e – p) rates by calculating changes in the specific humidity along air parcels trajectories backward tracked from over the CRB to identify the moisture sources of the basin. Regions where evaporation exceeds precipitation ((E – P) > 0) were considered moisture sources. A forward analysis from the sources permitted us to know their seasonal role on the moisture supply to the target area, which is determined by the condition (E – P) < 0 over the CRB.

II. LAGRANGIAN METHOD

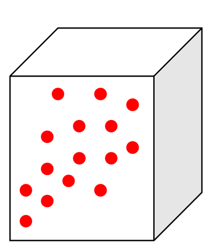
FLEXPART v9.0 model [1] + Meteorological reanalysis data from ERA-Interim Project. Period 1980-2010.

For each tracked parcel (~2 million, with the same mass *m*) are calculated changes of Specific humidity (*q*) through differences of evaporation (*e*) and precipitation (*p*) every 6 hours.



$$e - p = m\frac{dq}{dt}$$

Calculating for all parcel residing in the atmospheric column over a target area, we obtain (E-P). Integration in 10 days.



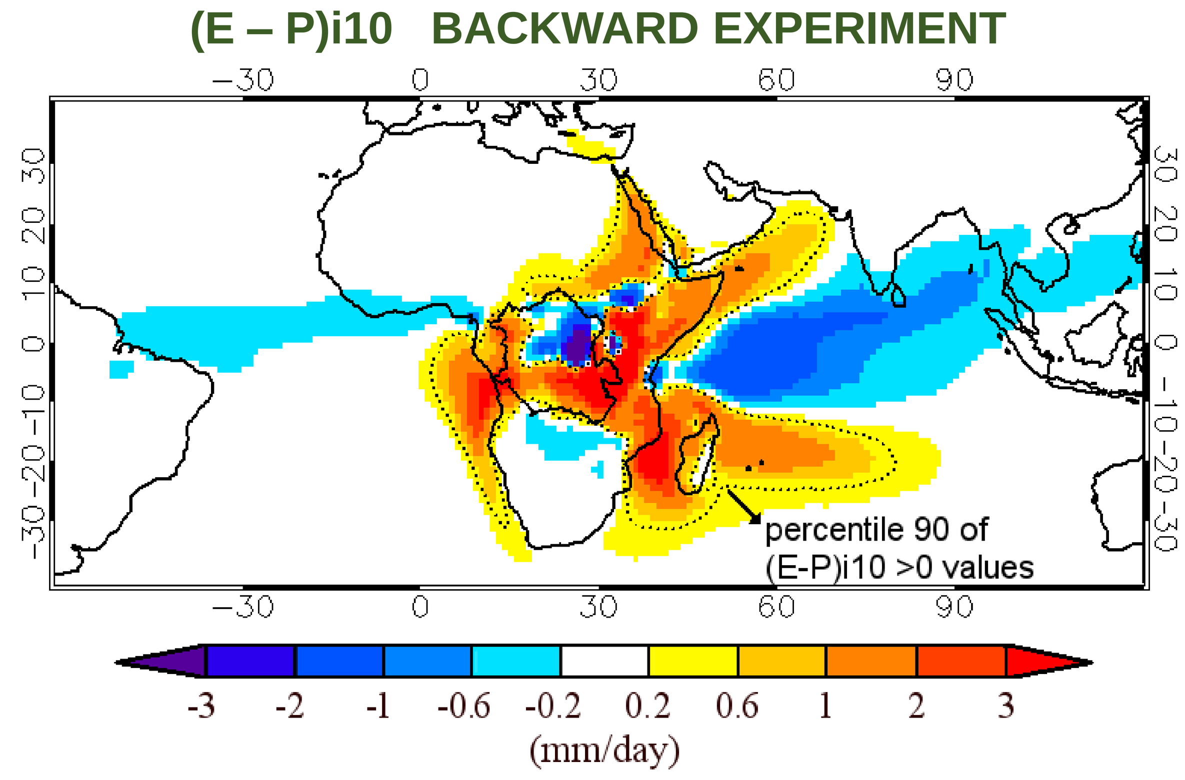
$$E - P \approx \frac{\sum_{k=1}^{K}(e-p)}{A}$$

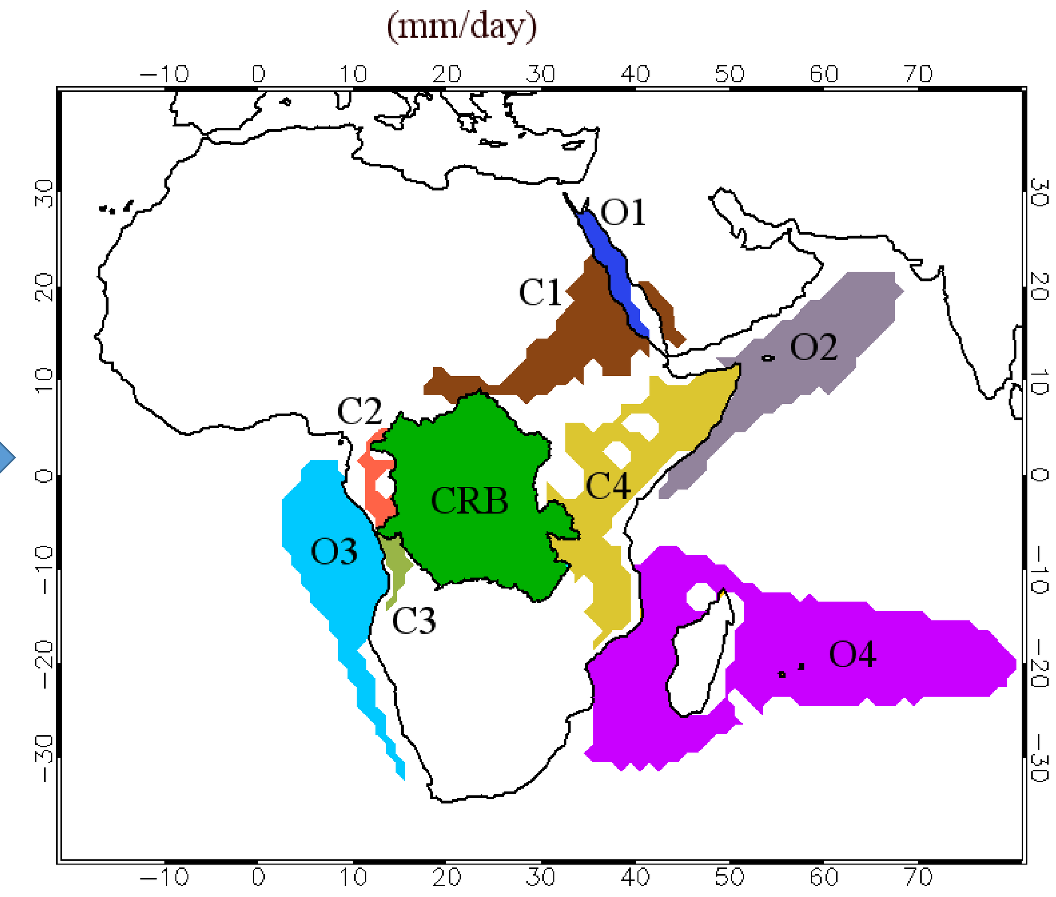
E → evaporation
P → precipitation
K → No parcels

III. FLEXPART EXPERIMENTS

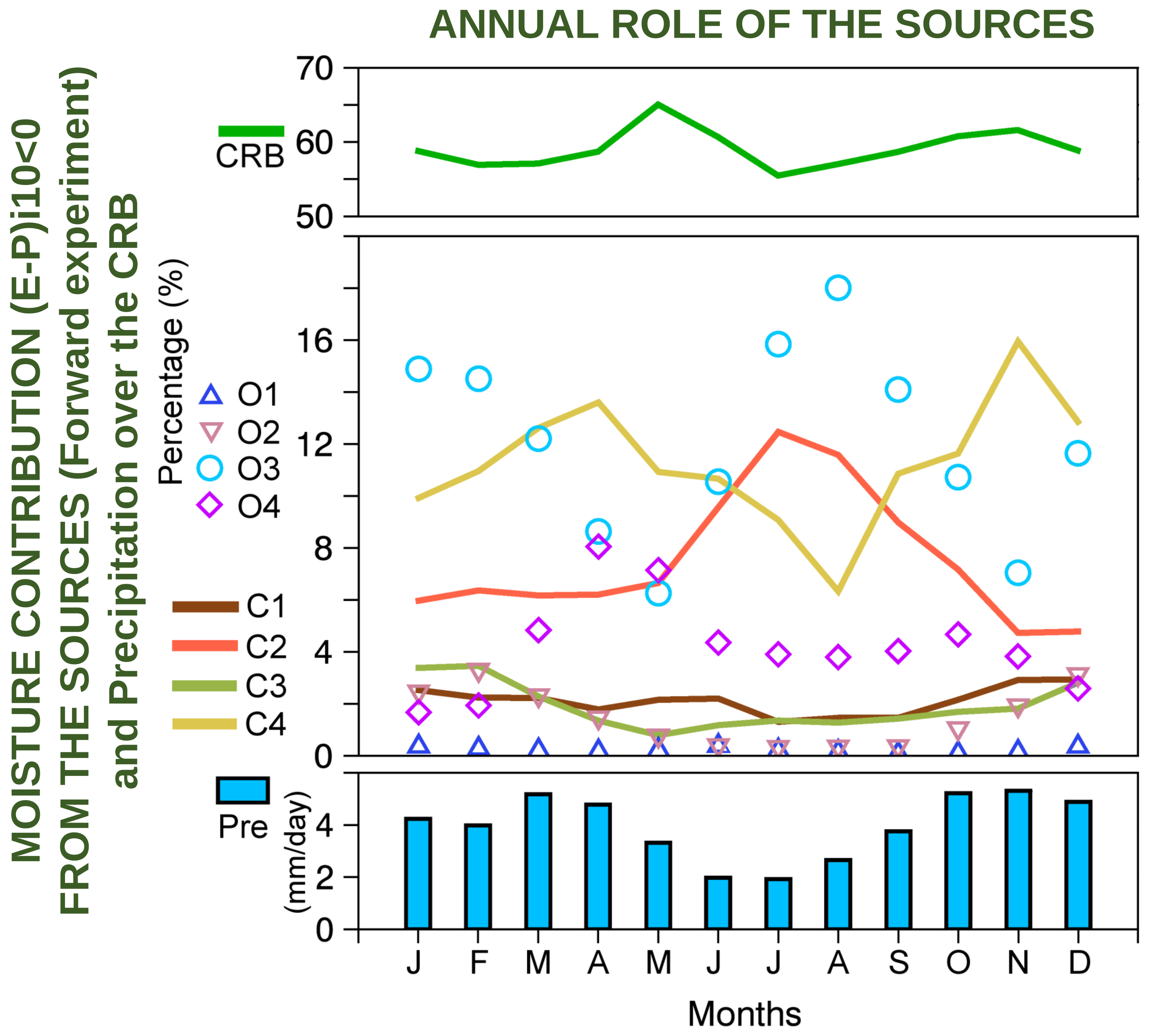
Looking for the Sources of Moisture

(E – P)i10 BACKWARD EXPERIMENT



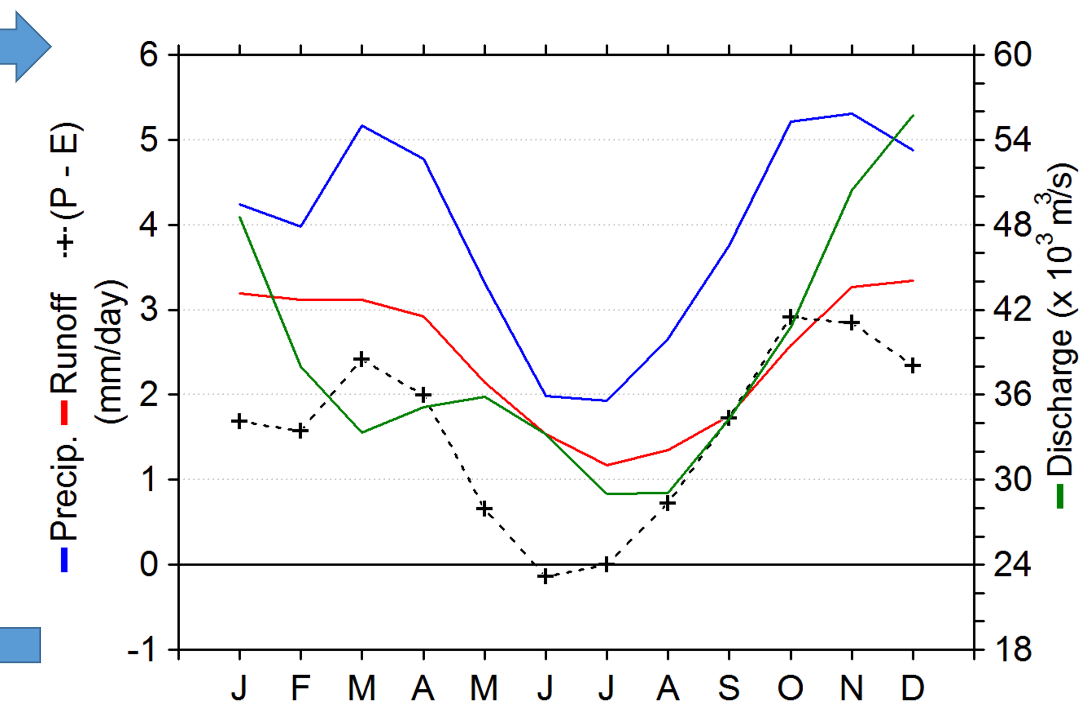


ANNUAL ROLE OF THE SOURCES



IV. THE CRB HYDROCLIMATOLOGY

Mean annual cycle of the Precipitation (CRU datasets), Runoff (ERA Interim), Precipitation minus Evaporation (GLEAM) and Congo River discharge at Kinshasa gauge station, all averaged for the whole CRB.



- Approximately 1 month lag between the precipitation, runoff and river discharge; the time needed by rainfall to travel and fed the river.
- Maximum precipitation occurs in March and October/November.
- Minimum precipitation occurs in June/July.
- In June the evaporation exceeds the precipitation.

Monthly correlation between the Precipitation, Runoff, River discharge at the CRB and the (E-P)i10<0 values over the CRB forward tracked from the sources. *Red number are significant correlation at $p<0.05$.*

	C1	C2	C3	C4	CRB	O1	O2	O3	O4
Precipitation	0.60	0.53	0.67	0.78	0.81	0.36	0.60	0.60	0.58
Runoff	0.66	0.43	0.72	0.69	0.74	0.59	0.73	0.59	0.42
Discharge	0.49	0.10	0.59	0.53	0.54	0.36	0.47	0.55	0.12

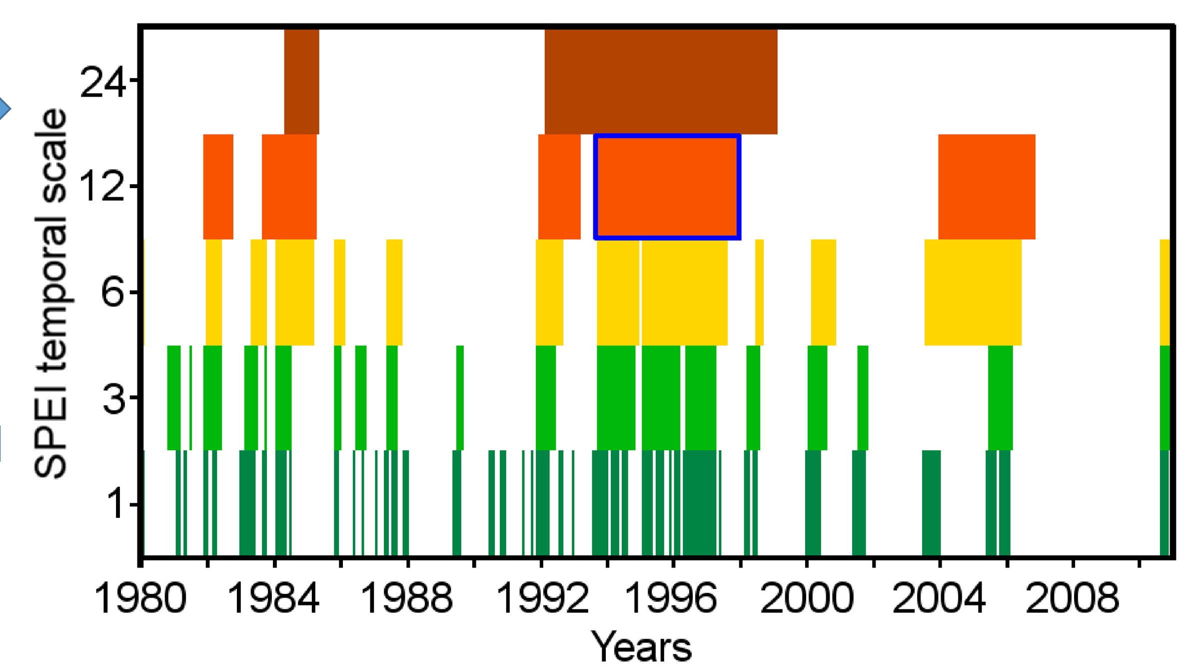
V. DROUGHT CONDITIONS and ROLE OF THE SOURCES

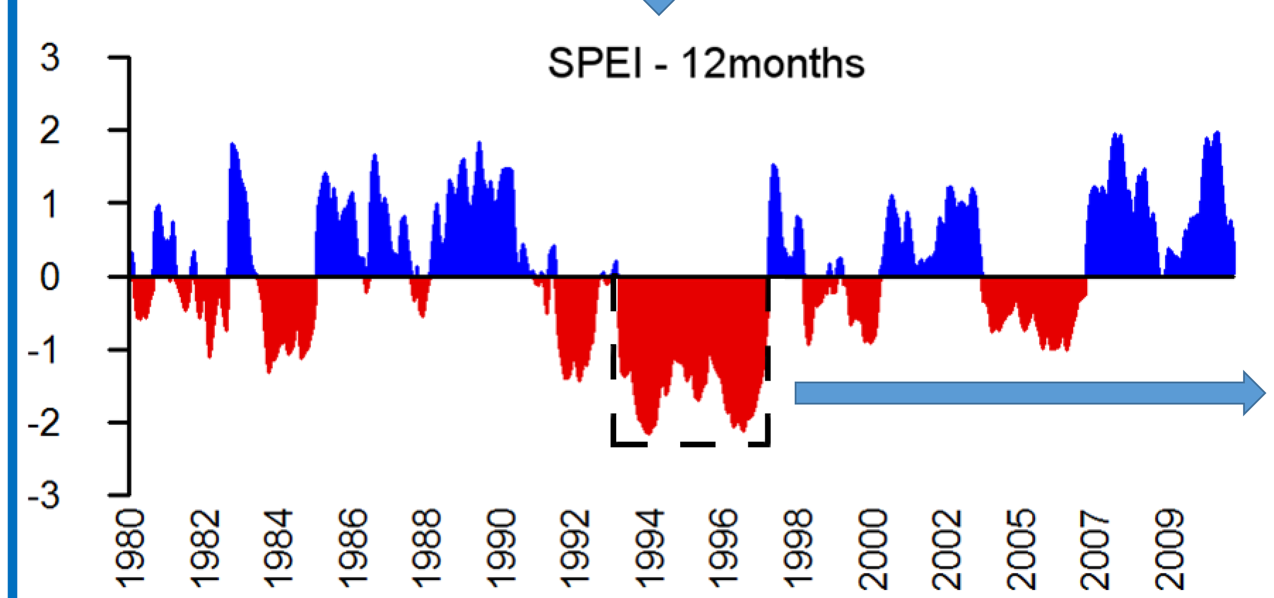
- Drought conditions in the CRB were identified using the SPEI Index [2].
- To identified drought episodes was adopted the criterion of *Mckee et al.* [3] that argue that: *"The drought begins when the SPI first falls below zero and ends with the positive value of SPI following a value of -1.0 or less. ".*

Number of drought episodes and duration in the period 1980-2010.

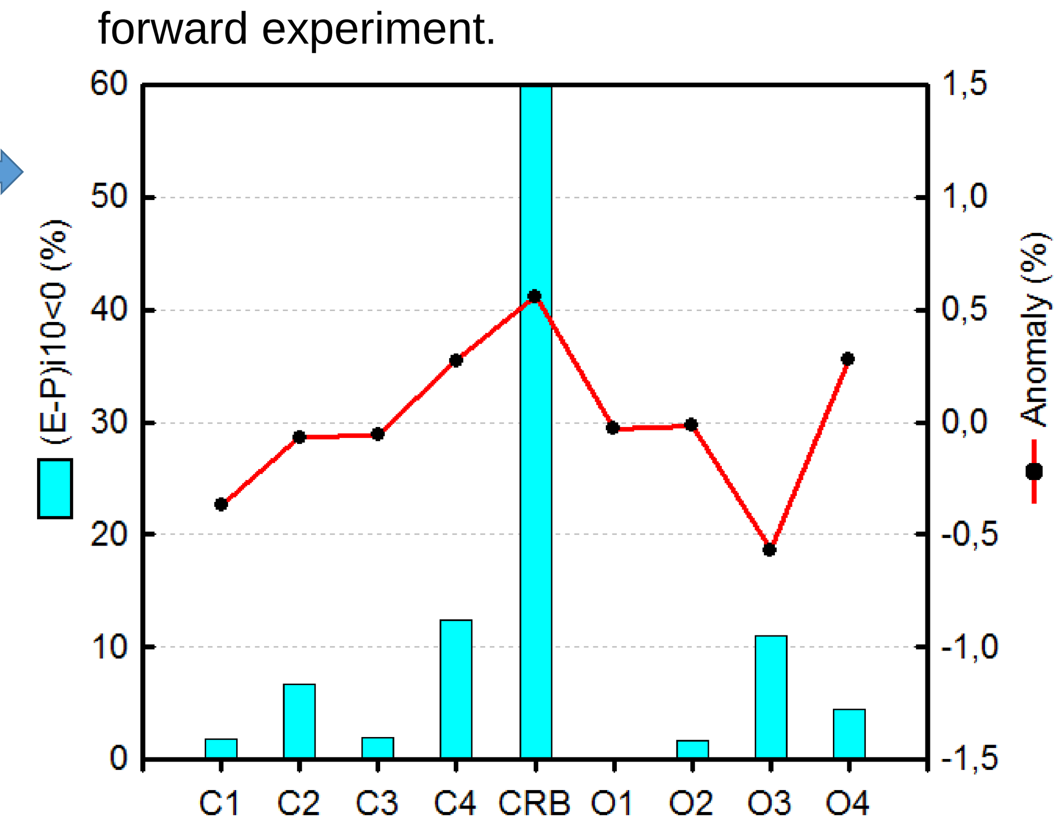
From 1992 to 1997 drought conditions are predominant in the CRB at all time scales.

The longest episode identified with the SPEI12 occurred between 09/1993 – 11/1997 (51 months) (**case of study: blue box**).





Role of the sources during the case of study. Were utilized (E-P)i10<0 of the forward experiment.



- As average the CRB itself supplies almost the 60 % of the total moisture contribution to the CRB in this drought episode.
- Negative anomalies occurred on moisture contribution from the sources C1, C2, C3, O1, O2 and the highest from O3.

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[1] Stohl, A., and James, P. (2005). A Lagrangian analysis of the atmospheric branch of the global water cycle. Part II: Moisture transports between the Earth's ocean basins and river catchments. *J. Hydrometeorol*. 6, 961–984, doi:10.1175/JHM470.1.

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[3] McKee, T. B., Doesken, N. J., Kleist, J. (1993). The Relationship of Drought Frequency and Duration to Time Scales. Proceedings of the Eighth Conference on Applied Climatology. American Meteorological Society: Boston; 179–184.

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