WORLD METEOROLOGICAL ORGANIZATION

Geneva, June 17th, 2025
WMO - 79 Executive Council
6.00-7.00 pm
Location: Salle Obasi

SPECIAL EVENT

The Cryosphere of the ‘Third Pole’: The Role of the Italian Cooperation in Aligning with WMO Priorities

Organized by The Italian Permanent Representative to WMO, Gen. B. Luca Baione, Italian Air Force, Member of the WMO Executive Council – Region VI

EvK2CNR

Consiglio Nazionale delle Ricerche

SANT'ANNA SCHOOL OF ADVANCED STUDIES PISA

UNIVERSITAS STUDIORUM MEDIOLANENSIS

WORLD METEOROLOGICAL ORGANIZATION

Pyramid and Spantik Labs: Atmospheric Observations in the Himalayas and Karakorum

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The National Research Council of Italy is the largest public research institution in Italy, the only one under the Research Ministry performing multidisciplinary activities.

Well established **collaboration** to study the processes affecting the atmospheric composition variability and their impact on cryosphere and water availability in the Himalayas and Karakorum

EvK2CNR

EvK2CNR is a recognized association that, since 35 years, manages scientific and technological research at high and extreme altitudes, with a focus on the areas belonging to the so-called Third Pole (Himalayas and Karakorum)

From the scientific questions to long-term observational capabilities to ensure the understanding of atmospheric and climate processes.

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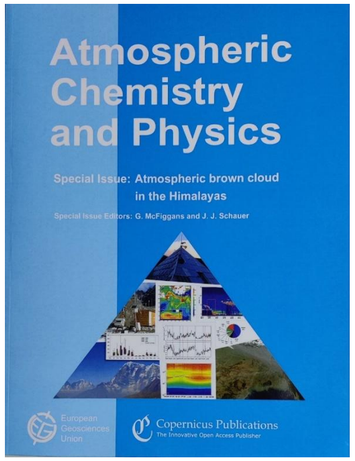
The Nepal Climate Observatory @ Pyramid

WMO GAW

GAW-WMO Global Station, 5079 m, Himalayas



2006-2015

Ten Years of Continuous Observations of Atmospheric Composition in the Himalayas: Sources, Transport, and Impacts on Climate and Air Quality

CNR ISAC · cnrs · 1506 UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

Restarting Observational Programs 2025-2027
Fully operative foreseen in 2028

Short-lived climate forcers/pollutants (SLCF/P) like **atmospheric aerosol** (in particular, the light-absorbing aerosol fraction) and **ozone** characterize South Asia, with severe implications recognized for **population health, ecosystem integrity** as well as **regional climate impacts**, especially for what concerns hydrological cycle, monsoon regimes and cryosphere.

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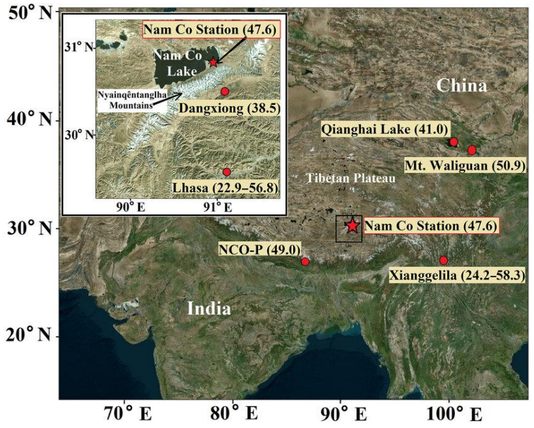
33 GAW Global stations, 5 in Asia

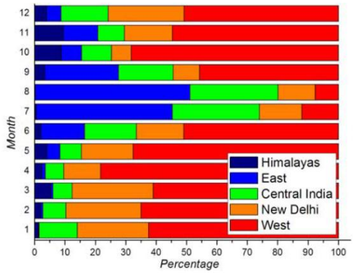
Only 2 in the Asian continent (inland)

Mt. Waliguan (China)
WLG; 3816 m a.s.l.

Nepal Climate Observatory - Pyramid (Nepal)
PYR; 5079 m a.s.l.



Non GAW global stations:
Nam Co (Tibetan Plateau) and Mukteshwar (Northern India)



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Scientific goals

Key urgent scientific challenges

- **What are the impacts of pollutants on climate and on the Himalayan cryosphere? …**
- … and on air quality of Khumbu Valley?
- **What are the interactions between the variability of Himalayan atmospheric composition and the Indian monsoon system?**

- **Study of the seasonal and interannual variability** of SLCF/P concentrations in the Himalayan region
- Study of anthropogenic and natural sources of SLCF/P
- **Investigation of pollutant transport mechanisms to high-altitude areas, including the role of Atmospheric Brown Clouds (ABC).**
- Study of SLCF/P impacts on climate at regional scale, air quality and cryosphere

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Essential Climate Variables observed 24/365

		INSTRUMENTS	06	07	08	09	10	11	12	13	14	15			25
Aerosol	Particle Number Size Distribution	SMPS + OPC, CPC													
	Absorption Coefficient	MAAP													
	Scattering Coefficient	Nephelometer													
	Chemical Composition	Filter sampling													
	AOD	CIMEL													
	PM10-PM1	ß absorption													
Gas	Surface Ozone	Thermo 49i													
	Sulfur Dioxide	Thermo 43iQ													
	Halocarbons	flask sampling											2022		
	Atmospheric Hg														
	Global radiation	Radiometers													
	Meteorological parameters	Meteo station													

2014 Last calibration --- 2015 end of first part of data series ---

2025 PNSD restarted and next campaign

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Scientific Results NCO-P

- Knowledge of the net seasonality of atmospheric composition and variability of SLCF/P in the high Southern Himalayas.
- **Observation of systematic acute pollution episodes (O_3 > 80 ppb; eqBC > 500 ng m^{-3}), especially during the pre-monsoon season.**
- The Himalayan valleys represent a direct channel for the transport of SLCF/P toward the high Himalayas, also triggering secondary aerosol formation.
- **Fires in South Asia play a significant role in the occurrence of high-altitude pollution events.**
- The large scale atmospheric circulation play a role in triggering the monsoon start.
- **Stratospheric intrusions play a significant role in O3-BC variability modulation (especially in winter).**
- Pollution transport towards Himalayas impacts radiative forcing and snow/ice albedo with severe implications for cryosphere survive.
- **Asian baseline for HFC is consistent with other measurements sites in the world (e.g. Monte Cimone).**

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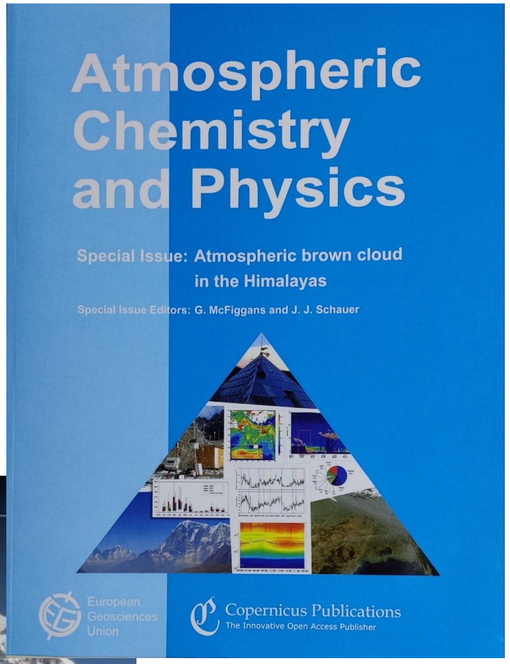
Scientific Results NCO-P

- Realization of a high-altitude observatory, part of several international program/projects: ABC-UNEP, GAW-WMO, ACTRIS, AERONET-NASA, GEWEX-WMO.
- **Special Issue (13 papers): Atmospheric Brown Cloud in the Himalayas** https://acp.copernicus.org/articles/special_issue162.html
- Many outreach broadcast on TV
- **Papers on PNAS, JGR, The Cryosphere, Nature Geoscience**

  https://www.nature.com/articles/s41561-020-00661-5

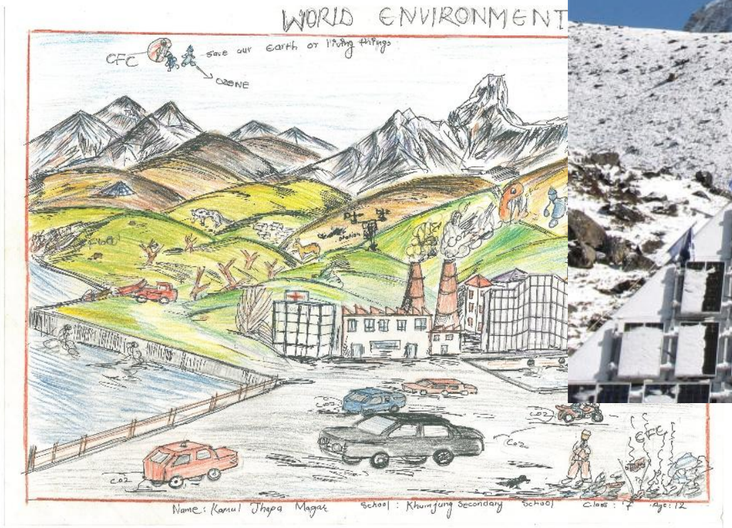


- **Involvement of local communities**

  Draw contest

  «DRAW YOUR MOUNTAIN»

  (Khumjung, Chaurikharka schools).



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Remote regions like high-mountain areas represent suitable locations where “background” atmospheric processes can be profitably investigated.

Mountains provide indications of global climate change through phenomena such as modifications of biological diversity, the retreat of mountain glaciers and changes in seasonal runoff

Mountains are also very sensitive regions where impact of anthropogenic pressures have significant impacts on ecosystems and local people

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There are several issues related with performing continuous scientific measurements at high altitudes in mountain regions:

Installation of permanent station is difficult and (often) unaffordable

Absence or low/discontinuous power supply

Need for in-situ personnel (often for long period)

Severe or unstable meteorological conditions

Requirement for specialized monitoring

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For these reasons, scientific activities in remote high-mountain regions are still limited. This represent a limitation for a better investigation of climate and environmental processes

NEW TECHOLOGICAL DEVELOPMENTS

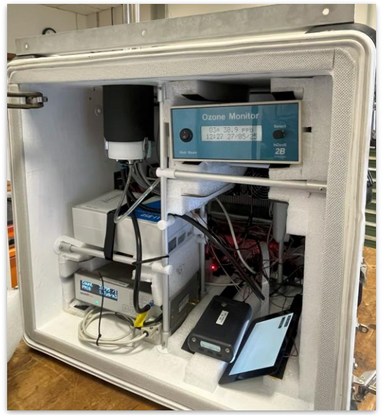
ARES

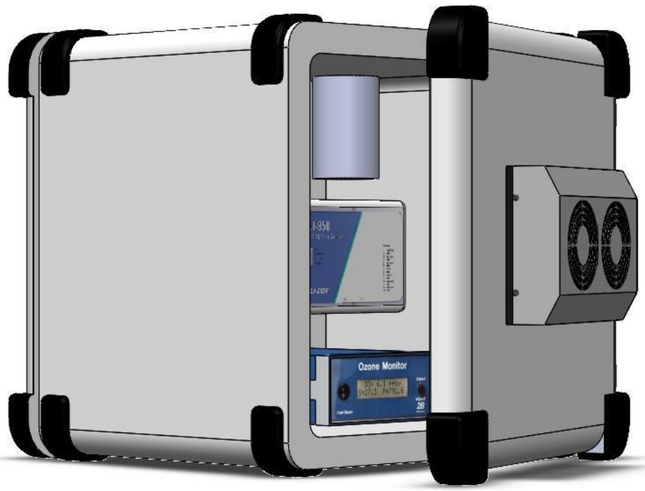
Autonomous Remote Environmental Station

inkode
Research and Enterprise Software

PROAMBIENTE
innovation & environment

EvK2Mino





IHEMS

Indoor **H**ealth and **E**nvironment **M**onitoring **S**ystem

RI3TECHNOLOGY

inkode
Research and Enterprise Software

PROAMBIENTE
innovation & environment

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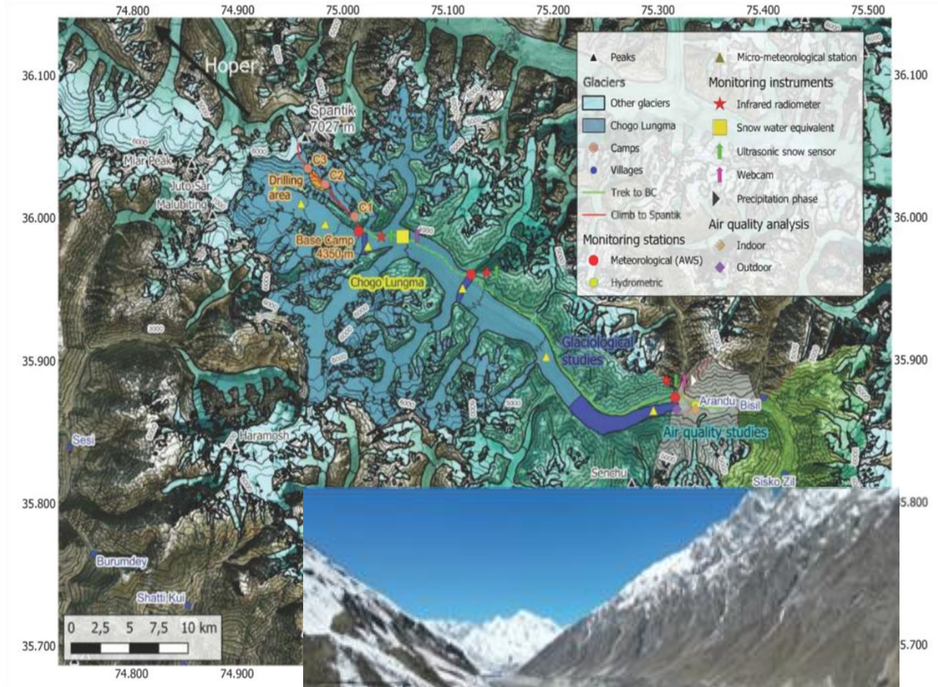
ARES and IHEMS will be employed in Karakorum in the frame of Spantik Lab and Breathing Karakorum projects

- ARES is now in testing phase at CNR Observatory “Vittori”, on top of Monte Cimone (GAW global, ACTRIS-ICOS station) 2165 m a.s.l.
- In July it will be employed for a long field campaign, near Chogo Lungma glacier in Karakorum region (Pakistan, >3000 m a.s.l.)
- A second unit will be installed on the Italian Apennines (Abruzzo region).



Chogo Lungma Glacier (Pakistan)

Atmospheric Environment
Volume 97, November 2014, Pages 75-82

New atmospheric composition observations in the Karakorum region: Influence of local emissions and large-scale circulation during a summer field campaign

D. Putero [a], P. Cristofanelli [a], P. Laj [c], A. Marinoni [a], P. Villani [c], A. Broquet [c], M. Alborghetti [b], U. Bonafè [a], F. Calzolari [a], R. Duchi [a], T.C. Landi [a], G.P. Verza [b], E. Vuillermoz [b], P. Bonasoni [a]

ARES and IHEMS will be employed in Karakorum in the frame of Spantik Lab and Breathing Karakorum projects

- ECG
- Respiratory Trace
- Skin Temperature
- Motion Analysis

- Black Carbon
- Carbon dioxide
- Temperature
- Relative humidity

European Journal of Internal Medicine
Volume 61, March 2019, Pages 81-87

ELSEVIER

Indoor air pollution exposure effects on lung and cardiovascular health in the High Himalayas, Nepal: An observational study

Lorenza Pratali [a 1], Angela Marinoni [b 1], Annalisa Cogo [c 1], Kristian Ujka [a], Stefania Gilardoni [b], Eva Bernardi [c], Paolo Bonasoni [b], Rosa Maria Bruno [a e], Luca Bastiani [a], Elisa Vuillermoz [d], Paolo Sdringola [f], Sandro Fuzzi [b]

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New plan for drilling ice cores in Karakorum

…our challenge against time to save environmental history, understand change and think about tomorrow

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SPECIAL EVENT

Contact: a.marinoni@isac.cnr.it

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THANK YOU!

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