



UNIVERSITÀ
DI TRENTO

Dipartimento di
Ingegneria Civile, Ambientale e Meccanica

ATMOSPHERIC POLLUTANT DISPERSION OVER COMPLEX TERRAIN

SHORT COURSE ON INTRODUCTION TO AIR POLLUTION MODELLING

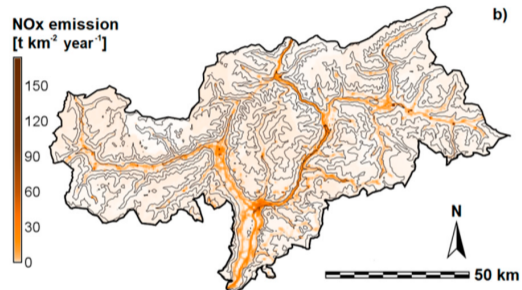
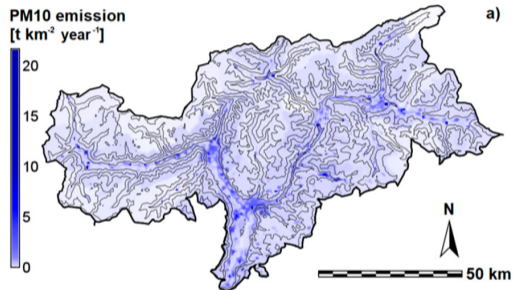
Lorenzo Giovannini

`lorenzo.giovannini@unitn.it`

University of Trento, Department of Civil, Environmental and Mechanical Engineering

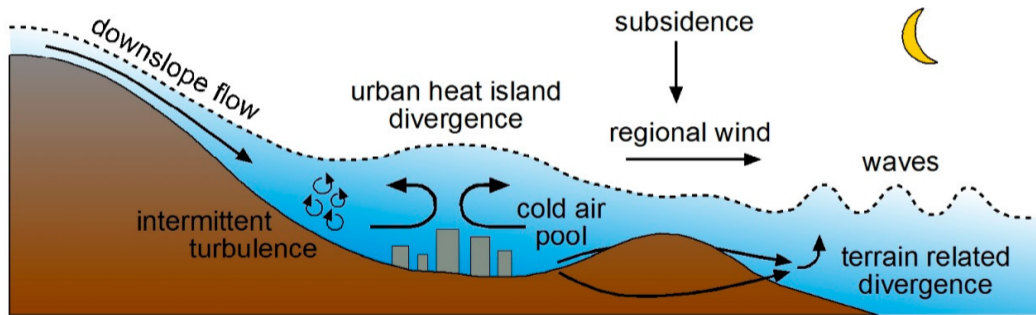
14 November 2024

EMISSIONS



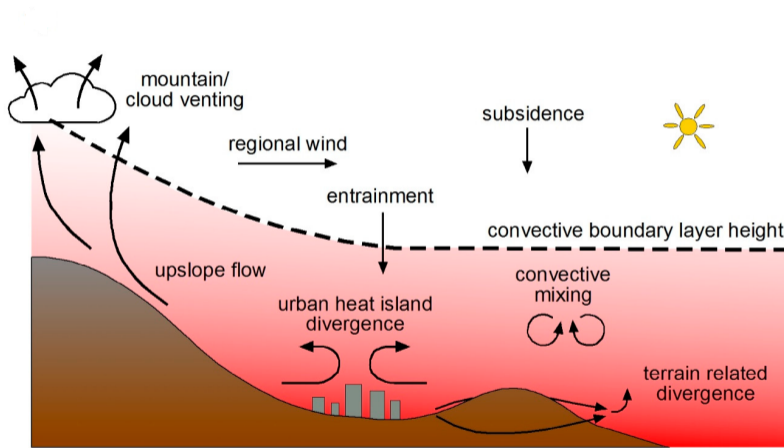
Giovannini et al. 2020

DISPERSION: NIGHTTIME



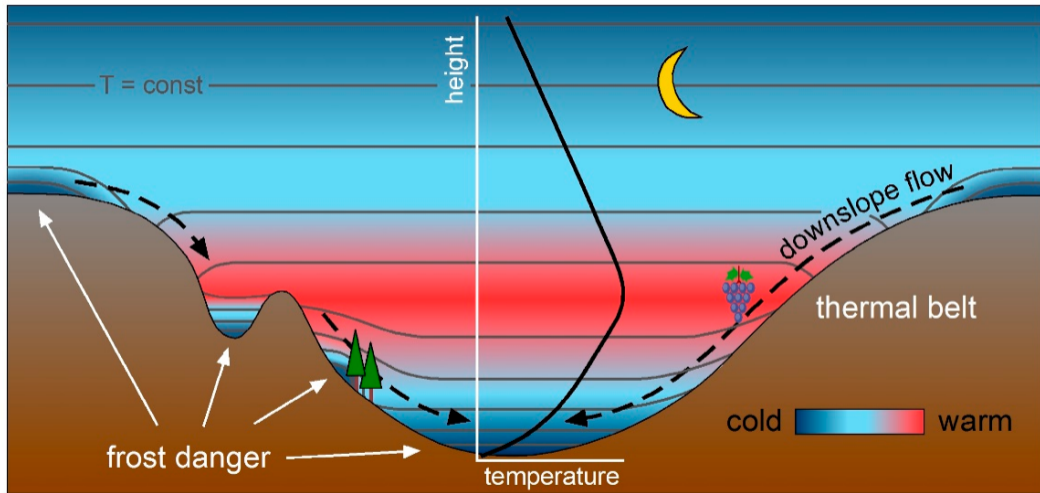
De Wekker et al. 2018

DISPERSION: DAYTIME



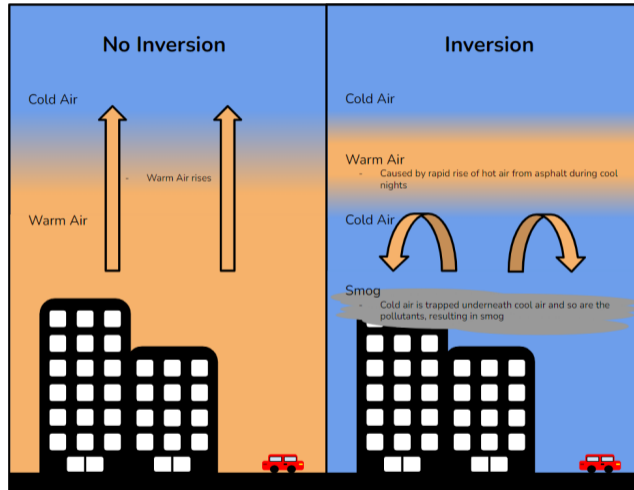
De Wekker et al. 2018

THERMAL INVERSION IN VALLEYS AND BASINS



De Wekker et al. 2018

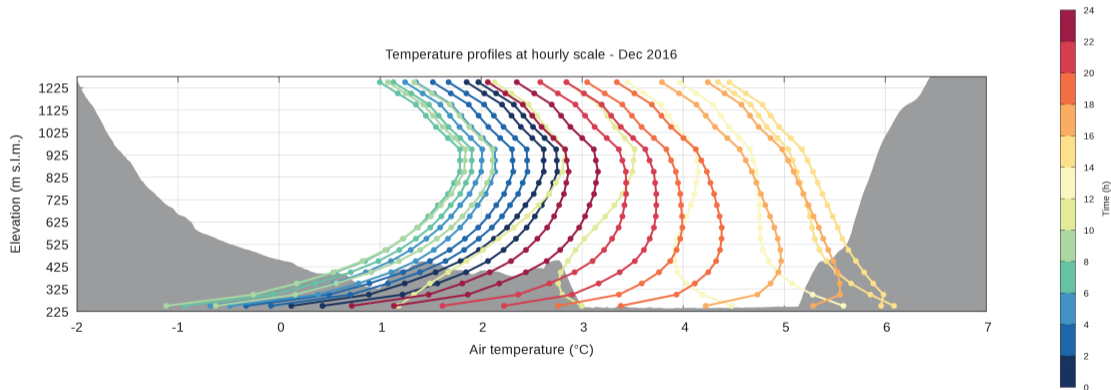
THERMAL INVERSION IN VALLEYS AND BASINS



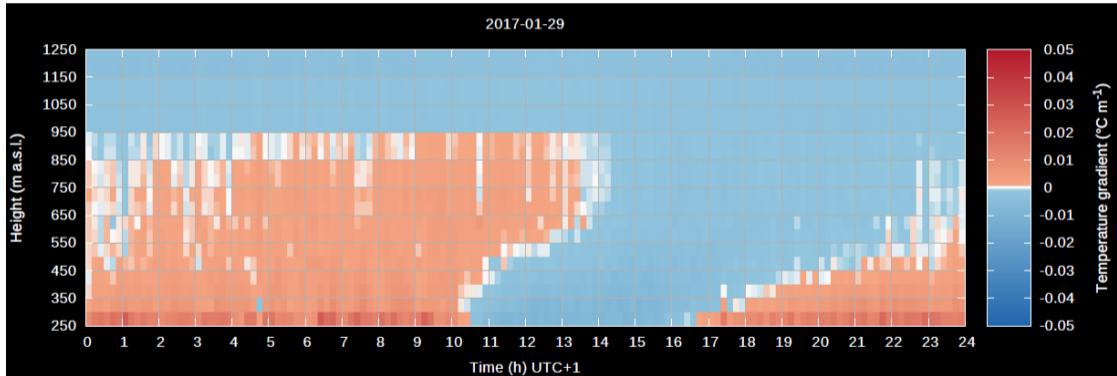
By Tyler Chow - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=132495796>

THERMAL INVERSION IN VALLEYS AND BASINS

Average temperature profiles at Bolzano - December 2016



THERMAL INVERSION IN VALLEYS AND BASINS



THERMAL INVERSION AND POLLUTANT DISPERSION



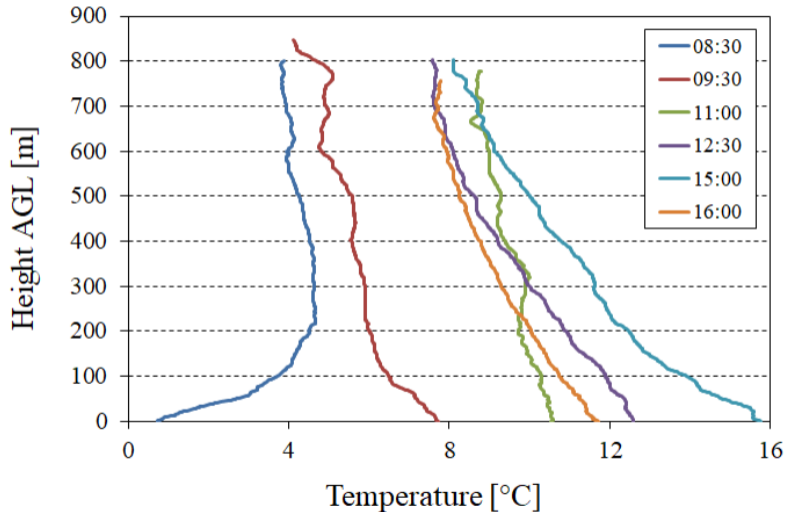
Igors Jefimovs, CC BY 3.0 <<https://creativecommons.org/licenses/by/3.0/>>, via Wikimedia Commons

THERMAL INVERSION AND POLLUTANT DISPERSION

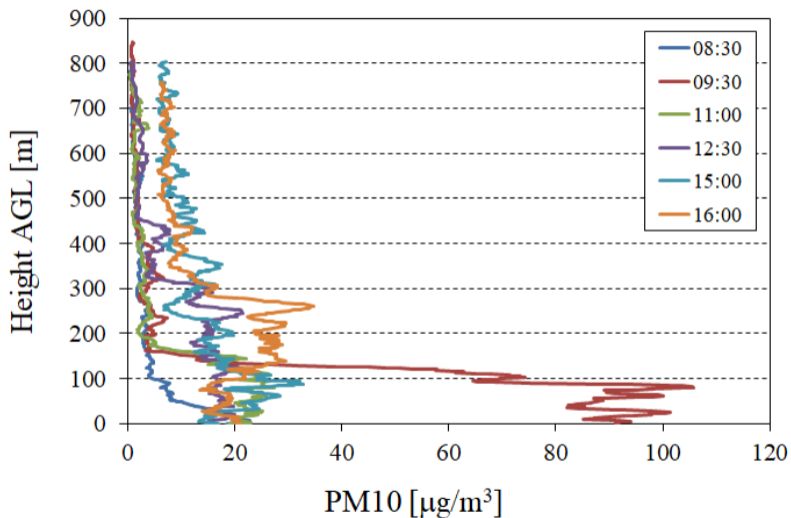


JohanTheGhost, CC BY-SA 3.0 <<http://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons

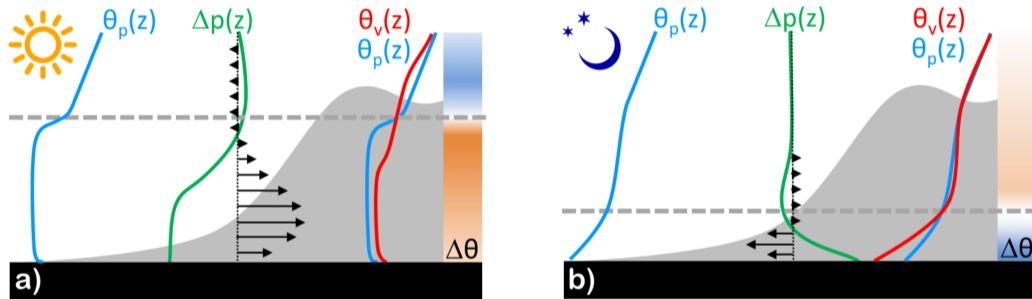
THERMAL INVERSION AND POLLUTANT DISPERSION



THERMAL INVERSION AND POLLUTANT DISPERSION



VALLEY WINDS



Serafin et al. 2018

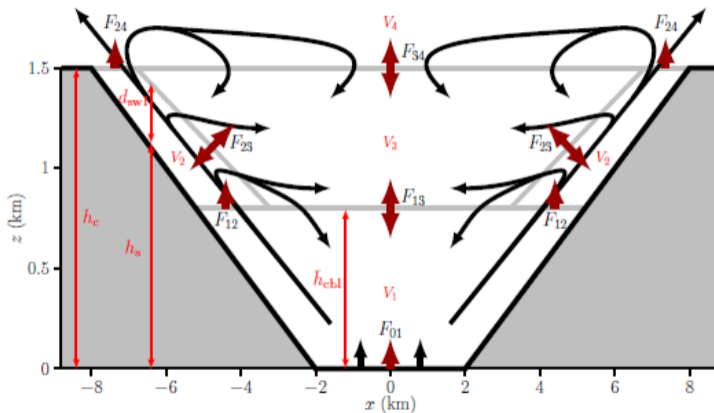
VALLEY WINDS

Courtesy Andrea Zonato

VALLEY WIND

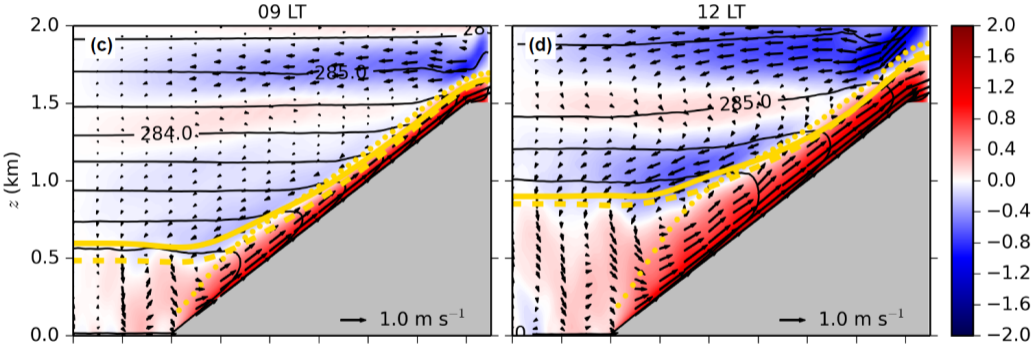
Courtesy Andrea Zonato

SLOPE WINDS



Leukauf et al. 2016

SLOPE WINDS



Leukauf et al. 2016

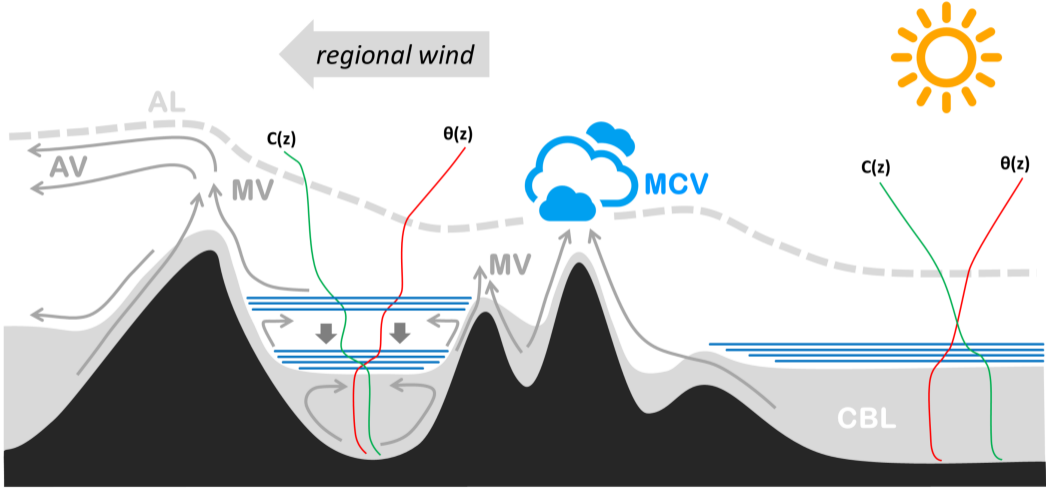
SLOPE WIND

Courtesy Andrea Zonato

SLOPE WINDS

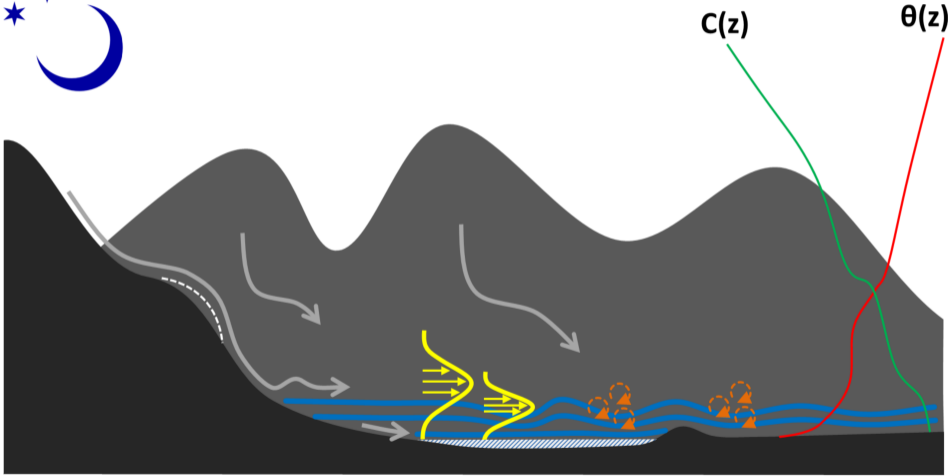
Courtesy Andrea Zonato

SLOPE WINDS



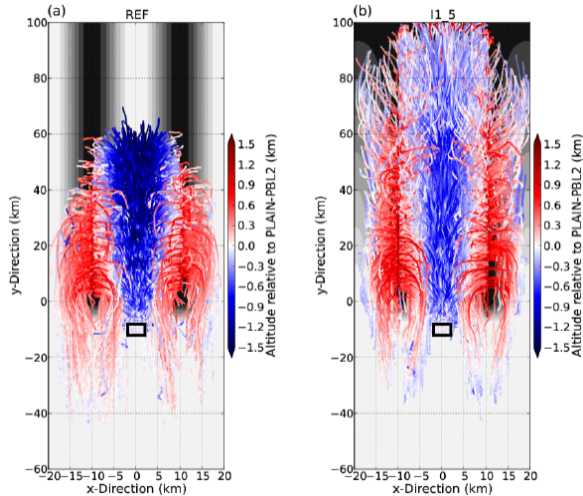
Serafin et al. 2018

SLOPE WINDS



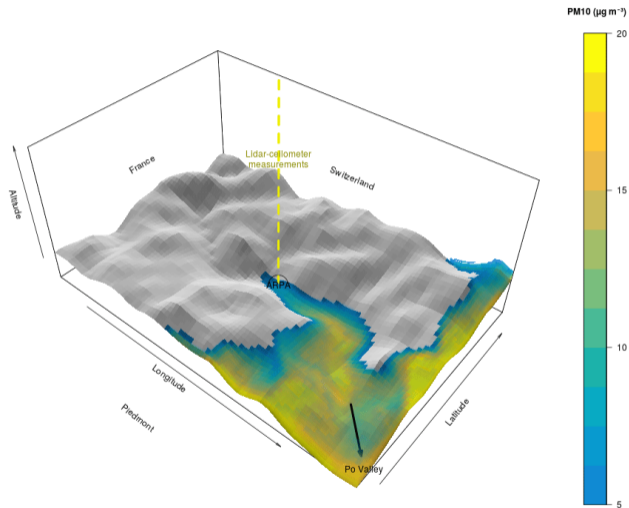
Serafin et al. 2018

VALLEY CIRCULATIONS AND POLLUTANT DISPERSION



Wagner et al. 2015

VALLEY CIRCULATIONS AND POLLUTANT DISPERSION



Diémoz et al. 2019 - <https://av.tib.eu/media/38391>

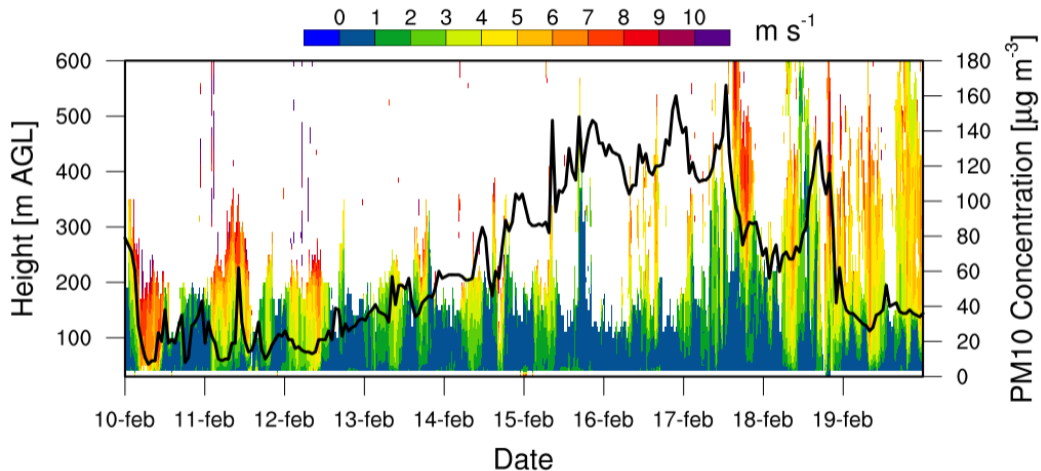
VALLEY CIRCULATIONS AND POLLUTANT DISPERSION



VALLEY CIRCULATIONS AND POLLUTANT DISPERSION

Courtesy Matteo Calzá

VALLEY CIRCULATIONS AND POLLUTANT DISPERSION

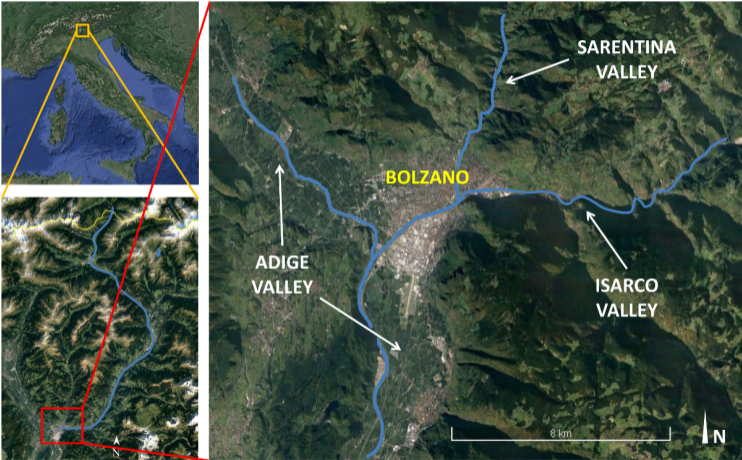


Giovannini et al. 2020

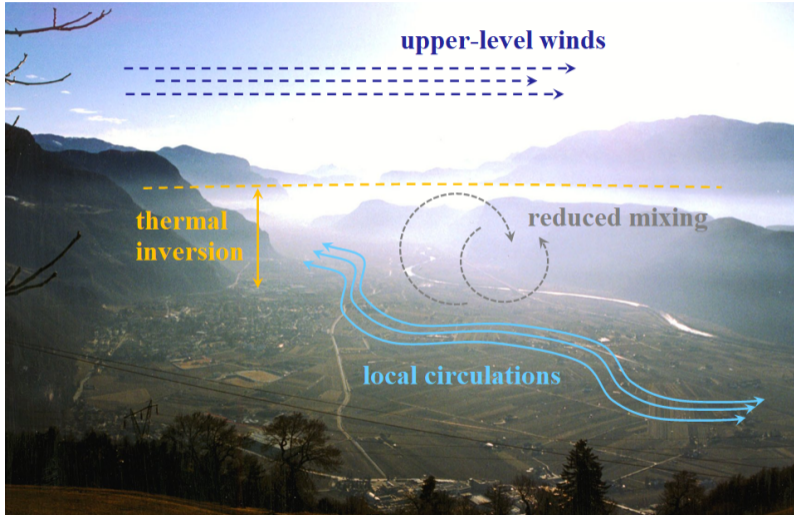
THE BOLZANO TRACER EXPERIMENT



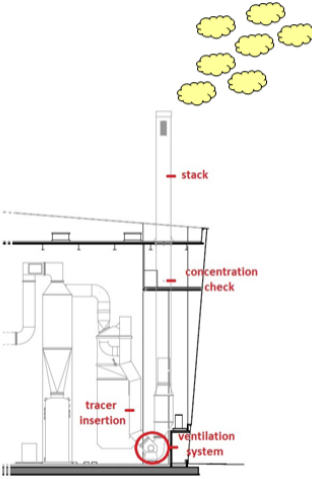
THE BOLZANO TRACER EXPERIMENT



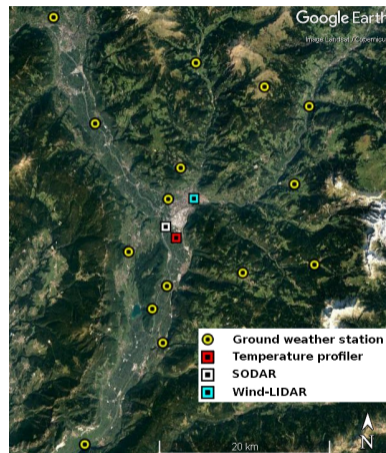
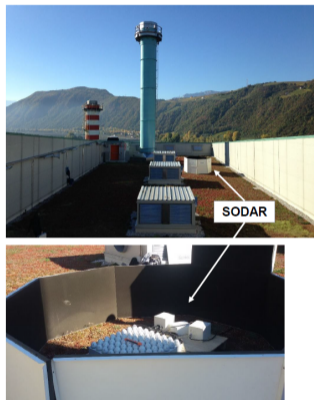
THE BOLZANO TRACER EXPERIMENT



THE BOLZANO TRACER EXPERIMENT



THE BOLZANO TRACER EXPERIMENT



Falocchi M., Tirlir W., Giovannini L., Tomasi E., Antonacci G., Zardi D., 2020: A dataset of tracer concentrations and meteorological observations from the Bolzano Tracer EXperiment (BTEX) to characterize pollutant dispersion processes in an Alpine valley. *Earth Syst. Sci. Data*, **12**, 277-291.

THE BOLZANO TRACER EXPERIMENT: 29 JAN 2017

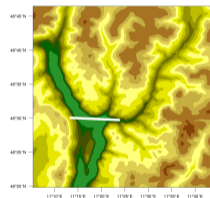
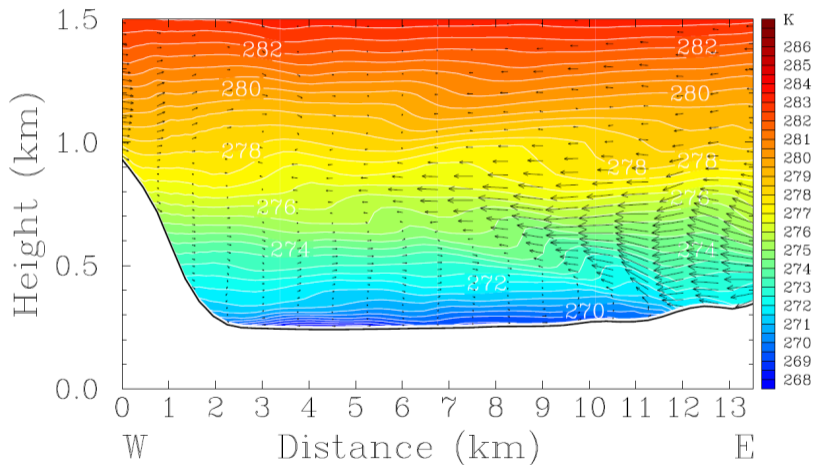
Wind @ 10 m AGL - 06:00 LST



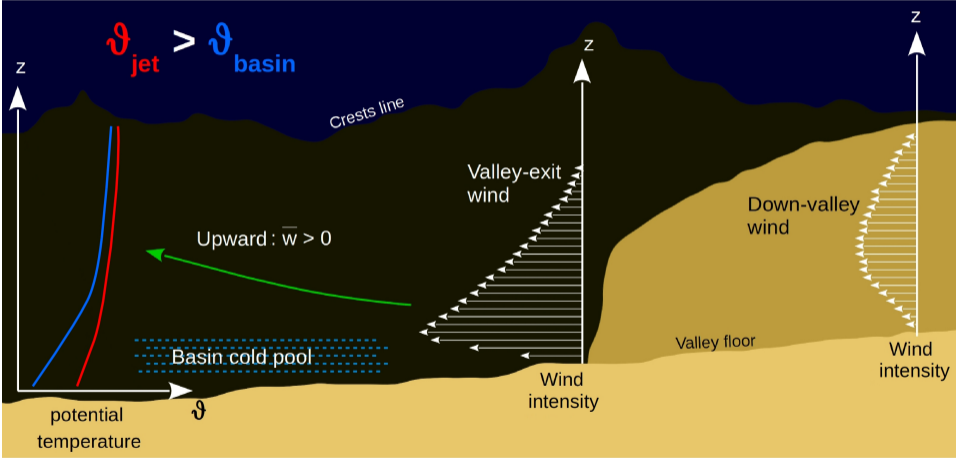
Wind @ 950 hPa - 06:00 LST



THE BOLZANO TRACER EXPERIMENT: 29 JAN 2017

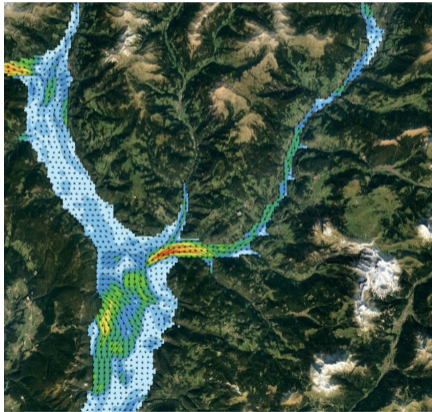


THE BOLZANO TRACER EXPERIMENT: 29 JAN 2017

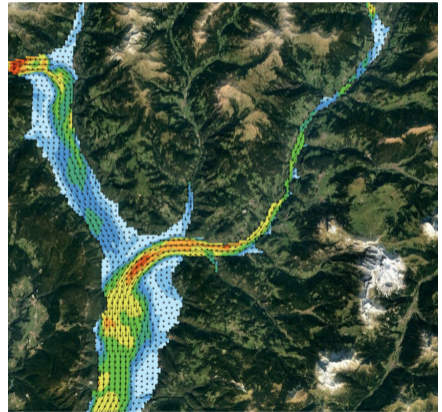


THE BOLZANO TRACER EXPERIMENT: 14 FEB 2017

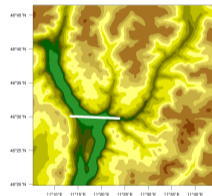
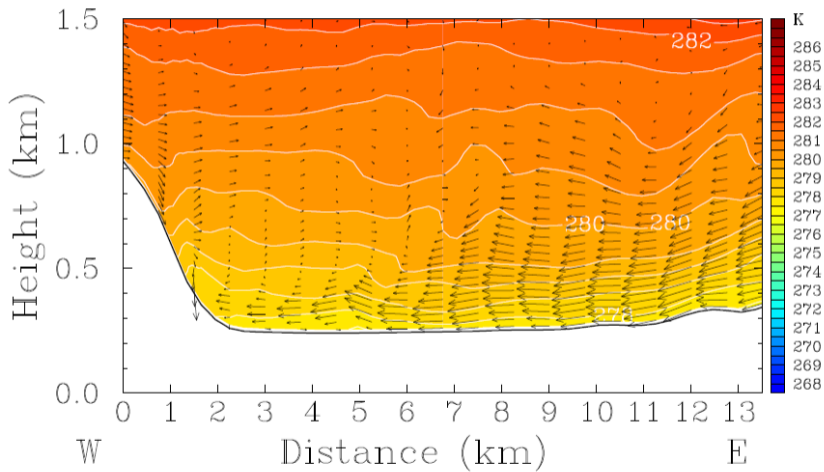
Wind @ 10 m AGL - 06:00 LST



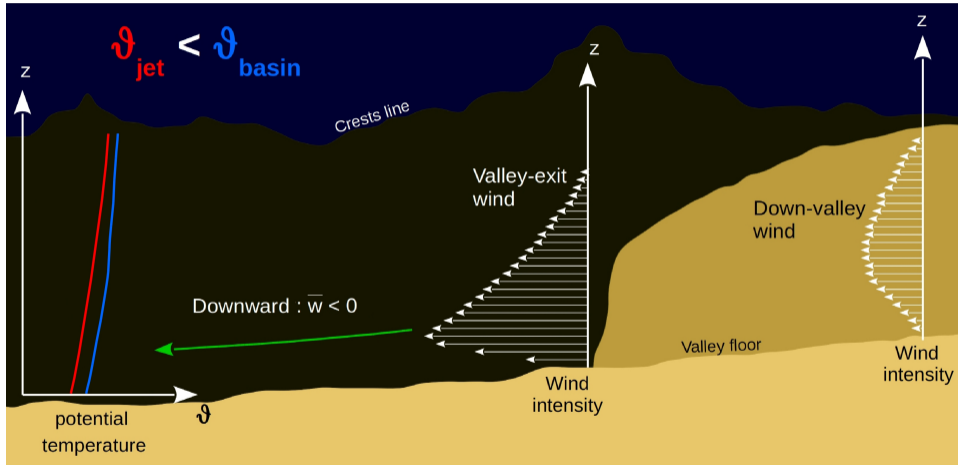
Wind @ 950 hPa - 06:00 LST



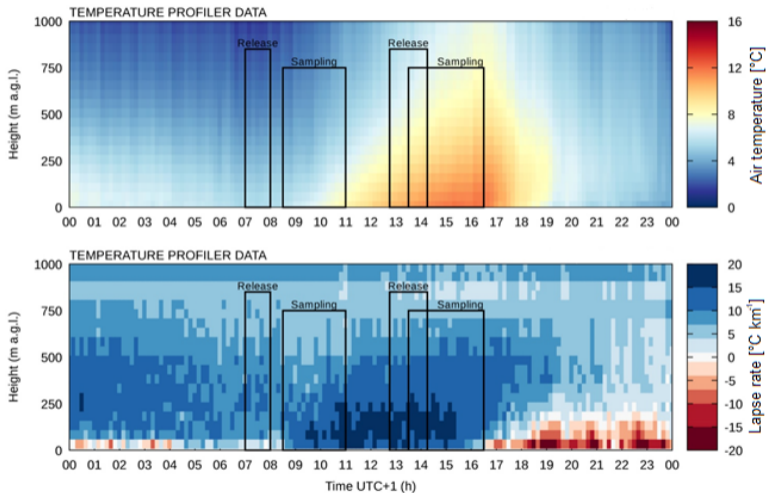
THE BOLZANO TRACER EXPERIMENT: 14 FEB 2017



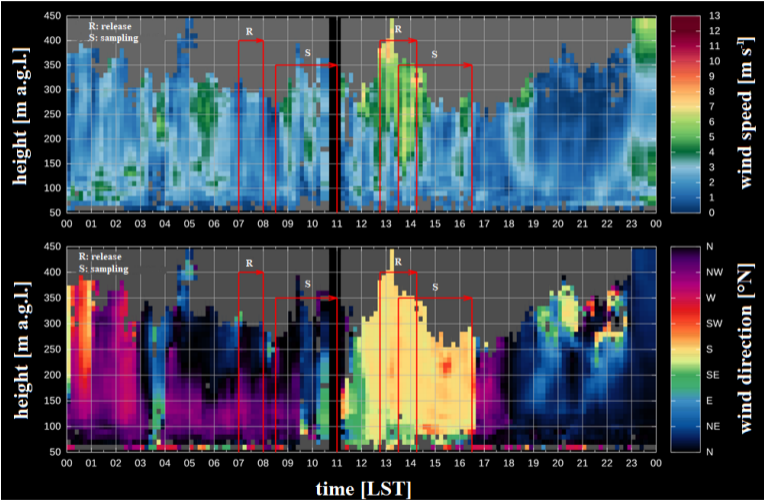
THE BOLZANO TRACER EXPERIMENT: 14 FEB 2017



THE BOLZANO TRACER EXPERIMENT



THE BOLZANO TRACER EXPERIMENT



THE BOLZANO TRACER EXPERIMENT

THE BOLZANO TRACER EXPERIMENT

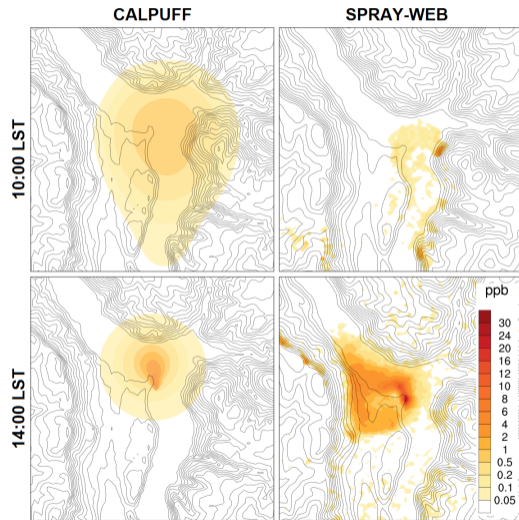
Dispersion simulations with the Gaussian puff model **CALPUFF** and the lagrangian particle model **SPRAY-WEB**.

Simulations with **SPRAY-WEB** were performed using different parameterizations for the dispersion coefficients:

- ▶ based on surface-layer scales, as in **CALPUFF**
- ▶ based on surface-layer scales, following Hanna (1982)
- ▶ based on TKE calculated by WRF

Tomasi E., Giovannini L., Falocchi M., Antonacci G., Jiménez P., Kosovic B., Alessandrini S., Zardi D., Delle Monache L., Ferrero E., 2019: Turbulence parameterizations for dispersion in sub-kilometer horizontally non-homogeneous flows. *Atmos. Res.*, **228**, 122-136.

THE BOLZANO TRACER EXPERIMENT



Giovannini et al. 2020

THE BOLZANO TRACER EXPERIMENT

REFERENCES

- De Wekker S.F.J., M. Kossmann, J.C. Knievel, L. Giovannini, E.D. Gutmann, D. Zardi, 2018: Meteorological applications benefiting from an improved understanding of atmospheric exchange processes over mountains, *Atmosphere*, **9**, 371, <https://doi.org/10.3390/atmos9100371>
- Diémoz, H., F. Barnaba, T. Magri, G. Pession, D. Dionisi, S. Pittavino, I.K.F. Tombolato, M. Campanelli, L.S. Della Ceca, M. Hervo, L. Di Liberto, L. Ferrero, G.P. Gobbi: Transport of Po Valley aerosol pollution to the northwestern Alps - Part 1: Phenomenology, 2019: *Atmospheric Chemistry and Physics*, **19**, 3065-3095, <https://doi.org/10.5194/acp-19-3065-2019>.
- Falocchi M., W. Tirlor, L. Giovannini, E. Tomasi, G. Antonacci, D. Zardi, 2020: A dataset of tracer concentrations and meteorological observations from the Bolzano Tracer EXperiment (BTEX) to characterize pollutant dispersion processes in an Alpine valley. *Earth System Science Data*, **12**, 277-291, <https://doi.org/10.5194/essd-12-277-2020>
- Giovannini L., E. Ferrero, T. Karl, M.W. Rotach, C. Staquet, S. Trini Castelli, D. Zardi, 2020: Atmospheric pollutant dispersion over complex terrain: challenges and needs for improving air quality measurements and modeling, *Atmosphere*, **11**, 646, <https://doi.org/10.3390/atmos11060646>
- Leukauf D., A. Gohm, M.W. Rotach, 2016: Quantifying horizontal and vertical tracer mass fluxes in an idealized valley during daytime, *Atmospheric Chemistry and Physics*, **16**, 13049-13066, <https://doi.org/10.5194/acp-16-13049-2016>
- Serafin S., B. Adler, J. Cuxart, S.F.J. De Wekker, A. Gohm, B. Grisogono, N. Kalthoff, D.J. Kirshbaum, M.W. Rotach, J. Schmidli, I. Stiperski, Z. Večenaj, D. Zardi, 2018: Exchange processes in the atmospheric boundary layer over mountainous terrain, *Atmosphere*, **9**, 102. <https://doi.org/10.3390/atmos9030102>
- Tomasi E., L. Giovannini, M. Falocchi, G. Antonacci, P. Jiménez, B. Kosovic, S. Alessandrini, D. Zardi, L. Delle Monache, E. Ferrero, 2019: Turbulence parameterizations for dispersion in sub-kilometer horizontally non-homogeneous flows, *Atmospheric Research*, **228**, 122-136, <https://doi.org/10.1016/j.atmosres.2019.05.018>
- Wagner, J.S., A. Gohm, M.W. Rotach, 2015: Influence of along-valley terrain heterogeneity on exchange processes over idealized valleys, *Atmospheric Chemistry and Physics*, **15**, 6589-6603, <https://doi.org/10.5194/acp-15-6589-2015>

THANKS FOR YOUR KIND ATTENTION!



JohanTheGhost, CC BY-SA 3.0 <<http://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons