# EVALUATING TRANSPORT IN THE WRF MODEL ALONG THE CALIFORNIA COAST.

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## INTRODUCTION

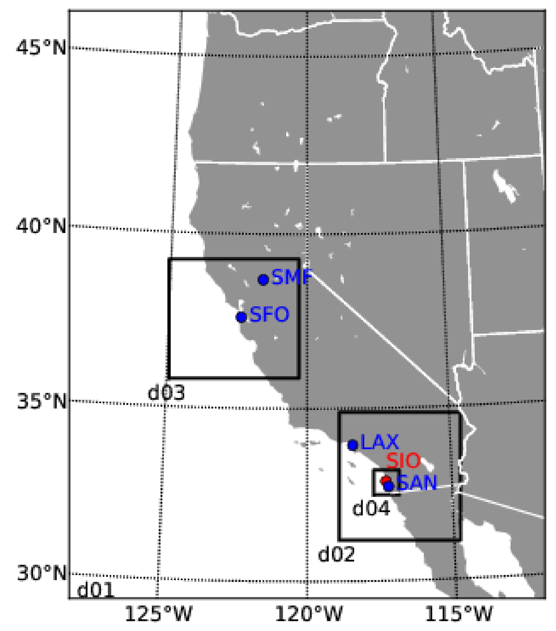
Improving the accuracy in greenhouse gas (GHG) emissions quantification has become a critical need in testing the success of environmental policies to achieve the targeted overall reductions [1]. Emissions are typically estimated through "bottom-up" methods, using economic reporting, emission factors and a conversion algorithm. "Top-down" methods are independent validation techniques that use modeling of atmospheric transport combined with measurements of the tracer of interest and an inversion algorithm to infer emissions.

We present the first step toward the development of a method to provide a top-down estimate of halocarbon emission inventories in California [2]. The data and model configuration are shortly presented. Then results for San Diego, San Francisco and Sacramento airports and the La Jolla GHG measurement station [3] are detailed.

## WRF DOMAIN

- Data
  - NCEP NAM + RTG_SST (NAM) and ERA-interim + GODAE SST (ERA) for initial and lateral boundary conditions (I/BCL)
  - ACARS aircraft landing and taking-off meteorological reports for model evaluation at San Diego, San Francisco, Los Angeles and Sacramento airports [4]
  - EDGAR v4.1 2005 0.1 °resolution HFC-134a emission as prior emission [5]
  - HFC134a measurements at La Jolla station (32.86°N, 117.25°W)
- WRF [6]
  - Coarse domain 12km, nests: 4 and 0.8km centered on California
  - Physic schemes (different from default): 2$^{nd}$ order diffusion, RRTMG, Grell-3D cumulus, WSM 3-class microphysics, NOAH land surface model
  - 8 PBL schemes tested
- Simulations

| Name | WRF | PBL | I/BCL |
|---|---|---|---|
| P1N12 | WRF 12km | YSU | NAM |
| P2N12 | WRF 12km | MYJ | NAM |
| P3N12 | WRF 12km | QNSE | NAM |
| P4N12 | WRF 12km | MYNN2 | NAM |
| P5N12 | WRF 12km | ACM2 | NAM |
| P6N12 | WRF 12km | BouLac | NAM |
| P7N12 | WRF 12km | UW | NAM |
| P8N12 | WRF 12km | TEMF | NAM |
| P4N12b | WRF 12km | MYNN2 | NAM |
| P4E12 | WRF 12km | MYNN2 | ERA |
| P4E04 | WRF 4km | MYNN2 | ERA |
| P4E08 | WRF 0.8km | MYNN2 | ERA |
| P4E12c | WRF/CHEM [7] 12km | MYNN2 | ERA |



## REFERENCES

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[2] C. Yver, et al., "Evaluating transport in the WRF model along the California coast," in *ACPD*, 2012
[3] R. G. Prinn, et al., "A history of chemically and radiatively important gases in air deduced from ALE/GAGE/AGAGE," in *Journal of Geophysical Research*, 2000.
[4] ACARS, `http://madis.noaa.gov/madis_acars.html`
[5] J. G. J. Olivier, et al., "Description of EDGAR Version 2.0: A set of global emission inventories of greenhouse gases and ozone-depleting substances for all anthropogenic and most natural sources on a per country basis and on 1 degree x 1 degree grid," in *Rijksinstituut voor Volksgezondheid en Milieu RIVM*, 1996.
[6] W. C. Skamarock and J. B. Klemp, "A time-split nonhydrostatic atmospheric model for weather research and forecasting applications," in *Journal of Computational Physics*, 2008.
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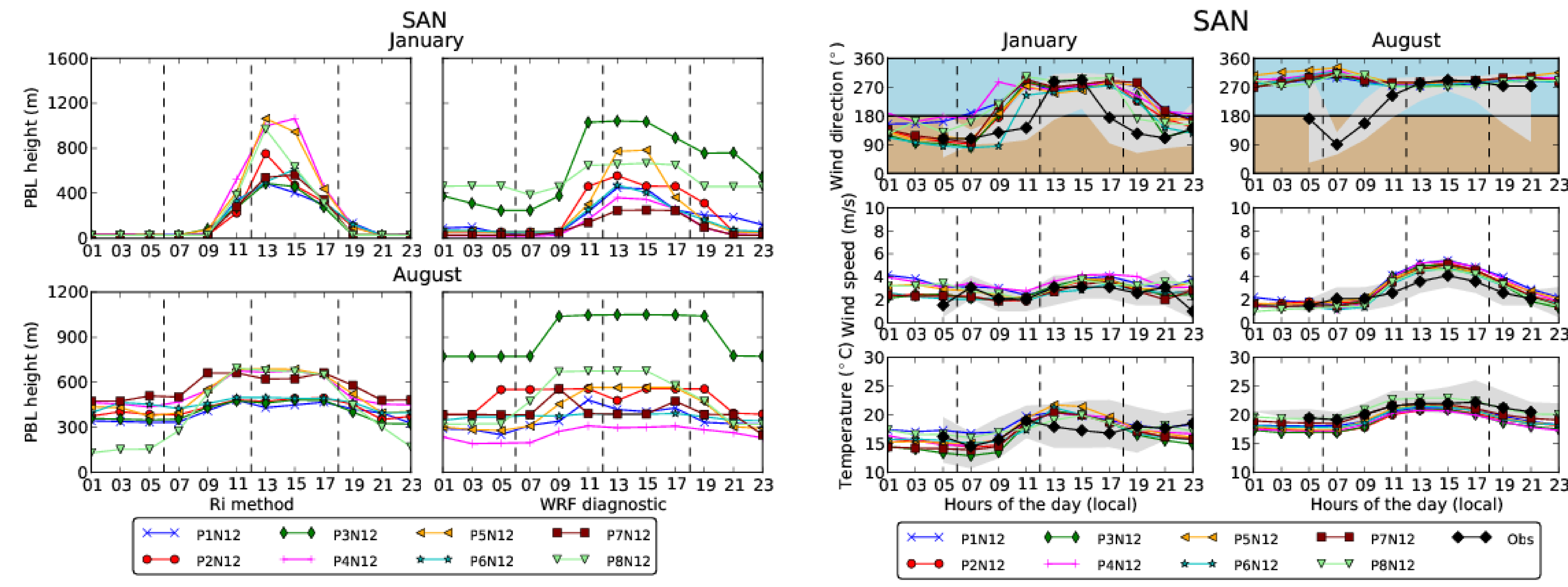
## PBL DAILY CYCLES

PBL heights, wind direction, wind speed and temperature daily cycles at San Diego (SAN) airport

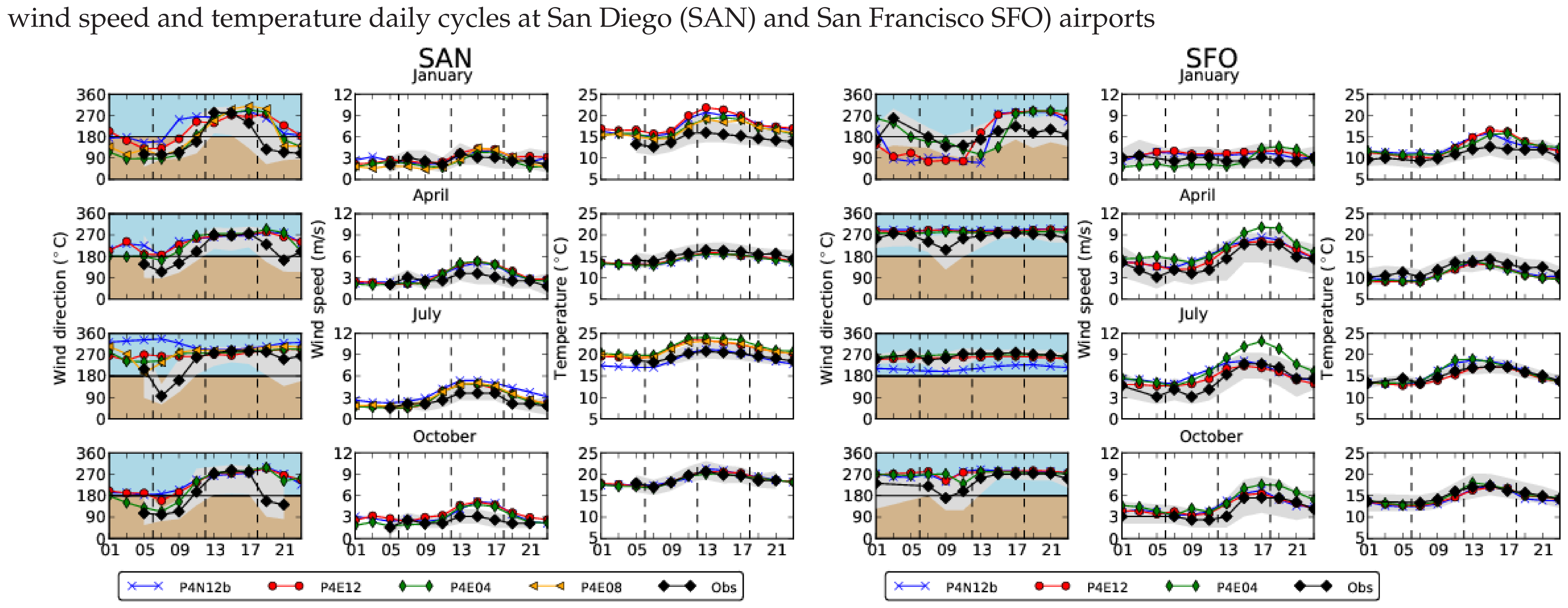
- PBL heights calculated with the bulk Richardson number are more similar than from WRF diagnostics for the different schemes.
- No major difference is observed between the different schemes for the wind direction, wind speed and temperature.
- In summer, all the schemes fail to represent the morning land breeeze.



## DAILY CYCLES

Wind direction, wind speed and temperature daily cycles at San Diego (SAN) and San Francisco SFO) airports

- Simulations with ERA-interim (P4E*) usually perform better than the simulation with NAM (P4N12).
- At SAN, no difference is observed between the 4 and the 0.8 km resolution simulations.
- At SAN, the nested simulations perform better or as good as the coarse grid simulation.
- At SFO, the nested simulations are overestimating the wind speed.

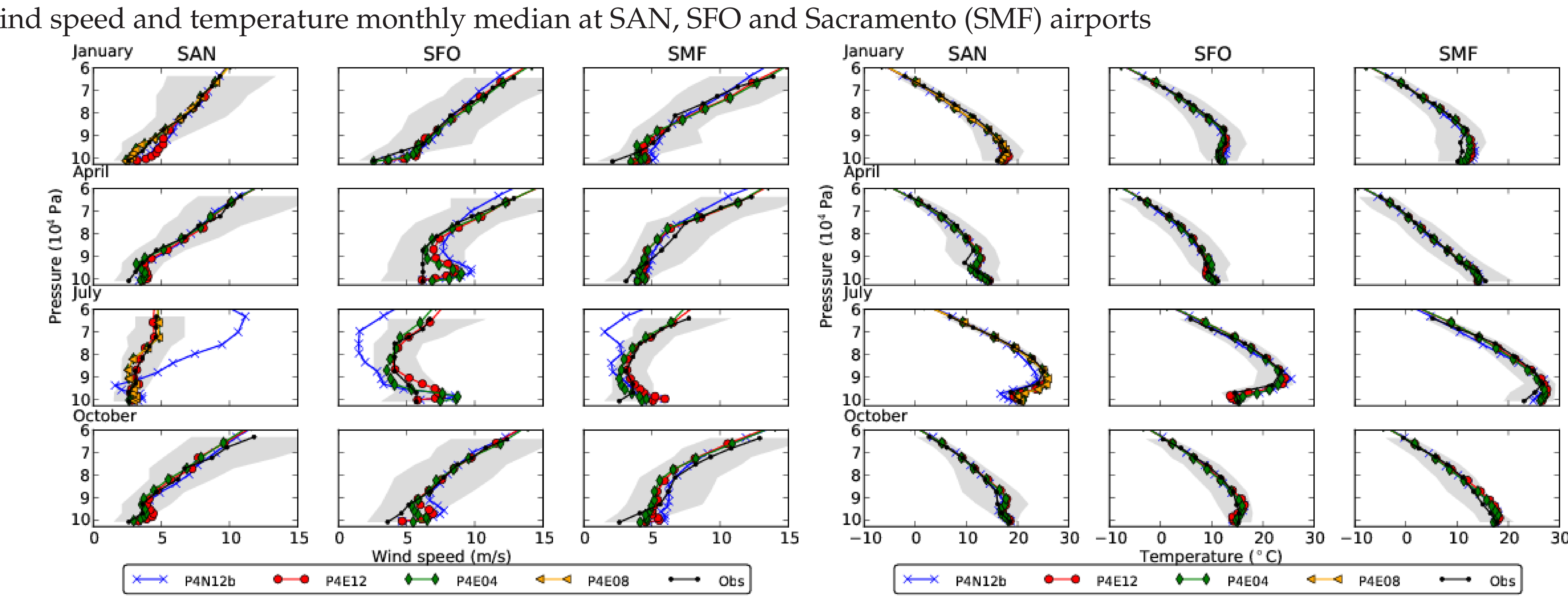


## VERTICAL PROFILES

Vertical profile of the wind speed and temperature monthly median at SAN, SFO and Sacramento (SMF) airports

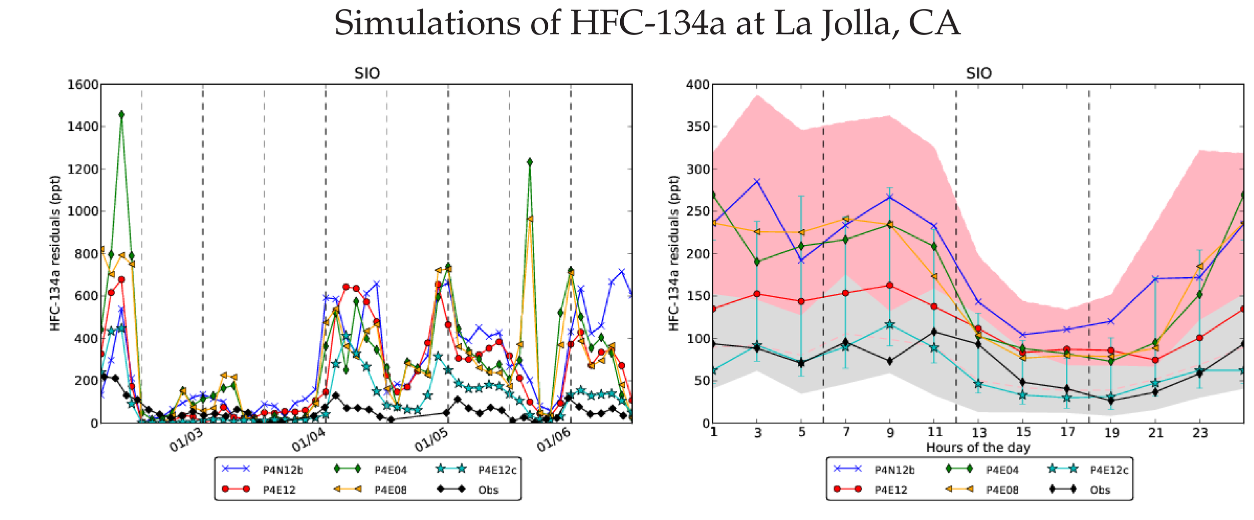
The same conclusions as for the daily cycles can be drawn:

- Simulations with ERA-interim (P4E*) perform better than the simulation with NAM (P4N12) especially in July for the wind speed.
- At SAN, no difference is observed between the 4 and the 0.8 km resolution simulations.
- At SAN, the nested simulations perform better or as good as the coarse grid simulation with a reduction of the surface inversion which is not observed.
- The simulated temperature profile is close to the observations for all the simulations.



## TRACER SIMULATIONS

Simulations of HFC-134a at La Jolla, CA



Time series and daily cycles using median and quartiles to show the range

- The temporal variations are fairly well reproduced by the simulations.
- The amplitude of the variations is overestimated for all simulations except the WRF/CHEM simulation (P4E12c).
- For P4E12c, the mean diurnal cycle of HFC-134a is similar to the observations, but individual observations generally show lower HFC-134a concentration than the simulated HFC-134a concentration.

## CONCLUSIONS

**@ Transport**

**⟶ No major differences in the temperature and winds arise from using different PBL schemes.**
**⟶ The initial and lateral boundary conditions play a more important role: the simulation with ERA-interim reanalysis performs better than the simulation with NAM analysis even though NAM has a lower resolution (12km vs 80km)**
**⟶ Increasing the resolution from 12 to 4km improves the agreement with observations in general, especially at SAN.**
**⟶ Further increasing the resolution does not improve the agreement.**
**⟶ The simulated temperature agrees well with the observations for all the simulations except for the nested simulation at SFO.**

**@ Tracer**

**⟶ Using WRF/CHEM improves greatly the simulation of HFC-134a.**
**⟶ Inferring emissions of HFC-134a is likely to require a comprehensive inversion, rather than a simple scaling of the prior emissions.**