Numerical Prediction of Role of ENSO on the Transport of Biomass Burning Plume from Northern Southeast Asia to Mountain Site in Taiwan

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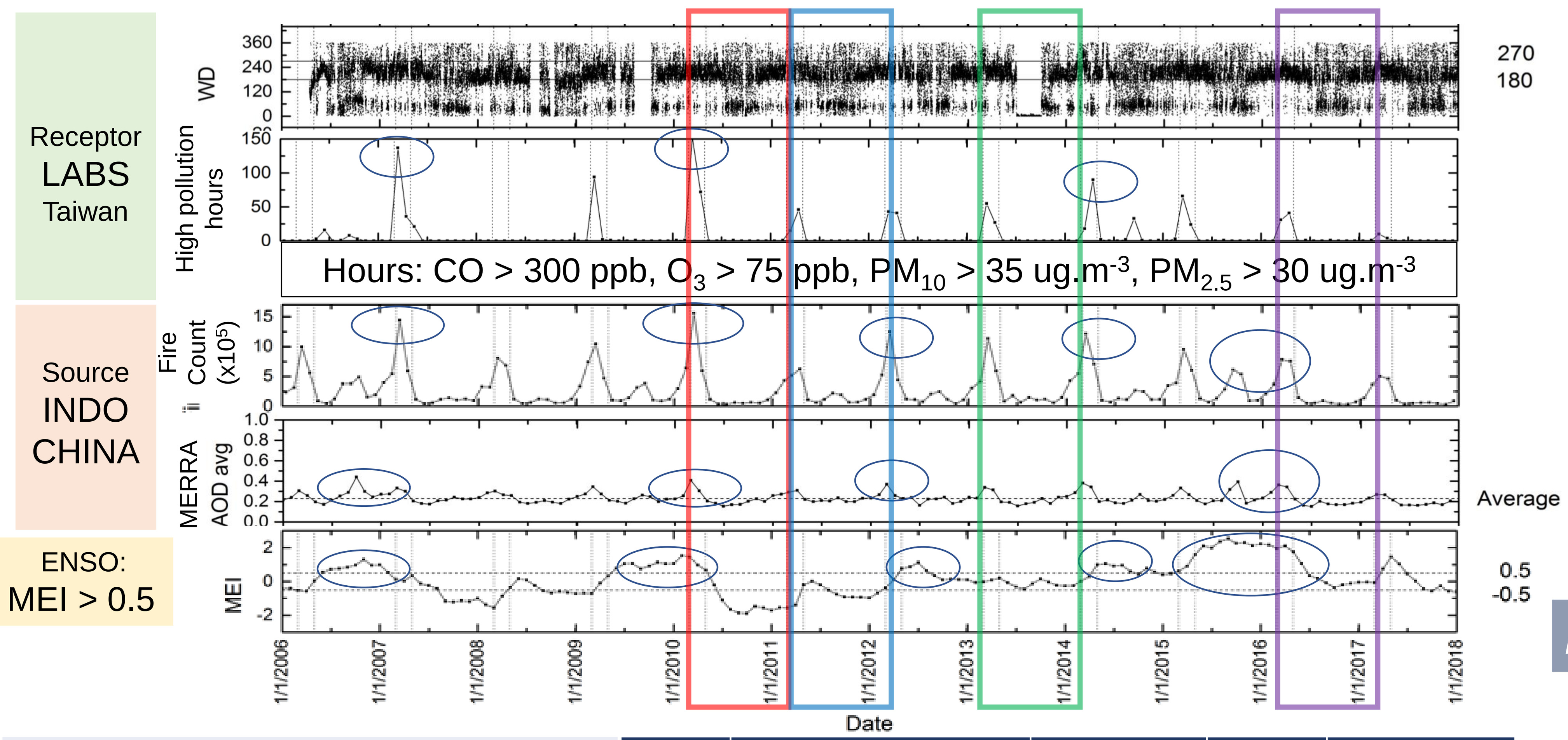
Aim

Study the role of ENSO (El-Niño Southern Oscillation) to transport of biomass burning (BB) plume in northern Indochina (NIC) to the LABS (Lulin Atmospheric Background Station; 2862m AMSL; 23°28'07'' N, 120°52'25'' E).

Background Study

Observation, satellite and reanalysis data



ENSO Years:

(Burning) Hotspot count
(Emission) AOD
(Transport) Mt Lulin
higher polluted hours

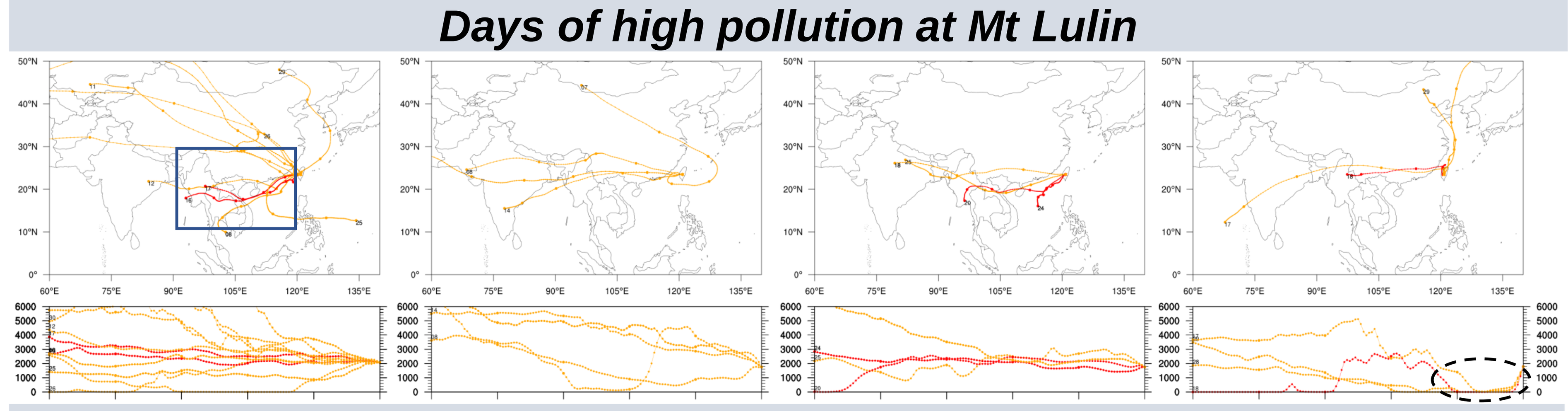
Mar	Anomaly condition	Hotspot (x10^5)	AOD	Polluted hours
2010	**ENSO**	**15.6**	**0.41**	**94**
2011	**La-Niña**	5.2	0.30	15
2013	**Neutral**	11.3	0.34	55
2016	**Extreme ENSO**	7.8	0.36	31

4 years representing different ENSO anomaly conditions studied.

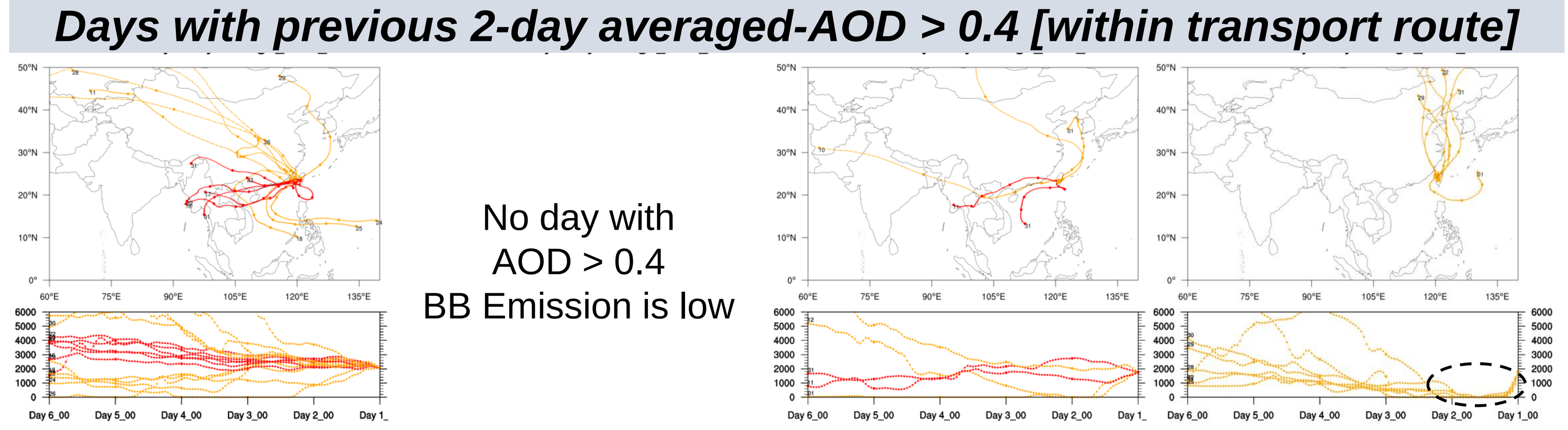
Backward Trajectories in March

ENSO (2010) **La-Niña (2011)** **Neutral (2013)** **Extreme ENSO**

Days of high pollution at Mt Lulin



Days with previous 2-day averaged-AOD > 0.4 [within transport route]



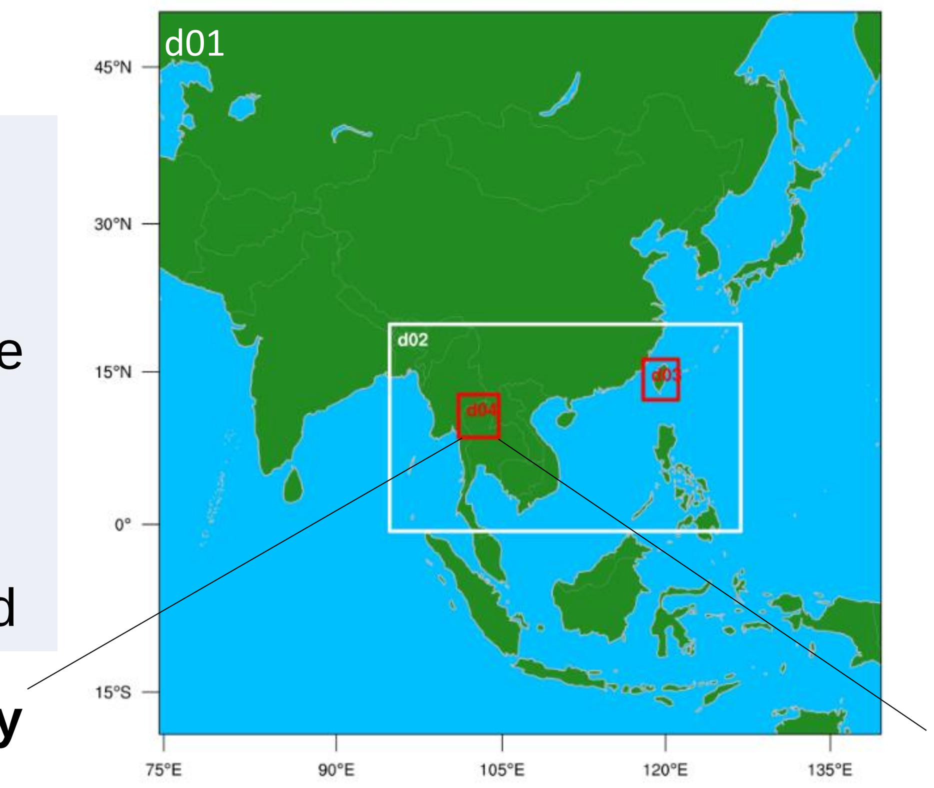
ENSO: Air mass comes from IndoChina around 3 – 4km.
La-niña: Less burning emissions.
Neutral: Moderate burning emissions.
Extreme ENSO: All airmass sank before reaching Taiwan.

Model Settings and Performance

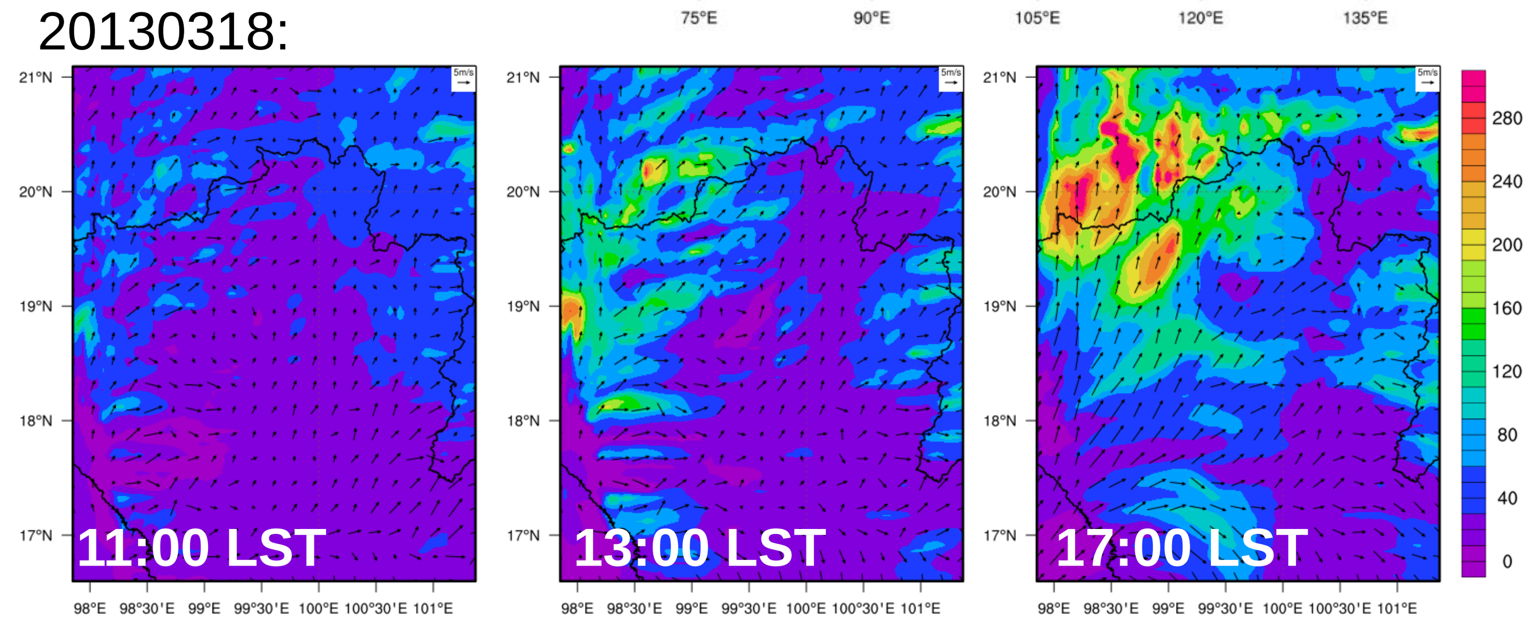
Model setup	Settings
Weather model	WRF version 3.9.1; NCEP FNL lateral boundary condition
Weather nudging	Grid and observation nudging
Period	1st– 31th Mar 2010, 2011, 2013, 2016 with 2010 fire emission (max burning)
Gas & aerosol chem mechanism	CB05e51 + AE6 (with aqueous chemistry)
Emission inventory	MICS-ASIA 2010
Biomass burning emission	FINN v1.5 + CMAQ **in-line plume rise algorithm**

Domain setup

Domain 1 (45km)
Majority of Asia
Domain 2 (15km)
BB transport route
Domain 3 (5km)
Taiwan only
Domain 4 (5km)
Northern Thailand



PM_{10} on burning day 20130318:

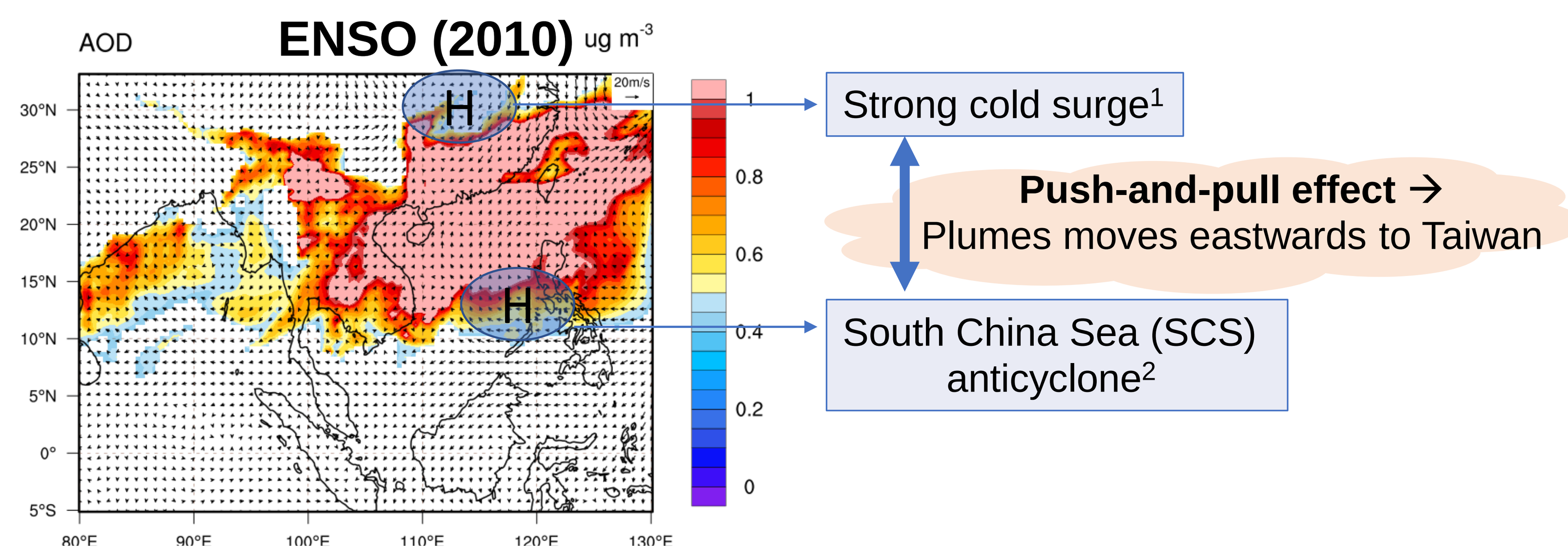


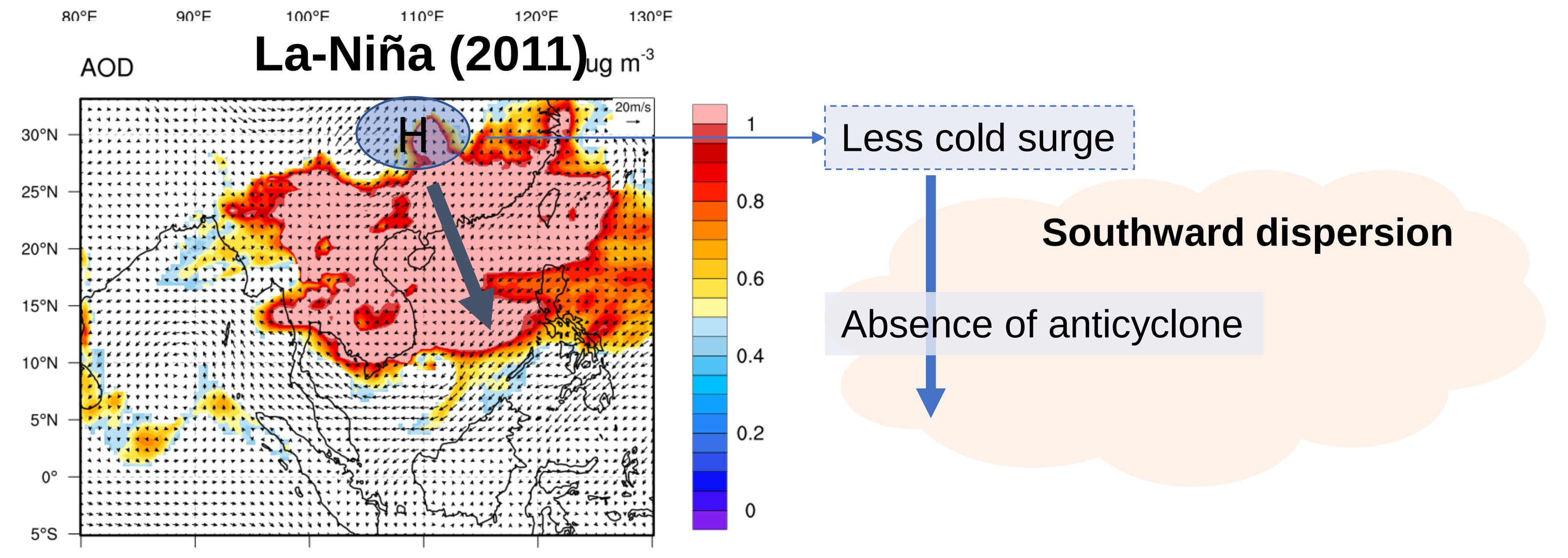
Model performance

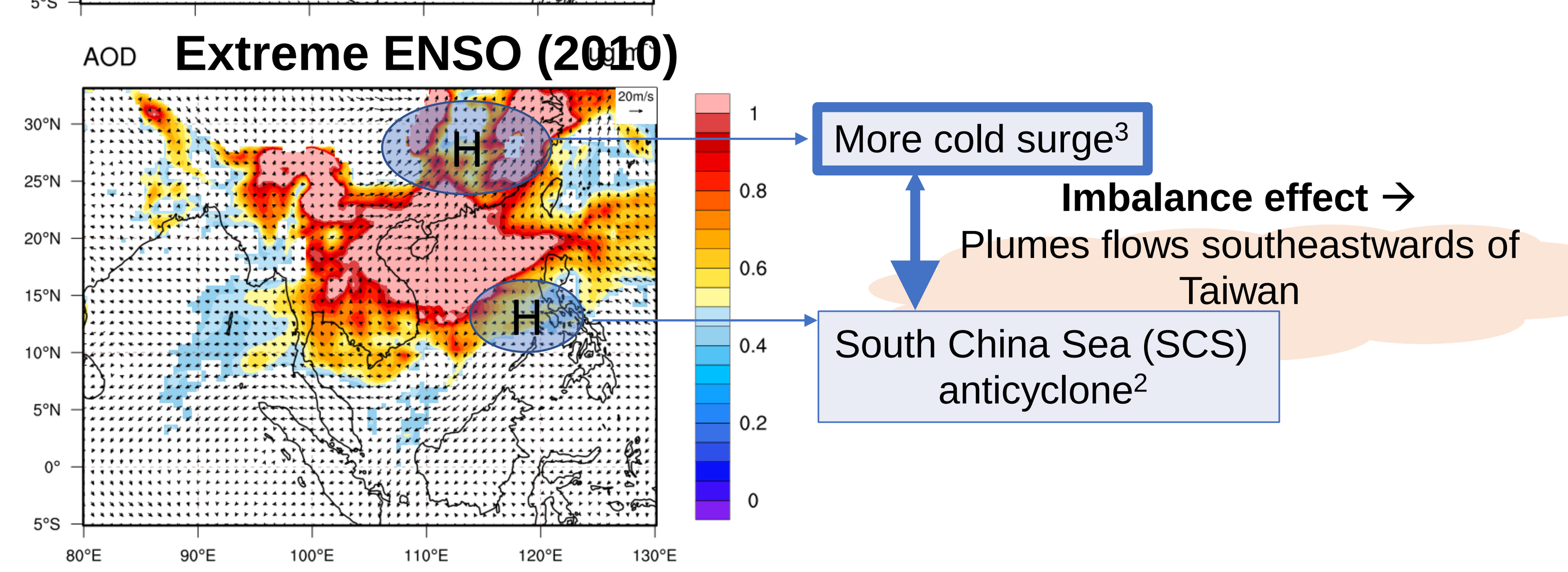
Daily	Stations	Corr (>0.5)	MFB (<±0.65)	MFE (<0.85)
PM_{10}	Mt. Lulin	0.65	-0.07	0.29
CO	Mt. Lulin	0.73	0.14	0.25
O_3	Mt. Lulin	0.77	0.04	0.13

Result and Analysis - AOD

Polluted hours at Mt Lulin:
- Observed: La-Nina < Extreme ENSO < Neutral < ENSO
- Modelled : La-Nina < ENSO = Neutral < Extreme ENSO







Conclusions

- The BB and its emission control are important during both ENSO and extreme ENSO years; ENSO is prone to create dry environment for burning to sustain, extreme ENSO years can transport more emission to LABS.
- Further effort will look into (1) the role of upwind weather anomaly on the burning and (2) vertical lifting on the burning site the vertical lifting and distribution of the plumes, by calibrating the plume rise model.

References: [1] Wu and Leung (2009) Atmos. Sci. Letts, 10 (2), 94-101 [2] Yen et al (2013) Atmos. Environ., 78, 35–50 [3] Geng et al (2017) Scientific Reports, 7 (3770), 2045-2322

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