Pescadero Fog Workshop Summary

Coastal Fog as a System: Developing an Interdisciplinary Research Agenda

June 2014

Kathleen C. Weathers, Ph.D.
Cary Institute of Ecosystem Studies
Box AB, 2801 Sharon Turnpike
Millbrook, NY 12545
Tel: (845) 677-7600 x137
www.caryinstitute.org

Coastal Fog as a System Steering Committee:
Jeffrey Collett, Jr., Ph.D.
Rene Garreaud, Ph.D.
Carolyn Jordan, Ph.D.
Patricia Matrai, Ph.D.
Michael O'Rourke, Ph.D.
Alicia Torregrosa, MS
Kathleen C. Weathers (Chair), Ph.D.
Lisa Borre (scribe), MES

Introduction

Fog researchers convened in a workshop "Coastal Fog as a System: Developing the Research Agenda" held 25-27 June 2013 in Pescadero, California.

The workshop was part of an interdisciplinary fog research planning project headed by Dr. Kathleen Weathers, Cary Institute of Ecosystem Studies, in collaboration with a steering committee (Dr. Jeffrey Collett, Colorado State University; Dr. Rene Garreaud, University of Chile; Dr. Carolyn Jordan, University of New Hampshire; Dr. Patricia Matrai, Bigelow Laboratory for Ocean Sciences; Dr. Michael O'Rourke, Michigan State University; Alicia Torregrosa, US Geological Survey) who guided the one-year project, The workshop was funded by the Gordon and Betty Moore Foundation through Grant GBMF3414 to Kathleen C. Weathers, Cary Institute of Ecosystem Studies.
Dr. Weathers, along with Facilitators Dr. Jonathan Kramer and Ms. Emily Shepard (illustrator), and the Steering Committee, planned and organized the two and a half day workshop. The agenda included both structured and unstructured time for participants to work in plenary and small group sessions and to have time for informal discussions and to get to know one another. Four disciplinary background presentations provided a foundation for the interactive discussions that followed.

The specific goals of the workshop were to address several key questions:

- What are the research frontiers? What are the basic science questions?
- What are the tools, models and methods necessary? What do fog researchers need to advance our field?
- How do we catalyze interdisciplinary fog research?

The 25 participants represented various disciplines of active fog research, and included climatologists, meteorologists, atmospheric scientists, oceanographers, geospatial analysts, ecologists, and eco-hydrologists. It was the first multi-disciplinary gathering of the fog research community for most in attendance.

At the outset of the workshop, Dr. Weathers encouraged the participants to reach beyond their disciplines to achieve success, and pointed to potential *barriers* to success:

- *Not moving intellectually out of our silos or boxes.* Participants were invited, and indeed, strongly encouraged to move outside their disciplinary boundaries during workshop discussions.
- *Getting lost in the details.* Participants were encouraged to think about the big picture of fog systems research and see the forest not just the trees.
- *Focusing on what we cannot do.* Participants were encouraged to focus on "What can we do?" and "How can we move forward?" rather than become mired in what cannot be done.

Participants at the Fog Research Frontiers Workshop in June 2013.

Workshop Participants

Sara Baguska, University of California, Santa Barbara
Lisa Borre (Writer), Cary Institute of Ecosystem Studies
Jan Cermak, Ruhr-Universität Bochum
Patrick Chuang, University of California, Santa Cruz
Jeff Collett, Colorado State University
Clive Dorman, Scripps Institution of Oceanography
Eli Dueker, CUNY Queens College
Gary Ellrod, NOAA
Holly Ewing, Bates College
Ian Faloona, University of California, Davis
René Garreaud, Universidad de Chile
Ismail Gültepe, Environment Canada
Barbara Han, University of Georgia
Lelia Hawkins, Harvey Mudd College
Barry Huebert, University of Hawaii
Jim Johnstone, University of Washington
Carolyn Jordan, University of New Hampshire
Jon Kramer, University of Maryland-SESYNC
Paty Matrai, Bigelow Laboratory for Ocean Sciences
Mel Nordquist, National Weather Service NOAA
Travis O'Brien, Lawrence Berkeley National Lab
Michael O'Rourke, Michigan State University
Zach Piso, Michigan State University
Kerri Pratt, University of Michigan
Martha Scholl, U.S. Geological Survey

Emily Shepard (Illustrator)
Armin Sorooshian, University of Arizona
Robert Tardif, University of Washington
Alicia Torregrosa, U.S. Geological Survey
Kathleen Weathers, Cary Institute of Ecosystem Studies
Chris Zappa, Columbia University

Facilitator Jon Kramer of SESYNC during the opening session of the workshop.

Facilitation Process

Facilitator Dr. Jonathan Kramer, Director of Interdisciplinary Science at the Socio-Environmental Synthesis Center (SESYNC), Annapolis, MD, led the group through interactive discussions with the help of Emily Shepard, a San Francisco-based artist and illustrator with experience in graphic facilitation.

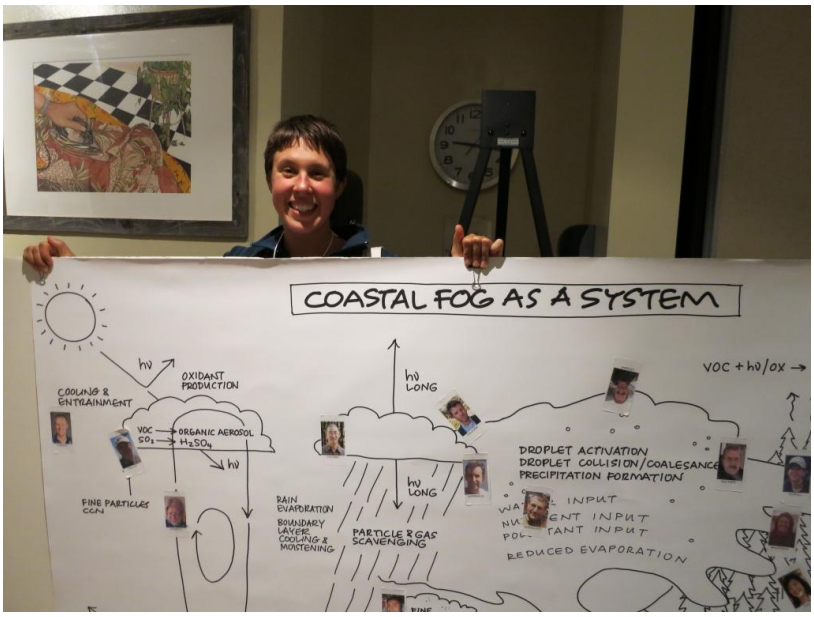
In preparation for the workshop, Shepard, with input from Weathers, Collett and Kramer helped to refine the conceptual framework diagram ("coastal fog as a system") developed by the Steering Committee. During the workshop, Shepard recorded the discussion on a white board in real-time, including illustrations and visual representations of the discussion topics. This was the first experience any of the participants had with a graphic artist helping facilitate discussions. Illustrations are provided in Appendix 1.

Artist Emily Shepard illustrated discussions during the workshop.

Lisa Borre, a writer, was engaged to prepare this summary of the workshop and a draft of the White Paper.

Conceptual Framework

The conceptual framework for Coastal Fog as a System developed by the Steering Committee was used as a visual tool for participants to discuss and reach an understanding of the boundaries and connections in fog research, and to determine where each person's research interests fit in. A poster-size illustration of the conceptual framework was available throughout the meeting.



Doctoral student Sara Baguska at the Pescadero Fog Research Frontiers Workshop.

During the first evening session, participants introduced themselves after dinner by stating their name and affiliation, placing their photo (mounted on a sticky label) on a part of the diagram that they identified with in terms of their own research, and briefly explaining why they placed the photo where they did (Fig. 1). The photos were distributed throughout the diagram, with several participants noting secondary interests. The exercise turned out to be an extremely effective "ice breaker" and an informative way to visually represent the multi-disciplinary nature of the group.

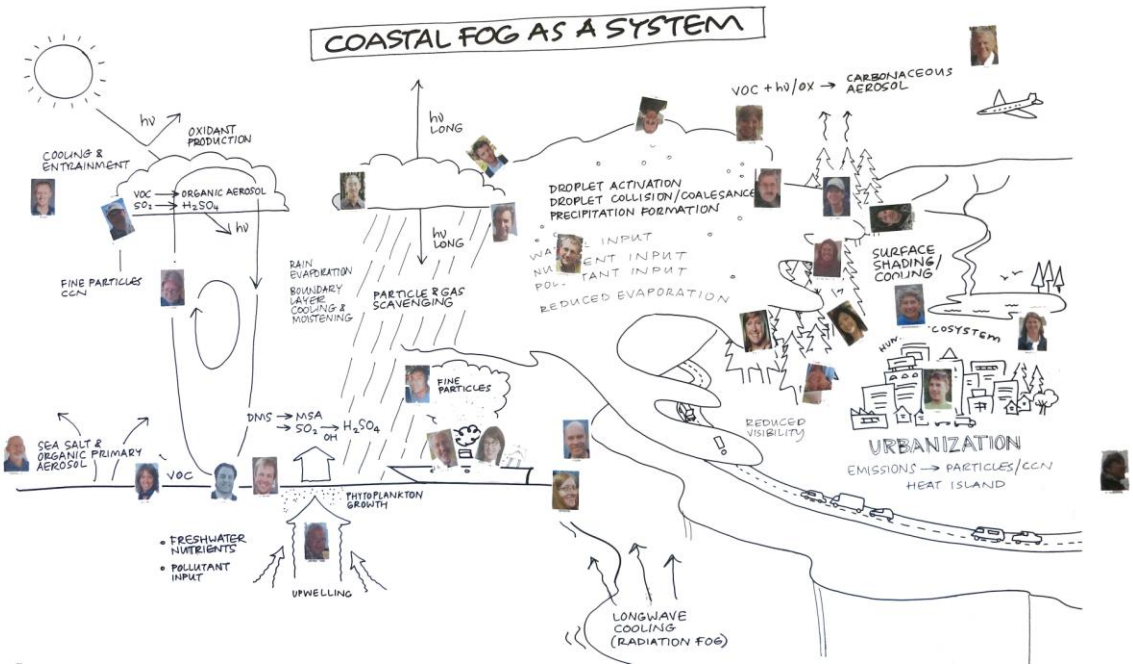
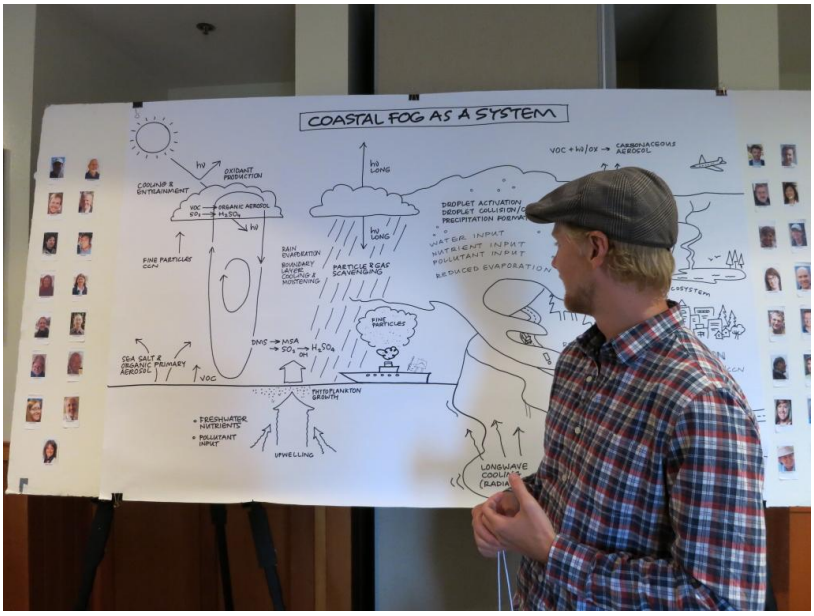


Figure 1. Coastal Fog as a System diagram after participant introductions.



Travis O'Brien studies the Coastal Fog as a System conceptual framework before placing his photo on the diagram during Pescadero workshop introductions.

The conceptual framework was also used during the meeting wrap-up where participants had an opportunity to suggest modifications to the diagram and to indicate how their interests evolved during the meeting. Most kept their photo in its original location but used a red marker to indicate new research interests or areas of the fog system where they would like to start working (Fig. 2). Almost every participant expressed interest in new areas of research and in working collaboratively with scientists in other disciplines.

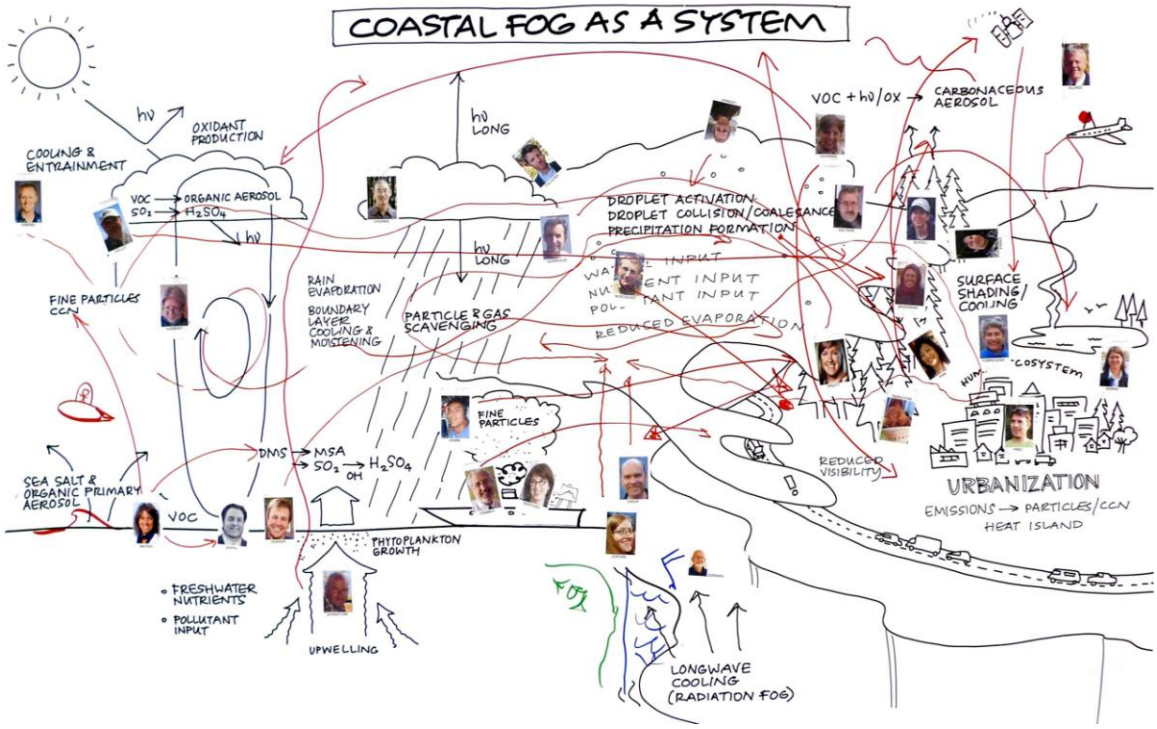


Figure 2. Coastal Fog as a System diagram at the end of the Pescadero Research Frontiers Workshop.

By the end of the workshop, consensus was reached on using the Coastal Fog as a System diagram as a conceptual framework for developing an interdisciplinary fog research agenda.

Lightning Round Research Introductions

Interested participants were invited to present two slides over five minutes on the most interesting topic they are working on. The Lightning Round Research Introductions were an informal and voluntary event after dinner on Days 1 and 2. It was an "off the record" opportunity for presenters to share a few of their fog research passions and ideas.

The following workshop participants made presentations during the first "Lightning Round": Jeff Collett, Carolyn Jordan, Rene Garreaud Salazar, Paty Matrai, Alicia

Torregrosa, Kathleen Weathers, Sara Baguskas, Barry Huebert, Martha Scholl, Mel Nordquist and Jan Cermak.

Presentations during the second "Lightning Round" included: Robert Tardif, Lelia Hawkins, Travis O'Brien, Eli Dueker, Jim Johnstone, Ismael Gültepe, Chris Zappa and Barry Huebert.

Presentations on the Current State of Fog Research

As a way to establish a foundation for the research planning discussions at the workshop, four participants were challenged to provide broad overviews of the current state of research in four subject areas:

- Ocean-Atmosphere (Patrick Chuang)
- Chemistry-Biology (Barry Huebert)
- Fog Frequency and Geographic Distribution (Gary Ellrod)
- Deposition and Impacts to Natural and Human Systems (Holly Ewing (Kathleen Weathers, Todd Dawson))

These are summarized in the illustrations provided in Appendix 1.

Disciplinary Research Frontiers

Workshop participants identified disciplinary research priorities during the first small group discussion session. These are summarized in the White Paper and in the illustration provided in Appendix 1.

Small group discussions at the Pescadero Fog Research Frontiers Workshop.

Interdisciplinary Research Frontiers

The second and third small group discussions were devoted to identifying interdisciplinary research frontiers. These are summarized in the White Paper and in the illustration provided in Appendix 1.

Key Knowledge Gaps and Research Challenges

The following knowledge gaps were identified:

- Improve understanding of fog precursor aerosols
- How does the fog activation process differ from cloud activation?
- Fog and aerobiology
- What makes fog different in different locations?
- Literature Review of Fog Research to Date
- Need to consider cold fog
- Finding ways to link non-uniform data and make those data available to fog researchers
- The role of topography in fog formation
- How can we better predict the wind three-dimensionally, in addition to temperature?
- What is the correct scale?
- Understanding how climate change and variability will affect fog
- Lack of information about paleo-fog and the history of fog
- Lack of climate proxies
- Better decision support and prediction of fog events on a short-term time scale
- International collaboration
- Research platform restrictions
- Common definitions and standard methods

Key knowledge gaps and research challenges are described in the White Paper and summarized in the illustration provided in Appendix 1.

Outcomes

The results of the workshop are documented in the White Paper, and include:

- Review of the current state of research and key gaps in knowledge.
- Identification of some research frontiers.
- Agreement on the utility of a conceptual framework around which to structure coastal fog research.
- New interdisciplinary research collaborations initiated.

Factors Contributing to the Workshop Success

The Steering Committee evaluated the workshop outcomes and determined that a number of factors contributed to its resounding success, including:

- Meeting designed with careful attention to facilitation (skilled facilitator who understands science working with an illustrator were conscious choices).
- Meeting agenda allowed time for informal discussions and small group sessions.
- Workshop participants were carefully selected by the Steering Committee to represent a broad range of backgrounds, disciplines and career stages, and an interest in working across disciplines.
- Meeting held in a beautiful, comfortable and relatively remote setting with healthy meals.
- All participants required to attend for the duration of the workshop and to stay at the meeting venue.
- Participants were encouraged to limit phone and internet communications during workshop proceedings to minimize distractions. Although not by design, the meeting venue had limited cell phone and internet access.

Foggy mornings created an appropriate setting for the workshop.

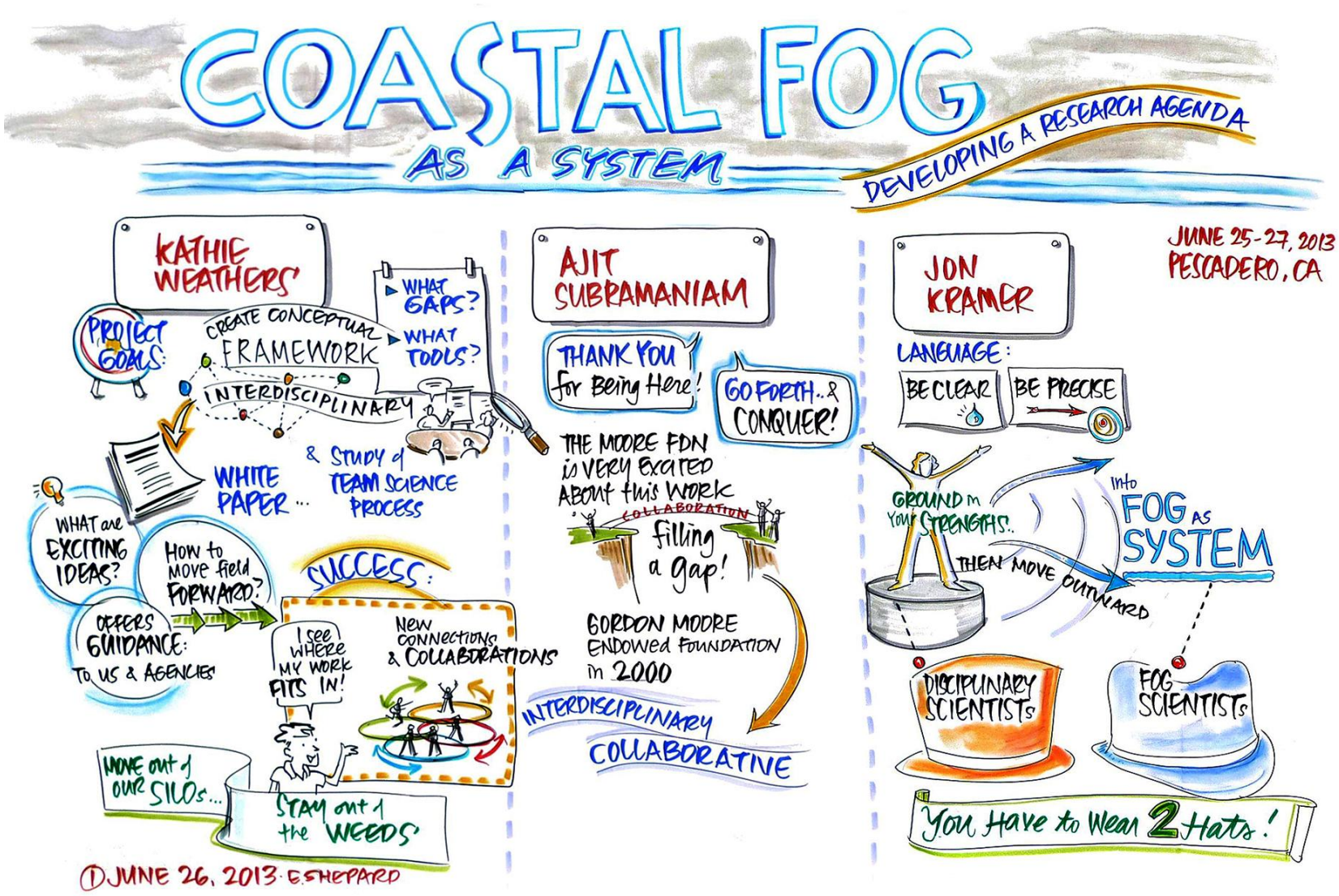
Appendices

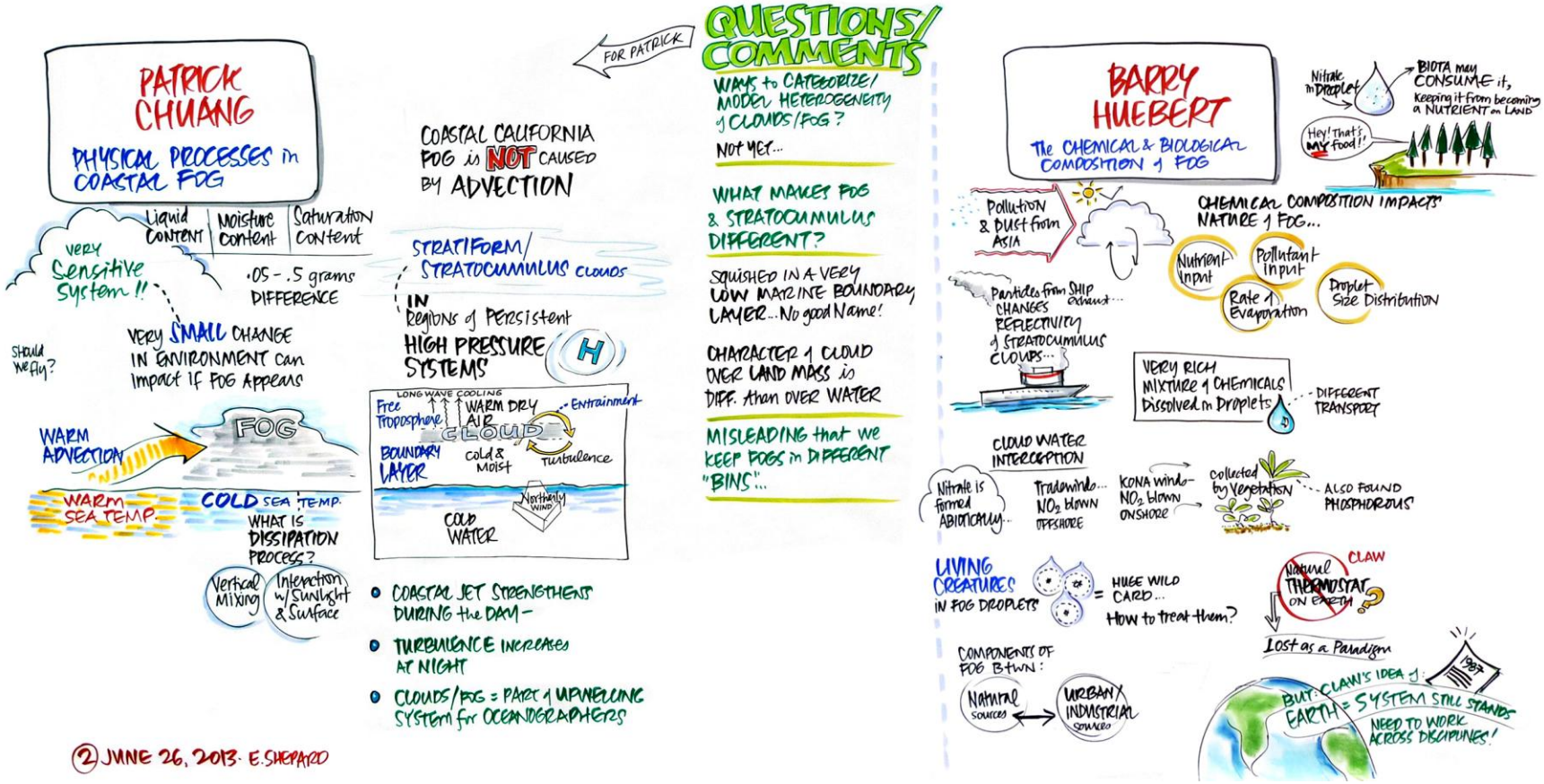
A.1. Illustrations by Emily Shepard

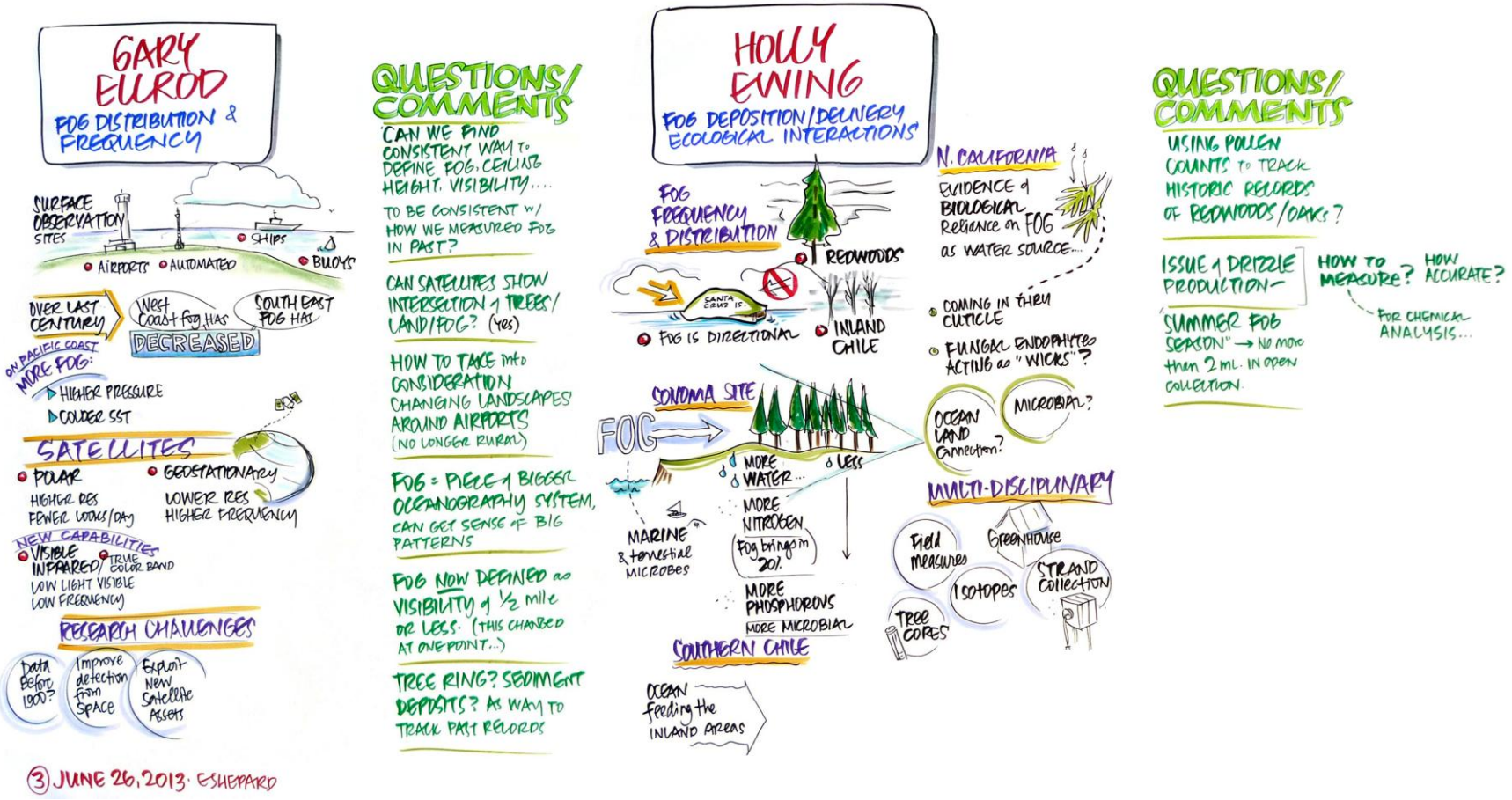
List of Illustrations:

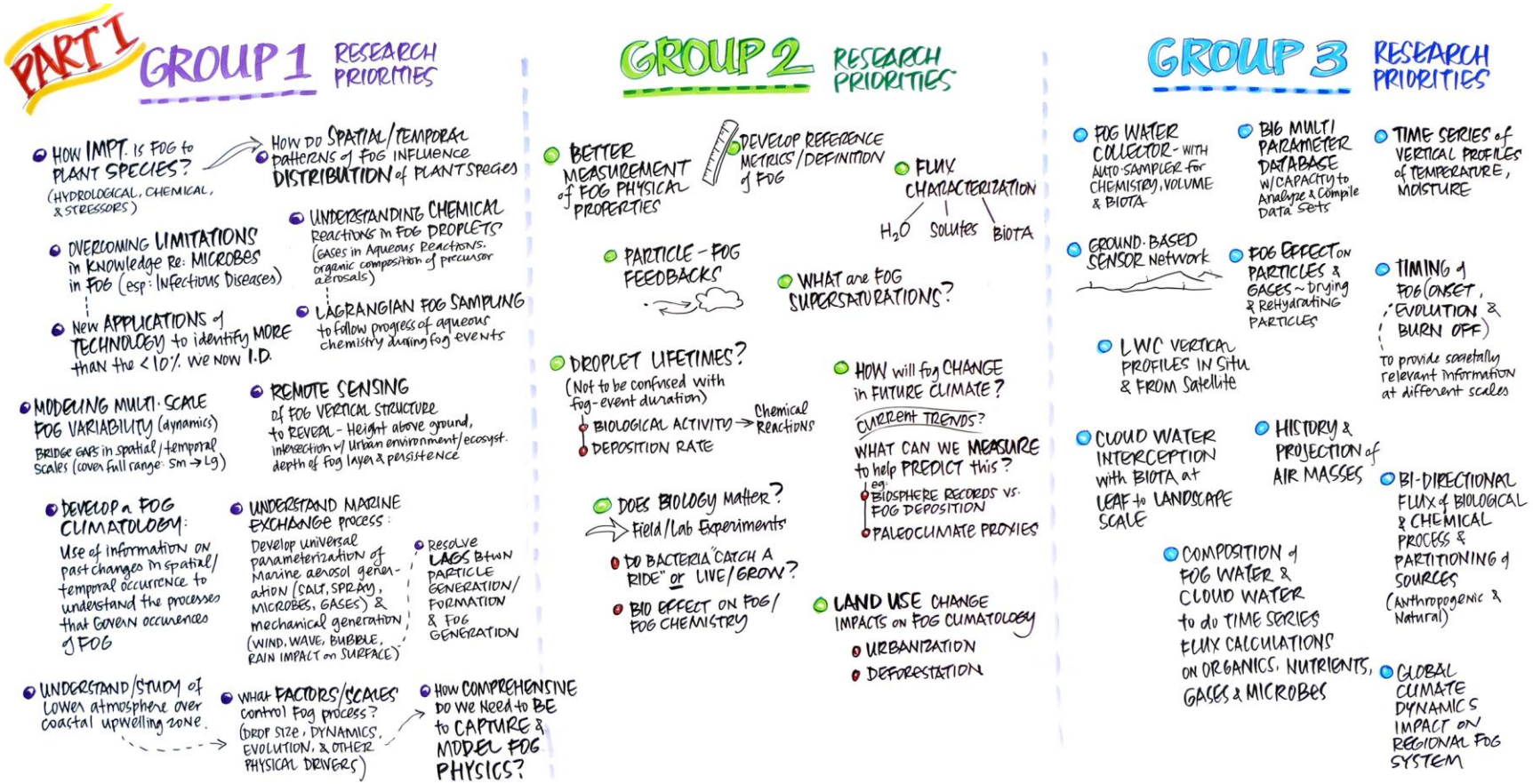
1. Agenda
2. Opening Session
3. Research Presentations (Chuang and Huebert)
4. Research Presentations (Ellrod and Ewing)
5. Session 1 Group Reports
6. Session 2 Group Reports
7. Session 3 Group Reports
8. Common Elements, Challenges and Gaps
9. Fog Definitions
10. Interdisciplinary Research Opportunities and Closing

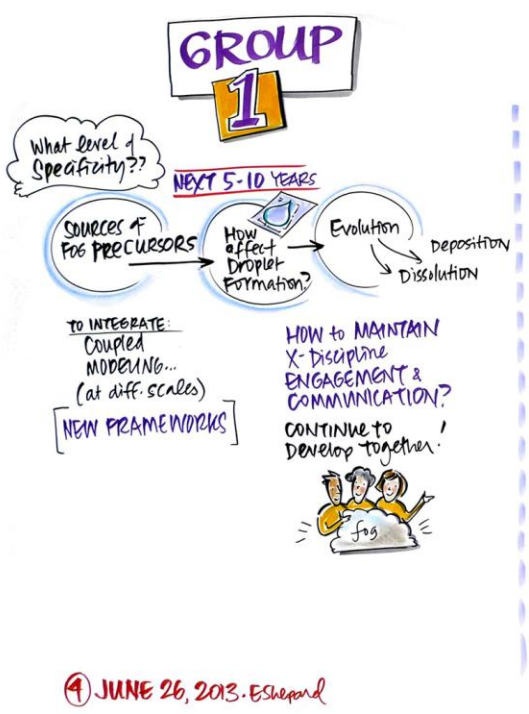

FOG AS A SYSTEM
AGENDA
DAY ONE
7:30 BREAKFAST
8:30 WELCOME & EXPECTATIONS
9:30 FOG as a SYSTEM PRESENTATIONS
• PATRICK CHUANG • BARRY HUEBERT
10:30 BREAK
11:00 • GARY ELLROD • HOLLY EWING
12:00 LUNCH
1:30 INTROs to SMALL GROUP DISCUSSIONS
1:45 PART I: FOUNDATIONAL FOG SCIENCE & RESEARCH PRIORITIES
3:00 BREAK
3:20 PLENARY/INSTRUCTIONS
3:30 PART II: SPANNING FOG RESEARCH DISCIPLINARY BOUNDARIES
4:30 SMALL GROUP REPORT OUTS
5:00 ADJOURN
6:30 DINNER: REDWOOD/OAK ROOM
DAY TWO
7:30 BREAKFAST
8:30 PART III: SYNTHETIC INTERDISCIPLINARY FRONTIERS
9:30 GROUP REPORT OUTS
10:30 BREAK
11:00 PLENARY DISCUSSION of FINDINGS, GAPS & INSIGHTS
12:00 LUNCH
1:00 AGENCY PERSPECTIVES & FUTURE ENGAGEMENT
2:00 REVISIT & REVISE CONCEPTUAL FRAMEWORKS/ NEXT STEPS
3:50 ADJOURN
THE CARY INSTITUTE


COASTAL FOG
AS A SYSTEM
DEVELOPING A RESEARCH AGENDA
JUNE 25-27, 2013
PESCADERO, CA
KATHIE WEATHERS
PROJECT GOALS:
CREATE CONCEPTUAL FRAMEWORK
WHAT GAPS?
WHAT TOOLS?
INTERDISCIPLINARY
& STUDY of TEAM SCIENCE PROCESS
WHITE PAPER ...
WHAT are EXCITING IDEAS?
How to MOVE field FORWARD?
OFFERS GUIDANCE: TO US & AGENCIES
SUCCESS:
I see WHERE MY WORK FITS IN!
New CONNECTIONS & COLLABORATIONS
MOVE out of OUR SILOS...
STAY out of the WEEDS
©JUNE 26, 2013 E.SHEPARD
AJIT SUBRAMANIAM
THANK YOU for Being Here!
GO FORTH.. & CONQUER!
THE MOORE FDN is VERY EXCITED ABOUT this WORK
COLLABORATION
filling a gap!
GORDON MOORE ENDOWED FOUNDATION in 2000
INTERDISCIPLINARY
COLLABORATIVE
JON KRAMER
LANGUAGE:
BE CLEAR
BE PRECISE
GROUND in YOUR STRENGTHS..
THEN MOVE OUTWARD
into FOG AS SYSTEM
DISCIPLINARY SCIENTISTS
FOG SCIENTISTS
You Have to Wear 2 Hats!


PATRICK CHUANG
PHYSICAL PROCESSES in COASTAL FOG
Liquid Content
Moisture content
Saturation Content
very Sensitive System !!
.05 - .5 grams DIFFERENCE
Should we fly?
VERY SMALL CHANGE IN ENVIRONMENT can Impact IF FOG Appears
WARM ADVECTION
FOG
WARM SEA TEMP.
COLD SEA TEMP.
WHAT IS DISSIPATION PROCESS?
Vertical Mixing
Interaction w/ Sunlight & Surface
COASTAL CALIFORNIA FOG is NOT CAUSED BY ADVECTION
STRATIFORM/ STRATOCUMULUS clouds
IN Regions of Persistent HIGH PRESSURE SYSTEMS
H
LONG WAVE COOLING
Free Troposphere
WARM DRY AIR
Entrainment
CLOUD
BOUNDARY LAYER
cold & MOIST
Turbulence
Northerly WIND
COLD WATER
COASTAL JET STRENGTHENS DURING the DAY -
TURBULENCE INCREASES AT NIGHT
CLOUDS/FOG = PART of UPWELLING SYSTEM for OCEANOGRAPHERS
② JUNE 26, 2013 · E. SHEPARD
FOR PATRICK
QUESTIONS/ COMMENTS
WAYS to CATEGORIZE/ MODEL HETEROGENEITY of CLOUDS/FOG?
Not yet...
WHAT MAKES FOG & STRATOCUMULUS DIFFERENT?
SQUISHED IN A VERY LOW MARINE BOUNDARY LAYER... No good Name!
CHARACTER of CLOUD OVER LAND MASS is DIFF. than OVER WATER
MISLEADING that we KEEP FOGS in DIFFERENT "BINS"...
BARRY HUEBERT
The CHEMICAL & BIOLOGICAL COMPOSITION of FOG
Nitrate in Droplet
BIOTA may CONSUME it, keeping it from becoming a NUTRIENT on LAND
Hey! That's MY food!
Pollution & Dust from ASIA
CHEMICAL COMPOSITION IMPACTS NATURE of FOG...
Nutrient Input
Pollutant Input
Rate of Evaporation
Droplet Size Distribution
Particles from SHIP exhaust... CHANGES REFLECTIVITY of STRATOCUMULUS CLOUDS...
VERY RICH MIXTURE of CHEMICALS Dissolved in Droplets
DIFFERENT TRANSPORT
CLOUD WATER INTERCEPTION
Nitrate is formed ABIOTICALLY...
Tradewinds... NO_2 blown OFFSHORE
KONA winds - NO_2 blown ONSHORE
Collected by Vegetation
ALSO FOUND PHOSPHOROUS!
LIVING CREATURES IN FOG DROPLETS
= HUGE WILD CARD...
How to treat them?
Natural THERMOSTAT ON EARTH?
CLAW
Lost as a Paradigm
1987
BUT CLAW'S IDEA of EARTH = SYSTEM STILL STANDS
NEED TO WORK ACROSS DISCIPLINES!
COMPONENTS OF FOG B'twn:
Natural sources
URBAN/ INDUSTRIAL sources

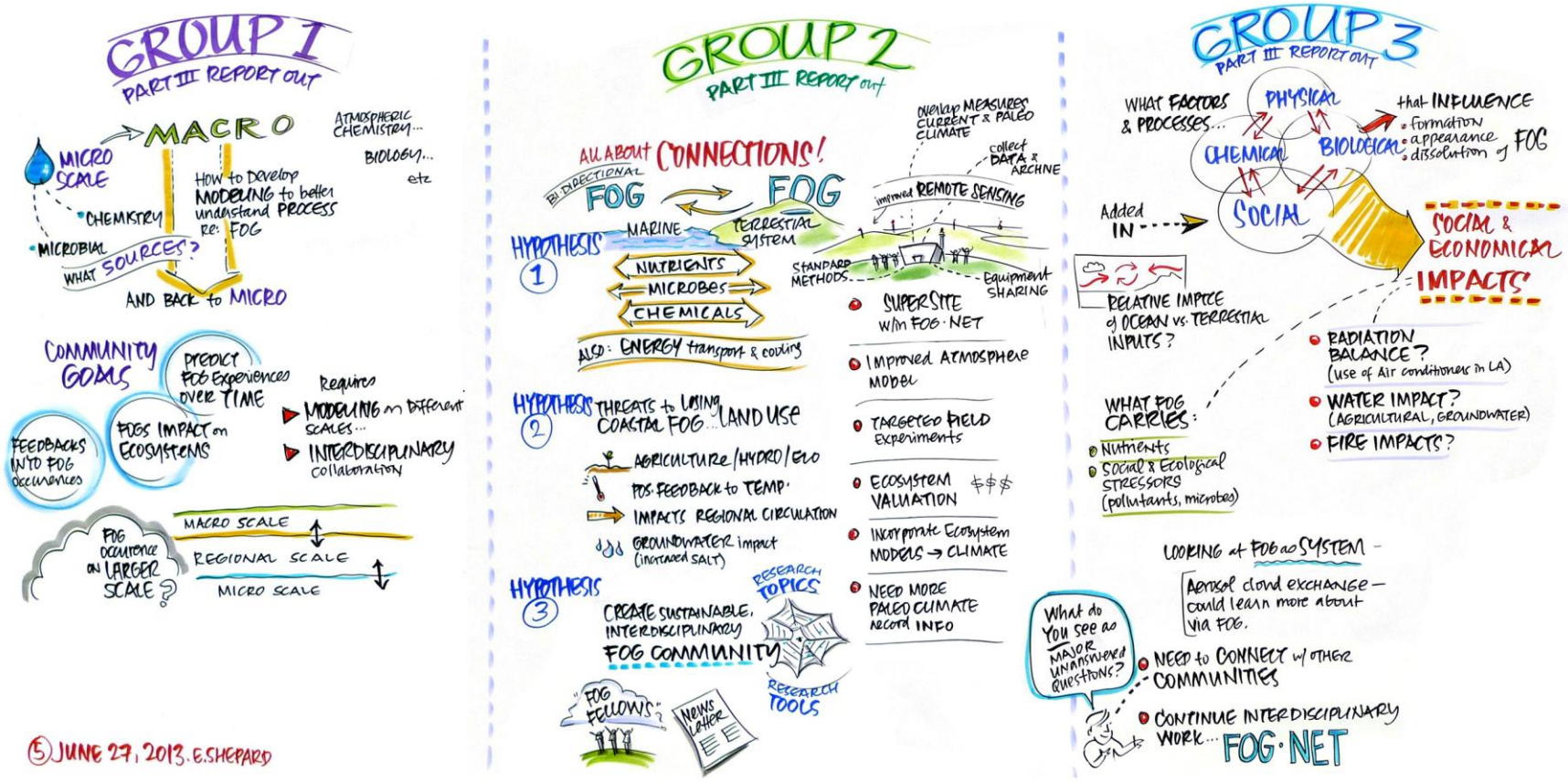

GARY ELROD
FOG DISTRIBUTION & FREQUENCY
SURFACE OBSERVATION SITES
SHIPS
BUOYS
AIRPORTS
AUTOMATED
OVER LAST CENTURY
West Coast fog has DECREASED
SOUTH EAST FOG HAS
ON PACIFIC COAST MORE FOG:
HIGHER PRESSURE
COOLER SST
SATELLITES
POLAR
HIGHER RES
FEWER LOOKS/DAY
GEOSTATIONARY
LOWER RES
HIGHER FREQUENCY
NEW CAPABILITIES
VISIBLE INFRARED/ TRUE COLOR BAND
LOW LIGHT VISIBLE
LOW FREQUENCY
RESEARCH CHALLENGES
Data before 1900?
Improve detection from space
Exploit new satellite assets
QUESTIONS/ COMMENTS
CAN WE FIND CONSISTENT WAY TO DEFINE FOG, CEILING HEIGHT, VISIBILITY....
TO BE CONSISTENT W/ HOW WE MEASURED FOG IN PAST?
CAN SATELLITES SHOW INTERSECTION of TREES/ LAND/FOG? (yes)
HOW TO TAKE into CONSIDERATION CHANGING LANDSCAPES AROUND AIRPORTS (NO LONGER RURAL)
FOG = PIECE of BIGGER OCEANOGRAPHY SYSTEM, CAN GET SENSE of BIG PATTERNS
FOG NOW DEFINED as VISIBILITY of ½ mile OR LESS. (THIS CHANGED AT ONE POINT...)
TREE RING? SEDIMENT DEPOSITS? As WAY TO TRACK PAST RECORDS
HOLLY EWING
FOG DEPOSITION/DELIVERY ECOLOGICAL INTERACTIONS
FOG FREQUENCY & DISTRIBUTION
REDWOODS
SANTA CRUZ IS.
FOG IS DIRECTIONAL
INLAND CHILE
SONOMA SITE
FOG
MORE WATER...
LESS
MORE NITROGEN
Fog brings in 20%
MORE PHOSPHORUS
MORE MICROBIAL
MARINE & terrestrial MICROBES
SOUTHERN CHILE
OCEAN feeding the INLAND areas
N. CALIFORNIA
EVIDENCE of BIOLOGICAL Reliance on FOG as WATER SOURCE...
COMING IN THRU CUTICLE
FUNGAL ENDOPHYTES ACTING as "WICKS"?
OCEAN LAND Connection?
MICROBIAL?
MULTI-DISCIPLINARY
Field measures
Greenhouse
ISOTOPES
STRAND COLLECTION
TREE CORES
QUESTIONS/ COMMENTS
USING POLLEN COUNTS TO TRACK HISTORIC RECORDS OF REDWOODS/OAKS?
ISSUE of DRIZZLE PRODUCTION—
HOW TO MEASURE?
HOW ACCURATE?
FOR CHEMICAL ANALYSIS...
SUMMER FOG SEASON" → No more than 2 mL. IN open collection.
③ JUNE 26, 2013 · ESHEPARD

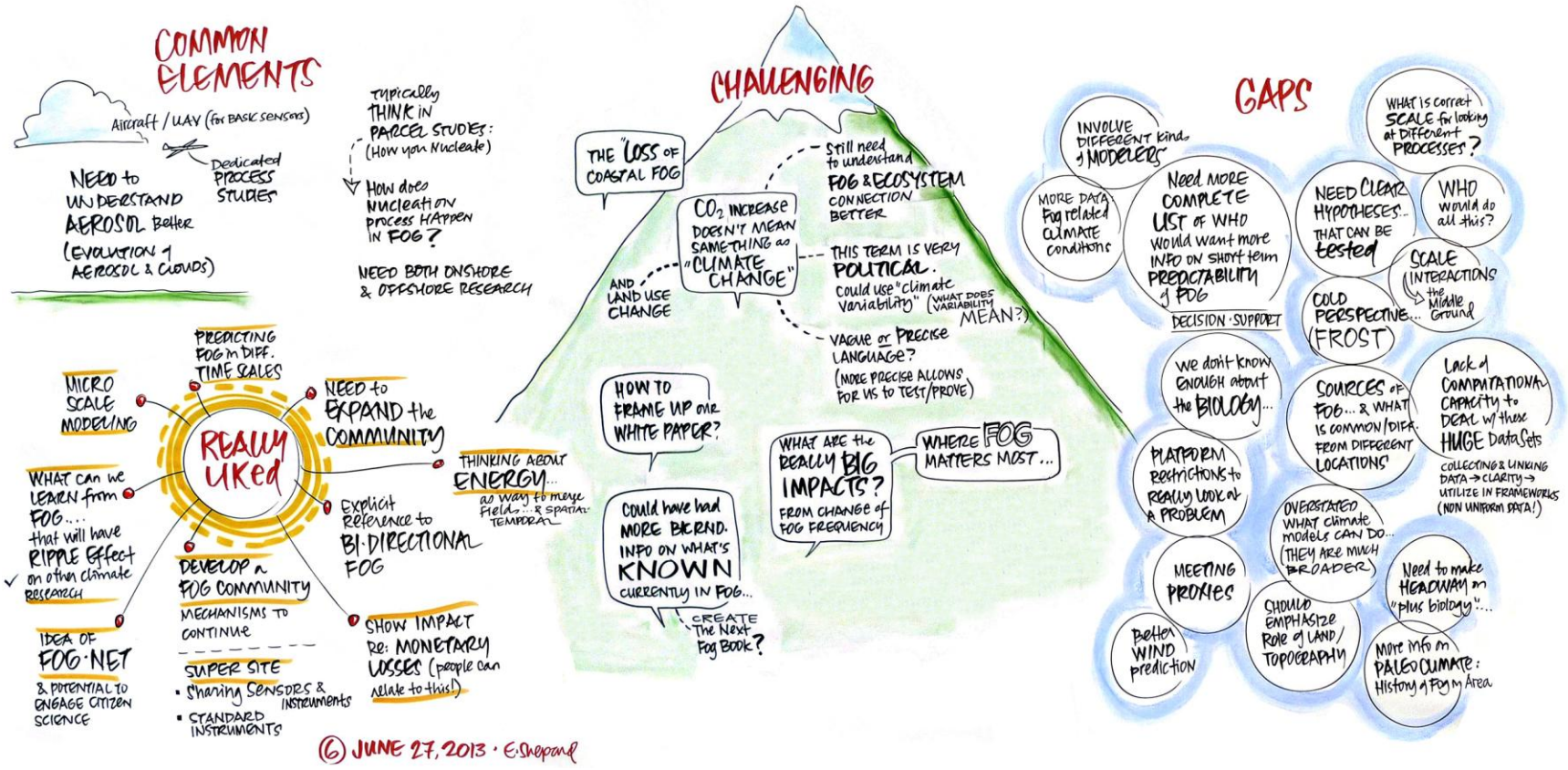

PART 1
GROUP 1 RESEARCH PRIORITIES
HOW IMPT. IS FOG to PLANT SPECIES? (HYDROLOGICAL, CHEMICAL, & STRESSORS)
HOW DO SPATIAL/TEMPORAL PATTERNS of FOG INFLUENCE DISTRIBUTION of PLANT SPECIES
OVERCOMING LIMITATIONS in KNOWLEDGE Re: MICROBES in FOG (esp: Infectious Diseases)
UNDERSTANDING CHEMICAL REACTIONS in FOG DROPLETS? (Gases in Aqueous Reactions. organic composition of precursor aerosols)
LAGRANGIAN FOG SAMPLING to follow progress of aqueous chemistry during fog events
New APPLICATIONS of TECHNOLOGY to identify MORE than the <10% we NOW I.D.
MODELING MULTI-SCALE FOG VARIABILITY (dynamics) BRIDGE GAPS in spatial/temporal Scales (cover full range: Sm → Lg)
REMOTE SENSING of FOG VERTICAL STRUCTURE to REVEAL - Height above ground, intersection w/ Urban environment/ecosyst. depth of Fog layer & persistence
DEVELOP a FOG CLIMATOLOGY: Use of information on past changes in spatial/temporal occurrence to understand the processes that Govern occurrences of FOG
UNDERSTAND MARINE EXCHANGE process: Develop universal parameterization of Marine aerosol generation (SALT, SPRAY, MICROBES, GASES) & mechanical generation (WIND, WAVE, BUBBLE, RAIN IMPACT on SURFACE)
Resolve LAGS Btwn PARTICLE GENERATION/ FORMATION & FOG GENERATION
UNDERSTAND/STUDY of Lower atmosphere over coastal upwelling zone.
What FACTORS/SCALES control Fog process? (DROP SIZE, DYNAMICS, EVOLUTION, & OTHER PHYSICAL DRIVERS)
How COMPREHENSIVE do We Need to BE to CAPTURE & MODEL FOG PHYSICS?
GROUP 2 RESEARCH PRIORITIES
BETTER MEASUREMENT of FOG PHYSICAL PROPERTIES
DEVELOP REFERENCE METRICS/DEFINITION of FOG
FLUX CHARACTERIZATION
H_2O
Solutes
BIOTA
PARTICLE - FOG FEEDBACKS
WHAT are FOG SUPERSATURATIONS?
DROPLET LIFETIMES? (Not to be confused with fog-event duration)
BIOLOGICAL ACTIVITY → Chemical Reactions
DEPOSITION RATE
HOW will fog CHANGE in FUTURE CLIMATE?
CURRENT TRENDS?
WHAT CAN WE MEASURE to help PREDICT this?
eg:
BIOSPHERE RECORDS vs. FOG DEPOSITION
PALEOCLIMATE PROXIES
DOES BIOLOGY Matter?
Field/Lab Experiments
DO BACTERIA "CATCH A RIDE" or LIVE/GROW?
BIO EFFECT ON FOG/ FOG CHEMISTRY
LAND USE CHANGE IMPACTS on FOG CLIMATOLOGY
URBANIZATION
DEFORESTATION
GROUP 3 RESEARCH PRIORITIES
FOG WATER COLLECTOR - WITH AUTO-SAMPLER for CHEMISTRY, VOLUME & BIOTA
BIG MULTI PARAMETER DATABASE w/CAPACITY to Analyze & Compile Data Sets
TIME SERIES of VERTICAL PROFILES of TEMPERATURE, MOISTURE
GROUND-BASED SENSOR Network
FOG EFFECT ON PARTICLES & GASES ~ Drying & ReHydrating PARTICLES
TIMING of FOG (ONSET, EVOLUTION, & BURN OFF)
To provide societally relevant information at different scales
LWC VERTICAL PROFILES in Situ & FROM Satellite
CLOUD WATER INTERCEPTION with BIOTA at LEAF to LANDSCAPE SCALE
HISTORY & PROJECTION of AIR MASSES
BI-DIRECTIONAL FLUX of BIOLOGICAL & CHEMICAL PROCESS & PARTITIONING of SOURCES (Anthropogenic & Natural)
COMPOSITION of FOG WATER & CLOUD WATER to do TIME SERIES FLUX CALCULATIONS ON ORGANICS, NUTRIENTS, GASES & MICROBES
GLOBAL CLIMATE DYNAMICS IMPACT on REGIONAL FOG SYSTEM


GROUP 1
What level of Specificity??
NEXT 5-10 YEARS
Sources of Fog Precursors
How affect Droplet Formation?
Evolution
Deposition
Dissolution
TO INTEGRATE:
Coupled MODELING...
(at diff. scales)
NEW FRAMEWORKS
HOW to MAINTAIN X-Discipline ENGAGEMENT & COMMUNICATION?
CONTINUE to Develop Together!
fog
JUNE 26, 2013. ESheppard


GROUP 2
NEXT 5-10 YEARS
FOG CONNECTS to MARINE & TERRESTRIAL ECOSYSTEMS.
FOG WILL DIMINISH...
TOOLS:
STANDARD MEASURING METHODS
REMOTE SENSING PRODUCTS
IMPROVED MODES of COMMUNICATION
RESEARCH CENTER
Social media
Journal
TRANSFORMATIONAL:
HIGHER RESOLUTION OCEAN Atmosphere MODELS
IMPROVED Satellites
REAL TIME FOG MEASURING Systems
UAV MEASURING DEVICES


GROUP 3
WHAT CHARACTERISTICS & PROCESSES of FOG SYSTEM ARE responsible for Generation ... Dissolution OF FOG?
INPUTS from Outside
VS.
Relative Importance of History...
TRANSFORMATIONS WITHIN
INFLUENCING FORCES at DIFFERENT SCALES
impacts
impacts
PHYSICAL
BIOLOGICAL
CHEMICAL
INTERACTION of these SYSTEMS
TERRESTIAL & Societal IMPACTS?
TOOLS:
WE NEED A "FOG-NET"
Buoys
LAND BASED Automated SAMPLING
STANDARDIZED... UNIFORM
CONTINUED COMMUNICATION Needed...


GROUP 1
PART III REPORT OUT
MACRO
ATMOSPHERIC CHEMISTRY...
BIOLOGY...
etc
MICRO SCALE
CHEMISTRY
MICROBIAL
How to Develop MODELING to better understand PROCESS re: FOG
WHAT SOURCES?
AND BACK to MICRO
COMMUNITY GOALS
PREDICT FOG Experiences OVER TIME
FOGS IMPACT on ECOSYSTEMS
FEEDBACKS INTO FOG OCCURRENCES
Requires
MODELING on different SCALES...
INTERDISCIPLINARY collaboration
FOG OCCURRENCE on LARGER SCALE?
MACRO SCALE
REGIONAL SCALE
MICRO SCALE
⑤ JUNE 27, 2013. E.SHEPARD
GROUP 2
PART III REPORT OUT
ALL ABOUT CONNECTIONS!
BI DIRECTIONAL
FOG
FOG
TERRESTRIAL SYSTEM
MARINE
NUTRIENTS
MICROBES
CHEMICALS
ALSO: ENERGY transport & cooling
HYPOTHESIS 1
Develop MEASURES CURRENT & PALEO CLIMATE
collect DATA & ARCHIVE
improved REMOTE SENSING
STANDARD METHODS
Equipment SHARING
SUPERSITE w/in FOG-NET
Improved ATMOSPHERE MODEL
TARGETED FIELD Experiments
ECOSYSTEM VALUATION $$$
Incorporate Ecosystem MODELS → CLIMATE
NEED MORE PALEO CLIMATE RECORD INFO
HYPOTHESIS 2
THREATS to LOSING COASTAL FOG ... LAND USE
AGRICULTURE/HYDRO/ECO
POS. FEEDBACK to TEMP.
IMPACTS REGIONAL CIRCULATION
GROUNDWATER impact (increased SALT)
HYPOTHESIS 3
CREATE SUSTAINABLE, INTERDISCIPLINARY FOG COMMUNITY
RESEARCH TOPICS
RESEARCH TOOLS
"FOG FELLOWS"?
NEWS LETTER
GROUP 3
PART III REPORT OUT
WHAT FACTORS & PROCESSES...
PHYSICAL
CHEMICAL
BIOLOGICAL
that INFLUENCE
• formation
• appearance
• dissolution of FOG
Added IN
SOCIAL
SOCIAL & ECONOMICAL IMPACTS
RELATIVE IMPACT of OCEAN vs. TERRESTRIAL INPUTS?
WHAT FOG CARRIES:
Nutrients
Social & Ecological STRESSORS (pollutants, microbes)
RADIATION BALANCE? (use of Air conditioners in LA)
WATER IMPACT? (AGRICULTURAL, GROUNDWATER)
FIRE IMPACTS?
LOOKING at FOG as SYSTEM
Aerosol cloud exchange — could learn more about via FOG.
What do You see as MAJOR UNANSWERED QUESTIONS?
NEED to CONNECT w/ other COMMUNITIES
CONTINUE INTERDISCIPLINARY WORK...
FOG-NET


COMMON ELEMENTS
Aircraft / UAV (for BASIC sensors)
Dedicated PROCESS STUDIES
NEED to UNDERSTAND AEROSOL better (EVOLUTION of AEROSOL & CLOUDS)
Typically THINK in PARCEL STUDIES: (How you Nucleate)
How does Nucleation process HAPPEN in FOG?
NEED BOTH ONSHORE & OFFSHORE RESEARCH
REALLY LIKED
PREDICTING FOG in DIFF. TIME SCALES
MICRO SCALE MODELING
NEED to EXPAND the COMMUNITY
THINKING ABOUT ENERGY... as way to merge Field... & SPATIAL TEMPORAL
WHAT can we LEARN from FOG.... that will have RIPPLE Effect on other climate RESEARCH
Explicit Reference to BI-DIRECTIONAL FOG
DEVELOP a FOG COMMUNITY
MECHANISMS to CONTINUE
IDEA of FOG-NET
& POTENTIAL to ENGAGE CITIZEN SCIENCE
SUPER SITE
• Sharing SENSORS & INSTRUMENTS
• STANDARD INSTRUMENTS
SHOW IMPACT re: MONETARY LOSSES (people can relate to this!)
⑥ JUNE 27, 2013 · E.Shepard
CHALLENGING
THE "LOSS" of COASTAL FOG
CO_2 INCREASE DOESN'T MEAN SAME THING as "CLIMATE CHANGE"
AND LAND USE CHANGE
Still need to understand FOG & ECOSYSTEM CONNECTION BETTER
THIS TERM is very POLITICAL. Could use "climate Variability" (WHAT DOES VARIABILITY MEAN?)
VAGUE or PRECISE LANGUAGE? (MORE PRECISE ALLOWS FOR US to TEST/PROVE)
HOW TO FRAME UP one WHITE PAPER?
Could have had MORE BKGRND. INFO on WHAT'S KNOWN CURRENTLY IN FOG...
CREATE The Next Fog Book?
WHAT ARE the REALLY BIG IMPACTS? FROM CHANGE of FOG FREQUENCY
WHERE FOG MATTERS MOST...
GAPS
INVOLVE DIFFERENT kinds of MODELERS
MORE DATA Fog related CLIMATE conditions
Need MORE COMPLETE LIST of WHO Would want more INFO on SHORT term PREDICTABILITY of FOG
DECISION-SUPPORT
WHAT is correct SCALE for looking at DIFFERENT PROCESSES?
NEED CLEAR HYPOTHESES... THAT CAN BE tested
WHO would do all this?
SCALE INTERACTIONS the Middle Ground
COLD PERSPECTIVE... (FROST)
We don't know ENOUGH about the BIOLOGY...
SOURCES of FOG... & WHAT is COMMON/DIFF. FROM DIFFERENT LOCATIONS
Lack of COMPUTATIONAL CAPACITY to DEAL w/ these HUGE DataSets
COLLECTING & LINKING DATA → CLARITY → UTILIZE IN FRAMEWORKS (NON UNIFORM DATA!)
PLATFORM RESTRICTIONS to REALLY LOOK at A PROBLEM
OVERSTATED WHAT climate models CAN DO... (THEY ARE MUCH BROADER)
MEETING PROMISES
Need to make HEADWAY on "plus biology"...
SHOULD EMPHASIZE Role of LAND / TOPOGRAPHY
Better WIND prediction
More info on PALEOCLIMATE: History of Fog in Area

FOG DEFINITIONS:

(INCLUDE YOUR LENS / PERSPECTIVE)

cloud at the ground

Land: cooler

Fog - B.L. cloud that touches ground, vis. < ~1km.

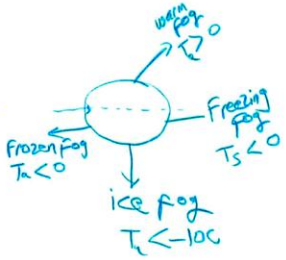
a cloud that intercepts the ground, from which water is deposited horizontally by impaction rather than by falling vertically (atmospheric deposition/ ecology)

Fog is a cloud touching the ground, OR temp = dew pt. temp OR visibility ≤ 3 km. (lens of micrometeorology)

FUNCTIONAL: CLOUD DROPLETS AT NEAR GROUND | Ditto

PRACTICAL: EXTREMELY LOW STRATUS | ATMOSPHERIC SCIENCE

Fog = Funky Organic Goo | Funny? happy hour



Fog: pea soup (driver)

Meteorology

fog = reduction in visibility caused by many tiny, suspended water droplets.

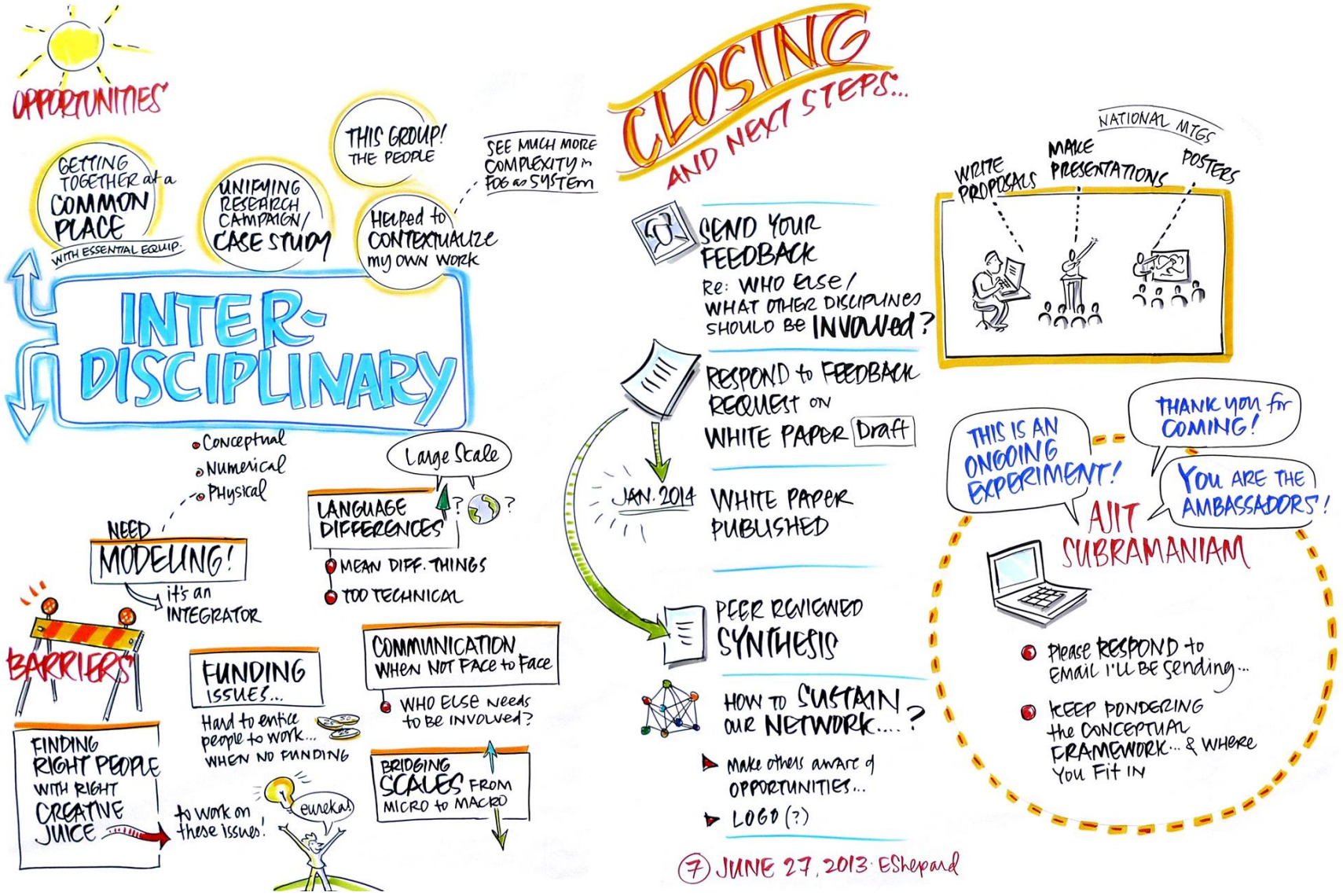
fog represents particles with sizes less than a defined size that particles stays in without falling. (Micrometeorology)

Suspension of small/microscopic water droplets in the air, usually reducing visibility at the Earth surface to < 1000 m (WMO)

Atm chemist

Ground level cloud with small droplets such that solute concentrations are high and pH can be quite low

Satellite: a low cloud w/ a fairly uniform surface (stratiform), not too thin, touching the ground


OPPORTUNITIES
GETTING TOGETHER at a COMMON PLACE
WITH ESSENTIAL EQUIP.
UNIFYING RESEARCH CAMPAIGN/ CASE STUDY
THIS GROUP! THE PEOPLE
Helped to CONTEXTUALIZE my own WORK
SEE MUCH MORE COMPLEXITY in FOG as SYSTEM
INTER-DISCIPLINARY
Conceptual
Numerical
Physical
NEED MODELING!
it's an INTEGRATOR
Large Scale
LANGUAGE DIFFERENCES
MEAN DIFF. THINGS
TOO TECHNICAL
BARRIERS
FUNDING ISSUES...
Hard to entice people to work... WHEN NO FUNDING
COMMUNICATION WHEN NOT FACE to Face
WHO ELSE needs to be INVOLVED?
FINDING RIGHT PEOPLE WITH RIGHT CREATIVE JUICE
to work on these issues!
eureka!
BRIDGING SCALES FROM MICRO to MACRO
CLOSING AND NEXT STEPS...
SEND YOUR FEEDBACK
Re: WHO ELSE/ WHAT OTHER DISCIPLINES SHOULD BE INVOLVED?
RESPOND to FEEDBACK REQUEST on WHITE PAPER Draft
JAN. 2014 WHITE PAPER PUBLISHED
PEER REVIEWED SYNTHESIS
HOW to SUSTAIN OUR NETWORK....?
Make others aware of OPPORTUNITIES...
LOGO (?)
NATIONAL MTGS
WRITE PROPOSALS
MAKE PRESENTATIONS
POSTERS
THIS IS AN ONGOING EXPERIMENT!
THANK you for COMING!
YOU ARE THE AMBASSADORS!
AJIT SUBRAMANIAM
Please RESPOND to EMAIL I'LL BE Sending...
KEEP PONDERING the CONCEPTUAL FRAMEWORK... & WHERE You Fit IN
⑦ JUNE 27, 2013 · EShepard